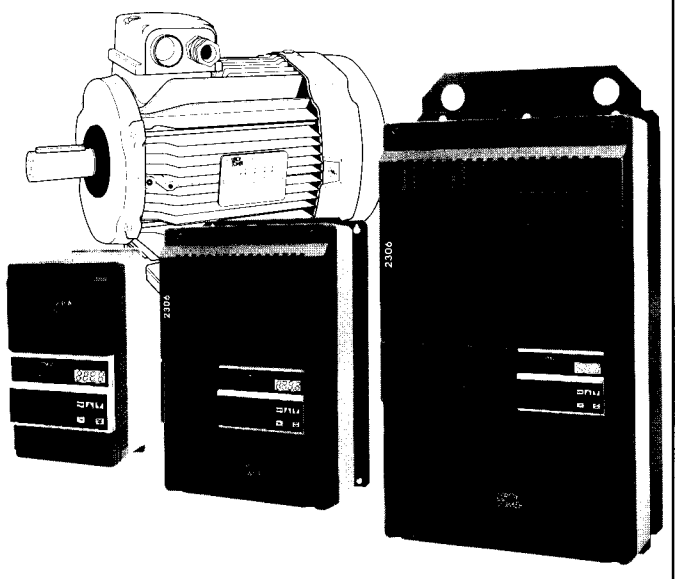
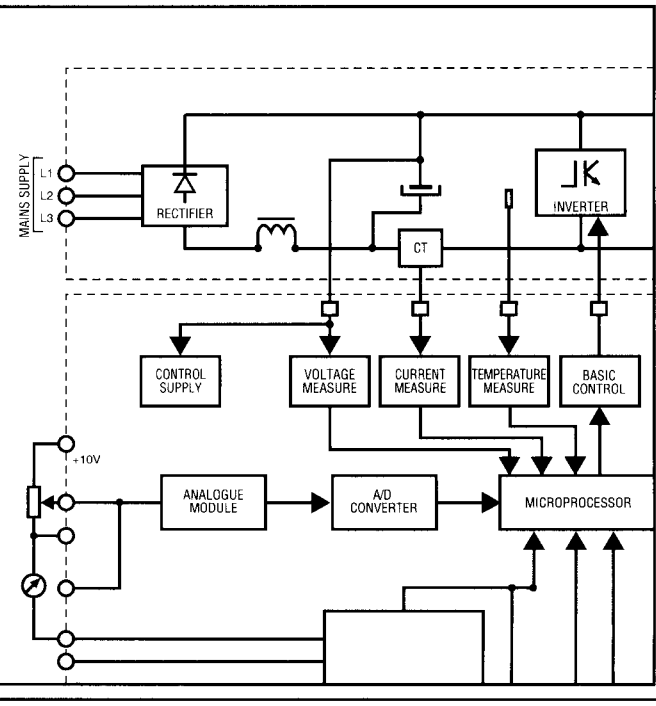
LEROY SOMER®

Réf. 1775 - O33 / a - 5.94





FMV 2306/FMV 2306 AS

Digital frequency inverter for induction motors

Installation and maintenance

NOTE

LEROY-SOMER reserves the right to modify its product characteristics at any time to incorporate the latest technological developments. The information contained in this document may therefore be changed without prior warning.

LEROY-SOMER gives no contractual guarantee whatsoever concerning the information published in this document and cannot be held responsible for any errors it may contain, nor for any damage arising from its use.

CAUTION

For the user's own safety, this frequency inverter must be connected to an approved earth (⏚ terminal).

Power electronic equipment such as speed controllers, frequency inverters, soft starters and inverters cannot be used as circuit-breaking or isolating devices as specified in EN 60204 - 1 standard (1992), section 5.
If an accidental start of the installation represents a risk for personnel or the machinery to be driven, it is imperative to supply the equipment via an isolating device and a circuit-breaking device (power contactor) controllable by an external safety system (emergency stop, fault detector).

The frequency inverter is fitted with safety devices which can, in the case of certain faults, stop the frequency inverter and the motor. The motor can itself be jammed by mechanical means. Finally voltage fluctuations, and particularly power cuts, can also cause the frequency inverter to switch off.
The removal of the cause of the shutdown can lead to restarting, with consequent hazard for certain machines or installations. In these cases, therefore, it is important for the user to be protected against such risks of restarting.

This equipment meets existing standards. Nonetheless, it may create interference and the user is responsible for carrying out the appropriate action to eliminate such interference.

The frequency inverter is designed to power a motor over and above its rated speed (up to 19 times with some settings).
If the motor is not mechanically capable of operating at such speeds, the user risks serious damage arising from mechanical deterioration of the motor.
Before programming a high speed, it is essential that the user ensures that the motor can tolerate it.

LEROY-SOMER declines all responsibility in the event of the above recommendations not being observed.

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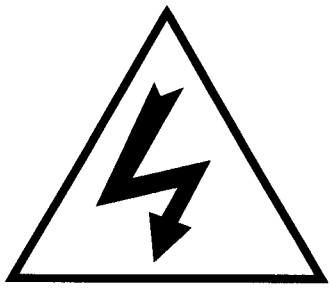


DANGER

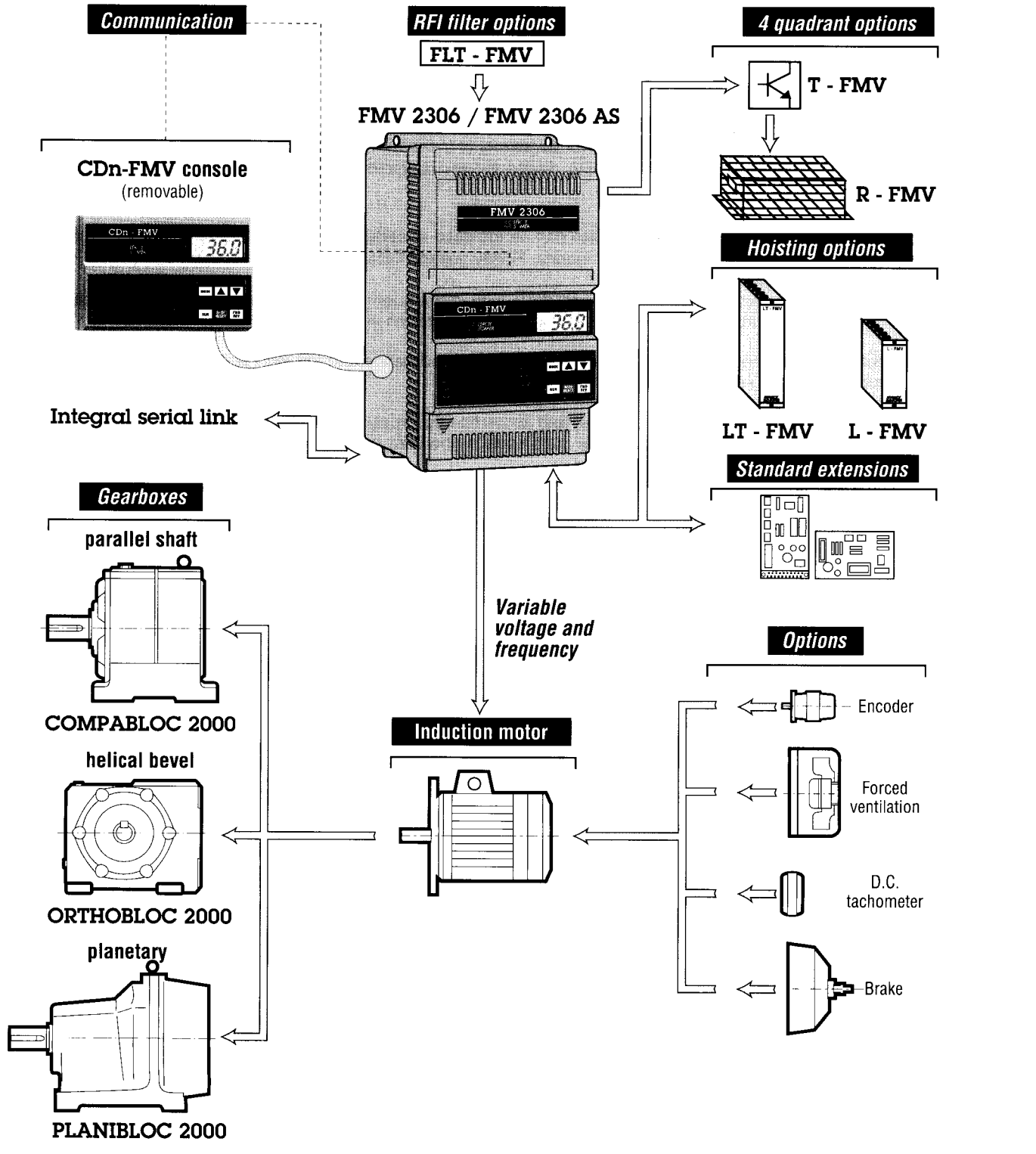
IMPORTANT

Before any intervention, whether to do with the electrics or the mechanics of the installation or machine :
- ensure that the power to the inverter has been switched off (fuse isolator or circuit-breaker) and locked manually,
- wait 7 minutes before working on the inverter.

PREFACE

This manual describes how to commission the **FMV 2306 and FMV 2306 AS** digital frequency inverter. It gives details of all procedures which should be adopted when working on the inverter and shows extension options.

FMV 2306 refers to the frequency inverters for general applications involving high overtorque.
FMV 2306 AS refers to the frequency inverters for general applications and centrifugal machines.
The main difference between these two ranges is the overload capacity : **- 150 % of In for FMV 2306**
- 120 % of In for FMV 2306 AS



CONTENTS

1 - GENERAL INFORMATION

1.1 - General operating principle

The synchronous speed (min^{-1}) of a cage induction motor is a function of the number of poles (P) it has and the frequency (F) of its power supply. These values are related by the equation :

$$N = \frac{120 \times F}{P}$$

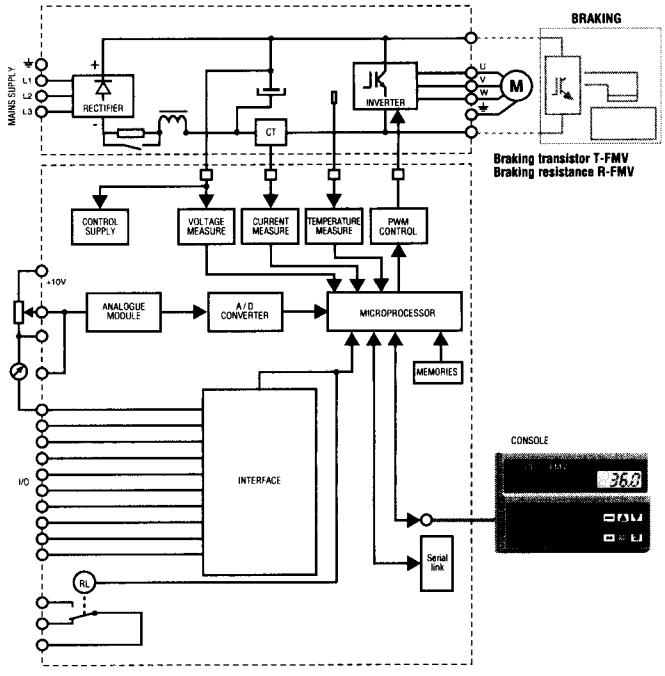
Thus, changing the frequency (F) also changes the synchronous speed (N) of a given motor.
However, changing the frequency without changing the supply voltage varies the density of magnetic flux in the motor. **FMV 2306 / FMV 2306 AS inverters** cause the VOLTAGE and FREQUENCY of the output to vary simultaneously. This allows optimisation of the motor torque curve and prevents overheating.
FMV 2306 / FMV 2306 AS inverters power the motor by means of a voltage generated from a steady internal D.C. voltage. Voltage modulation is achieved using the principle of pulse width modulation (P.W.M.).
This provides the motor with a current close to a sine wave with few harmonics.
LS FMV motors are designed for use with a frequency inverter. Their magnetic circuits and windings have been adapted for use with **FMV 2306 / FMV 2306 AS inverters.** Thus the motor-inverter unit provides guaranteed torque performances in all types of operating conditions (please consult LEROY-SOMER).

1.1.1 - Functional description of the variable speed controller

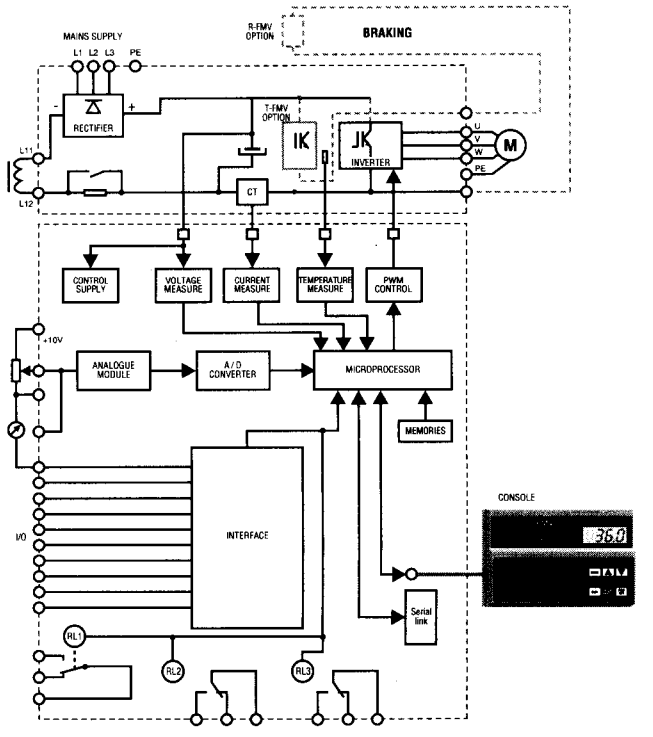
The variable speed controller comprises :
• **A RECTIFIER** for the mains supply voltage, along with a **SMOOTHING CAPACITOR** to provide a steady D.C. voltage which depends on the mains supply voltage.
• **AN INVERTER :** this D.C. voltage supplies power to the 6-transistor inverter (IGBT). The inverter converts the D.C. voltage to an A.C. voltage which is modulated in voltage and frequency.
• **AN INTERNAL CURRENT MEASUREMENT.**
• **AN ELECTRONIC CONTROL BOARD**
comprising : the microprocessor, the ASIC circuit which generates PWM and the circuits which amplify the power control signals.
• **A CONSOLE** for entering parameters, reading data and controlling the inverter.

1.1.2 - Operating diagrams

- FMV 2306 : 1.5 T to 11 T
- FMV 2306 AS : 1.5 T to 11 T



- FMV 2306 16 T to 100 T
- FMV 2306 AS : 16 T to 120 T



1.2 - Product designation

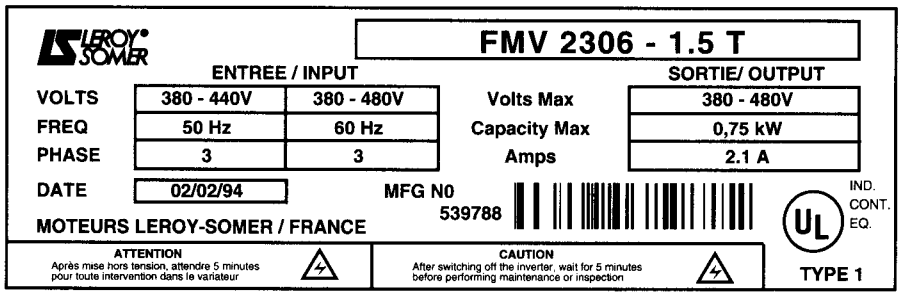
Examples : **FMV 2306 - 1.5 T and FMV 2306 AS - 120T**

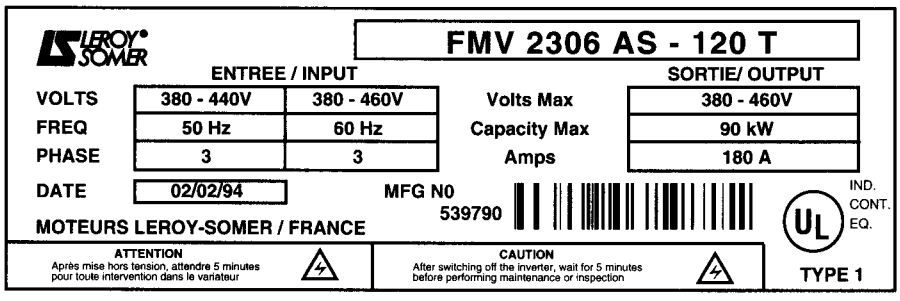
FMV 2306 : frequency inverter for general applications involving high overtorque.

FMV 2306 AS : frequency inverter for general applications and centrifugal machines.

1.5 = Rating in kVA at 380 V.
T = 3-phase supply.

This designation is shown on the identification plate.





1.3 - Main characteristics

The functions and characteristics of both the FMV 2306 and FMV 2306 AS inverter ranges are the same, especially for :

- FMV 2306 1.5 T to 11 T and FMV 2306 AS 1.5 T to 11 T,

- FMV 2306 16 T to 40 T and FMV 2306 AS 16 T to 50 T,

- FMV 2306 50 T to 100 T and FMV 2306 AS 60 T to 120 T.

FMV 2306 1.5 T to 11 T refers to ratings : 0.75 - 1.1 - 1.5 - 2.2 - 4 - 5.5 - 7.5 kW at 380 V,

FMV 2306 AS 1.5 T to 11 T refers to ratings : 0.75 - 1.1 - 1.5 - 2.2 - 4 - 5.5 - 7.5 kW at 380 V,

FMV 2306 16 T to 40 T refers to ratings : 11 - 15 - 18.5 - 22 - 30 kW at 380 V,

FMV 2306 AS 16T to 50 T refers to ratings : 11 - 15 - 18.5 - 22 - 30 - 37 kW at 380 V,

FMV 2306 50 T to 100 T refers to ratings : 37 - 45 - 55 - 75 kW at 380 V,

FMV 2306 AS 60 T to 120 T refers to ratings : 45 - 55 - 75 - 90 kW at 380 V.

1.3.1 - Inverter electrical output characteristics

- FMV 2306

FMV 2306	Inverter output capacity (kVA)		* Maximum motor output power (4-pole) (kW)		Continuous rated inverter current (output) (A)
	380 V 50 / 60 Hz	460 V 50 / 60 Hz	380 V 50 / 60 Hz	460 V 50 / 60 Hz	
1.5 T	1,4	1,7	0.75	0.9	2.1
2 T	1,8	2,2	1.1	1.3	2.8
2.5 T	2,5	3,0	1.5	1.8	3.8
3.5 T	3,7	4,5	2.2	2.7	5.6
5.5 T	6,2	7,6	4	4.8	9.5
8 T	7,9	9,6	5.5	6.7	12.0
11 T	10,5	12,7	7.5	9.1	16.0
16 T	16,5	19,9	11	13.3	25
22 T	20,4	24,7	15	18.2	31
27 T	25,0	30,3	18.5	22.4	38
33 T	30,2	36,6	22	26.6	46
40 T	38,8	47,0	30	36.3	59
50 T	50,0	60,5	37	44.8	76
60 T	59,9	72,5	45	54.5	91
75 T	72,4	87,6	55	66.6	110
100 T	98,7	119,5	75	90.8	150

- FMV 2306 AS

FMV 2306 AS	Inverter output capacity (kVA)		* Maximum motor output power (4-pole) (kW)		Continuous rated inverter current (output) (A)
	380 V 50 / 60 Hz	460 V 50 / 60 Hz	380 V 50 / 60 Hz	460 V 50 / 60 Hz	
1.5 T	1,4	1,7	0.75	0.9	2.1
2 T	1,8	2,2	1.1	1.3	2.8
2.5 T	2,5	3,0	1.5	1.8	3.8
3.5 T	3,7	4,5	2.2	2.7	5.6
5.5 T	6,2	7,6	4	4.8	9.5
8 T	7,9	9,6	5.5	6.7	12.0
11 T	10,5	12,7	7.5	9.1	16.0
16 T	16,5	19,9	11	13.3	25
22 T	21,0	25,5	15	18.2	32
27 T	25,0	30,3	18.5	22.4	38
33 T	30,2	36,6	22	26.6	46
40 T	40,8	49,4	30	36.3	62
50 T	46,0	55,8	37	44.8	70
60 T	59,9	72,5	45	54.5	91
75 T	72,4	87,6	55	66.6	110
100 T	94,8	114,7	75	90.8	144
120 T	118,5	143,4	90	108.9	180

* Always ensure that the rated motor current is lower than the continuous rated inverter current.

1.3.2 - Characteristics and functions

Rating	FMV 2306 1.5 T to 11 T FMV 2306 AS 1.5 T to 11 T	FMV 2306 16 T to 40 T FMV 2306 AS 16 T to 50 T	FMV 2306 50 T to 100 T FMV 2306 AS 60 T to 120 T
CHARACTERISTICS			
SUPPLY VOLTAGE (3-phase)	380 to 440V ±10 % - 50 Hz ± 2 Hz 380 to 480V ±10 % - 60 Hz ± 2 Hz	380 to 460V ±10 % - 50/60 Hz ± 2 Hz	
REGULATION MODE	Voltage/Frequency characteristic		
REGULATION	Frequency reference. " Torque " reference : current regulation in the motor. Speed regulation if encoder feedback is used on the motor		
CHARACTERISTIC Voltage (U) / Frequency (f)	U/f ratio may be adjusted by the base frequency. Fixed U/f ratio : constant torque, or dynamic U/f ratio : variable torque.		
SWITCHING FREQUENCY (Adjustment)/ OUTPUT FREQUENCY (Maximum range)	Adjustment / Maximum range 2.9 kHz / 0 to 240 Hz 5.9 kHz / 0 to 480 Hz 8.8 kHz / 0 to 480 Hz 11.7 kHz / 0 to 960 Hz	Adjustment / Maximum range 2.9 kHz / 0 to 240 Hz 5.9 kHz / 0 to 480 Hz	Adjustment / Maximum range 2.9 kHz / 0 to 240 Hz
	The frequency range shown above may be reduced for a given switching frequency : Eg : 0 to 120 Hz for switching f = 11.7 kHz.		
FREQUENCY PRECISION	± 0.01 % of the maximum adjusted range for a digital reference.		
SPEED PRECISION (WITH ENCODER)	± 0.01 % of the maximum adjusted range for a digital reference.		
FREQUENCY RESOLUTION	Adjustment via digital reference * : 0.1 Hz. Except : - reference via console > 100 Hz : 1 Hz, - Pr0, Pr1, Pr7, Pr10 to Pr15, Pr20 to Pr27 as follows. 0.1 Hz, F_{output} = 0 to 120 Hz 0.2 Hz, F_{output} = 0 to 240 Hz 0.4 Hz, F_{output} = 0 to 480 Hz 0.8 Hz, F_{output} = 0 to 960 Hz	0.1 Hz, F_{output} = 0 to 120 Hz 0.2 Hz, F_{output} = 0 to 240 Hz 0.4 Hz, F_{output} = 0 to 480 Hz	0.1 Hz, F_{output} = 0 to 120 Hz 0.2 Hz, F_{output} = 0 to 240 Hz
DISPLAY RESOLUTION	0.1 Hz.		
SLIP COMPENSATION (Open loop)	Adjustment : 0 to 5 Hz, $F_{output} \leq$ 120 Hz 0 to 10 Hz, $F_{output} \leq$ 240 Hz 0 to 20 Hz, $F_{output} \leq$ 480 Hz 0 to 25 Hz, $F_{output} \leq$ 960 Hz	Adjustment : 0 to 5 Hz, $F_{output} \leq$ 120 Hz 0 to 10 Hz, $F_{output} \leq$ 240 Hz 0 to 20 Hz, $F_{output} \leq$ 480 Hz	Adjustment : 0 to 5 Hz, $F_{output} \leq$ 120 Hz 0 to 10 Hz, $F_{output} \leq$ 240 Hz
OVERLOAD CAPACITY	FMV 2306 : 150% I_N for 60 s.		
	FMV 2306 AS : 120% I_N for 180 s.	FMV 2306 AS : 120% I_N for 60 s.	
BRAKING	Hypersynchronous braking: - inverter alone, - with R - FMV and T - FMV options. D.C. injection braking.		
TORQUE AT LOW FREQUENCY (Boost)	Manual or automatic adjustment of output voltage.		

* Digital reference : via serial link or CDn - FMV console.

Rating	FMV 2306 1.5 T to 11 T FMV 2306 AS 1.5 T to 11 T	FMV 2306 16 T to 40 T FMV 2306 AS 16 T to 50 T	FMV 2306 50 T to 100 T FMV 2306 AS 60 T to 120 T
CONTROL INVERTER CONTROL	Via CDn-FMV console (removable). Via terminal block. Via serial link.		
FREQUENCY REFERENCE (SPEED REFERENCE IF ENCODER FEEDBACK)	Analogue setpoint : – 0 to +10 V D.C. (input impedance 110 kΩ) : voltage source or 2.2 kΩ potentiometer, – -10 to +10 V D.C. (input impedance 110 kΩ) : external voltage source, – 4 to 20 mA – 20 to 4 mA } Input impedance 100 Ω. – 0 to 20 mA Digital setpoint : – programmable via CDn-FMV console, – programmable via serial link.		
TORQUE REFERENCE	Analogue setpoint : 0 to +10 V D.C. (input impedance 27 kΩ) : voltage source or 10 kΩ potentiometer. Digital setpoint : programmable via serial link.	Analogue setpoint : 0 to +10 V D.C. (input impedance 110 kΩ) : voltage source or 10 kΩ potentiometer. Digital setpoint : programmable via serial link.	
LOCAL / REMOTE FREQUENCY REFERENCE CHANGEOVER	Via terminal 16 : - Local : voltage, terminal 5, - Remote : current, terminal 8 following b11.	Via terminal 16 : - Local : voltage, terminal 5, - Remote : current, terminal 8 or voltage, terminal A7 following b11.	
ENCODER FEEDBACK	Closed loop control of real speed using encoder : 15 pulses per motor pole per revolution. Maximum encoder impedance 20Ω.		
FWD / REV OPERATION	Via the terminal block, terminal 15 Forward Operation, terminal 17 Reverse Operation. Via serial link.		
OPERATION ACCELERATION/ DECELERATION RAMPS	Separate adjustments from 0.2 to 600 s : linear characteristic.		
PRESET SPEEDS	Either : 3 programmable speeds (plus the setpoint) + jog (inch) function Or : 7 programmable speeds (plus the setpoint).		
ACCELERATION/ DECELERATION RAMPS WITH PRESET SPEEDS	Each preset speed has an associated acceleration and deceleration ramp, or uses the speed reference ramps.		
FREQUENCY LIMITATION Minimum / Maximum	0 Hz ≤ F min ≤ F max ≤ F maximum range.		
FREQUENCY SKIPPING	3 frequency skips with adjustable skip band, to prevent mechanical resonance phenomena.		
JOGGING	Adjustable speed : 0 to15 Hz. Separate acceleration and deceleration ramps : 0.2 to600 s.		
STOPPING MODE	Freewheel stop : instantaneous break of motor supply. Ramp (2 modes). D.C. injection braking.		

Rating	FMV 2306 1.5 T to 11 T FMV 2306 AS 1.5 T to 11 T	FMV 2306 16 T to 40 T FMV 2306 AS 16 T to 50 T	FMV 2306 50 T to 100 T FMV 2306 AS 60 T to 120 T
OPERATION			
D.C. INJECTION BRAKING	Braking torque : - FMV 2306 : 40 to 150 % I_N. - FMV 2306 AS : 40 to 120 % I_N. Braking until motor stop and holding torque for 1 second.		
AUTOMATIC RESTART	Power on : restart after 120 ms. Power cut : restart after 120 ms. After a trip : - wait 1 second for RESET, - immediate restart after RESET. After a " STOP " command : restart as soon as a run command is received.		
FLYING RESTART	Possibility of starting the inverter when the motor is rotating.		
TRIPS			
LOSS OF CURRENT REFERENCE (4-20 / 20-4 mA)	Setpoint value < 3.5 mA.		
CPU FAULT	Internal inverter fault at power up.		
EXTERNAL TRIP	Trip forced by the terminal block or via the serial link.		
OVERLOAD (I x t)	Electronic thermal relay.		
AMBIENT TEMPERATURE OUT OF RANGE	–	-10 °C > $T_{ambient}$ +50°C < $T_{ambient}$	
OVERHEATED INVERTER	Protection of the inverter by thermal probes on the cooling unit.		
OVERHEATED MOTOR	• PTC probe Tripping with PTC resistance > 3 kΩ (motor too hot). Reset with PTC resistance = 1.8 kΩ. • PTO probe		
OVERCURRENT	185 % of the rated current.		
SHORT-CIRCUIT PHASE - PHASE PHASE - EARTH	Protection against short-circuits between phases and earths.		
PHASE LOSS / PHASE IMBALANCE	A phase voltage less than 380V - 15 % or phase imbalance.		
WARNING OF LOW SUPPLY	Power < 380V -15 % : ramp down to zero speed. Trip on phase loss if the voltage does not rise above 380V -15 % before the motor-inverter reaches zero speed.		
UNDERVOLTAGE	D.C. bus voltage below its operating range.		
OVERVOLTAGE	For an inappropriate deceleration time or for too high a voltage on the mains supply.		
INTERNAL SUPPLY FAULT	Monitoring of inverter internal power supplies.		
RESET	Trip reset : " STOP / RESET " key on the console or terminal 13 on the terminal block, depending on the control mode.		
INDICATIONS			
DISPLAY	On the CDn-FMV console : - output frequency in Hz, or - output current as a % of the rated current I_N.		

Frequency inverters
FMV 2306
FMV 2306 AS

Rating	FMV 2306 1.5 T to 11 T FMV 2306 AS 1.5 T to 11 T	FMV 2306 16 T to 40 T FMV 2306 AS 16 T to 50 T	FMV 2306 50 T to 100 T FMV 2306 AS 60 T to 120 T
INDICATIONS PROGRAMMABLE RELAY	240 V A.C. relay - 7A (resistive load).		
	Activated when : –the inverter is healthy, or –frequency is greater than minimum frequency (Pr0).	Activated when : – the inverter is running, or – at frequency.	
MINIMUM FREQUENCY RELAY	See PROGRAMMABLE RELAY	240 V A.C. - 7A (resistive load). Activated when the frequency is greater than the minimum frequency.	
INVERTER STATUS RELAY	See PROGRAMMABLE RELAY	240 V A.C. - 7A (resistive load). Activated when inverter healthy	
PROGRAMMABLE LOGIC OUTPUT	Open collector : – 50 mA, internal source 24V, – 250 mA, external source to 0V.		
	Activated when : - the inverter is running, or - the frequency is greater than minimum frequency.	Activated when : - there is an overload alarm, or - the inverter is healthy.	
FREQUENCY OUTPUT : DIGITAL SIGNAL	–	Open collector + 24 / 0 V ±10 mA Squared frequency signal equal the output frequency.	
FREQUENCY OUTPUT : ANALOGUE SIGNAL	0 to +10V, 5 mA, precision ± 2 %, 0V = zero frequency, 10V = maximum adjusted frequency.		
LOAD OUTPUT : ANALOGUE SIGNAL	0 to ± 10 V, 5 mA, precision ± 10 % for speeds above 15 Hz. 0 V : zero current. +10 V : FMV 2306 150 % I_N (driven load), FMV 2306 AS 120 % I_N (driven load). -10 V : FMV 2306 150 % I_N (driven motor), FMV 2306 AS 120 % I_N (driven motor).		
DIAGNOSTIC	The last 10 trip codes are stored.		
SERIAL LINK	Communication : PLC, PC, etc. RS 485 and RS 422. Protocol ANSI x 3.28 - 2.5 - A4.		
OPTIONS RFI FILTER FLT - FMV	FLT - FMV 11 This filter fits inside the inverter.	FLT - FMV 22, 33 and 40 This filter is external to the inverter. FLT - FMV / FMV 2306 / FMV 2306 AS 22 / 16T and 22T / 16T and 22T 33 / 27T and 33T / 27T to 40T 40 / 40T / 50T	FLT - FMV 75 and 100 This filter is external to the inverter. FLT - FMV / FMV 2306 / FMV 2306 AS 75 / 50T to 75T / 60T and 75T 100 / 100T / 100T and 120T
MOTOR CHOKES FOR LEAKAGE CURRENT ATTENUATION	SELF MC 3.5T SELF MC 11T	SELF MC 27T SELF MC 50T	SELF MC 50T SELF MC 75T SELF MC 120T
RESISTANCE BRAKING (4 QUADRANTS) T - FMV R - FMV	Transistor external to the inverter : T - FMV 30, T - FMV 32. Resistance unit external to the inverter : R - FMV 320 to R - FMV 2000.	Transistor within the inverter : T - FMV 25, T - FMV 50, T - FMV 75. Resistance unit external to the inverter : R - FMV 320 to R - FMV 4000.	Transistor within the inverter : T - FMV 150. Resistance unit external to the inverter : R - FMV 1000 to R - FMV 4000.
HOISTING MODULES	External unit LT - FMV + resistance R - FMV	External unit L - FMV + transistor T - FMV within FMV + resistance R - FMV.	
REMOTE CONNECTION OF CONSOLE	CD - CORD 1.5, CD - CORD 3, CD - CORD 5 for remote connection of the console to the inverter at a distance of 1.5m, 3m and 5m (on request up to 100m) respectively.		

1.4 - Environmental characteristics

1.4.1 - General

Rating	FMV 2306 1.5 T to 11 T FMV 2306 AS 1.5 T to 11 T	FMV 2306 16 T to 100 T FMV 2306 AS 16 T to 120 T
Casing protection	IP 10	IP 00
Storage temperature	- 40°C to + 50°C.	
Operating temperature	- 10°C to + 50°C.	
Altitude	• ≤ 1000 m without derating. • Derating : 1 % of I_N per 100 m above 1000m up to 4000 m.	
Humidity	Non condensing.	95 % of relative humidity at 40°C non condensing.
Vibration	1g (5 to 150 Hz)	0.5 g (5 to 150 Hz)

1.4.2 - Installation in a cubicle

Installing the inverter in a cubicle calls for special precautions with regard to the size of the enclosure. It is important to check that there is sufficient heat dissipation.

a - Table of losses in Watts (W)

- FMV 2306 overall losses

Switching frequency	Rating															
	1.5 T	2 T	2.5 T	3.5 T	5.5 T	8 T	11 T	16 T	22 T	27 T	33 T	40 T	50 T	60 T	75 T	100 T
2.9 kHz	72	72	117	117	170	286	286	358	404	490	572	698	934	1106	1322	1897
5.9 kHz	82	82	132	132	195	346	346	440	498	615	724	886	–	–	–	–
8.8 kHz	92	92	147	147	220	401	401	–	–	–	–	–	–	–	–	–
11.7 kHz	102	102	162	162	250	456	456	–	–	–	–	–	–	–	–	–

- FMV 2306 AS overall losses

Switching frequency	Rating																
	1.5 T	2 T	2.5 T	3.5 T	5.5 T	8 T	11 T	16 T	22 T	27 T	33 T	40 T	50 T	60 T	75 T	100 T	120 T
2.9 kHz	72	72	117	117	170	286	286	368	442	491	593	761	834	1124	1357	1774	2323
5.9 kHz	82	82	132	132	195	346	346	455	544	606	742	961	1068	–	–	–	–
8.8 kHz	92	92	147	147	220	401	401	–	–	–	–	–	–	–	–	–	–
11.7 kHz	102	102	162	162	250	456	456	–	–	–	–	–	–	–	–	–	–

- Optional filters FLT - FMV

Losses (W)	Rating																
	1.5 T	2 T	2.5 T	3.5 T	5.5 T	8 T	11 T	16 T	22 T	27 T	33 T	40 T	50 T	60 T	75 T	100 T	120 T
FMV 2306	1.6	1.9	1.6	2.8	5	10.5	14.8	10	10	10	10	13	42	42	42	30	-
FMV 2306 AS	1.6	1.9	1.6	2.8	5	10.5	14.8	10	10	10	10	10	13	42	42	30	30

- D.C. link chokes

Losses from the D.C. link chokes on the **FMV 2306** 16T to 100T and the **FMV 2306 AS** 16T to 120T are already included in the tables of global losses.

Losses (W)	Rating									
	16 T	22 T	27 T	33 T	40 T	50 T	60 T	75 T	100 T	120 T
FMV 2306	37.5	45.5	63.8	48.4	53.9	60.9	52	78.8	99.5	-
FMV 2306 AS	37.5	45.5	63.8	48.4	53.9	60.9	52	78.8	99.5	96.3

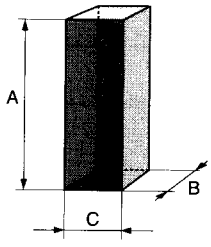
b - Installation in a non-ventilated cubicle

The minimum required surface area for heat exchange is calculated from the following equation : $S = \frac{Pi}{k\,(Tj - Tamb)}$

where : Pi = loss from all heat-producing equipment (W).
Tj = maximum permissible ambient operating temperature (°C).
Tamb = maximum ambient external temperature (°C).
k = thermal transmission cœfficient.
S = heat exchange area (m^2).

k = 5.5 for 2mm thick sheet steel.

Example : installation of an FMV 2306 16T in a non-ventilated IP 54 cubicle (cubicle placed against a wall).
Pi = 440W.
Tj = 50°C (FMV 2306 and FMV 2306 AS).
Tamb = 25 °C for example.
k = 5.5.
The calculated heat exchange area is S = 3.2 m^2 and S =2 (AB) + AC + BC.
Taking the following values for A and B :
A = 1.8 m (height) - B = 0.5 m (depth),
the minimum calculation for C = 0.61 m.



c - Installation in a ventilated cubicle

If it is possible to use forced ventilation (FV), the size of cubicle can be reduced. A minimum space of 100 mm should be left around the inverter.

The flow rate of FV in m^3/h is calculated using the formula $V = \frac{3.1\ Pi}{Tj - Tamb} = 55 m^3/h$ for the previous example.

1.5 - Weight and dimensions

1.5.1 - Weight

FMV 2306	Weight (kg)
1.5 T	4.4
2 T	4.4
2.5 T	5.65
3.5 T	5.65
5.5 T	5.65
8 T	6.4
11 T	6.4
16 T	22.3
22 T	22.3
27 T	22.3
33 T	24.0
40 T	24.0
50 T	54.0
60 T	56.0
75 T	56.0
100 T	56.0

FMV 2306 AS	Weight (kg)
1.5 T	4.4
2 T	4.4
2.5 T	5.65
3.5 T	5.65
5.5 T	5.65
8 T	6.4
11 T	6.4
16 T	22.3
22 T	22.3
27 T	22.3
33 T	24.0
40 T	24.0
50 T	24.0
60 T	56.0
75 T	56.0
100 T	56.0
120 T	58.0

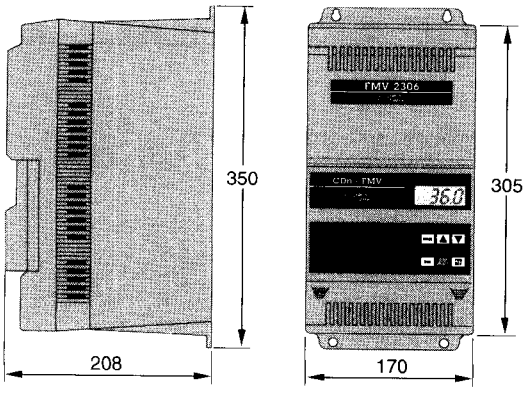
Note : For ratings > 11T, the weight of the D.C. link choke is not included (see section 2.5).

1.5.2 - Dimensions

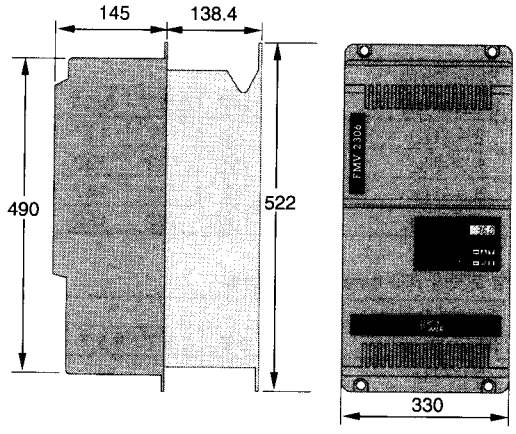
These are identical for inverters :

- **FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T**
- **FMV 2306 16T to 40T and FMV 2306 AS 16T to 50T**
- **FMV 2306 50T to 100T and FMV 2306 AS 60T to 120T**

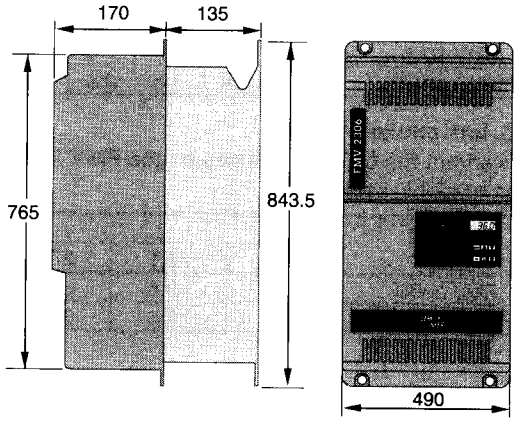
FMV 2306 1.5T to 11T
FMV 2306 AS 1.5T to 11T



FMV 2306 16T to 40T
FMV 2306 AS 16T to 50T



FMV 2306 50T to 100T
FMV 2306 AS 60T to 120T



2 - MECHANICAL INSTALLATION

2.1 - Checks on receipt

Before installing the inverter, ensure that :
- the inverter has not been damaged in transit,
- the identification plate corresponds to the power supply and the motor,
- **for ratings ≥ 16T the D.C. link choke is supplied with the inverter.**

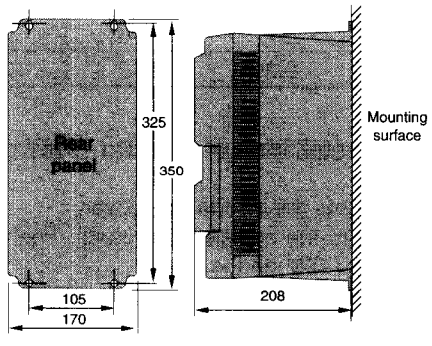
2.2 - Installation precautions

FMV 2306 and **FMV 2306 AS** inverters must be installed in a risk-free atmosphere, away from conductive dust, corrosive gases and water leaks.
Should this not be the case, it is recommended that they be installed in an enclosure or a cubicle. (See section 1.4.2 for cubicle dimensions).
Mount the inverter upright, allowing 100 mm all round it.
To prevent overheating problems, install the inverters side by side and not on top of each other.
Never obstruct the inverter ventilation louvres.

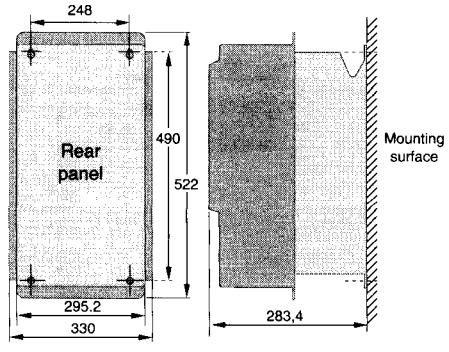
2.3 - Mounting dimensions showing the rear of the inverter

These are identical for inverters :
- **FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T**
- **FMV 2306 16T to 40T and FMV 2306 AS 16T to 50T**
- **FMV 2306 50T to 100T and FMV 2306 AS 60T to 120T**

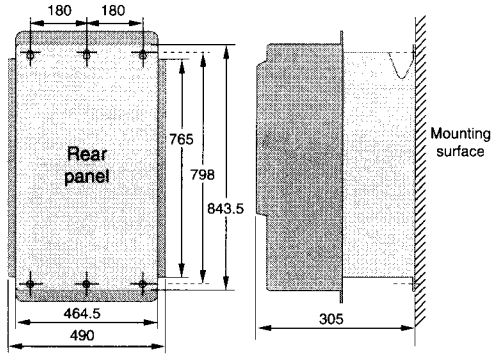
FMV 2306 1.5T to 11T
FMV 2306 AS 1.5T to 11T
Fixed via the rear panel using 4 M6 screws.



FMV 2306 16T to 40T
FMV 2306 AS 16T to 50T
Fixed via the rear panel using 4 M6 screws.



FMV 2306 50T to 100T
FMV 2306 AS 60T to 120T
Fixed via the rear panel using 6 M8 screws.

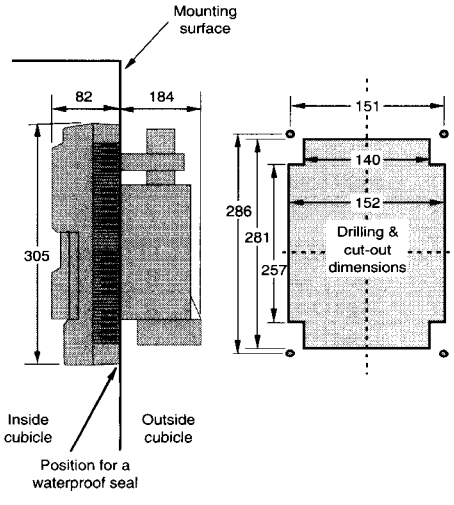


2.4 - Dimensions for cooling unit through-panel mounting in cubicle

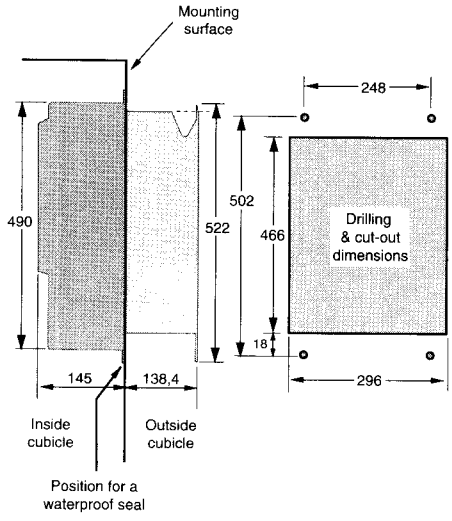
These are identical for inverters :
- **FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T**
- **FMV 2306 16T to 40T and FMV 2306 AS 16T to 50T**
- **FMV 2306 50T to 100T and FMV 2306 AS 60T to 120T**

FMV 2306 1.5T to 11T
FMV 2306 AS 1.5T to 11T
The moulded plastic rear case should be removed :
1 - Unplug the console.
2 - Remove the terminal block cover.
3 - Undo the 2 M4 x 10 screws on each side of the power terminal block
4 - Lift the terminal block edge of the top cover by 30 °.
5 - Unhook the top cover on the other side (upper side).
6 - This releases the top cover and the IN50 control board, which can be removed.
7 - Remove the 4 M4 x 10 screws in each corner holding the power section to the rear case.
8 - The rear case is released, and is of no further use.
9 - Repeat steps 6 to 1 in reverse order, replacing the IN 50 control board on the top cover, then the top cover on the power section.

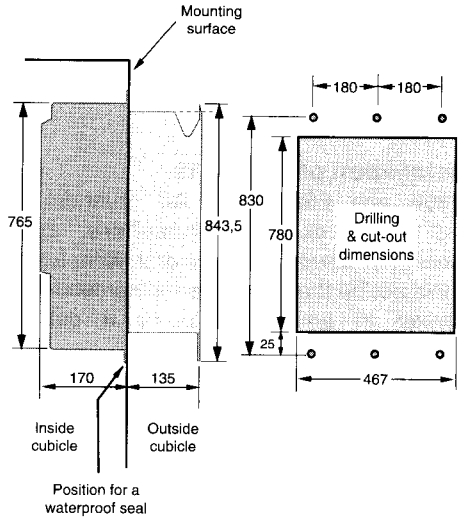
Fixed using 4 M4 x 16 screws



FMV 2306 16 T to 40 T
FMV 2306 AS 16 T to 50 T
Fixed using 4 M6 screws on the front panel heatsink mounting surface.



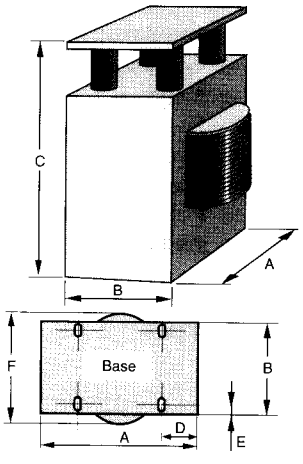
FMV 2306 50 T to 100 T
FMV 2306 AS 60 T to 120 T
Fixed using 6 M8 screws on the front panel heatsink mounting surface.



2.5 - Installation of a D.C. link choke

FMV 2306 16T to 100T - FMV 2306 AS 16T to 120T
The D.C. link choke is mounted externally to the inverter (see section 3.1.2 for wiring instructions).
It is essential for operation.

2.5.1 - Dimensions and fixing



FMV 2306 FMV 2306 AS	A	B	C	D	E	F	Fixing screw Ø	Weight (kg)
16 T	118	70	155	27	7	95	M8	3.5
22 T	118	82	155	27	7	105	M8	4.5
27 T	137	84	175	24	10	115	M8	6.4
33 T	118	95	155	27	7	120	M8	5.4
40 T	137	116	175	24	10	140	M8	8.4
50 T	167	132	200	39	8	165	M8	16.5
60 T	167	119	197	39	8	170	M8	14.5
75 T	195	138	230	46	11	175	M10	22.5
100 T	215	166	254	51	13	195	M10	32
120 T	215	177	254	51	13	200	M10	35

Note :
Dimensions are expressed in mm.

2.5.2 - Electrical characteristics

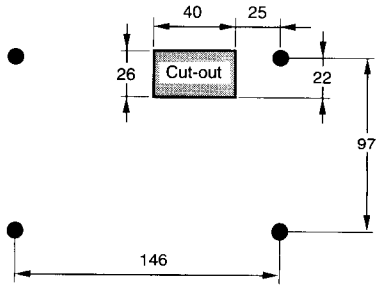
FMV 2306 FMV 2306 AS	Choke (mH)	Current average (A)	Current peak (A)
16 T	1.25	32.5	65
22 T	1.35	39	72
27 T	1.5	45	85
33 T	0.65	60	128
40 T	0.7	75	143
50 T	0.8	89	167
60 T	0.45	111	224
75 T	0.5	130	251
100 T	0.4	176	352
120 T	0.3	212	350

2.6 - Remote installation of the CDn - FMV console

This is mounted :
- either directly onto the inverter top cover,
- or remotely onto the cubicle front panel. The distance must be less than 100 metres.

It is connected via a 9-pin SUB-D plug located at the rear of the console.

Mounting on cubicle front panel
Fixed using 4 Ø 4.0 mm screws.
Diagram for cut-out and drilling :

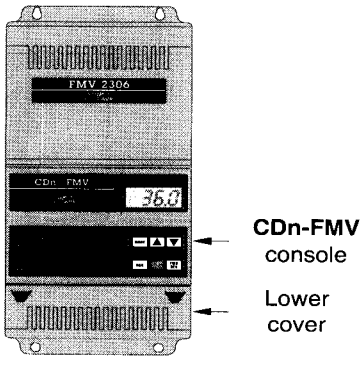


3 - CONNECTIONS

Connection is identical for inverters :
- **FMV 2306 1.5T to 11T** and **FMV 2306 AS 1.5T to 11T.**
- **FMV 2306 16T to 100T** and **FMV 2306 AS 16T to 120T.**

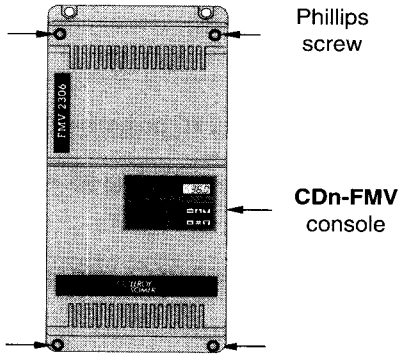
• FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T.
To gain access to the control and power terminal blocks, remove the lower cover by sliding it downwards (see illustration below) :

Inverter top cover



• FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T.
To gain access to the control and power terminal blocks, remove the top cover which is held in place by 4 captive Phillips screws, one in each corner (see illustration below) :

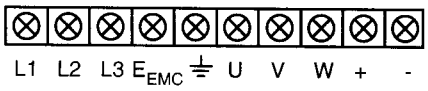
Inverter top cover



3.1 - Power terminal block

3.1.1 - FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T

Located at the bottom of the inverter, the terminal block comprises 10 cross-head screw terminals.

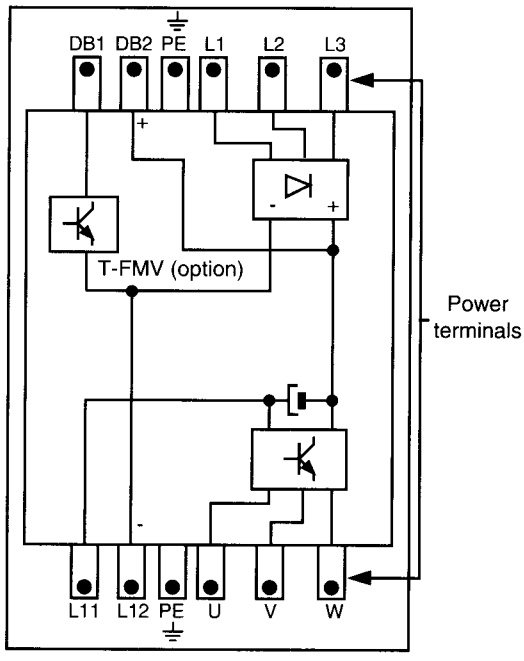


Reference	Function
L1 - L2 - L3	Inverter 3-phase supply.
U - V - W	Motor power supply.
+, -	Braking unit connection.
⏚	Earthing connections to power supply and motor.
E_{EMC}	Use with option FLT - FMV 11.

Caution :
- Never connect a circuit such as a bank of capacitors between the inverter output and the motor.
- Never connect the A.C. supply to the inverter U.V.W. terminals.
- When the inverter is fitted with an optional FLT – FMV 11 filter, the power is supplied via the top of the inverter unit to terminals L1, L2, L3 and ⏚.

3.1.2 - FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T

Located at the top and bottom of the inverter, the terminal block comprises 12 M8 screw clamp terminals (tightening torque = 8.5 Nm).
FMV 2306 16T to 40T and **FMV 2306 AS** 16T to 50T : M8.
FMV 2306 50T to 100T and **FMV 2306 AS** 60T to 120T : M10.



Reference	Function
L1 - L2 - L3	Inverter 3-phase supply.
U - V - W	Motor power supply.
L11 - L12	Connection for D.C. link choke (supplied with the inverter).
DB1 - DB2	Connection for R-FMV braking resistances.
PE ⏚	Earth connection (mains supply and motor).

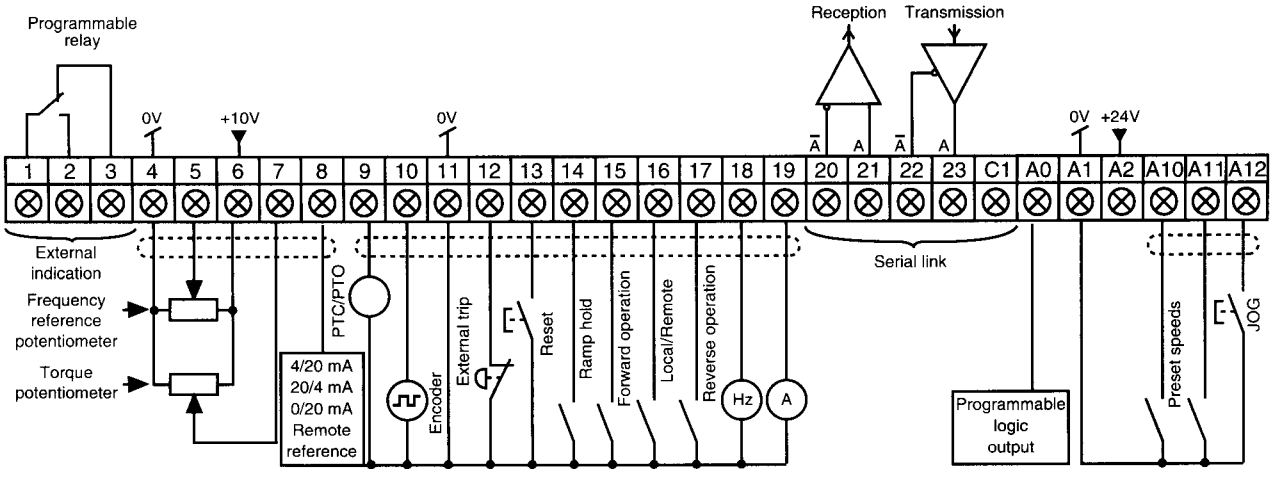
Note : The inverter D.C. bus can be accessed between terminals L12 (-) and DB2 (+).

Caution :
- Never connect a circuit such as a bank of capacitors between the inverter output and the motor.
- Never connect the A.C. supply to the inverter U.V.W. terminals.
- The inverter cannot operate without its D.C. link choke.

3.2 - Control terminal block

3.2.1 - FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T

Located above the power terminal block, on the control board (IN 50), this comprises 30 screw terminals.



Terminal	Function	Type	Electrical characteristic
1 2 3	Programmable relay : inverter status / minimum frequency. 1 - common point, 2 - normally open contact, 3 - normally closed contact.	Logic output	240VAC, 7A, resistive load. Contact 1 - 2 closed when : - the inverter is switched on and is not tripped (b50 = 0), or - the inverter is switched on, is not faulty and the frequency is above Pr0 (b50 = 1).
4	0V common to terminals 11 and A1.	-	0V floating.
5	Voltage frequency reference.	Analogue input	Input impedance = 110 kΩ : - 0 to 10VDC : voltage source or 2.2 kΩ potentiometer *, - ±10VDC : external voltage source.
6	Power supply for frequency and torque reference potentiometers.	Analogue output	+ 10VDC, ± 2 %, 5mA maximum.
7	Torque reference or torque limitation (following b0).	Analogue input	Input impedance = 27 kΩ : 0 to 10VDC : voltage source or 10 kΩ potentiometer.
8	Current frequency reference.	Analogue input	Input impedance = 100 Ω. Current signal : 4 to 20 mA, 20 to 4 mA, 0 to 20 mA. Enable with terminal 16. Select with b11.
9	Motor probe feedback (PTC or PTO). (1)	Analogue input	U output < 2.5V (possibility of 1 to 6 PTCs, 250 Ω in series). Trip threshold : 3 kΩ, ± 15 %. Reset threshold : 1.8 kΩ, ± 15 %.
10	Encoder feedback.	Logic input	Encoder signal : - 0/+ 5 V, 16 mA, open collector (maximum voltage = 24V), -rise / fall time ≤ 50 µs, - 15 pulses per motor pole per revolution. Maximum encoder impedance 20 Ω.
11	0V common to terminals 4 and A1.	-	0V floating.
12	External trip (PTO probe, etc).	Logic input	0V interrupt = external fault. (2) (5)
13	Reset.	Logic input	0V pulse = trip reset. (2) (5)
14	Ramp hold.	Logic input	Connection to 0V = ramp fixed. (2) (5)
15	Forward run/stop	Logic input	Connection to 0V = forward operation. (2) Not connected = stop. Terminals 15 and 17 at 0V = stop.
16	Selection of frequency reference Local/Remote.	Logic input	Connection to 0V = remote frequency reference. (2) (3) Not connected = local frequency reference.

* If the torque reference potentiometer is connected, a 10 kΩ potentiometer must be used.

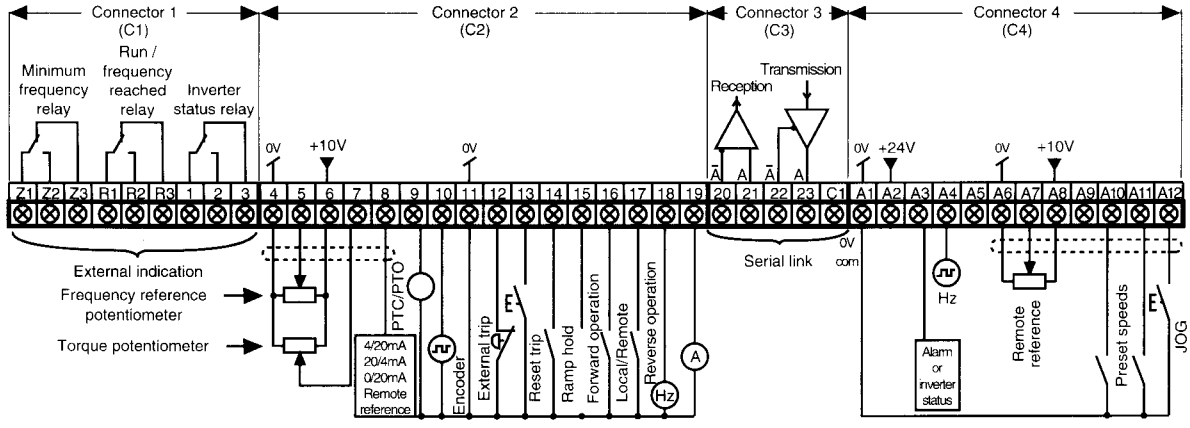
Terminal	Function	Type	Electrical characteristic
17	Reverse run/stop	Logic input	Connection to 0V = Reverse operation. (2) Not connected = stop. Terminals 15 and 17 at 0V = stop.
18	Frequency output signal.	Analogue output	0 to + 10VDC, 5 mA, ± 2 % precision, 0V = zero frequency, 10VDC = maximum frequency (Pr1).
19	Current output signal.	Analogue output	0 to ±10VDC, 5 mA, ± 10 % precision (frequency > 15 Hz), 0V = zero current, +10V = 150 % I_N (operating as a motor), -10V = 150 % I_N (operating as a generator).
20	Serial link, $\overline{A}$ or B reception	Logic input	Two cables for differential reception. (4) Differential input : - input impedance = 3.5 kΩ, - 0 to 5VDC, - U (A - $\overline{A}$) > + 0.2V = high logic level, - U (A - $\overline{A}$) < - 0.2V = low logic level.
21	Serial link, A reception	Logic input	
22	Serial link, $\overline{A}$ or B transmission	Logic output	Two cables for differential transmission. (4) Differential output : - 0 to 5VDC, - current capability ± 60 mA, - high logic level A = 5V, $\overline{A}$ = 0V, - low logic level A = 0V, $\overline{A}$ = 5V.
23	Serial link, A transmission	Logic output	
C1	Serial link, 0V.	-	0V isolated from terminals 4, 11 and A1.
A0	Programmable output : inverter running / zero speed. ** ** below minimum frequency Pr0.	Logic output	Output at 0V (2) when : - the inverter is running (b53 = 0), or - the speed is at minimum (b53 = 1). Open collector : 0 / + 24VDC. 50 mA, internal source. 250 mA, external source.
A1	0V common to terminals 4 and 11.	-	0V floating
A2	General power supply (encoder, external relay, etc).	Analogue output	+ 24 VDC, ± 10 %, 100 mA.
A10 A11	Selection of preset speeds.	Logic input	Selection via a binary combination of 3 preset speeds plus the setpoint. Impedance 10 kΩ. (2)
A12	Inching (JOG) or extension for preset speeds.	Logic input	Input used for : - the inching command (JOG), (b20 = 0). or - selection via a binary combination with A10 and A11 of 7 preset speeds plus the setpoint, (b20 = 1). Impedance 10 kΩ. (2)

(1) If a motor thermal probe is used, set jumper PL6 on the IN50 board between 2 and 3.
Caution : if the inverter is used with factory settings, the motor thermal probe is disabled.
(2) It is possible to have positive control logic on terminals 12, 13, 14, 15, 16, 17, A10, A11 and A12 by setting jumper PL5 between 2 and 3. These terminals are then enabled by the 24V (terminal A2 or PLC, etc).
(3) Local : the voltage frequency reference is input terminal 5.
Remote : the current frequency reference is input terminal 8 (select using b11) and the parameters can be modified via the serial link.
(4) See section 3.7 for the specific serial link connections.
(5) Action taken into account if the duration is 16 ms or more.

See section 4.2 for access to jumpers PL5 and PL6.

3.2.2 - FMV 2306 16T to 100T - FMV 2306 AS 16T to 120T

Located at the bottom of the control board (IN 40), the terminal block comprises 42 screw terminals grouped together on 4 plug-in connectors.



	Terminal	Function	Type	Electrical characteristic
C1	Z1 Z2 Z3	Relay : minimum frequency. Z1 : common point, Z2 : normally open contact, Z3 : normally closed contact.	Logic output	• 240VAC, 7A, resistive load. Contact 1 - 2 closed when : frequency is above minimum frequency (Pr0).
C1	R1 R2 R3	Programmable relay : inverter running / frequency reached. R1 : common point, R2 : normally open contact, R3 : normally closed contact.	Logic output	• 240VAC, 7A, resistive load. Contact 1 - 2 closed when : - the inverter is running (b50 = 0), or - frequency reached (b50 = 1).
C1	1 2 3	Relay : inverter status. 1 : common point, 2 : normally open contact, 3 : normally closed contact.	Logic output	• 240VAC, 7A, resistive load. Contact 1 - 2 closed when : the inverter is switched on and not tripped.
C2	4	0V common to terminals 11, A1 and A6.	-	0V floating.
C2	5	Local frequency reference.	Analogue input	Input impedance = 110 kΩ : - 0 to 10VDC : voltage source or 2.2 kΩ potentiometer *, - ±10VDC : external voltage source.
C2	6	Power supply for frequency and torque reference potentiometers	Analogue output	+10VDC, ± 2 %, 10 mA maximum. (Terminal 6 connected to terminal A8).
C2	7	Torque reference or torque limitation. Following b0.	Analogue input	Input impedance = 110 kΩ : 0 to 10VDC : voltage source or 10 kΩ potentiometer.
C2	8	Remote frequency reference.	Analogue input	Input impedance = 100 Ω. Current signal : 4 to 20 mA, 20 to 4 mA, 0 to 20 mA. Enable with terminal 16. Select with b11.
C2	9	Motor probe feedback (PTC or PTO). (1)	Analogue input	U output < 2.5V (possibility of 1 to 6 PTCs, 250Ω in series). - Trip threshold : 3 kΩ, ± 15 %. - Reset threshold : 1.8 kΩ, ± 15 %.
C2	10	Encoder feedback.	Logic input	Encoder signal : - 0/+5V, 16mA open collector (maximum voltage = 24V), - rise/fall time ≤ 50 µs, - 15 pulses per motor pole per revolution. Maximum encoder impedance 20 Ω.
C2	11	0V common to terminals 4, A1 and A6.	-	0V floating.
C2	12	External trip (PTO probe, etc).	Logic input	0V interrupt = external trip. (2) (5)
C2	13	Reset.	Logic input	0V pulse = reset. (2) (5)
C2	14	Ramp hold.	Logic input	Connection to 0V = ramp fixed. (2) (5)
C2	15	Forward run/stop.	Logic input	Connection to 0V = forward operation. (2)
C2	16	Selection of frequency reference.	Logic input	Connection to 0V = remote frequency reference. (2) (3) Not connected = local frequency reference.
C2	17	Reverse run/stop.	Logic input	Connection to 0V = reverse operation. (2)
C2	18	Frequency output signal.	Analogue output	0 to +10VDC, 5 mA, ± 2 % precision, 0V = zero frequency, 10VDC = maximum frequency (Pr 1).

* If torque reference and remote reference potentiometers are connected, a 10 kΩ potentiometer must be used.

	Terminal	Function	Type	Electrical characteristic
C2	19	Current output signal.	Analogue output	0 to ±10VDC, 5mA, ± 10 % precision (frequency >15Hz). 0V = zero current, + 10V = 150 % I_N (operating as a motor), - 10V = 150 % I_N (operating as a generator).
C3	20	Serial link, $\overline{A}$ or B reception	Logic input	Two cables for differential reception. Differential input : - 0 to 5VDC, - input impedance = 3.5 kΩ, - U (A - $\overline{A}$) > + 0.2V = high logic level, - U (A - $\overline{A}$) < - 0.2V = low logic level. (4)
	21	Serial link, A reception		
	22	Serial link, $\overline{A}$ or B transmission	Logic output	Two cables for differential transmission. Differential output : - 0 to 5VDC, - current capability ± 60 mA, - high logic level A = 5V, $\overline{A}$ = 0V, - high logic level A = 0V, $\overline{A}$ = 5V. (4)
	23	Serial link, A transmission		
	C1	Serial link, 0V.	-	0V isolated from terminals 4, 11, A1 and A6.
C4	A1	0V common to terminals 4, 11 and A6	-	0V floating.
	A2	General power supply (encoder, external relay, etc).	Analogue output	+ 24VDC, ± 10 %, 100 mA.
	A3	Programmable output : overload alarm or inverter status.	Logic output	Output at 0V (2) when : - inverter overloaded (b53 = 0), or - inverter is not tripped (b53 = 1). Open collector : 0 / + 24VDC. 50 mA : internal source. 250 mA : external source.
	A4	Frequency output.	Logic output	Open collector + 24/0V ± 10 mA. Square wave frequency signal = inverter output frequency.
	A5	Terminal not used.	-	Do not connect anything.
	A6	0V common to terminals 4, 11 and A1.	-	0V floating.
	A7	Second frequency reference	Analogue input	Input impedance : 110 kΩ : - 0 to 10VDC : voltage source or 10 kΩ potentiometer. Enable with terminal 16. Select with b11 = Ur.
	A8	Power supply for the reference potentiometer	Analogue output	+ 10VDC, ± 2 %, 10 mA maximum. (Terminal A8 connected to terminal 6).
	A9	Terminal not used.	-	Do not connect anything.
	A10-A11	Selection of preset speeds.	Logic input	Selection via a binary combination of 3 preset speeds plus the reference. Impedance 10 kΩ. (2)
	A12	Inching (JOG) or extension for preset speeds.	Logic input	Input used for : -the inching command (JOG) (b20 = 0), or - selection via a binary combination (of A10, A11 and A12) of 7 preset speeds plus the reference (b20 = 1). Impedance 10 kΩ.(2)

(1) If a motor thermal probe is used, set jumper LK11 to position 1 (to the left).
If the motor is not fitted with a PTC probe do not connect anything to terminal 9 and leave jumper LK11 in position 2 (to the right).
Caution : if the inverter is used with factory settings, the motor thermal probe is disabled.

(2) It is possible to have positive control logic at terminals 12, 13, 14, 15, 16, 17, A10, A11 and A12 by moving the jumper from LK1 to LK2. These terminals are then enabled by the + 24V (terminal A2 or PLC, etc).

(3) Local : the voltage frequency reference is input terminal 5.
Remote : the current frequency reference (terminal 8) or voltage frequency reference (terminal A9) following b11 is selected and the parameters can be modified via the serial link.

(4) See section 3.7 for the specific serial link connections.

(5) Action taken into account if the duration is 16 ms or more.

See section 4.2 for access to jumpers LK1, LK2 and LK11.

3.3 - Electrical and electromagnetic phenomena associated with frequency inverters

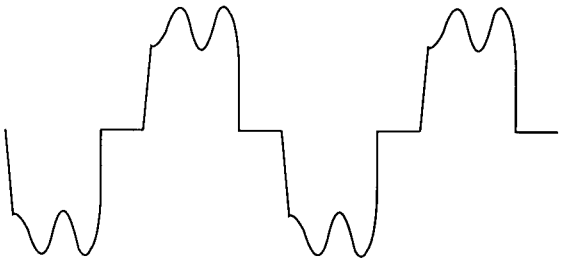
3.3.1 - General

The power structure of frequency inverters leads to the occurrence of two types of phenomena :
- low frequency harmonic generation on the power supply,
- emission of radio frequency signals which may interfere with the operation of other equipment.

These are separate phenomena, which have different consequences on the electrical environment.

3.3.2 - Low frequency harmonics

As the diode bridge at the head of the frequency inverter rectifies the supply voltage it generates a non-sinusoidal A.C. line current.



Mains supply line current drawn by a diode bridge.

This current carries harmonics of the order $6n \pm 1$.
The lower the order of these harmonics, the higher the level.
Harmonics 5, 7, 11 and 13 are 250 Hz, 350 Hz, 550 Hz and 650 Hz respectively for a supply frequency of 50 Hz, and are the most significant.
Their amplitudes depend on the impedance of the mains supply before the rectifier bridge, and the structure of the D.C. bus after the rectifier bridge.
The more inductive the mains supply and the D.C. bus, the more these harmonics are reduced.
They have virtually no effect on the level of electrical energy consumption. Temperature rises associated with these harmonics in transformers and motors connected directly to the mains supply are negligible.

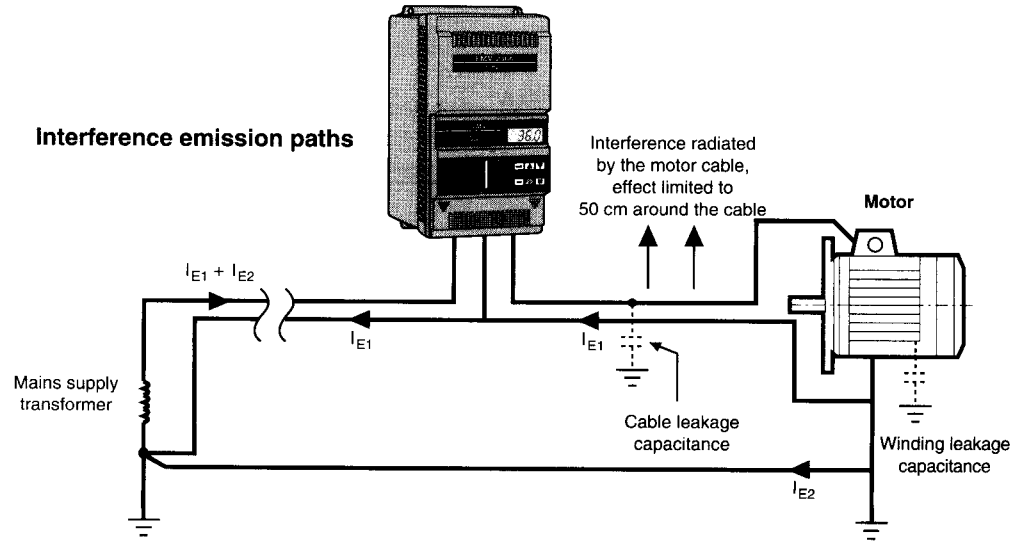
These low frequency harmonics never cause interference on sensitive equipment.

They may affect the energy distributor due to the fluctuating resonances which may be present in the meshed system, and the additional losses in the supply cables. However these are minor consequences. They only have a significant effect on frequency inverter loads of several hundred kVA and where these loads are more than a quarter of the total on-site load.

3.3.3 - Radio frequency interference

Frequency inverters use high-speed switches (transistors, semi-conductors) for switching high voltages (around 550V) and high currents at high frequency (several kHz). This provides a high level of efficiency and a low level of motor noise.
This results in the generation of radio frequency signals which may disturb the operation of other equipment or distort sensor measurements :
- due to high frequency leakage currents which escape to earth via the inverter/motor cable leakage capacitance, and the leakage capacitance of the motor across the metal structures which support the motor.
- by conduction or generation of radio frequency signals on the supply cable,
- by direct radiation close to the power supply cable or the inverter/motor cable.

These phenomena have direct consequences for the user. The frequency range concerned (radio frequency) does not cause interference for the energy distributor.



I_{E1} = leakage current at the inverter caused by the cable and motor leakage capacitances.
I_{E2} = leakage current escaping via metal structures.

3.3.4 - Standards

a) Low frequency harmonics

There is no standard for current harmonics.

Current harmonics introduce voltage harmonics on the mains supply. The amplitude of these harmonics depends on the impedance of the mains supply.

The power distributor, who is affected by these phenomena in the case of **high power installations (see 3.3.2)**, will have his own **recommendations** on the level of voltage harmonics. Eg. French distributor "EDF" :

- 0.6 % on even order harmonics,
- 1 % on uneven order harmonics,
- 1.6 % on the overall harmonics.

This applies to the power distributor connection point, and not to each harmonic generator.

Reduction of harmonics generated on the mains supply

The impedance before and after the rectifier must be increased :

- add mains supply 3-phase chokes,
- install a D.C. link choke in the D.C. bus.

The first solution causes a small but permanent voltage drop.

The second solution is more effective and reduces the ripple at the D.C. bus capacitor terminals (less stress on this component).

FMV 2306 and FMV 2306 AS 2.5T to 120T ratings are supplied with this D.C. link choke as standard.

b) Radio frequency interference

To prevent interference to sensitive equipment, European standards EN 50081 and EN 50082 stipulate the following :

- Interference levels below which sensitive equipment is not affected : interference immunity following :
EN 50082.1 for domestic equipment,
EN 50082.2 for industrial equipment.
- The maximum levels of interference generated on the supply, or radiated by power cables :
EN 50081.1 for domestic equipment,
EN 50081.2 for industrial equipment.

Interference immunity

FMV 2306 and FMV 2306 AS inverters conform to standards EN 50082.1 and 2. These standards are based on IEC 801.

Radio frequency emission

FMV 2306 and FMV 2306 AS inverters fitted with RFI (Radio-Frequency Interference) filters: option FLT - FMV, conform to the EN 50081 standard which is based essentially on the VDE 875 standard.

	Domestic environment EN 50081.1 VDE 875 N	Industrial environment EN 50081.2 VDE 875 G
FMV 2306 1.5T to 11T FMV 2306 AS 1.5T to 11T	**Conforms**, with internal FLT - FMV 11 filter switching frequency = 2.9 kHz	**Conforms**, with internal FLT - FMV 11 filter switching frequency = 2.9 to 11.7 kHz
FMV 2306 16T to 40T FMV 2306 AS 16T to 50T	Please consult LEROY-SOMER	**Conforms**, with external FLT - FMV* filter switching frequency = 2.9 to 5.9 kHz
FMV 2306 50T to 100T FMV 2306 AS 60T to 120T	Please consult LEROY-SOMER	**Conforms**, with external FLT - FMV* filter switching frequency = 2.9 kHz

* Different ratings depending on the inverter rating, see section 7.

Note on leakage currents

High frequency leakage currents occur as interference currents on the inverter power supply.

They may reach values above the isolation controller trip threshold.

Previous standards which set the maximum leakage current levels for the supply of motors connected directly to the 50 Hz supply, can no longer be observed when a frequency inverter is used.

In the absence of any specific standard, European manufacturers use the EN 60950 standard which allows the leakage current to rise to 5 % of the load current per phase.

3.4 - Wiring instructions

3.4.1 - Earthing (⏚)

The earth conductor should have as large an area as possible. The inverter(s) should preferably be placed in a metal cubicle, mounted on a chassis or conductive metal grid (unpainted).

Flat braid cables should be used to connect the various devices to the chassis.

The motor body should be connected directly to the inverter earth terminal by a standard cross-section earth cable.

If a shielded connection cable is used between the inverter and the motor to prevent radiation, the shielding must be connected at both ends (motor body and inverter earth terminal).

If the cross-section of the shielding is insufficient, it can be doubled by a cable running the length of the shielded cable, outside the shielding. This cable should be connected to the same two ends as the shielding. This cable prevents the circulation of high currents in the shielding.

The quality of the earth connections must be checked periodically, as with other power connections.

3.4.2 - Wiring inside cabinets

Do not place power cables and cables carrying signals next to one another in the same cable trough, even if the latter are shielded (distance > 0.5m).
Do not place inverter power supply cables next to motor cables, especially if the inverter is fitted with an RFI filter, as this would significantly reduce the efficiency of the filter.
Keep the power supply terminal blocks separate from the motor power terminal blocks and the signal terminal blocks.
Shield sensitive circuits. The shielded cable must be good quality, with flexible copper wire shielding, and very tight meshing. Connect the shielding at both ends.
Connect the various devices in a star configuration directly to the cabinet general earth, as specified in the safety standards.
Remote control : the remote control relays and contactors should be fitted with RC circuits.

Control cables

These should be copper, shielded with a minimum cross-section of 0.5 mm^2.

3.4.3 - Wiring external to cabinets

Power cables should preferably be in steel cableways to reduce radiation.
If the inverter/motor cable is long (> 20m), it is advisable to install a suitable choke (SELF - MC) at the inverter output to reduce high frequency leakage currents, caused by the cable leakage capacitance. This depends on the length of the cable. The choke should be installed as close as possible to the inverter (see section 7.5).

Power cables

These should be copper multicore cables with 600V insulation for A.C. voltages and 1000V for D.C. voltages.

3.4.4 - Installation in a domestic environment

The loads are generally fairly low.
The mains supply is shared by several users.
Other users of the supply may be affected by radio frequency interference fed back by the inverter to the mains. Equipment most sensitive to interference includes : radio receivers, computers, etc.

A series of steps can be taken to solve the interference problems on a site. It may not be necessary to perform them all, as there is no need to continue once the phenomena have disappeared.

1 - Observe the wiring instructions.
2 - Connect the inverter to the general earth of the building using a good quality connection : flat cable, as short as possible.
3 - Make it a priority to install the frequency inverter close to the motor.
4 - Fit an FLT - FMV filter to the inverter to reduce radio frequency feedback to the mains to a level acceptable to the standards.
5 - Connect the motor to the frequency inverter using a shielded cable with the screening connected at both ends : motor body and inverter earth.

3.4.5 - Installation in an industrial environment

In an industrial environment, it is unlikely that one user will cause interference to another.
Installing RFI filters at the inverter input, which is often costly, especially for high power ratings, is not always the solution.
A 3-phase choke installed at the inverter output is the most effective solution to reduce high frequency leakage currents associated with the motor cables.
An in-depth analysis of the problems encountered in an installation which is currently being used (or an evaluation of the risks for a future installation) is essential in order to implement the best technical and financial solution.

A series of operations can be performed to solve the interference problems in an installation. It may not be necessary to perform them all, as there is no need to continue once the phenomena have disappeared.

1 - Observe the wiring precautions.
2 - Interference suppression on probes.
Measurement probes are sensitive devices which may be affected by interference.
Most problems can be solved by installing small bypass capacitors (0.1 to 0.5 µF) on the probe feedback signals. This solution is only possible for D.C. voltage signals (12, 24 or 48V) or 50 Hz A.C. voltage up to 220V.
3 - Protective devices for sensitive equipment.
If the inverter power rating is significantly higher than that of sensitive equipment connected to the mains supply, it is more economical to install an RFI filter on the supply to the lower rated equipment than to install an RFI filter on the inverter input. The installation precautions are the same : filter close to the device, earth the device using a short connection, keep the filter input and output wires separate.
4 - 3-phase chokes at the inverter output.
Downstream interference, high frequency leakage currents are effectively suppressed by installing a suitable 3-phase choke as close as possible to the inverter output.
5 - FLT - FMV filters
If points 2 and 3 do not solve the problems associated with interference generated on the mains supply, an RFI filter should be installed at the frequency inverter input.
6 - Shielded motor cable
The efficiency of this is comparable with standard cables running through metal cable ducts.
This will significantly limit interference radiated by the motor cables.
7 - Additional cable on the shielding of the control electronics.
If these connections have to run through areas where there is a high degree of interference, it may be necessary to double the shielding by using an additional cable connected at both ends in the same way as the shielding. The circulating currents are thus concentrated in this cable and not in the shielding of the low level connections.

3.5 - Definition of cables and protective devices

Protection of FMV 2306 1.5T to 100T inverters

FMV 2306 rating	Motor rating (kW)	Current			gl fuses		Power cable diameter *** (mm^2)			
		motor (A)	mains (A)	D.C. bus (A)	mains (A)	D.C. bus ** (A)	motor	mains	D.C. bus	PE or ⏚
1.5T	0.75	2.1	5.4 *	1.7	8.0	4	1.5	1.5	2.5	1.5
2T	1.1	2.8	5.9 *	2.4	8.0	4	1.5	1.5	2.5	1.5
2.5T	1.5	3.8	5.3	3.3	8.0	6	1.5	1.5	2.5	1.5
3.5T	2.2	5.6	7.1	4.9	10	8	1.5	1.5	2.5	1.5
5.5T	4	9.5	9.5	8.7	12	12	1.5	1.5	2.5	1.5
8T	5.5	12	13.7	11.9	16	16	1.5	2.5	2.5	2.5
11T	7.5	16	16.3	15.7	20	25	2.5	2.5	2.5	2.5
16T	11	25	26.5	22	32	32	6	6	4	6
22T	15	31	29.5	30	40	40	6	10	6	6
27T	18.5	38	36.4	37	40	50	10	10	10	10
33T	22	46	49.1	44	63	63	10	16	10	16
40T	30	59	57.9	60	63	80	16	16	16	16
50T	37	76	72.7	74	80	100	25	25	25	16
60T	45	91	90	90	100	125	35	35	35	25
75T	55	110	106	110	125	160	50	50	50	25
100T	75	150	144	150	160	200	70	70	70	35

Protection of FMV 2306 AS 1.5T to 120T inverters

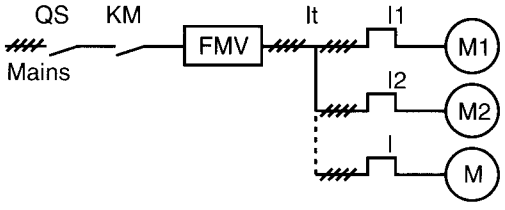
FMV 2306 AS rating	Motor rating (kW)	Current			gl fuses		Power cable diameter *** (mm^2)			
		motor (A)	mains (A)	D.C. bus (A)	mains (A)	D.C. bus ** (A)	motor	mains	D.C. bus	PE or ⏚
1.5T	0.75	2.1	5,4 *	1.2	8,0	4	1.5	1.5	2.5	1.5
2T	1.1	2.8	5,9 *	2.4	8,0	4	1.5	1.5	2.5	1.5
2,5T	1.5	3.8	5.3	3.3	8,0	6	1.5	1.5	2.5	1.5
3.5T	2.2	5.6	7.1	4.9	10	8	1.5	1.5	2.5	1.5
5.5T	4	9.5	9.5	8.7	12	12	1.5	1.5	2.5	1.5
8T	5.5	12	13.7	11.9	16	16	1.5	2.5	2.5	2.5
11T	7.5	16	16.3	15.7	20	25	2.5	2.5	2.5	2.5
16T	11	25	25.6	22	32	32	6	6	4	6
22T	15	32	31.8	30	40	40	6	10	6	10
27T	18.5	38	35	37	40	50	10	10	10	10
33T	22	46	49.1	44	63	63	10	16	10	16
40T	30	62	61	60	80	80	16	16	16	16
50T	37	70	67	74	80	100	25	25	25	16
60T	45	91	90	90	100	125	35	35	35	25
75T	55	110	106	110	125	160	50	50	50	25
100T	75	144	139	150	160	200	70	70	70	35
120T	90	180	173	180	200	250	95	95	95	50

* The D.C. bus does not have a D.C. link choke on models 1.5T and 2T.
** See section 3.6.5 : parallel D.C. bus connection of inverters.
*** The recommended diameters are those for electrical enclosures and do not take account of line voltage drops due to the length of the cables.

THESE TABLES IN NO WAY REPLACE THE CURRENT STANDARDS.

3.6 - Special connections

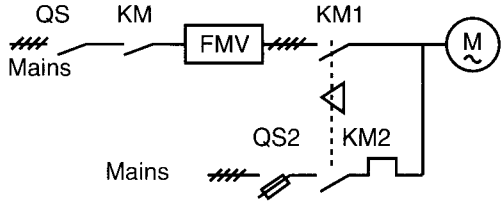
3.6.1 - Combination of motors in parallel



Several motors with different power ratings can be supplied by a single frequency inverter. Each motor must be protected by a thermal relay.
Calculation of the inverter rating :

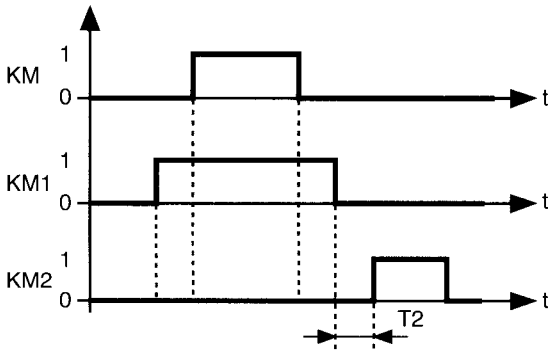
I_N inverter > I1 + I2 + ... + I

3.6.2 - Connecting the motor directly to the mains supply (by-pass)



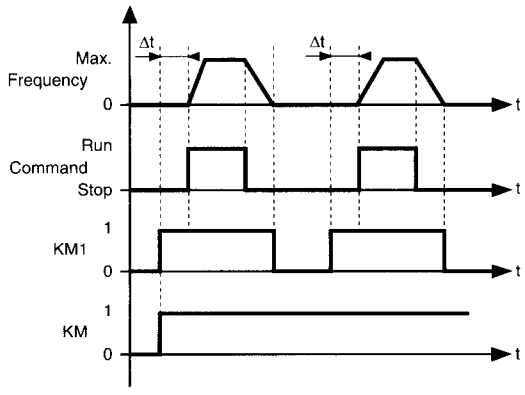
Sequence to follow :
- KM1 must be activated before KM,
- mechanical locking between KM1 and KM2.

The time T2 = 1.5s must be strictly adhered to. This corresponds to demagnetisation of the motor.

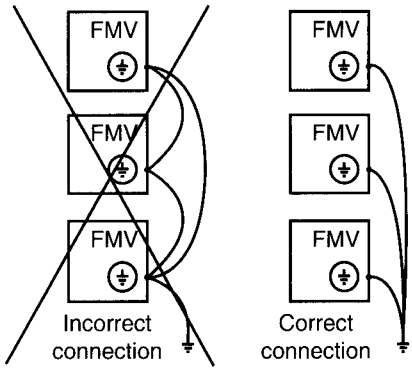


3.6.3 - Opening of the motor contactor at stop

Sequence to follow :
- KM1 must not open until the motor has stopped (detected by the inverter),
- the run command must only be given once KM1 is energised.



2.6.4 - Connecting the earths of several inverters

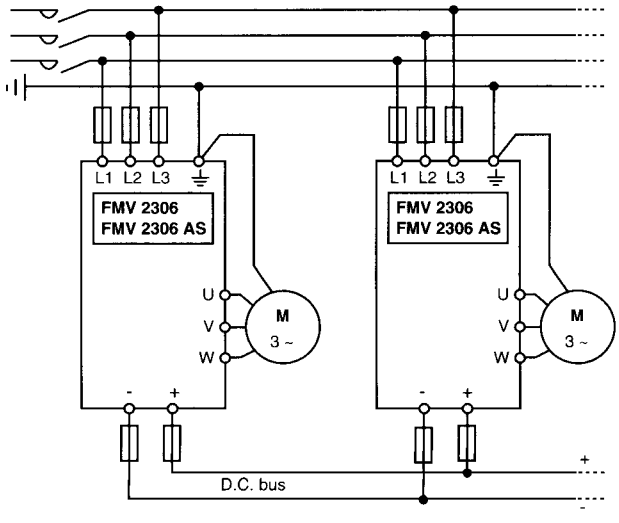


3.6.5 - Parallel D.C. bus connection of inverters

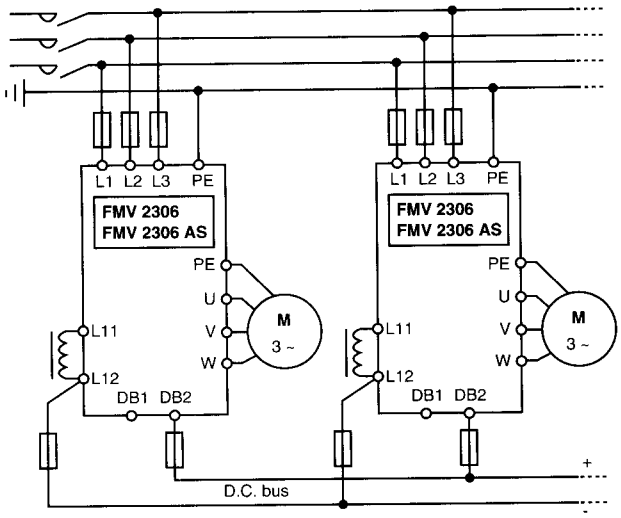
a) General

Inverters which are connected in parallel should have the **same rating** and should be switched on simultaneously.
The D.C. bus of each inverter should be fitted with fuses. (See section 3.5).
It avoids the need to use or limits the number of optional braking units when the motoring energy is greater than the regenerated energy.

b) Connection diagram for models 1.5T to 11T



c) Connection diagram for models 16T to 120T

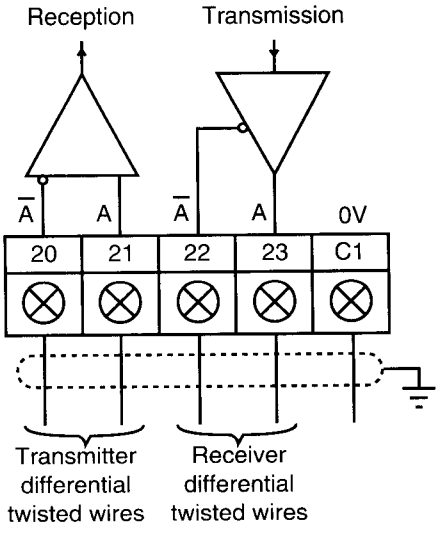


3.7 - Connection of the serial link

3.7.1 - General

The protocol used is ANSI x 3.28.2.5 A4.
The serial link can be set up using RS 485 and RS 422 standards which provide differential data transmission and reception via 5 wires.
As the output on most PCs is RS 232 standard, an RS 232/RS 422 or RS 232/RS 485 interface must be added as close as possible to the PC.

3.7.2 - Standard RS 485/RS 422 connection

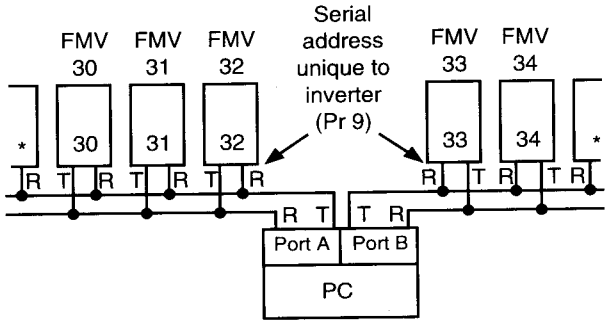


- RS 485 : 2 pairs of twisted shielded wires + 0V wire,
  - characteristic impedance = 120 Ω,
  - impedance matching resistance = 120 Ω,
  - maximum cable length = 1200 m.

- RS 422 : 2 pairs of twisted shielded wires + 0V wire,
  - characteristic impedance = 100 Ω,
  - impedance matching resistance = 100 Ω,
  - maximum cable length = 1200 m.

Note : With the RS 485 standard, it is possible to communicate with up to 32 inverters connected on the same line from a single PC (or PLC). Each inverter has a unique serial address.

RS 485 serial link with 32 inverters per port



R : receiver input
T : transmitter output

* Impedance matching resistances are installed on the furthest inverter. They are R 125 for models ≤ 11T and R 281 for models ≥ 16T (see section 4.2 for their layout).

3.7.3 - Configuration of the FMV 2306

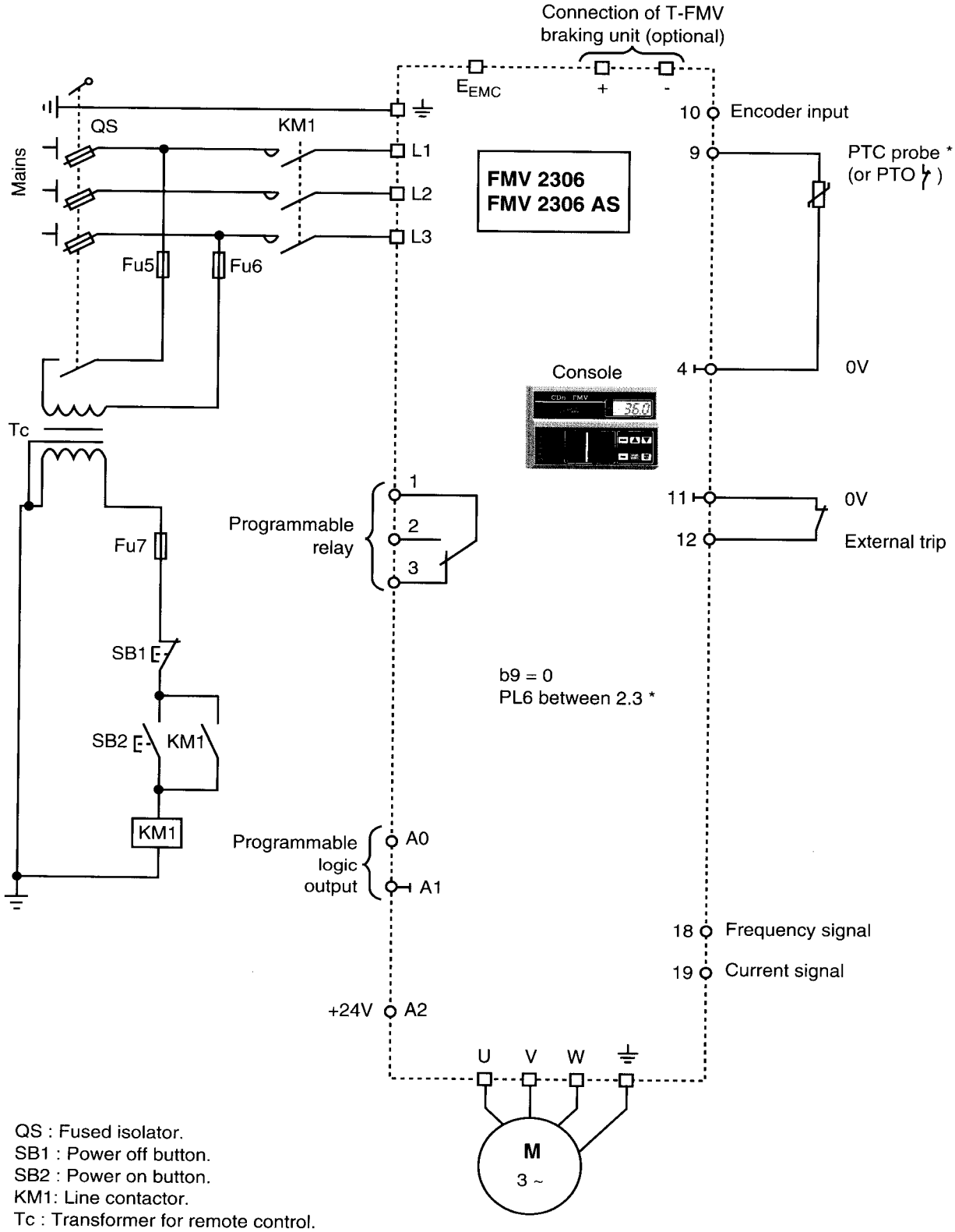
- Program :
  - Pr09 : inverter address,
  - b12 : exchange speed,
  - b10 : select parity.
- Connect :
  - terminal 12, external trip (at 0V),
  - terminal 16, remote control (at 0V).

from this moment the inverter parameters can be read,

- Access level :
  - if b6 = 0 : read only of parameters,
  - if b6 = 1 : read and write of parameters,
  - b9 = 1 : control via the terminal block.

3.8 - Connection diagrams

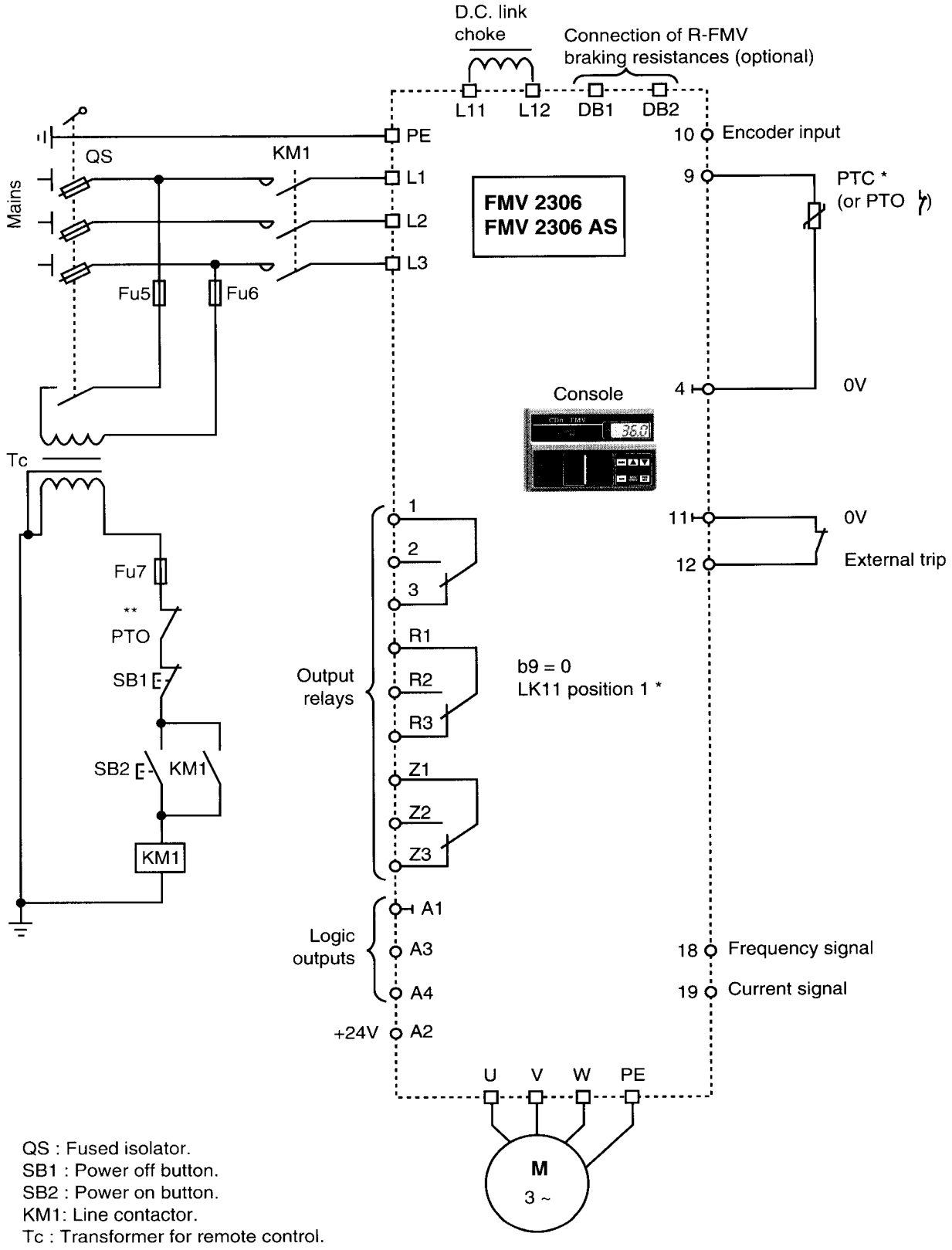
3.8.1 - FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T Controlled via CDn-FMV console.



QS : Fused isolator.
SB1 : Power off button.
SB2 : Power on button.
KM1: Line contactor.
Tc : Transformer for remote control.
* No PTC or PTO probe : PL6 between 1 and 2.

Notes : - The contactor coil should be fitted with an RC circuit.
- The inverter only has one ⏚ terminal.
- Shield the control electronics connections.

3.8.2 - FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T
Controlled via CDn-FMV console.

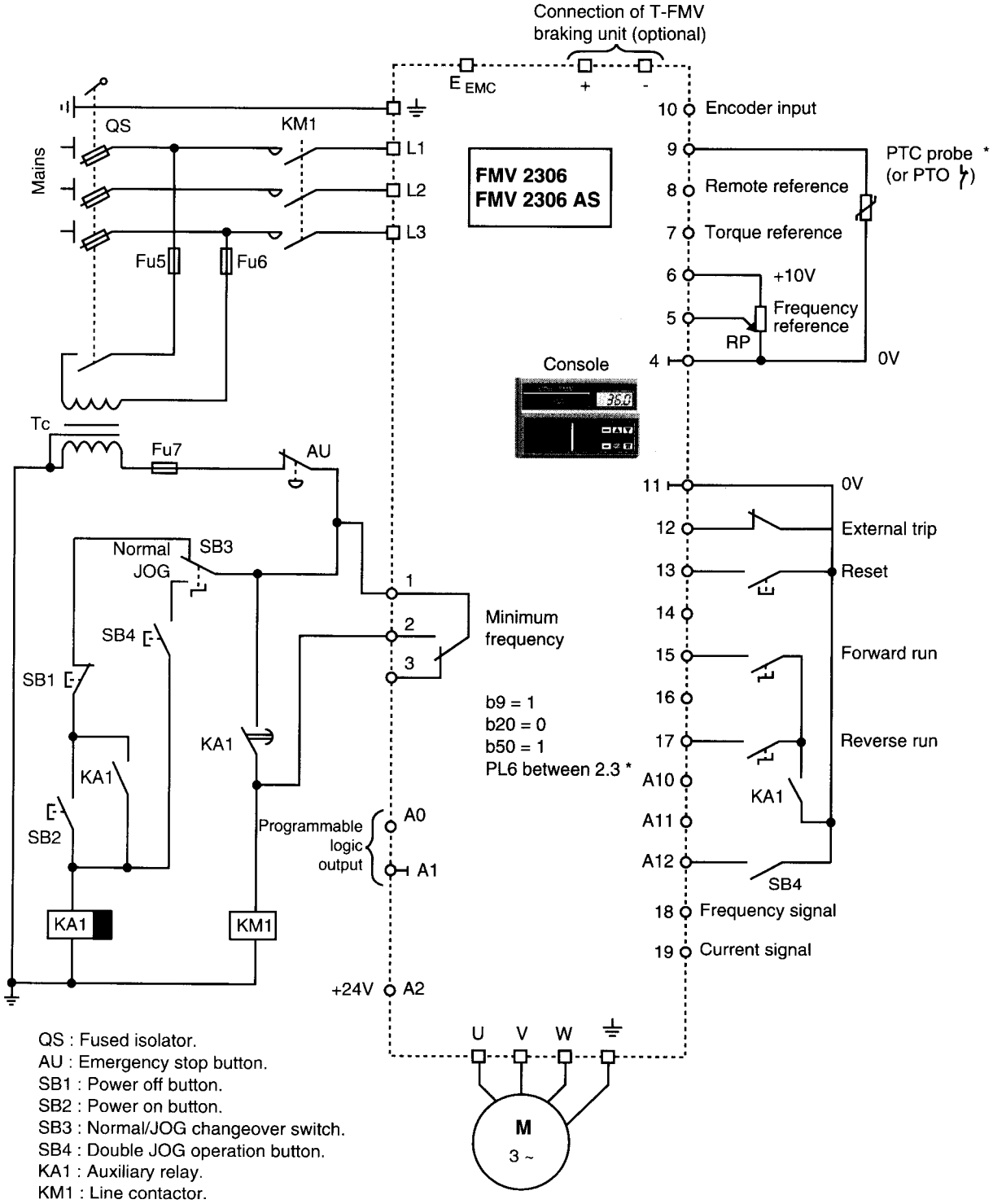


QS : Fused isolator.
SB1 : Power off button.
SB2 : Power on button.
KM1: Line contactor.
Tc : Transformer for remote control.
* No PTC or PTO probe : LK11 position 2.

Notes : - The contactor coil should be fitted with an RC circuit..
- Shield the control electronics connections.

3.8.3 - FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T

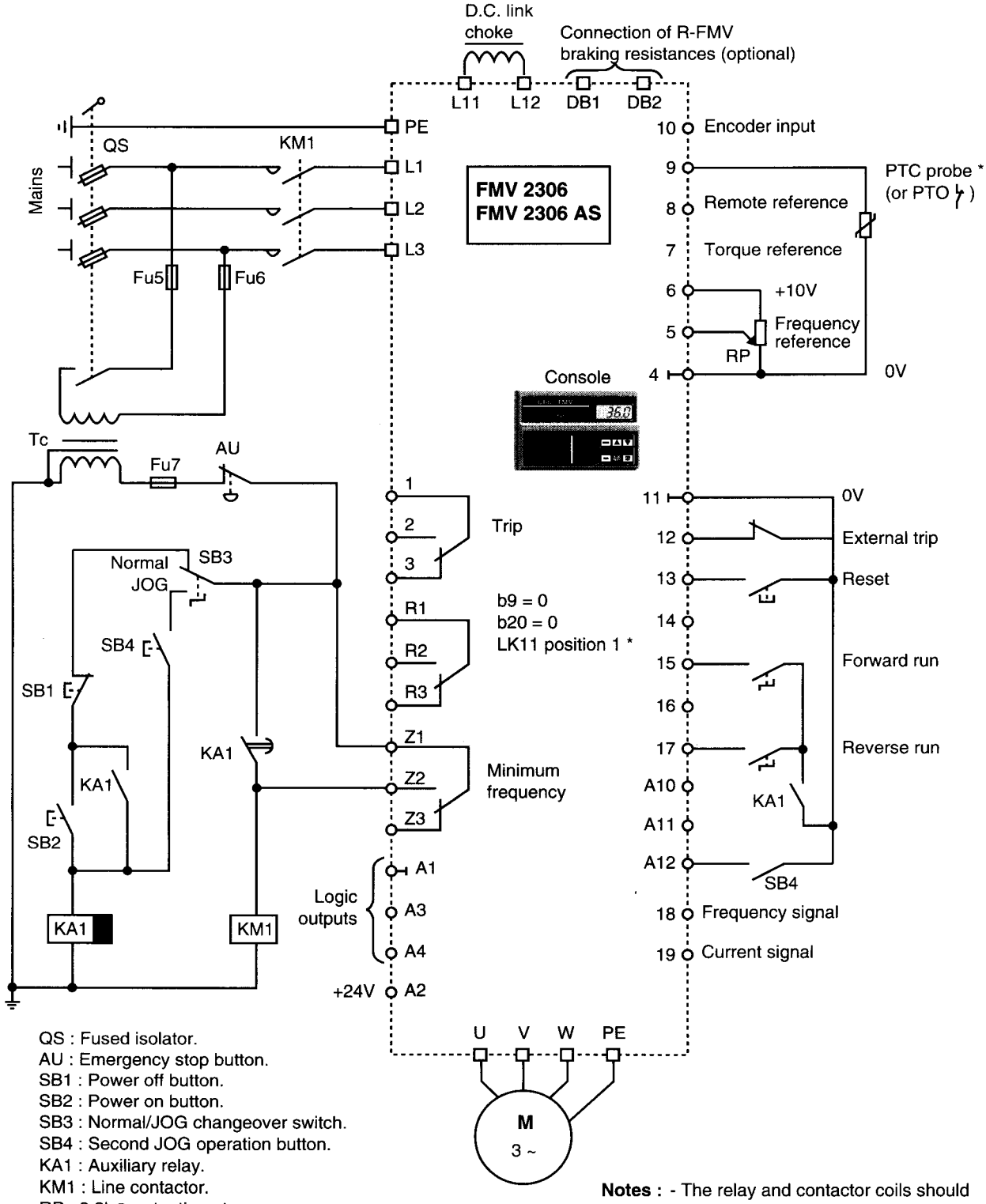
Controlled via terminal block :
- operation with controlled stop,
- jog.



QS : Fused isolator.
AU : Emergency stop button.
SB1 : Power off button.
SB2 : Power on button.
SB3 : Normal/JOG changeover switch.
SB4 : Double JOG operation button.
KA1 : Auxiliary relay.
KM1 : Line contactor.
RP : 2.2kΩ potentiometer.
Tc : Transformer for remote control.
* No PTC or PTO probe : PL6 between 1 and 2.

Notes : - The relay and contactor coils should be fitted with an RC circuit.
- The inverter only has one ⏚ terminal.
- Shield the control electronics connections.

3.8.4 - FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T
Controlled via terminal block :
- operation with controlled stop,
- jog.

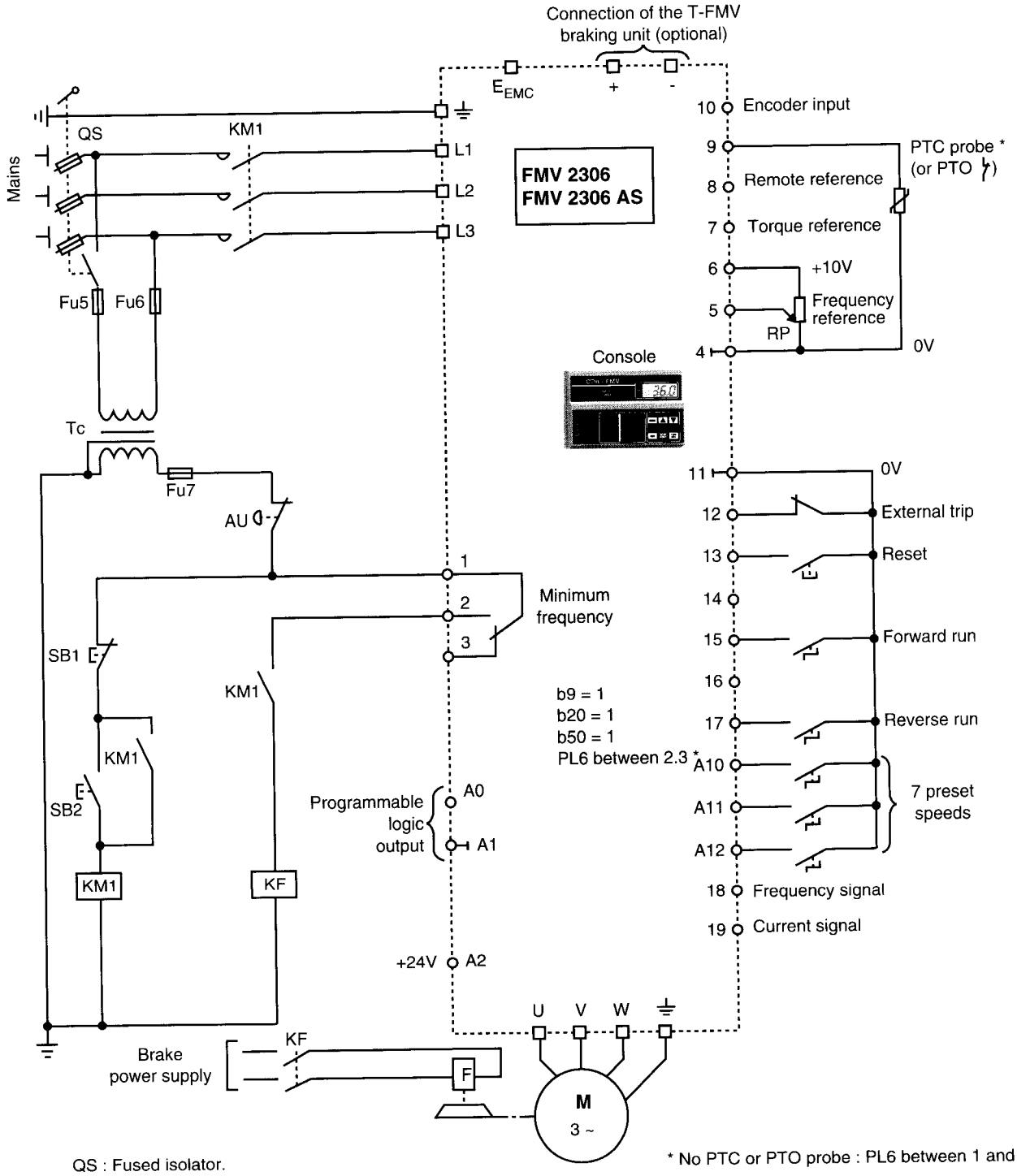


QS : Fused isolator.
AU : Emergency stop button.
SB1 : Power off button.
SB2 : Power on button.
SB3 : Normal/JOG changeover switch.
SB4 : Second JOG operation button.
KA1 : Auxiliary relay.
KM1 : Line contactor.
RP : 2.2kΩ potentiometer.
Tc : Transformer for remote control.
* No PTC or PTO probe : LK11 position 2.

Notes : - The relay and contactor coils should be fitted with RC circuits.
- Shield the control electronics connections.

3.8.5 - FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T

Controlled via terminal block :
- operation : 7 preset speeds + reference,
- brake control.



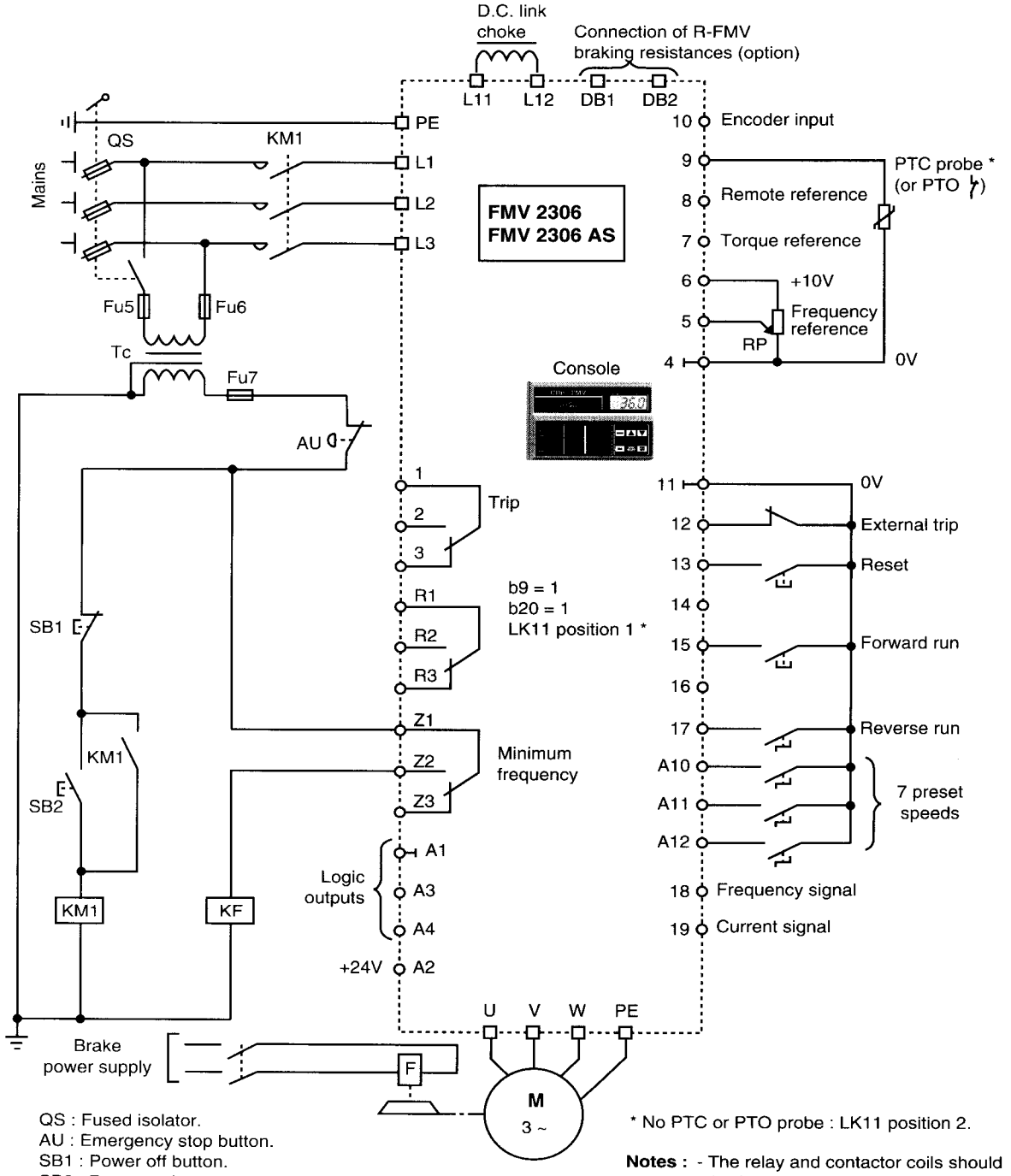
QS : Fused isolator.
AU : Emergency stop button.
SB1 : Power off button.
SB2 : Power on button.
RP1 : 2.2kΩ potentiometer..
Tc : Transformer for remote control.
KM1 : Line contactor
KF : Braking contactor.
F : Brake coil.

* No PTC or PTO probe : PL6 between 1 and 2.

Notes : - The relay and contactor coils should be fitted with RC circuits.
- The inverter only has one ⏚ terminal.
- **Shield the control electronics connections.**

3.8.6 - FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T

Controlled via terminal block :
- operation : 7 preset speeds + reference,
- brake control.



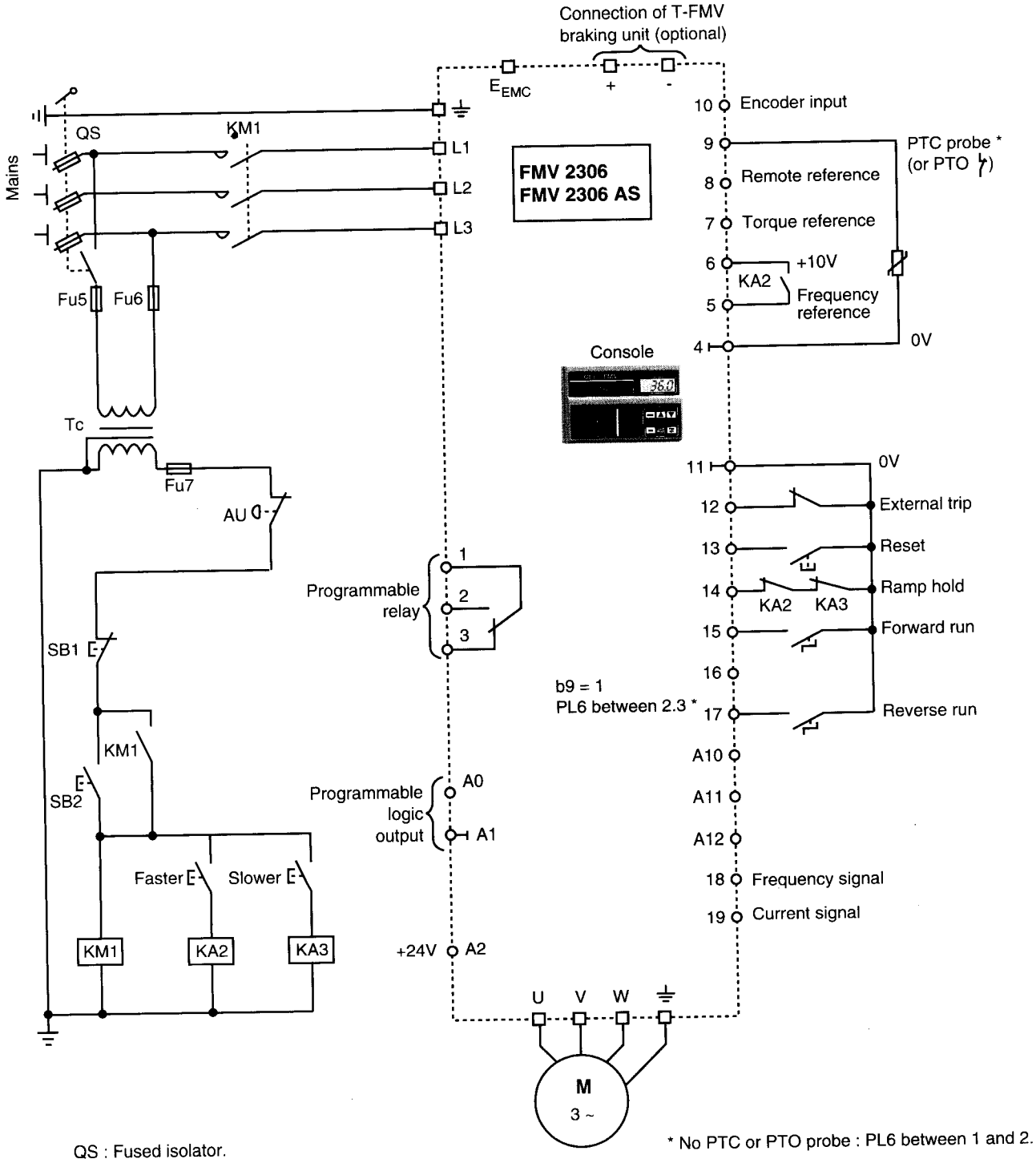
QS : Fused isolator.
AU : Emergency stop button.
SB1 : Power off button.
SB2 : Power on button.
RP : 2.2kΩ potentiometer .
Tc : Transformer for remote control.
KM1 : Line contactor.
KF : Braking contactor.
F : Brake coil.

* No PTC or PTO probe : LK11 position 2.

Notes : - The relay and contactor coils should be fitted with RC circuits.
- Shield the control electronics connections.

3.8.7 - FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T

Controlled via terminal block :
- faster/slower reference via pushbutton (see section 4.4).



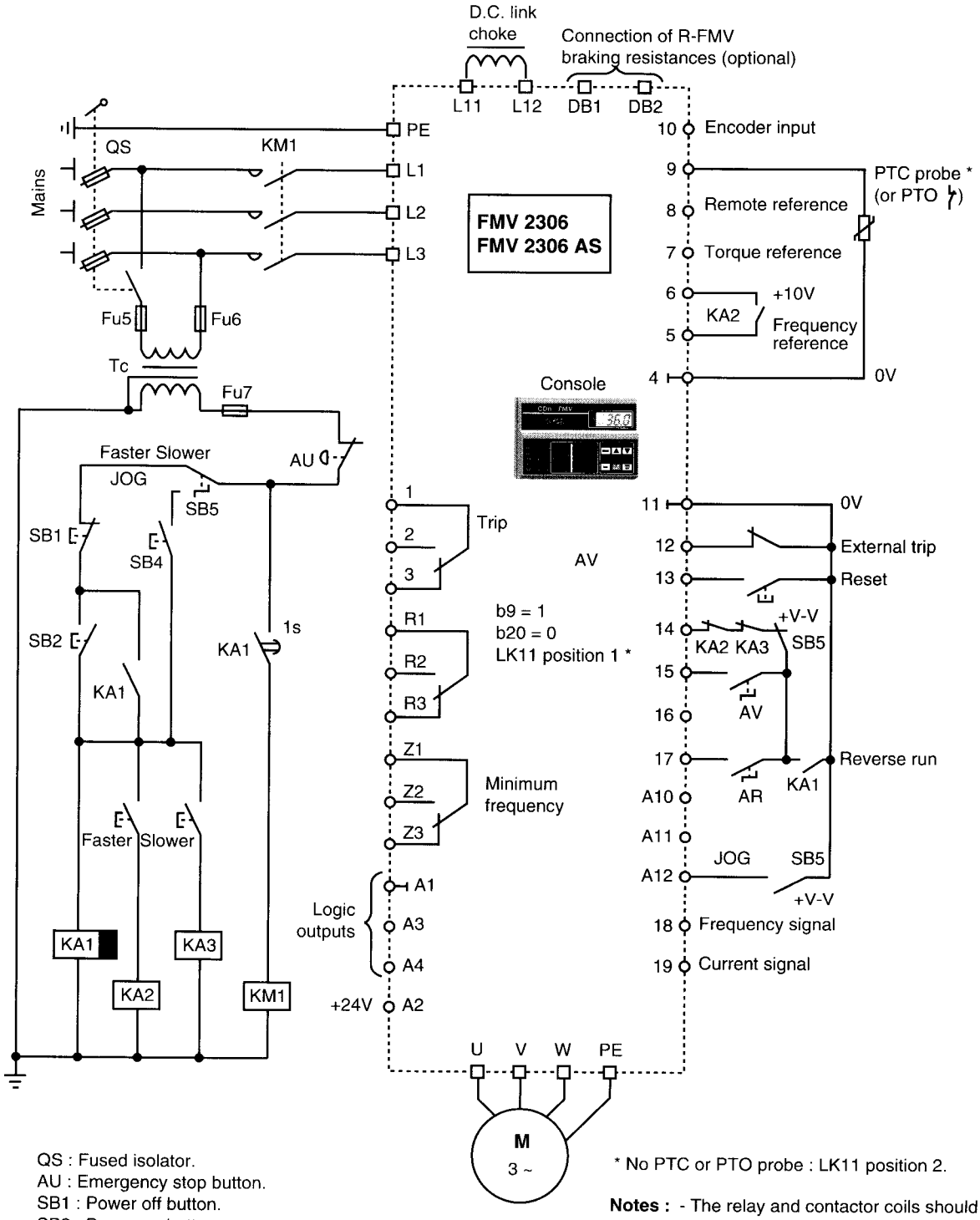
QS : Fused isolator.
AU : Emergency stop button.
SB1 : Power off button.
SB2 : Power on button.
Tc : Transformer for remote control.
KM1 : Line contactor.
KA2 : Faster relay.
KA3 : Slower relay.

* No PTC or PTO probe : PL6 between 1 and 2.

Notes : - The relay and contactor coils should be fitted with RC circuits.
- The inverter only has one ⏚ terminal.
- **Shield the control electronics connections.**

3.8.8 - FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T

Controlled via terminal block :
- faster/slower reference via pushbutton (see section 4.4),
- jog.



QS : Fused isolator.
AU : Emergency stop button.
SB1 : Power off button.
SB2 : Power on button.
SB4 : JOG pushbutton.
SB5 : JOG / faster slower changeover switch.
Tc : Transformer for remote control.
KA1 : Auxiliary relay.
KA2 : Faster relay.
KA3 : Slower relay.
KM1 : Line contactor.

* No PTC or PTO probe : LK11 position 2.

Notes : - The relay and contactor coils should be fitted with RC circuits.
- Shield the control electronics connections.

4 - COMMISSIONING

4.1 - Procedure for using the CDn - FMV console

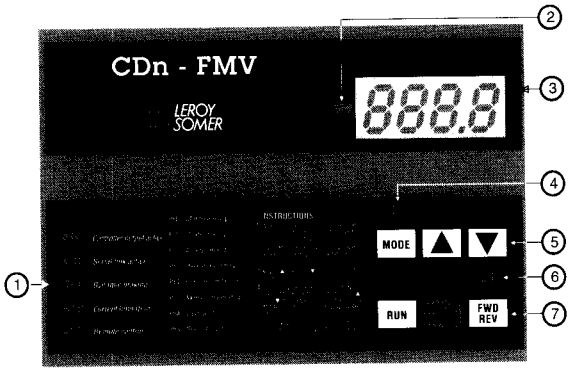
4.1.1 - Presentation

All inverter consoles are identical, and provide access to adjustment parameters and control of the inverter.

• Connection

The console can be unplugged and used remotely.
Remote connection is via a shielded cable with Sub-D type connectors (9 female pins on the console, 9 male pins on the inverter).
Maximum cable length = 100 m.
The console can be removed during operation (the inverter will come to a stop if it was being controlled via the console.

• Description



① 5 red LEDs for indicating inverter status.

② 1 red LED for indicating negative values.

③ 4 7-segment displays for reading : parameters, inverter status or the output frequency/current measurement.

④ 1 green LED " PAR " indicating that the " MODE " key has been pressed and that the display is showing the number of a parameter (" Pr - - " or " b - - ") alternately with its contents.

⑤ 2 keys for scrolling parameters and modifying their value.

⑥ 1 red LED " FWD " indicates that the inverter is in forward operation.

⑦ 3 keys for initiating the commands : Run, Stop (" RESET ") and direction of rotation, after a command from the console.

• Initial display

When switched on, the four 7-segment displays show the "Initial display", indicating the inverter status.

Inverter status	Initial display	
	Controlled via CDn-FMV	Controlled via TERM. BLOCK
Stopped	**"rdY"** <--> **"0"** : inverter ready signal **"rdY"** displayed alternately with the frequency reference **"0"**	**"rdY"** : inverter ready
Running	Frequency reference	- either output frequency (Hz), - or output current (%IN) *
Tripped	"Trip code" flashing alternately with the frequency setpoint	Trip code flashing

* Whichever value is displayed, the other can be seen by simultaneously pressing both △ ▽ keys when control is via the terminal block.

• 5 LED status indicators

Information about the inverter status and control is provided by 5 LEDs.

LED ref	Status	Information
Inverter output active	On	The inverter is running (possibly at zero speed). The "FWD" LED is also lit if a forward movement command has also been given
Serial comms active	On	The inverter is receiving or sending data via the serial link
Dynamic brake active	On	Indicates that the maximum voltage threshold of the D.C. bus has been exceeded(driving load)
Current limit active	On	The inverter is in current limitation, the load exceeds : - the overload current value (Pr4) or - the torque limitation set at terminal 7
Remote control of drive	On	Indicates that the inverter is being controlled via : - a current signal speed reference* - or the serial link

* or the remote voltage signal speed reference for ratings ≥ 16T.

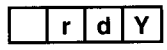
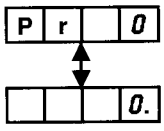
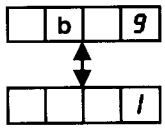
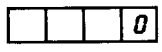
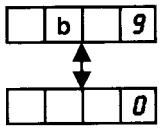
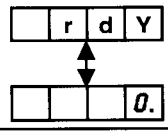
4.1.2 - Adjustment parameters

The inverter is configured for any given application by programming the parameters. This is performed either via the console or via the serial link.
There are two types of parameter :
- numerical parameters ("Pr X X") which are used to adjust the current and frequency, etc. Apart from Prc, they can be modified while the inverter is running.
- logic or bit parameters ("b Y Y"), which are used to select or enable functions. They can only be modified if the inverter output is not active (no run command and the "inverter output active" LED not lit).

a) Manipulating parameters using the CDn-FMV console
• Parameter selection

Step	Action on the keypad	Display	Remarks
POWER ON		rdY	The inverter will start if the automatic starting function is selected.
SELECTION OF A PARAMETER	Press MODE once	Pr 0 ↕ 0 — Parameter n° ↕ Parameter value	The "PAR" LED lights up. The parameter number is displayed alternately with its value. Pr 0 = minimum output frequency.
	8 seconds pause	rdY	If no key is pressed in the next 8 seconds, the "Initial display" reappears. The "PAR" LED goes out.
SCROLLING OF PARAMETERS	Press MODE once	Pr 0 ↕ 0.	The "PAR" LED lights up. The parameter number is displayed alternately with its value.
	Press △ once	Pr 1 ↕ 50.0	The next parameter number is displayed alternately with its value. Pr 1 = maximum output frequency. All the main parameters can be selected using this procedure.
	8 seconds pause	rdY	If no key is pressed in the next 8 seconds, the "Initial display" reappears. The "PAR" LED goes out.
SELECTION OF A PARAMETER	Press MODE once	Pr 1 ↕ 50.0	The "PAR" LED lights up. The number of the last selected parameter is displayed alternately with its value.

• **Parameter modification** (example : programming for console (keypad) control).

Step	Action on the keypad	Display	Remarks
POWER ON			
SELECTION OF PARAMETER b9	Press MODE once		The "PAR" LED lights up.
	Press △ or ▽ several times to select parameter b9		b9 = selection of type of control. b9 = 1 : control via terminal block, b9 = 0 : control via keypad.
MODIFICATION OF THE SETTING	Press MODE once		The "PAR" LED goes out. The value of parameter b9 is fixed. If the value is flashing, see (*).
	Press △ or ▽		The value of parameter b9 changes to 0. Control of the inverter is via the keypad.
	Press MODE once		The "PAR" LED lights up. The new value of parameter b9 is stored.
	8 seconds pause		**Note :** The 3 keys on the bottom of the RUN / STOP RESET / FWD REV keypad are now enabled and can be used for activating : Run, Stop/Reset, Forward/Reverse. If no key is pressed in the next 8 seconds, the "Initial display" reappears. The "PAR" LED goes out.

Note :

• If no key is pressed for 8 seconds during the course of the above procedure, the display returns to the "Initial display". By pressing MODE the number of the last selected parameter is displayed alternately with its value.

• Before modifying the adjustment parameters, check the inverter status via the display and the five LED status indicators.

Numerical type **Pr** parameters can be modified during operation, except for parameter **Prc** which is used to adjust the base frequency (nominal point).

(*) Logic parameters **b** and **Prc** can only be modified if the inverter output is not active (see indicator LED).

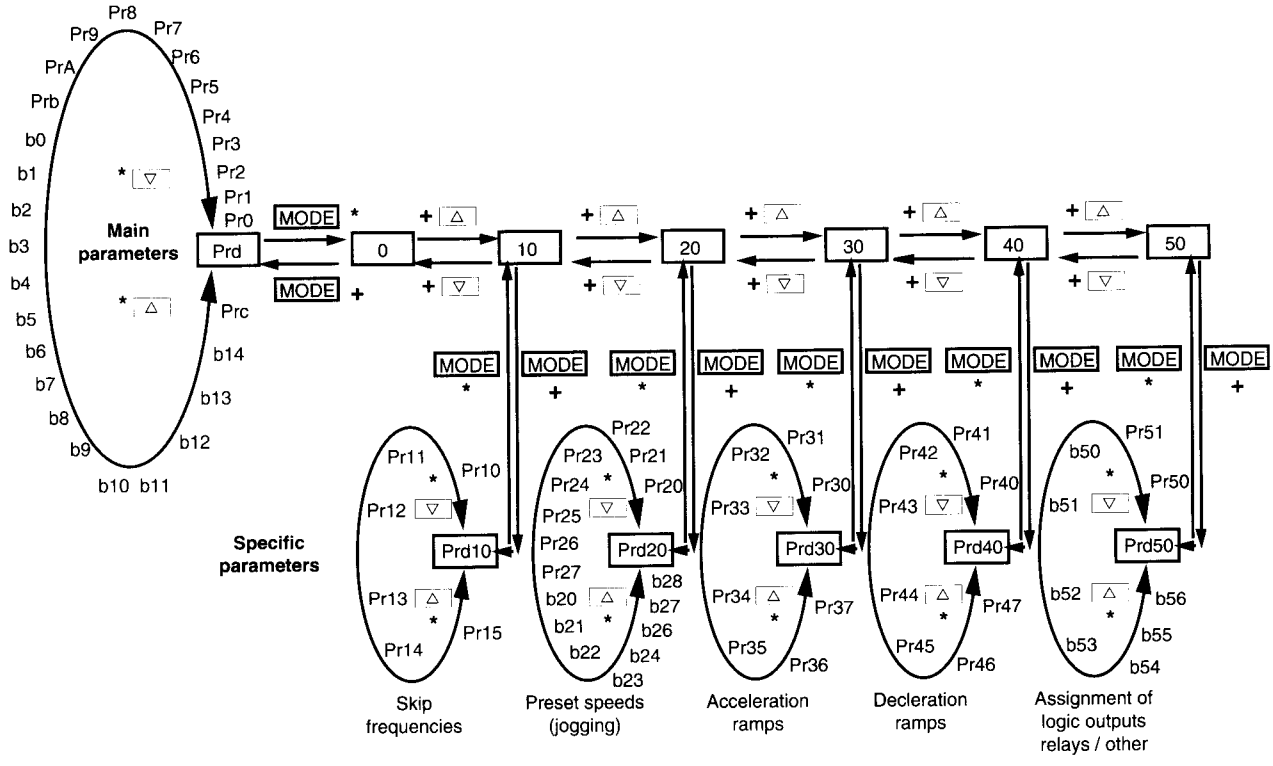
• Once a parameter has been modified, its new value is stored automatically (even after a power break).

• The display may flash for the following reasons :
- the inverter is tripped and the trip code is flashing,
- a parameter has been adjusted to the limit of its range,
- decimal points (not being used) flash to indicate that the inverter is overloaded (I x t).

• The FWD REV key is enabled if b51 = 1.

b) Parameter organisation

Access to the main parameters is gained simply by using [△] and [▽] keys when the "PAR" LED is lit.
Parameters which are specific to functions : frequency skips, preset speeds and their associated acceleration/deceleration ramps, jogging and assigning logic outputs, are organised into five groups which can be accessed by programming values 10, 20, 30, 40 and 50 in the Prd parameter.



* [△] : Press [△] when the " PAR " LED is on.
\+ [△] : Press [△] when the " PAR " LED is off.
* [▽] : Press [▽] when the " PAR " LED is on.
\+ [▽] : Press [▽] when the " PAR " LED is off.

MODE * : Press MODE when the "PAR" LED is on.

MODE + : Press MODE when the " PAR " LED is off.

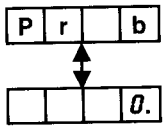
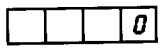
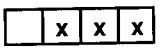
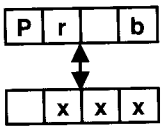
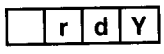
c) Reverting to factory settings

Step	Action on the keypad	Display	Remarks
PARAMETER SELECTION	Press MODE once and then press [△] or [▽] several times to select parameter b13	rdY b13	The "PAR" LED lights up. b13 = 0 : inactive, b13 = 1 : revert to factory settings.
PARAMETER MODIFICATION	Press MODE once Press [△] or [▽]	0. 0 1	The "PAR" LED goes out. The value of parameter b13 is fixed. If the value is flashing, check that the inverter is not active or see the section **Security code**.
	Press MODE once	b13 0	Parameter b13 is automatically reset to zero. All parameters revert to their original value.

d) Security code

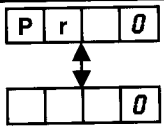
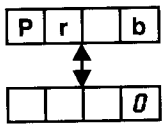
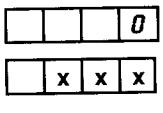
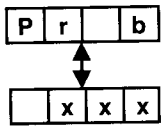
Access to the inverter can be restricted by programming a personalized code.

• Programming code

Step	Action on the keypad	Display	Remarks
INSTALLING THE CODE VIA THE KEYPAD	Press MODE once and press △ or ▽ several times to select parameter Prb.		The "PAR" LED lights up. Prb = 0 : open access to all parameters, Prb = 100 to 255 : no parameter can be modified unless the correct code is programmed. (*)
	Press MODE once		The "PAR" LED goes out.
	Hold down △ or ▽ to choose the code		
	Press MODE once		The "PAR" LED lights up.
POWER OFF			
POWER ON			Parameters can no longer be modified unless the correct code is programmed.

(*) The security code may be programmed via the serial link with a value between 0 and 255 inclusive.

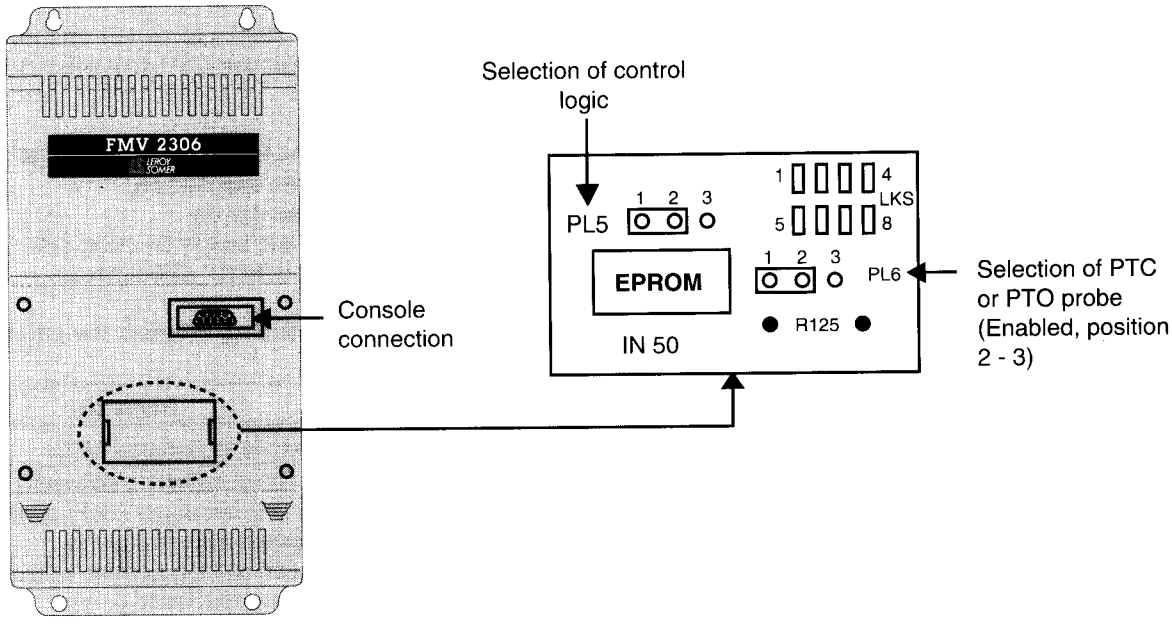
• Modifying parameters protected by a code

ACCES TO PARAMETERS	Press MODE once		The "PAR" LED lights up.
	Press △ or ▽ several times to select parameter Prb		The security code is no longer visible.
	Press MODE once Hold down △ or ▽ to select the code		The "PAR" LED goes out.
	Press MODE once		Any parameter can be modified.

4.2 - Access to resistances and jumpers

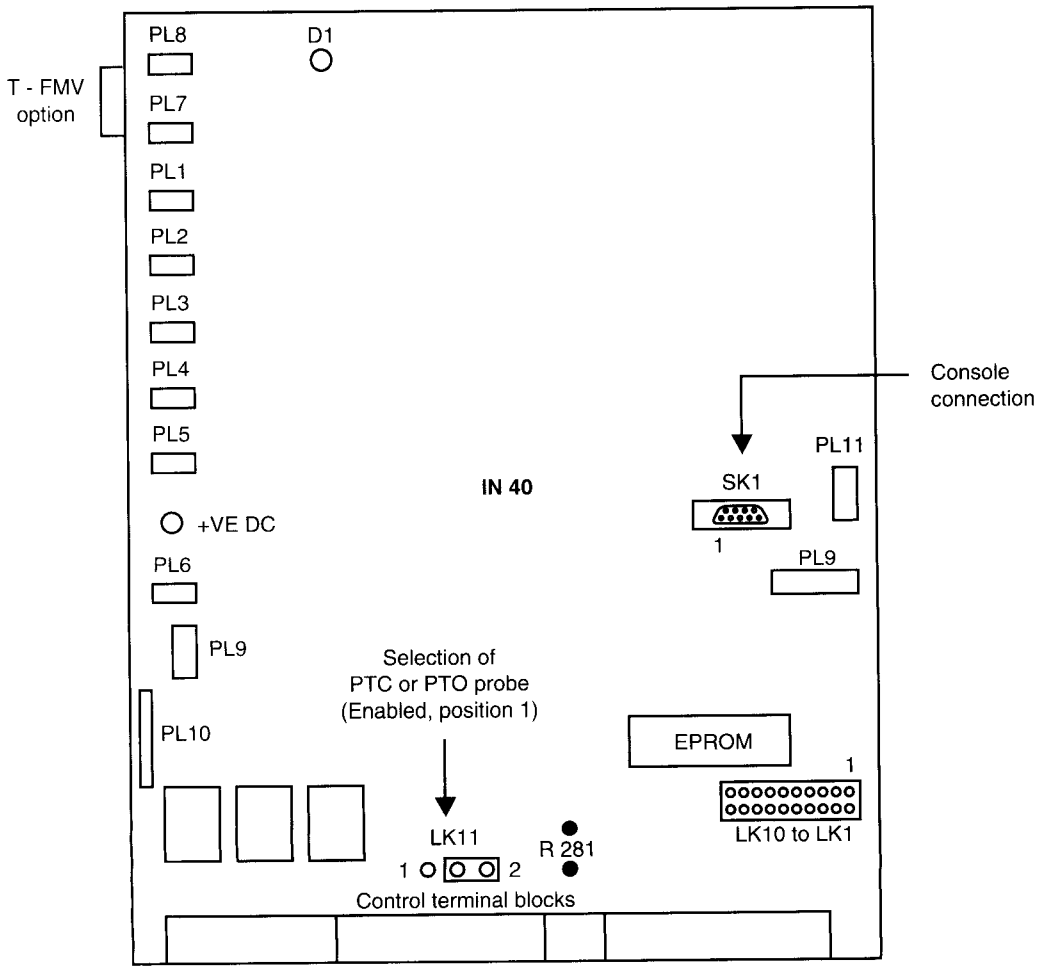
4.2.1 - FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T

Unplug the console to access the trap.
Lift the trap to access the IN 50 board.



4.2.2 - FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T

Unplug the console.
Remove the cover (held in place by 4 Phillips screws) to access the IN 40 control board.



4.3 - Setting up the motor-inverter

4.3.1 - Control via the console (keypad)

• Wiring the motor-inverter

Refer to the diagrams in section 3.8.1 or 3.8.2.

• Connecting a PTC or PTO probe

Position jumper PL6 (on the IN 50 board) between 2 and 3 for models FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T or set jumper LK11 to position 1 (on the left) on the IN 40 board for models FMV 2306 and FMV 2306 AS ≥16T.

• External trip

Do not forget to link terminals 11 and 12, or the inverter will display "Et" when switched on.

• Switching the inverter on

Close the isolator and switch on using SB2. The display indicates "rdY" and the "FWD" LED lights up.

• Programming

Without a run command, program the parameters one after another.

Parameter	Remarks
b9 = 0	Control via the keypad
b14	Selection of the switching frequency and the upper limit frequency (ULF) depending on the desired motor frequency
Prc	Selection of the maximum voltage frequency depending on b14
Pr1	Selection of the maximum motor frequency
Pr5	Adjustment of maximum continuous motor current (as % of I_N)
Pr4	Adjustment of maximum motor overload current (as % of I_N)
Pr6	Adjustment of the torque required for starting
Pr2	Adjustment of acceleration ramp
Pr3	Adjustment of deceleration ramp
b2 et b7	Selection of mode of stopping
b1 = 1	Controlled start
b51 = 1	Enable FWD/REV key

• Run command

Press [RUN], and the "Inverter output active" LED lights up.

• Adjustment of the output frequency

Press [△], the display shows the inverter output frequency.

Release [△], when the desired frequency has been reached.

• Slip compensation

Load the motor and program Pr7 so that it rotates at the same speed with no load or with load.

• Stopping the motor

Press [STOP RESET].

The value shown on the display decreases to 0, then it indicates "rdY" alternately with the frequency requested previously and the "Inverter output active" LED goes out.

• Switching the inverter off

Switch off using SB1.

4.3.2 - Control via the terminal block

• Wiring the motor-inverter

See diagrams in section 3.8.3 or 3.8.4.

• Connecting a PTC or PTO probe

Position jumper PL6 (on the IN 50 board) between 2 and 3 for models FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T or set jumper LK11 to position 1 (on the left) on the IN 40 board.

• External trip

Do not forget to link terminals 11 and 12, or the inverter will display "Et" when switched on.

• Switching the inverter on

Close the isolator and switch on using SB2. The display shows "rdY" and the "FWD" LED lights up.

• Programming

Without a run command, program the parameters one after another.

Parameter	Remarks
b9 = 1	Control via the terminal block
b14	Selection of switching frequency and the upper limit frequency (ULF) depending on the desired motor frequency
Prc	Selection of the maximum voltage frequency depending on b14
Pr1	Selection of the maximum motor frequency
Pr5	Adjustment of maximum continuous motor current (as % of I_N)
Pr4	Adjustment of maximum motor overload current (as % of I_N)
Pr6	Adjustment of the torque required for starting
Pr2	Adjustment of acceleration ramp
Pr3	Adjustment of deceleration ramp
b2 and b7	Selection of mode of stopping
b1 = 1	Controlled start

• Run command

Enable the run command (terminal 15 or 17), the "Inverter output active " LED lights up.

• Adjustment of the output frequency

Provide a frequency setpoint to terminal 5, the display indicates the inverter output frequency.

• Slip compensation

Load the motor and program Pr7 so that it rotates at the same speed with no load or with load.

• Stopping the motor

Disable the run command (terminal 15 or 17).

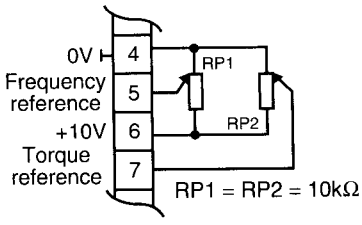
The value shown on the display decreases to 0, then it indicates "rdY" and the "Inverter output active" LED goes out.

• Switching the inverter off

Switch off using SB1.

For all control modes (terminal block, keypad) when the inverter operates with manual BOOST (b3 = 1), if the run command is left enabled (inverter output active) with zero frequency reference, DC current is injected at standstill.
This condition must not be maintained for longer than 60 seconds to avoid overheating of the motor.

4.3.3 - Using terminal 7 : torque limitation or control



• b0 = 1 : torque limitation (motor current).
The inverter frequency is controlled (terminal 5) and the torque is dependent on the reference signal at terminal 7 (10V : torque limited to Pr4, 0V : zero torque).
• b0 = 0 : torque control (motor current).
The inverter is torque controlled following the reference signal at terminal 7 (10V : torque equal to Pr4, 0V : zero torque).
The frequency reference potentiometer is no longer used and the output frequency is limited to Pr1, motor unloaded.

4.4 - Using terminal 14 : ramp hold

4.4.1 - Description of function

When terminal 14 is enabled, the motor speed is fixed. The frequency reference modifications are not taken into account. When terminal 14 is disabled, the motor follows the new frequency reference.

4.4.2 - Application : implementing a faster/slower speed control

Connection diagrams section 3.8.7 and 3.8.8. (independent of ratings). When operating in faster/slower speed control using KA2, KA3, the direction of rotation of the motor is only reversed by decreasing the output frequency through zero.

4.5 - Using encoder feedback

4.5.1 - Precautions

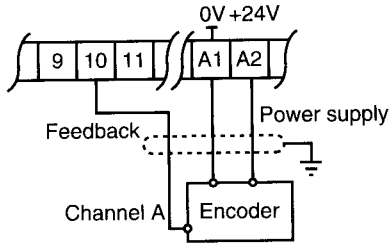
• Encoder specifications
- 1 channel not complemented,
- 15 pulses per pole and per motor revolution (60 pulses for a 1500 min^{-1} motor),
- 24 VDC power supply, maximum consumption of 100 mA,
- internal resistance ≤ 20 Ω.

• Wiring :
Use shielded cables.

FMV 2306	Encoder
Terminal A1	- power supply (0V)
Terminal A2	+ power supply (24V)
Terminal 10	Channel A

4.5.3 - Commissioning

• Wiring the motor-inverter
See diagrams in section 3.8.3 or 3.8.4 and wire the encoder as follows :



• Connecting a PTC or PTO probe
Position jumper PL6 (on the IN 50 board) between 2 and 3 for models FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T or set jumper LK11 to position 1 (on the left) on the IN 40 board.

• External trip
Do not forget to link terminals 11 and 12, or the inverter will display " Et " when switched on.

• Switching the inverter on
Close the isolator and switch on using SB2. The display shows "rdY" and the "FWD" LED lights up.

• Programming
Without a run command, program the parameters one after another.

Parameter	Remarks
b9 = 1	Control via the terminal block
b5 = 0	Enable encoder feedback
b14	Selection of switching frequency and the upper limit frequency (ULF) depending on the desired motor frequency
Prc	Selection of the maximum voltage frequency depending on b14
Pr1	Selection of the maximum motor frequency
Pr5	Adjustment of maximum continuous motor current (as % of I_N)
Pr4	Adjustment of maximum motor overload current (as % of I_N).
Pr6	Adjustment of the torque required for starting
Pr2	Adjustment of acceleration ramp
Pr3	Adjustment of deceleration ramp
b2 and b7	Selection of mode of stopping
b1 = 1	Controlled start

• Run command
Enable the run command (terminal 15 or 17), the "Inverter output active " LED lights up.

• Adjustment of the motor speed
Provide a **speed** setpoint to terminal 5, the display indicates the inverter **output frequency**.
Load the motor and check that the speed remains the same as for no-load, the slip compensation should not be adjusted.

• Stopping the motor
Disable the run command (terminal 15 or 17).
The value shown on the display decreases to 0, then it indicates "rdY" and the "Inverter output active" LED goes out.

• Switching the inverter off
Switch off using SB1.

4.6 - Regulation with integrated PI control loop

4.6.1 - Use

This loop is used to regulate pressure, temperature, speed, etc via a sensor providing feedback of the regulated characteristic.

4.6.2 - Precautions

• Feedback specifications

- output 4 - 20 mA, 20 - 4 mA or 0 to 20 mA,
- power supply (if provided by the FMV 2306) : 24 VDC, 100 mA max.

• Wiring :

Use shielded cables.

4.6.3 - Connection

FMV 2306 / FMV 2306 AS	Sensor
Terminal A1	- power supply (0V)
Terminal A2	+ power supply (24V)
Terminal 8	Feedback

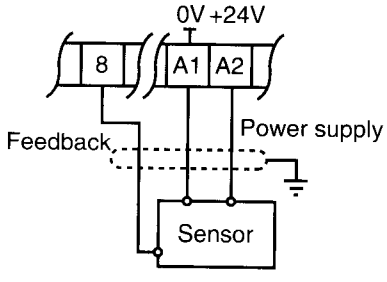
If the sensor has an external power supply or its own power supply, only terminals A1 and 8 should be connected.

4.6.4 - Commissioning

• Wiring the motor-inverter

From the diagrams in section 3.8.3 or 3.8.4.

- 1 running direction
- PI sensor as follows :



• The motor-inverter should be commissioned following the standard procedure in section 4.3.2.

• Check that the direction of rotation of the motor is correct.

• Disable the run command (terminal 15 or 17).

• Program one after the other.

Parameter	Remarks
b28 = 1	Enable the PI function
Pr20 = 0	Adjustment of proportional gain
Pr21 = 0	Adjustment of integral gain
b11	Selection of feedback type depending on the sensor (in mA) --> 4 - 20, 20 - 4 ou 0 - 20.
Pr2 = 1.5	Adjustment of acceleration ramp
Pr3 = 1.5	Adjustment of deceleration ramp

• Enable the run command (terminal 15 or 17).

• Adjustment procedure for Pr20 and Pr21

- Set the reference of the characteristic to be adjusted (flow rate, pressure, temperature, etc) to 10 % (at terminal 5).
- Slowly increase the value of Pr20 so that the motor starts to rotate. The speed should stabilise between 5 and 20 % of its maximum value.
- Increase the value of Pr20 again until the motor becomes unstable, then decrease it by 20 %.
- Increase the value of Pr21 again until the motor becomes unstable, then decrease it by 20 %.
- Increase the reference and check that the sensor feedback signal changes linearly (use a milliammeter connected in series with terminal 8).
- If the system is unstable, decrease the proportional gain Pr20.

• Stopping the motor

Disable the run command.

The value shown on the display decreases to 0, then it indicates "rdY" and the "Inverter output active" LED goes out.

• Switching the inverter off

Switch off using SB1.

Note : If they are enabled, the preset speeds have priority over the other references and Pr20 and Pr21 become preset speed references 1 and 2.

4.7 - List of parameters

The list of parameters for **FMV 2306 and FMV 2306 AS** inverters is provided below.
The tables are followed by an explanation of the function of each parameter.
Numerical parameters are preceded by "**Pr**".
Logic parameters are preceded by "**b**".
Parameters followed by (1.5T to 11T) are specific to FMV 2306 and FMV 2306 AS with ratings 1.5T to 11T.
Parameters followed by (≥ 16T) are specific to FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T.

4.7.1 - Table of parameters

Main parameters (Prd = 0)

Parameter	Description	Adjustment range	Unit	Factory setting
Pr0	Minimum output frequency	0 to Pr1	Hz	0
Pr1	Maximum output frequency	Pr0 to ULF ① (ULF = Upper Limit freqency).	Hz	50
Pr2	Acceleration ramp	0.2 to 600	s	- FMV 2306 1.5T to 100T : 5.0 - FMV 2306 AS 1.5T to 11T : 5.0 - FMV 2306 AS 16T to 120T : 100
Pr3	Deceleration ramp	0.2 to 600	s	- FMV 2306 1.5T to 100T : 10,0 - FMV 2306 AS 1.5T to 11T : 10.0 - FMV 2306 AS 16T to 120T : 100
Pr4	Maximum overload current : - FMV 2306 - FMV 2306 AS	 Pr5 to 150 Pr5 to 120	% I_N (inverter rating)	 150 120
Pr5	Maximum continuous current	10 to 105 (≤ Pr4)	% I_N	100
Pr6	Torque at low speed (BOOST)	0 to 25.5	% U_N (supply voltage)	2
Pr7	Slip compensation : - FMV 2306 1.5T to 11T FMV 2306 AS 1.5T to 11T - FMV 2306 16T to 40T FMV 2306 AS 16T to 50T - FMV 2306 50T to 100T FMV 2306 AS 60T to 120T	 0 to 5 (ULF = 120) 0 to 10 (ULF = 240) 0 to 20 (ULF = 480) 0 to 25 (ULF = 960) 0 to 5 (ULF = 120) 0 to 10 (ULF = 240) 0 to 20 (ULF = 480) 0 to 5 (ULF = 120) 0 to 10 (ULF = 240)	Hz	0
Pr8	Level of braking by D.C. injection : - FMV 2306 - FMV 2306 AS	 40 to 150 40 to 120	 % I_N % I_N	 150 120
Pr9	Inverter address - serial link	0 to 99	-	11
PrA	Log of last 10 faults	0 to 9	-	-
Prb	Security code - via keypad - via serial link	 100 to 255 0 to 255	 - -	 0 0
b0	Selection : " torque " or frequency reference	b0 = 0 : torque b0 = 1 : frequency	-	1
b1	Selection : automatic or controlled starting	b1 = 0 : automatic b1 = 1 : controlled	-	1
b2 - b7	Selection : mode of stopping b2 b7 0 0 Stopping following ramp or prolongation of the ramp 0 1 Freewheel stop 1 0 D.C. injection 1 1 Stopping following ramp	b2 = 0 or 1 b7 = 0 or 1	- -	0 0

① ULF = Upper Limit Frequency. This is the highest frequency that the inverter is able to provide.
Its value can be adjusted, but is limited by the selected switching frequency (see b14).

4.7.1 - Continued

Parameter	Description	Adjustment range	Unit	Factory setting
b3	Selection : automatic or manual BOOST	b3 = 0 : automatic b3 = 1 : manual	-	1
b4	Selection : reference polarity terminal 5	b4 = 0 : ± 10V b4 = 1 : 0 to +10V	-	1
b5	Selection : speed feedback	b5 = 0 : with encoder b5 = 1 : without feedback	-	1
b6	Selection : master or slave mode	b6 = 0 : master, controlled via the terminal block b6 = 1 : slave, controlled via the serial link (with terminal 16 to 0V)	-	0
b7	See parameter b2.	b7 = 0 or 1	-	0
b8	Selection : display of output current or frequency	b8 = 0 : frequency (Hz) b8 = 1 : current (% In) *	-	0
b9	Selection : control via the keypad or terminal block	b9 = 0 : keypad b9 = 1 : terminal block	-	1
b10	Selection : parity (serial link)	b10 = 0 : even b10 = 1 : odd	-	0
b11 **	Selection : remote frequency reference			
	- FMV 2306 1.5T to 11T FMV 2306 AS 1.5T to 11T	b11 = 4.20 : 4 to 20 b11 = 20.4 : 20 to 4 b11 = 0.20 : 0 to 20	mA mA mA	4.20
	- FMV 2306 16T to 100T FMV 2306 AS 16T to 120T	b11 = 4.20 : 4 to 20 b11 = 20.4 : 20 to 4 b11 = 0.20 : 0 to 20 b11 = Ur : 0 to 10	mA mA mA V	4.20
b12	Selection : speed of data exchange via the serial link	b12 = 4.8 : 4800 b12 = 9.6 : 9600	baud baud	4.8
b13	Selection of the original parameters (factory settings).	b13 = 0 : not active b13 = 1 : factory setting	-	0
b14	Selection : Switching frequency and ULF (Upper Limit Frequency).	Fswitching/ULF		
	- FMV 2306 1.5T to 11T FMV 2306 AS 1.5T to 11T	b14 = 2.9/120 or 240 b14 = 5.9/120 or 240 or 480 b14 = 8.8/120 or 240 or 480 b14 = 11.7/120 or 240 or 480 or 960	kHz/Hz kHz/Hz kHz/Hz kHz/Hz	2.9/120
	- FMV 2306 16T to 40T FMV 2306 AS 16T to 50T	b14 = 2.9/120 or 240 b14 = 5.9/120 or 240 or 480	kHz/Hz kHz/Hz	2.9/120
	- FMV 2306 50T to 100T FMV 2306 AS 60T to 120T	b14 = 2.9/120 or 240	kHz/Hz	2.9/120
Prc	Maximum voltage frequency : MVF	ULF/16 to ULF	Hz	50
Prd	Access to specific parameters	0 to 50	-	0

* Only if b9 = 1 (controlled by the terminal block).
** The remote frequency references are enabled via terminal 16.

Note :
For all control modes (terminal block, keypad) when the inverter operates with manual BOOST (b3 = 1), if the run command is left enabled (inverter output active) with zero frequency reference, DC current is injected at standstill.
This condition must not be maintained for longer than 60 seconds to avoid overheating of the motor.

Specific parameters

Prd = 10 : skip frequencies.

Parameter	Description	Adjustment range	Unit	Factory setting
Pr10	Skip frequency threshold 1	Pr0 to Pr1	Hz	0
Pr11	Skip frequency threshold 2			
Pr12	Skip frequency threshold 3			
Pr13	Skip width each side of threshold 1	± 0.5 to ± 5.0	Hz	± 0.5
Pr14	Skip width each side of threshold 2			
Pr15	Skip width each side of threshold 3			

Prd = 20 : preset speeds/JOG.

Parameter	Description	Adjustment range	Unit	Factory setting
Pr20	Preset speed - 1 *	Pr0 to ± Pr1	Hz	0
Pr21	Preset speed - 2 *			
Pr22	Preset speed - 3			
Pr23	Preset speed - 4			
Pr24	Preset speed - 5			
Pr25	Preset speed - 6			
Pr26	Preset speed - 7			
Pr27	Jog frequency	0 to 15	Hz	1.5
b20	Selection : Jog + 3 preset speeds or 7 preset speeds.	b20 = 0 : 3 speeds + JOG b20 = 1 : 7 speeds	-	0
b21 b23	Selection : Standard or specific acceleration/deceleration ramps.	b21 / b23 / Ramps 0 / 0 / standard 1 / 0 / specific 1 / 1 / specific 0 / 1 / specific	-	0 0
b22	Not used	0 or 1	-	0
b24	Function of terminal 19	b24 = 0 : current signal b24 = 1 : logic output	-	0
b26	Disable " AC uu " detection	b26 = 0 : enabled b26 = 1 : disabled	-	0
b27	Specific braking	0 or 1 combined with b2 and b7	-	0
b28	Enable PI control loop	b28 = 0 : disabled b28 = 1 : enabled	-	0

*** When the PI control is enabled (b28 = 1), Pr20 becomes the proportional gain and Pr21 the integral gain.**

Prd = 30 : acceleration ramps (preset speeds).

Parameter	Description	Adjustment range	Unit	Factory setting
Pr30	Acceleration preset speed - 1	0.2 to 600	s	FMV 2306 : 5,0 FMV 2306 AS 1.5T to 11T : 5.0 FMV 2306 AS 16T to 120T : 100
Pr31	Acceleration preset speed - 2			
Pr32	Acceleration preset speed - 3			
Pr33	Acceleration preset speed - 4			
Pr34	Acceleration preset speed - 5			
Pr35	Acceleration preset speed - 6			
Pr36	Acceleration preset speed - 7			
Pr37	Acceleration - jogging	0.2 to 600	s	0.2

Prd = 40 : deceleration ramps (preset speeds).

Parameter	Description	Adjustment range	Unit	Factory setting
Pr40	Deceleration preset speed - 1	0.2 to 600	s	FMV 2306 : 10.0 FMV 2306 AS 1.5T to 11T : 10 FMV 2306 AS 16T to 120T : 100
Pr41	Deceleration preset speed - 2			
Pr42	Deceleration preset speed - 3			
Pr43	Deceleration preset speed - 4			
Pr44	Deceleration preset speed - 5			
Pr45	Deceleration preset speed - 6			
Pr46	Deceleration preset speed - 7			
Pr47	Deceleration - jog	0.2 to 600	s	0.2

Prd = 50 : assignment of logic outputs / other functions.

Parameter	Description	Adjustment range	Unit	Factory setting
Pr50	Number of automatic resets	0 to 5	-	0
Pr51	Delay of automatic resets	1 to 5	s	1
b50 (1.5T to 11T)	Selection of the relay function, terminals 1 - 2 - 3 : inverter status or minimum frequency	b50 = 0 : inverter status b50 = 1 : minimum frequency	-	FMV 2306 and FMV 2306 AS 1.5T to 11T : 0
b50 (≥ 16T)	Selection of the relay function, terminals R1 - R2 - R3 : inverter running or frequency reached	b50 = 0 : running b50 = 1 : frequency reached	-	FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T : 0
b51	Enable "FWD/REV" key	b51 = 0 : disabled b51 = 1 : enabled	-	0
b52	Enable flying restart	b52 = 0 : disabled b52 = 1 : enabled	-	0
b53	Selection of logic output A0 : inverter running or minimum frequency	b53 = 0 : running b53 = 1 : minimum frequency	-	FMV 2306 and FMV 2306 AS 1.5T to 11T : 0
	Selection of logic output A3 : alarm overload or inverter status	b53 = 0 : alarm b53 = 1 : no trip	-	FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T : 0
b54	Selection : fixed or dynamic U/f characteristic	b54 = 0 : fixed b54 = 1 : dynamic	-	0
b55	Ramps on loss of mains supply	b55 = 0 : Pr3, Pr2, b55 = 1 : Pr46, Pr36.	-	0
b56	Management of minor trips	b56 = 0 : freewheel stop b56 = 1 : stop following ramp	-	0

4.7.2 - Explanation of parameters

Pr0 : Minimum output frequency.
Adjustment range : 0 to (Pr1) Hz.
Factory setting : 0 Hz.
In increments of 0.1 Hz to 0.8 Hz depending on b14.
In increments of 1 Hz for Pr0 ≥ 100 Hz.
This is the lowest operating frequency.
When the reference is at minimum, the output frequency is Pr0.

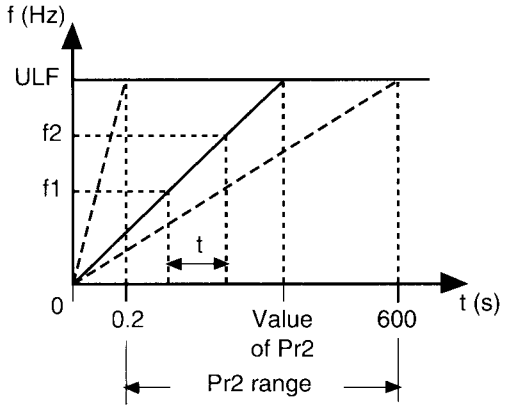
Pr1 : Maximum output frequency.
Adjustment range : (Pr0) to (ULF) Hz.
Factory setting : 50 Hz.
In increments of 0.1 Hz to 0.8 Hz depending on b14.
In increments of 1 Hz for Pr1 > 100 Hz.
This is the highest operating frequency.
When the reference is at maximum, the output frequency is Pr1.

Note : The frequency reference can be set :
- by the console mounted on the inverter or installed remotely (100m max),
- by the control terminal block (analogue signal, voltage 0 to 10V or current 4 to 20 mA, 20 to 4mA, 0 to 20 mA),
- by the RS 422 or RS 485 serial link.

Important :
The maximum frequency (Pr1) can be set as high as 960 Hz (for some inverters) corresponding to more than 19 times the speed of a standard motor.
Check that the motor being used is capable of tolerating this value mechanically; if not, use a motor with special characteristics (please consult LEROY-SOMER).

Pr2 : Acceleration ramp
Adjustment range : 0.2 to 600s.
Factory setting : 5.0 s - FMV 2306 1.5T to 100T
5.0 s - FMV 2306 AS 1.5T to 11T,
100s - FMV 2306 AS 16T to 120T.
In increments of 0.1s.
Adjustment of the time for acceleration from 0 Hz to the Upper Limit Frequency (ULF) defined by b14.
Calculation of acceleration time from frequency f1 to f2 :

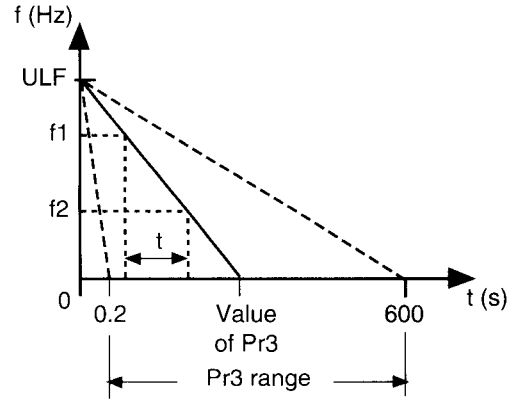
$$t = (f2 - f1) \times \frac{Pr2}{ULF}$$



Note : The ramp time is only maintained when the inverter is not in current limitation.

Pr3 : Deceleration ramp
Adjustment range : 0.2 to 600s.
Factory setting : 10s -FMV 2306 1.5T to 100T
10s - FMV 2306 AS 1.5T to 11T,
100s - FMV 2306 AS 16T to 120T.
In increments of 0.1s.
Adjustment of the deceleration time from the Upper Limit Frequency (ULF) defined by b14 to 0 Hz.
Calculation of the deceleration time from frequency f1 to frequency f2 :

$$t = (f1 - f2) \times \frac{Pr3}{ULF}$$



Note : The ramp time is only maintained when the energy regenerated by the motor can be absorbed by the D.C. bus, otherwise the T - FMV and R - FMV options should be connected.

Pr4 : Maximum overload current
Adjustment range : Pr5 to 150 % I_N - FMV 2306
Pr5 to 120 % I_N - FMV 2306AS.
Factory setting : 150 % I_N - FMV 2306.
120 % I_N - FMV 2306 AS.
In increments of 0.1 % for Pr4 < 100 and 1 % for Pr4 ≥ 100.
This is the maximum permissible output current for a period defined by Pr4 and Pr5 (I x t overload).

Note : The internal current limitation is scaled in relation to the input voltage on terminal 7 :
- 10V : limitation to Pr4 value,
- 0V : zero value.

Pr5 : Maximum continuous current
Adjustment range : 10 to 105 % I_N (≤Pr4).
Factory setting : 100 % I_N.
In increments of 0.1 % for Pr5 < 100 and 1 % for Pr5 ≥ 100.
This is the allowed continuous current for adapting the inverter to the motor :

$$Pr5 = \frac{\text{nominal motor current}}{\text{nominal inverter current}} \times 100$$

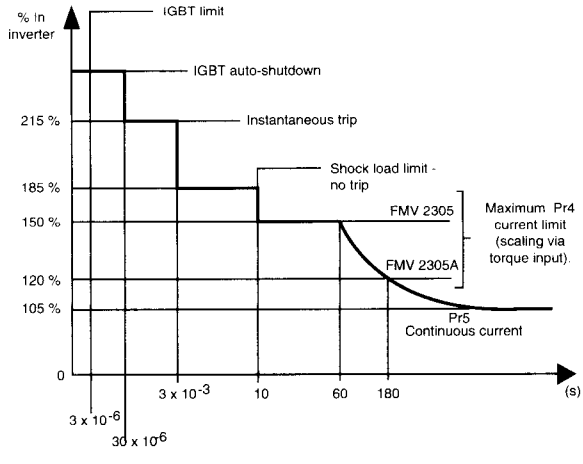
Pr5 adjusts the threshold over which the overload protection I x t starts to integrate the current excess. The decimal points on the display flash when this protection is activated. Should this condition persist, the inverter will trip after a period of time (t) defined as follows :

$$t = \frac{k \times Pr5}{(\%\ \text{output current} - Pr5)^2}$$

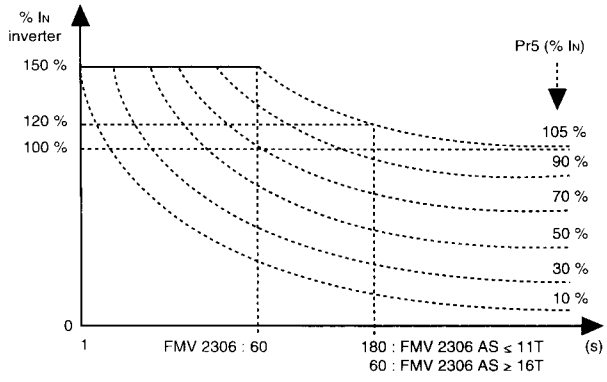
k = 25.7 - FMV 2306 1.5T to 100T,
FMV 2306 AS 1.5T to 11T.
k = 8.57 - FMV 2306 AS 16T to 120T.

See the next two diagrams for the various levels of protection and for current limitation.

Overcurrent levels



I x t characteristics depending on the value of Pr5

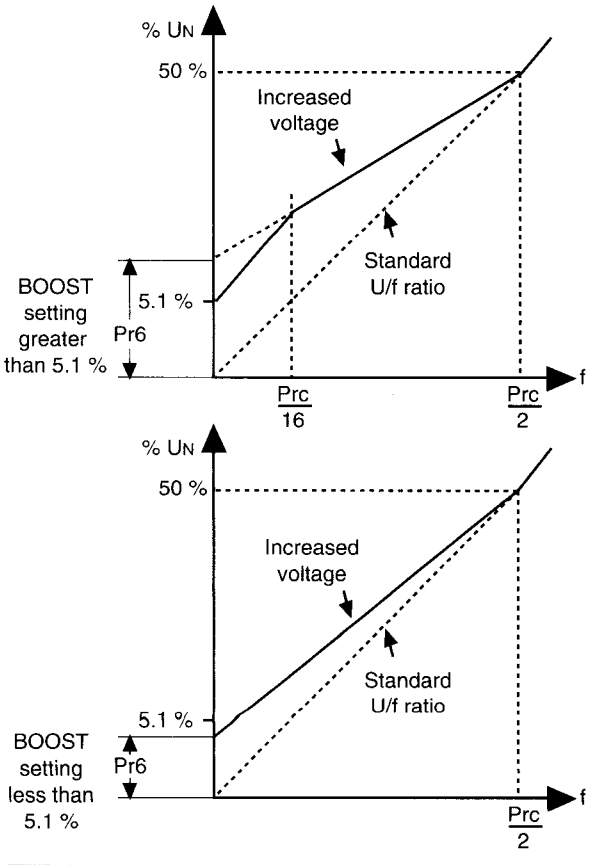


Pr6 : Torque at low speed (BOOST)

Adjustment range : 0 to 25.5 % U_N (supply voltage).
Factory setting : 2 % U_N.
In increments of 0.4 %.
Pr6 increases the U/f ratio between 0 Hz and Prc/2 (base frequency/2), increasing the voltage and hence the torque at low speed.
An "automatic BOOST" for variable loads can be selected (see b3) so that :

$$\text{applied BOOST} = Pr6 \times \frac{\text{load (\% } I_N)}{Pr5}$$

Note : It is important to increase the BOOST value gradually, to start the motor smoothly and without any delay. Too high a value can stall the motor.
See the diagrams below for the distribution of the additional voltage.
This parameter is not active if b3 = 0 (automatic BOOST).



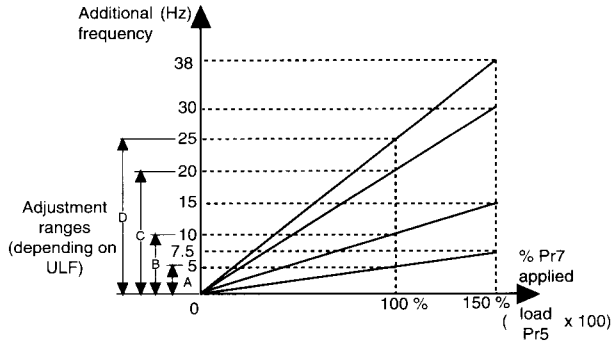
Pr7 : Slip compensation

Adjustment range : 0 to 5 Hz (ULF = 120 Hz) A
0 to 10 Hz (ULF = 240 Hz) B
0 to 20 Hz (ULF = 480 Hz) * C
0 to 25 Hz (ULF = 960 Hz) * D
* ULF = 480 or 960 Hz is not available on all inverters (see b 14).
Factory setting : 0 Hz.
In increments of 0.1 Hz to 0.8 Hz depending on b14.
Pr7 increases the inverter output frequency above the reference point, as a function of the load. Pr7 can be used to minimise the difference in motor speed between a motor at no load and a motor with load.

$$\text{Compensation (Hz)} = Pr7 \times \frac{\text{output current}}{Pr5} \text{ \%}.$$

At full load, the additional frequency is the value which is set in Pr7.

Note : Pr7 is not active if the inverter is in encoder feedback mode (b5 = 0).



Pr8 : Level of braking by D.C. injection

Adjustment range : 40 to 150 % I_N - FMV 2306.
40 to 120 % I_N - FMV 2306 AS.
Factory setting : 150 % I_N - FMV 2306.
120 % I_N - FMV 2306 AS.
This is the adjustment of the maximum level of braking current by D.C. injection.
The braking torque is a function of the value of Pr8. The injection time is calculated automatically by the inverter and a holding torque is applied to the motor for one second when the motor reaches a speed close to zero. The level of the holding torque is a proportion of Pr8.

Note :
- This type of braking is only activated after a stop command and if : b2 = 1 and b7 = 0. (See b2, b7).
- If it is being used for constant torque applications, check that Pr8 ≥ 1.15 Pr5.

Pr9 : Inverter address - serial link

Adjustment range : 0 to 99.
Factory setting : 11.
In increments of 1.
This address, unique to the inverter, is used for communication between several inverters and a PC (or PLC) connected on the same line.

PrA : Fault log

The last 10 faults are recorded in the order in which they appeared. Access to the log is gained as follows :

Step	Action on the keypad	Display	Remarks
POWER ON		rdY	
SELECTION OF PrA	Press MODE once. and press △ or ▽ to select PrA.	Pr 0 ⇕ 0. ⇕ PrA ⇕ 0xxx	The "PAR" LED lights up.
SELECTION OF THE LAST TRIP	Press MODE once.	0xxx	The "PAR" LED goes out. " 0 " is the number of the last trip. " x x x " is the associated trip code. (See section 5.2 for an explanation of codes).
SELECTION OF THE LAST TRIP BUT ONE	Press ▽ once.	- 1YYY	"- 1 " is the number of the last trip but one. "Y Y Y" is the associated trip code.
SCROLLING OF TRIPS IN ORDER OF OCCURRENCE	Press ▽.	- 2ZZZ - 9WWW	" - 9 " is the 10th and oldest trip in the memory.

Note :

- The 10 last faults remain in the memory even if the inverter is switched off.
- The trip "UU" or "Ph" when the unit is switched off (D.C. bus voltage outside the range) is not recorded if the inverter is already tripped before power down.

Prb : Security code

Adjustment range : 0, 100 to 255 (controlled via the keypad),
0 to 255 (controlled via the serial link).
Factory setting : 0.
In increments of 1.
It is possible to prevent modification of all parameters by programming a value other than 0.
Access to parameters is then only possible if the personalised code is entered into Prb. See section 4.1.2.

b0 : Selection - "torque" or frequency reference

Adjustment range : 0 or 1.
Factory setting : 1.
b0 = 0 : the motor is current controlled (the speed reference is not active). The "torque" reference is provided via terminal 7 (or via the serial link if terminal 16 is connected to 0V and b6 = 1).
0V = zero torque.
+ 10V = torque equal to Pr4.
The output frequency is limited to the value of Pr1.
b0 = 1 : the motor is frequency controlled. The frequency reference is set either via :
- the △ and ▽ keys on the console if b9 = 0,
- the terminal block if b9 = 1,
- the serial link (if terminal 16 is connected to 0V and b6 = 1).

The torque is limited via its reference point terminal 7.

Note : If terminal 7 is not connected, the "torque" reference (b0 = 0), or the torque limitation (b0 = 1) equals Pr4.

b1 : Selection - automatic or controlled starting

Adjustment range : 0 or 1.
Factory setting : 1.
See Pr50 and Pr51 for automatic reset.
b1 = 0 : automatic starting.
120 ms after power up, the motor starts, provided a direction of operation is selected and no trip is registered. After a mains power cut the motor restarts - whatever its status - 120 ms after the power returns.
b1 = 1 : controlled starting.
A run command is required in all situations. If the inverter is tripped, press RESET followed by a run command.

b2 - b7 : Selection - mode of stopping
Adjustment range : 0 or 1.
Factory setting : 0.
Four modes of stopping can be selected by using a binary combination of b2 and b7 as shown below :

b2	b7	Mode	Display (during the stopping phase)
0	0	Stopping following ramp or prolongation of the ramp	Frequency or current (depending on b8)
0	1	Freewheel stop	"**Inh**"
1	0	D.C. injection.	"**dc**".
1	1	Stopping following ramp	Frequency or current (depending on b8).

Notes : Depending on the selected stopping mode, "Freewheel stopping" and "D.C. injection" modes are only active after a stop command. Both ramp modes are also active when the reference is changed.
- When the braking options are used (R - FMV and T–FMV), the inverter can still be programmed with b2 = b7 = 0 or b2 = b7 = 1.

Stopping following ramp or ramp prolongation : deceleration according to the ramp (linear) set via Pr3 (or Pr30 to 36 if the specific ramps are used : b21 = 1).
If the load has a significant inertia, resulting in the energy regenerated by the motor to the inverter increasing the D.C. bus voltage to its maximum limit, the ramp time is prolonged so that the inverter does not trip on overvoltage fault "OU".

Freewheel stopping : the inverter output is deactivated after a stop command. The motor stops in freewheel mode. 1 second after the stop command, "**rdY**" appears on the display and restarting is possible.

D.C. injection : the motor is quickly brought to a low speed by D.C. injection, then a holding current is applied for one second (restarting is only possible after this time). See also Pr8.

Stopping following ramp
Linear deceleration according to the ramp. If the motor inertia and its load is too high, the inverter trips and indicates "OU" as the D.C. bus voltage has reached its maximum limit.
To avoid the "OU" trip, use the **T - FMV and R - FMV options** which limit the D.C. bus voltage.

b3 : Selection - automatic or manual BOOST
Adjustment range : 0 or 1.
Factory setting : 1.
b3 = 0 : automatic BOOST, for variable loads with low starting torque, the inverter automatically applies a fraction of Pr6 depending on the current demand from the motor (see Pr6).
b3 = 1 : manual BOOST, (set by PR6) for fixed loads with higher starting torque.

b4 : Selection - reference polarity
Adjustment range : 0 or 1.
Factory setting : 1.
b4 = 0 : bidirectional reference -10V to +10V.
• With terminal 15 (Forward operation) connected to 0V.
-10V = maximum reference (reverse),
+10V = maximum reference (forward).
• With terminal 17 connected to 0V (Reverse operation).
-10V = maximum reference (forward),
+10V = maximum reference (reverse).
b4 = 1 : unidirectional reference 0 to +10V.
The direction of rotation is controlled via terminals 15 (Forward operation) and 17 (Reverse operation).
Note : A reference < 0V is regarded as 0V.

b5 : Selection - speed feedback
Adjustment range : 0 or 1.
Factory setting : 1.
b5 = 0 : operation in closed loop with encoder feedback. Slip compensation (Pr7) is no longer active. If the encoder feedback is lost, then the inverter operates in open loop with a fixed slip compensation defined as follows :

ULF (Hz)	120	240	480 *	960 *
Additional frequency (Hz)	7.6	15.2	33	60.6

* Not available on all inverters (See b14).
b5 = 1 : operation in open loop. Slip compensation Pr7 is active.

b6 : Selection - master mode or slave mode (with terminal 16 connected to 0V)
Adjustment range : 0 or 1.
Factory setting : 0.
b6 = 0 : master mode, both speed and torque are controlled via the terminal block.
b6 = 1 and terminal 16 connected to 0V : slave mode, speed and torque are controlled via the serial link.

Note : Parameter modification via the serial link is only possible if b9 = 1.

b7 : see b2

b8 : Selection - display of output frequency or current
Adjustment range : 0 or 1.
Factory setting : 0.
Only when controlled via terminal block (b9 = 1).
b8 = 0 : displays the frequency supplied to the motor when controlled via the terminal block (b9 = 1).
b8 = 1 : displays the current supplied to the motor when controlled via the terminal block (b9 = 1). ±10% precision above 15 Hz.

Notes :
- Whichever way b8 is programmed, the alternative information can be obtained by pressing the △ and ▽ keys at the same time.
- When controlled by the console only the frequency reference can be displayed.

b9 : Selection - control via the keypad or terminal block
Adjustment range : 0 or 1.
Factory setting : 1.
b9 = 0 : the inverter is controlled via the keypad :
- △ and ▽ gives the frequency reference,
- Pr4 adjustment gives the torque,
- RUN gives the run command,
- STOP RESET gives the command to stop and reset,
- FWD REV gives the forward/reverse command, if b51 = 1.

b9 = 1 : the inverter is controlled via the terminal block or via the serial link (see b6).

b10 : Selection - checking parity of the serial link
Adjustment range : 0 or 1.
Factory setting : 0.
b10 = 0 : even parity.
b10 = 1 : odd parity.
b10 must be correctly adjusted for the serial link of the controlling device (PC, PLC, etc).

b11 : Selection - remote frequency reference
Adjustment range : - FMV 2306 1.5T to 11T,
FMV 2306 AS 1.5T to 11T,
4.20 or 20.4 or 0.20
- FMV 2306 16T to 100T,
FMV 2306 AS 16T to 120T,
4.20 or 20.4 or Ur or 0.20.
Factory setting : 4.20.
When remotely controlled the current frequency reference is applied to terminal 8, for models FMV 2303 16T to 100T and FMV 2306 AS 16T to 120T, the voltage frequency reference (if Ur is selected) is applied to terminal A7.

b11	Reference range	Frequency range
4.20	4 to 20 mA	Pr0 to Pr1
20.4	20 to 4 mA	Pr0 to Pr1
Ur*	0 to +10V when b4 = 1	Pr0 to Pr1
0.20	0 to 20 mA	Pr0 to Pr1

* Only for **FMV 2306** 16T to 100T and **FMV 2306 AS** 16T to 120T.

Note : Remote references are only active if b6 = 0 and b9 = 1 and they are enabled by terminal 16.

b12 : Selection - data transmission speed over the serial link
Adjustment range : 4.8 or 9.6.
Factory setting : 4.8.
b12 = 4.8 : 4800 baud.
b12 = 9.6 : 9600 baud.
b12 must be correctly adjusted to the data transmission speed via the serial link of the controlling device (PC, PLC, etc).

b13 : Selection - original parameters (factory settings)
Adjustment range : 0 or 1.
Factory setting : 0.
b13 = 0 : parameters set by customer.
b13 = 1 : all parameters are reset to their original value (factory setting). See section 4.1.2 for procedure.

b14 : Selection - switching frequency and Upper Limit Frequency ULF
1. Switching frequency in kHz.
2. Maximum output frequency limit (ULF) in Hz.

- FMV 2306 - 1.5T to 11T,
FMV 2306 AS- 1.5T to 11T.

	Fswitching	ULF
Adjustment range	2.9	120 - 240
	5.9	120 - 240 - 480
	8.8	120 - 240 - 480
	11.7	120 - 240 - 480 - 960
Factory setting	2.9	120

- FMV 2306 - 16T to 40T,
FMV 2306 AS - 16T to 50T.

	Fswitching	ULF
Adjustment range	2.9	120 - 240
	5.9	120 - 240 - 480
Factory setting	2.9	120

- FMV 2306 - 50T to 100T,
FMV 2306 AS - 60T to 120T.

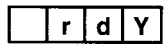
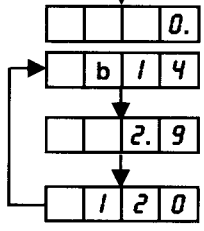
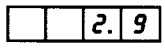
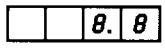
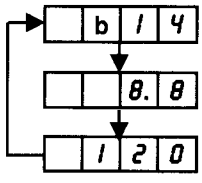
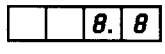
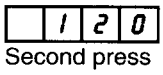
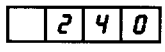
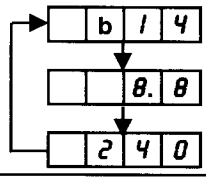
	Fswitching	ULF
Adjustment range	2.9	120 - 240
Factory setting	2.9	120

Switching frequency.
For applications which require high torque at low speed (high inertia, intermittent duty), selection of a low switching frequency is preferable.
If operation with reduced acoustic noise is desired, a high frequency should be chosen.
The selected switching frequency also limits the choice of maximum possible frequency (ULF) and, in consequence, the operating range.

Upper limit frequency : ULF.
This is the highest possible frequency at the inverter output. Any adjustment of ULF must take into account the desired maximum operating frequency (Pr1).

Note :
- Changing the value of ULF may change other parameters automatically (Pr0, Pr1, Pr7, Prc, Pr 10 to 12, Pr20 to 26).
- The frequency resolution depends on the selected value of ULF :
- ULF = 120 Hz - 0.1 Hz ,
- ULF = 240 Hz - 0.2 Hz ,
- ULF = 480 Hz - 0.4 Hz,
- ULF = 960 Hz - 0.8 Hz .

Procedure for adjusting b14 :

Step	Action on the keypad	Display	Remarks
POWER ON			
SELECTION OF b14	Press MODE once		The"PAR" LED lights up.
	and press △ or ▽ several times to select b14		b14 is displayed alternately with the value of : - the switching frequency : part 1, and - ULF : part 2.
* MODIFICATION OF PART 1	Press MODE once		The"PAR" LED goes out.
	Press △ and ▽ to change the value		The switching frequency is modified from 2.9 kHz to 8.8 kHz.
	Press MODE twice		The"PAR" LED lights up.
* MODIFICATION OF PART 2	Press MODE twice	 First press  Second press	The"PAR" LED goes out.
	Press △ and ▽ to change the value		ULF is modified from 120 Hz to 240 Hz.
	Press MODE once		The"PAR" LED lights up.

* b14 can only be modified if the inverter output is not active.

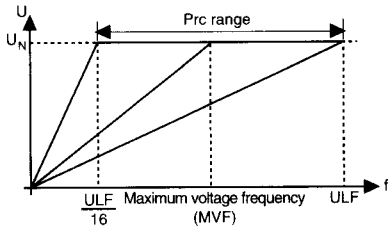
Prc : Maximum voltage frequency (MVF)

Adjustment range : $\frac{ULF}{16}$ to ULF (Hz)

Factory setting : 50 Hz.

In increments of 0.1 to 0.8 Hz according to b14, and 1 Hz for Prc ≥ 100 Hz.

This is the frequency at which the inverter output voltage reaches its maximum (U_N). See diagram below.



From 0 to Prc, it is the output voltage which increases with frequency (operation at constant torque) then from Prc to ULF, the output frequency increases at constant voltage (operation at constant power).

Note : Prc can be modified automatically during operation if the dynamic U/f function is selected (see b54).

Important :
Modification of the maximum voltage frequency (Prc) causes a significant variation in flux in the motor, which may be over-saturated (Prc value too low) or under-saturated (Prc value too high). It may then be necessary to use a motor with special characteristics (please consult LEROY-SOMER).

Prd : Access to specific parameters

Adjustment range : 0 to 50.

Factory setting : 0.

In increments of 10.

Provides access to specific groups of parameters (see section 4.1.2 - Parameter organisation).

Prd = 0 : main parameters.

Prd = 10 : skip frequencies.

Prd = 20 : preset speeds and jogging.

Prd = 30 : acceleration ramps (preset speeds and jog).

Prd = 40 : deceleration ramps (preset speeds and jog).

Prd = 50 : configuring logic outputs / miscellaneous functions.

Pr10 to Pr12 : Skip frequency thresholds 1 to 3

Adjustment range : Pr0 to Pr1 (Hz).

Factory setting : 0 Hz.

In increments of : see Pr0 and Pr1.

Allows skipping over 3 frequencies which may harm operation (noise, vibration, resonance). The skip points (1 to 3) are set via Pr10 to Pr12 respectively. They act on the frequency rise or fall.

Note :

- If one of the set skips corresponds to Pr0 or Pr1, it is ignored.
- Skip frequencies are modified, if Pr0 and Pr1 are modified.
- Skip frequencies are ignored during inching operation.

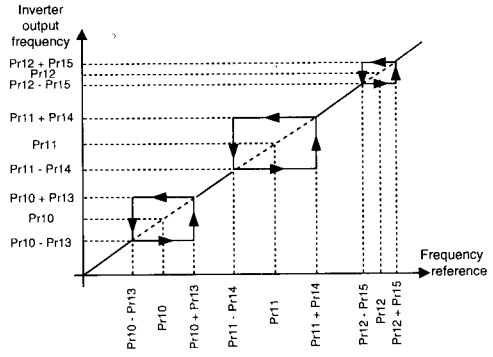
Pr13 to Pr15 : Skip width each side of thresholds 1 to 3

Adjustment range : ± 0.5 to ± 5.0 Hz.

Factory setting : ± 0.5 Hz.

Incrementation depending on Pr0 and Pr1.

Each skip point, Pr10 to Pr 12, has an associated skip band, set via Pr13 to Pr15 respectively. Three adjustable frequency zones can be avoided during operation. (See diagram below).



Note :

- These frequency zones can overlap, giving a greater skip band.
- The output frequency will always be within the limits defined by Pr0 and Pr1 whatever the skip frequency zone.

Pr20 to Pr26 : Preset speeds

Adjustment range : Pr0 to Pr1 (Hz).

Factory setting : 0 Hz.

Incrementation depending on Pr0 and Pr1.

Allows selection of operating speeds which will be enabled via terminals A10, A11 and A12 during operation.

The references of the preset speeds 1 to 7 are set via Pr20 to Pr26 respectively and can be positive or negative (next page : programming a negative preset speed). Terminal 15 gives the run command and multiplies the reference by +1. Terminal 17 gives the run command and multiplies the reference by -1.

Note :

- if b20 = 0 : 3 preset speeds are available,
- if b20 = 1 : 7 preset speeds are available,
- if b28 = 1, Pr20 = PI loop proportional gain and Pr21 = PI loop integral gain (Pr20 and Pr21 adjustment in section 4.6).

Pr27 : Jogging frequency

Adjustment range : 0 to 15 Hz.

Factory setting : 1.5 Hz.

Incrementation depending on Pr0 and Pr1.

The jogging reference is set by Pr27 (always positive). Terminal 15 gives the run command and multiplies the reference by +1. Terminal 17 gives the run command and multiplies the reference by -1. It is enabled by terminal A12 when b20 = 0.

Programming a negative preset speed

• Example : Pr22 adjustment = - 40.0 Hz.

Step	Action on the keypad	Display	Remarks
POWER ON		rdY	
SELECTION OF Prd	Press MODE once,	Pr0	The"PAR" LED lights up.
	and press △ or ▽ to select Prd.	0. / Prd / 0	
ACCESS TO SPECIFIC PARAMETERS Prd = 20	Press MODE once.	0	The"PAR" LED goes out.
	Press △ twice.	20	
	Press MODE once.	Prd	The"PAR" LED lights up. Access to the specific parameters for preset speeds (Prd = 20).
SELECTION OF Pr 22	Press △ or ▽ several times to select Pr22.	20 / Pr22	
MODIFICATION OF Pr 22	Press MODE once.	0	The"PAR" LED goes out.
	Press and hold down △ to set the value of Pr22.	0 / 40.0	Pr22 = 40 Hz.
CHANGE OF POLARITY OF THE VALUE OF Pr 22	Press FWD REV once.	-40.0	
	Press MODE once.	Pr22 / -40.0	Pr22 = -40 Hz, the negative value is shown by the LED on the left of the display.

b20 : Selection - inching operation (JOG) plus 3 preset speeds or 7 preset speeds

Adjustment range : 0 or 1.
Factory setting : 0.
b20 = 0 : preset speeds 1 to 3 can be selected (plus the frequency reference) via a combination of terminals A10, A11, as can the inching operation function via terminal A12.
b20 = 1 : preset speeds 1 to 7 can be selected via a combination of terminals A10, A11, A12.

Note : the inching function is enabled when b20 = 0 and terminal A12 is linked to 0V, with the direction of rotation selected by terminals 15 or 17. The motor rotates at the speed set via Pr27 until the link to 0V of one of terminals A12, 15 or 17 is opened.

b20	A12	A11	A10	Function available	Associated parameter
0	0	0	0	Frequency reference	-
0	0	0	1	Preset speed 1	Pr20
0	0	1	0	Preset speed 2	Pr21
0	0	1	1	Preset speed 3	Pr22
0	1	0	0	Inching operation	Pr27
1	1	0	0	Preset speed 4	Pr23
1	1	0	1	Preset speed 5	Pr24
1	1	1	0	Preset speed 6	Pr25
1	1	1	1	Preset speed 7	Pr26
1	0	0	0	Frequency reference	-

Note :

- 0 = terminal not connected to A1 (0V),
  1 = terminal connected to A1 (0V).
- Terminals A12, A11 and A10 are not active if the inverter is in " slave " mode (terminal 16 at 0V and b6 = 1, see b6).

b21 - b23 : Selection - standard or specfic acceleration and deceleration ramps
Adjustment range : 0 or 1.
Factory setting : 0.
The combination of b21 and b23 is used to select specific ramps for preset speeds or to program specific ramps for the frequency reference (using terminals A10, A11 and A12).

b21	b23	
0	0	The preset speeds use Pr02 and Pr03.
1	0	The preset speeds use Pr30 to Pr36 and Pr40 to Pr46.
1	1	The preset speeds use Pr30 to Pr36 and Pr40 to Pr46.
0	1	The analogue frequency reference uses specific ramps as follows :

A12	A11	A10	Ramps used
0	0	0	Pr02 and Pr03
0	0	1	Pr30 and Pr40
0	1	0	Pr31 and Pr41
0	1	1	Pr32 and Pr42
1	0	0	Pr33 and Pr43
1	0	1	Pr34 and Pr44
1	1	0	Pr35 and Pr45
1	1	1	Pr36 and Pr46

If b20 = 1 : all ramps in the table are available.
If b20 = 0 : only the first 4 lines are available and terminal A12 is released enabling JOG operation

b24 : Function of terminal 19
Adjustment range : 0 or 1.
Factory setting : 0.
b24 = 0 : inverter current output signal (from 0 to ± 10 VDC).
b24 = 1 : logic output providing 0V when the load is lower than Pr05, + 10V when the load is greater than or equal to Pr5.

b26 : Disable " Ac UU " and " Ph " detection
Adjustment range : 0 or 1.
Factory setting : 0.
b26 = 0 : " Ac UU " detection operates normally.
b26 = 1 : " Ac UU " detection is no longer taken into account.

b27 : Specific braking
Adjustment range : 0 or 1.
Factory setting : 0.
During a change of reference or during " Ac UU " detection, the motor brakes as in the table below.

b27	b2	b7	Type of braking
0	0	0	Following ramp or prolongation of the ramp (identical to b2 = b7 = 0).
0	0	1	
0	1	0	
0	1	1	Following ramp (identical to b2 = b7 = 1).
1	0	0	
1	0	1	
1	1	0	
1	1	1	

b28 : Enable PI control loop
Adjustment range : 0 or 1.
Factory setting : 0.
b28 = 0 : the PI loop is disabled, the frequency inverter is controlled by the frequency reference (or "torque") in the usual way.
b28 = 1 : the PI loop is enabled, the frequency inverter can regulate an external measurement (flow rate, pressure, temperature, etc).
The proportional gain Pr20 varies from 0 to 15, a gain of 1 is obtained by setting Pr20 = 0.6.
The integral gain constant Pr21 varies from 1 (Pr21 = 25.5) to 240s (Pr21 = 0.1).
The reference of the characteristic to be regulated is input on terminal 5. The sensor feedback is a current signal on terminal 8 (see commissioning, section 4.6).

Pr30 to Pr36 : Acceleration ramps for preset speeds 1 to 7
Adjustment range : 0.2 to 600s.
Factory setting : 5.0s - FMV 2306 1.5T to 100T,
5.0s - FMV 2306 AS 1.5T to 11T,
100s - FMV 2306 AS 16T to 120T.
In increments of 0.1s.
With b21 = 1, each preset speed, Pr20 to Pr26, has an associated acceleration ramp, set via Pr30 to Pr36 respectively.
Eg. : the acceleration ramp for reaching preset speed Pr22 is set via Pr32.
See the diagram for parameter Pr47.

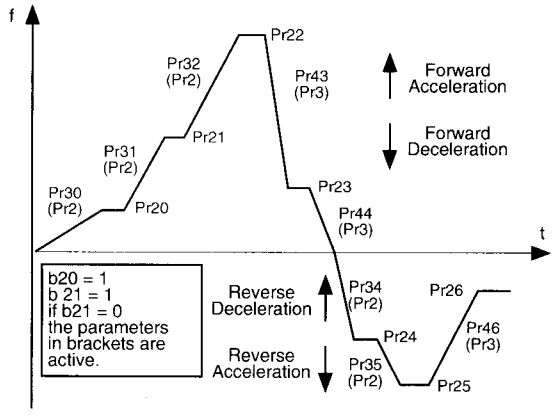
Pr37 : Acceleration ramp for inching operation
Adjustment range : 0.2s to 600s.
Factory setting : 0.2s.
In increments of 0.1s.
The inching operation function always has an associated acceleration ramp, set via Pr37.

Pr40 to Pr46 : Deceleration ramps for preset speeds 1 to 7

Adjustment range : 0.2s to 600s.
Factory setting : 10s - FMV 2306 1.5T to 100T,
10s - FMV 2306 AS 1.5T to 11T,
100s - FMV 2306 AS 16T to 120T.
In increments of 0.1s.
With b21 = 1, each preset speed, Pr20 to Pr26, has an associated deceleration ramp, set via Pr40 to Pr46 respectively.
Eg. : the deceleration ramp for reaching preset speed Pr26 is set via Pr46.
See the diagram for Pr47.

Pr47 : Deceleration ramp for inching operation

Adjustment range : 0.2s to 600s.
Factory setting : 0.2s.
In increments of 0.1s.
The inching operation function always has an associated deceleration ramp, set via Pr47.



Eg : Pr43 calculation to obtain a time t between Pr22 and Pr23.

$$Pr43 = t \times \frac{ULF}{Pr22 - Pr23}.$$

Where t is in s and ULF, Pr22, Pr23, Pr43 in Hz.

Pr50 : Number of automatic resets after a trip

Adjustment range : 0 to 5.
Factory setting : 0.
In increments of 1.
The inverter resets automatically after a trip. If the automatic starting function is enabled (b1 = 0), the inverter can then control the motor with no external intervention.
If b1 = 1 : the inverter remains in ready state (RdY) and waits for a run command.
Pr50 sets the number of resets which the inverter will perform before remaining tripped due to a persistent fault. If Pr50 = 0, the function is disabled.
Each time an automatic reset is performed (Pr50 ≠ 0), the number of resets still available is displayed together with the trip code.

Note :

• The counter for number of remaining resets is reset to Pr50 when :
- the cause of the trip disappears before all the reset attempts have occurred,
- the power is switched on,
- the value of Pr50 is modified.
• The trip is only registered in the fault log when all the attempts to reset have been performed without success.
• The external trip "Et" (terminal 12) cannot be reset by this function

Pr51 : Automatic reset delay

Adjustment range : 1 to 5s.
Factory setting : 1s.
In increments of 0.1s.
Allows adjustment of the time between the trip condition and its automatic reset.

b50 : Selection - programmable relay function

Adjustment range : 0 or 1.
Factory setting : 0.
- **FMV 2306** 1.5T to 11T
FMV 2306 AS 1.5T to 11T } relay 1, 2, 3

b50 = 0 : the relay is active when the inverter is switched on and not tripped.
b50 = 1 : the relay is active when the inverter output frequency is above the minimum frequency Pr0.
See also section 3.2.1 - terminals 1 - 2 - 3.

- **FMV 2306** 16T to 100T,
FMV 2306 AS 16T to 120T. } relay R1, R2, R3

b50 = 0 : the relay is active when the inverter is active ("Inverter output active" LED lit), the motor may be at zero speed.
b50 = 1 : the relay is active when the inverter output frequency reaches the frequency reference.
See also section 3.2.2 - terminals R1 - R2 - R3.

b51 : Enable the FWD REV key

Adjustment range : 0 or 1.
Factory setting : 0.
b51 = 0 : the direction of rotation (Forward/Reverse) cannot be controlled via the FWD REV key.

b51 = 1 : the direction of rotation (Forward/Reverse) can be controlled via the FWD REV key, if b9 = 0.

b52 : Enable flying restart
Adjustment range : 0 or 1.
Factory setting : 0
b52 = 0 : the function is disabled.
b52 = 1 : allows an inverter run command when the motor shaft is turning.
The inverter searches for the motor frequency from Pr1 to 0 Hz in both directions of rotation ("SCAN" appears on the display during this operation). After synchronisation, the motor accelerates until it reaches the reference. Depending on the dynamic conditions of the system, this operation may take up to 5 seconds.

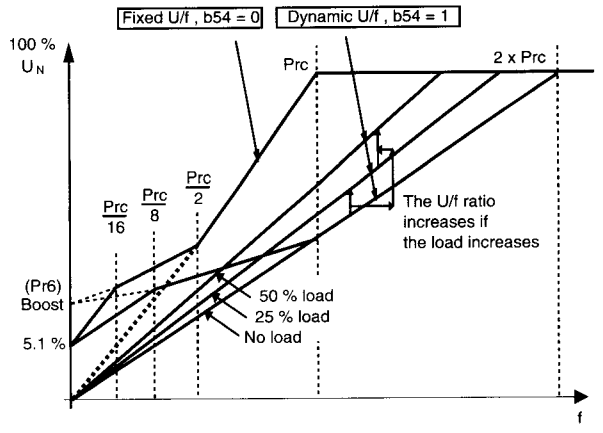
CAUTION
- Do not open the line contactor during this operation.
- Systems without a mechanical load in these conditions can change speed or turn slowly in both rotational directions before starting during this operation.

The search is faster when the forward run command is selected. For a single direction of rotation, use forward run and if necessary swap 2 phases on the motor side for the required motor direction.

b53 : Selection - logic outputs (A0) or (A3)
Adjustment range : 0 or 1.
Factory setting : 0.
- **FMV 2306** 1.5T to 11T
  FMV 2306 AS 1.5T to 11T } A0
b53 = 0 : the logic output is active when the inverter output is active ("Inverter output active" LED lit), the motor may be stopped.
b53 = 1 : the logic output is active when the inverter output frequency is at its minimum (Pr0).
See also section 3.2.1 - terminal A0.

- **FMV 2306** 16T to 100T
  FMV 2306 AS 16T to 120T } A3
b53 = 0 : the output is active when the overload protection I x t is active (the decimal points on the display flash). The output remains active if the inverter trips on I x t ("I t").
b53 = 1 : the logic output is active when the inverter is not tripped.
See also section 3.2.2 - terminal A3.

b54 : Selection - fixed or dynamic U/f characteristic
Adjustment range : 0 or 1.
Factory setting : 0
b54 = 0 : the U/f ratio is fixed and set via Prc.
b54 = 1 : the voltage applied to the motor is automatically reduced depending on the motor load. This enables a saving in energy and a reduction of noise with low and variable loads (eg. : centrifugal pump).
This automatic modification of the U/f characteristic will also modify the frequency at which the maximum voltage frequency (MVF) is reached, and the BOOST action (Pr6).
See following diagram.



FMV rating	Prc value applied when b54 = 1
2306 1.5T to 11T 2306 AS 1.5T to 11T	$2 \frac{\%\ \text{load}}{0.7 \times Pr5} \times Prc\ \text{set}$
2306 16T to 100T 2306 AS 16T to 120T	$2 \frac{\%\ \text{load}}{Pr5} \times Prc\ \text{set}$

Note : If the motor is at no load, the maximum voltage frequency (MVF), set via Prc, will be reached for a frequency which is twice as high.
If the load increases, the voltage increases up to the fixed U/f ratio, MVF = Prc (set).

b55 : Ramps on loss of mains supply
Adjustment range : 0 or 1.
Factory setting : 0.
b55 = 0 : braking is performed following ramp Pr3, restart following Pr2.
b55 = 1 : braking is performed following ramp Pr46, restart following Pr36.

b56 : Management of minor trips
Adjustment range : 0 or 1.
Factory setting : 0.
b56 = 0 : all trips cause an inverter freewheel stop.
b56 = 1 : minor trips ("Et", "cL", "Oh" and "th") cause the inverter to stop following the reference ramp. If b50 = 0, the relay will change status on detection of the trip.

4.8 - Guide to settings

This guide to settings is designed to help you customise your inverter and to highlight functions which are described in detail in section 4.7.2.

PRINCIPAL SETTINGS

Selecting inverter commands

Run, reverse, stop the motor.	•Via terminal block if b9 = 1. •Via keypad if b9 = 0.
Adjustment of the frequency.	• Via terminal block if b9 = 1 : - local : terminal 16 not connected to the 0V, - remote : terminal 16 connected to the 0V. •Via keypad if b9 = 0.
Adjustment of the torque.	•Via terminal block if b9 = 1.
Stop the motor in the event of a fault.	• Automatic restarts : number depending on Pr50, delay depending on Pr51. • Restart after reset if Pr50 = 0.

Starting

Adjustment of the acceleration time.	•Acceleration ramp : via Pr2.
Adjustment of the acceleration torque.	•manual BOOST (torque optimisation at low speed) via Pr6. - fixed value if b3 = 1, - automatic adjustment if b3 = 0.

Running : selecting operating frequencies

Selection of the inverter frequency range.	• Selection of the maximum frequency range : b14.
Selection of minimum and maximum operating frequencies.	• Selection of the maximum motor frequency : Pr1. • Selection of the minimum motor frequency : Pr0.
Maintain the frequency under load.	• Slip compensation : via Pr7.

Running : displaying inverter operation

Display of the inverter frequency or load (b9 = 1).	•Output frequency if b8 = 0. •Inverter load (as a % of I_N) if b8 = 1.
Display of the direction of rotation.	•red FWD LED on during forward operation. •red FWD LED off during reverse operation.
Display of the inverter status.	•Via LEDs on the left side of the console.
Display of faults.	• The last 10 trips are stored in PrA.

Running : optimising the quality of the drive system

Motor protection.	•Maximum overload current : Pr4. •Maximum continuous current : Pr5. •PTC or PTO motor probe connected to terminal 9.

Stopping the motor

Selection of the mode of stopping.	•4 modes available depending on b2 and b7.
Controlled stop.	•Adjustment of the deceleration ramp : Pr3.
Freewheel stop.	•On external trip "Et". •On power cut.

SPECIFIC SETTINGS

Selecting inverter commands

Run, reverse, stop the motor.	• Via RS 485, RS 422 or RS 232 serial link : b6 = 1. • Via terminal block : b6 = 0. • Option to prohibit changing direction by pressing key on the keypad via b51. FWD REV
Adjustment of the frequency.	• Via RS 482 or RS 422 serial link : b6 = 1. • Via keypad if b9 = 0. • Via terminal block if b9 = 1. Selection of local or remote operation via terminal 16 : - local if terminal 16 is not connected to 0V, select reference polarity via b4, - remote if terminal 16 is connected to 0V.
Selection of the regulation mode.	• Regulation by torque or by frequency via b0. • Operation in master or slave mode via b6.
Stop the motor in the event of a fault.	• Automatic restart via Pr50. • Time delay before restart via Pr51. • Flying restart if b52 = 1.
Lock programmed instructions.	• By security code in Prb. • By disconnecting the console.

Starting

Initiate commands.	• Via RS 485 or RS 422 serial link. • Via terminal block : run forward/stop, run reverse/stop. • Via keypad : run, stop, reverse.
Adjust the acceleration torque.	• Manually via Pr6, if b3 = 1. • Automatically if b3 = 0.

Running : selecting operating frequencies

Selection of the operating frequency range.	• The maximum frequency is determined by b14.
Use of the preset speeds.	• Control via terminal block : - of 3 speeds plus the reference if b20 = 0, - of 7 speeds plus the reference if b20 = 1. • Adjustment of the level via Pr20 to Pr26. • Selection of acceleration and deceleration ramps : - standard and common to all speeds if b21 = 0, - specific to each speed if b21 = 1.
Use of inching operation.	• Enable via b20 = 0. • Adjustment of the level via Pr27. • Adjustment of acceleration and deceleration ramps via Pr37 and Pr47.

Running : measuring operating parameters

Selection of the type of display (b9 = 1).	• The output frequency (in Hz) if b8 = 0. • The output current as % I_N if b8 = 1.
Analogue signals.	• Of the output frequency (in Hz) at terminal 18. • Of the output current (as % I_N) at terminal 19.
Indication of frequency reached.	• Available at the terminal block : - terminals R1, R2, R3 for FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T if b50 = 1.

Running : optimising the inverter - motor drive system

Adjustment of the switching frequency.	• Adjust b14.
Vibration : prohibit critical frequencies.	• 3 skip frequencies programmed in Pr10 to Pr12. • Skip band adjustable via Pr13 to Pr15.
Precision of speed under load.	• Open loop control when b5 = 1, Manual compensation via Pr7. • Closed loop control (encoder feedback) when b5 = 0, no compensation necessary.
Motor protection and torque limitation.	• Adjustment of the maximum overload current via Pr4. • Adjustment of the maximum continuous current via Pr5. • Integration of I x t overload depends on Pr4 and Pr5. • External limitation of the torque via terminal 7.
Slip compensation.	• Variable depending on the load via Pr7.

Stopping the motor

Selection of the mode of stopping.	• Following ramp (with prolongation depending on the inertia) : b2 = 0, b7 = 0. • Freewheel : b2 = 0, b7 = 1. • With D.C. injection : b2 = 1, b7 = 0 : - level adjustable via Pr8. • Following ramp b2 = 1, b7 = 1.
Ramp adjustment.	• Time adjusted via Pr3.
Control of an electro-mechanical brake.	• For FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T via the logic output A0 with b53 = 1 or via the programmable relay with b50 = 1. • For FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T via the minimum frequency relay (terminals Z1, Z2, Z3).

5 - FAULTS - DIAGNOSTICS

• Information about the inverter status is provided by 5 LEDs, and by the display (see below).
• Faults are shown in mnemonic form flashing on the display.

The last ten faults are stored in the memory (even after a mains power break) in parameter PrA.
• Information about the inverter status is also provided by the display unit.
• Some inverter states are provided by the logic outputs (relays and open collector transistors).

5.1 - Indication via LEDs

LED ref	Status	Information provided
Inverter output active	On	The inverter is running (possibly at zero speed).The "FWD" LED is also on if a Forward run command has been given.
Serial comms active	On	The inverter is receiving or sending data via the serial link.
Dynamic brake active	On	Indicates that the maximum voltage threshold on the D.C.bus has been exceeded during a motor deceleration phase.
Current limit active	On	The inverter is in current limitation because the load exceeds : - the maximum motor overload (parameter - Pr4), - or the torque limitation set at terminal 7.
Remote control of drive	On	Indicates that the inverter is controlled via - a remote reference, or - the serial link.

Note : The inverter will trip if the "Current limitation" LED stays on for a period determined by the setting of Pr4 and Pr5.

5.2 - Display indication - error messages

Display mnemonic	Reason for trip	Check points	Solution
cL	Loss of current signal speed reference.	Level of current setpoint 4 - 20 mA or 20 - 4 mA. (1)	Check that the input reference level is > 3.5 mA.
Err *	Hardware trip when unit switched on.	Control board : • IN 50 (FMV 2306 1.5T to 11T FMV 2306 AS 1.5T to 11T), • IN 40 (FMV 2306 16T to 100T FMV 2306 AS 16T to 120T).	RESET is no longer active. Power the inverter off and then on again. If the fault persists, consult your supplier.
Et	External trip.	• Terminal 12. • Control via the serial link.	• Check that terminal 12 is connected to 0V. • Check the control commands via the serial link.
It	I x t overload fault.	• Motor load. • Adjustment of I x t threshold (parameters Pr4, Pr5).	• Check that the motor is not overloaded. • Check that the I x t protection is correctly set.
OA (2)	Ambient temperature outside the range.	•Ambient temperature. •Ventilation holes. •Cooling fan. (3)	• Make sure the ambient temperature is between -10 and +50°C. • Check that there is sufficient space around the inverter. • Check that the cooling holes are not blocked and that the fans are working.
Oh	Cooling unit overheated. The in-rush contactor has not closed during power on. (4)	• Cooling fans (3). • Ambient temperature. • The in-rush contactor (internal).	• Check that : - the fans are turning, - the cooling holes are not obstructed. • The ambient temperature is lower than 50°C, • There is sufficient space around the inverter. • Power the inverter off and then on again.

*
1: ASIC error,
2 : EEPROM does not respond,
3 : EEPROM error,
4 : processor error,
5 : CDn-FMV fault,
6 : EEPROM initialisation fault,
7 : power supply imbalance +15V,
8 : power supply imbalance -15V,
9 : PWM circuit initialisation fault,
10 : memory stack error.

5.2 - Continued

Display mnemonic	Reason for trip	Check points	Solution
OI	Instantaneous overcurrent.	Terminals : U, V, W, PE. • Short-circuit between phases or faulty earth. • Significant variation in the load. • Speed of deceleration. • Motor power greater than that of inverter. • Cable between the motor and the inverter too long. • Power module in short-circuit.	• Check the output wiring. • Eliminate the short-circuit. • Eliminate the variation. • Program a longer time period for Pr3. • Check the setting of b2 and b7. • Check the motor and inverter name plates. • Use motor chokes. • Return the inverter for repair.
OU	Overvoltage on the D.C. bus.	• Rapid deceleration (inertial load) : operation above Prc. • Terminals L1, L2, L3 : Overvoltage on mains supply.	• Program a greater deceleration time period at Pr3. • Check the stop mode set via b2 and b7. • Use a braking unit (optional). • Check the mains supply.
Ph (5)	Disappearance of one or two phases.	Terminals : L1; L2, L3 : Voltage of one or two input phases < 380V - 10 %.	Check the three mains supply phases.
PS	Internal supply fault.	Internal supply terminals.	Power the inverter off and then on again. If the fault persists, consult your supplier.
th	Triggering of motor probe (PTC or PTO).	• Motor temperature too high (PTC resistance > 3 kΩ or open PTO).	• Check the motor load. • Reduce the authorised overload level. • Check the motor ventilation and the ambient temperature. • Check the probe wiring.
UU (5)	Undervoltage on the D.C. bus.	• Terminals : L1, L2, L3 : prolonged undervoltage on the mains supply. (6)	• Check the mains supply .
AcUU	Low mains supply warning. (7)	• Terminals : L1, L2, L3 : undervoltage on the mains supply < 380V - 10 %.	• Check the mains supply.

Note : All trips can be cleared using "RESET" except "PS" and "Err" which require the power to be turned off and then back on. Thermal devices should not be triggered and reset several times in succession.

(1) "cL" protection is not active if b11 = 0.20 (0 to 20 mA).
(2) "OA" protection is only available on the following inverters : FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T.
(3) Inverters which have a cooling fan are : FMV 2306 3.5T to 100T and FMV 2306 AS 3.5T to 120T.
(4) Only for inverters FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T.
(5) At power off, the "Ph" or "UU" trips which appear are not recorded in the fault log (PrA), if the inverter is already tripped.
(6) The "UU" trip may result from a failure of the internal components. Please consult your supplier.
(7) The display "AcUU" does not indicate a fault, but simply indicates a reduction in input voltage.
- If the mains supply re-establishes itself before the motor stops, the inverter tries to reaccelerate the motor to the setpoint level.
- If the motor reaches zero speed, the inverter will trip on "UU" or "Ph" after a few seconds.

5.3 - Display indication - inverter status

Display	Description
"rdY"	Motor stopped, inverter output inactive.
Numeric value	Motor operating (see section 4.1.1) "initial display". The numeric value is : - the output frequency (Hz), or - the output current (% IN), or - the frequency setpoint (Hz) depending on the programming of b8 and b9.
"dc"	D.C. injection braking is active. (See b2, b7).
"Inh"	The motor will stop in freewheel mode, the inverter output is not active. (See b2, b7).
"SCAN"	The inverter looks for the motor frequency to perform a flying restart. (See b52).
Flashing decimal points	The inverter is in I x t overload. (See Pr4, Pr5).

Note : The signals above do not indicate a fault status, but the inverter operating status. However, flashing decimal points are an alarm. If the inverter remains in a state of I x t overload for longer than a period defined by Pr4 and Pr5, it will trip.

5.4 - Indication via logic outputs

5.4.1 - FMV 2306 1.5T to 11T
FMV 2306 AS 1.5T to 11T

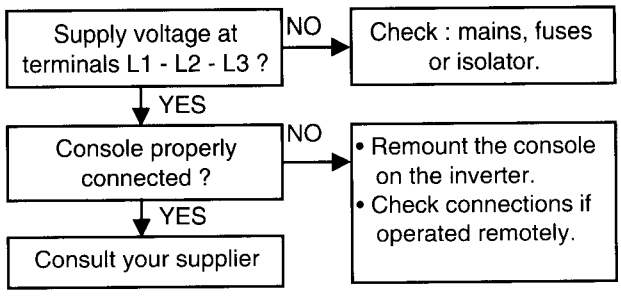
Terminal	Type of output	Information supplied	Associated parameter
1 2 3	Relay (assignable)	The inverter is not tripped or frequency > Pr0.	b50 Pr0
A0	Transistor with open collector (assignable)	Inverter running or Pr0 frequency.	b53 Pr0

5.4.2 - FMV 2306 16T to 100T
FMV 2306 AS 16T to 120T

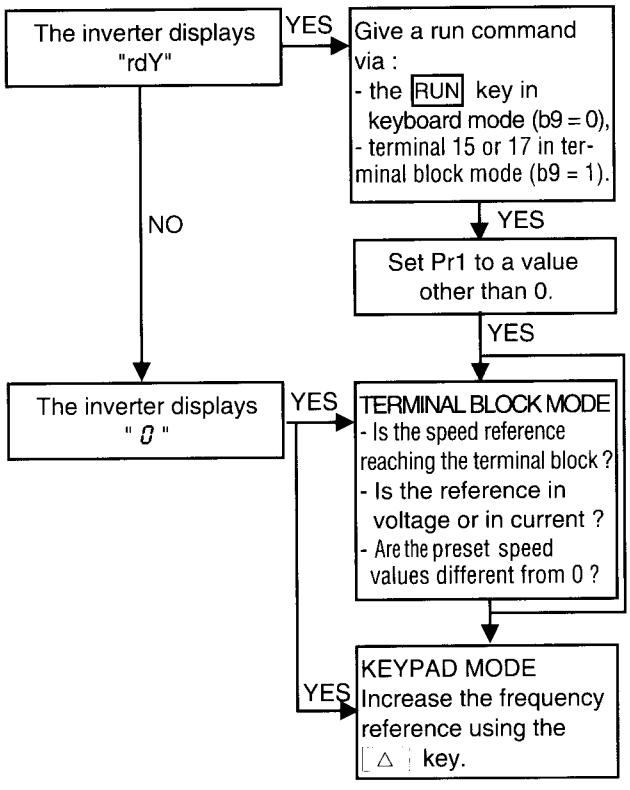
Terminal	Type of output	Information supplied	Associated parameter
Z1 Z2 Z3	Relay	Frequency > Pr0.	Pr0
R1 R2 R3	Relay (assignable)	Inverter running or at frequency.	b50
1 2 3	Relay	The inverter is not tripped.	-
A3	Transistor with open collector (assignable)	I x t overload or Inverter tripped.	Pr4, Pr5 b53

5.5 - Flow charts for locating malfunctions

• The inverter display does not come on

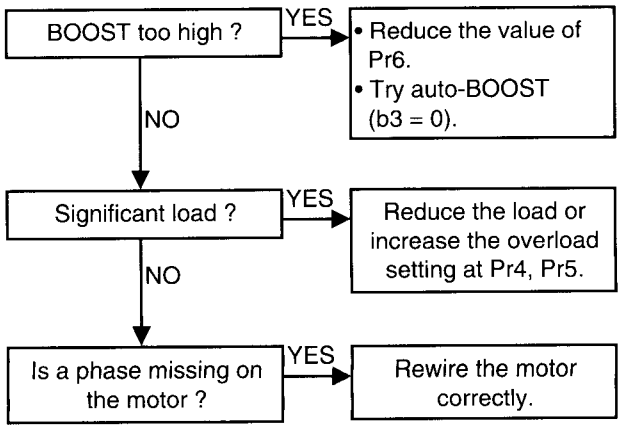


• The motor will not start

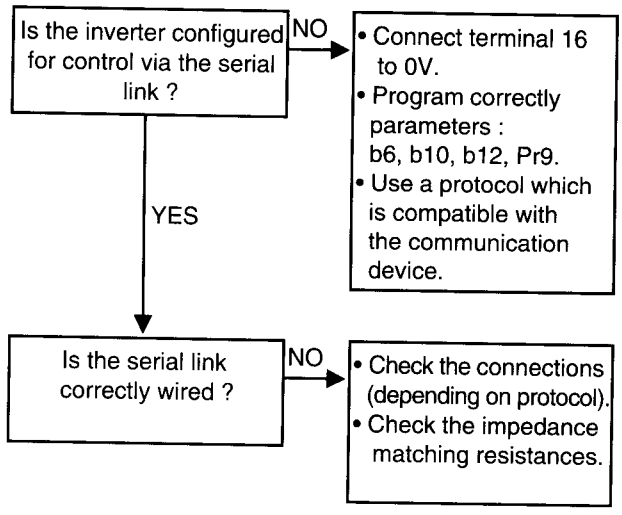


• Display of a trip code
See section 5.2.

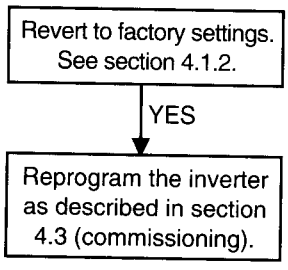
• The motor does not accelerate and is noisy



• The inverter does not react to programming instructions via the serial link



• Inverter parameters incorrectly set



Note :
- The inverter malfunction is often due to incorrect settings. A guide to settings is given in section 4.8.
- If, after performing all the above checks, the system still does not work, contact your supplier.

6 - MAINTENANCE

6.1 - Introduction and advice

Caution

The power board printed circuit (lower circuit) is connected directly to the mains.

Do not perform any operations on the inverter without first manually opening the supply circuit of the power stages (fused isolator or circuit-breaker) **or opening the KM input contactor and manually locking** (key) **the remote control of KM.**

Note also that the smoothing capacitor can be subjected to very high voltages. Do not touch the inverter terminals without first performing or checking one of the following three operations.

a) - After switching the power off to the inverter, wait 5 minutes for the capacitors to discharge.

b) - Use a voltmeter to check that the voltage on the D.C. bus is less than 15 volts.

c) - Should it not be possible to perform the above operations due to lack of time, place a discharge resistor (30 W-500Ω) very carefully (High voltage !!!) on the D.C. bus terminals for at least 15 seconds.

FMV 2306 - FMV 2306 AS inverters require a minimum of maintenance and repair operations on the part of the user. Detailed below are normal maintenance operations and simple methods for checking that the inverter is operating correctly and for making an initial diagnosis of correct operation on the power stages.

6.2 - Care

For the inverter, it is important to bear in mind that all electronic equipment may be subject to problems after being exposed to excessive heat, humidity, oil, dust, or if any external matter is allowed to penetrate.

Clean the motor ventilation holes from time to time and follow any lubricating instructions for the bearings as indicated on the name plate.

Printed circuits and their components do not normally require any maintenance. Contact your retailer or nearest approved service centre if any problems occur.

DO NOT REMOVE PRINTED CIRCUIT BOARDS DURING THE GUARANTEE PERIOD, AS THIS WILL IMMEDIATELY RENDER IT NULL AND VOID.

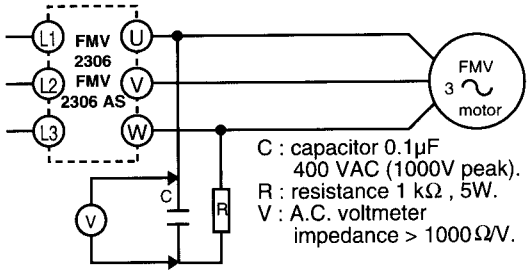
Do not touch integrated circuits or the microprocessor with your fingers or with any charged or live material. Earth yourself, as well as the bench or soldering iron before any intervention on the circuits.

Do not handle the socket-mounted integrated circuits located on the printed control circuit (risk of damage).

6.3 - Measuring voltage, current and power

6.3.1 - Measuring the voltage at the inverter output

The harmonics from the inverter mean that it is not possible to measure the voltage at the motor input correctly with an ordinary voltmeter. However, you can obtain an approximate value of the rms voltage of the fundamental wave (which has a bearing on the torque) by using a standard voltmeter and the arrangement described in the diagram below.



6.3.2 - Measuring the motor current

The current drawn by the motor and the inverter input current can be measured approximately using an ordinary moving coil ammeter.

6.3.3 - Measuring the inverter input and output power

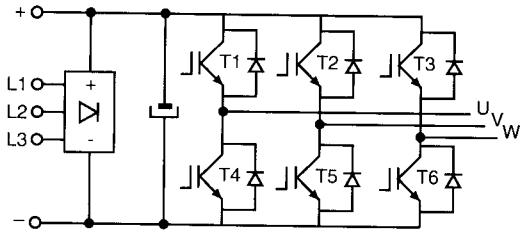
The inverter input and output power can be measured using an electro-dynamic instrument.

6.4 - Testing the inverter power stages

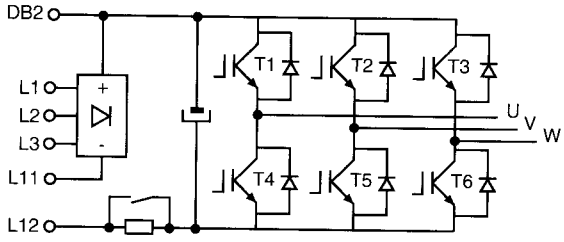
Preliminary remarks :

The tests described below are intended to **perform a qualitative test** of the state of the power stages. Use an analogue ohmmeter (moving coil) set to the 1 Ω scale and take measurements after switching off the inverter and waiting for the smoothing capacitor to discharge completely. Each measurement must last for at least 10 seconds to avoid false readings from any charge which might still be present in the inverter circuits. If there is any doubt about the power stages, make a visual check of the state of the gate drive modules which may have been damaged subsequently.

The following diagrams represent the general schematic diagram of the transistor inverter stage in the speed controller.
- FMV 2306 1.5T to 11T
  FMV 2306 AS 1.5T to 11T



- FMV 2306 16T to 100T
  FMV 2306 AS 16T to 120T

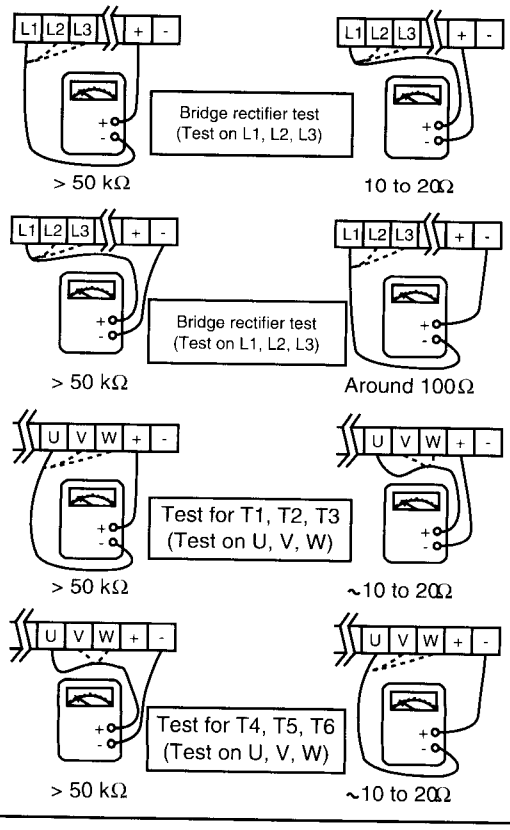


Two levels of test can be performed :

6.4.1 - Test using the terminal block

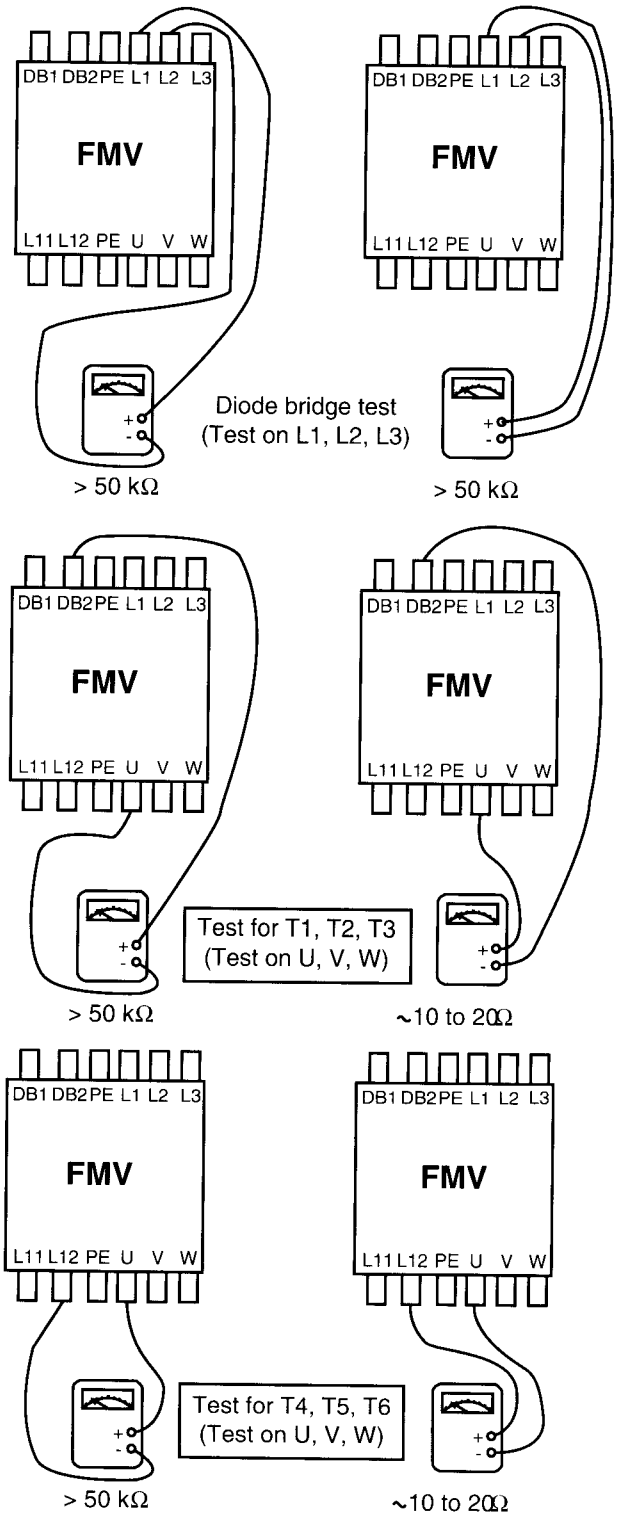
This test is fairly crude. A positive response does not necessarily mean that the power stages are undamaged. However, a negative response generally indicates that they have been damaged.
- FMV 2306 1.5T to 11T
  FMV 2306 AS 1.5T to 11T

Use the L1, L2, L3, U, V, W, +, - terminals on the power circuit.



- FMV 2306 16T to 100T
  FMV 2306 AS 16T to 120T

Use the L1, L2, L3, U, V, W, DB2, L12 terminals on the power circuit.



Note : The measurements in this section are performed using an analogue ohmmeter.

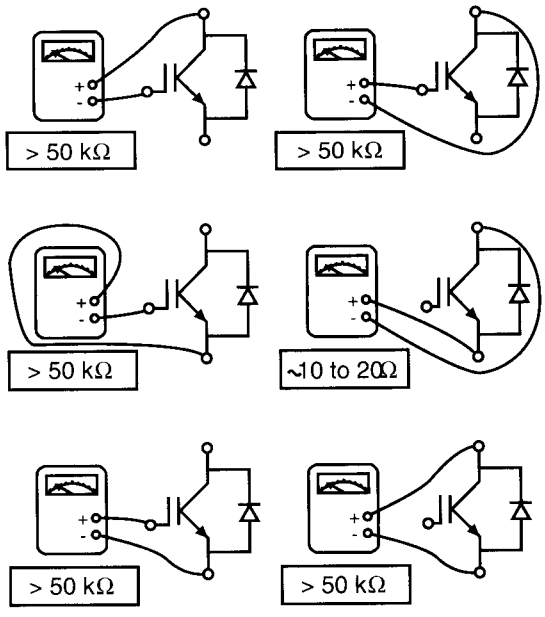
6.4.2 - Testing power modules individually

This test is much more comprehensive. As before, this is a test which is able to detect faults, but cannot guarantee that the equipment is undamaged.

CAUTION :
For this test it is necessary to dismantle the inverter printed circuits. Do not follow this procedure during the guarantee period. The guarantee would be invalidated as a result.

To perform this test, check each of the six power modules according to the diagrammatic instructions below.

When replacing a power module, apply silicon grease for thermal conduction over the module cooling surface.



Note : The measurements in this section are performed using an analogue ohmmeter.

6.5 - Testing the inverter isolation and withstand voltage

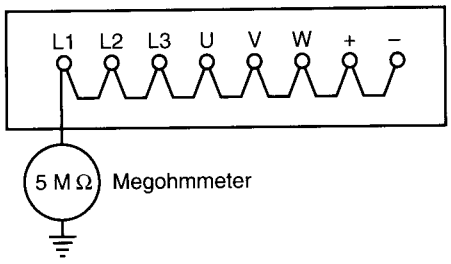
6.5.1 - Introduction

CAUTION :
The tests decribed below should be performed wth care. Should the power stages be destroyed as a result of a handling error or not following the instructions they would not be covered by the guarantee.

6.5.2 - Testing inverter isolation

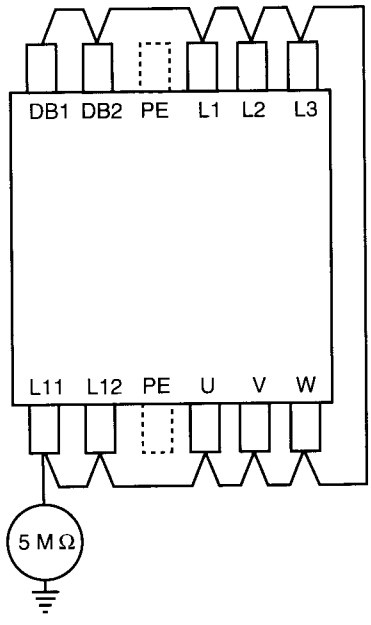
Short-circuit all the terminals on the power terminal block, except the PE terminal (earth), as shown below. Use a megohmmeter to measure the resistance between these terminals and the earth. This resistance should be at least 5 MΩ.

- FMV 2306 1.5T to 11T
  FMV 2306 AS 1.5T to 11T



DO NOT CARRY OUT ISOLATION OR WITHSTAND VOLTAGE TESTS ON ANY TERMINALS OTHER THAN THOSE SHOWN ABOVE.

- FMV 2306 16T to 100T
  FMV 2306 AS 16T to 120T



DO NOT CARRY OUT ISOLATION OR WITHSTAND VOLTAGE TESTS ON ANY TERMINALS OTHER THAN THOSE SHOWN ABOVE.

6.5.3 - Testing the inverter withstand voltage

Apply an A.C. voltage of 2000V for one minute (after gradually increasing it) between the earth and the short-circuited power terminal block as described in the diagrams above.
Check that nothing abnormal happens during the test.

CAUTION :
Never carry out a withstand voltage test on any terminals other than those indicated above. Such an operation would damage the inverter and invalidate the guarantee.

6.6 - Spare parts list

6.6.1 - FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T

Consult LEROY-SOMER.

6.6.2 - FMV 2306 16T to 40T and FMV 2306 AS 16T to 50T

FMV 2306 16T to 40T *

Type	Designation	Rating				
		16T	22T	27T	33T	40T
Control board IN40 / ISS3	9300 - 4004	1	1	1	1	1
Power board IN 41	9300 - 4102	1	1	1		
	9300 - 4103				1	1
Console	9202 - 0000	1	1	1	1	1
Power transistor **	9203 - 0030	3				
	9203 - 0031		3	3		
	9203 - 0032				3	3
Rectifier module	2423 - 0090	1	1			
	2423 - 0110			1		
	2423 - 0130				1	
	2423 - 0160					1
Fuse for D.C. bus	4300 - 0040	1				
	4300 - 0050		1			
	4300 - 0060			1		
	4300 - 0070				1	
	4300 - 0090					1
Forced ventilation	3251 - 0113	1	1	1	2	2
Front cover	3581 - 0034	1	1	1	1	1

FMV 2306 AS 16T to 50T *

Type	Designation	Rating					
		16T	22T	27T	33T	40T	50T
Control board IN40 / ISS3	9300 - 4004	1	1	1	1	1	1
Power board IN 41	9300 - 4102	1	1	1			
	9300 - 4103				1	1	1
Console	9202 - 0000	1	1	1	1	1	1
Power transistor **	9203 - 0030	3	3				
	9203 - 0031			3	3		
	9203 - 0032					3	3
Rectifier module	2423 - 0090	1	1	1			
	2423 - 0110				1		
	2423 - 0130					1	
	2423 - 0160						1
Fuse for D.C. bus	4300 - 0040	1					
	4300 - 0050		1				
	4300 - 0060			1			
	4300 - 0070				1		
	4300 - 0090					1	
	4300 - 0125						1
Forced ventilation	3251 - 0113	1	1	1	2	2	2
Front cover	3581 - 0034	1	1	1	1	1	1

6.6.3 - FMV 2306 50T to 100T and FMV 2306 AS 60T to 120T

FMV 2306 50T to 100T *

Type	Designation	Rating			
		50T	60T	75T	100T
Control board IN40 / ISS3	9300 - 4004	1	1	1	1
Power board IN 46	9300 - 4611	1			
	9300 - 4612		1	1	
	9300 - 4613				1
Console	9202 - 0000	1	1	1	1
Power transistor **	9203 - 0033	6			
	9203 - 0034		6	6	
	9203 - 0035				6
Rectifier module	2423 - 3114	3			
	2423 - 8114		3		
	2423 - 8614			3	
	2423 - 1614				3
Fuse for D.C. bus	4300 - 0125	1			
	4300 - 0150		1		
	4300 - 0175			1	
	4300 - 0250				1
Forced ventilation	3251 - 0113	2	2	3	
	3251 - 0110				3
Front cover	3581 - 0064	1	1	1	1

FMV 2306 AS 60T to 120T *

Type	Designation	Rating			
		60T	75T	100T	120T
Control board IN40 / ISS3	9300 - 4004	1	1	1	1
Power board IN 46	9300 - 4612	1	1		
	9300 - 4613			1	
	9300 - 4614				1
Console	9202 - 0000	1	1	1	1
Power transistor **	9203 - 0033	6			
	9203 - 0034		6	6	
	9203 - 0035				6
Rectifier module	2423 - 3114	3			
	2423 - 8114		3		
	2423 - 8614			3	
	2423 - 1614				3
Fuse for D.C. bus	4300 - 0150	1			
	4300 - 0175		1		
	4300 - 0250			1	
	4300 - 0300				1
Forced ventilation	3251 - 0113	2	3	3	
	3581 - 0110				3
Front cover	3581 - 0064	1	1	1	1

* The tables show the quantities required for one inverter.
** The T - FMV optional braking transistor is not included.

7 - OPERATING EXTENSIONS

7.1 - T - FMV braking transistors

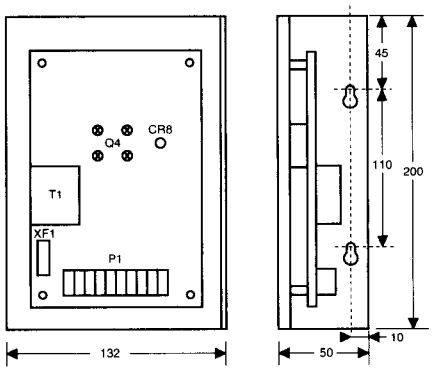
7.1.1 - FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T : T - FMV 30 or T - FMV 32

The T - FMV 30 consists of a printed circuit mounted on an aluminium angle bracket which acts as a heatsink.
The T - FMV 32 consists of a metallic rectangular box housing the printed circuit with plug-in connectors.
The T - FMV 30 and T - FMV 32 have 2 functions :
- during braking operations, it switches energy fed back from the motor to the resistances so that it can be dissipated,
- it relays logic information originating from the FMV inverter. For example, this relay can control an electromechanical brake from the "minimum frequency" information.

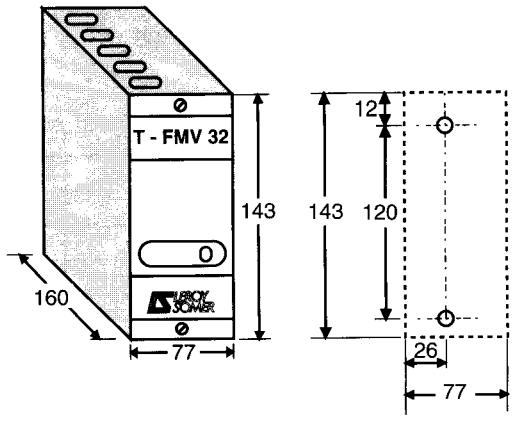
Characteristics T - FMV 30 and T - FMV 32

Braking function	Supply voltage	• 380 to 415V ±10 % 50 Hz single phase. • 400 to 460V ±10 % 60 Hz single phase.
	Peak permissible current	30 A
	Average permissible current	7.5 A
	Associated minimum ohmic value	28Ω
	Fuse for D.C. bus (not supplied)	gl 12A
Relay function	Relay breaking capacity	6 A at 250 VAC, resistive load
	Relay power supply	24 VDC - 8.3 mA

Dimensions and mounting
T - FMV 30



T - FMV 32



T - FMV 30/FMV 2306 connections

T - FMV 30	T - FMV 32	FMV 2306	Others
L1	L1		A.C. power supply
L2	L2		
+	+	+ *	
-	-	-	
R1	DB1		R - FMV resistance
R2	DB2		
+24V	A2	A2 (24V)	
CDE	CDE	A0	
	NC***		
	R1		Remote control
	R2		

* Via a 12A gl fuse.
** Via a thermal relay.
*** Not used.

7.1.2 - FMV 2306 16T to 40T and FMV 2306 AS 16T to 50T : T - FMV 25, 50 or 75

Their function is to switch energy fed back by the motor to the resistances during deceleration or braking operations.
These options are mounted inside the inverter in the factory.

T - FMV	25	50	75
Peak current	25A	50A	75A
Permissible permanent current	18A	36A	55A
Associated minimum ohmic value	33Ω	17Ω	11Ω

7.1.3 - FMV 2306 50T to 100T and FMV 2306 AS 60T to 120T : T - FMV 150

Its function is to switch energy fed back by the motor to the resistances during deceleration or braking operations.
This option is mounted inside the inverter in the factory.

Peak current	Permissible permanent current	Associated minimum ohmic value
150A	115A	6 Ω

7.2 - R - FMV braking resistances

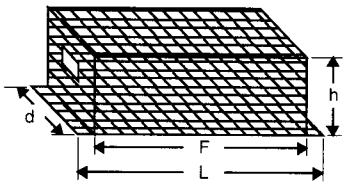
- R - FMV 320T to 2000T for FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T.
- R - FMV 320T to 4000T for FMV 2306 16T to 100T and FMV 2306 AS 16T to 120T.

Characteristics

R - FMV	320T	640T	1000T	2000T	3000T	4000T
Ohmic value (Ω)	180	90	68	34	22.6	17
Thermal power (W)	320	640	1000	2000	3000	4000
Peak power (W)	2700	5400	7200	14400	21600	28800
I rms (A) *	1.33	2.66	3.8	7.7	11.5	15.3
Protection index	IP20 on 5 sides, 6th side = mounting surface					

*** Adjustment value of thermal protection relay wired in series with R - FMV resistance.**

Weights and dimensions



R - FMV	320T	640T	1000T	2000T	3000T	4000T
Weight (kg)	1.5	2.1	3.6	5.1	7.5	7.5
Dimensions (mm) L x d x h	425 x 134 x 114		565 x 224 x 180		565 x 404 x 180	
Distance between fixing points (mm) F	395		535		535	

Note : R - FMV resistances can be connected in parallel if their equivalent value is not lower than the minimum ohmic value for the T - FMV transistor.

7.3 - L - FMV and LT - FMV lifting interfaces

7.3.1 - Operating principle

L - FMV and LT - FMV interfaces control an FMV 2306 frequency inverter and manage the mechanical brake in lifting applications (cranes, hoists, traversing crane, etc). They take complete control of the FMV 2306 inverter using commands from the operator.

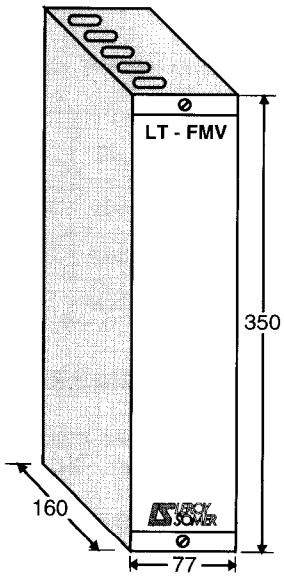
They have several control modes : analogue speed reference via potentiometer, logic command via faster/slower pushbuttons or preset speeds.

Use with FMV 2306 inverters

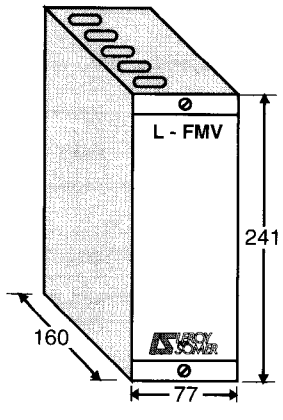
LT - FMV	FMV 2306 1.5T to 11T
L - FMV	FMV 2306 16T to 100T

7.3.2 - Dimensions

LT - FMV

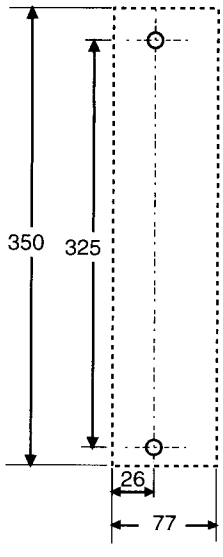


L - FMV

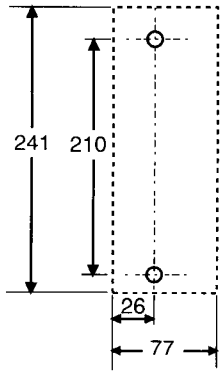


7.3.3 - Installation

LT - FMV



L - FMV



7.4 - FLT - FMV mains filters

These are used to reduce electro-magnetic emissions from inverters, and to ensure that the inverters conform to EN-50081.2 European standards for all switching frequencies available (see section 3.3).

7.4.1 - FMV 2306 1.5T to 11T and FMV 2306 AS 1.5T to 11T

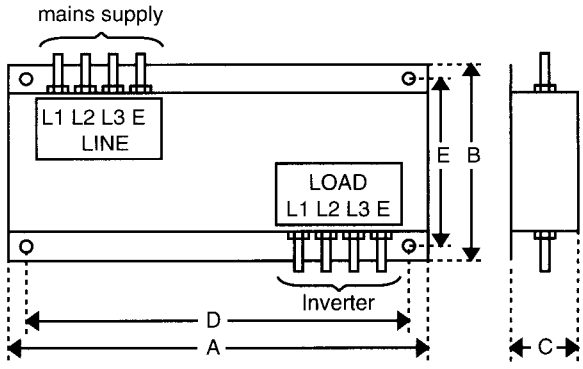
The filter is supplied fitted inside the inverter, thus no space is needed for its installation. The power supply for the inverter therefore enters via the top of the unit.

FMV rating	Filter reference	I_N filter (A)	Leakage current (mA)*
2306 1.5T to 11T 2306 AS 1.5T to 11T	FLT - FMV 11	20	12

* For 415V, 50 Hz mains supply.

7.4.2 - FMV 2306 16T to 100T and FMV 2306 AS 16T to 100T

The filter is in the form of a rectangular block which should be installed directly above the inverter. The cables for connection to the inverter should be no longer than 300mm.



FMV rating	Filter reference	I_N filter (A)	Leakage current (mA) *	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)
2306 16T and 22T 2306 AS 16T and 22T	FLT - FMV 22	30	25	330	190	102	292	165
2306 27T and 33T 2306 AS 27T to 40T	FLT - FMV 33	50	25	330	190	102	292	165
2306 40T 2306 AS 50T	FLT - FMV 40	70	25	330	229	140	292	203
2306 50T to 75T 2306 AS 60T and 75T	FLT - FMV 75	110	25	432	253	127	394	228
2306 100T 2306 AS 100T and 120T	FLT - FMV 100	170	25	490	253	152	451	228

* For a 415V, 50 Hz mains supply.

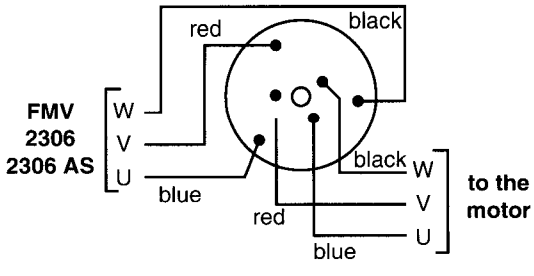
7.5 - Three-phase motor chokes for leakage current attenuation : SELF - MC

They are connected directly to the inverter output (terminals U, V, W) and attenuate leakage currents and thus emitted interference.
They are cylindrical and mounted by a central fixing hole.

SELF - MC rating	FMV 2306 FMV 2306 AS rating	Dimensions		
		Diameter	Height	Hole Ø
3.5T	1.5T to 3.5T	80	50	5.1
11T	5.5T to 11T	80	50	5.1
27T	16T to 27T	125	55	6.2
50T	33T to 50T	125	65	6.2
75T	60T to 75T	145	90	8.3
120T	100T and 120T	145	200	8.3

Dimensions are in mm.

• Wiring
The SELF - MC must be connected as close as possible to the inverter following the diagram below.



7.6 - Cables for remote connection of the console CD - CORD

They are used to connect the console at a distance from the inverter, in order to fix it on the front of the enclosure or on a control panel using 9-pin SUB-D connectors.
The standard lengths are :

Length	Reference
1.5m	CD - CORD 1.5
3m	CD - CORD 3
5m	CD - CORD 5

For longer lengths (up to 100m maximum) please consult LEROY-SOMER.

Notes

8 - SUMMARY OF SETTINGS

Parameter		Factory setting	Your setting date :	Your setting date :
Pr0	Minimum output frequency	0		
Pr1	Maximum output frequency	50		
Pr2	Acceleration ramp	- FMV 2306 1.5T to 100T : 5.0 - FMV 2306 AS 1.5T to 11T : 5.0 - FMV 2306 AS 16T to 120T : 100		
Pr3	Deceleration ramp	- FMV 2306 1.5T to 100T : 10.0 - FMV 2306 AS 1.5T to 11T : 10.0 - FMV 2306 AS 16T to 120T : 100		
Pr4	Maximum overload current : - FMV 2306 - FMV 2306 AS	 150 120		
Pr5	Maximum continuous current	100		
Pr6	Torque at low speed (BOOST)	2		
Pr7	Slip compensation	0		
Pr8	Level of braking by D.C. injection : - FMV 2306 - FMV 2306 AS	 150 120		
Pr9	Inverter address - serial link	11		
PrA	Log of last 10 faults	-		
Prb	Security code	0		
b0	Selection : " torque " or frequency reference	1 (frequency)		
b1	Selection : automatic or controlled starting - FMV 2306 - FMV 2306 AS	1 (controlled)		
b2 - b7	Selection : mode of stopping b2 b7	 0 (stopping following ramp or 0 prolongation of ramp)		
b3	Selection : automatic or manual BOOST	1 (manual)		
b4	Selection : reference polarity	1 (0/10V)		
b5	Selection : speed feedback	1 (without feedback)		
b6	Selection : master or slave mode	0 (master)		
b7	See parameter b2	0		
b8	Selection : display of output current or frequency	0 (frequency)		
b9	Selection : control via the keypad or terminal block	1 (terminal block)		
b10	Selection : parity (serial link)	0 (even)		
b11	Selection : remote frequency reference	4.20 (4/20 mA)		
b12	Selection : speed of data exchange via the serial link	4.8		
b13	Selection of original parameters	0 (not active)		
b14	Selection : Switching frequency and ULF (Upper Limit Frequency)	2.9/120		
Prc	Maximum voltage frequency : MVF	50		
Prd	Access to specific parameters	0		

Parameter		Factory setting	Your setting date :	Your setting date :
Pr10	Skip frequency threshold 1	0		
Pr11	Skip frequency threshold 2			
Pr12	Skip frequency threshold 3			
Pr13	Skip width each side of threshold 1	± 0.5		
Pr14	Skip width each side of threshold 2			
Pr15	Skip width each side of threshold 3			
Pr20	Preset speed - 1	0		
Pr21	Preset speed - 2			
Pr22	Preset speed - 3			
Pr23	Preset speed - 4			
Pr24	Preset speed - 5			
Pr25	Preset speed - 6			
Pr26	Preset speed - 7			
Pr27	Jog frequency	1.5		
b20	Selection : jog + 3 preset speeds or 7 preset speeds	0 (3 speeds + JOG)		
b21 - b23	Selection : standard or specific acceleration/deceleration ramps	0		
b22	Not used			
b24	Function of terminal 19.	0		
b26	Disable " Ac uu " detection	0		
b27	Specific braking	0		
b28	Enable PI control loop	0 (disabled)		
Pr30	Acceleration preset speed - 1	FMV 2306 : 5.0 FMV 2306 AS 1.5T to 11T : 5.0 FMV 2306 AS 16T to 120T : 100		
Pr31	Acceleration preset speed - 2			
Pr32	Acceleration preset speed - 3			
Pr33	Acceleration preset speed - 4			
Pr34	Acceleration preset speed - 5			
Pr35	Acceleration preset speed - 6			
Pr36	Acceleration preset speed - 7			
Pr37	Acceleration - jogging	0.2		
Pr40	Deceleration preset speed - 1	FMV 2306 : 10.0 FMV 2306 AS 1.5T to 11T : 10.0 FMV 2306 AS 16T to 120T : 100		
Pr41	Deceleration preset speed - 2			
Pr42	Deceleration preset speed - 3			
Pr43	Deceleration preset speed - 4			
Pr44	Deceleration preset speed - 5			
Pr45	Deceleration preset speed - 6			
Pr46	Deceleration preset speed - 7			
Pr47	Deceleration - jogging	0.2		
Pr50	Number of automatic resets	0		
Pr51	Delay of automatic resets	1		

Parameter		Factory setting	Special setting	Special setting
b50	Selection of the relay function, terminals 1 - 2 - 3 : inverter status or minimum frequency - FMV 2306 1.5T to 11T FMV 2306 AS 1.5T to 11T Selection of the relay function, terminals R1 - R2 - R3 : inverter running or at frequency - FMV 2306 16T to 100T FMV 2306 AS 16T to 120T	0 (inverter status) 0 (running)		
b51	Enable "FWD/REV" key	0 (disabled)		
b52	Enable flying restart	0 (disabled)		
b53	Selection of logic output A0 : inverter running or minimum frequency - FMV 2306 1.5T to 11T FMV 2306 AS 1.5T to 11T Selection of logic output A3 : overload alarm or inverter status - FMV 2306 16T to 100T FMV 2306 AS 16T to 120T	0 (running) 0 (overload)		
b54	Selection : fixed or dynamic U/f characteristic	0 (fixed U/f)		
b55	Ramps on loss of mains supply	0 (Pr3 and Pr2)		
b56	Management of minor trips	0 (freewheel stop)		

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