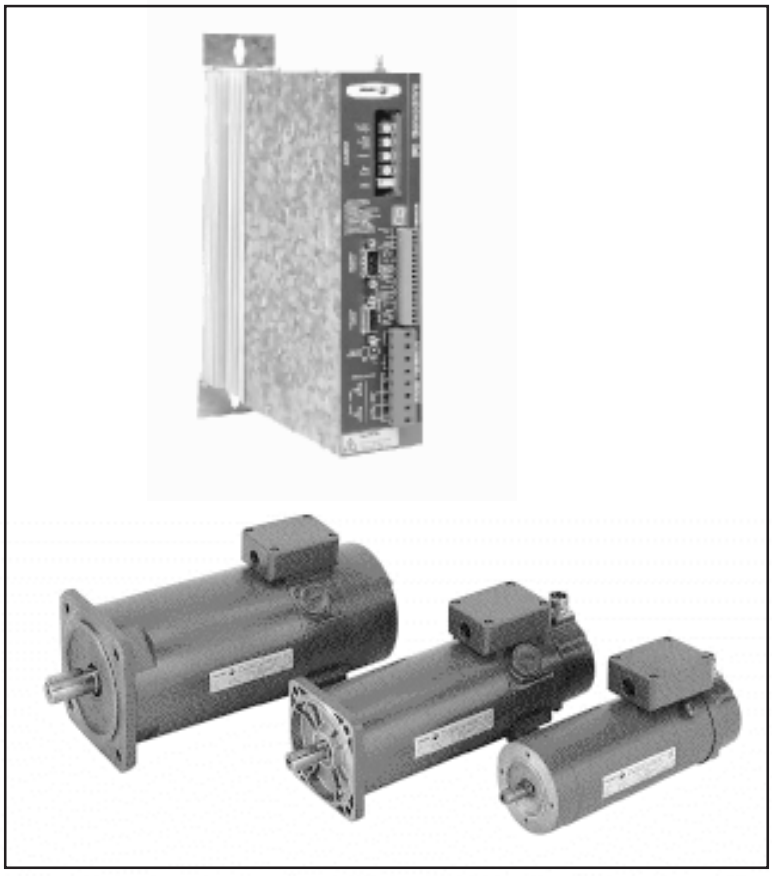
Fagor Automation, S.Coop.

DC Servo Drive System Manual.

Ver: 0002



FAGOR

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Declaration of conformity

Manufacturer: Fagor Automation, S. Coop.
Barrio de San Andrés s/n, C.P. 20500, Mondragón -Guipúzcoa- (SPAIN)

We hereby declare, under our responsibility that the product:

Fagor DC Servo Drive System.

consisting of the following modules and motors:

Servodrives: DCS Series
DC Motors: DCM Series

mentioned on this declaration,
with the basic requirements of the European Directives 73/23/CE on Low Voltage (Basic Safety Regulation, Machinery Electrical Equipment EN60204-1:95) and 89/336/CE on Electromagnetic Compatibility (EN 61800-3:1996, Specific Regulation on Electromagnetic Compatibility for Servo Drive Systems).

Fagor Automation, S. Coop. Ltda.
Director Gerente,

Fdo.: Julen Busturia

In Mondragón, February 15th, 2000

Introduction

Fagor offers you a wide range of servo drive systems (motor and drive) for applications requiring between 1 and 12 Nm at speeds between 1200 rpm and 4000 rpm.

This manual describes the elements in detail and guides step by step through the installation and setup of the drive system.

When installed for the first time, it is a good idea to read the whole document.
Should you have any doubts or questions, please do not hesitate to contact our technicians at any of our subsidiaries worldwide.

Thank you for choosing Fagor.

DC Motors, DCM

1.1 INTRODUCTION

Fagor DCM motors (DC) are especially designed to be controlled by Fagor DC servo drives.

These DC motors are easier and less expensive to govern than brushless motors, they output a torque with less ripple and its mechanics is an industrial standard.

Winding voltage	100-130 Vdc
Number of poles	2 (DCM2); 4 (DCM4 and DCM5)

Shaft end	Cylindrical with keyway.
Mounting (meets IEC-34- 7-72)	Face flange. B14, V18, V19 on DCM2; B5, V1, V3 on DCM4 and DCM5.
Mechanical tolerance	Standard class (meets IEC 72/1971)
Bearings life	10000 hours
Balancing	Class N (meets DIN 45665) (balancing with keyway)
Noise	Meets IEC 34-9-72

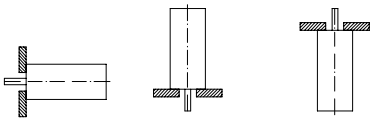
Brake (optional)	24 Vdc

Insulation	Class F and H

Degree of protection	IP44 (**)
Operating temperature range	From 0°C to +40°C (32°F to 104°F)
Maximum overtemperature	130°C (266°F)
Thermal switch	N. C. 120°C (248°F) 13 Amp (250 Vac); 18 Amp (24 Vdc)
Maximum altitude	1000 meters (1281 ft) above sea level.

Feedback	20 Volt/Krpm tachometer 2500 lines/turn encoder TTL

(*) The diagram below shows the meaning of the mounting codes.



B14/B5 V18/V1 V19/V3

(**) IP44 means that it is protected against particles with a diameter greater than 1 mm and against water splashes in all directions.

1.2 GENERAL CHARACTERISTICS

			DCM2			DCM4									DCM5		
			DCM21	DCM22	DCM23	DCM41			DCM42			DCM43			DCM51		DCM52
MOTOR PARAMETERS		UNIT	21.40A	22.40A	23.25A	41.12A	41.20A	41.30A	42.12A	42.20A	42.30A	43.12A	43.20A	43.30A	51.12A	51.20A	52.12A
Continuous stall torque	(1)	Nm	1,12	2,2	3,1	2,6	2,5	2,4	4,6	4,4	4,2	7,2	7,0	6,8	9,5	9	12
Peak stall torque		Nm	4,7	10	14	19,3	19,3	19,3	31	29	31	54	54	54	50	50	70
Rated torque		Nm	0,9	1,5	2	2,3	2	1,6	4,5	4	3,5	6,8	5,5	4	8	6	11
Rated power		Kw	0,37	0,62	0,52	0,29	0,42	0,5	0,56	0,83	1,1	0,85	1,15	1,25	1	1,25	1,38
Mechanical time constant		ms	28,8	20	21,2	16	14,2	13,7	10,7	11,1	11,7	6,8	8,8	8,7	10,4	12,1	10
Electrical time constant		ms	4,8	5,7	5	3,5	3,9	4,3	5	5,1	4,4	7,5	5,5	6	6	5,7	7,6
Theoretical acceleration at peak torque		rad/s²	4.950	5.555	5.185	9.190	9.190	9.190	9.687	9.687	9.687	11.250	11.250	11.250	5.000	5.000	5.400
THERMAL PARAMETERS																	
Thermal time constant		min	45	55	60	50			60			70			80		90
ELECTRICAL PARAMETERS																	
Torque constant (KT)	(2)	Nm/A	0,24	0,25	0,43	0,88	0,53	0,35	0,88	0,56	0,38	0,98	0,58	0,39	1,00	0,60	1,00
Voltage constant	(2)	V/(rad/s)	0,24	0,25	0,43	0,88	0,53	0,35	0,88	0,56	0,38	0,98	0,58	0,39	1,00	0,60	1,00
Armature resistance w/o brushes	(2)	ohms	1,6	0,55	1,2	5,80	1,80	0,70	2,5	0,9	0,38	1,12	0,44	0,18	1,03	0,36	0,70
Armature resistance with brushes	(2)	ohms	1,75	0,7	1,4	5,90	1,90	0,80	2,6	0,98	0,45	1,22	0,54	0,25	1,10	0,42	0,77
Armature inductance		mH	8,5	4	7	21	7,5	3,5	13	5	2	9	3	1,3	6,7	2,4	6
Back EMF	(2)	V	103	105	113	110,5	111	110	110,5	118	120	123	123	123	125	125	125
Continuous stall current		A	4,7	8,8	7,2	2,9	4,7	6,9	5,2	7,8	11,0	7,3	12,0	17,4	9,5	15,0	12,0
Peak current		A	19,5	40	32,5	22	36,5	55	35	52	80	55	95	140	50	83	70
Maximum speed		rpm	4.000	4.000	2.500	1.200	2.000	3.000	1.200	2.000	3.000	1.200	2.000	3.000	1.200	2.000	1.200
MECHANICAL PARAMETERS																	
Inertia	(2)	(Kg·m²)·10E-3	0,95	1,8	2,7	2,1			3,2			4,8			9,6		13
Total weight with tachometer		Kg	5,2	7,3	9,5	9,3			12,4			17			21		23

BRAKE PARAMETERS		DCM2	DCM4	DCM5
Power Supply voltage, (power)	Vdc, (W)	24, (12)	24, (15)	24, (25)
Hold/Release time	sec	5/7	7/15	18/55
Inertia	Kg.cm²	0.38	1.05	8.5
Parking torque	Nm	2	5	20
Brake mass	Kg	0,6	1	3

TACHOMETER PARAMETERS -T0-

Voltage Gradient		V / Krpm	20 ± 5%
Voltage Ripple	(3)	%	≤1,5
Armature resistance	(2)	ohms	26
Temperature coefficient		% / °C	0,02
Minimum load resistance value		Kohms	6

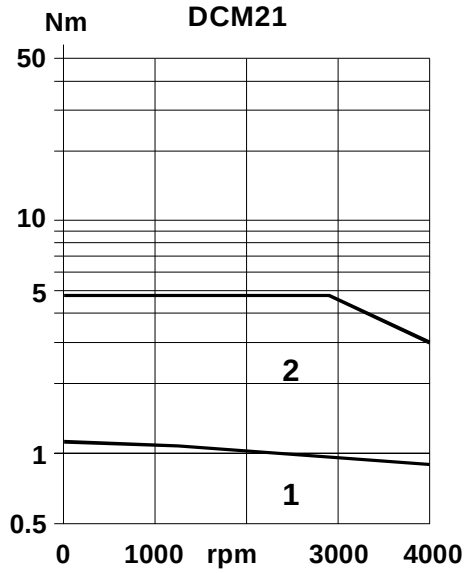
ENCODER PARAMETERS -E0-

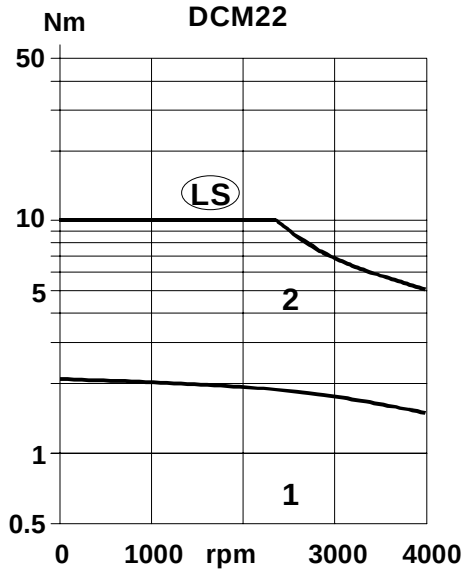
Signal	square wave TTL +5 Vdc 20 mA max.
Resolution	2500 lines per turn
Power supply	DC +5 Vdc 200 mA max.

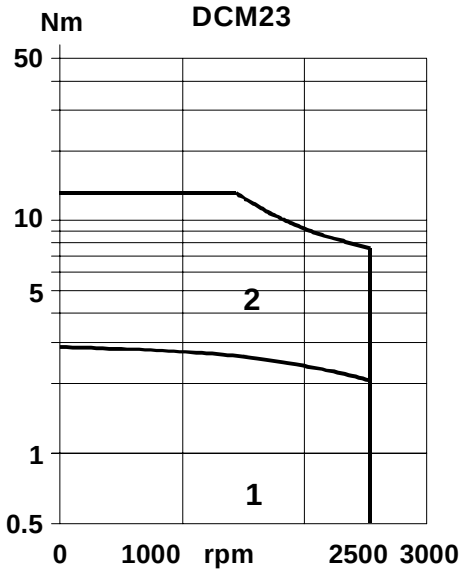
(1) Ambient temperature: 40°C
(2) Tolerance ±10 %
(3) Peak-to-peak value / average value. Measured with filter at max. motor speed

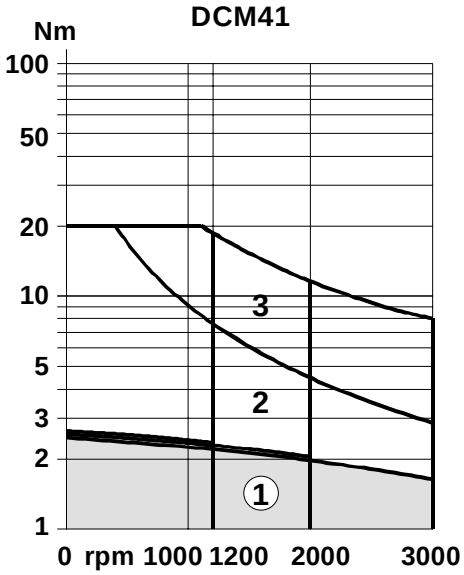
Important: The torque offered by the motors could be limited by the maximum current of the drive governing them. See table on page 17.

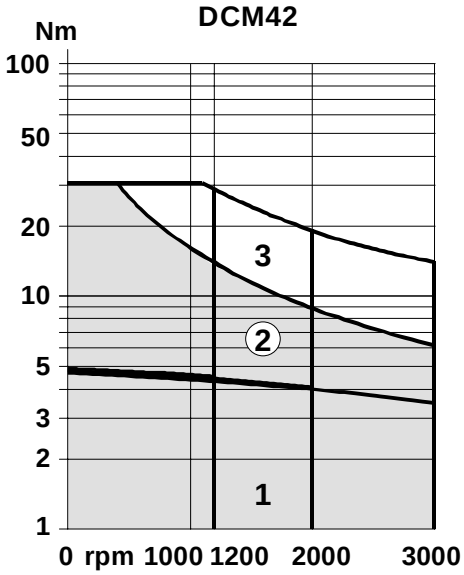
1.3 TORQUE-SPEED CURVES

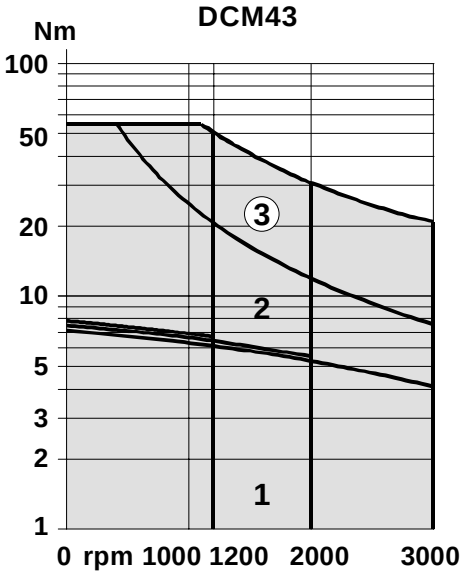


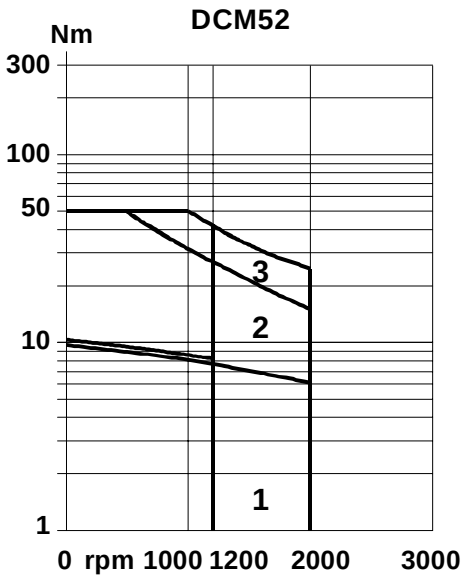


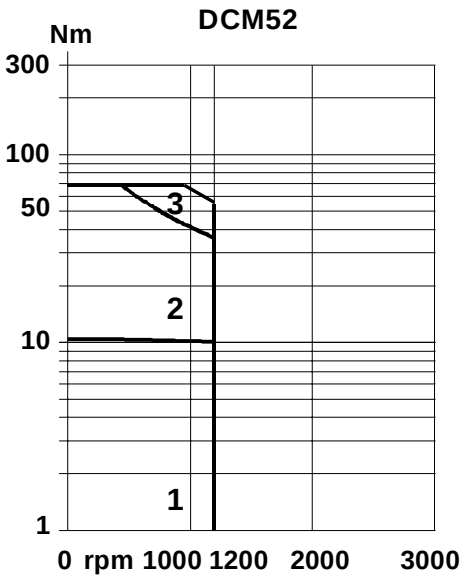












① Work area in continuous duty cycle S1. Torque available in continuous mode.

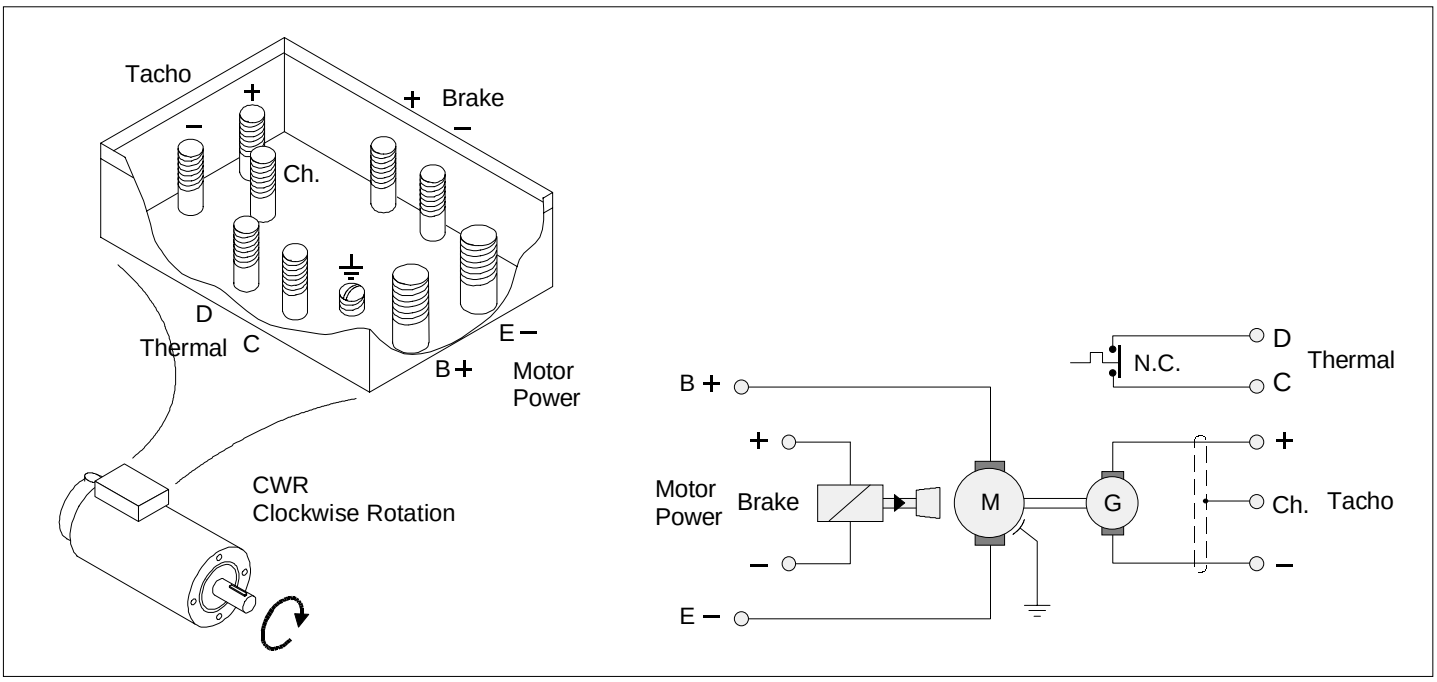
② Work area in intermittent duty cycle. Torque available in cyclic acceleration and deceleration.

③ Work area in sporadic acceleration and deceleration. Working in this area, reduces the life span of the brushes.

(L.S.) Demagnetizing limit at 25°C (77°F). The DCS drive, equipped with the proper IM board, watches the motor so it never exceeds those demagnetizing currents.

1.4 TERMINAL BOX

Includes terminals for:
Power input for the motor winding.
Tacho voltage output.
Input for electromechanical brake
Safety thermal contact

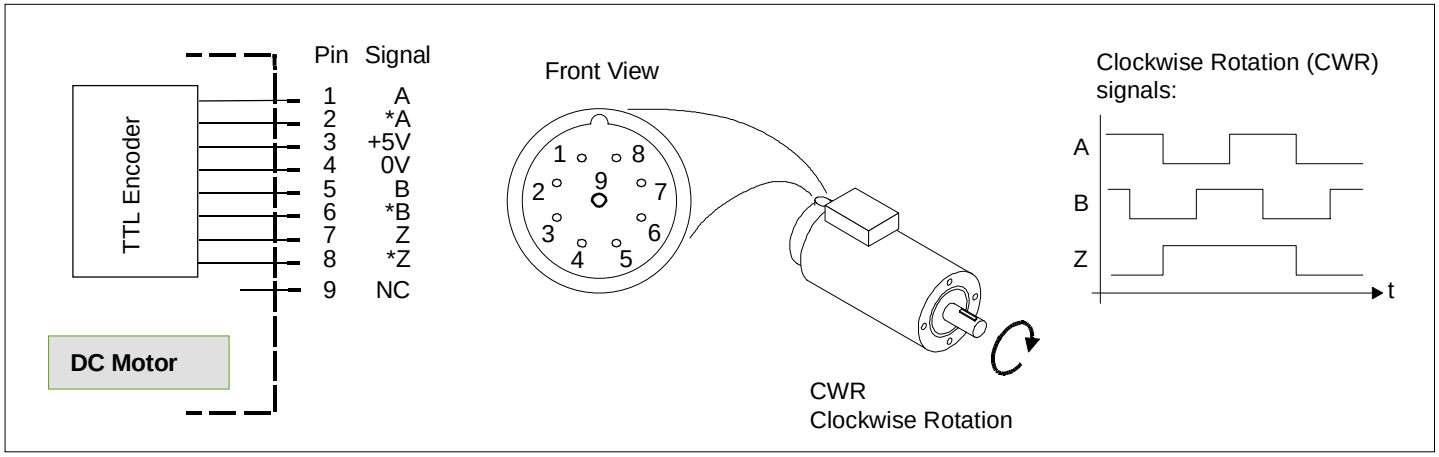


When the motor winding is supplied with the polarity indicated on the terminal box (B+, E-), the rotor turns clockwise (CWR, clockwise rotation), as shown in the diagram. And, for this turning direction, the tacho generates a voltage at its terminals (Tacho) also with the polarity indicated on the box (+, -).

The electromechanical brake releases the motor shaft when applied 24 Vdc.
When stationary, it holds the motor shaft.

The thermal switch watches the armature winding temperature.

1.5 ENCODER OUTPUT CONNECTOR



1.6 CHARACTERISTICS PLATE AND SALES REFERENCE

Example of the plate that comes with each DCM motor.

FAGOR			**Permanent Magnet D.C. Servomotor**		CE
			TYPE: DCM42.20A.E0.000		
SN: E190057			KT: 0.56 Nm/A		Iso.Cl.: F
Mo	4.4	Nm	Io: 7.8 A	MAX. RPM:	2000
Mp	29	Nm	Ip: 52 A	B.E.M.F.:	118 V
TACHO:		V/KRPM	BRAKE:	V	A

Sales reference description for DCM motors

DC MOTORS					Example	DCM	4	2.	20	A.	E0.	0	0	0
DIRECT CURRENT MOTOR														
MOTOR SIZE	**2**	95 mm												
	4	115 mm												
	5	153 mm												
LENGTH	**1, 2, 3**	See drawings												
MAXIMUM SPEED	**12**	1200 rpm	**30**	3000 rpm										
	20	2000 rpm	**40**	4000 rpm										
	25	2500 rpm												
WINDING	**A**	Standard												
FEEDBACK	**E0**	TTL Encoder (standard)												
	T0	Tacho												
	F0	Encoder and Tacho (not available)												
FLANGE AND SHAFT	**0**	With keyway (standard)												
	1	Without keyway												
BRAKE OPTION	**0**	Without brake (standard)												
	1	With brake (24 Vdc)												
POWER CONNECTION	**0**	Terminal box												
	1	Power connector (not available)												

1.7 SERVICE INSTRUCTIONS

The brushes must be checked for the first time after being running for 500 hours and, then, every 1000 hours. One must check the way they sweep, their surface and that of the collector.
The life span of the brushes depend on how they are used and on ambient conditions.
They must be replaced with brushes of same quality and dimensions: 10 mm for the DCM2, and 11 mm for the DCM4 and DCM5.

2.1 INTRODUCTION

The D.C.Servo drive is a compact speed drive which includes the power supply and is designed to control a single DC motor.
There are two modules of different power offering rated currents of 8 and 14 Amps and whose main characteristics are:

- Three-phase power supply through a transformer.
- PWM Mosfets.
- Encoder feedback (standard) or tacho.
- Velocity or Torque command.
- Velocity command filtered with ramps.
- Logic inputs to control the motor.
- Galvanic isolation between power and control
- Analog outputs to monitor speed and current.
- Control against excessive acceleration/deceleration.
- Dynamic braking during mains failures.
- Protection against motor current drifts.
- Protection against feedback loss.
- Protection against excessive temperature, Bus voltage and output current.
- 7-segment display to monitor the status of the servo drive system.

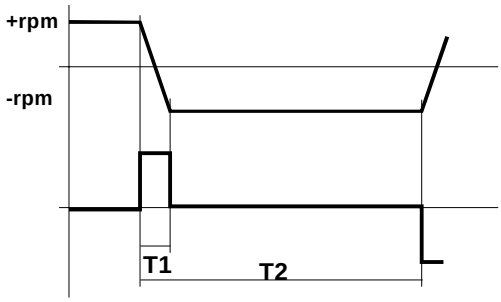
2.2 GENERAL CHARACTERISTICS

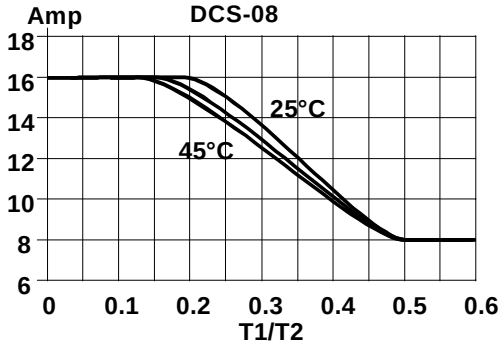
	Fagor D.C.Servodrive	
	DCS-08	DCS-14
Power supply	110 Vac between phases. 50/60 Hz (range 94-120 Vac)	
Consumption, Amperes -RMS-	9	16
Maximum in-rush current	350 Amp for 10 msec.	
Maximum output voltage	150 Vdc	
Rated output current	8 Amp	14 Amp
Peak current (4.5 sec)	16 Amp	28 Amp
Overvoltage protection	192 V	
Overcurrent protection	20 A	33 A
Internal Ballast	10 Ohms, 200 W	
Ballast trigger	184 V	
Thermal protection	90°C (194°F)	
Ambient temperature	5°C / 45°C (41°F / 113°F)	
Storage temperature	-20°C / 60°C (-4°F / 140°F)	
Insulation	IP20 (*)	
Module width	62 x 300 x 230 mm (2.48 x 11.8 x 9.05 inches)	
Module weight	3,5 Kg (7.76 lbs)	

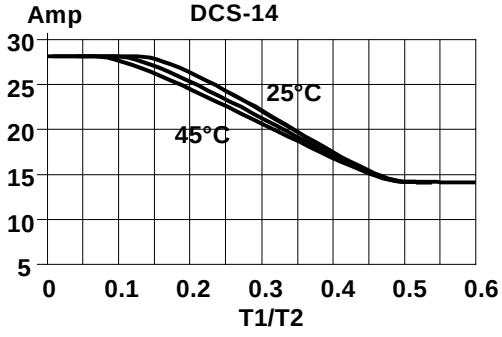
(*) **IP20** means that it is protected against particles with diameter greater than 12.5 mm; but not against water splashes. In other words, the equipment must be mounted inside the electrical enclosure.

Maximum peak current.

The drive withstands a maximum peak current in repetitive cycles
The first graph shows the duty cycle analyzed on a motor without load.
The following graph shows the maximum peak current allowed at the DCS depending on the duration of the pulse and for different temperatures.
In any case, the duration of the maximum current pulse (T1) must not exceed 4.5 seconds.







2.3 CONNECTORS

Power Terminals

Motor Output: ±150 Vdc output voltage applied to the motor
Output current to the motor (continuous/peak for 4.5 seconds):

DCS-08: 8A/16A
DCS-14: 14A/28A

Maximum current with PWM on a carrier frequency of 10 kHz.

Watch out for polarity. See page 23.

Power Input: 94-120Vac three-phase supply through a transformer. See page 22.

The maximum cable section at these power terminals is: **2.5 mm²**.
Total isolation between power and control circuits.

Control Signals

±10V voltages, Pins 1,2,3: Internal power supply so the user can easily generate a velocity command. It offers a maximum current of 20mA limited internally.

Velocity command. Pins 4,5,6:
Current command. Pins 4,7:
See page 25. The motor torque is directly proportional to the current. "Torque command".

Tacho feedback. Pins 8,9: Velocity feedback input from the tacho into the drive. Be careful with the polarity. See page 24.

Monitoring. Pins 10,11,12: Voltage outputs for monitoring motor speed and current. Voltage range of ±10V. See page 23.

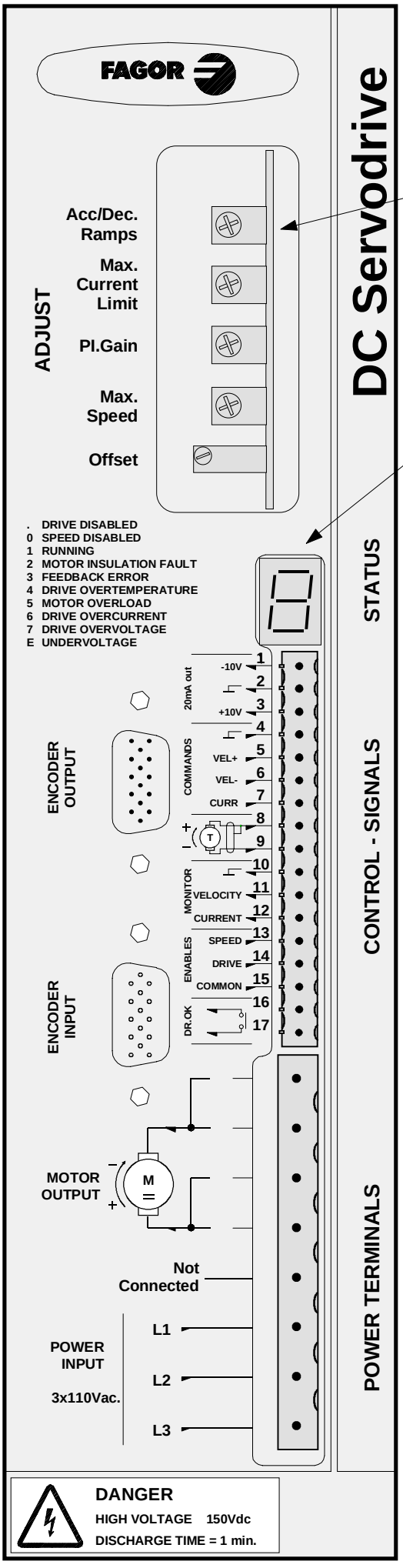
Common, Pin 15: Reference point for the following Enable signals:
Drive Enable, Pin 14: At 0Vdc, disables current through the motor which loses its torque.
Speed Enable, Pin 13: A 0Vdc, forces a "zero speed" command.
These control signals are activated at +24Vdc.

Drive OK. Pins 16,17: Relay contact that closes when the internal status of the drive is OK. It must be included in the electrical manoeuver. See page 26.

Encoder Input: Encoder signal input to the motor for velocity feedback.
Encoder Output: Encoder output for closing the loop at the CNC. See page 24.

The maximum section for these cables is **0.5 mm²**.

Front panel and Connectors.

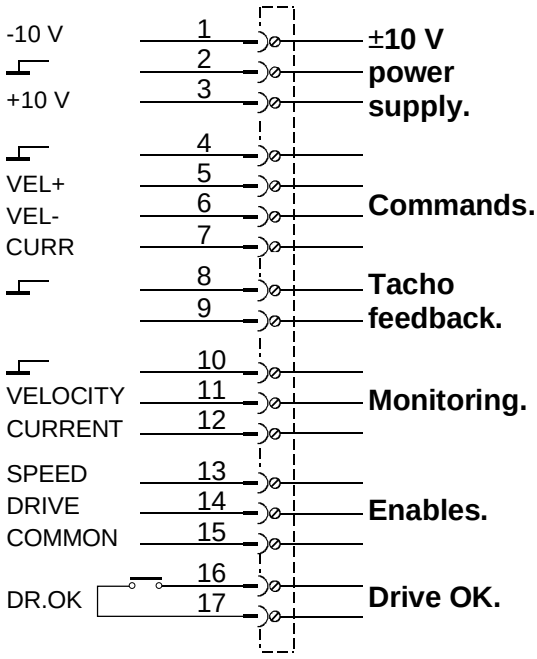


Identity module: IM.
- See corresponding section -

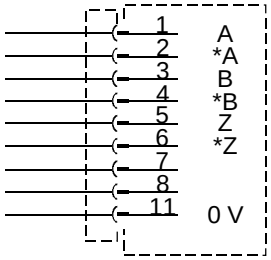
Meaning of the possible messages at the Status display.

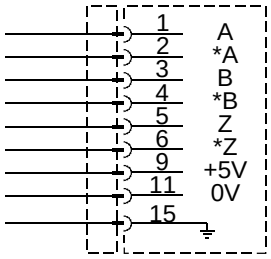
Drive status display.

Connector for drive control signals.

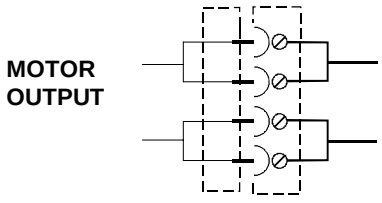


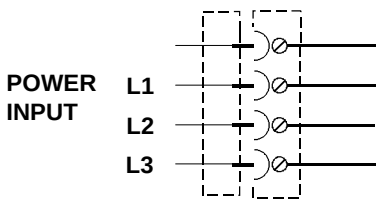
Encoder output connector for the CNC.





Encoder feedback input connector.





2.4 STATUS DISPLAY

It is a 7-segment display for monitoring the Drive status.

The unit is under power, the "Drive Enable" pin is deactivated, (0 Volts at pin 14). The motor has no torque.

"Speed Enable" off (0 Volts at pin 13), and **"Drive Enable"** (+24V at pin 14). The motor has torque with no velocity command.

Everything is OK. "Drive Enable" and "Speed Enable" are active and the Motor responds to the command.

Current leak from power lines to ground.
Solutions: carry out the motor maintenance procedures. Check the insulation of the power cables.

No Feedback.
Solutions: Check that jumper J1 selects the feedback mode being used. Check that the feedback cable and connectors are properly connected. Check that the winding circuit is not open. When working in velocity command mode, make sure that jumper J4 is in the (bc) position. When working in torque command mode, make sure that the RAPT resistor of the identity module is short-circuited.
In the case of an Encoder, check the polarity of the voltage applied to the winding and that the signal pairs (A,*A) and (B,*B) are not interchanged.

In the case of tacho feedback, check the polarity of the winding and that of the tacho. Check that the tacho is not open or defective.

Drive overtemperature.
Solutions: Smooth the duty cycle. Improve its cooling. The unit will return to its normal running status when it cools down below 78°C (172°F).

Motor overload. The I·T protection has gone off. In other words, the motor has maintained an average current greater than the maximum allowed ($Iomax_M$) for too long. The duty cycle is too demanding for the capabilities of the motor. The motor is working beyond its rated current.
Solutions: Smooth the duty cycle. Limit motor acceleration with ACC/DEC RAMPS. Limit the commands, MAX.CURRENT LIMIT and MAX.SPEED. Decrease the RIT, thus allowing the system to further force the motor.

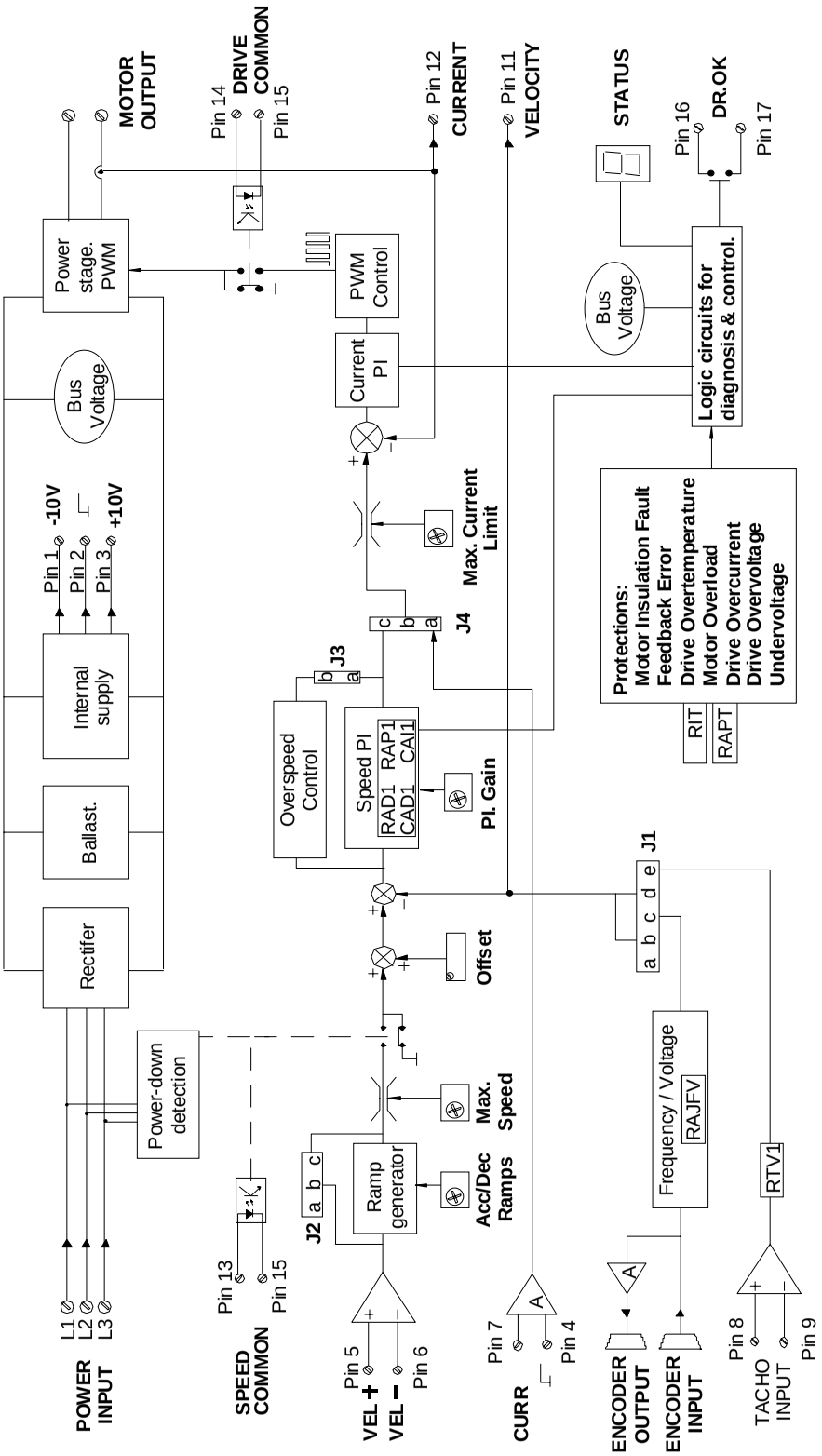
Overcurrent. There has been an instantaneous current peak greater than the maximum allowed according to the table on page 11.
Solutions: Limit motor acceleration with ACC/DEC RAMPS. If the motor has low inductance and the current ripple is excessive, add an inductance in series with the winding circuit (this is never required with Fagor DCM motors).

Overvoltage. For an instant, the internal Bus voltage has exceeded 193 V.
Solutions: The Ballast circuit may be defective or the supply voltage is too high.

Low-voltage. The supply voltage is too low.

Notes:
All the alarms except the **4.** and **E.** are latched and the unit must be powered off and, after 30 seconds, turned back on.
J1, J4, RAPT, ACC/DEC RAMPS, MAX.CURRENT LIMIT, MAX.SPEED and RIT are elements for adjusting the servo drive system and they are described in the section on "the Identity Module IM".

2.5 INTERNAL OPERATION DIAGRAM



2.6 SPECIFICATIONS PLATE AND SALES REFERENCE

Examples of the **specs plate** that comes with each Fagor DC drive.

FAGOR	Fagor Automation S. Coop.(Spain) DC SERVODRIVE	CE
MODEL: DCS-14-E0	INPUT : 3 X 110 VAC / 50-60 Hz	
S.N.: 22-19040001	OUTPUT: 0-150 VDC	
PM FV VAR FR 00A 00A 00A	Io 14 Amp Imax 28 Amp	W: 3,5 Kg

FAGOR	Fagor Automation S. Coop.(Spain) DC SERVODRIVE	CE
MODEL: DCS-08-T0	INPUT : 3 X 110 VAC / 50-60 Hz	
S.N.: 22-19040000	OUTPUT: 0-150 VDC	
PM VAR FR 00A 00A	Io 8 Amp Imax 16 Amp	W: 3,5 Kg

"PM", "FV", "VAR" and "FR" indicate manufacturing related aspects (hardware design versions) that are useful for technical consultations and repairs.

Codes of the **sales reference** of Fagor DC drives.

D.C. SERVODRIVES			Example: DCS - 08 - E0
D.C. SERVODRIVE			
CURRENT		Rated	Peak (4.5 sec)
	08	8 Amp	16 Amp
	14	14 Amp	28 Amp
FEEDBACK	**T0**	Basic drive. Ready to control motors with tacho	
	E0	Drive especially equipped to also control motors with Encoder (E0 and F0). Standard.	

Motor-Drive set

Rated and peak torque

The characteristics of rated and peak torques of the motors are often limited by the current capabilities of the Drive controlling them.

This table considers these possible limitations.

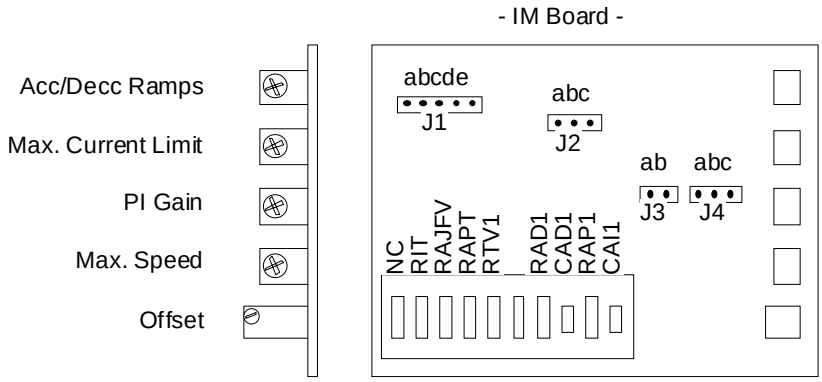
MOTORS	Speed -rpm-	DCS-08 DRIVE Stall Torque -Nm-	DCS-08 DRIVE Peak Torque -Nm-	DCS-14 DRIVE Stall Torque -Nm-	DCS-14 DRIVE Peak Torque -Nm-
DCM21.40A	4000	1.12	3.8		
DCM22.40A	4000	2	4	2.2	7
DCM23.25A	2500	3.1	6.8	3.1	12
DCM41.12A	1200	2.6	15.2		
DCM41.20A	2000	2.5	8.5		
DCM41.30A	3000	2.4	5.6		
DCM42.12A	1200	4.6	15.2		
DCM42.20A	2000	4.4	8.9	4.4	15.6
DCM42.30A	3000			4.2	10.6
DCM43.12A	1200	7.2	15.6	7.2	27.4
DCM43.20A	2000			7	16.2
DCM43.30A	3000			5.5	10.9
DCM51.12A	1200			9.5	28
DCM51.20A	2000			8.4	16.8
DCM52.12A	1200			12	28

Identity Module, IM

This card is inserted into the DCS drive module. Its passive components and jumpers adjust the drive electronics to the DCM motor it governs.
There is an IM card for each correct combination of DCM motor and DCS drive as shown on the next page. The IM-000 board is used for setting DCS Drives with non-Fagor motors. The calculation of the passive components is described on the next pages.

The potentiometers accessible from the outside allow a final adjustment of the servo drive system.

The component layout of this card and their functions are described next.



Passive components:

NC: Empty.

RIT: It sets the current value from which the I·T protection starts integrating. If this resistor is short-circuited, this protection is removed.

RAJFV: When using encoder feedback, it sets the relationship between the frequencies of the encoder pulses and the equivalent voltage in the internal drive circuits.

RAPT: The system is protected against motor runaway should it lose feedback. This resistor sets the overspeed value triggering this protection. The smaller the value of the RAPT the more tolerant the system is. If short-circuited, this protection will be removed. When working in current command mode, this RAPT must be short-circuited.

RTV1: It adapts the voltage generated by the tacho to the internal Drive circuits.

RAD1, CAD1: They set the derivative compensation at the velocity PI.
RAP1, CAI1: They set the proportional and integral action of the velocity PI.

Jumpers (**in bold**, default position):
J1: Feedback type selector. Via **encoder** (**bc**). Via tacho (de).
J2: Ramp generator, **active** (**ab**), or not (bc).
J3: Activates the acceleration overshooting control. **Active** (**ab**).
J4: Selector for the type of command. Current command (ab) or **velocity** (**bc**).

These are the names of the identity modules (IM) for each Motor-Drive set.

	IM Board	
	DCS-08	DCS-14
DCM21.40A	**IM-2140A-08**	
DCM22.40A	**IM-2240A-08**	**IM-2240A-14**
DCM23.25A	**IM-2325A-08**	**IM-2325A-14**
DCM41.12A	**IM-4112A-08**	
DCM41.20A	**IM-4120A-08**	**IM-4120A-14**
DCM41.30A	**IM-4130A-08**	**IM-4130A-14**
DCM42.12A	**IM-4212A-08**	**IM-4212A-14**
DCM42.20A	**IM-4220A-08**	**IM-4220A-14**
DCM42.30A		**IM-4230A-14**
DCM43.12A	**IM-4312A-08**	**IM-4312A-14**
DCM43.20A		**IM-4320A-14**
DCM43.30A		**IM-4330A-14**
DCM51.12A		**IM-5112A-14**
DCM51.20A		**IM-5120A-14**
DCM52.12A		**IM-5212A-14**

General purpose: **IM-0000**

And these are the values of the passive components on each of those cards.

	RIT		RAJFV	RTV1
	DCS-08	DCS-14		
DCM21.40A	**75K**		**5,6K**	**82K**
DCM22.40A	**39K**	**68K**	**5,6K**	**82K**
DCM23.25A	**43K**	**82K**	**10K**	**39K**
DCM41.12A	**130K**		**22K**	**10K**
DCM41.20A	**75K**	**130K**	**12K**	**27K**
DCM41.30A	**47K**	**91K**	**8,2K**	**56K**
DCM42.12A	**68K**	**130K**	**22K**	**10K**
DCM42.20A	**39K**	**75K**	**12K**	**27K**
DCM42.30A		**56K**	**8,2K**	**56K**
DCM43.12A	**43K**	**82K**	**22K**	**10K**
DCM43.20A		**47K**	**12K**	**27K**
DCM43.30A		**39K**	**8,2K**	**56K**
DCM51.12A		**62K**	**22K**	**10K**
DCM51.20A		**39K**	**12K**	**27K**
DCM52.12A		**47K**	**22K**	**10K**

RAPT = 15K **RAP1 = 82K** **CAI1 = 100nF**

Adjustment potentiometers:

Acc/Dec Ramps: To adjust the ramp filtering the velocity command. Ramps with a duration of up to 10 seconds may be applied for a 10 volt step of analog voltage.
Turning this pot clockwise means smoother behavior (longer ramp).
WATCH OUT! If jumper J2 of the identity module is set in the (bc) position, no ramps will be applied.

Max. Current Limit: Each drive is factory set to provide the maximum current to the motor which corresponds to the maximum value of the current command. This adjustment may be used to decrease the value of that current limit.
Turning this pot clockwise allows more current to flow through the motor.

PI Gain: For adjusting the overall gain of the velocity PI.
Turning this pot clockwise increases the gain and, therefore, makes the system perkier.

Max. Speed: Every drive is factory set so the motor turns at its maximum speed when applied maximum velocity command.
In this case, this pot will be turned 3/4 of its full travel. Therefore, it may be used to limit or force slightly the maximum motor speed.
Turning this pot clockwise allows greater speed.

Offset: To compensate for the difference between the velocity command and the actual motor speed.

Adjustment of IM components for governing Non-Fagor motors

RTV1 calculation:

Vmaxtac = Nmax · 1.3 · Ktac

RTV1 = Vmaxtac - 22 (KΩ)

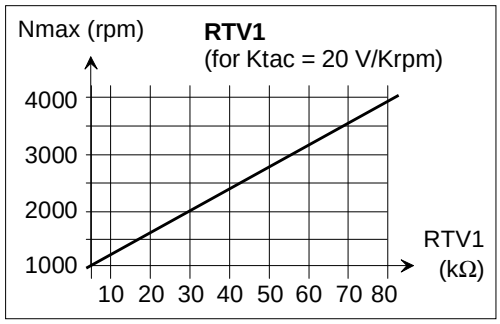
This RTV1 must be of 1/4 Watts

Example of calculation:

Maximum Speed: 1200 rpm
Tacho Constant: 20 V/Krpm
1200 · 1.3 · 0.02 = 31.2
RTV1 = 31.2 - 22 = 9.2 KΩ / 0.25 W

This calculation is independent of whether the maximum speed is later limited with Max.Speed or not.
This calculation is OK for velocity commands of ±10V.
If, for example, the command is ±8V for a maximum speed of ±1200 rpm, the previous calculation will result in 1200·10/8 = 1500 rpm.

Graph for calculating the RTV1 resistor when using a 20 V/Krpm tacho.
(the one carried by the Fagor motors mentioned in this manual)



RAJFV calculation:

$$RAJFV\ (K\Omega) = \frac{68{,}4 \cdot 10^6}{(Pulses/turn) \cdot Nmax \cdot 1.15}$$

This RAJFV must be of 1/4 Watt

Example of calculation:

Maximum Speed: 1200 rpm
Encoder pulses per turn: 2500

$$RAJFV\ (K\Omega) = \frac{68{,}4 \cdot 10^6}{2500 \cdot 1200 \cdot 1.15} = 19.8\ K\Omega$$

This calculation is independent of whether the maximum speed is later limited with Max.Speed or not.
This calculation is OK for velocity commands of ±10V.
If for example, the command is ±8V for a maximum speed of ±1200 rpm, the previous calculation will result in a maximum speed of 1200·10/8 = 1500 rpm.

RIT calculation:

$$RIT\ (K\Omega) = \frac{150}{In \cdot K} - 10$$

where:
K = 0.39 (DCS-8)
K = 0.22 (DCS-14)

This RIT must be of 1/4 Watt

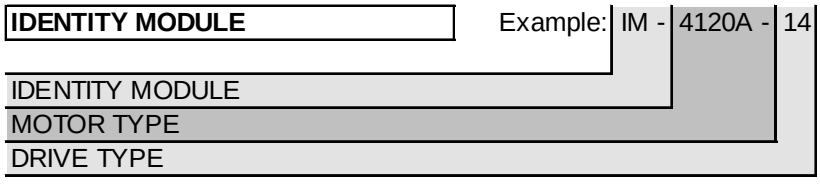
Example of calculation:

DCS-08 drive
DCM41.20 motor : In = 4.72 Amp

$$RIT\ (K\Omega) = \frac{150}{4.72 \cdot 0.39} - 10 = 71.5\ K\Omega$$

"In" is the rated current of the motor according to the characteristics table or the current used in a duty cycle considered nominal.

Codes of the **sales reference** for the identity cards:



Installation

5.1 GENERAL CONSIDERATIONS

About the Motor:

Remove the anti-corrosion paint of the shafts before mounting them on to the machine.
The motor may be mounted as described in the first chapter
Watch for the ambient conditions:
Mount it somewhere that is dry, clean and accessible for maintenance.
-remember that it meets the IP44 degree of protection.
It must be easily cooled. Avoid corrosive or flammable environments.
Guard the motor with a cover if it is exposed to splashes.
Use flexible couplings for direct transmission.
Avoid radial and axial loads on the motor shaft.

About the Drive:

The module must be installed in an electrical enclosure that is clean, drive free of dust, oil or other pollutants - remember that its degree of protection is IP20-. Never install it exposing it to flammable gases. Avoid excessive heat and humidity. The ambient temperature must never exceed 45°C (113°F).

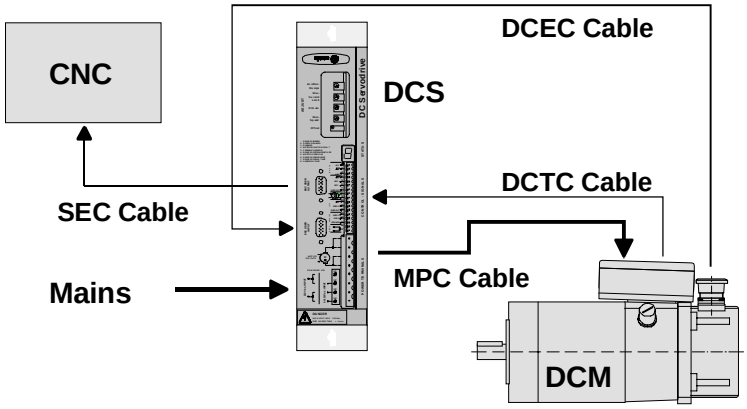
Mount the modules vertically (as shown on the photos). Avoid vibrations.
Leave at least 30 cm of clearance above and below the module for better air flow.

About the connections:

All the cables must be shielded, to reduce the interference on the control of the motor due to the commutation of the PWM. The shield of the motor power cable must be connected to the chassis screw at the bottom of the module and it, in turn, taken to Mains ground.
A transformer MUST BE used. It must serve as a filter to limit the start-up current to the maximum allowed by the unit. See characteristics on page 10.
The command signal lines must be shielded twisted pairs. The shield must be connected to the voltage reference at the module (pins 2, 4 or 10).
Keep the signal cables away from the power cables.

All the pins with the GND symbol (2, 4, 10) are the same electrical point and are interchangeable.

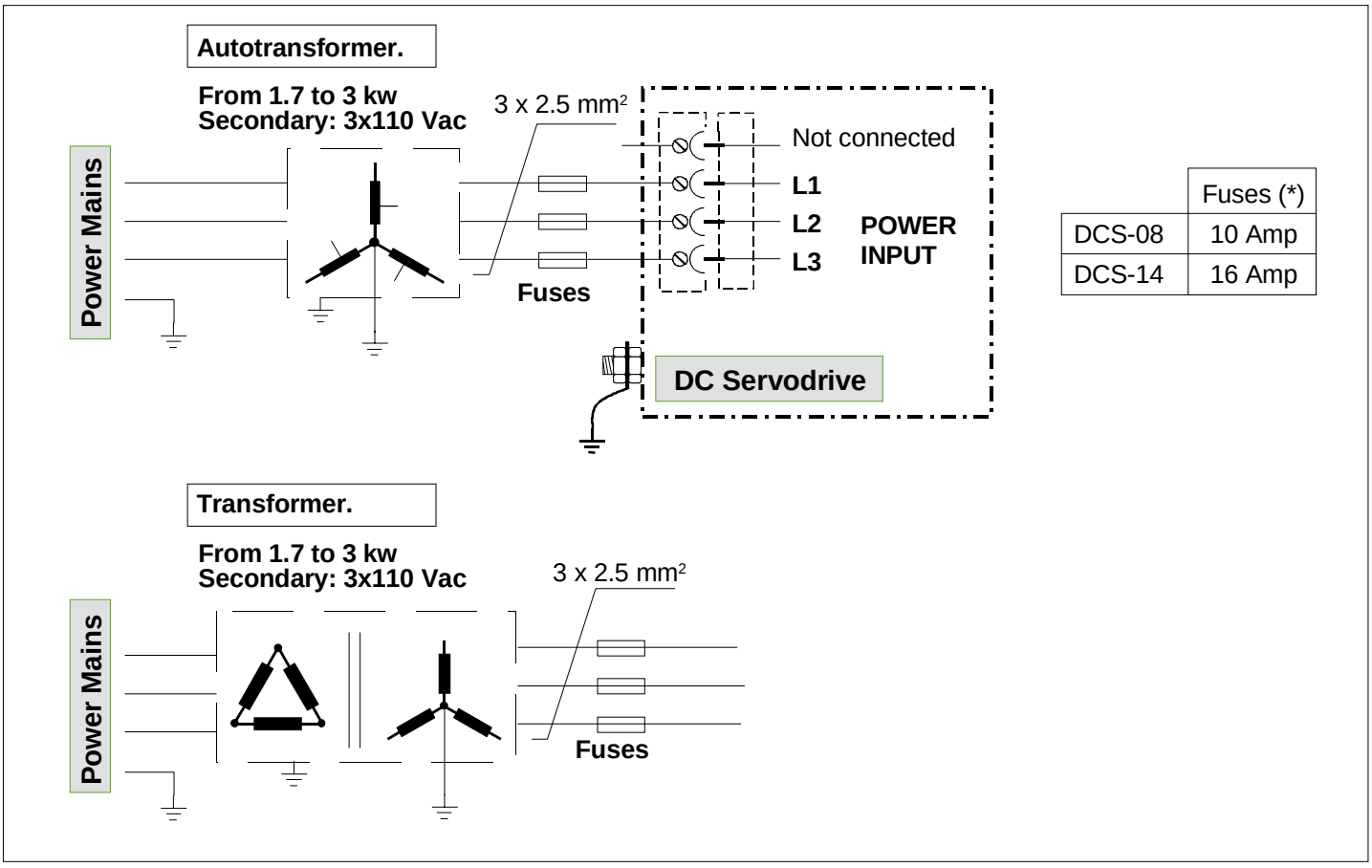
Basic interconnection diagram



5.2 ELECTRICAL CONNECTIONS

Power connection: Mains-Drive.

The drive power supply must be three-phase. A transformer MUST BE used. It must be used to filter the start-up current to the maximum value allowed by the unit.
See characteristics on page 10.



	Fuses (*)
DCS-08	10 Amp
DCS-14	16 Amp

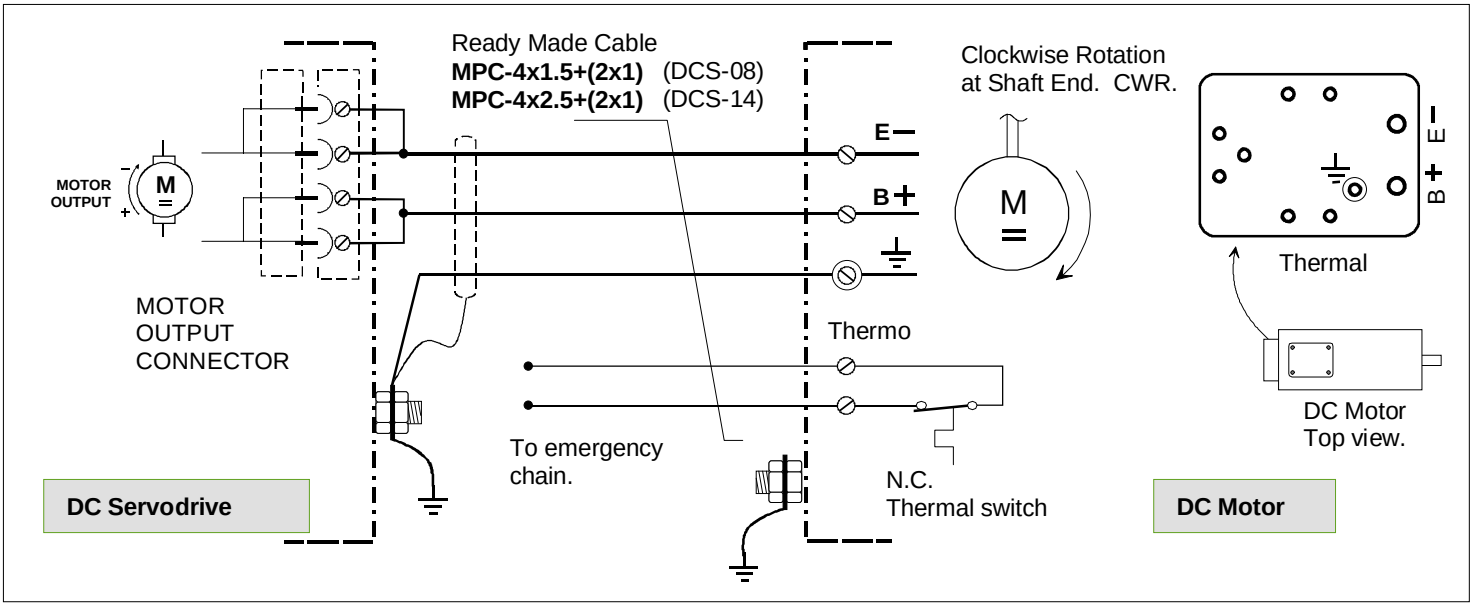
(*) Recommended values. They are slow general purpose fuses. If they are installed on the Mains input lines, their maximum currents will depend on the value of the Mains voltage.

Cartridges 5SE0 016-OY and 5SE0 020-OY from Siemens are good for this application.

A thermal switch may optionally replace the fuses.

Important: The secondary windings must have a star connection with its middle point connected to ground.

Power connection: Drive-Motor.



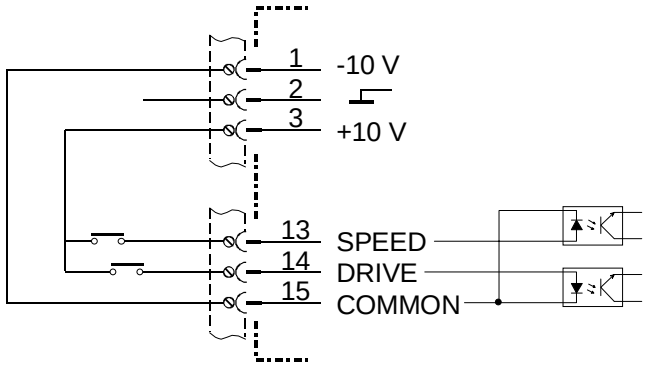
The Fagor DCS drive has been designed to govern motors with a winding inductance greater than 2.5 mHr. Motors with an inductance lower than that need a coil installed in series.
This coil must never have an inductance value greater than 8 mHr.

Warning: A short-circuit between the E- and B+ terminals may cause great damage to the Drive.

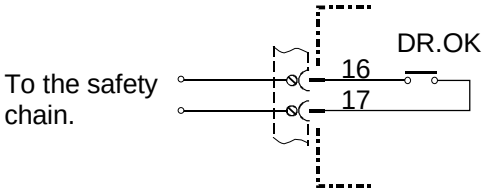
Connection of the monitoring and control signals.

Monitoring: The drive offers +10Vdc at its "velocity" output when, receiving the maximum command of +10V, the motor turns at the speed which the RTV1 resistor has been calculated for (usually the motor's maximum speed). The "current" output offers +10Vdc when the drive provides its peaks current (table page 10).

Enable signals using ±10V:



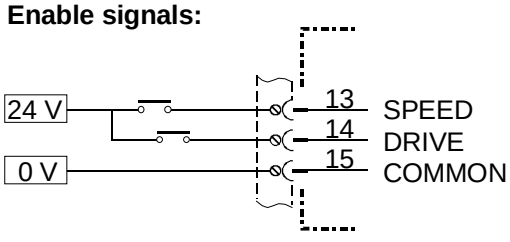
Drive OK signal:



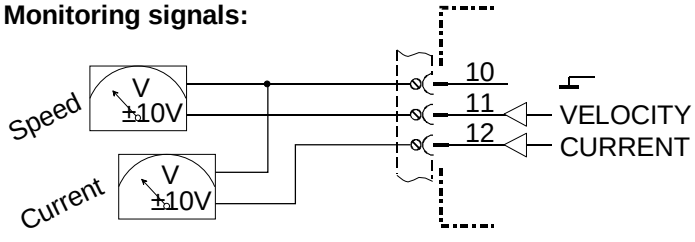
Drive OK: contact

0.6A - 125Vac
0.6A - 110Vdc
2A - 30Vdc

Enable signals:

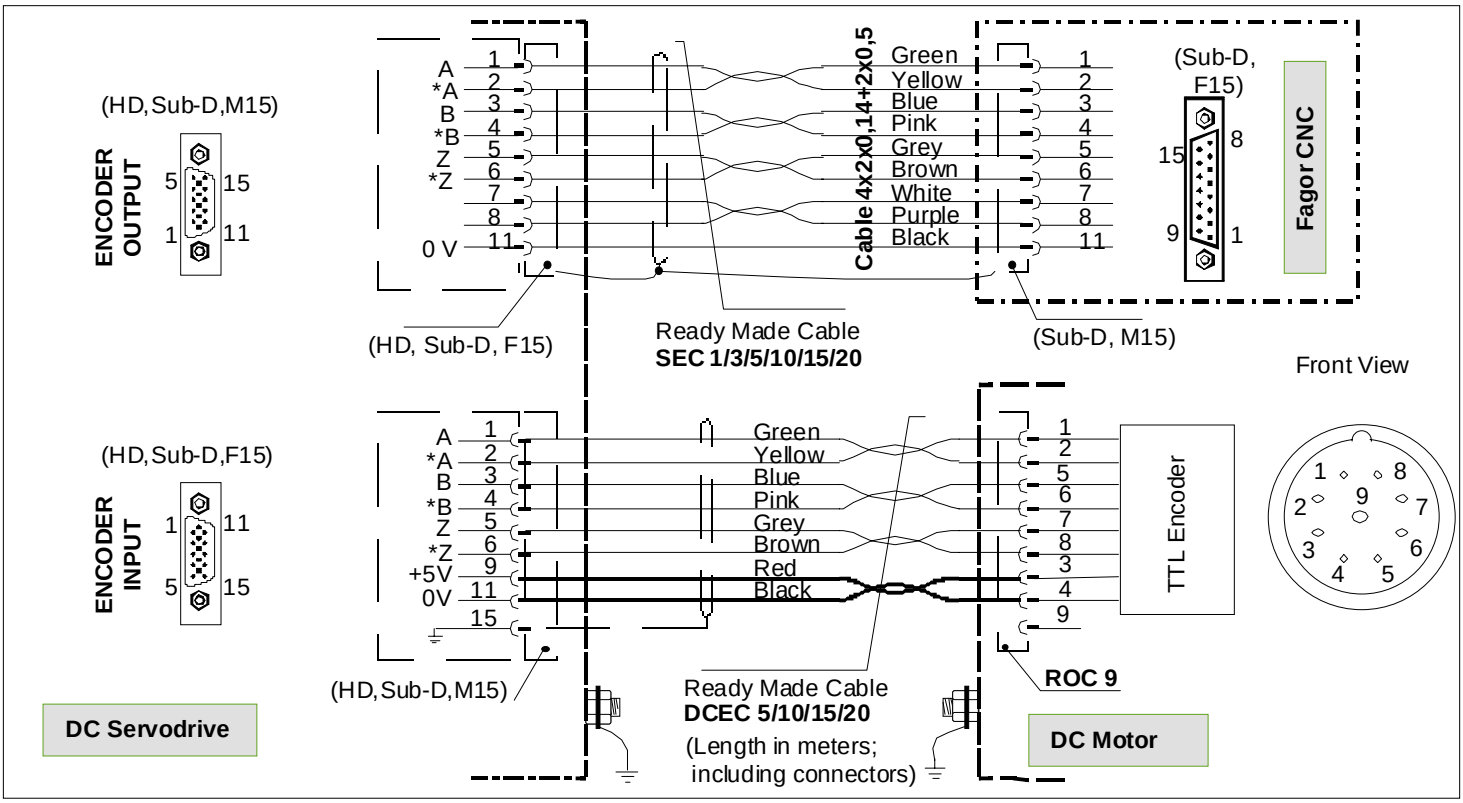


Monitoring signals:



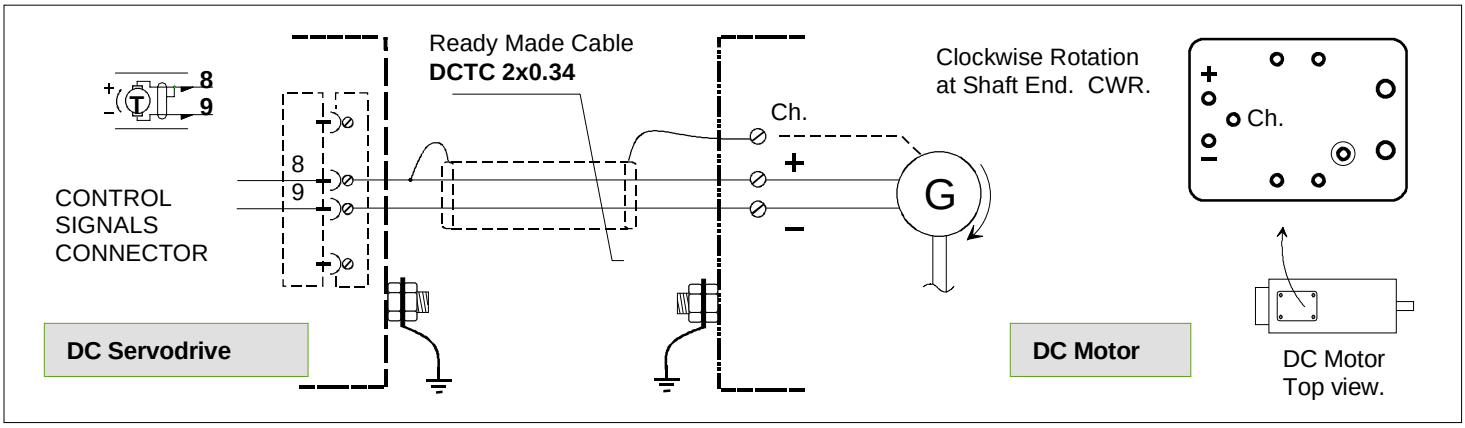
Encoder feedback connection.

The encoder signals must be taken to the ENCODER INPUT of the DCS.
The DCS amplifies these signals and it sends them out through the ENCODER OUTPUT connector. This serves as position feedback to close the position loop at the CNC.
The encoder must turn with the motor shaft and it must not be installed anywhere else in the transmission chain. It must output 2000 or more pulses per turn for a good regulation and its signals must be differential (double ended) 5V.
The encoders installed on Fagor DCM motors appearing in this manual meet these requirements.
On the identity card, put selector **J1** in the (**bc**) position.
Fagor supplies these full connections (cable + connectors), SEC and DCEC.



Tacho feedback connection.

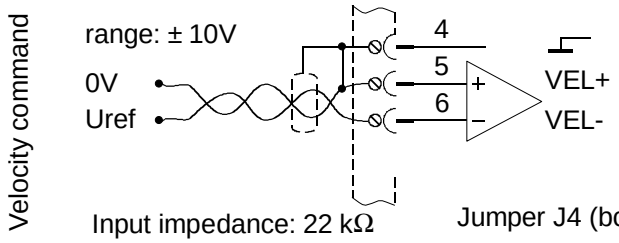
The tacho must turn with the motor shaft and it must not be mounted anywhere else in the transmission chain.
On the identity card, put selector **J1** in the (**de**) position.
Fagor supplies this full connection (cable + connectors), DCTC.



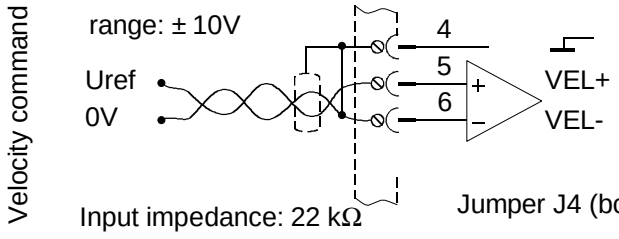
Command signal connection.

The command governing the motor may be a velocity or current command.
All the command signal lines must be shielded twisted pairs and the shield must be connected to the voltage reference at the module (pins 2, 4 or 10).
The input impedance of the velocity command is 22 kOhms (a range of ±10 V).
The input impedance of the current command is 10 kOhms (a range of ±6.2 V).

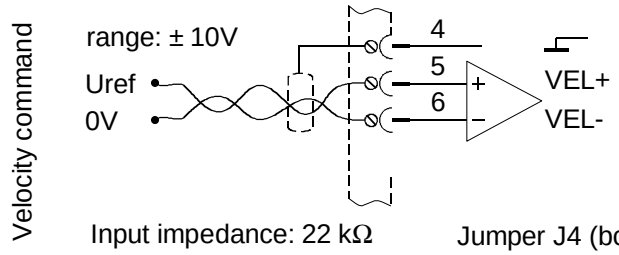
Inverted velocity command input:



Uninverted velocity command input:

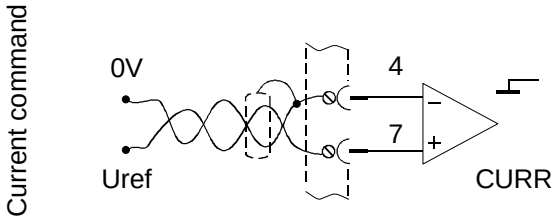


Differential velocity command input:



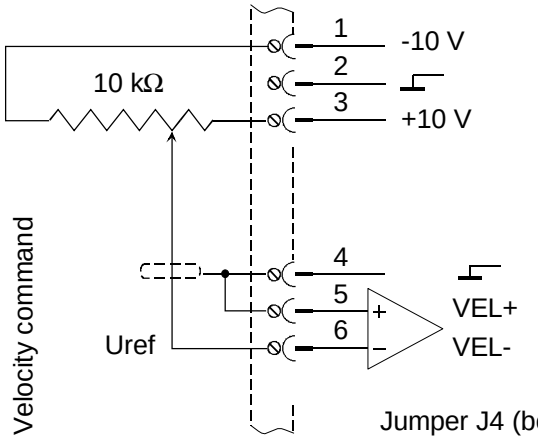
Current command input:

shortcircuit RAPT on the IM. Jumper J4 (ab)



range: ± 6.2 Vdc
Input impedance: 10 kΩ

Generation of the inverted velocity command and application to the drive:



Codes of the sales references for the cables supplied by Fagor:

ENCODER CABLE Example: **DCEC - 20**

DC ENCODER CABLE
LENGTH (m) **5, 10, 15, 20.**

SUB-D HD M15 — ROC 9

ENCODER-CNC CABLE Example: **SEC - 20**

ENCODER SIMULATOR CABLE
LENGTH (m) **1, 3, 5, 10, 15, 20.**

SUB-D M15 — SUB-D HD F15

TACHO CABLE Example: **DCTC - 2 x 0,34**

DC TACHOMETER CABLE
Nr. LINES x SECTION (mm2)

MOTOR POWER CABLE Example: **MPC - 4x2.5+ (2x1)**

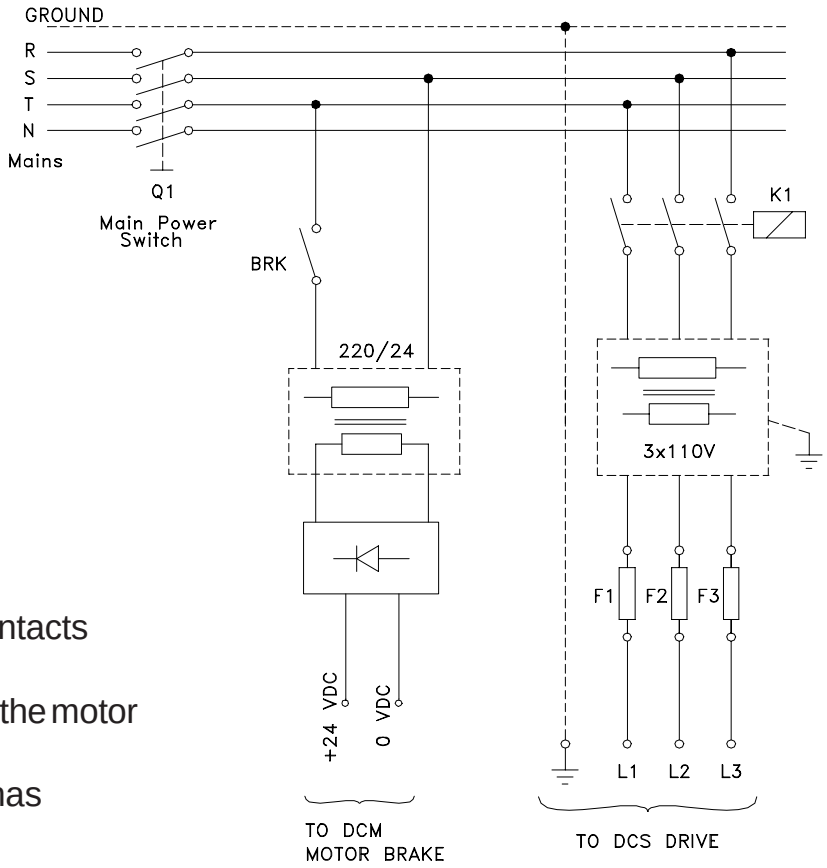
DC MOTOR POWER CABLE
Nr. LINES x SECTION (mm2) **4 x 1,5** (for DCS-08)
4 x 2.5 (for DCS-14)
Nr. LINES x SECTION (mm2) **2 x 1**

5.3 ELECTRICAL ENCLOSURE DIAGRAM

This is a sample diagram for an electrical enclosure. It may be modified to meet the needs of a particular application.

It includes a simple circuit to power the brake of the DCM.

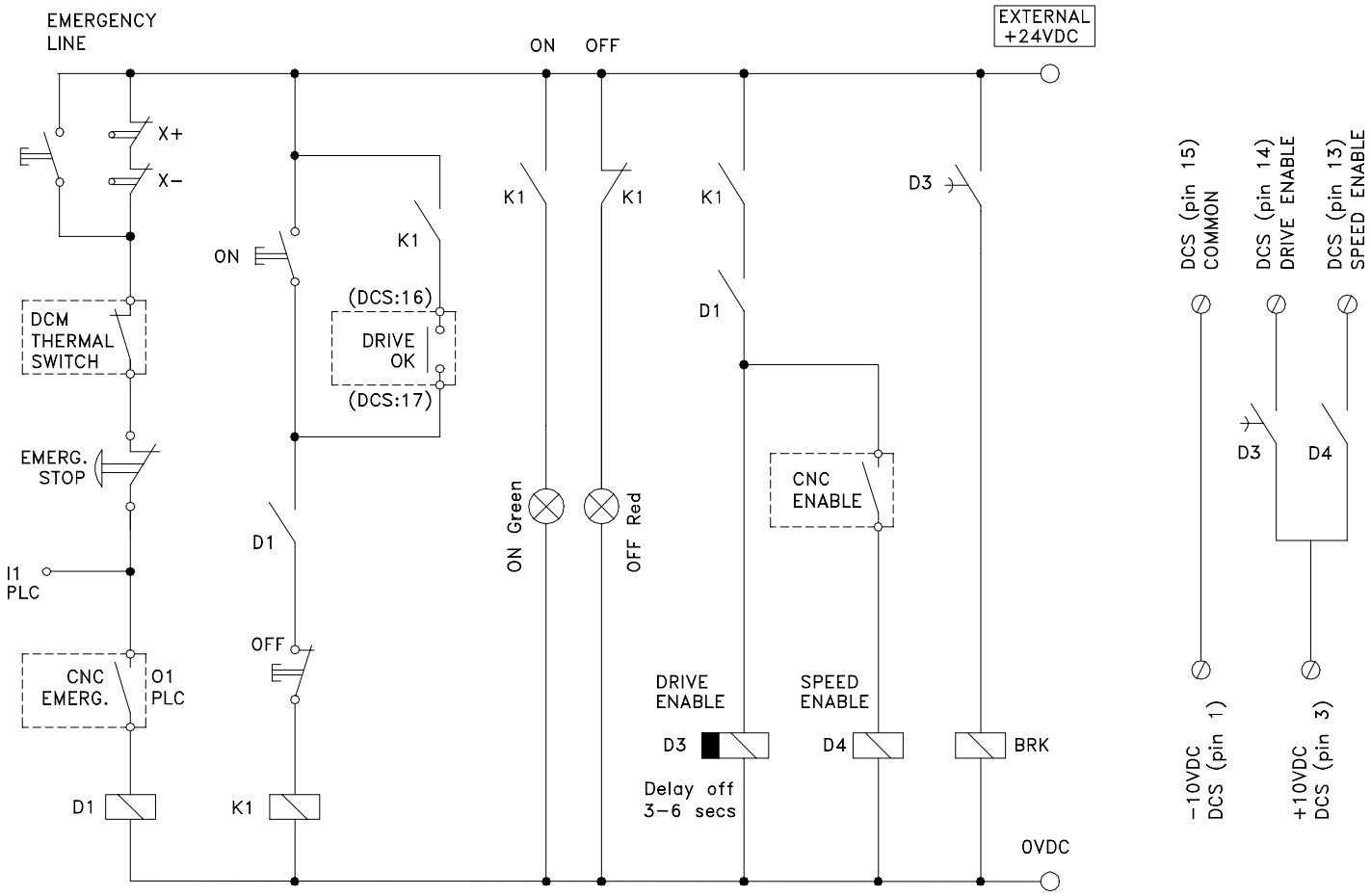
Warning: When using an autotransformer, the secondary must have a star connection with its middle point connected to ground. Fuses are MANDATORY.



The delay when disconnecting the D3 contacts serves for:

- the "Drive_Enable" to stay active while the motor is braking at maximum torque.
- for the brake to hold the motor after it has stopped.

If the system moves a vertical axis, it should be compensated for (with counterweight).



5.4 INITIALIZATION AND SETUP

Verify that the identity card **IM** is the right one. The name of the card itself (page 20) indicates which motor and drive combination it has been designed for.

Verify that the type of feedback selected with jumper **J1** matches the feedback device installed on the motor. Encoder (J1-bc). Tacho (J1-de).

Select whether Ramps are to be generated or not using jumper **J2**.
Yes (J2-ab). No (J2-bc).

To cancel the control of excessive acceleration, change the jumper **J3** position. Active (J3-ab).

Verify that jumper **J4** selects the type of command to govern the motor and that it is applied at the right pins. Current (J4-ab). Velocity (J4-bc).

Somehow, measure the motor speed (with the CNC when using encoder feedback or with a voltmeter when using a tacho). Apply the maximum velocity command.
Then, turn the **Max.Speed** potentiometer until reaching the desired speed for that command. For 10V of velocity command with the motor turning at the maximum speed which the RTV1 has been calculated for, the monitoring output (pins 10 and 11) will provide 10V.

Use the **Max.Current.Limit** potentiometer to adjust the maximum peak current (maximum motor torque). To monitor the peak current, the motor may be turned back and forth at full torque and without generating ramps.

Adjust the gain of the velocity PI with the **PI.Gain** potentiometer until the desired behavior is obtained.

Adjust the velocity offset.

Send to the drive an analog voltage of 0 Volts (by jumpering pins 4,5 and 6 of Control-Signals connector). Measure somehow the motor speed (with the CNC when using encoder feedback or a voltmeter when using a tacho). Turn the **Offset** potentiometer on the identity card until the motor stops. But, CAREFUL, by this method, only the drive offset is eliminated, the CNC may have an offset of its own. Now the CNC offset should be adjusted.

To adjust the offset in the complete control loop, set the CNC in DRO mode, but with the "Drive_Enable" and "Speed_Enable" signals actives. Turn the offset potentiometer until stopping the motor. Another way could be to set a position for the axis with the CNC and turn this potentiometer until a symmetrical following error is obtained.

Adjust the ramp value. If the generation of ramps has been activated with J2, turn the **Acc/Dec Ramps** potentiometer until obtaining the desired behavior.

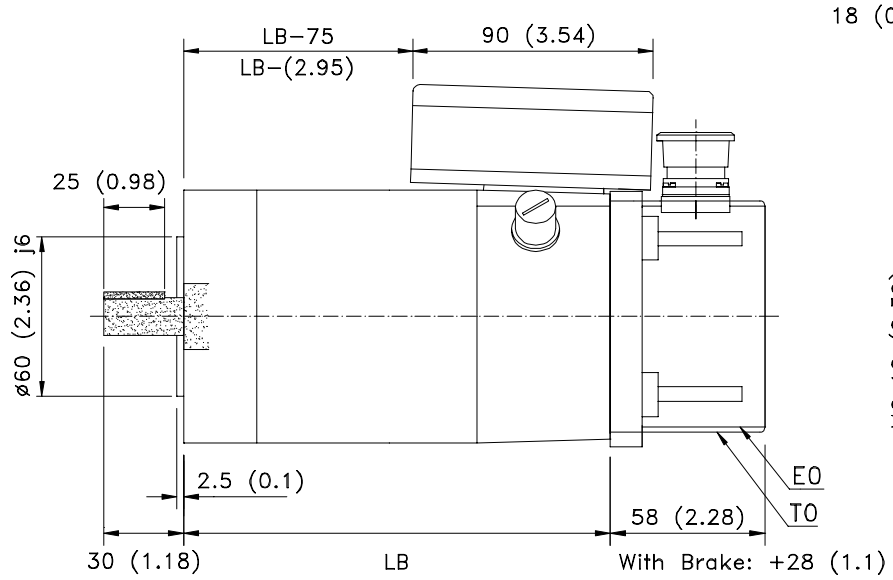
Mechanicals Dimensions

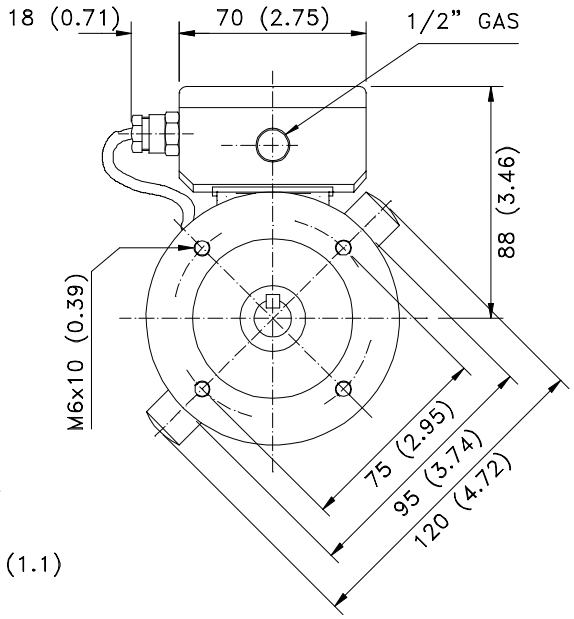
DC MOTORS

DCM2 SERIES

mm (inches)

	LB
DCM21	160 (6.3)
DCM22	215 (8.46)
DCM23	270 (10.63)



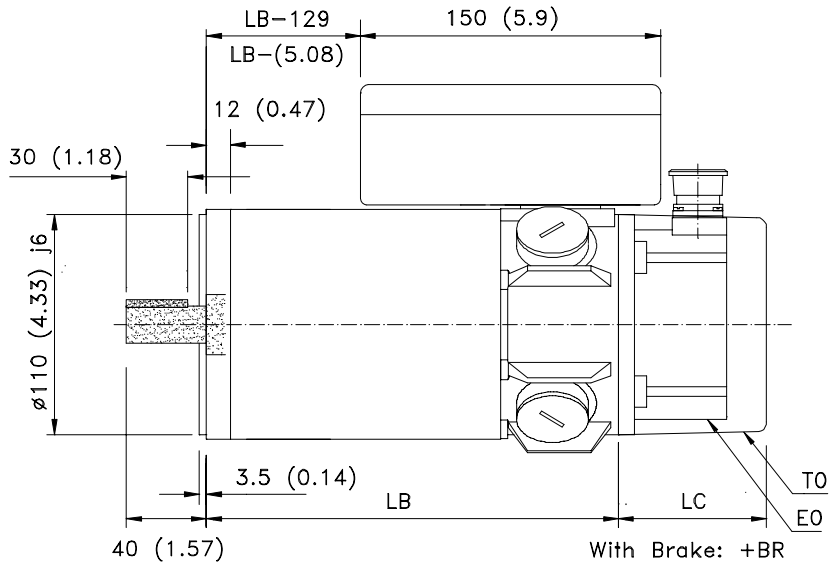


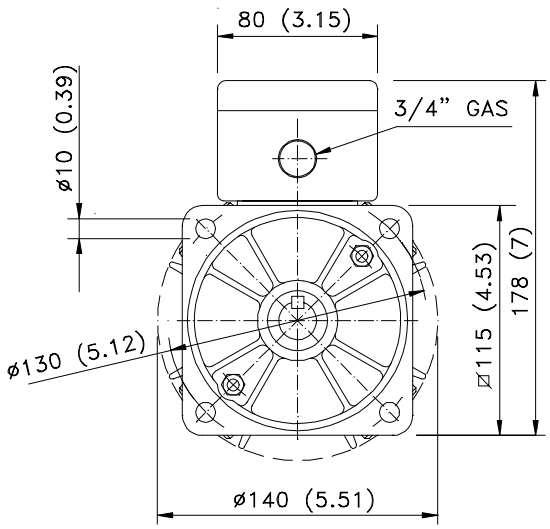
DCM4 SERIES

mm (inches)

	LB
DCM41	206 (8.11)
DCM42	261 (10.27)
DCM43	341 (13.42)

	LC	BR
E0	54 (2.12)	42 (1.65)
T0	74 (2.91)	40 (1.57)



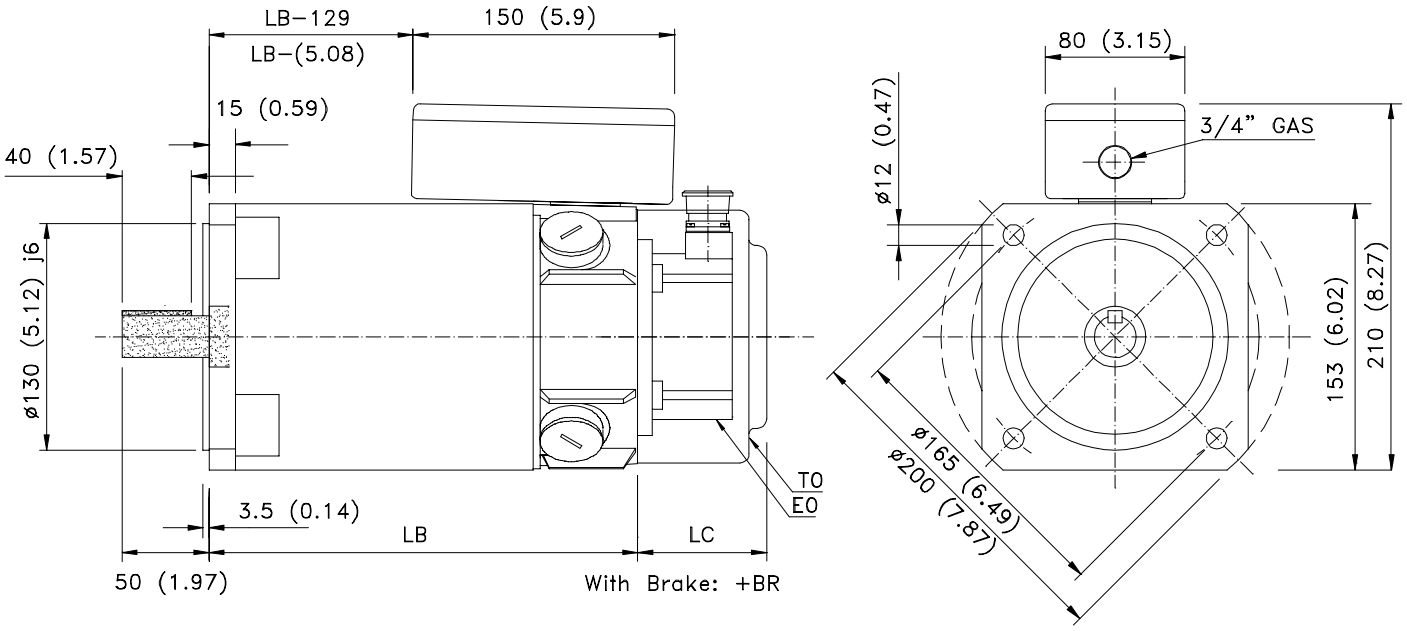


DCM5 SERIES

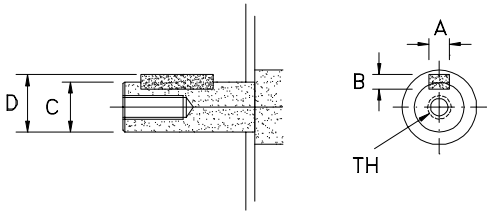
mm (inches)

	LB
DCM51	246 (9.68)
DCM52	276 (10.86)

	LC	BR
E0	56 (2.2)	53 (2.09)
T0	74 (2.91)	60 (2.36)

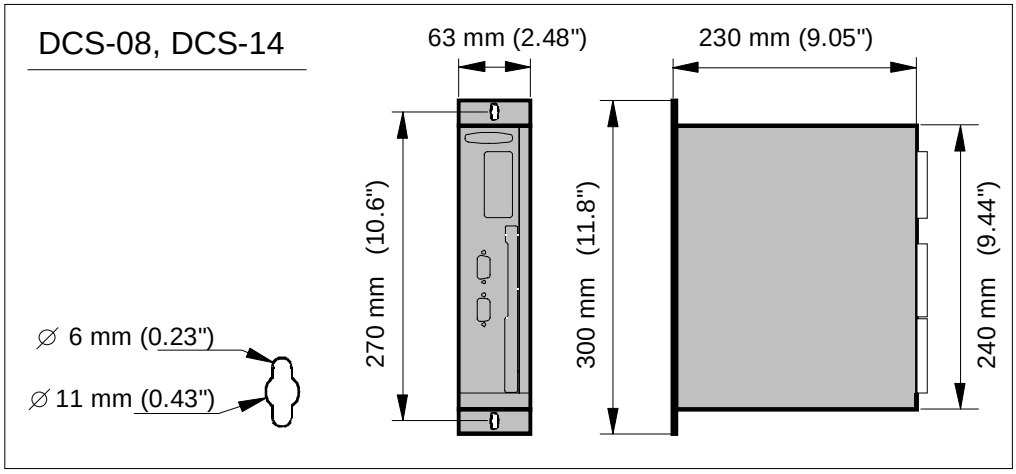


Details of the motor shafts and keyways.



	A	B	C	D	TH
DCM2	5 (0.19)	5 (0.19)	14 (0.55) j6	16 (0.62)	M5x12 (0.47)
DCM4	6 (0.24)	6 (0.24)	19 (0.75) j6	21.5 (0.85)	M6x16 (0.63)
DCM5	8 (0.31)	7 (0.27)	24 (0.94) j6	27 (1.07)	M8x19 (0.75)

DC SERVODRIVE



Product codes.

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DCM21.40A.T0.100	84400002	DCM42.12A.T0.100	84400082	DCM51.12A.T0.100	84400182
DCM21.40A.T0.110	84400003	DCM42.12A.T0.110	84400083	DCM51.12A.T0.110	84400183
DCM21.40A.E0.000	84400004	DCM42.12A.E0.000	84400084	DCM51.12A.E0.000	84400184
DCM21.40A.E0.010	84400005	DCM42.12A.E0.010	84400085	DCM51.12A.E0.010	84400185
DCM21.40A.E0.100	84400006	DCM42.12A.E0.100	84400086	DCM51.12A.E0.100	84400186
DCM21.40A.E0.110	84400007	DCM42.12A.E0.110	84400087	DCM51.12A.E0.110	84400187
DCM22.40A.T0.000	84400010	DCM42.20A.T0.000	84400090	DCM51.20A.T0.000	84400190
DCM22.40A.T0.010	84400011	DCM42.20A.T0.010	84400091	DCM51.20A.T0.010	84400191
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DCM41.30A.T0.100	84400072	DCM43.30A.T0.100	84400152	IM-5112A-14	84600028
DCM41.30A.T0.110	84400073	DCM43.30A.T0.110	84400153	IM-5212A-14	84600029
DCM41.30A.E0.000	84400074	DCM43.30A.E0.000	84400154	IM-4330A-14	84600030
DCM41.30A.E0.010	84400075	DCM43.30A.E0.010	84400155	IM-5120A-14	84600031
DCM41.30A.E0.100	84400076	DCM43.30A.E0.100	84400156	IM-0000	84600040
DCM41.30A.E0.110	84400077	DCM43.30A.E0.110	84400157		

DCS-08-E0	84500000	SEC-1	84040050		
DCS-08-T0	84500001	SEC-3	84040051	DCEC-5	84600050
DCS-14-E0	84500002	SEC-5	84040052	DCEC-10	84600051
DCS-14-T0	84500003	SEC-10	84040053	DCEC-15	84600052
MPC-4x1,5+(2x1)	04040165	SEC-15	84040054	DCEC-20	84600053
MPC-4x2,5+(2x1)	04040166	SEC-20	84040055	DCTC-2x0,34	84600100

Warranty

INITIAL WARRANTY

All products manufactured or marketed by FAGOR carry a 12-month warranty for the end user.

In order to prevent the possibility of having the time period from the time a product leaves our warehouse until the end user actually receives it run against this 12-month warranty, the OEM or distributor must communicate to FAGOR the destination, identification and installation date of the machine by filling out the Warranty Form that comes with each product.

The starting date of the warranty for the user will be the one appearing as the installation date of the machine on the Warranty Form.

This system ensures the 12-month warranty period to the user.

FAGOR offers a 12-month period for the OEM or distributor for selling and installing the product. This means that the warranty starting date may be up to one year after the product has left our warehouse so long as the warranty control sheet has been sent back to us. This translates into the extension of warranty period to two years since the product left our warehouse. If this sheet has not been sent to us, the warranty period ends 15 months from when the product left our warehouse.

FAGOR is committed to repairing or replacing its products from the time when the first such product was launched up to 8 years after such product has disappeared from the product catalog.

It is entirely up to FAGOR to determine whether a repair is to be considered under warranty.

EXCLUDING CLAUSES

The repair will take place at our facilities. Therefore, all shipping expenses as well as travelling expenses incurred by technical personnel are NOT under warranty even when the unit is under warranty.

This warranty will be applied so long as the equipment has been installed according to the instructions, it has not been mistreated or damaged by accident or negligence and has been handled by personnel authorized by FAGOR.

If once the service call or repair has been completed, the cause of the failure is not to be blamed the FAGOR product, the customer must cover all generated expenses according to current fees.

No other implicit or explicit warranty is covered and FAGOR AUTOMATION shall not be held responsible, under any circumstances, of the damage which could be originated.

SERVICE CONTRACTS

Service and Maintenance Contracts are available for the customer within the warranty period as well as outside of it.

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Fax: 34-943-791712
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