

This manual describes the **option "f"** of the **SMT-BD1** amplifier: **Spindle motor indexing**. The general information about the digital amplifier commissioning are described in the standard **SMT-BD1** manual.

This manual may be used in conjunction with appropriate and referenced drawings pertaining to the various specific models.

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

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

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

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

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

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

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

OPTION "f"

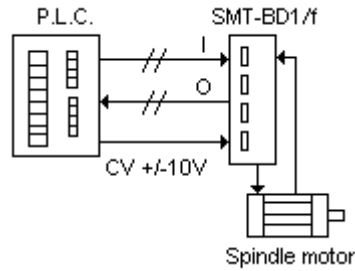
SPINDLE MOTOR INDEXING WITH THE SMT-BD1/f AMPLIFIER

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CHAPTER 1 - GENERAL DESCRIPTION

Applications with spindle motor indexing require the **SMT-I2-BD1** daughter board on the **SMT-BD1** amplifier and the firmware memory version **X.XF**. In this configuration, the **SMT-BD1/f** amplifier ensures the positioning of the spindle motor shaft during the tool exchange, according four programmable positions. The spindle motor must be equipped with a one pole pair resolver (speed 1) for the absolute definition of the four indexing positions on one shaft revolution. The logic inputs and outputs which are necessary for this kind of operation, are wired on the amplifier **X2** connector as shown below.



Both logic inputs **IDX0** and **IDX1** allow the selection of the desired indexing position among the four programmed positions. When the logic input **STOP** is activated, the motor shaft stops on the position previously selected.

The programming of the four indexing positions can be performed in teach mode by moving the motor shaft manually or by using the logic inputs **JOG+** et **JOG-** of the **X2** connector. Pushing the **Offset** push button of the amplifier front panel allows to store the present indexing position into the amplifier EEPROM. The four indexing positions can also be programmed by means of the **BPCW** software and stored in the amplifier.

During the amplifier operation in speed mode, the logic output **VEL** is enabled when the motor speed is equal to the speed input command.

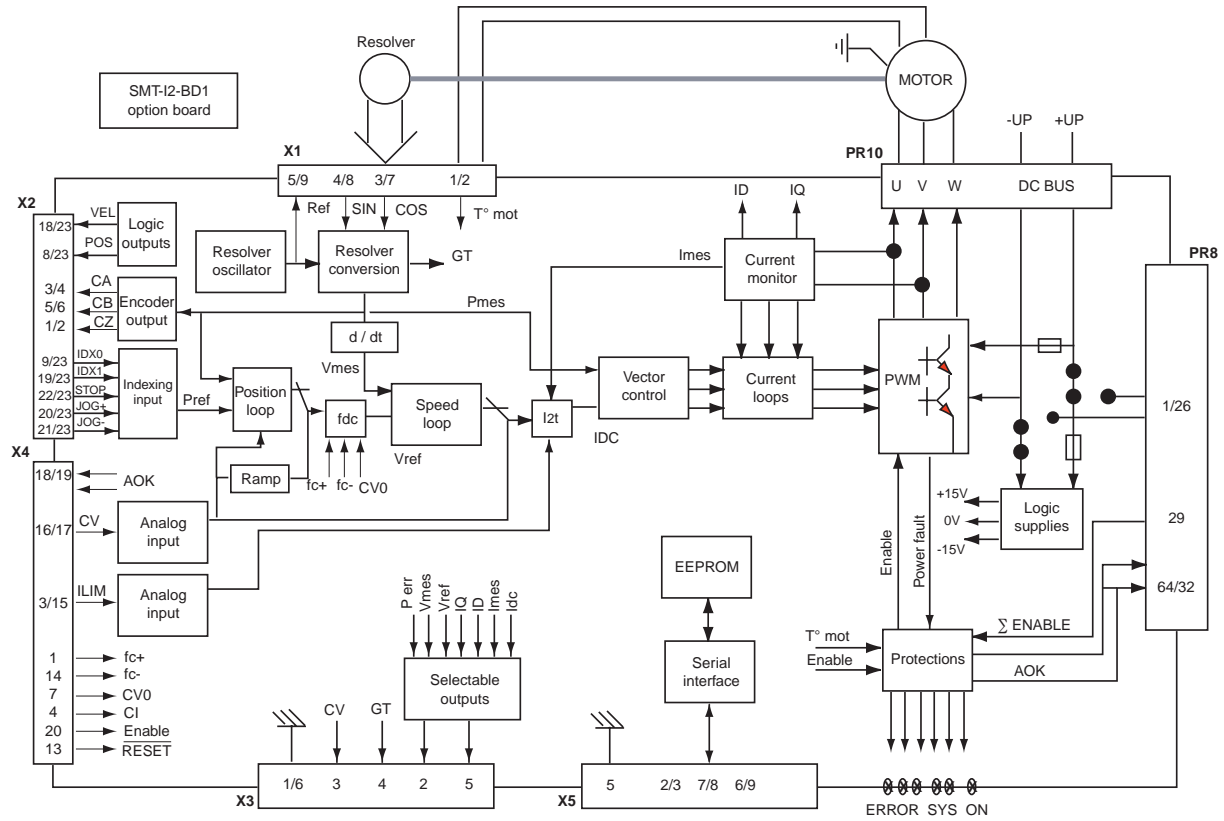
During the amplifier operation in indexing mode, the logic output **POS** is enabled when the motor shaft is on the indexing position.

CHAPTER 2 - SPECIFICATIONS

1 - TECHNICAL DATAS

Logic inputs	IDX0 : Axis indexing selection among 4 IDX1 : Axis indexing selection among 4 STOP : Stop on selected indexing JOG+ : Indexing displacement in positive direction JOG- : Indexing displacement in negative direction Optocoupled inputs : from 5 V to 24 V
Logic outputs	VEL : Indication "speed input command is reached" POS : Indication "indexing position is reached" Optocoupled outputs I _{max} 5 mA
Drive position repetability	1 motor shaft revolution/65536 (resolver speed 1)
Drive position accuracy (*)	8 Arc mins as standard (2 arc mins optional)
(*) The total accuracy must take into account the resolver accuracy.	
Speed / position regulator	Sampling period of 0,5 ms Integrator antisaturation system Adjustable digital gains Antiresonance filter
Speed / position bandwidth	Cut-off frequency for 45° phase shift Selectable : 50 Hz, 75 Hz, 100 Hz

2 - AMPLIFIER BLOCK DIAGRAM



CHAPTER 3 - INPUTS - OUTPUTS

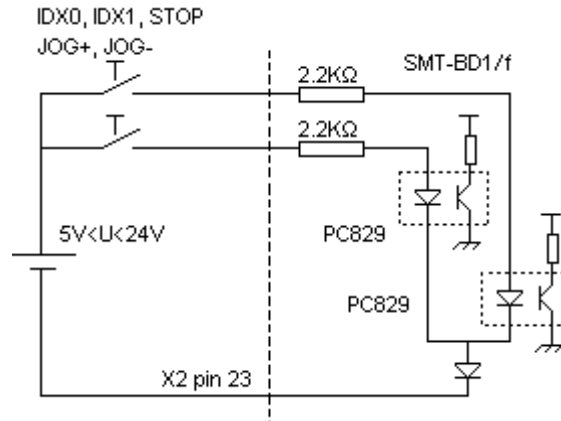
1 - X2 POSITION CONNECTOR

1.1 - PINS REFERENCES

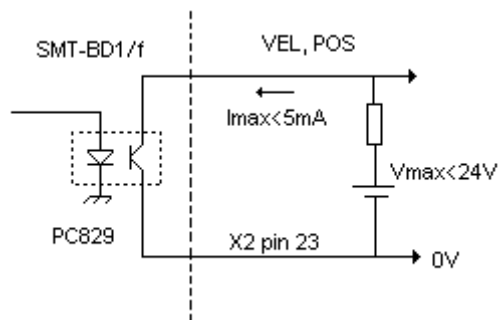
PIN	FUNCTION	I / O	REMARK
1	CZ/	O	Motor encoder output of the marker pulse Z/ (5 V max. current 20 mA)
2	CZ	O	Motor encoder output of the marker pulse
3	CA/	O	Motor encoder output channel A/ (5 V max. current 20 mA)
4	CA	O	Motor encoder output channel A
5	CB/	O	Motor encoder output channel B/ (5 V max. current 20 mA)
6	CB	O	Motor encoder output channel B
7,10,11	0 V		GND
12,13,14	Reserved		Reserved
15,16,17	Reserved		Reserved
9	IDX0	I	Logic input IDX0 : Indexing selection
19	IDX1	I	Logic input IDX1 : Indexing selection
22	STOP	I	Logic input STOP : Stop on indexing
20	JOG+	I	Logic input JOG+ : Indexing displacement pos. direction
21	JOG-	I	Logic input JOG- : Indexing displacement neg. direction
18	VEL	O	Logic output VEL : Speed input command is reached
8	POS	O	Logic output POS : Indexing position is reached
23	0 V I/O		0 Volt logic inputs and outputs
24	+ 5 V	O	+/- 5 % 300 mA available with jumper 5 V closed
25	0 V		

1.2 - SPECIFICATION OF THE LOGIC INPUTS / OUTPUTS

The **IDX0**, **IDX1**, **STOP**, **JOG+** and **JOG-** are optocoupled and operate in positive logic according to the diagram shown below. The input voltage corresponding to the level 1 is between 5 and 24 V.



The **VEL** and **POS** outputs are "open collector" and "optocoupled" outputs. The transistor is inhibited as long as the output is not activated. The traditional application scheme is shown below. The maximum output current is 5 mA.



2 - X3 TEST CONNECTOR

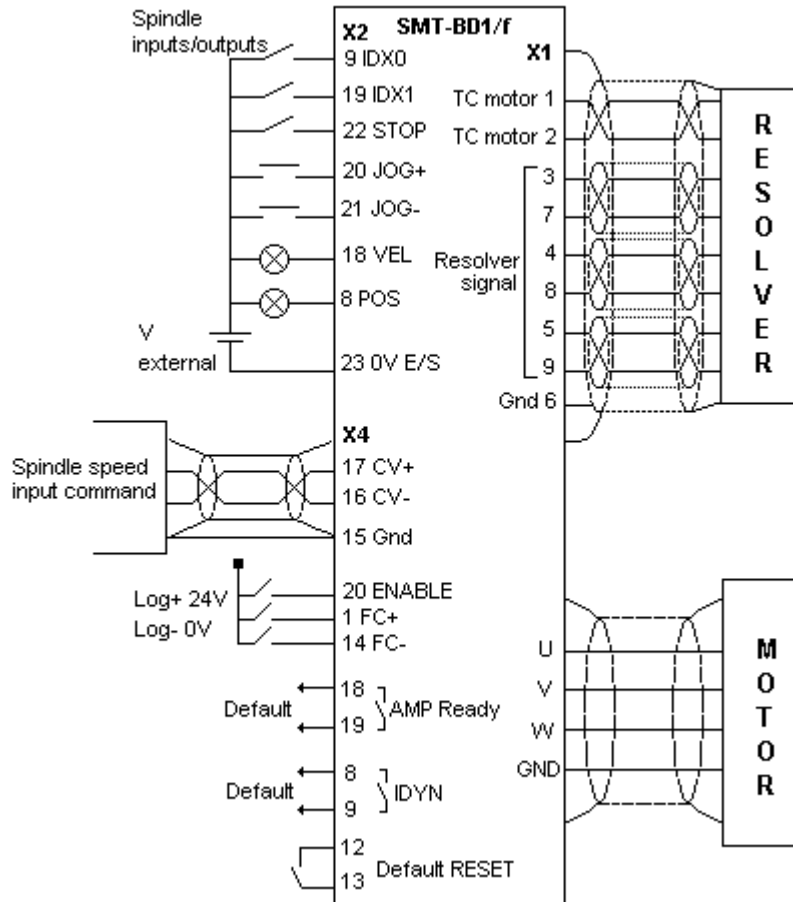
PIN	FUNCTION	REMARK
1 - 6	0 V	
2	DAC 1 output	± 10 V resolution 8 bits, linearity: 2 % (IDC, Imon., ID, IQ, Vref, Vmon., Pos err) *
3	Speed input command CV	± 10 V for \pm max. speed
4	Speed monitor GT	± 8 V for $\pm 14\ 000$ rpm
5	DAC 2 output	± 10 V resolution 8 bits, linearity: 2 % (IDC, Imon., ID, IQ, Vref, Vmon., Pos err) *

* See manual "BPCW Options", part 2 "Digital oscilloscope".

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

CHAPTER 4 - CONNECTIONS

1 - CONNECTION DIAGRAM



2 - MANDATORY WIRING

For the analogue input command signal **CV**, use a shielded twisted pair cable with a 360° shield connection ensured by means of the metal plated connectors at both cable ends (see standard manual "SMT-BD1 digital drive, Chapter 8, part 6). The amplifier 0 Volt (**X4, pin 15**) MUST be connected to the NC (**Gnd**).

The input command wiring (**CV**) must be made according to the polarities between both NC and amplifier (**CV+** on "diff. high" of the NC).

CHAPTER 5 - ADJUSTABLE PARAMETERS

The parameters concerning spindle drive applications with axis indexing are accessible via the submenus **Spindle indexing** and **Indexing positions** of the menu **Advanced functions** in the **BPCW** software version 2.0. and greater.

Spindle indexing	
Indexing speed (rpm)	<input type="text" value="500"/>
Position error (degree)	<input type="text" value="0.5"/>
Velocity accuracy (%)	<input type="text" value="2"/>
<input type="button" value="OK"/> <input type="button" value="Cancel"/> <input type="button" value="Help"/>	

Indexing motor shaft positions		
Position 1 (degree)	<input type="text" value="0.00"/>	(IDX0=ON IDX1=ON)
Position 2 (degree)	<input type="text" value="90.00"/>	(IDX0=ON IDX1=OFF)
Position 3 (degree)	<input type="text" value="180.00"/>	(IDX0=OFF IDX1=ON)
Position 4 (degree)	<input type="text" value="270.00"/>	(IDX0=OFF IDX1=OFF)
<input type="button" value="OK"/> <input type="button" value="Cancel"/> <input type="button" value="Help"/>		

1 - OPERATION MODE

When the logic input **STOP** is not activated, the operation in speed mode with a **PI** or **PI²** mode is the same as the one of the standard amplifier. The logic output **VEL** indicates that the motor speed has reached the value of its input command with the accuracy defined by the parameter **Velocity accuracy**.

When the logic input **STOP** is activated, the motor decelerates according to the ramp defined by the parameter **Accel/Decel Time**. It then moves in the same direction until the indexing position selected by means of the logic inputs **IDX0** and **IDX1** according to the speed value defined by the parameter **Indexing speed**. The motor position is then controlled at this indexing position by a **PIV** + feedforward regulator. The logic output **POS** indicates that the motor has reached the indexing position with the accuracy defined by the parameter **Position error**.

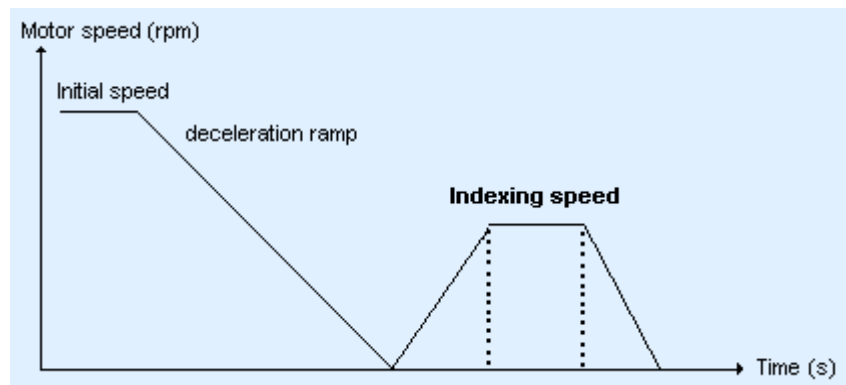
2 - APPLICATION PARAMETERS

The following parameters are accessible via the submenu **Spindle indexing** in the menu **Advanced functions** from the **BPCW** software 2.0 on.

The parameter **Position error** defines the tolerance on the position error for the activation of the **POS** output in the axis indexing mode. When the logic input **STOP** is activated and when the error between both motor and indexing position is below this value, the **POS** output is activated in order to indicate that the motor has reached the indexing position. This parameter is expressed in mechanical degrees on the motor shaft (with a one pole pair resolver "speed 1"). The adjustment range is between 0 and 180°.

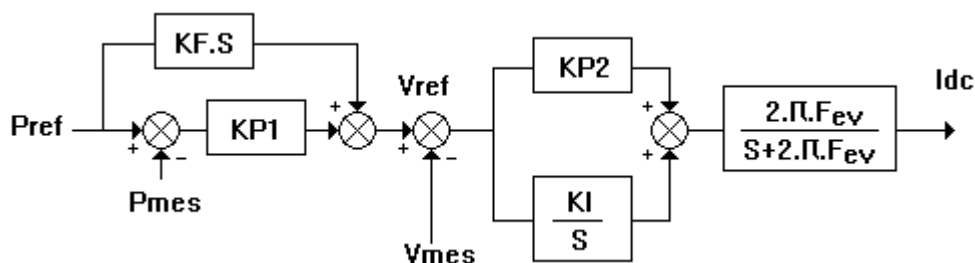
The parameter **Velocity accuracy** defines the motor speed accuracy in % for the activation of the **VEL** output in speed control (logic input **STOP** disabled). At speeds higher than 200 rpm and when the error between the motor speed and its input command remains within the tolerance (speed input command x **Velocity accuracy**), the **VEL** output is activated in order to indicate that the motor has reached its input command speed. At speeds lower than 200 rpm, the **VEL** output is not activated. This parameter is expressed in %; the adjustment range is between 1 % and 50 %.

The parameter **Indexing speed** defines the motor rotation speed during the indexing positioning phase, when the logic input **STOP** is activated. The motor decelerates according to the ramp defined by the parameter **Accel/Decel Time**. The displacement until the indexing position is then made in the same direction according to the trapezoidal curve shown below. The deceleration and acceleration times are automatically calculated in order to avoid a current saturation in the amplifier. This parameter is expressed in rpm; the adjustment range is between 2 rpm and the value of the parameter **Maximum speed**.



3 - POSITION REGULATOR PARAMETERS

The structure of the regulator used in the indexing mode with the logic input **STOP** activated is shown below.



The function **Controller parameters** of the menu **Advanced functions** in the **BPCW** software allows the access to all regulator parameters.

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

The parameter **Proportional speed gain** defines the proportional gain (**KP2**) of the regulator acting on the speed error. The adjustment range is between 0 and 4 095.

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

The parameter **Proportional position gain** defines the proportional gain acting on the position error (**KP1**). The adjustment range is between 0 and 1.

The parameter **Feedforward position gain** defines the amplitude of the anticipating term (**KF**) corresponding to the speed input command (derivation of the position input command). This anticipating term allows to reduce the following error during the motor acceleration and deceleration phases. The adjustment range is between 0 and 1.

All these gain parameters are automatically calculated during the execution of the **AUTOTUNING** function.

4 - INDEXING POSITIONS

The four indexing position values are accessible via the submenu **Indexing positions** of the menu **Advanced functions** in the **BPCW** software version 2.0 and greater. The value range is between 0 and 360°.

CHAPTER 6 - COMMISSIONING

1 - CHECKING THE CONFIGURATION

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

Check for the presence of the **SMT-I2-BD1** daughter board between both logic and power boards (see chapter 8 (Appendix): Location diagram of the hardware options).

Check for the **X.XF** firmware memory version.

Check that the jumpers **E** and **S** of the amplifier logic board are open (see chapter 8 (Appendix): Location diagram of the hardware options).

2 - POWERING

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

3 - START AND ADJUSTMENT

Start the amplifier commissioning and adjustment as described in chapter 6 of the standard **SMT-BD1** manual by selecting a **PI** or **PI²** speed regulator in the **BPCW** software before executing the **AUTO-TUNING** function in the **CONTROLLER** module.

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

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

Display the module **Spindle motor indexation** accessible in the menu **Advanced functions** in the **BPCW** software version 2.0 and greater.

Initialize the parameter **Indexing speed** at a low value (i.e. 50 rpm) if you want a soft indexing positioning.

Initialize the parameters **Position error** and **Velocity accuracy** according to the application.

4 - PROGRAMMATION OF THE INDEXING POSITIONS

A. *Programmation in teach mode*

Select the code of the first indexing position on the logic inputs **IDX0** and **IDX1**.

If a positioning on the index without overshooting is required, set the **Feedforward gain** parameter at zero (in the **Controller parameters** window).

Activate the logic input **STOP** :

- when the amplifier input **ENABLE** is activated, the motor will be controlled at the indexing position presently stored in the amplifier EEPROM. Then, use the inputs **JOG+** and **JOG-** for moving the motor shaft until the desired indexing position.
- when the amplifier input **ENABLE** is not activated, manually move the motor shaft until the desired indexing position.

When the motor shaft is on the desired position, push the amplifier push button **OFFSET** to make the acquisition of the indexing position and store its value into the amplifier EEPROM.

Disable the logic input **STOP**.

Select the next indexing position code on the logic inputs **IDX0** and **IDX1**.

Activate the logic input **STOP** and use the same procedure as for the first indexing position.

B. Programmation with the BPCW software (version 2.0 and greater)

Select the submenu Indexing positions in the menu **Advanced functions**.

Set the four indexing position values and click on "OK".

Execute the command **Store parameters** to EEPROM before quitting the **BPCW** software.

CHAPTER 7 - FAULT FINDING

1 - LOUD CRACKLING NOISES IN THE MOTOR AT STANDSTILL

Check that the Motor-Amplifiers-PLC ground connections answer the requirements of chapter 4.
Check that the wiring of the speed input command answer the requirements of chapter 4.

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

Check for the rigidity of the mechanical coupling between motor and load (backlashes and elasticities in the gearboxes and couplings).

Execute the **AUTO-TUNING** function again by selecting a lower bandwidth (**Medium** or **Low**).

If the problem remains, renew the **AUTO-TUNING** procedure by activating the antiresonance filter (**Filter = Antiresonance**). The antiresonance filter is accessible from the **BPCW** software version **2.6** and the amplifier EPROM version **5.7**.

3 - MOTOR POSITION OSCILLATION AT STANDSTILL

Check for the rigidity of the mechanical coupling between motor and load (backlashes and elasticities in the gearboxes and couplings).

Reduce the value of the parameter **Proportional position gain** in the submenu **Controller parameters** accessible via the menu **Advanced functions**.

CHAPTER 8 - APPENDIX

LOCATION DIAGRAM OF THE HARDWARE OPTIONS

