

# SMT-BD1-400/I

gb

**Digital amplifier  
for 400 VAC  
sinusoidal brushless  
motor**





**WARNING**

This is a general manual describing a series of servo amplifiers having output capability suitable for driving AC brushless sinusoidal servo motors. This manual may be used in conjunction with appropriate and referenced drawings pertaining to the various specific models.

Instructions for storage, use after storage, commissioning as well as all technical details require the MANDATORY reading of the manual before getting the amplifiers operational.

**Maintenance procedures should be attempted only by highly skilled technicians having good knowledge of electronics and servo systems with variable speed (EN 60204-1 standard) and using proper test equipment.**

The conformity with the standards and the "CE" approval is only valid if the items are installed according to the recommendations of the amplifier manuals. Connections are the user's responsibility if recommendations and drawings requirements are not met.



Any contact with electrical parts, even after power down, may involve physical damage. Wait for at least 5 minutes after power down before handling the amplifiers (a residual voltage of several hundreds of volts may remain during a few minutes).

**ESD INFORMATION (ElectroStatic Discharge)**

INFRANOR amplifiers are conceived to be best protected against electrostatic discharges. However, some components are particularly sensitive and may be damaged if the amplifiers are not properly stored and handled.

**STORAGE**

- The amplifiers must be stored in their original package.
- When taken out of their package, they must be stored positioned on one of their flat metal surfaces and on a dissipating or electrostatically neutral support.
- Avoid any contact between the amplifier connectors and material with electrostatic potential (plastic film, polyester, carpet...).

**HANDLING**

- If no protection equipment is available (dissipating shoes or bracelets), the amplifiers must be handled via their metal housing.
- Never get in contact with the connectors.

**ELIMINATION**

In order to comply with the 2002/96/EC directive of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE), all INFRANOR devices have got a sticker symbolizing a crossed-out wheel dustbin as shown in Appendix IV of the 2002/96/EC Directive.

This symbol indicates that INFRANOR devices must be eliminated by selective disposal and not with standard waste.

INFRANOR does not assume any responsibility for any physical or material damage due to improper handling or wrong descriptions of the ordered items.

Any intervention on the items, which is not specified in the manual, will immediately cancel the warranty.

Infranor reserves the right to change any information contained in this manual without notice.

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# Chapter 1 – General description

## 1 - INTRODUCTION

Series **SMT-BD1-400/I** digital servo modules are PWM servo amplifiers that provide speed control for AC sinusoidal motors (brushless) with transmitter resolver.

The pluggable **SMT-BD1-400/I** system is available as a multi-axis version that can receive up to three axes in a standard 19" rack including the power supply.

\* The basic amplifier module **SMT-BD1-400/I / a** or **b** provides the speed control for AC synchronous motors with +/- 10 V analog speed input command.

\* The **SMT-BD1-400/I / c** version with its specific option board allows the direct position control of the motor by means of an incremental position input command of the type "Pulse and Direction for stepping motors emulation applications".

\* The **SMT-BD1-400/I / d** version with its specific option board allows the direct position control of the motor by means of an incremental encoder position input command for electronic gearing applications.

\* The **SMT-BD1-400/I / e** version with its specific option board allows the tension control of a material (thread or film) by means of an analog tension sensor for winding/unwinding applications.

\* The **SMT-BD1-400/I / f** version with its specific option board allows the positioning of a spindle motor axis for tool exchanges, according to four programmable positions over one revolution.

\* The **SMT-BD1-400/I / g** version with its specific option board allows the product registration for conveyor applications.

\* The **SMT-BD1-400/I / i** version with its specific option board allows the unwind / rewind tension control.

\* The **SMT-BD1-400/I / j** version with its specific option board allows the unwind / rewind accumulator control.

The parameter setting software **BPCW**, which is IBM-PC compatible with the operating system WINDOWS®, allows the display of all amplifier parameters as well as their easy modification.

## 2 - CONFORMITY WITH EUROPEAN STANDARDS: "CE" APPROVAL

### 2.1 - GENERAL DESCRIPTION

The **SMT-BD1-400/I** amplifiers have their own DC/DC converter to provide appropriate logic voltage to the modules. This auxiliary supply uses, as a source, the direct 230 VAC single-phase mains, necessary for the DC/DC converter operation and particularly when the position output information need to be saved. Each **SMT-BD1-400/I** amplifier has a DC/DC converter operating by means of the auxiliary supply that provides the required voltages.

The power supply is directly connected to the industrial 400 VAC mains. A current smoothing reactance coil can be used for improving the current harmonics, but it is not mandatory. A soft start system of the power capacitors is integrated in the power supply.

Each module is packaged as a 6 U "double Eurocard":

- one power board with IGBT transistors
- one logic board with DSP (Digital Signal Processing).

The **SMT- BD1-400/I** amplifier directly controls the motor torque and speed by means of the information provided by a transmitter resolver sensor.

The motor speed or torque input command is an analog command ( $\pm 10$  V). The motor position is available as two channels A and B in quadrature, and one or several marker pulse(s) per revolution. The resolution per revolution is programmable. The main faults are displayed on the amplifier front panel.

All control parameters are programmable by means of a serial link and saved in a single EEPROM memory. The auto-configuration and auto-tuning functions allow an easy and quick commissioning of the amplifier.

The basic **BPCW** software, which is IBM-PC compatible with the operating system WINDOWS®, allows the clear display and easy modification of all amplifier parameters. The extended versions of the **BPCW** software include the digital oscilloscope function as well as some other special functions.

## 2.2 - REFERENCE TO THE STANDARDS

The **SMT-BD1-400/I** amplifiers operating in the BF rack in 400 VAC, which is equipped with the mains filter F-400-35/70, have been approved for their conformity with the Electromagnetic Compatibility standards:

- EN 55011, Group 1, Class A regarding conducted and radiated radioelectric disturbances,
- CEI 801 - 2 - 3 - 4 regarding the immunity.

The tests have been made by an external laboratory which is the SCHAFFNER Company, well-known for its competence regarding EMC.

The results of the tests made according to the Low Voltage directive are referenced in the LCIE report n° 413777.

Standard to be applied to the electrical equipments of industrial machines: EN 60204.1.

## 2.3 - "CE" MARK

The "CE" mark has been affixed since 1995.

## 3 – OTHER DOCUMENTS FOR THE AMPLIFIER COMMISSIONING

[Rack BF/400 Vac manual.](#)



## Chapter 2 – Specifications

### 1 - MAIN TECHNICAL SPECIFICATIONS

Rated DC bus voltage	565 VDC, that is 400 VAC rated at rack input
Maximum DC bus voltage	685 VDC, that is max. 480 VAC at rack input
Minimum DC bus voltage	480 VDC, that is min. 340 VAC at rack input
Rated auxiliary supply	325 VDC (250 V < Uaux < 360 VDC)
Motor phase-phase output voltage	380 Vrms for 565 VDC bus

Output currents for the **Fusing mode of the I<sup>2</sup>t protection** (see Chapter 8, section 3.3)

AMPLIFIER TYPE	Urated (Vrms)	I <sub>max</sub> (Arms) 1 s	Max. authorised rated current (Arms) of the amplifier	
			Without fan*	Fan type 2*
SMT-BD1-400/15	400	15,5	5	7,5
SMT-BD1-400/30	400	30	8	15
SMT-BD1-400/45	400	48	10	19
SMT-BD1-400/60	400	60		28
SMT-BD1-400/100	400	100		35

Output currents for the **Limiting mode of the I<sup>2</sup>t protection** (see Chapter 8, paragraph 3.3)

AMPLIFIER TYPE	Urated (Vrms)	I <sub>max</sub> (Arms) 1 s	Max. authorized continuous current (Arms) of the amplifier	
			Without fan*	Fan type 2*
SMT-BD1-400/15	400	15,5	Unusable	5
SMT-BD1-400/30	400	30	Unusable	10
SMT-BD1-400/45	400	48	7	15
SMT-BD1-400/60	400	60		23
SMT-BD1-400/100	400	100		28

\* Maximum ambient temperature = + 40° C, fan 2 = 90 l/s.

Switching frequency PWM	10 KHz
Minimum inductance between phases	2 mH
Current regulator (PI)	adjusted to motor
Current loop bandwidth	Cut-off frequency for 45° phase shift: > 1 KHz
Internal current limitation	I <sub>max</sub> : 20% to 100%, I <sub>rated</sub> : 20% to 50% I <sub>max</sub> duration = 1 sec.
External current limitation	0 to 10 V (resolution: 12 bits) 100% to 0% of the internal I <sub>max</sub> limitation
Analog speed input command CV	±10 V, resolution: 12 bits in standard, 16 bits optional
Accel/Decel ramp range	0 s to 30 s between zero speed and max. speed
Speed regulator PI <sup>2</sup>	Sampling period = 0,5 ms Anti-wind-up system of the integrator Adjustable digital gains
Speed loop bandwidth	Selectable cut-off frequency for 45° phase shift: 50 Hz, 75 Hz or 100 Hz
Max. motor speed	Adjustable from 100 rpm to 14000 rpm

Speed range	1 : 2048 with 12 bit input command 1 : 32768 with 16 bit input command
Encoder position output	Two A and B channels in quadrature with n marker pulse(s) per revolution. RS422 line driver Programmable resolution: max. 8192 ppr up to 900 rpm max. 4096 ppr up to 3600 rpm max. 1024 ppr up to 14000 rpm Accuracy: 8 arc minutes + 1/4 point in standard (2 arc minutes + 1/4 point optional) NB: The total position accuracy must take into account the resolver accuracy
Analog outputs (test points)	<ul style="list-style-type: none"> <li>• Speed input command (CV): <math>\pm 10</math> V for <math>\pm</math> max. speed</li> <li>• Speed monitor (GT): <math>\pm 8</math> V for <math>\pm 14000</math> rpm, linearity: 10 %</li> <li>• Current input command (I DC): <math>\pm 10</math>V for amplifier current rating, DAC OUT1: resolution: 8 bits</li> <li>• Current monitor (Imon.): <math>\pm 10</math> V for amplifier current rating, DAC OUT2: resolution: 8 bits</li> </ul>
Logic inputs	Enable / Disable: ENABLE Limit switch +: FC+ Limit switch -: FC- Current command: CI Zero speed input command: CV0 Reset: RAZ
Logic outputs	Relay contact $U_{max} = 50$ V, $I_{max} = 100$ mA, $P_{max} = 5$ W <ul style="list-style-type: none"> <li>• "Amp ready": closed if amplifier OK, open if fault</li> <li>• "Power ready": closed if power OK, open if fault</li> <li>• IDYN signal: open if <math>I^2t</math> threshold is reached</li> </ul>
Error display	LED on front panel and diagnostic via serial link
Motor and application parameter setting	Serial link RS232 (standard) or RS422 (option)
Automatic functions	Amplifier adjustment to the motor (AUTO-PHASING) Automatic regulator tuning (AUTO-TUNING) Offset compensation on analog input CV
Conformity with the standards: <b>CE</b> approval with multiaxis power supply configuration BF-400 rack and mains filter F400-35 or 70, "360°" shield; equipotentiality according to the wiring rules.	<p>- Standards regarding the Electromagnetic Compatibility: Immunity: CEI standards 801- 2 - 3 - 4 Conducted and radiated disturbances: EN 55011, Group 1, class A</p> <p>- Electrical standards for industrial machines: EN 60204.1: - Insulator: 2500 Vdc/1 min. - Leakage current &gt; 3 mA (EMI filters; remove the filter capacitors for this measurement).</p>
Temperature * storage - 40°C to + 70°C * operation 5°C to +40°C	From 40°C on, the rated currents must be reduced of 3 %/°C. Max. temperature: 50°C
Altitude	3000 m

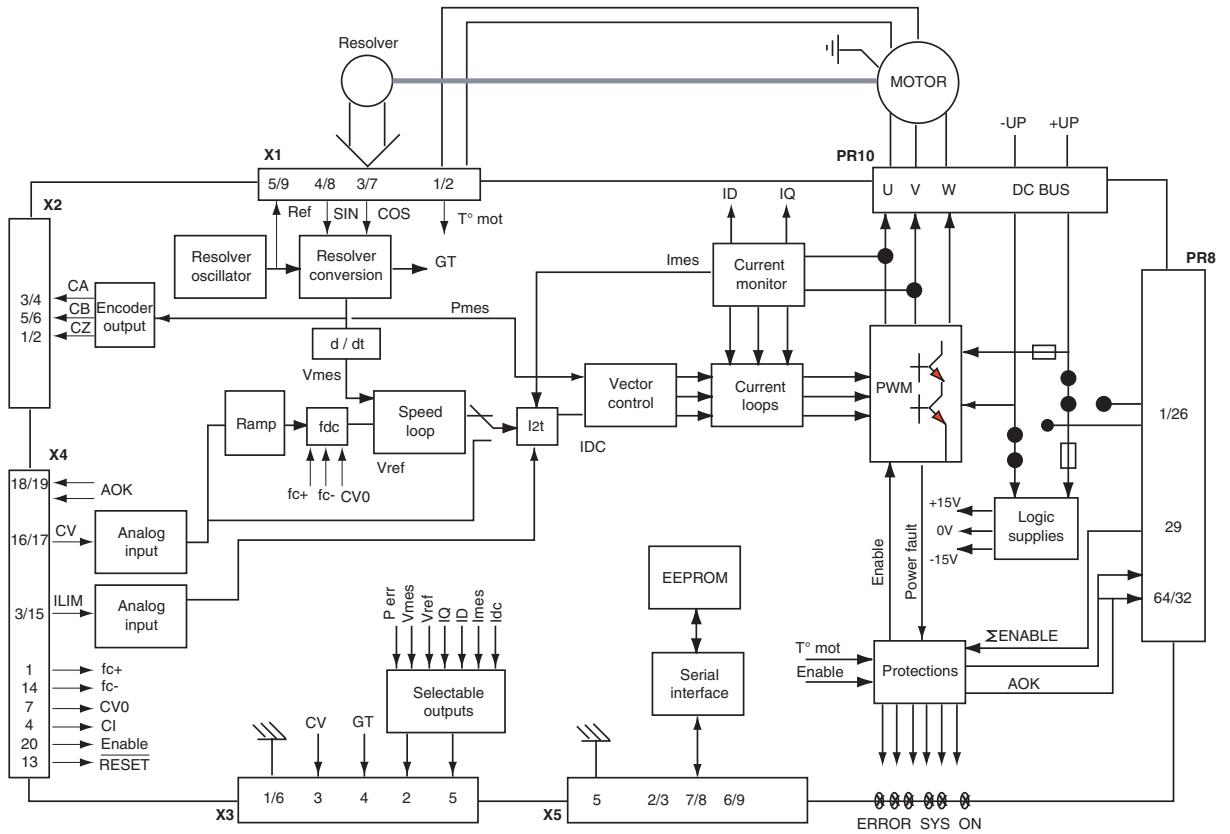
Moisture

< 50 % at 40°C and < 90 % at 20°C  
(EN 60204.1 standard)

Cooling

Natural convection or forced air, according to the  
rated current (see current table, [chapter 2, part 1](#))

**2 - BLOCK DIAGRAM**



### 3 - MAIN PROTECTIONS

#### 3.1 - DISPLAYED PROTECTIONS

PROTECTION	ERROR DISPLAY	LED*
Amplifier rated current overload (see Chapter 8, section 3.3) . blinking display = Idyn signal (I <sup>2</sup> t threshold is reached) . continuous display = amplifier inhibited (I <sup>2</sup> t fault)	I <sup>2</sup> t	⊗ ● ● ●
Resolver cable interruption	Resolver	● ⊗ ● ●
Power stage failure: . power supply overvoltage . internal switch protection . short-circuit between phases or IGBT module overheating	Power stage	⊗ ⊗ ● ●
Resolver converter failure	R. D. C	● ● ⊗ ●
Amplifier overtemperature	°C Amp	⊗ ● ⊗ ●
Power supply undervoltage	Undervolt.	● ⊗ ⊗ ●
Motor overtemperature	°C Motor	⊗ ⊗ ⊗ ●
Amplifier parameter storage fault	EEPROM	⊗ ● ⊗ ⊗
Amplifier automatic procedure: . blinking display = procedure operating . continuous display = operating error	Busy	⊗ ⊗ ⊗ ⊗

\* ● = LED is unlit      ⊗ = LED is lit.

All these faults are memory stored in the amplifier except for the "Undervolt." fault

The reset of a stored fault can be made:

- ◇ by means of the RESET function in the **BPCW** software
- ◇ via the fault RESET input (pin 13 of the X4 connector)
- ◇ by switching off the amplifier power supply.

#### 3.2 - FUSE PROTECTION

F1 : Control of the average DC current of the backplane power board supply (see chapter 8).

F2 : Control of the average DC current of the logic board supply (see chapter 8).

AMPLIFIER TYPE	F2 POWER
SMT-BD1-400/15	1 A
SMT-BD1-400/30	1 A
SMT-BD1-400/45	1 A
SMT-BD1-400/60	1 A
SMT-BD1-400/100	1 A

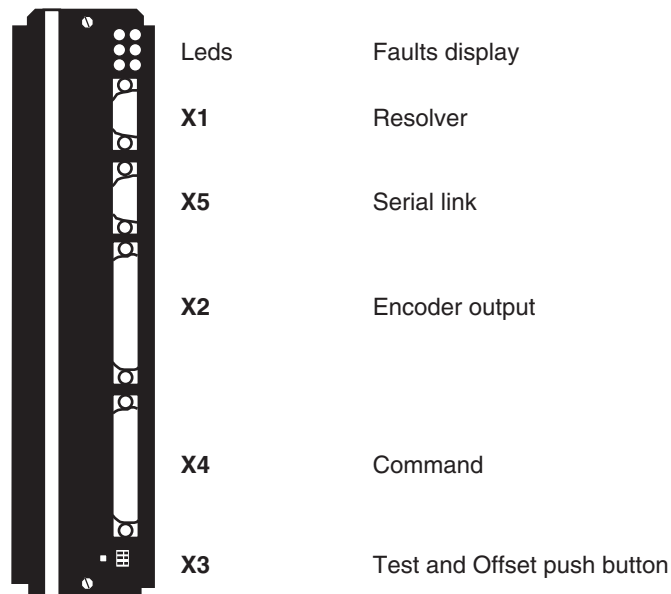
## Chapter 3 – Inputs – Outputs

### 1 – CONNECTORS

#### 1.1 - CONNECTORS LOCATION WITH BF-400 RACK

See Rack BF/400 Vac manual.

#### 1.2 – AMPLIFIER CONNECTORS



#### 2 - X1 RESOLVER CONNECTOR (Sub D 9 points female)

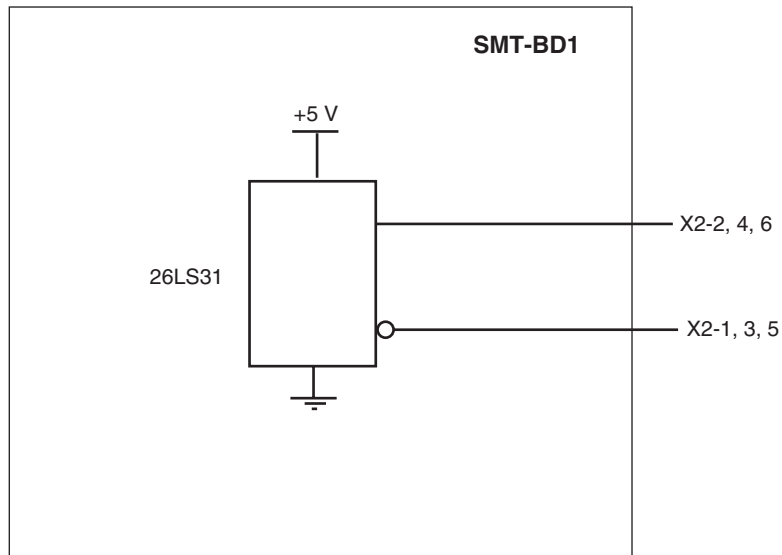
PIN	FUNCTION	REMARKS
1	TC (pin H sensor connector)	If thermal switch connected to X1
6	Shield connection	If no "360°" connection on the connector
2	TC (pin I sensor connector)	If thermal switch connected to X1
7	S1 (pin C sensor connector)	MAVILOR motor
3	S3 (pin D sensor connector)	MAVILOR motor
8	S4 (pin B sensor connector)	MAVILOR motor
4	S2 (pin A sensor connector)	MAVILOR motor
9	R2 (pin F sensor connector)	MAVILOR motor
5	R1 (pin E sensor connector)	MAVILOR motor

See chapter 8, section 2 for the connection of other resolver types.

**3 - X2 POSITION CONNECTOR (Sub D 25 points female)**

PIN	FUNCTION	I / O	REMARKS
1	Marker Z/	O	Differential output of the encoder marker pulse (5 V, 20 mA max.)
2	Marker Z	O	Differential output of the encoder marker pulse
3	Channel A/	O	Differential output of the encoder channel A/ (5 V, 20 mA max.)
4	Channel A	O	Differential output of the encoder channel A
5	Channel B/	O	Differential output of the encoder channel B/ (5 V, 20 mA max.)
6	Channel B	O	Differential output of the encoder channel B
7	0 V	O	
8 and 9	reserved		
10 and 11	0 V	O	
12,13,14	reserved		
15,16,17	reserved		
18 and 19	reserved		
20,21,22	reserved		
23,24	reserved		
25	0 V	O	

TTL ENCODER OUTPUT SPECIFICATION



Recommended driver: 26LS32

#### 4 - X3 TEST CONNECTOR

PIN	FUNCTION	REMARKS
1 - 6	0 Volt	
2	Current input command I DC	$\pm 10$ V; resolution: 8 bits, linearity: 2 % (DAC out 1)*
3	Speed input command CV	$\pm 10$ V for $\pm$ max. speed
4	Speed monitor GT	$\pm 8$ V for $\pm 14000$ rpm
5	Current monitor I mes	$\pm 10$ V; resolution: 8 bits, linearity: 2 % (DAC out 2)*

\* 10 V for amplifier current rating

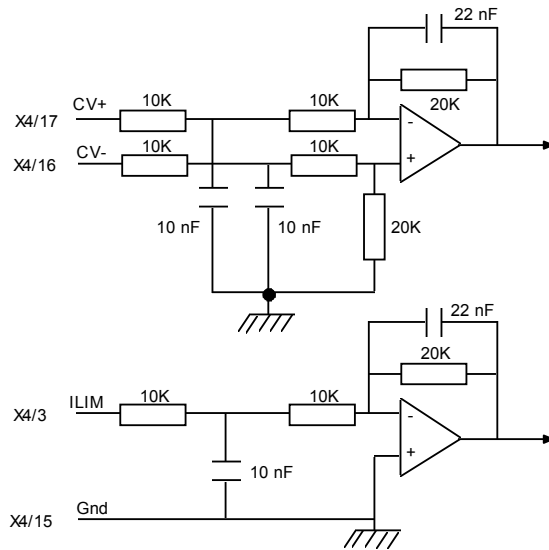
Linearity = 10 % for logic board type 01612A, 01612B or 01612C.

#### 5 - X4 INPUT - OUTPUT COMMAND CONNECTOR (Sub D 25 points male)

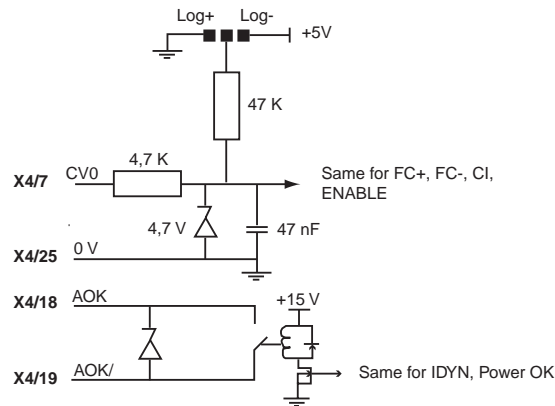
Pin	Function	I / O	REMARKS
1	Limit switch +	I	Positive or negative logic ( <a href="#">see Chapter 8, part 4</a> )
14	Limit switch -	I	Positive or negative logic ( <a href="#">see Chapter 8, part 4</a> )
24	0 Volt of limit switch	I	
20	ENABLE	I	Positive or negative logic ( <a href="#">see Chapter 8, part 4</a> )
23	0 Volt ENABLE	I	
4	Current command CI	I	Positive or negative logic ( <a href="#">see Chapter 8, part 4</a> )
7	CV0 Zero speed input command	I	Positive or negative logic ( <a href="#">see Chapter 8, part 4</a> )
25	0 Volt	I	
13	RESET	I	Resets amplifier via 0 V (contact between 13 and 12)
12	0 Volt of RESET input	I	
17	+ Speed input command CV +	I	$\pm 10$ V speed input command for max. speed or current $\pm 10$ V input command for I <sub>max</sub> with "CI" input active
16	- Speed Input command CV -	I	
15	0 Volt speed input command CV	I	
3	Current limitation I limit	I	External current limitation 0 to 10 V for 100 % to 0 % of I <sub>max</sub>
10	Speed monitor output	O	$\pm 8$ V for $\pm 14000$ rpm; linearity: 10 %; max. load: 10 mA
2	Current monitor output	O	$\pm 10$ V; resolution: 8 bits; load: 10 mA; (DAC out 2)
11	0 Volt analog output	O	10 V for amplifier current size.
8, 9	I dyn signal	O	Relay contact: open if I dyn threshold is reached P <sub>max</sub> = 10 W with U <sub>max</sub> = 50 V or I <sub>max</sub> = 100 mA
18, 19	Amplifier ready	O	Relay contact: closed if amplifier OK, open if fault. P <sub>max</sub> = 10 W with U <sub>max</sub> = 50 V or I <sub>max</sub> = 100 mA
21	+ 15 V	O	50 mA maximum output current
22	- 15 V	O	50 mA maximum output current
5, 6	non connected		

For the use of a negative command logic, please [see Chapter 8, part 4.1](#).

**5.1 - SPECIFICATION OF THE ANALOG INPUTS**



**5.2 - SPECIFICATION OF THE LOGIC INPUTS / OUTPUTS**



**6 - X5 SERIAL LINK (Sub D 9 points male)**

PIN	FUNCTION	REMARKS
5	0 Volt	GND (connection of the shield if no "360°" connection on the connector)
3	TXD	Transmit data RS 232
2	RXD	Receive data RS 232
6	TXH	Transmit data RS422
7	TXL	Transmit data RS422
8	RXL	Receive data RS422
9	RXH	Receive data RS422



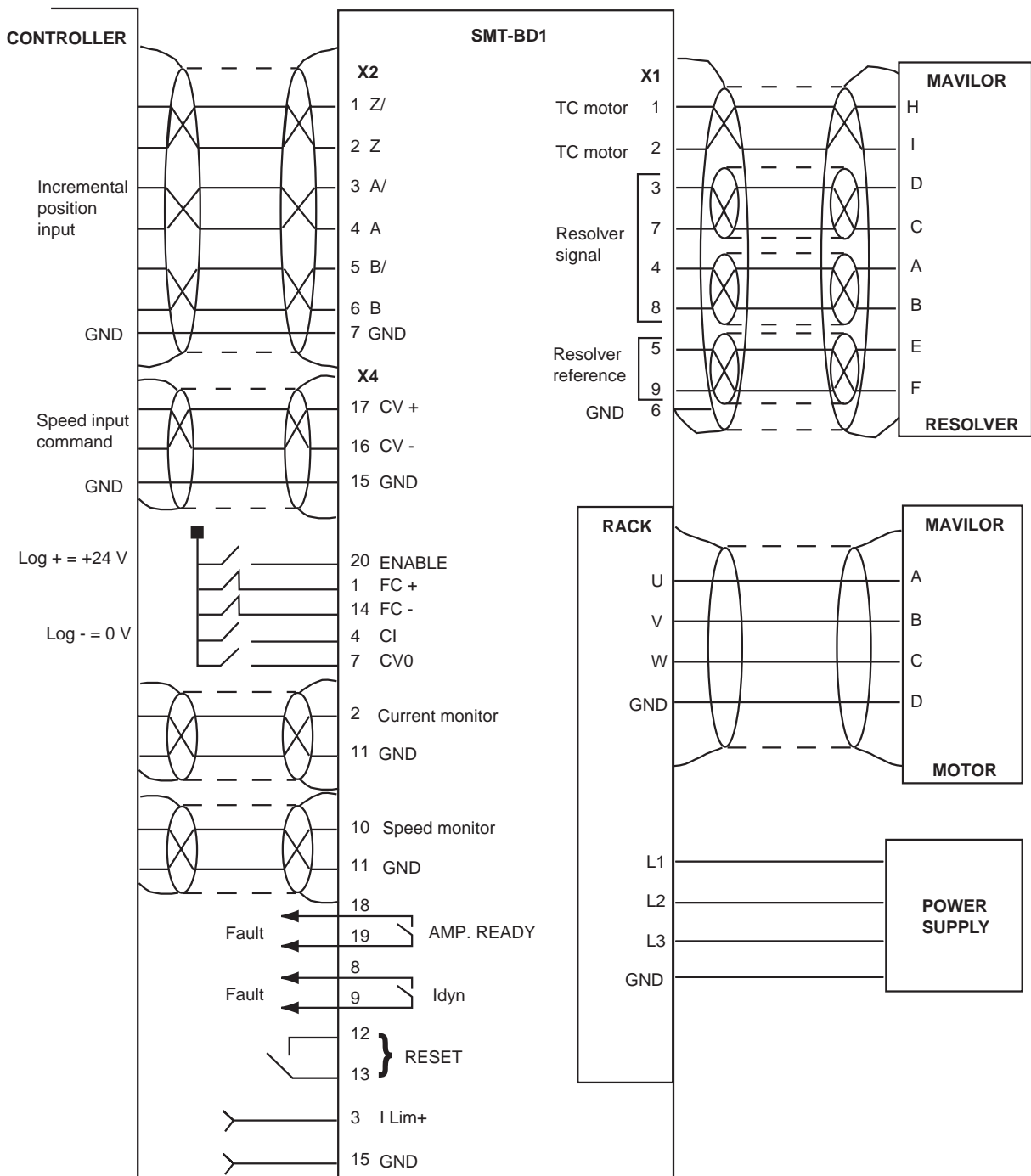
# Chapter 4 – Connections

## 1 - CONNECTION DIAGRAMS

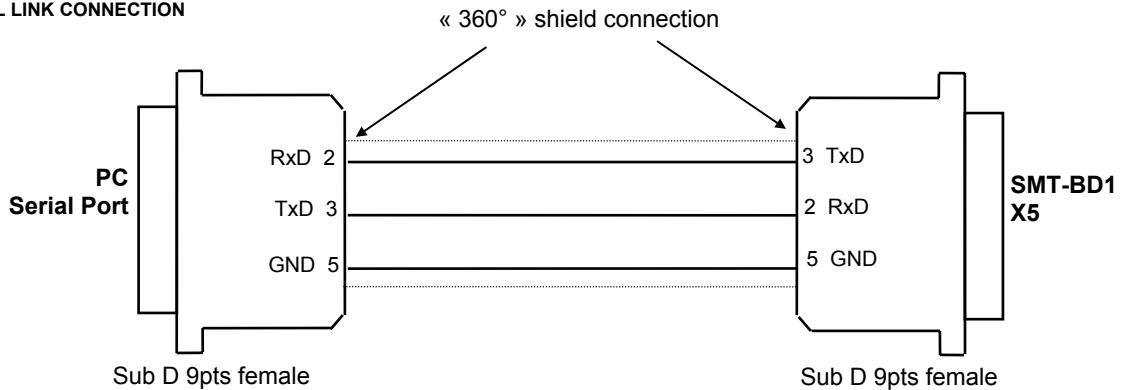
### 1.1 - POWER CONNECTION WITH THE BF-400 RACK

See Rack BF/400 VAC manual.

### 1.2 - LOGIC CONNECTION



### 1.3 - SERIAL LINK CONNECTION



## 2 - WIRING (according to CEI 801 and EN 55011 standards)

See enclosed drawings ([chapter 8, part 6](#))

### 2.1 - GND WIRING AND GROUNDING

The reference potential is the **earth (ground)**. Motors and resolvers are grounded via their housing. If a reference of potential is existing, like a main chassis or a cabinet, with a low impedance between the different elements, it should be used to connect ALL reference to it and also connect this reference to the earth (ground).

In order to ensure a good equipotentiality between the different elements, remove any paint or isolating material and fasten the different elements with fan type lockwashers. For the connection of the mechanical units, use metal bradings instead of large section cables.

Long reference potential connections are suitable **ONLY** if these connections have a very low impedance (< 0,1  $\Omega$ ).

Cables with low potential should **NEVER** run in the proximity of power lines (min. distance: 50cm. No parallel wiring but 90° wiring).

**Each conductor cable** (carrying a potential) must be **shielded**. Several wires in the **same sleeve** must be **twisted** and **shielded**.

According to the **CEI 801 standard**, the connectors must be metallic or metal plated and must have a **360° shield connection** (see [Chapter 8, part 6](#)).

### 2.2- MOTOR AND RESOLVER CABLES

Cable ends should have a metallic collar allowing a 360° shielded connection.

If the connectors are of metallic, with a 360° shield connection, the shield must be fastened as close to the motor as possible, by means of a metallic collar on the motor or machine chassis, after having removed the paint.

The resolver cable must be **pair twisted and shielded** (sin, cos, ref.).

Motor cables **MUST** also be shielded.

### 2.3 - INPUT COMMAND AND SERIAL LINK CABLES

The analog input command signal CV requires a pair twisted and shielded cable. The shield must have a "360°" connection via metallic collars at both ends. If the shield is connected by means of a pig tail, it must be connected at one end to a 0 Volt pin of X4 on the amplifier side with a connection as short as possible. This method is prohibited from the EMC point of view.

The input command (CV) wiring must be made according to the polarities between the NC and the amplifier (CV on "diff high" of the NC). The logic 0 Volt is directly connected to the amplifier housing. The connection continuity is ensured by the fastening screws on the rack front panels. **The amplifier 0 Volt and the controller 0 Volt MUST be connected by means of a wire. The shield MUST NEVER be used as a conductor of the 0 Volt potential.**

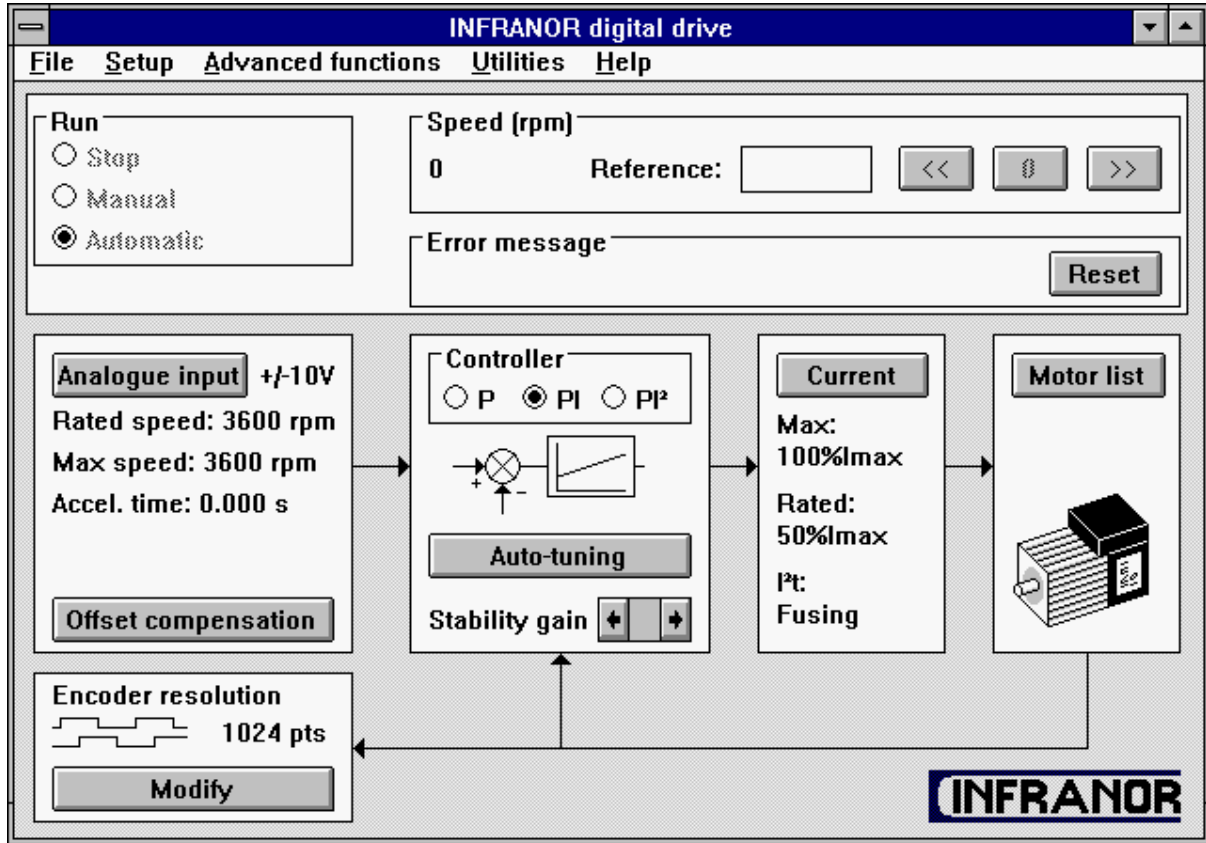


The serial link cable must also be shielded according to the above mentioned shielding rules.

The command cables (input command, serial link, position, resolver) as well as the power cables **MUST** be **connected** and **disconnected** with the amplifier OFF.

## Chapter 5 - Adjustable functions

The **BPCW** programme is IBM PC compatible with the operating system WINDOWS® and allows a very easy adjustment of the amplifier.



### 1 - PC GRAPHIC WINDOW (INFRANOR Digital Drive)

The **INFRANOR Digital Drive** graphic window has an adjustment panel, a control panel and functions accessible via menus. This presentation allows a quick adjustment of the main system parameters during the commissioning and the adjustment phases.

#### 1.1 - CONTROL PANEL

This panel allows the direct control of the motor by means of the PC during the commissioning phase. The **RUN** and **SPEED** functions must be confirmed by means of the **Software control** function in the **Setup** menu of the **BPCW** software version 2.0 (see Chapter 5, § 2).

**RUN**: this function starts and stops the amplifier and the motor during the commissioning and adjustment phases.

- On **STOP** position, the amplifier is disabled and the motor is not controlled.
  - On **MANUAL** position, a digital speed input command is directly entered by the **SPEED** function of the PC.
  - On **AUTOMATIC** position, the analog speed or torque input command is entered via the CV input of X4.
- SPEED**: this function allows to control the motor speed by means of the PC during the commissioning and adjustment phases
- The digital speed input command value (in rpm) is entered into the **Reference** block.

- The three buttons, on the right, in the **Speed** block give a positive (>>), negative (<<) or zero (0) speed input command (**Reference**).

**ERROR MESSAGE:** this function clearly displays on the screen the error information, and the stored errors can be cancelled by the **RESET** function.

## 1.2 - ADJUSTMENT PANEL

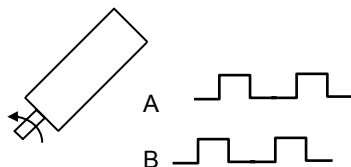
The main adjustable parameters as well as the automatic commissioning aid functions are accessible in the adjustment panel. The whole system is represented as a block diagram for a better display of the parameters.

**ANALOG INPUT:** this module concerns the adjustable parameters for entering the motor speed input command.

- The **Maximum speed (rpm)** parameter defines the maximum motor rotation speed for an input command voltage of 10 V on the CV input of X4. The adjustment range is between 100 and 14000 rpm. This parameter is automatically calculated with regard to the rated speed value (**Rated speed**) entered by the operator.
- The **Rated speed (rpm)** parameter defines the motor rated speed for an input command of 8 or 9 V on the CV input of X4. The adjustment range is between 80 and 11 200 rpm for an 8 V input command and between 90 and 12 600 rpm for a 9 V input command. If this parameter is modified after the programming of the encoder output, check that the new maximum speed value (**Maximum speed**) is compatible with the **Encoder resolution** parameter.
- The **Accel / decel time (ms)** parameter defines the motor acceleration or deceleration time between 0 and the maximum speed value (**Maximum speed**) defined above. The adjustment range is between 0 and 30 s.
- The **Reverse movement** function allows the reversal of the motor rotation according to the polarity of the speed input command CV. For the encoder position output, the counting direction with regard to the motor rotation is not modified. The following diagram shows the standard configuration of the MAVILOR motors according to the wiring set by the manufacturer.

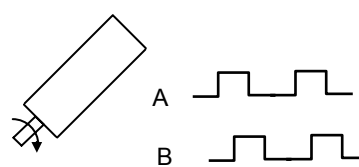
**Reverse movement**

Input command > 0  
CCW rotation  
FC- stops the motor



**Reverse movement**

Input command > 0  
CW rotation  
FC+ stops the motor



- The **Offset compensation** function identifies the offset voltage value on the CV analog input and cancels its effect on the speed input command. It is also accessible via the button **OFFSET** on the amplifier front panel.

**CONTROLLER:** this module allows the adjustment of the amplifier digital speed regulator

- The choice of the regulator type (**P**, **PI** or **PI<sup>2</sup>**) is made in the upper part of the **CONTROLLER** block.
  - Position **P**: the speed regulator is only a proportional regulator.
  - Position **PI**: the speed regulator is a proportional and integral regulator.
  - Position **PI<sup>2</sup>**: the speed regulator is a proportional plus two integral terms regulator. The use of the second integral term allows to increase the axis stiffness and a better regulation accuracy at very low speeds.
- The **AUTO-TUNING** control identifies the motor and load specifications and calculates the gain parameters of the regulator. During the procedure, the **Bandwidth** box allows to select the speed loop bandwidth (**Low** = 50 Hz, **Medium** = 75 Hz and **High** = 100 Hz) and the **Filter** box allows to select the low pass filter on the speed error (**Standard** = 1<sup>st</sup> order, **Antiresonance** = 3<sup>rd</sup> order). The **Filter** box is accessible from the **BPCW** version 2.6 and the amplifier EPROM version **5.7**.

- Both **Stability Gain** buttons at the bottom of the **CONTROLLER** space allow to increase (-> ) or decrease (<- ) the loop gain.

**CURRENT:** this module allows the adjustment of the amplifier current limitation.

- The amplifier type is selected in the **Drive list** table.
- The fan type is selected in the part **Fan**.
- The amplifier rated current limitation mode is selected in the part **I<sup>2</sup>t mode**.  
In **Fusing** position, the amplifier is disabled when the current limitation threshold is reached ([chapter 8, § 3.3](#)).  
In **Limiting** position, the current is only limited at the value defined by the parameter **Rated current** when the limitation threshold is reached ([chapter 8, § 3.3](#)).
- The **Maximum current (%)** parameter defines the maximum current of the amplifier. It can vary from 0 % to 100 % of the amplifier current rating. This parameter is defined according to the amplifier and motor specifications ([see chapter 2, § 1](#)).
- The **Rated current (%)** parameter defines the threshold of the amplifier RMS current limitation (I<sup>2</sup>t). It can vary from 20 % to 50 % of the amplifier current rating. This threshold is defined according to the amplifier and motor specifications ([see chapter 2, § 1](#)).

The **MOTOR LIST** module allows the automatic initialization of the motor parameters (Pole pairs, Phase order, Resolver offset, Current phase lead) by selecting a motor in the appropriate table.

The **ENCODER RESOLUTION** concerns the amplifier encoder output. The **MODIFY** function allows to define the specifications of the A, B and Z signals that are available on the X2 connector.

- The **Encoder resolution** parameter defines the encoder resolution on channels A and B of the encoder position output for one motor revolution of the motor shaft. Binary and decimal values are both accepted. The maximum encoder resolution per revolution is limited by the motor speed as shown in the table below:

MAXIMUM POSSIBLE SPEED (rpm)	900	3600	14000
MAXIMUM ENCODER RESOLUTION	8192	4096	1024

- The **Number of zero pulse** parameter defines the number of zero pulses on channel Z for one revolution of the motor shaft. The adjustment range is between 1 and 16.
- The **Zero pulse origin shift** parameter defines the shift between the first zero pulse on channel Z and the resolver marker pulse. The adjustment range is between 0 and 32 768 points. 32 768 points correspond to one revolution of the motor shaft.
- The **Zero pulse width** parameter defines the width (as a resolution) of the zero pulses on channel Z. The adjustment range is between 8 and 32 768. 32 768 corresponds to one revolution of the motor shaft.
- The **Programmation** function modifies the encoder output memory according to the new parameters entered by the operator.

## 2 - PARAMETER FILE MENU (Files)

The **SAVE PARAMETERS FILE** function saves all amplifier parameters contained in a file Name.**PAR** stored in the PC for filing.

The **LOAD PARAMETERS FILE** function loads all amplifier parameters in a file Name.**PAR** stored in the PC.

The **SAVE PARAMETERS TO EEPROM** function saves all parameters in the amplifier EEPROM. These parameters are kept in the amplifier even after power off. They are automatically loaded in **BPCW** programme when starting with the amplifier already on.

The **EXIT** function allows to leave the **BPCW** programme and to return to WINDOWS®. If you do not want to save the parameter modifications, leave the software without saving the parameters in the amplifier EEPROM. After switching off and reapplying power, the amplifier is initialized with the previous EEPROM parameters. When starting the **BPCW** programme again, the parameters of the amplifier are automatically loaded in the software.

## 3 - SOFTWARE CONFIGURATION MENU (Setup)

The submenu **Communication** allows the definition of the PC communication port connected to the amplifier (COM1 or COM2) as well as the transmission speed on the serial link.

- The communication port (**Com. port**) is selected in the left part of the **Communication setup** block. The port number can be stored in a PC file via the **Save configuration** function.
- The transmission speed (**Baudrate**) is selected in the right part of the **Communication setup** block. When an amplifier is connected, the **BPCW** software automatically acquires the communication speed saved in the amplifier. This value can be modified by the operator and saved into a PC file via the **Save configuration** function.
- The **Save configuration** function allows to save the serial port configuration in a PC file **BPCW. CFG** for avoiding the automatic research and a quicker restarting of the **BPCW** software.

The submenu **Software control** (accessible in the **BPCW** software version 2.0 and greater) allows the direct control of the amplifier by means of the PC via the functions **RUN** and **SPEED** during the commissioning phase (see chapter 5, § 1.1). This operation mode is also necessary for the use of the **AUTOPHASING PROCEDURE** function (see chapter 6, § 3.4).

## 4 - ADVANCED FUNCTIONS MENU

### 4.1 - MOTOR PARAMETERS

The **AUTO-PHASING PROCEDURE** function identifies the parameters **Pole pairs**, **Phase order** and **Resolver offset** for a motor type which is not contained in the module **MOTOR LIST**.

The **MOTOR PARAMETERS DEFINED BY USER** function allows the access to all motor parameters described below:

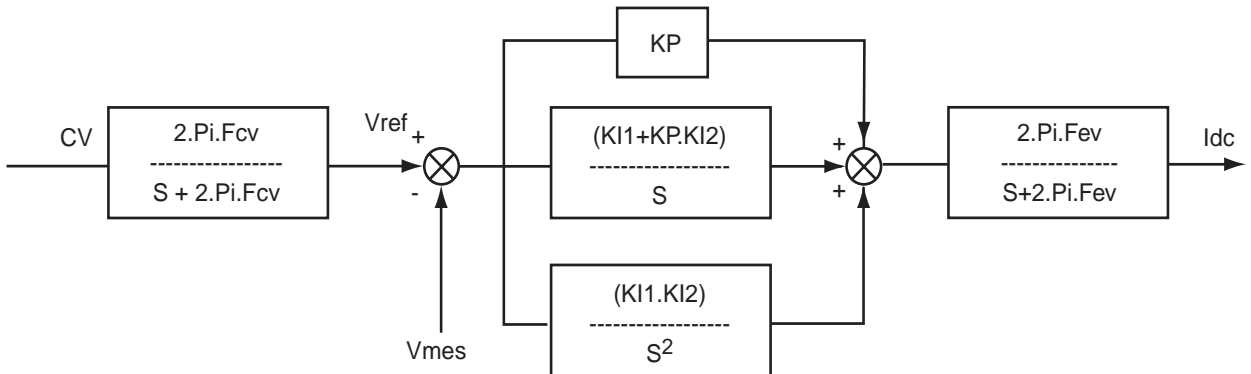
- The **Pole pairs** parameter defines the number of motor pole pairs.
- The **Phase order** parameter defines the sequence of the motor phases.
- The **Resolver offset** parameter defines the mechanical shift between both motor and resolver references.
- The **Current phase lead** parameter defines the current phase lead for the maximum speed of the motor. This phase lead is proportional to the motor speed and compensates the phase shift of the current loops in order to keep a maximum torque / current ratio in the motor.

The **CURRENT PHASE LEAD CALCULATION** function calculates the **Current phase lead** parameter according to the following motor specifications: **Motor torque constant** (in Nm/A), **Motor terminal inductance** (in mH)

and **Motor maximum speed** (in rpm). This procedure is used for motors which are not included in the module **MOTOR LIST**.

#### 4.2 - CONTROLLER PARAMETERS

The structure of the speed regulator is shown below:



Adjustable gain parameters:

- The **Speed error low pass filter** parameter defines the cut-off frequency at - 3 db (Fcv) of the first order filter (speed error). The value of this parameter depends on the selected band width.
- The **Proportional speed gain** parameter defines the proportional gain (KP) of the regulator (speed error). The adjustment range is between 0 and 4095.
- The parameter **Integral 1 speed gain** defines the first integral gain (KI1) of the regulator (speed error). The adjustment range is between 0 and 255.
- The parameter **Integral 2 speed gain** defines the second integral gain (KI2) of the regulator (speed error). The adjustment range is between 0 and 1.

All these gain parameters are automatically calculated during the execution of the **AUTO-TUNING** function.

#### 4.3 - ANALOG INPUT FILTER

The parameter **Analog input low pass filter** defines the cut off frequency at - 3 db (Fcv) of the first order filter which acts on the speed input command CV (or the current input command in torque mode) received by the amplifier. In standard, the value is set at 1000 Hz.

#### 4.4 – PULSE INPUT MODE DISABLING

The **Pulse input mode** function disables the pulse input mode selected for the "c" and "d" options (electronic gearing and stepping motor emulation) and enables the standard speed mode.

## 5 - UTILITIES

### 5.1 - READ DRIVE STATUS

This function allows the access to the display window of the logic inputs **ENABLE**, **FC+**, **FC-**, **CI** and **CV0** and to ALL amplifier faults (only the 1st priority fault is displayed on the amplifier front panel. [See chapter 7, section 2](#)).

Note: The information of this window correspond to the amplifier status when opening the window. The amplifier status modifications during the display of the window are not taken into account.

### 5.2 - DIGITIZING OSCILLOSCOPE

This function is accessible without the hardware key from the **BPCW** version **2.6**. It allows the access to the graphic window of the digitizing oscilloscope for the display of the amplifier control signals. The digitizing oscilloscope functions description is accessible in the **Help** menu of the **BPCW** software (select the **Help** menu, then the **Software menu** submenu, **Utilities** and **Digitizing oscilloscope**).

## 6 - "HELP" MENU

This menu allows the access to the information regarding the use of the **BPCW** software and the **SMT-BD1/400/I** amplifier.



## Chapter 6 – Commissioning

### 1 - CHECKING THE AMPLIFIER CONFIGURATION

The standard amplifier configuration for MAVILOR motors is the following:

- Customization board **P RES** resolver: 4 x 12,7 K $\Omega$  1 %.
- Adjustment of the current loops according to the table of [chapter 8, part 1](#).
- Motor thermal switch PTC : jumper **MN**.
- Positive logic: jumpers **E. F. G** closed.
- No auxiliary supply: jumper **JK** closed and jumper **KL** open.

See [Chapter 8, parts 2, 3 and 4](#) for the amplifier adjustment to other motor or resolver types or to another control logic.

### 2 - PUTTING INTO OPERATION

ENABLE input contact open and CV analog input open or short-circuited.

Check the auxiliary supply: **rated value 230 Vrms single-phase**.

Switch on the auxiliary supply. The green Led "ON" must lit and the "Undervolt." fault must be displayed.

Check the DC bus voltage: **rated value 400 Vrms between phases**.

**Never exceed the maximum value of 480 Vrms (any mains fluctuation tolerances included).**

Switch on the power supply; the "Undervolt." fault must be cancelled.

The braking resistor must remain cool (**CAUTION ! This resistor is under very high voltage: 800 VDC**).

Check that the front panel fastening screws are correctly screwed in the rack.

#### CAUTION

In case of cut-off of the amplifier auxiliary supply, WAIT AT LEAST. 30 SECONDS before switching on again.

**After switching off the power supply, wait at least 3 min. before disconnecting or handling the amplifiers.**

### 3 - AMPLIFIER COMMISSIONING AND ADJUSTMENT

#### 3.1 - COMMUNICATION VIA THE SERIAL LINK

Connect the serial link RS 232 between the PC and the amplifier.

The "ENABLE" input must be open and the analog input command CV open or short-circuited.

Turn amplifier on and start the **BPCW** software under WINDOWS® on the PC by clicking twice on the **BPCW** icon ([see chapter 8, part 5](#) for installing the **BPCW** software).

If the message "**Drive is not on line**" appears on the screen, click on **OK** and check following points:

- the amplifier is on (green LED **ON** must lit),
- the amplifier and the PC are correctly connected via the RS 232 link,
- the software configuration (**Com. port and Baudrate**) in the submenu **Communication** via **Setup** menu is correct.

Leave the **Communication Setup** window by means of the button **Save configuration**.

### 3.2 - AMPLIFIER CONFIGURATION

Select the appropriate motor type in the **MOTOR LIST**. If the motor used is not in the **MOTOR LIST** module, see [part 3.4 of this chapter](#).

Select the amplifier type (**Drive list**) and the fan type (**Fan**) in the module **CURRENT**.

Select the amplifier current limitation mode (**I<sup>2</sup>t mode**) in the menu **CURRENT**. The **Fusing** mode should be selected for commissioning phases.

Check that the values of the **Maximum current** and **Rated current** parameters of the **CURRENT** module are compatible with the motor and the amplifier. Otherwise, modify them according to the appropriate motor and amplifier specifications.

Check that the values of the **Maximum speed** and **Accel. Time** parameters of the **ANALOG INPUT** module are compatible with the motor and the application. Otherwise, modify them according to the appropriate motor and application specifications.

Select the speed regulator type **P**, **PI** or **PI<sup>2</sup>** in the **CONTROLLER** module. In the case of an axis with an unbalanced load (constant torque due to a vertical load), see [part 3.5 of this chapter](#).

Select the **Software control** function accessible in the **Setup** menu of the **BPCW** software version 2.0 and switch on **STOP** position in the **RUN** module.

**Before applying the AUTO-TUNING command of the CONTROLLER module, check that the motor shaft is free and for free rotation (1 revolution) that is not dangerous for the operator and the machine.**

After the **AUTO-TUNING** procedure, check that the motor correctly runs in both directions in manual control mode (**MANUAL**), with the **SPEED** function and a digital speed input command in the **Reference** block.

In case of loud noise in the motor at standstill and when running, check the rigidity of the transmission between motor and load (backlashes and elasticities in gears and couplings).

If necessary, renew the **AUTO-TUNING** procedure by selecting a lower bandwidth (**Bandwidth = Medium or Low**). If the problem remains, renew the **AUTO-TUNING** procedure by activating the antiresonance filter (**Filter = Antiresonance**). The antiresonance filter is accessible from the **BPCW** version **2.6** and amplifier EPROM version **5.7**.

Check the response at a low speed level without IDC saturation in manual control (**MANUAL**) with the **SPEED** function or in automatic control (**AUTOMATIC**) with an analog speed input command on CV of X4.

Adjust with more accuracy the speed loop response stability by means of the **Stability gain** buttons in the lower part of the **CONTROLLER** module, if necessary.

Short-circuit the "CV" input of the X4 connector or enter a zero speed input command in the NC if you want to compensate the offset of the whole system amplifier + NC.

Start the **OFFSET COMPENSATION** function of the **ANALOG INPUT** module or by means of the **OFFSET** button on the amplifier front panel.

Start the **MODIFY** function in the module **ENCODER RESOLUTION** and select the encoder signal specifications on the channels A, B and Z of the X2 connector (see [chapter 5, § 1 - 2](#) for the resolution limitation with the motor maximum speed).

The **Programmation** function starts the memory programming of the encoder output on the amplifier.

### 3.3 - SAVING OF THE AMPLIFIER PARAMETERS

Save all parameters in the amplifier EEPROM by means of the **SAVE PARAMETERS TO EEPROM** function of the menu **Files**.

Save all parameters in a file **File Name.PAR** by means of the function **SAVE PARAMETERS FILE** of the **Files** menu. This file can then be loaded into the **BPCW** software by the function **LOAD PARAMETERS FILE** of the **Files** menu.

Leave the **BPCW** software via the **EXIT** function of the **Files** menu.

### 3.4 - AMPLIFIER ADJUSTMENT TO A NEW MOTOR

If the motor used is not in the **MOTOR LIST** module, proceed as follows:

Select the amplifier type (**Drive list**) and the fan type (**Fan**) in the module **CURRENT**.

Select the amplifier current limitation mode (**I<sup>2</sup>t mode**) in the menu **CURRENT**. The **Fusing** mode should be used for the commissioning phases.

Check that the value of the **Maximum current** and **Rated current** parameters of the **CURRENT** module are compatible with the motor and the amplifier. Otherwise, modify them according to the appropriate motor and amplifier specifications.

Check that the value of the **Maximum speed** and **Accel. Time** parameters of the **ANALOG INPUT** module are compatible with the motor and the application. Otherwise, modify them according to the appropriate motor and application specifications.

Uncouple the motor from the mechanical load and check that the motor shaft is free and for free rotation (1 revolution) that is not dangerous for the operator.

Select the **Software control** function of the **Setup** menu in the **BPCW** software version 2.0 and switch on **STOP** position in the **RUN** module.

Select the function **AUTOPHASING PROCEDURE** in the menu **Advanced Functions** for defining the **Pole pairs**, **Phase order** and **Resolver offset** parameters.

Then select the **CURRENT PHASE LEAD CALCULATION** function of the **Advanced Functions** menu for the calculation of the **Current phase lead** parameter according to the specific motor parameters (this function is especially useful for motors with a low inductance and running at high speeds).

### 3.5 - SPEED LOOP ADJUSTMENT WITH A VERTICAL LOAD

In the case of an axis with an unbalanced load (constant torque due to a vertical load), proceed as follows:

1st method: load control by the PC

Select the current limitation mode **LIMITING** in the module **CURRENT**.

Select the speed regulator type **PI** or **PI<sup>2</sup>** in the **CONTROLLER** module.

Select the **Software control** function of the **Setup** menu in the **BPCW** software (this function is available from the **BPCW** version 2.0) and switch on **STOP** position in the **RUN** module.

Start at first the **AUTO-TUNING** function of the **CONTROLLER** module with the motor unloaded in order to initialize the speed loop gains.

Couple the motor to the load and move the shaft in manual control (**MANUAL**) with the **SPEED** function and a low digital speed input command in the **Reference** block until a maintaining position. Check that the free rotation (1 revolution) is not dangerous for the operator and the machine. Use the **MANUAL** function via the **SPEED** function and select a low digital speed input command in the **Reference** box for moving the shaft.

Then start the **AUTO-TUNING** function in the **CONTROLLER** module with the motor enabled at its maintaining position ( zero speed input command).

In case of loud noise in the motor at standstill and when running, check the rigidity of the transmission between motor and load (backlashes and elasticities in gears and couplings).

If necessary, renew the **AUTO-TUNING** procedure by selecting a lower bandwidth (**Bandwidth = Medium** or **Low**). If the problem remains, renew the **AUTO-TUNING** procedure by activating the antiresonance filter (**Filter = Antiresonance**). The antiresonance filter is accessible from the **BPCW** version 2.6 and amplifier EPROM version **5.7**.

Check then for the response at a low speed level without IDC saturation as in a traditional case without vertical load.

Go back to the shaft standstill position before switching on **STOP** or **AUTOMATIC** mode.

#### 2nd method: load control by the NC

(This method is only possible from the **BPCW** software version 2.0 and the **Firmware memory** version 2.4 of the **SMT-BD1** amplifier on).

Select the current limitation mode **LIMITING** in the module **CURRENT**.

Select the speed regulator type **PI** or **PI<sup>2</sup>** in the **CONTROLLER** module.

Start at first the **AUTO-TUNING** function of the **CONTROLLER** module as described in [chapter 6, § 3.2](#)) with the motor uncoupled from its mechanical load in order to *initialize* the speed loop gains.

Start the **MODIFY** function of the module **ENCODER RESOLUTION** and select the encoder signal specifications on the channels A, B and Z of the X2 connector according to the position resolution in the NC.

The **Programmation** function starts the memory programming of the encoder output on the amplifier.

**Couple the motor with its load** and connect the amplifier with the NC. If possible, make an open loop control by means of the NC, otherwise close the position loop with a *stable gain*.

Move the shaft by means of the NC until a maintaining position where one motor revolution is not dangerous for operator and machine (far enough from the mechanical stops).

Start the **AUTO-TUNING** function of the **CONTROLLER** module with the motor at standstill. If the shaft is moving, then the **AUTO-TUNING** function has not been accepted by the amplifier.

In case of loud noise in the motor at standstill and when running, check the rigidity of the transmission between motor and load (backlashes and elasticities in gears and couplings).

If necessary, renew the **AUTO-TUNING** procedure by selecting a lower bandwidth (**Bandwidth = Medium or Low**). If the problem remains, renew the **AUTO-TUNING** procedure by activating the antiresonance filter (**Filter = Antiresonance**). The antiresonance filter is accessible from the **BPCW** version 2.6 and amplifier EPROM version **5.7**.

Adjust the position loop gains in the NC in order to get the required response.

If necessary, adjust more accurately the response stability of the speed loop by means of the push buttons **Stability gain** of the **CONTROLLER** module.

## Chapter 7 - Fault finding

### 1 - SYSTEM FAULT

If the red **SYS** led is lit when the amplifier is on, the logic board is defective.

- Check that the EPROM firmware memory is correctly plugged on the amplifier.
- Check for the possible presence of any conducting dust that may involve short-circuits on the amplifier logic board.

### 2 - STORED FAULTS

If a fault occurs on the amplifier, it can generate the detection of several other faults which are only a consequence of the original one. In order to make diagnostic and maintenance easier, the faults are displayed and processed with the priority described below. For safety reasons, the power must be turned off for the cancelling of some faults that requires the handling of the amplifier; in this case, the RESET is automatic when power is turned on again. If power is not turned off, do not forget to make a RESET immediately after the fault elimination (pin 13 of X4 or RESET command in the **BPCW** software).

#### 2.1 - "BUSY" FAULT

- If the BUSY fault is continuously displayed after applying power to the amplifier, the **AUTOTEST** procedure has failed and the board is not ready for operation.
- If the BUSY fault is continuously displayed after the execution of the **AUTO-PHASING** function, the procedure has failed because of an external cause and the calculated parameters are wrong. Check that the **ENABLE** input is actually open. Then check that the motor is unloaded and the shaft movement is free during the procedure.
- If the BUSY fault is continuously displayed after the execution of the **AUTO-TUNING** function, the procedure has failed because of an external cause and the calculated parameters are wrong. Check that the **ENABLE** input is actually open. Then check that the motor is unloaded and the shaft movement is free during the procedure.
- If the BUSY fault is continuously displayed after the execution of the **OFFSET COMPENSATION** function, the offset is exceeding 1 Volt. Check the voltage on the speed command input during the procedure.
- If the BUSY fault is continuously displayed after the execution of the **PROGRAMMATION** function in the **ENCODER RESOLUTION** module, the amplifier encoder output memory is defective.

#### 2.2 - "EEPROM" FAULT

- Check the presence of the EEPROM and check its correct orientation.
- If the fault remains, the EEPROM is not correctly initialized (**CHECKSUM**) or is not compatible with the amplifier software.

#### 2.3 - MOTOR OVERTEMPERATURE

- If the fault appears when starting the amplifier:
  - \* Check the configuration of the **MN** and **OP** jumpers with regard to the type of thermal switch used in the motor.
  - \* Check the connection between the thermal switch and the amplifier on the front panel X1 connector or the X6 connector on the back of the rack.
- If the fault appears during the operation:
  - \* Check the motor temperature and look for the reason of this overheating (mechanical shaft overload, duty cycle too high, ...).

#### 2.4 - "UNDERVOLT." FAULT

- If the fault appears when starting the amplifier:
  - \* Check that the power supply is on.

#### 2.5 - "°C AMPLIFIER" FAULT

Check that the fan is correct with regard of the rated current required (see current table, [Chapter 2, part 1](#)).

#### 2.6 - "POWER STAGE" FAULT

- If the fault appears when starting the amplifier:
  - \* Check the DC bus voltage and the terminal voltage of the three-phase power input 400 VAC (DC bus < 800 VDC and three-phase input < 480 VAC).
- If the fault appears during the operation:
  - \* Check the braking system during the deceleration phases,
  - \* Check the sizing of the braking resistor with regard to the deceleration phases.
  - \* Check that the current cycle corresponds to the current table ([see chapter 2, part 1](#)).
  - \* Check for no short-circuit in the motor wiring and at the motor terminals.

#### 2.7 - "RESOLVER" FAULT

- Check the resolver connection on the amplifier connector X1.
- Check the presence of the P-RES components.
- Check that the resolver type is correct with regard to the P-RES components.
- Check the connections between the resolver and the amplifier and the resolver terminals.

#### 2.8 - "R.D.C" FAULT

- If the fault appears when starting the amplifier:
  - \* Check that the values of the P-RES components and the resolver transformation ratio are correct.
- If the fault appears during the operation:
  - \* Check that the motor speed does not exceed the speed limit defined below.
    - If **Maximum speed** ≤ 900 rpm, then the speed limit = 900 rpm.
    - If 900 rpm < **Maximum speed** ≤ 3600 rpm, then the speed limit = 3600 rpm.
    - If 3600 rpm < **Maximum speed** ≤ 14000 rpm, then the speed limit = 14000 rpm.
  - Be careful about the torque mode operation (CI command activated on X4) where the motor speed is determined by the load.

#### 2.9 - "I<sup>2</sup>T" FAULT

- Check the rated current value required with regard to the table of currents authorized in pulse mode cycle ([chapter 2, part 1](#)).
- Check the rated current of the amplifier defined in the **Rated current** parameter with regard of the current required for the operation cycle.

### 3 - OPERATING PROBLEMS

#### 3.1 - MOTOR DOES NOT MOVE

- Check that the amplifier is on.
- Check that the power supply is on.
- Check the amplifier fuses (F1 and F2) and the motor connection.
- Check the logic wiring of the signals FC+, FC- and ENABLE ([chapter 8, part 4](#)).

#### 3.2 - MOTOR SUPPLIED, BUT NO TORQUE

- Check that the **Maximum current** and **Rated current** parameters have no zero value.
- Check that the amplifier is not operating in torque mode (CI command active on X4) with zero input command.

#### 3.3 - SHAFT LOCKED, ERATIC OSCILLATIONS OR ROTATION AT MAXIMUM SPEED

- Check that the **Pulse input mode** is disabled in the **Advanced functions** menu ([chapter 5, part 4.4](#)).
- Check the proper motor choice in the **MOTOR LIST** module.
- Check the resolver wiring on the X1 connector and the mechanical mounting of the resolver on the motor.
- Check the value of the **Motor parameters** parameter in the **Advanced Functions** menu and execute the **AUTO-PHASING** command again, with unloaded motor, if necessary ([see chapter 6, part 3](#)).

#### 3.4 - DISCONTINUOUS MOTOR ROTATION WITH ZERO TORQUE POSITIONS

- Check the connection of the 3 phase cables between motor and amplifier.

#### 3.5 - MOTOR DRIFT WITH ANALOG INPUT COMMAND AT ZERO SPEED

- Check that the input command wiring between the controller and the amplifier corresponds to the recommendations of chapter 4 (CV at diff. low of the NC and 0 Volt cable).
- Check the offset compensation and, if necessary, execute the **Offset compensation** command.

#### 3.6 - LOUD CRACKLING NOISE IN THE MOTOR AT STANDSTILL

- Check that the motor-amplifier-controller ground connections correspond to the [recommendations of chapter 4](#).
- Check that the speed input command wiring between controller and amplifier correspond to the [recommendations of chapter 4](#) and check the shield connection of the resolver cables.

### 3.7 - LOUD NOISE IN THE MOTOR AT STANDSTILL AND WHEN RUNNING

- Check the rigidity of the mechanical transmission chain between motor and load (backlash and elasticity in the gearboxes and couplings).
- Execute the **AUTOTUNING** command again by choosing a lower bandwidth (**Medium** or **Low**).
- If the problem remains, renew the **AUTO-TUNING** procedure by activating the antiresonance filter (**Filter = Antiresonance**). The antiresonance filter is accessible from the **BPCW** version 2.6 and amplifier EPROM version **5.7**.

### 3.8 - POSITION CONTROL NOT POSSIBLE WITH THE NC

- Check the presence of the A, B and Z signals on the amplifier X2 connector by turning manually the motor shaft and check the wiring between NC and amplifier.
- Check if the **Maximum speed** and **Encoder resolution** parameters are correct ([see table in chapter 5, part 1.2](#)).
- Check the counting direction of the NC with regarding to the sign of the speed input command. If there is a reversal, use the function **Reverse Movement** in the **BPCW** software to get a correction operation.

## 4 - SERVICE AND MAINTENANCE

When exchanging an amplifier on a machine, proceed as follows:

- Check for the new amplifier has the same hardware configuration as the old amplifier,
- Plug in the **parameter EEPROM** (or a copy of it) of the old amplifier on the new one,
- Apply a zero speed input command and start the automatic **offset compensation** procedure by means of the button on the amplifier front panel.

**The new amplifier is configurated like the old one.**



## Chapter 8 – Appendix

### 1 - HARDWARE ADJUSTMENTS

All hardware adjustments of the SMT-BD1-400/I amplifier module are located on the hardware location diagram.

For the **BL** and **MA MAVILOR** motor series, the current loop adjustments are made by means of the **B1**, **B2**, **B3** jumpers according to the table below:

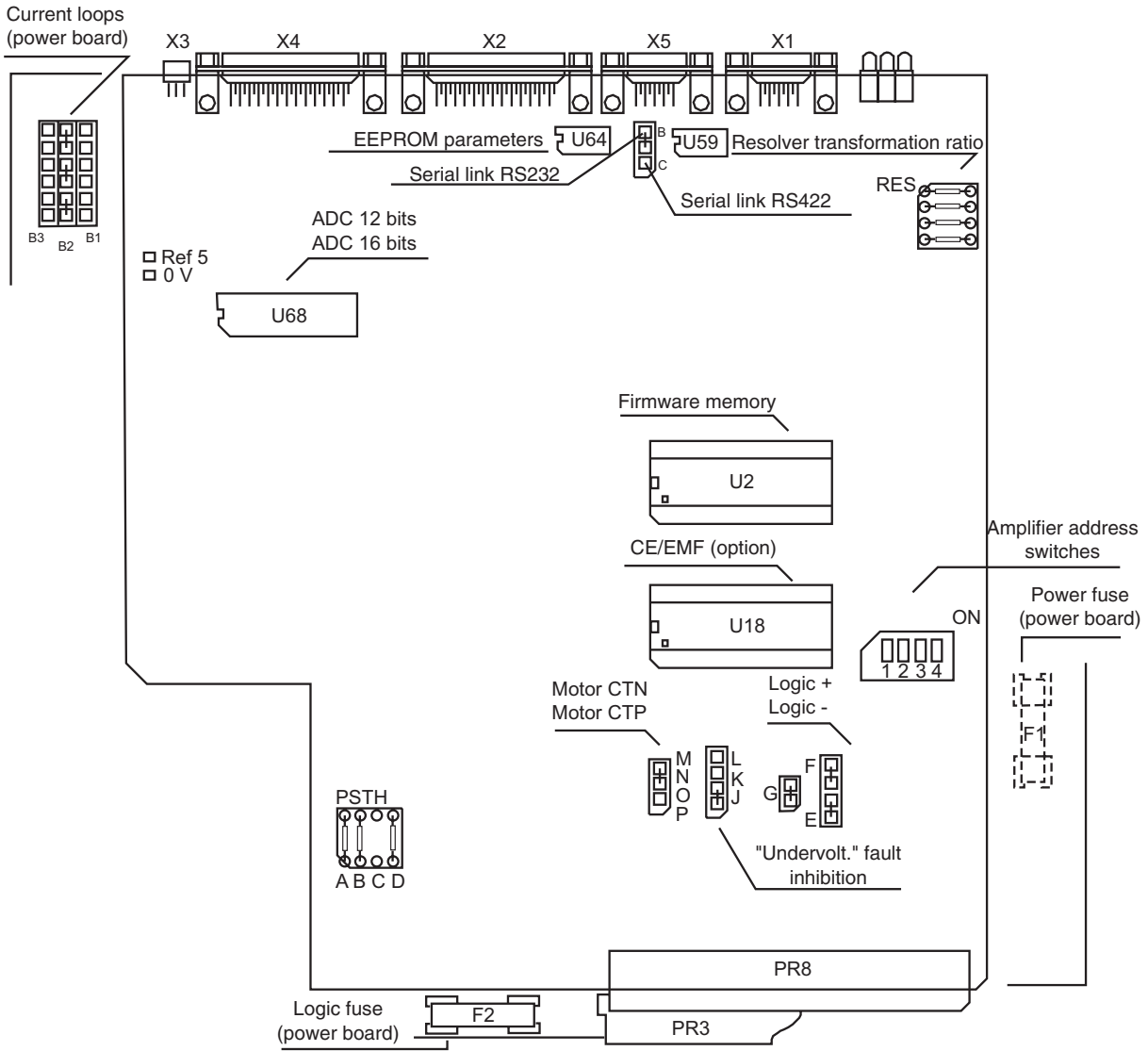
MOTOR	AMPLIFIER	15 A	30 A	45 A	60 A	100 A
MA 10		B2	B1			
MA 20		B2	B1	B2		
MA 30		B3	B2	B2	B2	
MA 45			B3	B3	B2	
MA 55				B3	B3	
BL 112		B3	B2			
BL 113		B3	B3	B3		
BL 114		B3	B3	B3		
BL 115			B3	B3		
BL 141			B3	B3	B2	
BL 142			B3	B3	B2	
BL 143			B3	B3	B2	
BL 144			B2	B2	B2	
BL 191					B3	B2
BL 192					B3	B2

In standard, the analog-digital converter (ADC) of the analog speed input command has a 12 bit resolution (ref.: **ADS 7804**). In option, the amplifier is available with a 16 bit converter (ref.: **ADS 7805**).

In standard, the serial link is the RS232 link (**jumper B closed**). In option, the amplifier can be delivered with a RS422 serial link (**jumper C closed**).

The **Firmware memory** of the amplifier standard version is "**X.XA**" with the logic board 01612A, "**X.XB**" with the logic board 01612B, "**X.XC**" with the logic board 01612C and "**X.XC**" with **X.X** greater than 5.0 with the logic board 01640A.

**DIAGRAM OF THE HARDWARE ADJUSTMENTS**

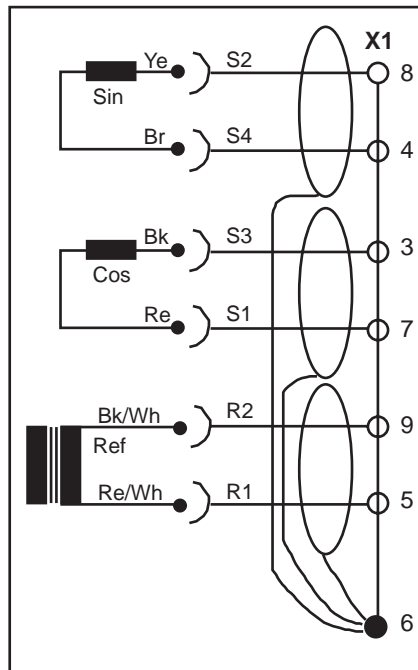


**NOTE:** PSTH = Threshold adjustment for thermal probe on logic board 01640 only

**For amplifier ratings 4 A to 100 A**

## 2 - RESOLVER CONNECTIONS

For the use of other **resolvers** others than those mounted on standard MAVILOR motors, please see wiring diagram below, as well as the manufacturer's specifications.



Bk = black      Re = red      Bl = blueWh = white      Br = brown      Ye = yellow

For the use of **resolvers** with **transformation ratios** others than 0,5, the Cos and Sin signal amplitude must be adjusted by means of the "P-RES" components according to the table below:

TRANSFORMATION RATIO	P-RES			
	0,3	0,45	0,5	1
A - B - C - D (tolerance < 1 %)	21 K	14,3 K	12,7 K	6,34 K

It may be sometimes necessary, for some resolvers, to adjust the phase shift between the Reference and the Cos and Sin signals, by means of a specific capacitor. This adjustment is factory set by INFRANOR.

### Note

When using resolvers with a number of pole pairs  $N > 1$ , all speed values displayed in the amplifier are equal to  $N$  times the motor rotation speed.

## 3 - MOTOR CONNECTIONS

### 3.1 - MOTOR THERMAL SENSOR

The thermal probe is connected to the **X1** resolver connector, pins 1 and 2.

#### 3.1.1 - PTC THERMAL PROBE

On motors with a PTC thermal probe (relay opening at triggering), the amplifier configuration is the following: **MN** jumper closed and **OP** jumper open.

The triggering threshold adjustment for the PTC thermal probes is made by means of the PSTH components, as described below:

PSTH-D = 14,3 k $\Omega$  / PSTH-B = 28 k $\Omega$

PSTH-A = 3 x RPTC (120°C) in k $\Omega$ .

RPTC (120°C): ohmic value of the PTC thermal probe resistor at 120°C.

As standard, PSTH-A = 10 K $\Omega$ , that is RPTC (120°C) # 3 K $\Omega$ .

### 3.1.2 - NTC THERMAL PROBE

On motors with an NTC thermal probe (relay closing at triggering), the amplifier configuration is the following: **OP** jumper closed and **MN** jumper open.

The triggering threshold adjustment for the NTC thermal probes is made by means of the PSTH components, as described below:

PSTH-D = 14,3 k $\Omega$  / PSTH-B = 28 k $\Omega$

PSTH-A = 3 x RNTC (120°C) in k $\Omega$ .

RNTC (120°C): ohmic value of the NTC thermal probe resistor at 120°C.

As standard, PSTH-A = 10 K $\Omega$ , that is RNTC (120°C) # 3 K $\Omega$ .

### 3.2 - CURRENT LOOPS

The adjustment of the current loop **P.I. regulators** according to the **amplifier current** and to the **inductance between the motor terminals** is made as follows:

15 A and 30 A AMPLIFIERS

- Calculation of **G = 0,8. Amplifier current (A) . Inductance between phases (mH)**,
- If **G < 60**, current loop jumpers (x3) on **B3** position,
- If **60 < G < 100**, current loop jumpers (x3) on **B2** position,
- If **G > 100**, current loop jumpers (x3) on **B1** position.

45 A, 60 A AND 100 A AMPLIFIERS

- Calculation of **G = 0,8. Amplifier current (A) . Inductance between phases (mH)**,
- If **G < 100**, current loop jumpers (x3) on **B3** position,
- If **100 < G < 250**, current loop jumpers (x3) on **B2** position,
- If **G > 250**, current loop jumpers (x3) on **B1** position.

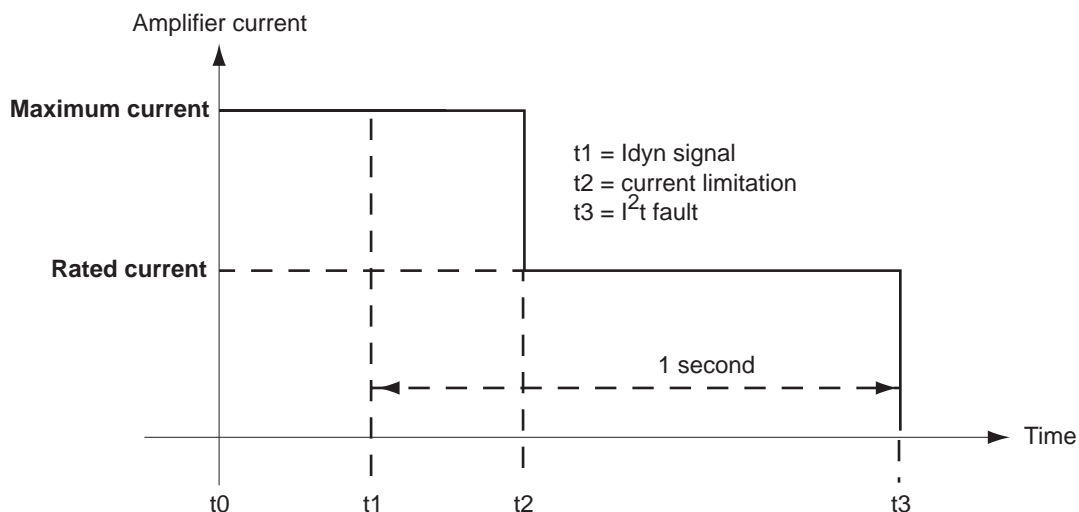
### 3.3 - I<sup>2</sup>t PROTECTION

#### Current limitation in Fusing mode

When the amplifier RMS current (I<sup>2</sup>t) reaches 85 % of the **Rated current**, the Idyn signal output is activated and the I<sup>2</sup>t error display is blinking on the amplifier front panel. If the RMS current (I<sup>2</sup>t) has not dropped below 85 % of the **Rated current** within 1 second, the I<sup>2</sup>t fault is released and the amplifier is disabled (otherwise, the Idyn signal and the blinking I<sup>2</sup>t error display are both cancelled).

When the amplifier RMS current (I<sup>2</sup>t) reaches the **Rated current** value, the I<sup>2</sup>t protection limits the amplifier current at this value.

The amplifier current limitation diagram in an extreme case (motor overload or locked shaft) is shown below.



The maximum current duration before the release of the Idyn signal depends on the value of the **Rated current** and **Maximum current** parameters. This value is calculated as follows:

$$T_{\text{dyn}} (\text{second}) = t_1 - t_0 = 3.3 \times \left[ \frac{\text{Rated current (\%)}}{\text{Maximum current (\%)}} \right]^2$$

The maximum current duration before the limitation at the rated current also depends on the value of the **Rated current** and **Maximum current** parameters. This value is calculated as follows:

$$T_{\text{max}} (\text{second}) = t_2 - t_0 = 4 \times \left[ \frac{\text{Rated current (\%)}}{\text{Maximum current (\%)}} \right]^2$$

#### NOTE 1

The above formulas are valid as long as the **Maximum current / Rated current** ratio is higher than 3/2. When the **Maximum current / Rated current** ratio is close to 1, the calculated values of Tdyn and Tmax are quite below the real values. For example when **Maximum current / Rated current** = 1.2, the measured Tdyn = 3.4 seconds and the measured Tmax = 4.4 seconds. When the **Maximum current / Rated current** ratio is equal to 1, the I<sup>2</sup>t protection is no more disabling the amplifier but the current is limited at the **Rated current** value.

#### NOTE 2

The amplifier I<sup>2</sup>t signal can be displayed on the digitizing oscilloscope by selecting the "I<sup>2</sup>t" signal in the "Channel" menu. The I<sup>2</sup>t signal threshold values according to the I<sup>2</sup>t protection mode described above are calculated in the following manner :

$$\text{Idyn signal activation threshold (\%)} = \left[ \frac{\text{Rated current (\%)}}{70} \right]^2$$

$$\text{Current limitation threshold (\%)} = \left[ \frac{\text{Rated current (\%)}}{50} \right]^2$$

The corresponding amplifier RMS current value can be calculated according to following formula :

$$\text{Amplifier RMS current (\%)} = \left[ \text{I}^2\text{t signal value (\%)} \times 50 \right]^{1/2}$$



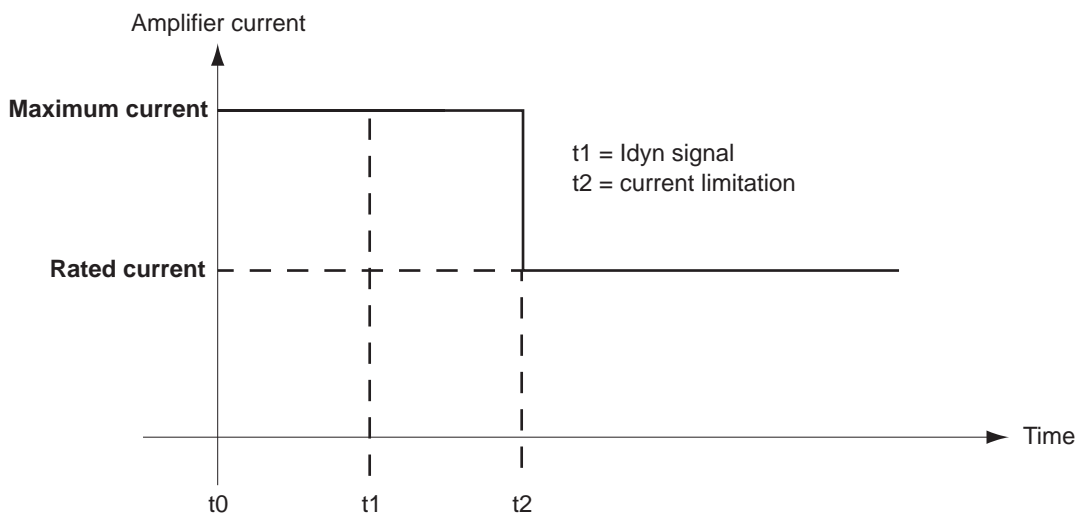
**In Fusing mode**, the amplifier **Rated current** value must be adjusted lower or equal to the **Maximum authorized rated current** of the amplifier (see [Chapter 2, section 1](#)).

Current limitation in **Limiting** mode (with the **BPCW** version 2.0 and greater and with amplifier EPROM version 2.4 and greater)

When the amplifier RMS current (I<sup>2</sup>t) reaches 85 % of the **Rated current**, the Idyn signal output is activated and the I<sup>2</sup>t error display is blinking on the amplifier front panel. When the RMS current (I<sup>2</sup>t) drops below 85 % of the **Rated current**, the Idyn signal and the blinking I<sup>2</sup>t error display are both cancelled.

When the amplifier RMS current (I<sup>2</sup>t) reaches the **Rated current** value, the I<sup>2</sup>t protection limits the amplifier current at this value.

The amplifier current limitation diagram in an extreme case (motor overload or locked shaft) is shown below.



The maximum current duration before the release of the  $I_{dyn}$  signal output ( $t_1 - t_0$ ) and before limitation at the rated current ( $t_2 - t_0$ ) is calculated the same way as for the **Fusing** mode.

The  $I^2t$  signal threshold values and the amplifier RMS current value on the digitizing oscilloscope, are also calculated the same way as for the **Fusing** mode.

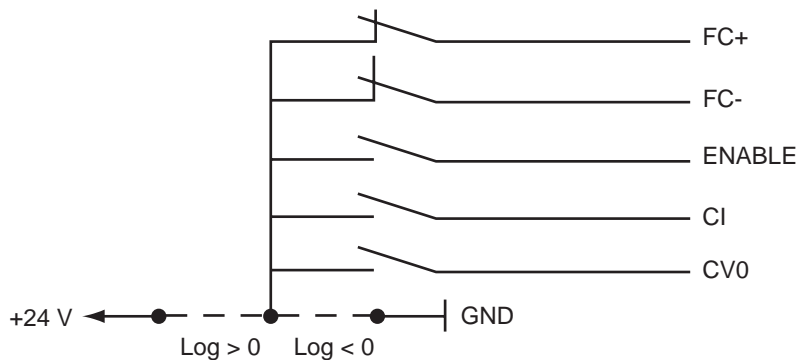


In **Limiting mode**, the amplifier **Rated current** value must be adjusted lower or equal to the **Maximum authorized continuous current** of the amplifier (see [Chapter 2, section 1](#)).

## 4 - LOGIC CONTROL ADJUSTMENT

### 4.1 - POSITIVE OR NEGATIVE LOGIC INPUTS

The logic inputs **FC+**, **FC-**, **ENABLE**, **CI** and **CV0** of the logic connector **X4** can be configured in positive logic (control by +24 V) or in negative logic (control by 0 V) as described below:



POSITIVE LOGIC: E-F-G jumpers closed.  
Input impedance: 10 K $\Omega$ .

Range: active at level  $5 < V < 30$  V.  
Response time: 500  $\mu$ s

NEGATIVE LOGIC: E-F-G jumpers open.  
Input impedance: 10 K $\Omega$ .

Range: inactive or open at level  $5 < V < 30$  V.  
Response time: 500  $\mu$ s

**Remark:** The five inputs (**FC+**, **FC-**, **ENABLE**, **CI**, **CV0**) of the **X4** connector must **all** be in positive logic, or **all** in negative logic.

### 4.2 - USE OF THE "LIMIT SWITCH" INPUTS

During the amplifier operation in speed mode (**CI** logic input disabled), the enabling of the **FC+** limit switch inhibits any CW motor rotation and the enabling of the **FC-** limit switch inhibits any CCW motor rotation.

During the amplifier operation in torque mode (**CI** logic input enabled), the enabling of the **FC+** limit switch locks the amplifier torque input commands between 0 V and + 10 V and the enabling of the **FC-** limit switch locks the amplifier torque input commands between 0 V and - 10 V. In the earlier amplifier EPROM versions than 5.7, the limit switches have no effect in torque mode.

### 4.3 - USE OF THE "AMP. READY" AND "POWER READY" OUTPUTS

If the position initialization references must be kept when a stored fault is released on the amplifier or when the power supply is interrupted, it must be possible:

- ◇ to reset the faults via pin 13 of X4 without interrupting the logic supply,
- ◇ to have a logic supply which is independent from the power supply (auxiliary supply) in order to be able to cut the power supply without cutting the logic supply.

If the amplifier has an auxiliary supply on the PR8 connector, which is independent from the power supply, the **IJK** jumper of the power board allows to inhibit or to release the "**Undervolt**." fault when switching on the auxiliary supply before switching on the power supply.

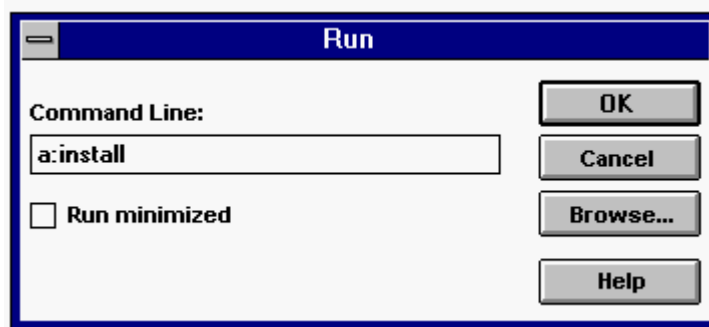
◇ **JK jumper closed and KL jumper open.** With the auxiliary supply applied before the main power supply, the "Undervolt." fault is displayed and can hide a fault of lower priority. The "AMP READY" and "POWER READY" outputs are both inactive (contact is open) until the power supply is on.

◇ **JK jumper open and KL jumper closed.** The "Undervolt." fault is inhibited when turning on the auxiliary supply before switching on the main power supply. The "AMP READY" output is then active and "POWER READY" remains inactive (contact open) until the main power supply is on. In this case, the amplifier control must have following relay logic.

For the wiring of the "AMP. READY" and "POWER READY" outputs:  
[see manual BF-400 rack.](#)

## 5 - BPCW SOFTWARE INSTALLATION

Under WINDOWS, select "execute" in the menu "File" of the **Programme manager**.  
 Then enter **a: install** ("a" is for the drive where the original software disk is into).



When the installation programme appears on the screen, modify, if necessary, the inputs "Source", "Destination" and "Group". Then click on "Install" to start the software installation.



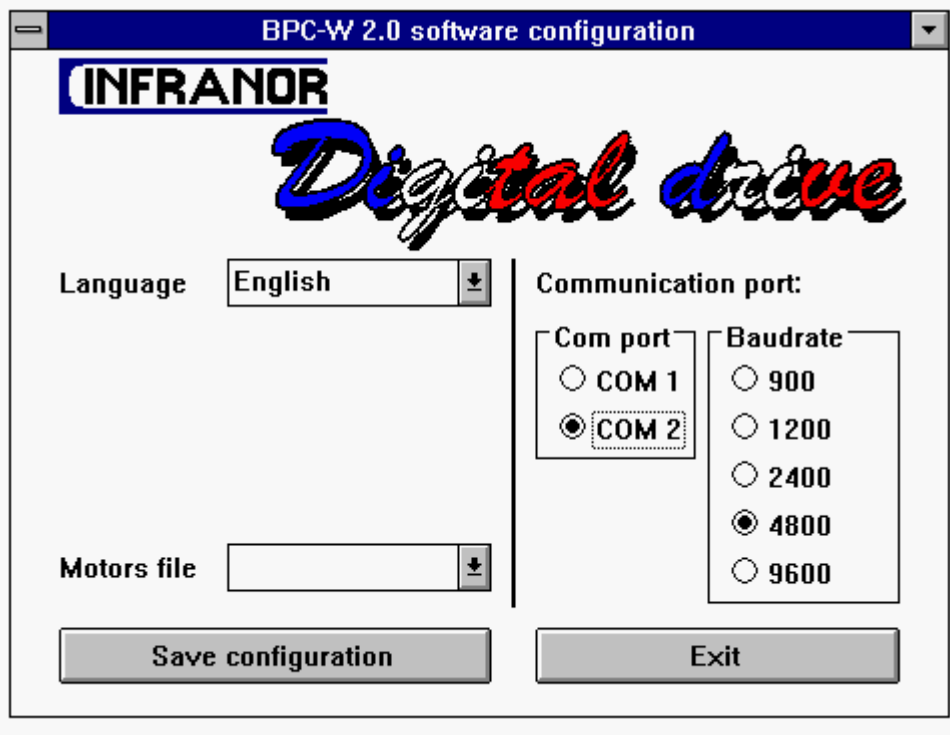
"Source" indicates the directory of the software original files.

"Destination" indicates the directory where the files will be loaded.

"Group" is the name of the software group under "Programme Manager".

After the copy of all files, click on "Exit" to close the installation procedure.

Under "Programme Manager", click on "Setup" in the group "Smtbd" for starting the software configuration programme.



Configure the communication port (port number and transmission speed). Click then on "Save configuration".

Leave the configuration programme by clicking on "Exit".

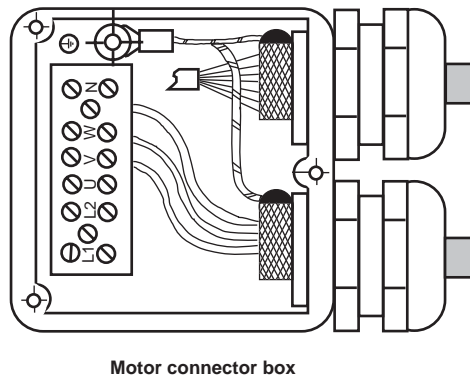
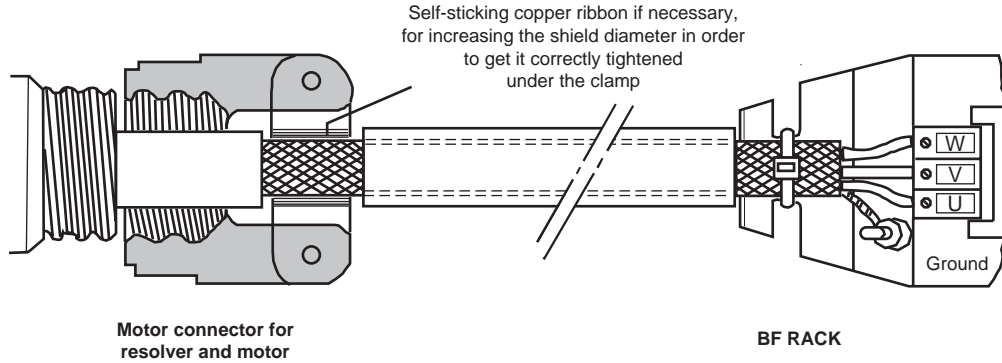
Click on "BPCW" for starting the "BPCW" software.



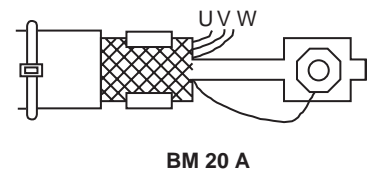
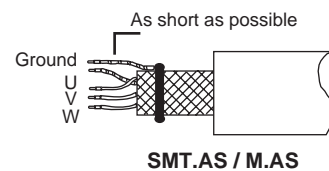
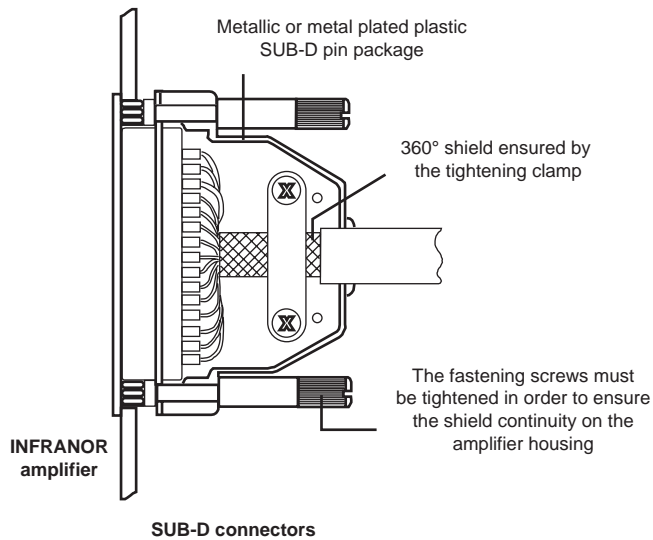
## 6 - 360° SHIELD ON THE CONNECTORS

### RULE

The shield must never be interrupted or corrupted over the whole cable length.



The cable can be soldered on the shield because the connector box is metallic. This solution does not exactly meet the EMC requirements but it is acceptable.



### NOTE

When the 360° shield is made by means of a clamp, it is not necessary to additionally connect a cable on the appropriate connection pin of the SUB-D connector.

## 7 - COGGING TORQUE COMPENSATION

The cogging torque in brushless permanent magnet rotating motors results from the interaction between the rotor magnets and the stator slots. This disturbance is due to the difference of reluctance between the copper of the windings and the iron of the stator teeth. For a given motor, the cogging can be easily evaluated by simply moving the motor manually when the amplifier is disabled. The Cogging Torque Compensation available in the SMT-BD1 amplifier allows to cancel the motor cogging effects for specific applications where torque accuracy higher than 1 % is required.

Proceed as follows for the cogging torque compensation setup:

Check for the presence of the **CT/EMF** memory (option) mounted on the amplifier logic board.

Check that the hardware key is correctly plugged on the parallel port of the PC in order

### **CAUTION**

The cogging torque compensation can only be used on motors equipped with a speed 1 resolver (resolver with one pole pair).

Start the amplifier commissioning and adjustment as described in [chapter 6](#).

Uncouple the motor from the load in order to avoid any external disturbance on the shaft during the cogging torque acquisition procedure.

Select the **PI<sup>2</sup>** controller type and execute the **auto-tuning** procedure with a **High bandwidth** while selecting the **Standard** filter.

Disable the **Reduced stiffness at standstill** command if selected.

Execute the **Cogging torque acquisition** procedure in **Software control** mode while selecting **Stop**. This procedure takes a few minutes because the motor is moving at low speed over 1 or 2 revolutions in both directions. The acquired cogging torque value is automatically stored in the amplifier EEPROM at the end of the procedure.

### **CAUTION**

The motor shaft must not be disturbed during the cogging torque acquisition procedure.

For checking the cogging torque compensation effects on the motor shaft, proceed as described below:

Switch the amplifier in torque control mode by activating the Ci input (X4 connector, pin 4) and short-circuit or open the analog command input CV (X4 connector, pins 15, 16 and 17).

Execute the **Offset compensation** procedure.

Check manually for the reduction of the cogging torque effects by moving the motor shaft when the **Cogging compensation** command is activated or deactivated with the amplifier enabled. If some resistant points do remain over one complete motor shaft revolution, renew the acquisition procedure.

Switch off the amplifier and couple the motor to the load.

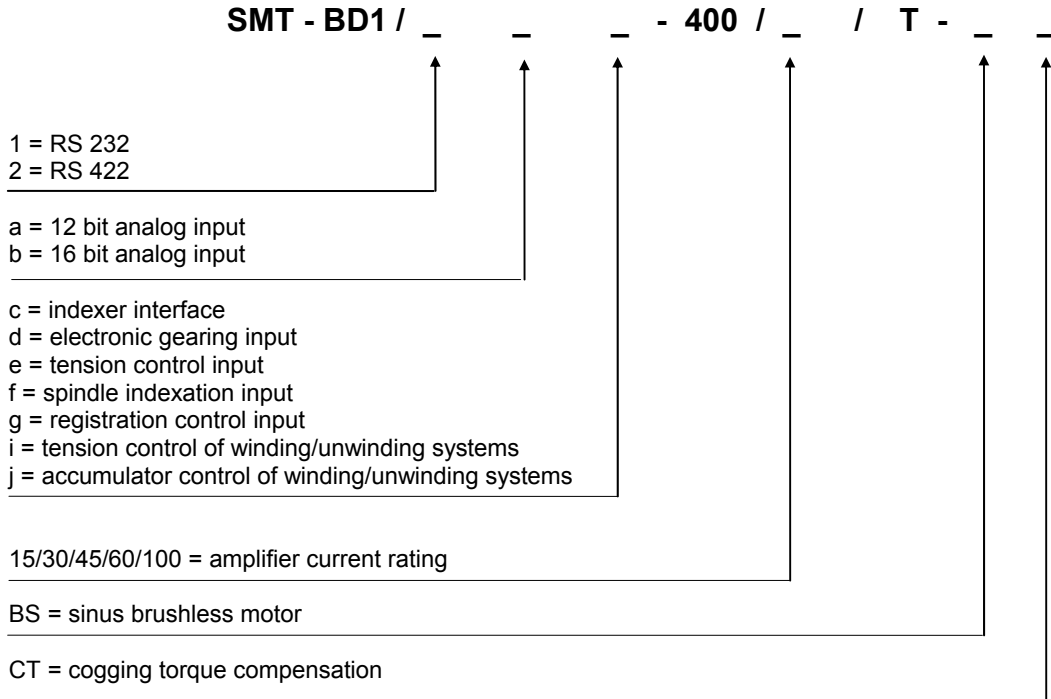
Switch on the amplifier again, enable the **Cogging compensation** command and execute the **Save parameters to EEPROM** procedure.

### **CAUTION**

When changing either the motor, the resolver, the amplifier or the EEPROM memory, the cogging torque acquisition procedure must be renewed.

## 8 - AMPLIFIER AND SOFTWARE TYPES

### 8.1 - AMPLIFIER TYPES



### 8.2 - BPCW SOFTWARE TYPE WITH THE HARDWARE KEY FOR WINDOWS®

