BSL STIMULATORS

Modular Stimulators (0-100 V):
BSLSTMB for MP36/36R/35
BSLSTMA for MP30/35/36/36R

Low Voltage Stimulator/Adapter:
OUT3 Output Adapter for built-in Stimulator (MP36 only)
SS58L Low Voltage Stimulator (MP35 only)

See also: **HSTM01**, **ELSTM1**, **ELSTM2**, **EL300S** and **EL400** electrodes.

BSLSTMB

BSLSTMA

Lab set up note
Placing the BSLSTMA/B unit too close to MP3X hardware can result in data distortion of the BSLSTMA/B pulse width signal; the distortion is more apparent at higher sampling rates.

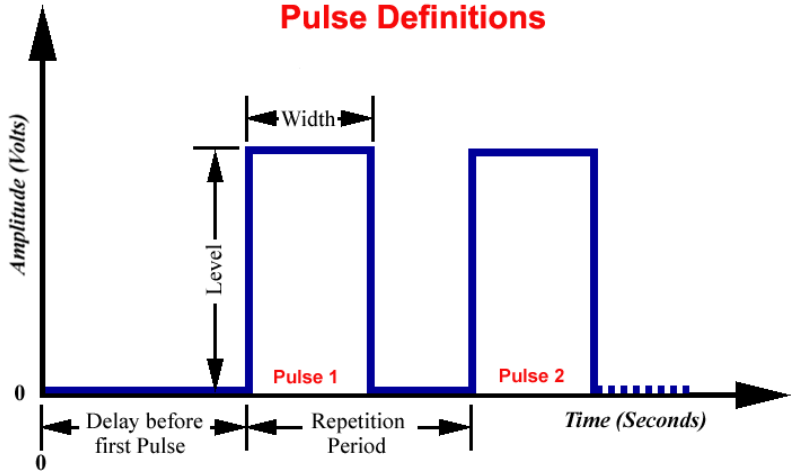
- NEVER set the BSLSTMA/B atop an MP3X
- Position the BSLSTMA/B away from the MP3X to reduce the signal distortion

Note The older "BSLSTM" uses dial reading and a flip range switch. The same guidelines and cautions described here apply, except when noted.

The BSLSTM Stimulator works in conjunction with the Biopac Student Lab System to allow precise stimulus pulse outputting. Use the BSLSTM and the BSL *PRO* to perform a wide array of measurements, such as:

- Twitch sub-threshold & threshold
- Maximum twitch responses
- Single twitch, summation
- Muscle tension/length vs. force
- Tetanic contraction
- Nerve conduction
- Fatigue
- Velocity

STIMULATOR PULSE DEFINITIONS



Pulse width — The time that the pulse is in the non-zero or active state.

Delay before first pulse — The initial delay from the start of acquisition to the start of the first pulse.

Repetition period — The time between pulses, as measured from the start of one pulse to the start of the next pulse. This is the inverse of the Pulse rate.

Pulse rate — The number of pulses that occur in a one-second interval, expressed in Hz.
The **Pulse rate** relates to the **Pulse period** as follows:

Also called —
Pulse frequency
Repetition rate
Events per second

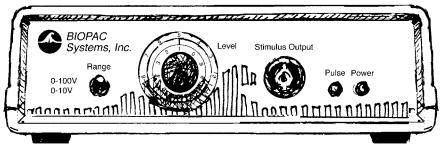
Pulse rate (Hz) = 1000 / Repetition period (milliseconds)

Pulse Repetition	Use when referring to either Pulse rate or Pulse period.
Pulse level	The amplitude of the pulse, expressed in Volts. The output of the BSLSTM is 0 Volts when the pulse is not active.
Number of pulses	The number of successive pulses that will be sent out at the selected Pulse Width, Pulse Rate, or Pulse Period, and Pulse Level.

FRONT PANEL TERMINOLOGY

BSLSTMA/B — Digital Display & Keyed Switch

BSLSTM — Dial Reading & Flip Switch



Range control

Establishes the stimulus pulse output level range in Volts (0-10 Volts or 0-100 Volts).

BSLSTMA/B key control: Turn right to select a range of 0-10 Volts.
Turn left to select a range of 0-100 Volts.
Remove the key for added safety and control.

BSLSTM switch control: Flip down to select a range of 0-10 Volts.
Flip up to select a range of 0-100 Volts.

- If the **Range** is changed before recording begins, the **Preset** must also be changed (under the "Setup channels" option of the **MP3X** menu) in order to maintain direct Level recordings.
- If the **Range** is changed during recording, the user should manually enter a software marker to note the change (by holding down F9 on a PC or Esc key on a Mac). The pulse Level could then be determined by (mentally) moving the decimal place to the right or left, depending on how the **Range** was changed.

Reference

BSLSTMA/B only: Refers to the pulse width of the signal on the Reference Output (on the back panel).

- **Actual** reflects the actual output width.
- **Fixed (15 ms)** establishes a pulse width of 15 ms, regardless of the actual pulse width.

The Reference control only affects the pulse width; in either case, the pulse level reflects the actual output level.

Level

Level is used in conjunction with **Range** to set the stimulus pulse output level.

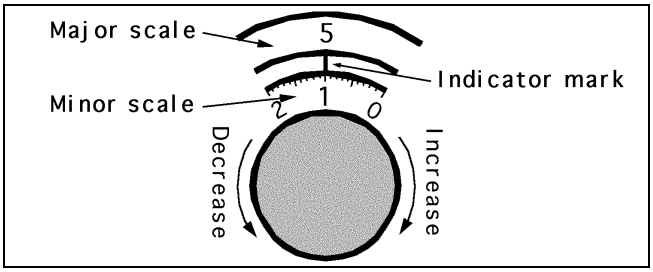
BSLSTMA/B digital display: Turn the Level control (right to increase, left to decrease) to establish the desired Level, as indicated on the digital display.

BSLSTM knob dial: The **Level** knob has a "Major scale" and a "Minor scale" which indicate the voltage level as shown below:

Range switch	**Major scale**	**Minor scale**
0-10 V	Volts	Volt / 10
0-100 V	Volts x 10	Volts

Turning the **Level** knob clockwise increases the voltage level, and turning it counterclockwise decreases the voltage. In the following close-up of the **Level** knob, the level reads 5.1 Volts (Range 0-10 V) or 51 Volts (Range 0-100 V).

As shown in the following diagram, the indicator mark is between the two dials.



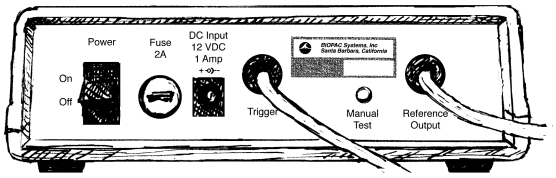
Close-up of "Level" adjustment knob

Stimulus output — Stimulus pulse output for connection to external electrodes or other devices. This is a standard BNC style connector.

Pulse indicator — LED flashes when the stimulus pulse is active: BSLSTMA/B = red. BSLSTM = green.

Power indicator — Activated when the DC adapter is plugged in and the power switch on the back panel is turned ON.
BSLSTMA/B: The LCD display is activated.
BSLSTM: LED indicator lights green

BACK PANEL TERMINOLOGY



Power switch — Rocker switch for turning the BSLSTM power ON and OFF.

Fuse holder — If the fuse blows and must be replaced, use a screwdriver to open (counterclockwise) and close (clockwise) the fuse cap.

DC Input — Socket for BIOPAC DC adapter.

Trigger cable — Connects to the Analog Out connector on the back of the MP3X acquisition unit. The MP3X sends the Pulse width and Pulse rate information via this cable.

Manual Test button — Used to diagnose problems with the BSLSTM stimulator unit.

When the **Trigger** and **Reference Output** cables are **disconnected** from the MP3X , the **Manual Test** button can be used to initiate a stimulus with a fixed pulse width of 2.5 milliseconds.

Reference Output Cable — The stimulus marker output is labeled **Reference Output** on the back panel of the BSLSTM. This output cable connects to any of the four channel inputs (CH1, CH 2, CH 3, or CH 4) on the front of the MP3X acquisition unit. The output cable carries the stimulator marker pulse to the MP3X. The marker pulse has a fixed pulse width 15 ms and is generated each time the stimulator generates a pulse.

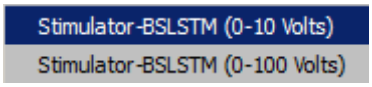
- BSLSTMA/B: Use the front panel Reference switch to select Actual or Fixed.
- BSLSTM has a fixed pulse width of 15 ms, selected so that the MP30 can capture the pulse with a sample rate as low as 100 samples per second.

If the BSL *PRO* software has been setup correctly, the amplitude of this marker will reflect the **Level** knob setting on the BSLSTM. See the **Range switch** section for information on how this reading can be affected.

Calibration

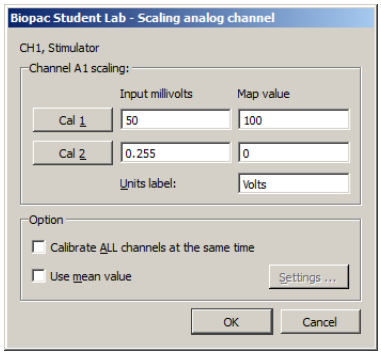
The "Reference Output" signal from the BSLSTM must be calibrated to ensure accurate results.

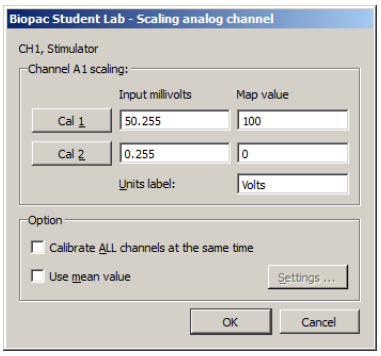
1. Choose the correct **Preset** (via MP3X menu > Set Up Data Acquisition > Channels).



   - For example, if using the BSLSTMA/B, (this Preset found in older BSL 3.7.x software only) don't choose a "BSLSTM..." Preset.
   - Also, make sure the Preset matches the Voltage Range that will be used (0-10 V, or 0-100 V).

2. With stimulator connected and ON, turn the **Level** control counter-clockwise until the display reads 0 (or as close to 0 as possible).
3. Get into the **Scaling** window for the Reference Output channel (via MP3X menu > Set Up Data Acquisition > Channels > Setup... > Scaling ...).
4. Press the **Cal 2** button to obtain the signal representing 0 V out of the stimulator.





5. **Add** the Input value found in Cal 2 to the Input Value displayed for Cal 1.
   - For example, if "Cal 2" is pressed and provides an Input Value of .255 V, add the number .255 V to the existing 50 V and manually enter the total value of 50.255 V for Cal 1 Input Value.
   - *Note*: Even if the Cal 2 Input Value is negative, it must still be "added" to the number for Cal 1 (which essentially subtracts it) to arrive at the proper value.
6. Click **OK** to close out of the Scaling window and then close out of the Setup Channel window. The system is now ready to record.
7. *Optional*: Save the setup as a Graph Template to save these new scale settings. As long as neither the MP3X nor stimulator changes, the calibration should not need to be repeated.

NOTE: In earlier versions of BSL software (3.7.x) the Cal 1 and Cal 2 fields are **reversed** in the Scaling dialog. To calibrate using this older software, reverse the above instructions for Cal 1 and Cal 2.

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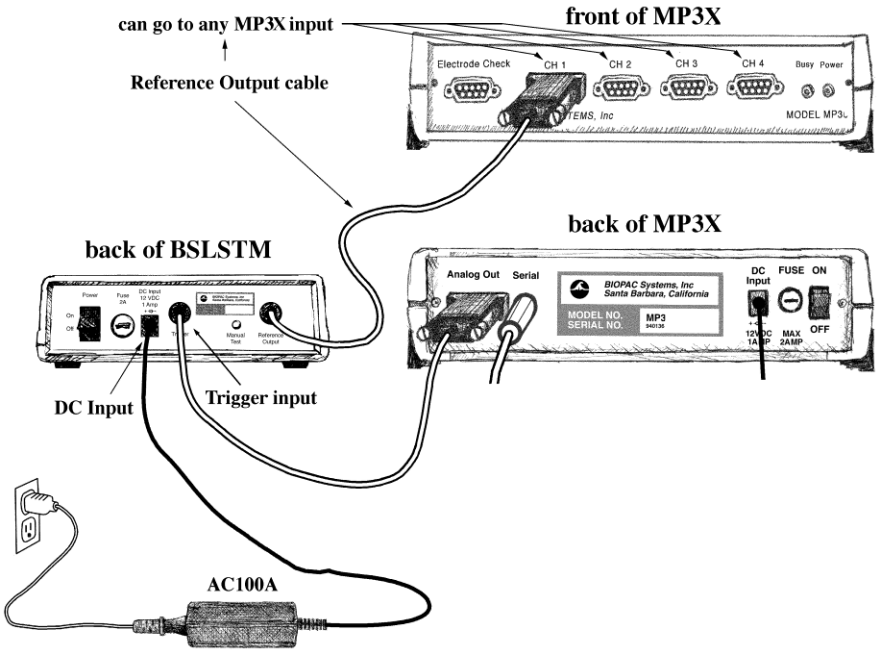
CONNECTING THE BSLSTM TO THE MP3X

1) Turn the **MP3X** unit **OFF**.
2) Confirm that **Power** switch on the back of the **BSLSTM** is in the **OFF** position.
3) Set the **Range** on the front of the **BSLSTM** to **0-10 V**.
4) Set the **Level** to 1 Volt.
   - BSLSTM: 1 Volt is set when the Major Scale (top number) is 1 and the Minor Scale (lower number) is 0.
5) Plug the **Trigger** cable (female DB9 connector) from the back of the **BSLSTM** into the **Analog Out** port (DB9 Male connector) on the back of the **MP3X**.



6) Plug the **Reference Output** cable (Male DB9 connector) from the back of the **BSLSTM** into an open channel input port (DB9 female connectors: CH 1, CH 2, CH 3, or CH 4) on the front of the **MP3X**.
7) Plug the 12 Volt **DC adapter** into the wall.
8) Mate the **DC output** connector on the end of the adapter cable to the **DC Input** socket on the back of the **BSLSTM**.
   - Make sure the connector is pressed in completely.
9) Plug the stimulator electrode assembly into the BNC connector on the front of the stimulator, labeled Output on the BSLSTMA/B and Stimulus Output on the BSLSTM.
10) Place the BSLSTMA/B unit away from the MP3X. Placing the BSLSTMA/B too close to MP3X hardware can result in data distortion of the BSLSTMA/B pulse width signal; the distortion is more apparent at higher sampling rates.
    - NEVER set the BSLSTMA/B atop an MP3X.
    - Position the BSLSTMA/B away from the MP3X to reduce the signal distortion.

BSLSTMA/B SPECIFICATIONS (This new unit has digital display and a keyed range switch)

Pulse width

Controlled by:	Computer, with lockable width limit
Range:	0.49 – 100 milliseconds
Resolution:	2 microseconds
Accuracy:	5% (Can be improved to better than 2% using the "Correction factor" in the "Stimulator Preferences' window.)
Correction factor	Range: 0 - 150 microseconds Average value: 60 microseconds

Pulse Repetition

Controlled by:	Computer-based software (BSL or Acq*Knowledge*)
Pattern:	Selectable (1-254 pulses) or continuous
Ranges—No Load:	5 seconds - .499 milliseconds Period (.2 - 3,333 Hz Rate)
Ranges—Load:	2 K Ohm load

0 - 10 Volt Range: 5 seconds to the following minimum repetition period:

100 ms P.W.	300 ms
10 ms P.W.	30 ms
1 ms P.W.	3 ms

0 - 100 Volt Range: 5 seconds to the following minimum repetition period:

100 ms P.W.	100 Volts:	1 second
	50 Volts:	300 ms
10 ms P.W.	100 Volts:	400 ms
	50 Volts:	30 ms
1 ms P.W.	100 Volts:	4 ms
	50 Volts:	3 ms

Limits:	User adjustable lower and upper rate limits
Resolution:	2 microseconds
Accuracy:	Better than 2%

Initial Pulse Delay

Time range:	Off or .5 - 100 milliseconds (software controlled)
Resolution:	2 microseconds

Pulse level

Control:	Manual (10 turn potentiometer)
Range (selectable with *Key Switch*):	*Range 1*: .025 - 10 Volts *Range 2*: .12 - 100 Volts Infinite (potentiometer adjustable) range
Current Output:	1 ms pulse: 500 ma 100 µs pulse: 1000 ma
Accuracy:	5% accuracy to digital readout

Reference Output

Correlates to actual pulse output (Requires Calibration)

Pulse width:	Fixed (15 millisecond) or Direct (follows actual pulse output)
Amplitude:	0 - 50 mV correlates to 0 – 10 V actual output or 0 – 100 V actual output.

Manual Test Pulse

(Button on back panel)
Note: Will only function when "Trigger" cable is <u>not</u> connected to the MP3X.

Pulse Width: 1 millisecond

Stimulator isolation

Volts:	2,000 Volts DC (HI POT test)
Capacitance coupling:	60 pF

Power requirements

12 Volts DC adapter (included), 1 Amp

Fuse

250 V, 2 A, fast blow

Fuse Dimensions: 1.25" length × .25" diameter

Module Weight

610 grams

Module Dimensions

16 cm x 16 cm x 5 cm

BSLSTM SPECIFICATIONS

(This older unit uses dial reading and a flip range switch)

Pulse width

Controlled by:	Computer, with lockable width limit
Range:	50 microseconds – 100 milliseconds
Resolution:	2 microseconds
Accuracy:	5% (Can be improved to better than 2% using the “Correction factor” in the “Stimulator Preferences’ window.)
Correction factor	Range: 0 - 150 microseconds Average value: 110 microseconds

Pulse Repetition

Controlled by:	Computer-based software
Pattern:	Selectable (1-254 pulses) or continuous
Range—No Load:	5 seconds - .3 milliseconds Period (.2 - 3,333 Hz Rate)
Range—Load:	2 K Ohm load

0 - 10 Volt Range: 5 seconds to the following minimum repetition period:

100 ms P.W.	150 ms
10 ms P.W.	10.1 ms
1 ms P.W.	1.1 ms

0 - 100 Volt Range: 5 seconds to the following minimum repetition period:

100 ms P.W.	100 Volts:	beyond functional limits
	50 Volts:	250 ms
10 ms P.W.	100 Volts:	200 ms
	50 Volts:	150 ms
1 ms P.W.	100 Volts:	20 ms
	50 Volts:	2.5 ms

Limits:	User adjustable lower and upper rate limits
Resolution:	2 microseconds
Accuracy:	Better than 2%

Initial Pulse Delay

Time range:	None or .5 - 100 milliseconds
Resolution:	2 microseconds

Pulse level

Controlled by:	Manually (10 turn potentiometer)
Range (switchable):	*Range 1*: .025 - 10 Volts *Range 2*: .15 - 100 Volts Infinite (potentiometer adjustable) range
Accuracy:	5% accuracy to dial indicator

Reference Output

Correlates to actual pulse output (Requires Calibration)

Pulse width:	15 millisecond fixed pulse width
Amplitude:	0 - 10 mV correlates to 0 – 10 V actual output or 0 – 100 V actual output

Manual Test Pulse

(Button on back panel)
Note: Will only function when “Trigger” cable is <u>not</u> connected to the MP3X.

Pulse Width:	2.5 - 3 milliseconds

Stimulator isolation

Volts:	2,000 Volts DC (HI POT test)

Capacitance coupling:

60 pF

Power requirements

12 Volts DC adapter (included), 1 Amp

Fuse

250 V, 2 A, fast blow

Dimensions:	1.25” length × .25” diameter

Module Weight

610 grams

Module Dimensions

16 cm x 16 cm x 5 cm

LOW VOLTAGE STIMULATOR

OUT3

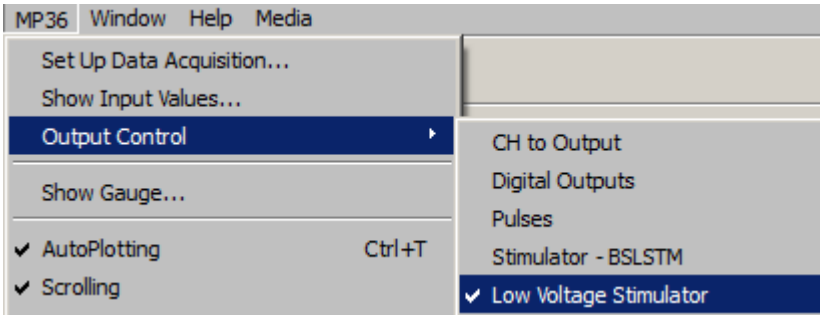
The **MP36** includes a built-in low voltage stimulator—just use the Analog Out port.

- For connection to BIOPAC electrodes, add the **OUT3 BNC Adapter.**

SS58L

The **MP35** uses the **SS58L Low Voltage Stimulator** to the Analog Out port.

Connect any electrode or lead with a BNC connector (such as needle electrodes or clip leads) for direct stimulation of animal or tissue preps. Control the stimulus with the Output Control option of the BSL *PRO* software. Output can be monitored directly on the computer without any external cable.



Interface options:	Nerve chambers — use BSLCBL3A or BSLCBL4B
	Stimulation electrodes — use ELSTM2
	Clip leads — use BSLCBL7, BSLCBL11, or BSLCBL12
Pulse level:	-10 V to + 10 V, software adjustable in 5 mV increments
Pulse width:	0.05-100 milliseconds
Pulse repetition:	5 seconds-0.1 millisecond (0.2-10,000 Hz)
Power:	No additional power required

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STIMULATOR ELECTRODE GUIDELINES

— *PLEASE READ* —

It is very important to follow the electrode placement guidelines when connecting stimulator electrodes from the BSLSTM to a subject.

The BSLSTM can output lethal levels of energy!

- Always set the **Level** to "0" Volts prior to connecting the stimulator electrodes to the subject.
- Increase the **Level** adjustment slowly until a response is noted.
- Never increase the **Level** more than necessary to obtain the desired response.
- The **BSLSTM** should only be used under direct supervision of an Instructor.
- Never place any stimulator leads in the mouth or any other body orifice.
- To prevent a "Ground loop," the **Ground** of the stimulator electrode and the **Ground** of the measuring electrode(s) must always be connected to the same location.
- Use the **HSTM01 Human Stimulation Electrode** for human stimulation.
- To prevent a current path that goes across or through the heart, the stimulator electrodes and the measuring electrodes should always be in close proximity.

  For example, if making measurements on an arm, the stimulator electrodes and measuring electrodes — including the ground electrodes — must be on the same arm. Any other electrodes or transducers that make electrical contact with the body should not be connected while the stimulator is connected.