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Printed in FRANCE
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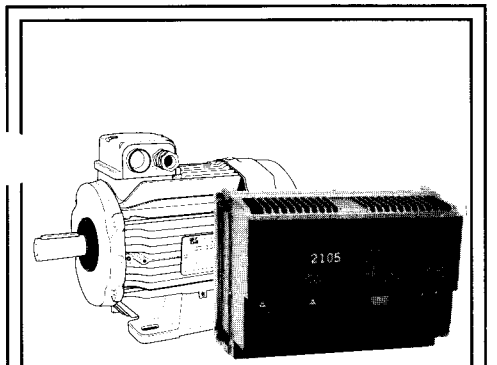
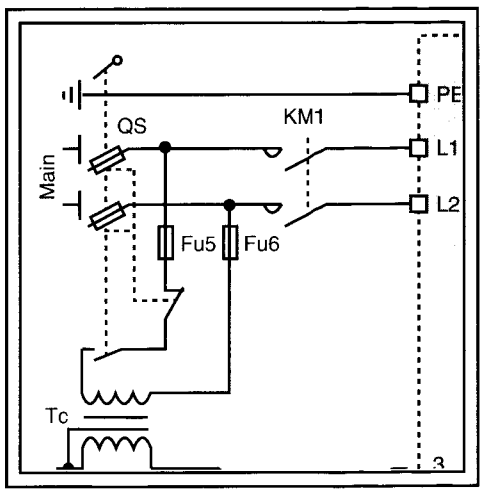
Réf. 1370 - 033 / a - 2.93





LS FMV 2105

Asynchronous motor for speed modulation

Installation and maintenance

DIL Switch		Factory default settings	First change			Second change		
				Date	Set by		Date	Set by
SW1A	Relay function	Off = trip relay						
SW1B	Relay function	Off = trip relay						
SW1C	Analogue output of speed or load	Off = same as display						
SW1D	Fixed/dynamic V/F	Off = fixed V/F						
SW1E	Normal or "Wireproof" mode	Off = normal						
SW1F	Pr0 = Min speed or Pr0 = Preset 2	Off = Pr0 is min speed						

8 - PARAMETER SETTING RECORD

Parameter		Factory default settings	First change			Second change		
				Date	Set by		Date	Set by
Pr0	Min freq/Preset 2	O Hz						
Pr1	Max freq/Preset 3	50 Hz						
Pr2	Acceleration time	5 seconds						
Pr3	Deceleration time	10 seconds						
Pr4	Current limit	150 %						
Pr5	Continuous current	100 % FLC						
Pr6	Voltage boost	9.8 %						
Pr7	Jog frequency/ Preset 1 frequency	0 Hz						
Pr8	DC braking period	1 s						
Pr9	Serial address	11						
PrA	Trip	Et						
Prb	Security code	0						
b0	Auto reset	0 = disabled						
b1	Auto/Manual start	1 = manual start						
b2	Stop mode with b7	0 = standard ramp						
b3	Auto/fixed boost	0 = auto						
b4	Jog/Preset	1 = preset						
b5	Catch spinning motor	0 = disabled						
b6	Analogue/Serial comms	0 = analogue						
b7	Stop mode with b2	0 = standard ramp						
b8	Freq/Load display	0 = frequency						
b9	Keypad/Terminal	1 = terminal						
b10	Even/Odd parity	0 = even						
b11	Analogue speed ref	U_r voltage input						
b12	Baud rate	4.8 kb						
b13	Reset defaults	0 = inactive						
b14	PWM / ULF	2.9 kHz / 120 Hz						
PrC	MVF	50 Hz						

NOTE

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LEROY-SOMER gives no guarantee, whether expressed or implied, covering the information contained in this bulletin, and accepts no responsibility to any errors contained therein, nor for damage occasioned by its use.

WARNING

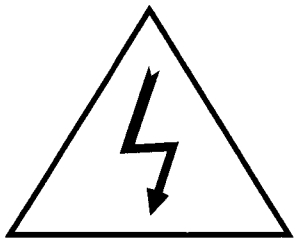
- For user safety, this frequency controller should be earthed (⏚).

- The frequency controller is fitted with safety devices which can, in the case of certain faults, stop the frequency controller and the motor. The motor itself can be jammed by mechanical means. Finally, voltage fluctuations, and particularly power cuts can also cause the controller 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, by fitting a zero speed detector which will cut the supply to the controller, in the case of unprogrammed stoppages.

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.



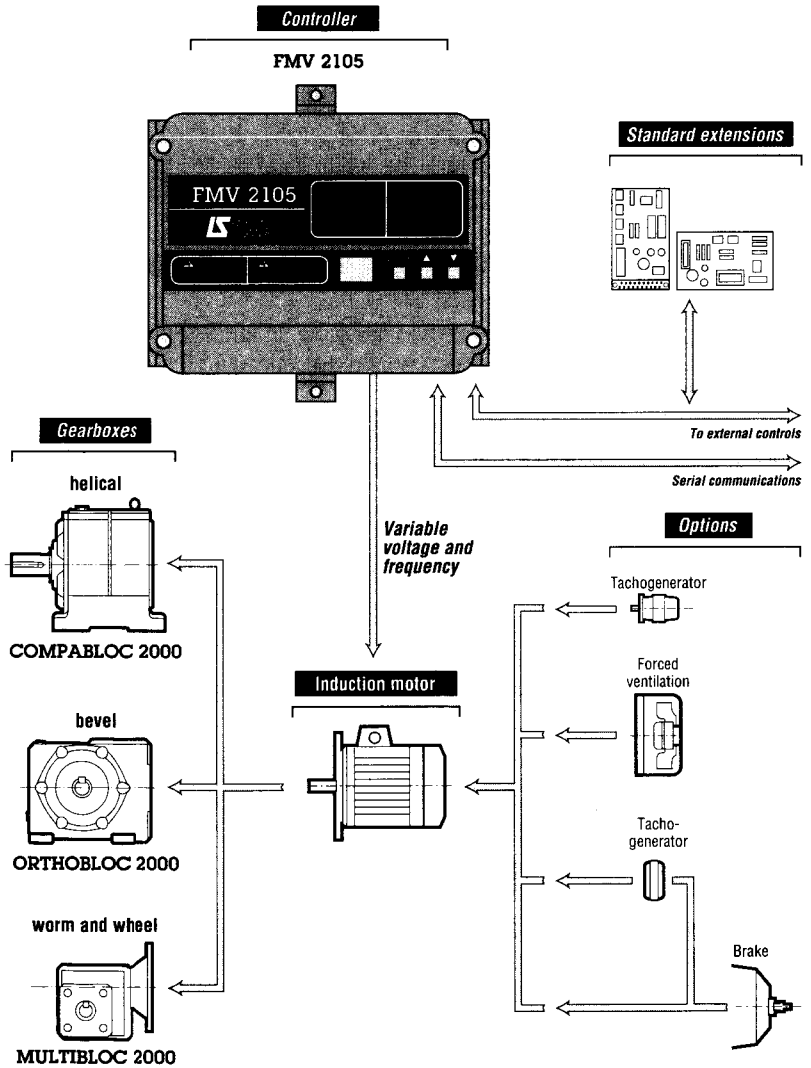
DANGER

IMPORTANT

BEFORE TOUCHING ANY PART OF THE ELECTRICAL OR MECHANICAL PARTS OF THE INSTALLATION OR MACHINE :
- check that the controller power supply is switched off (fuse disconnector or circuit-breaker) and manually locked (with key),
- wait until the discharge of the capacitors (after approximately 60s).

FOREWORD

This technical booklet describes the installation of the **FMV 2105** digital frequency controller. It describes in detail the relevant procedures required when commissionning the controller and the possible peripheral devices.



Drives
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7.5.7 - C1 – Drive configuration word 1 (2 hexadecimal digits)

This is a one byte hex value word (two hexadecimal digits) enabling the state of the dil switch and internal link 0 to be read. (It is read only).
The two digits following the > symbol decode into binary states to indicate the state of the dil switch and link 0.

For example, to read C1 for drive num-ber 11, send :

EOT Control-D	1	1	1	1	C	1	ENQ Control-E

The drive replies, for example :

STX Control-B	C	1		>			0	7	ETX Control-C	H (BCC)

The data following the > character are treated as hex characters, and decode to binary as follows :
0 — 0000, 7 — 0111

The message decodes, from the C1 table, as : Lk0 in — SW1F ON — SW1E ON — SW1D ON — SW1C OFF — SW1B OFF — SW1A OFF (see Chapter 6 for full definition of the switch functions).

C1 – Configuration word

Digit position	Function	0	1
1st	Not used	–	–
	Lk0	IN	OUT
	SW1F	ON	OFF
	SW1E	ON	OFF
2nd	SW1D	ON	OFF
	SW1C	ON	OFF
	SW1B	ON	OFF
	SW1A	ON	OFF

Example

Hex	Binary
0	0 (msb)
	0
	0
	0 (lsb)
F	0 (msb)
	1
	1
	1 (lsb)

7.5.6 - CW – Command word (2 hexadecimal digits)

This is a one-byte hex-value word enabling the drive to be controlled through the serial link. It is important to note that some of the terminal inputs are not disabled, even when b6=1 they remain operative (START, STOP, RESET, EXTERNAL TRIP, local/-remote).

The two digits decode into states which control the principal command functions of the drive, as follows :
RESET, TRIP (external), STOP, START

CW allows the drive to state the direction of rotation as set by the control terminal Forward/Reverse (TB1/6) in reply to interrogation, but cannot be used to reverse the rotation.

REVERSE command is given by using a negative speed reference SP (see table of mnemonics).
To read CW for drive number 11, send :

EOT Control-D	1	1	1	1	C	W	ENQ Control-E

The drive replies, for example :

STX Control-B	C	W				>	1	6	ETX Control-C	• (BCC)

The data following the character > decodes from hex to binary, to mean :
not reset — emergency stop/external trip input closed — direction set to forward — jog/preset terminal closed — not stop — not run.

Command word CW

Digit position	Function	Terminal input status 0	Terminal input status 1
1st	Not used	–	–
	Not used	–	–
	Reset	open	closed (reset)
	Emergency stop/External trip	open (tripped)	closed
2nd	fwd/rev*	open (fwd)	closed (rev)
	local/remote*	open (local)	closed (remote)
	Stop	open (stop)	closed
	Start	open	closed (run)

Example

Hex	Binary
1	0 (msb)
	0
	0
	1 (lsb)
6	0 (msb)
	1
	1
	0 (lsb)

* Cannot be changed through the serial communications link using CW

Typical values of command word CW

Function option selected	CW values during... Power-up	Start	Stop	Reset	Ext trip	Not start Not reset Not trip
forward remote	16	17	14	36	06	16
reverse remote	1E	1F	1C	3E	0E	1E
forward local	12	13	10	32	02	12
reverse local	1A	18	18	3A	0A	1A

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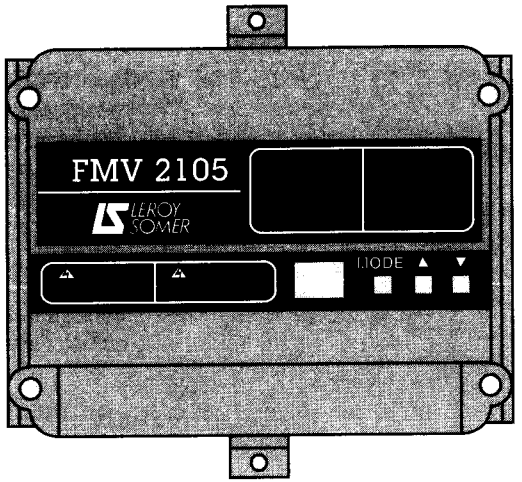

Figure 1-1

1 - INTRODUCTION

- Full digital control.
- Digital adjustment of most drive parameters.
- Insulated gate bi-polar transistor (IGBT) output bridge for high speed switching and low power consumption.
- Choice of up to four switching frequencies in range 2.9 to 11.7 kHz.
- High output frequency. Up to 960Hz available.
- Variable and fixed V/F characteristics.
- Internal monitoring and protection includes Ixt overload, current limit, peak limit, instantaneous overcurrent and individual IGBT protection.
- Isolation between control and power electronics.
- Ability to start drive into coasting motor, rotating in either direction with no large transient torque or current.
- 150% current.
- DC injection braking.
- 3 Preset speeds or jog facility.
- Auto restart after trip.
- Last fault indication.
- Security code protection.
- Selectable relay function.
- Selectable 'Wireproof' Mode.
- RS485 serial communications interface.
- Single phase mains supply. Wide range of input voltage.
- Voltage control for both constant and speed dependent torque applications.
- Sinusoidal waveform at all output frequencies.

There are four possible states of **analogue reference.**

Analogue reference		Speed reference input
a	b	
0	0	0/20 mA
0	1	4/20 mA
1	0	20/4 mA
1	1	Ur

There are four possible states of **stopping mode.**

Parameter		Mode
b2	b7	
0	0	Standard ramp
0	1	Coast
1	0	Inject dc
1	1	High level ramp

7.5.5 - FQ – PWM switching frequency & ULF (2 hexadecimal digits)

FQ is a one-byte word. The status of PWM switching frequency and ULF are given by the following FQ codes :

To read FQ for drive number 15, send :

EOT Control-D	1	1	1	1	D	S	ENQ Control-E

The drive replies, for example :

STX Control-B	D	S		>	4	F	8	4	ETX Control-C	t (BCC)

The two characters following the symbol > require no further translation. They are compared with the codes in the table for FQ. The reply in this example means that drive 15 is operating at 5.9kHz PWM switching frequency, and the ULF is set at 120Hz.

The settings of these frequency parameters can be changed by an operator (computer) or by a plc programmed to send the FQ codes. To set the frequency parameters of drive number 15 to 5.9kHz and 120Hz, the complete message is :

EOT Control-D	1	1	5	5	STX Control-B	F	Q				>	1	0	ETX Control-C	+ (BCC)

Word FQ	PWM switching frequency	MVF
00	2,9 kHz	120 Hz
01	2,9 kHz	240 Hz
10	5,9 kHz	120 Hz
11	5,9 kHz	240 Hz
12	5,9 kHz	480 Hz
20	8,8 kHz	120 Hz
21	8,8 kHz	240 Hz
22	8,8 kHz	480 Hz
30	11,7 kHz	120 Hz
31	11,7 kHz	240 Hz
32	11,7 kHz	480 Hz
33	11,7 kHz	960 Hz

The data following the > character are treated as hex digits, and decode to binary as follows : 4 — 0100, F — 1111, 8 — 1000, 4 — 0100

The message decodes, from the Drive Setup table, as :
speed control mode — auto start mode — coast to stop — fixed boost — jog input — catch spinning motor disabled — serial mode — frequency (speed) display — keypad control — even parity bit — 4/20mA speed reference — Baud rate 4800.

To write to drive number 11, sending the same parameter settings as in the previous example, which is a complete set-up command, the message would be :

EOT Control-D	1	1	1	1	STX Control-B	D	S		>	4	F	8	4	ETX Control-C	t (BCC)

The drive replies ACK if the transmitted data is understood, or NAK if not (in which case look for an error in writing the characters or in the format of the message).
Note that parameters **b6**, **b10** and **b12** cannot be written to the drive through the Serial Communications link, although they must be included to form a complete message. The drive ignores these when received, but does not ignore them when interrogated about the drive configuration.

Drive setup DS

Digit position	Bit parameter		0	1
1st	Not used		–	–
	Auto reset	**b0**	enabled	disabled
	Start mode	**b1**	auto	manual
	Stopping mode	**b2**	see stopping mode table	
2nd	Boost mode	**b3**	auto	fixed
	Jog/Preset	**b4**	jog	preset
	Catch spinning motor	**b5**	disabled	enabled
	Analogue input/serial comms	**b6**	analogue	serial
3rd	Stopping mode	**b7**	see stopping mode table	
	Display	**b8**	frequency	load
	Control mode	**b9**	keypad	terminal
	Parity bit	**b10**	even	odd
4th	Analogue reference – **a**	**b11**	see analogue reference table	
	Analogue reference – **b**	**b11**	see analogue reference table	
	Not used		–	–
	Baud rate	**b12**	4800	9600

Example

Hex	Binary
0	0 (msb)
	1
	0
	0 (lsb)
F	1 (msb)
	1
	1
	1 (lsb)
8	1 (msb)
	0
	0
	0 (lsb)
4	0 (msb)
	1
	0 (lsb)

Drives
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2 - DRIVE SPECIFICATION

2.1 - Ratings

The **FMV 2105** 1.5 M to 3.5 M range is rated for current output, therefore the actual power output depends on the output voltage, which in turn depends on the supply voltage.

2.1.1 - Power supply

Input supply voltage range and frequency : 200 - 240V AC ±10%, 48 - 62 Hz single phase

Minimum supply source impedance : 0.09 Ohms (@ drive terminals)

2.1.2 - Output ratings

The drive system is for general purpose industrial drives which require a short term overload capability of 150% for 60 seconds refer to table 2-1.

Drive model	Output		Motor rating	Input	
	FLC A rms	Overload 150 % Arms	kW (1)	FLC A rms (2)	Overload (150%) A rms (2)
FMV 2105 - 1.5 M	4.0	6.0	0.75	10.5	14.5
FMV 2105 - 2.5 M	7.0	10.5	1.5	18.7	25.9
FMV 2105 - 3.5 M	10.0	15.0	2.2	25.6	35.6

Drive model	Input			
	Displacement factor (appx) (3)	Power factor (4)	Maximum switch on surge a peak (5)	Maximum i^2T of switch on surge A^2S (5)
FMV 2105 - 1.5 M	0.95	0.52	195	28
FMV 2105 - 2.5 M	0.95	0.52	200	51
FMV 2105 - 3.5 M	0.95	0.53	419	171

Notes :

(1) Typical motor power for stated output current, based on a typical 4 pole machine at 220V.
(2) With 220V supply and minimum source impedance.
(3) Displacement factor is the cosine of the phase angle between fundamental voltage and fundamental current and approximates to unity with a low impedance supply.
(4) Power factor is (average power supplied) / (Vrms x Arms (input)). The value shown is at 220V and minimum source impedance.
(5) With 240V +10% supply and minimum source impedance.

2.2 - Specifications - General

2.2.1 - Losses

Drive model	Heat loss W	Efficiency %
FMV 2105 - 1.5 M	85	93
FMV 2105 - 2.5 M	115	94
FMV 2105 - 3.5 M	135	95

2.2.2 - Altitude

Rated up to 1000 meters above sea level. Above 1000 meters above sea level derate FLC by 1%/100 meters to a maximum altitude of 4000 meters above sea level.

RELEVANT SPECIFICATION

IEC 146-2, Section 3.1.a.
VDE 0160, Section 5.2.1.1, Part c
UL508, Section 52.2
CSA 22.2, Section 6.2.3

2.2.3 - Ambient temperature and humidity

Rated ambient temperature :
- -10°C to +40°C

Maximum operating ambient temperature :
0°C to +50°C
Maximum storage ambient temperature :
-25°C to +50°C
Humidity : Non condensing

2.2.4 - Environmental protection

Ingress protection IP10 (Finger protection).

2.2.5 - Materials

All plastics have flammability rating UL94 VO.

2.2.6 - Weights

Module weight, including chassis, is 2.9kg.

2.2.7 - Response time

Time to energise output stage is 20 ms (maximum) using electronic "start" terminal, or 100 ms (maximum) from application of power to the input terminal block TB1 (Auto-start mode).

2.2.8 - Current loop response time

Fastest selectable acceleration and deceleration times 0.2 seconds to upper limit frequency.

Current loop response is fast enough to prevent tripping on fastest acceleration setting or instantaneous application of a load of 150%.

2.2.9 - Electromagnetic Compatibility

EMC

The drive is designed to facilitate compliance with EMC requirements such as EC Directive 89/336/EEC.

IMMUNITY

Meets IEC801 without significant disturbance to operation at the following levels:

Part 4 (Transient Burst)
Level 4 at all terminals.

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Status word SW

Digit position	Flags and trip code		ok	fault
1st	Not used		–	–
	Drive over-temperature	**Ot**	0	1
	Motor over-temperature	**th**	0	1
	I x t overload	**It**	0	1
2nd	Current peak trip	**OI**	1	0
	Power supply failure	**PS**	1	0
	Undervoltage trip	**UU**	1	0
	Overvoltage trip	**OU**	1	0
3rd	Not used		–	–
	Current loop loss	**cL**	0	1
	Error flag	**Err**	0	1
	Tripped flag		0	1
4th	Run flag. 1 = set to run		See ready table	Run/status
	Ready flag. 1 = drive ready			
	Not used		–	–
	Not used		–	–

Example

Hex	Binary
0	0 (msb)
	0
	0
	0 (lsb)
E	1 (msb)
	1
	1
	0 (lsb)
1	0 (msb)
	0
	0
	1
C	1 (msb)
	1
	0
	0 (lsb)

Run / Ready states

Run	Ready	Status indicated
0	0	Drive stopping on ramp control
0	1	Drive stopped and ready to run (rdY)
1	0	Drive running
1	1	Drive tripped, awaiting RESET, and trip code flashing on the keypad display

Note that trip states are held in **PrA** even after a reset and will be changed only by a subsequent trip. The trip itself, however, continues to exist only if the tripped flag equals "fault".
To detect an external trip (**PrA** = **Et**), note that the tripped flag indi-cates 1 while all other indications and flags are **ok** — not faulty.

7.5.4 - DS – Drive setup (4 hexadecimal digits)

This is a 2-byte hex-value word enabling the state of bit-parameters b0 to b12 inclusive to be read or changed.

Parameters b6, b9, b10 and b12 are read-only and cannot be changed. The four characters following the > symbol decode into binary states, in a similar way as for the Status Word, to indicate the value of the bit parameters. For example, to read DS for drive number 11, send :

EOT Control-D	1	1	1	1	D	S	ENQ Control-E

The drive replies, for example :

STX Control-B	D	S		>	4	F	8	4	ETX Control-C	t (BCC)

7.5 - Configuring the drive through serial communications

Most drive mnemonic parameters can be expressed by six digit numbers, however the following mnemonic are expressed by two or four hexadecimal code digits :

SE Serial Address (Pr9)
SC Security Code (Prb)
SW Status Word, SW
DS Drive Setup
FQ PWM Switching Frequency and ULF (b14)
CW Command Word
C1 Configuration Word

The drive configuration (DS), for example, expresses the state of each of the 13 parameters b0 to b12 inclusive.
This simplifies the programming of such changes and enables blocks of relatively complex data to be delivered by one message using two-byte hexadecimal "word" codes.
Hex Code Words are transmitted in ASCII format, but are always preceded by the symbol ">" which enables the receiving drive/host to decode them in a special way. This is best explained by an illustration of each of the above special mnemonics.

7.5.1 - SE – Serial address (2 hexadecimal digits)

This is a read-only parameter. To read SE for drive number 22, for example, send :

EOT Control-D	2	2	2	2	S	E	ENQ Control-E

The drive will reply :

STX Control-B	S	E				>	1	6	ETX Control-C	, (BCC)

The data following the > symbol is hex 16, which is 22 decimal, confirming the Serial Address.

7.5.2 - SC – Security code

7.5.3 - SW – Status word (4 hexidecimal digits)

This is a 2-byte hex value word which enables the status or previous trip indications of the drive to be read. (It is read only). The four characters decode to indicate the status of :
Last trip — Error Flag — Trip Flag — Run/Ready status

Thus, to read the state of drive number 11, send :

EOT Control-D	1	1	1	1	S	W	ENQ Control-E

The drive replies, for example :

STX Control-B	S	W		>	0	E	1	C	ETX Control-C	> (BCC)

The four characters following the > symbol are treated as hex digits and are further decoded into their binary equivalents :
0 — 0000, E — 1110, 1 — 0001, C — 1100

Comparing each character with the appropriate section of the Status Word table enables the message to be translated as :

0 means not tripped on any of the trips defined by the 1st hex digit.
E last trip was overvoltage trip.
1 tripped flag indicating a fault.
C drive tripped; indicating RESET and trip code flashing on keypad display.

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2.3 - Specifications - Control

2.3.1 - Analogue inputs

(1) Local speed reference (TB2/11) :
unipolar 0 to +5V, 100K input impedance

(2) Local speed reference (TB2/9) :
0 to +10V, 200 K input impedance

(3) Remote speed reference (current) (TB2/15) :
4 to 20mA, 100 Ohms input impedance or
20 to 4mA, 100 Ohms input impedance or
0 to 20mA, 100 Ohms input impedance

(4) Motor thermistor (PL6/2) :
External resistor connected to OV
Voltage out < 2.5V, capable of protecting 6 standard 250R machine thermistors connected in series.
Trip resistance 3k ±15%, reset 1k8 ±15%.
Trip when resistance < 100R ±15%.

Note : An internal 1k5ohm resistor is connected via LK4 across this input. If the user wishes to use this input LK4 must be removed.

2.3.2 - Analogue output

Hardware DIL switch selectable.
Frequency (speed) (TB2/13) :
0 to 5Vdc, or 1 mA capability ;
0V = 0Hz, 5V = <Pr1>. Accuracy ±3%.

Load (torque) (TB2/13) :
0V = no load, 5V = +150%
Accuracy ±15%

2.3.3 - Digital inputs

Each digital input has an internal 10Kohm pull up resistor to 5V.

(1) Start (TB2/4) :
momentary low = start
(N/O contact to oV common)

(2) Stop (TB2/5) :
low = not stop, momentary high = stop
(N/C contact to 0V common)

(3) Forward/Reverse (TB2/6) :
low = select reverse direction
(contact to 0V common)
high = select forward direction

(4) Jog/Preset Speed (PL6/4) :
low = jog/preset 1 speed
(contact to 0V common)

Note : This input can be software selectable by bit parameter b4 to give either jog input or a preset 1 speed select input.

(5) External trip (PL6/8) :
low = not stop/trip
(N/C contact to 0V common)
momentary high = stop/trip

(6) Reset (TB2/10) :
momentary low = reset
(N/O contact to 0V common),
edge triggered input

(7) Local/Remote (PL6/9) :
low = remote, i.e. all inputs useable
high = local, i.e. speed reference from TB2/9 or 11 only

(8) Preset speed 2 input (PL6/6) :
low = active

2.3.4 - Digital outputs

Drive relay (TB2/1, 2 and 3) :
volt free contact. Rated 110V ac, 7A. resistive.
Switch configured (SW1 A, B) for STATUS/AT SPEED/ZERO SPEED, or RUN RELAY function.
Changeover type relay.

2.3.5 - Serial communications interface

RS485, RS422.
Protocol is ANSI x 3.28 - 2.5 - A4
Hardware interfacing is 5 wire, RS485 which is upwardly compatible with RS422. RS232 can be accomodated with some systems see Chapter 7 for details. The hardware supports multidrop operation with a maximum of 32 receiver channels connected to any one transmit channel. The hardware is not isolated.

Note : For interface cable details, refer to Chapter 4 "Installation - Electrical".

SERIAL COMMUNCATIONS I/O
Differential input :
0 to 5Vdc, input impedance 3.5k
V(A-A\) > +0.2V = logic high at the receiver
V(4-A\) < -0.2V = logic low at the receiver

Differential output transmitting :
Output is 0.7 to 4Vdc with no load,
current capability ±60mA.
Logic high at the microprocessor
A = 4V, A\ = 0.7V.
Logic low at the microprocessor
A = 0.7V, A\ = 4V.

i.e. the differential voltage is ±3.3V on no load.
Maximum input voltage 12V wrt 0V.
Minimum input voltage -7V wrt 0V.

2.3.6 - Accuracy

Frequency :
- accuracy ±0.01% full scale
- resolution 0.1% full scale

Note : These figures imply :
- crystal controlled internal reference.
- display resolution 0.1 Hz.

2.3.7 - Resolution

When parameters are set from the keypad or serial communications link, resolution is ±0.1 unit except for the following.

Value > 100 units ±1.0 unit, keypad mode

Acceleration and deceleration rates :
resolution becomes coarser towards 600 seconds.

Pr0, Pr1, Pr7 :
±0.2 Hz for ULF = 240 Hz
±0.4 Hz for ULF = 480 Hz
±0.8 Hz for ULF = 960 Hz

Pr6 :
±0.4%

Display resolution :
±0.1 Hz

2.3.8 - Auxiliary supplies and references

(1) +5V ±2%, 0.5mA

(2) 0V common (Qty 3)

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7.4.4 - Block checksum (BCC)

To ensure that data received can be verified, a block checksum is attached to the end of each command or data response. The BCC is automatically calculated by the sending device (either host or drive) and is derived in the following manner.
First, a binary exclusive-OR is performed on all nine characters of the message after .he start-of-text command mnemonic (but excluding the parity, stop and start bits).
For example, if the message to be sent to drive number 14 is :
"set frequency to 47.6Hz in reverse"
it is sent as :

RESET	EOT (Control-D)
Serial address	1 1 4 4
Start of text	STX (Control-B)
	Not included in BCC calculation
	BCC calculation starts here
Set frequency mnemonic SP	SP
Reverse	- (a minus sign)
47.6	0 4 7 . 6
End of message	ETX (Control-C)
finally,	the calculated BCC

Each of the nine separate digits, "S" "P" "-" "0" "4" "7" "." "6" and "Control-C", is represented by a hexadecimal character and calculated in binary as shown in the table below; the XOR is shown progressively for each character.

Character	ASCII Binary code	XOR
S	0101 0011	–
P	0101 0000	0000 0011
- (minus)	0010 1101	0010 1110
0	0011 0000	0001 1110
4	0011 0100	0010 1010
7	0011 0111	0001 1101
. (decimal)	0010 1110	0011 0011
6	0011 0110	0000 0101
ETX (Control-C)	0000 0011	0000 0110

The final XOR, underlined, is the BCC provided that its equivalent decimal value exceeds 32 decimal (20 hex). As the ASCII characters from hex 00 to IF plus "space", are used only for control codes, the BCC has to exceed the value of 32 decimal. Whenever the XOR produces a (decimal equivalent) number less than 32, 32 is added. Thus, in the above example,
0000 0110 = 6 decimal, so that the BCC must be : 6 + 32 = 38 decimal, for which the ASCII character is "&".

Thus the complete message to set the speed of drive number 14, to 47.6Hz in reverse is :

EOT Control-D	1	1	4	4	STX Control-B	S	P	-	0	4	7	.	6	ETX Control-C	& (BCC)

SERIAL COMMUNICATION RESPONSE TIMING
Transmitting and receiving messages takes a finite time, to which further time must be added for the drive to process the information. To send a new drive parameter value will take 43.5ms at 4800 baud or 25.8ms at 9600 baud. To read a drive parameter will take 47.7ms at 4800 baud, or 27.9ms at 9600 baud.

CONTROL	ADDRESS				CONTROL	MNEM		DATA						CONTROL	BCC
EOT Control-D	1	1	4	4	STX Control-B	S	P	-	0	4	7	.	6	ETX Control-C	&

The drive will reply with an acknowledgement, either :
- ACK if the message is understood (whether implemented or not), or
- NAK if the message is invalid, the data is too long, or the BCC is incorrect.

If a value sent is outside the limits for a parameter, the drive will set the maximum value.
Parameters which cannot be written to are : b6, b10 and b12 (contained in DS), AC, C1, LD, SE, SW.

7.4.3 - Reading data

The format of a data request message is :

• Host request :
reset - address - mnemonic - end

For example, to find the speed set point SP of drive number 12, send :

CONTROL	ADDRESS				MNEM		CONTROL
EOT Control-D	1	1	2	2	S	P	ENQ Control-E

• The drive replies in the following form :
start - mnemonic - 6 characters of data - end - BCC

For example:

CONTROL	MNEM		DATA						CONTROL	BCC
STX Control-B	S	P	+	0	1	1	.	2	ETX Control-C	,

The reply first confirms that the data sent is the speed set point, SP; the six characters immediately following give the present setting in Hz.

The first character is either + or -, to indicate direction of rotation; the remainder is the numerical value - "forward at 11.2Hz" in this example.

The host may now request more information by (or starting a new request as described above) :

a) **Repeat enquiry** (From host)
The negative acknowledgement NAK (Control-U) sent by the host causes the drive to repeat the data sent for the same mnemonic. This process can be repeated as often as necessary by the host.

b) **Next parameter** (Enquiry from host)
To obtain data from the same drive for the next mnemonic in the mnemonic table (see below) send the positive acknowledgement ACK (Control-F). The drive will respond by transmitting the data relating to the next mnemonic in sequence.

Mnemonic sequence with ACK response is as follows :
SP → AC → LD, MN, MX, AL, DL, TR, TH, BO, PI, BR, SE, SC, SW, DS, FQ, BS, CW, C1

INVALID MNEMONIC (From host)
If the host sends a mnemonic which the drive does not recognise, eg XY, the drive will respond by repeating back the unrecognised characters in a message of the form :
start of text - unrecognised mnemonic - reset
Thus:

STX Control-B	X	Y	EOT Control-D

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3 - INSTALLATION - MECHANICAL

3.1 - Drive mounting

Principal dimensions are as shown in Fig. 3-1. The drive must be mounted in the orientation as shown, ie with the terminals at the bottom. Any other mounting position may interfere with the drive cooling.

3.2 - Location

The installation should be located in a place free from dust, corrosive vapours, gases and all liquids. Care must also be taken to avoid condensation of vaporised liquids, including atmospheric moisture.

If the drive is to be located where condensation is likely to occur when the drive is not in use, a suitable anti-condensation heater must be installed. The heater must be switched OFF when the drive is energised. An automatic changeover switching arrangement is recommended.

FMV 2105 drives are not to be installed in classified hazardous areas unless correctly mounted in an approved enclosure and certified (refer to "Hazardous Areas" Chapter 4 "Installation - Electrical").

3.2.1 - IP Rating

The drive enclosure conforms to international enclosure specification IP10 it is therefore necessary to consider the location of the module in the light of local safety regulations applicable to the type of installation.

3.2.2 - Hazardous areas

The application of variable speed drives and soft starters of all types may invalidate the hazardous area certification (Apparatus Group and/or Temperature Class) of Ex-protected squirrel cage induction motors. Approval and certification should be obtained for the complete installation of motor and drive.

3.3 - Cooling and ventilation

3.3.1 - Enclosure minimum dimensions

Care must be taken that the enclosure in which the drive is sited is of adequate size to dissipate the heat generated by the drive and any other equipment. A minimum clearance of 100 mm all around the drive is essential (refer to Fig. 3-3). All equipment in the enclosure must be taken into account in calculating the internal temperature so as not to raise the internal temperature of the cubicle above the maximum allowable for the drive.

3.3.2 - Effective heat-conducting area

The required surface area A_e for an enclosure containing equipment which generates heat is calculated from the following equation :

$$A_e = \frac{P_L}{k\,(T_i - T_{amb})}$$

where A_e = Effective heat-conducting area, in m^2, equal to the sum of the areas of the surfaces which are not in contact with any other surface.

k = Heat transmission coefficient of the material from which the enclosure is made.

T_i = Maximum permissible operating temperature of the drive module in °C.

T_{amb} = Maximum external ambient temperature in °C.

P_L = Power loss of all heat-producting equipment in Watts.

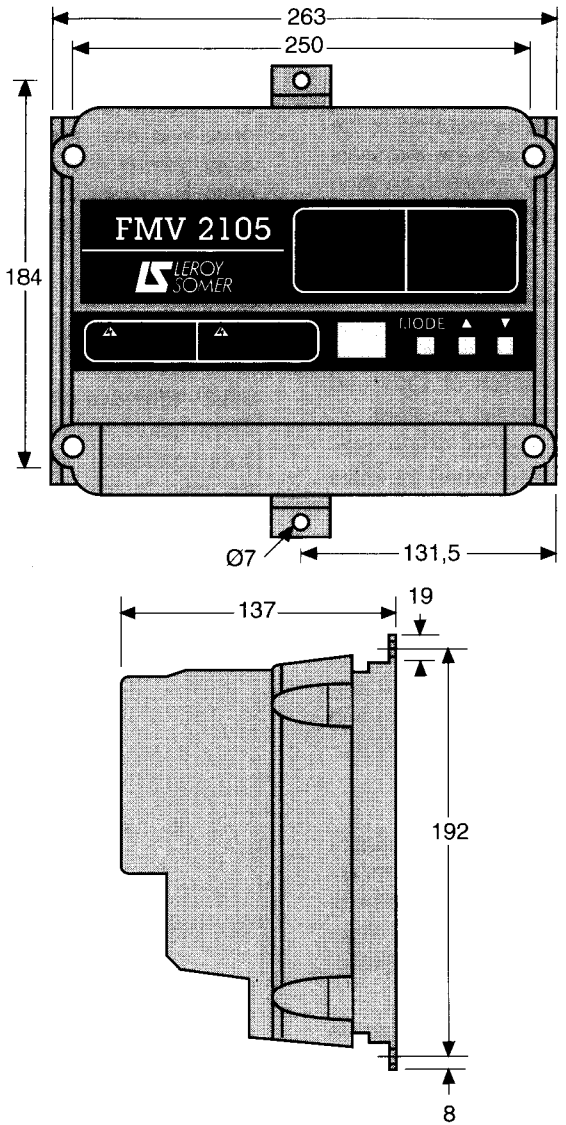

Figure 3-1
FMV 2105 - Drive mounting dimensions

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7.4 - Structure of messages

7.4.1 - Introduction

HOST TO DRIVE

A message cannot be sent to two or more more addresses simultaneously. If the same request or instruction is to be sent to more than one drive, it must be repeated with the new address each time.

Messages from host to the drive are of two kinds :
a request for information (Reading data) or a command (Sending data)

DRIVE TO HOST

Messages from the drive to the host are of two kinds :
a reply to a data request,
(see section "Reading Data") or
acknowledgement of a message
(see section "Sending Data")

DRIVE/HOST SET-UP

The following drive/host set-up is important to ensure correct and satisfactory communications.
Each drive requires a unique identity number, or serial address set by parameter **Pr9**. The baud rate **b12**, and the parity bit **b10**, require to be set to match the host. Data, drive status and the parameter set-up can be read from the drive in any mode, provided only that the drive is energised, and the above conditions met.
To enable the host to control the drive or to change parameter settings, the drive mode must have the above settings and be adjusted as follows :

Note : Local/Remote must be in remote to enable serial comms to write to parameters.

Four parameters are required to be set to enable operation of the serial communications link :

• Parity bit to be adjusted to suit the host
b10 = 0 even parity
b10 = 1 odd parity

• Baud rate to suit the host
b12 = 4.8 4800 baud
b12 = 9.6 9600 baud

• Serial address
Pr9 = 0 to 99

• Analogue input/serial communications mode to be set as follows
b6 = 1 if parameters are to be adjusted by the host.
b6 = 0 allows parameters to be read by the host.

7.4.2 - Sending data (from host to drive)

Note : If the data to be sent is one of the following :
Drive Configuration DS
or PWM Switching Frequency FQ
or Max. Voltage Frequency BS
the drive must also be in the rdY or tripped state, that is with the motor stopped or tripped.

The format of the command from host to drive is :
Host command :
reset - address - start of text - mnemonic - 6 characters - end - BCC

If the intended message to the drive is, for example, "change set frequency of drive number 14 to 47.6Hz in reverse", it would be sent as.

Table 7-3 - Data mnemonics in alphabetical order

Mnemonic	Name	Type of Data	Read	Write, only when rdy or tripped	Parameter
AC	Actual frequency	numeric (Hz)	•		-
AL	Acceleration time	numeric (s)			Pr2
BO	Boost level	numeric (% of Vmax)			Pr6
BR	DC brake time	numeric (s)			Pr8
BS	Base speed	numeric (Hz)		•	Prc
C1	Configuration	hex code	•		SW1A to SWF
CW	Command word	hex code			-
DL	Deceleration time	numeric (s)			Pr3
DS	Drive set-up	hex code		•	b0 to b12
FQ	Frequency (switching frequency & ULF)	hex code		•	b14
LD	Load	numeric (% of FLC) with sign	•		-
MN	Minimum frequency	numeric (Hz)			Pr0 also preset 2
MX	Maximum frequency	numeric (Hz)			Pr1 also preset 3
P1	Preset/jog frequency	numeric (Hz)			Pr7
SC	Security code	with sign hex number			
SE	Seria address	hex number	•		Pr9
SP	Set point frequency	numeric (Hz) with sign			-
SW	Status word	hex code	•		PrA
TH	Thermal current limit	numeric (% of FLC)			Pr5
TR	Transient current limit	numeric (% of FLC)			Pr4

Note : Parameters associated with serial communication are also read-only, b6, b10, b12. It is not possible to read or write to b13.

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Drive model	Heat loss W	Efficiency %
FMV 2105 - 1.5 M	85	93
FMV 2105 - 2.5 M	115	94
FMV 2105 - 3.5 M	135	95

Example :
Calculation of the size of an IP54 cubicle for a **FMV 2105** - 2.5 M drive

The "worst case" is taken as the basis of the example, so the following conditions are assumed :
- The installation is to conform to IP54, which means that the drive module and its heat sink are to be mounted wholly within the cubicle, and that the cubicle is virtually sealed and without any ventilation of the air inside. Heat can escape only by conduction through the wall of the cubicle, which is cooled by radiation to the external air.
- If the drive module is fitted into a cubicle its base and back surfaces cannot be considered to play any part in the cooling process (Fig. 3-2). The effective heat-conducting area, Ae, is provided by the top, front, and two sides only.
- The cubicle is to be made of 2mm sheet steel, painted.
- The maximum ambient temperature is 30°C.

To find the required heat-conducting area : the values of the variables appropriate to the above specification are :

P_L = 128 (losses)
T_i = 40°C (for all FMV 2105 drives)
T_{amb} = 30°C
k = 5.5 (typical value for 2mm sheet steel, painted)

$$A_e = \frac{128}{5.5\ (40 - 30)} = 2.33\ m^2$$

Note : It is essential to include any other heat-generating equipment in the value for P_L.

To find the dimensions of the enclosure :
If a cubicle is to be fabricated to suit the installation, there is a free choice of dimensions. Alternatively, it may be decided to choose a cubicle from a range of standard products.
Either way, it is important to take into account the dimensions of the drive module, and the minimum clearance of 100mm round the module as shown in Fig 3-3.
The procedure is to estimate two of the dimensions — the height and depth, for example — then calculate the third, and finally check that it allows adequate internal clearance.
The effective heat-conducting area of a cubicle as shown in Fig. 3-2 is :

$A_e = 2HD + HW + DW$

Where H is the cubicle height, D is the depth and W the width. Suppose the cubicle height H is 1.4m and the depth D is 0.3m, as a first estimate. The actual figures chosen in practice will be guided by available space, or standard enclosure sizes.
Since A_e H and D are known, the dimensions to be calculated is W. The equation needs to be re-arranged to enable W to be found, thus :

$Ae - 2HD = W\ (H + D)$

therefore $$W = \frac{A_e - 2HD}{H + D}$$

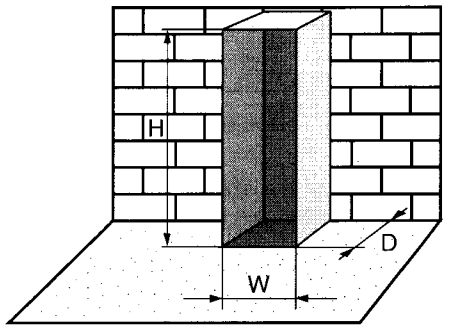
Substituting known values $$W = \frac{2.33 - 2 \times 1.4 \times 0.3}{1.4 + 0.3}$$

$W = 0.87$ m

Clearance on either side of the inverter module must be checked. The width of the module is 238mm, clearance of 100mm is required on either side. So the minimum internal width of the enclosure must be 438mm. This is within the calculated width, and therefore acceptable.

If a catalogue stock enclosure is to be used the corresponding surface area should be not less than the figure calculated above for A_e.

As a general rule, it is better to locate heat-generating equipment low in an enclosure to encourage internal convection and distribute the heat. If it is unavoidable to place such equipment near the top, consideration should be given to increasing the height of the cubicle or installing "stirrer" fans to ensure air circulation.



Enclosure with typically two surfaces unable to disperse heat.

Figure 3-2
Cubicle

Enclosure ventilation

If a high IP rating is not a critical factor, the enclosure can be smaller if a ventilating fan is used to exchange air between the inside and the outside of the enclusure.

To calculate the volume of ventilating air, V, the following formula is used :

$$V = \frac{3.1\ P_L}{T_i - T_{amb}}$$

where V = Required air flow in $m^3\ h^{-1}$

To find the ventilation required for a FMV 2105 - 2.5 M :

If P_L = 128W
T_i = 40°C (for all FMV 2105 drives)
T_{amb} = 30°C (for example)

Then $V = \frac{3.1 \times 128}{40 - 30}$

$V = 40\ m^3\ h^{-1}$

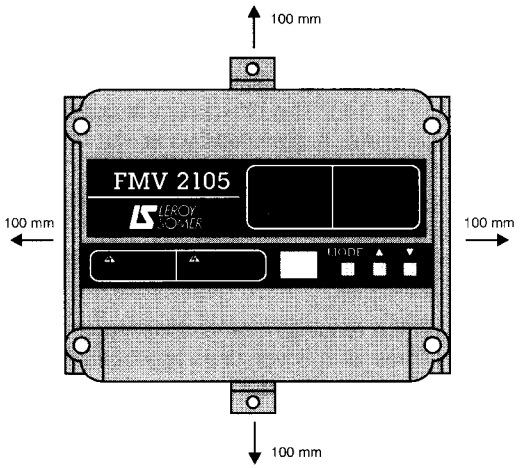


Figure 3-3
Minimum ventilation distances

Table 7-2 - "Low" ASCII character set

HEX	Most significant	0	1	2	3	4	5	6	7
Last significant	Binary	0000	0001	0010	0011	0100	0101	0110	0111
0	0000	NUL (^@) 0	DLE (^P) 16	Space 32	0 48	@ 64	P 80	` 96	p 112
1	0001	SOH (^A) 1	DC1 (^Q) 17	! 33	1 49	A 65	Q 81	a 97	q 113
2	0010	STX (^B) 2	DC2 (^R) 18	" 34	2 50	B 66	R 82	b 98	r 114
3	0011	ETX (^C) 3	DC3 (^S) 19	# 35	3 51	C 67	S 83	c 99	s 115
4	0100	EOT (^D) 4	DC4 (^T) 20	$ 36	4 52	D 68	T 84	d 100	t 116
5	0101	ENQ (^E) 5	NAK (^U) 21	% 37	5 53	E 69	U 85	e 101	u 117
6	0110	ACK (^F) 6	SYN (^V) 22	& 38	6 54	F 70	V 86	f 102	v 118
7	0111	BEL (^G) 7	ETB (^W) 23	' 39	7 55	G 71	W 87	g 103	w 119
8	1000	BS (^H) 8	CAN (^X) 24	(40	8 56	H 72	X 88	h 104	x 120
9	1001	HT (^I) 9	EM (^Y) 25	) 41	9 57	I 73	Y 89	i 105	y 121
A	1010	LF (^J) 10	SUB (^Z) 26	* 42	: 58	J 74	Z 90	j 106	z 122
B	1011	VT (^K) 11	ESC (^[) 27	+ 43	; 59	K 75	[91	k 107	{ 123
C	1100	FF (^L) 12	FS (^\) 28	, 44	< 60	L 76	\ 92	l 108	| 124
D	1101	CR (^M) 13	GS (^]) 29	_ 45	= 61	M 77	] 93	m 109	} 125
E	1110	SO (^N) 14	RS (^^) 30	. 46	> 62	N 78	^ 94	n 110	~ 126
F	1111	SI (^O) 15	US (^-) 31	/ 47	? 63	O 79	— 95	o 111	DEL 127

Note : Control characters also marked as (^D).

Start bit	"Low" ASCII character byte							Parity bit	Stop bit
	Seven data bits, variable								
0	lsb	"	"	"	"	"	msb		1
1st	2nd	"	"	"	"	"	8th	9th	10th
bit	bit						bit	bit	bit

Time

Each bit is transmitted for a set defined time as indicated by the baud rate (i.e. bits per seconds).

7.3.1 - Control characters

To conform to the standard structure of a message, the stages of a message are signalled by control characters.

SERIAL ADDRESS

Each drive is given a unique identity or address **(Pr9)** so that only the drive that is addressed will respond. For security, the format is that each digit of the two-digit drive address is repeated, thus the address of drive number 23 is sent as four characters :

	2	2	3	3	

The serial address follows immediately after the first control character of the message.

DATA MNEMONICS

To identify which operating parameter a message relates to, the parameters are represented by a data mnemonic (refer to Table 7-3), which is a simple two-character code. When data is being communicated, it is preceded by the appropriate mnemonic. The data mnenonic follows the serial address characters.

DATA

Data to be sent or requested occupies the next six characters after the data mnemonic. Data is handled in two different forms :
- as a plain numerical value, or
- as a Hex Code Word.

Most of the operating parameters of the drive, are **numerical** data, such as a value of frequency, load, current, etc. For example, speed is given as frequency in the range +960.0 to - 960.0 Hz. The value "95Hz in a reverse direction" is sent as :

Data	-	0	9	5	.	0
Character number	1	2	3	4	5	6

To enable the **state of bit-parameters** (and **Pr9**) to be transmitted conveniently, 2-byte and 4-byte Hex Code Words are used, as described fully under Hex Code Words below. Each byte decodes to describe the status of the bit parameter in detail. Use of a code for this purpose enables blocks of complex data to be handled quickly and economically and avoids long series of messages to cover the many bit parameters.

BLOCK CHECKSUM BCC

To permit the drive and the host to ensure that messages from one to the other have not become corrupted in transmission, all communications other than acknowledgements are terminated by a block checksum character.

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4 - INSTALLATION - ELECTRICAL

4.1 - Installation safety

4.1.1 - Safety

ELECTRIC SHOCK RISK!

Whenever the drive has been energised, it MUST be ISOLATED before work may continue. A period of ten minutes (**FMV 2105** - 3.5 M), seven minutes (**FMV 2105** - 2.5 M), or four minutes (**FMV 2105** - 1.5 M) MUST elapse after isolation to allow the internal capacitors to discharge fully. Until the discharge period has passed, dangerous voltages may be present within the module.
Persons supervising and performing electrical installation or maintenance must be suitably-qualified and competent in these duties, and should be given the opportunity to study, and to discuss if necessary, this User's Guide before work is started.

4.1.2 - Earthing

The drive must be connected to the system Earth by the heatsink Earth connection.
Earth impedance must conform to the requirements of local industrial safety regulations and should be inspected and tested at regular intervals.

4.1.3 - Motor speed

Standard squirrel-cage AC induction motors are designed as single speed machines. If it is intended to use the capability of the drive to run the motor at speeds above its designed maximum, it is strongly recommended that the motor manufacturer is consulted first.
The principal risks due to overspeeding are the destruction of the rotor by centrifugal force, or of the bearings by vibration or heat.
Low speed is liable to result in overheating of the motor because the effectiveness of the internal cooling fan reduces in proportion to the square of the reduction of speed. Motors should be equipped with thermistor protection, and if full benefit of the use of low speeds is to be gained from a variable speed drive it may be necessary to arrange additional cooling for the motor.

IMPORTANT NOTE

In order for access be obtained to the switches and links it is necessary for the module cover to be removed. Removal of the module cover requires that all power and control connections are disconnected.
It is therefore advised that the required drive configuration is selected by the necessary link and switch selections before the module cover is fitted.
It is also advised to connect any option boards e.g. T-FMV8 at this stage.
When re-fitting the module cover it is necessary to ensure that the keypad ribbon cable is correctly fitted.

4.2 - Power connections

Access to the power and control connections are gained by removing the snap-fit cover at the bottom of the drive.

L1 Line 1 (R) } TB1
L2 Line 2 (S) }
Earth/Ground - on heatsink

"U" Motor phase - U
"V" Motor phase - V } TB3
"W" Motor phase - W

Earth/ground connections are made to the metal heatsink. There are three earth/-ground terminals, one for the mains input, motor output and control terminals.

4.2.1 - Fuses and cabling

Drive model	*Line contactor A	Minimum cable size mm²
FMV 2105 - 1.5 M	16	1.5
FMV 2105 - 2.5 M	32	4.0
FMV 2105 - 3.5 M	40	6.0

*The use of slow fuses is recommended because a current surge may appear at power on. As an alternative to fuses, mcbs or mccbs may be used if equipped with adjustable thermal and magnetic trip devices of a suitable rating.
The supplier of the mcbs or mccbs should be asked to advise.

Drive model	Input			
	Displacement factor (appx)	Power factor	Maximum switch on surge a peak	Maximum i^2T of switch on surge A^2S
FMV 2105 - 1.5 M	0.95	0.52	195	28
FMV 2105 - 2.5 M	0.95	0.52	200	51
FMV 2105 - 3.5 M	0.95	0.53	419	171

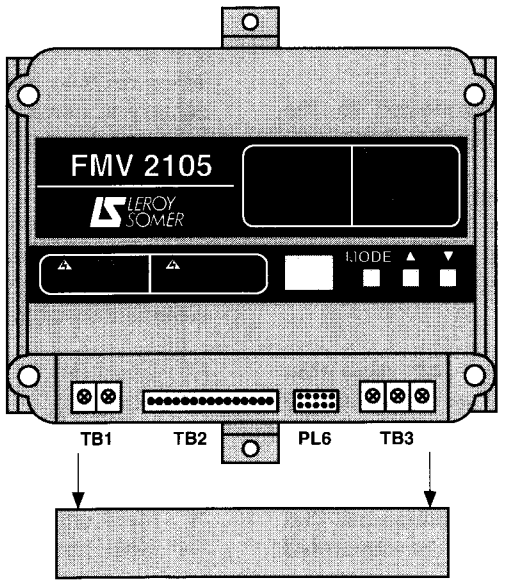

Figure 4-1
Terminal blocks location

Two hexadecimal characters each of four bits, making eight bits in all, are known as a "byte".
Each byte can be used to repre-sent a character of data.
The character set used in LEROY-SOMER drives is the "low" American Standard Code for information interchange (ASCII), comprising 128 characters. In the "low" ASCII set only 7 data bits are used in the byte to represent the characters, refer to Table 7-2.
The first 32 characters in the ASCII set (hex 00 to IF, "NUL" to "os") are used to represent special codes.

These are the Control Codes, each of which has a par-ticular meaning refer to Table 8-1. For example, "start of text" is STX, and, from a keyboard, is made by holding down the Control key and striking B once (Control-B). This is hex 02, and the actual trans-mission is the binary byte 0000 0010. The drive is programmed to know that this cha-racter signals that a command will follow :
Table 7-1 details the only control codes that the **FMV 2105** drive will respond to, other control codes and the "space" character (20h) should not be used when communicating with the **FMV 2105** drive.

Table 7-1 - Control characters in FMV 2105 Drives

Character	Meaning	ASCII code hex –	Keyed as... Control
EOT	Reset	04	D
ENQ	Enquiry, interrogating the drive	05	E
STX	Start of text	02	B
ETX	End of text	03	C
ACK	Acknowledge (message accepted)	06	F
NAK	Negative acknowledge (message not understood)	15	

The components of all messages between the host and a **FMV 2105** drive are formed of ASCII characters.
Each ASCII character that is transmitted or received has a start bit prior to the 7 ASCII bits, a parity bit and a stop bit. The 3 extra bits are necessary to synchronise data transmission and provide error checking.

The convention is that the start bit is a 0 and the stop bit a 1.
The parity bit is present to allow the re-ceiver of the character to check that the character is valid.
The format (i.e. time sequence) of the ASCII character is shown diagrammati-cally.

7.2.3 - RS485 Connection

Refer to Figs. 7-2, 7-3 and 7-5.
The standard connection used is RS485 which must use a braided screened 120 Ohm twisted pair cable, terminated at each end with a 120 Ohm resistor.

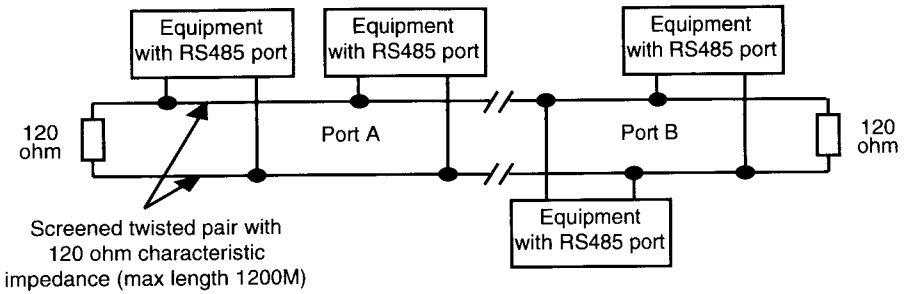

Figure 7-5
Standard RS485 connections

Stub connections to the equipment from the main cable must be as short as possible. If a **FMV 2105** Drive is connected at the end of a cable the terminating resistor can be fitted into the **FMV 2105** Drive (R113).

Note : Resistor value : 120 Ohm 0.25Watt.

7.2.4 - RS232 Connection

Refer to Fig. 7-1.
The serial port on the **FMV 2105** Drive can be configured to interface with an RS232 link. Using this configuration only one drive and receiver can be connected together. A terminating resistor is not used.
The user should note that the **FMV 2105** is not specified to be compatible with RS232. Some PLC's or computers generate and accept voltage levels outside of the specification of this product.
For users requiring reliable connection RS485 or RS422 should be used.

7.3 - Components of messages

Digital communications systems such as RS485 communicate by means of binary logic. Binary logic is "two state", and is readily implemented by an electrical circuit which is either "on" or "off". The two different states represent two distinct bits of data, either binary digit (bit) 0 or 1.

By fixing a time duration for each bit, a series of bits transmitted can be recognised by a receiver. If a group of bits contains the same number of bits it becomes possible to construct a variety of different "characters" that the receiver can recognise and decode.

A group of four bits has sixteen possible variants – 0000, 0001, 0010, and so on to 1111. Each of the sixteen variants represents one "hexadecimal" character-unit – the decimal numerals 0 to 9 followed by the six letters A to F – making 16 different and distinct characters.

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LS FMV 2105

4.2.2 - Power cable rating

600/1000V ac/dc cable sizes specified are for PVC/SWA cables laid under defined conditions, and are general recommendations only. Cabling should conform to local codes of practice and regulations.

IMPORTANT : The mains supply to the drive must be protected by either fuses, or an M.C.B.

The power connections to the motor, from the drive output, may be switched, for isolation purposes, but not for control purposes, as the drive may trip.
Installations prone to mains voltage disturbances may need special considerations; if so, consult with your supplier.
Long cable runs, in excess of 20 metres, between the drive and the motor may give rise to spurious tripping due to transmission line effects. If in doubt consult the supplier of the drive. Installations with long cable runs, to the motor, may need the addition of motor line chokes, to prevent nuisance tripping of the drive <PrA> = [OI], caused by capacitative leakage effects.

4.2.3 - Terminal block TB1

Terminal N°		
1	L1	200 to 240VAC ±10%
2	L2	

48 Hz - 62 Hz single phase

Minimum supply source impedance :
0.09 ohms (@ drive terminals)

Earth connection is via heatsink

RFI :
In common with all inverter drives, the unit will produce a certain level of Radio Frequency Interference. It is the users' responsibility, to ensure compliance with local requirements for RFI control. Filters specifically designed for use with the inverter are available from your supplier. In some cases general purpose mains supply RFI filters may be sufficient. Note that lowest levels of RFI emissions occur at the lowest switching frequencies.

4.2.4 - Terminal block TB3

Terminal N°	I/O	Name	Specification
U	O	Motor phase O/P U	Max. output nominally equal to supply input voltage. Variable frequency.
V	O	Motor phase O/P V	
W	O	Motor phase O/P W	

Motor speed

WARNING : Standard induction motors are not designed to operate at 240, 480 or 960 Hz. Any attempt to run such a motor at above twice synchronous speed may result in catastrophic motor failure. Consult your motor supplier for advice and details of special high frequency motors.

4.3 - Control connections

For control connections use cable of 0.5 mm^2 screened.
Connect screen to "earth" AT DRIVE ONLY using a very short connection (50mm Max.).
Always segregate control and power cabling.
Connections to terminals should be made to "earth" at sending end if long cables are used (i.e. greater than 5 m).

4.3.1 - Terminal block TB2

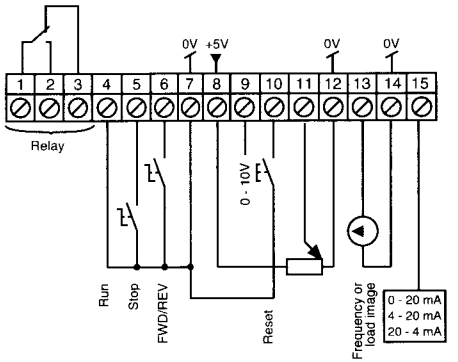
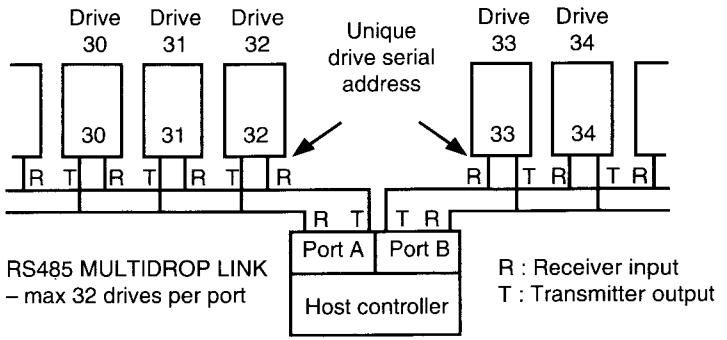


Figure 4-2

Terminal N°	I/O	Name	Specification
1	O	Relay N/C	110V ac, 7A non-inductive
2	O	Relay N/O	
3	O	Relay common	
4	I	Start input	Momentary low to start (low = 0V)
5	I	Stop input	Momentary high to stop
6	I	Forward/Rev	Low to select reverse direction
7	O	0V common	
8	O	+5V reference potentiometer O/P	5V ±2% tolerance, 0.5 mA
9	I	0 to 10V input	
10	I	Reset input	Momentary low to reset
11	I	0 to 5V input	e.g. via 10K potentiometer
12	O	0V common	
13	O	Frequency/Load Output	0 - 5V (> 100K source impedance) or, 0 - 1 mA (< 500Ω source impedance) to 100% speed (Pr1) or 150% load
14	O	0V common	
15	I	Current loop input	0-20mA, 4-20mA, 20-4mA selectable by bit 11 (b11)

All contactor coils, solenoids and brake coils must be suppressed with an RC network or equivalent.
The control electronics will be interfaceable with other industrial control products referenced to potentials within ± 50V (peak) relative to earth of the drives mains supply input.
Load signal : For a positive load, i.e. motoring, the display shows a steady value. For a negative load, i.e. regenerating, the display flashes. The analogue output, TB2/13 only gives an indication for positive load.

Drives
LS FMV 2105



Basic RS485 serial communications arrangement

Figure 7-3
RS485 Multidrop link connections

7.2.2 - RS422 Connection

Refer to Figs. 7-2 and 7-4.
Using a RS422 standard limits the number of receivers to a maximum of 10, also all receivers must be connected at the end of the cable and NOT along its length. The cable must be braided screen, 100 Ohm, twisted pair, terminated at the receiver end by a 100 Ohm resistor.

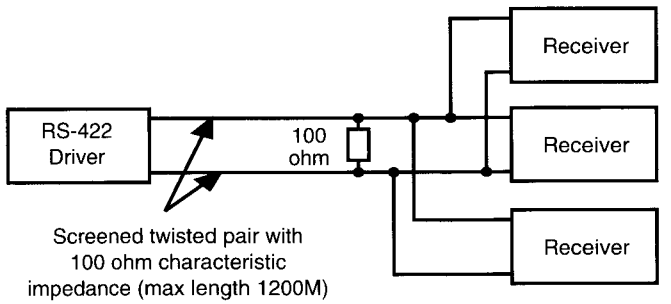


Figure 7-4
Standard RS422 connections

Note : The 100 Ohm terminating resistor (R113) can be fitted into one of the **FMV 2105** Drives. For Serial Port pin connections, refer to Fig. 7-2.

7 - SERIAL COMMUNICATIONS

7.1 - Introduction

A communications link is standard in all **FMV 2105** drives. It is a machine-machine link, enabling one or more drives to be used in systems controlled by a host such as a programmable logic controller (PLC) or computer. **FMV 2105** drives can be directly controlled, their operating configuration can be altered, and their status can be interrogated by such a host, and continuously monitored by data logging equipment. A host can operate up to thirty-two drives, refer to Fig. 7-3, and up to 99 if line buffers are used.

The communication port of the drive module is the four terminals 1, 3, 5, 7 (PL6), and the 0V terminal 10 (PL6). The standard connection is five wire RS485, or RS422 (refer to Fig. 7-2), three wire RS232 can be used in some systems (refer to Fig. 7-1).

The serial communications protocol used is ANSI x 3.28 - 2.5 A4 which is standard for many industrial interfaces.

7.2 - Connecting serial communications

7.2.1 - Serial communication connections

Serial communications :

- RS485 cable type :
braid screened, 120 Ohm characteristics impedance dual twisted pair and 0V.
- Termination : cable terminated at each end by 120 Ohm resistor.
- Maximum cable length : 1200 metres
- Operation : multidrop, equipment can be connected along the cable.

- RS422 cable type :
braid screened, 100 Ohm characteristics impedance dual twisted pair and 0V.
- Termination : cable terminated at receiver end by 100 Ohm resistor.
- Maximum cable length : 1200 metres.
- Operation : one transmitter can drive 10 receivers at the end of the cable.

- RS232 cable type :
braid screened, 3 core.
- Termination : None.
- Maximum cable length : 5 metres.
- Operation : one transmitter can drive one receiver.

Voltage levels :

Maximum + voltage with respect to 0V at any terminal = +12V

Maximum - voltage with respect to 0V at any terminal = -7V

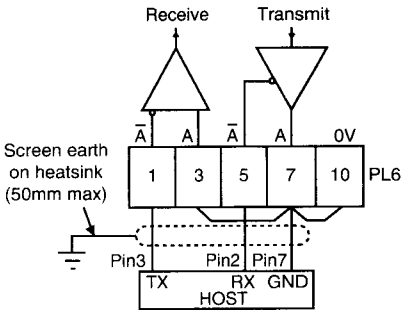


Figure 7-1
RS232 Communications link connections

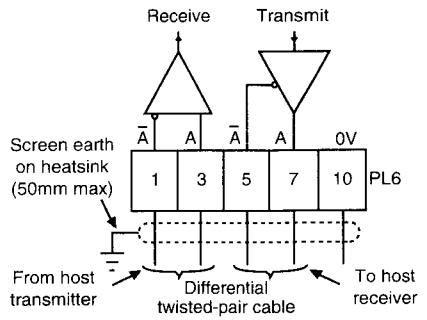


Figure 7-2
RS422/485 Communications link connections

4.3.2 - Connector PL6

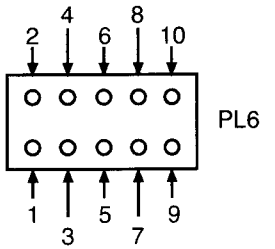


Figure 4-3
Connector PL6

Connector Pin	I/O	D/A	
1	I	D	Serial link receive Ā
2	I	A	Motor thermal protection thermistor input (ref. Note 1)
3	I	D	Serial link receive A
4	I	D	Jog/Preset 1 input
5	O	D	Serial link transmit Ā
6	I	D	Preset speed 2
7	O	D	Serial link transmit A
8	I	D	External trip (ref. Note 2)
9	I	D	Local/Remote (low = remote) (ref. Note 4)
10	O	D/A	OV common

Notes :

(1) If motor thermistor is fitted then remove link 4 (by PL6)

(2) To prevent the drive tripping the "Et" trip is disabled via a jumper link fitted between PL6 pins 8 and 10. If features associated with PL6 are required then this link can be removed and the connection made elsewhere.

(3) Serial communications I/O

Differential input : 0 to 5Vdc, input impedance 3.5 k
V(A-Ā) > +0.2V = logic high at the receiver
V(A-Ā) < -0.2V = logic low at the receiver

Differential output : Output is 0.7 to 4Vdc with no load, current capability ±60mA
Logic high at the microprocessor A = 4V, Ā = 0.7V
Logic low at the microprocessor A = 0.7V, Ā = 4V
i.e. the differential voltage is ±3.3V on no load

(4) If the local/remote facility (Pin 9) is to be used then link 5 must be removed.

5 - DRIVE CONFIGURATION

5.1 - Operating procedures

Parameters are the means by which the operating characteristics of a system are controlled and monitored. The two principal kinds of parameter of a digital drive are the operating parameters and the bit parameters.

Operating parameters have a real-value range, for example from 0 to 150%.

Bit parameters are used for selecting different control configurations and are "either-or" functions.

The response of the drive and the motor depends fundamentally on the set up of the drive parameters. These values are accessible through the keypad, and additionally by signals through the serial communications link from a host computer, a terminal, a programmable logic controller, or other communicating device.

The operator can read the value or state of any parameter, so all parameters are "read" parameters. Those which the operator can change are called "write" parameters. Some parameters are therefore known as "read-write". The rest are "read only". Read-write parameters can be adjusted in any sequence and changed as desired.

Operating parameters can be adjusted while the motor is running. Bit parameter adjustment requires the motor to be stopped and the display to show rdY, or to be tripped, when the display will flash the Trip Code indicating the condition.

Note : In the keypad mode, adjusting the para-meters while the drive is tripped will reset the drive.

No parameter can be adjusted to a value outside the operating range of the drive, and all are limited to safe levels of inverter operation.

All parameters can be allowed to remain at their default values, or as set at the factory during final test, or can be adjusted in any sequence to suit specific applications. Default values are settings to which all parameters can be caused to return at will, and are listed in the Parameters Quick Reference (Chapter 6). The values set at the factory (as delivered values) may, for special customer requirements, differ from default values.

5.1.1 - Manipulating the parameters via the keypad

TO SELECT A PARAMETER

The MODE key enables a parameter number to be selected. When the MODE key is pressed, a parameter number is displayed, and alternates with the parameters value. With the parameter number alternating with its value, press the UP or the DOWN key once to select the NEXT parameter. To scroll through parameter numbers press UP or DOWN repeatedly. If there is a delay of more than 8 seconds in pressing another key, the display will default to the Present Indication (see below) of the output of the drive. Pressing MODE again returns to the parameter selected.

TO READ A PARAMETER

Select a parameter by pressing the MODE key once. The display will show the Pr number, alternating with the value, of whichever parameter was last read or adjusted. The display will alternate between the parameter number and its value for a period of 8 seconds, after which it will default to the Present Indication. If a different parameter is required, select as explained above. The new parameter will alternate with its value in the display for 8 seconds.

(suite)

Par.	Function	Units	Min.	Max.	Def.	Mnem.
b0	0 = not auto-reset 1 = auto-reset enable		0	1	0	DS
b1	0 = auto-start en. 1 = manual start enable		0	1	1	DS
b2	braking b2, b7 = 00 = standard ramp 01 = coast 10 = inject DC 11 = high level ramp (resistive)		0	1	0	DS
b3	0 = auto boost 1 = fixed boost		0	1	0	DS
b4	0 = jog speed en. 1 = preset speeds enable		0	1	1	DS
b5	0 = not catch 1 = catch spinning motor		0	1	0	DS
b6	0 = analogue 1 = serial comms control		0	1	0	DS
b7	braking (see b2)		0	1	0	DS
b8	0 = freq display 1 = load display		0	1	0	DS
b9	0 = keypad mode 1 = terminal mode		0	1	1	DS
b10	0 = even parity 1 = odd parity		0	1	0	DS
b11	current-loop speed ref	mA	Ur, 0.20, 4.20, 20.4			DS
b12	serial comms rate	kbaud	4.8 ; 9.6		4.8	DS
b13	0 = no action 1 = set defaults		0	1	0	CW
b14	PWM switching frequency	kHz	2.9 ; 5.9 ; 8.8 ; 11.7		2.9	FQ
b14	ULF (upper limit of freq) (max 240 @ 2.9 ; 480 @ 5.9 & 8.8)	Hz	120 ; 240 ; 480 ; 960		120	FQ
PrC	MVF (max voltage frequency)	Hz	50.0	ULF	50.0	BS

SW1A	SW1B	Drive status when : Relay energised	Relay de-energised
off	off	healthy	tripped
off	on	running	stopped (rdy)
on	off	above min speed	at min speed
on	on	at set speed	not at speed

SW1C freq or load o/p — Off = same as display ; On = opposite
SW1D — Off = fixed v/f ; On = dynamic v/f ratio
SW1E — Off = normal ; On = wireproof
SW1F — Off = Pr0 min spd ; On = 0 min spd, Pr0 preset 2
LK4 Thermistor input ; — In = disable
LK5 Local/Remote input ; — In = remote

SW1F
Pr0 Function selector :

SW1F - off : Pr0 functions as minimum speed. and preset speed 2. Both are the same.

SW1F - on : Minimum speed is set to zero, value in Pr0 becomes preset speed 2. See parameter Pr7 for further information on preset speeds.

Default value = off.

6.4 - Links

LK4 Motor themistor input enable
In = input disabled (prevents tripping on th when a thermistor is not used).
Out = output enabled.
Default value = In.

LK5 Local/Remote input enable
In = input disabled (effectively remote selected)
Out = output enabled
Default value = in.
See b6 and b11 for more information.

6.5 - Parameter quick reference

Par.	Function	Units	Min.	Max.	Def.	Mnem.
Pr0	min speed ; preset 2 speed	Hz	0	Pr1	0.0	MN
Pr1	max speed ; preset 3 speed	Hz	Pr0	1ULF	50.0	MX
Pr2	accel time (0 to ULF)	sec	0.2	600	5.0	AL
Pr3	decel time (ULF to 0)	sec	0.2	600	10.0	DL
Pr4	current limit	%FLC	Pr5	150	150	TR
Pr5	max continuous current	%FLC	10.0	105 or Pr4	100	TH
Pr6	voltage (torque) boost	%supply V	0	25.5	9.8	BO
Pr7	jog speed ; preset 1 speed	Hz	0	ULF	0	PI
Pr8	DC braking period	sec	0	16.0	1.0	BR
Pr9	serial comms address		0	99	11	SE
PrA	last trip				Et	SW
Prb	security code (0 = none)		0	255	0	SC

Drives
LS FMV 2105

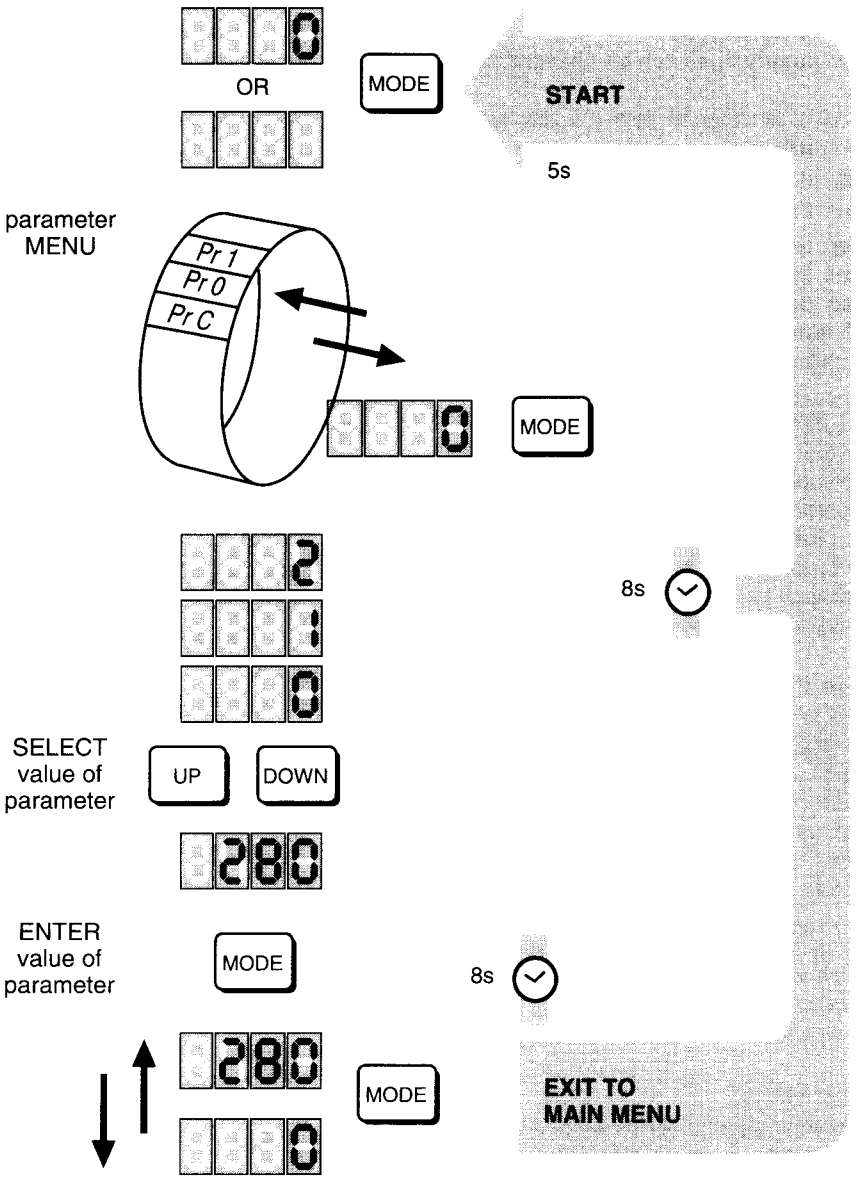


Figure 5-1
Configuration of drive parameter menus

TO CHANGE A PARAMETER

Stop for bit parameters

Bit-parameter values can be changed only when :

- the drive is stopped and the display is showing **rdY**, or
- the drive has tripped, then the Trip Code will flash in the display.

To stop the drive, press the DOWN key until the display shows 0 if the drive is in Keypad control mode (**b9**=0), or open the STOP terminal TB2/5 in Terminal control mode (**b9**=1). Wait until the display shows **rdY**.

Select the required parameter and press the MODE key once more. The display will hold the parameter value steady. If a further keystroke is not made within 8 seconds, the displayed value will default to the Present Indication.

The values of all **Pr** parameters can be adjusted whether the motor is running or not.

Change the parameter value by pressing the UP or the DOWN key. A single keystroke changes the value by plus or minus one digit. Press either key repeatedly to increase or decrease through the parameter values to the maximum or minimum available. The parameter change acts immediately on the internal setting. If the drive is operating the motor, the motor responds to the change as it is being made. The last parameter value set is stored if the power supply is disconnected, and is restored when next the drive is energised.

Decimal values

The display operates an automatic floating decimal point. According to the range of values of the parameter, the display inserts a decimal point appropriately.

ACCESS TO PARAMETERS

Figure 5-1 shows an example setting parameter 0 (Pr0) to 28.0 Hz. To adjust other parameters the user can use the UP (▲) and DOWN (▼) keys to scroll through the parameter menu loop.

5.2 - Configuration examples

5.2.1 - Safety

Safety procedures must be properly observed

It is advisable particularly to take care to check the direction of rotation of the motor

Ensure that...

- the person in charge of the trial run is fully competent to perform or supervise the mechanical and the electrical installation.
- The motor rating is compatible with the inverter rating.
- The motor is securely bolted down.
- The inverter is firmly attached in an upright position and is properly ventilated.

Preliminary

For access to the power and control terminals, refer to Chapter 4 "Installation - Electrical".

- Electrical supply connections must be earthed in accordance with local industrial safety regulations.
- Protective hrc fuses or a circuit breaker of the correct rating must be installed in the supply, refer to Chapter 4 "Installation - Electrical".

5.2.2 - Basic application

It is required to drive a 1.1 kW, 4.4A indication motor to 50 Hz frequency.

Basic control of speed and direction is required, with a controlled ramp to stop.

No motor thermistor is fitted.

Connections

Typical connections are shown in Fig. 5-2.

Drives
LS FMV 2105

SW1E "wireproof" control selector

SW1E = Off : START, STOP, REVERSE, RESET (terminals have their normal functions).

SW1E = On : "Wireproof" input selected (this redefines the functions of ther terminals).

Default value : off

START TB2/4, STOP TB2/5, FORWARD/-REVERSE TB2/6 and RESET TB2/10, so that only permanent status of the inputs cause the drive to run. (In normal mode a momentary contact closure, starts the drive).

Other differences are :

At 0Hz the drive output stage is completely off and therefore the motor is not energized.

If autostart **b1 = 1** is enabled and there is a brief interuption in the mains supply, but not long enough to completely shut it down, the drive will restart if either run forward or run reverse is selected.

If manual start **b1 = 0** is selected the same brief interuption will cause the drive to show UU trip and a reset will be required to restart.

Terminal number	TB2/10	TB2/5	TB2/4	TB2/6		
New designation	inhibit	run/stop	run forward	run reverse	Action	See note
	open	x	x	x	drive inhibited i.e. if running coasts to a halt, "Inh" displayed	2,3
	closed	open	x	x	stop according to b2 and b7	2
	closed	closed	open	open	stop after 65 ms delay (1) according to b2 and b7	1,2
	closed	closed	open	closed	run in reverse	
	closed	closed	closed	open	run in forward	
	closed	closed	closed	closed	stop according to b2 and b7	3

Notes :

(1) The 65ms delay is to allow the run forward and run reverse contacts to change over via this state without actually putting the drive into stop mode.

(2) If this stop mode is activated first and then TB2/10 is opened second the drive will stop according to b2 and b7.
If this stop mode is activated second and then TB2/10 is opened first the drive will inhibit.

(3) If this stop mode is activated and TB2/10 is opened either first or second the drive will inhibit.

Reset

In this mode to reset after a trip, open inhibit, TB2/10, and then close it again. The drive will start after a 1 second delay if, it is in a run state.

SW1C
Analogue output selector :
Off = as quantity indicated on 3 digit LED display
On = alternate quantity

Default value : Off

When the analogue output is configured to be alternate to the displayed quantity, it is possible to have a displayed quantity of frequency while the load signal is presented at the analogue output (TB2/13).

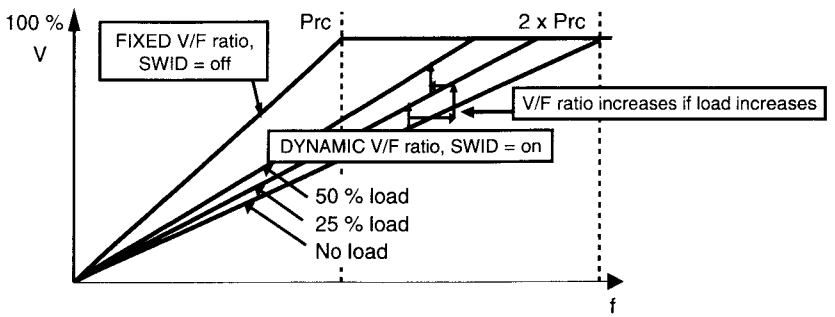
LED Display

b8	SW1C	information on LED display	Information at analogue output TB2/13
0	off	frequency	frequency
0	on	frequency	load
1	off	load	load
1	on	load	frequency

SW1D
V/f characteristic selector :
Off = fixed V/f
On = dynamic V/f (load dependent)

Default value : Off

Provides the option of load sensitive voltage response, with energy saving and reduced noise at light loadings. At no load, the applied voltage is 50% of the normal full voltage. As the load increases the applied voltage increases in proportion, to a maximum of the normal voltage at full load.



In dynamic V/F mode the V/F ratio is proportional to load. (Not to scale).

Figure 6-9
Fixed/Dynamic V/f ratio

Commissioning
A **FMV 2105** - 2.5 M is chosen to run the 1.1 kW, 4.4A motor. In order to provide some motor thermal protection the in-built thermal model is to be re-scaled.
Power up the drive and set parameter 5 (maximum continuous current) to 4.4/7.0 x 100 = 63%. The drive can now be run by closing the run switch.

Speed can be controlled by the setting of the speed potentiometer.
Further adjustments can be made at this stage, including minimum and maximum speed adjustment (Pr0, Pr1) and also acceleration and deceleration rates (Pr2, Pr3). Frequency can be monitored on the 3 digit display.

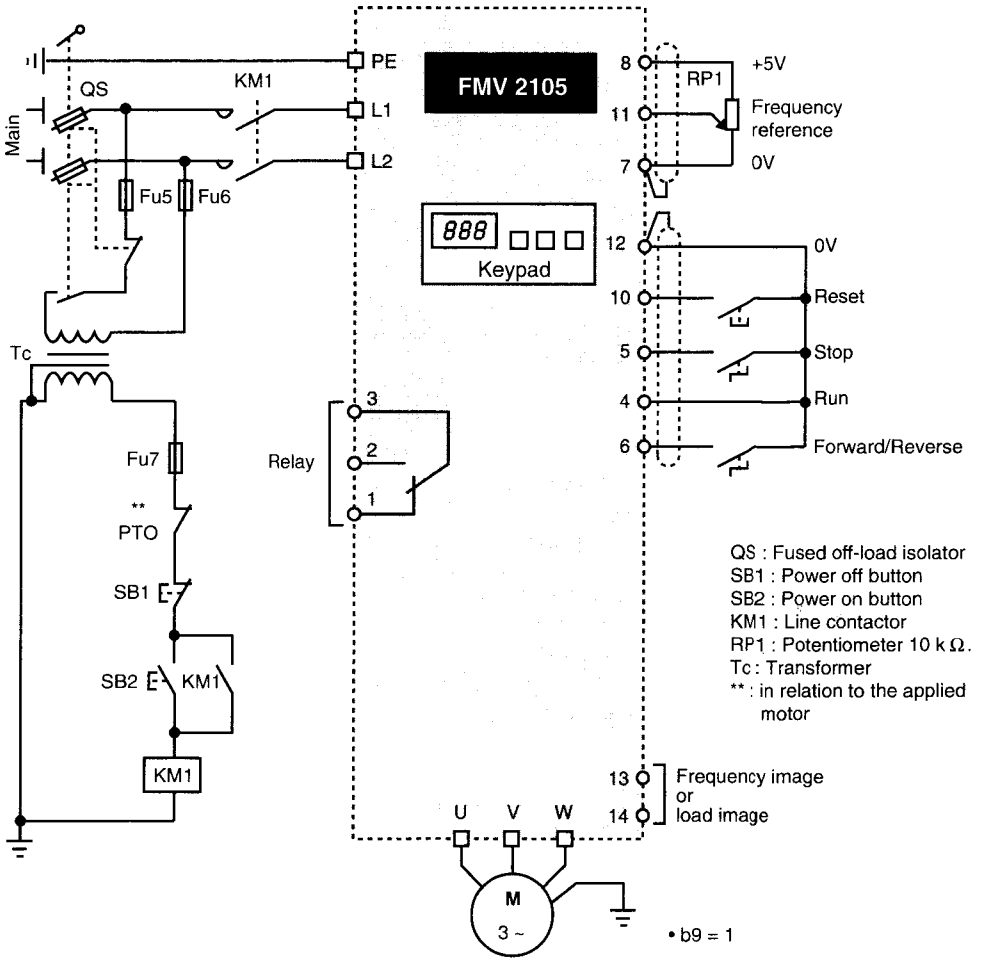


Figure 5-2

5.2.3 - HVAC application

It is required to drive a 1.5 kW (6A) motor to 70 Hz frequency for a HVAC application. Noise is a prime consideration and an automatic restart facility is required to restart the drive in the event of a spurious trip.
Three fan speeds are required (30, 50 and 70 Hz) and an indication of "at speed" is also required.

Connections

Typical connections are shown in Fig. 5-3.

Note : When using PL6 the jumper link (LK4) has to be removed and the external trip connection re-made externally across pins 8 and 10..

Commissioning

A **FMV 2105** - 2.5 M is chosen to drive the 1.5 kW motor and the motor is suitable for operation at 70 Hz.

Parameters

Automatic start is required and is set by b1 to 0.
Automatic reset is required and is set by b0 to 0.

Note : Will automatically start the motor in the event of a trip. See detailed parameter description in Chapter 6.
The ability to catch a spinning motor is required and is carried out by setting b5 to 1.

Note : Scn will be displayed when run.
Bit parameter b14 is adjusted to the maximum allowable switching frequency.

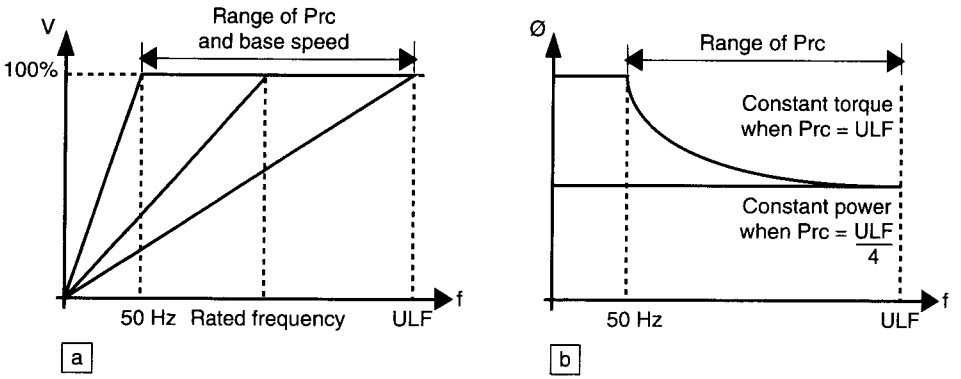
Switches

Switches 1A and 1B are set to "ON" to configure the relay as an 'at speed' relay.
Switch 1D is set to "ON" to set dynamic v/f characteristic to quieten the motor on light load.
Switch 1F is set to on to select Pr0 as a preset speed.
By configuring the control switches in a binary sequence the preset speeds can be selected as set in parameters 0, 1 and 7. (see graph shown in Fig. 5-3).

x	y	Speed (Hz)
off	off	0*
off	on	30
on	off	50
on	on	70

* Assumes no connection is made to analogue inputs, e.g. terminal 11.

Note : Parameter 7 must be set to the range Pr0 ≤ Pr7 ≤ Pr1 as Pr0 and Pr1 will act as a clamp on Pr7.



Profiling the drive & motor output characteristic by relating the values assigned to Prc.
(a) Prc can be made equal to any value between 50 Hz & ULF
(b) Shows how the torque profile changes according to Prc

Note that ULF is itself selectable from one of four frequencies.

Figure 6-8
Inverter output profiling - Prc and ULF

6.3 - DIL switch

DIL switch settings cannot be adjusted via the serial link and are only read when the drive is powered up.
DIL switch must not be adjusted when the drive is energised.

SW1A, B
Relay selector :
Default value : Off.

SW1A	SW1B	Drive status when : Relay energised	Relay de-energised
off	off	healthy	tripped
off	on	running	stopped (rdy)
on	off	above min speed	at min speed
on	on	at set speed	not at speed

When the relay is configured as "at speed", "min speed", or "zero speed" there is a 0.5 Hz hysteresis to prevent chatter. Relay is also de-energised when there is no mains power to the drive.

UPPER LIMIT FREQUENCY (ULF)
Selected by parameter **b14** (second entry) – integer values of 120Hz, 240Hz, 480Hz or 960Hz are displayed successively by repeated operation of the UP or the DOWN key.
If the selected PWM switching frequency is 2.9kHz, the high ULF values (480Hz and 960Hz) **are not available,** and cannot be selected. If 960Hz is required then the PWM switching frequency must be set at 11.7kHz.
The ULF is the highest frequency of the inverter AC output sinewave and is an upper limit for **Pr1**. If the motor is a standard 50Hz or 60Hz machine, the ULF will normally be set to 120Hz. If the motor is a special high speed machine one of the higher ULF values would be chosen.
The behaviour of the other control functions is dependent on the ULF value chosen :

- acceleration – Pr2
- deceleration – Pr3
- frequency resolution

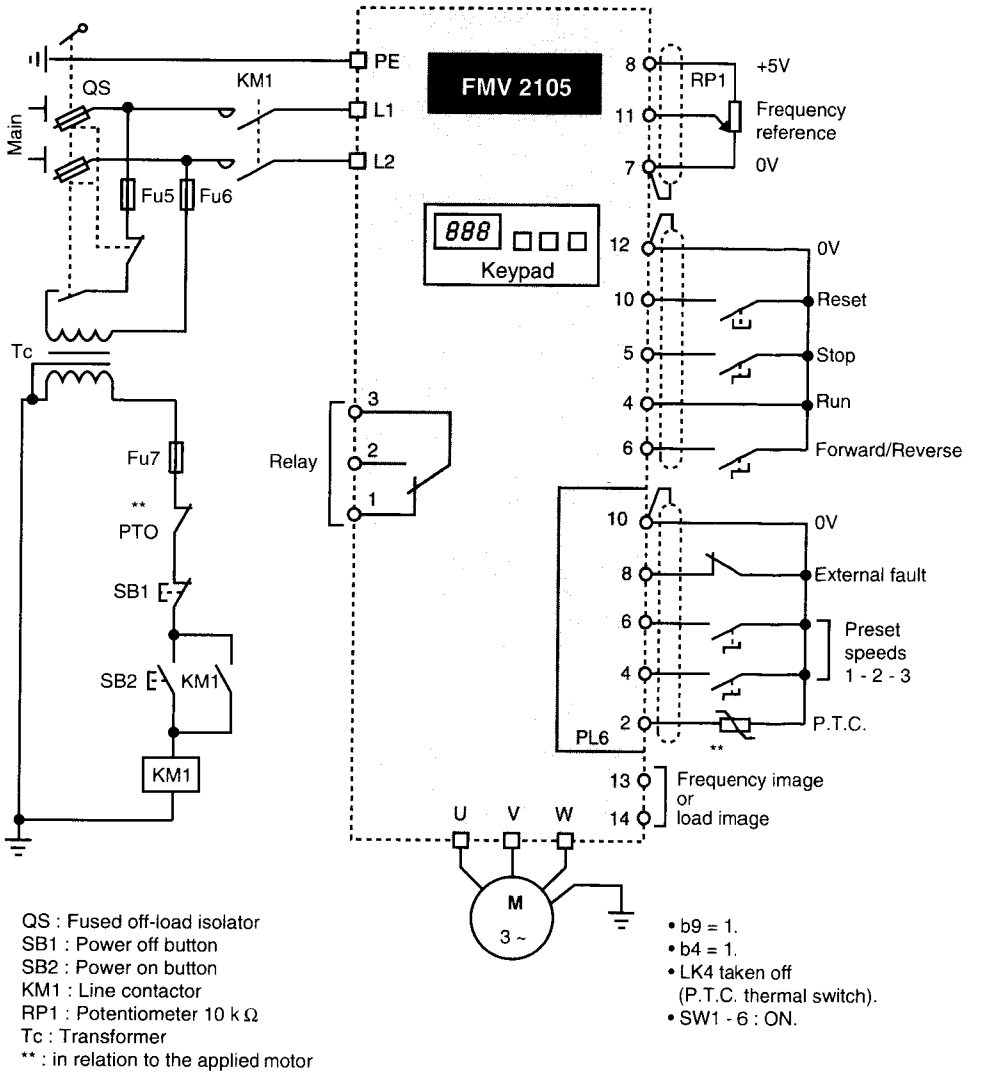
ULF is adjusted by bit parameter **b14** as a second entry after setting the PWM switching frequency. It is necessary to press the MODE key once again, after it has been pressed to set the PWM switching frequency, and then to enter the ULF value, finally pressing MODE once more. To set the ULF without entering a value for PWM first, press MODE twice after adjusting the parameter code to **b14**.

Note : After changing b14 ensure **Pr0, Pr1, Pr2, Pr3** and **Prc** are set correctly before running.

PARAMETER : Prc
Max. voltage frequency :
Defines the frequency at which the drive delivers the rated voltage.

Range : 50Hz < Prc < ULF
Default value : 50Hz
Serial mnemonic : BS

TORQUE-SPEED CHARACTERISTIC
The voltage-to-frequency ratio (V/f) delivered by a drive is normally held constant up to the maximum (rated) voltage and frequency of the motor — the base speed. Up to this point the motor torque is, in principle, constant. Above base speed, where the voltage can no longer increase, further increase of frequency output produces a constant-power characteristic.
FMV 2105 drives permit a wide range of output frequencies to be assigned at the rated voltage. In other words, the base speed can, within wide limits, be modified to suit the application and motor.
This facility enables the profile of the inverter output V/f characteristic to be varied. Curves in Fig. 6-8 show this at one extreme the whole of the V/f characteristic is a constant torque output, whereas at the other extreme almost the entire speed range is constant power. This feature of **FMV 2105** drives enables the user to adjust the V/f profile to match the motor characteristic to a wide variety of applications.
The value of the frequency when the drive reads its maximum output voltage is called the **maximum voltage frequency** (MVF) and is adjusted by parameter Prc. The maximum value of the PrC is equal to the ULF. The minimum value is 50Hz.

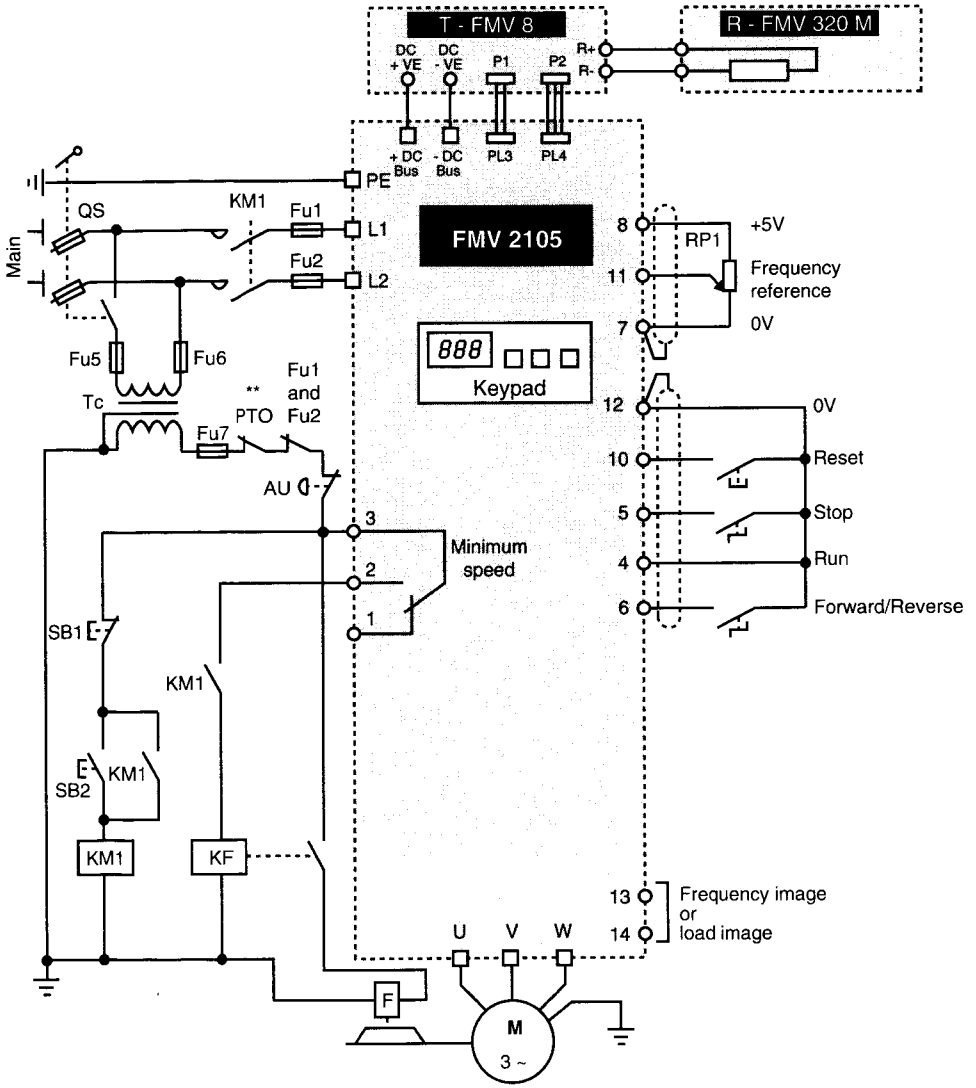


QS : Fused off-load isolator
SB1 : Power off button
SB2 : Power on button
KM1 : Line contactor
RP1 : Potentiometer 10 kΩ
Tc : Transformer
** : in relation to the applied motor

- b9 = 1.
- b4 = 1.
- LK4 taken off (P.T.C. thermal switch).
- SW1 - 6 : ON.

Figure 5-3
Reference by preset speeds

5.2.4 - Electromechanical application : dynamic braking



QS : Fused off-load isolator.
AU : Emergency button.
SB1 : Power off button.
SB2 : Power on button.
KM1 : Line contactor.

F : Brake coil.
KF : Braking contactor.
RP1 : Potentiometer 10 kΩ.
Tc : Transformer.
** : In relation to the applied motor.

- PR0 = 0.
- b9 = 1.
- SW1 - 1 : ON.
- SW1 - 2 : OFF.

Figure 5-4

Drives
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PARAMETER : b10
Parity selector :
0 = even parity
1 = odd parity

Default value : b10 = 0
Serial mnemonic : DS

PARAMETER : b11
Analogue speed reference :
0 to +5V = ur
0 to 20mA = 0.20
4 to 20mA = 4.20
20 to 4mA = 20.4

Default value : b11 = Ur
Serial mnemonic : DS

See b6 and LK5 for more information.

PARAMETER : b12
Baud rate selector :
4.8 = 4800 baud
9.6 = 9600 baud

Default value : 4.8
Serial mnemonic : DS

PARAMETER : b13
Reset parameters to default values :
0 = inactive
1 = set default values

Default value : 0
Serial mnemonic : CW

Note : The action of setting default values will set b13 back to "0".

PARAMETER : b14
Define PWM switching frequency and ULF :
First entry – PWM switching frequency :
2.9 = 2.9kHz
5.9 = 5.9kHz
8.8 = 8.8kHz
11.7 = 11.7kHz
Second entry – Upper Limit Frequency :
120 = 120Hz
240 = 240Hz
480 = 480Hz
960 = 960Hz @ 11.7kHz

Default values :
- PWM 2.9kHz
- ULF 120Hz

Serial mnemonic : FQ

PWM SWITCHING FREQUENCY
Selected by parameter **b14** (first entry) – alternative values are displayed by repeated operation of the UP or the DOWN key.
The alternating sinewave output of the inverter is synthesised from the DC bus by a pattern of on-off switching applied to the control gates of the IGBT bridge. This method of producing an alternating output from a DC source is called pulse width modulation (PWM). The pulsed switching pattern is generated by an application-specific integrated circuit (ASIC) which is itself controlled by a microprocessor.
In making a choice of PWM switching frequency, the factors to be considered are the effect on the drive and motor, and the relationship to the upper limit of inverter output frequency (ULF, see below).
Parameter **b14** also enables the ULF to be adjusted as a second entry, see below. To leave PWM switching frequency, without entering a ULF value after adjusting the PWM value, press MODE twice instead of once.

LK5	PL6/9 Local/Remote	b6	b11	Frequency reference source
in	x	0	Ur	voltage
in	x	0	0-20	current input
			4-20	
			20-4	
in	x	1	x	serial communications input
out	L	x	x	voltage input
out	R	0	Ur	voltage input
out	R	0	0-20	current input
			4-20	
			20-4	
out	R	1	x	serial communications input

PARAMETER : b7
See **b2**
Serial mnemonic : DS

PARAMETER : b8
Indicate frequency or load current value :
0 = frequency (Hz)
1 = load (%FLC)

Default value : b8 = 0
Serial mnemonic : DS

Note : The analogue output (terminal 13 on TB2) can either indicate the value of the displayed quantity or the quantity of the non-displayed function, see SW1C.

PARAMETER : b9
Keypad or terminal mode selector :
0 = keypad
1 = terminal

Default value : b9 = 1
Serial mnemonic : DS

Notes :
(1) Keypad must NOT be disconnected/-connected when the drive is energised.

(2) Keypad Control b9 = 0
This method of control is recommended for commissioning purposes rather than for normal drive control. By changing b9 to a "0", control of speed, stop/start, and reset, can be achieved using the keypads alone. All control inputs are inhibited, except for the serial link, reverse input TB2/6 and the motor thermistor input PL6/2.
If auto start, b1 = 0, has been selected, the drive will, on power-up, accelerate to the last speed set. If manual start, b1 = 1, has been selected, the drive will, on power-up, display [rdY]. To start the drive, just press either the UP or DOWN keys, and the drive will acelerate to the last speed set. The output frequency can be increased or decreased by using the UP or DOWN keys. The display shows the set point frequency, and not the actual frequency, (which is indicated in TERMINAL control).

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5.3 - Diagnostics and fault finding

DISPLAY does not illuminate and drive does not run.
CHECK mains supply, supply fuses or circuit breaker
Replace supply fuses if blown, or reclose circuit breaker, but if supply fuses blow or breaker trips again contact the supplier of the drive.
If key pad is remote mounted, check extension cable wiring.

MOTOR does not start, display shows **rdY**.
Drive is in MANUAL start mode.
Operate UP key, or START pushbutton
CHECK the control wiring, and that external stop/run/trip contacts and circuits are in order.

MOTOR does not start, display shows **0**.
CHECK wiring of speed reference, and that the correct mode (REMOTE/LOCAL) has been selected. If in KEYPAD mode press UP key.
Check preset speed is not selected with a setting of "0" Hz.
Check max frequency parameter (**Pr1**) is not "0" Hz.

TRIP CODE at display .
Note that:
- Thermal trip devices should not be continually tripped and reset.
- **OI** trip can be caused by shock load, cable or motor insulation faults, length of cable to motor too great, or attempting to accelerate too large a motor.
- **OI** and **OU** trips may be caused by decelerating too quickly :
when operating below motor base speed : **OI** trip
when operating above motor base speed : **OU** trip
Increase the value of **Pr3** and check that **b2** and **b7** are set for ramp stop.
- If PS or Err are displayed, try disconnecting the drive from the supply, wait 2 seconds, reconnect and run the drive. If the fault persists, contact the supplier of the drive.

MOTOR fails to turn the load, and is noisy
Fixed boost setting too high **(Pr6)**.
Also check the settings of current limits **Pr4** and **Pr5**.
Check mechanical load is free to turn.

DRIVE fails to respond to serial communications
CHECK serial communications mode **(b6)**, parity **(b10)**, baud rate **(b12)**, and serial address **(Pr9)** are set correctly.
CHECK the wiring and termination of the serial link.

DRIVE appears to be set to an unusable state.
Set **b13** = 1 to reset all parameters to default values.

If, after performing any of the above checks, the drive still malfunctions, contact the supplier for assistance.

Any trip, internal or external, immediately stops the drive.
The IGBT bridge is no longer active, and the motor coasts to rest.
Internal protection trips are always active and cannot be disabled.
An external trip **Et** can be forced by the operator.

5.3.1 - Trip codes

cL	4/20mA current loop loss. The current has fallen to < 3.5mA when b11 = 4.20 or 20.4 when b11 = 0.20 current loop loss trip is inactive
Err**	Hardware fault within the drive. Occurs only at power-up. Is a lock-out condition - no reset. Hardware fault : 1 - ASIC reading error 4 - Processor error in serial interrupt 5 - Keyboard fault 6 - NOVRAM initialised 7 - Current sense circuitry has too high positive offset at power up 8 - Current sense circuitry has too high negative offset at power up
Et	External trip is operated by terminal PL6/8 or via the serial comms word CW.
It	Integrating overload (Ixt) trip. The output current as defined by Pr4 and Pr5 has reached the allowable time limit.
Oh	Heat sink overtemperature. The heatsink has reached its upper safe working limit due to loss of cooling air or cooling air too hot.
Ol	Instantaneous overcurrent trip. Excess current flowing in the IGBT inverter bridge, caused by short circuit, low impedance earth fault or excessive shock load.
OU	DC bus overvoltage. Caused by main supply overvoltage (even if momentary), or high impedance earth fault, or excessive regeneration due to a high rate of deceleration.
PS**	Internal power supply fault.
th	Motor thermistor (if fitted) impedance high due to sensing excess temperature, or impedance less than 100Ω due to cable short circuit or similar.
to	"timeout". Trip to indicate that the auto reset function has failed to reset the drive after the third attempt to start with the same trip fault.
UU	The internal power supply voltage has fallen below the operating range. The drive trips instantaneously.
**	UU trip can also be caused by a failure of internal components of the drive.
**	*These conditions require expert attention. Please consult the supplier of the drive.*

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PARAMETER : b3
Low speed torque boost selector :
0 = auto boost
1 = fixed boost

Default value : b3 = 0
Serial mnemonic : DS

VOLTAGE (TORQUE) BOOST
To increase the torque available for starting frictional loads and to compensate for the increase in motor losses at low speeds it is useful if torque is boosted (increased) by raising the voltage output above the linear V/f ratio over the lower part of the speed range from 0Hz. The drive offers two alternative ways of applying the boost, selected by parameter **b3**.

PARAMETER : b4
Jog/preset selector :
1 = preset
0 = jog

Default value : b4 = 1
Serial mnemonic : DS

JOG FREQUENCY/PRESET FREQUENCY
Either jog or preset frequency can be selected using **b4** with **Pr7** setting the frequency.
When jog is selected and with the drive in **rdy** mode, closing terminal PL6/4 will start the drive and will ramp up to the frequency set by **Pr7,** opening PL6/4 will cause the drive to ramp down and stop.
When preset is selected the drive must be already running for the command from PL6/4 and/or PL6/6 to have any effect. When PL6/4 and/or PL6/6 is closed the drive will ramp from its existing frequency to the frequency set by **Pr7**.
See **Pr7** for more information.

PARAMETER : b5
Catch spinning motor selector :
1 = enabled
0 = disabled

Default value : b5 = 0
Serial mnemonic : DS

Enables the drive to be energised onto a motor whose shaft is rotating, without causing a trip.
On receiving a start signal, the drive scans the motor frequency and connects itself at a synchronising value.
During the scanning period the keypad displays "Scn".
On systems where there is no mechanical load on the motor when it is over-running, a change of speed may be observed during the scanning operation.
Dependent on the system and the dynamic conditions, there may be a delay of up to 5 seconds before the drive resumes normal operation.

PARAMETER : b6
Analogue input/serial comms mode :
0 = controlled by analogue input
1 = controlled by serial comms link

Default value : b6 = 0
Serial mnemonic : DS

See b11 and LK5 for more information.

Note : Drive data can be read at any time independently of b6.

• **MANUAL start**
- When drive initially energised :
(**rdY** code signalled)
Waits for START signal.
- When stopped by any signal other than a trip : Signals **rdY**, requires START signal.
- When stopped by a trip signal : Signals a trip code, waits for RESET, then waits for START signal.

PARAMETER : b2 & b7
Braking method selector :

Parameter		Mode
b2	b7	
0	0	Standard ramp
0	1	Coast
1	0	Inject DC
1	1	High level ramp

Default values : b2 = 0
b7 = 0
Serial mnemonic : DS

STOPPING & BRAKING MODES
Selected by parameters **b2** and **b7**, with **Pr8** additionally for the DC INJECTION option. A STOP command is required to bring the motor to rest regardless of which of the stopping or braking options is chosen.
The **FMV 2105** range of drives is available with or without the dynamic braking option. Without it, high level ramp (resistive) braking is of no advantage.
In high level ramp, the drive automatically changes to fixed boost on ramp down. This gives fast stopping, even faster than dc brake, but a dynamic brake unit is required.
In standard ramp, the V/F characteristics follow the characteristics set by parameter **b3**.

Resistive braking is preferable for applications where the inertia of the load is high and short stopping times are required. Care must be taken to select a resistor suited to both the motor and the application. The supplier of the drive should be consulted if there is any difficulty about resistor ratings. The options for bringing the motor to a halt are :

Option	Keypad display during stopping period
Coast	**Inh**
ramp	normal – speed or load according to **b8**
injection	**dcb**

RAMP MODE
Ramp brings the motor to rest in a time proportional to the decelerating time parameter **Pr3** (refer to CHANGE OF SPEED RAMPS). Ramp is used if a different stopping time to the natural coasting time is required, or if a linear rate of deceleration is required.
If **b2** = **b7** = 0 (standard ramp) the ramp is halted if the DC link voltage reaches an internal limit and continues when the voltage falls below the limit.
If **b2** = **b7** = 1 (high level ramp) the ramp is continuous. This setting requires the use of the dynamic brake unit.

DC INJECTION MODE
Injection braking requires parameter **Pr8** to be adjusted between the limits of 0 and 16 seconds of motor rated FLC. The applied braking voltage is fixed (Refer to Fig. 6-7).
At the STOP command, the output voltage is rapidly reduced at constant frequency, refer to Fig. 6-7, so that the motor is defluxed. A braking voltage is then applied at zero frequency. As the motor comes to rest, direct current is applied for a period as defined by **Pr8**.

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5.3.2 - Healthy indications

rdY	Motor stopped, drive energised.
Numerical value displayed	Motor speed (Hz) or load (%FLC) dependent on the setting of **b8** or a parameter value if accessed.
dcb	dc braking active.
Inh	Motor coasting to rest ; IGBT bridge inhibited.
Scn	Spinning motor software is selected and the drive is scanning for the correct motor frequency before catching the motor/load and taking them to the set speed.
Flashing decimal point	This indicates that the drive is in the Ixt region.

6 - PARAMETERS & SWITCHES

6.1 - Operating parameters

Parameters are listed in the sequence which they appear in the keypad display when the UP key is used.

PARAMETER : Pr0

Minimum/Preset 2 : the lower limit of inverter

Frequency : output frequency, determining the minimum speed of the motor.

Range : 0Hz < Pr0 < Pr1
Default value : 0Hz
Serial mnemonic : MN

Minimum speed is set by parameter **Pr0**, which can be any value less than or equal to **Pr1**. The logic does not allow the value of **Pr0** to be greater than **Pr1**. The 0 to +5V range of the external reference operates on the difference between **Pr0** and **Pr1**. For example, if **Pr0** = 10, the inverter output is 10Hz when the minimum speed reference is 0V. If **Pr1** = 50, then when the speed reference is 5V the output frequency is 50Hz.

For values of speed reference voltage between 0 and 5V, the output frequency is given by :

$$f = (Pr1 - Pr0)\frac{V}{5} + Pr0$$

Note : f = frequency
V = speed reference voltage

e.g. if V = 2.5
then $f = (50 - 10)\frac{2.5}{5} + 10$
= 30 Hz

or if switch SW1.F is "on".

Minimum/Preset 2 frequency becomes the value of the second preset speed when energised from terminal 6 of PL6.

Note : The minimum frequency is automatically set to zero 0Hz in this mode.

See **Pr7** description for further details on preset speeds.
Parameters **Pr0** and **Pr1** apply to both forward and reverse operation.

FREQUENCY RELATIONSHIP
The ULF, the full speed frequency **Pr1**, and the minimum speed frequency **Pr0** are related as follows :

0Hz ≤ **Pr0** ≤ **Pr1** ≤ ULF

FREQUENCY RESOLUTION

0 to 120Hz	0.1Hz
0 to 240Hz	0.2Hz
0 to 480Hz	0.4Hz
0 to 960Hz	0.8Hz

PARAMETER : Pr1

Maximum/Preset 3 : the value of frequency in Hz above

Frequency : which the motor is not to operate. Additionally, is the set speed as energised by preset speed 3.

Range : Pr0 < Pr1 < ULF
Default value : 50Hz
Serial mnemonic : MX

SPEED
An induction motor runs at a speed which is dependent on the applied frequency, voltage and load. Control of speed is achieved primarily by control of frequency. The drive can supply any frequency up to the maximum for which it is designed (960Hz). It can also reverse the direction of field rotation and so reverse the direction of the motor.
Motor **full speed frequency** is selected by adjusting the value of parameter **Pr1**. For example, **Pr1** = 50 makes the maximum output frequency equal to 50Hz. **Pr1** cannot be greater than ULF, or less than **Pr0**.

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If the third trip is the same as the previous trip during the 8 seconds monitoring period then the drive will stay in trip mode. The display flashes "to" for time out in auto reset operation. Also the auto start (Not auto reset) function will be disabled (b1 becomes 1 automatically) to prevent the drive from running if power supply interrupted. Even after power interruption the parameter PrA will show the trip condition which disabled the drive.
After the drive has tripped on timeout "to" the drive can be reset from the terminal strip with one further life remaining.
In order to totally reset the Auto reset memory the drive will have to be powered down and up again. The drive will then power up in manual start mode (b1=1).

Exceptions
External trip : No restart available automatically.
Under voltage trip : Normal power down condition. If power is reapplied then the drive will restart.

Default value : b0 = 0
Serial mnemonic : DS

PARAMETER : b1

Auto start or manual start selector :
0 = auto start
1 = manual start

Default value : b1 = 1
Serial mnemonic : DS

In the AUTO-start mode, the inverter starts the motor (delay 100ms) when the power supply circuit to the inverter is energised, provided that a STOP command has not been given.

If there is a temporary loss of supply, auto-start mode restarts the motor under proper control when the supply is restored, regardless of the operating status of the motor at the time of supply failure.
Manual-starting will normally be used where it is essential that there should be a start command before the drive runs. To start the motor in MANUAL start mode, the drive must receive a start signal from the external control system after the drive has been energised from the main supply, or after supply has been restored after a temporary loss of power.

RESET
• In AUTO start mode and with terminal control mode selected (b9=1) : after a trip has occurred, performing a RESET will cause the drive to restart immediately.
• In MANUAL start mode and with terminal control mode selected (b9=1): after a trip has occurred, performing a RESET will set the drive to rdY. The drive then requires an external START signal to start the motor.

SUMMARY OF STARTING CHARACTERISTICS
• **AUTO start**
- When drive is initially energised : 100ms delay then auto start.
- After stopping due to power supply disturbance : 100ms delay then auto start.
- When in a TRIP condition :
(trip code signalled)
1.0s delay to RESET
Immediate start after RESET or if in keypad mode (b9=0), waits for UP (▲) or DOWN (▼) key to be pressed.
- When in a STOP condition :
(**rdY** signalled)
Waits for START signal or if in keypad mode (b9=0), waits for UP (▲) key to be pressed.

PARAMETER : Pr9
Serial address : Identifies the inverter to enable serial device to address a selected drive in a multiple drive system.

Range : 0 to 99
Default value : 11
Serial mnemonic : SE

PARAMETER : PrA
Trip mode : Contains the code for the last trip experienced by the drive.
Range : All trip codes
Default : Et

Last trip (PrA)
A useful feature for system fault finding is that the reason for the last trip of the drive is available by selecting PrA. This information is not lost even if the drive is powered down and up once after the trip, refer to Chapter 5-3 "DIAGNOSTICS AND FAULT FINDING" for trip codes. The default values for PrA is Et but after the drive has been powered up and down once this will revert to UU as an under voltage trip is inevitable at power down.

Note : If the drive is in auto-reset mode and time out (to) occurs then PrA will indicate the trip fault code.

PARAMETER : Prb
Security code selector : Permits the choice of the security code for each inverter. Prb = 0 corresponds to no security code. Values of 100 to 255 can be set via keypad, or 1 to 255 via serial communications.

Range : 0 to 255
Default value : 0
Serial mnemonic : SC

6.2 - Bit parameters

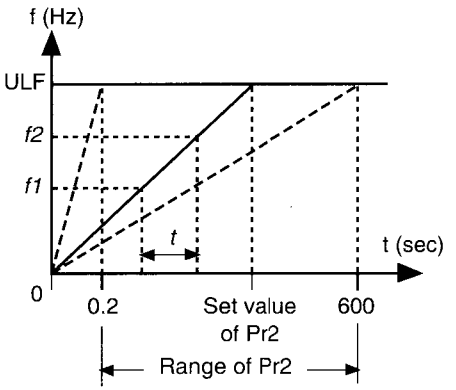
PARAMETER : b0
Auto reset :
1 = enabled
0 = disabled
This parameter enables the mode of operation of the drive to be configured to reset and start after a trip (Other than external trip or under voltage), automatically. The auto start function should also be enabled (b1=0) to use this mode of operation. Basically this mode of operation attempts to restart the drive from a trip after 1 second delay. Also the number of identical trips in a specified time window is monitored. If the number of identical trips exceed three, then the drive stays in trip status and disables the auto start operation. So that even after a power interruption drive would not attempt to restart.

Operation
After a trip other than external trip, the drive will attempt to start again after a 1 second delay. Also a trip monitoring period of 8 seconds will be enabled. If the drive trips on any trip other than the previous one during this period then the drive will attempt to start again after a 1 second delay. After the 8 seconds monitoring period any trips will be handled as mentioned above.
If the second trip is the same as the previous trip during the 8 seconds monitoring period then the drive will attempt to restart after 8 seconds delay. Also a further 8 seconds period of trip monitoring will be enabled. If the drive trips on any trip other than the previous one during this period then the drive will attempt to start again after a 1 second delay. After the 8 seconds monitoring period any trips will be handled as mentioned.

Also if terminals 4 and 6 of PL6 are both energised then preset speed 3 is set as per **Pr1**. See parameter 7 description for further details on preset speeds.

PARAMETER : Pr2
Acceleration time : the time to accelerate from 0Hz to the selected value of ULF; determines the slope of the acceleration ramp.

Range : 0.2s to 600s
Default value : 5.0s
Serial mnemonic : AL



Acceleration time Pr2. The time *t* to accelerate from *f1* to *f2* depends on the value selected for the ULF as well as for Pr2.

Figure 6-1
Acceleration time Pr2

Acceleration time is set by parameter **Pr2** which has a range from 0.2s to 600.0s. The actual time to accelerate from any speed to any other is then a linear proportion of **Pr2**, Fig.6-1.

A short acceleration time combined with a high inertia load may demand a current higher than the maximum continuous current **Pr5** (CURRENT & PROTECTION) and the current is likely to enter the I x t inverse time protection zone. Only if the drive were grossly under-rated relative to load inertia or if the current limit **Pr4** (CURRENT & PROTECTION) were set low would there be a likelihood of an overload trip during acceleration.

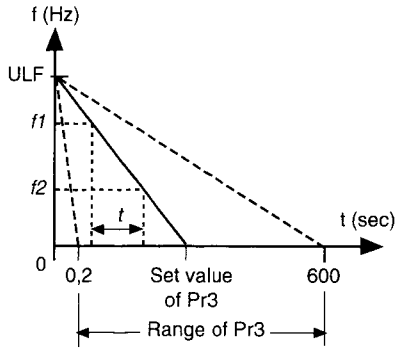
PARAMETER : Pr3
Deceleration time : the time to decelerate from theselected value of ULF to 0Hz; determines the slope of the deceleration ramp.

Range : 0.2s to 600s
Default value : 10.0s
Serial mnemonic : DL

Deceleration time is set by parameter **Pr3** which has a range from 0.2s to 600.0s, Fig.6-2. The effect of deceleration time is, however, not exactly analogous to acceleration time, even though the two characteristics shown in Figs. 6-1 and 6-2 apparently have much in common.

When the frequency of the supply to an induction motor is reduced while it is rotating, slip takes a negative value. In effect, the motor becomes a generator and returns power to the inverter. To some extent, this power can be absorbed by the DC link capacitor and by losses within the system, but the DC voltage cannot be allowed to rise without risk of damage to drive components.

If it is found that a chosen deceleration time causes the inverter to trip and indicate a DC link overvoltage, either the deceleration time must be increased or, if this is not possible due to the needs of the driven system, the dynamic braking mode will have to be utilised with an external resistor to absorb the excess energy.



Deceleration time Pr3. The time *t* to decelerate from *f1* to *f2* depends on the value selected for the ULF as well as for Pr3.

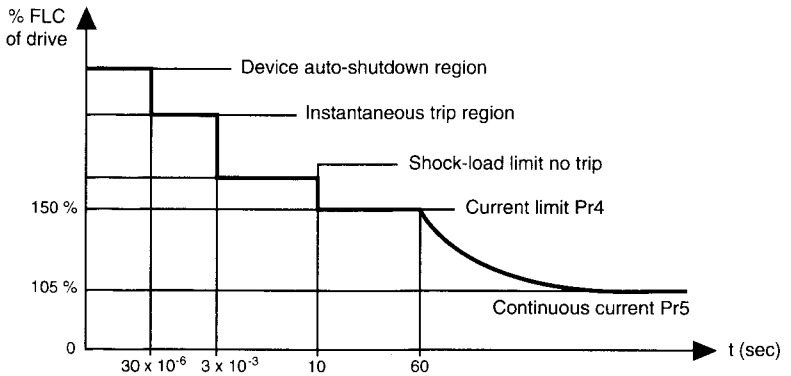
Figure 6-2 - Deceleration time Pr3

PARAMETER : Pr4
Current limit : Maximum level of current overload.

Range : Pr5 ≤ Pr4 ≤ 150%FLC for industrial rating drives
Default values : 150% FLC for industrial rating drives
Serial mnemonic : TR

CURRENT LIMIT
The level of controlled maximum current output is set by **Pr4**. Its maximum value is 150% of inverter FLC. **Pr4** can be set to any value between **Pr5** and 150%.

OVERCURRENT
The drive logic recognises three levels of high transient current above the current limit **Pr4**, such as might be caused by severe shock loading, or by short circuit or earth fault in the motor or cable.
The logic responds to transients protecting the motor, the cable and the drive by shutting down the inverter IGBT bridge. The speed of electronic fault detection is greatly superior to the performance of hrc fuses.



Overcurrent protection by internal electronic monitoring.

Figure 6-3 - Overcurrent protection

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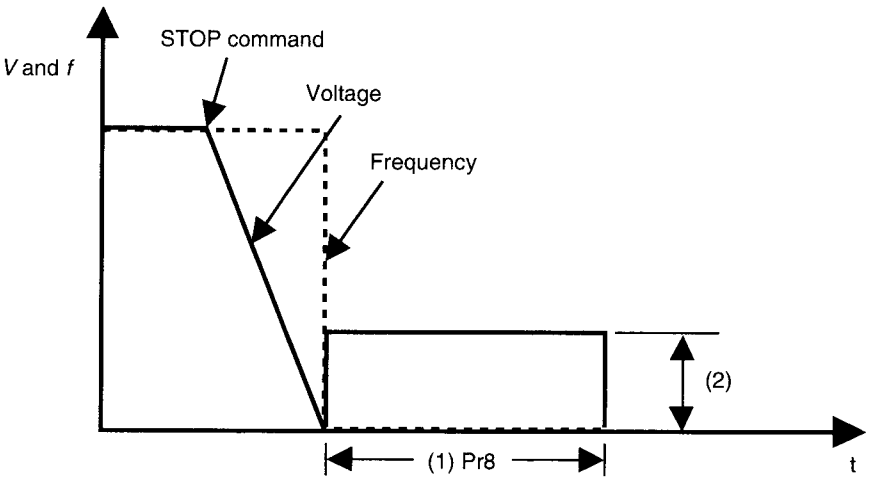
PARAMETER : Pr8
DC braking period : the period of injection at 150% of full load current limit.

Range : 0 to 16 seconds
Default value : 1 second
Serial mnemonic : BR



Injection braking. shows the effect of STOP command, which causes the voltage to be reduced linearly to zero at full frequency followed by :
(1) injection of braking current for a period which is defined by Pr8.
(2) the dc braking current limit level (2) is set to 150%.

Figure 6-7
Injection braking

Notes :

(1) Forward/Reverse Terminal (TB2.6) can be used independently to select the desired direction with the selected preset speed.

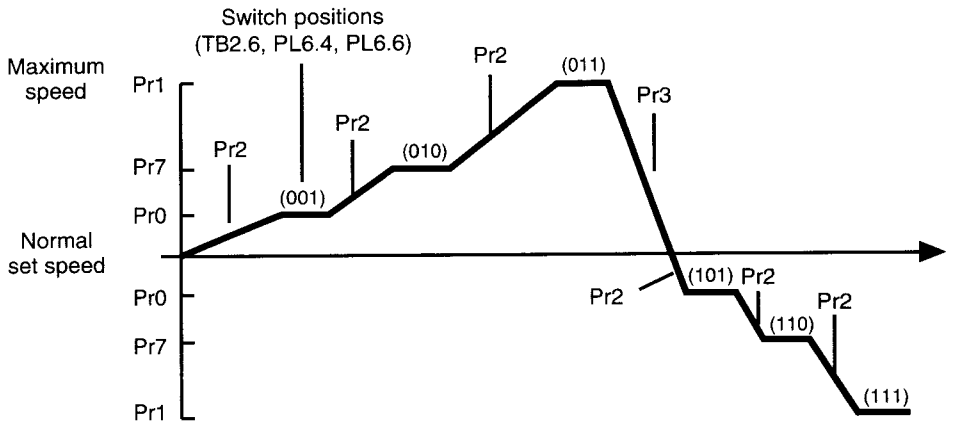
(2) In Jog mode, pressing stop will stop the drive, but on release of stop button the drive will restart if PL6.4 is still connected to 0V.

(3) Pr0 contains the minimum frequency set point and the drive speed cannot be set below this frequency by any reference inputs, except with SW1E on : b4 = 0; preset can be below the min frequency set by Pr0.

(4) Pr1 contains the maximum frequency set point and the drive speed cannot be set above this frequency by any reference inputs.

(5) If SW1F is on then the minimum frequency set point is set at 0 Hz and this cannot be changed by any means. Pr0 is then used to adjust the frequency for preset 2.

Acceleration and deceleration during preset frequency approach are controlled by parameters Pr2 and Pr3.



Note : Diagram assumes SW1F in on position. If SW1F in off position then only one preset speed is available, but the drive can be taken to max. or min. speed as shown in table.

Figure 6-6
Applications of preset speed

Drives
LS FMV 2105

PARAMETER : Pr5

Max. continuous current : Percentage of FLC at which current can be supplied continuously ; threshold level of timed current limit.

Range : 10% to 105%FLC, and not greater than **Pr4**
Default value : 100%FLC
Serial mnemonic : TH

CURRENT & PROTECTION

CONTINUOUS CURRENT LIMIT

An inverter is usually selected with a maximum continuous current rating to match that of the motor. To prevent overheating at full load the motor full load current (FLC) rating must not be exceeded.

The continuous current limit is parameter Pr5 and its value is the ratio of the motor rated FLC to the inverter FLC, expressed as a percentage :

Pr5 = (motor FLC / inverter FLC) x 100

Pr5 is the lower threshold of the inverse time-current protection of the motor and its cable. Current in excess of **Pr5** starts the I x t integration and is signalled at the display by flashing of the unused decimal points and will, if sustained, result in tripping of the inverter. Curves are shown in Fig. 6-4.

Trip time = k x **Pr5**/(actual % current - Pr5) in seconds,

where k = 25.7

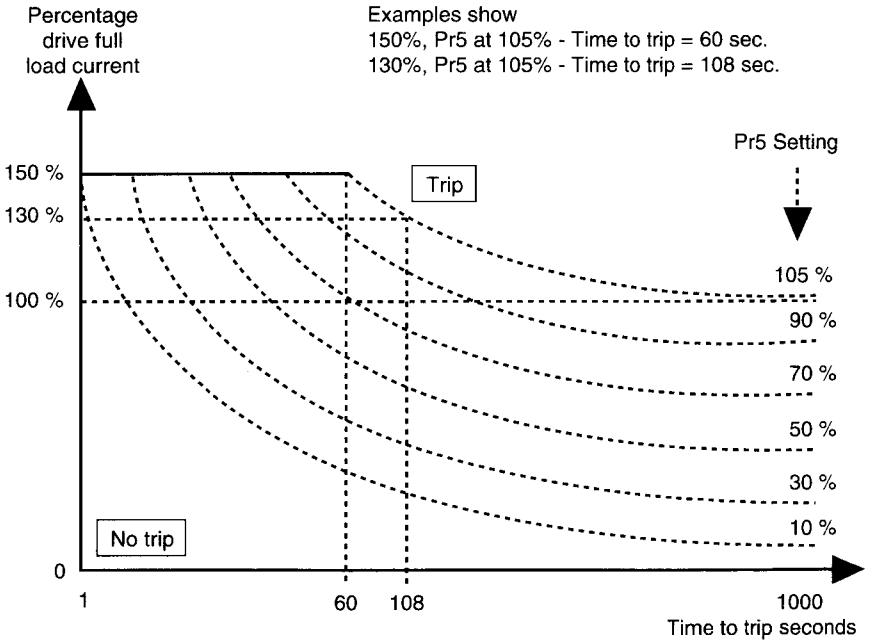


Figure 6-4
I x t characteristics (Not to scale)

PARAMETER : Pr6

Voltage (torque) boost : Maximum level of voltage boost at zero frequency.
Range : 0 to 25.5% of main supply voltage
Default value : 9.8%
Serial mnemonic : BO

VOLTAGE (TORQUE) BOOST

To increase the torque available for starting frictional loads and to compensate for the increase in motor losses at low speeds it is useful if torque is boosted (increased) by raising the voltage output above the linear V/f ratio over the lower part of the speed range from 0Hz. The drive offers two alternative ways of applying the boost, selected by parameter b3.

AUTO boost is selected by **b3** = 0
FIXED boost by b3 = 1.

The degree or amount of boost is determined by paramter **Pr6**, which can be given any value up to 25.5% of main supply voltage.

When the value of **Pr6** is set below 9.8% the boost V/f characteristic starts at Pr6% of max output voltage at 0 Hz and tapers linearly to meet the normal V/f characteristic at a frequency of $\frac{Prc}{2}$, Fig. 6-5.

When the value of **Pr6** is set above 9.8% the boost characteristic has a break point at a frequency of Prc/16.

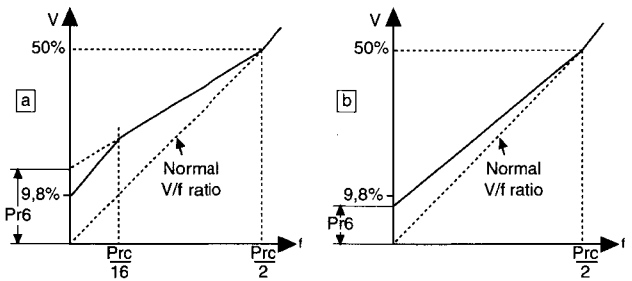
The boost tapers from this break point to 9.8% of maximum output voltage at 0 Hz and to the normal V/f characteristic at a frequency of Prc/16, Fig. 6-5.

It is best to choose the lowest effective degree of boost as too high a value may cause the current to reach the current limit level. This has the effect of stopping any increase in frequency, and the motor appears to stall. For this reason it is recommended that **Pr6** should be increased in small steps from a low value until the motor starts smoothly and with minimal hesitation.

When AUTO boost is selected, the drive applies a voltage increase proportional to the load demand as a percentage of the chosen value of maximum continuous current **Pr5**. If, for example :
the selected value of **Pr6** is 20%
the selected value of **Pr5** is 105% FLC
and the actual current demand is 90% FLC
then the drive calculates the voltage boost at 0Hz as : (0.2 x 0.90 / 1.05) = 17.1%.

This is tapered to zero boost at 50% of MVF (ie at 0.5 x Prc).

FIXED boost is the better choice for constant-torque loads requiring a very high starting torque and high inertia loads where rapid acceleration is required i.e. in situations where the machine is more susceptible to stalling. AUTO boost is better for variable-torque loads where the load at starting is also variable i.e. where the machine is less susceptible to stalling.



Voltage (torque) boost Pr6.
(a) High level of boost, tapering to 9.8% at 0Hz. Note that boost is maintained at high level down to a frequency of one sixteenth of Prc.
(b) Low level of boost - tapers evenly from Pr6 is < 9.8% of maximum voltage

Figure 6-5 - Voltage (torque) Boost Pr6

Drives
LS FMV 2105

PARAMETER : Pr7
Jog frequency/Preset frequency :

If Bit parameter b4 = 0
Jog frequency : The frequency that the drive will run at when the jog/preset terminal is active from **rdy** mode (i.e drive will start from **rdy** and attain the frequency set by **Pr7**).

If Bit parameter b4 = 1
Preset frequency : The frequency that the drive will run at when the preset terminals select this preset speed (only if the drive is already running).

Range : Pr0 < Pr7 < Pr1
Default Value : 0Hz
Serial mnemonic : P1

Preset Speeds (Frequencies)

Warning : Check the maximum frequency set point (Pr1) before using preset terminals (PL6.4 and PL6.6) as the PL6.4 and PL6.6 = 1 condition selects the maximum frequency set point.

Up to three preset speeds can be selected any of which can then be instantly applied in any direction by configuring the two external switches (mechanical or open-collector) connected to control terminals (PL6.4, PL6.6). (1 = switch on, or input closed). For an example see Chapter 5 (Drive Configurations).

If "wireproof" mode is selected, SW1E on, there is no jog function only preset speeds. The operation is defined by Table 6-2.

Table 6-1

b4	Drive status	PL6/6	PL6/4	Frequency reference	Frequency set by	See note
0	x	x	open	normal	analogue/serial input	
0	rdy	x	closed	jog	Pr7	2
0	running	open	x	normal	analogue/serial input	
x	running	closed	open	preset 2	Pr0	5
x	running	closed	closed	preset 3	Pr1	
1	x	open	open	normal	analogue/serial input	
1	running	open	closed	preset 1	Pr7	

Table 6-2

b4	Drive status	PL6/6	PL6/4	Frequency reference	Frequency set by	See note
x	running	open	open	normal	analogue/serial input	
x	running	open	closed	preset 1	Pr7	3
x	running	closed	open	preset 2	Pr0	5
x	running	closed	closed	preset 3	Pr1	