I N F R A N O R

CAN communication protocol

SERIES SMTBD1

DIGITAL BRUSHLESS SERVO CONTROLLERS

(Version 1.1)
European version 1.0

RECEIVING AND HANDLING

Upon delivery of the equipment, inspect the shipping containers and contents for indications of damages incurred in transit. If any of the items specified in the bill of lading are damaged, or the quantity is incorrect, do not accept them until the freight or express agent makes an appropriate notation on your freight bill or express receipt.

Claims for loss or damage in shipment must not be deducted from your invoice, nor should payment be withheld pending adjustment of any such claims.

Store the equipment in a clean, dry area. It is advisable to leave the equipment in its shipping container until ready for use. Each amplifier is checked carefully before shipment. However, upon receipt, the user should make sure that the amplifier received corresponds to or is properly rated in terms of rated voltage and current for the type of motor which is to be driven. The descriptive label affixed to the amplifier specifies electrical ratings.

OPERATING MANUAL
INFRANOR
SERIES SMTBD1
CAN PROTOCOLE
(July 1997)

CHAPTER 1 - GENERAL DESCRIPTION

Main characteristics :

- The maximum data transfer output (controlled by the NC) is 500 kHz.
- Axes synchronization per amplifier group and by means of synchro messages.
- Each amplifier has a switch defined address from 1 to 15 belonging to 2 possible synchro groups. The 0 address is assigned to the host of the network (the NC).
- Several possible control modes of the amplifier (speed / incremental position / absolute position).

The operation of this amplifier is governed by the messages exchanges on the CAN bus. There are 2 types of communication messages:

- synchronous messages,
- asynchronous messages.

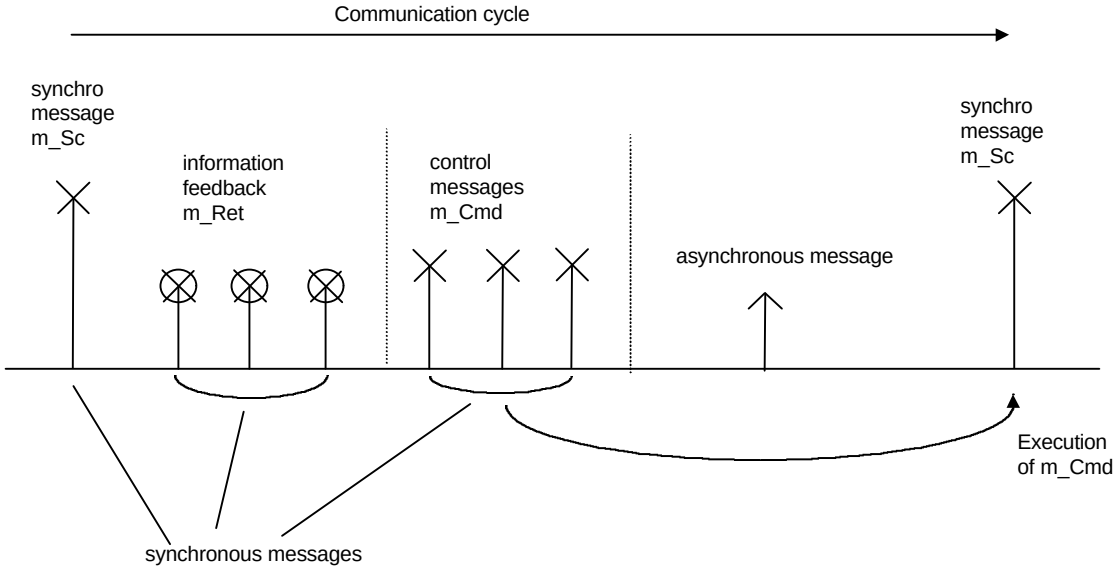
The synchronous messages control the amplifier and the asynchronous messages allow the amplifier parameter setting.

CHAPTER 2 - SYNCHRONOUS MESSAGES

These are periodic messages such as position controls or position feedbacks. These messages control the amplifier.

There are 3 types of synchronous messages:

- synchro message (m_Sc),
- control message (m_Cmd),
- feedback message (m_Ret).



At constant time intervals (cycle time), the NC sends a synchro message **m_Sc** and the amplifiers of the same synchronization group acquire their position and send the messages containing their position (**m_Ret**). After the reception of the positions, the NC sends the input command messages (**m_Cmd**) to the amplifiers of this same synchro group.

1 - SYNCHRO MESSAGES

The synchro message contains no data. It synchronizes the various axes on the network and defines the data transfer rythm.

There are 2 synchro groups defined by the amplifiers addresses:
- group 0 (G0) : addresses 1 to 7
- group 1 (G1) : addresses 8 to 15.

The synchro message is emitted by the NC and is received by all amplifiers of a same group.

There are 2 types of synchro messages :

Control synchro **m_Sc**: this message triggers
- the returning of the information feedback message (**m_Ret**) if it has been programmed,
- the taking into account of the input command (**m_Cmd**) transmitted before.

Feedback synchro **m_Sr** :
- The feedback synchro message triggers the returning of the information feedback message (**m_Ret**). This message makes it possible to get position feedbacks at a rythm different from the one of the controls.

There is one control synchro message and one feedback synchro message for each amplifier group.

2 - CONTROL MESSAGES

There is one control message per axis. In this message, it is possible to define, for each axis:

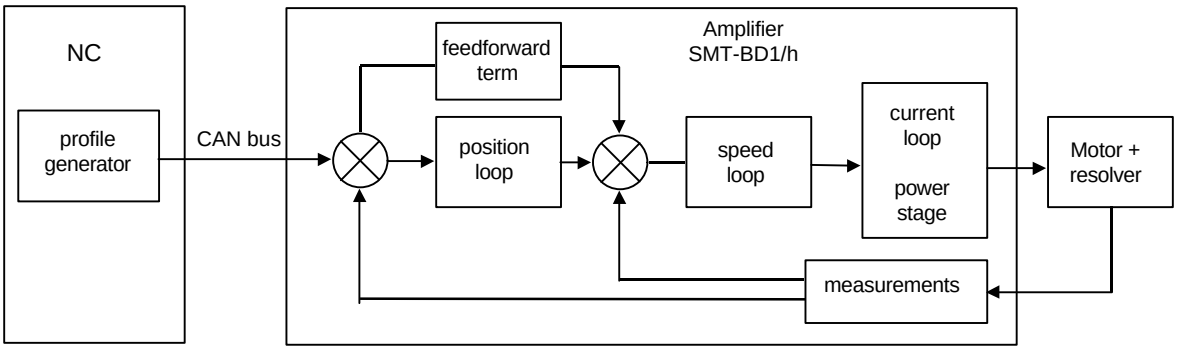
- an absolute position input command (32 bits) or an incremental position input command (16 bits),
- a speed input command,
- a torque input command.

Position input command mode

In this mode, the amplifiers periodically receive the position input command by the NC. The profile generator is in the NC; this allows the axes synchronization.

The amplifier cycle time is 500 µs. The position input command interpolation is linear.

The position input command can be:
- absolute (32 bits),
- or incremental (16 bits).



Note:
The position feedback is optional. This allows to reduce the traffic on the bus.

Double command

There is also a particular mode for the absolute position input command:

- In this mode, a control message can contain 2 absolute position input commands for 2 amplifiers.

- The addresses of both amplifiers must be sequential. For the first amplifier which address is [ABC0], the control is in the bytes 1 to 4 of the message. For the second amplifier which address is [ABC1], the control is in the bytes 5 to 8 of the message.

- This mode makes it possible to reduce the number of messages used.

3 - FEEDBACK MESSAGES

There is one feedback message per axis. In this message, it is possible to define, for each amplifier:

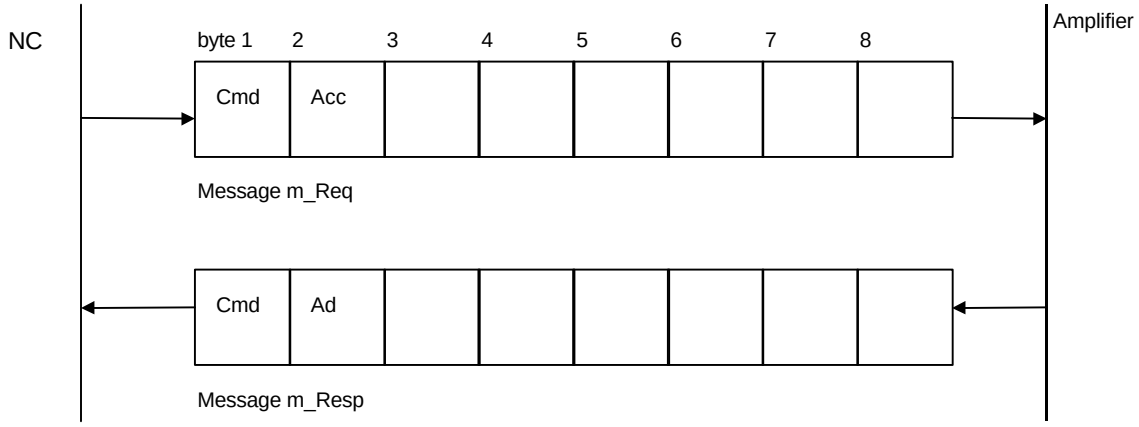
- an absolute position feedback (32 bits) or an incremental position feedback (16 bits),
- a speed monitor,
- a torque monitor,
- an amplifier error code.

CHAPTER 3 - ASYNCHRONOUS MESSAGES

These messages are used for the parameter transmission between NC and amplifiers.

1 - STRUCTURE OF THE MESSAGES

- The master sends a message m_Req in order to initialize a transfer. The transfer direction is defined by the bit L/E.
- The appropriate slave answers with a message m_Resp, except for the case where bit T = 1 (see diagram below).



Message m_Req :

- Byte 1 : Transfer command
- Byte 2 : access mode:

7	6	5	4	3	2	1	0
L/E	**T**	**0**	**0**	**Ad3**	**Ad2**	**Ad1**	**Ad0**

L/E = 0 Reading of a parameter
L/E = 1 Writing of a parameter
T = 0 Concerns one single amplifier which address is defined by "Ad3 Ad2 Ad1 Ad0".
T = 1 All axes are concerned. "Ad3 Ad2 Ad1 Ad0" are not taken into account.

Bytes 3 to 8 : parameters.

Message m_Resp :

- Byte 1 : Transfer command
- Byte 2 : address of the questionned amplifier:

7	6	5	4	3	2	1	0
0	**0**	**0**	**0**	**Ad3**	**Ad2**	**Ad1**	**Ad0**

"Ad3, Ad2, Ad1, Ad0" : slave address (amplifier).

- Bytes 3 to 8 : parameters.

Note **:**
In the case of 16 or 32 bit datas, the low weight bytes are stored before the high weight bytes.

2 - LIST OF THE PARAMETER TRANSFER COMMANDS

Notes:

- 1 word = 2 bytes.
- All parameter setting commands are not buffered.
- The execution time of a command is about 1 to 2 ms (except for procedures which execution time is not known in advance).
- During the execution of a procedure, the execution of another command can be delayed.

2.1 - OPERATION PARAMETERS

Amplifier mode

Command 40 (0x28)
defines the amplifier operation mode (position / speed or torque).

Parameters 1 byte.

1	torque mode
2	speed mode with PI regulator
4	position mode
8	speed mode with P regulator
16	speed mode with PI^2 regulator

Conversion Limitation

Execution Remarks During the execution of this command, the amplifier must generally be disabled. Only the switching on to torque mode or from torque mode can be made with enabled amplifier. The torque input command must be available (see configuration of control and feedback messages - Command 42).

Cycle time

Command 41 (0x29)
defines the cycle time of the NC. This value is necessary for the interpolation of the position input command.

Parameters 1 word. This value is in µs and is between 1000 and 20000.

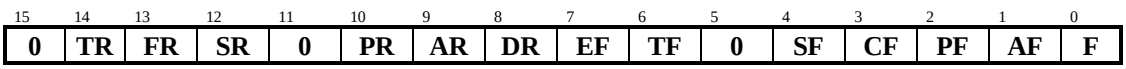
Conversion Limitation

Execution Remarks Amplifier disabled.

Configuration of the control and feedback messages

Command 42 (0x2A)
defines the configuration of the control (m_Cmd) and feedback (m_Ret) messages.

Parameters 1 word.



15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**TR**	**FR**	**SR**	**0**	**PR**	**AR**	**DR**	**EF**	**TF**	**0**	**SF**	**CF**	**PF**	**AF**	**F**

TR	torque control (16 bits) in torque mode.
FR	speed feedforward
SR	speed control (16 bits) in speed mode.
PR	position control in position mode (absolute or incremental).
AR	absolute position control 32 bits.
DR	double position control (absolute 32 bits).
EF	amplifier status feedback (16 bits)
TF	current monitor feedback (16 bits).

SF	speed monitor feedback (16 bits).
CF	Position feedback via external encoder instead of a resolver
PF	position feedback (absolute or relative position).
AF	absolute position feedback 32 bits.
F	authorizes a feedback message (m_Ret) as an answer to a control synchro message (m_ScGx).

The DR bit makes it possible to define two 32 bit position controls for 2 amplifiers in the same message.
The addresses of both amplifiers must be sequential.
For the first amplifier which address is [Ad3 Ad2 Ad1 0], the control is in bytes 1 to 4 of the message.
For the second amplifier which address is [Ad3 Ad2 Ad1 1], the control is in bytes 5 to 8 of the message.

The position control and the position feedback receive the same scaling factor (see command 50). The maximum position value depends on the position resolution = -32768 x Resolution at 32767 x Resolution.

The speed control and speed feedback vary between -32768 and 32767 and correspond to the maximum application speed defined by the **command 61**.

The torque control and torque feedback vary between -32768 and 32767 and correspond to the maximum current defined by the **command 76**.

When the FR bit is set at 1, the regulator uses the speed input command (the speed input command must be programmed in the same message) as a feedforward instead of the one calculated by the regulator (see drawing in section 2.4 of this chapter).

When the CF bit is set at 1, the position sent back by the message m_Ret is the one given by the external encoder and not the one of the resolver.

The amplifier status is defined as follows:

Bit (0-15)	**Description**
0	Power stage fault: - power overvoltage, - short-circuit, - IGBT module overheating
1	I²t fault
2	Resolveur-digital conversion fault or resolver cable interruption
3	Position following error
4	EEPROM fault or amplifier thermal switch fault or motor thermal switch fault.
5	CAN reference fault.
6	Power undervoltage.
7	Procedures execution error
8	FC+
9	FC-
10	CI
11	INDEX
12	ENABLE
13	Amplifier enabled.
14	Current execution of a procedure.
15	A motor position is captured.

Bit 15 indicates that a motor position captured by the Inactive-Active transition of the CI input is memory stored. The reading of this position by means of command 66 resets this bit at 0.

Conversion

Limitation The number of bytes for the control or feedback message is 8. The configuration of these messages must take into account this limitation.
When a synchronous message (command or feedback) contains several information (position, speed, current...), the sequence of these information in the message (if they are in the message) is the following:

- position
- speed
- current
- status

Execution Amplifier disabled.

CAN bus error threshold

Command 43 (0x2B)
defines the time after which the amplifier triggers the CAN reference error when the control synchro message (m_Sc) or the input command message (m_Cmd) are missing.

Parameters 1 word. The recommended value is 500 or 1000.

Conversion The parameter value corresponds to the time in µs.

Limitation

Execution The CAN reference error is triggered by the absence of synchro message m_Sc or input *Remarks* command message m_Cmd.

Position resolution

Command 50 (0x32)
defines the position resolution (ppr).

Parameters 1 word.

Conversion From 513 to 32767, except for the value 0 which corresponds to a resolution of 65536 (full scaling).

Limitation

Execution Amplifier disabled.

Remarks This position resolution consequently defines the position input command and position feedback format.

Hardware configuration

Command 51 (0x33)

Parameters 1 word. Indicates the optional amplifier configuration.

Bit (0 - 15)	**Description**
0	Non volatile RAM (option CT-EMF)
3	RAM (always at 1 if bit 0 is at 1)
4	Option "auxiliary encoder input"
5	Option "logic inputs/outputs
7	CAN interface available (always at 1)

Conversion

Limitation Reading only

Execution

Remarks

Version

Command 52 (0x34)

Parameters 6 bytes.
1 word : version number of the amplifier software.
4 bytes : identification code of the manufacturer: (INFR) for Infranor.

Conversion

Limitation Reading only.

Amplifier status

Command 53 (0x35)
Parameters 2 words.
1st word: Amplifier fault.

Bit (0-15)	Fault
1	I^2t
2	Resolver-digital conversion
3	Position following error
4	EEPROM
5	CAN input command
7	Procedure execution error
9	Power stage fault : - power overvoltage, - short-circuit, - IGBT module overheating
10	Resolver cables interrupted
11	Power undervoltage.
12	Amplifier thermal probe.
13	Motor thermal probe.

2nd word: Statement of the amplifier logic inputs.

Bit (0-15)	Meaning
	Encoder input marker pulse statement
3	0 = positive logic. 1 = negative logic.
4	0 = FC+ off 1 = FC+ on
5	0 = FC- off 1 = FC- on
6	0 = CI off 1 = CI on
7	0 = Index off 1 = Index on
8	0 = ENABLE off 1 = ENABLE on
12	0 = Amplifier off 1 = Amplifier on
14	1 = A position is captured by the Inactive-Active transition of the CI input
15	1 = A position is captured by the Active-Inactive transition of the CI input

3rd word: indicates the statement of a procedure.
A procedure is an action of the amplifier during which the amplifier does not answer the NC input command.
A procedure is executed by the amplifier in an autonomous way.

Bit (0-15)	Meaning
0	Auto-phasing procedure phase 1
1	Auto-phasing procedure phase 2
2	Cogging torque acquisition procedure phase 1
3	Cogging torque acquisition procedure phase 2
4	Auto-tuning procedure
5	Index research procedure
8	EEPROM saving procedure
9	Encoder output programmation procedure
13	Procedure cancelled
14	Procedure correctly executed
15	Procedure over because of an error

Conversion

Limitation Reading only

Execution Remarks When a procedure is called, the bits 13, 14 and 15 of the procedure status are set at 0. During the procedure execution, the corresponding bit is set at 1. At the end of the procedure, this bit is reset at 0, and one or two of bits 13, 14, 15 are set at 1.

The amplifier fault RESET command (**command 93**) allows to cancel any procedure during its execution.

If the amplifier is disabled after a fault, the fault RESET command cancels the fault but does not enable the amplifier. To enable the amplifier, use **command 91** "ENABLE".

Speed/current monitor

Command 54 (0x36)

Parameters 2 words
1 word: speed monitor.
1 word: current monitor.

Conversion

Limitation Reading only.

Execution

Remarks The formats of the speed monitor or the current monitor are 16 bits full scaling, that is 32767 for maximum speed (defined by command 61 : max. application speed) or maximum current (defined by the amplifier sizing). These formats are also used for the speed and current input commands.

Masking of the amplifier faults

Command 55 (0x37)

Parameters 1 word
Each bit of this word is corresponding to an amplifier fault. The meaning of these bits is given by command 53.
Bit = 0: the corresponding fault is masked.
Bit = 1: the fault will disable the amplifier.

Conversion

Limitation Only the following error and CAN input command faults can be masked.

Execution

Remarks When an error has occured and when the corresponding fault is masked by this command, the amplifier is not stopped, but only the fault is displayed (command 53 "amplifier status").

Logic inputs / outputs

Command	56 (0x38). Allows the reading of the logic inputs or the writing of the logic outputs of X2.
Parameters	1 word In writing: bits 0 to 3 are corresponding to the logic outputs LOUT0 to LOUT3. In reading: bits 0 to 5 are corresponding to the logic inputs LIN0 to LIN5. When the option "auxiliary encoder input" is available (**command 51**), the logic inputs 0 and 1 are not available.
Conversion	
Limitation	
Execution	
Remarks	For the logic inputs / outputs, see Part 1 of this manual, chapter 3, section 3: "X2 encoder connector".

Reversal of the rotation direction

Command	60 (0x3C) This command allows the reversal of the rotation direction with regard to the input command. It also reverses the position feedback. The second byte allows to reverse the position counting of the encoder input, if available.
Parameters	1st byte. = 0 : normal. ≠ 0 : reversed. 2nd byte = 0 : normal. ≠ 0 : reversed.
Conversion	
Limitation	
Execution	Amplifier disabled.
Remarks	

Maximum application speed

Command	61 (0x3D) defines the maximum speed (as well as the speed scaling) of the application.
Parameters	1 word.
Conversion	For getting the speed in rpm: x 1.8310546875
Limitation	This parameter varies between 55 (100 rpm) and 7446 (14000 rpm)
Execution	Amplifier disabled.
Remarks	

Absolute position measurement

Command	62 (0x3E). Allows the reading of the motor position.
Parameters	32 bits.
Conversion	See position resolution.
Limitation	Reading only.
Execution	
Remarks	

Position reset

Command	63 (0x3F) Resets the position sent back by the amplifier.
Parameters	
Conversion	
Limitation	Writing only.
Execution	Amplifier disabled.
Remarks	

Position error reading

Command	64 (0x40). Allows the reading of the position error.
Parameters	32 bits.
Conversion	See position resolution.
Limitation	Reading only.
Execution	
Remarks	

Position error threshold

Command	65 (0x41). Defines the position error triggering threshold.
Parameters	1 word.
Conversion	See position resolution.
Limitation	
Execution	
Remarks	

Reading of the position captured on Inactive-Active transition

Command	66 (0x42) Allows to read the value of the motor position captured by the Inactive-Active transition of the CI input (pin 4 of the X4 connector).
Parameters	Position: 32 bits. Capture indicator: 16 bits.
Conversion	See position resolution.
Limitation	Reading only.
Execution	
Remarks	Bit 0 of the indicator indicates if the position has just been captured; this bit will be reset at 0 by the amplifier after the reading. This bit is the same as bit 15 of the amplifier status in the synchronous message feedback (see also **command 42**). If the CI input is configurated in positive logique (see Part 1 of the manual, chapter 8, section 4.1), the Inactive-Active transition corresponds to the up edge of the signal. The active level duration must be higher than 50 µs.

Reading of the position captured on Active-Inactive transition

Command	67 (0x43) Allows to read the value of the motor position captured by the Active-Inactive transition of the CI input (pin 4 of the X4 connector).
Parameters	Position : 32 bits. Capture indicator: 16 bits.
Conversion	See position resolution.
Limitation	Lecture uniquement.
Execution	
Remarks	Bit 0 of the indicator indicates if the position has just been captured; this bit will be reset at 0 by the amplifier after the reading. If the CI input is configurated in positive logique (see Part 1 of the manual, chapter 8, section 4.1), the Inactive-Active transition corresponds to the down edge of the signal. The inactive level duration must be higher than 50 µs.

Filtering of the CI input

Command	68 (0x44)
Parameters	1st word: filter parameter. 2nd word: acceptance threshold.
Conversion	1st word: x 50 µs. 2nd word: see position resolution.
Limitation	
Execution	
Remarks	The first parameter defines the signal filter per 50 µs pitch. This filter allows to cancel disturbing pulses. The signal duration must then be higher than this parameter x 50 µs. This parameter can vary between 1 and 32767. The second parameter defines the minimum signal width (in position). This parameter can be 0 (no limitation) or between 1 and 32767 (same format than the position).

Bandwidth

Command	69 (0x45) This parameter defines the position error threshold in which the position loop is open.
Parameters	1 word.
Conversion	See position resolution.
Limitation	
Execution	
Remarks	

2.2 - MOTOR PARAMETERS

Synchronous motor parameters

Command	71 (0x47) defines the parameters necessary for the driving of a synchronous motor. These parameters can be calculated by the auto-phasing procedure.	
Parameters	3 words.	
	1st word:	Motor phase: corresponds to the phases order (U, V, W) of the motor connection.
	2nd word:	Resolver adjustment: phase shift between resolver and motor rotor.
	3rd word:	Number of motor pole pairs (1 to 12).
Conversion	Motor phase:	2 possible values (0x5555 or OxAAAA).
	Resolver adjustment:	5.4931640625e-3* (number of pole pairs). The resulting value is the shift in electrical degree.
Limitation		
Execution	Amplifier disabled.	
Remarks		

Phase lead factor

Command	72 (0x48)
Parameters	16 bits. (55-7446)
Conversion	4.57771654e-5 (electrical degree / 1000 rpm)
Limitation	
Execution	
Remarks	See also Part 1, chapter 6, section 3.1.

Encoder output marker pulse

Command	73 (0x49)
Parameters	1st word: number of encoder pulses (1-16). 2nd word: phase shift with regard to the resolver zero (0-65535). 3rd word: marker pulse width (16-32767).
Conversion	Marker pulse phase shift: 65536 is equivalent to 360°. Marker pulse width: 65536 is equivalent to 360°.
Limitation	Number of marker pulses: 1 to 16. Phase shift with regard to the resolver zero: 0 to 65535. Marker pulse width: 16-32767.
Execution	The amplifier takes into account the phase shift value withr regard to the resolver zero and
Remarks	the number of marker pulses during the index research procedure (**command 97**). The encoder output takes into account these values only after execution of the procedure "encoder output programmation".

Encoder output resolution

Command	74 (0x4A) defines the encoder output resolution.
Parameters	1 word: encoder resolution
Conversion	
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	Amplifier disabled
Remarks	The encoder output is only effective after the execution of the encoder output programmation procedure (command 98).

Cogging torque compensation

Command	75 (0x4B)
Parameters	1 byte = 0 disables the compensation ≠ 0 enables the compensation
Conversion	
Limitation	The "CT-EMF" option must be available and the cogging torque identification procedure must be executed before (**command 100**).
Execution	
Remarks	For more information, see manual "Options BPCW", part 1.

2.3 - CURRENT LIMITATION PARAMETERS

Maximum current

Command	76 (0x4C) defines the maximum current limitation in the motor.
Parameters	1 word.
Conversion	in percent of the amplifier current sizing: x 3.051850948e-3.
Limitation	6554 (20%) to 32767 (100 %)
Execution	
Remarks	This parameter is set according to the amplifier and motor specifications.

Rated current

Command	77 (0x4D) defines the rated current limitation in the motor.
Parameters	1 word.
Conversion	in percent of the amplifier current sizing : x 3.051850948e-3.
Limitation	6554 (20 %) to 16384 (50 %)
Execution	
Remarks	This parameter is set according to the amplifier and motor specifications.

I^2t mode

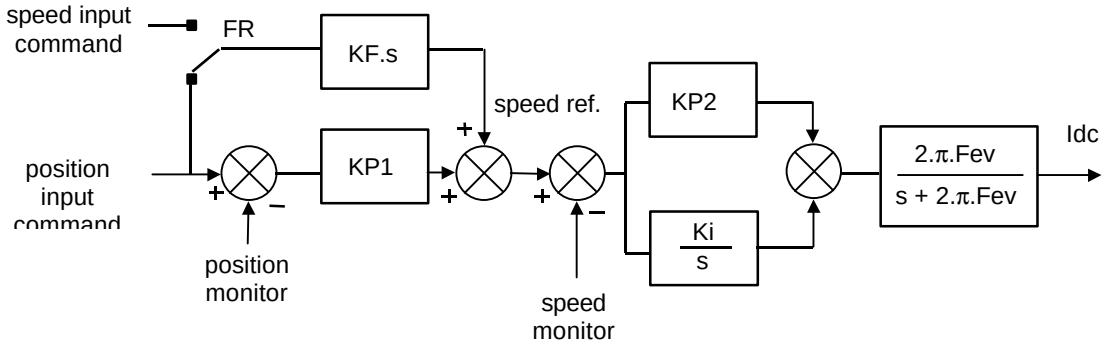
Command	78 (0x4E)
Parameters	1 byte. 0 limiting mode. 1 fusing mode.
Conversion	
Limitation	
Execution	
Remarks	For the I^2t operation mode, see standard manual of the SMT-BD1 amplifier.

Current limitation

Command	79 (0x4F) defines the current limitation in the motor with regard to the value defined by the command 76 (maximum current).
Parameters	1 word.
Conversion	
Limitation	0 to 32767 (100 % Imax)
Execution	
Remarks	

2.4 - REGULATOR PARAMETERS (POSITION AND SPEED)

The structure of the regulator is shown below:



All these gain parameters (KF, KP1, KP2, Ki and Fev) are automatically calculated during the auto-tuning procedure.

Speed loop proportional gain

Command	81 (0x51) defines the proportional gain (KP2) of the regulator, that is acting on the speed error.
Parameters	1 word
Conversion	1/16
Limitation	0 to 65535

Speed loop integral gain

Command	82 (0x52) defines the integral gain (KI) of the regulator, that is acting on the speed error.
Parameters	1 word
Conversion	1/256
Limitation	0 to 65535
Execution	
Remarks	

Position loop proportional gain

Command	83 (0x53) defines the proportional gain that is acting on the position error (KP1).
Parameters	1 word
Conversion	1/65536
Limitation	0 to 65535
Execution	
Remarks	

Feedforward gain

Command	84 (0x54) defines the feedforward amplitude (KF) corresponding to the a priori speed input command (derivation of the position input command). This feedforward term allows to reduce the following error during the motor acceleration and deceleration phases.
Parameters	1 word
Conversion	1/65536
Limitation	0 to 65535
Execution	
Remarks	

Acceleration ramp

Command	85 (0x55) defines the acceleration or deceleration time of the motor, that is corresponding to the maximum speed.
Parameters	1 word
Conversion	in second: x 0.0005
Limitation	1 (without acceleration ramp) to 65535 (# 30 s).
Execution	
Remarks	This parameter is only useful in speed mode.

Current control low pass filter

Command	86 (0x56) defines the cut-off frequency at -3dB (Fev) of the first order filter that is acting on the current control. The value of this parameter is depending on the selected bandwidth.
Parameters	1 word
Conversion	Frequency (Hz) = 1000/π*Ln (65536/parameter)
Limitation	This parameter can have a value between 2832 (1000 Hz) and 61545 (20 Hz).
Execution	
Remarks	

2.5 - PARAMETERS "UTILITY FUNCTIONS"

Enabling

Command	91 (0x5B) Enables the amplifier with a time delay of the brake relay output.
Parameters	1 word. This parameter gives, in ms, the time between the enabling and the disabling of the brake relay output. • enabling of the amplifier • time delay • disabling of the brake relay output.
Conversion	
Limitation	Writing only. The maximum time is 16 s.
Execution	
Remarks	The amplifier can only be enabled by this command. The ENABLE signal is a necessary but not sufficient condition. In standard, the amplifier is disabled at power on. If the parameter is ≠ 0, the end of the time delay is indicated by bit 14 of the procedures status (command 53).

Disabling

Command	92 (0x5C) Disables the amplifier with a time delay of the brake relay output.
Parameters	1 word. This parameter gives, in ms, the time between the enabling of the brake relay output and the disabling of the amplifier. • enabling of the brake relay output. • time delay • disabling of the amplifier.
Conversion	
Limitation	Writing only. The maximum time is 16 s.
Execution	When the parameter is ≠ 0, the end of the time delay is displayed by bit 14 of the procedures
Remarks	status (**command 53**).

Amplifier fault RESET

Command	93 (0x5D)
Parameters	None.
Conversion	
Limitation	Writing only.
Execution	
Remarks	The fault RESET command also cancels any procedure during its execution.

Saving in the EEPROM

Command	94 (0x5E) Saves all amplifier parameters in the EEPROM.
Parameters	None.
Conversion	
Limitation	Writing only.
Execution	Amplifier disabled.
Remarks	All parameters modified by the other commands mentioned in this manual are not stored. This command must be executed in order to definitely store them in the amplifier.

Auto-phasing

Command 95 (0x5F)
Parameters None.
Conversion
Limitation Writing only.
Execution
Remarks This procedure allows the automatic calculation of the motor parameters:

- number of motor pole pairs,
- motor phases order,
- resolver offset.

The motor must first be disabled by means of **command 92** and uncoupled from its mechanical load. The ENABLE signal must be activated (after execution of command 92). Before starting the procedure, check that the motor shaft is free and that its rotation over one revolution is not dangerous for the operator.

Auto-tuning

Command 96 (0x60). This procedure identifies the motor and load specifications and calculates the regulator gain parameters.
Parameters 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
Conversion
Limitation
Execution With disabled amplifier: via command 92 and ENABLE signal activated.
With enabled amplifier: at zero speed.
Remarks During the procedure execution, the operator can select the speed loop bandwidth (Low, Medium, High). These values correspond to the cut-off frequency for a 45° speed loop phase shift. The reading gives the bandwidth used before (0, 1, 2, 3, 4 or 5).
Before starting the procedure, check that the motor shaft is free and that a rotation over one revolution is not dangerous for the operator.

Index research procedure

Command 97 (0x61)
Parameters 1 byte: command

Bit (0 - 7)	**Description**
0	0 Leaves index research procedure 1 Starts the procedure
1	Index research with switch
2	Index research on marker pulse Combination of bits 1 and 2: 01 with switch 10 on marker pulse 11 with switch and on marker pulse 00 position reset
3	0 positive direction 1 negative direction
4	0 parameter = displacement speed + TimeOut 1 parameter = index position
5	1 cancels the index research procedure. The motor will be stopped: leave the index research mode by means of bit 0.

- 1 word: displacement speed defined in percentage of the maximum speed defined by command 61. A value of 32767 corresponds to the maximum speed.
- 1 word: TimeOut. Limited procedure time in seconds (max. 32767 s)
- or 1 word: 32 bits. Position "preset" . This value will be allocated to the index position found. Same format as the 32 bit position (see command 42). In standard, this value is 0.

Conversion
Limitation
Execution With disabled amplifier and in position mode (command 40).
Remarks When bit 0 of the first byte is set at 1, bit 3 must be = 0; this means that it is not possible to start the procedure and send a "preset" position at the same time. The parameter must be the speed and TimeOut.
During the procedure execution, the NC must always send the synchronous message and the input command message.
When the index position has been found, the motor is standing still. Bit 5 of the procedures status (command 90) remains at 1 and bit 14 is set at 1. The NC must readjust the position input command message according to the new position sent by the amplifier and leave the index research procedure (bit 1 of the first byte of command 97 = 0). Bit 5 of the procedures status is switching on to 0. The amplifier will then follow again the position input command of the NC.

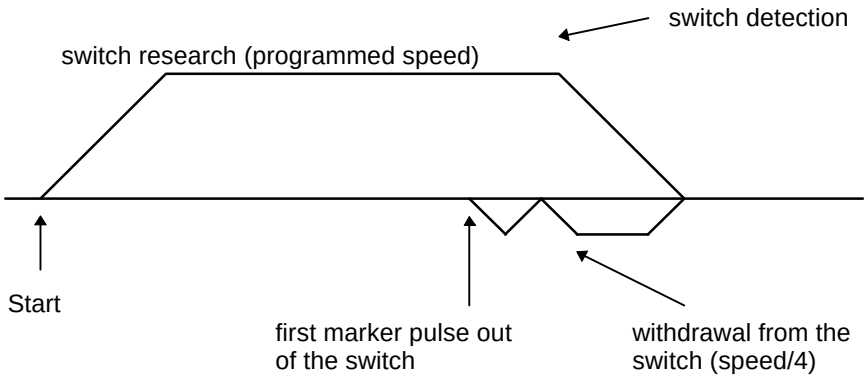
The resolver marker pulse position can be modified by the value of the encoder output marker pulse shift (command 73).

Acceleration and deceleration are firm and equal to 384 rad/s^2.

On the SMT-BD1/h amplifiers, it is not advisable to make the indexing with the single switch (without marker pulse). The detection accuracy of the switch is limited by the speed:

$\varepsilon P \leq 2.08333.10^{-6}$ Speed (speed in rpm)

Procedure diagram:



It is possibleto "force" the position counter with a value given by the value "0x01" in the command byte, that is neither switch nor marker pulse. In this special case, the amplifier does not need to be enabled.

Encoder output programmation

Command 98 (0x62)
This procedure programs the encoder output by means of the parameters defined by the commands 73 and 74.
Parameters
Conversion
Limitation Writing only.
Execution Amplifier disabled.
Remarks

Manual brake relay control

Command	99 (0x63) This command allows to enable or disable the brake.
Parameters	1 byte. = 0 disables the brake relay output (relay closed). ≠ 0 enables the brake relay output (relay open).
Conversion	
Limitation	Writing only.
Execution	
Remarks	

Cogging torque indentification procedure

Command	100 (0x64) This command triggers the motor cogging torque identification procedure.
Parameters	
Conversion	
Limitation	Writing only.
Execution	
Remarks	The CT-EMF option must be available. The motor must previously be disabled by **command 92** and uncoupled from its mechanical load. Then, start an auto-tuning procedure with a high bandwidth. The ENABLE signal must also be activated. Before executing the command, check that the motor shaft is free and that its rotation over 2 revolutions in both directions is not dangerous for the operator. For more information, see manual "BPCW options", part 1 "Cogging torque compensation".

CHAPTER 4 - MESSAGES IDENTIFIERS

1 - SYNCHRONOUS MESSAGES

Synchro messages :

m_ScG0: Identifier = 16 (010h)
m_ScG1: Identifier = 48 (030h)
m_SrG0: Identifier = 32 (020h)
m_SrG1: Identifier = 64 (040h)

Length of the message: 0 byte.

Command messages : m_Cmd

Identifier:

10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**0**	**1**	**1**	**0**	**Ad3**	**Ad2**	**Ad1**	**Ad0**

[Ad3 Ad2 Ad1 Ad0] is the amplifier address (1 to 15).

Length of the message: programmable.

Information feedback messages : m_Ret

Identifier:

10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**0**	**1**	**1**	**1**	**Ad3**	**Ad2**	**Ad1**	**Ad0**

[Ad3 Ad2 Ad1 Ad0] is the amplifier address (1 to 15).

Length of the message: programmable.

2 - ASYNCHRONOUS MESSAGES

Message m_Req :

Identifier = 160 (0A0h)

Message m_Res :

Identifier = 176 (0B0h)