

STMISO STIMULUS ISOLATION ADAPTERS

See also: Stimulator Setup notes in AcqKnowledge Software Guide

BIOPAC offers three stimulus isolation adapters:

- STMISOC** constant current or constant voltage (5X / 10X) stimulation
- STMISOD** multiplies STM100C voltage by 5
- STMISOE** multiplies STM100C voltage by 10

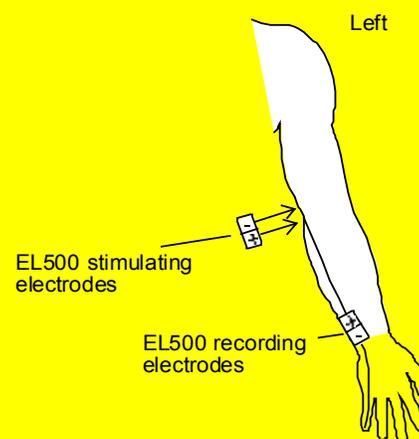
IMPORTANT SAFETY NOTES!

When using the STMISOC, STMISOD, or STMISOE, it is possible to generate voltages as high as 200 v p-p. These voltages are potentially dangerous, especially if the stimulator's high voltage outputs are connected across the subject's heart. Across the heart means that the heart is potentially in the electrical path from lead to lead. This situation occurs when the stimulation electrodes are placed on opposite sides of the subject's body.

NEVER PLACE STIMULATION ELECTRODES ON OPPOSITE SIDES OF THE SUBJECT'S BODY!

Always use the stimulator with the leads placed in relatively close proximity to each other and relatively far from the heart, and with the leads placed only on the **SAME** side of the body. The figure to the right illustrates correct connection techniques when using the STMISOC/D/E.

Example of correct stimulation electrode placement:



STMISO SAFETY

The harmonized, international regulatory standard relating to the safety of nerve and muscle stimulators is **IEC 60601-2-10:2015**. Certain stimulation equipment is excluded from this standard, such as stimulators intended for cardiac defibrillation; however, for the purposes of defining relevant safety metrics for STMISOC, STMISOD, or STMISOE stimulation units, this standard is quite relevant.

STMISOC, STMISOD, and STMISOE stimulation units are designed in such a manner that the power available to stimulate the subject is limited. This limitation of power is achieved through the use of stimulus isolation transformers which have physical constraints (due to their size and construction) which absolutely—in accordance to known physical laws—constrain the maximum transferable power to be no more than a specific level.

The IEC 60601-2-10:2015 standard clearly specifies the **limitation of output power** for a variety of wave types.

- * For stimulus pulse outputs, the maximum energy per pulse shall not exceed 300mJ, when applied to a load resistance of 500 ohms,
- * For stimulus pulse outputs, the maximum output voltage shall not exceed a peak value of 500 V, when measured under open circuit conditions.

STMISOC, STMISOD, and STMISOE units employ stimulus isolation transformers that limit the output pulse width to 2 ms maximum, under 500 ohm load conditions. In addition, the highest available output voltage is 200 V pk-pk (STMISOC or STMISOE) under open circuit conditions.

For the pulse energy calculation for STMISOC and STMISOE:

Joules = Watts x Seconds

Watts (instantaneous maximum) = $(200 \text{ V} \times 200 \text{ V}) / 500 \text{ ohms} = 80$

Joules = $80 \text{ W} \times 0.002 \text{ seconds} = 0.16 \text{ Joules} = 160 \text{ mJ}$

Accordingly, the highest possible energy output using the STMISOC or STMISOE is **160 mJ**.

The remaining stimulus isolation unit, STMISOD, has a maximum voltage output of 100 V. In this case, the maximum energy output is:

Watts (instantaneous maximum) = $(100 \text{ V} \times 100 \text{ V}) / 500 \text{ ohms} = 20$

Joules = $20 \text{ W} \times 0.002 \text{ seconds} = 0.04 \text{ Joules} = 40 \text{ mJ}$

In all cases the maximum available energy, from the STMISO series stimulus isolation units, is limited to be considerably **less than the 300 mJ maximum** as specified by IEC 60601-2-10:2015.

CAUTIONS FOR USE!

Even the safest stimulation units, if used incorrectly, can cause serious harm. The following points illustrate fundamental rules for using stimulus isolation units to stimulate subjects.

1) **NEVER APPLY THE STIMULUS SIGNAL IN SUCH A MANNER AS TO CAUSE CURRENT TO FLOW THROUGH THE HEART.**

Primarily considered, this rule implies that stimulation leads should never be split apart so as to be able to touch opposing sides of the body surrounding the heart.

For example: NEVER CONNECT THE STIMULUS ISOLATION UNIT SO THAT ONE LEAD TOUCHES THE LEFT ARM AND THE OTHER LEAD TOUCHES THE RIGHT ARM.

Both stimulus leads [(+) and (-)], should be applied to the SAME side (left or right) of the subject's body. Furthermore, always stimulate AWAY from the heart. Stimulation probes (such as BIOPAC's EL350 or the EL351), which constrain the distance from the positive stimulation output to the negative stimulation output, should always be used for skin surface stimulation of nerve or muscle.

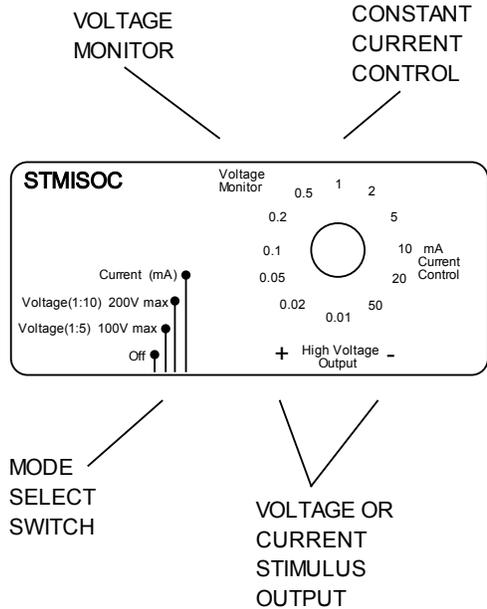
The EL350 or the EL351 stimulation probes fix the distance between stimulation outputs to 35mm. It is not recommended that this distance be increased for skin surface stimulation of nerve or muscle. An increase in this distance simply allows stimulation currents to circulate over a larger area, which is usually not necessary for nerve or muscle stimulation scenarios.

2) **Always start the stimulation process with the stimulator control set the LOWEST possible level.** The control for the STMISO series stimulus isolation units is located on the STM100C stimulation module. Set the control knob to the 0% level, prior to the onset of the stimulation protocol. During the protocol, increase the stimulus intensity by SLOWLY turning the control knob towards the 100% level. Stop increasing the intensity at the first sign of subject discomfort.

IMPORTANT NOTES!

- A) It takes as little as **15 micro-amps** directed across the heart to instigate ventricular fibrillation. This situation can be readily achieved by using sub-surface stimulation needle electrodes that insert directly into the heart. It is considerably more difficult to achieve ventricular fibrillation on the same heart using surface electrodes, but it is possible to do so, evidenced by the performance of cardiac defibrillation units used in hospitals or by paramedics.
- B) **Qualified experienced professionals** should supervise any protocols where electrical stimulation is applied to human subjects. Electrical stimulation protocols are not simple. Please contact BIOPAC Systems for any questions regarding the use of BIOPAC's stimulation units or accessories.

STMISOC CONSTANT VOLTAGE OR CONSTANT CURRENT STIMULUS ISOLATION ADAPTER



To use the STMISOC, an MP System with (minimally) one STM100C Stimulator module is required.

Plug the STMISOC directly into the EXT STIM jack on the STM100C module.

Use two LEAD110 electrode leads to connect the stimulus output to the subject. The LEAD110 electrode leads are required because they have the proper plug type for the new safety lead standard used on the STMISOC module. (1.6 mm pin connectors)

In the Voltage mode, the STMISOC can be used with bipolar stimulation and with different waveform types (square, sine, triangle).

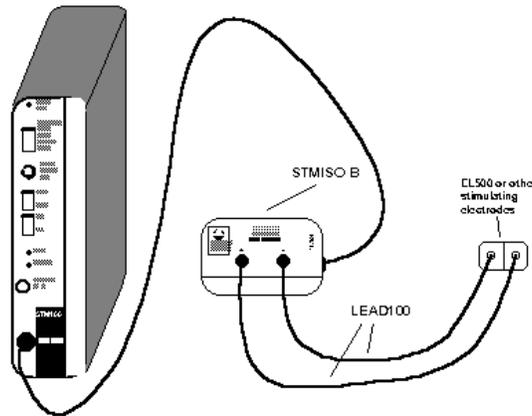
See also: **Safety Notes**

STMISOC Mode	Signal output if LEVEL control is set to 100%
OFF	No signal will be output from the STMISOC.
Voltage (1:5) 100 V Max	Signal output will be 5x the values shown in the Stimulator Setup dialog (acts like a STMISOD).
Voltage (1:10) 200 V Max	Signal output will be 10x the values shown in the Stimulator Setup dialog (acts like a STMISOE).
Current	<p>Signal output will be positive constant current output; set signal value with the Current Control rotary switch.</p> <p>It's important to output positive pulses only. Pulses should have a height of at least 10 V because pulse height output determines the voltage compliance of the current stimulation signal. The compliance of the current stimulation signal is determined by multiplying the pulse voltage amplitude by 10. For a 10 V pulse, the compliance would be 100 V. This means that the STMISOC can output a current of up to 100 V/R load. If R load = 5 k ohms, in this case the maximum output current would be 100 V/5 k = 20 ma. The maximum pulse height can be as much as 20 V, so it's possible to have a compliance as high as 200 V.</p>

STMISOC SPECIFICATIONS

Stimulus Pulse Width:	50 µsec to 2 msec (voltage and current)
Stimulus Sine Wave Range:	100 Hz to 5kHz (voltage only)
Step Up Voltage Ratio:	Selectable: (1:5) or (1:10)
Maximum Output Voltage:	(1:5) mode 100 V (p-p); (1:10) mode 200 V (p-p) into 5 k ± load
Constant Current Range:	0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0, 5.0, 10.0, 20.0, 50.0 ma (unipolar only)
Current Source Compliance:	200 V maximum
Current stimulation mode:	Positive current only
Isolation Capacitance:	150 pf
Isolation Voltage:	1500 VDC (from amplifier ground)
Cable Length:	1.8 meters
Weight:	190 grams
Dimensions:	10 cm (wide) x 5 cm (deep) x 4.5 cm (high)
Interface:	STM100C
Off mode:	Turns off Voltage or Current stimulation to subject.
Voltage Monitor output:	
Output via	3.5 mm mono phono jack
(1:5) mode	1:10 of stimulation voltage
(1:10) mode	1:20 of stimulation voltage
Current mode	disabled
OFF Reports	a signal of approximately 50% of the voltage indicated in the stimulator setup window

STMISOD (5X VOLTAGE)
STMISOE (10X VOLTAGE)



See Safety Notes

STMISOD/E setup for EL500 electrodes

The STMISOD/E plugs into the STM100C external stimulus output to provide an isolated voltage stimulus for response studies requiring a voltage stimulus (nerve conduction, somatosensory, etc.).

STMISOD adapter boosts the voltage of the STM100C by a multiple of **5x** to provide a stimulus of up to ± 50 V (or 100 V pk-pk).

STMISOE adapter boosts the voltage of the STM100C by a multiple of **10x** to provide a stimulus of up to ± 100 V (or 200 V pk-pk).

The front of the STMISOD/E has two 1.6 mm pin plugs that accept any of BIOPAC’s “safe lead” electrode leads, including bar electrodes, needle electrodes, and reusable electrodes.

The STMISOD/E has 1.6 mm “safe lead” pin plug outputs to accept most needle or stimulating electrodes. For voltage stimulus applications, the EL500 bar electrode or the EL500 electrodes with two of the LEAD110 electrode leads are recommended.

The STMISOD/E comes with an attached 2-meter cable that has a 1/4” phone plug on the end that connects to the EXT STIM output on the STM100C.

STMISOD/E CALIBRATION

To use the STMISOD/E, simply set up the stimulator in the software, and hook the STMISOD/E adapter as shown in the previous figure. Then, hook the stimulating electrodes of the choice to the two 1.6 mm “safe lead” pin plugs.

The STMISOD/E provides an additional barrier of galvanic isolation between the MP160/150 and the stimulating electrodes. When using the STMISOD/E to create a pulsed voltage stimulus output, the pulse width must be between 50 μ sec and 2 msec.

If the pulse is narrower than 10 μ sec, the STMISOD/E will not reproduce the pulse well, due to rise-time constraints.

If the pulse is greater than 2 msec, the pulse output will sag due to lower frequency response limits. The pulse may sag before 2 msec, depending on load and drive levels.

When using the STMISOD/E for voltage stimulus applications, turn the level control to 0% on the STM100C, then, after stimulation has begun, turn the level control up slowly. This approach will help to determine the appropriate voltage level for stimulating the subject.

STMISOD/E SPECIFICATIONS

Stimulus Pulse Width:	50 μ sec to 2 msec (voltage only)
Stimulus Sine Wave Range:	100 Hz to 5 kHz (voltage only)
Step Up Voltage Ratio:	STMISOD (1:5) STMISOE (1:10)
Maximum Output Voltage:	STMISOD 100 V (p-p) into 5 k ohm load STMISOE 200 V (p-p) into 5 k ohm load
Isolation Capacitance:	120 pf
Isolation Voltage:	1500 VDC (from amplifier ground)
Cable Length:	1.8 meters
Weight:	140 grams
Dimensions (WxDxH):	6.5 cm x 5 cm x 4.8 cm
Interface:	STM100C