



*PIONEERS IN NERVE STIMULATION AND MONITORING*

**The MAGSTIM Company Ltd**

## **200<sup>2</sup> / Bistim<sup>2</sup> Host Interface Communication Protocol**

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## 1. Introduction

The following document details how a 200<sup>2</sup>/Bistim<sup>2</sup> can be controlled remotely by the serial interface. The first few sections detail the information required to establish and maintain communications with the base, followed by a section which gives a detailed breakdown for each of the possible commands. The final section details a method to test that control has been established.

## 2. Interface

The following tables detail the hardware and software interface. Note the cable used to connect to the 200<sup>2</sup>/Bistim<sup>2</sup> should only contain the three identified connections.

### 2.1. Serial Communication

Baud Rate	9600 bps
Data	8 bits
Stop	1 bit
Parity	None
Flow Control	None

### 2.2. Connection

The stimulator will have one of two connection types. The pin details for both types are shown below.

Location	Rear of Stimulator		Rear of Stimulator
Type	9 Way D-Type (Female)		26 Way D-Type (Female)
Signal Levels	RS232		RS232
Pin Signals	TX	Pin 2 – (Output from Stimulator)	Pin 13 – (Output from Stimulator)
	RX	Pin 3 – (Input to Stimulator)	Pin 12 – (Input to Stimulator)
	GND	Pin 5	Pin 1

## 3. Protocol

Each command is made up of a variable length series of ASCII characters. Each command is made up of three elements, a unique command character, one or more data characters and one checksum character; see section 4 for more details.

To obtain and maintain control via the serial link the following criteria have to be met:

- The enable remote control command has to be accepted by the 200<sup>2</sup>/Bistim<sup>2</sup> first, before any control can take place
- Once communication is established, the 200<sup>2</sup>/Bistim<sup>2</sup> has to receive a valid command which will return a system status every ten seconds when in the standby state, and every second in the armed state. To ensure smooth operation it is best to send a valid command every 500ms.

### 3.1. Checksum (CRC) Calculation

The CRC calculation for each data packet sent or received will be determined by adding the sum of all the bytes in the packet (Except the CRC byte), truncating the value to use only the lower 8 bits if result is greater than 0xff, then bit inverting the result.

### 3.2. Padding Byte

So that all commands can be entered via a standard terminal, some of the commands contain a padding byte. The base will ignore this byte.

### 3.3. Response to Bad Commands

The base will respond to bad commands in the following ways:

- If the base receives an invalid command byte then the base will respond with a '?'.
  - If the base receives a valid command byte but faulty data then the base will respond with <CMD received>?<CRC>.
  - If the base receives a valid command with valid data but it conflicts with the current system configuration then the base will respond with <CMD received>S<CRC>.

## 4. Base Command Interface

### 4.1. Set Power A

Host Command									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	0	0	0	0	0	40	Command
N	N	N	N	N	N	N	N	NN	Power 'HUNDREDS' value ASCII format
N	N	N	N	N	N	N	N	NN	Power 'TENS' value ASCII format
N	N	N	N	N	N	N	N	NN	Power 'UNITS' value ASCII format
N	N	N	N	N	N	N	N	NN	CRC
Base Controller Response									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	0	0	0	0	0	40	Command Acknowledge
N	N	N	N	N	N	N	N	NN	Instrument Status (see section 5)
N	N	N	N	N	N	N	N	NN	CRC

Note: This command will only work if an "Enable Remote Control" command has previously been sent.

### 4.2. Set Power B (Bistim only)

Host Command									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	0	0	0	0	1	41	Command
N	N	N	N	N	N	N	N	NN	Power 'HUNDREDS' value ASCII format
N	N	N	N	N	N	N	N	NN	Power 'TENS' value ASCII format
N	N	N	N	N	N	N	N	NN	Power 'UNITS' value ASCII format
N	N	N	N	N	N	N	N	NN	CRC
Base Controller Response									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	0	0	0	0	1	41	Command Acknowledge
N	N	N	N	N	N	N	N	NN	Instrument Status (see section 5)
N	N	N	N	N	N	N	N	NN	CRC

Note: This command will only work if an "Enable Remote Control" command has previously been sent.

### 4.3. Set Pulse Interval (Bistim only)

Host Command									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	0	0	0	1	1	43	Command
N	N	N	N	N	N	N	N	NN	Millisecond 'HUNDREDS' value in low resolution mode and 'TENS' value in high resolution mode. ASCII format.
N	N	N	N	N	N	N	N	NN	Millisecond 'TENS' value in low resolution mode and 'UNITS' value in high resolution mode. ASCII format
N	N	N	N	N	N	N	N	NN	Millisecond 'UNITS' value in low resolution mode and 'TENTHS' value in high resolution mode. ASCII format
N	N	N	N	N	N	N	N	NN	CRC
Base Controller Response									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	0	0	0	1	1	43	Command Acknowledge
N	N	N	N	N	N	N	N	NN	Instrument Status (see section 5)
N	N	N	N	N	N	N	N	NN	CRC

Note: This command will only work if an "Enable Remote Control" command has previously been sent.

## 4.4. Set Base Mode

Host Command									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	0	0	1	0	1	45	Command
N	N	N	N	N	N	N	N	NN	Mode Setting Byte Format (see section 6)
N	N	N	N	N	N	N	N	NN	CRC
Base Controller Response									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	0	0	1	0	1	45	Command Acknowledge
N	N	N	N	N	N	N	N	NN	Instrument Status (see section 5)
N	N	N	N	N	N	N	N	NN	CRC

Note: With the exception of sending a “Stop Mode Request”, this command will only work if an “Enable Remote Control” command has previously been sent.

## 4.5. Enable Remote Control.

Host Command									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	1	0	0	0	1	51	Command
0	1	0	0	0	0	0	0	40	Padding Byte
0	1	1	0	1	1	1	0	6E	CRC
Base Controller Response									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	1	0	0	0	1	51	Command Acknowledge
N	N	N	N	N	N	N	N	NN	Instrument Status (see section 5)
N	N	N	N	N	N	N	N	NN	CRC

Note: This command has to be sent to the stimulator before external control of the stimulator can take place.

## 4.6. Disable Remote Control.

Host Command									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	1	0	0	1	0	52	Command
0	1	0	0	0	0	0	0	40	Padding Byte
0	1	1	0	1	1	0	1	6D	CRC
Base Controller Response									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	1	0	0	1	0	52	Command Acknowledge
N	N	N	N	N	N	N	N	NN	Instrument Status (see section 5)
N	N	N	N	N	N	N	N	NN	CRC

Note: Sending this command to the stimulator returns control of the stimulator back to the UI.

## 4.7. Enable Bistim High Resolution Time Setting Mode. (Bistim Only)

Host Command									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	1	1	0	0	1	59	Command
0	1	0	0	0	0	0	0	40	Padding Byte
0	1	1	0	0	1	1	0	66	CRC
Base Controller Response									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	1	1	0	0	1	59	Command Acknowledge
N	N	N	N	N	N	N	N	NN	Instrument Status (see section 5)
N	N	N	N	N	N	N	N	NN	CRC

Note: This command will only work if an “Enable Remote Control” command has previously been sent.

## 4.8. Disable Bistim High Resolution Time Setting Mode. (Bistim Only)

Host Command									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	1	1	0	1	0	5A	Command
0	1	0	0	0	0	0	0	40	Padding Byte
0	1	1	0	0	1	0	1	65	CRC
Base Controller Response									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	1	1	0	1	0	5A	Command Acknowledge
N	N	N	N	N	N	N	N	NN	Instrument Status (see section 5)
N	N	N	N	N	N	N	N	NN	CRC

Note: This command will only work if an “Enable Remote Control” command has previously been sent.

## 4.9. Get Current Parameter Settings

Host Command									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	0	0	1	1	1	4A	Command
0	1	0	0	0	0	0	0	40	Padding Byte
0	1	1	1	0	1	1	0	75	CRC
Base Controller Response (Standard system)									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	0	0	1	1	1	4A	Command Acknowledge
N	N	N	N	N	N	N	N	NN	Instrument Status (see section 5)
N	N	N	N	N	N	N	N	NN	Power A ‘HUNDREDS’ value ASCII format
N	N	N	N	N	N	N	N	NN	Power A ‘TENS’ value ASCII format
N	N	N	N	N	N	N	N	NN	Power A ‘UNITS’ value ASCII format
0	0	1	1	0	0	0	0	30	‘0’ value ASCII format
0	0	1	1	0	0	0	0	30	‘0’ value ASCII format
0	0	1	1	0	0	0	0	30	‘0’ value ASCII format
0	0	1	1	0	0	0	0	30	‘0’ value ASCII format
0	0	1	1	0	0	0	0	30	‘0’ value ASCII format
0	0	1	1	0	0	0	0	30	‘0’ value ASCII format
N	N	N	N	N	N	N	N	NN	CRC
Base Controller Response (BISTIM system)									Description
D7	D6	D5	D4	D3	D2	D1	D0	HEX	
0	1	0	0	0	1	1	1	4A	Command Acknowledge
N	N	N	N	N	N	N	N	NN	Instrument Status (see section 5)
N	N	N	N	N	N	N	N	NN	Power A ‘HUNDREDS’ value ASCII format
N	N	N	N	N	N	N	N	NN	Power A ‘TENS’ value ASCII format
N	N	N	N	N	N	N	N	NN	Power A ‘UNITS’ value ASCII format
N	N	N	N	N	N	N	N	NN	Power B ‘HUNDREDS’ value ASCII format
N	N	N	N	N	N	N	N	NN	Power B ‘TENS’ value ASCII format
N	N	N	N	N	N	N	N	NN	Power B ‘UNITS’ value ASCII format
N	N	N	N	N	N	N	N	NN	Millisecond ‘HUNDREDS’ value in low resolution mode and ‘TENS’ value in high resolution mode. ASCII format.
N	N	N	N	N	N	N	N	NN	Millisecond ‘TENS’ value in low resolution mode and ‘UNITS’ value in high resolution mode. ASCII format
N	N	N	N	N	N	N	N	NN	Millisecond ‘UNITS’ value in low resolution mode and ‘TENTHS’ value in high resolution mode. ASCII format
N	N	N	N	N	N	N	N	NN	CRC

## 5. Instrument Status Byte Format

The following table details the format of the status byte used by the base controller to relay current instrument status.

BIT	Description (Active state indicated when bit set to 1).
0 LSB	Standby
1	Armed
2	Ready
3	Coil present
4	Replace coil
5	Error present
6	Error type: 1 = fatal: 0 = non fatal.
7 MSB	Remote control status.

## 6. Mode Setting Byte Format

The following table details the format of the mode setting byte used by the host controller to change the status of the base controller.

BIT	Description
0 LSB	Set stimulator in Stopped mode
1	Set stimulator in Armed mode
2	Always '0'
3	Trigger stimulator
4	Always '0'
5	Always '0'
6	Always '1'
7 MSB	Always '0'

## 7. System Test Example

The following test will ensure that the system is working properly

- 7.1.1. Connect a PC to the 9 Way connector on the back of the 200<sup>2</sup>/Bistim<sup>2</sup>
- 7.1.2. Run Hyper Terminal on the PC
- 7.1.3. Power up the 200<sup>2</sup>/Bistim<sup>2</sup> and allow the unit to display 30% on the UI or remote control coil if connected
- 7.1.4. Press the ENTER key on the PC whilst having Hyper Terminal active. You should find that you get a '?' displayed on Hyper Terminal for each press of the ENTER key. If this does not happen then either the cable is faulty/incorrectly wired or the PC has not been setup correctly
- 7.1.5. Once the above step is working, type in the string 'Q@n'. Wait for a response, then type in the string '@050\*'. The power should now change on the UI display or remote control coil if connected

### 7.2. Example of CRC Calculation

	Hexadecimal Notation	ASCII Character
Command	40	@
Data	30	0
Data	35	5
Data	30	0
CRC	40+30+35+30=D5 One's Complement of D5=2A	*