

## STMISOL: Linear Isolated Stimulator

The STMISOL Constant Current and Constant Voltage Stimulator will connect to any analog output signal drive ( $\pm 10$  V input) and has two functional modes:



- **Voltage and current stimulator (unipolar or bipolar)**—the STMISOL connects directly to the STM100C (50  $\Omega$  output port) or the UIM100C Analog Output (A0 or A1 port) associated with the MP1X0 system.
- **Linear stimulator**—the STMISOL can be used to generate stimulation signals that can have arbitrary waveshape. Typically, stimulators can only generate simple unipolar or bipolar pulses. The STMISOL, however, can output unipolar or bipolar **arbitrary** waves such as pulse (single or train), square, sine, triangle, exponentially decaying, modulated envelopes and fully user-specified signal types.

The STMISOL can output either voltage or current waveforms.

- **Voltage (V) mode**—the STMISOL multiplies the Control Input Voltage by a factor of 20, to present that amplified signal at the STMISOL output.
  - In the case of a maximum  $\pm 10$  V input control signal, the STMISOL will output a  $\pm 200$  V signal, with a current compliance of  $\pm 100$  ma.
- **Current (I) mode**—the STMISOL will multiplies the control voltage by a factor of (10 ma/V) to present that associated output current at the STMISOL output.
  - In the case of a maximum  $\pm 10$  V Control Input Voltage, the STMISOL will output a  $\pm 100$  ma current signal, with a voltage compliance of  $\pm 200$  V.

**Isolation characteristics**—The STMISOL isolates the Control Input Voltage from the stimulus output to 1500 VDC HiPot and approximately 90 pF of coupling capacitance.

This *very high degree of input/output isolation* helps ensure subject safety and helps to substantially reduce, or eliminate, stimulus artifact.

Stimulus artifact results when some percentage of electrical current from the stimulation site is directed to the recording site due to electrical leakage paths intrinsic to the stimulation/recording equipment. In the case of the STMISOL, the leakage conductances and capacitances that permit this artifact to occur are reduced to extremely small values.

### OPERATING DETAILS

**→ Review Important Notes and Safety Notes before operating the STMISOL**

#### Important Notes

- In Current (I) Mode stimulation, if the output has a load (typically high impedance) that induces railing for the specific output current, then the STMISOL will immediately go into “Protect” mode. In the case of an unloaded output, this state will happen as soon as the STMISOL is placed into Current (I) Mode stimulation. This happens because an “unloaded” STMISOL output simply means that an arbitrarily high resistance load is attached to the STMISOL. To correctly operate in Current (I) Mode stimulation, the proper load must be placed between stimulation electrodes and then “Reset” pushbutton must be pressed to 3 seconds to activate the unit.
- In either stimulation mode (V or I), the output level (OL) will directly be a function of the applied Control Input Voltage (CIV). The conversion ratios are as follows:
  - Voltage (V) Mode:  $CIV \text{ (volts)} * 20 \text{ (volts/volts)} = OL \text{ (volts)}$
  - Current (I) Mode:  $CIV \text{ (volts)} * 10 \text{ (ma/volts)} = OL \text{ (ma)}$
- In order to be sensitive to output waveform presence, the output waveform indicator—**red** LED just above BNC output connector —will glow very slightly. Waveform output indication can be observed as an increasing intensity of this red LED. This output waveform indicator is designed to provide a visual indication of output, even if the wave duration is extremely short, so it may be possible that this indicator shows a waveform output for some brief period of time after the output wave has already passed.

#### Safety Notes

- Never place the stimulation electrodes so that it’s possible for stimulation current to pass through the subject’s heart. This can happen if electrodes are placed so that the leads “straddle” to the left and right sides of the subject’s body. Place the stimulation electrodes close together on the **SAME** (left or right) side of the subject’s body appendage. Only place stimulation electrodes so they are on the appendage of interest. For example, for left leg stimulation, only place stimulation electrodes on the left leg and on **NO** other location on the body.
- Do not power ON or OFF the STMISOL unit while electrodes attached to the subject. Always be sure to place the STMISOL in **VOLTAGE** mode, with zero volts applied to input, before attaching/removing electrodes to/from the subject. Zero volts is automatically applied to the STMISOL input if the STMISOL input cable is unplugged from any signal source.

**Safety Notes *continued***

3. It is ideal to use the STM100C for stimulation control, because it permits manual control of the stimulation level. To use the STM100C:
  - Plug the Control Input Voltage line for the STMISOL into the 50 ohm output of the STM100C.
  - Before stimulation begins, turn the Output Level Control knob to 0%.
  - Initiate stimulation in the *AcqKnowledge* software (see Application Note AH162).
  - After stimulation is initiated, slowly turn the STM100C Output Level Control to the desired level.
  - When the stimulation session is ended, turn the STM100C Output Level Control back to 0%.
4. Do not remove electrodes while in current (I) mode; it's possible for subjects to receive a shock if they remove electrodes while the STMISOL is in current (I) mode because the STMISOL responds to the impedance increase and causes the current source to swing to a positive or negative rail.

**Operating Procedure****→ Review Important Notes and Safety Notes before operating the STMISOL**

1. Plug AC100A into back of STMISOL unit.
2. Connect Control Input (3.5 mm male phono plug) to output: UIM100C (Analog Out 0 or 1) or STM100C (50 ohms).
3. **Before powering ON the STMISOL** (turning from OFF to ON), make sure that stimulation electrodes are not attached to the subject.
4. Power ON STMISOL.
  - Note that "Protect" red LED on front panel is ON, when STMISOL is powered ON.
5. Set "Output Mode" switch to **V** for Voltage stimulation.
6. Press "Reset" pushbutton switch for 3 seconds to enable STMISOL.
7. Make sure that STMISOL input voltage is Zero volts.
8. Connect electrodes to subject and then to STMISOL output.
9. Place STMISOL in Current (I) mode, if desired.
  - Note that if output is unloaded and if STMISOL is in Current (I) Mode, then the "Protect" light will stay ON, thus activating shutdown protection (see Important Note A).
10. Send Control Voltage (STMISOL input) to affect desired wave output (see *AcqKnowledge* Software Guide or BIOPAC Application Notes AH162 and AS200).
11. When stimulation session is ended, place STMISOL in Voltage (V) Mode and make sure that STMISOL unit input control voltage is Zero volts.
12. **Before powering OFF the STMISOL** (turning from ON to OFF), remove stimulation leads and/or electrodes from subject.
  - Do not remove electrodes while in current (I) mode; it's possible for subjects to receive a shock if they remove electrodes while the STMISOL is in current (I) mode because the STMISOL responds to the impedance increase and causes the current source to swing to a positive or negative rail.
13. Power OFF STMISOL after making sure that stimulation electrodes are not attached to the subject.

**STMISOL Specifications**

Control Voltage:	±10 V maximum input
Ctrl Voltage Interface:	Male 3.5 mm mono phone plug
Isolation:	Control Voltage GND to Isolated Output GND: 90 pF at 1500 VDC HiPot
Output Stimulation:	Voltage (V) Mode: ±200 V with ±100 ma compliance; output impedance = 100 Ω Current (I) Mode: ±100 ma with ±200 V compliance; output impedance = 1 GΩ
Timing:	Voltage Rise time: 200 V in 12 μsec (T10-T90) Current Rise Time: 100 ma in 12 μsec (T10-T90) Max pulse width: 100 msec Max sine frequency: 30 kHz (-3 dB)
Input to Output Ratio:	Voltage (V) Mode: ±10 VDC input creates output of ±200 VDC (1:20 ratio - V/V) Current (I) Mode: ±10 VDC input creates output of ±100 mA (1:10 ratio - V/ma)
Input Control Voltage:	Physical Interface: 3.5mm male mono phone plug Compatibility: UIM100C (Analog Output A1 or A0); STM100C (50 Ω), MP36 with OUT3 and BSLCBL6; MP35 with SS58L and BSLCBL6; any signal generator which outputs in ±10 V range
Protection:	Wave (pulse) Duration: Output or current compliance voltage (Vout): Vout (magnitude) < 100 V - fully arbitrary, no limit to wave (pulse) duration Output or current compliance voltage (Vout): Vout (magnitude) > 100 V - 100 msec typical (limiting to 20 ms at 100 ma current drive) Current Limiting: ±350 ma <(short circuit) Voltage Limiting: ±210 V <(nominal) Reset Push Button: Required with each power ON < in for 3 seconds to Reset
Manual Test:	Voltage Output Pulse: 100 V for 2 msec Current Output Pulse: 50 ma for 2 msec
Output Indicator:	ON for P-P amplitudes > 1% FSR
Fuse:	2 amp fast blow
Power Adapter	12 VDC at 1 amp (AC100A)