This manual describes the **option "i"** of the **SMT-BD1** amplifier: **Tension control of winding / unwinding systems**.

The general information about the digital amplifier commissioning are described in the standard **SMT-BD1** manual. This manual may be used in conjunction with appropriate and referenced drawings pertaining to the various specific models**.**

Maintenance procedures should be attempted only by highly skilled technicians (EN 60 204.1 standard) using proper test equipment.

The conformity with the standards and the "CE" approval are only valid if the items are installed according to the recommendations of the racks and amplifiers manuals.

Any contact with electrical parts, even after power down, may involve physical damage.

Wait for 30 seconds after power down before handling the rack or the amplifiers (residual voltage).

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

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

This manual is a translation of the original document and does not commit INFRANOR's responsibility. The french manual is the only reference document.

Updating index: **2.21**

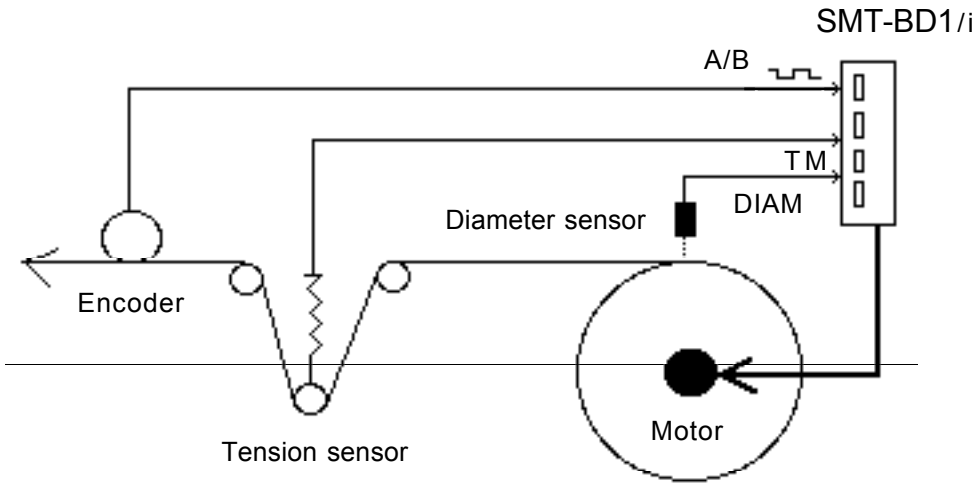
OPTION "i"

TENSION CONTROL OF WINDING/UNWINDING SYSTEMS

CONTENTS

CHAPTER 1 - GENERAL DESCRIPTION

The tension control for winding/unwinding systems requires the **SMT-I3-BD1** daughter board and the **X.X 6** EEPROM. In this configuration, the **SMT-BD1/i** amplifier controls the speed of the motor driving the spool, in order to maintain a constant material tension independently of its line speed and of the spool diameter. The material tension is controlled by the amplifier via a ± 10 V analogue signal (**TM**) provided by a tension sensor. The spool diameter measurement (**DIAM**) is also received by the amplifier as an analogue voltage between 0 V and 10 V. These signals are entered on the amplifier command connector **X4**. The material line speed is measured by an encoder which differential signals **A**, **/A** and **B**, **/B** in quadrature are received on the amplifier command connector **X2**. The system structure is described below.



The rotation speed of the empty spool is defined by the ratio between the line encoder resolution and the motor resolution (Empty spool speed = Line encoder speed x Ligne encoder resolution / Motor resolution). The motor encoder resolution is programmable between 1 and 8192 ppr. The maximum motor rotation speed (corresponding to the empty spool) is adjustable between 100 rpm and 14 000 rpm.

The motor speed reference value is continuously calculated in the amplifier according to the material line speed and the spool diameter (Motor speed = Line encoder speed x Line encoder resolution / Spool diameter / Motor resolution). A **P** or **PI** speed regulator continuously adjusts the motor speed to this reference value. The speed regulator gains are automatically matched according to the spool diameter in order to keep the dynamic performances and the stability of the servo loop in all load conditions.

The calibration, in the amplifier, of the diameter measurement allows an easy adjustment to various sensor types. The ratio between maximum diameter of the full spool and minimum diameter of the empty spool is adjustable between 1 and 100. In case of bad operation, if the diameter measurement (**DIAM**) is out of the normal variation range defined in the amplifier, the logic output **DER** is disabled on the command connector **X2**.

When placing the spool, it is possible to manually wind and unwind the material by using the logic inputs **JOG+** and **JOG-** when the tension regulator is disabled (logic input **TDI** active).

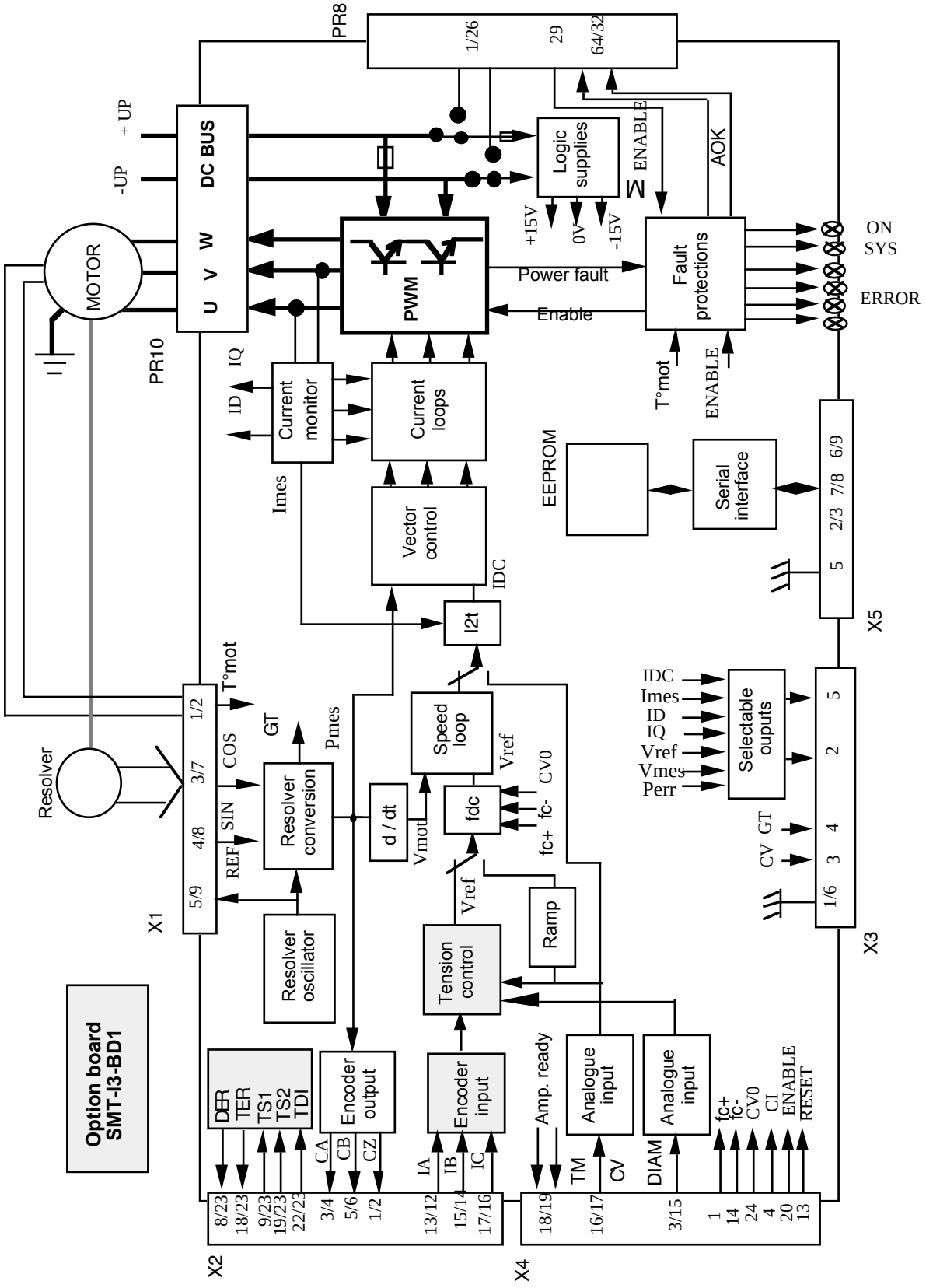
When the tension regulator PID is on (logic input **TDI** disabled), the motor speed is continuously adjusted in order to maintain a constant material tension (**TM**). Three different tension input command values can be programmed in the amplifier and are selectable by means of the logic inputs **TS1**and **TS2** on the command connector **X2**. In case of material breaking, when the tension measurement (**TM**) is below the reference threshold stored in the amplifier, the logic output **TER** is disabled on the command connector **X2**. The enabling of the logic input **CV0** on the command connector **X4** allows to quickly stop the spool.

CHAPTER 2 - SPECIFICATIONS

1 - MAIN TECHNICAL DATAS

Line speed measurement	Differential encoder input A, A/ and B, B/ Max. frequency = 250 kHz
Motor / encoder speed ratio (empty spool)	LER / MER LER = Line encoder resolution MER = Motor encoder resolution
Programmable motor encoder resolution	Max. 8 192 ppr up to 900 rpm Max. 4 096 ppr up to 3 600 rpm Max. 1 024 ppr up to 14 000 rpm
Spool diameter measurement	0 V to 10 V analogue input Resolution: 11 bits (15 bits optional) Low-pass filter: 10 Hz
Calibration of the spool diameter sensor	Voltage for minimum and maximum diameter: adjustable between 0 V and 10 V
Spool diameter ratio = max. diameter / min. diameter	Adjustable parameter from 1 to 100 Resolution = 0.005
P or PI speed regulator	Sampling period: 0,5 ms Anti-resonance filter Auto-tuning at setup Automatic Gains-Spool diameter matching
Speed loop bandwidth	Adjustable cut-off frequency: 50, 75 or 100 Hz
Material tension measurement	Analogue input: - 10 V to + 10 V Resolution: 12 bits (16 bits optional) Adjustable frequency low-pass filter
Material tension regulator PID	Sampling period: 0,5 ms Adjustable digital gains Adjustable tension ramping
Logic inputs	CV0: Spool stop TDI: Tension regulator disabling JOG+: Motor rotation direction + JOG-: Motor rotation direction - TS1: Tension reference selection (1 of 3) TS2: Tension reference selection (1 of 3)
Logic outputs	DER: Diameter measurement error TER: Tension measurement error

2 - AMPLIFIER BLOCK DIAGRAM



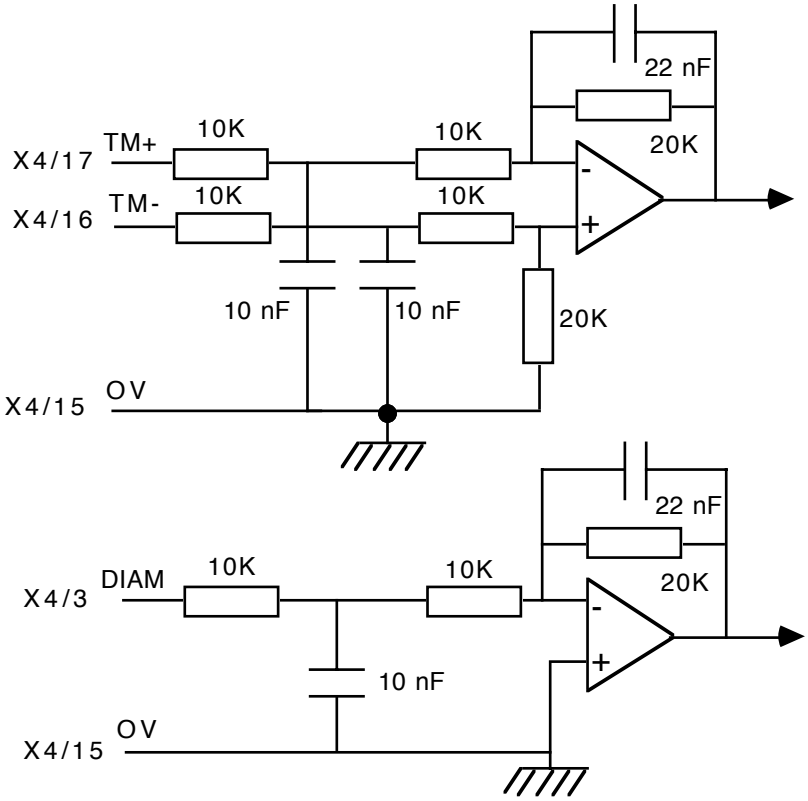
CHAPTER 3 - INPUTS - OUTPUTS

1 - X4 COMMAND CONNECTOR

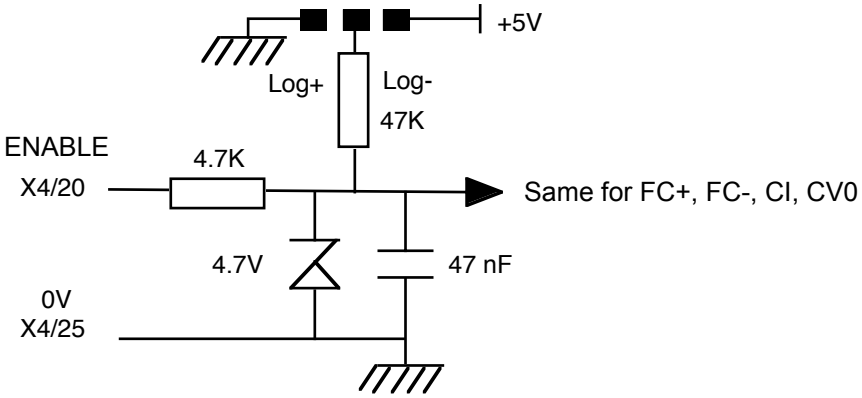
1.1 - PINS ALLOCATION

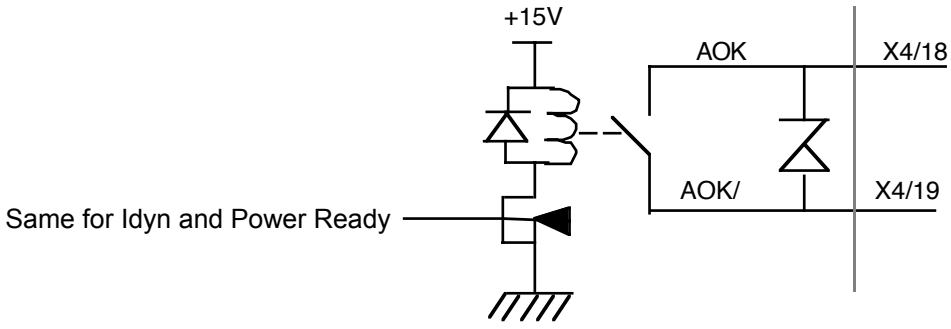
Pin	Function	I / O	REMARKS
1	Limit switch +	I	Positive or negative logic (see standard manual SMT-BD1)
14	Limit switch -	I	Positive or negative logic (see standard manual SMT-BD1)
24	0 V limit switch		
20	ENABLE	I	Positive or negative logic (see standard manual SMT-BD1)
23	0 V ENABLE		
4	Torque control CI	I	Positive or negative logic (see standard manual SMT-BD1)
7	P mode braking CV0	I	Positive or negative logic (see standard manual SMT-BD1)
25	0 Volt logic input		
13	Amplifier fault RESET	I	Resets amplifier via 0 V (contact between 13 and 12)
12	0 V RESET input		
17	Tension measurement TM+	I	Differential input of material tension measurement
16	Tension measurement TM-	I	between - 10 V and + 10 V
3	Diameter measurement DIAM	I	Spool diameter measurement input between 0 V and + 10 V
15	0 V analogue input		
10	Speed monitor output	O	± 8 V for ± 14000 rpm; linearity = 10 %; max. load: 10 mA
2	Current monitor output	O	± 10 V; resolution: 8 bits; load: 10 mA; (DAC out 2)
11	0 V analogue output		(10 V for amplifier current rating).
8, 9	I dyn warning of I^2t	O	Relay contact: open if I dyn threshold is reached Pmax = 10 W with Umax = 50 V or Imax = 100 mA
18, 19	Amp. Ready	O	Relay contact: closed if amplifier OK, open if fault. Pmax = 10 W with Umax = 50 V or Imax = 100 mA
21	+ 15 V	O	Max. 50 mA available
22	- 15 V	O	Max. 50 mA available
5, 6	non connected		

1.2 - ANALOGUE INPUTS OF X4



1.3 - LOGIC INPUTS/OUTPUTS OF X4



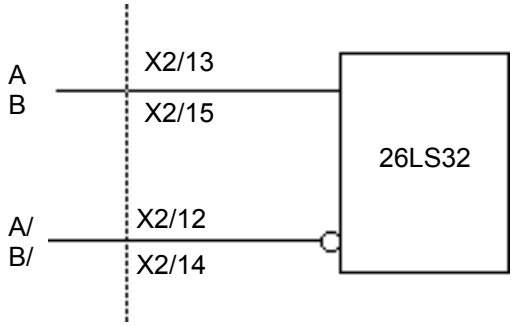


2 - X2 COMMAND CONNECTOR

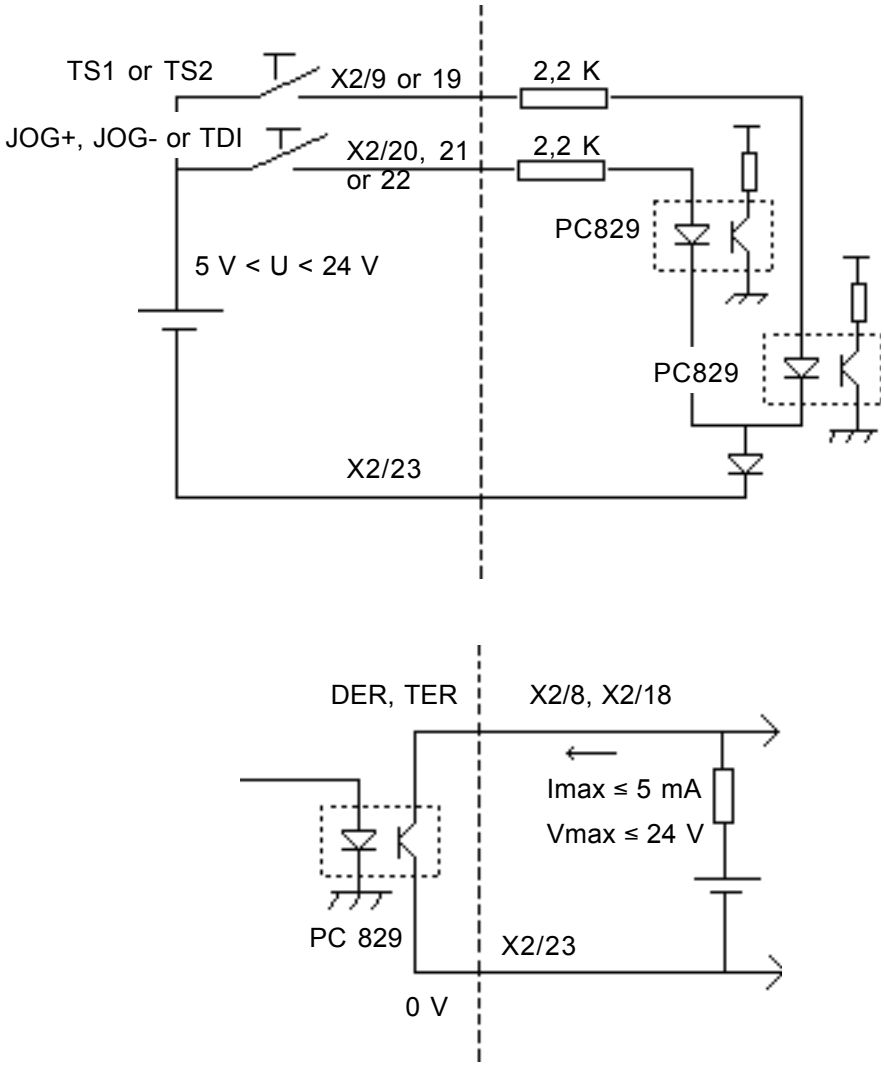
2.1 - PINS ALLOCATION

PIN	FUNCTION	I/O	REMARK
1	CZ/	O	Motor encoder output of the marker pulse (5 V, 20 mA)
2	CZ	O	Motor encoder output of the marker pulse
3	CA/	O	Motor encoder output channel A (5 V, 20 mA)
4	CA	O	Motor encoder output channel A
5	CB/	O	Motor encoder output channel B (5 V, 20 mA)
6	CB	O	Motor encoder output channel B
7,10,11	0 V		GND
12	IA/	I	Master encoder input channel A (5 V, consumption 2 mA)
13	IA	I	Master encoder input channel A
14	IB/	I	Master encoder input channel B (5 V, consumption 2 mA)
15	IB	I	Master encoder input channel B
24	+ 5 V		± 5 % 300 mA available with jumper 5 V closed, for master
25	0 V		encoder supply (if necessary)
16, 17	Reserved		Reserved
18	TER	O	Logic output: Tension measurement error
8	DER	O	Logic output: Diameter measurement error
23	0 V I/O	I	0 V of inputs/outputs
9	TS1	I	Logic input > 0: Selection of tension reference
19	TS2	I	Logic input > 0: Selection of tension reference
20	JOG+		Logic input > 0: Motor rotation direction +
21	JOG-	O	Logic input > 0: Motor rotation direction -
22	TDI		Logic input > 0: Tension disabling

2.2 - X2 ENCODER INPUT



2.3 - LOGIC INPUTS/OUTPUTS OF X2



3 - TEST CONNECTOR

Pin	Function	CHARACTERISTICS
1 - 6	0 V	
2	DAC 1 output	+/- 10 V, resolution: 8 bit, linearity: 2 % (IDC, Imon, ID, IQ, Vref, Vmon)*
3	Speed input command CV	+/- 10 V for +/- max. speed
4	Speed signal GT	+/- 8 V for +/- 14 000 rpm
5	DAC 2 output	+/- 10 V, resolution: 8 bit, linearity: 2 % (IDC, Imon, ID, IQ, Vref, Vmon)*

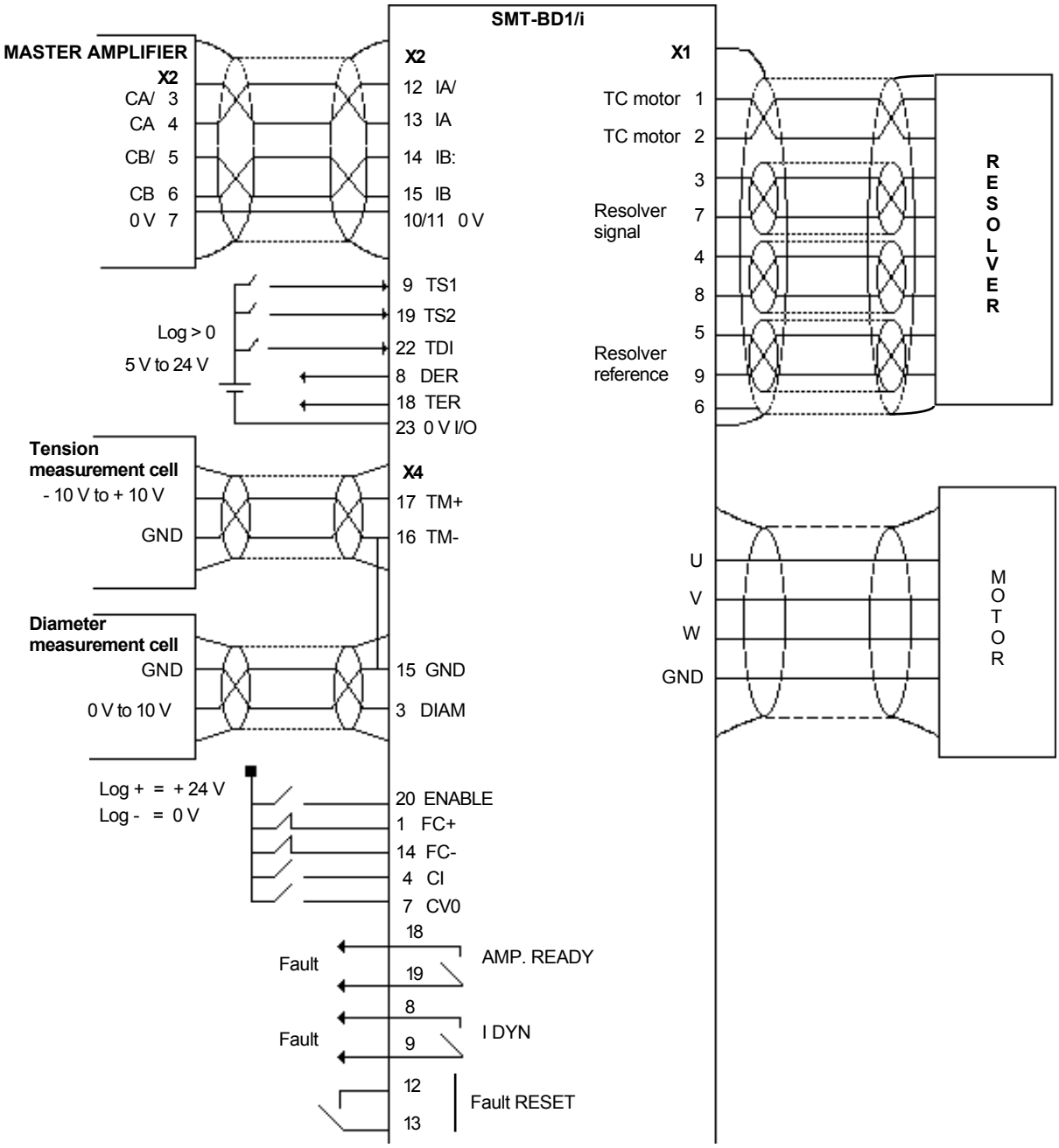
* See manual "**BPCW** Options", part "Digital oscilloscope".

Linearity = 10 % on logic boards 01612A, 01612B and 01612C.

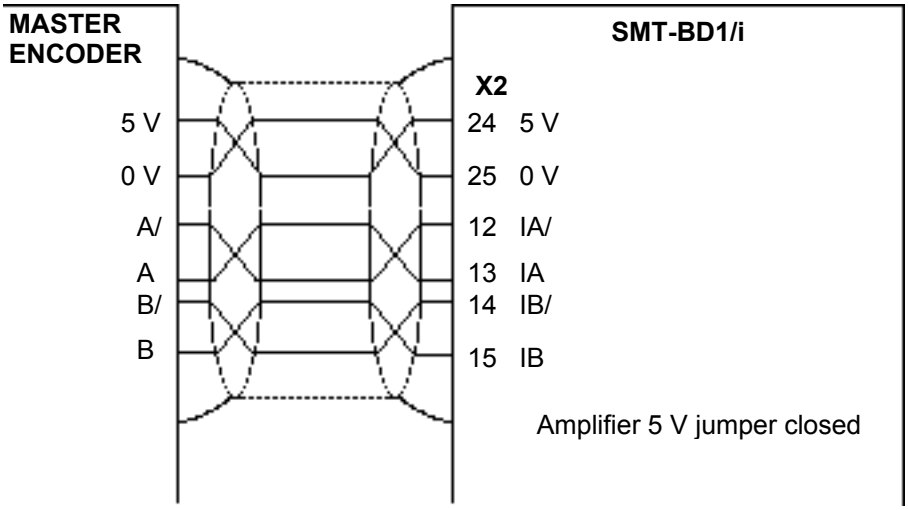
CHAPTER 4 - CONNECTIONS

1 - CONNECTION DIAGRAM

1.1 - CONNECTION WITH THE MASTER AMPLIFIER



1.2 - CONNECTION WITH THE MASTER ENCODER



2 - MANDATORY WIRING

It is mandatory to use a shielded cable for the encoder signals A and B. Cable ends should have a 360° shield connection by means of the metallic X2 connector (refer to Chapter 8, section 6 of the SMT-BD1 standard manual). The amplifier 0 V (X2, pins 10/11) and the encoder or master amplifier 0 V (Gnd) must be connected together.

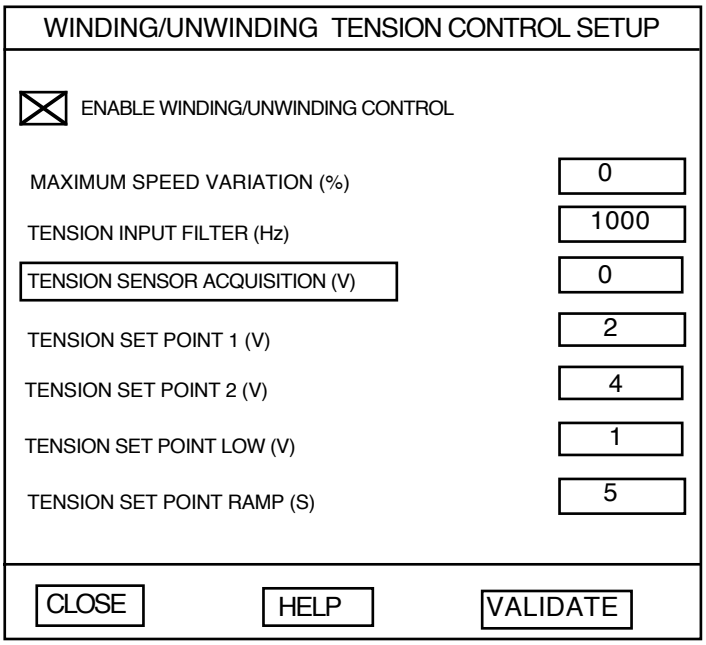
The crossing of the **A** and **B**, **A** and **A/** or **B** and **B/** signals on the encoder input changes the motor rotation direction with regard to the rotation direction of the encoder or of the master motor.

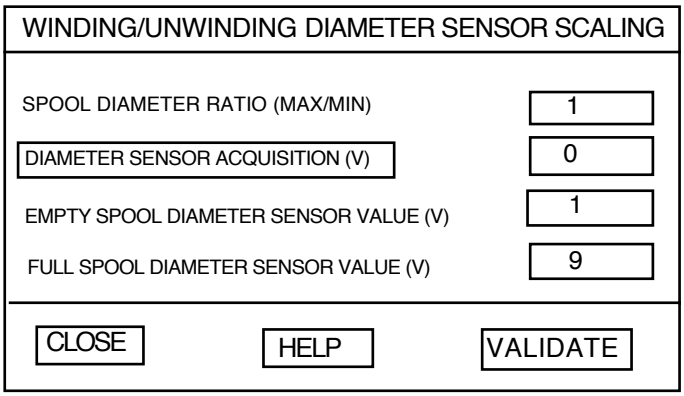
It is necessary to use a twisted and shielded cable for the analogue signals TM and DIAM. Both cable ends must have a 360° shield connection by means of the metal connectors.

The analogue signals TM and DIAM must be wired according to the polarities between the sensor cells and the amplifier (TM+ and DIAM on diff. high of the cells), and the amplifier 0 V MUST be connected to the cells 0 V by means of a cable (pins 15 and 16 must be connected together on the X4 connector at the amplifier end).

CHAPTER 5 - ADJUSTABLE PARAMETERS

The specific parameters used for the tension control of winding/unwinding systems are accessible via the **Winding/unwinding tension control setup** and **Winding/unwinding diameter sensor scaling** submenus of the **Advanced functions** menu, in the **BPCW** software version 2.52 and greater.





1 - OPERATION MODE

The operation in winding/unwinding tension control is selected by the **Enable winding/unwinding control** function in the **Winding/unwinding tension control parameters** submenu of the **Advanced functions** menu.

This mode corresponds to speed control of the motor that drives the spool, in order to maintain a constant material tension independently from its line speed and from the spool diameter. The motor speed reference is then calculated according to the material line speed, the spool diameter measurement and the material tension measurement.

2 - APPLICATION PARAMETERS

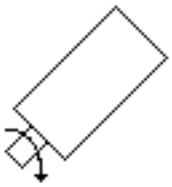
The following parameters are accessible in the main window of **BPCW**.

The parameter **Maximum speed (rpm)** defines the maximum motor rotation speed (for the minimum spool diameter). The adjustment range is between 100 and 14 000 rpm.

The function **Reverse movement** reverses the motor rotation direction with regard to the rotation direction of the material line speed measurement encoder, as shown below.

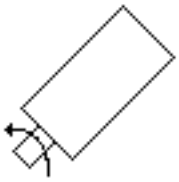
Reverse movement ☐

Encoder rotation CW
Motor rotation CW
FC+ stops the motor



Reverse movement ☒

Encoder rotation CW
Motor rotation CCW
FC- stops the motor



The **Encoder resolution** parameter defines the encoder resolution for one revolution of the slave motor. This parameter allows to define the ratio between the motor speed and the speed of the material line speed measurement encoder. The limit value of this parameter according to the maximum motor speed (**Maximum speed**) is indicated in the chart below:

MAX. SPEED (rpm)	900	3 600	14 000
MAX. ENCODER RESOLUTION	8 192	4 096	1 024

The parameters allowing the sizing of the spool diameter sensor are accessible via the submenu **Winding / Unwinding diameter sensor scaling** of the menu **Advanced Functions**.

The **Spool diameter ratio (Max/Min)** parameter defines the ratio between the maximum and the minimum diameters of the spool to be unwinded. The adjustment range is between 1 and 100.

The **Diameter sensor acquisition (V)** allows the reading of the voltage given by the diameter sensor. The reading range is between 0 V and 10 V.

The parameter **Empty spool diameter sensor value (V)** defines the voltage value provided by the diameter sensor when the spool is empty (minimum diameter). The adjustment range of this parameter is between 0 V and 10 V.

The parameter **Full spool diameter sensor value (V)** defines the voltage value provided by the diameter sensor when the spool is full (maximum diameter). The adjustment range of this parameter is between 0 V and 10 V.

The parameters regarding the winding / unwindung tension control are accessible via the submenu **Winding / unwinding tension control setup** of the menu **Advanced Functions**.

The parameter **Maximum speed variation** defines the maximum value of the differential speed input command (BM) given by the PID tension regulator for the material tension control. This parameter also defines the motor rotation speed when activating the inputs **JOG+** and **JOG-** for the manual spool unwinding. The adjustment range is between 0 % and 100 % of the maximum motor speed defined by the parameter **Maximum speed**.

The parameter **Tension input filter** defines the cut-off frequency at -3db (Fcv) of the first order low-pass filter acting on the tension measurement signal issued from the tension cell. The value of this parameter is chosen according to the noises and disturbances of the analogue tension cell signal. The adjustment range is between 20 Hz and 1000 Hz.

The parameter **Tension sensor acquisition** allows the reading of the voltage (**TM**) issued from the tension sensor. The range is between - 10 V and + 10 V.

The parameter **Tension set point 1** defines the tension input command (**TS**) for the tension regulator, when the logic inputs TS1 and TS2 are both inhibited. The adjustment range is between - 10 V and + 10 V.

The parameter **Tension set point 2** defines the tension input command (**TS**) for the tension regulator, when the logic input TS1 is enabled and TS2 inhibited. The adjustment range is between - 10 V and + 10 V.

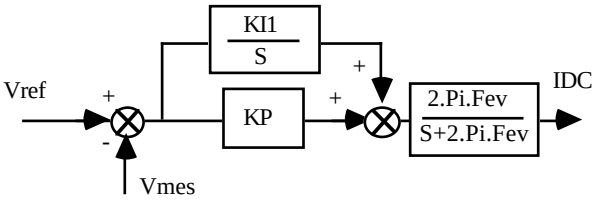
The parameter **Tension set point Low** defines the tension reference value (**TS**) for the tension regulator when the logic input **TS2** is enabled. This parameter also defines the threshold corresponding to the minimum tension measurement for the detection of material breaking. The adjustment range is between - 10 V and + 10 V.

The parameter **Tension set point ramp** defines the minimum authorized response time (**TL**) for a variation of the tension adjustment point between 0 and the maximum value (10 V). The adjustment range is between 0 and 32 seconds.

3 - REGULATOR PARAMETERS

3.1 - SPEED REGULATOR

The PI speed regulator structure is shown below:



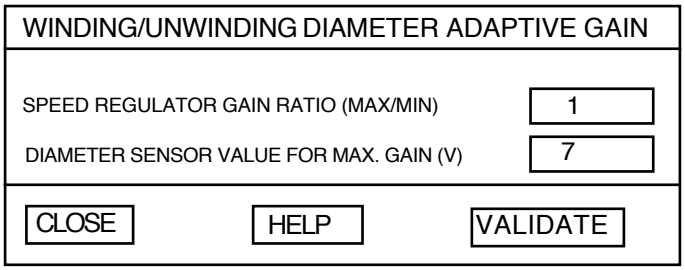
The gain parameters are automatically calculated during the **AUTO-TUNING** procedure and are accessible via the submenu **Controller parameters** of the menu **Advanced Functions**.

The parameter **Speed error low-pass filter** defines the cut-off frequency at - 3 db (Fev) of the first order filter acting on the speed error. The value of this parameter depends on the selected bandwidth.

The parameter **Proportional speed gain** defines the proportional gain (KP) of the regulator acting on the speed error. The adjustment range is between 0 and 4 095.

The parameter **Integral 1 speed gain** defines the integral gain (KI1) of the regulator acting on the speed error. The adjustment range is between 0 and 255.

The parameters regarding the automatic gain adjustment of the speed regulator according to the spool diameter are accessible via the submenu **WInding/Unwinding diameter adaptive gaine** of the menu **Advanced functions**.

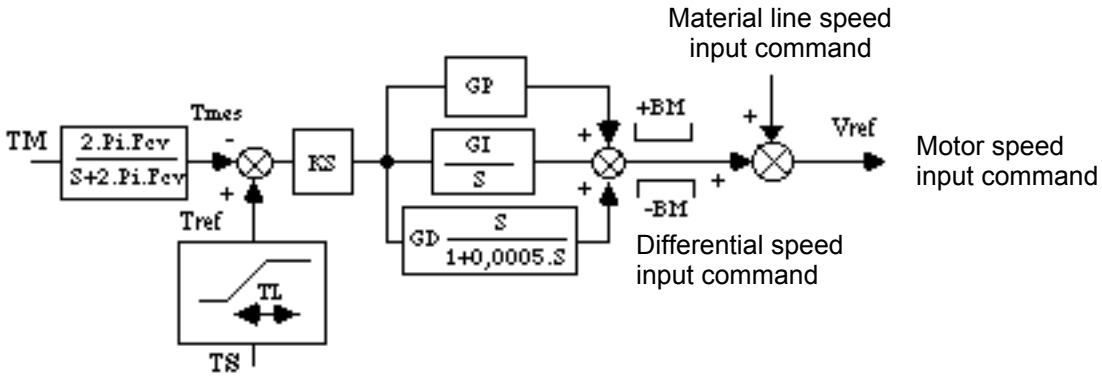


The parameter **Speed regulator gain ratio (Max/Min)** defines the ratio between the maximum gain of the speed regulator corresponding to the full spool (maximum diameter) and the minimum gain of the speed regulator corresponding to the empty spool (minimum diameter). The adjustment range of this parameter is between 1 and 1000.

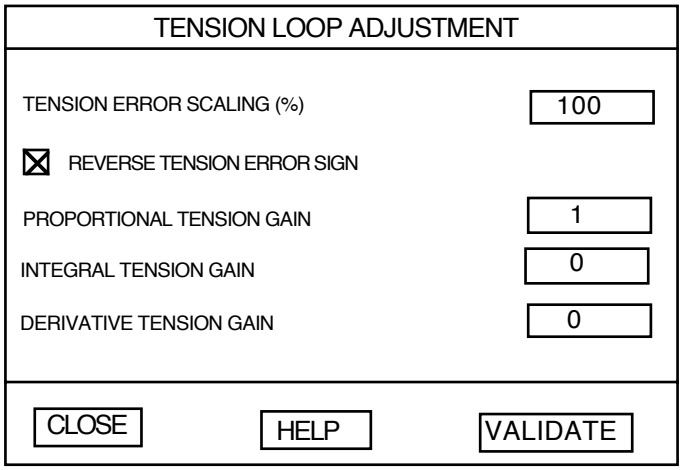
The parameter **Diameter sensor value for maximum gain (V)** defines the voltage value provided by the diameter sensor for which the speed regulator gain is maximum. The adjustment speed of this parameter is between 0 V and 10 V.

3.2 -TENSION REGULATOR

The structure of the PID tension regulator is shown below:



The gain parameters of the tension regulator are accessible in the submenu **Tension loop adjustment** of the menu **Advanced Functions** of the **BPCW** software.



The parameter **Tension error scaling** defines the reduction factor (**KS**) acting on the tension error in order to adjust the tension regulator gains to the application specifications.The adjustment range is between 10 % and 100 %.

The **Reverse tension error sign** function allows to reverse the tension regulator error sign according to the polarity of the tension measurement provided by the tension sensor in order to ensure servo loop stability.

The **Proportional tension gain** parameter defines the proportional gain (**GP**) of the tension regulator. The adjustment range is between 0 and 256.

The **Integral tension gain** parameter defines the integral gain (**GI**) of the tension regulator. The adjustment range is between 0 and 1.

The **Derivative tension gain** parameter defines the derivative gain (**GD**) of the tension regulator. The adjustment range is between 0 and 256.

CHAPTER 6 - COMMISSIONING

1 - CHECKING THE CONFIGURATION

Check the amplifier standard configuration as described in Chapter 6 of the standard **SMT-BD1** manual.

Check for the presence of the **SMT-I3-BD1** daughter board between both logic and power boards (see chapter 8: Hardware location diagram).

Check that the **E** and **S** jumpers are open on the logic (see chapter 8: Hardware location diagram).

Check for the version of the firmware memory that must be **X.X6**.

If using an external encoder for the master motor, check that the **5 V** jumper is correctly made on the logic board for the encoder supply (see Chapter 8: Hardware location diagram).

2 - APPLYING POWER

Turn on the amplifier as described in Chapter 6 of the standard **SMT-BD1** manual.

3 - MASTER/SLAVE STARTING AND ADJUSTMENT

Start and adjust the amplifier by means of the **BPCW** software,as described in Chapter 6 of the standard **SMT-BD1** manual.

3.1 - ADJUSTMENTS WITH EMPTY SPOOL

Select the **MODIFY** function of the **ENCODER RESOLUTION** module accessible in the main BPCW window. The value of the **Encoder resolution** parameter is calculated as follows:

$$\textbf{Encoder resolution (ppr)} = \text{Line encoder resolution (ppr)} \times \frac{\text{Line encoder speed (rpm)}}{\text{Motor speed with empty spool (rpm)}}$$

Execute the function **Programmation** before leaving the module **ENCODER RESOLUTION**.

Enter the maximum motor speed corresponding to the empty spool in the box **Rated speed** of the **Analogue input** module of **BPCW** by selecting **Reference voltage = 10 V**. This speed is calculated according to the minimum spool diameter and the maximum material line speed.

Put on the winding/unwinding spindle an empty spool corresponding to the minimum diameter and check that the motor shaft free rotation is not dangerous for operator and machine.

Select the submenu **Winding/unwinding diameter sensor scaling** in the menu **Advanced functions**.

Read the voltage value given by the diameter sensor (**DIAM**) for the minimum spool diameter by using the push button **Diameter sensor acquisition** and enter this value in the parameter box **Empty spool diameter sensor value**.

Select the function **Enable winding/unwinding control** in the module **Winding/unwinding tension control setup**.

Set at 0 the parameter **Maximum speed variation** or activate the logic input **TDI** on connector **X2**.

Execute the function **AUTO-TUNING** in the module **CONTROLLER** to calculate the regulator gains.

Important note: The **AUTO-TUNING** function must always be executed with empty spool corresponding to the minimum inertia reflected to the motor.

Enable the motor in order to check its stability. In case of loud noises in the controlled motor, execute again the **AUTO-TUNING** procedure by selecting a lower bandwidth. If the problem remains, renew the **AUTO-TUNING** function by activating the antiresonance filter (**Filter = Antiresonance)**. The antiresonance filter is accessible in the **BPCW** software version 2.6 and up and the amplifier EPROM version **5.7** and up.

When using a proportional speed regulator (**P**), cancel the parameter **Integral 1 speed gain** in the module **Controller parameters** of the menu **Advanced functions**.

Check the motor rotation direction with regard to the rotation direction of the line speed measurement encoder. If necessary, change the motor rotation direction by means of the function **Reverse movement** accessible in the module **Analogue input**.

3.2 - ADJUSTMENTS WITH FULL SPOOL

Put on the winding/unwinding spindle a full spool corresponding to the maximum diameter and check that the motor shaft free rotation is not dangerous for operator and machine.

Select the submenu **Winding/unwinding diameter sensor scaling** in the menu **Advanced functions**.

Read the voltage value given by the diameter sensor (**DIAM**) for the maximum spool diameter by using the push button **Diameter sensor acquisition** and enter this value in the parameter box **Full spool diameter sensor value** and then in the box **Diameter sensor value for maximum gain** of the module **Winding/unwinding diameter adaptive gain**.

Enter the ratio value between both maximum and minimum spool diameters in the parameter **Spool diameter ratio (Max/Min)** of the module **Winding/unwinding tension control setup** in the menu **Advanced functions**.

Enable the motor and check its stability. In case of loud noises in the controlled motor, remove the full spool and re-engage the empty one. Then, 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**).

Increase progressively the parameter **Speed regulator gain ratio (Max/Min)** in the module **Winding/unwinding diameter adaptive gain** up to the maximum possible value without noises in the motor. Do not exceed the limit value calculated by to the ratio between both full and empty spool inertias reflected to the motor shaft (Jmax motor / Jmin motor). If it is not possible to enough increase the parameter **Speed regulator gain ratio (Max/Min)** in order to obtain the required stability, remove the full spool and re-engage the empty one and renew the **AUTO-TUNING** procedure by activating the antiresonance filter (**Filter = Antiresonance**).

Check the adjustment stability up to the maximum speed of the full spool corresponding to the maximum line encoder speed. If it is not possible to move the line encoder, disable the function **Enable winding/unwinding control** in the module **Winding:unwinding tension control setup** and send manually the speed input command (**Manual**) in the box **Reference** of the main **BPCW** window.

Enter the value of the parameter **Diamenter sensor value for maximum gain (V)** in the module **Winding/unwinding diameter adaptive gain** in order to define accurately the gain adjustment range according to the spool diameter. This parameter must be reduced when the value of the parameter **Speed regulator gain ratio (Max/Min)** adjusted before remains quite below the ratio between both full and empty spool inertias reflected on the motor shaft (Jmax motor / Jmin motor). This parameter can be calculated as follows:

$$\textbf{Diameter sensor value for maximum gain (V)} = \textbf{Empty spool diameter sensor value (V)} + [\textbf{Full spool diameter sensor value (V)} - \textbf{Empty spool diameter sensor value (V)}] \times [(\textbf{Speed regualtor gain ratio (Max/Min)} - 1) \times (\text{Jmin motor / Jmax motor})]^{0,25}$$

3.3 - TENSION CONTROL ADJUSTMENT

Preliminary remark: It is advisable to limit the motor torque during the commissioning phase in order to avoid a material braking if the tension regulator loop becomes instable.

Engage the material in the winding/unwinding system and lock it by means of the downstream traction system. Then stretch the material and adjust manually the tension.

Read the value given by the tension sensor (**TM**) in the module **Winding/unwinding tension control setup** by using the push button **Tension sensor acquisition** and enter this value in the parameter box **Tension set point 1** with logic inputs TS1 and TS2 inhibited.

Initialize the parameter **Maximum speed variation** at 5 % and initialize the parameter **Tension input filter** at 1000 Hz.

Initialize the **Tension set point ramp** parameter at a few seconds in order to get a progressive material tension.

Select the submenu **Tension loop adjustment** accessible via the **Advanced functions** menu of the **BPCW** software.

Initialize the **Tension error scaling** parameter at 10 %.

Initialize the parameters **Integral tension gain** and the **Derivative tension gain** at 0.

Initialize the **Proportional tension gain** parameter at its minimum value.

Disable the **TDI** input to enable the tension regulator and activate the ENABLE input.

If the tension loop is instable (continuous material unwinding or saturated motor torque), select the **Reverse error sign** function.

If the tension loop is oscillating, reduce the value of the **Tension error scaling** parameter until the loop remains stable.

When the system is stable, increase the **Proportional tension gain** parameter up to the value where its starts oscillating; then reduce the parameter **Proportional tension gain** in order to ensure the tension stability.

Increase progressively the parameters **Derivative Tension gain** and **Integral tension gain** in order to optimize the tension loop response in the case of a manual jerking of the spool or of the material.

Adjust the parameter **Maximum speed variation** according to the differential speed input command that is necessary for regulating the material tension over the whole speed range (generally 5 to 10 %).
Increase progressively the material line speed in order to check the correct operation of the winding/unwinding system over the whole speed range.

In case of loud noises on the material tension measurement signal, reduce the parameter **Tension input filter** in the submenu **Winding:unwinding tension control setup** of the menu **Advanced functions**.

If necessary, wire the logic input **CV0** in order to emergency stop the spool with the maximum motor torque in both rotation directions.

Select the function **SAVE PARAMETERS TO EEPROM** function before quitting **BPCW**.

CHAPTER 7 - FAULT FINDING

1 - LOUD CRACKLING NOISE IN THE MOTOR AT STANDSTILL

Check that the Motor-Amplifier-Controller ground connections answer the requirements of Chapter 4.
Check that the encoder wiring answers the requirements of Chapter 4.
Check that the wiring of the tension and diameter sensor answers the requirements of Chapter 4 ("360" shield connection).

2 - LOUD NOISE IN THE MOTOR AT STANDSTILL AND WHEN RUNNING

Check the rigidity of the mechanical coupling between motor and load (backlashes and elasticities in the gearboxes and couplings).
Execute the **AUTO-TUNING** procedure again by selecting a lower bandwidth (**Medium** or **Low**) . If the problem remains, renew the **AUTO-TUNING** function by activating the antiresonance filter (**Filter = Antiresonance**). The antiresonance filter is accessible in the **BPCW** software version 2.6 and up and the amplifier EPROM version **5.7** and up.

3 - LOUD NOISE IN THE MOTOR WHEN RUNNING

Select the highest position resolution on the slave motor (**Encoder resolution**) according to the maximum rotation speed (see chart in Chapter 5). It is also necessary to modify the master encoder resolution in order to keep the same reduction ratio.

Decrease the **Tension input filter** parameter value (in the **Winding/unwinding tension conrol setup** module accessible via the **Advanced Functions** menu) in order to filter the tension measurement, if necessary.

Reduce slightly the value of the **Speed error low pass filter** parameter in the module **Controller parameters** of the menu **Advanced functions**.

CHAPTER 8 - APPENDIX

LOCATION DIAGRAM OF THE HARDWARE OPTIONS