SERVO-DRIVESYSTEM

General Manual

Ver. 0002 (ing)

Title	Servo-Drive System
Type of documentation	Description, Installation and setup of motors and digital drives.
Internal code	04754001
Model	MAN REGUL (IN)
Version	0002
Software	Version 04.01
Electronic document	D_DDS.pdf

Headquarters

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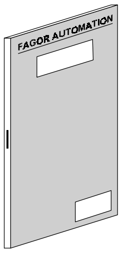
Evolution

Version	items
9702	First version
9707	PS-65, RM-15, CM-60, APS24, AXD3.., y SPD3.. PowerPro 110A, new motors FXM.
9802	Compact 8,25, 50,75, DDS PROGRAM MOD. Software 02.xx: Halt signal via digital input. Range expansion, (C axis) SERCOS interface. (connection and parameters)
9810	Software 03.xx: Sincoder feedback (E1). Motor identification at the encoder. Description of the XPS. Emergency ramps. Current filter. Sercos interface (servo system adjustment). Expansion of parameters for gear ratios. Communications with the PLC. Overload detection. Spindles at low rpm.
9904	Software 03.03: New fanned motors FXM. New SPM 180M motor. New products (Mains voltage 460 Vac). Full motor identification. Description and installation of the XPS. New drive AXD/SPD 1.35. EMK. filters. Drive off delay time, GP9.
0002	SPMxx.1 Motors Absolut encoder A1 PS-25B Improved AXD/SPD 1.15. Resistences ER. Digital I/O boards. Software 04.01: Current filter. Position Loop: Feedforward, Homing, Backlash compensation, Following error control, Modulo Format. Direct feedback.

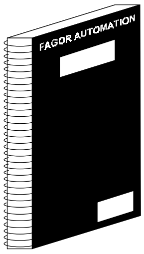
RELATED DOCUMENTATION

Selection



Fagor Motors and Drives
Ordering Handbook

Description
Installation
an setup



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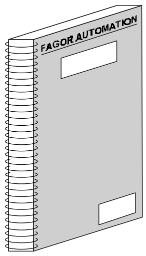
Servo Drive System
Code: 04754001



Sistema de Regulación
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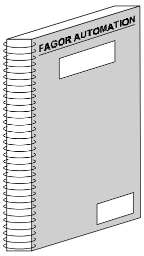
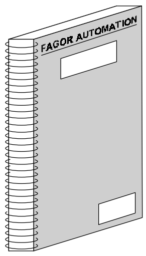
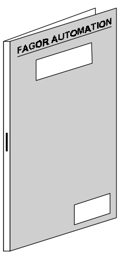


Fagor Motion Control
Code: 04xxxxxx

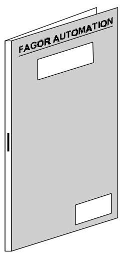


Fagor Motion Control
Code: 04xxxxxx

Quick Reference



Fagor Modular Drives and
Motors Quick Reference
Code: 14460010



Fagor Compact Drives and
Motors Quick Reference
Code: 14460012

General Index

APPENDIX:

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 Servo Drive System

Consisting of the following modules and accessories:

Power Supplies: XPS-25, XPS-65, PS-25A, PS-25B, PS-65A y APS 24
Modular Drives: AXD/SPD 1.08, 1.15, 1.25, 1.35, 2.50, 2.75, 3.100, 3.150
Compact Drives: ACD/SCD 1.08, 1.15, 1.25, 2.50, 2.75
Accessory Modules: RM-15, ER, CM-60, CHOKES y DDS PROG MODULE
Power Supply Filter: EMK 3040, EMK 3120
Motors: Brushless AC Fagor FMX, AXM
and Spindle Asynchronous Fagor SPM

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 Mondragon, February 15, 2000

WARRANTY TERMS

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 for 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.

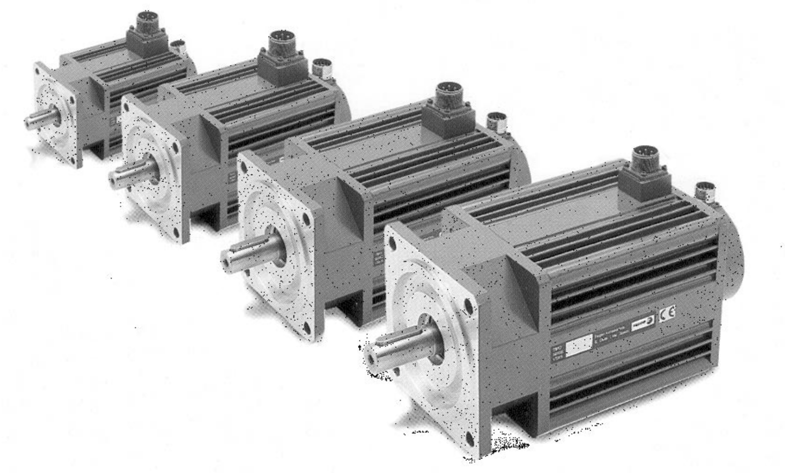
SERVICE CONTRACTS

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

SM. FXM SERIES SYNCHRONOUS MOTORS

FXM series **Fagor** synchronous servo motors are **AC Brushless,** with permanent magnets. These motors are designed to work with Fagor servo drives.

They are ideal to control feed and positioning axes in machine-tool applications as well as on material handling applications, textile machinery, printing, robotics, etc. and in any application requiring great positioning accuracy.



These motors have been manufactured in accordance with the European regulations EN 60204-1 and EN 60034 as instructed by the European directive 89/392/CE on machine safety.

The major advantages of this type of motor are its smooth torque output, a high torque density, has no brushes, high reliability and low maintenance. These are essential in many applications like feeders, punch presses, etc.
Its main disadvantage is cost associated with the permanent magnets.

Only the stator of these three-phase servomotors heat up and, therefore, this heat can be easily dissipated via the armature. With this, if the customer so demands, they can reach a protection level of IP65, thus being immune to liquids and dirt. Its normal protection level is IP64.

The system incorporates a temperature sensor for monitoring the internal temperature. They also carry a feedback encoder or resolver and can have an optional electromechanical brake.

The fan-cooled option of this motor range means a 50% increase in their features.

SM.1 GENERAL CHARACTERISTICS

Standard characteristics of FXM motors:

Excitation	Permanent rare earth magnets (SmCo)
Temperature sensor	Thermistor

Shaft end	Cylindrical with keyway. (Option: with no keyway)
Mounting	Face flange
Mounting method	B5-V1-V3 (as recommended by IEC-34-3-72)
Mechanical tolerances	Normal class (IEC-72/1971)
Balancing	Class N (Class R optional) (DIN 45665) (balanced with the whole key)
Roller bearings' life	20,000 hours
Noise	DIN 45635
Vibration resistance	Withstands 1G along the shaft and 3G sideways (G = 10 m/s²).

Electrical Insulation	Class F (155°C) (311°F)
Isolating resistance	500 Vdc, 10 MOhms or greater
Dielectric Strength	1500 Vac, one minute

Degree of Protection	Overall: IP64 standard, IP54 with fan Axis: IP64 standard, IP65 with oil seal
Storage temperature	From -20°C to +80°C (-4°F / 176°F)
Permited ambient temperature	From 0°C to +40°C (32°F / 74°F)
Permited ambient humidity	From 20% to 80% (non condensing)

Fan	Optional on models: FXM5 and FXM7. Supply voltage: 220 Vac - 50/60 Hz Consumption: 40 W - 0.25 Amp

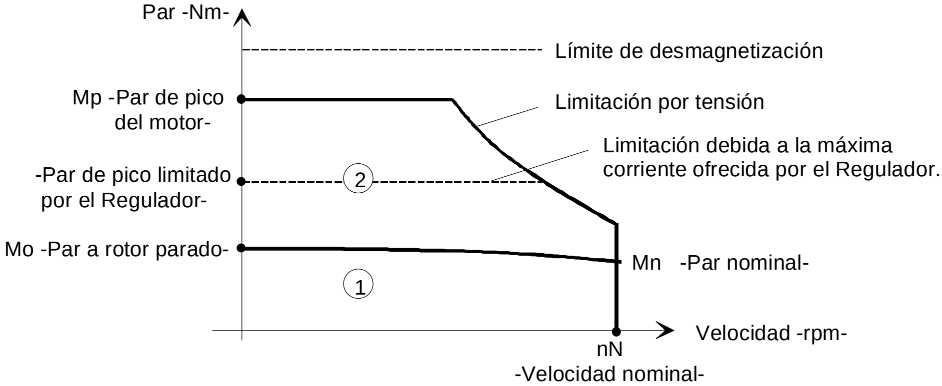
Brake	Optional on all models. See section on "Brake characteristics"

Feedback	Sine-wave Encoder or Resolver

The F class isolation on the motor maintain the dielectric properties as long as the work temperature stays below 155°C (311°F).

SM.2 ELECTRICAL CHARACTERISTICS

Torque/speed characteristic of synchronous motors:



1 Work area for permanent duty cycle (S1). Limited by the motor stall torque and the torque at rated speed.

2 Work area for intermittent duty cycle. The maximum torque to be provided by the motor is limited by the magnetic properties of the rotor and the maximum winding voltage.

The following pages show the characteristics tables for each FXM motor.
The drive recommended to govern each motor will provide the rated current necessary for the motor to give its rated torque and <u>it will limit its peak current</u> to keep the motor inside the intermittent duty cycle area.

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NON-VENTILATED MOTORS	Power conn	Stall Torque	Peak Torque	Rated Speed	Stall Current	Peak Current	Power	Torque Constant	Acceleration Time	Inductance inter-phases	Resistance inter-phases	Inertia	Weight	Peak Torque (Nm) for 0.5 seconds.							
		Mo	Mp	nN	Io	Imax	Pow	KT	tac	L	R	J	P	1.08	1.15	1.25	1.35	2.50	2.75	3.100	3,150
		-Nm-	-Nm-	-rpm-	-A-	-A-	-kW-	Nm/A	-ms-	-mHr-	Ohms	Kg.cm2	-Kg-	-Nm-	-Nm-	-Nm-	-Nm-	-Nm-	-Nm-	-Nm-	-Nm-
FXM11.20A.xx.xx0		0,65	3,3	2000	0,3	1,3	0,1	2,6	11,6	213,0	104,0	1,8	3,3	**3,3**							
FXM11.30A.xx.xx0		0,65	3,3	3000	0,4	2,0	0,2	1,6	17,4	115,0	56,0	1,8	3,3	**3,3**							
FXM11.40A.xx.xx0		0,65	3,3	4000	0,5	2,5	0,3	1,3	23,2	67,0	32,7	1,8	3,3	**3,3**							
FXM12.20A.xx.xx0		1,3	6,5	2000	0,5	2,5	0,3	2,6	9,3	134,0	43,4	2,9	4,3	**6,5**							
FXM12.30A.xx.xx0		1,3	6,5	3000	0,8	4,0	0,4	1,6	14,0	83,0	27,0	2,9	4,3	**6,5**							
FXM12.40A.xx.xx0		1,3	6,5	4000	1,0	5,0	0,5	1,3	18,7	54,0	17,7	2,9	4,3	**6,5**							
FXM13.20A.xx.xx0		1,9	9,5	2000	0,8	4,0	0,4	2,4	10,8	125,0	33,6	4,9	6,4	**9,5**							
FXM13.30A.xx.xx0		1,9	9,5	3000	1,1	5,5	0,6	1,7	16,2	56,0	15,0	4,9	6,4	**9,5**							
FXM13.40A.xx.xx0		1,9	9,5	4000	1,5	7,5	0,8	1,3	21,6	31,0	8,4	4,9	6,4	**9,5**							
FXM14.20A.xx.xx0		2,6	13,0	2000	1,0	5,0	0,5	2,6	9,7	75,0	18,0	6,0	7,6	**13,0**							
FXM14.30A.xx.xx0		2,6	13,0	3000	1,6	8,0	0,8	1,6	14,5	42,0	10,0	6,0	7,6	**13,0**							
FXM14.40A.xx.xx0		2,6	13,0	4000	2,0	10,0	1,1	1,3	19,3	25,0	6,0	6,0	7,6	10,4	**13,0**						
FXM31.20A.xx.xx0		2,0	10,0	2000	0,8	4,0	0,4	2,5	9,4	133,0	37,0	4,5	5,5	**10,0**							
FXM31.30A.xx.xx0		2,0	10,0	3000	1,1	5,5	0,6	1,8	14,1	59,0	16,4	4,5	5,5	**10,0**							
FXM31.40A.xx.xx0		2,0	10,0	4000	1,5	7,5	0,8	1,3	18,8	43,0	11,9	4,5	5,5	**10,0**							
FXM32.20A.xx.xx0		3,9	19,5	2000	1,5	7,5	0,8	2,6	7,9	85,0	15,7	7,4	7,5	**19,5**							
FXM32.30A.xx.xx0		3,9	19,5	3000	2,3	11,5	1,2	1,7	11,9	35,0	6,5	7,4	7,5	13,6	**19,5**						
FXM32.40A.xx.xx0		3,9	19,5	4000	3,1	15,5	1,6	1,3	15,9	22,0	4,0	7,4	7,5	10,1	18,9	**19,5**					
FXM33.20A.xx.xx0		5,8	29,0	2000	2,3	11,5	1,2	2,5	7,6	53,0	8,1	10,5	9,6	20,2	**29,0**						
FXM33.30A.xx.xx0		5,8	29,0	3000	3,5	17,5	1,8	1,7	11,4	29,0	4,5	10,5	9,6	13,3	24,9	**29,0**					
FXM33.40A.xx.xx0		5,8	29,0	4000	4,6	23,0	2,4	1,3	15,2	16,0	2,5	10,5	9,6		18,9	**29,0**					
FXM34.20A.xx.xx0		7,9	39,5	2000	3,1	15,5	1,7	2,5	7,4	44,0	6,0	14,0	11,5	20,4	38,2	**39,5**					
FXM34.30A.xx.xx0		7,9	39,5	3000	4,7	23,5	2,5	1,7	11,1	22,0	3,0	14,0	11,5		25,2	**39,5**					
FXM34.40A.xx.xx0		7,9	39,5	4000	6,2	31,0	3,3	1,3	14,8	13,0	1,8	14,0	11,5		19,1	31,9	**39,5**				
FXM53.12A.xx.xx0		10,0	50,0	1200	2,4	12,0	1,3	4,2	5,8	88,0	10,7	23,0	15,8	33,3	**50,0**						
FXM53.20A.xx.xx0		10,0	50,0	2000	4,0	20,0	2,1	2,5	9,6	34,0	4,2	23,0	15,8	20,0	37,5	**50,0**					
FXM53.30A.xx.xx0		10,0	50,0	3000	6,0	30,0	3,1	1,7	14,4	16,0	1,9	23,0	15,8		25,0	41,7	**50,0**				
FXM53.40A.xx.xx0		10,0	50,0	4000	8,0	40,0	4,2	1,3	19,3	9,0	1,1	23,0	15,8			31,3	43,8	**50,0**			
FXM54.12A.xx.xx0		13,6	68,0	1200	3,2	16,0	1,7	4,3	6,8	65,0	7,0	37,0	17,8	34,0	63,8	**68,0**					
FXM54.20A.xx.xx0		13,6	68,0	2000	5,5	27,5	2,8	2,5	11,4	26,0	2,8	37,0	17,8		37,1	61,8	**68,0**				
FXM54.30A.xx.xx0		13,6	68,0	3000	8,1	40,5	4,3	1,7	17,1	12,0	1,3	37,0	17,8			42,0	58,8	**68,0**			
FXM54.40A.xx.xx0		13,6	68,0	4000	10,2	51,0	5,7	1,3	22,8	6,5	0,7	37,0	17,8			33,3	46,7	66,7	**68,0**		
FXM55.12A.xx.xx0		17,0	85,0	1200	4,0	20,0	2,1	4,3	6,6	51,0	5,0	45,0	20,0	34,0	63,8	**85,0**					
FXM55.20A.xx.xx0		17,0	85,0	2000	6,8	34,0	3,6	2,5	11,1	20,0	2,0	45,0	20,0		37,5	62,5	**85,0**				
FXM55.30A.xx.xx0		17,0	85,0	3000	10,2	51,0	5,3	1,7	16,6	9,0	0,9	45,0	20,0			41,7	58,3	83,3	**85,0**		
FXM55.40A.xx.xx0		17,0	85,0	4000	13,3	66,5	7,1	1,3	22,2	5,0	0,5	45,0	20,0				44,7	63,9	**85,0**		

In bold, the combinations where the drive automatically limits its peak current to avoid damaging the motor.

NON-VENTILATED MOTORS	Power conn	Stall Torque	Peak Torque	Rated Speed	Stall Current	Peak Current	Power	Torque Constant	Acceleration Time	Inductance inter-phases	Resistance inter-phases	Inertia	Weight	Peak Torque (Nm) for 0.5 seconds.							
		Mo -Nm-	Mp -Nm-	nN -rpm-	Io -A-	Imax -A-	Pow -kW-	KT Nm/A	tac -ms-	L -mHr-	R Ohms	J Kg.cm2	P -Kg-	1.08 -Nm-	1.15 -Nm-	1.25 -Nm-	1.35 -Nm-	2.50 -Nm-	2.75 -Nm-	3.100 -Nm-	3,150 -Nm-
FXM73.12A.xx.xx0		19,5	97,5	1200	4,7	23,5	2,5	4,1	11,9	58,0	4,8	92,0	29,0		62,2	**97,5**					
FXM73.20A.xx.xx0		19,5	97,5	2000	7,8	39,0	4,1	2,5	19,8	22,0	1,8	92,0	29,0			62,5	87,5	**97,5**			
FXM73.30A.xx.xx0		19,5	97,5	3000	11,3	56,5	6,1	1,7	29,6	10,0	0,8	92,0	29,0			43,1	60,4	86,3	**97,5**		
FXM73.40A.xx.xx0		19,5	97,5	4000	15,4	77,0	8,2	1,3	39,5	6,0	0,5	92,0	29,0				44,3	63,3	95,0	**97,5**	
FXM74.12A.xx.xx0		26,0	130,0	1200	6,2	31,0	3,3	4,2	11,6	44,0	3,1	120,0	31,6		62,9	104,8	**130,0**				
FXM74.20A.xx.xx0		26,0	130,0	2000	10,4	52,0	5,4	2,5	19,3	16,0	1,2	120,0	31,6			62,5	87,5	125,0	**130,0**		
FXM74.30A.xx.xx0		26,0	130,0	3000	15,4	77,0	8,2	1,7	29,0	8,0	0,6	120,0	31,6				59,1	84,4	126,6	**130,0**	
FXM74.40A.xx.xx0		26,0	130,0	4000	20,6	103,0	10,9	1,3	38,6	4,0	0,3	120,0	31,6					63,1	94,7	126,2	**130,0**
FXM75.12A.xx.xx0		32,0	160,0	1200	7,7	38,5	4,0	4,2	12,6	34,0	2,2	160,0	36,0			103,9	145,5	**160,0**			
FXM75.20A.xx.xx0		32,0	160,0	2000	12,9	64,5	6,7	2,5	20,9	13,0	0,8	160,0	36,0				86,8	124,0	**160,0**		
FXM75.30A.xx.xx0		32,0	160,0	3000	19,3	96,5	10,1	1,7	31,4	6,0	0,4	160,0	36,0					82,9	124,4	**160,0**	
FXM75.40A.xx.xx0	*	32,0	160,0	4000	25,3	126,5	13,4	1,3	41,9	3,0	0,2	160,0	36,0						94,9	126,5	**160,0**
FXM76.12A.xx.xx0		39,0	195,0	1200	9,3	46,5	4,9	4,2	12,2	29,0	1,8	189,0	40,0			104,8	146,8	**195,0**			
FXM76.20A.xx.xx0		39,0	195,0	2000	15,4	77,0	8,2	2,5	20,3	12,0	0,7	189,0	40,0				88,6	126,6	189,9	**195,0**	
FXM76.30A.xx.xx0		39,0	195,0	3000	22,6	113,0	12,3	1,7	30,4	5,0	0,3	189,0	40,0					86,3	129,4	172,6	**195,0**
FXM76.40A.xx.xx0	*	39,0	195,0	4000	31,0	155,0	16,3	1,3	40,6	3,0	0,2	189,0	40,0						94,4	125,8	188,7
FXM77.12A.xx.xx0		45,0	225,0	1200	10,9	54,5	5,7	4,1	13,0	25,0	1,5	232,0	43,0			103,2	144,5	206,4	**225,0**		
FXM77.20A.xx.xx0		45,0	225,0	2000	17,3	86,5	9,4	2,6	21,6	10,0	0,6	232,0	43,0				91,0	130,1	195,1	**225,0**	
FXM77.30A.xx.xx0	*	45,0	225,0	3000	26,5	132,5	14,1	1,7	32,4	4,0	0,3	232,0	43,0						127,4	169,8	**225,0**
FXM77.40A.xx.xx0	*	45,0	225,0	4000	35,7	178,5	18,8	1,3	43,2	3,0	0,1	232,0	43,0						94,5	126,1	189,1
FXM78.12A.xx.xx0		52,0	260,0	1200	12,5	62,5	6,5	4,2	13,0	23,0	1,3	270,0	47,0			104,0	145,6	208,0	**260,0**		
FXM78.20A.xx.xx0		52,0	260,0	2000	20,6	103,0	10,9	2,5	21,7	8,0	0,4	270,0	47,0					126,2	189,3	252,4	**260,0**
FXM78.30A.xx.xx0	*	52,0	260,0	3000	31,0	155,0	16,3	1,7	32,6	4,0	0,2	270,0	47,0						125,8	167,7	251,6
FXM78.40A.xx.xx0	*	52,0	260,0	4000	41,2	206,0	21,8	1,3	43,5	2,0	0,1	270,0	47,0							126,2	189,3

(*) Motors with a power "base" which need to be connected via MC 46 type socket. All the others with MC 23.
In bold, the combinations where the drive automatically limits its peak current to avoid damaging the motor.

Mo, Io: Stall torque, with Io current permitted without time limit
Mp, Imax: Peak torque and maximum current
Very important: Imax must never be exceeded, because it would demagnetize the rotor.
n_N: Rated (nominal) turning speed.
Pow: Rated Power = Mo • n_N / 9550
KT: Torque constant. Torque generated depending on the supplied current.
tac: Acceleration time of the motor from 0 rpm up to its rated speed at its maximum torque.
L, R: Winding inductance and resistance between phases.
J: Rotor inertia.
P: Weight.

Conversion table

Metric →	to →	Imperial
mm	÷ 25.4	inch
$Kg{\cdot}m^2$	÷ 0.113	$lb{\cdot}in{\cdot}sec^2$
Nm	÷ 0.113	lb·in
°C	x 1.8 → + 32	°F
Kw	÷ 0.746	HP

VENTILATED MOTORS	Power conn	Stall Torque	Peak Torque	Rated Speed	Stall Current	Peak Current	Power	Torque Constant	Acceleration Time	Inductance inter-phases	Resistance inter-phases	Inertia	Weight	Peak Torque (Nm) for 0.5 seconds.							
		Mo	Mp	n_N	Io	Imax	Pow	KT	tac	L	R	J	P	1.08	1.15	1.25	1.35	2.50	2.75	3.100	3,150
		-Nm-	-Nm-	-rpm-	-A-	-A-	-kW-	Nm/A	-ms-	-mHr-	Ohms	Kg.cm2	-Kg-	-Nm-	-Nm-	-Nm-	-Nm-	-Nm-	-Nm-	-Nm-	-Nm-
FXM53.12A.xx.xx1		15,0	50,0	1200	3,6	12,0	1,9	4,2	5,8	88,0	10,7	23,0	20,0	33,3	**50,0**						
FXM53.20A.xx.xx1		15,0	50,0	2000	6,0	20,0	3,1	2,5	9,6	34,0	4,2	23,0	20,0		37,5	**50,0**					
FXM53.30A.xx.xx1		15,0	50,0	3000	9,0	30,0	4,7	1,7	14,4	16,0	1,9	23,0	20,0			41,7	**50,0**				
FXM53.40A.xx.xx1		15,0	50,0	4000	12,0	40,0	6,3	1,3	19,3	9,0	1,1	23,0	20,0			31,3	43,8	**50,0**			
FXM54.12A.xx.xx1		20,4	68,0	1200	4,8	16,0	2,6	4,3	6,8	65,0	7,0	37,0	22,0		63,8	**68,0**					
FXM54.20A.xx.xx1		20,4	68,0	2000	8,3	27,5	4,3	2,5	11,4	26,0	2,8	37,0	22,0			61,8	**68,0**				
FXM54.30A.xx.xx1		20,4	68,0	3000	12,2	40,5	6,4	1,7	17,1	12,0	1,3	37,0	22,0			42,0	58,8	**68,0**			
FXM54.40A.xx.xx1		20,4	68,0	4000	15,3	51,0	8,5	1,3	22,8	6,5	0,7	37,0	22,0				46,7	66,7	**68,0**		
FXM55.12A.xx.xx1		25,5	85,0	1200	6,0	20,0	3,2	4,3	6,6	51,0	5,0	45,0	24,2		63,8	**85,0**					
FXM55.20A.xx.xx1		25,5	85,0	2000	10,2	34,0	5,3	2,5	11,1	20,0	2,0	45,0	24,2			62,5	**85,0**				
FXM55.30A.xx.xx1		25,5	85,0	3000	15,3	51,0	8,0	1,7	16,6	9,0	0,9	45,0	24,2				58,3	83,3	**85,0**		
FXM55.40A.xx.xx1		25,5	85,0	4000	20,0	66,5	10,7	1,3	22,2	5,0	0,5	45,0	24,2					63,9	**85,0**		
FXM73.12A.xx.xx1		29,3	97,5	1200	7,1	23,5	3,7	4,1	11,9	58,0	4,8	92,0	33,2		62,2	**97,5**					
FXM73.20A.xx.xx1		29,3	97,5	2000	11,7	39,0	6,1	2,5	19,8	22,0	1,8	92,0	33,2			62,5	87,5	**97,5**			
FXM73.30A.xx.xx1		29,3	97,5	3000	17,0	56,5	9,2	1,7	29,6	10,0	0,8	92,0	33,2				60,4	86,3	**97,5**		
FXM73.40A.xx.xx1	*	29,3	97,5	4000	23,1	77,0	12,3	1,3	39,5	6,0	0,5	92,0	33,2					63,3	95,0	**97,5**	
FXM74.12A.xx.xx1		39,0	130,0	1200	9,3	31,0	4,9	4,2	11,6	44,0	3,1	120,0	35,8			104,8	**130,0**				
FXM74.20A.xx.xx1		39,0	130,0	2000	15,6	52,0	8,2	2,5	19,3	16,0	1,2	120,0	35,8				87,5	125,0	**130,0**		
FXM74.30A.xx.xx1	*	39,0	130,0	3000	23,1	77,0	12,3	1,7	29,0	8,0	0,6	120,0	35,8					84,4	126,6	**130,0**	
FXM74.40A.xx.xx1	*	39,0	130,0	4000	30,9	103,0	16,3	1,3	38,6	4,0	0,3	120,0	35,8						94,7	126,2	**130,0**
FXM75.12A.xx.xx1		48,0	160,0	1200	11,6	38,5	6,0	4,2	12,6	34,0	2,2	160,0	40,2			103,9	145,5	**160,0**			
FXM75.20A.xx.xx1		48,0	160,0	2000	19,4	64,5	10,1	2,5	20,9	13,0	0,8	160,0	40,2					124,0	**160,0**		
FXM75.30A.xx.xx1	*	48,0	160,0	3000	29,0	96,5	15,1	1,7	31,4	6,0	0,4	160,0	40,2						124,4	**160,0**	
FXM75.40A.xx.xx1	*	48,0	160,0	4000	38,0	126,5	20,1	1,3	41,9	3,0	0,2	160,0	40,2							126,5	**160,0**
FXM76.12A.xx.xx1		58,5	195,0	1200	14,0	46,5	7,4	4,2	12,2	29,0	1,8	189,0	44,2				146,8	**195,0**			
FXM76.20A.xx.xx1	*	58,5	195,0	2000	23,1	77,0	12,3	2,5	20,3	12,0	0,7	189,0	44,2					126,6	189,9	**195,0**	
FXM76.30A.xx.xx1	*	58,5	195,0	3000	33,9	113,0	18,4	1,7	30,4	5,0	0,3	189,0	44,2						129,4	172,6	**195,0**
FXM76.40A.xx.xx1	**	58,5	195,0	4000	46,5	155,0	24,5	1,3	40,6	3,0	0,2	189,0	44,2							125,8	188,7
FXM77.12A.xx.xx1		67,5	225,0	1200	16,4	54,5	8,5	4,1	13,0	25,0	1,5	232,0	47,2				144,5	206,4	**225,0**		
FXM77.20A.xx.xx1	*	67,5	225,0	2000	26,0	86,5	14,1	2,6	21,6	10,0	0,6	232,0	47,2						195,1	**225,0**	
FXM77.30A.xx.xx1	*	67,5	225,0	3000	39,8	132,5	21,2	1,7	32,4	4,0	0,3	232,0	47,2							169,8	**225,0**
FXM77.40A.xx.xx1	**	67,5	225,0	4000	53,6	178,5	28,3	1,3	43,2	3,0	0,1	232,0	47,2								189,1
FXM78.12A.xx.xx1		78,0	260,0	1200	18,8	62,5	9,8	4,2	13,0	23,0	1,3	270,0	51,2					208,0	**260,0**		
FXM78.20A.xx.xx1	*	78,0	260,0	2000	30,9	103,0	16,3	2,5	21,7	8,0	0,4	270,0	51,2						189,3	252,4	**260,0**
FXM78.30A.xx.xx1	**	78,0	260,0	3000	46,5	155,0	24,5	1,7	32,6	4,0	0,2	270,0	51,2							167,7	251,6
FXM78.40A.xx.xx1	**	78,0	260,0	4000	61,8	206,0	32,7	1,3	43,5	2,0	0,1	270,0	51,2								189,3

(*) Motors with a power "base" which need to be connected via MC 46 type socket.

(**) Motors with a power "base" which need to be connected via MC 80 type socket. All the others with MC 23.

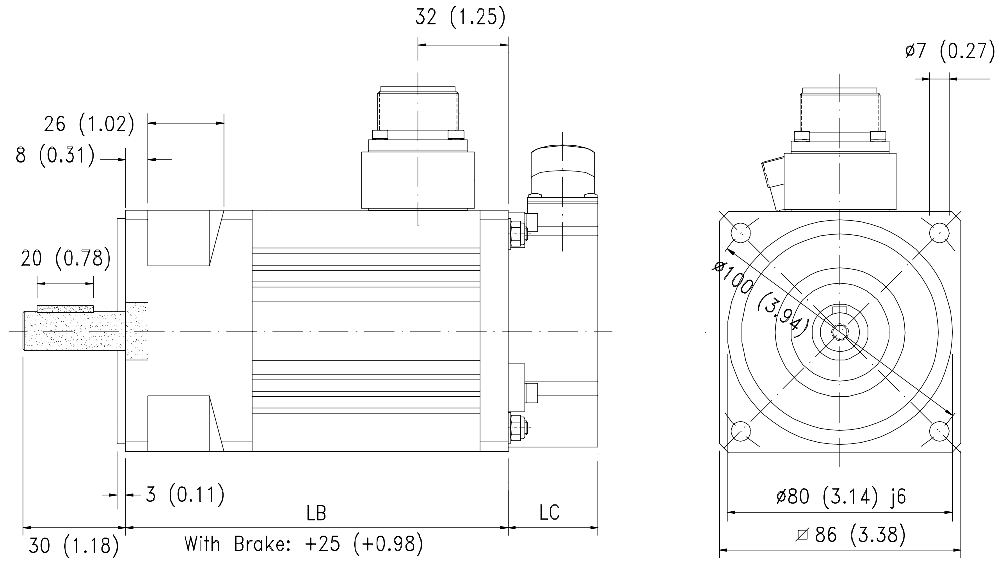
In bold, the combinations where the drive automatically limits its peak current to avoid damaging the motor.

SM.3 DIMENSIONS

FXM1 SERIES mm (inches)

	LB
FXM11	136 (5.35)
FXM12	171 (6.7)
FXM13	206 (8.11)
FXM14	241 (9.48)

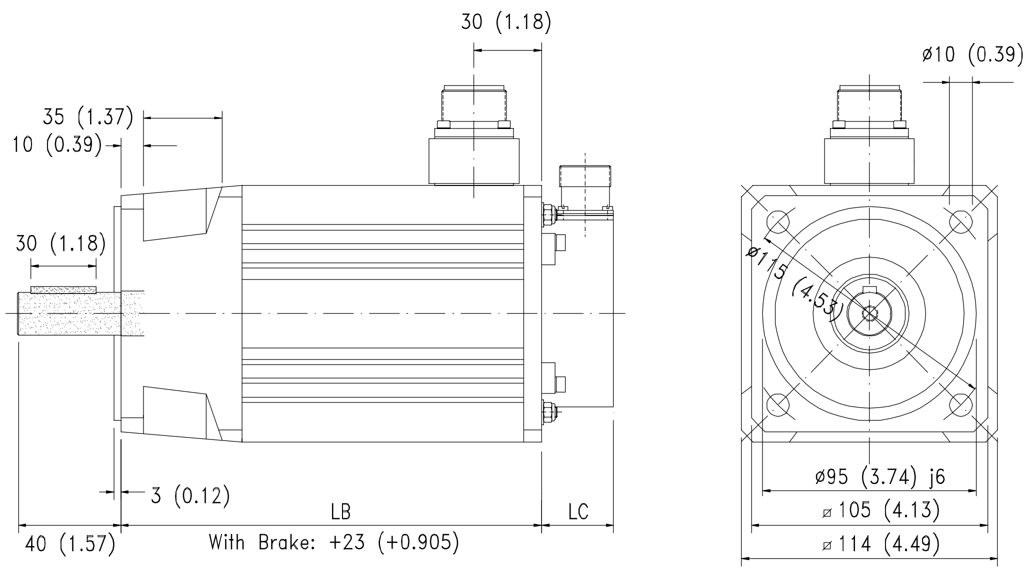
	LC
RESOLVER:	33.5 (1.32)
ENCODER:	46 (1.81)



FXM3 SERIES mm (inches)

	LB
FXM31	152 (5.98)
FXM32	187 (7.36)
FXM33	222 (8.74)
FXM34	257 (10.12)

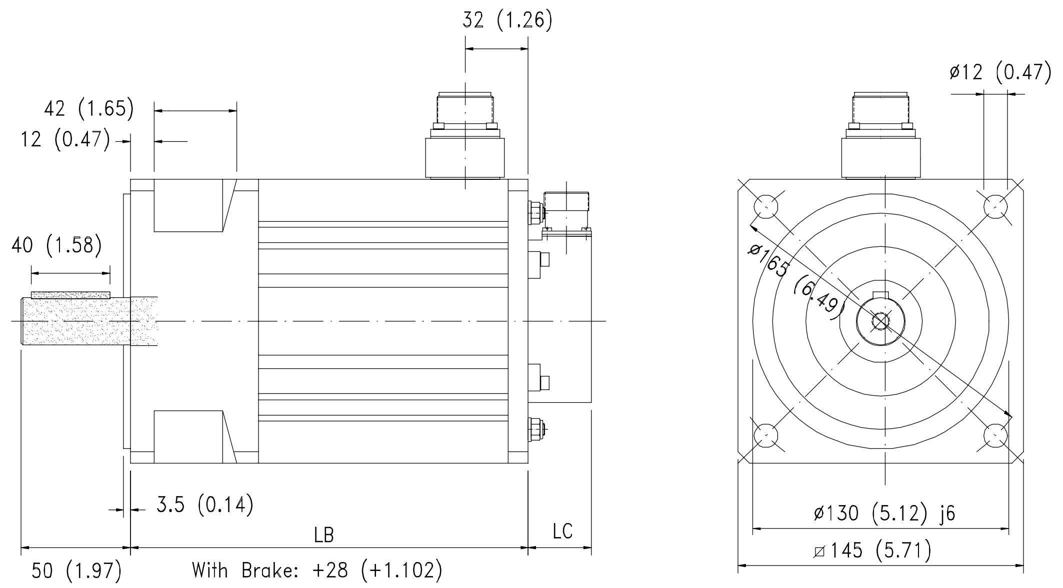
	LC
RESOLVER:	33.5 (1.32)
ENCODER:	46.5 (1.83)



FXM5 SERIES mm (inches)

	LB
FXM53	237 (9.33)
FXM54	272 (10.71)
FXM55	307 (12.08)

	LC
RESOLVER:	33.5 (1.32)
ENCODER:	46.5 (1.83)

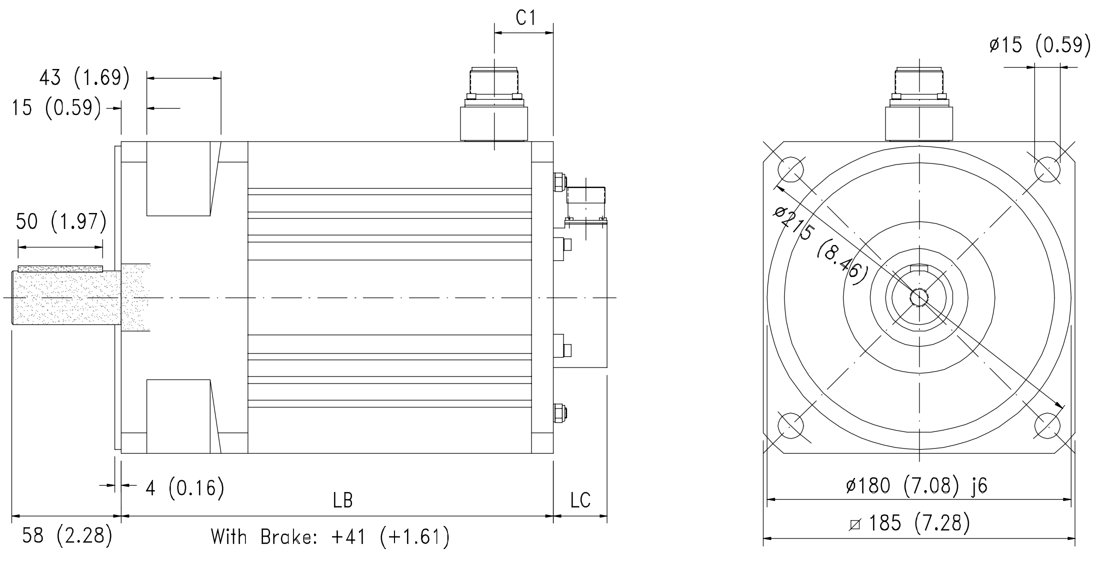


FXM7 SERIES mm (inches)

	LC
RESOLVER:	33.5 (1.32)
ENCODER:	46.5 (1.83)

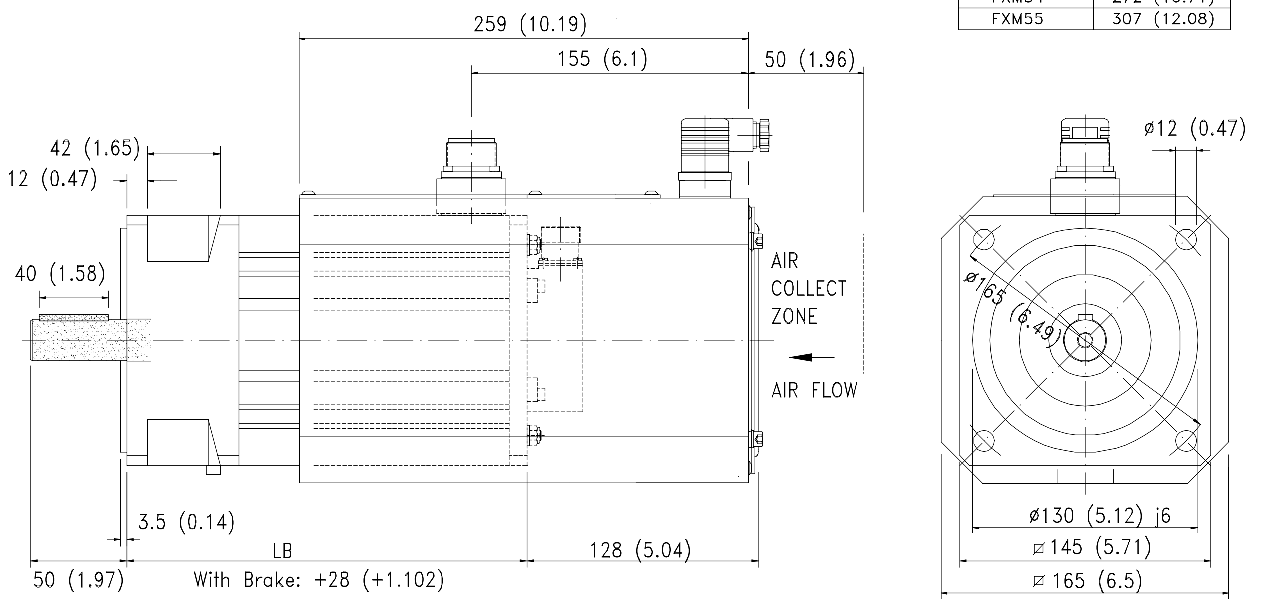
	C1
MC-23 BASE	35 (1.38)
MC-46 BASE	40 (1.57)

	LB
FXM73	256 (10.08)
FXM74	291 (11.46)
FXM75	326 (12.84)
FXM76	361 (14.22)
FXM77	396 (15.59)
FXM78	431 (16.97)



Ventilated FXM5 SERIES mm (inches)

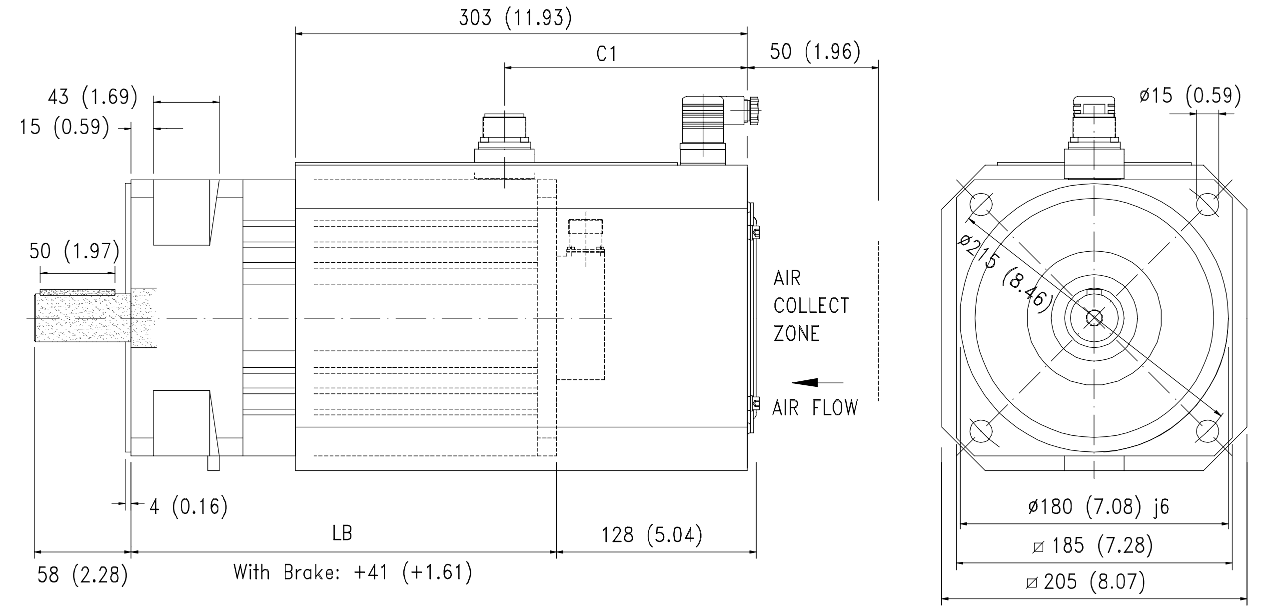
	LB
FXM53	237 (9.33)
FXM54	272 (10.71)
FXM55	307 (12.08)



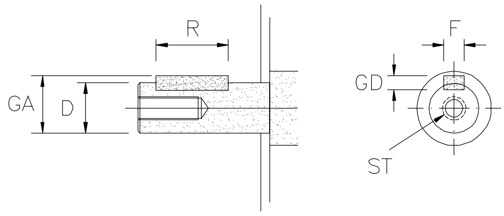
Ventilated FXM7 SERIES mm (inches)

	C1
MC-23 BASE	157 (6.18)
MC-46 BASE	162 (6.38)
MC-80 BASE	167 (2.64)

	LB
FXM73	256 (10.08)
FXM74	291 (11.46)
FXM75	326 (12.84)
FXM76	361 (14.22)
FXM77	396 (15.59)
FXM78	431 (16.97)



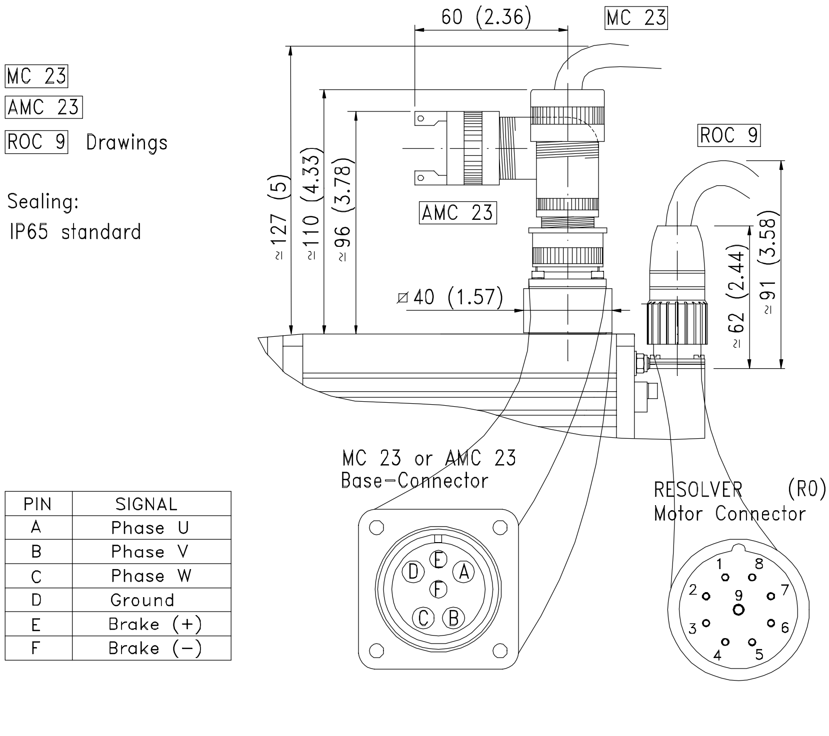
Detail on the internal thread of the shaft.



	F	GD	R	D	GA	ST
FXM1	5 (0.19)	5 (0.19)	20 (0.78)	14 (0.55) j6	16 (0.62)	M5x12.5 (0.49)
FXM3	6 (0.24)	6 (0.24)	30 (1.18)	19 (0.75) j6	21.5 (0.85)	M6x16 (0.63)
FXM5	8 (0.31)	7 (0.27)	40 (1.58)	24 (0.94) j6	27 (1.07)	M8x19 (0.75)
FXM7	10 (0.39)	8 (0.31)	50 (1.97)	32 (1.26) k6	35 (1.38)	M10x22 (0.86)

Detail on power and feedback connectors for FXM motors.

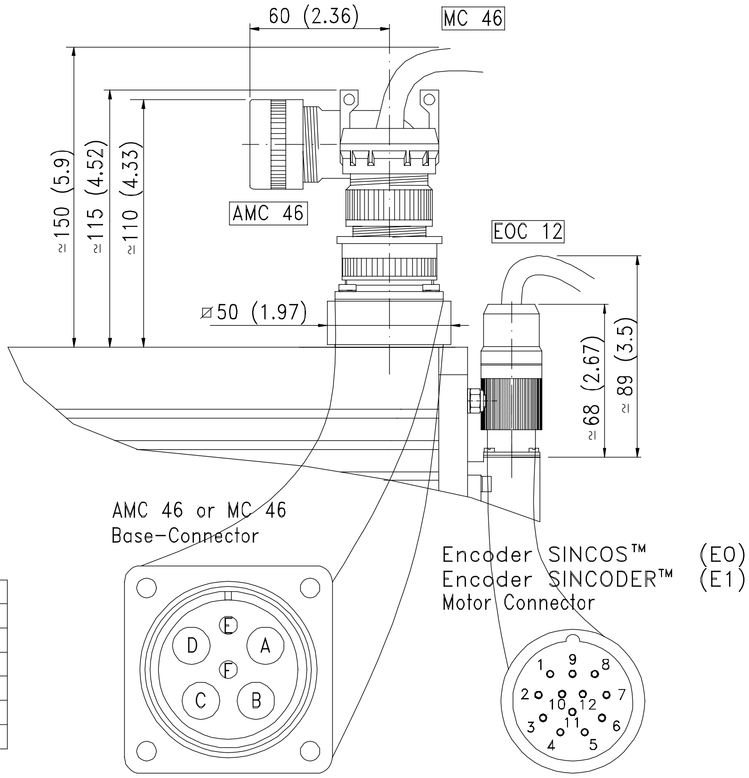
- Power connector for motors with a rated current smaller than 23 Amp. Feedback connector via Resolver ROC 9.
- Power connector for motors with a rated current greater than 23 Amp. Feedback connector via Encoder EOC 12.
- Power connector for motors with a rated current greater than 46 Amp.
- Power connector for optional fan on FXM5 and FXM7 motors



PIN	SIGNAL
A	Phase U
B	Phase V
C	Phase W
D	Ground
E	Brake (+)
F	Brake (−)

MC 46
AMC 46
EOC 12 Drawings

Sealing:
IP65 standard

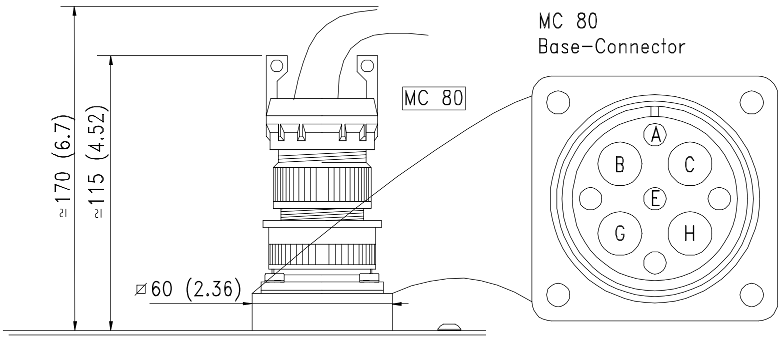


PIN	SIGNAL
A	Phase U
B	Phase V
C	Phase W
D	Ground
E	Brake (+)
F	Brake (−)

MC 80 Drawings

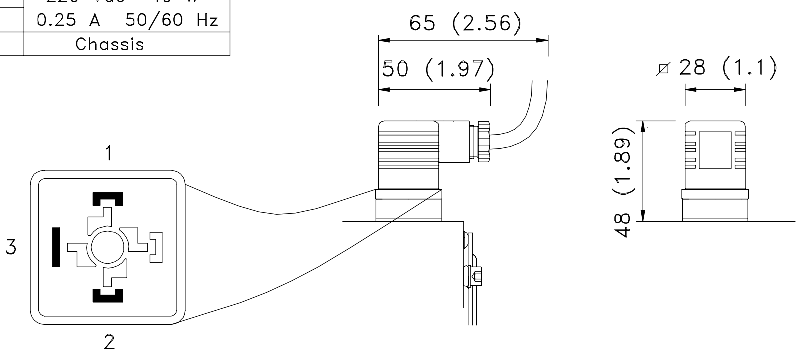
Sealing:
IP65 standard

PIN	SIGNAL
C	Phase U
H	Phase V
G	Phase W
B	Ground
A	Brake (+)
E	Brake (−)



PIN	SIGNAL
1	220 Vac 40 W
2	0.25 A 50/60 Hz
3	Chassis

mm (inches)



SM.4 BRAKE CHARACTERISTICS

FXM motors have a brake that acts by friction against the shaft. It is used to hold the motor. It MUST NOT be used to stop the motor when it is turning.

Motor Type	Torque	Maximum RPM	Power	On/Off Delay	Unlocking voltage margin	Inertia	Weight
	Nm (in.lb)	rpm	W (HP)	ms	Vdc	Kg.cm² (lb.in²)	Kg (lbf)
FXM 1	2.5 (22.12)	10000	12 (0.016)	7/5	22 - 26	0,38 (0.13)	0,3 (0.66)
FXM 3	5 (44.25)	8000	16 (0.021)	15/7		1,06 (0.36)	0,6 (1.32)
FXM 5	12 (106.2)	6000	18 (0.024)	30/13		3,6 (1.23)	1.1 (2.42)
FXM 7	40 (354)	3600	35 (0.047)	100/30		31,8 (10.86)	3.5 (7.71)

The brake MUST NEVER exceed its maximum turning speed.

Voltages between 22 and 26 volts release the shaft. Watch that no voltage over 26 V is applied. That would prevent the shaft from turning.

When installing the motor, verify that the brake releases the shaft completely before turning it for the first time.

SM.5 CONNECTORS

SM.5.1 POWER AND BRAKE CONNECTOR

It is a straight male socket connector. It ensures a sealing standard IP65.

There are three different models, for currents up to 23 Amps, 46 Amps or 80 Amps detailed on the previous page. The socket connector of the motors will be connected to straight terminal strips called MC 23, MC 46 and MC 80, or AMC 23 and AMC 46 if they are angled.
Fagor supplies them separately (not with the motor) and upon request.

Only certain motor models carry 46 Amp and 80 Amp connectors. See characteristics tables on the previous pages.

Make sure that the U, V, W and Ground terminals of the Drive are connected to the U1, V1, W1 and Ground terminals of the Motor respectively.
Otherwise, the motor will not run properly.

SM.5.2 FEEDBACK CONNECTOR

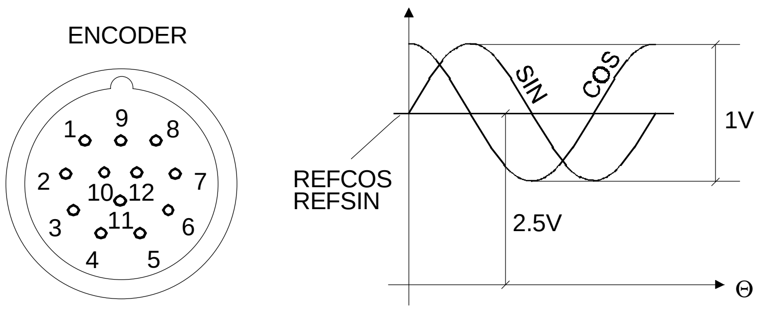
Depending on the type of feedback integrated into the motor (encoder or resolver) the connector will be either a 12-pin or a 9-pin.

SM.5.2.1 ENCODER FEEDBACK CONNECTOR

It is a 12-pin male Conney type connector which meets the IP65 sealing standard. The various encoder types available use this connector.

The cable necessary to connect this connector with the drive module is the one referred to as **EEC**. Chapter IN describes this cable in detail.

Connector and signals (front view) Θ is the angular rotor position.



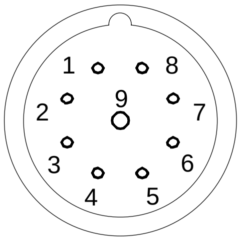
Pin	Signal	Function
1	REFCOS	Reference level for the cosine signal 2.5 Vdc
2	+ 485	RS 485 type serial line transmission signal
3	TEMP	Thermistor
4	TEMP	
5	SIN	1 Vpp sinusoidal signal generated by the Encoder.
6	REFSIN	Reference level for the sine signal 2.5 Vdc
7	- 485	RS 485 type serial line transmission signal
8	COS	1 Vpp cosinusoidal signal generated by the Encoder.
9	CHASSIS	Metallic housing of the Encoder
10	0 V	Ground
12	+ 8 Vdc	Power for the encoder

SM.5.2.2 RESOLVER FEEDBACK CONNECTOR

It is a 9-pin male Conney type connector which meets the IP65 sealing standard.

Connector and signals
(front view):

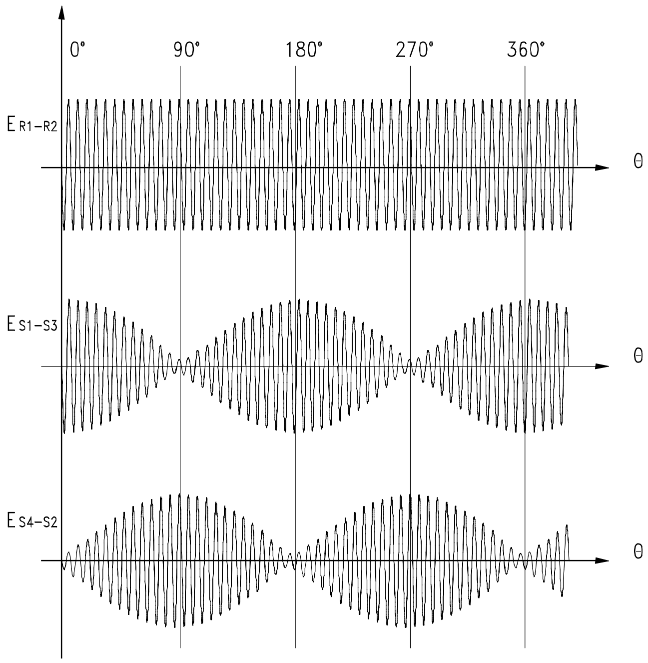
RESOLVER

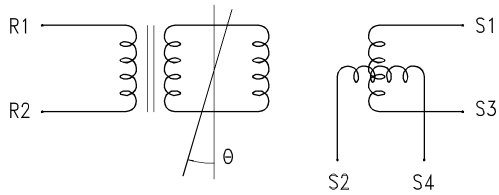


Pin	Signal	Function
1	S1	Cosinewave signal provided by the Resolver.
2	S3	
3	S4	Sinewave signal provided by the Resolver.
4	S2	
5	R1	Sinewave signal for the excitation of the rotating transformer primary.
6	R2	
7	TEMP	Thermistor
8	TEMP	
9	CHASSIS	Resolver body

The cable necessary to connect this connector with the drive module is the one referred to as **REC**. IN chapter describes this cable in detail.

The figure shows the typical excitation and output signals of a resolver as well as its equivalent circuit.





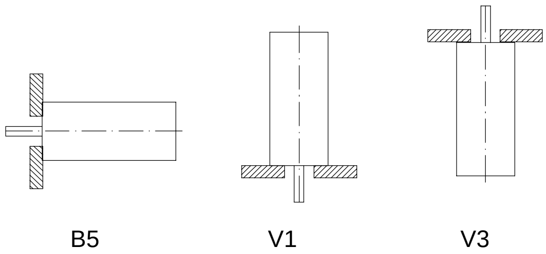
$E_{S1-S3} = K.E_{R1-R2.}Cos\ \Theta$
$E_{S4-S2} = K.E_{R1-R2}.Sin\ \Theta$

Resolver Structure
Θ is the rotating angle of the rotor

SM.6 INSTALLATION AND MOUNTING CONDITIONS

Before installing it onto the machine, the anti-rust paint should be removed from the rotor shaft and the flange.

The motor admits the B5, V1 and V3 mounting methods.



The ambient conditions recommended for the motor are the ones indicated in the general characteristics bearing in mind that:

It must always be in a dry and clean place.
Mounted so it is easily inspected, cleaned and maintained.
Free of corrosive atmosphere and / or explosive gasses or liquids.
If the motor is going to be continuously exposed to oil splashes, it should be protected with a guard.

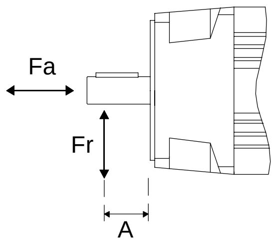
SM.7 RADIAL AND AXIAL LOADS

The misalignment between the motor and the machine causes vibrations on the shaft and decreases the life span of the roller bearings and couplings.

Please follow these advises in order to avoid those problems:
Use flexible couplings for direct coupling.
Avoid radial and axial loads on the motor shaft which exceed the values in the table below:

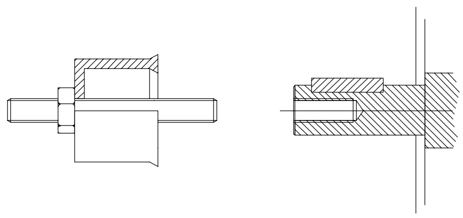
Note: For radial and axial loads combined, decrease the value of the permitted radial force Fr to 70% of the table value.

Motor Type	Axial Force Fa	Radial Force Fr	Distance A
FXM1	105 Nw (23.6 lbf)	500 Nw (112.4 lbf)	15 mm (0.59")
FXM3	138 Nw (31 lbf)	660 Nw (148.3 lbf)	20 mm (0.78")
FXM5	157 Nw (35.3 lbf)	745 Nw (167.4 lbf)	25 mm (0.98")
FXM7	336 Nw (75.5 lbf)	1590 Nw (357.4 lbf)	29 mm (1.14")



When installing pulleys or gears for transmission, avoid hitting the shaft.

Use some tool that is supported in the threaded hole on the shaft to insert the pulley or the gear.



SM.8 IDENTIFICATION BOARD

Example:

FAGOR	Fagor Automation S. Coop. (Spain) AC BRUSHLESS SERVOMOTOR			CE
Type FXM 32.20A.R0.000		Ver.: 00	SN F170000.01	
Mo 3.9 Nm Mmax 19.5 Nm	Io 1.5 Amp Imax 7.5 Amp	Nominal Speed: 2000 rpm B.E.M.F.: 320 v		 Iso.cl F
BRAKE 24 VDC / 20W		IP64	W: 12 kg	Bal.cl N

SM.9 REGISTRATION NUMBERS FOR FXM MOTORS

Many of the Drive's Software parameters are directly related to the characteristics of the motor it governs. For the Fagor motors in this manual, the software knows the values that must be assigned to those parameters.

Motors equipped with Encoder (sales reference E0, E1 and A0) have their reference stored in their electronic memory, so the drive parameter setting is done automatically. See the GSU chapter. In a manual setting, one must "tell" the drive which motor is going to govern.

Sales reference coding for synchronous motors.

AXIS MOTORS, FXM

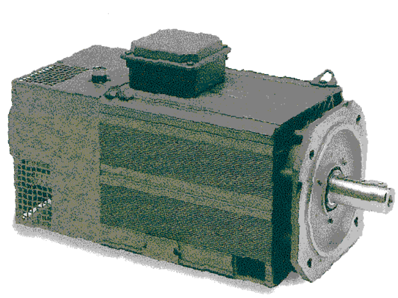
Example: FXM 34.30A . E1 . 0 0 0

FAGOR A**X**IS **M**OTOR		
SIZE	**1, 3, 5, 7**	
LENGTH		
MAXIMUM SPEED	**12** 1200 rpm **30** 3000 rpm	**20** 2000 rpm **40** 4000 rpm
WINDING	**A**	380 Vac
FEEDBACK TYPE	**E0**	Encoder Sincos™ (Except for FXM1 type)
	E1	Encoder Sincoder™
	A0	Encoder Absoluto Sincos™ (Except for FXM1 type)
	R0	Resolver Tamagawa™
FLANGE AND SHAFT	**0**	With Keyway (Siemens™ 1FT5)
	1	Without Keyway
BRAKE OPTION	**0**	Without brake
	1	With standard brake (24 Vdc)
VENTILATION	**0**	Without Fan
	1	With Fan (220 Vac)

AM. SPM ASYNCHRONOUS MOTORS

Fagor asynchronous motors, also called induction motors, are designed to work on machine-tool spindles.

SPM motors are asynchronous "squirrel cage" motors and are especially designed to work with Fagor drives.



To control the axes of a machine, the FXM servomotors must be used. They are described in the SM chapter of this manual.

There is a wide range of motors available: from 2.2 Kw to 37 Kw in S1.
The particular characteristics of each motor are described on the following pages.

These motors have been manufactured in compliance with the EN 60204-1 and EN 60034 standards as instructed by the European Directive 89/392/CE on machine safety.

AM.1 GENERAL CHARACTERISTICS

The Class F isolation on the motor maintains its dielectric properties as long as the work temperature is kept below 155°C (311°F).

Motor type.	Induction. Squirrel cage
Thermal protection	Thermistor: klixon N.C. (250 V - 2.5 A)

Balancing	Degree S -ISO2373-, (SR degree, upon request) (with the key mounted on the shaft)
Mounting	IM 2001 B3/B5, (optionally V1/V5, V3/V6)
Gear box	Special flange (optional)

Noise	Meets IEC 34-9 standard

Electrical Insulation	class F (155°C) (311°F)

Protection	IP 54
Storage temperature	Between -20°C and +80°C (-4°F / 176°F)
Maximum ambient temperature	Between 0°C and +40°C (32°F / 74°F)
Maximum ambient humidity	Between 20% and 80% (non condensing)
Altitude	1000 m. (3280 ft) over sea level.

Axial fan	Standard on all models. Independent power supply.

Brake	Optional for all models. 220Vac

Feedback	Sinewave encoder

AM.2 ELECTRICAL CHARACTERISTICS

Electric characteristics table of the new **SPMxxx.xx.xxxxx.1** motors:

		SPM 90L	SPM 90P	SPM 100LBE	SPM 112ME	SPM 112LE	SPM 112XE	SPM 132L	SPM 132X	SPM 132XL	SPM 160M
Rated power S1	kW	2,2	3	4	5,5	7,5	11	15	18,5	22	22
Rated power S6-40%	kW	3,3	4	6	8	11	16	22	26	28	33
Rated Torque S1	Nm	14	19	25,5	35	47,7	70	95,5	118	140	140
Rated Torque S6-40%	Nm	21	25	38	50	70	101	140	165	178	210
Rated current S1	Arms	7,78	10,13	13,6	18,6	24	33,9	47,7	56,2	62,3	65,5
Rated current S6-40%	Arms	11,7	13,5	20,4	27	34,5	49,3	70	79	79,3	98,3
Rated speed	rpm	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Maximum speed	rpm	9000	9000	9000	7500	7500	7500	7500	7500	7500	7000
Maximum speed (*)	rpm	- -	- -	- -	9000	9000	9000	9000	9000	9000	9000
Inertia	Kg·m2	0,0035	0,0044	0,0061	0,011	0,014	0,022	0,062	0,07	0,07	0,13
Weight	Kg	19,2	23,8	35,3	45	53	70	108	119	119	158

(*) Maximum speed when special bearings are used. Optional.
Small motors reach 9000 rpm with their roller bearings.

Conversion table

Metric →	to →	Imperial
mm	÷ 25.4	inch
Kg·m²	÷ 0.113	lb·in·sec²
Nm	÷ 0.113	lb·in
°C	x 1.8 → + 32	°F
Kw	÷ 0.746	HP

SPMxxx.xx.xxxxx.0 motors differ from these only on the values of their current:

		SPM 90L	SPM 90P	SPM 100LBE	SPM 112ME	SPM 112LE	SPM 112XE	SPM 132L	SPM 132X	SPM 132XL	SPM 160M	SPM 160L	SPM 180MA
Rated power S1	kW	2,2	3	4	5,5	7,5	11	15	18,5	22	22	30	37
Rated power S6-40%	kW	3,3	4	6	8	11	16	22	26	28	33	45 (**)	55 (**)
Rated Torque S1	Nm	14	19	25,5	35	47,7	70	95,5	118	140	140	191	235
Rated Torque S6-40%	Nm	21	25	38	50	70	101	140	165	178	210	286	350
Rated current S1	Arms	6,4	8,26	11,1	15	19,7	28,8	39	46	51	53,6	76	87
Rated current S6-40%	Arms	9,5	11	16,7	21,7	28,3	40,3	57,2	67	64,9	77,3	114	129
Rated speed	rpm	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Maximum speed	rpm	9000	9000	9000	7500	7500	7500	7500	7500	7500	7000	6300	6500
Maximum speed (*)	rpm	- -	- -	- -	9000	9000	9000	9000	9000	9000	9000	9000	9000
Inertia	Kg·m2	0,0035	0,0044	0,0061	0,011	0,014	0,022	0,062	0,07	0,07	0,13	0,17	0,34
Weight	Kg	19,2	23,8	35,3	45	53	70	108	119	119	158	196	260

(*) Maximum speed when special bearings are used. Optional.
Small motors reach 9000 rpm with their roller bearings.
(**) The maximum power in S6-40% will be 43.3 kW (SPM 160L) and 45 kW (SPM 180MA) with SPM3.150 drives.

AM.3 FAN CHARACTERISTICS

<table>
<tr><th></th><th></th><th>SPM 90L</th><th>SPM 90P</th><th>SPM 100LBE</th><th>SPM 112ME</th><th>SPM 112LE</th><th>SPM 112XE</th><th>SPM 132L</th><th>SPM 132X</th><th>SPM 132XL</th><th>SPM 160M</th><th>SPM 160L</th><th>SPM 180MA</th></tr>
<tr><td colspan="2">Power supply</td><td colspan="12">single-phase</td></tr>
<tr><td>Voltage (frequency)</td><td>V (Hz)</td><td colspan="12">220 (50/60)</td></tr>
<tr><td>Current</td><td>A</td><td colspan="2">0.3</td><td colspan="4">0.36</td><td colspan="3">0.6</td><td colspan="3">0.55</td></tr>
<tr><td>Power</td><td>W</td><td colspan="2">40</td><td colspan="4">80</td><td colspan="3">130</td><td colspan="2">115</td><td>120</td></tr>
</table>

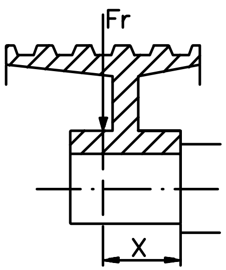
AM.4 BRAKE CHARACTERISTICS (OPTIONAL)

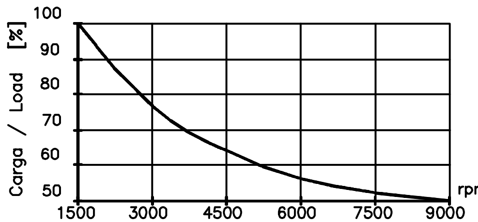
		SPM 90L	SPM 90P	SPM 100LBE	SPM 112ME	SPM 112LE	SPM 112XE	SPM 132L	SPM 132X	SPM 132XL	SPM 160M	SPM 160L	SPM 180MA
Power supply		220											Upon request
Power	W	16	22			25		29					
Continuous torque	Nm	10	30			50		150					
Inertia	Kg.m2	0.00011	0.0003			0.00057		0.0023					

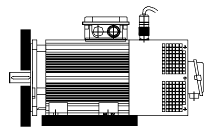
AM.5 CHARACTERISTICS OF THE ROLLER BEARINGS

		SPM 90L	SPM 90P	SPM 100LBE	SPM 112ME	SPM 112LE	SPM 112XE	SPM 132L	SPM 132X	SPM 132XL	SPM 160M	SPM 160L	SPM 180MA
Drive end		6205 Z	6206 Z	6207 Z	6209 Z			6209 Z			6310 Z		6311 Z
Non-drive end		6205 Z	6205 Z	6205 Z	6205 Z			6209 Z			6309 Z		6311 Z
Radial load -Fr-	N	800	900	1300	1600	1800		1800			2300		3700
-X- distance	mm	25		40	40			55			55		55
Axial load	N	400	450	800	1000	1100		1100			1400		2300

This table refers to the motor bearings for horizontal mounting B3/B5. It is not valid for other types of mounting.
The graph shows how the radial force permitted on the axis decreases as the turning speed increases. The illustration on the right shows radial force applied onto the axis (Fr) and distance to the roller bearings.







B3/B5

AM.6 POWER AND TORQUE CHARACTERISTICS

The following sections show the electrical and mechanical characteristics of power and torque for each SPM motor.

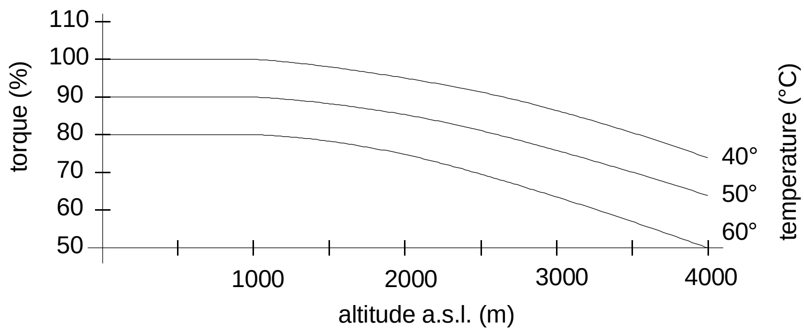
The Power-Speed curves are shown for the S1 and S6 cycles at 40%.

Over the curves for each motor, the powers that may be reached with the various Fagor Drives are also indicated. This is very useful for selecting the right drive for each motor and application.

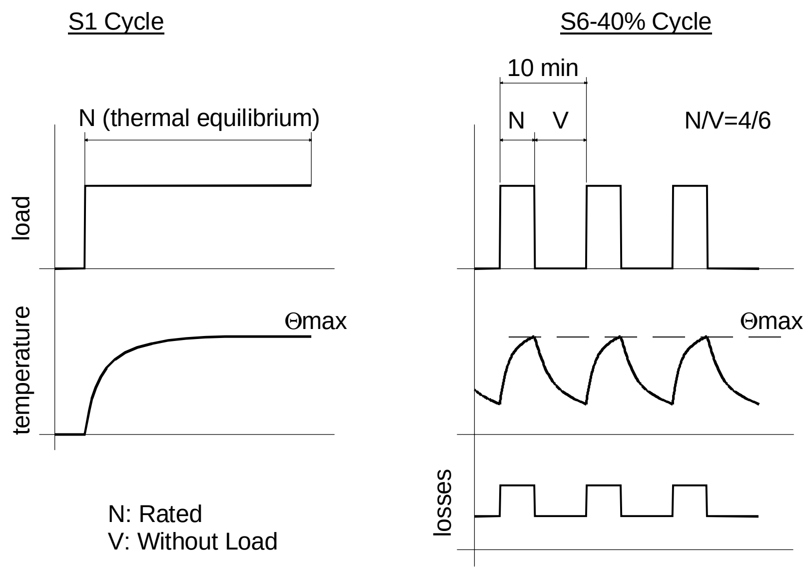
Very important: It is assumed that the drive system is powered at 380 Vac from Mains.

The following graphics indicate how the temperature and the altitude over sea level affect the properties of the SPM motors. They also indicate the meaning of duty cycles S1 and S6 according to international standards.

POWER/AMBIENT CHARACTERISTIC

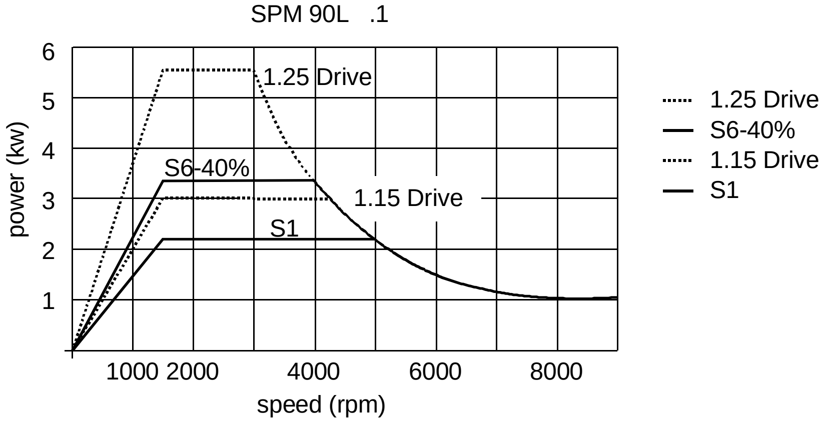


DUTY CYCLES
According to the
IEC 34-1



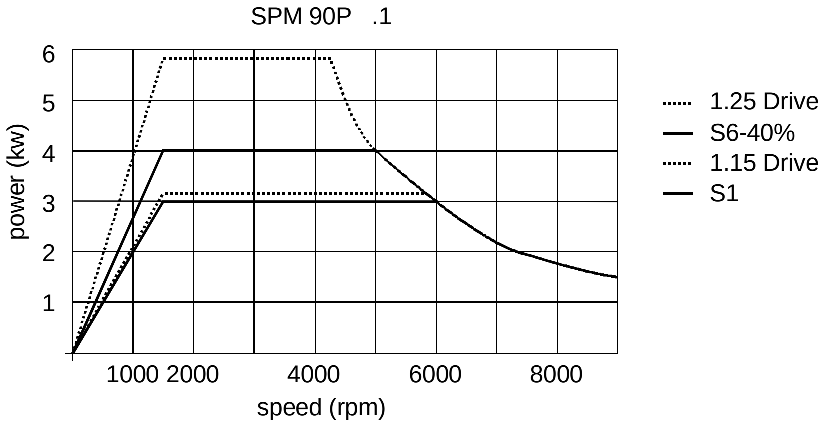
SPM 90L

		SPM 90L
Rated power S1	kW	2,2
Rated power S6-40%	kW	3,3
Rated Torque S1	Nm	14
Rated Torque S6-40%	Nm	21
Rated current S1	Arms	7,78
Rated current S6-40%	Arms	11,7
Rated speed	rpm	1500
Maximum speed	rpm	9000
Maximum speed (*)	rpm	- -
Inertia	Kg·m2	0,0035
Weight	Kg	19,2



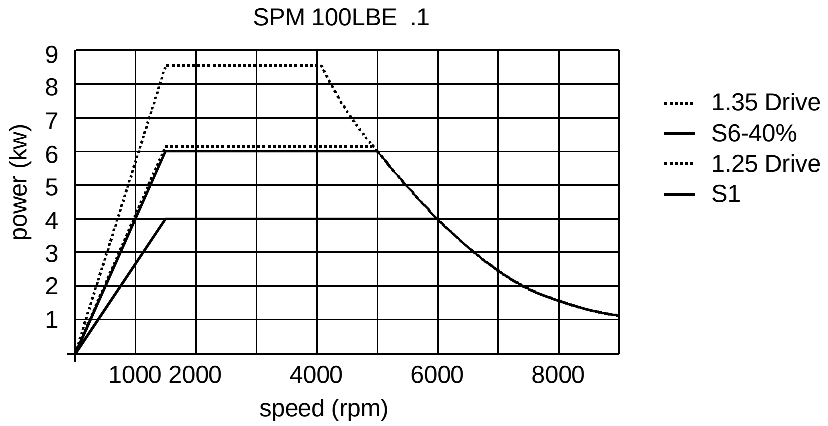
SPM 90P

		SPM 90P
Rated power S1	kW	3
Rated power S6-40%	kW	4
Rated Torque S1	Nm	19
Rated Torque S6-40%	Nm	25
Rated current S1	Arms	10,13
Rated current S6-40%	Arms	13,5
Rated speed	rpm	1500
Maximum speed	rpm	9000
Maximum speed (*)	rpm	- -
Inertia	Kg·m2	0,0044
Weight	Kg	23,8



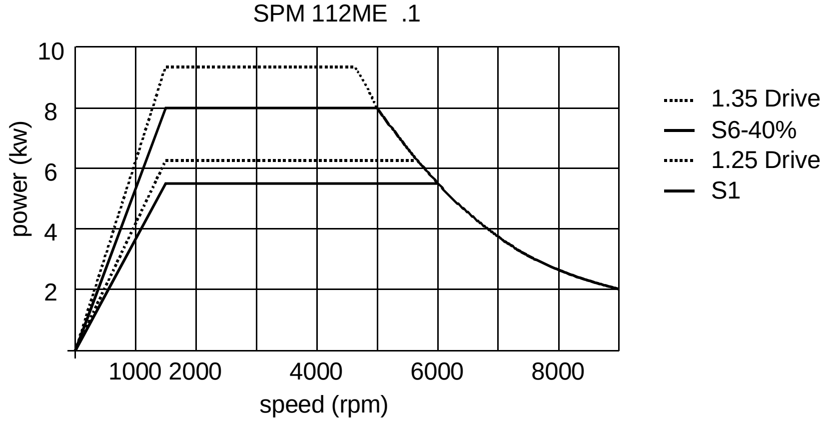
SPM 100LBE

		SPM 100LBE
Rated power S1	kW	4
Rated power S6-40%	kW	6
Rated Torque S1	Nm	25,5
Rated Torque S6-40%	Nm	38
Rated current S1	Arms	13,6
Rated current S6-40%	Arms	20,4
Rated speed	rpm	1500
Maximum speed	rpm	9000
Maximum speed (*)	rpm	- -
Inertia	Kg·m2	0,0061
Weight	Kg	35,3



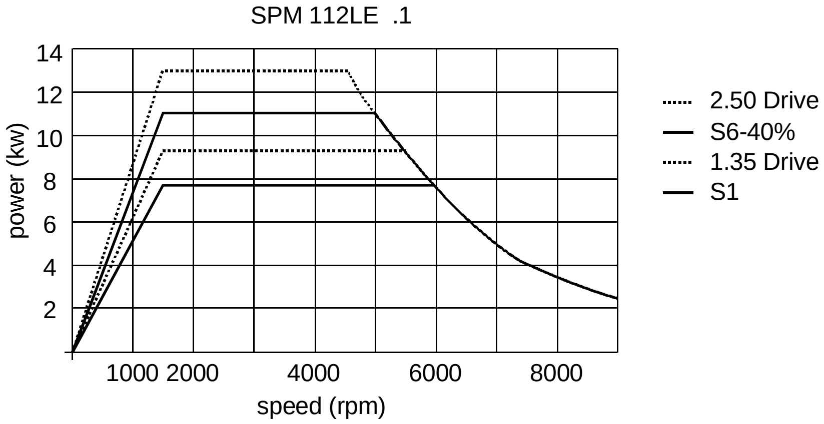
SPM 112ME

		SPM 112ME
Rated power S1	kW	5,5
Rated power S6-40%	kW	8
Rated Torque S1	Nm	35
Rated Torque S6-40%	Nm	50
Rated current S1	Arms	18,6
Rated current S6-40%	Arms	27
Rated speed	rpm	1500
Maximum speed	rpm	7500
Maximum speed (*)	rpm	9000
Inertia	Kg·m2	0,011
Weight	Kg	45



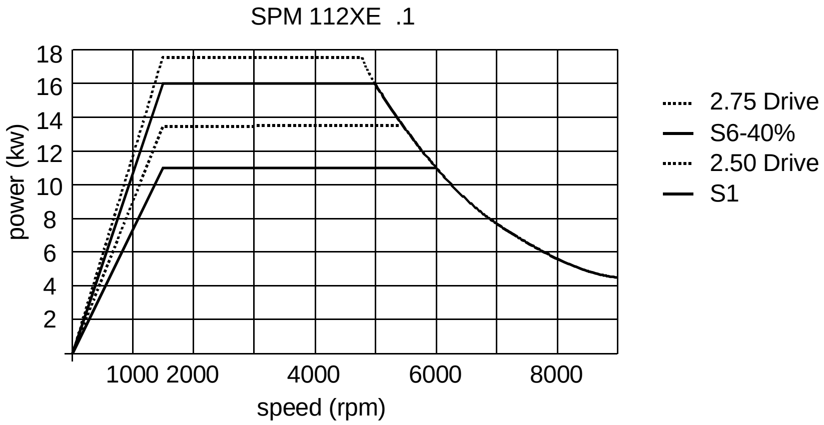
SPM 112LE

		SPM 112LE
Rated power S1	kW	7,5
Rated power S6-40%	kW	11
Rated Torque S1	Nm	47,7
Rated Torque S6-40%	Nm	70
Rated current S1	Arms	24
Rated current S6-40%	Arms	34,5
Rated speed	rpm	1500
Maximum speed	rpm	7500
Maximum speed (*)	rpm	9000
Inertia	Kg·m2	0,014
Weight	Kg	53



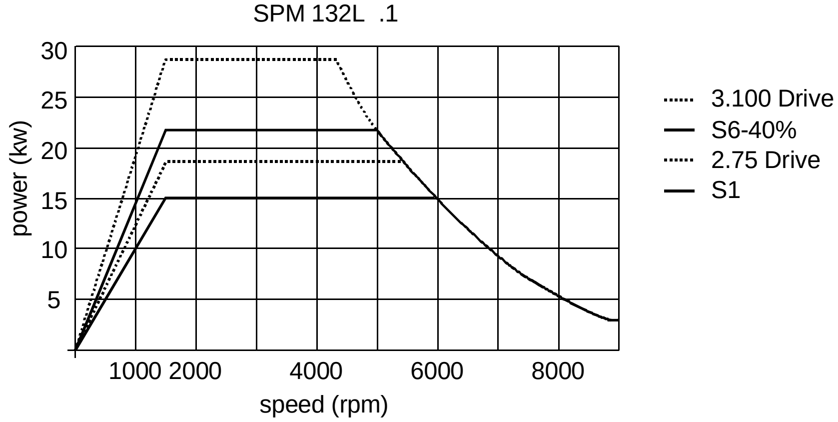
SPM 112XE

		SPM 112XE
Rated power S1	kW	11
Rated power S6-40%	kW	16
Rated Torque S1	Nm	70
Rated Torque S6-40%	Nm	101
Rated current S1	Arms	33,9
Rated current S6-40%	Arms	49,3
Rated speed	rpm	1500
Maximum speed	rpm	7500
Maximum speed (*)	rpm	9000
Inertia	Kg·m2	0,022
Weight	Kg	70



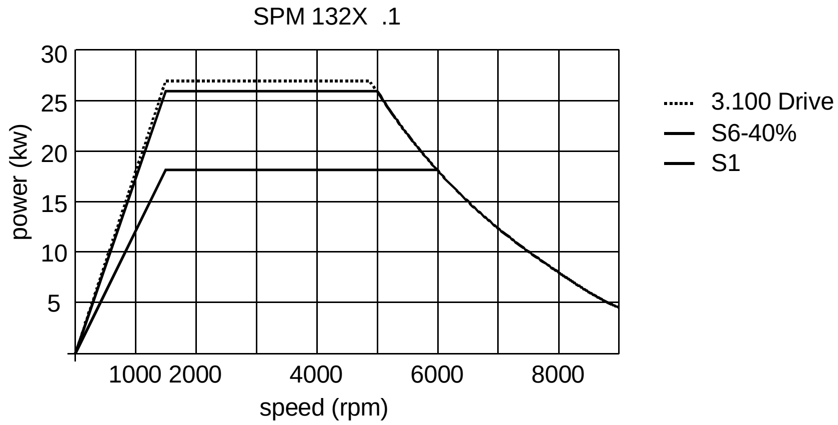
SPM 132L

		SPM 132L
Rated power S1	kW	15
Rated power S6-40%	kW	22
Rated Torque S1	Nm	95,5
Rated Torque S6-40%	Nm	140
Rated current S1	Arms	47,7
Rated current S6-40%	Arms	70
Rated speed	rpm	1500
Maximum speed	rpm	7500
Maximum speed (*)	rpm	9000
Inertia	Kg·m2	0,062
Weight	Kg	108



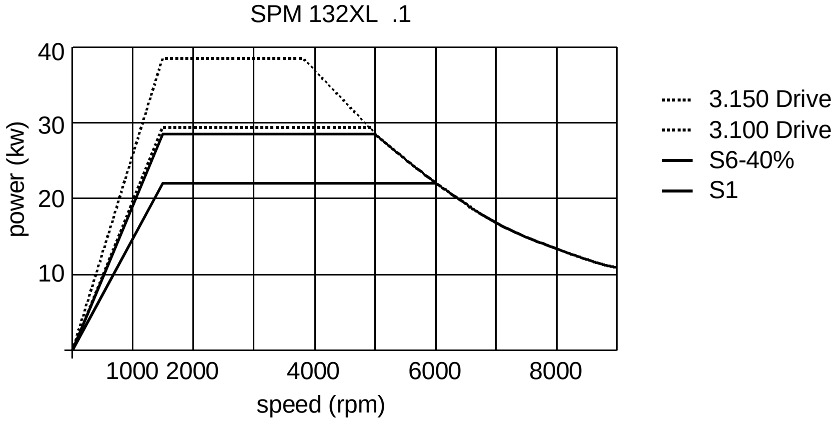
SPM 132X

		SPM 132X
Rated power S1	kW	18,5
Rated power S6-40%	kW	26
Rated Torque S1	Nm	118
Rated Torque S6-40%	Nm	165
Rated current S1	Arms	56,2
Rated current S6-40%	Arms	79
Rated speed	rpm	1500
Maximum speed	rpm	7500
Maximum speed (*)	rpm	9000
Inertia	Kg·m2	0,07
Weight	Kg	119



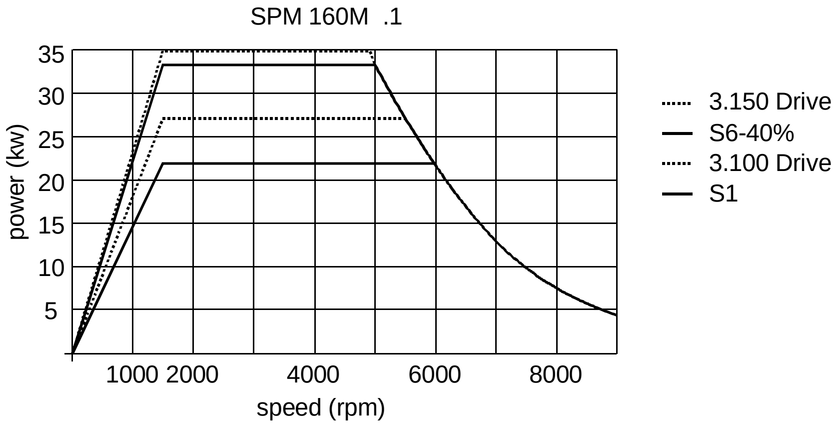
SPM 132XL

		SPM 132XL
Rated power S1	kW	22
Rated power S6-40%	kW	28
Rated Torque S1	Nm	140
Rated Torque S6-40%	Nm	178
Rated current S1	Arms	62,3
Rated current S6-40%	Arms	79,3
Rated speed	rpm	1500
Maximum speed	rpm	7500
Maximum speed (*)	rpm	9000
Inertia	Kg·m2	0,07
Weight	Kg	119



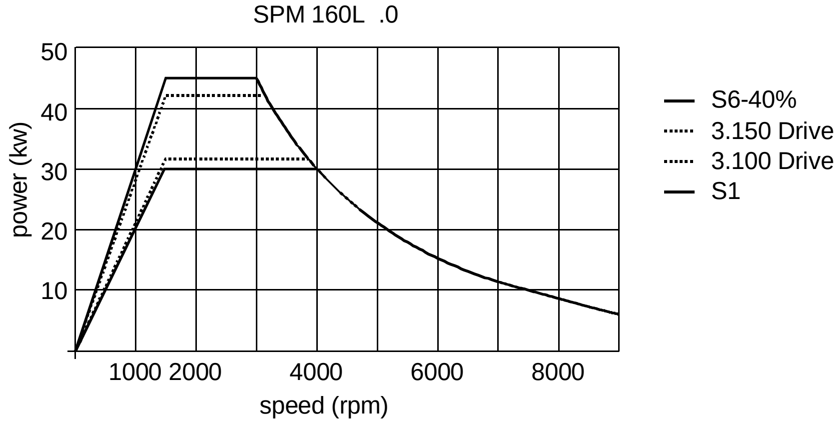
SPM 160M

		SPM 160M
Rated power S1	kW	22
Rated power S6-40%	kW	33
Rated Torque S1	Nm	140
Rated Torque S6-40%	Nm	210
Rated current S1	Arms	65,5
Rated current S6-40%	Arms	98,3
Rated speed	rpm	1500
Maximum speed	rpm	7000
Maximum speed (*)	rpm	9000
Inertia	Kg·m2	0,13
Weight	Kg	158



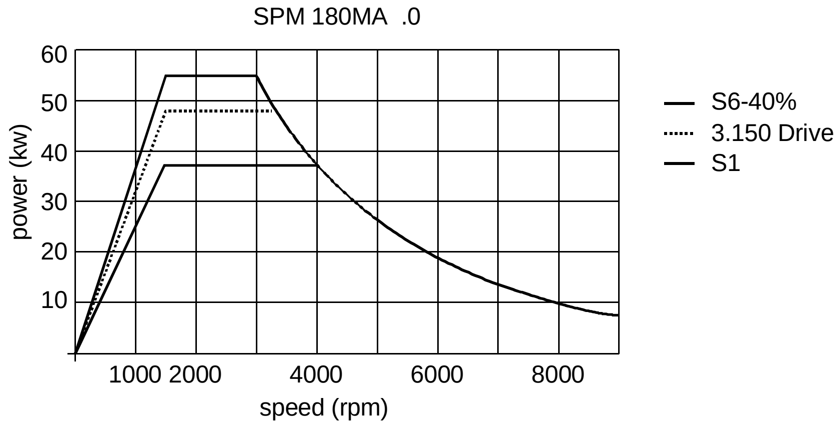
SPM160L

		SPM 160L
Rated power S1	kW	30
Rated power S6-40%	kW	45
Rated Torque S1	Nm	191
Rated Torque S6-40%	Nm	286
Rated current S1	Arms	76
Rated current S6-40%	Arms	114
Rated speed	rpm	1500
Maximum speed	rpm	6300
Maximum speed (*)	rpm	9000
Inertia	Kg·m2	0,17
Weight	Kg	196



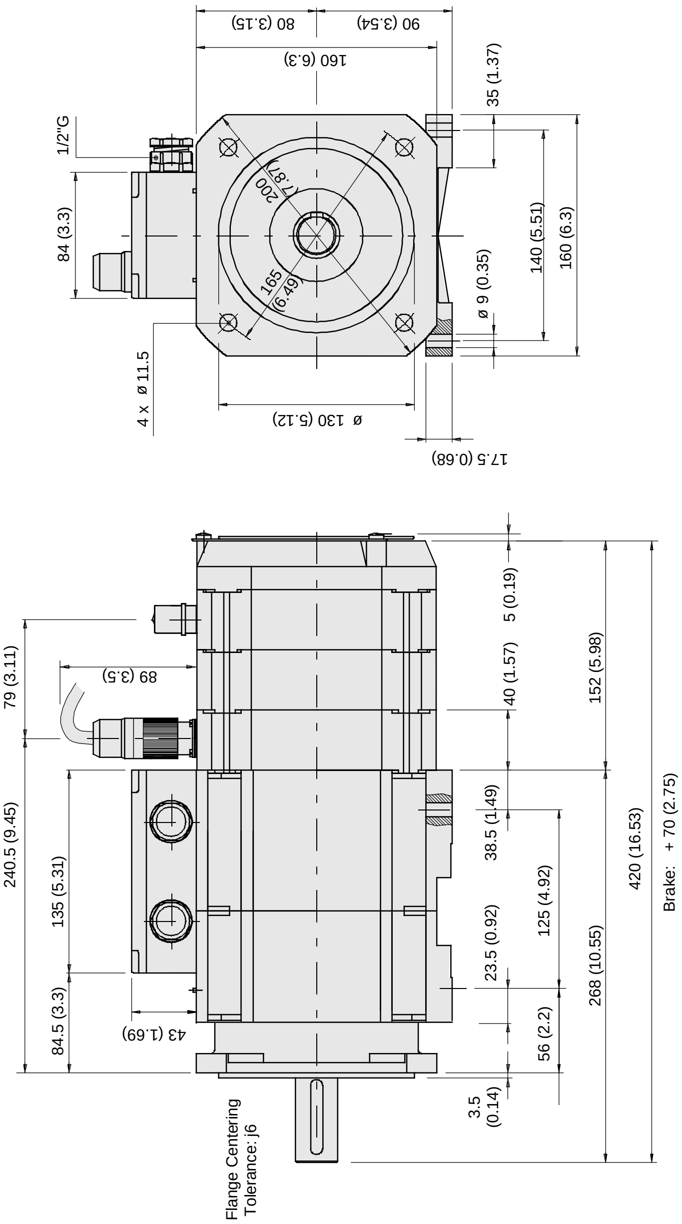
SPM180MA

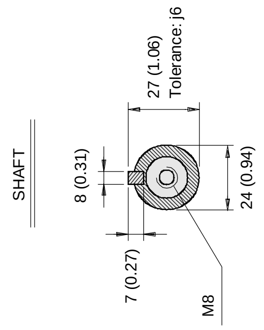
		SPM 180MA
Rated power S1	kW	37
Rated power S6-40%	kW	55
Rated Torque S1	Nm	235
Rated Torque S6-40%	Nm	350
Rated current S1	Arms	87
Rated current S6-40%	Arms	129
Rated speed	rpm	1500
Maximum speed	rpm	6500
Maximum speed (*)	rpm	9000
Inertia	Kg·m2	0,34
Weight	Kg	260

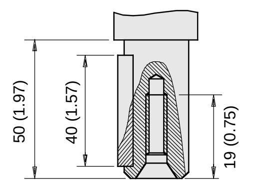


AM.7 DIMENSIONS

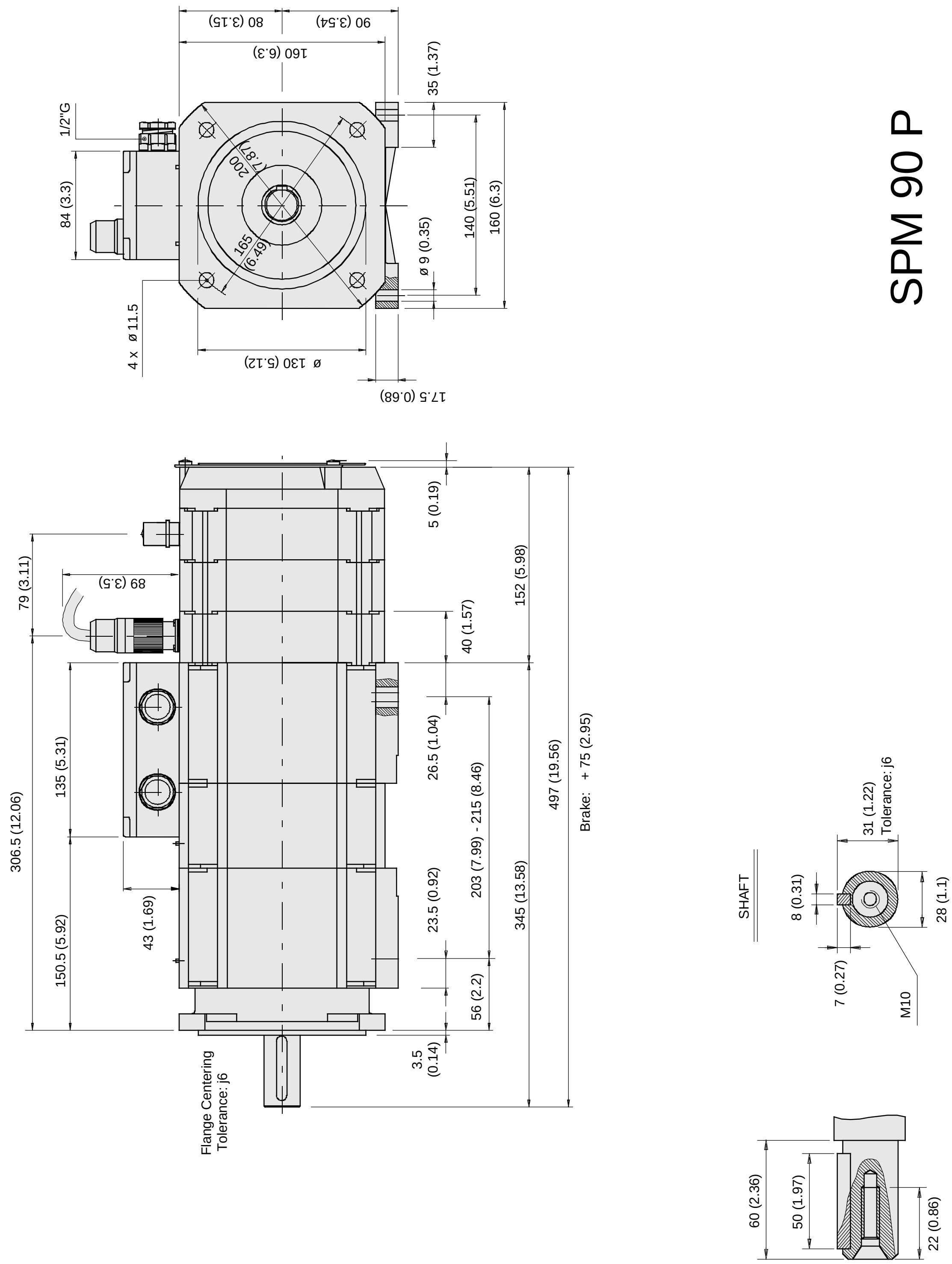
SPM 90 L



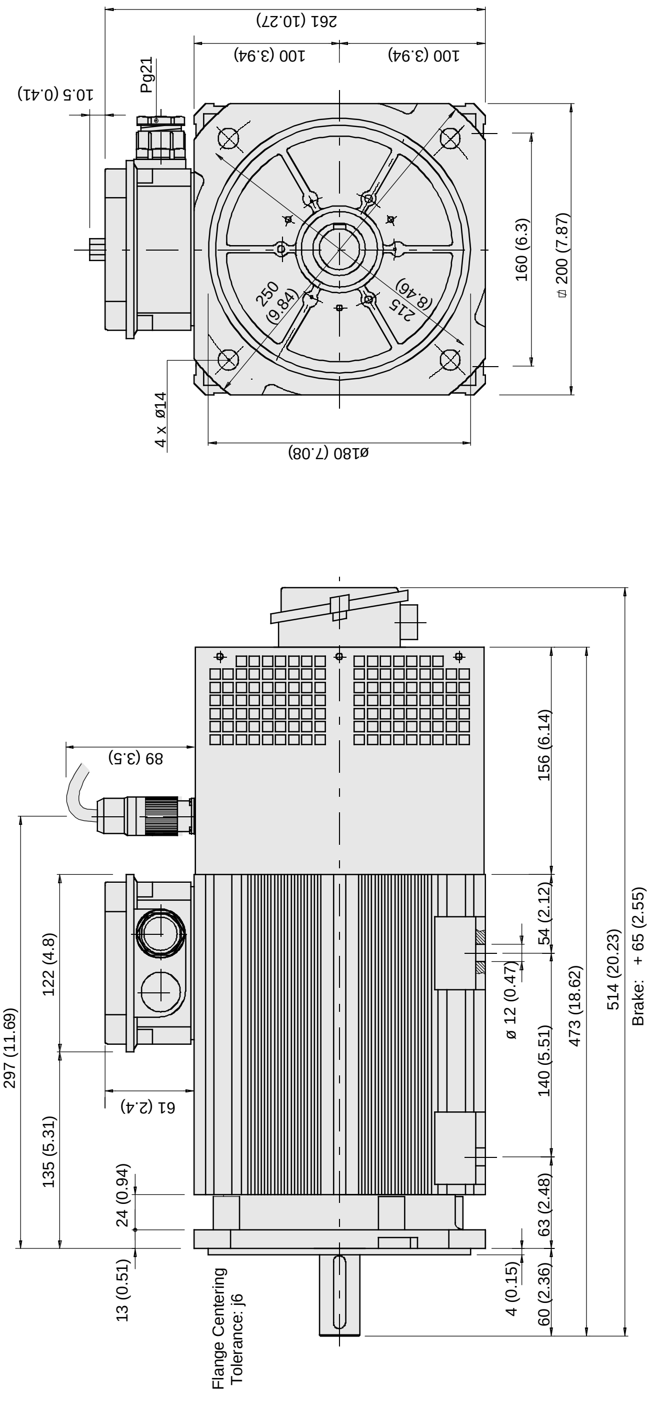




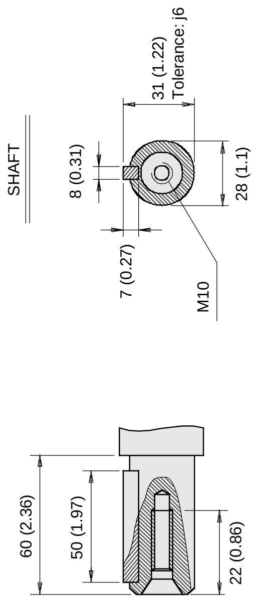
SPM 90 P


80 (3.15)
90 (3.54)
160 (6.3)
35 (1.37)
1/2"G
84 (3.3)
200 (7.87)
165 (6.49)
140 (5.51)
160 (6.3)
ø 9 (0.35)
4 x ø 11.5
ø 130 (5.12)
17.5 (0.68)
5 (0.19)
79 (3.11)
89 (3.5)
152 (5.98)
40 (1.57)
306.5 (12.06)
135 (5.31)
26.5 (1.04)
203 (7.99) - 215 (8.46)
497 (19.56)
Brake: + 75 (2.95)
150.5 (5.92)
43 (1.69)
23.5 (0.92)
345 (13.58)
56 (2.2)
3.5 (0.14)
Flange Centering
Tolerance: j6
SHAFT
31 (1.22)
Tolerance: j6
8 (0.31)
28 (1.1)
7 (0.27)
M10
60 (2.36)
50 (1.97)
22 (0.86)

SPM 100 LBE



261 (10.27)
100 (3.94)
100 (3.94)
10.5 (0.41)
Pg21
160 (6.3)
ø 200 (7.87)
250
(9.84)
215
(8.46)
4 x Ø14
ø180 (7.08)
89 (3.5)
156 (6.14)
54 (2.12)
ø 12 (0.47)
140 (5.51)
473 (18.62)
514 (20.23)
Brake: + 65 (2.55)
297 (11.69)
122 (4.8)
61 (2.4)
135 (5.31)
24 (0.94)
63 (2.48)
13 (0.51)
4 (0.15)
60 (2.36)
Flange Centering
Tolerance: j6



SHAFT
31 (1.22)
Tolerance: j6
8 (0.31)
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M10
60 (2.36)
50 (1.97)
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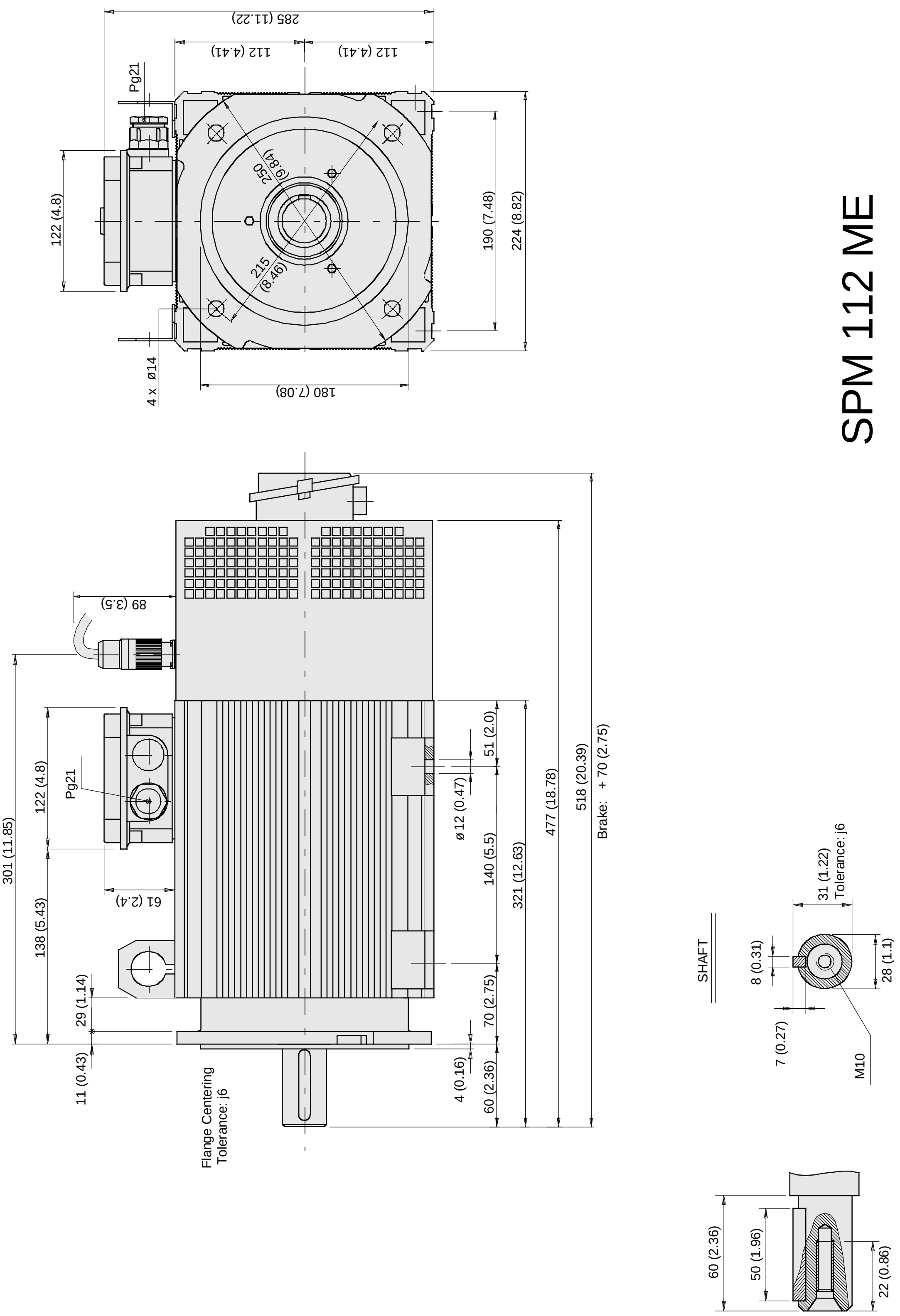
SPM 112 ME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112 (4.41)
Pg21
122 (4.8)
250 (9.84)
215 (8.46)
190 (7.48)
224 (8.82)
4 x ø14
180 (7.08)
89 (3.5)
301 (11.85)
122 (4.8)
Pg21
61 (2.4)
138 (5.43)
29 (1.14)
11 (0.43)
Flange Centering
Tolerance: j6
51 (2.0)
ø 12 (0.47)
140 (5.5)
70 (2.75)
4 (0.16)
60 (2.36)
321 (12.63)
477 (18.78)
518 (20.39)
Brake: + 70 (2.75)
SHAFT
8 (0.31)
7 (0.27)
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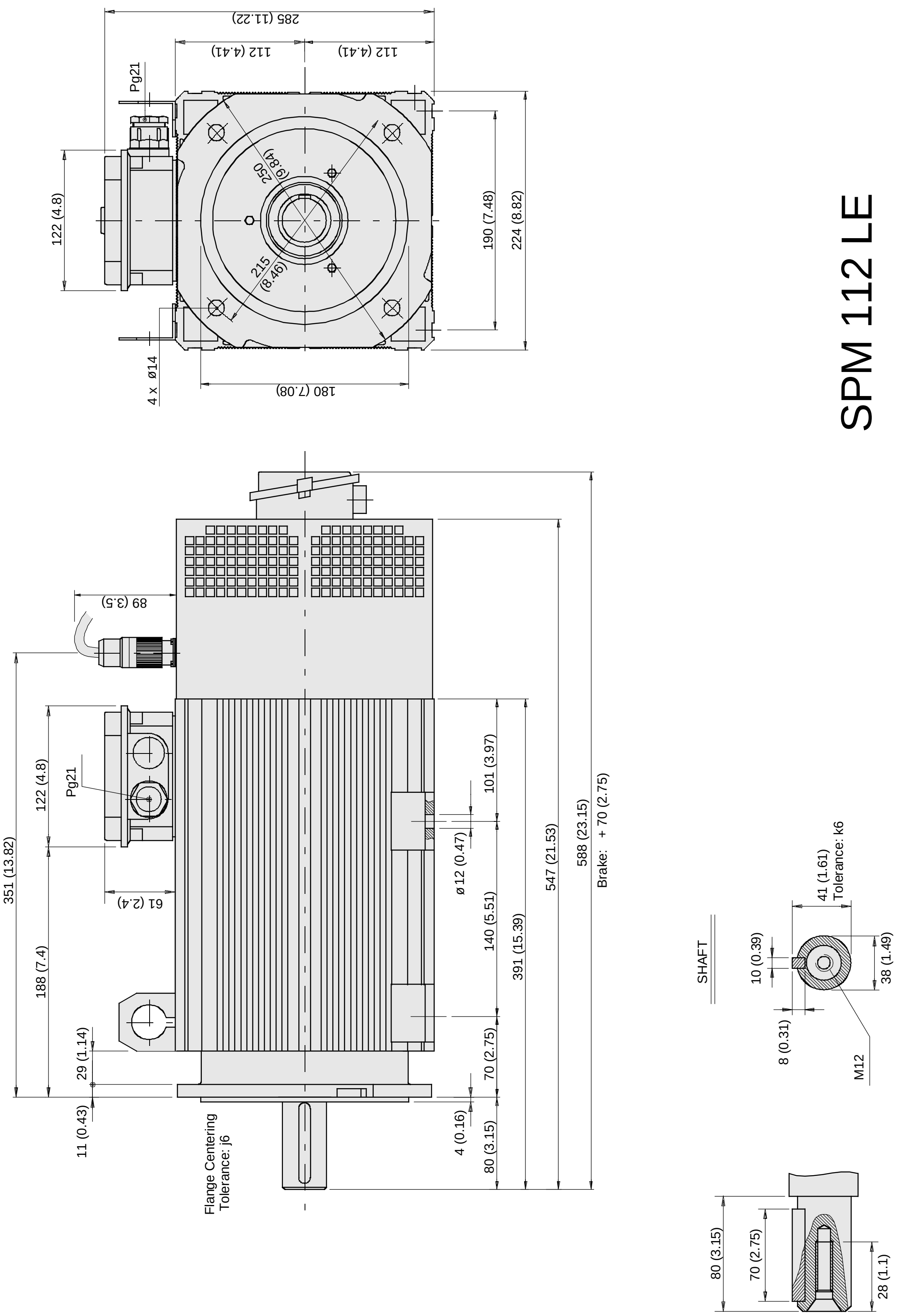
M10
60 (2.36)
50 (1.96)
22 (0.86)

SPM 112 LE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250 (9.84)
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224 (8.82)
4 x ø14
180 (7.08)
89 (3.5)
351 (13.82)
122 (4.8)
Pg21
61 (2.4)
188 (7.4)
29 (1.14)
11 (0.43)
Flange Centering
Tolerance: j6
101 (3.97)
ø 12 (0.47)
140 (5.51)
70 (2.75)
4 (0.16)
80 (3.15)
391 (15.39)
547 (21.53)
588 (23.15)
Brake: + 70 (2.75)
SHAFT
41 (1.61)
Tolerance: k6
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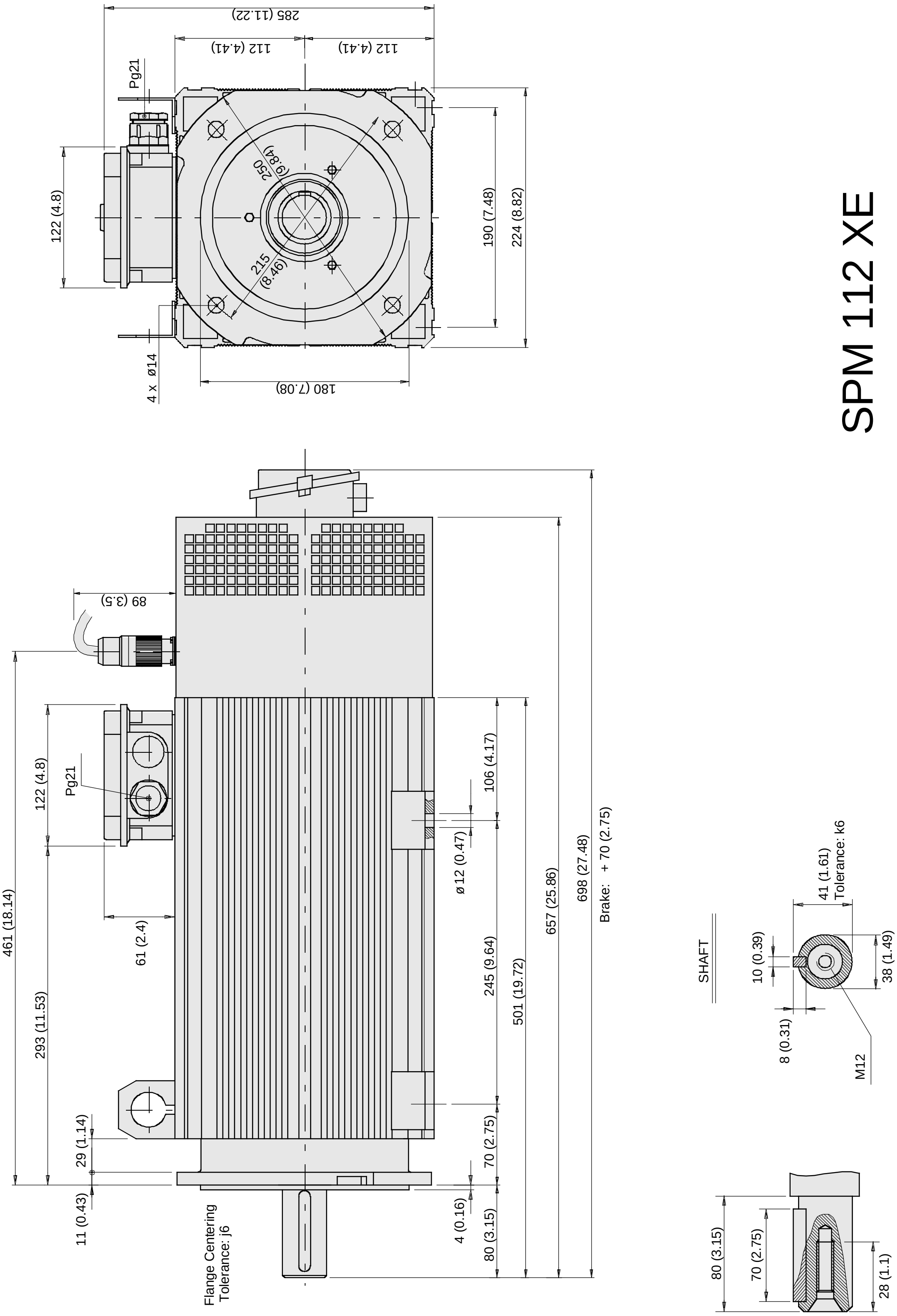
M12
80 (3.15)
70 (2.75)
28 (1.1)

SPM 112 XE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89 (3.5)
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122 (4.8)
Pg21
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61 (2.4)
29 (1.14)
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Flange Centering
Tolerance: j6
106 (4.17)
ø 12 (0.47)
245 (9.64)
70 (2.75)
4 (0.16)
80 (3.15)
501 (19.72)
657 (25.86)
698 (27.48)
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SHAFT
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M12
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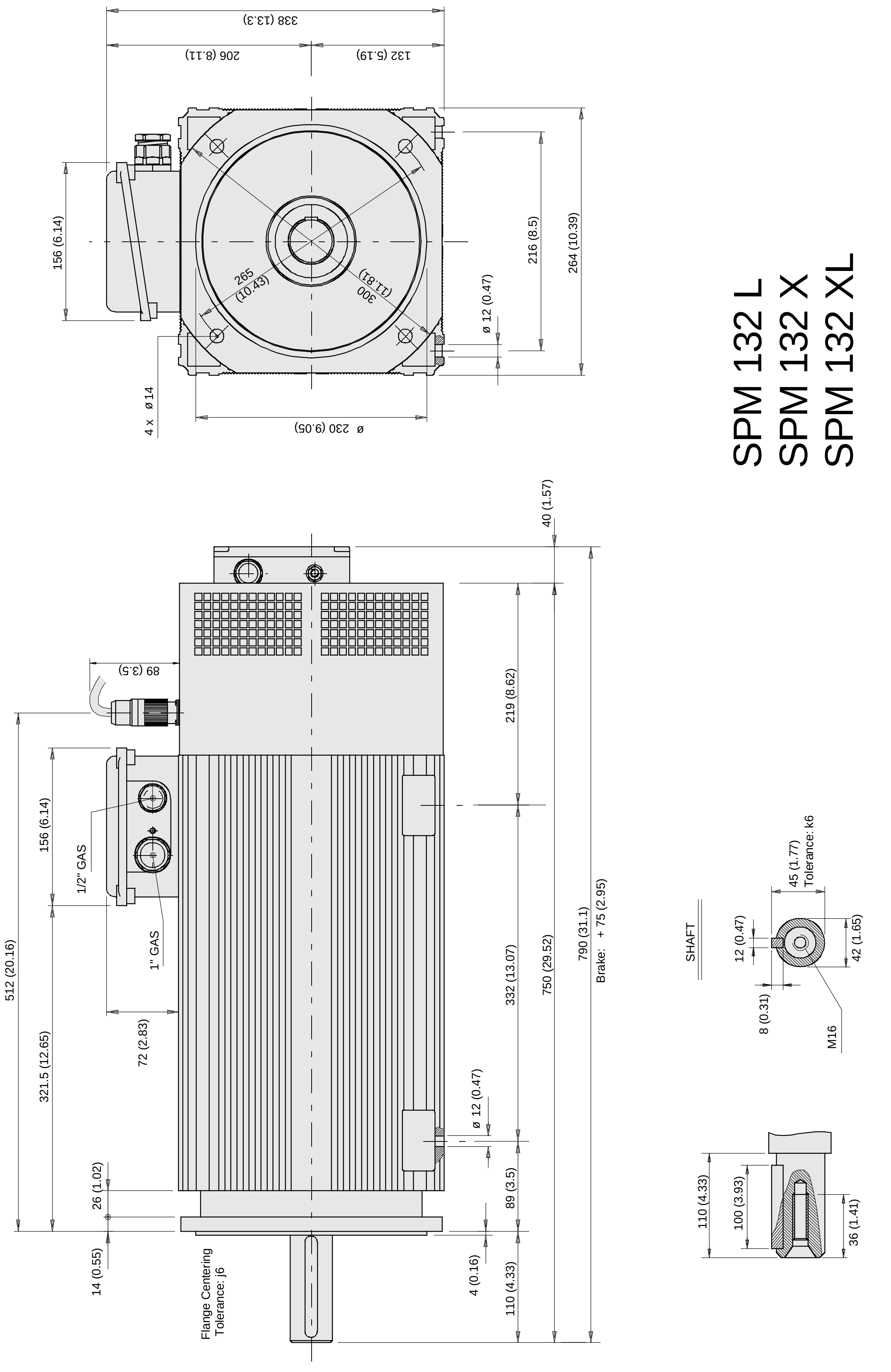
70 (2.75)
28 (1.1)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SPM 132 X
SPM 132 XL
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132 (5.19)
156 (6.14)
216 (8.5)
264 (10.39)
265 (10.43)
300 (11.81)
ø 12 (0.47)
4 x ø 14
ø 230 (9.05)
40 (1.57)
89 (3.5)
219 (8.62)
1/2" GAS
1" GAS
512 (20.16)
321.5 (12.65)
72 (2.83)
332 (13.07)
750 (29.52)
790 (31.1)
Brake: + 75 (2.95)
26 (1.02)
14 (0.55)
Flange Centering
Tolerance: j6
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110 (4.33)
SHAFT
45 (1.77)
Tolerance: k6
12 (0.47)
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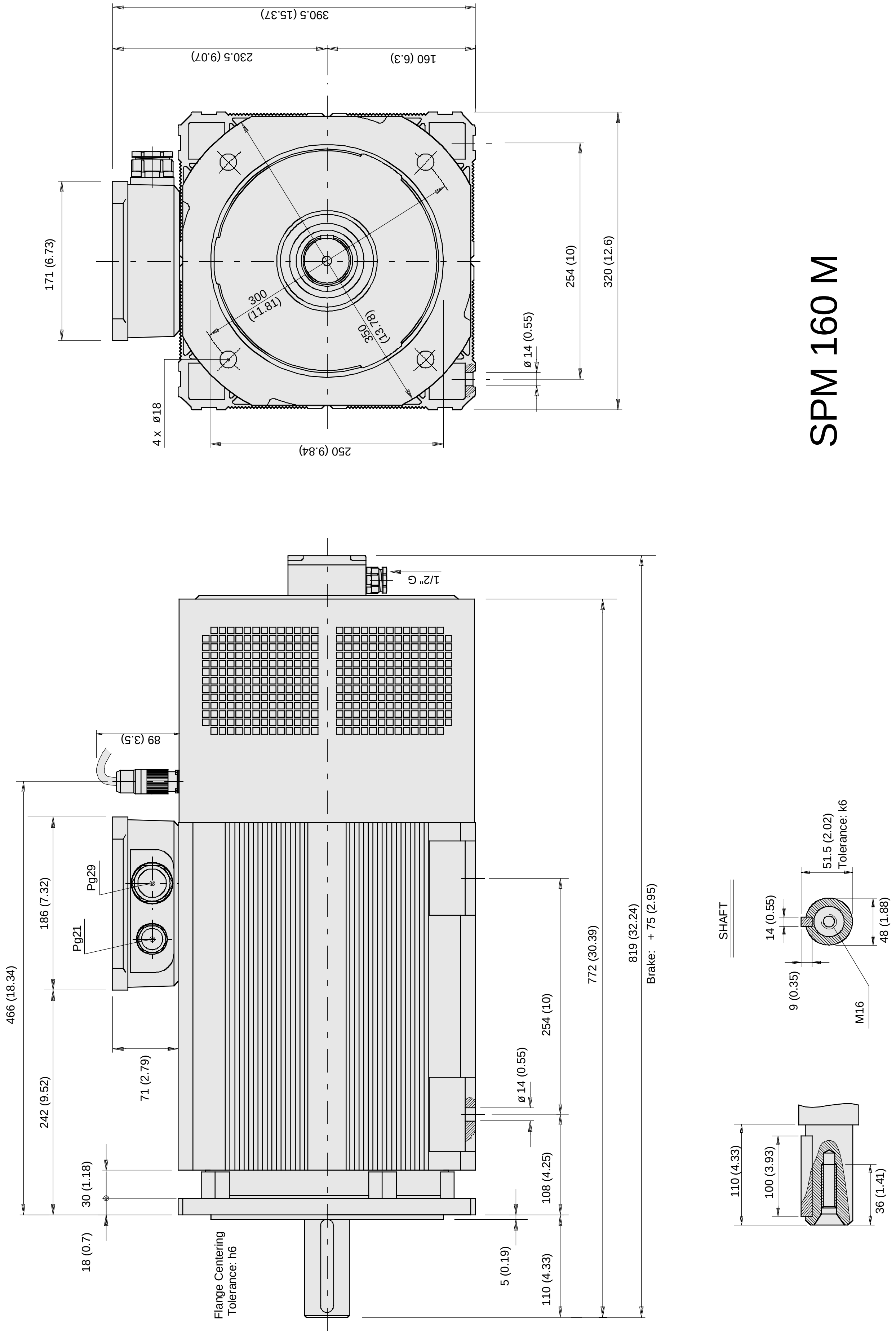
M16
100 (3.93)
36 (1.41)

SPM 160 M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230.5 (9.07)
160 (6.3)
171 (6.73)
300 (11.81)
350 (13.78)
254 (10)
320 (12.6)
ø 14 (0.55)
4 x ø18
250 (9.84)
1/2" G
89 (3.5)
Pg29
Pg21
466 (18.34)
186 (7.32)
242 (9.52)
71 (2.79)
30 (1.18)
18 (0.7)
Flange Centering
Tolerance: h6
5 (0.19)
110 (4.33)
108 (4.25)
254 (10)
ø 14 (0.55)
772 (30.39)
819 (32.24)
Brake: + 75 (2.95)
SHAFT
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Tolerance: k6
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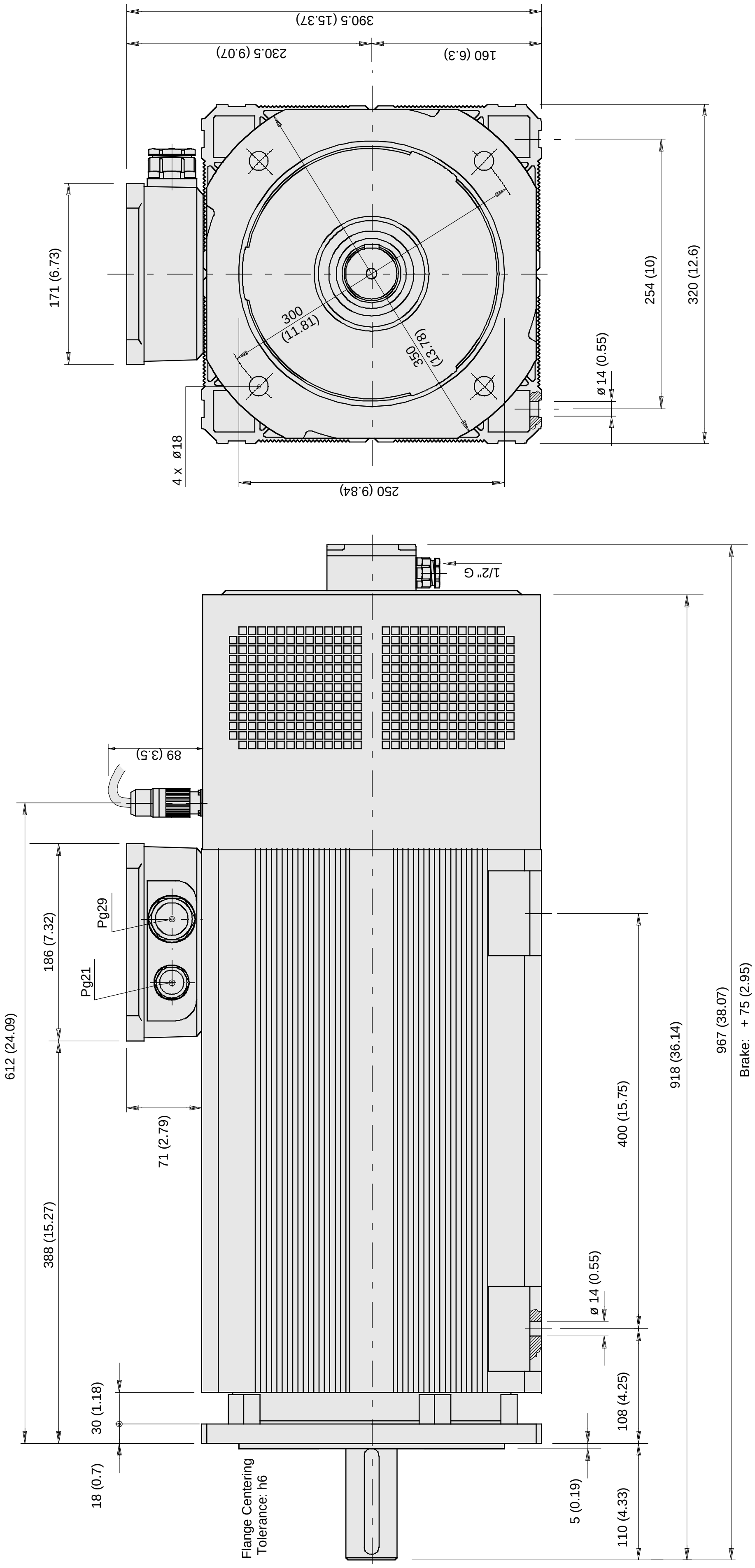
M16
110 (4.33)
100 (3.93)
36 (1.41)

SPM 160 L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160 (6.3)
171 (6.73)
300 (11.81)
350 (13.78)
254 (10)
320 (12.6)
ø 14 (0.55)
4 x ø18
250 (9.84)
1/2" G
89 (3.5)
612 (24.09)
186 (7.32)
Pg29
Pg21
71 (2.79)
388 (15.27)
30 (1.18)
18 (0.7)
Flange Centering
Tolerance: h6
400 (15.75)
ø 14 (0.55)
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5 (0.19)
110 (4.33)
918 (36.14)
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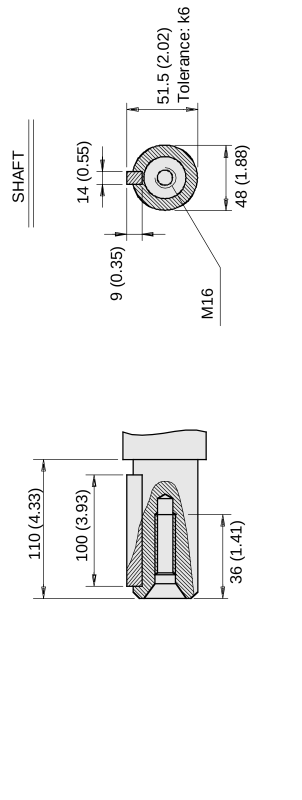
Brake: + 75 (2.95)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M16
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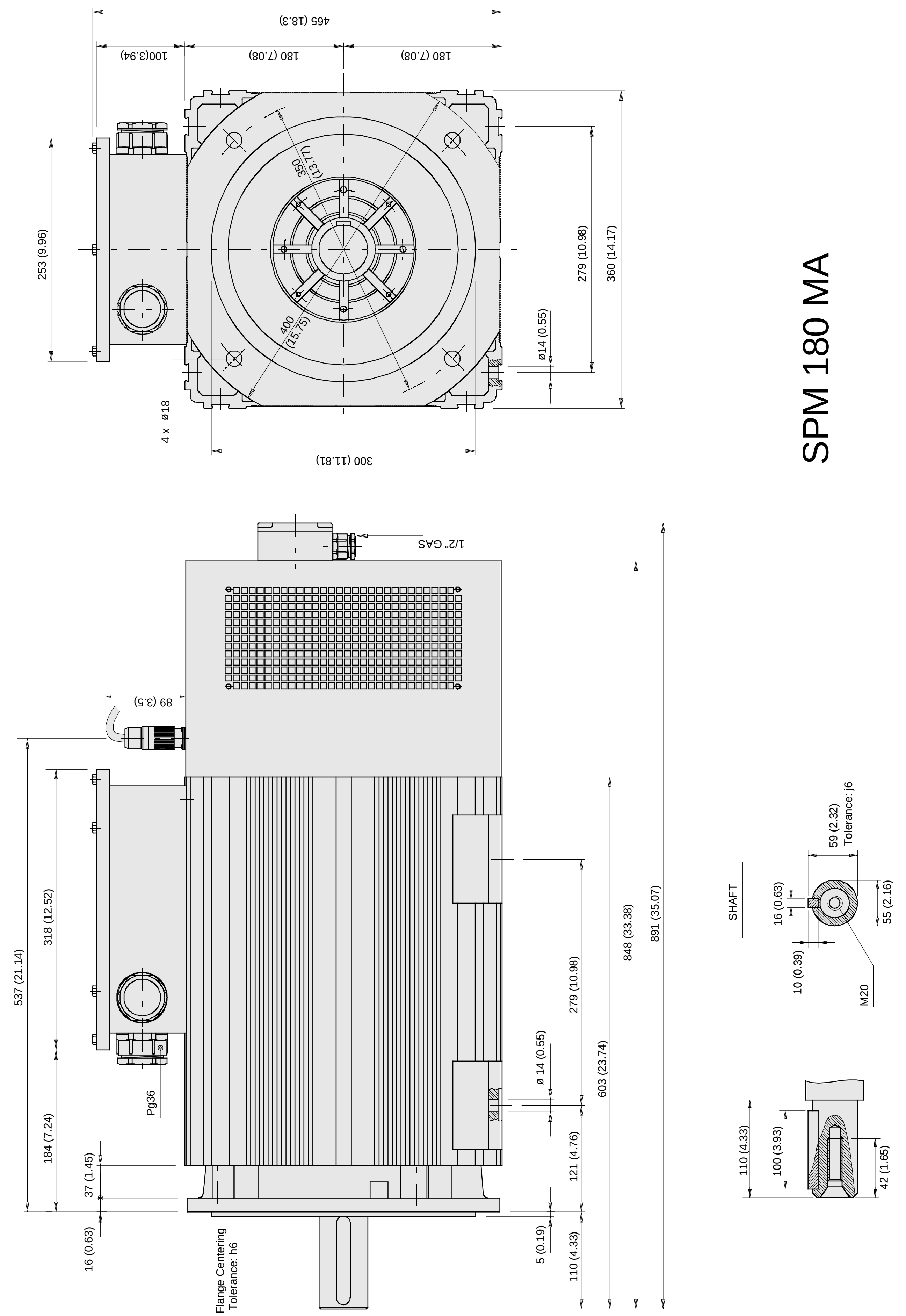
36 (1.41)

SPM 180 MA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100(3.94)
180 (7.08)
180 (7.08)
350 (13.77)
400 (15.75)
253 (9.96)
279 (10.98)
360 (14.17)
ø14 (0.55)
4 x ø18
300 (11.81)
1/2" GAS
89 (3.5)
537 (21.14)
318 (12.52)
184 (7.24)
37 (1.45)
16 (0.63)
Pg36
Flange Centering
Tolerance: h6
ø 14 (0.55)
279 (10.98)
121 (4.76)
5 (0.19)
110 (4.33)
603 (23.74)
848 (33.38)
891 (35.07)
SHAFT
59 (2.32)
Tolerance: j6
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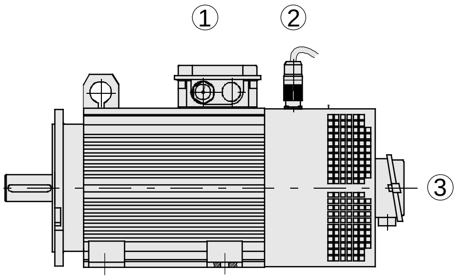
10 (0.39)
M20
110 (4.33)
100 (3.93)
42 (1.65)

AM.8 CONNECTORS



① Terminal box for power and brake (option) connection.
② Encoder feedback connector
③ Terminal box or connector for the fan (the ①, ②, ③, name is not printed on the motor)

AM.8.1 POWER AND BRAKE CONNECTION

It is done through an internal terminal box.

* Power terminals.
* Internal thermal switch contacts (Klixon 150°C (302°F)).
* Brake contacts as an option.

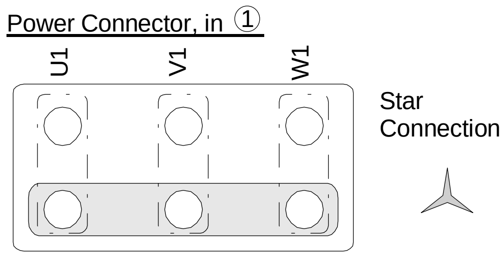
There is internal thermal switch as a protection against overtemperature. It is a normally closed contact that opens when the temperature exceeds 150°C (302°F). It has no polarity and withstands up to 250V/2.5A. This contact should be included in the Emergency chain.

Make sure that the U, V, W and Ground terminals of the Drive Module are connected to the U1, V1, W1 and Ground terminals of the Motor respectively. Otherwise, the motor would not work properly.

For further information about the characteristics of the power supply cables for the asynchronous motors as well as the selection criteria, see chapter IN.

To control the brake a single-phase mains (220 Vac) connection is needed.
The brake must be released when applying these 220 Vac. That way, in case of a power outage, the motor will be braked.

The windings of the motor have a star connection (as shown here) and it cannot be changed for any reason because it would make it run improperly.

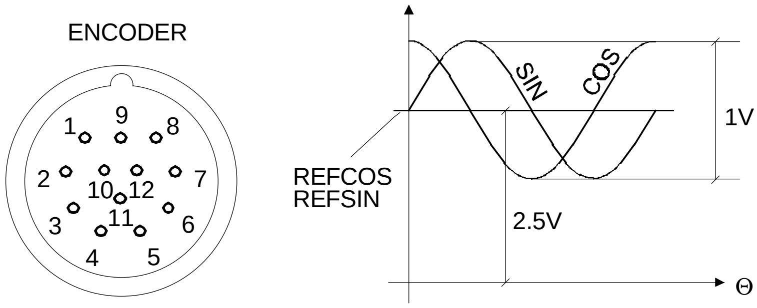


AM.8.2 FEEDBACK CONNECTION. ENCODER

It is done through a 12-pin male Conney connector which assures a sealing degree of IP65. The various available encoder models use this connector.

The cable required to connect this connector with drive module is the one referred to as **EEC**. Chapter IN describes this cable in detail.

Connector and signals (front view). Θ is the angular rotor position.



Pin	Signal	Function
1	REFCOS	Reference level for the cosine signal 2.5 Vdc
2	+ 485	RS 485 type serial line transmission signal
3	TEMP	Thermistor
4	TEMP	
5	SIN	1 Vpp sinusoidal signal generated by the Encoder.
6	REFSIN	Reference level for the sine signal 2.5 Vdc
7	- 485	RS 485 type serial line transmission signal
8	COS	1 Vpp cosinusoidal signal generated by the Encoder.
9	CHASSIS	Metallic housing of the Encoder
10	0 V	Ground
12	+ 8 Vdc	Power for the encoder

AM.8.3 FAN CONNECTION

The fan is always supplied with 220Vac. On most motors, it is carried out through a terminal box. Only SPM90 motors use a connector that is provided with the motor (maximum cable section, 2.5 mm^2).

A previous section describes the characteristics of the fans.

AM.9 INSTALLING RECOMMENDATIONS

The motor should be installed in a clean, dry and well ventilated place.

It should be easily accessible for inspection and maintenance.

There must be a gap between the armature of the motor and the structure of the machine NEVER SMALLER than 5 mm in order to avoid electromagnetic interference and transmission of vibration.

Make sure that air circulates around the motor.
Provide an unobstructed air entry and output for the fan.

AM.9.1 VENTILATION

SPM series motors carry an electric fan that generates a constant air flow regardless of the motor speed. That way, proper cooling is assured for any working condition. The motors can run at their rated current or peak current at low speeds without losing their specifications.

The electric fan must be turned on before powering the motor and must never be stopped while the machine is on.

Important:

Make sure that the air taken in by the fan is always fresh, clean and dry. For motors installed inside the structure of another machine and/or protected by panels or other type of covers, it is absolutely essential that the air comes in from the atmosphere through the corresponding conduit and channel system and that it is sent back out through the ventilation openings. The fresh air intake and the hot air outlet must be as far apart from each other as possible. In any case, make sure that the hot air (going out) and the fresh air (coming in) are not mixed.

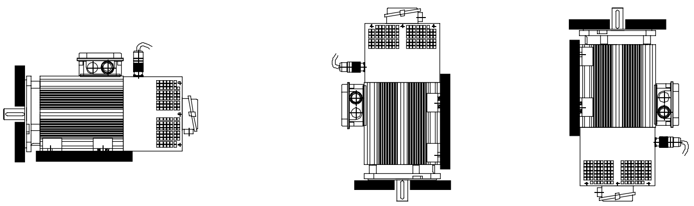
AM.9.2 MOUNTING OPTIONS

These motors may be supplied as to be mounted horizontally B3/B5 (feet/flange) or vertically types: V1/V5 or V3/V6. The motor nomenclature indicates the mounting type. See appendix C.

The motor must be fitted onto a flat, solid and sturdy surface. If the motor suffers excessive vibrations, it is often due to the weakness of the base supporting it.

When foot-mounted, the supports are located on the base of the motor itself and its dimensions and supports are standard. The motor must be mounted onto a perfectly flat surface in order to avoid deforming and breaking the protections which could cause contact between the rotor and the stator. If necessary, step up the motor support until perfectly flat and uniform motor mounting is achieved. Any element used to step it up must be made of the proper material and not smaller, in dimensions, than the motor foot itself.

Secure the motor with the right size bolts, nuts and self-locking washers. Make sure that the tools used to secure the motor do not interfere with its operation or damage it.



B3/B5 V1/V5 V3/V6

AM.9.3 AMBIENT CONDITIONS

Before mounting it onto the machine, the anti-rust paint should be removed from the rotor shaft and the flange.

The environmental conditions recommended for the motor are the ones indicated in the general characteristics bearing in mind that:

- It must be located in a clean and dry place.
- Easily accessible for inspection, cleaning and maintenance.
- Free of corrosive ambient and explosive gasses or fluids.
- If the motor is going to be exposed to oil splashes, it should be cover with a guard.

When installing it in difficult areas due to dust, water, too much humidity, vapor, smokes, oil, solvents, etc. a motor meeting a higher sealing standard may be ordered.

None of the motors described in this manual can be installed in places with any risk of explosion.

AM.10 COUPLING

The circular motion of the motor can be transmitted to the machine through direct coupling or by using pulleys or gear boxes.

AM.10.1 DIRECT COUPLING

Use a joint which does not transmit axial loads to the roller bearings and does not compensate for alignment errors between the transmission shafts. In the case of direct coupling (linked shafts) be extra careful in order to guarantee the alignment between the motor shaft and the pulled axis and between the coupling flanges. Any vibration or irregular rotation will indicate poor alignment which will result in poor performance and shorter life-span of the bearings.

AM.10.2 COUPLING THROUGH TRANSMISSION PULLEYS

Install the motor with shaft perfectly parallel and aligned with the pulley shaft in order to avoid axial loads on the supports. The tension of the pulleys must be enough to avoid slippage when the motor is working at full load, but it must never exceed the maximum load described in this manual. Too much tension on the pulleys may wear out the bearings faster and even break the shafts.

Regarding the peripheral speed of the pulleys, transmitted power, diameter ratios of the pulleys, etc. Refer to the technical data supplied by the manufacturer. Always use balanced pulleys.

AM.10.3 COUPLING THROUGH GEAR BOXES

Refer to the "direct coupling" section and to any information provided by the manufacturer of the gear boxes.

AM.10.4 BALANCING

The rotor is dynamically balanced with the key inserted in the keyway. It is an "S" degree balancing and, upon request, an "SR" degree can be obtained. It is important that the pulley, half-joint or rack be dynamically balanced (without the key) before inserting them in the transmission shaft. Any vibration while the motor is running indicates an unbalanced gear box and must be corrected.

AM.10.5 MOUNTING THE GEAR BOXES

Upon request, the motor may carry a special flange for mounting gear boxes.

The joints, pulleys, pinions, etc. must always be adjusted very accurately and with the right tools. Never use a hammer since it can damage the bearings and accessories, especially those of the feedback device.

Before manipulating the gear box, remove the anti-rust paint from the motor shaft by using alcohol or the proper solvent (the solvent must not get into the bearings). Do not use sandpaper or any other abrasive element to remove the paint.

Lubricate the end of the shaft and the keyway before inserting the transmission and assemble it by following the manufacturer's instructions.

AM.11 RADIAL AND AXIAL LOADS

A poor alignment between the motor and the machine increases the vibrations on the shaft and reduces the life-span of the bearings and couplings.

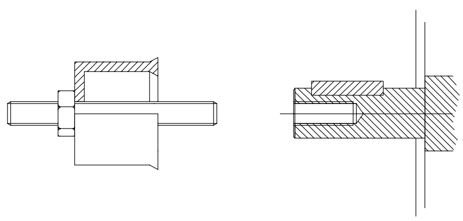
In order to avoid these problems, follow these advises::

- Use flexible couplings when the coupling is direct.
- Avoid radial and axial loads onto the motor shaft, making sure that they do not exceed the values indicated in the table at the beginning of the chapter.

Note: For combined axial and radial loads, decrease the value of the allowed radial force to 70%.

When installing pulleys or gears for transmission, avoid hitting the shaft.

Use some tool supported in the threaded hole of the shaft to insert the pulley or the gear.



AM.12 BEARINGS

The special bearings are the ball-bearing type, suitable for high speeds and lubricated with special greases resistant to high rotation and temperature conditions.
The maximum theoretical life of the bearings is calculated in about 20,000 hours of continuous operation at 1500 rpm approx. For higher average rotation speeds, the life of the bearings varies as follows:

- 30 - 50% of n_{max}. – about 16,000 hours
- 50 - 60% of n_{max}. – about 12,000 hours
- 60 - 70% of n_{max}. – about 8,000 hours

The data and the operating hours are calculated for normal operating conditions, without vibrations and with temperatures within the limits imposed by the bearing manufacturers.

The speed n_{max} is to intended as the maximum limit of rotation and not as continuous operating speed, which is limited to about 70% of n_{max}.

Notes:
On the non drive side, a rigid radial ball bearing is always installed.
For coupling with a pulley, the radial load acting on the shaft can be calculated using the following formula:

$$Fr = 19.5 \cdot 10^6 \cdot \frac{Pn \cdot K}{D \cdot Nn} \pm Pp$$

Fr = Radial load in [N]	Pn = Nominal power in [kW]
Nn = Nominal speed in [rpm]	D = Diameter of pulley in [mm]
Pp = Weight of pulley in [N]	K = 1 - 1.5 for cog belts
	2 - 2.5 for V-belts
	3 - 4 for flat belts

Caution: It is advisable, at the first start up of the motor, to carry out the breaking-in of the bearings. Increase progressively the velocity of the motor from 0 to about 70% of n_{max} in about 20 min. Never operate the motor at the maximum speed for long periods of time.
Watch the temperature and possible abnormal noises.
During the first minutes of operation, a higher than normal noise can be heard, due to the non uniform distribution of the grease inside the bearing. The noise should return back to normal at the end of the break-in.
As for special bearings (high speed for spindles), the break-in operation is a must.
During the break-in, the fan must be in operation. Clamp securely the key before starting the motor.
Any gasket or seal rings installed as protection for the bearing can be removed only if not deemed necessary to the purpose (particularly clean environment, additional external mechanical protections). By doing so, the friction and the operating temperature will decrease.

AM.13 MAINTENANCE INTERVALS

First inspection: in normal cases and after about 500 hours of operation, at any rate within a year from start-up date. Check that the plate data are followed and there are no vibrations, noises, high temperatures or structural damages to the motor and accessories.

Re-lubing of bearings:

Fagor recomends the lube oil from KLUBER (ISOFLEX LDS 18 SPECIAL A).
Depending on the type of bearing, dimensions, average speed and operating and temperature conditions. From a minimum of about 1000 hours to a maximum of 8000 hours. At any rate within 3 years.

a) Re-lube the bearings by putting in new grease of the same type or compatible with the existing one.
b) Do not exceed the quantity of grease which could cause high temperatures and contamination of the motor windings. The following formula can be used to establish the quantity of grease to be put in:

$$Gp = D * B * 0{,}005$$

Gp = quantity of grease to be put in [gr]
D = external bearing diameter [mm]
B = bearing height [mm]

Replacement of the bearings: at the most, after 20000 hours of operation
a) Replace the bearings following the instructions indicated in the next paragraph.
b) The type and name of the bearing is indicated in the manual.

AM.13.1 BEARING REPLACEMENT

1) Extract the rotor from the stator paying the utmost attention not to damage the windings.

2) Position the rotor on a stable support and block it in order to prevent its rotation or accidental fall.

3) Extract the bearing using a specific extractor inserting a copper or aluminum plate between the shaft and the extractor's pin in order not to damage the shaft or the thread, if any.

4) Do not exert any pressure on the encoder/resolver shaft. Use a bushing if necessary.

5) Replace the bearing with others of the same type and dimension (pay attention to the complete denomination indicated on the bearing).

6) In order to assemble the new bearings, use the specific tool or assemble it by warming it up (max 100 ºC).

7) The use of a hammer is specifically forbidden.

8) Lube the non shielded bearings and proceed with the motor assembly. (For the grease quantity to be put in and the type, please see the bearing manufacturer catalog).

9) At the end of the operation proceed to the break-in of the bearings, if necessary.

AM.14 IDENTIFICATION BOARD

The identification plate of each motor has the shape shown in the next figure.

Fagor Automation S. Coop. (Spain)		3 Phase AC Induction Motor	
Type SPM 112LE.E1.00000.1 Rel. C SN 96L 1078 Year 1999			
S1 Pn 7.5 kW In 24 A	S6 P 11 kW I 34.5 A	Vn 330 Vac Nm 47.7 Nm Slip 55 rpm	Hz 50 Conn. IP 54
Speed Nn/Nmax 1500/7500 rpm Magnetizing current 11.4 A Resistance (ph/ph) 0.44 Ω Inductance (ph/ph) 5.3 mH		W 53 kg M V1/V5 Transducter type Brake type	I. cl F B. cl S Stegman
Electric Fan type R2E190 Ph1 V 220 A 0.35 Hz 50/60 IP54			

AM.15 REGISTRATION NUMBERS FOR SPM MOTORS

Many of the Drive's Software parameters are directly related to the characteristics of the motor it governs; see appendix A. For the Fagor motors in this manual, the software knows the values that must be assigned to those parameters.

Motors equipped with Encoder (sales reference E0, E1) have their reference stored in their electronic memory so the parameter setting at the drive is done automatically. See the GSU chapter. In a manual setting, the drive must be "told" which motor is going to govern.

Appendix C shows the codes of this reference for asynchronous motors. These identifiers (motorid) are followed by the version release identifier (Rel) in all cases.

For example: SPM112LE.E1.00000.1-C

EM. ELECTRONIC MODULES

The Fagor Servo-Drive System has a modular stackable design.

It is connected directly to a three-phase mains of 50/60 Hz with a rated voltage between 380Vac-15% and 460Vac+10%. It supplies the motors with three-phase 380 Vac and variable frequency to control its speed.

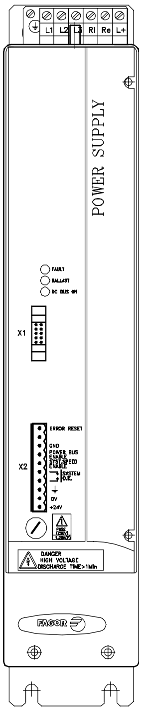
Depending on the user's needs, it may consists of the following elements:

<u>**Power Supply Module.**</u>	**PS.** Module in charge of converting the alternating current of mains into dc voltage for the drives.
<u>**Regenerative Power Supply**</u>	**XPS.** Power Supply with the possibility to return energy to Mains.
<u>**Modular Drive**</u>	**AXD, SPD.** They are fully digital modules which can govern a synchronous and an asynchronous motor respectively.
<u>**Compact Drive**</u>	**ACD, SCD.** Autonomous modules for governing a synchronous and asynchronous motor respectively
<u>**Auxiliary Power Supply Module.**</u>	**APS 24.** Module in charge of supplying 24 Vdc to the control circuits of the rest of the modules.
<u>**Capacitor Module.**</u>	**CM-60.** Increases the capability of the Bus and it serves as a temporary energy buffer.
<u>**Resistor Module.**</u>	**RM-15, ER.** To facilitate a great energy dissipation while braking.
<u>**Programming Module.**</u>	**DDS PROG MODULE.** Connected to the drive module through the serial line, it allows displaying and programming its internal parameters. It has an internal nonvolatile memory and the possibility to send and receive parameter tables.
<u>**Mains Filter**</u>	**EMK.** Additional module to protect mains and the Drive System against mutual disturbances. Optional although absolutely necessary for complying with the European Directive on Electromagnetic Compatibility 89/336/CE or the international standard CEI/IEC 1800-3.

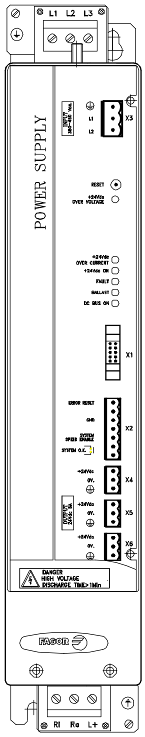
The following illustrations show all these elements: Power Supplies, Modular Drives in three possible sizes, Compact Drives, Programming Module, Auxiliary Power Supply, Capacitor and Resistor Modules as well as the Mains Filters.

This system has been manufactured in accordance with the EN 60204-1 standard in compliance with European Directive 73/12/CE on Low Voltage.

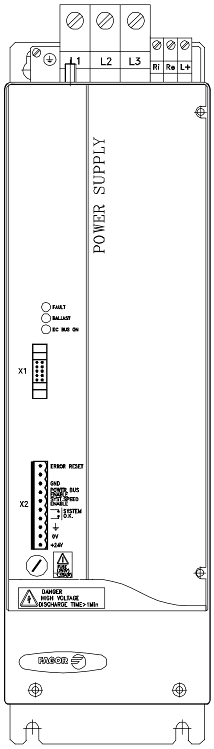
PS-25A



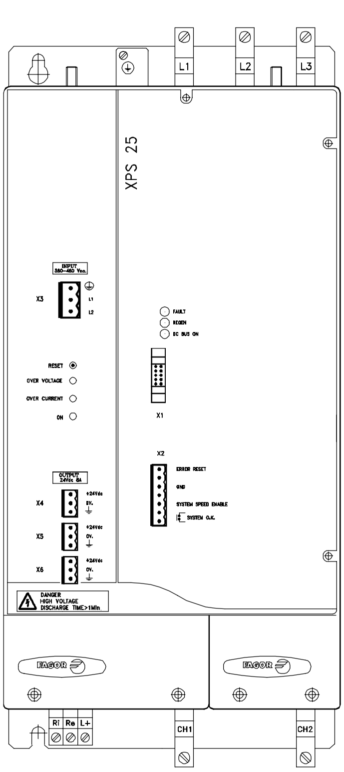
PS-25B



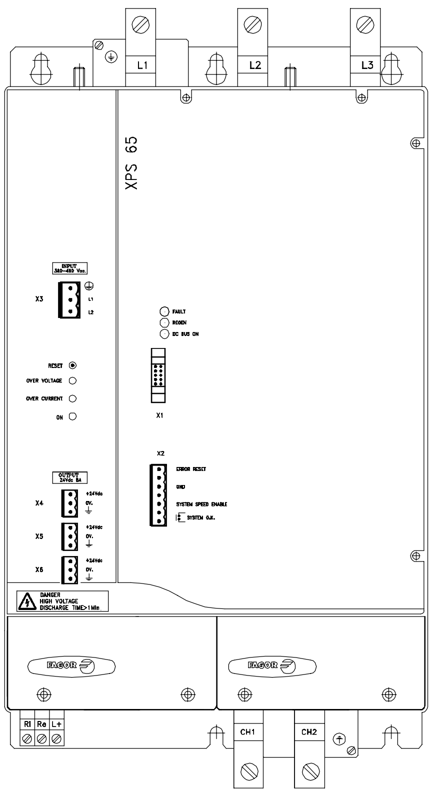
PS-65A



XPS-25



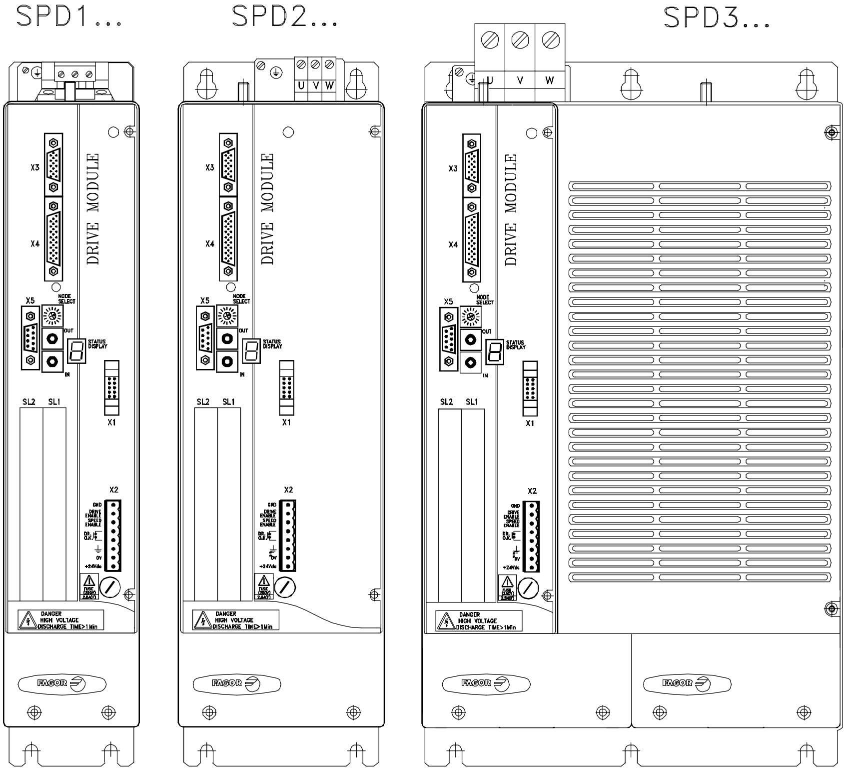
XPS-65



AXD1...
SPD1...

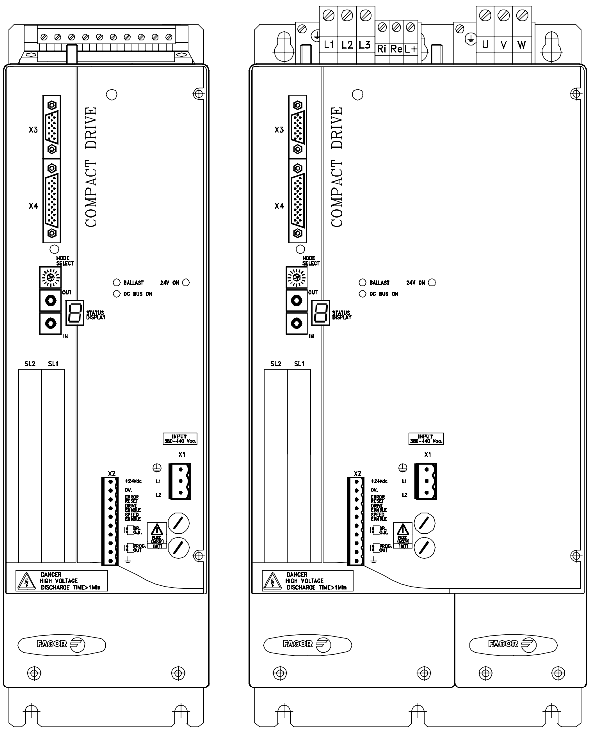
AXD2...
SPD2...

AXD3...
SPD3...

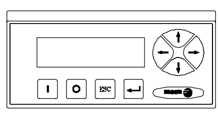


ACD1...
SCD1...

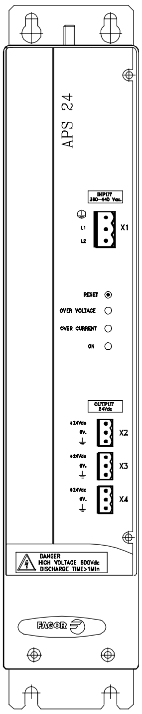
ACD2...
SCD2...



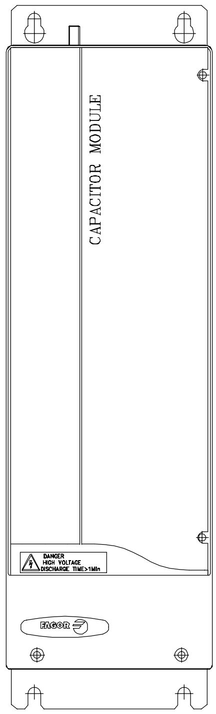
DDS PROG MODULE



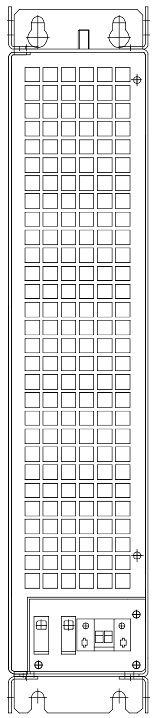
APS 24



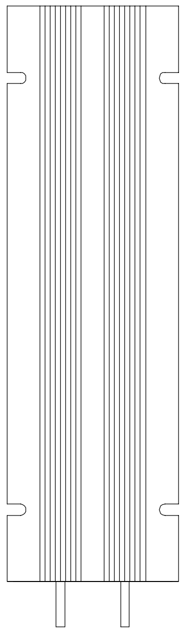
CM-60



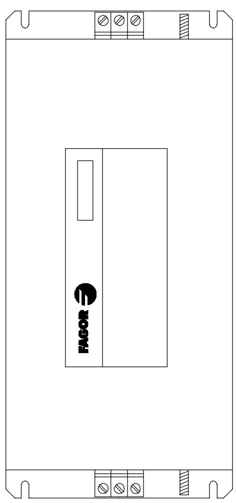
RM-15



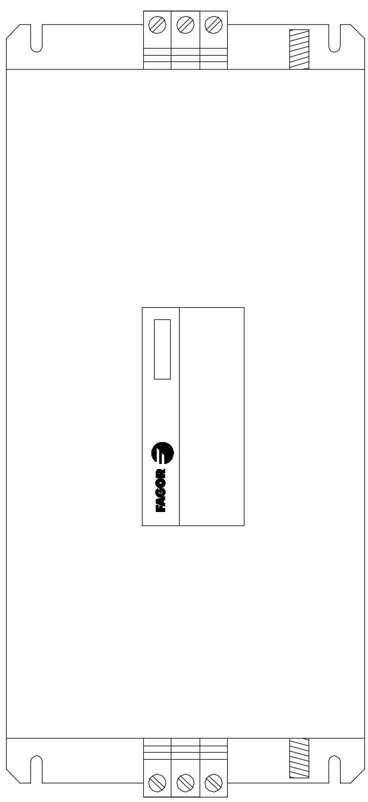
ER



EMK 3040



EMK 3120



EM.1 POWER SUPPLY MODULE

They are directly connected to 380-460 Vac, 50/60 Hz Mains and provide a dc voltage output of about 600 Vdc depending on Mains power. This voltage supplies to the Drive Modules through what we call Power Bus.

These Power Supplies also handle the energy excess accumulated at the Power Bus usually due to motor braking.

We call them Non-regenerative Power Supplies when this excess of energy is dissipated as heat on certain electrical resistors.

We call them Regenerative Power supplies when this excess of energy is returned to Mains. This option reduces the consumption of the electrical signal without generating additional heat.

Non-regenerative Power Supplies

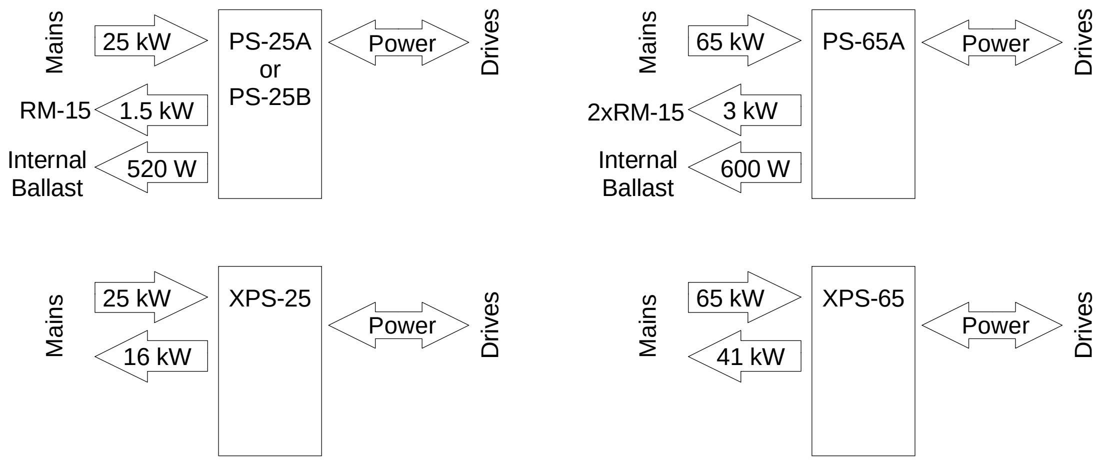
They are the ones referred to as **PS-25A, PS-25B** and **PS-65A,** and provide 25 and 65 kilowatts to the Drives respectively. They admit a voltage range between 380 Vac to 460 Vac. The previous **PS-25** and **PS-65** only admitted 380 Vac. See appendix D.

Regenerative Power supplies

They are the ones referred to as **XPS-25** and **XPS-65,** (25 and 65 kilowatts) and they can return 16 and 41 kilowatts respectively in a continuous fashion.
They admit a voltage range between 380 Vac and 460 Vac.

When energy regeneration is activated, the "REGEN" lamp turns on.
The module also has a little Ballast Circuit for dissipating energy in an emergency. That is, when there is no Mains voltage and the overvoltage alarm goes off.

These modules also offer an Auxiliary 24 Vdc Power Supply for the control circuits of the Drive modules.



EM.1.1 GENERAL CHARACTERISTICS OF THE NON-REGENERATIVE POWER SUPPLIES

	PS-25A Module	PS-65A Module
Power supply (Vmains)	Three-phase 50/60 Hz, with a voltage range between 380Vac -15%. and 460Vac +10% (**)	
Mains power consumption	38 Amp -RMS-	100 Amp -RMS-
Maximum connection cable section	4 mm^2	50 mm^2
Power bus voltage $VBUS_{NOM}$	540 Vdc / 650 Vdc	
Rated (peak) output current (*)	45 Amp (135 Amp, 1 sec)	120 Amp (360 Amp, 1 sec)
Rated (peak) output power	25 kW (75 kW, 1 sec)	65 Kw (195 kW, 1 sec)
Power for the module control circuit	24 Vdc (between 21 Vdc and 28 Vdc)	
Consumption of the module control circuit itself	1 Amp at 24 Volts (24 watts)	
Internal Ballast resistance (Power (*))	18 Ohms (520 W)	9 Ohms (600 W)
Energy pulse to be dissipated	18 kWs (0.6 sec)	36 kWs (0.6 sec)
Ballast circuit On/Off	768 Vdc / 760 Vdc (712 Vdc / 704 Vdc (***))	
Minimum external Ballast resistance	18 Ohms	9 Ohms
Filter capacity	705 microF, 900 Vdc	750 microF, 900 Vdc
Energy stored in the capacitors	$0.5 \cdot C \cdot V^2$	
Maximum "System OK" contact voltage	125 Vac, 150 Vdc	
Maximum "System OK" contact current	2 Amp	
Module width	77 mm (3.03 inches)	117 mm (4.61 inches)
Module weight	6.8 Kg (15 lbs)	9.9 Kg (22 lbs)
Power dissipated at maximum load	160 W	275 W
Ambient temperature (*)	5°C / 45°C. (41°F / 113°F)	
Storage temperature	-20°C / 60°C (-4°F / 140°F)	
Humidity	less than 95% (non-condensing at 45°C / 113°F)	
Maximum altitude without loss of features	1000 meters (3281 ft) above sea level	
Operating vibration	10..60 Hz, 0.1..5 G, 2 hr	
Shipping vibration	60..300 Hz, 5 G, 2 hr	
Sealing	IP2x	
Protections	Over-voltage, heat-sink temperature, hardware error, Ballast overload	

(*) See derating curves in case of high temperatures
(**) Previous power supplies PS-xx only admitted Vmains of 380 Vac
(***) When the module is set for Vmains = 380 Vac

IMPORTANT NOTE: PS-25A and PS-65A power supplies admit a mains voltage of up to 460 Vac. The rest of their characteristics, connectors and so forth of previous PS-25 and PS-65 are identical.

See appendix D for compatibility with the drives.

	PS-25B Module
Power supply (Vmains)	Three-phase 50/60 Hz, with a voltage range between 380Vac -15%. and 460Vac +10% (**)
Mains power consumption	38 Amp -RMS-
Maximum connection cable section	10 mm^2

Power bus voltage $VBUS_{NOM}$	540 Vdc / 650 Vdc
Rated (peak) output current (*)	45 Amp (135 Amp, 1 sec)
Rated (peak) output power	25 kW (75 kW, 1 sec)

Internal Ballast resistance (Power (*))	18 Ohms (400 W)
Energy pulse to be dissipated	35 kWs (1 sec)
Ballast circuit On/Off	768 Vdc / 760 Vdc (712 Vdc / 704 Vdc (***))
Minimum external Ballast resistance	18 Ohms
Filter capacity	705 microF, 900 Vdc
Energy stored in the capacitors	$0.5 \cdot C \cdot V^2$

Maximum "System OK" contact voltage	125 Vac, 150 Vdc
Maximum "System OK" contact current	2 Amp

Module width	77 mm (3.03 inches)
Module weight	6 Kg (13.2 lbs)
Power dissipated at maximum load	180 W
Ambient temperature (*)	5°C / 45°C. (41°F / 113°F)
Storage temperature	-20°C / 60°C (-4°F / 140°F)
Humidity	less than 95% (non-condensing at 45°C / 113°F)
Maximum altitude without loss of features	1000 meters (3281 ft) above sea level
Operating vibration	10..60 Hz, 0.1..5 G, 2 hr
Shipping vibration	60..300 Hz, 5 G, 2 hr
Sealing	IP2x
Protections	Over-voltage, heat-sink temperature, hardware error, Ballast overload

(*) See derating curves in case of high temperatures
(**) Previous power supplies PS-xx only admitted Vmains of 380 Vac
(***) When the module is set for Vmains = 380 Vac

Output voltage , maximum current	24 Vdc (5%), 10 Amp
Input voltage	380 Vac (-15%) - 460 Vac (+10%); 50/60 Hz
Mains consumption	0.75 Amp (380 Vac) 0.63 Amp (460 Vac)
Maximum inrush current	23.9 Amp (460 Vac)
Bus consumption	0.5 Amp (540 Vdc) 0.44 Amp (650 Vdc)
Bus maximum voltage	790 Vdc

IMPORTANT NOTE: The PS-25B model power supply admits a Mains voltage of up to 460 Vac.
See appendix D to know about compatibility with the drives.

EM.1.2 GENERAL CHARACTERISTICS OF THE REGENERATIVE POWER SUPPLIES

	XPS-25 Module	XPS-65 Module
Power supply (Vmains)	Three-phase 50/60 Hz, with a voltage range between 380Vac -15%. and 460Vac +10%	
Mains power consumption	38 Amp -RMS-	100 Amp -RMS-
Maximum connection cable section	16 mm^2	50 mm^2
Voltage of the Power Bus. $VBUS_{NOM}$	540 Vdc / 650 Vdc	
Rated (peak) output current (*)	45 Amp (100 Amp, 1 sec)	120 Amp (120 Amp, 1 sec)
Rated (peak) output power	25 kW (55 kW, 1 sec)	65 kW (108 kW, 1 sec)
Regenerating circuit on/off voltage	Vmains x 1.414 + 30V	
Rated regenerated current (returned to mains) (*)	25 Amp -RMS-	62 Amp -RMS-
Rated regenerative power (returned to mains)	16 kW	41 kW
Related Choke	CHOKE XPS-25	CHOKE XPS-65
Choke-Drive Cable (max. length: 2 m (80 inches))	16 mm^2	50 mm^2
Output voltage of the Auxiliary Power Supply	24 Vdc ± 5%	
Maximum current supplied	8 Amps at 24 Volts (192 watts)	
Mains consumption for 24 Vdc generation	0.75 Amp (380 Vac) 0.63 Amp (460 Vac)	
Internal Ballast resistance (Power (*))	18 Ohms (520 W)	9 Ohms (1800 W)
Energy pulse that could be dissipated	18 kWs (0.6 sec)	50 kWs (1 sec)
Ballast circuit On/Off voltage	765 Vdc / 755 Vdc (616 Vdc / 608 Vdc (***))	
Minimum external Ballast resistance	18 Ohms	9 Ohms
Filter capacity	1175 microF, 900 Vdc	2115 microF, 900 Vdc
Energy stored in the capacitors	$0.5 \cdot C \cdot V^2$	
Maximum "System OK" contact voltage	125 Vac, 150 Vdc	
Maximum "System OK" contact current	2 Amp	
Module width	194 mm (7.64 inches)	234 mm (9.21 inches)
Module weight	14 Kg (31 lbs)	19 Kg (42 lbs)
Power dissipated at maximum load	180 W	350 W
Ambient temperature (*)	5°C / 45°C. (41°F / 113°F)	
Storage temperature	-20°C / 60°C (-4°F / 140°F)	
Humidity	less than 95% (non-condensing at 45°C / 113°F)	
Maximum altitude without loss of features	1000 meters (3281 ft) above sea level	
Operating vibration	10..60 Hz, 0.1..5 G, 2 hr	
Shipping vibration	60..300 Hz, 5 G, 2 hr	
Sealing	IP20	
Protections	Overvoltage, Overcurrent, ambient temperature, hardware error.	

(*) See derating curves in case of high temperatures
(***) When the module is set for Vmains = 380 Vac

EM.1.3 POWER SUPPLY CONNECTORS

1. Power connectors for Mains.
2. Power connectors for the external Ballast resistor.
3. Ground connector for the cable hose from Mains and intermodular Chassis connections.

4. Lamps indicating the status of the Main Power Supply.
   "FAULT". When blinking, it indicates that one or several Mains phases are missing.
   "FAULT" on, it indicates an error specified at the display of the drives.
   "BALLAST" it comes on when the energy dissipating Ballast circuit is activated.
   "DC BUS ON" comes on when the module offers all its power at the Bus.

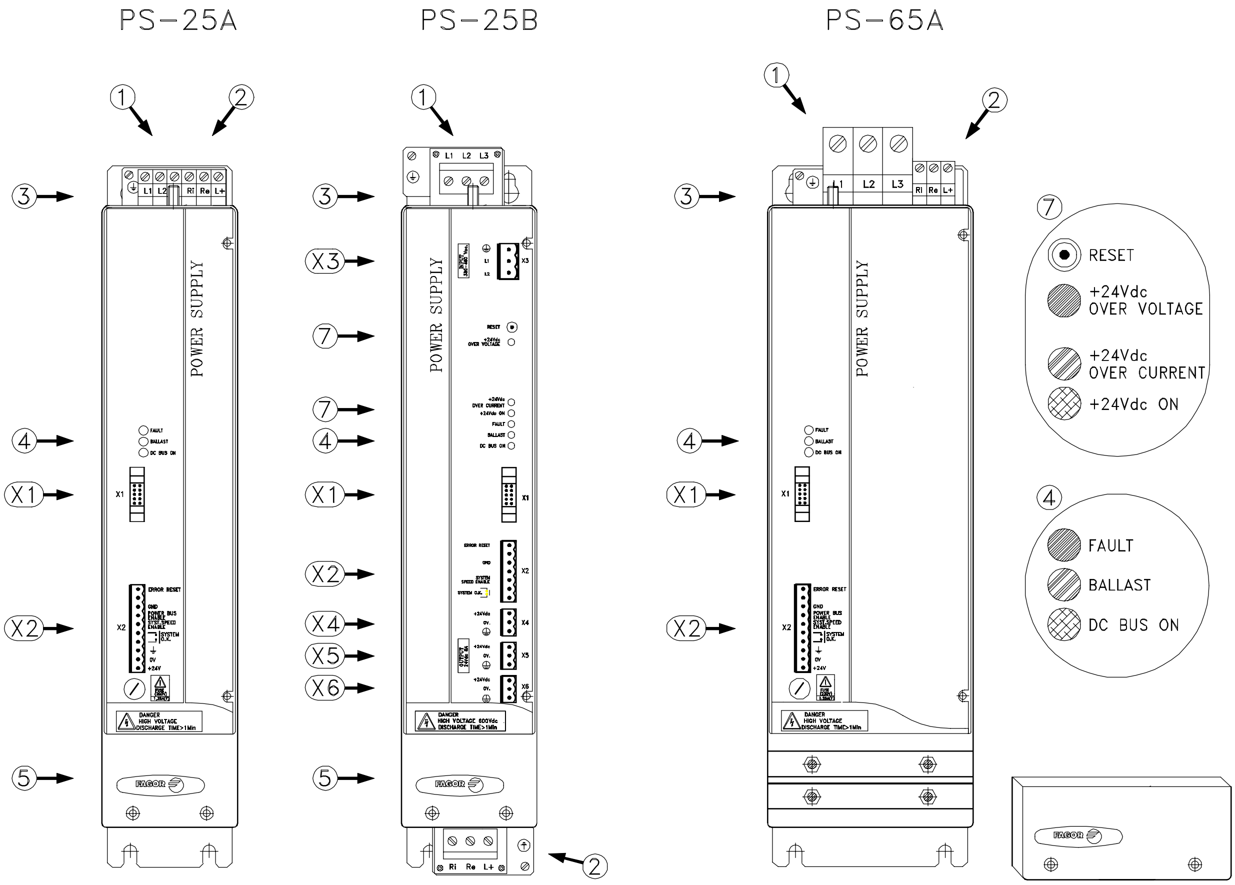
   And at the XPS:
   "REGEN" comes on when the module is working in Energy Regenerating mode.

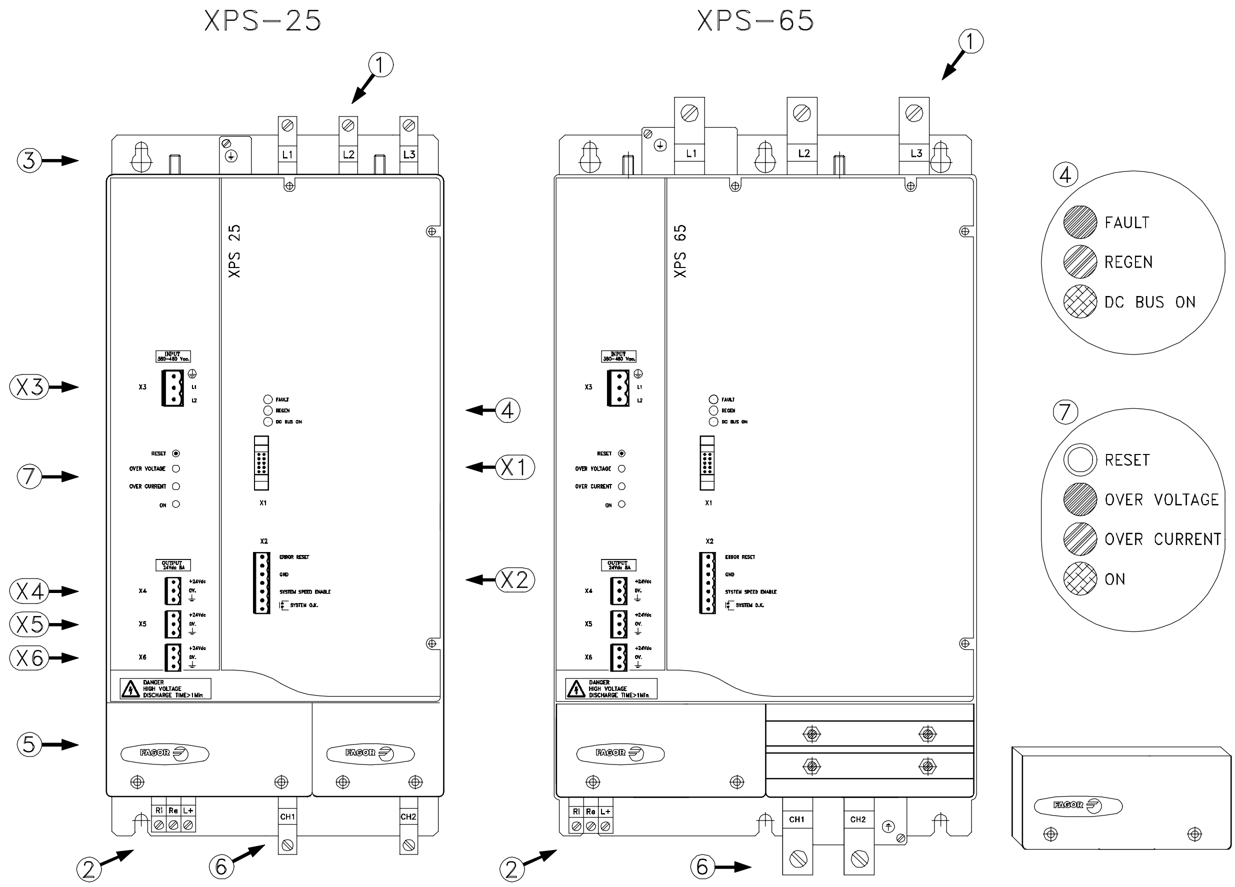
5. Power Bus supplying power to the Drive modules through metal bars.
6. Connectors for the inductance needed on XPS models.
7. Lamps indicating the status of the Auxiliary Power Supply and reset button.
   "RESET" initializes the Auxiliary 24 Vdc Power Supply after an overvoltage error.
   "OVER VOLTAGE" indicates an overvoltage error at the 24 Vdc output.
   "OVER CURRENT" indicates and overcurrent error at the 24 Vdc output.
   "ON", it comes on when the 24 Vdc is available.

X1 Connector intermodular communications. Internal Bus.
X2 Connector providing access to the basic control signals.
X3 Input connector supplying to the internal Auxiliary Power Supply from Mains.
X4, X5 and X6 Output connectors of the Auxiliary Power Supply offering 24 Vdc.

Conversion table

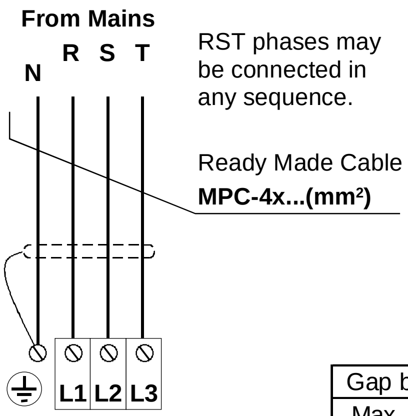
Metric	→ to →	Imperial
mm	÷ 25.4	inch
$Kg \cdot m^2$	÷ 0.113	$lb \cdot in \cdot sec^2$
Nm	÷ 0.113	lb·in
°C	x 1.8 → + 32	°F
Kw	÷ 0.746	HP


PS-25A
PS-25B
PS-65A
POWER SUPPLY
RESET
+24Vdc OVER VOLTAGE
+24Vdc OVER CURRENT
+24Vdc ON
FAULT
BALLAST
DC BUS ON
L1 L2 L3
Rl Re L+
X1 X2 X3 X4 X5 X6
DANGER HIGH VOLTAGE DISCHARGE TIME>1Min
FAGOR


XPS-25
XPS-65
XPS 25
XPS 65
FAULT
REGEN
DC BUS ON
RESET
OVER VOLTAGE
OVER CURRENT
ON
L1 L2 L3
Rl Re L+
CH1 CH2
X1 X2 X3 X4 X5 X6
DANGER HIGH VOLTAGE DISCHARGE TIME>1Min
FAGOR

EM.1.3.1 POWER CONNECTORS OF THE POWER SUPPLIES

Terminal strip for connection to Mains.



The phases may be connected in any sequence.

The ground connection of the cable shields is made from the vertical plate next to the terminal strip.

	PS-25A	PS-25B	XPS-25	PS-65A XPS-65
Gap between terminals (mm)	8.1	10,16	12.1	18.8
Max. tightening torque (Nm)	1	1,5	2	7
Maximum Section (mm2)	4	10	16	50

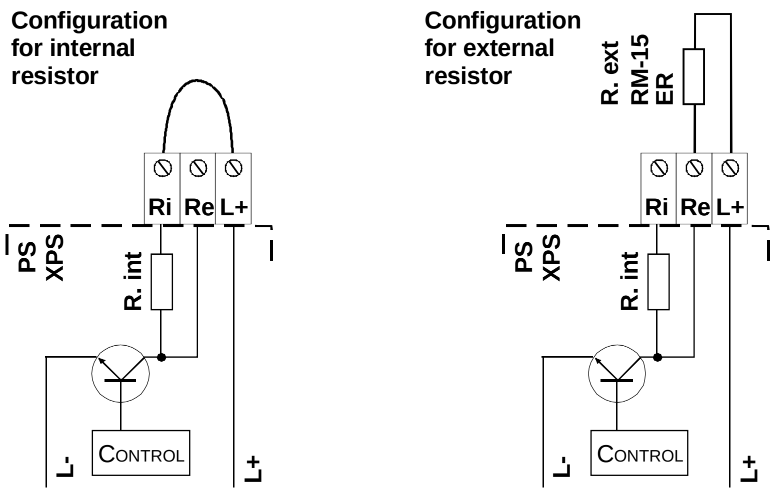
The equipment must be protected with fuses on the three-phase line L1, L2 and L3 as instructed on the chapter IN.

Terminal strip for the external Ballast Resistor.

The drive is supplied from factory with a wire jumper between terminals "Ri" and "L+". This configures the Power Supply to work with its internal Ballast resistor.

If the internal resistor cannot handle enough power, it could be set up to work with an external resistor. The following diagram shows the configuration for an external resistor.

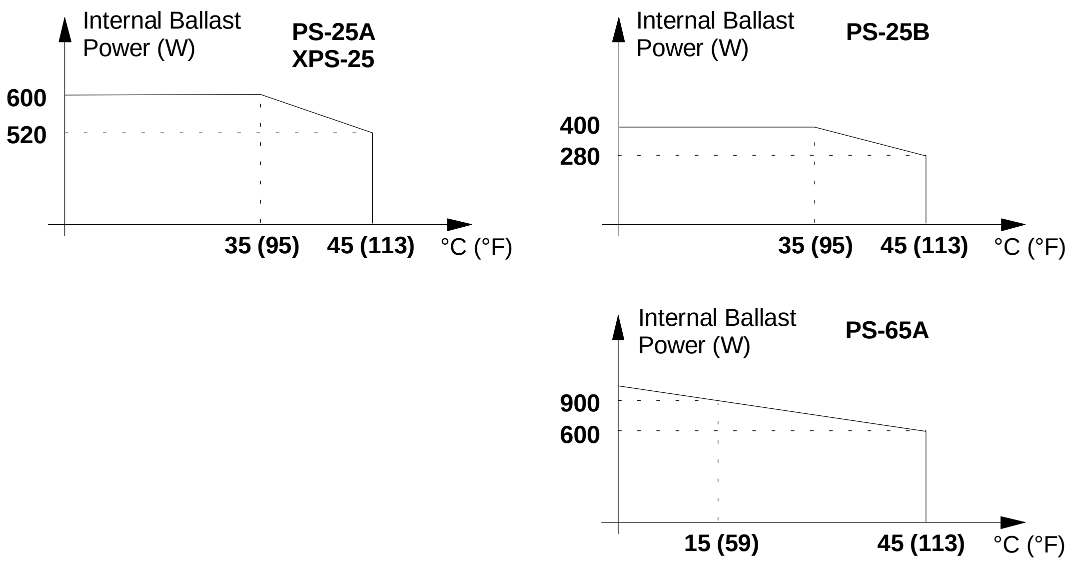
	PS-25A XPS-25 XPS-65	PS-25B PS-65A
Gap between terminals (mm)	8.1	10.16
Max. tightening torque (Nm)	1	1.5/1.7
Maximum Section (mm2)	4	10



If this jumper between "Ri" and "L+" is eliminated and no external resistor is connected, error 215 or 304 will be issued. In the case of the PS-25B module, the Power bus will not be loaded.

The power supply carries a protection against over-temperatures which triggers error 301 when reaching 105°C (221°F).

The power being dissipated by these resistors depends on the ambient temperature according to the following derating curves.



Regenerative power supplies (XPS) also have a small Ballast Circuit for dissipating energy in case of an emergency. This emergency is issued when there is no connection to Mains and the Ballast circuit activating value is exceeded (see general characteristics table).

The performance of the Ballast resistor of the XPS-65 does not suffer at high temperatures.

Connection terminals for the Power Bus

At the bottom of the module, covered by screwed on lid, there are the connection terminals for the Power Bus. This Bus supplies a DC voltage of about 600 Vdc (when the Mains voltage is 380 Vac) for the drive modules.

Two plates are supplied with each module to join the terminals of the adjacent modules. The fastening torque at these terminals must be between 2.3 and 2.8 Nm.

Fagor Power Supplies have a **Soft Start** for charging this Power Bus.

The Soft start begins when two necessary and sufficient conditions are met:

- No errors at the modules connected to that Power Supply through the internal bus (X1).
- Presence of the three phases at the input of the Power Supply module.

In the case of the PS-25B power supply, it will be enough to have all three phases of Mains

The start process begins when the "FAULT" lamp stops blinking and it is over, the "DC BUS ON" lamp comes on.

Before handling these leads, proceed in the following order:

1st Stop the motors.

2nd Disconnect the Mains voltage at the electrical cabinet.

3rd Wait, before handling these leads.
The Power Supply module needs time to decrease the voltage of the Power Bus down to safe values (< 60Vdc). The green "DC BUS ON" light off does NOT mean that it is safe to handle the Power Bus. The discharge time is about 4 minutes depending on the number of elements connected.

The Power Buses of different Power Supply Modules MUST NEVER be connected in parallel.

Inductive filter -Choke- connection terminals. (only at XPS)

The XPS-25 and XPS-65 power supplies offer the connection terminals labeled CH1 and CH2 at the bottom of the module for connecting the inductive filter. See attached table.

This inductance is a must to filter the current circulating from the Power Bus to Mains.

Fagor supplies the CHOKE XPS-25 and CHOKE XPS-65 for this application.

Use cables with the maximum section allowed (16 and 50 mm^2) and shorter than 2 meters (6 feet). They do not have to be shielded.

	CHOKE XPS-25	CHOKE XPS-65
Max. tightening torque	2 Nm	7 Nm
Maximum cable section	16 mm^2	50 mm^2

The inductance is an absolute must for the operation of a regenerative power supply.

Installing a Filter with an inductance other than the one recommended in the general characteristics table may cause severe damage to the unit.

EM.1.3.2 X1 CONNECTOR, INTERNAL BUS

Interconnects all the elements of the Servo Drive System. All the modules powered with the same Power Supply must be connected to this Bus and it is required to run it. **The Bus must <u>not</u> be disconnected while the system is running.**

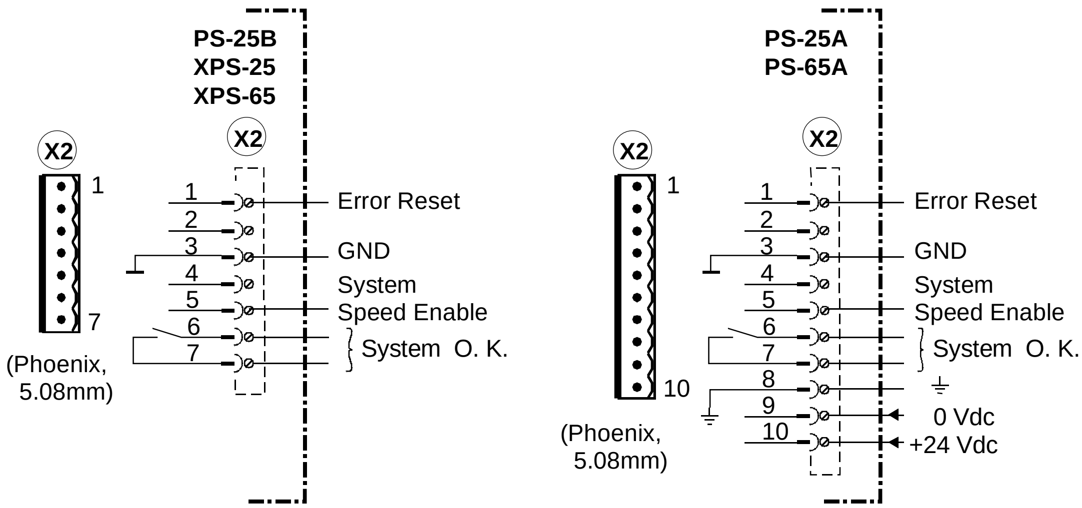
A ribbon cable is provided with each module (Power Supply or Drive) for this connection.

When using two Power Supply modules within the same Servo system, each group must carry its own internal Bus.

EM.1.3.3 X2 CONNECTOR, CONTROL

This connector is used to control the power supply module.

The internal circuits of the nonregenerative Power Supplies PS-xxA require an external 24 Vdc supply. That's why their X2 connector has three more terminals. An 1.25 Amp fuse protects the internal circuits.



1	Error Reset	System Error Reset Input (24 Vdc) (4.5 - 7 mA)
2	Not connected	
3	GND	0 Volts Reference for digital inputs Error Reset (1) and System Speed Enable (5)
4	Not connected	
5	System Speed Enable	General System Speed Enable (24 Vdc (4.5 - 7 mA))
6	System Ok	Contact indicating module estatus (Opens when fault) Limit: 1 Amp at 24 Vdc
7	System Ok	

8	CHASSIS	Chassis connection (only on PS-xxA models)
9	0 Vdc	Voltage for Control circuits (only on PS-xxA models) between 21 and 28 Vdc (maximum consumption: 1 Amp)
10	+24 Vdc	

Procedure to turn on the Power Supply module:

1. At the PS-xxA models.
   Supply 24 Vdc to the control circuits of the module through connector X2 (pins 9 and 10).

1. At the XPS and PS-25B.
   Apply power to the Auxiliary Power Supply from Mains through connector X3 (pins 2 and 3). These will power the control circuits of the module and provide 24 Vdc at connectors X4, X5 and X6.

2. The Power Supply module will check the system status.
   If not OK, it will turn on the red "FAULT" lamp.

   If the status is OK, the "System OK" contact will close (pins 6 and 7).
   This contact will stay closed while the control circuits stay under power and while no errors come up at any of the system modules.

3. Apply power to the Power Supply from Mains through the power connectors on top of the module. The soft start will begin and the red "FAULT" lamp will turn off.

4. After 4 seconds, the green “DC BUS ON” lamp will turn on indicating that the DC voltage is now available at the "Power Bus".

If an error occurs at the Power Supply module or at any Drive module it supplies to, the system will act as follows:

The green “DC BUS ON” light will go off.
The red "FAULT" light will stay on if the error is at the power supply.
The "FAULT" light will blink if the error is at some drive.
It will eliminate the voltage supply to the Power Bus (it does not eliminate the capacitors' charge).

With the <u>Error Reset</u> input (pin 1), it is possible to eliminate the errors at the drives constituting the system (See appendix B, resettable errors) and it acts as follows:

It will normally be at 0V. When activated (24V), the errors existing in the memory of each one of the system modules will be deleted.

If the cause of the error persists, the corresponding module will show it again. If the error is serious, it can only be eliminated by powering the unit down and back up.

The <u>System Speed Enable</u> input (pin 5) is related to the "Speed Enable" input of the drive modules.

"System Speed Enable", must normally be at 24 Vdc.

If the "System Speed Enable" pin is set to 0 Vdc, all servo drives connected to the power supply through the same internal Bus will brake their motors at maximum torque and once stopped or the limit time (programmable by parameter GP3) has elapsed, the motor torque is removed.

The consumption of each input is between 4.5 and 7 mA.

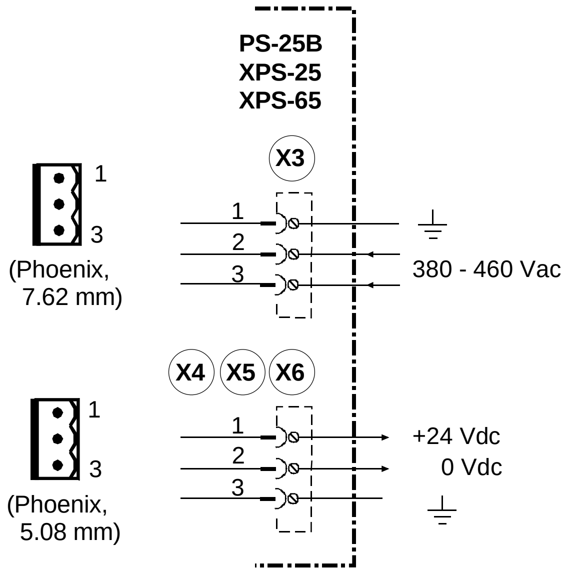
EM.1.3.4 CONNECTORS X3, X4, X5, X6 (XPS AND PS-25B)

All four connectors belong to the Auxiliary Power Supply.

X3 receives power from Mains. It admits between 380 Vac and 460 Vac.

This power supply generates 24 Vdc to feed the control circuits of the module itself.

Also, up to 8 Amps of dc voltage are supplied through X4, X5 and X6 . These three connectors are identical and offer greater connecting flexibility.



Very important:

In case of micro-surges or total loss of Mains power, this module guarantees stable and maintained 24 Vdc while the emergency braking of the motor. This is a MUST for the machine to comply with the CE seal.

EM.2 MODULAR DRIVE (AXES AND SPINDLE)

There are modular drives specific for controlling axes (synchronous motors) and the spindle (asynchronous motors).

This chapter is common to both models because their external characteristics: dimensions, connectors, etc. are the same.

EM.2.1 GENERAL CHARACTERISTICS, MODULAR DRIVES

EM.2.1.1 AXIS AND SPINDLE DRIVES

	Axis Drive (Synchronous Motors)							
	AXD 1.08	AXD 1.15	AXD 1.25	AXD 1.35	AXD 2.50	AXD 2.75	AXD 3.100	AXD 3.150
Rated current (Amp)	4	7,5	12,5	17.5	25	37,5	50	75
Maximum peak current (500ms) in cycles longer than 10 seconds	8	15	25	35	50	75	100	150

Power voltage input	456 - 800 Vdc							
Power to control circuits	24 Vdc (between 21Vdc and 28 Vdc)							
Consumption of these circuits (24Vdc)	0.9 Amps				1.25 Amps		2 Amps	
Speed feedback	Encoder / Resolver							
Controling method	PWM, sinewave AC, Vector Control							
Communication	Serial line							
Interface	Standard analog or digital via Sercos							
Status display	7 - segment display							
Protections	Over-voltage, Overcurrent, overspeed, heat sink temperature, ambient temperature, motor temperature, hardware error, overload, etc. See appendix E.							
Speed range with analog input	1:8192							
Current bandwidth	800 Hz							
Speed bandwidth	100 Hz (Depends on the motor/drive set)							
Ambient temperature	5°C / 45°C. (41°F / 113°F) From 40°C (104°F) on, see Derating tables							
Storage temperature	-20°C / +60°C (-4°F / +140°F)							
Sealing grade	IP2x							
Maximum humidity	Less than 95% (non condensing at 45°C / 113°F)							
Weight kg (lbs)	6 (13.3)				10 (22.2)		18,5 (41.1)	

Imax	5,6	10,6	19,6	28.5	35,4	53	80	106
	SPD 1.08	SPD 1.15	SPD 1.25	SPD 1.35	SPD 2.50	SPD 2.75	SPD 3.100	SPD 3.150
	Spindle Drive (Asynchronous Motors)							

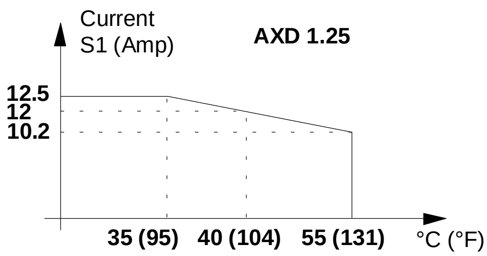
EM.2.2 DERATING OF THE MODULAR DRIVES

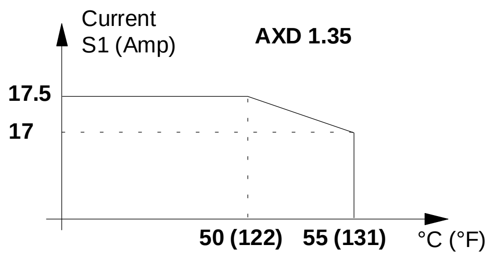
The following graphs show the maximum rms current in continuous duty cycle that the various Drive modules can provide depending on ambient temperature.

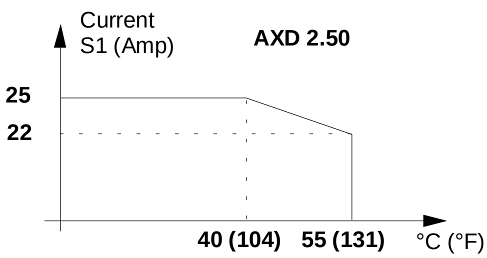
Axis drives:

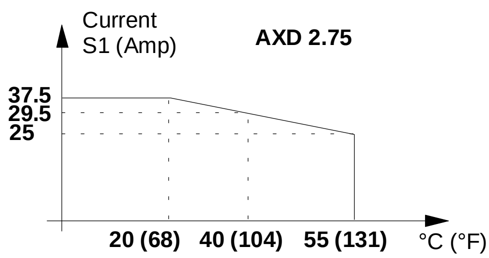
For a maximum time period of <u>0.5 seconds</u>, and always in cycles longer than <u>10 seconds,</u> they may output <u>twice the current.</u>

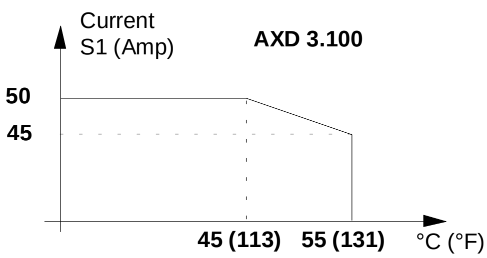
The AXD 1.08 and AXD 1.15 models, <u>maintain their best characteristics,</u> indicated in the previous table, <u>throughout the full temperature range, between 5 and 55°C (41 ºF and 131 ºF).</u>

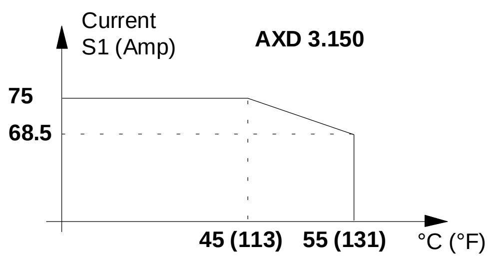








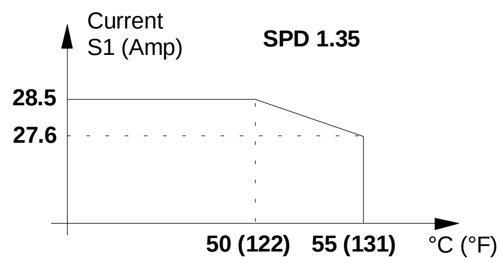


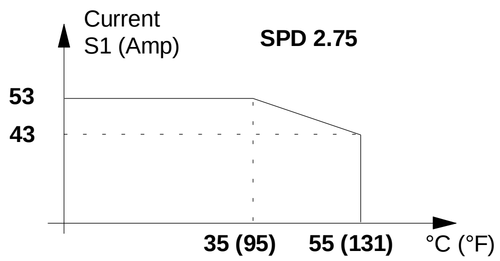


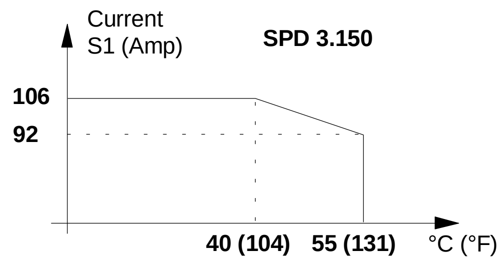
Spindle drives:

The drive can output the indicated current in any duty cycle.

Models SPD 1.08, SPD 1.15, SPD 1.25, SPD 2.50 and SPD 3.100, maintain their best characteristics, indicated in the previous table, throughout the full temperature range, between 5 and 55°C (41ºF and 131 ºF).





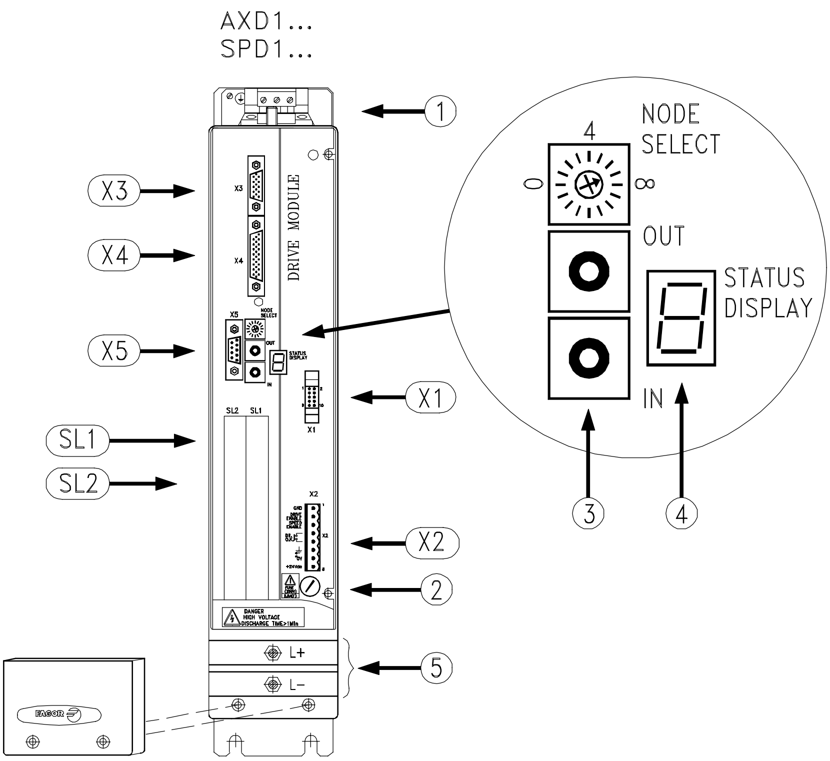


EM.2.3 CONNECTORS OF THE MODULAR DRIVE

The next figure shows the elements appearing on the front plate of the modular drive:

1) Power connectors for motor connection.
2) 2.5 Amp (F) / 250V Fast fuse.
To protect the internal control circuits.
3) Sercos Interface connectors.
4) Status Display. Shows status information for the drive itself or the relevant code when there is an error.
5) Power connectors at the bottom to power the Drive module.

X1) Connector for module interconnection through the internal BUS.
A connector is supplied with each module for connecting it to the BUS. This connection is described in detail in the section corresponding to the power supply.
If during system setup or maintenance, any module is constantly generating an error, the whole system is completely disabled. To temporarily ignore this error, disconnect the internal bus of that module and keep the other ones connected.
X2) Connector for the basic control signals.
X3) Connector with two possible uses:
- as output of the Encoder simulator.
- as input of a second feedback for the position loop.
X4) Motor speed feedback connector.
X5) Serial line connector.
SL1) Slot for cards: A1, 16DI-8DO and 8DI-16DO.
SL2) Slot for cards: 16DI-8DO and 8DI-16DO.

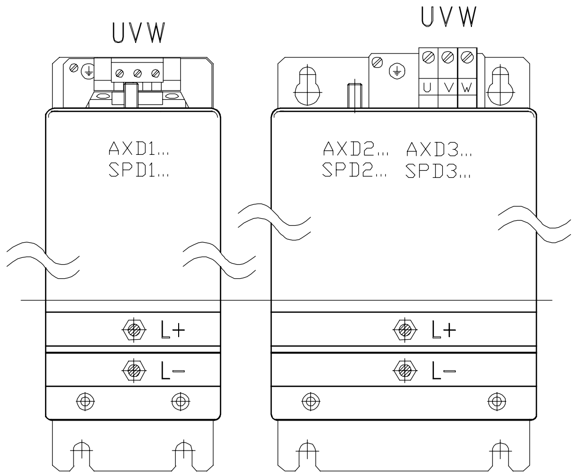


EM.2.3.1 POWER CONNECTORS

The upper connectors are for connecting the motor.
The ground connection of the cable shields is made from the vertical plate next to the connectors.

The bottom connectors correspond to the power bus input. The drive needs 456-800Vdc which can vary depending on the Mains voltage and the load. The power supply module is in charge supplying this voltage.

2 plates are supplied with each module for this connection and another one for connecting the chassis with each other.



	AXD/SPD 1.08/15	AXD/SPD 1.25	AXD/SPD 1.35	AXD2 SPD2	AXD3.100 SPD3.100	AXD3.150 SPD3.150
Gap between terminals (mm)	7.5	7.5	8.1	10.1	15.1	18.8
Max. tightening torque (Nm)	0.6	0.6	1	1.7	7	7
Maximum Section (mm2)	2.5	4	4	10	25	50

When connecting the drive module and its corresponding motor, connect terminal "U" of the drive module with the terminal corresponding to the "U" phase of the motor as well as terminals "V-V", "W-W" and "Ground-Ground".

Otherwise, it might not perform properly.
The cable must have a metal shield which must be connected to the ground terminal of the drive and NOT to that of the motor in order to comply with EEC directives.

Before handling these terminals, proceed as follows:

1st Disconnect the Mains voltage at the electrical cabinet.

2nd Wait, before handling these terminals

The power supply module takes about 4 minutes (depending on the number of elements connected) to bring the power bus voltage down to safe values (< 60Vdc). The green “DC BUS ON” light off does NOT mean that we can handle the power bus.

EM.3 COMPACT DRIVE (AXES AND SPINDLE)

The Fagor Compact Drive has its own power supply and it can be connected directly to Mains. Its behavior, functionality and parameters are the same as those of the Modular Drive.

EM.3.1 GENERAL CHARACTERISTICS

See the table on the next page,

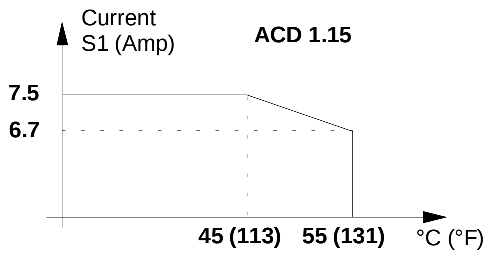
EM.3.2 DERATING, COMPACT DRIVES

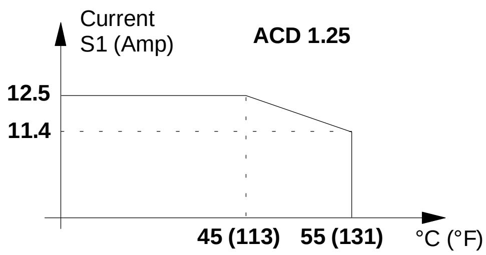
The following graphs show the maximum rms current in continuous duty cycle offered by the various compact drives depending on ambient temperature.

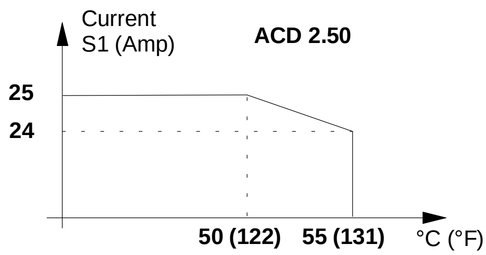
Fagor ACD 2.75 compact drives for synchronous motors offer an rms current of up to 34.7 Amps and Fagor SCD 2.75 compact drives for asynchronous motors 53 Amps.

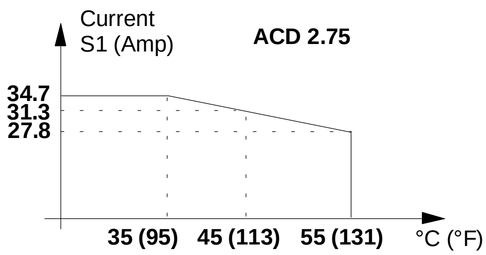
Models ACD 1.08, SCD 1.08, SCD 1.15, SCD 1.25 and SCD 2.50, maintain their best characteristics, indicated in the previous table, in the full range of temperatures between 5 °C and 55 °C (between 41 °F and 131 °F).

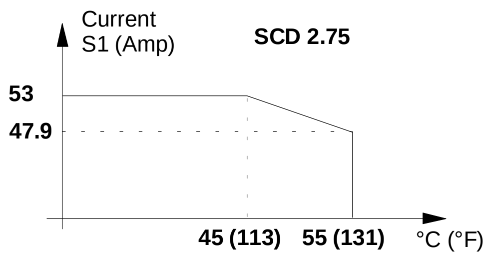
Axis Compact Drives:
They can supply twice as much current for a maximum of 0.5 seconds and always in cycles longer than 10 seconds.
Spindle Compact Drives:
The compact drive can supply the indicated current in any duty cycle.











	Axis Compact Drive (Note 1)					Spindle Compact Drive (Note 2)				
	ACD 1.08	ACD 1.15	ACD 1.25	ACD 2.50	ACD 2.75	SCD 1.08	SCD 1.15	SCD 1.25	SCD 2.50	SCD 2.75
Rated current (Amp)	4	7,5	12,5	25	37,5					
Maximum peak current for 500ms in cycles longer than 10 seconds.	8	15	25	50	75					
Maximum current in any duty (Note 3)						5,6	10,6	17,7	35,4	53
Power supply	Three-phase mains 50/60 Hz, with a voltage range between 380Vac -15%. and 460Vac + 10%									
Internal power bus voltage.	540-650- Vdc									
Filter capacity	330 µF, 800 Vdc			705 µF, 800 Vdc		330 µF, 800 Vdc			705 µF, 800 Vdc	
Energy stored in the capacitors.	$0.5 \cdot C \cdot V^2$									
Internal Ballast resistor -Ohms- (Power -W-)	82 (60)	41 (120)	23 (210)	12 (240)	8.2 (240)	82 (60)	41 (120)	23 (210)	12 (240)	8.2 (240)
Energy pulse that can be dissipated. -kWs- (Pulse duration -sec-)	1 (0.45)	2 (0.4)	3.6 (0.45)	12 (0.7)	12 (0.5)	1 (0.45)	2 (0.4)	3.6 (0.45)	12 (0.7)	12 (0.5)
Ballast circuit ON/OFF	764 Vdc / 756 Vdc									
Minimum external Ballast Res. -Ohms-	82	41	23	12	8.2	82	41	23	12	8.2
Feedback	Encoder /Resolver					Encoder				
Control method	PWM, sinewave AC, Vector Control									
Communications	Serial line to connect to a PC or to the Programming Module									
Interface	Standard analog, or digital via SERCOS									
Status display	7 - segment display									
Speed range with analog input	1:8192									
Current bandwidth	800 Hz									
Velocity bandwidth	100 Hz (Depends on the motor/drive combination)									
Protections	Overvoltage, Overcurrent, overspeed, heat-sink temperature, ambient temperature, motor temperature, Ballast temperature, Hardware error, overload. See appendix E.									

Notes:
1.- Drives for synchronous motors 2.- Drives for asynchronous motors
3.- This current must be equal to or greater than that of the corresponding spindle motor in S6.

Power for Internal circuits (24 Vdc)	
Input voltage (X1 connector)	Between 380Vac (-15%) and 460Vac (+10%); 50/60Hz
Mains consumption	160 mA (380 Vac), 130 mA (460 Vac)
Bus consumption	112 mA (540 Vdc), 92 mA (650 Vdc)
Maximum voltage at the Bus	780 Vdc
Output voltage, maximum current	24 Vdc (5%), 110 miliAmp. (X2 connector, pins 1 and 2)

Ambient conditions				
Ambient temperature	5°C / 45°C. (41°F / 113°F) From 40°C (104°F) See Derating tables			
Storage temperature	-20°C / +60°C (-4°F / +140°F)			
Maximum humidity	Less than 95% (non condensing at 45°C / 113°F)			
Vibration while running	10..60 Hz, 0.1..5 G, 2 hr			
Vibration while shipping	60..300 Hz, 5 G, 2 hr			
Sealing	IP2x			
Weight. Kg (lbs)	8.3 (18.4)	13.2 (29.3)	8.3 (18.4)	13.2 (29.3)

EM.3.3 CONNECTORS OF THE COMPACT DRIVE

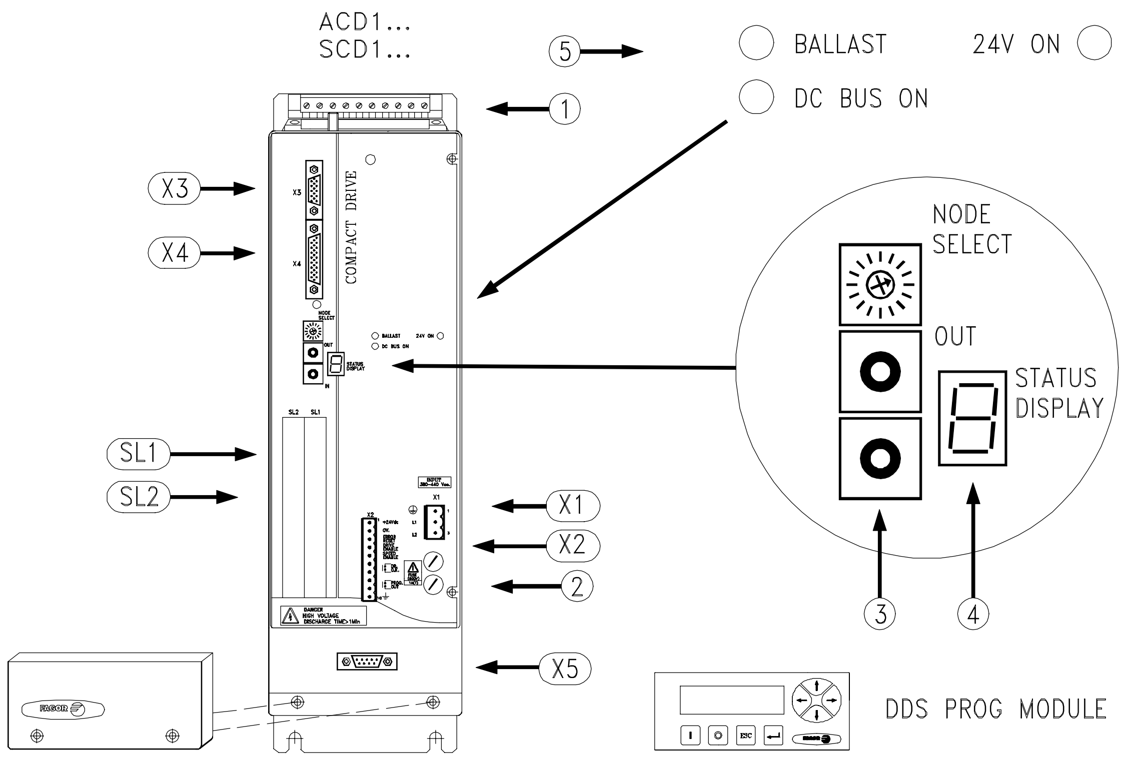
The next diagram shows the elements appearing on the front plate of the Compact Drive:

1) Power connectors for motor and mains connection. Access to the power bus.
2) Fuses to protect the internal control circuit.
Two 1 Amp (T) / 500V slow fuses on the power supply lines.
3) Sercos Interface connectors.
4) Status Display. Shows the status information of the drive itself or the corresponding error code.
5) Compact Drive Status Leds. Activation of the Ballast circuit, presence of power at the Bus and 24 Vdc available.

X1) Connector for the internal 24 Vdc power supply (two-phase 380-460 Vac).
X2) Connector for the basic control signals.
X3) Connector with two possible uses:
- as output of the Encoder simulator.
- as input of the second feedback for the position loop.

X4) Connector for the motor speed feedback. Encoder or Resolver.
X5) Serial line connector
SL1) Slot for cards: A1, 16DI-8DO and 8DI-16DO.
SL2) Slot for cards: 16DI-8DO and 8DI-16DO.

DDS PROG MODULE) Accessory for adjusting and monitoring the system, it can be mounted into the compact drive. Available upon request.

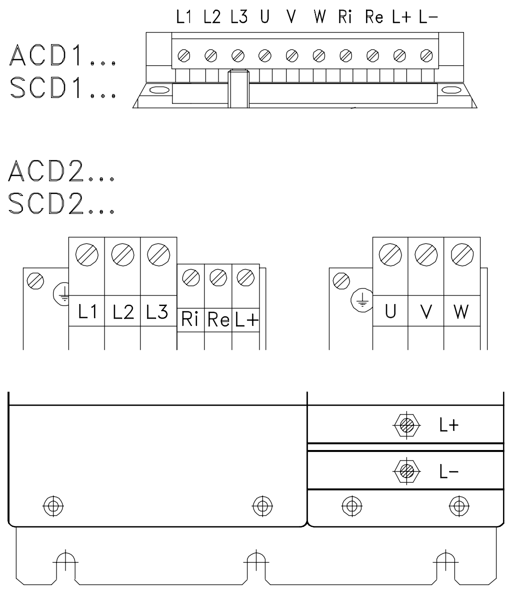


EM.3.3.1 POWER CONNECTORS

They are used for connecting the compact drive to mains (L1, L2, L3) and to the motor (U, V, W). They also have the necessary terminals for connecting an external Ballast resistor.
For the ACD1... and SCD1... type drives, this same upper connector gives access to the Power Bus (L+, L-).

The ground connection of the cable shields is made from the vertical plate next to these connectors.

The ACD2... and SCD2... provide the Bus via the lower connector like modular drives.
2 plates are provided with each module to make this connection and another one for connecting the chassis to each other.



	ACD1 SCD1	ACD2 SCD2 power	ACD2 SCD2 ballast
Gap between terminals (mm)	8.1	12.1	10.16
Max. tightening torque (Nm)	1	2	1.6
Maximum Section (mm2)	4	16	10

The equipment must be protected with fuses on the three-phase supply lines L1, L2 and L3.
Follow the instructions on the installation chapter (IN).

When connecting an external Ballast Resistor to the Compact Module, check that the ohmage of the resistor is equal to than that of the internal Ballast Resistor. See the characteristics table and the IN chapter of the installation manual. Therefore, the RM-15 MUST NOT be used with the Compact drives.

When connecting the drive module with its corresponding motor, connect Terminal "U" of the drive module with the corresponding "U" phase of the motor, same as terminals "V-V", "W-W" and "Ground-Ground".

Otherwise, it will not run properly. The cable hose must have a metallic shield which must be connected to the drive's ground terminal and not to that of the motor in order to comply with CE directives.

Before handling these terminals proceed as follows:

1st Disconnect the Mains voltage at the electrical cabinet.

2nd Wait before handling these terminals
The module needs time to bring the voltage at the power bus down to safe values (< 60Vdc). The fact that the green "DC BUS ON" light is off does not mean that it is safe to handle the power bus.
The discharge time depends on the number of elements connected to this Bus and it is approximately 4 minutes..

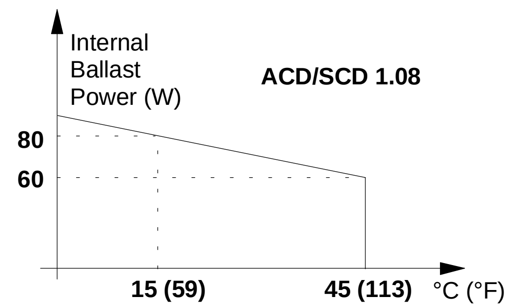
Terminals **Ri, Re, L+** are used for configuring the Ballast circuit which dissipates the energy generated when braking the motors.

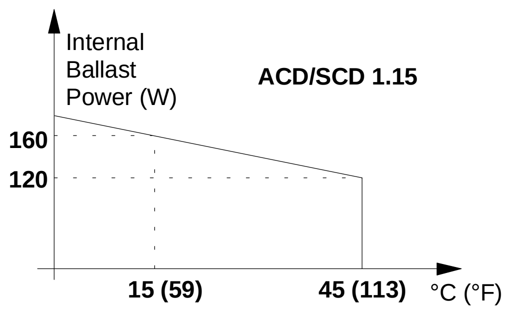
By short-circuiting the terminals (Ri, L+), the system is configured so as to work with the internal resistor of the compact drive module. Up to 45 °C (113 °F), this internal resistor dissipates the power indicated in the previous characteristics table. It also incorporates a protection against overtemperature which issues an error 301 when reaching 105 °C (221 °F).

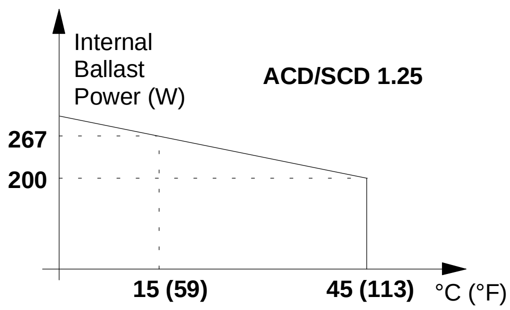
By removing this jumper (Ri, L+) an external resistor may be connected between Re and L+ which will then dissipate the energy.

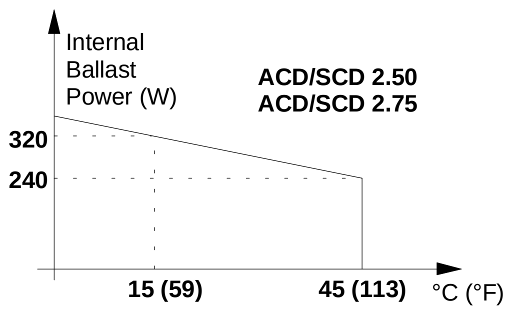
See the drawing on the next page.

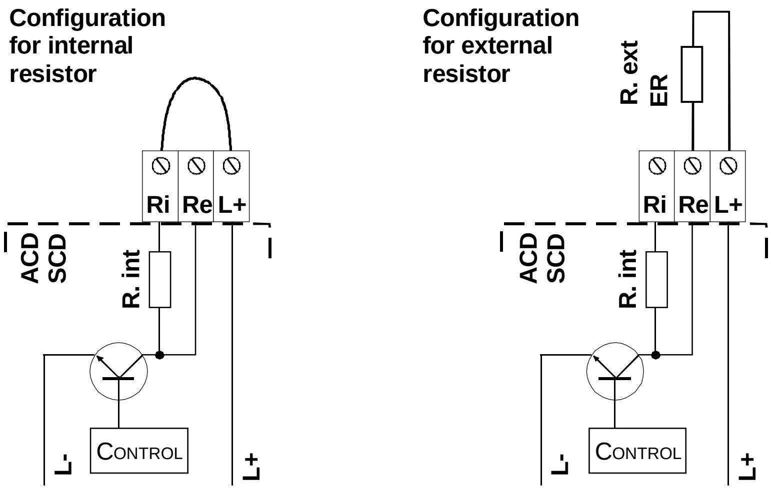
The following graphs show the power derating of the compact drives:

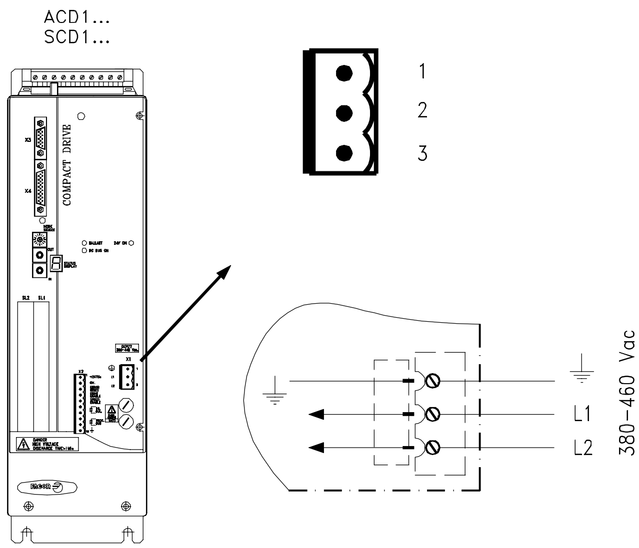












EM.3.3.2 CONNECTOR X1

Compact Drives internally generate the 24Vdc necessary for the internal circuits.
In regular operation, this voltage is obtained from the Power Bus and from mains when starting up the system.

The mains energy necessary for start-up is supplied via this three-prong Phoenix connector.

The start-up process needs an internal module test prior to supplying power to the upper terminals. Therefore, bear in mind the following warning:

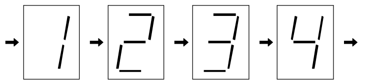
Power from this internal power supply, through this connector X1, must be the very first thing to do before any other electrical manoeuvre.
Current from mains phases to these lines L1 and L2 must be obtained from a point before the contactor providing the three-phase power to the upper connectors of the Compact Drive. See sample schematic of an electrical cabinet on chapter IN.

The Module is protected by 1 Amp fuses one per phase.

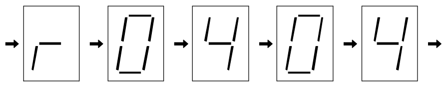
EM.4 ASPECTS COMMON TO BOTH MODULAR AND COMPACT

EM.4.1 STATUS DISPLAY

During the module start up, in order to check that all the display segments are operating correctly, this display shows the following information:



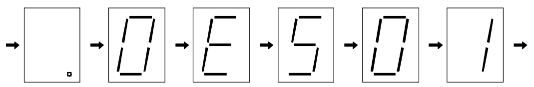
First, the display is seen completely off, and then it shows numbers 1, 2, 3 and 4 corresponding to the four initializing stages and, then, it will turn back off.



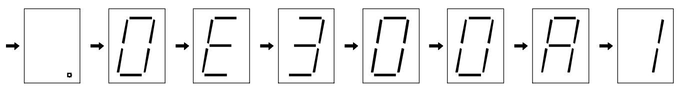
Then, the version of the software used by the module is shown. First, the letter "r" is shown (indicating the -release- version) followed by the version number (digit by digit).

When the drive is active and the axis is being governed, the display will show a zero with a blinking dot. While loading parameters, the display only shows the middle segment.

Lastly, if there are any error messages or warnings, the display shows them as indicated by these two examples. The period resets the error and warning display.



Error "501" has occurred.



Error "300", and warning "1".

See Appendix B for the meanings of errors and warnings

The system will not start running until all the errors detected at the drive have been eliminated. To eliminate these errors, their cause has to have disappeared and, then, an "Error Reset" must be carried out. This Reset may be carried out via X2(1) of the power supply module, <u>or pin X2(3) of the Compact Drive.</u>

There are errors indicated as "Non-resettable" in appendix B and they cannot be removed by this method. Those non-resettable errors can only be removed by turning the unit off and back on provided their cause has been previously eliminated.

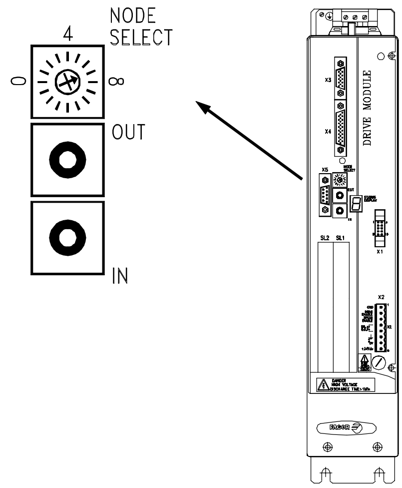
EM.4.2 SERCOS CONNECTION

The IEC 1491 SERCOS interface is an international standard for digital communications between CNCs and servo drives of CNC machines.

The Sercos communications ring integrates several functions.
It carries the velocity command from the CNC to the drive in digital format with greater accuracy and immunity against outside disturbances. It carries the feedback signal from the Drive to the CNC. It communicates the errors and manages the basic control signals of the Drive (Enables). It allows setting, monitoring and diagnosis of the parameters from the CNC with simple and standard procedures.

All this drastically reduces the hardware required at the Drive, thus, making it more reliable.

Its open and standard structure provides compatibility between CNCs and servo systems from different manufacturers on the same machine.



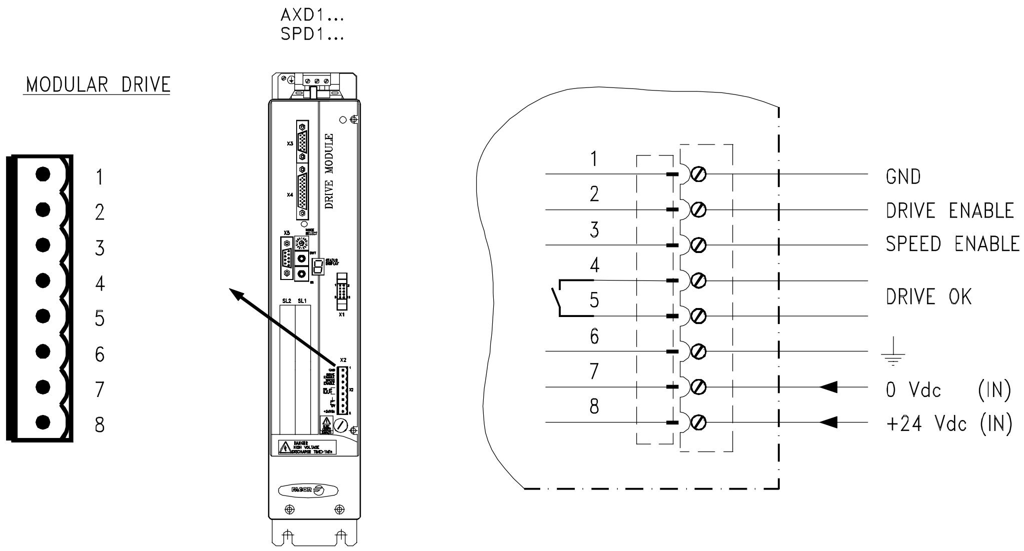
EM.4.3 CONNECTOR X2, CONTROL

Modular drive:

When the control circuit is supplied with 24 Vdc (pins 7 and 8) the drive runs an internal test. If the system is OK, it closes the module status contacts (pins 4 and 5 "Drive OK). This contact stays closed while the drive is supplied with 24 Vdc and it runs properly. To govern a motor, the drives also needs energy at the Power Bus.

The maximum internal consumption of the 24 Vdc supply input is 2 Amp for the bigger Drives. The internal circuits are protected by a 2.5Amp fuse.
See the characteristics table of the previous sections.

With the “Drive Enable” and “Speed Enable” inputs (pins 2 and 3) together with the velocity command, it is possible to govern the motor. The consumption of these control signals is between 4.5 and 7 mA. A later graph shows the behavior of the Drive depending on the “Drive Enable” and “Speed Enable” inputs



MODULAR DRIVE

1	GND	Control signals	Reference "0V" for control signals.
2	Drive Enable		Through-the-motor current enable (24Vdc)
3	Speed Enable		Drive Speed Enable (24Vdc)
4	Drive Ok	Module status contact (it opens in case of failure) Limit: 1 Amp at 24 Vdc.	
5	Drive Ok		
6	CHASSIS	Chassis connection.	
7	0 Vdc (in)	Supply input for the control circuit.	Reference "0V".
8	+ 24 Vdc (in)		Positive voltage input (21 Vdc ... 28 Vdc).

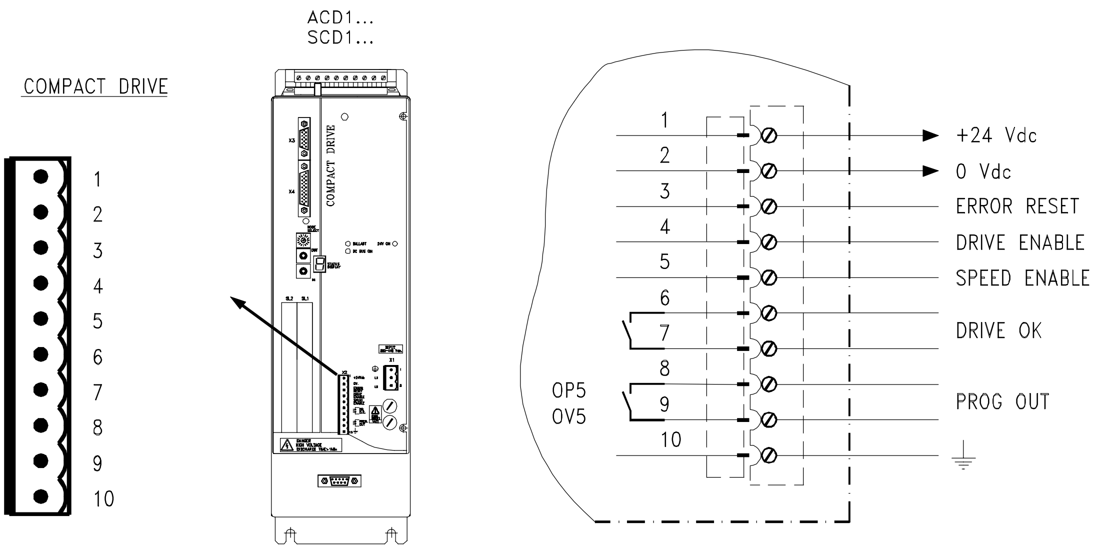
Compact Drive

Integrates specific functions of the Power Supply and modular Drives.

Specific of the Power Supply: With the Error Reset input (pin 3), it is possible to remove the errors at the compact drive (see appendix D, resettable errors). When activated, (24V) those errors are eliminated. If the cause of the error persists, the "status display" will show the error again. But if it is a major error, it can only be eliminated by powering the unit off and back on. Pins 1 and 2 offer a 24 Vdc output for the user. **The maximum output current is 100 mA.**

Specific of the modular Drive: control signals. The “Drive Enable” and “Speed Enable” inputs (pins 4 and 5) together with the velocity command govern the motor. The consumption of these control signals is between 4.5 and 7 mA. The following page describes the behavior of the drive depending on these control signals.
The “Drive OK” contact (pins 6 and 7) will stay closed as long as the compact drive runs properly.

New: The “Prog Out” contact (pins 8 and 9) is a user programmable output by means of the drive's internal parameter OP5 -F00291-. Its value may be forced with variable OV5 -F00292-.



COMPACT DRIVE

1	+ 24 Vdc (out)	Internal Power Supply output	Positive Voltage Output. (24 Vdc, 100 mA)
2	0 Vdc (out)		"0 V" Reference.
3	Error Reset	System Error Reset input. (24Vdc) (4.5-7mA)	
4	Drive Enable	Control Signals	Motor current enable. (24Vdc)
5	Speed Enable		Drive Speed Enable. (24Vdc)
6	Drive Ok	Module Status Contact (it opens in case of failure) Limit: 1 Amp at 24 Vdc.	
7	Drive Ok		
8	Prog Out	Programmable internal contact Limit: 1 Amp at 24 Vdc.	
9	Prog Out		
10	CHASSIS	Chassis connection.	

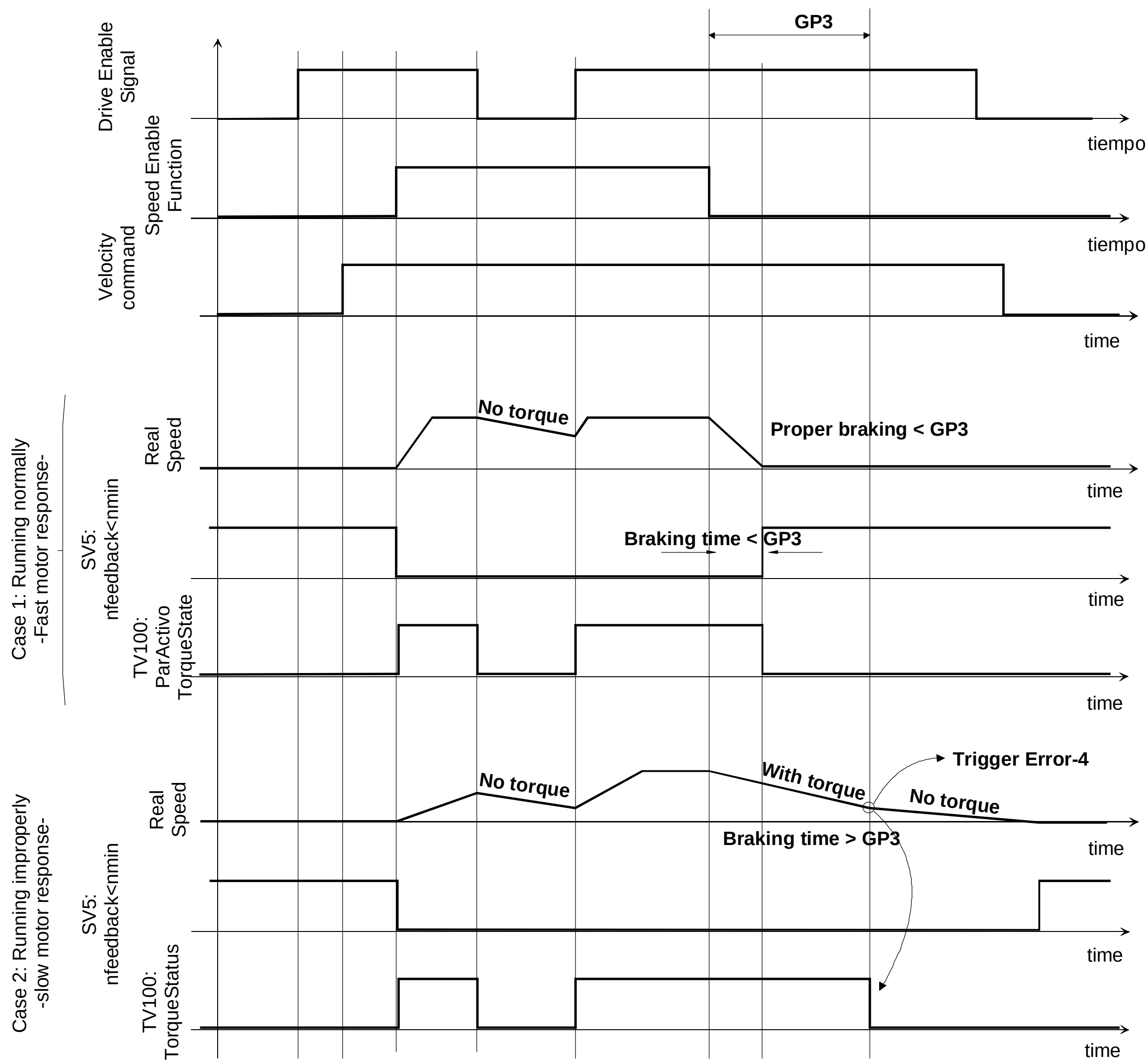
EM.4.3.1 SPEED ENABLE, DRIVE ENABLE

Normal operation mode.

1. Activate inputs “Drive Enable” and “Speed Enable”
   They may be activated in any order. Before doing so, the "Soft Start" process (smoothly reaching the power bus voltage) must be over. **The torque at the motor will only be available when Drive_Enable is active and there is voltage at the Power Bus. The motor speed will be controlled by a velocity command when Speed_Enable function is active.**

Attention: For activating the Speed_Enable function, the system MUST request it in three different ways: electrical signal at connector X2, variable BV7 -F00203- and variable DRENA of the PLC when using the Sercos interface. It could be deactivated through any of them.

2. The motor will respond to all analog command variations only while both inputs (“Drive Enable” and “Speed Enable”) are at 24 Vdc. If any of them is deactivated, the following will happen:



Deactivation of the Drive Enable input

The “Drive Enable” input (pin 2) controls the Current Loop by hardware.

When it is powered with 24 Vdc, the Current Loop is enabled and the drive can work.

If the "Drive Enable" input is set to 0 Vdc, the power circuit turns off and the motor loses its torque. In this situation the motor is no longer governed and will turn freely “stopping by friction”.

Deactivation of the "Speed Enable" function

When Speed_Enable is set to 0 Vdc, the "internal velocity command" switches to 0 rpm and:

Case 1: The Torque is kept active by braking the motor. When it stops, variable SV5 -S00331- is activated. The motor has stopped in a time period shorter than the one indicated by parameter GP3 -F00702-. The torque is canceled and the rotor is free.

Case 2: The Torque is kept active by braking the motor. The motor does not stop in a time period shorter than the one indicated by parameter GP3 -F00702-. Error-4 is issued, the torque is canceled and the rotor is free. The motor stops when its inertia runs out (by friction).

GP3 and SV5 -S00331- are internal parameters and may be consulted in Appendix A.

Safety standards (EN-60204-1) require the drive module to have a software independent input in order to always assure that the motor will stop.

The "Drive Enable" input, using only hardware, can cancel the Power Circuit leaving it deactivated.. This allows stopping even when the software fails.

In case of mains failure, the control circuit and its signals must maintain their 24 Vdc while the motors are braking.

On the Modular Drive, the 24 Vdc for supply and "Drive_Enable" activation must be provided by a power supply that can maintain it during that time. The Power Supply PS-25B, the Auxiliary Power Supply APS 24 and the Regenerative Power Supplies XPS meet this condition.

In the case of the Compact Drive, the 24 Vdc at pins 1 and 2 meets this requirement and are appropriate for managing the control signals.

EM.4.4 CONNECTOR X3

This connector offers two possible configurations:

- encoder simulator
- second feedback

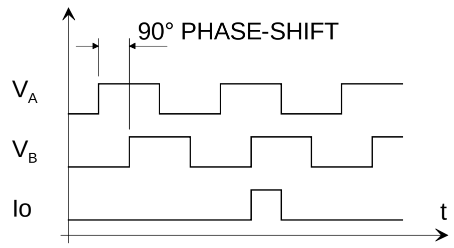
EM.4.4.1 X3, ENCODER SIMULATOR

For the simulator, X3 is a high density 15-pin SUB-D type male connector whose pins are galvanically isolated from the rest of the drive.

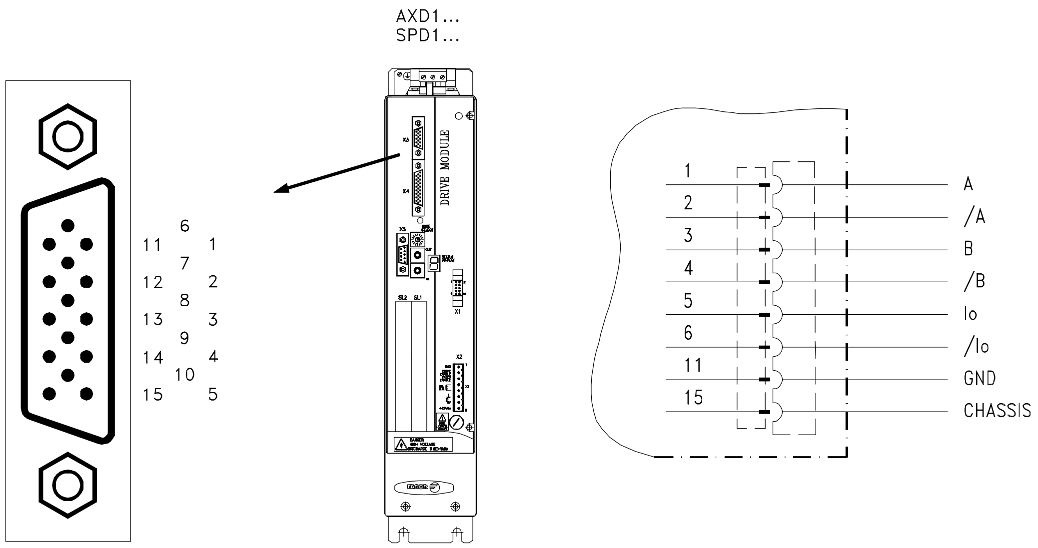
It outputs square differential TTL pulses simulating those of an encoder that would be mounted on the motor shaft.

The number of pulses per turn and the position of the reference mark "I_0" are programmable.
The parameter that set up the characteristics of this simulated encoder are:
EP1 -F00500-, EP2 -F00501-, EP3 -F00502- and EC1 -F00503-.
The setting procedure is described in the SSU chapter and the parameters in appendix A.

The connection cable for this encoder simulator is supplied with the name of SEC and it comes with a length of up to 25 meters.



$V_{OH} > 2.5$ V
$V_{OL} < 0.5$ V
$I_{SURCE} < 20$ mA
$I_{SINK} < 20$ mA



EM.4.4.2 X3, DIRECT FEEDBACK

For direct feedback, X3 is a high density 15-pin SUB-D type female connector

This connector admits three different types of feedback signals (see diagram below):

- Square TTL signals
- Square differential TTL signals (double-ended)
- 1Vpp sinewave signals

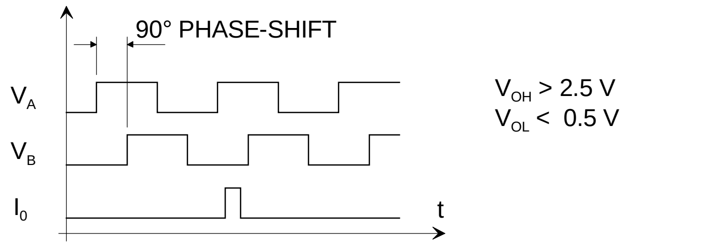
It admits the following frequencies:

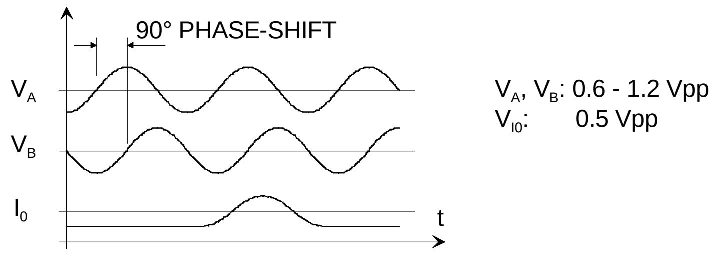
- 1 MHz with square signals
- 200 KHz with sinewave signals.

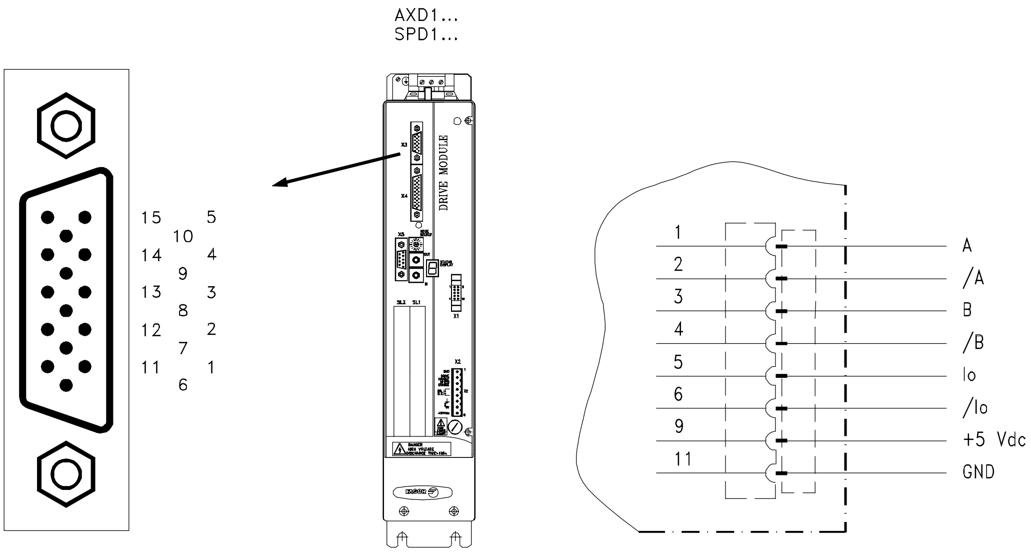
The input impedance for sinewave signals is 120 Ohms.

Software involved:

Parameters AP1 -S32-, GP10 -F719-, PP115 -S115- and NP117 -S117- identify different aspects of the direct feedback. The gear ratio between the motor and the ballscrew is indicated by NP121 -S121-, NP122 -S122- and NP123 -S123-.







EM.4.5 CONNECTOR X4, FEEDBACK

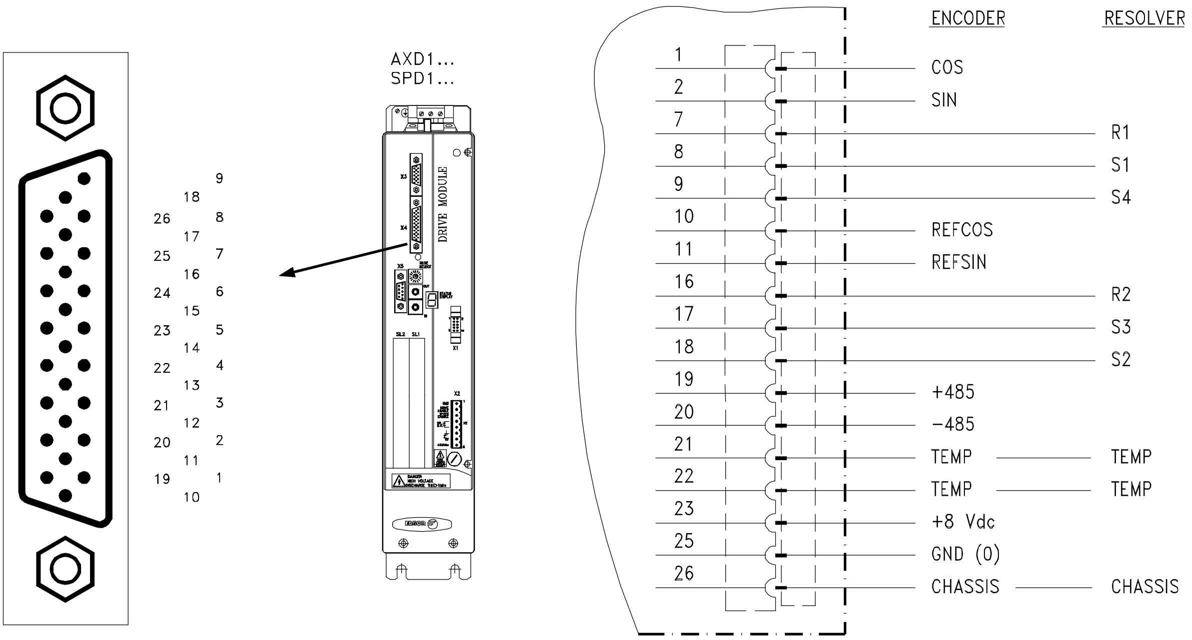
Connector X4 receives the signals coming from the feedback at the motor shaft.

The feedback on Fagor motors may be through a **sinusoidal encoder** or a **resolver**. In either case, the signals must be taken to different pins using the connection cables EEC and REC respectively.

Fagor supplies these cables with lengths of up to 25 meters.

X4 is high density 26-pin Sub-D type female connector.

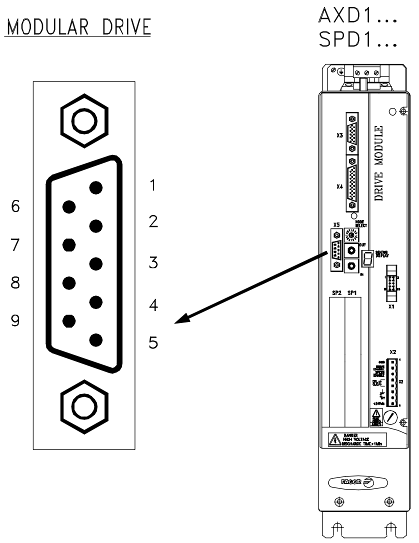
General parameter GP2 -F00701- determines the type of sensor that the rotor has. The parameter group "R" sets the features of the sensor.



EM.4.6 CONNECTOR X5, SERIAL LINE

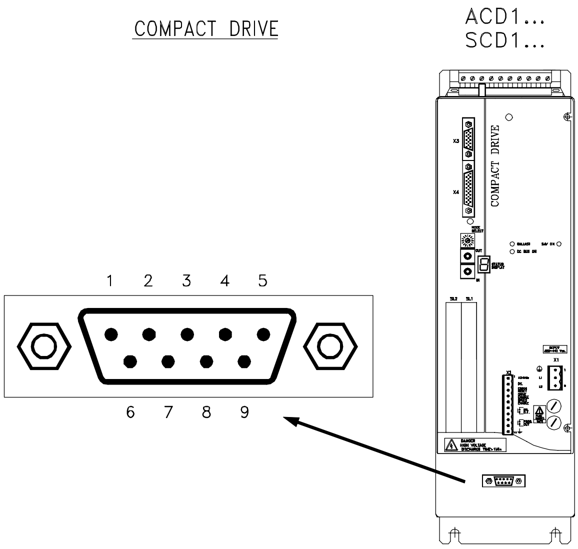
To set the configuration parameters and adjust the Drive module, it must be connected to a PC, or the Programming Module "DDS PROG MODULE".
This connection is made via connector X5.

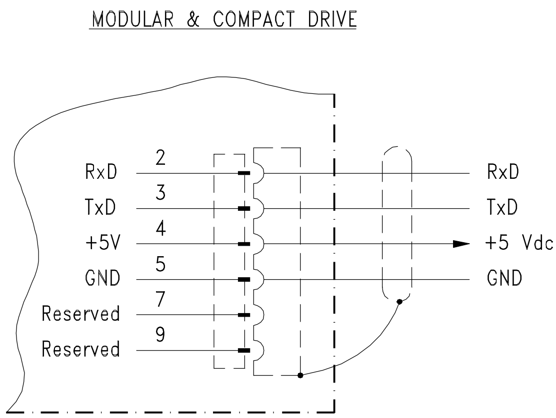
It is a 9-pin Sub-D type male connector for serial line communications.
It also offers the 5Vdc supply for the Programming Module.



1		Not connected
2	RxD	Receive data
3	TxD	Transmit data
4	+5V	Supply output
5	GND	Zero volts Reference
6		Not connected
7		Reserved*
8		Not connected
9		Reserved*
Chassis	Chassis	Cable shield

* Reserved pins musn't be connected to anything.





EM.4.7 CONNECTORS AT SL1 AND SL2

EM.4.7.1 A1 card

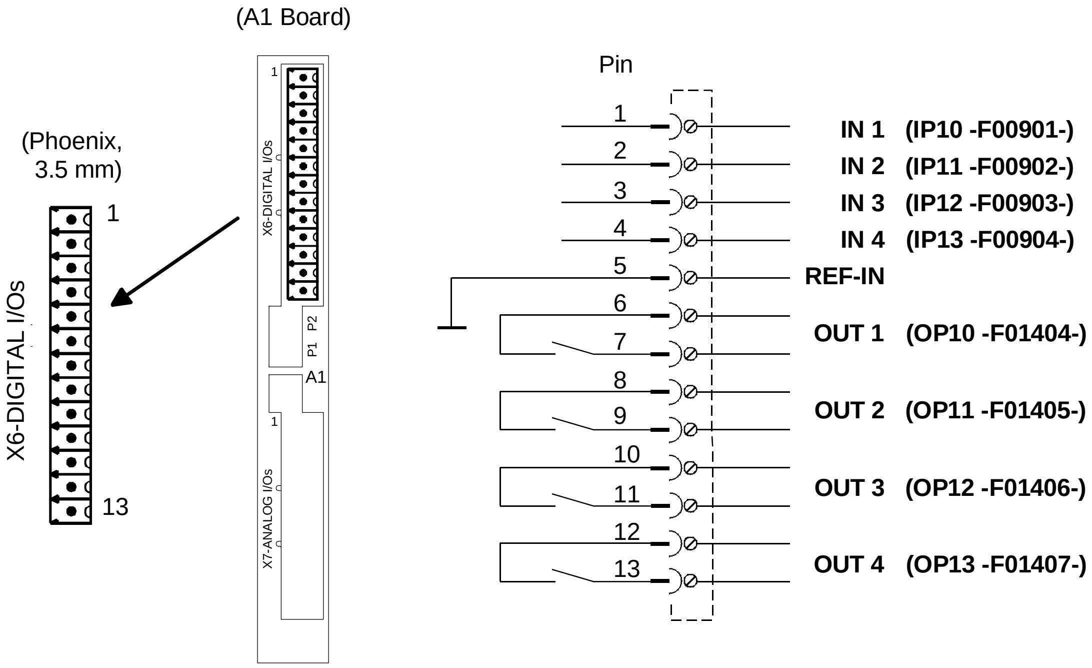
The A1 card must always be in **SL1**.

X6, digital inputs and outputs

It offers four digital inputs and four digital outputs, all of them fully programmable.
The digital inputs are optocoupled and referred to a common point (pin 5).
The digital outputs are contact type and also optocoupled.

Each input and output is associated with a parameter as shown in the diagram.

The operator may assign internal boolean type variables to these parameters (for example: SV3 -S00332-, SV5 -S00331-, TV10 -S00333-, etc.) in order to indicate the system status through electrical contacts. These variables are set by means of the monitoring program for PC or through the DDS PROG MODULE.



Digital Inputs Characteristics:

Nominal voltage (maximum)	24 Vdc (36 Vdc)
Turn-on/off Input voltage	18 Vdc / 5 Vdc
Typical consumption (maximum)	5 mA (7 mA)

Digital Outputs Characteristics:

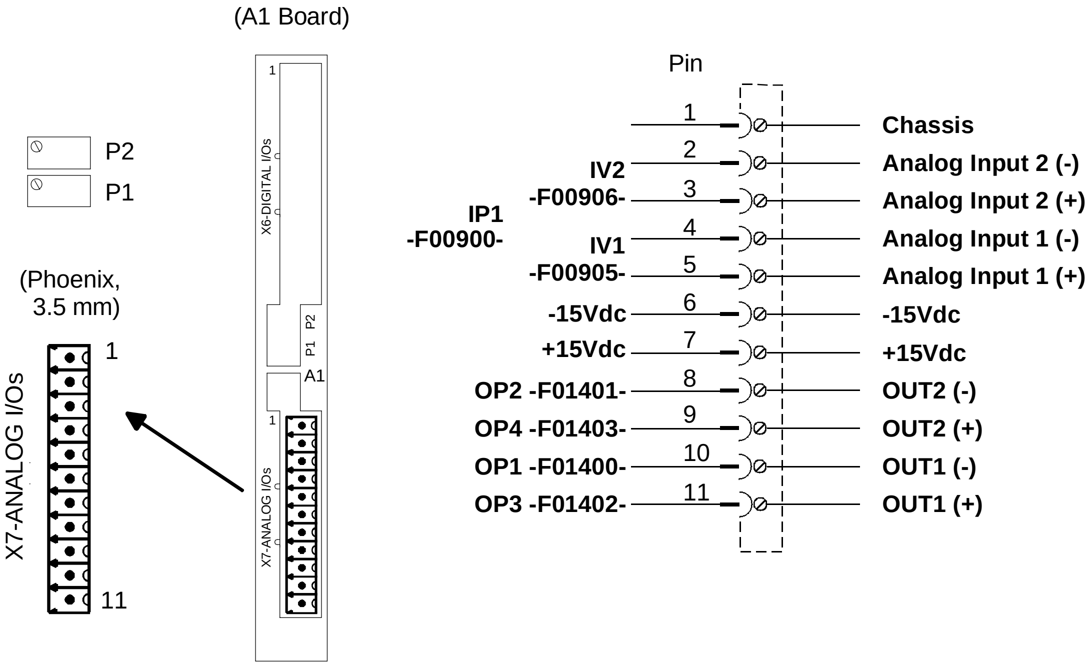
Maximum voltage	250 Volts
Maximum load current (peak)	150 mA (500 mA)
Maximum internal resistance	24 Ohms
Galvanic isolation voltage	3750 Volts (1 min)

X7, analog inputs and outputs

It offers two inputs and two outputs, all of them fully programmable.

Each input and output is associated with certain parameters as indicated in the drawing.

It offers a ±15V power supply for easily generating the command.



1	Chassis
2	Analog input 2 (-)
3	Analog input 2 (+)
4	Analog input 1 (-)
5	Analog input 1 (+)
6	- 15Vdc output for adjustment (User)
7	+15Vdc output for adjustment (User)
8	Reference for Analog output 2 (-)
9	Analog output 2 (+)
10	Reference for Analog output 1 (-)
11	Analog output 1 (+)

Analog input 1 (pins 4 and 5)

It is the usual input for the velocity command (±10Vdc) generated by the CNC.

The initial offset adjustment is made through parameter **SP30 -F01603-**.
Later adjustments may be made with potentiometer **P1.**

Analog input 2 (pins 2 and 3)

This is an input for an auxiliary command.

The initial offset adjustment is made through parameter **SP31 -F01604-**.
Later adjustments may be made with potentiometer **P2.**

Variables IV1 -F00905- AnalogInput1 and IV2 -F00906- AnalogInput2 register the value of these analog inputs at all times. Parameter IP1 -F00900- selects which of these inputs is considered by the drive as its velocity command.

Parameter **SP20 -F00031-** and **SP21 -F00081-** set the relationship between the voltage applied at the input and the velocity command it corresponds to. See chapter SSU.

Analog Inputs Characteristics:

Resolution		1.22 mV
Input voltage range		±10 Vdc
Input Overvoltage	Continuous mode	80 Vdc
	Transients	250 Vdc
Input Impedance	With respect to GND	40 KOhms
	Between both inputs	80 KOhms
Voltage in common mode		20 Vdc

Dip-Switches.

The status of the Dip-Switch (DS1, DS2) MUST NOT be changed by the operator.

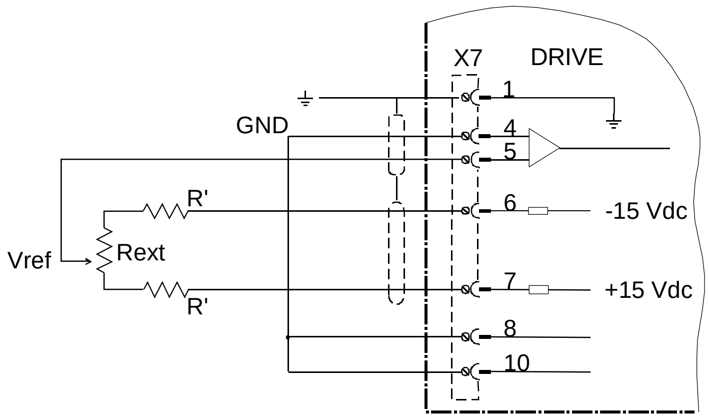
Adjustment outputs (pins 6 and 7)

With these outputs and a potentiometer, the user can obtain a variable analog voltage for adjusting the servo system during setup. The voltage, with no load, at these pins is ±15 Vdc.

The figure below shows the electrical circuit necessary to obtain the reference voltage. The table next to it shows the resistor values recommended for a **Vref** voltage range of about ±10 Vdc.

±10 Volt Range

Rext	=>	R'
1 KOhms	=>	0 Ohms
5 KOhms	=>	820 Ohms
10 KOhms	=>	1.8 KOhms
20 KOhms	=>	3.3 KOhms



Analog outputs (pins 8-9 and 10-11)

These outputs provide the status of the two internal system variables with an analog value. They are especially designed to be connected to an oscilloscope and facilitate system setup or to continuously monitor those internal variables.

Note: If the output current is high, the voltage range may decrease.

The parameters controlling these analog outputs are OP1 -F01400-, OP2 -F01401-, OP3 -F01402- and OP4 -F01403-. The internal variables (speed reference, Actual speed, torque, etc.) that can be associated with each one of the outputs are set by means of the monitor program for PC-Windows supplied by Fagor: "DDS-SETUP". See chapter SSU.

Analog Outputs Characteristics

Resolution	4.88 mV
Voltage range	±10 Vdc
Maximum current	±15 mA
Impedance (respect to GND)	112 Ohms

EM.4.7.2 Cards 8DI-16DO and 16DI-8DO

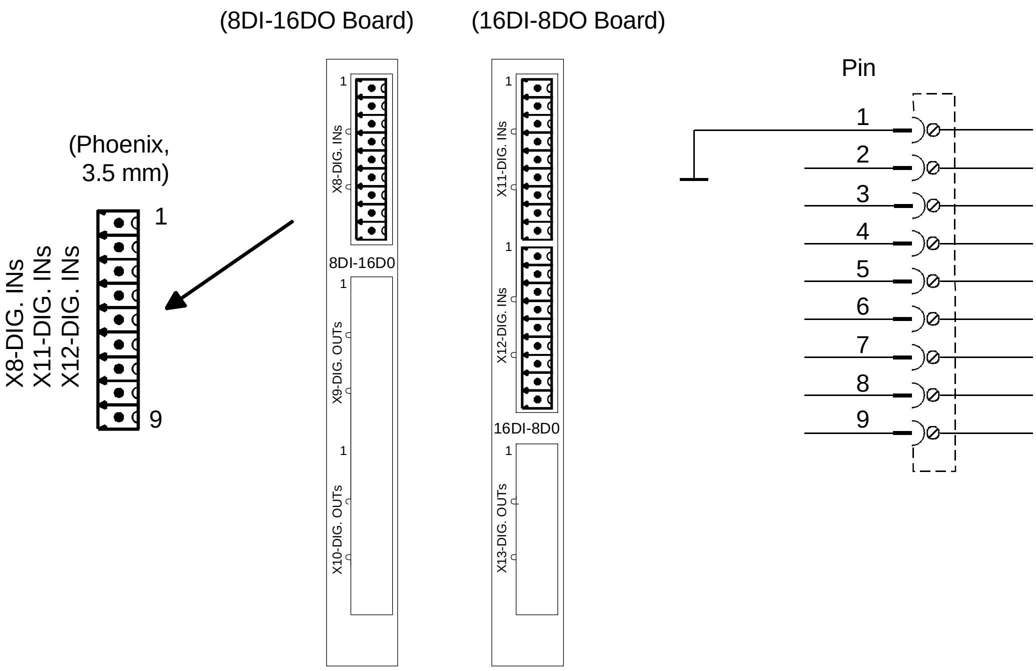
These cards may be located in **SL1** and/or **SL2**.

- 8I-16O offers to the user eight digital inputs and sixteen outputs.
- 16I-8O offers to the user sixteen digital inputs and eight outputs.

X8, X11, X12, digital inputs

They offer eight fully programmable digital inputs.
The digital inputs are optocoupled and referred to a common point (pin 1) and they admit digital signals at **5 Vdc** or at **24 Vdc**. The four least significant bits of parameter IP5 -F00909- DigitalInputsVoltage determine this configuration for the input voltage.

Each input is associated with a PLC resource.

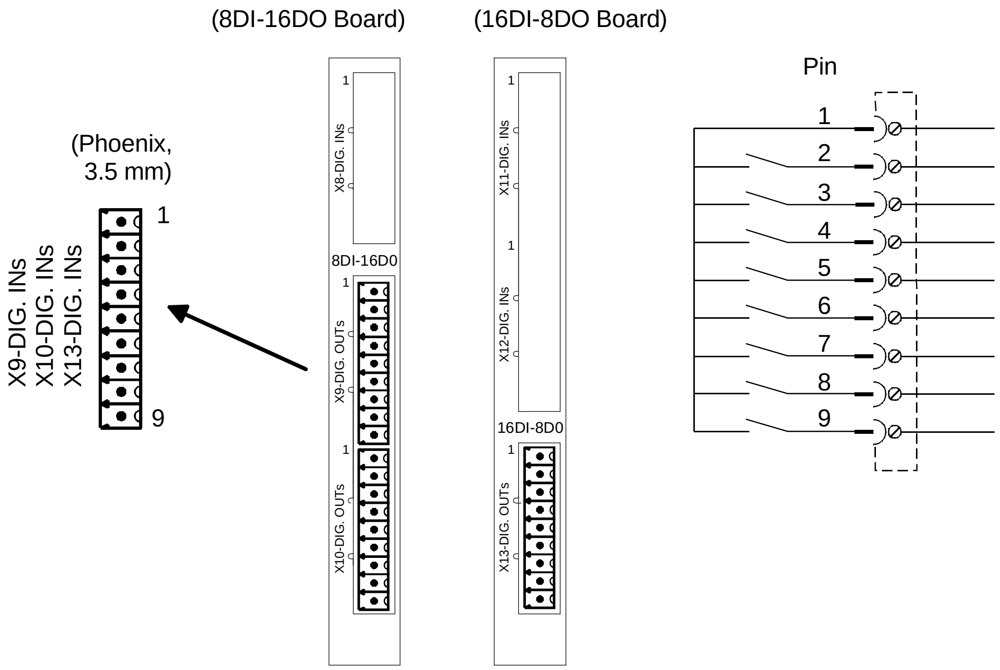


Digital inputs characteristics. Configuration:	5 V	24 V
Rated voltage (maximum)	5 Vdc (40 Vdc)	24 Vdc (40 Vdc)
Turn-on/off Input voltage	2.6 Vdc / 1.4 Vdc	12 Vdc / 6 Vdc
Typical consumption (maximum)	3 mA (5 mA)	5 mA (7 mA)

X9, X10, X13, digital outputs.

They offer eight fully programmable digital outputs.
These outputs are optocoupled and of the contact type referred to a common point (pin 1).

Each output is associated with a PLC resource.



Digital outputs characteristics:

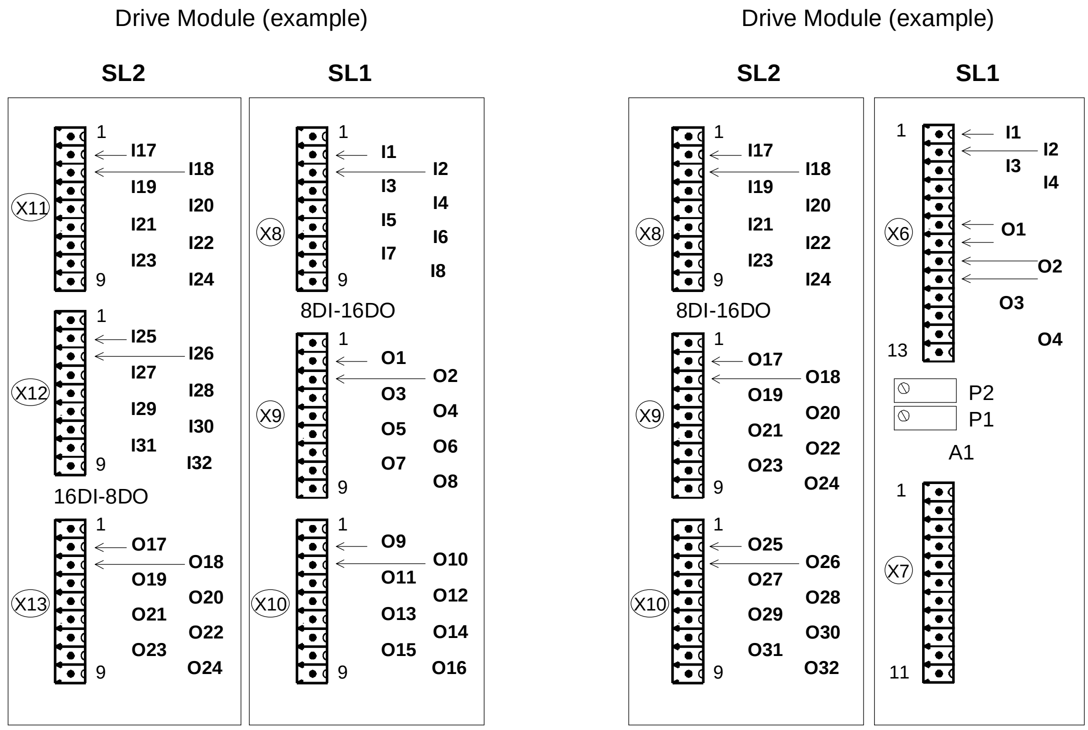
Maximum voltage	250 Volts
Maximum load current	150 mA
Current selflimitation	200 mA
Maximum internal resistance	20 Ohms
Galvanic isolation voltage	3750 Volts (1 min)

EM.4.7.3 Numbering of the PLC resources on the cards

Inserting the cards in slots SL1 and SL2 permits all the possible combinations except for two A1 type cards.

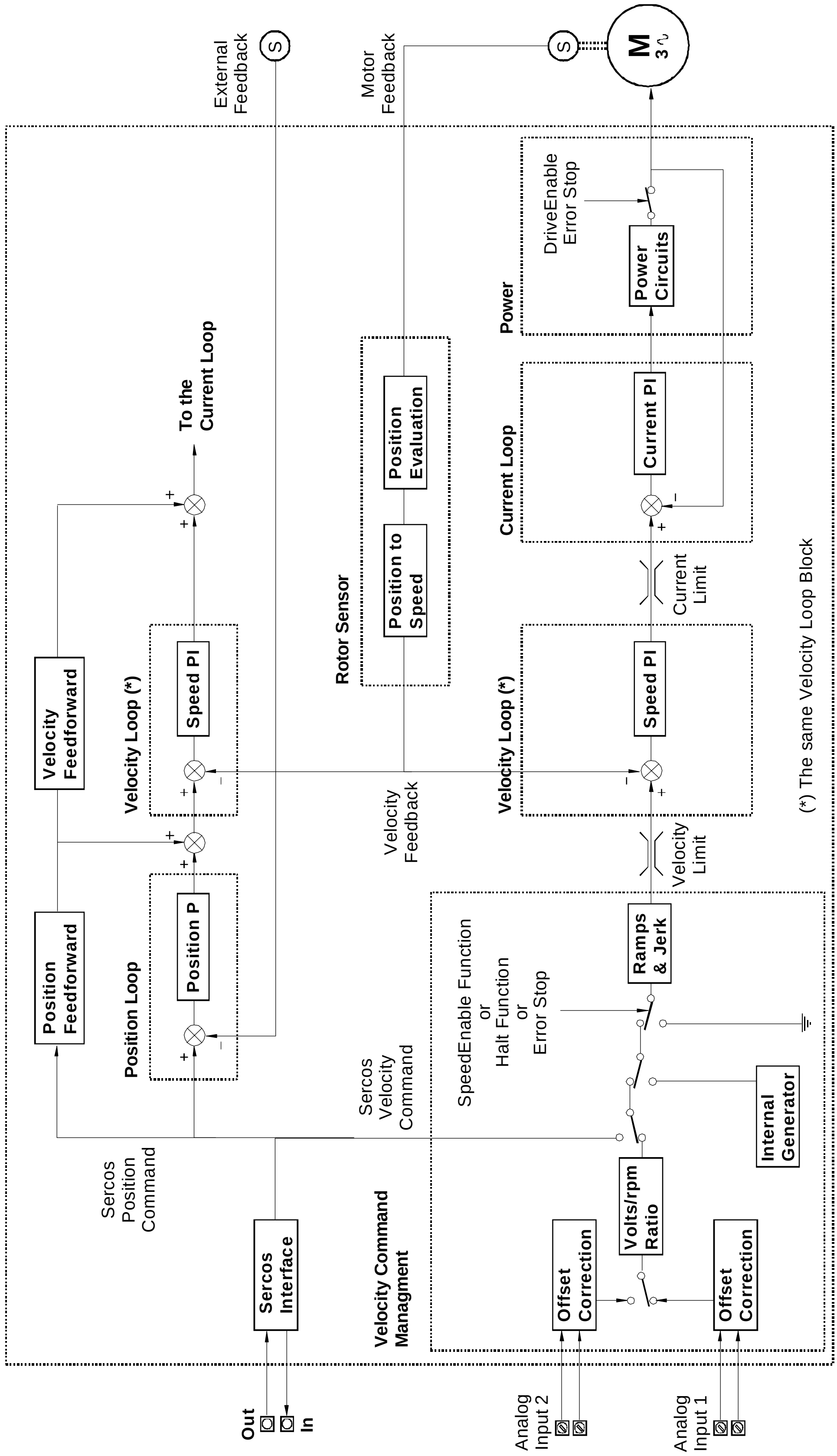
At the PLC, the input/output resources can be named according to their location in SL1 and/or SL2:

- The card inserted in slot SL1 numbers the pins from I1 and O1 on.
- The card inserted in slot SL2 numbers the pins from I17 and O17 on.
- The resources are numbered from top to bottom.



EM.4.8 INTERNAL CONFIGURATION

The following graphic is the internal diagram of the drive consisting of four basic blocks which are: Position loop, Velocity loop, Current loop and Rotor Sensor processing.



EM.5 MAINS FILTER, EMK

In order to comply with **European Directive 89/336/CE on Electromagnetic Compatibility**, a Mains Filter **EMK** must be mounted between mains and the Drive system (modular or compact).

It softens the conducted disturbances emitted by the Drive (within the levels specified by the European norm), and it also makes it immune to fast transients or voltage pulses.

	EMK 3040	EMK 3120
Rated voltage	480 Vac (50/60 Hz)	
Rated current	40 Amps	120 Amps
Aproximated weight	2.3 Kg (5 lbs)	11 Kg (24.2 lbs)
Rated leaking current	0.5 mA	0.75 mA
Maximum leaking current	27 mA	130 mA
Power loss	30 W	45 W

Characteristics of the connection terminals.

	EMK 3040	EMK 3120
Gap between terminals (mm)	10.1	15.1
Max. tightening torque (Nm)	1.7	7
Maximum Section (mm2)	10	25

The last section of this chapter describes the mechanical dimensions.

The filter must be placed near the Drive system. IN chapter describes the installation rules that must be strictly followed.

EM.6 CHOKE FOR AN "XPS" POWER SUPPLY

When returning power to Mains, the impedance of Mains for the outgoing current is very low. Thus, the up ramps of this current must be limited with a choke.

This choke is installed in the circuit in series with the returning line from the power bus to mains. To do this, it must be connected to the bottom power terminals of the XPS.

The internal switching mechanism of the XPS generates a regenerative current to Mains which is filtered by this choke.

Fagor supplies the chokes that the XPS power supplies necessarily come with.
The following table shows the characteristics of these chokes.

The last section of this chapter describes the mechanical dimensions.

	CHOKE XPS-25	CHOKE XPS-65
Inductance (10kHz)	0.35 mH	0.35 mH
Rated current	50 Amp	120 Amp
Peak current	100 Amp	150 Amp
Max. section cable	10 mm^2	50 mm^2
Operating ambient temperature	5°C - 45°C (41°F - 113°F)	
Storage temperature-	-25°C - 60°C (-13°F - 140°F)	
Relative humidity	80% max.	
Operating vibration	10..60 Hz, 0.1..5 G, 2 hr	
Shipping vibration	60..300 Hz, 5 G, 2 hr	
Sealing	IP20	
Weight	8 Kg (17.6 lbs)	23 Kg (50.6 lbs)

The use of these Chokes IS A MUST for the proper operation of the XPS regenerative power supplies.

The length of the cable joining the choke with the power supply must never exceed 2 meters.

EM.7 RESISTOR MODULES: RM-15, ER.

These modules are designed for dissipating the energy excess at the Power Bus when requiring a Ballast resistor with greater power than can be dissipated inside the Power Supply module. They do not need an external power supply.

<u>Stackable module RM-15.</u>

The module can be mounted on either side and it has a safety thermal switch. Next, the general characteristics of the module are described, its derating graph and the power connector data.

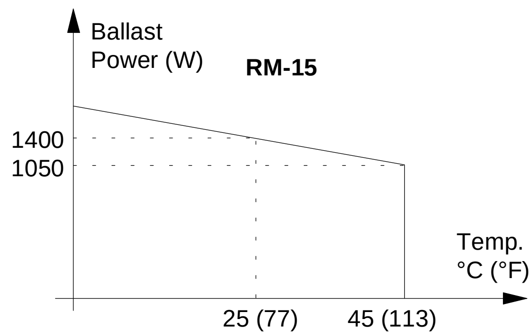
The last section of this chapter shows the <u>module dimensions</u>.

The PS-65A and XPS-65 must be connected to two RM-15 modules in parallel. The PS-25A, PS-25B and XPS-25 must be connected to a single RM-15 module.
The Compact Drives <u>must never be connected</u> to an only RM-15.

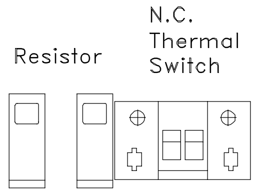
	RM-15
Resistance	18 Ohms
RMS Power	1480 Watios
Peak Energy	72 kWs (1.2 sec)

Operating ambient temperature	5°C - 45°C (41°F - 113°F) (*)
Thermal switch	Klixon NC, 140°C (284°F)
Storage temperature	-20°C - 60°C (-4°F - 140°F)
Relative Humidity	95% non condensing at 45°C (113°F)
Running vibration	10..60 Hz, 0.1..5 G, 2 hr
Shipping vibration	60..300 Hz, 5 G, 2 hr
Sealing	IP2x
Weight	4.6 Kg (10.12 lbs)

(*) It may reach 55°C (131°F) but with a 15W/°C reduction in dissipated power.



	RM-15 Power
Gap between terminals (mm)	8.1
Max. tightening torque (Nm)	1
Maximum Section (mm2)	4



Independent resistors ER.

They are electrical resistors which may also be applied to the Compact Drives.

Here below may be found the general characteristics of these three models.

The last section of this chapter indicates their dimensions:

	ER-43/350	ER-24/750	ER-18/1100
Resistance	43 Ohms	24 Ohms	18 Ohms
RMS Power	300 Watts	650 Watts	950 Watts
Peak Energy	50 kWs (1 sec)	100 kWs (1 sec)	150 kWs (1 sec)

Operating ambient temperature	5°C - 45°C (41°F - 113°F)		
Storage temperature	-20°C - 60°C (-4°F - 140°F)		
Relative Humidity	95% non condensing at 45°C (113°F)		
Running vibration	10..60 Hz, 0.1..5 G, 2 hr		
Shipping vibration	60..300 Hz, 5 G, 2 hr		
Sealing	IP55		
Weight	460 gr (1.01 lbs)	920 gr (2.02 lbs)	1250 gr (2.75 lbs)

The rms power data is given for the following conditions: The resistor is mounted vertically, with the connection cables at the bottom and separated at least 10 cm from the closest surface.

The resistor surface may sometimes reach 375 °C (707 °F).

Ohmage.

The following table indicates how to combine resistors RM-15 and ER to obtain the Ohm value required for each Power Supply and compact module.

PS-25x, XPS-25	18 Ohms	1.5 kW	RM-15
		950 W	ER-18/1100
PS-65A, XPS-65	9 Ohms	3 kW	RM-15 // RM-15
		1.9 kW	ER-18/1100 // ER-18/1100
SCD/ACD 1.15	41 Ohms	300 W	ER-43/350
SCD/ACD 1.25	24 Ohms	650 W	ER-24/750
SCD/ACD 2.50	12 Ohms	1.3 kW	ER-24/750 // ER-24/750
SCD/ACD 2.75	9 Ohms	3 kW	RM-15 // RM-15
		1.9 kW	ER-18/1100 // ER-18/1100

EM.8 CAPACITOR MODULE, CM-60

This module stores the energy returned while the motors are braking. Also, in systems sporadically demanding great peak currents from the power bus, it is recommended to install the capacitor module improving the capacity of the bus itself.

This module is connected in parallel to the power bus. Energy wise, it is more efficient than the Resistor module.

Two plates are provided with each module for connecting it to the Power Bus.

The last section of this chapter shows the module dimensions.

	CM-60
Capacity	4 mF
Maximum Bus voltage	797 Vdc
Operating ambient temperature	5°C - 45°C (41°F - 113°F)
Storage temperature-	-20°C a 60°C (-4°F - 140°F)
Relative humidity	95% non condensating at 45°C (113°F)
Operating vibration	10..60 Hz, 0.1..5 G, 2 hr
Shipping vibration	60..300 Hz, 5 G, 2 hr
Sealing	IP2x
Weight	8.6 Kg (18.92 lbf)

EM.9 AUXILIARY POWER SUPPLY MODULE, APS 24

The purpose of this module is to generate the 24 Vdc needed by the power supply and drive modules to power the control circuits. This voltage is supplied through three identical connectors connected in parallel.

The APS 24 includes protections against overcurrent and overvoltage both at the input and at the output.

Using this Power Supply makes no sense in the case of Compact drives or XPS Power Supplies, since they already offer these features.

The last section of this chapter shows the module dimensions.

	APS 24
Output voltage, maximum current	24 Vdc (5%), 10 Amp.
Input voltage -Singlephase-	380Vac (-15%) - 460Vac (+10%) 50/60Hz
Mains consumption	0.75 Amp (380 Vac) 0.63 Amp (460 Vac)
Maximum inrush current	23.9 Amp (460 Vac)
Bus consumption	0.5 Amp (540 Vdc) 0.44 Amp (650 Vdc)
Maximum Bus voltage	790 Vdc
Operating temperature	5°C - 45°C (41°F - 113°F)
Storage temperature	-20°C - 60°C (-4°F - 140°F)
Relative humidity	95% non condensing at 45°C (113°F)
Operating vibration	10..60 Hz, 0.1..5 G, 2 hr
Shipping vibration	60..300 Hz, 5 G, 2 hr
Sealing	IP2x
Weight	4.3 Kg (9.46 lbf)

Conversion table

Metric →	to →	Imperial
mm	÷ 25.4	inch
$Kg{\cdot}m^2$	÷ 0.113	$lb{\cdot}in{\cdot}sec^2$
Nm	÷ 0.113	lb·in
°C	x 1.8 → + 32	°F
Kw	÷ 0.746	HP

Very important: In case of microsurges or total mains power outage, this module guarantees the stability of the 24 Vdc for as long as the emergency stop of the motors lasts. This is an absolute must in order to comply with the "CE" requirement for the machine.

This auxiliary power supply has three LEDs to indicate the operating status.

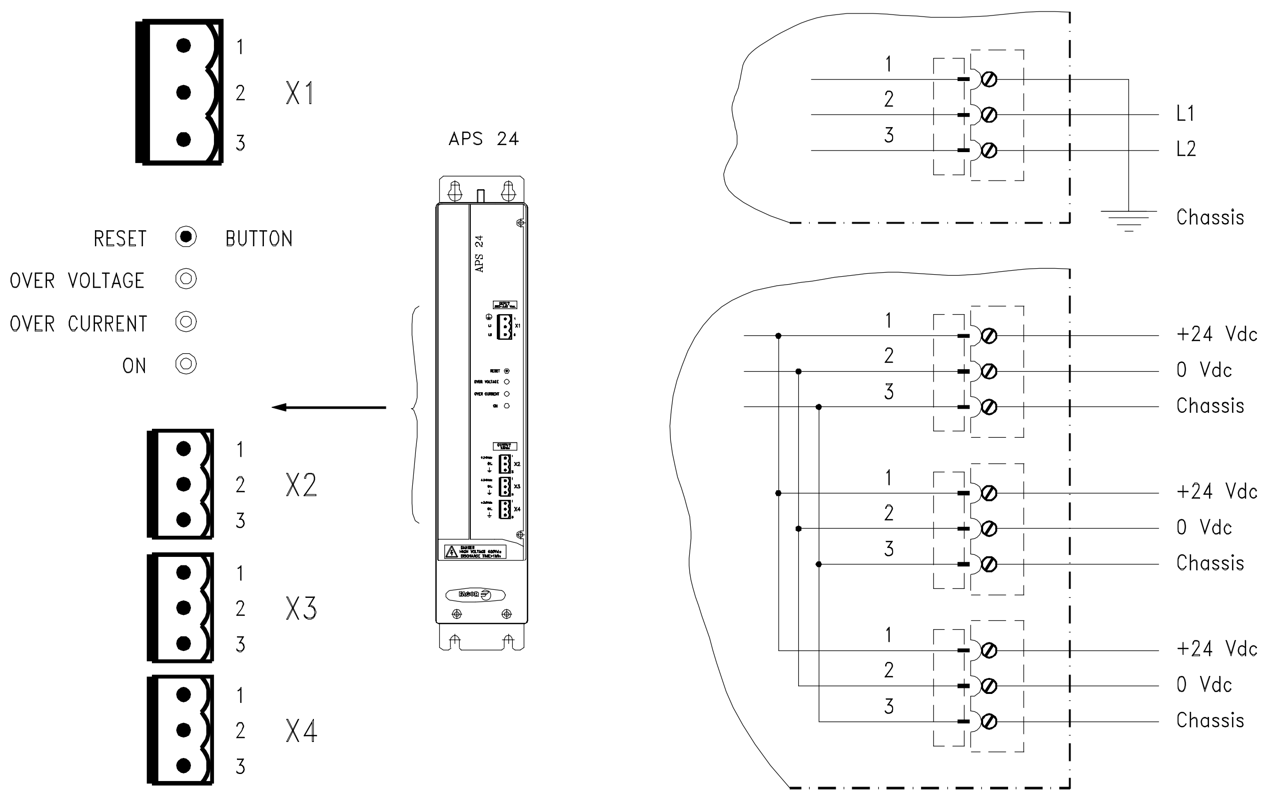
- Red led1: Output overvoltage. The power supply has exceeded 28 Vdc and it is not working.
- Red led2: Output overcurrent. The power supply has exceeded 10 Amps and its output voltage is less than 24 Vdc.
- Green Led: Running OK.

When the power supply quits working due to overvoltage, the module has push-button for system reset.

The last section of this chapter shows the module dimensions.

This APS 24 power supply is to be used to supply to the electrical control circuits and signals to run the drive.
It MUST NEVER be used for the brake of a motor.
The brake may generate voltage peaks that could damage the module.

EM.9.1 APS 24 CONNECTORS



EM.10 PROGRAMMING MODULE, DDS PROG MODULE

The Programming Module is a small portable unit that could replace a PC for setting the parameters and monitoring the system.

It is connected to the Drive module via the serial communications line. It can transfer parameter tables, edit them when setting them, execute commands, monitor internal variables and save that parameter table in its internal nonvolatile memory.

It can also be connected to a PC for transferring parameter tables.

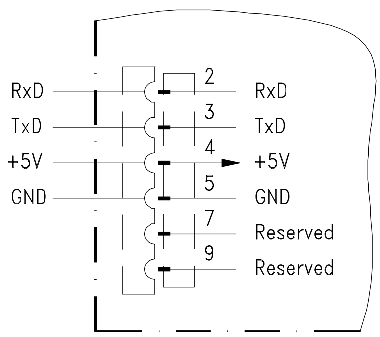
Its electrical installation is limited to the connection of that serial communications line since it receives the 5Vdc supply through it.

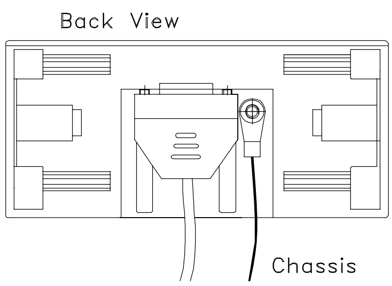
It may be built into any of the compact modules ACD or SCD. It can be mounted inside the electrical cabinet onto (32mm) or (35mm) type metallic rails.

It can be shown on the outside of the enclosure using a front adapter supplied by Fagor and described in the last section of this chapter.

The last section of this chapter shows the module dimensions.

Electrical connections:





Operating ambient temperature	5°C - 45°C (41°F - 113°F)
Storage temperature	-25°C - 60°C (-13°F - 140°F)
Relative humidity	80% max
Operating vibration	10..60 Hz, 0.1..5 G, 2 hr
Shipping vibration	60..300 Hz, 5 G, 2 hr
Sealing	IP4x (IP5x front panel)
Weight	150 gr (0.330 lbs)

EM.11 FAGOR CABLES

Power cables:

Fagor supplies the cables for transferring electrical power to the motors via three phases with a ground wire. Other cables include two thinner wires used to govern the brake on synchronous motors or for the connection of the thermal switch on the asynchronous motors.

The Fagor cables with their references and mechanical characteristics are:

Reference	Motor Power Cable Section
MPC - 4 x 1.5	4 x 1,5 mm^2
MPC - 4 x 2.5	4 x 2,5 mm^2
MPC - 4 x 4	4 x 4 mm^2
MPC - 4 x 6	4 x 6 mm^2
MPC - 4 x 10	4 x 10 mm^2
MPC - 4 x 16	4 x 16 mm^2
MPC - 4 x 1.5 + (2 x 1)	4 x 1,5 mm^2 + (2 x 1 mm^2)
MPC - 4 x 2.5+ (2 x 1)	4 x 2,5 mm^2 + (2 x 1 mm^2)
MPC - 4 x 4 + (2 x 1)	4 x 4 mm^2 + (2 x 1 mm^2)
MPC - 4 x 6 + (2 x 1)	4 x 6 mm^2 + (2 x 1 mm^2)
MPC - 4 x 10 + (2 x 1)	4 x 10 mm^2 + (2 x 1 mm^2)
	4 x 16 mm^2 + (2 x 1.5 mm^2)
	4 x 25 mm^2 + (2 x 1 mm^2)
MPC - 4 x 35 + (2 x 1)	4 x 35 mm^2 + (2 x 1 mm^2)

Type: Shielded (EMC compatible)
Flexibility: Great. Especially suited for cable carrying chains with a minimum bending radius of 10 times its diameter.
Covering: PUR. Polyurethane immune to the chemical agents used in Machine Tools.
Temperature: Working: From -5°C to +70°C (From 23°F to 158°F)
Storage: From -40°C to +90°C (From -40°F to 194°F)
Work voltage: U_0/U 300 / 500 Volts

Feedback cables:

Several cables are available to the user for connecting encoders, resolvers or encoder simulator boards. Their maximum length is 25 meters (82 ft.). Check this table:

FEEDBACK CABLES			
Length	Reference		
	Encoder	Resolver	Encoder Simulation
1m (3.2ft)			SEC-1
3m (9.8ft)			SEC-3
5m (16.4ft)	EEC-5	REC-5	SEC-5
10m (32.8ft)	EEC-10	REC-10	SEC-10
15m (49.2ft)	EEC-15	REC-15	SEC-15
20m (65.6ft)	EEC-20	REC-20	SEC-20
25m (82ft)	EEC-25	REC-25	

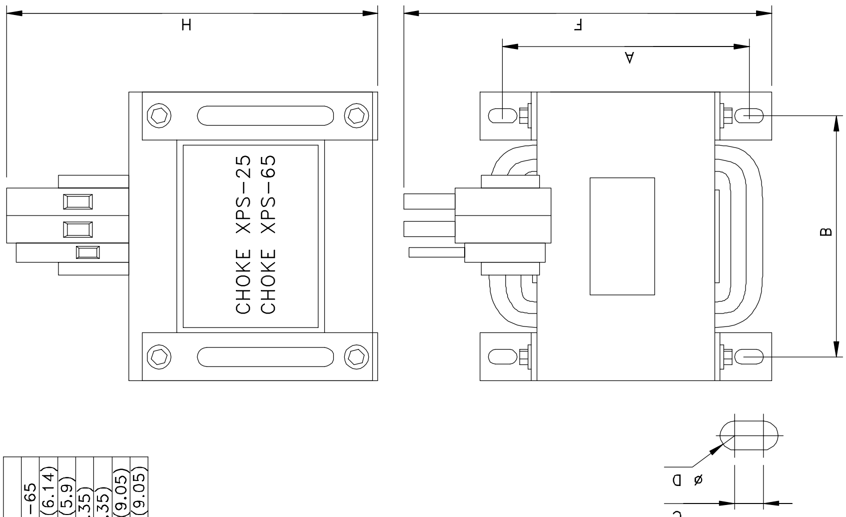
For Sercos connection:

Fagor Automation supplies the fiber optic cables for Sercos communications between the Group of Drives and the CNC in lengths ranging from 1 to 7 meters. The cables between drives come with the connectors for each module.

SERCOS FIBER OPTIC	
Length	Reference
1m (3.2ft)	SFO-1
2m (6.4ft)	SFO-2
3m (9.8ft)	SFO-3
5m (16.4ft)	SFO-5
7m (22.4ft)	SFO-7

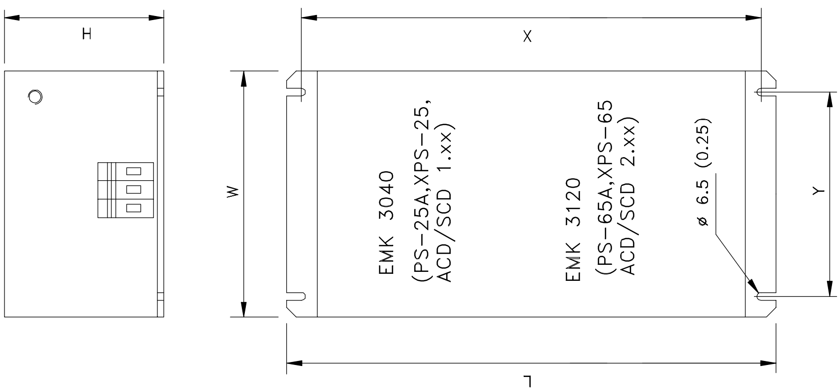
EM.12 DIMENSIONS

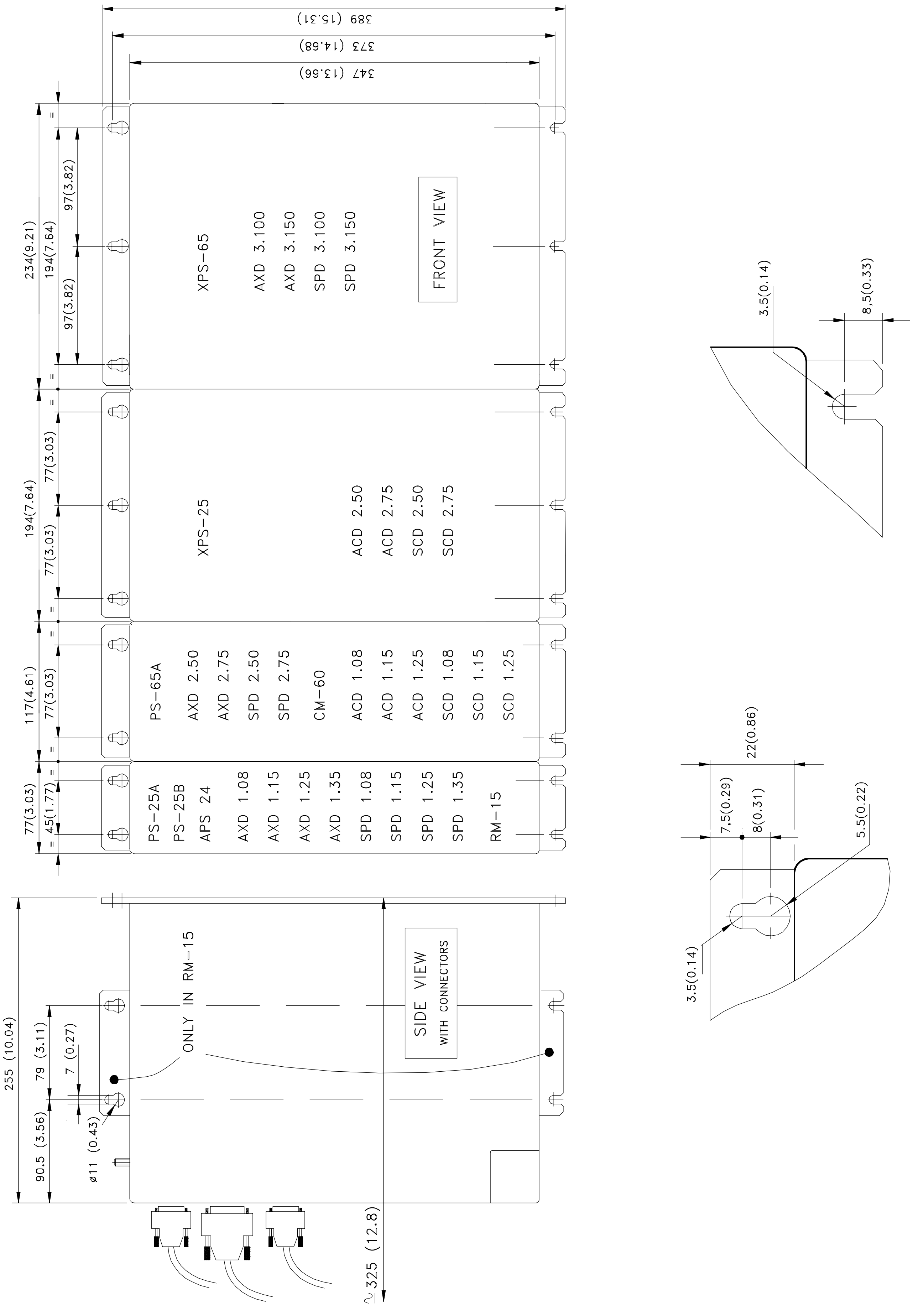
When making the electrical cabinet, also take into account the necessary room for the connectors and their cables. The one for the top power connectors may be up to 45 mm high mm (inches).



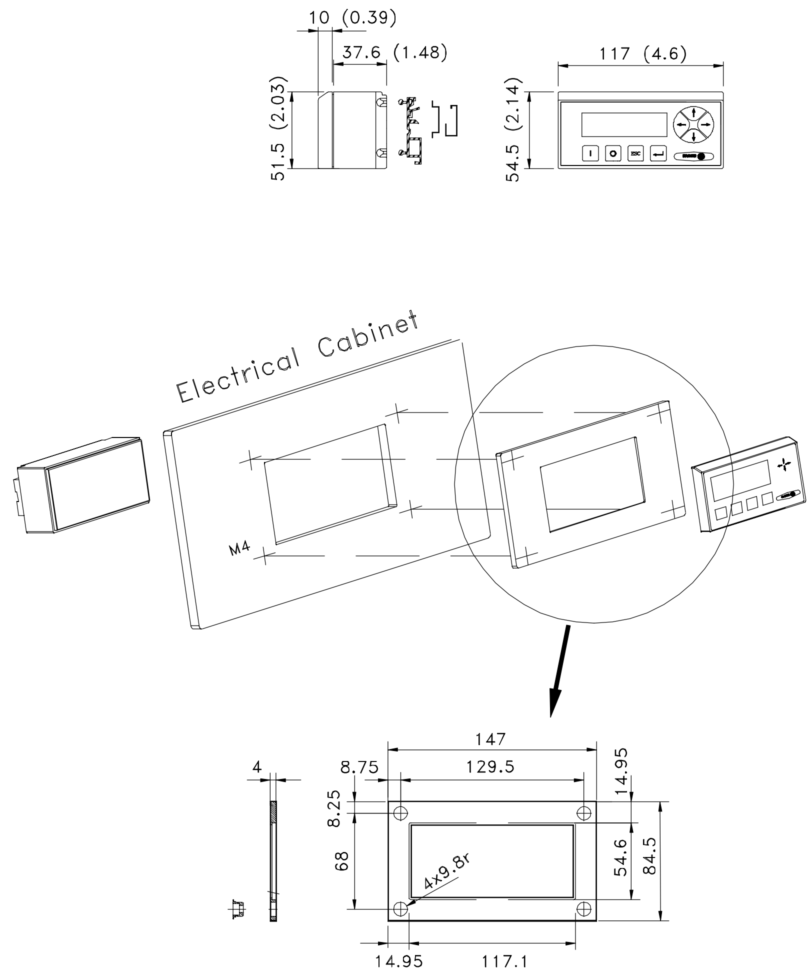
	CHOKE	
	XPS-25	XPS-65
A	115 (4.52)	156 (6.14)
B	105 (4.13)	150 (5.9)
C	10 (0.39)	9 (0.35)
D	9 (0.35)	9 (0.35)
H	165 (6.49)	230 (9.05)
F	180 (7.08)	230 (9.05)

	MAINS FILTERS	
	EMK 3040	EMK 3120
L	270 (10.63)	430 (16.93)
W	140 (5.51)	200 (7.87)
H	62 (2.44)	130 (5.12)
X	258 (10.15)	408 (16.06)
Y	106 (4.17)	166 (6.53)



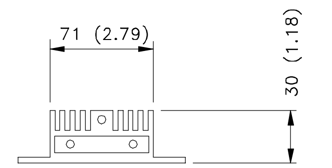

389 (15.31)
373 (14.68)
347 (13.66)
234(9.21)
194(7.64)
97(3.82)
97(3.82)
194(7.64)
77(3.03)
77(3.03)
117(4.61)
77(3.03)
77(3.03)
45(1.77)
XPS-65
AXD 3.100
AXD 3.150
SPD 3.100
SPD 3.150
FRONT VIEW
XPS-25
ACD 2.50
ACD 2.75
SCD 2.50
SCD 2.75
PS-65A
AXD 2.50
AXD 2.75
SPD 2.50
SPD 2.75
CM-60
ACD 1.08
ACD 1.15
ACD 1.25
SCD 1.08
SCD 1.15
SCD 1.25
PS-25A
PS-25B
APS 24
AXD 1.08
AXD 1.15
AXD 1.25
AXD 1.35
SPD 1.08
SPD 1.15
SPD 1.25
SPD 1.35
RM-15
255 (10.04)
79 (3.11)
7 (0.27)
90.5 (3.56)
ø11 (0.43)
ONLY IN RM-15
SIDE VIEW
WITH CONNECTORS
≃325 (12.8)
3.5(0.14)
8,5(0.33)
22(0.86)
7,5(0.29)
8(0.31)
5.5(0.22)
3.5(0.14)

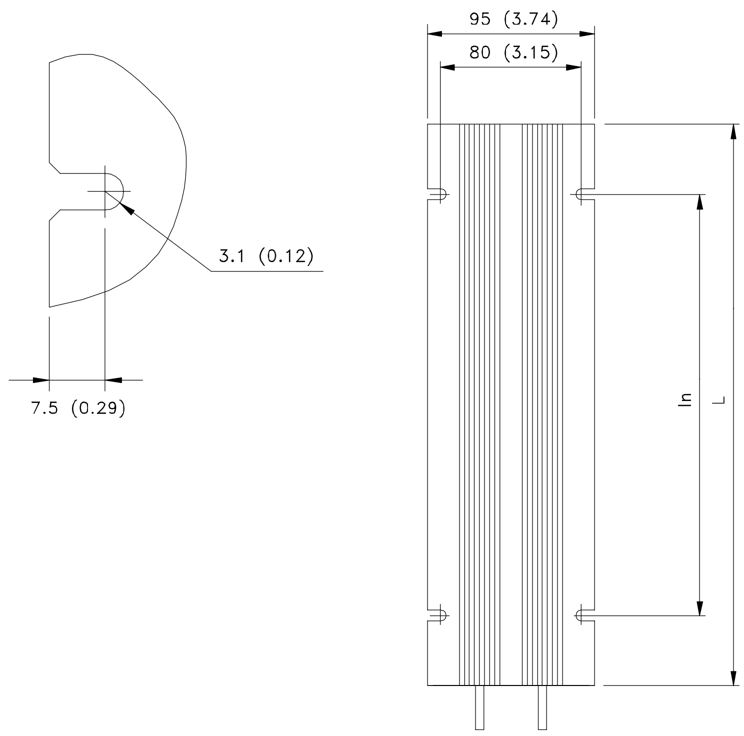
DDS PROG MODULE



EXTERNAL RESISTOR -ER-

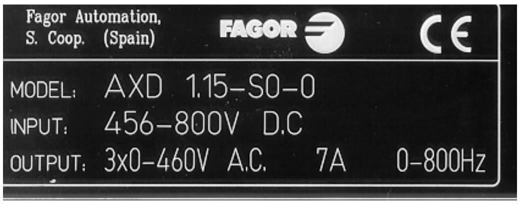
	ER-41/350	ER-24/750	ER-18/1100
In	60 (2.36)	140 (5.51)	240 (9.45)
L	110 (4.33)	220 (8.66)	320 (12.6)



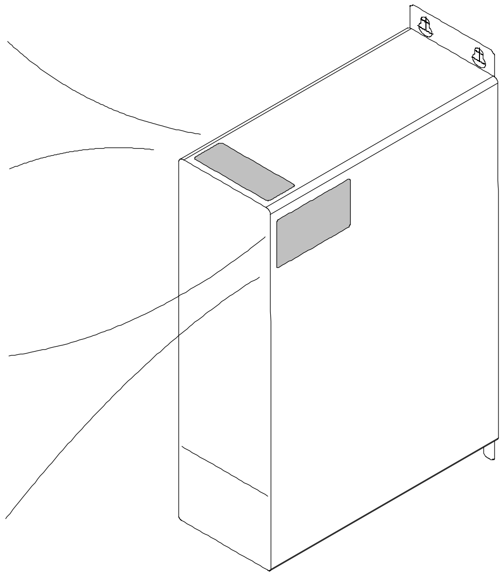


EM.13 MODULE IDENTIFICATION.

Each electronic module is identified by its "characteristics plate". It indicates the model and its main technical characteristics.



Versions plate.

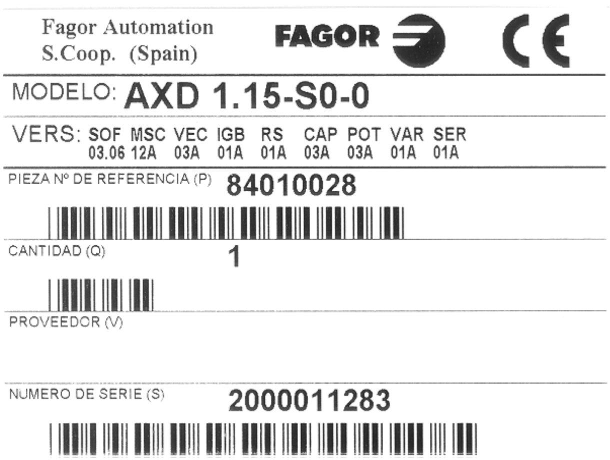


Characteristics plate.

The "versions plate" shows the hardware and software versions of the equipment. For example, the IGBT board mounted in this module has version 01A (IGB); the software version is 03.02.

These two plates fully identify the module and must be referred to when repairing or replacing these units. They also help solve compatibility problems between versions.

The drive is also labeled on its package.



User notes:

IN. INSTALLATION

Follow these steps for a complete system installation:

Prepare the supports for the module in the electrical cabinet.
Unpack and mount all the system modules in the electrical cabinet.
Mount the Mains filter in the cabinet.
Electrical interconnection of the Drive system:

- Power Bus bars at the bottom of each module.
- Ground bars at the top and connection of the assembly to the Ground connection.
- Internal bus between the modules powered by the same Power Supply and the power supply itself.
- Connection to the External Ballast resistor RM-15 or ER if applicable.

Supply voltage. Connection with motors and the CNC:

- Cable hose from mains to the Drive system through the Filter.
- Power cable hose from each Motor to each Drive.
- Feedback cables from each Motor to each Drive.
- Circuit for the control of the Brake.
- Power for the 24Vdc auxiliary power supply from mains (APS 24, XPS or PS-25B).
- Power the control circuits of each drive module with 24 Vdc.

Control and communication signals:

- Encoder simulation cables from each Drive to the CNC if applicable.
- Analog velocity command voltages from the CNC to each Drive.
- Connection of the control signals of the modules, inputs and outputs.
- Sercos connection.
  - Identify each system drive with a rotary switch.
  - Connect the Modules and the CNC through the fiber optic.

Adjust the modules through the serial line.

In order for the Fagor Servo System to meet the European Directive on Electromagnetic Compatibility 89/336/CE, the modules installation rules must be strictly followed regarding:

- The mounting of the Filter to Mains
- Electrical installation of the power stage
. Wiring to mains
. Power connection motor-drive

IN.1 SECURING ALL THE ELEMENTS

1.- Prepare the fixtures in the electrical cabinet. See the EM chapter -dimensions-.
2.- Unpack the system motors and modules
3.- Mount each of the motors on the machine
4.- Install all the modules making up the Servo-Drive System in the electrical cabinet

IN.1.1 PLACEMENT OF THE SERVO DRIVE SYSTEM

<u>Ambient conditions:</u>

Never install the Servo-Drive System in places where there are corrosive gases.

Always install it well away from areas with unfavorable atmospheric conditions, avoiding exposure to oil, water, hot air, high humidity, excessive dust or metal particles.

Especially:
When installing the RM-15 outside the electrical cabinet, it must be done away from water, coolant, chips, etc. since the module only guarantees a sealing protection of IP2x.
The sealing degree of the ER resistors is: IP55.

It is entirely up to the installer to take care of these matters.

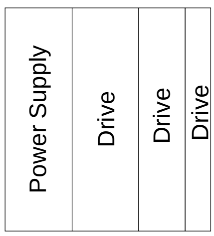
<u>Mechanical conditions:</u>

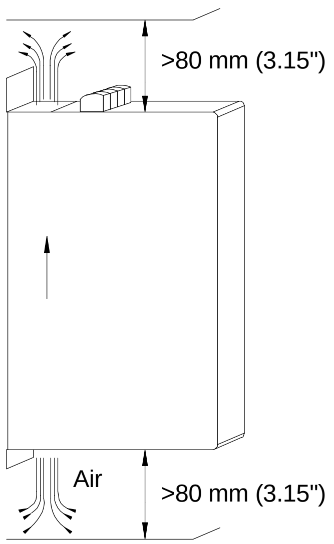
The Drive system must be mounted vertically in the electrical cabinet. To secure it, use the holes and slots made for that purpose.

Vibrations should be avoided. If necessary use securing means made of a material which absorbs or minimizes vibrations.

To facilitate heat removal, the equipment should be installed so as to leave at least 80 mm (3.15 inches) above and below it. See figure.

Important:
Mount the Drive Module of greater power next to the Power Supply module and use the same criteria for the rest of the Drive Modules.





Climate conditions:

Watch that temperature in the electrical cabinet is always kept under 55°C (131°F). Never install the Servo-Drive System beside a heat source.

The modules themselves generate heat. The following table shows the power dissipated by each one of them. These are data to be borne in mind when deciding whether the electrical cabinet needs external cooling or not.

External Ballast resistors RM-15 and ER should be mounted outside the electrical cabinet because they are power dissipating elements which generate a lot of heat. They must be installed away from splashes of water, coolant, metal chips, etc.

When applying external cooling to the system, make sure that water condensation does not fall on the equipment.

Module	Dissipated power
PS-25A	160 W
PS-65A	275 W
PS-25B	180 W
XPS-25	180 W
XPS-65	350 W

AXD 1.08	65 W
AXD 1.15	110 W
AXD 1.25	180 W
AXD 1.35	208 W
AXD 2.50	335 W
AXD 2.75	430 W
AXD 3.100	680 W
AXD 3.150	1200 W
SPD 1.08	70 W
SPD 1.15	135 W
SPD 1.25	200 W
SPD 1.35	296 W
SPD 2.50	385 W
SPD 2.75	570 W
SPD 3.100	830 W
SPD 3.150	1260 W

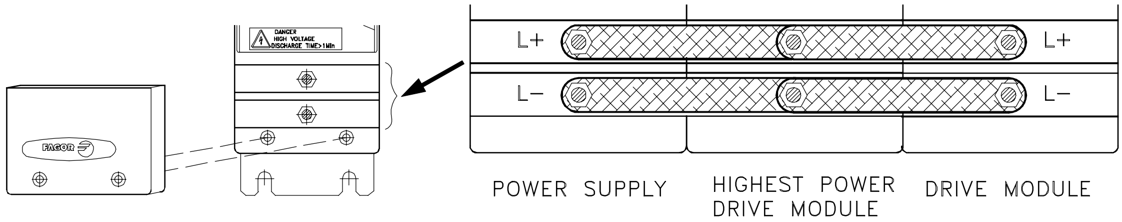
Module	Dissipated power
APS 24	60 W
CM-60	0 W
RM-15	(*)
ER	(*)
ACD 1.08	92 W
ACD 1.15	172 W
ACD 1.25	220 W
ACD 2.50	415 W
ACD 2.75	575 W
SCD 1.08	98 W
SCD 1.15	173 W
SCD 1.25	238 W
SCD 2.50	485 W
SCD 2.75	677 W
EMK 3040	30 W
EMK 3120	45 W

(*) It depends on how often the protection Ballast circuit is activated.

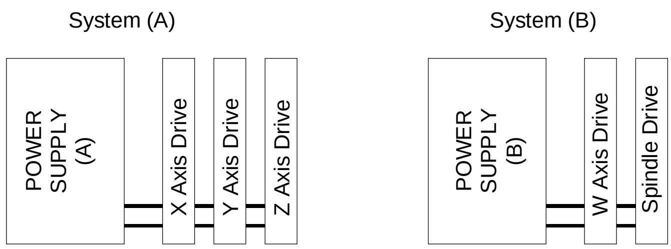
IN.2 INTER-MODULAR CONNECTION

IN.2.1 POWER BUS CONNECTION

Use 2 of the 3 plates and the washers and nuts supplied with each module to make the connection of the Power bus (lower part of the module). All the modules must be tightly joined to each other guaranteeing a good electrical contact. The tightening torque must be between 2.3 and 2.8 Nm. These plates are identical and no particular order or direction has to be observed.



The Power Supply module must provide the power needed by all the drives connected to it. If the power required by the group of motors exceeds the maximum that a single power supply can provide, two power supplies must be used assigning to each one the supply of a separate group of drives.

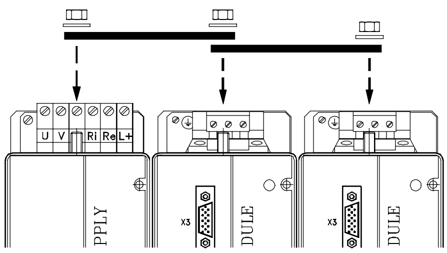


The Power Buses of different Power Supply Modules must NEVER be connected in parallel.

Always make separate groups, connecting each Power Supply to a different group of drives.

IN.2.2 GROUND CONNECTION

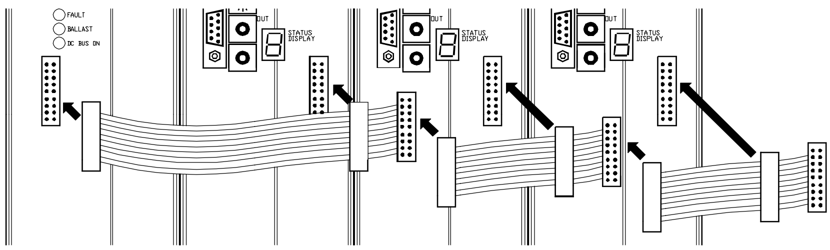
Use the 3rd plate and the washers and nuts supplied with each module for making the ground connection. The tightening torque must be between 2.3 and 2.8 Nm.



Important: Run a grounding cable as short as possible and with a section of 6 mm^2 or larger from one end to the main ground point of the machine.

IN.2.3 INTERNAL BUS CONNECTION

Connect connectors X1 using the cables supplied with each module as shown below.



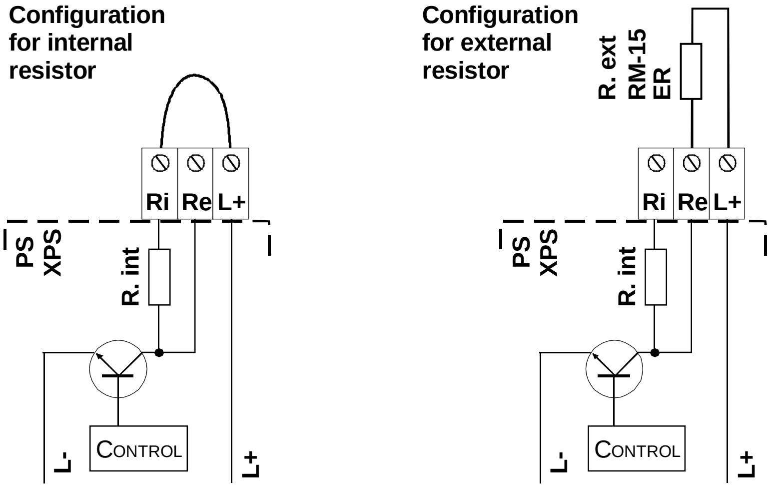
If the machine uses two separate servo drive systems (each one with its own power supply), they must have two separate internal buses.

IN.2.4 CONNECTION TO THE EXTERNAL BALLAST RESISTOR

If the energy to be dissipated when braking the motors is too high, an external ballast resistor must be installed. The Fagor modules "RM-15" and "ER" are designed for this purpose. See the section on Resistor Modules: RM-15, ER" of the chapter EM.

To know whether this module is necessary or not on your machine, refer to the relevant section of the DS chapter.

Electrical configurations and Ohm value.



PS-25x, XPS-25	18 Ohms	1.5 kW	RM-15
		950 W	ER-18/1100
PS-65A, XPS-65	9 Ohms	3 kW	RM-15 // RM-15
		1.9 kW	ER-18/1100 // ER-18/1100
SCD/ACD 1.15	41 Ohms	300 W	ER-43/350
SCD/ACD 1.25	24 Ohms	650 W	ER-24/750
SCD/ACD 2.50	12 Ohms	1.3 kW	ER-24/750 // ER-24/750
SCD/ACD 2.75	9 Ohms	3 kW	RM-15 // RM-15
		1.9 kW	ER-18/1100 // ER-18/1100

The Ohm value of the external Ballast resistor must be the same as that of the internal resistor of that module.

NEVER connect an external resistor in parallel with the internal Ballast resistor. It may cause severe damage to the system.

Compact Drives MUST NEVER be connected to the RM-15 module.

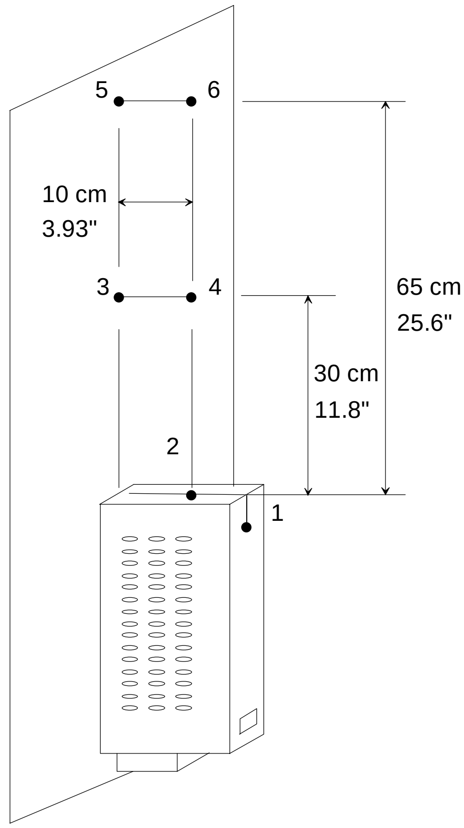
Heat dissipation.

Ballast resistors can generate a great deal of heat. Optionally, a PAPST 614 type fan may also be installed for better dissipation.

The figure and table below show the temperatures reached in the gap above the module and the fan effect.

Dissipated power -W-	734	896	1042	1400	1400 (*)
Ambient temperature	25	22	24	24	24
T1	90	89	115	138	74
T2	157	170	185	217	113
T3	80	79	88	104	64
T4	60	68	72	82	46
T5	50	54	57	65	47
T6	40	40	44	45	44

(*) With a PAPST 614 fan
Temperatures in °C *(°F = °C · 1.8 + 32)*

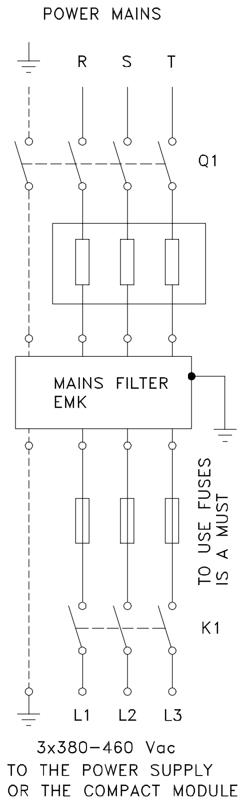


Above the RM-15 and ER the air temperature may reach 120°C (248°F). Therefore, it should be mounted away from the rest of the modules or even outside the electrical cabinet, always vertically and away from cables and other temperature sensitive material.

Warning: The RM-15 module guarantees a sealing degree of IP2x.
The ER guarantees a degree of IP55.

IN.3 POWER LINE CONNECTION

IN.3.1 CABLING OF THE SYSTEM TO MAINS



<u>Possible safety elements and adaptation to mains.</u>

Some mandatory protection elements must be inserted on the lines going from Mains to the servo drive system. Other elements may be optional.

The diagram shows which these possibilities are and how to connect them.

After the main switch Q1, there is a transformer or autotransformer. It adapts the mains to the 380-460 Vac range. Some chokes in line may help smooth the mains interferences.

Then, the filter for electromagnetic interference.

And the fuses MUST BE installed before the power switch.

IN.3.1.1 MAINS FILTER, EMK.

In order for the Fagor Servo drive system to meet the **European Directive on Electromagnetic Compatibility 89/336/CE** the EMK Mains filter, must also be installed.

To install it, it must be properly connected to ground and the wires connecting to the power supply module must be as short as possible. See the figure for ground connection.

In the following table is shown the appropriate filter for each module.

If we choose not to install the mains filter "EMK", a choke should be inserted on each line instead, a transformer or an autotransformer that minimizes mains disturbances.

These solution do not assure compliance with the afore mentioned CE directive.

Module	Filter
PS-25x, XPS-25	EMK 3040
PS-65A, XPS-65	EMK 3120
ACD/SCD 1.xx	EMK 3040
ACD/SCD 2.xx	EMK 3120

IN.3.1.2 FUSES.

To protect the Servo Drive system, <u>fuses must be included</u> on the lines coming from Mains.

The fuses are selected according to the characteristics indicated in the first table. The second table offers a group of fuses from different manufacturers which be used.

Fuse characteristics	Power Supply Module				Compact Drives			
	PS-25A PS-25B	PS-65A	XPS-25	XPS-65	ACD/SCD 1.08/15	ACD/SCD 1.25	ACD/SCD 2.50	ACD/SCD 2.75
I_N	> 40 Amp	> 100 Amp	> 40 Amp	> 100 Amp	> 10.6 Amp	> 17.7 Amp	> 35.4 Amp	> 53 Amp
I_{SURGE}	> 115 Amp (1 seg)	> 360 Amp (1 seg)	> 100 Amp (1 seg)	> 300 Amp (1 seg)	> 15 Amp (0.5 seg)	> 25 Amp (0.5 seg)	> 50 Amp (0.5 seg)	> 75 Amp (0.5 seg)
Clearing I^2t (A^2s)	< 500	< 15000	< 1150	< 6400	< 500 Amp	< 900 Amp	< 900 Amp	< 2000 Amp

Manufacturer	Power Supply Module				Compact Drives			
	PS-25A PS-25B	PS-65A	XPS-25	XPS-65	ACD/SCD 1.08/15	ACD/SCD 1.25	ACD/SCD 2.50	ACD/SCD 2.75
BUSSMANN	FWH45B	RF00-125A	FWH45B	RF00-125A	FC-12	FC-20	FE-40	FE-63
	XL50F-45A	XL50F-125A	XL50F-45A			RF-000-25	RF-000-40	RF-000-63
	RF-000-40A	RF-000-125A	RF-000-40A					
	40FE	100FE	40FE	100FE				
	170M2611	170M1318	170M2611					
	170M3009	170M3013	170M3009	170M3013				
GOULD	A00-66C5D8	A00-66C125D8	A00-66C5D8	A00-66C125D8	ST-12 10x38	ST-20 10x38	ST-40 14x51	000-63
	A00-66C5D1	A00-66C125D1	A00-66C5D1	A00-66C125D1	A60x12	A60x20	000-40	000/80-63
							000/80-40	A70Q60
FERRAZ	6,9 gRB 00 D08L 040	6,9 gRB 00 D08L 125	6,9 gRB 00 D08L 040					
	6,6 gRB 000 DO8/040	6,6 gRB 000 DO8/100	6,6 gRB 000 DO8/040	6,6 gRB 000 DO8/100				
SIBA	20 189 20-50A.	20 189 20-125A.	20 189 20-50A.	20 189 20-125A.				
WICKMANN	45FEE	140FEE	45FEE					
SIEMENS	3NE8 003	3NE8 021	3NE8 003	3NE8 021	3NE8015 3NE8003	3NE8015 3NE8003	3NE8017 3NE8020 3NE8021 3NE8018	3NE8020 3NE8021 3NE8018

IN.3.1.3 TRANSFORMER OR AUTOTRANSFORMER.

If the Mains voltage has to be adapted to the system levels, an isolating transformer or autotransformer must be used. This element will help reduce the mains harmonics, although it does not assure compliance with the CE directive.

When having a mains perfectly referenced to ground, autotransformers may be used to adapt to the mains voltages.

However, when having a mains not referenced to ground, an isolating transformer must be used because dangerous overvoltage could appear on some phases with respect to ground which could damage the equipment. In this case, the secondary must have a star connection with its middle point connected to ground to the mains neuter line.

On systems with XPS power supplies, the transformer must have a very low impedance which could be negligeable as compared to the inductive value of the CHOKE XPS-xx.

IN.3.1.4 LINE INDUCTANCE

Line Inductance means including chokes on each of the three power lines. Its function is to reduce the harmonics generated in mains. The recommended value is given by the formula below. To simplify the choice, we could consider optimum the values given in the table.

$$L = \frac{V \cdot 0.04}{2\pi f \cdot Irms}$$

	PS-25A PS-25B	PS-65A	ACD/SCD 1.08/15	ACD/SCD 1.25	ACD/SCD 2.50	ACD/SCD 2.75
L (mHr)	1	0.4	5	3	1.5	1
I rms (A)	40	100	11	18	36	53

If the "Power Pro" filter has not been installed, the Line Inductance is recommended in order to minimize disturbances, although is warned that this does not guarantee CE marking compliance.

No Line Inductances must be installed in line with XPS power supplies since they would interfere with their regenerating function.

IN.3.1.5 SECTION OF THE CABLES FOR MAINS CONNECTION.

The table on the right gathers the regulation applicable to typical installations of Drive Systems.
Determines the maximum current in continuous duty cycle, admitted by three-phase conductors in PVC hoses and installed on the machines through conduits and channels.
The ambient temperature considered is 40 °C (94 °F).

At any rate, the section of the mains connection cables must be equal to or greater than that of the cables used to connect any motor.

Section (mm^2)	Max Current (Amp RMS)
1.5	12.2
2.5	16.5
4	23
6	29
10	40
16	53
25	67
35	83

To determine the cables needed to connect the **Power Supply to Mains**, proceed as indicated in the DS chapter.

This is the cable selection offered by Fagor:

Reference number of cables x section (mm^2)
MPC - 4 x 1.5
MPC - 4 x 2.5
MPC - 4 x 4
MPC - 4 x 6
MPC - 4 x 10
MPC - 4 x 16
MPC - 4 x 1.5 + (2 x 1)
MPC - 4 x 2.5 + (2 x 1)
MPC - 4 x 4 + (2 x 1)
MPC - 4 x 6 + (2 x 1)
MPC - 4 x 10 + (2 x 1)
MPC - 4 x 16 + (2 x 1.5)
MPC - 4 x 25 + (2 x 1)
MPC - 4 x 35 + (2 x 1)

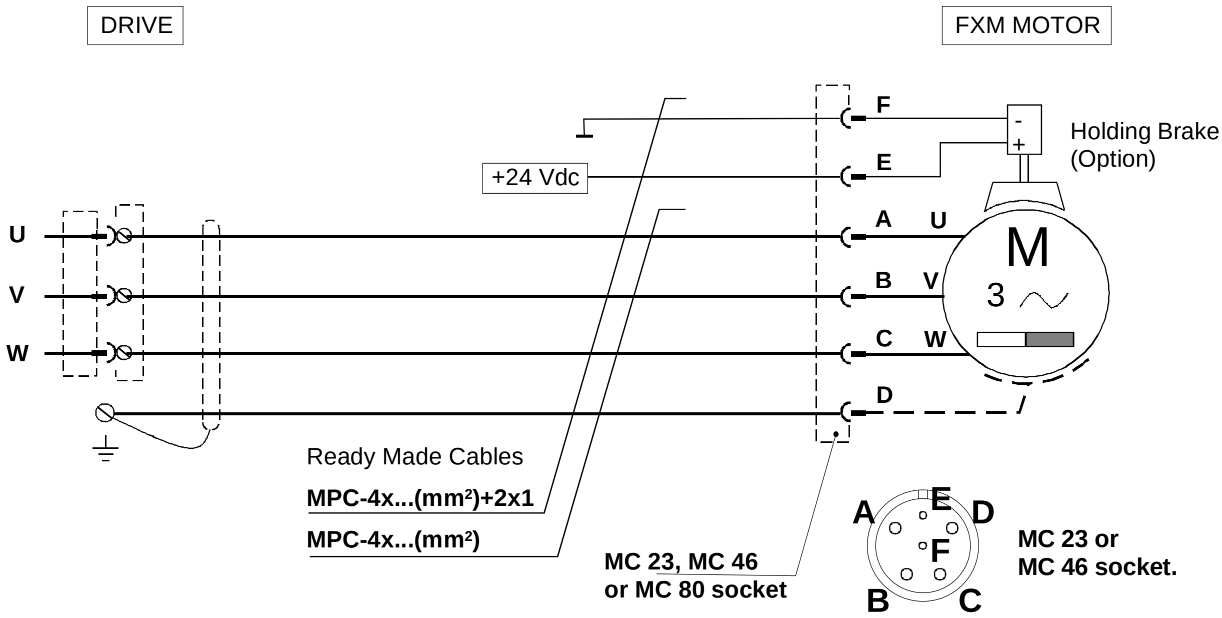
IN.3.1.6 MECHANICAL CHARACTERISTICS OF THE CONNECTORS

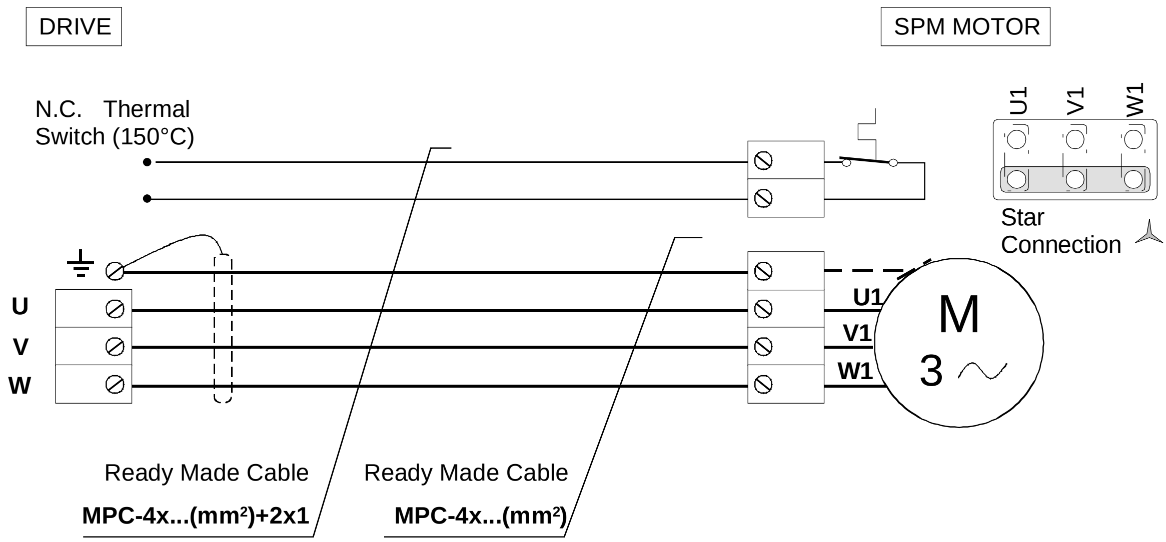
Module	Gap between terminals (mm)	Max. tightening torque (Nm))	Maximum Section (mm²)
AXD 1.08/15, SPD 1.08/15	7.5	0.6	2.5
AXD 1.25, SPD 1.25, SCD 1.08/15/25, ACD 1.08/15/25	7.5	0.6	4
PS-25A, AXD 1.35, SPD 1.35	8.1	1	4
EMK 3040, AXD 2.50/75, SPD 2.50/75 PS-65A (ballast), XPS-65 (ballast) ACD 2.50/75 (ballast), SCD 2.50/75 (ballast)	10.1	1.7	10
PS-25B	10.1	1.5	10
XPS-25 ACD 2.50/75 (power), SCD 2.50/75 (power)	12.1	2	16
EMK 3120, AXD 3.100, SPD 3.100	15.1	7	25
AXD 3.150, SPD 3.150 PS-65A (power), XPS-65 (power)	18.8	7	50

IN.3.2 MOTOR/DRIVE CONNECTION

When connecting the Drive module with its corresponding motor, connect terminal "U" of the drive module with the terminal corresponding to the "U" phase of the motor.
Same as terminals "V-V", "W-W" and "Ground-Ground".

In order for the system to comply with the European Directive on Electromagnetic Compatibility, the hose grouping all four cables U-V-W-Ground must be shielded and must be connected only at the drive end as shown on the diagrams. These conditions are a must.





IN.3.2.1 GUIDE FOR SELECTING THE POWER CABLES OF THE MOTORS

The following tables serve as guides for selecting the power cables of the synchronous motors (FXM) and of the asynchronous motors (SPM).
They show the right cable section for each motor.

They meet the European directive and the mechanical compatibility with the drive and motor connectors.

(**A**) In these cases, do not use the angled socket -AMC- .
(**O**) In order to meet regulations on current density, these cables must not be run in channels.

	Rated Current (Amp)	1.5 mm^2	2.5 mm^2
FXM11.20A.xx.xx0	0,3	▓	░
FXM11.30A.xx.xx0	0,4	▓	░
FXM11.40A.xx.xx0	0,5	▓	░
FXM12.20A.xx.xx0	0,5	▓	░
FXM12.30A.xx.xx0	0,8	▓	░
FXM12.40A.xx.xx0	1,0	▓	░
FXM13.20A.xx.xx0	0,8	▓	░
FXM13.30A.xx.xx0	1,1	▓	░
FXM13.40A.xx.xx0	1,5	▓	░
FXM14.20A.xx.xx0	1,0	▓	░
FXM14.30A.xx.xx0	1,6	▓	░
FXM14.40A.xx.xx0	2,0	▓	░
FXM31.20A.xx.xx0	0,8	▓	░
FXM31.30A.xx.xx0	1,1	▓	░
FXM31.40A.xx.xx0	1,5	▓	░
FXM32.20A.xx.xx0	1,5	▓	░
FXM32.30A.xx.xx0	2,3	▓	░
FXM32.40A.xx.xx0	3,1	▓	░
FXM33.20A.xx.xx0	2,3	▓	░
FXM33.30A.xx.xx0	3,5	▓	░
FXM33.40A.xx.xx0	4,6	▓	░
FXM34.20A.xx.xx0	3,1	▓	░
FXM34.30A.xx.xx0	4,7	▓	░
FXM34.40A.xx.xx0	6,2	▓	░
FXM53.12A.xx.xx0	2,4	▓	░
FXM53.20A.xx.xx0	4,0	▓	░
FXM53.30A.xx.xx0	6,0	▓	░
FXM53.40A.xx.xx0	8,0	▓	░
FXM54.12A.xx.xx0	3,2	▓	░
FXM54.20A.xx.xx0	5,5	▓	░

	Rated Current (Amp)	1.5 mm^2	2.5 mm^2	4 mm^2	6 mm^2	10 mm^2
FXM54.30A.xx.xx0	8,1	▓	░			
FXM54.40A.xx.xx0	10,2	▓	░			
FXM55.12A.xx.xx0	4,0	▓	░			
FXM55.20A.xx.xx0	6,8	▓	░			
FXM55.30A.xx.xx0	10,2	▓	░			
FXM55.40A.xx.xx0	13,3		▓			
FXM73.12A.xx.xx0	4,7	▓	░			
FXM73.20A.xx.xx0	7,8	▓	░			
FXM73.30A.xx.xx0	11,3	▓	░			
FXM73.40A.xx.xx0	15,4		▓			
FXM74.12A.xx.xx0	6,2	▓	░			
FXM74.20A.xx.xx0	10,4	▓	░			
FXM74.30A.xx.xx0	15,4		▓			
FXM74.40A.xx.xx0	20,6			▓ A		
FXM75.12A.xx.xx0	7,7	▓	░			
FXM75.20A.xx.xx0	12,9		▓			
FXM75.30A.xx.xx0	19,3			▓ A		
FXM75.40A.xx.xx0 (*)	25,3				▓	░
FXM76.12A.xx.xx0	9,3	▓	░			
FXM76.20A.xx.xx0	15,4		▓			
FXM76.30A.xx.xx0	22,6			▓ A		
FXM76.40A.xx.xx0 (*)	31,0					▓
FXM77.12A.xx.xx0	10,9	▓	░			
FXM77.20A.xx.xx0	17,3			▓ A		
FXM77.30A.xx.xx0 (*)	26,5				▓	░
FXM77.40A.xx.xx0 (*)	35,7					▓
FXM78.12A.xx.xx0	12,5		▓			
FXM78.20A.xx.xx0	20,6			▓ A		
FXM78.30A.xx.xx0 (*)	31,0					▓
FXM78.40A.xx.xx0 (*)	41,2					▓ O

Best Option ▓ (*) MC 46 ░ Valid Options

	Rated Current (Amp)	1.5 mm²	2.5 mm²	4 mm²	6 mm²	10 mm²	16 mm²	25 mm²	35 mm²
FXM53.12A.xx.xx1	3,6	Best	Valid						
FXM53.20A.xx.xx1	6,0	Best	Valid						
FXM53.30A.xx.xx1	9,0	Best	Valid						
FXM53.40A.xx.xx1	12,0	Best	Valid						
FXM54.12A.xx.xx1	4,8	Best	Valid						
FXM54.20A.xx.xx1	8,3	Best	Valid						
FXM54.30A.xx.xx1	12,2	Best	Valid						
FXM54.40A.xx.xx1	15,3		Best						
FXM55.12A.xx.xx1	6,0	Best	Valid						
FXM55.20A.xx.xx1	10,2	Best	Valid						
FXM55.30A.xx.xx1	15,3		Best						
FXM55.40A.xx.xx1	20,0			Best (A)					
FXM73.12A.xx.xx1	7,1	Best	Valid						
FXM73.20A.xx.xx1	11,7	Best	Valid						
FXM73.30A.xx.xx1	17,0			Best (A)					
FXM73.40A.xx.xx1 (*)	23,1				Best				
FXM74.12A.xx.xx1	9,3	Best	Valid						
FXM74.20A.xx.xx1	15,6		Best						
FXM74.30A.xx.xx1 (*)	23,1				Best				
FXM74.40A.xx.xx1 (*)	30,9					Best			
FXM75.12A.xx.xx1	11,6	Best	Valid						
FXM75.20A.xx.xx1	19,4			Best (A)					
FXM75.30A.xx.xx1 (*)	29,0				Best	Valid			
FXM75.40A.xx.xx1 (*)	38,0					Best			
FXM76.12A.xx.xx1	14,0		Best						
FXM76.20A.xx.xx1 (*)	23,1				Best				
FXM76.30A.xx.xx1 (*)	33,9					Best			
FXM76.40A.xx.xx1 (**)	46,5						Best		
FXM77.12A.xx.xx1	16,4		Best						
FXM77.20A.xx.xx1 (*)	26,0				Best	Valid			
FXM77.30A.xx.xx1 (*)	39,8					Best			
FXM77.40A.xx.xx1 (**)	53,6							Best	Valid
FXM78.12A.xx.xx1	18,8			Best (A)					
FXM78.20A.xx.xx1 (*)	30,9					Best			
FXM78.30A.xx.xx1 (**)	46,5						Best		
FXM78.40A.xx.xx1 (**)	61,8							Best	Valid

(*) MC 46 (**) MC 80 Best Option Valid Options

(**A**) In these cases, do not use angled sockets -AMC- .

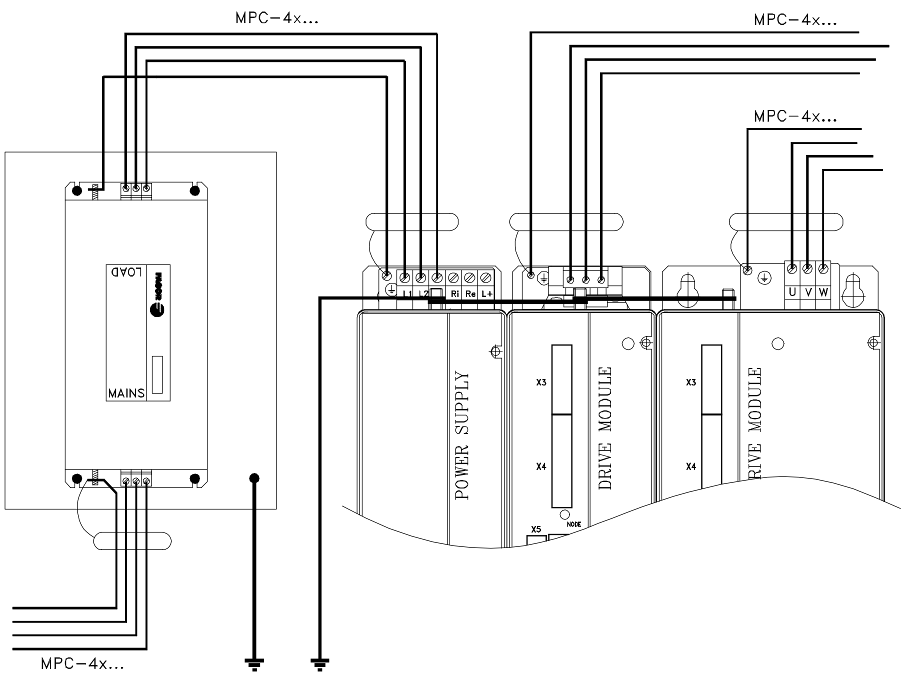
	Rated Current S1 (Amp)	1.5 mm^2	2.5 mm^2	4 mm^2	6 mm^2	10 mm^2	16 mm^2	25 mm^2	35 mm^2	50 mm^2
SPM 90L xx.1	7,8	■	▒							
SPM 90P xx.1	10,1	■	▒							
SPM 100LBE xx.1	13,8		■	▒						
SPM 112ME xx.1	18,6			■						
SPM 112LE xx.1	24,0				■	▒				
SPM 112XE xx.1	33,9					■				
SPM 132L xx.1	47,7						■	▒		
SPM 132X xx.1	56,2							■		
SPM 132XL xx.1	62,3							■		
SPM 160M xx.1	65,5							■		
SPM 160L xx.0	76,0								■	
SPM 180MA xx.0	87,0									■

■ Best Option ▒ Valid Options

IN.3.3 GROUND CONNECTION

The ground connections of the drives (screwed-on plates) must go to a single point and from there to the ground terminal of the electrical cabinet. When applying a 10A current between this ground point and any of these points, the voltage drop must not exceed 1 Volt.

When not having a separate ground point, join the plates to the terminal of the Power Supply module which, in turn, will be connected to Mains Ground.



CE directive.

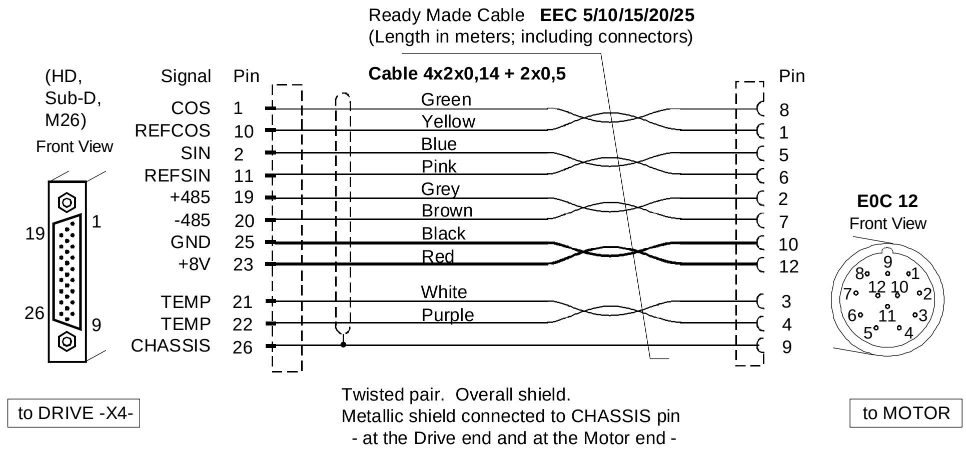
In order to ensure compliance with the European Directive on Electromagnetic Compatibility 89/336/CE, It is a must to:

- **power the system through mains filter EMK**
- **secure the Filter onto a metallic support with a good contact on its whole base, good ground connection and as close to the Power Supply as possible.**
- **Make all the Ground connections indicated on the next figure with a cable having a section equal to or greater than the three-phase power supply and at least 6 mm^2.**
- **always use shielded cables for three-phase motor connections.**

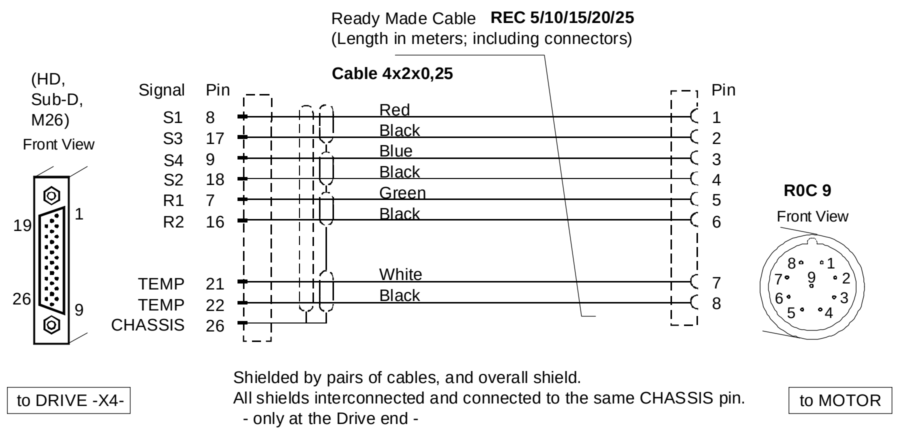
IN.4 CONNECTING THE MOTOR FEEDBACK TO THE DRIVER

Use the cable with connectors supplied by Fagor to lead the motor feedback to connector X4 of the Drive module. The motor feedback can be one of two types: encoder or resolver.

IN.4.1 EEC ENCODER CONNECTION



IN.4.2 REC RESOLVER CONNECTION



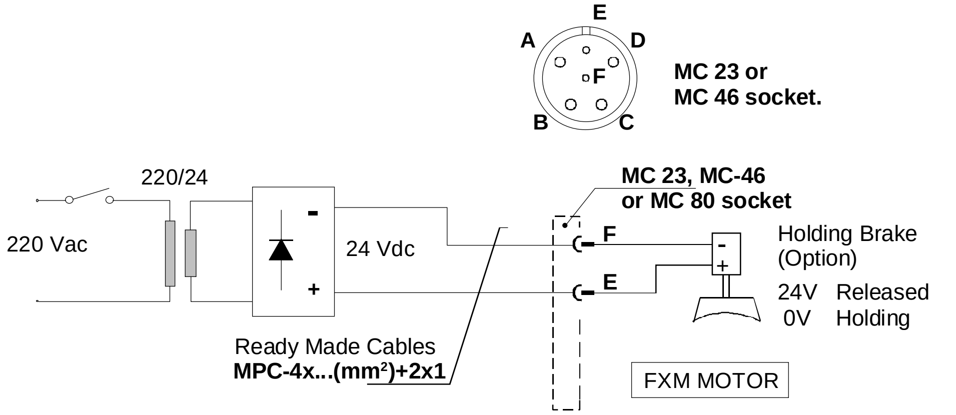
IN.5 BRAKE CONTROL

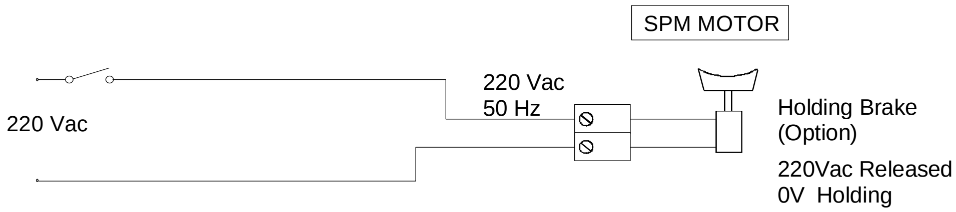
To govern the mechanical brake optionally incorporated on some motors, they have to be supplied with:

- **24 Vdc,** for **FXM** -axis motors-
- **220 Vac** for **SPM** -spindle motors-.

The consumption power of the brakes is indicated on chapters SM and AM.

A simple transformer-rectifier circuit like the one below should be enough to power the FXM motor brake.





Applying the indicated voltages releases the motor shaft.

When installing the motor, verify that the brake fully releases the shaft before turning it for the first time.

The 24 Vdc generated by modules like the PS-25B, APS 24 or XPS, or that being generated by another power supply handles the control signals of the drive MUST NEVER be used to also control these brakes.
These brakes generate voltage peaks that can damage the drive.

On the FXM, watch that no voltage over 26 V is applied which would prevent the shaft from turning.

IN.6 CONTROL POWER SUPPLY FOR THE MODULES

The internal circuits of all electronic modules need 24 Vdc.

The PS-25A and PS-65A power supply modules and modular Drives must be supplied with this voltage through their X2 connector.
These modules have stabilizing system for the supplied voltage.

The maximum consumption of each module is: **PS Power Supply .... 1 Amp.**
Modular Drive ....2 Amps.

Important:

The 24 Vdc voltage supply is essential for the system to run.

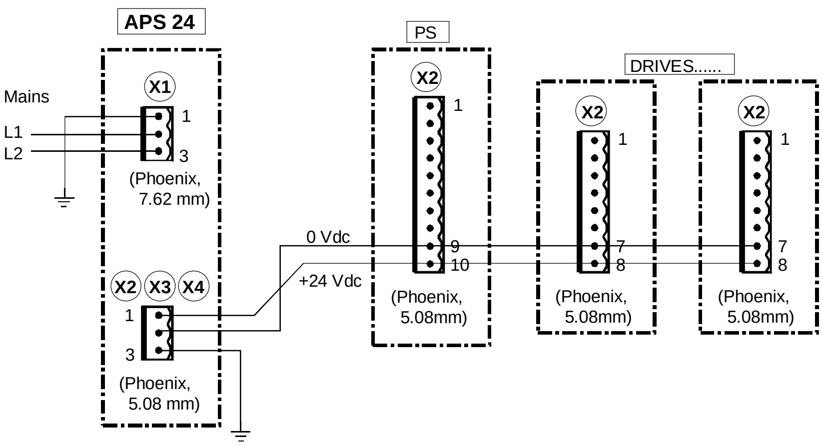
The APS 24 auxiliary power supply offers these 24 Vdc and 10 Amp.
Regenerative power supplies XPS-25 and XPS-65 and the PS-25B power supply are self-supplied and they also offer 8 Amps of these 24Vdc.
Compact Drives are self-supplied and offer up to 110 mA of these 24 Vdc.

Important:

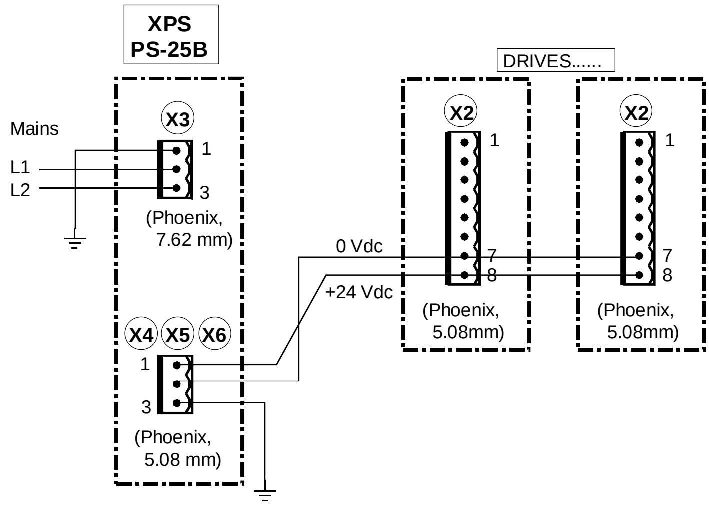
All these 24 Vdc power supplies assure the presence of this voltage as long as the motor braking lasts due to mains power outage.
This is a must for obtaining the "CE seal" for the machine.

These 24 Vdc can also be used in the circuit of the electrical cabinet, but <u>NEVER</u> to activate the brake of a motor.

<u>Connection of the APS power supply.</u>



Connection of the PS-25B and XPS power supplies



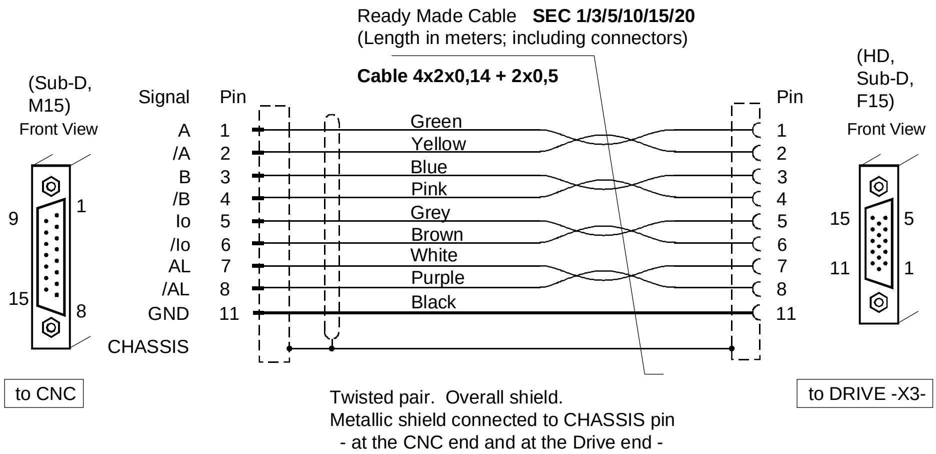
IN.7 CONTROL AND COMMUNICATION SIGNALS

Connect the encoder simulator signal to the CNC.
If the Drive is going to work with analog interface, take the ±10 Vdc velocity command from the CNC.
When working with Sercos interface, identify the Drives and connect them with each other.

IN.7.1 ENCODER SIMULATION CONNECTION, SEC

Depending on the type of motor feedback, the drive generates a set of signals that simulate the TTL signals of an encoder mounted onto the rotor of the motor.

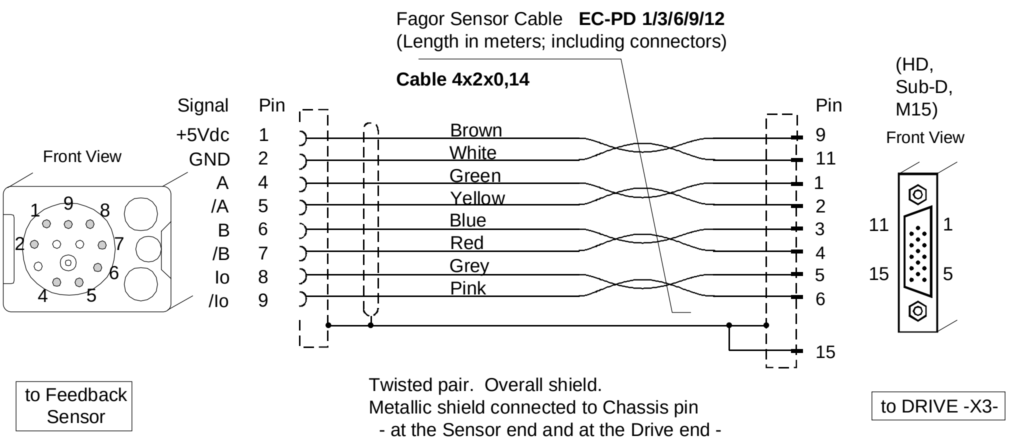
Take these signals from the Drive to the CNC with the SEC cable.



IN.7.2 DIRECT FEEDBACK CONNECTION

When using the drive as a positioning drive (with the 8070 CNC or independently -Motion Control-).

Take these signals from the feedback to the drive.



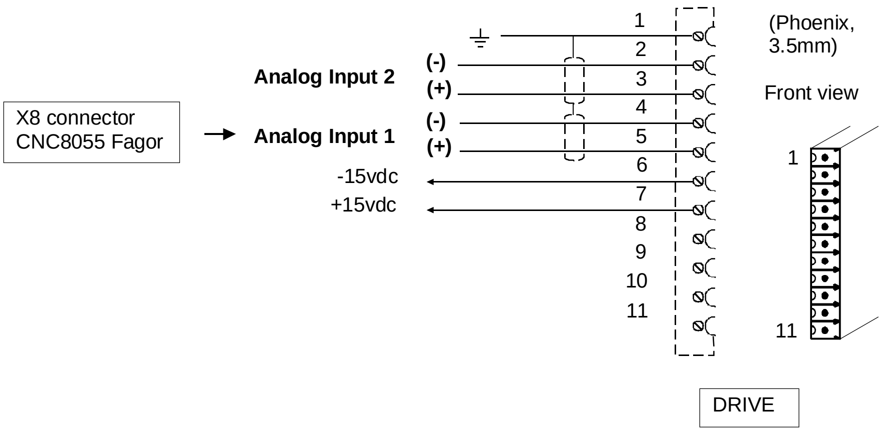
IN.7.3 ANALOG VELOCITY COMMAND

Take the analog velocity command from the CNC to the Drive.

Connector X7 of the drive has two analog inputs. By means of an internal parameter IP1 -F00900-, it is possible to select which one the drive has to attend to.

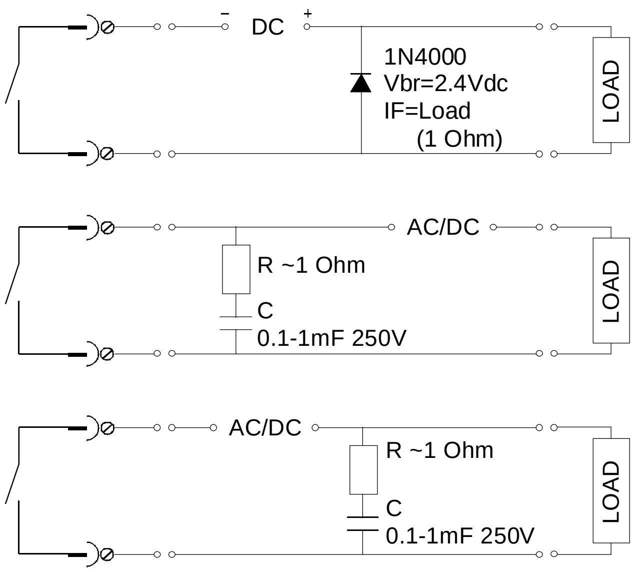
F00900 = 1 Main input (Analog Input 1, pins 4/5 of X7)
F00900 = 2 Auxiliary input (Analog Input 2, pins 2/3 of X7)

The connector offers ±15 Vdc to easily generate the velocity command with a potentiometer.



IN.7.4 DIGITAL OUTPUTS

When the drive digital outputs are connected to inductive loads, we must protect the opto-coupler with circuits such as the ones shown here:



IN.7.4 SERCOS CONNECTION

Identification.

Distinguish each Drive by means of the 16-position rotary switch (Node_Select) with sequential numbers starting from One. After any change at the Node_Select switch, the module has to be reset for the change is assumed.

Important:

Give to the SERCOSIS parameters of the CNC the same id numbers as the ones assigned by means of the Node_Select switch. See drawing.
If the same motor is to be used as "C" axis and "spindle", the two CNC tables must have the same value for the SERCOSID parameter.

If the Zero identifier is assigned to a Drive, that module will be ignored, even when the ring stays closed for all purpose for the rest of the elements. That drive may receive the velocity command in an analog way and can be adjusted through the serial line.

Important:

For example, a system with four drives identified as 1,2,3,4. If we wish to ignore the second one, we must renumber some of the other ones so they are sequential. The easiest way would be: 1,0,3,2.

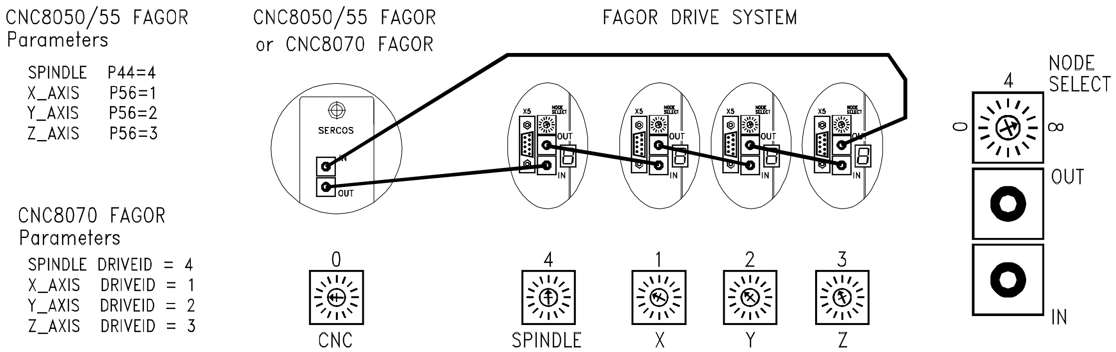
Remember that the SERCOSID parameters of the CNC can also be modified the same way.

Interconnection.

Connect in the Sercos ring all the drives that will be governed by the CNC.
Connect, with each fiber optic line, an OUT terminal with another IN terminal. See drawing.

Each Drive comes with a fiber optic line to connect it to the adjacent module. Fagor provides the other necessary fiber optic lines upon request.

If the machine has two separate servo drive systems (each with its own power supply) and a single CNC, the same ring must interconnect all the drives of the machine.



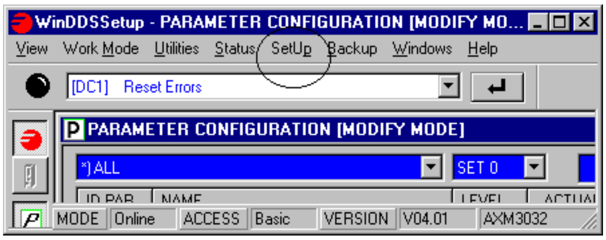
IN.7.5 SERIAL LINE CONNECTION

To transfer the parameter table and set up the system, the drive must be connected to a **PC-compatible** computer or with the **Programming Module** "DDS PROG MODULE" through a serial line.

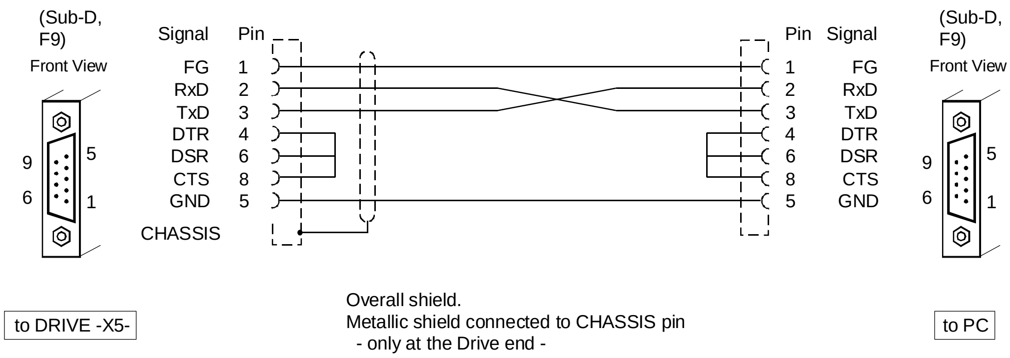
The metal shield must be soldered to the hood of the connector at the Drive end. The pins labeled as "Reserved" in the drawings MUST NOT be connected anywhere by the operator.

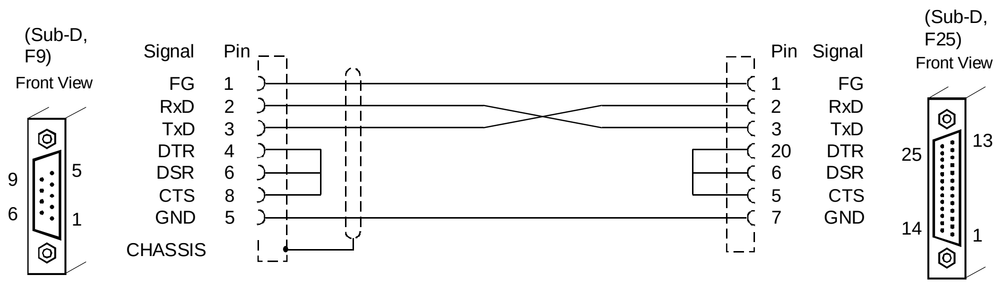
Serial line to a PC.

If the PC has more than one serial port, it must be selected by means of the setup window of the communication program WinDDSSetup. See the GSU chapter



The "serial port" of the PC may be accessible through either a 9-pin or a 25-pin SUB-D type connector.

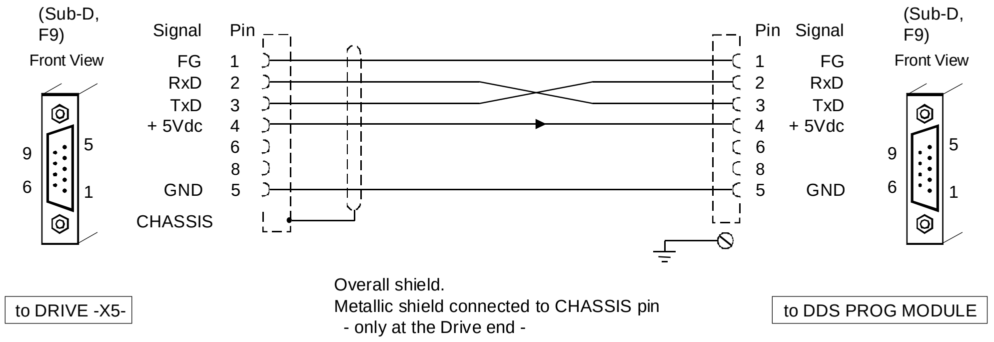




Serial line to DDS PROG MODULE.

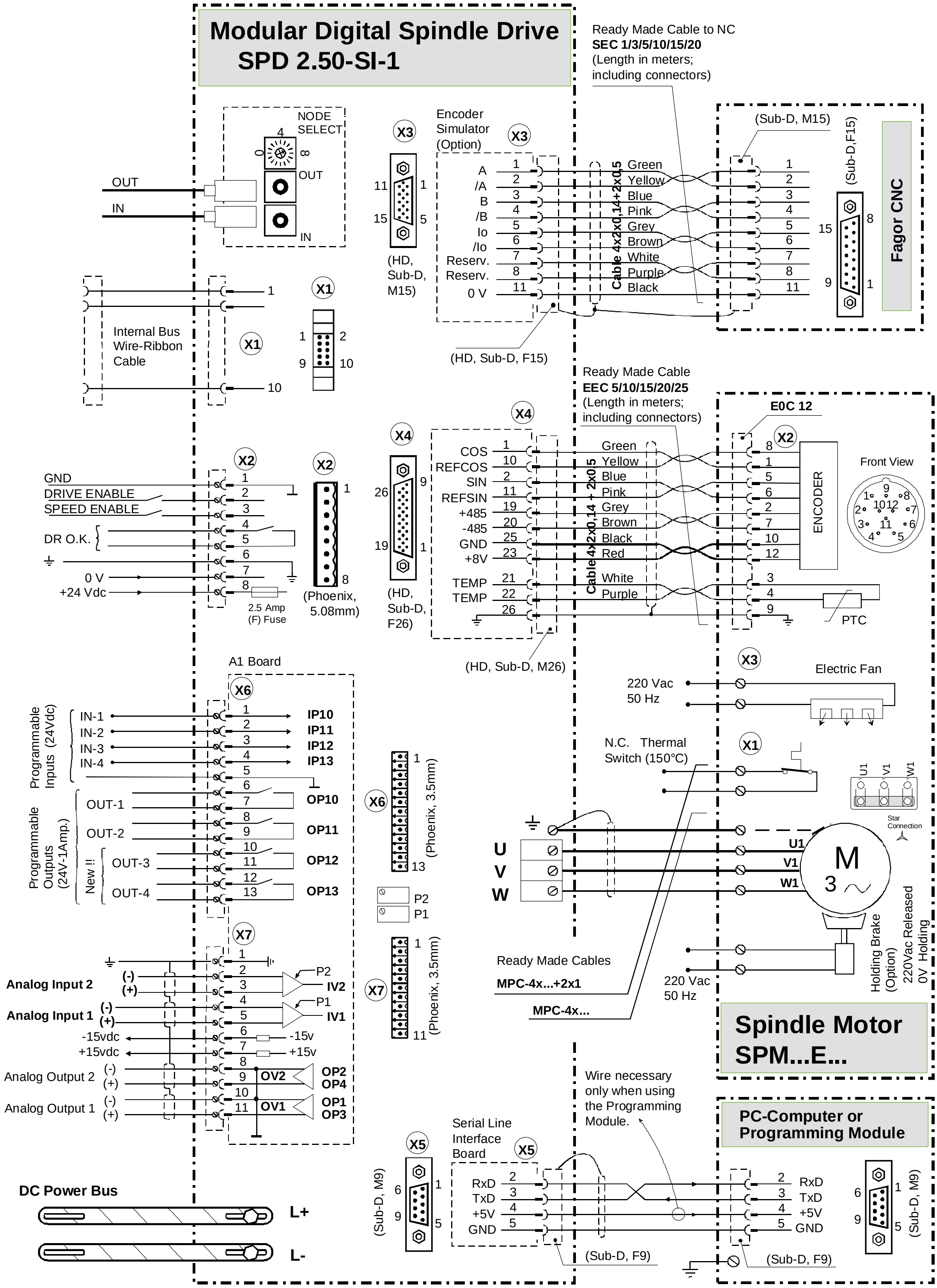
The line labeled as +5V is only required when using the Programming Module "DDS PROG MODULE".

When mounting the Programming Module away from the drive, the screw located next to the connector should be connected to a Chassis pin.

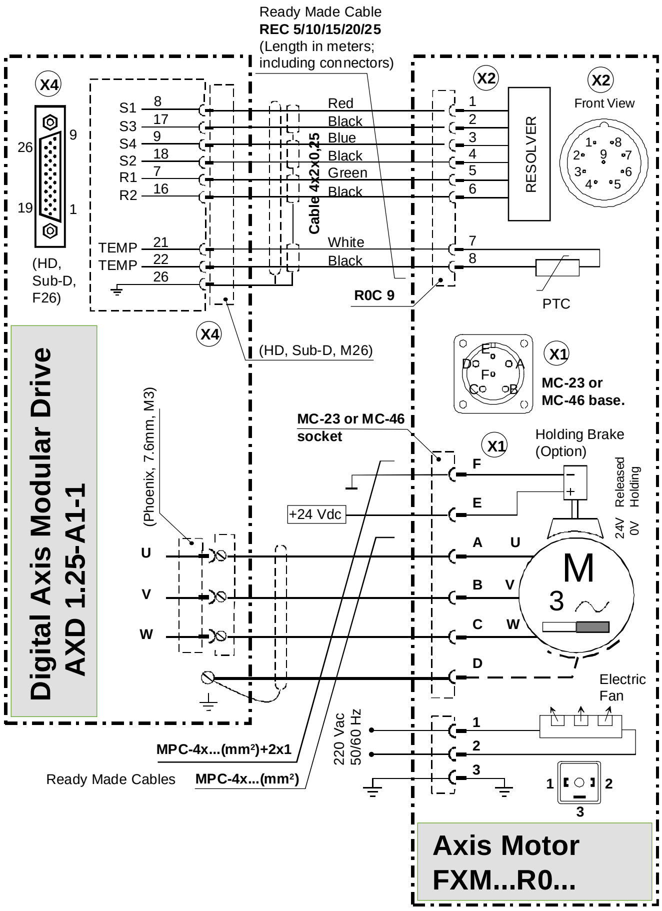


IN.8 CONNECTIONS

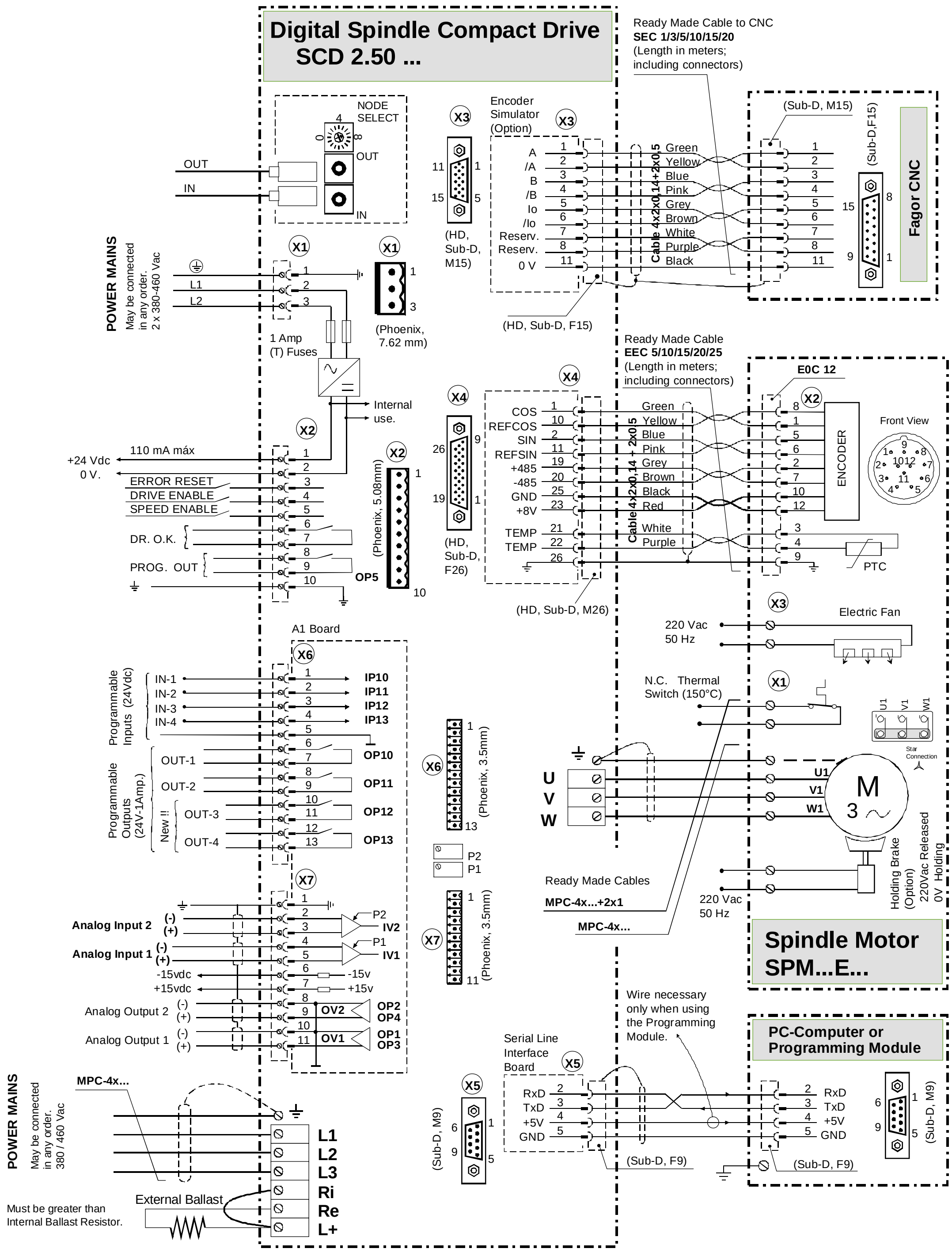
Connection of an SPD module with an SPM spindle motor and encoder feedback.



Connecting an AXD module with an FXM servomotor and resolver feedback.



Connection of an SCD module with a spindle motor SPM and encoder feedback.



IN.9 ELECTRICAL CABINET DRAWINGS

Let us first see which is the system power-up procedure.

The internal control circuits of each Power supply module, Drive or compact drive must be supplied with 24Vdc.

Compact modules, XPS power supplies and the PS-25B power supply do not need an external 24 Vdc power supply. These modules need two-phase 380-460 Vac.

Each module verifies its hardware and internal configuration.
If the status is correct, the DRO.OK contacts are closed.
If all the drives are OK, the Power Supply closes its "System OK" contact.
We supply mains power to the Power Supply module.
The Power Supply "loads" the Power Bus with a "Soft Start".
We activate the Drive_Enable control input of each Drive.
We activate the Speed_Enable control input of each Drive and the System_Speed_Enable input of the Power Supply.
The motor is now ready to follow the velocity command given by the CNC.

The following diagrams for power and control circuits in the electrical cabinet are <u>only orientative for the technician designing the machine and they may be further completed or simplified at will</u> according to each application.

Next, we offer a brief description of the function of each part of the circuit.

When turning the main switch on (Q1), the 24 V power supply powers the control circuit of each module. These circuits perform an internal test of the module. If there is no errors, the corresponding Driver_OK contact closes and this status is communicated to the Power Supply module via the internal bus. If all the modules associated with a Power supply are "OK" and the latter does not detect any errors in its own module, it closes the System_OK contact.

In the case of the compact modules <u>as well as the XPS and PS-25B</u> power supplies, the closing of Q1 must take two phases to connector X1 without the need for external fuses.

Emergency line. The D1 relay confirms that the system is mechanically and electrically in working condition and it will be activated by the System_OK contact of the Power Supply. D1 will be deactivated if an emergency occurs at the CNC, if the operator presses the E-stop button (mushroom), if the SPM motor overheats or if any axis of the machine hits the end-of-travel (limit) switch. A normally open push-button is included in parallel with the limit switches in order to be able to take apart the axes of the machine.

We are now ready to turn on the system by pushing the ON button which activates contactor K1. By pushing OFF, power can be removed.

Error Reset. Should any module have errors, its Driver_OK and the System_OK would be open, D1 deactivated, and the Power Supply could not be powered up. Some of these errors may be eliminated by applying 24 Vdc to the Error_Reset pin of the Power Supply. The errors are reset by means of the contact associated with the ON button. This may cause the Driver_OK and System_OK contacts to close activating D1 and, while ON is pressed, activate K1.

This circuit configuration joins the error reset and the system power-up in a single push-button.

Activating D2 activates the relay D3 which in turn confirms the Drive_Enables of all drive modules. The green and red lamps indicate that there is or not motor torque (Drive_Enable).

When activating the System_Speed_Enable signal of the power supply, the D2 contact is executed.

Now, the CNC may enable each axis (CNC_Enable) and confirm the Speed_Enable signal to each drive by means of D4, D5, D6 and D7. Remember that a drive will only respond to an external velocity command when the Drive_Enable, Speed_Enable and System_Speed_Enable signals are active (24 Vdc).

Stop. When D1 is deactivated on the emergency line or the OFF button is pressed, K1 is deactivated and the power supply loses its three-phase power. The System_Speed_Enable signal drops and, with zero velocity command, the motors try to stop.
To obtain a controlled stop, with torque:

- the drives' control circuits must be under power and
- the Drive_Enable signal must remain active while braking the motor.

These two points are obtained:

- using a 24Vdc power supply that maintains those 24Vdc by using the energy returned by the motor to the power bus. The auxiliary power supply APS 24, as well as the internal power supplies of the XPS, PS-25B, and compact modules meet this condition. (24 Vdc (*) on the diagrams)
- delaying the cancelling of D3 and using a maintained 24Vdc voltage to activate the Drive_Enable pin shown with an asterisk (*) on the diagram.

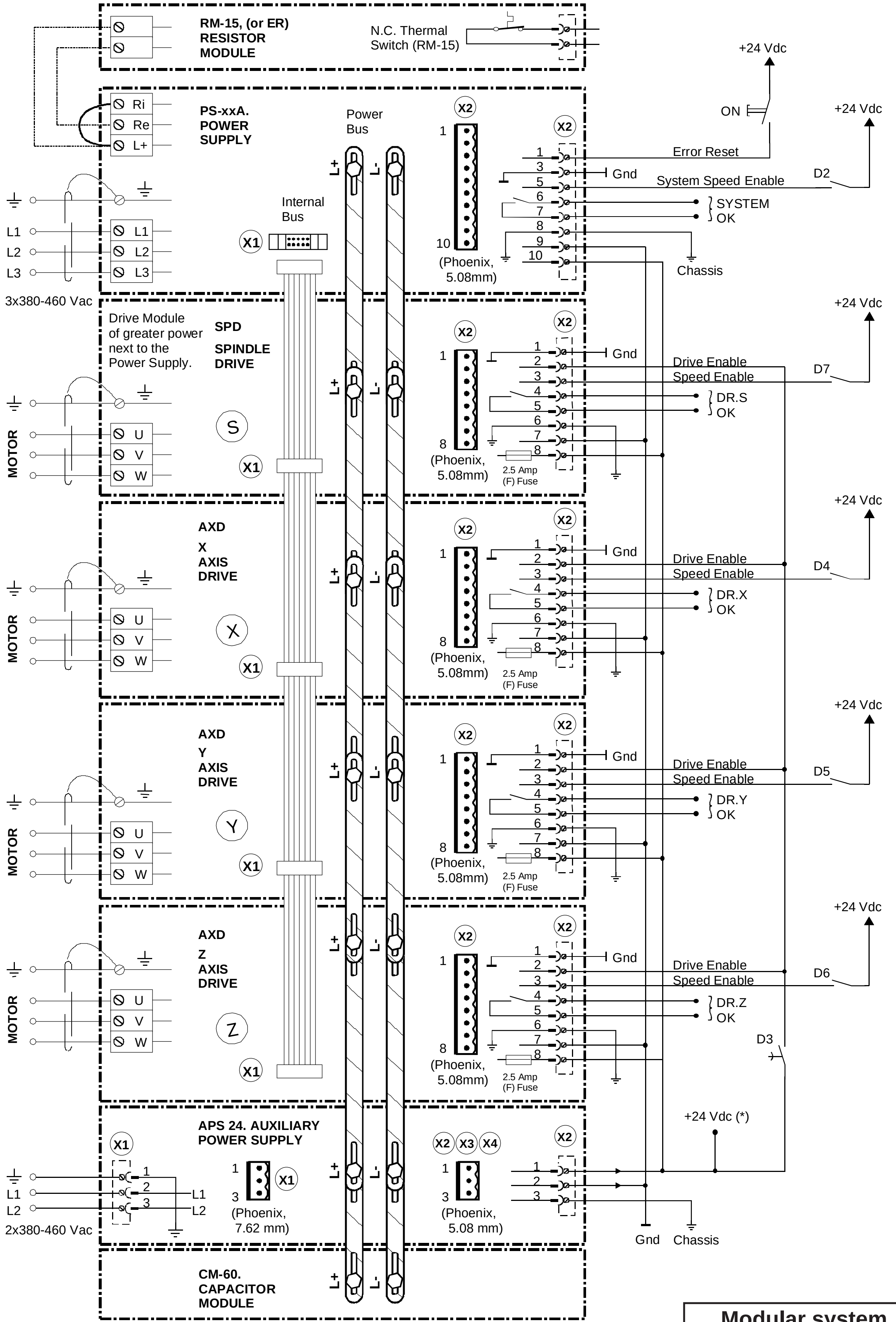
When opening Q1, the braking must also be controlled.

Controlling the brake. In some applications, the Z axis on a milling machine, a electromechanical brake is used over the rotor in order to lock it.

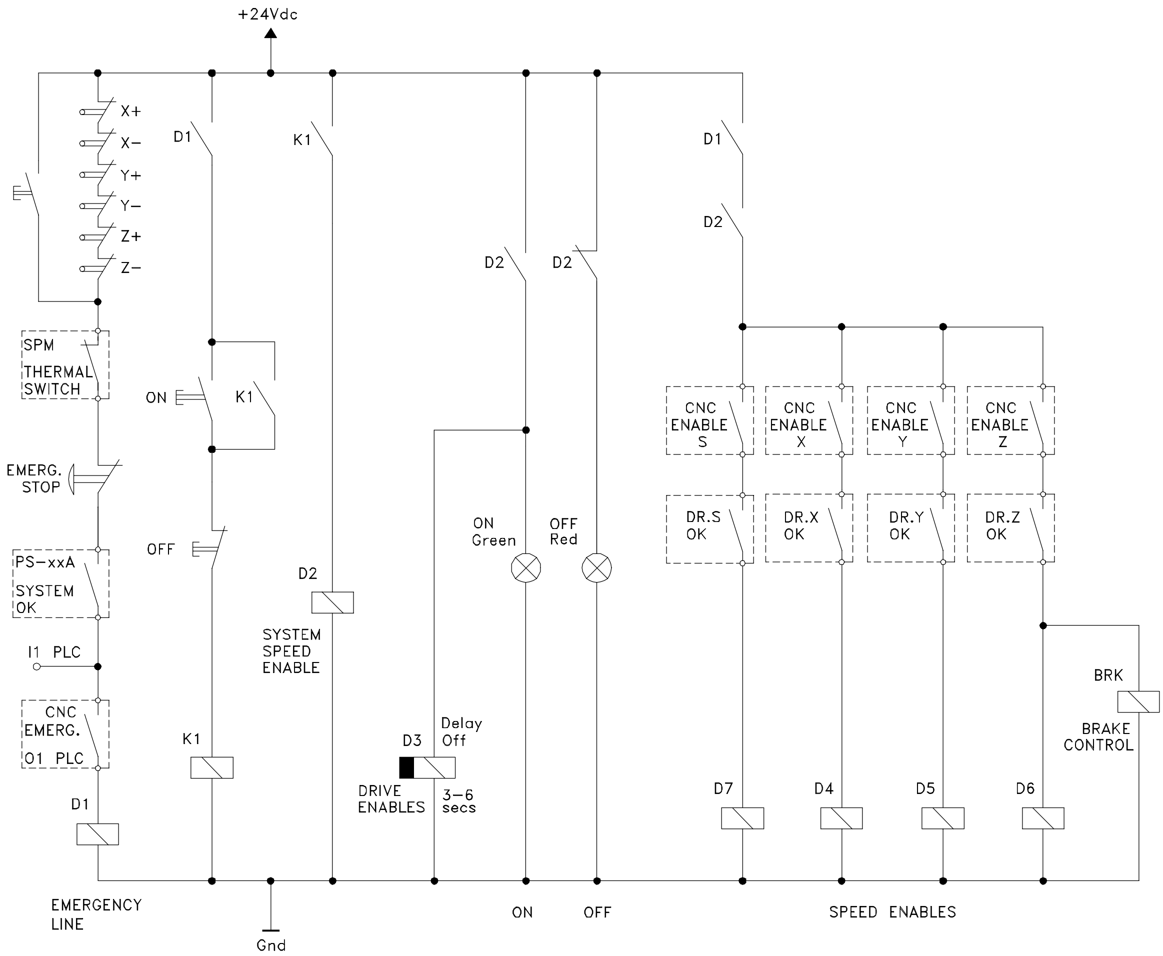
The brake holds the rotor when it loses voltage at its terminals. Therefore, when the machine is down, the brake locks the Z axis so it does not drop. The reaction time of a brake may be anywhere from 200 ms to several seconds.

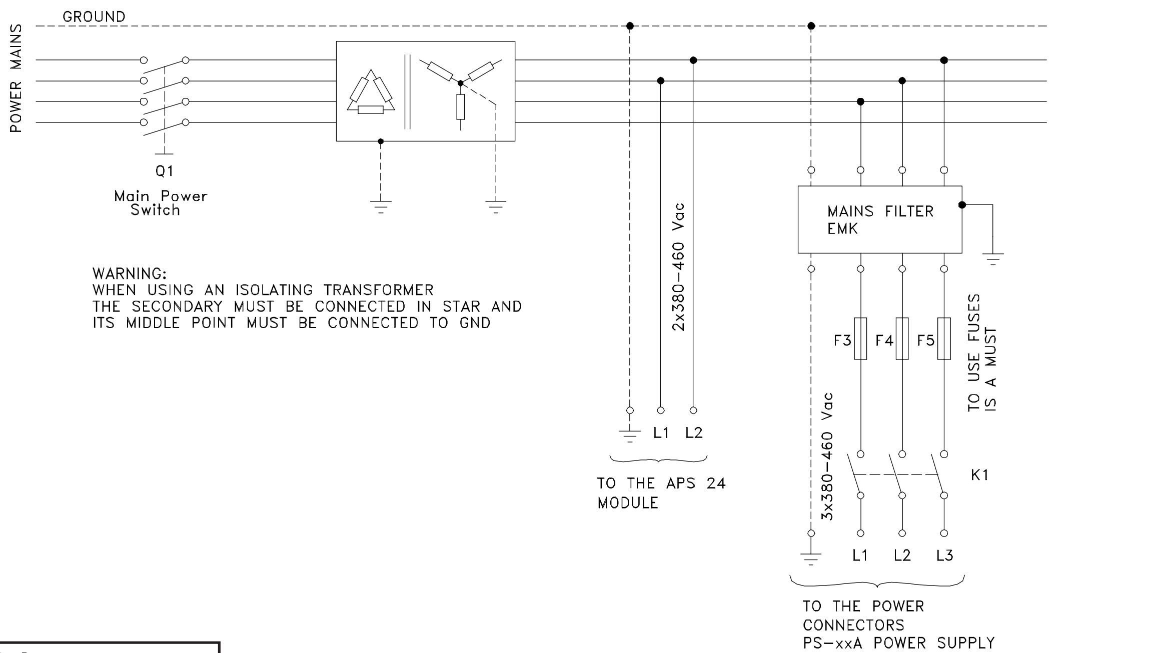
While the brake is locking the motor, the motor must be kept with torque. To do this, the drive has parameter GP9 -S00207- DriveOffDelayTime. This GP9 indicates how long the drive will maintain its torque active after stopping the motor (speed ~ 0) . GP9 -S00207- is given in milliseconds. By assigning to GP9 a value slightly larger than the brake holding time, one assures that the axis does not drop in emergency stops.

When powering the machine up, the brake must not be released until the system assumes control of that axis. This can also be controlled by means of internal variable TV100 -F01702- TorqueStatus.

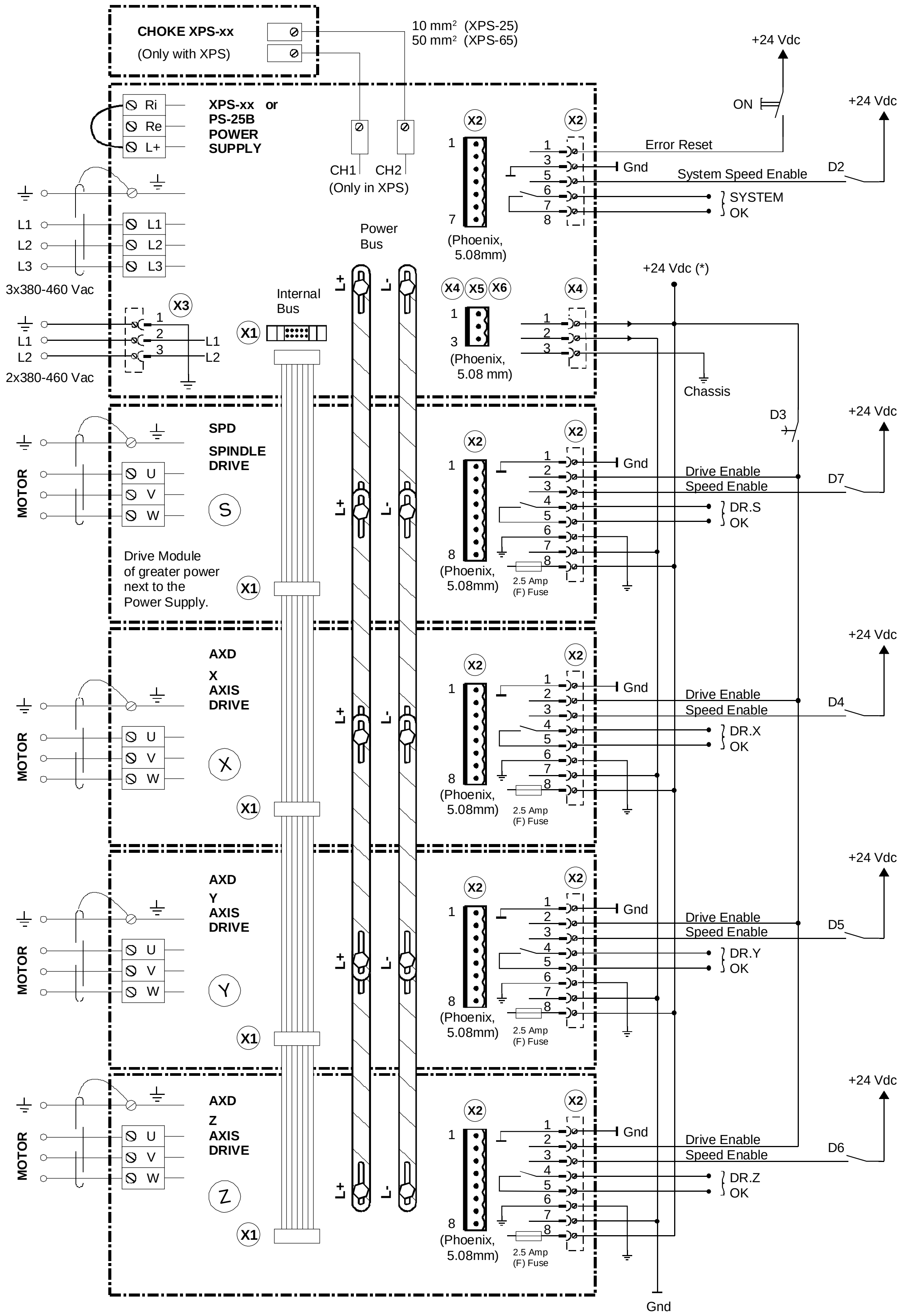


Modular system with PS-xxA.



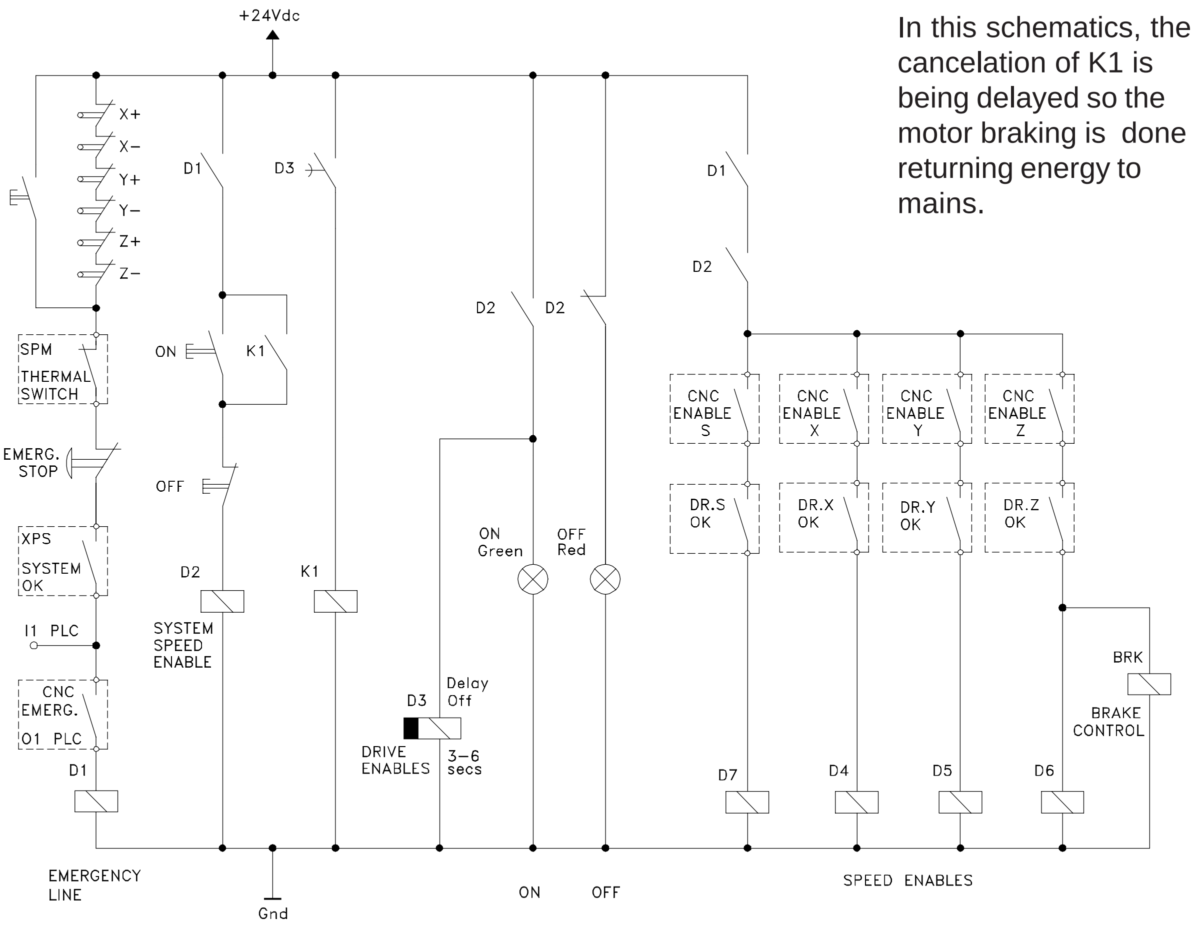


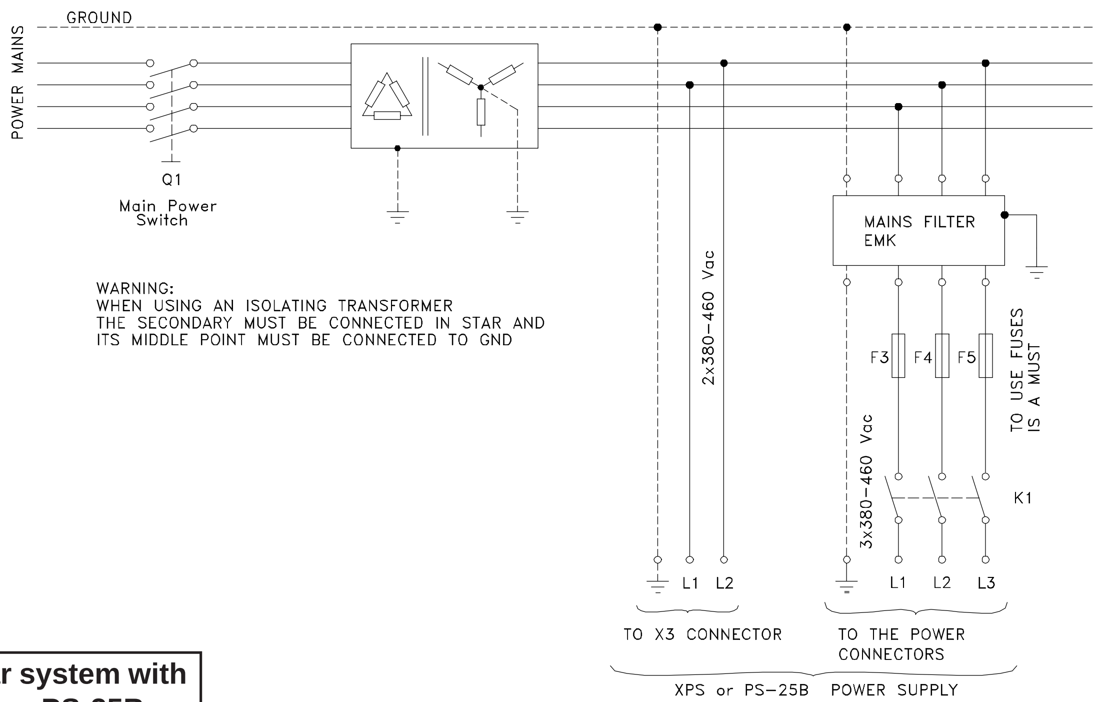
Modular system with PS-xxA



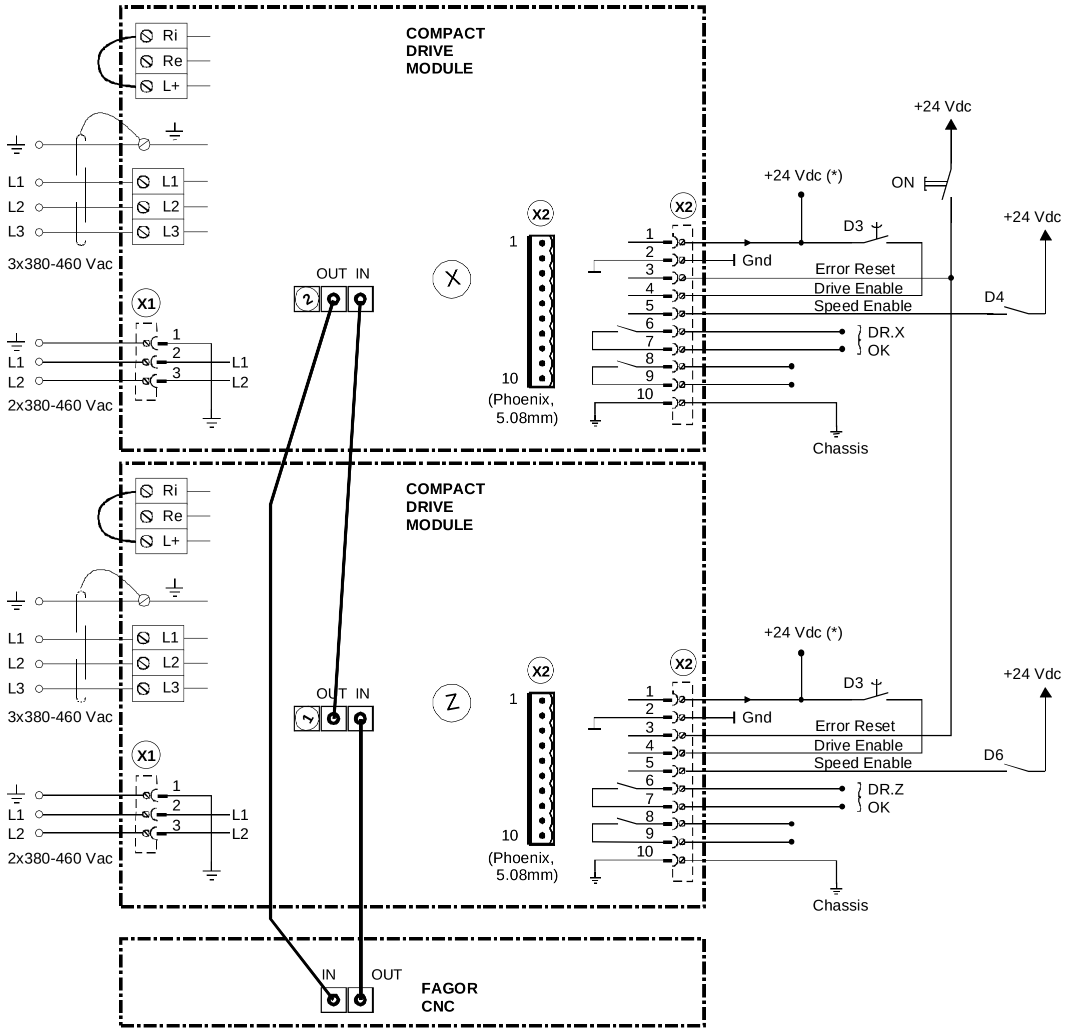
Modular system with XPS or PS-25B.

In this schematics, the cancelation of K1 is being delayed so the motor braking is done by returning energy to mains.





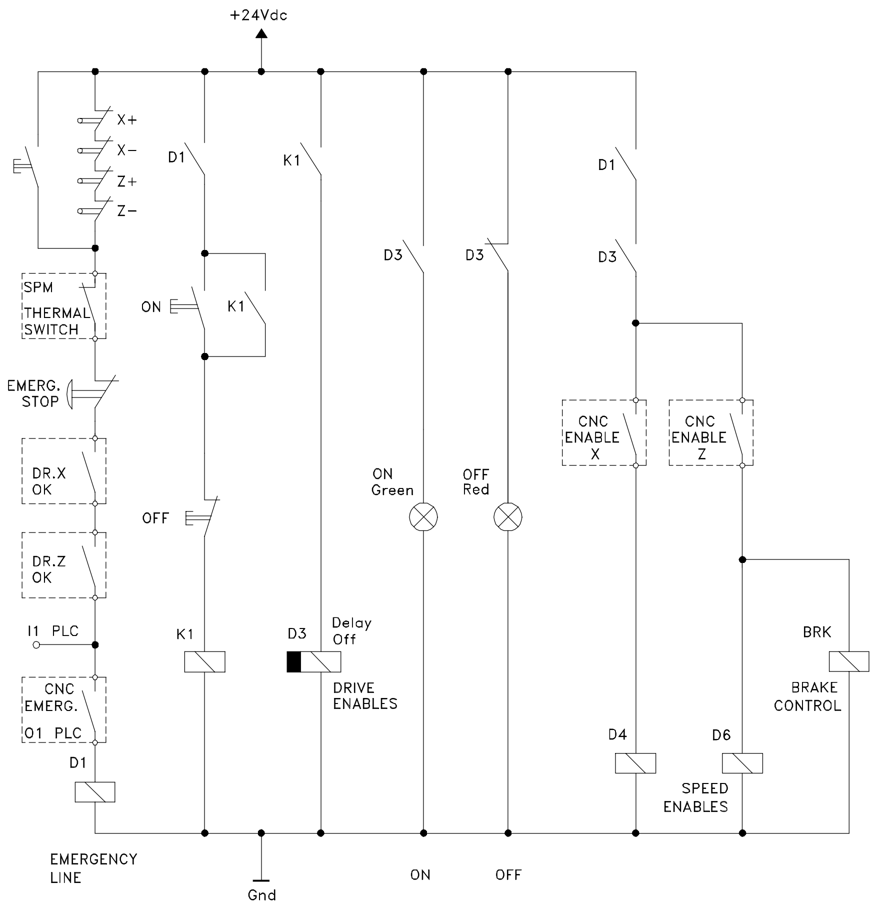
Modular system with XPS or PS-25B.

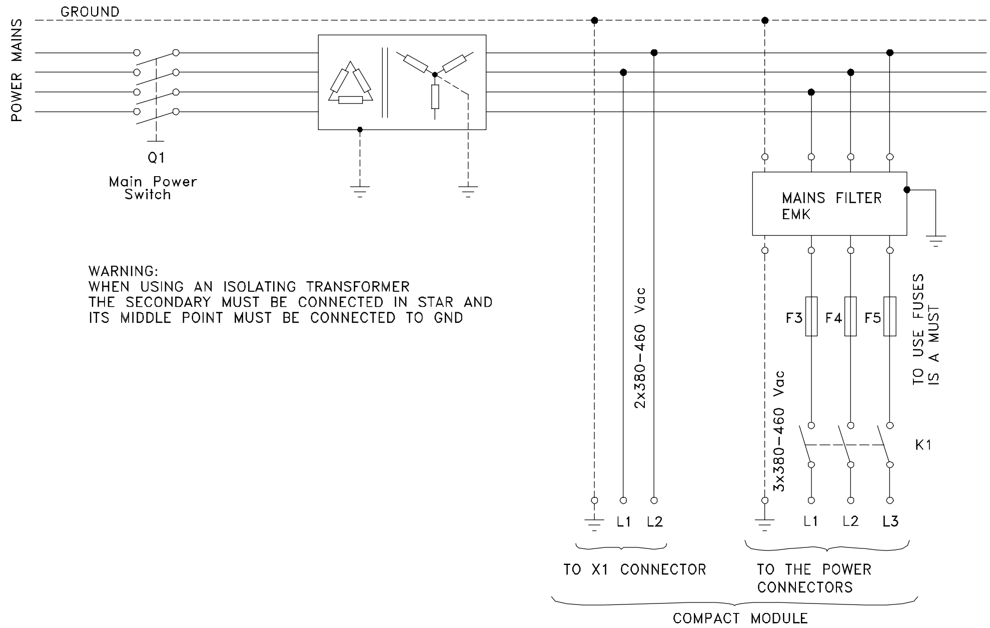


Compact modules do not have the System_Speed_Enable signals.

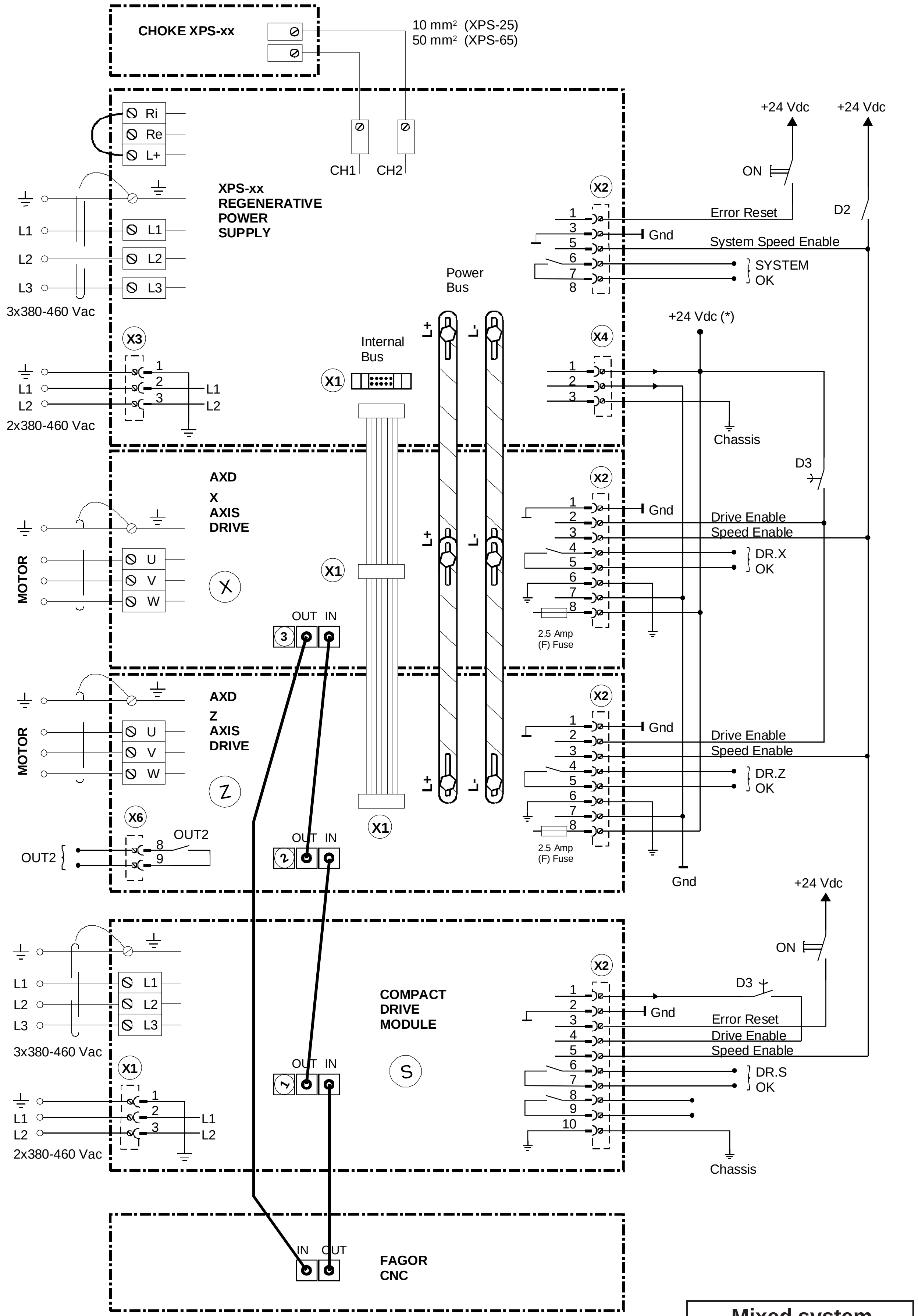
In this schematics, in spite of having Sercos interface, electrical signals are used to activate the enables.

Compact system with Sercos

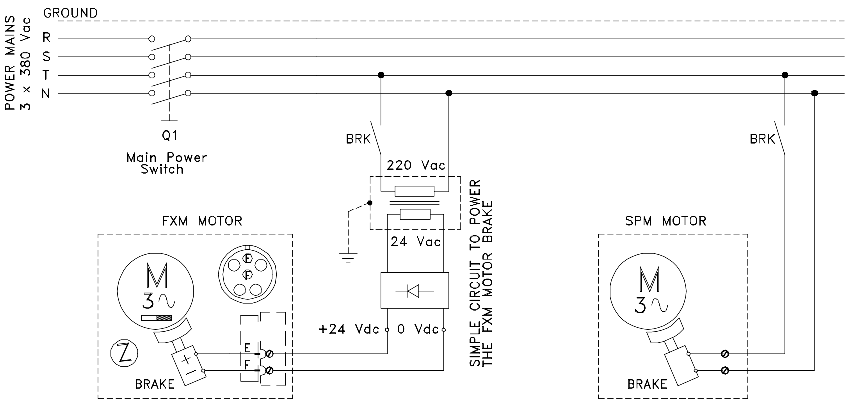




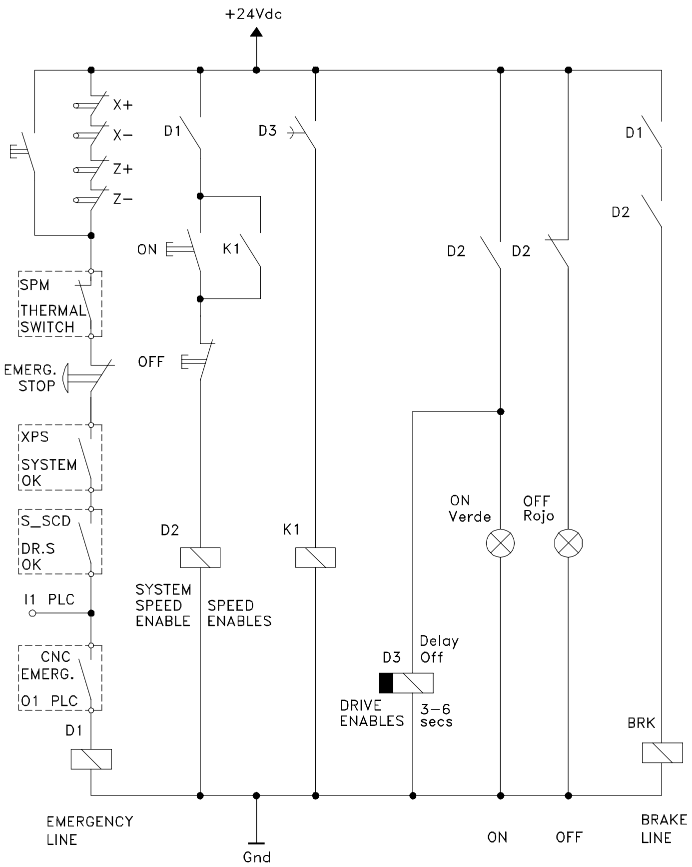
Compact system with Sercos



Mixed system with Sercos



Brake connection



Mixed system with Sercos

User notes:

GSU. COMMON SETUP

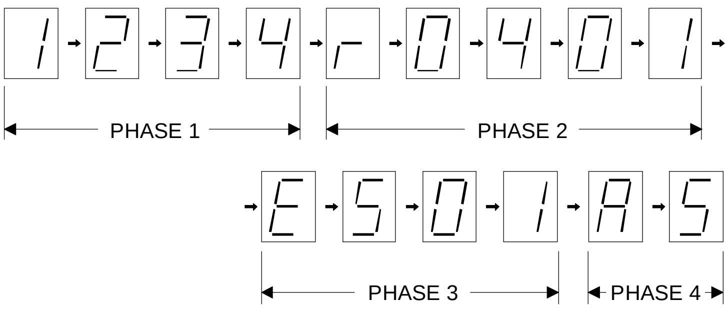
This chapter describes some of the steps of the adjustment process for the drive module DDS. It only considers the ones that are common to the "Velocity drive" and "Position drive" applications. The specific steps of each application are described in the following SSU and PSU chapters.

GSU.1 MODULE POWER-UP

When powering up the DDS module or doing a Reset, various messages appear on the seven-segment display:

1.- Initializing stages: values 1, 2, 3 and 4 are shown.
2.- Software version, after the "r" with the identifying digits.
3.- Error listing.
4.- Warning list.
5.- Return to step 3.

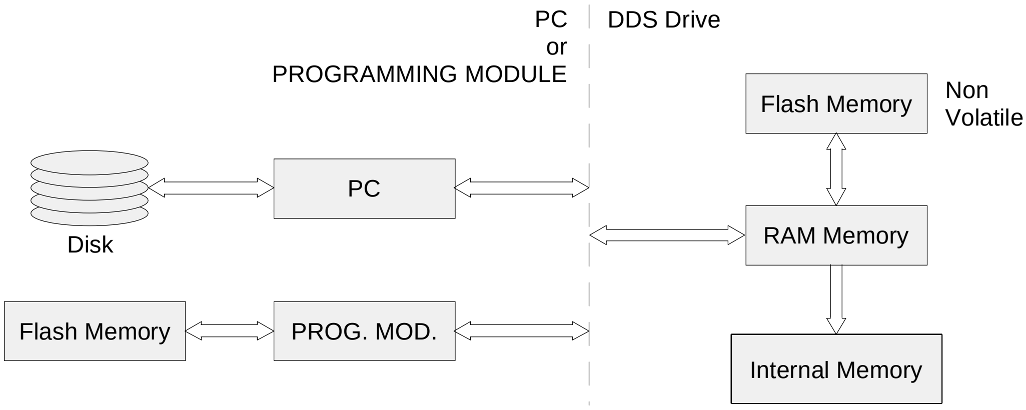
Phases shown on the 7-segment display (04.01 version) DDS



GSU.2 DATA STORAGE STRUCTURE

Both the PC and the Programming module as well as the Drive itself have nonvolatile memory: the **hard disk** and the **Flash** memories respectively. These systems keep the stored data even when power is removed.

Also, the Drive has another two memory areas used for its internal operation and communications: **Internal memory and RAM memory**. The diagram below shows the interconnection between all of them.



> **Very important:**
>
> **The operation of the Drive depends on the data stored in its internal memory.**

GSU.3 WINDDSSETUP

With the Fagor program **WinDDSSetup** (Windows based) it is possible to set up the Drive through the **serial line**.

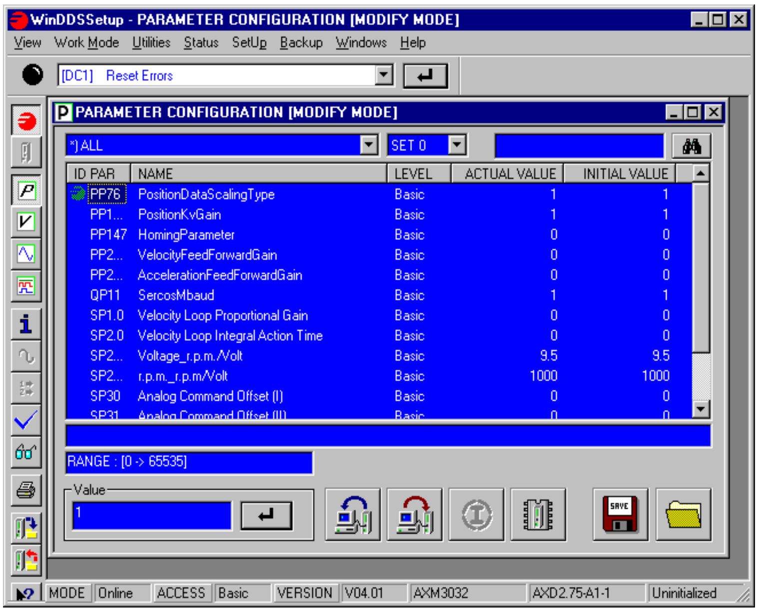
To install this program at the PC, execute **setup.exe** which comes in Floppy Disk number 1 of the **DDS-SETUP**.

Important:

The minimum PC hardware requirements for the proper operation of the WinDDSsetup are:

486 microprocessor at 66 MHz and 16 Mb of RAM.

It may also be adjusted from the portable Programming Module "DDS PROG MODULE" although with fewer choices than those offered by the PC program.



GSU.4 ACCESS LEVELS

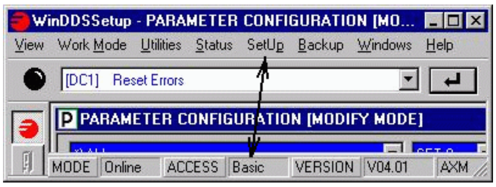
A parameter table determines the operation of the Drive depending on the motor it governs and on the desired behavior.

All these parameters, variables and commands of the Drive are organized by access levels.

These levels are: 1.- USER level.
2.- OEM level. 3.- FAGOR level

To access each parameter, the drive must be set up at the access level required by that parameter. See appendix A.

The access to each level requires a password.
To change the access level from the WinDDSSetup program, execute the "Access Level" option on the "SetUp" menu. The bottom of the screen shows the currently active level.



The **USER level** is the basic level. On power up, the Drive access this level by default, thus not requiring password.

At USER level, it is possible to access a group of parameters that slightly modify the behavior of the Drive depending on the application developed.
(Free access).

The **OEM level** is an intermediate access level. Appendix A describes which variables, parameters and commands may be accessed from this level.

At OEM level, it is possible to access a large group of parameters depending on the motor being connected which set how the electronics of the Drive is adapted to that particular motor and to the particular application being developed. (Access restricted to the Fagor Servo Drive System installer).

The **FAGOR level** allows full access to all system variables, parameters and commands.

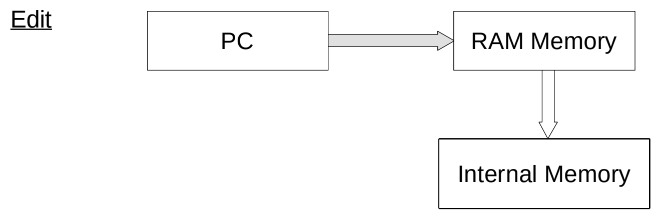
At Fagor level, it is possible to access a group of parameters depending on the electronics of the drive and that are factory sets. (Access restricted to the manufacturing process and technicians from Fagor Automation).

GSU.5 PARAMETER EDITING

Regarding the editing of parameters, the following warning must borne in mind:

Important:

The editing of parameters with WinDDSSetup or with the portable Programming Module affects all the data stored in the drive's RAM memory.



Only the modification of certain parameters (CP30 -F00308-, SP1 -S00100-, SP2 -S00101-, SP4 -S00211-, SP5 -S00212-, SP30 -F01603-, SP31 -F01604-, OP1 -F01400-, OP2 -F01401-, OP3 -F01402- and OP4 -F01403-) also affects the data stored in internal memory.
These parameters may be changed On-Line.

In order for the changes made in RAM memory to have an effect on the Drive's behavior, they must be **Saved into Flash memory** and the Drive module must be **Reset**.
See the following sections of this chapter.

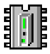
GSU.6 SAVE INTO FLASH MEMORY

In order for the values given to the parameters during setup stay as a permanent Drive configuration, they must be transferred into the Flash memory.

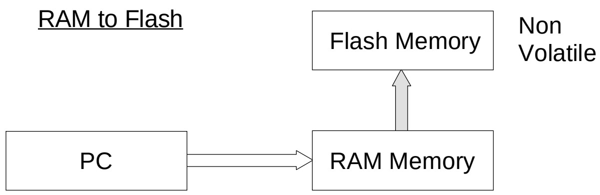
1st.- The Drive must be connected to power.

2nd.- Save the parameters

To do this, execute the command to save into Flash.

- At the WinDDSSetup, press the  button
- With the command **ParametersToFlash** of the portable programming module.

When it is done saving, the Status Display will display the OK message or the errors (if any). Then, it requests whether the Drive is to be Reset or not.

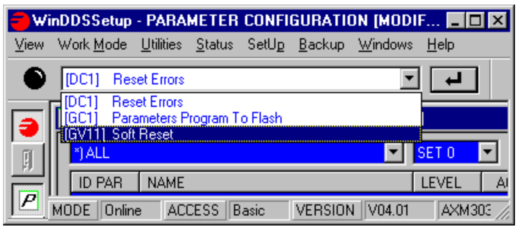


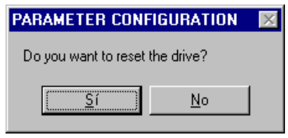
3rd.- Then, the Drive should be Reset.

GSU.7 INITIALIZATION PROCESS

Turning the Drive causes it to Reset. This reset may also be caused by the user:

- By means of the push-button located on top of the drive module.
- With the **SoftReset** command of the portable programmable module.
- At the WinDDSSetup program using the **[GV11] Soft Reset** command. See figure.





This Reset has the following effect:

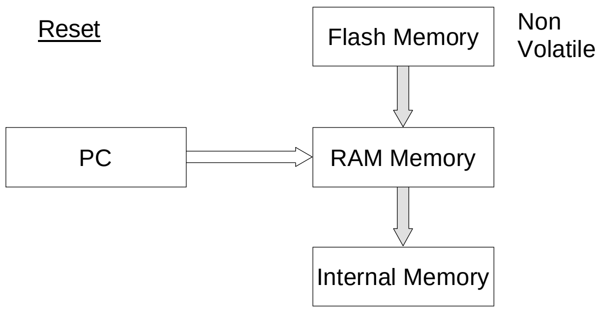
- The Status Display shows the initialization sequence.
- The data stored in the Flash memory (parameters and variables defining its configuration) go into **RAM** memory, and from it into the **internal memory**.
- The data is cross-checked and verified.
- Any detected errors are indicated on the display of the face plate.

Error Reset.

If the system detects any errors, their cause must be removed and then, an "Error Reset" must be done.

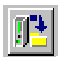
- **Electrically**, through pin X2(1) of the Power Supply (pin X2(3) at the Compact).
- Executing the command: **[DC1] Reset Errors** at the WinDDSSetup program.

There are errors considered as "non-resettable", See Appendix B.
These errors can only be eliminated by a Reset of the Drive.



GSU.8 TRANSFERRING PARAMETER TABLES

From the **Flash** of the Drive to the hard disk of the **PC**:

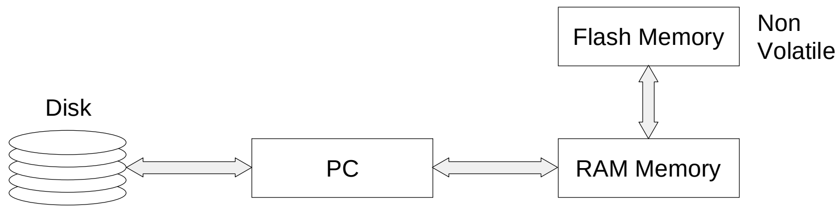
- at the WinDDSSetup program, press 

  it is used to save the configuration of a drive

From the hard disk of the **PC** to the **Flash** of the drive:

- at the WinDDSSetup program, press 

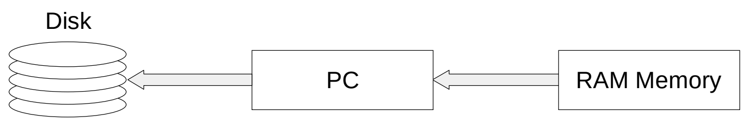
  it is used to copy a known configuration into a new Drive.



From **RAM** of the Drive to the hard disk of the **PC**:

- at the WinDDSSetup program, press 

  Warning: This operation saves into the PC the parameter table stored in RAM of the drive, which cannot coincide with the data stored in the Flash of the drive.
- at the portable module, execute the command: "Parameters\Save DDS->PM"

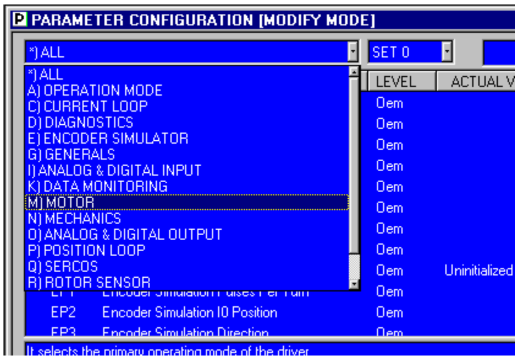


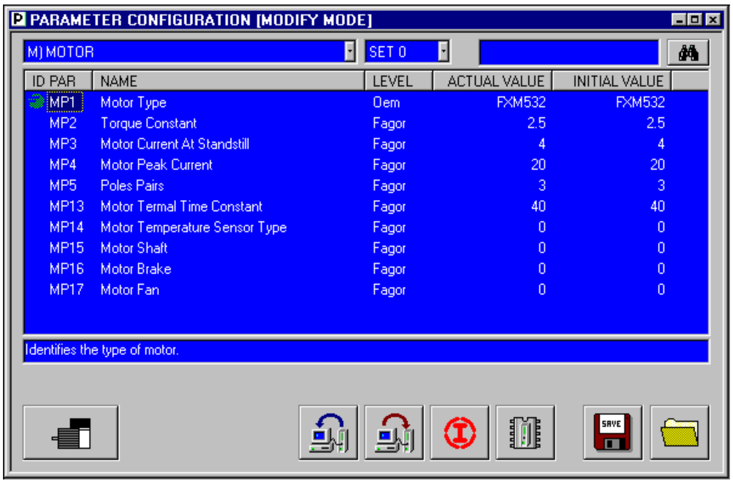
GSU.9 MOTOR IDENTIFICATION

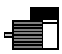
Each motor appearing in this manual requires a specific configuration of the drive software. This software contains a table with the right parameter data for each of these motors. Appendix A shows which parameters are related to the motor.

In order to set the right values in these motor-related parameters, one must communicate to the drive which motor it is going to govern.

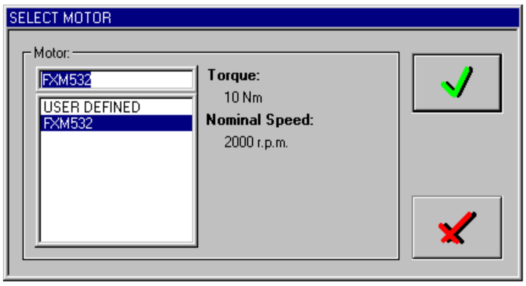
At the WinDDSSetup program, select the editing of M parameters.



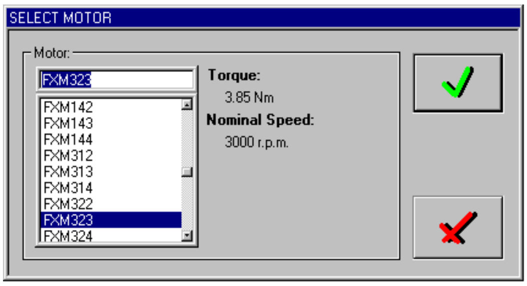


At the OEM access, click on the  button to select the motor.

The motor selection window will be similar to one of these:



Motor with Encoder feedback.



Motor with Resolver feedback.

<u>When the Motor uses Encoder feedback:</u>

The new Fagor motors equipped with Encoder feedback (ref. E0, E1 or A0) store the motor sales reference in the encoder's permanent memory.

Software version 03.03 and later are capable of reading this reference and executing an automatic motor identification process. This way, the motor selection window only offers the possibility to choose between the motor currently connected and a "user motor".

This automatic process does not include the adjustment of the PI which must be done by the user.

<u>When the motor uses Resolver feedback:</u>

Fagor Motors equipped with Resolver feedback (ref. R0) do not have auto-identification.

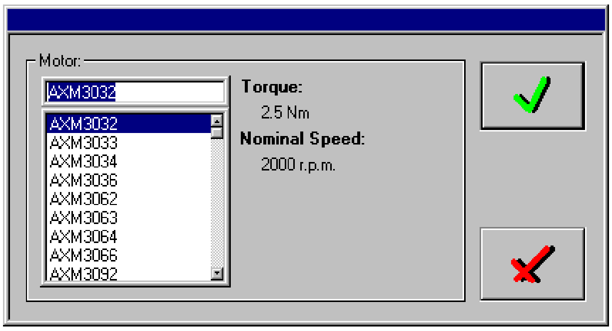
One must inform the drive module of which motor is connected to it. The selection window offers the full range of motors. If the connected motor is, for example, the FXM32 of 2000 rpm, select FXM322 in this window.

Important: The selection of the motor using these selection windows modifies the MP1 -S00141- MotorType. Assigning a particular reference to parameter MP1 -S00141- means that all the motor parameters (shown in Appendix A with an M) take a fixed value that cannot be changed.

Motor identification and initialization.

The motor may be identified through the initialization button .

Selection and initialization window:



The motor selection using this procedure sets the motor parameters and also sets the rest of the parameters of the drive to their default values.

Within the group of parameters expanded in Sets and Reductions, this initialization only affects those belonging to set and reduction Zero. Set 0 and Reduction 0 are left as the only useful ones.

This identification process + initialization is the starting point recommended for the first start-up of a servo system.

Automatic identification process on motors with Encoder feedback.

When connecting the EEC feedback cable for the first time, the Drive reads the reference stored on the encoder, identifies the motor and initializes the parameters.

After this automatic setup, modifying parameter MP1 -S00141- MotorType will have no effect on the drive.

Only when they are given a "user motor" value (a name starting with zero) its motor parameters may be changed.

The voltage supply loss of the drive or disconnecting the EEC feedback cable will have no effect on the parameter values. Only when the drive detects a different motor connected to it, will it start a new automatic setup process.

User motor.

When installing a non-Fagor motor (user motor) or to get access to certain "motor parameters", MP1 -S00141- MotorType must be loaded with a value starting with "0", for example, 0supermotor.

The drive software only admits one user motor. To keep the parameter tables of several "user motors", the various parameter transferring functions must be used. See the previous section on "transferring parameter tables".

Save to Flash.

Remember that after any of the identification processes described earlier, the motor reference is stored in RAM memory of the drive and it still has no effect on how it runs. Therefore:

After the adjustment by any of the previous methods, it is necessary to Save the parameter table into Flash Memory.

On power-up or after a Reset, the system will check that the value given to MP1 -S00141- MotorType (manually or automatically) is correct. In other words, that the motor and the drive are compatible with each other. The error codes will identify the mistake made.

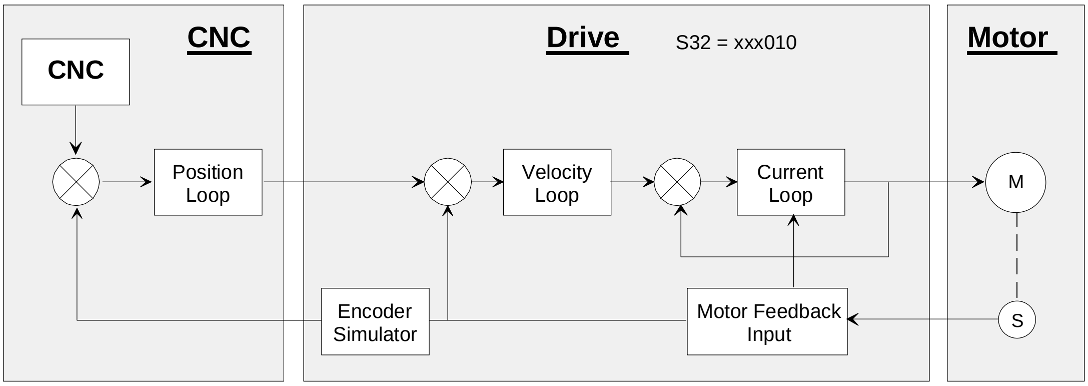
GSU.10 POSITION OR VELOCITY DRIVE

After identifying the motor other adjustments are necessary.

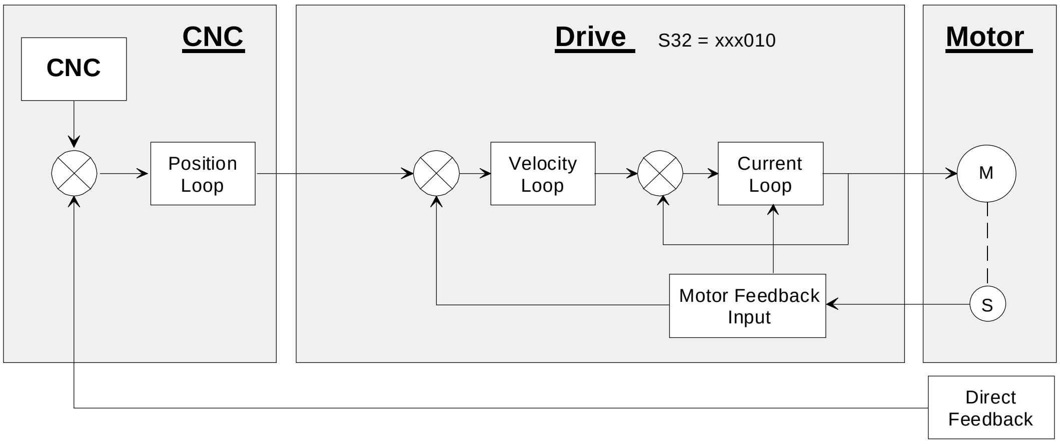
The drive, with the CNC and the feedback, is ready to work with different configurations. Parameter AP1 -S32- configures the drive to work with each of these configurations.

Velocity drive (see SSU chapter)

a) Velocity drive with encoder simulator.

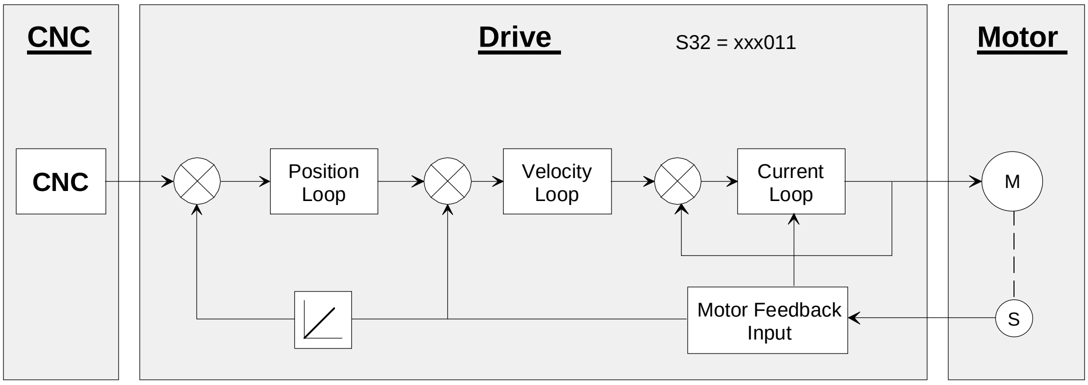


b) Velocity drive with direct feedback.

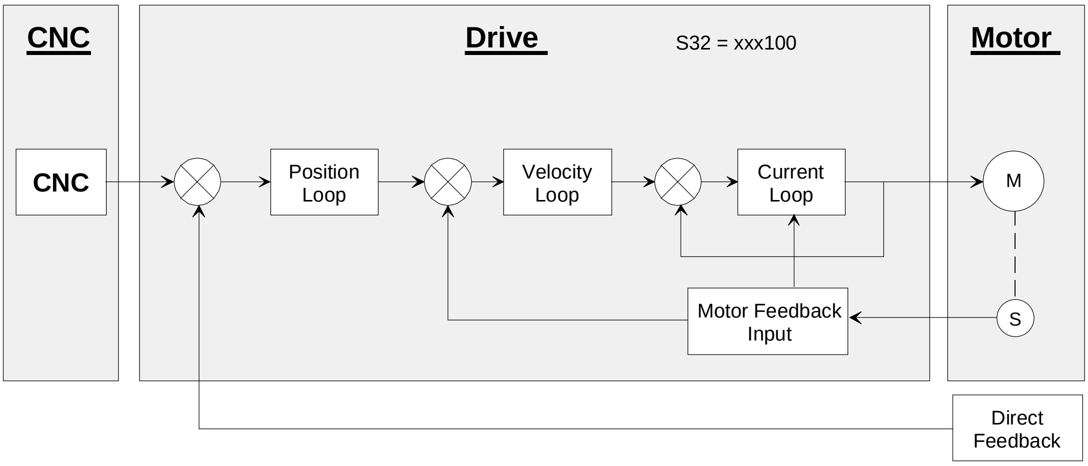


Position drive (see PSU drive)

c) Position drive without direct feedback.



d) Position drive with direct feedback.



Resume the setup as indicated in the following chapters SSU and PSU for the "Velocity Drive" and "Position Drive" respectively.

GSU.11 ADJUSTMENT OF THE ENCODER OFFSET

After adjusting the control loops, the motor might make a high-pitch noise due to some misadjustment in the generation of feedback signals. To solve this problem, the offsets and the gains used by the drive software to handle the feedback signals must be adjusted.

Circle adjustment.

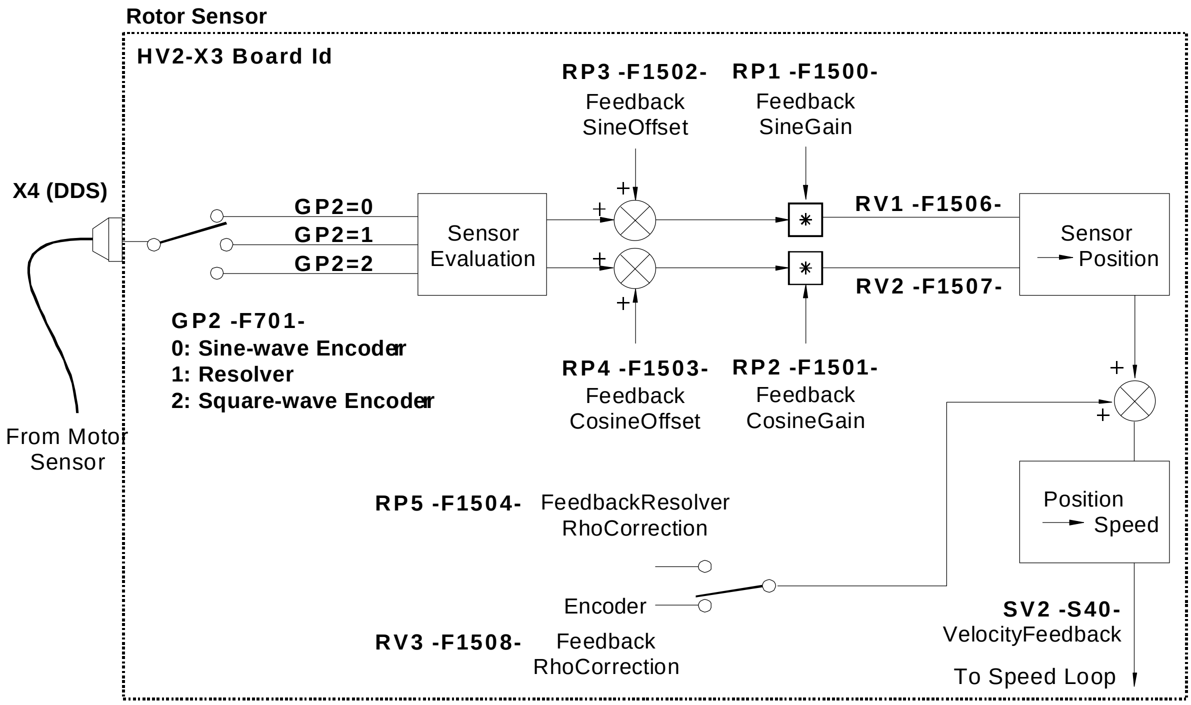
It is the process that adjusts the processing of the feedback signals so the Sine and Cosine signals (RV1 -F01506-, RV2 -F01507-) are mathematically correct. In other words, they have to make a perfect circle.

Adjustment procedure:

- Make the motor turn very slowly, at about 5 to 10 rpm.
- Set variable RV8 -F01519- to "1". This will start the automatic adjustment.
- Monitor this variable RV8 -F01519- .
- When RV8 -F01519- recovers its default value (0), the adjustment will be concluded.

This procedure, which may last up to 2 minutes, modifies the values of RP1 -F01500-, RP2 -F01501-, RP3 -F01502- and RP4 -F01503-, eliminating the noise and improving the control over the motor.

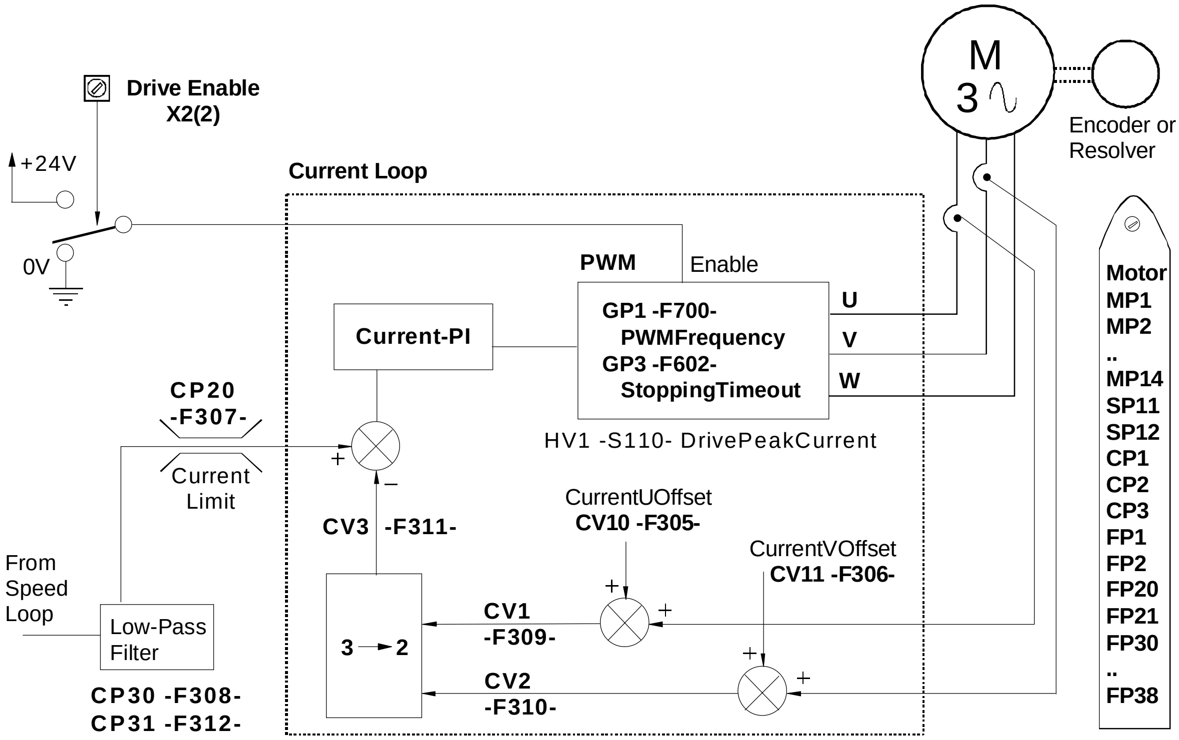
Once this procedure is completed, **Save to Flash** and do a **Reset** .



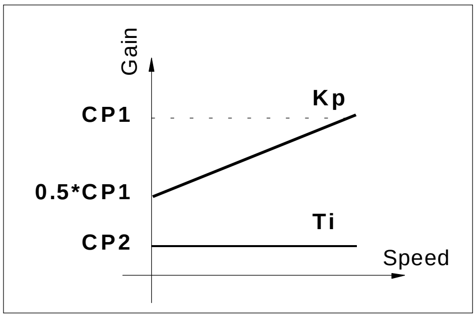
GSU.12 CURRENT FILTER ADJUSTMENT

The current loop parameters are factory set for each drive and each motor. Almost all of them require a Fagor access level to be edited.

Current loop diagram:

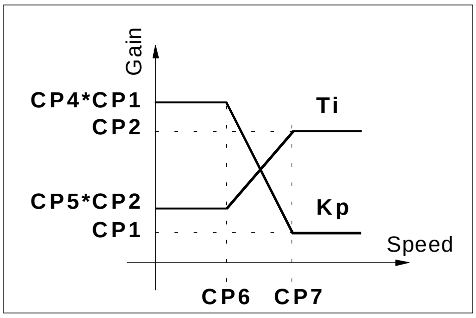


Synchronous Motor
Adapter-Current-PI



CP1 -S106- CurrentProportionalGain
CP2 -S107- CurrentIntegralTime

Asynchronous Motor
Adapter-Current-PID



CP4 -F301- CurrentAdaptationProportionalGain
CP5 -F302- CurrentAdaptationIntegralTime
CP6 -F303- CurrentAdaptationLowerLimit
CP7 -F304- CurrentAdaptationUpperLimit

Parameters CP20 -F00307- and CP30 -F00308- can be modified at the OEM access level.

Current command limit CP20 -F00307-

It is a parameter that is factory set to the value that protects the motor and the drive against overcurrent.

- On servo systems with an FXM motor, CP20 takes the smaller of the values given by the peak current of the drive and that of the motor.

- On systems with an SPM motor, it takes the value of the maximum current of the drive. On applications requiring lots of power when threading, the value of CP20 may be up to 15% higher than the maximum current of the drive.

Current command filter, CP30 -F00308- and CP31 -F00312-

Some FXM motors generate a high-pitch noise that may be eliminated using a low-passing filter for the current command.

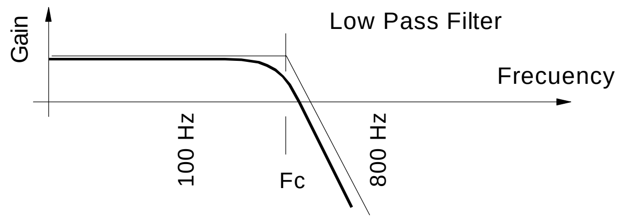
This filter is not applicable to systems using SPM motors.

This filter may be configured by giving its natural frequency and the damping factor.

Break frequency:

Giving to CP30 -F00308- CurrentFilter1TimeConstant a value between 0 and 8, sets the break frequency of this filter.

Current Command Filter:



Fc	CP30
no filter	0
100 Hz	8
200 Hz	7
300 Hz	6
400 Hz	5
500 Hz	4
600 Hz	3
700 Hz	2
800 Hz	1

User notes:

SSU. VELOCITY DRIVE SETUP

This chapter describes the setup procedure for DDS drive module when used as "Velocity Drive". The necessary steps for the application as "Position Drive" are described in the next PSU chapter.

SSU.1 ADJUSTMENT OF THE OFFSET OF THE ANALOG SIGNAL

Power the Drive on. The next step is to eliminate the possible offset of the analog command. When using Sercos interface, this section is not applicable.

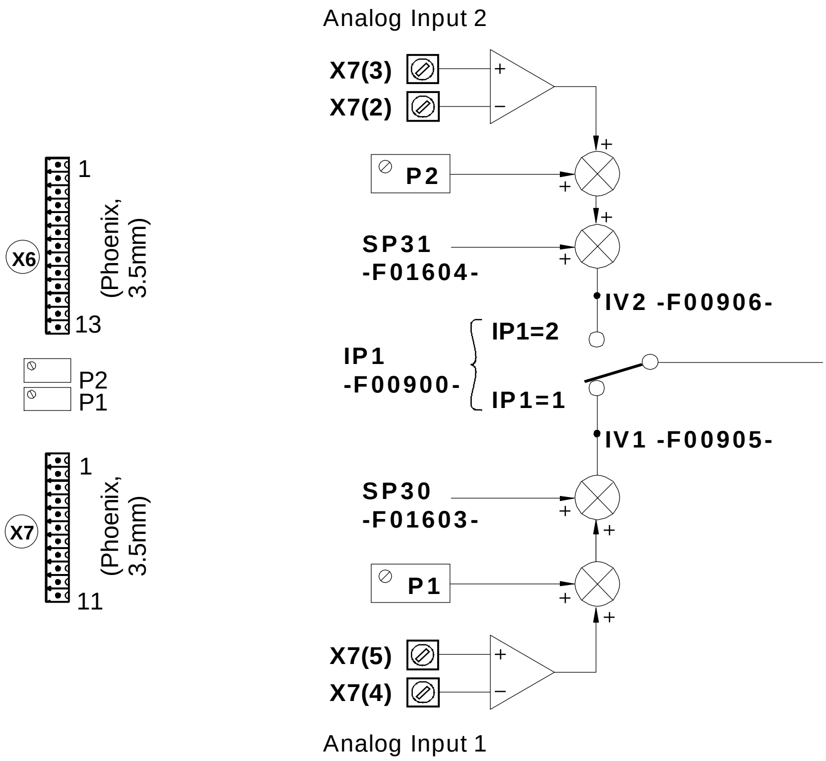
Send 0V command to the drive. Monitor the motor speed at the CNC or by "watching" the SV2 -S00040-. Assign values to the offset parameter **SP30 -F01603-**, (with the opposite sign of SV2 -S00040-) until the motor stops completely. But, careful, this way, only the drive's offset is eliminated, the CNC may have another offset. Now adjust the CNC offset.

To adjust the offset of the whole control loop, get the CNC in dro mode but with the "Drive_Enable" and "Speed_Enable" active, give values to SP30 -F01603- until the motor stops. Another procedure may be to set a position for the axis with the CNC and adjust SP30 -F01603- until the following error is symmetrical (same in both directions).

After having determined the proper value, the result has to be **Saved into Flash memory** and the unit must be **Reset**. Procedure explained in the GSU chapter.

Apart from this adjustment mechanism, there is a potentiometer (See drawing, **P1**) designed so the user can correct the slight drifts suffered by the electrical components with time.

Same for Analog input 2
with **SP31 -F01604-** and **P2**.



SSU.2 VOLTS-SPEED OF THE ANALOG VOLTAGE

On equipment having an analog interface and on spindle drives with Sercos interface, one must indicate the relationship between the analog voltage and the velocity command.

There are three parameters to set this voltage-speed relationship.

SP20 -F00031- and **SP21 -F00081-** establish the voltage/speed ratio of the velocity command.

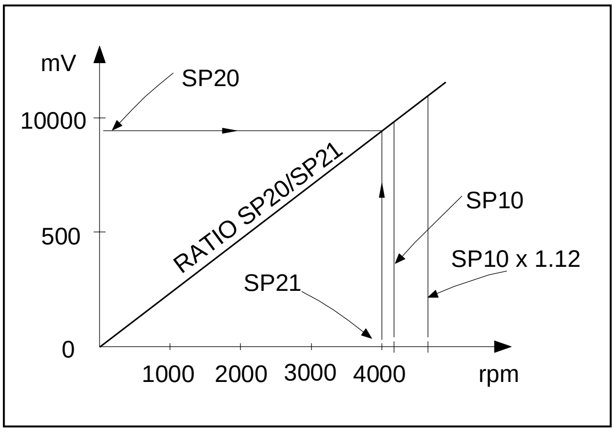
SP21 -F00081- is allocated the maximum speed to be supplied by the motor in our application. And SP20 -F00031- is allocated the analog voltage to be applied for that maximum speed. The hardware limits SP20 -F00031- to 10000 millivolts (10 Volts).

SP10 -S0091- sets the maximum velocity command effective at the drive. Its value is given by the characteristics of the motor and those of the machine.
The drive's software does not allow SP10 -S0091- values greater than 10% over the rated (nominal) motor speed. If the instantaneous speed of the motor exceeds the SP10 value over 12%, Overspeed error 200 will be issued.

Example:
If the application requires a speed of 4000 rpm. when applying an analog voltage of 9.5 V, and the motor has a nominal speed of 4000 rpm, the values for these parameters could be:

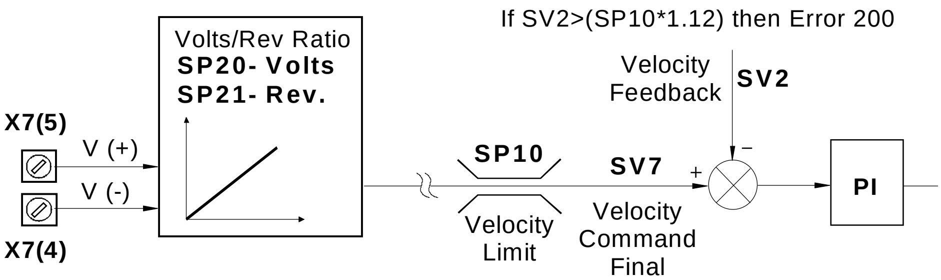
SP20=9500 millivolts
SP21=4000 rpm
SP10=4200 rpm

SP10, SP20, SP21:



Avoid setting parameters SP21 -F00081- and SP10 -S0091- to similar values in order to allow instantaneous speed values greater than the SP21 -F00081- values.

The modification of these parameters has no on-line effect. They stay in the drive's RAM memory. To make them effective, they have to saved into Flash memory and the equipment must be re-initialized.



SSU.3 PARAMETERS FOR THE ENCODER SIMULATOR

The Drive can generate a simulated incremental Encoder output with differential TTL signal from the signal of the motor feedback.
They are square signals A and B, their inverted signals /A and /B, and reference marks Io and /Io.
This is an optional feature.

The Encoder simulator is programmable by means of the following parameters:

EP1 -F00500- Number of pulses per turn.
EP2 -F00501- The point where the reference marker pulse is generated I_0,
EP3 -F00502- Counting direction.

SSU.3.1 NUMBER OF PULSES

The number of pulses must be programmed before starting up the motor using parameter EP1 -F00500-.

SSU.3.2 MARKER PULSE (HOME I_0) POSITION

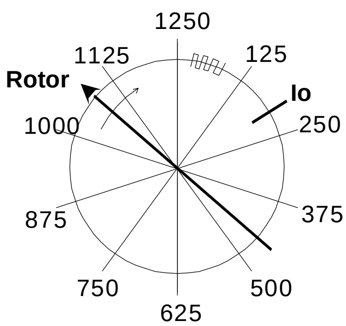
It is the location of the reference mark. The inverted marker pulse signal ($/I_0$) is also available.

The home position may be set by following any of these two different procedures:

1st- Orient the rotor shaft to the desired home position.
Then, execute the command **EC1 -F00503-.**

2nd- Move the marker pulse point by means of parameter **EP2 -F00501-.**
For example: if EP1 -F00500- is 1250 and we wish to move the current marker pulse position 58°, we must load parameter EP2 -F00501- with a value of 1250*58/360 which is approximately equal to 200.
The range for this parameter varies from 1 to the value assigned to parameter EP1 -F00500- although it is recommended to reset it to "1". If a home value greater the number of pulses defined by EP1 -F00500- is indicated, the initialization process will generate error 500.

<u>**Example**</u>
EP1 -F500- = 1250
EP2 -F501- = 200
EP3 -F502- = 0

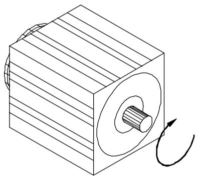


SSU.3.3 COUNTING DIRECTION

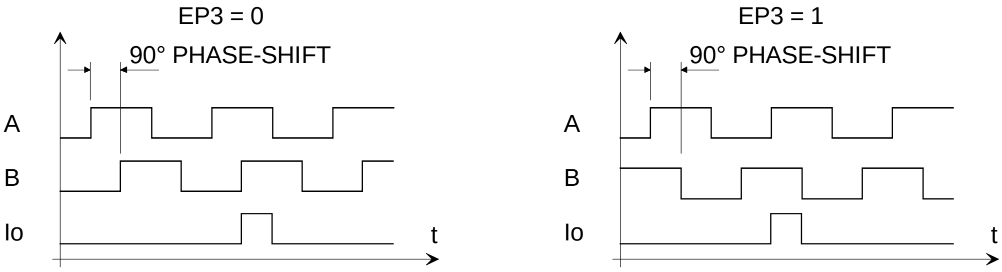
For the turning direction of the diagram below (clockwise), the encoder simulator generates the A signal 90° ahead of the B signal when parameter **EP3 -F00502-** has its default value EP3 = 0.

If EP3 = 1, the simulator will generate the B signal 90° ahead of the A signal for the same turning direction of the motor.

Obviously, the opposite turning direction (counterclockwise) inverts the order of the signals.

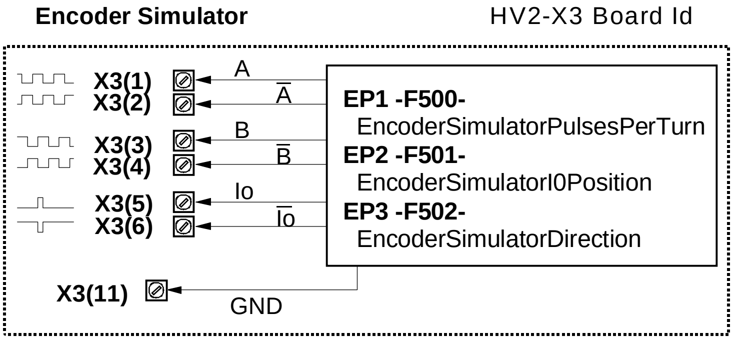


CLOCKWISE TURN



SSU.3.4 PIN-OUT OF THE ENCODER SIMULATOR CONNECTOR

Drive connector X3 is the one outputting the signals generated by the encoder simulator.

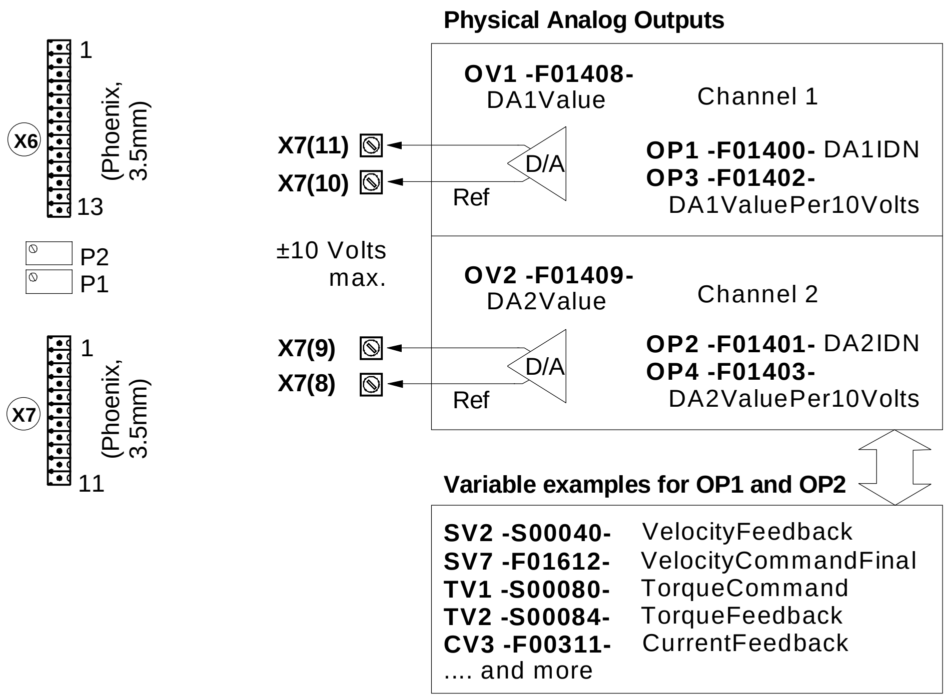


SSU.4 ANALOG OUTPUTS

The DDS module has two analog outputs at connector X7 between pins 10 and 11 (channel 1) and pins 8 and 9 (channel 2) which can be programmed for displaying the various internal variable of the drive. Anyway, the most common ones are:

1.- Velocity loop
2.- Torque parameters
3.- Rotor sensor
4.- Encoder simulator
5.- Function generator.

The variables are selected by means of parameters OP1 -F01400- and OP2 -F01401-. OP3 -F01403- and OP4 -F01404- set the values of these variables corresponding to an analog output voltage of 10 Vdc. The modification of these variables has an immediate effect (on line). To keep the values of these parameters, they have to be saved into Flash memory.



Analog outputs as adjustment tools.

With an oscilloscope connected to these analog outputs, it is possible to monitor those internal variables of the Drive and check overshooting, stabilizing times, accelerations, system stability, etc.

For example, to display the torque and instant speed signals:

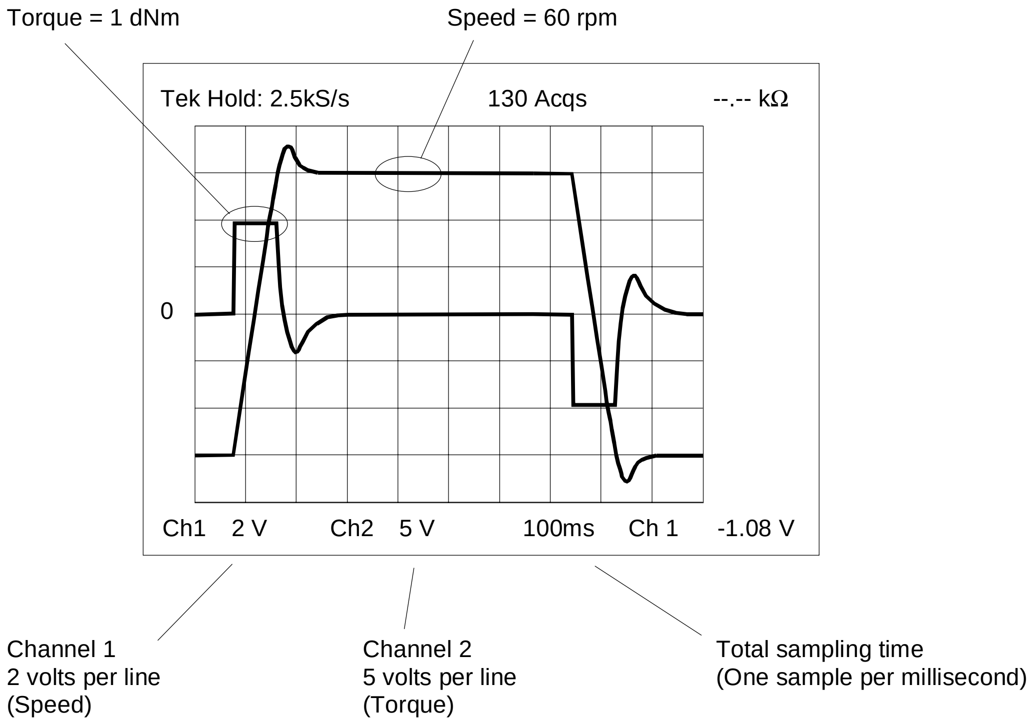
OP1=SV2	Actual speed via channel 1, pins 10/11 of connector X7
OP2=TV2	Actual torque via channel 2, pins 8/9 of connector X7
OP3=100	(100 rpm / 10 volts)
OP4=1	(1 deciNm / 10 volts)

The figure shows a possible look of the oscilloscope screen and its interpretation depending on the gains set.

During the setup process, it is common practice to monitor the velocity command (SV1 -S00036-) and the actual speed (SV2 -S00040-).

CALCULATION OF VALUES

Speed = 100 rpm/10volts * 2 volt/division * 3 divisions = 60 rpm
Torque= 1 dNm/10volts * 5 volt/division * 2 divisions = 1 dNm = 0.1Nm



Warning:

Give to OP3 -F01403- and OP4 -F01404 values that cannot be reached by the chosen internal variables. This way, the output will never exceed the ±10V range.

For example, if the speed is not expected to ever exceed 2500 rpm, the gain may be set in 2500 rpm/10 volts or greater.

If the values given to OP3 -F01403- and OP4 -F01404 are too small, the electrical signal will be saturated when reaching ±10 V.

The **WinDDSSetup** program for setting the drive up from a PC includes an oscilloscope. This way, the setup is much easier.

SSU.5 VELOCITY LOOP SETTING

The next step consists in adjusting the velocity loop. To do this:

- We will use the internal velocity command generator of the drive itself.
- We will adjust the PI of the velocity loop.
- We can filter this command using the acceleration limit and/or the choke.

The next sections describe these steps in detail.

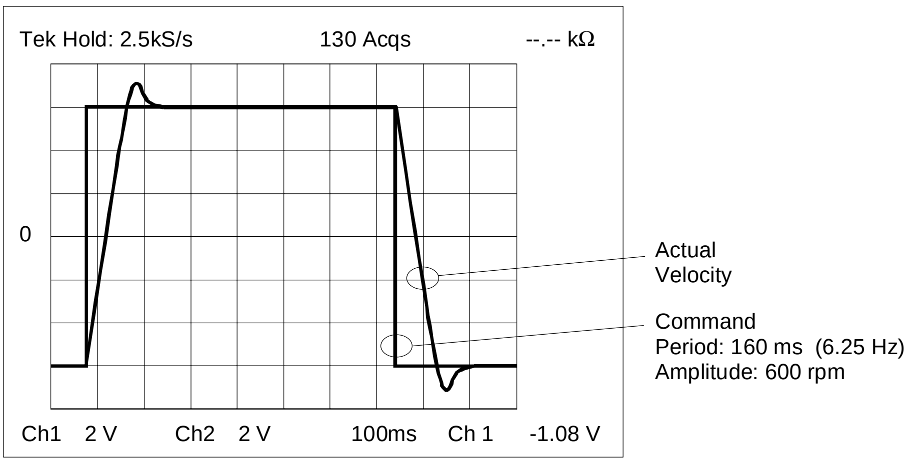
SSU.5.1 VELOCITY COMMAND GENERATOR

This function generates velocity commands internally. When activated, the drive ignores the analog signal coming from the outside. This function can be used for moving the system with known analog voltages and, then, monitor their behavior.

It can generate two types of signals: square and DC. Their frequency and amplitude are programmable. The squarewave is commonly used to see how the system reacts when faced with a step. For example:

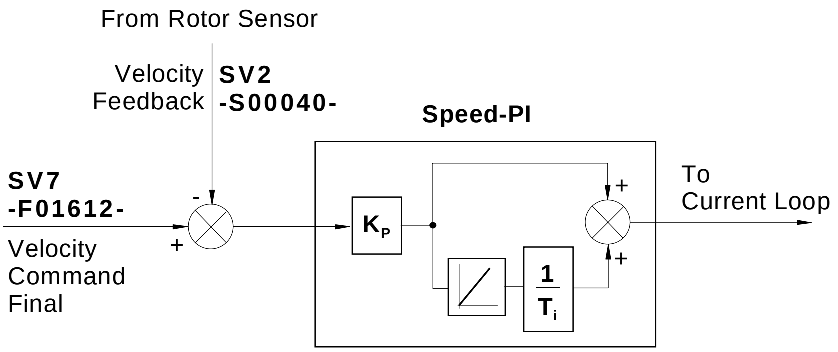
WV4=1 Activates the internal generator. Velocity command.
WV1=1 Squarewave.
WV2=160 Period of 160ms (6.26 Hz)
WV3=600 Amplitude of the velocity command corresponding to 600 rpm.
... and after adjusting the PI and the filter described in the next sections...
WV4=0 Deactivates the internal generator.

The motor will turn trying to follow the programmed velocity command.
This command can be used for adjusting the velocity loop.
By programming the analog outputs to be able to observe variables WV5 and SV2 (Oscilloscope mode) we would obtain on the screen a graph similar to this one:



SSU.5.2 SPEED-PI ADJUSTMENT

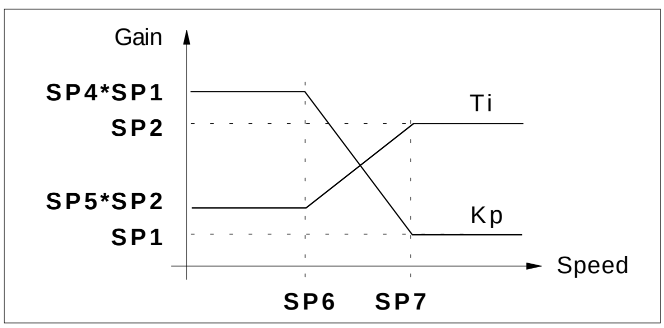
The Velocity Loop basically consists of a Proportional-Integral (PI) controller shown in the diagram below. The operation of this PI is determined by two constants: *Kp* and *Ti*.



For better system performance, *Kp* and *Ti* may be assigned different values depending on the speed of the motor. Usually, a greater proportional and integral factor is preferred when the motor turns slowly. In other words, high *Kp* and low *Ti,* as shown below:

Adapter-Speed-PI:

SP1 -S00100-
SP2 -S00101-
SP4 -S00211-
SP5 -S00212-
SP6 -S00209-
SP7 -S00210-



The Velocity Loop may be adjusted by using an internal command (previous section) or by using directly the command of the external controlling device.

It is very common to generate a square signal which serves as an internal velocity command and observe the actual speed and the command itself through the analog outputs.
To make the system adjust its performance to a particular external command, it must be applied between pins 4 and 5 of connector X7, (or between pins 2 and 3 of X7 through the auxiliary input).

The following parameters are available for the adjustment:

is the integral factor (Ti) of the Velocity Loop. A greater Ti factor

SP1 -S00100- is the proportional factor (Kp) of the Velocity Loop.

SP2 -S00101- is the integral factor (Ti) of the Velocity Loop. A higher *Ti* factor means a smaller integral effect of the PI.

SP4 -S00111- adapts the value of the proportional action at low speeds.

SP5 -S00112- adapts the value of the integral action at low speeds.

SP6 -S00209- is the maximum limit for the speeds considered "low".

SP7 -S00210- is the minimum limit for the speeds considered "high".

For example, if SP4 = 1500 (150%)
and SP1 = 30 (0.030 A_{RMS}/rpm),
The value for the proportional action Kp at low speeds will be:
the 150% of SP1, that is: 0.045 A_{RMS}/rpm.

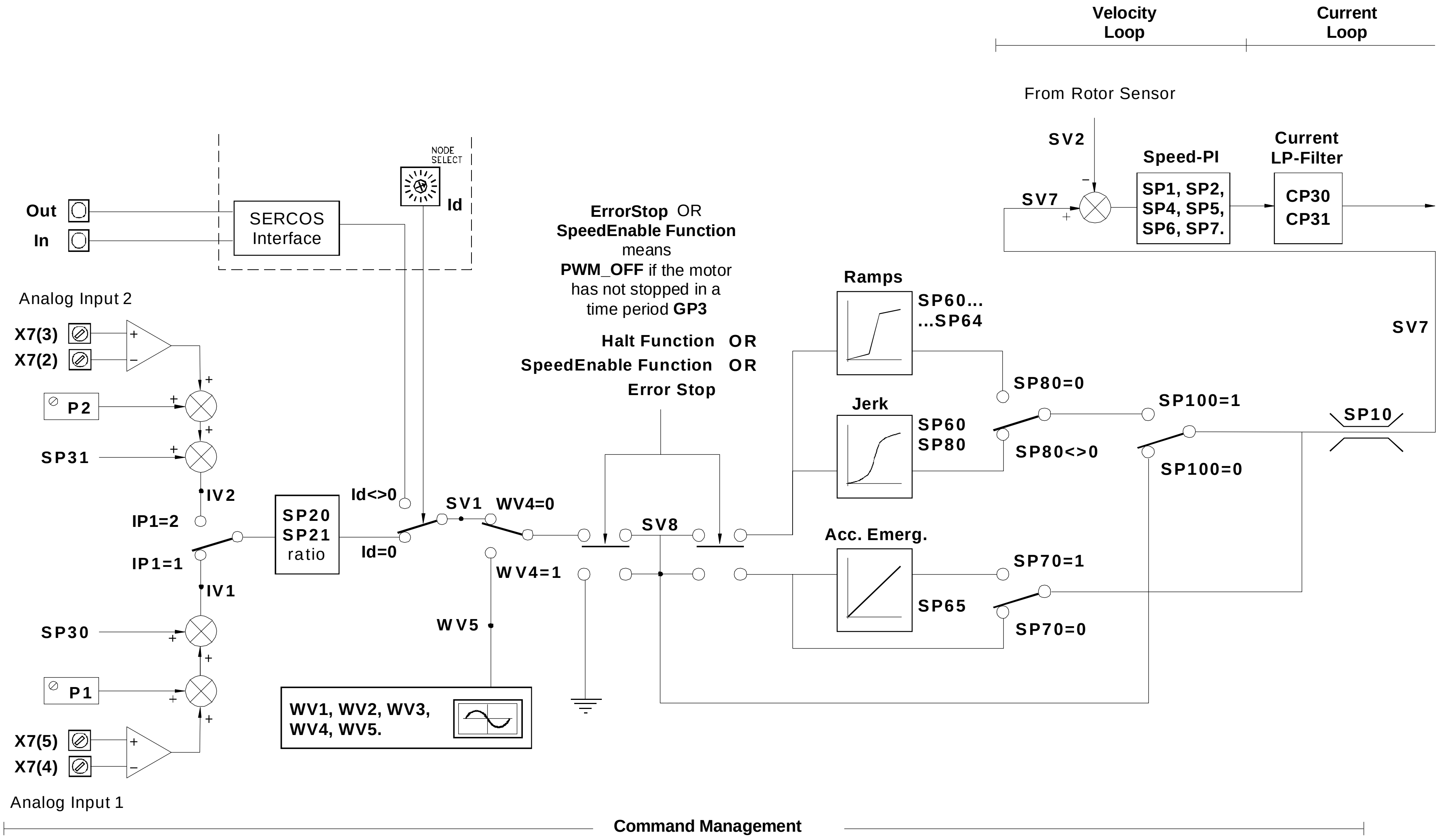
To properly adjust it, the effect of the velocity command filters prior to the PI must be taken into account. This filters are described in the next section.

The next diagram shows the complete internal structure of the Velocity Loop of the DDS.

Depending on the system's response and the type of application, the user changes the PI parameters.

The modifications to these parameters are immediately effective. When the desired performance is achieved, these values must be **Saved** in the DDS, and then, the unit must be **Reset**, (in this order).

To do this, follow the indications detailed in the chapter on "Saving into Flash memory" of this chapter.

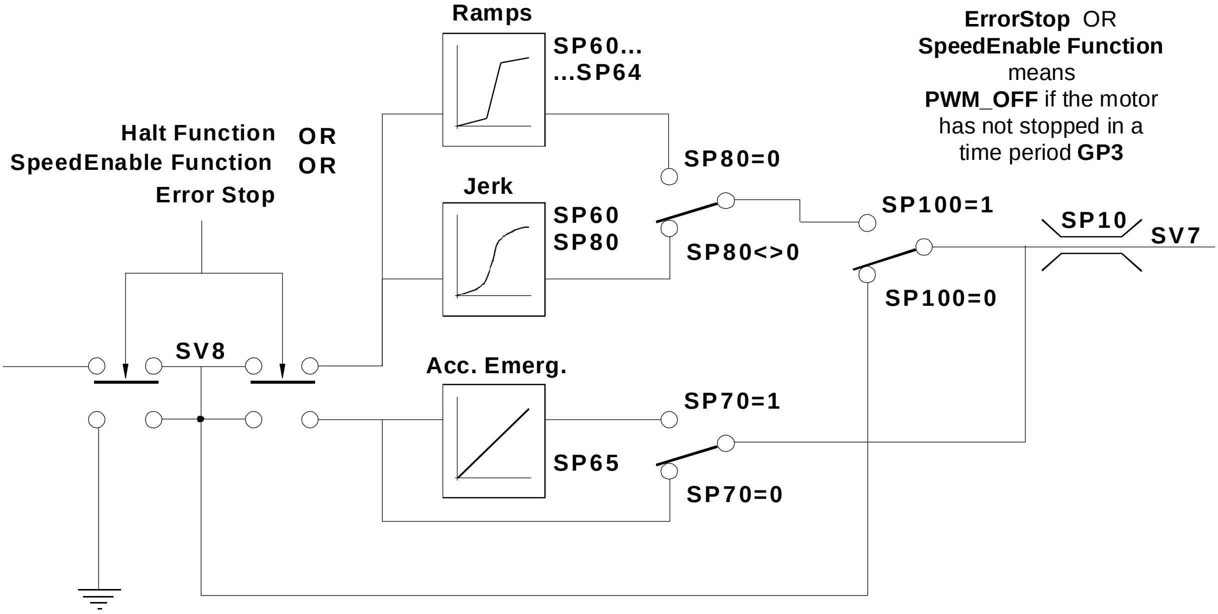

Velocity Loop
Current Loop
From Rotor Sensor
SV2
SV7
Speed-PI
SP1, SP2, SP4, SP5, SP6, SP7.
Current LP-Filter
CP30
CP31
Out
In
SERCOS Interface
NODE SELECT
Id
ErrorStop OR SpeedEnable Function means PWM_OFF if the motor has not stopped in a time period GP3
Halt Function OR
SpeedEnable Function OR
Error Stop
Ramps
SP60...
...SP64
Jerk
SP60
SP80
SP80=0
SP80<>0
SP100=1
SP100=0
SP10
SV7
Analog Input 2
X7(3)
X7(2)
P2
SP31
IV2
IP1=2
IP1=1
IV1
SP20
SP21
ratio
Id<>0
Id=0
SV1
WV4=0
WV4=1
WV5
SV8
Acc. Emerg.
SP65
SP70=1
SP70=0
SP30
P1
X7(5)
X7(4)
Analog Input 1
WV1, WV2, WV3, WV4, WV5.
Command Management

SSU.5.3 VELOCITY COMMAND FILTERS

To smooth motor movement, the velocity command can be "filtered" in two ways described in the following sections. The first one is converting the command into velocity ramps limiting the acceleration "Ramp Generation". The second one is limiting the acceleration and the jerk of the command "Jerk Limit".

These command filters can be eliminated permanently by setting **SP100 -F01611- to "0"**.

In an emergency stop (Halt function, SpeedEnable or Error) the braking deceleration can be limited to a safe value. It is the "emergency acceleration limit".

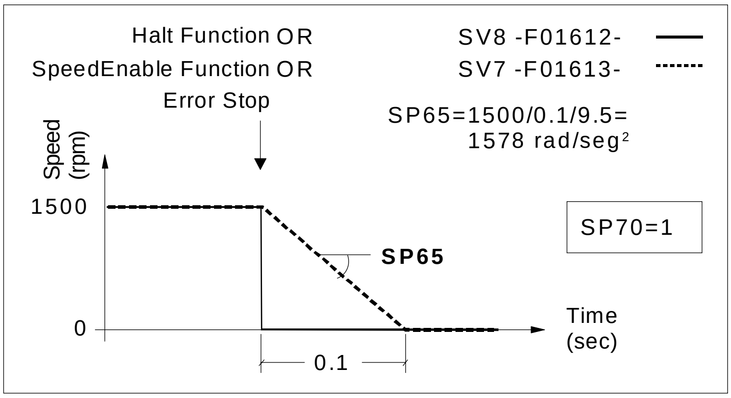


SSU.5.3.1 EMERGENCY ACCELERATION LIMIT

To filter the velocity command in an emergency stop, set **SP70 -F01610- to "1"**.

An emergency stop is the one requested by activating the Halt function, by deactivating the SpeedEnable, or the one due a Drive malfunction.

Emergency Ramp (example):



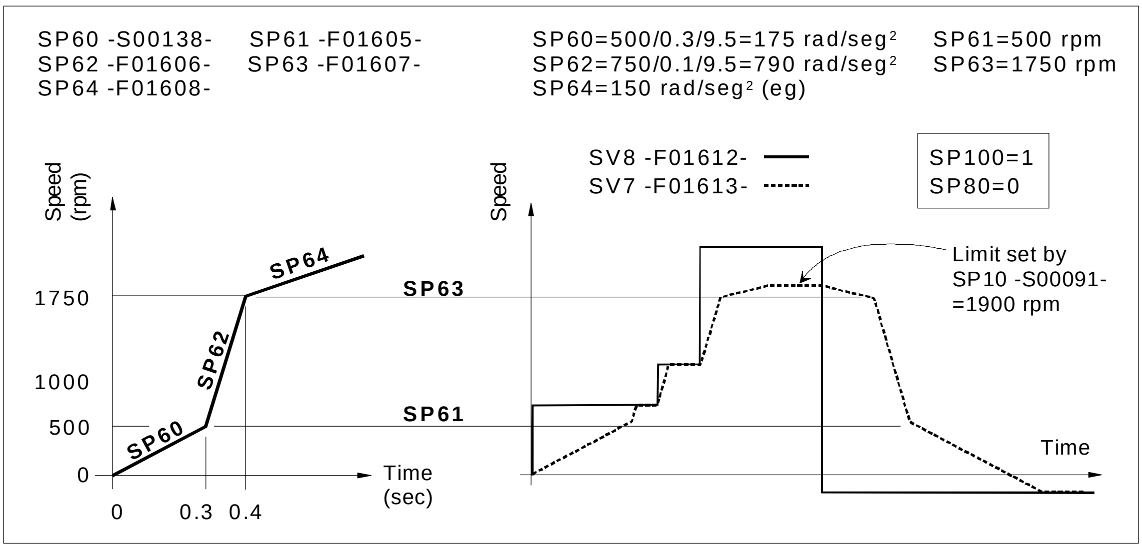
SSU.5.3.2 RAMP GENERATION

For this type of velocity command filter, set **SP80 -S00349- = 0 and SP100 -F01611- = 1**

The action of this Ramp Generator is divided into three velocity sections.
In each one of them, the acceleration can be limited to a different value.

From 0 rpm to SP61	Acceleration limited to **SP60**.
From **SP61** to SP63	Acceleration limited to **SP62**.
And from **SP63** on	Acceleration limited to **SP64**.

Ramps (example):



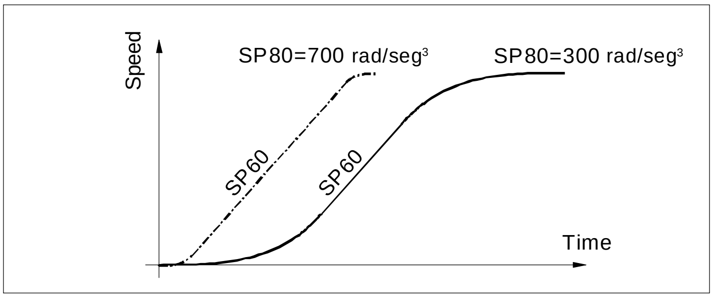
SSU.5.3.3 JERK LIMIT

For this velocity command filter, set **SP80 -S00349- other than "0" & SP100 -F01611- = 1**.

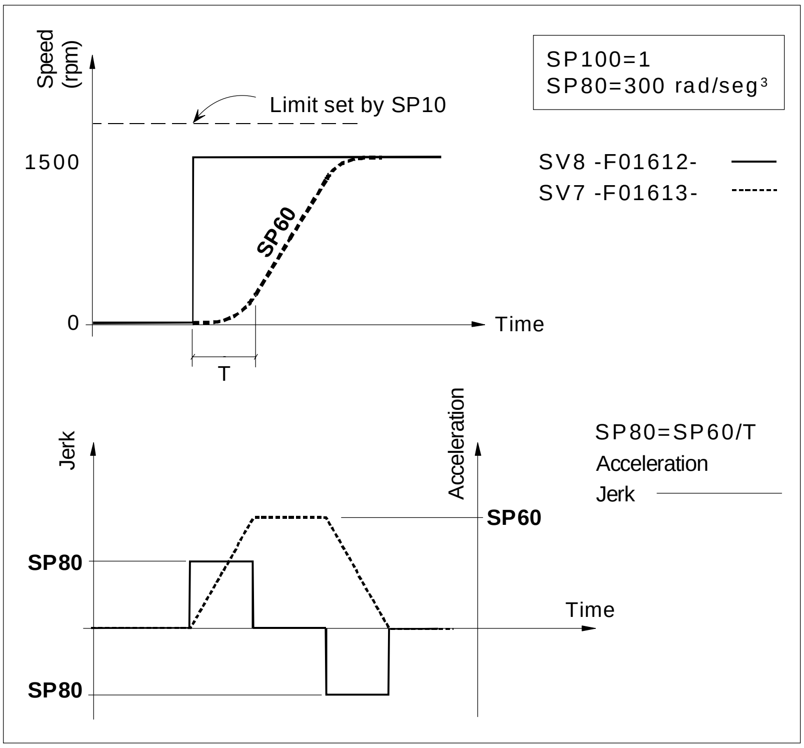
The jerk is a physical magnitude representing the variation of acceleration in time.

SP80 -S00349- sets the jerk limit. The smaller this parameter is, the more smoothly the motor will run.
SP60 -S00138- sets the maximum acceleration in this operating mode.

Jerk Limit effect:



Jerk Limit (example):



SSU.5.4 REMOVAL OF THE INTERNAL COMMAND

If the adjusting process has been done, the **parameters must be saved** into the Flash memory and the **unit must be reset.** The system reset deactivates the command generator.

If only the generator is to deactivated, it could be done by setting the WV4 -F1803- variable to "0".

PSU. POSITION DRIVE SETUP

This chapter describes some characteristic aspects for setting up the DDS module when using it as a "Position Drive". The previous SSU chapter describes the necessary steps for setting up a "Velocity Drive".

The last section summarizes step by step the Drive setup procedure.

The "Position Drive" is the result of integrating a "Velocity Drive" and a "position control loop". Thus, the documentation for the "Velocity Drive" can also be used here.

PSU.1 POSITION LOOP

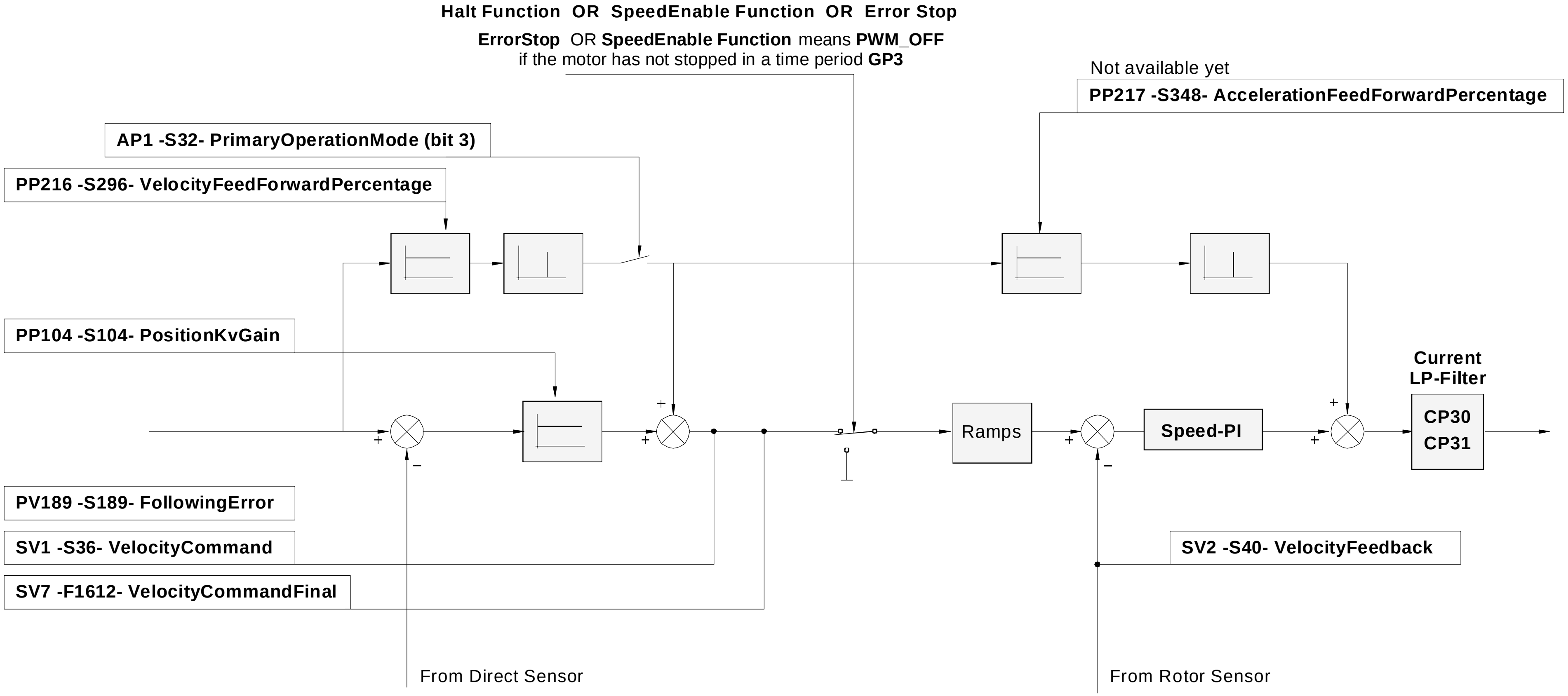
From software version 04.01 on, the Drive is capable of closing the position loop and, therefore, attend to positioning commands. The position loop consists of a Proportional control and a Feedforward Derivative control. See diagram.

The position feedback may be taken from the motor feedback or from a feedback located on the load (direct feedback).

First of all, the operating mode of the Drive must be determined with parameter **AP1 -S32-**:

- whether the position feedback is on the motor or on the load.
    - the motor feedback will be connected to connector X4 of the drive.
    - the feedback signal on the load (direct feedback) will go to connector X3 of the drive.
- whether Feedforward will be applied in the position loop or not.

The position loop also offers a parameter for controlling the ballscrew backlash and, in rotary movement, it can handle the command in module format.


Halt Function OR SpeedEnable Function OR Error Stop
ErrorStop OR SpeedEnable Function means PWM_OFF
if the motor has not stopped in a time period GP3
Not available yet
PP217 -S348- AccelerationFeedForwardPercentage
AP1 -S32- PrimaryOperationMode (bit 3)
PP216 -S296- VelocityFeedForwardPercentage
PP104 -S104- PositionKvGain
Current
LP-Filter
CP30
CP31
Ramps
Speed-PI
PV189 -S189- FollowingError
SV1 -S36- VelocityCommand
SV7 -F1612- VelocityCommandFinal
SV2 -S40- VelocityFeedback
From Direct Sensor
From Rotor Sensor

PSU.2 DIRECT FEEDBACK

The position feedback may be mounted directly on the moving load. From now on, this will be referred to as "Direct Feedback".

To work with direct feedback,

- Take the signal to connector X3 of the drive.
- activate bit 2 of parameter **AP1 -S32-**.
- indicate to the Drive the type of feedback device and the type of signal using these parameters:

GP10 -F234-	**Feedback2Type**
NP117 -S117-	**ResolutionOfFeedback2**
PP115 -S115-	**PositionFeedback2Type**

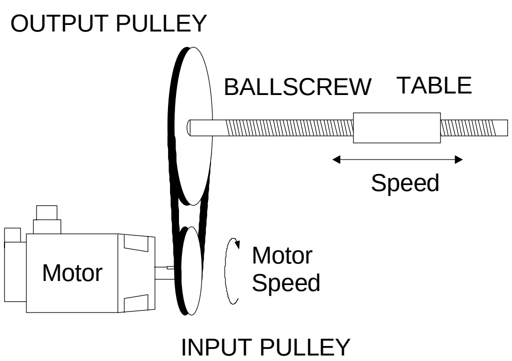
To work with motor feedback,

- take the signal to connector X4 of the drive.
- deactivate bit 2 of parameter **AP1 -S32-**.
- indicate to the Drive the type of feedback device and the type of signal using these parameters:

GP2 -F701-	**Feedback1Type**

In order for the drive to know the mechanical ratio between the motor movement and the direct position feedback, set the following parameters:

NP121 -S121-	**InputRevolutions**
NP122 -S122-	**OutputRevolutions**
NP123 -S123-	**FeedConstant**



Example:
Diameter of the output pulley = 25.75 mm
Diameter of the input pulley = 15.3 mm

NP121 = 2575
NP122 = 1530

Gear ratio =2575/1530 =1.683

Ballscrew pitch = 5 mm

NP123 = 5 milimeters

PSU.3 PROPORTIONAL CONTROL

It is the basic element of the position loop. Its function at the drive is the same as that of CNC parameter "PROGAIN" (P23) .

Proportional gain setting.

The gain is given at the drive by parameter:

PP104 -S104- PositionKvGain

It is given in m/min of programmed velocity command per mm of following error.

Examples:

S104=1 means that to a programmed feedrate of 1000 mm/min (F1000 at the CNC), corresponds a following error of 1 mm.

S104=2 at F1000, the following error will be 0.5 mm.

For a following error of 5 microns at F2000, Kv will be 2/0.005, that is: S104=400

Set this parameter depending on the following error desired for a given feedrate.

Experience shows that most machines behave fine with a proportional gain of S104=1.

PSU.4 VELOCITY FEEDFORWARD

It is complementary to proportional control. Its function at the drive is identical to that of parameter "FFGAIN" (P25) at the Fagor CNC.

The effect of the anticipated command "Feedforward" helps reduce the following error without increasing the gain, thus maintaining system stability.

Feedforward gain setting

Set up the effect of the velocity Feedforward using this parameter:

PP216 -S296- VelocityFeedForwardPercentage

It indicates the portion of the final velocity command that is anticipated to the movement which does not depend on the following error (open loop). The rest of the final velocity command will be due to the proportional gain. See the previous block diagram.

Example:

S296=80 80% of the velocity command comes from the feedforward
20% of the velocity command comes from the proportional effect

The following values can be used as a rule of thumb:

Machines with low machining feedrates	between 40 and 60%
Machines with normal machining feedrates	between 60 and 80%
Fast machines (laser, plasma)	between 80 and 100%

PSU.5 HOME SEARCH

The "Position Drive" is capable of carrying out an automatic home searching process. This feature is not required in the case of motors with an absolute encoder (ref A0).

PSU.5.1 INCREMENTAL FEEDBACK

This procedure may be activated with the servo system in any initial position. When detecting the "Reference Point" (⊡) it ends the procedure and sets the Machine Reference Zero (◕) as the coordinate origin for the following movements in absolute coordinates.

Automatic home searching procedure.

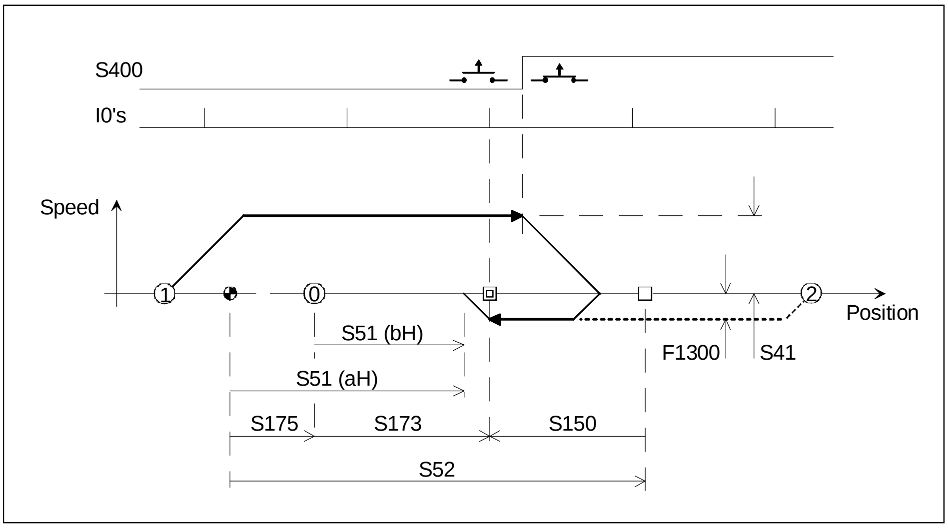
Let us consider here that the parameters correspond to a feedback device mounted on the motor. A later note mentions the parameters corresponding to a direct feedback.

⓪ It is a random point on machine power-up. Initially, the position feedback PV51 -S51- (PositionFeedback1) takes that point as coordinate origin.
---- (bH) = before Homing = before executing HOME ----
---- (aH) = after Homing = after executing HOME ----

When executing the HOME instruction, the motor starts turning automatically in search of the reference point with two possible behaviors:

① With the home-switch released PV200 -S400- = 0. Solid line.
② With the home-switch pressed PV200 -S400- = 1. dashed line.

Parameters PP41 -S41- (HomingVelocityFast) and PP1 -F1300- (HomingVelocitySlow) set the homing feedrate in each phase of the process.



▣ Is the point with the searched marker pulse. When going over that point, which is always done at low feedrate PP41 -S41-, the system registers the value of the position feedback in parameter PV173 -S173- (MarkerPositionA).

PV208 -S408- (ReferenceMarkerPulseRegistered) is activated.
The motor stops.

◕ Is the Machine Zero point for the absolute references. To set the new PV51 -S51-, set PV175 -S175- (DisplacementParameter) by means of the formula: S175 = S52 + S150 - S173.

PV203 -S403- (PositionFeedbackStatus) is activated.

The internal position command PV47 -S47- (Position Command) is given the value of the new position feedback PV51 -S51-.

Finally, the "Position Drive" remains ready to execute absolute movements.

Warning:

After several home searches in a row, the motor may be left in different final positions. This is because the braking is not always the same, but "home" has always been found correctly.

Change of the location of point ▣.

Replacing the feedback device or the motor may change the location of the marker pulse. To keep the same home location, set the offset parameter PP150 -S150-. Determine this offset based on a known position in the previous reference system.

Note:

Direct feedback.
When the position feedback is obtained through a direct feedback sensor for the movement (connector X3 of the Drive) some of the parameters mentioned earlier are replaced by their "twins".

Attending to the motor's own feedback:

PP52 -S52- (ReferenceDistance1)
PP150 -S150- (ReferenceOffset1)
PV51 -S51- (PositionFeedback1)
PV175 -S175- (DisplacementParameter1)

Attending to the Direct Feedback:

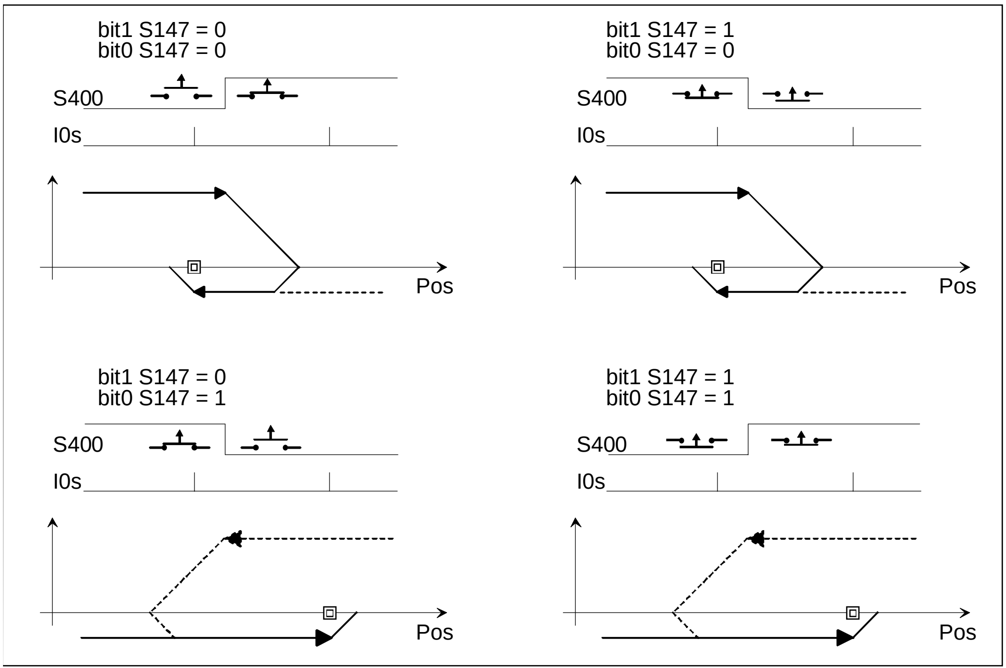
PP54 -S54- (ReferenceDistance2)
PP151 -S151- (ReferenceOffset2)
PV53 -S53- (PositionFeedback2)
PV176 -S176- (DisplacementParameter2)

Drive parameters ReferenceDistance and ReferenceOffset are equivalent to axis parameters "REFVALUE" (P53) and "REFSHIFT" (P47) of the 8050/55 CNC.

Home search setting.

It is possible to set the home searching direction and the boolean logic of the home switch.

Bits 1 and 2 of parameter PP147 -S147- set the positive home searching direction and whether the home switch closes its contacts or opens them when activated.



Electrical connection of the "home switch" and parameter setting.

When connecting the electrical contact to one of the digital inputs of the drive.

If no PLC is used, assign variable PV200 -S400- to one of parameters IP10 ... IP13 (in the Sercos nomenclature, F901 ... F904). Connect the "home switch" to the digital input associated with the chosen parameter.

If a PLC is used, use an instruction to indicate that bit "0" of parameter S400 must take the value of one of the digital inputs (for example I1). The instruction would be: I1 = B0S400.

When the electrical contact is taken to one of the digital inputs of the 8070 CNC.

The CNC communicates the status of the contact via Sercos; but the Drive is still the one controlling the home search process.

Mechanical location of the "home switch".

In der to avoid possible repeatability problems when homing, it is recommended to take certain precautions regarding the location of the home switch.

Feedback without marker pulses (reference marks) (E0 on the Fagor motor reference).

In each encoder turn, the load moves a distance L:

$$L = \frac{NP122}{NP121} \cdot NP123$$

At the time when the home search ends, and the motor stops, the position coordinate must be within the ± L/4 margin.

Place the home switch in the load travel point meeting the previous condition

Feedback with marker pulses (E1 or R0 on the Fagor motor reference).

When the gap between the flank of the Home switch and the nearest marker pulse is very small, there could be repeatability problems in the home search.

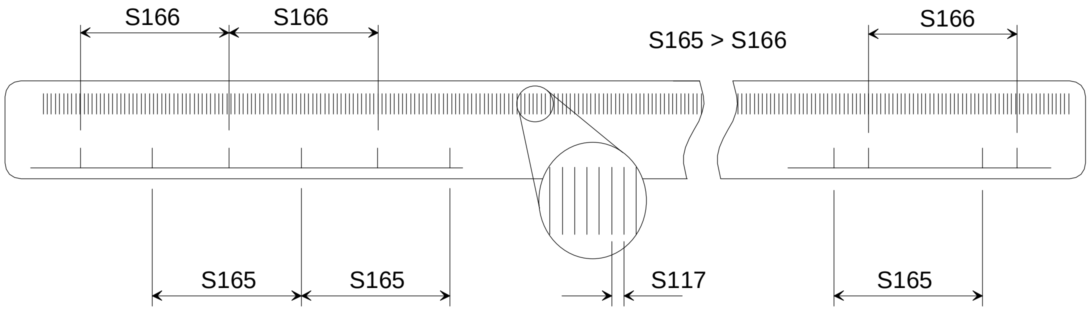
Move the home switch further away from the reference mark (marker pulse).

PSU.5.2 LINEAR FEEDBACK WITH DISTANCE-CODED REFERENCE MARKS

A slight movement of the motor is enough for the Drive to identify the absolute position of the machine.

To carry out this procedure, the feedback device must be identified using the following parameters.

NP117 -S117- ResolutionOfFeedback2
NP118 -S118- ResolutionOfLinearFeedback
NP165 -S165- DistanceCodedReferenceMarksA
NP166 -S166- DistanceCodedReferenceMarksB



For example, Fagor steel tape scales have several reference marks separated 100 signal cycles, the group of marks alternating with the previous ones are separated 100.1 signal cycles and their resolution is 10 microns.

Let us suppose that in this particular scale model and using a multiplying factor of x10, an accuracy of 1 micron is obtained. The values to be assigned to these parameters are:

S117 = 20 microns	S118 = 2 microns
S165 = 1001	S166 = 1000

To operate with this type of feedback, set the following bits:

5, 3, 1 and 0 of PP115. Proceed as follows:

- PP115 (bit 0) = 1
- PP115 (bit 1) = 1
- move the axis in the direction to be set as positive; if the position coordinate decreases, invert the value of PP115 (bit 3).
- Do a home search, move the axis in the positive direction and do a home search again, if the coordinate given after the second home search is smaller than the one given in the first one, invert the value of PP115 (bit 5).

The manufacturing of linear scales with distance-coded reference marks causes each feedback device to have a different zero point. To set the coordinate origin at a particular point of their travel, proceed as follows:

- Do a home search.
- Move the axis to the point selected as zero.
- Reed the PV53 -S53- PositionFeedback2 variable
- Set parameter PP178 -S178- AbsoluteDistance2 to the value read in PV53.

Fagor scales have the following characteristics:

Type	Feedback signal period	Distance between I0s	Incremental distance between I0s
COC	20 micr	10 mm	20 micr
COVC	20 micr	10 mm	20 micr
COVP	20 micr	10 mm	20 micr
COVS	20 micr	10 mm	20 micr
COVX	4 micr	10 mm	20 micr
COX	4 micr	10 mm	20 micr
FOC	100 micr	50 mm	100 micr
FOP	100 micr	50 mm	100 micr
FOS	100 micr	50 mm	100 micr
FOT	20 micr	50 mm	100 micr
FOX	4 micr	50 mm	100 micr
MOVC	20 micr	10 mm	20 micr
MOVP	20 micr	10 mm	20 micr
MOVS	20 micr	10 mm	20 micr
MOVX	4 micr	10 mm	20 micr
MOVY	2 micr	10 mm	20 micr

To calculate the values to be given to the parameters:

$$NP166 = \frac{\text{(Distance between I0s) x 2}}{\text{(Increment distance between I0s)}}$$

NP117 = Feedback signal period

$$NP165 = \frac{\text{(Distance between I0s) x 2 + (Incremental distance between I0s)}}{\text{(Incremental distance between I0s)}}$$

Thus, for example:

Fagor FOP feedback:

$$NP166 = \frac{50 \cdot 2}{0.1} = 1000$$

NP117 = 100 microns

$$NP165 = \frac{50 \cdot 2 + 0.1}{0.1} = 1001$$

In fact all Fagor scales appearing in this table are adjusted with NP166 = 1000 and NP165 = 1001.

PSU.5.3 ABSOLUTE FEEDBACK

The absolute feedback on Fagor FXM motors registers the value of their angular position along more than 4000 turns and it does not lose it when turning the machine off. Thus, the drive knows from the very first instant which is the absolute position of that axis.

To place the machine zero at a particular point of the axis travel, proceed as follows:

- Take the axis to the point selected as zero.
- Read the PV51 -S51- PositionFeedback1 variable
- Set parameter PP177 -S177- AbsoluteDistance1 with the value read in PV51.

PSU.6 BALLSCREW BACKLASH COMPENSATION

When the position feedback is obtained on the motor shaft, the ballscrew backlash must be compensated for.

Feedback on the motor.

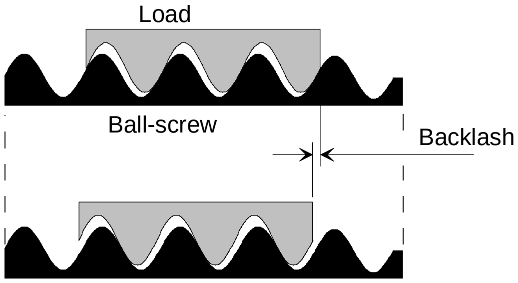
The drive can compensate for any backlash between the load and the ballscrew by internally acting upon the position command. Thus correcting the movement hysteresis originated when reversing the direction of the axis.

Set this parameter:

PP58 -S58- Backlash

This ballscrew backlash compensation only takes place if:
- the Drive is in position control mode and
- there is no feedback on the load.

Warning: Both the drive and the CNC offer parameters setting the value of ballscrew backlash. This value must ONLY be registered AT ONE OF THEM. The other parameter must be set to "0".



PSU.7 FOLLOWING ERROR MONITORING

The monitoring of following error prevents the axes from running away.

The drive compares these parameters:

PV189 -S189- FollowingError
PP159 -S159- MonitoringWindow

If FollowingError > MonitoringWindow means that the servo system follows the command with an excessive delay and it triggers the error message:

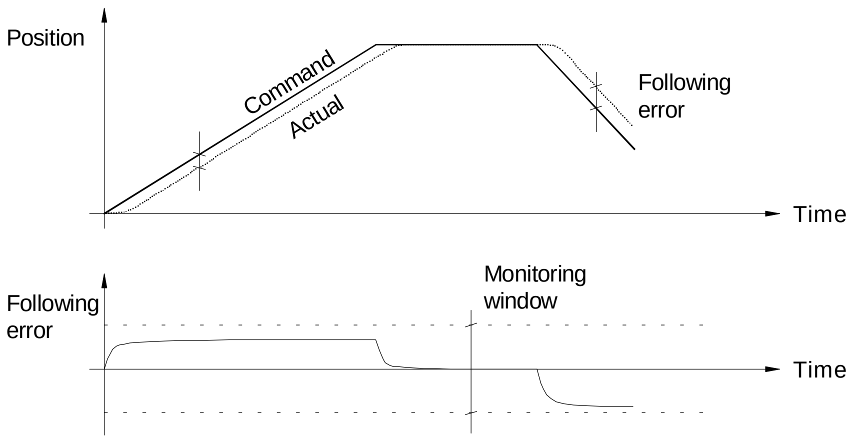
Error 205 ExcessivePositionDeviation (DV1 -S11-, Bit 11)

This monitoring of the Following Error is only done if:

- if the drive is in position control mode, (see AP1 -S32-)
- parameter MonitoringWindow is other than zero, PP159 > 0 and
- there is motor torque, TV100 -F1702- = 1.

If parameter PP159 -S159- MonitoringWindow is "zero", the following error will not be monitored. It is very important to set it to a value other than zero to prevent the axes from running away out of control.

The CNC also monitors the maximum amount of following error allowed by indicating in its relevant parameter in the parameter table for each axis at the CNC.



PSU.8 MODULE FORMAT

The "drive" can work in "module format". This is format mainly used on rotary axes.

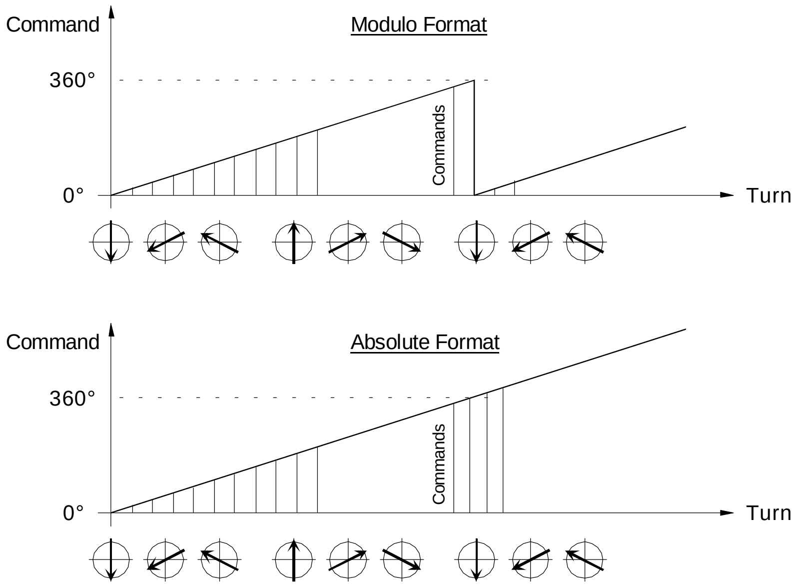
This means that it is ready to handle the full mechanical travel of the axis by means of command or feedback data restricted to a range of values; usually between 0 and 360.

This range of values is set by parameter:

PP103 -S103- ModuloValue

The drive uses bit 7 of the following parameter for selecting the "module" or "absolute" configuration format.

PP76 -S76- PositionDataScalingType



Working in Module format, the Drive does not admit:

- commands in absolute value greater than PP103
- increments greater than half PP103 between consecutive position commands.

Verify that the CNC defines that axis the same way (module or linear format).

PSU.9 STARTUP SUMMARY

General parameters

AP1: Selects the operating mode of the drive.
= 3: Position loop using motor feedback without Feedforward.
= 4: Position loop using direct feedback without Feedforward.
= 11: Position loop using motor feedback with Feedforward. (PP216)
= 12: Position loop using direct feedback with Feedforward. (PP216)

GP10: Direct feedback signal type.
= 0 There is no direct feedback.
= 1 Square TTL signal
= 2 "1Vpp" sinewave signal or differential square TTL signal.

Check the value taken by the parameter:
GP2: Motor feedback type.
= 0 Sinewave encoder
= 1 Resolver.
= 2 Squarewave TTL encoder.
= 5 Heidenhain encoder (ERN 1387) for Siemens motors, 1FT6 family.

When using motor feedback (AP1=3 or AP1=11)

The following parameters are ignored:
GP10: Direct feedback signal type.
PP54: Refvalue with direct feedback.
PP115: Direct feedback parameter setting.
NP117: Pitch/pulses setting for direct feedback.

When using external feedback (AP1=4 or AP1=12)

The following parameters are ignored:
PP150: Refshift for motor feedback.
PP52: Refvalue with motor feedback.

Resolution related parameters:

PP115: External feedback parameter setting.

Bit 5: Structure of distance coded feedback
= 0 counting positive with positive direction
= 1 counting negative with positive direction
Bit 3: Direction polarity
= 0 not inverted
= 1 inverted
Bit 1: Feedback type
= 0 rotational feedback. See NP117.
= 1 lineal. See NP118.
Bit 0: Direct feedback type:
= 0 Rotary (encoder), (NP117 will give pulses per turn).
= 1 Linear (scale), (NP117 will give the period of the scales feedback signal).

NP117: Resolution of the rotary direct feedback in pulses per turn.

NP118: Resolution of the linear direct feedback.
- period of the scale signal. 20 microns for Fagor scales (graduated glass), S118 = 20 microns.

NP121, NP122: The "NP121/NP122" ratio indicates the gear ratio between the motor and the ballscrew. They only admit integer values up to 32767.

NP123: Ballscrew pitch. If it is a rotary axis, set NP123 = 360000.

Parameters to identify a linear feedback with distance-coded reference marks:

NP165: Distance between reference marks.
NP166: Distance between "coded" reference marks.

Home search parameters.

PP147: Setting of the home search.

Bit 5: = 0 The home switch is monitored (by default)
= 1 The home switch is ignored

Bit 3: = 0 Motor feedback (see PP52, PP150)
= 1 Direct feedback (see PP54, PP151)

Bit 1: = 0 Home switch normally open.
= 1 Home switch normally closed.

Bit 0: = 0 The motor shaft turns clockwise when searching home.
= 1 The motor shaft turns counterclockwise when searching home.

With the 8070 CNC take the electrical contact "home switch" to one of its digital inputs.

PP1: Slow motor speed when the home search is controlled by the Drive itself.

PP41: Fast motor speed when the home search is controlled by the Drive itself.

PP42: Acceleration of the movements when searching home.

PP52: Machine reference point position (home) with respect to Machine Reference Zero (Refvalue motor feedback).

PP54: Machine reference point position (home) with respect to Machine Reference Zero (Refvalue direct feedback).

Parameters PP52 and PP53 of the drive are equivalent to the "REFVALUE" (P53) of the 8050/55 CNC axis.

PP150: Position of the reference mark with respect to the machine reference point (home) (Refshift motor feedback).

PP151: Position of the reference mark with respect to the machine reference point (home) (Refshift direct feedback).

Parameters PP150 and PP151 of the drive are equivalent to axis parameter "REFSHIFT" (P47) of the 8050/55 CNC except that the Drive does not move to return to the "REFVALUE" (P53) position.

Homing method. The home switch may be connected directly to the PLC or to the drive, this is now irrelevant.

Gain related parameters.

PP104: Proportional gain in the position loop. It is similar to axis parameter "PROGAIN" (P23) of the 8050/55 CNC. PP104=1, means a following error of 1 mm at F1000 mm/min.

PP216.#: % of velocity FeedForward (0 to 100%). It is similar to axis parameter "FFGAIN" (P25) of the 8050/55 CNC

PP159: Maximum amount of following error permitted. If this parameter is set to "0", the following error is not monitored. It is very important to set it to a value other than "0" to prevent the axes from running away out of control. At the CNC the maximum following error permitted is also watched. This value is indicated in its relevant parameter in the parameter table for each axis at the CNC.

PV 189: Monitoring of the following error.

Various parameters for the position loop.

PP49, PP50: Indicate the maximum position that can be reached by the servo system in both positive and negative directions respectively. These limits are observed only when all the position data is referred to Machine Reference Zero. That is, Bit 0 of PV203 -S403- PositionFeedbackStatus is set to "1".

If the variable PV58 -S258 TargetPosition exceeds the position limits, the drive will activate bit 13 of DV9 -S12- Class2Diagnostics (Warnings) TargetPositionOutsideTheTravelZone.

The CNC also observes the travel limits defined in its axis parameter tables.

PP55: Controls the polarity of various position data.
- **Bit 4:** Position limits
  - = 0 active (by default). See PP49 and PP50.
  - = 1 cancels the position limits.
- **Bit 3:** Direct position feedback value
  - = 0 non-inverted
  - = 1 inverted (by default)
- **Bit 2:** Motor position feedback value
  - = 0 non-inverted
  - = 1 inverted (by default)
- **Bit 0:** Position commandvalue
  - = 0 non-inverted
  - = 1 inverted (by default)

PP58: Ballscrew error. With motor feedback, the drive compensates for the backlash in changing direction. Both the drive and the CNC offer parameters to set the value of the ballscrew backlash; but this value must only be registered in either one of them. The other parameter must be set to "0".

PP76: Command application in module format. Verify that the CNC defines that axis the same way (module or absolute format).
- **Bit 7:** = 0 The module format is not applied.
  - = 1 The module format is applied to the axis.

PP103 : Value of the module to be applied on to rotary axes that do not work as linear axes (usually 360º).

QP1 : Loop cycle time. Read-only parameter that indicates how often the loop is being closed at the drives.

Parameters to be used only in Motion Control applications.

PP57: In-position zone. It indicates the difference allowed between the real and final position (PV58 -S258- TargetPosition) for considering that the axis is in position.

User notes:

AP. APPLICATIONS

This chapter describes some particularities of the Servo Drive system:

- Considerations for the system start-up with Sercos interface.
- Adjustment of the motors for spindle at low rpm.
- Motor locking function, Halt.
- Monitoring the drive's internal variables.
- Set of Parameters and Gear Ratios.
- Spindle overload detection.

Important:
The features documented in this chapter need the following software versions:
8050/55 CNC versions V13.02 (mill) and V12.01 (lathe).
Drive versions V03.01 and later.

AP.1 SERCOS CONNECTION WITH THE 8050/55 CNC

Sercos is a communications standard designed especially for the machine-tool industry and simplifies the connection between CNCs and servo drives of different manufacturers.

All the data and commands are transmitted in digital format through fiber optic lines. These lines form a ring interconnecting all the electronic elements forming a system (CNC and servo drives).

The Drives with Sercos interface carry special connections for the fiber optic lines with the display and their sales reference is **SI,** and **S0**, for example, AXD1.25.SI.0, SPD2.75.S0.0

The Sercos interface reduces considerable the needed hardware and simplifies the cabling making the system more robust since it improves its immunity to electrical noise.
See chapter IN of this manual.

Sequence of start-up operations

- Connection of the fiber optic lines and identification of the Drives.
- Parameter setting at the CNC 50/55.
- Description of the manoeuver at the PLC 50/55.
- Parameter setting at the Drives.
- Powering the machine up again.
- Troubleshooting

AP.1.1 CONSIDERATIONS AT THE 8050/55 CNC

When using the Sercos interface, the Drives must be identified in the ring and determine the operation mode.

Certain CNC 50/55 and Drive parameters must also be set.

AP.1.1.1 IDENTIFICATION AND OPERATION MODE

The following CNC parameters must be set for each servo drive.

SERCOSID (Parameters: P056 for the axes, P044 for the spindles, P044 for the auxiliary spindle)

Function: Identifies each Drive in the Sercos ring. Its value must match the selection at the Node_Select switch.

Possible values:
- 0 The Drive is "transparent" in the communications within the ring; but it is not recognized as one of its elements.
- 1..8 The Drive is identified in the ring with the SERCOSID element number , and will have all the features of the Sercos interface.

Example: See illustration.

SERCOSLE (Parameters: P063 for the axes, P051 for the spindles)

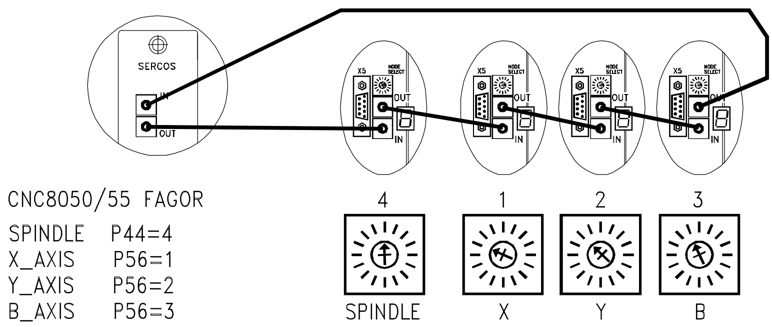
Function: Determines the feedback source at this servo drive system. In other words, if the CNC receives the feedback from that servo system through its connector at the axes module or through the Sercos interface. In either case, the velocity command is sent out to the drives via Sercos.

Possible values:
- 0 (Mode 0) The servo system has an encoder or scale outside the motor and the CNC 50/55 receives the signals through the corresponding connector at its axes module.
- 1 (Mode 1) The CNC 50/55 receives the feedback position from the Drive through the Sercos ring. This Drive has generated that signal based on the motor feedback itself.

Important:

The value of the SERCOSID parameter must match the address selected with the "Node Select" switch at the Drive module.
Remember that the numbers must be correlative and starting from One.
If the same motor is to be used as "C axis" and as spindle, the SERCOSID parameter of both CNC 50/55 tables must have the same value.

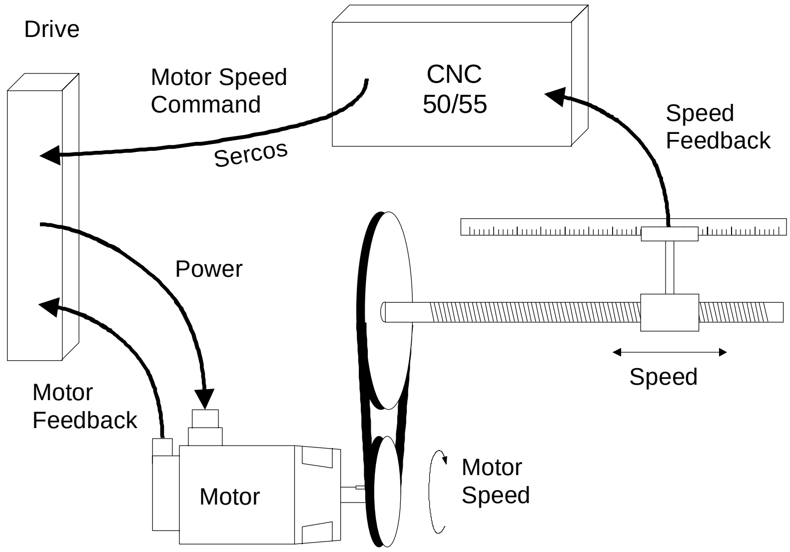
The servo drive identified as number 1 (for example) does not have to correspond to the X axis, the Y axis to another and so on. However, it would be much simpler to make the axes of the machine X, Y, Z, U, V, W, A, B and C follow a sequential numbering system. The diagram below shows an example.



Use to parameter **SERCOSLE** to select the communications line for feedback signals which means two work modes well differentiated. They are described in the following sections..

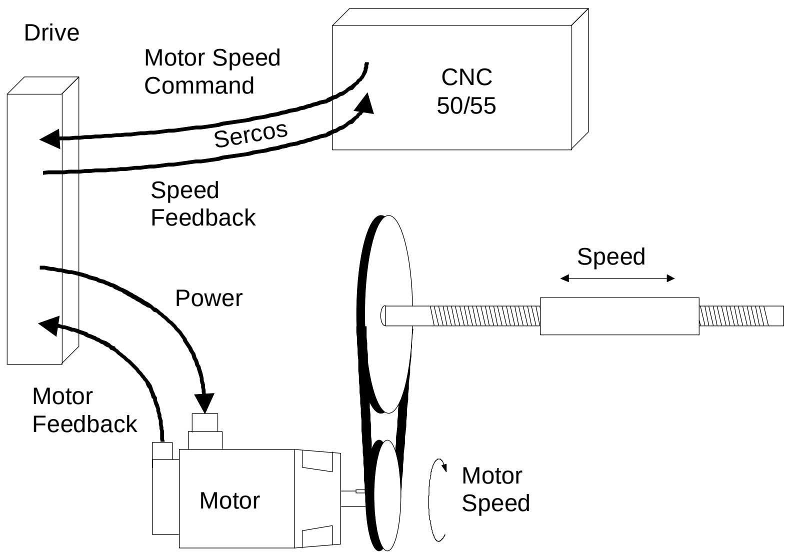
AP.1.1.1.1 8050/55 in "0" mode (external feedback)

The CNC receives the position feedback through its connector at the axes module.
The velocity command is sent out to the Drive through the fiber optics given in rpm and referred to the motor.



AP.1.1.1.2 8050/55 CNC in "1" mode (motor's own feedback)

The CNC receives the position feedback through the fiber optic lines of the Sercos ring.
This feedback is generated by the Drive based on the feedback of the motor itself.
The velocity command is sent out to the Drive through the fiber optics. It is in rpm and referred to the motor.



AP.1.1.2 OTHER 8050/55 CNC PARAMETERS

The analog velocity command at the 8050/55 CNC is adjusted by means of parameters PROGAIN, FFGAIN, DERGAIN, ACFGAIN, MAXVOLT, MAXVOLT1...4.

PROGAIN (PROportional GAIN) (Parameters: P023 for axes and spindles)

Function: Proportional gain. It is the constant that sets the ratio between the velocity command and the following error (axis lag). The main component of the Velocity Command is proportional to the Following error and to this parameter PROGAIN. It must be adjusted.
Axes: PROGAIN indicates the mV of velocity command desired for a following error of 1 mm.
Spindle: PROGAIN indicates the mV of velocity command for a following error of 1º. Only when the spindle is working in M19 mode or Rigid Tapping.

Possible values: 0..65535 mV/mm (1000 mV/mm by default), or in mV/degree for the spindle.

DERGAIN (DERivative GAIN) (Parameters: P024 for the axes and spindles)

Function: Derivative gain. It gives an additional component to the Velocity Command.
Its function depends on the value of another parameter (ACFGAIN):
If ACFGAIN=NO
DERGAIN is the constant that sets the ratio between the Velocity Command and the variation of the Following Error every 10 milliseconds.

If ACFGAIN=YES
DERGAIN is the constant that sets the ratio between the Velocity Command and the variation of speed every 10 milliseconds.
If for example ACFGAIN=NO, then:
Axes: DERGAIN indicates the mV of command corresponding to a variation of following error of 1mm in 10 ms.
Spindle: DERGAIN indicates the mV of command for a change of 1º of following error in 10 ms. Only when the spindle is working in M19 mode or Rigid Tapping.

Possible values: 0..65535 mV/(mm/10ms) (0 mV/(mm/10ms) by default).

FFGAIN (Feed Forward GAIN) (Parameters: P025 for axes and spindles)

Function: Axes: defines the percentage of additional command due to the programmed feedrate.
Spindle: defines the percentage of additional command due to the programmed speed. Only when the spindle is working in M19 mode or Rigid Tapping.

Possible values: 0..100 (0 by default)

ACFGAIN (AC-Forward GAIN) (Parameters: P046 for the axes, P042 for the spindles)

Function: Determines whether the axis machine parameter DERGAIN is applied to the variations in following error or to the variations of the programmed feedrate. See DERGAIN function.

Possible values: No: on following error
Yes: on variation of programmed speed

MAXVOLT (MAXimum VOLTage) (Parameter: P037 for the axes)

Function: Indicates the value of the analog voltage of velocity command for G00FEED.

Possible values: 0...9999 mV (9500 mV by default)
On axis drives when working with Sercos interface, this parameter must always be set to 9500.

MAXVOLTn (MAXimum VOLTage gear n) (Parameters: P037...P040 for n=1...4 at the spindles)

Function: Indicates the value of the analog voltage of velocity command for the maximum speed of the gear n.

Possible values: 0...9999 mV (9500 mV by default)

These parameters are described in chapters three and four of the installation manual of the 8050/55 CNC.

These parameters and the way to calculate them are also applicable to generate the digital Sercos velocity command.
This command is transmitted through fiber optics in motor rpm.
This command conversion from a mV to a digital command requires some parameters to be sent at the CNC as well as at the Drive. The following sections show how to se them.

AP.1.1.2.1 On Axis drives

The CNC communicates to the Drive and through the Sercos ring the desired motor speed in rpm (MS) calculated as follows:

$$MS = \underbrace{f[PROGAIN, FFGAIN...]}_{mV} \times \frac{G00FEED}{MAXVOLT} \times \frac{1}{NP123} \times \frac{NP121}{NP122} \text{ (rpm motor)}$$

NP121 -S00121-, NP122 -S00122- and NP123 -S00123- are parameters of the drive.
Thus, for a proper setup of the system, proceed as follows:

At the drive:
- Set parameters **NP121, NP122 and NP123** according to the gear ratios installed.
- **SP20 -F00031-** and **SP21 -F00081-** are ignored.

At the CNC:
- Set **MAXVOLT = 9500** that is: 9.5 volts.
- Calculate the **PROGAIN** constant based on a command of 9500 mV. Thus:

$$PROGAIN = \frac{9500}{EdS} = \frac{9500 \cdot Kv \cdot 1000}{G00FEED} \text{ (mV / mm)}$$

where:
EdS (mm) = following error at G00FEED.
Kv is a constant indicating the ratio between G00FEED and the EdS. Thus:
for Kv=1, the EdS (following error) will be 1 mm for a feedrate of 1 m/min.
for Kv=2, the EdS (following error) will be 0.5 mm for a feedrate of 1 m/min.

Feedback parameter setting at the axis drive:

With SERCOSLE=0
Using external feedback requires that all the feedback parameters to be set at the CNC: **PITCH (P007), NPULSES (P008), DIFFBACK (P009), SINMAGNI (P010), FBACKAL(P011), REFPULSE (P032), IOTYPE (P052), ABSOFF (P053)** and **EXTMULT (P057).** They are located in the parameter table for each axis a the 8050/55 CNC.

With SERCOSLE=1
The Drive indicates the motor speed to the CNC 50/55 by means of digital commands through Sercos. Therefore, the feedback characteristics will be set by the parameters of the Drive. At the CNC 50/55, the parameters mentioned earlier are ignored.

AP.1.1.2.2 On spindle drives in open loop.

The CNC 50/55 indicates to the spindle drive, through the Sercos ring, the desired motor speed in rpm (MS) which is calculated as follows:

$$MS = \underbrace{ProgrammedSpeed \cdot \frac{MAXVOLTn}{MAXGEARn}}_{mV} \cdot \frac{SP21}{SP20} \text{ (motor rpm)}$$

To properly setup the drive, proceed as follows:

<u>At the Drive:</u>

- Set parameters **SP20 -F00031-** and **SP21 -F00081-** with the maximum motor speed for this application and 9500 millivolts respectively.
- Set **NP121 -S00121-, NP122 -S00122-** and **NP123 -S00123-** when wishing to display the tool speed on the screen while working with SERCOSLE=1.

<u>At the CNC 50/55:</u>

- Set the CNC 50/55 **MAXGEARn** parameters with the maximum tool speed for that gear "n".
- Set the **MAXVOLTn** parameters according to the following equation:

$$MAXVOLTn = \underbrace{MAXGEARn \cdot Ratio}_{motor\ rpm} \cdot \frac{SP20}{SP21} \text{ (mV)}$$

$$Ratio = Gear\ Ratio = \frac{N\ motor}{N\ tool}$$

<u>Example of open loop spindle</u>

A machine has three gear ratios: 4/1, 2/1 and 1/1. The maximum motor speed is 4000 rpm and the maximum tool speeds are: 1000, 2000 and 3800 rpm in each.

Therefore, proceeding as indicated earlier:

SP21 -F00081- = 4000, and
SP20 -F00031- = 9500.
MAXGEAR1 = 1000 rpm,
MAXGEAR2 = 2000 rpm, and
MAXGEAR3 = 3800 rpm.
The MAXVOLTn parameters will be:

$$MAXVOLT1 = 1000 \cdot \frac{4}{1} \cdot \frac{9500}{4000} \text{ (mV)} = 9500 \text{ mV}$$

$$MAXVOLT2 = 2000 \cdot \frac{2}{1} \cdot \frac{9500}{4000} \text{ (mV)} = 9500 \text{ mV}$$

$$MAXVOLT3 = 3800 \cdot \frac{1}{1} \cdot \frac{9500}{4000} \text{ (mV)} = 9025 \text{ mV}$$

<u>Feedback parameter setting at the spindle drive in open loop:</u>

<u>With SERCOSLE=0</u>

Using external feedback requires all the feedback parameters to be set at the CNC 50/55: **NPULSES (P013), DIFFBACK (P014), FBACKAL(P015)** and **REFPULSE (P032).**

<u>With SERCOSLE=1</u>

The Drive indicates the motor speed to the CNC 50/55 by means of digital commands through Sercos. Therefore, the feedback characteristics will be set by the parameters of the Drive. At the CNC 50/55, the parameters mentioned earlier are ignored.

AP.1.1.2.3 On spindle drives in closed loop, M19 or Rigid Tapping.

The CNC indicates to the drive, through the Sercos ring, the desired motor speed (MS) which is calculated in a way similar to that of the axis drive.

$$MS = \underbrace{f\left[PROGAIN, FFGAIN...\right]}_{mV} \cdot \frac{SP21}{SP20} \text{ (motor rpm)}$$

To properly set the drive, proceed as follows:

<u>At the Drive:</u>

- Set parameters **SP20 -F00031-** and **SP21 -F00081-** with the maximum motor speed value for this application and 9500 millivolts respectively.
- Set parameters **NP121, NP122 and NP123** according to the gear ratios installed.

<u>At the CNC 50/55:</u>

- Set the **MAXGEARn** parameters of the CNC 50/55 with the maximum tool speed value for that gear "n".
- Set the **MAXVOLTn** parameters according to the equation shown in the previous section.

And:

<u>At the CNC 50/55:</u>

- The constants PROGAIN, DERGAIN, etc. must also be set. For example:

  Two CNC 50/55 parameters:

  REFEED1 (P034) = Maximum angular speed in M19 (°/min).

  REFEED2 (P035) = Maximum angular speed of the tool when searching home in M19.

  and two concepts similar to MaxGear and MaxVolt used earlier:

  MG_M19 = Maximum tool turning speed in M19 (rpm).

  MV_M19 = Analog voltage for REFEED1 (mV).

Hence, PROGAIN is calculated as follows:

$$PROGAIN = \frac{MV\_M19}{EdS} = \frac{MV\_M19 \cdot Kv \cdot 1000}{REFEED1} \text{ (mV/°)}$$

where:

$$MV\_M19 = \frac{MAXVOLT1}{MAXGEAR1} \cdot \frac{REFEED1}{360} \text{ (mV)}$$

and

$$REFEED1 = MG\_M19 \cdot 360 \text{ (°/min)}$$

and where:

EdS (mm) = Following error at a speed of REFEED1.

Kv is a constant indicating the ratio between REFEED1 and the EdS, Thus:

for Kv=1 the EdS will be 1° for a speed of 1000 °/min.

for Kv=2 the EdS will be 0.5° for a speed of 1000 °/min.

The next page shows an example.

Example for a spindle in closed loop:

Using the example for a spindle in open loop, we have:

The machine has three gear ratios: 4/1, 2/1 and 1/1.
Maximum motor speed for this application: 4000 rpm.
SP21 -F00081- = 4000, and SP20 -F00031- = 9500.
MAXGEAR1 = 1000 rpm, MAXGEAR2 = 2000 rpm y MAXGEAR3 = 3800 rpm.
MAXVOLT1 = 9500 mV, MAXVOLT2 = 9500 mV, MAXVOLT3 = 9025 mV.

And:

The maximum tool speed in this mode is: 100 rpm.
The maximum tool speed when searching home is 50 rpm.
The following error must be 1° for every 1000°/min. (Kv=1)
A gear ratio of "1" is the right one to work with spindle orientation (M19), since MAXGEAR1 is the next value up from the 100 rpm foreseen for M19.

Therefore:

$$\text{REFEED1} = 100 \cdot 360 = 36000\ °/\text{min}$$

$$\text{REFEED2} = 50 \cdot 360 = 18000\ °/\text{min}$$

$$\text{MV\_M19} = \frac{9500}{1000} \cdot \frac{36000}{360} = 950\text{mV}$$

$$\text{EdS} = 36° \text{ for the } 36000°/\text{min of REFEED1}$$

$$\text{PROGAIN} = \frac{9500 \cdot 1 \cdot 100}{360000} = \frac{950}{36} = 26.38\ (\text{mV}/°)$$

Parameter PROGAIN does not admit decimals. Therefore, in this example, in order to keep accuracy, we can use another parameter to change the units for PROGAIN:

When GAINUNIT (P041) is equal to 0, we will set PROGAIN = 26
When GAINUNIT (P041) is equal to 1, will set PROGAIN = 2638

These can be found in the spindle parameter table of the 8050/55 CNC.

Feedback parameter setting at the spindle drive in closed loop:

With SERCOSLE=0

Using external feedback requires all the feedback parameters to be set at the CNC 50/55: **NPULSES (P013), DIFFBACK (P014), FBACKAL(P015)** and **REFPULSE (P032).**

With SERCOSLE=1

When no external encoder is used, the motor encoder may be used by setting SERCOSLE=1 at the CNC 50/55. At the drive, the existing gear ratios must be set by means of GP6 -F00717-, NP121 -S00121-, NP122 -S00122- and NP123 -S00123-.

At the CNC 50/55, the feedback parameters mentioned earlier are ignored.

Important:

When working with SERCOSLE=1, the motor feedback is only useful to work in M19 mode and/or Rigid Tapping when the spindle only has one gear and the Gear Ration meets one of these two conditions:

- The Gear Ratio is 1/1. The Reference mark of the spindle (I_0) is that of the motor feedback.
- The Gear Ratio is of the n/1 type where "n" is an integer (no decimals). In this case, a microswitch must be used for selecting a particular reference pulse among the "n" signals generated by the motor encoder per spindle turn.

AP.1.2 CONSIDERATIONS AT THE DRIVES

When using the Sercos interface, certain Drive parameters are no longer needed.
If neither the "Encoder Simulation" nor the "I/O" boards are installed, their associated parameters are not needed either.

Parameters **NP121 -S00121-, NP122 -S00122-** and **NP123 -S00123-** must be properly set in the following cases:

- At the axis drives, ALWAYS.
- At the spindle drives, when wishing to display tool speed or to work in closed loop (M19 or Rigid Tapping) while working with motor feedback (SERCOSLE=1).

At the spindle drives with external feedback (SERCOSLE=0) the NP parameters need not be set.

SP20 -F00031- and **SP21 -F00081-** must be set:

- At the spindle drives, ALWAYS. Set them with the maximum motor speed values for that application and 9500 millivolts respectively.
- They need not be set at the axis drives.

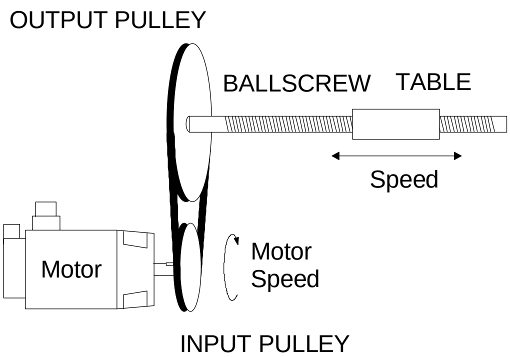
Example for setting parameters NP121, NP122 and NP123:

If for every 5 turns of the motor shaft, the ballscrew turns 3 times. The parameters must be set as follows:
NP121 = 5 NP122 = 3

If it is a linear axis where for each ballscrew turn, the table moves 4 mm:
NP123 = 40000 tenths of a micron.

If it is a rotary axis where each turn of the output pulley means a 360º turn:
NP123 = 3600000 ten-thousandths of a degree.

For example:



Example:
Diameter of the output pulley = 25.75 mm
Diameter of the input pulley = 15.3 mm

NP121 = 2575
NP122 = 1530

Gear ratio =2575/1530 =1.683

Ballscrew pitch = 5 mm

NP123 = 5 milimeters

AP.1.3 CONTROL SIGNALS PLC8050/55 - DRIVE

Signals from the PLC 50/55 to the Drive.

The Drive "Speed Enable" and "Drive Enable" can now be controlled from the PLC 50/55 through the Sercos ring. To do that, the PLC 50/55 now offers two new output logic variables:

SPENAn (SPeed ENAble n) (n=1..7) (M5110, M5160, M5210, M5260, M5310, M5360 and M5410)
SPENAm (SPeed ENAble m) (m=S,S2,AS) (M5462, M5487and M5449)

Function:	Identifies the electrical signal "Speed Enable" of connector X2 of the Drive.	
Possible values:	0	Disables the velocity command. Motor with command zero.
	1	Enables the velocity command. The motor follows the command.

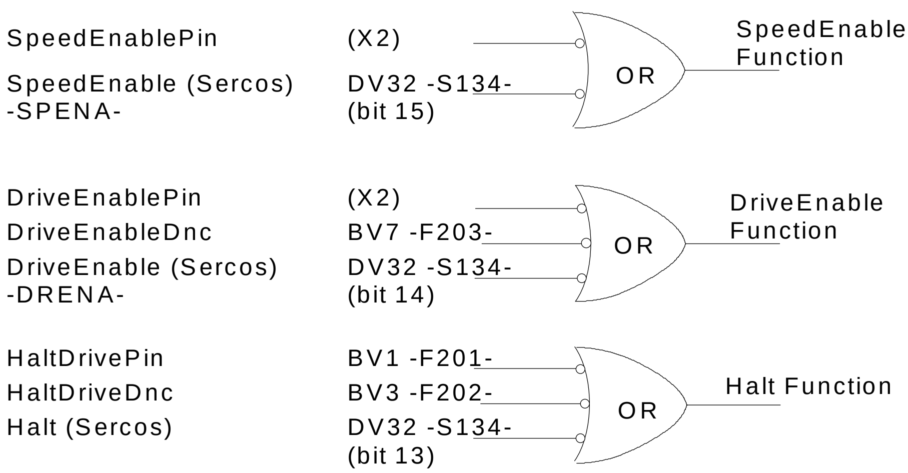
DRENAn (DRive ENAble n) (n=1..7) (M5111, M5161, M5211, M5261, M5311, M5361 and M5411)
DRENAm (DRive ENAble m) (m=S,S2,AS) (M5463, M5488 and M5448)

Function:	Identifies the electrical signal "Drive Enable" of connector X2 of the Drive.	
Possible values:	0	Disables the Drive. The motor has no torque.
	1	Enables the Drive.

The "Speed Enable" function at the drive will be activated when the SPENA variable is activated and the electrical signal Speed_Enable is activated at the pins of connector X2. The "Drive Enable" function will be activated when the DRENA variable is activated and the electrical signal Drive_Enable is activated at the pins of connector X2. See diagram below.

Safety regulations (EN-60204-1) demand the Drive Module to have an input non-software related to guarantee that the motor will stop.

The hardware control over the electrical signal "Drive_Enable" MUST NOT be removed even when using the Sercos interface.



Signals from the Drive to the PLC 50/55.

The Drive offers two bits to the PLC 50/55 to indicate the operating status.
These are: **DRSTAFn** and **DRSTASn**. The table below shows the meaning of these signals.

DRSTAFn (DRive STAtus First n) (n=1..7,S,S2,AS) (M5603, M5653, M5703, M5753, M5803, M5853 and M5903 at the axes. M5953, M5978 and M5557 at the spindles)
DRSTASn (DRive STAtus Second n) (n=1..7,S,S2,AS) (M5604, M5654, M5704, M5754, M5804, M5854 and M5904 at the axes. M5954, M5979 and M5556 at the spindles)

Function: They are the bits indicating the Drive status to the PLC. This way, the PLC program will handle the drive control signals depending on its status.
Possible values: 0,1 with the meaning explained in the next table.

Important:

As a general rule, the PLC assigns the id numbers to all the axis variables in the following order: X, Y, Z, U, V, W, A, B and C. The SERCOS id numbers (SERCOSID, Node_Select) assigned to the drives have nothing to do with this.

If the machine has three axes (for example: X,Y,B):
Variables SPENA1, DRENA1, and bits DRSTAF1 and DRSTAS1 will correspond to the X axis, those with the index 2 to the Y axis and those of the index 3 to the B axis.
Those with the S, S1 and AS index will correspond to the main, second and auxiliary spindle respectively.

The installation manual of the 8050/55 also mentions these PLC variables.

DRSTAFn	**DRSTASn**	Status	Action
0	0	The Drive is not ready. Do not apply Mains power to the Power Supply.	Check the 24 Vdc, and/or solve the errors.
0	1	The Drive is ready to receive Power at the Bus. The Drive_OK contact is closed.	Apply Mains power to the Power Supply.
1	0	The Drive is ready to attend to the control signals.	Enable the Drive with Drive_Enable and Speed_Enable.
1	1	The Drive_Enable and Speed_Enable functions activated. The motor follows the command.	Govern the motor with the command.

This is an example of how to program a Fagor PLC.
It handles the drive's control signals depending on its status and other variables.

```
;-----  This machine has two axes (X, Z) an a spindle (S)
;-----  The Z axis is vertical and it is not compensated. It has a brake controlled by the O20 output.

;----- DRIVE STATUS MANAGEMENT -----

DRSTAF1 = B1R101                                 ;X axis drive status
DRSTAS1 = B0R101
;
DRSTAF2 = B1R102                                 ; Z  axis drive status
DRSTAS2 = B0R102
;
DRSTAFS = B1R103                                 ;Spindle drive status
DRSTASS = B0R103
;
CPS R101 GE 1 = M101                             ;X axis drive OK
CPS R102 GE 1 = M102                             ;Z axis drive OK
CPS R103 GE 1 = M103                             ;Spindle drive OK
M101 AND M102 AND M103 = M123                    ;All the drives are ready
                                                 ;the machine can be powered up

;----- MANAGING EMERGENCIES -----

M123 AND I1                                      ;Emergency  inputs
AND (other conditions) = /EMERGEN
/EMERGEN AND /ALARM
AND (other conditions) = O1                      ;Emergency output

;----- MANAGING AXES ENABLES -----

CPS R101 GE 2 = M111                             ;The X axis has power
CPS R102 GE 2 = M112                             ;The Y axis has power
M111 AND M112 = M133                             ;All the axis drives OK and with power

M111 AND NOT LOPEN AND O1                        ;X axis enable
AND (others) = SERVO1ON = SPENA1                 ;Speed Enable for the X axis
= TG3 1 300
T1 = DRENA1                                      ;Drive Enable with a 300ms delayed deactivation
                                                 ; for emergency stops.

M112 AND NOT LOPEN AND O1 AND (others)           ;Z axis (vertical) enable
= TG3 2 400 = O20                                ;Brake controlling signal
T2 = DRENA2 = SERVO2ON = SPENA2                  ;Speed and Drive Enable with a 400 ms delayed
                                                 ; deactivation to prevent axis sag.

;----- MANAGING SPINDLE ENABLES -----

CPS R103 GE 2 = M113                             ;The spindle drive has power

M3 OR M4 = SET M140                                      ;Request for Spindle rotation
M2 OR M5 OR M30 OR RESETOUT OR NOT O1= RES M140          ;Cancel spindle rotation

M19 = SET M119                                                  ;Request for M19
M2 OR M3 OR M4 OR M5 OR M30 OR RESETOUT OR NOT O1 = RES M119    ;Cancel M19

(M140 OR (M119 AND NOT LOPEN)) AND M113 = SPENAS = TG3 3 4000
T3 = DRENAS                                                     ;4 sec. delayed deactivation
                                                                ; for emergency stops.
SPENAS AND (M119 OR RIGID) AND NOT LOPEN = SERVOSON ;M19 or Rigid Tapping, close the loop.

;----- MANAGING FEED HOLD AND STOP -----

M133 AND (others) = /FEEDHOL
```

AP.2 CONNECTION WITH THE FAGOR 8070 CNC

The Fagor 8070 CNC has some general configuration parameters similar to those of the Fagor drive. These parameters must be set so they are consistent with the ones set at the drive.

The are:

OPMODEP Similar to parameter AP1 -S32- PrimaryOperationMode.

Give this parameter a value consistent with that of AP1 at the drive.

LOOPTIME Similar to parameter QP1 -S1- ControlUnitCycleTime of the drive.

Same.

Other parameters must also be set for each axis.

They are:

DRIVETYPE Indicates the type of interface being used.

To connect the 8070 CNC with Fagor drives, DRIVETYPE = Sercos

TELEGRAMTYPE Telegram type used in Sercos communication.

Set TELEGRAMTYPE = 4.

DRIVEID Identifies the drive in the Sercos ring.

Set this parameter with the same value as the one selected at the drive's thumbwheel.

NPULSES
PITCH Parameters that determine feedback resolution.

The 8070 can work with a resolution of a tenth of a micron.
Thus, the relationship between these two parameters must be:

$$\frac{\text{PITCH}}{\text{NPULSES} \cdot 4} = 0.1\ \mu$$

AP.3 PARAMETER SET AND GEAR RATIOS

The Fagor Servo Drive System is configured by means of a parameter table.

Some of these parameters are arrays of eight elements, ordered with endings going from zero up.

One of these arrays is, for example: SP1.0, SP1.1, SP1.2, ... SP1.6 and SP1.7.

The parameters extended into "arrays" are organized in two groups called "Parameter set" and "Gear Ratios". The illustration shows the organization of the table.

Terminology:

Parameter Set refers to the set of parameters of the Drive which determine the setup of the drive and are grouped by the same ending.

For example, the Parameter set Zero consists of CP20.0, IP1.0, SP1.0 ··· SP10.0, SP20.0, SP21.0, SP40.0, SP41.0, SP60.0 ··· SP65.0, SP80.0 and SP100.0.

Each parameter set may configure the same drive differently. This choice may be made by just changing the Active Set.

The parameter setup for a "C" axis MUST BE made using the Parameter Set Seven.

Gear refers to the purely mechanical ratio regardless of how the parameters have been set.

Gear 0 refers to "out of gear". No transmission (in neutral).
Gear 1 is the lowest gear with the greatest speed reduction.
Gear 2 and the rest will be higher gears.

Gear Ratio refers to the set of Drive parameters grouped by the same ending and that informs the Drive of the motor-machine transmission (gear) ratio.

For example, Gear Ratio 2 consists of NP121.2, NP122.2 and NP123.2. The choice can be made by just changing the Active Ratio.

They are numbered from Gear Ration 0 to 7.

The gear ratio parameters inform of the gear in operation according to:

Gear Ratio 0	Gear 1	
Gear Ratio1	Gear 2	
Gear Ratio2	Gear 3	etc...

Any parameter may be edited at any time (eight sets and eight gear ratios). The Backup and Restore operations affect the whole parameter table.

Each time, only one of those "sets" and one of those "gear ratios" determine the operation of the system . They are the Set and Gear ratio active at the time.
All Set-GearRatio combinations are possible.

Important parameters:

GP4, number of useful sets	**GP6**, number of useful gear ratios
GV21, active set	**GV25**, Active gear ratio.

The drawing shows an example:

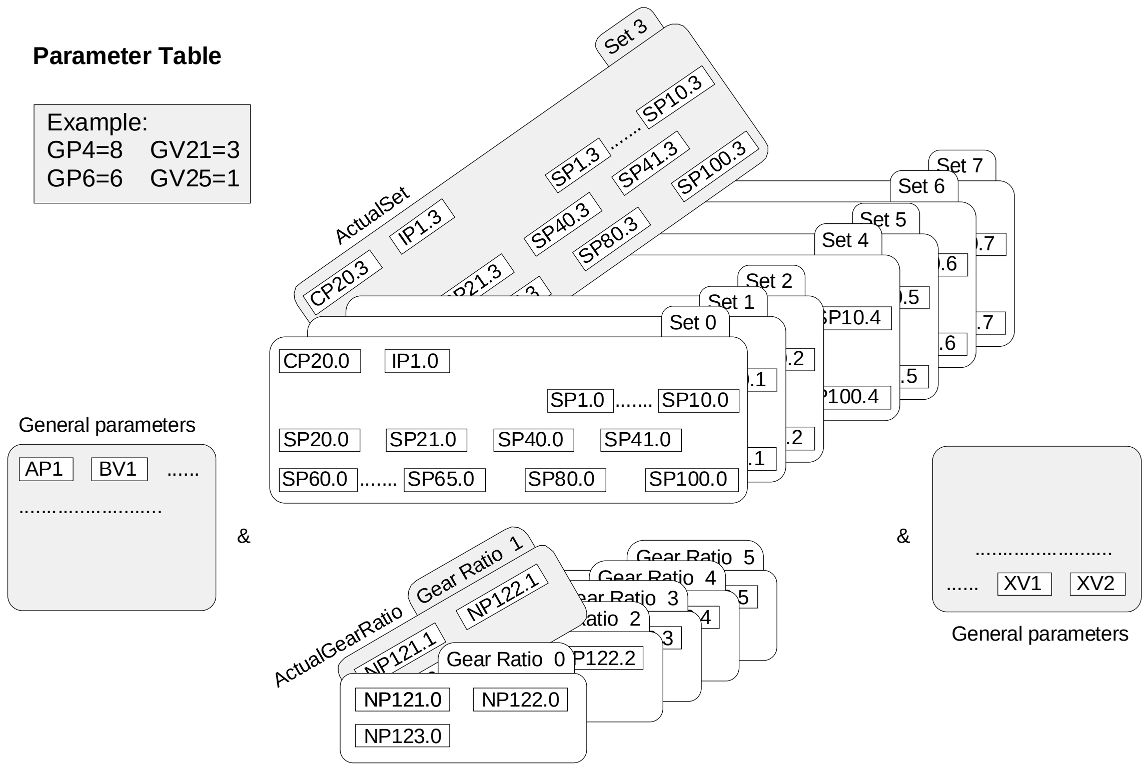
Parameters GP4 and GP6 limit the number of sets and gear ratios that can be activated. For example, with GP4=4 the values of Active Set are limited to between 0 and 3.

Important:

Assigning a motor ID to the **GV10** variable resets the whole parameter table to their default values. Particularly, GP4=1 and GP6=1 thus leaving Set 0 and Gear Ratio 0 as the only ones that can activated.

Turning the drive back up sets GV21=0 and GV25=0.

The next sections describe the operation of these two subsets.



AP.3.1 PARAMETER SET

The Active Set may be changed by means of external digital signals or through the Sercos interface.

AP.3.1.1 SET CHANGE THROUGH DIGITAL INPUTS

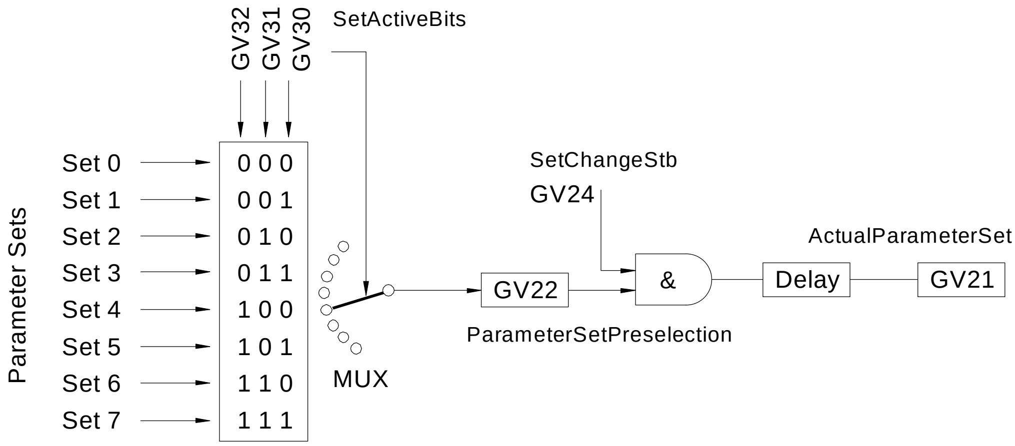
Running status:

Parameter **GP4** sets the number of useful sets ($1 \leq GP4 \leq 8$).
Variable **GV21** informs of which is the currently active set.
($0 \leq GV21 < GP4$).

Boolean variables to change the active set:

GV32, **GV31** and **GV30** are used to preselect the new active set.
GV22 registers this preset.
GV24 "Strobe" lets or not change the active set.
GV23 "Acknowledge" is the acknowledgment of the set change.

The default value of all three preselection variables is zero.
The default value of the Strobe signal is "1" (active).

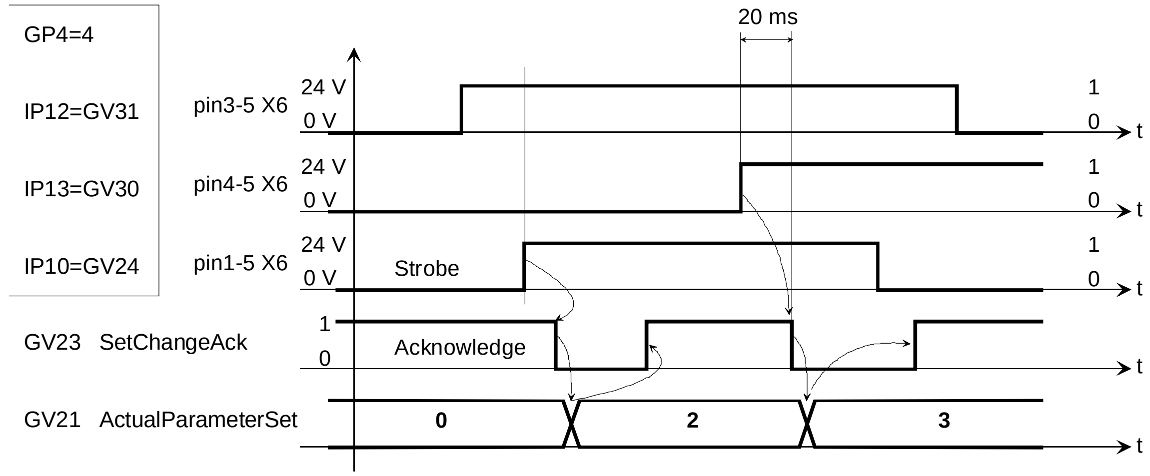


<u>Set change procedure:</u>

Assign to inputs IP10-13 the boolean variables to be governed.
Use these digital inputs to preselect the new set that will be active.
Activate the "Strobe" signal by means of the electrical signal assigned to GV24.

The "Strobe" signal GV24 may be deactivated with a delay or as a result of an up flank (leading edge) of the "Acknowledge" GV23.

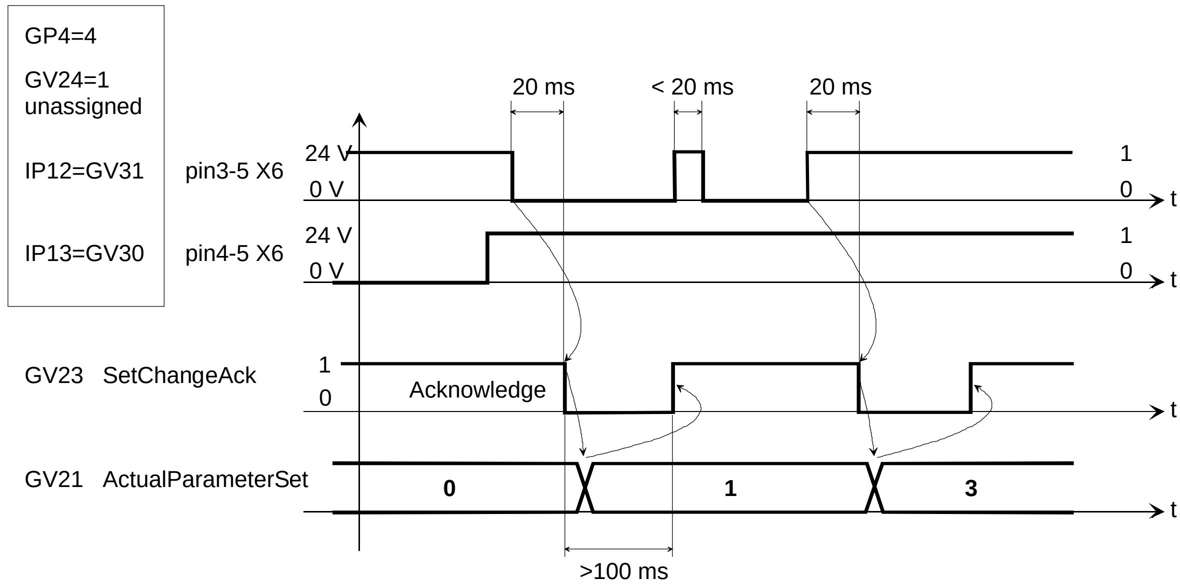
The diagram of the following page is an example:



Operation with the Strobe always active:

GV24 "Strobe" will stay active if it is not assigned to a digital input.
This way the change of sets is handled directly without control signals, with GV32-30. in order to avoid possible disturbances or rebounds on those electrical signals, they should maintain their new values for at least 20 milliseconds.

The drawing below is an example.



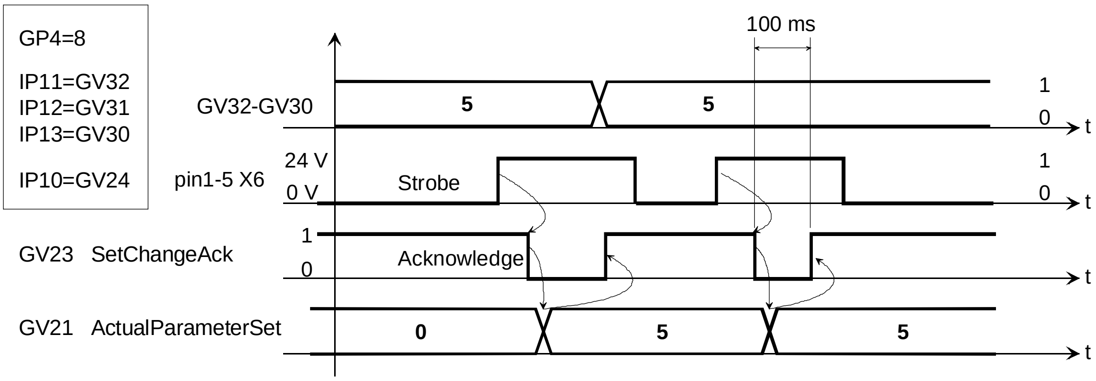
Remarks:

The active set may be changed while the motor is running. If the motor is turning faster than the limit established by the new parameter set, the speed will decrease automatically until the value of such limit is reached and only then, the new parameter set will become effective. The ramp used to make this change of speed will be the one determined by the previous set.

"Acknowledge" signal for a set change set.

This signal is used as confirmation of the change. It will go to "0" with the up flank of the "Strobe" signal and it will go back to "1" when the change is completed.

Even when the new set is the same as the old one, this acknowledge signal GV21 will be set to "0" for 100 milliseconds.
See the diagram below.



AP.3.1.2 SET CHANGE THROUGH SERCOS INTERFACE

The procedure is identical and parallel to the change of gear ratio.
See the section on "Change of gear ratio through Sercos interface".

There is a very important aspect to be considered when changing Sets through Sercos Interface:

To change a parameter set through Sercos interface, the variables GV24, GV30, GV31 and GV32 MUST NOT be assigned to a digital input.

AP.3.2 GEAR RATIOS

The gear ratios consist of parameters NP121, NP122 and NP123 only.
These parameters indicate the mechanical transmission ratio between the motor and the axis ballscrew or between the motor and the tool in the spindle. NP123 indicates the pitch of the ballscrew.

<u>Axes:</u>

These parameters must be set for each Gear Ration and change the Active Ratio with each gear change.

<u>Spindle:</u>

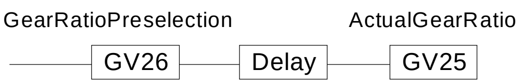
These NP parameters must be updated for each change of Gear only when working in SERCOSLE=1 mode and if we want to display the spindle speed on the CNC screen or work in M19 mode or in Rigid Tapping.

In those cases, the mechanical maneuver in the machine gear box will be accompanied by a change of Active Gear Ratio

The command to change gears is given through the <u>Sercos interface</u>. This change cannot be handled through digital inputs.

Operation status:

Parameter **GP6** sets the number of useful gear ratios ($1 \leq GP6 \leq 8$).
Variable **GV25** informs which is the current (actual) gear ratio ($0 \leq GV25 < GP6$).
Variable **GV26** registers the preselected Gear Ratio



AP.3.2.1 CHANGE OF GEAR RATIO THROUGH SERCOS INTERFACE

Change procedure via Sercos also applicable to the change of Sets.

The CNC changes gear ratios by means of commands M41, M42, M43 and M44. By setting parameter AUTOGEAR (P006) to "YES", the CNC will automatically generate the previous M codes according to the selected speed. If AUTOGEAR="NO", the user must include these M codes into the part-program.

Procedure:

First, determine the number of useful sets and gears by writing into these variables:

GP4	33471	(F00703)	SetNumber
GP6	33485	(F00717)	GearRatioNumber

Write into the CNC variables which the new set and new gear ratio will be:

SETGEX, SETGEY, SETGEZ, etc	for the axes
SETGES	for the main spindle
SSETGS	for the second spindle.

The four least significant bits of these variables register the active gear and the other four the active set as shown in the diagram below:

Bit 7 6 5 4		Bit 3 2 1 0	
0 0 0 0	Set 0 → GV21=0	0 0 0 0	→ Gear Ratio 0 → Range 1 → GV25=0
0 0 0 1	Set 1 → GV21=1	0 0 0 1	→ Gear Ratio 1 → Range 2 → GV25=1
0 0 1 0	Set 2 → GV21=2	0 0 1 0	→ Gear Ratio 2 → Range 3 → GV25=2
etc..		etc..	

These writings are done through the Service Channel (slow). This channel is accessed via part-program instructions, from the PLC channel or from the user channel.

A new PLC mark (SERPLCAC -Sercos PLC Acknowledge-) serves as a confirmation of the change. It will stay active from when a new set or gear ratio is requested with the previous variables (SETGEX,etc..) until the Drive assumes the new values for its GV21 parameters: ActualParameterSet and GV25 ActualGearRatio.

While these mark is active, no other SETGE* change can be requested because the command would be lost.

AP.3.2.2 EXAMPLE OF A PLC PROGRAM FOR A GEAR CHANGE AT THE MAIN SPINDLE

Example of a spindle with SERCOS interface on the next page.

The spindle has two ranges and works in open loop.
It does not use external feedback, but that of the motor itself, that is: SERCOSLE=1.
Therefore, to display the real "S" at the CNC, one must change the gear ratio at the drive with each range change at the machine.

The drive of the main spindle is identified with the number 3 of the SERCOS ring.
(SERCOSID = 3 in the parameter table of the main spindle S).

Therefore, one must set the PLC parameter P28(SRR700) = 3.33172.
("33172" is the SERCOS identifier of the variable DV11 (F-404)).
This makes register R700 (associated with parameter P28) contain the variable DV11 "FagorDiagnostics" of the main spindle through which we know the "ActualGearRatio" (GV25).

At the CNC, the spindle table must be defined.
Spindle in open loop with three ranges.
The feedback is defined with SERCOSLE=1
SERCOSID = 3

At the drive.
Two gear ratios an a single parameter set must be defined:

Gear Ratio 0	Gear 1	Parameter set 0.
Gear Ratio 1	Gear 2	

GP4 = 1
GP6 = 2

; -- EXAMPLE OF A PLC PROGRAM FOR A GEAR CHANGE AT THE MAIN SPINDLE --

```
;
; Information on resources in use:
;
; I41  = Detector for first gear (M41)
; I42  = Detector for second gear (M42)
; I79 = "Drive OK" Spindle Drive
;
; O141 = Electric valve to activate the first gear (M41)
; O142 = Electric valve to activate the second gear (M42)
;
; M41  = Decoding of  "M41" from CNC: Change to first gear
; M42  = Decoding of  "M42" from CNC: Change to second gear
;
; With parameter PLC P28 (R700) = 3.33172, we define the SERCOS identifier Fagor Diagnostics,
; because in this case, at the spindle, SERCOSID = 3
; B10R700 = SV3. This bit is activated when the spindle speed is lower than the minimum "N"  (SP40).
;
CY1
;
END
;
PRG
REA
;
;---------- DRIVE STATUS ---------
;
DRSTAFS = B1R104
DRSTASS = B0R104                         ; Reading of the spindle drive running status.
;
CPS R104 GE 1 = M104                     ; Spindle drive OK
;
M104                                     ;Drive OK (by software)
AND I79                                  ;Drive OK (by hardware)
= M200                                   ;Drive OK.
;
CPS R104 GE 2 = M114                     ; Spindle drive under power
;
I1 AND M200 = /EMERGEN                   ; Emergency to the CNC
/EMERGEN AND /ALARM = O1                 ;Emergency contact to the electrical cabinet
;
;---------- GEAR CHANGE ---------
;
M2047  = AND R700 $0F R45                ;Read variable GV25 «ActualGearRatio»
;
B9R700 = TG2 30 200                      ; Confirmation delay N=0
B10R700 = TG2 31 200                     ; Confirmation delay N=Nmin
T30 = M155                               ; N=0
T31 = M156                               ;   N=Nmin

I41 AND NOT I42 = TG2 41 200             ;Confirmation delay for 1st gear
I42 AND NOT I41 = TG2 42 200             ;Confirmation delay for 2nd gear
;
T41 = GEAR1                              ;Confirmation of 1st gear at the machine
T42 = GEAR2                              ;Confirmation of 2nd gear at the machine
;
M114 AND M41
AND NOT GEAR1
= SET M141                               ;Request for change into first gear
;
M114 AND M42
AND NOT GEAR2
= SET M142                               ;Request for change into second gear
;
M141 OR M142 = M150                      ;Spindle gear change in progress
= TG2 10 5000
```

```
;
T10 = SET MSG10                                ;Gear change time exceeded
RESETOUT OR NOT O1= RES MSG10
;
;
M150 AND M156 = MOV 100 SANALOG = PLCCNTL      ;Gear change oscillation (100*0,3=30 mV.)
PLCCNTL  AND M2011 = SPDLEREV                  ;Reversal during gear change
;
;
M141 AND NOT SERPLCAC                          ;Request and free service channel
= SET M241                                     ;Latching the request for drive's first gear ratio
NOT M242 AND GEAR1
AND NOT CPS R45 EQ $00                         ;1st gear does not match drive's gear ratio
AND NOT SERPLCAC
= SET M341                                     ;Latching the request for drive's first gear ratio
;
M241 OR M341 = M146
DFU M146 = MOV $00 R41
= CNCWR(R41,SETGES,M1000)                      ;Request for drive's first gear ratio
;
M146 AND CPS R45 EQ $00
AND NOT SERPLCAC AND GEAR1
= RES M141 = RES M241
= RES M341                                     ;Confirmation of the change into first gear
;
M142 AND NOT SERPLCAC                          ;Request and free service channel
= SET M242                                     ;Latching the request for drive's second gear ratio
NOT M241 AND GEAR2
AND NOT CPS R45 EQ $01                         ;2nd gear does not match drive's gear ratio
AND NOT SERPLC
= SET M342
;
M242 OR M342 = M147
DFU M147= MOV $01 R41
            = CNCWR(R41,SETGES,M1000)          ;Request for drive's second gear ratio
;
M242 AND CPS R45 EQ $01
AND NOT SERPLCAC AND GEAR2
= RES M142 = RES M242
= RES M342                                     ;Confirmation of the change into second gear
;
T10 OR NOT O1 OR RESETOUT                      ;Cancel request for a gear change
= RES M141= RES M142 = RES M241
= RES M242= RES M341 = RES M342
;
M241 AND O1 AND M156 = O141                    ;Activate servo valve to change into first gear,
M242 AND O1 AND M156 = O142                    ;Activate servo valve to change into second gear,
;
;---------- ENABLING THE DRIVE ---------
;
M3 OR M4 = SET M140                            ; Request for spindle rotation.
M2 OR M5 OR M30
OR NOT O1 OR RESETOUT = RES M140               ; Cancelation of spindle rotation.
;
(M140 OR PLCCNTL )
AND M114                                       ; Drives under power
AND (Closed door conditions)                   ; Closed door
= SPENAS = TG3 3 4000                          ; Enabling the spindle analog
T3 = DRENAS                                    ; Enabling the spindle drive
```

```
;---------- AUXEND, /XFERINH, /FEEDHOLD ---------
;
DFU STROBE OR DFU TSTROBE
OR DFU T2STROBE OR DFU MSTROBE
 = TG1 1 100                          ; confirmation pulse STROBES
;
NOT T1
AND NOT M150                          ; Gear change in progress at the drive
= AUXEND                              ; M,S,T functions being executed
;
NOT M241 AND NOT M242                 ; Gear change in progress at the drive
= /XFERINH                            ; Locked CNC block reading
= /FEEDHOLD                           ; Feedhold for CNC axes
;
END
```

AP.3.2.3 EXAMPLE OF A PLC PROGRAM FOR A PARAMETER SET CHANGE

This example shows how to work with in both spindle and "C" axis mode with the same drive.

The drive of the main spindle (S) is identified as number 3 in the Sercos ring.

At the drive.

A different parameter set must be defined (it must be the last set -7- for the "C" axis). In the "C" axis mode, the machine must be forced to work in the lowest range (greater gear ratio) and indicate it to the Drive (Gear Ratio 0).
Set: GP4 = 8 (to make it possible to activate set 7)
GP6 = 1 (to only work with Gear Ratio 0, in this example).

Two tables must be defined at the CNC:

Spindle table.	SERCOSID = 3
"C" axis table.	Spindle in closed loop working as a regular axis. Set the external feedback (SERCOSLE=0) with all the necessary parameters. SERCOSID = 3

Important:
When using the same motor as "C" axis or as a spindle, both CNC tables must have the same SERCOSID parameter value.

Set PLC parameter P28(SRR700) = 3.33172.
(The number 33172 is the SERCOS identifier of variable DV11 (F-404))
This way, register R700 (associated with parameter P28) will contain the DV11 -F00404- variable "FagorDiagnostics" of the main spindle making it possible to know variables "ActualParameterSet" (GV21) and "ActualGearRatio" (GV25) through it.

;-- EXAMPLE OF A PLC PROGRAM FOR A SET CHANGE AT THE MAIN SPINDLE (C AXIS) ---

```
;
; Information of the resources being used:
;
; I79 = "Drive OK" spindle drive ("C")
;
; PLC parameter P28 (R700) = 3.33172, set SERCOS identifier Fagor Diagnostics,
; because, in this case, at the spindle, SERCOSID = 3
;
CY1
;
END
;
PRG
REA
;
;---------- DRIVE STATUS --------
;
DRSTAFS = B1R104
DRSTASS = B0R104                          ; Spindle drive status
DRSTAF3 = B1R105
DRSTAS3 = B0R105                          ; "C" axis drive status
;
; The DRSTAFS and DRSTASS signals behave like the DRSTAF3 and DRSTAS3 signals
;
CPS R104 GE 1 = M104                      ; Spindle OK
CPS R105 GE 1 = M105                      ; "C" axis OK
;
M104 AND M105                             ; Drive OK (by software)
AND I79                                   ; Drive OK (by hardware)
= M200                                    ; Drives OK.
;
CPS R104 GE 2 = M114                      ; Spindle drive under power
CPS R105 GE 2 = M115                      ; "C" axis drive under power
;
I1 AND M200 = /EMERGEN                    ; Emergency to the CNC
/EMERGEN AND /ALARM = O1                  ; Emergency contact to the electrical cabinet
;
;---------- "C" AXIS ----------
;
M2047 = AND R700 $FF R45                  ; Mask to get GV21 and GV25
                                          ; GV21: Active parameter table
                                          ; GV25: Active gear ratio
;
DFU CAXIS = SET M251                      ; "C" axis request
;
M115 AND M251 AND NOT M262
AND NOT SERPLCAC                          ; Free user channel
 = SET M252                               ; Write permission for parameter table at the drive
;
DFU M252 = MOV $77 R41
    = CNCWR(R41,SETGES,M1000)              ; Selects parameter table 7 at the drive
;
CPS R45 GE $77 AND NOT CAXIS
= SET M261                                ; End of "C" axis mode.
;
M115 AND M261 AND NOT M252
AND NOT SERPLCAC
= SET M262                                ; Write permission for parameter table at the drive
;
DFU M262
= MOV $00 R41
= CNCWR(R41,SETGES,M1000)                 ; Selects parameter table 0 at the drive
;
```

```
M252 AND CPS R45 EQ $77                         ;Selected C axis parameter table
    AND NOT SERPLCAC
   = RES M251
    = RES M252
;
M262 AND CPS R45 EQ $00                         ; Spindle parameter table selected
    AND NOT SERPLCAC
    = RES M261
    = RES M262
;
CAXIS AND NOT M251 = SET CAXSEROK                ; "C" axis confirmation to the CNC via sercos Ready
NOT CAXIS AND NOT M261 = RES CAXSEROK
;
;---------- ENABLING THE DRIVE ----------
;
CAXSEROK                                        ; Active "C" axis
AND M115                                        ; Drives under power
AND (Closed door conditions)                    ; Closed door
AND NOT LOPEN
    = TG3 58 4000
   = SPENA3                                     ; Speed enable of the "C" axis
   = SERVO3ON                                   ; Enabling the "C" axis
;
T58 = DRENA3                                    ; "C" axis "Drive enable"
;
M3 OR M4 = SET M140                             ; Request for spindle rotation.
M2 OR M5 OR M30
OR NOT O1 OR RESETOUT = RES M140                ; Cancelation of spindle rotation.
;
((M140 OR PLCCNTL )
OR (CAXIS AND NOT CAXSEROK))
AND M114                                        ; Drives under power
AND (Closed door conditions)                    ; Closed door
= SPENAS = TG3 3 4000                           ; Enabling the spindle analog
T3 = DRENAS                                     ; Enabling the spindle drive
;
;---------- AUXEND, /XFERINH, /FEEDHOLD --------
;
DFU STROBE OR DFU TSTROBE
OR DFU T2STROBE OR DFU MSTROBE
 = TG1 1 100                                    ; STROBES confirmation
;
NOT T1 AND
NOT SERPLCAC                                    ; Parameter set change in progress
  = AUXEND                                      ; M,S,T functions being executed
;
NOT SERPLCAC                                    ; Parameter set change in progress
= /XFERINH                                      ; CNC block reading locked
= /FEEDHOLD                                     ; Feedhold for CNC axes
;
END
```

AP.3.3 SETS AND GEAR RATIOS AT THE DDSSETUP MONITOR

This section describes how the monitoring program handles the sets and gear ratios.

Listing of values and meanings of the parameters of a set:
Driver > *S 3 <return>* lists the values of the parameters of set number three.

Edit / modify a parameter of a single set.
Driver > *SP1.3 100<return>* it will assign a value of 100 to SP1 of set number three.

Edit / modify a particular parameter in all the sets:
Driver > *SP2.* 300<return>* it will assign the value of 300 to the SP2 of all eight sets.

Any modification made onto a parameter without indicating a particular set will affect the parameter corresponding to set zero.

Note: the numerical data of these parameters and variables are given in the units used by the DOS-based "ddssetup.exe". The Winddssetup (for Windows) may use different units which will be displayed on the screen.

AP.4 VARIABLE MONITORING

The continuous monitoring of internal variables of the Drive module may be carried out in two ways: By electrical signals through the digital and analog outputs or by showing their values on the display of the Programming Module.

For example, to monitor the power of the asynchronous motors (TV50) and the motor torque on the synchronous ones (TV2) through the analog outputs and to see if the motor is stopped (SV5) through a digital output:

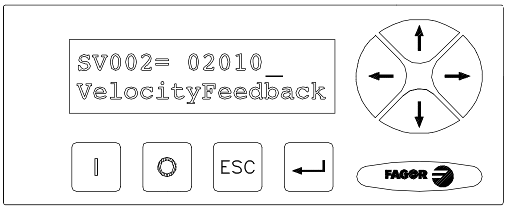
OP1=TV50	Power variable through channel 1, pins 10/11 of X7.
OP3=10000	Ten Kilowatts per volt
OP2=TV2	Torque variable through channel 2, pins 8/9 of X7
OP4=1000	A thousand deciNm per 10 volts (10 Nm / volt)
OP10=SV5	Closed contact between pins 6/7 of X6 is the motor is stopped.

AP.4.1 PROGRAMMING MODULE AS MONITOR

Internal Drive variables may be monitored permanently on the screen of the Programming Module.

Select the digital or analog variable from the VARIABLES menu.
Bear in mind that their units are the ones appearing in the Appendix A and when the cursor is located under the value of a variable, the monitoring is temporarily frozen.

The bottom line shows the name of the variable. Its full name can be displayed by pressing the **O** key. Example:



AP.4.2 DIGITAL ELECTRICAL SIGNALS FOR PLC OR MANOEUVER

Four internal boolean variables of the Drive can be taken to the digital outputs offered by connector X6 of the A1 card. These digital outputs may participate in the maneuver of the electrical cabinet.

The variables chosen most often are:

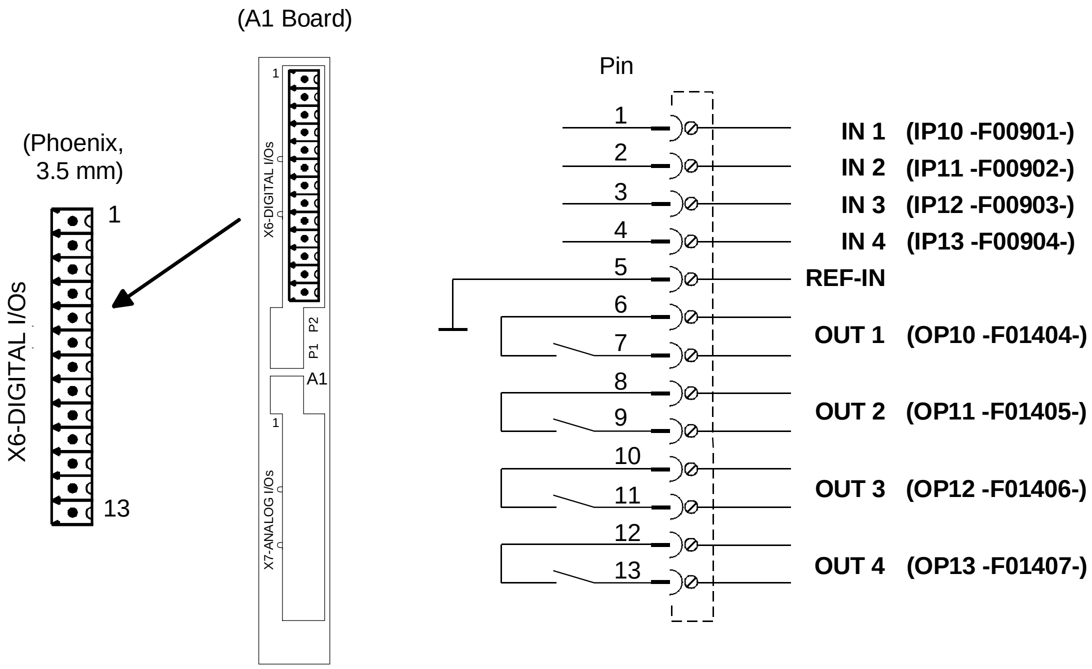
Speed lower than Nx	SV3 =	nFeedbackMinorNx	(See SP40)
Command speed reached	SV4 =	nFeedbackEqualNCommand	(See SP41)
Motor stopped	SV5 =	nFeedbackEqual0	(See SP42)
Torque smaller than Tx	TV10 =	TGreaterTx	(See TP1)

Example:

OP12=TV10 The contact between pins 10/11 will be closed if the motor torque exceeds the threshold value Tx set by parameter TP1.

OP10=SV5 The contact between pins 6/7 will be closed if the motor is stopped.

Check the EM chapter of this manual in order not to exceed the electrical limitations for these electrical contacts.



AP.4.3 ANALOG OUTPUTS FOR THE "DIAL"

Two internal variables of the Drive can be represented permanently on the machine's operator panel by means of volt-meters.

The most often monitored variables are:

On spindle drives:	Power in use, TV50.
On axis drives:	Motor torque, TV2.
on both:	TV3, portion of available power being developed by the motor. This variable is given in a $^0/_{00}$ and is valid for synchronous and asynchronous motors in any duty cycle.

1st example:
Let us suppose that we have a volt-meter with a measuring range of +5Vdc corresponding to a range from 0% to 100%. We wish to use it to represent the percentage of power being used with respect to the one available. The setting must be as follows:

OP2=TV3	Percentage of power used with respect to the maximum power available, channel 2, pins 8/9 of connector X7.
OP4=2000	2000 $^0/_{00}$ / 10volts = 1000 $^0/_{00}$ / 5volts (TV3 in $^0/_{00}$)

2nd example:
We installed a volt-meter with a measuring range of +12Vdc corresponding to a range between 0% and 200%. We wish to use it to represent the percentage of rated power (S1) being developed. The spindle motor has a rated power S1 = 11 kW.
The setting must be as follows:

OP1=TV50	Power feedback, channel 1, pins 10/11 of connector X7.
OP3=1833	1833 DecaWatts / 10volts (TV50 comes in DecaWatts) according to:

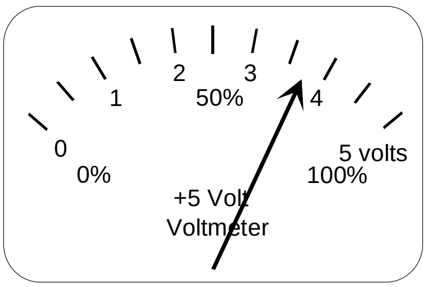
$$11\text{kW} \cdot 2 \cdot \frac{10}{12} = 18.33\text{kW} = 1833\text{DecaWatts}$$

Even if the needle never reaches the top of the scale because the maximum output voltage will be 10V. At its maximum power in S6 (16kW) the dial will show 8.72 V.

Warning:

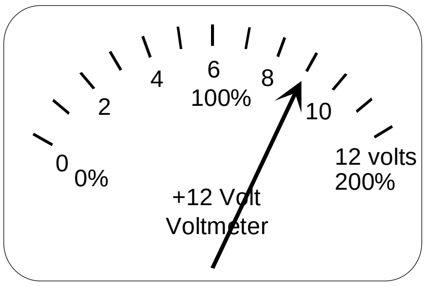
If the values assigned to OP3 and OP4 are too small the electrical signal will saturate when reaching 10 Volts.

1st example.
Power Percentage



2.5V → 50%
5V → 100%

2nd example.
Power S1 Percentage



6V → 100% → 11kW
8.72V → 145% → 16kW
10V → 166% → 18.3kW

AP.5 HANDLING OF INTERNAL VARIABLES VIA SERCOS

The features documented in this chapter need the following software versions:
8050/55 CNC versions V13.02 (mill) and V12.01 (lathe).
Drive versions V03.01 and later.

The data transmitted through the Sercos ring is classified in two groups:

Cyclic channel (fast):
It is updated at every position loop. It contains the velocity commands, feedback, etc. Each variable read or written at the Drive is included in this information package. In order not to overload the interface, one must limit the number of affected variables of the drive to a minimum.

Service channel (slow):
Data transmitted at every certain number of position loops (monitoring, etc.)
This channel is accessed through part-program instructions, from the PLC channel or from the user channel.

Cyclic channel. Variables of the Drive to be read from the PLC.

These variables are:
(See appendix A of this manual):

Driver name	Sercos ID		Name
DV9	00012	-S12-	Class2Diagnostics(Warnings)
DV10	00013	-S13-	Class3Diagnostics(OperationStatus)
SV2	00040	-S40-	VelocityFeedback
PV51	00051	-S51-	PositionFeedback1
TV2	00084	-S84-	TorqueFeedback
CV3	33079	-F311-	CurrentFeedback
DV11	33172	-F404-	FagorDiagnostics
IV1	33673	-F905-	AnalogInput1
IV2	33674	-F906-	AnalogInput2
IV10	33675	-F907-	DigitalInputs
TV50	34468	-F1700-	PowerFeedback
TV3	34469	-F1701-	TorqueFeedbackPercentage

Identify the drive parameter to be read in one of the parameters P28-P67 of the PLC table. Use an "n.i" format where "n" is the drive identifier in the Sercos ring and "i" is the Sercos identifier of the drive parameter. See the next example.

These PLC parameters P28-P67 are associated with registers:
P28 with R700 P29 with R701 P30 with R702 etc...

Reading example: Set P28=4.33172 in the CNC machine parameters.

This way, PLC register R700 will contain the value of the variable DV11 -F00404- which belongs to the drive identified with the Sercos number 4.

Cyclic channel. Drive variables to be written from the PLC.

Use PLC machine parameters P68-P87 associated with registers:

P68 with R800 P69 with R801 P70 with R802 etc...

The Drive variables which can be written from the PLC are:
(see appendix A of this manual):

Driver name	Sercos ID		Name
OV1	34176	-F1408-	DA1Value
OV2	34177	-F1409-	DA2Value
OV10	34178	-F1410-	DigitalOutputs
SV1	00036	-S36-	VelocityCommand
		(This variable SV1 can only be written for axes set as DRO axes)	

Reading example: Set P69=1.34176 in CNC machine parameters.

This way, the value of OV1 of the drive identified as Sercos number 1 may be assigned to PLC register R801.
If we now write ... = MOV 8000 R801
the analog output of channel 1 (pins 11/10 of connector X7) will output 2441 mV.

Voltage = Register · 0.3 Volts

Service channel. Drive variables to be read or written.

This Service Channel can only be accessed through a high-level block of the part-program, PLC channel or user channel. Use CNC machine parameters P100-P299.

All "non-string" type variables can be accessed (see appendix A of this manual).

From the part-program or user channel:

Reading example: (P100=SVARX 40)
Parameter P100 will be assigned the value of the X axis motor speed. That is: VelocityFeedback (00040).
If, for example, the speed were 200 rpm, P100 would assume a value of 200000.

Writing example: (SVARZ 36=P110)
It will assign the value of parameter P110 to the Z axis velocity command, VelocityCommand (00036)
If P110 were 3500000, the velocity command would be forced to 350 rpm.

Parameter = Velocity (rpm) · 10000

From the PLC channel:

Reading example: ...=CNCEX((P100=SVARX 40),M1)

Writing example: ...=CNCEX((SVARZ 36=P110),M1)

AP.6 SPINDLE MOTORS AT LOW RPM

In some cases, it would interesting to avoid the gear box on the machine spindle. That requires a drive offering constant power at low speed.

This motor behavior may be achieved by limiting its power.
The next example shows how to do it:

A motor is to be installed on a machine offering 5 kW in S1 for speeds over 500 rpm.

Solution:
The SPM132L motor offers a rated power of 15 kW in S1 and 22 kW in S6-40%. Its base speed (from which it really offers that power) is 1500 rpm.

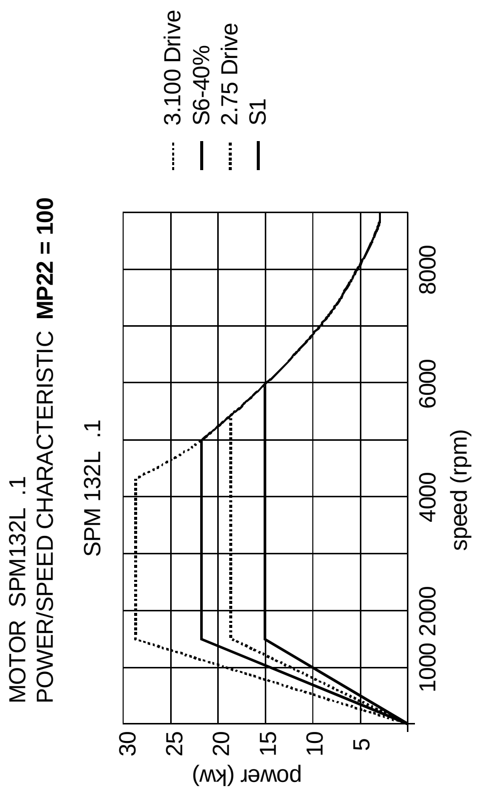
By limiting its maximum power to a third of its capability, the effective base speed will be reduced to one third, that is 500 rpm.

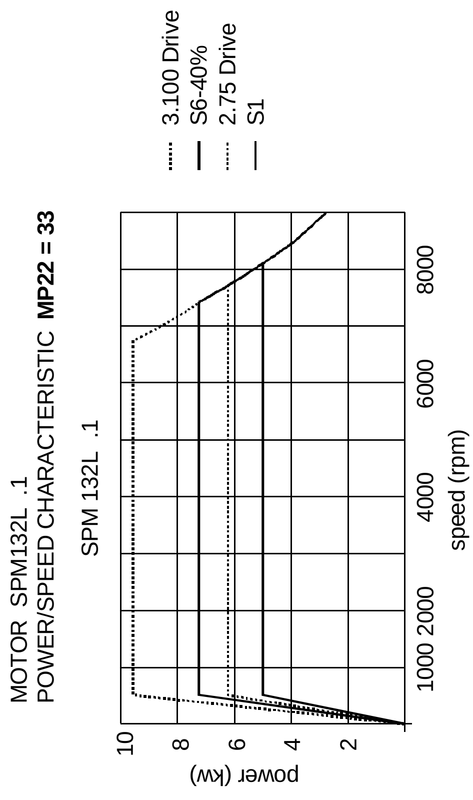
This effect is controlled by means of parameter **MP22** (Fagor access level).

Important:

The power limitation at the motor does not imply the possibility of controlling it by a smaller drive.

However, the power demanded to the Power Supply will be smaller.



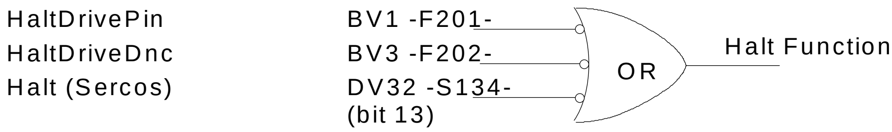


AP.7 HALT FUNCTION

Activating the HALT function means setting the velocity command to zero while keeping the rotor locked (with torque). As opposed to the effect of deactivating the Speed_Enable function, the Halt function does not free the motor when it has stopped it.

It can be activated through an electrical signal at one of the digital inputs of the drive, by the monitoring program through the serial line or through the Sercos interface.
The Halt function is activated (stops the motor) when:

when applying zero volts at the electrical input assigned to variable BV1 -F00201-, or
when requested from the monitoring program (variable BV3 -F00202-= 0), or
when requested from the PLC of the CNC via Sercos (bit 13 of DV32 -S00134- is set to "0").

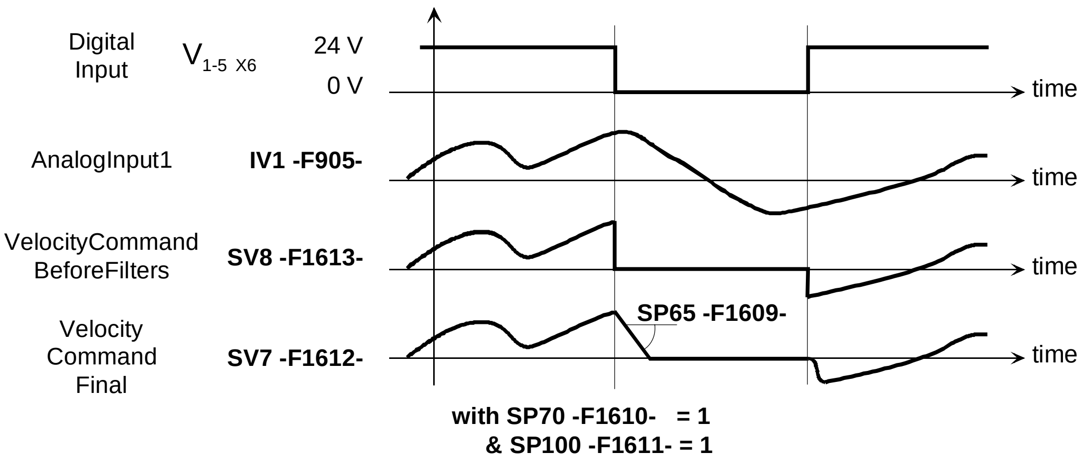


By programming drive variable BV1, one of the four digital inputs of connector X6 can perform the Halt function. To make the motor stop more smoothly, its deceleration can be limited with parameter SP65 (SP70=1, SP100=1).

This is a programming example with a graph showing its operation:

IP10 -F00901- = BV1 -F00201-
SP70 -F01610- = 1
SP100 -F01611- = 1
SP65 -F01609- = 500 rad/sec^2

This way, when pin 1 (referred to pin 5) of connector X6 receives zero volts, BV1 -F00201- will assume the zero value and the Halt function will be activated. The motor will stop with a maximum deceleration of 500 rd/s^2 and will stay locked. With 24 V at that pin, the servo drive will continue to follow the velocity command.



Note: the numerical data of these parameters and variables are given in the units used by the DOS-based "ddssetup.exe". The Winddssetup (for Windows) may use different units which will be displayed on the screen.

AP.8 MOTOR STOP DUE TO TORQUE OVERLOAD

From software version 02.04 on, includes a new feature especially designed for spindle drives although it is also available for axes.

It offers the possibility to detect that the motor has stopped when, for instance, the tool gets stuck.

This detection triggers an Error message and it is handled by means of two new parameters.

Operation:

When the Drive detects that
the motor speed is below the threshold set by GP8 -F236-
and
the internal current command is near its maximum value (CP20 -F307-),
an internal timer starts running.

If the time elapsed under these conditions (torque overload condition) exceeds the time value set by GP7 -F235-, error 203 is issued.
If the internal torque command drops below its maximum value or the motor speed is resumed, the internal timer is reset back to zero.

Parameters:

GP7 O (F235) OverloadTimeLimit

Function:	When the overload conditions exceed this time period, the error is issued.
Valid values:	0..10000 milliseconds. With GP7 =0 this protection is disabled.
Default value:	200
Version:	Available from version 02.04 on.

GP8 O (F236) OverloadVelocityThreshold

Function:	Sets the speed threshold under which the motor is considered to be stopped in terms of overload detection.
Valid values:	0..1000 rpm
Default value:	100 (Asynchronous Motors), Rated Speed (Synchronous Motors).
Version:	Available from version 02.04 on.

Generated Error message:

203 Torque overload error.

- The servo drive is locked up and it can not turn freely. Due to too high a torque, the turning speed has not exceeded the GP8 value for a time period greater than the GP7 -F235- value.

Free the motor. If the error comes up for no apparent reason, increase the GP7 -F235- and/or GP8 -F236- values. If GP7 is set to "0", the error message is never issued.

AP.9 FLUX REDUCTION WITHOUT LOAD

Software version 04.01 includes a new feature for spindle motors.

While the motor is turning without a load, this feature makes it possible to momentarily decrease the magnetizing current. This considerably decreases the noise generated by the motor and its heating.

This reduction does not affect the power output, since the magnetizing current increases automatically when motor torque is needed.

The parameter used for this is:

FP40.# -F613.#- FluxReduction

Since the settling of the flux and maximum motor torque has a delay, it is not recommended to use this flux reduction on motors used to feed the axes.

This parameter is expanded in eight sets of values for adapting it with each gear change.

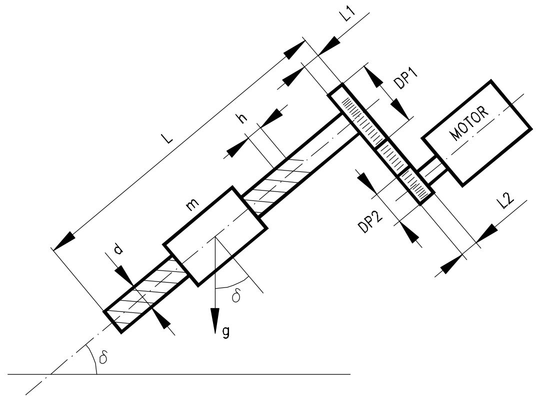
User notes:

DS. DESIGN

DS.1 AXIS MOTOR AND SERVO DRIVE SELECTION

DS.1.1 FIRST MOTOR PRE-SELECTION

The **motor** must meet the specifications on Torque (Nm), speed, duty cycles or other kind of requirements of the axis to be moved. An axis may be like this:



Calculation of the necessary Motor Torque (M)

The total motor torque necessary has two components,
the Continuous Torque M_S (to maintain the table at a constant speed or fixed in a position), and the Acceleration Torque M_A (to change its speed).
The reduction in the Motor ballscrew transmission (*i*) is a factor to be considered in many of the following calculations.

$$M_T = M_S + M_A \Rightarrow \left(M_{TOTAL} = M_{CONTINUOUS} + M_{ACCELERATION}\right) \qquad i = \frac{DP1}{DP2}$$

The Continuous Torque M_S is due to:
the friction between table with its ways and with the ballscrew M_F,
to the weight of the table when not moving horizontally M_W,
and to the cutting force of the tool M_C.

$$M_S = M_F + M_W + M_c \Rightarrow \left(M_{CONTINUOUS} = M_{FRICTION} + M_{WEIGHT} + M_{CUTTING}\right)$$

Friction torque M_F :

$$M_F = \left(M_{F(TABLE)} + M_{F(BALLSCREW)}\right)\cdot\frac{1}{i} = \left(\frac{m\cdot g\cdot\mu\cdot h}{2\pi} + \frac{d}{10}\right)\cdot\frac{1}{i}$$

M_F is the torque due to friction and is given in Nm.
m is the table mass in Kg.
d is the diameter of the ballscrew in mm
g is the gravitational acceleration 9.81 m/s²
h is the ballscrew pitch in meters per turn.
μ is the friction coefficient between the table and the ways it moves on:

Typical μ values depending on material:

Iron	0.1÷0.2
Turcite	0.05
Roller bearings	0.01÷0.02

Torque due to weight of the table M_w :
When the move does not move horizontally, but at an angle "δ" like in the previous figure, the torque due to the weight of the table must also be considered:

$$M_W = \frac{m \cdot g \cdot sin\delta \cdot h}{2\pi} \cdot \frac{\%}{i}$$

M_w is the torque due to table weight and is given in Nm.
δ is the incline angle of the ballscrew with respect to the horizontal axis.
% is a mass compensation factor that can vary between 0 and 1.

If the total table weight is compensated for by means of some sort of hydraulic system or counterweights so the motor makes the same effort to move the table up as to move it down, the % factor will be "0". At the other end, if no compensation is applied, % will be "1".

Torque to the needed cutting force M_C:
There is a cutting force between the tool and the part and this means a hindrance for moving the table. The torque necessary at the motor to make this movement is calculated as follows:

$$M_C = \frac{F \cdot g \cdot h}{2\pi} \cdot \frac{1}{i}$$

M_C is the torque due to the cutting force of the tool and is given in Nm.
F is the cutting force of the tool and is given in Kg.
g is the gravitational acceleration, 9.81 m/s^2

<u>Motor speed calculation</u> (RPM_{MOTOR}).

The machine will need a maximum speed **RPM_{MOTOR}** in a linear movement of the table. Therefore, the motor must have a maximum speed of:

$$RPM_{MOTOR} = \frac{Vmax}{h} \cdot i$$

Vmax is the maximum linear speed the table needs.

From the characteristics table for Fagor synchronous motors (chapter SM), select a motor that has:

A Stall torque equal to or greater than the calculated continuous torque M_S.
A maximum turning speed equal to or greater than the calculated value, RPM_{MOTOR}

DS.1.2 SECOND MOTOR PRE-SELECTION

Calculation of Inertia ***(J)***

The next step is to calculate the load that the motor has to move when accelerating; that is, the Moment of Inertia of all the elements it moves. The total inertia J_{TOTAL} is due to the load J_{LOAD} and to the rotor of the motor itself J_{MOTOR}.

$$J_{TOTAL} = J_{LOAD} + J_{MOTOR}$$

The inertia due to load can be subdivided into that of the table + that of the ballscrew + that of the system used to compensate for non-horizontal axes + that of the pulley or gear used for transmission and which turns with the ballscrew *"PULLEY1"*. All these elements are affected by the reduction factor " *i* " as shown by the following equation.

The inertia due to the "pulley" that turns with the motor "PULLEY2" is not affected by the "i" factor.

$$J_{LOAD} = \frac{J_{TABLE} + J_{BALLSCREW} + J_{PULLEY1} + J_{COMPENSATION}}{i^2} + J_{PULLEY2}$$

Next, each one of the inertias are defined:

$$J_{TABLE} = m \cdot \left(\frac{h}{2\pi}\right)^2 \qquad J_{BALLSCREW} = \frac{d^4 \cdot L \cdot \pi \cdot \alpha}{32}$$

$$J_{PULLEY1} = \frac{D_{P1}{}^4 \cdot L_1 \cdot \pi \cdot \alpha}{32} \qquad J_{PULLEY2} = \frac{D_{P2}{}^4 \cdot L_2 \cdot \pi \cdot \alpha}{32}$$

The resulting inertias are in $Kg.m^2$
L is the ballscrew length in meters.
L_2 is the width of pulley-2 in meters.
D_{P2} is the diameter of pulley-2 in meters.
α is the material density:

i, μ, h, δ are data used before.
L_1 is the width of pulley-1 in meters.
D_{P1} is the diameter of pulley-1in meters.

700 Kg/m^3 for iron/steel
2700 Kg/m^3 for aluminum

Motor inertia J_{MOTOR} will be:

$$J_{MOTOR} = J_{ROTOR} + J_{BRAKE}$$

which are data that may be obtained from the characteristics in chapter SM.

Verify that in the characteristics table the **rotor of the motor** chosen in the 1st selection has an **inertia** which meets the following condition:

J_{MOTOR} equal to or greater than (J_{LOAD}/K)

where K is a factor depending on the application destined for this motor.
The ideal will be to obtain a J_{MOTOR} equal to J_{LOAD}
For a Positioning Axis, the typical value of K will be between 1 and 3

If this requisite is not met, a new motor must be selected which meets the conditions of the 1st selection and the 2nd one.

DS.1.3 THIRD MOTOR PRE-SELECTION

Calculation of the acceleration torque and time

The required acceleration torque is determined by the Total Inertia to be moved and the needed acceleration. This acceleration is given by the Acceleration Time t_{AC} which is the time required for the motor to reach the rated speed from resting position (0 rpm).

$$M_{ACCELERATION} = J_{TOTAL} \frac{2\pi \cdot n_N}{60 \cdot t_{AC}}$$

n_N is the rated (nominal) motor speed
t_{AC} is the time it takes the motor to go from "0" rpm to the rated speed.

From the same equation:

$$t_{AC} = J_{TOTAL} \frac{2\pi \cdot n_N}{60 \cdot M_{ACCELERATION}}$$

Calculation of the needed rms torque (M_{RMS})

The third and last motor selection requires a new data, the RMS Torque:

$$M_{RMS} = \sqrt{\left(M_F + M_W + M_{AC}\right)^2 \frac{t_{AC}}{T} + \left(M_F + M_W\right)\frac{t_P}{T} + \left(M_F + M_W + M_C\right)^2 \frac{t_C}{T}}$$

where:

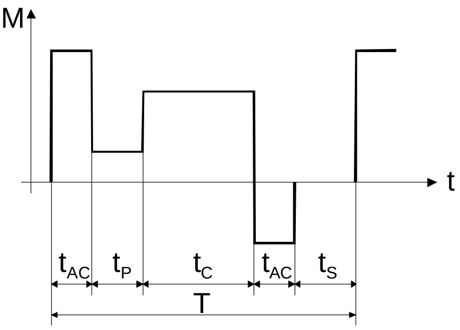
t_{AC} is the acceleration time mentioned earlier.
t_P is the tool positioning time.
t_C is the cutting time in a typical machining cycle.

The typical values for t_{AC}, t_P, and t_C in machine-tool cycle are:

$$\frac{t_C}{T} = 0.6$$

$$\frac{t_P}{T} = 0.4$$

$$\frac{t_{AC}}{T} \cong 0$$



Calculation of the motor peak torque *(M_{PEAK})*

The required maximum torque is the sum of the Friction, Weight and Acceleration torques:

$$M_{MAX} = M_F + M_W + M_{AC}$$

For a given acceleration time, we will need specific acceleration torque and maximum torque. The motor must be able to provide a Peak Torque equal to or greater than the calculated maximum torque.

Verify that the motor chosen in previous selections meets the following condition:

Peak torque equal to or greater than the calculated maximum torque: $M_{PEAK} > M_{MAX}$
Rated torque equal to or greater than the calculated RMS value: $M_{RATED} > M_{RMS}$

Summary of the three pre-selections:

Maximum speed equal to or greater than calculated value (RPM_{MOTOR})
Stall torque equal to or greater than calculated continuous value ($M_{CONTINUOUS}$)
Motor inertia equal to or greater than inertia: (J_{LOAD} / K)
Peak torque equal to or greater than calculated value (M_{MAX})
Rated torque equal to or greater than calculated RMS value (M_{RMS})

DS.1.4 DRIVE SELECTION

Once the motor has been selected, check the tables on electrical characteristics at the chapter SM. There are several drives available for each motor and the peak torque obtained with each one of them will be different. A drive has to be chosen whose peak current is greater than the one calculated for the application.

DS.2 SPINDLE MOTOR AND SERVO DRIVE

On the spindles of machine tools, it is important to maintain a constant turning speed of the spindle. To control this speed, the drive applies torque to the load according to the characteristics of this load as well as to the adjusted accelerations and decelerations. Procedure to calculated the needed motor power.

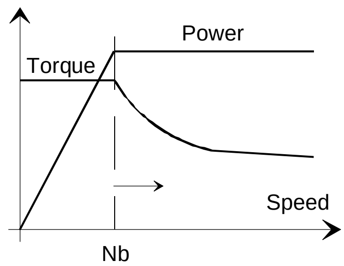
1. Depending on the characteristics of the load, determine the rated values of the needed power (in continuous cycle, instantly and periodically).
2. Increase the value of that needed power, considering the efficiency of the power transmission and load dispersion.
3. Select the drive that offers the current needed to govern the motor in all duty cycles for that machine.

DS.2.1 POWER DEMANDED FROM A MOTOR FOR A PARTICULAR LOAD

To determine the needed motor power, use the following formula:

$$P_{MOTOR} > P_{LOAD} + P_{ACCELERATION/DECELERATION}$$

Motor power ≥ (Power required by a load) +
(Power required for the Accelerations/Decelerations of the Machine)



Load type:	Constant power, regardless of speed.
Examples:	Constant tension coils, Mill spindle, Lathe spindle
Torque/speed characteristics:	The torque decreases from base speed on
Motor power:	Rated drive power will be the one demanded by the load.

DS.2.1.1 POWER REQUIRED BY THE LOAD

The power demanded from a spindle motor in a turning or machining center is determined by the cutting power.

A good cutting process requires the spindle motor to be working at constant power and with a power range between 1:3 and 1:5.

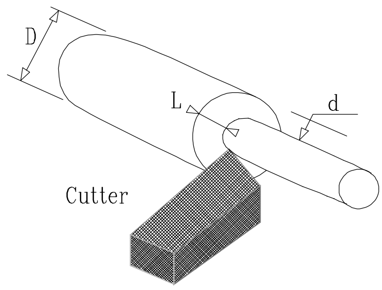
The powers used for cutting in a lathe, mill, machining center with drilling are calculated as shown below.

For a more accurate calculation of the power required, one must bear in mind different factors such as cutting oil, material, shape of the tools, hardness of the material machined, etc.

For **lathe** work, a cutting blade forces against the part to be machined, while this turns as shown in the Illustration. The power required, P_C, is calculated as follows:

$$P_C = \frac{K_S dLV}{60*1000*\eta_C} = \frac{dLV}{S_C*\eta_C} \text{ (kW)}$$

$$V = \frac{\pi * DN_S}{1000} \text{ (m/min)}$$

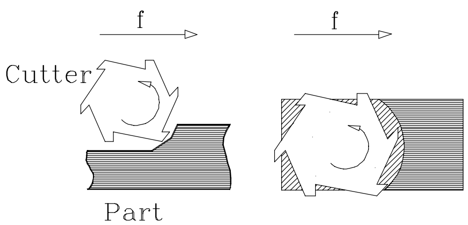


here:

K_S is the relative cutting resistance in N/mm^2.
d is the depth of the cut in mm.
L is the length of the blade, or feedrate per full turn in mm.
D is the diameter of the part machined in mm.
N_S is the turning speed of the spindle in r.p.m.
η_C is the mechanical efficiency (varies from 0.7 to 0.85).
S_C is the cutting efficiency, that is, cut volume per kilowatt each minute in cm^3/kW/min.

In the case of a **milling machine**, the cutter is mounted on the spindle itself and turns with this to cut the material as shown in the Illustration. The power required in this case P_F is calculated as follows :

$$P_F = \frac{K_S dWf}{60*1000^2*\eta_F} = \frac{dWf}{1000^2*S_F*\eta_F} \text{(kW)}$$

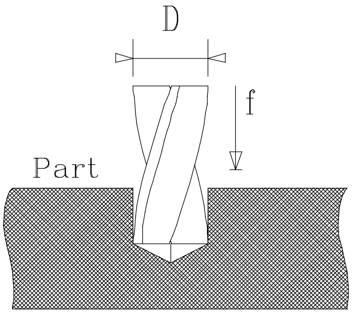


where:

K_S is the relative cutting resistance in N/mm^2.
d is the depth of the cut in mm.
W is the width of the cut in mm.
f is the feedrate in mm/min.
η_F is the mechanical efficiency (varies from 0.7 to 0.8).
S_F is the cutting efficiency that is, cut volume per kilowatt each minute in cm^3/kW/min.

In the case of a **drill**, the bit is mounted on the spindle itself and turns with this to drill the material as shown in the Illustration. The power required in this case, P_D , is calculated as below:

$$P_D = \frac{M * 2\pi n}{60 * 100 * 1000 * \eta_D} = \frac{\pi D^2 f}{4 * 1000 * S_D * \eta_D} \text{ (kW)}$$

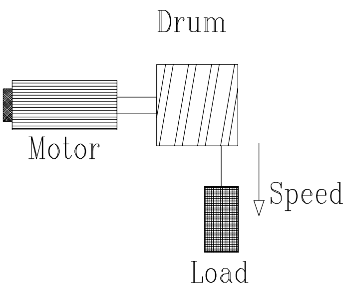


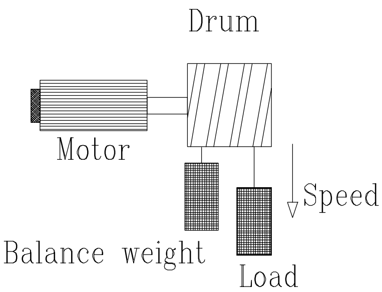
where:

M is the drill load torque in N·cm.
n is the spindle turning speed in r.p.m.
D is the diameter of the hole in mm. n is the spindle speed in r.p.m.
f is the feedrate in mm/min.
η_D is the mechanical efficiency (varies from 0.7 to 0.85).
S_D is the cutting efficiency, that is, cut volume per kilowatt each minute in cm³/kW/min.

In the event of governing a **gravitational load**, the power required depends very much on the presence or absence of balance weights. (crane or elevator). The power required in this case, P_{GL}, is calculated in the following way:

$$P_{GL} = \frac{m_L * V}{6120 * \eta} \text{ (kW)} \qquad P_{GLC} = \frac{(m_L - m_C) * V}{6120 * \eta} \text{ (kW)}$$



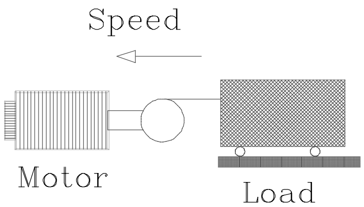


where:

V is the linear speed in m/min.
m_L is the load mass in kg.
η is the mechanical efficiency.
m_C is the balance weight mass in kg.

Governing a **frictional load**. This is the case of horizontal movements such as a conveyor belt or a movable table. For a friction coefficient m, the power required in this case, P_F , is calculated as follows:

$$P_F = \frac{\mu m_L * V}{6120 * \eta} \text{ (kW)}$$



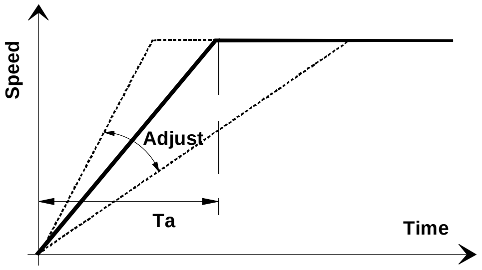
where:

μ is the friction coefficient.
m_L is the load mass in kg.
V is the linear speed in m/min.
η is the mechanical efficiency.

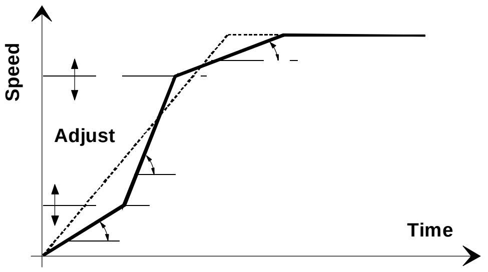
DS.2.1.2 POWER NEEDED FOR THE ACC / DEC OF THE SPINDLE MOTOR

There are three methods to control the acceleration and deceleration process of the machine spindle:

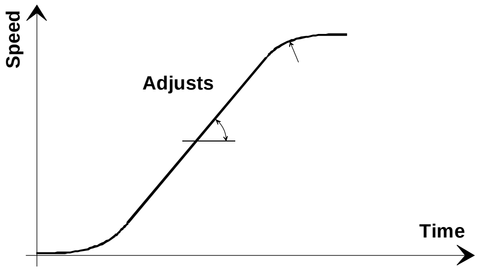
1.- Acceleration limited by time
2.- Different acceleration ramps depending on the speed reached
3.- Limited acceleration and choke. Choke = variation of acceleration.



Method	Acceleration limited by time
Control	Speed increases linearly in time until the command speed is reached
Comments	The acceleration torque is constant



Method	Different accelerations depending on speed.
Control	Linear acceleration avoiding abrupt variations in transmitted torque.
Comments	Emulation of the square sine function for speed by using ramps.



Method	Acceleration and choke limit
Control	Progressive acceleration, avoiding abrupt variations of transmitted torque.
Comments	Approach square sine function (bell shape) for the speed

The capability demanded from the motor is determined by the following formulae:

Capacity required by the Motor in the constant torque area $(0 < N_M < N_B)$:

$$P_N = \left(\frac{2\pi}{60}\right)^2 \frac{J_M N_M^2}{1000t} \text{ (kW)}$$

Capacity required by the Motor in the constant torque and constant power area $(0 < N_M < N_{Max})$:

$$P_N = \left(\frac{2\pi}{60}\right)^2 \frac{J_M (N_M^2 + N_B^2)}{2000t} \text{ (kW)}$$

where:

J_M is the inertia of the load in kg.m^2 as viewed from the motor shaft
P_N is the rated power at the base speed, kW.
N_{MAX} is the maximum motor speed in rpm.
N_B is the base motor speed in rpm.
N_M is the motor speed in rpm reached after a time period **t.**
t is the acceleration time in seconds until the **N_M** is reached.

We will now give several examples of calculations using a mechanical specification and for a standard Motor. The results could vary from real ones through mechanical losses, fluctuations in mains voltage, or inaccuracies of mechanical data.

Example.

· Acceleration time: From 0 to 1500 rpm. in 0.5 sec. (1)
From 0 to 6000 rpm. in 2.5 sec. (2)

· Motor inertia: J_M: 0,13 kg·m^2

· Motor base speed: N_B : 1500 rpm.

Calculations :

1.- When the speed ranges from 0 to 1500 r.p.m.

$$P_N = \left(\frac{2\pi}{60}\right)^2 \frac{J_M N_M^2}{1000t} \text{ (kW)} = \left(\frac{2\pi}{60}\right)^2 \frac{0{,}13 * 1500^2}{1000 * 0{,}5} = 6{,}41 \text{ (kW)} \qquad (1)$$

2.- When the speed ranges from 0 to 6000 r.p.m.

$$P_N = \left(\frac{2\pi}{60}\right)^2 \frac{J_M (N_M^2 + N_B^2)}{2000t} \text{ (kW)} = \left(\frac{2\pi}{60}\right)^2 \frac{0{,}13 * (6000^2 + 1500^2)}{2000 * 2{,}5} = 10{,}89 \text{ (kW)} \qquad (2)$$

DS.2.2 CALCULATION OF ACCELERATION AND BRAKING TIME

After selecting the mechanical characteristics and the power of the Drive, the acceleration and braking time is calculated as follows.

Constant torque area ($0 < N_M < N_B$):

$$t_1 = \frac{2\pi * J_M * N_M}{60 * T_M} \text{ (seg.)}$$

Constant power area ($N_B < N_M < N_{Max}$) :

$$t_2 = \frac{2\pi * J_M (N_M^2 - N_B^2)}{120 * T_M * N_B} \text{ (seg.)}$$

Constant torque and constant power area ($0 < N_M < N_{Max}$) :

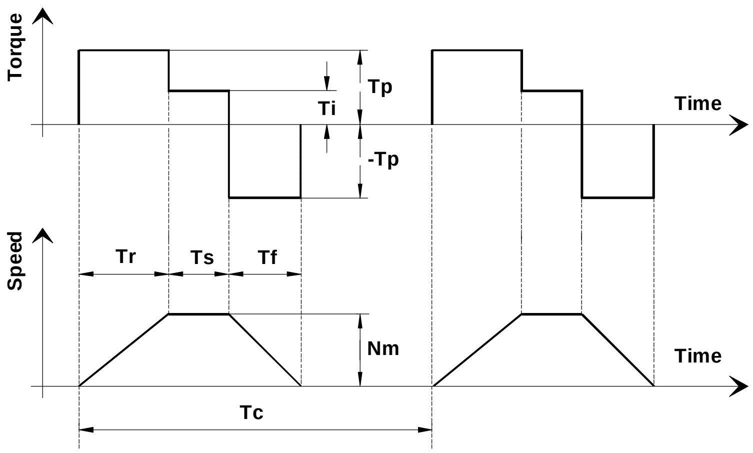
$$t_3 = t_1 + t_2 = \frac{2\pi * J_M (N_M^2 + N_B^2)}{120 * T_M * N_B} \text{ (seg.)}$$

where:

- **J_M** is the inertia of the load in kg.m² as viewed from the motor shaft.
- **T_M** is the rated torque in KW at the base speed.
- **N_{MAX}** is the maximum motor speed in rpm.
- **N_B** is the base motor speed in rpm.
- **N_M** is the motor speed in rpm after the acceleration time.

DS.2.3 CALCULATION OF POWER WITH INTERMITTENT LOAD

Forming the Drive to the right dimensions has to be done with the greatest care when the application involves a periodical starting and stopping operation, frequently repeated as in the case of threading with a miller. For a cycle like the one shown in the figure, which includes acceleration and stopping, the equivalent effective torque T_R of Equation 16 must be within the S1 dimension given for the Drive torque. The maximum T_P value is 120% of dimension S2 30 minutes of the Motor.



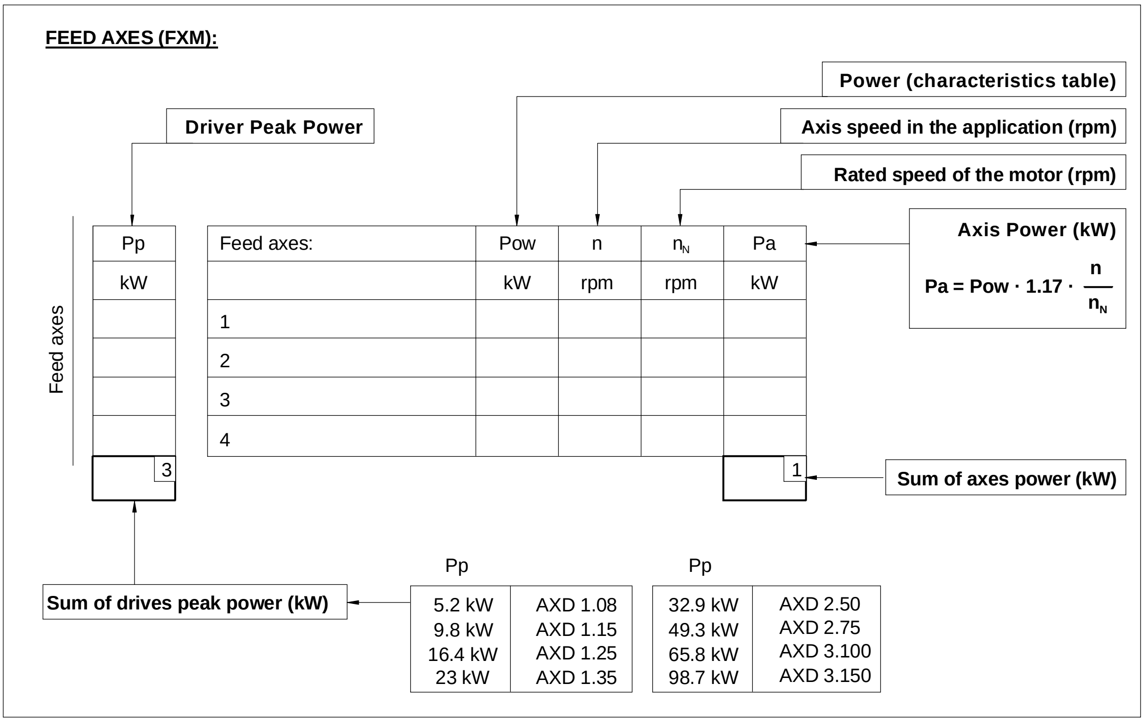
$$T_R = \sqrt{\frac{T_P^2 * (t_r + t_f) + T_L^2 * t_s}{t_c}} \text{ (Nm)}$$

DS.2.4 DRIVE SELECTION

Once the motor has been selected, check the characteristics curves in the AM chapter. These curves indicate the power that the various drives can obtain from that motor.

DS.3 POWER SUPPLY SELECTION

Power demanded to the Power Supply for servo systems with a synchronous motor (axis):



where:

Pow	Motor power (kW), according to the characteristics tables of the FXM.
1.17	Coefficient combining the performance of the motor (0,9) and that of the drive (0.95)
n	Maximum work speed of the motor in that application. (rpm)
n_N	Nominal motor speed (Nm)
Pv	Power dissipated by the drive (W). It depends on the model (see table below)

Power demanded to the Power supply for servo systems with an asynchronous motor (spindle):

SPINDLES (SPM):

Maximum Power consumption of the Power Supply (kW)

Spindles:	Pm (kW)
1	
2	
	2

Sum of spindle powers (kW)

Pm (kW)

Spindle Motors	Spindle Drive 1.15	1.25	1.35	2.50	2.75	3.100	3.150	
SPM 90L	5.1	9.5			23	36.2		SPM 132L
SPM 90P		9.2				34.6		SPM 132X
SPM 100LBE		8.9	13.1			36.7	49.6	SPM 132XL
SPM 112ME		8.7	13.1			36.4	48	SPM 160M
SPM 112LE			12.6	16.7		41.4	57.6	SPM 160L
SPM 112XE				15.3	24.6		59.7	SPM 180MA

Pm: Power extracted from the Power necessary for the spindle drive.

These data include the internal losses of the drive.

where:

Pm Maximum power that the servo system may demand from the Power Supply for each Motor-Drive combination.
It includes the power dissipated by the Drive itself.

Selection Criteria.

1. **The "Power Supply" module must be capable of supplying the power required by the set of servo system connected to it.**

First Criterion.

The "Power Supply" module must be capable of supplying the power required by all the Drive + Motor combinations connected to it.

Power Supply needed: (1 + 2) = [ ] (kW) →

Rated Power (S1)	Power Supply Module
kW	Reference
< 25 < 65 > 65	**PS-25A, PS-25B or XPS-25** **PS-65A or XPS-65** **(*)**

(*) Until reaching the needed power from the Power Supply
Very important: When using two Power supplies on the same machine, they have to form two separate groups with their respective drives. Only the Sercos ring, if there is one, may be common to both groups.

NEVER connect the power supplies in parallel.

2. **The "Power Supply" module must be able to supply the peak power required by the set of servo systems connected to it.**

Second Criterion.

The "Power Supply" module must be capable of supplying the peak power required by all the Drive + Motor combinations connected to it.

Peak Power Supply needed: (3 + 2) = [ ] (kW) →

Peak Power	Power Supply Module
kW	Reference
< 75 < 195 > 195	**PS-25A or PS-25B** **PS-65A** **(*)**

Regenerative →

kW	Reference
< 55 < 108 > 108	**XPS-25** **XPS-65** **(*)**

(*) Until reaching the needed peak power from the Power Supply
Very important: When using two Power supplies on the same machine, they have to form two separate groups with their respective drives. Only the Sercos ring, if there is one, may be common to both groups.

NEVER connect the Power Supplies in parallel.

4. Use the following sheet to calculate the input transformer, and the section of the mains cables.

Mains voltage

The Fagor Servo Drive system requires **380-460 Vac.**

Transformer:

The transformer or autotransformer being used must be of the power:

([1] + [2]) **x** 1.05 (kW) = [4] (kW)

Very important: when using an isolation transformer, the secondary must be of the star type its mid point being accessible so it can be connected to ground.

Power cables for mains connection

Vmains = From **380** to **460 Vac.**

Rated current through the mains cable:

Power Supply

$$[4]\ (kW) \times \frac{1000}{Vmains\sqrt{3}} = \square\ (Amp) \longrightarrow$$

Axis Compact Module (ACD):

FXM Motor Rated Current = ☐ (Amp) ⟶

Spindle Compact Module (SCD):

Maximum SPM Motor Current = ☐ (Amp) ⟶

	Power Cable
Amp	Reference
< 12.2	**MPC-4x1.5**
< 16.5	**MPC-4x2.5**
< 23	**MPC-4x4**
< 29	**MPC-4x6**
< 40	**MPC-4x10**
< 53	**MPC-4x16**
< 67	**25 mm²** (MPC-4x25 + (2x1))
< 83	**35 mm²** (MPC-4x35 + (2x1))

The length of these power cables must be specifically ordered (in meters).

DS.4 CM-60 SELECTION GUIDE

The CM-60 is a module that increases the electrical capacitance of the power bus in 4 millifarads. It should be installed on machines with very short duty cycles (very repetitive accelerations and decelerations) and with low braking energy. Punch presses are a typical example of this.

The following table indicates how much energy can be stored in Watts second, when the Bus voltage increases from the nominal value *(Vbus)* to the Ballast circuit activating value *(*$Vballast_{ON}$*)*.

Considering the different combinations of power supplies + CM-60 modules and different mains voltages.

$$W = \frac{1}{2} \cdot C \cdot (Vballast_{ON}^{\;2} - Vbus^2)(Ws)$$

where:

C comes in farads
V in volts DC
W in watts second (jules)

V mains:	380 Vac	460 Vac
PS-25x	76	59
PS-65A	81	63
XPS-25	52	96
XPS-65	93	172
CM-60 + PS-25x	507	394
CM-60 + PS-65A	511	397
CM-60 + XPS-25	227	421
CM-60 + XPS-65	269	498
	Watts·sec	

DS.5 BALLAST RESISTOR SELECTION GUIDE

Calculate the value of:

Wm is the energy generated by the braking of each system motor.
Pe is the rms power generated by all braking of all the motors throughout a complete duty cycle.

Based on the following formulae:

$$Wm = Wp + \frac{1}{2} \cdot Jt \cdot \left(\frac{2\pi \cdot n}{60}\right)^2 (Ws)$$

$$Wp = m \cdot g \cdot \Delta h$$

$$Pe = \sqrt{\frac{\sum_i \frac{W_{mi}^{\;2}}{t_i}}{T}}(W)$$

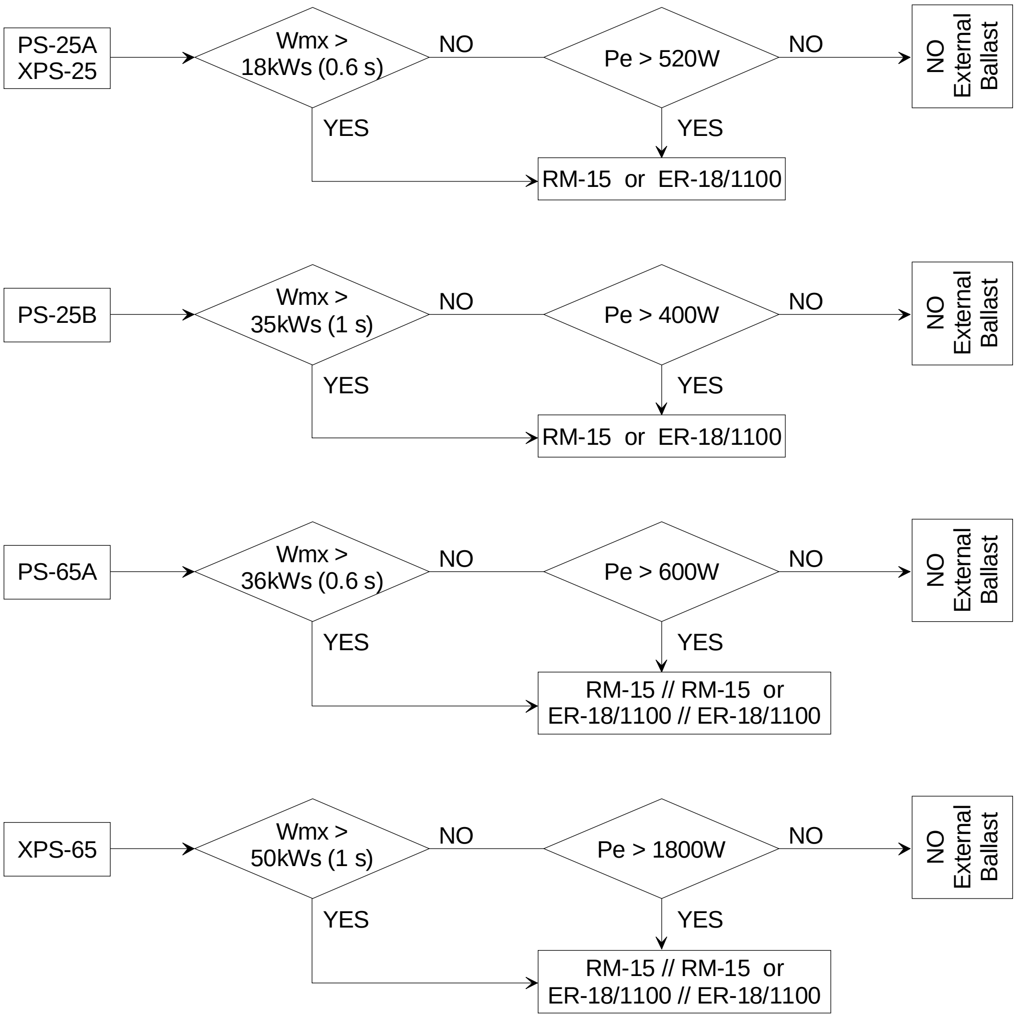
where:

Jt is the total inertia of the servo drive system (motor + mechanics) (Kg.m²)
n is the turning speed of the motor when the braking starts (rpm)
Wmi is the energy of each braking. during a cycle of time *T* (Ws)
Wp is the potential energy lost by the mass of the machine for as long as the braking lasts. Only on axes not compensated (Ws)
ti is the braking time where the *Wmi* energy is generated (sec)
T is the time of full cycle (sec)
Δh is the height lost when braking (m)

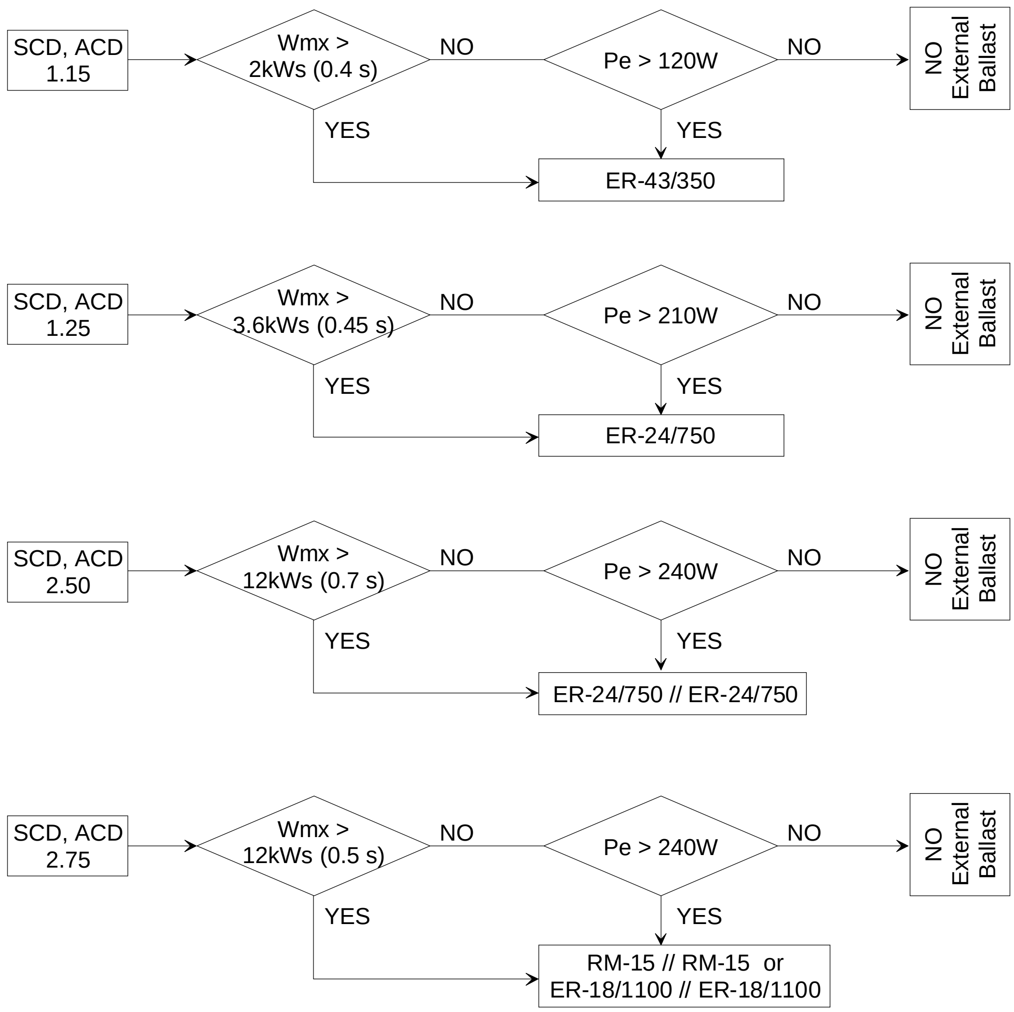
Wmx will be the maximum of all the *Wm*

Once the values of Wmx and Pe are calculated, follow these flow charts.

<u>Power supplies for Modular drives.</u>



Compact Drives.



APPENDIX A:

PARAMETERS
VARIABLES & COMMANDS

Parameter, variable and command list: (page)

NOTATION USED :

[Group][Type][Index][.Range] where:

Group: Identifying character of the logic group to which the parameter or variable belongs. There are the following groups of parameters:

GROUPS OF PARAMETERS AND VARIABLES

Nº	FUNCTION	GROUP	LETTER
1	Operating Mode	Application	A
2	Control signals	Terminal box	B
3	Current control loop	Current	C
4	Error diagnosis	Diagnosis	D
5	Encoder simulator	Encoder	E
6	Flux control loop	Flux	F
7	General of the system	General	G
8	System hardware	Hardware	H
9	Analog and digital inputs	Inputs	I
10	Temperatures and voltages	Monitoring	K
11	Motor properties	Motor	M
12	Sercos	Sercos	N
13	Analog and digital outputs	Outputs	O
14	Positioning	Position	P
15	Rotor sensor properties	Rotor	R
16	Velocity control loop	Speed	S
17	Torque and power parameters	Torque	T
18	Internal function generator	Internal generator	W
19	Parameter setting assistance	Miscellaneous	X

Type: Character identifying the type of data which the information corresponds to.
May be: a parameter defining the system operation (P),
a variable that can be read and modified dynamically (V),
or a command that carries a specific action (C).

The difference between parameter and variable is that the parameter has a programmable initial value and that, except rarely, their value changes only affect after saving the parameters and resetting the drive.

Index: Character identifying the parameter or the variable within the group to which this belongs.

Set: Lots of parameters are divided into "ranges". Each range is a set of parameters that can configure the system differently. This only makes sense for parameters, not for variables. See section "Parameter Sets and Gear Ratios" in chapter AP.

Definition examples:

SP10.4: “S” Group, (P) Parameter, (Nº) 10, Set 4.
CV21: “C” Group, (V) Variable, (Nº) 21.
GC1: "G" Group, (C) Command, (Nº) 1.

Identification of parameters:

After the name, the following characteristics are described:

Parameter sets.	**#**	Parameter expandable in sets.
Immediate effect.	*****	Parameter modifiable **on-line**.
Modifiable variable.	**W**	It is a modifiable variable (from any level).
Access level.	**F**	Fagor. **O** OEM. (USER by default)
Sign.	**s**	With sign.
Related to the motor.	**M**	Value set by MP1 -S141- MotorType
Motor type.	**S**	Synchronous. **A** Asynchronous. (exclusively).

The identifier between ( ) corresponds to the SERCOS interface.
The ones starting with an "S" correspond to the SERCOS standard and those starting with an "F" to Fagor. The numbers for the SERCOS standard of Fagor parameters and variables are obtained by adding 32768 to their index, for example:

The F24 is referred to in SERCOS as S(24+32768); that is: S32792.

By the same token, the SERCOS numbers for the range extended parameters are obtained by adding 4096 to each range, for example:

Parameter VelocityLoopProportionalGain (SP1) is extended in ranges; thus the SERCOS number for SP1.0 will be S100, for SP1.1 will be S4196, for SP1.2 will be S8292, etc...

Fagor parameters with range extension are affected by these considerations.

Examples:
- parameter MP4, is identified with:

MP4 FMS (S109) MotorPeakCurrent

It means that it is a parameter which belongs to the Motor group, it cannot be expanded in sets or modified on line and it can only be modified from the Fagor access level unsigned by the MotorId and it only makes sense for synchronous motors. Its ID number in the SERCOS interface is 109.

- variable SV7, is identified with:

SV7 s (F1612) VelocityCommandFinal

It means that a signed read-only Variable (without W). Its SERCOS interface ID number is 1612+32768=34380.

Warning:

The physical units and ranges for each parameter or variable of this appendix are those used by the DOS based ddssetup monitor for PC as well as by the programming module.

1. GROUP APPLICATION "A".

Function: It determines the way it operates as far as the system configuration is concerned.

Bit	Name
4	
3	It sets the activation of Feedforward (when working with position command) = 1 Feedforward active = 0 Feedforward cancelled
2	It determines whether the motor feedback or direct feedback is used. = 1 Direct X feedback = 0 Motor feedback
1, 0 (LSB)	Determine whether it is a velocity or position command. = 10 Velocity command (without position loop) = 11 Position command

See the section on "Velocity or Position Drive" in the GSU chapter of this manual.

Valid values: 1..15 (3 by default, position loop with motor feedback).

AP5 O (F2001) PlcPrgScanTime

Function: It determines the repetition period of the main PLC module (PRG)
Valid values: 4, 8, 12, 16 or 20 ms (4 ms, by default)

2. NON-PROGRAMMABLE INPUT-OUTPUT "B"

Groups the variables related to the non-programmable hardware control signals and logic variables associated with the Halt and Drive_Enable functions through the serial line.

Activating the Halt function means setting the velocity command to zero while keeping the rotor locked (with torque). It can be activated by means of an electrical signal at certain digital inputs of the drive using the monitoring program through the serial line or Sercos interface.
The Halt function is activated (stops the motor) when applying zero volts to the electrical input assigned to variable BV1, when requested from the monitoring program (variable BV3=0), or when requested from the PLC of the CNC via Sercos (bit 13 of DV32 set to 0).

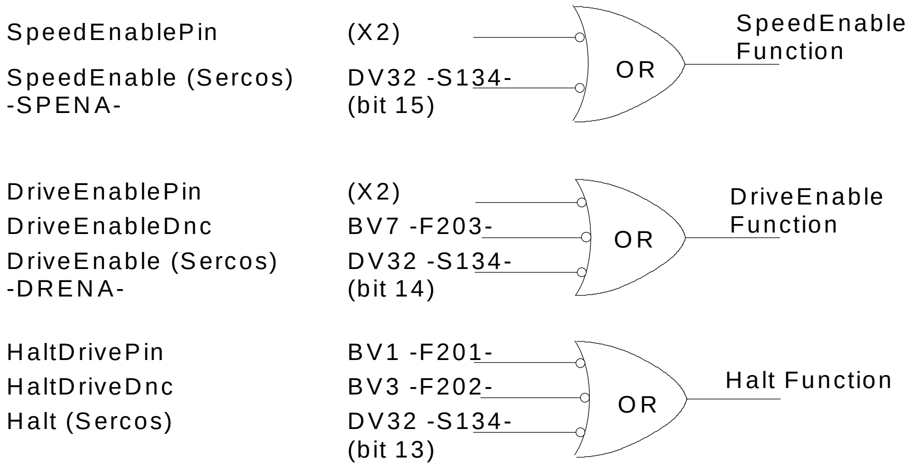
BV1 O (F201) HaltDrivePin

Function: Controls the Halt function through an electrical signal. BV1 is assigned to the parameter IP10-IP13 corresponding to the digital input that will be used as Halt.
Default value: 1 (it has no effect).
Example: IP11 = BV1 (digital input 2 performs the Halt function. In other words, applying 0V to pin 2 with respect to pin 5, activates the Halt function and the motor stops).
Version: Available from version 02.01 on.

BV3 O (F202) HaltDriveDnc

Function: Controls the Halt function through the serial line.
Default value: 1 (it has no effect).
Example: BV3 = 0 (activates the Halt function).

Activating the DriveEnable function enables the current to flow through the Motor.
It can be deactivated by means of an electrical signal at the control connector X2 of the Drive, from the monitoring program through the serial line or via Sercos interface.
The DriveEnable function is deactivated (removes motor torque) when applying zero volts at that electrical input, when requested from the monitoring program (variable BV7 = 0), or when requested from the PLC of the CNC via Sercos (bit 14 of DV32 -variable DRENA at the PLC- is set to 0).



BV7 O (F203) DriveEnableDnc

Function: Controls the DriveEnable function through the serial line.
Default value: 1 (it has no effect).
Example: BV7 = 0 (deactivates the DriveEnable function, -removes motor torque-)

BV14 (F204) NotProgrammableIOs

Function: Indicates the logic values of the electrical control signals of the Drive.
-24 volts at this electrical input mean a logic "1" at the bits of this variable.-

Bit	Signal
4 (MSB)	Lsc_Status (at the intermodular Bus X1)
3	Error_Reset
2	DR_OK (at the microprocessor, not at the pins of X2)
1	Speed_Enable & Syst.Speed_Enable (Drive and Power Supply)
0 (LSB)	Drive_Enable

Example: BV14 = 18 which is the same as binary 10010. This means that "Lsc_Status" and Speed_Enable & Syst.Speed_Enable are active
Note: The DR_OK bit not always coincides with the actual output at the control connector X2 because there are logic circuits beyond the microprocessor which can change this value (for example: Errors in the power circuits).
Version: Available from version 02.01 on.

3. CURRENT GROUP "C".

CP1 OM (S106) CurrentProportionalGain
CP3 FMA (F300) CurrentDerivativeGain

Function : Value of the proportional / derivative action of the current PID.
Valid values: 0..8000

CP2 OM (S107) CurrentIntegralTime

Function : Value of the integral action of the current PID.
Valid values: 0..2000

CP4 FMA (F301) CurrentAdaptationProportionalGain
CP5 FMA (F302) CurrentAdaptationIntegralTime

Function: Adapting to the value of the proportional /integral action of the current PI.
Valid values: 10 .. 1000% in other words, The action of the PI at low speeds may be between one tenth to ten times the action at high speeds.
CP4*CP1 / 1000 must be smaller than the maximum value of CP1.
CP5*CP2 / 1000 must be smaller than the maximum value of CP2.
Default values: 100% (constant proportional / integral action at any speed)

CP6 FMA (F303) CurrentAdaptationLowerLimit

Function: Is the upper rpm limit of the speeds considered "low".
Valid values: Must be smaller than: CP7

CP7 FMA (F304) CurrentAdaptationUpperLimit

Function: Is the lower rpm limit of the speeds considered "high".
Valid values: Must be: smaller than SP10
greater than CP6

CP20.# O (F307.#) CurrentLimit

Function: Limit of the current command that reaches the system's current loop. See the internal configuration diagram. Imposed by the user.
Valid values: 0..300 (depends on the Driver being connected) Amperes RMS
Default value: On drives with FXM motors, CP20 takes the smaller of the Drive's and motor peak current values.
On the SPM, it takes the maximum Drive current value. In applications requiring great threading power, the value of CP20 may be up to 15% greater than the maximum current of the drive.

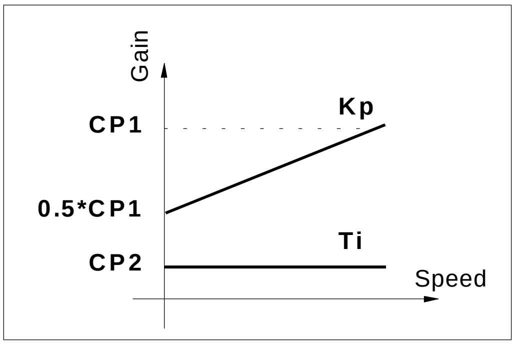
CP30.# *O (F308.#) CurrentFilter1TimeConstant

Function: It sets the natural frequency of the low passing filter that acts upon the current command. It is only applicable on servo drive systems with FXM motors, not with SPM motors.
Valid values: 0, filter disabled
1, Natural frequency at 800 Hz   2, Natural frequency at 700 Hz
3, Natural frequency at 600 Hz   4, Natural frequency at 500 Hz
5, Natural frequency at 400 Hz   6, Natural frequency at 300 Hz
7, Natural frequency at 200 Hz   8, Natural frequency at 100 Hz
> 10 sets the natural frequency (not implemented yet)
Default value: 0, filter disabled
Version: Operative from version 02.02 on, expanded in version 04.01

CP31.# O (F312.#) CurrentFilter1Damping

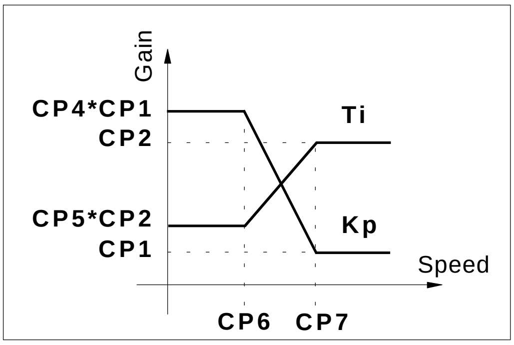
Function: It sets the damping factor of the low passing filter that acts upon the current command. The greater the value of this parameter, the slower the response of the filter. A damping factor of 07 (default value of this parameter) is considered to closer follow the filter's theoretical curve.
Valid values: 500...50000
Default value: 7071
Version: Operative from version 04.01 on

Synchronous Motor
Adapter-Current-PI



CP1 -S106- CurrentProportionalGain
CP2 -S107- CurrentIntegralTime

Asynchronous Motor
Adapter-Current-PID



CP4 -F301- CurrentAdaptationProportionalGain
CP5 -F302- CurrentAdaptationIntegralTime
CP6 -F303- CurrentAdaptationLowerLimit
CP7 -F304- CurrentAdaptationUpperLimit

CV1 s (F309) CurrentUFeedback
CV2 s (F310) CurrentVFeedback

Function: Display of the feedback value of the U / V current.
Valid values: -200..200 Amperes (instantaneous values).

CV3 (F311) CurrentFeedback

Function: Display of the motor rms current.
Valid values: -200..200 Amperes rms

CV10 Fs (F305) CurrentUOffset
CV11 Fs (F306) CurrentVOffset

Function: Current feedback offset compensation for the U / V phase.
Valid values: -5000..5000 (depends on the Drive connected)
Default value: 0, This value is factory measured and adjusted.

4. DIAGNOSTICS GROUP "D"

DP1 O (F400) ErrorsDisables

Function: Using 13 32-bit, it registers the possible disabling of each error. This parameter may be modified through variables DV15 -F2101- and DV16 -F2102-.

DP142 O (S142) ApplicationType

Function: For information only. It contains the type of application the Drive is being used for (e.g. spindle, rotary axis, etc.)

DV1 (S11) Class1Diagnostics (Errors)

Function: The DV1 variable contains the numeric data which in 16-bit binary code represents the error status according to the table below. Bit (from MSB to LSB) name, code at front display of the module.

Bit	Name	Error
15 (MSB)	ManufacturerSpecificError	Rest.
14	Class1Reserved	
13	TravelLimit	
12	ComunicationError	400->499
11	ExcessivePositionDeviation	205
10	PowerSupplyPhaseError	
9	UndervoltageError	307
8	OvervoltageError	304,306
7	OvercurrentError	212
6	ErrorInElectronicCommutationSystem	213->214
5	FeedbackError	600->699
4	ControlVoltageError	100->105
3	CoolingErrorShutdown	106
2	MotorOvertempShutdown	108
1	AmplifierOvertempShutdown	107
0 (LSB)	OverloadShutdown	201, 202, 203

Bit = 0 no error
Bit = 1 error

Example: DV1 = 32804 same as 1000000000100100 in binary. Therefore, there is FeedbackError, a MotorOvertempShutdown, and another one of the manufacturerSpecificError type
Version: Available from version 02.01 on.

DV9 (S12) Class2Diagnostics (Warnings)

Function: The DV9 variable contains the numeric data which in 16-bit binary code represents the warning status according to the table below. Bit (from MSB to LSB).

Bit	Name	Warning
15,14	Reserved	
13	TargetPositionOutsideTheTravelZone	(warning 13)
12, 11,10	Reserved	
9,8	Reserved	
3	CoolingErrorShutdown	(warning 3)
2	MotorOvertempShutdown	(warning 2)
1	AmplifierOvertempShutdown	(warning 1)
0 (LSB)	OverloadShutdown	(warning 0)

Bit = 0 no warning
Bit = 1 warning

Example: DV9 = 8 same as 0000000000001000 in binary. Therefore, there is CoolingErrorShutdown warning

Version: Available from version 02.01 on.

DV10 (S13) Class3Diagnostics (OperationStatus)

Function: The DV10 variable contains a numeric data which in 16-bit binary code represents the status of the logic marks (operation status) according to the table below. From MSB to LSB.

Bit	Marks	Meaning
15,14,13,12	Reserved	
11,10,9,8	Reserved	
7	TV60 (S337)	| TV50 | > TP2
6	PV136	| PV189 | > PP57
5	Reserved	
4	Reserved	
3	TV10 (S333)	| TV2 | > TP1
2	SV3 (S332)	| SV2 | < SP40
1	SV5 (S331)	| SV2 | < SP42
0 (LSB)	SV4 (S330)	SV2 = SV1

Example: DV10 = 14 same as 0000000000001110 in binary.
Therefore, SV5, SV3 and TV10 have been activated.

Version: Available from version 02.01 on.

DV11 (F404) FagorDiagnostics

Function: Variable DV11 contains a numeric value which in 16-bit binary code represents the status of some of the most interesting variables of the Drive. Bits (from the least to the most significant ones).

Bit	Variable	Name
15,14,13	Reserved	
12	TV60 (S337)	PGreaterPx
11	TV10 (S333)	TGreaterTx
10	SV3 (S332)	nFeedbackMinorNx
9	SV5 (S331)	nFeedbackEqual0
8	SV4 (S330)	nFeedbackEqualNCommand
7,6,5,4	GV21 (S254)	ParameterSetActual
3,2,1,0	GV25 (S255)	GearRatioActual

Example: DV11 = 1280 (0000010100000000 in binary)
Therefore, it is operating with Range 0, Set 0, it follows the command OK, it is stopped and under the Nx, Tx and Px thresholds.

Version: Available from version 03.01 on.

DV14 (F400) ErrorsInDncFormat

Function: For reading all the errors currently active. See appendix B for the errors.

DV15 O (F401) ErrorDisable

Function: When writing an error identifying number into this variable, it is disabled. Even if the reason for the error is generated again, it is not triggered and the Drive keeps on running normally.
Example: If the drive shows error 108 "motor overheating", after writing the value of 108 into the DV15 -F2101- variable, saving it and resetting the drive, the Status Display of the drive will no longer indicate this error.
Units: Natural number, identifying the type of error. See appendix B for the errors.

DV16 O (F402) ErrorEnable

Function: When writing an error identifying number into this variable, it is enabled. It cancels the disabling effect of the DV15 -F2101-.
Example: Using the previous example, when writing the value of 108 into the DV16 -F2102- variable, saving it and resetting the drive, the Status Display of the drive will show this error again.

DV31 (S135) DriverStatusWord

Function: The DV31 variable contains the numeric data which in 16-bit binary code represents various aspects of the system status according to the table below. From the MSB to the LSB. This variable communicates with the CNC through the Sercos interface. Bits 15 and 14 are assigned to PLC variables DRSTAF and DRSTAS respectively.

Bit	Meaning	Possible values	
15,14	PowerAndTorqueStatus	Bits (15,14)	Meaning
		(0,0)	DoingInternalTests
		(0,1)	ReadyForPower
		(1,0)	PowerOn
		(1,1)	TorqueOn
	Indicates at which point of the start-up sequence the drive is.		
13	error		
12	WarningChangeBit		
11	OperationStatusChangeBit		
9,8	ActualOperationMode	Bits (9,8)	Meaning
		(0,0)	InPrimaryMode
		(0,1)	InSecondary1Mode
		(1,0)	InSecondary2Mode
		(1,1)	InSecondary3Mode
7	Real Time StatusBit1		
6	Real Time StatusBit0		
5	ChangeBitCommands		
4,3,2,1,0	Reserved		

Example: DV31 = 11479 same as the binary 0010110011010110 and it means that it is running an internal test (DoingInternalTests), has an error, etc.
Version: Available from version 02.01 on.

DV32 (S134) MasterControlWord

Function: The DV32 variable contains the numeric data which in 16-bit binary code represents the status of various control signals that the CNC sends to the Drive through the Sercos interface. Bits (from the least to the most significant ones).
Bits 15 and 14 correspond to the values of the digital PLC outputs SPENA and DRENA respectively (at the PLC of the 8050/55 CNC).

Bit	Name
15	SpeedEnable (SPENA)
14	DriveEnable (DRENA)
13	Halt
12,11,10	Reserved
9,8,7,6,5	Reserved
4,3,2,1,0	Reserved

Example: DV31 = 1110000000000000 in binary. The CNC "wants" the motor to turn following the velocity command.

DV95 (S95) DiagnosticMessage

Function: Not being used at this time

DC1 (S99) ResetClass1Diagnostics

Function: Reset the errors appearing on the display. Available on the command menu of the programming module "DDS PROG MODULE" as ResetClass1Diagnostics.

Version: Available from version 02.01 on.

5. SIMULATOR ENCODER GROUP "E".

EP1 O (F500) EncoderSimulatorPulsesPerTurn

Function: Number of pulses per rotor turn generated by the encoder simulator.
Valid values: 1..16360 (Integer)
Default value: 1250

EP2 O (F501) EncoderSimulatorI0Position

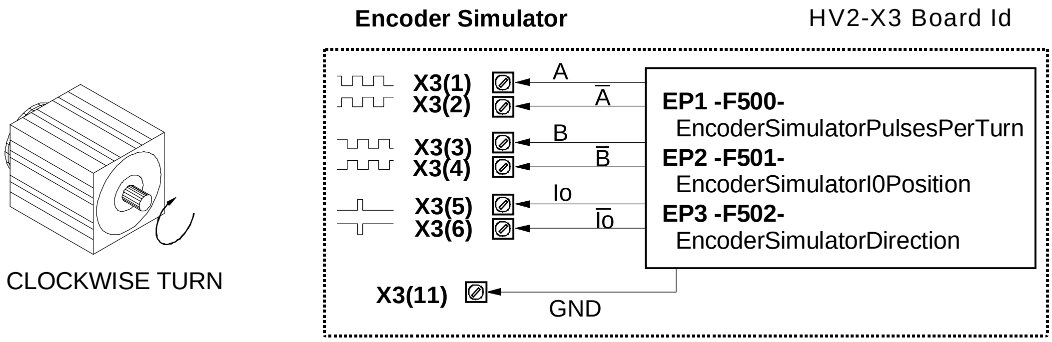
Function: Rotor position where the encoder simulator generates the home marker pulse (Io).
Valid values: 1..EP1 (Integer)
Default value: 1

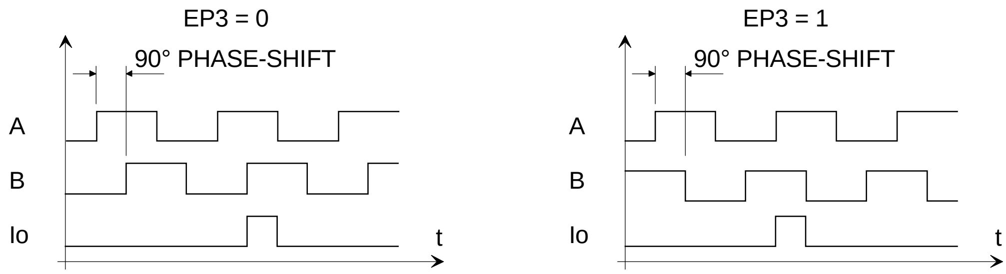
EP3 O (F502) EncoderSimulatorDirection

Function: With this parameter the turning direction of the simulated encoder is selected. This parameter may be modified with the "C" command from the "ddssetup".
Valid values: 0 and 1, clockwise and counterclockwise rotation respectively.
Default value: 0 (clockwise).

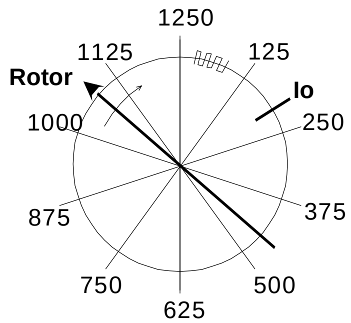
EC1 O (F503) EncoderSimulatorSetI0

Function: The execution of this command sets the current rotor position as the home point (I_0). Available in the command menu of the programming module "DDS PROG MODULE" as EncoderSimulatorFixI0Command .





Example
EP1 -F500- = 1250
EP2 -F501- = 200
EP3 -F502- = 0



6. FLUX GROUP "F"

FP1 OMA (F600) MotorFluxProportionalGain
FP2 OMA (F601) MotorFluxIntegralTime
FP20 OMA (F602) MotorBEMFProportionalGain
FP21 OMA (F603) MotorBEMFIntegralTime

Function : Value of the proportional / integral action of the PI for flux and Back EMF.
Valid values: 0..32000
Default value: 0

FP30 FMA (F604) MotorInductance1
FP31 FMA (F605) MotorInductance2
FP32 FMA (F606) MotorInductance3
FP33 FMA (F607) MotorInductance4
FP34 FMA (F608) MotorInductance5
FP35 FMA (F609) MotorInductance6
FP36 FMA (F610) MotorInductance7
FP37 FMA (F611) MotorInductance8
FP38 FMA (F612) MotorInductance9

Function: Values of the magnetic saturation curve of the stator iron.
Valid values: 0.1 .. 10%
Default value: 1%

FP40.# FMA (F613.#) FluxReduction

Function: Indicates the percentage of magnetizing current that circulates through the motor when applying load. It reduces the amount of motor noise and its overheating when turning without load. To cancel the effect of this parameter, set it to 100%.
Valid values: 1 .. 100%
Default value: 100%

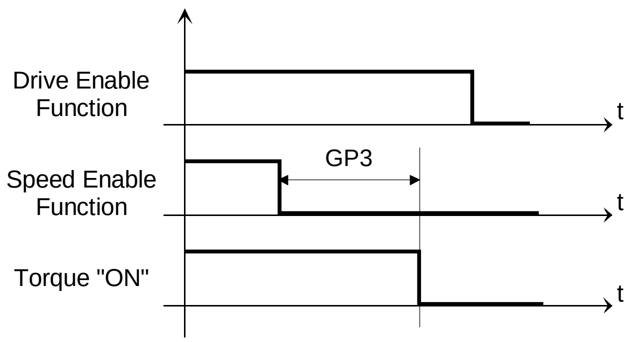
7. GENERAL GROUP "G"

GP1 O (F700) PwmFrequency

Function: Selects the communications frequency of the IGBTs.
Units: KHz
Valid values: 4 (by default on Asynchronous motors)
8 (by default on Synchronous motors)

GP2 O (F701) Feedback1Type

Function: Type of motor feedback.
Valid values: 0- Sinewave encoder 1-Resolver 2-Squarewave encoder, TTL
5-Heidenhain encoder (ERN 1387) for Siemens motors, 1FT6 family
Default value: 0-Sinewave encoder



GP3 O (F702) StoppingTimeout

Function:	After deactivating the SPEED_ENABLE and once the GP3 time period has elapsed, if the motor has stopped, the TORQUE is automatically deactivated and an Error-4. If the motor stops within the GP3 time period, the TORQUE is also deactivated, but without issuing an error.
Valid values:	0..65535 (depends on the motor) msec.
Default value:	500 on axes, 5000 on spindles

GP4 O (F703) SetNumber

Function:	Number of useful parameter sets. They are numbered from zero on. Only the number of sets limited by GP4 may be activated.
Valid values:	1..8 (From a single Set up to all of them)
Default value:	1 (a single Set)
Version:	Available from version 02.01 on.

GP5 (F704) ParameterVersion

Function:	It stores the version of the motor parameter table. Read only.
Version:	Available from version 02.01 on.

GP6 O (F717) GearRatioNumber

Function:	Number of useful gear ratios. The useful gear ratios must be numbered from zero on. Only a number of gear ratios limited by this parameter GP6 can be activated.
Possible values:	1..8 (From a single gear ratio up to all of them)
Default value:	1 (A single gear ratio)
Version:	Available from version 03.01 on.

GP7 O (F235) OverloadTimeLimit

Function:	When the overload conditions exceed this time period, the error is issued. See GP8.
Valid values:	0..10000 milliseconds. With GP7 =0 this protection is disabled.
Default value:	200
Version:	Available from version 02.04 on.

GP8 O (F236) OverloadVelocityThreshold

Function:	Sets the speed threshold under which the motor is considered to be stopped in terms of overload detection. See GP7.
Valid values:	0..1000 rpm
Default value:	100 (Asynchronous Motors), Rated Speed (Synchronous Motors).
Version:	Available from version 02.04 on.

GP9 O (S207) DriveOffDelayTime

Function:	After stopping the motor by disabling the SpeedEnable function or by activating an error, the DriveEnable function is disabled (involving PWM-OFF) with a delay set by GP9. It is very useful when the axes do not have a blocking brake. See electrical diagrams in chapter IN.
Valid values:	0..65535 milliseconds.
Default value:	0 (after stopping the motor due to SpeedEnable or ErrorStop, the motor torque is removed)
Version:	Available from version 03.03 on.

GP10 O (F234) Feedback2Type

Function:	It determines the type of electrical signal received from direct feedback through X3.
Valid values:	0- No feedback. 1- Square TTL signal 2- 1 Vpp sinewave signal or differential (double ended) square TTL signal.
Default value:	0- (No feedback)
Version:	Available from version 04.01 on

GV2 (S30) ManufacturerVersion

Function:	Display of the current version and the type of drive (axis or spindle).

GV3 s (F705) ParameterChecksum

Version: Available from version 01.04 on.

GV4 (S380) DCBusVoltage

Function: Reports on the voltage at the Power Bus (in volts).
Version: Available from version 02.01 on.

GV5 s (F706) CodCheckSum

Version: Available from version 01.04 on.

GV7 W (S267) Password

Function: Variable used to enter the password to change access levels. The system will change to the access level corresponding to the password entered.

GV8 (F707) AccessLevel

Function: Informs of the current access level.
Valid values: 1-User, 2-OEM, 3-FAGOR.

GV9 (S140) DriveType

Function: Informs of which is the Drive reference.
Valid values: All of them according to the coding given in Appendix C.

GV10 O (S262) LoadDefaultsCommand

Function: Motor identification and initialization. Assigning a reference identifying a particular motor to this variable (see appendix C) configures the parameters related to the motor to govern it and the rest of the parameters to their default values.
See the section on "Motor Identification" of chapter on GSU.
Valid values: The references for the motors indicated in appendix C.

GV11 W (F708) SoftReset

Function: Variable for doing a Reset by software. See the section on "Reset, initialization process" of the chapter on GSU.

GV13 (F709) PowerBusStatus

Function: Indicates whether there is voltage at the power BUS or not.
Valid values: 0 / 1 no / yes

GV14 F (F710) PowerVoltageMinimum

Function: While torque is active, if the bus voltage is lower than GV14, error 307 is issued.
Units: Volts
Version: Available from version 02.01 on.

GV20 (S219) IDNListOfParameterSet

Function: It offers the list of parameters expandable in sets.

GV21 (S254) ParameterSetActual

Function: Determines which one the active parameter set used by the system.
Valid values: 0..7 (Eight Sets possible)
Default value: 0 (Set 0)
Version: Available from version 02.01 on.

GV22 W (S217) ParameterSetPreselection

Function: Determines which is the parameter set that will be active when receiving the admission signal (GV24)
Valid values: 0..7 (Eight Sets possible)
Default value: 0 (Set 0)
Version: Available from version 02.01 on.

GV23 F (F711) ParameterSetAck
GV24 W (F712) ParameterSetStb

Function: Variables related to the change of active Set. "GV24" must be set to "1" ("Strobe") in order to be able to change the set with GV30, GV31, GV32. When the set change is effective, the Drive indicates so through the GV23 variable.
If GV24 is not assigned to any digital input, it keeps a value of "1" (active) and therefore all the changes in GV30-32 have an immediate effect on the active Set.
Valid values: 0 / 1 (inactive / active)
Version: Available from version 02.01 on.

GV25 (S255) GearRatioActual

Function: Indicates which is the active Gear Ratio in the software.
Valid values: 0..7 (Eight gear ratios possible)
Default value: 0 (Gear Ratio 0)
Version: Available from version 03.01 on.

GV26 W (S218) GearRatioPreselection

Function: Determines which will be the active Gear Ratio (software) when making the change through the Sercos interface.
Valid values: 0..7 (Eight gear ratios possible)
Default value: 0 (Gear Ratio 0)
Version: Available from version 03.01 on.

GV30 W (F713) ParameterSetBit0
GV31 W (F714) ParameterSetBit1
GV32 W (F715) ParameterSetBit2

Function: Boolean variables forming the number identifying the active set.
GV32 is the most significant bit (MSB) and GV30 the least (LSB). To make the active set change effective, GV24 must be enabled.
By assigning these four variables to parameters IP10-IP13 makes it possible to control which will be the active set by means of electrical signals.
Valid values: 0 / 1, (assigned to the IP corresponding to (0 / 24 Vdc) respectively)
Example: GV32=1, GV31=1 and GV30=0, represent the sixth range (6).
Version: Available from version 02.01 on.

GV33 F (F716) TMODE_Select

Function: It is a useful variable for testing the hardware of the Sercos ring.
Valid values: 0, Normal operation mode.
1, Zero Bit String.
2, Continuous light output.
Default value: 0
Version: Available from version 03.01 on.

GV35 (F718) PlcResourceData

Function: Parameter to be used internally by the system. It defines the location and structure of the PLC resources in the Drive memory so all the modules can access those resources. These resources are: registers, counters, marks, images of the marks, images of the inputs and outputs.

GV36 (F722) KernelResourceData

Function: Parameter to be used internally by the system. It defines the location and structure of the resources of the MC software in the Drive memory so all the modules can access those resources. These resources are: user variables and arrays

GV37 **(F2012)** **PlcErrors**

Function: When the PLC indicates through the display Status a compiling or execution error, this variable indicates its exact meaning. See PLC manual.

GC1 **(S264)** **BackupWorkingMemoryCommand**

Function: Transfers parameters contained in RAM memory to Flash memory. Available on the command menu of the programming module "DDS PROG MODULE" as BackupWorkMemoryProcedureCommand.

GC2 **(S216)** **ParameterSetSwitch**

Function: Execution of the change of ranges and parameter Sets.

8. HARDWARE GROUP "H"

HV1 **(S110)** **DrivePeakCurrent**

Function: Identifies the power of the Drive module (Peak current for an FXM)
Valid values: 8, 15, 25, 35, 50, 75, 100, 150

HV9 **(F806)** **ModularOrCompact**

Function: Shows whether the Drive is modular or compact.
Valid values: 0-Modular 1-Compact

HV10 **(F290)** **VsMSC**

Function: It informs of the different hardware possibilities.

HV11 **(F291)** **FlashManufacturerCode**

Function: Indicates the code of the manufacturer of the flash memories used in the drive.

9. GROUP OF INPUTS "I"

IP1.# O (F900.#) AnalogReferenceSelect

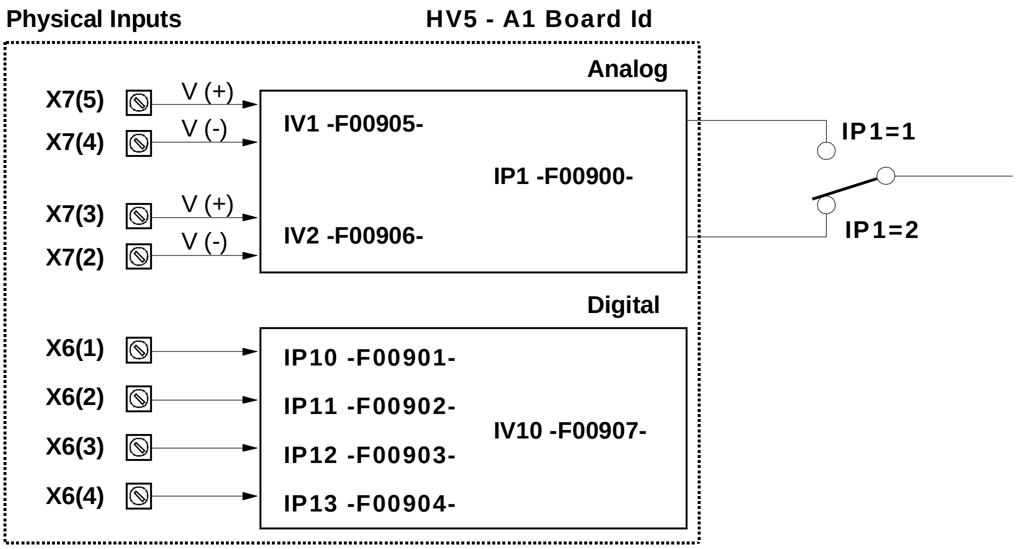
Function: Selects the analog input used as velocity command.
Valid values:
1: Analog input 1 (by default)
2: Analog input 2

IP5 O (F909) DigitalInputVoltage

Function: Its four least significant bits configure the digital inputs of the 8I-16O and 16I-8O cards to operate at an input voltage of 5 Vdc or 24 Vdc.
The card for connectors X6 and X7 cannot be configured by this parameter.
Bits 0 (LSB) and 1 configure the inputs of slot SL1.
Bit 0 configures the group of inputs I1-I8.
Bit 1 configures the group I9-I16.
Bits 2 and 3 configure the inputs of slot SL2.
Bit 2 configures the group I17-I24.
Bit 3 configures I25-I32.
Valid values:
0: inputs configured for 24 Vdc (by default at all four bits)
1: inputs configured for 5 Vdc
Version: Operative from version 04.01 on

IP10 O (F901) I1IDN
IP11 O (F902) I2IDN
IP12 O (F903) I3IDN
IP13 O (F904) I4IDN

Function: Contain the identifiers of the parameters or variables which will be assigned the logic value of the electrical signal going into the Drive through:
pin-1 (referred to pin-5) for IP10
pin-2 (referred to pin-5) for IP11
pin-3 (referred to pin-5) for IP12
pin-4 (referred to pin-5) for IP13
Default value: 0 (not assigned)
Examples:
IP10 = GV24 (pin 1 referred to 5, is the Strobe for Set selection)
IP11 = BV1 (pin 2 referred to 5, performs the Halt-hardware function)
IP12 = 0 (pin 3 referred to 5, performs no function)
Version: The parameters IP12 and IP13 are available from version 02.01 on.



IV1 s (F905) AnalogInput1
IV2 s (F906) AnalogInput2

Function: They monitor de input voltages for analog input 1 (pins 4-5 of X7) and analog input 2 (pins 2-3 of X7).
Their values cannot be changed. They are read-only variables.
Valid values: -10..10 Volts
Version: Operative from version 02.01 on

IV10 O (F907) DigitalInputs

Function: The IV10 variable contains a numeric data, in binary code, which represents the status of the digital inputs present in slot SL1.
- If slot SL1 is occupied by connectors X6 and X7, these inputs correspond to parameters IP10-13 (four digital inputs).
- If slot SL1 is occupied by any of the I/O cards 16DI-8DO or 8DI-16DO these inputs correspond to PLC resources I1-I16.

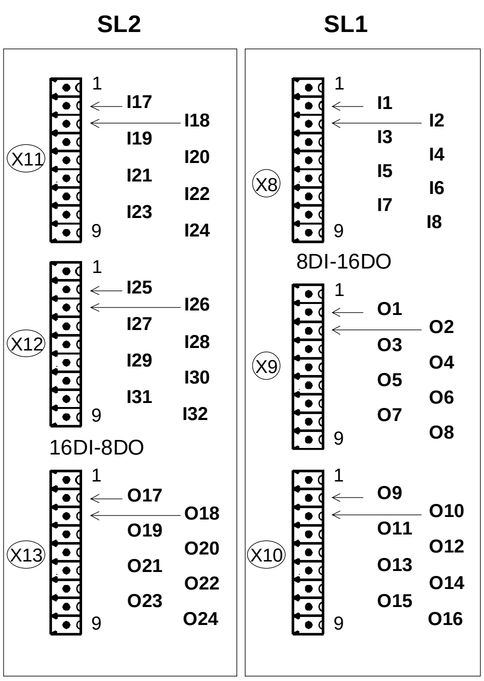
Valid values: 0..65535 ($FFFF)
Example: We read that IV10 = 3 whose binary code is: 0011. This means that inputs 1 and 2 of connector X6 are active (receiving 24 Vdc) and inputs 3 and 4 are inactive (at 0 Vdc).
Version: Operative from version 02.01. Renewed in version 04.01

IV11 O (F908) DigitalInputsCh2

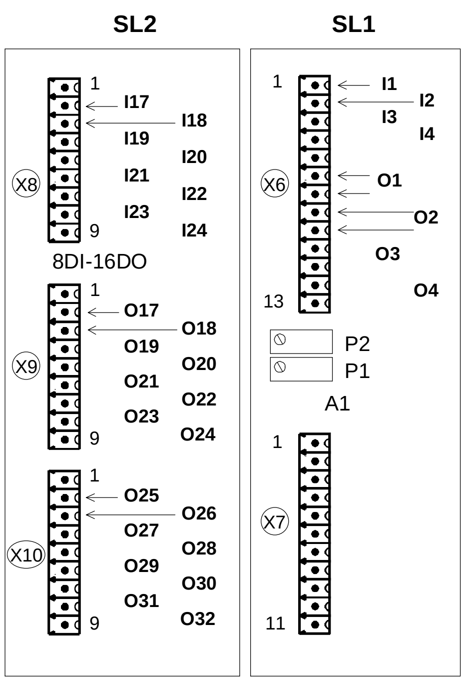
Function: The IV11 variable contains a binary coded numeric data which represents the status of the digital inputs present in slot SL2.
- Slot SL1 can only be occupied by one of the I/O cards: 16DI-8DO or 8DI-16DO. When working with the PLC, these inputs correspond to resources I17-I32.

Valid values: 0..65535 ($FFFF)
Example: We read that IV11 = 30 whose binary code is 00011110. This means that inputs I18, I19, I20, I21 are active and the rest are inactive (at 0 Vdc).
Version: Operative from version 04.01 on.

Drive Module (example)



Drive Module (example)



10. MONITORING GROUP "K"

KP1 F (F1112) DriveI2tErrorEffect

Function: It determines whether the i^2t causes the motor to stop or it limits its current to the nominal value.
Valid values: 0, Stops the system.
1, limits the current through the motor to its rated value.
Default value: 0 (Stops the system)
Version: Available from version 03.01 on.

KP2 O (F1113) ExtBallastResistance

Function: It contains the Ohm value of the External Ballast resistor of a Compact Drive. This is useful for the i^2t protection of that resistor.
Valid values: 0..6K5 (0 by default)
Version: Operative from version 03.07 on

KP3 O (F1114) ExtBallastPower

Function: It contains the value of the power of the External Ballast resistor of a Compact Drive. This is useful for the i^2t protection of that resistor.
Valid values: 0..65 kw (0 by default)
Version: Operative from version 03.07 on.

KP4 O (F1116) ExtBallastEnergyPulse

Function: It contains the value of the energy pulse that can be dissipated by the External Ballast resistor of a Compact Drive. This is useful for the i^2t protection of that resistor.
Valid values: 0..65 kWs (0 by default)
Version: Operative from version 03.07 on.

KV2 (F1100) DriveTemperature
KV4 W (F1101) DriveTmperatureErrorLimit

Function: Read / write of the limits set by the user for the warning and temperature error of the Driver.
Valid values: 5..100 degrees centigrade (^oC)
Version: Operative from version 02.01 on.

KV5 W (S201) MotorTemperatureWarningLimit
KV6 (S383) MotorTemperature
KV8 W (S204) MotorTemperatureErrorLimit

Function: Same for the motor. (KV6 is only applicable for AXM motors)
Valid values: 0..130 degrees centigrade (^oC)
Version: Operative from version 02.01 on

KV9 W (S202) CoolingTemperatureWarningLimit
KV12 W (S205) CoolingTemperatureErrorLimit

Function: Same for the drive and its temperature
Valid values: 0..110 degrees centigrade (^oC)

KV10 (F1102) CoolingTemperature
KV20 s (F1103) SupplyPlus5V
KV21 s (F1104) SupplyPlus8V
KV22 s (F1105) SupplyPlus18V
KV23 s (F1106) SupplyMinus5V
KV24 s (F1107) SupplyMinus8V
KV25 s (F1108) SupplyMinus18V

Function: Monitoring of heatsink temperature (degrees centigrade (^oC)) and of power supply voltages present at the module.
Version: Operative from version 02.01 on

KV32 (F1109) I2tDrive
KV36 F (F1111) I2tMotor

Function: Variables being used internally by the system. They measure the levels of the internal load of the i^2t calculation at the Drive and at the motor as "the percentage used of the maximum.

Version: Operative from version 03.01 on. Renewed in version 04.01

KV40 (F1115) ExtBallastOverload

Function: It shows the percentage of load on the External Ballast resistor in a Compact Drive. This is useful for the i^2t protection of that resistor. A value over 100% in this variable will trigger error 301.

Version: Operative from version 03.07 on.

11. MOTOR GROUP "M"

MP1 O (S141) MotorType

Function: Motor identification and initialization. Assigning to this parameter a reference identifying a particular motor (see appendix C) configures the motor related parameters to govern that motor.
See the section on "motor identification" in the GSU chapter.
To govern a non-Fagor motor or to modify some of these "M" parameters, MP1 must be set to a value starting with "0", for example: MP1=0supermotor.

Valid values: The references appearing in appendix C for the motors.

MP2 FMS (F1200) MotorTorqueConstant

Function : Contains the torque constant of the synchronous motor (motor torque depending on the rms current).

Valid values: 0.1..1000 Nm/Arms.

MP3 FM (S111) MotorContinuousStallCurrent

Function: Rated motor current.

Valid values: 0.1..200 (it depends on the motor connected) Amperes RMS

MP4 FMS (S109) MotorPeakCurrent

Function: Peak current of the synchronous motor. Is the amount of current never to be exceeded at the motor.

Valid values: 0.1..300 (it depends on the motor connected) Amperes RMS

MP5 FM (F1201) MotorPolesPairs

Function: Number of pairs of poles

Valid values: 1..24 (integer)

MP6 FMA (F1202) MotorRatedSupplyVoltage

Function: Is the rated voltage of the Asynchronous motor.

Valid values: 10..400 RMS Vac

MP7 FMA (F1203) MotorPowerFactor

Function: Power factor of the asynchronous motor

Valid values: 1..99 hundredths

MP8 FMA (F1204) MotorConstantPowerEndVelocity

Function: Maximum speed for the constant power zone in S1

Valid values: 10..10000 rpm

MP9 FMA (F1205) MotorSlip

Function: Slippage on the asynchronous motor.

Valid values: 10..200 tenths of rpm.

MP10 FMA (F1206) MotorStatorResistance

Function: Stator Resistance.

Valid values: 1..20000 milliOhms

MP11 FMA (F1207) MotorStatorInductance

Function: Stator inductance.

Valid values: 0.1..1000 mH.

MP12 FMA (F1208) MotorNominalPower

Function: Nominal Power.
Valid values: 1..2000 tenths of Kw.

MP13 FM (F1209) MotorThermalTimeConstant

Function: Motor Thermal Time Constant.
Valid values: 1..200 minutes.

MP14 FM (F1210) MotorTempSensorType

Function: Identifies the sensor of the Fagor motor
Valid values: 0 - SPM and FXM: Triple, sensitive between 130°C and 160°C
1 - AXM: Simple, sensitive between 0 and 155 ºC

MP15 FM (F1211) MotorShaft

Function: Offers information about the shaft type installed on the motor.
On FXM motors:
MP15 = 0 means that the shaft has a standard keyway
MP15 = 1 means that it does not have a keyway.
On SPM motors:
MP15 = 0 means that it is a normal shaft.
MP15 = 1 means that the shaft is sealed (against oil from the gear box).
MP15 = 2..9 it is a special shaft supplied upon request.

MP16 FM (F1212) MotorBrake

Function: It indicates whether the motor has a brake (MP16 = 1) or not (MP16 = 0).

MP17 FM (F1213) MotorFan

Function: It indicates whether the motor has a fan (MP17 = 1) or not (MP17 = 0).
It only makes sense on FXM motors because the SPM motors always carry a fan.

MP18 FMA (F1214) MotorMounting

Function: It indicates how the SPM motor is mounted. The roller bearings of that motor will be designed for that particular way of mounting.
MP18 = 0 for a horizontal mount B3/B5
MP18 = 1 for a vertical mount with the shaft facing down V1/V5
MP18 = 2 for a vertical mount with the shaft facing up V3/V6

MP19 FMA (F1215) MotorBalancing

Function: It indicates the balancing degree of the motor.
MP19 = 0 -> standard "degree: "S"..
MP19 = 1 -> better balancing degree: SR.

MP20 FMA (F1216) MotorBearings

Function: It indicates the type of roller bearings.
MP20 = 0 -> normal bearings.
MP20 = 1 -> high speed bearings.

MP22 FMA (F1218) MotorPowerReduction

Function: Limits the maximum power of an asynchronous motor.
Valid values: 0..100%
Default value:: 100%

MP24 FM (F1220) MotorMomentumOfInertia

Function: Motor inertia.
Valid values: 1..10000 Kgr/cm^2
Default value: 10 Kgr/cm^2

12. SERCOS GROUP "N"

NP1 FM (F2200) ReducedActuatedMomentumOfInertiaPercentage

Function: (Parameter not available at this time). It shows the ratio between load inertia and that of the motor rotor. To calculate this ratio one must consider the mechanical transmission ratio (gear ratio) between the movement of the load and the rotation of the motor.
This parameter is A MUST for the internal processing of the acceleration feedforward in the position loop.
Valid values: 0 .. 1000%
Default values: 0%

NP117 O (S117) ResolutionOfFeedback2

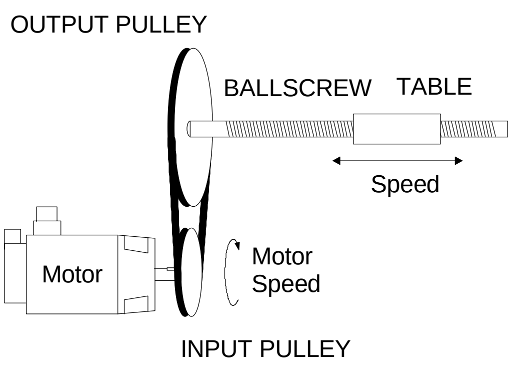
Function: It indicates feedback resolution for the direct feedback at X3.
Units: If it is a linear feedback (a scale), the signal period is given in microns. For Fagor scales (graduated glass), this resolution is 20 microns. In other words, S117=20
If it is a rotary encoder, this resolution is given in lines per turn.
Valid values: 1..2147483647
Default values: 2048 (2048 lines per turn of the rotary encoder)

NP118 O (S118) ResolutionOfLinearFeedback

Function: It indicates what linear feedback resolution is used as Direct Feedback. If the feedback signal is modified by an external multiplier, the value of this parameter must reflect the effect of that multiplier.
Units: If it is a linear scale, the feedback signal period is given in decimicrons. In the case of Fagor linear glass scales this resolution is 20 microns (S118 = 200). In the case of Fagor Steel tape scales this resolution is 100 microns (S118 = 1000).
When applying a "x10" multiplying factor to a Fagor glass scale (20 microns), then: S118 = 20 decimicrons.
Valid values: 1..2147483647
Default values: 2048

NP121.# O (S121.#) InputRevolutions
NP122.# O (S122.#) OutputRevolutions

Function: They define the transmission ratio between the motor shaft and the final axis moving the machine. For example, if the motor turns 5 times for every 3 turns of the ballscrew, these parameters should be set as follows:
(S121) = 5
(S122) = 3
Valid values: 1..32767 turns
Default values: 1 turn for both parameters (direct coupling)



Example:
Diameter of the output pulley = 25.75 mm
Diameter of the input pulley = 15.3 mm

NP121 = 2575
NP122 = 1530

Gear ratio =2575/1530 =1.683

Ballscrew pitch = 5 mm

NP123 = 5 milimeters

NP123 O (S123) FeedConstant

Function: They define the linear movement of the machine and the axis moving it. For example, if the table moves 4 mm for every turn of the ballscrew. This parameter should be set as S123 = 40000
In the case of a rotary axis, NP123 = 3600000, (360 degrees per turn)
Valid values: 1..214 m
Default values: 5000 microns (5 mm per turn)

NP165 O (S165) DistanceCodedReferenceMarksA

Function: When the linear scale has distance-coded reference marks, this parameter indicates the distance between two "coded" consecutive reference marks . For example, for Fagor glass scales, it is 20.02 mm.
Valid values: 1001, 2002
Default values: 1001

NP166 O (S166) DistanceCodedReferenceMarksB

Function: When the linear scale has distance-coded reference marks, this parameter indicates the distance between two consecutive reference marks. For example, for Fagor glass scales, it is 20 mm.
Valid values: 1000, 2000
Default values: 1000

NV31 (S301) RealTimeControlBit1IDN
NV33 (S303) RealTimeControlBit2IDN
NV35 (S305) RealTimeStatusBit1IDN
NV37 (S307) RealTimeStatusBit2IDN

Function: Internal system variables.

13. ANALOG AND DIGITAL OUTPUT GROUP "O"

OP1 *O (F1400) DA1IDN
OP2 *O (F1401) DA2IDN

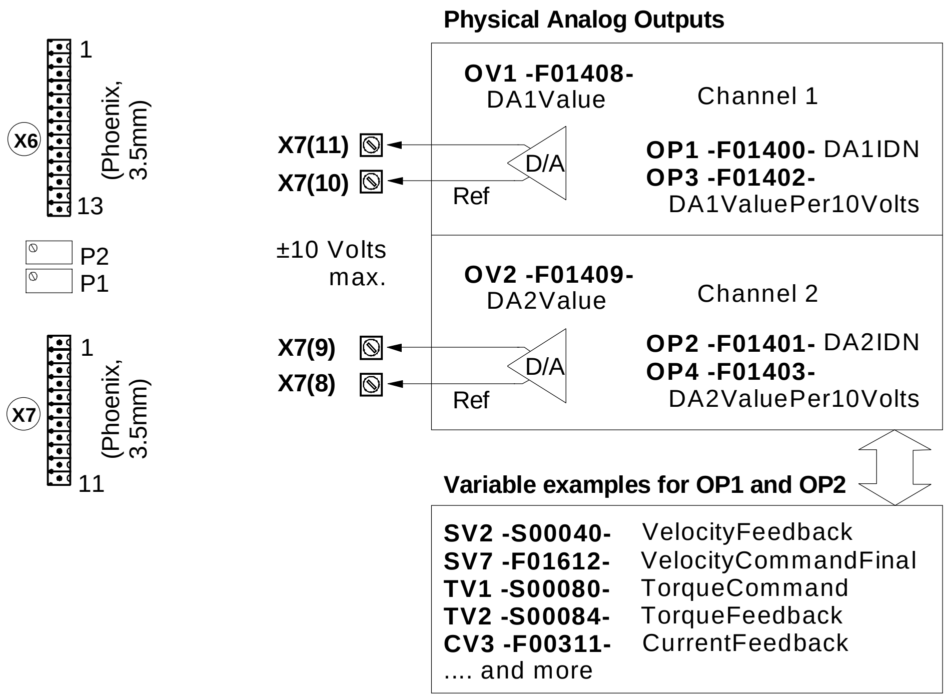
Function:	They identify the internal analog variables of the Drive which will be reflected at the electrical outputs and will be affected by the OP3 and OP4 gains respectively. Channel 1 (pins10-11 of X7) and channel 2 (pins 8-9 of X7). Assign a "0" value to OP1 and 7 or OP2 to allow forcing the value of the electrical signals by means of OV1 and/or OV2.
Valid values:	Name of any variable or parameter.
Default values:	SV1 in the case of OP1, and SV2 in the case of OP2.

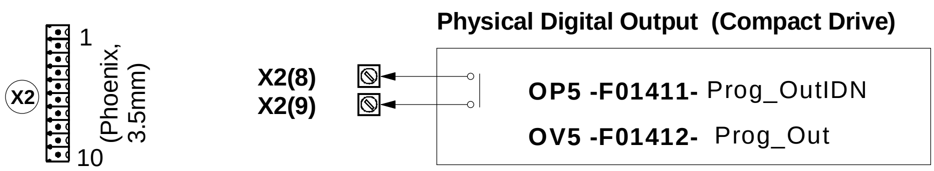
OP3 *O (F1402) DA1ValuePer10Volt
OP4 *O (F1403) DA2ValuePer10Volt

Function:	They define the gains of channel 1 (pins 10-11 of X7) and channel 2 (pins 8-9 of X7). These gains are given through the value of the variable corresponding to an output of 10 V.
Units:	Those of the variable being displayed.
Valid values:	1..65535
Default value:	1000
Example:	If OP1=SV2 (VelocityFeedback, in rpm) and OP3=3000. This means that when SV2 = 3000 rpm. The analog voltage will be 10 V (pins 10-11 of X7). It will maintain this rpm/Volt ratio for the full range of ±10V.

OP5 O (F291) Prog_OutIDN

Function:	Identifies the boolean variable which will be reflected at the digital output Prog_OUT of the Compact Drive (pins 8-9 of connector X2).
Default value:	0 (not assigned), In that situation, Prog_OUT may be forced with OV5.
Example:	OP5 = TV100 (the contact is closed when there is torque)
Version:	Operational from version 02.03 on.





OP10 O (F1404) O1IDN
OP11 O (F1405) O2IDN
OP12 O (F1406) O3IDN
OP13 O (F1407) O4IDN

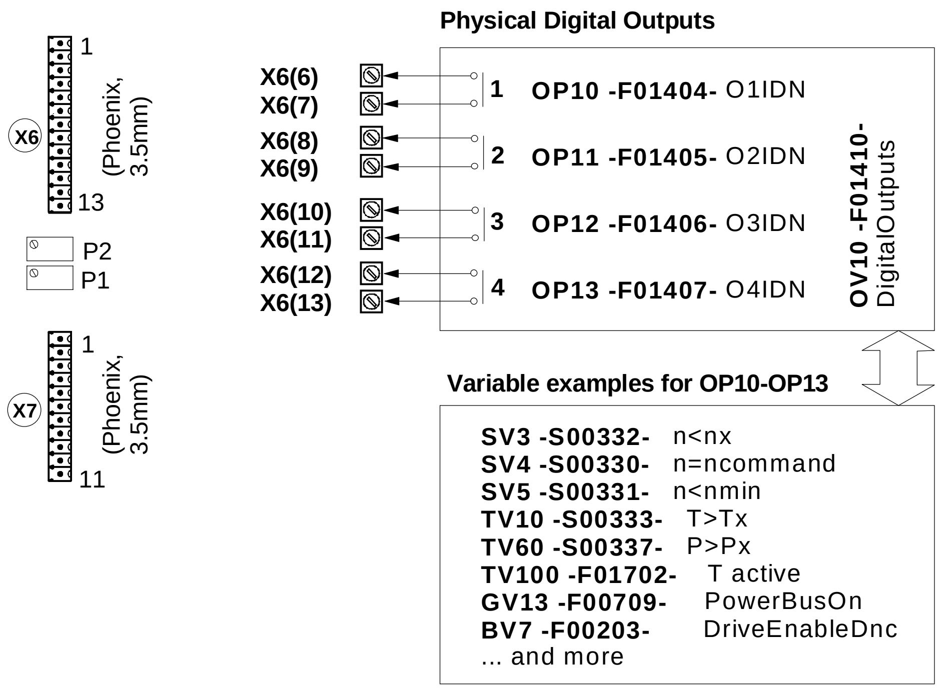
Function:	They identify the boolean system variables that will appear at the digital outputs 1 / 2 / 3 and 4 through pins (6,7), (8,9), (10,11) and (12,13) of connector X6. Units: Name of the parameter or variable to be displayed. Boolean only.
Default value:	0 (not assigned)
Examples:	OP11 = TV100 (the contact between pins 8 and 9, is closed when there is torque)
Version:	OP12 and OP13 are operational from version 02.01 on and with the new I/O board (X6 has 13 pins).

OV1 Os (F1408) DA1Value
OV2 Os (F1409) DA2Value

Function:	These variables are used for forcing the value of the electrical signal at the analog outputs of connector X7. This can be done only when assigning a "0" value to these outputs (OP1, OP2). OV1 gives the value of the output through channel 1 (pins 11 and 10 of connector X7). OV2 gives the value of the output through channel 2 (pins 9 and 8 of connector X7).
Valid values:	-10000...10000 Millivolts
Example:	When OP1=0; assign a value of 2000 to OV1 and there will be 2 Volts at pins 11/10 of X7.
Note:	It does not make sense to read these values.

OV5 O (F292) Prog_Out

Function:	The OV5 variable contains the binary data representing the status of the Prog_OUT output of the compact drive. With two operation modes: Read mode: Value of the digital output Prog_OUT. Write mode: Value forced onto this output if OP5 has no function assigned to it (OP5 = 0).
Valid values:	0 / 1
Example:	We read that OV5 = 1 while OP5 = TV100, this means that there is torque. If with OP5 = 0 we write OV5 = 1, we will close the Prog_OUT contact.
Version:	Operational from version 02.03 on.



OV10 O (F1410) DigitalOutputs

Function: The OV10 variable contains a binary coded numeric value which represents the status of the digital outputs present in slot SL1.

- If slot SL1 is occupied by connectors X6 and X7, these outputs correspond to parameters OP10-OP13. When working with the PLC, these outputs represent PLC resources O1-O4.
- If slot SL1 is occupied with any of the I/O cards (16DI-8DO, 8DI-16DO), OV10 refers to PLC resources O1-O16.

When reading: Value of the digital outputs.

When writing: Values forced onto those digital outputs which do not have functions associated by parameters OP10-OP13.

Valid values: 0..65535 ($FFFF)

Default value: 0 (unassigned)

Example: We read that OV10 = 11 whose binary code is 1011. This means that outputs 1, 2 and 4 of connector X6 are active and output 3 is inactive. In other words, that contacts (6,7), (8,9) and (12,13) are closed and contact (10,11) is open.

If we write that same data, we will be forcing the contacts to those positions, as long as OP10-OP13 are not associated.

Version: Operative from version 02.01 on. Renewed in version 04.01

OV11 O (F1413) DigitalOutputsCh2

Function: The OV11 variable contains a binary coded numeric value which represents the status of the digital outputs present in slot SL2.

- At the PLC, the value of OV11 refers to resources O17-O32

When reading: Value of the digital outputs.

When writing: Values forced upon the digital outputs.

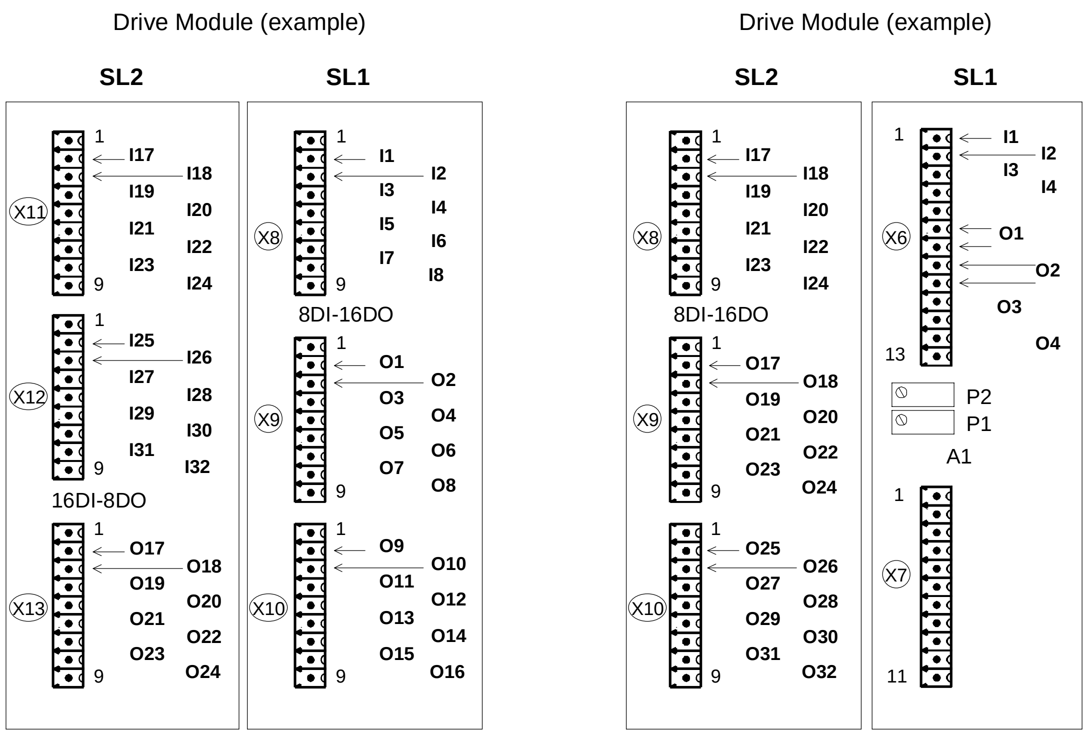
Valid values: 0..65535 ($FFFF)

Default value: 0 (unassigned)

Example: We read that OV11 = 35 whose binary code is 00100011. This means that resources O17, O18 and O22 are active and the rest are inactive.

If we write this same data, we will be forcing the activation or deactivation of those resources.

Version: Operative from version 04.01 on.



14. GROUP FOR THE POSITIONING DRIVE "P"

This group will be operative from software version 04.01 on.

PP1.# O (F1300.#) HomingVelocitySlow

Function:	It is the slow homing speed controlled by the Drive itself. This parameter is required when the homing operation is controlled by the drive: PC148 -S148- DriveControlledHoming active.
Valid values:	motor rpm: 0 .. 214000
Default value:	Motor rpm: 100

PP10 (F1310) ProcessBlockMode

Function:	In MC programs, it defines how the dynamic link is applied between positioning blocks that do not specify the parameter L (LINK).
Valid values:	0, NULL 1, NEXT 2, WAIT_IN_POS 3 , PRESENT
Default value:	0 (NULL, at zero speed)

PP11 (F1311) FeedrateOverrideLimit

Function:	It defines the maximum value the Feedrate override registered in the variable: PV108 -S108- FeedrateOverride.
Valid values:	0 .. 250%
Default value:	250%

PP12 s (F1312) PositioningVelocityDefault

Function:	In MC programs, it defines the positioning feedrate applied to movement blocks that do not specify the parameter V (VELOCITY).
Valid values:	-214 .. 214 km/min
Default value:	10 m/min

PP22 s (F1322) JogVelocity

Function:	It is used as the value assigned to parameter V (VELOCITY) in the program "manual.mc". Feedrate for all JOG movements.
Valid values:	-214 .. 214 km/min
Default value:	5 m/min

PP23 s (F1323) JogIncrementalPosition

Function:	Distance moved (step) in incremental jog with each up flank (leading edge) of the JOG signals. It is used as the value assigned to parameter D (DISTANCE) in the incremental JOG movements programmed in the "manual.mc".
Valid values:	-214 .. 214 m
Default value:	1 mm

PP25 (F1325) InPositionTime

Function:	Parameter related to the positioning blocks with L=WAIT_IN_POS. This link ends the movement at zero speed. It waits for the target position to be reached and for it to remain in that position a time period set by this parameter InPositionTime.
Valid values:	0 .. 65535 ms
Default value:	10 ms

PP41.# O (S41.#) HomingVelocityFast

Function:	It is the fast homing feedrate when controlled by the Drive itself. This parameter is required when the homing operation is controlled by the Drive: PC148 -S148- DriveControlledHoming active.
Valid values:	Motor rpm: 0 .. 214000
Default value:	Motor rpm: 200

PP42.# O (S42.#) HomingAcceleration

Function: It is the acceleration applied when the homing operation is controlled by the Drive itself. This parameter is required when the homing operation is controlled by the Drive itself: PC148 -S148- DriveControlledHoming active.

Valid values: 0 .. 2140000 rd/sec²

Default value: 60 rd/sec²

PP49 Os (S49) PositivePositionLimit
PP50 Os (S50) NegativePositionLimit

Function: They indicate the maximum position (coordinate) that can be reached in the positive and negative direction respectively.
These limits are only considered when all the position data is referred to Machine Reference Zero (home).
In other words, Bit 0 of PV203 -S403- PositionFeedbackStatus is "1".
If variable PV58 -S258 TargetPosition exceeds the position limits, the drive activates bit 13 of DV9 -S12- Class2Diagnostics (Warnings) TargetPositionOutsideTheTravelZone.

Valid values: -214 .. 214 m

Default value: 214 m (-214 m)

PP52 Os (S52) ReferenceDistance1

Function: When working with motor feedback, this parameter indicates the distance between Machine Reference Zero point and home. It is similar to parameter "REFVALUE" (P53) of the axes of the 8050/55 CNC.

Valid values: -214 .. 214 m

Default value: 0 m

PP54 Os (S54) ReferenceDistance2

Function: When working with direct feedback, this parameter indicates the distance between Machine Reference Zero point and home. It is similar to parameter "REFVALUE" (P53) of the axes of the 8050/55 CNC.

Valid values: -214 .. 214 m

Default value: 0 m

PP55 O (S55) PositionPolarityParameters

Function: 16-bit register used to reverse the sign of the different position data. When in position loop, except for the position command, the signs are only changed on the monitored data and not internally. In the case of turning motors we will consider that if the sign of the position command is positive, they will turn clockwise. This parameter cannot be used to solve a positive feedback problem (motor runaway) due to the fact the second feedback is counting in the opposite direction. That problem is solved using parameter PP115 -S115- PositionFeedback2Type.

Bit	Meaning
15 (MSB), 14, 13, 12, 11, 10, 9, 8, 7, 6, 5 (reserved)	
4,	Position limits = 0 active (by default). See PP49 and PP50. = 1 cancels the position limits.
3,	Direct position feedback value = 0 non-inverted = 1 inverted (by default)
2,	Motor position feedback value = 0 non-inverted = 1 inverted (by default)
1,	(reserved)
0, (LSB)	Position commandvalue = 0 non-inverted = 1 inverted (by default)

PP57 O (S57) PositionWindow

Function: It indicates the maximum difference allowed between the real position and the final position PV58 -S258- TargetPosition to consider that the drive is in position. Then, the Drive will activate parameter PV136 -S336- InPosition.
While executing the command.

Valid values: 0 .. 214 m

Default value: 0.1 mm

PP58 Os (S58) Backlash

Function: Leadscrew backlash. It is only useful with motor feedback. It is used for the Position Drive to compensate for that backlash when reversing the movement of the axis, thus making a load movement more similar to the position command. Both the Drive and the CNC offer parameters determining the value of the leadscrew backlash. This value must only be registered at one these units. The other parameter must be set to "0".

Valid values: -3.2 .. 3.2 m (in linear movements), -3.2 .. 3.2° (in rotary over 360°)

Default value: 0

PP76 (S76) PositionDataScalingType

Function: 16-bit register configuring the position measurement scales. All of them must be "0" except bit 6 (1) and bit 7 which determines the activation or cancellation of the module format in the received commands

Bit	Meaning
15 (MSB), 14, 13, 12, 11, 10, 9, 8	(reserved) = 0
7,	Format = 0 Absolute format (by default) = 1 Module format. See PP103 and PP243. Watch for the CNC to define this axis the same way (module or linear format).
6,	= 1 (by default)
5, 4, 3, 2,	(reserved)
1, 0 (LSB)	Scaling method = 00 no scaling = 01 linear scaling (by default) = 10 rotational scaling

manual.mc

```
#INCLUDE "C:\Fagor\MyFiles\MCFiles\fagor.inc"
; Modify the path if necessary

PROGRAM
	PROG_OFFSET = 0				; Eliminate programmable position offset
	WHILE(1)				; Endless loop
		WAIT(!JOG_POS AND !JOG_NEG)	; Wait for Jog+ & Jog- to be zero
		WAIT(JOG_POS OR JOG_NEG)	; Wait for either one to be activated
		IF(JOG_POS AND !JOG_NEG)	; If Jog+ is activated but not Jog-
			IF(K_MAN_SUBMODE)		; If incremental Jog ...
				MOVE D=JOG_INC_POS V=JOG_VEL L=NULL
			ELSE				; If continuous Jog ...
				MOVE P=(LIM_POS-1) V=JOG_VEL
			ENDIF
		ELSEIF(JOG_NEG AND !JOG_POS)		; If Jog- is on but not Jog+
			IF(K_MAN_SUBMODE)		; If incremental Jog ...
				MOVE D=-JOG_INC_POS V=JOG_VEL L=NULL
			ELSE				; If continuous Jog ...
				MOVE P=(LIM_NEG+1) V=JOG_VEL
			ENDIF
		ENDIF
	ENDWHILE
END
```

PP103 Os (S103) ModuloValue

Function: Module value. If bit 7 of PP76 selects the "module format", this parameter defines the position data range it works with. The increment between consecutive position commands cannot be greater than half the value of PP103.

Valid values: 1 .. 214000°

Default value: 360° (since it is usually used in rotary axes)

PP104.# (S104.#) PositionKvGain

Function: It sets the proportional constant value in the position loop "Kv". It is similar to parameter "PROGAIN" (P23) for the 8050/55 CNC axes. It is given in m/min of programmed velocity command per mm of following error.

Valid values: 0..32767 (m/min/mm)

Examples: S104=1 means that the following error for a programmed feedrate of 1000 mm/min (F1000 at the CNC) will be 1 mm.

S104=2 at F1000 the following error will be 0.5 mm.

To obtain a following error of 5 microns at F2000, Kv will be: 2/0.005, that is: S104=400

Default value: 1 (1 mm of following error at a feedrate of F1000)

PP115 O (S115) PositionFeedback2Type

Function: It indicates various aspects of the Direct feedback X3:

Bit	Meaning
15 (MSB), 14, 13, 12, 11, 10, 9, 8	(reserved)
7, 6, 4, 2,	(reserved)
5,	Structure of distance coded feedback = 0 counting positive with positive direction = 1 counting negative with positive direction
3,	Direction polarity = 0 not inverted = 1 inverted
1,	Distance coded feedback = 0 no distance coded reference marks = 1 distance coded reference marks. See NP165, NP166.
0 (LSB)	Feedback type = 0 rotational feedback. See NP117. = 1 lineal. See NP118.

PP147 (S147) HomingParameter

Function: 16-bit register to determine the mechanical and electrical relationship between the homing process and the installation of the machine, the CNC or the Drive. When homing is controlled by the Drive, only bits 0, 1, 2, 3, 5, 6 and 7 are applicable. When homing is controlled by the CNC, only bits 1, 2, 3 and 4 are applicable

Bit	Meaning
15 (MSB), 14, 13, 12, 11, 10, 9, 8	(reserved)
7,	Position after the procedure controlled by the Drive (reserved)
6,	The reference mark I0 is ignored or not (reserved)
5,	The home-switch is ignored or not = 0 the home-switch is not ignored (by default) = 1 the home-switch is ignored
4,	To be interpreted at the drive (reserved)
3,	Feedback being used = 0 motor feedback (by default) = 1 direct feedback
2,	Home-switch connection (reserved)
1,	Reference Mark position referred to that of the home-switch = 0 first I0 after the up-flank of the home-switch (by default) = 1 First I0 after the down-flank of the home-switch
0 (LSB)	Movement direction = 0 positive: the motor shaft turns clockwise (by default) = 1 negative: the motor shaft turns counterclockwise

PP150 Os (S150) ReferenceOffset1

Function: Parameter setting the position of the reference mark with respect machine reference point (home) according to the motor feedback. It is similar to parameter "REFSHIFT" (P47) for the 8050/55 CNC axes, except that it does not move to return to the position of PP52 -S52- ReferenceDistance1, "REFVALUE" (P53) at the CNC.
Valid values: -214 .. 214 m
Default value: 0 m

PP151 Os (S151) ReferenceOffset2

Function: Parameter setting the position of the reference mark with respect machine reference point (home) according to the direct feedback. It is similar to parameter "REFSHIFT" (P47) for the 8050/55 CNC axes, except that it does not move to return to the position of PP52 -S52- ReferenceDistance1, "REFVALUE" (P53) at the CNC.
Valid values: -214 .. 214 m
Default value: 0 m

PP159 O (S177) MonitoringWindow

Function: It sets the maximum range for the following error. When the following error exceeds the value given by PP159, the drive issues error 205 ExcessivePositionDeviation (DV1 -S11-, Bit 11). If this parameter is set to "0", the following error is not monitored. It is very important to give it a value other than "0" to prevent the axes from running away out of control. At the CNC, this maximum following error range is monitored by setting its relevant parameters for each axis.
Valid values: 0 .. 214 m (0 = the following error is not monitored)
Default value: 30 mm

PP177 O (S177) AbsoluteDistance1

Function: For motors with absolute encoder. It indicates the distance between the zero position for the drive and the theoretical zero according to the absolute feedback of the encoder.
Valid values: 214 .. 214 m
Default value: 0 m

PP178 O (S178) AbsoluteDistance2

Function: For absolute direct feedback. It indicates the distance between the zero position for the drive and the theoretical zero according to the absolute feedback of the encoder.
Valid values: 214 .. 214 m
Default value: 0 m

PP216.# (S296.#) VelocityFeedForwardPercentage

Function: It sets the percentage of velocity Feedforward to be applied. It is similar to "FFGAIN" (P25) for the axes of the 8050/55 CNC. It indicates the % of velocity command anticipated to the movement independent from the following error (open loop).
Valid values: 0 .. 120%
Default value: 0% (Feedforward is not applied)

PP217.# (S348.#) AccelerationFeedForwardPercentage

Function: (Not available yet)
It sets the percentage of acceleration Feedforward to be applied.
Valid values: 0 .. 120%
Default value: 0% (Feedforward is not applied)

PP243.# O (S393.#) ModuloComandMode

Function: When the Modulo function is active, the interpretation of position commands is dependent upon the Modulo command mode setting.

Bit	Meaning	
15 (MSB) - 2	(reserved)	
1, 0 (LSB)	= 00	clockwise
	= 01	Counterclockwise
	= 10	shortest path (by default)
	= 11	reserved

Valid values: 0 .. 2
Default value: 2

PV13 W (F1313) KernelOperationMode

Function: It indicates which is the main operation mode.
Valid values: 0, Automatic mode (by default after drive power-up)
1, Manual mode

PV14 W (F1314) KernelAutoMode

Function: It indicates which is the operation submode within the automatic mode (PV13 = 0).
Valid values: 0, Continuous submode
1, Single Block submode
2, Single instruction submode

PV15 W (F1315) KernelStartSignal

Function: Digital signal which sets (with its up flank 0-to-1 transition), the start of the MC program execution in automatic or manual mode. After powering the system up, the execution must ALWAYS be started through this "Start" signal as well as after any of the Stop, Reset and Abort signals has been activated. An up flank of this signal must also be generated to resume execution while in "Single Block" or "Single instruction" mode.

PV16 W (F1316) KernelStopSignal

Function: Digital signal which sets, (with its up flank 0-to-1 transition) the momentary interruption of the movement block and stops the motor. This signal does not finish the block, it only interrupts it so when the "Start" signal PV15 -F1315- KernelStartSignal is activated, it goes on to execute the remaining portion of the block.

PV17 W (F1317) KernelResetSignal

Function: Digital signal which resets (with its up flank 0-to-1 transition) the execution of the MC program. This signal interrupts the execution, restores the initial values and the drive remains waiting for a new "Start" signal PV15 -F1315- KernelStartSignal.

PV18 W (F1318) KernelAbortSignal

Function: Digital signal which sets (with its up flank 0-to-1 transition) the final interruption of the movement block and stops the motor. This signal ends the block and the drive remains waiting for a new "Start" signal PV15 -F1315- KernelStartSignal.

PV19 W (F1319) KernelManMode

Function: It indicates which is the operation submode within the manual mode (PV13 = 1).
Valid values: 0, Continuous submode (by default)
1, Incremental submode

PV20 W (F1320) JogPositiveSignal

Function: Digital signal used in the "manual.mc" program to activate the JOG movement in the positive direction.

PV21 W (F1321) JogNegativeSignal

Function: Digital signal used in the "manual.mc" program to activate the JOG movement in the negative direction.

PV24 (F1324) FeedrateOverrideEqualCero

Function: Digital signal which indicates that the value of the FeedrateOverride at the machine is zero and, therefore, the motor cannot be moved in any way.

PV26 Ws (F1326) ProgramPositionOffset

Function: With this variable it is possible to set an offset with respect to the machine reference point (home) and it may be applied to the absolute positioning blocks in the MC program. The ZERO statement updates this variable.

Valid values: -214 .. 214 m (0 m by default)

PV27 (F1327) KernelInitError

Function: Index indicating the exact meaning of error 900.
Error 900 comes up on the Drive's status display when initializing the MC program. It cancels the system initialization process and prevents the MC software from running.

Valid values:

0 If no error comes up when initializing.
1 AUTOMATIC application not loaded into memory
2 MANUAL application not loaded into memory
3 Wrong AUTOMATIC application file
4 Wrong MANUAL application file
5 AUTOMATIC application file too large (8Kbytes max.)
6 MANUAL application file too large (512 bytes máx.)
7 Wrong drive variable in AUTOMATIC application
8 Wrong drive variable in MANUAL application
9 Too many drive variables in AUTOMATIC application
10 Too many drive variables in MANUAL application
11 Code checksum error
12 Internal error when initializing the drive table
13 Internal error when initializing variable indexes
14 Error when initializing the application
15 PLC resources not accessible in AUTOMATIC application
16 PLC resources not accessible in MANUAL application
17 Too many PLC MARKS in AUTOMATIC application
18 Too many PLC MARKS in MANUAL application
19 Too many PLC REGISTERS in AUTOMATIC application
20 Too many PLC REGISTERS in MANUAL application
21 Too many PLC COUNTERS in AUTOMATIC application
22 Too many PLC COUNTERS in MANUAL application

PV28 (F1328) KernelExecError

Function: Variable that groups the execution errors of the MC program (901-915)
This errors are communicated via the Drive Status Display. They interrupt the execution of the program and prevent the MC software from running making it possible to consult the values of the variables and parameters.

Valid values:

0 If no error has come up.
1 Division by zero (error 901 at the Status display)
2 Array size exceeded (error 902, etc.)
3 Call nesting limit exceeded
4 Error when writing a variable
5 Internal error when reading a variable
6 Internal error when writing a variable
7 Overflow when evaluating a statement
8 Stack overflow
9 Stack Underflow
10 Overflow when calculating position
11 Absolute positioning without homing
12 Attempt of writing a PLC counter
13 Unknown Pcode
14 TargetPosition exceeds ModuloValue
15 The position increment is greater than half the ModuloValue

PV47 Ws (S47) PositionCommand
PV51 s (S51) PositionFeedback1
PV53 s (S53) PositionFeedback2

Function: Position command value. Position command value through motor feedback. Position command value through direct feedback. They are transferred from the drive to the control unit.
Valid values: -214 .. 214 m

PV58 Ws (S258) TargetPosition

Function: Target position for the current positioning block. The system attends to the target position indicated in the MC instruction and not to the one indicated in this parameter
Valid values: -214 .. 214 m

PV59 Ws (S259) PositioningVelocity

Function: Positioning velocity for the current positioning block (in module). The system attends to the positioning velocity indicated in the MC instruction and not to the one indicated in this parameter.
Valid values: 0 .. 214 m/min

PV60 Ws (S260) PositioningAcceleration

Function: Acceleration applied to all the positioning blocks.
Valid values: 0 .. 200 m/s^2

PV108 W (S108) FeedrateOverride

Function: Override applied to the positioning feedrate in all the programmed movements. The value that this variable can take is limited by parameter PP11 -F1311- FeedrateOverrideLimit.
Valid values: It would vary between 0% and the value indicated by PP11 -F1311- FeedrateOverrideLimit.

PV115 (S315) PositioningVelocityGreaterLimit

Function: It is a mark that is activated when the positioning feedrate exceeds the limit set by SP10 -S91- VelocityLimit.
Valid values: 0, 1 (0 by default)

PV123 (S323) TargetPositionOutsideOfTravelRange

Function: It is a mark that is activated wen the target position programmed for the current positioning block is out of the position limits set by parameters PP49 -S49- PositivePositionLimit, or PP50 -S50- NegativePositionLimit.
Valid values: 0, 1 (0 by default)

PV136 (S336) InPosition

Function: It is a mark that is activated when the target position has been reached PV58 -S258- TargetPosition. In this positioning, there is a tolerance margin (dead band) set by parameter PP57 -S57- PositionWindow
Valid values: 0, 1 (0 by default)

PV142 (S342) TargetPositionAttained

Function: It is a mark that indicates that the interpolator has reached the target position. It is activated when the position command PV47 -S47- PositionCommand is equal to PV58 -S258- TargetPosition
Valid values: 0, 1 (0 by default)

PV143 (S343) InterpolatorHalted

Function: It is a mark that indicates that the interpolation has been interrupted (the position command does not change) but the current positioning block is not completed.
Valid values: 0, 1 (0 by default)

PV173 s (S173) MarkerPositionA

Function: In the homing process, when the drive detects the reference mark (I0), it stores the instantaneous value of the position feedback (PositionFeedback not yet homed) in this variable MarkerPositionA.
Valid values: -214 .. 214 m (0 by default)

PV175 O (S175) DisplacementParameter1

Function: It indicates the shift in the coordinate system after the drive has homed the axes (when working with motor feedback).
Valid values: -214 .. 214 m (0 by default)

PV176 O (S176) DisplacementParameter2

Function: It indicates the shift in the coordinate system after the drive has homed the axes (when working with direct feedback).
Valid values: -214 .. 214 m (0 by default)

PV189 s (S189) FollowingError

Function: It registers the difference between the position command and the position feedback.
PV189 = PV47 - PV51/53
FollowingError = PositionCommand – PositionFeedback1/2
Units: tenths of a micron in linear movements and ten-thousandths of a degree in rotary movements.

PV193 Os (S193) PositioningJerk

Function: Jerk limit for the current positioning block (in module).
Valid values: 0 .. 1000 m/s^3

PV200 O (S400) HomeSwitch

Function: This binary parameter represents the logic state of the Home-switch. To do this, this variable must be associated with one of the digital inputs of the drive connected to the switch.
Example: If no PLC is used, assign the PV200 variable to parameter IP10 (pins 1 and 5 of X6).
If a PLC is used, the instruction may be: I1 = B0S400.
Valid values: 0, switch off
1, switch on (the axis is positioned on the switch)

PV203 (S403) PositionFeedbackStatus

Function: The drive activates this binary parameter to inform that the feedback position is to be considered as referred to Machine Reference Zero.
The parameter is deactivated when the following command is executed:
PC148 -S148- DriveControlledHoming
and it is reactivated when it is carried out successfully.
or when the drive loses its reference to Machine Reference Zero.

Valid values: 0, position data referred to Machine Reference Zero.
1, position data referred to any point.

PV204 W (S404) PositionCommandStatus

Function: Parameter for internal system use. It indicates whether the position command is referred to machine reference zero or not.

PV207 (S407) HomingEnable

Function: Homing enable
The drive takes this function into account only if the homing process is controlled by the CNC. In other words, through the command: PC146 -S146- NCControledHoming.
Valid values: 0, homing disabled
1, homing enabled

PV208 (S408) ReferenceMarkerPulseRegistered

Function: This binary parameter is activated when the drive detects the reference mark when homing. At that instant, the drive stores the PositionFeedback in the MarkerPositionA

Valid values: 0, 1

PC146 (S146) NCControlledHoming

Function: Command to activate the homing process controlled by the CNC. When the reference mark is detected in the homing process, the drive stores the PositionFeedback in the MarkerPositionA. Later on, the drive activates the ReferenceMarkerPulseRegistered mark.

Valid values: 0, 3

PC148 (S148) DriveControlledHoming

Function: Command to activate the homing process controlled by the drive. The PV203 -S403- PositionFeedbackStatus is deactivated.
This process is configured with the following parameters:
- PP147 -S147- HomingParameter
- PP41 -S41- HomingVelocityFast
- PP42 -S42- HomingAcceleration
- PP1 -F1300- HomingVelocitySlow

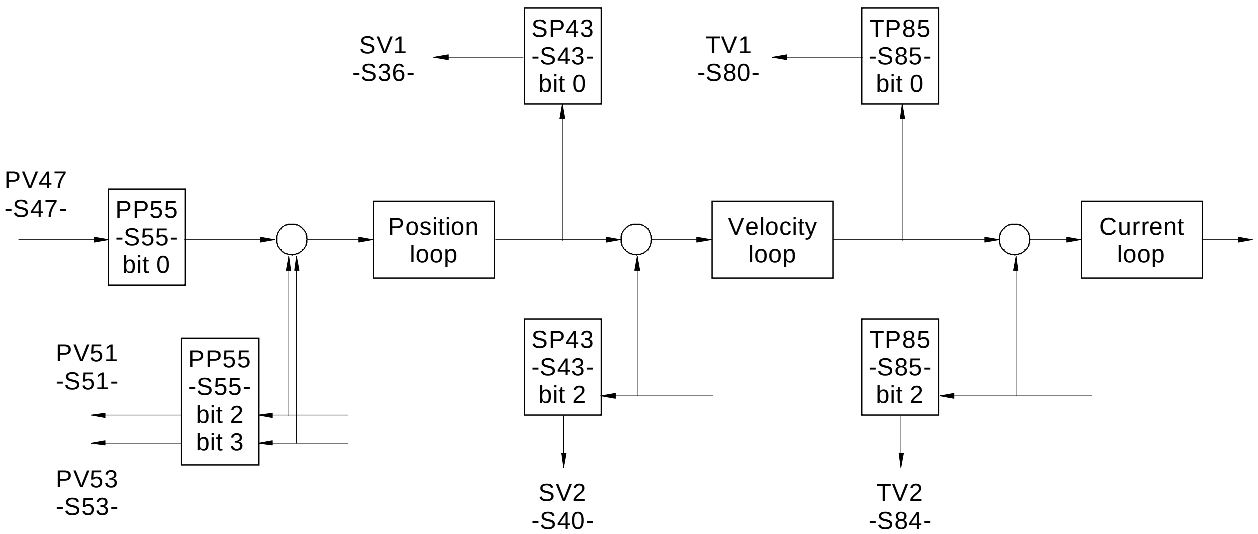
And the variables involved in its execution are:
- PV200 -S400- HomeSwitch
- PV173 -S173- MarkerPositionA
- PV208 -S408- ReferenceMarkerPulseRegistered

The process ends when the motor stops and the position feedback value is referred to machine reference zero. The drive adjusts the position command so it matches the new feedback position. Then, the drive activates parameter PV203 -S403- PositionFeedbackStatus.

Valid values: 0, 3

PC171 (S171) CalculateDisplacement_C
PC172 (S172) DisplacementToTheReferenceSystem

Function: Commands for internal system use.



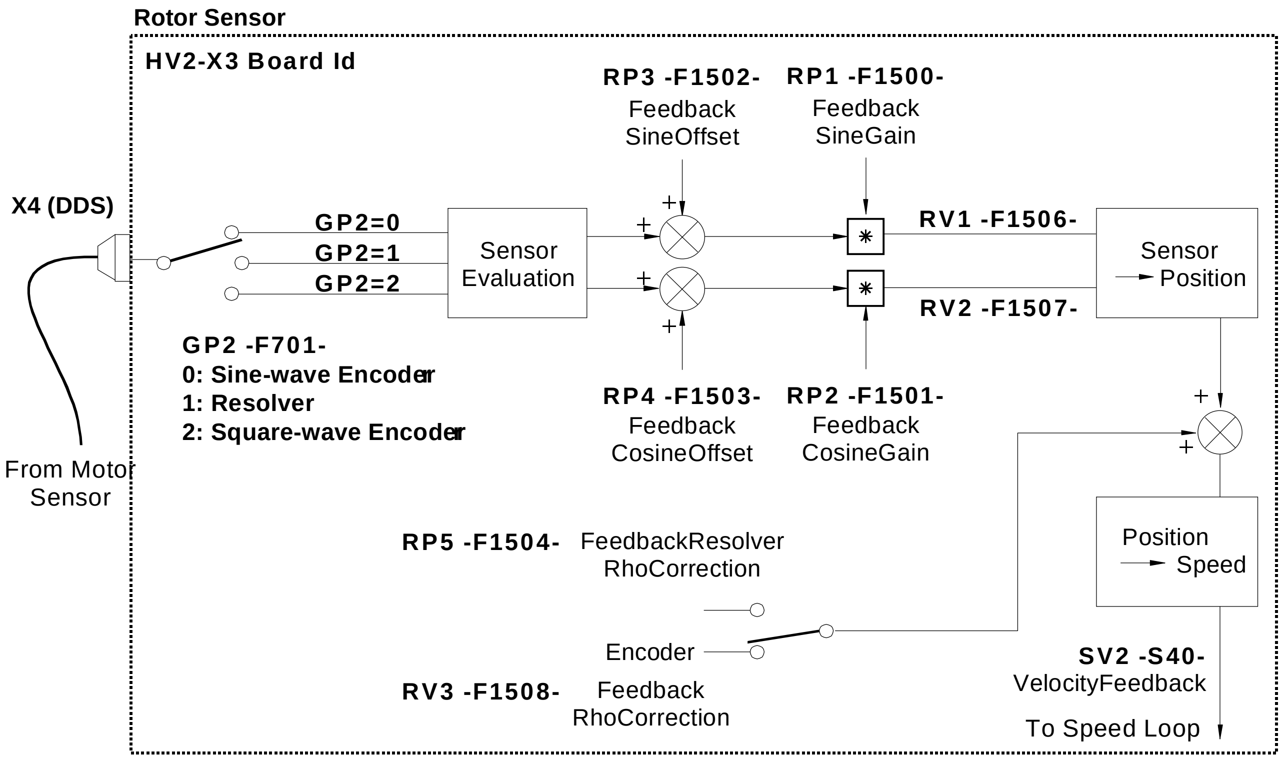
15. SERCOS COMMUNICATION GROUP "Q"

QP1 (S1) ControlUnitCycleTime

Function: Read-only parameter that indicates the loop closing period at the drive.
Valid values: 32 .. 1 ms (every 4 ms by default)

QP11 (F2000) SercosMbaud

Function: It sets the data transmission speed (baudrate) through the Sercos ring. The CNC has a similar parameter. In order to be able to establish communication, they both have to be set to the same baudrate.
Valid values: 1, 2 Megabaud (by default)
0, 4 Megabaud



16. ROTOR SENSOR GROUP "R"

RP1 O (F1500) FeedbackSineGain
RP2 O (F1501) FeedbackCosineGain

Function: Compensation (proportional gain mode) of the sine/cosine signal that reaches the drive from the motor feedback.
Valid values: 1500..3070 (2032 by default)

RP3 Os (F1502) FeedbackSineOffset
RP4 Os (F1503) FeedbackCosineOffset

Function: Compensation (offset mode) of the sine/cosine signal that reaches the drive from the motor feedback.
Valid values: -1000..1000 (0 by default)

RP5 O (F1504) FeedbackResolverRhoCorrection

Function: Corrects the phase shift between the magnetic shaft of the resolver and the rotor of the motor. The motors are factory set and, normally, it should not be necessary to touch RP5 .
Valid values: 0..65535 (0 by default)

RP6.# O (F1505.#) FeedbackErrorDisable

Function: It allows inhibiting the communication of possible feedback errors (5xx group).
Valid values: 0, Normal operation. If there is a malfunction, an error message is issued (by default).
1, Feedback errors are ignored.

RP10 O (F1514) Feedback2Interface
Function: Type of electrical signal provided by the direct feedback.
Valid values: 0, no feedback
1, squarewave (by default)
2, Sinewave 1 Vpp

RP51 O (F1550) Feedback2SineGain
RP52 O (F1551) Feedback2CosineGain

Function: Compensation (proportional gain mode) of the sine/cosine signal that reaches the drive from the direct feedback.
Valid values: 1500..2032 (2032 by default)

RP53 Os (F1552) Feedback2SineOffset
RP54 Os (F1553) Feedback2CosineOffset

Function: Compensation (offset mode) of the sine/cosine signal that reaches the drive from the direct feedback.
Valid values: -1000..1000 (0 by default)

RV1 s (F1506) FeedbackSine
RV2 s (F1507) FeedbackCosine

Function: Sine and Cosine of the feedback reaching the drive from the motor as internal system variables.
Valid values: -32768..32767

RV3 F (F1508) FeedbackRhoCorrection

Function: Corrects the phase shift between the shaft of the encoder and that of the rotor of the motor. The motors are factory set and the value of this variable is stored in the encoder memory. Executing the EC1 command acts upon this value stored in the encoder.
Valid values: 0..65535

RV4 **(F1509)** **FeedbackRadius**

Valid values: 0 .. 32767
Version: Available from version 02.01 on.

RV5 **(F1515)** **EncoderType**

Function: The RV5 variable contains a 16-bit numeric value. The least significant bits indicate the type of Encoder installed on the motor according to the following table:

Bits	Values	Meaning
7-0	02h	Sincos Encoder
	12h	SincoderEncoder
15-8		Reserved

RV6 **(F1510)** **EncoderError**

Function: The RV6 variable contains a list of feedback errors for the exclusive use of Fagor technicians.

RV7 **(F1511)** **StegmannMotorType**

Function: The motor encoder stores in its memory the motor id reference. This variable RV7 reflects in the drive memory the reference stored in the encoder. See sales references in appendix "C".
RV7 will keep this value as long as the motor is not changed.
Valid values: The sales references of the motors listed in appendix "C".
Version: Operative from version 03.03 on.

RV8 **F** **(F1512)** **CircleAdjust**

Function: Variable for activating the "Circle Adjustment". This adjustment consists in setting parameters RP1, RP2, RP3 and RP4 to the right values to make the motor run more quietly. It is called "Circle adjustment" because it refers to the Sine and Cosine signals handled by software (RV1, RV2) so they are mathematically correct. In other words, they represent a perfect circle.
This process is only applicable to an Encoder, not a Resolver. See chapter SU.
Valid values: 1 Adjustment in progress.
0 Adjustment completed.
Version: Operative from version 03.03 on.

RV51 **s** **(F1556)** **Feedback2Sine**
RV52 **s** **(F1557)** **Feedback2Cosine**

Function: Sine and Cosine of the feedback signal reaching the drive from the direct feedback as internal system variables.
Valid values: -32768..32767
Version: Operative from version 04.01 on

RV54 **(F1559)** **Feedback2Radius**

Valid values: 0..32767
Version: Operative from version 04.01 on.

RC1 O (F1509) EncoderParameterStoreCommand

Function: It has several functions:
- For Sincos, it formats the encoder memory like the Sincoder. In the latter, the formatting is fixed.
- It records the offset of the encoder.
- It records the registration number of the motor.
- It records the registration version (this is for internal use only).

Uses: - Software upgrades.
When programming a 3.1 version onto a 2.X version. Use this command to record the registration number on the encoder.
- Recording the encoder offset.
Be it a brand new encoder or a used one, this command is good for either one. Be sure that MP1 has the right registration number when executing this command.
It works all the same with Sincos as with Sincoder.

Version: Available from version 03.01 on.

17. SPEED GROUP "S".

SP1.# * (S100.#) VelocityProportionalGain
SP2.# * (S101.#) VelocityIntegralTime

Function : Value of the proportional/integral action of the speed PI.
Valid values: SP1: 0..16384 RMS milliAmperes / rpm.
SP2: millisecond

SP4.# * (S211.#) VelocityAdaptationProportionalGain
SP5.# * (S212.#) VelocityAdaptationIntegralTime

Function: Adapting the proportional / integral of the PI at low speeds.
SP4 is the multiplying factor applied to SP1 when the motor moves at low speed. SP5 is the multiplying factor applied to SP2 at low speeds.
Units: Deci% (thousandths)
Valid values: 25 .. 400% In other words, the PI action at low speeds can go from 25% to 400% of that at high speeds.
SP4*SP1 / 1000 must be smaller than the maximum value of SP1.
SP5*SP2 / 1000 must be smaller than the maximum value of SP2.
Default value: 100% (constant proportional / integral action at any speed)

SP6.# O (S209.#) VelocityAdaptationLowerLimit

Function: Is the upper limit of the speeds considered "low".
Valid values: Must be smaller than: SP7 (VelocityLoopUpperAdaptationLimit) rpm.
Default value: 10% of SP10 (VelocityLimit) rpm.

SP7.# O (S210.#) VelocityAdaptationUpperLimit

Function: Is the lower limit of the speeds considered "high".
Valid values: Must be: smaller than SP10 (VelocityLimit) rpm.
greater than SP6 (VelocityLoopLowerAdaptationLimit)rpm.
Default value: 80% of SP10 (VelocityLimit) rpm.

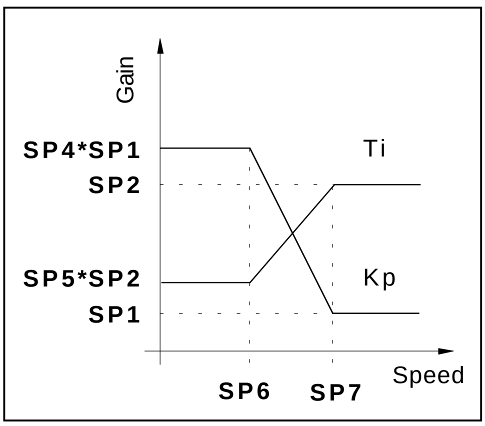
SP10.# O (S91.#) VelocityLimit

Function: Maximum value to be assumed by SV7 (VelocityLoopUpperAdaptationLimit).
If SV2 (VelocityFeedback) is 12% greater than this parameter, error 200 is generated "overspeed"
Valid values : 0..10000 (depends on the motor connected) rpm.
Default value: 110% of SP12 (NominalMotorSpeed); SP11 (MaximumMotorSpeed) rpm.

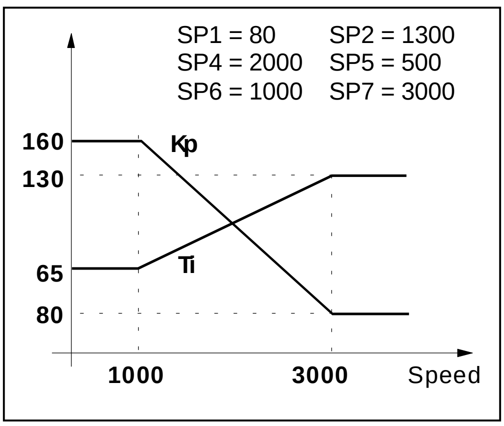
SP11 FMA (S113) MotorMaximumSpeed

Function: Maximum speed attainable by an asynchronous motor
Valid values: Smaller than SP10 (otherwise, it issues 500-3-)

Adapter-Speed-PI:



Example:



SP12 FM (F1600) MotorRatedSpeed

Function:	Synchronous: Rated Speed
	Asynchronous: Base Speed. The constant power area is beyond this base speed
Valid values:	Synchronous: Must be greater than SP10. otherwise, it issues 500 DV15=3
	Asynchronous: Must be smaller than SP11.

SP20.# (F31.#) VoltageRpmVolt

Function:	Parameters Voltage_rpm/Volt (SP20) and rpm_rpm/Volt (SP21), define the ratio between the analog voltage and the motor speed. Corresponds to the CNC feedrate concept of G00 Feed.
Valid values:	1000..10000 Millivolts
Default value:	9500 Millivolts

SP21.# (F81.#) RpmRpmVolt

Function:	See SP20.
Valid values:	10..10000 (depends on the motor connected) rpm.
Default value:	SP11 (MaximumMotorSpeed) rpm.
	SP12 (RatedMotorSpeed) rpm.

SP30 *s (F1603) AnalogInputOffset1
SP31 *s (F1604) AnalogInputOffset2

Function:	Compensation of the offset of analog inputs 1 and 2 respectively.
Valid values:	-10000..10000 mV
Default value:	0 mV

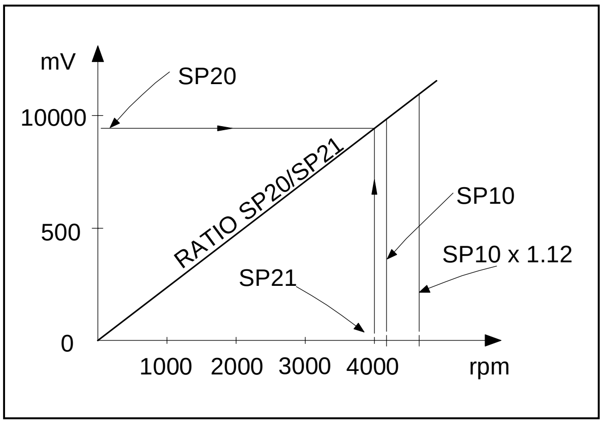
SP40.# O (S125.#) VelocityThresholdNx

Function:	Speed value below which logic mark "$n_{feedback} < n_x$" is activated. The logic mark is the SV3 variable. It can be used to know when the speed exceeds a particular value. This nomenclature n_x corresponds to the one defined by Sercos. In the machine-tool industry it is referred to as n_{min}. Example of how to use it: If in a particular application, we would like to know when the motor exceeds 400 rpm. We will set this parameter, SP40, with a value of 400. When the motor exceeds this speed, its associated mark SV3 will be activated.
Valid values:	0..SP12 (depends on the motor connected) rpm.
Default value:	20 rpm.

SP41.# O (S157.#) VelocityWindow

Function:	Speed window assigned to logic mark "$n_{feedback} = n_{command}$". The logic mark is variable SV4. This mark is used to find out when the actual motor speed ($n_{feedback}$) has reached the command value ($n_{command}$) within the boundaries of this window SP41
Valid values:	0..12% of parameter SP10 (VelocityLimit)
Default value:	20 rpm.

SP10, SP20, SP21:



SP42 O (S124) StandStillWindow

Function: Margin of low speeds that will activate logic mark “$n_{feedbackl} < n_{min}$”.
The logic mark is variable SV5.
This nomenclature, n_{min}, corresponds to the one defined by SERCOS. In the machine-tool world, it is called n=0.
Example:
If in a particular application, we would like to know when the motor is stopped within a 10 rpm margin, we would set this parameter SP42 with a value of 10 and when the motor stops, its associated mark SV5 will be activated.
Valid values: 0..SP12 (NominalMotorSpeed) rpm.
Default value: 20 rpm.

SP43 O (S43) VelocityPolarityParameter

Función: This parameter is used to switch polarities of velocity data for specific applications. When in velocity loop, except for the velocity command, the sign is changed only on the monitored data, but not internally. The motor shaft turns clockwise when there is a positive velocity command difference and no inversion is programmed. This parameter cannot be used to solve the positive feedback problem originated because the 2nd feedback counts in the opposite direction (motor run away). This case is only solved using parameter PP115 -S115- PositionFeedback2Type.
Version: Operative from version 04.01 on.

Bit	Meaning
15 (MSB) - 3	(reserved)
2,	Velocity feedback value = 0 non-inverted = 1 inverted
1,	(reserved)
0 (LSB)	Velocity command value = 0 non-inverted = 1 inverted

SP60.# O (S138.#) AccelerationLimit
SP62.# O (F1606.#) AccelerationLimit2
SP64.# O (F1608.#) AccelerationLimit3

Function: Acceleration limit 1, 2, 3. They define, together with SP61 and SP63, the ramps for filtering the velocity command SV8.
In order for them to be effective, SP80 must be "0".
SP60 is also useful in the Jerk limitation mode.
Units: rad/s^2. The conversion is 1 rad/sec^2 = 9.5492 rpm/s = 0.009549 rpm/ms
Valid values: $0..2^{16}$ (by default, 1000)

SP61.# O (F1605.#) AccelerationLimitVelocity2
SP63.# O (F1607.#) AccelerationLimitVelocity3

Function: Velocity limit up to which acceleration 1, 2 is applied. They define, together with SP60, SP61 and SP62, the ramps for filtering the velocity command SV8.
In order for them to be effective, SP80 must be "0".
Valid values: 0..10000 rpm.
Default value: 1000 rpm.

SP65.# O (F1609.#) EmergencyAcceleration

Function: In an emergency stop, it limits the velocity command acceleration to stop the motor. When set to "0", its limiting effect is canceled. SP70 must be set to "1" in order for the SP65 limitation to be applied during an emergency stop.
Units: rad/s^2. The conversion is 1 rad/sec^2 = 9.5492 rpm/s = 0.009549 rpm/ms
Valid values: $0..2^{16}$ (by default, 1000)

SP70 O (F1610) AccelerationOnEmergency

Function: Determines whether or not in an emergency stop caused by Speed_Enable, Halt function, or Stop due to Error, the acceleration limit set by SP65 is applied or not.
Valid values: 0,1 (No ramps applied / Yes)
Default values: 0 (No ramps applied)

SP80.# O (S349.#) JerkLimit

Function: Limits the "jerk" of the velocity command. In other words, how fast the acceleration varies. It acts together with the acceleration limit SP60.
To cancel the effect of this limitation, parameter SP80 must be set to "0".
Units: rad/s^3. The conversion is 1 rad/sec^3 = 9.5492 rpm/s^2
Valid values: 0..2^{16} (by default, 1000)

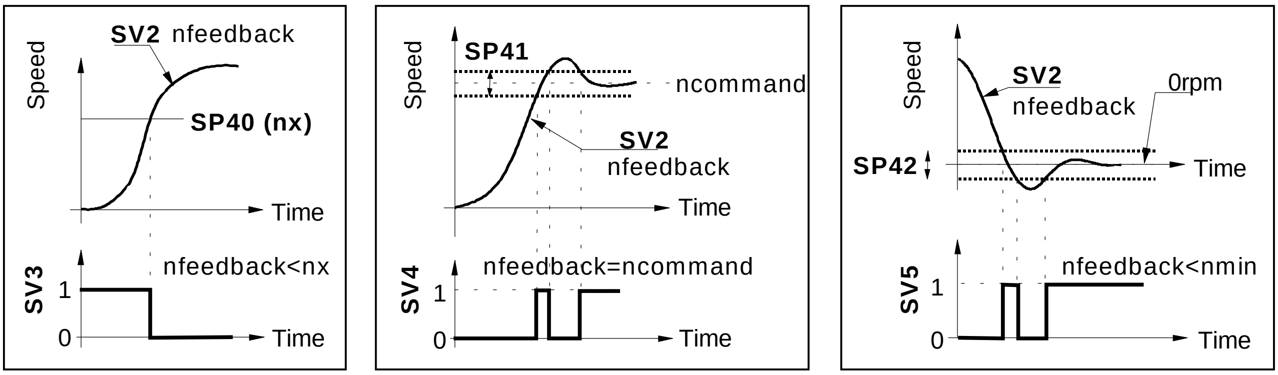
SP100.# O (F1611.#) AccelerationLimitOn

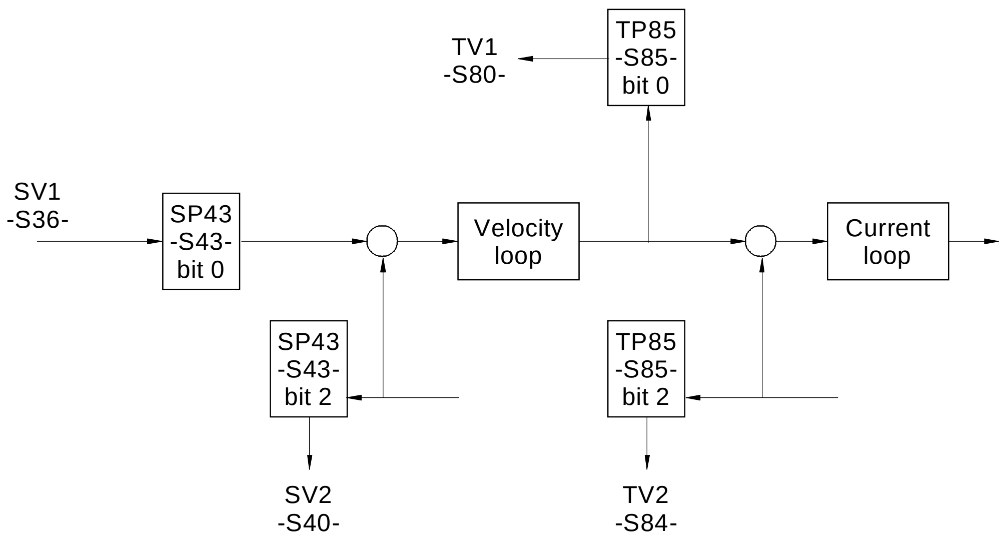
Function: Activates or deactivates the set of command limits and filters (ramps, Jerk). It does not affect the acceleration limitation in an Emergency.
Valid values: 0 / 1 (Off / On)
Default value: 0 (limits off)

SV1 Ws (S36) VelocityCommand
SV2 s (S40) VelocityFeedback

Function: Display of velocity command /feedback values. They are transferred from the drive to the control unit.
Units: rpm.

SP40, SV3: **SP41, SV4:** **SP42, SV5:**





SV3 (S332) nFeedbackMinorNx

Function: Logic mark associated to: $n_{feedback} < n_x$ See parameter SP40.
Valid values: 0 / 1, no / yes

SV4 (S330) nFeedbackEqualNCommand

Function: Logic mark associated to: $n_{feedback} = n_{command}$ See SP41.
Valid values: 0 / 1, no / yes

SV5 (S331) nFeedbackEqual0

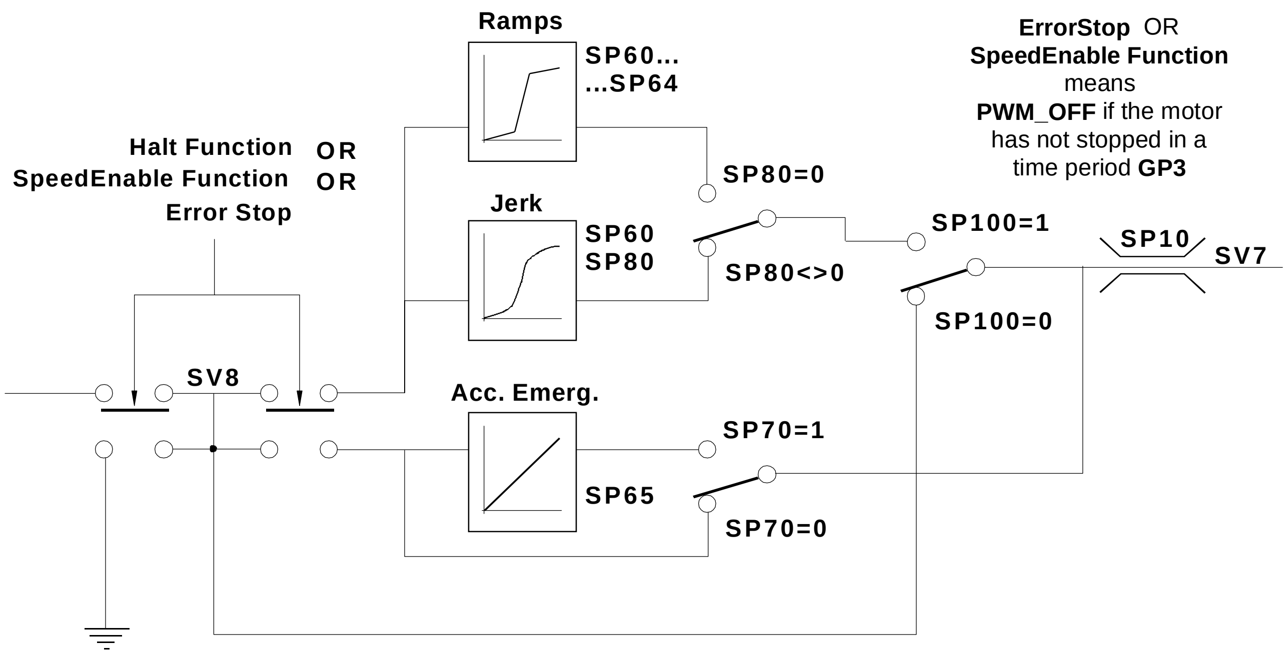
Function: Logic mark associated to: $n_{feedback} < n_{min}$ See parameter SP42.
Valid values: 0 / 1, no / yes

SV7 s (F1612) VelocityCommandFinal

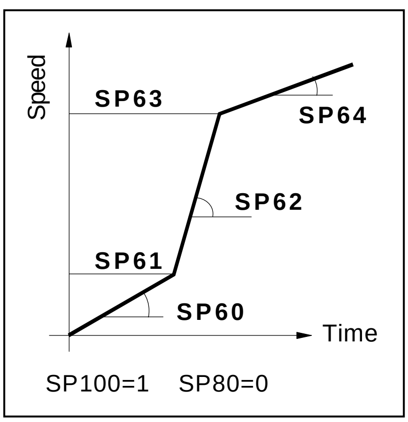
Function: It returns the velocity command value before limitations, ramps, etc.
Units: rpm.

SV8 s (F1613) VelocityCommandBeforeFilters

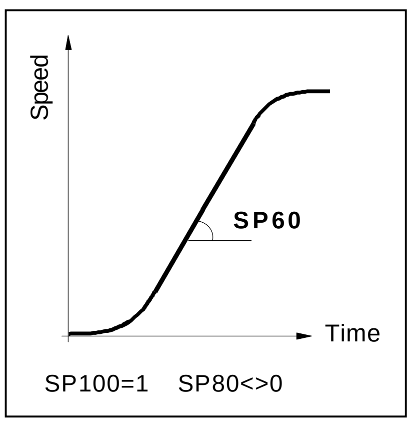
Function: It gives the value of the velocity command before the limitations, ramps, etc.
Units: rpm.



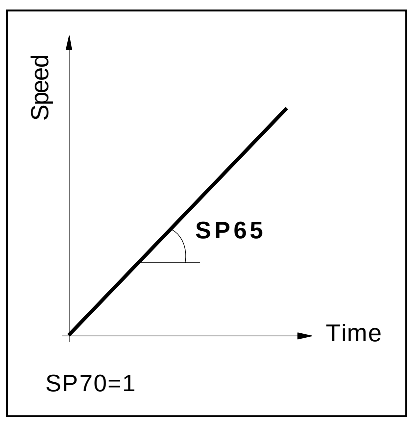
Ramps:



Jerk:



Emergency:



18. TORQUE AND POWER GROUP "T".

TP1 Os (S126) TorqueThresholdTx

Function: Torque threshold set by the used to activate logic mark TV10.
Units: Fraction of the rated motor torque.
Valid values: 0..100% (it depends on the Driver connected)
Default value: 5%

TP2 Os (S158) PowerThresholdPx

Function: Power threshold set by the user to activate logic mark TV60.
This value is given as a fraction of the motor power.
The power of the motor is:
On a synchronous FXM motor = the product of three elements:
MP2 -F1200- MotorTorqueConstant
MP3 -S111- MotorContinuousStallCurrent
SP12 -F1600- MotorRatedSpeed
On an asynchronous SPM motor =
MP12 -F1208- MotorNominalPower
Units: Fraction of the rated (nominal) motor power.
Valid values: 1..100%
Default value: 5%

TP85 O (S85) TorquePolarityParameter

Función: This parameter is used to switch polarities of reported torque data for specific applications. Polarities are not switched internally but externally (on the input and output) of a closed loop system. The motor shaft turns clockwise when there is a positive torque command difference and no inversion is programmed. This parameter cannot be used to solve the positive feedback problem originated because the 2nd feedback counts in the opposite direction (motor run away). This case is only solved using parameter PP115 -S115- PositionFeedback2Type.
Version: Operative from version 04.01 on.

Bit	Meaning
15 (MSB) - 3	(reserved)
2,	Torque feedback value = 0 non-inverted = 1 inverted
1,	(reserved)
0 (LSB)	Torque command value = 0 non-inverted = 1 inverted

TV1 s (S80) TorqueCommand
TV2 s (S84) TorqueFeedback

Function: Display of the torque command/feedback value. They are transferred from the drive to the control unit.
Valid values: -1000..1000 Nm.

TV3 s (F1701) TorqueFeedbackPercentage

Function: Instantaneous display of the percentage of power used with respect to the maximum available at that velocity and servo drive system (Motor, Drive, current limit)
Valid values: 0..1000 º/oo
Version: Operational from version 02.03 on

TV10 (S333) TGreaterTx

Function: Logic mark to indicate that the Torque (TV2) is greater than the TorqueThresholdTx (TP1). See TP1.
Valid values: 0, TV2 < TP1
1, TV2 > TP1

TV50 s (F1700) PowerFeedback

Function: Display of the power feedback value.
Valid values: -100..100 KiloWatts.

TV60 (S337) PGreaterPx

Function: Logic mark to indicate that the Power (TV50) is greater than the PowerThresholdPx (TP2). See TP2.
Valid values: 0, TV50 < TP2
1, TV50 > TP2

TV100 (F1702) TorqueStatus

Function: Indicates whether there is torque or not.
Caution: there is also torque when braking.
The error causing it to brake does not disable the torque.
Valid values: 0, There is no torque
1, There is torque

19. INTERNAL GENERATOR GROUP "W"

WV1 W (F1800) GeneratorShape

Function: It indicates the waveform of the internal command generator.
Valid values:
0- Sinusoidal
1- Square
2- Triangular
3- Continuous

WV2 W (F1801) GeneratorPeriod

Function: It indicates the period of the signal from the internal command generator.
Valid values: 2..65535 msec.

WV3 Ws (F1802) GeneratorAmplitude

Function: It indicates the amplitude of the signal from the internal command generator.
Valid values: 0..32767 rpm if it is a velocity command
microns if it is a position command for a linear axis.
tenths of a degree if it is a position command for a rotary axis.

WV4 O (F1803) GeneratorType

Function: It establishes upon which magnitude the internal velocity command is applied.
Valid values:
0-Generator off (by default)
1-Generator on. Speed Command.
2-Generator on. Torque Command.
Version: Inoperative from version 04.01 on.

WV5 s (F1804) GeneratorOutput

Function: Is the value of the signal generated by the internal function generator.
Valid values: -32768 .. 32767 given in the units indicated for WV3.
Version: Operative from version 04.01 on.

WV6 W (F1805) GeneratorDutyCycle

Function: For generating square signals (WV1=1), this variable gives the percentage of duty cycle. For example a cycle of S6-40%, WV6=40.
Valid values: 1 .. 99 (50 by default)
Version: Operative from version 04.01 on.

WV7 W (F1806) GeneratorWaves

Function: Number of waves generated after the unit has been turned on. Then, the generator stops. By making WV7=0 the generator works continuously.
Valid values: 0 .. 65535 (0 by default)
Version: Operative from version 04.01 on.

WV8 W (F1807) GeneratorOn

Function: To turn the generator on or off.
Valid values:
0, Generator off. (by default)
1, Generator on.
Version: Operative from version 04.01 on.

WV9 Ws (F1808) GeneratorOffset

Function: It makes it possible to apply an offset to the signal of the internal command generator.
Valid values: -32768 .. 32767
Version: Operative from version 04.01 on.

20. MISCELLANEOUS GROUP "X"

These variables are available from version 02.01 on.

XV0 (S0) NullId
XV1 (F1900) One
XV2 (F1901) Zero

Function:	Serves to force a "1" or a "0" at a digital output.	
	Write a "0" so a digital input does not perform any function.	
Example:	OP10 = XV1	Sets the logical output to a logic state "1".
	IP12 = 0	Removes any functionality from the digital input.

S- 0	X V 0	NullId
S- 1	Q V 1	ControlUnitCycleTime
S- 2	Q V 2	CommunicationCycleTime
S- 3	Q V 3	ShortestATTransmisionStartingTime
S- 4	Q V 4	TransmitReceiveTransitionTime
S- 5	Q V 5	MinimumFeedbackProcessingTime
S- 6	Q V 6	ATTransmisionStartingTime_T1
S- 7	Q V 7	FeedbackAcquisitionPoint_T4
S- 8	Q V 8	CommandValidTime_T3
S- 9	Q V 9	PositionOfDataRecordInMDT
S- 10	Q V 10	LengthOfMDT
S- 11	D V 1	Class1Diagnostics (Errors)
S- 12	D V 9	Class2Diagnostics (Warnings)
S- 13	D V 10	Class3Diagnostics (OperationStatus)
S- 14	Q V 14	InterfaceStatus
S- 15	Q V 15	TelegramTypeParameter
S- 16	Q V 16	ConfigurationListOfAT
S- 17	Q V 17	IDNListOfAllOperationData
S- 21	Q V 21	IDNListOfInvalidOperationDataForCP2
S- 22	Q V 22	IDNListOfInvalidOperationDataForCP3
S- 24	Q V 24	ConfigurationListOfMDT
S- 25	Q V 25	IDNListOfAllProcedureCommands
S- 28	Q V 28	MSTErrorCounter
S- 29	Q V 29	MDTErrorCounter
S- 30	G V 2	ManufacturerVersion
S- 32	A P 1	PrimaryOperationMode
S- 36	S V 1	VelocityCommand
S- 40	S V 2	VelocityFeedback
S- 41	P P 41	HomingVelocityFast
S- 42	P P 42	VelocityPolarityParameter
S- 43	S P 43	HomingAcceleration
S- 44	S P 44	VelocityDataScalingType
S- 47	P V 47	PositionCommand
S- 49	P P 49	PositivePositionLimit
S- 50	P P 50	NegativePositionLimit
S- 51	P V 51	PositionFeedback1
S- 52	P P 52	ReferenceDistance1
S- 53	P V 53	PositionFeedback2
S- 54	P P 54	ReferenceDistance2
S- 55	P P 55	PositionPolarityParameters
S- 57	P P 57	PositionWindow
S- 58	P P 58	Backlash
S- 76	P P 76	PositionDataScalingType
S- 80	T V 1	TorqueCommand
S- 84	T V 2	TorqueFeedback
S- 85	T P 85	TorquePolarityParameter
S- 87	Q V 87	TransmitToTransmitRecoveryTime
S- 88	Q V 88	ReceiveToReceiveRecoveryTime
S- 89	Q V 89	MDTTransmissionStartingTime_T2
S- 90	Q V 90	CommandValueProceedingTime
S- 91	S P 10	VelocityLimit
S- 95	D V 95	DiagnosticMessage
S- 96	Q V 96	SlaveArrangement
S- 99	D C 1	ResetClass1Diagnostics
S- 100	S P 1	VelocityProportionalGain
S- 101	S P 2	VelocityIntegralTime
S- 103	P P 103	ModuloValue
S- 104	P P 104	PositionKvGain
S- 106	C P 1	CurrentProportionalGain
S- 107	C P 2	CurrentIntegralTime
S- 108	P V 108	FeedrateOverride
S- 109	M P 4	MotorPeakCurrent
S- 110	H V 1	DrivePeakCurrent
S- 111	M P 3	MotorContinuousStallCurrent
S- 113	S P 11	MotorMaximumSpeed
S- 115	P P 115	PositionFeedback2Type
S- 117	N P 117	ResolutionOfFeedback2
S- 121	N P 121	InputRevolutions
S- 122	N P 122	OutputRevolutions
S- 123	N P 123	FeedConstant

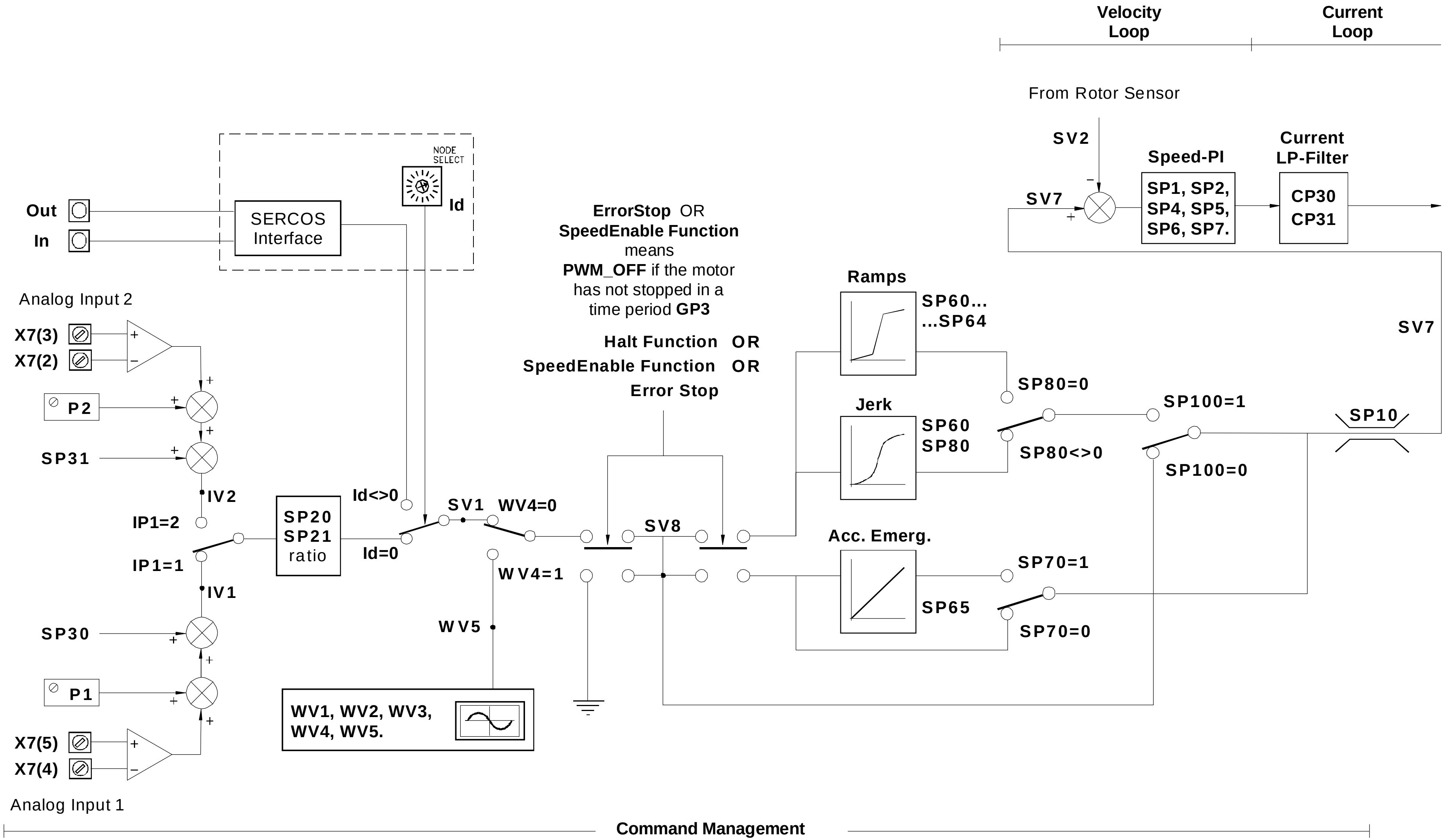
S- 124	S P 42	StandStillWindow
S- 125	S P 40	VelocityThresholdNx
S- 126	T P 1	TorqueThresholdTx
S- 127	Q V 127	CP3TransitionCheck
S- 128	Q V 128	CP4TransitionCheck
S- 134	D V 32	MasterControlWord
S- 135	D V 31	DriverStatusWord
S- 138	S P 60	AccelerationLimit
S- 140	G V 9	DriveType
S- 141	M P 1	MotorType
S- 142	D P 142	ApplicationType
S- 143	Q V 143	SercosInterfaceVersion
S- 146	P C 146	NCControlledHoming
S- 147	P P 147	HomingParameter
S- 148	P C 148	DriveControlledHoming
S- 150	P P 150	ReferenceOffset1
S- 151	P P 151	ReferenceOffset2
S- 157	S P 41	VelocityWindow
S- 158	T P 2	PowerThresholdPx
S- 159	P P 159	MonitoringWindow
S- 171	P C 171	CalculateDisplacement_C
S- 172	P C 172	DisplacementToTheReferenceSystem
S- 173	P V 173	MarkerPositionA
S- 175	P V 175	DisplacementParameter1
S- 176	P V 176	DisplacementParameter2
S- 185	Q V 185	MaxLengthOfAT
S- 186	Q V 186	MaxLengthOfMDT
S- 187	Q V 187	IDNListOfConfigurableAT
S- 188	Q V 188	IDNListOfConfigurableMDT
S- 189	P V 189	FollowingError
S- 193	P V 193	PositioningJerk
S- 201	K V 5	MotorTemperatureWarningLimit
S- 202	K V 9	CoolingTemperatureWarningLimit
S- 204	K V 8	MotorTemperatureErrorLimit
S- 205	K V 12	CoolingTemperatureErrorLimit
S- 207	G P 9	DriveOffDelayTime
S- 209	S P 6	VelocityAdaptationLowerLimit
S- 210	S P 7	VelocityAdaptationUpperLimit
S- 211	S P 4	VelocityAdaptationProportionalGain
S- 212	S P 5	VelocityAdaptationIntegralTime
S- 216	G C 2	ParameterSetSwitch
S- 217	G V 22	ParameterSetPreselection
S- 218	G V 26	GearRatioPreselection
S- 219	G V 20	IDNListOfParameterSet
S- 254	G V 21	ParameterSetActual
S- 255	G V 25	GearRatioActual
S- 258	P V 58	TargetPosition
S- 259	P V 59	PositioningVelocity
S- 260	P V 60	PositioningAcceleration
S- 262	G V 10	LoadDefaultsCommand
S- 264	G C 1	BackupWorkingMemoryCommand
S- 267	G V 7	Password
S- 296	P P 216	VelocityFeedForwardPercentage
S- 301	N V 31	RealTimeControlBit1IDN
S- 303	N V 33	RealTimeControlBit2IDN
S- 305	N V 35	RealTimeStatusBit1IDN
S- 307	N V 37	RealTimeStatusBit2IDN
S- 315	P V 115	PositioningVelocityGreaterLimit
S- 323	P V 123	TargetPositionOutsideOfTravelRange
S- 330	S V 4	nFeedbackEqualNCommand
S- 331	S V 5	nFeedbackEqual0
S- 332	S V 3	nFeedbackMinorNx
S- 333	T V 10	TGreaterTx
S- 336	P V 136	InPosition
S- 337	T V 60	PGreaterPx
S- 342	P V 142	TargetPositionAttained
S- 343	P V 143	InterpolatorHalted
S- 348	P P 217	AccelerationFeedForwardPercentage
S- 349	S P 80	JerkLimit
S- 380	G V 4	DCBusVoltage

S- 383	K	V	6	MotorTemperature
S- 392	S	P	110	VelocityFilterTimeConstant
S- 400	P	V	200	HomeSwitch
S- 403	P	V	203	PositionFeedbackStatus
S- 404	P	V	204	PositionCommandStatus
S- 407	P	V	207	HomingEnable
S- 408	P	V	208	ReferenceMarkerPulseRegistered
F- 1	%	V	2	CanalVariableDSP1
F- 2	%	V	3	CanalVariableDSP2
F- 3	%	V	4	CanalVariableDSP3
F- 4	%	V	5	VariableDSP0
F- 5	%	V	6	VariableDSP1
F- 6	%	V	7	VariableDSP2
F- 7	%	V	8	VariableDSP3
F- 8	%	V	11	pVariable0
F- 9	%	V	12	pVariable1
F- 10	%	V	15	Variable0
F- 11	%	V	16	Variable1
F- 12	%	V	20	CanalPecDSP0
F- 13	%	V	21	CanalPecDSP1
F- 14	%	V	22	VariablePecDSP0
F- 15	%	V	23	VariablePecDSP1
F- 16	%	V	1	CanalVariableDSP0
F- 17	%	V	24	InputGainChange
F- 18	%	V	25	AD3Offset
F- 19	%	V	27	Feedback2I0Analog
F- 20	%	C	1	PositionReferenceGenerator_C
F- 21	%	C	2	HacerEncoderVirgen
F- 31	S	P	20	VoltageRpmVolt
F- 81	S	P	21	RpmRpmVolt
F- 201	B	V	1	HaltDrivePin
F- 202	B	V	3	HaltDriveDnc
F- 203	B	V	7	DriveEnableDnc
F- 204	B	V	14	NotProgrammableIOs
F- 290	H	V	10	VsMSC
F- 291	H	V	11	FlashManufacturerCode
F- 300	C	P	3	CurrentDerivativeGain
F- 301	C	P	4	CurrentAdaptationProportionalGain
F- 302	C	P	5	CurrentAdaptationIntegralTime
F- 303	C	P	6	CurrentAdaptationLowerLimit
F- 304	C	P	7	CurrentAdaptationUpperLimit
F- 305	C	V	10	CurrentUOffset
F- 306	C	V	11	CurrentVOffset
F- 307	C	P	20	CurrentLimit
F- 308	C	P	30	CurrentFilter1TimeConstant
F- 309	C	V	1	CurrentUFeedback
F- 310	C	V	2	CurrentVFeedback
F- 311	C	V	3	CurrentFeedback
F- 312	C	P	31	CurrentFilter1Damping
F- 404	D	V	11	FagorDiagnostics
F- 405	D	V	14	ErrorsInDncFormat
F- 500	E	P	1	EncoderSimulatorPulsesPerTurn
F- 501	E	P	2	EncoderSimulatorI0Position
F- 502	E	P	3	EncoderSimulatorDirection
F- 503	E	C	1	EncoderSimulatorSetI0
F- 600	F	P	1	MotorFluxProportionalGain
F- 601	F	P	2	MotorFluxIntegralTime
F- 602	F	P	20	MotorBEMFProportionalGain
F- 603	F	P	21	MotorBEMFIntegralTime
F- 604	F	P	30	MotorInductance1
F- 605	F	P	31	MotorInductance2
F- 606	F	P	32	MotorInductance3
F- 607	F	P	33	MotorInductance4
F- 608	F	P	34	MotorInductance5
F- 609	F	P	35	MotorInductance6
F- 610	F	P	36	MotorInductance7
F- 611	F	P	37	MotorInductance8
F- 612	F	P	38	MotorInductance9
F- 613	F	P	40	FluxReduction
F- 700	G	P	1	PwmFrecuency

F- 701	G	P	2	Feedback1Type
F- 702	G	P	3	StoppingTimeout
F- 703	G	P	4	SetNumber
F- 704	G	P	5	ParameterVersion
F- 705	G	V	3	ParameterChecksum
F- 706	G	V	5	CodeChecksum
F- 707	G	V	8	AccessLevel
F- 708	G	V	11	SoftReset
F- 709	G	V	13	PowerBusStatus
F- 710	G	V	14	PowerVoltageMinimum
F- 711	G	V	23	ParameterSetAck
F- 712	G	V	24	ParameterSetStb
F- 713	G	V	30	ParameterSetBit0
F- 714	G	V	31	ParameterSetBit1
F- 715	G	V	32	ParameterSetBit2
F- 716	G	V	33	TMODE_Select
F- 717	G	P	6	GearRatioNumber
F- 718	G	V	35	PlcResourceData
F- 719	G	P	10	Feedback2Type
F- 720	G	P	7	OverloadTimeLimit
F- 721	G	P	8	OverloadVelocityThreshold
F- 722	G	V	36	KernelResourceData
F- 806	H	V	9	ModularOrCompact
F- 900	I	P	1	AnalogReferenceSelect
F- 901	I	P	10	I1IDN
F- 902	I	P	11	I2IDN
F- 903	I	P	12	I3IDN
F- 904	I	P	13	I4IDN
F- 905	I	V	1	AnalogInput1
F- 906	I	V	2	AnalogInput2
F- 907	I	V	10	DigitalInputs
F- 908	I	V	11	DigitalInputsCh2
F- 909	I	P	5	DigitalInputsVoltage
F- 1000	J	P	1	OsciloBuffer1Id
F- 1001	J	P	2	OsciloBuffer2Id
F- 1002	J	P	3	OsciloBuffer3Id
F- 1003	J	P	4	OsciloBuffer4Id
F- 1004	J	V	5	OsciloBuffer1
F- 1005	J	V	6	OsciloBuffer2
F- 1006	J	V	7	OsciloBuffer3
F- 1007	J	V	8	OsciloBuffer4
F- 1008	J	P	9	OsciloBufferLength
F- 1009	J	V	10	OsciloRun
F- 1010	J	V	11	OsciloTriggered
F- 1011	J	P	12	OsciloSamplePeriode
F- 1012	J	P	13	OsciloTriggerLevel
F- 1013	J	P	14	OsciloTriggerPosition
F- 1014	J	P	15	OsciloTriggerEdge
F- 1015	J	V	16	OsciloTraceStart
F- 1016	J	V	17	OsciloTraceCounter
F- 1017	J	P	18	OsciloTriggerBit
F- 1018	J	P	19	OsciloTriggerChanel
F- 1019	J	P	5	OsciloChOneShift
F- 1020	J	P	6	OsciloChTwoShift
F- 1021	J	V	18	OsciloCh1Data
F- 1022	J	V	19	OsciloCh2Data
F- 1023	J	V	20	OsciloStore
F- 1100	K	V	2	DriveTemperature
F- 1101	K	V	4	DriveTemperatureErrorLimit
F- 1102	K	V	10	CoolingTemperature
F- 1103	K	V	20	SupplyPlus5V
F- 1104	K	V	21	SupplyPlus8V
F- 1105	K	V	22	SupplyPlus18V
F- 1106	K	V	23	SupplyMinus5V
F- 1107	K	V	24	SupplyMinus8V
F- 1108	K	V	25	SupplyMinus18V
F- 1109	K	V	32	I2tDrive
F- 1111	K	V	36	I2tMotor
F- 1112	K	P	1	DriveI2tErrorEfect
F- 1200	M	P	2	MotorTorqueConstant

F- 1201	M P 5	MotorPolesPairs
F- 1202	M P 6	MotorRatedSupplyVoltage
F- 1203	M P 7	MotorPowerFactor
F- 1204	M P 8	MotorConstantPowerEndVelocity
F- 1205	M P 9	MotorSlip
F- 1206	M P 10	MotorStatorResistance
F- 1207	M P 11	MotorStatorInductance
F- 1208	M P 12	MotorNominalPower
F- 1209	M P 13	MotorThermalTimeConstant
F- 1210	M P 14	MotorTempSensorType
F- 1211	M P 15	MotorShaft
F- 1212	M P 16	MotorBrake
F- 1213	M P 17	MotorFan
F- 1214	M P 18	MotorMounting
F- 1215	M P 19	MotorBalancing
F- 1216	M P 20	MotorBearings
F- 1218	M P 22	MotorPowerReduction
F- 1220	M P 24	MotorMomentumOfInertia
F- 1300	P P 1	HomingVelocitySlow
F- 1310	P P 10	ProcessBlockMode
F- 1311	P P 11	FeedrateOverrideLimit
F- 1312	P P 12	PositioningVelocityDefault
F- 1313	P V 13	KernelOperationMode
F- 1314	P V 14	KernelAutoMode
F- 1315	P V 15	KernelStartSignal
F- 1316	P V 16	KernelStopSignal
F- 1317	P V 17	KernelResetSignal
F- 1318	P V 18	KernelAbortSignal
F- 1319	P V 19	KernelManMode
F- 1320	P V 20	JogPositiveSignal
F- 1321	P V 21	JogNegativeSignal
F- 1322	P P 22	JogVelocity
F- 1323	P P 23	JogIncrementalPosition
F- 1324	P V 24	FeedrateOverrideEqualCero
F- 1325	P P 25	InPositionTime
F- 1326	P V 26	ProgramPositionOffset
F- 1327	P V 27	KernelInitError
F- 1328	P V 28	KernelExecError
F- 1400	O P 1	DA1IDN
F- 1401	O P 2	DA2IDN
F- 1402	O P 3	DA1ValuePer10Volt
F- 1403	O P 4	DA2ValuePer10Volt
F- 1404	O P 10	O1IDN
F- 1405	O P 11	O2IDN
F- 1406	O P 12	O3IDN
F- 1407	O P 13	O4IDN
F- 1408	O V 1	DA1Value
F- 1409	O V 2	DA2Value
F- 1410	O V 10	DigitalOutputs
F- 1411	O P 5	Prog_OutIDN
F- 1412	O V 5	Prog_Out
F- 1413	O V 11	DigitalOutputsCh2
F- 1500	R P 1	FeedbackSineGain
F- 1501	R P 2	FeedbackCosineGain
F- 1502	R P 3	FeedbackSineOffset
F- 1503	R P 4	FeedbackCosineOffset
F- 1504	R P 5	FeedbackResolverRhoCorrection
F- 1505	R P 6	FeedbackErrorDisable
F- 1506	R V 1	FeedbackSine
F- 1507	R V 2	FeedbackCosine
F- 1508	R V 3	FeedbackRhoCorrection
F- 1509	R V 4	FeedbackRadius
F- 1510	R V 6	EncoderError
F- 1511	R V 7	StegmannMotorType
F- 1512	R V 8	CircleAdjust
F- 1513	R C 1	EncoderParameterStoreCommand
F- 1514	R C 2	EncoderParameterReadCommand
F- 1515	R V 5	EncoderType
F- 1516	R P 10	Feedback2Interface
F- 1550	R P 51	Feedback2SineGain

F- 1551	R P 52	Feedback2CosineGain
F- 1552	R P 53	Feedback2SineOffset
F- 1553	R P 54	Feedback2CosineOffset
F- 1556	R V 51	Feedback2Sine
F- 1557	R V 52	Feedback2Cosine
F- 1559	R V 54	Feedback2Radius
F- 1600	S P 12	MotorRatedSpeed
F- 1603	S P 30	AnalogInputOffset1
F- 1604	S P 31	AnalogInputOffset2
F- 1605	S P 61	AccelerationLimitVelocity2
F- 1606	S P 62	AccelerationLimit2
F- 1607	S P 63	AccelerationLimitVelocity3
F- 1608	S P 64	AccelerationLimit3
F- 1609	S P 65	EmergencyAcceleration
F- 1610	S P 70	AccelerationOnEmergency
F- 1611	S P 100	AccelerationLimitOn
F- 1612	S V 7	VelocityCommandFinal
F- 1613	S V 8	VelocityCommandBeforeFilters
F- 1614	S P 111	VelocityFilterDamping
F- 1700	T V 50	PowerFeedback
F- 1701	T V 3	PowerFeedbackPercentage
F- 1702	T V 100	TorqueStatus
F- 1800	W V 1	GeneratorShape
F- 1801	W V 2	GeneratorPeriod
F- 1802	W V 3	GeneratorAmplitude
F- 1803	W V 4	GeneratorType
F- 1804	W V 5	GeneratorOutput
F- 1805	W V 6	GeneratorDutyCycle
F- 1806	W V 7	GeneratorWaves
F- 1807	W V 8	GeneratorOn
F- 1808	W V 9	GeneratorOffset
F- 1900	X V 1	One
F- 1901	X V 2	Zero
F- 2000	Q P 11	SercosMbaud
F- 2001	A P 5	PlcPrgScanTime
F- 2012	G V 37	PlcErrors
F- 2100	D P 1	ErrorsDisables
F- 2101	D V 15	ErrorDisable
F- 2102	D V 16	ErrorEnable
F- 2200	N P 1	ReducedActuatedMomentumOfInertiaPercentage


Velocity Loop
Current Loop
From Rotor Sensor
SV2
SV7
Speed-PI
SP1, SP2, SP4, SP5, SP6, SP7.
Current LP-Filter
CP30 CP31
NODE SELECT
Id
Out
In
SERCOS Interface
Analog Input 2
X7(3)
X7(2)
P2
SP31
IV2
IP1=2
IP1=1
IV1
SP30
P1
X7(5)
X7(4)
Analog Input 1
SP20 SP21 ratio
Id<>0
Id=0
SV1
WV4=0
WV4=1
WV5
WV1, WV2, WV3, WV4, WV5.
ErrorStop OR
SpeedEnable Function
means
PWM_OFF if the motor
has not stopped in a
time period GP3
Halt Function OR
SpeedEnable Function OR
Error Stop
SV8
Ramps
SP60...
...SP64
Jerk
SP60
SP80
Acc. Emerg.
SP65
SP80=0
SP80<>0
SP70=1
SP70=0
SP100=1
SP100=0
SP10
SV7
Command Management

User notes:

APPENDIX B:

LIST OF ERRORS WARNINGS AND TROUBLESHOOTING

List of errors and warnings: (page)

EFFECT OF THE SYSTEM ERRORS

Activating any of the errors listed in this appendix causes certain effects on the system that depend on the type of interface being used.

Analog interface.
The activated error is shown on the drive's display.

Sercos interface.
The activated error is shown on the drive's display.
This error is also displayed on the CNC screen.
The CNC may display the errors listed in this appendix as well as those of the Sercos communication itself.
CNC actions
Activates bit 13 of DV31 -S135-
Activates the bit corresponding to that error in the DV1 -S11- variable.
Interrupts the execution of the program.
Stops the axes and the spindles.
Sets marks /ALARM and O1 to zero. These marks are always present in the PLC program which will handle that emergency without having to know which error has been activated.

Error reset.

The system will not start running until all the errors detected at the drive have been eliminated. To eliminate these errors, their cause has to have disappeared and, then, an "Error Reset" must be carried out.

This Reset may be carried out via X2(1) of the power supply module, or pin X2(3) of the Compact Drive.

Certain errors cannot be reset or eliminated with this method. Those errors can only be eliminated by turning the unit off and back on, but provided that the cause for the error has been solved. These errors are:

1	2	5	6	50	51	52	53	54
55	100	101	102	103	104	105	109	211
502	503	504	700	701	702	703	704	705
706	707	801	802	803	804	805	806	900

Stopping the motor.

Activating certain errors cancels the current through the motor. These errors are:

2	4	5	6	50	51	52	53	54
55	66	67	68	69	109	200	202	203
211	212	213	214	215	301	302	303	304
306	501	502	503	504	602	603	604	605
606	607	608	700	701	702	703	704	705
706	707	801	802	803	804	806		

LIST OF ERRORS

1 Internal Error.

Get in touch with Fagor Automation.

2 Internal Error.

Get in touch with Fagor Automation.

3 While having torque, there is a voltage drop at the Power Bus.

- Having torque, a voltage drop has been detected at the Power Bus. Probably one of the three-phase line has dropped or one of the drives has failed.
Check the proper condition of the lines and the drives and restart the system.

4 Emergency stop and time limit "GP3" exceeded.

- An attempt has been made to stop the motor by disabling "Speed Enable". The system has tried to stop the motor at maximum torque, but it has not been able to stop within the time period set by parameter GP3 (DriveOffDelayTime = maximum braking time allowed before issuing an error) or the parameter which determines when the motor is considered to be stopped SP42 (MinimumMotorSpeed) is too small (bear in mind that zero speed or absolute lack of speed is impossible). There is always a small amount of speed "noise" due to feedback.

The load to be stopped by the motor is too great for the time window set by GP3 (increase the value of this parameter). The threshold or speed window considered as zero SP42 is too small (increase the value of this parameter). The module's performance is poor or is unable to stop the motor. The module may be defective.

5 Code Checksum Error.

- The checksum for the code of the program loaded is not correct.
Reload the software. If the problem persists, the Flash or Ram memories may be defective or the loaded code may defective.
Get in touch with Fagor Automation.

6 Error on the Sercos board.

Change the board. If the error persists, change the Vecon card.

50 - 55 Internal PLC compiling error

- See the PLC manual for the meaning of this error.
Correct the program.

66 - 69 PLC execution error

- See the PLC manual for the meaning of this error.

100 Internal +5 Voltage out of range (old error 16)
101 Internal -5 Voltage out of range (old error 17)
102 Internal +8 Voltage out of range (old error 18)
103 Internal -8 Voltage out of range (old error 19)
104 Internal +18 Voltage out of range.
105 Internal -18 Voltage out of range.

Get in touch with Fagor Automation.

106 Outside temperature on the heatsink. (Heatsink of the IGBTs)

- The drive is doing something which causes the power devices to overheat.
Stop the system for a few minutes and reduce the amount of effort required of the Drive.
- The drive is exposed to excessive temperature.
Cool it down.

107 Drive overtemperature. (CPU board)

The ambient temperature of the drive is too high. It must be lowered.

108 Motor overtemperature.

The cables measuring motor temperature (position sensor cables), or the thermistor itself are defective.
The application requires high current peaks.
Stop the system for a few minutes and decrease the amount of effort demanded to the motor. Ventilate the motor.

109 Overvoltage at digital inputs.

- The digital inputs of the drive receive a voltage higher than what they have been set up for.
Check the configuration (parameter IP5 -F00909-) and the electrical voltage applied.

150 Travel limit overrun.

- The travel limits of the axis have been exceeded.
Check the values of these limits and the programming of these movements.

152 Command module exceeded.

- While working with a command in module format, a command has been received whose value exceeds the one set by parameter PP103.
Check the value of this parameter together with its equivalent parameter at the CNC. Check that both the drive and the CNC work in the same command mode.

154 Excessive Feedforward velocity command.

- The path required by the position command causes a feedforward velocity command which is too high.
Decrease the path demands in terms of required feedrate.

155 Excessive Feedforward acceleration command.

- The path required by the position command causes a feedforward acceleration command which is too high.
Decrease the path demands in terms of required acceleration.

156 Excessive following error.

- The axis follows the position command with a "following error" (axis lag) PV189 -S189- FollowingError which is greater than the maximum allowed by PP159 -S159- MonitoringWindow
Check the setting of all these factors involved in "following error". Check the value given to PP159.

200 Speed overrun.

- The motor speed has exceeded the SP10 value by more than 12%.
Problem with the cables of the position sensor or of the motor power. The velocity loop is poorly adjusted.
Decrease the speed overshoot of the response.

201 Motor overload.
202 Drive overload.

- The I^2t protection of the motor or of the drive has triggered.
The duty cycle is greater than the system can provide.

203 Torque overload error.

- The servo drive is locked up and it can not turn freely. Due to too high a torque, the turning speed has not exceeded the GP8 value for a time period greater than the GP7 value.
Free the motor. If the error comes up for no apparent reason, increase the GP7 and/or GP8 values. If GP7 is set to “0”, the error message is never issued.

211 Internal Error.

Get in touch with Fagor Automation.

212 Overcurrent.

- Too much current at the Drive module. Drive malfunction.
Reset the error, the parameter settings might be wrong and they cause overcurrent.

213 Undervoltage at the IGBT drive.

- Low supply voltage is detected in the IGBT attack circuitry in the Drive module. Possible failure on the drive of the IGBT or the IGBT itself.
Reset the error, and if this goes on, get in touch with Fagor Automation.

214 Short-circuit.

- Short-circuit at the Drive Module.
Reset the error. If it persists, the power cables might be connected in the wrong order or that they touch each other causing the short-circuit. The parameters might be wrong or there is a Drive malfunction. Contact Fagor Automation

215 Overvoltage at the Power Bus of the drive (hard).

- The hardware of the drive module has detected excessive voltage at the Power bus. Internal Ballast connection jumper missing (see power connectors). Or, when using an external Ballast, it is not connected properly. The Ballast resistor is burned out.
Power it down and check for proper Ballast circuit connection.
See errors 304 and 306.

250 - 253 Homing error.

Get in touch with Fagor Automation.

300 Overtemperature at the heatsink of the Power Supply, or Compact module.
301 Overtemperature at the Ballast of the Power Supply, or Compact module.

- Temperature of the heatsink or of the Ballast circuit of the Power Supply module too high.
Stop the system for a few minutes and reduce the level of effort required of this module.

302 Short-circuit at the Ballast of the Power Supply module.

Get in touch with Fagor Automation.

303 Supply voltage of the Ballast circuit driver out of range.

Get in touch with Fagor Automation.

304 Overvoltage at the power bus of the PS.

- The power supply has detected excessive voltage at the power bus. The internal Ballast may be disconnected (see Power Supply Module) or, when using an external Ballast, it is not connected.
Turn the power off and check that the lines are OK.
See errors 215 and 306.

305 Protocol error at the interface between the Power Supply and the Drive.

- Communication errors between the Power Supply module and the Drive through the internal Bus. Get in touch with Fagor Automation.

- The XPS models can detect a group of errors that drives with software version 03.05 or older cannot indicate at the Status Display. In this case, the XPS models indicate those errors by means of different LED combinations on their face plate. The following table shows how to interpret those errors.

FAULT	REGEN	DC BUS ON	Error	
On	On	Off	Sobrecorriente en el circuito de devolución	308
On	On	On	Cortocircuito en el High Side IGBT	309
On	On	Blink	Baja tensión en el driver del High Side IGBT	310
On	Blink	On	Cortocircuito en el Low Side IGBT	311
On	Blink	Blink	Baja tensión en el driver del Low Side IGBT	312
On	Off	On	Sobrecorriente en el consumo	313

306 Overvoltage at the power bus of the drive (soft).

- The software of the drive module has detected excessive voltage at the power bus. The application demands high current peaks and the mains power has too much impedance.
See errors 215 and 304.

307 Undervoltage at the Power Bus.

- The mains voltage is lower than permitted (Rated voltage < 380Vac)
Turn the power off and check that the lines are OK.

308 Overcurrent in the regenerating circuit.

Get in touch with Fagor Automation.

309 Short-circuit at the High Side IGBT.

Get in touch with Fagor Automation.

310 Low voltage at the driver of the High Side IGBT.

Get in touch with Fagor Automation.

311 Short-circuit at the Low Side IGBT.

Get in touch with Fagor Automation.

312 Low voltage at the driver of the Low Side IGBT.

Get in touch with Fagor Automation.

313 Consumption overcurrent.

- The current demanded from the power supply is too high.
Decrease the demands of the duty cycle.

403 MST fault
404 MDT fault
405 Err_InvalidPhase
406 Err_PhaseUpshift
407 Err_PhaseDownshift

- 400 series errors refer to various communication problems through the fiber optic ring. Check the connections at the ring and the identification of each module.

500 Inconsistent parameters.

- See error 502.

501 Parameter Checksum Error

- The parameter Checksum has been found to be incorrect.
The Soft version has probably been changed and the new version requires a different number of parameters.
When this error comes up the servo-drive takes the default values of the parameters.
The user has two options:
- Confirm the Default values: To do this simply save the parameters again.
- Recover the previous values: To do this, load the parameters into RAM and check them out with the PC. If the operator considers that they are valid, he/she can validate them by storing them.

502 Wrong Parameter.

(This error does not come up from software version 03.01 on)
- A parameter has a wrong value: This error indicated an incongruence of a parameter in terms of inexistence, out of limits, etc.
Correct the parameter. The DV16 variable, indicated the code of the wrong parameter.

From software version 03.01 on:
Variable QV22 -S22- contains the list of wrong parameters conflicting with other parameters or merely wrong. For now, this variable can only be seen by means of the "ddssetup.exe" running on DOS.
Correct these parameters.

503 Wrong default motor values table.

(This error does not come up from software version 03.01 on)
The table has not be saved. This table must be saved.

504 Wrong parameter in SERCOS stage two.

- Only with Sercos interface: parameter QV21 -S21- contains the wrong parameter list corresponding to stepping to stage two of the Sercos protocol. For now, it can only be seen by means of the ddssetup.exe on DOS.
Correct the parameter.

505 Connected motor different from the one set in Flash memory

- The drive RAM memory parameters have been set for the new motor connected. However, the setting of the parameters stored in Flash memory correspond to another motor. In other words, the MP1 value in Flash and in RAM are not the same. This error does not interrupt the normal operation of the drive.
Save the parameters in Flash memory to work with the connected motor.

600 Error in the Communication with the Rotor Encoder.
601 Error in the Communication with the Rotor Encoder.

(These errors don't come up on software version 03.01 or later). They are displayed as errors 8xx.
Check the sensor cable and if it is the right one, check the sensor itself and the X4 card.

602 Motor feedback B signal saturated.

- Defective rotor sensor cabling, encoder or X4 card. RP1 (gain of the sine signal of the rotor sensor) or RP3 (offset of the sine signal of the rotor sensor) is too large.
Check the cable of the Encoder and that of the X4 card or increase the value of these parameters.

603 Motor feedback A signal saturated.

- Defective rotor sensor cabling, encoder or X4 card. The offset and/or gain (RP1, RP2, RP3 and RP4) of the signals is too large.
Check the cable of the Encoder and that of the X4 card or increase the value of these parameters.

604 Saturation of the values of motor feedback signal A and/or B.
607 Saturation of the values of direct feedback signal A and/or B.

- Defective cabling, feedback device or feedback board (connector X4 or X3).
- The value of parameter RP1, RP2, RP3, or RP4 is too high.
Check the cable, the feedback device, the cards or decrease the value of these parameters.

605 Motor feedback signal A and/or B too weak.
608 Direct feedback signal A and/or B too weak.

- Defective cabling, feedback device or feedback board (connector X4 or X3).
- The value of parameter RP1, RP2, RP3, or RP4 is too low.
Check the cable, the feedback device, the cards or increase the value of these parameters.

606 Excessive rotor sensor signal drift.

- The quality of the signals has dropped. Wiring of the rotor sensor faulty,
Encoder faulty, X4 card faulty or ground connection faulty.
Check the state of the cable, of the Encoder or of the X4 card, or the ground connections.

700 Error when identifying the serial line board.
701 Error when identifying the VeCon board.
702 Sercos board missing. I/O board missing.
703 Wrong I/O board version.
704 Wrong AD selection on the I/O board.
705 Error when identifying the Power board.
706 Error when identifying the motor feedback board.
707 Error when identifying the Encoder simulator board.

The 700 series errors refer to the improper operation of the hardware or that any of the necessary boards is missing. Contact Fagor Automation.

801 Encoder undetected

Parameter GP2 has been set to "0" (sinewave encoder) and the motor feedback is actually a Resolver. The value of GP2 must be consistent with the feedback device installed. Contact Fagor Automation.

802 Communication error with the Encoder

Contact Fagor Automation.

803 Encoder not initialized

Contact Fagor Automation.

804 Defective encoder

The Encoder is not working properly.
Contact Fagor Automation.

805 Encoder detected.

The Drive has been set to have a Resolver (GP2) and the motor feedback is not of this type.
Maybe the motor has an Encoder instead of a Resolver.
The value of GP2 must be consistent with the feedback device installed. Contact Fagor Automation.

806 Homing error with Sincoder

Contact Fagor Automation.

900 MC program initialization error

Refer to the MC manual for the meaning of this error.

9xx MC program execution errors

Refer to the MC manual for the meaning of this error.

LIST OF WARNINGS

A warning on the 7-segment display appears with an "A" instead of an "E" which is used to display errors. Warnings indicate that the Drive is getting to an error limit.

1 Inside Overtemperature prior to error 107
2 Motor Overtemperature prior to error 108
3 Outside temperature at the heatsink prior to error 106

The warning temperature (KV1, KV5 or KV9, respectively) has been exceeded.

TROUBLESHOOTING

This section is intended to be an assistance to solve some of the typical problems that come up when installing the Servo Drive system.

The synchronous motor runs away. The axis with encoder simulator runs away.

Wrong encoder absolute position offset, or Resolver installed wrong.
Change the counting direction of the encoder signals, modify EP3.
Motor with sinewave encoder whose parameters have been set for a squarewave encoder. Modify GP2.

The synchronous motor does not turn smoothly, it applies force but intermittently.

The power phases between the drive and the motor are not cabled correctly.
The signal phases between the drive and the rotor sensor are not cabled correctly.

The torque of the synchronous motor is low.

Check the system's current limit. CP20. Wrong encoder absolute position offset.
The encoder, or resolver, has moved from the correct position.

The synchronous motor is overheated

Wrong encoder absolute position offset. Motor calculated wrong. Vertical axis not compensated. Too much friction.

After the setup and with the Drive active, the motor moves.

Resolver feedback has been selected while actually using an encoder, modify GP2.

The motor does not turn properly and makes a lot of noise.

The resolver cable shield is not connected to connector X4 of the drive module. Pin 26.

The motor moves with a lot of noise and when stopped, it seems to jerk.

The encoder cable shield is connected at the motor end.

The following error depends on motor speed.

It is due to the effect of the PI which varies depending on speed (SP1, 2, 4, 5, 6, 7). Try adjusting it so this does not happen. Remember that the minimum following error is only required for machining not for moving.

The motor makes noise and heats up.

The resolver or encoder is positioned wrong. The encoder or resolver cable shield is not connected.

The Ballast kicks in without apparent reason.

The motor cable leaks to ground.

The motor loses torque, it does not reach the speed, it does not position properly and it does not repeat position.

The encoder is loose and its rotor shifts with respect to the rotor of the motor.

The desired motor cannot be selected, it doesn't seem to be on the motor list.

The loaded drive software is older than version V01.04 and data D01.06. These versions did not have all the possible motors.

The asynchronous motor, with a light load and requiring great acceleration (much greater than the rated value for the motor) loses control or oscillates.

The solution consists in applying an acceleration ramp providing a smoother speed transition (SP60, 61, 62, 63 and 64).

The asynchronous motor has no torque.

Low current limit value, CP20.

While the drive is activated, the spindle vibrates sporadically. Identical or opposed speeds cannot be obtained when changing the sign of the velocity command.

There is poor ground connection or a leak at the cable carrying the velocity command.

The gear box generates noise.

The velocity command must be continuous. Apply ramps to velocity commands, limit the jerk (ramps in S) or install an external filter.

The spindle moves properly but it makes a lot of noise.

The electrical connection to the asynchronous motor is wrong. Instead of being a star connection it is a triangle. The encoder cable shield is loose at the motor end.

The motor makes a strange noise when turning, as if the feedback were noisy.

The rotor sensor cable has a shield in electrical contact with the body of the motor.

User notes:

APPENDIX C:

REFERENCES OF FAGOR PRODUCTS

Motor references

AXIS MOTORS, FXM

Example: FXM 34.30A . E1 . 0 0 0

FAGOR A**X**IS **M**OTOR		
SIZE	**1, 3, 5, 7**	
LENGTH		
MAXIMUM SPEED	**12** 1200 rpm **30** 3000 rpm	**20** 2000 rpm **40** 4000 rpm
WINDING	**A** 380 Vac	
FEEDBACK TYPE	**E0** Encoder Sincos™ (Except for FXM1 type) **E1** Encoder Sincoder™ **A0** Encoder Absoluto Sincos™ (Except for FXM1 type) **R0** Resolver Tamagawa™	
FLANGE AND SHAFT	**0** With Keyway (Siemens™ 1FT5) **1** Without Keyway	
BRAKE OPTION	**0** Without brake **1** With standard brake (24 Vdc)	
VENTILATION	**0** Without Fan **1** With Fan (220 Vac)	

SPINDLE MOTORS, SPM xx.0

Example: SPM 100LBE . E 1 . 0 0 0 0 0 . 0

SPINDLE**M**OTOR				
MOTOR MODEL (rated power in S1/S6-40% -kW-)	**90L**	2.2/3.3	**90P**	3/4
	100LBE	4/6	**112ME**	5.5/8
	112LE	7.5/11	**112XE**	11/16
	132L	15/22	**132X**	18.5/26
	132XL	22/28	**160M**	22/33
	160L	30/45	**180MA**	37/55
FEED-BACK	**E0** Encoder Sincos™ **E1** Encoder Sincoder™			
MOUNTING	**0** B3/B5 Horizontal (standard) **1** V1/V5 Vertical downward **2** V3/V6 Vertical upward			
FLANGE AND SHAFT	**0** Standard **1** Protection Seal **2** Flange for mounting on ZF boxes **3** Without keyway **4..9** Special flange or shaft			
BALANCING GRADE	**0** S, standard balancing grade **1** SR, balancing grade			
BRAKE OPTION	**0** Without brake **1** With standard brake (220 Vac)			
BEARINGS	**0** Standard **1** Special, high speed			

SPINDLE MOTORS, SPM xx.1

Example: SPM 100LBE . E 1 . 0 0 0 0 0 . 1

SPINDLE**M**OTOR		

MOTOR MODEL (rated power in S1/S6-40% -kW-)	**90L**	2.2/3.3	**90P**	3/4
	100LBE	4/6	**112ME**	5.5/8
	112LE	7.5/11	**112XE**	11/16
	132L	15/22	**132X**	18.5/26
	132XL	22/28	**160M**	22/33

FEED-BACK	**E0**	Encoder Sincos™
	E1	Encoder Sincoder™

MOUNTING	**0**	B3/B5 Horizontal (standard)
	1	V1/V5 Vertical downward
	2	V3/V6 Vertical upward

FLANGE AND SHAFT	**0**	Standard
	1	Protection Seal
	2	Flange for mounting on ZF boxes
	3	Without keyway
	4..9	Special flange or shaft

BALANCING GRADE	**0**	S, standard balancing grade
	1	SR, balancing grade

BRAKE OPTION	**0**	Without brake
	1	With standard brake (220 Vac)

BEARINGS	**0**	Standard
	1	Special, high speed

References of Modular Drives

AXIS DRIVE, AXD

Example: AXD 1 . 25 - A1 - 0

AXIS **D**RIVE		
SIZE	**1** Width 77mm	(08, 15, 25, 35 Amp)
	2 Width 117mm	(50, 75 Amp)
	3 Width 234mm	(100, 150 Amp)
CURRENT (nominal, peak)	**08** (4 Amp, 8 Amp)	
	15 (7.5 Amp, 15 Amp)	
	25 (12.5 Amp, 25 Amp)	
	35 (17.5 Amp, 35 Amp)	
	50 (25 Amp, 50 Amp)	
	75 (37.5 Amp, 75 Amp)	
	100 (50 Amp, 100 Amp)	
	150 (75 Amp, 150 Amp)	
INTERFACE	**A1** Analog	
	SI Sercos	
	S0 Sercos & Analog	
ADDITIONAL FEEDBACK FEATURES	**0** None	
	1 Encoder simulator	
	2 Direct feedback	

SPINDLE DRIVE, SPD

Example: SPD 2 . 50 - SI - 0

SPINDLE **D**RIVE	
SIZE	**1** Width 77mm
	2 Width 117mm
	3 Width 234mm
CURRENT (in any duty cycle)	**08** (5.6 Amp)
	15 (10.6 Amp)
	25 (19.6 Amp)
	35 (28.5 Amp)
	50 (35.4 Amp)
	75 (53 Amp)
	100 (80 Amp)
	150 (106 Amp)
INTERFACE	**A1** Analog
	SI Sercos
	S0 Sercos & Analog
ADDITIONAL FEEDBACK FEATURES	**0** None
	1 Encoder simulator
	2 Direct feedback

POWER SUPPLY, PS

Example: PS - 25A

POWER **S**UPPLY (Mains voltage of 380-460 Vac)	
POWER (power, rated current)	**25A** (25 kw, 45 Amp) **65A** (65 kw, 120 Amp)

The old PS-xx admitted a mains voltage of 380 Vac.

PS POWER SUPPLY
WITH INTEGRATED AUXILIARY 24 Vdc POWER SUPPLY

Example: PS - 25B

POWER **S**UPPLY (Mains voltage of 380-460 Vac)	
POWER (power, rated current)	**25B** (25 kw, 45 Amp) (24 Vdc, 8 Amp)

REGENERATIVE
POWER SUPPLY, XPS

Example: XPS - 25

X-circuit **P**OWER **S**UPPLY	
POWER (power, rated current)	**25** (25 kw, 45 Amp) **65** (65 kw, 120 Amp)

Conversion table

Metric	to	Imperial
mm	÷ 25.4	inch
Kg·m²	÷ 0.113	lb·in·sec²
Nm	÷ 0.113	lb·in
°C	x 1.8 → + 32	°F
Kw	÷ 0.746	HP

References of Compact Drives

AXIS COMPACT DRIVE, ACD

Example: ACD 1 . 25 - A1 - 1

AXIS **C**OMPACT **D**RIVE		
SIZE	**1**	Width 117mm (8/15/25 Amp)
	2	Width 194mm (50/75 Amp)
CURRENT (nominal, peak)	**08**	(4 Amp, 8 Amp)
	15	(7.5 Amp, 15 Amp)
	25	(12.5 Amp, 25 Amp)
	50	(25 Amp, 50 Amp)
	75	(37.5 Amp, 75 Amp)
INTERFACE	**A1**	Analog
	SI	Sercos
	S0	Sercos & Analog
ADDITIONAL FEEDBACK FEATURES	**0**	None
	1	Encoder simulator
	2	Direct feedback

SPINDLE COMPACT DRIVE, SCD

Example: SCD 2 . 50 - SI - 0

SPINDLE **C**OMPACT **D**RIVE		
SIZE	**1**	Width 117mm
	2	Width 194mm
CURRENT (in any duty cycle)	**08**	(5.6 Amp)
	15	(10.6 Amp)
	25	(17.7 Amp)
	50	(35.4 Amp)
	75	(53 Amp)
INTERFACE	**A1**	Analog
	SI	Sercos
	S0	Sercos & Analog
ADDITIONAL FEEDBACK FEATURES	**0**	None
	1	Encoder simulator
	2	Direct feedback

References of other necessary elements.

ACCESORY MODULES

Example: EMK 3040

FAGOR MAINS FILTER	EMK
MAXIMUM CURRENT: **3040** 40 Amp; **3120** 120 Amp	3040

AUXILIARY POWER SUPPLY (24 Vdc)	APS 24
CAPACITOR MODULE (4 mF)	CM-60
RESISTOR MODULE (18 Ohms, 1500 Watts)	RM-15
PORTABLE PROGRAMMING MODULE	DDS PROG MODULE

EXTERNAL RESISTOR (43 Ohms, 350 Watts)	ER-43/350
(24 Ohms, 750 Watts)	ER-24/750
(18 Ohms, 1100 Watts)	ER-18/1100

INDUCTANCE FOR XPS

Example: CHOKE XPS-25

CHOKE INDUCTIVE FILTER FOR THE XPS	CHOKE
XPS POWER SUPPLY For the XPS-25, or XPS-65	XPS-25

SOFTWARE

INITIALIZING, SET-UP AND MONITORING SOFTWARE	DDS-SETUP

SIGNAL CABLES

Example: EEC - 20

EEC **E**NCODER **E**XTENSION **C**ABLE **REC** **R**ESOLVER **E**XTENSION **C**ABLE **SEC** **S**IGNAL (SIMULATOR) **E**XTENSION **C**ABLE	EEC
LENGTH (m) **1, 3, 5, 10, 15, 20, 25.**	20

FIBER OPTIC LINES Example: SFO - 2

SFO **S**ERCOS **F**IBER **O**PTIC	
LENGTH (m)	**1, 2, 3, 5, 7.**

POWER CABLES Example: MPC - 4 x 10 + (2 x 1)

MOTOR **P**OWER **C**ABLE
LINES x SECTION (mm²)
LINES x SECTION (mm²)

CONNECTORS FOR THE MOTORS Example: MC 23

POWER CONNECTOR FOR FXM	**AMC** Angled **MC** Vertical	
MAXIMUM CURRENT	**23** (23 Amp) **46** (46 Amp) **80** (80 Amp)	
ENCODER FEEDBACK CONNECTOR (12 pins)		E0C 12
RESOLVER FEEDBACK CONNECTOR (9 pins)		R0C 9

Ordering example.

QTY	FAGOR AUTOMATION S. COOP. **REFERENCE**	**DESCRIPTION**	**UNIT PRICE US $**	**NET PRICE US $**
1	FXM 33.30A.R0.000	Axis Motor 5,77 Nm, 3.000 with resolver		
1	FXM 33.30A.R0.000	Axis Motor 5.77 Nm, 3,000 with resolver		
2	MC 23	Motor power connectors (socket)		
2	AXD 1.15-A1-1	15 Amp axis drives with encoder simulator		
1	SPM 112LE.E0.00000.0	7.5 Kw S1 spindle (1,500 at 7,500 rpm)		
1	SPD 2.50-A1-1	50 Amp spindle drive with encoder simulator		
1	PS-25A	25 Kw Power supply		
2	REC - 5	5 m Resolver extension Cable		
1	EEC - 5	5 m Resolver extension Cable		
3	SEC - 1	1m Signal Encoder Cable		
	TOTAL DRIVE SYSTEM			

Manufacturing Codes

POWER SUPPLIES AND ACCESSORIES

PS-25	84070000	XPS-25	84070005	POWER-PRO 36A	04600050
PS-65	84070002	XPS-65	84070006	POWER-PRO 110A	04600052
PS-25A	84070003	CHOKE XPS-25	84090010	EMK 3040	04600060
PS-65A	84070004	CHOKE XPS-65	84090011	EMK 3120	04600061
PS-25B		CM-60	84070010	DDS PROG MODULE	84090000
		RM-15	84070011		
APS 24	84090001			ER-43/350	84200002
				ER-24/750	84200003
				ER-18/1100	84200004

CABLES AND CONNECTORS

EEC-5	84080003	MPC-4x1,5	04040152	MC 23	84080050
EEC-10	84080004	MPC-4x2,5	04040153	MC 46	84080051
EEC-15	84080005	MPC-4x4	04040154	MC 80	
EEC-20	84080006	MPC-4x6	04040155	AMC 23	84080052
EEC-25	84080007	MPC-4x10	04040156	AMC 46	84080053
		MPC-4x16	04040157		
SEC-1	84040050			E0C 12	84080110
SEC-3	84040051	MPC-4x1,5+(2x1)	04040165	R0C 9	84080111
SEC-5	84040052	MPC-4x2,5+(2x1)	04040166		
SEC-10	84040053	MPC-4x4+(2x1)	04040167	SFO-1	83900010
SEC-15	84040054	MPC-4x6+(2x1)	04040168	SFO-2	83900011
SEC-20	84040055	MPC-4x10+(2x1)	04040169	SFO-3	83900012
		MPC-4x16+(2x1,5)	04040170	SFO-5	83900013
REC-5	84080010	MPC-4x25+(2x1)	04040173	SFO-7	83900014
REC-10	84080011	MPC-4x35+(2x1)	04040174		
REC-15	84080012				
REC-20	84080013				
REC-25	84080014				
ENCODER CABLE	84040040				
RESOLVER CABLE	84040041				

OTHERS

DDS-SETUP	84080150	MAN REGUL (CAS)	04754000	MODULAR QUICK REF	14460010
		MAN REGUL (IN)	04754001	COMPACT QUICK REF	14460012
		MAN DDS MC (CAS)	04754010		
		MAN DDS MC (IN)	04754011		

MODULAR AXES DRIVES

AXD 1.08-A1-0	84010000	AXD 1.08.S0.0	84010013	AXD 1.08-SI-0	84010010
AXD 1.08-A1-1	84010001	AXD 1.08.S0.1	84010014	AXD 1.08-SI-1	84010011
AXD 1.15-A1-0	84010015	AXD 1.15.S0.0	84010028	AXD 1.15-SI-0	84010025
AXD 1.15-A1-1	84010016	AXD 1.15.S0.1	84010029	AXD 1.15-SI-1	84010026
AXD 1.25-A1-0	84010030	AXD 1.25.S0.0	84010043	AXD 1.25-SI-0	84010040
AXD 1.25-A1-1	84010031	AXD 1.25.S0.1	84010044	AXD 1.25-SI-1	84010041
AXD 1.35-A1-0	84010050	AXD 1.35-S0-0	84010045	AXD 1.35-SI-0	84010056
AXD 1.35-A1-1	84010051	AXD 1.35-S0-1	84010046	AXD 1.35-SI-1	84010057
AXD 2.50-A1-0	84010060	AXD 2.50.S0.0	84010073	AXD 2.50-SI-0	84010070
AXD 2.50-A1-1	84010061	AXD 2.50.S0.1	84010074	AXD 2.50-SI-1	84010071
AXD 2.75-A1-0	84010075	AXD 2.75.S0.0	84010088	AXD 2.75-SI-0	84010085
AXD 2.75-A1-1	84010076	AXD 2.75.S0.1	84010089	AXD 2.75-SI-1	84010086
AXD 3.100-A1-0	84010100	AXD 3.100.S0.0	84010113	AXD 3.100-SI-0	84010110
AXD 3.100-A1-1	84010101	AXD 3.100.S0.1	84010114	AXD 3.100-SI-1	84010111
AXD 3.150-A1-0	84010115	AXD 3.150.S0.0	84010128	AXD 3.150-SI-0	84010125
AXD 3.150-A1-1	84010116	AXD 3.150.S0.1	84010129	AXD 3.150-SI-1	84010126

MODULAR SPINDLE DRIVES

SPD 1.08-A1-0	84050000	SPD 1.08-S0-0	84050013	SPD 1.08-SI-0	84050010
SPD 1.08-A1-1	84050001	SPD 1.08-S0-1	84050014	SPD 1.08-SI-1	84050011
SPD 1.15-A1-0	84050015	SPD 1.15-S0-0	84050028	SPD 1.15-SI-0	84050025
SPD 1.15-A1-1	84050016	SPD 1.15-S0-1	84050029	SPD 1.15-SI-1	84050026
SPD 1.25-A1-0	84050030	SPD 1.25-S0-0	84050043	SPD 1.25-SI-0	84050040
SPD 1.25-A1-1	84050031	SPD 1.25-S0-1	84050044	SPD 1.25-SI-1	84050041
SPD 1.35-A1-0	84050080	SPD 1.35-S0-0	84050090	SPD 1.35-SI-0	84050086
SPD 1.35-A1-1	84050081	SPD 1.35-S0-1	84050091	SPD 1.35-SI-1	84050087
SPD 2.50-A1-0	84050050	SPD 2.50-S0-0	84050063	SPD 2.50-SI-0	84050060
SPD 2.50-A1-1	84050051	SPD 2.50-S0-1	84050064	SPD 2.50-SI-1	84050061
SPD 2.75-A1-0	84050065	SPD 2.75-S0-0	84050078	SPD 2.75-SI-0	84050075
SPD 2.75-A1-1	84050066	SPD 2.75-S0-1	84050079	SPD 2.75-SI-1	84050076
SPD 3.100-A1-0	84050100	SPD 3.100-S0-0	84050113	SPD 3.100-SI-0	84050110
SPD 3.100-A1-1	84050101	SPD 3.100-S0-1	84050114	SPD 3.100-SI-1	84050111
SPD 3.150-A1-0	84080115	SPD 3.150-S0-0	84050128	SPD 3.150-SI-0	84050125
SPD 3.150-A1-1	84050116	SPD 3.150-S0-1	84050129	SPD 3.150-SI-1	84050126

COMPACT AXES DRIVES

ACD 1.08-A1-0	84060000	ACD 1.08.S0.0	84060150	ACD 1.08-SI-0	84060006
ACD 1.08-A1-1	84060001	ACD 1.08.S0.1	84060151	ACD 1.08-SI-1	84060007
ACD 1.15-A1-0	84060010	ACD 1.15.S0.0	84060160	ACD 1.15-SI-0	84060016
ACD 1.15-A1-1	84060011	ACD 1.15.S0.1	84060161	ACD 1.15-SI-1	84060017
ACD 1.25-A1-0	84060020	ACD 1.25.S0.0	84060170	ACD 1.25-SI-0	84060026
ACD 1.25-A1-1	84060021	ACD 1.25.S0.1	84060171	ACD 1.25-SI-1	84060027
ACD 2.50-A1-0	84060100	ACD 2.50.S0.0	84060180	ACD 2.50-SI-0	84060106
ACD 2.50-A1-1	84060101	ACD 2.50.S0.1	84060181	ACD 2.50-SI-1	84060107
ACD 2.75-A1-0	84060120	ACD 2.75.S0.0	84060190	ACD 2.75-SI-0	84060126
ACD 2.75-A1-1	84060121	ACD 2.75.S0.1	84060191	ACD 2.75-SI-1	84060127

COMPACT SPINDLE DRIVES

SCD 1.08-A1-0	84060030	SCD 1.08.S0.0	84060060	SCD 1.08-SI-0	84060036
SCD 1.08-A1-1	84060031	SCD 1.08.S0.1	84060061	SCD 1.08-SI-1	84060037
SCD 1.15-A1-0	84060040	SCD 1.15.S0.0	84060070	SCD 1.15-SI-0	84060046
SCD 1.15-A1-1	84060041	SCD 1.15.S0.1	84060071	SCD 1.15-SI-1	84060047
SCD 1.25-A1-0	84060050	SCD 1.25.S0.0	84060080	SCD 1.25-SI-0	84060056
SCD 1.25-A1-1	84060051	SCD 1.25.S0.1	84060081	SCD 1.25-SI-1	84060057
SCD 2.50-A1-0	84060200	SCD 2.50.S0.0	84060111	SCD 2.50-SI-0	84060206
SCD 2.50-A1-1	84060201	SCD 2.50.S0.1	84060112	SCD 2.50-SI-1	84060207
SCD 2.75-A1-0	84060220	SCD 2.75.S0.0	84060131	SCD 2.75-SI-0	84060226
SCD 2.75-A1-1	84060221	SCD 2.75.S0.1	84060132	SCD 2.75-SI-1	84060227

Accessories supplied in a plastic bag with the modules.

ELEMENT	POWER SUPPLIES						MODULAR DRIVES			COMPACTO DRIVES		ACCESORY MODULES	
	PS-25B	PS-25A	PS-65A	XPS-25	XPS-65	APS 24	AXD 1 SPD 1	AXD 2 SPD 2	AXD 3 SPD 3	SCD 1 ACD 1	SCD 2 ACD 2	RM-15	CM-60
Connection plates (77 mm)	3	3		3		3	3						
Connection plates (117 mm)			3		3			3	6				3
Hex nut M6	3	3	3	3	3	3	3	3	6	1	1	1	3
Washer B6.4MS	6	6	6	6	6	6	6	6	12	1	1	2	6
Washer 6AZ	3	3	3	3	3	3	3	3	6	1	1	1	3
Power connector PC-4, 10-pins + cable										1			
Power connector PC-4, 3-pins							1 (*)						
Thermo-Switch connector, 2-pins												1	
1.25 Amp. fuses	1	1	1										
1 Amp. fuses										2	2		
2.5 Amp. fuses							2	2	2				
10-wire ribbon cable set	1	1	1	1	1		1	1	1	1	1		
Phoenix 10p. 5mm female connector		1	1							1	1		
Phoenix 7p. 5mm female connector	1			1	1								
Phoenix 8p. 5mm female connector							1	1	1				
Phoenix 3p. 7.6mm female connector	1			1	1	1				1	1		
Phoenix 3p. 5mm female connector	3			3	3	3							
Sub-D 26 HD - Male connector							1	1	1	1	1		
SUB-D 26pin connector hood							1	1	1	1	1		
Sub-D 9 pin - female connector							1	1	1	1	1		
SUB-D 9 pin connector hood							1	1	1	1	1		
Optional digital and analog I/O board													
13 pin female connector							1	1	1	1	1		
11 pin female connector							1	1	1	1	1		
Encoder simulator option													
Sub-D 15 HD - female connector							1	1	1	1	1		
SUB-D 9pin connector hood							1	1	1	1	1		
SERCOS interface option:													
250 mm fiber optic cable							1	1	1	1	1		

(*) Except the AXD and SPD 1.35 modules

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APPENDIX D:

COMPATIBILITY

1. MAINS VOLTAGE: 380 - 460

Originally, the drives and power supplies were designed for a mains voltage of 380 Vac, 50Hz/60Hz. They have now been redesigned to work with mains voltage ranging between 380 Vac and 460 Vac at 50Hz/60 Hz.

They are identified as:

	Elements for 380 Vac	Elements for 380-460 Vac
Power Supplies	Fagor Automation, S.Coop.(Spain) MODEL PS-25 INPUT 3x380 Vac 50/60Hz OUTPUT 600 Vdc 45A	Fagor Automation, S.Coop.(Spain) MODEL PS-25A INPUT 3x380÷460Vac 50/60Hz OUTPUT 537-650 Vdc 45A
Drives	Fagor Automation, S.Coop.(Spain) MODEL AXD 1.15-A1-1 INPUT 600-800 Vdc OUTPUT 3x380 Vac 7A 0-800Hz	Fagor Automation, S.Coop.(Spain) MODEL AXD 1.15-A1-1 INPUT 456-800 Vdc OUTPUT 3x0÷460 Vac 7A 0-800Hz

Compatibility:

The elements ready for mains voltage between 380 Vac and 460 Vac:
- **Drive (version MSC 12A and later),**
- **Auxiliary power supply "APS 24" (version PF 05A and later),**
- **Capacitor module "CM-602" (version 01A and later) and**
- **Mains Filters EMK**

are compatible with all the "PS" and "XPS" power supplies.

The elements ready for a mains voltage of 380 Vac:
- **Drive (version MSC 11A and older),**
- **Auxiliary power supply "APS 24" (version PF 04A and older),**
- **Capacitor module "CM-60" (version 00A) and**
- **Mains Filters Power-Pro**

are not compatible with "PS-xxA" and "XPS" power supplies.

Replacing a 380 Vac module with a 460Vac module:

New drive "MSC 12A".
New capacitor module "01A".
New Auxiliary Power Supply APS 24 "PF 05A".
They may be incorporated into any servo drive system regardless of its power supply.

New power supply "PS-xxA".
If the system includes any element for a mains voltage of 380 Vac:
An "MSC 11A" drive, or an APS 24 power supply "PF 04A", or a Capacitor module CM-60 "00A" it needs a "PS-xx" power supply.
(the "PS-xx" is nothing but a "PS-xxA" factory limited to work at 380 Vac)
It will take a mains voltage limited to 380 Vac.

Obviously, if the system includes only "MSC 12A" drives, there is no problem.
It will take a mains voltage range of 380-460 Vac.

New Power Supply PS-25B.
If the system includes an element for a Mains voltage of 380 Vac:
an "MSC 11A" drive or a Capacitor module CM-60 "00A", the PS-25B must be set up to work at 380 Vac.
It will admit a Mains voltage limited to 380 Vac.

Note: The new Compact Drives (version MSC 05A and later) are designed to also run at 380-460 Vac but they have no compatibility problems with previous equipment.

2. VECON BOARD 03A - SOFTWARE 03.03

The new Vecon board version (03A) expands the capacity of its Flash memory and improves the Flash and RAM memory speed.

This improved Vecon board is related to software version v03.03.

This board (VEC 03A) is incompatible with software version 03.02 and older.

However, the software version 03.03 **is** compatible with Vecon board versions older than VEC 03A.

3. 03A VECON BOARD - SOFTWARE MC+PLC

Software version v04.01 includes the options of Motion control (MC) and PLC.

This v04.01 option is compatible with Vecon boards with versions older than VEC 03A, but:

The Motion Control (MC) and PLC implemented in version v04.01 require a Vecon board version VEC 03A.

User notes:

APPENDIX E:

PROTECTIONS ON DRIVES AND MOTORS

PROTECTIONS AGAINST OVERCURRENT AND OVERTEMPERATURE ON DRIVES AND MOTORS

This document describes the various limitations and monitoring that the drive carries out to protect the servo system against excessive temperature and current.

1. PROTECTIONS OF THE DRIVE

The elements setting the current limit through the drive are the power semiconductors IGBTs. The range of Fagor drives carry IGBTs whose maximum current (I_{IGBT}) ranges between 8A and 150A as shown in the table below.

AXD, SPD, ACD, SCD	1.08	1.15	1.25	1.35	2.50	2.75	3.10-0	3.15-0
I_{IGBT}	8	15	25	35	50	75	100	150

The IGBTs of the drive may be damaged if:

- The current exceeds the permitted peak value. To prevent this, the drive limits the current command it will attend to ($i_{command}$) and watches the real instantaneous current (i_{real}). See section 1.1 in this Appendix.
- The drive works with over-demanding duty cycles that cause the rms current to exceed the maximum permitted. This causes the IGBTs to overhear. To prevent this, there are two protections:
    - Some thermal sensors located on the heat-sink watch the actual temperature of these power semiconductors. See section 1.2.
    - The drive estimates this rms current with the integral of the I^2t product. This gives an estimate of the temperature of the IGBTs. See section 1.3.

1.1 PEAK CURRENT LIMIT AT THE DRIVE

The operator may adjust the value of parameter CP20 -F00307- to limit the current command. This way, the drive will never attend to current commands exceeding the I_{peak}.

Parameter setting:

CP20 < i_{peak}

Bear in mind that:

$Ipeak = I_{IGBT}$ on synchronous motors

$Ipeak = \frac{I_{IGBT}}{\sqrt{2}}$ on asynchronous motors

Monitoring:

if (I_{real} > k * I_{IGBT}) => the current will be temporarily cut off

where the value of k is: 1.5 on synchronous motors
1.33 on asynchronous motors.

When exceeding this limit, the drive will cut off the current and when the current returns below this limit, it will be activated back. Working in this area will cause undesired current oscillations.

If (I_{real} > 1.6 * I_{IGBT}) => it will issue error 212

Exceeding this limit would damage the IGBTs.

1.2 TEMPERATURE SENSORS ON THE HEAT-SINK.

There is a temperature sensor (gage) on the drive's heat-sink.
KV10 -F01102- variable provides information about this temperature.

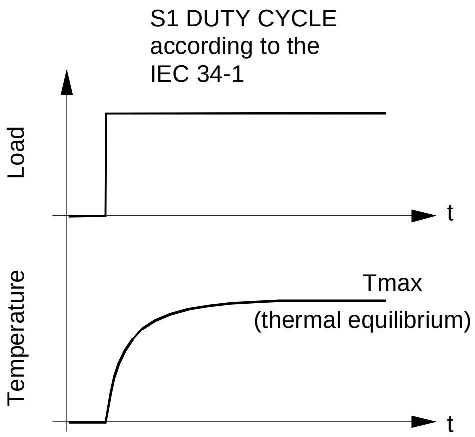
KV10 (F01102) CoolingTemperature

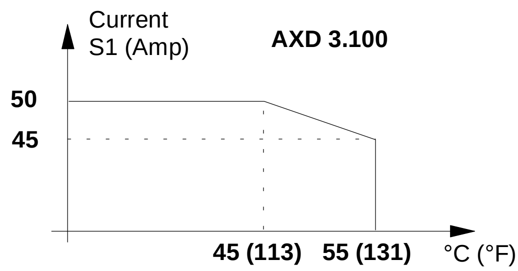
Function: Reading of the heat-sink temperature of the module
Units: Tenths of degree Centigrade

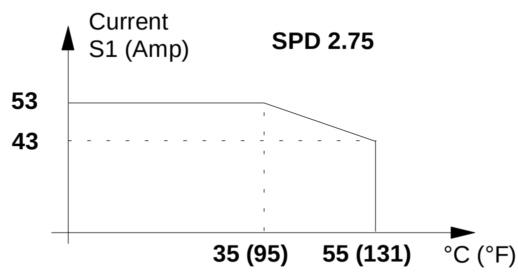
1.3 PERMANENT DUTY CYCLES ALLOWED TO THE DRIVE, CALCULATING THE I2T PRODUCT.

Chapter EM indicates which is the maximum current allowed for permanent duty cycles (S1). The higher the ambient temperature, the lower the capabilities of the drive. Thus, the operator must decrease the demands in the duty cycles. This effect of the temperature is called "power Derating".

The graphs below include two examples of Derating. The duty cycle S1 means a constant load that brings the system to its maximum temperature.







The drive estimates the temperature of the IGBTs based on the rms current circulating through them.

The following equation calculates the rms current: $Irms = \int_{t+\tau}^{t} i^2(t) \cdot d(t)$

This temperature estimate is based on the calculation we call I^2t.

If this temperature exceeds a predetermined value, **error 202** will be activated Drive overload.

For a system with some particular IGBTs, the drive allows rms currents (estimated by calculating the I^2t) of:

$Irms = 0.5 \cdot I_{IGBT}$ for synchronous motors.

$Irms = \frac{I_{IGBT}}{\sqrt{2}}$ for asynchronous motors.

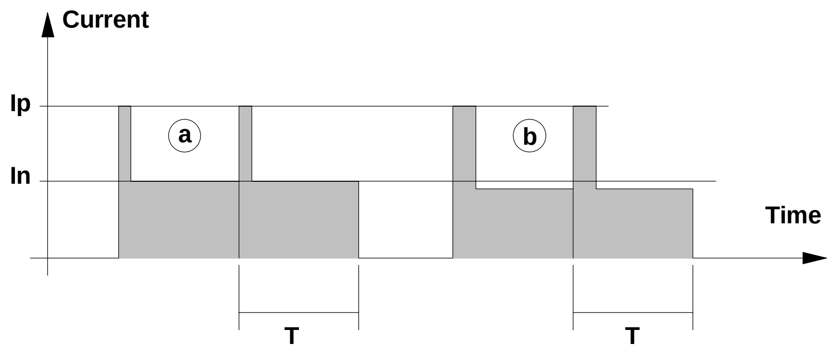
Calculating the I^2t implies an ambient temperature of 40°C (104°F). For temperatures of up to 55°C (131°F) (the maximum allowed) and since the driver does not know the actual ambient temperature, this protection may not be sufficient. In this case and if the operator would use a cycle which would exceed the derating, it could damage the drive.

As soon as it is possible to vary the frequency of the PWM, the maximum limit of the I^2t allowed it will adapt automatically in order to consider the losses in the commutations corresponding to each frequency.

Equivalent duty cycles.

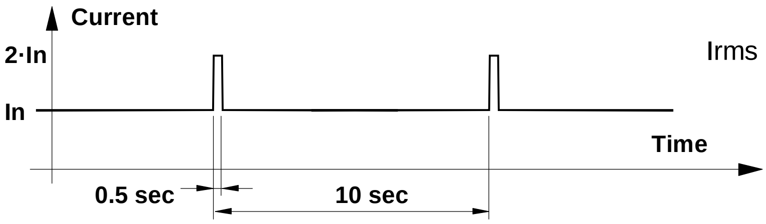
These drives will also admit any other equivalent duty cycle whose rms current is the one permitted in its derating graph.

The graph below shows an example of two equivalent duty cycles. The integral of the I^2t is the same in both cases even when the integral of the It product is greater in the first case (a).



Typical cycle of the drive for synchronous motors.

The synchronous drive withstands, for example, cycles equivalent to this one:



$$Irms = \sqrt{(2 \cdot In)^2 \cdot \frac{0.5}{10} + In^2 \cdot \frac{9.5}{10}} = 1.07 \cdot In$$

Where In is the rated current which is the following for each drive (in Amps):

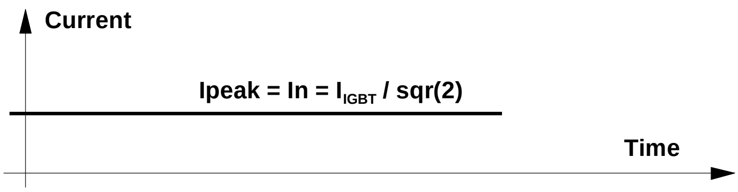
AXD, ACD	1.08	1.15	1.25	1.35	2.50	2.75	3.100	3.150
In	4	7.5	12.5	17.5	25	37.5	50	75
Ipeak	8	15	25	35	50	75	100	150

$$Ipeak = I_{IGBT} = 2 \cdot In$$

As long as the IGBTs are below their rated working temperature (for example, on start-up) they will be allowed some more demanding initial cycles.

Typical cycle of the drive for asynchronous motors.

The asynchronous drive withstands indefinitely cycles equivalent to their rated current In, which is also the maximum it can offer (that is: I_{peak}=In). The maximum current limit is sufficient to protect the asynchronous drives and, consequently, do not need the calculation of the I^2t.



Where In is the rated current which is the following for each drive (in Amps):

AXD, ACD	1.08	1.15	1.25	1.35	2.50	2.75	3.100	3.150
Ipeak = In	5.6	10.6	19.6	28.5	35.4	53	80	106

2. PROTECTIONS OF THE MOTOR

The mechanical power limit of a motor is determined, among other causes, by the maximum temperature allowed in its windings and, in motors with permanent magnets, by the conservation of its magnetic properties.

As with the protection of the drives, the protection of the motors is watched in three modes at the same time:

- Watch that the current does not exceed the maximum peak value permitted. To prevent this, the drive limits the current command which it will attend to ($i_{command}$) and it watches the real instantaneous current (i_{real}). See section 2.1.
- In permanent duty cycles, the motor temperature is monitored—
    - by thermal sensors located in the motor. See section 2.2.
    - by estimating the rms current based on the integral of the I^2t product. This offers a temperature estimate. See section 2.3.

2.1 PEAK CURRENT LIMIT AT THE MOTOR.

The operator may adjust the value of its parameter CP20 -F00307- to limit the current command. Thus, the drive will never attend to current commands exceeding MP4 -S00109-, which is the maximum peak current allowed at the motor.

That maximum peak current MP4 -S00109- is the one shown in the table of section SM.2 of the general manual. This data is not related to any duty cycle (S3 or S6). It only sets a preventive current limit to avoid demagnetizing the motor.

CP20 < MP4

MP4 -S00109- is a parameter for synchronous motors only.
In asynchronous motors, the current command is not monitored.

2.2 TEMPERATURE SENSORS IN THE MOTOR.

The motors have an overtemperature sensor (gage) PTC.
It is a triple sensor which permits detecting overtemperatures in the windings of each phase. This sensor is connected to the drive through the feedback cable of the motor itself. **Error 108** will be issued when the limit temperature for the motor is reached (which in Class F is 150°C (302°F)).

The asynchronous motor also has a thermal Klixon switch that opens when those 150°C are reached. This switch must be included in the emergency chain of the electrical cabinet.

2.3 PERMANENT DUTY CYCLES ALLOWED FOR THE MOTOR, CALCULATING THE I2T PRODUCT.

The drive software offers a procedure to calculate the integral of I^2t applied to both the synchronous and asynchronous motors.

The permanent watch of the I^2t product tolerates any equivalent duty cycle producing a maximum temperature equal to the one produced in the S1 cycle with a time constant set by parameter MP13 -F01209- MotorThermalTimeConstant

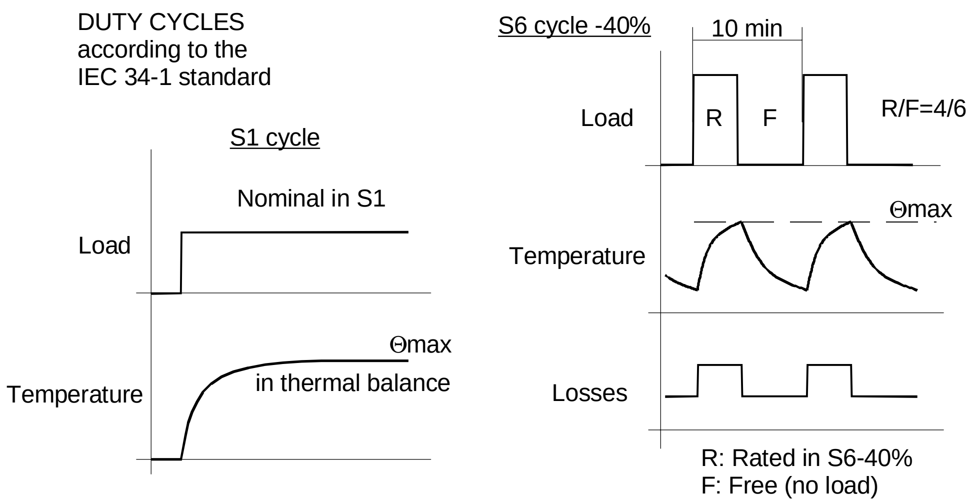
However, the overheating caused by very high peak currents cannot be modelled with the I^2t calculation. In this case, the temperature sensors of the motors will be the ones detecting the overheating.

Synchronous Motors

The table of chapter SM indicates the rated currents and the maximum peak currents at the motors.

Asynchronous Motors

The table of chapter AM describes the maximum currents through the motor in the S1 and S6 duty cycles. When increasing the ambient temperature and the altitude, the operator must decrease the demand on the requested cycles.



3. EXTERNAL MONITORING OF THE REAL I^2T LEVELS.

The user may know the effort level of the drive by checking the value of the I^2t product through the variable: realvalue: KV32 -F01109- I2tDrive

The user may know the effort level of the motor by checking the value of the I^2t product through the variable: realvalue: KV36 -F01111- I2tMotor

These values are given as "percentage used over the maximum". In software versions prior to V04.01 the units were absolute and it used two more parameters.

To determine whether a duty cycle demands a bearable degree of effort indefinitely from the servo system (drive+motor), it has to be brought to the rated running temperature and then execute that cycle.

By editing these variables: KV32 -F01109- and KV36 -F01111-, it is possible to simulate an "increase" of the temperature of the servo. Later, execute a test cycle. The I^2t calculation will determine whether the servo system withstands or not that particular cycle.

The oscilloscope integrated into the WinDDSSetup may be used to display the KV32 -F01109- and KV36 -F01111- variables during the cycle being analyzed. Then, calculate the I^2t product over the graph and determine whether the servo system can withstand it or not.

4. PROTECTION OF THE EXTERNAL BALLAST RESISTOR

From software version 03.07 on, the Drive internally calculates the i^2t to protect the Ballast resistor of the Compact Modules (ACD and SCD).

If the Compact Module uses an External Ballast Resistor:

The Drive must know the electrical specifications of that external resistor through the following parameters:

KP2 O (F1113) ExtBallastResistance

Function: It contains the ohm value of the External Ballast Resistor on a Compact Drive.
Valid values: 0..6K5 (0 by default)

KP3 O (F1114) ExtBallastPower

Function: It contains the power value of the External Ballast Resistor on a Compact Drive.
Valid values: 0..65 kw (0 by default)

KP4 O (F1116) ExtBallastEnergyPulse

Function: It contains the value of the energy pulse that can be dissipated through the External Ballast Resistor on a Compact Drive.
Valid values: 0..65 kWs (0 by default)

KV40 (F1115) ExtBallastOverload

Function: It shows the % of overload on the External Ballast resistor for a Compact Drive. A value greater than 100% at this variable will trigger error message 301.

If the Compact Module DOES NOT use an External Ballast Resistor:

The software knows the specifications of the resistors of each Compact Drive model and monitors the i^2t on its own.

Important: If any of the KP2, KP3 or KP4 parameters is set to "0", the i^2t protection will be carried out according to the characteristics of the internal resistors of the modules.

Important: If all three parameters KP2, KP3 and KP4 are set to "65535" the i^2t protection will be disabled.

5. PROTECTION AGAINST A MAINS PHASE DROP

From drive software version 03.07 on and with MSC board version 06A or later, the Compact Modules (ACD and SCD) monitor the presence of all three mains phases.

Should any of them drop for over 10 msecs, Error 3 will be triggered.

User notes: