

SMT-BD1/t

gb

UNWINDER/REWINDER SERVO DRIVE WITH PROFIBUS DP INTERFACE

INFRANOR®



WARNING



This is a general manual describing a series of servo amplifiers having output capability suitable for driving AC brushless sinusoidal servo motors.

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/t servo modules are PWM servo amplifiers that provide current and speed control for AC sinusoidal motors (brushless) with transmitter resolver.

The SMT-BD1/t servo drive is 220 VAC or 400 VAC mains operated. The SMT-BD1 plug-in system with 220 VAC power supply is available as a single-axis block version or as a multi-axis version that can receive up to six axes in a standard 19" rack including the power supply. The SMT-BD1/t plug-in system with 400 VAC power supply is available as a multi-axis version that can receive up to three axes in a standard 19" rack including the power supply.

2 - GENERAL DESCRIPTION

Series SMT-BD1 amplifiers have their own DC/DC converter to provide the appropriate supply voltage (+5 V, +/-15V). The source supply voltage for the control board is the auxiliary 310 VDC supply voltage. The auxiliary supply voltage allows to have the amplifier control board still active when the power supply voltage is turned off.

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

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

The SMT-BD1/t servo amplifiers are suited for unwind/rewind and tension control applications. Up to 64 control sequences including tension control, speed control and torque control can be programmed and combined in order to solve various unwind/rewind and tension control applications. The sequence chaining capability allows to define macro-sequences for complex applications: several control sequences can be linked together in order to be automatically executed one after the other. The control sequences are pre-programmed. So, the application programming simply consists in initializing the sequences parameters with the desired values.

The SMT-BD1/t servo amplifier most typical unwind/rewind and tension control applications are listed below :

- Material unwind/rewind force control based on diameter sensor feedback
- Material unwind/rewind line speed control based on diameter sensor feedback
- Material unwind/rewind force control based on line encoder feedback
- Material unwind/rewind line speed control based on line encoder feedback
- Accumulator control for material unwinder based on diameter and accumulator sensors feedback
- Material unwind/rewind tension control based on line encoder and dancer feedback
- Material unwind/rewind tension control based on diameter sensor and dancer feedback

The SMT-BD1/t servo amplifier operates with a PROFIBUS DP interface. The servo amplifier control and the parameter setting can both be made via the PROFIBUS DP connection. The servo amplifier control via PROFIBUS DP connection simply consists in selecting one of the amplifier pre-programmed control sequences and start its execution.

The SMT-BD1/t servo amplifier can also operate with the RS-232 serial link for the parameters setting and the sequences programming. The INFRANOR BPCW parameter setting software which is IBM-PC compatible makes the amplifier commissioning and the application programming easier.

The SMT-BD1/t servo amplifier can also run in stand-alone mode without the PROFIBUS DP connection. In this configuration, a pre-programmed control sequence is selected via the SEL1 and SEL2 logic inputs and its execution is started by using the START logic input. However, in this case only the sequence numbers 0 to 3 can be selected by the SEL1 and SEL2 logic inputs activation.

3 - REFERENCE TO THE STANDARDS

The 220 VAC version of the SMT-BD1/t amplifiers operating in the BF rack, which is equipped with the mains filter BF-35 or 70, has been approved for its compliance with the Electromagnetic Compatibility standards:

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

The 220 VAC version of the SMT-BD1/t amplifiers operating in the single-axis racks BM 20 A – BMM 05F – BMM 05A, which are equipped with the appropriate mains filter (FN 612-20/06 or FN 356-16/06 or BF-35), has been approved for its compliance with the Electromagnetic Compatibility standards:

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

The 400 VAC version of the SMT-BD1/t amplifiers operating in the BF-400 rack, which is equipped with the mains filter BF400-35 or 70, has been approved for its compliance with the Electromagnetic Compatibility standards:

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

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

The SMT-BD1 amplifiers have been "CE" marked since year 1995.

4 - REFERENCE TO OTHER DOCUMENTS

- ◆ [BF-400 rack](#) – for the use of the 400 VAC amplifier version in a multiaxis rack.
- ◆ [BF rack](#) – for the use of the 220VAC amplifier version in a multiaxis rack.
- ◆ [BM20A/BMM05F/05AF single-axis rack](#) – for the use of the 220 VAC amplifier version in a single-axis rack.

Chapter 2 - Specifications

1 - TECHNICAL SPECIFICATIONS

1.1 - Current ratings for the 220 VAC amplifier version

Operating voltage	DC bus 310 VDC (270 VDC < DC bus < 340 VDC max.)
Auxiliary supply voltage	310 VDC (200 VDC < Uaux < 340 VDC max.)
Motor terminal to terminal output voltage	200 Vrms for 310 VDC bus

Authorized output currents for **current pulse mode** operation (I^2t protection in fusing mode)

AMPLIFIER	U rated (Vrms)	Imax (A rms) 1 s	Max. authorized rated current (Arms) of the amplifier		
			WITHOUT FAN*	FAN TYPE 1*	FAN TYPE 2*
SMT-BD1/t - 220/04	240	4,4	2		
SMT-BD1/t - 220/08	240	8,8	4		
SMT-BD1/t - 220/12	240	13,8	6		
SMT-BD1/t - 220/17	240	17,7	8,5		
SMT-BD1/t - 220/30	240	30,8	10	12	15
SMT-BD1/t - 220/30r	240	30,8	10	15	
SMT-BD1/t - 220/45	240	48,6	10	15	20
SMT-BD1/t - 220/45r	240	48,6	10	20	23
SMT-BD1/t - 220/60	240	61	10	19	25
SMT-BD1/t - 220/60r	240	61	12	26	30
SMT-BD1/t - 220/70	240	70	25	30	35
SMT-BD1/t - 220/100	240	100	25	30	35

Authorized output currents for **continuous current mode** operation (I^2t protection in limiting mode)

AMPLIFIER TYPE	U rated (Vrms)	Imax (A rms) 1 s	Max. authorized continuous current (Arms) of the amplifier		
			WITHOUT FAN*	FAN TYPE 1*	FAN TYPE 2*
SMT-BD1/t - 220/04	240	4,4	2		
SMT-BD1/t - 220/08	240	8,8	4		
SMT-BD1/t - 220/12	240	13,8	6		
SMT-BD1/t - 220/17	240	17,7	8,5	8,5	
SMT-BD1/t - 220/30	240	30,8	8,5	12	15
SMT-BD1/t - 220/30r	240	30,8	10	15	
SMT-BD1/t - 220/45	240	48,6	8,5	15	18
SMT-BD1/t - 220/45r	240	48,6	10	20	23
SMT-BD1/t - 220/60	240	61	8,5	17	20
SMT-BD1/t - 220/60r	240	61	12	26	30
SMT-BD1/t - 220/70	240	70	17	30	35
SMT-BD1/t - 220/100	240	100	25	30	35

* Maximum ambient temperature = + 40° C, fan 1 = 56 l/s, fan 2 = 90 l/s.

Note: The **SMT-BD1/t-X/Xr** amplifier types are equipped with an additional heatsink in order to improve the heat dissipation and increase their rated current. The width of these amplifier types is then 18 TE instead of 12 TE.

Minimum inductance between phases	1 mH
Conformity with the standards: CE approval with multi-axis power supply configuration BF rack with mains filter BF-35 or 70, or SMTB.M 20 A / BMM05F/AF single-axis rack with filters FN 612-20/06 or FN 356-16/06 or BF-35. 360° shields; equipotentiality according to the wiring rules.	<ul style="list-style-type: none"> - EMC standards Immunity: CEI standards 801- 2 - 3 - 4 Conducted and radiated disturbances: EN 55011, Group 1, class A - Electrical standards for industrial machines: EN 60204.1: <ul style="list-style-type: none"> - Insulator: 1500 VAC/1 min. - Leakage current > 3 mA (EMI filters)
Temperature range	<ul style="list-style-type: none"> * storage - 20°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

1.2 - Current ratings for the 400 VAC amplifier version

Operating voltage	DC bus 565 VDC (480 VDC < DC bus < 685 VDC max.)
Auxiliary supply voltage	310 VDC (200 VDC < Uaux < 340 VDC max.)
Motor terminal to terminal output voltage	380Vrms for 565 VDC bus

Authorized output currents for **current pulse mode** operation (I^2t protection in fusing mode)

AMPLIFIER	U rated (Vrms)	Imax (A rms) 1 s	Max. authorized rated current (Arms) of the amplifier	
			WITHOUT FAN*	FAN TYPE 2*
SMT-BD1/t - 400/15	400	15.5	5	7.5
SMT-BD1/t - 400/30	400	30	8	15
SMT-BD1/t - 400/45	400	48	10	19
SMT-BD1/t - 400/60	400	60	not used	28
SMT-BD1/t - 400/100	400	100	not used	35

Authorized output currents for **continuous current mode** operation (I^2t protection in limiting mode)

AMPLIFIER TYPE	U rated (Vrms)	Imax (A rms) 1 s	Max. authorized continuous current (Arms) of the amplifier	
			WITHOUT FAN*	FAN TYPE 2*
SMT-BD1/t - 400/15	400	15.5	not used	5
SMT-BD1/t - 400/30	400	30	not used	10
SMT-BD1/t - 400/45	400	48	not used	15
SMT-BD1/t - 400/60	400	60	not used	23
SMT-BD1/t - 400/100	400	100	not used	28

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

Minimum inductance between phases	2 mH
Conformity with the standards: CE approval with multi-axis power supply configuration BF-400 rack and mains filter F400-35 or 70. 360° shields; equipotentiality according to the wiring rules.	<ul style="list-style-type: none"> - EMC standards Immunity: CEI standards 801- 2 - 3 - 4 Conducted and radiated disturbances: EN 55011, Group 1, class A - Electrical standards for industrial machines: EN 60204.1: <ul style="list-style-type: none"> - Insulator: 2500 VAC/1 min. - Leakage current > 3 mA (EMI filters without condensators)
Temperature range	<ul style="list-style-type: none"> * storage - 20°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

1.3 - Other specifications

PWM switching frequency	8 kHz
Current regulator (PI)	Adjusted to the motor
Current loop bandwidth	Cut-off frequency for 45° phase shift > 1 kHz
Internal current limitation	Imax: 20 % to 100 % and Irated: 20 % to 50 % Imax duration = 1 second
Speed regulator (PI)	Sampling period = 0,5 ms Adjustable digital gains
Tension regulator (PID)	Sampling period = 1 ms 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 14 000 rpm
Encoder position output	Two channels A and B in quadrature + n marker pulses per revolution. RS 422 line driver Programmable 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 Accuracy: 8 arc minutes + ¼ point (optional: 2 arc minutes + ¼ point) Note: The total position accuracy must take into account the accuracy of the motor resolver
Master encoder input	Two channels A and B in quadrature + Z marker pulse RS 422 line receiver. Maximum pulses frequency: 250 kHz
Analog outputs (monitor)	Speed input command (CV): ±10 V for ± max speed Speed monitor (GT): ±8 V for ±14 000 rpm, linearity: 10% Current input command (IDC): ±10 V for ± current rating, DACout1 resolution = 8 bits Current monitor (Imes): ±10 V for ± current rating, DACout2 resolution = 8 bits
Analog inputs (control)	ANin1 +/- 10V resolution = 12 bit standard (16 bit optional) Torque or Speed reference Dancer or Load cell tension measurement ANin2 0V to 10V resolution = 12 bit standard (16 bit optional) Diameter sensor measurement
Dedicated logic inputs	Positive logic or negative logic: - Amplifier enabling: ENABLE - Sequence selection: SEL1, SEL2 (stand alone operation) - Sequence start : START (stand alone operation) - Motor stop: STOP - Fault reset: RAZ Optocoupled: - Tension control disable: TDI
Dedicated logic outputs	Open collector: Umax = 24V Imax = 5 mA « Tension error »: active if tension OK, inactive if tension error

Relay outputs	Relay contact: Umax = 60 V Imax = 200 mA, Pmax = 10 W « Amp ready »: closed if amplifier OK, open if fault « Power ready »: closed if power OK, open if fault « Brake control » : closed for disabling the motor brake
General purpose I/Os	Programmable input: Lin1 (Optocoupled) Programmable output: Lout1 (Open collector)
PROFIBUS link	PPO-1 or PPO-2 or PPO-3 or PPO-4.
Fault display	LEDs on front panel and diagnostic by serial link RS232 + diagnostic by PROFIBUS.
Motor and application parameter setting	Serial link RS232 or Profibus DP link
Automatic functions	Amplifier adjustment to the motor (AUTO-PHASING) Automatic regulator tuning (AUTO-TUNING)
Altitude	1000 m
Moisture	< 50% to 40° C and < 90% to 20° C: EN 60204-1 standard
Cooling	Natural convection or forced air according to the rated current

2 - FUSE PROTECTION

2.1 - Fuse protection for the 220 VAC amplifier version

F1 : Control of the average DC current of the power board supply (see [Hardware adjustments in chapter 5](#)).
F2 : Control of the average DC current of the logic board supply (see [Hardware adjustments in chapter 5](#)).

AMPLIFIER TYPE	F1 Power	F2 Logic
SMT-BD1/t -220/04 to 12	10 AT	1 A
SMT-BD1/t -220/17 and 30	15 AT	1 A
SMT-BD1/t -220/45	20 AT	1 A
SMT-BD1/t -220/60	20 AT	1 A
SMT-BD1/t -220/70	-	1 A
SMT-BD1/t -220/100	-	1 A

2.2 - Fuse protection for the 400 VAC amplifier version

F2 : Control of the average DC current of the logic board supply (see [Hardware adjustments in chapter 5](#)).

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

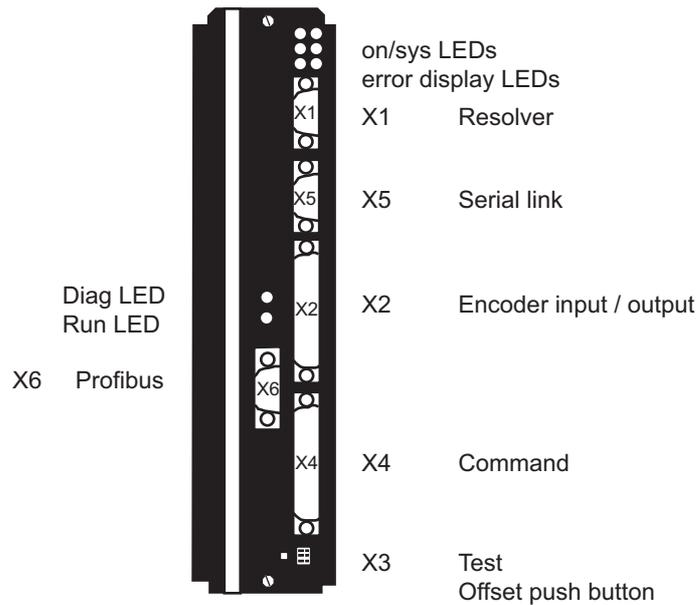
Chapter 3 - Inputs / Outputs

1 - CONNECTORS LOCATION

1.1 - RACK connectors

For the 400 VAC amplifier version, [see BF-400 RACK manual](#).
 For the 220 VAC amplifier version, [see SMTB.M 20 A SINGLE-AXIS RACK manual](#) or [BF RACK manual](#).

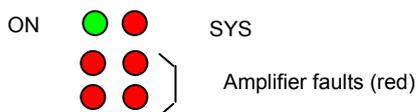
1.2 - Amplifier connectors



2 - LEDs

2.1 - Amplifier fault LEDs

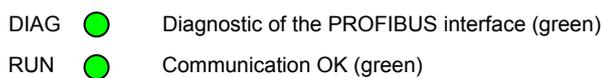
Location: above the resolver connector X1



ON (green) : power supply
 SYS (red) : system fault

2.2 - Profibus communication LEDs

Location: above the Profibus connector X6



3 - X1: RESOLVER CONNECTOR

Sub D 9 pins female.

PIN	FUNCTION	NOTE
1	TC (motor thermal sensor)	pin H sensor connector for MAVILOR motor
6	Shield connection	If no « 360° » connection on the connector
2	TC (motor thermal sensor)	pin I sensor connector for MAVILOR motor
7	S1 (+sin resolver)	pin C sensor connector for MAVILOR motor
3	S3 (-sin resolver)	pin D sensor connector for MAVILOR motor
8	S4 (+cos resolver)	pin B sensor connector for MAVILOR motor
4	S2 (-cos resolver)	pin A sensor connector for MAVILOR motor
9	R2 (+ref resolver)	pin F sensor connector for MAVILOR motor
5	R1 (-ref resolver)	pin E sensor connector for MAVILOR motor

4 - X2: ENCODER CONNECTOR

Sub D 25 pins female.

PIN	SIGNAL	I/O	DESCRIPTION
1	/CZ	O	Differential output of the encoder marker pulse /Z (5 V, 20 mA max.) Recommended line receiver: 26LS32
2	CZ	O	Differential output of the encoder marker pulse Z (5 V, 20 mA max.) Recommended line receiver: 26LS32
3	/CA	O	Differential output of the encoder channel /A (5 V, 20 mA max.) Recommended line receiver: 26LS32
4	CA	O	Differential output of the encoder channel A (5 V, 20 mA max.) Recommended line receiver: 26LS32
5	/CB	O	Differential output of the encoder channel /B (5 V, 20 mA max.) Recommended line receiver: 26LS32
6	CB	O	Differential output of the encoder channel B (5 V, 20 mA max.) Recommended line receiver: 26LS32
7, 10, 11	0 V		
12	/IA	I	Input of the master encoder channel /A (5 V, 2 mA) Recommended line driver: 26LS31
13	IA	I	Input of the master encoder channel A (5 V, 2 mA) Recommended line driver: 26LS31
14	/IB	I	Input of the master encoder channel /B (5 V, 2 mA) Recommended line driver: 26LS31
15	IB	I	Input of the master encoder channel B (5 V, 2 mA) Recommended line driver: 26LS31
21	Lin1	I	Programmable input (Optocoupled, 5 V to 24 V)
22	TDI	I	Tension disabled (Optocoupled, 5 V to 24 V)
8	Lout1	O	Programmable output (open collector: 24 V max, 5 mA max)
18	TER	O	Tension error (open collector: 24 V max, 5 mA max)
23	0V logic I/Os	O	
24	+5V	O	Master encoder supply: 5 V +/- 5 %, 300 mA, with 5 V jumper closed
25	GND		
other pins	reserved		

5 - X4: CONTROL CONNECTOR

Sub D 25 pins male.

PIN	SIGNAL	I/O	REMARK
1	SEL1	I	Positive logic or negative logic (stand alone operation only)
14	SEL2	I	Positive logic or negative logic (stand alone operation only)
4	START	I	Positive logic or negative logic (stand alone operation only)
7	STOP	I	Positive logic or negative logic
23,24,25	0 V logic input		
20	ENABLE	I	Positive logic or negative logic
23	0 V ENABLE	I	
13	RAZ	I	Fault reset via 0 Volt (contact between pins 13 and 12)
12	0 V RAZ	I	
3	ANin2	I	0 V to 10 V resolution = 12 bits, Diameter sensor measurement
17	ANin1 +	I	+/- 10V resolution = 12 bits, Torque or Speed reference, Dancer or Load cell tension measurement
16	ANin1 -	I	
15	0 Volt analog inputs	I	
10	Speed monitor output	O	GT: ± 8 V for $\pm 14\ 000$ rpm, linearity: 10%
2	Current monitor output	O	DACout2: ± 10 V for \pm current rating, resolution = 8 bits
11	0 Volt analog output	O	
18,19	Amp ready	O	Relay contact: closed when amplifier OK Pmax = 10 W with Umax = 60 V or Imax = 200 mA
8, 9	Brake control output	O	Relay contact Pmax = 10 W with Umax = 60 V or Imax = 200 mA
21	+15 Volts	O	Max. 50 mA
22	-15 Volts	O	Max. 50 mA
5, 6	non connected		

6 - X6: PROFIBUS

Sub D 9 pins female.

PIN	SIGNAL	DESCRIPTION
1	Shield	Shield
2		
3	RxD/TxD-P	Data reception/transmission (Plus)
4	CNTR-P	Control signal
5	DGND	0 V
6	VP	Supply for termination resistor
7		
8	RxD/TxD-N	Data reception/transmission (Minus)
9		

7 - X5: RS-232 CONNECTOR

Sub D 9 pins male.

PIN	FUNCTION	NOTE
5	0 Volt	GND (shield connection if no « 360° » connection on the connector)
3	TXD	Transmit data RS-232
2	RXD	Receive data RS-232
6	TXH	Transmit data RS-422
7	TXL	Transmit data RS-422
8	RXL	Receive data RS-422
9	RXH	Receive data RS-422

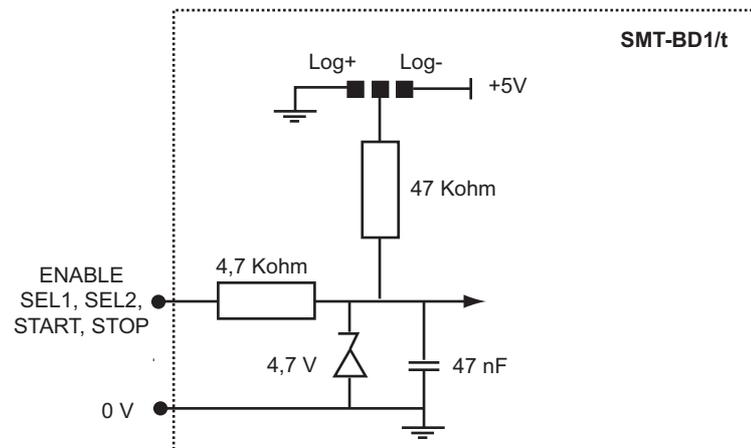
8 - X3: TEST CONNECTOR

PIN	FUNCTION	NOTE
1 - 6	0 Volt	
2	Current input command IDC	± 10 V; resolution: 8 bits, linearity: 10 % (DACout1)*
4	Speed monitor GT	± 8 V for ± 14000 rpm
5	Current monitor Imes	± 10 V; resolution: 8 bits, linearity: 10 % (DACout2)*
3	Reserved	

* : 10 V for amplifier current rating.

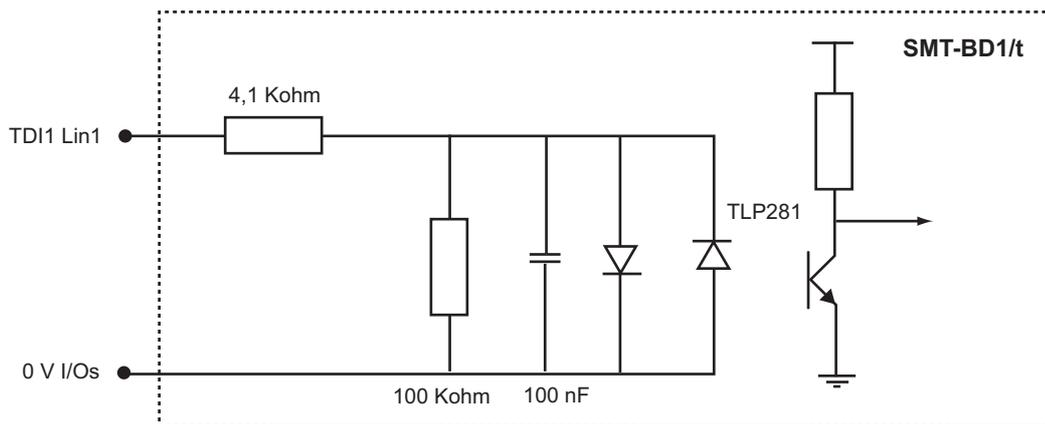
9 - LOGIC INPUTS-OUTPUTS SPECIFICATIONS

9.1 - Logic inputs: ENABLE, SEL1, SEL2, START, STOP



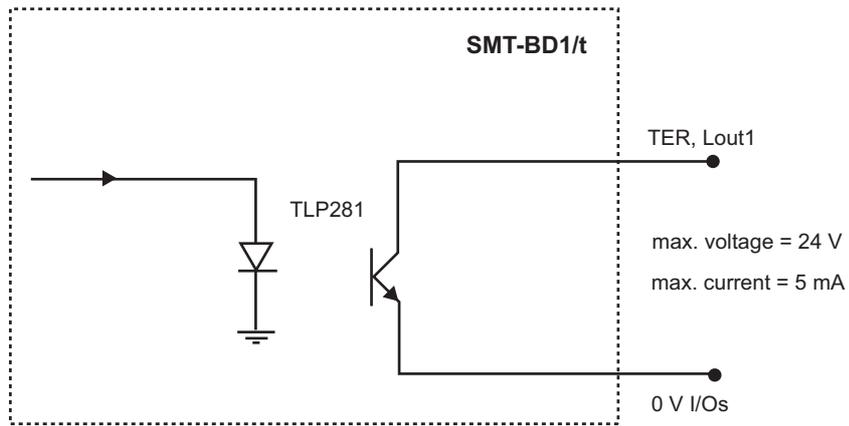
These inputs can be configured in positive or negative logic by means of jumpers.

9.2 - Logic inputs: TDI, Lin1



These inputs are opto-isolated from the amplifier 0V reference.

9.3 - Logic outputs: TER, Lout1



These outputs are opto-isolated from the amplifier 0V reference.

Chapter 4 - Connections

1 - CONNECTION DIAGRAMS

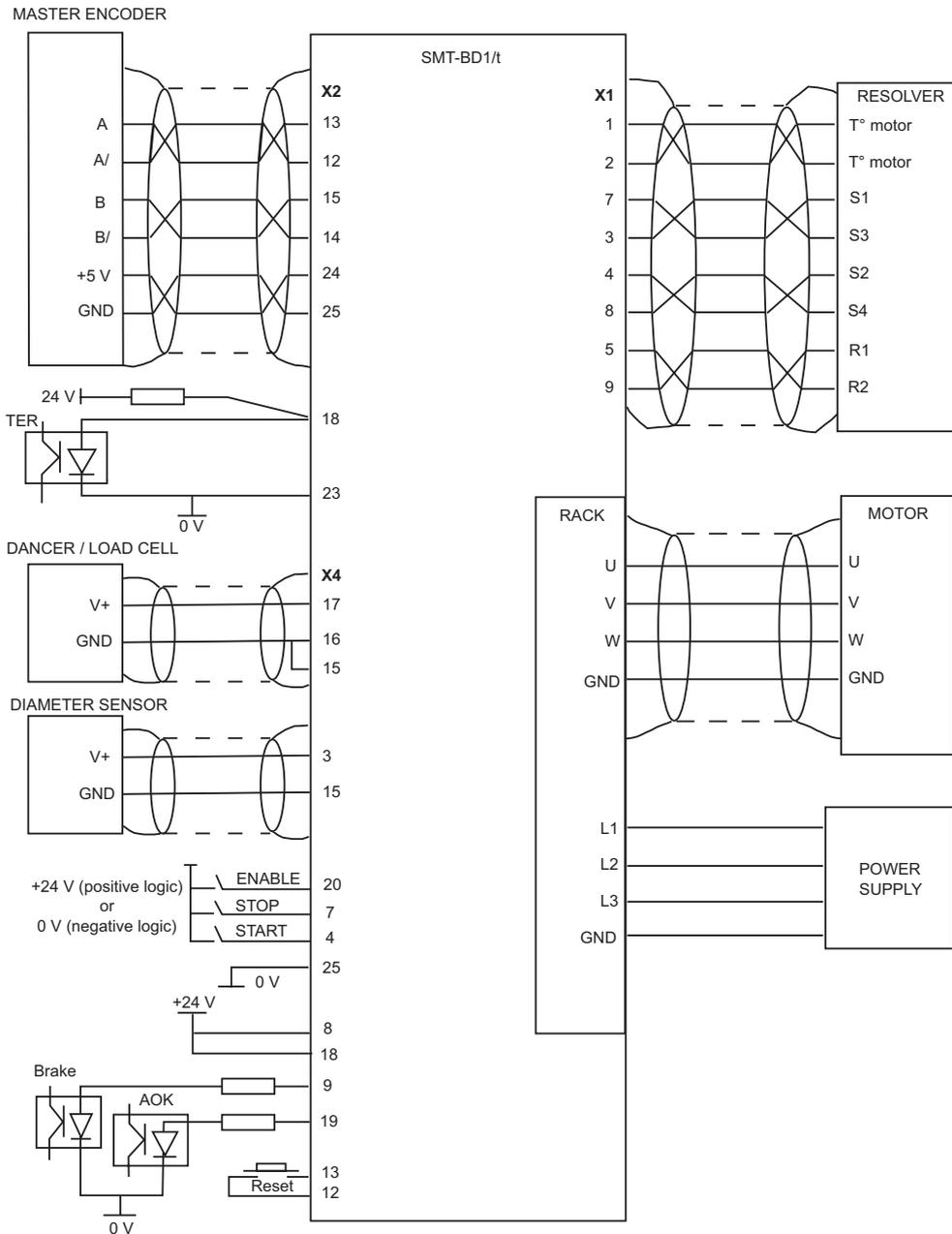
1.1 - Power supply and motor connections

For the 400 VAC amplifier version, [see BF-400 RACK manual](#).

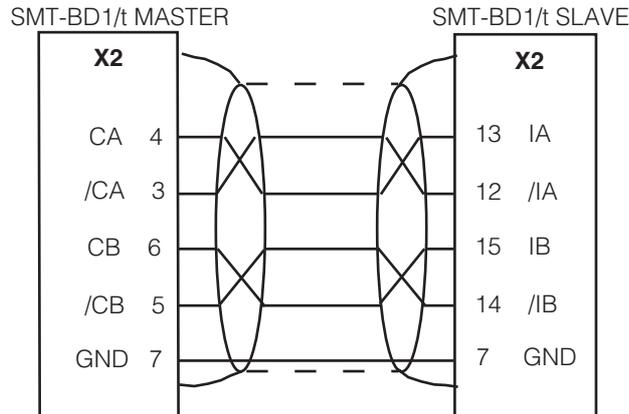
For the 220 VAC amplifier version, [see SMTB.M 20 A SINGLE-AXIS RACK manual](#) or [BF RACK manual](#).

1.2 - Amplifier I/O connections

1.2.1 - AMPLIFIER CONNECTION WITH MASTER ENCODER

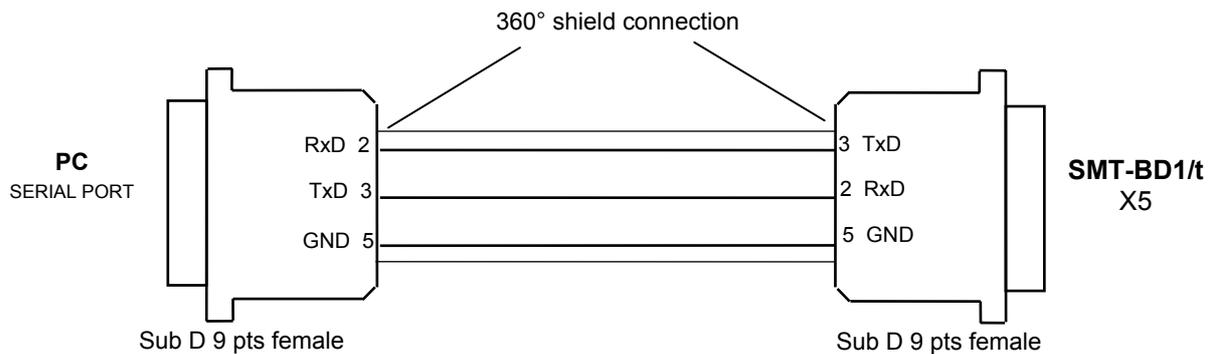


1.2.2 - MASTER / SLAVE AMPLIFIER CONNECTION



An SMT-BD1/t master amplifier can supply up to 10 SMT-BD1/t slave amplifiers.

2 - RS-232 SERIAL LINK CONNECTION



3 - WIRING RECOMMENDATIONS

3.1 - GND wiring and ground connections

CAUTION

Each potential conducting element must be shielded. Several potential conductors **in the same sleeve** must be **twisted and shielded**.

A shield has no effect if it is not connected:

- to a reference potential,
- by a connection as short as possible (a few centimeters; 10 centimeters is prohibited),
- by a "360°" shield connection. This means that the whole circumference of the shield sleeve must be connected to the reference conductor via a metal collar.

The connectors used for the compliance with the CEI 801 standard must be metal or metallized connectors and must allow the 360° shield connections.

Reference potential connections (especially with the ground) are recommended **only** if these connections have a very low impedance ($< 0,1 \Omega$). Any shield that is used as a conductor can be connected at both ends with the condition to be connected over 360° at both ends by means of metal links in order to ensure the shield continuity.

The preferred reference potential is the **ground**.

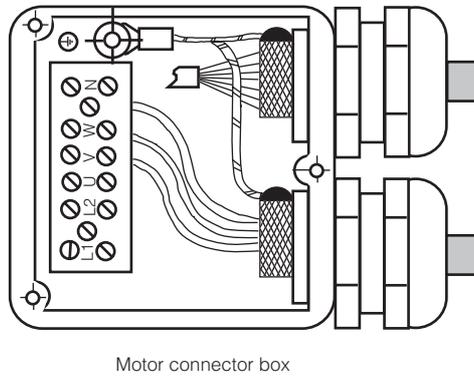
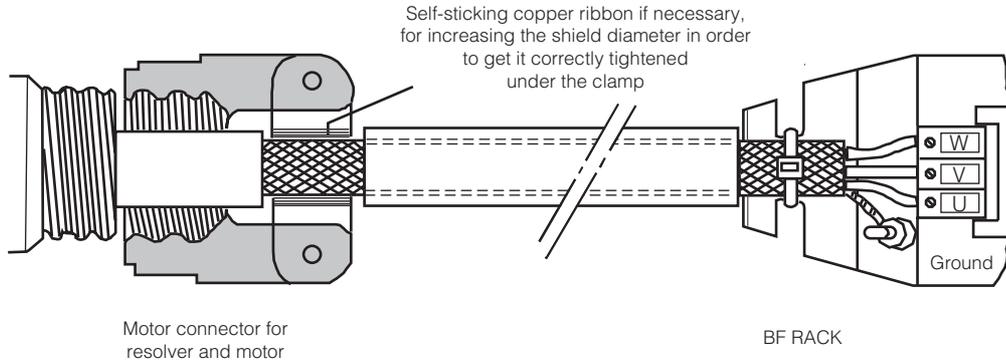
Cables with low potential should **never** run in the proximity of power lines.

If there is a potential reference, i.e. a main chassis or cabinet with a low impedance between its various elements, it should be used to connect ALL reference to it and also being grounded itself.

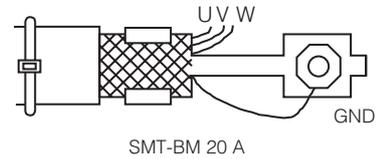
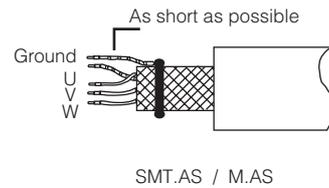
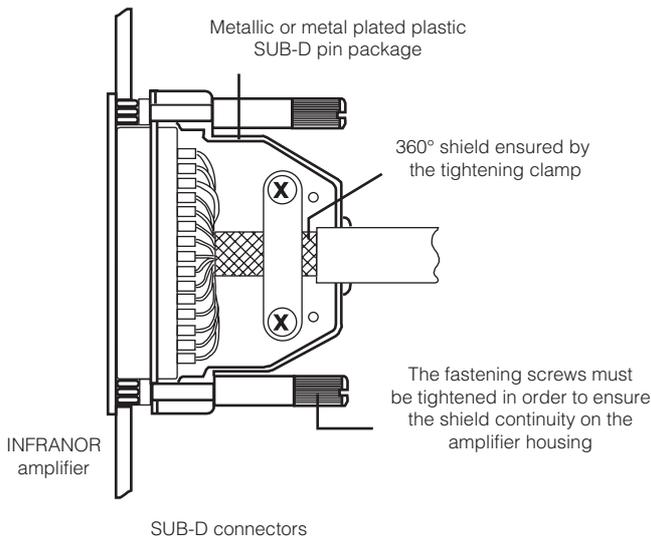
3.2 - CONNECTORS SHIELD CONNECTION

RULE

The shield should 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 connection is made by means of a collar, it is not necessary to connect a cable on the appropriate pin of the SUB-D connector.

3.3 - MOTOR AND RESOLVER CABLES

Motors and resolvers are grounded via their housing.

Cable inputs should be made by means of metal connectors with collars allowing the 360° shield connection.

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

3.4 - SERIAL LINK CABLES

The serial link cable must also be shielded according to the above mentioned shield connection recommendations.

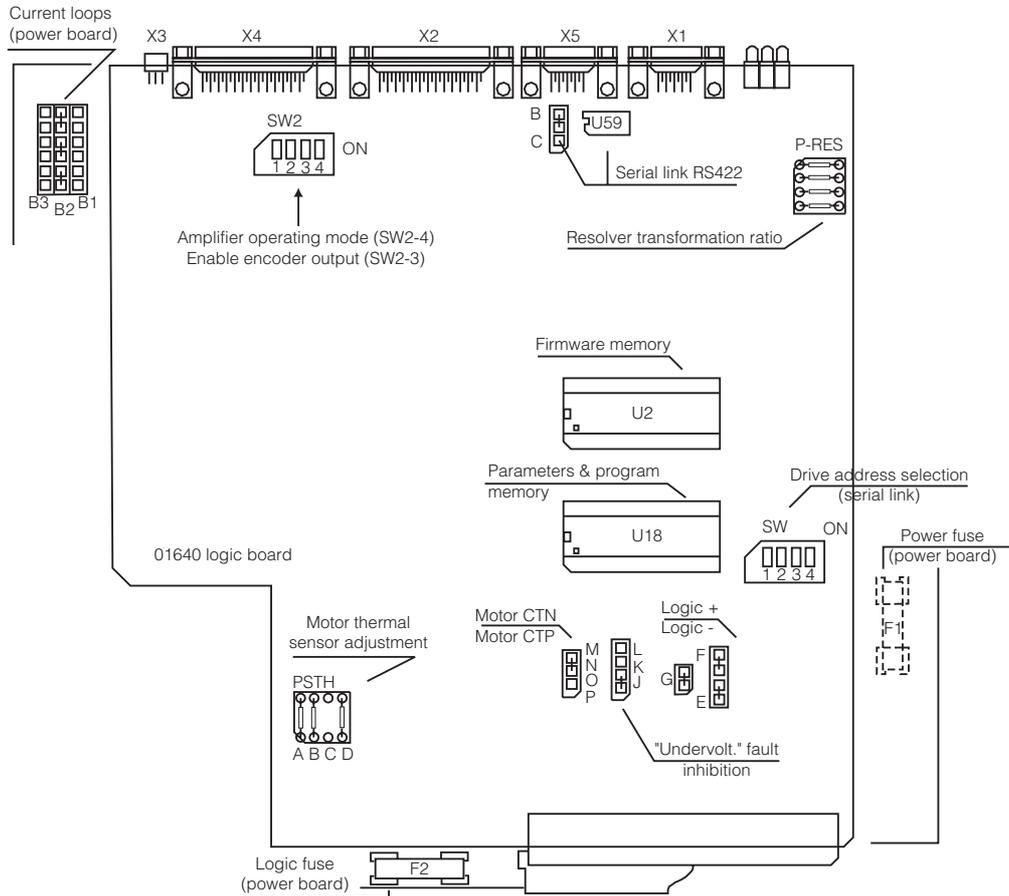
CAUTION

Command cables (resolver, serial link, Profibus) as well as the power lines must be connected and disconnected with amplifier **OFF**.

Chapter 5 - Adjustable functions

1 - HARDWARE ADJUSTMENTS

All hardware adjustments of the SMT-BD1/t amplifier module are presented on the following diagrams.



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

FOR AMPLIFIER RATINGS 4 A TO 100 A

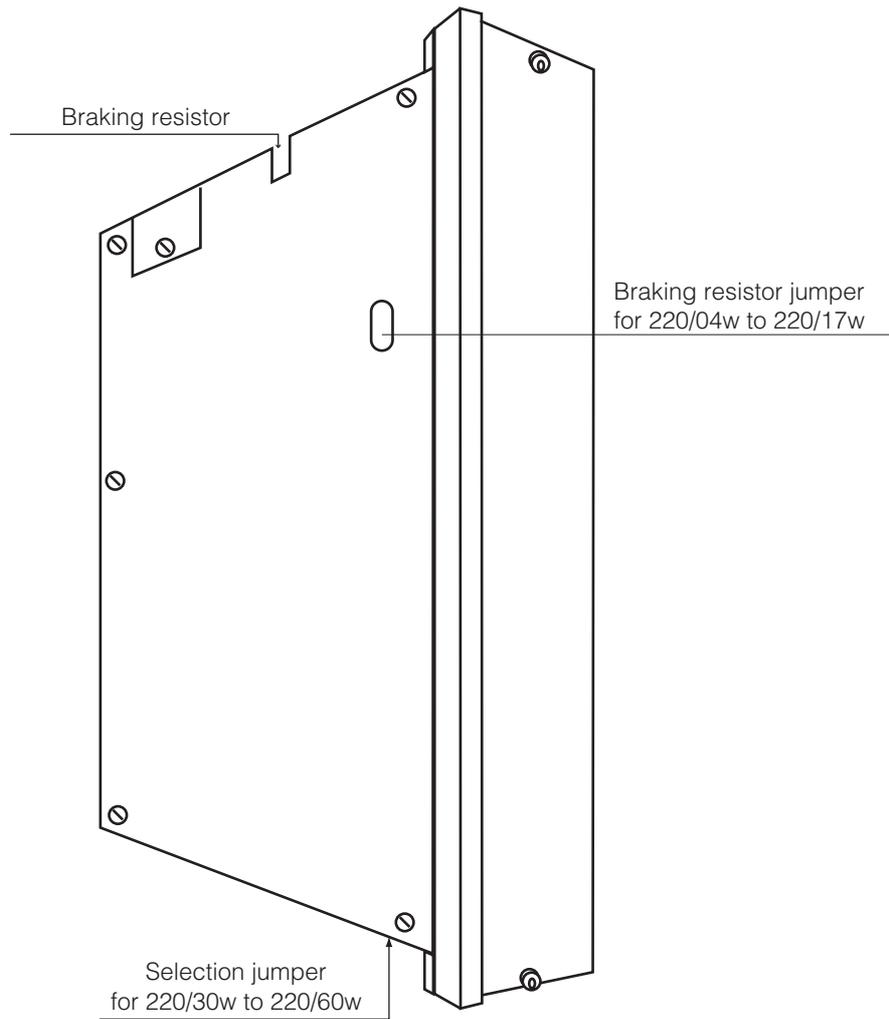


For amplifier versions with 70 A and 100 A current ratings in 220 V and serial numbers lower than 260600, please contact INFRANOR.

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

Resolver transformation ratio adjustment	P-RES			
Transformation ratio value	0,3	0,45	0,5	1
A - B - C - D tolerance < 1 %	21 K	14,3 K	12,7 K	6,34 K

In standard, the serial link is the RS-232 link, with jumper B closed. In option, the amplifier can be delivered with an RS-422 serial link, with jumper C closed.



BRAKING SYSTEM SELECTION FOR SMT-BD1/t-220/04w to 220/60w

SMT-BM20 A / BMM05F/05AF single-axis racks: Braking resistor jumper closed.
 BF rack: Braking resistor jumper open.

NOTE

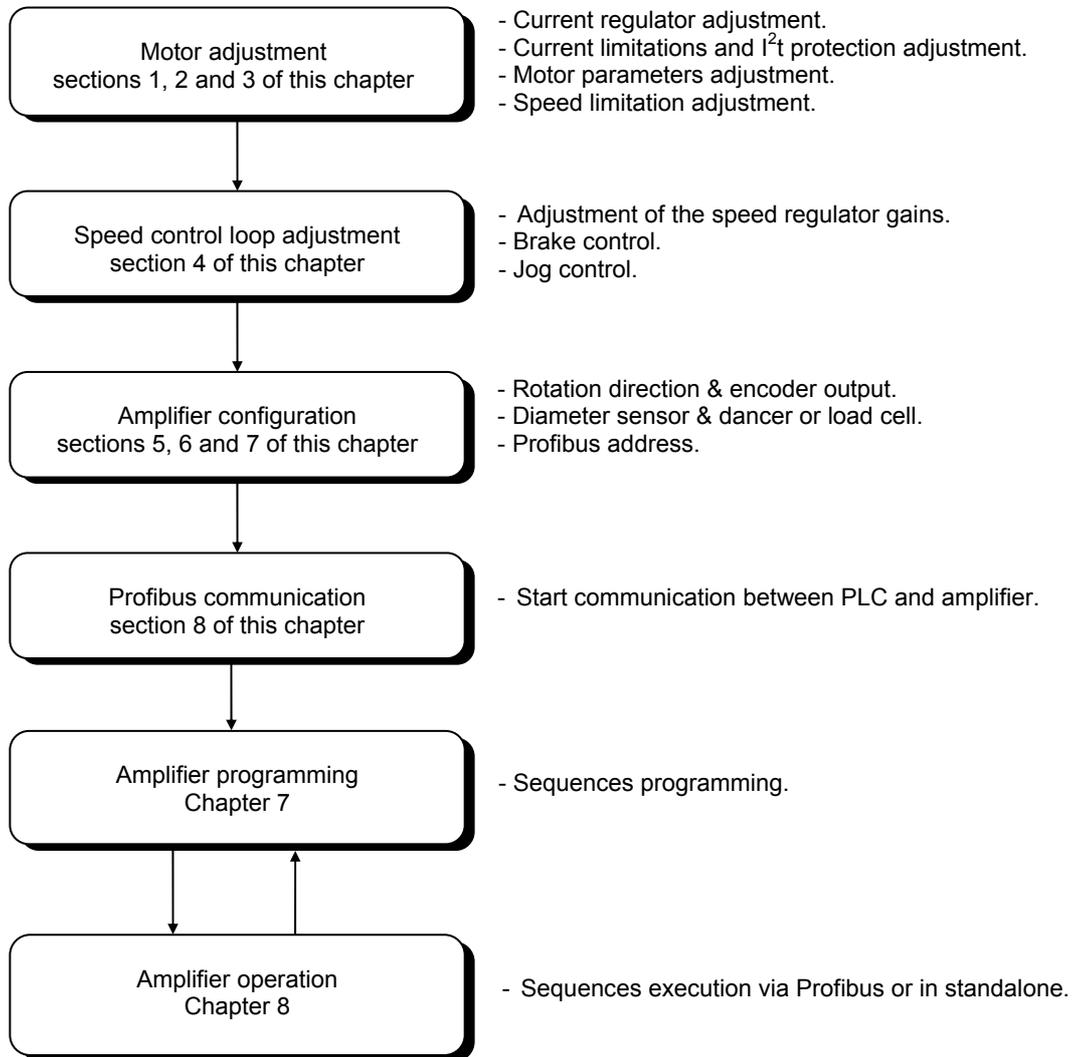
The braking resistor selection is only available on "w" referenced amplifiers

2 - ADJUSTABLE PARAMETERS

The SMT-BD1/t parameters can be modified either via the Profibus link or via the serial link and the BPCW software. The serial link connector (X5) must be connected to the serial interface of a PC for the parameter setting operation. The BPCW software, which is IBM-PC compatible with the WINDOWS® operating system, allows the clear display and easy modification of all amplifier parameters. The SMT-BD1/t parameters setting requires the BPCW software version 2.7 or higher.

Chapter 6 - Commissioning

The successive steps of the first amplifier commissioning are described below:



The amplifier parameters are accessible via:

- the serial link and the BPCW software,
- or by the PKW of the PROFIBUS DP.

CAUTION

Do not make the drive parameter setting by means of both BPCW software and Profibus at the same time.

INSTALLATION OF THE PC SOFTWARE

At first, connect the serial RS232 link between PC and amplifier.

The BPCW software is operating with Windows® 3.11/95/98/2000.

The SMT-BD1/t parameters setting requires the BPCW software version 2.7 or higher.

To install the software, insert the disk in driver A and start the installation programme by entering A:INSTALL
Enter the communication port (COM1 or COM2), select the language and start the installation.

1 - AMPLIFIER HARDWARE CONFIGURATION

1.1 - Standard configuration

The amplifier standard configuration is the following:

SMT-BD1/t unwinder/rewinder:

- Resolver adjustment card P RES: 4 x 12,7 K Ω 1%.
- Motor thermal probe PTC: Jumper MN.
- Current loops adjustment: medium gains in position B2.
- Positive control logic: Jumpers E. F. G closed.
- No auxiliary supply: Jumper JK closed and jumper KL open.
- SW "OFF" on all switches: selection of the address 0 for the serial link.
- SW2 "OFF" on all switches: Profibus operating mode and encoder output disabled.

1.2 - Motor thermal sensor configuration

Select the right MN or OP jumper setting according to the motor thermal sensor type (PTC or NTC).

1.2.1 - PTC THERMAL SENSOR

On motors equipped with a PTC thermal sensor (triggering on high impedance), the amplifier configuration is the following: MN jumper closed and OP jumper open. The triggering threshold adjustment for the PTC thermal sensor is made by means of the PSTH components, as described below : PSTH-D = 14,3 k Ω ; PSTH-B = 28 k Ω ; PSTH-A = 3 x RPTC (120°C) in k Ω . RPTC (120°C) = ohmic value of the PTC thermal sensor resistor at 120°C; the default adjustment is RPTC (120°C) # 3 k Ω with PSTH-A = 10 k Ω .

1.2.2 - NTC THERMAL SENSOR

On motors equipped with a NTC thermal sensor (triggering on low impedance), the amplifier configuration is the following: OP jumper closed and MN jumper open. The triggering threshold adjustment for the NTC thermal sensor is made by means of the PSTH components, as described below: PSTH-D = 14,3 k Ω ; PSTH-B = 28 k Ω ; PSTH-A = 3 x RNTC (120°C) in k Ω . RNTC (120°C) = ohmic value of the NTC thermal sensor resistor at 120°C; the default adjustment is RNTC (120°C) # 3 k Ω with PSTH-A = 10 k Ω .

1.3 - Current loops adjustments

1.3.1 - CURRENT LOOPS ADJUSTMENTS FOR THE 400 VAC AMPLIFIER VERSION

Select the right current loops jumpers setting (B1, B2 or B3 position) according to motor and amplifier specifications.

For the 400 VAC version of the BL MAVILOR motor series, the current loops adjustments are made according to following selection table.

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

For other motors, the adjustment of the current loops according to the **amplifier current rating** and to the **inductance between the motor terminals** is made as follows:

15 A and 30 A amplifier current ratings

Calculation of $G = 0.8 \times \text{Amplifier current rating (A)} \times \text{Inductance between phases (mH)}$,

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 amplifier current ratings

Calculation of $G = 0.8 \times \text{Amplifier current rating (A)} \times \text{Inductance between phases (mH)}$,

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.

1.3.2 - CURRENT LOOPS ADJUSTMENTS FOR THE 220 VAC AMPLIFIER VERSION

Select the right current loops jumpers setting (B1, B2 or B3 position) according to motor and amplifier specifications.

For the BL and MA MAVILOR motor series, the current loops adjustments are made according to following selection table.

AMPLIFIER \ MOTOR	4 A	8 A	12 A	17 A	30 A	45 A	60 A	70 A	100 A
MA 3		B1							
MA 6		B1	B1						
MA 10		B2	B1	B1	B1				
MA 20		B2	B1	B1	B1	B1	B1		
MA 30				B2	B2	B2	B1	B1	
MA 45					B2	B2	B1	B1	B1
MA 55						B2	B2	B2	B1
BL 55-3	B1								
BL 55-5	B1								
BL 71		B2							
BL 72		B2	B1	B1					
BL 73		B2	B1	B1					
BL 74		B2	B1	B1					
BL 111		B1	B1						
BL 112		B2	B2	B1	B2				
BL 113		B3	B3	B2	B2	B2			
BL 114				B3	B3	B2	B2		
BL 115				B3	B3	B2	B2	B2	
BL 141				B2	B2	B2	B1	B1	
BL 142				B3	B3	B2	B2	B1	
BL 143				B3	B2	B2	B1	B1	B1
BL 144				B2	B2	B2	B1	B1	B1

For other motors, the adjustment of the current loops according to the **amplifier current rating** and to the **inductance between the motor terminals** is made as follows:

4 A, 8 A, 12 A and 17 A amplifier current ratings

Calculation of $G = 1,4 \times \text{Amplifier current rating (A)} \times \text{Inductance between phases (mH)}$,

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.

30 A, 45 A, 60 A, 70 A and 100 A amplifier current ratings

Calculation of $G = 1,4 \times \text{Amplifier current rating (A)} \times \text{Inductance between phases (mH)}$,

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.

2 - PUTTING INTO OPERATION

The auxiliary supply voltage must be applied to the amplifier before the power supply voltage.

Test the auxiliary supply voltage :

Rated value = 230 Vrms single-phase.

Maximum value (must never be exceeded) = 260 Vrms, all mains variation tolerances included.

Switch on the auxiliary supply. The green ON Led must be lit and the UNDERVOLT error must be displayed.

Test the power supply voltage :

- For the 220 VAC amplifier version: **Rated value = 230 Vrms between phases.**

Maximum value (must never be exceeded) = 260 Vrms, all mains variation tolerances included.

- For the 400 VAC amplifier version: **Rated value = 400 Vrms between phases.**

Maximum value (must never be exceeded) = 480 Vrms, all mains variation tolerances included.

Switch on the power supply. The UNDERVOLT error Leds must be unlit. The braking resistor must remain cool.

CAUTION

The braking resistor is under high voltage.

When turning off the amplifier, wait for at least 5 seconds before turning power on again.

Check that the amplifiers front panel screws are correctly fastened on the rack.

If the parameter setting operation is made by the BPCW software, please select the **Software control** mode in order to enable and disable the amplifier by the software commands **Stop** and **Manual** during the commissioning operations.

3 - MOTOR ADJUSTMENT

3.1 - Motor parameter setting

Select the motor used in the motor list of the BPCW software or send the motor parameter values via Profibus.

Select the amplifier current limitation in **Fusing** mode for the commissioning phases. In **Fusing** mode, the amplifier is disabled when the current limitation threshold is reached. In **Limiting** mode, the current is only limited at the value defined by the **Rated current** parameter when the limitation threshold is reached.

The parameter **Max. current** defines the maximum current value supplied by the amplifier. It can vary between 20% and 100% of the amplifier current rating. This parameter is defined according to the amplifier and motor specifications.

The **Rated current** parameter defines the limitation threshold of the RMS current (I^2t) supplied by the amplifier. It can vary between 20 % and 50 % of the amplifier current rating. This threshold is set according to the amplifier and motor specifications.

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

The **Max. speed** parameter defines the maximum motor rotation speed. The speed range is between 100 and 14000 rpm and the resolution is 5 rpm. Check that its value is complying with motor and application. Otherwise, modify it according to the motor and application specifications.

3.2 - Adjustment to a new motor

When the motor used cannot be selected in the motor list or if the motor parameter values are unknown, proceed as follows:

Uncouple the motor from the mechanical load and check that the motor shaft is free and that its free rotation over 1 revolution is not dangerous for the operator. Execute the auto-phasing procedure (the amplifier must be disabled and the ENABLE signal must be activated) in order to define the parameters **Number of pole pairs**, **Motor phase** and **Resolver adjustment**. Please note that during the auto-phasing procedure the motor is automatically enabled and then disabled when the procedure is over.

The auto-phasing procedure calculates the following parameters:

- The parameter **Number of pole pairs** defines the number of motor pole pairs.
- The parameter **Phases order** defines the motor phases order.
- The parameter **Resolver offset** defines the mechanical shift between both motor and resolver references.

Calculate the parameter **Phase lead** from the specific motor parameters (the effects of this parameter are particularly useful on low inductance motors running at high speeds).

4 - SPEED CONTROL LOOP ADJUSTMENT

4.1 - Regulator parameters adjustment

Check at first that the **Speed regulator gain ratio** parameter value is set at 1 (servo loop gains adaptation mechanism disabled).

The **Auto-tuning** procedure identifies the motor and load specifications and calculates the regulator gain parameters. During the procedure, the operator can select a bandwidth (Low = 50 Hz, Medium = 75 Hz and High = 100 Hz). The auto-tuning can be executed with disabled or enabled motor, but the ENABLE signal must always be activated. The auto-tuning must be executed with the motor shaft coupled to the mechanical load: the unwind/rewind spindle and an empty spool corresponding to the minimum diameter value.

Check for free motor shaft rotation over one revolution that is not dangerous for operator and machine before starting the **Auto-tuning** with the **Standard** filter.

After the auto-tuning procedure, check that the motor correctly runs in both directions in speed mode with a digital set point or in jog mode. Check the response for a small speed reference without IDC saturation.

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. If the problem remains, renew the auto-tuning procedure with the **Antiresonance** filter selection.

If the motor instability is due to the coupling backlashes between the motor and the load, activate the **Reduced stiffness at standstill** command and test its effect when the motor is at standstill and then when the motor is running at a constant speed higher than 100 rpm.

4.2 - Enabling

The enabling can be made:

- by Profibus ([see operation diagram for the enabling procedure](#)) or
- by the BPCW software, in **Software control** mode.

4.3 - Brake control

The SMT-BD1/t amplifier is equipped with a brake control signal. This brake control signal is low powered and cannot directly control the brake. The BMM 05 AF single-axis rack is therefore equipped with a power relay that allows the brake control but the other racks are not equipped with this relay.

The brake control is activated (relay open) or disabled (relay closed) according to the amplifier status (disabled or enabled). The following parameters allow to adjust the brake control operation:

Brake delay active: defines the time between the brake enabling and the amplifier disabling.

- brake activation (relay open),
- delay time (= 0 in standalone mode),
- amplifier disabling.

Brake delay inactive: defines the time between the amplifier enabling and the brake disabling:

- amplifier enabling,
- delay time (= 0 in standalone mode),
- brake disabling (relay closed).

4.4 - Jog control

The motor is continuously running while the jog input is activated (Jog+ for a movement in the positive direction and Jog- for a movement in the negative direction). The jog inputs can only be activated with the Profibus control word. The following parameters allow to adjust the jog control operation:

Jog speed: defines the motor speed set point value in jog mode.

Jog accel time: defines the ramping time value for the motor acceleration from 0 to the maximum speed.

Jog decel time: defines the ramping time value for the motor deceleration from the maximum speed value to 0.

For the amplifier commissioning by means of the BPCW software, jog control can be provided in the control panel by setting the digital speed reference value.

5 - UNWINDER/REWINDER CONFIGURATION

5.1 - Rotation direction

The **Reverse movement** parameter allows to modify the motor rotation direction with regard to the speed reference polarity. For the encoder position output, the counting direction remains unchanged with regard to the motor rotation direction.

5.2 - Gearing ratio adjustment

The parameter **Encoder resolution** defines the encoder resolution on channels A and B (X2 connector) of the encoder position output for one motor shaft revolution. Binary and decimal values are both accepted. The maximum encoder resolution per revolution is limited by the motor rotation speed as shown in the table below.

Max. possible speed (rpm)	900	3600	14000
Max. encoder resolution	8192	4096	1024

The **Encoder resolution** parameter value also defines the master/slave gearing ratio value corresponding to the empty spool (minimum diameter and maximum line speed) according to the following formula:

Encoder resolution (ppr) / Master encoder resolution (ppr) = Master encoder speed (rpm) / Motor speed (rpm)

Enter the parameter **Maximum speed** according to the following formula:

Maximum speed (rpm) = 1.2 x Motor speed (rpm) at the maximum line speed value and the minimum diameter

Enter then the parameter **Encoder resolution** according to the following formula:

Encoder resolution (ppr) = Master encoder resolution (ppr) x Master encoder speed (rpm) at the maximum line speed value / Motor speed (rpm) at the maximum line speed value and the minimum diameter.

5.3 - Diameter sensor calibration

If the **Gearing ratio adaptation by diameter sensor** or **Set point ratio modulation by diameter sensor** operation are required, proceed as follows for the diameter sensor calibration :

Put an empty spool corresponding to the minimum diameter value on the unwind/rewind spindle and read the voltage value given by the diameter sensor by using the command **Diameter sensor value**. This value is then entered in the parameter **Diameter sensor value for min. diameter**.

Put a full spool corresponding to the maximum diameter value on the unwind/rewind spindle and read the voltage value given by the diameter sensor by using the command **Diameter sensor value**. This value is then entered in the parameter **Diameter sensor value for max. diameter**.

Enter the ratio value between the minimum spool diameter and the maximum spool diameter in the parameter **Spool diameter ratio (Min/Max)**.

Enable the motor and check its stability with full spool. In case of loud noises in the motor, remove the full spool and re-engage the empty one. Then, renew the auto-tuning procedure with the empty spool by selecting a lower bandwidth. If the problem remains, renew the auto-tuning procedure with the empty spool by activating the antiresonance filter. The audible noise in the motor must be cancelled under both empty spool and full spool conditions.

If a better servo loop stiffness is required under full spool condition, proceed as follows for the calibration of the gain / diameter adaptation :

Enter the value of the parameter **Diameter sensor value for max. diameter** in the parameter **Diameter sensor value for max. gain**.

Increase progressively the parameter **Speed regulator gain ratio (Max/Min)** up to the maximum possible value without noises in the motor. Do not exceed the limit value calculated by the ratio between both full and empty spool inertia reflected on the motor shaft ($J_{max\ motor} / J_{min\ motor}$).

Adjust the value of the parameter **Diameter sensor value for max. gain** in order to accurately define the gain adjustment range according to the spool diameter. This parameter must be reduced when the value of the parameter **Speed regulator gain ratio** adjusted before remains quite below the ratio between both full and empty spool inertia reflected on the motor shaft ($J_{max\ motor} / J_{min\ motor}$). This parameter can be calculated as follows:
Diameter sensor value for max. gain = **Diameter sensor value for min. diameter** + (**Diameter sensor value for max. diameter** - **Diameter sensor value for min. diameter**) x [(**Speed regulator gain ratio** - 1) x ($J_{min\ motor} / J_{max\ motor}$)]^{0,25}

5.4 - Encoder ratio calibration

If **Gearing ratio adaptation by line encoder** or **Set point ratio modulation by line encoder** operation is required, enter the ratio value between both minimum and maximum spool diameters in the parameter **Spool diameter ratio (Min/Max)**.

5.5 - Tension measurement calibration

If a tension control sequence type must be executed, proceed as follows for the tension measurement sensor (dancer or load cell) calibration :

Set the analog input 1 (ANin1) on the X4 connector at 0 volt and execute the offset compensation procedure with the amplifier disabled.

Put the dancer or the load cell in the « low » position corresponding to the minimum material tension value. Read the voltage value given by the dancer or the load cell by using the **Tension measurement value** command. This value can be entered in the parameter **Undertension limit**.

Put the dancer or the load cell in the « high » position corresponding to the rated material tension value. Read the voltage value given by the dancer or the load cell by using the **Tension measurement value** command. This value can be entered in the **Tension set point** parameter value for the tension sequence programming.

If a ratio init sequence must be executed (unwind/rewind operation without diameter sensor), proceed as follows for the ratio init procedure calibration :

Engage the material in the unwinder/rewinder via the master encoder roller, up to the traction system.

Stretch the material up to the « low » position of the dancer corresponding to the minimum material tension value.

Reset the **master encoder position** value.

Stretch the material up to the « high » position of the dancer corresponding to the rated material tension value.

Read the **master encoder position** value. This value can then be entered in the **master encoder reference displacement** parameter value for the ratio init sequence programming. Read the corresponding voltage value given by the dancer by using the **Tension measurement value** command. This value can be entered in the **Tension set point** parameter value for the ratio init sequence programming.

5.6 - PID loop adjustment for tension control

CAUTION

It is advisable to limit the motor torque by limiting the amplifier **Max. current** and **Rated current** during the PID adjustment phase in order to avoid a material braking if the tension loop becomes instable.

The PID loop parameters are at first initialised according to the following values :

Error scaling gain is set at 10 %.

Proportional gain is set at 1.

Integral gain and **Derivative gain** are both set at 0.

Speed variation limit parameter is set at a low value (100 rpm).

The tension control parameters are at first initialised according to the following values :

Tension error tolerance is set at 10 %.

Overspeed limit is set at the **Maximum motor speed** value.

Tension sequence error link is not defined in order to get the motor stopped in case of tension sequence error.

If possible, the **Undertension limit** parameter value is set out off the voltage range given by the dancer or the load cell (according to the previous tension measurement sensor calibration). This avoids the tension sequence error to be released during the PID adjustment.

A tension control sequence is programmed according to following conditions:

Tension set point is set according to the previous tension measurement sensor calibration.

Holding time parameter value is set at more than 16000 ms in order to have the sequence active until the STOP input activation.

Engage the material in the unwinder/rewinder and lock it by means of the downstream traction system.

The TDI input must be disabled in order to enable the PID loop for the tension regulation.

Start the tension control sequence execution.

If the tension loop is instable (continuous material unwinding or saturated motor torque), reverse the sign of the **error scaling gain** parameter.

If the tension loop is oscillating, reduce the value of the **Proportional gain** until the loop remains stable. When the system is stable, increase the **Proportional gain** parameter up to the value where it starts oscillating; then reduce the parameter **Proportional gain** in order to ensure the tension stability.

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

In case of loud noise in the motor due to the tension measurement signal, reduce the **Tension input filter** cut-off frequency value.

Adjust the parameter **Speed variation limit** according to the speed offset command value that is necessary for regulating the material tension over the whole speed range (generally 5 to 10 % of the maximum motor speed value).

5.7 - Parameters setting for tension control

Enter the value of the parameter **Overspeed limit** according to following calculation:

Overspeed limit (rpm) = Speed variation limit (rpm) + Motor speed (rpm) at rated line speed value and minimum diameter.

In this case, when the material is running at rated line speed, a tension sequence error will be generated if the material tension error becomes too high (dancer or load cell fault), bringing the PID loop to saturation.

The **Undertension limit** parameter value is set according to the previous tension measurement sensor calibration in order to have a tension sequence error in case of material braking :

Undertension limit \geq to the dancer or the load cell voltage value in « low » position

Undertension limit $<$ to the dancer or the load cell voltage value corresponding to the tension set point

The **Tension error tolerance** must be set at the appropriate level regarding the tension measurement variation when the material is running at the maximum line speed value. In this case, when the tension error value exceeds the tolerance level, the TER output desactivation allows to detect any unwinder/rewinder problem.

This parameter value must be carefully adjusted when the **Gearing ratio adaptation by line encoder** operation is selected. In this case, when the tension error value exceeds the tolerance level, the gearing ratio gain adaptation is stopped in order to avoid any wrong gearing ratio value calculation. So, if the tolerance level is too low, the gearing ratio adaptation cannot be performed anymore and can cause the unwinder/rewinder material braking.

The **Tension sequence error link** parameter can define the number of the sequence to be executed when a tension sequence error is generated. This allows to program the unwinder/rewinder behaviour in case of material braking according to the application. If the **Tension sequence error link** parameter is not defined, when a tension sequence error is generated, the motor is braking according to the STOP deceleration ramp.

6 - PROFIBUS ADDRESS

Each amplifier of the network is identified by one single address (1 to 125). The SMT-BD1/t unwinder/rewinder amplifier is delivered with the default address 126 which is not an operational address. This address must be modified before putting the bus into operation.

The SMT-BD1/t address can be modified:

- by the serial RS-232 link (BPCW software). The new address must be saved in the EEPROM and the amplifier must be switched on in order to get the new address operational;
- or by a Profibus class 2 master device. The address modification is only possible when the bus is not running. In this case, the address will be automatically saved in the amplifier EEPROM and will be operational at the bus start.

The identity number of the SMT-BD1/t unwinder/rewinder under Profibus is 0x05B3.

7 - PARAMETERS SAVING

When all adjustments are made, the parameters must be saved in the EEPROM (with disabled amplifier).

8 - PROFIBUS OR STAND ALONE MODE SELECTION

Switch off the amplifier after the parameters saving and select the desired operation mode (Profibus control or stand alone operation) by using the SW2-4 configuration switch:

SW2-4 = ON for selecting the stand alone operation mode

SW2-4 = OFF for selecting the Profibus operation mode

In the Profibus operation mode, servo amplifier control and parameter setting can both be made via the PROFIBUS DP connection. The servo amplifier control via PROFIBUS DP connection simply consists in selecting one of the amplifier pre-programmed control sequences and start its execution.

In the stand alone operating mode, a pre-programmed control sequence is selected via the SEL1 and SEL2 logic inputs and its execution is started by using the START logic input. However, in this case only the sequences numbered 0 to 3 can be selected by the SEL1 and SEL2 logic inputs activation.

Chapter 7 - Programming

1 - GENERAL DESCRIPTION

The SMT-BD1/t amplifiers can have up to 64 pre-programmed sequences. Each sequence can be either :

- a gearing ratio initialisation sequence or
- a tension control sequence or
- a speed control sequence or
- a torque control sequence.

The control sequences can be automatically linked up: as soon as a sequence is over, another one can be executed. This allows to easily solve complex unwind/rewind and tension control applications by chaining several basic control sequences.

The SMT-BD1/t amplifiers have got 8 programmable logic outputs (triggering at the sequences execution) and 8 programmable logic inputs allowing to control a sequence start or stopping. The logic input 1 is entering the X2 connector on pin 21 (Lin1) while the logic inputs 2 to 8 are virtual. The virtual logic inputs can only be activated or deactivated on the serial bus interface for the sequence control and have no physical existence. Logic output 1 is located on the X2 connector on pin 8 (Lout1) while the logic outputs 2 to 8 are virtual. The virtual logic outputs are only visible on the serial bus interface for the sequence control and has no physical existence.

The programming consists in initializing the sequence parameters with the desired values.

2 - CONTROL SEQUENCE PARAMETERS

Type	Defines the control sequence type. RATIO INIT : gearing ratio initialisation. TENSION : tension control. SPEED 1 : single loop speed control. SPEED 2 : dual loop speed control. TORQUE : torque control.
Tension	Defines the dancer or load cell tension measurement value in Volt (range: -10 V to +10 V) corresponding to the material tension set point value. If the sequence type is a gearing ratio initialisation, Tension then indicates the dancer position to be reached during the spool rewind movement for the gearing ratio estimation procedure.
Stretching	Defines the material stretching ramp in ms when the tension set point is changing (range 0 to 16000).
Holding	Defines the time duration in ms for the material to be maintained at the tension set point (range 0 to 16000). If this parameter value exceeds 16000, the material is maintained at the tension set point until the sequence stop condition.
Speed	Defines the motor speed in rpm.
Acceleration	Defines the motor acceleration time from 0 to the motor max. speed in ms (range 0 to 16000).
Running	Defines the motor running time in ms (range 0 to 16000). If this parameter value exceeds 16000, the motor is continuously running until the sequence stop condition.
Deceleration	Defines the motor deceleration time from the motor max. speed to 0 in ms (range 0 to 16000). This parameter can be equal to 0 if a sequences linkage can be made without stopping the motor.
Gearing ratio	The master/slave gearing ratio value is calculated according to the master encoder resolution and the motor encoder resolution as described below : $\text{Motor speed (rpm)} / \text{Master encoder speed (rpm)} = (\text{Gearing ratio gain}(\%) / 100) \times \text{Master encoder resolution (ppr)} / \text{Motor encoder resolution (ppr)}$
Torque	Defines the motor current set point value in % of the amplifier maximum current. The corresponding motor torque value is calculated according to the motor torque/current ratio value.

Time Out	Defines the time in seconds after which the amplifier releases a procedure error if it cannot correctly estimate the gearing ratio value during the gearing ratio initialisation sequence.
Next sequence	Defines the sequence to be executed after the current one.
Counter	Defines how many times the sequence must be executed. This counter is decremented each time a sequence is over.
Jump	Defines the number of the sequence to be executed while the counter is not at 0.
Logic outputs	Defines the possible effect on the outputs.
Triggering	Defines the outputs triggering moment.

3 - SEQUENCE SET POINT SELECTION

For each type of control sequence (Tension, Speed 1, Speed 2, Torque), various set point sources can be selected according to the final application.

The sequence **Internal** set point is stored into the program memory and remains constant during the complete sequence execution.

When **Analog set point** is selected in the sequence, the set point value can be continuously modified during the sequence execution. In this case, the set point source can be either the amplifier analog input 1 (ANin 1) voltage value or the PROFIBUS process data words according to the **Amplifier configuration** parameter.

When **Master encoder gearing** is selected for a tension control or speed 1 sequence type, the sequence speed set point value is given by the frequency of the amplifier encoder input pulses.

4 - VARIABLE DIAMETER OPERATION

4.1 - Speed gearing ratio adaptation

The amplifier gearing ratio gain is valid during the Tension, Speed 1 and Torque sequences execution and also in "Jog" mode. The Speed 2 control sequence is the only sequence which is not concerned by the amplifier gearing ratio. At the amplifier power up, the gearing ratio gain value is set at 1. The gearing ratio gain value is neither modified during a Speed 2 control sequence execution nor in Jog mode. During a Tension, Speed 1, Torque or Ratio init sequence execution, the gearing ratio gain value can be calculated by different ways according to the unwind/rewind application. The sequence parameter setting allows to select the most appropriate calculation method as described below :

When **Constant gearing ratio gain** or **Constant set point ratio** is selected , the sequence **Gearing ratio gain** or **Torque set point ratio** parameter value is giving the amplifier gearing ratio gain value to be applied during the complete sequence execution. If the sequence **Gearing ratio gain** or **Torque set point ratio** parameter value is set at 0, the sequence is started with the current amplifier gearing ratio gain value (final value of the former sequence) and this value is maintained during the complete sequence execution.

When **Gearing ratio adaptation by diameter sensor** or **Set point ratio modulation by diameter sensor** is selected , the amplifier gearing ratio gain value is continuously calculated according to the spool diameter value during the sequence execution. In this case, the effective diameter value source can be either the current analog input 2 (ANin 2) voltage value or the current diameter value received via the PROFIBUS process data words depending on the **Amplifier configuration** parameter.

When **Gearing ratio adaptation by line encoder** or **Set point ratio modulation by line encoder** is selected , the amplifier gearing ratio gain value is calculated according to the encoder/motor speed ratio during the sequence execution. In this case, the sequence **Gearing ratio gain** or **Torque set point ratio** parameter value is giving the amplifier gearing ratio gain to be applied at the sequence start. If the sequence **Gearing ratio gain** or **Torque set point ratio** parameter value is set at 0, the sequence is started with the current amplifier gearing ratio gain value (final value of the former sequence). The amplifier gearing ratio gain calculation by the encoder/motor speed ratio is only valid when the material is stretched and the tension set point is stable.

During a tension control sequence execution, the gearing ratio gain calculation is only performed when the tension set point error is lower than the tension error tolerance parameter value (TER output activated). During a torque control sequence execution, the gearing ratio gain calculation is only performed when the torque set point value is reached (TER output also activated).

The ratio init sequence allows to calculate the gearing ratio gain value for a tension control application based on a dancer feedback. This sequence must be executed before entering a variable diameter tension control sequence when **Gearing ratio adaptation by line encoder** operation is selected, in order to correctly initialise the gearing ratio gain calculation procedure before starting the material running.

4.2 - Torque set point ratio adaptation

The amplifier torque set point ratio is only valid during the Torque sequence execution. The other control sequences and the "Jog" mode are not concerned by the torque set point ratio value. At the amplifier power up, the torque set point ratio value is set at 1. During a Tension, Speed 1 or Ratio init sequence execution, the torque set point ratio value is continuously updated according to the speed gearing ratio gain value on the following way : Torque set point ratio = Spool diameter ratio / Speed gearing ratio gain. During a Torque sequence execution, the torque set point ratio value can be calculated on various ways according to the unwind/rewind application. The Torque sequence parameter setting allows to select the most appropriate calculation method as described below :

When **Constant set point ratio** is selected , the sequence **Torque set point ratio** parameter value is giving the amplifier torque set point ratio value to be applied during the complete sequence execution. If the sequence **Torque set point ratio** parameter value is set at 0, the sequence is started with the current amplifier torque set point ratio value (final value of the former sequence) and this value is maintained during the complete sequence execution.

When **Set point ratio modulation by diameter sensor** is selected , the amplifier torque set point ratio value is continuously calculated according to the spool diameter value during the sequence execution. In this case, the effective diameter value source can be either the current analog input 2 (ANin 2) voltage value or the current diameter value received via the PROFIBUS process data words depending on the **Amplifier configuration** parameter.

When **Set point ratio modulation by line encoder** is selected , the amplifier torque set point ratio value is calculated according to the encoder/motor speed ratio during the sequence execution. In this case, the sequence **Torque set point ratio** parameter value is giving the amplifier torque set point ratio value to be applied at the sequence start. If the sequence **Torque set point ratio** parameter value is set at 0, the sequence is started with the current amplifier torque set point ratio value (final value of the former sequence). The amplifier torque set point ratio calculation by the encoder/motor speed ratio is only valid when the material is stretched. During the torque control sequence execution, the torque set point ratio calculation is only performed when the torque set point value is reached (TER output activated).

During the Torque sequence execution, the speed gearing ratio gain value is continuously updated according to the torque set point ratio value in the following way :

$$\text{Speed gearing ratio gain} = \text{Spool diameter ratio} / \text{Torque set point ratio.}$$

4.3 - Servo loop gains adaptation

The speed servo loop gains adaptation mechanism is always active when the amplifier is enabled. The proportional and integral speed regulator gains are both continuously multiplied by the gain ratio value. The gain ratio value is calculated according to the diameter sensor measurement value in order to adapt the speed servo loop gain values with regard to the spool inertia value. This allows to maintain the best speed servo loop stability when the spool diameter is changing. The **Diameter sensor calibration** menu allows to adjust the gains adaptation parameters according to the spool characteristics. When the **Speed regulator gain ratio** parameter is set at 1, the servo loop gains adaptation mechanism is disabled. In this case, the speed regulator gains are maintained at their rated value regardless of the diameter sensor measurement value.

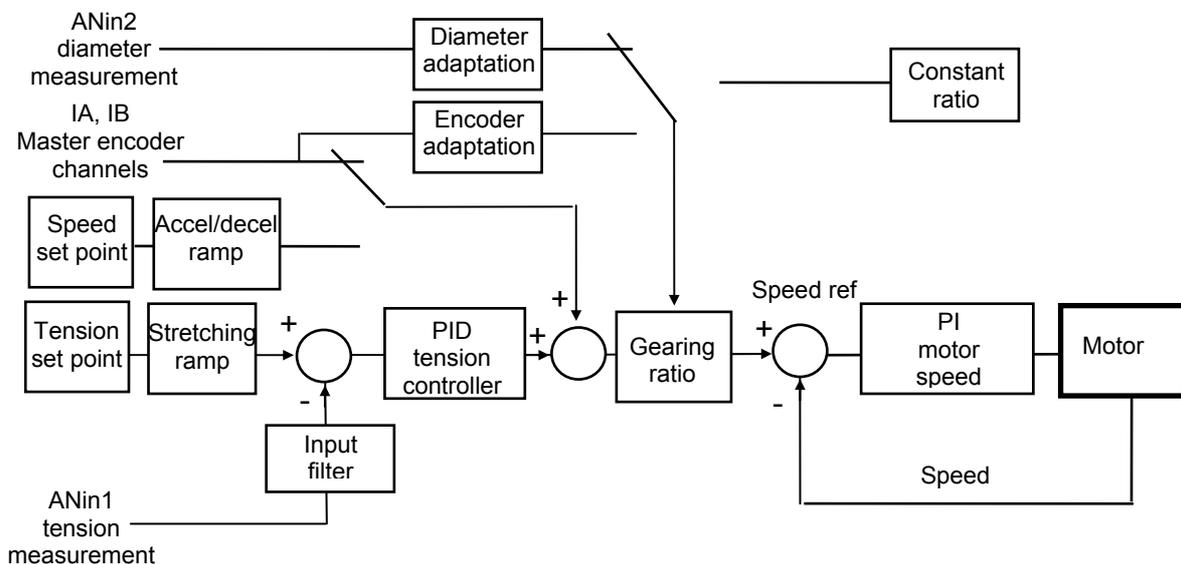
5 - EDITION OF A CONTROL SEQUENCE

5.1 - Tension control sequence

Tension control sequence parameters :

Sequence type	= TENSION
Tension set point (V)	= 2.5
Stretching time (ms)	= 300
Holding time (ms)	= 5000
<input checked="" type="radio"/> Internal speed set point Speed set point value (rpm) = 200 Accel/decel time (ms) = 500	
<input type="radio"/> Master encoder gearing	
Gearing ratio gain (%)	= 70
<input type="radio"/> Constant gearing ratio gain <input checked="" type="radio"/> Gearing ratio adaptation by diameter sensor <input type="radio"/> Gearing ratio adaptation by line encoder	
Next sequence	= 5
Counter	=
Jump	=
Output (87654321)	=
Output trigger	= End
Start condition (87654321)	=[] Stop

The tension control structure associated to this sequence is presented below :



When the TDI input (X2 connector pin 22) is activated, the PID tension controller output is set at 0.

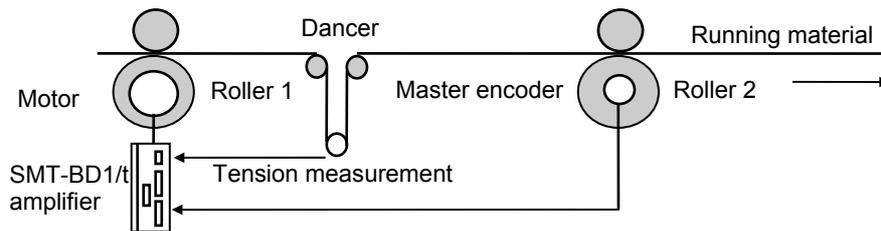
When the tension set point value is reached, if the tension controller error is lower than the **Tension error tolerance** parameter value, the TER logic output is activated.

When the motor speed reference value exceeds the **Overspeed limit** parameter value because of a dancer fault (blocking or failure), a tension sequence error is generated. When the dancer or the load cell tension measurement value drops below the **Undertension limit** parameter value because of a material braking, a tension sequence error is also generated. When a tension sequence error is generated, the TER logic output is deactivated and the tension control sequence is immediately stopped and the sequence which number is given by the **Sequence error link** parameter value is then automatically executed.

When the **Gearing ratio adaptation by diameter sensor** operation is selected, the **Gearing ratio gain** parameter value is no more valid because the gearing ratio is directly calculated from the spool diameter measurement value.

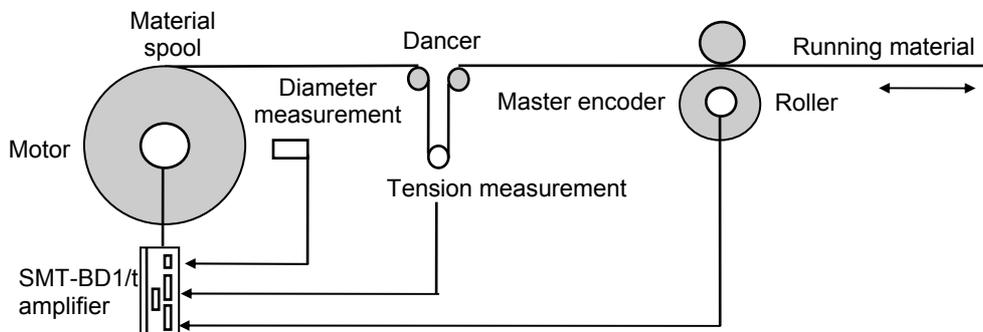
The **Gearing ratio adaptation by line encoder** operation is only valid when the master encoder is connected. In this case the gearing ratio adaptation procedure is initialised by the **Gearing ratio gain** parameter value. If the **Gearing ratio gain** parameter value is set at 0, the gearing ratio adaptation procedure is initialised according to the gearing ratio value estimated during a former ratio init sequence.

- A material tension control application with a constant gearing ratio is presented on the following diagram :



The SMT-BD1/t amplifier is driving the roller 1 motor and provides the running material tension control according to the tension measurement signal coming from the dancer and the master encoder pulses. In this case, the **Constant gearing ratio gain** operation is selected and the corresponding gearing ratio value is adjusted by the **Gearing ratio gain** parameter.

- An unwind/rewind tension control application with a variable gearing ratio is presented on the following diagram :



The SMT-BD1/t amplifier is driving the spool motor and provides the running material tension control according to the tension measurement signal coming from the dancer and the master encoder pulses. When the spool diameter is changing, the new value of the gearing ratio gain is calculated according to the diameter measurement value (**Gearing ratio adaptation by diameter sensor** selected).

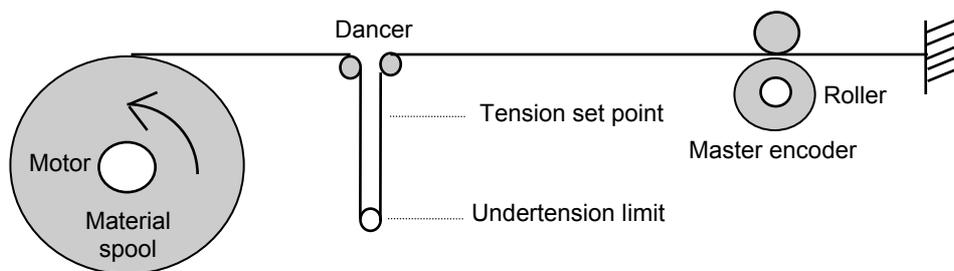
If the diameter measurement sensor is not available for a given process, when the spool diameter is changing, the new value of the gearing ratio gain is calculated during the material running according to the current encoder/motor speed ratio when the dancer position is stable (**Gearing ratio adaptation by line encoder** selected). In this case, the **Gearing ratio gain** parameter value is used for the gearing ratio initialisation when starting the tension control sequence, in order to be able to run the motor and stretch the material before starting the encoder/motor gearing ratio gain calculation. If the **Gearing ratio gain** parameter is set at 0, the gearing ratio is initialised according to the gearing ratio gain value estimated during a former ratio init sequence.

5.2 - Gearing ratio initialization sequence

Gearing ratio initialization sequence parameters :

Sequence type	= RATIO INIT
Tension set point (V)	= 2.5
Master encoder reference displacement (pulses)	= 3500
Rewind motor speed (rpm)	= -20
Accel./Decel. time (ms)	= 500
Time out (s)	= 4
Next sequence	= 5
Output (87654321)	=
Start condition (87654321)	=

This sequence must be executed before starting a variable diameter tension control sequence when **Gearing ratio adaptation by line encoder** operation is selected in order to initialise correctly the gearing ratio gain adaptation procedure before starting the material running. The gearing ratio gain estimation procedure is described below :



- The material must be stopped and locked at the roller level in order to be stretched by the spool driving motor.
- The spool driving motor is running at the constant rewind speed in order to stretch the material
- The motor displacement is measured from the “Undertension limit” dancer position up to the “Tension set point” dancer position and the gearing ratio gain is then calculated in the following manner :

$$\text{Gearing ratio gain} = \text{Measured motor displacement} / \text{Master encoder reference displacement}$$

If the master encoder displacement during the ratio init procedure execution is exceeding 10 % of the **Master encoder reference displacement** parameter value (when the material is not correctly locked at the master roller level), a ratio init sequence error is generated. When the **Time out** value is over before the end of the ratio init procedure execution , a ratio init sequence error is also generated. When a ratio init sequence error is generated, the ratio init sequence is immediately stopped and the sequence which number is given by the **Sequence error link** parameter value is then automatically executed.

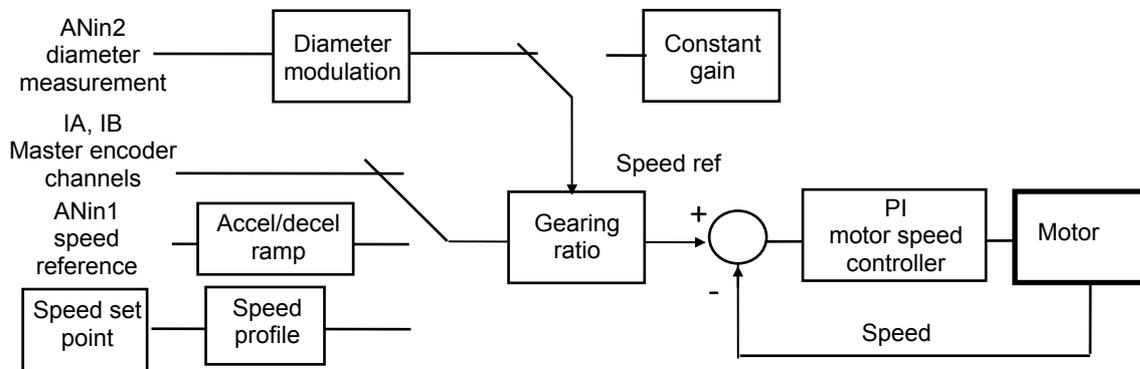
The **Master encoder reference displacement** parameter is measured when the material spool driving motor is locked and the material is stretched at the roller level in order to move the dancer from the **Undertension limit** position up to the **Tension set point** position. The **Undertension limit** parameter value is entered in the **Tension control** parameters menu.

5.3 - Speed 1 control sequence

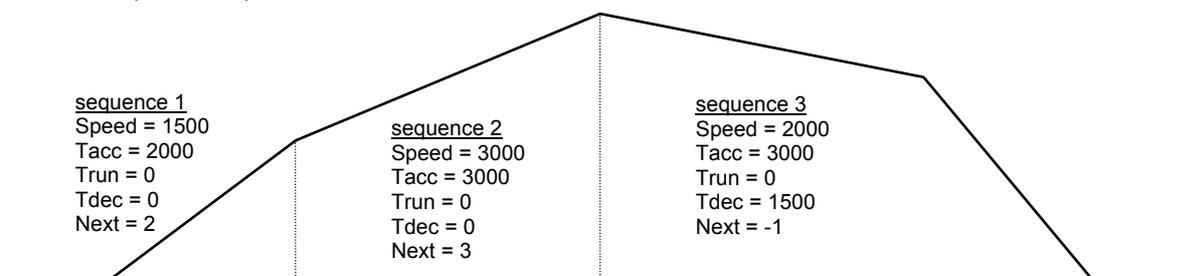
Speed 1 control sequence parameters :

Sequence type	= SPEED 1
Acceleration time (ms)	= 500
Running time (ms)	= 500
Deceleration time (ms)	= 500
<input checked="" type="radio"/> Internal speed set point Speed set point value (rpm) = 200	
<input type="radio"/> Analog speed reference Analog input offset (V) = 2	
<input type="radio"/> Master encoder gearing	
Gearing ratio gain (%)	= 70
<input checked="" type="radio"/> Constant gearing ratio gain	
<input type="radio"/> Gearing ratio modulation by diameter sensor	
Next sequence	= 5
Counter	=
Jump	=
Output (87654321)	=
Output trigger	= End
Start condition (87654321)	=[] Stop

The speed control structure associated to this sequence is presented below :

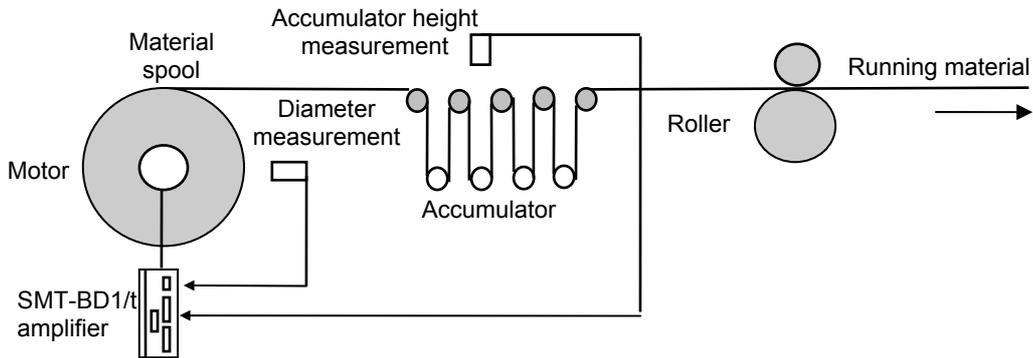


When the **Internal speed set point** is selected, the sequences linkage allows to create any desired speed profile as described below. If the **Running time** parameter value exceeds 16000 ms, the motor is continuously running until the sequence stop condition.



Note: Next = -1 corresponds to an empty field in the PC.

The selection of both **Analog speed reference** and **Gearing ratio modulation by diameter sensor** allows a typical unwinder accumulator control application, as shown on the following diagram:



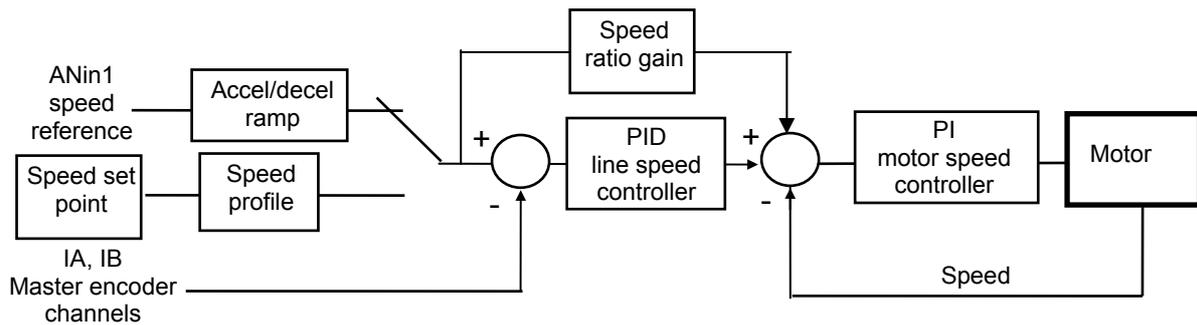
The SMT-BD1/t amplifier is driving the spool motor according to the accumulator height measurement signal and the diameter measurement signal. When the accumulator material is taken by the roller, the accumulator is going up and the spool must start running in order to supply new material to the accumulator. So the accumulator height must be controlled in order to have a linear height variation with regard to the material line speed. Furthermore, when the spool diameter is decreasing, the motor speed value must be increased according to the diameter measurement value in order to maintain the right accumulator height with regard to the material line speed. The accumulator position at standstill (material line speed =0) can be easily adjusted by using the **Analog input offset** parameter. This parameter adjustment allows to get an automatic material spool rewind up to the accumulator standstill position at the sequence start.

5.4 - Speed 2 control sequence

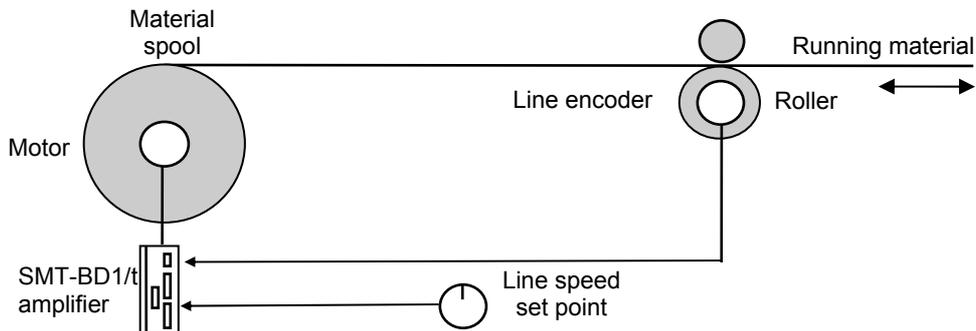
Speed 2 control sequence parameters :

Sequence type	= SPEED 2
Acceleration time (ms)	= 500
Running time (ms)	= 500
Deceleration time (ms)	= 500
<input checked="" type="radio"/> Internal speed set point Speed set point value (rpm) = 200 <input type="radio"/> Analog speed reference	
Speed ratio gain (%)	= 50
Next sequence	= 5
Counter	=
Jump	=
Output (87654321)	=
Output trigger	= End
Start condition (87654321)	=[] Stop

The speed control structure associated to this sequence is presented below :



The selection of the **Analog speed reference** operation allows a typical unwinder/rewinder speed control application as shown on the following diagram:



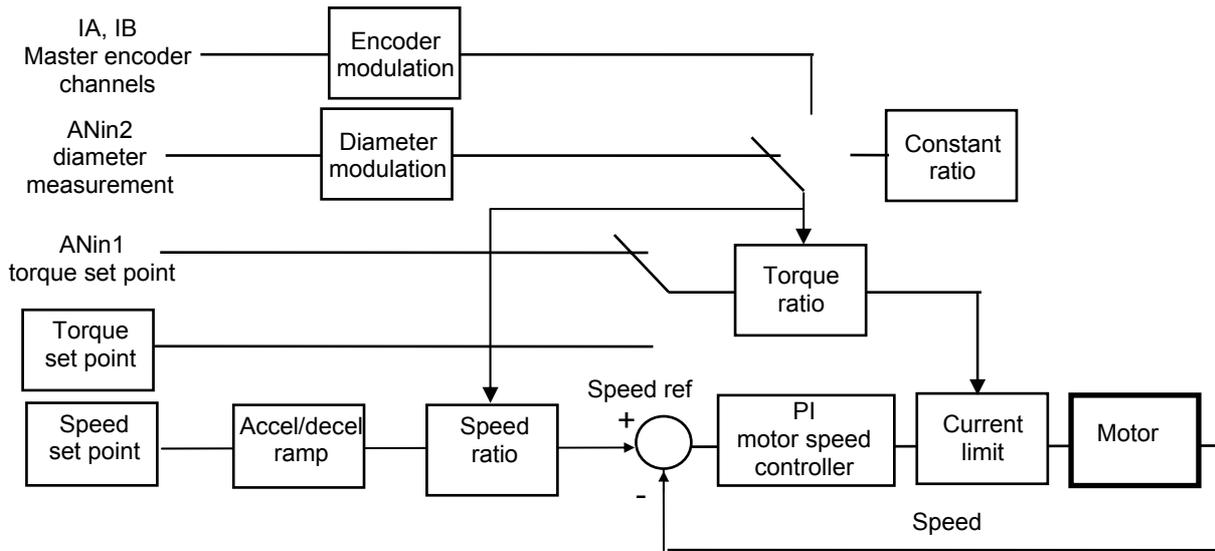
The SMT-BD1/t amplifier is driving the spool motor and provides a constant material line speed control according to the analog line speed set point value. When the spool diameter is changing, the motor speed value is updated by the PID line speed controller in order to cancel the line speed error (line speed error = line speed set point - line speed measurement given by the line encoder). This dual speed loop control structure can ensure very accurate line speed regulation according to the spool diameter variation without any diameter sensor.

5.5 - Torque control sequence

Torque control sequence parameters:

Sequence type	= TORQUE
Speed set point value (rpm)	= -100
Acceleration time (ms)	= 500
Torque holding time (ms)	= 8000
<input checked="" type="radio"/> Internal torque set point Torque set point value (%) = 40	
<input type="radio"/> Analog torque set point	
Torque set point ratio (%)	= 50
<input type="radio"/> Constant set point ratio <input checked="" type="radio"/> Set point ratio modulation by diameter sensor <input type="radio"/> Set point ratio modulation by line encoder	
Next sequence	= 5
Counter	=
Jump	=
Output (87654321)	=
Output trigger	= End
Start condition (87654321)	=[] Stop

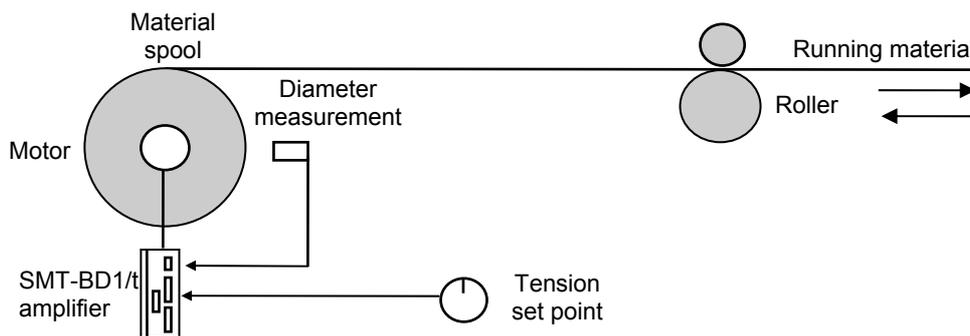
The torque control structure associated to this sequence is presented below :



At the start of a torque control sequence, the motor is accelerating and then running at the **Speed set point** parameter value until the shaft is locked. The motor running direction depends on the sign of the **Speed set point** parameter. When the motor shaft displacement has been stopped in the running direction, the current is raising up to the limit value defined by the **Internal torque set point** parameter or the value given by the ANin1 analog input voltage if **Analog torque set point** is selected. When the current limit value has been reached, the TER logic output is activated and the amplifier is holding the torque set point during the time value defined by the parameter **Torque holding time**. The torque control sequence is then automatically over after the holding time value. If the **Torque holding time** parameter value exceeds 16000 ms, then the torque holding time is infinite and the sequence stop condition can be used to leave the torque control sequence.

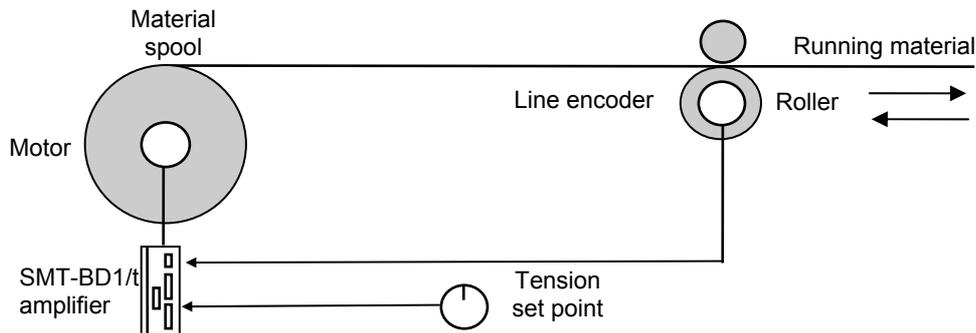
During the torque holding time, if the motor speed value is exceeding the **Overspeed limit** parameter value because of a material braking, a torque sequence error is generated. When a torque sequence error is generated, the TER logic output is deactivated and the torque control sequence is immediately stopped. The sequence which number is given by the **Sequence error link** parameter value is then automatically executed. This security is useful for a winding application where it is necessary to set the **Speed set point** parameter value higher than the line speed value in order to reach the current limitation during the winding operation.

The selection of both **Analog torque set point** and **Set point modulation by diameter sensor** allows a typical winder or unwinder tension control application, as shown on the following diagram:



The SMT-BD1/t amplifier is driving the spool motor and provides a constant material tension control according to the analog set point (**Analog torque set point** selected) and the diameter measurement signal (**Set point ratio modulation by diameter sensor** selected). When the spool diameter is changing, the motor torque value is modified according to the diameter measurement value in order to maintain the right material force with regard to the tension set point. In an unwinding application, the **Speed set point** parameter is set at a low value in order to have the material automatically rewound and progressively stretched up to the tension set point at the sequence start. In a winding application, the **Speed set point** parameter must be set at a higher value than the maximum value of the line speed during the winding operation in order to reach the current limitation.

The selection of both **Analog torque set point** and **Set point ratio modulation by line encoder** allows a second winder or unwinder tension control application, as shown on the following diagram:



The SMT-BD1/t amplifier is driving the spool motor and provides a constant material tension control according to the analog set point and the encoder/motor gearing ratio. When the spool diameter is changing, the motor torque value is modified according to the encoder/motor gearing ratio value in order to maintain the right material force with regard to the tension set point. In this case, the **Torque set point ratio** parameter value is used for the torque set point initialisation when starting the torque control sequence, in order to be able to run the motor and stretch the material at the correct tension value before starting the gearing ratio gain calculation. In an unwinding application the **Speed set point** parameter is set at a low value in order to have the material automatically rewound and progressively stretched up to the tension set point at the sequence start. In a winding application, the **Speed set point** parameter must be set at a higher value than the maximum value of the line speed during the winding operation in order to reach the current limitation.

6 - SEQUENCES CHAINING

6.1 - Sequence control

6.1.1 COUNTER LOOP

The sequences linkage is controlled by the parameters "Next sequence", "Counter" and "Jump".

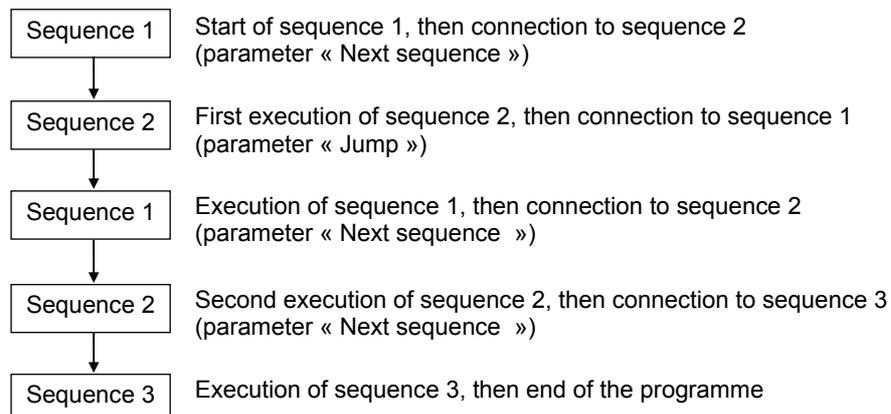
Application example:

```

Sequence 1:  Next sequence = 2
              Counter = 0
              Jump = -1
Sequence 2:  Next sequence = 3
              Counter = 2
              Jump = 1
Sequence 3:  Next sequence = -1
              Counter = 0
              Jump = -1
  
```

Note: Next = - 1 or Jump = - 1 correspond to the empty field in the PC software.

If the execution starts at sequence 1, the programme will be the following:



6.1.2 - CONDITIONAL JUMP

The conditional jump is controlled by using the “Start condition” and the parameters “Next sequence”, “Counter” and “Jump”.

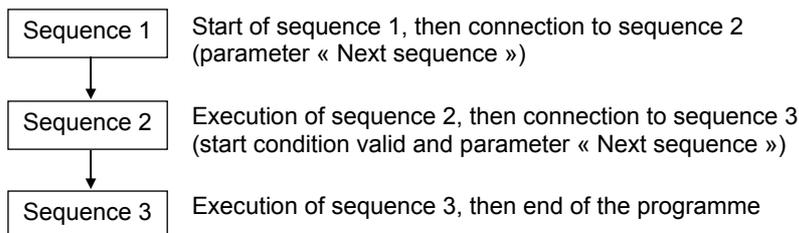
Application example:

```

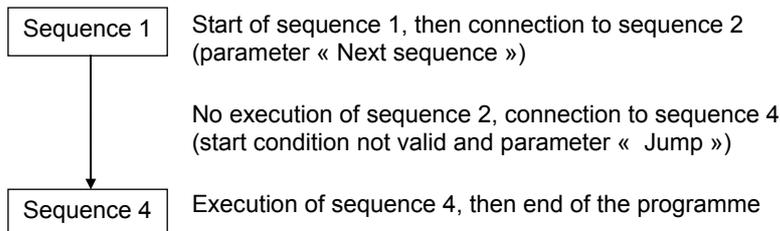
Sequence 1:  Next sequence = 2
              Counter = 0
              Jump = -1
Sequence 2:  Next sequence = 3
              Counter = 0
              Jump = 4
              Start condition = 0x0100 (Logic input 1 activated )
Sequence 3:  Next sequence = -1
              Counter = 0
              Jump = -1
Sequence 4:  Next sequence = -1
              Counter = 0
              Jump = -1
  
```

Note: Next = - 1 or Jump = - 1 correspond to the empty field in the PC software.

If the execution is starting at sequence 1 and logic input 1 is activated, the programme will be the following:



If the execution is starting at sequence 1 and logic input 1 is deactivated, the programme will be the following:



6.2 - Logic inputs

Logic input 1 is entering the X2 connector on pin 21 (Lin1) while logic inputs 2 to 8 can only be activated or deactivated on the serial bus interface (PROFIBUS DP) for the sequence control and have no physical existence.

The inputs can be used either as a sequence start condition or as a sequence stop condition. A sequence stop condition is only valid when the running time or the holding time value is higher than 16000 ms.

The 8 logic inputs can be selected as follows:

- ignore the input status,
- trigger on positive level (input activated),
- trigger on negative level (input deactivated).

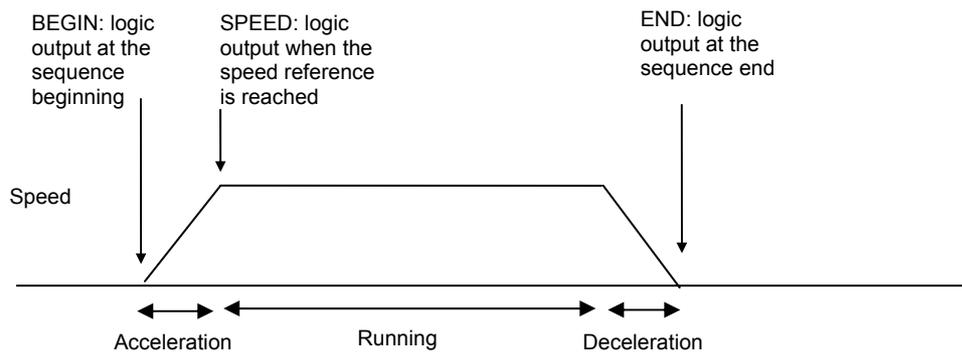
6.3 - Logic outputs

Logic output 1 is located on pin 8 (Lout1) of the X2 connector while logic outputs 2 to 8 are only visible on the serial bus interface (PROFIBUS DP) for the sequence control and have no physical existence.

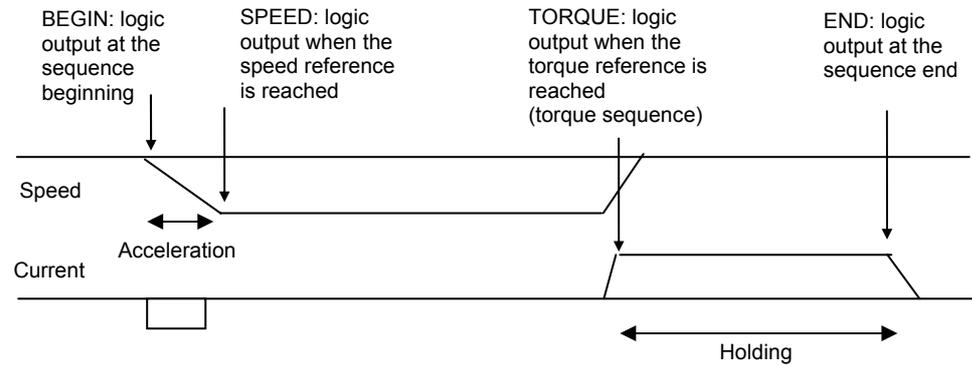
- Outputs** The action on the 8 logic outputs can be defined as follows:
- do not modify the output status,
 - set the output at 1,
 - set the output at 0,
 - reverse the output status (toggle).

Triggering The outputs triggering moment can be defined during a control sequence according to the different ways described below.

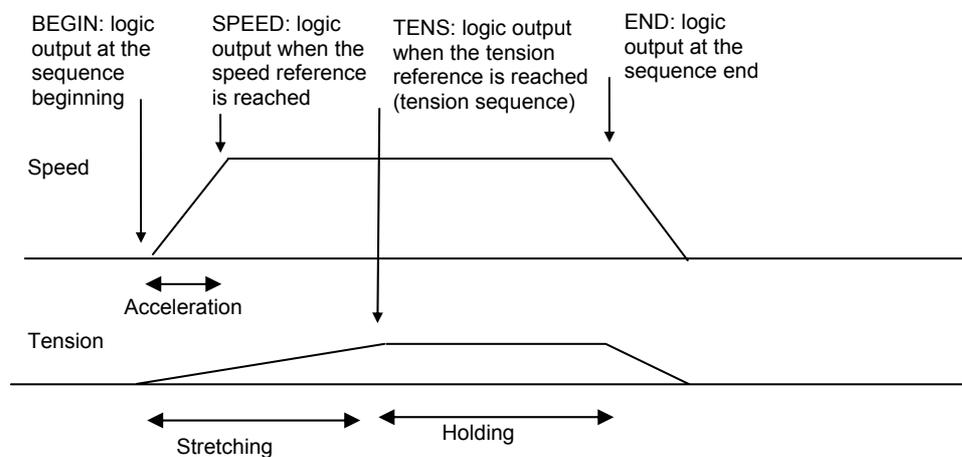
Speed 1 or speed 2 sequence outputs:



Torque sequence outputs:



Tension sequence outputs:



In a ratio init sequence, the outputs trigger only at the end of the sequence.

Chapter 8 - Operation with Profibus

1 - PROFIBUS COMMUNICATION

The Profibus communication is a master-slave communication. The INFRANOR® amplifier is a slave device and the only important parameter to be defined for the communication is the amplifier address on the bus.

All other parameters (communication speed, configuration, parameters) are defined in the PLC (master) and will be automatically sent to the amplifier:

- the available communication speeds are: 9,6 KB, 19,2 KB, 93,72 KB, 187,5 KB, 500 KB, 1,5 MB, 3 MB, 6 MB, 12 MB and will be automatically detected by the amplifier.
- the configuration used will be sent to the slave at the bus start. The available configurations are PPO1, PPO2, PPO3 or PPO4,
- default parameter setting: not used by the amplifier.

These various possibilities are pre-defined in a GSD file proper to each product range running with Profibus. The GSD file for the INFRANOR® unwinder/rewinder is **INFR05B3.GSD** and is provided by the BPCW software disk (version 2.7 or higher).

When defining the network on the master, please:

- import the slave GSD file if this has not yet been done,
- create a network with the master,
- connect a slave on the network with the same address as defined in the slave.

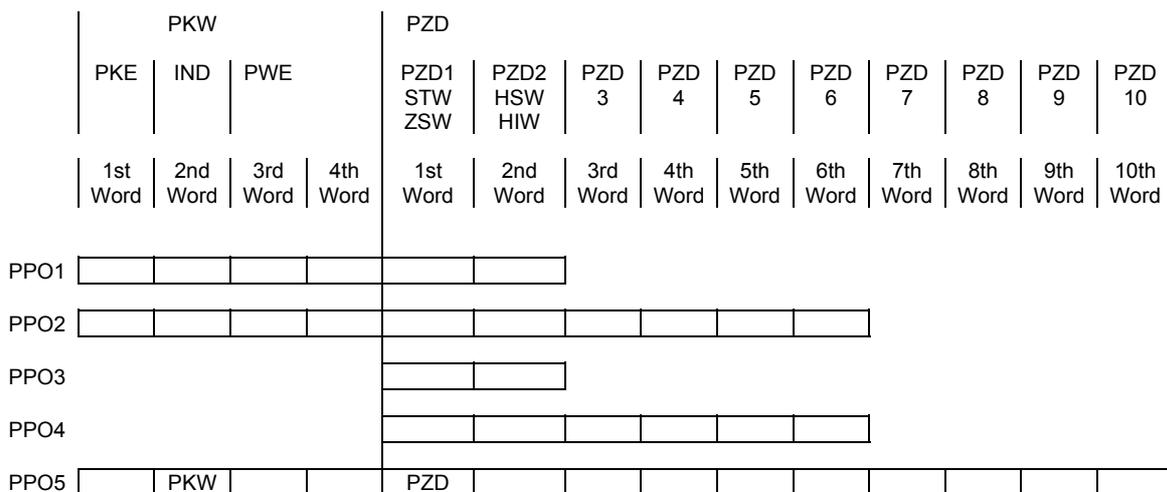
Note: When the communication is established, the green "RUN" LED lights up.

1.1 - PPO message

In the PROFIBUS-DP communication model, a slave module consists of a certain number of inputs-outputs or inputs-outputs modules. Each module is defined by an identifier. This identifier contains information on the module direction (input, output or input-output), on the number of bytes or words and on the module consistency. The configuration is defined in the DP master and is sent to the slave by means of the Chk_Cfg functions at the bus start. The slave checks if this configuration is compatible and configures itself before switching to data exchange mode (Data_Exchange).

There is also a communication mechanism more complicated than a basic inputs/outputs identifier: the PPO messages. These messages are often used in the "device profiles".

There are 5 PPO types defined for the various device profiles under Profibus:



PKW Parameter setting data.
PKE Parameter code (bytes 1 to 2).
IND Index (byte 3).
PWE Parameter value (bytes 5 to 8).

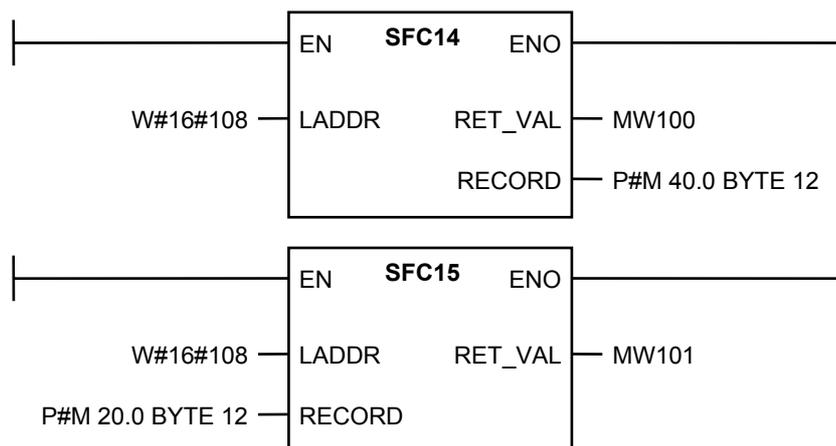
PZD Process data (cyclically transferred).
STW Control.
ZSW Status.
HSW Input command.
HIW Information feedback.

A PPO message can contain 1 or 2 modules called PKW and PZD.

Each module (PKW or PZD) is defined as input-output and is consistent over the whole module length. The communication is made by the reading or writing of PPO messages (the PKW and PZD modules are input and output at the same time). The master sends a message by a PPO-write and receives a message by PPO-read. The PPO-write and PPO-read messages are cyclically transferred by the PROFIBUS DP Data_Exchange function.

The modules are consistent. This means that the different words of a same message must be transmitted or received in one single transfer. So, it is not possible to directly read or write in the PLC inputs/outputs area; special functions must be used for the data reading or writing.

Example: In the STEP7[®] software, the SFC14 and SFC15 functions are used for the reading and writing of the consistent modules.



In the above example, the SFC14 and SFC15 functions are used for reading or writing the PZD module (PPO2 case). The W#16#108 address is the physical module address on the network that is obtained when connecting the slave to the network. This address is the same for the reading (SFC14) and writing (SFC15) because the module is an input-output module. The result of the reading will be transferred in the memory area at the address 40 by SFC14 (12 bytes). The SFC15 function will transfer the data at the address 20 (12 bytes) on the bus.

The PKW will require a SFC14 (reading) and a SFC15 (writing) and the PZD will require a SFC14 and a SFC15.

PKW is by definition used for the amplifier parameter setting and PZD is used for its operational control.

The INFRANOR[®] amplifier uses the PPO messages mechanism for communicating by Profibus-DP.

The SMT-BD1/t amplifier accepts the PPO1, PPO2, PPO3 or PPO4 types.

1.2 - Configuration

Normally, the identifiers of the various PPO types are automatically provided by the GSD file. Otherwise, they can be manually defined with values indicated in the table below:

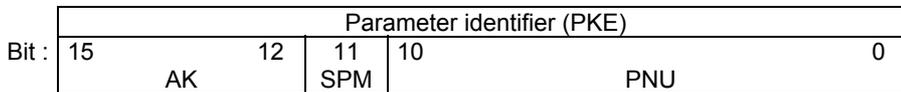
PPO type	PKW	PZD
Type 1 ReadPPO1, WritePPO1 Configuration	PKW (4 words) Inputs/outputs module 4 words Consistency 0xF3	PZD Inputs/outputs module 2 words Consistency 0xF1
Type 2 ReadPPO2, WritePPO2 Configuration	PKW (4 words) Inputs/outputs module 4 words Consistency 0xF3	PZD Inputs/outputs module 6 words Consistency 0xF5
Type 3 ReadPPO3, WritePPO3 Configuration		PZD Inputs/outputs module 2 words Consistency 0xF1
Type 4 ReadPPO4, Write PPO4 Configuration		PZD Inputs/outputs module 6 words Consistency 0xF5

Example

When PPO2 is used, the identifiers are 0xF3 and 0xF5 (4 words for PKW and 6 words for PZD).

1.3 - Parameter setting (PKW)

The parameter area (PKW) allows to read or modify a parameter.



- AK: Instruction or reply code (0-15)
- SPM: Toggle bit for parameter data signal processing.
- PNU: Parameter number (1..1999)

1.3.1 - INSTRUCTION/REPLY (PKW)

Instructions code (master -> slave):

Instruction Code	Function	Positive reply code	Negative reply code
0	No instruction	0	
1	Read a parameter	1	7 / 8
2	Modify a parameter (word)	1	7 / 8
3	Modify a parameter (double word)	2	7 / 8

The reply code mentioned in the above table includes the normal replies associated with the instructions. The parameter code (PKE) is always of 16 bits.

Bits 0 to 10 include the parameter number (PNU).

Bit 11 indicates an event message: the parameter is both modified and sent by the amplifier.

Bits 12 to 15 include the instruction or reply code.

Reply codes (slave -> master):

Reply code	Function
0	No function.
1	Value of the transferred parameter (word).
2	Value of the transferred parameter (double word).
7	Instruction cannot be executed (see error code).
8	PKW interface inhibited.

For instructions that cannot be executed, the slave answers with an error number in the 4th word of the PKW (bits 7 and 8).

Error number	Description
0	PNU illegal.
1	Parameter cannot be changed.
2	Exceeding of lower or upper limit.
3	Index error (2 nd word of PKW)
5	Incorrect data type
17	Instruction cannot be executed during operation.
18	Other error

1.3.2 - PARAMETER VALUE (PWE)

PWE includes the data for the parameter to be transferred:

- word: bytes 7 (MSB) and 8 (LSB).
- double word: bytes 5 (MSB) to 8 (LSB).

1.3.3 - RULE OF THE INSTRUCTION/REPLY COMMUNICATION

- The master sends an instruction to the slave with the message "PPO write". It repeats this instruction until it gets a reply from the slave by "PPO read". This procedure guarantees the instruction/reply communication by the operator.
- Just one single instruction can be executed at once.
- A slave provides the reply until the master sends a new instruction.
- An instruction (8 bytes) must be completely transferred in a message, and a reply as well.
- If no parameter setting information is required, the master must send 0 in AK (no instruction).

1.4 - Global control

The PROFIBUS DP global control mechanism can be used for synchronizing the outputs and inputs of several modules and several slaves. There are 4 global controls: SYNC, UNSYNC, FREEZE and UNFREEZE.

When the master sends a global SYNC control, the outputs of the addressed slave are frozen at their current values. When the master sends the next data, those are stored in the slave and the outputs status remains unchanged. When the next SYNC control is sent, the stored outputs values are switched through to the outputs. An UNSYNC control can be used for ending the synchronous mode.

The FREEZE control also allows the slave to freeze the inputs at their current values and to send them with the next data transfers. The inputs are not updated until the next FREEZE control. The FREEZE mode can be left by means of an UNFREEZE control.

The SMT-BD1/t amplifier accepts the global controls SYNC, UNSYNC, FREEZE and UNFREEZE.

2 - CONTROL VIA PROFIBUS

The unwinder/rewinder is driven by Profibus with the PZD data area.

Master -> slave (PLC -> unwinder/rewinder):
 - Control word (STW)
 - Input command (HSW)

Slave -> master (unwinder/rewinder -> PLC):
 - Status (ZSW)
 - Feedback (HIW)

2.1 - Control word

Bit	Value	Meaning	Notes
0	1 0	ON OFF1	Enabling. Stop, braking and disabling.
1	1 0	Operational condition OFF2	Amplifier ready.
2	1 0	Operational condition OFF3	Emergency stop: maximum deceleration.
3	1	Operation enabled	
4	1 0	Operational condition for the unwinder/rewinder Stop	A sequence can be executed on a 6 bit edge. Maximum braking.
5	1 0	Operational condition for the unwinder/rewinder Intermediate stop	Must be set at 1 for a sequence execution. Braking with programmed deceleration.
6	↓↑	Execute unwinder/rewinder function	Each edge on this bit releases the execution of the selected sequence.
7	↑	Fault acknowledgment	Amplifier fault reset.
8	1 0	Jog +	Continuous motor movement in the positive direction.
9	1 0	Jog -	Continuous motor movement in the negative direction.
10	1 0	Command Local	Control by Profibus Local mode control by RS-232
11			
12			
13			
14			
15			

2.2 - Input command

The input command is contained in the PZD part of the PPO (2nd word of PZD to 6th word of PZD).
 It has got different meanings according to the unwind/rewind or speed control mode.

In unwind/rewind mode:

PZD2 contains the sequence control input (bits 0 to 7: number of the sequence to be executed ; bits 8 to 15: logic inputs (1 to 8) used for the sequence start or stop conditions).

If PPO2 or PPO4 is used:

PZD3 contains the tension sequence set point (0x7FFF corresponds to 10 V).

PZD4 contains the speed sequence set point (0x7FFF corresponds to the maximum motor speed).

PZD5 contains the torque sequence set point (0x7FFF corresponds to the maximum current).

PZD6 contains the diameter value (0x7FFF corresponds to 10 V).

Remark: PZD3 to PZD6 are only valid when **Analog set point** is selected in the sequence and **PROFIBUS** is selected as the set point source in the **Amplifier configuration** parameter (PNU742).

In speed mode (as from firmware EPROM version 506.64):

PPO2 or PPO4 must be used:

PZD2 contains the speed input command (0x7FFF corresponds to the maximum motor speed).

PZD5 contains the current limitation (0x7FFF corresponds to the maximum current).

2.3 - Status

Bit	Value	Meaning	Notes
0	1 0	Ready for enabling Not ready	Ready for enabling (ENABLE).
1	1 0	Ready for operation	
2	1 0	Operation enabled	
3	1 0	Error	Amplifier fault after error reset; is in "disabled" status.
4	1 0	No OFF2 OFF2	Instruction "OFF2" available
5	1 0	No OFF3 OFF3	Instruction "OFF3" available
6	1 0	Enabling inhibited Enabling	
7	1 0	Warning	Warning signal; the amplifier goes on operating.
8	1 0	No following error Following error	
9	1 0	Operation via Profibus Operation in local mode	
10	1 0		
11	0 1	Ratio init already achieved	
12	↓↑	Input command acknowledgment	Acknowledgment of a sequence triggering
13	1 0	Motor stopped	
14	1 0	Sequence running	
15	1 0	Speed is reached	

Note

When switching from the "Profibus" mode to local mode or vice versa, the amplifier is disabled.

2.4 - Feedback

The feedback is included in the PZD part of the PPO (2nd word of PZD to 6th word of PZD).

It has got different meanings according to the unwind/rewind or speed control mode.

In unwind/rewind mode:

PZD2 contains the sequence control feedback (bits 0 to 7 of the HIW: number of the running sequence (otherwise 0xFF) ; bits 8 to 15 of the HIW: programmable logic outputs (1 to 8) of the amplifier).

If PPO2 or PPO4 is used:

PZD3 contains the tension monitor (0x7FFF corresponds to 10 V).

PZD4 contains the speed monitor (0x7FFF corresponds to the maximum motor speed).

PZD5 contains the torque monitor (0x7FFF corresponds to the maximum current).

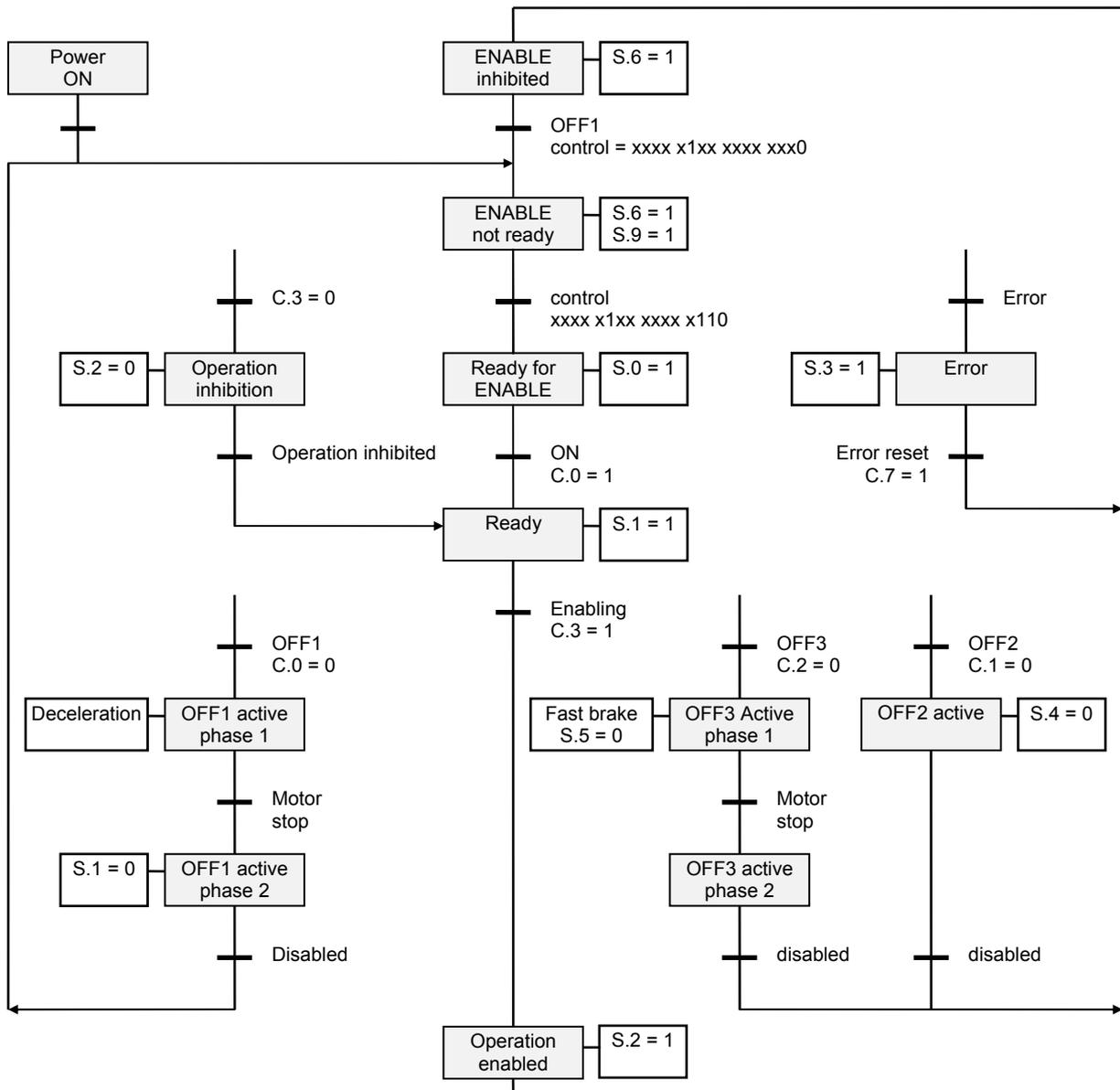
PZD6 contains the diameter monitor (0x7FFF corresponds to 10 V).

In speed mode (as from firmware EPROM version 506.64):

PPO2 or PPO4 must be used:
 PZD2 contains the motor speed value (0x7FFF corresponds to the maximum motor speed).
 PZD5 contains the current monitor (0x7FFF corresponds to the maximum current).

3 - OPERATION DIAGRAM

3.1 - Amplifier control process



Notes:
 ENABLE Enabling.
 C.n Indicates bit n of the control word (see section 2.2).
 S.n Indicates bit n of the status word (see section 2.2).

This diagram describes the amplifier behaviour.

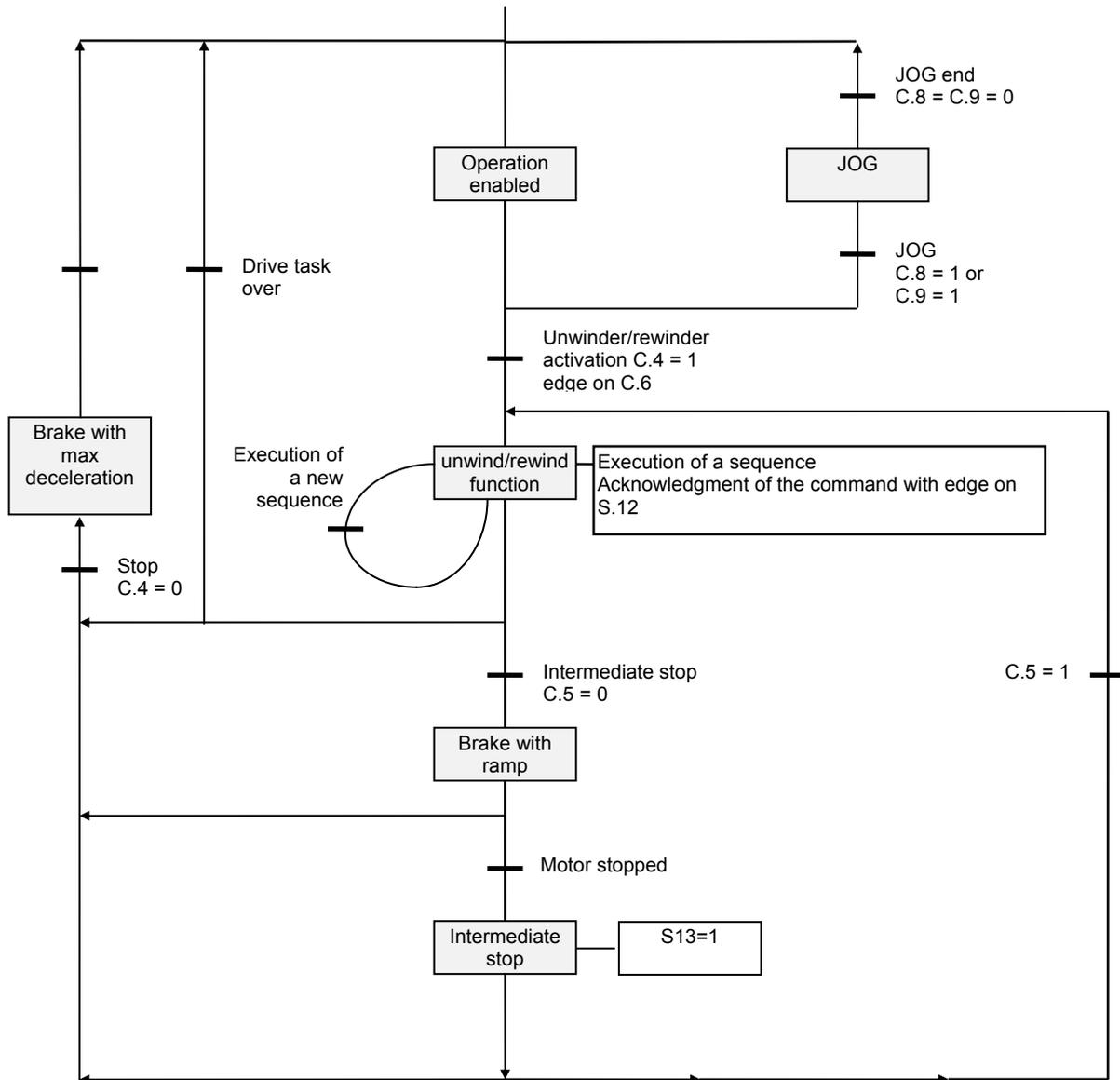
The enabling process includes 5 stages: "ENABLE inhibited", "ENABLE not ready", "Ready for ENABLE", "Ready" and "Operation enabled".

The 3 OFF1, OFF2 and OFF3 functions allow various ways to disable the motor.

The functions "Error" and "OFF" are effective at each level of the diagram. "OFF3" is a stop with maximum deceleration. "OFF2" has a priority over "OFF1" which has a priority over "OFF3".

Contrarily to the parameter setting, there is no direct acknowledgement for each control word bit. The unwinder/rewinder status must be checked in order to make sure that the command could be executed.

3.2 - Unwind/rewind mode



When the unwinder/rewinder is in "Operation enabled" status, the following is possible:

- starting a sequence execution (bit 6),
- jog+ or jog- (bit 8 or 9),
- stopping the motor with a programmed deceleration - the one defined by JOG (bit 5) -,
- stopping the motor with maximum deceleration (bit 4).

4 - DRIVING OF THE UNWINDER/REWINDER

4.1 - Enabling/disabling

The enabling procedure is defined in the diagram of [section 3.1](#)

Example of a simplified enabling:

Stages	Communication	Value
1	PLC -> Unwinder/rewinder	Send control word = 0400h
2	PLC -> Unwinder/rewinder	Send control word = 0406h
3	PLC -> Unwinder/rewinder	Send control word = 0407h
4	PLC -> Unwinder/rewinder	Send control word = 043Fh
5	Unwinder/rewinder -> PLC	Check status word = xxxx xx11 xx11 0111b

Notes

- The unwinder/rewinder bus cycle time is 1 ms; check for at least 1 ms between 2 commands.
- In the above procedure, the unwinder/rewinder status is not checked at each stage but only at the end.

The disabling can be simply made by disabling one of the OFF1 or OFF2 or OFF3 bits.

4.2 - Starting a sequence

When the unwinder/rewinder is in "Operation enabled" status, a sequence is started by:

- entering the sequence number in PZD 2,
- reversing bit 6 of the control word.

If a new sequence is started whereas the unwinder/rewinder is executing a sequence, the unwinder/rewinder immediately executes the new sequence without stopping the motor.

4.3 - Other movements

The other possible non programmed movements are executed by the jog inputs : jog+ or Jog- (bit 8 or 9),

4.4 - All-speed control

As from firmware EPROM version 506.64, it is also possible to control the amplifier in all-speed mode (P, PI or PI²) :

- switch to speed mode by means of parameter PNU 720, with disabled amplifier.
- the PLC must send the speed command in PZD2 (16 bits full scale) and the current limit command in PZD5 (16 bits full scale) of the PPO-write.
- the PLC can read the motor speed monitor in PZD2 (16 bits full scale) and the current monitor in PZD5 (16 bits full scale) of the PPO-read.

Chapter 9 - Parameter setting by Profibus

1 - PARAMETER LIST

PNU	Parameter	Unit	Min.	Max.	Size	R/W	Saving	Default value
700	Number of motor pole pairs		1	12	word	R/W	E	4
701	Motor phases order				word	R/W	E	0xAAAA
702	Resolver shift		0	65535	word	R/W	E	0
703	Phase lead				word	R/W	E	0
704	Auto-phasing procedure				-	W		
710	Max. current	%/327	6553	32767	word	R/W	E	0x7FFF
711	Rated current	%/327	6553	16384	word	R/W	E	0x4000
712	I ² t protection mode				Boolean	R/W	E	1
720	Amplifier mode				word	R/W		
721	Max. motor speed	rpm	100	14000	word	R/W	E	3000
722	Motor rotation direction				Boolean	R/W	E	0
723	Acceleration ramp	ms	0	16000	word	R/W	E	1
724	Speed following error	rpm	1	14000	word	R/W	E	14000
726	Brake control active delay	ms	0	16000	word	R/W	E	0
727	Brake control inactive delay	ms	0	16000	word	R/W	E	0
728	Manual brake control				Boolean	W		
729	Saving in an EEPROM				-	W		
880	Offset compensation				-	W		
730	Proportional speed loop gain		0	65535	word	R/W	E	0x64
731	Integral speed loop gain		0	65535	word	R/W	E	0
732	Integral 2 speed loop gain		0	65535	word	R/W	E	0
734	Current control filter		2832	61545	word	R/W	E	0x3000
735	Anti-resonance filter		0	1	Boolean	R/W	E	0
736	Auto-tuning procedure		0	5	word	W		
749	Reduced stiffness at standstill		0	1	Boolean	R/W	E	0
875	Cogging acquisition procedure				-	W		
876	Cogging torque compensation		0	1	Boolean	R/W	E	0
742	Amplifier configuration				word	R/W	E	0
750	Encoder output resolution		16	8192	word	R/W	E	0x400
751	Number of marker pulses		1	16	word	R/W	E	1
752	Marker pulse shift		0	32767	word	R/W	E	0
753	Marker pulse width		0	32767	word	R/W	E	0x10
754	Encoder output programming				-	W		
755	Encoder output enabling		0	1	Boolean	R/W		0
763	Speed in jog	%/327	-32767	32767	word	R/W	E	0x1F4
764	Acceleration in jog	ms	1	16000	word	R/W	E	0x320
765	Deceleration in jog	ms	1	16000	word	R/W	E	0x320
770	Amplifier software version	-			double	R		
771	Profibus software version	-			word	R		
773	Amplifier error	-			double	R		
774	Motor position	pulse			double	R		
775	Resolver value	pulse	0	65535	word	R		
768	Master encoder position	pulse			double	R/W		

780	Sequence reading				word	W		
781	Sequence writing				word	W		
782	Sequence control				16 bits	R/W	S	
783	Ref. displacement for ratio init	pulse	-2 ³¹	+2 ³¹	double	R/W	S	
785	Acceleration	ms	1	16000	word	R/W	S	
786	Deceleration/Stretching	ms	0	16000	word	R/W	S	
787	Running/Holding/Time out	ms	0	16767	word	R/W	S	
788	Next sequence		-1	63	word	R/W	S	
789	Counter		0	32767	word	R/W	S	
790	Jump		-1	63	word	R/W	S	
791	Condition inputs				16 bits	R/W	S	
792	Programmable logic outputs				16 bits	R/W	S	
794	Tension set point/Torque set point	V/3276	-32767	32767	word	R/W	S	
810	Speed set point	%/327	-32767	32767	word	R/W	S	
811	Gearing ratio gain	%/327	0	32767	word	R/W	S	
830	PID loop scaling gain	%/327	-32767	32767	word	R/W	E	32767
831	Proportional PID loop gain		0	65535	word	R/W	E	1
832	Integral PID loop gain		0	65535	word	R/W	E	0
833	Derivative PID loop gain		0	65535	word	R/W	E	0
834	Speed variation limit	rpm	0	14000	word	R/W	E	0
840	Diameter filter	ms	1	10000	word	R/W	E	128
841	Min. diameter	V/3276	0	32767	word	R/W	E	0
842	Max. diameter	V/3276	0	32767	word	R/W	E	32767
843	Diameter value	V/3276	0	32767	word	R		
844	Diameter ratio	1/32767	328	32767	word	R/W	E	32767
845	Gearing ratio	1/32767	328	32767	word	R/W		
846	Max gain diameter	V/3276	0	32767	word	R/W	E	32767
847	Regulator gain ratio	1/16	16	16000	word	R/W	E	16
860	Tension filter		2832	61545	word	R/W	E	2832
861	Tension value	V/3276	-32767	32767	word	R		
862	Tension tolerance	%/327	0	32767	word	R/W	E	32767
863	Overspeed limit	rpm	0	14000	word	R/W	E	14000
864	Undertension limit	V/3276	-32767	32767	word	R/W	E	0
865	Sequence error link		-1	63	word	R/W	E	63
870	Overtorque factor	%/163	0	16383	word	R/W	E	0
871	Diameter ratio for overtorque	1/32767	328	32767	word	R/W	E	32767

Note:

R/W Reading/Writing
R Reading only
W Writing only

E These parameters are saved in the EEPROM by instruction 729.
S These parameters are saved in the EEPROM by the instruction "Sequence writing" 781.

2 - PARAMETERS DESCRIPTION**2.1 - Motor parameters****Synchronous motor parameters****PNU : 700, 701, 702**

Defines the parameters required for driving synchronous motors. These parameters can be calculated by the auto-phasing procedure.

Parameter Number of motor pole pairs (1 to 12).
Motor phase order: corresponds to the phase order (U, V, W) of the motor connection.
Sensor adjustment: phase shift between resolver and motor rotor.

Conversion Motor phase 2 possible values (0x5555 or 0xAAAA).
Sensor adjustment 5.4931640625e-3*(number of pole pairs). The value obtained is the shift electrical degrees.

Execution With disabled amplifier.

Auto-phasing		PNU :	704
<i>Parameter</i>	None.		
<i>Limitation</i>	Writing only.		
<i>Note</i>	This procedure allows the automatic calculation of the motor parameters: <ul style="list-style-type: none"> - number of motor pole pairs, - motor phase order, - resolver offset. The motor must first be disabled and uncoupled from the mechanical load . The ENABLE signal (X4 connector) must also be active. Before executing the procedure, check for free motor shaft rotation over one revolution, that is not dangerous for the operator. When the motor parameters are known, it is not necessary to execute the auto-phasing.		

Phase lead coefficient		PNU :	703
<i>Parameter</i>	16 bits. (55-7446)		
<i>Conversion</i>	4.57771654e-5 (electrical degree/1000 rpm)		

Phase shift:

$$\tan\varphi = \frac{0,6 \cdot 10^{-7} \cdot K_t \cdot N_p \cdot (\text{Max.MotorSpeed})^2}{L \cdot I_{\text{rated}}}$$

Kt: motor torque constant (Nm/A_{rms})

Np: number of motor pole pairs

Max.MotorSpeed: maximum motor speed (rpm)

I_{rated}: motor current (A_{rms})

with: $0 \leq \varphi \leq 45^\circ$

Phase lead coefficient (electrical degree/1000 rpm):

$$\text{Coef} = \varphi \frac{1000}{\text{Max.MotorSpeed}}$$

2.2 - Current parameters

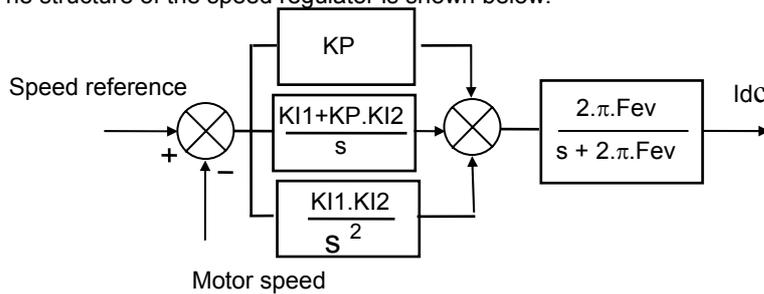
Maximum current		PNU :	710
Defines the max. current limitation in the motor.			
<i>Parameter</i>	1 word.		
<i>Conversion</i>	in percentage of the amplifier current rating: x 3.051850948e-3.		
<i>Limitation</i>	6554 (20%) to 32767 (100%)		
<i>Execution</i>			
<i>Note</i>	This parameter is defined according to the amplifier and motor specifications.		

Rated current		PNU :	711
Defines the rated current limitation in the motor.			
<i>Parameter</i>	1 word.		
<i>Conversion</i>	in percentage of the amplifier current rating: x 3.051850948e-3.		
<i>Limitation</i>	6554 (20 %) to 16384 (50%)		
<i>Execution</i>			
<i>Note</i>	This parameter is defined according to the amplifier and motor specifications.		

I²t mode		PNU :	712
<i>Parameter</i>	1 word.		
	0 limiting mode.		
	1 fusing mode.		
<i>Note</i>	See chapter 11 (Appendix) for the I ² t protection mode description.		

2.3 - Speed regulator parameters

The structure of the speed regulator is shown below:



All gain parameters (KP, KI1, KI2 and Fev) are automatically calculated during the auto-tuning procedure.

Proportional speed loop gain	PNU :	730
-------------------------------------	--------------	------------

Defines the proportional regulator gain (KP) that acts upon the speed error.

Parameter 1 word.
Conversion 1/16
Limitation 0 to 65535

Integral speed loop gain	PNU :	731
---------------------------------	--------------	------------

Defines the integral regulator gain (KI1) that acts upon the speed error.

Parameter 1 word.
Conversion 1/256
Limitation 0 to 65535

Integral 2 speed loop gain	PNU :	732
-----------------------------------	--------------	------------

Defines the integral 2 regulator gain (KI2) that acts upon the speed error.

Parameter 1 word.
Conversion 1/65536
Limitation 0 to 65535
Note This parameter can only be used in speed mode.

Current control low-pass filter	PNU :	734
--	--------------	------------

Defines the cut-off frequency at -3 dB (Fev) of the first order filter that acts upon the current control. The value of this parameter is depending on the selected bandwidth.

Parameter 1 word.
Conversion Frequency (Hz) = 1000/pi*Ln(65536/parameter)
Limitation This parameter can take a value between 2832 (1000 Hz) and 61545 (20 Hz).

Antiresonance filter	PNU :	735
-----------------------------	--------------	------------

Releases or inhibits the antiresonance filter.

Parameter 1 word.
 = 0: inhibits the filter,
 = 1: releases the filter.

Auto-tuning	PNU :	736
--------------------	--------------	------------

This procedure identifies the specific motor and load parameters and calculates the regulator gain parameters.

Parameter 1 word.
 0 low bandwidth.
 1 medium bandwidth.
 2 high bandwidth.
 3 low bandwidth with antiresonance filter.
 4 medium bandwidth with antiresonance filter.
 5 high bandwidth with antiresonance filter.

Limitation Writing only.

Execution With disabled amplifier and ENABLE signal activated, or enabled amplifier and motor at standstill (zero speed).

Note When executing this procedure, the speed loop bandwidth can be selected (low, medium or high). These values correspond to the cut-off frequency for a 45° speed loop phase shift. The reading indicates the previously selected bandwidth (0, 1, 2, 3, 4 or 5). Before executing this instruction, check for free motor shaft rotation over one revolution, that is not dangerous for the operator. The auto-tuning procedure is not required when the regulator parameters are known.

Reduced stiffness at standstill **PNU :** **749**

Reduce the speed regulator gain values at low speeds (below 100 rpm) when activated.
This parameter allows to reduce the motor vibrations in case of motor-load coupling backlashes.

Parameter 1 word.
= 0: disable the gains reduction,
= 1: enable the gains reduction.

Cogging acquisition procedure **PNU :** **875**

Parameter None.
Limitation Writing only.
Note This procedure allows the automatic acquisition of the motor cogging torque value in order to provide the motor cogging torque compensation.
The motor cogging torque compensation is only necessary for specific applications where torque accuracy better than 1 % is required. When changing either the motor, the amplifier or the EEPROM, the cogging torque acquisition procedure must be renewed.
The motor must first be disabled and **uncoupled from the mechanical load**. The ENABLE signal (X4 connector) must also be active. Before executing the procedure, check for free motor shaft rotation over one revolution, that is not dangerous for the operator. Disable the **Reduced stiffness at standstill** command if selected, then execute an **Auto-tuning** procedure with the **High bandwidth** and the **Standard** filter selection before starting the cogging torque acquisition procedure. The motor shaft must not be disturbed during the cogging torque acquisition procedure. The procedure is taking 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 memory during the procedure execution.

Cogging torque compensation **PNU :** **876**

Enable the cogging torque compensation when activated.

Parameter 1 word.
= 0: disables the cogging torque compensation,
= 1: enables the cogging torque compensation.

Note The motor cogging torque compensation is only necessary for specific applications where torque accuracy better than 1 % is required. When changing either the motor, the amplifier or the EEPROM, the cogging torque acquisition procedure must be renewed. The cogging acquisition procedure must first be executed before enabling the cogging torque compensation.

2.4 - Application parameters

Amplifier mode **PNU :** **720**

Defines the amplifier operation mode (unwind/rewind, speed or torque).

Parameter 1 word
1 torque mode
2 speed mode with PI regulator
4 unwind/rewind mode
8 speed mode with P regulator
16 speed mode with PI² regulator

Execution This instruction must be executed with disabled amplifier.
The amplifier is always configured by default in unwind/rewind mode at power on.

Note As from firmware EPROM version 506.64, the amplifier operating mode is saved in the parameter EEPROM.

Maximum motor speed **PNU :** **721**

Defines the maximum motor speed value (and the speed scale as well) according to the application.

Parameter 1 word.
Limitation This parameter varies between 100 rpm and 14000 rpm.
Execution With disabled amplifier.

Motor rotation direction **PNU :** **722**

This instruction allows to reverse the motor rotation direction with regard to the input command. It also reverses the position feedback.

Parameter 1 word :
= 0: normal.
= 1: reversed.

Execution With disabled amplifier.

Acceleration ramp	PNU :	723
Defines the motor acceleration or deceleration time that corresponds to the maximum speed.		
<i>Parameter</i>	1 word.	
<i>Unit</i>	ms	
<i>Limitation</i>	1-16000	
<i>Note</i>	This parameter can only be used in speed mode.	
Speed following error	PNU :	724
Defines the limit value for the regulator speed error before the following error to be released.		
<i>Parameter</i>	1 word.	
<i>Limitation</i>	This parameter varies between 0 rpm and 14000 rpm.	
<i>Execution</i>	With disabled amplifier.	
Brake delay active	PNU :	726
Defines the time between the brake release and the amplifier disabling.		
<i>Parameter</i>	1 word	
<i>Unit</i>	ms	
<i>Limitation</i>	0-16000	
<i>Note</i>	This parameter is not active when the amplifier is configured in standalone mode. In standalone mode the brake release and the amplifier disabling are simultaneous.	
Brake delay inactive	PNU :	727
Defines the time between the amplifier enabling and the brake inhibition.		
<i>Parameter</i>	1 word	
<i>Unit</i>	ms	
<i>Limitation</i>	0-16000	
<i>Note</i>	This parameter is not active when the amplifier is configured in standalone mode. In standalone mode, the amplifier enabling and the brake inhibition are simultaneous.	
Manual brake control	PNU :	728
This instruction enables or inhibits the brake.		
<i>Parameter</i>	1 word.	
	0	disables the motor brake (relay closed).
	1	activates the motor brake (relay open).
<i>Limitation</i>	Writing only.	
Saving in the EEPROM	PNU :	729
Saves all amplifier parameters in the EEPROM.		
<i>Parameter</i>	none.	
<i>Limitation</i>	Writing only.	
<i>Execution</i>	With amplifier disabled.	
<i>Note</i>	All parameters modified by the other instructions (except for the sequence parameters) are not saved. This instruction must be used to store them definitively in the amplifier.	
Offset compensation	PNU :	880
Execute the offset compensation procedure for the analog input 1 (ANin1).		
<i>Parameter</i>	none.	
<i>Limitation</i>	Writing only.	
<i>Execution</i>	With amplifier disabled.	
<i>Note</i>	The ANin1 input on the X4 connector must first be set at 0 volt before executing the offset compensation procedure. If the analog input voltage value is higher than 0.5 volts, a procedure error is generated. The offset value is automatically stored in the amplifier EEPROM at the end of the procedure.	
<i>Remark</i>	The offset compensation procedure can also be executed by activating the Offset push button on the amplifier front panel.	

2.5 - Unwinder/rewinder parameters

Amplifier configuration PNU : 742

Defines the amplifier input signals selection (tension set point, speed set point, torque set point, diameter value).

<i>Parameter</i>	1 word	
	bit	description
	0	Tension set point source
	0	internal
	1	Profibus (PZD3)
	1	Speed set point source
	0	Analog input Ain1
	1	Profibus (PZD4)
	2	Torque set point source
	0	Analog input Ain1
	1	Profibus (PZD5)
	3	Diameter value source
	0	Analog input Ain2
	1	Profibus (PZD6)

The **Tension set point** selection allows to select the tension set point source when a tension control sequence is executed. The effective tension set point can be either the tension set point value stored in the sequence parameter or the current tension set point value received via the PROFIBUS process data words (PZD3).

The **Speed set point** selection allows to select the speed set point source when a Speed 1 or Speed 2 control sequence type is executed. This choice is only valid when **Analog speed reference** has been selected during the sequence programming. In this case, the effective speed set point can be either the current analog input 1 (ANin 1) voltage value or the current speed set point value received via the PROFIBUS process data words (PZD4).

The **Torque set point** selection allows to select the torque set point source when a torque control sequence is executed. This choice is only valid when **Analog torque set point** has been selected at the sequence programming. In this case, the effective torque set point can be either the current analog input 1 (ANin 1) voltage value or the current torque set point value received via the PROFIBUS process data words (PZD5).

The **Diameter value** selection allows to select the diameter input source when **Modulation by diameter sensor** or **Ratio adaptation by diameter sensor** have been selected in the control sequence. In this case, the effective diameter value can be either the current analog input 2 (ANin 2) voltage value or the current diameter value received via the PROFIBUS process data words (PZD6).

Execution This instruction must be executed with disabled amplifier.

Unwinder/rewinder software version PNU : 770

Reading of the unwinder/rewinder software version.

<i>Parameter</i>	32 bits in hexadecimal.
<i>Example</i>	Version 506.14 is coded as 0x00050614

Profibus software version PNU : 771

Software version reading of the amplifier Profibus interface.

<i>Parameter</i>	16 bits in hexadecimal.
<i>Example</i>	Version 4.21 is coded as 0x0421

Amplifier error code

PNU :

773

Reading of the amplifier error code.

Parameter 3 bytes

Byte 1 (low weight):

Bits	Meaning	Descriptions
0		
1	I ² t	I ² t
2	RDC	Resolver converter error
3	POS	Speed following error
4	MEM	Memory error
5	BUS	Profibus DP mode error
6		
7	BUSY	Procedure error

Byte 2:

Bits	Meaning	Descriptions
0		
1	POWER	Power stage error
2	RES	Resolver cable interruption error
3	AP	Power undervoltage error
4	ST	Amplifier temperature error
5	TMOT	Motor temperature error
6	CDG	Watchdog error
7		

Byte 3 (high weight):

Bits	Meaning	Descriptions
0		
1	E2PPAR	Parameters EEPROM checksum error
2	E2PSEQ	Sequences EEPROM checksum error
3		
4	SEQWR	Sequence writing error
5		
6		
7		

Motor position

PNU :

774

Reading of the motor position.

Parameter 32 bits**Resolver value**

PNU :

775

Reading of the value provided by the resolver. This value is an absolute position over one revolution.

Parameter 16 bits**Master encoder position**

PNU :

768

Reading of the master encoder position.

Parameter 32 bits*Note* The master encoder position can be reset by sending the value 0.**2.6 - Encoder output****Encoder output resolution**

PNU :

750

Defines the encoder output resolution.

Parameter 1 word: encoder resolution*Limitation* The encoder resolution is limited by the maximum application speed.

Max. speed	Max. encoder resolution
100-900	8192
900-3600	4096
3600-14000	1024

Execution With disabled amplifier.*Note* The encoder output is only effective after the end of the encoder output programming procedure.

Encoder output marker pulse		PNU :	751, 752, 753
<i>Parameter</i>	Number of encoder pulses (1 - 16). Phase shift with regard to the resolver marker pulse (0 - 65535). Marker pulse width (16 - 32767).		
<i>Conversion</i>	Marker pulse phase shift: 65536 is equivalent to 360°. Marker pulse width: 65536 is equivalent to 360°.		
<i>Limitation</i>	Number of encoder pulses: 1 - 16. Phase shift with regard to the resolver marker pulse: 0 - 65535. Marker pulse width: 16 - 32767.		
<i>Note</i>	The encoder output only takes into account these values after the end of the encoder output programming procedure.		

Encoder output programming		PNU :	754
This procedure programs the encoder output with the parameters defined above.			
<i>Limitation</i>	Writing only.		
<i>Execution</i>	With disabled amplifier.		
<i>Note</i>	The execution of this procedure takes approximately 5 s.		

Enable encoder output		PNU :	755
This command allows to enable or disable the amplifier encoder output lines.			
<i>Parameter</i>	1 word. = 0: encoder output disabled (output lines at high impedance), = 1: encoder output enabled (CA, /CA, CB,/CB signals active).		
<i>Note</i>	This parameter is not saved in the EEPROM. At the amplifier power up, the encoder output lines status (enabled/disabled) depends on the SW2-3 switch position.		

2.7 - Manual jog parameters

Speed in jog		PNU :	763
Defines the internal speed set point value for the jog mode.			
<i>Parameter</i>	word		
<i>Unit</i>	% of the motor maximum speed value		
<i>Variation</i>	signed value -32767 to +32767		
<i>Conversion</i>	1/327.67		
<i>Note</i>	This parameter is saved in % of the maximum motor speed value in rpm. If the maximum motor speed value is modified, the jog speed value in rpm is modified accordingly.		

Acceleration ramp in jog		PNU :	764
<i>Parameter</i>	This parameter, defined in ms, corresponds to the acceleration time from standstill up to max. speed.		
<i>Limitation</i>	1 - 16000		
<i>Note</i>	The minimum value depends on the motor and on the system inertia.		

Deceleration ramp in jog		PNU :	765
<i>Parameter</i>	This parameter, defined in ms, corresponds to the deceleration time from max. speed down to standstill.		
<i>Limitation</i>	1 - 16000		
<i>Note</i>	This parameter value is also used for the motor STOP operation (braking with ramp).		

2.8 - PID loop parameters

Scaling gain of the PID loop		PNU :	830
Defines the signed scaling gain of the PID loop for a tension or speed 2 control sequence. The sign of this gain is chosen in order to get a stable servo loop according to the feedback signal polarity. The absolute value of this gain is chosen in order to get a stable servo loop according to the open loop gain value of the process.			
<i>Parameter</i>	1 word.		
<i>Unit</i>	%		
<i>Conversion</i>	1/327,67		
<i>Variation</i>	327 to 32767 for the absolute value		

Proportional gain of the PID loop	PNU :	831
Defines the proportional gain of the PID loop for a tension or speed 2 control sequence.		
<i>Parameter</i>	1 word.	
<i>Conversion</i>	1/512	
<i>Limitation</i>	0 to 65535	
Integral gain of the PID loop	PNU :	832
Defines the integral gain of the PID loop for a tension or speed 2 control sequence.		
<i>Parameter</i>	1 word.	
<i>Conversion</i>	1/65535	
<i>Limitation</i>	0 to 65535	
Derivative gain of the PID loop	PNU :	833
Defines the derivative gain of the PID loop for a tension or speed 2 control sequence.		
<i>Parameter</i>	1 word.	
<i>Conversion</i>	1/32	
<i>Limitation</i>	0 to 65535	
Speed variation limit	PNU :	834
Defines the maximum value of the motor speed reference given by the PID regulator.		
<i>Parameter</i>	1 word.	
<i>Limitation</i>	This parameter varies between 0 rpm and the maximum motor speed value in rpm.	
<i>Note</i>	This parameter refers to the motor speed value at the minimum diameter. The actual speed variation limit on the motor is obtained by multiplying this value by the current gearing ratio gain.	
<i>Remark</i>	When the TDI input (X2 connector pin 22) is activated during a tension control sequence, the PID regulator output is set at 0.	

2.9 - Gearing ratio calibration parameters

Diameter low-pass filter	PNU :	840
Defines the time constant of the first order filter that acts upon the diameter measurement signal or the encoder ratio measurement signal.		
<i>Parameter</i>	1 word.	
<i>Unit</i>	ms	
<i>Variation</i>	1 to 10000	
Diameter sensor value for min. diameter	PNU :	841
Defines the voltage value provided by the diameter sensor when the spool is empty (minimum diameter).		
<i>Parameter</i>	1 word.	
<i>Unit</i>	Volts	
<i>Conversion</i>	1/3276,7	
<i>Variation</i>	0 to 32767	
Diameter sensor value for max. diameter	PNU :	842
Defines the voltage value provided by the diameter sensor when the spool is full (maximum diameter).		
<i>Parameter</i>	1 word.	
<i>Unit</i>	Volts	
<i>Conversion</i>	1/3276,7	
<i>Variation</i>	0 to 32767	
Diameter sensor value	PNU :	843
Reads the voltage value provided by the diameter sensor. The former parameters can be easily initialised according to the following method: In a first time, an empty spool corresponding to the minimum diameter is put on the machine and the voltage value read is entered in the Diameter sensor value for min diameter parameter. Then, the same operation is executed with a full spool in order to initialise the Diameter sensor value for max diameter parameter.		
<i>Parameter</i>	1 word.	
<i>Unit</i>	Volts	
<i>Conversion</i>	1/3276,7	
<i>Variation</i>	0 to 32767	

Spool diameter ratio PNU : **844**

Defines the ratio between the minimum and maximum diameter values of the spool to be unwound or rewind.

Parameter 1 word.
Unit min/max ratio (≤ 1)
Variation 328 to 32767
Conversion 1/32767

Gearing ratio PNU : **845**

Reads the current gearing ratio value.

Parameter 1 word.
Variation Spool diameter ratio value to 32767
Conversion 1/32767

Diameter sensor value for max. gains PNU : **846**

Defines the voltage value provided by the diameter sensor which gives the maximum value for the speed regulator gains according to the **Speed regulator gain ratio** parameter.

Parameter 1 word.
Unit Volts
Conversion 1/3276,7
Variation 0 to 32767

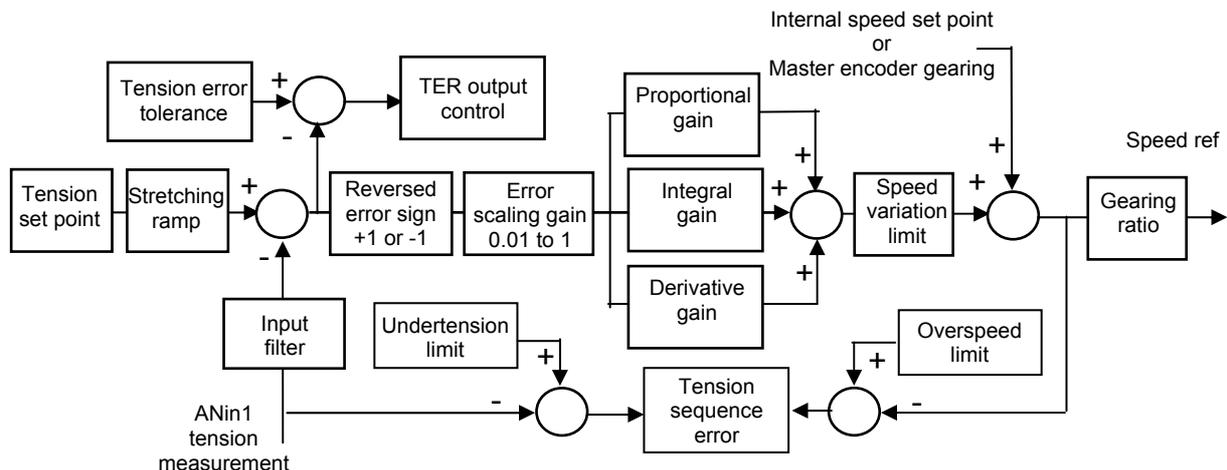
Speed regulator gain ratio PNU : **847**

Defines the ratio between the maximum gain value of the speed regulator for the full spool and the rated gain value of the speed regulator for the empty spool. The speed regulator gains are automatically adapted according to this ratio when the spool diameter sensor value is varying between the **Diameter sensor value for min. diameter** and the **Diameter sensor value for max. gains**.

Parameter 1 word.
Unit max/min ratio (≥ 1)
Conversion 1/16
Variation 16 to 16000

2.10 - Tension control parameters

These parameters are only active for a tension control sequence. The tension controller structure used in this case is presented below :



Tension measurement low-pass filter PNU : **860**

Defines the cut-off frequency at -3 dB of the first order low-pass filter that acts upon the tension measurement.

Parameter 1 word.
Conversion Frequency (Hz) = $1000/\pi * \ln(65536/\text{parameter})$
Limitation This parameter can take a value between 2832 (1000 Hz) and 61545 (20 Hz).

Tension measurement value **PNU :** **861**

Reads the voltage value provided by the tension sensor (dancer or load cell).

Parameter 1 word.
Unit Volts
Conversion 1/3276,7
Variation -32767 to +32767

Tension error tolerance **PNU :** **862**

Defines the limit value of the regulator tension error for the TER logic output to be activated when the tension set point is reached in the tension control sequence.

Parameter 1 word.
Unit %
Conversion 1/327,67
Variation 0 to 32767
Note 100 % correspond to 10 Volts in the tension measurement scale

Overspeed limit **PNU :** **863**

This parameter allows to detect a dancer fault (blocking or failure) when the motor speed reference value is exceeding this parameter value. In this case, a tension sequence error is generated.

Parameter 1 word.
Limitation This parameter varies between 0 rpm and the **maximum motor speed** value in rpm.
Note This parameter refers to the motor speed value at the minimum diameter. The actual overspeed limit on the motor is obtained by multiplying this value by the current gearing ratio gain.

Undertension limit **PNU :** **864**

This parameter allows to detect the material braking when the dancer or the load cell tension measurement value drops below this parameter value. In this case, a tension sequence error is generated. This parameter is also used into the ratio init sequence as the start point for the dancer displacement.

Parameter 1 word.
Unit Volts
Conversion 1/3276,7
Variation -32767 to +32767
Note When the dancer or the load cell tension measurement value at the start of the tension sequence is below the Undertension limit parameter value, the material braking detection is disabled during the material stretching time and activated only when the tension set point is reached.

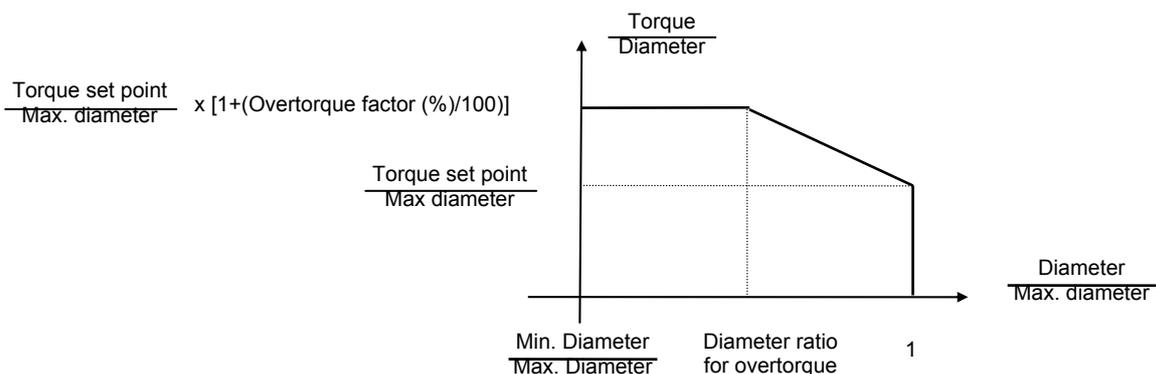
Sequence error link **PNU :** **865**

This parameter defines the sequence number to be executed when a tension sequence error is generated. When a tension sequence error is generated, the tension control sequence is immediately stopped. Then the sequence number indicated by the **Sequence error link** parameter is automatically executed.

Parameter 1 word.
Variation 0 to 63 number of the sequence
 -1 no link
Note If the number of the sequence is not defined (-1 value), in case of a tension sequence error, the motor will stop with the deceleration ramp.

2.11 - Torque control parameters

The material force value variation versus the spool diameter ratio is shown on the following diagramme:



Overtorque factor for minimum diameter **PNU :** **870**

This parameter allows to increase the material force value for the minimum spool diameter when starting a spool rewind. The actual torque set point value for the minimum diameter is calculated as follow : actual torque set point = Torque set point x Spool diameter / Max diameter x [1+(Overtorque factor (%)/100)].

Parameter 1 word.
Unit %
Variation 0 to 16383
Conversion 1/163,83

Diameter ratio range for overtorque **PNU :** **871**

This parameter defines the spool diameter range for increasing the torque set point. When the diameter ratio exceeds this value, the actual torque set point is continuously decreased down to the torque set point value corresponding to the max. diameter.

Parameter 1 word.
Unit min/max ratio (less or equal to 1)
Variation from **Spool diameter ratio** parameter value to 32767
Conversion 1/32767

Overspeed limit **PNU :** **863**

This parameter allows to detect a material braking in a winding application with a torque control sequence where it is necessary to set the **Speed set point** parameter value higher than the line speed value in order to reach the current limitation during the winding operation. When the motor speed value is exceeding this parameter value during the torque holding time, because of a material braking, a torque sequence error is generated.

Parameter 1 word.
Limitation This parameter varies between 0 rpm and the **maximum motor speed** value in rpm.
Note This parameter refers to the motor speed value at the minimum diameter. The actual overspeed limit on the motor is obtained by multiplying this value by the current gearing ratio gain.

Sequence error link **PNU :** **865**

This parameter defines the number of the sequence to be executed when a torque sequence error is generated. When a torque sequence error is generated, the torque control sequence is immediately stopped. Then the sequence number indicated by the **Sequence error link** parameter is automatically executed.

Parameter 1 word.
Variation 0 to 63 number of the sequence
 -1 no link

Note If the number of the sequence is not defined (-1 value), in case of a tension sequence error, the motor will stop with the deceleration ramp.

2.12 - Sequence Reading/Writing

A sequence is defined by a list of parameters (PNU 782 to PNU 811):

- Sequence control
- Tension/Torque
- Speed
- Acceleration
- Deceleration/Stretching
- Running/Holding/Time out
- Ratio
- Next sequence
- Counter
- Jump
- Condition
- Logic outputs

All sequences are saved in the EEPROM. The direct access to a sequence is not possible. The transfer requires a buffer: command PNU 780 allows to transfer the EEPROM parameters to the buffer and command PNU 781 allows to transfer the buffer parameters to the EEPROM. The writing or reading of the buffer parameters are made by commands PNU 782 to PNU 811.

Reading of a sequence **PNU :** **780**

<i>Parameter</i>	0-63	sequence number
<i>Limitation</i>	Writing only.	
<i>Note</i>	This instruction transfers the sequence parameters from the EEPROM to the buffer. This allows the parameter values to be read in the buffer (see below).	

Writing of a sequence **PNU :** **781**

<i>Parameter</i>	0-63	sequence number
	128	checksum
<i>Limitation</i>	Writing only.	
<i>Note</i>	This instruction transfers the sequence parameters from the buffer to the EEPROM. The sequence parameters must of course be previously written in the buffer (see below). When all sequences are written, a sequence must be written with a value of 128; this allows to update the checksum in the EEPROM (otherwise, the amplifier will indicate an EEPROM fault at its next powering). The writing in the EEPROM is not instantaneous; wait at first for the amplifier reply before writing other parameters.	

All instructions below allow the access to the parameters of the sequence contained in the buffer.

Sequence control **PNU :** **782**

<i>Parameter</i>	bit	description
	0-3	define the sequence type
	0	non valid sequence
	1	ratio init sequence
	2	tension sequence
	3	speed 1 sequence
	4	speed 2 sequence
	5	torque sequence.
	4-7	reserved.
	8 -10	define the triggering for the logic inputs:
	0	End
	1	Begin
	2	Tension
	3	Speed
	4	Torque
	11-12	define the sequence set point selection:
	0	internal set point
	1	set point via analog input or Profibus input
	2	set point via master encoder input
	13-14	define the sequence gearing ratio adaptation mode:
	0	constant ratio value
	1	adaptation by the diameter sensor
	2	adaptation by the master encoder / motor speed ratio
	15	= 0 conditional start = 1 conditional stop

Note To invalidate a sequence, just send this instruction with value 0; the other parameters will be ignored.

Reference displacement for ratio init **PNU :** **783**

This parameter defines the master encoder reference displacement value used for the ratio init sequence.

<i>Parameter</i>	double word
<i>Unit</i>	encoder edges
<i>Variation</i>	-2^{31} to $+2^{31}$

Speed set point **PNU :** **810**

Defines the internal speed set point value for the sequence.

<i>Parameter</i>	word
<i>Unit</i>	% of the motor maximum speed value
<i>Variation</i>	signed value -32767 to +32767
<i>Conversion</i>	1/327.67
<i>Note</i>	This parameter is saved in % with regard to the maximum motor speed value in rpm. If the maximum motor speed value is modified, all the sequence speed set point values in rpm are modified accordingly.

Tension set point/Torque set point/Speed set point offset **PNU :** **794**

This parameter defines either:

- the material tension set point value for a tension control or ratio init sequence or,
- the motor torque set point value for a torque control sequence or,
- the offset value of the analog speed set point for a speed 1 control sequence.

Parameter word

Conversion 1/3276,7 for getting the tension set point value in V

1/327.67 for getting the motor torque set point value in % of the motor maximum current value

1/3276,7 for getting the offset value of the analog speed set point in V

Gearing ratio gain/Speed ratio gain/Torque set point ratio **PNU :** **811**

This parameter defines either:

- the master/slave gearing ratio gain for a tension or speed1 control sequence or,
- the speed ratio gain for a speed 2 control sequence or,
- the torque set point ratio for a torque control sequence.

Parameter word

Conversion 1/327,67 for getting the value in %

Unit % of the encoder gearing ratio for a tension or speed 1 control sequence

% of the speed set point value for a speed 2 control sequence

% of the torque set point value for a torque control sequence

Acceleration **PNU :** **785**

This parameter defines the motor acceleration time for the sequence.

Parameter word

Unit ms

Variation 1 to 16000

Note The real minimum value depends on the motor and the inertia.

Deceleration/Stretching **PNU :** **786**

This parameter defines either:

- the motor deceleration time for a speed control sequence or,
- the material stretching time for a tension control sequence.

Parameter word

Unit ms

Variation 0 to 16000

Note The value 0 allows to link up to another speed control sequence (parameter **Next sequence**) without stopping the motor.

Running/Holding/Time out **PNU :** **787**

This parameter defines either:

- the motor running time at constant speed for a speed control sequence or,
- the time for the material tension holding for a tension control sequence or,
- the time for the torque to be maintained for a torque control sequence or,
- the time out for a ratio init sequence.

Parameter word

Unit ms for the tension, torque and speed sequences

seconds for the ratio init sequence

Variation 0 to 16000

Next sequence **PNU :** **788**

Parameter 0-63 number of the next sequence to be executed

-1 no link

Counter **PNU :** **789**

Parameter word

Variation 1 - 32767

0 no counter

-1 conditional jump

Jump **PNU :** **790**

Parameter 0-63 number of the link sequence for the counter loop or the conditional jump

-1 no link

Note For a conditional jump, the counter value must be -1

Start conditions **PNU :** **791**

This parameter defines the condition inputs for the start or the end of this sequence.

Parameter word

bit description

1-7 The inputs 2 to 8 must be set at 0.

9-15 The inputs 2 to 8 must be set at 1

Example

Conditions: inputs 2 and 4 = 1, input 7 = 0
the value will be 0x0A40

Remark

Input 1 is entering the X2 connector on pin 21 (Lin1) and cannot be activated by the serial bus interface (PROFIBUS DP). Inputs 2 to 8 have no physical existence and can only be activated or deactivated on the serial bus interface.

The inputs can be used either as a sequence start condition or as a sequence stop condition (this is defined by bit 15 of PNU 782). A sequence stop condition is only valid when the running time or the holding time value is higher than 16000 ms. The sequence stop condition is only tested when the sequence set point value has been reached (at the end of the acceleration time or the stretching time).

Logic outputs **PNU :** **792**

This parameter defines the effect on the logic outputs in this sequence.

Parameter word

bit description

0-7 mask s for outputs 1 to 8.

8-15 mask r for outputs 1 to 8.

The combination of the s and r masks gives:

rs

01 -> sets at 1 the corresponding output.

00 -> sets at 0 the corresponding output.

10 -> keeps the output unchanged.

11 -> reverses the output.

Example

If no output is modified, the value is 0xFF00

Remark

Output 1 is located on the X2 connector, pin 8 (Lout1), while outputs 2 to 8 have no physical existence; they are only visible on the serial bus interface (PROFIBUS DP).

Chapter 10 - Troubleshooting

1 - DIAGNOSTICS

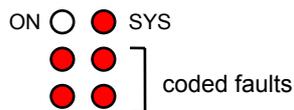
A fault diagnostic can be made:

- by display: front panel LED display.
- by serial link: clear fault display in the BPCW software.
- by Profibus link: reading of the error code.

At an error triggering, the amplifier is disabled.

1.1 - SMT-BD1/t fault display

The 5 red LEDs available on the SMT-BD1/t front panel are indicating the fault type:



PROTECTION	DISPLAY CODE	LED
Amplifier rated current overload: - blinking display = I_{dyn} signal (I^2t threshold is reached) - continuous display = amplifier disabled (I^2t fault)	I^2t	● ○ ○ ○
PROFIBUS fault (DP mode)	Profibus	● ○ ○ ●
Speed following error	Position	○ ○ ○ ●
Resolver cable interruption	Resolver	○ ● ○ ○
Power stage failure: - power supply overvoltage - internal switch protection - short circuit between phases	Power stage	● ● ○ ○
Resolver converter failure	R.D.C	○ ○ ● ○
Amplifier overtemperature	°C Amp.	● ○ ● ○
Power supply undervoltage	Undervolt.	○ ● ● ○
Motor overtemperature	°C Motor	● ● ● ○
Fault of the amplifier parameter memory	EEPROM	● ○ ● ●
Amplifier automatic procedure: - blinking display = procedure running - continuous display = operating error	Busy	● ● ● ●

○ : Led is unlit

● : Led is lit

All these faults are stored in the amplifier, except for the "Undervolt." and "Profibus" faults.

1.2 - Fault reset

The reset of a stored fault can be made:

- via the fault RESET input of X4, pin 13,
- via the serial link,
- by the control issued from Profibus,
- by switching off the amplifier auxillary supply.

2 - FAULT FINDING

2.1 - System fault

If the red "SYS" LED is lit at power on, the logic board is defective.

- * Check that the EPROM (firmware memory) is correctly plugged on the amplifier.
- * Check that the EPROM firmware version is correct.
- * Check for no conducting dust that may involve short-circuits on the amplifier logic board.

2.2 - Non stored faults

2.2.1 - BUS FAULT (PROFIBUS)

This fault is only displayed when the Profibus communication is interrupted. The fault is cancelled as soon as the communication is restored.

2.2.2 - "UNDERVOLT." FAULT

If the fault occurs when starting the amplifier:

- * Check that the power supply is on.

If the fault occurs during the operation:

- * Check that the power supply connections are correct
- * Check that the power supply voltage value is correct

2.3 - 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 initial 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 is cancelled.

2.3.1 - "BUSY" FAULT

- If the BUSY fault is continuously displayed after applying power to the amplifier, the **AUTOTEST** procedure has failed and the amplifier is not ready for operation.
- If the BUSY fault is continuously displayed after the execution of the **AUTOPHASING** function, the procedure has failed because of an external cause and the calculated parameters are wrong. Check that the **ENABLE** input is actually activated. 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 **AUTOTUNING** function, the procedure has failed because of an external cause and the calculated parameters are wrong. Check that the **ENABLE** input is actually activated. Then check that the motor shaft movement is free during the procedure.
- If the BUSY fault is continuously displayed after the execution of the **OFFSET** function, the procedure has failed because of an external cause and the calculated offset is wrong. Check that the **ENABLE** input is actually deactivated. Then check that the input voltage value on the analog input 1 is less than 0.5 Volts.

2.3.2 - "EEPROM" FAULT

- Check for the presence of the EEPROM and check its correct orientation.
- If the fault remains, the EEPROM is not correctly initialised (wrong checksum value) or is not compatible with the amplifier software.
- This fault may occur if the motor is enabled during a parameter saving or during a sequences transfer between the PC and the amplifier.
- This fault may also occur if the cogging torque compensation has been enabled and the parameters saved in the EEPROM without doing the cogging acquisition procedure.

- To cancel this fault, if it is:
 - * due to the parameters, renew the amplifier parameter setting and the parameter saving,
 - * due to the sequences, send the sequences file to the amplifier again.
 - * due to the cogging, disable the cogging torque compensation and save parameters to EEPROM or renew the cogging acquisition procedure.

2.3.3 - "°C MOTOR" FAULT

- If the fault occurs when commissioning 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 X1 front panel connector or the X6 rear connector of the rack.
- If the fault occurs during the operation:
 - * Check the motor temperature and look for the reason of this overheating (mechanical shaft overload, duty cycle too high, ...).

2.3.4 - "°C AMP." FAULT

- Check for the correct fan type with regard to the rated current required.

Remark: This fault is only valid on amplifiers with current ratings 220/70 and 220/100.

2.3.5 - "POWER STAGE" FAULT

- If the fault occurs when starting the amplifier:
 - * Check the DC bus voltage and the terminal voltage of the power transformer secondary :
 - For the 220 VAC version of the amplifier DC bus < 370 VDC and V secondary < 260 VAC
 - For the 400 VAC version of the amplifier DC bus < 800 VDC and V secondary < 480 VAC
- If the fault occurs during the operation:
 - * Check the correct braking system operation during the deceleration phases,
 - * Check the sizing of the braking resistor with regard to the deceleration phases.
 - * Check for no short-circuit in the motor wiring and at the motor terminals.
 - * For amplifiers with 220/04 to 220/60 current ratings and 400 VAC range, check that the fan and the heatsink configurations are correct with regard to the required rated current.

2.3.6 - "RESOLVER" FAULT

- Check the resolver connection on the amplifier connector X1.
- Check for the value of the P-RES components with regard to the resolver type.
- Check the connections between the resolver and the amplifier and at the resolver terminals.

2.3.7 - "R.D.C." FAULT

- If the fault occurs at the amplifier commissioning:
 - * Check that the values of the P-RES components with regard to the resolver transformation ratio are correct.
- If the fault occurs 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 where the motor speed is determined by the load.

2.3.8 - "I²T" FAULT

- Check the rated current value required with regard to the table of currents authorized in pulse mode cycle.
- Check the rated current of the amplifier defined in the **Rated current** parameter with regard to the current required or the operation cycle.

2.3.9 - "POSITION" (FOLLOWING ERROR) fault

Check that the **Speed following error** parameter value is compatible with the required amplifier operating cycle. If necessary, increase the **Speed following error** parameter value.

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 wiring of the ENABLE logic input.
- Check that the amplifier is enabled.

3.2 - Motor supplied but no torque

- Check that the **Maximum current** and **Rated current** parameters have no zero value.

3.3 - Shaft locked, erratic oscillations or rotation at maximum speed

- 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 (number of pole pairs, resolver wiring, motor phase).

3.4 - Discontinuous motor rotation with zero torque positions

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

3.5 - Loud crackling noise in the motor at standstill

- Check that the Motor-Amplifier-Controller ground connections comply with the recommendations

3.6 - 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**).

3.7 - Sequence not executed

If in "operation enabled" status, the motor does not move at a sequence start:

* Check if a start condition has been defined for this sequence and not been fulfilled.

4 - SERVICE AND MAINTENANCE

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

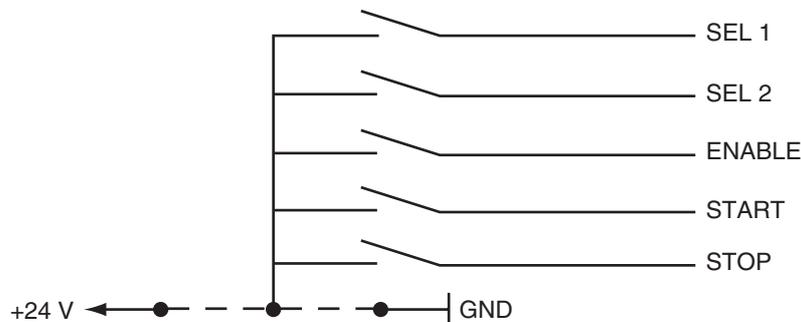
- Check that the new amplifier has the same hardware configuration as the old one (including its address),
- Plug the parameter EEPROM of the old amplifier on the new one.

The new amplifier is configured like the old one.

Chapter 11 - Appendix

1 - USE OF THE POSITIVE & NEGATIVE LOGIC INPUTS

The logic inputs **SEL1**, **SEL2**, **ENABLE**, **START**, **STOP** of the logic X4 connector 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.

Range: active at level: $5 < V < 30$ V
 Input impedance: 4,7 K Ω
 Response time: 500 μ s

NEGATIVE LOGIC: E-F-G jumpers open

Range: inactive or open at level $5 < V < 30$ V
 Input impedance: 4,7 k Ω
 Response time: 500 μ s

NOTE

The inputs SEL1, SEL2, ENABLE, START, STOP must all be in positive logic or all in negative logic.

2 - USE OF THE "AMP. READY" & "POWER READY" OUTPUTS

When an amplifier fault is released, the **AMP. READY** output is immediately disabled (contact is open). After elimination of the error source, the amplifier can be reset via pins 12 and 13 of the X4 connector.

If the amplifier control board must be kept active when a stored fault is released on the amplifier and the power supply turned off, it is necessary to have an auxiliary supply for the logic board which is independent from the power supply. In this case, the **JK** and **KL** jumpers of the logic board allow to inhibit or to release the "Undervolt." fault when the amplifier is turned on.

JK jumper closed and KL jumper open configuration :

If the auxiliary supply is turned on 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 configuration :

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.

NOTE

The **POWER READY** output is only available on the BF rack housing (see BF RACK or BF-400 RACK manuals). If the **POWER READY** signal is not used, make the **JK** jumper on the amplifier in order to have the **AMP. READY** signal taking into account the power statement.

3 - SPEED FOLLOWING ERROR PROTECTION

During the amplifier operation, when the speed controller error reaches the Following error threshold value, the Following error fault is released and the amplifier is disabled. The Speed following error threshold parameter value must be adjusted at its minimum value according to the operation cycle in order to detect any uncontrolled motor movements that may be dangerous for operator and machine.

CAUTION

Speed following error protection is inactive during the Auto-phasing and the Auto-tuning procedures. When the amplifier is operating in torque mode (Torque control sequence), the speed following error protection is also inactive.

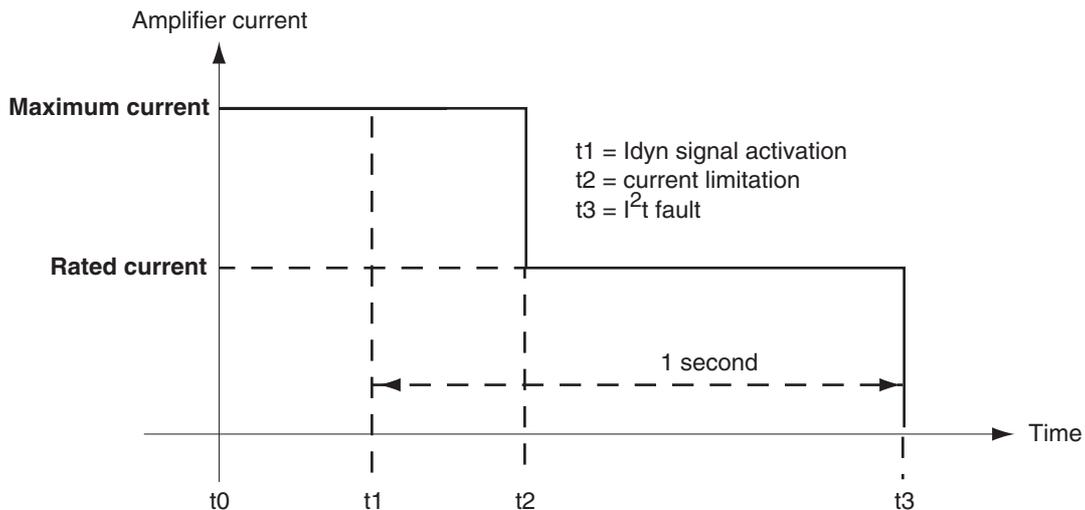
4 - I²t PROTECTION

4.1 - Current limitation in Fusing mode

When the amplifier RMS current (I²t) reaches 85 % of the **Rated current**, the Idyn signal output is activated and the I²t error display is blinking on the amplifier front panel. If the RMS current (I²t) has not dropped below 85 % of the **Rated current** within 1 second, the I²t fault is released and the amplifier is disabled (otherwise, the Idyn signal and the blinking I²t error display are both cancelled).

When the amplifier RMS current (I²t) reaches the **Rated current** value, the I²t 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 T_{dyn} and T_{max} are quite below the real values. For example when **Maximum current / Rated current** = 1.2, the measured T_{dyn} = 3.4 seconds and the measured T_{max} = 4.4 seconds. When the **Maximum current / Rated current** ratio is equal to 1, the I²t protection is no more disabling the amplifier but the current is limited at the **Rated current** value.

NOTE 2

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

$$\begin{aligned} \text{Idyn signal activation threshold (\%)} &= [\text{Rated current (\%)}]^2 / 70 \\ \text{Current limitation threshold (\%)} &= [\text{Rated current (\%)}]^2 / 50 \end{aligned}$$

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

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

CAUTION

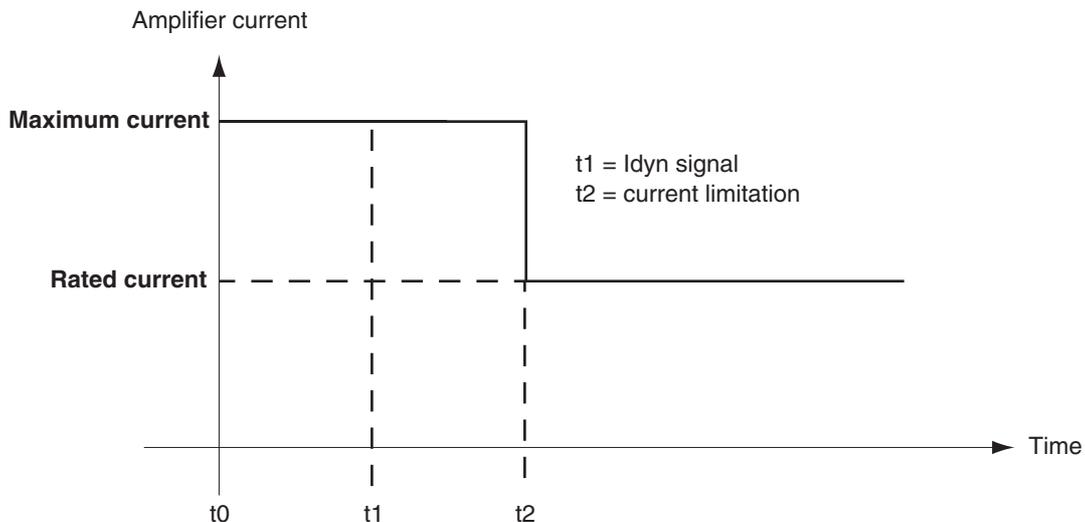
In **Fusing mode**, the amplifier **Rated current** value must be adjusted in order to be lower or equal to the **Maximum authorized rated current** of the amplifier.

4.2 - Current limitation in Limiting mode

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

When the amplifier RMS current (I^2t) reaches the **Rated current** value, the I^2t 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 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**.

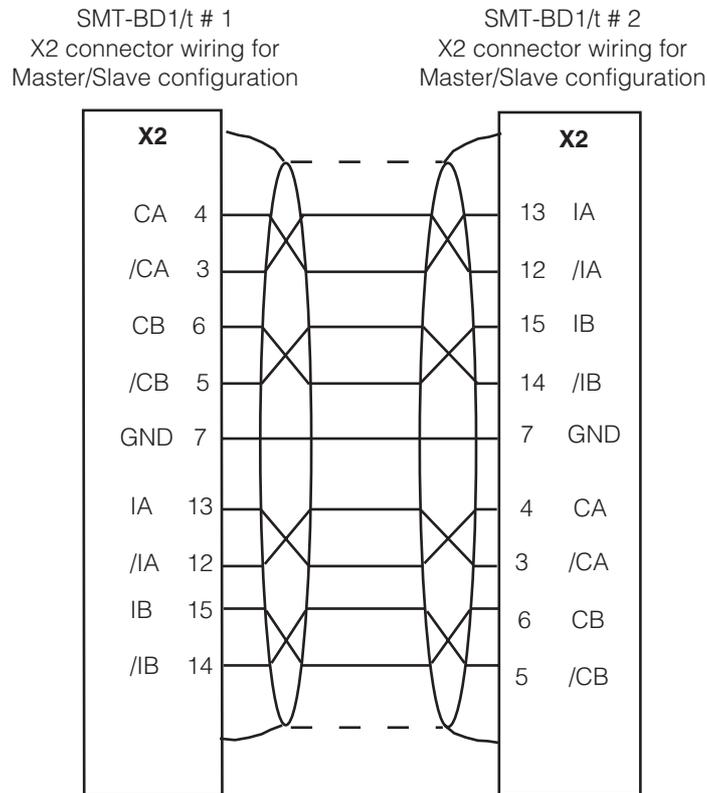
CAUTION

In **Limiting mode**, the amplifier **Rated current** value must be adjusted in order to be lower or equal to the **Maximum authorized continuous current** of the amplifier.

5 - MASTER/SLAVE CONFIGURATION

The following master/slave amplifiers connection schemes allow to easily modify the master and slaves configuration of the machine according to the unwind/rewind process via the Profibus link.

5.1 - Reversible master/slave gearing operation with two SMT-BD1/t amplifiers



When amplifier #2 is executing a control sequence with the « Master encoder gearing » set point selection, amplifier #1 is operating as the master and amplifier #2 is operating as the slave.
When amplifier #1 is executing a control sequence with the « Master encoder gearing » set point selection, amplifier #2 is operating as the master and amplifier #1 is operating as the slave.

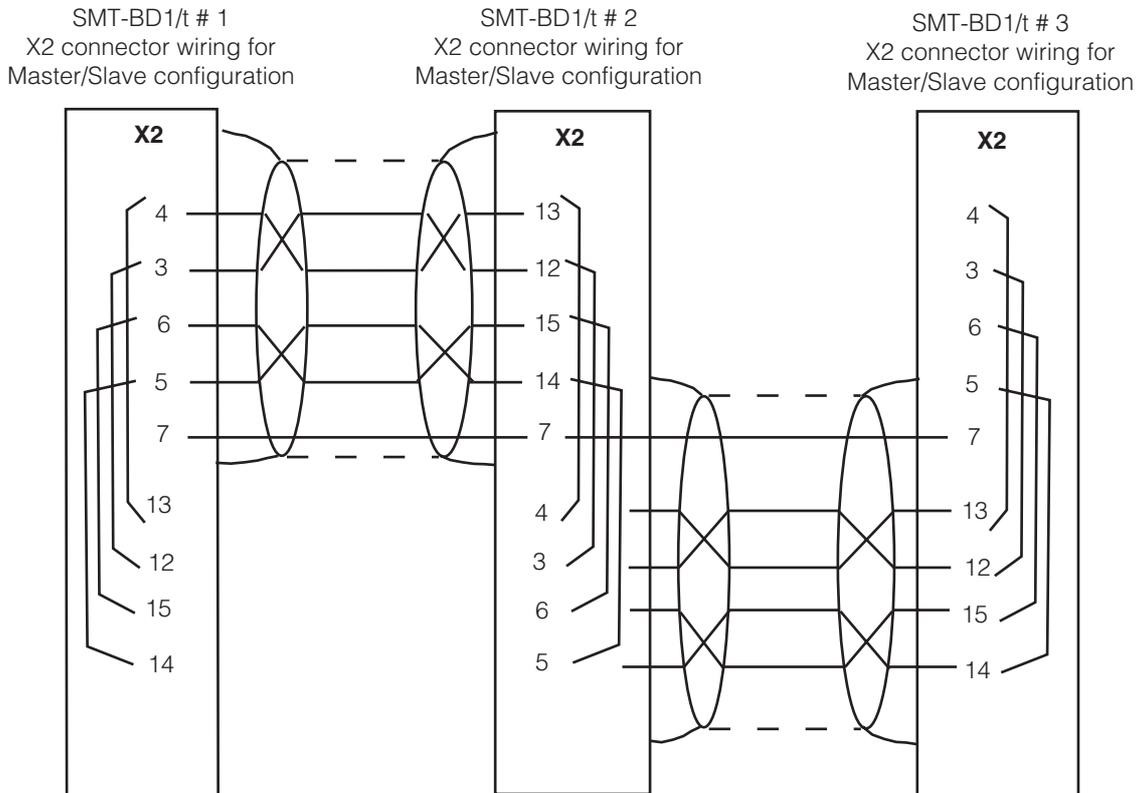
CAUTION

If both amplifiers are executing a sequence with the « Master encoder gearing » set point selection, the master/slave configuration is basically instable and both motors can run up to their maximum speed.

NOTE:

In this wiring configuration the encoder output lines can be enabled on both amplifiers at the same time without any problem.

5.2 - Configurable master/slave gearing operation with more than two SMT-BD1/t amplifiers



When the encoder output lines are enabled on one amplifier, it is operating as the master and the other amplifiers are operating as slaves. The slave amplifiers encoder output lines must be disabled. A wrong configuration of the amplifiers encoder output can damage the amplifier electronic if the encoder output lines are enabled in many amplifiers at the same time.

Operation in Profibus control mode:

- Put the SW2-3 switch in OFF position on all the amplifiers in order to have all the encoder output lines disabled at power up.
- After the amplifiers power up, the master amplifier is addressed via Profibus and its encoder output lines are enabled by means of the **Enable encoder output** command.

Operation in stand alone mode:

- Put the SW2-3 switch in ON position on the master amplifier and in OFF position on all the slave amplifiers at power off.
- After the amplifiers power up, the master/slave configuration is immediately valid.

CAUTION

Please check carefully the position of the SW2-3 switches before the first amplifier power up with the master/slave cable connected to the X2 connector. The amplifiers electronic components can be damaged if several switches are in ON position.

Please be also very careful when modifying the amplifiers master/slave configuration via the Profibus link: encoder output lines must first be disabled on all amplifiers before enabling the master amplifier encoder output lines.

6 - 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 torque can be easily evaluated by simply moving the motor manually when the amplifier is disabled. The Cogging torque compensation available in the SMT-BD1/t 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 :

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.

Disable the **Reduced stiffness at standstill** command if selected, then execute an **Auto-tuning** procedure with the **High bandwidth** and the **Standard** filter selection.

Execute the **Cogging torque acquisition** procedure. This procedure is taking 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 execution.

CAUTION

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

7 - AMPLIFIER TYPES

SMT-BD1 / _ t - _ / _ _ / _ - T - BS

Serial link :

1 = RS 232 / 2 = RS 422

Amplifier voltage ratings: 220 VAC or 400 VAC

Amplifier current ratings:

4 A to 100 A (220 VAC) or 15 A to 100 A (400 VAC)

r = Additional heatsink for 220 VAC amplifiers
(total width = 18 TE)

w = Braking system for 220 VAC amplifiers (single-axis rack)