Divisione S.B.C.



SPD

(2, 5, 8, 16, 24)

USER'S MANUAL

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(software rel. 12)

Parker Hannifin S.p.A.
Divisione S.B.C.
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COMPANY
WITH QUALITY SYSTEM
CERTIFIED BY DNV
ISO 9001/2000

DICHIARAZIONE DI CONFORMITÀ CE
CE DECLARATION OF CONFORMITY

Dichiarazione N. *Declaration N.*	**DC011-R 0.0**
Costruttore *Manufacturer*	**PARKER HANNIFIN S.p.A. – Divisione S.B.C.**
Indirizzo *Address*	**Via Gounod, 1** **20092 Cinisello Balsamo (MI)** **ITALIA**
Prodotto *Product*	**Azionamento** ***Drive***
Nome del Prodotto *Product name*	**SPD2, SPD5, SPD8, SPD16, SPD24**

Il prodotto sopra descritto è conforme a:
The above product is conform to:

Doc. N. / *Doc. Nr.*	Titolo / *Title*	Edizione / *Edition*
CEI EN 60065	*Apparecchi audio, video ed apparecchi elettronici similari- Requisiti di sicurezza.* *Audio, video and similar electronic apparatus - Safety requirements.*	8a / 6768 Gennaio 2003
CEI EN 50178	*Apparecchiature elettroniche da utilizzare negli impianti di potenza.* *Electronic equipment for use in power installations*	1a/5080 Marzo 1999
CEI EN **61000-6-2**	*Compatibilità elettromagnetica Parte 6-2: Norme Generiche – Immunità per gli ambienti industriali.* *Electromagnetic compatibility 6-2: Generic Standards- Immunity for industrial environments*	2a / 6671 Ott.2002
CEI EN **61000-6-4**	*Compatibilità elettromagnetica Parte 6-4: Norme generiche – Emissioni per gli ambienti industriali.* *Electromagnetic compatibility 6-4: Generic Standards- Emission standard for industrial environments*	1a / 6673 Ott.2002
CEI EN 61800-3 e /A11	*Azionamenti elettrici a velocità variabile. Parte 3:Norma di prodotto relativa alla compatibilità elettromagnetica ed ai metodi di prova specifici.* *Adjustable speed electrical power drive systems Part 3: EMC product standard including specific test methods.*	1a / 2861 Settembre 1996 5805 Ottobre 2000
CEI EN 60204-1	*Sicurezza del macchinario Equipaggiamento elettrico delle macchine, Parte 1: Regole Generali* *Safety of machinery – Electrical equipment of machines, Part1: General requirements*	3a/4455 Aprile 1998

Note/*notes*:
I prodotti devono essere installati seguendo scrupolosamente le indicazioni riportate nel manuale d'uso e manutenzione.
These products must be installed scrupulously following the instructions written on the handbook.

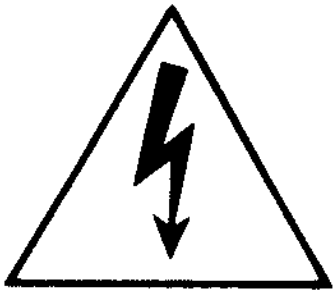
I prodotti inclusi sono conformi ai requisiti della Direttiva 73/23/CEE modificata dalla 93/68/CEE, e alla Direttiva 89/336/CEE.
These products are corresponding to the 73/23/CEE requirements guideline, modified by 93/68/CEE and 89/336/CEE guidelines.

Cinisello Balsamo, 05/06/2003

Parker Hannifin S.p.A.
Divisione S.B.C.

Ottorino SALVALAI, Direttore Generale (*General Manager*)

DANGER



HIGH VOLTAGE!

Some internal circuits of the converter are subject to voltages that can create serious danger for individuals and they can even cause death.

The converter must not be accessed when it is powered-on.

Whenever it is necessary to access it, be sure it has been powered off for fifteen minutes to allow the condensers to discharge. The user must make sure that the device has been installed in accordance with the workplace safety regulations currently in force.

In this regard, note that the converter is to be considered a component, not a machine. Any unauthorized repair or tampering with the device invalidates the warranty immediately. The device is under warranty for one year. This user manual is for the standard version of the converter. La Parker Hannifin S.p.A. – Divisione S.B.C. declines any responsibility for any type of damage that may be caused by the inappropriate use of the converter.

Only qualified and trained personnel who have a basic knowledge of electronics may install and carry out maintenance operations on the converter and the devices connected to it.

Only qualified and trained personnel with a good knowledge of electronics and converter technology is allowed to commissioning.

On request, Parker Hannifin S.p.A. – Divisione S.B.C. organises training courses.

The performance of SPD converter is guaranteed only with synchronous motors with permanent magnets MB and SMB Series that have been manufactured by us.

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1 INTRODUCTION

1.1 General information

This manual describes the installation and commissioning of the frequency converter for SPD brushless motors.
Please, read all chapters **carefully**.

1.2 Product description

The SPD is a digital frequency converter for brushless motors. The operator interface based on parameters makes it easy to configure the converter. Configurations of different kinds make suitable it for many applications.

The SPD features a series of integrated auxiliary functions that allow minimising the control electronics in the applications, with a considerable cost saving.
It uses widely diffused industrial programming standards and guarantees a high degree of freedom in selecting inputs and outputs. The SPD also offers the possibility to develop additional functions that are not included in the basic functionality of the converter such as gain correction for loops based on speed or space, monitoring the used torque for tool life control, etc.

It can be configured through the serial keypad, the serial line or the can bus.

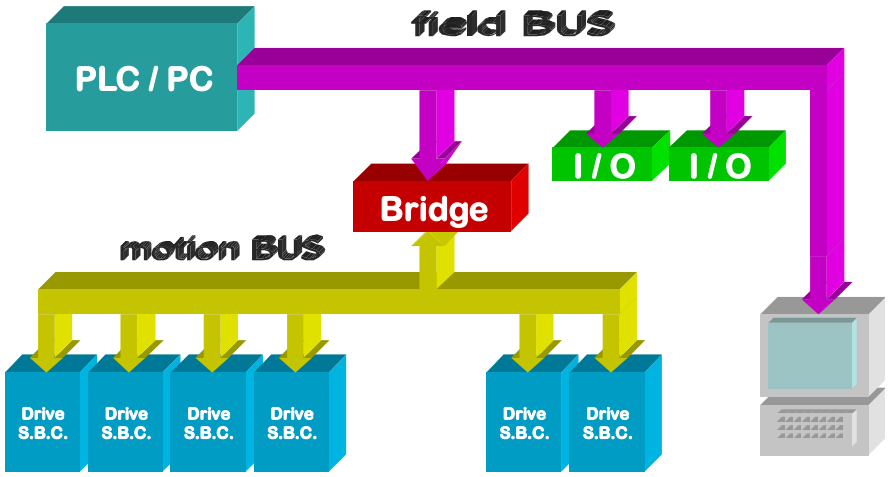
1.3 Main software features

The following functions have been implemented in the basic software of the SPD:

Speed controller
Advanced manager of torque limits
Management of speed windows
Torque motor control
Torque control with speed control overlaying
Positioning with trapezoidal Speed profiles
Provides the functions of an electrical shaft with variable ratio and phase correction
Electronic cam
Simulates a stepper motor
It is provided with an internal PLC for programming the Serial interface RS422-485 integrated can bus interface inputs/outputs: each drive has two independent nodes.

1.4 Expansibility: the Parker-S.B.C. bridge and its philosophy

Manufacturing companies of machines that use "servo" motor drives frequently have the need of combining the PLC with the axis control.
The two programmable components are often heterogeneous; the first one sees to the machine logics management, whereas the second one sees top the motor motion profile management. The skills required to manage the two products are so different that they require different persons, with a consequent increase of costs and new problems to manage, that is, the interface between two non-homogeneous worlds.
Besides having all of the features required by the market of a servo converter, the Parker-S.B.C. drives for brushless motors are also capable of executing "motion" functions that can be used for a large number of applications, without having the typical need of programming an axis control. Their feature is that they can operate as "MOTION ENGINE", that is, with a component that commands the motor to execute the desired motion profile, while the MACHINE LOGICS is still managed by the PLC or by the machine PC.



The group of converters used for an application become a single peripheral unit of the PLC/PC using standard FIELD BUS (Profibus or DeviceNet), and the architecture of the plant control system becomes of the type shown in the figure.

With the Bridge philosophy, the user or the manufacturer can write motion programs using a standard PLC, thus avoiding to realise specific application communication protocols.
This philosophy aims at allowing the manufacturer to reach his goals, in terms of time-to-market, allowing him to focus the efforts on the design activity and avoiding multiple problems connected to the drive use and interfacing.

1.5 Support tools

To simplify the drive configuration in motion-control applications, a software package is provided to be installed on a personal computer (PC), which implements a serial communication with the drive.

1.6 Conformity to EMC standards

Immunity:

EN50082-1* / EN61000-6-2	Basic immunity specifications
CEI - EN61800-3	Product standard: Variable speed electric drives, includes: Immunity for electrostatic charge Immunity for electromagnetic field Immunity for fast transient burst Emission:
EN50081-1* / EN61000-6-4	Basic specifications for radio interference
CEI - EN61800-3	Product standard

In order to conform with the standards, installation must be carried out as explained in chapter "Installation and safety instructions".

1.7 Safety

Safety rules	EN60065,EN50178
Low voltage regulation	73/23/CEE modified by 93/68/CEE
Applied regulation	EN60204-1

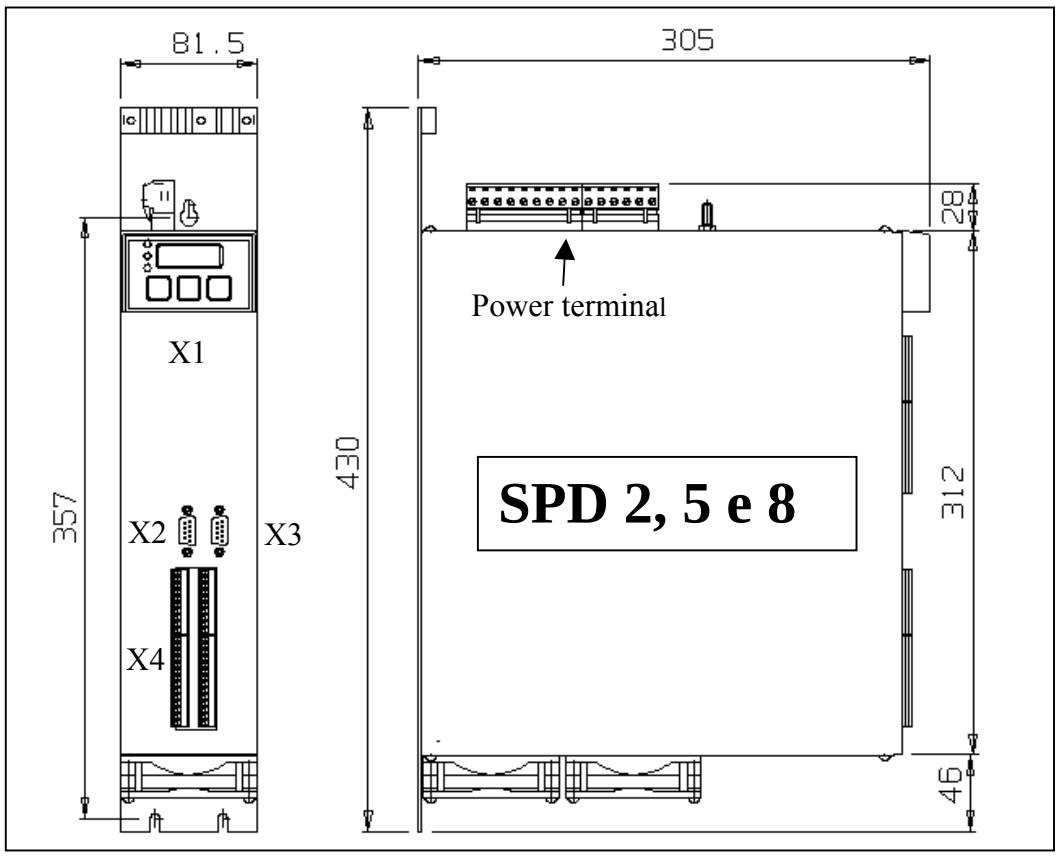
This is a product of the restricted sales distribution class according to EN61800-3.
Ina domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

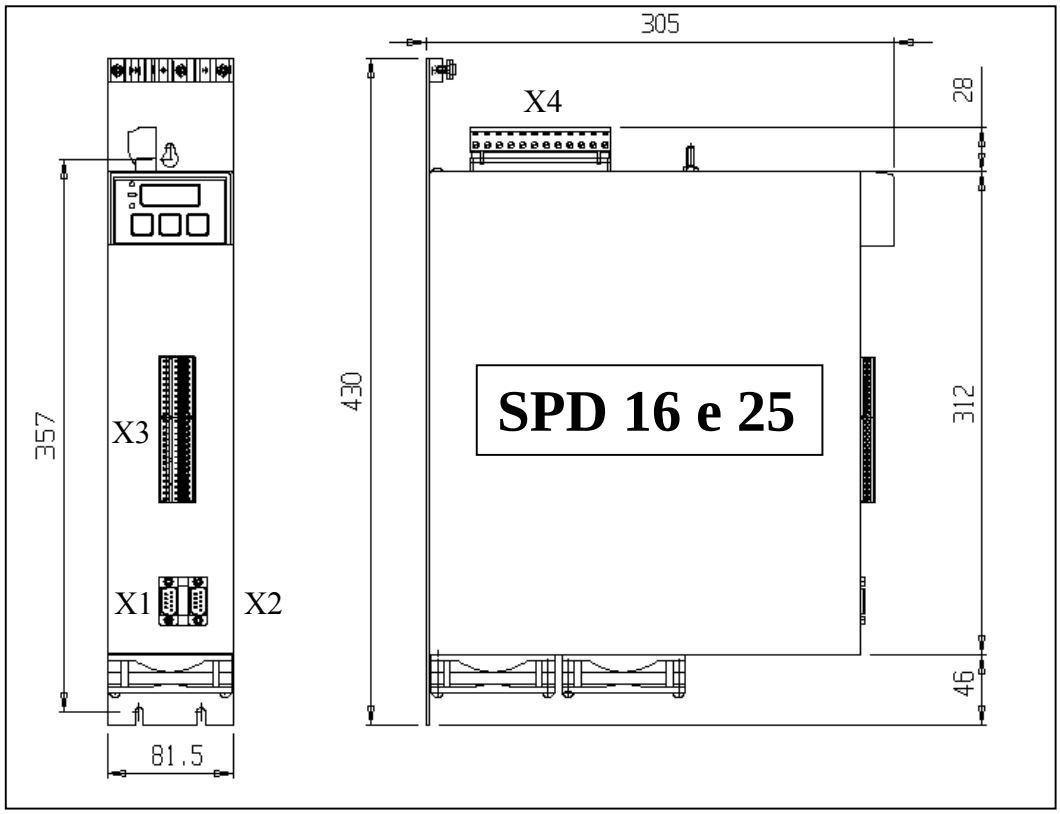
1.8 Data for the UL certification

The drive could be installed in the environments of type: Pollution degree 2, like suitable from the UL norm 508C, Par. 35.9.4a1.
Data of the braking resistance:

DRIVE	Max current [Amps]		Max Duty Cycle [%]	Power [W]	Min resistance D.B.U. [Ω]
	Peak	Rms			
SPD**2**,**5**,**8**	20	0,15	0,75	120	40

1.9 Mechanical dimensions





weight: 6kg

2 Technical specifications

Item	*U.o.m.*	*Value*				
Power supply	V~	380..480 ± 10%				
Control voltage	V=	24 - 2 A				
Models		SPD2	SPD5	SPD8	SPD16	SPD24
Rated output current	A	2	5	8	16	25
Peak output current (4 s)	A	4	10	16	32	50
Shaft power	KW	1	2.6	4.2	7.5	12.8
Control electronics dissipation	W	21				
Power stage dissipation	W	50	120	175	250	320
Ambient temperature	°C	0÷45				
Storage temperature	°C	-20 ÷ +65				
Relative humidity	%	<85 without condensate				
Internal braking resistors dissipation	W	120				
Feedback	Resolver/encoder					
Power stage switching frequency	KHz	8				
Maximum output fundamental frequency	Hz	450				
Degree of protection	IP 20					
Digital inputs Impedance input 7K VH=24Vnom. (15-30) VL=0÷3V	nº	4				
Digital outputs PNP open collector 24V = / 100mA, for single output Maximum total current 500mA	nº	2				
Encoder simulation RS-422	step/rev	4÷2500				
Frequency / sign or encoder Input	KHz	800 / 200				
Analogue reference Input impedance >20K ohm Resolution 15 bits (with sign) ;CMMR >60dB	V	±10 differential				
Auxiliary analogue input Input impedance >20K ohm	V;mA	5V; 700mA				
Auxiliary analogue output bits Io	V	±10 differential				
Serial line	V mA	±4.5 1.5				
Field bus	RS-422 / RS-485					
Power supply	CanBus ISO/DIS11898					

3 Connectors and terminal boards

Note: if there isn't corrispondence between the label on the drive and this manual, please contact the service department.

3.1 SPD 2, 5 and 8

Power terminal connections SPD2, SPD5 and SPD8

1	L1	LINE
2	L2	
3	L3	
4	Earth I	MOTOR
5	U-I	
6	V-I	
7	W-I	
8	Earth II	N. C.
9	U-II	
10	V-II	
11	W-II	
12	+B	BUS CONFIGURATION AND BREAKING RESISTOR
13	IR	
14	CB	
15	-B	

Signal terminal connections (X4)

1	AUX Ref. + (AN1+)	Analogue Ref. + (+REF)	25
2	AUX Ref. – (AN1-)	Analogue Ref. – (-REF)	26
3	0VA (shield)	0VA (shield)	27
4	Vout	+ ECC Resolver	28
5	0VA (shield)	- ECC Resolver	29
6	IN0	+ SIN Resolver	30
7	IN1	- SIN Resolver	31
8	IN2	+ COS Resolver	32
9	IN3	- COS Resolver	33
10	0VQ (0V panel)	0VA (shield)	34
11	OUT0	+ PTC	35
12	OUT1	- PTC	36
13	+A ENCODER OUT	+A ENCODER IN	37
14	-A ENCODER OUT	-A ENCODER IN	38
15	+B ENCODER OUT	+B ENCODER IN	39
16	-B ENCODER OUT	-B ENCODER IN	40
17	+C ENCODER OUT	+C ENCODER IN	41
18	-C ENCODER OUT	-C ENCODER IN	42
19	0VQ (0V panel)	0VE (0V ENCODER)	43
20	+SR + DRIVE ENABLE	+ CK	44
21	-SR - DRIVE ENABLE	- CK	45
22	SC-A FEEDBACK	+ 5VE (SUPPLY ENCODER)	46
23	SC-B FEEDBACK	0VE (0V ENCODER)	47
24	0VQ 0V POWER SUPPLY	+24V IN POWER SUPPLY	48

CAN bus (X2) *(DB9 male)*		
N. Pin	Signal	Description
1	n.c.	
2	CAN_L	Low communication line
3	CAN_GND	CAN ground
4	n.c.	
5	CAN_SHLD	Optional screen connection
6	GND	Optional CAN ground
7	CAN_H	High communication line
8	n.c.	
9	n.c.	

Serial 422 / 485 (X3) *(DB9 female)*	
N. Pin	Signal
1	TX
2	RX
3	/TX
4	/RX
5	
6	+BR
7	-BR
8	0 V
9	0 V

3.2 SPD 16 e 25

Power terminal connections (X4) SPD16 and SPD25

1	L1	LINE
2	L2	
3	L3	
4	Earth	MOTOR
5	U	
6	V	
7	W	
8	+C	BUS CONFIGURATION AND BREAKING RESISTOR
9	+B	
10	IR	
11	CB	
12	-B	

Signal terminal connections (X3)

1	AUX Ref. + (AN1+)	Analogue Ref. + (+REF)	25
2	AUX Ref. – (AN1-)	Analogue Ref. – (-REF)	26
3	0VA (shield)	0VA (shield)	27
4	Vout	+ ECC Resolver	28
5	0VA (shield)	- ECC Resolver	29
6	IN0	+ SIN Resolver	30
7	IN1	- SIN Resolver	31
8	IN2	+ COS Resolver	32
9	IN3	- COS Resolver	33
10	0VQ (0V panel)	0VA (shield)	34
11	OUT0	+ PTC	35
12	OUT1	- PTC	36
13	+A ENCODER OUT	+A ENCODER IN	37
14	-A ENCODER OUT	-A ENCODER IN	38
15	+B ENCODER OUT	+B ENCODER IN	39
16	-B ENCODER OUT	-B ENCODER IN	40
17	+C ENCODER OUT	+C ENCODER IN	41
18	-C ENCODER OUT	-C ENCODER IN	42
19	0VQ (0V panel)	0VE (0V ENCODER)	43
20	+SR + DRIVE ENABLE	+ CK	44
21	-SR - DRIVE ENABLE	- CK	45
22	SC-A FEEDBACK	+ 5VE (SUPPLY ENCODER)	46
23	SC-B FEEDBACK	0VE (0V ENCODER)	47
24	0VQ 0V POWER SUPPLY	+24V IN POWER SUPPLY	48

Serial 422 / 485 (X2)
(DB9 female)

N. Pin	Segnale
1	TX
2	RX
3	/TX
4	/RX
5	
6	+BR
7	-BR
8	0 V
9	0 V

CAN bus (X1)
(DB9 male)

N. Pin	Signal	Description
1	n.c.	
2	CAN_L	Low communication line
3	CAN_GND	CAN ground
4	n.c.	
5	CAN_SHLD	Optional screen connection
6	GND	Optional CAN ground
7	CAN_H	High communication line
8	n.c.	
9	n.c.	

4 Installation and Safety instructions

- The converter must be mounted vertically with the power block above using an omega guide.
- A space of at least 100 mm. must be left free above and beneath the converter.
- Make sure that the converter is sized properly for the motor it will be used with. Compare the rated voltages and currents.
- Connect the cabinet/converter/motor in accordance with the instructions that are given in this section, with the regulations for electromagnetic compatibility and with the safety regulations that are in force.
- The user is responsible for the protection fuses in the AC power supply of the converter.
- Power and control cables must be kept separate (min. 20cm) and, if crossing is necessary, it should be right-angled. The motor cables and the power cables can never be parallel.
- All power cables must have a sufficient section (see the table given in paragraph 2.7) and must conform to the IEC227-2 regulation.
- The cables connected to the converter at the terminal cannot be consolidated with tin-lead welding (EN60065, Art.15.3.5).
- Make sure that the converter and the motor are correctly grounded.
- Make sure the maximum power at terminals L1, L2, and L3 does not exceed by more than 10% the rated voltage even in the worst case (see EN60204-1, section 4.3.1). Excessive supply voltage can damage the converter.
- Do not ever remove the electrical connections from a live converter.
- Follow carefully the instructions given in this manual step by step during the installation. If you have questions or problems, contact our customer assistance service.
- After power supply has been disconnected and the converter has been off for 60 seconds, dangerous voltage levels may persist. Do not touch any power cable during this time.
- Do not ever open the converter. This is dangerous and invalidates the warranty.

The installation and cabling operations must be done when there is absolutely no voltage in the entire electric cabinet. Make sure that the power switch on the converter is cut off from the emergency circuit. The first time the cabinet is powered up, qualified technical personnel must be present.

4.1.1 How to suppress interference

For the drive to meet the product requirements regarding electromagnetic compatibility, the installation must be carried out according to the following instructions.
The criteria are essentially based on grounding, filtering and screening.

It is usually necessary to use external filters in addition to internal filters the drive is provided with, on the mains input and sometimes on the motor output. Ferrite toroids are generally used for the motor output, with multiple turns obtained by winding the 3 motor cables contemporarily.

4.1.2 Grounding and screening

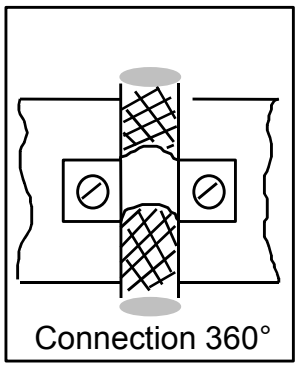
In the electric panels where the drives are usually installed there are two ground systems:
- EMC ground, or HF reference (high frequency), represented by the wall made of non-painted metal, onto which drives and filters are fixed.

- The safety ground, or PE (protective earth), according to the EN60204-1 standard

Fix drive and mains filters, the 24Vdc power supply etc. on the metal wall, making sure that there is a proper electric contact (HF connection).

Carry the safety ground using cables having a minimum section of 10mm²

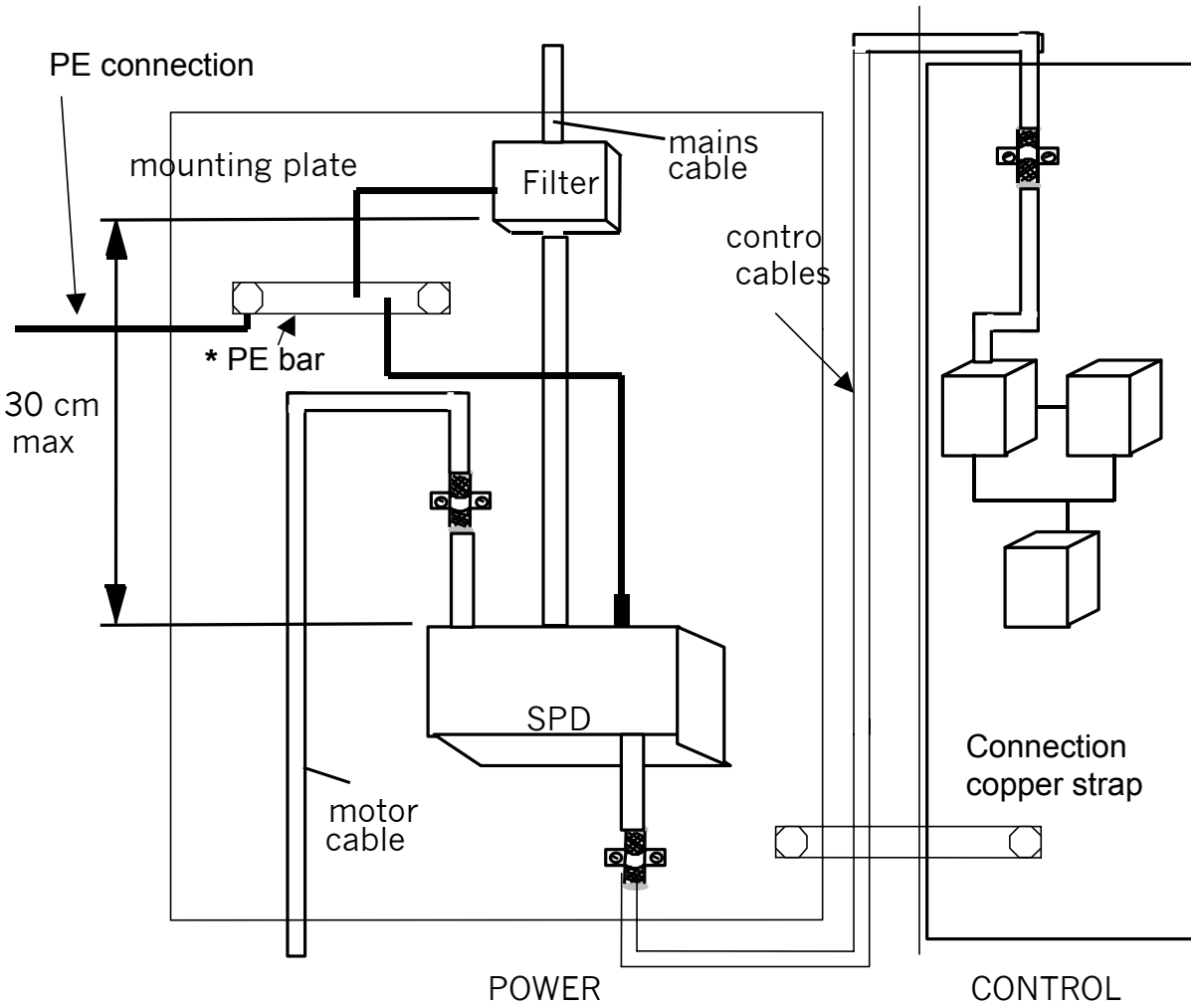
Ground the cables screened at both sides using the cable clamps connections as shown in the drawing (at 360º)



Use a screened cable to connect the drive to the motor

Use a screened cable both for the resolver connection and for the control signals.

Into the panel, connect the panels with one another using a copper strap.



*The PE bar must be mounted directly in contact; insulated columns are not to be used.

4.1.3 Filters

The mains filter must be mounted onto the same drive panel and as close as possible. If distance exceeds 30cm, the effect decreases and a screened cable must be used between filter and converter.

4.1.4 Further suggestions

Keep the power cable separate from signal cables (20cm. are sufficient in most cases).
When the power cables must cross control cables, implement the crossing at an approximate angle of 90 degrees.

Keep the main cables separate from motor cables.
If the motor is of the embedded brake type, **keep** the 24Vdc brake cables **separate** from the other cables (resolver and motor).

4.2 POWER CONNECTIONS

4.2.1 Motor cable

A choice shall be made between a cable for flexible or static installation.
The cable must be shielded and sized properly in terms of insulation and sections. It should be made of reticular polypropylene since it has a lower distributed capacity. Once the length has been selected (max 60m.), the conductor-conductor capacity must not exceed 8 nF.
The minimum conductor section must be of 1.5 mm^2 for sizes 2 and 5A, 2.5 mm^2 for size8A, end 4mm^2 for size 16A and 25A

4.2.2 Protection fuse and power supply cable

Mains cables are not screened.
The minimum conductor section must be of 1.5 mm^2 for sizes 2A and 5A, 2.5 mm^2 for size 8A end 4mm^2 for size 16A and 25A.

Model	Slo-blow fuses [A]
2 A	6
5 A	10
8 A	16
16A	20
25	25

4.3 SIGNAL CABLES

4.3.1 Resolver cable

The cable must consist of three individually shielded twisted pairs protected by a shield.
The conductor-conductor capacity for the length used cannot exceed 10 nF and the section cannot be less than 0.22 mm^2 for length up to 35m. For higher lengths and up to 60m. the section cannot be less than 0.35mm^2.
The wiring diagram shows a resolver cable for motors Type "MB". For motors Type SMB, refer to the terminal board shown in Motor Manual.

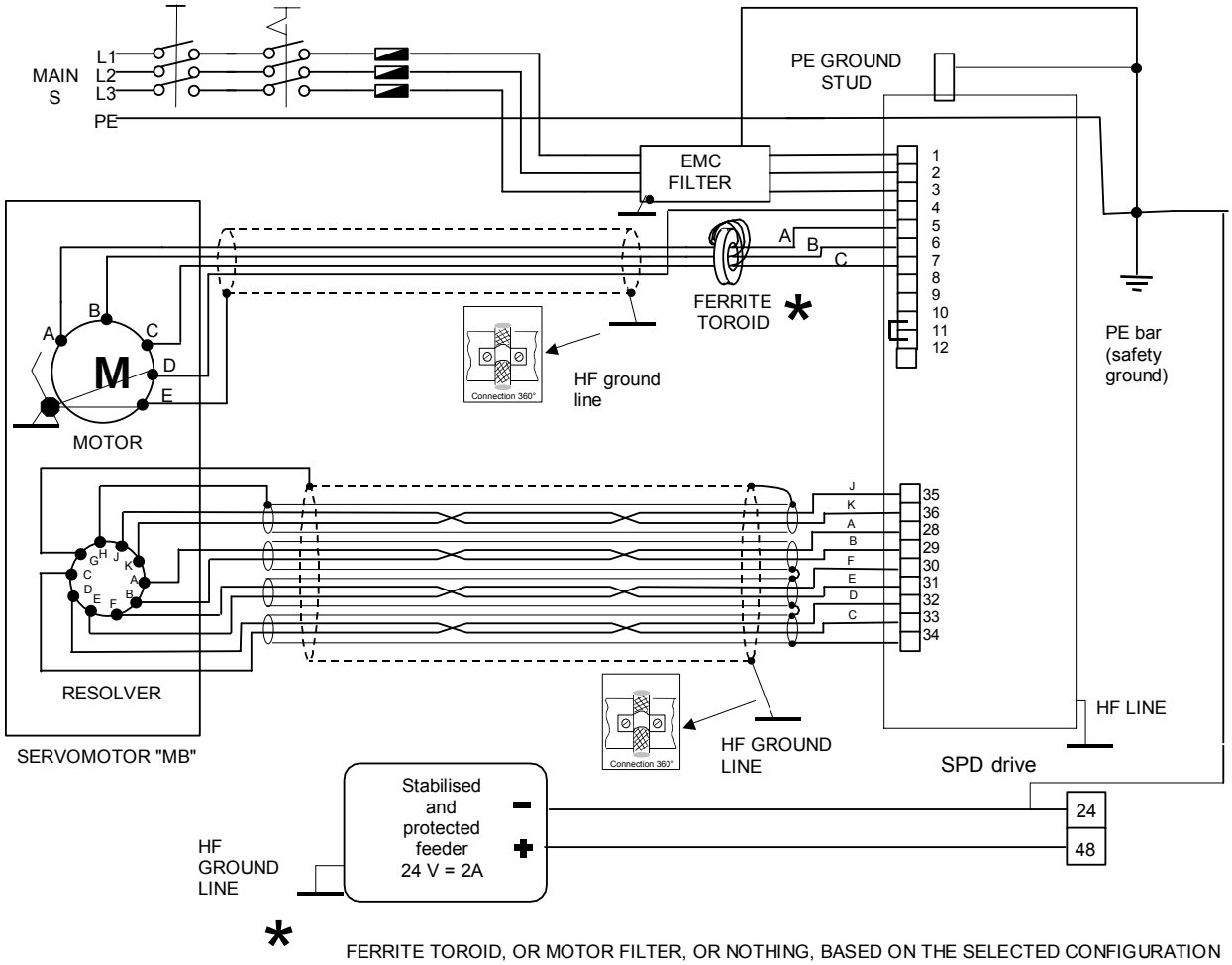
4.3.2 Signal cables connection

The cable used for the analogue reference must be a shielded twisted pair.
The cable used to connect the signals of the simulated encoder must consist of three twisted pairs with a general shield.
Shielded cables are also recommended for digital inputs and outputs.

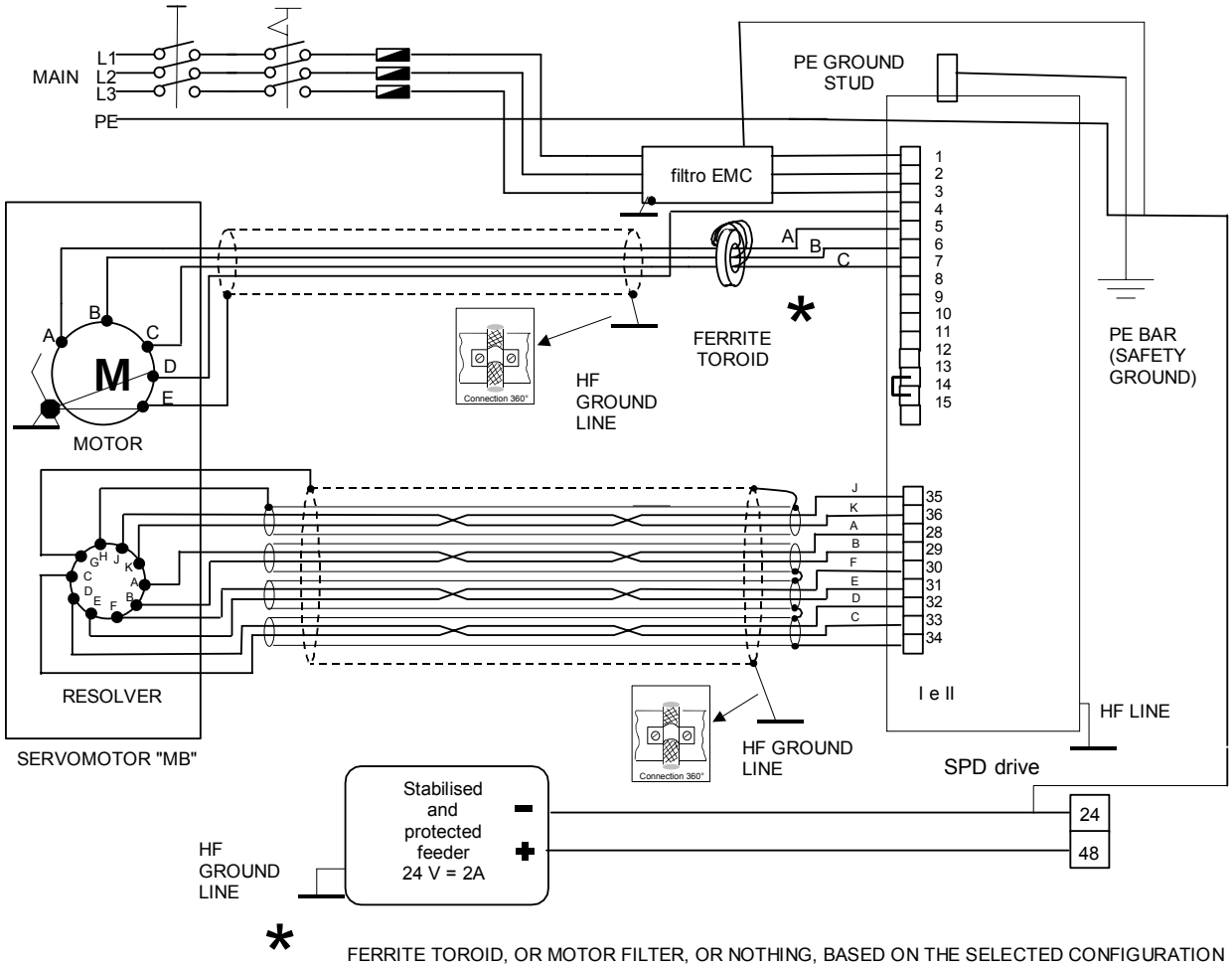
All cables must have a minimum section of 0.22 mm^2

4.4 Power connection diagrams

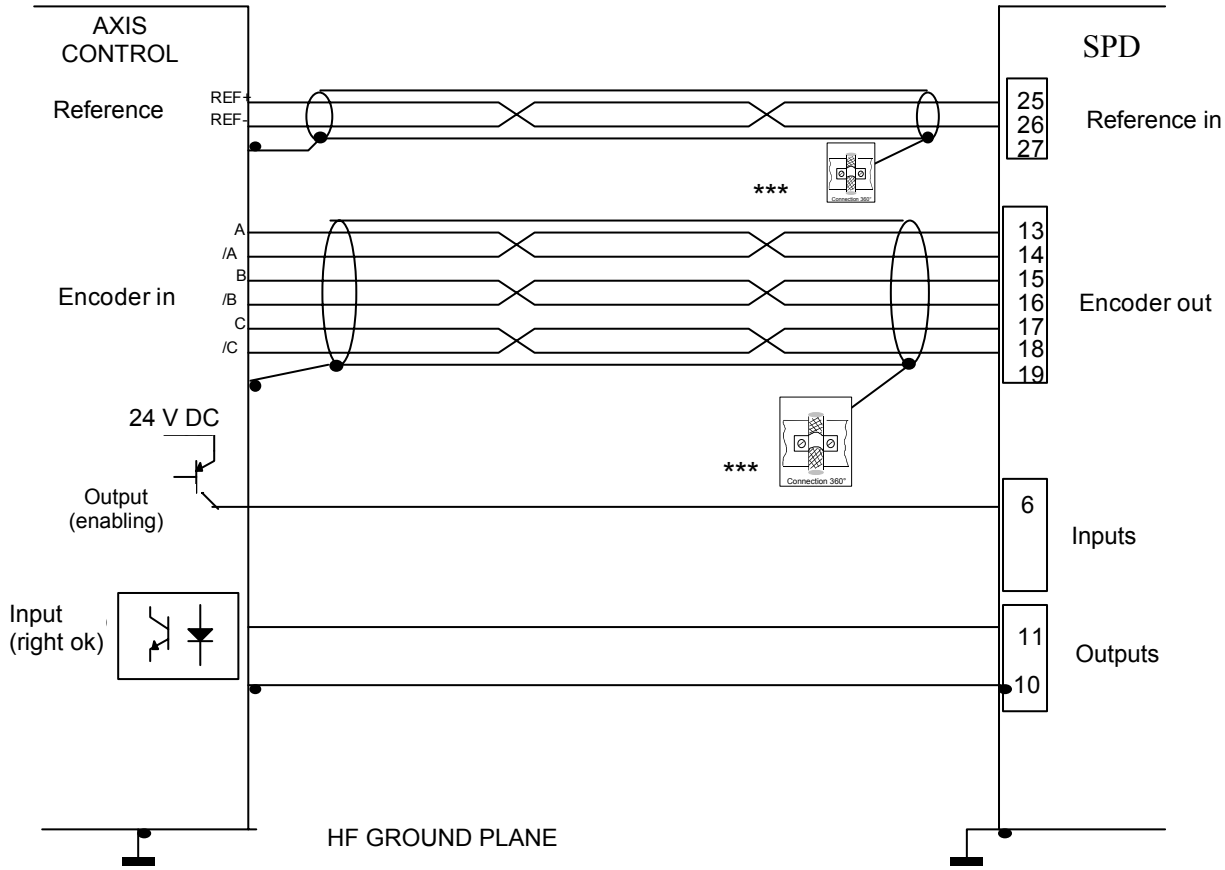
4.4.1 Power connection diagrams for SPD16 and SPD25



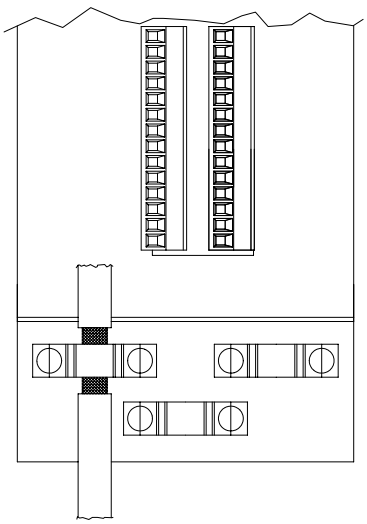
4.4.2 Power connection diagrams for SPD2, SPD5 e SPD8



4.4.3 Signal connection diagrams

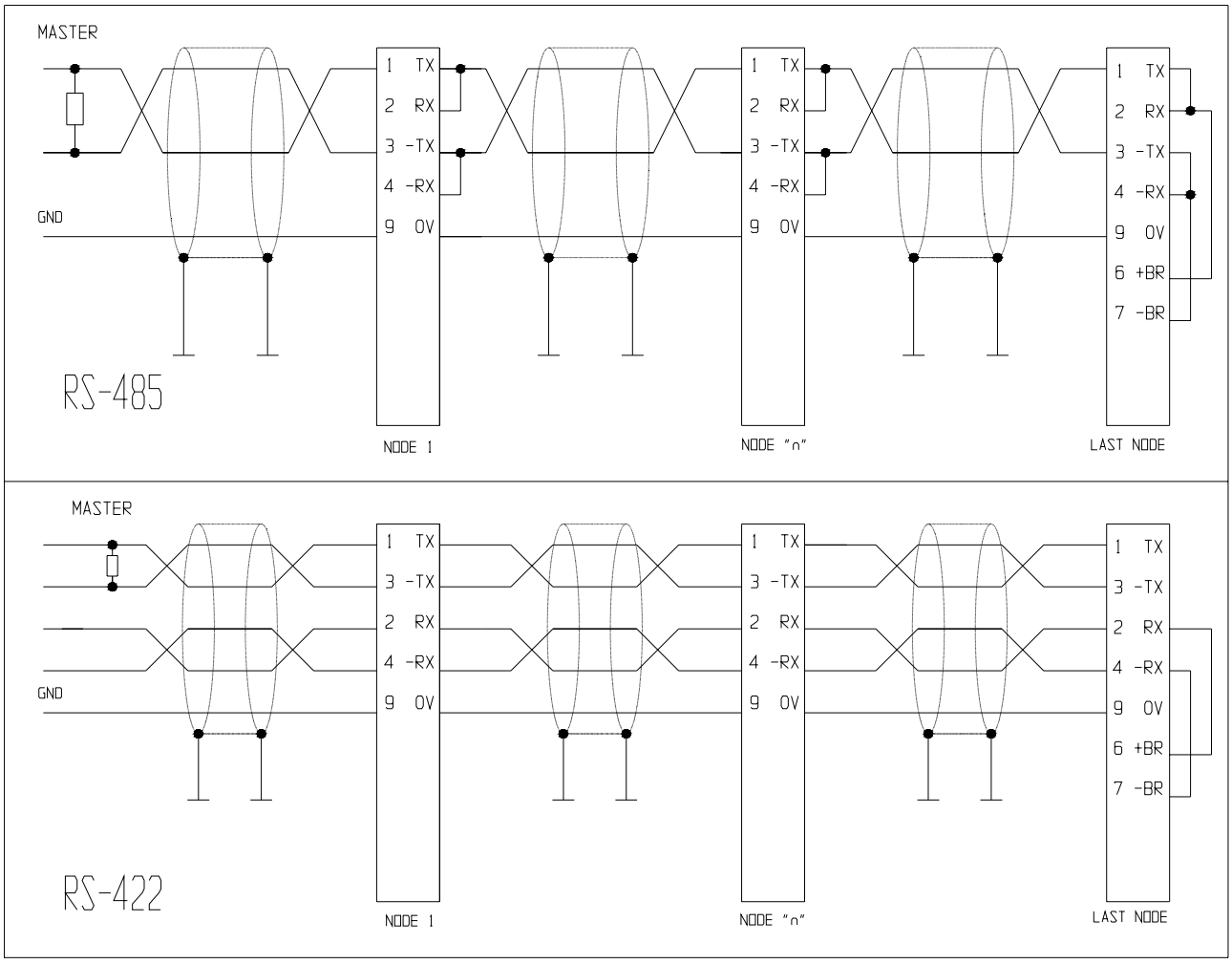


*** For the fixing of the cable-shields use the connections on the frame on the bottom of the drive's front pannel (as shown on the picture beneath).



4.4.4 Serial line connection

The serial line of the SPD can be configured as either RS-422 or as RS-485 depending on how the connection is made. In both cases you must use termination resistors (150 Ω). If more converters are connected on the same line, the last node must be terminated using the drive-side internal termination (+Br, -Br), as shown in the following figure, for both configurations. For pin setting, refer to chapter "Connectors and terminal boards".

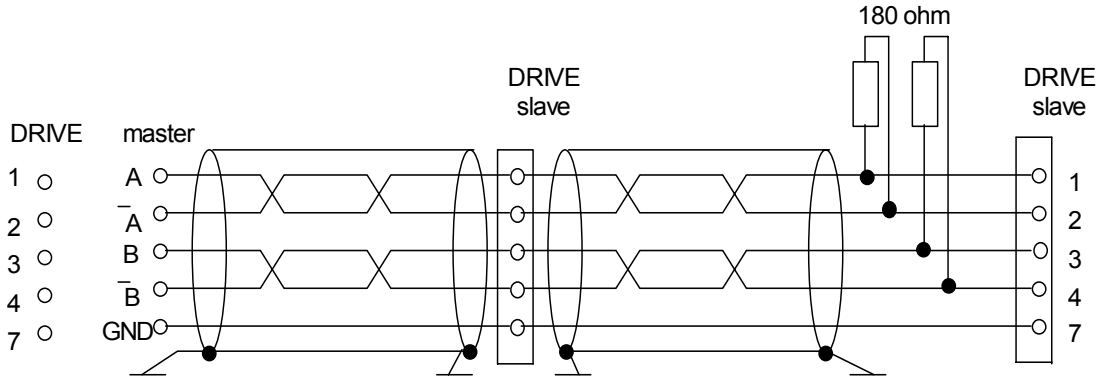


4.4.5 Frequency input/output connection

The frequency input/output connector X3 (RS-422) can be configured by the software in different functional modes by using the binary parameters b42.0 and b42.5. To this purpose, refer to chapter "Functions and operating modes", paragraph "Frequency input/output".

A line closing 180 Ohm resistance should be connected between A /A and B /B. If several input ports are connected in parallel, this operation must be carried out only on the last unit in the chain.

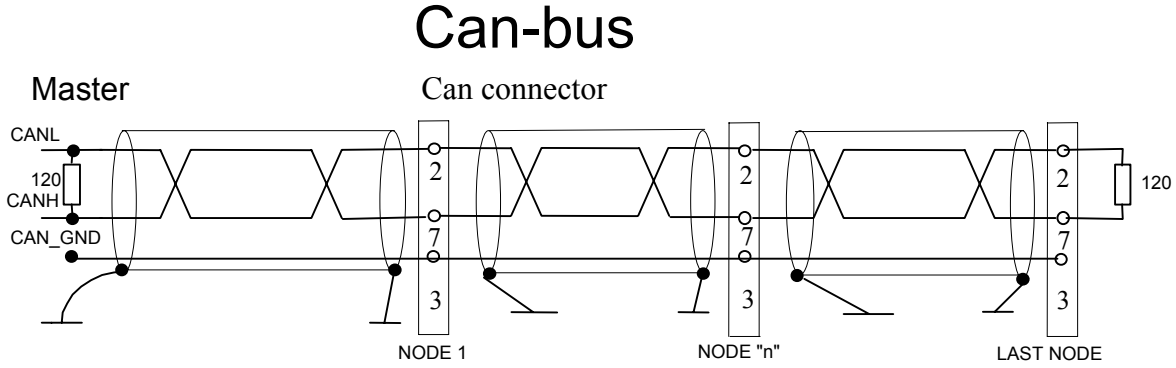
Connecting to the electrical shaft



In the example given above, the connection of two SPD to the electrical shaft with a master is shown, but the diagram could be extended to several converters respecting the series connection. The line charge resistors must be connected to the last converter. The master can be an encoder powered externally or an encoder simulator of another converter.
The signal of the master encoder must in any case be of differential type 5V RS-422. Therefore, it is possible to connect a maximum of ten slave SPD.
If the master is a SPD type converter, you can connect up to 32 converters to the electrical shaft by using the same signal of the simulated encoder (standard RS-422).
For the relevant programming, refer to paragraph *Electric shaft + positioner* described in section "Operating modes" of this manual.

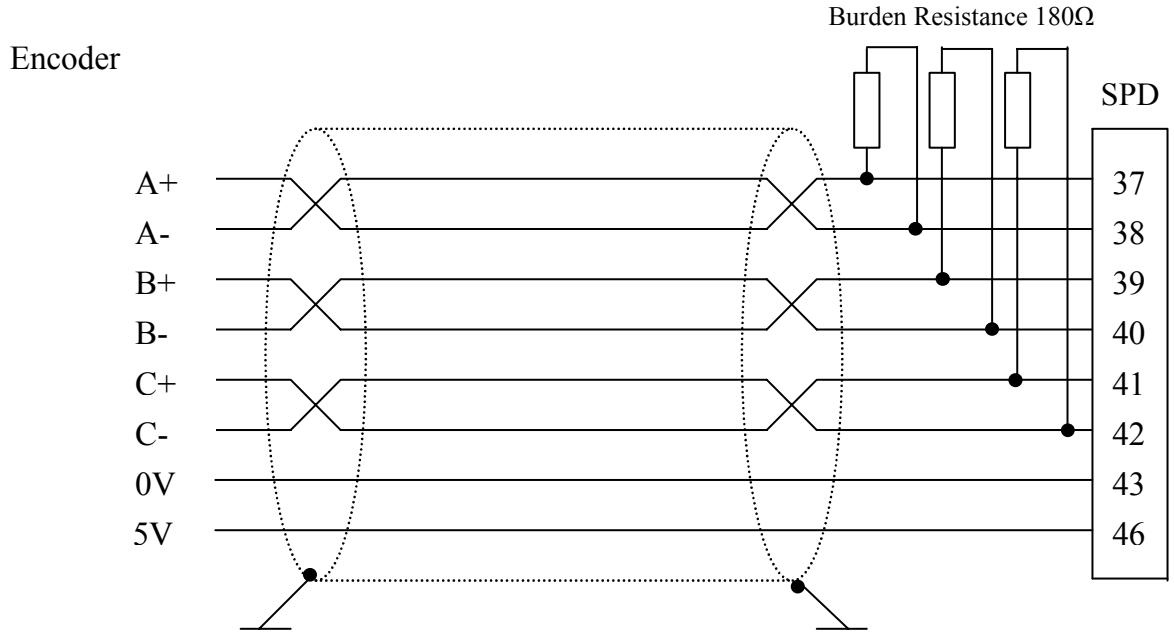
4.4.6 CANBUS connection

A CanBus interface based on the physical layer ISO/DIS11898 is included on the SPD converter. The Data link layer is the full CAN version 2.0 part A (ID 11 bit) and a subset of the application layer SBCCAN is used. The termination resistance on the last drive must be connected externally.

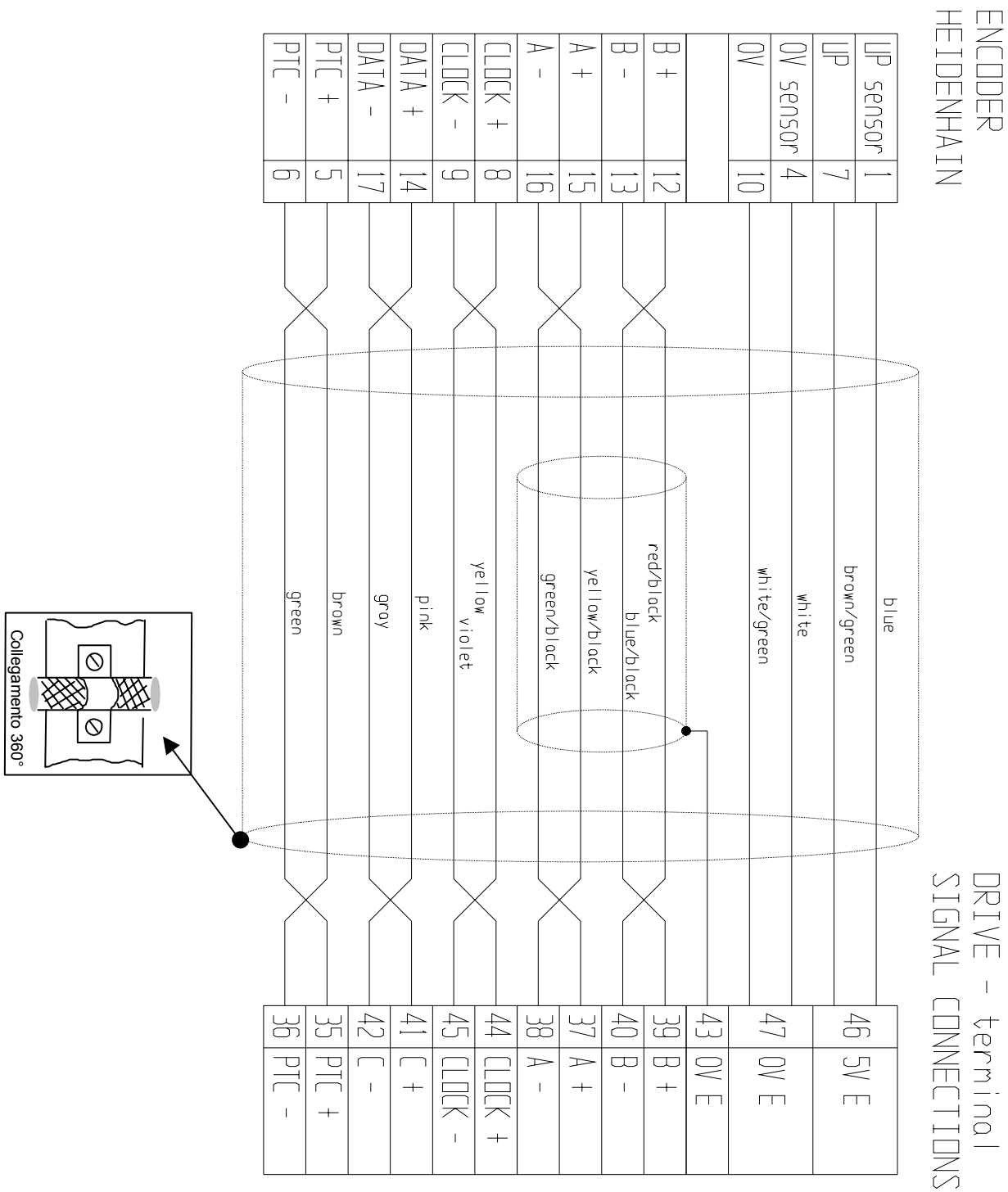


4.4.7 Incremental Encoder connection

The following picture shows the connection of the external incremental encoder.
The termination resistance are necessary and the value is show in the picture.



4.4.8 Heidenhain Encoder connection



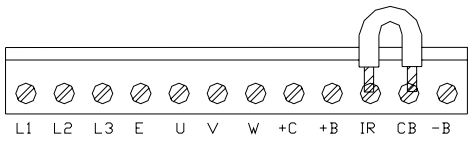
It's possible use a Heidenhain cable or a cable with equal characteristics, but the length must be less to 20 meters.

4.5 External braking resistance

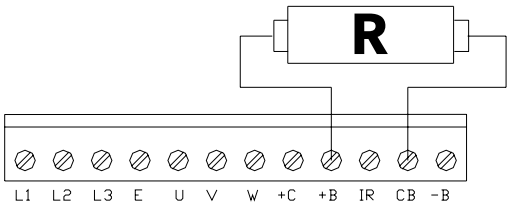
The drive has an internal braking resistance. When a higher braking power is needed, it is possible to connect an external braking resistance to the drive.
The external braking resistance value must be 27 Ohm (**REF2**) for SPD25, while must be 40 Ohm (**REF1**) for the other version, and it is necessary to place a magneto-thermal switch (or a fuse) between the external braking resistance and the drive.
The minimum cross section of the conductors depends on the drive size and it is equal to the minimum cross section of the conductors between motor and drive (see paragraph "Power connections"). It is necessary to minimize the connection cable length. In any case the cable length must be less than 3 m.
The connection of the external braking resistance is shown in the following pictures. The bridge between IR and CB terminals (see pictures) enables the internal braking resistance; when the external braking resistance is connected, the IR-CB bridge must be removed.
Connect the external resistance to the pins: +B and CB.

Terminal power X4 for SPD 16 and 25

Internal resistance

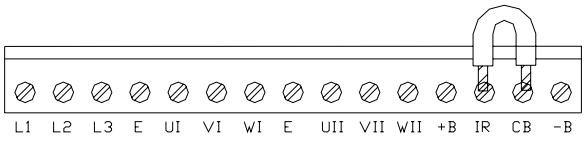


External resistance

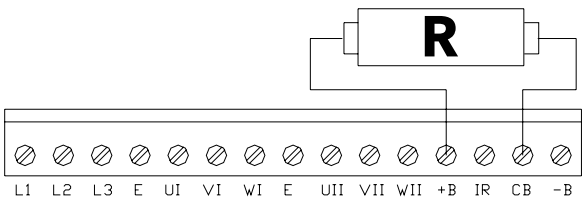


Terminal power for SPD 2, 5 and 8

Internal resistance



External resistance

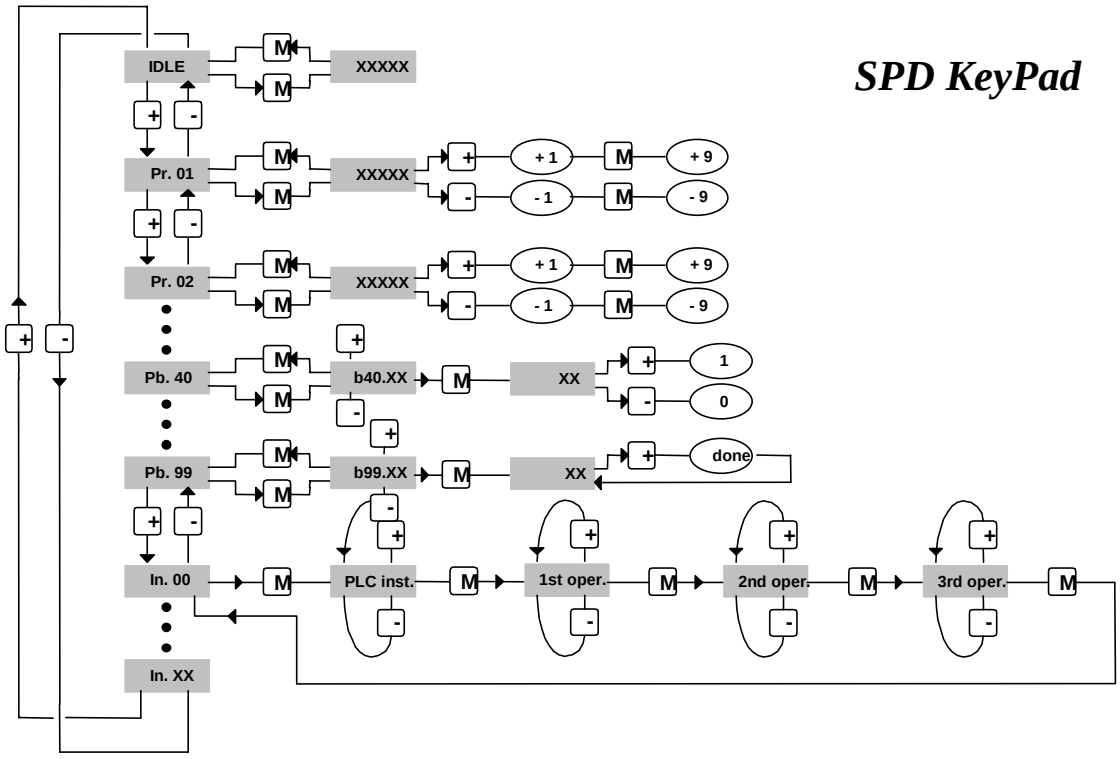


Resistance value: RFE1= 40Ω; RFE2= 27Ω

It's possible see the appendix: "external braking modul".

5 Using the keyboard

The keyboard-display module is easy to use. It is useful to program the functional data, control the status of the converter and send commands. It consists of only three keys located directly beneath the display. The keys are marked: [M], [+], [-].
The [M] key is use to modify the display and consequently the function of the [+] e [-] keys.
There are two types of display: parameter mode and parameter value mode.
When the converter is powered on, if there is no alarm, the user sees 'IDLE' or 'RUN' on the screen, depending on whether the converter is on or off. This is also the position of the Pr0 parameter.
To view all the parameters, press the [+] o [-] keys. If you want to verify the value, press the [M] key. When the value is displayed, it can be modified by using the [+] e [-] keys. To return to parameter mode, press the [M] key again.
The type of display depends on the type of parameter displayed.
If you need to increment or decrement quickly the value of a parameter, you can do this by pressing the [M] key while the increment [+] key or decrement [-] key is held down.



The following messages may be displayed on the screen, in addition to the value of the parameters and the instructions of the pico-PLC:

r. xx When the converter is powered on, this message indicates which version of the software is installed.
IdLE When the converter is powered on and corresponding to Pr0, this message indicates that there is no alarm and that the converter is off.
run When the converter is powered on and corresponding to Pr0, this message indicates that there is no alarm and that the converter is on. The motor shaft may be rotating.
Er. xx Corresponding to Pr0, this message indicates that the converter has registered an alarm (xx indicates the alarm code) and has shut off. When it registers an alarm, the converter is brought to Pr0, displaying the alarm code.
Pr. xx Indicates the parameter xx whose value can be displayed by pressing the [M] key.
Pb. xx Indicates the parameter at bit xx.
bxx.yy Indicates the bit yy of parameter xx. By pressing the [M] key, the status of the bit is displayed.
In. xx Indicates instruction xx of the PLC program.
donE Is displayed for about 1 second whenever a command is sent.
rESet Is displayed for about 1 second whenever an alarm reset command is sent (b99.10).
dEF Indicates that the drive is set to default status and must be programmed with the basic parameters of the motor.
triP.x Indicates that the converter has malfunctioned.

IF YOU CANNOT MODIFY THE READ-WRITE PARAMETERS USING THE KEYPAD, BE SURE THAT PB99.7 IS 0; IF IT WAS 0, PROBABLY THE SAME PARAMETERS WERE MODIFIED BY THE PLC PROGRAM.

6 Parameter

Reduced and extended menu

In the SPDgital drive, the parameters are of two basic classes: decimal parameters, that can be adjusted in a range of real numerical values, characterised by the initial letters Pr, e.g. Pr3, and Type bit parameters, that configure the drive or activate some functions that can only take the values of 0 or 1 and are characterised by the initial letters Pb before the number, e.g. 40.0 When the SPD in the default status, only a limited number of parameters is displayed. These parameters are the only ones needed in the applications where the SPD used in speed adjustment, when the advanced performances of the converter are not to be used (for example, if the SPD used with a numerical control or with an intelligent axis board).
To switch between the limited menu and the extended menu, enter b99.6: limited menu if equal to 0, extended menu is 1. The extended menu offers access to all the parameters and instructions of the pico-PLC, in addition to those specified above.

· To change parameters, b99.7 must be set to zero (safety).
The parameters can be divided into blocks, based on their function:

Pr0 to Pr49 Pb99.6 to Pb99.15 Pr140 to Pr149	Main block parameters General use Functions/commands Cam programmer
Pr50 to Pr70	Position loop
Pr71 to Pr99 Pr151 to Pr163	pico-PLC parameters
Pr100÷ Pr139,Pb150	Parameters used by the operating modes
In0 to In127	pico-PLC instructions

The various operating modes and the different functions are described in the following parameters; chapter *pico-PLC* describes how to associate inputs/outputs to the converter parameters. The units of measurement and the main resolutions of the parameters are:

Parameter type	Unit	Resolution
Speed	Revolutions/minute	1
Acceleration	Seconds/1000 revolutions/minute.	0,001
Position	4096 steps/revolution	1/4096 of a revolution
Current	% of the peak current of the converter	0.1

· The parameters that can be used in the reduced menu are those in bold in column "Par." of the following summary tables;

· In column "Type/Notes", "R" means read only and "R/W" means both readable and writable, "K" means software key-protected (Pb94.3); these parameters must be changed with disabled drive. "M" means stored (Pb99.15). "L" means double.

· The man Block parameters, common to all operating modes, have been divided into two tables, one referring to the decimal parameters (Pr) and one referring to binary parameters (Pb).

7 Main block decimal parameters table

Par.	Description	Field	Def.	Type/ Notes
Pr 0	**Motor speed;** message Pr0 will never be shown on the display, and the message corresponding to the converter status (run, idle, …) is displayed in its place. Press "M" to display the speed.	± 9000 rpm.		R
Pr 1	**Analogue reference offset:**	± 10000 [1=~0.3mV]	0	R/W M
Pr 2	**First full scale of analogue reference:** This is the speed corresponding to a reference voltage of 10V. If b40.0=0 and b40.12=0, the value of Pr7 will be equal to: Vin ·Pr2 / 9.76 where Vin is the voltage at the analogue input.	± 10000 rpm.	3000	R/W M
Pr 3	**Second full scale of the analogue reference:** If b40.0=0 and b40.12=0, the value of Pr7 will be equal to: Vin ·Pr2 / 9.76 where Vin is the voltage at the analogue input. If b42.0=1, b42.1=42, and b5.1=3, Pr3 is the speed of the virtual axis.	± 10000 rpm.	3000	R/W M
Pr 4	**Full scale of frequency reference:** If b40.12=1 and b40.13=1, the value of Pr1 will be the following: if b42.5=0 Pr7=Fin·Pr4/(2000000*2) (frequency/sign signals). If b42.5=1, Pr7 = Fin*Pr4/(500000*2) (quadrature signals) where Fin is the frequency present at the encoder input: Fin = enc speed [Rpm]*enc pulses turn / 60.	± 32767 rpm.	3000	R/W M
Pr 5	**Internal reference**: If b40.12=1 and b40.13=0, Pr7 will be equal to Pr5.	±9000 [rpm]	0	R/W M
Pr 6	**Speed Reference reserved to operating modes:** If b40.2=1 is used as reference for the speed adjuster, the operating mode will write its speed request in Pr6.	±9000 [rpm]		R
Pr 7	**Main reference:** If b40.2=0 is used, Pr7 is the reference for the speed regulator. In some operating modes Pr7 can be used as a reference for other values (torque/acceleration) and in these cases Pr7 will be expressed in the most suitable unit of measurement.	±9000 [rpm]		R

Par.	Description	Field	Def.	Type/ Notes
Pr 8	**Acceleration/deceleration ramp in the reduced menu**; **Acceleration ramp for positive speed in the extended menu** **Positive speed acceleration** required by the motor via the speed reference is internally limited so that to achieve an acceleration of 1000 rpm, Pr8 seconds are necessary.	0,002÷65,535 [s/krpm]	0,002	R/W M
Pr 9	**Deceleration ramp for positive speed**: Positive speed deceleration required by the motor via the speed reference is internally limited so that to achieve an acceleration of 1000 rpm, Pr9 seconds are necessary.	0,002÷65,535 [s/krpm]	0,002	R/W M
Pr 10	**Acceleration ramp for negative speed**: Negative speed acceleration required by the motor via the speed reference is internally limited so that to achieve an acceleration of 1000 rpm, Pr10 seconds are necessary.	0,002÷65,535 [s/krpm]	0,002	R/W M
Pr 11	**Deceleration ramp for negative speed**: Positive speed deceleration required by the motor via the speed reference is internally limited so that to achieve an acceleration of 1000 rpm, Pr11 seconds are necessary.	0,002÷65,535 [s/krpm]	0,002	R/W M
Pr 12	**Deceleration ramp for limit switch and stop functions**: Deceleration required by the motor for limit switch and stop functions is internally limited so that to achieve an acceleration of 1000 rpm, Pr12 seconds are necessary.	0,002÷65,535 [s/krpm]	0,002	R/W M
Pr 13	**Overspeed limit**: If the absolute value of the motor speed exceeds the value set in Pr13, b41.0 will be =1, Otherwise, it will be = 0.	0÷13000 [rpm]	3500	R/W M
Pr 14	**High speed limit**: If b40.7 = 0 and if the difference in speed between the motor and the reference is less than Pr14 and greater than Pr15, b41.1 = 1. Otherwise, = 0. If b40.7=1 and if the motor speed is less than Pr14 and greater than Pr15, b41.1 =1. Otherwise, = 0.	±13000 [rpm]	20	R/W M
Pr 15	**Low speed limit**: If b40.7 = 0 and if the difference in speed between the motor and the reference is less than Pr14 and greater than Pr15, b41.1 = 1. Otherwise, = 0. If b40.7=1 and if the motor speed is less than Pr14 and greater than Pr15, b41.1 =1. Otherwise, = 0.	±13000 [rpm]	-20	R/W M
Pr 16	**Integral gain** of the speed regulator:	0÷32767	120	R/W,M
Pr 17	**Damping of the speed regulator**: If Pr16=0, Pr17 is the proportional gain of the speed regulator.	0÷32767	2000	R/W M
Pr 18	**Band width limiter**: Pr18 is used to set the time constant of a first order filter placed on the digital signal of the torque request. The frequency of the filter cut will be: 1240/Pr18 Hertz.	1÷1000 [1=128usec.]	3	R/W M

Par.	Description	Field/Unit	Def.	Type/ Notes
Pr 19	**Peak current**: This is the maximum current that the converter can supply to the motor. It is expressed as a percentage of the peak current of the converter. In general, it should never exceed three times the rated current of the motor.	0÷100.0 [%Ip]	100.0	R/W M
Pr 20	**DC bus voltage**: Displays the value of the voltage present on the DC bus.	0÷850 [Volt]		R
Pr 21	**Torque limiter** (read-only): Can be used by the operating modes to limit the torque to the motor.	0÷100 [%Cn]		R
Pr 22	**Auxiliary analogue reference**: The value displayed will be Pr22= Vin·100/9.76. The resolution is of 0.2%.	±100 [%]		R
Pr 23	**Alarm code**: This is the code for the alarm that is present.Code 0 represents the absence of alarms. Refer to the alarm and diagnostics appendix.	1÷16		R
Pr 24	**Latest alarm**: This parameter contains the latest alarm. Pr24 will be set to 0 during the execution of the alarm reset command (b 23?0).≠ Refer to the alarm and diagnostics appendix.	1÷16		R M
Pr 25	**Software version code** (read-only): Indicates the version of the software that has been installed.	0÷255		R
Pr 26	**Serial line speed code**: Default=8. This is the code for programming the transmission speed. For more information, consult the section on the serial interface.	0÷8	5	R/W M
Pr 27	**Serial line address code**: For more information, consult the section on the serial interface.	0÷31	0/1	R/W M
Pr 28	**Motor shaft position** (read-only): Indicates the position of the motor shaft in the revolution. In motors with revolver, the position is absolute in the revolution	0÷4095 [count]		R
Pr 29	**Number of motor poles**:	2÷64	0	R/W K,M
Pr 30	**Offset of the resolver position**: Used to correct electronically the mechanical position of the resolver.	± 32767	0	R/W M
Pr 31	**Operating mode**: Used to select the active operating mode. The value 0 means that no operating mode has been selected.	0÷15	0	R/W M
Pr 32	**Maximum speed** The speed that has been set is used to limit the speed request. It should thus be set to approximately 10% more than the maximum operating speed. It is also the scale bottom of the speed Analogue outputs	0÷10000 [rpm]	0	R/W K,M
Pr 33	**Rated current of the motor:** the rated current of the motor must be set. The limit (In) depends on the SPD size	0.1÷In [A]	0	R/W K,M
Pr 34	**Number of poles on the resolver**: Must be <=Pr29	2÷4÷8	0	R/W K,M
Pr 35	**Torque monitor**: Indicates the percentage of the torque or of the current that the motor is supplying.	0÷100.0 [%]		R

Par.	Description	Field/Unit	Def.	Type/ Notes
Pr 36	**Thermal image winding** (read-only): Indicates the estimate of the heat in the innermost coils of the motor. If this reaches the value of 100.0 % equal to the nominal value, b41.11 will become 1 and therefore the current will be limited to the nominal value.	0÷100.0 [%Temp]		R
Pr 37	**Thermal image of the braking resistor** (read-only): estimate of braking resistance heat.	0÷100.0 [%Temp]		R
Pr 38	**Auxiliary analogue output:** Resolution 8 bit. If b40.11 = 1, the auxiliary analogue output will be equal to38/100 .	±100.0% [% of 4.5V]	0	R/W
Pb40	**See Bit Main Block param. table**			
Pb41	**See Bit Main Block param. table**			
Pb42	**See Bit Main Block param. table**			
Pr 43	**Zero encoder offset**. This parameter is used to modify the position of the output zero trace for the zero resolver (Pr28).	0÷4095	0	R/W M
Pr 44	**Number of pulses per revolution**: This is the number of pulses per revolution that is used by the simulation encoder. Maximum frequency is of 120KHz.	4÷2048	1024	R/W M
Pr 45	**Main analogue input:** Represents the value of the main analogue input.	±32767 [1=~0.3mV]		M
Pr 46	**Motor resistance:** The phase-phase resistance of the motor.	0.1÷300.0 ohm	0	K,M
Pr 47	**Motor inductance**: The phase-phase inductance of the motor.	0.1÷500.0 [mH]	0	K ,M
Pr 48	**Speed Can bus**. For further details, refer to chapter *CANBUS.*	0÷7	0	M
Pb90	**See Bit Main Block param. table**			
Pr140 Pr141	**Offset Cam Programmer; For these and following ones, refer to the Function "Programmable output on module"**	$\pm 2^{15}$	0	M
Pr142 Pr143	**Cam Programmer;**	$0 \div 2^{31}$	0	M,L
Pr144 Pr145	**Module on Can programmer output**	$0 \div 2^{31}$	0	M,L
Pr146 Pr147	**Compare values for toggle OUT1**		0	M,L
Pr148 Pr149	**Compare values for toggle OUT1**		0	M,L

7.1 Binary parameters main block

Par.	Description	Def.	Type/ Notes
Pb40.0	**Selection of the first or second full scale of the speed reference:** If = 0, Pr2 will be used to rate the analogue reference 2, If = 1, parameter Pr3 will be used.	0	R/W M
Pb40.1	**Activation of the algorithm to suppress vibration at 0 speed:** If = 1, the algorithm is turned on.	0	R/W M
Pb40.2	**Selection of the reserved/user reference:** If one, the reserved reference coming from the current operating mode is used, if zero, the reference selected by Pr40.0, Pr40.12 and Pr40.13 is used	0	R/W M
Pb40.3	**Reference hold:** If = 1, the reference will not be updated and the motor will not follow the variations of the input reference. If = 0, the reference will follow the variation of the input reference.	0	R/W M
Pb40.4	**Left limit switch:** If = 1 and the reference selected requires negative speed, the reference is set to 0 following the ramp set in Pr12. If = 0, no control is made	0	R/W M
Pb40.5	**Right limit switch:** If = 1 and the reference selected requires negative speed, the reference is set to 0 following the ramp set in Pr12. If = 0, no control is made	0	R/W M
Pb40.6	**Stop function**: If = 1, the motor is set to zero speed following the ramp set in Pr12.	0	R/W M
Pb40.7	**Selection of the absolute/relative speed window:** If equal to zero, the speed window Pr14 Pr15 Pb41.1 will operate in relative mode. Otherwise, if = 1, it will function in absolute mode.	0	R/W M
Pb40.8	**Analogue torque limit:** If = 1, Pr22 will be used and also the auxiliary analogue input in order to limit the torque to the motor.	0	R/W M
Pb40.9	**Software enable:** If = 0, the converter cannot be enabled.	1	R/W M
Pb40.11	**Selector for auxiliary analogue output**: If = 0, a signal proportional to the torque supplied by the motor will be present at the auxiliary analogue output 42.4=0. If – 1, a value proportional to Pr38 will be present.		R/W M
Pb40.12	**Selection of the digital/analogue reference**: If = 0, the analogue input will be selected as the main reference. If = 1, the reference will be digital and b40.13 can be used to select parameter Pr4 or parameter Pr5.	0	R/W M

Par.	Description	Def.	Type/ Notes
Pb40.13	**Selector of internal reference** Pr5 or frequency reference Pr4: If Pb40.12=1 through Pb40.13 it can be selected, If = 0, the internal reference can be used, if one, the frequency input (encoder-in), which in turn can be configured as frequency/direction or as signal in quadrature using Pb42.5.	0	R/W M
Pb40.15	**Reserved:** Must always be set to 0.	0	R/W M
Pb41.0	**Overspeed**: When the absolute value of the motor speed exceeds the value set in Pr13, b41.0 = 1. Otherwise, b41.0 = 0.		R
Pb41.1	**In speed**: If b40.7 = 0 and if the difference in speed between the motor and the reference is less than Pr14 and greater than Pr15, b41.1 = 1. Otherwise, = 0. If b40.7=1 and if the motor speed is less than Pr14 and greater than Pr15, b41.1 =1. Otherwise, = 0.		R
Pb41.2	**Zero speed**: If the motor speed (Pr0) = 0, b 41.2=0.		R
Pb41.3	**Forward**. If the motor speed (Pr0) is positive, b 41.3=0.		R
Pb41.4	**Converter O.K**. If = 1, there is no alarm =0.		R
Pb41.5	**Status of hardware enable:** to one when the drive is enabled. (Can be accessed through picoPLC, via serial or canbus).		R/W
Pb41.6	**Encoder phasing signalling bit** 1=OK (successful)		R
Pb41.7	**External alarm**. An alarm that can be used by the user.(Can be accessed through picoPLC).		R/W
Pb41.8	**Auxiliary alarm**. A second alarm that can be used by the user. (Can bge accessed through picoPLC).		R/W
Pb41.9	**Can bus watchdog.** Set to one at each reception of the block sync via SBCCAN.		R
Pb41.10	**Speed adjuster saturation**.		R
Pb41.11	**I^2T active**: Indicates that Pr36 has reached the 100.0 % value and therefore the converter is limiting the current to the nominal value.		R
Pb41.12	**Converter enabled**. Status bit.		R
Pb41.13	**Bus warning**. Indicates a momentary communication error on the SBCCAN.		R
Pb41.14	**Bus off error.** Indicates a permanent communication error on the SBCCAN.		R
Pb41.15	**Can bus watchdog.** Set to one at each reception of the sync via SBCCAN.		R
Pb42.0	Virtual encoder enabled: 1= function enabled (see Functions and operating modes,).	0	R/W M
Pb42.1	**Voltage management.** (0) 400V supply voltage, (1) 230V supply voltage. This command is read at the start up of the drive, so is necessary to save the configuration and restart the drive.	0	R/W M
Pb42.2	**Torque control**. If =1 the mean analog reference is valid with torque control (drive mode torque control)	0	R/W M

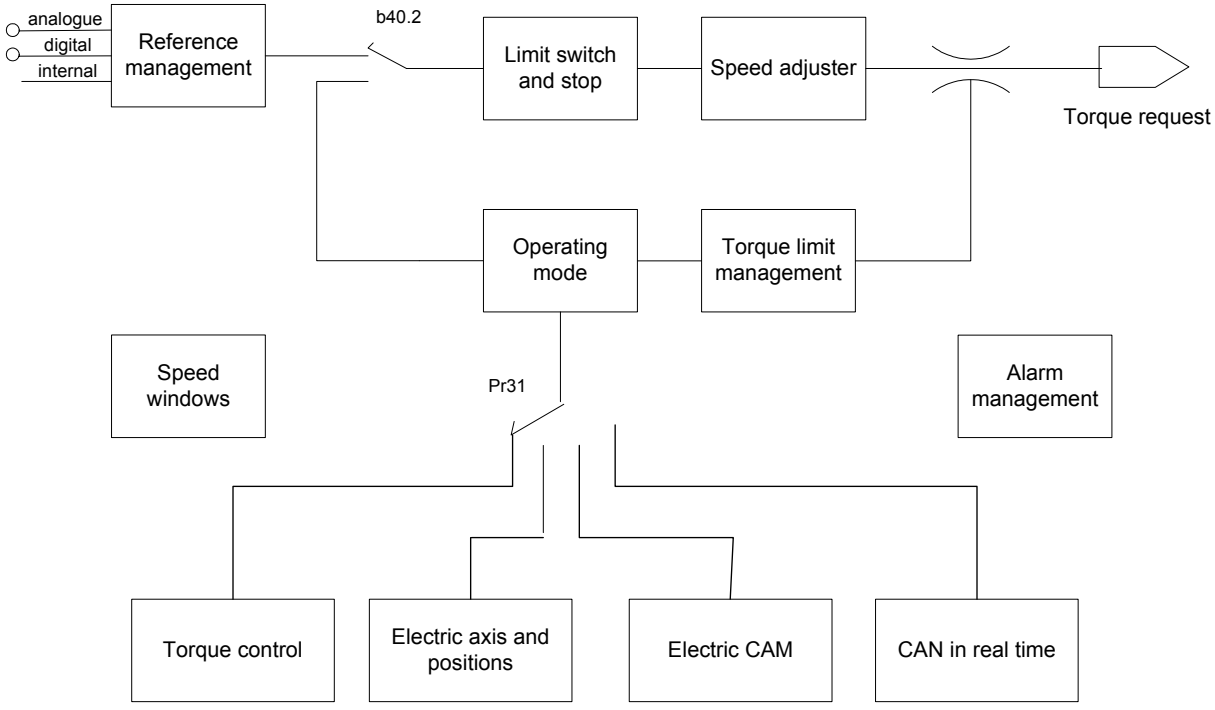
Par.	Description	Def.	Type/ Notes
Pb42.3	**Reinitialising the serial line and the SBCCAN.** Command to reinitialise serial or Canbus communication if address or operating speed have been changed. The serial line and the SBCCAN are in any case initialised when the converter is powered on.	0	R/W M
Pb42.4	**Selector to configure analogue output**: If set to 0, the analogue output represents the instantaneous speed of the motor with voltage equal to 4.27V at the speed of Pr32. If set to 1, it represents the instantaneous torque with voltage equal to 4.5V at the converter peak current. The selector is valid only if b40.11 = 0.	0	R/W M
Pb42.5	**Frequency input (X3 connector): If set to 1, the frequency input is programmed to receive two quadrature phases and this is the default value.** If set to 0, a frequency/direction type of input can be received.	1	R/W M
Pb42.6 and Pb42.6	**Speed feedback selector:** 0,0 (Resolver); 1,0 (Incremental Encoder); 1,1 (SinCos or SinCos + Endat); 0,1 (reserved)		M
Pb94.0	**See picoPLC**		
Pb94.1	**Command to set the main reference offset to 0.** This command is used to automatically set the Pr1 parameter in order to automatically set the voltage offset on the main analogue reference to 0. This operation can be done only if the absolute value of the offset is less than 200 mV.		
Pb94.2	**Phasing command**		
Pb94.3	**Safety Main parameters.** 1=Enable change (see chapter *Firt SPD start up*).		
Pb94.5	**See picoPLC**		
Pb94.6	**See picoPLC**		
Pb94.8	**Value comparator.** (See Further functions paragraph)		
Pb94.9	**Value comparator.** (See Further functions paragraph)		

Par.	Description	Def.	Type/ Notes
Pb94.10	**Value comparator.** (See paragraph Functions and operating modes)		R/W
Pb94.11	**Value comparator.** (See Further functions paragraph)		R/W
Pb99.0	**See picoPLC**		
Pb99.1	**See picoPLC**		
Pb99.2	**See picoPLC**		
Pb99.3	**See picoPLC**		
Pb99.6	**Extended menu enable**. If set to 1, the extended menu is enabled.	0	R/W M
Pb99.7	Safety. If set to 1, parameters cannot be modified .	0	R/W M
Pb99.8	**UV auto reset** If set to 1, the under-voltage alarm will automatically be set to 0 when power returns.	0	R/W M
Pb99.10	**Command to reset alarms**. (Con Pr23≠0) 24;If the alarm continues, it is displayed on the screen. This command cannot be used if there is a check-sum error (Pr23 = 10, 11). In this case, it is necessary to set the default parameters (b99.12) and then reset the alarm.	0	R/W
Pb99.11	**Default values of the parameters in operating mode.** This command sets the operating mode parameters to the default values. The command is executed only if b 40.2= 0.	0	R/W
Pb99.12	**Default values.** This command sets all parameters to the default values and sets those used by the operating mode to 0. Furthermore, it sets the pico-PLC program as described in Appendix F Appendix D:. There is a check-sum alarm, Pr23 and Pr24 will be set to 0, thereby permitting the alarm to be reset. The command is executed only if b 99.13=0.	0	R/W M
Pb99.13	**See picoPLC**		
Pb99.14	**Storing of the pico-PLC instructions.** This command saves the pico-PLC program. It cannot be used if a check-sum alarm has been indicated. In this case, it is necessary to set the default parameters, reset the alarm and then store the new parameters.	0	R/W
Pb99.15	**Storing of parameters.** This command stores all parameters. It cannot be used if a check-sum alarm has been indicated. In this case, it is necessary to set the default parameters, reset the alarm and then store the new parameters.	0	R/W

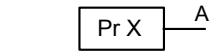
8 Functions and operating modes

8.1 Block diagram and introduction to parameter setting

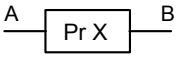
The torque, speed, acceleration and position control functions are carried out by special digital electronics.
In this section we explain how parameters are set and the meaning of each parameter. We also provide the functional block diagram and the description of advanced functions. The system is easy to use and flexible.



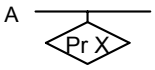
In the diagram below the general block diagram of the part of the converter that is controlled by parameters is presented. Parameter Pr31 (default = 0) is used to select the operating mode. The Pb40.2 (default=0) determines whether the reference comes from the reference management block or from the operating mode being used. Below we describe how to interpret the symbols used in the block diagrams. The main block diagram describes graphically how the converter works. Each rectangular block represents one or more read-write parameters. The rhomboid blocks represent read-only parameters. You can find other functional blocks in the diagram such as: greater than, equal to, less than, logical AND/OR. For all these functional blocks, standard symbols are used. Binary parameters are represented as switches and the position in the diagram corresponds to the default value.



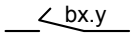
- Read/write of the PrX parameter
  A = value of the PrX parameter



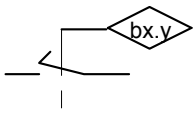
- Read/write of the PrX parameter
  B = value that depends on the values of A and PrX



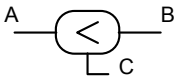
- Read-only parameter
  PrX indicates the value of A which can also be binary



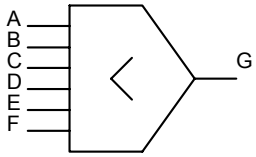
- Read/write of binary parameter
  The position of the switch indicates bx.y=0



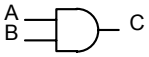
- The value of the binary parameter bx.y positions the switch.



- If A is less than B, C=1 (true). Otherwise, C=0 (false)



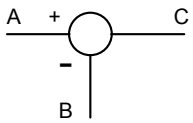
- The value of G is the lowest value of A B C D E F.



- Only if A = 1, B = 1 then C = 1, otherwise C = 0



- If A or B is equal to 1 C = 1, otherwise C = 0



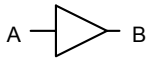
- C = A - B



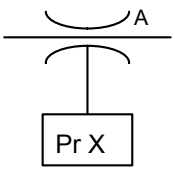
- values coming from the hardware



- values sent to the hardware

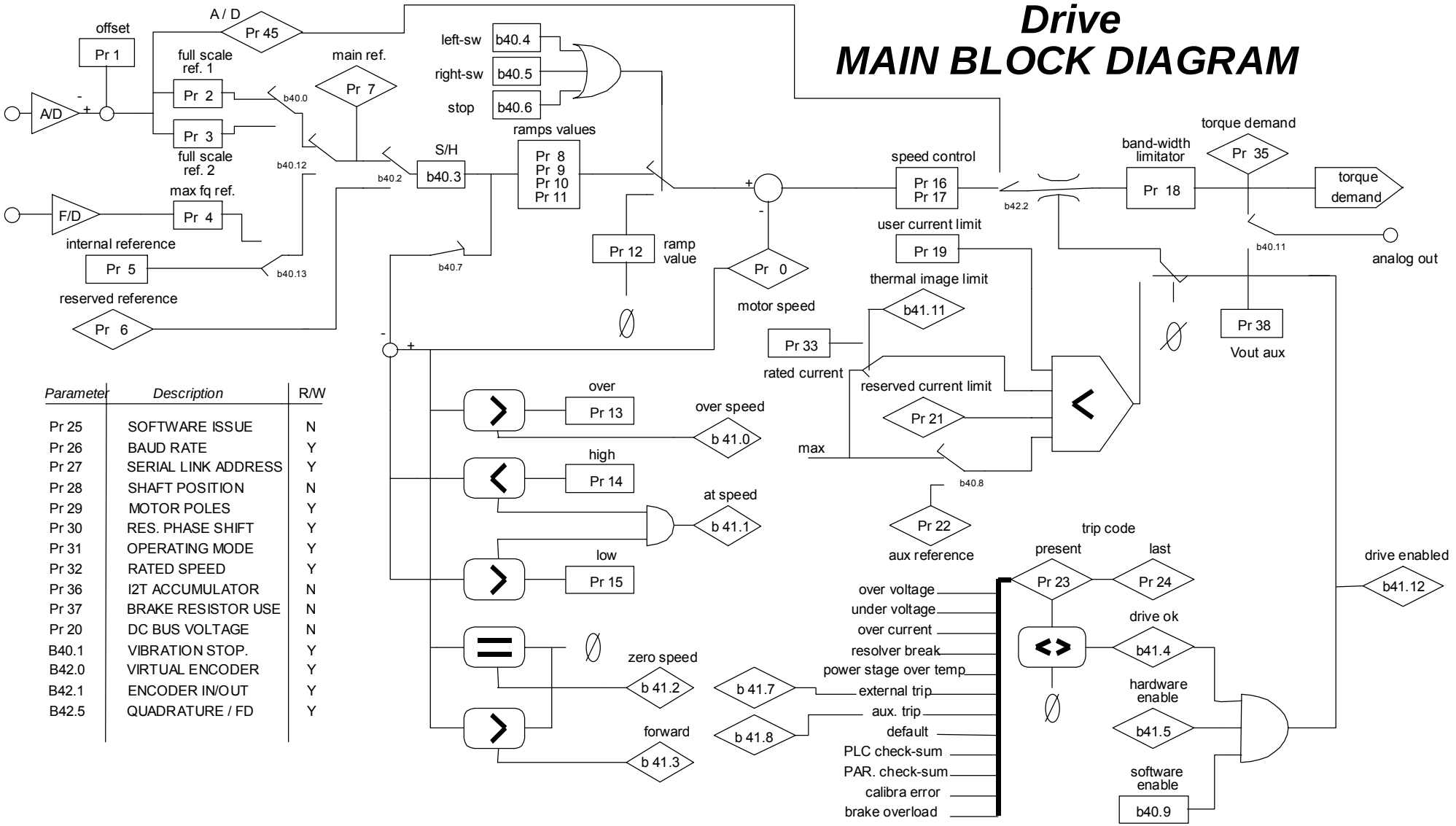


- the value of A is converted to B. For example, if A/D is displayed in the triangle symbol, the analogue value of A is converted into the digital value B



- The maximum value of A will be PrX.

Drive
MAIN BLOCK DIAGRAM



Parameter	*Description*	R/W
Pr 25	SOFTWARE ISSUE	N
Pr 26	BAUD RATE	Y
Pr 27	SERIAL LINK ADDRESS	Y
Pr 28	SHAFT POSITION	N
Pr 29	MOTOR POLES	Y
Pr 30	RES. PHASE SHIFT	Y
Pr 31	OPERATING MODE	Y
Pr 32	RATED SPEED	Y
Pr 36	I2T ACCUMULATOR	N
Pr 37	BRAKE RESISTOR USE	N
Pr 20	DC BUS VOLTAGE	N
B40.1	VIBRATION STOP.	Y
B42.0	VIRTUAL ENCODER	Y
B42.1	ENCODER IN/OUT	Y
B42.5	QUADRATURE / FD	Y

8.2 Basic functions

The standard drive functions include protection functions whose parameters can be set, such as automatic limitations of current delivered based on the estimated dissipation (thermal image or i^2t drive and motor); diagnostic functions, always available to the user, who can always check the drive status; configuration functions for some drive inputs/outputs; the activation of parameter saving/restoring procedures, and further functions common to motion-control equipment.

8.2.1 Saving/restoring default parameters

Upon start up, the drive loads the parameters from the memory (EEPROM) and transfers them to the working memory (RAM).
All variations relative to parameters are carried out in the working memory (RAM).
After defining the changes/calibrations, they must be saved permanently (EEPROM) to retrieve them upon the subsequent drive start up.
To save the parameters, use PB99.15. Saved parameters are those marked by "M" in the notes field of the parameter tables.
To save the PLC program, use PB99.14

Sometimes, due to several changes and saves, the operating conditions may be not satisfactory anymore. It may then be necessary to restore default parameters, that is, those defined by SBC and residing in the system memory (EPROM), which cannot be written to. They are first loaded to the RAM and then saved to the EEPROM

Restoring the default:
- disable the converter
- power the converter on
- the IdLE message appears on the screen
- set Pb99.7 and Pb99.13 to zero
- issue the command Pb99.12
- save the set up using commands Pb99.14 and Pb99.15.

8.2.2 Homing function

The homing function, which is available exclusively with operating modes 13, 14 or 15, provides a typical axis reset procedure. Before using the homing function perform the following settings:
- connect the homing sensor to digital input 3
- set the homing speed in parameter Pr4 (pay attention to the direction of rotation)
- set Pr5 = 0, b40.12=1, b40.13=0, b40.2=0.

To activate the homing procedure set b94.12=1 for a type 1 reset, or b94.13=1 for a type 2 reset. When the homing procedure is concluded the respective activation bit will be reset. If you wish to abort the procedure, reset the command bit, stop the motor (e.g. by resetting Pr5) and, if necessary, read b40.2 which will remain on zero.

RESET TYPE 1 - DESCRIPTION

When the procedure is activated (b94.12=1) the axis is brought to the speed programmed in Pr4 (Pr5=Pr4); the axis is then brought to zero speed (Pr5=0) on the positive front of the homing sensor signal; after 150ms with the motor stopped parameters Pr61:60 and Pr63:62 are reset, the position loop is enabled by setting b40.2=1, and command b94.12 is reset. The homing sensor signal must be maintained active in high status for the entire duration of the motor stopping phase.
If the homing sensor is already engaged when the procedure is activated, the axis moves at the speed programmed in Pr4 but in the opposite direction until the homing sensor is freed; At this point the procedure continues as described above.

RESET TYPE 2 - DESCRIPTION

When the procedure is activated (b94.13=1) the axis is brought to the speed programmed in Pr4 (Pr5=Pr4); the axis is then brought to zero speed (Pr5=0) on the positive front of the homing sensor signal; after 150ms with the motor stopped parameters Pr61:60 and Pr63:62 are programmed with the value of parameter Pr28, the position loop is enabled by setting b40.2=1, and command b94.13 is reset. The homing sensor signal must be maintained active in high status for the entire duration of the motor stopping phase.
If the homing sensor is already engaged when the procedure is activated, the axis moves at the speed programmed in Pr4 but in the opposite direction until the homing sensor is freed; at this point the procedure continues as described above.

8.2.3 Backup

If it is necessary to keep the control electronics of the converter powered up even when there is no current, for example, to keep the encoder simulation operating, it is sufficient to keep power on terminals 24 and 48 of the X4.

8.2.4 Speed adjustment

In the operating mode default conditions (Pr31=0), the drive adjusts the motor in speed based on the reference value.
The reference orign can be selected with the main block parameters, between analogue (external potentiometer), internal (digital), or external pulse string.

It is possible to make comparison by zero speed, and other speeds, set acceleration and deceleration ramps, change the current and torque limits, and check the drive status.

The main block diagram shows the main drive structure, how the configuration parameters act (bit or Pb parameters) and the main numerical parameters (Pr).

8.2.5 Current or torque adjustment (typical)

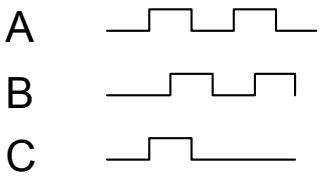
To set the converter to Current mode (torque adjustment), the speed ring is excluded by setting Pb42.2=1.
The main analogue reference is assumed as torque reference (current).
If the nominal current value is exceeded, the thermal image trips as in the speed operation.

8.2.6 Frequency input/output (Encoder ports)

The frequency input/output connector X422 (RS-422) can be configured by the software in different functional modes by using the binary parameters b42.0, b42.1 and b42.5 as given in the table below.
Pb42.0, and Pb42.5. See App. for the Signal and counter conventions used.

	Description of the modes
Pb42.0=0	**Incremental Encoder simulation**, On encoder out pin; the number of turn pulses must be programmed in Pr 44.
Pb42.0=1	The function **Virtual encoder simulation** is enabled (Dummy Master)
Pb42.5=1	**Encoder input is programmed as input in quadrature** (phases A and B), this configuration must be used with the operating modes 13 and 14.
Pb42.5=0	**Encoder inputs are programmed as frequency/sign input.** The mode must be set when you want to simulate a stepper motor or the pulses train function. The frequency connects to A /A input while the direction connects to B /B input

After the programming, the configuration must be saved and the unit must be powered off and on again. When configured as encoder simulator or o virtual encoder, the counters Encoder In input used by the operating modes are active. Incremental encoder outputs:



With the "Virtual encoder" function enabled, a virtual encoder (dummy Master) will be available, whose speed will be that set in Pr3. The set speed has a resolution equal to 1 rpm and a value in the range -3500 and +3500 rpm. Output signals (phase A, phase B) will simulate an encoder of Pr44 step / revolution, with phase C of zero not coupled to a reference zero.

8.2.7 Feedback from SinCos encoder or SinCsos + Endat encoder

This type of feedback must be expressly requested when placing your order.
Because the hardware of the drive must be modify and in this configuration the drive can't use other type of feedback.
If the order hasn't the feedback requested, the configuration of the drive is standard: the resolver is typology of the feedback.
It's important to remember that feedback from SinCos or Endat si possible only with software release n° 8 or more.
About the connection draw, see the paragraph "Hedenhain Encoder connection".

Set Pb42.7=1 and Pb42.6=1 when SinCos or SinCos +Endat is the feedback. Pr 52 and Pr53 are updated in automatic, if it is present the Endat interface, to the values made from read the Eeprom inside to the encoder. In case the feedback is from SinCos, Pr53 must be =1 and Pr 52 has the value necessary for to have a product equal to 65536, specified from product of number of sinusoidal to turn by 4 and by Pr52.
Save the data (Pb99.15), turn off the drive and turn on again for activate the new formulation.
The user must not use Pr159-Pr160 (reserved)
The procedure of the phasing is the same for incremental encoder (see paragraph "feedback from incremental encoder").
If the Endat interface, single turn or multiturn, after the phasing is possible to save this information so at every start up the phasing procedure isn't necessary; for take it, to bring the motor shaft in the position that Pr28=0, disable the drive and save with command Pb99.9=1. After this command is necessary start again the drive.
Alternative to this procedure, when Endat interface, disconnect and disable the drive, is available to supply a positive tension between phase B and C respect the phase A so that the shaft aligned, set the command Pb99.9=1 and start again the drive.

In the case of an encoder with EnDat single turn at power up, Pr62:63 = Pr28, that is the absolute revolution position. With a multiturn encoder, initialize the absolute position read at power up in Pr2:63 by following the procedure below:

- bring the axis on the desired mechanical position
- set an operating mode in the drive that uses the position loop (Pr31=13 or 14);
- enable the operating mode when bit b40.2=1;
- disable drive hardware when b41.5=0;
- set the desired position in Pr64:65;
- enter command b94.14=1 to complete the phasing;
- switch off and on again.

When the unit is powered on, Pr62:63 shows the desired position on the absolute multiturn. Such absolute position has a range of $\pm 2^{23}$.

IMPORTANT: after set one of the above mentioned command (Pb94.14 and Pb99.9 with drive disabled) the flag Pb41.6, encoder ok; set to 0, the drive needs to restart for to permit new enable of the axe.

8.2.8 Feedback from incremental encoder

In place of the resolver it is possible to use an incremental encoder, which provides feedback for both speed control and space. Select the feedback from encoder, setting Pb42.6=1 and Pb42.7=0. Modifications at this bits are available only after resta 180Ω burden resist oder input signals are on the terminal "Connections" of the axis I/II (pin 37÷43) and made reference to the section "frequency input/output connection". The encoder can be supplied by own drive (+5VE, 0VE; pin 46, 47).
The phasing procedure must be run upon every drive start up.
It's possible choose among two type of procedure, and it's necessary that the motor shaft must be free to rotate, also when the motor is mounted into the system (the brake of the motor must be disable). During the phasing procedure 1, the drive checks the connections, and the movement of the motor is brodest, so this procedure is recommended for the first time.

PROCEDURE 1
Pb94.2 actives this procedure. The parameters are shown in the table below:

Par.	Description	field/Unit	Def.	Type/ Note
Pb94.2	**Command phasing 1**. It's necessary to disable the software (Pb40.9=0); enable the hardware (Pb41.5=1), and driver OK (Pr23=0). The motor executes two movements and the last is about 90° degree electric, with control sign of the encoder feedback. Introduce the correct number of the motor poles (Pr29).		0	
Pr 52 Pr 53	Used to normalise the number of encoder pulses on the motor shaft revolutions to the standard value 65536, through the following relation: (Pr52/Pr53)*((encoder pulses/motor shaft revolutions)*4)=65536 The sign determines the feedback (positive or neg.)	±32767	1	R/W M
Pr89	**Status**: 0 if positive result 2 if wrong enabling 3 if positive feedback 4 if wrong motor poles (tolerance ±22.5 electric degrees) 5 if drive not ready (Pr23 ≠0 or open inr ush)			R
Pb42.6	=1, select the feedback from encoder		0	M
Pb42.7	=0, select the feedback from encoder		0	M
Pb41.6	Phasing result :=1 if positive result of the procedure and necessary condition for drive OK (Pb41.4)		0	R

PROCEDURE 2:

Pb94.4 actives this procedure. The parameters are shown in the table below:

Par.	Description	Field/Unit	Def.	Type/ Note
Pb94.4	**Command phasing 2**. It's necessary to disable he software (Pb40.9=0); enable the hardware (Pb41.5=1), and driver OK (Pr23=0). The motor executes a vibration, the standing depends to the type of the motor and to the load.		0	
Pr 52 Pr 53	Used to normalise the number of encoder pulses on the motor shaft revolutions to the standard value 65536, through the following relation: (Pr52/Pr53)*((encoder pulses/motor shaft revolutions)*4)=65536 The sign determines the feedback (positive or neg.)	±32767	1	R/W M
Pr89	**Status**: 0 if positive result 2 if wrong enabling 5 if drive not ready (Pr23 ≠0 or open inrush) 6 Pr30 parameter calculated (frequency of vibration) is different of 25 unit from starting value 7 Pr30 parameter calculated (frequency of vibration) exceeds 200 unit (max. value)			R

Par.	Description	Def.	Type/ Note
Pb42.6	=1, select the feedback from encoder	0	M
Pb42.7	=0, select the feedback from encoder	0	M
Pb41.6	Phasing result :=1 if positive result of the procedure and necessary condition for drive OK (Pb41.4)	0	R

The calculated value of Pr30 at the end of the procedure, if it is save, it permits at the new start-up that the procedure starts from this value, and if the mechanical conditions don't change, makes only one vibration of standing fixed by Pr30.

N.B.: *(*) during the phasing procedure the motor must be motionless, so if the motor is on vertical axe, this system must be motionless without to use the brake.*
(**) the encoder simulation can't use zero encoder track as reference for reset the machine, when the system uses a axis control and the FBK is a incremental encoder.

8.2.9 Value comparators

The Pr96:95 and Pr98:97 parameters have the alternative function of value comparators.
With b94.10 = 0, then b94.8 = 1 if Pr96:95 > Pr63:62 (or Pr66:67 if feedback encoder)
With Pb94.10 = 1 then Pb94.8 = 1 se Pr96:95 > Pr61:60
With b94.11 = 0, then b94.9 = 1 if Pr98:97 > Pr63:62 (or Pr66:67 if feedback encoder)
With Pb94.11 = 1 then Pb94.9 = 1 se Pr98:97 > Pr61:60
This function is run every 6.144 ms.
If the value comparators functions are not used, the Pr95, Pr96, Pr97, Pr98, b94.10 and b94.11 parameters by the PLC program as general purpose registers.

8.2.10 Value capture

At every positive front of digital input 1, the value of Pr63:62 (or Pr66:67) is captured and stored in Pr68:69 and b70.15 is set to 1 to signal the event. B70.15 is not reset automatically but must be executed by the pico-PLC or the serial line.

At each In0 or the Zero Encoder input (Pb70.0) Pr66:67→Pr58:59 Pb70.14=1

8.2.11 Output programmable on module

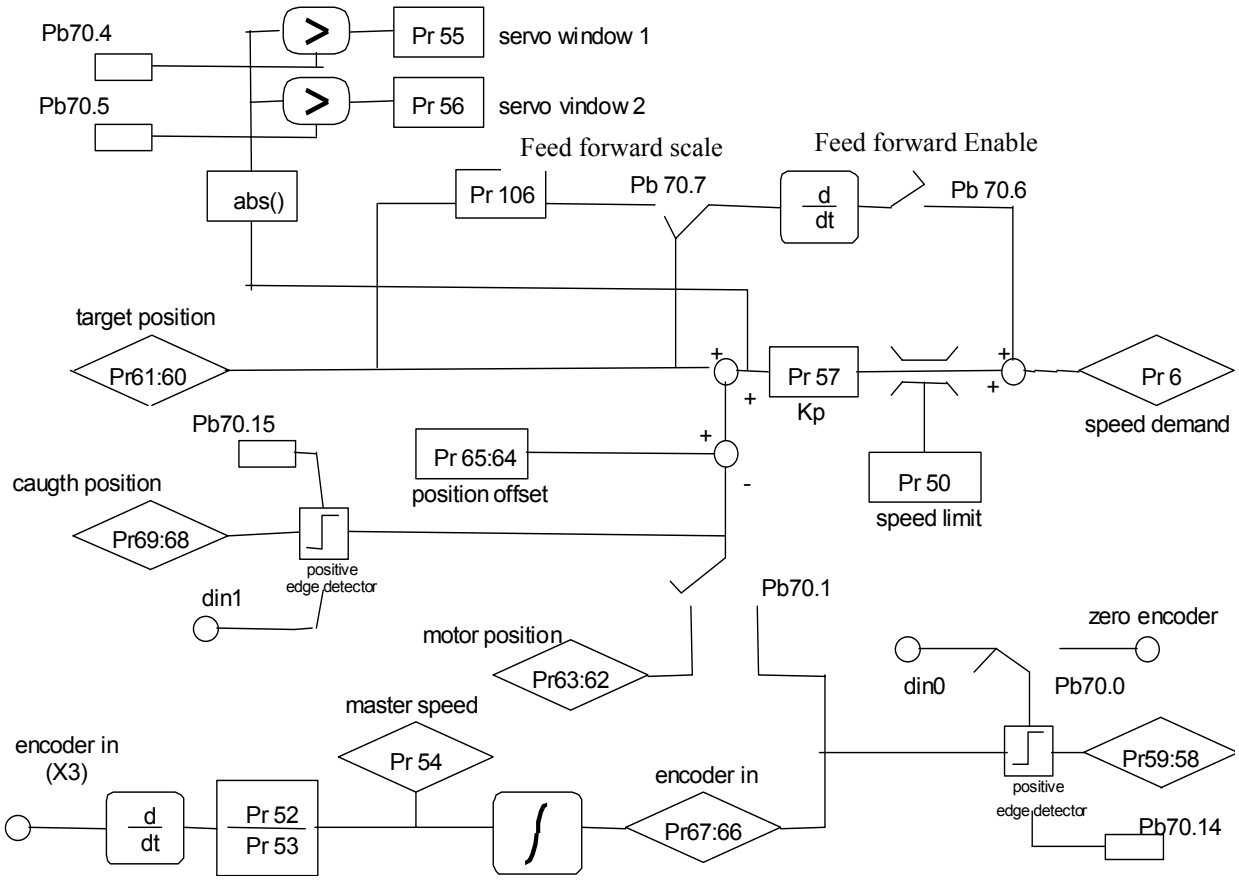
This function allows having the status of a digital function based on the position of the motor shaft into a module. The user must set such module in Pr144:145, besides two positions Pr146:147 and Pr148:149 into the module to define the points at which the output 1 must be inverted 1 (terminal 8 of X4). The initial position value of the motor shaft must be set to parameter Pr142:143, the output status to Pb91.1; the function is enabled if b70.3=1 and in this case, Pr142:143 indicates the motor Position in the same module. The Position can be changed placing an offset in Pr140. The digital output is updated every 512 μs. The limits that can be set are reported in the parameter list; in addition, it should be:
0 =< Pr146:147 =< Pr148:149 =< Pr144:145.

If the b99.8 bit is set to 1, when power supply is restored, the undervoltage alarm will be automatically reset.

8.3 Slow operating modes management

New functions can be added to the basic ones, for specific applications, by setting one of the operating modes from 1 to 15.

Every operating mode controls speed using parameter Pr6 and can use parameter PR21 to limit the torque at the motor (see the block diagram). Speed control will use as reference Pr7 or Pr6, depending on the value of b 40.2 . Before changing Pr31, Pb40.2 must be reset to prevent undesired motor motions, then it is possible to set Pr31 to the value corresponding to the selected operating mode and through Pb99.11, the default parameters of the operating mode must be set. By setting b40.2 to 1, the operating mode will be turned on. All operating modes need to control the motor in position (13, 14, 15) by using the position loop described in the diagram in the figure.



Summary of useful operating modes parameters; for settable ranges, units of measurement and default values, refer to the parameter tables.

Par.	Description	Field/Unit	Def.	Type/ Notes
Pr50	**Maximum speed**. This parameter limits the maximum speed of the motor. It can be useful to limit the speed during a sudden link or during a quick change of speed.	0÷9000 [rpm]	3000	R/W M
Pr51	**Position error**	-32768 ÷ +32767 [count]	0	R/W M
Pr52	**Reference multiplier**. Using this parameter and Pr53, the user can set the ratio desired for the input reference frequency.		1	R/W M
Pr53	**Reference divider.** Using this parameter and Pr52, the user can set the ratio desired for the input reference frequency.	[rpm]	1	R/W M
Pr54	**Encoder-in rotation speed (read-only).** Indicates the input reference frequency translated into rpm (based on 4096 imp/revolution).	[rpm]	0	R
Pr55	**Window for servo-error 55.** If the position error as an absolute value exceeds the value set in Pr55 b70.4=1 otherwise is set to70.4 = 0.	[count]	1000	R/W M
Pr56	**Window for servo-error 56.** If the position error as an absolute value exceeds the value set in Pr56 b70.5=1 otherwise is set to70.5 = 0.	[count]	100	R/W M
Pr57	**Proportional gain for the position regulator**	0 ÷ 32000	100	R/W M
Pr58:59	**Value captured**. Value of Pr66:67 acquired on the positive front of the relevant input (refer to Pb70.0).	[count]	0	
Pr60:61	**Regulator position reference.**	[count]	0	R
Pr62:63	**Motor position** (resolver). If incremented by 4096 steps per revolution.	[count]	0	R
Pr64:65	**Position offset**.	[count]	0	R/W M
Pr66:67	**Encoder-in counter**.	[count]	0	R
Pr68:69	**Value captured**. Value of the position of the motor captured on the positive end of the input (X (0).	[count]	0	R
Pr106	**Feed forward scale**	0 ÷ 1000	0	R/W M

Par.	Description	Def.	Type/ Notes
Pb70.0	**Encoder in capture**. If set to zero, the master encoder value is captured by input 0, otherwise by the zero encoder track input.	0	R/W M
Pb70.1	**Feedback.** If = 0, feedback is done by the resolver, if set to one, the feedback is from the encoder; In this last case, the parameters Pr52 and Pr53 serve to rate the pulses per revolution at 4096.	0	R/W M
Pb70.2	**Feedback direction** . If = 1, the rotation of the motor is inverted. Only with feedback done by the resolver.	0	R/W M
Pb70.4	**Servo error**. B70.4 will be set to 1 if the position error as an absolute value exceeds the value set in Pr55.	0	R
Pb70.5	**Servo error**. B70.5 will be set to 1 if the position error as an absolute value exceeds the value set in Pr56.	0	R
Pb70.6	**Feed-forward enable**. If set to 1, the feed-forward on the position regulator is enabled.	0(*)	R/W M
Pb70.7	**Feed-forward scale enable**.	0	R/W M
Pb70.13	**Monitor error**. If set to one, Pr38 = Pr51 / 2^{Pr89} .	0	R/W M
Pb70.14	**Value master captured** If set to 1, this means that the value master has been captured. The user must reset the bit.	0	R/W M
Pb70.15	**Value motor captured** If set to 1, this means that the value motor has been captured. The user must reset the bit.	0	R/W M

(*) 1 for operative mode 14
0 for the other.

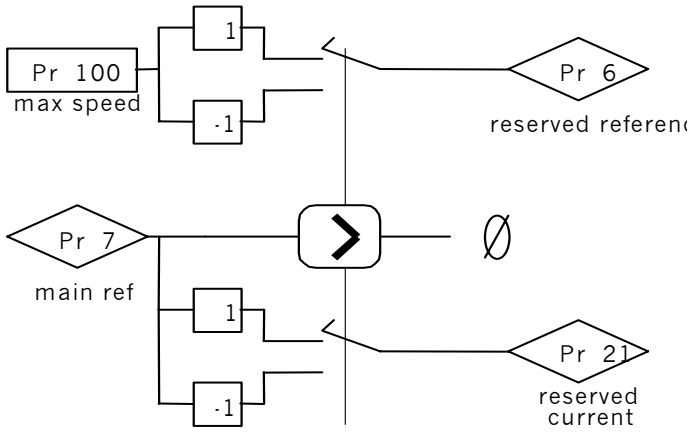
8.4 Torque control (operating mode 1)

This operating mode does not control the torque in the classic way since the speed control continues to work to control the speed limit. The torque reference will be the Pr7 main reference. To set up the torque control, you must first adjust the speed control in order to establish a stable system and then set Pr31 = 1 in order to program the operating mode by setting the default values with the command b 99.11. Set Pr2 = 1000 (10 V = 100.0 % of the torque), b40.0 = 0, b40.12 = 0, b40.2 = 1 to enable the reserved reference and Pr100 to limit the maximum speed of the motor.

OPERATING MODE 1 PARAMETERS

Par.	Description	Field/Unit	Def.	Type/ Notes
Pr100	**Maximum speed**. This parameter is used to limit the absolute maximum speed of the motor during the torque function.	0÷9000 [rpm]	3000	R/W M

opm 1 for SPDdrive



8.5 Electrical shaft + Positioner (operating mode 13)

Operating mode 13 includes the electrical shaft, dynamic positioner and flow speed functions in order to use them at the same time.
The tracking function refers to the input frequency signal (X42 connector) set as an input encoder signal by setting b42.0=0 and b42.5=1. This encoder signal is counted at every end of the communication of A and B signals. The counter of the motor position is incremented at the rate of 4096 steps per revolution. The user can program the ratio between the master and the slave by using parameters Pr52 and Pr53. It is possible to choose the ramp to use during the engaging or release phase (Pr103). The main ramps and the internal PLC can be used to program different engaging and release modes with or without phase recovery. See the connection diagrams in the section, Input frequency connection. If you use a digital input for the engaging command, the digital input 0 in FAST-IN mode must be used in order to minimize phase errors.
The positioner function follows a trapezoidal profile in which the acceleration and deceleration ramps are defined by Pr109, the full speed by Pr108 and the final position by Pr118:119 (one revolution of the motor equals 4096 steps). The parameters can be modified at any time. The current position of the positioner is given by the parameter Pr116:117. You can add a speed by using Pr104.

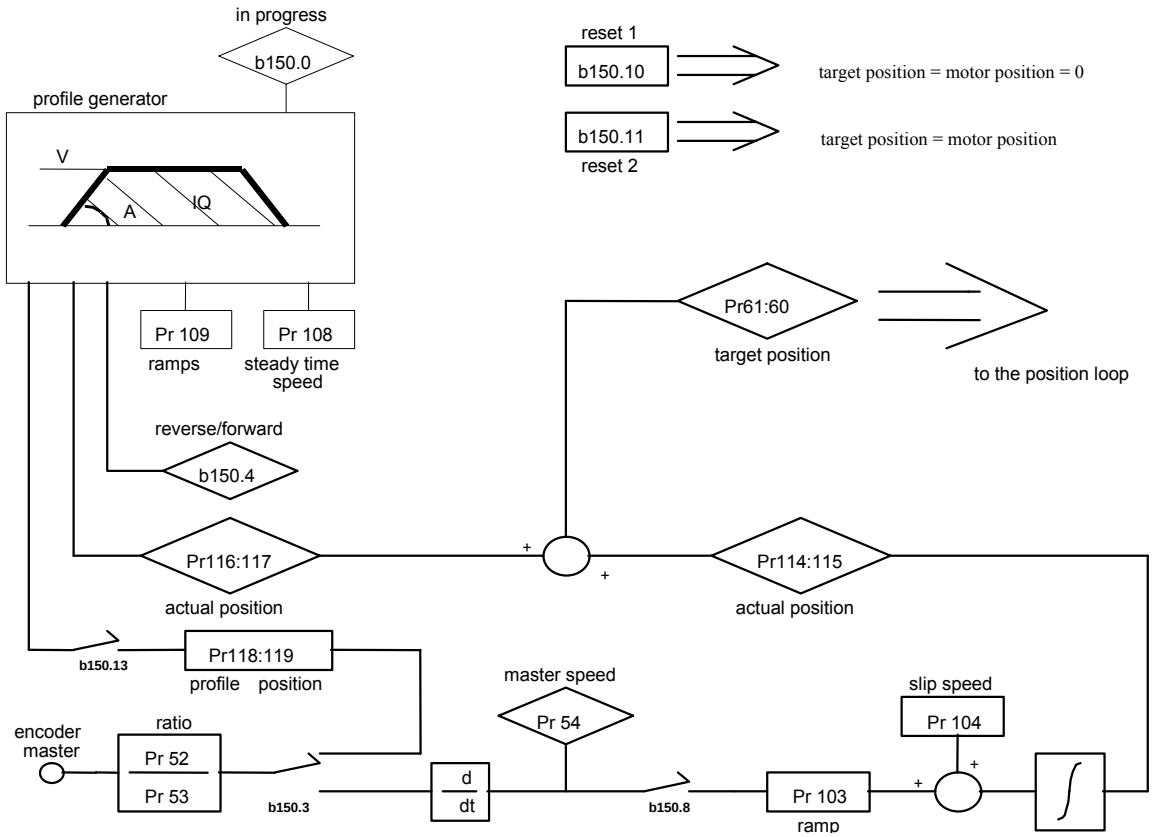
OPERATING MODE 13 PARAMETERS

Par.	Description	Field/Unit	Def.	Type / Notes
Pr103	**Acceleration and deceleration ramp (el. axis)**. The acceleration and deceleration required for the motor can be limited in order to achieve a jump of 1000 rpm that takes Pr103 thousandths of a second. This can be useful when the axis is suddenly attached.	0÷30000 [s/Krpm]	0,500	R/W
Pr104	**Addition speed.**	±6000	0	R/W
Pr108	**Full speed (positioner).** This is the full speed that will be used during the generation of the position profile.	0÷9000	1000	R/W
Pr109	**Acceleration time (positioner)**. This is the acceleration ramp that will be used during the positioning profile.	0,002÷30000 [s/Krpm]	0.5	R/W
Pr114 Pr115	**Actual position (electrical shaft).** Indicates the actual position with reference to the electrical shaft.	[counts]		R
Pr116 Pr117	**Actual position (positioner).** read-only parameter. Indicates the actual position with reference to the trapezoidal profile.	[counts]		R
Pr118 Pr119	**Final position (positioner)**. The parameter used to set the final position desired for the generator of the trapezoidal profile, based on 4096 steps per revolution.	[counts]		R/W

OPERATING MODE 13 BIT PARAMETERS

Par.	Description	Def	Type/ Notes
Pb150.0	**Active positioner.** During the positioning (Pr118:119 ≠ Pr116:117) this bit is high.	0	R/W M
Pb150.2	**Engaged electrical shaft**. During the engaging phase when the ramp (Pr103) is not 0, this bit indicates the end of the transitory phase.	0	R/W M
Pb150.3	**Encoder in selection**. If =0 the encoder input, conditioned by Pr52 and Pr53, used as master for digital lock function, if =1 directly updates Pr118:119 to execute the step like or pulses string function	0	R/W M
Pb150.4	**Profile direction.** Read-only flag. Indicates the direction of the motion of the positioner.	0	R M
Pb150.6	**Profile feedforward.** If set to one, disables the feedforward part caused by the trapezoidal profile generator.	0	R/W M
Pb150.8	**El axis engaging/release.** This bit it used to engage (= 1) and release (= 0) the axis from the input encoder reference.	0	R/W M
Pb150.10	**Type 1 reset** Command to set all the motor positions and references to 0.	0	R/W
Pb150.11	**Type 2 reset** Command that sets the position of the motor shaft (Pr62:63) to the main reference (Pr60:61) and of the positioner (Pr116:117) by setting that of the electrical shaft to 0.	0	R/W
Pb150.13	**Final position evaluation enable/disable (Pr118:119).** If 0, any modifications to Pr118:119 will not be considered.	1	R/W M

opm 13 for drive



8.6 Electronic cam (operating mode 14)

Operating mode 14 was expressly designed to meet the needs of packaging machines that require electronic cams. The table of the cam function is described with a vector composed of 257 elements, each of which indicates the position that must be assumed by the controlled axis when the master axis is in the position (element_number * master_module) / 256. The value of the elements of the vector falls within the range 0 – 9999, where 10000 corresponds to the number of counts set in the slave module parameter. The 257th element defines the cam as closed if it = 0, or as open if it = 10000.
The mode selector can be used to select the source for the position loop the possible sources are: no source, positioning, electronic cam and speed.
POSITIONING. The parameters that regulate movement are: target_pos, acc, speed. Target_pos indicates the absolute position that is to be achieved; if it is included in the movement direction module, it is given by the sign of the difference between target_pos and Pr60:61. Acc is the maximum acceleration allowed during the movement and speed is the maximum speed. The path generator will begin its work when the mode selector is set to 1, When the position has been achieved, the mode selector automatically returns to. Alternatively, the positioner module can be used to sum a phase on the master axis by setting target_pos based on the actual offset phase position Pr116:117. At the start the calculation of the path will be such as to guarantee continuity with the actual speed of the motor.

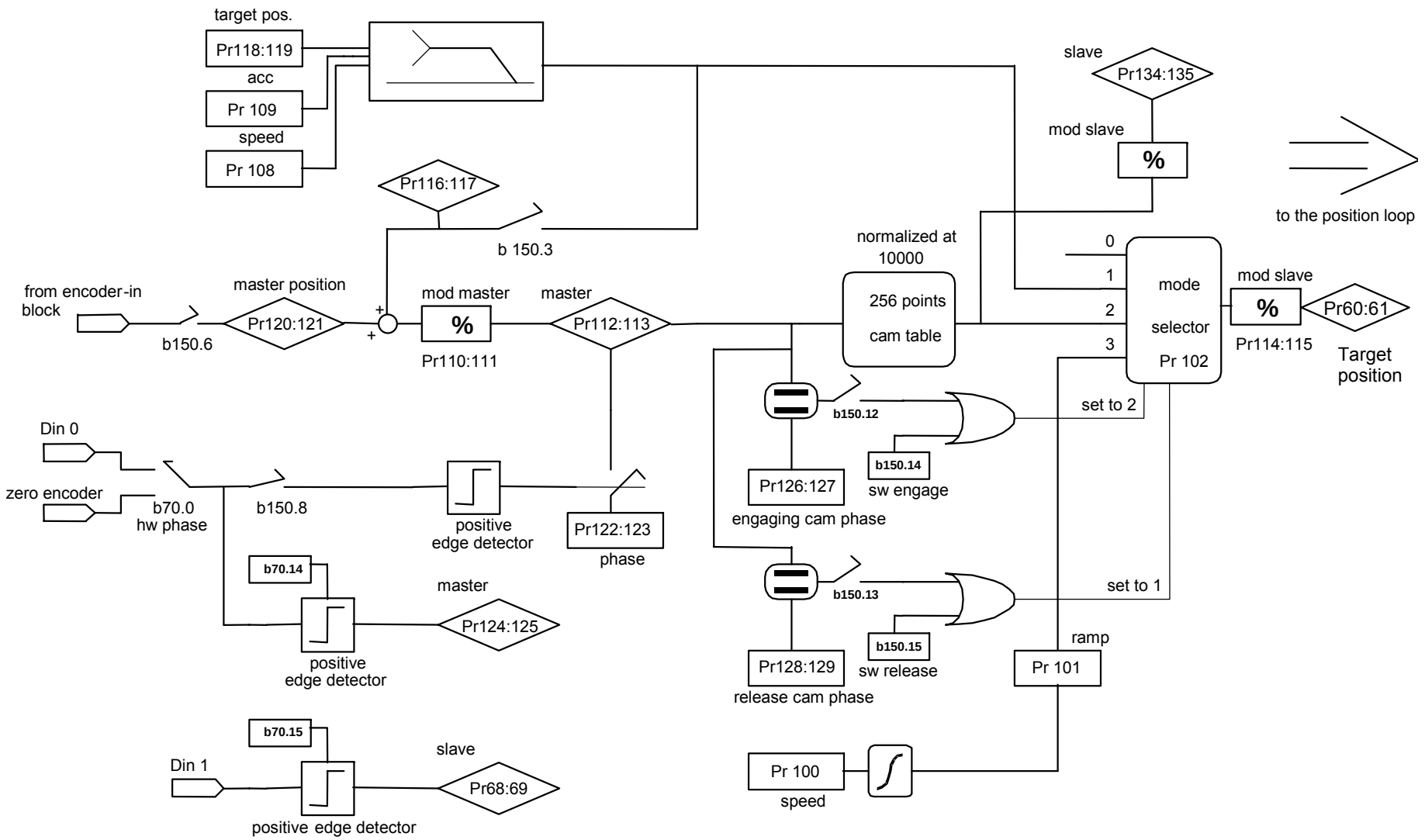
MASTER RE-PHASING. By setting the function (b150.8) the user can define the position of the master (Pr122:123) on the positive side of digital input 0 or of the zero trace encoder input (selector b70.0). b70.14 means that re-phasing was successful, and the user must set this flag to. For this function b42.0=0 (see chapter *Input/output connection in frequency*).
CAM ENGAGING. A master phase can be defined to which the selector will automatically be set to position 2 by enabling the cam module. A similar procedure can be used for release, In this case, when the release phase has been programmed, the positioner will be enabled to reach the desired position. The functioning of operating mode 14 is described in detail in the block diagram.
Coupling is also possible in phase with the linear ramp, using command b150.11. In this case, the master direction must be positive; setting b150.11=1 when the master Position reaches the value of Pr132:133 the slave starts to move following a linear ramp so as to cover the space defined by Pr136:137 when the master reaches point Pr126:127. In this point, the value of Pr134:135 must be equal to the Position reached by the slave at the end of the ramp, or at the beginning of the ramp the slave must be in advance relative to the phase coupling point, by a distance equal to Pr136:137. The bit B150.11 is reset at the beginning of the ramp setting b150.12=1. The continuity between the speeds (ramp and cam) is to be managed by the user.
Three functions are pre-defined that can be used to set the cam profile. By setting Pr102 = 5, the function is y = x, Pr102=6 the function is y = x-sinx, Pr102=7 the function is y = sinx where y is rated to 10000 on the 256 points of the cam. The compilation of the cam table is done in the background and at the conclusion Pr102 is set to 0. Make sure that if b40.2=0, the parameter Pr102 is nevertheless forced to 0.

Par.	Description	Field/Unit	Def.	Type/ Notes
Pr100	**Speed in speed mode.**	0÷±6000 [rpm]	0	R/W
Pr101	**Ramp time for Pr100.** This is the acceleration ramp that will be used by the speed mode.	0,002÷30000 [s/Krpm]	0,500	R/W
Pr102	**Function selector.** Enables the functioning as: a halted motor, positioning, electronic cam and speed.	0÷3	0	R/W
Pr103	**Pointer to the cam table.** Pr103 is used to access the cam table. Pr104 will contain the value of the Pr103th element in the table.	0÷257	257	R/W
Pr104	**Table element value.** Pr104 is the value of the Pr103th element in the table.	0÷10000	0	R/W
Pr108	**Full speed (positioner).** This is the full speed that will be used during the generation of the position profile.	0÷9000 [rpm]	1000	R/W
Pr109	**Acceleration time (positioner).** This is the acceleration ramp that will be used during the positioning profile.	0,002÷30000 [s/Krpm]	0.5	R/W
Pr110:111	**Master axis modul.** This is the value of the master axis module.	$0 \div 2^{18}$ [counts]	10000	R/W
Pr112:113	**Master axis position.** This is the present position of the master axis.	[counts]	0	R

Par.	Description	Field/Unit	Def.	Type/ Notes
Pr114:115	**Slave axis modul.**This is the value of the slave axis module.	0÷218 [counts]	10000	R/W
Pr116:117	**Offset master axis position**.	0÷223 [counts]	0	R
Pr118:119	**Final position (positioner).** Parameter to which the desired final Position must be set for the trapezoidal profile generator, considering 4096 steps per revolution.	[counts]	0	R/W
Pr122:123	**Master axis phase for release**. If b150.8 = 1 at the first positive front of digital input 0 or of the zero encoder input (see the block diagram), the position of the master axis become Pr122:123.	0÷223 [counts]	0	R/W
Pr124:125	**Master axis phase captured**. At each positive front of digital input 0 or of the zero encoder input *(see the block diagram)*, the position of the master axis is copied into in Pr124:125.	0÷223 [counts]	0	R
Pr126:127	**Master axis phase for engaging**. If b150.12 = 1, when the position of the master Pr112:113 exceeds Pr126:127, Pr102 is brought to position 2 and b150.12 returns to 0 to indicate that engaging has been achieved.	0÷223 [counts]	0	R/W
Pr128:129	**Master axis phase for release**. If b150.13=1, when the position of the master Pr112:113 exceeds Pr128:129, Pr102 is brought to position 1 and b150.13 returns to 0 to indicate that the positioner has been enabled and will control the release phase.	0÷223 [counts]	0	R/W
Pr132:133	**Cam coupling with ramp**. Defines the starting point of the coupling ramp relative to the master Position.	0÷223 [counts]	0	R/W
Pr134:135	**Slave position from cam**. Independently of selector Pr102, it indicates the position of the slave axis in output from the electronic cam.	0÷223 [counts]	0	R
Pr136:137	**Cam coupling ramp**. Defines the space to be covered during the coupling ramp in slave steps; the value must be less than half a slave module.	0÷215 [counts]	0	R/W

Par.	Description	Def	Type/ Notes
Pb150.2	**Position loop.** If 1, the Position loop works in absolute, otherwise in slave module.	0	R/W M
Pb150.3	**Master phase-shift command.** If = 1, the positioner module is used to change the phase between the master and the slave or as the generator of the virtual axis. When the final position Pr118:119 equals Pr116:117, this bit is automatically set to 0. Do not use this command together with Pr102=1.	0	R/W M
Pb150.6	**Enable encoder input**. If 1, enables the master encoder reading.	1	R/W M
Pb150.8	**Phase master axis enable.** If = 1, the copying of parameter Pr122:123 to Pr112:113 to the first front of the rise of input 0 or the zero encoder is enabled.	0	R/W M
Pb150.10	**Type 1 reset.** Command to set all the motor positions and references to 0.	0	R/W
Pb150.11	**Cam coupling with ramp**. Command to engage the cam movement when the master reaches the level of Pr126:127 through a linear ramp defined by parameters Pr132:133 and Pr136:137.	0	R/W M
Pb150.12	**Electronic cam engaging in phase**. Command to engage the cam movement when the master reaches the level of Pr126:127. This bit is automatically set to 0 when the command has been enabled.	0	R/W M
Pb150.13	**Electronic cam release in phase.** Command to release the cam movement when the master reaches the level of Pr128:129. This bit is automatically set to 0 when the command has been enabled.	0	R/W M
Pb150.14	**Immediate electronic cam engaging**. Command to engage the cam movement. This bit is automatically set to 0 when the command has been enabled.	1	R/W M
Pb150.15	**Immediate electronic cam release.** Command to release the cam movement This bit is automatically set to 0 when the command has been enabled.		R/W M

opm 14 for SPD drive



8.7 Position control through the CanBus (operating mode 15)

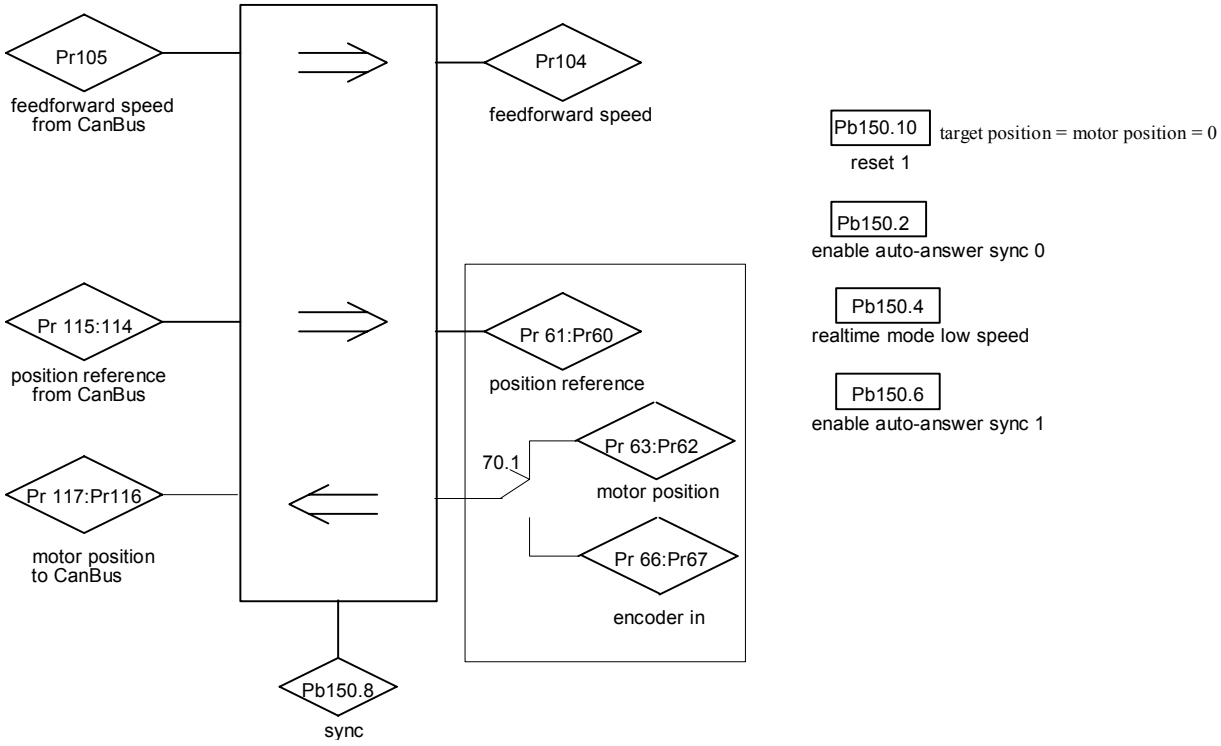
If the operating mode 15 is enabled, the SPD will execute a Position loop of proportional type with feed-forward, the profile generator is regarded as external and it will send the information regarding the position and speed reference via CANBUS, according to the SBCCAN protocol (see chapter *CANBUS*). If Pb70.1=0 the feedback is from resolver, if Pb70.1=1 the feedback is from encoder.

OPERATING MODE 15 PARAMETERS

Par.	Description	Field/Unit	Def.	Type/ Notes
Pr102	**CanBus status** (see the section on the *CANBUS*).		0	R/W
Pr103	**CanBus status** (see the section on the *CANBUS).*		0	R/W
Pr104	**Feed-forward spee**.The value of this parameter is summed at the output of the position loop in order to obtain the speed request Pr6.	0..±9000 [rpm]	0	R/W
Pr105	**Feed-forward speed via CanBus**. This is the feed-forward value received via the CanBus. When the SYNC (Pb150.8=1) is received, Pr105 will be copied to Pr104 and will become active.	[rpm]	0	R/W
Pr114:115	**Position reference via CanBus** This is the position reference received via the CanBus. When the SYNC (Pb150.8=1) is received, Pr114:115 will be copied to Pr60:61 and will become active.	[count]	0	R/W
Pr116:117	**Motor position via the CanBus** When the SYNC (Pb150.8=1) is received, Pr62:63 will be copied to Pr116:117 and, if feedback transmission has been enabled (b150.2=1), it will automatically be transmitted via the CanBus.	[count]	0	R/W

Par.	Description	Def	Type/ Notes
Pb150.2	**Feedback transmission enable**. If = 1, when the type 0 SYNC is received, Pr116:117 will be transmitted via the CanBus.	0	R/W
Pb150.3	**Reply status.** In the cyclic reply message, if b150.3=0 the status consists of the 16 bit of Pr103, otherwise by the first 8 bit 5 only	0	R/W
Pb150.4	**Low speed mode.** Default=0. In the case Pr48=0: if equal to one, sets the speed of the operating mode of the CANBUS real time to 500kbps, .	0	R/W
Pb150.6	**Feedback transmission enable**. If = 1, when the type 1 SYNC is received, Pr116:117 will be transmitted via the CanBus.	0	R/W
Pb150.8	**Sync type 8 bits.** The command via the CanBus of synchronism sets b150.8 to 1, thereby allowing the torque of Pr105 on Pr104, Pr115:114 on Pr61:60 and Pr63:62 on Pr117:116. The references of the position control are updated and after this procedure b150.8 is automatically set to 0.	0	R/W
Pb150.10	**Type 1 reset.** Command to set the motor positions and reference to 0.	0	R/W
Pb150.11	**Type 2 reset.** Command that sets the motor position and the reference to the position of the motor shaft Pr28 and Pr64:65 to 0.	0	R/W
Pb150.12	**Type 3 reset.** Command that copies the motor position to the reference and sets Pr64:65 to 0.	0	R/W

opm 15 for SPD drive



9 Start up and calibrations

9.1 First SPD start up

When the drive is started for the first time, of after giving the command "load default parameters" the message **dEF** is shown on the display, to indicate the converter status.
At this point, the main parameters must be set for the motor connected to each axis. The basic parameters are:

Pr29	Number of motor poles	N.
Pr32	Rated speed of the motor	rpm.
Pr33	Rated current of the motor	A
Pr34	Number of resolver poles	N.
Pr46	Phase-phase motor resistance	ohm
Pr47	Phase-phase motor inductance	mH

After setting the motor parameters, the operator must give the data saving command, Pb99.15. the drive shall calculate the correct values of Pr2, Pr3, Pr16, Pr17, Pr18, Pr19 and shall save the parameter. The drive shall not calculate the values if during this procedure there is an error. At this point the basic parameters cannot be modified. If you want to change one or more parameters, set Pb94.3=1, the converter will show the alarm "dEF", and after updating the parameter value, you must save again by Pb99.15.

9.2 First commissioning of the drive

The steps to be followed carefully the first time the converter is used are given below.

1. Check that the connections have been implemented based on the provided diagrams and instructions.
2. Make sure that the converter is shut off (pin 6 of the terminal board).
3. Power the converter on
4. the IdLE message appears on the screen
5. Set the analogue reference to 0 V (pin 25, 26 of the terminal board) and power the converter on (24 V at pin 6 of the terminal board).
6. At this point the motor shaft should be stopped. Any change in the voltage of the analogue reference should produce a proportional change in the speed of the motor. If this does not happen, control the cabling.

The drive enabling bit (Pb41.5) can be set with a logical input <u>only</u> through the picoPLC, or directly through serial or canbus

The converter comes with default values pre-defined that satisfy most applications. In the default status the pico-PLC in the converter runs the program (described in *Appendix*) and the following functions will be set at the input/output connectors:

inputs	
6	Converter on (24V - on) IN
7	Stop / Start (24V – Stop) IN
outputs	
11	Drive OK (24V - ok) OUT
12	Motor Overloaded (i^2t) OUT

9.3 Speed control adjustment

9.3.1 Some important concepts

SPEED LOOP: The main task of a converter is to control motor speed so that it follows as faithfully as possible the speed request that is generally known as the REFERENCE. Faithfully following the reference means that the motor speed should equal the reference in static conditions and also that the motor speed is as equal as possible to the speed requested during dynamic conditions. To carry out this task, the converter must know some of the features of the motor used and the mechanical part attached to it. This information is communicated to the converter by using the so-called ADJUSTMENT PARAMETERS.
ERROR: The error is the difference between the reference speed and the motor speed. The size of the error is used by the speed loop in order to evaluate how much current must be supplied to the motor, based on the adjustment parameters.
TORQUE: The current that circulates in the windings of the motor is transformed in torque, thereby allowing the motor to accelerate or decelerate.
GAIN: Given the typical applications of the converter, when we speak of gain in this document we refer to the rigidity of the axis, better known as the STIFFNESS. To better illustrate what stiffness means, we can imagine a motor controlled by a converter with a requested speed of 0. The motor shaft will appear immobile, but if we apply a torque to the shaft, it will demonstrate an angle that is proportional to the torque applied. Suppose we apply the rated torque of the motor and measure the stiffness in degrees. The degrees measured will be the index of the quality of the regulator as parameterized. Clearly, it is not only the index of quality.

9.3.2 What is needed

To adjust a converter correctly, an oscilloscope with memory must be used. A technician who can use it to carry out the operation will also be needed. If it is not possible to use an oscilloscope, a more approximate but applicable adjustment method will be illustrated at the end of this section.

9.3.3 Before starting

Study the diagram below carefully (Fig. 1):

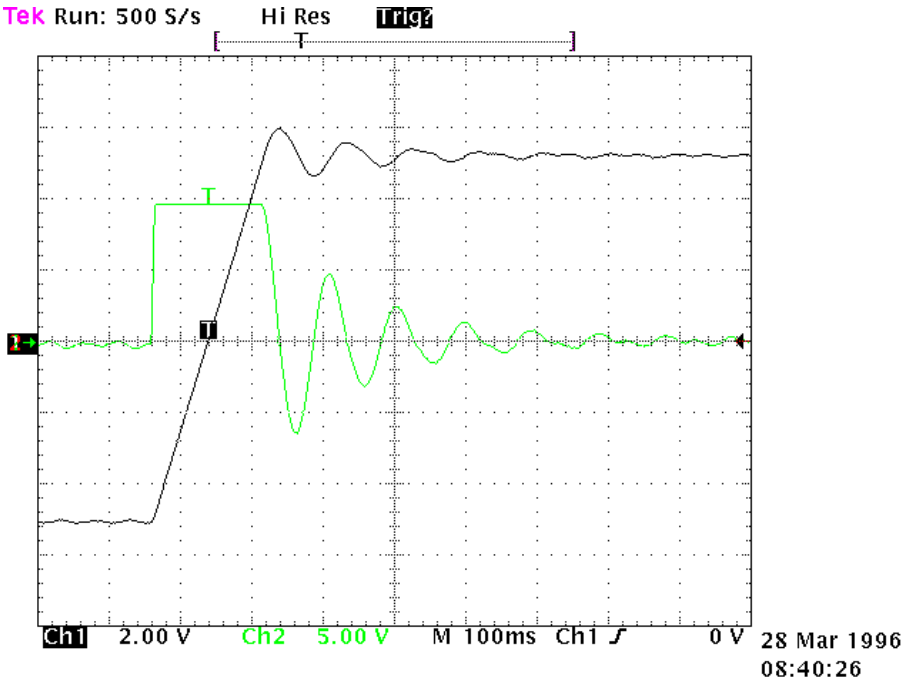


Fig. 1

This diagram shows the response of the system to a square wave speed reference. Channel 1 (Ch1) represents the speed and channel 2 (Ch2) the current of the motor. In the practice, the probe has been connected to the terminal (Vout), The two traces cannot be seen at the same time, but the trace to be displayed can be programmed using the binary parameter Pb42.4. The V/div scale and the time basis will not be discussed here since they can vary greatly.

9.3.4 ESTIMATING THE Pr16 e Pr17

Before turning the converter on, the user should estimate the value of Pr16. The value of Pr16 is what defines the gain of the system. To convert the value of Pr16 into grades per rated torque, the formula to be used is the following: $\alpha = \frac{Pr33*100}{Pr16*Ipd} \cdot 28$ where α represents the stiffness and Ipd is the peak current of the drive. Before using the formula, Pr33 must be set with the correct value of the rated current of the motor. To evaluate the correct value of α let's consider that, if the mechanical part to be moved is rigid (non-elastic) and if there is no transmission play, the optimal stiffness would be about 4 degrees. If the mechanical part is not rigid enough, it could be necessary to reduce the gain. If the torque of the motor has been sized in order to obtain strong acceleration, but during the operation, the disturbing torques are very low, it is possible to choose stiffness angles of 20, 30 or 40 degrees, thereby maintaining acceptable performance. If it is difficult to choose the proper stiffness angle, the

user can begin with 10 degrees that is the default adjustment if a motor with the same rated current as the converter's is used.
At this point, let us set the Pr16 to the estimate and turn on the axis with a square wave reference. (Danger: the reference amplitudes and frequencies must be selected carefully to prevent problems if the axis is with limited stroke). If we look at the oscilloscope, we can note that as the Pr17 changes, the response changes too; for decreasing values of Pr17, the system response shall be as shown in figure 2.

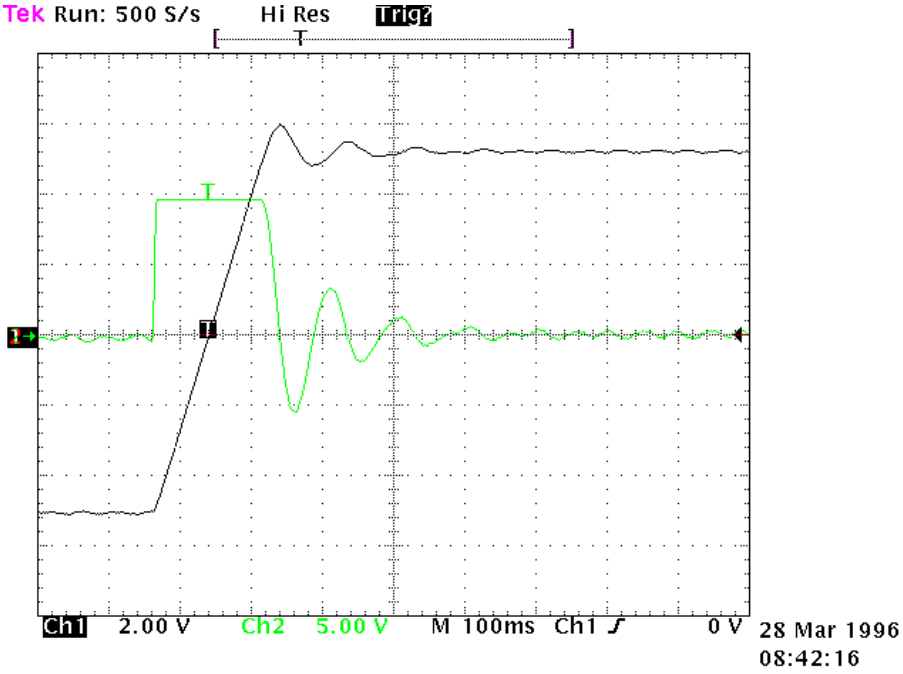


Fig.2

For increasing values of Pr17, the response of the system will be similar to what is shown in figure 3 below:

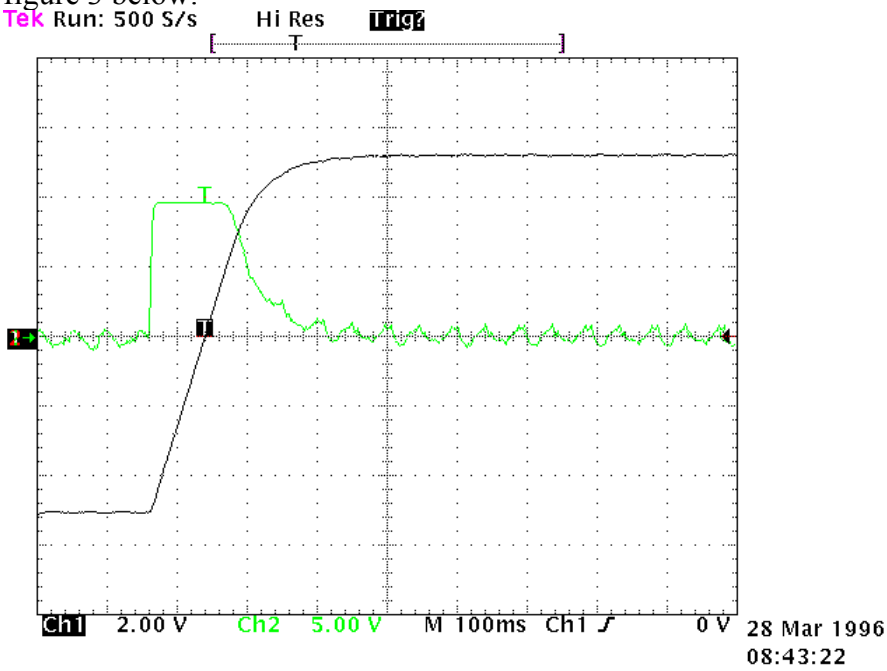


Fig.3

The optimal value of Pr17 will be attained with a response of the system as shown in figure 4 below:

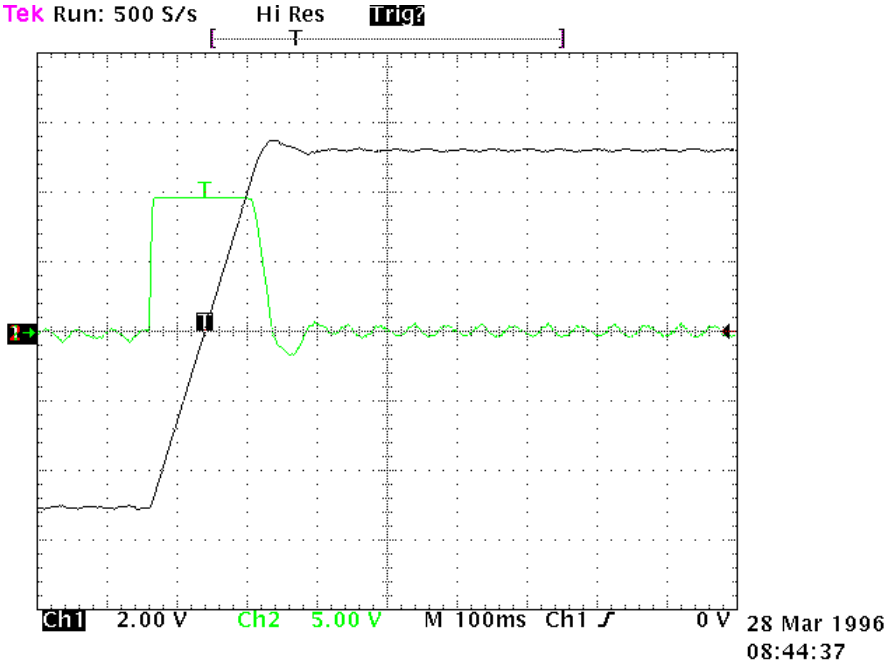


Fig. 4

An overshoot of about 10% must be obtained. It is important that after the overshoot, an undershoot does not occur.

Once the optimal value of Pr17 has been established, we must analyse the movement of the axis. If it moves without vibrations and acoustic noise, the adjustment of the system is complete. .

In some applications it is possible to reduce acoustic noise by using a higher value of Pr18. Figure 5 shows that once the optimal adjustment has been achieved, there is also an oscillation of the current that can produce acoustic noise and mechanical vibration. By raising the value of Pr18 to 9, the situation is much improved (fig. 6).

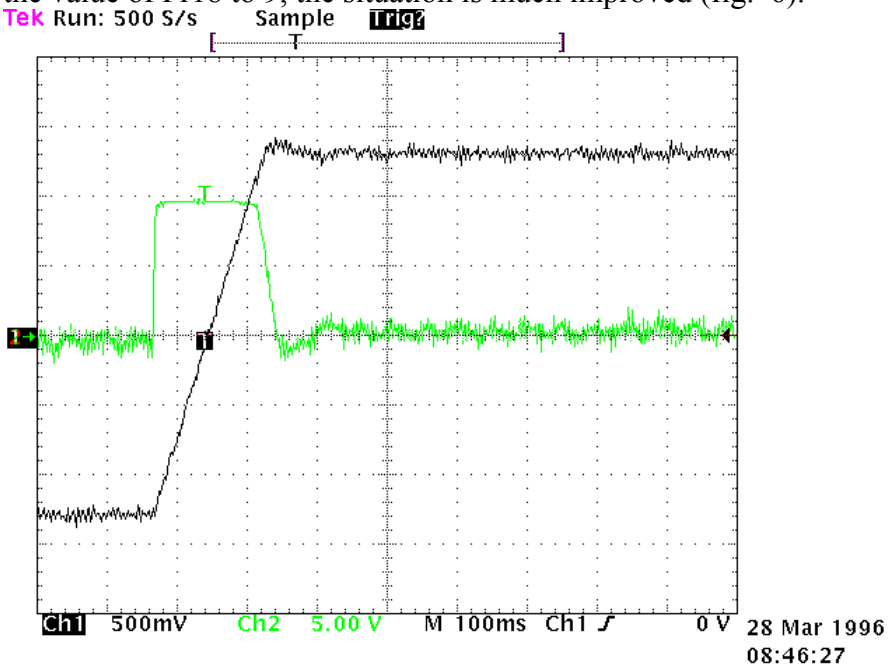


Fig. 5

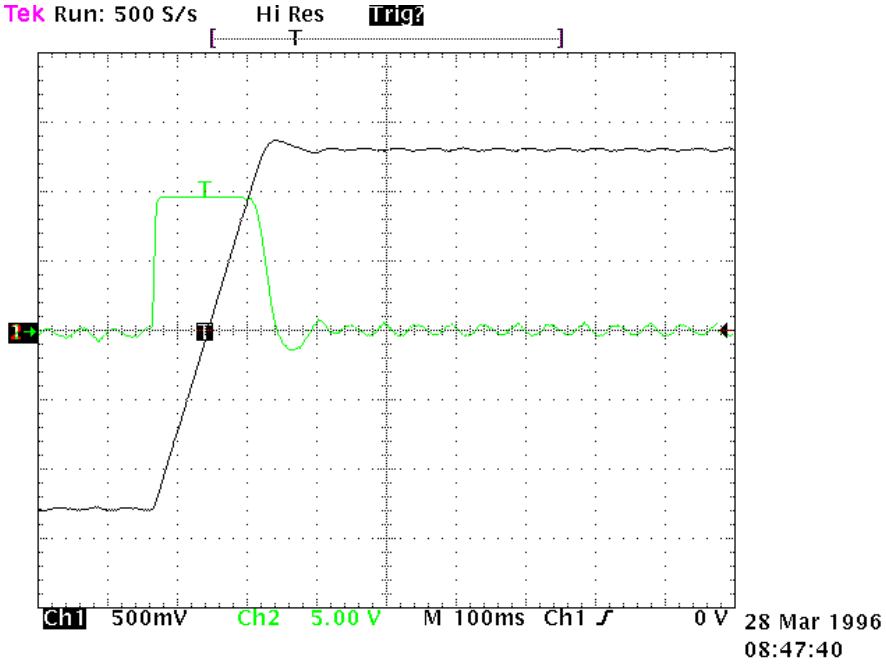


Fig. 6

If mechanical parts are used which very easily tend to enter into oscillation, we recommend you use very low values of Pr16. In this configuration the SPD typically dampens the torque request of the motor in order to avoid triggering mechanical oscillations. This configuration is shown in figure 7.

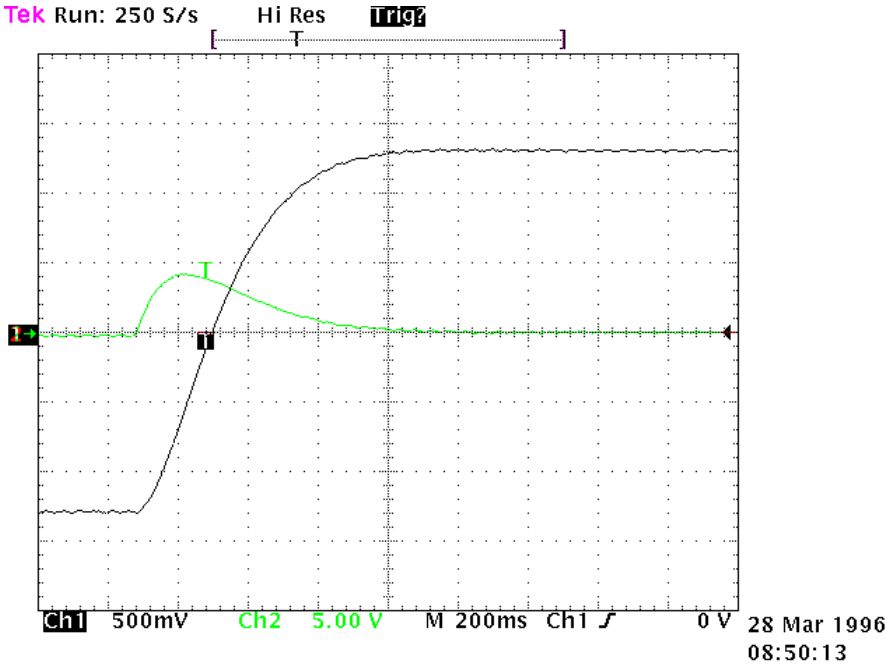


Fig. 7

9.3.5 Adjustment without using instrumentation

If you do not have an oscilloscope, you must:

Determine the value of Pr16 as described above.
Determine the Pr17 parameter by using the following formula:

$$\mathrm{Pr17} = 1488 \cdot \sqrt{\frac{153.41 \cdot \mathrm{Pr16} \cdot J_{tot}}{Nm_{picco}}}$$

where: $\mathrm{J}_{\mathrm{tot}}$ is the total inertia (motor + load) expressed in kgm^2

$\mathrm{Nm}_{\mathrm{picco}}$ is the available torque with the peak current of the converter.

Turn on the converter and use the external control to move the axis. Move Pr17 to find the value where the axis seems to move best.
Estimate the value of Pr18 by using the following formula:

$$\mathrm{Pr18} = 0.68 \cdot \frac{\mathrm{Pr17}}{\mathrm{Pr16}}$$

If the result is less than 1 it must be set to 1.

If the adjustment is not satisfactory, repeat the procedure with lower values of Pr16.

10 Programming digital inputs/outputs

10.1 The pico-PLC

The internal pico-PLC is used to connect the external world (inputs/outputs) with the world of the parameters of the drive. The PLC can be used to copy digital input to a binary parameter, to copy a binary parameter to a digital output and to execute mathematical and Boolean operations. The PLC program must be inserted as a list of instructions by using the keyboard To change the instructions Pb99.13 must be set to zero. The default parameter setting (Pb99.12) corresponds to a PLC program (see *Appendix*) written for a large number of applications. In most cases it is not necessary to program the PLC itself.

The main features of the pico-PLC are:

Program steps	**128**
scanning time	**6,144 ms**
number of timers	**2**
number of instructions	**15**
stack depth	**1**
mathematical operations	**16 / 32 bits**
fast inputs	**2 - (512 μs)**

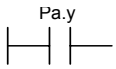
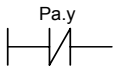
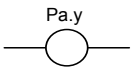
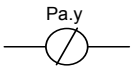
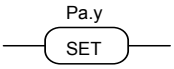
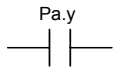
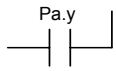
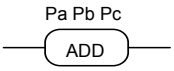
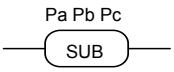
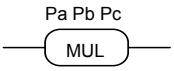
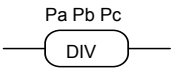
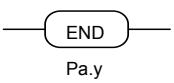
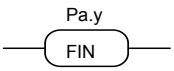
10.2 Decimal parameters PLC

Par.	Description	Field/Unit	Def.	Type/ Notes
Pr 71	**Constant value=-1** Double Word		-1	R/W
Pr 72	**Constant value=0** Double Word		0	
Pr 73	**Constant value=1** Double Word		1	
Pr 74	**Constant value=2** Double Word		2	
Pr 75	**Constant value=10** Double Word		10	
Pr76	**Constant value= 100** Double Word		100	
Pr 77	**Constant value = 1000.** Double word.		1000	
Pr 78	**Constant value = 1024.** Double word.		1024	
Pr 79	**Constant value = 4096.** Double word.		4096	
Pr 80÷89	**Free parameters.** Parameters that can be stored and available to the user (word).	+/-32767	0	R/W M
Pr 92	**First timer of the PLC** , if equal to zero, Pb99.0=1.	0÷32767	0	R/W
Pr 93	**Second timer of the PLC** , if equal to zero Pb99.1=1.	0÷32767	0	R/W
Pr151÷Pr163	**Free parameters.** Parameters that can be stored and available to the user (word).	+/-32767	0	R/W M

10.3 Bit parameters of the pico-PLC

Par.	Description	Def.	Type/ Notes
Pb90.X	**Status of digital input X**. If X is greater than 3, this is a bit that can be stored by the user (b90.0 = converter enabled).		R/W M
Pb91.Y	**Status of digital output Y.** If Y is greater than 1 this is a bit that can be stored by the user. Parameter Pb91 is not saved and is set to 0 when the unit is powered on.		R/W
Pb94.0	**Force a double word formatted operation**. When the unit is powered on, this is 0. If it is set to 1, the first mathematical operation executed by the pico-PLC is done by using three double word type operands. After the execution of the operation b94.0 is automatically set to 0. If Pr58..Pr68 Pr110...Pr148 are used, the double word formatting is implicit.		R/W
Pb94.5	**First fast input disabl (94.5=1)**. When the unit is powered on, this is 0.		R/W M
Pb94.6	**Second fast input disable (94.6=1)**. When the unit is powered on, this is 0.		R/W M
Pb99.0	**Status of the first timer** Equal to 1 if Pr92 = 0.	1	R/W
Pb99.1	**Status of the second timer** Equal to 1 if Pr93 = 0.	1	R/W
Pb99.2	Equal to 1 if the result of the last PLC operation is negative.		R/W
Pb99.3	Equal to 1 if the result of the last PLC operation is 0.		R/W
Pb99.13	**PLC status.** Default=1. If set to 1, the PLC program is executed, If 0, the program is not executed, but the PLC instructions can be modified.	1	R/W M

10.4 pico-PLC instructions

	**LD**	**Pa.y**	loads the y bit of the Pa parameter on the stack
	**LDN**	**Pa,y**	loads the negated y bit of the Pa parameter on the stack
	**OUT**	**Pa,y**	sets the y bit of the Pa parameter to the value loaded on the stack
	**OUTN**	**Pa,y**	places the y bit of the Pa parameter to the value of stack negating it
	**SET**	**Pa,y**	if the stack = 1, the y bit of the Pa parameter is set to 1
	**RES**	**Pa,y**	if the stack = 1, the y bit of the Pa parameter is set to 0
	**AND**	**Pa,y**	if the bit loaded on the stack contains the result of the logical AND operation between itself and the y bit of the Pa parameter
	**ANDN**	**Pa,y**	the bit of the stack contains the result of the logical AND operation between itself and the y bit of the negated Pa parameter
	**OR**	**Pa,y**	the bit loaded on the stack contains the result of the logical OR operation between itself and the y bit of the Pa parameter
	**ORN**	**Pa,y**	the bit on the stack contains the result of the logical OR operation between itself and the y bit of the negated Pa parameter
	**ADD**	**Pa, Pb, Pc**	if the bit on the stack = 1, the addition operation is executed on the parameters in which: Pc = Pa + Pb
	**SUB**	**Pa, Pb, Pc**	if the bit on the stack = 1, the subtraction operation is executed on the parameters in which: Pc = Pa - Pb
	**MUL**	**Pa, Pb, Pc**	if the bit on the stack = 1, the multiplication operation is executed on the parameters in which: Pc = Pa · Pb
	**DIV**	**Pa, Pb, Pc**	if the bit on the stack = 1, the division operation is executed on the parameters in which: Pc = Pa / Pb
	**END**		end of program
	**FIN**	**y, 0/1**	input with fast scanning

10.5 Functional description

The pico-PLC program scan occurs every 6.144 milliseconds, thus with this sampling the inputs are read first, then the two timers are updated (Pr92 Pr93 Pb99.0 and Pb99.1), the user program is scanned and the outputs are finally updated. For this reason reading the input and setting the output can vary by 6.144 ms with respect to the physical event. If the microprocessor is overloaded with work (the operating mode is active, there are frequent serial requests and the PLC program is long), it may take more than 6.144 milliseconds to scan the entire PLC program.
All the instructions of the pico-PLC with the exception of the arithmetic instructions are single bit instructions. The available stack has a depth of only one bit.
The LD (LDN) instruction loads the bit defined as the operant on the stack with all the other logical instructions work on the stack itself. The arithmetic instructions are executed only if the stack bit is set to 1.
The truth table for the logical operations is given below for the convenience of the user.

AND logical operation		
bit A	bit B	result
0	0	0
0	1	0
1	0	0
1	1	1

OR logical operation		
bit A	bit B	result
0	0	0
0	1	1
1	0	1
1	1	1

The respective negative operations ANDN and ORN follow the same logic except that the negated value of the bit specified will be used.
12 bits from b90.4 to b90.15 are reserved on the PLC and can be stored. 14 additional bits from b91.2 to b91.15 are available on the PLC but cannot be stored. They are always set to 0 when the converter is powered on.
10 more word parameters are reserved, in particular from Pr80 to Pr89, which can be stored and used as 5 parameters double word, as well as 13 more parameters from Pr151 to Pr163.
The pico-PLC includes 9 constants for arithmetic operations. These are from Pr71 to Pr79 and can be the constants most used by normal applications.
When the arithmetic operations (ADD, SUB, MUL, DIV) are used, the operators are assumed to be words and are signed. If a double word operation is required, set b94.0 = 1 before the operation itself. After the operation the PLC will automatically set this bit to 0. The parameters Pr60...Pr69 and Pr110...Pr149 are treated as double words so that in an operation such as [ADD 71 72 64] the result –1 will be written in the double word Pr64:65 without having to set b94.0=1 before the operation 94.0=1. If Pr80=-1 and Pr81=0 the operation [ADD 80 72 64] will give the result Pr64:65=-1, while the same operation executed with b94.0=1 will assume Pr81 as the high word of the double word Pr80:81 and the result will be Pr64:65=65535. In the first case, operators other than Pr60...Pr69, Pr110...Pr149 are treated as words, while in the second case they are treated as double words.
In the mathematical operations on double words, the operands and the result are defined as follows: the parameter of the operand defines the least significant part while the most significant part is represented by the next word.
After every arithmetic operation, b99.2=0 if the result is positive and b99.2=1 if it is negative. In the same way b99.3=0 if the result is 0 and b99.3=1 if it is not 0.

These settings remain active until the next arithmetic operation is executed (the operation is executed only if the stack bit is equal to 1). A mathematical operation can be executed by placing the result in one of the constant parameters (Pr71...Pr79) in order to set bit b99.2 and b 99.3.
If the DIV operation is executed on a double word, the most significant part of the result contains the remainder of the division, that is, if b94.0=1 and the operation [DIV 79 77 80] is executed, the result will be Pr80=4 and Pr81=96.

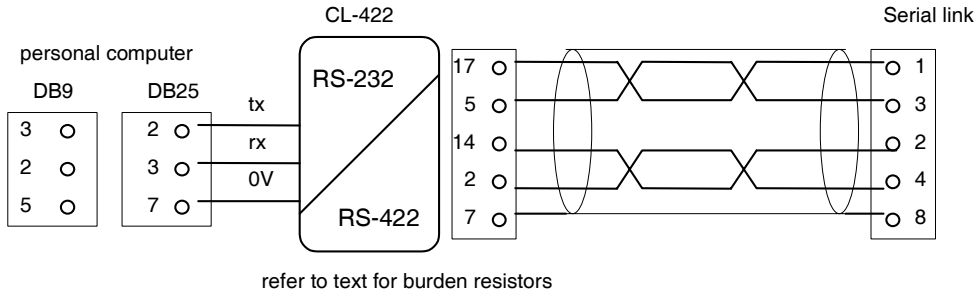
The FIN instruction. Two instructions are available for the fast acquisition of inputs: in this case the scanning occurs at the rate of 512μs (normal scanning is at the rate of 6.144ms). If this is used, they must be the first instructions of the PLC. The first instruction FIN copies digital input 0 to the y bit of the Pb40 parameter (the second operand =0) or Pb150 (the second operand=1). The second FIN copies digital input 1 to the y bit of the pPb40 parameter (second operand=0) or Pb150 (second operand=1). If the value 2 is added to the second operand, the input must be negated before being copied. If an FIN instruction is inserted in a different position, it will not have any effect. The FIN instructions can be enabled/disabled using a bit for each FIN: 1° FIN abilitato se Pb94.5=0;2 FIN abilitato se Pb94.6=0. The FIN instruction inserted in the PLC program after the first two instructions and in any case if it follows any instruction that is not a FIN instruction is ignored.

The user can make use of two timers, Pr92 and Pr93. To use the first timer load the time as a number of sampling (6.144 ms) into PR92. For example, Pr92=100 is equal to 614 milliseconds. Pr92 will automatically be decremented as time goes by and the b99.0 bit will remain set to 0 until the timer has expired. When Pr92=0 then Pb99.0=1. The second timer works the same way using the PR93 parameter and the b99.1 bit 99.1. Pr92, Pr93, b99.0 and b99.1 are updated only before the pico-PLC program is scanned.
The maximum number of instructions is 128. The arithmetic operations occupy the space of two logical operations. If they are used, the maximum number of instructions accepted is reduced.
The PLC program must always end with the END instruction.
The pico-PLC program can be edited on a PC or directly using the keyboard. In this last case, in order to facilitate the modification of the program, if you want to delete an instruction, go to the instruction to be deleted and hit the [M] key. The type of instruction is then displayed. By holding down the [M] key and pressing the [-] key, the instruction will be deleted when both keys are released. If you want to add an instruction after the In06, go to the next instruction In07 and hit the [M] key. The type of instruction is then displayed. By holding down the [M] key and pressing the [+] key, the FIN instruction will be inserted when both keys are released. In this last case make sure that the program does not exceed the maximum limit of the instructions, otherwise the last instructions will be lost. The pico-PLC program can be edited or modified only when the PLC is in stop (b (99.13=0).

11 Programming the drive by PC

It is available a **serial kit** is supplied to enable communication between a PC and the drive. The kit includes an RS-422/RS-232 converter, relative 230V~ power supply and serial connection cable. The enclosed communication software (supplied free of charge) designated MotionWiz has the following HW/SW requirements: PII microprocessor or higher, **Windows98* or more recent version, mouse and serial port for drive connections. The main features of Motion Wiz are:

- serial connection of up to 32 drives
- reading and setting of basic parameters and drive commands
- reading and setting of commands and parameters of operating modes
- functional block diagrams
- pico-PLC program displayed as text format
- display of pico-PLC program status during operation
- I/O status
- file storage of parameterisation including pico-PLC program
- uploading of parameterisation including pico-PLC program from a file that can be selected from among those previously stored
- oscilloscope function



To create line load (burden) resistances, jumper pins 2 and 6, and pins 4 and 7 on connector X3 of the last drive on the serial line.

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11.1 MotionWiz

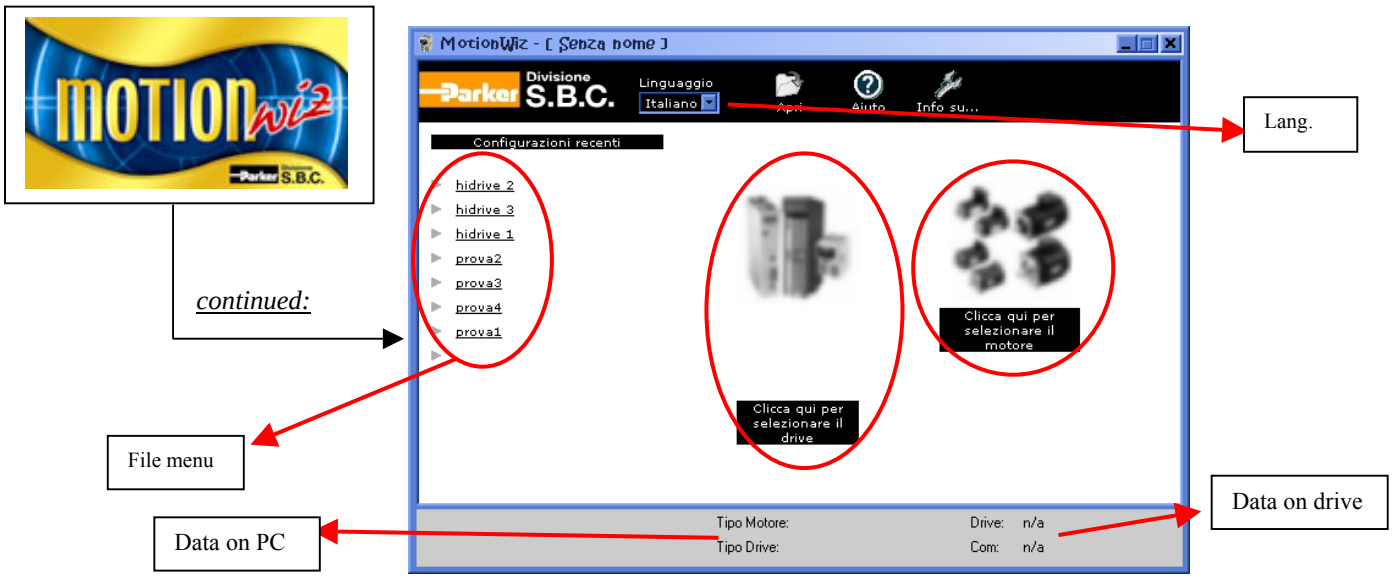
The configuration tool is called "MOTIONWIZ" and is used to program the drive while controlling the whole system in real time. PLC programs can also be edited and new files can be generated.
The first step is to install the program*:
click on the icon "SetupMotionWiz.exe"



Follow the instructions that appear during the installation . An icon linking to the program will be generated on your desktop at the end of the installation process :



Click on the icon to start the configuration program. The following window will be displayed on your monitor:



It is possible to select the desired language: Italian or English.
How to generate a new file:
to set the data for motor and drive, use the databases provided by the software, that can be accessed through the icons below the figures (when the drive and the motor pictures are out of focus, it means that the relevant data have not been set yet).
Press "**ENTER**" to access the configuration functions.
How to use an existing file:
the "*file menu*" shows a list of most recent files. To open a file, click on a name in the list Alternatively, using the "**Open**" tab it is possible to "search" previously stored files selecting the relevant route.



* The MotionWiz program can be found on the CD rom supplied with the drive or downloaded from our website: www.sbcelettronica.com

12 Diagnostics, alarms, troubleshooting

The drive is provided with a diagnostics program that allows the user an easier troubleshooting. The alarms immediately lock the drive. The error code is displayed on the keypad intermittently and corresponds to parameter Pr23. In Pr24, the last detected alarm is stored, except for that relating to under-voltage (2) which could occur upon every switching off. In this way, if the drive is automatically disconnected from the mains after an alarm, through Pr24 it is possible to assess the alarm that has caused the lock.

Alarms are of the non-returning type (except for UV, under-voltage, which has a programmable return): if an alarm has tripped, it remains stored also when the problems determining it has been solved. To deactivate the alarms, remove the problem first, by identifying the type of fault with the aid of the following table and carrying out the recommended actions, and then reset through the Pb99.10. Alarms can also be reset by disconnecting the logics or turning off and on again the drive.

12.1 Summary of alarm and diagnostics use bit parameters:

Par.	Description
Pb99.10	**Command to reset alarms.** This command sets Pr23 and Pr24 to 0. The bit is set to 1 on the keypad, "reset" is displayed and then returns to zero, if the alarm persists, it remains on the display. This command cannot be used if there is a check-sum error (Pr23 = 10, 11). In this case, it is necessary to set the default parameters (b99.12) and then reset the alarm. **Danger**: Recovering default parameters deletes the previous parameter calibrations.
Pb99.8	**UV auto reset.** Default=0. If set to 1, the under-voltage alarm will automatically be set to 0 when power returns.
Pb41.7	**External alarm**. An alarm that can be used by the user.
Pb41.8	**Auxiliary alarm**. A second alarm that can be used by the user. These two alarms can be reached through the PLC. The drive lock can be performed by loading a logical input or an event associated to a bit parameter of one of these alarms. All of these alarms can only be reset through Pb99.10.
Pb41.4	**Converter O.K.** , otherwise =0 . It can be used by the PLC to activate a logical fault reporting output.

12.2 Alarm codes

Alarm code (Pr23, Pr24)	Alarm	Description
0	No alarm	
1	Overvoltage	On the D.C. link; check the power supply three-phase line (max 480V); the braking circuit and the braking resistance
2	Undervoltage	Check that no phase is missing
3	Overcurrent	Check the motor connections and any phase-phase and phase-ground short circuits
4	Resolver alarm	Check connections and connectors at both sides (drive-motor).
5	Motor overtemp.	Check the PTC motor connection on pins: check setting of Pr33 (Inom) and Pr19 (Ipicco).
6	Converter overtemp.	Check the cooling fans, if any, and any air flow clogging. Check the braking cycle and the internal panel temperature where the drive is mounted.
7	External alarm	
8	Auxiliary alarm	
10	PLC check sum	
11	Parameter check sum	
15	default parameters	Enter all main parameters and save them upon start-up
16	Adjustment error	
TripP.x	With numerical "x"	Indicates that the converter has malfunctioned.

13 SERIAL INTERFACE

The serial communication of the converter is half-duplex, master-slave, using an asynchronous RS-485/RS-422 line. The converters take control of the line only if interrogated by the master.
The same serial line can be connected to up to 32 converters by setting a different serial address in each to the Pr27 parameter. It is also possible to set the transmission speed by using the Pr26 parameter as specified in the table below:

Pr26 (decimal base)	b/s	time-out (ms)
0	600	512
1	1200	256
2	2400	128
3	4800	64
4	9600 (*)	32
5	9600	32
6	19200	16
7	38400	12
8	57600	8

(*) The version with code Pr26=4 differs from Pr26=5 for the delay of the response of 25 ms. This version has been developed to interface with the PLCs that require such a feature.
For the connection diagrams, see the section, Connecting the serial line.

13.1 Communication protocol

The column on the right in the table above shows the time-out value expressed in milliseconds for each communication speed. This is the time within which the message must be sent, beginning from the start of each message (STX). If a message is interrupted after this time, the converter ignores what has been received and waits for the beginning of a new message. The message consists of several consecutive bits. The format of the bits is the following:

1 start bit
8 bit of data defined by a following byte enclosed within brackets
1 parity bit (even)
1 stop bit

The structure of the message is the following:
[STX] [CMD+ADDR] [BK+LUN] [PAR] [D0]... [Dn] [CHK]
where:
[STX] = $7E indicator of transmission start. If a field in the message different from STX assumes the value $7E, this field is followed by a 0 ($00) so that it will not be interpreted as an [STX].
[CMD+ADDRESS] = command and address of the device. This data is composed in the following way: the first 5 bits (bits 0-4) define the address of the converter (from 0 to 31); the remaining 3 bits (bits 5-7) define the type of message sent, as described in the following table:

CMD	bit 7	bit 6	bit 5	type of message
1	0	0	1	converter response
2	0	1	0	reading a pico-PLC instruction
3	0	1	1	writing a pico-PLC instruction
4	1	0	0	reading a parameter
5	1	0	1	writing a parameter
6	1	1	0	bit modification
7	1	1	1	writing a parameter to all the slaves

[BK+LUN] = the LUN field (first 3 bits) indicates the number of bytes of the data transmitted (a parameter or a PLC instruction); the values can range from 1 to 4. This value does not include eventual 0 characters ($00) which are inserted after the values that coincide with the character of transmission start ($7E). The length of every parameter is of 2 byte.
The BK field occupies the most significant 5 bit and represents the most significant 5 bit of the parameter address.
[PAR] = write/read address of the PLC parameter or instruction.
The parameter address is the number of the parameter *2 su 13 bit: PAR represents the less significant 8 bit of the address. The table used for the electronic cam is allocated from address 4096 on. The PLC INSTRUCTIONS occupy the area from address 0 to 255.
[D0]... [Dn] = data transmitted.
[CHK] = 256 module sum of all the fields excluding the [STX] (checksum).

13.2 Message types

[CMD1] = is the response message of the converter to a data request. The response message has the following format:

[STX] [001+ADDR] [BK+LUN] [PAR] [D0]... [Dn] [CHK]

or it can be the confirmation message to a data write or data modify. In this case, the format is the following:
[STX] [001+ADDR]
where ADDR always identifies which converter is answering.

[CMD2] = is the read message of an instruction in the PLC area. The message has the following format:
[STX] [010+ADDR] [BK+LUN] [PAR] [CHK]

[CMD3] = is the write message to an instruction in the PLC area. The message has the following format:
[STX] [011+ADDR] [BK+LUN] [PAR] [D0]... [Dn] [CHK]

[CMD4] = is the read message of a parameter. The message has the following format:
[STX] [100+ADDR] [BK+LUN] [PAR] [CHK]

[CMD5] = is the write message of a parameter. The message has the following format:

[STX] [101+ADDR] [BK+LUN] [PAR] [D0]... [Dn] [CHK]

[CMD6] = is the change bit message of a byte parameter. The message has the following format:
[STX] [110+ADDR] [BK+LUN] [PAR] [D0] [D1] [CHK]
In this case LUN=2 or else two bytes are sent for the data. The first byte is the mask containing the 0s in the positions of the bits to be changed and 1s in the other positions, while the second byte contains 1s in the positions of the bits that are to be set to 1 and 0s in the other positions. The PAR address is that of the parameter (byte) where one or more bits are to be modified. If the parameter is a word and the bit to be modified is one of the first 8 (b0...b7): PAR = the parameter address; otherwise, if the bit to be modified is one of the upper 8 (b8...b15): PAR = the address parameter + 1.

[CMD7] = is the write message of a parameter to all converters connected to the serial line. The message has the following format:
[STX] [11100000] [BK+LUN] [PAR] [D0]... [Dn] [CHK]
The address of the peripheral device (ADDR) must be 0.

Notes:

- The parameters that are represented on the screen with decimals must be treated as complete values. For example, a value of 978.5 is read and written as 9785.
- All values that are receded by the $ symbol are to be understood as hex numbers.
- The value included inside the brackets identifies the base unit (byte) of the message.
- All messages must be terminated with a time-out which is a function of the speed, well defined to be considered valid and must have the exact parity and checksum.
- The converter responds to a request or to a data send only if the message has been received correctly. In the case of an error in the message, no response is transmitted. The only exception is message type 7 that is used to send data with a single message to all the converters connected to the serial line.

13.3 Initialising and managing the serial line

The converter is delivered with a 0 address (Pr27=0) and a speed of 9600 bps (Pr26=5).
To modify the configuration, first set the speed in Pr26, then the serial address in Pr27 and finally initialise it by issuing the command b42.3. Use the b99.15 command to store the configuration.

Each pico-PLC instruction occupies 2 or 4 bytes whose format is the following:
Since the maximum length of each instruction in 2 bytes and the total area available in the PLC is 256 bytes, the PLC program can have at the most 128 instructions.

Instruction	Code	Length (in bytes)
LD Pa.y	0	2
LDN Pa.y	1	2
OUT Pa.y	2	2
OUTN Pa.y	3	2
AND Pa.y	4	2
ANDN Pa.y	5	2
OR Pa.y	6	2
ORN Pa.y	7	2
ADD Pa, Pb, Pc	8	4
SUB Pa, Pb, Pc	9	4
MUL Pa, Pb, Pc	10	4
DIV Pa, Pb, Pc	11	4
SET Pa.y	12	2
RES Pa.y	13	2
FIN Pb40.y/Pb150.y	14	2
END	15	2

The first 4 bits (b0..b3) of the first byte in each instruction contain the instruction code.
In the first 8 instructions in the table (LD… ORN) and the SET and RES instructions, the remaining 4 bit of the first byte (b4..b7) contain the value y, while the second byte contains the value Pa.
In the ADD, SUB, MUL e DIV instructions, the second byte contains the value Pa, the third byte the value Pb, and the fourth byte the value Pc.
In the END instruction, the second byte is not used.
In the FIN instruction, the fifth bit (b4) of the first byte selects the parameter: b4=0 if it refers to Pb40, b4=1 if it refers to Pb150; the sixth bit (b5) of the first byte is used for logical negation: b5=0 the bit is copied, b5=1 the bit is negated before being copied. The second byte of the FIN instruction contains the value of y.
If the FIN instructions are used, they must be the first instructions of the program and cannot be more than 2, . If a FIN instruction is inserted beginning at the 4h address or after any other instruction, the FIN instruction does not function and is ignored (NOP).
The instructions must follow each other beginning at address 0h and no byte can be left empty.
There is only one program and it is terminated with the END instruction.

13.4 Examples of using the serial line

In order to better understand how to implement the communication protocol on the serial line, some examples of each type of message are given below.
The values indicated are only indicative as examples.

First example: reading a 1 byte parameter
Suppose we want to read the value of the parameter Pr25 (release software) and that its value is 43. Suppose also that the converter has the serial address 0. The message to be sent is the following:
[$7E][$80][$01][$32][$B3]

The converter responds with the message:
[$7E][$20][$01][$32][$2B][$7E][$00]

Second example: reading a 2 byte parameter
Suppose we want to read the reference speed (Pr7) and that its value is 2000. Suppose also that the converter has the serial address 1. The message to be sent is the following:
[$7E][$81][$02][$0E][$91]
The converter responds with the message:
[$7E][$21][$02][$0E][$D0][$07][$08]

Third example: reading a 1 byte parameter
Suppose we want to select operating mode 1 (Pr31). Suppose also that the converter has the serial address 3. The message to be sent is the following:
[$7E][$A3][$01][$3E][$01][$E3]
The converter responds with the message:
[$7E][$23]

Fourth example: reading a 2 byte parameter
Suppose we want to set the rated current to 2.5 A (Pr33). Suppose also that the converter has the serial address 3. The message to be sent is the following:
[$7E][$A3][$02][$42][$19][$00][$00]
The converter responds with the message:
[$7E][$23]

Fifth example: setting a bit to 1
Suppose we want to send the command to save the PLC program (b99.14=1). Suppose also that the converter has the serial address 0. The message to be sent is the following:
[$7E][$C0][$02][$C7][$BF][$40][$88]
The converter responds with the message:
[$7E][$20]

Sixth example: setting a bit to 0
Suppose we want to disable the converter via software (b40.9=0). Suppose also that the converter has the serial address 0. The message to be sent is the following:
[$7E][$C0][$02][$51][$FD][$00][$10]
The converter responds with the message:
[$7E][$20]

Seventh example: reading a PLC instruction
Suppose we want to set the first instruction of the PLC as: LD 90.4; Suppose also that the converter has the serial address 0. The message to be sent is the following:
[$7E][$60][$02][$00][$40][$5A][$FC]
The converter responds with the message:
[$7E][$20]

14 SBC Can

A CanBus interface based on the physical layer ISO/DIS11898 is included on the SPD converter. The Data link layer is the full CAN version 2.0 part A (ID 11 bit) and a subset of the application layer SBCCAN is used.

The CanBus on the SPD has two functional modes.

The first functional mode is **real time mode**. This is to establish a real time digital link between 15 SPDs and a control that executes the calculation of the trajectories and sends the position reference, the speed reference or both to the SPDs which can change the actual position of the motors (b150.2=1). Real time mode is active when Pr31=15.

The second functional mode is **communication mode**. This is used to write or read every parameter of each SPD connected to the bus (maximum of 15). This function is very useful when you want to sue the motion functions that have already been realized in the base software of the SPD. Communication mode is automatically set when Pr31≠15.

The CanBus node must be set through Pr27 with values from 0 to 14 (*).

Transmission speed depends on Pr31, Pr48 e b150.4 as the following table:

Pr48	Pr31≠15	Pr31=15	b150.4	Max. length
0	125 kbps	1 Mbps	0	
0	125 kbps	500 kbps	1	
1	1 Mbps			40 m
2	500 kbps			100 m
3	250 kbps			250 m
4	125 kbps			500 m
5	50 kbps			1000 m
6	20 kbps			2500 m
7	10 kbps			5000 m

For bus length greater then about 1000 m bridge or repeater devices may be needed.

All changes in speed, address or function mode are activated using the b42.3 command or when the converter is powered on again.

(*) In the messages via CanBus, the node number is identified through Pr27+1, i.e. with values from 1 to 15

14.1 Description of the fields in real time mode

Cyclic message from the master to the SPD

Cyclic data															
Data length			8 bytes												
Field Name			Data												
Contents			position ref. bits							speed ref. bits			Pr102		
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	0	0	1	1	A3

A0:A3 SPD slave address (Pr27+1), valid values 1..15.
Pr102 is used as a command and must be managed by the pico-PLC.
The received data are interpreted as follows, based on the message length:

Data length			
8	Position reference (4 byte)	Speed reference (2 byte)	Pr102 (2 byte)
6	Position reference (4 byte)	Pr102 (2 byte)	
4	Speed reference (2 byte)	Pr102 (2 byte)	

Synchronism message from the mast to the SPD

Synchronism message															
Data length			3 bytes												
Field Name			Sync							no meaning					
Contents			Sync type 8 bits							no meaning 16 bits					
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
0	0	0	X	X	X	X	X	0	0	0	0	0	0	0	0

Type 0 synchronism (Sync = 0): every SPD activates the speed references and the position references and stores the actual position of the motor; if b150.2=1 the drive answers with a "*cyclic reply*".

Type 1 synchronism (Sync = 1): stores the actual position of the motor; if b150.6=1 the drive answer with a "*cyclic reply*".

Cyclic message from the SPD to the master

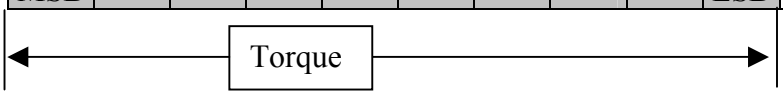
Cyclic reply															
Data length			6 bytes												
Field Name			Address			Data						Status			
Data			Pr27+1			motor position 32 bits						Pr103			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	1	0	1	0	A3

A0:A3 SPD slave address (Pr27+1), valid values 1..15.

The Pr103 parameter is used as the status, if b150.3=0 all the 16 bits are sent, if b150.3=1 only the first 8 bits are sent.

If b150.0=1 the message is 8 byte long, and it isn't dependet on b150.3; Pr103 made up of 16 bit. When b150.1=1, the message has the following information:

Byte 1								Byte8							
7bit	6bit	5bit	4bit	3bit	2bit	1bit	0bit	7bit	6bit	5bit	4bit	3bit	2bit	1bit	0bit
MSB									LSB			In3	In2	In1	In0



Multiple cyclical message from Master to SPD

MultiCyclic data															
Data length			2 bytes												
Field Name			Data												
Contents			speed ref. bits			speed ref. bits			speed ref. bits			speed ref. bits			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
0	A1	A0	X	X	X	X	X	0	0	0	0	1	1	1	0

This message contains several data which are sent to several slave drives. One data (speed reference) is addressed for one drive, based on an addressing logic. The following table shows which information (speed reference, Pr105) is sent to which drive, based on the A0:A1(=group address) value.

A0:A1	**Speed reference 0**	**Speed reference 1**	**Speed reference 2**	**Speed reference 3**
0	Drive 1	Drive 2	Drive 3	Drive 4
1	Drive 5	Drive 6	Drive 7	Drive 8
2	Drive 9	Drive 10	Drive 11	Drive 12
3	Drive 13	Drive 14	Drive 15	

Multiple synchronism message from Master to SPD

MultiSynchronism message															
Data length			1 bytes												
Field Name			Data												
Contents			Command 0			Command 1			Command 2				Command 3		
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
0	0	0	X	X	X	X	X	0	0	0	0	0	1	0	0

Each drive receives and executes the speed reference and saves the actual motor position; if b150.2=1 the drive answers with a "*cyclic reply*".
This message is for several drives. The following table shows to which drive the "Command" (Pr102 – first 8 bit) is sent to.

Drive	**Command0**	**Command 1**	**Command 2**	**Command 3**
Drive1	YES			
Drive2	YES			
Drive3		YES		
Drive4		YES		
Drive5			YES	
Drive6			YES	
Drive7				YES
Drive8				YES
Drive9	YES			
Drive10	YES			
Drive11		YES		
Drive12		YES		
Drive13			YES	
Drive14			YES	
Drive15				YES

Each command is made up of 8 bit (Pr102) and it is sent to several drives. Each command value is set by the user through the pico-PLC of each drive.

Acyclic data write message or parameter request from the master to the

Acyclic data write or request															
Data length			7 bytes												
Field Name			Cmd & Len					Data Address					Data		
Contents			5 bit command and 3 bit length					16 bit data address					32 bit data		
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	0	1	0	0	A3

A0:A3 SPD slave address (Pr27+1), valid values 1..15.

Cmd & Len	**Sub-field**	**Value**	**Meaning**	
	Cmd [0..4]	0	Read request	
		1	Write	
		2	SET bit	Pr = Pr .OR. Data
		3	RESET bit (.NOT.Data)	Pr = Pr .AND.
		4	TOGGLE bit	Pr = Pr .XOR. Data
		5 – 31	Not use	
	Len [5..7]	0- 4	Number of significant bytes in the data field	

Data Address
This is the address of the parameter interested in the operation (parameter number * 2).
The PLC instructions have the address from 8192 up to 8447.
The electronic cam table have the address from 4096 to 4610.

Data
If the parameter is written, it contains the value of the parameter.
If one or more bits are modified, it contains the mask of the bits to be modified.
If the parameter is to be read, the field has no meaning.
If plc programme is written, it contains the instruction code (see the section *Serial interface*).

Acyclic response message to a parameter request from the SPD to the master

Data reply															
Data length			5 bytes												
Field Name			Addr & Spare					Data							
Contents			Pr27+1					32 bit reply data							
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	1	1	0	0	A3

A0:A3 SPD slave address (Pr27+1), valid values 1..15.

Broadcast write parameter message from the master to the SPD

Broadcast data write															
Data length			7 bytes												
Field Name			Cmd & Len					Data Address					Data		
Contents			5 bit command and 3 bit length					16 bit data address					32 bit data		
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
1	1	1	X	X	X	X	X	0	0	1	0	0	0	1	1

Cmd & Len	**Sub-field**	**Value**	**Meaning**	
	Cmd [0..4]	0	Not used	
		1	Write	
		2	SET bit	Pr = Pr .OR. Data
		3	RESET bit (.NOT.Data)	Pr = Pr .AND.
		4	TOGGLE bit	Pr = Pr .XOR. Data
		5 – 31	Not used	
	Len [5..7]	0- 4	Number of significant bytes in the data field	

Data Address
This is the address of the parameter interested in the operation (parameter number * 2).
The PLC instructions have the address from 8192 up to 8447.

Data
If the parameter is to be written, it contains the value of the parameter.
If one or more bits are modified, it contains the mask of the bits to be modified.
If plc programme is written, it contains the instruction code (see the section *Serial interface*).

Alarm message from the SPD to the master

Error															
Data length			3 bytes												
Field Name			Address					Error							
Contents			Pr27+1					Pr23							
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	1	0	0	0	A3

A0:A3 SPD slave address (Pr27+1), valid values 1..15.

If the converter is in the alarm status, it will send this message on the bus (alarm 0 = no alarm).

To evaluate the minimum sampling time, use the following formula:

$$Tc_{min} = (Nr + Nt + 5) * 0.12$$

where: Tc_{min} is the minimum sampling time in milliseconds
Nr is the number of SPDs that receive the reference
Nt is the number of SPDs that transmit the feedback
The constant 0.12 is valid for 1 Mbps bus speed

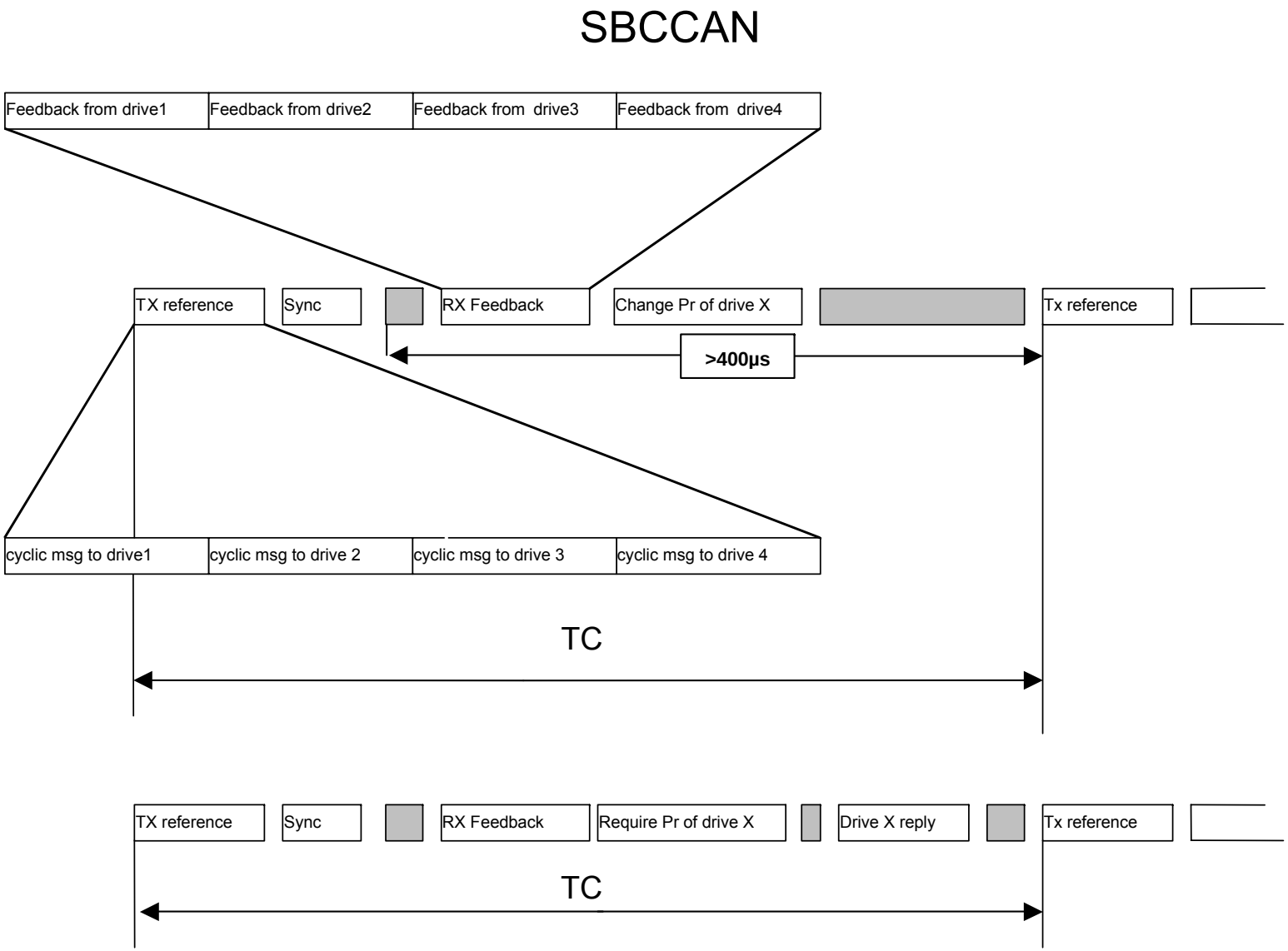
Note 1: bit 41.15 can be used in "real time mode"; bit 41.15 is set to 1 every synchronism and multisynchronism message receiving via SBCCAN.
Therefore, it is possible to check the communication status between Master and Slave via CanBus through a simple pico-PLC program.
The pico-PLC code on the drive be as follows:

```
…
Ld 41.15
Out 41.5
Rst 41.15
…
```

If the check of the communication status between Master and Slave via CanBus is implemented into the drive pico-PLC, the test is executed every 6.144 [ms] (i.e. minimum execution time of pico-PLC program) or multiples.
Attention: both Pr103 (Status) and Pr102 (Command) must be set through a specific pico-PLC program into each drive.

Note 2: the Master can send the new reference data only if at least 400 [µs] passed from the last synchronism message, or if the response message has already been received.

The typical timing of the SBCCAN in real time mode is shown in the diagram on the next page:


SBCCAN
Feedback from drive1
Feedback from drive2
Feedback from drive3
Feedback from drive4
TX reference
Sync
RX Feedback
Change Pr of drive X
Tx reference
>400µs
cyclic msg to drive1
cyclic msg to drive 2
cyclic msg to drive 3
cyclic msg to drive 4
TC
TX reference
Sync
RX Feedback
Require Pr of drive X
Drive X reply
Tx reference
TC

14.2 Description of the fields in communication mode

Write or parameter request message from the master to the

data write or request															
Data length			7 bytes												
Field Name			Cmd & Len					Data Address					Data		
Contents			5 bit command and 3 bit length					16 bit data address					32 bit data		
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	0	1	0	0	A3

A0:A3 SPD slave address (Pr27+1), valid values 1..15.

Cmd & Len	**Sub-field**	**Value**	**Meaning**	
	Cmd [0..4]	0	Read request	
		1	Write	
		2	SET bit	Pr = Pr .OR. Data
		3	RESET bit (.NOT.Data)	Pr = Pr .AND.
		4	TOGGLE bit	Pr = Pr .XOR. Data
		5 – 31	Not used	
	Len [5..7]	0- 4	Number of significant bytes in the data field	

Data Address
This is the address of the parameter interested in the operation (parameter number * 2).
The PLC instructions have the address from 8192 up to 8447.
The electronic cam table have the address from 4096 to 4610.

Data
If the parameter is written, it contains the value of the parameter.
If one or more bits are modified, it contains the mask of the bits to be modified.
If the parameter is to be read, the field has no meaning.
If plc programme is written, it contains the instruction code (see the section *Serial interface*).

Response to a parameter request message from the SPD to the master

Data reply															
Data length			5 bytes												
Field Name			Addr & Spare					Data							
Contents			Pr27+1					32 bit reply data							
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	1	1	0	0	A3

A0:A3 SPD slave address (Pr27+1), valid values 1..15.

Broadcast write parameter message from the master to the SPD

Broadcast data write															
Data length			7 bytes												
Field Name			Cmd & Len					Data Address					Data		
Contents			5 bit command and 3 bit length					16 bit data address					32 bit data		
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
1	1	1	X	X	X	X	X	0	0	1	0	0	0	1	1

Cmd & Len	**Sub-field**	**Value**	**Meaning**	
	Cmd [0..4]	0	Not used	
		1	Write	
		2	SET bit	Pr = Pr .OR. Data
		3	RESET bit	Pr = Pr .AND. (.NOT.Data)
		4	TOGGLE bit	Pr = Pr .XOR. Data
		5 – 31	Not used	
	Len [5..7]	0- 4	Number of significant bytes in the data field	

Data Address
This is the address of the parameter interested in the operation (parameter number * 2).
The PLC instructions have the address from 8192 up to 8447.

Data
When the parameter is written, it contains the value of the parameter.
If one or more bits are modified, it contains the mask of the bits to be modified.
If plc programme is written, it contains the instruction code (see the section *Serial interface*).

14.3 Description campi Extended message set #2

The set 2 extended message allows the exchange of memory areas between the master and the SPD both in communication and in real time mode. Data exchange is synchronous and the master transmits data to all SPD, which store them to a temporary buffer; then, the master transmits the synchronism message. When the drives receive this message, they copy the data blocks received from the temporary buffer to the parameter area and reply by sending their sets of parameters to the master.

Data transmission message from Master to SPD

The master sends data to the SPD using the following message:

Block send															
Data length	8 bytes														
Field Name	Data														
Contents	64 bit of data														
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	1	0	0	0	0	0	1	A3

A0:A3 Address of the drive, valid values 1..15.

Data synchronism message

Block sync															
Data length	0 bytes														
Field Name															
Contents	No data														
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
0	0	0	X	X	X	X	X	1	0	0	0	0	0	0	0

Received data are stored from Pr80 to Pr83 and the parameters are transmitted from Pr84 to Pr87 using the following message:

Response message from SPD to Master

Block reply															
Data length			8 bytes												
Field Name			Data												
Contents			64 bit of data												
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	1	0	0	0	0	1	0	A3

A0:A3 Unit address of the drive, valid values 1..15.

Note 1: as for the "real time mode", bit 41.9 is set to 1 every synchronism message receiving via SBCCAN.
Therefore, it is possible to check the communication status between Master and Slave via CanBus through a simple pico-PLC program.
The pico-PLC code on the drive be as follows:

```
…
Ld 41.9
Out 41.5
Rst 41.9
…
```

If the check of the communication status between Master and Slave via CanBus is implemented into the drive pico-PLC, the test is executed every 6.144 [ms] (i.e. minimum execution time of pico-PLC program) or multiples.

15 CAN Open

An alternative to the SBCCAN protocol is CANopen (to be expressly requested when placing your order: the drive may only have one protocol at a time) with the following implementations and functions:
The following objects are available based on CANopen's Pre-defined Connection Set:

Objects	Function code	COB-Ids	Index
NMT object	0000	0x00	-
EMERGENCY objec	0001	0x81-0xff	0x1014
SDO (tx) object	1011	0x581-0x5ff	0x1200
SDO (rx) object	1100	0x601-0x67f	0x1200
NMT Error Control (Node guarding)	1100	0x701-0x77f	0x100c- 0x100d

NMT object:

NMT state machine (DS301)

NMT Error Control & Boot Up Protocol:

- Boot Up
- Node Guarding – 39.14=1 for each receipt

EMERGENCY object :

Below is a description of emergency object implementation:

Emergency message dal Drive al master

Emergency message															
Data length			8 byte												
Field Name			Error code			Err. Reg		Drive address				Data			
Contents			16 bit code			8 bit error		8 bit address				32 bit reply data			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	1	A6	A5	A4	A3

A0:A6 Drive address (Pr49), valid values 1..127.
An alarm message and two pop-up messages are available for this object, and each of these can be enabled or disables by setting the appropriate commands.
- Alarm message (enabled if b150.1=1)
- Target position reached (enabled if b150.5=1)
- Value motor captured (enabled if b150.7=1)

The alarm message, if enabled, is sent each time that the current alarm status (Pr[23]) changes, so that when a new alarm occurs (or when the alarms are reset) the value 0x01 is sent to the field Err.Reg, and the least significant byte of the Data field will contain the drive's alarm code.

The field Error Code will contain a specific code based on the different drive alarm:

- Er01	(over voltage) :	0x3210
- Er02	(under voltage) :	0x3220
- Er03	(over current) :	0x2340
- Er04	(encoder break) :	0x7303
- Er05	(over tempeature motor) :	0x4110
- Er06	(over tempeature drive):	0x4310
- Er07	(aux trip 1) :	0xff00
- Er08	(aux trip 2) :	0xff01
- Er10	(checksum PLC) :	0x6310
- Er11	(checksum Parametri):	0x6310
- Er14	(braking resistance alarm):	0x7130
- Er15	(default Parameter) :	0x6320
- Er16	(calibration alarm) :	0xf03
- Er17	(calibration alarm) :	0xf08

When alarms are reset with b99.10, Error code will be 0x0000 .

Two additional pop-up message not related to alarms can be enabled using command bits, and in this case the Err.Reg field will contain 0x00, while Error code will be 0xff05 for the target position reached message and 0xff06 for the value drive captured message. The Data field, in addition to the drive address, will, in the first case, contain the position reached by the motor and, in the second case, the captured position of the motor on the positive front of the input IN1.

The target position reached message is generated when the motor, after the target position is changed (in operating mode 13 Pb150.0=1, in operating mode 14 Pr102 not zero), will go to the target position at less than a tolerance set in Pr55 for at least a time of Pr88*2.048msec. When this message is enabled, the parameters b70.4, Pr55 and Pr88 are reserved for this task and are no longer available for their standard functions (servo error window and PLC program).

A user message can be sent by setting Pb70.12 to 1. In this case, Error Code will be 0xFF09 and the Data field will contain the value in Pr152:153.
Pb 70,12 will be reset to 0 once the message has been sent.

SDO(tx/rx) object

Below is a list of the objects in the device dictionary:

Object dictionary:

Index	
0x1000 : Device type (301)	RO
0x1001 : Error register	RO
0x1014 : COB-ID emergency obj	RO
0x1018 : Identity	RO
0x100c : Guard time	RO
0x100d : Life time factor	RO
0x1200 : Server SDO parameters	RO
0x2000 : Parameters area	RW
0x2001 : Parameters area set bit	RW
0x2002 : Parameters area reset bit	RW
0x2003 : Pico-PLC area	RW
0x2004 : I table area CAM (0..254)	RW
0x2005 : II table area CAM (255..256)	RW

As a general rule, sub_index 0 of indexes 0x2000..0x2002 represents the number of the sub_indexes available, and the subsequent (1..N) sub_indexes represent the parameter number concerned +1.

Sub_index 1 → Pr[0]
Sub_index 2 → Pr[1]
....
Sub_index n+1 → Pr[n]

Example of device memory access by SDO:
Write Pr80 to the drive:
You will need to write the object by SDO with index-sub_index 0x2000-0x51 (80+1).
If the number of bytes written is greater than two, the operation will also change the parameter Pr81.

Read Pr60 from the drive:
You will need to read the object by SDO with index-sub_index 0x2000-0x3d (60+1). The value returned will have a length of 4 bytes, the most significant of which will contain Pr61. If they are not needed, they can simply be discarded.

Set bit 4 of Pr40:
You will need to write the object by SDO with index-sub_inidex 0x2001-0x20 (40+1) with the value (0x0010) that represents in binary the bits involved in the operation, in our case bit 4.

Reset bits 4 and 5 of Pr40:
You will need to write the object by SDO with index-sub_inidex 0x2002-0x29 (40+1) with the value (0x0030) that represents in binary the bits involved in the operation, in our case bits 4 and 5.

Write bytes 0 and 1 of the pico-PLC area:
You will need to write the object by SDO with index-sub_index 0x2003-0x01 (0+1) with the value corresponding to the operating code of the instruction to add. For example, the instruction LD 90.0 requires the value 0x00 to be written in byte 0 and 0x5a in byte 1.

In addition to the objects described above, other objects are implemented based on CANopen's Predefined Connection Set, although these are not found in the object dictionary. These objects can be useful in accessing drive movement parameters.

PDO (tx/rx) object

PDO2 (tx/rx) object :

A protocol for parameter access, pico-PLC instructions, and drive cam table is implemented by exchanging the 8+8 read/write bytes of the PDO2, which, when the master receives the message PDO2 rx, interprets the contents of the first 7 bytes in accordance with the following format:

Acyclic data write message or parameter request from master to drive (PDO 2)

Acyclic data write or request															
Data length			7 byte												
Field Name			Cmd & Len					Data Address				Data			
Contents			5 bit command and 3 bit length					16 bit data address				32 bit data			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	1	1	0	A6	A5	A4	A3

A0:A6 Drive movement address (Pr49), valid values 1..127.

Data For data writing, the field will contain the value of the parameter.
For bit change, the field will contain the mask of the bits to change.
For data reading, the field is insignificant.
For pico-PLC writing, it will contain the operating code of the instruction (see *Serial interface*).

Data Address This field is the address of the parameter involved in the operation (parameter number * 2). The PLC instructions have addresses in the range 8192 to 8447.

The cam table has addresses from 4096 to 4608.

Cmd & Len	**Sub-field**	**Value**	**Meaning**	
	Cmd [0..4]	0	Read request	
		1	Write	
		2	SET bit	Pr = Pr .OR. Data
		3	RESET bit	Pr = Pr .AND. (.NOT.Data)
		4	TOGGLE bit	Pr = Pr .XOR. Data
		5 – 31	Not use	
	Len [5..7]	0- 4	Number of significant bytes in the data field	

Acyclic response to a parameter request message from drive to master (PDO 2)

Data reply															
Data length			8 bytes												
Field Name			Addr & Spare			Data address			Data						
Contents			Pr27			16 address			32 bit reply data						
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	1	0	1	A6	A5	A4	A3

A0:A6 Drive address (Pr49), valid values 1..127.

PDO3 (tx) object :

This is used to generate a message with the data required to implement a reserved function.

PDO4 (tx/rx) object :

In this case, a parameter exchange function is implemented with the movement related to the logic functions managed by pico-PLC. In fact, for each transmission of PDO4 rx from the master to the drive node, the bytes contained in the message are interpreted as follows:

Parameter Pr80..83 write message from master to drive (PDO 4 rx)

Data receive															
Data length			8 bytes												
Field Name			Pr80			Pr81			Pr82			Pr83			
Contents			16 bit value			16 bit value			16 bit value			16 bit value			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	1	0	1	0	A6	A5	A4	A3

A0:A6 Slave drive address (Pr49), valid values 1..127.

The bytes of the message are written to the corresponding parameters only if the function described is enabled by setting bit b99.5 to 1, and is done immediately prior to the next pico-PLC scan cycle (every 6.144 msec) from the reception of the PDO4 rx message.

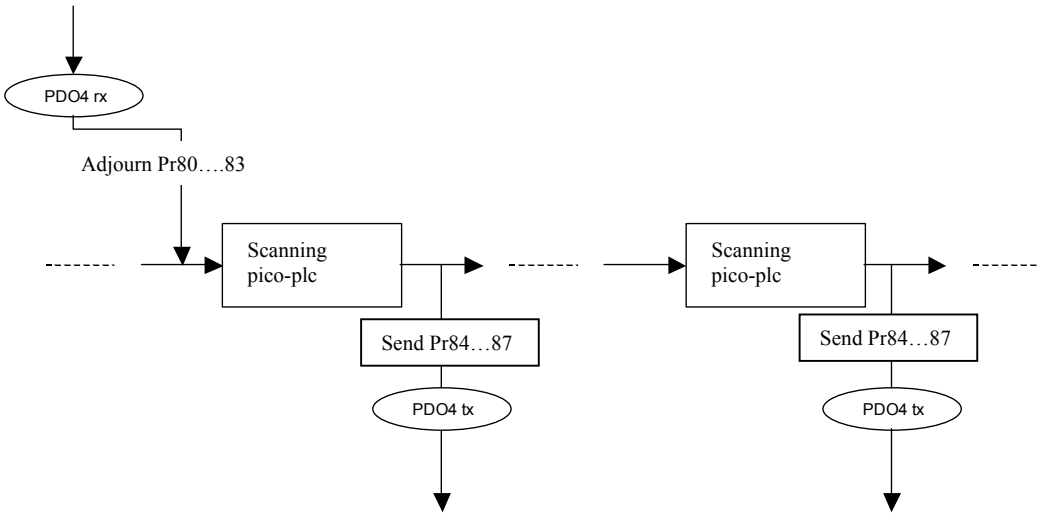
In much the same way as described above, the parameters Pr84..87 are sent through PDO4 tx by the slave to the master with the following format:

Parameter Pr84..87 read message from master to drive (PDO 4 rx)

Data send															
Data length			8 bytes												
Field Name			Pr84			Pr85			Pr86			Pr87			
Contents			16 bit value			16 bit value			16 bit value			16 bit value			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	1	0	0	1	A6	A5	A4	A3

The bytes of the message containing the parameters Pr84..87 are sent to the master only if the function described is enabled by setting bit b99.5 to 1, and is done every Pr161 pico-PLC scan cycles (every 6.144 msec). If Pr161 is set to zero, the bytes are not sent even if b99.5=1. The data is sent when the pico-PLC program scan is complete.

The exchange structure implemented by the PDO4 allows access to the parameters Pr80..87 that do not have a predefined function in the converter but can be processed and interpreted with different functions and meanings according to the logic implemented in the pico-PLC program.



PDO1 (tx/rx) object :

Realtime Mode (Pr31 = 15):

In the same way as for the SBCCAN protocol, a real-time mode has been implemented (operating mode 15) which, for CANopen networks, uses PDO1 (rx/tx) for cyclical data exchange and the SYNC message for synchronizing the position loops. The message COB-IDs are different from SBCCAN execution for the purposes of compatibility with CANopen networks.

Cyclic message from master to drive (PDO1 rx)

Cyclic data															
Data length			8/6/4 bytes												
Field Name			Data												
Contents			position ref. 32 bits					speed ref. 16 bits				Pr102			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	1	0	0	A6	A5	A4	A3

A0:A6 Slave drive address (Pr49), valid values 1..127.

Pr102 is used as a command and must be managed by the pico-PLC.

Based on the length of the message, the data received is interpreted in the following way.

Data length			
8	Position reference (4 byte)	Speed reference (2 byte)	Pr102 (2 byte)
6	Position reference (4 byte)	Pr102 (2 byte)	
4	Speed reference (2 byte)	Pr102 (2 byte)	

Synchronism message from master to drive

Synchronism message															
Data length			0 bytes												
Field Name															
Contents															
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
0	0	0	X	X	X	X	X	0	0	0	1	0	0	0	0

Upon receipt of the sync message, each drive activates the speed and position references and saves the current motor position. If b150.2=1, the drive responds with a message "*cyclic reply*".

Cyclic reply message from device to Master (PDO1 tx)

Cyclic reply															
Data length			8 bytes												
Field Name			Addr			Data					Status		spare		
Data			Pr49 (1 byte)			motor position 32 bits					Pr103(16bit)		reserved		
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	1	1	A6	A5	A4	A3

NOTE: The other features of SBC Can are no more available in this release.

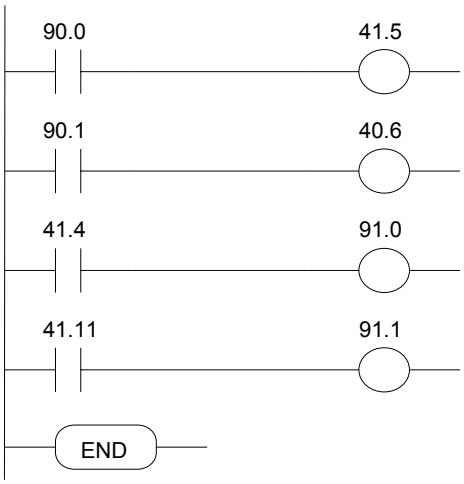
16 Appendix A : Conventions

Reference	Positive
Motor shaft movement (motor shaft view)	
Torque	Positive
Resolver counter	Increments
Encoder output	A  B 
Tachometer signal	Positive
Iu	$coppia \bullet \sin(\vartheta)$
Iv	$coppia \bullet sin\left(\vartheta + \frac{2 \bullet \pi}{3}\right)$
Positive auxiliary input	Pr22 positive
Pr38 positive	Positive auxiliary analogue output
Encoder In. A  B 	Increment counter

17 Appendix C : software timers

Period	Task
128 μs	current control
512 μs	speed control
	torque limits management
	speed reference management
	braking resistor management
	FIN management
6.144 ms	thermal motor image
	digital inputs
	program scanning pico-PLC
	digital outputs
49.152 ms	speed windows management

18 Appendix C : Default program for the pico-PLC



LD	**90.0**	digital input 0 used to power the drive
OUT	**41.5**	
LD	**90.1**	digital input 1 used for the stop function
OUT	**40.6**	
LD	**41.4**	digital output 0 indicates that the converter is OK
OUT	**91.0**	
LD	**41.11**	digital output 1 indicates that the thermal motor image is active
OUT	**91.1**	
END		end of the program

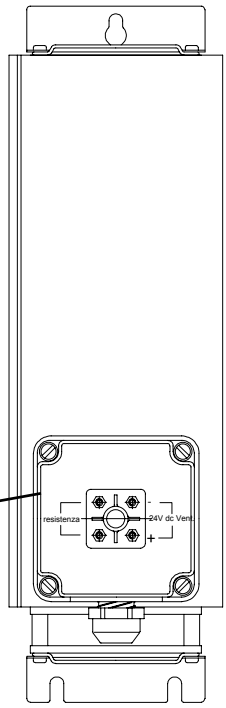
19 Appendix D : external braking modul

TECHNICAL CHARACTERISTICS

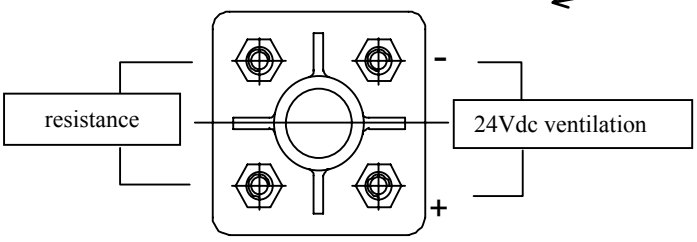
Resistance value:	RFE1 = 40 ohm, RFE2 = 27 ohm
IP protection	20
Max power dissipated	1000 W
Max ambient temperature	45° C
Delta T	90° C
Weight	2,5 Kg
Ventilation power supply	24 V=

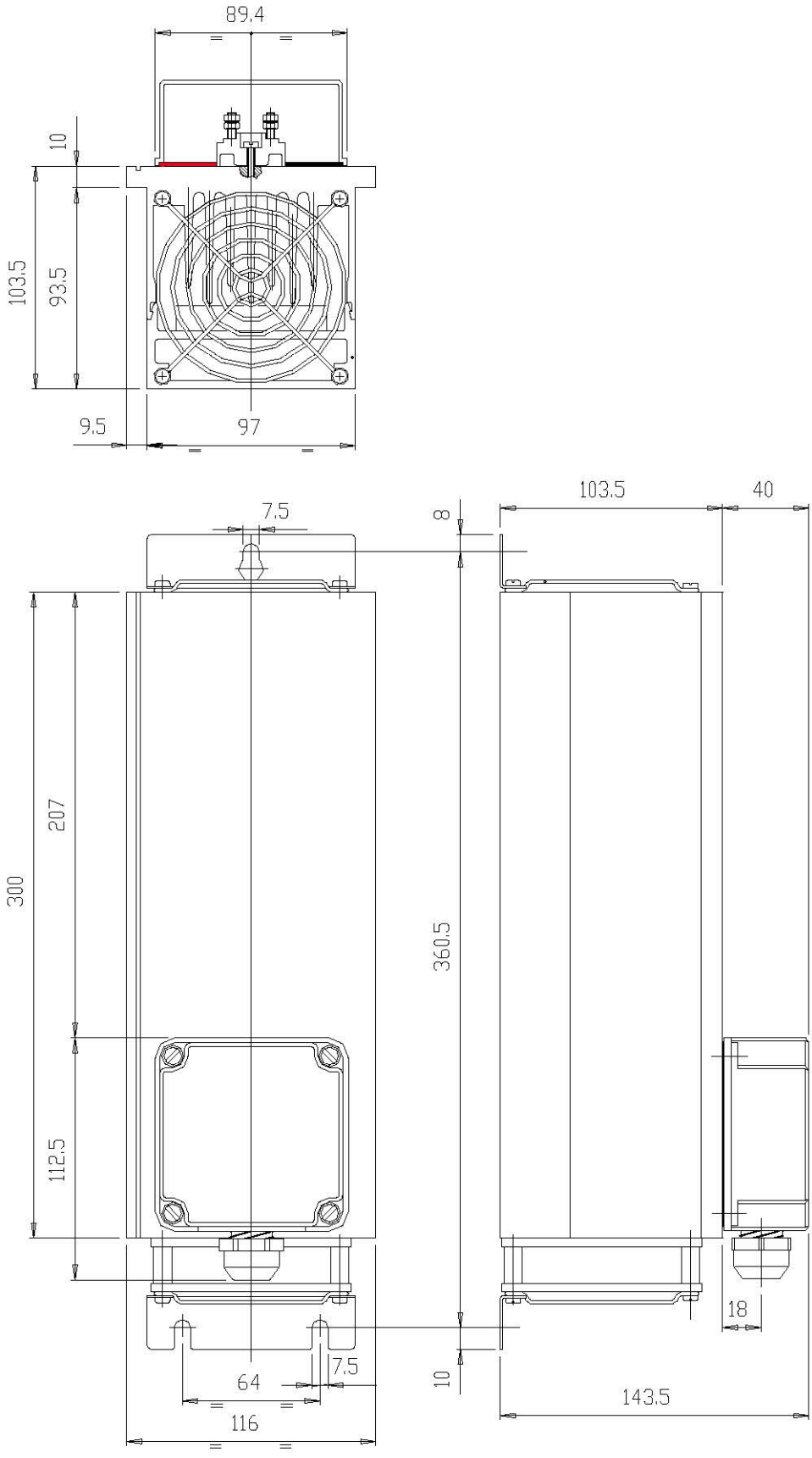
INSTALLATION

The RFE1 or 2 breaking module must be installed vertically as shown. A four-pole 4mm^2 cable must be used for the connection.
The 24v power supply used for the ventilator can cause disturbances. It is therefore a good idea not to use the same power line for electronic devices. The cable should not be longer than 4m. For the connection to the drive, see the related chapter in the converter manual and use a 30A thermo-magnetic switch.



Terminal pins REF1




89.4
10
103.5
93.5
9.5
97
7.5
8
103.5
40
300
207
112.5
360.5
18
64
7.5
10
143.5
116

20 History of the revisions of the User Manual

Rev. 0 : First edition of the user's manual; December 2002.

Rev. 1.0: data for the UL certification
Note about restricted sales

Rev. 2.7: June 2005
Adjournement english manual (equal to "manSPD II rev2.7")

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