DDS - HARDWARE

SERVO DRIVE SYSTEM
HARDWARE MANUAL

FAGOR

Ref.1109

GENERAL INDEX

- ABOUT THIS MANUAL -

Title

Servo drive system. Hardware manual.

Type of documentation

Description, installation and start-up of digital servo drives.

Internal code

It belongs to the manual directed to the manufacturer (OEM). The manual code depends on the software version: standard or advanced.

MAN REGUL (IN)	STAN	Code 04754000
MAN REGUL (IN)	AVANZ	Code 04754021

Manual reference

Ref.1109.

Startup

Verify that the machine on which the servo system is installed complies with European Directive 2006/42/EC on machine safety.

Before starting the servo drive system up, read the instructions in chapter 1 of this manual.

Warning

The information described in this manual may be subject to changes due to technical modifications.

FAGOR AUTOMATION, S. Coop. reserves the right to change the contents of this manual without prior notice.

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- ABOUT THE PRODUCT -

Software options

Bear in mind that some of the features or applications described in this manual depend on the software version installed.

These considerations are reflected in the "dds-software" manual supplied with this one.

- VERSION HISTORY -

The history of versions shows the list of the hardware elements added in each manual version. To know the features added in each software version and the version of the manual that describes them, see the "dds-software" manual that is supplied with this one.

Manual reference	Events
9702	First version
9707	PS-65, RM-15, CM-60, APS-24, AXD / SPD 3.xx
9802	Compact 8, 25, 50, 75, DDS PROG MODULE
9810	XPS-25, XPS-65.
9904	New fanned motors FXM. New SPM 180M motor. New products (mains voltage 460 V AC). Description and installation of the XPS. New drive AXD / SPD 1.35 EMK filters
0002 (only in CD Rom)	SPMxx.1 Motors PS-25B3 and PS-25B4 ER resistors WinDDSSetup Improved AXD / SPD 1.15. Digital I/O boards
0103	No new hardware has been implemented
0112	FXM motors at 400-15% V AC MMC and CMC drives ACD / SCD 1.08 / 1.15 drive (compact) Crowbar resistor: ER-18/1800 and ER-18/2200 RS-422 interface for MMC and CMC drives
0303	New drive SPD 2.85 New drive SPD 3.200 New capacitor module CM 1.60 (replaces the previous CM 60) New spindle motors FM7 (E01 and E02 versions)
0305	New encoder E3 (similar to E2 but with tapered shaft).
0310	No new hardware has been implemented
0403	From February of 2004 on, compact drive modules ACD 2.50, SCD 2.50, ACD 2.75, SCD 2.75, CMC 2.50, CMC 2.75 and the programming module DDS PROG MODULE will no longer be in Fagor Automation' catalog. However, all the documentation regarding them is kept in this manual just in case the user has already purchased any of these modules.

Manual reference	Events
0405	From this version on, our catalogs show the mains filter model MAINS FILTER 42A and MAINS FILTER 130A.
0407	No new hardware has been implemented.
0410	New SERCOS board (transmission speed up to 16Mbd)
0602	New compact drives: ACD / SCD / CMC 1.25A New compact drives: ACD / SCD / CMC 2.35 New resistors: ER-33/550 and ER-18/900 (as accessory) Regenerative regulated power supplies. Boost (step-up) power Supplies: RPS-75, RPS-45 and RPS-20. Choke RPS-75, choke RPS-45 and choke RPS-20.
0606	No new hardware has been implemented.
0612	New choke XPS-65 (smaller and lighter).
0706	New VECON3 board Sales references of the glass fiber optic cable SF0-V-FLEX New ER-18/1000+FAN resistor with fan.
0710	No new hardware has been implemented.
0802	New compact drives: ACD / SCD / CMC 2.50. There are now 3 switches for selecting the ballast resistor on PS-25B4 power supplies. New CAPMOTOR-2 board.
0806	The choke RPS-75-3 replaces the choke RPS-75. There are now 3 switches for selecting the ballast resistor on PS-65A power supplies.
0811	The following are being replaced: External 18 Ω /1800 W Ballast resistor that is supplied as an accessory in certain units for 18Ω/1800W with internal thermostat. External Ballast resistor ER-18/2200 by ER+TH-18/2200 with internal thermostat
0905	External 24Ω/750W Ballast resistor that is supplied as an accessory in certain units for 24Ω/750W with external thermostat. Changing the power connector for motor connection at SPD 3.200 drives.
1003	The external ballast resistor with fan ER-18/1000+FAN has been replaced with the new ER+TH-18/1000+FAN with fan and external thermostat. The auxiliary APS 24 power supply has been modified and it can now be connected to the DC bus of the PS, XPS and RPS power supplies. New regenerative regulated power supply RPS-80 New modular spindle drive SPD 3.250
1107	No new hardware has been implemented.
1109	No new hardware has been implemented.

0.

- DECLARATION OF CONFORMITY -

Manufacturer Fagor Automation S.Coop.
Bº San Andrés 19; C.P. 20500, Mondragón, Gipuzkoa - Spain.

We hereby declare, under our responsibility that the product:

DDS SERVO DRIVE SYSTEM

consisting of the following modules and accessories:

PS-25B4, PS-65A, APS-24
XPS-25, XPS-65,
RPS-80, RPS-75, RPS-45, RPS-20
APS-24
AXD/SPD/MMC 1.08, 1.15, 1.25, 1.35
AXD/SPD/MMC 2.50, 2.75, 2.85
AXD/SPD/MMC 3.100, 3.150, 3.200, 3.250
ACD/SCD/CMC 1.08, 1.15, 1.25
ACD/SCD/CMC 2.35, 2.50
ER+TH, ER+TH-18/x+FAN, CM 1.60, CHOKE
MAINS FILTER 42A, MAINS FILTER 130A, MAINS FILTER 180A
FXM, FKM, FM7, FM9

Note. Some additional characters may follow the model references indicated above. They all comply with the directives listed here. However, compliance may be verified on the label of the unit itself.

mentioned on this declaration, meet the requirements on:

Safety

EN 60204 -1: 2006 — Machinery safety. Electrical equipment of the machines.
Part 1: General requirements.

Electromagnetic compatibility

EN 61800 -3: 2004 — EMC directive on servo drive systems.

In compliance with EC directives 2006/95/EC on low voltage and 2004/108/CE on Electrical Compatibility.

Fagor Automation, S. Coop.

Director Gerente
Pedro Ruiz de Aguirre

In Mondragón July 1st 2009

FAGOR

DDS
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- SAFETY CONDITIONS -

Read the following safety instructions in order to prevent harming people and damage to this product or to the products connected to it.

The unit can only be repaired by personnel authorized by Fagor Automation.

Fagor Automation shall not be held responsible of any physical or material damage originated from not complying with these basic safety rules.

Precautions against personal harm

- **Use the right mains cables.**
  In order to avoid risks, use only the SERCOS and mains cables recommended for this unit.
- **Avoid electric shocks.**
  To avoid electric shocks and the risk of fire, do not apply electrical voltage beyond the range indicated in this manual.
- **Make the ground connection.**
  In order to avoid electric shocks, connect the ground terminal of this unit to the main ground point. Also, before connecting the inputs and outputs, make sure that the ground connection has been done.
- **Make sure that the ground connection has been made.**
  In order to avoid electric shocks, before turning the unit on, make sure that the ground connection has been made.
- **Make sure not to work in humid environments.**
  To avoid electric shocks, always work in environments where relative humidity is lower than 90% without condensation at 45°C (113°F).
- **Make sure not to work in explosive environments.**
  In order to avoid risks, harm or damages, do not work in explosive environments.

Precautions against damage to the product

- **Work environment.**
  This unit is ready to be used in industrial environments and comply with the current directives and regulations of the European Community.
  Fagor Automation shall not be held responsible for any damage that could suffer or cause when installed under other conditions (residential or domestic environments).
- **Install the unit in the right place.**
  We recommend that, whenever possible, the servo drive system be installed away from coolants, chemicals, blows, etc. that could damage it.
  This unit meets the European directives on electromagnetic compatibility. Nevertheless, it is recommended to keep it away from sources of electromagnetic disturbance, such as:
  - Powerful loads connected to the same mains as the unit.
  - Portable nearby transmitters (radio-telephones, CB radio emitters).
  - Nearby radio/TV transmitters.
  - Nearby arc welding machines.
  - Nearby high voltage lines.
  - ...
- **Enclosures.**
  It is up to the manufacturer to guarantee that the enclosure where the unit has been installed meets all the relevant directives of the European Union.

- **Connecting the power supply to ground.**
  The zero Volt point of the external power supply must be connected to the main ground point of the machine.

Precautions during repairs

- **Do not access the inside of this unit.**
  Only personnel authorized by Fagor Automation may access the interior of this unit.
- **Do not handle the connectors while the unit is connected to mains.**
  Before handling the connectors (mains, moving power, feedback, ...) make sure that the unit is not connected to mains.

Safety symbols

- **Symbols that may appear in this manual.**

Danger or prohibition symbol.

It indicates the actions or operations that could harm people or units.

Warning or caution symbol.

It indicates situations that could be caused by certain operations and the actions to take to prevent them.

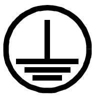
Mandatory symbol.

It indicates actions or operations that MUST be carried out.

Information symbol.

It indicates notes, warnings and advises.

- **Symbols that the product may carry.**



Ground protection symbol.

It indicates that that point must be under voltage.

- ADDITIONAL NOTES -

Install the DDS servo drive system away from coolants, chemicals, blows, etc that could damage it.

Before turning the unit on, verify that the ground connections have been made properly. See chapter **8. INSTALLATION** of this manual.

In case of a malfunction or product failure, disconnect it and call the technical service department. Do not access the inside of these units.

- RECOMMENDED DOCUMENTATION -

Available manuals

Manual available in electronic format, included in the CD-ROM	Manual available on paper

Product selection guides

Document	Description	Format
man_drive_ord_hand.pdf (only in English)	It describes the products that make up the dds system and allows selecting each element according to the user's needs.	CD-ROM
man_fm7/fm9_ord_hand.pdf (only in English)	It describes the FM7/FM9 asynchronous motors and allows selecting each model according to the user's needs.	CD-ROM
man_fxm_fkm_ord_hand.pdf (only in English)	It describes the synchronous motors and allows selecting each model according to the user's needs.	CD-ROM

Quick references

Document	Description	Format
man_dds_mod_quick_ref.pdf (only in English)	It describes each element that make up the system as well as the most important considerations regarding the installation of motors and modular drives, power supplies and accessories such as cables, connectors, etc.	CD-ROM, paper
man_dds_comp_quick_ref.pdf (only in English)	It describes each element that make up the system as well as the most important considerations regarding the installation of motors and compact drives and accessories such as cables, connectors, etc.	CD-ROM, paper

Servo drive system manuals

Document	Description	Format
man_dds_hard.pdf (in Spanish and **English**) For dds without CAN interface	It describes each device and equipment that make up the servo drive system as well as their installation. Note: Does not include CAN equipment.	CD-ROM, paper
man_dds_soft.pdf (in Spanish and English) For dds without CAN interface	It describes the adjustments of the servo drive system. Available parameters, variables and commands. Features. Operation of the WinDDSSetup software for PC.	CD-ROM, paper
man_dds_hard_canopen.pdf (in Spanish and English) For DDS with CAN interface	It describes each device and equipment that make up the servo drive system as well as their installation in system with CAN interface.	CD-ROM, paper
man_dds_soft_canopen.pdf (in Spanish and English) For DDS with CAN interface	It describes the adjustments of the servo drive system. Available parameters, variables and commands. Features. Operation of the WinDDSSetup software for PC, ... in systems with CAN system.	CD-ROM, paper

Motion Control manuals

Document	Description	Format
man_dds_mc.pdf (in Spanish and English)	It describes PLC programming and the Motion Control programming language and how to use it in the various applications.	

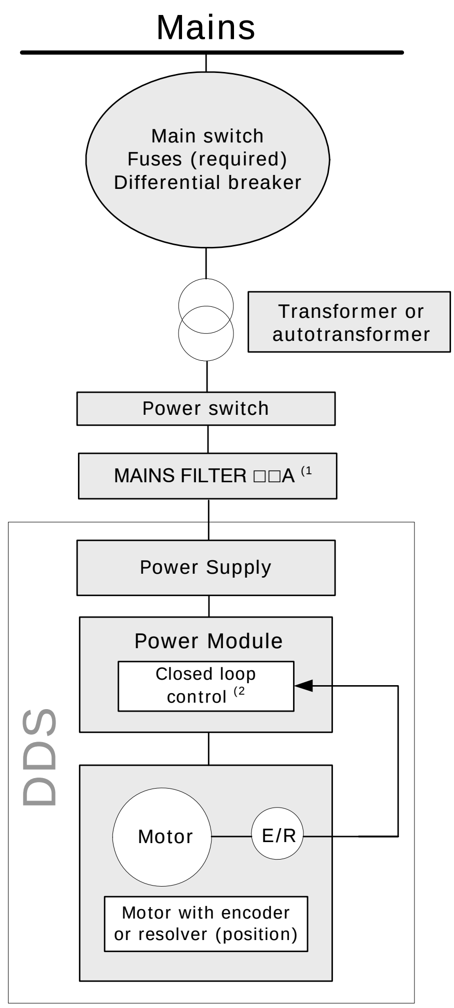
Electric motor manuals

Document	Description	Format
man_fm7_fm9_motors.pdf (in Spanish and English)	They describe the FM7/FM9 series of asynchronous motors of the Fagor catalog and how to install them with the DDS system.	
man_fxm_fkm_motors.pdf (in Spanish and English)	They describe each series of synchronous motors of the Fagor catalog and how to install them with the DDS system.	

1 DESCRIPTION

The DDS servo drive system is ready to be used in industrial environments. It may be used with the CNC to control the movements and devices of the machine.

The configuration of the main DDS servo drive system follows this general diagram:



Note 1. The "MAINS FILTER XXA" may be installed indistinctly before or after the power contactor KM1.

Note 2. The position value may be sent either to the drive or to the CNC to close the loop.

FIGURE H1.1

DDS servo drive system description.

Each element that make up the previous diagram will be explained in detail in the following chapters.

1.1 Description

Fagor Automation's Servo Drive System has a modular stackable design.

It may be connected directly to a TN type three-phase mains with a frequency of 50/60 Hz and with a rated voltage between 400-10% and 460+10% V AC.

This system supplies the electric motors with a three-phase voltage of 400-4.5% V AC and a variable frequency with which it will govern its speed.

Certain mandatory protection devices must be added between the mains lines and the DDS servo drive system. Others may be optional. These elements are:

Main switch	Mandatory
Fuses	Mandatory
Differential breaker	Optional
Transformer or auto-transformer	Optional
Power switch	Mandatory
Mains filter: MAINS FILTER □□A	Mandatory

According to the user's needs, the DDS system may consist of the following modules:

Non - regenerative power supplies	PS
Regenerative power supplies	XPS
Regenerative regulated power supplies (boost power supplies)	RPS
Modular drives:	
Axis velocity and position control	AXD
Spindle velocity and position control	SPD
Axis velocity and position control. It is capable of generating a path on its own	MMC
Compact drives:	
Axis velocity and position control	ACD
Spindle velocity and position control	SCD
Axis velocity and position control. It is capable of generating a path on its own	CMC
Auxiliary power supply module	APS-24
Capacitor module	CM 1.60
Choke	Choke XPS-□□ Choke RPS-75-3 Choke RPS-□□
Resistor module	ER+TH-x/x, ER+TH-18/x+FAN

i

The DDS system has been manufactured in accordance with EN 60204-1 in compliance with European Directive 2006/95/EC on Low Voltage.

1.2 General diagram

See the schematic description of all the elements that make up the DDS servo drive system:

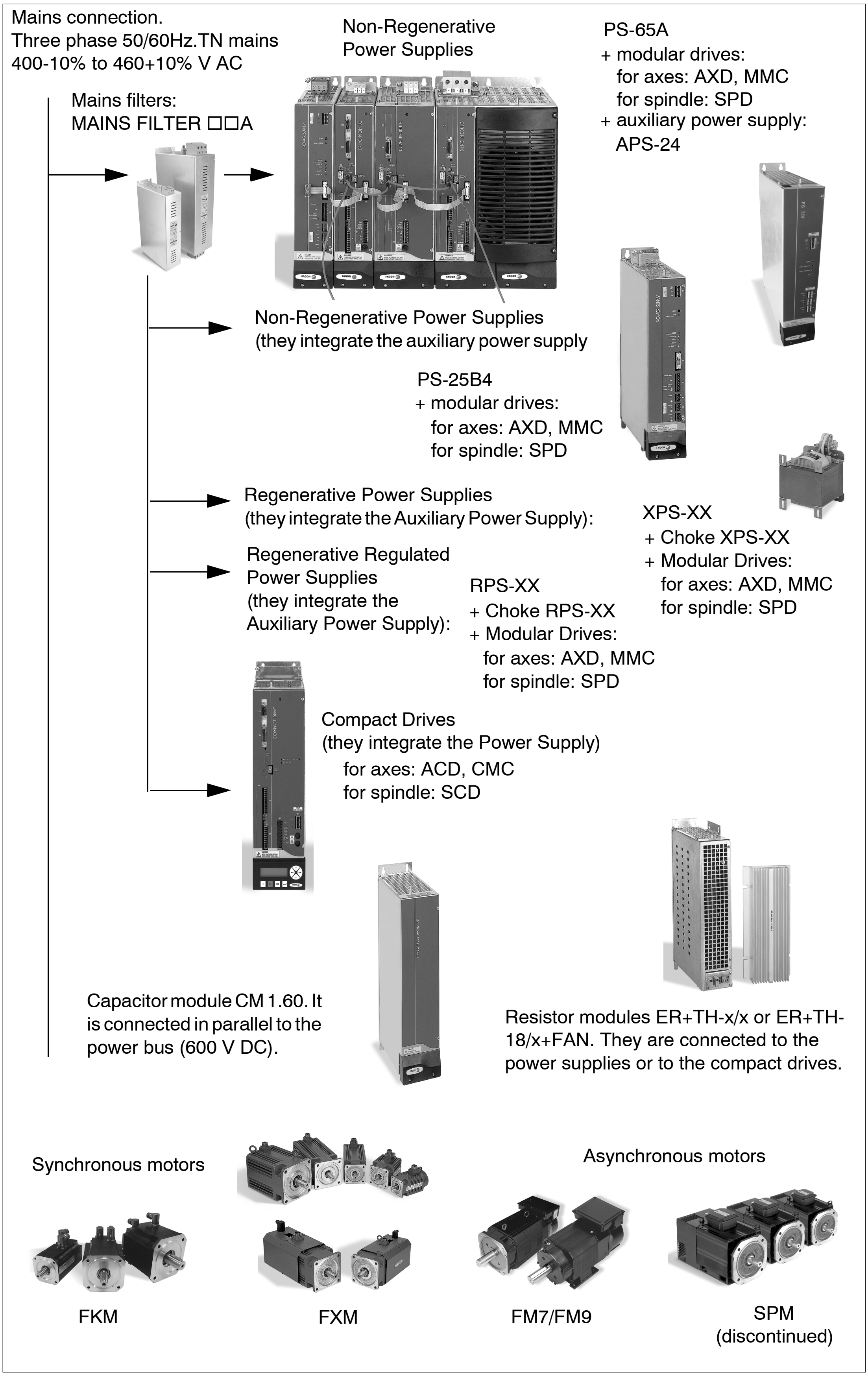


FIGURE H1.2

DDS servo drive system configurations.

1.3 Stages of the system configuration

The following steps are a reference to configure and install the DDS system.

> This DDS system configuration process assumes that the motors of the system are known motors.
> All the motors of the FAGOR catalog are described in their corresponding manuals:
> - Manual of synchronous servo motors. FXM, FKM families
> - Asynchronous motor manuals. FM7, FM9 families

1.3.1 Example procedure

Stage 1. Analysis of the system location

- Ambient conditions
- Climate conditions
- Cooling conditions
- Mechanical conditions

Stage 2. Component selection

- Motors
- Power supply module
- Drive modules
- Auxiliary modules

Stage 3. Connection configuration

- See block diagrams
- See connection diagrams
- See dimension drawings
- Power and signal cable selection
- Suggestions for cable installation
- Power line connection
- Electrical cabinet and its ventilation

POWER SUPPLIES

2

The Fagor power supplies are connected after the filter to mains - see **FIGURE H1.1** - with a mains voltage between 400 and 460 V AC at a mains frequency of 50/60 Hz and its functions are:

- Provide a DC voltage output that will supply the drive modules through the power bus.
- manage the energy excess accumulated in the power bus as a result of braking the motors.

Hence, we refer to:

Non-regenerative power supplies when they provide a DC voltage output (depending on mains voltage) and its exceeding energy is dissipated as heat in electrical resistors.

Regenerative power supplies when they provide a DC voltage (depending on mains voltage) and its exceeding energy is returned to mains, hence reducing the electrical consumption without generating additional heat.

Regenerative regulated power supplies (boost power supplies) when they provide a programmable DC voltage (depending on mains voltage) and its exceeding energy is returned to mains with a power factor close to 1, hence reducing the electrical consumption without generating additional heat.

2.1 Non - regenerative power supplies

When referring to non-regenerative power supplies, we'll use PS-25B4 and PS-65A. They all admit a voltage range between 400 to 460 V AC. They are:

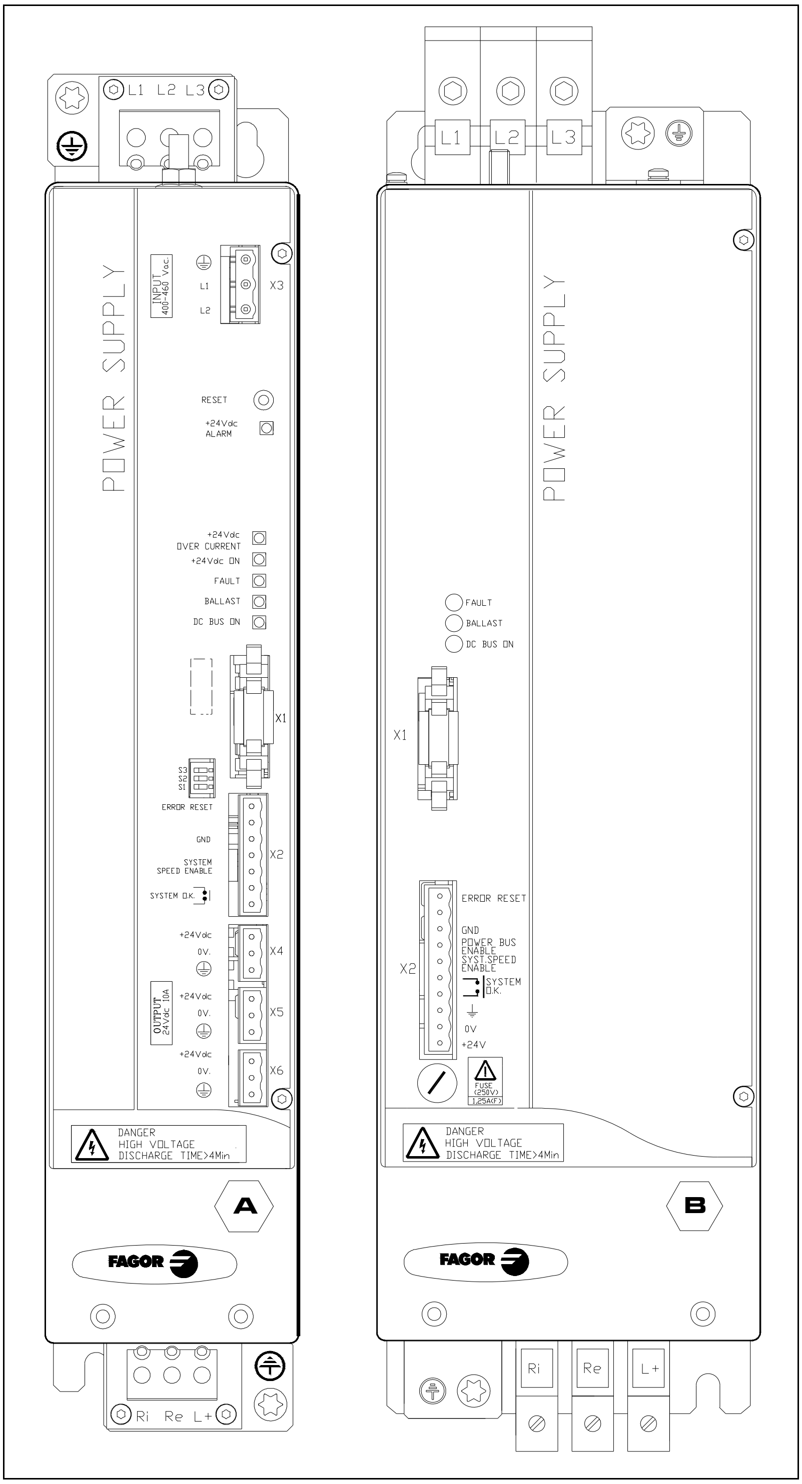


FIGURE H2.1

Non-regenerative power supplies: **A.** PS-25B4, **B.** PS-65A.

The **PS-25B4** supplies 25 kW and includes an internal auxiliary 24 V DC power supply for the control circuits of the modular drives. The over-voltage and ballast alarm activation levels are the ones of the power supplies that admit 460 V AC. The **PS-65A** supplies 65 kW and always needs an auxiliary power supply APS-24 for the control circuits of the modular drives.

2.1.1 PS-65A module

Technical data

TABLE H2.1 Technical characteristics.

	PS-65A module
Power supply (Vmains)	Three-phase 50/60 Hz, with a voltage range between 400-10% and 460+10% V AC
Mains power consumption (400 V AC)	95 Arms
Maximum connection cable section	50 mm²
Power bus voltage VbusNom	565 V DC / 650 V DC
Rated (peak) output current [1]	120 A (360 A, 1 s)
Rated (peak) output power	65 kW (195 kW, 1 s)
Power for the module control circuit	24 V DC (between 21 V DC and 28 V DC)
Consumption of the module control circuit itself	1 A at 24 V DC (24 W)
Internal Ballast resistance (power) [1]	9 Ω (600 W)
Energy pulse to be dissipated	36 kW (0.6 s)
Ballast circuit on/off	768 V DC / 760 V DC
Minimum external Ballast resistance	9 Ω
Filter capacity	750 µF, 900 V DC
Energy stored in the capacitors	$0.5\,C{\cdot}V^2$
Maximum “SYSTEM OK“ contact voltage	125 V AC, 150 V DC
Maximum “SYSTEM OK“ contact voltage	1 A
Width	117 mm (4.61 in)
Approx. mass	9.9 kg (22 lb)
Power dissipated at maximum load	275 W

1 See derating curves in case of high temperatures.

TABLE H2.2 Ambient conditions and other characteristics.

	PS-65A module
Ambient temperature [1]	5°C / 45°C (41°F / 113°F)
Storage temperature	-20°C / 60°C (-4°F / 140°F)
Maximum humidity	< 90% (non condensing at 45°C / 113°F)
Maximum altitude without loss of features	1000 m (3281 ft) above sea level
Operating vibration	0.5 G
Shipping vibration	2 G
Sealing	IP 2x
Protections	Over-voltage, heat-sink temperature, hardware error, Ballast overload.

1 See derating curves in case of high temperatures.

Note that PS-65A power supplies admit a mains voltage of up to 460 V AC.

Power diagram

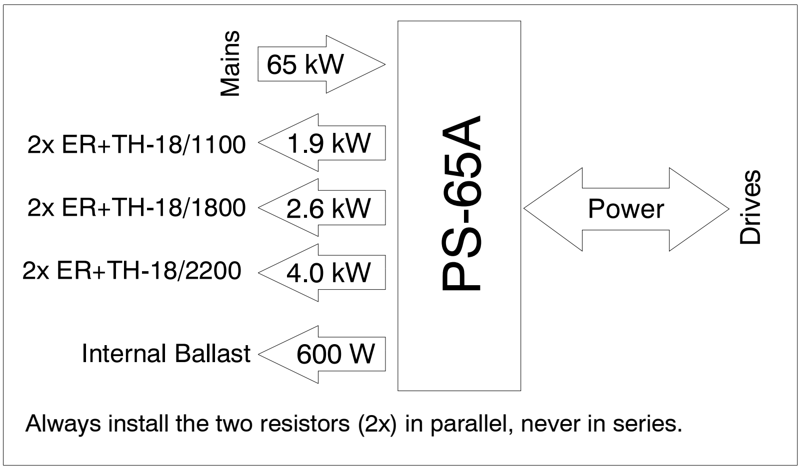


FIGURE H2.2

Power diagram.

Block diagram

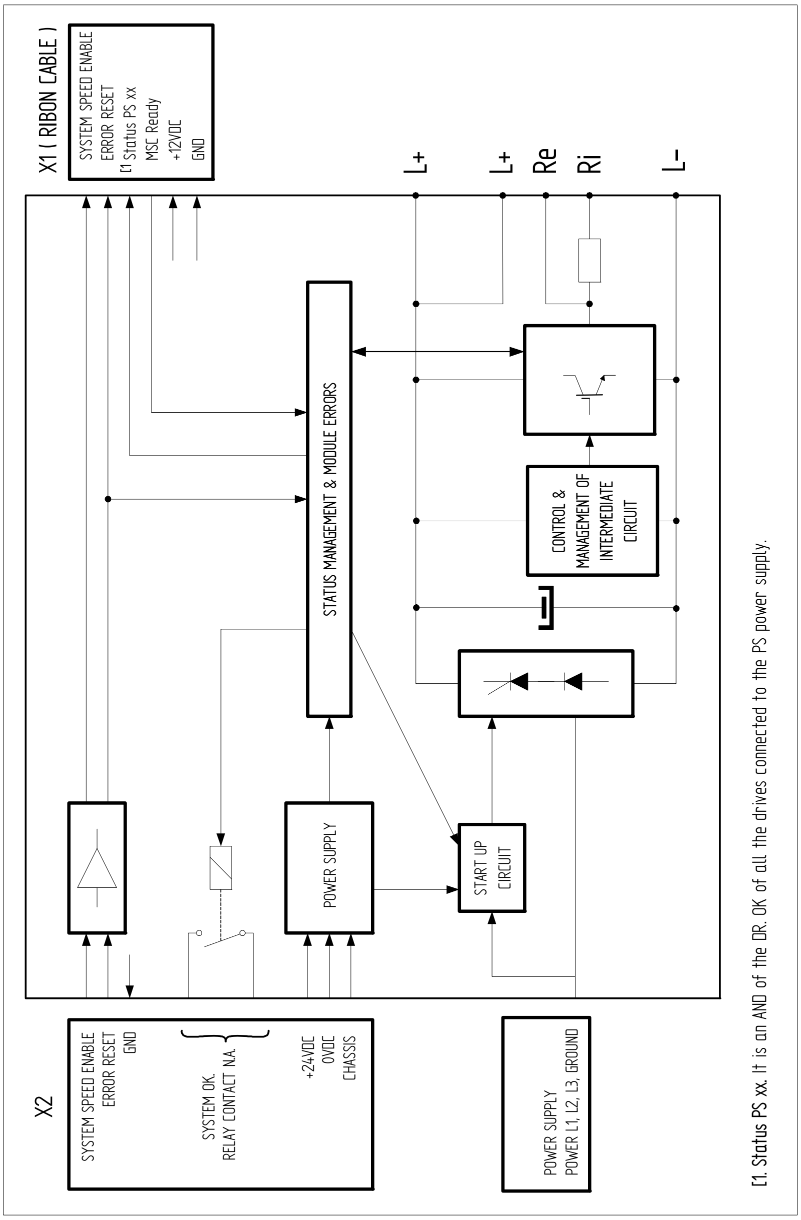


FIGURE H2.3

Block diagram.

Connectors

The non-regenerative power supply PS-65A has the following connectors:

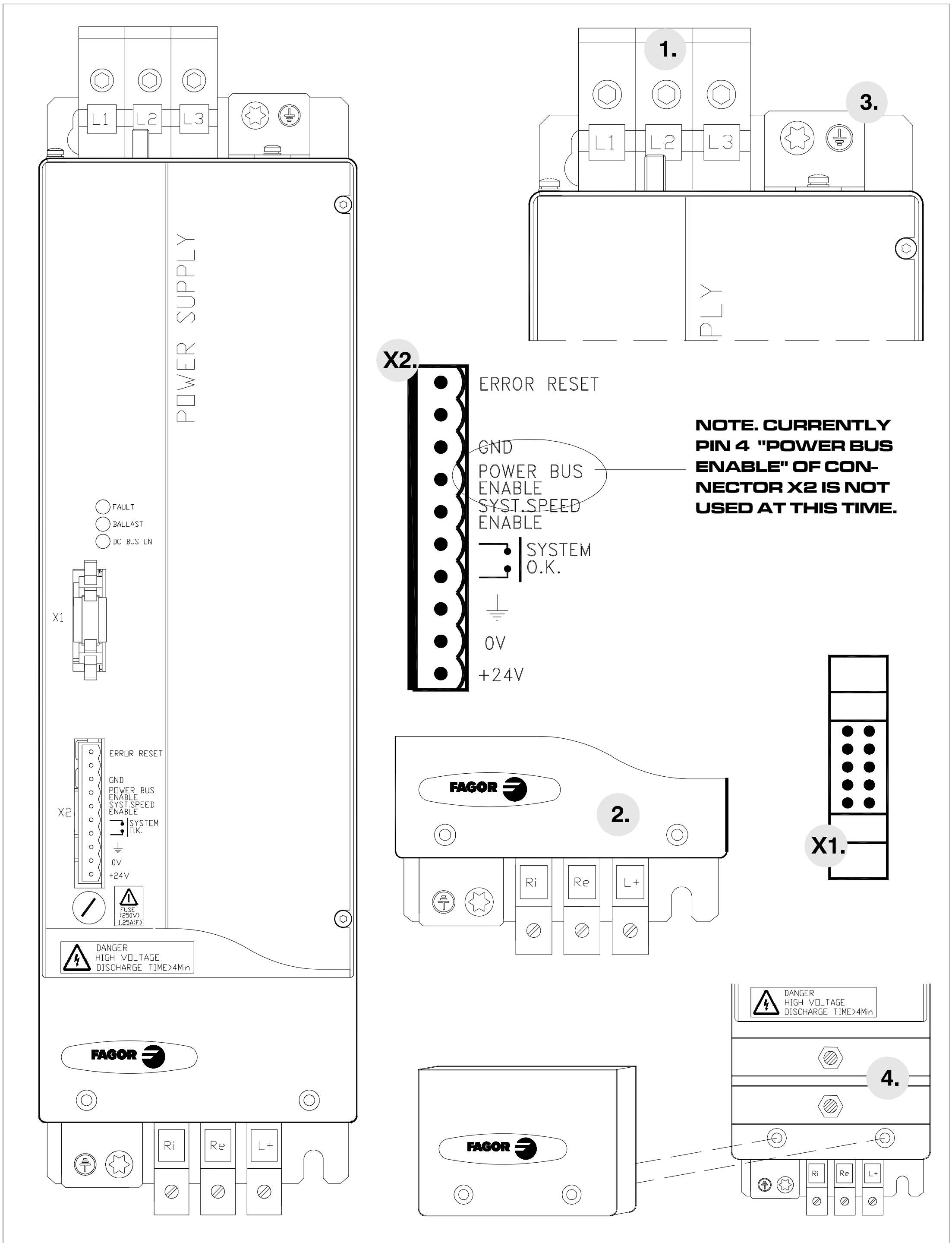
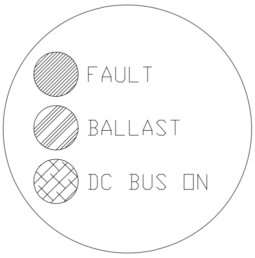


FIGURE H2.4

Connectors of the PS-65A power supply.

1. Power connector for the three-phase mains.
2. Power connector for the external Ballast resistor connection.
3. Ground connection for the mains cable.
4. Power Bus supplying power to the drive modules through metal bars.
X1. Connector for inter-module communication.
X2. Connector for the basic control signals.

Status indicator lamps

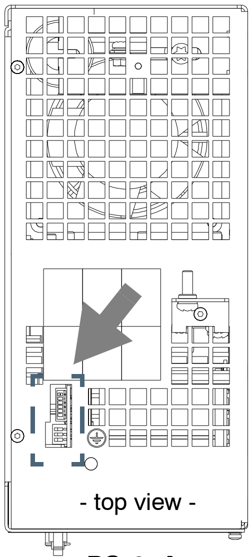


The non-regenerative power supply PS-65A has the following lights on the front panel to indicate the status of the main power supply.

- **FAULT blinking.** The blinking red led indicates that **there are no errors** and that **one or several mains phases are missing**.
- **FAULT turned ON.** The steady red led on indicates that there is an error. The error is indicated on the display of the drive modules.
- **FAULT turned OFF.** The led off indicates that there is no error and that all mains phases are OK.
- **BALLAST turned ON.** The amber led is lit when the energy dissipating Ballast circuit is activated.
- **DC BUS ON.**The green led indicates that the module is supplying all its power at the bus.

For further detail on these indicator lights, see the combination table for interpretation in the description of the E305 code on the error listing shown in chapter 14 of the "dds-hardware" manual.

Ballast resistor selection



PS-65A

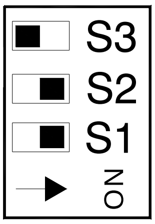
Model currently in the catalog

Non-regenerative power supplies PS-65A have three dip-switches on top, next to the terminal strip for mains connection (see figure) for selecting the external Ballast resistor. Refer to the attached table to make the type selection properly according to the setting of the switches while the i2t protection stays enabled.

Selecting "internal resistor or RM-15 module (already discontinued)" implies disabling the I2t protection. There is no risk of destroying the resistor because they both carry their own thermostat for their protection.

Selecting "resistor disabled" implies disablilng the I2t protection. There is a risk of destroying the resistor without warning. Select only this switch setting when installing a resistor of more power than the ones supplied by Fagor.

TABLE H2.3 Layout of the switch after selecting the resistor.



S3	S2	S1	RESISTOR
OFF	OFF	OFF	Internal
OFF	OFF	ON	2x ER+TH-18/1100
OFF	ON	OFF	2x ER+TH-18/1000+FAN
OFF	ON	ON	2x ER+TH-18/1800
ON	OFF	OFF	2x ER+TH-18/2200
ON	ON	OFF	2x RM-15 (discontinued)
ON	OFF	ON	Disabled
ON	ON	ON	Disabled

■ represents the moving element of the switch in the figure.

Example.

For the switch combination shown in the figure and verified in the table, the Ballast Resistor selected would correspond to the 2x ER+TH-18/1800.

S3	S2	S1	RESISTOR
OFF	ON	ON	2x ER+TH-18/1800

2.1.2 PS-25B4 modules

Technical data

TABLE H2.4 Technical characteristics.

	PS-25B4 module
Power supply (Vmains)	Three-phase 50/60 Hz, with a voltage range between 400-10% and 460+10% V AC
Mains power consumption (400 V AC)	36 Arms
Maximum connection cable section	10 mm²
Power bus voltage Vbus rated	565 V DC / 650 V DC
Rated (peak) output current [1]	45 A (135 A, 1 s)
Rated (peak) output power	25 kW (75 kW, 1 s)
Internal Ballast resistance (power) [1]	16.5 Ω (500 W)
Energy pulse to be dissipated	6 kW (0.2 s)
Ballast circuit on / off	768 V DC / 760 V DC
Minimum external Ballast resistance	16.5 Ω
Filter capacity	705 μF, 900 V DC
Energy stored in the capacitors	$0.5\, C \cdot V^2$
Maximum “SYSTEM OK“ contact voltage	125 V AC, 150 V DC
Maximum “SYSTEM OK“ contact voltage	1 A
Width	77 mm (3.03 in)
Approx. mass	6.0 kg (13.2 lb)
Power dissipated at maximum load	180 W

1 See derating curves in case of high temperatures.

Connection of the auxiliary power supply	
Output voltage, maximum current	24 V DC (5 %), 10 A
Input voltage	Between 400 (-10%) and 460 (+10%) V AC 50/60 Hz
Mains consumption	0.72 A (400 V AC); 0.63 A (460 V AC)
Maximum Inrush current	23.9 A (460 V AC)
Bus consumption	0.485 A (565 V DC); 0.44 A (650 V DC)
Maximum voltage at the bus	790 V DC

TABLE H2.5 Ambient conditions and other characteristics.

	PS-25B4 module
Ambient temperature [1]	5°C / 45°C (41°F / 113°F)
Storage temperature	-20°C / 60°C (-4°F / 140°F)
Maximum humidity	< 90% (non condensing at 45°C / 113°F)
Maximum altitude without loss of features	1000 m (3281 ft) above sea level
Operating vibration	0.5 G
Shipping vibration	2 G
Sealing	IP 2x
Protections	Over-voltage, heat-sink temperature, hardware error, Ballast overload.

1 See derating curves in case of high temperatures.

Power diagram

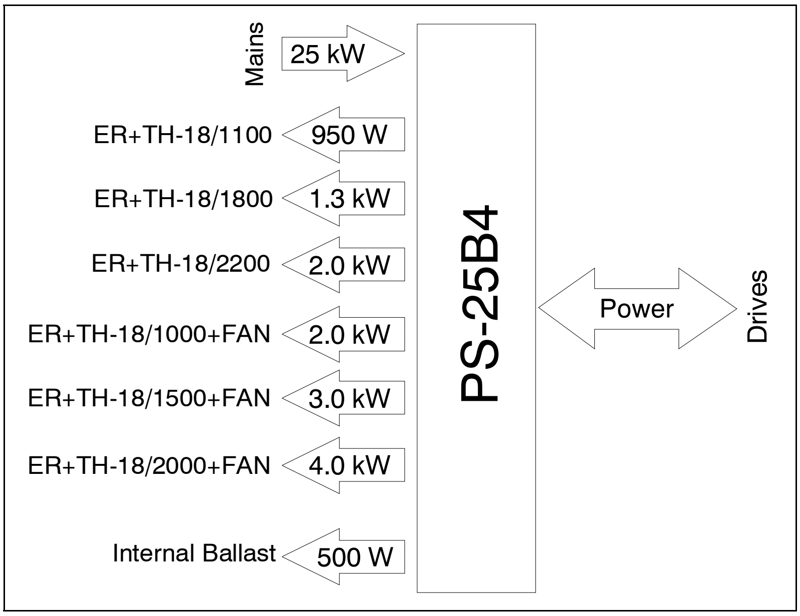


FIGURE H2.5

Power diagram.

Block diagram

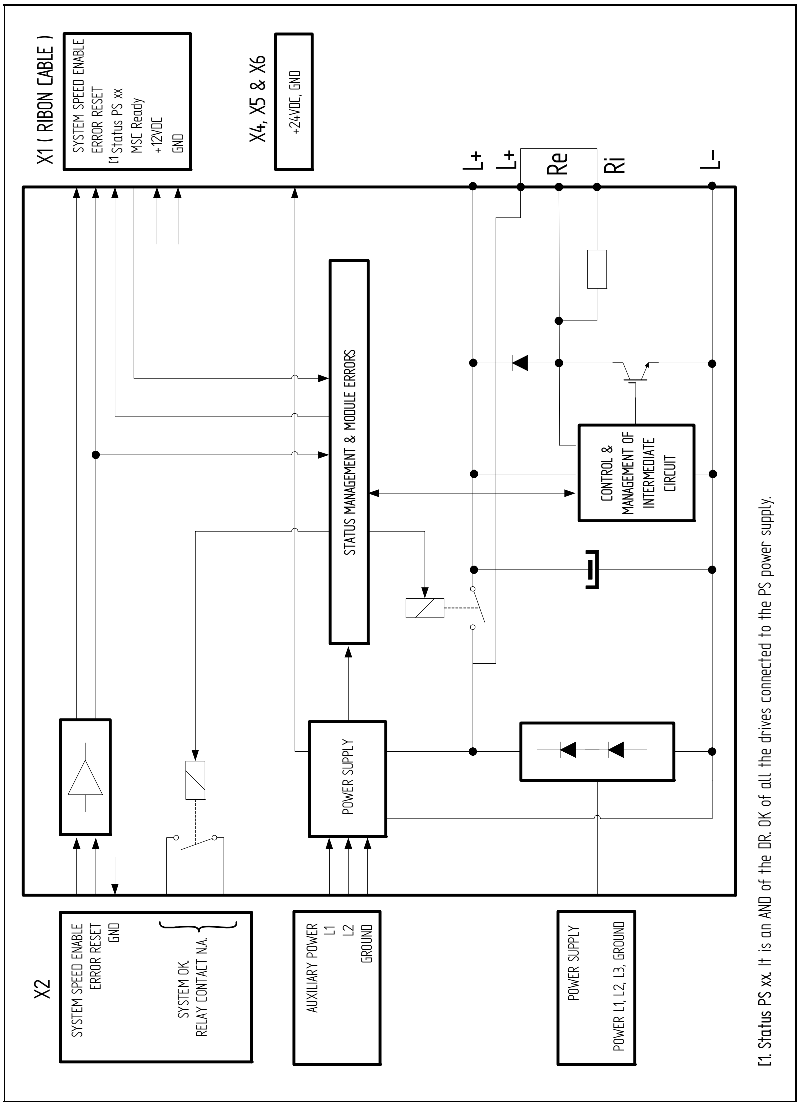


FIGURE H2.6

Block diagram.

Connectors

The non-regenerative power supply PS-25B4 has the following connectors:

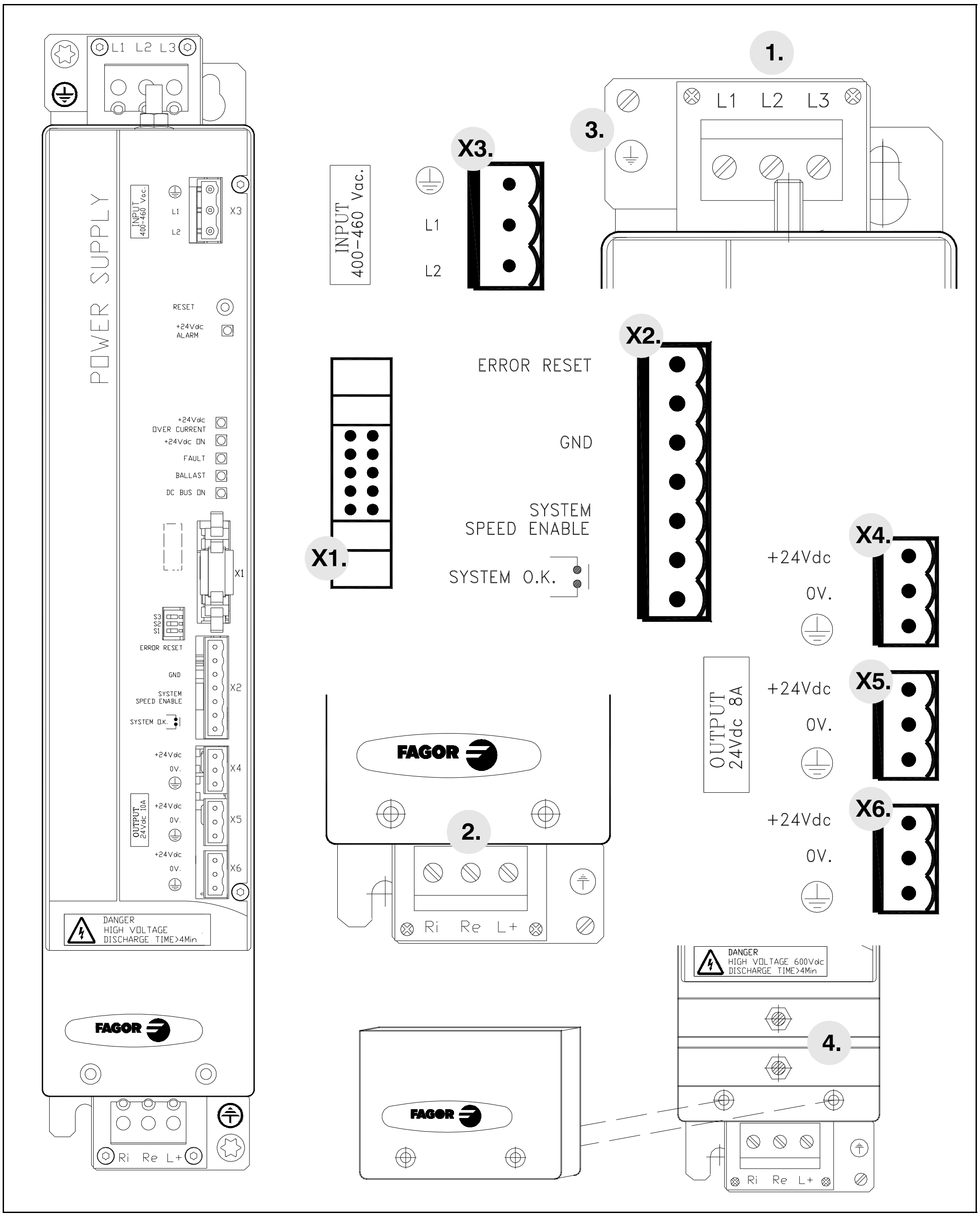
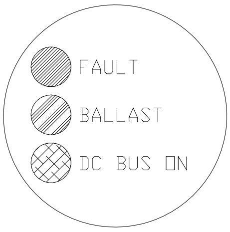


FIGURE H2.7

Connectors of the PS-25B4 power supply.

1. Power connector for the three-phase mains.
2. Power connector for the external Ballast resistor connection.
3. Ground connection for the mains cable.
4. Power Bus supplying power to the drive modules through metal bars.
X1. Connector for inter-module communication.
X2. Connector for the basic control signals.
X3. Input connector supplying from mains to the auxiliary power supply integrated into the module. The mains power is received through it. It admits a voltage between 400 and 460 V AC.
X4. Output connector of the auxiliary 24 V DC power supply integrated into the module.
X5. Output connector of the auxiliary 24 V DC power supply integrated into the module.
X6. Output connector of the auxiliary 24 V DC power supply integrated into the module.

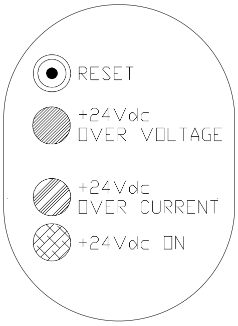
Lights indicating the status of the main power supply



The non-regenerative power supply PS-25B4 has the following lights on the front panel to indicate the status of the main power supply.

- **FAULT blinking.** The blinking red led indicates that **there are no errors** and that **one or several mains phases are missing**.
- **FAULT turned ON.** The steady red led on indicates that there is an error. The error is indicated on the display of the drive modules.
- **FAULT turned OFF.** The led off indicates that there is no error and that all mains phases are OK.
- **BALLAST turned ON.** The amber led is lit when the energy dissipating Ballast circuit is activated.
- **DC BUS ON.** The green led indicates that the module is supplying all its power at the bus.

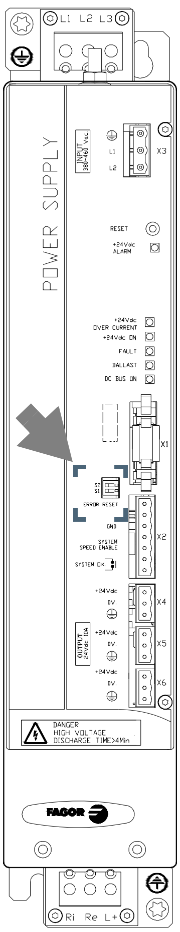
Lights indicating the status of the auxiliary power supply



The non-regenerative power supply PS-25B4 has the following status indicating lights on the front panel of the module for the integrated internal auxiliary power supply.

- **RESET.** Initializes the auxiliary 24 V DC power supply.
- **OVER VOLTAGE.** The red led indicates that there is an over-voltage error at the 24 V DC output or due to over-temperature.
- **OVER CURRENT.** The red led indicates that there is an over-current error at the 24 V DC output.
- **ON.** The green led it indicates that there are 24 V DC at the output.

Ballast resistor selection



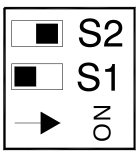
Discontinued model

PS-25B4

Note. The model with two selection switches has been discontinued. If you still have this model, refer to this section to configure the selection of the Ballast resistor. If you have the model with three switches, see the next page.

The non-regenerative power supply PS-25B4 had two switches on the front and next to connector X1 (see figure) for selecting the external Ballast resistor. If you have a model like this one, refer to the attached table to select the right resistor model according to the setting of the switches that enables the i2t protection. Remember that selecting the internal resistor or having the RM-15 module means disabling the "I2t" protection because they both include their own thermostat for their own protection.

TABLE H2.6 Layout of the ballast resistor selector switches



S1	S2	RESISTOR
ON	ON	ER-18/1100
OFF	ON	ER-18/1800 or ER+TH-18/1000+FAN
ON	OFF	ER+TH-18/2200
OFF	OFF	RM-15 or internal R

■ represents the moving element of the switch in the figure.

Example.

For the switch combination shown in the figure and verified in the table, the selected ballast resistor would correspond to the ER-18/1800 or ER+TH-18/1000+FAN.

S1	S2	RESISTOR
OFF	ON	ER-18/1800 or ER+TH-18/1000+FAN

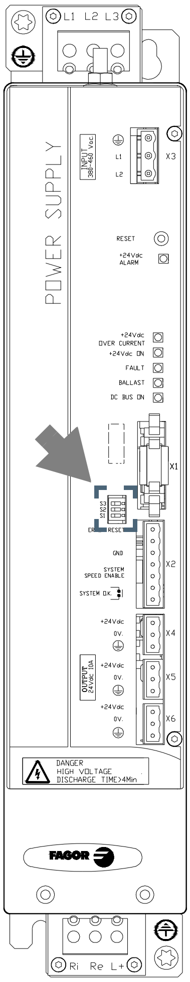
2.

POWER SUPPLIES

Non - regenerative power supplies

DDS HARDWARE

Ref.1109



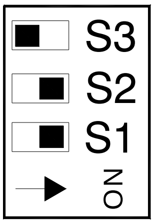
Model currently in the catalog

PS-25B4

Note. This is the current model with three micro-switches to configure the selection of the Ballast resistor installed.

The non-regenerative power supply PS-25B4 has three switches on the front and next to connector X1 (see figure) for selecting the external Ballast resistor. If you have a model like this one, refer to the attached table to select the right resistor model according to the setting of the switches that enables the i2t protection. Remember that selecting the internal resistor or having the RM-15 module means disabling the "I2t" protection because they both include their own thermostat for their own protection.

TABLE H2.7 Layout of the ballast resistor selector switches



S3	S2	S1	RESISTOR
OFF	OFF	OFF	Internal
OFF	OFF	ON	ER+TH-18/1100
OFF	ON	OFF	ER+TH-18/1000+FAN
OFF	ON	ON	ER+TH-18/1800
ON	OFF	OFF	ER+TH-18/2200
ON	ON	OFF	RM-15 (discontinued)
ON	OFF	ON	Disabled
ON	ON	ON	Disabled

■ represents the moving element of the switch in the figure.

Example.

For the switch combination shown in the figure and verified in the table, the ballast resistor selected would correspond to the ER+TH-18/1800.

S3	S2	S1	RESISTOR
OFF	ON	ON	ER+TH-18/1800

2.2 Connectors

2.2.1 Power connectors

Terminal strip for mains connection

When connecting the power supplies to mains through terminals L1, L2 and L3, the phases may be connected in any order.

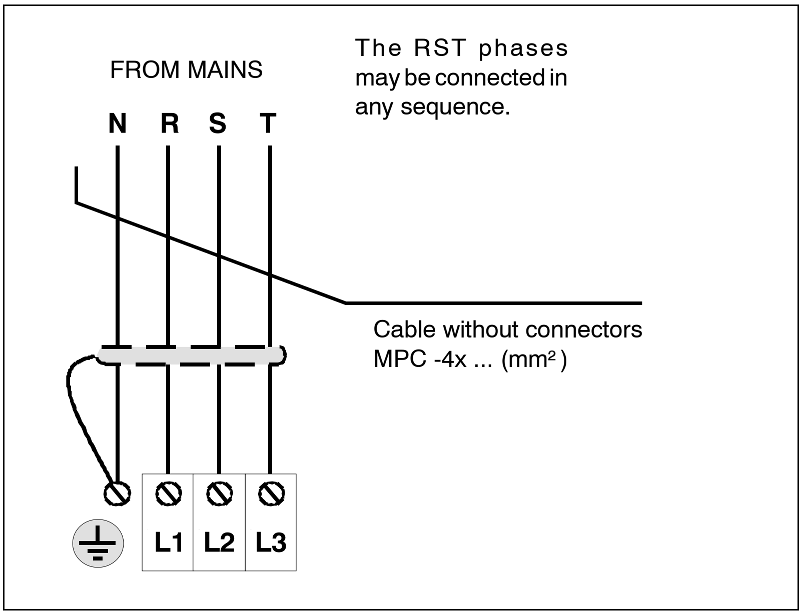


FIGURE H2.8

Terminal strip for connection to mains.

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

The following table shows the values for gap, tightening torque (wire entry holes) and other data regarding these power screw-on terminals:

TABLE H2.8 Technical data of the mains connection terminals.

Connector data	PS-25B4	PS-65A
Gap (mm)	10.16	-----
Min/max tightening torque (N·m)	1.2/1.5	6/8
Screw thread	M4	M6
Min./max. section (mm^2)	0.5/16	16/50
Rated current In (A)	76	150
Wire data		
Min. section (mm^2)	10	50
Length to strip (mm)	10	24

The equipment must be protected with fuses on the three-phase supply lines L1, L2 and L3. Follow the instructions given in chapter **6. POWER LINE CONNECTION** of this manual.

Terminal strip to connect the Ballast resistor

The power supply is supplied from factory with a wire jumper between terminals Ri and L+. This configuration of the power supply means that it comes from the factory with its internal Ballast resistor.

However, if with this internal resistor it is not possible to dissipate enough power (e.g. when braking), the configuration must be modified so the power supply can work with an external ballast resistor capable of dissipating that energy. Remove the wire between terminals Ri and L+ and connect the proper external resistor between terminals Re and L+. See the diagram in the figure.

Note. Removing the jumper between Ri and L+ and not connecting an external ballast resistor generates error code E215 or E304 on the display. On PS-25B4 power supplies, the power bus will not be charged.

Here is a graphic representation of the two possible configurations:

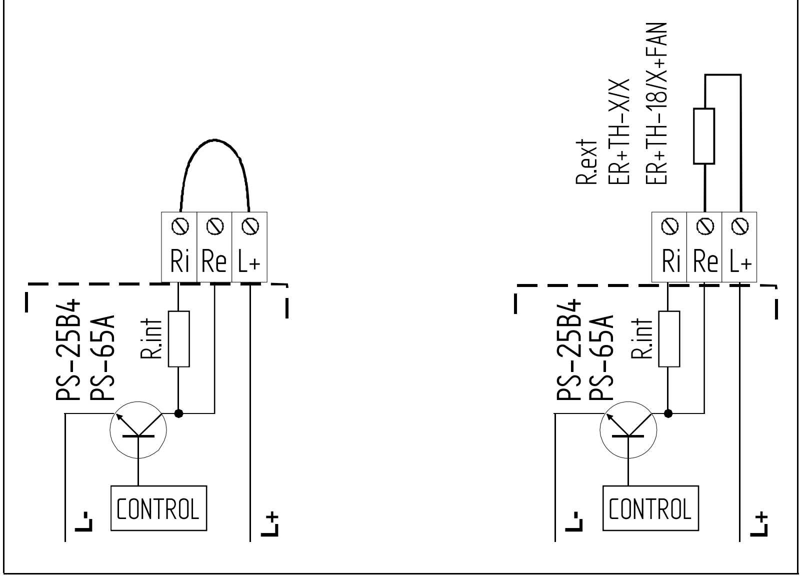


FIGURE H2.9

Ballast resistor connection configurations.

The following table shows the values for gap, tightening torque (wire entry holes) and other data regarding the screw-on terminals of the ballast resistor according to power supply model:

TABLE H2.9 Technical data of the connection terminals of the ballast resistor.

Connector data	**PS-25B4**	**PS-65A**
Gap (mm)	10.16	-----
Min/max tightening torque (Nm)	1.2/1.5	2/2.3
Screw thread	M4	M5
Min./max. section (mm²)	0.5/16	0.5/25
Rated current In (A)	76	76
Wire data		
Min. section (mm²)	10	10
Length to strip (mm)	10	16

These power supply carry a protection against over-temperature which triggers error E301 on the display and stops its operation when reaching 105°C (221°F).

Derating curves

The power these resistors can dissipate depends on the ambient temperature according to the following derating curves.

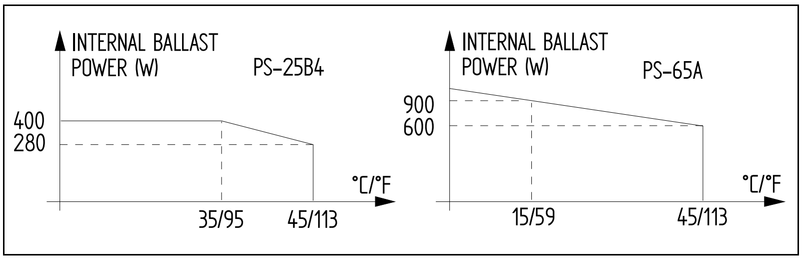


FIGURE H2.10

Derating curves of the ballast dissipation power on non-regenerative power supplies.

Connection terminals for the Power DC bus

At the bottom of the module, covered by a screwed on lid, the power supply offers the terminal for the power bus. This bus provides a dc voltage output of 565 V DC (when the mains voltage is 400 V AC) that feeds all the drive modules that are part of the servo drive system.

Important. All the modules powered by the same power supply must be joined by the same power bus. This condition is a must for the system to work.

Warning. Never connect the power bus while the system is running.
There are voltages of about 600 V DC !

Two plates are supplied with each module to join them with the adjacent drive modules.

Warning. The tightening torque of these terminals must be between 2.3 and 2.8 Nm. This point is very important to ensure good electrical contact between modules.

Fagor power supplies have a Soft Start for charging the power bus.

The soft start begins when two necessary and sufficient conditions are verified:

- No errors on any of the modules connected through the internal bus (connector X1)
- Presence of the three mains phases at the input of the module.

Note that for PS-25B4 power supplies, it is enough to have **two mains phases**.

This startup process begins when the FAULT indicator stops blinking and ends when the status indicator DC BUS ON turns on.

Warning. Before handling these leads, proceed in the following order:

- Stop the motors
- Disconnect the mains voltage at the electrical cabinet.
- Wait, before handling these leads. The power supply module needs time to decrease the voltage of the power bus down to safe values (< 60 V DC). The green indicator DC BUS ON being turned OFF does not mean that the power bus may be handled or manipulated.
- The discharge time depends on the number of elements connected and it is about 4 minutes.

Warning. Never connect in parallel the power buses of different power supplies.

Important. Install an auxiliary power supply APS-24 (24 V DC, 10 A) to the DC bus of any DDS system with non-regenerative power supply PS-65A ☐☐ (mandatory) or PS-25B4 (suggested, not mandatory).

Note. Do not install external protection fuses in these power lines of the auxiliary power supply. They are already integrated in the power supply itself.

Remember that the purpose of connecting an auxiliary power supply APS-24 to the DC bus of a DDS system is to ensure the supply to all the control circuits of the power supply and of the drive modules connected to the DC bus in case of a mains power outage in the auxiliary power supply ensuring a controlled stop of the moving axes instead of braking out of control by friction.

Bear in mind that the PS-65A power supplies do not come with internal auxiliary power supply for their own control circuits and for those of the modules connected to the DC bus as well as other elements like fans, etc. That is why it is a must to install the APS-24 auxiliary power supply to do the installation properly.

PS-25B4 power supplies do come with an internal auxiliary power supply (24 V DC and a total of 8 A, 192 W). Therefore, it is not a must to install an APS-24 next to them, but it is highly suggested because, sometimes, higher power may be required to feed the control circuits of the modules than what the internal auxiliary power supply can provide (when installing a lot of drive modules).

Observe that the APS-24 auxiliary power supply offers 3 outputs with 24 V DC and a total of 10A, 240 W.

For further information about the auxiliary module APS-24, see chapter 4. AUXILIARY MODULES in this manual.

X1 connector. Internal Bus

The communication between all the modules that make up the DDS servo drive system is established through connector X1.

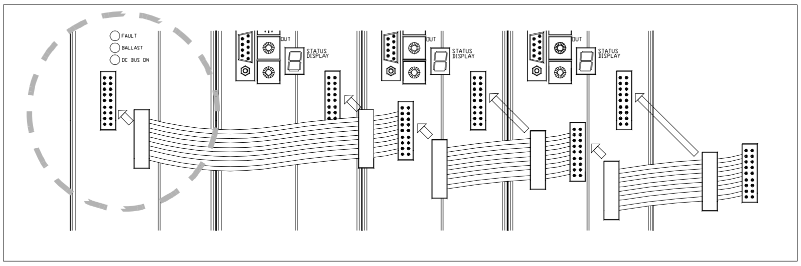


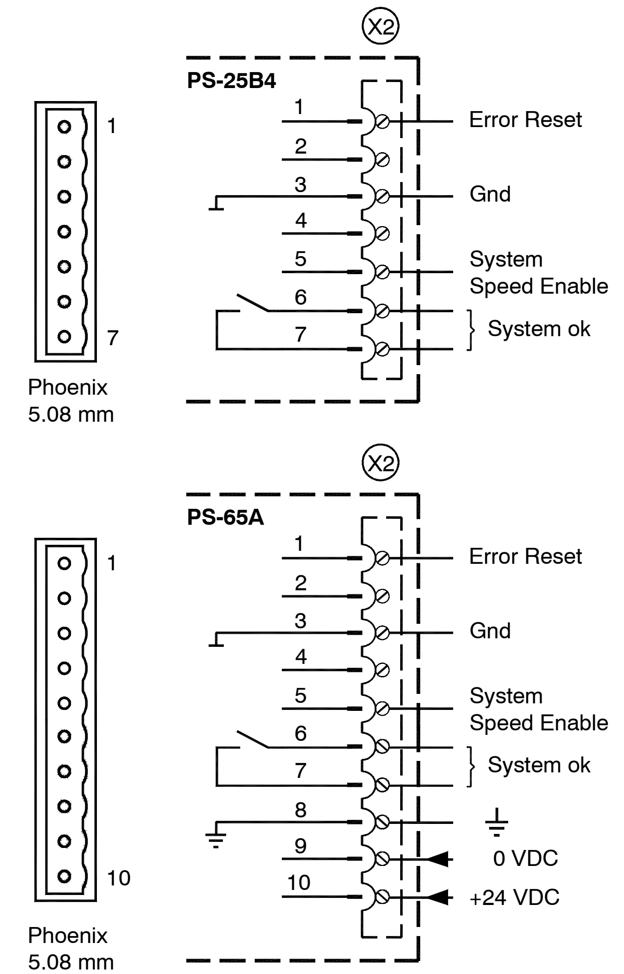
FIGURE H2.11

Connection of the internal bus between modules through connector X1.

A ribbon cable is provided with each power supply or drive module for the connection.

X2 connector. Control

The power supply module may be controlled through connector X2.



Note. Pin 4 "Power Bus Enable" of connector X2 located on the front of PS-65A power supplies **is not used at this time**.

FIGURE H2.12

Control of the power supply module through connector X2.

The internal circuits of the non-regenerative power supplies PS-65A require an external 24 V DC supply. This is why its connector X2 has three more pins than for the PS-25B4 power supply that integrates an auxiliary power supply.

The internal circuits are protected with a 1.25A fuse.

The following table shows the values for gap, tightening torque, sections and other data of the plug-in connector for X2.

TABLE H2.10 Characteristics of the pins of connector X2.

Connector data	PS-25B4	PS-65A
Nr of poles	7	10
Gap (mm)	5.08	5.08
Min/max tightening torque (N·m)	0.5/0.6	0.5/0.6
Screw thread	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5
Rated current In (A)	12	12
Wire data		
Min. section (mm²)	1.5	1.5
Length to strip (mm)	7	7

The next table shows the signals and other considerations related to each pin of connector X2:

TABLE H2.11 Description of the pins of connector X2.

1	Error RESET	System error RESET input (24 V DC ; 4.5 - 7 mA).
2	Not connected	N.C.
3	GND	0 volts reference for digital inputs. Error RESET (1) and System Speed Enable (5).
4	Not connected	N.C.
5	System Speed Enable	General system speed enable. (24 V DC ; 4.5 - 7 mA).
6	System OK	Contact indicating module status. It opens in case of failure. Limit 1 A at 24 V.
7	System OK	
8	Chassis	Chassis connection (only on PS-65A power supplies)
9	0 V DC	Voltage supply of the control circuits (only on PS-65A power supplies) between 21 V DC and 28 V DC. Max. consumption 1 A.
10	+ 24 V DC	

Connectors X3, X4, X5 and X6

These connectors belong to the auxiliary power supply integrated into the main power supply PS-25B4.

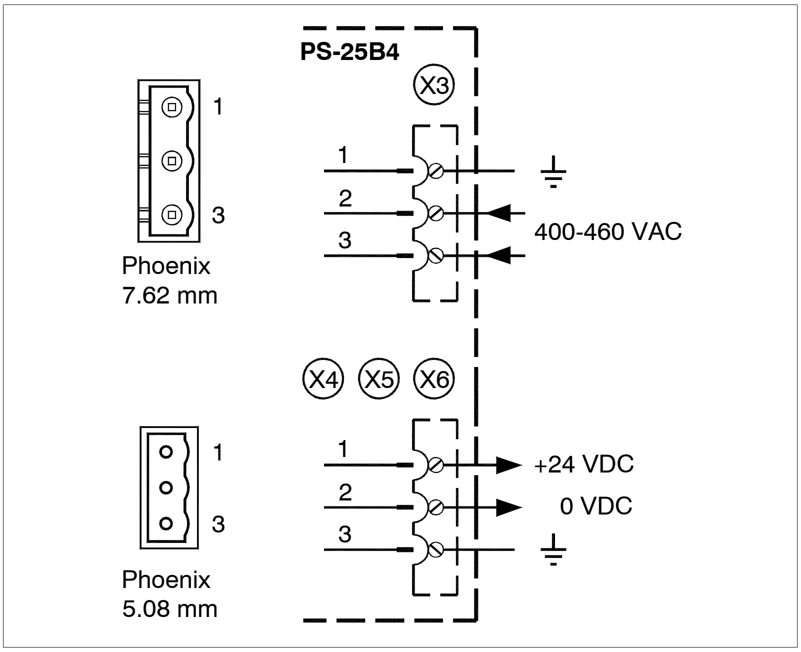


FIGURE H2.13

Connectors X3, X4, X5 and X6 of the auxiliary power supply integrated into the PS-25B4.

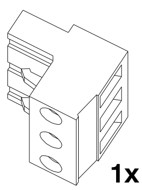
Connector X3 receives power from mains. It admits a voltage between 400 V AC and 460 V AC.

There is no need to install external protection fuses in these power lines. They are already integrated into the power supplies.

This auxiliary power supply generates 24 V DC and its purpose is to feed the control circuits of the module itself. Also, it supplies up to 10 A of this dc voltage through connectors X4, X5 and X6. These three connectors are identical and offer greater connecting flexibility.

The gap and tightening torque and sections of the screws of the plug-in connectors for X3 and X4, X5, X6 are given by the table:

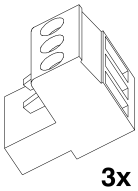
TABLE H2.12 Data of the plug-in connector for X3.



1x

Connector data	**PS-25B4**	
Nr of poles	3	
Gap (mm)	7.62	
Min/max tightening torque (N·m)	0.5/0.6	
Screw thread	M3	
Min./max. section (mm²)	0.2/2.5	
Rated current In (A)	12	
Wire data		
Min. section (mm²)	1.5	
Length to strip (mm)	7	

TABLE H2.13 Data of the 3 identical plug-in connectors for X4, X5 and X6.



3x

Data of each connector	PS-25B4	
Nr of poles	3	
Gap (mm)	5.08	
Min/max tightening torque (N·m)	0.5/0.6	
Screw thread	M3	
Min./max. section (mm²)	0.2/2.5	
Rated current In (A)	12	
Wire data		
Min. section (mm²)	1.5	
Length to strip (mm)	7	

i

In cases of micro-surges or total loss of mains power, this module guarantees stable and maintained 24 V DC while the motors are being stopped. This is an absolute must in order to comply with the CE requirement for the machine.

2.2.2 Module power-up

1. For PS-65A power supplies:

Supply 24 V DC to the control circuits of the power supply through pins 9 and 10 of connector X2.

For PS-25B4 power supplies:

Apply power to the Auxiliary Power Supply from mains through pins 2 and 3 of connector X3; These will power the control circuits of the power supply and provide 24 V DC at connectors X4, X5 and X6.

2. The power supply checks the system status:

If the status is correct:

The **System Ok** contact closes (pins 6 and 7) and it stays closed while the control circuits are powered and no error comes up in any of the modules of the system.

The red FAULT indicator light blinks (it is not indicating an error because there are no phases yet).

If the status is not correct:

The red FAULT indicator light is permanently on (not blinking).

3. Apply power to the power supply:

Power is applied from mains through the power connectors on top of the power supply.

The soft start begins.

The red FAULT indicator light turns off.

4. green DC BUS ON light on:

After 4 seconds, the green DC BUS ON indicator light turns on meaning that the power bus has the proper dc voltage.

If for any reason an error is activated at the power supply module or at any drive module it supplies to, the system will act as follows:

1. The green DC BUS ON light will turn off.

2. The red FAULT light will be on permanently.

3. The power supply will stop supplying voltage to the power bus.

Warning. It does not discharge the capacitors !

With the Error RESET input (pin 1), it is possible to eliminate the errors at the drives that are part of the system - see chapter 14, resettable errors, of the dds-software manual - and it acts as follows:

- Its state will be 0 Volt. Activating it with 24 V DC erases all the errors stored in the memory of each drive of the system.

- Should the cause of the error persist, the corresponding module will show the same error again and it will be necessary to turn the unit back on to eliminate the error if it is a serious error.

The System Speed Enable input (pin 5) is related to the Speed Enable inputs of the drive modules.

- The state of the System Speed Enable is usually 24 V DC.
- If the System Speed Enable pin is set to 0 V DC, all the drive modules joined together by the same internal bus will brake the motors that they control at full torque and when stopped or when reaching the time limit to stop (programmable with parameter GP3, see chapter 13 of the "dds-software" manual), it cancels the motor torque.

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

2.3 Regenerative power supplies

When referring to regenerative power supplies, we'll use XPS-25 and XPS-65. They all admit a mains voltage between 400-10% and 460+10% V AC and can return power back to mains. They are:

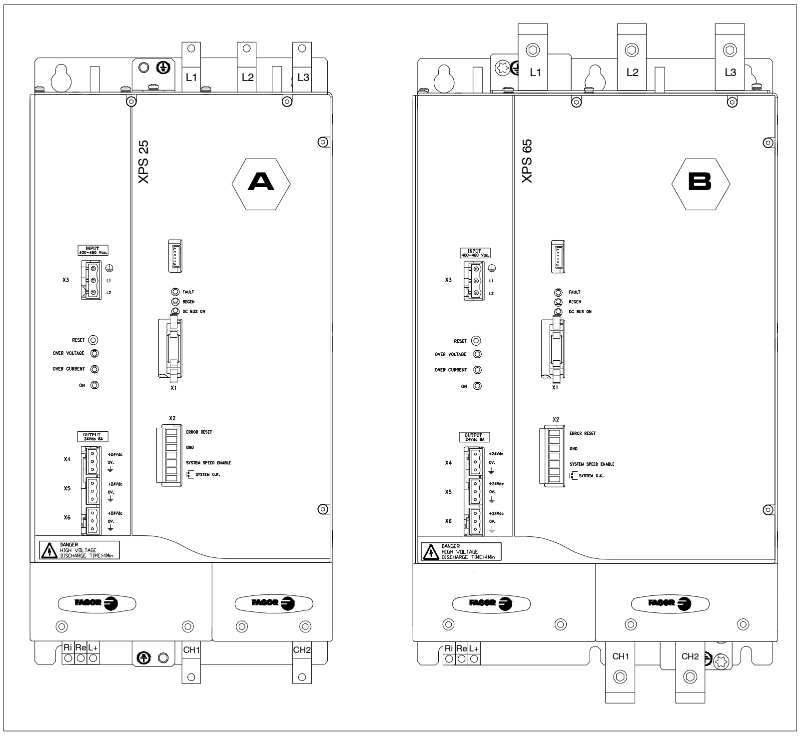


FIGURE H2.14

Regenerative power supplies: **A.** XPS-25, **B.** XPS-65.

The **XPS-25A** supplies 25 kW and can return 20 kW to mains. It integrates an auxiliary 24 V DC power supply to feed the control circuits of the modular drives. Consequently, it will not need an APS-24 to perform this function.

The **XPS-65A** supplies 65 kW and can return 54 kW to mains. It integrates an auxiliary 24 V DC power supply to feed the control circuits of the modular drives. Consequently, it will not need an APS-24 to perform this function.

2.3.1 XPS-XX modules

Technical data

TABLE H2.14 Technical characteristics.

	XPS-25 module	XPS-65 module
Power supply (Vmains)	Three-phase 50/60 Hz, with a voltage range between 400-10% and 460+10% V AC	
Mains power consumption (400 V AC)	36 Arms	95 Arms
Maximum connection cable section	16 mm²	50 mm²
Power bus voltage VbusNom	565 V DC / 650 V DC	
Rated (peak) output current [1]	45 A (135 A, 1 s)	120 A (120 A, 1 s)
Rated (peak) output power	25 kW (55 kW, 1 s)	65 kW (108 kW, 1 s)
Regenerating circuit on / off voltage	V mains · 1.414 + 150 V	
Rated regenerated current (returned to mains) [1]	28 Arms	72 Arms
Rated regenerated power (returned to mains)	20 kW	54 kW
Isolated choke	CHOKE XPS-25	CHOKE XPS-65
Choke-drive cable (max length: 2 m)	16 mm²	50 mm²
Output voltage of the auxiliary power supply	24 V DC ± 5%	
Maximum current supplied	8 A at 24 V (192 W)	
Mains consumption to generate 24 V DC	0.72 A (400 V AC); 0.63 A (460 V AC)	
Internal Ballast resistance (power) [1]	18 Ω (520 W)	9 Ω (1800 W)
Energy pulse to be dissipated	18 kW (0.6 s)	kW
Ballast circuit on / off	765 V DC / 755 V DC	
Minimum external Ballast resistance	18 Ω	9 Ω
Filter capacity	1175 μF, 900 V DC	2115 μF, 900 V DC
Energy stored in the capacitors	**0.5 C V²**	
Maximum “SYSTEM OK“ contact voltage	125 V AC, 150 V DC	
Maximum “SYSTEM OK“ contact voltage	1 A	
Width	194 mm (7.64 in)	234 mm (9.21 in)
Approx. mass	14 kg (31 lb)	19 kg (42 lb)
Power dissipated at maximum load	180 W	350 W

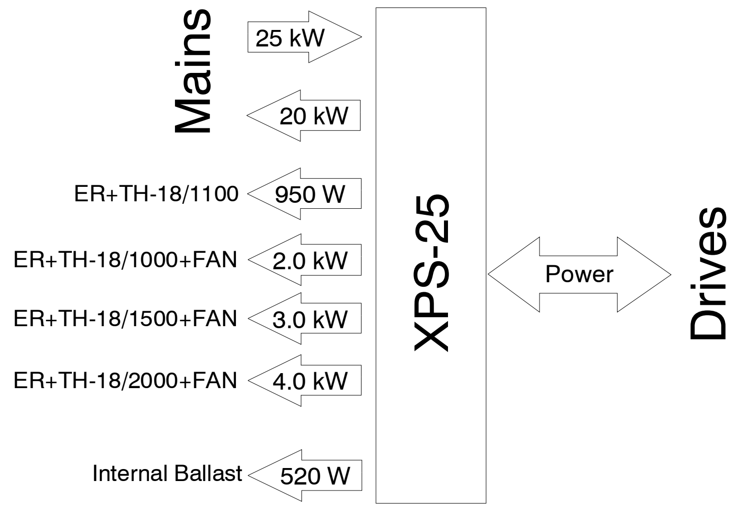
[1] See derating curves in case of high temperatures.

TABLE H2.15 Ambient conditions and other characteristics.

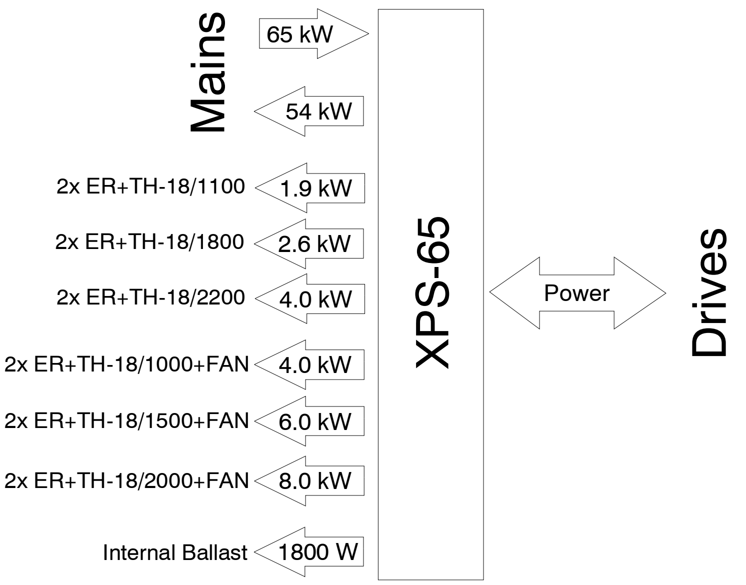
	XPS-25 module	XPS-65 module
Ambient temperature [1]	5°C / 45°C (41°F / 113°F)	
Storage temperature	-20°C / 60°C (-4°F / 140°F)	
Maximum humidity	< 90% (non condensing at 45°C / 113°F)	
Maximum altitude without loss of features	1000 m (3281 ft) above sea level	
Operating vibration	0.5 G	
Shipping vibration	2 G	
Sealing	IP 2x	
Protections	Over-voltage, over-current, hardware error, ambient temperature.	

[1] See derating curves in case of high temperatures.

Power diagram



To dissipate more than 520 W, connect one of the external resistors indicated on the graphics depending on the power to be dissipated.



To dissipate more than 1800 W, connect in parallel (never in series) one of the pairs of the external resistors indicated on the graph depending on the power to be dissipated.

FIGURE H2.15

Power diagram.

Block diagram

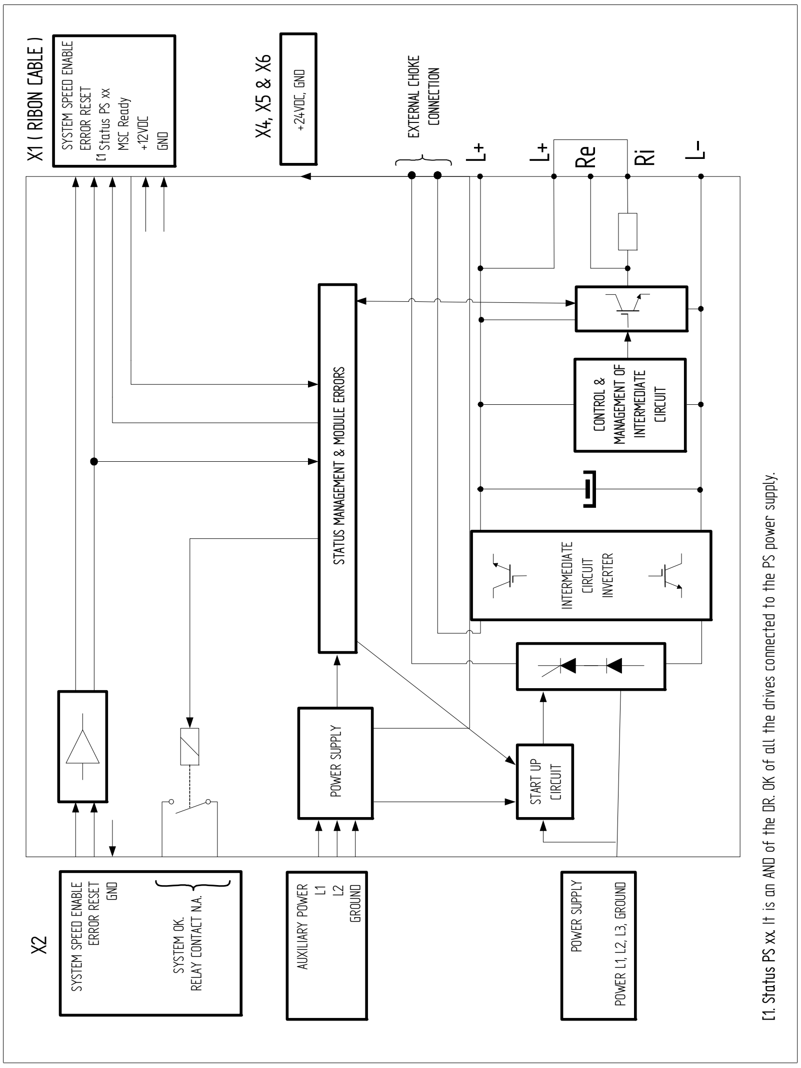


FIGURE H2.16

Block diagram.

Connectors. XPS-25. Description

The regenerative power supply XPS-25 has the following connectors:

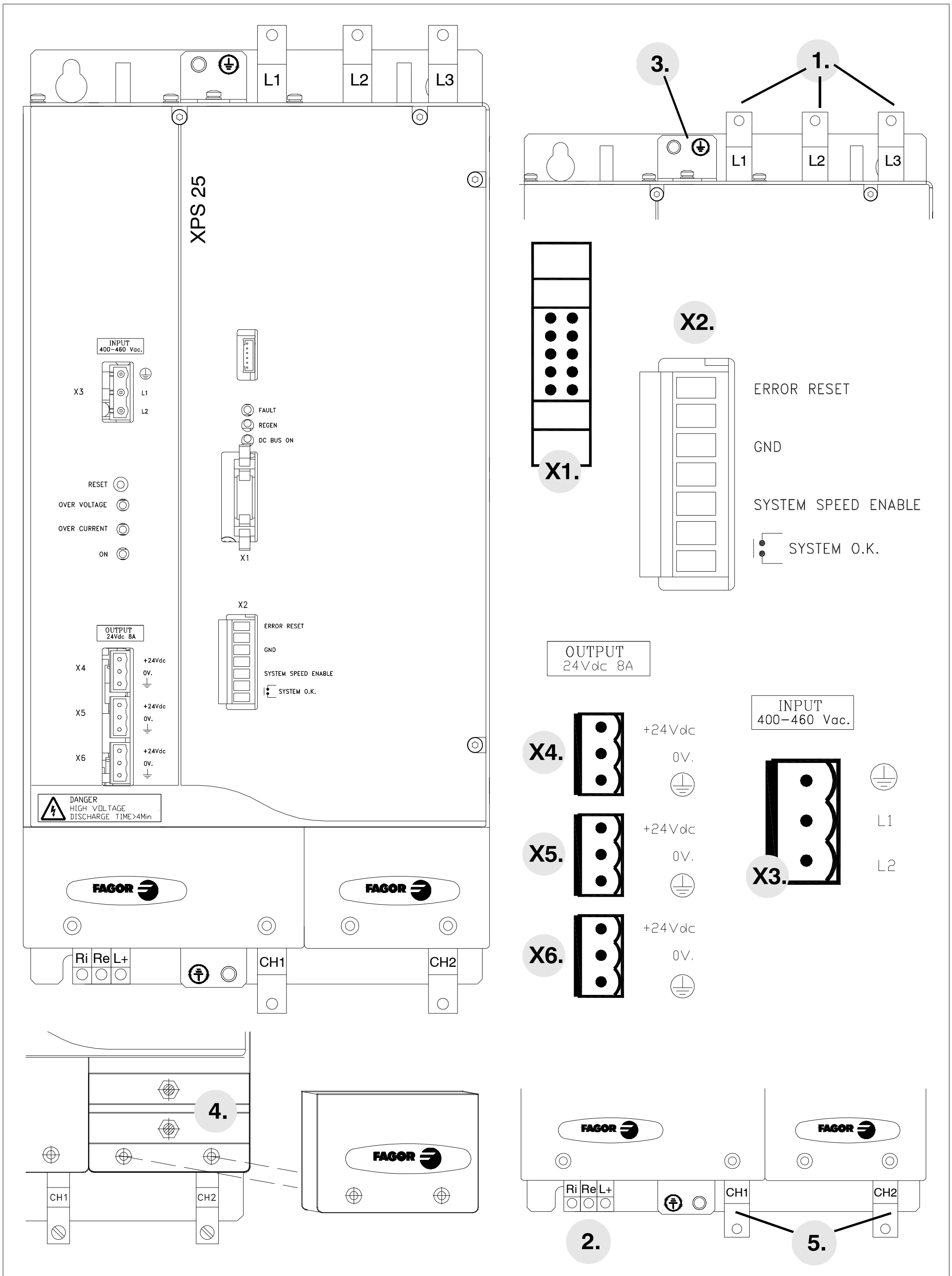
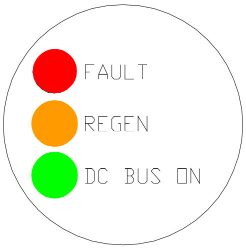


FIGURE H2.17

Connectors of the PS-25 power supply.

1. Power connector for the three-phase mains.
2. Power connector for the external Ballast resistor connection.
3. Ground connection for the mains cable.
4. Power Bus supplying power to the drive modules through metal bars.
5. Connectors for the choke of the XPS-25.
X1. Connector for inter-module communication.
X2. Connector for the basic control signals.
X3. Input connector supplying from mains to the auxiliary power supply integrated into the module. The mains power is received through it. It admits a voltage between 400 V AC and 460 V AC.
X4. Output connector of the auxiliary 24 V DC power supply integrated into the module.
X5. Output connector of the auxiliary 24 V DC power supply integrated into the module.
X6. Output connector of the auxiliary 24 V DC power supply integrated into the module.

Lights indicating the status of the main power supply

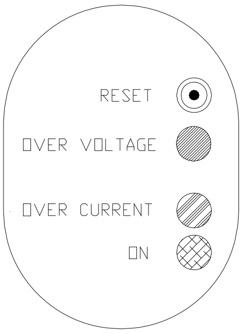


The regenerative power supply XPS-25 has the following lights on the front panel to indicate the status of the main power supply:

- **FAULT blinking.** The blinking red led indicates that **there are no errors** and that **one or several mains phases are missing**.
- **FAULT turned ON.** The steady red led on indicates that there is an error. The error is indicated on the display of the drive modules.
- **FAULT turned OFF.** The led off indicates that there is no error and that all mains phases are OK.
- **REGEN.** The led is lit when the module is working in energy regenerating mode.
- **DC BUS ON.**The green led indicates that the module is supplying all its power at the bus.

For further detail on these indicator lights, see the combination table for interpretation in the description of the E305 on the error listing shown in chapter **14. Error codes and messages**, of the "dds-software" manual.

Lights indicating the status of the auxiliary power supply



The regenerative power supply XPS-25 has the following lights on the front panel to indicate the status of the integrated auxiliary power supply:

- **RESET.** Initializes the auxiliary 24 V DC power supply.
- **OVER VOLTAGE.** The red led indicates that there is an over-voltage error at the 24 V DC output or due to over-temperature.
- **OVER CURRENT.** The red led indicates that there is an over-current error at the 24 V DC output.
- **ON.** The green led it indicates that there are 24 V DC at the output.

Connectors. XPS-65. Description

The regenerative power supply XPS-65 has the following connectors:

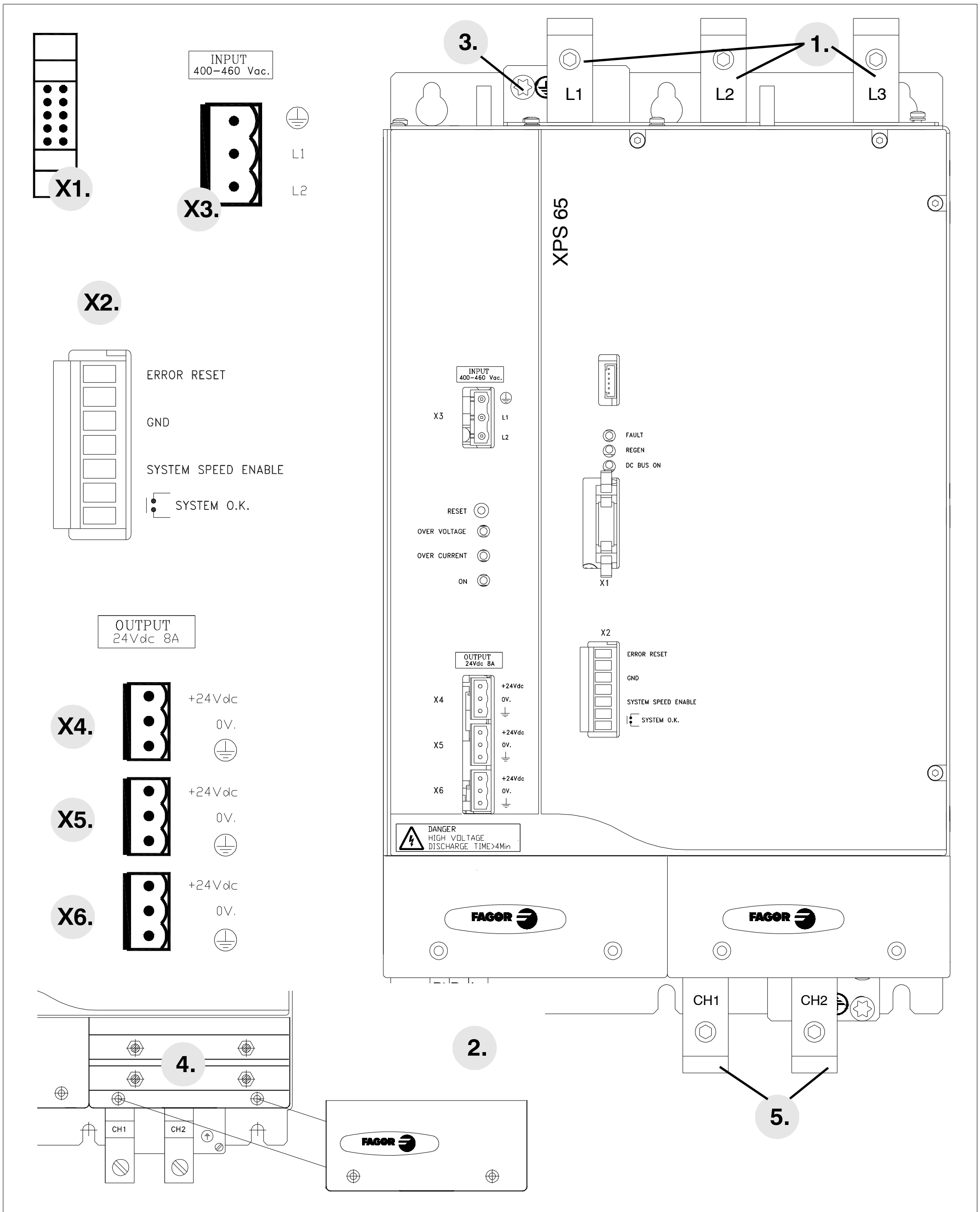
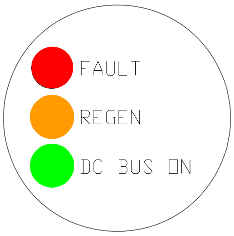


FIGURE H2.18

Connectors of the PS-65 power supply.

1. Power connector for the three-phase mains.
2. Power connector for the external Ballast resistor connection.
3. Ground connection for the mains cable.
4. Power Bus supplying power to the drive modules through metal bars.
5. Connectors for the choke of the XPS-65.
X1. Connector for inter-module communication.
X2. Connector for the basic control signals.
X3. Input connector supplying from mains to the auxiliary power supply integrated into the module. The mains power is received through it. It admits a voltage between 400 and 460 V AC.
X4. Output connector of the auxiliary 24 V DC power supply integrated into the module.
X5. Output connector of the auxiliary 24 V DC power supply integrated into the module.
X6. Output connector of the auxiliary 24 V DC power supply integrated into the module.

Lights indicating the status of the main power supply



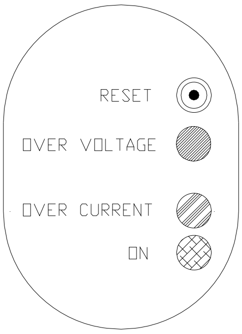
The regenerative power supply XPS-65 has the following lights on the front panel to indicate the status of the main power supply:

- **FAULT blinking.** The blinking red led indicates that **there are no errors** and that **one or several mains phases are missing**.
- **FAULT turned ON.** The steady red led on indicates that there is an error. The error is indicated on the display of the drive modules.
- **FAULT turned OFF.** The led off indicates that there is no error and that all mains phases are OK.
- **REGEN.** The led is lit when the module is working in energy regenerating mode.
- **DC BUS ON.**The green led indicates that the module is supplying all its power at the bus.

i

For further detail on these indicator lights, see the combination table for interpretation in the description of the E305 on the error listing shown in chapter 14. Error codes and messages of the "dds-software" manual.

Lights indicating the status of the auxiliary power supply



The regenerative power supply XPS-65 has the following lights on the front panel to indicate the status of the integrated auxiliary power supply:

- **RESET.** Initializes the auxiliary 24 V DC power supply.
- **OVER VOLTAGE.** The red led indicates that there is an over-voltage error at the 24 V DC output or due to over-temperature.
- **OVER CURRENT.** The red led indicates that there is an over-current error at the 24 V DC output.
- **ON.** The green led it indicates that there are 24 V DC at the output.

2.4 Connectors

2.4.1 Power connectors

Terminal strip for mains connection

When connecting the power supplies to mains, the phases may be connected in any order.

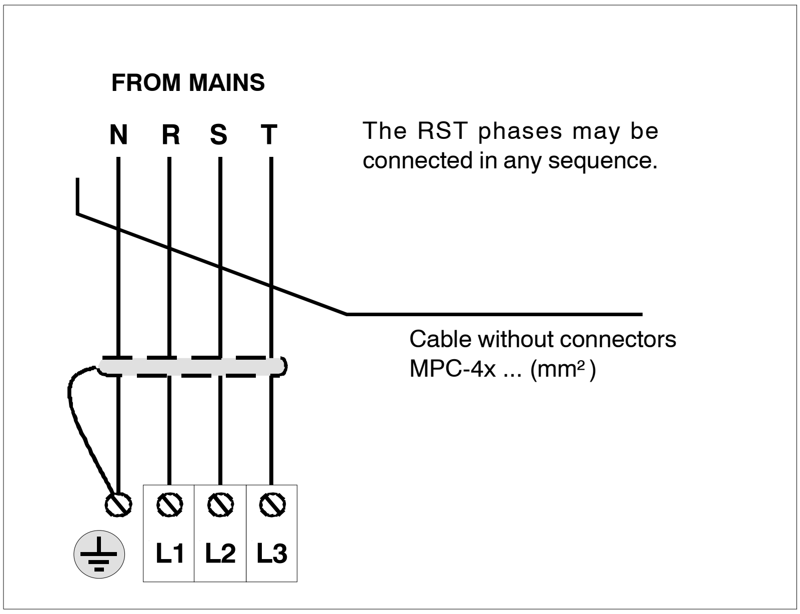


FIGURE H2.19

Terminal strip for connection to mains.

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

The following table shows the values for gap, tightening torque, sections and other interesting data of the power feed-through terminal blocks:

TABLE H2.16 Technical data of the feed-through terminal blocks for mains connection

Connector data	**XPS-25**	**XPS-65**
Min/max tightening torque (N·m)	2.0/2.3	6/8
Screw thread	M5	M6
Min./max. section (mm^2)	0.5/16	16/50
Rated current In (A)	76	150
Wire data		
Min. section (mm^2)	16	50
Length to strip (mm)	16	24

The equipment must be protected with fuses on the three-phase supply lines L1, L2 and L3. Follow the instructions given in chapter **6. POWER LINE CONNECTION** of this manual.

Terminal strip to connect the Ballast resistor

Regenerative power supplies 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 voltage is exceeded. See TABLE H2.14 in this chapter. Here are the two possible configurations:

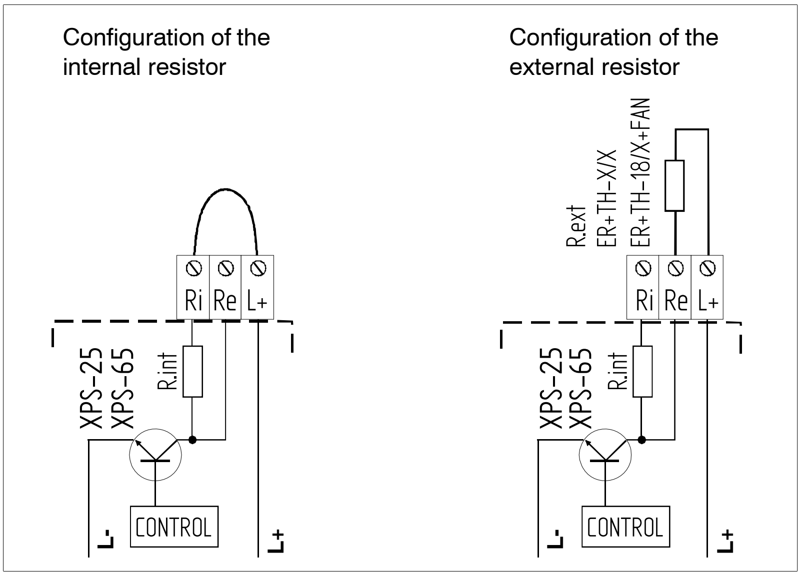


FIGURE H2.20

Ballast resistor connection configurations.

Removing this jumper between Ri and L+ (factory setting) and not connecting an external resistor between Re and L+ generates error code E215 or E304 on the display.

The following table shows the values for gap, tightening torque, sections and other interesting data of the feed-through terminals blocks for connecting the ballast resistor:

TABLE H2.17 Technical data of the feed-through terminal blocks for connecting the ballast resistor.

Connector data	XPS-25	XPS-65
Min/max tightening torque (N·m)	0.6/0.8	0.6/0.8
Screw thread	M3	M3
Min./max. section (mm²)	0.2/4	0.2/4
Rated current In (A)	32	32

These power supplies carry a protection against over-temperature which triggers error E301 on the display when reaching 105°C (221°F).

Derating curves

The power that may be dissipated through the internal ballast resistor located inside the power supply XPS-25 depends on the ambient temperature as determined by the derating curve.

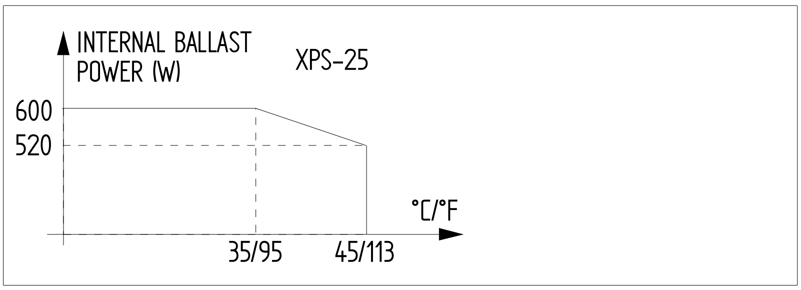


FIGURE H2.21

Derating curve of regenerative power supplies XPS-25.

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

Connection terminals for the Power DC bus

At the bottom of the module, covered by the screwed-on lid on the right (see **FIGURE H2.17** & **FIGURE H2.18**) the power supply offers the terminal for the power bus. This bus provides a dc voltage output of 565 V DC (when the mains voltage is 400 V AC) that feeds all the drive modules that are part of the DDS system.

All the modules powered with the same power supply must be connected through the power bus and this condition is a must to run it.

Warning. Never connect the power bus while the system is running.
There are voltages of about 600 V DC !

Two plates are supplied with each module to join them with the adjacent drive modules.

The tightening torque of these terminals must be between 2.3 and 2.8 N·m. This point is very important to ensure good electrical contact between modules.

Fagor power supplies have a Soft Start for charging the power bus.

The soft start begins when these two conditions, that are necessary and sufficient, are met:

- No errors at the modules connected through the internal bus (connector X1)
- Presence of the three mains phases at the input of the module.

This startup process begins when the FAULT indicator stops blinking and ends when the status indicator DC BUS ON turns on.

Before handling these leads, proceed in the following order:

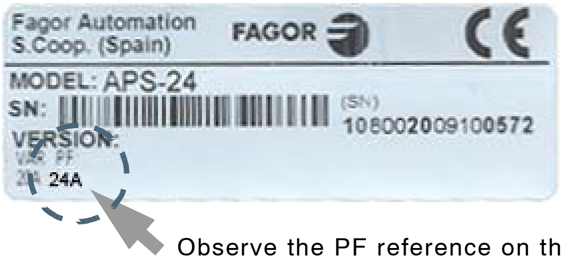
- Stop the motors
- Disconnect the mains voltage at the electrical cabinet.
- Wait, before handling these leads. The power supply module needs time to decrease the voltage of the power bus down to safe values (< 60 V DC). The green indicator DC BUS ON being turned OFF does not mean that the power bus may be handled or manipulated.
- The discharge time depends on the number of elements connected and it is about 4 minutes.

The power buses of different power supply modules must never be connected in parallel.

Important note.

Important. If necessary, the auxiliary power supply APS-24 (24 V DC, 10 A) can only be connected to the DC bus of any regenerative power supply XPS-XX or RPS-XX when the version label of the APS-24 (located on top of it) indicates a reference newer than **PF 23A**.

Warning. Never install an APS-24 to the DC bus of a DDS system with a regenerative power supply XPS-XX if the reference of the APS-24 is PF 23A or older.



Observe the PF reference on the versions label. Depending on this reference, it will be possible to connect the APS-24 or not to the DC bus of the DDS system with XPS regenerative power supplies.

FIGURE H2.22

Version label of the APS-24.

Note. It will not be necessary to install external protection fuses in these power lines of the auxiliary power supply. They are already integrated in the power supply itself.

Remember that the purpose of connecting an auxiliary power supply APS-24 to the DC bus of a DDS system is to ensure the supply to all the control circuits of the power supply and of the drive modules connected to the DC bus in case of a mains power outage in the auxiliary power supply ensuring a controlled stop of the moving axes instead of braking out of control by friction.

Bear in mind that although XPS power supplies come with an internal auxiliary power supply offering 3 outputs with 24V DC and a total of 8 A, 192 W, this power may not be enough to feed the control circuits of all the modules connected or other elements (e.g. a fan). That is why it may be necessary to also install an APS-24 auxiliary power supply to guarantee all the power needed.

The APS-24 auxiliary power supply offers 3 outputs with 24 V DC and a total of 10A, 240 W.

For further information about the auxiliary module APS-24, see chapter **4. AUXILIARY MODULES** in this manual.

Choke connection terminals

Regenerative power supplies XPS-25 and XPS-65 offer the connection terminals labeled CH1 and CH2 at the bottom of the module for connecting the choke. See **FIGURE H2.17** and **FIGURE H2.18**.

This inductive device is a must to limit 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 y and shorter than 2 meters (6 feet). They do not have to be shielded.

TABLE H2.18 Data of the feed-through terminal blocks for connecting the choke.

Connector data	Choke XPS-25	Choke XPS-65
Min/max tightening torque (N·m)	2/2.3	6/8
Screw thread	M5	M6
Min./max. section (mm²)	0.5/16	16/50
Rated current In (A)	76	150

The choke is an absolute must for the operation of a regenerative power supply. Installing the coil with an inductance other than the choke recommended in **TABLE H2.14** may cause severe damage to the unit.

2.4.2 Other connectors

X1 connector. Internal Bus

The communication between all the modules that make up the DDS servo drive system is established through connector X1.

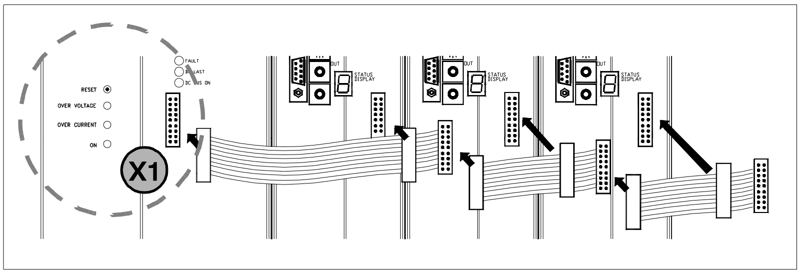


FIGURE H2.23

Connection of the internal bus between modules through connector X1.

A ribbon cable is provided with each module (power supply or drive) for this connection.

X2 connector. Control

The power supply module may be controlled through X2.

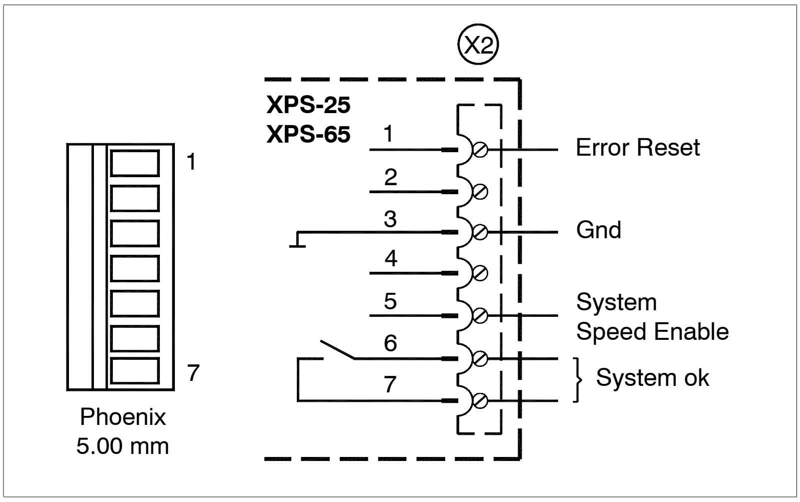


FIGURE H2.24

Control of the power supply module through connector X2.

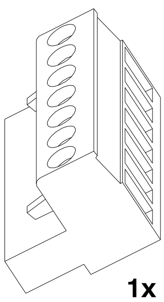
The internal circuits are protected with a 1.25A fuse.

> **Note.** Remember that the internal circuits of PS-65A non-regenerative power supplies must be powered by an external 24 V DC power supply, "APS-24"; that's why its control connector has three terminals more than connector X2 of the XPS-□□.

The following table shows the values for gap, tightening torque, sections and other data of the plug-in connector for X2.

TABLE H2.19 Data of the plug-in connector for X2.

Connector data	XPS-25	XPS-65
Nr of poles	7	7
Gap (mm)	5.00	5.00
Min/max tightening torque (N·m)	0.5/0.6	0.5/0.6
Screw thread	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5
Rated current In (A)	12	12
Wire data		
Min. section (mm²)	1.5	1.5
Length to strip (mm)	7	7



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The next table shows the signals and other considerations related to each pin of connector X2:

TABLE H2.20 Description of the pins of connector X2.

1	Error RESET	System error RESET input (24 V DC; 4.5 - 7 mA).
2	N.C.	Not connected
3	GND	0 volts reference for digital inputs. Error RESET (1) and System Speed Enable
4	N.C.	Not connected
5	System Speed Enable	General system speed enable. (24 V DC; 4.5 - 7 mA).
6	System OK	Contact indicating module status. It opens in case of failure. Limit 1 A at 24 V.
7	System OK	

Connectors X3, X4, X5 and X6

These connectors belong to the auxiliary power supply integrated into the main power supplies XPS-25 and XPS-65.

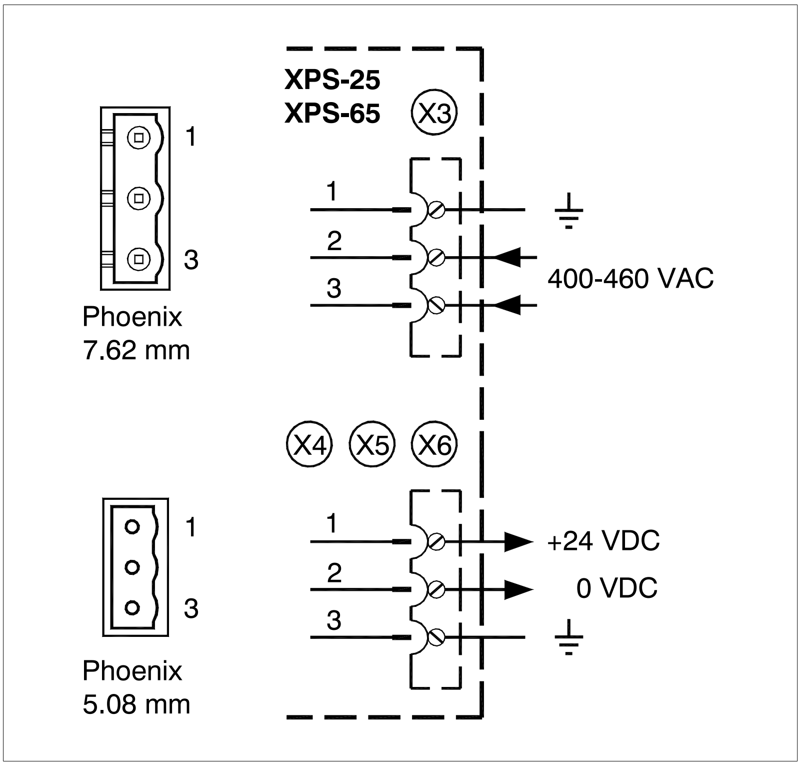


FIGURE H2.25

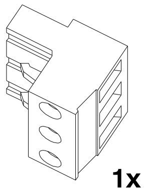
Connectors X3, X4, X5 and X6 that belong to the auxiliary power supply integrated into regenerative power supplies XPS-25 and XPS-65.

Connector X3 receives power from mains. It admits a voltage between 400 and 460 V AC.

This auxiliary power supply generates 24 V DC and its purpose is to feed the control circuits of the module itself. Also, it supplies up to 8 A of this dc voltage through connectors X4, X5 and X6. These three connectors are identical and offer greater connecting flexibility.

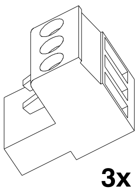
The gap and tightening torque and sections of the screws of the plug-in connectors for X3 and X4, X5, X6 are given by the table:

TABLE H2.21 Data of the plug-in connector for X3.



Connector data	XPS-25	XPS-65
Nr of poles	3	3
Gap (mm)	7.62	7.62
Min/max tightening torque (N·m)	0.5/0.6	0.5/0.6
Screw thread	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5
Rated current In (A)	12	12
Wire data		
Min. section (mm²)	1.5	1.5
Length to strip (mm)	7	7

TABLE H2.22 Data of the 3 identical plug-in connectors for X4, X5 and X6.



Data of each connector	XPS-25	XPS-65
Nr of poles	3	3
Gap (mm)	5.08	5.08
Min/max tightening torque (N·m)	0.5/0.6	0.5/0.6
Screw thread	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5
Rated current In (A)	12	12
Wire data		
Min. section (mm²)	1.5	1.5
Length to strip (mm)	7	7

In cases of micro-surges or total loss of mains power, this module guarantees stable and maintained 24 V DC while the motors are being stopped. This is an absolute must in order to comply with the CE requirement for the machine.

2.4.3 Module power-up

1. For the XPS-25 and XPS-65 power supplies:

Apply power to the Auxiliary Power Supply from mains through pins 2 and 3 of connector X3; These will power the control circuits of the power supply and provide 24 V DC at connectors X4, X5 and X6.

2. The power supply checks the system status:

If the status is correct:

The **System OK** contact closes (pins 6 and 7) and it stays closed while the control circuits are powered and no error comes up in any of the modules of the system.
The red FAULT indicator light blinks (it is not indicating an error because there are no phases yet).

If the status is not correct:

The red FAULT indicator light is permanently on (not blinking).

3. Apply power to the power supply:

Power is applied from mains through the power connectors on top of the power supply.
The soft start begins.
The red FAULT indicator light turns off.

4. green DC BUS ON light on:

After 4 seconds, the green DC BUS ON indicator light turns on meaning that the power bus has the proper dc voltage.

If for any reason an error is activated at the power supply module or at any drive module it supplies to, the system will act as follows:

1. The green DC BUS ON light will turn off.

2. The red FAULT light will be on permanently.

3. The power supply will stop supplying voltage to the power bus.

Warning. It does not discharge the capacitors !

With the Error RESET input (pin 1), it is possible to eliminate the errors at the drives that are part of the system - see chapter 14, resettable errors, of the dds-software manual - and it acts as follows:

- Its state will be 0 V. Activating it with 24 V DC erases all the errors stored in the memory of each drive of the system.
- Should the cause of the error persist, the corresponding module will show the same error again and it will be necessary to turn the unit back on to eliminate the error if it is a serious error.

The System Speed Enable input (pin 5) is related to the Speed Enable inputs of the drive modules.

- The state of the System Speed Enable is usually 24 V DC.
- When removing the 24V DC from the System Speed Enable pin is set to 0 V DC, all the drive modules joined together by the same internal bus will brake the motors that they control at full torque and when stopped or when reaching the time limit to stop [programmable with parameter GP3, see chapter 13 of the "dds-software" manual, it cancels the motor torque.

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

2.5 Regenerative regulated power supplies

When referring to regenerative regulated (step-up or boost) power supplies, we'll use RPS-80, RPS-75, RPS-45 and RPS-20. They all admit a mains voltage between 400-10% V AC and 460+10% V AC (with a mains frequency of 50/60Hz) and can consume and return to mains sinusoidal DC power with a maximum power factor close to 1. Unlike XPS-□□ regenerative power supplies, their bus voltage is programmable and independent from the mains voltage; i.e. for the same power absorbed, the bus voltage of the RPS-□□ can be higher than the that of the XPS

These power supplies look like this on the outside:

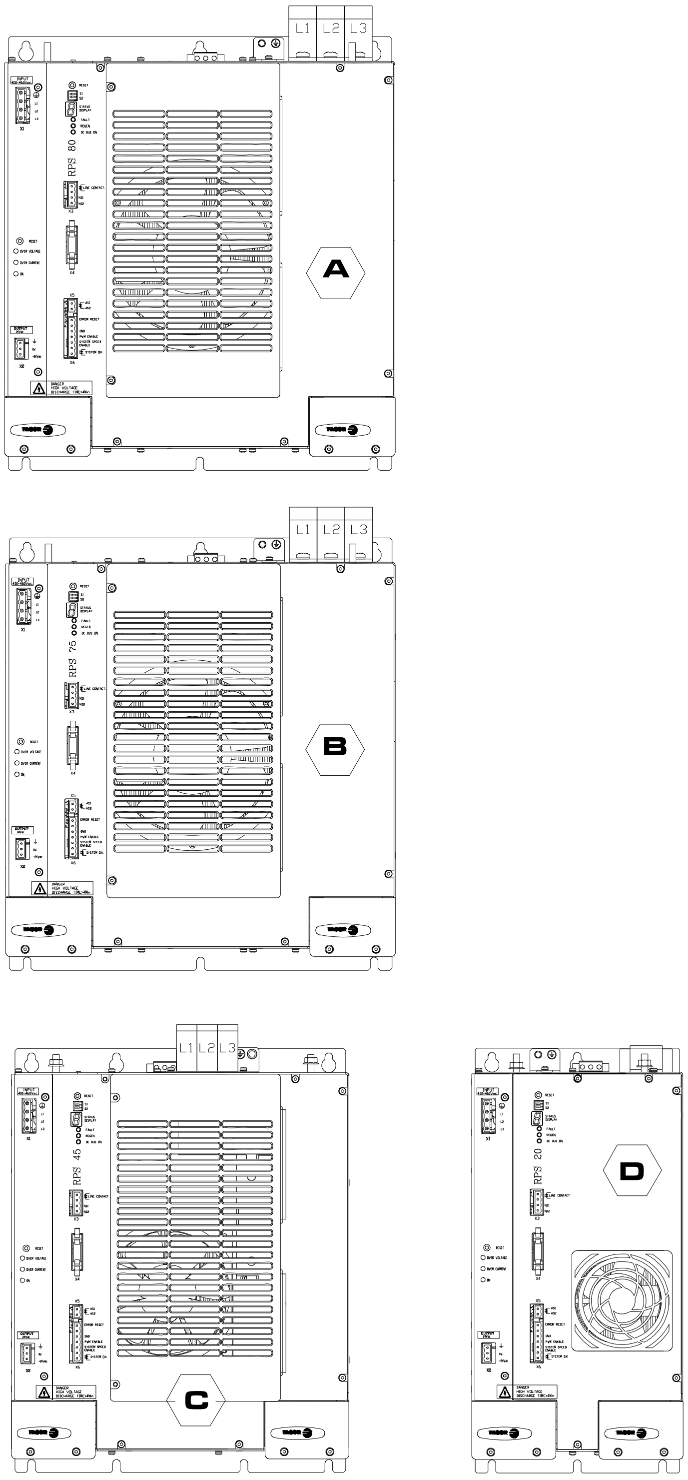


FIGURE H2.26

Regenerative regulated power supplies:
A. RPS-80 **B.** RPS-75, **C.** RPS-45, **D.** RPS-20.

However:

The **RPS-80** supplies 80 kW and can return up to 80 kW to mains for an S1 duty cycle. For an S6-40% duty cycle it supplies 104 kW and can return 104 kW to mains.

The **RPS-75** supplies 75 kW and can return up to 75 kW to mains for an S1 duty cycle. For an S6-40% duty cycle it supplies 97 kW and can return 97 kW to mains.

The **RPS-45** supplies 45 kW and can return up to 45 kW to mains for an S1 duty cycle. For an S6-40% duty cycle it supplies 59 kW and can return 59 kW to mains.

The **RPS-20** supplies 20 kW and can return up to 20 kW to mains for an S1 duty cycle. For an S6-40% duty cycle it supplies 26 kW and can return 26 kW to mains.

They all integrate an auxiliary 24 V DC, 8 A power supply to feed its own control circuits and those of the modular drives connected to them. Consequently, they will not require the auxiliary power supply APS-24 to perform this function unless more than 8 A are required.

2.5.1 RPS-XX modules

Technical data

TABLE H2.23 Technical characteristics of the RPS-☐☐ modules.

	RPS-80	RPS-75	RPS-45	RPS-20
Power supply (Vmains)	Three-phase 50/60 Hz, with a voltage range between 400-10% and 460+10% V AC			
Rated mains power consumption	80 kW	76 kW	46 kW	21 kW
Minimum power cable section [1]	70 mm²	70 mm²	35 mm²	10 mm²
Power bus voltage $VBUS_{PROG}$	600, 625 or 725 V DC. Programmable with VP5			
Max. power bus voltage $VBUS_{MAX}$	775 V DC			
Rated (peak, in S6) output current [2]	128 A (166.5 A)	120 A (156 A)	72 A (95 A)	32 A (41.6 A)
Rated (peak, in S6) output power [3]	80 kW (104 kW)	75 kW (97 kW)	45 kW (59 kW)	20 kW (26 kW)
Power dissipated at maximum load	1 kW	1 kW	0.7 kW	0.5 kW
Related chokes (three-phase)	choke RPS-75-3	choke RPS-75-3	choke RPS-45	choke RPS-20
Choke cable - RPS (shielded) (max. length: 2 m) [1]	70 mm²	70 mm²	35 mm²	10 mm²
Power for the module control circuit (24 V DC)	Three-phase 50/60 Hz, with a voltage range between 400-10% and 460+10% V AC			
Mains consumption to generate 24 V DC	0.7 A			
Output voltage of the auxiliary power	24 V DC ± 5%			
Maximum current supplied	8 A at 24 V DC (192 W)			
Filter capacity	2145 µF, 900 V		825 µF, 900 V	560 µF, 900 V
Energy stored in capacitors	**0.5 C V²**			
Maximum " SYSTEM OK ", " LINE CONTACT " and " AS1-AS2 " contact	125 V AC, 150 V DC			
Maximum current at contacts " SYSTEM OK ", " LINE CONTACT " and " AS1-AS2 "	2 A			
Status display	7-segments display			
Width (mm/inches)	350 / 13.8	350 / 13.8	311 / 12.2	194 / 7.6
Approx. mass (kg/lb)	20 / 44.1	20 / 44.1	16 / 35.3	10 / 22.0

[1] Depending on the rated operating power.
[2] For a bus voltage of 625 V.
[3] See derating curves in case of high temperatures.

TABLE H2.24 Ambient conditions and other characteristics of the RPS-☐☐ modules.

	RPS-80	RPS-75	RPS-45	RPS-20
Ambient temperature [3]	5°C / 45°C (41°F / 113°F)			
Storage temperature	-20°C/60°C (- 4°F/140°F)			
Maximum humidity	< 90% (non condensing at 45°C / 113°F)			
Maximum altitude without loss of features	1000 m (3281 ft) above sea level			
Operating vibration	0.5 G			
Shipping vibration	2 G			
Sealing	IP 2x			

[3] See derating curves in case of high temperatures.

Power diagram

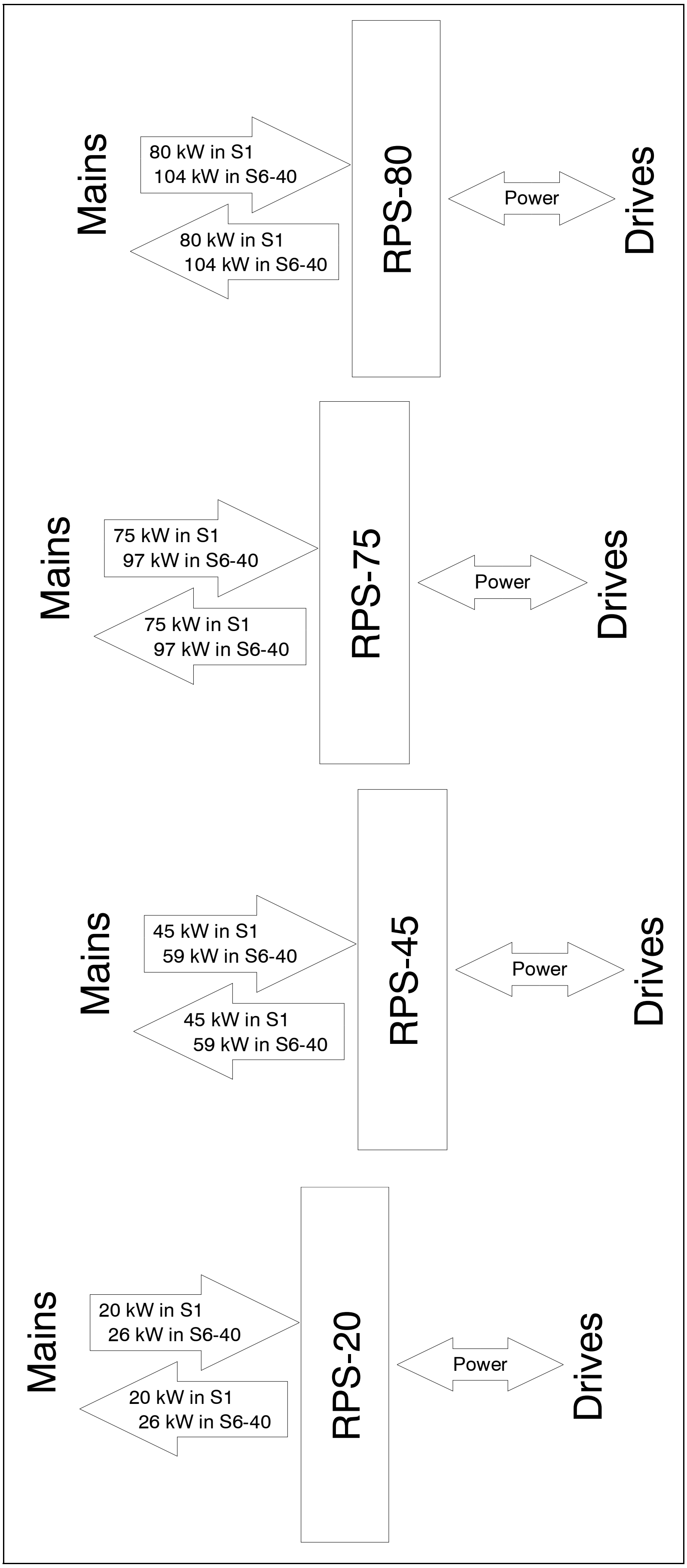


FIGURE H2.27

Power diagram when using the RPS-□□ power supplies.

2.5.2 Power derating

The following graph shows the maximum rms current in continuous S1 (Pn) and intermittent S6-40% (Pmax) duty cycles for a switching frequency of the power transistors of 8kHz in a temperature range between 5°C (41°F) and 60°C (140°F). See the load cycles in the next section.

Power derating graph / RPS-80

TABLE H2.25 Power derating on RPS-80 power supply (8 kHz).

Tamb		Pn (power in S1)	P_{S6} (power in S6-40%)
in ° C	in °F	in kW	in kW
35	95	80.0	104
40	104	80.0	104
45	113	80.0	104
50	122	76.6	99.5
55	131	72.0	93.6
60	140	67.3	87.5

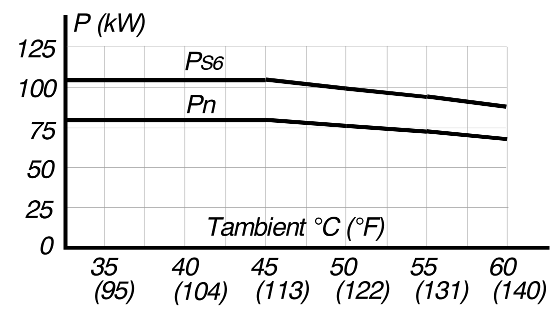


FIGURE H2.28

Power derating on RPS-80 power supply for fc=8 kHz.

Power derating graph / RPS-75

TABLE H2.26 Power derating on RPS-75 power supply (8 kHz).

Tamb		Pn (power in S1)	P_{S6} (power in S6-40%)
in °C	in °F	in kW	in kW
35	95	75.0	97.5
40	104	75.0	97.5
45	113	75.0	97.5
50	122	71.1	92.5
55	131	67.1	87.2
60	140	63.0	81.9

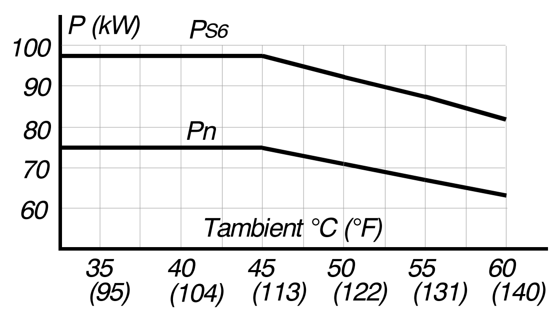


FIGURE H2.29

Power derating on RPS-75 power supply for fc=8 kHz.

Power derating graph / RPS-45

TABLE H2.27 Power derating on RPS-45 power supply (8 kHz).

Tamb		Pn (power in S1)	P_{S6} (power in S6-40%)
in °C	in °F	in kW	in kW
35	95	45.4	59.0
40	104	45.4	59.0
45	113	45.4	59.0
50	122	41.4	53.9
55	131	37.4	48.6
60	140	33.2	43.1

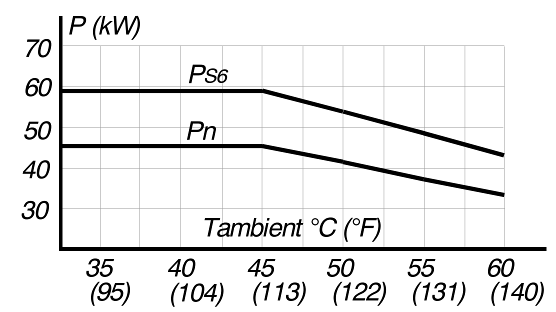


FIGURE H2.30
Power derating on RPS-45 power supply for fc=8 kHz.

Power derating graph / RPS-20

TABLE H2.28 Power derating on RPS-20 power supply (8 kHz).

Tamb		Pn (power in S1)	P_{S6} (power in S6-40%)
in °C	in °F	in kW	in kW
35	95	20.4	26.5
40	104	20.4	26.5
45	113	20.4	26.5
50	122	19.4	25.2
55	131	18.0	23.4
60	140	16.6	21.6

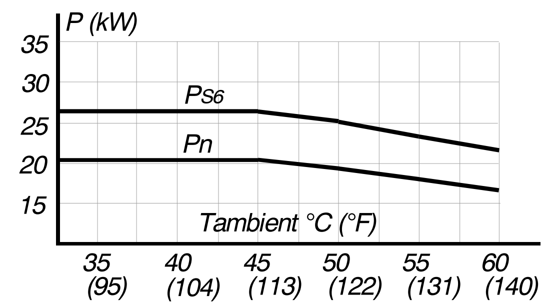


FIGURE H2.31
Power derating on RPS-20 power supply for fc=8 kHz.

2.5.3 Operating cycles

Load cycle S1

Continuous duty. Operation with constant load and long enough to achieve thermal balance.

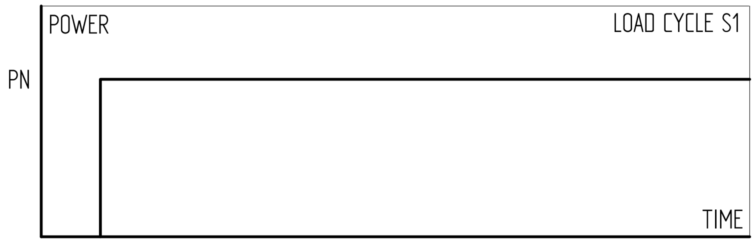


FIGURE H2.32

Load cycle S1.

Load cycle S6-40%

Periodic uninterrupted duty cycle with intermittent load. Succession of identical duty cycles, each with a running period under constant load and another period without load. There is no rest period. The 40% running factor indicates that for a 10 minute cycle, it works at constant power for 4 minutes P S6 -40% and without load for 6 minutes (0.4 x rated current Pn).

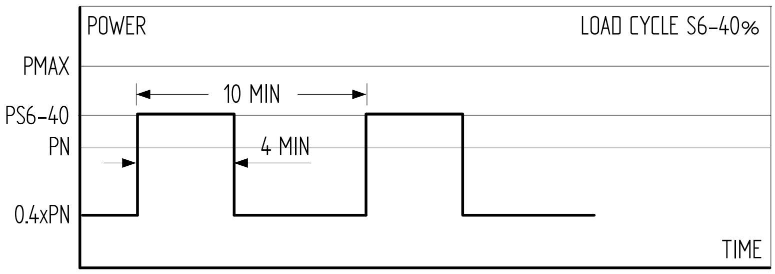


FIGURE H2.33

Load cycle S6-40%.

Cycle at Pmax without previous load

Periodic intermittent duty. Succession of identical duty cycles, each with a rest period. The 40% running factor means that for a 10 minute cycle, it works at 1.6xPn for 4 minutes and it rests (no power) for 6 minutes.

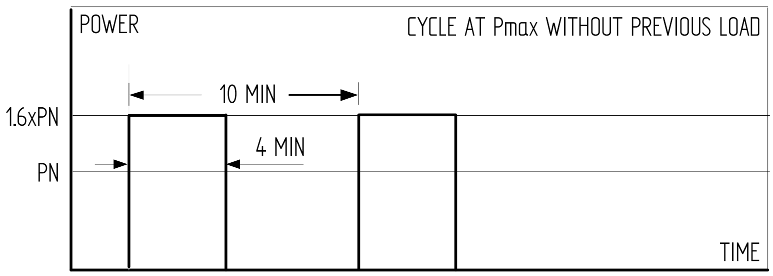


FIGURE H2.34

Cycle at Pmax without previous load.

Block diagram

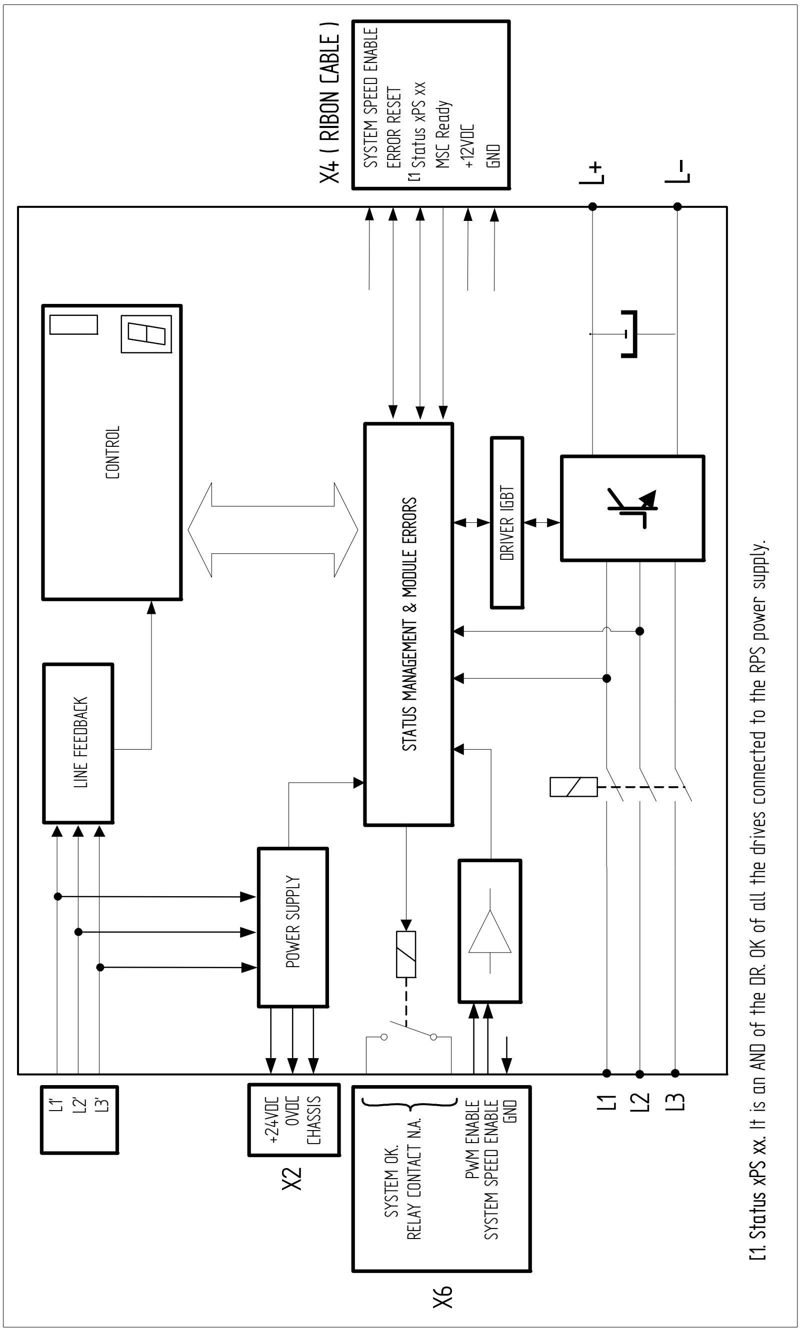


FIGURE H2.35

Block diagram of the RPS-☐☐ power supplies.

Connectors. RPS-80. Description

The following figure shows the regenerative regulated power supply RPS-80 and its connector layout:

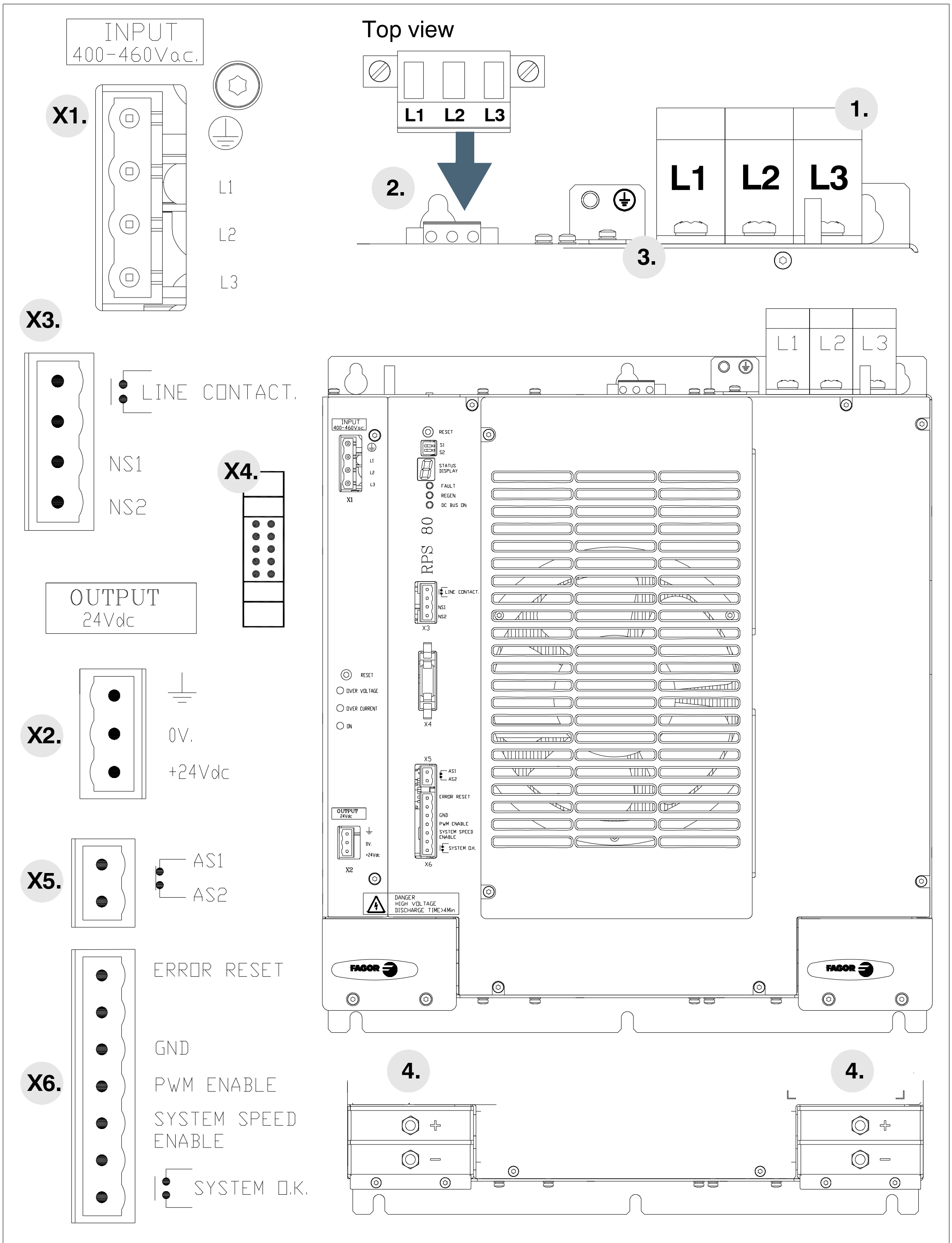


FIGURE H2.36

Connectors of the RPS-80 power supply.

1. Power connector for the three-phase mains.
2. Line input connector for synchronism.
3. Ground connection for the mains cable.
4. Power Bus supplying power to the drive modules through metal bars.
X1. Connector of the integrated auxiliary three-phase power supply.
X2. Output connector of the auxiliary 24 V DC power supply integrated into the module.
X3. Connector to be used to open/close the main internal contactor (pins NS1 and NS2) and acknowledge externally the status of the contactor (LINE CONTACT pins).
X4. Connector to communicate with the modular drives through the internal bus.
X5. Connector for the external acknowledgment of the status of the integrated safety relay.
X6. Connector for the basic control signals.

Connectors. RPS-75. Description

The following figure shows the regenerative regulated power supply RPS-75 and its connector layout:

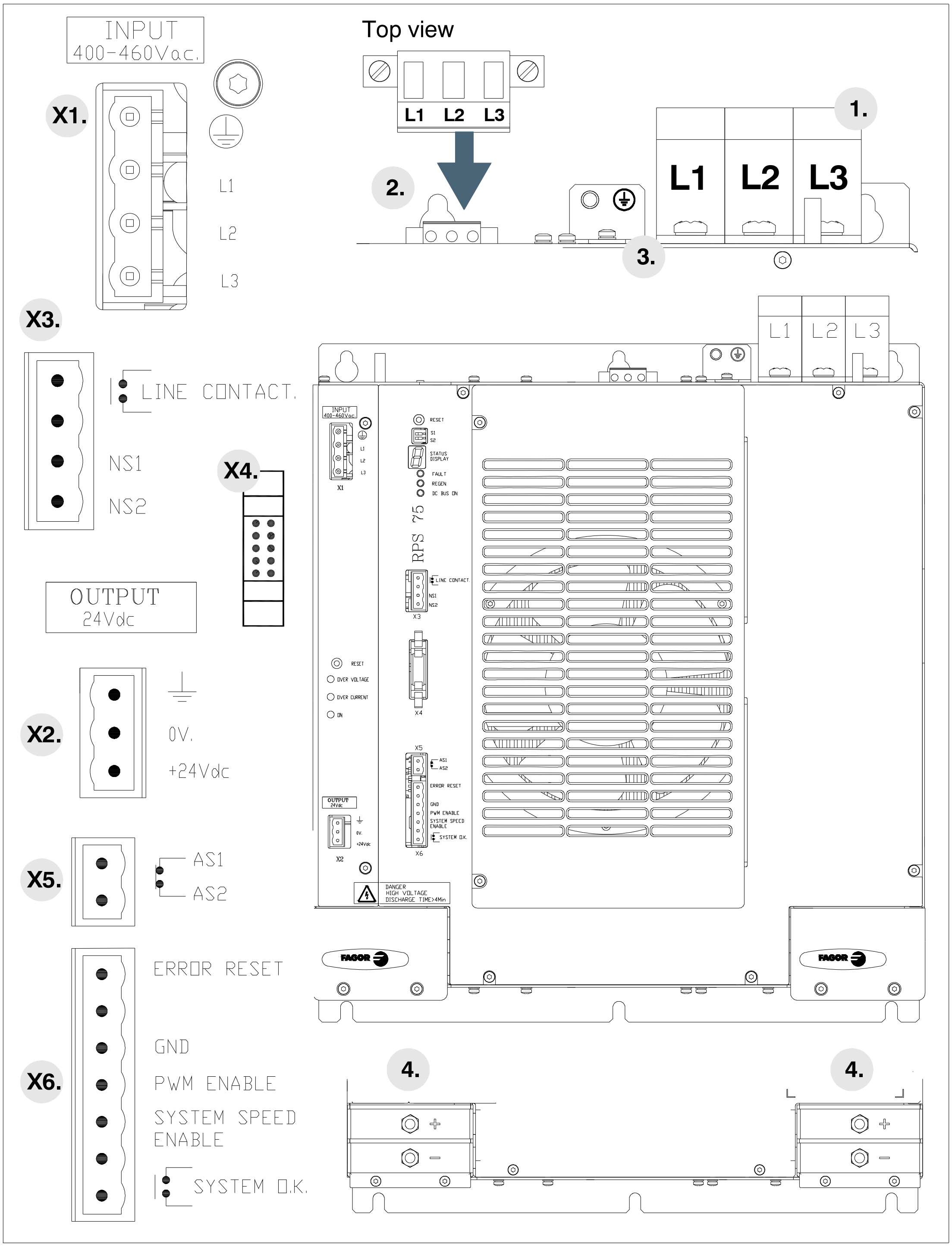


FIGURE H2.37

Connectors of the RPS-75 power supply.

1. Power connector for the three-phase mains.
2. Line input connector for synchronism.
3. Ground connection for the mains cable.
4. Power Bus supplying power to the drive modules through metal bars.
X1. Connector of the integrated auxiliary three-phase power supply.
X2. Output connector of the auxiliary 24 V DC power supply integrated into the module.
X3. Connector to be used to open/close the main internal contactor (pins NS1 and NS2) and acknowledge externally the status of the contactor (LINE CONTACT pins).
X4. Connector to communicate with the modular drives through the internal bus.
X5. Connector for the external acknowledgment of the status of the integrated safety relay.
X6. Connector for the basic control signals.

Connectors. RPS-45. Description

The following figure shows the regenerative regulated power supply RPS-45 and its connector layout:

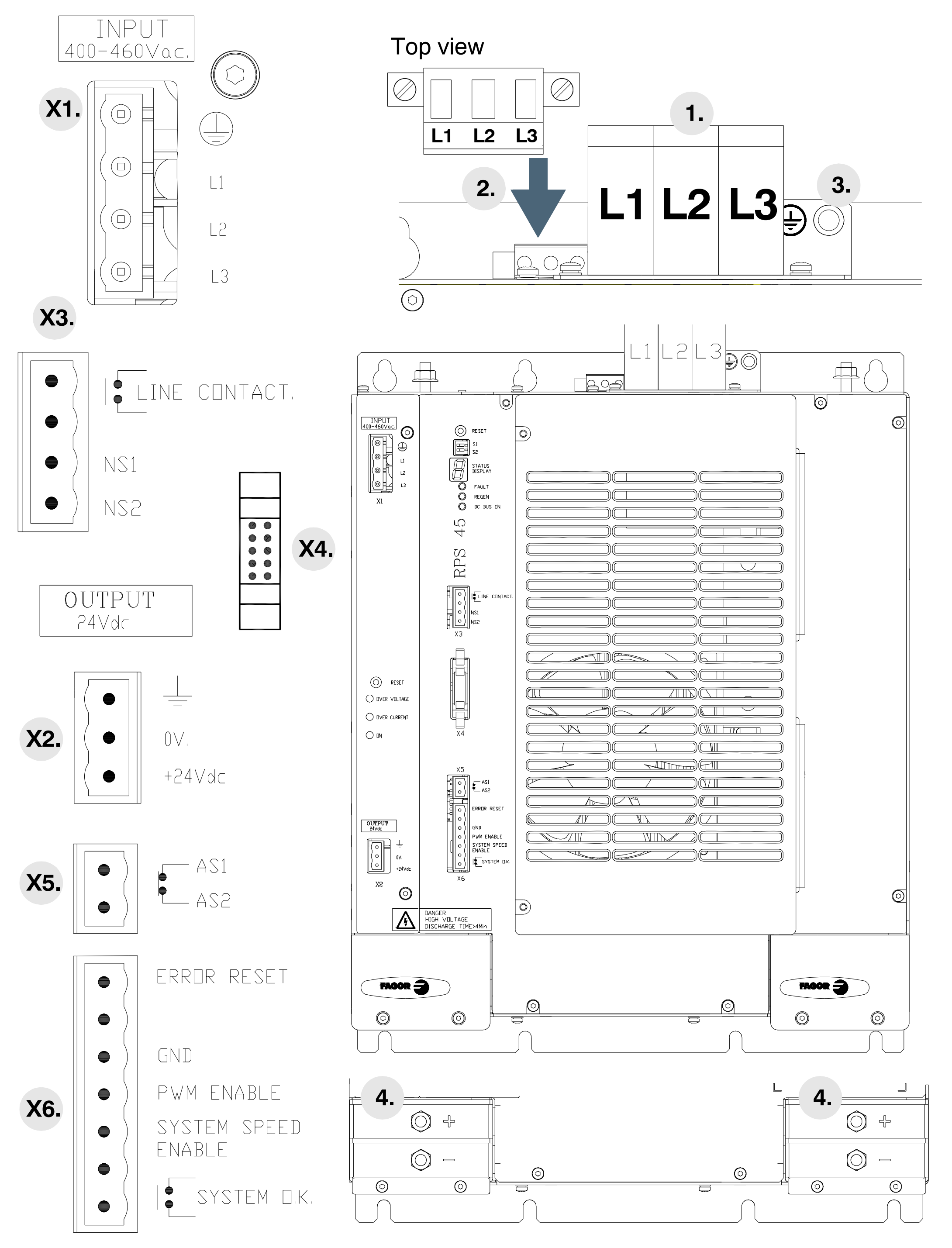


FIGURE H2.38

Connectors of the RPS-45 power supply.

1. Power connector for the three-phase mains.
2. Line input connector for synchronism.
3. Ground connection for the mains cable.
4. Power Bus supplying power to the drive modules through metal bars.
X1. Connector of the integrated auxiliary three-phase power supply.
X2. Output connector of the auxiliary 24 V DC power supply integrated into the module.
X3. Connector to be used to open/close the main internal contactor (pins NS1 and NS2) and acknowledge externally the status of the contactor (LINE CONTACT pins).
X4. Connector to communicate with the modular drives through the internal bus.
X5. Connector for the external acknowledgment of the status of the integrated safety relay.
X6. Connector for the basic control signals.

Connectors. RPS-20. Description

The following figure shows the regenerative regulated power supply RPS-20 and its connector layout:

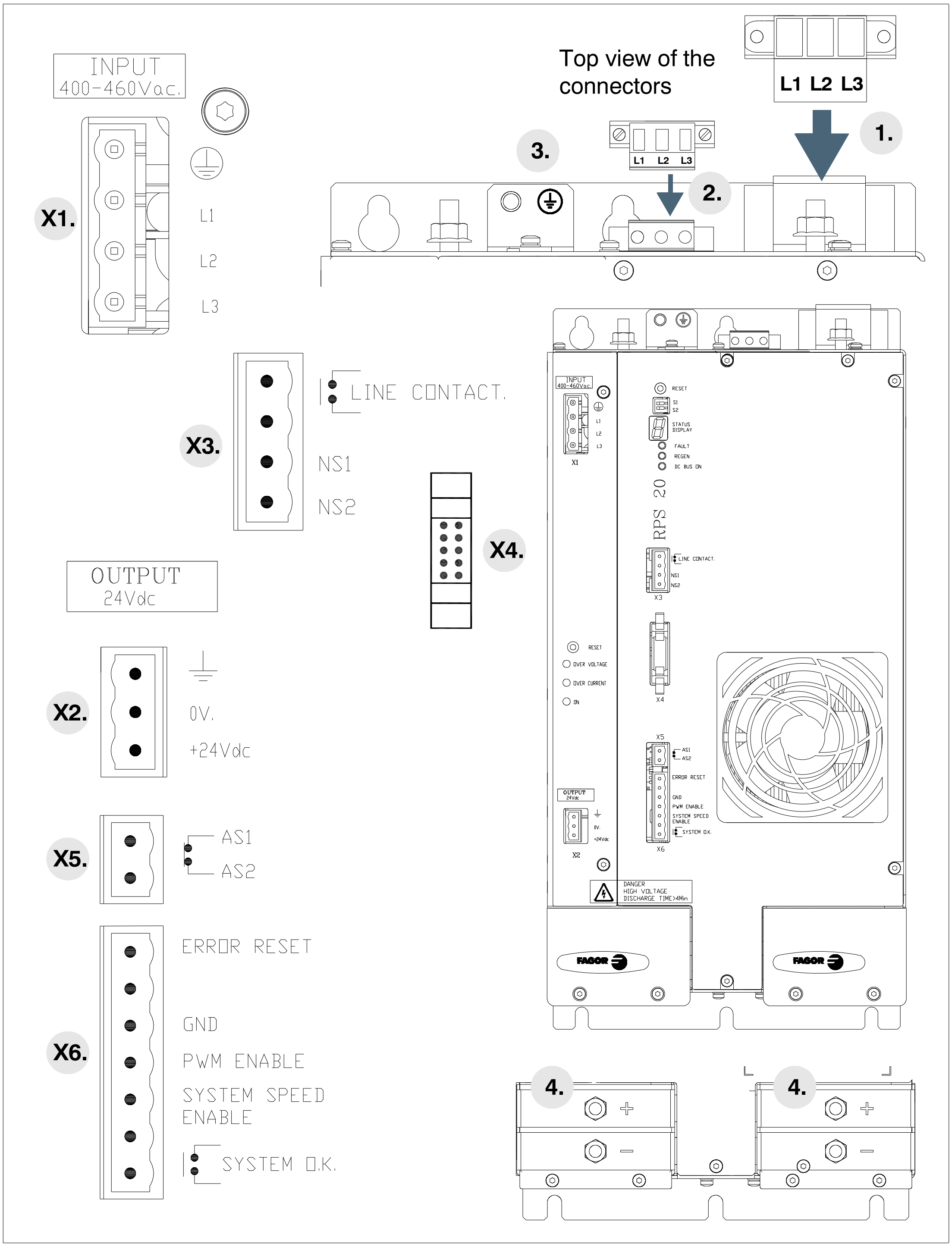
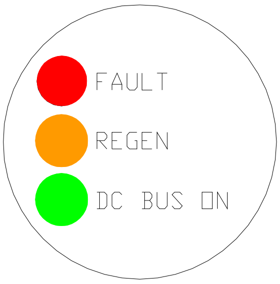


FIGURE H2.39

Connectors of the RPS-20 power supply.

1. Power connector for the three-phase mains.
2. Line input connector for synchronism.
3. Ground connection for the mains cable.
4. Power Bus supplying power to the drive modules through metal bars.
X1. Connector of the integrated auxiliary three-phase power supply.
X2. Output connector of the auxiliary 24 V DC power supply integrated into the module.
X3. Connector to be used to open/close the main internal contactor (pins NS1 and NS2) and acknowledge externally the status of the contactor (LINE CONTACT pins).
X4. Connector to communicate with the modular drives through the internal bus.
X5. Connector for the external acknowledgment of the status of the integrated safety relay.
X6. Connector for the basic control signals.

Lights indicating the status of the main power supply



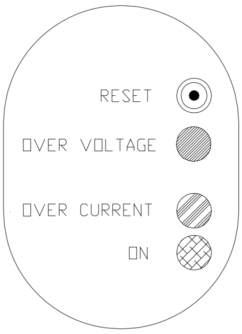
All the RPS-☐☐ regenerative regulated power supplies has the following lights on the front panel to indicate the status of the main power supply:

- **Blinking FAULT.** Blinking red LED. It indicates that the system is ready waiting for mains to be connected. It indicates, therefore, that there is no error and that there is no mains voltage. (0 state of the operating modes).
- **FAULT turned ON.** Red LED on all the time. It indicates that there is an error either at the power supply or in some module of the DDS system. The error will be shown at the display of the power supply - see the section "status display" later on - as well as at that of the relevant drive. It indicates that the system is not ready (**SYSTEM OK** open). (4 state of the operating modes).

> **Note.** If the red LED is always on and the display of the power supply shows a 0 with a blinking point, - see the section "status display" later on -, the error has been originated in some module of the system, not at the RPS-☐☐ power supply**.**

- **FAULT turned OFF.** Red LED off. It indicates that the system is charging the DC BUS. It indicates, therefore, that there is no error and that the mains phases are on. (1 state of the operating modes).
- **REGEN.** Amber LED on. It indicates that the module is working in energy regenerating (returning to mains) mode. (3 state of the operating modes).
- **DC BUS ON.** Green LED on. It indicates that the DC BUS is fully charged and the module offers all its power at the bus. (States 2 and 3 of the operating modes).

Lights indicating the status of the auxiliary power supply



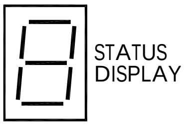
RPS-☐☐ regenerative power supplies have a reset button and the following lights on the front panel to indicate the status of the integrated auxiliary power supply:

- **RESET.** Initializes the auxiliary 24 V DC power supply.
- **OVER VOLTAGE.** It indicates an error due to over-voltage at the 24 V DC output or due to over-temperature.
- **OVER CURRENT.** It indicates an over-current error at the 24 V DC output.
- **ON.** It indicates that there are 24 V DC at the output when is turned on.

2.5.4 Other elements

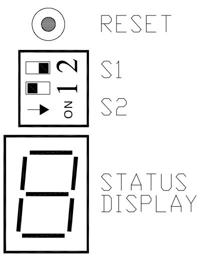
Besides the various connectors, the front panel of these power supplies has other elements that are mentioned next.

Status display

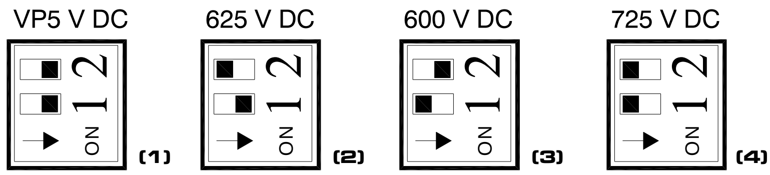


The 7-segment status display shows the system start-up sequence as well as the possible errors and warnings that could come up. For further detail, see the section <turning the module on> at the end of this chapter and go to appendix A "Error messages at the RPS power supplies" to interpret the errors and/or warnings displayed.

DC BUS command voltage selector switches



The two dip-switches located on top of the status display may be used to program the DC BUS voltage to a particular value. The possible combinations are:



■ This symbol represents the moving element of each switch.

Note. If the selected configuration is the option (1), i.e. both switches ON, the value of the bus voltage will be the one set by the user in parameter VP5 of the RPS. By default, this value is 675 V DC.

FIGURE H2.40

Bus voltage selector switches.

Example.

Let's suppose that the mains voltage is 460 V AC. The voltage that the DC BUS can supply is 1.41x460=650 V DC. Therefore, we must select a switch setting like FIGURE H2.40 - option (4) -, because any of the other settings generates a BUS voltage lower than 650 V DC and the purpose is to be able to raise the BUS voltage higher than the one mains can provide. See the note below for switch configuration - option (1) -.

If the mains voltage is 430 V AC. The voltage that the DC BUS can supply is 1.41x 430= 608 V DC. Therefore, we must select a switch setting that sets a bus voltage higher than this value; i.e. either the one given by - option (2) - or the one given by - option (4) - of FIGURE H2.40. Any of these two settings would be valid. See the note below for switch configuration - option -.

Clarifying note

In the conclusions drawn from these examples, the configuration - option (1) - has been ignored because the bus voltage depends on the value set in parameter VP5. This parameter admits values between 500 V DC and 750 V DC and by default it is assigned a voltage of 675 V DC.

Considering that it has been set to its default value (675 V DC), this switch configuration could also be set in both cases of this example.

For further information on parameter VP5 contact Fagor Automation S. Coop.

2.6 Connectors

2.6.1 Power connectors

Terminal strip for mains connection

This connector may be used to connect the power supply to mains. When connecting the power suppliy to mains, the phases may be connected in any order RST, RTS, TRS, etc.

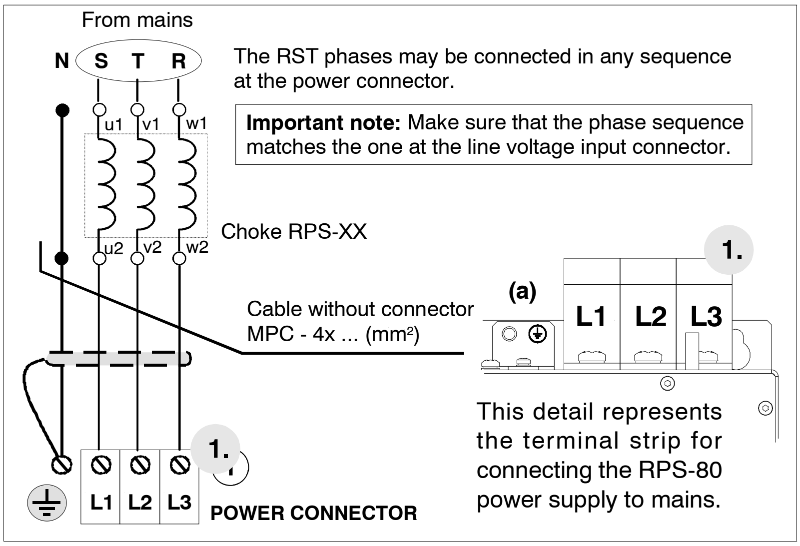


FIGURE H2.41

Terminal strip for connection to mains.

The ground connection of the cable shield is made from the vertical plate (a) next to the terminal strip. See **FIGURE H2.41**.

The following table shows the values for gap, tightening torque, sections and other interesting data of the power feed-through terminal blocks:

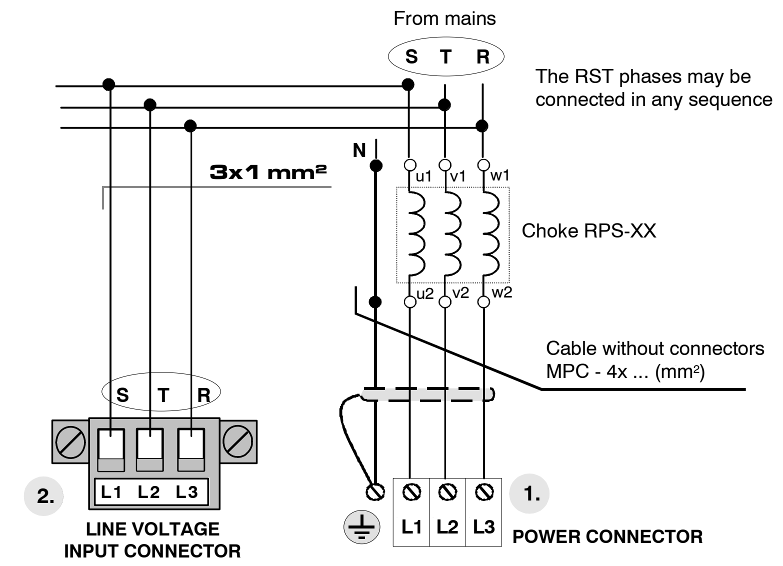
TABLE H2.29 Technical data of the feed-through terminal blocks for mains connection

Connector data	RPS-80 RPS-75	RPS-45	RPS-20
Gap (mm)	---	---	10.16
Min/max tightening torque (N·m)	15/20	6/8	1.2/1.5
Screw thread	M8	M6	M4
Min./max. section (mm²)	35/95	16/50	0.75/10
Rated current In (A)	232	125	41
Wire data			
Min. section (mm²)	70	35	10
Length to strip (mm)	27	24	12

The equipment must be protected with fuses on the three-phase supply lines L1, L2 and L3. Follow the instructions given in chapter **6. POWER LINE CONNECTION**, section "fuses" in this manual.

Terminal strip for connecting the mains voltage input

Three-phase line input taken at a point before the three single-phase RPS-☐☐ chokes (one choke per phase). This connection is needed to receive the mains line voltages and it is done through connector (2) as shown in **FIGURE H2.42**.

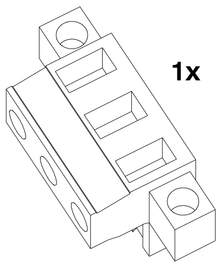


Important note: Make sure that if the phase sequence is e.g. S-L1,T-L2,R-L3 at the power connector, it must then match the sequence set at the line voltage connector; that is: S - L1, T-L2, R-L3 .

FIGURE H2.42

Terminal strip for connecting the mains voltage input.

TABLE H2.30 Data of the pins of the mains voltage sensor connector. See connector 2 of the previous figure.



Connector data	**RPS-80 RPS-75**	**RPS-45**	**RPS-20**
Nr of poles	3	3	3
Gap (mm)	7.62	7.62	7.62
Min/max tightening torque (N·m)	0.5/0.6	0.5/0.6	0.5/0.6
Screw thread	M3	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5	0.2/2.5
Rated current In (A)	12	12	12
Wire data			
Min. section (mm²)	1	1	1
Length to strip (mm)	7	7	7

The maximum current circulating through the wires (screwed into this connector) will be 8.5 mA for a mains voltage of 460 V AC (rms) Therefore, use wires with a minimum section of 1 mm².

Warning. The phase order in the line voltage input (2) must be exactly the same as the one selected at the power connector (1). See **FIGURE H2.42**.

For further detail, see chapter **6. POWER LINE CONNECTION** of this manual.

Connection to an external Ballast resistor

The RPS-☐☐ **power supplies do not carry a Ballast circuit** (also called crowbar circuit somewhere in this manual) and, consequently, do not have external Ballast resistors associated with them. When this circuit is required, off-the-shelf crowbar circuits must be installed.

Connection terminals for the Power DC bus

At the bottom of the module, at both ends and covered by the screwed-on lid - see **FIGURE H2.36** -, these power supplies offer the terminals for the power bus (DC BUS) at both ends.

Warning. Use the terminals of the power bus located at the end easiest to install the DDS system.

This bus provides a dc voltage output. Set the micro-switches (located on top of the status display) properly to determine its magnitude. The selected bus voltage will stay constant regardless of the mains voltage.

See **FIGURE H2.40** that shows how to set these switches to select the desired bus voltage.

This voltage set at the power bus can supply all the drive modules that make up the DDS system.

All the modules powered with the same power supply must be connected through the power bus and this condition is a must to run it.

Warning. Never connect the power bus while the system is running . There are voltages of 600 V DC and 725 V DC !

Two plates are supplied with each module to join them with the adjacent drive modules.

The tightening torque of these terminals must be between 2.3 and 2.8 N·m. This point is very important to ensure good electrical contact between modules.

Fagor power supplies have a Soft Start for charging the power bus.

The soft start begins when these two conditions, that are necessary and sufficient, are met:

- No errors at the modules connected through the internal bus (connector X1 at the drives and X4 at the RPS-□□ power supplies)
- Presence of the three mains phases at the input of the module.

This startup process begins when the FAULT indicator stops blinking and the status indicator DC BUS ON turns on.

Before handling these leads, proceed in the following order:

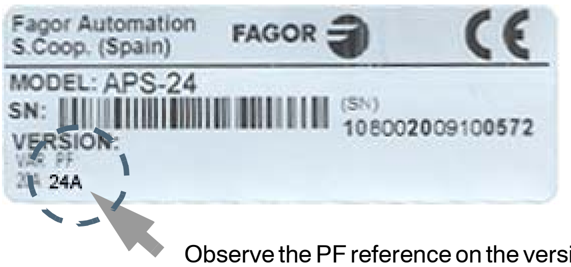
- Stop the motors.
- Disconnect the mains voltage at the electrical cabinet.
- Wait, before handling these leads. The power supply module needs time to decrease the voltage of the power bus down to safe values (< 60 V DC). The green indicator DC BUS ON being turned OFF does not mean that the power bus may be handled or manipulated.
- The discharge time depends on the number of elements connected and it is about 4 minutes.

The power buses of different power supply modules must never be connected in parallel.

Important note.

Important. If necessary, the auxiliary power supply APS-24 (24 V DC, 10 A) can only be connected to the DC bus of any regenerative power supply RPS-☐☐ when the version label of the APS-24 (located on top of it) indicates a reference newer than **PF 23A**.

Warning. Never install an APS-24 to the DC bus of a DDS system with a regenerative power supply RPS-☐☐ if the reference of the APS-24 is PF 23A or older.



Observe the PF reference on the versions label. Depending on this reference, it will be possible to connect the APS-24 or not to the DC bus of the DDS system with RPS-☐☐ regenerative power supplies.

FIGURE H2.43

Version label of the APS-24.

Note. It will not be necessary to install external protection fuses in these power lines of the auxiliary power supply. They are already integrated in the power supply itself.

Remember that the purpose of connecting an auxiliary power supply APS-24 to the DC bus of a DDS system is to ensure the supply to all the control circuits of the power supply and of the drive modules connected to the DC bus in case of a mains power outage in the auxiliary power supply ensuring a controlled stop of the moving axes instead of braking out of control by friction.

Bear in mind that although RPS-☐☐ power supplies come with an internal auxiliary power supply offering 3 outputs with 24V DC and a total of 8 A, 192 W, this power may not be enough to feed the control circuits of all the modules connected or other elements (e.g. a fan). That is why it may be necessary to also install an APS-24 auxiliary power supply to guarantee all the power needed.

The APS-24 auxiliary power supply offers 3 outputs with 24 V DC and a total of 10A, 240 W.

For further information about the auxiliary module APS-24, see chapter **4. AUXILIARY MODULES** in this manual.

Connection of the chokes

Warning. RPS-□□ regenerative regulated power supplies, unlike XPS-□□, **regenerative power supplies do not have connection terminals** called CH1 and CH2 at the bottom of the module for connecting the chokes.

These chokes called CHOKE RPS-□□ are connected in series with each phase of the three-phase line between the MAINS FILTER □□A and the RPS-□□ power supply module. The following table shows the choke associated with the power supply:

Power supply	RPS-80 / RPS-75	RPS-45	RPS-20
3-phase choke	Choke RPS-75-3	Choke RPS-45	Choke RPS-20

For further detail, see chapter 6. POWER LINE CONNECTION and chapter 8. INSTALLATION in this manual.

Warning. Chokes are a must to limit the current circulating from the power bus to mains.

Chokes are a must for the operation of a regenerative power supply. **Installing a choke with an inductance other than the one recommended for a choke may cause severe damage to the unit.**

Fagor supplies the right CHOKE RPS-□□ for this application. See the relevant cable section in TABLE H2.31. Note that the cable must be shielded.

TABLE H2.31 Data of the RPS choke connection terminals

CHOKES	RPS-75-3	RPS-45	RPS-20
Gap (mm)	-------	-------	10.16
Min/max tightening torque (N·m)	15/20	6	1.5
Section (mm²)	70	35	10

2.6.2 Other connectors

Connectors X1 and X2 (integrated auxiliary power supply)

These connectors belong to the auxiliary power supply integrated into the main RPS power supply.

This auxiliary power supply is fed through connector X1.

This electrical power is received from the three-phase line to the power supply connected to a point before the power connection operation (before contactor KM1). It admits a voltage between 400 and 460 V AC.

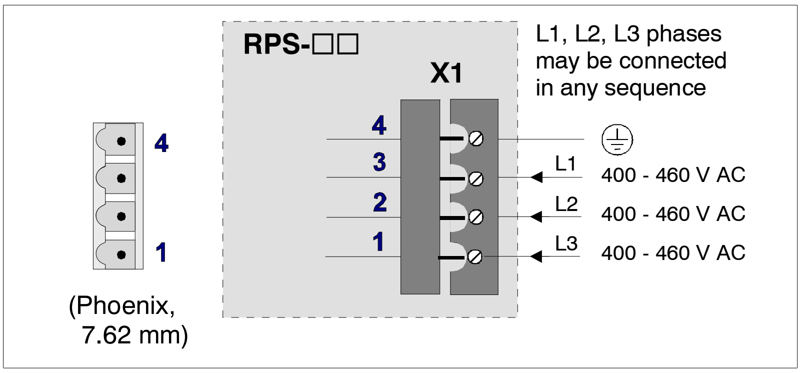


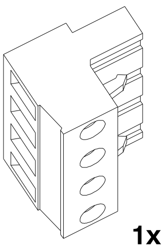
FIGURE H2.44

Connector X1. Powering the auxiliary power supply integrated into RPS power supplies.

Warning. The mains phases feeding terminals 1, 2 and 3 of connector X1 may be connected in any phase order; i.e. RST, RTS, STR, etc.

The following table shows the values for gap, tightening torque, sections of the screws and other data of the plug-in connector for X1.

TABLE H2.32 Data of the plug-in connector for X1.



Connector data	RPS-80 RPS-75	RPS-45 RPS-20
Nr of poles	4	4
Gap (mm)	7.62	7.62
Min/max tightening torque (N·m)	0.5/0.6	0.5/0.6
Screw thread	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5
Rated current In (A)	12	12
Wire data		
Min. section (mm²)	1.5	1.5
Length to strip (mm)	7	7

At the same time, pin 1 of connector X2 outputs 24 V DC, 8 A to feed the control circuits of the module itself and of the modular drives connected to the bus.

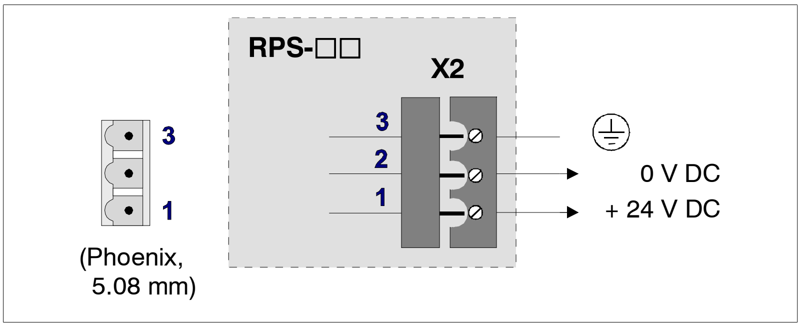
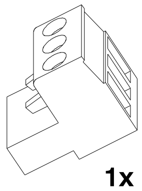


FIGURE H2.45

Connector X2. 24 V DC output.

The following table shows the values for gap, tightening torque, sections of the screws and other data of the plug-in connector for X2.

TABLE H2.33 Data of the plug-in connector for X2.



Connector data	**RPS-80 RPS-75**	**RPS-45 RPS-20**
Nr of poles	3	3
Gap (mm)	5.00	5.00
Min./max. tightening torque (N·m)	0.5/0.6	0.5/0.6
Screw thread	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5
Rated current In (A)	12	12
Wire data		
Min. section (mm²)	1.5	1.5
Length to strip (mm)	7	7

In cases of micro-surges or total loss of mains power, this module guarantees stable and maintained 24 V DC while the motors are being stopped. This is an absolute must in order to comply with the CE requirement for the machine.

Example regarding the 24 V DC of connector X2

A door closes an enclosure that contains a DDS system with an RPS-□□ power supply. The 24 V DC supplied at pin 1 of connector X2 may be taken to one end of the door opening/closing switch and connect the other end to pin 4 **<PWM ENABLE>** of control connector X6. When the door is closed, 24 V DC are applied to pin 4 **<PWM ENABLE>** hence letting the system run. When the door opens, the switch opens and voltage is no longer applied to pin 4 of X6 hence opening the integrated safety relay. The system stops.

Note. Do not take this example as a real application, but just as an approach to the functionality of the **PWM ENABLE**.

Connector X3 (main internal contactor)

The main integrated contactor "LINE CONTACT" (NO, **N**ormally **O**pen) is closed through connector X3.

Important

Pins 3 and 4 MUST BE short-circuited to close the internal contactor of the power supply and let the system run. Hence, get a 1 mm² cable and jumper NS1 (pin 3) and NS2 (pin 4) externally to close the main internal contactor. Remember that **these pins do not come short-circuited from the factory and if they are not short-circuited by the user, the DC bus will not be charged.**

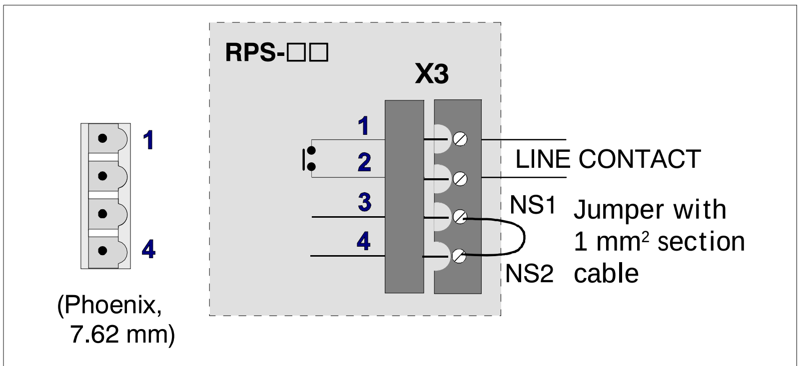


FIGURE H2.46

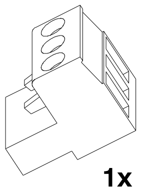
Connector X3. Closing the main internal contactor "LINE CONTACT".

The status of the contactor will be acknowledged through pins 1 and 2 of this connector and the CNC, PLC, control panel, etc. will confirm that the integrated contactor has actually closed.

> **Warning.** It is important to know that if NS1 (pin 3 de X3) and NS2 (pin 4 de X3) are not short-circuited by the user, the main internal contactor "LINE CONTACT" will stay open. The power supply will start up, but the DC BUS will not charge and, therefore, the axes cannot move. The status display may show the warning - **A315** - indicating that the DC bus charging time (SoftStart type) has exceeded the maximum set value because it never gets charged. **Therefore, the main internal contactor "LINE CONTACT" (pins 3 and 4) MUST BE CLOSED for the system to run.**

The following table shows the values for gap, tightening torque, sections of the screws and other data of the plug-in connector for X3.

TABLE H2.34 Data of the plug-in connector for X3.



Connector data	RPS-80 RPS-75	RPS-45 RPS-20
Nr of poles	4	4
Gap (mm)	5.00	5.00
Min/max tightening torque (N·m)	0.5/0.6	0.5/0.6
Screw thread	M3	M3
Min./max. section (mm^2)	0.2/2.5	0.2/2.5
Rated current In (A)	12	12
Wire data		
Min. section (mm^2)	1.5	1.5
Length to strip (mm)	7	7

Connector X4. Internal Bus

This connector may be used to connect the various modules to each other through the internal bus communicating with each other the power supply and all the servo drives that make up the DDS system.

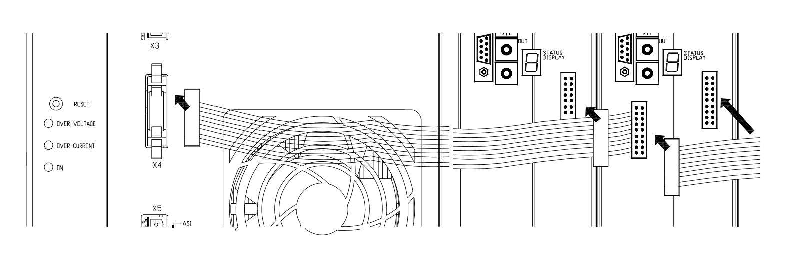


FIGURE H2.47

Connector X4. Internal bus connection between modules.

A ribbon cable is provided with each module (power supply or drive) for this connection.

Connector X5. Integrated safety

This connector X5 of the RPS-☐☐ power supply is associated with the second contact (**NC**, **N**ormally **C**losed) of an internal safety relay (with guided contacts). The status of the relay (initially closed) will be acknowledged through its two pins and a CNC, PLC, control panel, etc. will confirm that the integrated safety relay has actually opened or closed.

These two terminals are identified as AS1 and AS2. The opening or closing of this relay depends on whether 24 V DC are present at pin 4 **<PWM ENABLE>** of control connector X6.

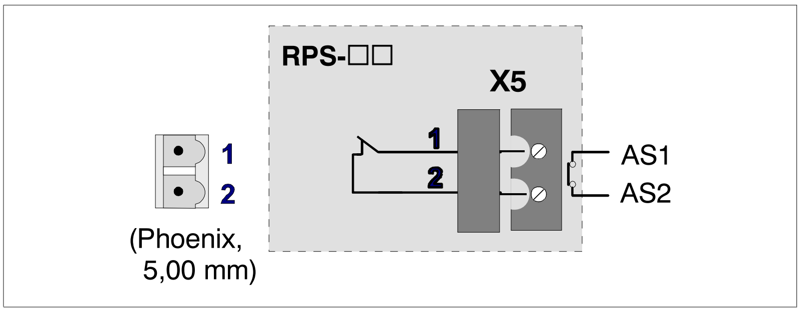


FIGURE H2.48

Connector X5. External acknowledgment of the status of the integrated safety relay.

The following table shows the values for gap, tightening torque, sections of the screws and other data of the plug-in connector for X5.

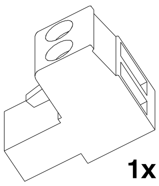


TABLE H2.35 Data of the plug-in connector for X5.

Connector data	**RPS-80 RPS-75**	**RPS-45 RPS-20**
Nr of poles	2	2
Gap (mm)	5.00	5.00
Min/max tightening torque (N·m)	0.5/0.6	0.5/0.6
Screw thread	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5
Rated current In (A)	12	12
Wire data		
Min. section (mm²)	1.5	1.5
Length to strip (mm)	7	7

Connector X6. Control circuits

The screwed-on 7-pin Phoenix connector with screw (5.00 pitch) that the RPS-□□ power supply has on its face plate for controlling the module.

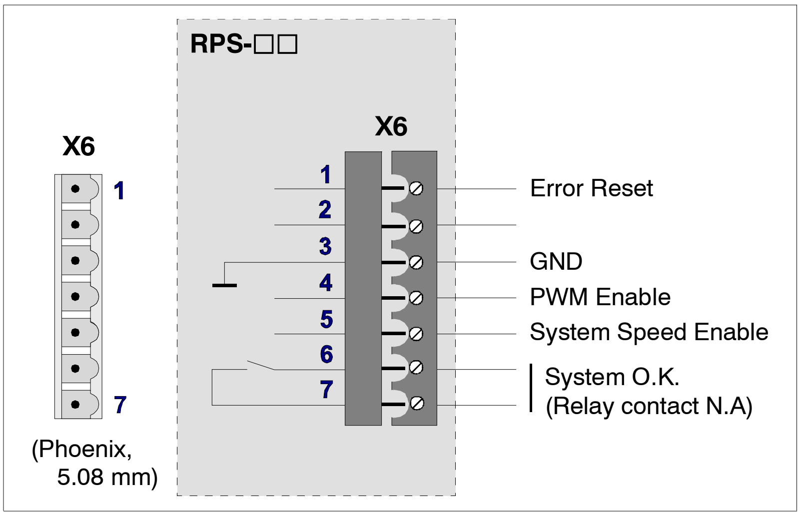


FIGURE H2.49

Connector X6. Control.

A 1.25 A fuse protects the internal circuits.

Note. Remember that the internal circuits of PS-65A non-regenerative power supplies must be powered by an external 24 V DC power supply, "APS -24"; that's why its control connector has three terminals more than connector X6 of the RPS-☐☐.

The following table shows the values for gap, tightening torque, sections of the screws and other data of the plug-in connector for X6.

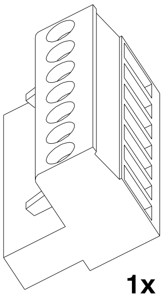


TABLE H2.36 Data of the plug-in connector for X6.

Connector data	**RPS-80 RPS-75**	**RPS-45 RPS-20**
Nr of poles	7	7
Gap (mm)	5.00	5.00
Min/max tightening torque (N·m)	0.5/0.6	0.5/0.6
Screw thread	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5
Rated current In (A)	12	12
Wire data		
Min. section (mm²)	1.5	1.5
Length to strip (mm)	7	7

The next table shows the signals and other considerations related to each pin of connector X6:

TABLE H2.37 Description of the pins of connector X6.

1	ERROR RESET	System error RESET input (24 V DC; 4.5 - 7 mA).
2	N.C.	Not connected
3	GND	0 volts reference for digital inputs. Error RESET (1) and System Speed Enable (5).
4	PWM ENABLE	Integrated safety. Power bus voltage enable input (24 V DC).
5	SYSTEMSPEED ENABLE	General system speed enable. (24 V DC; 4.5 - 7 mA).
6	SYSTEM OK	Contact indicating module status. It opens in case of failure. Limit 1 A at 24 V.
7	SYSTEM OK	

2.6.3 Module power-up

When turning on the RPS-☐☐ power supply module or doing a reset, various messages appear on its seven-segment display:

- ☐ Software version, after the **r** with the identifying digits.
- ☐ Error listing.

Stages shown on the 7-segment display:

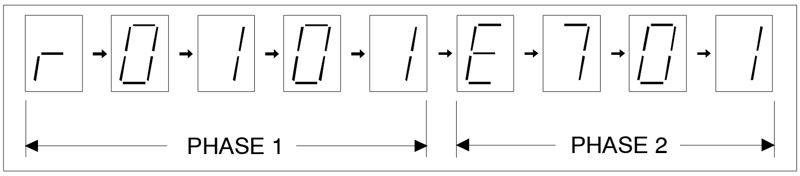


FIGURE H2.50

Module startup stages.

- ☐ Software version displaying stage: It shows the software version loaded in the module. It first shows the letter r (indicating the version <release>), followed by the version number (digit by digit) [A]. When the drive is active and the axis is being governed, the display will show the zero digit with a blinking dot [B].

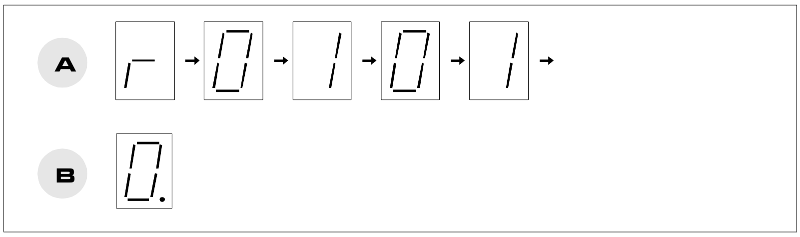


FIGURE H2.51

Stage to display the software version and other indications.

- ☐ Final stage: It displays error messages[C] or warnings[D] on the display when they come up. When the series ends, it begins a new sequence again repeating these messages again.

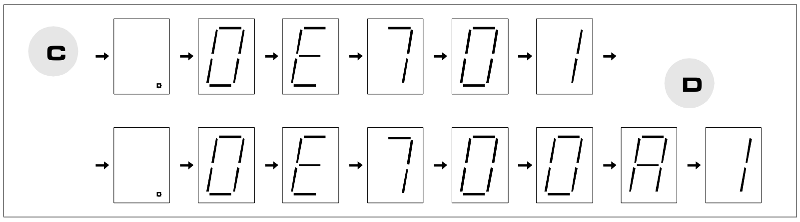


FIGURE H2.52

Final stage. Error and warning displaying STAGE.

See the meaning of errors and warnings that may be shown on the display in **chapter 14. Error codes and messages** of the "dds-software" manual.

The system will not start running until all the errors detected at the power supply 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 activated from the RESET button that the power supply has on top of the status display and the switches for selecting the DC BUS voltage.

1. For RPS-☐☐ power supplies:

   Apply power to the auxiliary power supply and close the main internal contactor - short-circuit NS1 and NS2 (pins 3 and 4) of connector X3 -.

2. The power supply checks the system status:

   If the status is correct:

   The **System OK** contact closes (pins 6 and 7 of X6) and it stays closed while the control circuits are powered and no error comes up in any of the modules of the system.

   The red <FAULT> indicator light blinks (it is not indicating an error because there are no phases yet).

   If the status is not correct:

   The red <FAULT> indicator light is permanently on (not blinking).

3. Apply power to the main power supply:

   Power is applied from mains through the power connector (1) on top of the power supply (L1, L2, L3). The red <FAULT> indicator light will turn off and the smooth start-up will begin.

   Note. If the PWM Enable (pin 4 of connector X6) is not active, the display will show the warning A004 and the power bus of the RPS will not start charging.

4. The green DC BUS ON light on:

   Having mains voltage and being the PWM Enable signal (pin 4 of connector X6) active, after 4 seconds, the green DC BUS ON indicator light turns on meaning that the power bus has the proper dc voltage.

If for any reason an error is activated at the power supply module or at any drive module it supplies to, the system will act as follows:

1. The green DC BUS ON light will turn off.
2. The red FAULT light will be on permanently.
3. The power supply will stop supplying voltage to the power bus.

With the Error Reset input (pin 1 of X6), it is possible to eliminate the errors at the drives that are part of the system - see chapter 14, section "resettable errors", of the dds-software manual - and it acts as follows:

- Its state will be 0 Volt. Activating it with 24 V DC erases all the errors stored in the memory of each drive of the system.
- Should the cause of the error persist, the corresponding module will show the same error again and it will be necessary to turn the unit back on to eliminate the error if it is a serious error.

The "System Speed Enable input" (pin 5 of X6) is related to the "Speed Enable" inputs of the drive modules.

- The state of the System Speed Enable is usually 24 V DC.
- If the "System Speed Enable" pin is set to 0 V DC, all the drive modules joined together by the same internal bus will brake the motors that they control at full torque and when stopped or when reaching the time limit to stop (programmable with parameter GP3, see **chapter 13. Parameters, variables and commands** of the "dds-software" manual), it cancels the motor torque.

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

Remember that if the RPS power supply is running, there is mains voltage and the PWM Enable signal is active. When canceling the PWM Enable signal the display shows the warning A004, turns on the FAULT LED and the power supply stops boosting the voltage causing a voltage drop with a value of $\sqrt{2}$ x Vred at the power bus. The drives connected to the power supply will interpret that the power supply is not OK.

2.7 Operating modes

See the next running status diagram:

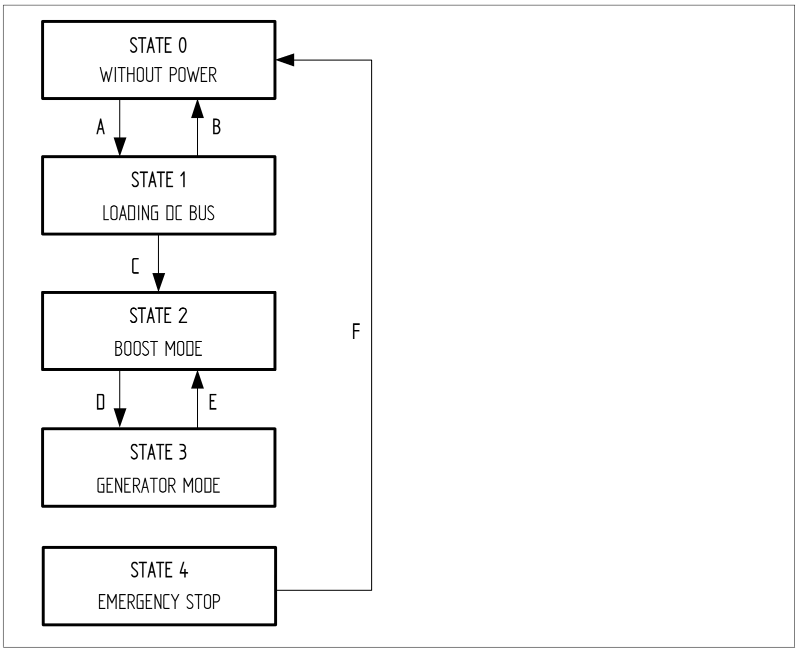


FIGURE H2.53

Running state diagram of the RPS-☐☐ power supply.

Running states

Description of the possible running states:

Status	Meaning
0	Without power line connection. Stand by.
1	Loading the DC BUS. Temporary state.
2	Running in BOOST mode. The system works like a BOOST power supply.
3	Running in REGENERATOR mode. The system works as a generator discharging the excess energy of the DC BUS into mains.
4	Emergency state.

Transitions between running states

The transitions between states are done automatically and the system adapts itself to the relevant operating mode depending on the mains voltage and on the DC BUS voltage. These transitions are:

Transition	Meaning
A	The power line connection is made.
B	The time set as the minimum time limit (3.2 s) to charge the DC BUS has been exceeded. The charge process has failed and error E315 of the DC BUS comes up. Temporary state.
C	The charge process has finished correctly. The line voltage is within the levels set to consider it **working in boost mode** (323 ÷ 424 V AC). The DC BUS voltage is lower than 625 V DC.
D	The BUS voltage is higher than the nominal voltage set for the DC BUS and the value of the mains voltage is within the limits set to work in generator mode.
E	The BUS voltage is lower than the nominal voltage set for the DC BUS and the value of the mains voltage is within the limits set to work in boost mode.
F	The emergency stop has ended.

Warning. When detecting an error, it will switch from any state 0, 1, 2 or 3 directly to state 4. From any of the states, it will switch to state 0 if a stop occurs due to the NO READY state of any of the drives connected to the power supply or because the power line has been disconnected or because the emergency stop button has been pressed or because the line voltage has dropped.

Follow this sequence to stop the system without having detected any errors:

- Disabling the drives; i.e. disable the Speed Enable of all the axes or the System Speed Enable.
- Disconnecting the power line by opening the contactor - KM1, usually by pressing the E-STOP button.

DRIVE MODULES

3

The drives that make up Fagor's DDS servo drive system are modular and stackable. They are connected directly to three-phase mains with a rated mains voltage between 400 -10% and 460+10% V AC at a mains frequency of 50/60 Hz. Its features are:

- supply the motor with a three-phase 400 - 4.5% V AC .
- provide the motor with a variable frequency to control its speed and position.

Hence, we refer to:

Modular drives

AXD: Digital module that can govern a synchronous motor in speed and position working as an axis.

SPD: Digital module that can govern a synchronous or an asynchronous motor in speed and position working as a spindle.

MMC: Digital module that can govern a synchronous motor in speed and position working as an axis or a spindle and also generate a tool path.

Compact drives

ACD: Digital module that can govern a synchronous motor in speed and position working as an axis.

SCD: Digital module that can govern a synchronous or an asynchronous motor in speed and position working as a spindle.

CMC: Digital module that can govern a synchronous motor in speed and position working as an axis or a spindle and also generate a tool path.

The drive modules just mentioned can operate with the following motors:

Synchronous: FXM and FKM series.

Asynchronous: FM7 and FM9 series.

The following sections analyze all of them showing their technical characteristics and other considerations.

3.1 Modular drives

When referring to modular drives, we will use AXD, SPD and MMC. They all admit a voltage range between 400 to 460 V AC. See all models in the following figures.

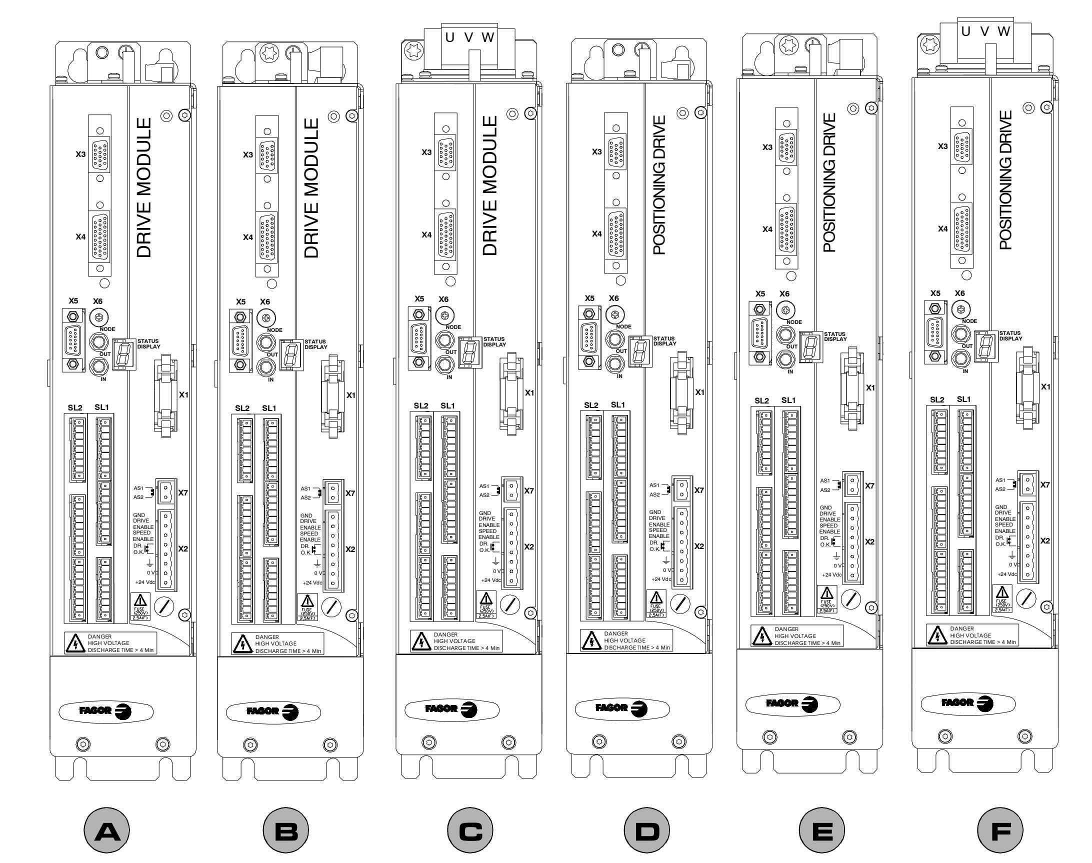


FIGURE H3.1

Size-1 modular drives of the Fagor catalog.
A. AXD/SPD 1.08/1.15, **B.** AXD/SPD 1.25, **C.** AXD/SPD 1.35, **D.** MMC 1.08/1.15, **E.** MMC 1.25, **F.** MMC 1.35

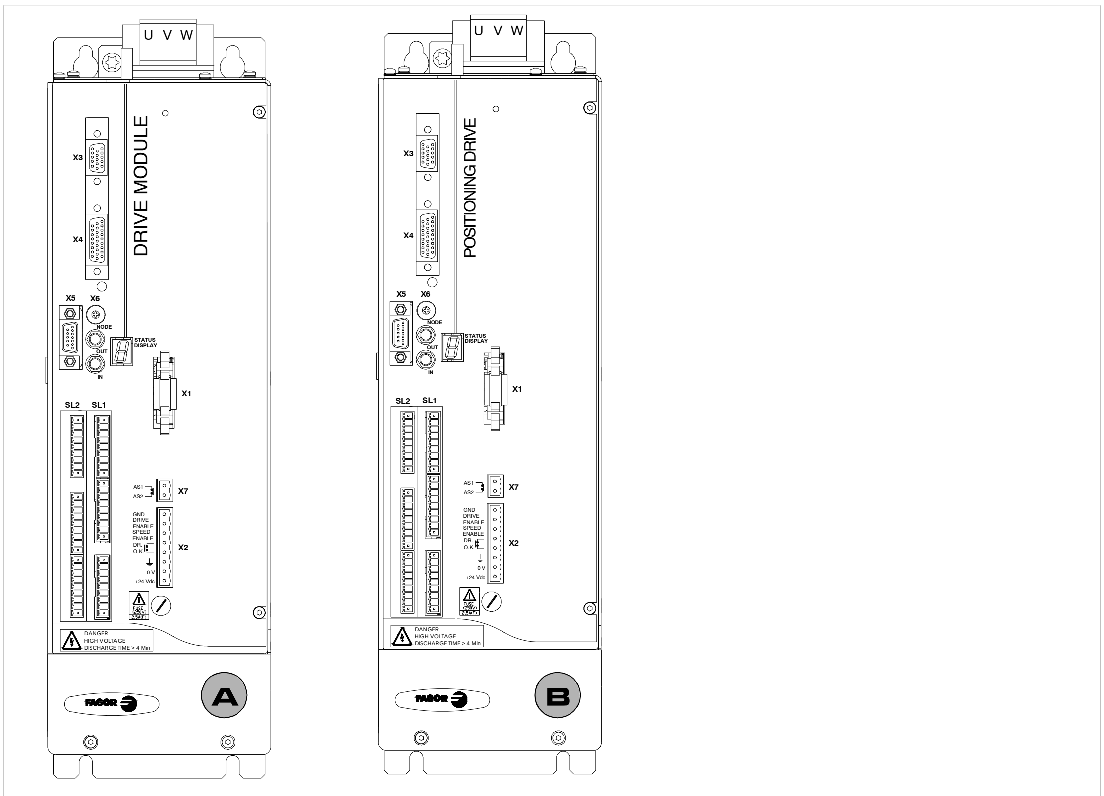


FIGURE H3.2

Size-2 modular drives of the Fagor catalog.
A. AXD/SPD 2.50/2.75, SPD 2.85, **B.** MMC 2.50/2.75/2.85.

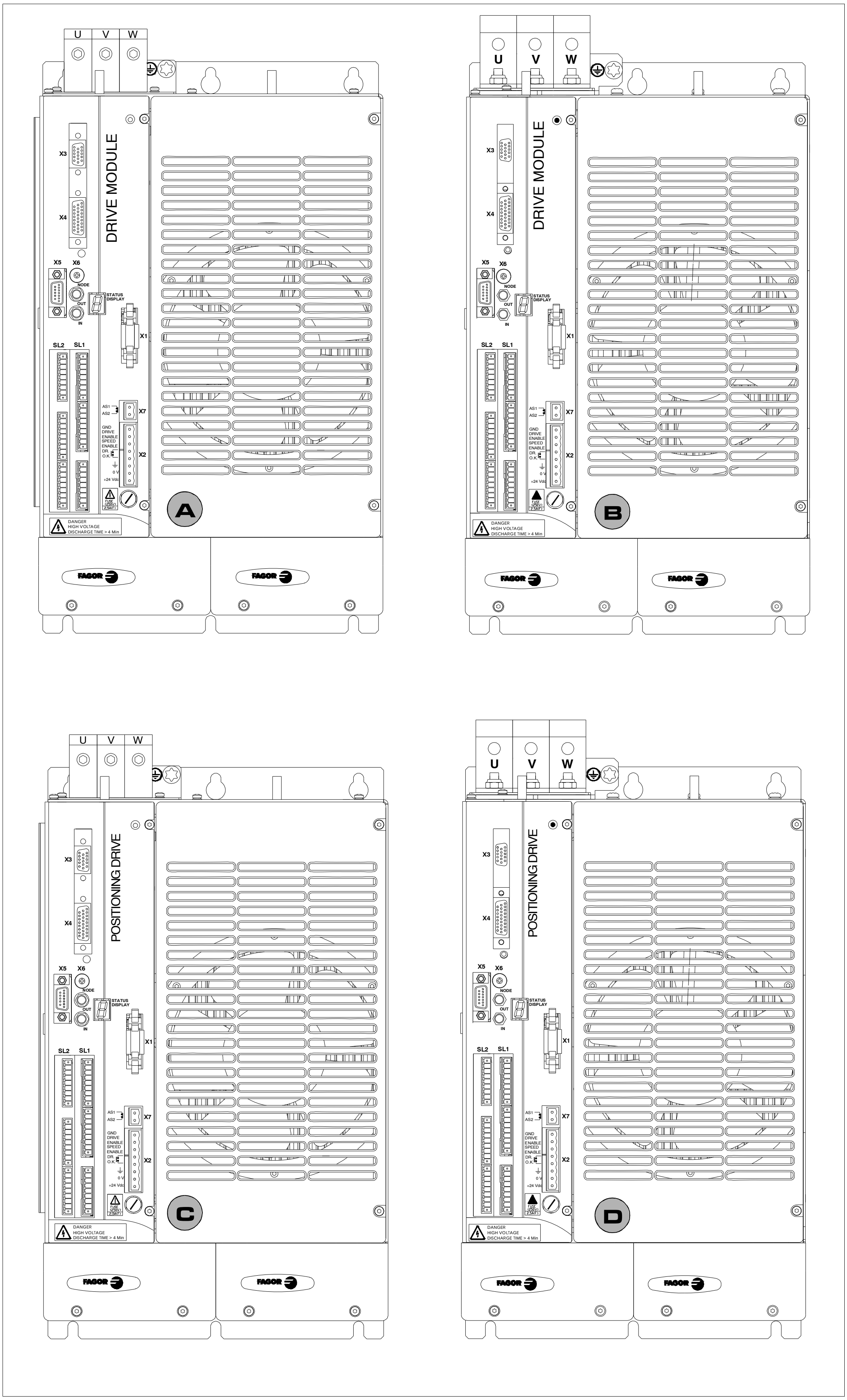


FIGURE H3.3

Size-3 modular drives of the Fagor catalog.
A. AXD/SPD 3.100/3.150, **B.** SPD 3.200/3.250, **C.** MMC 3.100/3.150, **D.** MMC 3.200/3.250.

3.1.1 Technical data

There are specific modular drives AXD to control synchronous motors (both for axis and spindle applications) and SPD to control asynchronous motors (in spindle applications).
This chapter is common to both models because their external characteristics (dimensions, connectors, ...) are the same.

TABLE H3.1 Currents on modular drives for synchronous motors. fc = 4 kHz.

With internal fan	Drive for synchronous motor (as axis)							
Models	**AXD MMC 1.08**	**AXD MMC 1.15**	**AXD MMC 1.25**	**AXD MMC 1.35**	**AXD MMC 2.50**	**AXD MMC 2.75**	**AXD MMC 3.100**	**AXD MMC 3.150**
I S1= In Arms	4	7.5	12.5	17.5	23.5	37.5	50	75
Imax S1 Arms	8	15	25	35	47	75	100	150
Dissipated power W	33	69	88	156	225	270	351	536

TABLE H3.2 Currents on modular drives for synchronous motors. fc = 8 kHz.

With internal fan	Drive for synchronous motor (as axis)							
Models	**AXD MMC 1.08**	**AXD MMC 1.15**	**AXD MMC 1.25**	**AXD MMC 1.35**	**AXD MMC 2.50**	**AXD MMC 2.75**	**AXD MMC 3.100**	**AXD MMC 3.150**
I S1= In Arms	4	7.5	12.5	17.5	23.5	37.5	50	75
Imax S1 Arms	8	15	25	35	47	75	100	150
Dissipated power W	44	89	132	195	305	389	510	840

TABLE H3.3 Current in modular drives for synchronous or asynchronous motors. fc = 4 kHz.

With internal fan	Drive for synchronous or asynchronous motor (as spindle)									
Models	**SPD 1.15**	**SPD 1.25**	**SPD 1.35**	**SPD 2.50**	**SPD 2.75**	**SPD 2.85**	**SPD 3.100**	**SPD 3.150**	**SPD 3.200**	**SPD 3.250**
I S1= In Arms	10.5	16	23.1	31	42	50	70	90	121	135
0.7 x In Arms	7.3	11.2	16.1	21.7	29	35	49	63	84.7	94.5
I S6-40 Arms	13.7	20.8	30	40.3	54.6	65	91	117	157.3	175.5
Dissipated power W	98	110	195	349	289	432	496	626	1163	1333

TABLE H3.4 Current in modular drives for synchronous or asynchronous motors. fc = 8 kHz.

With internal fan	Drive for synchronous or asynchronous motor (as spindle)									
Models	**SPD 1.15**	**SPD 1.25**	**SPD 1.35**	**SPD 2.50**	**SPD 2.75**	**SPD 2.85**	**SPD 3.100**	**SPD 3.150**	**SPD 3.200**	**SPD 3.250**
I S1= In Arms	10.5	13	18	27	32	37	56	70	97	108
0.7 x In Arms	7.3	9.1	12.6	18.9	22.4	25.9	39.2	49.7	67.9	75.6
I S6-40 Arms	11.6	16.9	23.4	35.1	41.6	48.1	72.8	91.0	126.1	140.4
Dissipated power W	98	130	201	350	333	438	546	668	1187	1344

Note that

MMC drives have the same currents as AXD drives.
fc. It represents the switching frequency of the IGBT's
The dissipated powers correspond to the operation at the rated current in S1 mode.
See the load duty cycle for the modular drives in the corresponding section of this chapter.

TABLE H3-5 Technical characteristics of the modular drives.

	AXD // SPD // MMC									
	1.08	**1.15**	**1.25**	**1.35**	**2.50**	**2.75**	**2.85**	**3.100**	**3.150**	**3.200** **3.250**
Power voltage input	542 - 800 V DC									
Power to control circuits	24 V DC (between 21 V DC and 28 V DC)									
Consumption of the control circuits	0.90 A				1.25 A			2.00 A		
Speed feedback	Encoder									
Controlling method	PWM, AC sinewave, vector control									
Communication	Serial line to connect to a PC									
Interface	Standard analog, digital SERCOS ring (in all models) Serial line RS-232/RS-422 (only in MMC drives)									
Status display	7-segments display									
Protections	Over-voltage, over-current, over-speed, heat-sink temperature, ambient temperature, motor temperature, hardware error, overload.									
Speed range with analog input	1 : 8192									
Current bandwidth	800 Hz									
Speed bandwidth	100 Hz (depends on the motor/drive set)									
Tambient	Between 5°C and 45°C (41°F/113°F) From 40 ºC (104 ºF) on. See derating curves.									
Storage temperature	Between - 20 °C and + 60 °C (- 4 °F/140 °F)									
Sealing	IP 2x									
Maximum humidity	< 90% (non condensing at 45 °C/113 °F)									
Operating vibration	0.5 G									
Shipping vibration	2 G									
Approx. mass in kg (in lb)	5.5 (12.1)		6.0 (13.2)	6.5 (14.3)	9.0 (19.8)	9.0 (19.8)	10.0 (22.0)	14.0 (30.8)		19.5 (43.0)

3.1.2 Load duty cycles

Load cycle S1

Continuous duty. Operation with constant load and long enough to achieve thermal balance.

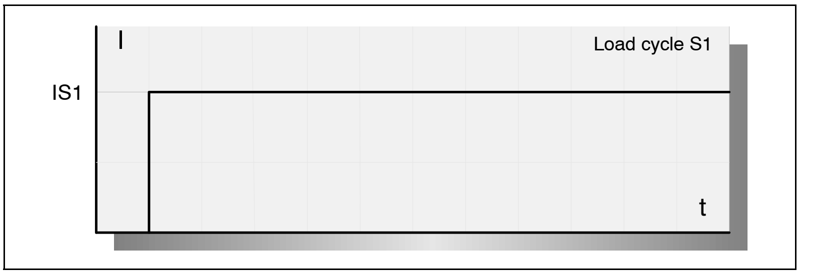


FIGURE H3.4

Load cycle S1.

Load cycle S1 with current peak

Periodic intermittent duty. Succession of identical duty cycles each having a period at constant maximum load and a period at constant rated load. In this duty cycle, the overheating effect of the start-up current is negligible. The 5% running factor means that for a 10 second cycle, it works at constant current Imax (2xInom) for 0.5 seconds and at rated current (Inom) for 9.5 seconds.

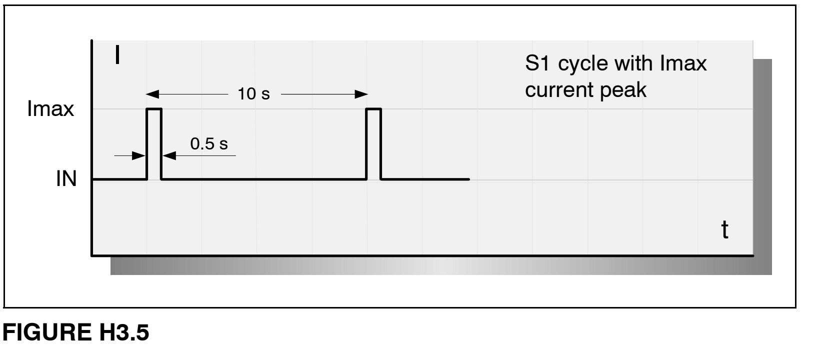


FIGURE H3.5

Load cycle S1 with current peak Imax.

Load cycle S6-40

Periodic uninterrupted duty cycle with intermittent load. Succession of identical duty cycles, each with a running period under constant load and another period without load. There is no rest period. The 40% running factor indicates that for a 10 minute cycle, it works at constant current for 4 minutes (I S6 -40%) and without load for 6 minutes (with magnetizing current = 0.7 x rated current In).

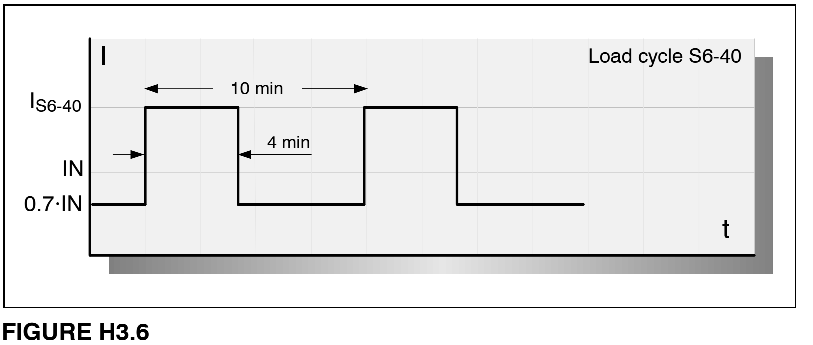


FIGURE H3.6

Load cycle S6-40.

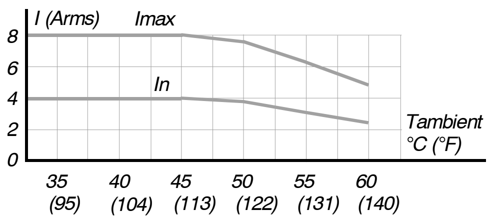
3.1.3 Current derating

Drives for an synchronous motor working as an axis

The following graphs show the maximum rms current in continuous S1 (In) and intermittent S3-5% (Imax and In) duty cycles depending on the switching frequency of the power transistors in a temperature range between 5°C (41°F) and 60°C (140°F).

See the load duty cycles.

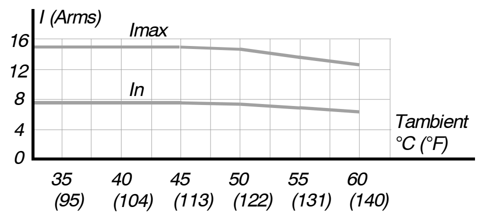
For a switching frequency fc = 4 kHz



AXD / MMC 1.08			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	4.0	8.0
40	104	4.0	8.0
45	113	4.0	8.0
50	122	3.8	7.6
55	131	3.1	6.3
60	140	2.4	4.8

FIGURE H3.7

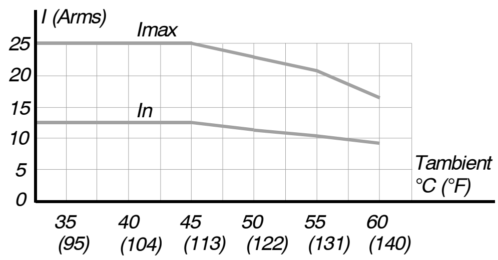
Current derating on "AXD/MMC 1.08" drives for fc= 4 kHz



AXD / MMC 1.15			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	7.5	15.0
40	104	7.5	15.0
45	113	7.5	15.0
50	122	7.3	14.7
55	131	6.8	13.6
60	140	6.3	12.6

FIGURE H3.8

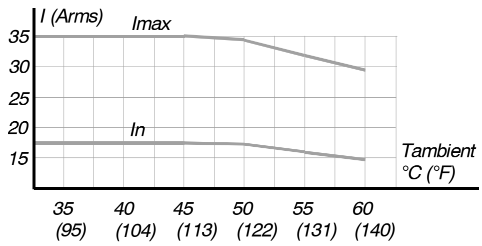
Current derating on "AXD/MMC 1.15" drives for fc = 4 kHz



AXD / MMC 1.25			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	12.5	25.0
40	104	12.5	25.0
45	113	12.5	25.0
50	122	11.4	22.9
55	131	10.4	20.7
60	140	9.2	18.5

FIGURE H3.9

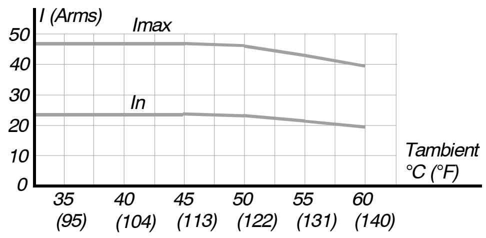
Current derating on "AXD/MMC 1.25" drives for fc = 4 kHz



AXD / MMC 1.35			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	17.5	35.0
40	104	17.5	35.0
45	113	17.5	35.0
50	122	17.3	34.5
55	131	16.0	32.0
60	140	14.8	29.5

FIGURE H3.10

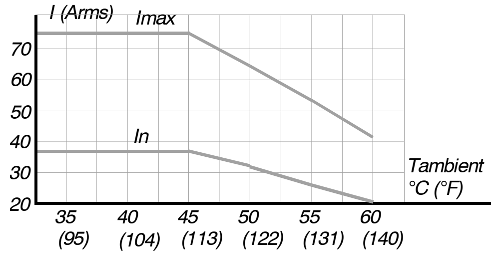
Current derating on "AXD/MMC 1.35" drives for fc = 4 kHz



AXD / MMC 2.50			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	23.5	47.0
40	104	23.5	47.0
45	113	23.5	47.0
50	122	23.2	46.5
55	131	21.5	43.0
60	140	19.7	39.5

FIGURE H3.11

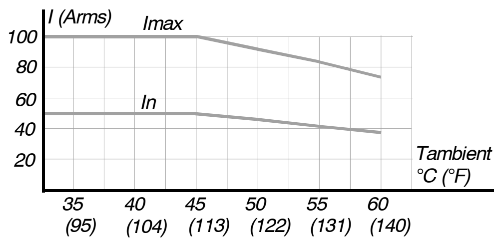
Current derating on "AXD/MMC 2.50" drives for fc = 4 kHz



AXD / MMC 2.75			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	37.5	75.0
40	104	37.5	75.0
45	113	37.5	75.0
50	122	32.2	64.4
55	131	26.6	53.3
60	140	20.7	41.3

FIGURE H3.12

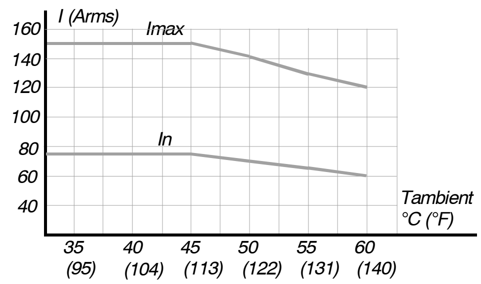
Current derating on "AXD/MMC 2.75" drives for fc = 4 kHz



AXD / MMC 3.100			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	50.0	100.0
40	104	50.0	100.0
45	113	50.0	100.0
50	122	45.8	91.7
55	131	41.3	82.7
60	140	36.7	73.3

FIGURE H3.13

Current derating on "AXD/MMC 3.100" drives for fc = 4 kHz

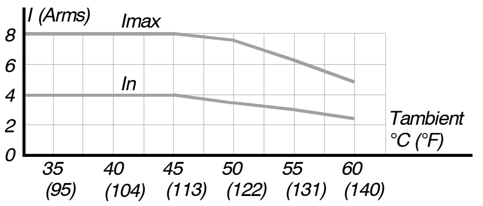


AXD / MMC 3.150			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	75.0	150.0
40	104	75.0	150.0
45	113	75.0	150.0
50	122	70.6	141.3
55	131	65.6	131.3
60	140	60.5	121.0

FIGURE H3.14

Current derating on "AXD/MMC 3.150" drives for fc = 4 kHz

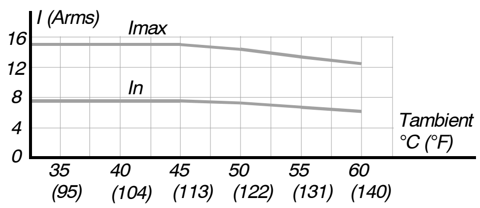
For a switching frequency fc = 8 kHz



AXD / MMC 1.08			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	4.0	8.0
40	104	4.0	8.0
45	113	4.0	8.0
50	122	3.5	7.0
55	131	3.0	5.9
60	140	2.4	4.8

FIGURE H3.15

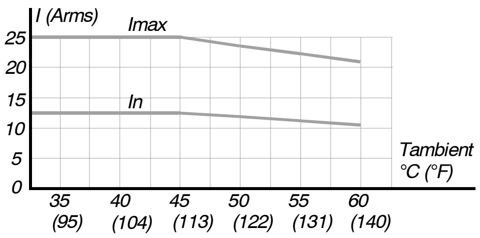
Current derating on "AXD/MMC 1.08" drives for fc = 8 kHz



AXD / MMC 1.15			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	7.5	15.0
40	104	7.5	15.0
45	113	7.5	15.0
50	122	7.1	14.3
55	131	6.7	13.4
60	140	6.3	12.5

FIGURE H3.16

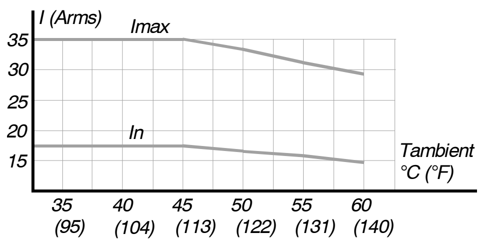
Current derating on "AXD/MMC 1.15" drives for fc = 8 kHz



AXD / MMC 1.25			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	12.5	25.0
40	104	12.5	25.0
45	113	12.5	25.0
50	122	11.8	23.7
55	131	11.1	22.2
60	140	10.3	20.7

FIGURE H3.17

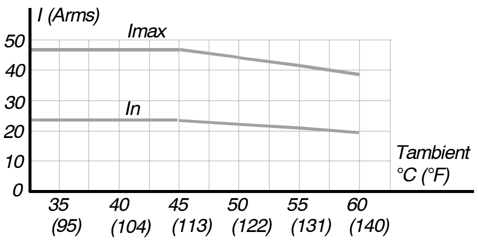
Current derating on "AXD/MMC 1.25" drives for fc = 8 kHz



AXD / MMC 1.35			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	17.5	35.0
40	104	17.5	35.0
45	113	17.5	35.0
50	122	16.6	33.3
55	131	15.7	31.3
60	140	14.7	29.3

FIGURE H3.18

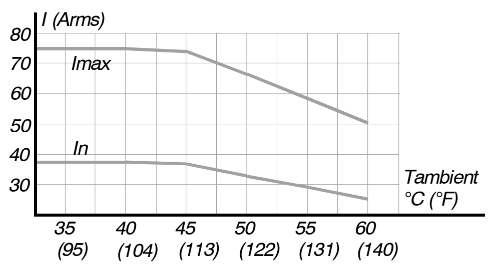
Current derating on "AXD/MMC 1.35" drives for fc = 8 kHz



AXD / MMC 2.50			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	23.5	47.0
40	104	23.5	47.0
45	113	23.5	47.0
50	122	22.2	44.4
55	131	20.9	41.7
60	140	19.5	38.9

FIGURE H3.19

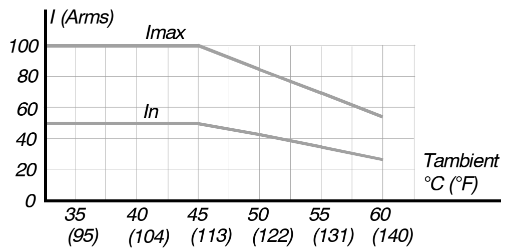
Current derating on "AXD/MMC 2.50" drives for fc = 8 kHz



AXD / MMC 2.75			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	37.5	75.0
40	104	37.5	75.0
45	113	37.1	74.2
50	122	33.3	66.5
55	131	29.3	58.6
60	140	25.2	50.4

FIGURE H3.20

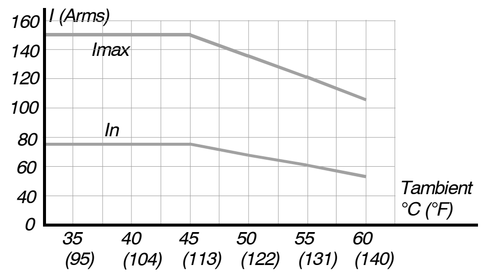
Current derating on "AXD/MMC 2.75" drives for fc = 8 kHz



AXD / MMC 3.100			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	50.0	100.0
40	104	50.0	100.0
45	113	50.0	100.0
50	122	42.7	85.4
55	131	35.2	70.3
60	140	27.3	54.5

FIGURE H3.21

Current derating on "AXD/MMC 3.100" drives for fc = 8 kHz



AXD / MMC 3.150			
Tamb		In	Imax
° C	°F	Arms	Arms
35	95	75.0	150.0
40	104	75.0	150.0
45	113	75.0	150.0
50	122	67.9	135.6
55	131	60.6	121.2
60	140	53.1	106.2

FIGURE H3.22

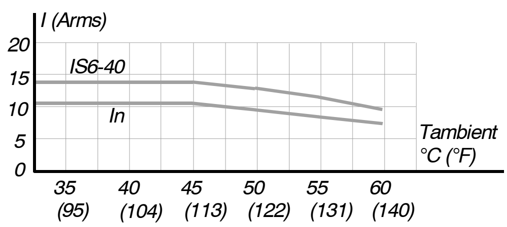
Current derating on "AXD/MMC 3.150" drives for fc = 8 kHz

Drives for a synchronous or asynchronous motor working as a spindle

The following graphs show the maximum rms current in continuous S1 (In) and intermittent S6-40 (I_{S6-40}) duty cycles depending on the switching frequency of the power transistors in a temperature range between 5°C (41°F) and 60°C (140°F).

See the load duty cycles.

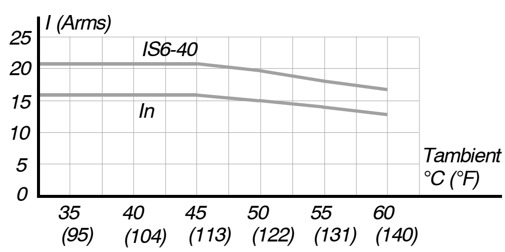
◻ For a switching frequency fc = 4 kHz



SPD 1.15			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	10.5	13.7
40	104	10.5	13.7
45	113	10.4	13.6
50	122	9.5	12.3
55	131	8.4	10.9
60	140	7.3	9.5

FIGURE H3.23

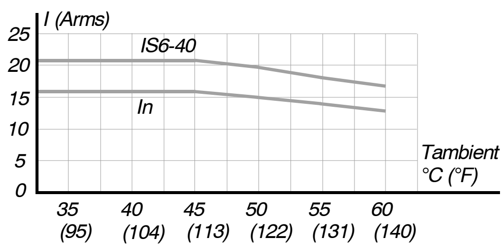
Current derating on "SPD 1.15 " drives for fc = 4 kHz



SPD 1.25			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	16.0	20.8
40	104	16.0	20.8
45	113	16.0	20.8
50	122	15.1	19.6
55	131	14.0	18.1
60	140	12.8	16.7

FIGURE H3.24

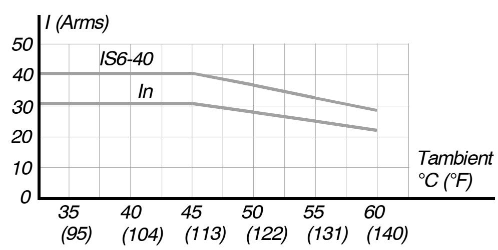
Current derating on "SPD 1.25 " drives for fc = 4 kHz



SPD 1.25			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	16.0	20.8
40	104	16.0	20.8
45	113	16.0	20.8
50	122	15.1	19.6
55	131	14.0	18.1
60	140	12.8	16.7

FIGURE H3.25

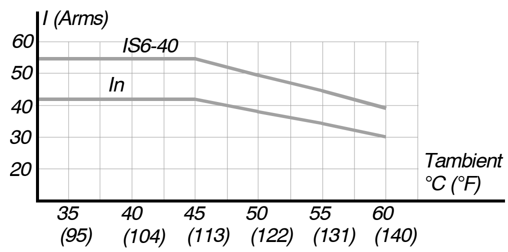
Current derating on "SPD 1.35 " drives for fc = 4 kHz



SPD 2.50			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	31.0	40.3
40	104	31.0	40.3
45	113	31.0	40.3
50	122	28.1	36.6
55	131	25.1	32.7
60	140	22.0	28.6

FIGURE H3.26

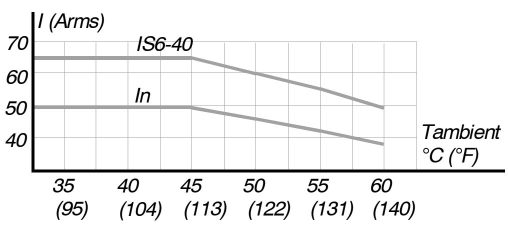
Current derating on "SPD 2.50 " drives for fc = 4 kHz



SPD 2.75			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	42.0	54.6
40	104	42.0	54.6
45	113	42.0	54.6
50	122	38.2	49.7
55	131	34.3	44.6
60	140	30.2	39.2

FIGURE H3.27

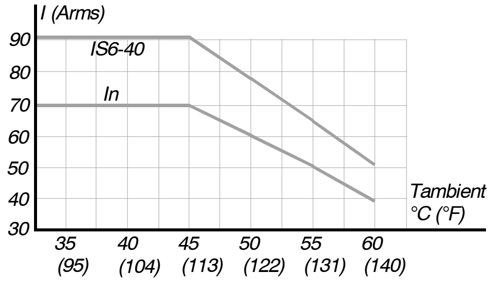
Current derating on "SPD 2.75 " drives for fc = 4 kHz



SPD 2.85			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	50.0	65.0
40	104	50.0	65.0
45	113	50.0	65.0
50	122	46.2	60.0
55	131	42.3	55.0
60	140	38.3	49.8

FIGURE H3.28

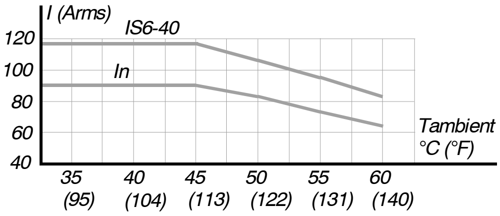
Current derating on "SPD 2.85 " drives for fc = 4 kHz



SPD 3.100			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	70.0	91.0
40	104	70.0	91.0
45	113	70.0	91.0
50	122	60.4	78.6
55	131	50.2	65.3
60	140	39.1	50.8

FIGURE H3.29

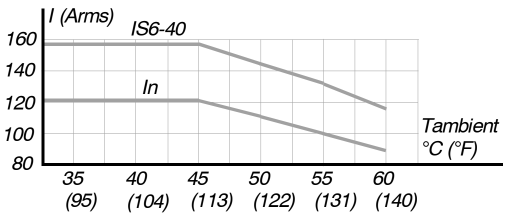
Current derating on "SPD 3.100 " drives for fc = 4 kHz



SPD 3.150			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	90.0	117.0
40	104	90.0	117.0
45	113	90.0	117.0
50	122	81.6	106.1
55	131	72.8	94.6
60	140	63.4	82.4

FIGURE H3.30

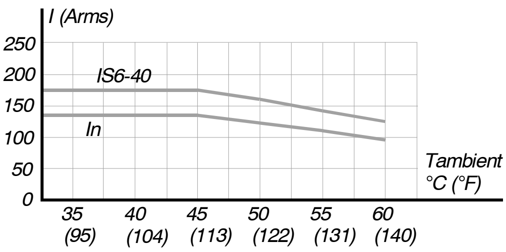
Current derating on "SPD 3.150 " drives for fc = 4 kHz.



SPD 3.200			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	121.0	157.3
40	104	121.0	157.3
45	113	121.0	157.3
50	122	110.8	144.1
55	131	100.2	130.3
60	140	89.1	115.9

FIGURE H3.31

Current derating on "SPD 3.200 " drives for fc = 4 kHz.

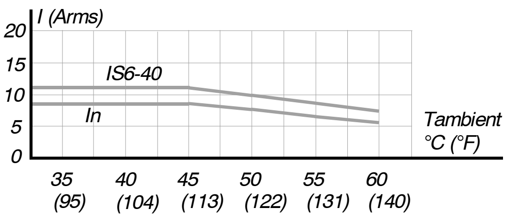


SPD 3.250			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	135.0	175.5
40	104	135.0	175.5
45	113	135.0	175.5
50	122	122.7	159.5
55	131	109.9	142.9
60	140	96.4	125.3

FIGURE H3.32

Current derating on "SPD 3.250 " drives for fc = 4 kHz.

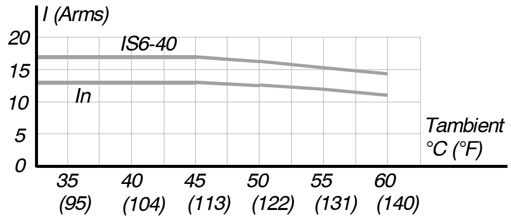
◻ For a switching frequency fc = 8 kHz



SPD 1.15			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	8.5	11.1
40	104	8.5	11.1
45	113	8.5	11.1
50	122	7.6	9.9
55	131	6.6	8.6
60	140	5.6	7.3

FIGURE H3.33

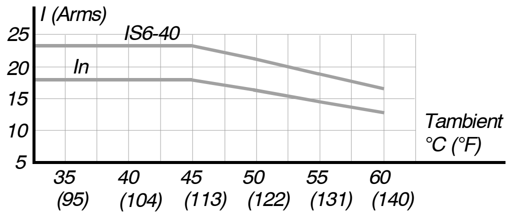
Current derating on "SPD 1.15 " drives for fc = 8 kHz



SPD 1.25			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	13.0	16.9
40	104	13.0	16.9
45	113	13.0	16.9
50	122	12.6	16.4
55	131	11.8	15.3
60	140	10.9	14.2

FIGURE H3.34

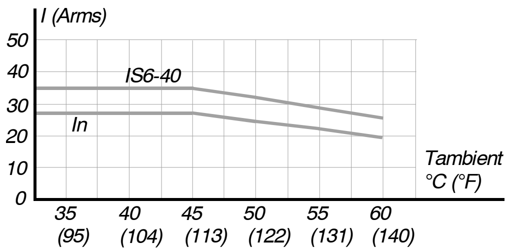
Current derating on "SPD 1.25 " drives for fc = 8 kHz



SPD 1.35			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	18.0	23.4
40	104	18.0	23.4
45	113	18.0	23.4
50	122	16.3	21.2
55	131	14.5	18.9
60	140	12.7	16.6

FIGURE H3.35

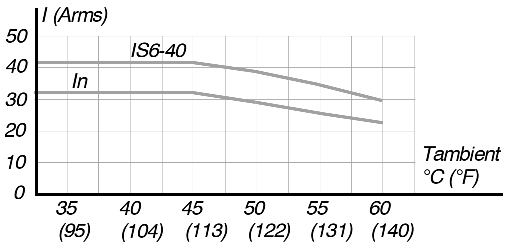
Current derating on "SPD 1.35 " drives for fc = 8 kHz



SPD 2.50			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	27.0	35.1
40	104	27.0	35.1
45	113	27.0	35.1
50	122	24.6	32.0
55	131	22.1	28.8
60	140	19.6	25.4

FIGURE H3.36

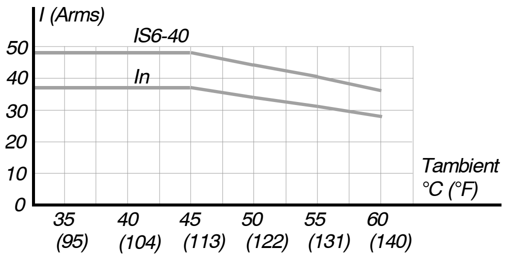
Current derating on "SPD 2.50 " drives for fc = 8 kHz



SPD 2.75			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	32.0	41.6
40	104	32.0	41.6
45	113	32.0	41.6
50	122	28.9	37.7
55	131	25.7	33.5
60	140	22.5	29.2

FIGURE H3.37

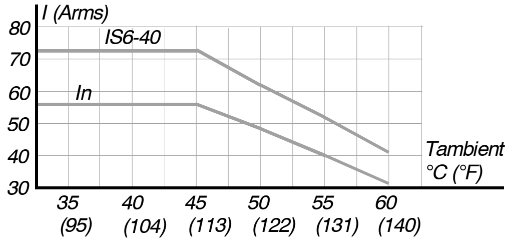
Current derating on "SPD 2.75 " drives for fc = 8 kHz



SPD 2.85			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	37.0	48.1
40	104	37.0	48.1
45	113	37.0	48.1
50	122	34.0	44.2
55	131	31.0	40.3
60	140	27.9	36.3

FIGURE H3.38

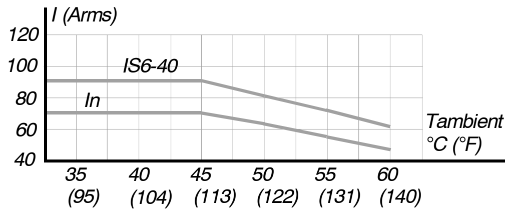
Current derating on "SPD 2.85 " drives for fc = 8 kHz



SPD 3.100			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	56.0	72.8
40	104	56.0	72.8
45	113	56.0	72.8
50	122	48.2	62.7
55	131	40.0	52.1
60	140	31.5	40.9

FIGURE H3.39

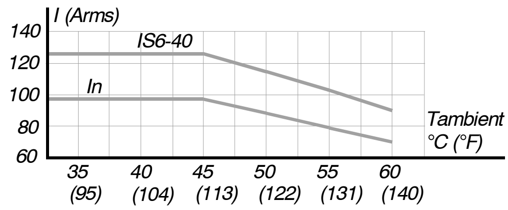
Current derating on "SPD 3.100 " drives for fc = 8 kHz



SPD 3.150			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	70.0	91.0
40	104	70.0	91.0
45	113	70.0	91.0
50	122	62.8	81.6
55	131	55.3	71.9
60	140	47.4	61.7

FIGURE H3.40

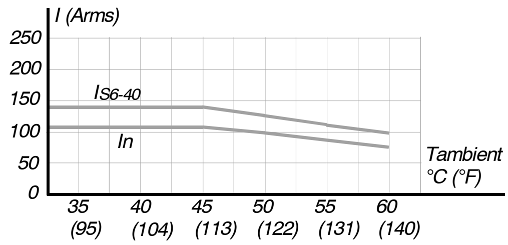
Current derating on "SPD 3.150 " drives for fc = 8 kHz



SPD 3.200			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	97.0	126.1
40	104	97.0	126.1
45	113	97.0	126.1
50	122	88.1	114.6
55	131	79.0	102.7
60	140	69.5	90.4

FIGURE H3.41

Current derating on "SPD 3.200 " drives for fc = 8 kHz



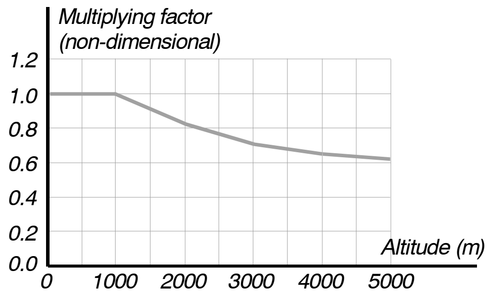
SPD 3.250			
Tamb		In	IS6-40
° C	°F	Arms	Arms
35	95	108.0	140.4
40	104	108.0	140.4
45	113	108.0	140.4
50	122	97.2	126.3
55	131	85.9	111.7
60	140	74.3	96.6

FIGURE H3.42

Current derating on "SPD 3.250 " drives for fc = 8 kHz

3.1.4 Power derating

The following graph shows the variation suffered by the output rated power of the modular drive (for all its models) depending on the installation altitude over sea level.



Output rated power ratio	
Altitude meters	Factor non-dimensional
0	1.00
1000	1.00
2000	0.82
3000	0.71
4000	0.65
5000	0.62

FIGURE H3.43

Derating of rated output power depending on the above-sea-level altitude of the installation.

3.1.5 Block diagram

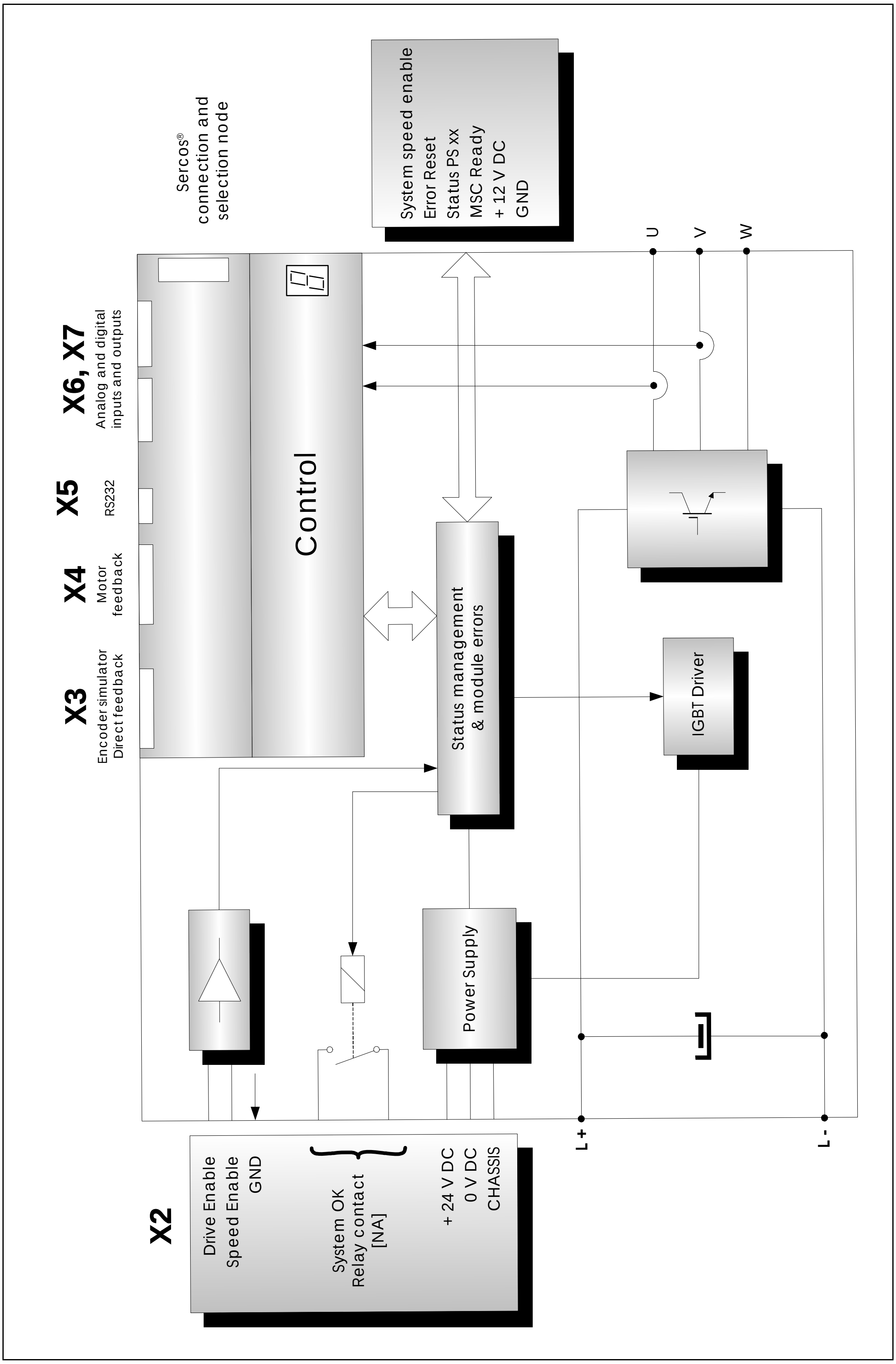


FIGURE H3.44

Block diagram of modular drives AXD and SPD.

3.1.6 Connector layout

AXD/SPD 1.08 / 1.15

These drive modules have the following connectors:

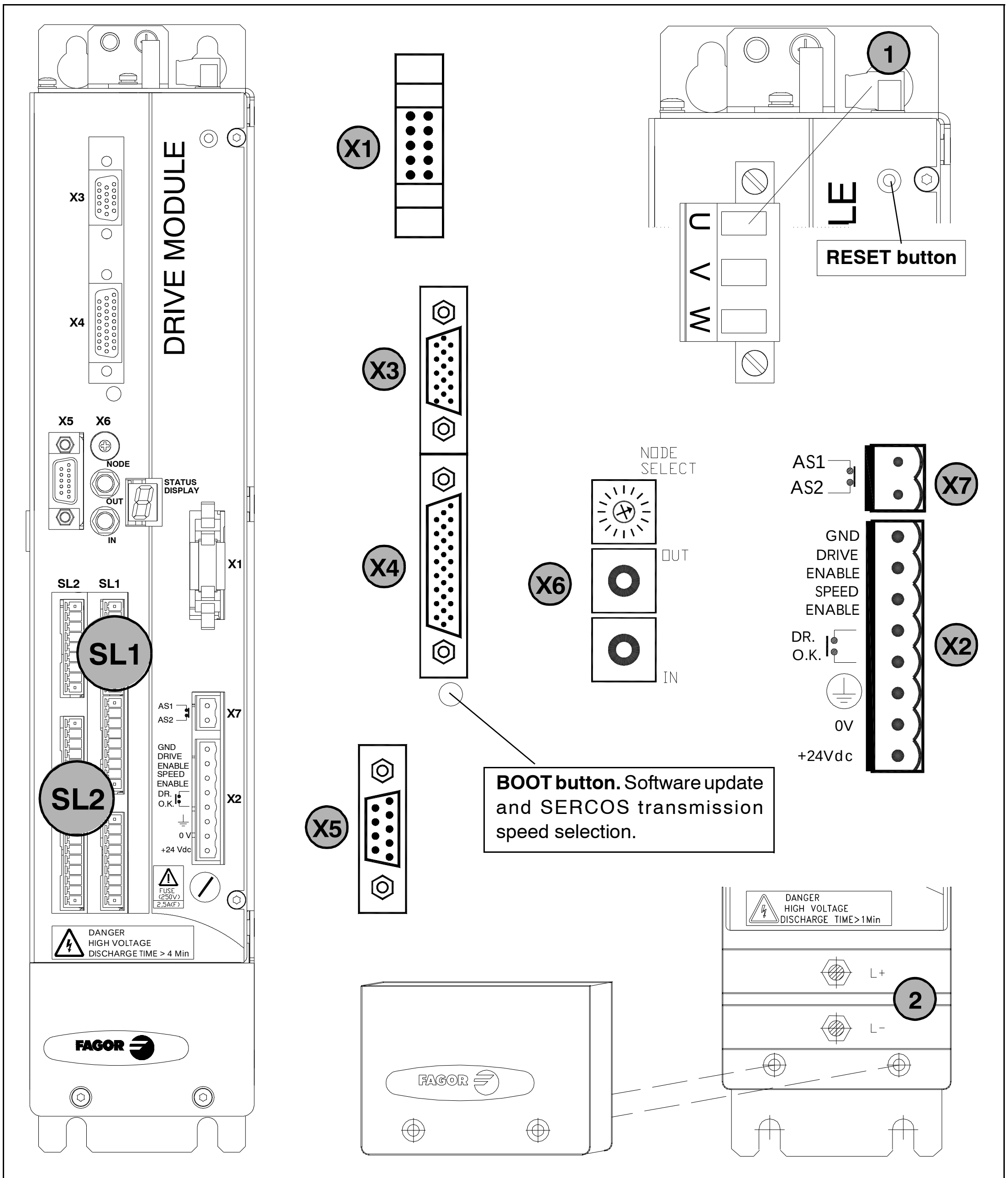


FIGURE H3.45

Connectors of "AXD/SPD 1.08/1.15" modular drives.

1. Power connector for motor connection.
2. Power bus that feeds the drive modules from the power supply through metal plates.
X1. Connector that may be used to establish communication between modules through the internal bus.
X2. Connector for the basic control signals.
X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.
X5. Connector for RS-232 serial line connection.
X6. SERCOS interface connector.
X7. Connector for external acknowledgment of the status of the safety relay.
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.
SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

AXD/SPD 1.25

These drive modules have the following connectors:

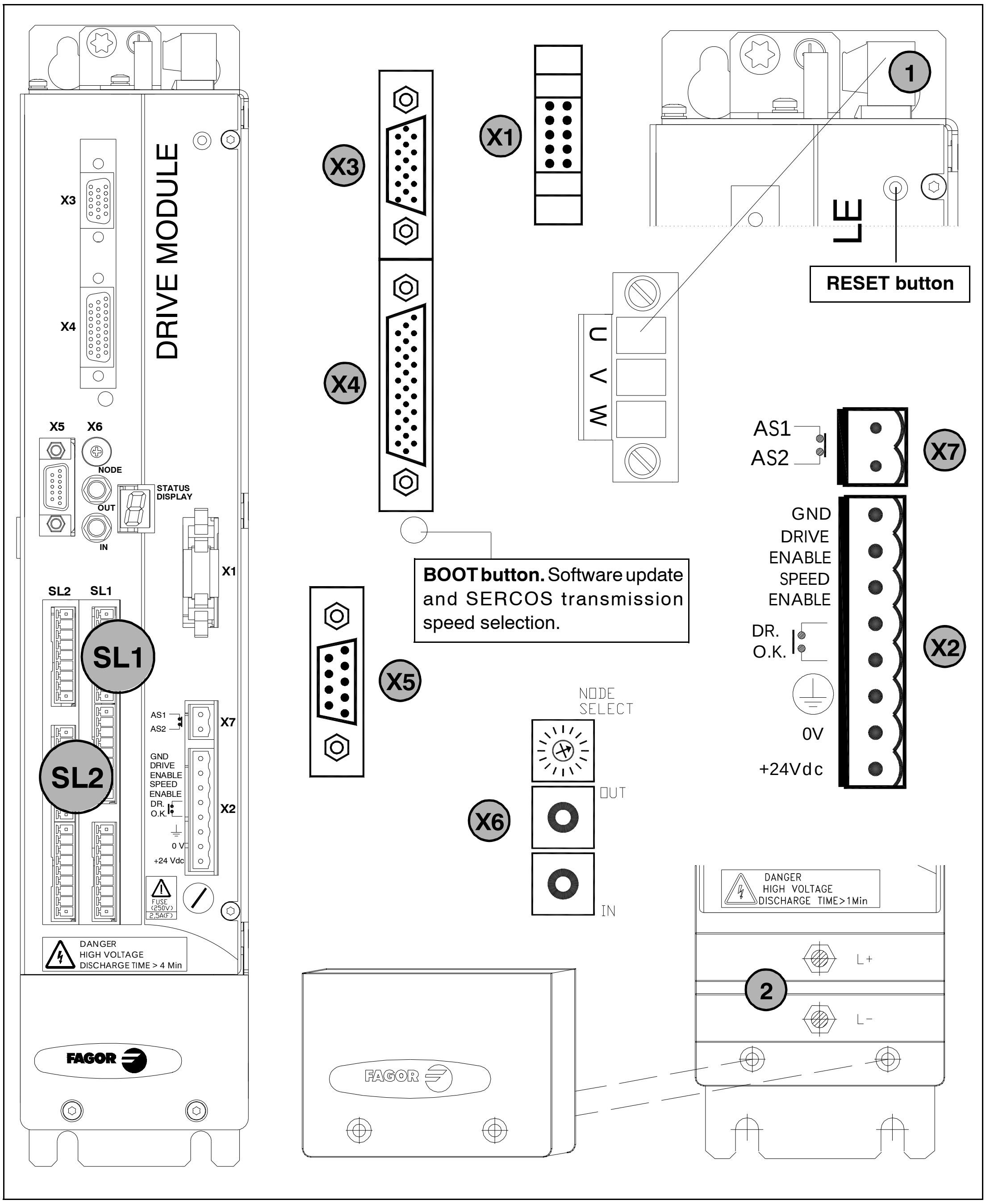


FIGURE H3.46

Connectors of "AXD/SPD 1.25" modular drives.

1. Power connector for motor connection.
2. Power bus that feeds the drive modules from the power supply through metal plates.
X1. Connector that may be used to establish communication between modules through the internal bus.
X2. Connector for the basic control signals.
X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.
X5. Connector for RS-232 serial line connection.
X6. SERCOS interface connector.
X7. Connector for external acknowledgment of the status of the safety relay.
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.
SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

AXD/SPD 1.35

These drive modules have the following connectors:

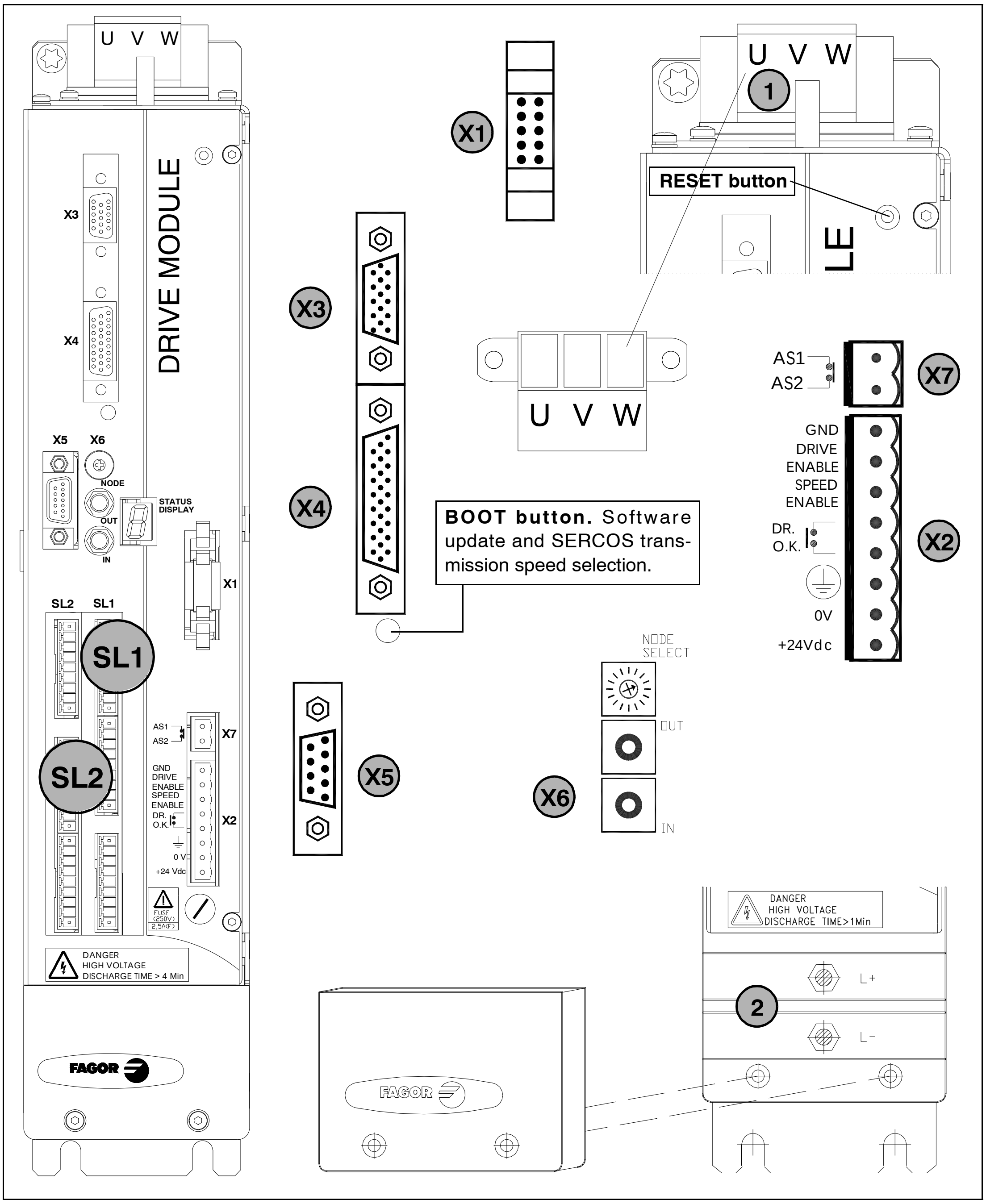


FIGURE H3.47

Connectors of "AXD/SPD 1.35" modular drives.

1. Power connector for motor connection.
2. Power bus that feeds the drive modules from the power supply through metal plates.
X1. Connector that may be used to establish communication between modules through the internal bus.
X2. Connector for the basic control signals.
X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.
X5. Connector for RS-232 serial line connection.
X6. SERCOS interface connector.
X7. Connector for external acknowledgment of the status of the safety relay.
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.
SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

AXD/SPD 2.50 / 2.75 / 2.85

These drive modules have the following connectors:

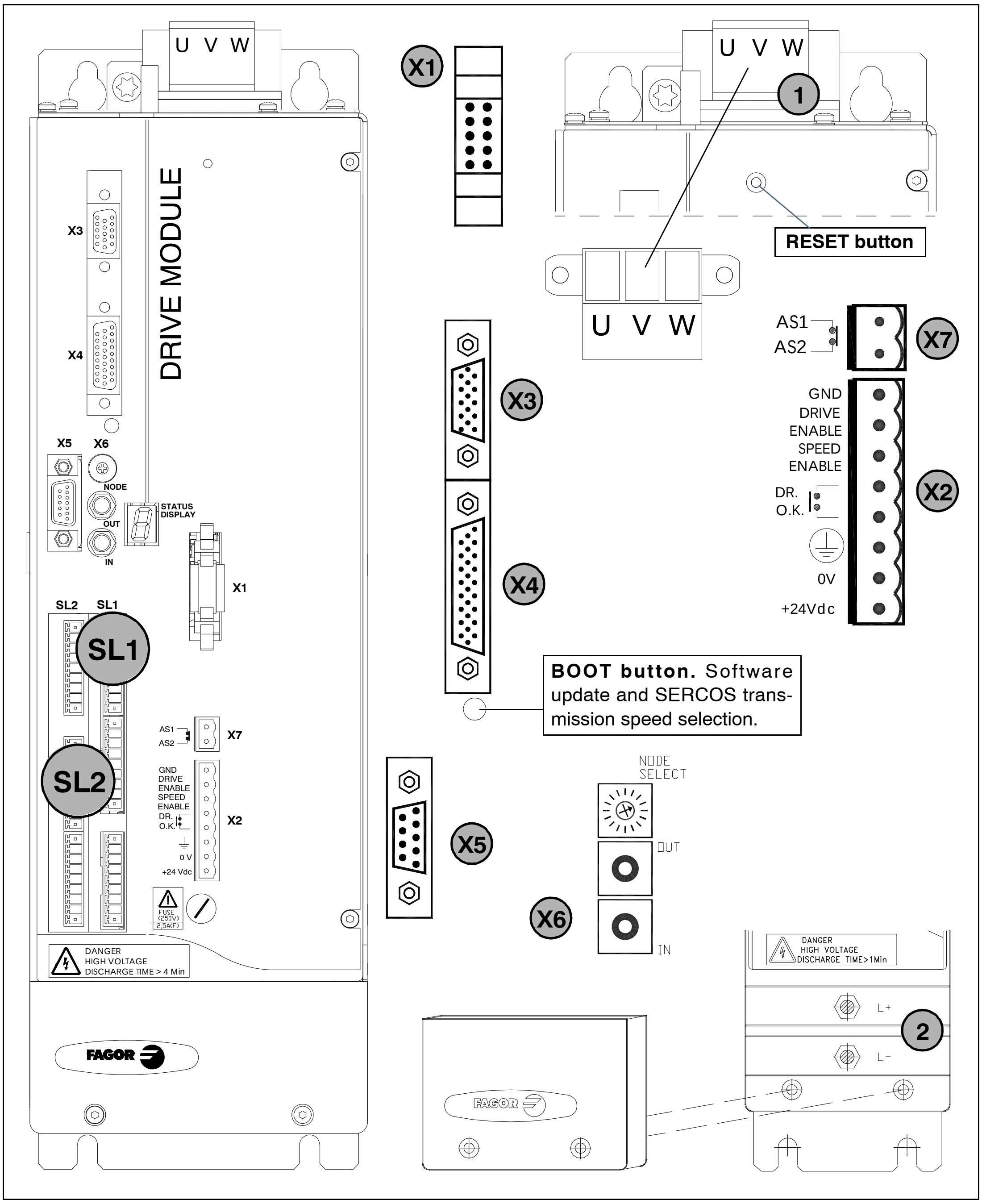


FIGURE H3.48

Connectors of "AXD/SPD 2.50/2.75/2.85" modular drives.

1. Power connector for motor connection.
2. Power bus that feeds the drive modules from the power supply through metal plates.
X1. Connector that may be used to establish communication between modules through the internal bus.
X2. Connector for the basic control signals.
X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.
X5. Connector for RS-232 serial line connection.
X6. SERCOS interface connector.
X7. Connector for external acknowledgment of the status of the safety relay.
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.
SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

AXD/SPD 3.100 / 3.150

These drive modules have the following connectors:

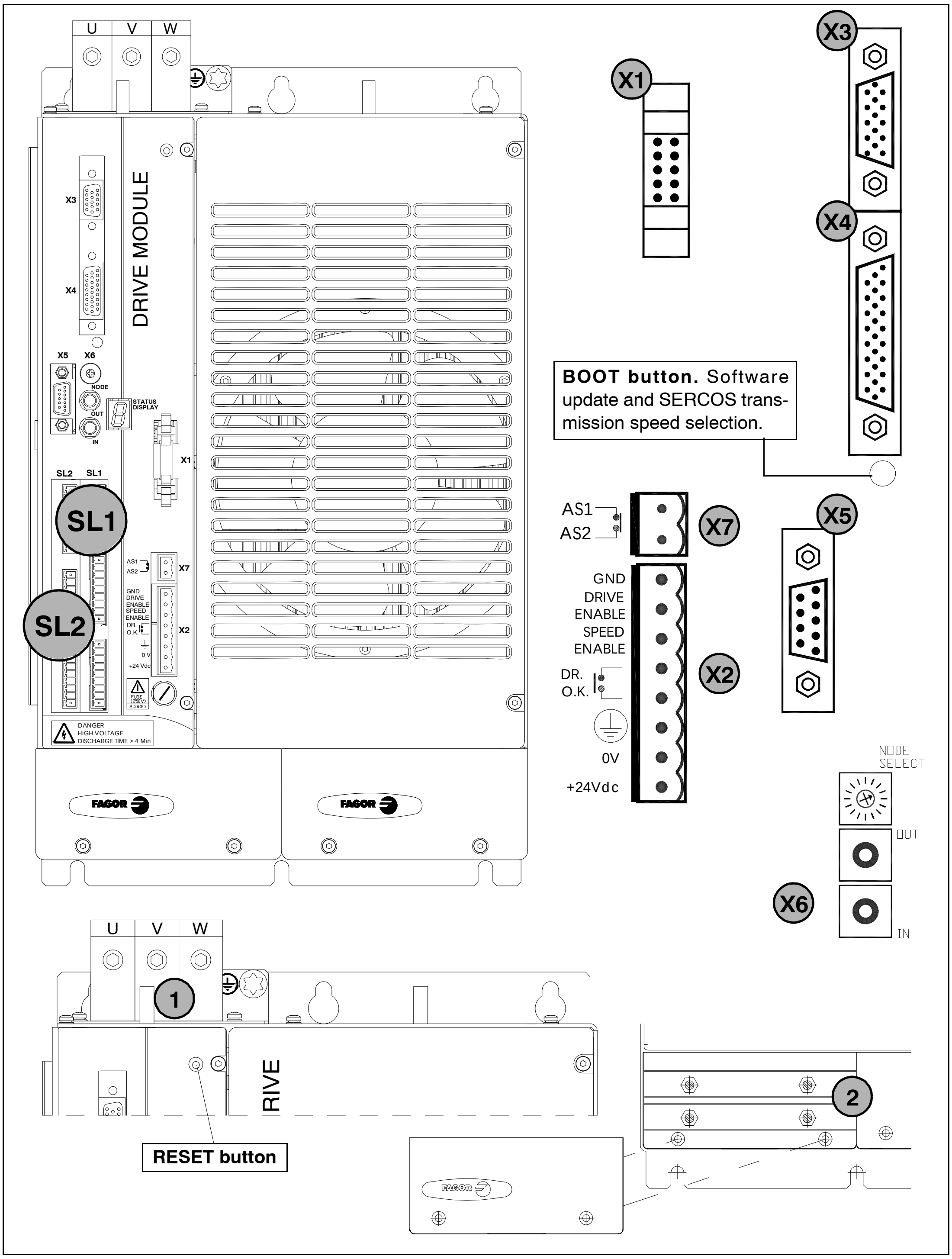


FIGURE H3.49

Connectors of "AXD/SPD 3.100/3.150" modular drives.

1. Power connector for motor connection.
2. Power Bus that can supply power to the drive modules through metal plates.
X1. Connector that may be used to establish communication between modules through the internal bus.
X2. Connector for the basic control signals.
X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.
X5. Connector for RS-232 serial line connection.
X6. SERCOS interface connector.
X7. Connector for external acknowledgment of the status of the safety relay.
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.
SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

SPD 3.200 / 3.250

This drive module has the following connectors:

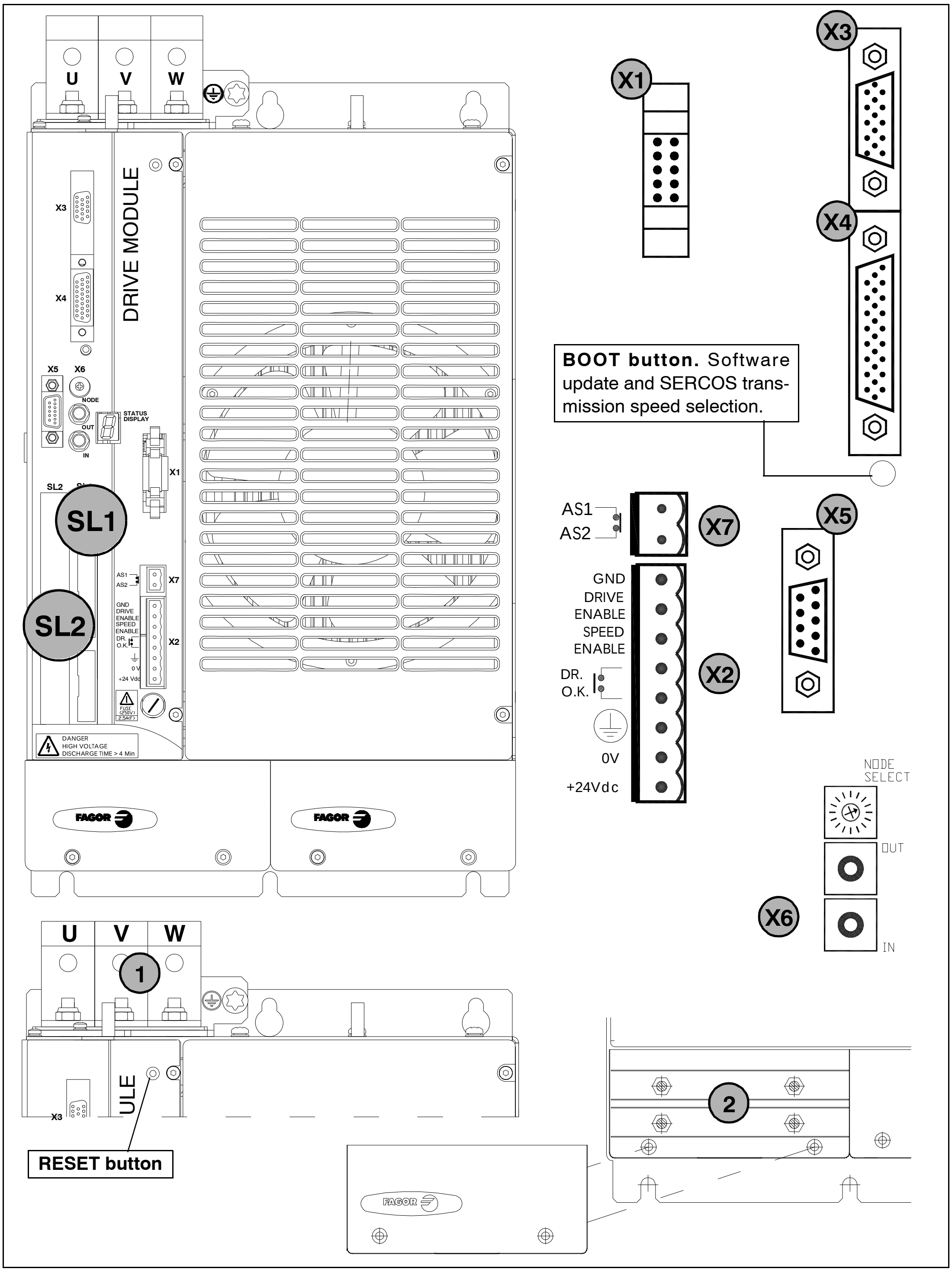


FIGURE H3.50

Connectors of "SPD 3.200/3.250" modular drives.

1. Power connector for motor connection.
2. Power Bus that can supply power to the drive modules through metal plates.
X1. Connector that may be used to establish communication between modules through the internal bus.
X2. Connector for the basic control signals.
X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.
X5. Connector for RS-232 serial line connection.
X6. SERCOS interface connector.
X7. Connector for external acknowledgment of the status of the safety relay.
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.
SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

MMC 1.08 / 1.15

These drive modules have the following connectors:

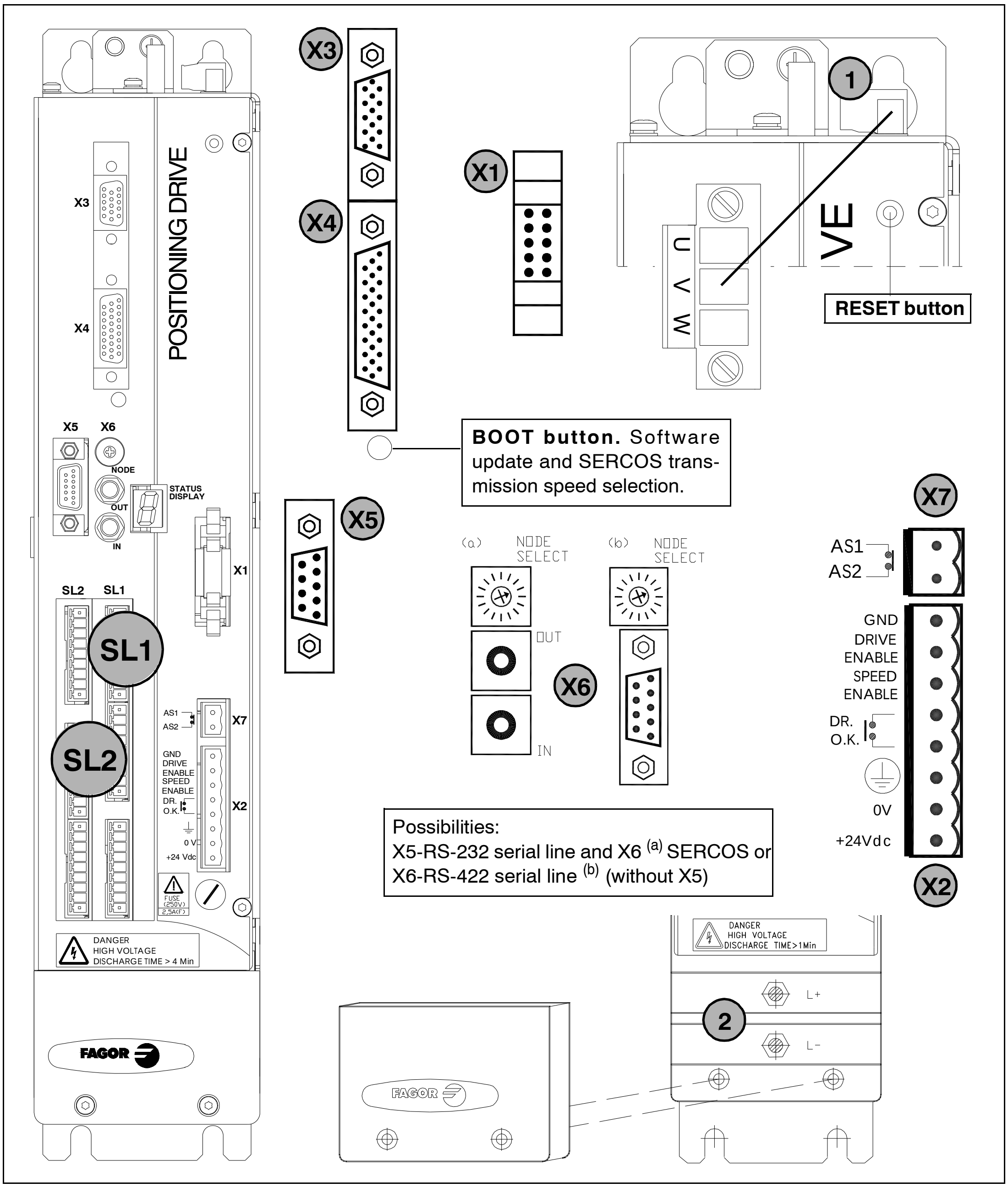


FIGURE H3.51

Connectors of "MMC 1.08/1.15" modular drives.

1. Power connector for motor connection.
2. Power bus that feeds the drive modules from the power supply through metal plates.
X1. Connector that may be used to establish communication between modules through the internal bus.
X2. Connector for the basic control signals.
X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.
X5. Connector for RS-232 serial line connection.
X6. Possible connectors that may be located in this position:
- SERCOS [a] interface connector (always with X5)
- Connector for RS-232 / RS-422 [b] serial line connection (never with X5)

X7. Connector for external acknowledgment of the status of the safety relay.
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.
SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

MMC 1.25

These drive modules have the following connectors:

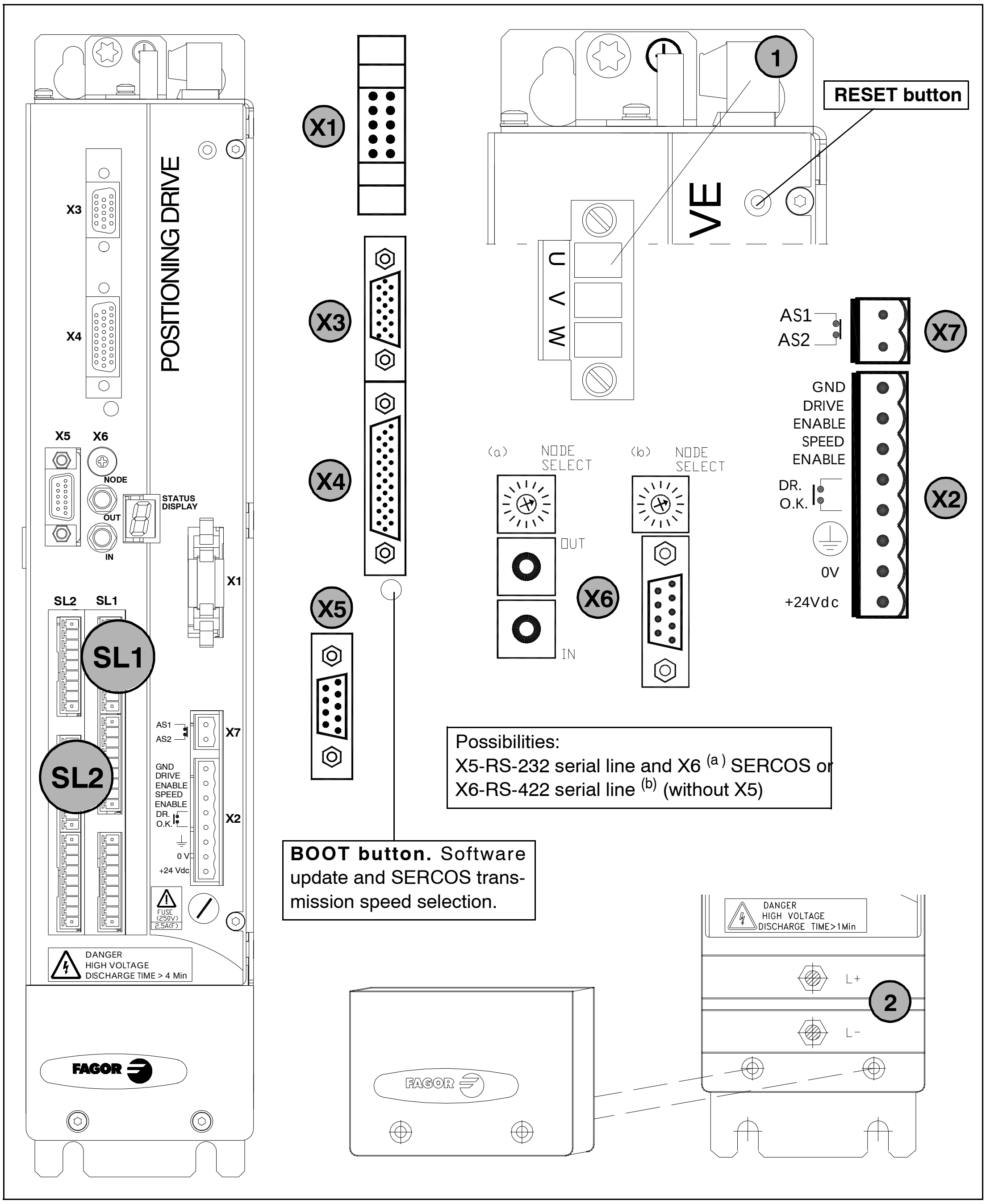


FIGURE H3.52

Connectors of "MMC 1.25" modular drives.

1. Power connector for motor connection.

2. Power bus that feeds the drive modules from the power supply through metal plates.

X1. Connector that may be used to establish communication between modules through the internal bus.

X2. Connector for the basic control signals.

X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.

X5. Connector for RS-232 serial line connection.

X6. Possible connectors that may be located in this position:
- SERCOS [a] interface connector (always with X5)
- Connector for RS-232/RS-422 [b] serial line connection (never with X5)

X7. Connector for external acknowledgment of the status of the safety relay.

SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.

SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

MMC 1.35

These drive modules have the following connectors:

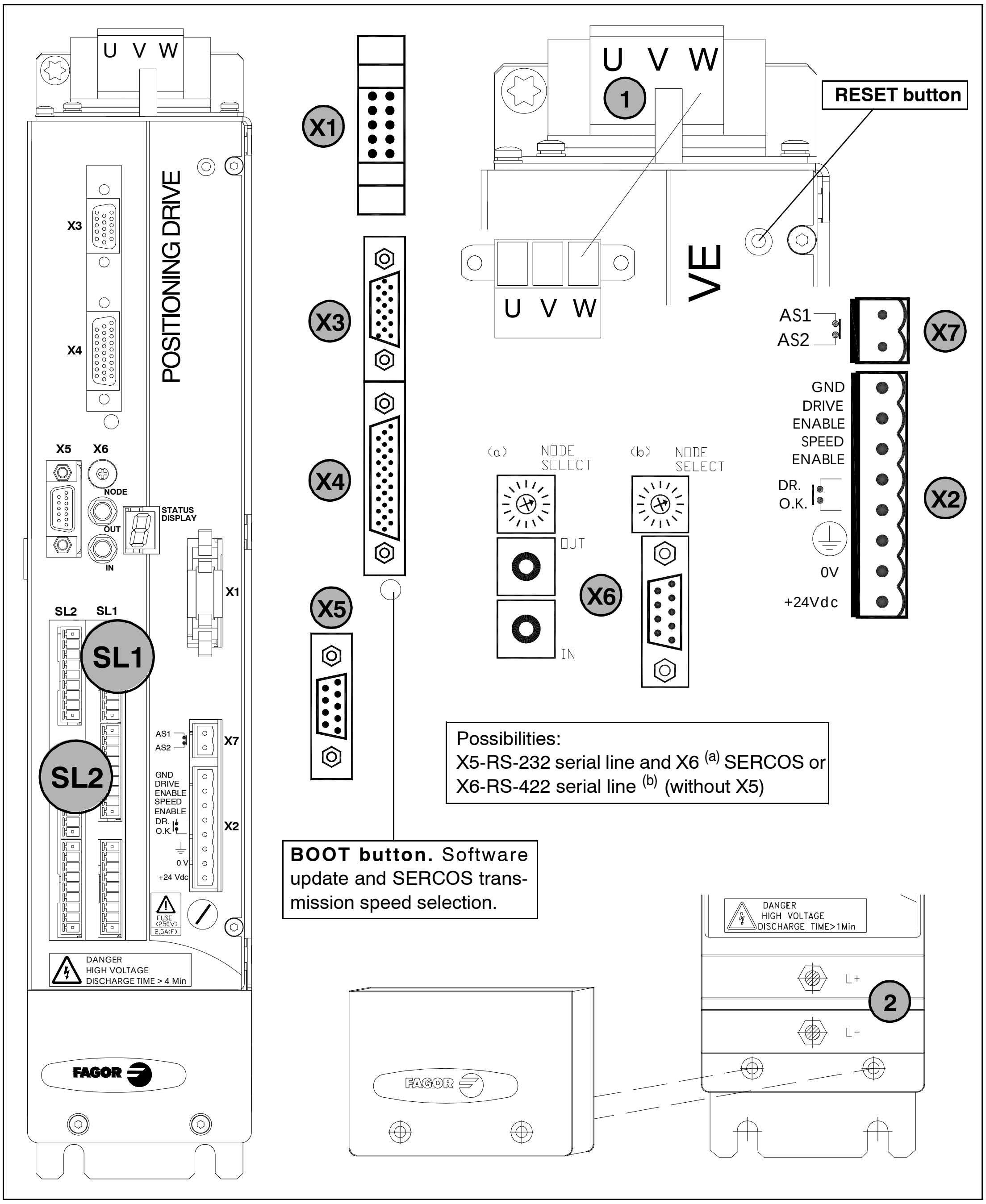


FIGURE H3.53

Connectors of "MMC 1.35" modular drives.

1. Power connector for motor connection.
2. Power bus that feeds the drive modules from the power supply through metal plates.
X1. Connector that may be used to establish communication between modules through the internal bus.
X2. Connector for the basic control signals.
X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.
X5. Connector for RS-232 serial line connection.
X6. Possible connectors that may be located in this position:
- SERCOS [(a)] interface connector (always with X5)
- Connector for RS-232/RS-422 [(b)] serial line connection (never with X5)

X7. Connector for external acknowledgment of the status of the safety relay.
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.
SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

MMC 2.50 / 2.75 / 2.85

These drive modules have the following connectors:

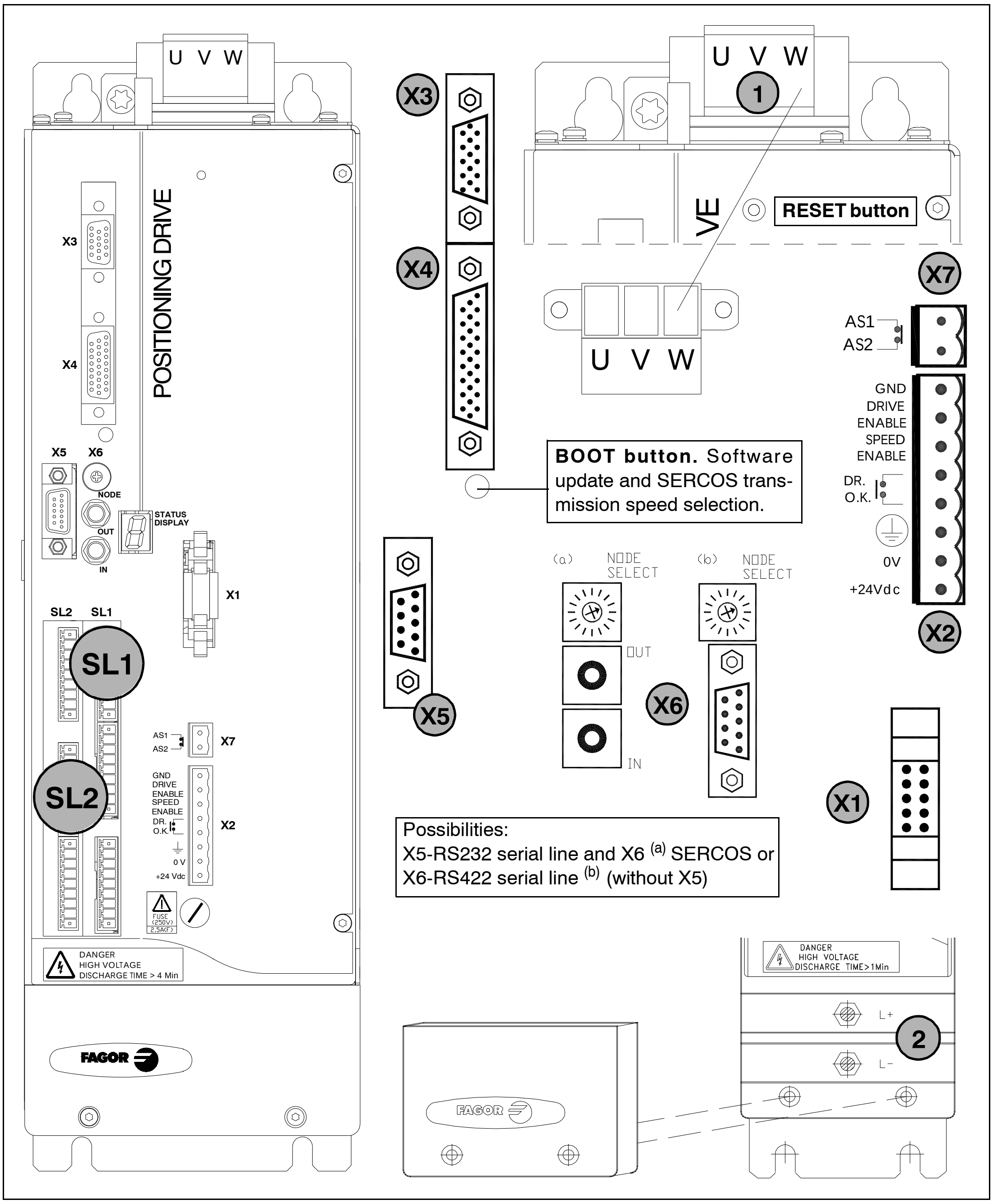


FIGURE H3.54

Connectors of "MMC 2.50/2.75/2.85" modular drives.

1. Power connector for motor connection.
2. Power bus that feeds the drive modules from the power supply through metal plates.
X1. Connector that may be used to establish communication between modules through the internal bus.
X2. Connector for the basic control signals.
X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.
X5. Connector for RS-232 serial line connection.
X6. Possible connectors that may be located in this position:
- SERCOS [a] interface connector (always with X5)
- Connector for RS-232/RS-422 [b] serial line connection (never with X5)

X7. Connector for external acknowledgment of the status of the safety relay.
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.
SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

MMC 3.100 / 3.150

These drive modules have the following connectors:

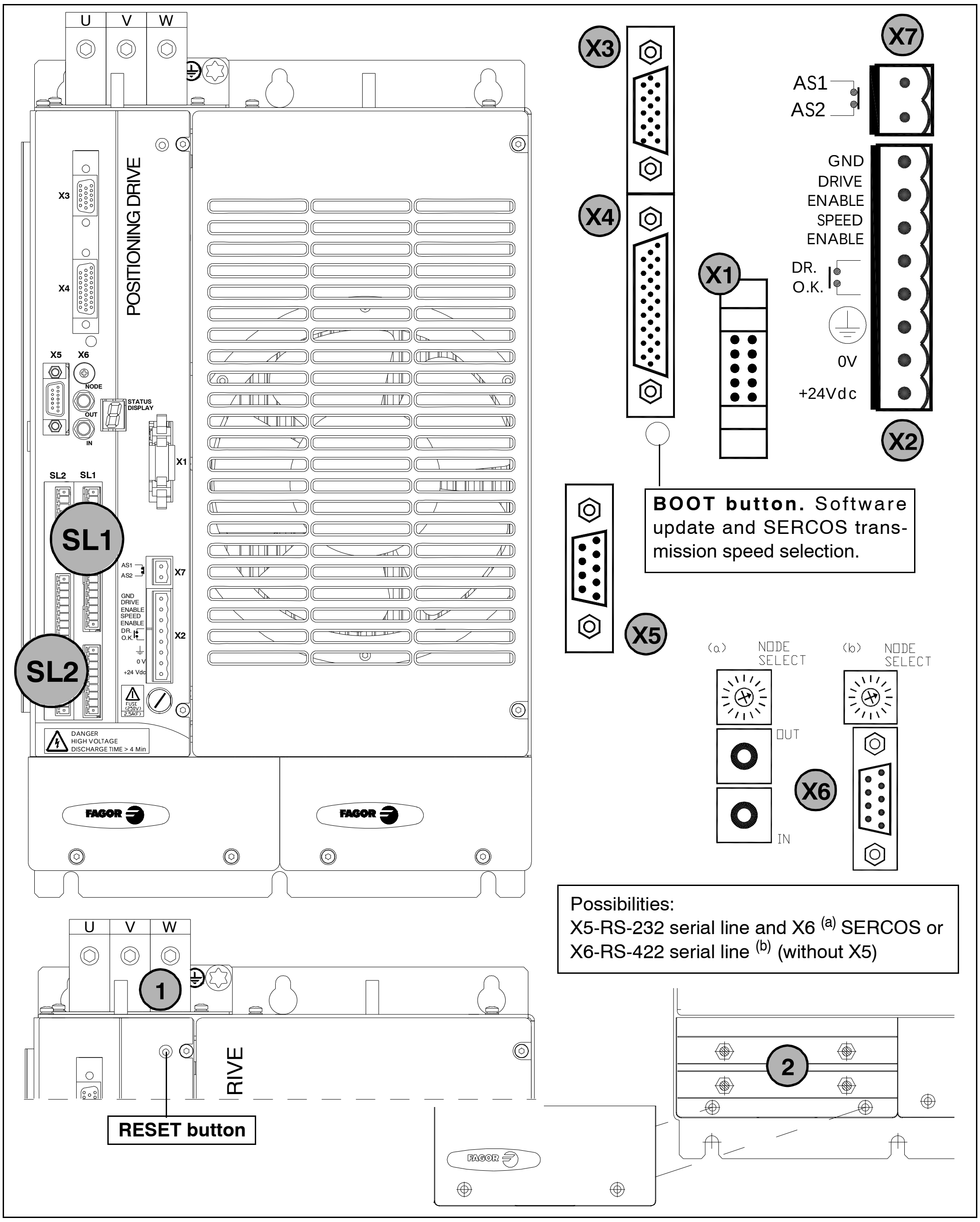


FIGURE H3.55

Connectors of "MMC 3.100/3.150" modular drives.

1. Power connector for motor connection.
2. Power bus that feeds the drive modules from the power supply through metal plates.
X1. Connector that may be used to establish communication between modules through the internal bus.
X2. Connector for the basic control signals.
X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.
X5. Connector for RS-232 serial line connection.
X6. Possible connectors that may be located in this position:
- SERCOS [a] interface connector (always with X5)
- Connector for RS-232 / RS-422 [b] serial line connection (never with X5)

X7. Connector for external acknowledgment of the status of the safety relay.
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.
SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

MMC 3.200 / 3.250

These drive modules have the following connectors:

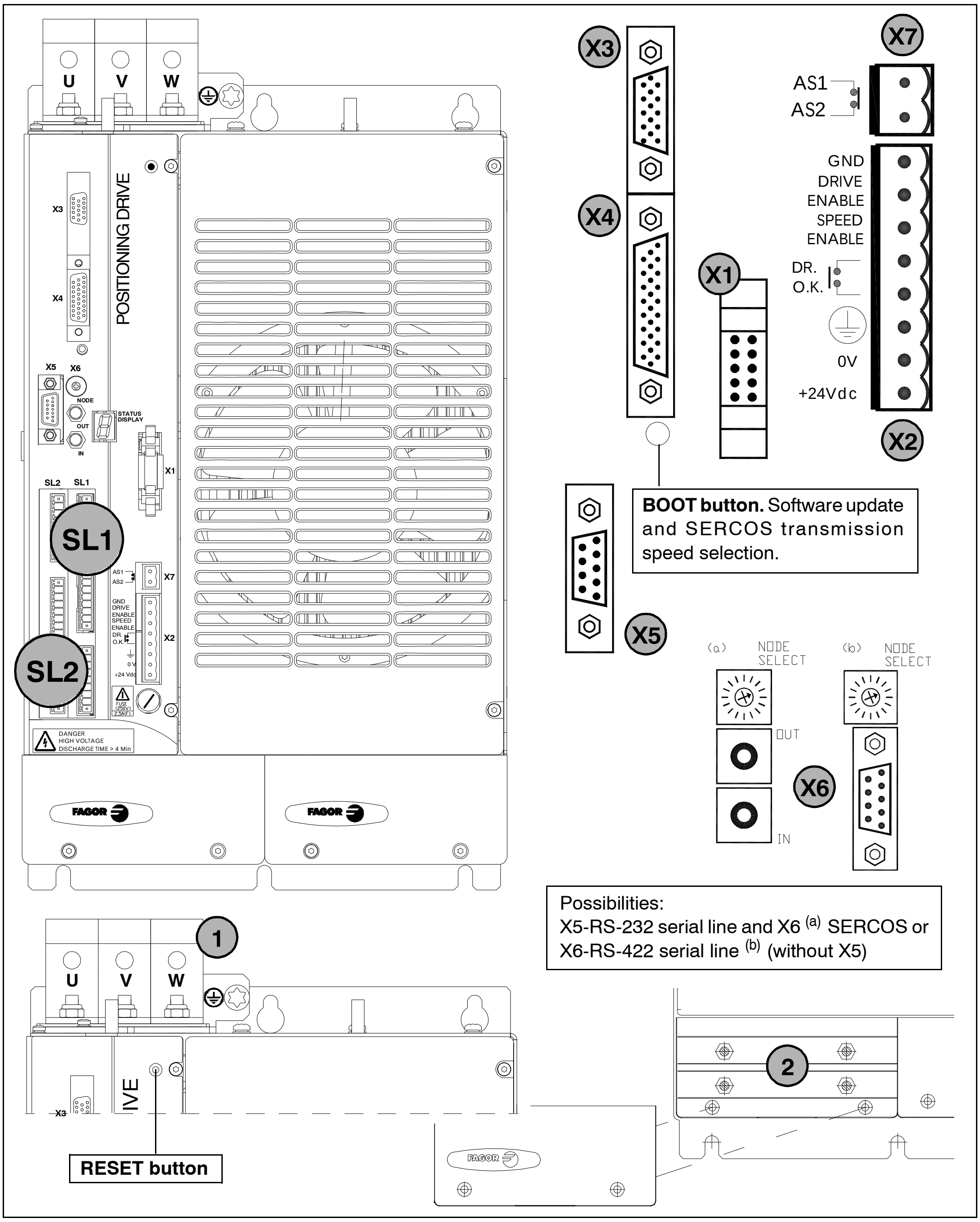


FIGURE H3.56

Connectors of "MMC 3.200/3.250" modular drives.

1. Power connector for motor connection.
2. Power bus that feeds the drive modules from the power supply through metal plates.
X1. Connector that may be used to establish communication between modules through the internal bus.
X2. Connector for the basic control signals.
X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

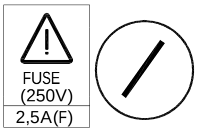
X4. Connector for motor feedback connection.
X5. Connector for RS-232 serial line connection.
X6. Possible connectors that may be located in this position:
- SERCOS [a] interface connector (always with X5)
- Connector for RS-232/RS-422 [b] serial line connection (never with X5)

X7. Connector for external acknowledgment of the status of the safety relay.
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.
SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

3.1.7 Other elements

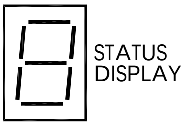
Besides the various connectors, the front panel of the drive has other elements that are mentioned next.

Fuse



The fuse on the front panel of each modular drive is a "2.5 A (F) / 250 V (fast)" fuse and it is used to protect the internal control circuits.

Status display



The seven-segment status display shows the information on the drive module status or the corresponding code when an error or warning occurs - see the section "turning a drive on" at the end of this chapter -. It can also display the transmission speed when setting it both with SERCOS interface.

3.1.8 Function of the connectors

Power connector

The power connectors located on top of each drive module are used to connect the motor.

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

The power bus input is located at the bottom of the modules and under the screwed-on lid. The drive needs 456-800 V DC 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.

The following table shows the values for gap, tightening torque, pole sections (wire entry holes) and other data regarding these screw-on connectors according to drive model:

TABLE H3.6 Technical data of the terminals of the power connector.

AXD / SPD / MMC	1.08 1.15	1.25	1.35	2.50 2.75	2.85	3.100 3.150	3.200 3.250
Connector data							
Gap (mm)	7.62	7.62	10.16	10.16	10.16	----	----
Min/max tightening torque (Nm)	0.5/0.6	0.7/0.8	1.2/1.5	1.7/1.8	1.7/1.8	6/8	15/20
Screw thread	M3	M3	M4	M4	M4	M6	M8
Min./max. section (mm²)	0.2/4	0.2/6	0.75/6	0.75/16	0.75/16	16/50	35/95
Rated current In (A)	20	41	41	76	76	150	232
Wire data							
Min. section (mm²)	4	6	6	16	16	50	95
Length to strip (mm)	7	10	12	12	12	24	27

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. Proceed the same way to connect the terminals V-V, W-W and ground-ground. If they are not connected like this, it could perform poorly. The cable must have a metallic shield that must be connected to the ground terminal of the drive and to that of the motor in order to comply with EU directives.

Observe that before handling these terminals, you must proceed as indicated and in the following order:

- Disconnect the mains voltage at the electrical cabinet.
- Wait a few minutes before handling these terminals.

The power supply needs time to decrease the voltage of the power bus down to safe values (< 60 V DC). The green indicator DC BUS ON being turned OFF does not mean that the power bus may be handled or manipulated. The discharge time depends on the number of elements connected and it is about 4 minutes.

Connector X1. Internal Bus

This connector may be used to connect the modules to each other through the internal bus communicating the elements of the servo drive system with each other.

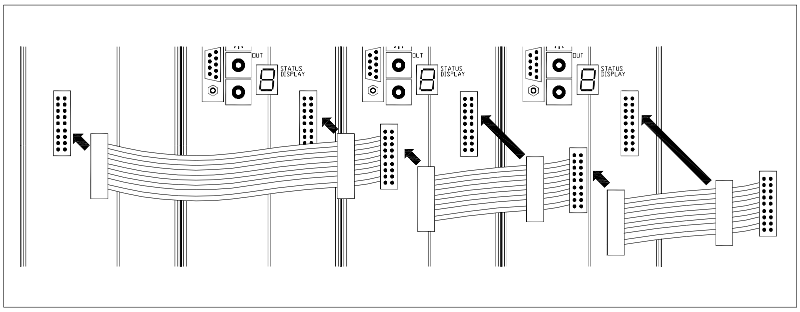


FIGURE H3.57

Connector X1. Internal Bus.

All the modules powered with the same power supply must be connected to this bus and this condition is must to run it.

Together with each module, a connector and a ribbon cable are supplied for this connection.

Warning. This bus must never be disconnected while the system is running.

Connector X2. Control

It is an 8-pin Phoenix connector of the modular drive.

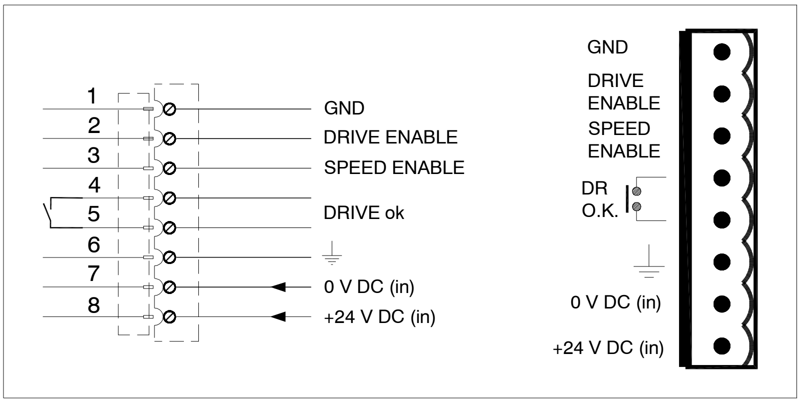


FIGURE H3.58

Connector X2. Control.

When the control circuit is supplied with 24 V DC (pins 7 and 8) the drive runs an internal test.

If the system is ok, it closes the module status Drive OK contacts (pins 4 and 5). This contact stays closed while the modular drive is supplied with 24 V DC and it runs properly.

To govern a motor, the drives also needs energy at the power bus.

The maximum internal consumption of the +24 V DC supply input is 2 A (for the bigger drives).

A 2.5 A fuse protects the internal circuits.

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.

The following table shows the values for gap, tightening torque, sections and other data of the plug-in connector for X2.

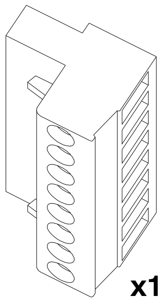

x1

TABLE H3.7 Characteristics of the pins of connector X2.

AXD / SPD / MMC	**1.08 1.15 1.25 1.35**	**2.50 2.75 2.85**	**3.100 3.150 3.200 3.250**
Connector data			
Nr of poles	8	8	8
Gap (mm)	5	5	5
Min/max tightening torque (Nm)	0.5/0.6	0.5/0.6	0.5/0.6
Screw thread	M3	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5	0.2/2.5
Rated current In (A)	12	12	12
Wire data			
Min. section (mm²)	1.5	1.5	1.5
Length to strip (mm)	7	7	7

The description of the pins of this connector is:

TABLE H3.8 Signals at the pins of connector X2 of the modular drive.

1	GND	Control signals	Reference 0 V for control signals
2	Drive Enable		Motor current enable (24 V DC)
3	Speed Enable		Drive speed enable (24 V DC)
4	Drive OK	Contact indicating module status. (it opens in case of failure). Limit 1 A at 24 V DC.	
5	Drive OK		
6	Chassis	Chassis connection.	
7	0 V DC (IN)	Supply input for the control circuit	Reference 0 V
8	+24 V DC (IN)		Positive voltage input (21÷28 V DC)

Speed Enable and Drive Enable

Normal operating mode

1. Activate the Drive Enable and Speed Enable inputs (24 V DC) in the desired order. Before activating, the Soft Start process (smoothly reaching the power bus voltage) must be over. The motor will have torque only when Drive Enable is active and there is voltage at the power bus. The motor speed will be controlled with a command when the Speed Enable function is active.

Activating the Drive Enable function requires to be requested by the system in three different ways. They are: 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 V DC. If any of them is deactivated, the following will happen. See the operation modes in FIGURE H3.59.

Deactivation of the Drive Enable input

The Drive Enable input lets the current circulate through the motor stator windings. When it is powered with 24 V DC the current loop is enabled and the drive can work.

If the Drive Enable input drops to 0 V DC (no voltage), the power circuit is off and the motor will have not torque, hence not being governed and will turn freely until it stops by inertia.

Deactivation of the Speed Enable input

When the Speed Enable input is set to 0 V DC, the internal velocity command switches to 0 rpm and:

- **Situation 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.

- **Situation 2**

  The torque is kept active by braking the motor. When it stops, variable SV5 (S00331) is activated. The motor does not stop in a time period set by parameter GP3 (F00702). The motor stops when its kinetic energy runs out.

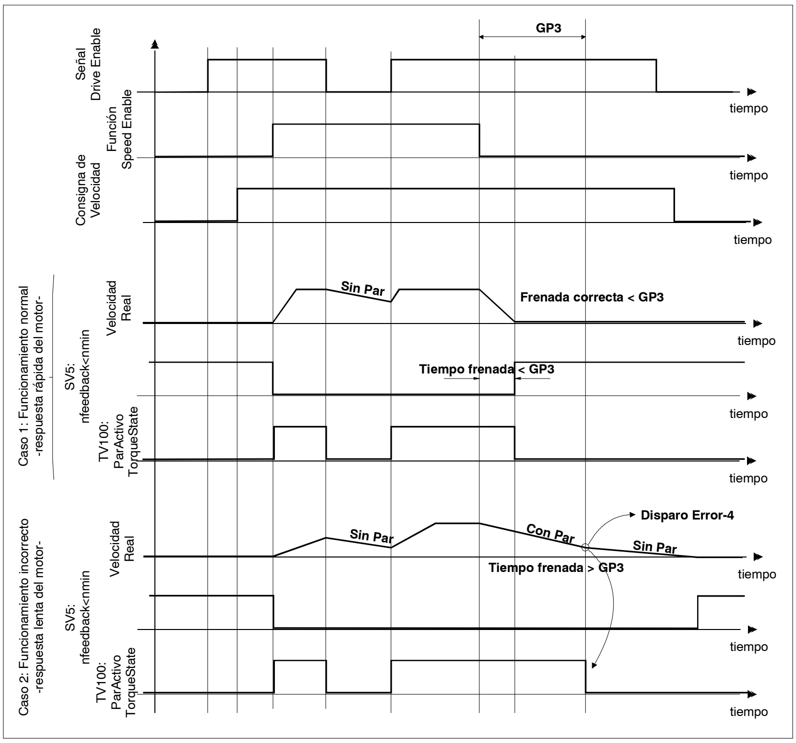


FIGURE H3.59

Operating modes of functions Drive Enable and Speed Enable.

See the internal parameter GP3 (F00702) and the internal variable SV5 (S00331) in chapter 13 of the "dds-software" manual that is supplied with this one.

Safety standard (EN 60204-1) requires the drive module to have a software independent input in order to always assure the motor stop of category 0. Software systems complying with the standards EN 954, IEC 61508, IEC 62061 are being accepted recently. See chapter 9, "Integrated safety" in this manual.

The Drive Enable input, using only hardware, can cancel the power circuit leaving it deactivated. This allows stopping the "0" category motor even when the software fails.

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

On modular drives, the 24 V DC needed to activate the Drive Enable must be obtained from a power supply that maintains its rated value during that period of time. The PS-25B4 power supply, the APS 24 auxiliary power supply and the regenerative XPS and RPS power supplies meet this condition.

This connector of the modular drive offers two possible configurations:

- Encoder simulator
- Direct feedback

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.

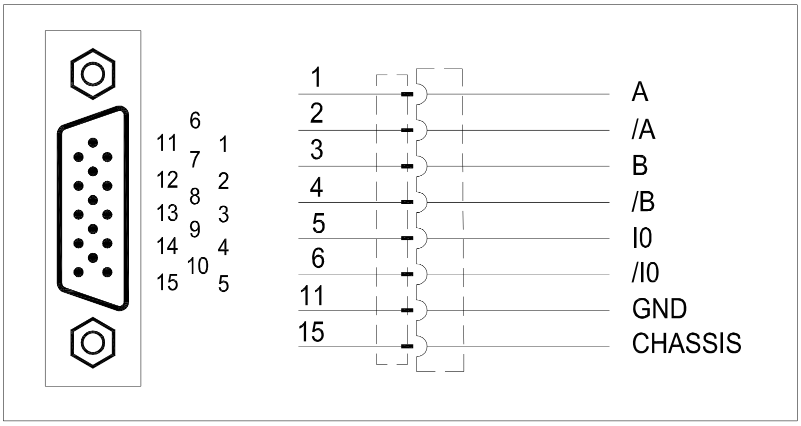


FIGURE H3.60

Connector X3. Encoder simulator.

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 I0 are programmable.

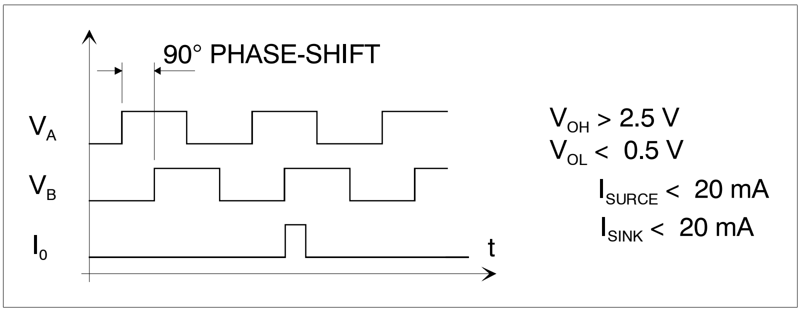


FIGURE H3.61

Connector X3. Pulses per revolution and reference mark position.

X3. Direct feedback

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

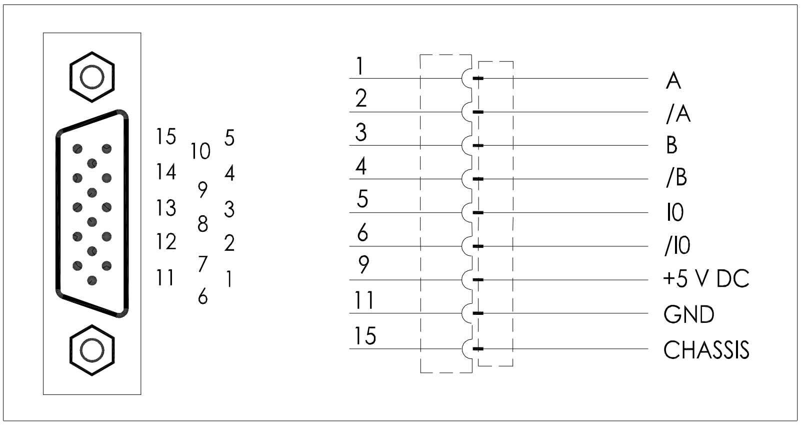


FIGURE H3.62

Connector X3. Direct feedback.

This connector admits three different types of feedback signals:

- Square TTL signals
- Square differential TTL signals (double-ended)
- 1 Volt peak-to-peak sinusoidal signals (1 Vpp).

It admits the following frequencies:

- 1 MHz with square signals
- 500 kHz with sinusoidal signals

The input impedance for sinusoidal signals is 120 Ω.

Incremental feedback

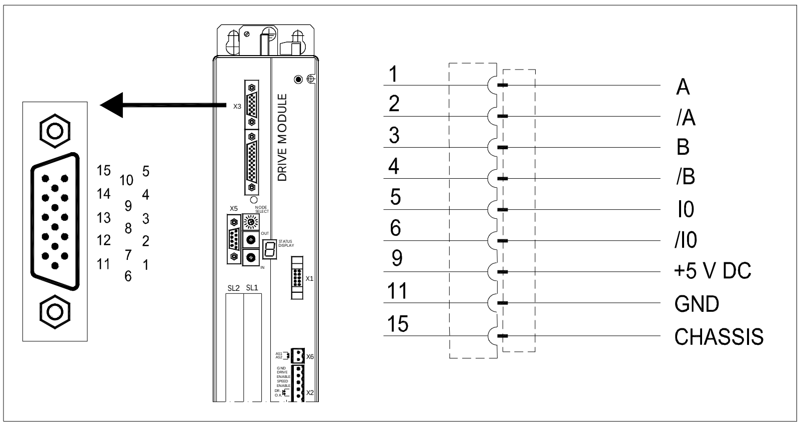


FIGURE H3.63

Connector X3. Incremental direct feedback..

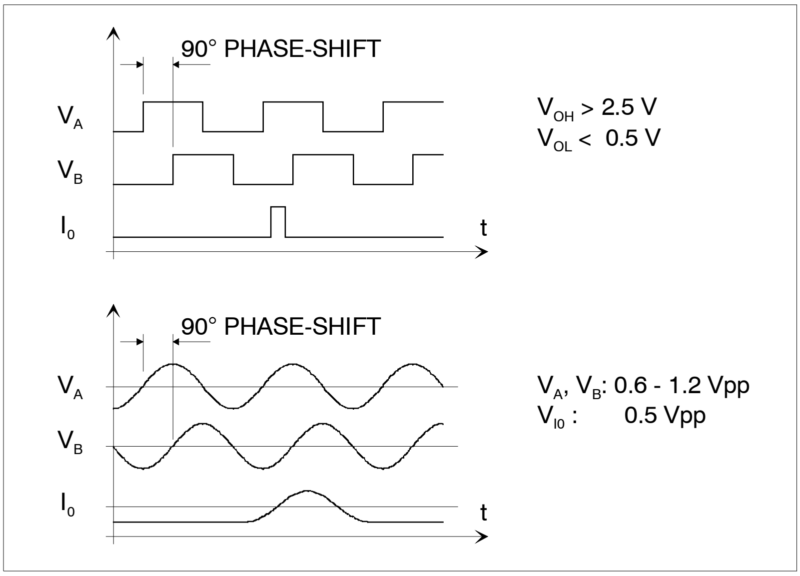


FIGURE H3.64

Characteristics of the TTL and 1Vpp signals.

Absolute feedback (SSI data interface)

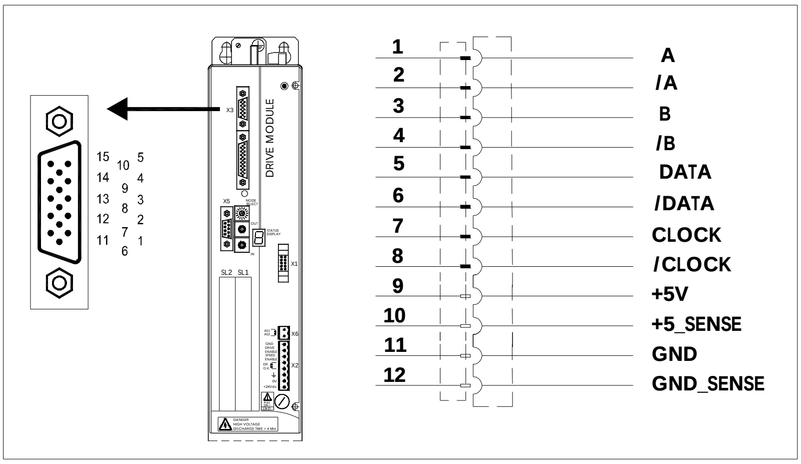


FIGURE H3.65

Connector X3. Absolute direct feedback.

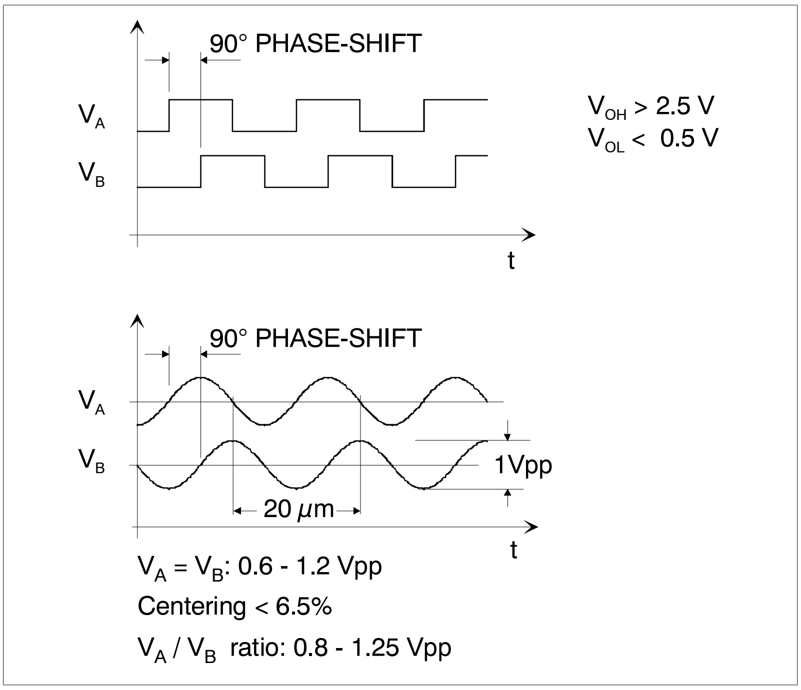
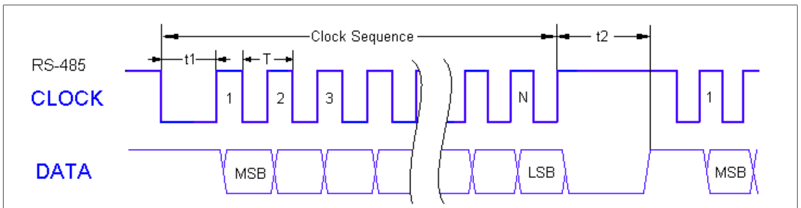


FIGURE H3.66

Characteristics of the TTL and 1Vpp signals.



N = 32 bits
T = 1μs = 10 μs
T1 > 1μs
t2 = 20 - 35 μs
Logic levels, according to EIA RS-485

FIGURE H3.67

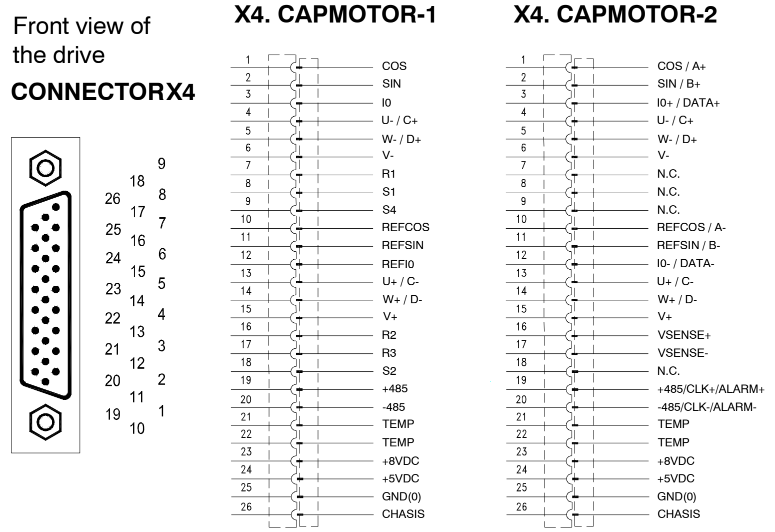
Characteristics of the SSI signals.

Connector X4

X4. Motor feedback

Is the connector for the motor feedback board that may come on modular drives. It is a high density (HD) 26-pin sub-D type female connector. Through it, the board receives the signals coming from the feedback device attached to the motor shaft.

The pinout of connector X4 depending on whether the motor feedback board installed at the drive is a CAPMOTOR-1 or a CAPMOTOR-2 is:



Notes.

Do not select a drive with CAPMOTOR-2 when the motor feedback is a resolver. They are incompatible. In this case, the drive must always carry a CAPMOTOR-1.

Do not connect an SSI or ENDAT feedback device to connector X4 of the drive of a CAPMOTOR-1 motor feedback board. They are incompatible.

FIGURE H3.68

Connector X4. Feedback on the motor. CAPMOTOR-1 or CAPMOTOR-2

To know whether your drive has a CAPMOTOR-2 installed, check the label on the side of the drive and see if the last field of the sales reference is a B. If not, it will have a CAPMOTOR-1.

The feedback of Fagor motors use sinusoidal encoder, incremental TTL encoder or resolver. Refer to the corresponding motor manual for the detailed description of the pinout of the feedback devices that can go with each motor family.

Connector X5

X5. RS232 serial line

This connector of the RS232 serial line board that may be included in a modular drive is a 9-pin male sub-D connector for RS232 serial connection to a PC in order to set the module configuration parameters and to adjust it.

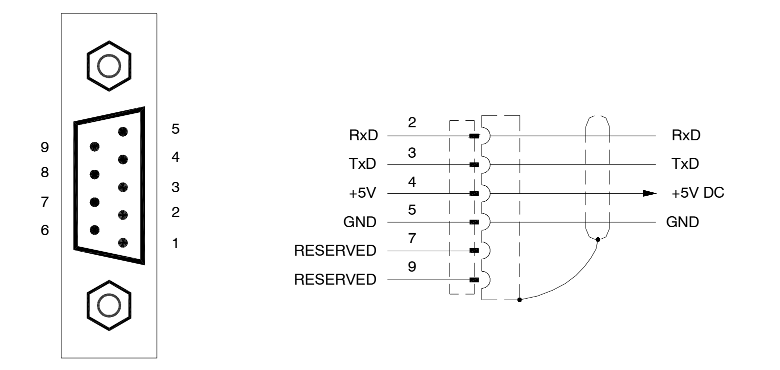


FIGURE H3.69

Connector X5. RS232 serial line.

The description of the pins of this connector is:

TABLE H3.9 Description of the pins of connector X5.
(*) Reserved pins must not be connected.

1		Not connected
2	R x D	Receive data
3	T x D	Transmit data
4	+ 5 V	Supply outputs
5	GND	Reference 0 V
6		Not connected
7		(*) Reserved
8		Not connected
9		(*) Reserved
CH	CHASSIS	Cable shield

Connector X6

X6. Communication interface

This connector of the modular drive identified as X6 may be:

- A SERCOS interface connector.
- An RS-232 / RS-422 serial line connector (only on MMC drives).

X6. SERCOS interface connector

This connector consists of a SERCOS signal receiver and emitter (Honeywell IN, OUT) and may be used to connect the modules of the DDS system with the CNC that governs them. The connection is made through fiber optic lines and it has a ring structure.

It will always come with a node selecting rotary switch (NODE SELECT) that lets identify each drive within the system.

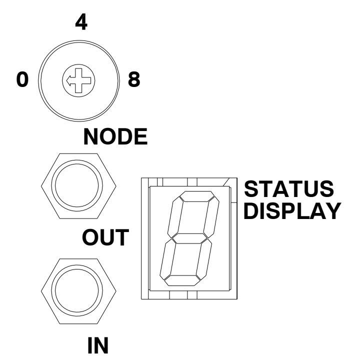


FIGURE H3.70
Honeywell emitter-receiver for SERCOS transmission.

Note that on modular drives (AXD, SPD and MMC), this connector will always come with connector X5.

X6. RS232/RS422 serial line connector

Note. Only MMC modular drives can have this connector.

It is a 9-pin male sub-D connector for connecting an RS-232/RS-422 serial line with a device acting as master. This device is usually a PC or an ESA video terminal (VT).

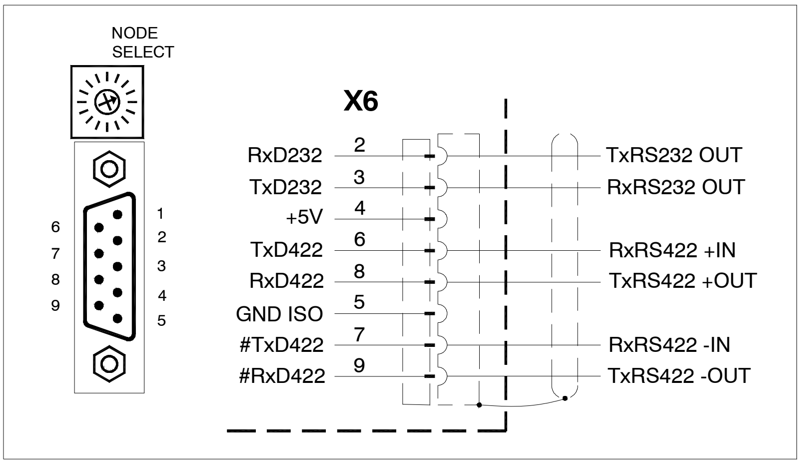


FIGURE H3.71

RS232/RS422 serial line connector.

Note that on modular drives, only the MMC models can have the RS232/RS422 connector and only when they do not have the connector X5.

The description of the pins of this connector is:

TABLE H3.10 Description of the pins of the RS-232/RS-422 connector.

1	N.C.	Not connected
2	R x D 232	RS-232 serial line data reception
3	T x D 232	RS-232 serial line data transmission
4	+ 5 V ISO	Supply outputs
5	GND ISO	Reference 0 V
6	T x D 422	RS-422 serial line data transmission
7	#T x D 422	
8	R x D 422	RS-422 serial line data reception
9	#R x D 422	
CH	CHASSIS	Cable shield

Connector X7

X7. Status of the integrated-safety relay

This connector X5 of the modular drive is associated with the second contact (**NC**, **N**ormally **C**losed) of an internal safety relay (with guided contacts). The status of the relay (initially closed) may be acknowledged through the two pins and a CNC, PLC or control panel, i.e. that the integrated safety relay has actually opened or closed. These two terminals are identified at the drive as AS1 and AS2. The opening or closing of this relay depends on whether 24 V DC are present or not at pin 2 <DRIVE ENABLE> of control connector X2. For further detail regarding this functionality of this connector, refer to the section "Safe Disable (SD)" in chapter 9. Integrated safety, of this manual.

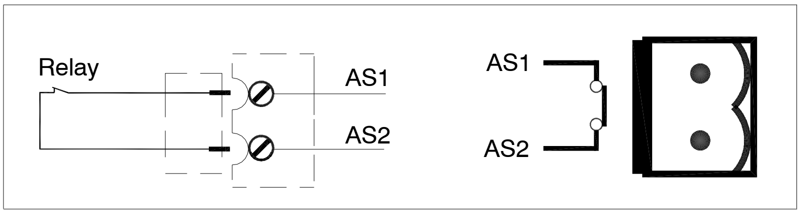


FIGURE H3.72

Connector X7. External acknowledgment of the status of the integrated safety relay.

The following table shows the values for gap, tightening torque, sections and other data of the plug-in connector for X7.

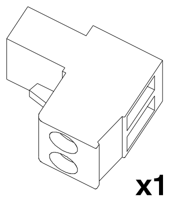


TABLE H3.11 Characteristics of the pins of connector X7.

AXD / SPD / MMC	**1.08 1.15 1.25 1.35**	**2.50 2.75 2.85**	**3.100 3.150 3.200 3.250**
Connector data			
Nr of poles	2	2	2
Gap (mm)	5	5	5
Min/max tightening torque (Nm)	0.5/0.6	0.5/0.6	0.5/0.6
Screw thread	M3	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5	0.2/2.5
Rated current In (A)	12	12	12
Wire data			
Min. section (mm²)	1.5	1.5	1.5
Length to strip (mm)	7	7	7

Connectors at slots SL1 and SL2

CARD A1

The A1 card must always be in slot SL1.

X6-DIGITAL I/O, digital inputs and outputs

If offers 4 digital inputs and 4 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. The user may assign to these parameters, internal Boolean type variables that may be used to show the system status via electrical contacts. See "dds-software" manual.

These assigned Boolean variables are set with the monitor program for PC (WinDDSSetup).

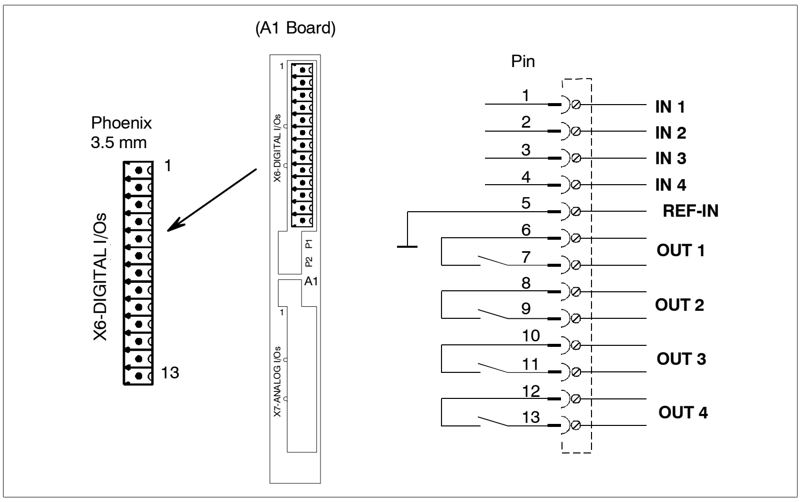


FIGURE H3.73

A1 card: X6-DIGITAL I/Os. Digital inputs and outputs.

Digital inputs characteristics

Maximum rated voltage	24 V DC (36 V DC)
ON / OFF voltage	18 V DC (5 V DC)
Maximum typical consumption	5 mA (7 mA)

Digital outputs characteristics

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

X7-ANALOG I/O, digital inputs and outputs

It offers 2 inputs and 2 outputs, all of them fully programmable. Each input and output is associated with a parameter. See "dds-software" manual. It offers a ± 15V power supply for generating a command easily.

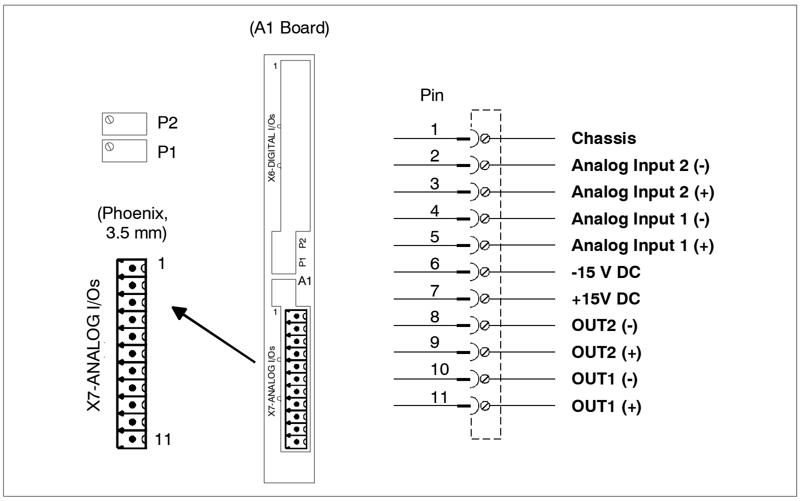


FIGURE H3.74

A1 card: X7- ANALOG I/Os. Analog inputs and outputs.

Pinout

TABLE H3.12 Description of the pins of connector X7-ANALOG I/O. Analog inputs and outputs.

1	Chassis
2	Analog input 2 (-)
3	Analog input 2 (+)
4	Analog input 1 (-)
5	Analog input 1 (+)
6	Adjustment output (-15 V DC) (user)
7	Adjustment output (+15 V DC) (user)
8	Reference for analog output 2 (-)
9	Analog output 2 (+)
10	Reference for analog output 1 (-)
11	Analog output 1 (+)

Analog input 1

Associated with pins 4 and 5. It is the usual input for the velocity command (±10 V DC) generated by the CNC.

Analog input 2

Associated with pins 2 and 3. It is the auxiliary command input.

Analog input characteristics

Resolution		1.22 mV
Input voltage range		±10 V DC
Input over-voltage	Continuous mode	80 V DC
	Transients	250 V DC
Input impedance	With respect to GND	40 kΩ
	Between both inputs	80 kΩ
Voltage in common mode		20 V DC

Dip-Switches (DS1, DS2)

The operator must not change the state of the dip-switches (DS1, DS2) located on the left when looking at the front of the unit.

Adjustment outputs

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 V DC.

The electrical circuit necessary to obtain a reference voltage and the recommended resistance values to obtain an approximate range of ± 10 V DC for the Vref are described next:

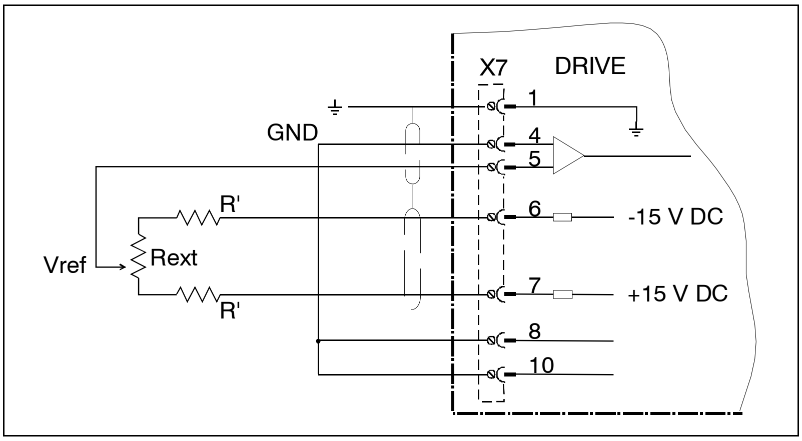


FIGURE H3.75

Adjustment outputs.

Range ±10 V	
Rext.	R’
1 kΩ	0 Ω
5 kΩ	820 Ω
10 kΩ	1.8 kΩ
20 kΩ	3.3 kΩ

Analog outputs

Associated with pins 8-9 and 10-11. These outputs provide an analog voltage indicating the status of the internal system variables. They are especially designed as permanent monitoring of these internal variables and also to be connected to an oscilloscope to make it easier to set the system up.

Note that if the output current is high, the voltage range may decrease.

Analog output characteristics

Resolution	4.88 mV
Voltage range	±10 V DC
Maximum current	±15 mA
Impedance (respect to GND)	112 Ω

CARDS 8DI-16DO and 16DI-8DO

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

- 8DI-16DO offers to the user 8 digital inputs and 16 outputs
- 16DI-8DO offers to the user 16 digital inputs and 8 outputs

X8-DIG.INs, X11-DIG.INs, X12-DIG.INs, digital inputs

They offer 8 fully programmable digital inputs.

The digital inputs are optocoupled and referred to a common point (pin 1) and they admit digital signals at 24 V DC.

Each input is associated with a PLC resource.

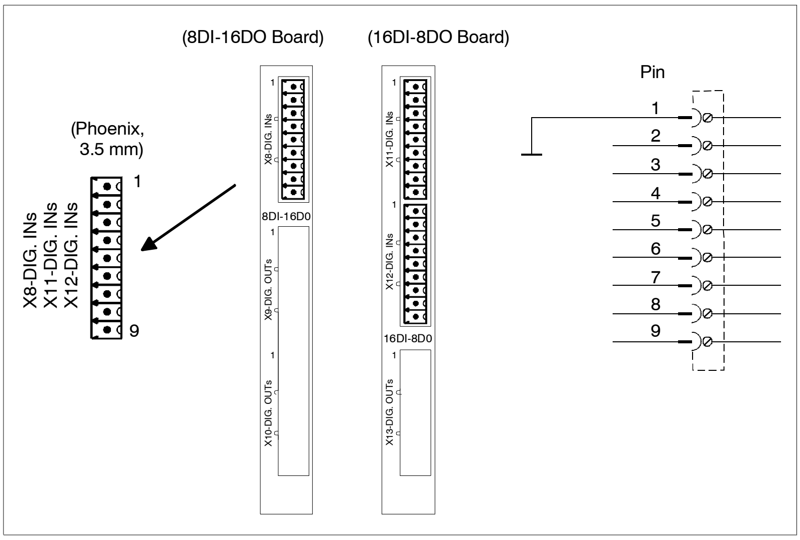


FIGURE H3.76

Cards 8DI-16DO and 16DI-8DO. X8-DIG.INs, X11DIG.INs and X12DIG.INs. Digital inputs.

Characteristics of the digital inputs (at 24 V)

Rated voltage (maximum)	24 V DC (40 V DC)
ON / OFF voltage	12 V DC / 6 V DC
Typical consumption (max)	5 mA (7 mA)

X9-DIG.OUTs, X10-DIG.OUTs, X13-DIG.OUTs, digital outputs

They offer 8 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.

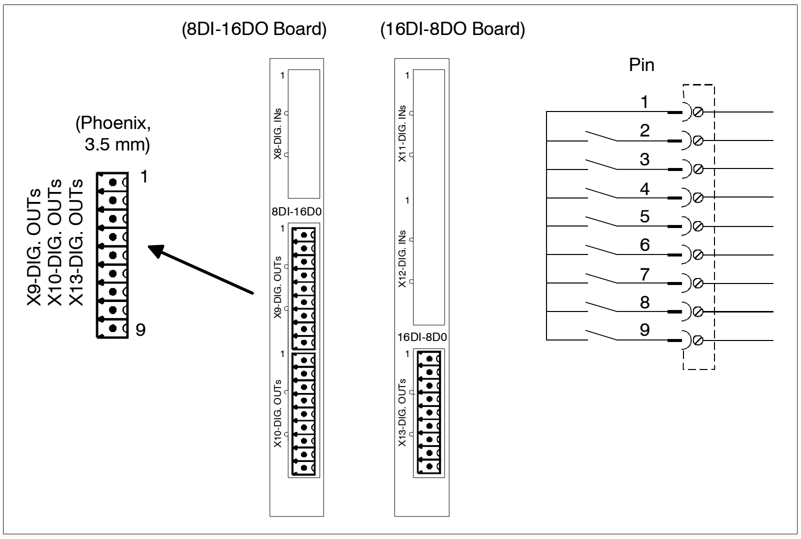


FIGURE H3.77

Cards 8DI-16DO and 16DI-8DO. X9-DIG.OUTs, X10-DIG.OUTs and X13-DIG.OUTs. Digital outputs.

Digital outputs characteristics

Maximum voltage	250 V
Maximum load current	150 mA
Current autosupply	200 mA
Maximum internal resistance	20 Ω
Galvanic isolation voltage	3750 V (1 min)

Names of the PLC resources

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.

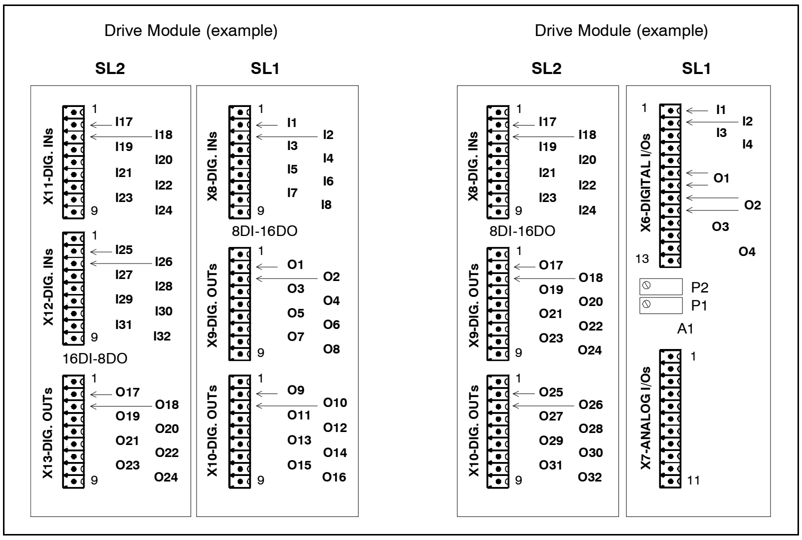


FIGURE H3.78

PLC resources on cards located in SL1 and SL2.

3.2 Compact drives

When referring to compact drives, we will use ACD, SCD and CMC. They have the power supply integrated into the module itself and are connected directly to mains. All of them admit a mains voltage between 400 and 460 V AC and, in general, their behavior, functions and parameters are identical to those of the modular drive. See all models in the following figures.

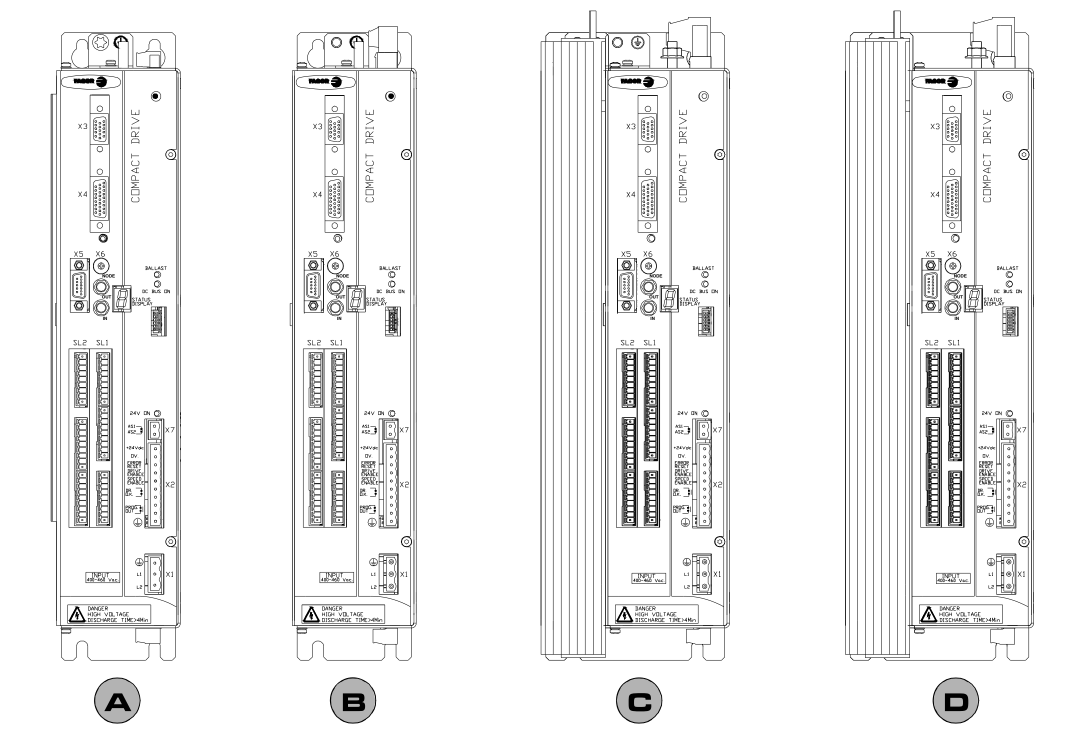


FIGURE H3.79

ACD/SCD compact drives of the Fagor catalog.
A. ACD/SCD 1.08/1.15, **B.** ACD/SCD 1.25, **C.** ACD/SCD 2.35, **D.** ACD/SCD 2.50

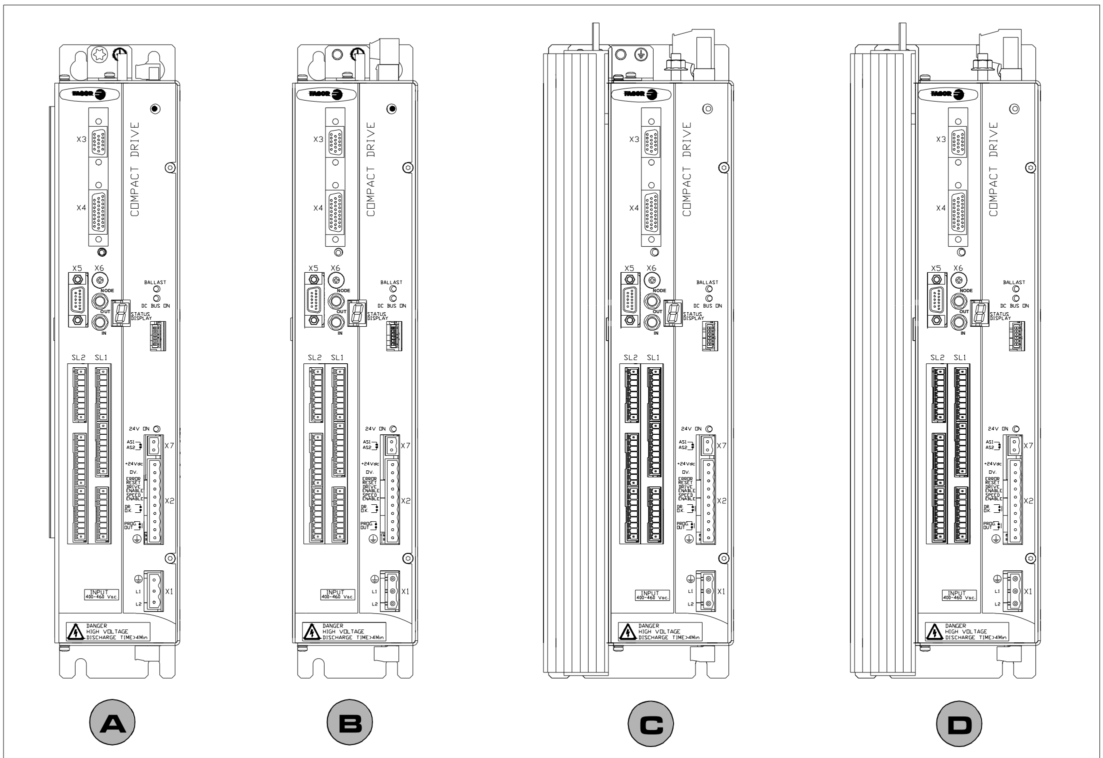


FIGURE H3.80

CMC compact drives of the Fagor catalog.
A. CMC 1.08/1.15, **B.** CMC 1.25, **C.** CMC 2.35, **D.** CMC 2.50

3.2.1 Technical data

TABLE H3.13 Current in compact drives for synchronous motors. fc=4 kHz.

With internal fan	Drive for synchronous motor (as axis)				
Currents at fc=4 kHz (A)	**ACD/CMC 1.08**	**ACD/CMC 1.15**	**ACD/CMC 1.25**	**ACD/CMC 2.35**	**ACD/CMC 2.50**
Rated current (Arms)	4.0	7.5	12.5	17.5	25.0
(*) Maximum peak current for 500 ms in 10 s cycles.	8.0	15.0	25.0	35.0	50.0
Dissipated power (W)	40	87	110	160	222

TABLE H3.14 Current in compact drives for synchronous motors. fc=8 kHz.

With internal fan	Drive for synchronous motor (as axis)				
Currents at fc=8 kHz (A)	**ACD/CMC 1.08**	**ACD/CMC 1.15**	**ACD/CMC 1.25**	**ACD/CMC 2.35**	**ACD/CMC 2.50**
Rated current (Arms)	4.0	7.5	9.5	17.5	20.0
(*) Maximum peak current for 500 ms in 10 s cycles.	8.0	15.0	19.0	35.0	40.0
Dissipated power (W)	50	118	139	206	226

TABLE H3.15 Current in compact drives for synchronous or asynchronous motors. fc=4 kHz.

With internal fan	Drive for synchronous or asynchronous motor (as spindle)				
Currents at fc=4 kHz (A)	**SCD 1.08**	**SCD 1.15**	**SCD 1.25**	**SCD 2.35**	**SCD 2.50**
(*) Maximum current in any duty cycle (Arms).	-----	10.6	17.5	28.0	38.0
Dissipated power (W)	-----	123	150	215	300

(*) This current must be equal to or greater than that of the corresponding asynchronous motor in S6.

TABLE H3.16 Current in compact drives for synchronous or asynchronous motors. fc=8 kHz.

With internal fan	Drive for synchronous or asynchronous motor (as spindle)				
Currents at fc=8 kHz (A)	**SCD 1.08**	**SCD 1.15**	**SCD 1.25**	**SCD 2.35**	**SCD 2.50**
(*) Maximum current in any duty cycle (Arms).	-----	10.6	12.5	19.5	27.0
Dissipated power (W)	-----	123	150	220	315

(*) This current must be equal to or greater than that of the corresponding asynchronous motor in S6.

Note. The indicated dissipated power values for the spindles correspond to the operation at rated current in S1 mode.

The following table shows other electrical, mechanical and ambient conditions:

TABLE H3.17 Technical characteristics of the compact drives.

	ACD / CMC					SCD				
	1.08	**1.15**	**1.25**	**2.35**	**2.50**	**1.08**	**1.15**	**1.25**	**2.35**	**2.50**
Power supply	Three-phase 50/60 Hz, with a voltage range between 400-10% and 460+10% V AC									
Internal power bus voltage	565-650 V DC									
Filter capacity	330 μF 900 V AC					330 μF 900 V AC				
Energy stored in the capacitors	**0.5 C·V²**									
Internal Ballast resistance (Ω) Power (W)	75 (150)	75 (150)	-----	-----		75 (150)	75 (150)	-----	-----	
Energy pulse that can be dissipated (kWs)	3.5 (0.40	3.5 (0.40	-----	-----		3.5 (0.40)	3.5 (0.40)	-----	-----	
Ballast V DC on/off	768 / 760									
Minimum Ballast resistance (Ω)	75	75	24	18	18	75	75	24	18	18
Speed feedback	Encoder or resolver					Encoder				
Controlling method	PWM, AC sinewave, vector control									
Communication	Serial line to connect to a PC									
Interface	Standard analog or digital via SERCOS (in all models). Serial line RS-232/RS-422 (only on CMC models)									
Status display	7-segments display									
Speed range of analog input	1 : 8192									
Current bandwidth	800 Hz									
Speed bandwidth	100 Hz (depends on the motor/drive combination)									
Protections	Over-voltage, over-current, over-speed, heat-sink temperature, ambient temperature, motor temperature, Ballast temperature, hardware error, overload. See chapter 14 of the "dds-software" manual.									
Power for internal circuits (24 V DC)										
Input voltage	Between 400-10% and 460+10% V AC - 50/60 Hz									
Mains consumption	124.5 mA (400 V AC), 108 mA (460 V AC)									
Output voltage, max. current	24 V DC (5%), 100 A Connector X2, pins 1 and 2.									
Ambient conditions										
Tambient	5°C/45°C (41°F/113°F) From 40ºC (104ºF) on. See derating curves.									
Storage temperature	-20°C/+60°C (-4°F/140°F)									
Sealing	IP 2x									
Maximum humidity	< 90% (non condensing at 45°C/113°F)									
Operating vibration	0.5 G									
Shipping vibration	2 G									
Approx. mass in kg (lb)	6.0 (13.2)		5.75 (12.7	6.1 (13.4)		6.0 (13.2)		5.75 (12.7)	6.1 (13.4)	

3.2.2 Load duty cycles

Load cycle S1 with current peak

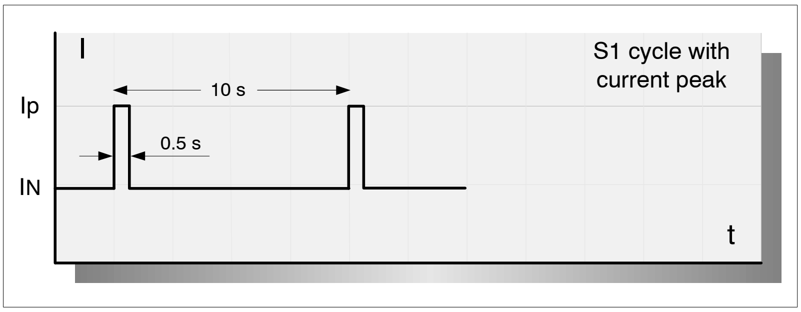


FIGURE H3.81

Load cycle S1 with current peak.

Load cycle S6

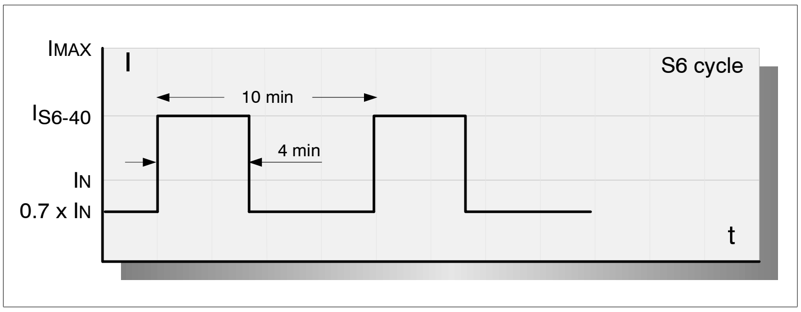


FIGURE H3.82

Load cycle S6-40.

Load cycle S6 with current peak

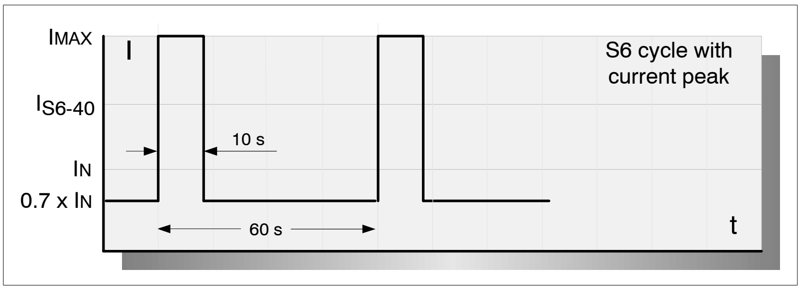


FIGURE H3.83

Load cycle S6 with current peak.

Definition of currents

On axes:

- In ➔ "Continuous duty cycle" current.
- Ip ➔ Peak current. See load duty cycles.

On spindles:

- In ➔ "Continuous duty cycle" current.
- IS6-40% ➔ Current that, in an intermittent duty cycle S6 with 10 minute cycle, circulates for 4 minutes with load (the other 6 minutes operates without load); in other words with magnetizing current = 0.7 x rated current In).
- Imax ➔ Maximum peak current. (See load duty cycles).

Note. The values of these currents are given in RMS.

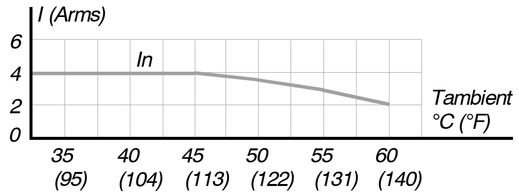
3.2.3 Current derating

Drives for an synchronous motor working as an axis

The following graphs show the maximum rms current in continuous duty cycle (that is, the rated one) depending on the switching frequency of the power transistors that the drive modules for synchronous motors can supply in a temperature range between 5°C (41°F) and 60°C (140°F).

> They can supply twice as much current for a maximum or 0.5 seconds, and always in cycles longer than 10 seconds.

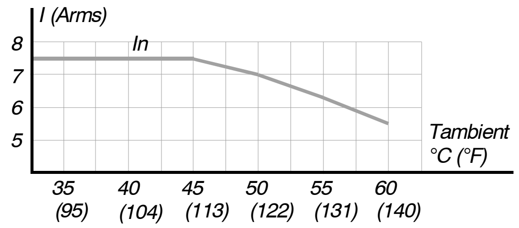
◻ For a switching frequency fc = 4 kHz



ACD / CMC 1.08		
Tamb		In
° C	°F	Arms
35	95	4.0
40	104	4.0
45	113	4.0
50	122	3.5
55	131	2.8
60	140	2.1

FIGURE H3.84

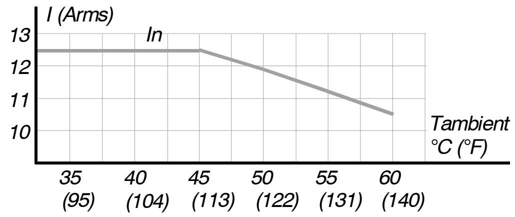
Current derating on "ACD/CMC 1.08" drives for fc = 4 kHz



ACD / CMC 1.15		
Tamb		In
° C	°F	Arms
35	95	7.5
40	104	7.5
45	113	7.5
50	122	7.0
55	131	6.3
60	140	5.5

FIGURE H3.85

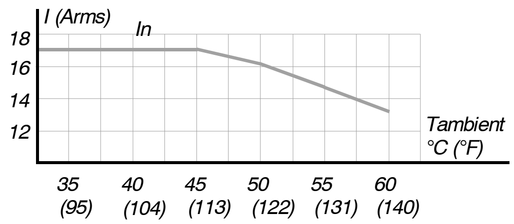
Current derating on "ACD/CMC 1.15" drives for fc = 4 kHz



ACD / CMC 1.25		
Tamb		In
° C	°F	Arms
35	95	12.5
40	104	12.5
45	113	12.5
50	122	11.9
55	131	11.2
60	140	10.5

FIGURE H3.86

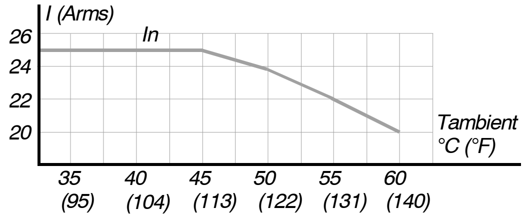
Current derating on "ACD/CMC 1.25" drives for fc = 4 kHz



ACD / CMC 2.35		
Tamb		In
° C	°F	Arms
35	95	17.5
40	104	17.5
45	113	17.5
50	122	16.3
55	131	14.7
60	140	13.2

FIGURE H3.87

Current derating on "ACD/CMC 2.35" drives for fc = 4 kHz

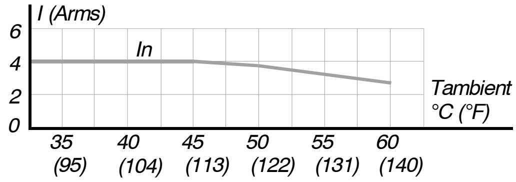


ACD / CMC 2.50		
Tamb		In
° C	°F	Arms
35	95	25.0
40	104	25.0
45	113	25.0
50	122	23.8
55	131	22.1
60	140	20.2

FIGURE H3.88

Current derating on "ACD/CMC 2.50" drives for fc = 4 kHz

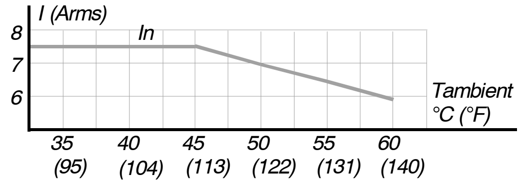
For a switching frequency fc = 8 kHz



ACD / CMC 1.08		
Tamb		In
° C	°F	Arms
35	95	4.0
40	104	4.0
45	113	4.0
50	122	3.7
55	131	3.2
60	140	2.7

FIGURE H3.89

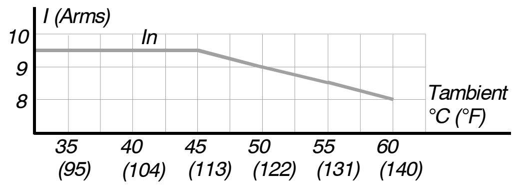
Current derating on "ACD/CMC 1.08" drives for fc = 8 kHz



ACD / CMC 1.15		
Tamb		In
° C	°F	Arms
35	95	7.5
40	104	7.5
45	113	7.5
50	122	6.9
55	131	6.4
60	140	5.9

FIGURE H3.90

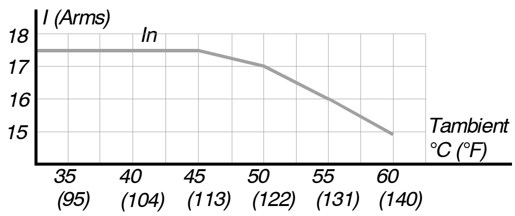
Current derating on "ACD/CMC 1.15" drives for fc = 8 kHz



ACD / CMC 1.25		
Tamb		In
° C	°F	Arms
35	95	9.5
40	104	9.5
45	113	9.5
50	122	9.0
55	131	8.5
60	140	7.9

FIGURE H3.91

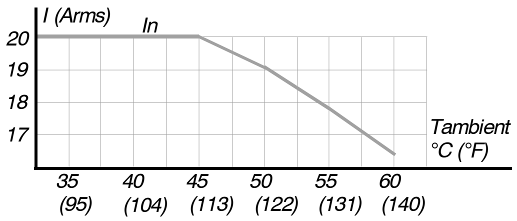
Current derating on "ACD/CMC 1.25" drives for fc = 8 kHz



ACD / CMC 2.35		
Tamb		In
° C	°F	Arms
35	95	17.5
40	104	17.5
45	113	17.5
50	122	17.0
55	131	15.9
60	140	14.9

FIGURE H3.92

Current derating on "ACD/CMC 2.35" drives for fc = 8 kHz



ACD / CMC 2.50		
Tamb		In
° C	°F	Arms
35	95	20.0
40	104	20.0
45	113	20.0
50	122	19.1
55	131	17.8
60	140	16.4

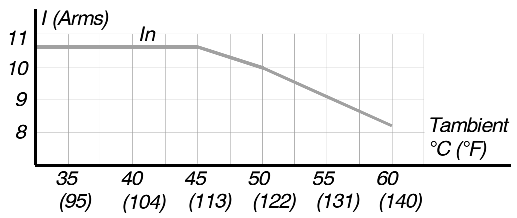
FIGURE H3.93

Current derating on "ACD/CMC 2.50" drives for fc = 8 kHz

Drives for a synchronous or asynchronous motor working as a spindle

The following graphs show the maximum rms current in continuous duty cycle (that is, the rated one) depending on the switching frequency of the power transistors that the drive modules for asynchronous motors can supply in a temperature range between 5°C (41°F) and 60°C (140°F).

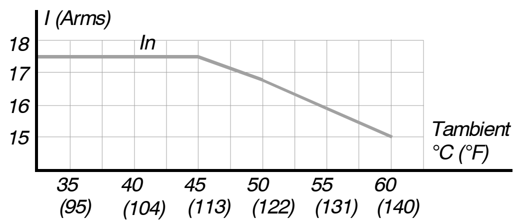
◻ For a switching frequency fc = 4 kHz



SCD 1.15		
Tamb		In
° C	°F	Arms
35	95	10.6
40	104	10.6
45	113	10.6
50	122	9.9
55	131	9.1
60	140	8.2

FIGURE H3.94

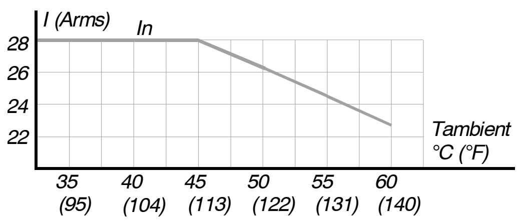
Current derating on "SCD 1.15" drives for fc = 4 kHz



SCD 1.25		
Tamb		In
° C	°F	Arms
35	95	17.5
40	104	17.5
45	113	17.5
50	122	16.8
55	131	15.9
60	140	14.9

FIGURE H3.95

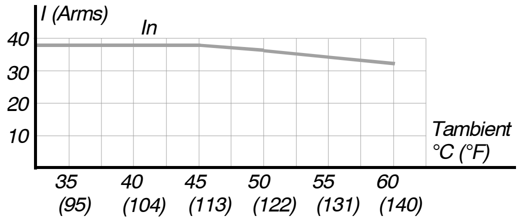
Current derating on "SCD 1.25" drives for fc = 4 kHz



SCD 2.35		
Tamb		In
° C	°F	Arms
35	95	28.0
40	104	28.0
45	113	28.0
50	122	27.2
55	131	24.5
60	140	22.7

FIGURE H3.96

Current derating on "SCD 2.35" drives for fc = 4 kHz

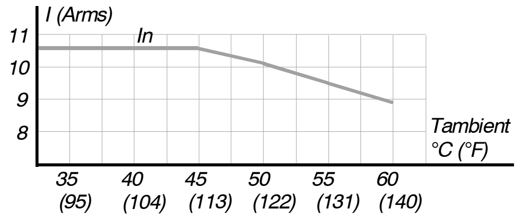


SCD 2.50		
Tamb		In
° C	°F	Arms
35	95	38.0
40	104	38.0
45	113	38.0
50	122	36.3
55	131	34.3
60	140	32.2

FIGURE H3.97

Current derating on "SCD 2.50" drives for fc = 4 kHz

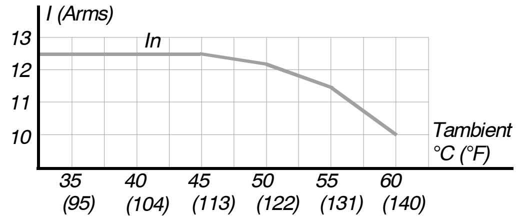
For a switching frequency fc = 8 kHz



SCD 1.15		
Tamb		In
° C	°F	Arms
35	95	10.6
40	104	10.6
45	113	10.6
50	122	10.1
55	131	9.5
60	140	8.9

FIGURE H3.98

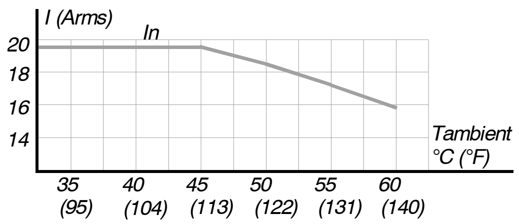
Current derating on "SCD 1.15" drives for fc = 8 kHz.



SCD 1.25		
Tamb		In
° C	°F	Arms
35	95	12.5
40	104	12.5
45	113	12.5
50	122	12.2
55	131	11.4
60	140	10.7

FIGURE H3.99

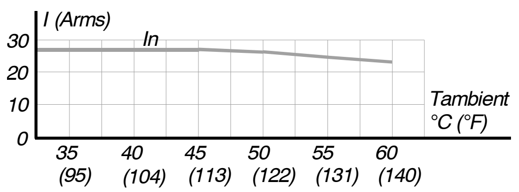
Current derating on "SCD 1.25" drives for fc = 8 kHz.



SCD 2.35		
Tamb		In
° C	°F	Arms
35	95	19.5
40	104	19.5
45	113	19.5
50	122	18.5
55	131	17.2
60	140	15.8

FIGURE H3.100

Current derating on "SCD 2.35" drives for fc = 8 kHz.



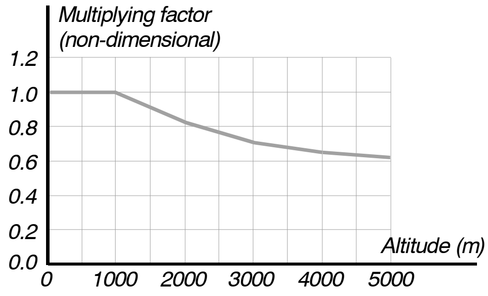
SCD 2.50		
Tamb		In
° C	°F	Arms
35	95	27.0
40	104	27.0
45	113	27.0
50	122	26.3
55	131	24.7
60	140	23.1

FIGURE H3.101

Current derating on "SCD 2.50" drives for fc = 8 kHz.

3.2.4 Power derating

The following graph shows the variation suffered by the output rated power of the compact drive (for all its models) depending on the installation altitude over sea level.



Output rated power ratio	
Altitude meters	Factor non-dimensional
0	1.00
1000	1.00
2000	0.82
3000	0.71
4000	0.65
5000	0.62

FIGURE H3.102

Derating of rated output power depending on the above-sea-level altitude of the installation.

3.2.5 Connector layout

The connectors of each compact drive are described next as well as other elements such as indicator lights, status display and so on that are on the front panel of the unit.

Initially it shows each compact drive model and mentions all its connectors and later on, it analyzes all of them one by one in a single section because most of them are the same for all the models.

ACD/SCD 1.08 / 1.15

These drive modules have the following connectors:

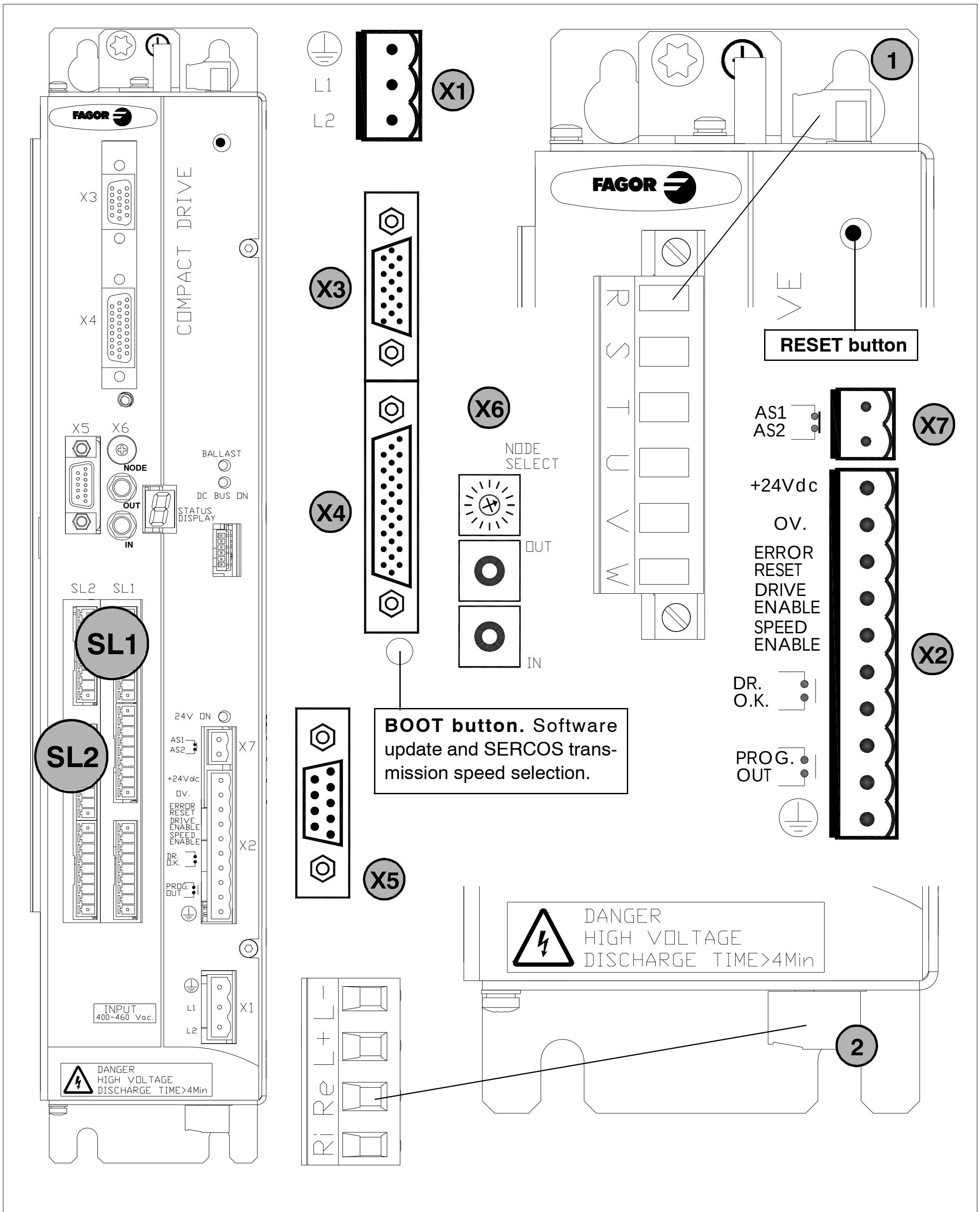


FIGURE H3.103

Connectors of "ACD/SCD 1.08/1.15" compact drives

1. Power connector for motor (U, V, W) and mains connection (R, S,T).
2. Connector for the internal (Ri) or external (Re) Ballast resistor and for accessing the power bus (L+, L-).
X1. Connector for the internal 24 V DC power supply (two phase 400 - 460 V AC).
X2. Connector for the basic control signals.
X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.
X5. Connector for RS-232 serial line connection.
X6. SERCOS interface connector.
X7. Connector for external acknowledgment of the status of the safety relay.
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.
SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

ACD / SCD 1.25

These drive modules have the following connectors:

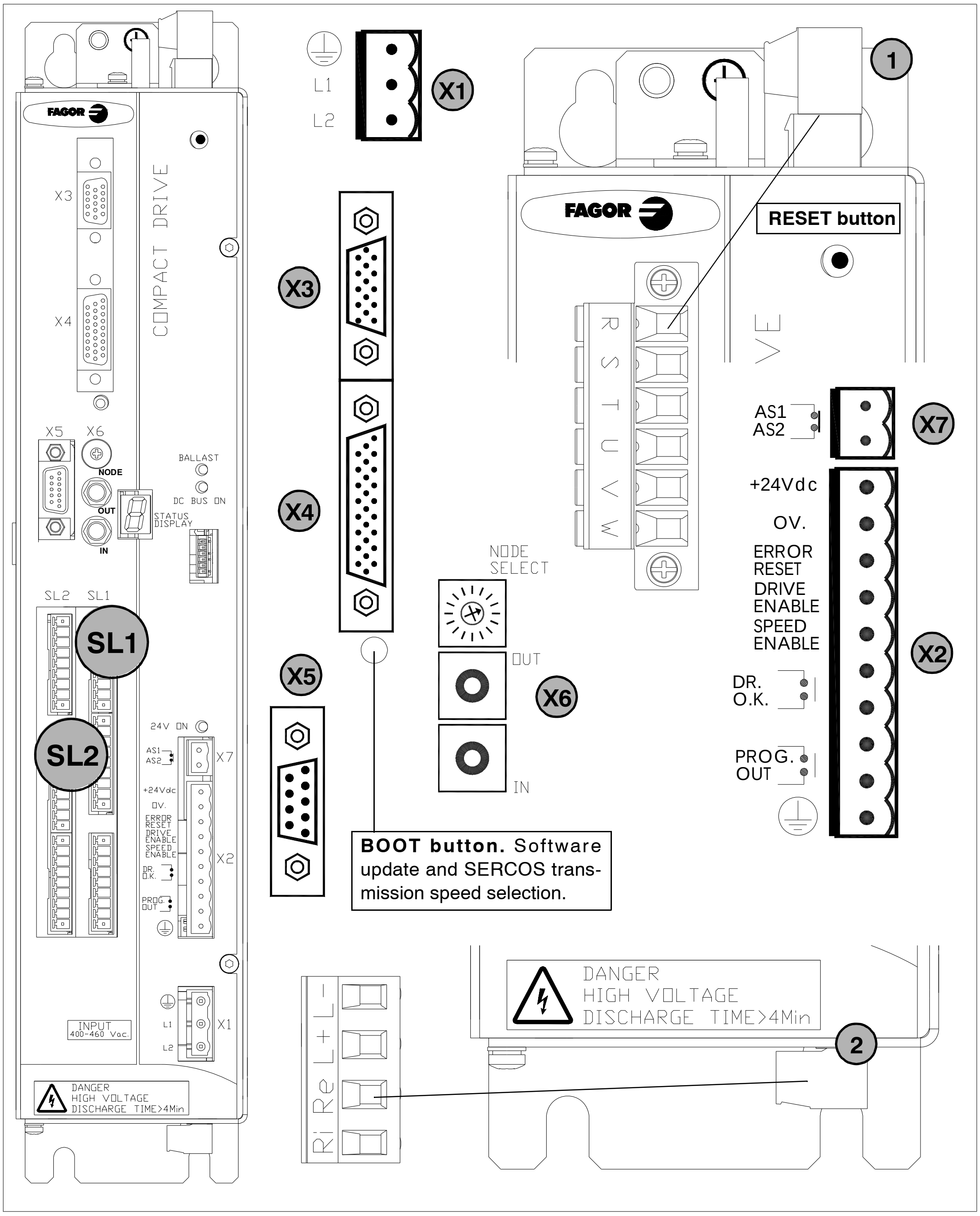


FIGURE H3.104

Connectors of "ACD/SCD 1.25" compact drives

1. Power connector for motor (U, V, W) and mains connection (R, S, T).

2. Connector for the external Ballast resistor (Re) and for accessing the power bus (L+, L-). Remember that (Ri) makes no sense in these drives.

X1. Connector for the internal 24 V DC power supply (two phase 400 - 460 V AC).

X2. Connector for the basic control signals.

X3. Connector with two possible uses:

- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.

X5. Connector for RS-232 serial line connection.

X6. SERCOS interface connector.

X7. Connector for external acknowledgment of the status of the safety relay.

SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.

SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

ACD / SCD 2.35

These drive modules have the following connectors:

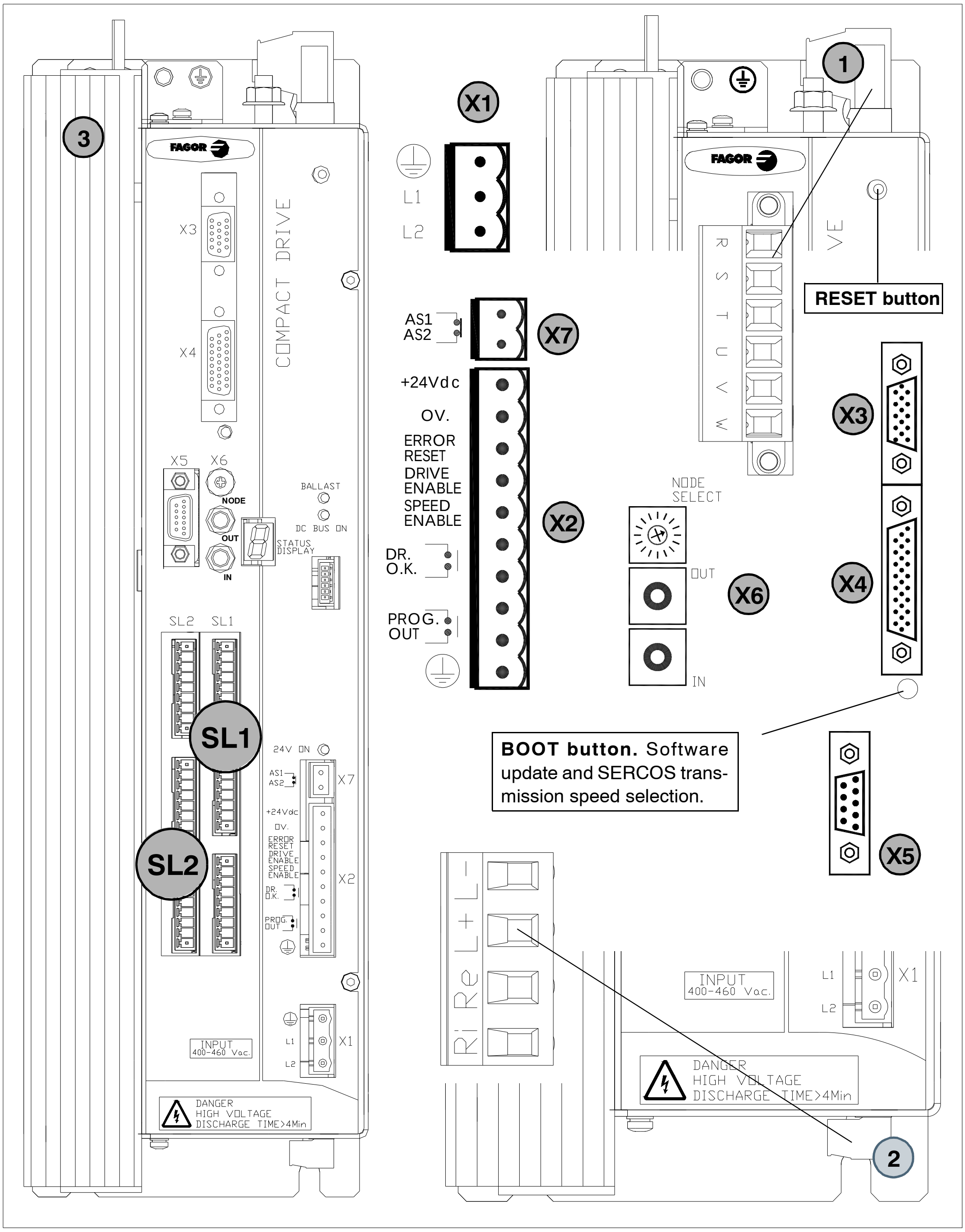


FIGURE H3.105

Connectors of "ACD/SCD 2.35" compact drives

1. Power connector for motor (U, V, W) and mains connection (R, S, T).

2. Connector for the external Ballast resistor (Re) and for accessing the power bus (L+, L-). Remember that (Ri) makes no sense in these drives.

3. External Ballast resistor.

X1. Connector for the internal 24 V DC power supply (two phase 400 - 460 V AC).

X2. Connector for the basic control signals.

X3. Connector with two possible uses:

- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.

X5. Connector for RS-232 serial line connection.

X6. SERCOS interface connector.

X7. Connector for external acknowledgment of the status of the safety relay.

SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.

SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

ACD / SCD 2.50

These drive modules have the following connectors:

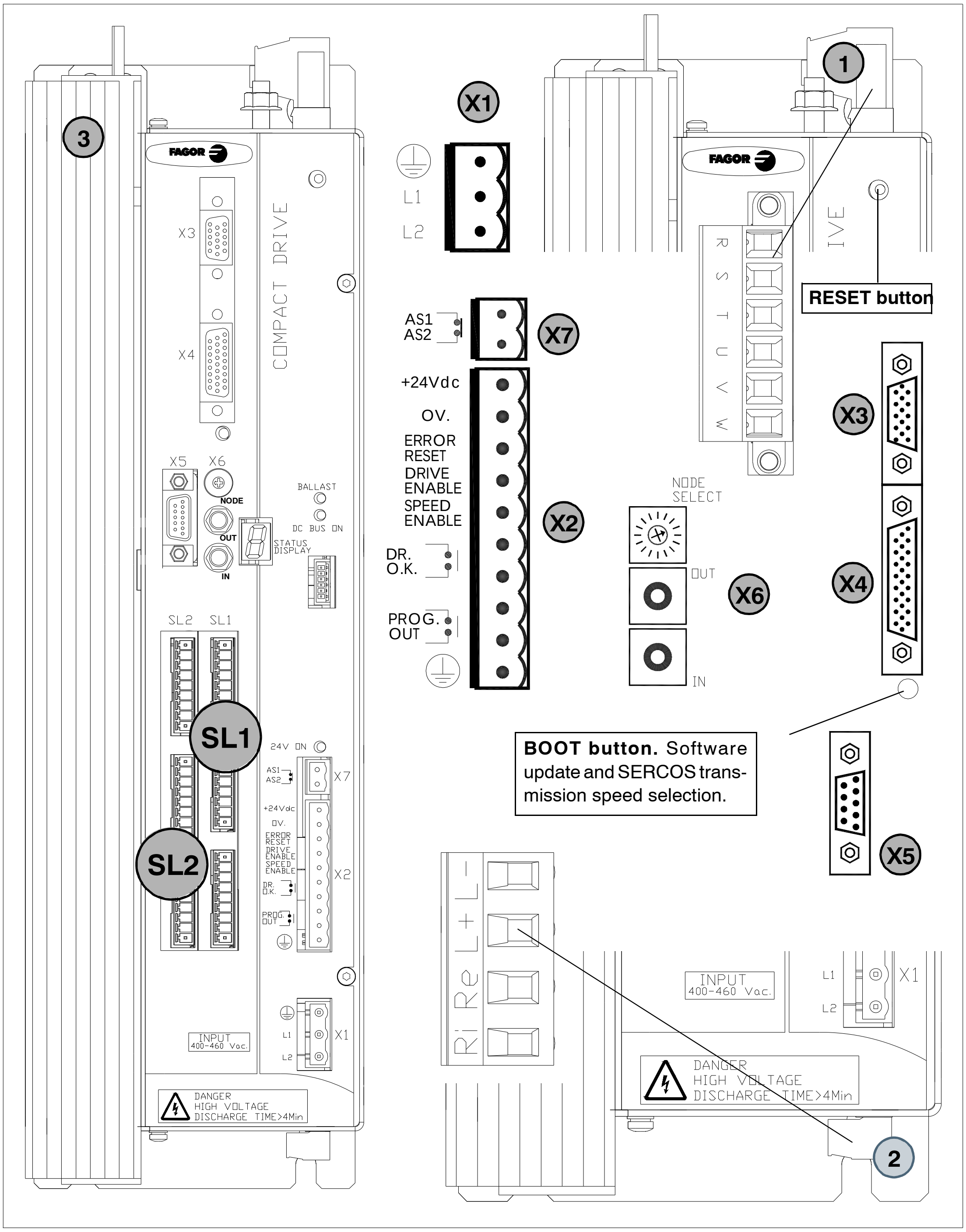


FIGURE H3.106

Connectors of "ACD/SCD 2.50" compact drives.

1. Power connector for motor (U, V, W) and mains connection (R, S, T).

2. Connector for the external Ballast resistor (Re) and for accessing the power bus (L+, L-). Remember that (Ri) makes no sense in these drives.

3. External Ballast resistor.

X1. Connector for the internal 24 V DC power supply (two phase 400 - 460 V AC).

X2. Connector for the basic control signals.

X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.

X5. Connector for RS-232 serial line connection.

X6. SERCOS interface connector.

X7. Connector for external acknowledgment of the status of the safety relay.

SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.

SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

CMC 1.08 / 1.15

These drive modules have the following connectors:

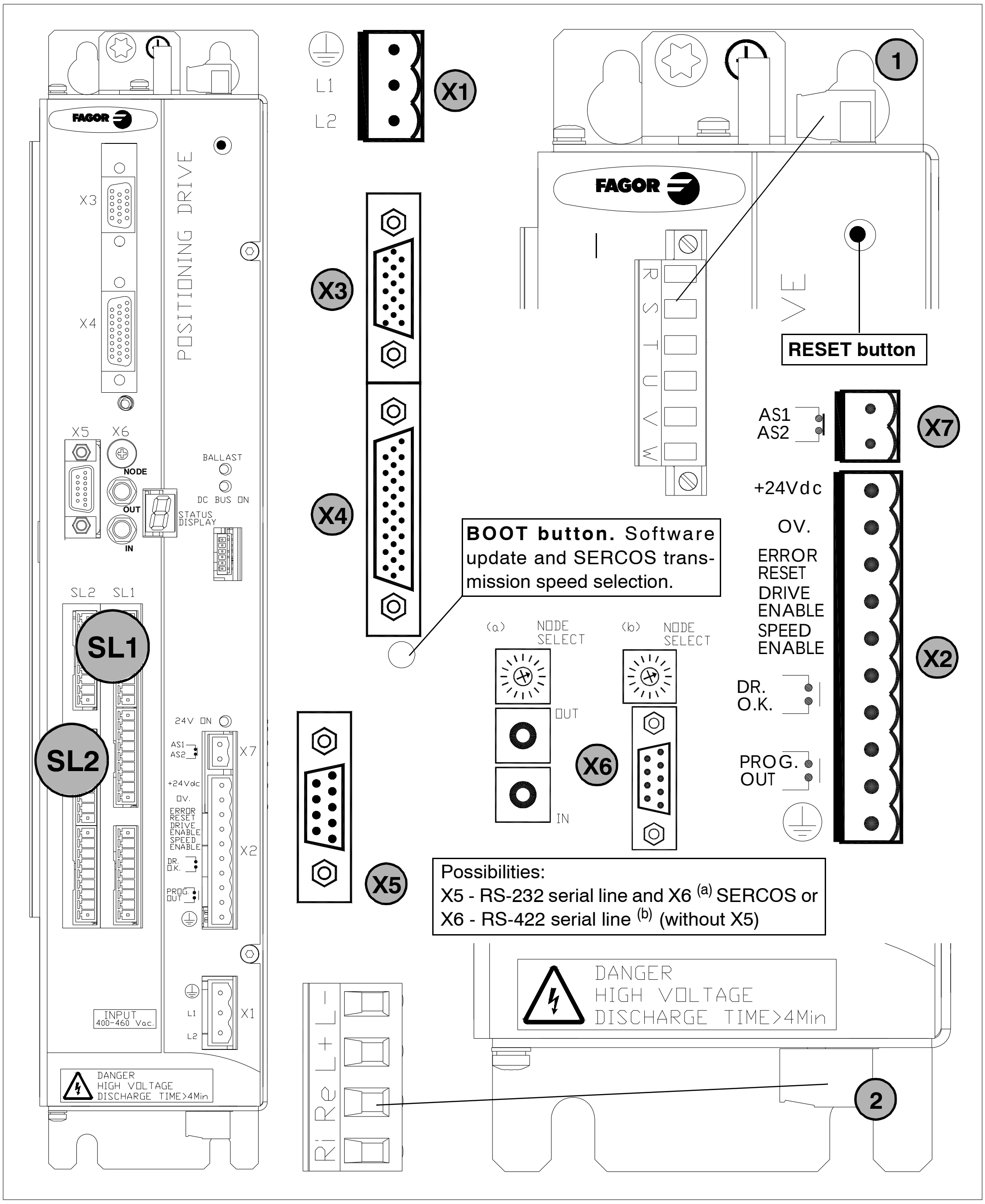


FIGURE H3.107

Connectors of compact drives CMC 1.08/1.15.

1. Power connector for motor (U, V, W) and mains connection (R, S, T).

2. Connector for the internal (Ri) (only on "1.08/1.15" models) or external (Re) Ballast resistor and for accessing the power bus (L+, L-).

X1. Connector for the internal 24 V DC power supply (two phase 400 - 460 V AC).

X2. Connector for the basic control signals.

X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.

X5. Connector for RS-232 serial line connection.

X6. Possible connectors that may be located in this position:
- SERCOS (a) interface connector (always with X5)
- Connector for RS-232/RS-422 (b) serial line connection (never with X5)

X7. Connector for external acknowledgment of the status of the integrated safety relay.

SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.

SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

CMC 1.25

These drive modules have the following connectors:

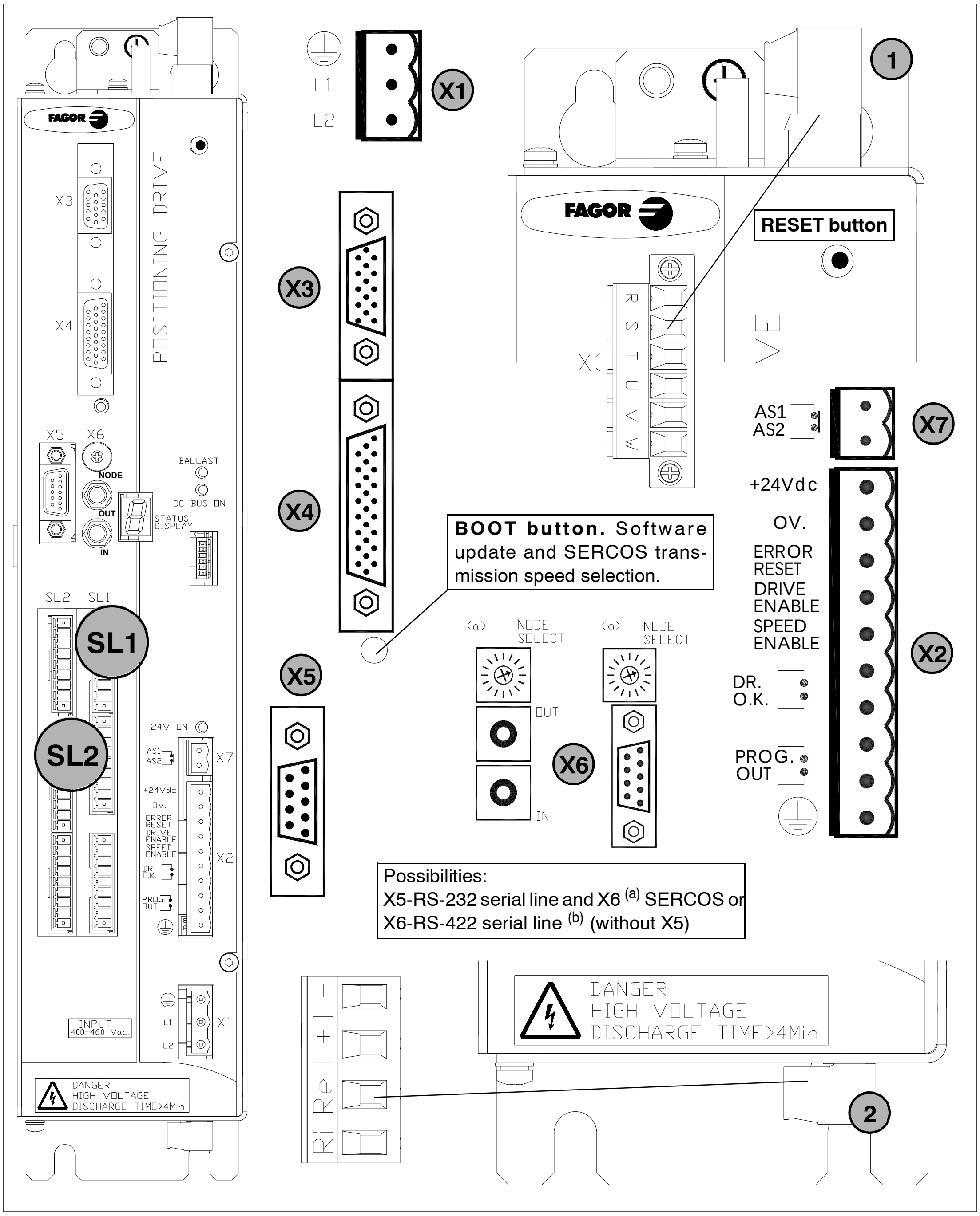


FIGURE H3.108

Connectors of compact drives CMC 1.25.

1. Power connector for motor (U, V, W) and mains connection (R, S, T).

2. Connector for the external Ballast resistor (Re) and for accessing the power bus (L+, L-). Remember that (Ri) makes no sense in these drives.

X1. Connector for the internal 24 V DC power supply (two phase 400 - 460 V AC).

X2. Connector for the basic control signals.

X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.

X5. Connector for RS-232 serial line connection.

X6. Possible connectors that may be located in this position:
- SERCOS (a) interface connector (always with X5)
- Connector for RS-232/RS-422 (b) serial line connection (never with X5)

X7. Connector for external acknowledgment of the status of the safety relay.

SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.

SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

CMC 2.35

These drive modules have the following connectors:

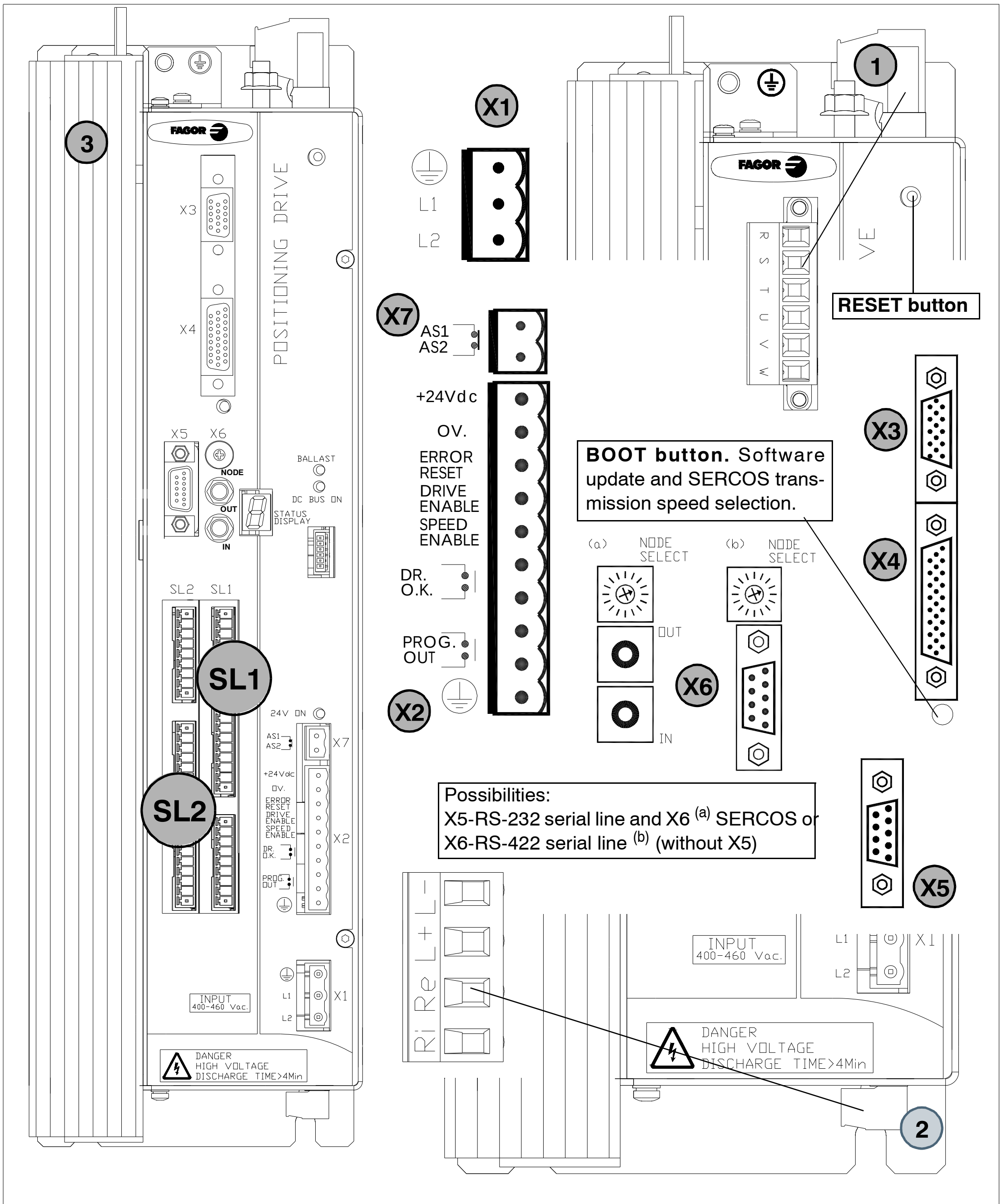


FIGURE H3.109

Connectors of compact drives CMC 2.35.

1. Power connector for motor (U, V, W) and mains connection (R, S, T).

2. Connector for the external Ballast resistor (Re) and for accessing the power bus (L+, L-). Remember that (Ri) makes no sense in these drives.

3. External Ballast resistor.

X1. Connector for the internal 24 V DC power supply (two phase 400 - 460 V AC).

X2. Connector for the basic control signals.

X3. Connector with two possible uses:

- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.

X5. Connector for RS-232 serial line connection.

X6. Possible connectors that may be located in this position:

- SERCOS [a] interface connector (always with X5)
- Connector for RS-232 / RS-422 [b] serial line connection (never with X5)

X7. Connector for external acknowledgment of the status of the safety relay.

SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.

SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

CMC 2.50

These drive modules have the following connectors:

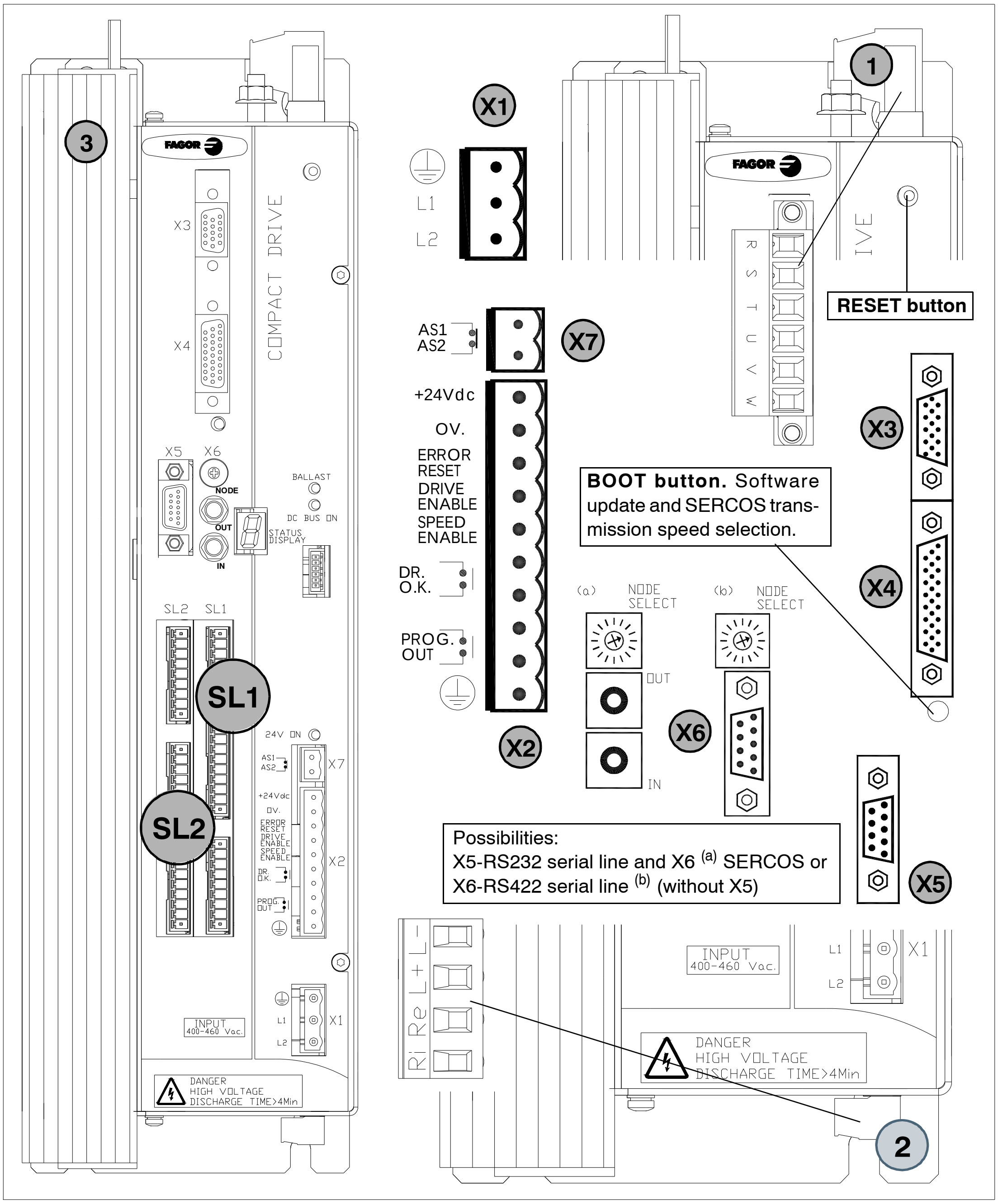


FIGURE H3.110

Connectors of compact drives CMC 2.50.

1. Power connector for motor (U, V, W) and mains connection (R, S, T).

2. Connector for the external Ballast resistor (Re) and for accessing the power bus (L+, L-). Remember that (Ri) makes no sense in these drives.

3. External Ballast resistor.

X1. Connector for the internal 24 V DC power supply (two phase 400 - 460 V AC).

X2. Connector for the basic control signals.

X3. Connector with two possible uses:
- as output of the encoder simulator.
- as input of the direct feedback for the position loop.

X4. Connector for motor feedback connection.

X5. Connector for RS-232/RS-422 serial line connection.

X6. Possible connectors that may be located in this position:
- SERCOS (a) interface connector (always with X5)
- Connector for RS-232/RS-422 (b) serial line connection (never with X5)

X7. Connector for external acknowledgment of the status of the safety relay.

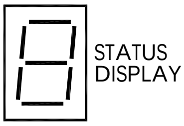
SL1. Slot for the cards A1, 16DI-8DO and 8DI-16DO.

SL2. Slot for the cards 16DI-8DO and 8DI-16DO.

3.2.6 Other elements

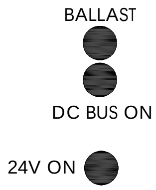
Besides the various connectors, the front panel of the drive has other elements that are mentioned next.

Status display



The status display shows the information on the drive module status or the corresponding code when an error or warning occurs - see the section "turning a drive on" at the end of this chapter -. It can also display the transmission speed when setting it both with SERCOS interface.

Status indicator lamps



The status LED's, when lit, show:

- **BALLAST.** That the Ballast circuit is on
- **DC BUS ON.** That there is power at the bus.
- **24V ON.** There are 24 V DC.

3.2.7 Function of the connectors

Power connectors

The power connectors on top of each drive module are used to connect the drive to mains (R, S and T) and to the motor (U, V and W).

There is another connector at the bottom of the module to connect the Ballast resistor (Ri, Re) and to access the power bus (L+, L-).

Note that the ACD/SCD/CMC 1.25, 2.35 and 2.50 models do not have an internal a Ballast resistor and, therefore, the power bus will not be charged if a (L+, Ri) configuration is used. **Pin Ri has no function in these modules.** Fagor provides the external resistor associated with each module as an accessory with the unit and the configuration will always be (L+, Re).

Note that this connector is only meant for connecting the Ballast resistor. **It must never be used to connect a capacitor module because it could destroy the power module.**

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

The following table shows the values for gap, tightening torque (wire entry holes) and other data regarding the screw-on terminals of the power connectors according to drive model:

TABLE H3.18 Technical data of the terminals of the power connector.

ACD/SCD/CMC	**1.08 1.15**	**1.25**	**2.35**	**2.50**
Connector data				
Nr of poles	6	6	6	6
Gap (mm)	7.62	7.62	10.16	10.16
Min/max tightening torque (Nm)	0.5/0.6	0.7/0.8	1.2/1.5	1.7/1.8
Screw thread	M3	M3	M4	M4
Min./max. section (mm²)	0.2/4	0.2/6	0.75/6	0.75/16
Rated current In (A)	20	41	41	76
Wire data				
Min. section (mm²)	2.5	4	10	16
Length to strip (mm)	7	10	12	12

When connecting the drive module with the motor connect terminal U of the drive module with the terminal corresponding to the U phase of the motor. Proceed the same way with the terminals V-V, W-W and ground-ground. Otherwise, it may not work properly.
The cable hose used must have a metallic shield which must be connected to the ground terminal of the drive and to that of the motor (i.e. at both ends) in compliance with the CE seal.

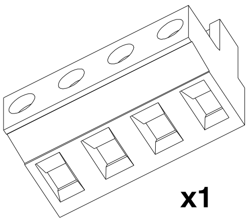
Observe that before handling these terminals, you must proceed as indicated and in the following order:

- Disconnect the mains voltage at the electrical cabinet.
- Wait a few minutes before handling these terminals.

The power supply needs time to decrease the voltage of the power bus down to safe values (< 60 V DC). The green indicator DC BUS ON being turned OFF does not mean that the power bus may be handled or manipulated. The discharge time depends on the number of elements connected and it is about 4 minutes.

The following table shows the values for gap, tightening torque (wire entry holes) and other data regarding the screw-on terminals of the ballast connectors according to drive model:

TABLE H3.19 Technical data of the terminals of the ballast connector.



x1

ACD/SCD/CMC	1.08 1.15	1.25	2.35	2.50
Connector data				
Nr of poles	4	4	4	4
Gap (mm)	7.62	7.62	7.62	7.62
Min/max tightening torque (Nm)	0.5/0.6	0.5/0.6	0.5/0.6	0.5/0.6
Screw thread	M3	M3	M3	M3
Min./max. section (mm^2)	0.2/2.5	0.2/2.5	0.2/2.5	0.2/2.5
Rated current In (A)	12	12	12	12
Wire data				
Min. section (mm^2)	2.5	2.5	2.5	2.5
Length to strip (mm)	7	7	7	7

In "ACD/SCD/CMC 1.08/1.15" models, when connecting an external Ballast resistor, make sure that its Ohm value is the same as that of the internal Ballast resistor. See the table indicating the associated internal resistor. There is no internal Ballast resistor in the rest of the compact modules; therefore, **always** install the external Ballast resistor supplied by Fagor with the unit.

The terminals (Ri, Re and L+) are used to configure the Ballast circuit whose purpose is to dissipate the energy generated while braking the motor.

By jumpering the terminals (Ri and L+), the system is configured so as to work with the internal resistor of the compact drive module; this configuration, as mentioned earlier, can only be set for ACD/SCD/CMC 1.08/1.15 models.

Never configure models ACD / SCD / CMC 1.25, 2.35 and 2.50 with internal Ballast resistor (jumper between Ri and L+). These modules do not have an internal Ballast resistor. If this warning is ignored and a (L+, Ri) configuration is used instead of (L+, Re), either unknowingly or inadvertently, there is no risk of destroying the module, but the power bus will not charge. Remember that pin Ri has no function in these modules.

Up to 45°C (113°F), this resistor dissipates the power indicated in the technical data table. See TABLE H3.17.

All the modules carry a protection against over-temperature which issues an error E301 when reaching 105°C (221°F).

In ACD/SCD/CMC 1.08/1.15 models, the jumper between (Ri and L+) may be removed and an external resistor may be connected between (Re and L+) for dissipating energy.

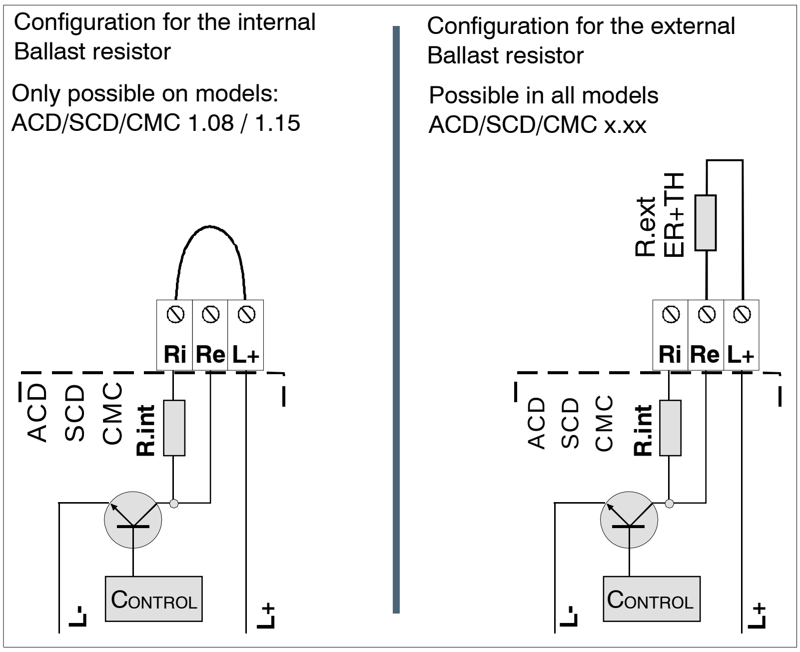


FIGURE H3.111

Ballast resistor configurations.

Connector X1. 24 V DC

Compact drives internally generate the 24 V DC necessary for the internal circuits.

In regular operation, this voltage is obtained from the power bus and from mains when starting up the system.

It is a three-pin Phoenix connector used to supply from mains the necessary start-up energy.

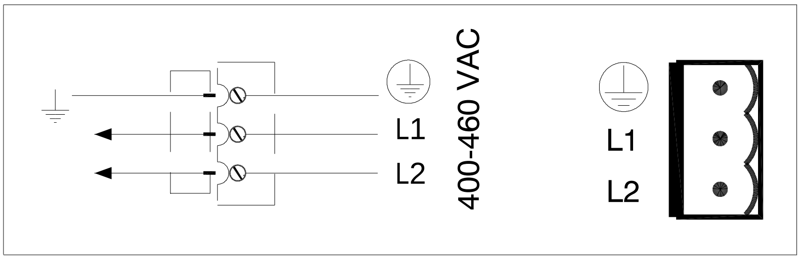


FIGURE H3.112

Connector X1. 24 V DC.

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

Warning. This internal power supply must be powered through connector X1 before carrying out any electrical maneuver.

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.

The following table shows the values for gap, tightening torque (wire entry holes) and other data regarding the screw-on terminals of the plug-in connector for X1 according to drive model:

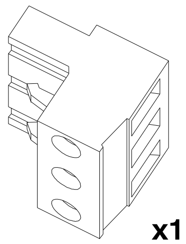


TABLE H3.20 Technical data of the terminals of the plug-in connector for X1.

ACD/SCD/CMC	**1.08 1.15**	**1.25**	**2.35**	**2.50**
Connector data				
Nr of poles	3	3	3	3
Gap (mm)	7.62	7.62	7.62	7.62
Min/max tightening torque (Nm)	0.5/0.6	0.5/0.6	0.5/0.6	0.5/0.6
Screw thread	M3	M3	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5	0.2/2.5	0.2/2.5
Rated current In (A)	12	12	12	12
Wire data				
Min. section (mm²)	2.5	2.5	2.5	2.5
Length to strip (mm)	7	7	7	7

Connector X2. Control

10-pin connector of the compact drive and integrates the functions of the power supply and the modular drive.

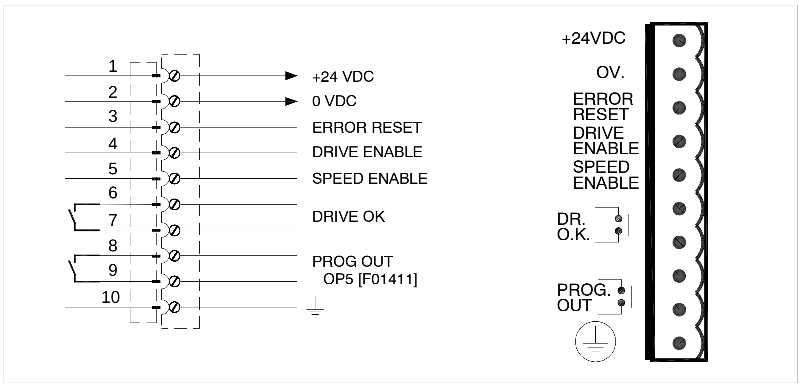


FIGURE H3.113

Connector X2. Control.

The following table shows the values for gap, tightening torque (wire entry holes) and other data regarding the screw-on terminals of the plug-in connector for X2 according to drive model:

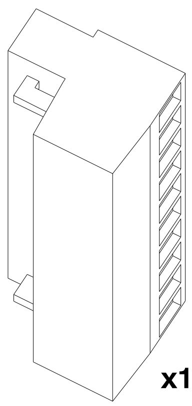


TABLE H3.21 Technical data of the terminals of the plug-in connector for X2.

ACD/SCD/CMC	**1.08 1.15**	**1.25**	**2.35**	**2.50**
Connector data				
Nr of poles	10	10	10	10
Gap (mm)	5.00	5.00	5.00	5.00
Min/max tightening torque (Nm)	0.5/0.6	0.5/0.6	0.5/0.6	0.5/0.6
Screw thread	M3	M3	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5	0.2/2.5	0.2/2.5
Rated current In (A)	12	12	12	12
Wire data				
Min. section (mm²)	2.5	2.5	2.5	2.5
Length to strip (mm)	7	7	7	7

Specific of the power supply

With the Error Reset input (pin 3), it possible to remove the errors at a compact drive. See "resettable errors" of chapter 14 of the "dds-software" manual. Hence, activating this input (24 V DC) eliminates the resettable errors.

If the cause of the error persists, the status display will show the same 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 V DC output for the user.

The maximum output current is 100 mA.

Specific functions of the modular drive

Control signals. With the "Drive Enable" and "Speed Enable" inputs (pins 4 and 5) together with the velocity command, it is possible to govern the motor.

The consumption of these control signals is between 4.7 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.

Other functions

The "Prog. Out" contact (pins 8 and 9) is a user programmable output by means of an internal parameter of the drive. See parameter OP5 in chapter 13 of the "dds-software" manual.

The description of the pins of this connector is:

TABLE H3.22 Description of the pins of connector X2 of the compact drive.

1	+24 V DC (OUT)	Power supply selection	Positive voltage output (24 V DC, 100 mA).
2	0 V. (OUT)		Reference 0 V.
3	ERROR RESET	System error reset input (24 V DC), (4.5 - 7 mA).	
4	DRIVE ENABLE	Control signals	Motor current enable (24 V DC).
5	SPEED ENABLE		Drive speed enable (24 V DC).
6	DR. OK.	Module status contact (open when failure)	
7	DR. OK.		
8	PROG. OUT	Programmable internal contact Limit: 1 A at 24 V DC.	
9	PROG. OUT		
10	CHASSIS	Chassis connection	

Speed Enable and Drive Enable

Normal operating mode

1. Activate the Drive Enable and Speed Enable inputs (24 V DC) in the desired order. Before activating, the Soft Start process (smoothly reaching the power bus voltage) must be over. The motor will have torque only when Drive Enable is active and there is voltage at the power bus. The motor speed will be controlled with a command when the Speed Enable function is active.

i

Activating the Drive Enable function requires to be requested by the system in three different ways. They are: 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 V DC. If any of them is deactivated, the following will happen. See the operation modes in FIGURE H3.114.

Deactivation of the Drive Enable input

The Drive Enable input lets the current circulate through the motor stator windings. When it is powered with 24 V DC the current loop is enabled and the drive can work.

If the Drive Enable input drops to 0 V DC (no voltage), the power circuit is off and the motor will have not torque, hence not being governed and will turn freely until it stops by inertia.

Deactivation of the Speed Enable input

When the Speed Enable input is set to 0 V DC, the internal velocity command switches to 0 rpm and

- **Situation 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.

- **Situation 2**

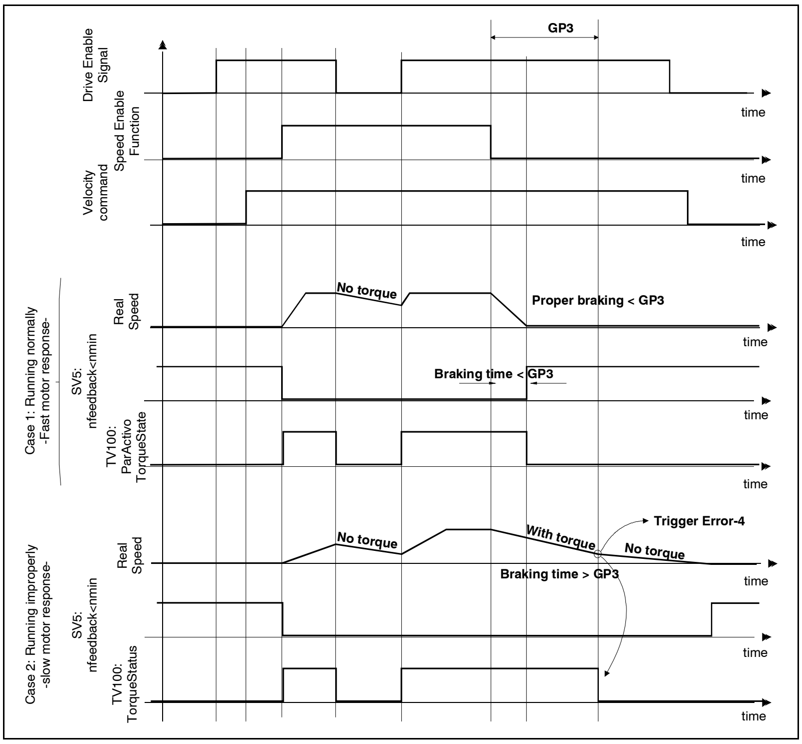


FIGURE H3.114

Operating modes of functions Drive Enable and Speed Enable.

The torque is kept active by braking the motor. When it stops, variable SV5 (S00331) is activated. The motor does not stop in a time period set by parameter GP3 (F00702). The motor stops when its kinetic energy runs out.

See the internal parameter GP3 (F00702) and the internal variable SV5 (S00331) in chapter 13 of the "dds-software" manual that is supplied with this one.

Safety standard (EN 60204-1) requires the drive module to have a software independent input in order to always assure the motor stop of category 0. Software systems complying with the standards EN 954, IEC 61508, IEC 62061 are being accepted recently. See chapter 9, "integrated safety" in this manual.

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 V DC while the motors are braking.

In the case of the compact drive, the 24 V DC at pins 1 and 2 of connector X2 meet this requirement and are appropriate for managing the control signals.

Connector X3

This connector of the compact drive offers two possible configurations:

- Encoder simulator
- Direct feedback

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.

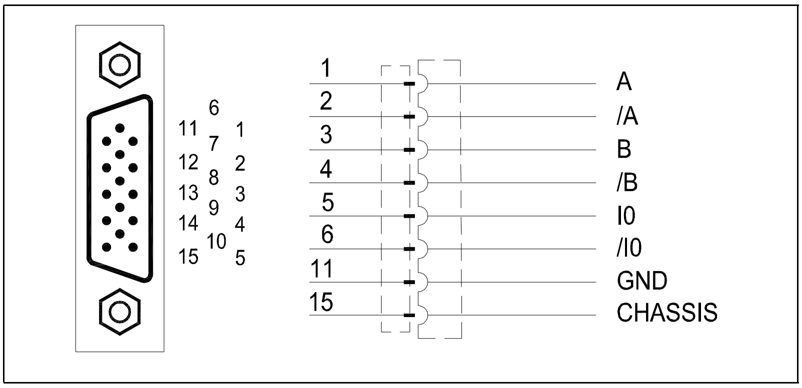


FIGURE H3.115

Connector X3. Encoder simulator.

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 I0 are programmable.

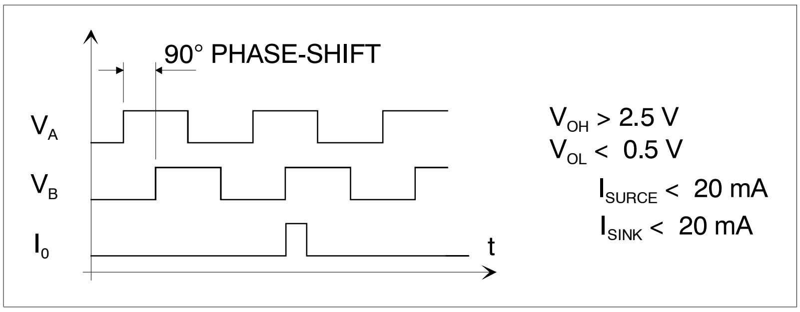


FIGURE H3.116

Connector X3. Pulses per revolution and reference mark position.

X3. Direct feedback

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

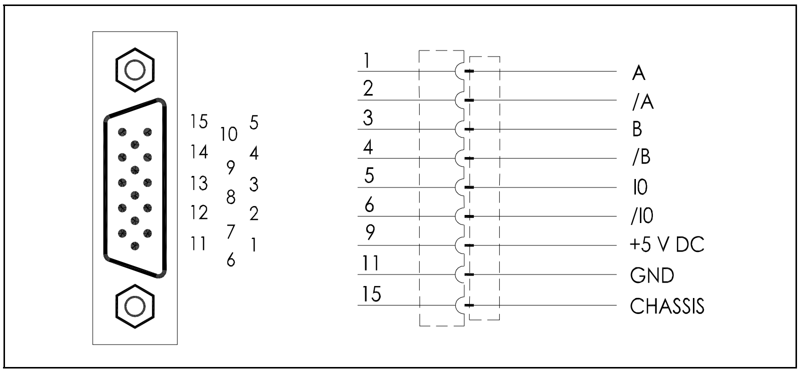


FIGURE H3.117

Connector X3. Direct feedback.

This encoder admits three different types of feedback signals:

- Square TTL signals
- Square differential TTL signals (double-ended).
- 1 Volt peak-to-peak sinusoidal signals (1 Vpp).

It admits the following frequencies:

- 1 MHz with square signals
- 500 kHz with sinusoidal signals

The input impedance for sinusoidal signals is 120 Ω.

Incremental feedback

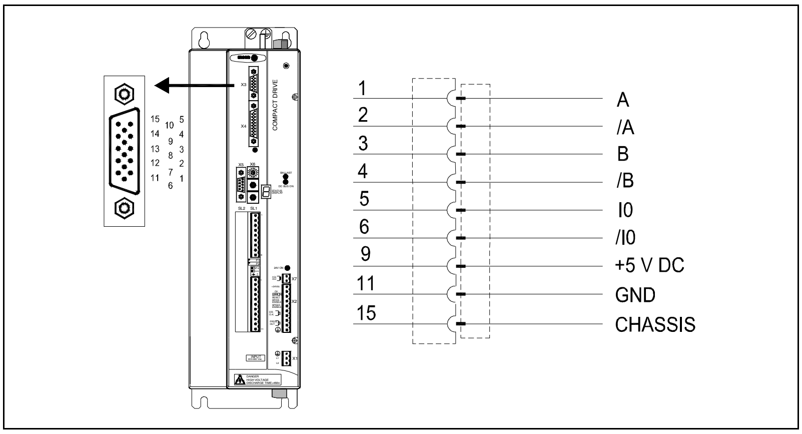


FIGURE H3.118

Connector X3. Incremental direct feedback.

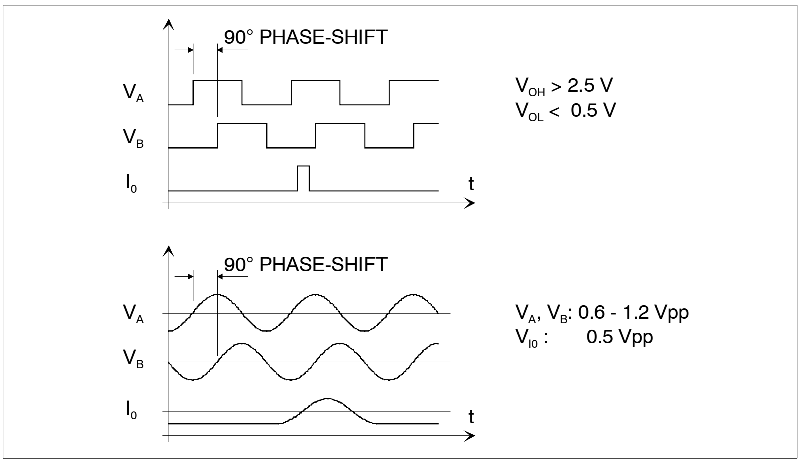


FIGURE H3.119

Characteristics of the TTL and 1Vpp signals.

Absolute feedback (SSI data interface)

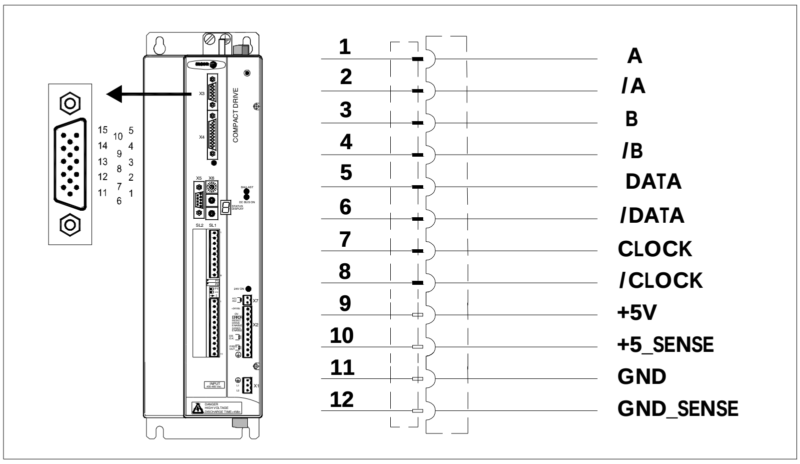


FIGURE H3.120

Connector X3. Absolute direct feedback.

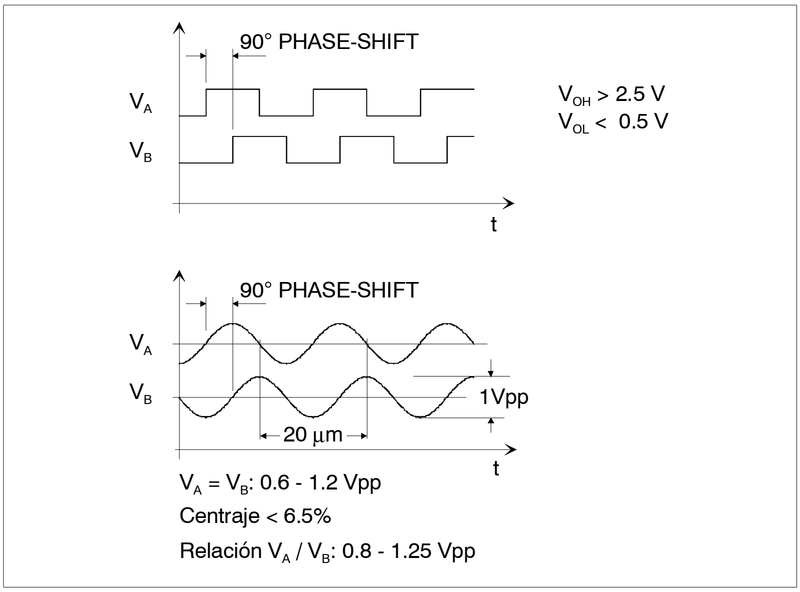


FIGURE H3.121

Characteristics of the TTL and 1Vpp signals.

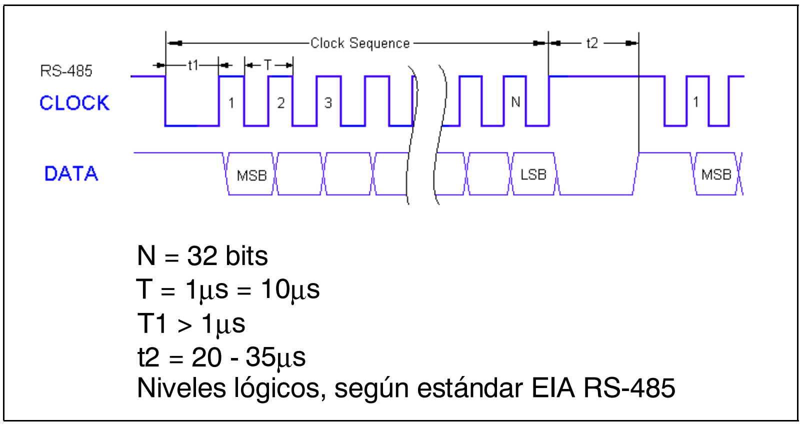


FIGURE H3.122

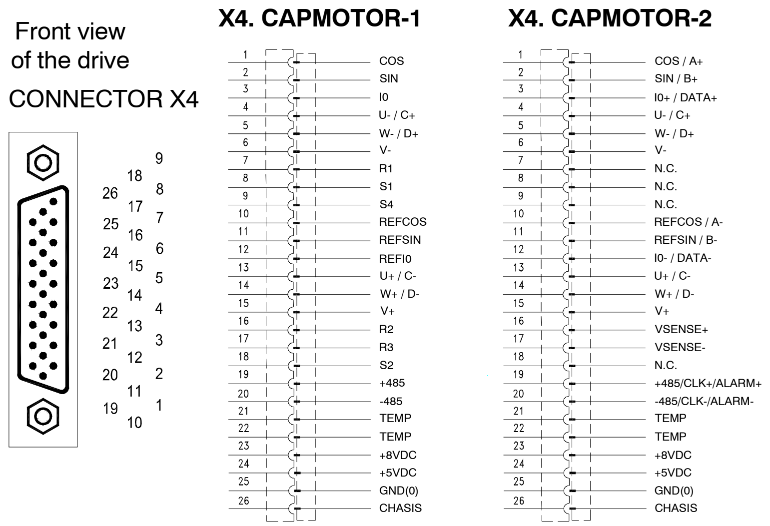
Characteristics of the SSI signals.

Connector X4

X4. Motor feedback

Connector for the motor feedback board that may come on compact drives. It is a high density (HD) 26-pin sub-D type female connector. Through it, the board receives the signals coming from the feedback device attached to the motor shaft.

The pinout of connector X4 depending on whether the motor feedback board installed at the drive is a CAPMOTOR-1 or a CAPMOTOR-2 is:



Notes.

Do not select a drive with CAPMOTOR-2 when the motor feedback is a resolver. They are incompatible. In this case, the drive must always carry a CAPMOTOR-1.

Do not connect an SSI or ENDAT feedback device to connector X4 of the drive of a CAPMOTOR-1 motor feedback board. They are incompatible.

FIGURE H3.123

Connector X4. Feedback on the motor. CAPMOTOR-1 or CAPMOTOR-2

To know whether your drive has a CAPMOTOR-2 installed, check the label on the side of the drive and see if the last field of the sales reference is a B. If not, it will have a CAPMOTOR-1.

The feedback of Fagor motors use sinusoidal encoder, incremental TTL encoder or resolver. Refer to the corresponding motor manual for the detailed description of the pinout of the feedback devices that can go with each motor family.

Connector X5

X5. RS-232 serial line

Connector for the RS-232 serial line board that may come on compact drives. It is a 9-pin male sub-D connector for RS-232 serial connection to a PC in order to set the module configuration parameters and to adjust it.

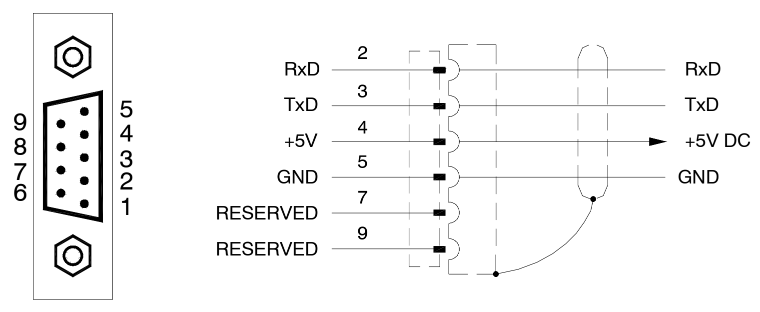


FIGURE H3.124

Connector X5. RS-232 serial line.

3.

DRIVE MODULES
Compact drives

FAGOR

DDS HARDWARE

Ref.1109

The description of the pins of this connector is:

TABLE H3.23 Description of the pins of connector X5.
(*) Reserved pins must not be connected.

1	N. C.	Not connected
2	R x D	Receive data
3	T x D	Transmit data
4	+ 5 V	Supply outputs
5	GND	Reference 0 V
6	N. C.	Not connected
7	N. C.	(*) Reserved
8	N. C.	Not connected
9	N. C.	(*) Reserved
CH	CHASSIS	Cable shield

Connector X6

X6. Communication interface

This connector of the compact drive identified as X6 may be:

- A SERCOS interface connector
- An RS-232 / RS-422 serial line connector (only on CMC drives).

X6. Sercos interface connector

This connector consists of a SERCOS signal receiver and emitter (Honeywell IN, OUT) and may be used to connect the modules of the DDS system with the CNC that governs them. The connection is made through fiber optic lines and it has a ring structure.

It will always come with a node selecting rotary switch (Node Select) that lets identify each drive within the system.

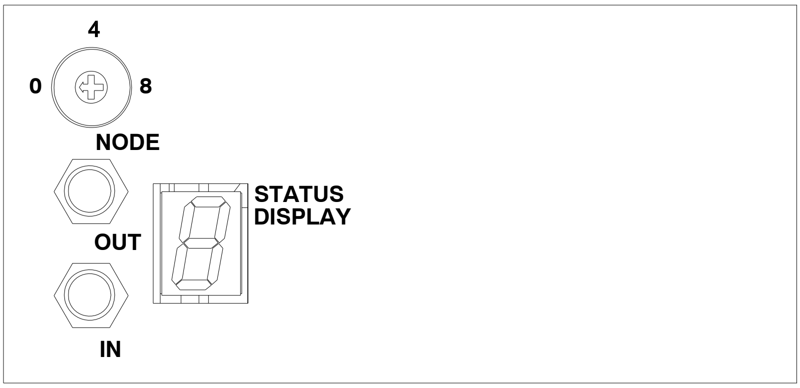


FIGURE H3.125

Honeywell emitter-receiver for SERCOS transmission.

Note that on compact drives ACD, SCD and CMC, this connector will always come with connector X5.

X6. RS-232/RS-422 serial line connector

Note. Only CMC compact drives can have this connector.

It is a 9-pin male sub-D connector for connecting an RS-232/RS-422 serial line with a device acting as master. This device is usually a PC or an ESA video terminal (VT).

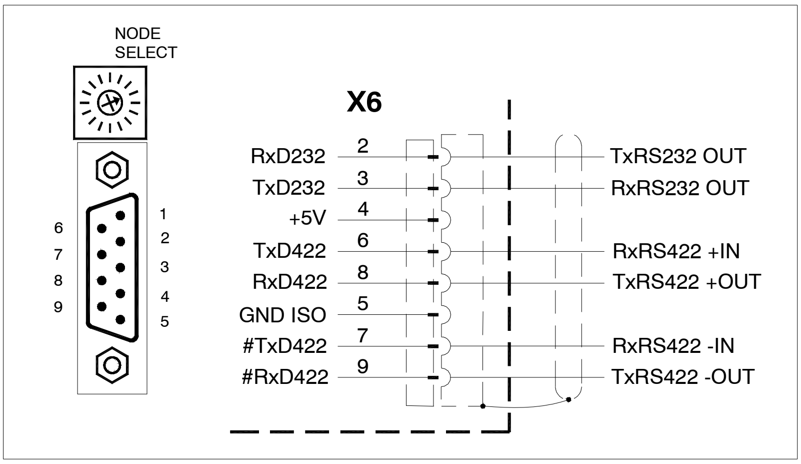


FIGURE H3.126

RS232/RS422 serial line connector X6.

Note that on compact drives, only the CMC models can have this RS232/RS422 connector and only when they do not have the connector X5.

The description of the pins of this connector is:

TABLE H3.24 Description of the pins of the RS-232/RS-422 connector.

1	N.C.	Not connected
2	R x D 232	RS-232 serial line data reception
3	T x D 232	RS-232 serial line data transmission
4	+ 5 V ISO	Supply outputs
5	GND ISO	Reference 0 V
6	T x D 422	RS-422 serial line data transmission
7	#T x D 422	
8	R x D 422	RS-422 serial line data reception
9	#R x D 422	
CH	CHASSIS	Cable shield

Connector X7

X7. Status of the safety relay

Connector X5 of the modular drive associated with the second contact (**NC**, **N**ormally **C**losed) of an internal safety relay (with guided contacts). The status of the relay (initially closed) may be acknowledged through the two pins and a CNC, PLC or control panel, i.e. that the relay has actually opened or closed. These two terminals are identified at the drive as AS1 and AS2. The opening or closing of this relay depends on whether 24 V DC are present or not at pin 2 <DRIVE ENABLE> of control connector X2. For further detail regarding this functionality of this connector, refer to the section "Safe Disable (SD)" in **chapter 9. Safety**, of this manual.

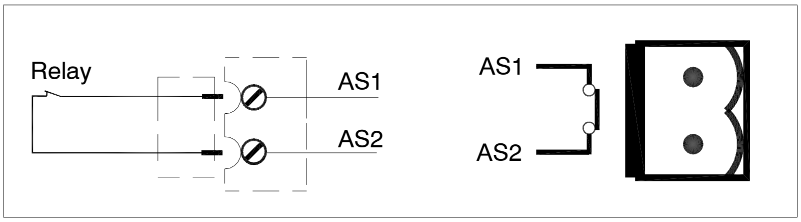


FIGURE H3.127

Connector X7. External acknowledgment of the status of the safety relay.

The following table shows the values for gap, tightening torque, sections and other data of the plug-in connector for X7.

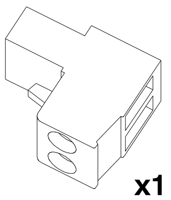


TABLE H3.25 Data of the pins of plug-in connector for X7.

ACD/SCD/CMC	**1.08 1.15**	**1.25**	**2.35**	**2.50**
Connector data				
Nr of poles	2	2	2	2
Gap (mm)	5.00	5.00	5.00	5.00
Min/max tightening torque (Nm)	0.5/0.6	0.5/0.6	0.5/0.6	0.5/0.6
Screw thread	M3	M3	M3	M3
Min./max. section (mm²)	0.2/2.5	0.2/2.5	0.2/2.5	0.2/2.5
Rated current In (A)	12	12	12	12
Wire data				
Min. section (mm²)	2.5	2.5	2.5	2.5
Length to strip (mm)	7	7	7	7

Connectors at slots SL1 and SL2

CARD A1

The A1 card must always be in slot SL1.

X6-DIGITAL I/O, digital inputs and outputs

If offers 4 digital inputs and 4 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. The user may assign to these parameters, internal Boolean type variables that may be used to show the system status via electrical contacts.
See "dds-software" manual.

These assigned Boolean variables are set with the monitor program for PC (WinddsSetup).

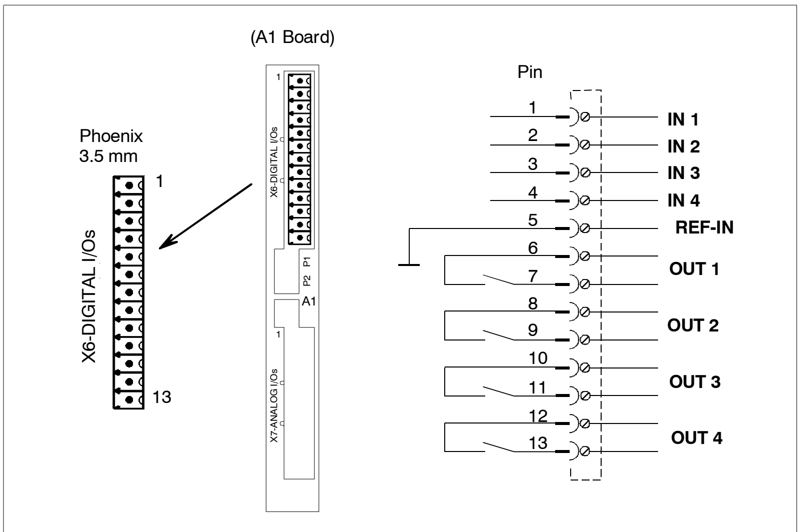


FIGURE H3.128

A1 card: X6-DIGITAL I/Os. Digital inputs and outputs.

Digital inputs characteristics

Maximum rated voltage	24 V DC (36 V DC)
ON / OFF voltage	18 V DC (5 V DC)
Maximum typical consumption	5 mA (7 mA)

Digital outputs characteristics

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

X7-ANALOG I/O, digital inputs and outputs

It offers 2 inputs and 2 outputs , all of them fully programmable.

Each input and output is associated with a parameter.
See "dds-software" manual.

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

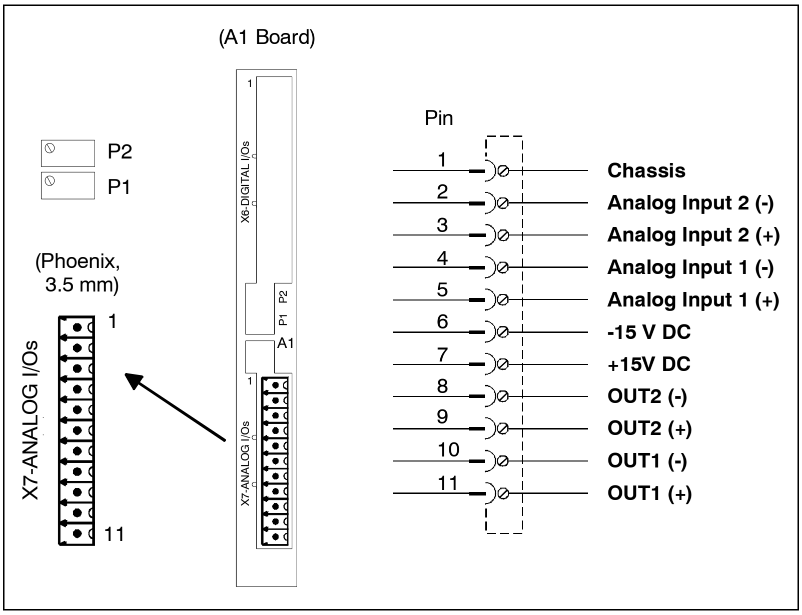


FIGURE H3.129

A1 card: X7- ANALOG I/Os. Analog inputs and outputs.

Pinout

TABLE H3.26 Description of the pins of connector X7-ANALOG I/O. Analog inputs and outputs.

1	Chassis
2	Analog input 2 (-)
3	Analog input 2 (+)
4	Analog input 1 (-)
5	Analog input 1 (+)
6	Adjustment output (-15 V DC) (user)
7	Adjustment output (+15 V DC) (user)
8	Reference for analog output 2 (-)
9	Analog output 2 (+)
10	Reference for analog output 1 (-)
11	Analog output 1 (+)

Analog input 1

Associated with pins 4 and 5. It is the usual input for the velocity command (±10 V DC) generated by the CNC.

Analog input 2

Associated with pins 2 and 3. It is the auxiliary command input.

Analog input characteristics

Resolution		1.22 mV
Input voltage range		±10 V DC
Input over-voltage	Continuous mode	80 V DC
	Transients	250 V DC
Input impedance	With respect to GND	40 kΩ
	Between both inputs	80 kΩ
Voltage in common mode		20 V DC

Dip-Switches (DS1, DS2)

The operator must not change the state of the dip-switches (DS1, DS2) located on the left when looking at the front of the unit.

Adjustment outputs

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 electrical circuit necessary to obtain a reference voltage and the recommended resistance values to obtain an approximate range of ± 10 V DC for the Vref are described next:

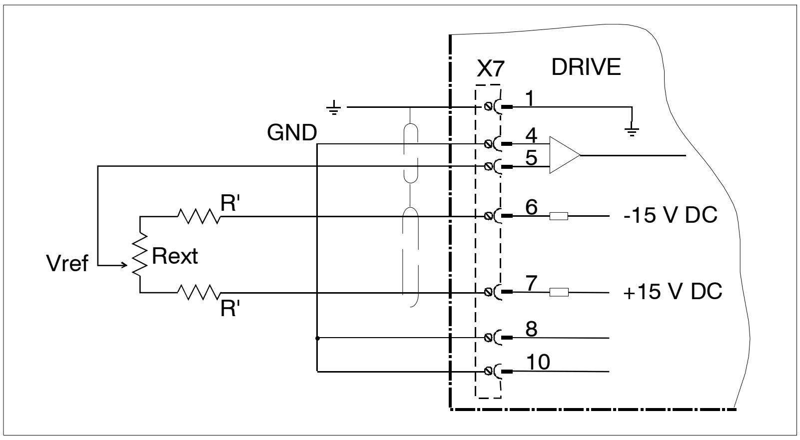


FIGURE H3.130

Adjustment outputs.

Range ±10 V	
Rext.	R'
1 kΩ	0 Ω
5 kΩ	820 Ω
10 kΩ	1.8 kΩ
20 kΩ	3.3 kΩ

Analog outputs

Associated with pins 8-9 and 10-11. These outputs provide an analog voltage indicating the status of the internal system variables. They are especially designed as permanent monitoring of these internal variables and also to be connected to an oscilloscope to make it easier to set the system up.

Note that if the output current is high, the voltage range may decrease.

Analog output characteristics

Resolution	4.88 mV
Voltage range	±10 V DC
Maximum current	±15 mA
Impedance (respect to GND)	112 Ω

CARDS 8DI-16DO and 16DI-8DO

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

- 8DI-16DO offers to the user 8 digital inputs and 16 outputs
- 16DI-8DO offers to the user 16 digital inputs and 8 outputs

X8-DIG.INs, X11-DIG.INs, X12-DIG.INs, digital inputs

They offer 8 fully programmable digital inputs.

The digital inputs are optocoupled and referred to a common point (pin 1) and they admit digital signals at 24 V DC.

Each input is associated with a PLC resource.

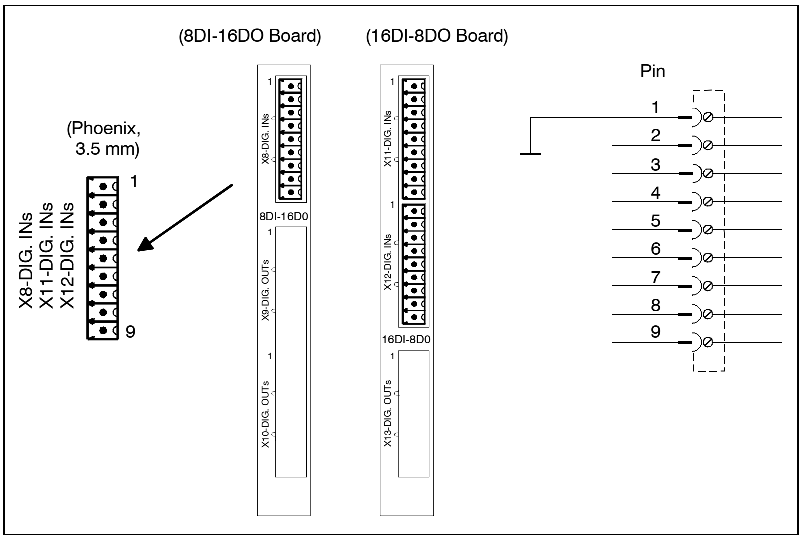


FIGURE H3.131

Cards 8DI-16DO and 16DI-8DO.
X8-DIG. INs, X11-DIG. INs and X12-DIG.INs. Digital inputs.

Characteristics of the digital inputs (at 24 V)

Rated voltage (maximum)	24 V DC (40 V DC)
ON / OFF voltage	12 V DC / 6 V DC
Typical consumption (max)	5 mA (7 mA)

X9-DIG. OUTs, X10-DIG. OUTs, X13-DIG. OUT, digital outputs

They offer 8 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.

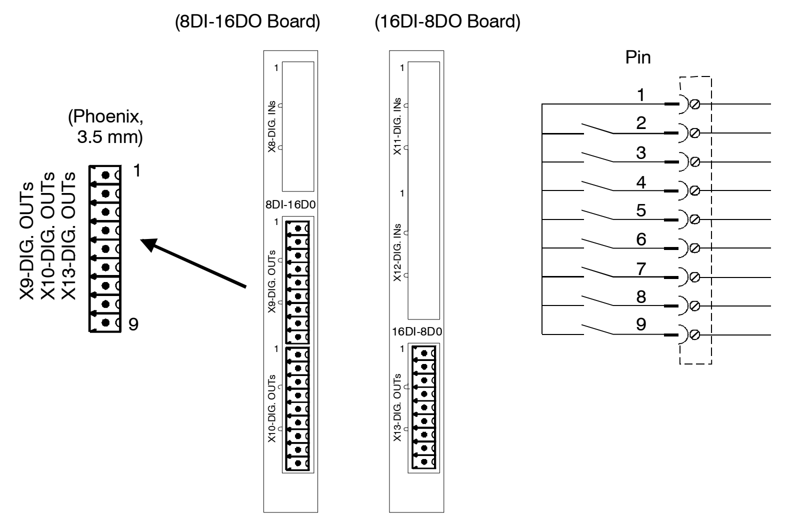


FIGURE H3.132

Cards 8DI-16DO and 16DI-8DO.
X9-DIG.OUTs, X10-DIG.OUTs and X13-DIG.OUTs. Digital outputs.

Digital outputs characteristics

Maximum voltage	250 V
Maximum load current	150 mA
Current autosupply	200 mA
Maximum internal resistance	20 Ω
Galvanic isolation voltage	3750 V (1 min)

Names of the PLC resources

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.

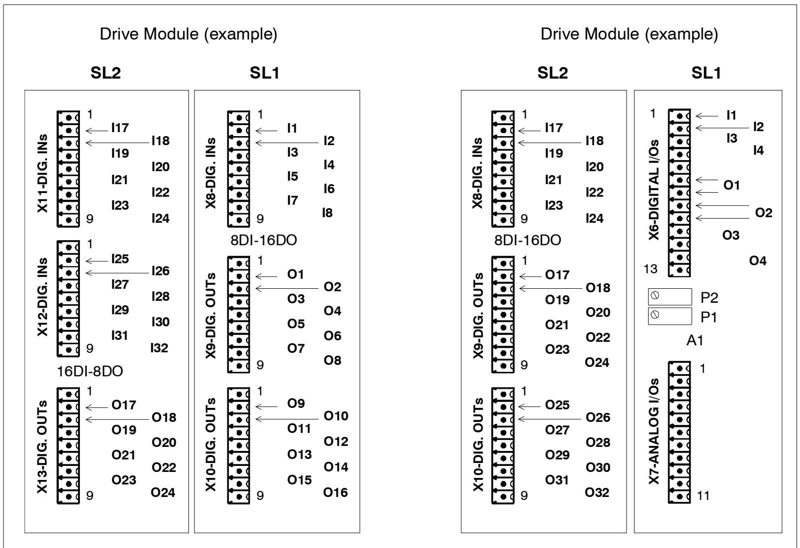


FIGURE H3.133

PLC resources on cards located in SL1 and SL2.

3.3 Turning a drive on

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

1. Initialization stages: they show values of 1, 2, 3 and 4.
2. Software version, after the **r** with the identifying digits.
3. Error listing.
4. Warning listing.
5. Return to step 3.

Stages shown on the 7-segment display:

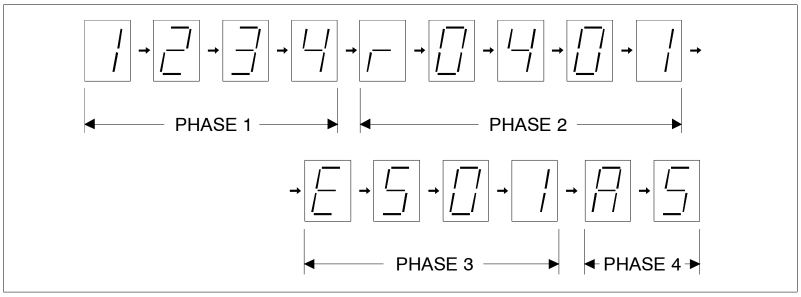


FIGURE H3.134

Module startup stages.

Its purpose is to verify that the startup stages are being executed properly. The information sequences that it is showing in the start-up process have the following meaning:

1. Initialization stage: After the display is turned off, digits 1, 2, 3 and 4 [a] are shown which correspond to the 4 initialization stages. The display then turns back off.

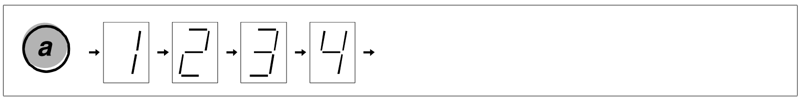


FIGURE H3.135

Initialization stage. STAGE 1.

2. Software version displaying stage: It shows the software version loaded in the module. It first shows the letter r (indicating the version "release"), followed by the version number (digit by digit)[b]. When the drive is active and the axis is being governed, the display will show the zero digit with a blinking dot[c].

   While loading parameters, the display only shows the middle segment[e].

   When the drive (in a system with SERCOS interface) is not in stage 4, i.e. the system communication between the CNC and the modules has not finished initializing and although the light ring is closed, it has not gone up to the next stage, the display shows a smaller fixed zero [d] (not blinking).

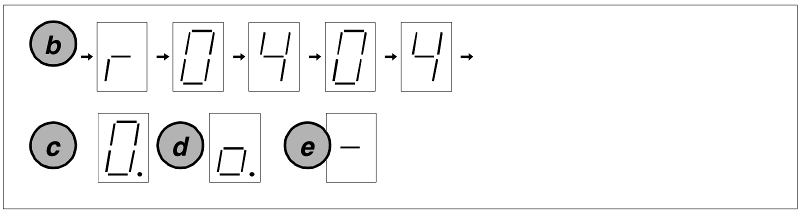


FIGURE H3.136

Stage to display the software version and other indications

If this zero (smaller) is not fixed (blinks) it means that the light ring is not closed (the light does not reach) or there is too much distortion.

This indication permits detecting which section of the optical fiber is causing the problem (or which drive is not sending light).

Hence, the module whose display blinks this smaller zero is the one that is not receiving light at the input.

3. Final stages: They display error messages or warnings on the display when they come up. When the series ends, it begins a new sequence again repeating these messages again.

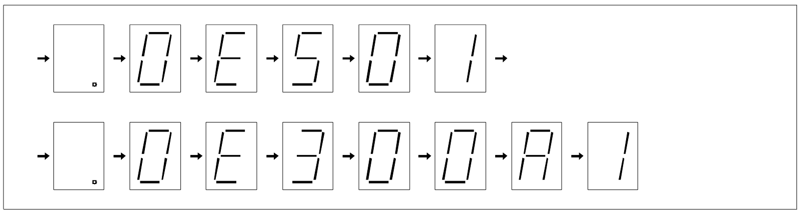


FIGURE H3.137

Final stages. Error and warning displaying STAGES.

See the meaning of errors codes and warnings that may be shown on the display of the drive in chapter **14. Error codes and messages**, of the "dds-software" manual.

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 activated from connector X2 (pin 1) of the power supply module (with modular drives) or from connector X2 (pin 3) of the compact drive.

> **Remember that** there are errors classified as < non-resettable > that cannot be eliminated with this method. These errors can only be eliminated by turning the unit off and back on and only if the cause of the error has been eliminated. See the section "non-resettable errors" in chapter 14 of the "dds-software" manual.

For further information on initialization and error reset, see the corresponding section of this chapter.

> **Remember that** the errors may be disabled from the <error disable> tab of the <Spy> window of the WinddsSetup application. For further detail, see **chapter 16. WinDDSSetup** of the "dds-software" manual.

AUXILIARY MODULES

4

Besides the power supplies and the drive modules that make up the Fagor DDS servo drive system, there is a set of auxiliary modules that are also part of the system and are used to perform a specific function.

Hence, we refer to:

- **Mains filters**

MAINS FILTER ☐☐A

- **Chokes**

Choke XPS-25
Choke XPS-65
Choke RPS-75-3
Choke RPS-45
Choke RPS-20

- **Resistor modules**

External resistors ER+TH-☐/☐ with thermostat
External resistors ER+TH-18/☐+FAN with thermostat and fan

- **Capacitor module**

CM 1.60

- **Auxiliary power supply module**

APS-24

The following sections analyze all of them showing their technical characteristics and other considerations.

4.1 Mains filters

In order to comply with European Directive 2004/108/CE on Electromagnetic Compatibility, it is mandatory to insert a mains filter.

This filter must be connected between the mains and the servo drive system (modular or compact).

Its main purpose is to reduce the conducted disturbances coming from the drive within the levels indicated by that directive mentioned earlier and, at the same time, make it immune to transient burst type over-voltages or voltage pulses.

4.1.1 Mains filters

Technical data

FIGURE H4.1
Mains filters.

TABLE H4.1 Technical characteristics.

MAINS FILTER	42A	130A	180A
Rated voltage	3 phases: 380 V AC - 480 V AC (50/60 Hz)		
Rated current (rating @ 50°C/122°F)	42 A	130 A	180 A
Approximate mass	2.8 kg (6.2 lb)	7.5 kg (16.5 lb)	11 kg (24.2 lb)
Rated leak current	0.50 mA	0.75 mA	0.75 mA
Max. leak current	27 mA	130 mA	130 mA
Power loss	19 W	40 W	61 W
Sealing	IP 20	IP 20	IP 20

TABLE H4.2 Characteristics of the terminals.

MAINS FILTER	42A	130A	180A
Max. tightening torque (Nm)	1.8	8	18
Terminals min./max. section (mm²)	1/6	16/50	35/95

i

Note that this filter must be mounted near the drive.

Chapter **6. POWER LINE CONNECTION** shows the strict rules that must be followed to properly install the mains filters.

Chapter **11. DIMENSIONS** of this manual describes their dimensions.

4.2 Chokes

The chokes (inductances or coils) are used with regenerative power supplies (XPS-25 and XPS-65) and regenerative regulated power supplies (RPS-80, RPS-75, RPS-45 and RPS-20).

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

These three-phase chokes for XPS and RPS power supplies must be connected to the power line input.

On the XPS power supplies, the choke must be connected to power terminals CH1 and CH2 located at the bottom of the module.

RPS power supplies do not have connection terminals at the bottom of the module like at XPS power supplies; therefore, it must be connected to the power line between the MAINS FILTER □□A and the RPS power supply itself. See diagrams in the corresponding chapter of this manual.

The internal switching mechanism of these power supplies generates a regenerative current to mains already filtered by this choke.

Fagor provides the XPS-25 and XPS-65 chokes that must necessarily go with the corresponding XPS power supplies and the RPS-75-3, RPS-45 and RPS-20 chokes that must go with RPS power supplies.

4.2.1 XPS-XX chokes

Technical data

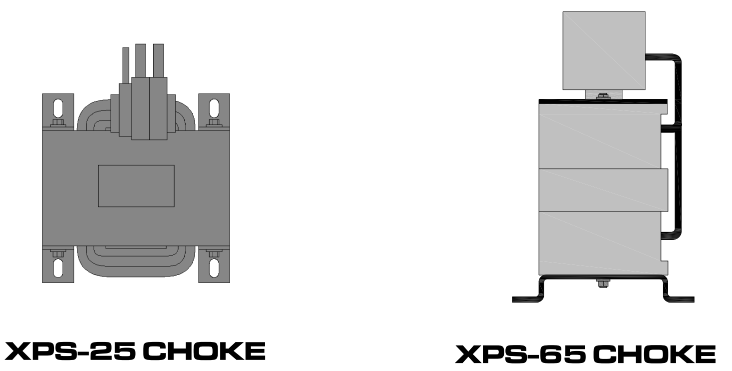


FIGURE H4.2

XPS-XX chokes.

TABLE H4.3 Technical characteristics.

	XPS-25 CHOKE	XPS-65 CHOKE
Inductance (10 kHz)	0.35 mH	0.175 mH
Rated current	50 A	120 A
Peak current	100 A	180 A
Minimum cable section	10 mm²	50 mm²
Approximate weight	8 kg (17.6 lb)	36 kg (79.3 lb)
Operating ambient temperature	5°C to 45°C (41°F to 113°F)	
Storage temperature	-20°C to 60°C (-4°F to 140°F)	
Relative humidity	80% max.	
Operating vibration	0,5 G	
Shipping vibration	2 G	
Sealing	IP 20	

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.

Chapter **6. POWER LINE CONNECTION** shows the strict rules that must be followed to properly install the chokes.

Chapter **11. DIMENSIONS** of this manual describes their dimensions.

4.2.2 RPS-XX chokes

Technical data

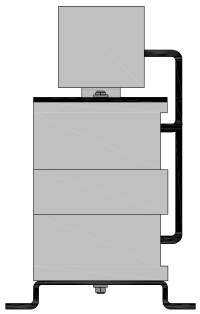


FIGURE H4.3

RPS-XX chokes.

TABLE H4.4 Technical characteristics.

CHOKE	RPS-20	RPS-45	RPS-75-3
Inductance (8 kHz)	0.90 mH	0.40 mH	0.175 mH
Rated current	32 A	72 A	120 A
Max current	50 A	125 A	180 A
Minimum cable section	10 mm²	35 mm²	70 mm²
Approx. mass kg (lb)	12.7 (28.0)	20.4 (44.9)	36.0 (79.3)
Operating ambient temperature	0°C to 60°C (32°F to 140°F)		
Storage temperature	-20°C to 60°C (- 4 °F to 140 °F)		
Relative humidity	< 90 % (non condensing at 45°C / 113°F)		
Operating vibration	0.5 G		
Shipping vibration	2 G		
Sealing	IP 20		

Installing chokes is an absolute must when using RPS-☐☐ regenerative regulated power supplies and they must always be installed between the RPS power supply and the MAINS FILTER ☐☐A). The length of the cable joining each choke with the power supply must never exceed 2 meters and must be shielded.

Chapter **6. POWER LINE CONNECTION** shows the strict rules that must be followed to properly install the chokes.

Chapter **11. DIMENSIONS** of this manual describes their dimensions.

4.3 Resistor modules

The resistor 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.

4.3.1 External resistors, ER+TH-x/x - with thermostat -

The independent resistors ER+TH-☐/☐ are electrical resistors that can also be used with power supplies and compact drives that have a thermostat (some internal and others external).

Technical data

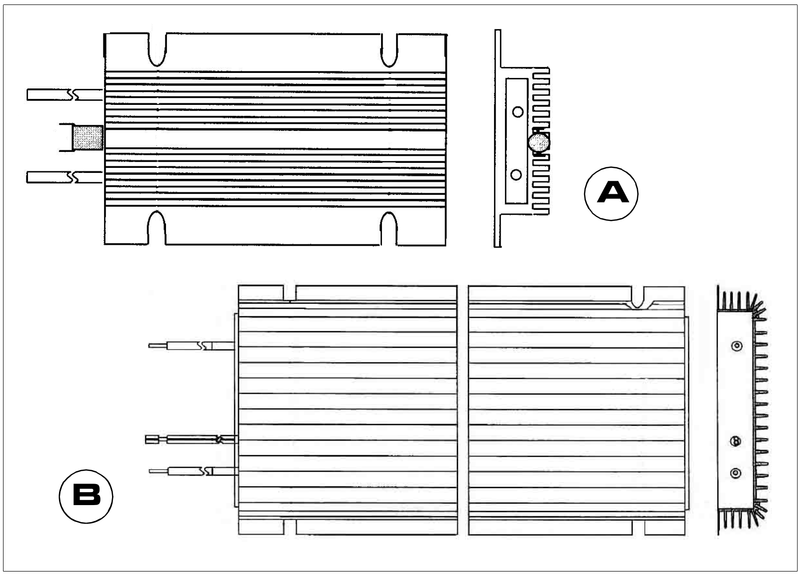


FIGURE H4.4

Braking resistors:
A. with external thermostat, **B.** with internal thermostat.

TABLE H4.5 Technical characteristics.

With external thermostat	ER+TH -24/750	ER+TH -24/1100	ER+TH -18/1100
Resistor	24 Ω	24 Ω	18 Ω
Tolerance	± 5%	± 5%	± 5%
RMS power	650 W	950 W	950 W
Energy absorbed in 5" overloaded	37 kJ	55 kJ	55 kJ
Operating ambient temperature	5°C to 45°C (41°F to 113°F)		
Storage temperature	-20°C to 60°C (-4°F to 140°F)		
Relative humidity	< 90% non condensing at 45 °C / 113 °F		
Operating vibration	0.5 G		
Shipping vibration	2 G		
Sealing degree	IP 55		
Approx. mass gr/lb	920 / 2.02	1250 / 2.75	1250 / 2.75

Note that the value for the rms power depends on the following conditions: Resistor installed vertically with the connection cables at the bottom and separated from the nearest surface at a distance of at least 10 cm (about 4 inches).

Careful with the surface of these resistors. Remember that its temperature may reach 400°C (752°F).

TABLE H4.6 Technical characteristics.

With internal thermostat	ER+TH-18/1800	ER+TH-18/2200
Resistor	18 Ω	18 Ω
Tolerance	± 5%	± 5%
RMS power	1300 W	2000 W
Energy absorbed in 5" overloaded	55 kJ	83 kJ
Operating room temperature	5°C to 45°C (41°F to 113°F)	
Storage temperature	-20°C to 60°C (-4°F to 140°F)	
Relative humidity	< 90% non condensing at 45°C/113°F	
Operating vibration	0.5 G	
Shipping vibration	2 G	
Sealing	IP 54	IP 54
Approx. mass kg/lb	3.0 / 6.61	7.0 / 15.43

Note that the value for the rms power depends on the following conditions: Resistor installed vertically with the connection cables at the bottom and separated from the nearest surface at a distance of at least 10 cm (about 4 inches).

Careful with the surface of these resistors. Remember that its temperature may reach 410°C (770°F).

Thermostats associated with external ballast resistors

All external Ballast resistors currently available come with a thermostat. They are classified as:

With internal thermostat	ER+TH-18/1800, ER+TH-18/2200 ER+TH-18/1000+FAN, ER+TH-18/1500+FAN, ER+TH-18/2000+FAN
With external thermostat	ER+TH-24/750, ER+TH-24/1100, ER+TH-18/1100

Thermostats. Technical characteristics

Internal thermostat	
Contact person	**N**ormally **C**losed
Contact opening temperature	160 °C (320 ºF) ±10%
Rated voltage	250 V AC
Rated current	2 A
Wire section	0.25 mm²

External thermostat	
Protection degree	IP 20
Contact person	**N**ormally **C**losed
Contact opening temperature	200 °C (320 ºF) ±10%
Rated voltage	250 V AC
Rated current	2.5 A
Wire section	0.25 mm²

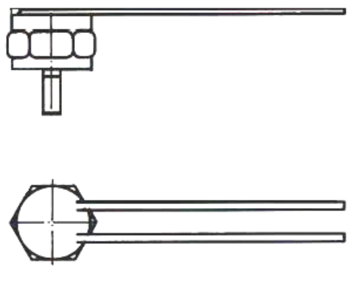


FIGURE H4.5

External thermostat.

Chapter 11. DIMENSIONS of this manual describes their dimensions.

4.3.2 External resistors ER+TH-18/x+FAN

The independent resistors ER+TH-18/☐+FAN are electrical resistors that can also be used with power supplies and compact drives that may be connected to an internal thermostat or carry a single-phase 220 V AC cooling fan.

Technical data

FIGURE H4.6

Braking resistors that may be connected to an external thermostat and with integrated fan.

ER+TH-OO/OOOO+FAN	**18/1000**	**18/1500**	**18/2000**
Resistor	18 Ω	18 Ω	18 Ω
RMS power	2000 W	3000 W	4000 W
Operating room temperature	-10°C / + 40°C (14°F / 104°F)		
Storage temperature	-20°C to 60°C (-4°F to 140°F)		
Relative humidity	< 90% non condensing at 45°C/113°F		
Operating vibration	0.5 G		
Shipping vibration	2 G		
Sealing	IP 20 / IP 65*		
Approx. mass kg/lb	6.0 / 13.2	7.0 / 15.4	8.0 / 17.6

* *To maintain a sealing protection of IP 65, the surface temperature of the resistor must not exceed 200°C / 392°F.*

Careful with the surface of these resistors. Remember that its temperature may exceed 300 °C (572 °F).

Chapter 6. POWER LINE CONNECTION shows the strict rules that must be followed to properly install the resistor modules.

Chapter 11. DIMENSIONS of this manual describes their dimensions.

4.3.3 Ohm value

WARNING. When connecting an external Ballast resistor other than the one shown in the following table, make sure that its Ohm value is the same as that of the internal Ballast resistor of the unit. See the technical characteristics table of the unit in chapter 3 of this manual that indicates the associated internal resistor.

Use the attached table to select the braking resistor for your module with enough rms power to dissipate the energy generated while braking.

ACD/CMC/SCD compact units without NR reference have a particular resistor associated with them; Fagor supplies it in an accessory bag inside the unit package and the user must install it. This is not the case for units with NR reference for which the user must select the appropriate resistor model depending on the energy to be dissipated in the application. Therefore, the latter do not come with the resistor in the accessory bag of the unit and it must be requested separately.

TABLE H4.7 Possible braking resistor combination for the power supplies and the compact modules. Required Ohm values.

PS-25B4	18 Ω	950 W	ER+TH-18/1100
		1.3 kW	ER+TH-18/1800
		2.0 kW	ER+TH-18/2200
		2.0 kW	ER+TH-18/1000+FAN
		3.0 kW	ER+TH-18/1500+FAN
		4.0 kW	ER+TH-18/2000+FAN
XPS-25	18 Ω	950 W	ER+TH-18/1100
		1.3 kW	ER+TH-18/1800
		2.0 kW	ER+TH-18/2200
		2.0 kW	ER+TH-18/1000+FAN
		3.0 kW	ER+TH-18/1500+FAN
		4.0 kW	ER+TH-18/2000+FAN
PS-65A	9 Ω	1.9 kW	2x ER+TH-18/1100 in parallel
		2.6 kW	2x ER+TH-18/1800 in parallel
		4.0 kW	2x ER+TH-18/2200 in parallel
		4.0 kW	2x ER+TH-18/1000+FAN in parallel
		6.0 kW	2x ER+TH-18/1500+FAN in parallel
		8.0 kW	2x ER+TH-18/2000+FAN in parallel
XPS-65	9 Ω	1.9 kW	2x ER+TH-18/1100 in parallel
		2.6 kW	2x ER+TH-18/1800 in parallel
		4.0 kW	E2x R+TH-18/2200 in parallel
		4.0 kW	2x ER+TH-18/1000+FAN in parallel
		6.0 kW	2x ER+TH-18/1500+FAN in parallel
		8.0 kW	2x ER+TH-18/2000+FAN in parallel
ACD 1.15	43 Ω	300 W	Internal R.
CMC 1.15	43 Ω	300 W	Internal R.
SCD 1.15	43 Ω	300 W	Internal R. or external ER+TH-43/350 (with external thermostat)
ACD 1.25	24 Ω	250 W	24Ω 550 W *
CMC 1.25	24 Ω	250 W	24Ω 550 W *
SCD 1.25	24 Ω	650 W	24Ω 750 W * with external thermostat
SCD 1.25...NR	24 Ω	950 W	ER+TH-24/1100
ACD 2.35	18 Ω	450 W	18Ω 900 W *
CMC 2.35	18 Ω	450 W	18Ω 900 W *
SCD 2.35	18 Ω	1.3 kW	18Ω 1800 W * with internal thermostat

TABLE H4.7 Possible braking resistor combination for the power supplies and the compact modules. Required Ohm values.

SCD 2.35...NR	18 Ω	2.0 kW	ER+TH-18/2200
		2.0 kW	ER+TH-18/1000+FAN
		3.0 kW	ER+TH-18/1500+FAN
		4.0 kW	ER+TH-18/2000+FAN
ACD 2.50	18 Ω	450 W	18Ω 900 W *
CMC 2.50	18 Ω	450 W	18Ω 900W *
SCD 2.50	18 Ω	1.3 kW	18Ω 1800 W * with internal thermostat
SCD 2.50...NR	18 Ω	2.0 kW	ER+TH-18/2200
		2.0 kW	ER+TH-18/1000+FAN
		3.0 kW	ER+TH-18/1500+FAN
		4.0 kW	ER+TH-18/2000+FAN

***** Fagor supplies the resistors indicated with an asterisk (see shaded rows) as accessories with the unit. The rest of them are supplied only upon request.

4.4 Capacitor module

This module stores the energy returned while the motors are braking.

The capacitor module should also be used when having systems that sporadically request high current peaks from the power bus hence increasing the bus' own capacity.

From the energy point of view, installing the capacitor module is more profitable than the resistor module.

4.4.1 Capacitor module, CM 1.60

Module that must be connected in parallel to the power DC bus. Fagor supplies with each module two plates for connecting them to the DC bus.

Technical data

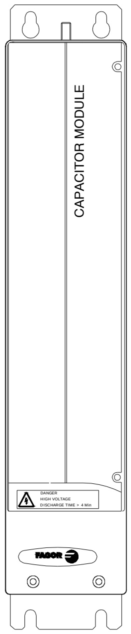


FIGURE H4.7

Capacitor module CM 1.60.

TABLE H4.8 Technical characteristics.

Capacitor module	**CM 1.60**
Capacity	4 mF
Maximum voltage at the bus	797 V DC
Operating ambient temperature	5°C to 45°C (41°F to 113°F)
Storage temperature	- 20°C to + 60°C (- 4°F to 140°F)
Relative humidity	< 90% (non condensing at 45°C/11°F)
Operating vibration	0.5 G
Shipping vibration	2 G
Sealing	IP 2x
Approx. mass kg/lb	6.0 / 13.2

Chapter **6. POWER LINE CONNECTION** shows the strict rules that must be followed to properly install the capacitor modules.

Chapter **11. DIMENSIONS** of this manual describes their dimensions.

4.5 Auxiliary power supply module

The main purpose of the auxiliary power supply module APS-24 is to generate 24 V DC for the control circuits of the drive modules and of the power supplies that do not integrate the auxiliary power supply (i.e. PS-65A). This voltage is supplied through three identical connectors (X2, X3 and X4) connected in parallel that may be accessed from the face of the module. Includes protections against over-current and over-voltage both at the input and at the output.

There is no need to use these power supplies for compact drives, regenerative power supplies (XPS-25, XPS-65, RPS-20, RPS-45, RPS-75 and RPS-80) and the non-regenerative power supply PS-25B4. They all integrate an auxiliary power supply already with these features. However, an auxiliary power supply may be installed next to the units mentioned here when the required consumption exceeds what the integrated auxiliary power supply can provide.

Hence, for example, when there are too many axes connected to the DC bus, there will be too many control circuits, fans etc. to supply power to. In that case, install an external auxiliary power supply that can provide all the required power.

4.5.1 Auxiliary power supply module, APS-24

Technical data

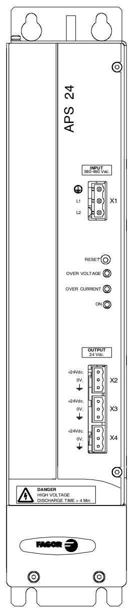


FIGURE H4.8

Auxiliary power supply module, APS-24.

TABLE H4.9 Technical characteristics

Auxiliary pow. supply module	**APS-24**
Output voltage, max. current	24 V DC (5%), 10 A
Input voltage	400-10% a 460+10% V AC, 50/60 Hz
Mains consumption	0,72 A (400 V AC), 0,63 A (460 V AC)
Max. Inrush current	23.9 A (460 V AC)
Bus consumption	0.48 A (565 V DC), 0.44 A (650 V DC)
Max. voltage at the bus	790 V DC
Operating ambient temperature	5°C to 45°C (41°F to 113°F)
Storage temperature	- 20°C to + 60°C (- 4°F to 140°F)
Relative humidity	< 90% non condensing at 45°C/113°F
Operating vibration	0.5 G
Shipping vibration	2 G
Sealing	IP 2x
Approx. mass	4.3 kg (9.4 lb)

In case of micro-surges or total mains power outage, this module guarantees the stability of the 24 V DC to feed the control circuits of the drive modules connected to the bus and maintain it for as long as the emergency stop of the motors lasts, thus stopping the axes in a controlled manner.

Note. See chapter **13. COMPATIBILITY** for the references of the compatible APS-24 power supplies with the XPS or RPS power supplies in case it is installed.

Block diagram

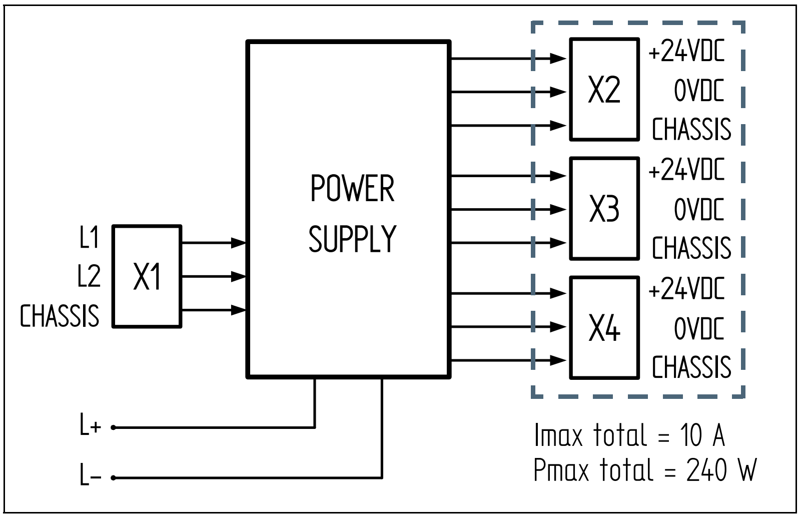
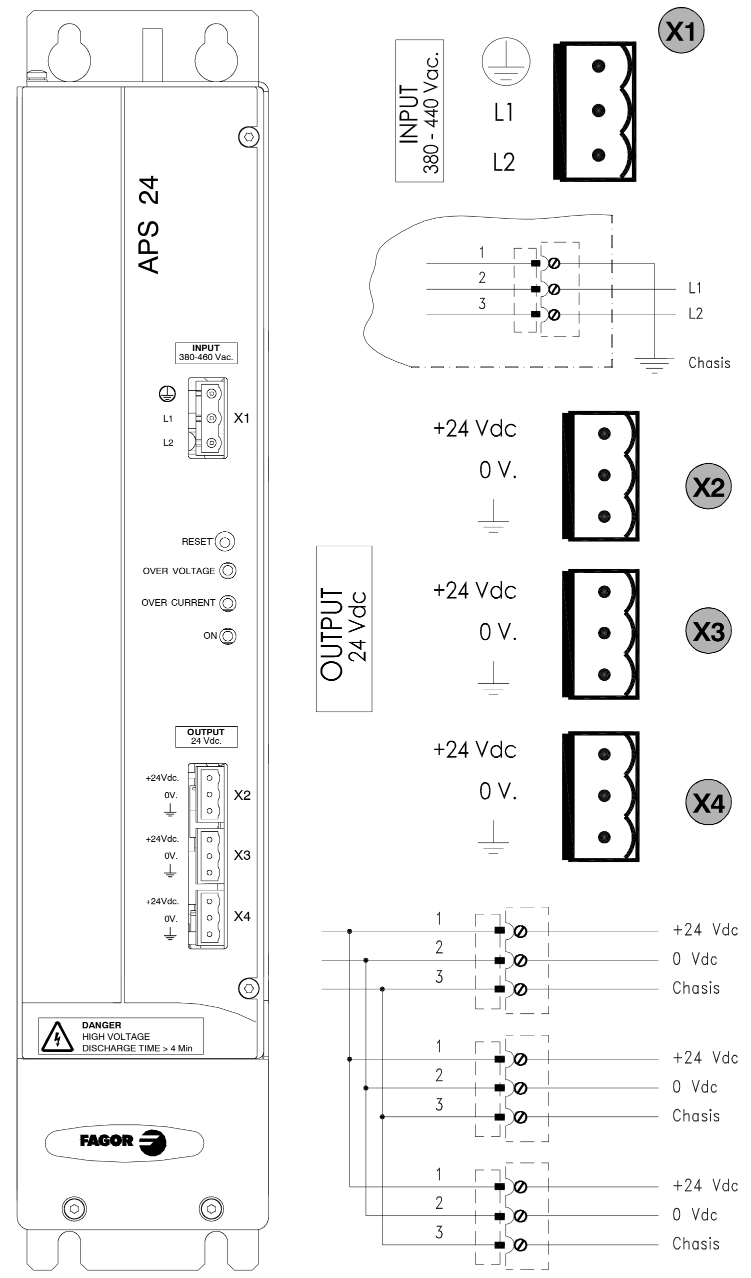


FIGURE H4.9

Block diagram of the auxiliary power supply APS-24.

Connectors

The auxiliary power supply APS-24 has the following connectors:



Imax total = 10 A
Pmax total = 240 W

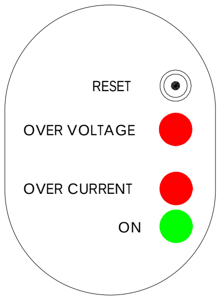
Note. The maximum current of 10 A is the total current that the power supply can provide as the sum of all the currents that may be supplied through the three 24 V DC connectors; in other words, it can provide a maximum total power of 240 W (all of them together), but not through each one.

FIGURE H4.10

Connectors of the APS-24 power supply.

X1. Input connector to feed the auxiliary power supply from mains. It admits a voltage between 400 V AC and 460 V AC.
X2. Output connector of the auxiliary power supply offering 24 V DC.
X3. Output connector of the auxiliary power supply offering 24 V DC.
X4. Output connector of the auxiliary power supply offering 24 V DC.

Status indicator lamps



The auxiliary power supply APS-24 has the following indicator lights that inform about its running status.

- **OVER VOLTAGE.** Red LED. Output over-voltage. It has exceeded 28 V DC and interrupts its operation.
- **OVER CURRENT.** Red LED. Output over-current. The power supply has exceeded 10 A and its output voltage is less than 24 V DC.
- **ON.** Green LED. It is working fine.
- **RESET.** When the power supply quits working due to over-voltage, the RESET button may be used to restart the system.

Other considerations

This APS-24 power supply is to be used to supply to the electrical control circuits and signals to run the drive.

Warning. This module must never be used to supply power to the brake of a motor !

The brake may generate voltage peaks that could damage the unit.

Chapter 6. POWER LINE CONNECTION shows the strict rules that must be followed to properly install the auxiliary power supply.

Chapter 11. DIMENSIONS of this manual describes their dimensions.

SELECTING CRITERIA 5

5.1 Selection of the synchronous motor and its associated drive

5.1.1 First motor pre-selection

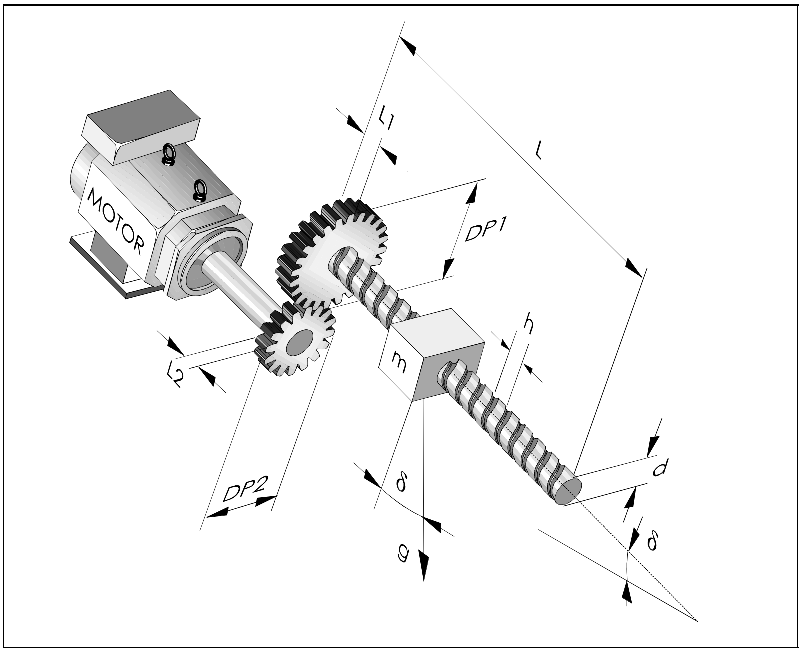


FIGURE H5.1

General diagram of a MOTOR - LEADSCREW - TABLE system.

The motor selection will depend on the mechanical and dynamic response characteristics that it must satisfy. Hence, the motor must meet the specifications on torque (Nm), speed, duty cycles or other kind of requirements of the motor to be moved.

Calculation of the necessary motor torque (M)

The required total motor torque $\mathbf{M_T}$ has two components:

- The static torque $\mathbf{M_S}$ to maintain the table at a constant speed or fixed in a position.
- The acceleration torque $\mathbf{M_A}$ to change its speed.

The reduction in the motor ballscrew transmission **[i]** is a factor to be considered in many of the following calculations:

$$M_T = M_S + M_A \qquad i = \frac{DP1}{DP2}$$

$$M_{TOTAL} = M_{CONTINUOUS} + M_{ACCELERATION}$$

- The continuous torque M_S:

$$M_S = M_F + M_W + M_C$$
$$M_{CONTINUOUS} = M_{FRICTION} + M_{WEIGHT} + M_{CUTTING}$$

is due to:

- the friction between table with its ways and with the ballscrew M_F,
- the weight of the table when not moving horizontally M_W,
- the cutting force of the tool M_C.

- Friction torque M_F:

$$M_F = [M_{F-TABLE} + M_{F-BALLSCREW}] \cdot \frac{1}{i} = \left[\frac{m \cdot g \cdot \mu \cdot h}{2\pi} + \frac{d}{10}\right] \cdot \frac{1}{i}$$

where:

M_F Torque due to friction in N·m.
m Table mass in kg.
d Leadscrew diameter in m.
g Gravitational acceleration, 9.81 in m/s².
h Leadscrew pitch per turn in m.
μ 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 the weight of the table M_W:

When the table does not move horizontally, but at an angle δ like in **FIGURE H5.1** the torque due to the weight of the table must also be considered.

$$M_W = \left[\frac{m \cdot g \cdot \sin\delta \cdot h}{2\pi}\right] \cdot \frac{\%}{i}$$

M_W Torque due to the weight of the table in N·m.
δ Inclination angle of the ballscrew with respect to the horizontal axis.
% Table weight 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 due 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:

$$M_C = \left[\frac{F \cdot g \cdot h}{2\pi}\right] \cdot \frac{1}{i}$$

M_C Torque due to the cutting force of the tool in N·m.
F Cutting force of the tool in kg-force.
g Gravitational acceleration, 9.81 in m/s².

Motor speed calculation (rev/min)

The machine will need a maximum speed **(rev/min motor)** in a linear movement of the table. Therefore, the motor must have a maximum speed of:

$$RPM_{motor} = \left[\frac{V_{max}}{h}\right] \cdot i$$

V_{max} is the maximum linear speed the table needs.

Select in the characteristics table of Fagor synchronous motors - see AC Servo drive manual. FXM and FKM - a motor having:

- 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.

5.1.2 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.

Total inertia (from now on **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 may be divided 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 (pulley 1). 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 (pulley 2) is not affected by the **i** factor.

$$J_{LOAD} = \frac{J_{TABLE} + J_{BALLSCREW} + J_{PULLEY1} + J_{COMPENSATION}}{i^2} + J_{PULLEY2}$$

The inertia of each element is:

$$J_{TABLE} = m \cdot \left[\frac{h}{2\pi}\right]^2 \qquad J_{BALLSCREW} = \frac{d^4 \cdot L \cdot \pi \cdot \alpha}{32}$$

$$J_{PULLEY1} = \frac{D_{p1}^4 \cdot L_1 \cdot \pi \cdot \alpha}{32} \qquad J_{PULLEY2} = \frac{D_{p2}^4 \cdot L_2 \cdot \pi \cdot \alpha}{32}$$

The resulting inertia will be in kg·m².

L Leadscrew length in m.

L_1 Width of pulley 1 in m.

L_2 Width of pulley 2 in m.

D_{p1} Diameter of pulley 1 in m.

D_{p2} Diameter of pulley 2 in m.

α Material density:

7700 kg/m³ for iron/steel

2700 kg/m³ for aluminum

i, h are data used earlier.

See previous sections.

The inertia of the motor J_{MOTOR} is:

$$J_{MOTOR} = J_{ROTOR} + J_{BRAKE}$$

this data may be obtained from the characteristics table of the corresponding motor manual.

Verify that in the characteristics table the rotor of the motor chosen in the 1st selection has an inertia J_{MOTOR} that meets the following condition:

$$J_{MOTOR} \geq [J_{LOAD} / K]$$

where **k** is a factor whose value depends on the application given to the motor.

The ideal will be to obtain a $J_{MOTOR} = J_{LOAD}$.

For a positioning axis, the typical value of "K" will be between 1 and 3.

Note that if this requisite is not met, a new motor must be selected which meets the conditions of the 1st selection and the 2nd one.

5.1.3 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.

The required acceleration is determined by the acceleration time t_{AC} which is the time estimated for the motor to reach its rated speed from zero rpm.

$$M_{ACCELERACION} = J_{TOTAL} \cdot \frac{2\pi \cdot n_N}{60 \cdot t_{AC}}$$

n_N Rated motor speed .

t_{AC} The time it takes the motor to go from 0 rpm to the rated speed.

Taking the value of t_{AC} from the equation:

$$t_{AC} = J_{TOTAL} \cdot \frac{2\pi \cdot n_N}{60 \cdot M_{ACCELERACION}}$$

Calculation of the needed rms torque M_{RMS}

The third and last motor selection requires a new data, the RMS torque.

$$M_{RMS} = \sqrt{(M_F + M_W + M_{AC})^2 \cdot \frac{t_{AC}}{T} + (M_F + M_W)^2 \cdot \frac{t_p}{T} + (M_F + M_W + M_C)^2 \cdot \frac{t_C}{T}}$$

where:

t_{AC} acceleration time.

tp tool positioning time.

tc Cutting time in a machine cycle.

5.

SELECTING CRITERIA

Selection of the synchronous motor and its associated drive

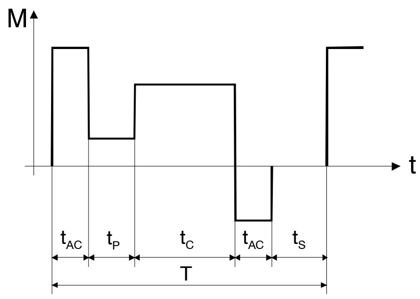
FAGOR

DDS HARDWARE

Ref.1109

The typical values for t_{AC}, t_p and t_C in machine tool cycle are:

$$\frac{t_C}{T} = 0.6 \qquad \frac{t_P}{T} = 0.4 \qquad \frac{t_{AC}}{T} \cong 0$$



Calculation of the motor peak torque M_{PEAK}

The required maximum torque is the sum of the friction, weight and acceleration torque.

$$M_{MAX} = M_F + M_W + M_{AC}$$

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:

$$M_{PEAK} \geq M_{MAX}$$

Rated torque equal to or greater than the calculated RMS value:

$$M_{RATED} \geq M_{RMS}$$

Summary of the three pre-selections

- Maximum speed equal to or greater than calculated value in RPM $_{motor}$
- Stall torque equal to or greater than calculate 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}

5.1.4 Drive selection

Once the motor has been selected, check the electrical characteristics table in the FXM and FKM AC servomotors manual.

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.

5.2 Asynchronous spindle motor and servo drive selection

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.

5.2.1 Power demanded from a motor for a particular load

To determine the needed motor power, use the following formula:

$$P_{MOTOR} > P_{LOAD} + P_{ACCEL/DECEL}$$

The power of the motor must be greater than the sum of the power required by the load and the power required by the machine's accelerations and decelerations.

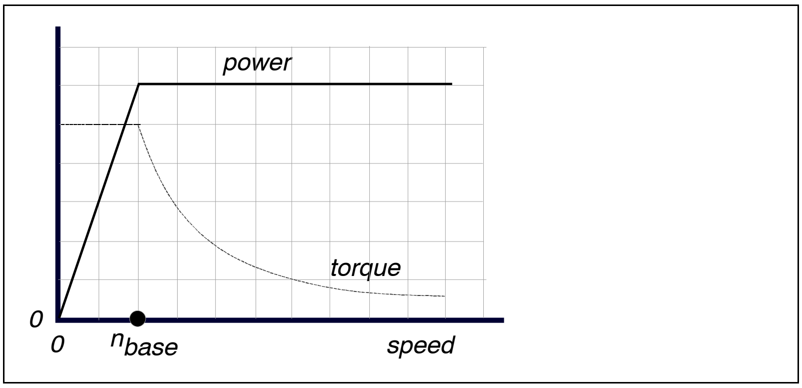


FIGURE H5.2

Constant power required from the motor for a load regardless of the load.

TABLE H5.1 Constant motor power demanded by a load.

Constant motor power	
Load type	Constant power, regardless of speed
Examples	Winding machines at constant tenstion Milling spindle Lathe spindle
Torque / speed characteristics	The torque decreases from base speed on
Motor Power	The rated power of the drive will be the one demanded by the load.

5.2.2 Power required by the load

The power demanded from an asynchronous spindle motor in a turning or machining center is determined by the cutting power.

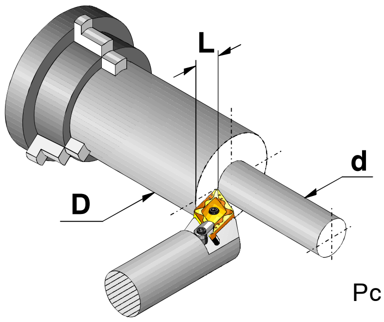
A good cutting process required the asynchronous spindle motor to be working at constant power and with a power range between 1:3 and 1:5.

The power values used for a cutting operation on a lathe, mill or machining center with a drill are calculated using the following formulas.

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 is turning. See **FIGURE H5.3**.

The power required, **Pc** is calculated as follows:



$$V = \frac{\pi \cdot DN_S}{1000} \quad (m/(min))$$

$$Pc = \frac{K_S\, d\, L\, V}{60 \cdot 1000 \cdot \eta_C} = \frac{d\, L\, V}{S_C\, \eta_C} \quad (kW)$$

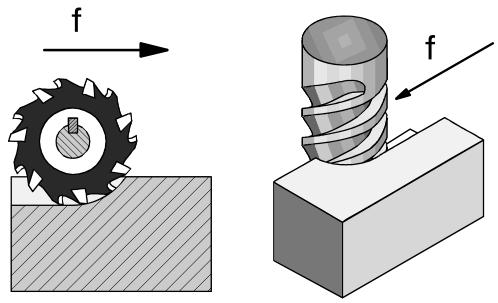
FIGURE H5.3

Machining for lathe. Cutting power.

V	Cutting speed in m/min
$\mathbf{K_s}$	Relative cutting resistance in N/mm²
d	Cutting depth in mm
L	Length of the blade, or feedrate per full turn in mm
D	Diameter of the part machined in mm
$\mathbf{N_s}$	Spindle turning speed in rpm
η_c	Mechanical efficiency (varies from 0.7 to 0.85)
$\mathbf{S_c}$	Cutting efficiency. Cutting volume per kilowatt every minute in (cm³/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. See **FIGURE H5.4**.

The power required, **Pf** is calculated as follows:



$$Pf = \frac{K_S\, d\, W\, f}{60 \cdot 1000^2 \cdot \eta_f} = \frac{d\, W\, f}{1000^2 \cdot S_f\, \eta_f} \quad (kW)$$

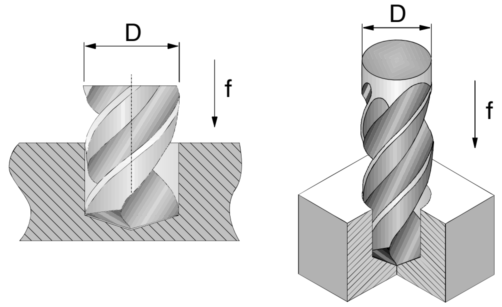
FIGURE H5.4

Machining for mill. Cutting power.

$\mathbf{K_s}$	Relative cutting resistance in N/mm²
d	Cutting depth in mm
W	Cutting width in mm
f	Feedrate in mm/min
$\mathbf{N_s}$	Spindle turning speed in rpm
η_f	Mechanical efficiency (varies from 0.7 to 0.8)
$\mathbf{S_f}$	Cutting efficiency. Cutting volume per kilowatt every minute (cm³/kW)/min

In the case of a drill, the bit is mounted on the spindle itself and turns with this to drill the material. See **FIGURE H5.5**.

The power required in this case **Pd** may be calculated with the following formula:



$$P_d = \frac{M \cdot 2\pi n}{60 \cdot 100 \cdot 1000 \cdot \eta_d} = \frac{\pi D^2 f}{4 \cdot 1000 \cdot S_d \eta_d} \quad (kW)$$

FIGURE H5.5

Drilling. Required power.

M Drilling load torque in N·cm

n Spindle turning speed in rpm

D Hole diameter in mm

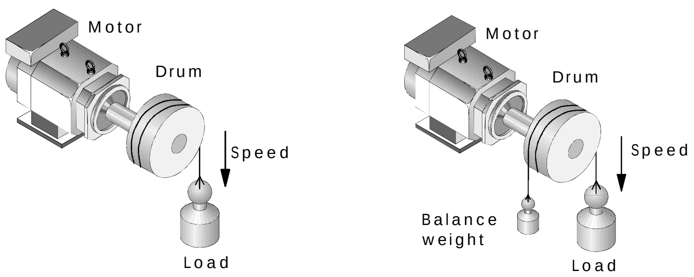
f Feedrate in mm/min

η_d Mechanical efficiency (varies from 0.7 to 0.85)

S_d Cutting efficiency. Cutting volume per kilowatt every minute (cm³/kW)/min

In the event of governing a **gravitational load**, the power required depends very much on the presence on absence of balance weights (crane or elevator). See **FIGURE H5.6**.

The power required in this case, P_{GL} and P_{GLC} may be calculated as follows:



$$P_{GL} = \frac{m_L \cdot V}{6120 \cdot \eta} \quad (kW) \qquad P_{GLC} = \frac{(m_L - m_C) \cdot V}{6120 \cdot \eta} \quad (kW)$$

FIGURE H5.6

Gravitational load. Required power.

V Linear speed in m / min

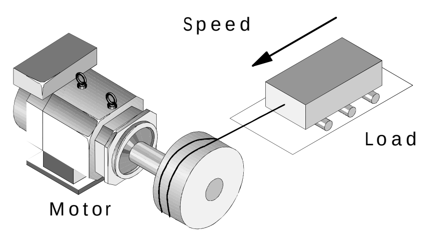
m_L Table mass in kg

η Mechanical efficiency

m_C Counterweight mass in kg

Governing a **frictional load**, this is the case of horizontal movements such as a conveyor belt or a movable table, the required power depends on the friction coefficient μ. See **FIGURE H5.7**.

The power required in this case P_F is calculated as follows:



$$P_F = \frac{\mu \cdot m_L \cdot V}{6120 \cdot \eta} \ (kW)$$

FIGURE H5.7

Frictional load. Required power.

μ	Friction coefficiente	η	Mechanical efficiency
m_L	Table mass in kg	**V**	Linear speed in m/min

5.2.3 Power needed to accel. and decel. an asynchronous spindle motor

There are three methods to control the acceleration and deceleration process of the machine spindle:

- Acceleration limited by time.

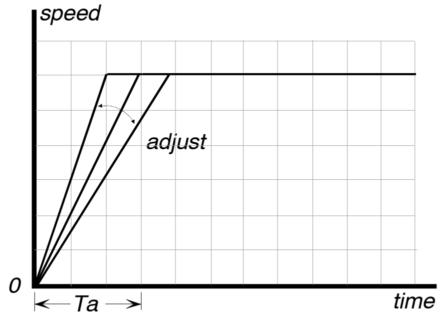


FIGURE H5.8

Acceleration limited by time.

TABLE H5.2 Acceleration limited by time.

Method	Acceleration limited by time.
Control	Speed increases linearly in time until the command speed is reached.
Comment	The acceleration torque is constant.

- Different acceleration ramps depending on the speed reached.

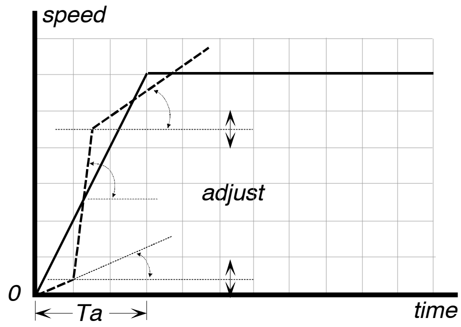


FIGURE H5.9

Different accelerations depending on speed.

TABLE H5.3 Different accelerations depending on speed.

Method	Different accelerations depending on speed
Control	Linear acceleration avoiding abrupt variations in transmitted torque.
Comment	Emulation of the square sine function for speed by using ramps.

- Limited acceleration and choke. Choke = (Δacceleration / Δ t).

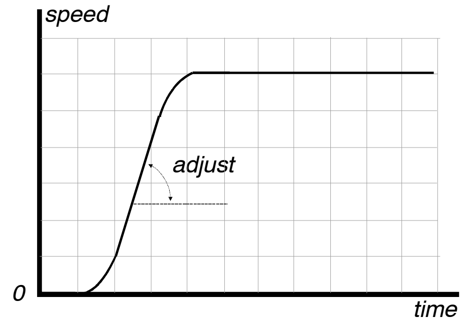


FIGURE H5.10
Acceleration and choke limit.

TABLE H5.4 Acceleration and choke limit.

Method	Acceleration and choke limit.
Control	Progressive linear acceleration, avoiding abrupt variations of transmitted torque.
Comment	Approach square sine function (bell shape) for the speed.

The capability demanded from the motor is determined by the following formulas:

Capacity required by the motor in the constant torque area: **($0 < N_M < N_B$)**	$P_N = \left(\frac{2\pi}{60}\right)^2 \cdot \frac{J_M \cdot N_M^2}{1000 \cdot t}$ (kW)
Capacity required by the motor in the constant torque and constant power area: **($0 < N_M < N_{max}$)**	$P_N = \left(\frac{2\pi}{60}\right)^2 \cdot \frac{J_M \cdot (N_M^2 + N_B^2)}{2000 \cdot t}$ (kW)

J_M Inertia of the load in kg·m² as viewed from the motor shaft
P_N Rated power at base speed kW
Nmax Maximum motor speed in rev/min.
N_B Motor base speed in rev/min.
N_M Motor speed reached after a time period t in rpm
t Acceleration time until N_M (in seconds) is reached

We will now give several examples of calculations using a mechanical specifications 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.

Data:

Acceleration time:

Between 0 and 1500 rpm in 0.5 s. (1)
Between 0 and 6000 rpm in 2.5 s. (2)

Motor inertia: J_{motor} = 0.13 kg·m²
Motor base speed: N_b = 1500 rev/min

Calculations:

1. With speed between 0 and 1500 rpm.

$$P_N = \left[\frac{2\pi}{60}\right]^2 \cdot \frac{J_M \cdot N_M^2}{1000t}\ [\mathrm{kW}] = \left[\frac{2\pi}{60}\right]^2 \cdot \frac{0.13 \cdot 1500^2}{1000 \cdot 0.5} = 6.41\ [\mathrm{kW}] \qquad [1]$$

2. With speed between 0 and 6000 rpm.

$$P_N = \left[\frac{2\pi}{60}\right]^2 \cdot \frac{J_M\left[N_M^2 + N_B^2\right]}{2000t}\ [\mathrm{kW}] = \left[\frac{2\pi}{60}\right]^2 \cdot \frac{0.13\left[6000^2 + 1500^2\right]}{2000 \cdot 2.5} = 10.89\ [\mathrm{kW}] \quad [2]$$

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:
($0 < N_M < N_B$)

$$t_1 = \frac{2\pi \cdot J_M \cdot N_M}{60 \cdot T_M}\ (\mathrm{s})$$

Constant power area:
($N_B < N_M < N_{max}$)

$$t_2 = \frac{2\pi \cdot J_M \cdot (N_M^2 - N_B^2)}{120 \cdot T_M \cdot N_B}\ (\mathrm{s})$$

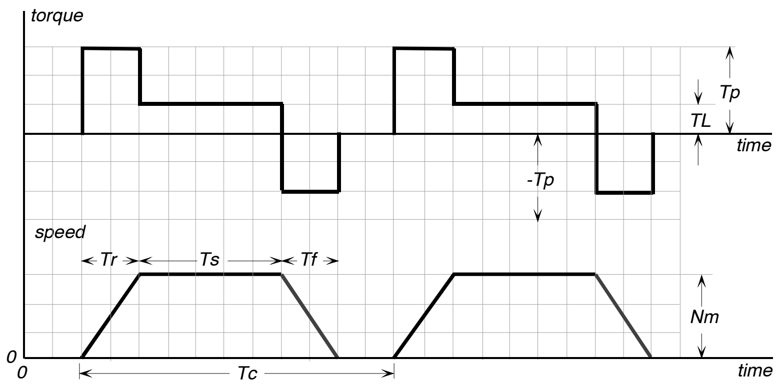
Constant torque & power area:
($N_B < N_M < N_{max}$)

$$t_3 = (t_1 + t_2) = \frac{2\pi \cdot J_M \cdot (N_M^2 + N_B^2)}{120 \cdot T_M \cdot N_B}\ (\mathrm{s})$$

J_M Inertia of the load in kg·m² as viewed from the motor shaft
T_M Rated torque at base speed in N·m
Nmax Maximum motor speed in rpm.
N_B Motor base speed in rpm.
N_M Motor speed reached after a time period t in rev/min

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.



$$T_R = \sqrt{\frac{T_P^2 \cdot (t_r + t_f) + T_L^2 \cdot t_s}{t_c}}\ (\mathrm{Nm})$$

FIGURE H5.11
Periodic start-stop operation

5.
SELECTING CRITERIA
Asynchronous spindle motor and servo drive selection

FAGOR

DDS HARDWARE

Ref.1109

For a cycle like the one shown in the **FIGURE H5.11** which includes acceleration and stopping, the equivalent effective torque T_R of equation must be within the S1 dimension given for the drive torque.

5.2.4 Drive selection

When selecting an SPM motor, see the characteristics curve in the MANUAL: AC SPINDLE MOTOR: SPM. These graphs indicate the power that the drives may obtain from this motor.

When selecting an FM7 or FM9 motor, see the manual: of the AC spindle motor that indicates the drive associated with the selected motor.

5.3 Power supply selection

5.3.1 Calculation of the power required from the power supply by the synchronous servo motors

Initially, considering the mechanical power provided by the motors:

TABLE H5.5 Power supply selection depending on the mechanical power output of the motor.

SYNCHRONOUS FXM & FKM

Power (characteristics table)

n : Max. axis speed in the application (rpm)
nN: Motor rated speed (rpm)
Pa= Pcal·1.17· [n/nN] : Axis power (kW)

	Axes	Pcal	n	nN	Pa
		kW	rpm	rpm	kW
GROUP I 0 to 2 kW Synchronous	**1**				
	2				
	3				
	Sum of GROUP I:				* Ki →
GROUP II 0 to 8.5 kW Synchronous	**1**				
	2				
	3				
	Sum of GROUP II:				* Kii →
GROUP III 8.5 to 27 kW Synchronous	**1**				
	2				
	3				
	Sum of GROUP III:				* Kiii →

Sum of GROUP I * Ki + Sum of GROUP II * Kii + Sum of GROUP III * Kiii =

SUM OF POWER: (kW) 1

Synchronous motors per group	K factor
1	1
2	0.63
3	0.50
4	0.38
5	0.33
6	0.28

... where:

Pcal: motor power (kW) according to the motor characteristics table.

1.17: coefficient that stores the efficiency of the motor (0.9) and that of the drive (0.95).

The servo set is divided in groups depending on their power by applying to each one a simultaneity factor Ki, Kii, Kiii.

5.
SELECTING CRITERIA
Power supply selection

FAGOR

DDS HARDWARE

Ref.1109

Then, depending on the power for S3-5% cycles that could be requested by the drives at any time:

TABLE H5.6 Selection of the power supply depending on the power for S3-5% cycles supplied by the drive for IGBT switching frequencies of 4 kHz and 8 kHz.

SYNCHRONOUS FXM & FKM

Power P (S3-5% cycle)

	P (S3-5%) kW						
GROUP I 0 to 2 kW Synchronous	**1**						
	2	**Sum of GROUP I:**		*	Ki	➔	
	3						
							+
GROUP II 0 to 8.5 kW Synchronous	**1**						
	2	**Sum of GROUP II:**		*	Kii	➔	
	3						
							+
GROUP III 8.5 to 27 kW Synchronous	**1**						
	2	**Sum of GROUP III:**		*	Kiii	➔	
	3						
							=

SUM OF POWER: **(kW)** 3

Synchronous motors per group	K factor
1	1
2	0.63
3	0.50
4	0.38
5	0.33
6	0.28

Drive	P (S3-5%)
AXD 1.08	6
AXD 1.15	12
AXD 1.25	19
AXD 1.35	27
AXD 2.50	36
AXD 2.75	48
AXD 3.100	77
AXD 3.150	95

in kW

5.3.2 Calculation of the power required from the power supply by the asynchronous motors.

SPM asynchronous spindle motor (discontinued)

TABLE H5.7 Selection of the power supply for an SPM asynchronous spindle motor.

ASYNCHRONOUS FOR SPINDLE, SPM

Max. power consumed by the power supply (kW)

ASYNCHRONOUS

Asynchronous for spindle	**Pm**
1	
2	

SUM OF POWER: (kW) 2

Pm: Required power obtained for the spindle drive in S6-40% cycles. This data includes the internal losses of the drive.

SPM asynchronous spindle motors	Drive for asynchronous spindle motor	**Pm** (kW)	SPM asynchronous spindle motors	Drive for asynchronous spindle motor	**Pm** (kW)
SPM 90L	SPD 1.15	5.1	**SPM 132L**	SPD 2.75	23.0
	SPD 1.25	9.5		SPD 3.100	36.2
SPM 90P	SPD 1.25	9.2	**SPM 132X**	SPD 3.100	34.6
SPM 100LBE	SPD 1.25	8.9	**SPM 132XL**	SPD 3.100	36.7
	SPD 1.35	13.1		SPD 3.150	49.6
SPM 112ME	SPD 1.25	8.7	**SPM 160M**	SPD 3.100	35.4
	SPD 1.35	13.1		SPD 3.150	48.0
SPM 112LE	SPD 1.35	12.6	**SPM 160L**	SPD 3.100	41.4
	SPD 2.50	16.7		SPD 3.150	57.6
SPM 112XE	SPD 2.50	15.3	**SPM 180MA**	SPD 3.150	59.7
	SPD 2.75	24.6			

where:

P_m	Maximum power that the drive may demand from the power supply in each motor - drive combination. It includes the power dissipated by the drive itself (in kW).

FM7 asynchronous spindle motor

TABLE H5.8 Power supply selection when using an FM7 asynchronous spindle motor with E01 and E02 releases.

ASYNCHRONOUS FOR SPINDLE, FM7. Releases E01 & E02

Max. power consumed by the power supply (kW)

ASYNCHRONOUS

Asynchronous for spindle	Pm
1	
2	

SUM OF POWER: (kW) 2

Pm: Required power obtained for the asynchronous spindle drive in S6-40 % cycles. This data includes the internal losses of the drive.

Asynchronous spindle motor	Power (kW)		η (%)		Drive power	Drive for asynchronous spindle motor	Drive	**Pm**
	S1	S6-40	S1	S6-40	(kW)		η (%)	(kW)
FM7-A037	3.7	5.5	83.5	83.5	6.6	SPD 1.25	90	7.4
FM7-A055	5.5	7.7	86.0	84.5	9.1	SPD 1.25	90	10.1
FM7-A075	7.5	11.0	86.5	84.6	13.0	SPD 1.35	90	14.4
FM7-A090	9.0	13.0	87.3	85.7	15.2	SPD 2.50	90	16.9
FM7-A110	11.0	15.5	90.2	89.2	17.4	SPD 2.50	90	19.3
FM7-A150	15.0	22.0	90.4	89.3	24.6	SPD 2.75	90	27.4
FM7-B120	12.0	18.5	91.0	90.4	20.5	SPD 2.75	90	22.7
FM7-A185	18.5	26.0	91.8	91.5	28.4	SPD 2.85	90	31.6
FM7-A220	22.0	33.0	89.2	88.1	37.5	SPD 3.100	90	41.6
FM7-B170	17.0	25.0	89.1	87.7	28.5	SPD 2.85	90	31.7
FM7-A300	30.0	45.0	92.1	91.6	49.1	SPD 3.150	90	54.6
FM7-A370	37.0	56.0	92.5	91.7	61.1	SPD 3.200	90	67.9
FM7-B220	22.0	33.0	91.3	90.5	36.5	SPD 3.100	90	40.5
FM7-B280	28.0	42.0	91.1	90.0	46.7	SPD 3.150	90	51.9
FM7-A510	51.0	71.0	92.8	92.2	77.0	SPD 3.200	90	85.6
FM7-C215	21.5	29.0	85.4	82.7	35.1	SPD 3.150	90	39.0
FM7-C270	27.0	37.0	86.6	83.9	44.1	SPD 3.200	90	49.0
FM7-E600	60.0	80.0	92.2	91.4	87.6	SPD 3.200	90	97.3

where:

P_m	Maximum power that the drive may demand from the power supply in each motor - drive combination. It includes the power dissipated by the drive itself (in kW).

TABLE H5.9 Power supply selection when using an FM7 asynchronous spindle motor with E03 release.

ASYNCHRONOUS FOR SPINDLE, FM7. Release E03)

Max. power consumed by the power supply (kW)

ASYNCHRONOUS

Asynchronous for spindle	**Pm**
1	
2	

SUM OF POWER: (kW) 2

Pm: Required power obtained for the asynchronous spindle drive in S6-40% cycles. This data includes the internal losses of the drive.

In star

Asynchronous spindle motor	Power (kW)		η (%)		Drive power	Drive for asynchronous spindle motor	Drive	**Pm**
	S1	S6-40	S1	S6-40	(kW)		η (%)	(kW)
FM7- D055	5.5	7.7	86.0	84.5	9.1	SPD 1.35	90	10.1
FM7- D075	7.5	11.0	86.5	84.6	13.0	SPD 2.50	90	14.4
FM7- D110	11.0	15.5	90.2	89.2	17.4	SPD 2.75	90	19.3
FM7- D150	15.0	22.0	90.4	89.3	24.6	SPD 2.85	90	27.4
FM7- D185	18.5	26.0	91.8	91.5	28.4	SPD 2.85	90	31.6
FM7- D220	22.0	33.0	89.2	88.1	37.5	SPD 3.100	90	41.6

In triangle

Asynchronous spindle motor	Power (kW)		η (%)		Drive power	Drive for asynchronous spindle motor	Drive	**Pm**
	S1	S6-40	S1	S6-40	(kW)		η (%)	(kW)
FM7- D055	5.5	10.0	86.0	84.5	11.8	SPD 1.35	90	13.1
FM7- D075	7.5	13.0	86.5	84.6	15.4	SPD 2.50	90	17.1
FM7- D110	11.0	20.0	90.2	89.2	22.4	SPD 2.75	90	24.9
FM7- D150	15.0	26.0	90.4	89.3	29.1	SPD 2.85	90	32.4
FM7- D185	18.5	32.0	91.8	91.5	35.0	SPD 2.85	90	38.9
FM7- D220	22.0	40.0	89.2	88.1	45.4	SPD 3.100	90	50.4

where:

P_m Max. power that the drive may demand from the power supply in each motor - drive combination. It includes the power dissipated by the drive itself (in kW).

TABLE H5.10 Power supply selection when using an FM7 asynchronous spindle motor with HS3 release.

ASYNCHRONOUS FOR SPINDLE, FM7. Release HS3

Max. power consumed by the power supply (kW)

ASYNCHRONOUS

Asynchronous for spindle	Pm
1	
2	

SUM OF POWER: (kW) 2

Pm: Required power obtained for the asynchronous spindle drive in S6-40% cycles. This data includes the internal losses of the drive.

In star

Asynchronous spindle motor	Power (kW)		η (%)		Drive power	Drive for asynchronous spindle motor	Drive	**Pm**
	S1	S6-40	S1	S6-40	(kW)		η (%)	(kW)
FM7- D075	7.5	11.0	86.5	84.6	12.7	SPD 2.50	90	14.1
FM7- D110	11.0	15.5	90.2	89.2	17.4	SPD 2.75	90	19.3
FM7- D185	18.5	26.0	91.8	91.5	28.4	SPD 2.85	90	31.6
FM7- D220	22.0	33.0	89.2	88.1	37.5	SPD 3.100	90	41.6

In triangle

Asynchronous spindle motor	Power (kW)		η (%)		Drive power	Drive for asynchronous spindle	Drive	**Pm**
	S1	S6-40	S1	S6-40	(kW)		η (%)	(kW)
FM7- D075	7.5	13.0	86.5	84.6	15.4	SPD 2.50	90	17.1
FM7- D110	11.0	20.0	90.2	89.2	22.4	SPD 2.75	90	24.9
FM7- D185	18.5	32.0	91.8	91.5	35.0	SPD 2.85	90	38.9
FM7- D220	22.0	40.0	89.2	88.1	45.4	SPD 3.100	90	50.4

where:

P_m Max. power that the drive may demand from the power supply in each motor - drive combination. It includes the power dissipated by the drive itself (in kW).

Non-Fagor asynchronous spindle motor

For non-Fagor asynchronous spindle motors (e.g.: a high speed spindle) the previous tables for standard Fagor motors are not available.

To properly calculate the power demanded by the non-Fagor asynchronous spindle from the power supply, it is necessary:

- To know the maximum power to be provided at the axis. Always use the mechanical power for cycles S1 or S6-40% (depending on the duty cycle of the applicaton).

Never use the peak power !

- Obtain the power at the motor terminals by dividing the previous value by the efficiency of the motor.

If the value of the motor efficiency (eff) is unknown, apply the following rule. For:

P < 22 kW	motor eff = 85%	(η = 0.85)
P > 22 kW	motor eff = 90%	(η = 0.90)

- Divide the result by the efficiency of the drive.

drive eff = 90% (η = 0.90)

Power supply selecting criteria

1. **The power supply module must be capable of supplying the power required by the set of motors and drives connected to it.**

TABLE H5.11 First criteria for selecting the power supply for the whole system.

FIRST CRITERIA

The "power supply" module must be capable of supplying the power required by all the motor-drive sets connected to it.

REQUIRED POWER: 1 + 2 = A kW

Rated Power (in duty cycle S1)	Power supply module
In kW	**Reference**
If A < 20	RPS-20
If 20 < A < 25	PS-25B4, XPS-25
If 25 < A < 45	RPS-45
If 45 < A < 65	PS-65A, XPS-65
If 65 < A < 75	RPS-75
If 75 < A < 80	RPS-80
If A > 80	(*)

(*) Until reaching the rated power demanded from the power supply. All the required power cannot be supplied, hence 2 power supplies will be needed.

Very important. When using two power supplies on the same machine, they must make up two independent groups with their own drives. Only the SERCOS ring (if there is one) may be common to both groups.

Note. If the power required by the set is greater than 80 kW, the set of motors and drives must be divided into groups and powered by different power supplies.

Warning. Never connect the power supplies in parallel !.

2. **The power supply module must be capable of supplying the peak power required by the set of motors and drives connected to it.**

TABLE H5.12 Second criteria for selecting the power supply for the whole system.

SECOND CRITERIA

The "power supply" module must be capable of supplying the peak power required (depending on the duty cycles) by all the motor-drive sets connected to it.

REQUIRED PEAK POWER: 3 + 2 = B **kW**

	Peak power (depending on the duty cycle)	Power supply module
	In kW	**Reference**
NON-REGENERATIVE POWER SUPPLIES	If B < 75	PS-25B4
	If 75 < B < 195	PS-65A
	If B > 195	- Read note -
REGENERATIVE POWER SUPPLIES	If B < 55	XPS-25
	If 55 < B < 108	XPS-65
	If B > 108	- Read note -
REGULATED REGENERATIVE POWER SUPPLIES	If B < 26	RPS-20
	If 26 < B < 59	RPS-45
	If 59 < B < 97	RPS-75
	If 97 < B < 104	RPS-80

Very important. When using two power supplies on the same machine, they must make up two independent groups with their own drives. Only the SERCOS ring (if there is one) may be common to both groups.

Note. If the peak power required by the set is greater than 108 kW for XPS power supplies or greater than 104 kW for RPS power supplies, the set of motors and drives must be divided into groups and powered by different power supplies.

Warning. Never connect the power supplies in parallel !.

3. The range of Fagor power supplies that may be selected is:

TABLE H5.13 Power supplies of the FAGOR catalog. They indicate: Rated power, admitted mains voltage and whether it outputs 24 V DC or not.

RANGE OF FAGOR POWER SUPPLIES

NON REGENERATIVE

Model	Output power S1	Input voltage	Integrated 24V power supply
PS-25B4	25 kW	400-460 V AC	Yes
PS-65A	65 kW	400-460 V AC	No

REGENERATIVE

Model	Output power S1	Input voltage	Integrated 24V power supply
XPS-25	25 kW	400-460 V AC	Yes
XPS-65	65 kW	400-460 V AC	Yes

Model	S1/S6-40% output power	Input voltage	Integrated 24V power supply
RPS-20	20/26 kW	400-460 V AC	Yes
RPS-45	45/59 kW	400-460 V AC	Yes
RPS-75	75/97 kW	400-460 V AC	Yes
RPS-80	80/104 kW	400-460 V AC	Yes

4. Use the following sheet to calculate the input transformer, and the section of the mains cable

TABLE H5.14 Power of the input transformer.

MAINS VOLTAGE

The Fagor DDS servo drive system requires a mains voltage between 400 and 460 V AC

TRANSFORMER

A power transformer or auto-transformer must be used

[1 + 2] * 1.05 kVA = 4 kVA

Very important. When using an isolating transformer, the secondary must have a star connection and its mid point must be accessible so it can be connected to ground. This means that the output voltage of the transformer/autotransformer is maintained for the indicated apparent power. **Note that** if the system has an **XPS power supply**, the rated power Pm of cell (2) of the previous expression corresponds to the sum of the Pn's of all the asynchronous spindle motors of the system, whose value is the result of applying the expression **Pn=1.4·Pmax** for each of them and then adding them all. **Pmax will be the motor's maximum braking power and it may be, in general, close to the power of the asynchronous spindle motor in S6. If it is a PS power supply**, cell (2) will register the value obtained from the table TABLE H5.7 or TABLE H5.8 accordingly.

TABLE H5.15 Selection of the mains connection cable.

POWER CABLE FOR MAINS CONNECTION

Vmains from 400 to 460 V AC

Rated current through the mains cable

MAINS POWER

4 **(kW)** *** 1000 / (√3 · Vmains)** = ____ **A** → C

COMPACT AXIS DRIVES (ACD):

RATED CURRENT ON FXM & FKM MOTORS = ____ **A** → C

COMPACT SPINDLE DRIVES (SCD):

MAX. CURRENT ON SPM & FM7 MOTORS = ____ **A** → C

	Power cable
In Amperes	Reference
if C < 12.5	MPC-4x1.5
if C < 16.5	MPC-4x2.5
if C < 23	MPC-4x4
if C < 29	MPC-4x6
if C < 40	MPC-4x10

The purchase order must indicate the length of the cables.

5.4 Capacitor module selection guide

The CM 1.60 is a capacitor module that increases the electrical capacitance of the power bus in 4230 μF. It should be installed on machines with very short duty cycles (very repetitive accelerations and decelerations) and with low braking energy (e.g. a punch press).

The following table indicates how much extra energy W is stored in (Ws) when the bus voltage increases from the rated value VBus to the Ballast circuit activating voltage (also called Crowbar activation voltage, VCrowbar).

Considering the different combinations of power supplies modules + CM 1.60 and different mains voltage.

$$W = \frac{1}{2} \cdot C \left(V_{CROWBAR}^2 - V_{BUS}^2 \right) \quad (\text{en Ws})$$

with units:

C in Farads

VCrowbar in volts

VBus = √2·Vmains in volts

W in Ws → jules)

TABLE H5.16 Extra energy that may be stored (in Ws)

Modules	Capac. (μF)	Crowbar activation voltage (V)	Crowbar deactivation voltage (V)	W (Ws) for Vmains 400 V	W (Ws) for Vmains 460 V
PS-25B4	820	770	760	111.9	69.6
PS-65A	940	770	760	128.3	79.8
XPS-25	1175	770	760	160.3	99.7
XPS-65	2520	770	760	343.8	213.8
CM 1.60+PS-25B4	5050	770	760	689.1	428.5
CM 1.60+PS-65A	5170	770	760	705.4	438.7
CM 1.60+XPS-25	5405	770	760	737.5	458.6
CM 1.60+XPS-65	6750	770	760	921.0	572.7

5.5 Ballast resistor selection guide

Calculate the value of:

Wm Energy generated by the braking of each system motor.

Pe Rms power generated by all braking of all the motors throughout a complete duty cycle.

Based on the following formulae:

$$W_m = W_p + \frac{1}{2} \cdot J_t \left[\frac{2\pi \cdot n}{60}\right]^2 \quad [\,Ws\,]$$

$$W_p = m \cdot g \cdot \Delta h$$

$$P_e = \sqrt{\frac{\sum_i \frac{W_{mi}^2}{t_i}}{T}} \quad [\,w\,]$$

where:

Jt Total inertia of the servo system (motor + mechanics) in kg.m².

n Turning speed of the motor when the braking starts in rpm.

Wmi Energy of each braking during a cycle of time T in Ws.

Wp Potential energy lost by the machine mass while braking (only on non-compensated axes) in Ws.

ti Braking time (in seconds) when the Wmi energy is generated.

T Time (in seconds) in a full cycle.

Dh Height (in m) lost while braking.

Wmx Maximum energy among all the Wm.

Pmx Maximum power generated by all the braking, given by the maximum value among all the (Wmi / ti) quotients of each braking in kW.

$$P_{mx} = \left(\frac{W_{mi}}{t_i}\right)_{max} \quad [\,kW\,]$$

Once the values of **Pmx** and **Pe** are calculated, follow these flow charts:

If you have external resistor ER+TH-□/□ or ER-TH-18/□+FAN, already discontinued, use this diagram to obtain the Ohm values required for each power supply.

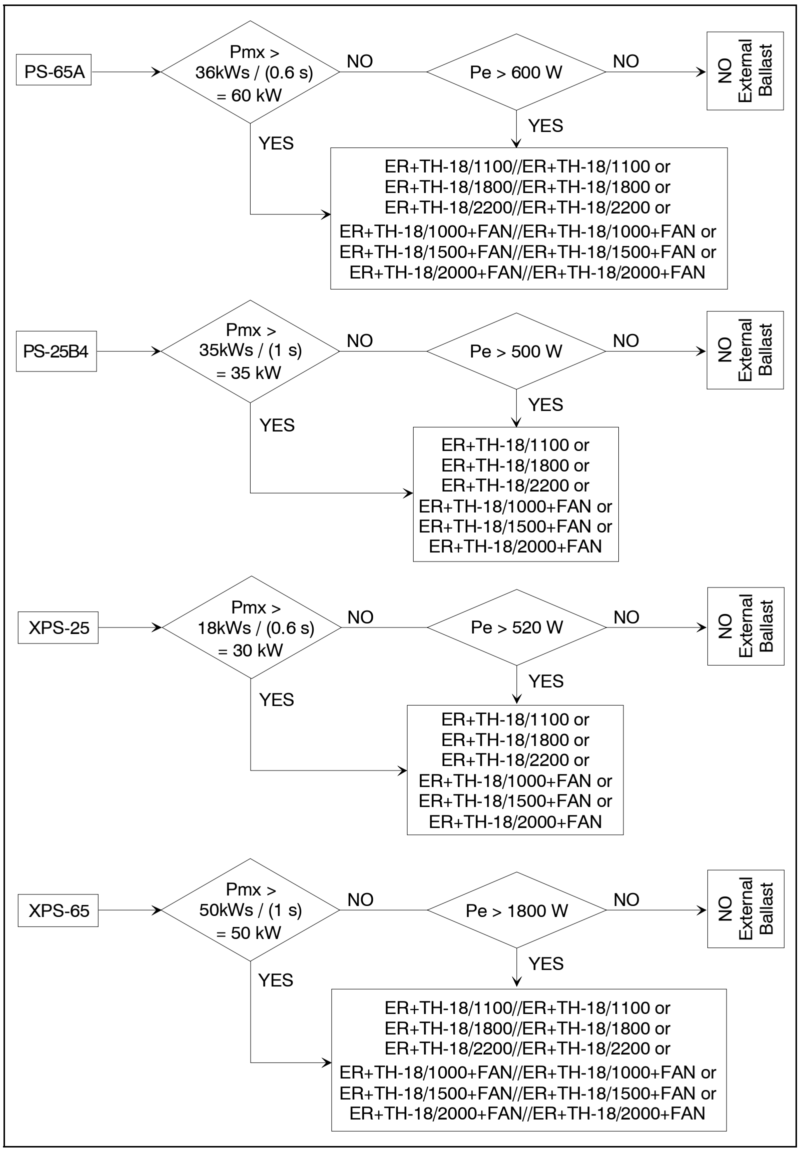


FIGURE H5.12

Selection of the ballast resistor for the power supplies.

- When using compact drive modules that integrate the power supply.

Warning. On all compact drives (except those whose reference is SCD-NR x.xx), the external resistor supplied with the units. ACD/SCD/CMC 1.08 /1.15 models are also an exception.

On compact drives "ACD//SCD//CMC 1.08 /1.15", as opposed to the rest of the compact models, do not install any external Ballast resistor. The internal one is enough, except on "SCD 1.15" models where it would be possible to install the internal resistor ER+TH-43/350 if the application so required.

In general, on compact models "ACD//CMC 1.08/1.15" the internal dissipation Ballast resistor will be enough, but if it is not in a particular situation, it is possible to install an external resistor of the same Ohm value as the internal one and greater dissipation power.

Note. Actually, the external resistor provided with the unit is considered enough for most applications. If it is not enough, install one of the same Ohm value and greater power.

On any compact drive whose reference is SCD-NR x.xx no external Ballast resistor will supplied with the unit. The user will place the order for the external resistor required by the application with a Fagor representative.

POWER LINE CONNECTION

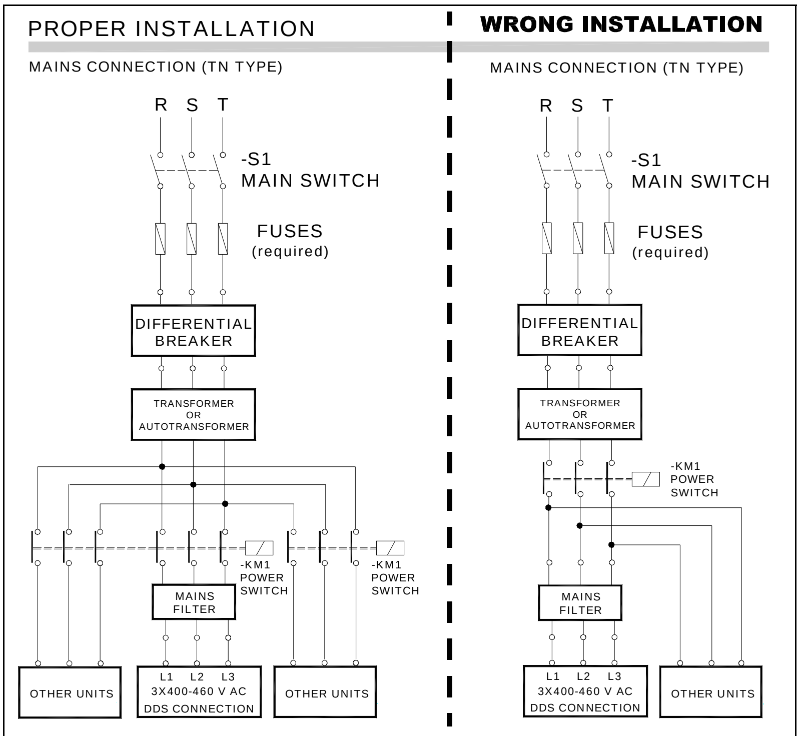
6

6.1 Mains connection

The Fagor DDS modular servo drive system is designed to be connected to TN type three-phase mains with values within the voltage range between 400-10% and 460+10% V AC and a mains frequency of 50/60 Hz.

Connecting it to a different voltage range requires the use of transformers or autotransformers.The connection may vary depending on the type of mains and electromagnetic compatibility required by the machine.

Certain mandatory protection devices must be added to the mains lines. Others are optional.



Warning. The DLC mains filter may be installed either before or after the power switch -KM1.

FIGURE H6.1

Diagram to connect the DDS system to mains.

Warning. Never connect other components (motors, inductive components, etc.) in parallel with the drive system. They may cause the system to perform poorly when stopping the machine. The equipment to be connected together with the DDS system must be powered through a second contactor or through auxiliary contacts of the drive's contactor.

The diagram of **FIGURE H6.1** shows the different possibilities and how to connect it. After the main switch -S1, place the protection fuses, the differential breaker, the 400/460 V AC transformer (only if necessary), the power switch -KM1 to turn on/off the DDS system and the MAINS FILTER □□A for electromagnetic disturbances.

Warning. The MAINS FILTER □□A may be installed either before or after the power switch -KM1.

6.1.1 Protection fuses

To protect the Fagor DDS servo drive system, fuses must be included **on the lines coming from mains.** **FIGURE H6.1** of this chapter shows its location.

Note that Fagor does not supply the fuses; in other words, the Fagor DDS servo drive system does not include the fuses as accessories.

The lines going to the auxiliary power supply, integrated in all Fagor power supplies (except the PS-65A that needs an external auxiliary power supply called APS-24) and even those of the compact drives do not need external protection fuses because they are already integrated in all of them. Therefore:

Do not install external protection fuses in the power lines feeding the auxiliary power supply. These fuses are already integrated into all Fagor power supplies.

Technical characteristics

Extremely fast fuses must be installed in the mains lines to protect the semiconductors sized according to the type of power supply.

Depending on the power supply being installed, they will be selected according to the characteristics indicated in **TABLE H6.1** which are the ones to be met by the fuses that must be installed in the line input of the servo drive system to protect it properly.

TABLE H6.1 Technical data of the fuses for power supplies.

	PS-25B4	PS-65A	XPS-25	XPS-65
In	≥ 40 A	> 100 A	≥ 40 A	> 100 A
Isurge (1 s)	> 115 A	> 325 A	> 115 A	> 325 A
Clearing I^2t (A^2s)	< 500	< 15000	< 500	< 15000

Warning. Actually, IGBT components cannot be protected with fuses. Therefore, when using RPS power supplies, the protection does not prevent the module from breaking down. Using them minimizes the number of components that may be damaged as a result of a possible malfunction.

When using compact drives (with integrated power supply), they will be selected according to **TABLE H6.2**:

TABLE H6.2 Technical data of the fuses for compact drives.

	ACD 1.08 SCD 1.08 CMC 1.08	ACD 1.15 SCD 1.15 CMC 1.15	ACD 1.25 SCD 1.25 CMC 1.25	ACD 2.35 SCD 2.35 CMC 2.35	ACD 2.50 SCD 2.50 CMC 2.50
In	> 5.6 A	> 10.6 A	> 17.7 A	> 28 A	> 28 A
Isurge (0.5 s)	> 8 A	> 15 A	> 25 A	> 35 A	> 35 A
Clearing I^2t (A^2s)	< 120	< 338	< 900	< 900	< 900

Recommended fuses

TABLE H6.3 and TABLE H6.4 offer a variety of fuses from different manufacturers and may be used as a reference. The references of the fuses shown in these tables are valid for installations where the system is connected directly to mains and for the rated power of the units.

For lower-than-rated power, the fuses should be selected according to the characteristics of each system.

TABLE H6.3 Fuses to be installed in mains line depending on the power supply installed.

Manufacturer	PS-25B4 XPS-25 RPS-20	PS-65A XPS-65 RPS-45	RPS-75 RPS-80
BUSMANN	FWH45B	RF00-125A	
	XL50F-45A	XL50F-125A	
	RF-000-40A	RF-000-125A	
	40FE	100FE	160FE
	170M2611	170M1318	170M1319
	170M3009	170M3013	170M3014
GOULD	A00-66C5D8	A00-66C125D8	
	A00-66C5D1	A00-66C125D1	
FERRAZ	6.9 gRB 00 D08L 040	6.9 gRB 00 D08L 125	6.9 gRB 00 D08L 160
	6.6 gRB 000 D08/040	6.6 gRB 000 D08/100	6.6 gRB 000 D08/160
SIBA	20 189 20-50A	20 189 20-125A	20 189 20-160A
WICKMAN	45FEE	140FEE	
SIEMENS	3NE8 003	3NE8 021	3NC8423-3
LITTELFUSE	---------------	L70S125	L70S150

TABLE H6.4 Fuses to be installed in mains line depending on the compact drive installed.

Manufacturer	ACD 1.08 SCD 1.08 CMC 1.08	ACD 1.15 SCD 1.15 CMC 1.15	ACD 1.25 SCD 1.25 CMC 1.25	ACD 2.35/50 SCD 2.35/50 CMC 2.35/50
BUSSMANN	FC-6A	FC-12A	FC-20A	FWC-32A10F
	XL50-10A	XL50-15A	RF-000-25	FWP-32A14F
	6CT	12CT		
	FWH-6.30A6F			
GOULD	ST-6 10x38	ST-12 10x38	ST-20 10x38	
	000-10	000-16	A60x20	
	000/80-10	000/80-16		
FERRAZ	6.600CP URC 14.51/6	12.600CP URC 14.51/6		
	6.621CP URC 14.51/6	12.621CP URC 14.51/6		
	6.6URE10/6	12.6URE10/6		
	A60Q6-2	A60Q12-2	A60Q20-2	A60Q30-2
	A60X6-1	A60X12-1		
SIEMENS			3NE8 015	3NE8 003

Warning. Using other protection devices instead of fuses (magneto-thermal switches, for example) does no guarantee proper protection of the equipment.

The fuse references given of the previous table are the ones that may be installed to obtain the maximum power on each model. In those cases where the power supply is oversized, the fuse value should be adjusted to the actual requirements of the machine.

Warning. When using an autotransformer or an isolating transformer, the fuses must be selected according to its characteristics depending on the structure of the installation. Therefore, the fuses must be selected specifically for each installation since it will be affected by a variable number of characteristics internal and external to the machine.

6.1.2 Differential breaker

On a DDS system, fault DC current, practically flat, may come up besides the AC currents and pulsating DC currents. This requires the use of a differential breaker. It must be universal **type B** breaker (valid for AC, pulsating DC and flattened DC currents) and selective switch-off (delayed switch-off).

Note. *The Siemens® model "5SZ6 468-0KG00", for example.*

These considerations must be taken into account if the differential breaker only affects a machine using a Fagor DDS servo drive system.

Warning. It is not recommended to use differential breakers sensitive to pulsating currents and, overall, general purpose differential breakers. In this cases, undesired stops might occur due to the high sensitivity of those devices to pulsating currents. **Therefore, never use AC type differential breakers!**

Alternate. Type A differential breakers may be used with selective switch-off. They are more economical than **type B** ones and usually valid for DDS systems with a Fagor filter. The off current **must not be < 500 mA** and they will have selecting switch-off.

Note. *The Siemens® model "5SM3 645 ", for example.*

When several machines share the same differential breaker, bear in mind the sum of the leak currents of all the machines involved.

Watch out for the total leak current when several machines share a differential breaker. All of them may add up to a considerable value !

Note that most of the leak current is due to the mains filter. Hence, it is up to the filter to discharge to ground the noise coming from mains. On the other hand, the leak current of the filters varies depending on mains conditions.

On the filters of the Fagor Automation catalog, these values may vary between 27 mA (typical value) and 150 mA (maximum value). They practically do not vary with temperature because their components are stable and certified.

The main reason for the variation of the leak current has to do with unbalanced mains voltage or with too many harmonics.

Bear in mind these considerations when installing differential breakers for several machines.

- Verify that the differential breaker to be installed is more immune and admits higher leak currents.
- Distribute the machines connected to each line when installing several differential breakers,
- Use fewer mains filters. Install one filter common to several machines instead of one for each machine. Verify that the machines connected to the same filter do not generate disturbances between them and meet the current regulations.

6.1.3 Isolating transformer or autotransformer

When the mains voltage must be isolated or adapted to the levels required by the DDS system, it may be connected through an isolating transformer or an auto-transformer. This element will also help reduce the amount of harmonics on the line although **it will not guarantee the compliance with the CE regulation.**

When having a mains perfectly referred to ground, autotransformers may be used to adapt the mains voltage. However, if mains is not referred to ground, an isolating transformer must be used in order to avoid possible dangerous voltage surges on any phase with respect to ground that could damage the equipment.
In this situation, the secondary must have a star configuration with access to the middle point. This middle point of the secondary must be connected to ground or the neuter of mains. This consideration is also applicable to IT type networks.

On systems with an XPS-☐☐ power supply, the inductance of the transformer must be very low and negligible against the inductive value of the Choke XPS-☐☐.

FIGURE H6.2 shows the position where the transformer or autotransformer must be installed within the whole power line connection system.

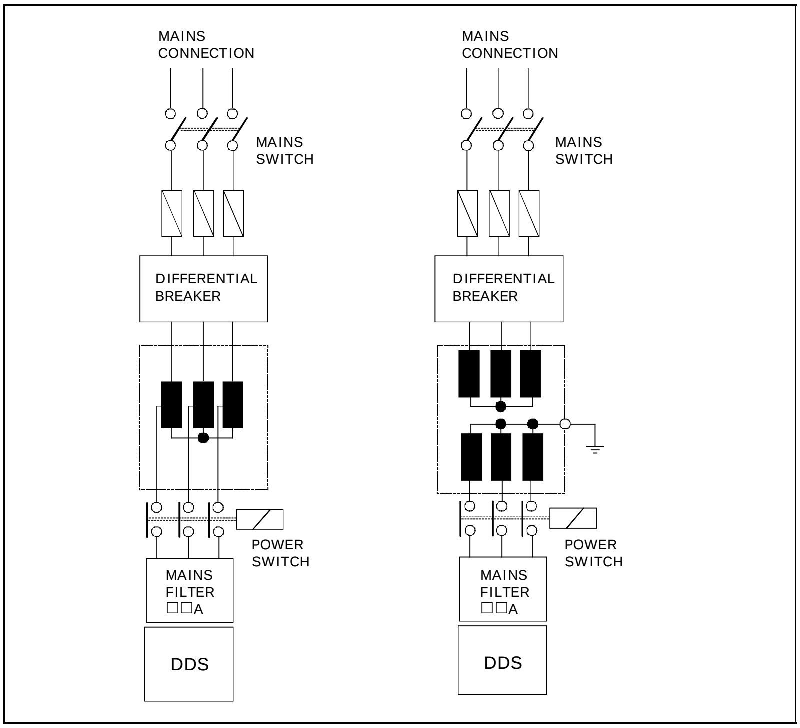


FIGURE H6.2

Position of the autotransformer or isolating transformer

When using transformers or autotransformers, the main contactor must be connected between them and the DDS system, never on the input line of the transformer or autotransformer.

For machines whose servo drive system includes XPS-☐☐ modules, the transformer or auto-transformer must be properly sized. The rated power of the auto-transformer must be the one resulting from applying the following formula: **Pn = 1.4·Pmax** ,where Pmax is the maximum braking power of the system. This power may be, in general, close to the power in the S6 duty cycle of the asynchronous spindle motor. See chapter **5. SELECTING CRITERIA.**

This means oversizing the transformer or autotransformer considerably in relation to the power of the machine. Hence, individual transformers should not be used for each machine; instead, several machines should be connected to a single transformer. Hence it is possible to apply simultaneity factors and decrease the power required by the transformer or auto-transformer.

Warning. Not complying with the given indications could cause the servo drive system to perform poorly.

Warning. The "MAINS FILTER □□A" mains filter may be installed indistinctly before or after the power switch -KM1.

Warning. To obtain greater power and accelerations than what the drives can provide, it is necessary to use an auto-transformer to raise the power bus voltage or to have a particular regulated power supply (also called boosting power supply, such as the Fagor RPS-□□). **Remember that** these power supplies require chokes installed at the power line input because they are regenerative power supplies.

6.1.4 Mains filters

In order for the Fagor DDS servo drive system to meet the European Directive on Electromagnetic Compatibility 2004/108/CE, the "**MAINS FILTER □□A**" must also be installed.

This does not guarantee the compliance with such CE Directive on Electromagnetic Compatibility **regarding the machine** because it may have other devices that could cause disturbances.

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.

They may be installed either horizontally or vertically. The three-phase line is connected to the terminals on top of the module and the load (power supply or compact drive) to those at the bottom. See the label on the front panel showing these terminals in full detail. See **FIGURE H6.3**.

TABLE H6.5 indicates the proper filter to be installed depending on the power supply or compact drive (the power supply is integrated into it) being used in the DDS system.

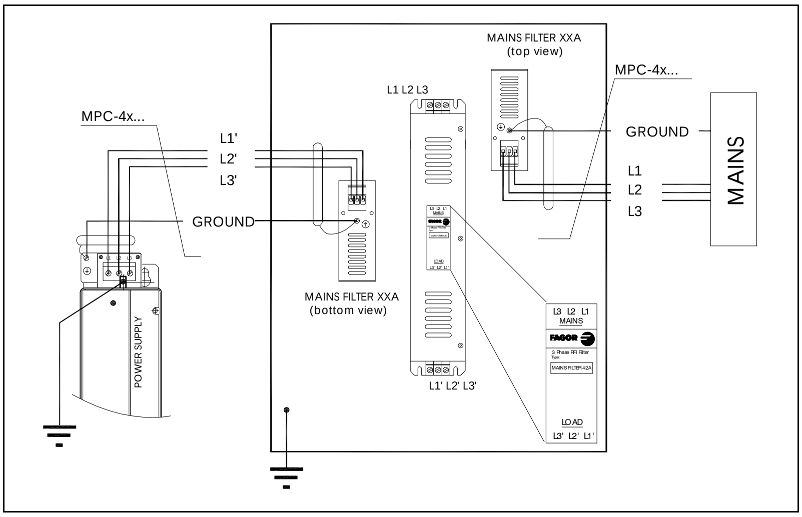


FIGURE H6.3

Installation of the MAINS FILTER □□A.

The "MAINS FILTER □□A" may be installed either before or after the power switch -KM1. See **FIGURE H6.1**. It is usually installed before the power switch -KM1, but it does not have to be necessarily installed in this position.

6.
POWER LINE CONNECTION
Mains connection

FAGOR

DDS HARDWARE

Ref.1109

TABLE H6.5 Mains filter selection according to the power supply or compact drive installed.

XPS-25, RPS-20	Mains Filter 42A
PS-25B4	Mains Filter 42A
PS-65A, XPS-65, RPS-45, RPS-75	Mains Filter 130A
RPS-80	Mains Filter 180A
ACD/SCD/CMC 1.08/1.15/1.25	Mains Filter 42A
ACD/SCD/CMC 2.35/2.50	Mains Filter 42A

For further information on mains filters, see section " Mains filters " of chapter 4 in this manual.

6.1.5 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:

$$L = \frac{V \times 0.04}{2\pi f \times I_{rms}}$$

To simplify the choice, we could consider optimum the values given in TABLE H6.6.

TABLE H6.6 Line inductance selection according to the power supply or compact drive installed.

	PS-25B4	**PS-65A**	**ACD/SCD/CMC 1.08/1.15**	**ACD/SCD/CMC 1.25**
L (mH)	1	0.4	5	3
Irms (A)	40	100	11	18

If the MAINS FILTER ☐☐A has not been installed, the line inductance is recommended in order to minimize disturbances, although is warned that **this inductance does not guarantee the compliance with the CE seal**.

Warning. No line inductance must be installed in line with RPS or XPS regenerative power supplies. They generate interference in the regenerating mechanism.

6.2 Types of mains

Depending on the diagram of the electric energy distribution circuit, there are three types of mains: TN, TT and IT.

Depending on the type of mains, the cabling in the electrical cabinet will vary considerably.

We here describe the characteristics and, later on, sample diagrams for a proper installation. **Note that** the diagrams do not show the main contactor (-KM1) that must be connected between the transformer or autotransformer and the DDS unit.

6.2.1 TN diagram

Distribution diagram that has a point connected directly to ground. The conductive parts of the installation are connected to this point through ground protection wires. This type of mains admits loads between one or several phases and the neuter.

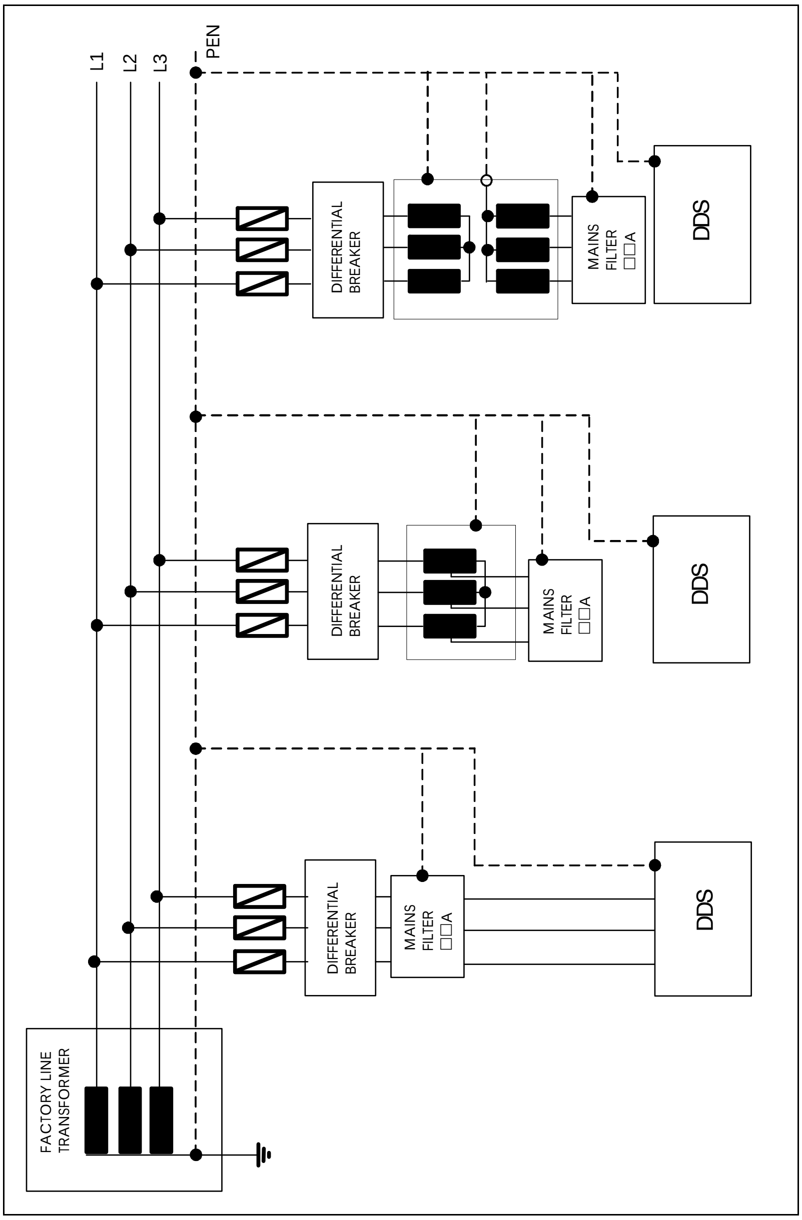


FIGURE H6.4

Installation diagram in TN-C type mains.

There are three types of TN systems depending on the protection neuter and ground combination:

- **TN-S diagram** where the neuter and the ground protection conductors are separated throughout the whole length of the system.
- **TN-C-S diagram** where the neuter and the ground protection wire are combined in a single conductor somewhere in the system.
- **TN-C diagram** where the neuter and the ground protection functions are combined in a single conductor throughout the system.

Warning. TN type mains are the only ones to which the DDS system can be connected either directly or through an auto-transformer.

See diagram **FIGURE H6.4** for properly installing the DDS system with TN-C type mains distribution.

6.2.2 TT diagram

Distribution diagram that has a point connected directly to ground. The conductive parts of the installation are connected to this ground point independently from the ground electrode of the power supply system.

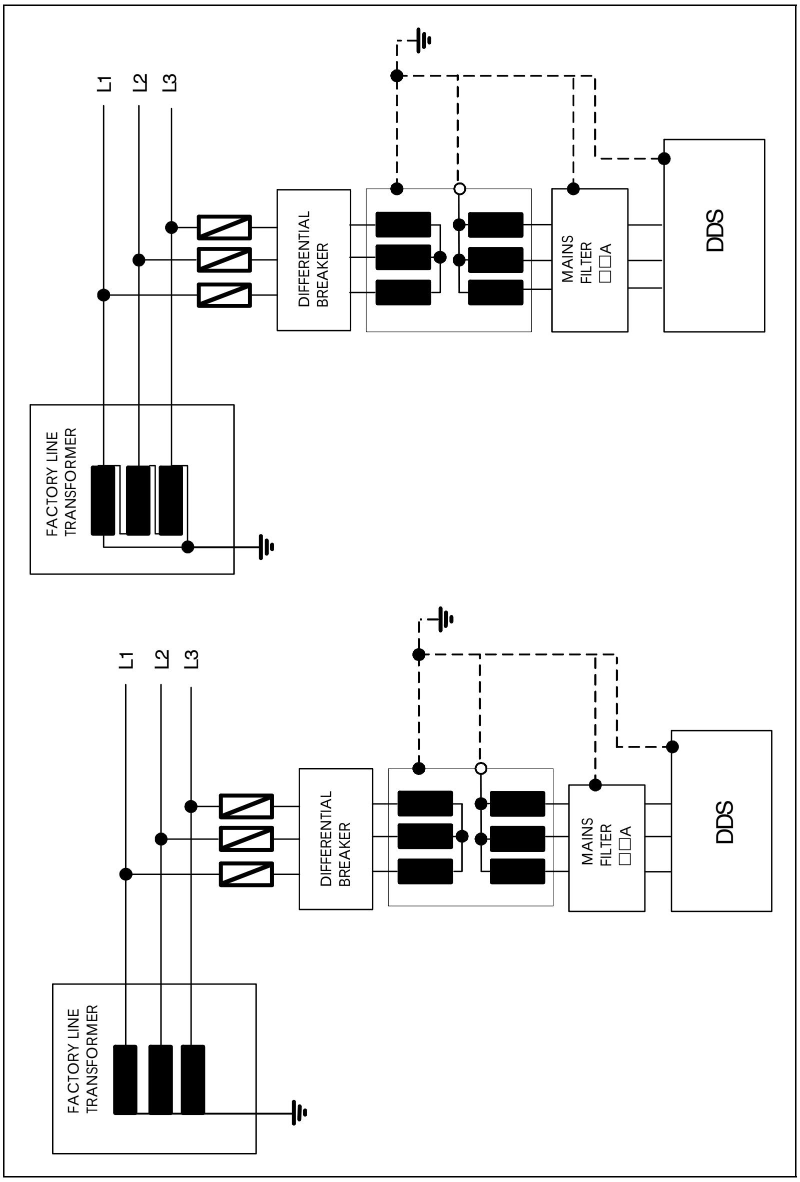


FIGURE H6.5

Installation diagram in a TT type mains.

6.2.3 IT diagram

Distribution diagram that has no point connected directly to ground. The conductive parts of the installation are connected to ground.

In this type of mains, the differential breaker is used assuming that the capacitance of mains with respect to ground is large enough to ensure that a minimum fault current flows with the same magnitude as that of the operating differential current assigned. Otherwise, its use is not necessary.

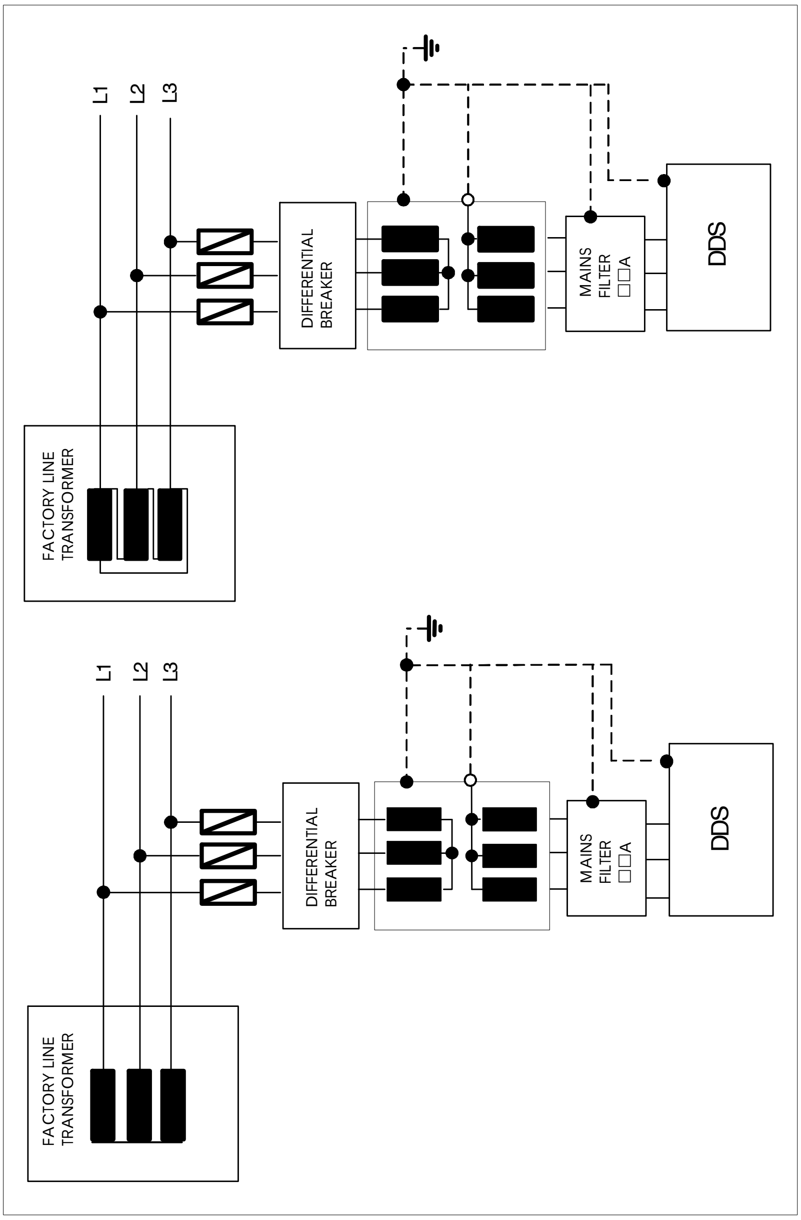


FIGURE H6.6

Installation diagram of an IT type mains.

Note that an IT type mains can also be controlled through an isolation watching device. Both protection measurements are compatible with each other.

6.3 Mains connection cables

For further information on the mains cabling for the DDS system, see chapter 7. CABLES, section "Mains connection cables".

CABLES 7

This chapter describes the cables needed to install the DDS servo drive system and the characteristics of the connectors of those cables. It also describes the mechanical characteristics of those cables.

Previous chapters of this manual already described the cabling of the DDS system for the power lines, feedback, optic fiber of the SERCOS ring connection, RS-232/RS-422 serial line connection, communications etc.

The attached **TABLE H7.1** gathers the regulation applicable to typical installation of drive systems.

It determines the minimum section of the cable through which the maximum current allowed in continuous duty can circulate on three-phase wires in PVC hoses or installed on the machine through conduits or channels according to EN 60204-1.

The ambient temperature is assumed to be 40°C (104°F).

Important. The dielectric insulation of the cable must be enough to withstand the test voltage at a minimum of 2000 V AC for 5 minutes for cables supporting voltages over 50 V AC (alternating current) or 120 V DC (direct current). Refer to the recommendations of the cable manufacturer before doing the installation.

TABLE H7.1 Cable section / Imax current.

Section (mm^2)	Imax (Arms)
0.75	8.5
1.0	10.1
1.5	13.1
2.5	17.4
4	23
6	30
10	40
16	54
25	70
35	86
50	103
70	130
95	156
120	179

7.1 Mains connection cable. Power supply - mains connection

Refer to TABLE H5.15 of chapter 5 to determine the cable needed to connect the power supply to mains. Note that compact drives have it integrated into them.

The TABLE H7.2 shows the mains connection cable supplied by Fagor and their sales reference is MPC-☐x☐.

TABLE H7.2 Range of mains connection cables.

MPC-4x1.5	MPC-4x4	MPC-4x10	MPC-4x25	MPC-4x50
MPC-4x2.5	MPC-4x6	MPC-4x16	MPC-4x35	MPC-4x70

The 4 wires of the mains cable must be connected to the power supply or to the compact drive (integrated power supply) as shown in FIGURE H7.1.

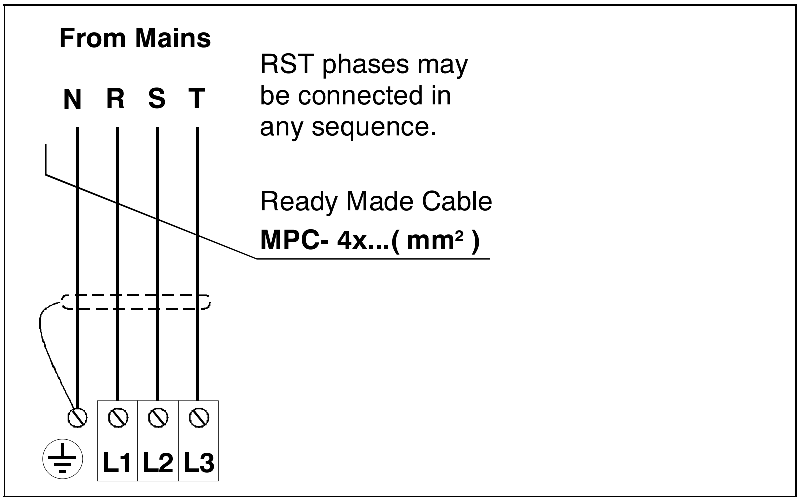


FIGURE H7.1

MPC cable connection from the power supply or compact drive to mains.

7.1.1 Mechanical characteristics of the power terminals

The TABLE H7.3 shows the mechanical characteristics of the terminals (L1, L2, L3, ground) at the power supplies and at the compact drives.

TABLE H7.3 Mechanical characteristics of the power connectors for the power supplies and compact drives.

Module	Gap (mm)	Max. tightenin torque (N·m)	Max. hole section (mm²)	Min. cable section (mm²)
PS-65A	18.8	7	70	50
PS-25B4	10.1	1.5	16	10
XPS-25	12.1	2	16	10
XPS-65	18.8	7	70	50
RPS-80	25.0	20	95	70
RPS-75	25.0	20	95	70
RPS-45	18.8	7	70	35
RPS-20	10.6	1.5	16	10
ACD/SCD/CMC 1.08/1.15	7.62	0.5	4	2.5
ACD/SCD/CMC 1.25	7.62	0.7	6	4
ACD/SCD/CMC 2.35	10.16	1.2	6	6
ACD/SCD/CMC 2.50	10.16	1.5	16	10

7.2 Power cable. Motor - drive connection

TABLE H7.4 and TABLE H7.5 show the range of power cables supplied by Fagor to connect a motor and a drive. **They are supplied without connectors** because the power connector will usually be different depending on the motor it will be connected to. The number of meters available upon request. It is available in lengths of 5, 10, 15, 20, 30, 40, 50, 75, 100, 150, 200, 250 and 300 meters for sections up to 10 mm^2 (included) and 5, 7, 10, 12, 15, 20, 25, 30, 35, 40, 45, 50, 75 and 100 for sections of up to 50 mm^2 (included). Their sales reference is:

MPC - ☐ x ☐	to connect motors without brake
MPC - ☐ x ☐ + (☐ x ☐)	to connect motors with brake

TABLE H7.4 Range of cables to connect a motor (without brake) and a drive.

MPC-4x1.5	MPC-4x4	MPC-4x10	MPC-4x25	MPC-4x50
MPC-4x2.5	MPC-4x6	MPC-4x16	MPC-4x35	MPC-4x70

TABLE H7.5 Range of cables to connect a motor (with brake) and a drive.

MPC-4x1.5+(2x1)	MPC-4x6+(2x1)	MPC-4x25+(2x1)
MPC-4x2.5+(2x1)	MPC-4x10+(2x1)	
MPC-4x4+(2x1)	MPC-4x16+(2x1.5)	

i

Remember that when a motor is mentioned here, it refers to any motor of the Fagor catalog, both synchronous and asynchronous.

!

Warning. In order for the system to comply with the European Directive on Electromagnetic Compatibility, the cable hose that carries 6 or 4 cables, depending on whether the motor has a brake or not, must be shielded and connected at both ends; i.e. both at the drive end and a the motor end. This condition is a must.

7.2.1 Mechanical characteristics of the power terminals

The mechanical characteristics of the terminals (U, V, W, ground) on modular drives are:

TABLE H7.6 Mechanical characteristics of the power connectors of the modular drives.

Module	**Gap (mm)**	**Max. tightenin torque (N·m)**	**Max. hole section (mm²)**	**Min. cable section (mm²)**
AXD/SPD/MMC 1.08/1.15	7.62	0.6	4	2.5
AXD/SPD/MMC 1.25	7.62	0.8	6	6
AXD/SPD/MMC 1.35	10.16	1.5	6	6
AXD/SPD/MMC 2.☐☐	10.16	1.8	16	16
SPD/MMC 2.85	10.16	1.8	16	16
AXD/SPD/MMC 3.100	----	8	50	25
AXD/SPD/MMC 3.150	----	8	50	50
SPD/MMC 3.200	----	20	95	70
SPD/MMC 3.250	----	20	95	95

The cable wires connected at the motor end must be kept inside their corresponding connector. The connector will be different depending on the user's motor.

For further details on the connector that must be mounted at the end of the MPC cable and connected at the motor end, see the manual of the corresponding motor.

7.2.2 Mechanical characteristics of the cable MPC- 4xO+(2xO)

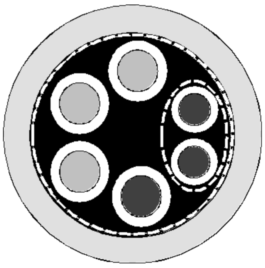


TABLE H7.7 Mechanical characteristics of the MPC-□x□+(□x□) cable.

Type	Shield. It ensures EMC Compatibility.
Flexibility	High. Special to be used in cable carrying chains with a bending radius of 10 times the Dmax under dynamic conditions and 6 times the Dmax under static conditions.
Covering	PUR. Polyurethane resistant to chemical agents used in machine-tools.
Temperature	Work: -20°C to +60°C (-4°F to 140°F) Storage: -50°C to +80°C (-58°F to 176°F)
Rated voltages	Uo / U: 600/1000 Volts.

7.2.3 MPC- 4xO+(2xO) cable selection

To select the cable needed for the power connection between the drive and the motor, see the manual of the corresponding motor that indicates the necessary cable depending on the user's motor.

7.3 Motor feedback cables

The motor feedback can be one of two types: encoder or resolver.

7.3.1 Encoder feedback cables

The attached tables show the range of motor encoder cables supplied by Fagor to connect the motor feedback and a drive. **They are supplied with connectors at both ends** (see note 1) and their sales reference is:

Motor	**Ref. Cable**	**Motor feedback**
FXM, FKM SPM	EEC-☐	1 Vpp sinusoidal encoder
	EEC-SP-☐	1 Vpp sinusoidal encoder (better immunity and flexibility)
FXM & FKM	IECD-☐	Incremental TTL encoder
FM7	EEC-FM7-☐	Incremental TTL encoder
	EEC-FM7S-☐	Incremental TTL encoder (better immunity and flexibility)
	EEC-FM7CS-☐	C axis SinCos encoder

1/ None of the motor encoder feedback cables for FM7 spindle motors will have the connector mounted at the motor end; a connector will be supplied with the cable for the user to mount it. See the manual: AC spindle motor - FM7 - for further detail on how to mount it.

Note. The encoder cable (without connectors) is only available upon request in lengths of 75, 100 150 m.

EEC-☐ cable

TABLE H7.8 Range of EEC-☐ cables. The number indicates their length in meters including the connectors.

EEC-1	EEC-10	EEC-30	EEC-50
EEC-3	EEC-15	EEC-35	
EEC-5	EEC-20	EEC-40	
EEC-7	EEC-25	EEC-45	

For further detail on how to connect the drive, see the manual of the corresponding motor.

Remember that using the cable reference EEC-☐ **does not guarantee** compliance with the EEC Directive on Electromagnetic Compatibility.

EEC-SP-☐ cable

TABLE H7.9 Range of EEC-SP-☐ cables. The number indicates their length in meters including the connectors.

EEC-SP- 5	EEC-SP-25	EEC-SP-45
EEC-SP-10	EEC-SP-30	EEC-SP-50
EEC-SP-15	EEC-SP-35	
EEC-SP-20	EEC-SP-40	

For further detail on how to connect the drive, see the manual of the corresponding motor.

Remember that using the cable reference EEC-☐ **does guarantee** compliance with the EEC Directive on Electromagnetic Compatibility.

IECD-☐ cable

TABLE H7.10 Range of IECD-☐ cables.The number indicates their length in meters including the connectors.

IECD - 5	IECD-15	IECD-25
IECD-10	IECD-20	IECD-30

For further detail on how to connect the drive, see the manual of the corresponding motor.

EEC-FM7-☐ cable

TABLE H7.11 Range of EEC-FM7-☐ cables.The number indicates their length in meters including the connector.

EEC-FM7- 5	EEC-FM7-15	EEC-FM7-25
EEC-FM7-10	EEC-FM7-20	

For further detail on how to connect the drive, see the manual of the corresponding motor.

EEC-FM7S-☐ cable

TABLE H7.12 Range of EEC-FM7S-☐ cables.The number indicates their length in meters including the connector.

EEC-FM7S- 3	EEC-FM7S-20	EEC-FM7S-40
EEC-FM7S- 5	EEC-FM7S-25	EEC-FM7S-45
EEC-FM7S-10	EEC-FM7S-30	EEC-FM7S-50
EEC-FM7S-15	EEC-FM7S-35	

For further detail on how to connect the drive, see the manual of the corresponding motor.

EEC-FM7CS-☐ cable

TABLE H7.13 Range of EEC-FM7CS-☐ cables.The number indicates their length in meters including the connector.

EEC-FM7CS- 5	EEC-FM7CS-25	EEC-FM7CS-45
EEC-FM7CS-10	EEC-FM7CS-30	EEC-FM7CS-50
EEC-FM7CS-15	EEC-FM7CS-35	
EEC-FM7CS-20	EEC-FM7CS-40	

For further detail on how to connect the drive, see the manual of the corresponding motor.

7.3.2 Resolver feedback cable

The attached tables show the motor resolver cable supplied by Fagor to connect the motor feedback and a drive. **They are supplied with connectors at both ends** and their sales reference is:

Motor	Ref. Cable	Motor feedback
FXM, FKM	REC-☐	Resolver

REC-☐ cable

TABLE H7.14 Range of REC-☐ cables. The number indicates their length in meters including the connectors.

REC-5	REC-15	REC-25
REC-10	REC-20	

For further detail on how to connect the drive, see the manual of the corresponding motor.

7.4 Direct feedback cable

The direct feedback is given by an external linear encoder (scale) or rotary encoder that may be incremental (with reference signals) or absolute (with reference signals).

7.4.1 External incremental feedback

The attached figure shows the cable of the direct feedback supplied by Fagor to connect an incremental feedback device (external linear or rotary) with Fagor sinusoidal signals (1 Vpp) or square signals (differential TTL) and the drive. **This cable is supplied with connectors at both ends** and its sales reference is:

EC-☐ PD cable

TABLE H7.15 Range of EC-☐ PD cables. The number indicates their length in meters including the connectors.

EC-1 PD	EC-3 PD	EC-6 PD	EC-9 PD	EC-12 PD
EC-2 PD	EC-4 PD	EC-8 PD	EC-10 PD	

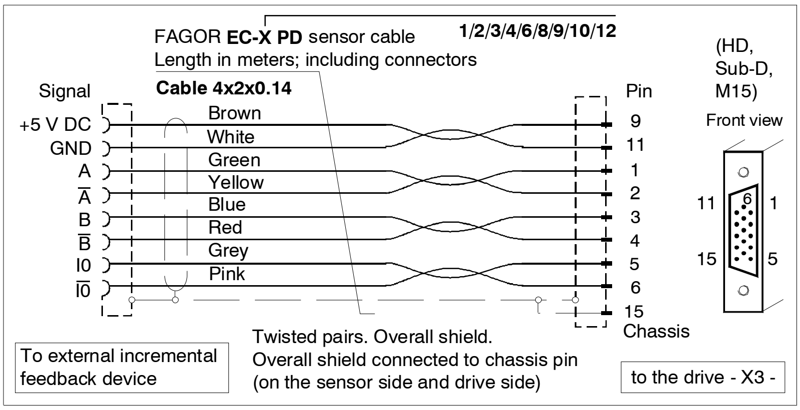


FIGURE H7.2

Diagram of the direct feedback cable for an external Fagor incremental feed-back (linear or rotary) sinusoidal (1 Vpp) or square-wave (differential TTL).

7.4.2 External absolute feedback

The attached figure shows the cable of the direct feedback supplied by Fagor to connect an external Fagor absolute linear encoder) with sinusoidal signals (1 Vpp) and the drive. This cable **is supplied with connectors at both ends** and its sales reference is:

EC-☐B-D cable

TABLE H7.16 Range of EC-☐B-D cables. The number indicates their length in meters including the connectors.

EC-1B-D	EC-3B-D	EC-6B-D	EC-9B-D

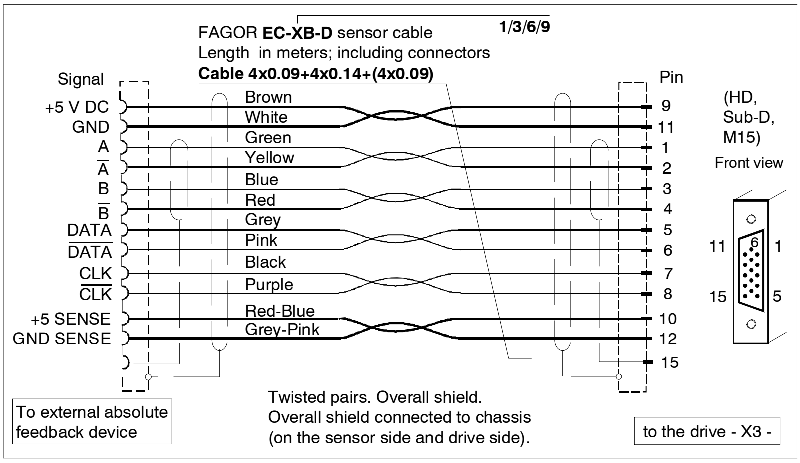


FIGURE H7.3

Diagram of the direct feedback cable for the Fagor absolute linear encoder.

7.4.3 External Stegmann sinusoidal encoder

Fagor does not supply the direct feedback cable for connecting an external Stegmann sinusoidal encoder **with the drive.** For this connection, you must know the pinout at the encoder end and match it with the pinout at the drive end. With this information, the user will be able to make the connection and make his own cable.

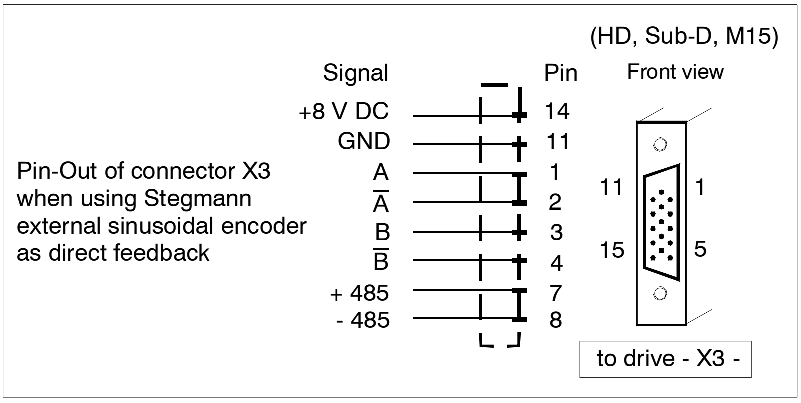


FIGURE H7.4

Pinout for the direct feedback cable when using a Stegmann sinusoidal encoder as external feedback.

7.5 Signal cables for control and communications

7.5.1 Encoder simulator from the drive to the CNC

Depending on motor feedback, the drive can generate a set of signals that simulate those of a differential TTL encoder attached to the rotor of the motor. The attached tables show this cable supplied by Fagor to connect the drive (X3) and the CNC 8055 (X1, X2, X3 or X4) / 8055i (X10, X11, X12 or X13) / 8065/8070 (LOCAL COUNTER 1/2). The attached tables show this cable supplied by Fagor to connect the drive and the CNC. They are supplied with connectors at both ends and their sales reference is:

SEC-HD-☐ cable

TABLE H7.17 Range of SEC-HD-☐ cables. The number indicates their length in meters including the connectors.

SEC-HD-1	SEC-HD-10	SEC-HD-25
SEC-HD-3	SEC-HD-15	SEC-HD-30
SEC-HD-5	SEC-HD-20	SEC-HD-35

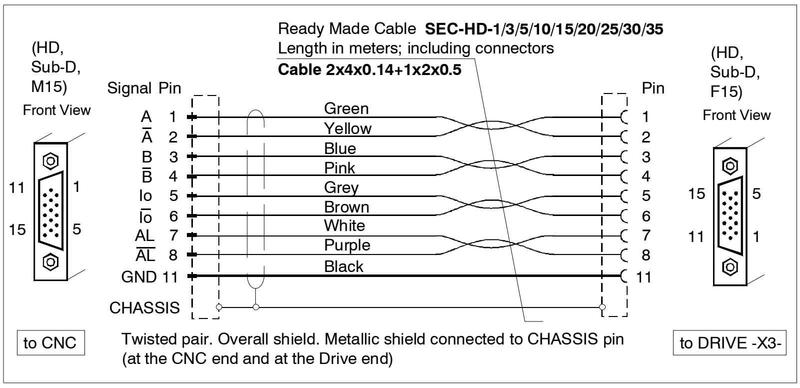


FIGURE H7.5

Connection of the cable for the encoder simulation and the CNC.

The max. length for SEC-HD-☐ cables for best performance is 50 meters.

7.5.2 SERCOS optical fiber

Fagor Automation supplies the fiber optic cables for SERCOS communications between the group of drives and the CNC in a ring connection and in lengths ranging from 1 to 100 meters. The cables between drives come with the connectors for each module. For SERCOS connection **under 40 m**, use the fiber optic cable with polymer core.

Its sales references are:

SFO-☐ cable

TABLE H7.18 Range of SFO-☐ cables. The number indicates their length in meters.

SFO-1	SFO-3	SFO-7	SFO-12
SFO-2	SFO-5	SFO-10	

SFO-FLEX-☐ cable

TABLE H7.19 Range of SFO-FLEX-☐ cables. The number indicates their length in meters.

SFO-FLEX-10	SFO-FLEX-20	SFO-FLEX-30	SFO-FLEX-40
SFO-FLEX-15	SFO-FLEX-25	SFO-FLEX-35	

The maximum length for fiber optic cables of the references mentioned earlier for best performance is 40 meters.

Mechanical characteristics of the SFO-☐ cable

TABLE H7.20 Mechanical characteristics of the SFO-☐ cable.

Flexibility	Normal. It must only be used in systems under static conditions where the minimum bending radius is 30 mm. Use only in static conditions !
Covering	PUR. Polyurethane resistant to chemical agents used in machine-tools.
Temperature	Work: -20°C to +80°C (-4°F to 176°F) Storage: -35°C to +85°C (-31°F to 185°F)

Mechanical characteristics of the SFO-FLEX-☐ cable

TABLE H7.21 Mechanical characteristics of the SFO-FLEX-☐ cable.

Flexibility	High. Special for cable-carrying chains with a minimum bending radius, in dynamic conditions, is 70 mm. Use only in dynamic conditions !
Covering	PUR. Polyurethane resistant to chemical agents used in machine-tools.
Temperature	Work: -20°C to +70°C (-4°F to 158°F) Storage: -40°C to +80°C (-40°F to 176°F)

i

The SFO-FLEX-☐ fiber optic cables are compatible with the SFO-☐ cables. The SFO-FLEX-☐ are more flexible.

Important. If the fiber optic cable for SERCOS communication between modules is going to be moving (dynamic conditions), **always** use the SFO-FLEX-☐ cable. The SFO-☐ cable will be enough for static conditions (resting). The useful life span of a SFO-☐ cable cannot be guaranteed if it is installed in applications where it works under dynamic conditions (moving).

For SERCOS connection **over 40 m**, use the fiber optic cable with glass core.

Their sales reference is:

SFO-V-FLEX-☐ cable

TABLE H7.22 Range of SFO-V-FLEX-☐ cables. The number indicates their length in meters.

SFO-V-FLEX-40	SFO-V-FLEX-60	SFO-V-FLEX-100
SFO-V-FLEX-50	SFO-V-FLEX-75	

TABLE H7.23 Mechanical characteristics of the SFO-V-FLEX-☐ cable.

Flexibility	The minimum bending radius will be 60 mm in dynamic conditions and 45 in static conditions.
Covering	PUR. Polyurethane resistant to chemical agents used in machine-tools.
Temperature	Work: -40°C to +80°C (-40°F to 176 °F) Storage: -40°C to +80°C (-40°F to 176°F)

7.5.3 RS232/RS422 BE adapter

Before showing other connections, it shows the adapter and the pinout for each end.

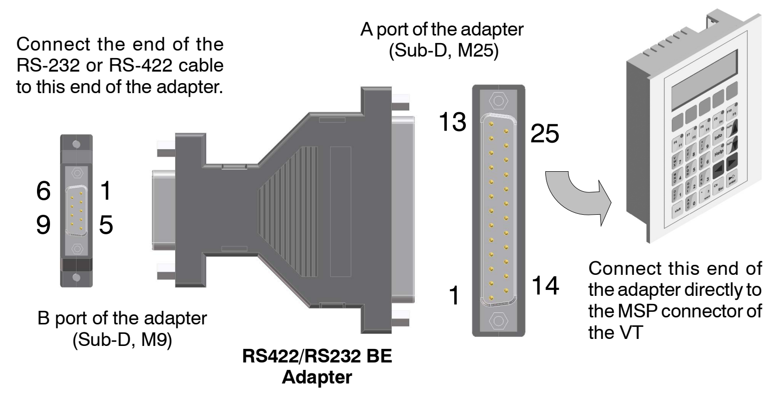


FIGURE H7.6

RS232/RS422 BE adapter.

TABLE H7.24 Description of the pinout of port B connector.

1	N.C. (not connected)
2	T x RS232 OUT
3	R x RS232 IN
4	N.C. (not connected)
5	RS232 GND
6	R x RS422 + IN
7	R x RS422 - IN
8	T x RS422 + OUT
9	T x RS422 - OUT

The pinout for port A is the same as for the MSP port of the VT panel from ESA.

TABLE H7.25 Description of the pinout of port A connector.

1	N.C. (not connected)	14	IKT OUT
2	T x RS232 OUT	15	IKR OUT
3	R x RS232 IN	16	+ 5 V DC (reserved)
4	RTS RS232 OUT	17	N.C. (not connected)
5	CTS RS232 IN	18	∗R x C.L. + IN
6	N.C. (not connected)	19	N.C. (not connected)
7	GND	20	N.C. (not connected)
8	N.C. (not connected)	21	N.C. (not connected)
9	∗T x C.L. + OUT	22	T x R x 485 + IN / OUT
10	T x R x 485 - IN / OUT	23	T x RS422 + OUT
11	∗T x C.L. -OUT	24	R x RS422 - IN
12	T x RS422 - OUT	25	∗R x C.L. - IN
13	R x RS422 + IN		

∗ C. L. : Current loop.

7.6 RS-232 serial line

Fagor does NOT supply these cables. Nevertheless, these are the connection diagrams. Note that the RS232/RS422 BE adapter may be used to connect the RS-232 or RS-422 serial line with a VT panel from ESA.

The user is free to use this Fagor adapter or not. But, it should be used unless indicated otherwise because it makes the connection easier.

7.6.1 RS-232 serial line between a PC and a drive

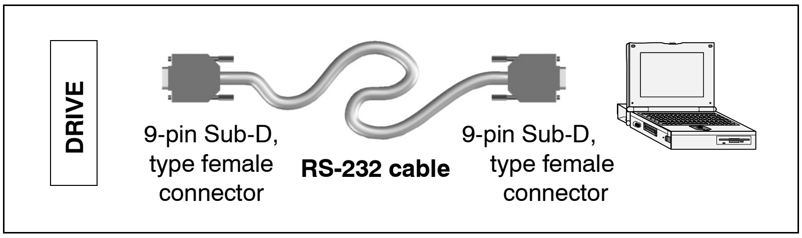


FIGURE H7.7

RS-232 serial line connection between a PC and a drive.

The following connections may be used:

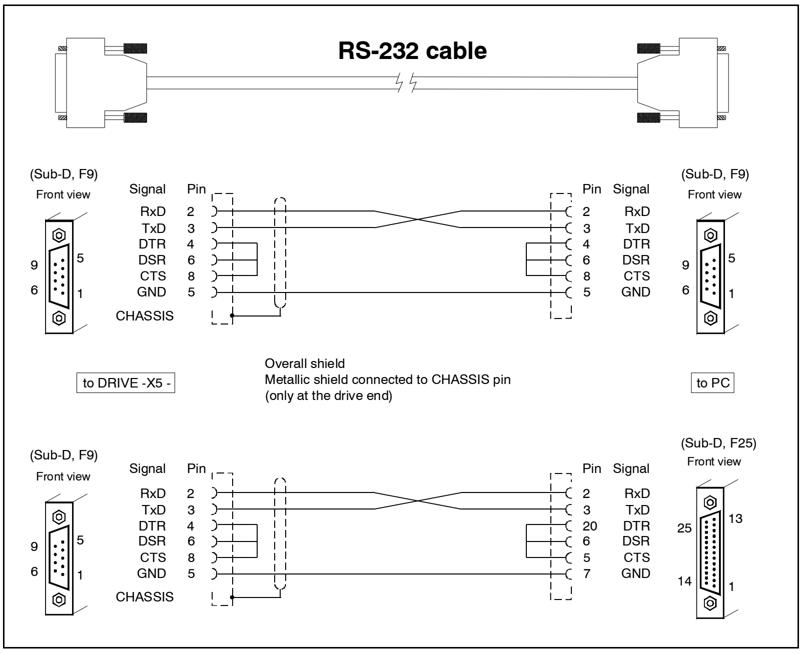


FIGURE H7.8

RS-232 serial line cable between a PC and a drive.

The metallic shield must be soldered to the hood of the connector at the drive end. The user must NOT connect the "reserved" pins anywhere.

It is up to the user to use the RS422/RS232 BE adapter or not for the connection. The following sections show all the connection possibilities.

7.6.2 RS-232 serial line cable between a PC and a VT from ESA

This VT - PC connection is essential for transferring the communication driver and the project.

The connection cable to use will depend on whether the adapter RS232/RS422 BE is used or not.

PC-VT connection using an RS-232 cable (without adapter)

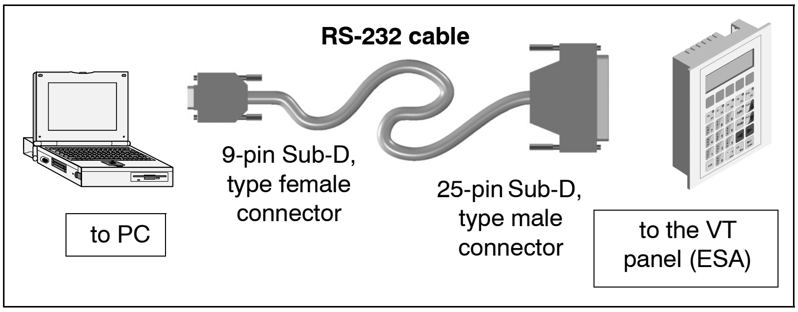


FIGURE H7.9

RS-232 serial line connection between a PC and VT from ESA (without adapter).

The connection cable when not using the adapter RS232/RS422 BE has the following connectors at its ends:

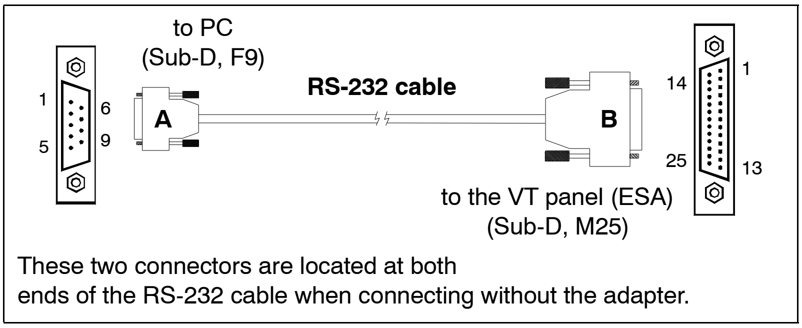


FIGURE H7.10

A. Connector of the RS-232 cable for direct connection to the PC.
B. Connector of the RS-232 cable for direct connection to the VT panel from ESA.

The connection is:

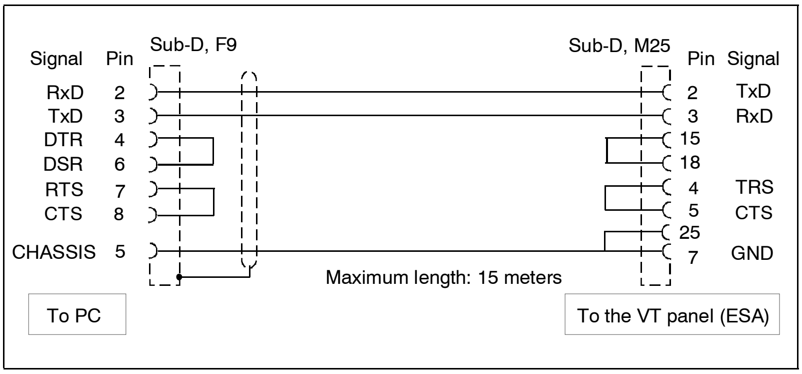


FIGURE H7.11

RS-232 connection between PC and VT without adapter.

See the previous section for further information on the pinout of the 25-pin connector of the MSP port of the VT panel from ESA .

PC-VT connection using an RS-232 cable (with adapter)

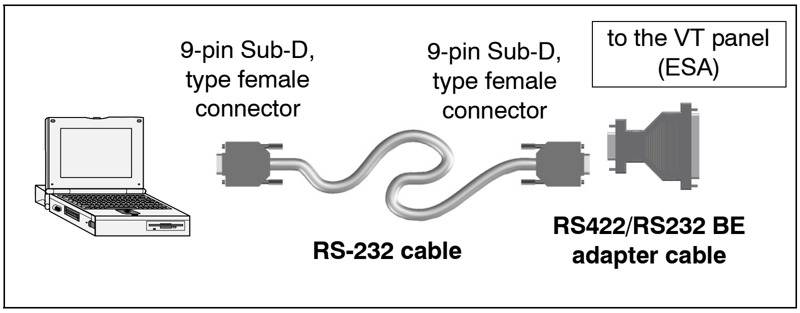


FIGURE H7.12

RS-232 serial line connection between a PC and VT from ESA (with adapter).

The adapter RS232/RS422 BE has the following connectors at its ends:

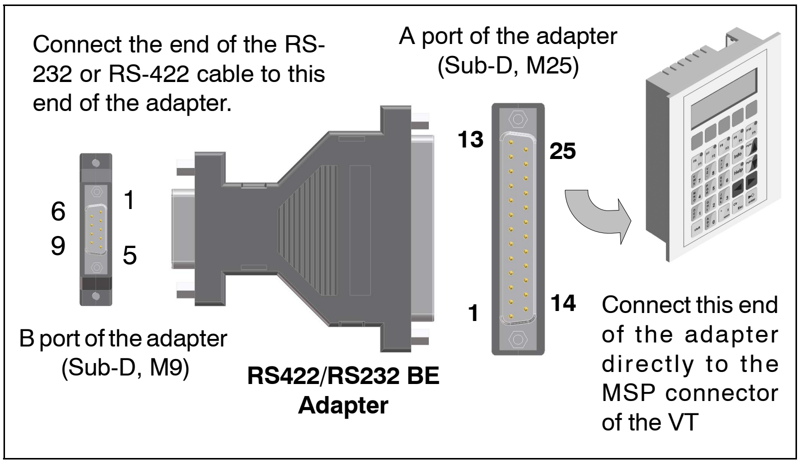
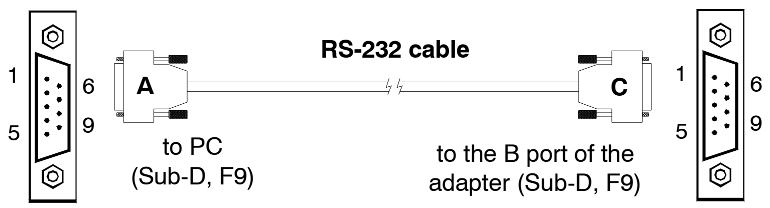


FIGURE H7.13

RS232/RS422 BE adapter.

The connection cable when using the adapter RS232/RS422 BE will have the following connectors at its ends:



These two connectors are located at both ends of the RS-232 cable when connecting with the adapter.

FIGURE H7.14

A. Connector of the RS-232 cable for direct connection to the PC.
C. Connector of the RS-232 cable to connect to the B port of the adapter.

The connection is:

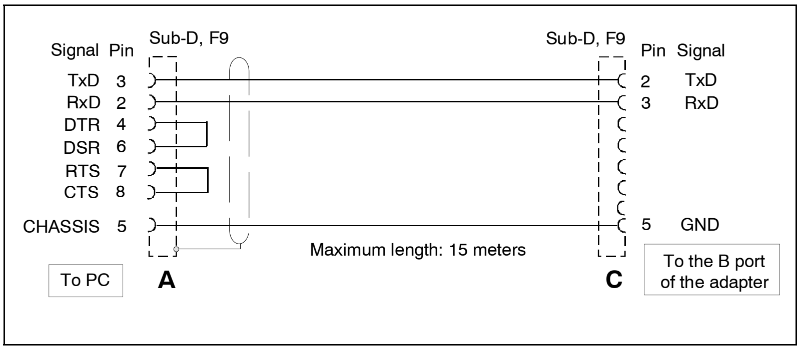


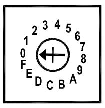
FIGURE H7.15

RS-232 connection between PC and VT with adapter.

7.6.3 RS-232 serial line cable between a VT and a drive

Once the project has been transferred from the PC to the VT (ESA), the video terminal may be connected to a single drive, hence establishing communication via the MSP serial port of the VT and the drive's RS-232 serial port.

> When mentioning a drive, it means any model of the Fagor catalog, i.e. AXD, SPD, ACD, SCD, MMC and CMC models.



Warning. The RS-232 serial line can only be used between the ESA VT and a single drive. The arrow of the drive's node selecting rotary switch (Node_Select) must be pointing at 0.

It is now possible to handle and control from the Video Terminal the process application by communicating with the connected drive. The connection cable to be used is described next.

> The adapter RS232/RS422 BE is not required in any case.

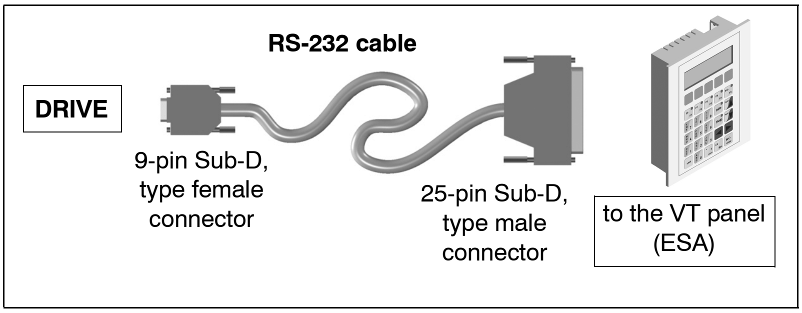


FIGURE H7.16

RS-232 serial line connection between the VT from ESA and a drive (without adapter).

The connection cable has the following connectors at its ends:

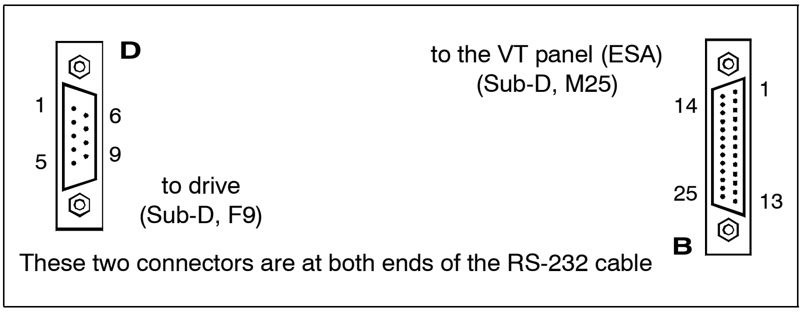
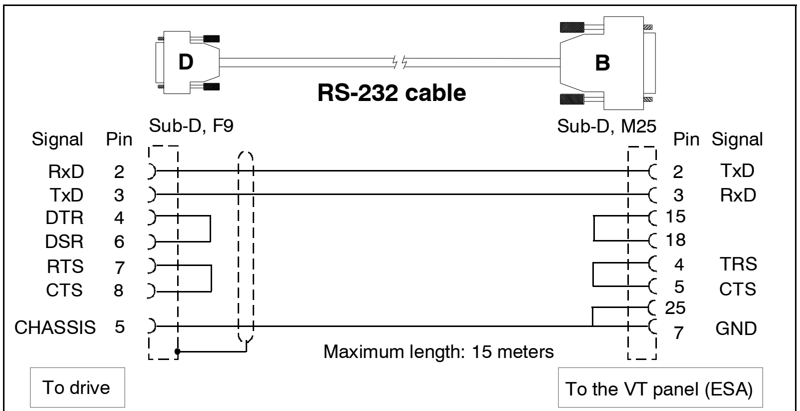


FIGURE H7.17

D. Connector of the RS-232 cable for direct connection to the drive.
B. Connector of the RS-232 cable for direct connection to the VT from ESA.

The connection is:



D. Note that the pairs of pins 4-6 and 7-8 must be jumpered.
B. Note that the pairs of pins 4-5, 7-25 and 15-18 must be jumpered.

FIGURE H7.18

RS-232 connection between a VT and a drive (without adapter).

7.7 RS-422 serial line

Fagor does NOT supply these cables. Nevertheless, these are the connection diagrams. Note that the RS232/RS422 BE adapter may be used to connect the RS-232 or RS-422 serial line with a VT panel from ESA.

The user is free to use this Fagor adapter or not. But, it should be used unless indicated otherwise because it makes the connection a lot easier.

7.7.1 RS-422 serial line cable between a VT and several drives (without adapter)

Important note. Only for MMC or CMC drives.

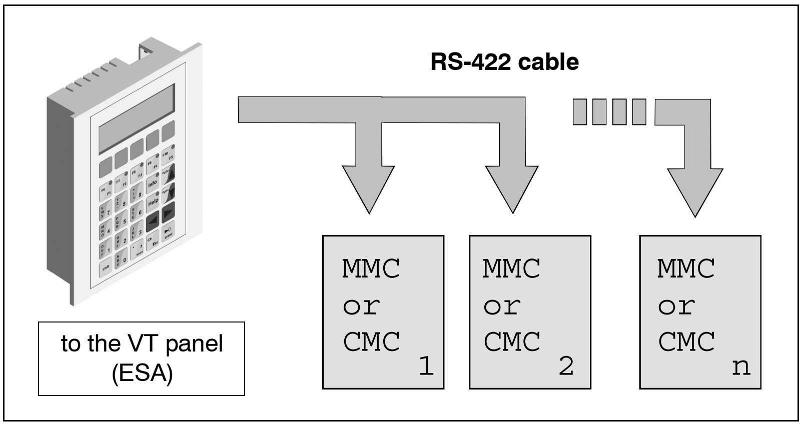


FIGURE H7.19

RS-422 serial line connection between a VT from ESA and several MMC or CMC drives (without adapter).

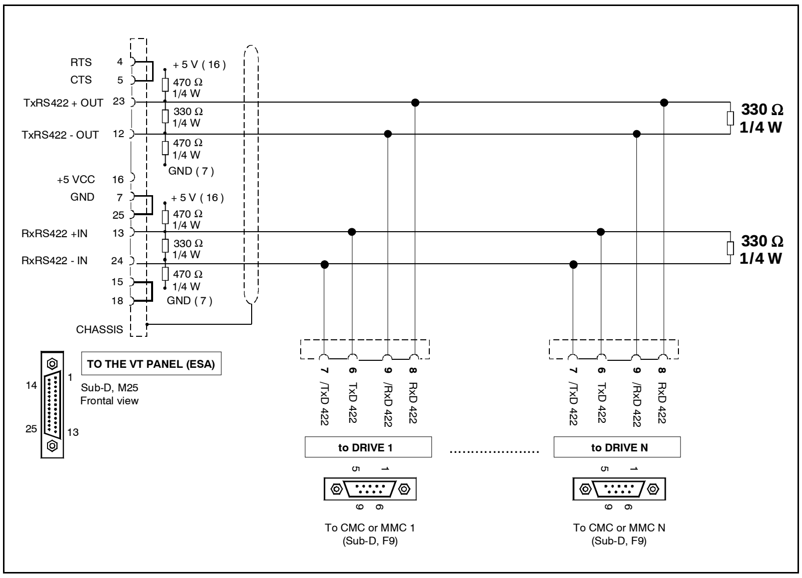


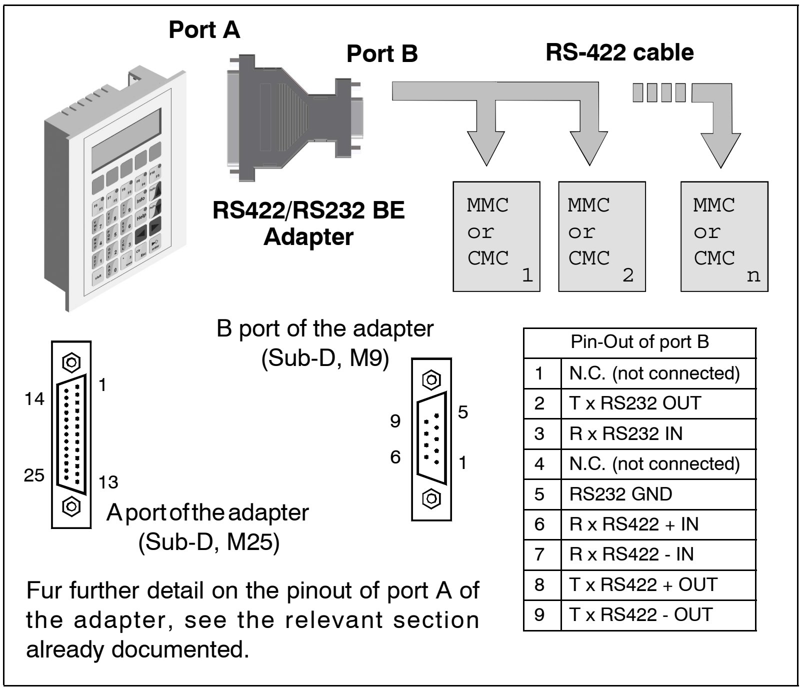
FIGURE H7.20

RS232 serial line cable between a VT from ESA and several MMC or CMC drives (without adapter).

If the user chooses **to use the RS232/RS422 BE adapter**, the RS-422 serial line must be connected as instructed in the following section. This chapter has already described all the details on this adapter as well as the pinouts of its ends.

7.7.2 RS-422 serial line cable between a VT and several drives (with adapter)

Important note. Only for MMC or CMC drives.



Pin-Out of port B	
1	N.C. (not connected)
2	T x RS232 OUT
3	R x RS232 IN
4	N.C. (not connected)
5	RS232 GND
6	R x RS422 + IN
7	R x RS422 - IN
8	T x RS422 + OUT
9	T x RS422 - OUT

Fur further detail on the pinout of port A of the adapter, see the relevant section already documented.

FIGURE H7.21

RS-422 serial line connection between a VT from ESA and several MMC or CMC drives (with adapter).

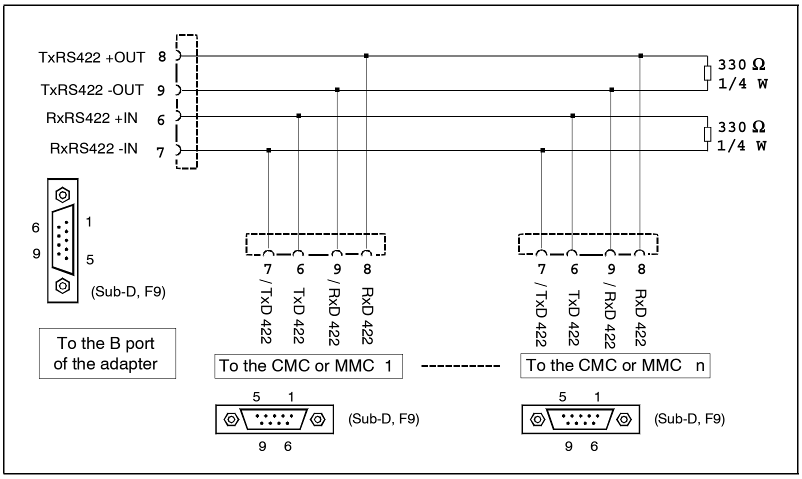


FIGURE H7.22

RS-422 serial line cable between port B of the adapter and several MMC or CMC drives. Port A of the adapter must be connected to the MSP port of the VT panel from ESA.

INSTALLATION

8

This chapter defines the installation process that only covers the DDS servo drive system itself.

The previous chapter already described how to connect the DDS system to the power lines.

8.1 Location

The type of considerations to bear in mind when placing the DDS servo drive system and run the cables must be:

- Environmental
- Mechanical
- Climatic
- Ventilation related
- Cabling related

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

8.1.1 Environmental considerations

It must be installed where:

- There are neither corrosive gasses nor explosives.
- The atmospheric conditions are favorable.
- It is not exposed to oils, water, hot air, high humidity, too much dust or metal particles suspended in the air.

8.1.2 Mechanical considerations

The servo drive system must be installed vertically inside the electrical cabinet.

To secure the modules, 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.

The unit must be installed with a minimum clearance of 80 mm (3.15 inches) on top and at the bottom for heat evacuation.

For further detail, see FIGURE H8.1.

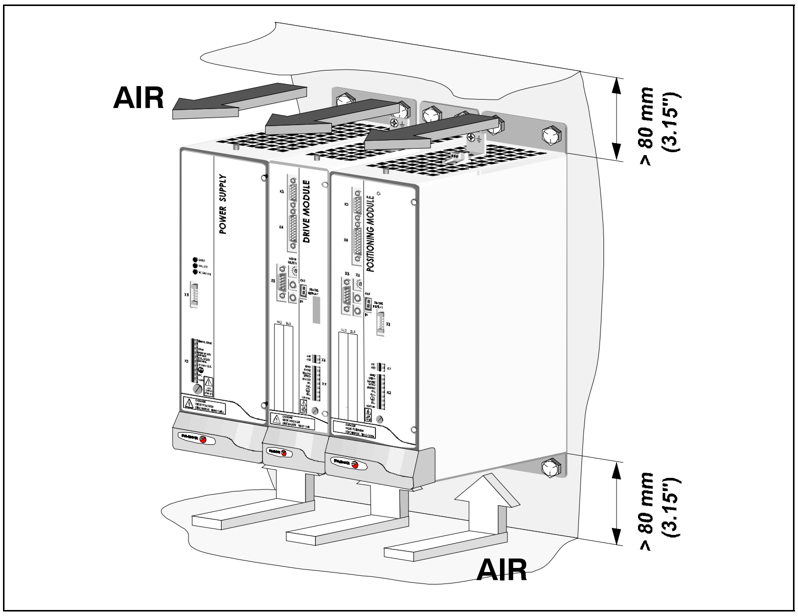


FIGURE H8.1

Top and bottom clearance when installing the DDS system for easier heat evacuation.

Warning. Mount the modular drive of greatest power next to the power supply module and use the same criteria for the rest of the drive modules.

8.1.3 Climatic considerations

The temperature inside the electrical cabinet containing the servo drive system must not exceed 55°C (131°F).

Warning. Never install the DDS system next to a heat source.

The modules generate heat and when trying to decide whether the electrical cabinet containing the DDS system needs external cooling or not, one must know the power dissipated by each one of its modules.

See TABLE H8.1 to know the power dissipated by each one of them.

TABLE H8.1 Power dissipated by the modules of the DDS system.

Power supply module	Power dissipated at max. load.
PS-65A	275 W
PS - 25B4	180 W
XPS-25	180 W
XPS-65	350 W
RPS-80	1 000 W
RPS-75	1 000 W
RPS-45	700 W
RPS-20	500 W
Auxiliary modules	**Dissipated power**
APS -24	60 W
CM 1.60	0 W
ER+TH-x/x and ER+TH-18/x+FAN	It depends on the activation frequency of the Ballast protection circuit.
MAINS FILTER 42A	19 W
MAINS FILTER 130A	40 W
MAINS FILTER 180A	61 W
Modular drives	**Power dissipated at 4 kHz / 8 kHz**
AXD / MMC 1.08	33 / 44 W
AXD / MMC 1.15	69 / 89 W
AXD / MMC 1.25	88 / 132 W
AXD / MMC 1.35	156 / 195 W
AXD / MMC2.50	225 / 305 W
AXD / MMC 2.75	270 / 389 W
AXD / MMC 3.100	351 / 510 W
AXD / MMC 3.150	536 / 605 W
SPD 1.15	98 / 98 W
SPD 1.25	110 / 130 W
SPD 1.35	195 / 201 W
SPD 2.50	349 / 350 W
SPD 2.75	289 / 333 W
SPD 2.85	432 / 438 W
SPD 3.100	496 / 546 W
SPD 3.150	626 / 668 W
SPD 3.200	1163 / 1187 W
SPD 3.250	1333 / 1344 W
Compact drives	**Power dissipated at 4 kHz / 8 kHz**
ACD / CMC 1.08	40 / 50 W
ACD / CMC 1.15	87 / 118 W
ACD / CMC 1.25	110 / 139 W
ACD / CMC 2.35	160 / 206 W
ACD / CMC 2.50	220 / 295 W
SCD 1.15	123 / 123 W
SCD 1.25	150 / 150 W
SCD 2.35	215 / 220 W
SCD 2.50	300 / 315 W

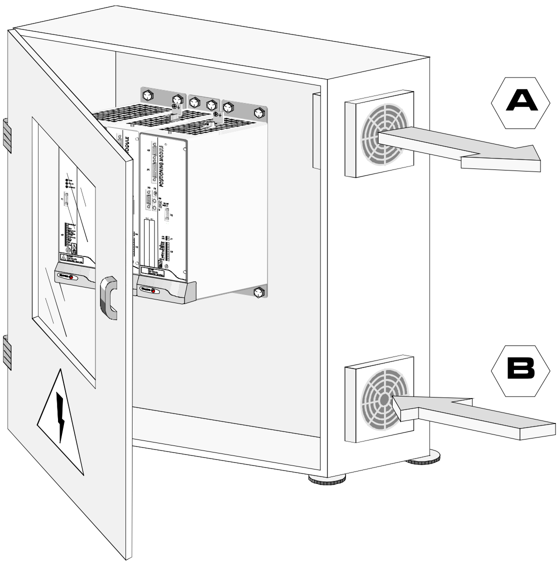
8.1.4 Ventilation related considerations

The following should be used to cool the electrical cabinet:

- **Heat exchangers**: They prevent contaminated air (mist, metallic dust in suspension, etc.) from getting into the electrical cabinet hence eliminating the chances of accumulating particles, condensation, etc. in the cooling circuits of the DDS system modules.

If it is impossible to use heat exchangers, then:

- **Air extraction system**: They prevent the air from entering the electrical cabinet with a fan.



A. Fan. Air output. It is recommended to install a filter.
B. Air input. It is mandatory to install a filter.

FIGURE H8.2

Location of the air intake and output in the electrical cabinet

- Place the extractor fan at the top of the cabinet and the air intake at the bottom. See FIGURE H8.2.
- To have a filter in the air input. The fan should also have a filter.
- Decrease the air intake speed from the outside by making the air input window larger than that of the fan. **The required power and air flow depends on the power installed.**
- Install the DDS system as far away as possible from air inputs and outputs.
- Carry out periodic maintenance on air filters.

Use the following suggestions to minimize the maintenance of this type of cooling systems and the contamination of the electrical cabinet:

- Set the fan to work only when the inside temperature of the electrical cabinet exceeds the predetermined limit (for example 45°C). This will decrease its running time and the flow of the incoming air while increasing the lifespan of the fan. The cost of this solution is minimal using a bimetal type thermostat or controlling it by using one of the outputs of the PLC or CNC.
- Install a fan whose speed varies depending on the air temperature. This type of fans have an NTC sensor either integrated into it or supplied as an accessory by the fan manufacturer.

8.1.5 Installation and cabling related considerations

When designing the electrical cabinet where the DDS system will be installed, the following suggestions should be kept in mind in order to avoid operating problems, breakdown, disturbances, etc.

Hence, we recommend to:

- **Avoid running signal cables and power cables together.** Try to run them as far away as possible form each other.
- Use **shielded cables** for the power cables.
- Lay out the modules and components of the system so **the power cables are as short as possible**, especially the general mains cables, the output cables to the motor and the connection to the choke for XPS or RPS regenerative power supplies.
- Use **double-shielded cables for motor feedback**. Although the system complies with the current regulation on immunity with single-shielded motor feedback cables; better results have been achieved with double-shielded cables considerably exceeding the requirements of such regulation.
- Connect the cable **to the point of same potential** or to ground as recommended.

See **FIGURE H8.3**, **FIGURE H8.4** and **FIGURE H8.5**.

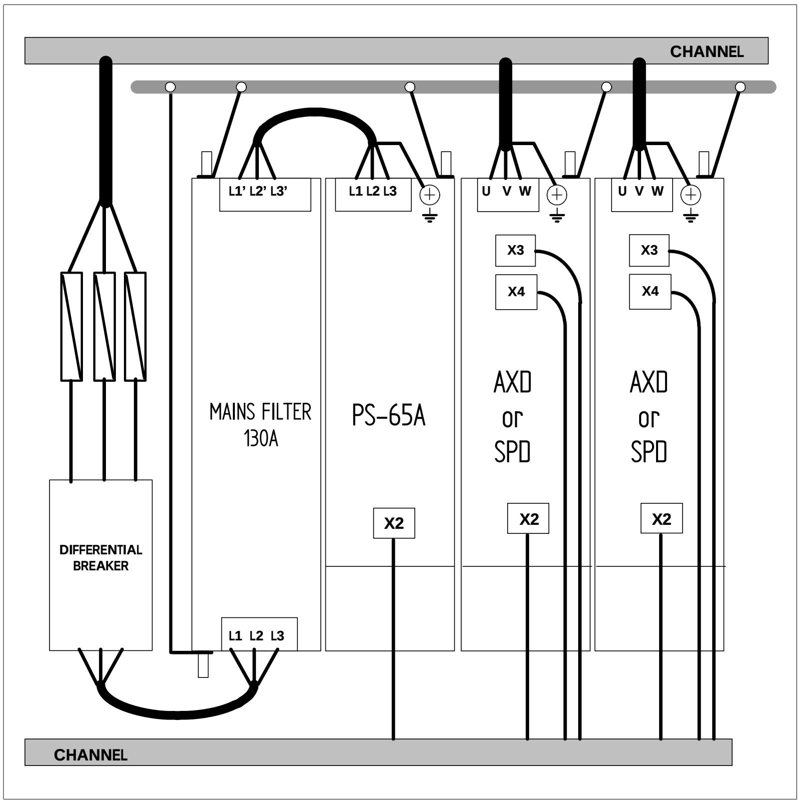


FIGURE H8.3

Cables for connecting the DDS system with a PS-65A power supply.

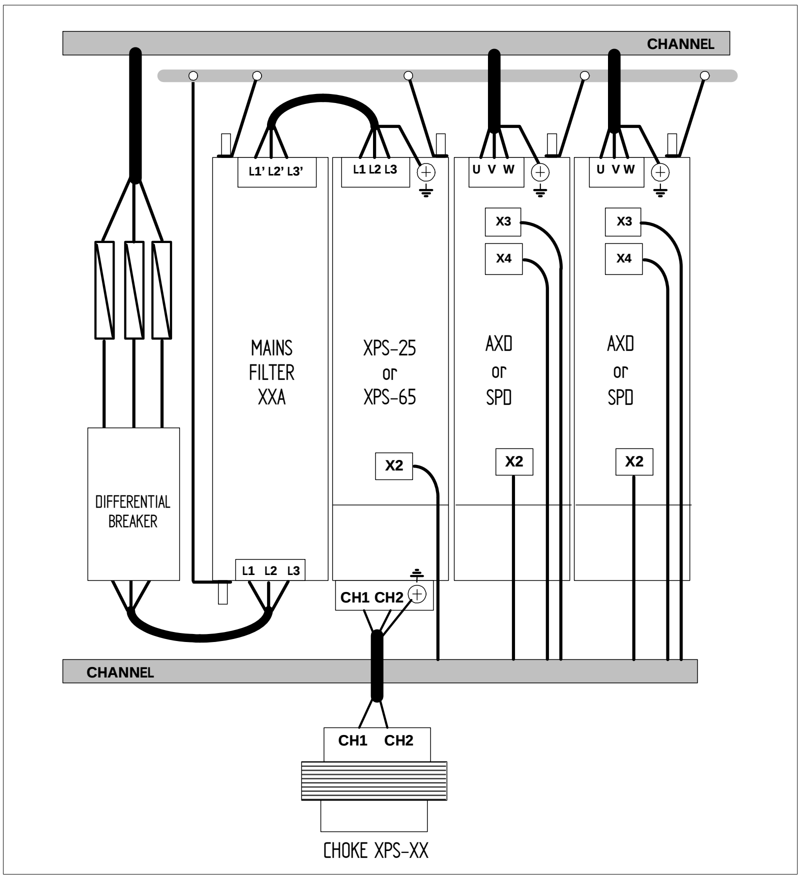


FIGURE H8.4

Cables for connecting the elements of the DDS system with an XPS-□□ power supply.

See **FIGURE H11.7** for further information on RPS-75-3, RPS-45 or RPS-20 chokes.

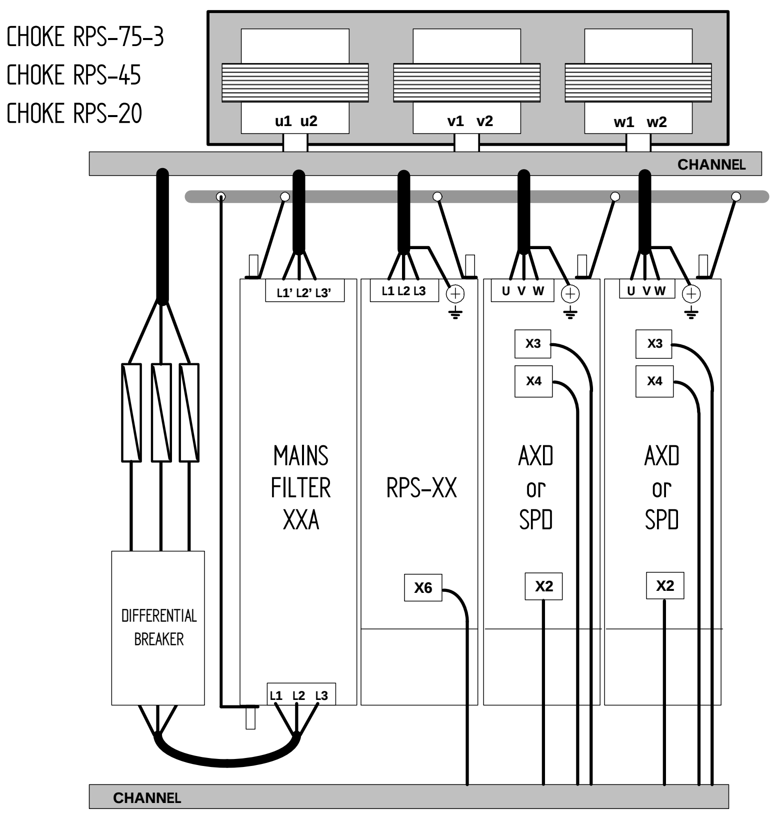


FIGURE H8.5

Cables for connecting the DDS system with an RPS-□□ power supply.

Considerations to bear in mind to improve electromagnetic compatibility.

- Usually, when connecting two units that are connected to ground, the cable shield must be connected at both ends.
- When the connections include analog signals, it will only be connected at one end (usually the receiver) .
- If one of the units does not have a ground connection, the shield must be connected only at the end of the unit connected to ground.
- When using shielded cables, interruptions must be avoided. When this is not possible, use the shielded interconnection systems (e.g.: connectors with metallic housing).
- If it is not possible to use shielded connectors (with metallic housing), make the cables as short as possible to ensure the best connection between the cable shields . See FIGURE H8.6.

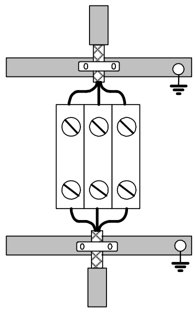


FIGURE H8.6

Make the shielded cables as short as possible when the connectors are not shielded.

- When connecting power cables, the shield of this cable should be connected to a ground bar. See FIGURE H8.7.

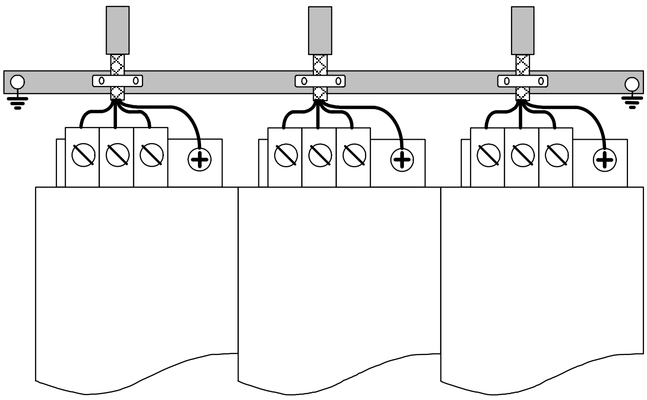


FIGURE H8.7

Connection of the power cable shield to a bar that is connected to ground.

8.2 Inductive components

8.2.1 Considerations

Installing the DDS system requires certain precautions regarding the connection of the inductive components such as contactors, relays, electrovalves, motor brakes or, in general, any type of coil.

Hence:

- All inductive circuits or components must have their own interference suppressor that must be installed as close as possible to the inductive component.
- The mentioned interference suppressors will be RC circuits, varystors or suppressor diodes.

Warning. Do **not** use **fly diodes** as interference suppression elements for inductive components. These diodes can only serve as interference suppressor of the inductance due to the cabling itself.

- The excitation cables of the inductive components and the signal cables must not run in the same channel especially when not using shielded cables for these signals. A typical scenario is when using inductive proximity switches or similar usually connected with an unshielded cable.
- In extreme situations and if the sensors used on the machine are very sensitive to the interference conducted through the supply cables (24 V DC), it may be necessary to isolate or decouple them from that of the supply of the system elements (inductive components, drives, etc.).

8.3 System installation

8.3.1 Preparation

After knowing the system's environment, the step before installing the DDS system is the following:

- Preparing the mounting fixtures inside the electrical cabinet. See chapter **11. DIMENSIONS**, that shows all the necessary values.
- Unpack motors, drive modules, auxiliary modules and other elements that make up the DDS system.
- Mount each of the motors on the machine.
- Install all the modules making up the servo drive system in the electrical cabinet.

8.3.2 Procedure

Follow these steps for a complete system installation:

- Mount all the system modules in the electrical cabinet.
- Mount the mains filter.
- Connect electrically and mechanically all the modules with each other.
  1. Connect the plates on the power bus located at the bottom of each module (under the cover).

Remember that a auxiliary power supply is already integrated into the XPS and RPS power supplies. If it is necessary to also install an APS-24 auxiliary power supply module for any reason together with one of these power supplies, **NEVER connect APS-24 modules whose reference is PF 23A or older.** With newer references, you may connect the APS-24 module to the power DC bus of the DDS system regardless of the main power supply it may come with.

  2. Connect the ground bars at the top and make the connection next to the ground terminal.
  3. Connect the internal bus.
  4. Connect the external Ballast resistor accordingly.
     See the section "heat dissipation" in this chapter.
- Connection with motors and the CNC.
  1. Cable from mains to the drive system through the filter.
  2. Power cable from each motor to each drive.
  3. Feedback cable from each motor to each drive.
  4. Circuit for the control of the brake (if applicable).
  5. Power for the 24 V DC auxiliary power supply from mains (APS -24, PS-25B4, XPS or RPS).
  6. Power the control circuits of each drive module with 24 V DC.
- Control and communications signals.
  1. Encoder simulator cable from each drive to the CNC (if applicable).
  2. Analog velocity command voltages from the CNC to each drive.
     See the section "analog command" in this chapter.
  3. Connection of the control signals of the modules, inputs and outputs.
  4. SERCOS ring connection.
     See the section "SERCOS connection" in this chapter.
  5. Identify each system drive with its rotary switch.
  6. Module connection with the CNC through a fiber optic ring (SERCOS).
     See the section "SERCOS connection" in this chapter.
  7. Module connection with an ESA panel via RS-422 if applicable. See the section "RS-422 serial line connection" in this chapter.

Remember that Fagor provides all the cables needed for the installation. If the user chooses to make his own cable, - see chapter **7. CABLES -** that indicates the pinout of the connectors at both ends, mechanical characteristics and other considerations.

- Adjust the modules through the RS-232 serial line using the application for PC (WinDDSSetup).

In order for the Fagor Servo System to meet the European Directive on Electromagnetic Compatibility 2004/108/EC, the modules installation rules must be strictly followed regarding:

- Installation of the "Mains Filter ☐A".
- Electrical installation of the power stage: wiring to mains and motor-drive power connection.

8.4 Connection between modules

8.4.1 Power bus connection

The power bus is connected through the terminals hidden under the cover at the bottom of each module. To do this, use 2 of the 3 plates and the washers and nuts supplied with each module.

Warning. All the modules must be tightly joined to each other guaranteeing a good electrical contact.

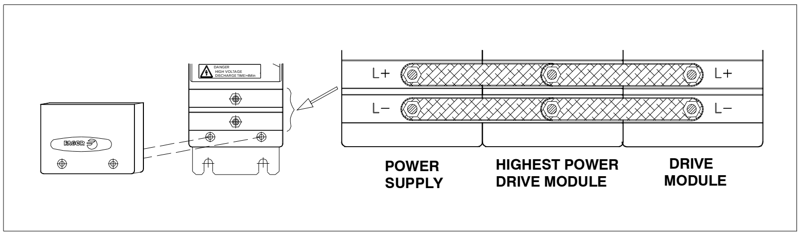


FIGURE H8.8

Power bus connection.

The tightening torque must be between 2.3÷2.8 Nm.

The power supply module must provide the power needed by all the drives connected to it. If this power exceeds the maximum value that the power supply can provide, two power supplies will be required.

Assign to each of them the supply of a separate group of drives.

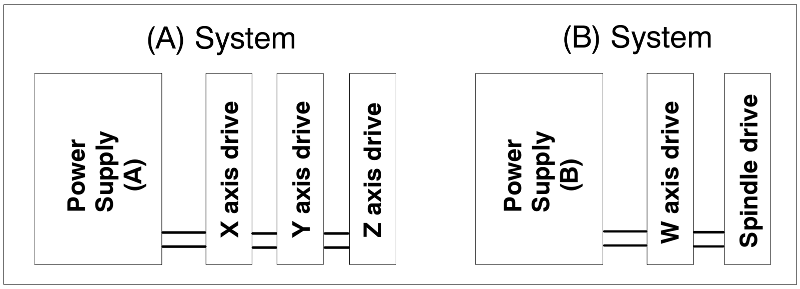


FIGURE H8.9

If two power supplies are needed, they must be installed in separate groups.

Warning. 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.

8.4.2 Joining the chassis between modules

The chassis of the modules must be connected to each other through the terminal on top of each module. To do this, the third plate and the washers and nuts supplied with each module.

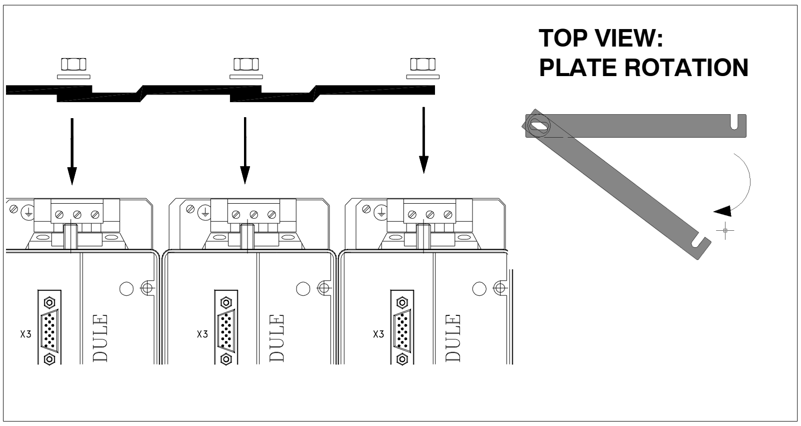


FIGURE H8.10

Joining the chassis between modules.

The tightening torque must be between 2.3÷2.8 Nm.

Connecting these terminals by means of metal plates offers mechanical rigidity; but **it does not guarantee** proper ground connection of each module.

To replace a drive module in case of a failure or remove it from the DDS system for inspection, follow these steps to "free" it from the other modules.

A. Loosen the screw and the nut of the affected module.

B. Loosen the nut of the adjacent drive on each side that joins it to the affected drive.

C. Rotate the plate of the affected drive and that of the one to its left, see FIGURE H8.10.

After these steps, the drive will be totally free from the rest of the drives that were joined by the plate.

All the cables connecting it to the rest of the modules must also be removed.

8.4.3 Ground connection

The chassis of each modules must be connected 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 1V. Use the washers and nuts supplied with each module to make the ground connection.

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.

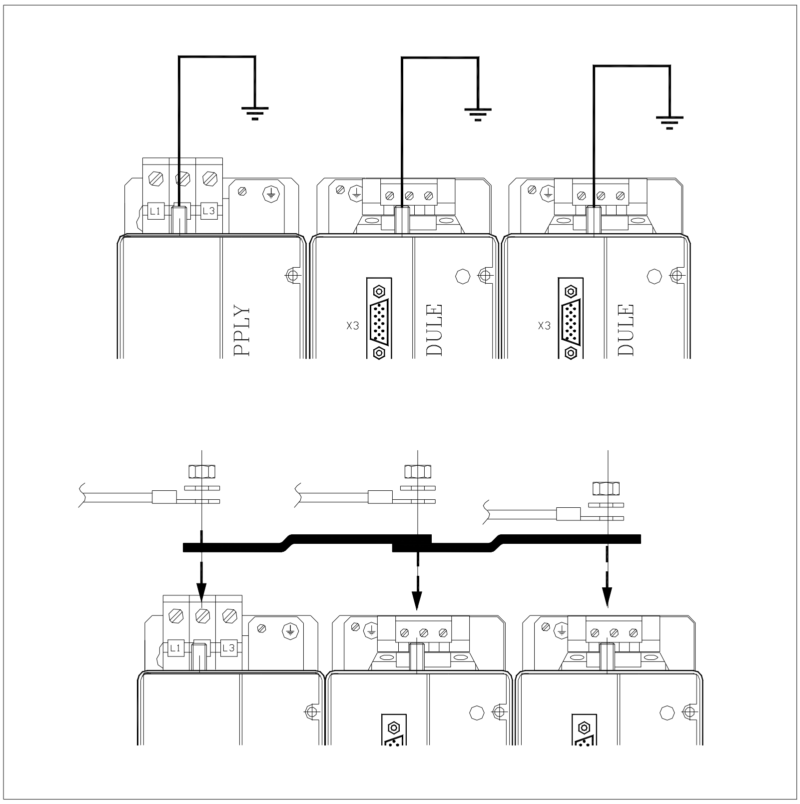


FIGURE H8.11

Ground connection.

The tightening torque must be between 2,3 ÷ 2,8 Nm..

Warning. Take a ground cable (as short as possible) from each module to each main machine ground point.

CE regulation:

Warning. In order to ensure compliance with the European Directive on Electromagnetic Compatibility 2004/108/CE, it is a must to:

- Power the system through "Mains Filter □A".
- 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 in **FIGURE H8.11** with a cable having a section equal to or greater than the three - phase power supply and at least 6 mm².
- Always use shielded cables for three-phase motor connections. See chapter **7. CABLES**.

8.4.4 Internal bus connection

To make this connection, join the X1 connectors of each module with the ribbon (flat) cables supplied with each of them as shown in FIGURE H8.12.

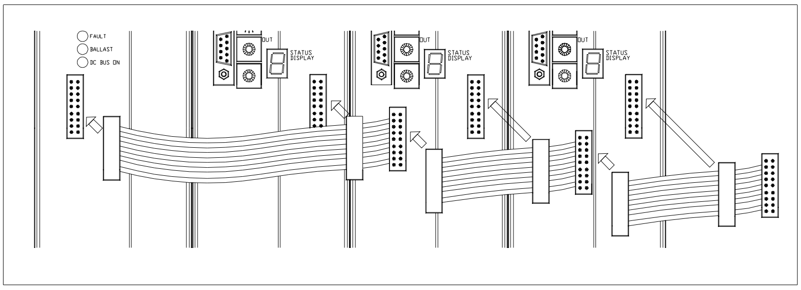


FIGURE H8.12

Internal bus connection.

8.4.5 Connection to the external Ballast resistor

The external resistor modules are designed to be installed in the corresponding terminals of the power supplies or compact drive modules (with an integrated power supply) in order to dissipate the excess energy generated when braking the servomotors.

See chapter **4. Resistor modules**, for further detail on the external Ballast resistors associated with the power supplies and with the compact drives.

See chapter **5. Ballast resistor selection guide** to know whether this module is required or not in the power supply.

Electrical configurations

The two possible configurations are the ones shown in FIGURE H8.13.

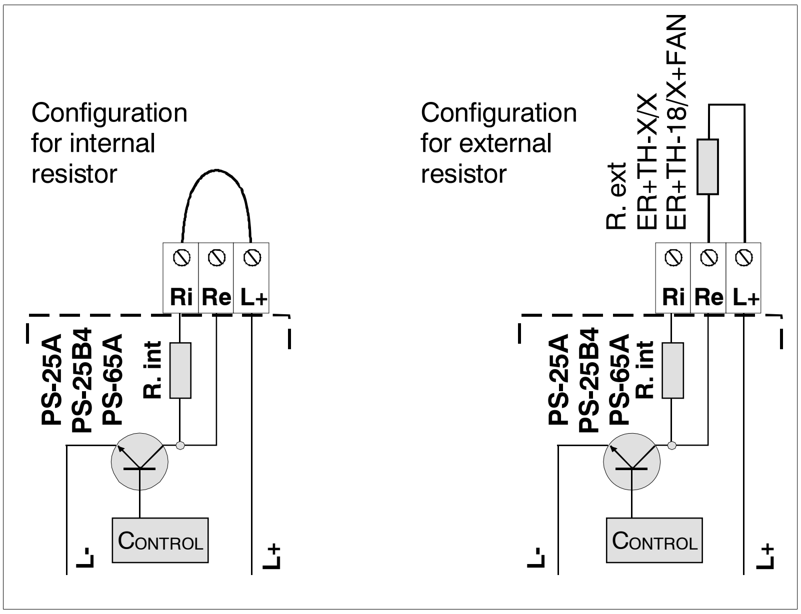


FIGURE H8.13

Electrical configurations of the Ballast resistor.

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

Ohm values

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

See the tables of **chapter 4. Resistor modules** that show the modules and the associated Ballast resistors.

Warning. On all compact drives (except those whose reference is SCD-NR x.xx), the external resistor supplied with the units. ACD/SCD/CMC 1.08 /1.15 models are also an exception.

On compact drives "ACD//SCD//CMC 1.08 /1.15", as opposed to the rest of the compact models, do not install any external Ballast resistor. The internal one is enough, except on "SCD 1.15" models where it would be possible to install the internal resistor ER+TH-43/350 if the application so required.

In general, on compact models "ACD//CMC 1.08/1.15" the internal dissipation Ballast resistor will be enough, but if it is not in a particular situation, it is possible to install an external resistor of the same Ohm value as the internal one and greater dissipation power.

Note. Actually, the external resistor provided with the unit is considered enough for most applications. If it is not enough, install one of the same Ohm value and greater power.

On any compact drive whose reference is SCD-NR x.xx no external Ballast resistor will supplied with the unit. The user will place the order for the external resistor required by the application with a Fagor representative.

Heat dissipation

Ballast resistors can generate a great deal of heat. That's why, sometimes, depending on the temperature of the installation area, it may be necessary to evacuate the heat by means of fans.

Warning. The Ballast resistors supplied by Fagor do not have a fan mounting system. If the location required installing one or several fans, it will be up to the user to get an off-the-shelf mounting device to install them.

Hence, when using a fan (a PAPST 614 type, for example) to evacuate the heat, the temperature reached at the top of the module and the effect of the fan may be seen in the table.

TABLE H8.2 Temperatures reached in the points defined earlier FIGURE H8.14. * Temperature variation due to the effect of the fan (PAPST 614). Temperature in °C (conversion: °F=32+1.8·°C).

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

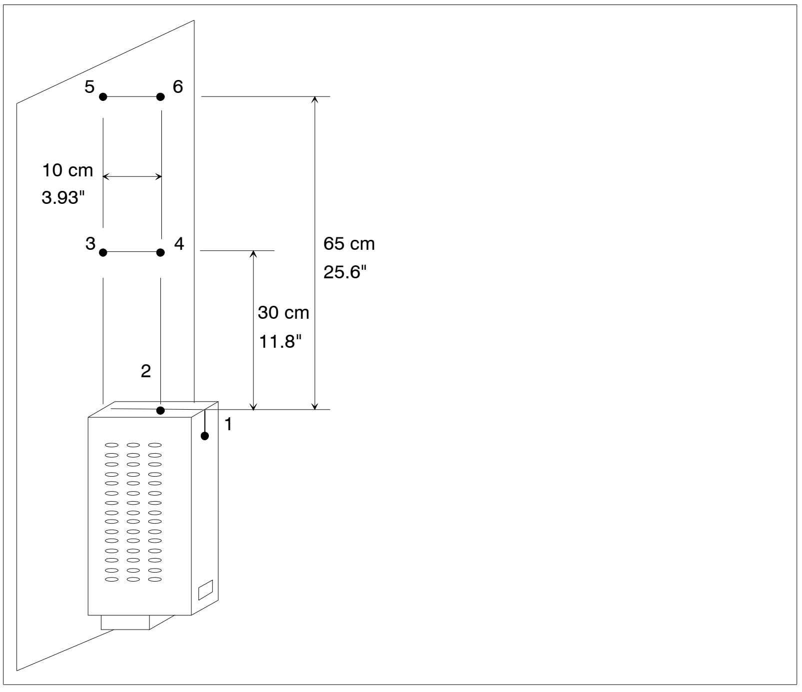


FIGURE H8.14

Location of the temperature measuring points.

Warning. On top of the ER+TH modules, the air temperature can reach values over 120°C (248°F). Therefore, the module 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.

8.5 Power supply connections

See chapter **6. POWER LINE CONNECTION** of this manual for connecting the mains cable through the filter.

To connect the power cable, the motor-drive cable and the brake control circuit, see the relevant chapter in the motor installation manual.

8.5.1 Power supply for the control of modules

The internal circuits of all electronic modules need 24 V DC.

The power supply module PS-65A and the modular drives need this voltage supplied through their connector X2.

These modules have stabilizing system for the supplied voltage.

The maximum consumption of each module is:

Power supply PS ➔ 1 A

Modular drive ➔ 2 A

Warning. The 24 V DC voltage supply is essential for the system to run.

The auxiliary power supply APS-24 offers 24 V DC and 10 A. Regenerative power supplies XPS-□□ and RPS-□□ and non-regenerative power supplies PS-25B4 supply themselves and also output a total of 8 A of their 24 V DC. Compact drives are self-supplied and offer up to 110 mA of these 24 V DC.

Warning. All these 24 V DC can also be used in the circuit of the electrical cabinet, but never to activate the brake of a motor. **This is an absolute must in order to comply with the CE requirement for the machine.**

Warning. The 24 V DC can also be used in the circuit of the electrical cabinet, but **NEVER TO ACTIVATE THE MOTOR BRAKE !**

Warning. Proper performance cannot be guaranteed in all possible cases and situations, especially when connecting inductive components.

8.5.2 Connection of the APS-24 power supply

Take two mains phases and ground to the input connector X1 of the auxiliary power supply APS-24. See **FIGURE H8.15**.

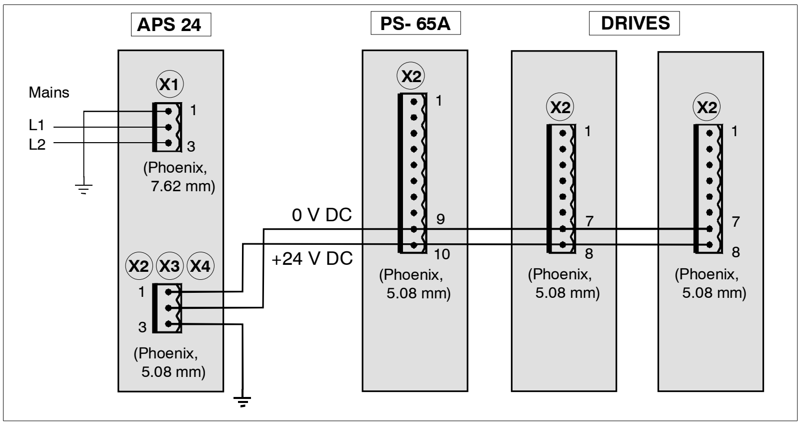


FIGURE H8.15

Connection of the APS-24 with the PS-65A power supply and the modular drives.

8.5.3 Connection of the auxiliary power supply integrated into the PS-25B4 & XPS-XX

Take the two mains phases and ground to the input connector X3 of the auxiliary power supply integrated into the main power supply. See **FIGURE H8.16**.

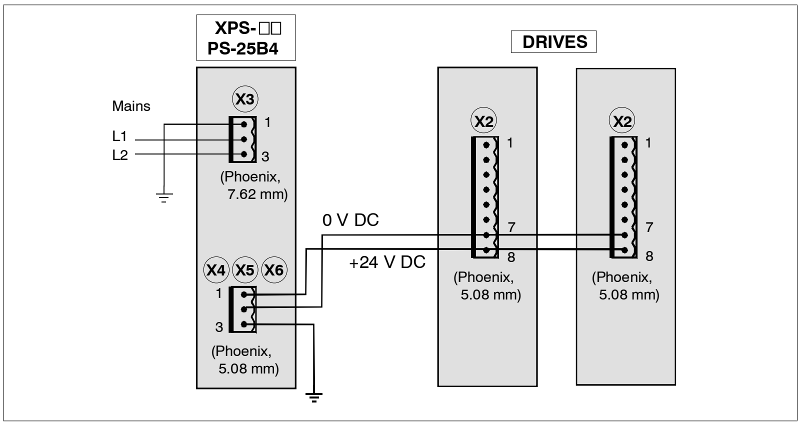


FIGURE H8.16

Connection of the auxiliary power supply integrated into the PS-25B4 and XPS-□□ with the modular drives.

8.5.4 Connection of the auxiliary power supply integrated into the RPS-XX

Take the three mains phases and ground to the input connector X1 of the main power supply See **FIGURE H8.17**.

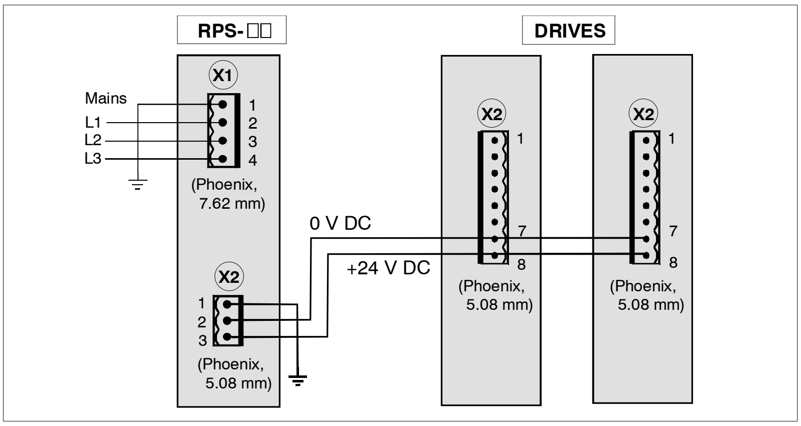


FIGURE H8.17

Connection of the auxiliary power supply integrated into the RPS-□□ with the modular drives.

8.6 Connection of the control and communications signals

8.6.1 Motor feedback connection

There are two types of motor feedback: encoder or resolver.

The connection is made between the motor feedback connector and connector X4 of the drive module. For further detail on the cables supplied by Fagor for connecting the motor feedback, see chapter **7. CABLES**. The technical data for the motor feedback connector is shown in the corresponding motor manual.

8.6.2 Direct feedback connection

There are two types of direct feedback: linear encoder (incremental or absolute scale) or external rotary encoder.

The connection is made between the connector of the linear encoder or external encoder and connector X3 of the drive module. For further detail on the cables supplied by Fagor for connecting the direct feedback, see chapter **7. CABLES**.

8.6.3 Encoder simulator connection

Depending on motor feedback, the drive can generate a set of signals that simulate those of a TTL encoder attached to the rotor of the motor.

The encoder simulator board of the drive module is connected to the CNC through the connector X3 of each drive (see its front panel) and connectors X1, X2, X3 or X4 of the 8055 CNC. For an 8055i CNC, the connectors will be X10, X11, X12 and X13.

For further detail on CNC connection, see the corresponding CNC manual.

See chapter **7. CABLES** for further detail on the cables supplied by Fagor for this connection.

8.6.4 Connection for the reception of the analog command.

Connector X7 of the drive has two analog input to receive the analog velocity command sent out from connector X8 of the 8055 CNC. Connector X7 offers ±15 V DC to easily generate the velocity command with a potentiometer. An internal parameter of the drive selects the input that the servo system attends to.

See parameter IP1 in chapter 13 of the "dds-software" manual.

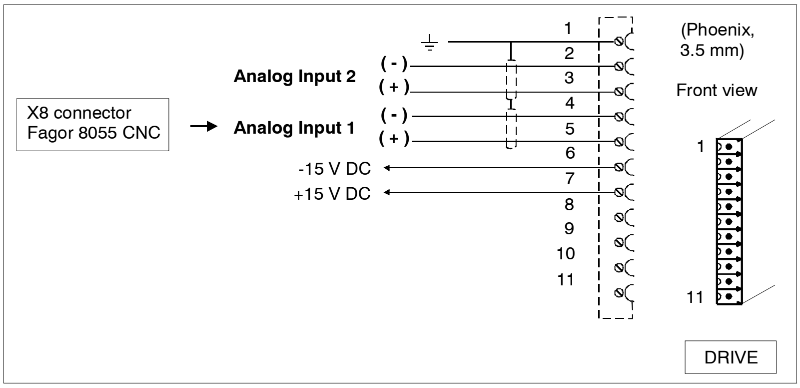


FIGURE H8.18

Analog velocity command inputs.

8.6.5 Connection for the digital outputs

When the drive outputs are connected to inductive loads, we must protect the optocoupler with circuits such as the ones shown in FIGURE H8.19.

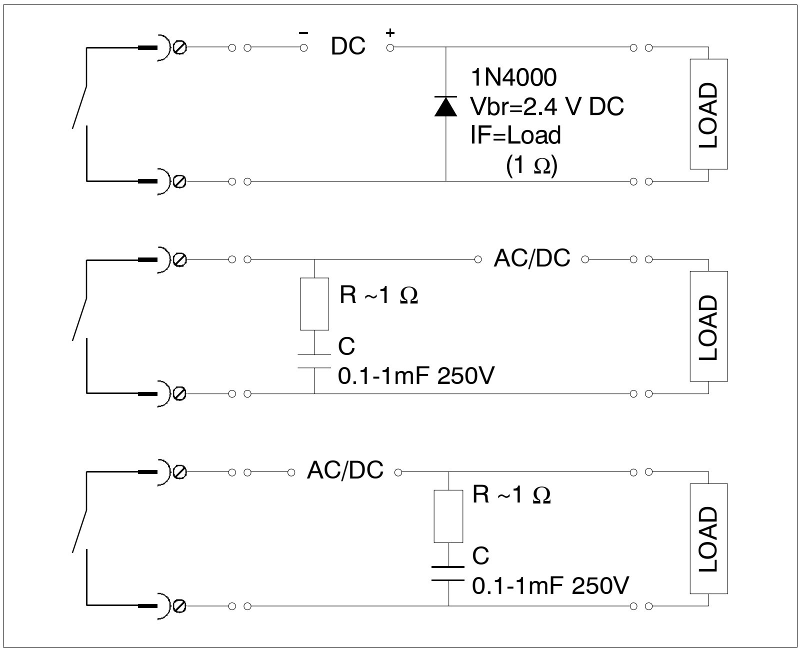


FIGURE H8.19

Protection circuits for the opto-coupler of the digital output with inductive loads.

8.6.6 SERCOS ring connection

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

The SERCOS communication 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, hence, making it more reliable.

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

The different drive modules and the CNC are connected through SERCOS connector X6 carried by each drive of the Fagor catalog (see their front panel) through optic fiber. See chapter 7. CABLES of this manual

It is a ring connection where the 16-position rotary switch (0-15) of each drive permits selecting the address of each module integrated in it.

Particular

Differentiate each drive with the 16-position rotary switch "NODE SELECT" with sequential numbers starting from 1.

Note. The module must be reset in order for any change made on the rotary switch to be effective.

Warning. The DRIBUSID parameters of the CNC must have the same ID numbers as the ones assigned by means of the Node_Select switch. Refer to FIGURE H8.20.
If the same motor is to be used as C axis and spindle, the two CNC tables must have the same value for the DRIBUSID parameter.

If the zero identifier is assigned to a drive, that module will be ignored, even when the ring stays closed for all purposes for the rest of the drives. That drive may receive an analog velocity command and be adjusted through the serial line.

Example.

For example, a machine has four servo drives identified as 1, 2, 3 and 4. To ignore the second one, another one must be renamed so they are consecutive. The easiest solution for a situation like this will be 1, 0, 3 and 2.

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

If the drive is going to be identified in the SERCOS ring with a number higher than 15, this value cannot be selected using the rotary " NODE SELECT " switch because it only has 15 positions. . Identifying axes in the ring with addresses higher than 15 requires setting QP13. See this parameter in chapter 13 of the "dds-software" manual.

Example.

How to identify an axis addressed in position 24 in the system SERCOS ring ?

When the identifier of the axis in the ring is higher than 15 (like in this case), QP13 must be set so it meets the ratio:

Defined Id = Id to be selected at the rotary switch + (15 x QP13).

Hence, for **defined Id = 24**, select the A position at the drive's rotary "NODE SELECT" switch (same as 9) and set QP13=1.

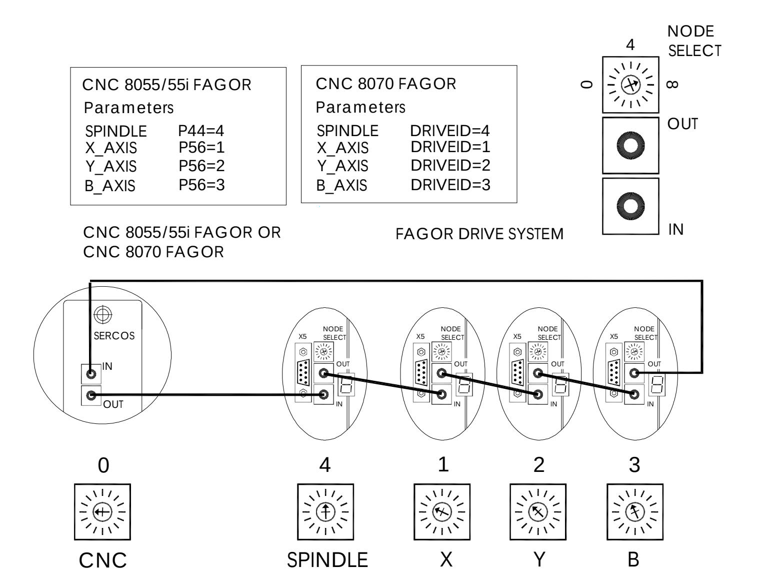
Interconnection

Connect in the SERCOS ring all the drives that will be governed by the CNC.

- With each fiber optic line, connect the OUT terminal of the first drive with the IN terminal of the next adjacent drive.
- Repeat this procedure with the second drive and so on up to the last drive.
- Connect the OUT terminal of the last drive with the IN terminal of the CNC.
- Connect the IN terminal of the first drive with the OUT terminal of the CNC.

When all these connections have been made, the ring will be closed. See FIGURE H8.20.

With each drive, Fagor supplies a fiber optic line to connect it to its adjacent module and, upon request, the rest of the required optical fiber. See chapter 7. CABLES.



Note. Remember that for sections longer than 40 meters, you must use the fiber optic cable (SF0-V-FLEX).

FIGURE H8.20

General connection diagram for the SERCOS ring between the CNC and the drives.

Note that if the machine has two separate servo drive system (each with its own power supply) and a single CNC, the same ring must interconnected all the drives of the machine.

Warning. The bending radius of fiber optic cables SF0 and SF0-FLEX must always be more than 30 mm. For SF0-V-FLEX cables, this radius must be more than 60 mm.

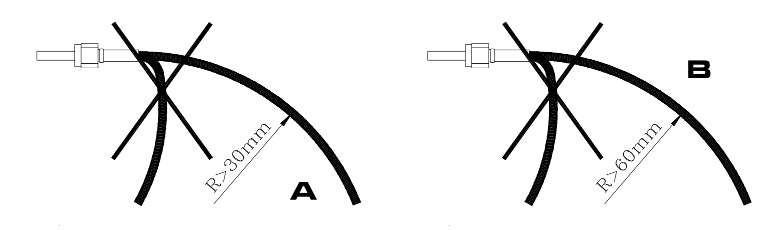


FIGURE H8.21

Minimum bending radius. **A.** Fiber optic cables SF0 and SF0-FLEX. **B.** Fiber optic cable SF0-V-FLEX.

Handling fiber optic cables

Fagor supplies the fiber optic cables with its terminals protected with a hood. Remove the terminal protecting hood before connecting any of these cables.

Either to remove the terminal protecting hood or to connect and disconnect the cable, the cable must always be held by the terminal, never pull at the cable because it could get damaged. See FIGURE H8.22.

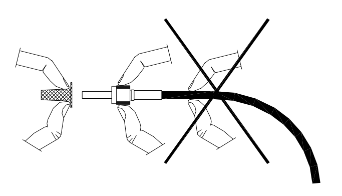


FIGURE H8.22

Handling fiber optic cables.

Transmission speed selection

From version 06.05 on, the drive may have a SERCOS board capable of transmitting data at 2, 4, 8 or 16 MBd.

This board is only compatible with software version 06.05 and later. See chapter 13. COMPATIBILITY.

In this data transmission, each drive can receive and transmit 8 IDns (SERCOS identifiers) or 16 Words through the fast channel.

The communication speed between all the drives being governed by the CNC in the SERCOS ring is selected by hardware using the "boot" button on top of the SERCOS board connector. See FIGURE H8.23.

Consequently, the serial connection will no longer be necessary to select the transmission speed.

The parameter associated with the communication speed selection of the SERCOS ring is QP11 and every time a speed is selected, this parameter is associated the corresponding value.

See TABLE H8.3 that shows the possible transmission speeds that will be displayed at the drive and chapter 13 of the "dds-software" manual to know the meaning of parameter QP11.

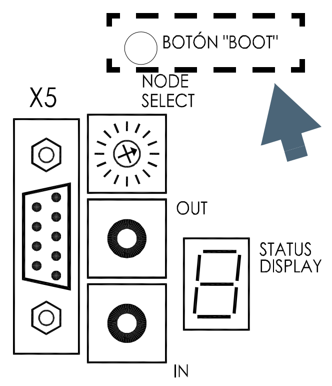


FIGURE H8.23

Location of the "BOOT" button at the drive.

Transmission speed changing procedure

In an initial state (0 state), the display shows the information that already showed in previous versions (errors, SERCOS phase, etc.). Keeping the "boot" button pressed for 3 seconds (long push) it switches to a new state (state 1) that is used for selecting the communication speed and the display shows the speed currently selected.

In this state 1, every time this button is pressed for less than 0,8 seconds (short push), the display shows the next communication speed value that may be selected.

Hence, apply several short pushes until the desired speed is displayed.

Once the display shows the desired speed, apply a long push and QP11 will be assigned its associated value that will be saved into the flash memory of the drive and will reset the drive.

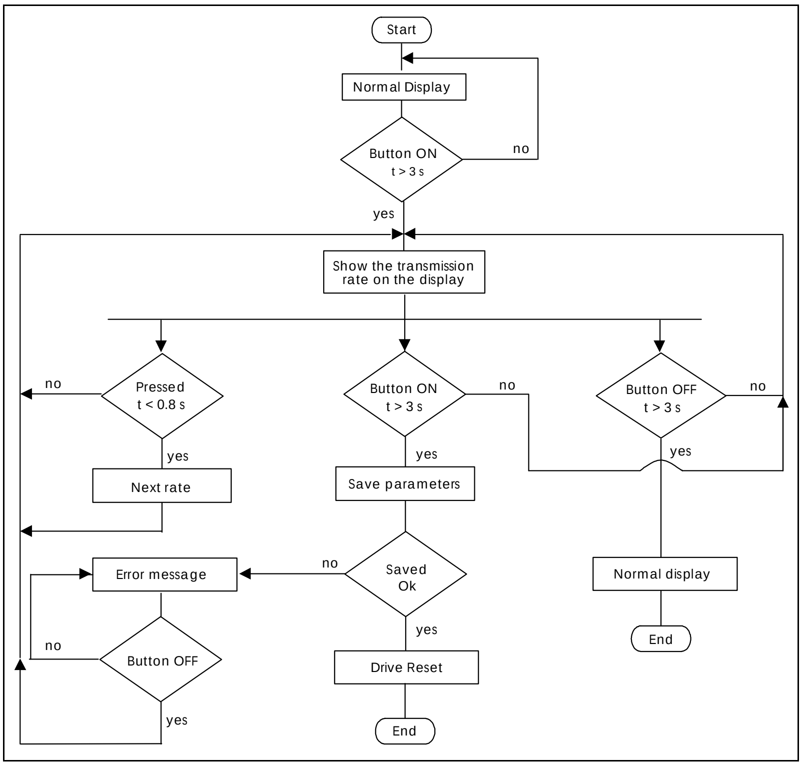


FIGURE H8.24

Diagram of the SERCOS transmission speed selecting procedure.

Anomalous events during the procedure

Any error that comes up when saving parameters into flash memory, will be displayed with an error message on the display while the "boot" button is pressed and then it will return to state 1 (speed selection).

Any attempt to select a value other than those assigned to the possible transmission speeds will generate an error and it will not be selected.

Any change of the communication speed is maintained after the drive is turned off if the command to save parameters has been previously executed successfully.

If, for any reason, the drive is turned off or reset in any stage of this procedure, when started up again, the transmission speed value given by QP11 will be the last one that was successfully assigned in previous changes.

The speed change procedure may be ignored (without making any changes) at any time if the command to save parameters has not been executed.

While in state 1, after 8 seconds without pressing the "boot" button, the drive switches to 0 state and the display shows the initial information.

Values that may be assigned to the transmission speed

The possible values, supported by the hardware, that may be selected to set the transmission speed are:

TABLE H8.3 Transmission speed with SERCOS interface. Display at the drive.

Value	Speed:	Shown on the display
QP11= 0*	4 MBd	4
QP11= 1*	2 MBd	2
QP11 = 2	2 MBd	2
QP11 = 4	4 MBd	4
QP11 = 8	8 MBd	8
QP11 = 16	16 MBd	1.

* to be compatible with previous versions of the SERCOS board.

See the values that will be assigned to their associated parameter QP11 in chapter 13 of the "dds-software" manual.

8.6.7 SERCOS connection with a Fagor 8055 CNC

A drive is connected to a Fagor 8055 CNC via SERCOS through connector COM1 located on the front panel of the CPU module. See **FIGURE H8.25**.

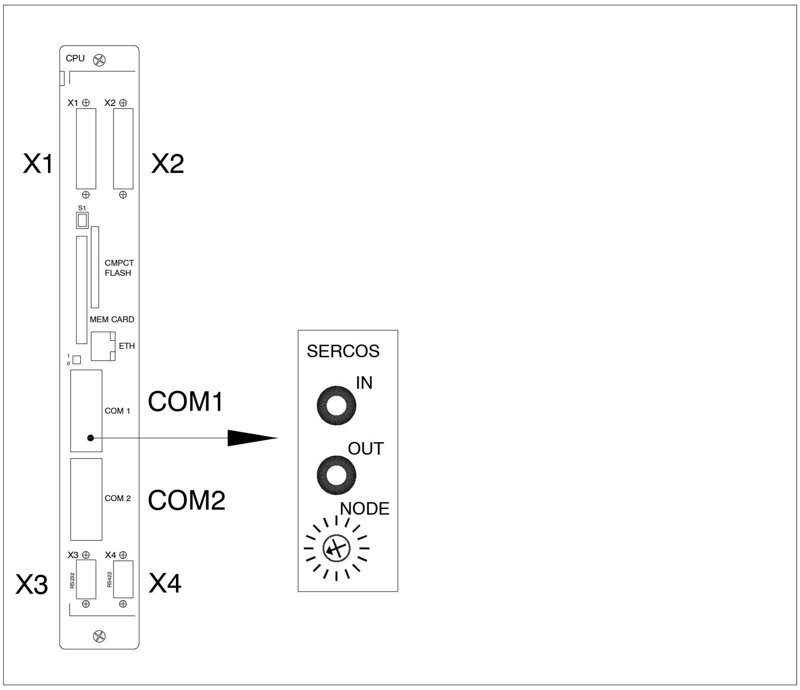


FIGURE H8.25
SERCOS connector of the Fagor 8055 CNC.

If the CNC has a CPU-turbo card, the SERCOS connection of the CNC with the drives will be made through the SERCOS module, not from the CPU module mentioned earlier.
See FIGURE H8.26.

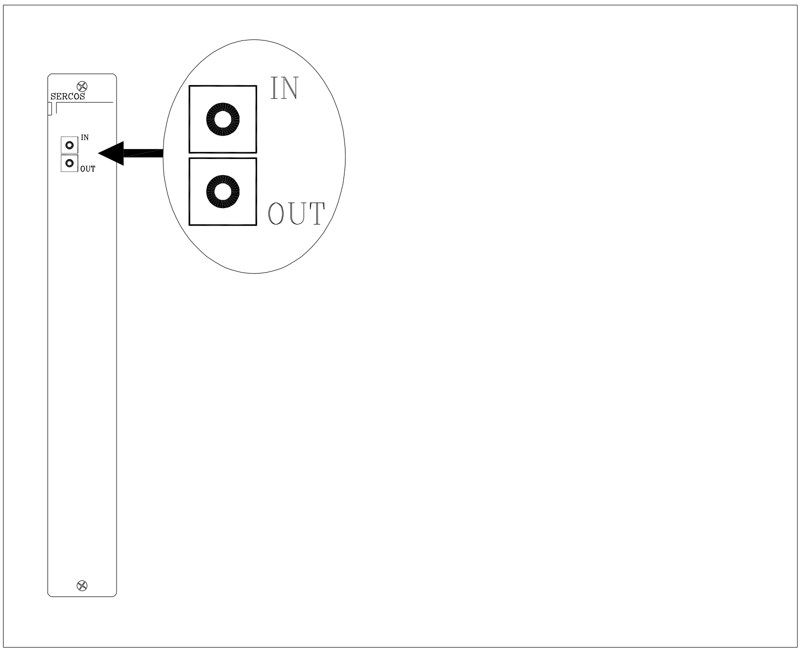


FIGURE H8.26
SERCOS connector of the Fagor 8055 CNC with CPU-turbo.

For further information, see the installation manual of the 8055 CNC.

8.6.8 SERCOS connection with a Fagor 8055i CNC

The SERCOS connection of the Fagor 8055i CNC will be made through the SERCOS DRIVES connector on the top rear of the module. See FIGURE H8.27.

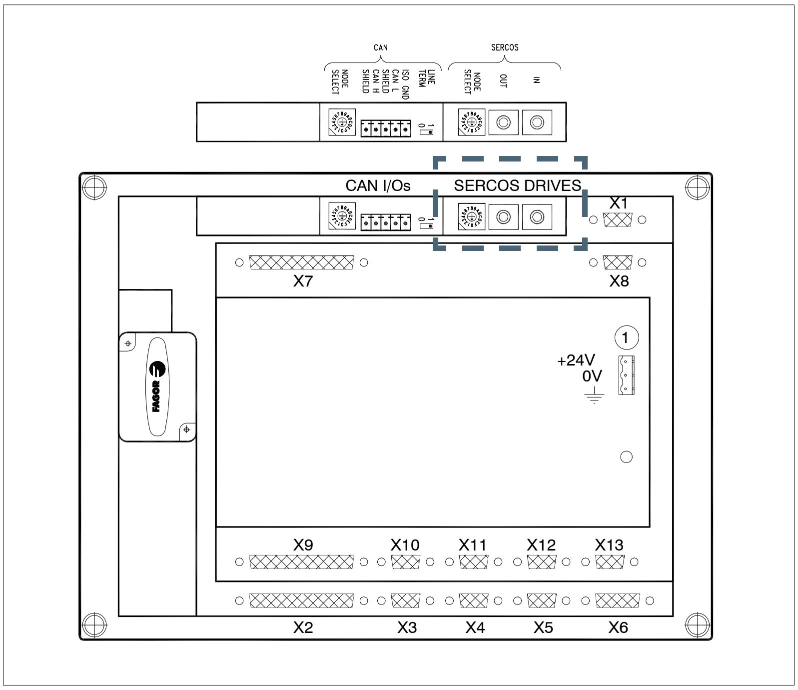


FIGURE H8.27
SERCOS connector of the Fagor 8055i CNC.

For further information, see the installation manuals of the Fagor 8055i CNC.

8.6.9 SERCOS connection with a Fagor 8070 CNC

The Fagor 8070 CNC is connected to the drives via SERCOS through the X2 connector located on the right side of the module. See FIGURE H8.28.

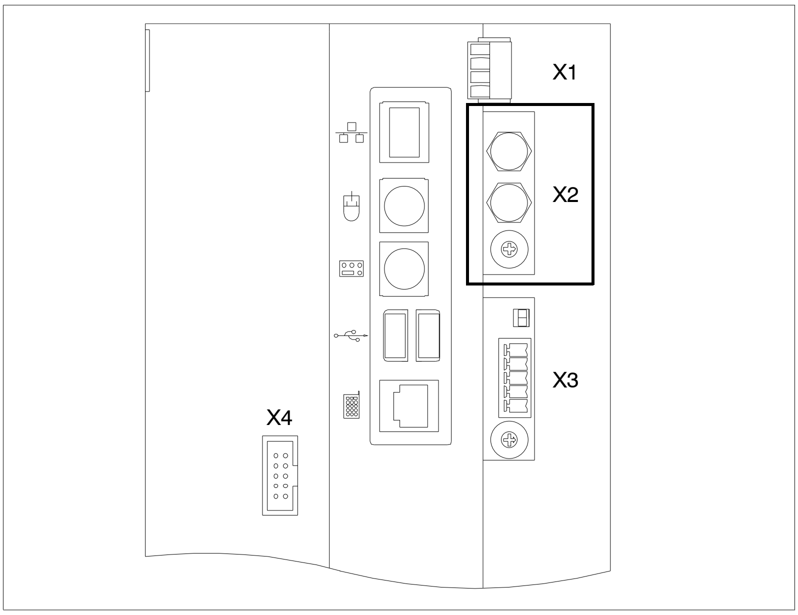


FIGURE H8.28

SERCOS connector of the Fagor 8070 CNC.

For further information, see the installation manual of the 8070 CNC.

8.6.10 Connector X5 , RS-422 serial line

This communication interface may be set only between drive modules MMC or CMC and an ESA video terminal as a master element.

The various drive modules and the ESA panel are connected through the RS-232/RS-422 serial port (connector X6) of the drive and the serial port of the video terminal (connector MSP).

The RS-232/RS-422 serial port is implemented only on Fagor drives in motion control applications (see their front panel).

The connection is made through the RS-232/RS-422 cable.

See chapter 7. CABLES of this manual.

It is a tree type connection where the 16-position rotary switch (0-15) of each drive permits selecting the address of each module integrated in it.

The system communication through RS-232/RS-422 is configured using the WinddsSetup application for PC. See the "communications" tab of the <preferences> menu in chapter 16, "WinddsSetup" of the "dds-software" manual.

Particular

In order to establish communication via RS-232 serial line, each drive of the system must be differentiated using the 16-position "NODE SELECT" switch. The direction of the arrow of the switch must coincide with an identifier other than zero, hence assigning a node number that will identify in the system.

If the drive is going to be identified in the SERCOS ring with a number higher than 15 in a tree-like structure that has RS-422 communications line, this value cannot be selected using the rotary "NODE SELECT " switch because it only has 15 positions.

Identifying the axes with addresses higher than 15 requires setting QP13. See this parameter in chapter 13 of the "dds-software" manual.

Example.

How to identify an axis addressed in position 26 in the system when communicating via RS-422 serial line ?

When the identifier of the axis is higher than 15 (like in this case), QP13 must be set so it meets the ratio:

Defined Id = Id to be selected at the rotary switch + (15 x QP13).

Hence, for **defined Id=26**, select C (same as 11) at the drive's rotary "NODE SELECT" switch and set QP13=1.

In order to establish communication via RS-232 serial line, the direction of the arrow of the switch of the corresponding module must coincide with the zero identifier.

The module must be reset in order for any change made on the rotary switch to be effective.

Interconnection

Use the RS-232/RS-422 cable to connect all the drives that will be governed by the video terminal. See chapter 7. CABLES of this manual.

8.6.11 RS-232/RS-422 serial line connection with an ESA video terminal

The RS-232/RS-422 connection of the ESA terminal with the drives is made through the MSP connector located at the bottom of the VT module. See FIGURE H8.29.

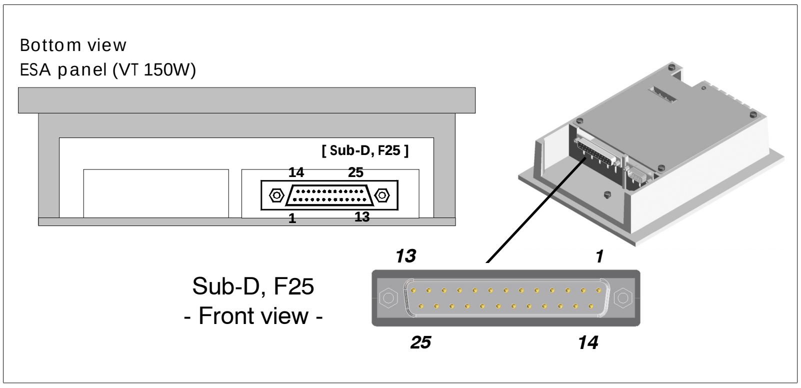


FIGURE H8.29

MSP connector of the ESA video terminal for the RS-422 connection.

The MSP serial port (Multi Serial Port) is a part of any ESA video terminal and is used to connect it with other devices. Hence, the project is transferred from the PC to the VT through this port.

This port is accessed from a 25-pin female SUB-D connector and may establish communication with other devices through RS-232, RS-422, RS-485 and C.L. (TTY-20 mA) protocols.

Note. Pin 16 does not contemplate communicating with any type of load. Any disturbance going into this pin can damage the video terminal and the process.

The pinout of the MSP connector is described in the following table:

TABLE H8.4 Pinout of the MSP connector.
* C.L. means < Current Loop >.

Pin	Signal	Pin	Signal
1	Not connected	14	IKT OUT
2	TxRS232 OUT	15	IKR OUT
3	RxRS232 IN	16	+5 V DC (reserved)
4	RTS RS232 OUT	17	Not connected
5	CTS RS232 IN	18	* R x C.L. +IN
6	Not connected	19	Not connected
7	GND	20	Not connected
8	Not connected	21	Not connected
9	* TxC.L. + OUT	22	TxRx485+IN/OUT
10	TxRx485-IN/OUT	23	TxRS422 +OUT
11	* TxC.L. - OUT	24	RxRS422 -IN
12	TxRS422 - OUT	25	* R x C.L. - IN
13	RxRS422 +IN		

8.6.12 RS-232/RS-422 serial line connection with a drive

The RS-232/RS-422 connection of the drive (only MMC or CMC models) is made through the X6 connector on the front panel of the module. See **FIGURE H8.30**.

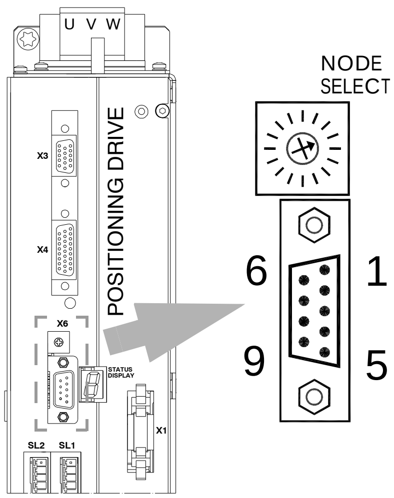


FIGURE H8.30
Connector X6 of the drive (MMC or CMC) for the RS-232 / RS-422 connection.

This port is accessed through a 9-pin male SUB-D type connector and can establish communication with other devices using the RS -232/422 protocol.

The pinout of connector X6 (RS-232 / RS-422 serial line) is described in **TABLE H8.5**.

TABLE H8.5 Pinout of connector X6 (RS-232/RS-422).

Pin	Signal	Pin	Signal
1	Not connected	6	TxD 422
2	RxD 232	7	#TxD 422
3	TxD 232	8	RxD 422
4	+5 V ISO	9	#RxD 422
5	GND ISO		

8.6.13 RS232 serial line connection between a PC and an ESA VT

To make this connection is essential for transferring the communication driver and the project.

The connection is made through the MSP connector at the bottom of the VT module and the RS-232 serial line connector of the PC.

The connection must be made according to the diagram shown in chapter **7. CABLES** in this manual.

8.6.14 RS-232 serial line connection between a PC and the drive

This connection is necessary in order to establish communication between the WinDDSSetup application for PC and the drive. This connection may be used to set up the drive.

The connection must be made according to the diagram shown in chapter **7. CABLES** in this manual.

SAFETY

9

9.1 Definitions of the term "machinery"

The Machine Directive 2006/42/CE defines the term "machinery" as:

An assembly of linked parts or components, at least one of which moves, with the appropriate actuators, control and power circuits, etc., joined together for a specific application.

This term may also be understood as:

- An assembly of machines which, in order to achieve the same end, are arranged and controlled so that they function an integral whole.
- An interchangeable equipment modifying the function of a machine, which is placed on the market for the purpose of being assembled with a machine or a series of different machines by the operator himself in so far as this equipment is not a spare part or a tool.

9.2 Machine safety

Machine safety is becoming more and more important every day and it is so reflected in European and Worldwide Regulations and Directives.

Evaluating the risks of a machine is a relatively complicated process that involves all the elements that constitute part of the machine from its mechanics to the circuits or electronic elements that contribute to its operation.

The logic process goes through evaluating the risks of a machine and later design in order to minimize the risk and gravity of their consequences.

All this translates into introducing "safety elements" in order to achieve a more reliable system.

EN 954-1, section 6 classifies the machines in different categories depending on their level of safety.
See **TABLE H9.1**.

The basic requirements that configure the control systems are defined in categories. Consequently, this tries to make the systems allow hardware failures.

In complex control systems (e.g.: programmable electronic systems) additional aspects must be considered, like being able:

- To control occasional hardware failures
- To avoid system failures and errors (software and hardware)
- Control system failures and errors (software and hardware)

to reach functional safety in critical tasks with assurance in terms of safety.

The following table describes the categories and their characteristics.

TABLE H9.1 Machine classification. Categories.

Category	Requirements	Behavior	Design principles
B	The parts related to the safety of command systems and/or protection equipment as well as their parts, must be designed, built, selected, mounted and combined in compliance with the relevant regulations so they can withstand the foreseen operation.	A failure can cause the loss of the safety function	Component selection. Selecting the cable section. Proper power supplies. Control without safety measures.
1	The requirements of the category B apply and it requires the use of components whose efficiency has been proven as well as acknowledged safety principles.	A failure can cause the loss of the safety function, but this is less likely to happen than for the Category B.	Selection of proven components (specific limit switches for safety, etc). Selection of proven safety principles (avoid short-circuits, element oversizing, etc.).
2	The safety function must be checked in periodic time intervals and according to the particular machine.	A failure can cause the loss of the safety function between verification intervals. The failure is detected in the following verification.	It is characterized by the structure: AUTOCONTROL [1] Proven components: Specific limit switch for safety, oversizing of safety elements.
3	The requirements of categories B and 1 must be met and also the safety related parts must be designed so: A single failure in one of its components does not cause the loss of the safety function. The failure is detected whenever possible.	When a single failure occurs, the safety function must be assured. Certain failures are detected but not all of them. An accumulation of undetected failures could cause the loss of the safety function.	It is characterized by the structure: REDUNDANCY [2] Proven components: Specific limit switch for safety, oversizing of safety elements.
4	The requirements of categories B and 1 must be met and also the safety related parts must be designed so: A single failure in one of its components does not cause the loss of the safety function. The first failure will be detected on the first request of the safety function or before. If this is not possible, an accumulation of failures must not cause the loss of the safety function.	When a simple failure occurs, the safety function is maintained. The failures are detected in time to prevent the safety loss.	It is characterized by the structure: REDUNDANCY [2] + AUTOCONTROL[1]. Proven components: Specific limit switch for safety, oversizing of safety elements.

In order to better understand these concepts, we'll now define the concepts used in safety systems:

Redundancy [2] It consists in replacing the failure of an organ that is critical to the safety function with the proper operation of another.

Redundancy is concept used when designing control systems and it belongs to categories 3 and 4.

Autocontrol [1] It consists in verifying the proper operation of each organ that changes states in each cycle in order to detect any failure or anomalous operation.

When detecting a failure during autocontrol, the machine stops and does not allow executing the next cycle.

The cyclic autocontrol assures category 2.
Permanent autocontrol is used in categories 3 and 4.

The combination of redundancy and autocontrol make up a category 4 safety system. If a failure occurs in one of the channels of a "dual channel" system, it will be detected by the autocontrol

9.3 Safety related aspects

The most important consideration to keep in mind to assure machine safety is to prevent any type of movement of its moving parts when accessing a particular area or zone.

Safely disable the servo system of the machine.

This result could obviously be reached by using conventional elements such as breaker switches between the motor and the DDS system.

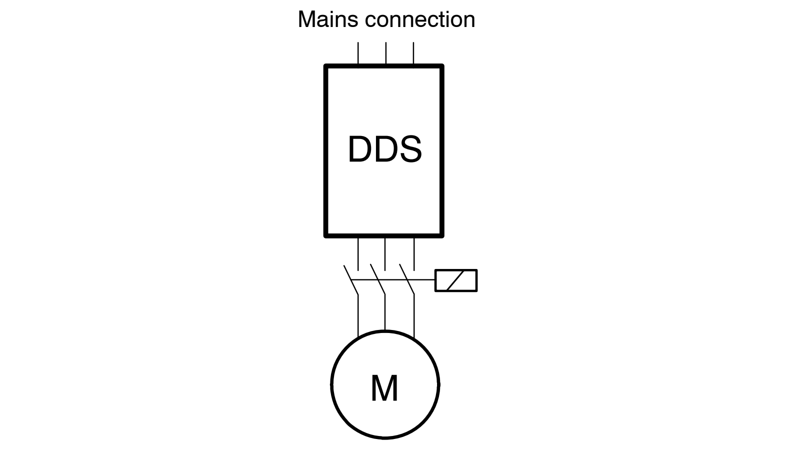


FIGURE H9.1

Disconnecting a motor from the system using a switch.

This type of solution obviously means adding new elements that although they offer safety, they do not offer functionality or features to the machine. Also, the system gets complicated and the cost increases considerably.

In order to solve this issue, Fagor drives offer a functionality called "SD" (**S**afe **D**isable) to help the designer by simplifying the whole design of the electrical cabinet and reducing costs.

The simplified diagram will come down to the one shown in FIGURE H9.2:

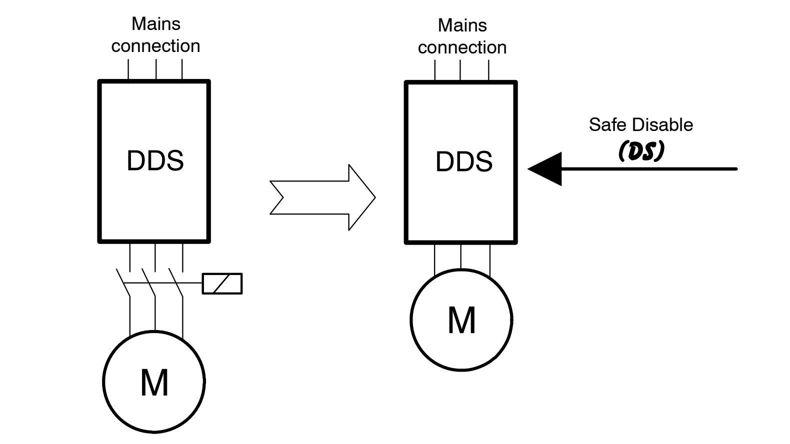


FIGURE H9.2

Disconnecting a motor from the system using the SD function.

Section: **S**afe **D**isable (SD) describes this function in detail.

Other aspects closely related to machine safety are:

- Machine stop function
- Emergency stop actions
- Speed limitation
- Travel limit
- Speed deviation
- ... and others.

Hence, the "stop" and "emergency stop" functions are specified in the EN 60204-1 regulation defining three types of stop regardless of the emergency situation.

Stop category 0	Uncontrolled stop. The power supply to the machine's servo system is turned off immediately.
Stop category 1	Controlled stop. The power supply to the machine's servo system is maintained until it stops and it then turns it off.
Stop category 2	Controlled stop. The power supply to the machine's servo system is kept on even after it has stopped.

9.4 Safe Disable (SD)

The **S**afe **D**isable function **(SD)** offered by Fagor drives permits disabling the power output of the drive making sure that the motor torque is eliminated as a safe situation.

This function is available through the "Drive Enable" section so called in standard Fagor DDS systems. Techniques and elements approved to be used in safety systems have been considered for its design and internal operation.

Hence, with a conventional drive (without SD), a contactor would have to be installed to assure a safe disable of the motor. However, using the safety techniques (implemented in Fagor drives) guarantees the same or greater safety without having to use external contactors, hence saving material and room in the electrical cabinet. See **FIGURE H9.2**.

9.4.1 Operation of the safety circuit

The following block diagram shows the circuit implemented in Fagor drives:

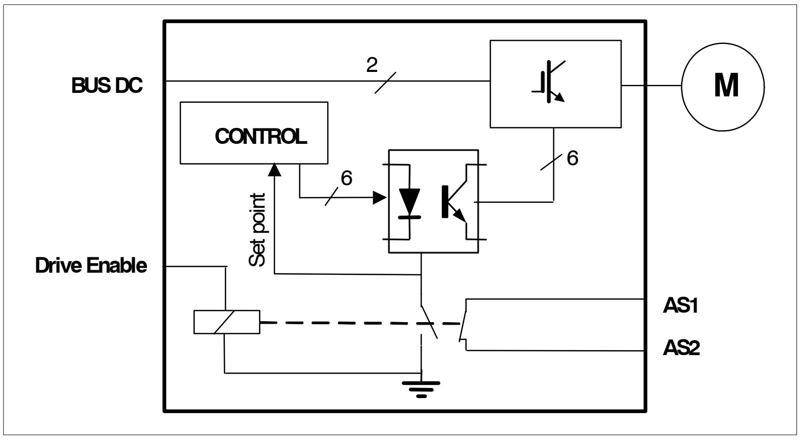


FIGURE H9.3

Block diagram of the safety circuit.

The "Drive Enable" pin already available on conventional Fagor drives works the same way on drives with **S**afe **D**isable although it has been implemented keeping the safety principles and protocols in mind.

For that, a safety relay with guided contacts has been considered so:

- The first contact (NA) enables the power inverter and sets the control part to rest assuring a redundancy when locking up.
- The second contact (NC) is used as an external acknowledgement of the status of the safety relay. This contact is available in an additional connector (with respect to the modules without this feature) located on the front panel of the module and identified with AS1 and AS2 pinouts.

The following figure shows a general diagram of a DDS system with **S**afe **D**isable (SD) made up with modular drives.

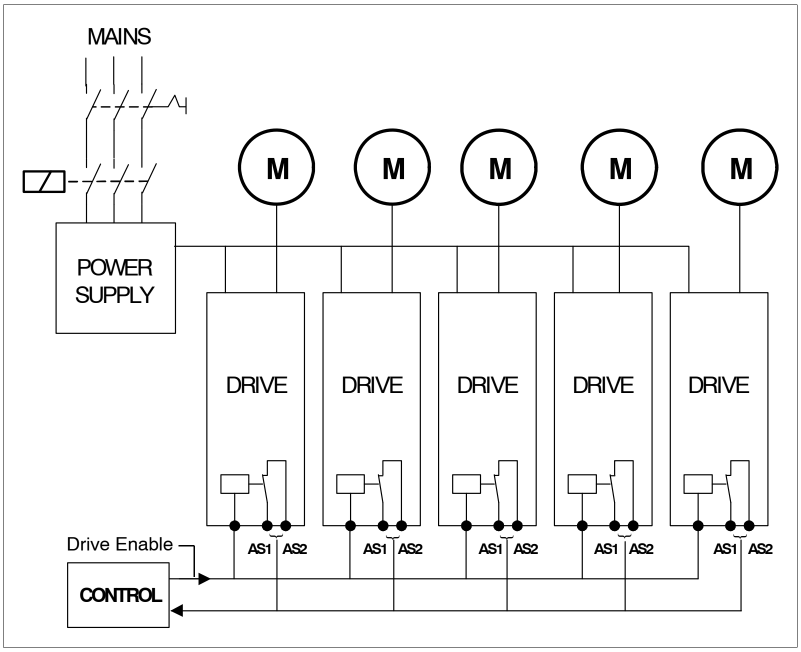


FIGURE H9.4

General diagram for a DDS with Safe Disable.

Note. The diagram of the safe power-off of **FIGURE H9.4** is not valid for an emergency stop. For this situation, refer to examples 2 and 3 at the end of the chapter.

The advantages of having Safe Disable are:

- The DC BUS may be kept charged and it is not necessary to disconnect the mains system.
- Only low voltage and low current elements switch.
- Minimum cabling.
- Functions approved by organizations knowledgeable in this matter.

However, certain considerations must be borne in mind regarding the use of this system:

- This option must only be used as a temporary prevention during the everyday use of the machine.
- Safe power-off alone is not enough to restrain the drives or the machine in emergency stops, maintenance, cleaning or repair. In those situations, the machine MUST be disconnected from mains hence removing the supply of power.
- Designing a safe machine or system requires a lot of knowledge and experience. Asserting categorically that the system is safe requires a deep overall study of the risks; therefore, the safety functions or elements do not guarantee by themselves the safety of the machine. The various functions must be properly implemented into the system.
- The **S**afe **D**isable does not provide galvanic isolation from mains and, therefore, does not eliminate the risk of electrical contact.
- If for any reason, the drive is disabled when the motor is turning, the motor cannot be stopped in a controlled and/or quick way. In view of the possibility of generating a situation of this kind (risky for the operator) the necessary circuits and mechanisms outside of the drive must be provided in order to execute the stop under the conditions demanded by the relevant regulation.

9.4.2 Setup

The SD function may be very useful during machine setup. Hence, often in this stage, the different drives are actuated individually and the machines may be tested by parts being able to run some parts of it while the other parts remain disabled.

During setup, it is also common to have some people near dangerous areas. Thanks to the implementation of the SD function, it will not be necessary to turn the power contactors constantly on and off which would deteriorate these components.

9.5 Application examples

The following examples try to show how useful the SD function is. These diagrams do not guarantee the safety of the machine, whose risk must have been analyzed and evaluated and must comply with the current Safety regulation in the country of destination of the machine.

Example 1.

Typical application for controlling the access to areas with moving elements on the machine. It shows a machine with two independent areas with moving elements.

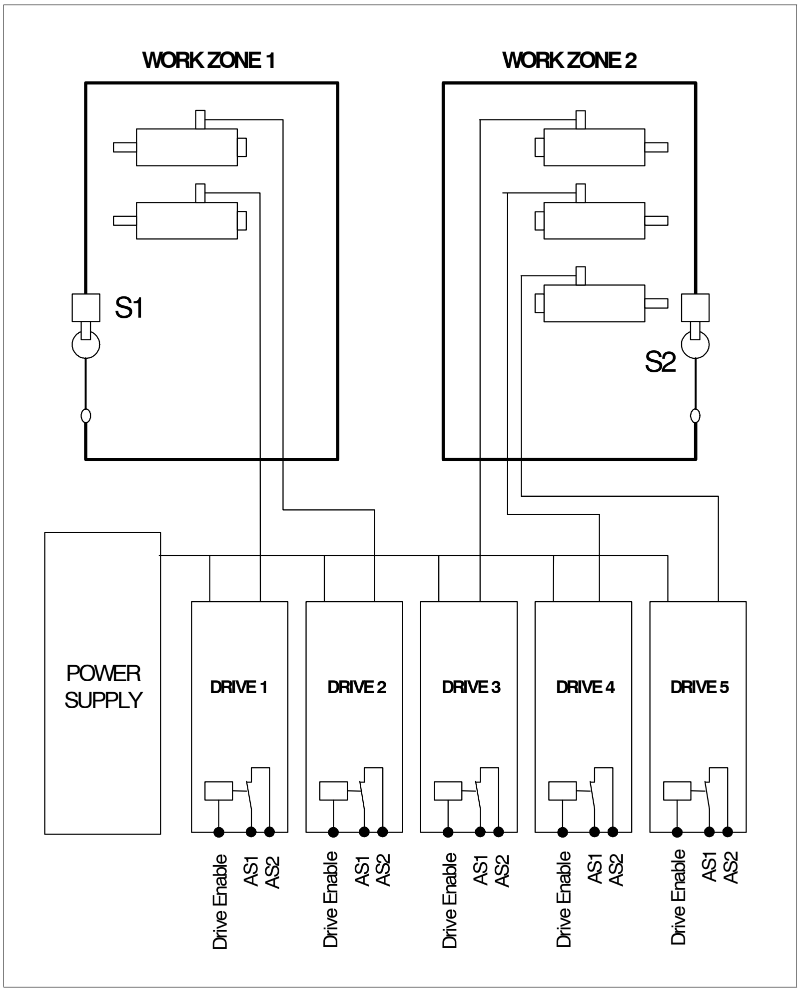


FIGURE H9.5

Diagram to control the access to areas with moving elements.

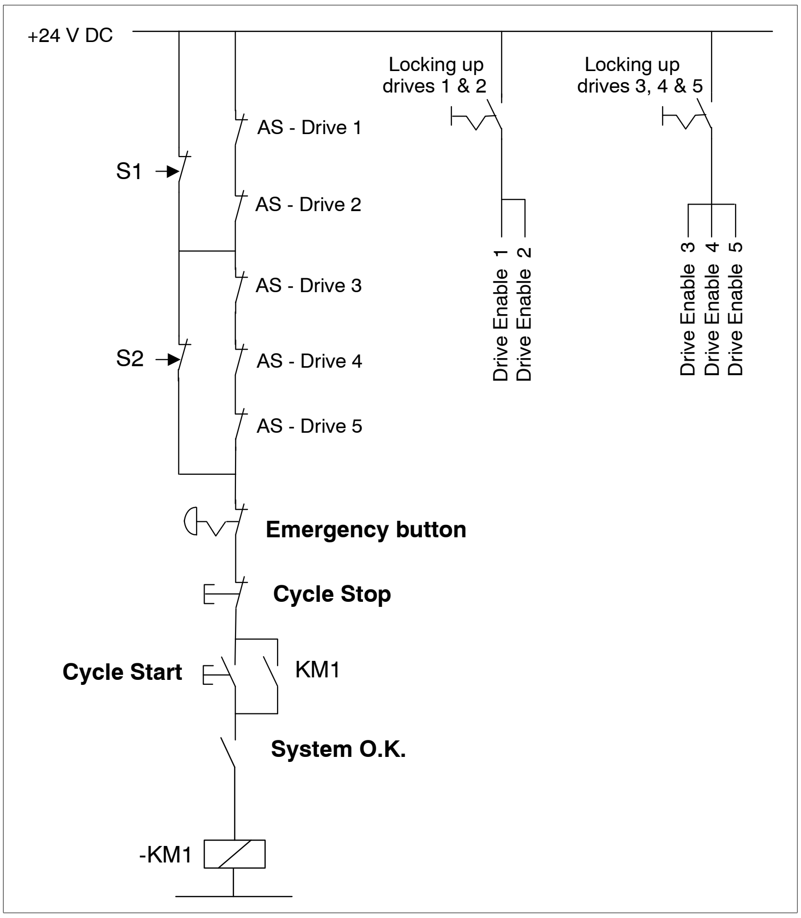
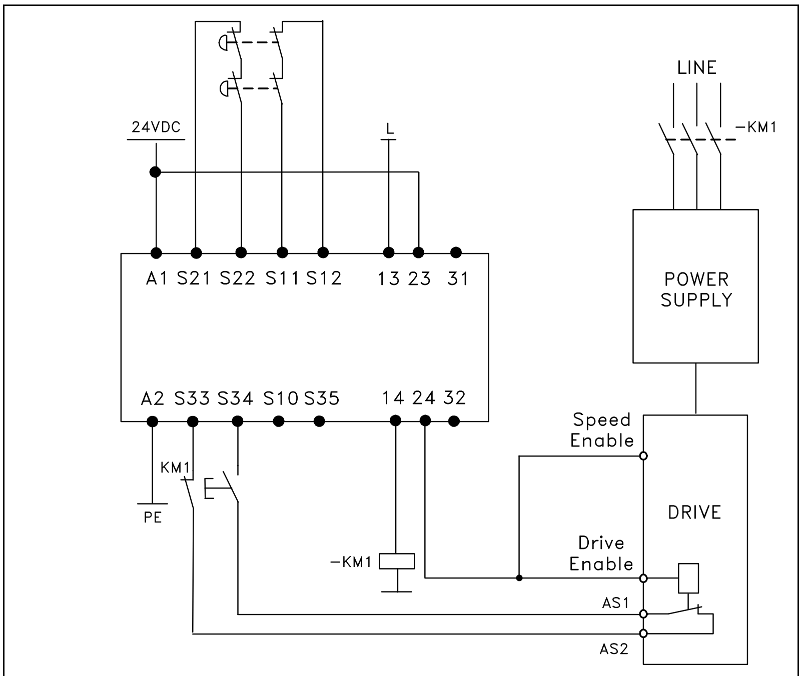


FIGURE H9.6

Diagram to control the access to areas with moving elements.

Example 2. Emergency stop. Stop category 0.

Safety circuit, category 3 according to EN 954-1. **Emergency stop, stop category 0**.



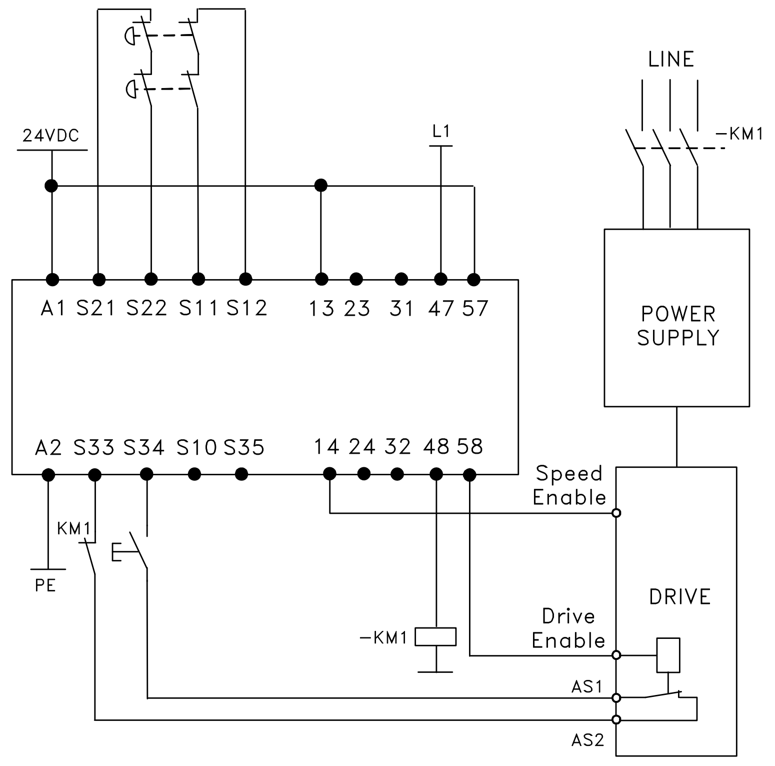
Pin 13. L represents the voltage supply of contactor -KM1.
Pin A2. PE is ground or GND.

FIGURE H9.7

Safety circuit, category 3 according to EN 954-1. Emergency stop, stop category 0.

Example 3. Emergency stop. Stop category 1.

Safety circuit, category 3 according to EN 954-1. **Emergency stop, stop category 1** because it has delayed contacts.



Pin 47. L represents the voltage supply of contactor -KM1.
Pin A2. PE is ground or GND.

FIGURE H9.8

Safety circuit, category 3 according to EN 954-1. Emergency stop, stop category 1.

CONNECTION DIAGRAMS

10

10.1 SPD modular drive with SPM asynchronous spindle motor

Connection diagram of an SPD modular drive with an SPM asynchronous spindle motor that has encoder feedback.

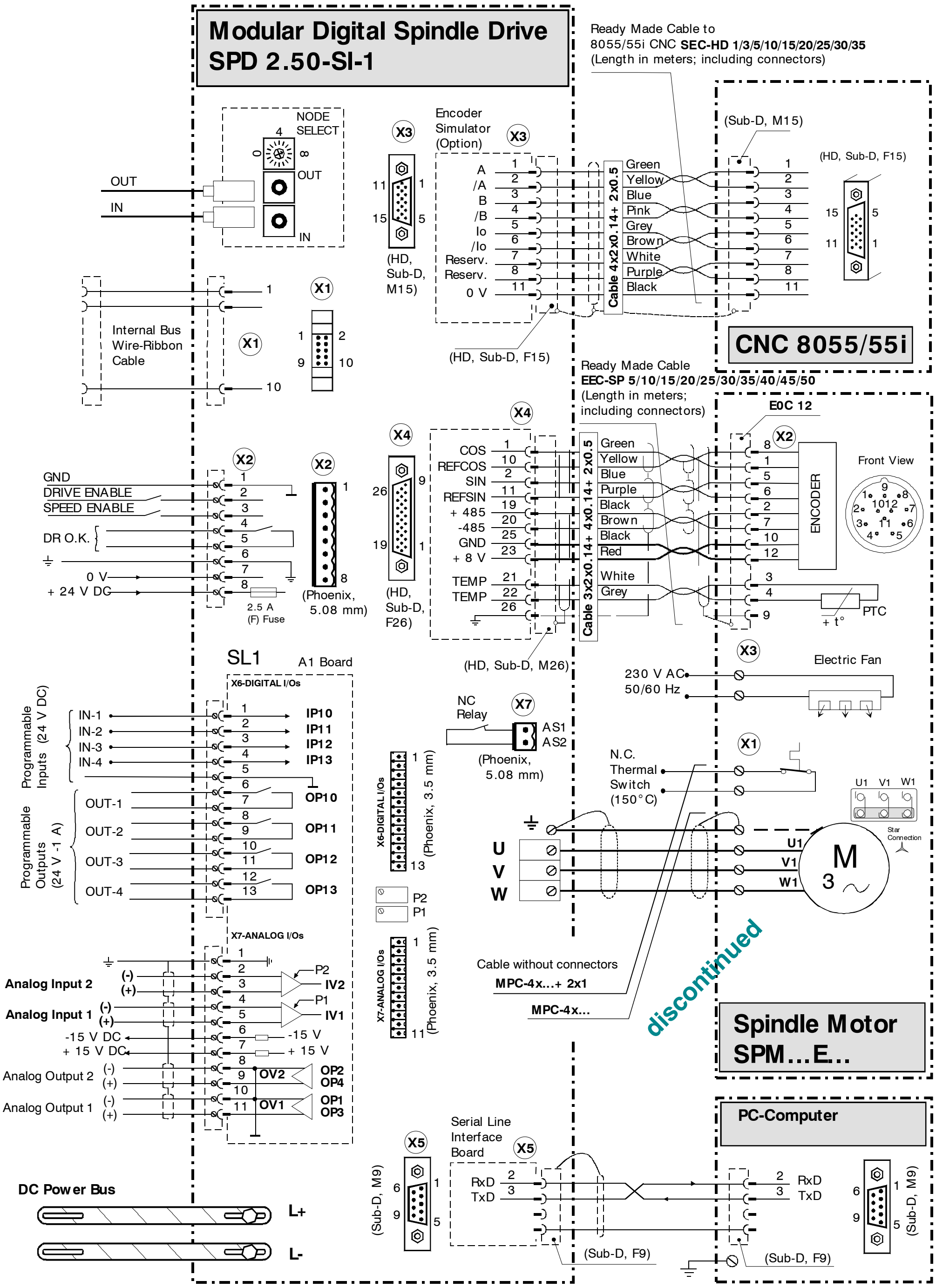


FIGURE H10.1

Connection of an SPD modular drive with an SPM asynchronous spindle motor with encoder.

10.2 SPD modular drive with FM7 asynchronous spindle motor

Connection diagram of an SPD modular drive with an FM7 asynchronous spindle motor that has TTL encoder feedback.

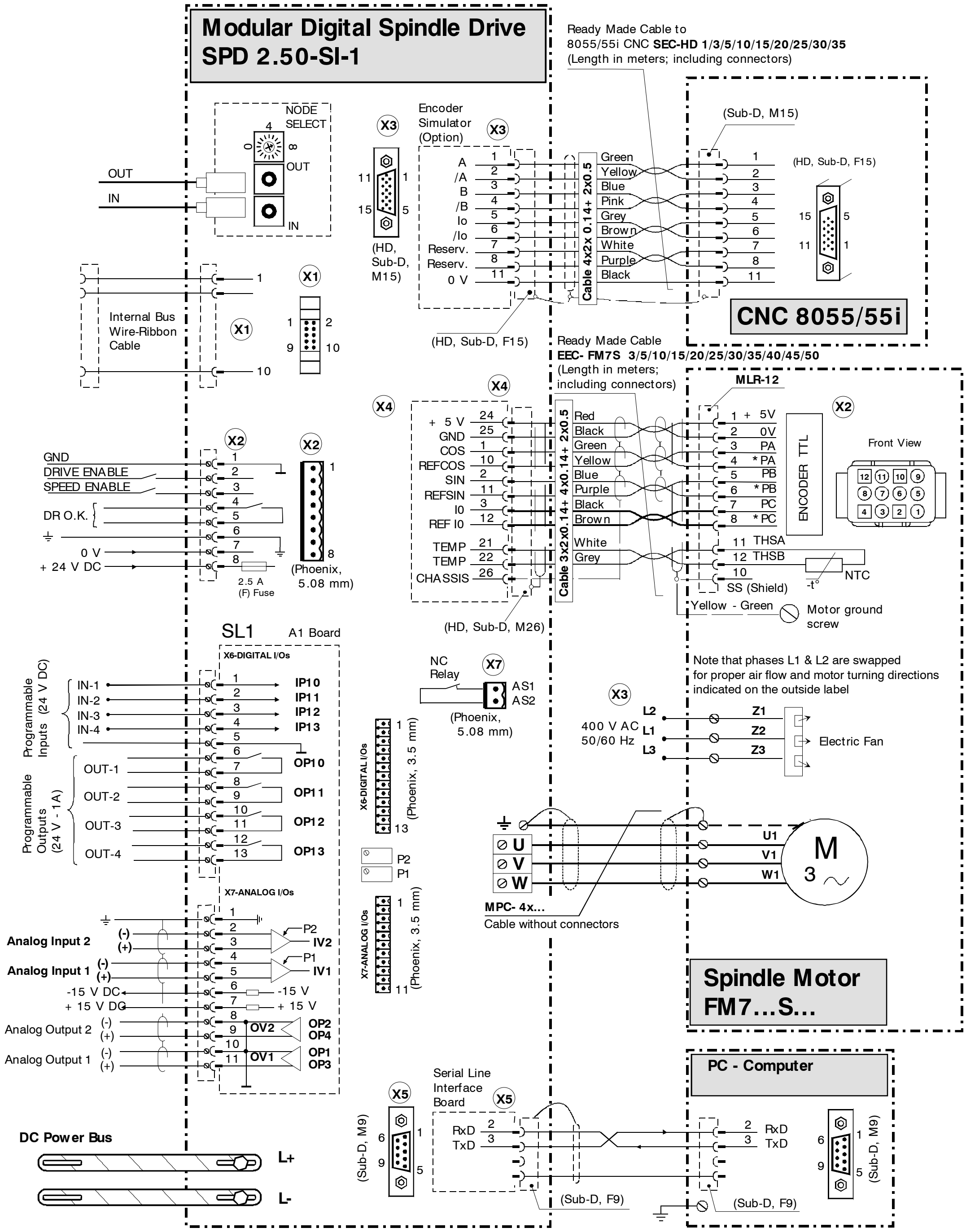
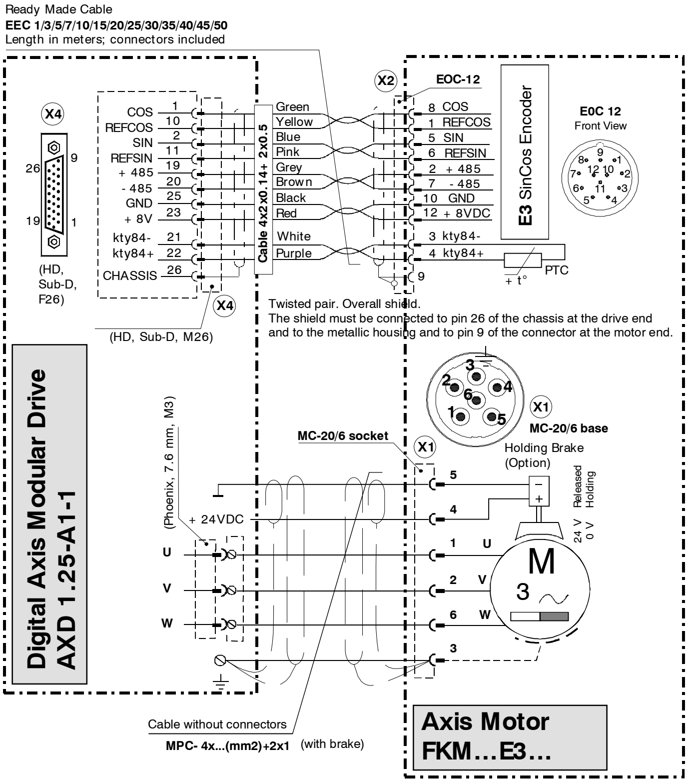


FIGURE H10.2

Connection of an SPD modular drive with an FM7 asynchronous spindle motor with TTL encoder.

10.3 AXD modular drive with FKM synchronous axis servo motor

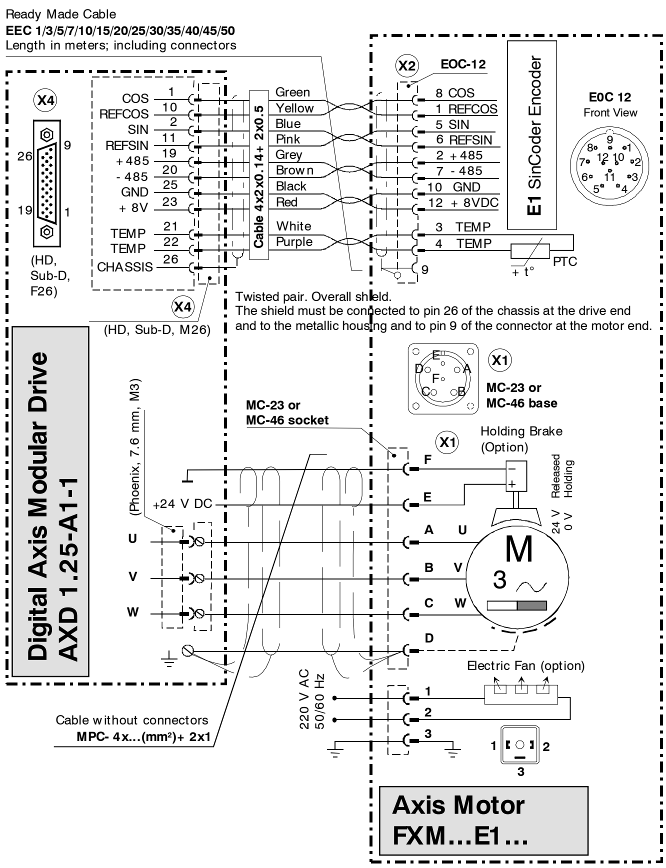


Connection diagram of an AXD modular drive with an FKM synchronous axis motor that has an encoder E3.

FIGURE H10.3

Connection of an AXD modular drive with an FKM synchronous axis servo motor with encoder E3.

10.4 AXD modular drive with FXM synchronous axis servo motor



Connection diagram of an AXD modular drive with an FXM synchronous axis motor that has an encoder E1.

FIGURE H10.4

Connection of an AXD modular drive with an FXM synchronous axis servo motor with encoder E1.

10.5 SCD compact drive with SPM asynchronous spindle motor

Connection diagram of an SCD compact drive with an SPM asynchronous spindle motor that has encoder feedback.

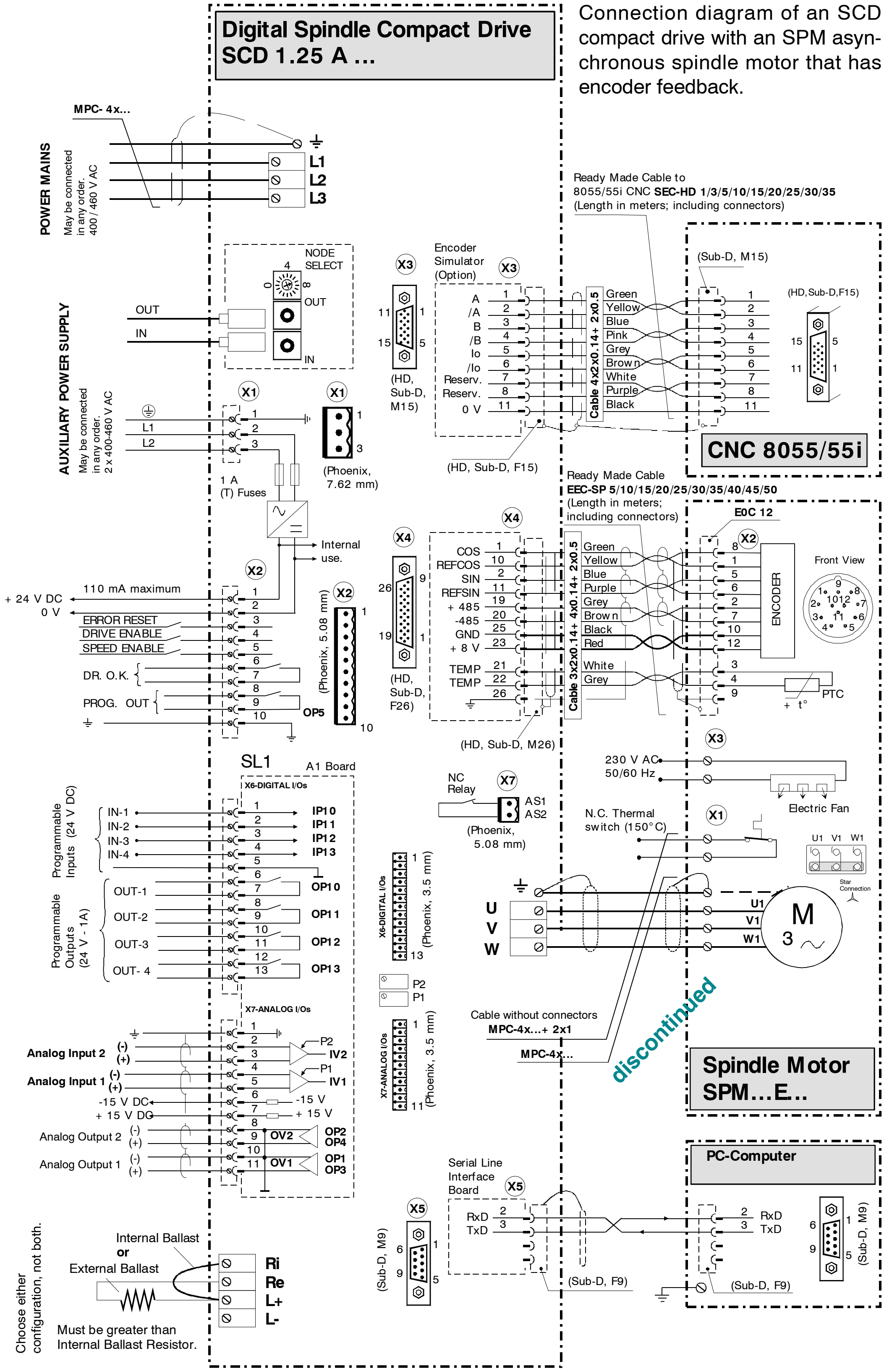


FIGURE H10.5

Connection of an SCD compact drive with an SPM asynchronous spindle motor with encoder.

10.6 SCD compact drive with FM7 asynchronous spindle motor

Connection diagram of an SCD compact drive with an FM7 asynchronous spindle motor that has encoder feedback.

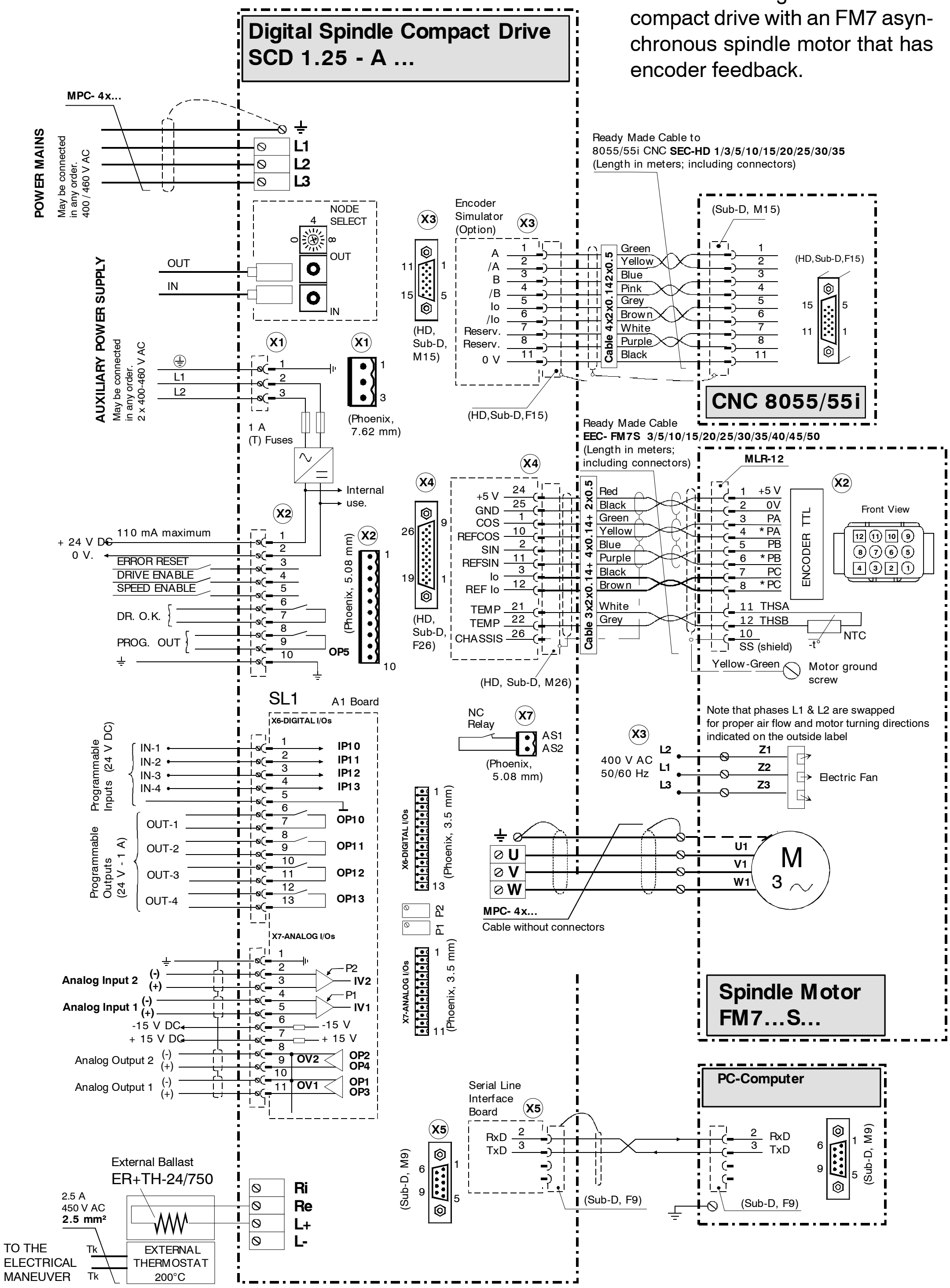


FIGURE H10.6

Connection of an SCD compact drive with an FM7 asynchronous spindle motor with TTL encoder.

10.7 ACD compact drive with FKM synchronous axis servo motor

Connection diagram of an ACD compact drive with an FKM synchronous axis motor that has encoder feedback.

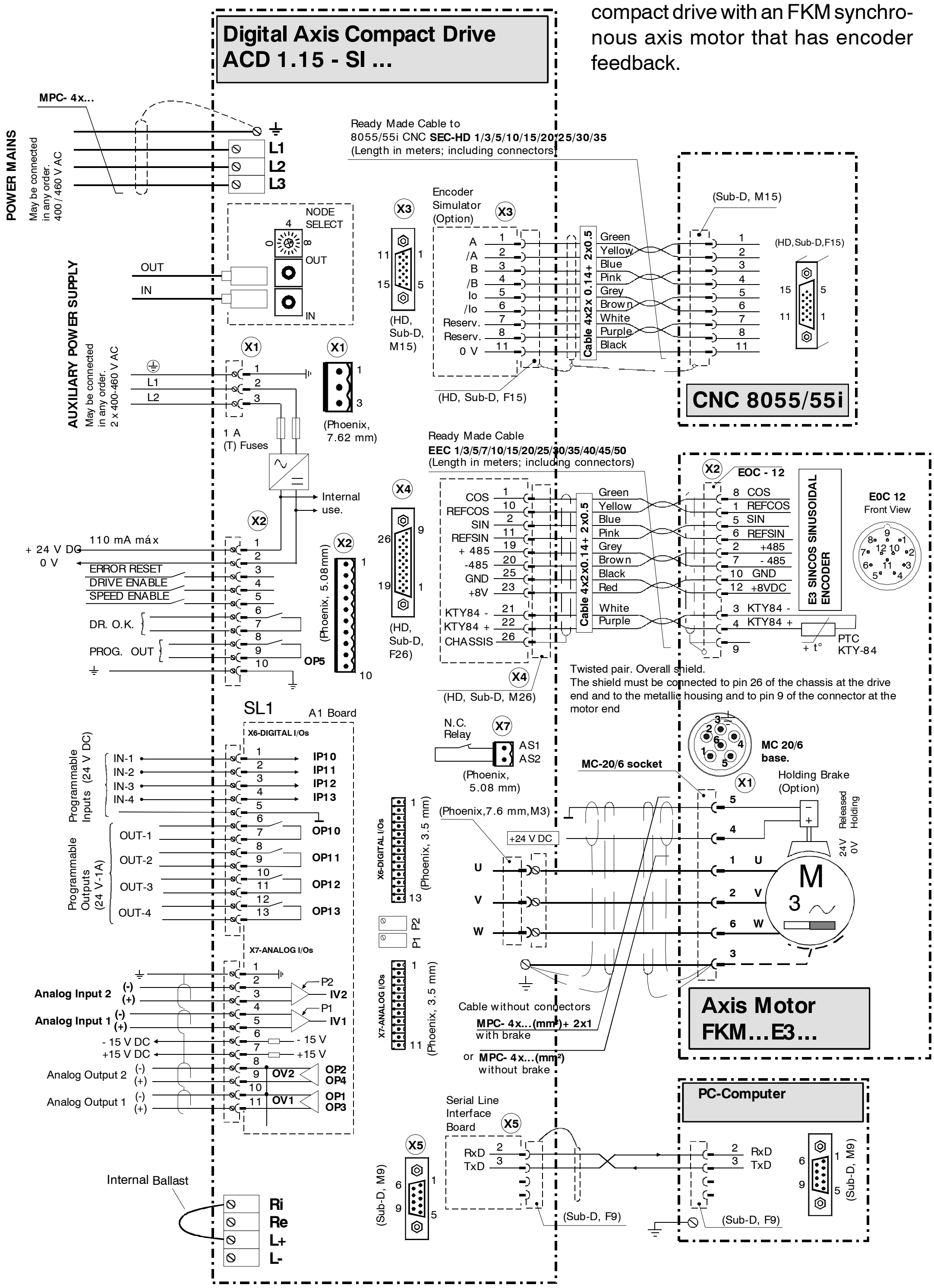


FIGURE H10.7

Connection of an ACD compact drive with an FKM synchronous axis servo motor with encoder.

10.

CONNECTION DIAGRAMS

ACD compact drive with FKM synchronous axis servo motor

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10.8 ACD compact drive with FXM synchronous axis servo motor

Connection diagram of an ACD compact drive with an FXM synchronous axis motor that has encoder feedback.

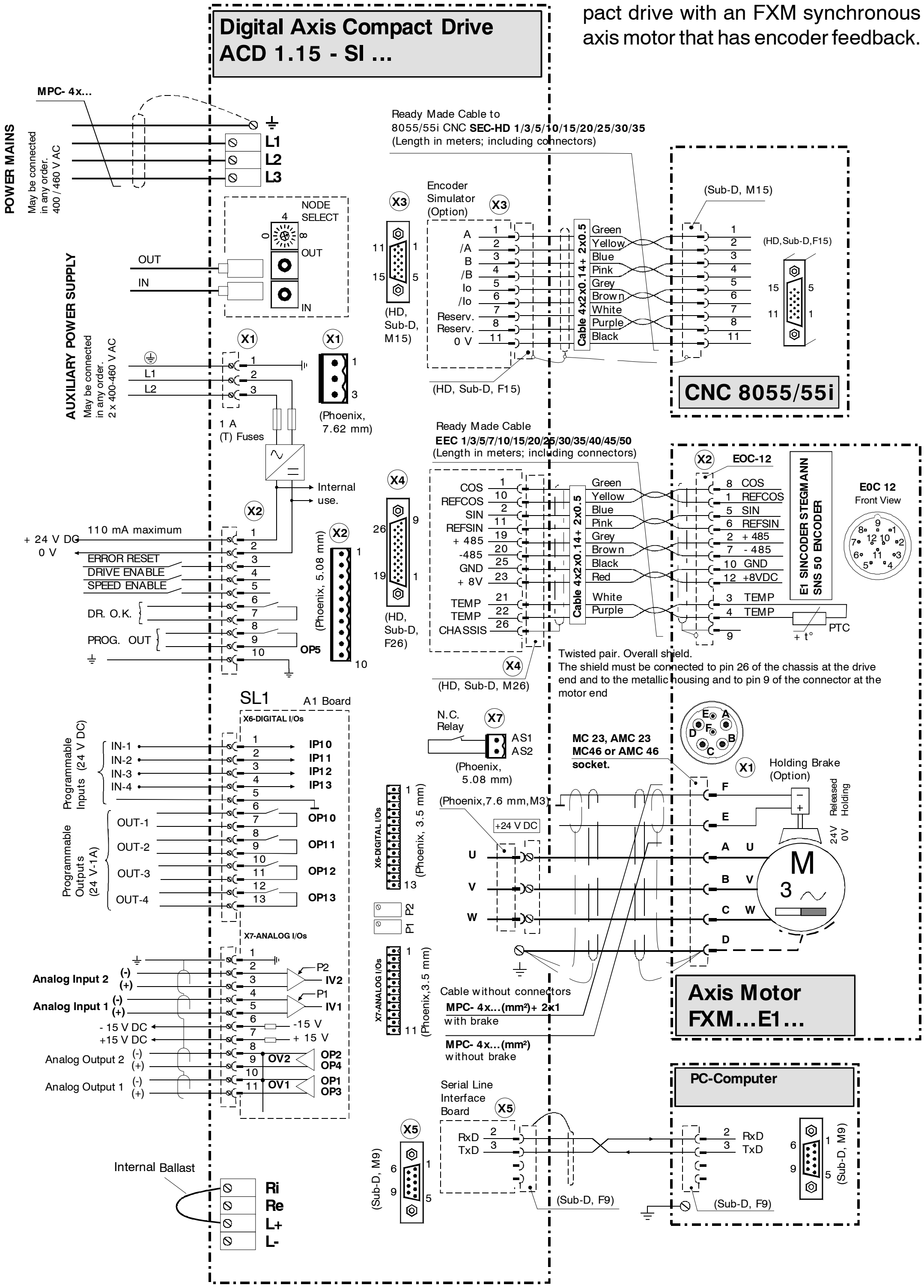

FIGURE H10.8

Connection of an ACD compact drive with an FXM synchronous axis servo motor with encoder.

10.9 Electrical cabinet. Diagrams

Before showing the diagrams of the electrical cabinet, described later on, read this brief explanation of the actions followed by the modules on system start-up. All the references to electrical devices, for example to the switch S1, contactor KM1, relay KA3 appear in later diagrams. Consult these diagrams to interpret the explanatory texts.

WARNING. Remember that all the diagrams related to integrated safety were already described in chapter 9 of this manual and to consult them, you must go to the relevant section of that chapter, not here.

Voltage for control circuits

- **Power** with 24 V the internal control circuits of each modular drive through the power supply module or of each compact drive through its integrated power supply, closing the main power switch or main key S1. Refer to the diagrams shown later to locate S1 in the system.

  Internally, each module checks its hardware and configuration.

  If the status of each drive is OK and no errors have occurred, each drive closes its DR.OK contact.

  If the status of **all** the drives that make up the DDS system is correct and no errors have occurred, each one of them lets the power supply know through the internal bus (only the modular drives). If the power supply does not register any errors either, it closes its "System OK" contact.

  The power supply then starts charging the power bus with a "Soft Start".
- **Activate** the control input "Speed Enable" of each drive and the "System Speed Enable" input of the power supply - see the location of the relay D2 in the diagrams. - The CNC, in turns, enables the SPENA mark -.
- **Activate** the control input "Drive Enable" of each drive - see the location of the relay KA3 in the diagrams. - The CNC, in turns, enables the DRENA mark -.

The motor is now ready to follow the velocity command given by the CNC.

All the following diagrams for power and control circuits in the electrical cabinet described in this chapter are only **orientation purposes** for the technician designing the machine and they may be further completed or simplified at will according to each application.

Emergency line

The purpose of relay KA1 is to confirm that the system is in running condition both mechanically and electrically. This relay closes its contact when **all and each of the** following conditions are met:

- The System_OK contact of the power supply is closed.
- No emergency has been activated.
- The spindle motor temperature is correct (it does not overheat) and
- none of the axes of the machine has reached its limit switch.

Observe that a push-button (N.O., **N**ormally **O**pen) is included in parallel with the limit switches for disabling (via PLC) the movement of the axes of the machine in the opposite direction.

After activating the relay KA1, its associated contact closes, to allow supplying three-phase power to the system by pressing the ON button closing the contactor KM1. To remove power, press the OFF button.

Error reset

When an error appears at any drive, its "Drive OK" and, therefore, the "System OK" contact of the power supply that feeds it will be open. The relay KA1 will be deactivated and its associated contact open and will not be possible to supply power to the power supply until the cause of the error is eliminated, as long as it is a non-resettable error.

Some of these errors (called non-resettable) may be eliminated by applying 24 V DC to the Error Reset pin of the power supply. See chapter 14 in the "dds-software" manual for further information on these errors.

The contact associated with the ON button resets the errors. This procedure may close the "Drive OK" and "System OK" activating the KA1 relay and, while ON is still pressed, enable KM1.

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

Activating the "System Speed Enable" of the power supply and the "Speed Enable" of the drives

The "System Speed Enable" signal of the power supply is activated after closing the contact KA2 with 24 V DC as a result of activating the relay KA2. Observe that KM1 has been closed earlier.

Now, the CNC may enable each axis (CNC Enable) and enable the "Speed Enable" signal of each drive by means of relays KA4, KA5, KA6 and KA7.

Activating the "Drive Enable" of the drives

Closing the contact associated with KA2 excites the relay KA3 with 24 V; this relay activates the "Drive Enable" signal of all the drive modules.

Observe that KA3 is a delayed-deactivation relay where the desired delay time t may be programmed. It may be used to keep contactor KM1 closed while braking a system for the necessary number of seconds to give the power supply enough time to return the excess energy to mains as long as the system has regenerative power supplies and it is connected to mains (S1 closed) obviously. The delay time "t" to program relay KA3 must be slightly longer than the time it takes the system to come to a full stop.

i

In the diagrams provided later on, the green ON light indicates that the "System Speed Enable" of the power supply is activated; in other words, the "Speed Enable" in each drive related to it and the SPENA signal of the CNC (sent to each drive via SERCOS) are activated and there will then be motor torque (Drive Enable signal at each drive and DRENA signal of the CNC). The red OFF light indicates that all the previous signals are disabled.

Remember that a drive will only respond to an external velocity command when the Drive Enable, Speed Enable and System Speed Enable signals (besides the DRENA and SPENA signals of the CNC) are active (24 V DC).

Stops

- Free stop

A free stop (uncontrolled) is when an error is activated while the system is running, it disables the Drive Enable function instantly and the motor stops by friction . According to EN-60204-1, it is a "category 0" stop or an uncontrolled stop.

- Controlled stop

A stop is controlled when the motor is braked with motor torque while the system is running and according to the parameters set for the emergency ramps. According to EN-60204-1, it is a "category 1" stop or a controlled stop.

A stop may be caused by:

- **opening the main power switch S1**, one or several fuses have blown or there is simply a power outage while the system is running. The motor brakes with emergency ramps if they were initially set by parameters. Regardless of the power supply being used, it will not be possible to return to mains the excess energy generated by braking (remember that the mains connection has been opened). It causes a voltage rise at the power bus as a result of saving that energy at the capacitors.

  Remember that the energy saved at the capacitors responds to the formula: **Energy saved = 0.5 C·V ²**

  When exceeding a certain bus voltage (760-768 V DC) the Ballast circuit is activated to dissipate that excess of energy in an resistor (internal or external) and the motor performs a controlled stop (with motor torque).

  Even when having activated the Ballast circuit, if there is a problem with it (e.g. poor connection of the external resistor) the bus voltage would keep rising until reaching its maximum value allowed (790 V DC) and would issue error **E215** for bus over-voltage. It would deactivate the "Drive Enable" function and the motor would stop by friction without motor torque.

- **Opening of power contactor KM1** because the contact KA1 associated with the relay D1 has opened. The braking operation would be the same as in the previous case when using a PS-65A or a PS-25B4 power supply. If it is a regenerative power supply (XPS or RPS) it brakes with emergency ramps if they have been previously set by parameters. The excess energy generated by braking is returned to mains just a few seconds before opening contactor KM1 thanks to the delayed deactivation of the relay KA3. If for any reason the power bus voltage kept rising, the braking operation would be the same as that of the previous case.

  Remember that RPS power supplies do not have a Ballast circuit and if the application requires one, an off-the-shelf circuit will have to be used.

Brake control

In some applications (e.g. the vertical Z axis on a milling machine) a electro-mechanical holding brake is used on the rotor of the motor.

Warning. This brake must never be used to brake moving axes. It must only be used to hold or lock vertical axes that have been stopped previously !

Hence, the brake holds the rotor when loses voltage at its terminals. When the machine is out of service, the brake locks up the vertical Z axis to keep it from falling due to gravity.

The reaction time of a brake integrated into an axis feeding FAGOR motor may vary between 7 ms and 97 ms depending on the model.

While the brake is locking the vertical axis motor, the motor must be kept with torque. See parameter GP9 in chapter 13 of the "dds-software" manual.

When powering the machine up, the brake must never be released until the system assumes control of that axis. See the TV100 variable in chapter 13 of the "dds-software" manual.

Remember that

The control circuits of compact drives as well as RPS, XPS and PS-25B4 power supplies are powered at 24 V DC by an internal auxiliary power supply. PS-65A power supplies will need an external APS-24 auxiliary power supply to power them because they do not have one integrated into them.

In compact drives and power supplies, the auxiliary power supply must be powered at **single-phase** 400-460 V AC. But not RPS power supplies; they must be powered at **three-phase** 400-460 V AC.

Closing the main power switch S1 must take two phases to connector X1 when using compact drives or an APS-24 as auxiliary power supply of the PS-65A and to connector X3 when using XPS or PS-25B4 power supplies. In the case of RPS power supplies, there are three phases instead of two and they must go to connector X1.

It is necessary to install external protection fuses in the power lines of the auxiliary power supply.
They are internally integrated into the power supplies.

Opening of contactor KM1 does not remove the supply of power to the auxiliary power supply in any case. But opening the main switch S1 does and the 24 V DC are maintained until the stop takes place.

BLOCK DIAGRAM OF THE DDS SYSTEM START-UP WITH PS-XX POWER SUPPLIES

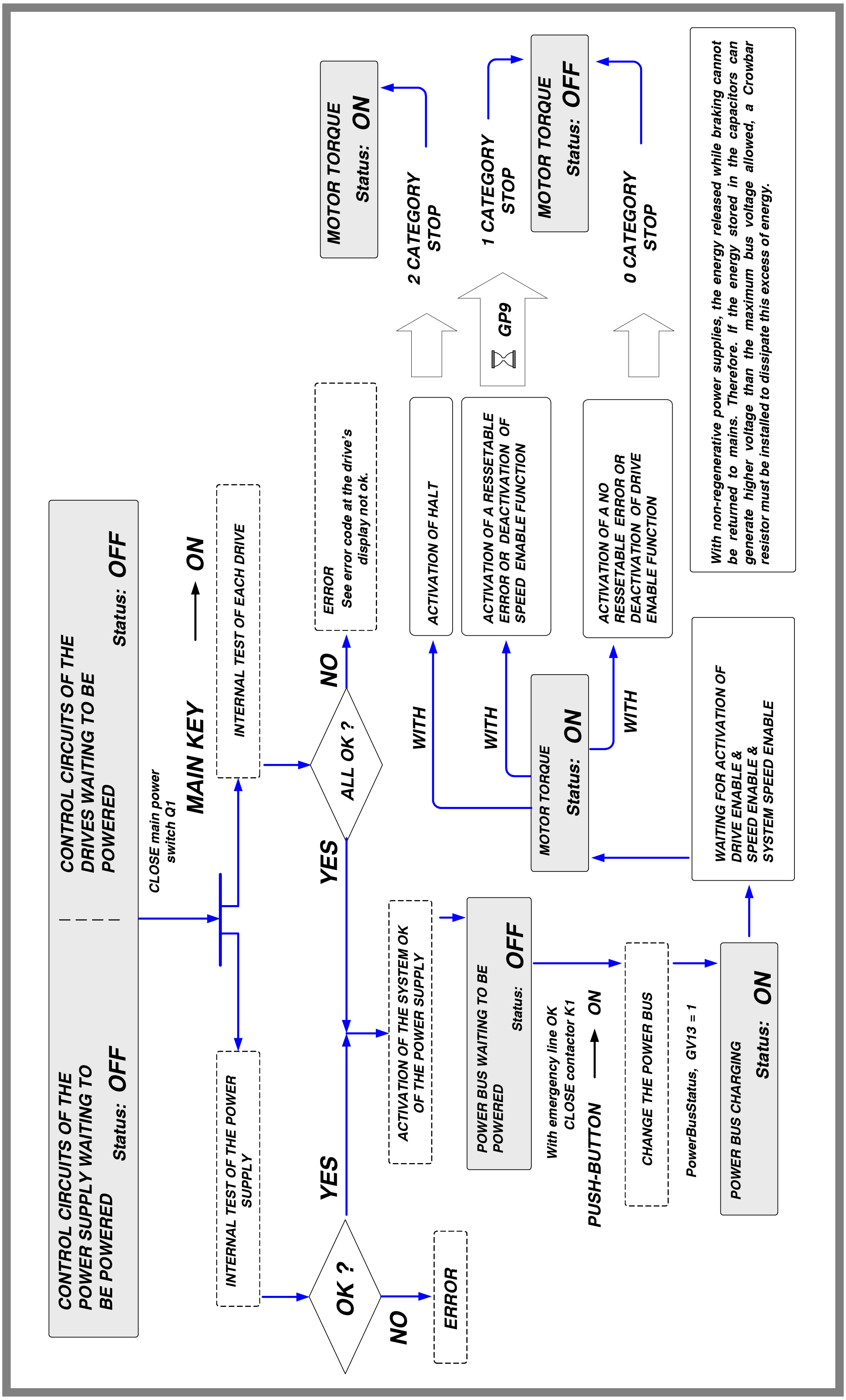

FIGURE H10.9

Block diagram of the DDS system start-up with non-regenerative power supplies.

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CONNECTION DIAGRAMS
Electrical cabinet. Diagrams

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BLOCK DIAGRAM OF THE DDS SYSTEM START-UP WITH XPS AND RPS POWER SUPPLIES

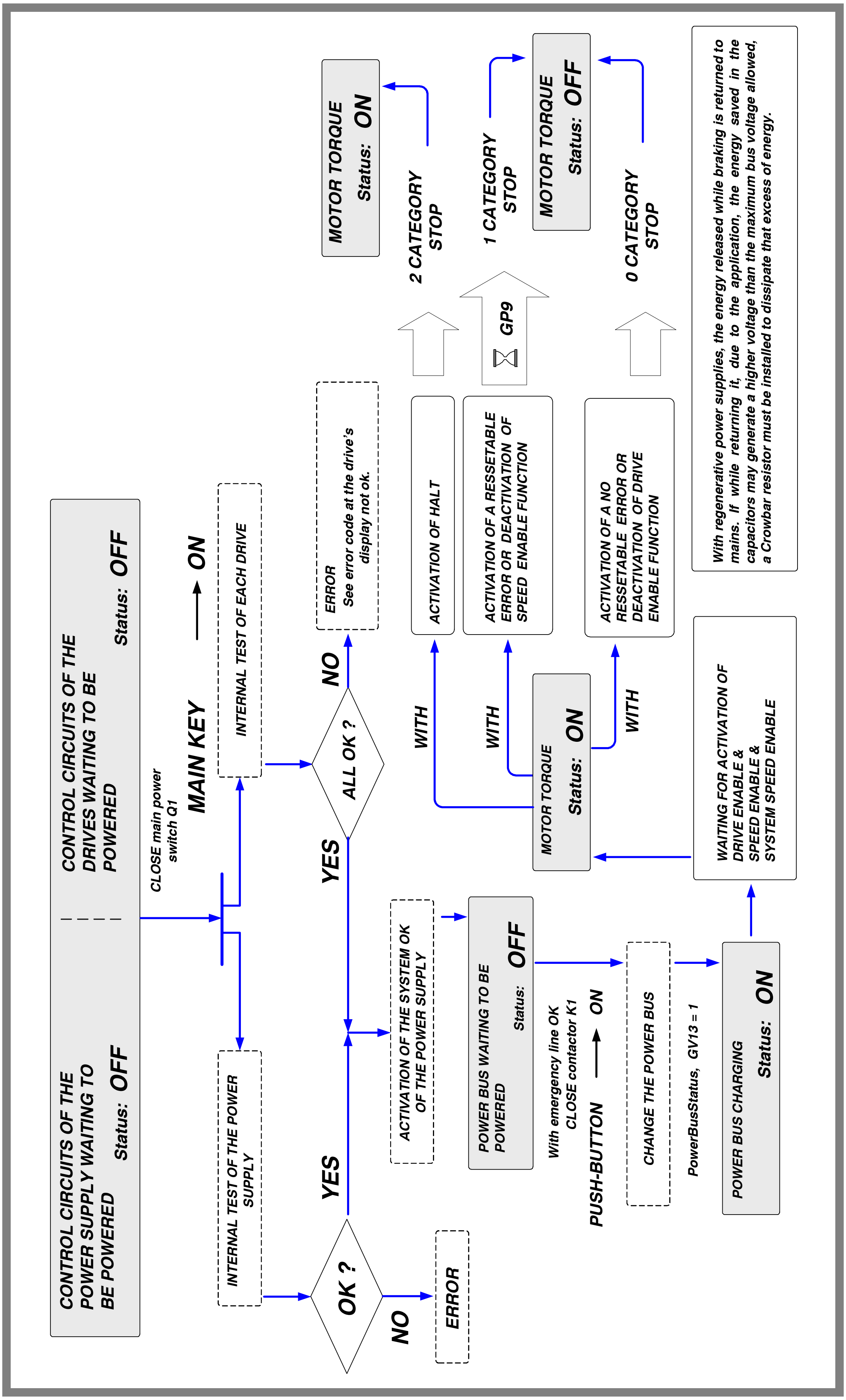


FIGURE H10.10

Block diagram of the DDS system start-up with regenerative power supplies.

10.10 Diagrams with a PS-65A power supply

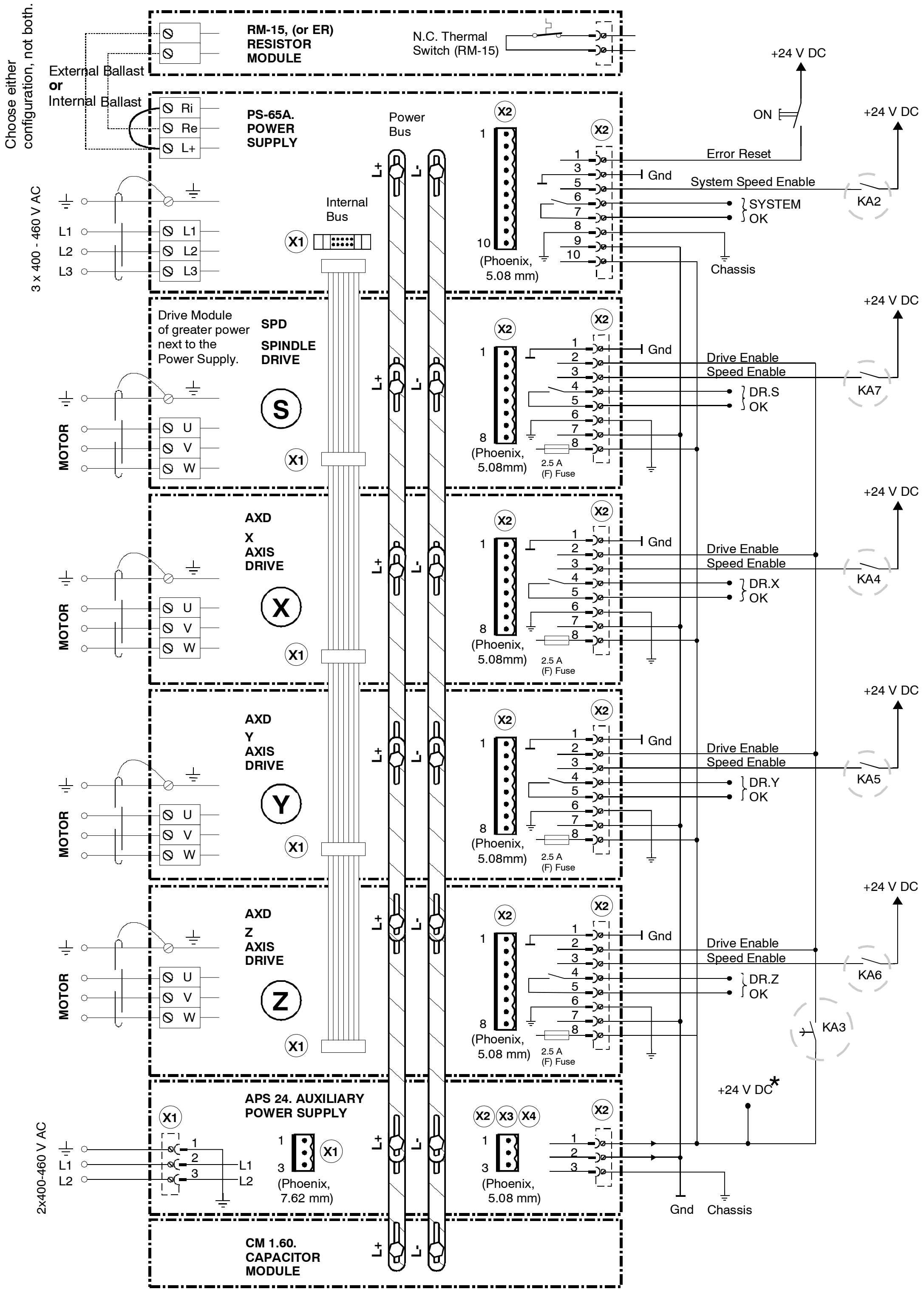


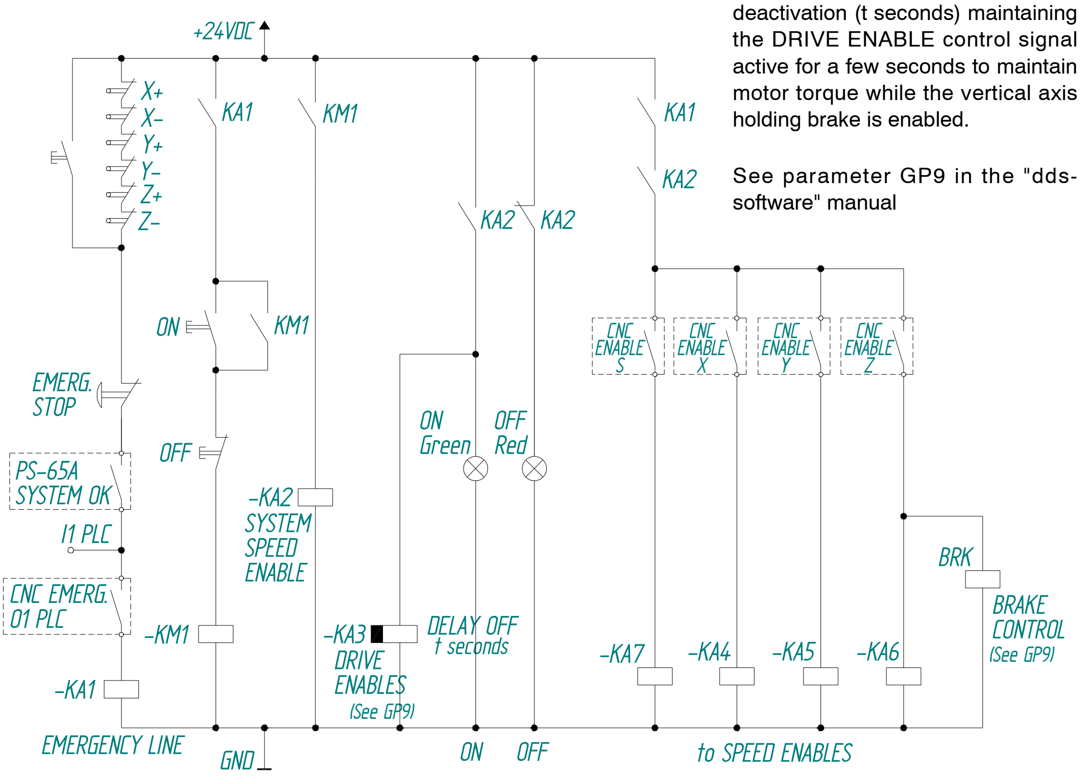
FIGURE H10.11

System with a PS-65A power supply.

OPERATION DIAGRAM. PS-65A

Note. The relay KA3 uses delayed deactivation (t seconds) maintaining the DRIVE ENABLE control signal active for a few seconds to maintain motor torque while the vertical axis holding brake is enabled.

See parameter GP9 in the "dds-software" manual

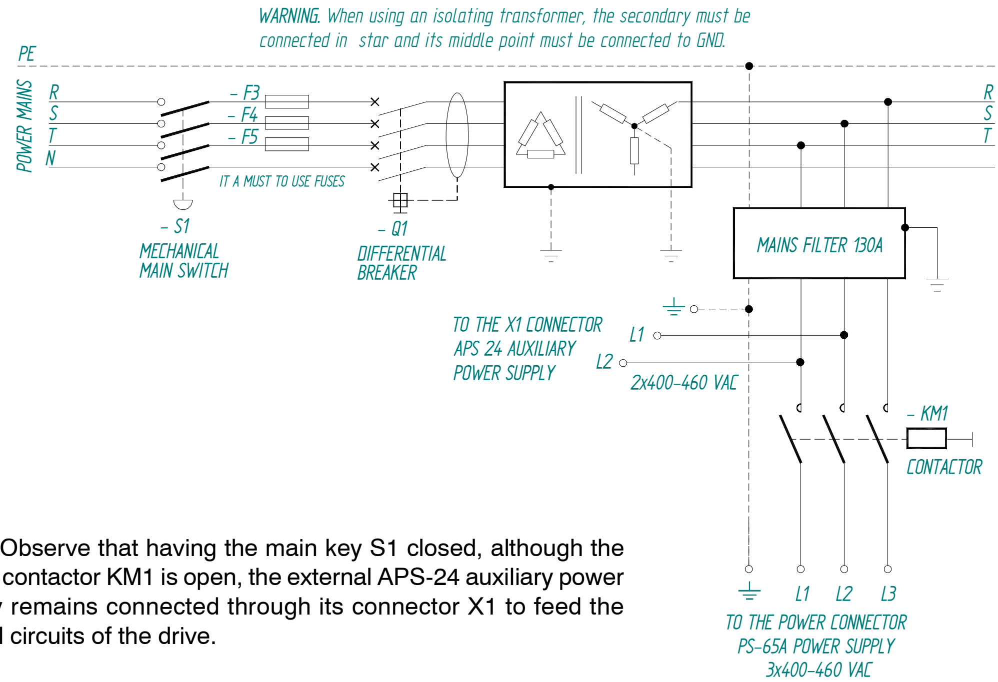


Note. CNC EMERG. will always be assigned to I1/O1 of the PLC with an 8055/55i CNC. With an 8070 CNC, it may be assigned to any I/O of the PLC. The contacts associated with relays KA2, KA3, KA4, KA5, KA6 and KA7 are shown inside a circle in **FIGURE H10.11** and the contactor KM1 in **FIGURE H10.13**.

FIGURE H10.12

System with a PS-65A power supply. Diagram of the maneuver.

GENERAL DIAGRAM. PS-65A



Note. Observe that having the main key S1 closed, although the power contactor KM1 is open, the external APS-24 auxiliary power supply remains connected through its connector X1 to feed the control circuits of the drive.

FIGURE H10.13

General diagram of a DDS system with a PS-65A power supply.

10.11 Diagrams with a PS-25B4 power supply

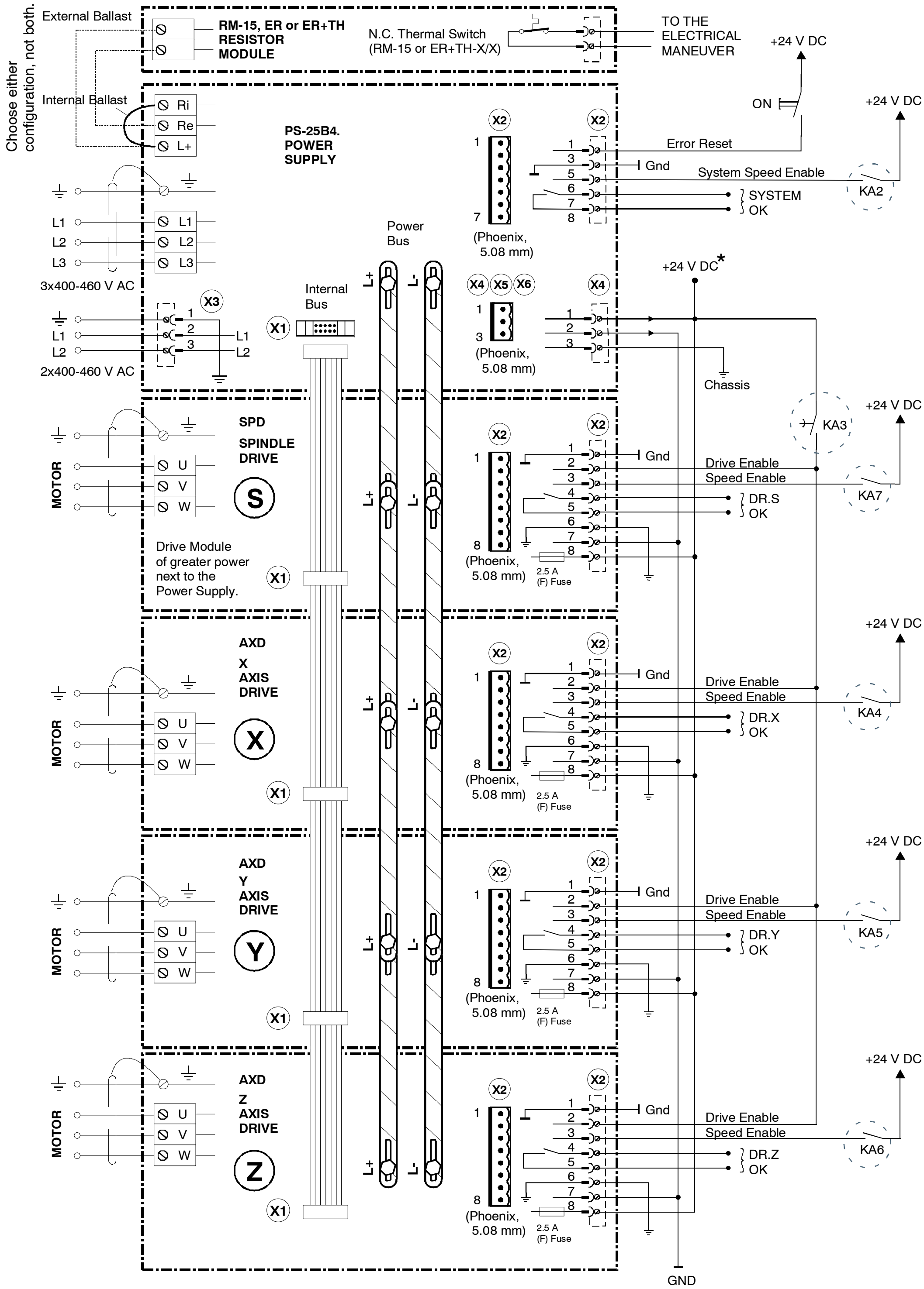
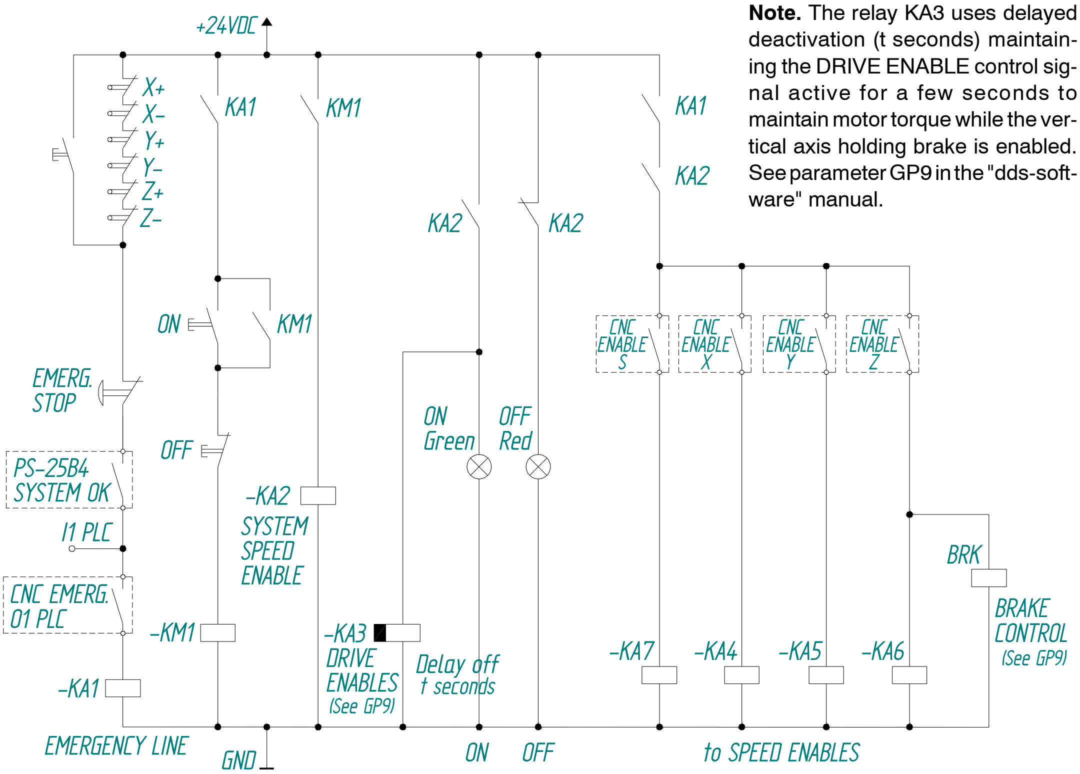


FIGURE H10.14

System with a PS-25B4 power supply

OPERATION DIAGRAM. PS-25B4

Note. The relay KA3 uses delayed deactivation (t seconds) maintaining the DRIVE ENABLE control signal active for a few seconds to maintain motor torque while the vertical axis holding brake is enabled. See parameter GP9 in the "dds-software" manual.

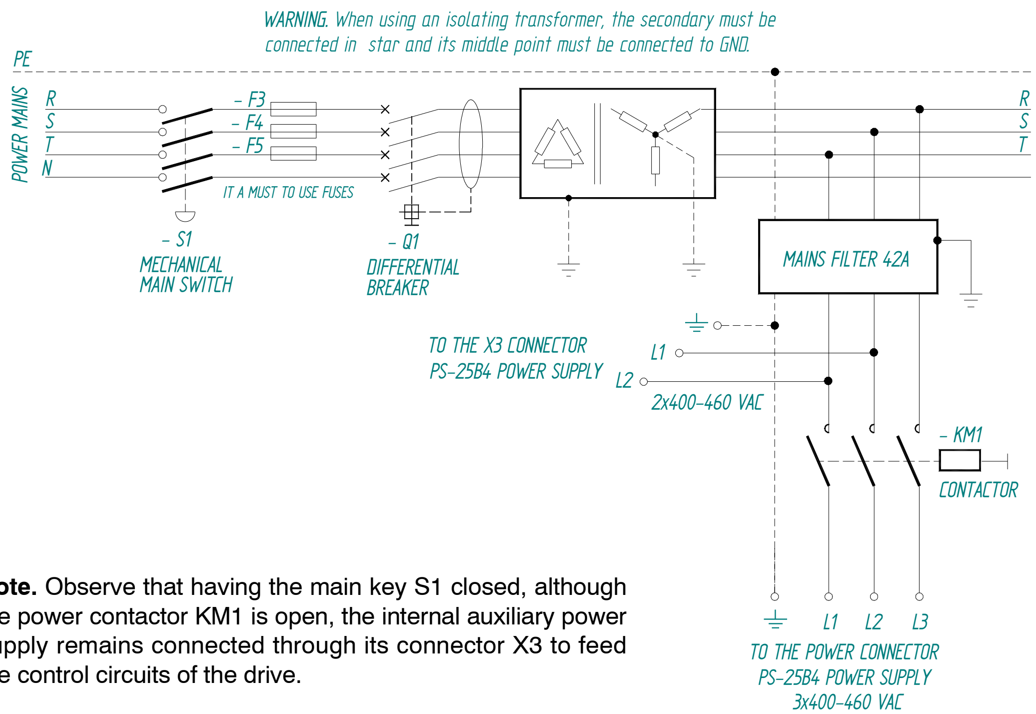


Note. CNC EMERG. will always be assigned to I1/O1 of the PLC with an 8055/55i CNC. With an 8070 CNC, it may be assigned to any I/O of the PLC. The contacts associated with relays KA2, KA3, KA4, KA5, KA6 and KA7 are shown inside a circle in **FIGURE H10.14** and the contactor KM1 in **FIGURE H10.16**.

FIGURE H10.15

System with a PS-25B4 power supply Diagram of the maneuver.

GENERAL DIAGRAM. PS-25B4



Note. Observe that having the main key S1 closed, although the power contactor KM1 is open, the internal auxiliary power supply remains connected through its connector X3 to feed the control circuits of the drive.

FIGURE H10.16

General diagram of a DDS system with a PS-25B4 power supply.

10.12 Diagrams with a XPS power supply

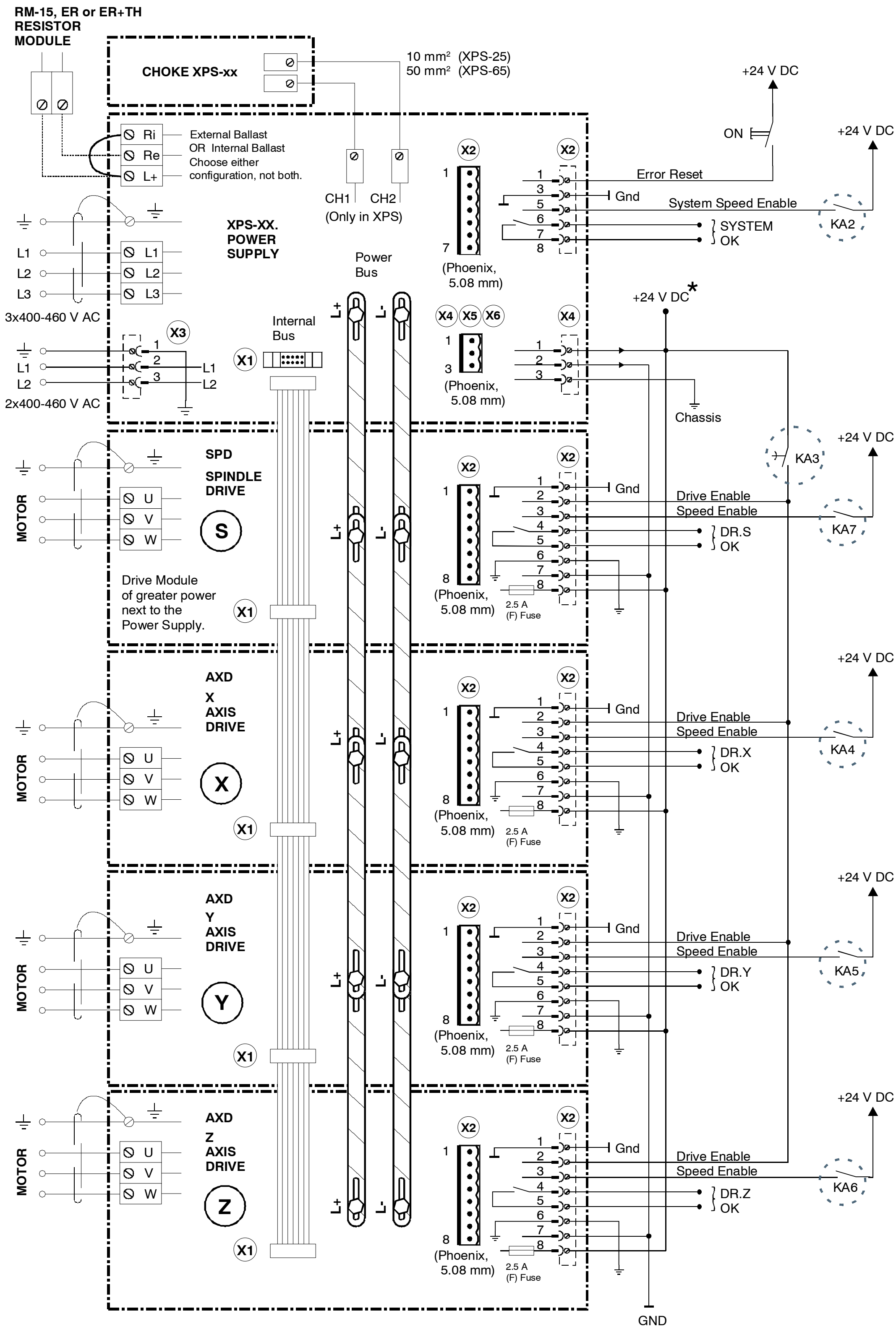
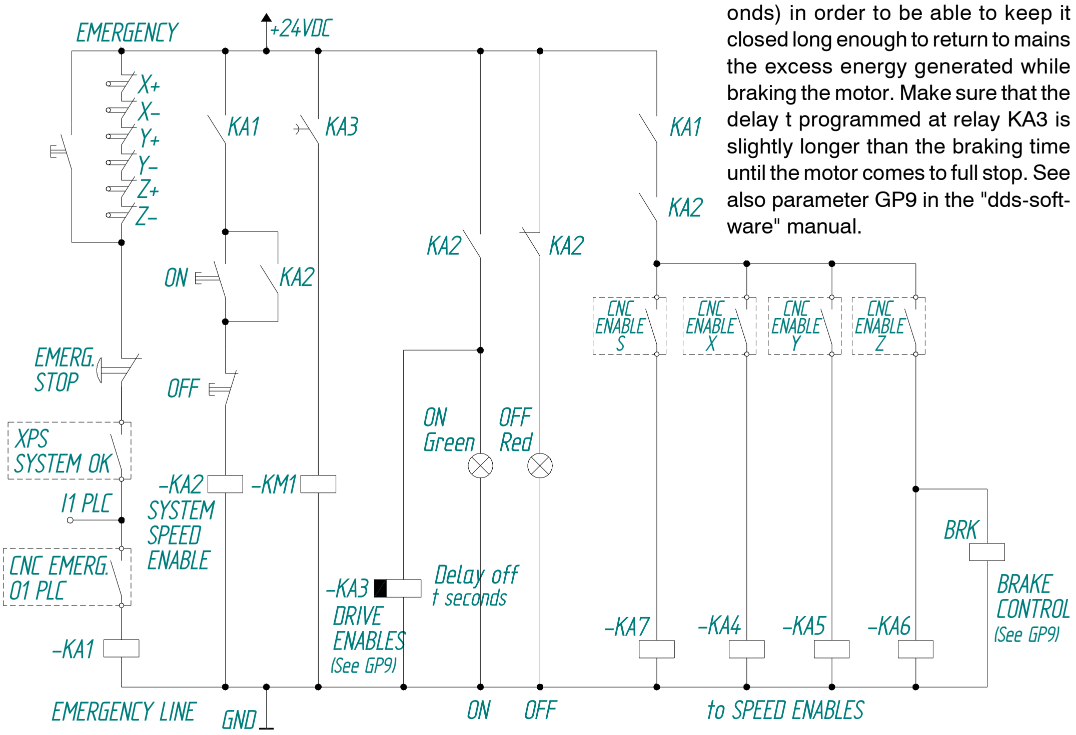


FIGURE H10.17

System with a XPS power supply.

OPERATION DIAGRAM. XPS-XX

Note. The relay KA3 uses delayed deactivation for contactor KM1 (t seconds) in order to be able to keep it closed long enough to return to mains the excess energy generated while braking the motor. Make sure that the delay t programmed at relay KA3 is slightly longer than the braking time until the motor comes to full stop. See also parameter GP9 in the "dds-software" manual.

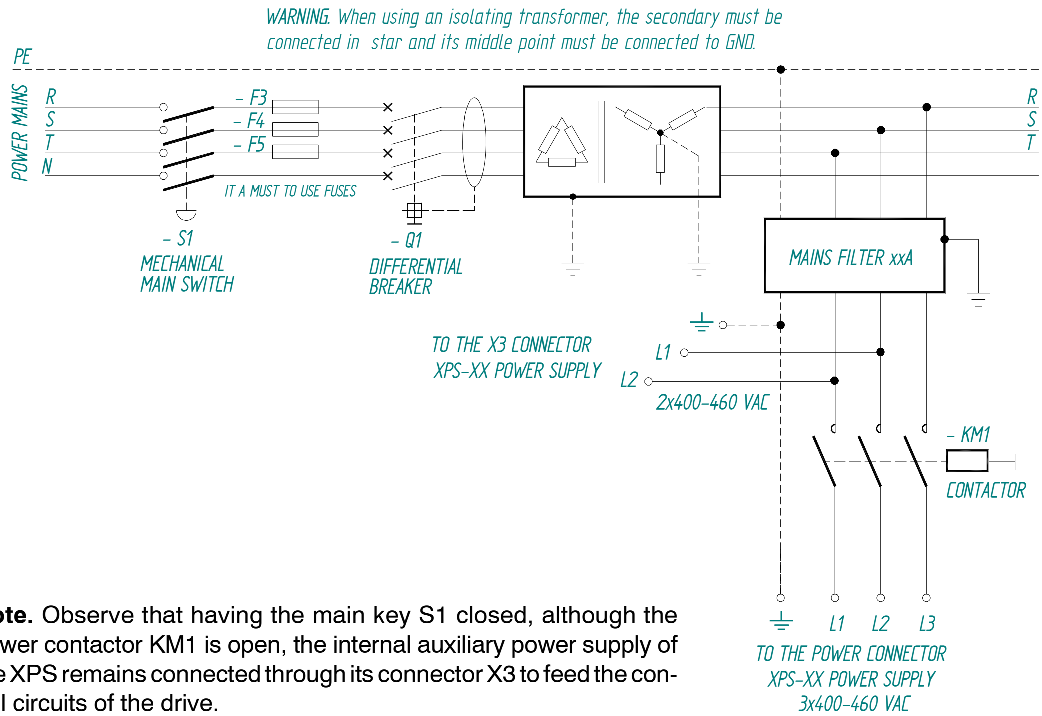


Note. CNC EMERG. will always be assigned to I1/O1 of the PLC with an 8055/55i CNC. With an 8070 CNC, it may be assigned to any I/O of the PLC. The contacts associated with relays KA2, KA3, KA4, KA5, KA6 and KA7 are shown inside a circle in **FIGURE H10.17** and the contactor KM1 in **FIGURE H10.19**.

FIGURE H10.18

System with a XPS power supply. Diagram of the maneuver.

GENERAL DIAGRAM. XPS-XX



Note. Observe that having the main key S1 closed, although the power contactor KM1 is open, the internal auxiliary power supply of the XPS remains connected through its connector X3 to feed the control circuits of the drive.

FIGURE H10.19

General diagram of a DDS system with a XPS power supply.

10.

CONNECTION DIAGRAMS

Diagrams with a XPS power supply

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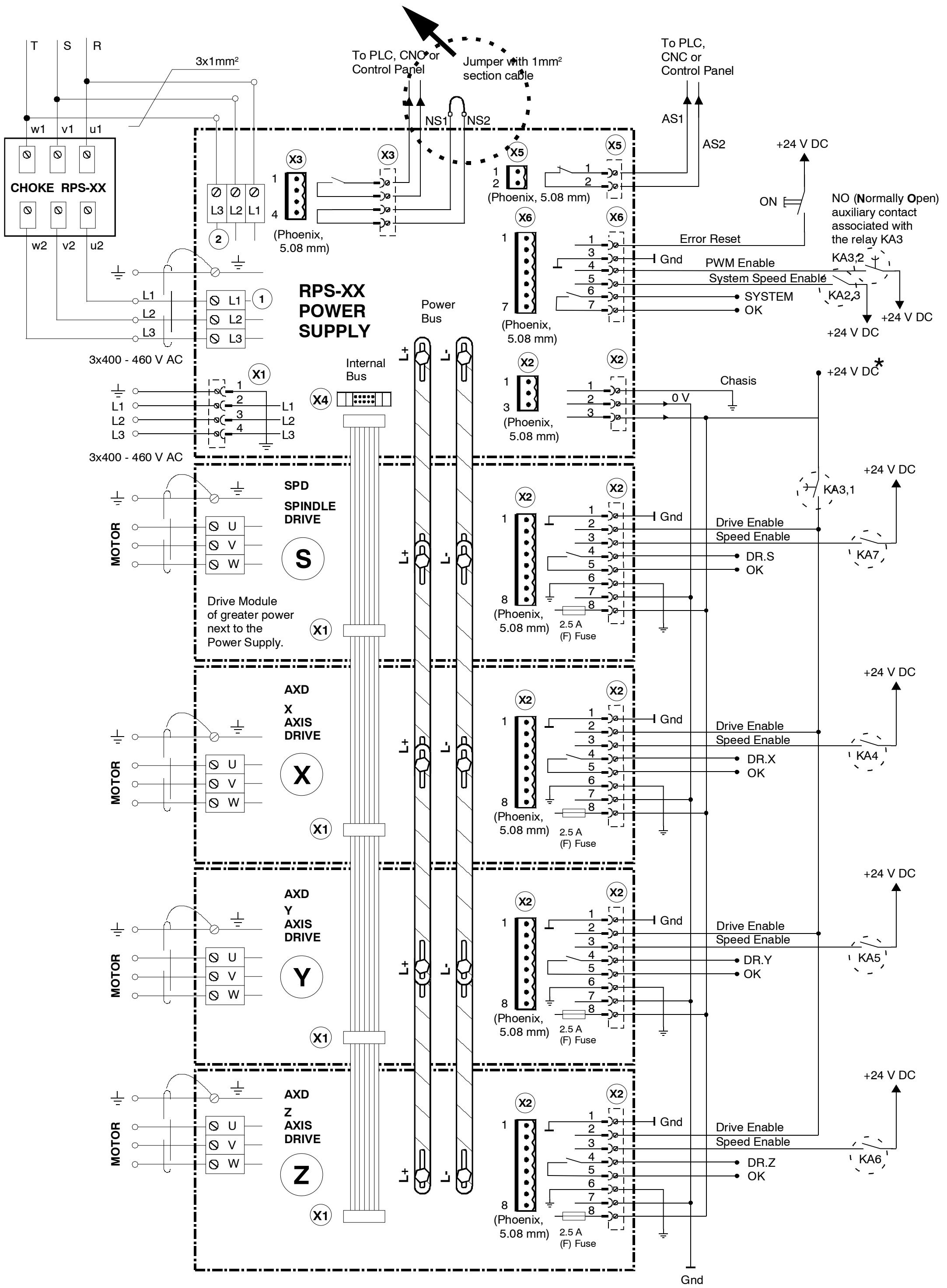
10.13 Diagrams with an RPS-XX power supply

IMPORTANT. It is absolutely necessary to short-circuit pins NS1 and NS2 externally with a wire of at least 1 mm^2 section for the RPS to work.



Note 1.
The auxiliary contact KA3,2 associated with relay KA3 appears in the diagrams of the next page.

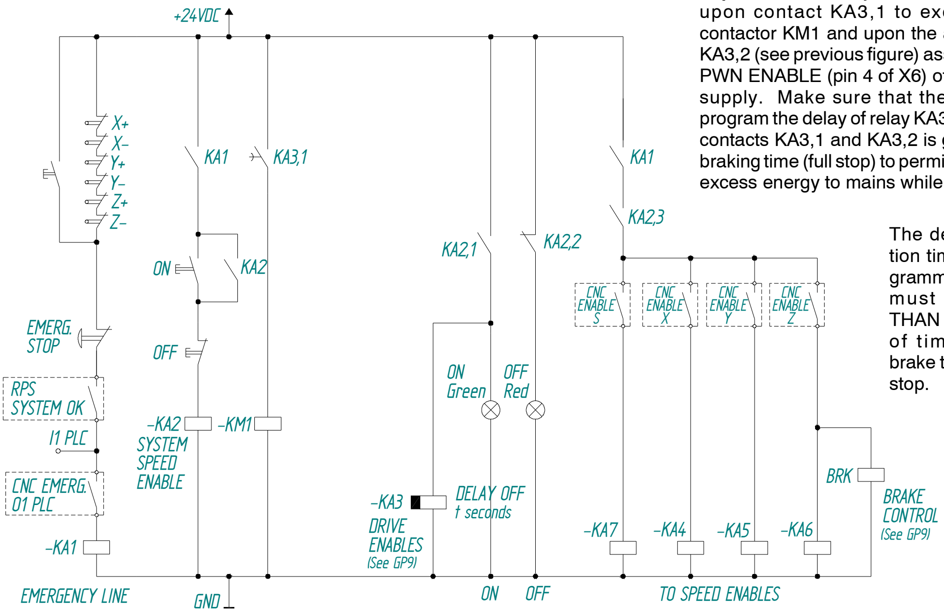
Note 2.
An "SPD 3.250" drive must always be installed next to an RPS-80 power supply.

FIGURE H10.20
System with RPS-☐☐ power supply.

OPERATION DIAGRAM. RPS-XX

Important. The relay KA3 acts simultaneously upon contact KA3,1 to excite the coil of contactor KM1 and upon the auxiliary contact KA3,2 (see previous figure) associated with the PWN ENABLE (pin 4 of X6) of the RPS power supply. Make sure that the time t used to program the delay of relay KA3 associated with contacts KA3,1 and KA3,2 is **greater** than the braking time (full stop) to permit returning all the excess energy to mains while braking.

The delay disconnection time "t" to be programmed at relay KA3 must be GREATER THAN the total amount of time required to brake the motor to a full stop.

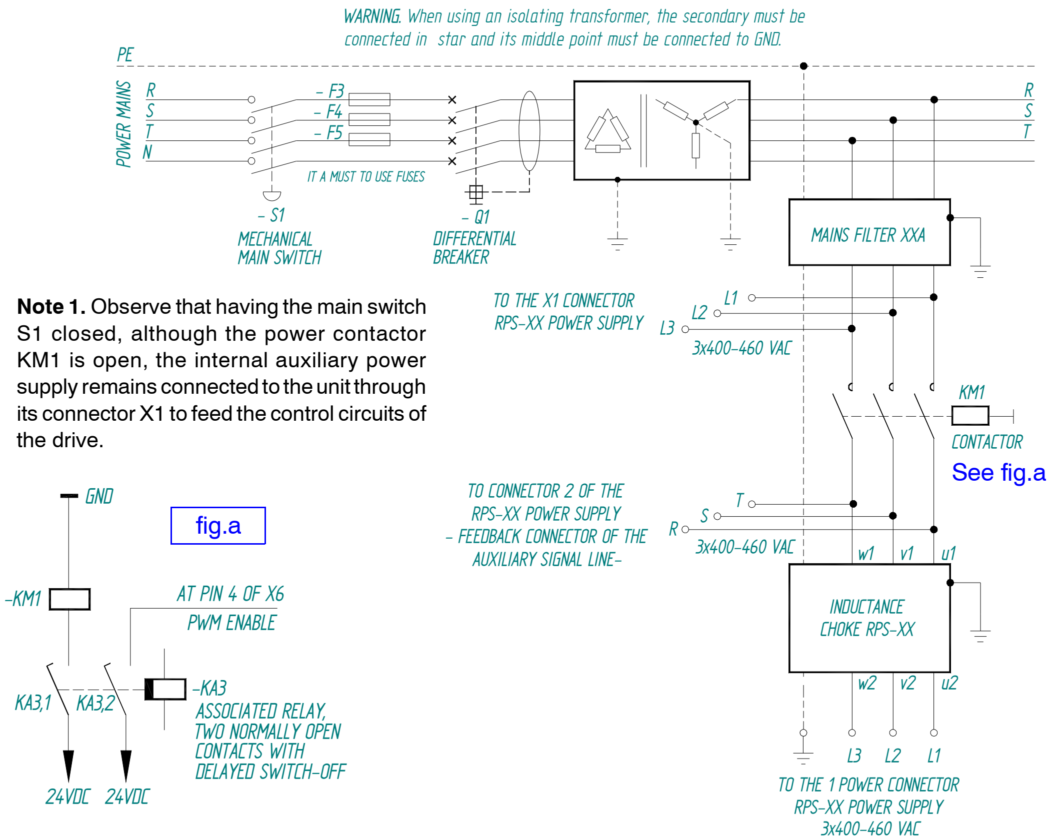


Note. CNC EMERG. will always be assigned to I1/O1 of the PLC with an 8055/55i CNC. With an 8070 CNC, it may be assigned to any I/O of the PLC. The contacts associated with relays KA2, KA3, KA4, KA5, KA6 and KA7 are shown inside a circle in FIGURE H10.20 and the contactor KM1 in FIGURE H10.22.

FIGURE H10.21

System with RPS-☐☐ power supply. Diagram of the maneuver.

GENERAL DIAGRAM. RPS-XX

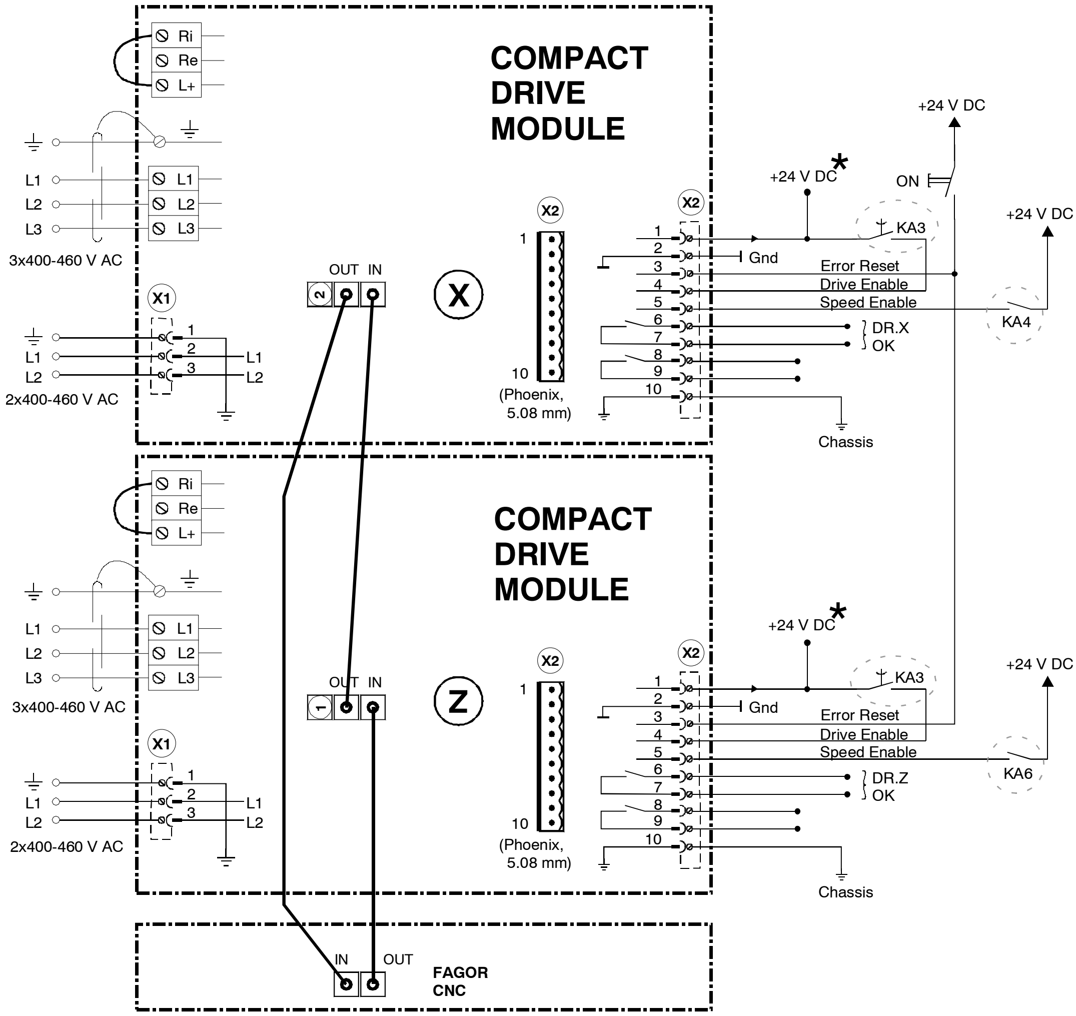


Note 1. Observe that having the main switch S1 closed, although the power contactor KM1 is open, the internal auxiliary power supply remains connected to the unit through its connector X1 to feed the control circuits of the drive.

FIGURE H10.22

System with RPS-☐☐ power supply. General diagram.

10.14 Compact system diagrams with SERCOS connection



Notes. Compact modules do not have the System_Speed_Enable signals.
In this diagram, in spite of having SERCOS interface, electrical signals are used to activate the enables.

FIGURE H10.23

Compact system with SERCOS connection.

OPERATION DIAGRAM. ACD/SCD

Note 1. The relay KA3 uses delayed deactivation (t seconds) maintaining the DRIVE ENABLE control signal active for a few seconds to maintain motor torque while the vertical axis holding brake is enabled. See parameter GP9 in the "dds-software" manual

Note 2. CNC EMERG. will always be assigned to I1/O1 of the PLC with an 8055/55i CNC. With an 8070 CNC, it may be assigned to any I/O of the PLC. The contacts associated with relays KA3, KA4 and KA6 are shown inside a circle in **FIGURE H10.23** and the contactor KM1 in **FIGURE H10.25**.

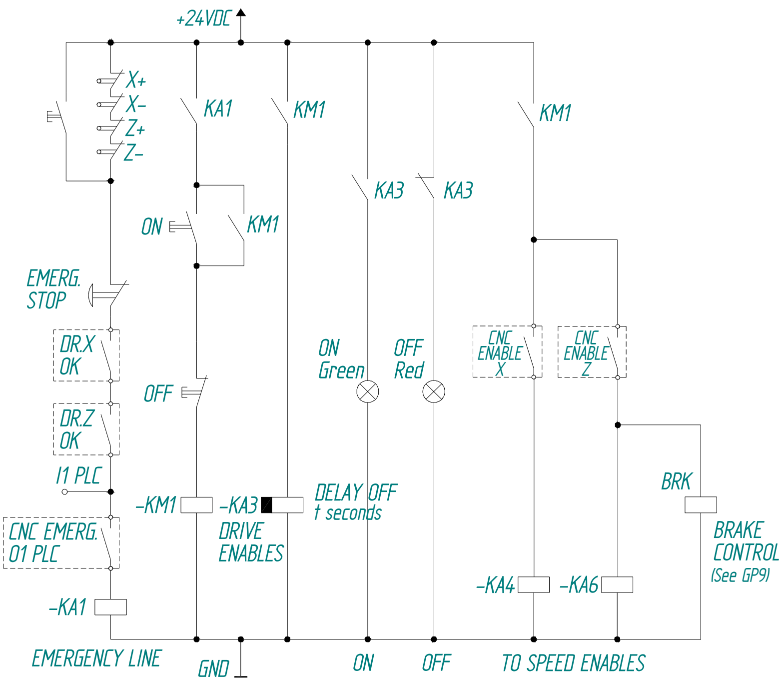
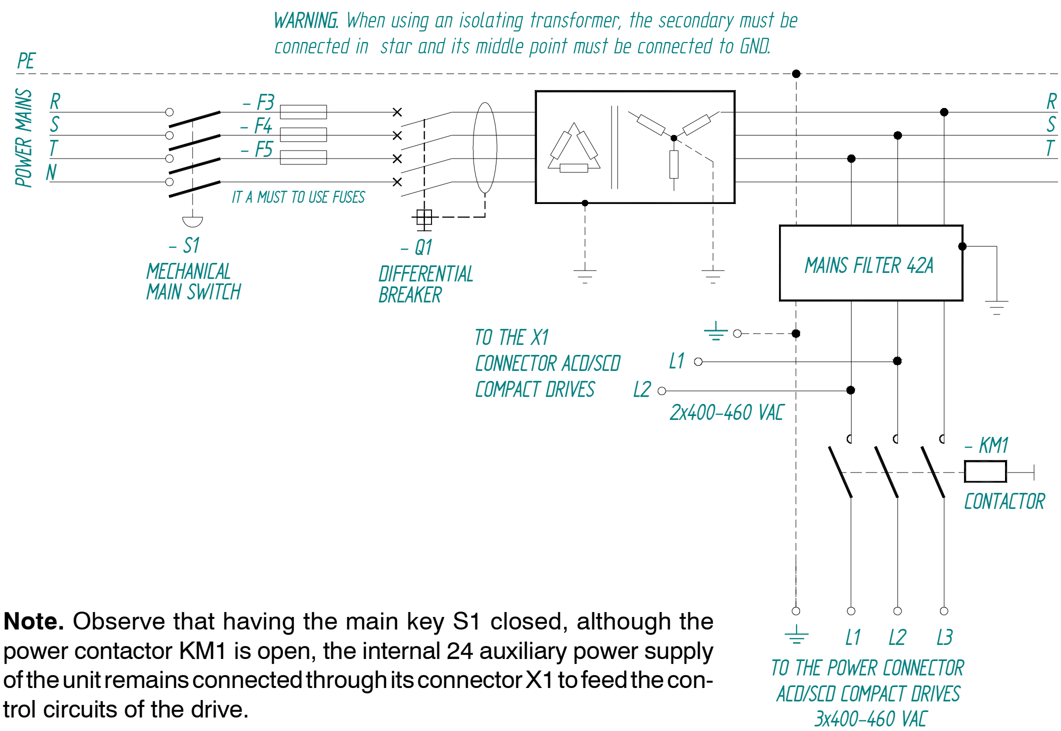


FIGURE H10.24

Compact system with SERCOS connection. Diagram of the maneuver.

GENERAL DIAGRAM. ACD/SCD



Note. Observe that having the main key S1 closed, although the power contactor KM1 is open, the internal 24 auxiliary power supply of the unit remains connected through its connector X1 to feed the control circuits of the drive.

FIGURE H10.25

General diagram of a compact DDS system with SERCOS connection.

10.15 Diagrams of a mixed (combined) system with SERCOS connection

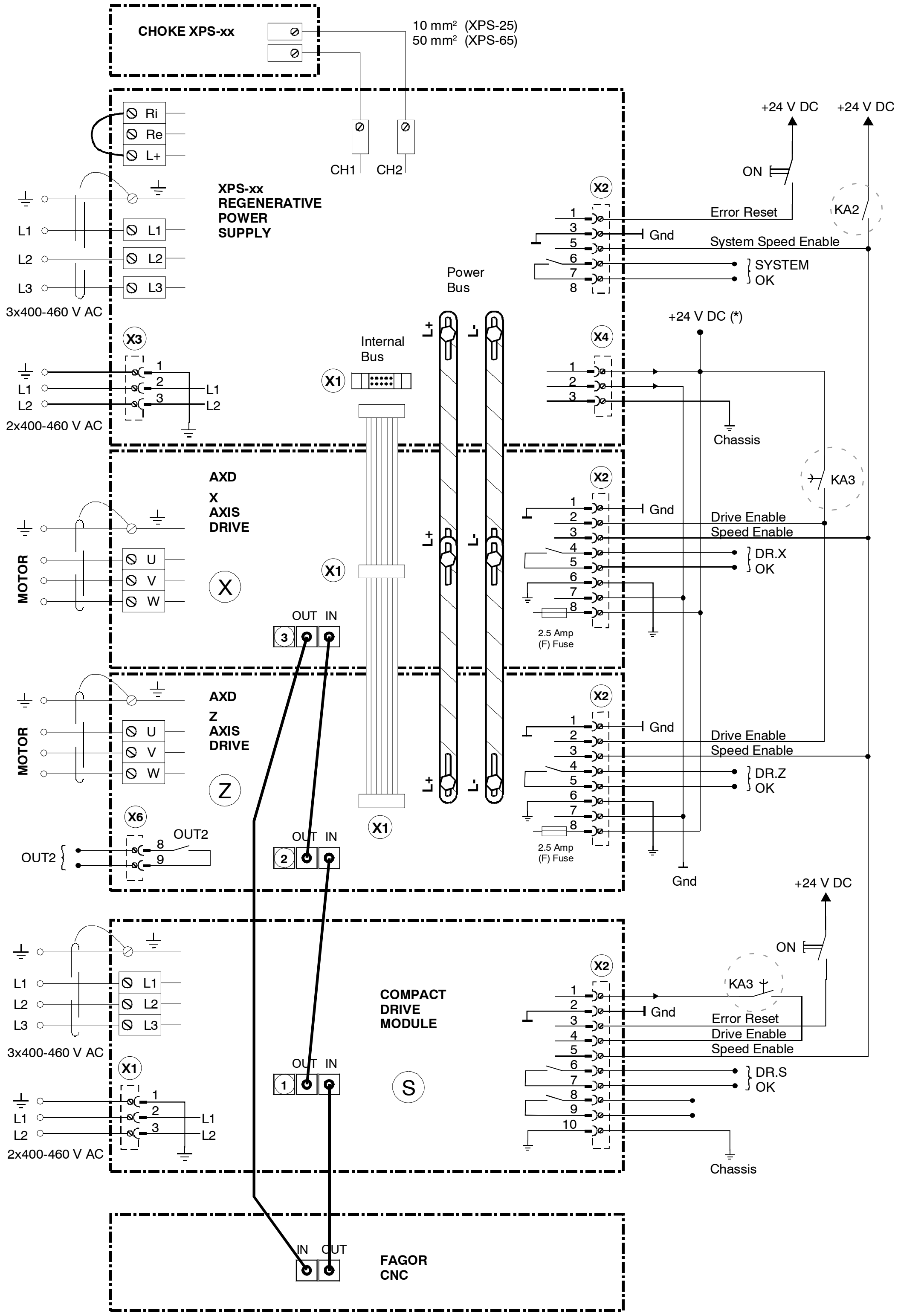


FIGURE H10.26

Mixed system with SERCOS connection.

OPERATION DIAGRAM

Note 1. KA3 is a relay for a delayed deactivation of contactor KM1 (t seconds) in order to be able to keep it closed long enough to return to mains (with XPS power supply) the excess energy generated while braking the motor.

Make sure that the delay "t" programmed at relay KA3 is slightly longer than the braking time of the application.

The delay disconnection time "t" to be programmed at relay KA3 must be GREATER THAN the total amount of time required to brake the motor to a full stop.

See parameter GP9 in the "dds-software" manual.

Note 2. CNC EMERG. will always be assigned to I1/O1 of the PLC with an 8055/55i CNC. With an 8070 CNC, it may be assigned to any I/O of the PLC.

The contacts associated with relays KA2 & KA3 are shown inside a circle in **FIGURE H10.26**.

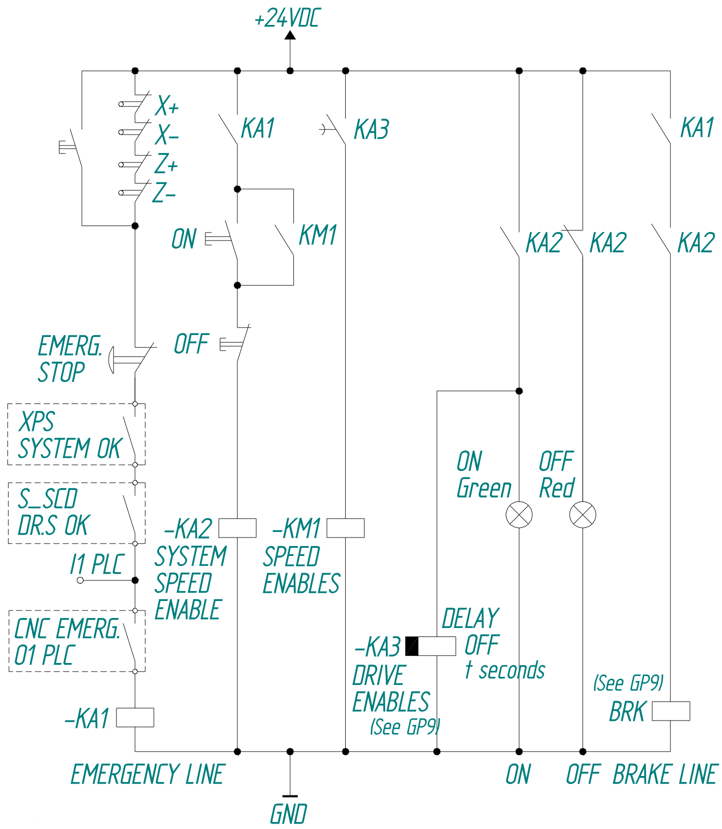


FIGURE H10.27

Mixed system with SERCOS connection. Diagram of the maneuver.

10.16 Brake connection diagram for synchronous axis servo motors.

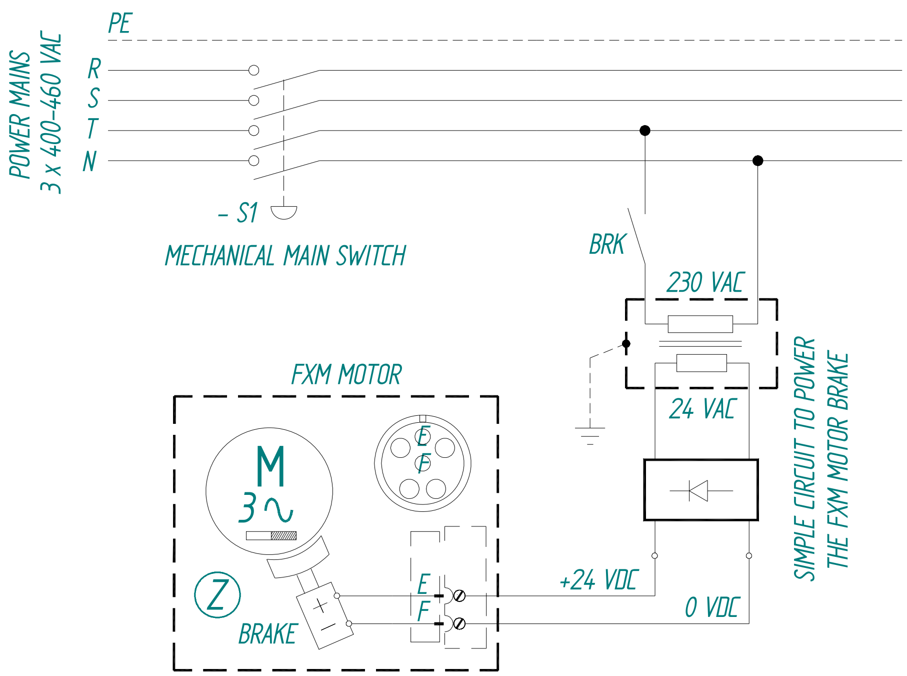


FIGURE H10.28

Connection diagram for the brake of an FXM synchronous servo motor.

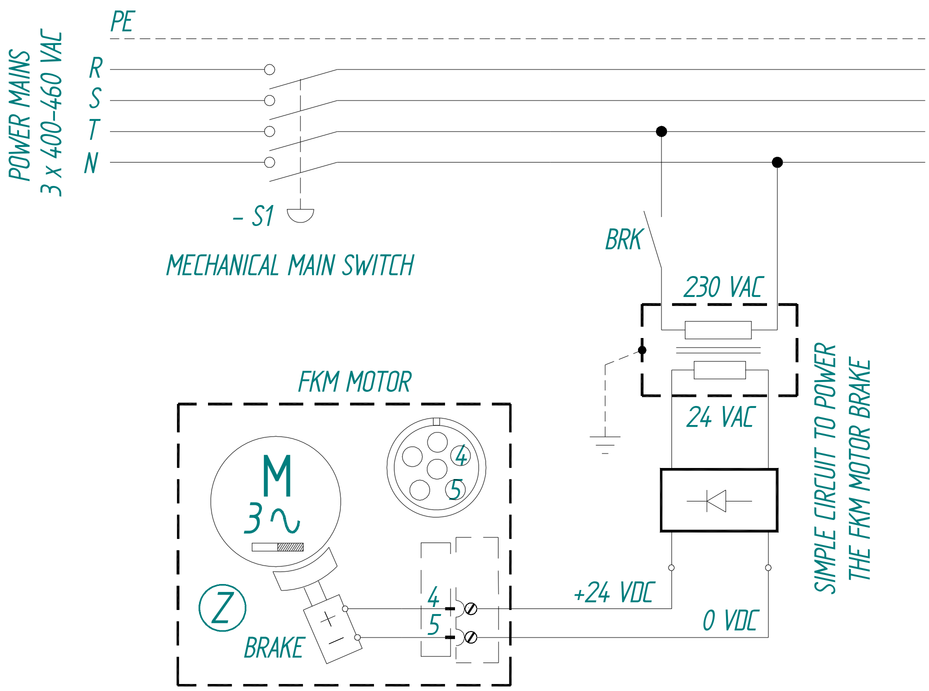
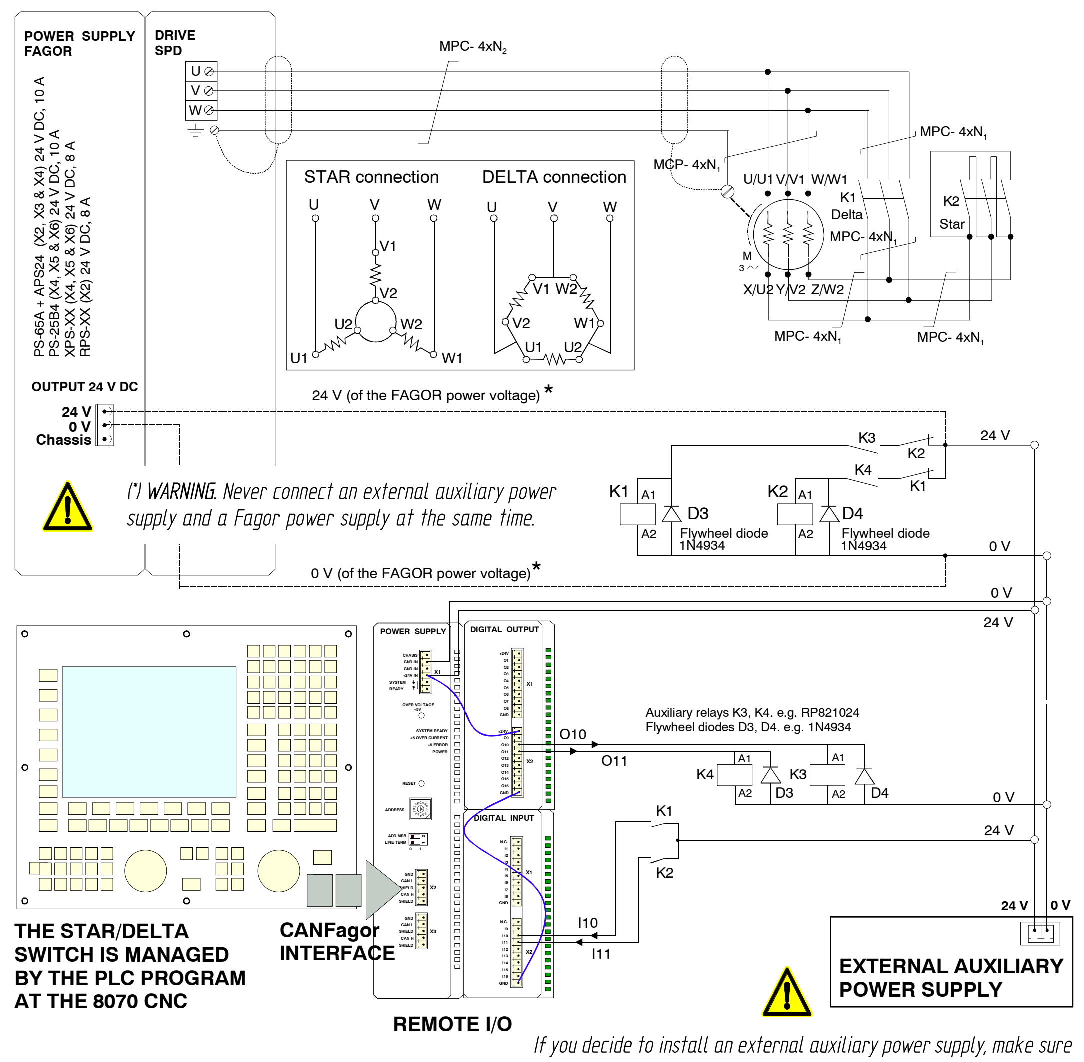


FIGURE H10.29

Connection diagram for the brake of an FKM synchronous servo motor.

10.17 On-the-fly start/delta connection switching on FM7 spindles, E03 & HS3 series



If you decide to install an external auxiliary power supply, make sure that in case of a power outage, the 24 V DC are ensured to brake the motor under control preventing it from braking by inertia. Ignoring this warning may cause personal injury.

Notes.

The I/O selected in the figure have been chosen arbitrarily. In general any Ixx and Oxx may be used always matching the ones used in the PLC.

It is very common to choose I1 and O1 for the external emergency. Therefore, we suggest not to use them for this application. If they are going to be used, make sure that they have not been set to be used as emergency input and output.

Important warnings.

1. Either an external auxiliary power supply or a FAGOR power supply may be used to supply the 24 V DC. **NEVER CONNECT BOTH AT THE SAME TIME !**

2. To brake the motor in a controlled way during a power failure, make sure that 24 V DC will be supplied to contactors K1 and K2 and relays K3 and K4. This situation is ensured if you have installed a FAGOR power supply next to an SPD modular drive. If you have installed an external auxiliary 24 V DC power supply, you must make sure that this condition is ensured.

3. When using a compact SCD drive to govern a spindle motor, you must necessarily install an external auxiliary power supply to provide the 24 V DC. These compact drives do not have an output 24 V DC connector.

Sizing of K1 and K2 power contactors.

Contactor K1: $I_{(K1)} \geqslant I_N$ (⅄)

Contactor K2: $I_{(K2)} \geqslant (1/\sqrt{3})\, I_N$ (⅄)

Note. See these currents in tables 6.8 and 6.10 of chapter 6. Selection, of the FM7 motor manual.

Sizing of motor power cables.

MPC- 4xN_1 → **N_1: section supporting I_N (⅄)**

MPC- 4xN_2 → **N_2: section supporting I_N (Δ)**

Note. See the necessary cable section according to table 4.5 of the installation chapter of the FM7 motor manual.

FIGURE 10.30

Diagram of on-the-fly Y/D (start/delta) connection switching for FM7-XXXX-XXX-E03/HS3 motors.

DIMENSIONS

11

When designing and building the electrical cabinet, it is crucial to consider the necessary space to include the modules that will make up the DDS system, auxiliary modules and other elements such as cables and connectors.

11.1 Main modules

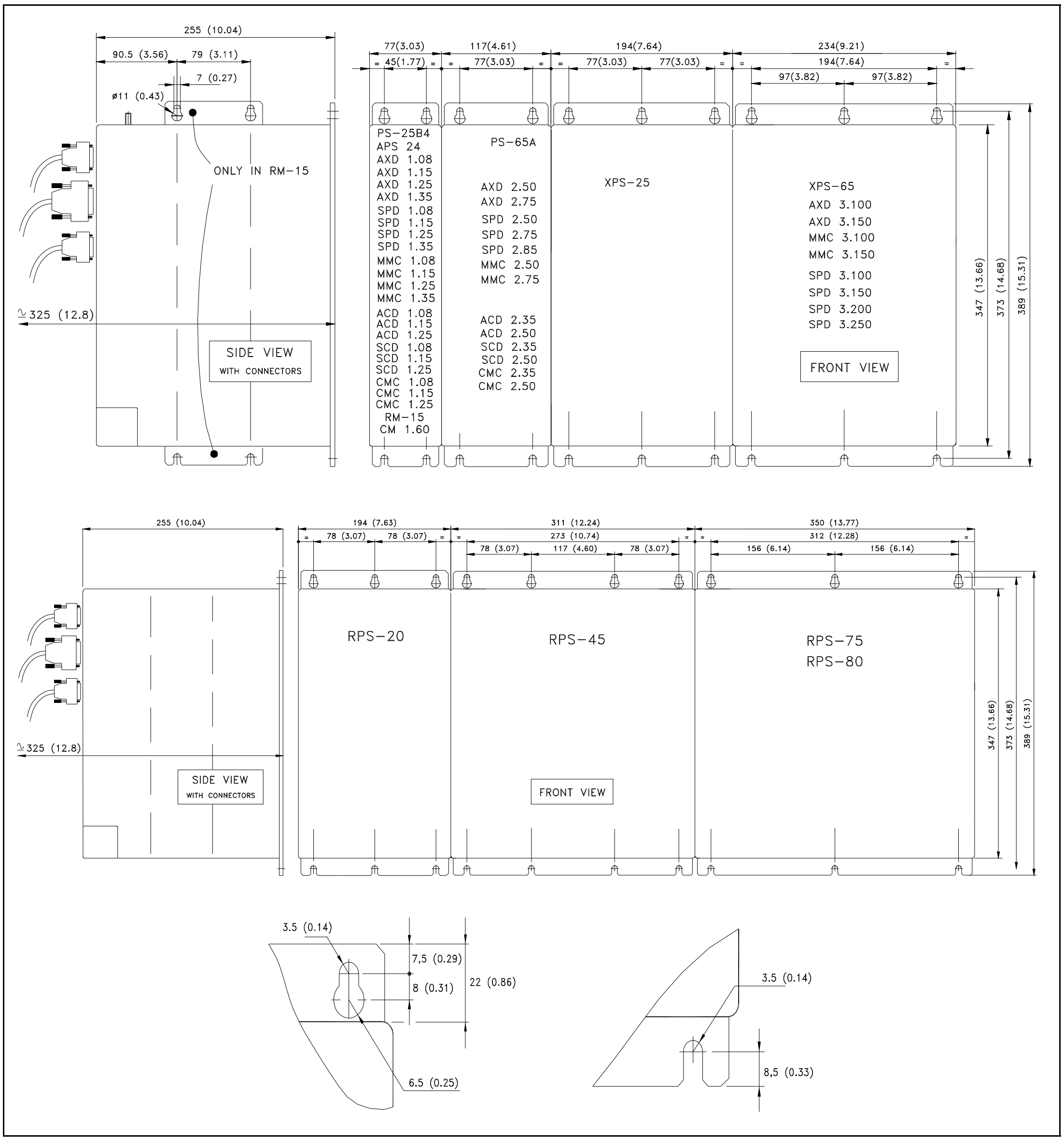


FIGURE H11.1

Dimensions of the main modules.

Remember that the upper power connectors may need a height of up to 45 mm.

11.2 Power supply modules

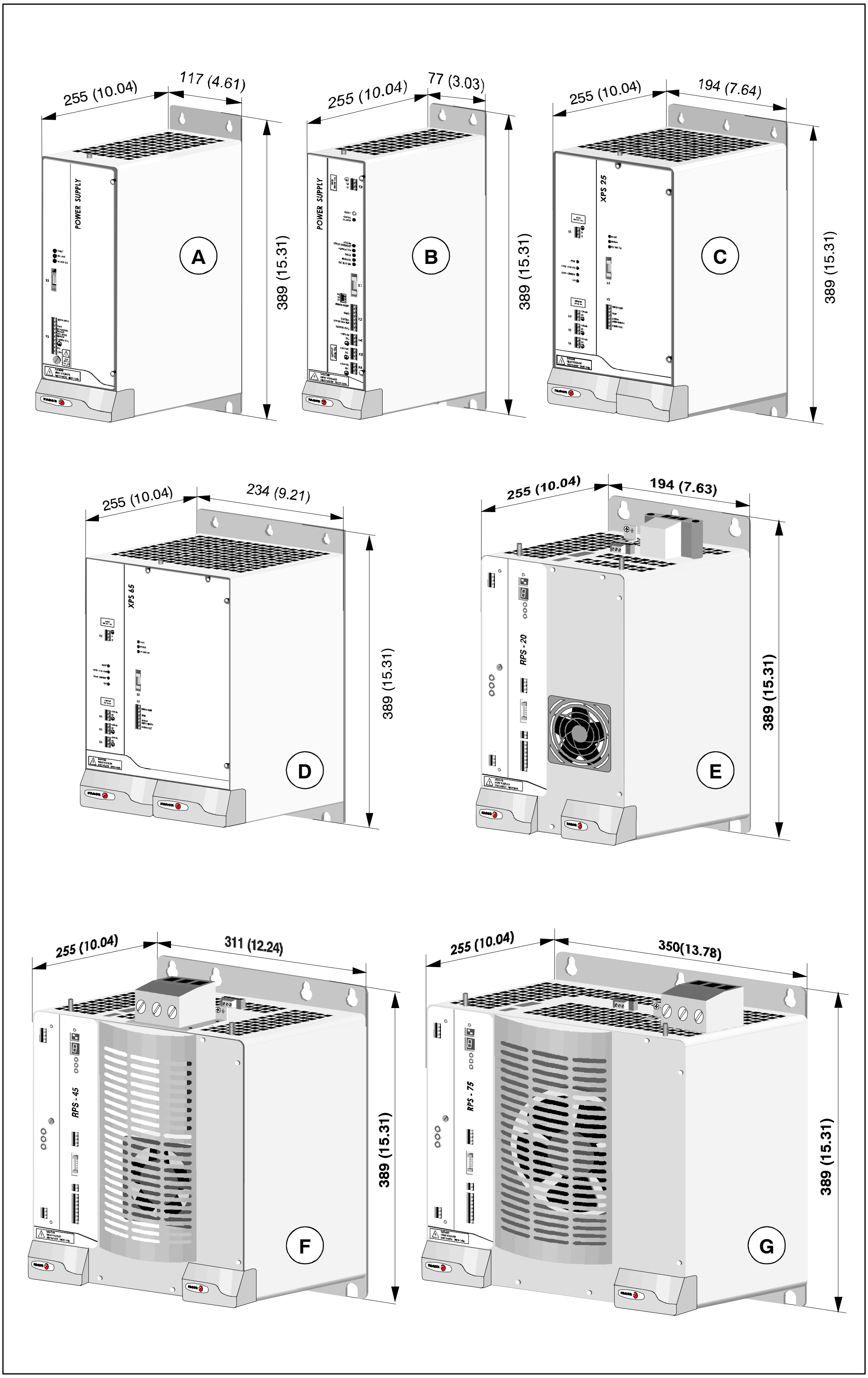


FIGURE H11.2

Dimensions of the power supplies.

A. PS-65A, **B.** PS-25B4, **C.** XPS-25, **D.** XPS-65, **E.** RPS-20, **F.** RPS-45, **G.** RPS-75 / RPS-80.

11.3 Modular drive modules

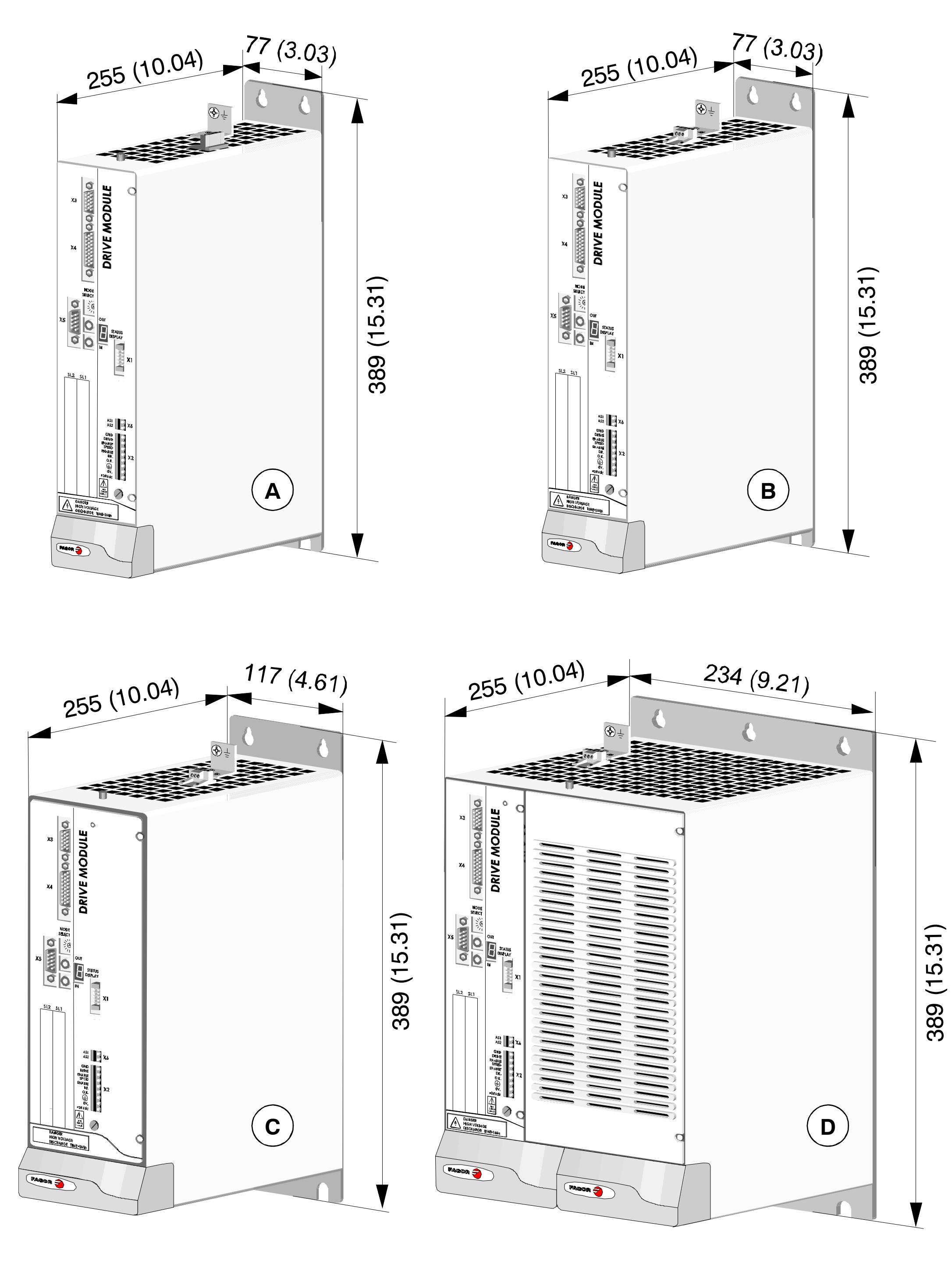


FIGURE H11.3

Dimensions of the modular drives.
A. AXD/SPD 1.08, 1.15, **B.** AXD/SPD 1.25, 1.35, **C.** AXD/SPD 2.☐☐, **D.** AXD/SPD 3.☐☐.

11.4 Compact drive modules

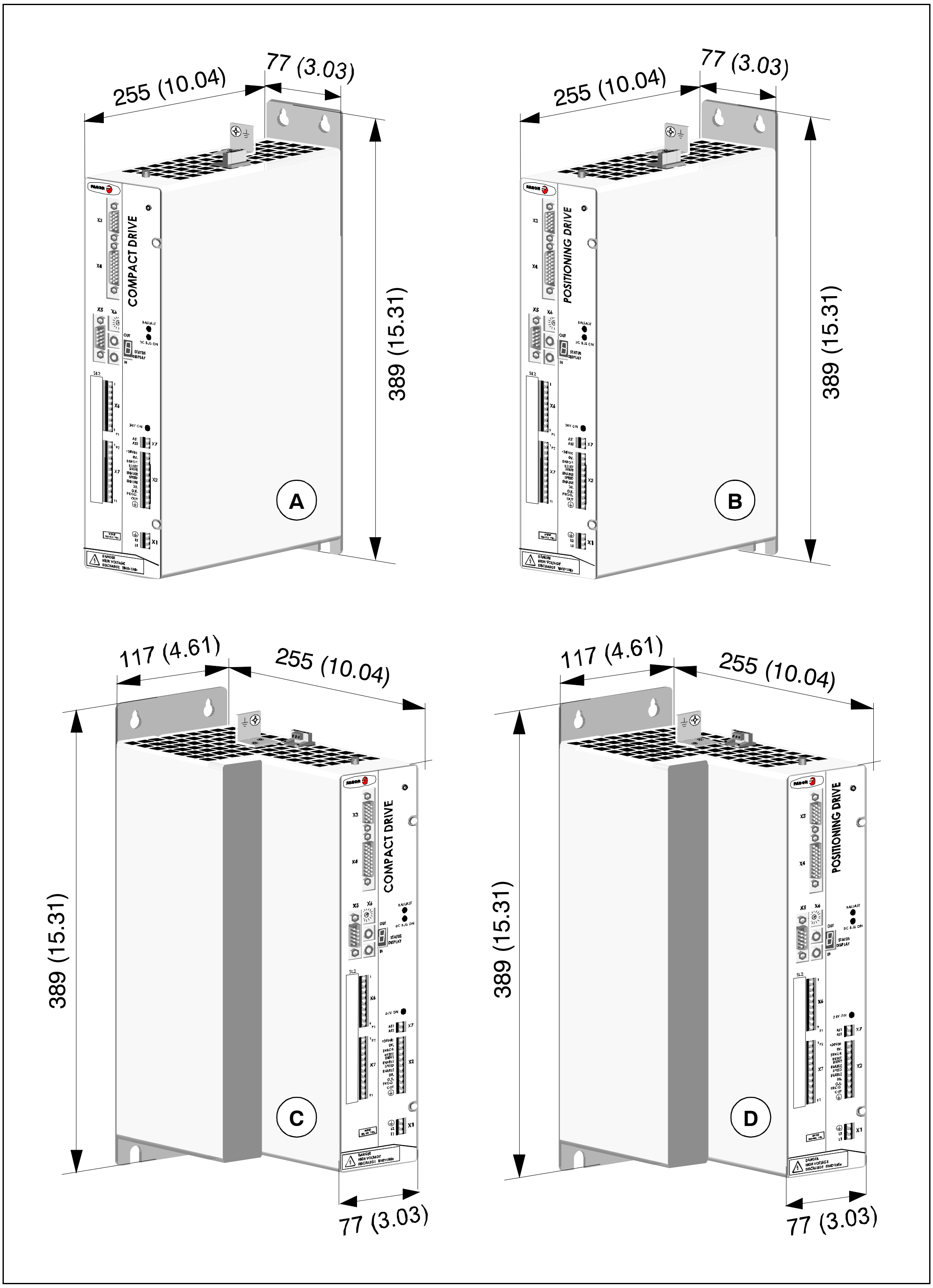


FIGURE H11.4

Dimensions of the compact drives.

A. ACD/SCD 1.08 / 1.15 / 1.25, **B.** CMC 1.08 / 1.15 / 1.25, **C.** ACD/SCD 2.35 / 2.50, **D.** CMC 2.35 / 2.50.

11.5 Auxiliary modules

11.5.1 Mains filters XXA

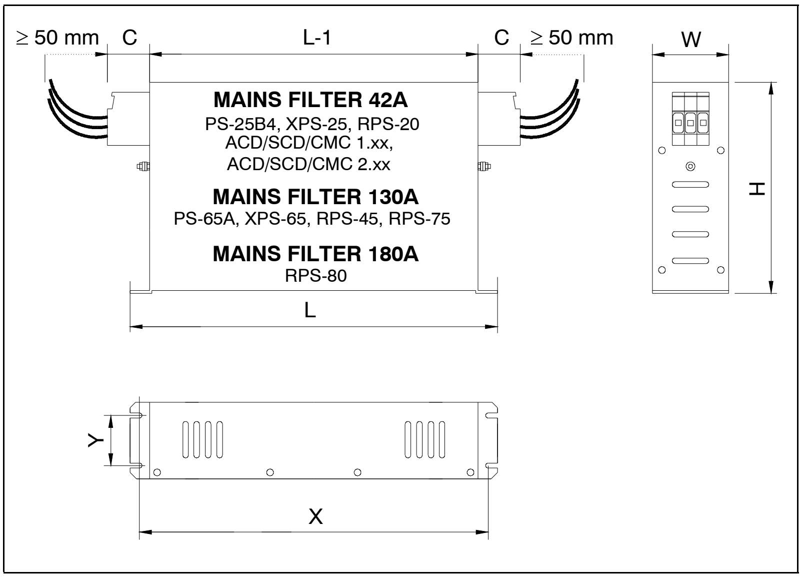


FIGURE H11.5

Mains filters, MAINS FILTER ☐☐A.

TABLE H11.1 Dimensions.

Models	Mains Filter 42A		Mains Filter 130A		Mains Filter 180A	
Units	mm	inches	mm	inches	mm	inches
L	330	12.99	440	17.32	440	17.32
L-1	300	11.81	400	15.74	400	15.74
C	15	0.59	45	1.77	45	1.77
W	70	2.75	110	4.33	110	4.33
H	185	7.28	240	9.44	240	9.44
X	314	12.36	414	16.29	414	16.29
Y	45	1.77	80	3.14	80	3.14

11.5.2 XPS chokes - for XPS power supplies -

Important note.
The new XPS-65 choke has replaced the previous model. Its size and weight are different. Depending on when the user purchases this product, he may get the new model. However, this section shows the dimensions of both models, i.e. those of the discontinued XPS-65 choke and those of the new XPS-65 choke.

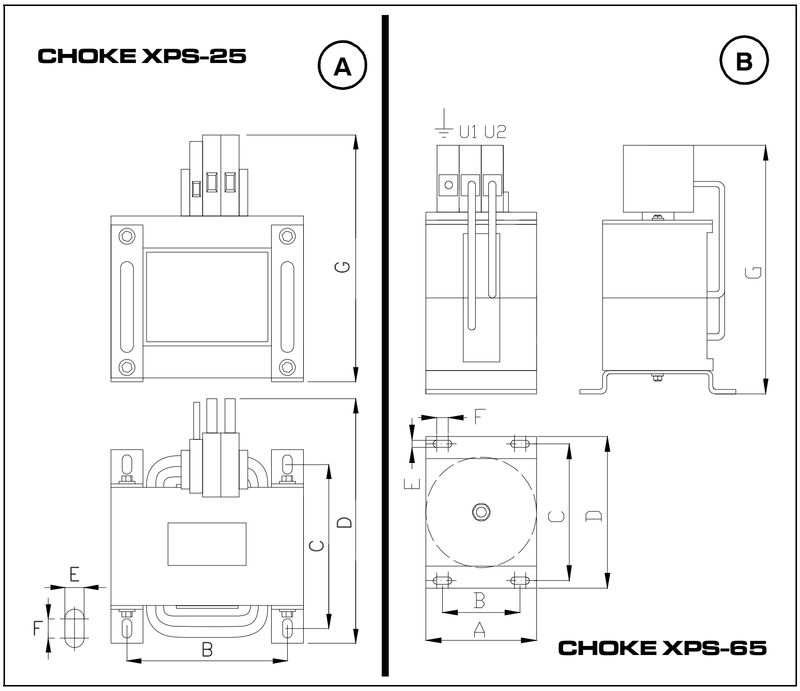


FIGURE H11.6
A. Choke XPS-25. **B.** Choke XPS-65.

TABLE H11.2 Dimensions.

	CHOKE XPS-25		CHOKE XPS-65	
	mm	inches	mm	inches
A	----	----	100	3.93
B	105	4.13	75	2.95
C	115	4.52	136	5.35
D	180	7.08	150	5.90
E	9	0.35	8	0.31
F	10	0.39	15	0.59
G	165	6.49	228	8.97

11.5.3 RPS chokes - for RPS power supplies -

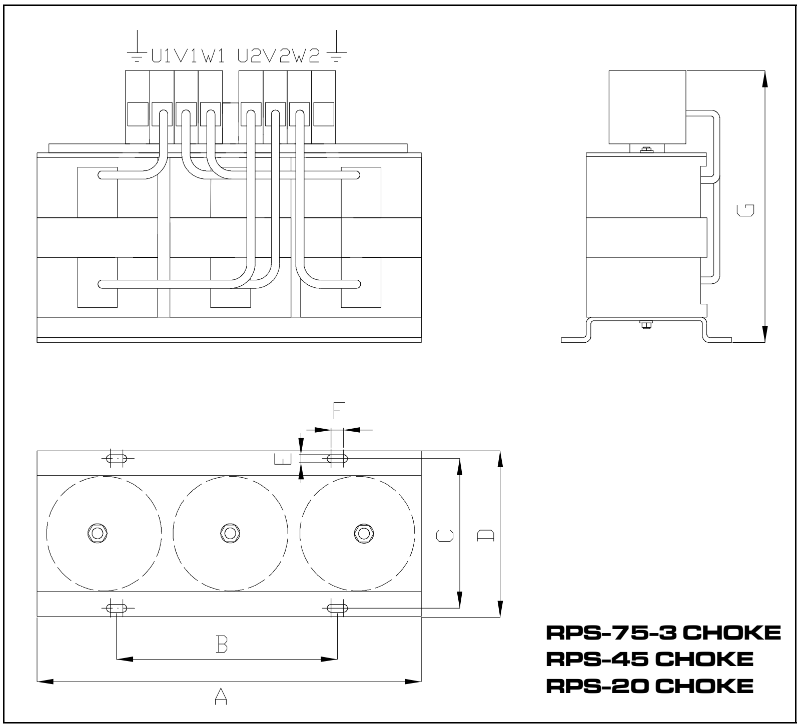


FIGURE H11.7

Chokes RPS-75-3, RPS-45 and RPS-20.

TABLE H11.3 Dimensions.

	CHOKE RPS-20		CHOKE RPS-45		RPS-75-3 CHOKE	
	mm	inches	mm	inches	mm	inches
A	330	12.99	330	12.99	380	14.96
B	175	6.88	175	6.88	235	9.25
C	136	5.35	136	5.35	152	5.98
D	150	5.90	150	5.90	170	6.69
E	8	0.31	8	0.31	9	0.35
F	15	0.59	15	0.59	18	0.70
G	162	6.37	228	8.97	271	10.66

11.5.4 External resistors with external thermostat

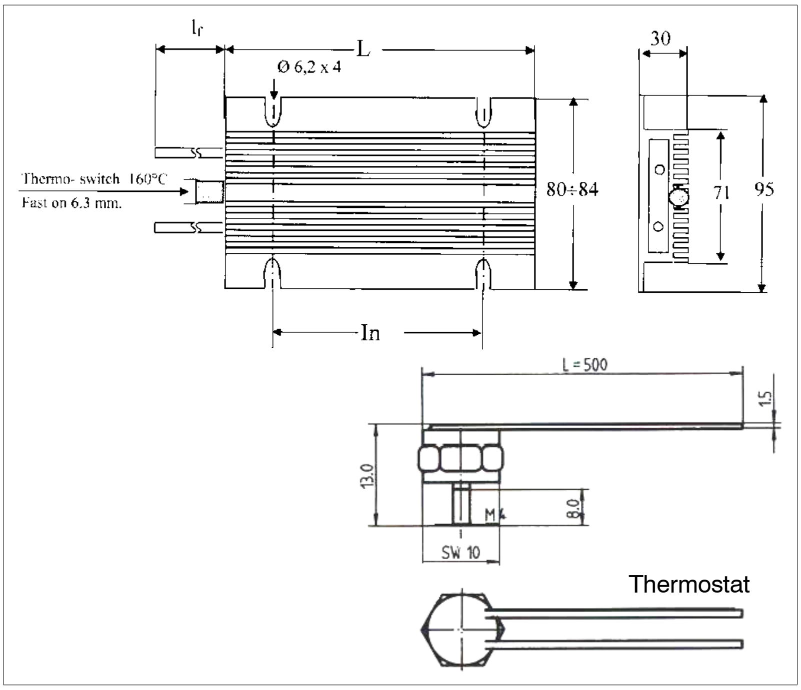


FIGURE H11.8

External resistors with external thermostat.

TABLE H11.4 Dimensions.

With external thermostat	**ER+TH-43/350**		**ER+TH-24/750**		**ER+TH-24/1100**	
Units	mm	inches	mm	inches	mm	inches
L	110	4.33	220	8.66	320	12.59
In	60	2.36	140	5.51	240	9.44
If	300	11.81	300	11.81	300	11.81

TABLE H11.5 Dimensions.

With external thermostat	**ER+TH-18/1100**					
Units	mm	inches				
L	320	12.59				
In	240	9.44				
If	300	11.81				

11.5.5 External resistors with internal thermostat

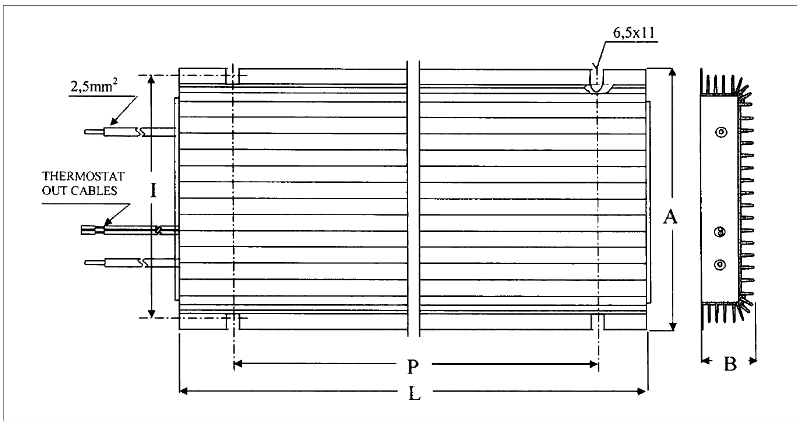


FIGURE H11.9

External resistor with internal thermostat.

TABLE H11.6 Dimensions.

With internal thermostat	ER+TH-18/1800		ER+TH-18/2200	
Units	mm	inches	mm	inches
A	120	4.72	190	7.48
B	40	1.57	67	2.63
L	380	14.96	380	14.96
I	107÷112	4.21÷ 4.40	177÷182	6.96÷7.16
P	300	11.81	300	11.81

11.5.6 External resistors with external thermostat and cooling fan

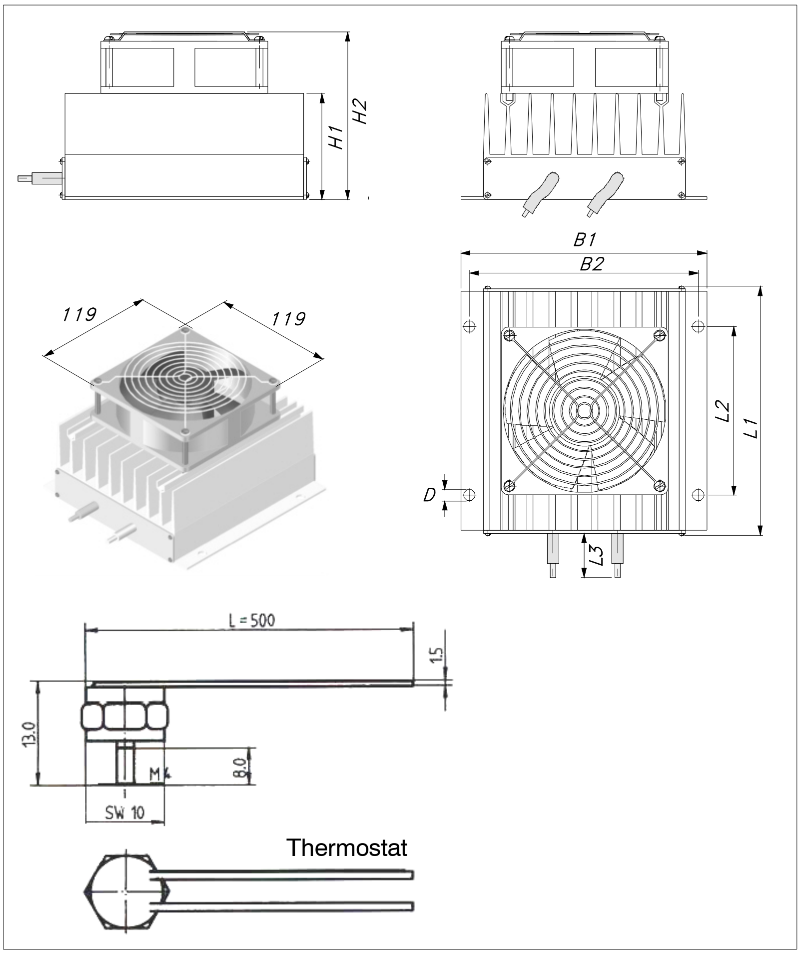


FIGURE H11.10

External resistors with external thermostat and fan.

TABLE H11.7 Dimensions.

With external thermostat & fan	ER+TH-18/1000+FAN		ER+TH-18/1500+FAN		ER+TH-18/2000+FAN	
Units	mm	inches	mm	inches	mm	inches
B1	175	6,88	175	6,88	175	6,88
B2	165	6,49	165	6,49	165	6,49
H1	75	2,95	75	2,95	75	2,95
H2	119	4,68	119	4,68	119	4,68
L1	170	6,69	330	12,99	530	20,86
L2	120	4,72	280	11,02	500	19,68
L3	250	9,84	250	9,84	250	9,84
D	6,5	2,55	6,5	2,55	6,5	2,55

SALES REFERENCES

12

This chapter indicates the sales references of all FAGOR products.

It refers to:

Synchronous servo motors	FXM, FKM
Asynchronous servo motors	FM7, FM9
Modular drives	AXD, SPD
Compact drives	ACD, SCD
MC drives	MMC, CMC
Power supply module	PS-25B4, PS-65, XPS-25, XPS-65, RPS-80, RPS-75, RPS-45 and RPS-20.
Accessory modules	"Mains Filter ☐A" mains filters, auxiliary power supply "APS-24", capacitor module "CM 1.60", external braking resistor modules "ER+TH-☐/☐" and "ER+TH-18/☐+ FAN=.
Chokes	Chokes RPS-75-3, RPS-45 and RPS-20.
Cables	For signal and power
Optic fiber	SERCOS interface
Connectors	On FXM and FKM motors

where it describes the meaning of each field of the sales reference of the product.

At the end of the chapter, it shows an example of how to place an order for the products of the FAGOR catalog.

12.1 References of synchronous servo motors

Sales reference of the synchronous servo motors, FXM.

FXM ☐☐.☐☐☐.☐☐.☐☐☐- X☐☐

MOTOR SERIES		
SIZE	1, 3, 5, 7	
LENGTH	1, 2, 3, 4, 5, 6, 7, 8	
RATED SPEED	**12** 1200 rev/min **20** 2000 rev/min	**30** 3000 rev/min **40** 4000 rev/min
WINDING	**A** 400 V AC **F** 220 V AC	
FEEDBACK TYPE	**E1** Sinusoidal SinCoder **A1** Absolute multi-turn SinCos **I0** Incremental TTL	
FLANGE & SHAFT	**0** With standard keyway **1** Without keyway	
BRAKE OPTION	**0** Without brake **1** With standard brake (24 V DC) (Neodine type H with double torque)	
FAN OPTION	**0** Without fan **1** With fan (only in sizes 5 and 7)	
SPECIAL CONFIGURATION	**X**	
SPECIFICATION OF THE SPECIAL CONFIGURATION	**01 → ZZ**	

A1 SinCos Stegmann™ SRM 50 (multi-turn), 1024 ppt
E1 SinCoder Stegmann™ SNS 50 (with taper shaft), 1024 ppt
I0 Tamagawa™ Encoder OIH48 TS5214N510, 2500 ppt

FIGURE H12.1

Sales reference of the synchronous servo motors, FXM.

Sales reference of the synchronous servo motors, FKM.

FKM ☐☐.☐☐☐.☐☐.☐☐☐- K☐☐

MOTOR SERIES		
SIZE	2, 4, 6,	***9***
LENGTH	1, 2, 4, 6	***4, 5, 6***
RATED SPEED	**60** 6000 rev/min **50** 5000 rev/min **45** 4500 rev/min	**40** 4000 rev/min **30** 3000 rev/min ***20** 2000 rev/min*
WINDING	**A** 400 V AC **F** 220 V AC	
FEEDBACK TYPE	**E3** Sinusoidal SinCosl **A3** absolute multi-turn SinCos **I0** TTL Incremental	
FLANGE & SHAFT	**0** With keyway (standard) **1** Cylindrical (with no keyway) **2** Shaft with key and seal **3** Keyless shaft with seal	
BRAKE OPTION	**0** Without brake **1** With standard brake (24 V DC)	
CONNECTION	**0** Rotating angled connectors **1** Cable exit without connectors	
SPECIAL CONFIGURATION	**K**	
SPECIFICATION OF THE SPECIAL CONFIGURATION	**01 → ZZ**	

A3 Sincos Stegmann™ SRM (multi-turn) (with taper shaft), 1024 ppt
E3 Sincos Stegmann™ SRS 50 (tape, sheet metal), 1024 ppt
I0 Tamagawa™ encoder OIH48 TS5214N510, 2500 ppt

FIGURE H12.2

Sales reference of the synchronous servo motors, FKM.

12.2 References of asynchronous motors

Sales reference of the asynchronous motors, FM7.

FM7- □□□□ - □□□□- E0□

FAGOR M7 MOTOR		
BASE SPEED	(SINGLE WINDING)	
	1500 REV/MIN	A
	1000 REV/MIN	B
	500 REV/MIN	C
	1250 REV/MIN	E

POWER (S1 DUTY CYCLE).
Note. The kW for each model are obtained from multiplying the given value by 0.1. E.g.. An FM7- B280 motor can supply up to 28 kW in the S1 duty cycle.

A	037 - 055 - 075 - 090 - 110 - 150 - 185 - 220 - 300 - 370 - 510
B	120 - 170 - 220 - 280
C	215 - 270
E	600

FEEDBACK	STANDARD ENCODER	S
(see note 3)	C AXIS ENCODER	C
MOUNTING	FLANGE	1
	FOOT	3
(see note 1)	FLANGE+FOOT	5
VIBRATION DEGREE	V10	B
	V5	C
(see note 3)	V3	D
SHAFT	PLAINT SHAFT (NO KEYWAY)	0
	KEYWAY (HALF-KEY BALANCING)	1
RELEASE	E01 SERIES	1
(see note 2)	E02 SERIES	2

NOTE 1. The "flange + foot" mount type comes in all models except A037, A055, A075 and A090. **NOTE 2.** Models A300, A370, B220, B280 and E600 are not available for the E02 series. **NOTE 3.** E600 models can only have the C axis option for feedback and V10 vibration degree.

FM7- □□□□ - □□□□- □□3

FAGOR M7 MOTOR		
BASE SPEED (option to configure the winding connection)		D
	1500 rev/min - star connection -	
	1000 rev/min - triangle connection -	

POWER (S1 DUTY CYCLE).
Note. The kW for each model are obtained from multiplying the given value by 0.1. E.g. An FM7- D150 motor can supply up to 15 kW in the S1 duty cycle.

D	055 - 075 - 110 - 150 - 185 - 220

FEEDBACK	MAGNETIC TTL ENCODER	S
MOUNTING	FLANGE	1
VIBRATION DEGREE	V3	D
SHAFT	PLAINT SHAFT (NO KEYWAY)	0
RELEASE	E03 SERIES	E0
	HS3 SERIE (hollow shaft)	HS

NOTE 4. The FM7-D055 and FM7-D150 models will not be available in the HS3 series.

FIGURE H12.3
Sales reference of the asynchronous motors, FM7.

12.3 References of modular drives

Sales reference of the modular drives for synchronous axis servo motors, AXD.

MODULAR AXIS DRIVE, AXD Example: AXD 1 . 25 - A1 - 1 - B

AXIS DRIVE

SIZE (width)	**1**	77 mm	< 08 / 15 / 25 / 35 >
	2	117 mm	< 50 / 75 >
	3	234 mm	< 100, 150 >

CURRENT (A) IS1, Imax for IGBT switching frequencies of 4 / 8 kHz.	**08**	4.0 / 8.0
	15	7.5 / 15.0
	25	12.5 / 25.0
	35	17.5 / 35.0
	50	23.5 / 47.0
	75	37.5 / 75.0
	100	50.0 / 100.0
	150	75.0 / 150.0

INTERFACE	**A1**	Analog I/O
	S0	SERCOS
	SI	SERCOS and Analog I/O
	SD	SERCOS, Analog and Digital 8I/16O

ADDITIONAL FEEDBACK FEATURES	**0**	None
	1	Encoder Simulator
	2	Direct Feedback

MOTOR FEEDBACK BOARD	**None**	CAPMOTOR-1
	B	CAPMOTOR-2

Examples:

AXD 1.08-S0-2 Modular axis drive, size 1, with a max. current of 8 A at 8 kHz, with SERCOS board, with Direct Feedback board, with CAPMOTOR-1

AXD 1.08-S0-2-B Modular axis drive, size 1, with a max. current of 8 A at 8 kHz, with SERCOS board, with Direct Feedback board, with CAPMOTOR-2

FIGURE H12.4

Sales reference of the AXD modular drive.

Sales reference of the modular drives for synchronous or asynchronous spindle motors, SPD.

MODULAR SERVODRIVES FOR SYNCHRONOUS OR ASYNCHRONOUS SPINDLE MOTORS, SPD Example: SPD 2 . 50 - S0 - 0 - B

SPINDLE DRIVE

SIZE (width)	**1**	77 mm	< 08 / 15 / 25 / 35 >
	2	117 mm	< 50, 75 >
	3	234 mm	< 100, 150, 200 >

CURRENT (A) IS1 / Imax	for fc = 4 kHz		for fc = 8 kHz	
	15	10.5 / 13.7	**15**	13 / 17.8
	25	16.0 / 20.8	**25**	13 / 17.8
fc: IGBT's switching frequencies	**35**	23.1 / 30.0	**35**	18 / 24.9
	50	31.0 / 43.0	**50**	27 / 39.1
	75	42.0 / 54.6	**75**	32 / 65
	85	50.0 / 65.0	**85**	37 / 53.6
	100	70.0 / 91.0	**100**	56 / 72.8
	150	90.0 / 117.0	**150**	71 / 110.4
	200	121.0 / 157.3	**200**	97 / 136.5
	250	135.0 / 175.5	**250**	97 / 136.5

INTERFACE	**A1**	Analog I/O
	S0	SERCOS
	SI	SERCOS and Analog I/O

ADDITIONAL FEEDBACK FEATURES	**0**	None
	1	Encoder Simulator
	2	Direct Feedback

MOTOR FEEDBACK BOARD	**None**	CAPMOTOR-1
	B	CAPMOTOR-2

Examples:

SPD 1.08-S0-2 Modular spindle drive, size 1, with a max. current of 8 A at 8 kHz, with SERCOS board, with Direct Feedback board, with CAPMOTOR-1.

SPD 1.08-S0-2-B Modular spindle drive, size 1, with a max. current of 8 A at 8 kHz, with SERCOS board, with Direct Feedback board, with CAPMOTOR-2.

FIGURE H12.5

Sales reference of the SPD modular drive.

12.4 References of compact drives

Sales reference of the compact drives for synchronous axis servo motors, ACD.

COMPACT AXIS DRIVE, ACD

Example: ACD 1 . 25 - S0 - 0 - B

AXIS **C**OMPACT **D**RIVE

SIZE (width)	**1** 77 mm	< 08, 15, 25 >
	2 177 mm	< 35, 50 >

CURRENT (A) Irated / Ipeak, fc: IGBT's switching frequencies	for fc = 4 kHz	for fc = 8 kHz
	08 4.0 / 8.0	**08** 4.0 / 8.0
	15 7.5 / 15.0	**15** 7.5 / 15.0
	25 12.5 / 25.0	**25** 9.5 / 19.0
	35 17.5 / 35.0	**35** 17.5 / 35.0
	50 25.0 / 50.0	**50** 20.0 / 40.0

INTERFACE	**A1**	Analog I/O
	SO	SERCOS
	SI	SERCOS and Analog I/O

ADDITIONAL FEEDBACK FEATURES	**0**	None
	1	Encoder Simulator
	2	Direct Feedback

MOTOR FEEDBACK BOARD	**A**	CAPMOTOR-1 (only ACD 1.25)
	None	CAPMOTOR-1 and it is not ACD 1.25
	B	CAPMOTOR-2

Note. The ACD 1.25-XX-X- **A** model is the only one that has the A indicator ath the end of the reference when carrying CAPMOTOR-1

Examples:

ACD 1.25-S0-2-A Compact axis drive, size 1, with a peak current of 25 A at 4 kHz, with SERCOS board, with Direct Feedback board and with CAPMOTOR-1

ACD 1.25-S0-2-B Compact axis drive, size 1, with a peak current of 25 A at 4 kHz, with SERCOS board, with Direct Feedback board and with CAPMOTOR-2

ACD 1.08-S0-2 Compact axis drive, size 1, with a peak current of 8 A at 4 kHz, with SERCOS board, with Direct Feedback board and with CAPMOTOR-1

FIGURE H12.6

Sales reference of the ACD compact drive.

Sales reference of the compact drives for synchronous or asynchronous spindle motors, SCD.

COMPACT DRIVE FOR SYNCHRONOUS OR ASYNCHRONOUS SPINDLE MOTORS, SCD

Example: SCD 1 . 25 - S0 - 0 - B

SPINDLE **C**OMPACT **D**RIVE

SIZ3 (width)	**1** 77 mm	< 15, 25 >
	2 177 mm	< 35, 50 >

CURRENT (A) Imax in any duty cycle, fc: IGBT's switching frequencies	for fc = 4 kHz	for fc = 8 kHz
	15 10.6	**15** 10.6
	25 17.5	**25** 12.5
	35 28.0	**35** 19.5
	50 38.0	**50** 27.0

INTERFACE	**A1**	Analog I/O
	S0	SERCOS
	SI	SERCOS and Analog I/O

ADDITIONAL FEEDBACK FEATURES	**0**	None
	1	Encoder Simulator
	2	Direct Feedback

MOTOR FEEDBACK BOARD	**A**	CAPMOTOR-1 (only SCD 1.25)
	None	CAPMOTOR-1 and it is not SCD 1.25
	B	CAPMOTOR-2

Note. The SCD 1.25-XX-X-**A** model is the only one that has the A indicator ath the end of the reference when carrying CAPMOTOR-1

Examples:

SCD 1.25-S0-2-A Compact spindle drive, size 1, with a maximum current of 25 A at 4 kHz, with SERCOS board, with Direct Feedback board and with CAPMOTOR-1.

SCD 1.25-S0-2-B Compact spindle drive, size 1, with a maximum current of 25 A at 4 kHz, with SERCOS board, with Direct Feedback board and with CAPMOTOR-2.

SCD 1.35-S0-2 Compact spindle drive, size 2, with a maximum current of 28 A at 4 kHz, with SERCOS board, with Direct Feedback board and with CAPMOTOR-1.

FIGURE H12.7

Sales reference of the SCD compact drive.

12.5 References of positioning drives

Sales reference of the modular positioning drive for synchronous axis motors, MMC.

MODULAR AXIS POSITIONING DRIVE, MMC

Example: MMC 1 . 25 - S0 - D2. D1 - 1 - 0 - B

MODULAR MOTION CONTROL (AXIS POSITIONING DRIVE)

SIZE (width)	**1** 77 mm < 08, 15, 25, 35 > **2** 117 mm < 50, 75 > **3** 234 mm < 100, 150 >	
CURRENT (A) I S1 / Imax S1 fc: IGBT's switching frequencies	for fc = 4 kHz / 8 kHz **08** 4.0 / 8.0 **15** 7.5 / 15.0 **25** 12.5 / 25.0 **35** 17.5 / 35.0	**50** 23.5 / 47.0 **75** 37.5 / 75.0 **100** 50.0 / 100.0 **150** 75.0 / 150.0
INTERFACE	**00** None **S0** SERCOS **RS** RS422- 485	
SL2	**00** None **D1** 16I/8O **D2** 8I/16O	
SL1	**A1** Analog I/O **D1** 16I/8O **D2** 8I/16O	
ADDITIONAL FEEDBACK FEATURES	**0** None **1** Encoder Simulator **2** Direct feedback	
SOFTWARE APPLICATIONS	**0** None	
MOTOR FEEDBACK BOARD	**None** CAPMOTOR-1 **B** CAPMOTOR-2	

Note. SLOT 1 must always carry a card. There are no model with sales references like MMC X.XX-XX-00.XX-X-X.
If the use wants to have 24I/24O, **the selection will be done using reference MMC X.XX-XX-D2.D1-X-X** , not using ref. MMC X.XX-XX-D1.D2-X-X which is not available.

Examples:

MMC 1.08-S0-D2.D1-2-0 Modular positioning drive, size 1, 8 A, with SERCOS board, with 8I/16O and 16I/8O boards, with direct feedback board, without soft applications and with CAPMOTOR-1

MMC 1.08-S0-D2.D1-2-0-B Modular positioning drive, size 1, 8 A, with SERCOS board, with 8I/16O and 16I/8O boards, with direct feedback board, without soft applications and with CAPMOTOR-2

FIGURE H12.8

Sales reference of the modular positioning drive for MC, MMC.

Sales reference of the compact positioning drive for synchronous axis motors, CMC.

COMPACT POSITIONING DRIVE, CMC

Example: CMC 1.25 - S0 - D2.D1 - 2 - 0 - B

COMPACT MOTION CONTROL

SIZE (width)	**1** 77 m < 08, 15, 25 > **2** 177 m < 35, 50 >	
CURRENT (A) Irated / Ipeak fc: IGBT's switching frequencies	for fc = 4 kHz **08** 4.0 / 8.0 **15** 7.5 / 15.0 **25** 12.5 / 25.0 **35** 17.5 / 35.0 **50** 25.0 / 50.0	for fc = 8 kHz **08** 4.0 / 8.0 **15** 7.5 / 15.0 **25** 9.5 / 19.0 **35** 17.5 / 35.0 **50** 20.0 / 40.0
INTERFACE	**00** None **S0** SERCOS **RS** RS-422/485	
SL2	**00** None **D1** 16I / 8O **D2** 8I / 16O	
SL1	**A1** Analog I/O **D1** 16I / 8O **D2** 8I / 16O	
ADDITIONAL FEEDBACK FEATURES	**0** None **1** Encoder Simulator **2** Direct Feedback	
SOFTWARE APPLICATIONS	**0** None	
MOTOR FEEDBACK BOARD	**A** CAPMOTOR-1 (only CMC 1.25) **None** CAPMOTOR-1 and it is not CMC 1.25 **B** CAPMOTOR-2	

Note 1. The CMC 1.25-XX-XX.XX-X-X-**A** model is the only one that has the "A" indicator at the end of the reference to distinguish it from the wider model CMC 1.25-XX-XX.XX-X-X that is no longer sold.

Note 2. SLOT 1 must always have a card. There are no models like CMC X.XX-XX-00.XX-X-X. If the user wants to have 24I/24O, **the selection must be done according to the reference CMC X.XX-XX-D2.D1-X-X** and not according to the reference CMC X.XX-XX-D1.D2-X-X that is not available.

Ejemplos:

CMC 1.08-RS-D2.D1-2-0 Compact positioning drive, size 1, with a peak current of 8 A, with RS422-485 board, with 8I/16O and 16I/8O boards, with direct feedback board, without soft applications and with CAPMOTOR-1

CMC 1.08-RS-D2.D1-2-0-B Compact positioning drive, size 1, with a peak current of 8 A, with RS422-485 board, with 8I/16O and 16I/8O boards, with direct feedback board, without soft applications and with CAPMOTOR-2

FIGURE H12.9

Sales reference of the compact positioning drive for MC, CMC.

12.6 Power supply references

Sales reference of the power supplies, PS-65A.

POWER SUPPLY, PS

Example: PS - 65A

POWER **S**UPPLY (Mains voltage of 400 - 460 V AC)

POWER
(power, rated current) **65A** (65 kW, 120 A)

FIGURE H12.10

Sales reference of the non-regenerative power supply, PS-65A.

Sales reference of the power supplies, PS-25B4.

POWER SUPPLY, PS
WITH INTEGRATED AUXILIARY 24 V POWER SUPPLY

Example: PS - 25B4

POWER **S**UPPLY (Mains voltage of 400 - 460 V AC)

POWER
(power, rated current) **25B4** (25 kW, 45 A)
(24 V DC, 8 A)

FIGURE H12.11

Sales reference of the non-regenerative power supply, PS - 25B4.

Sales reference of the power supplies, XPS.

REGENERATIVE
POWER SUPPLY, XPS

Example: XPS - 25

X-circuit **P**OWER **S**UPPLY (Mains voltage 400-460 V AC)

POWER
(power, rated current)
25 (25 kW, 45 A)
65 (65 kW, 120 A)

FIGURE H12.12

Sales reference of the regenerative power supplies, XPS.

Sales reference of the power supplies, RPS.

REGENERATIVE
BOOST POWER SUPPLY, RPS

Example: RPS - 80

REGENERATIVE **P**OWER **S**UPPLY (Mains voltage 400 - 460 V AC)

POWER
(Power S1/S6,
Current IS1/IS6-40%)
80 (80/104 kW, 128/166.5 A)
75 (75/97 kW, 120/156 A)
45 (45/59 kW, 72/95 A)
20 (20/26 kW, 32/41.6 A)

FIGURE H12.13

Sales reference of the regenerative regulated power supplies, RPS.

12.7 References of other elements

Sales reference of accessory modules.

ACCESORY MODULES Example: MAINS FILTER 42A

FAGOR MAINS FILTER	**MAINS FILTER**	
MAX. CURRENT	**MAINS FILTER 42A**	42 A
	MAINS FILTER 130A	130 A
	MAINS FILTER 180A	180 A
AUXILIARY POWER SUPPLY (24 V DC)		APS-24
CAPACITOR MODULE (4 mF)		CM 1.60
EXTERNAL RESISTOR WITH EXTERNAL THERMOSTAT (Resistance, RMS power)	(43 Ω, 300 W)	**ER+TH-43/350**
	(24 Ω, 650 W)	**ER+TH-24/750**
	(24 Ω, 950 W)	**ER+TH-24/1100**
	(18 Ω, 950 W)	**ER+TH-18/1100**
EXTERNAL RESISTOR WITH INTERNAL THERMOSTAT (Resistance, RMS power)	(18 Ω, 1300 W)	**ER+TH-18/1800**
	(18 Ω, 2000 W)	**ER+TH-18/2200**
EXTERNAL RESISTOR WITH EXTERNAL THERMOSTAT AND COOLING FAN (Resistance, RMS power)	(18 Ω, 2000 W)	**ER+TH-18/1000+FAN**
	(18 Ω, 3000 W)	**ER+TH-18/1500+FAN**
	(18 Ω, 4000 W)	**ER+TH-18/2000+FAN**

FIGURE H12.14

Sales reference of accessory modules.

Sales reference of the chokes for regenerative power supplies.

INDUCTANCES Example: CHOKE XPS-25

CHOKE INDUCTIVE FILTER

For regenerative power supplies	Chokes
XPS-25	Choke XPS-25
XPS-65	Choke XPS-65
RPS-80	Choke RPS-75-3
RPS-75	Choke RPS-75-3
RPS-45	Choke RPS-45
RPS-20	Choke RPS-20

FIGURE H12.15

Sales reference of the chokes for regenerative power supplies.

12.8 Cable references

Sales reference of power cables.

POWER CABLES

Example: MPC - 4 x 10 + [2 x 1]

MPC	MOTOR POWER CABLE
4 x 10	LINES x SECTION [mm²]
[2 x 1]	LINES x SECTION [mm²] (for the brake)

FIGURE H12.16

Sales reference of power cables.

Sales reference of signal cables.

SIGNAL CABLES

Example: SEC-HD - 20

SEC- HD	SIGNAL SIMULATOR EXTENSION CABLE - HIGHT DENSITY
LENGTH (m)	**1, 3, 5, 10, 15, 20, 25, 30, 35.**

Example: EEC - 20

EEC	ENCODER EXTENSION CABLE
LENGTH (m)	**1, 3, 5, 7, 10, 15, 20, 25, 30, 35, 40, 45, 50**

Example: EEC-SP - 20

EEC-SP	ENCODER EXTENSION CABLE - SHIELDED PAIR
LENGTH (m)	**5, 10, 15, 20, 25, 30, 35, 40, 45, 50**

Example: EEC-FM7 - 20

EEC-FM7	ENCODER EXTENSION CABLE - FAGOR MOTOR 7
LENGTH (m)	**5, 10, 15, 20, 25**

Example: EEC-FM7S - 20

EEC-FM7S	ENCODER EXTENSION CABLE - FAGOR MOTOR 7 SHIELD
LENGTH (m)	**3, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50**

Example: EEC-FM7CS - 20

EEC-FM7CS	ENCODER EXTENSION CABLE - FAGOR MOTOR 7 C AXIS SHIELD
LENGTH (m)	**5, 10, 15, 20, 25, 30, 35, 40, 45, 50**

FIGURE H12.17

Sales reference of signal cables.

Sales reference of the SERCOS interface cable

FIBER OPTIC LINES
(Polymer core)

Example: SFO - 2

SFO	**S**ERCOS **F**IBER **O**PTIC	
LENGTH (m)	**1, 2, 3, 5, 7, 10, 12**	

FIBER OPTIC LINES
(Polymer core)

Example: SFO - FLEX - 15

SFO - FLEX	**S**ERCOS **F**IBER **O**PTIC - **FLEX**
LENGTH (m)	**10, 15, 20, 25, 30, 35, 40**

FIBER OPTIC LINES
(Glass core)

Example: SFO - V - FLEX - 60

SFO - V- FLEX	**S**ERCOS **F**IBER **O**PTIC - V - **FLEX**
LENGTH (m)	**40, 50, 60, 75, 100**

FIGURE H12.18

Sales reference of the SERCOS interface cable

Sales reference of the connectors for synchronous servo motors.

CONNECTORS FOR THE FXM MOTORS

Example: MC 23

POWER CONNECTOR FOR FXM	**AMC** Angled **MC** Vertical
MAX. CURRENT	**23** (23 A) **46** (46 A) **80** (80 A)
ENCODER FEEDBACK CONNECTOR (12 pines)	E0C 12

CONNECTORS FOR THE FKM MOTORS

Example: MC 61/6

POWER CONNECTOR FOR FKM	**MC**
MAX. CURRENT	**20/6** (20 A) **61/6** (61 A)
ENCODER FEEDBACK CONNECTOR (12 pines)	E0C 12

FIGURE H12.19

Sales reference of the connectors for synchronous servo motors.

12.9 Order example

QTY	FAGOR AUTOMATION S. COOP. LTDA 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 A axis drives with encoder simulator		
1	SPM 112LE.E0.00000.1	7,5 kW S1 spindle (1.500 a 7.500 rev/min)		
1	SPD 2.50-A1-1	50 A spindle drive with encoder simulator		
1	PS-25A	25 kW Power Supply		
2	REC - 5	5 mts Resolver extension Cable		
1	EEC - 5	5 mts Encoder extension Cable		
3	SEC - 1	1 mt Signal Encoder Cable		
	TOTAL DRIVE SYSTEM			

FIGURE H12.20

Order example.

12.10 Module identification

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

Warning. The user must make sure that the references indicated on the packing list of the order match those supplied by each module on its characteristics plate before making any connection to avoid any possible shipping errors.

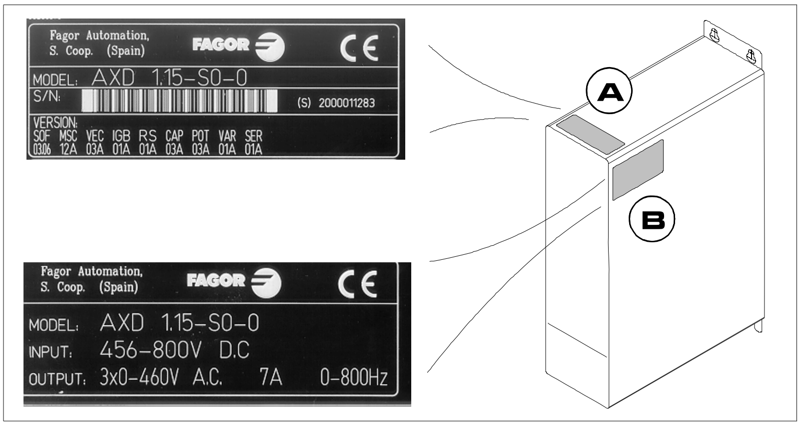


FIGURE H12.21

Module identification plates. **A.** Version label **B.** 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 0306 (SOF).

These two plates fully identify the module and must be referred to when repairing or replacing these units. They make it easier to solve compatibility conflicts between different versions.

The drive module is also labeled on its package:

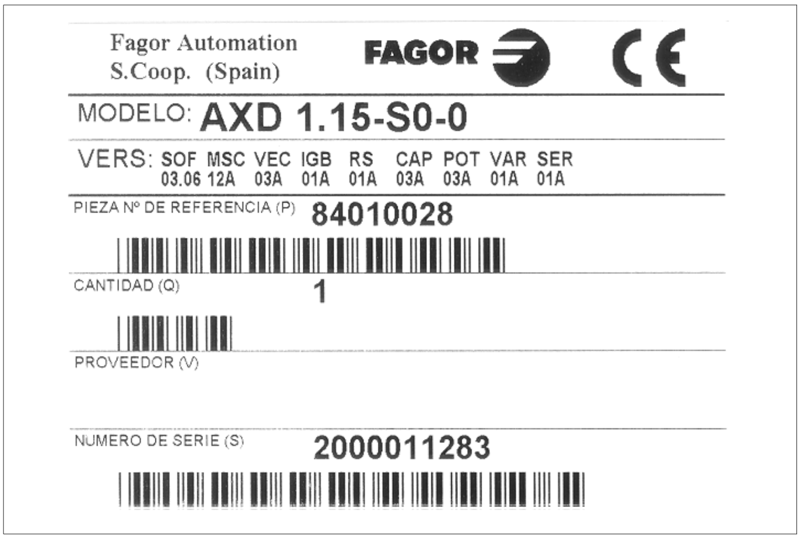


FIGURE H12.22

Packaging label of the drive module.

COMPATIBILITY 13

13.1 Mains voltage

Originally, the drives and power supplies were designed for a mains voltage of 380 V AC (50/60 Hz). They all have been now redesigned to work with mains voltage ranging between 380-460 V AC (50/60 Hz).

Their identification comes on the label that each of these module has.

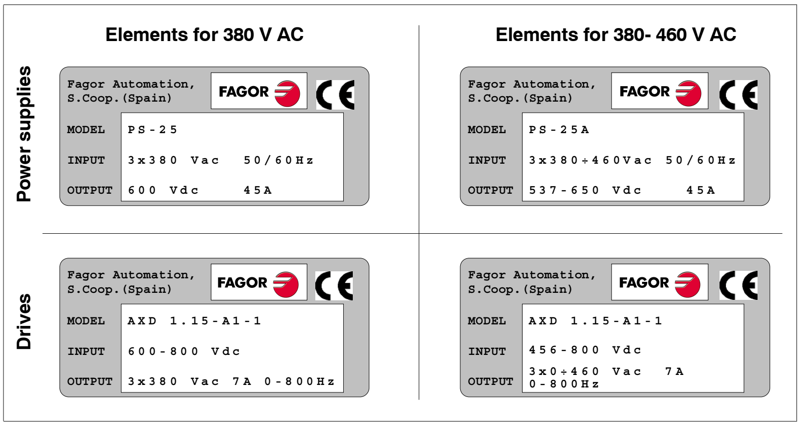


FIGURE H13.1

Module identification labels. Operating mains voltage.

13.2 Compatibility

The elements ready for mains voltage between 380-460 V AC:

- Drive (version MSC 12A and later).
- Auxiliary power supply APS-24 (version PF 05A and later).
- Capacitor module CM 60 (version 01A and later) or CM 1.60 (version [CAP 00A] [VAR 02A] and later) replacing the previous one.
- Mains filters EMK or MAINS FILTER □□A **compatible** with all power supplies PS, XPS and RPS.

The elements ready for mains voltage between 380 V AC:

- Drive (version MSC 11A and older).
- Auxiliary power supply APS 24 (version PF 04A and older).
- Capacitor module CM 60 (version 00A and later) or CM 1.60 (version [CAP 00A] [VAR 02A] and later) replacing the previous one.
- Mains filters Power-Pro **are not compatible** with power supplies PS-□□A, PS-25B□, XPS and RPS.

13.3 Module replacement

Replacing 380 V AC module with a new 460 V AC module involves:

- Drive MSC 12A or later.
- Auxiliary power supply APS 24 PF 05A and later.
- Capacitor module CM 1.60 (version [CAP 00A] [VAR 02A] and later).

It may be incorporated into any servo drive system regardless of its power supply.

- Power supply PS-□□A.

A PS-□□ power supply is required if the system includes an element that must work at a mains voltage of 380 V AC like an "MSC 11A" drive or an APS 24 "PF 04A" power supply or a capacitor module CM 60 "00A".
A PS-□□ is a PS-□□A. A factory limited to work at 380 V AC. It will admit a mains voltage limited to 380 V AC.

If the system includes only "MSC 12A" drives, there is no compatibility problem. It will admit a mains voltage between 380 and 460 V AC.

- Power supply PS-25B□.

A PS-25B3 power supply is required to work at 380 V AC if the system includes an element that must work at a mains voltage of 380 V AC like an "MSC 11A" drive or a capacitor module CM 60 "00A".

- Compact drives.

The compact drives (version MSC 05A and later) are designed to also run at 380-460 V AC; a PS-25B4 power supply must be installed; they have no compatibility problems with previous equipment.

13.4 VECON board

The compatibility between this board and the software versions is:

TABLE H13.1 Compatibility of the VECON2 board.

Version of the VECON board	Software version
VEC 03A and older	03.07 to 03.23
VEC 04A and later	03.24 and later 04.08 and later

It is not possible to regulate with direct feedback when using a drive with software versions 04.xx and 05.xx and an asynchronous motor FM7. It is possible with versions 06.xx and later.

13.5 VECON2 board

This board replaces the VECON board expanding the capacity of the flash memory and increasing the operating speed of the flash memory and of the RAM memory.

TABLE H13.2 Compatibility of the VECON2 board.

Version of the VECON2 board	Software version
VEC 01A and later	05.08 and later 06.01 and later

Software versions 04.xx and 05.xx of the drive have the same features. Their only difference consists in that they are supported by different hardware platforms because they have only VECON and VECON2 boards respectively.

It is possible but not recommended to have the same machine with several units where one controls its motor with a 04.xx version and hardware with VECON another one that controls its motor with a 05.xx version and hardware with VECON2 and a third one that control its motor with 06.xx version and hardware with VECON2.

13.6 VECON3 board

This board replaces the VECON2 board.

TABLE H13.3 Compatibility of the VECON3 board.

Version of the VECON3 board	Software version
VEC 01A and later	06.18 and later

It is possible but not recommended to have the same machine with several units where one controls its motor with a 04.xx version and hardware with VECON another one that controls its motor with a 05.xx version and hardware with VECON2 and a third one that controls its motor with 06.18 version or later and VECON3 hardware.

13.7 Boot for VECON2

The boot of version v.06.02 and later of the WinDDSSetup allow loading the software versions on VECON2 boards (version VEC2 02A).

The boot of previous WinDDSSetup versions is incompatible with board versions VEC2 02A.

13.8 Boot for VECON3

The boot of version 06.18 and older of the WinDDSSetup allow loading the software versions on VECON3 boards (version VEC3 01A).

The boot of previous WinDDSSetup versions is incompatible with board versions VEC3 01A.

13.9 SERCOS card (16 MBd)

This card will not be compatible with software versions older than 06.05.

With software versions 06.05 and later, this new board may be used to exchange data between the CNC and the drives that make up the SERCOS ring at 2, 4, 8 and 16 Mbaud.

Therefore, in order to select a baudrate higher than 4 Mbaud, the drive must have this SERCOS board and software version v.06.05 or newer.

Drives having this board or older ones may be added to the SERCOS ring. However, all the drives must set with the same transmission speed.

13.10 Recognizing RPS-XX power supplies

From drive software version 06.09 on, it recognizes the identifier of RPS-☐☐ regenerative regulated power supplies and their parameters may be set.

WinDDSSetup versions older than v.06.10 are incompatible with RPS-☐☐ power supplies.

13.11 Recognizing the CAPMOTOR-2 board

Software version 06.18 recognizes a new motor feedback board called CAPMOTOR-2 besides the present CAPMOTOR-1.

CAPMOTOR-2, as opposed to CAPMOTOR-1, can process the signals coming from a serial motor feedback with SSI protocol or ENDAT (with incremental A and B signals, necessarily). However, it cannot process signals coming from RESOLVER feedback, which can be processed by CAPMOTOR-1.

Never install a CAPMOTOR-2 motor feedback board when using a resolver as motor feedback. This combination is incompatible.

See chapter 12. SALES REFERENCES that describes how to know whether the drive has a CAPMOTOR-1 or a CAPMOTOR-2 motor feedback board.

13.12 CAPMOTOR-2 board and type of feedback

Feedback type	Motor feedback board
Resolver	Only with CAPMOTOR-1
Stegmann encoder	With CAPMOTOR-1 or CAPMOTOR-2
Encoder with square signals U, V and W	With CAPMOTOR-1 or CAPMOTOR-2
Encoder with C and D signals	With CAPMOTOR-1 or CAPMOTOR-2
Endat with incremental A and B signals	Only with CAPMOTOR-2
SSI	Only with CAPMOTOR-2

13.13 Motor feedback boards and VECON cards

VECONx board	CAPMOTOR-1 board	CAPMOTOR-2 board
VECON2	Compatible	Incompatible
VECON3	Compatible	Compatible

13.14 APS-24 auxiliary power supply with PS, XPS or RPS

APS-24	XPS or RPS power supplies
Ref. PF 23A or older	Incompatible
Newer than Ref. PF 23A	Compatible

APS-24	PS power supplies
All PF references	Compatible