BSL HARDWARE GUIDE

The BSL Hardware Guide describes how to connect and setup various signal electrodes, transducers and other devices for use with the BSL System using an MP35 or MP3X acquisition unit and includes sections that detail different applications and uses for the Biopac Student Lab *PRO* System.

IMPORTANT SAFETY NOTICE

BIOPAC Systems, Inc. instrumentation is designed for educational and research oriented life science investigations. BIOPAC Systems, Inc. does not condone the use of its instruments for clinical medical applications.

Instruments, components, and accessories provided by BIOPAC Systems, Inc. are not intended for the cure, mitigation, treatment, or prevention of disease.

The MP35/30 is an electrically isolated data acquisition unit, designed for biophysical measurements.

Exercise extreme caution when applying electrodes and taking bioelectric measurements while using the Biopac Student Lab with other external equipment that also uses electrodes or transducers that may make electrical contact with the Subject.

Always assume that currents can flow between any electrodes or electrical contact points. In case of equipment failure, it is very important that significant currents are not allowed to pass through the heart.

If electrocautery or defibrillation equipment is used, it is recommended that the BIOPAC instrumentation be disconnected from the Subject.

MP35/30 ACQUISITION UNIT

The MP35/30 data acquisition unit is the heart of the Biopac Student Lab *PRO* System. The MP35/30 has an internal microprocessor to control data acquisition and communication with the computer. The MP35/30 unit takes incoming signals and converts them into digital signals that can be processed with your computer. There are four analog input channels, one of which can be used as a trigger input. You will need to connect the MP35/30 to your computer and connect electrodes, transducers, and I/O devices to the MP35/30. You are encouraged to take a few minutes to familiarize yourself with the MP35/30 prior to making any connections.

SYMBOLS — MP35

Symbol	Description	Explanation
	**TYPE BF EQUIPMENT**	Classification
	**Attention**	Consult accompanying documents
	**On** (partial)	Turns MP35 on assuming AC300A power adapter is powered by the mains
	**Off** (partial)	Turns MP35 off if but AC300A power adapter remains powered by the mains
	**Direct current**	Direct current output
	**USB**	USB port

COMPLIANCE

SAFETY

The MP35 satisfies the Medical Safety Test Standards affiliated with IEC60601-1. The MP35 is designated as Class I Type BF medical equipment

EMC

The MP35 satisfies the Medical Electromagnetic Compatibility (EMC) Test Standards affiliated with IEC60601-1-2.

TYPES OF INPUT DEVICES

There are three types of devices that connect to the MP35/30: electrodes, transducers, and I/O devices.

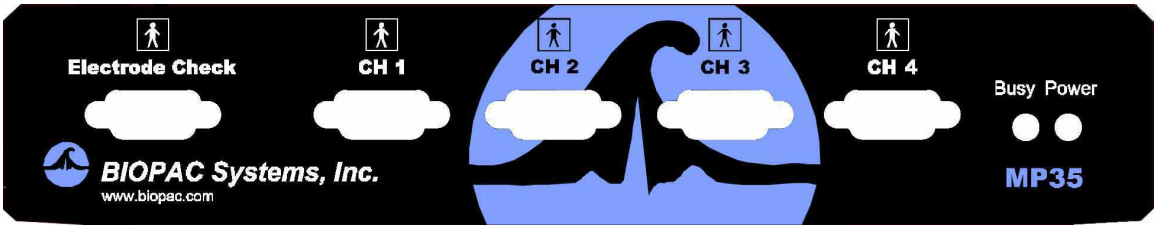
- Electrodes are relatively simple instruments that attach to the surface of the skin and pick up electrical signals in the body.
- Transducers, on the other hand, convert a physical signal into a proportional electrical signal.
- Input/Output devices (I/O for short) are specialized devices like pushbutton switches and headphones.

SIMPLE SENSOR CONNECTORS

Regardless of the type of device connected, every sensor or I/O device connects to the MP35/30 using a "Simple Sensor" connector. Simple Sensor connectors are designed to plugs only one way into the MP35/30, so you don't have to worry about plugging things in upside down or into the wrong socket.

- Electrodes, transducers, and the pushbutton switch all connect to the channel input ports on the front panel of the MP35/30.
- Headphones and the stimulator connect to the "Analog out" port on the back panel of the MP35/30.
- MP35 only: A digital device may connect to the "I/O Port" on the back panel
- MP35 only: A trigger device may be connected to the "Trigger" port on the back panel.

FRONT PANEL



Front Panel, MP35

The front panel of the MP35/30 has an electrode check port, four analog input ports, and two status indicators.

Electrode Check

- The Electrode Check port is a diagnostic tool used with the BSL *PRO* software to determine if the electrodes are properly attached to the subject.
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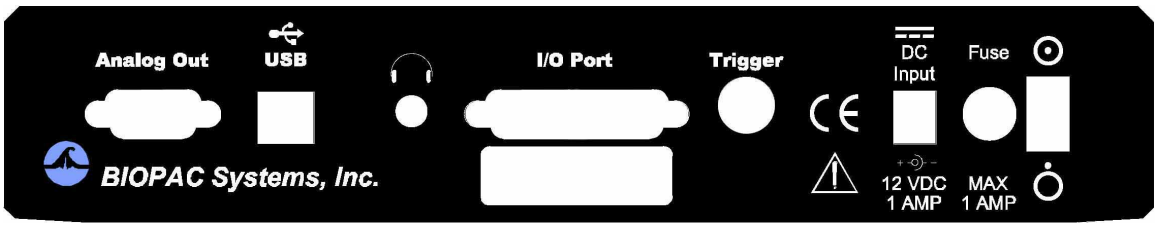
Input ports: CH 1, CH 2, CH 3, and CH 4

- The inputs on the MP35/30 acquisition unit are referred to as Channels. There are four 9-pin female analog input ports on the front of the MP35/30. The Biopac Student Lab Lessons software will always check to see that you have the proper sensors connected to the appropriate channel.

Status indicators

- The Busy status indicator is activated when the MP35/30 is acquiring data and also during the first few seconds after the MP35/30 is powered on to indicate that a self-test is in progress. (When the MP35/30 passes the power-on test, the Busy light will turn off.)
- The Power status indicator is illuminated when the MP35/30 is turned on.

BACK PANEL



Back Panel, MP35

The back panel of the MP35 has an analog output port, a USB port, an I/O Port, a Trigger Port, a DC input, a fuse holder, and a power switch, and the unit's serial number.

The back panel of the MP3X has an analog output port, a serial port, a DC input, a fuse holder, and a power switch, and the unit's serial number.

Analog Out port

There is one 9-pin male "D" analog output port on the back of the MP35/30 that allows signals to be amplified and sent out to devices such as headphones.

USB port (MP35 only)

The MP35 connects to the computer via a USB Port, located just below the word USB.

- Uses a standard USB connector.
- Should only be used to connect the MP3X to a PC or Macintosh.

Serial port (MP3X only)

The MP3X connects to the computer via a serial port, located just below the word Serial.

- Uses a standard MINI DIN 8 connector.
- Should only be used to connect the MP3X to a PC (with ISA or PCMCIA card) or Macintosh.

Headphone Output (MP35 only)

- Accepts a standard (1/4" or 6.3mm) stereo headphone jack.

I/O Port (MP35 only)

- Accepts a DB 25 Female connector.
- Input/Output port used to connect digital devices to the MP35.

Trigger Input (MP35 only)

- Accepts a male BNC connector.
- Input port used to send trigger signals from another device to the MP35.
- Used to synchronize MP35 units when more than one MP35 is used.

DC Input

⎓ Use the DC Input to connect a battery, AC/DC converter or other power supply to the MP35/30.

- ⚠ The power supply requirements for the MP35/30 are 12 VDC @ 1 Amp. Only use the AC300A power adapter with the MP35. The AC300A is a 12 VDC @ 1.25 Amp power supply adapter that can connect to any mains rated as 100-250 VAC @ 50/60Hz, 40VA.
- The receptacle is configured to accept a "+" (positive) input in the center of the connector and a "-" (negative) input on the connector housing.

Fuse holder

The fuse holder contains a fast-blow fuse that helps protect the MP35/30 from shorts on its power, analog, and digital I/O lines. The MP35 uses a 1.0 amp fast-blow fuse and the MP3X uses a 2.0 amp fast-blow fuse.

- To remove the fuse, use a screwdriver to remove the fuse cover located below the word Fuse.

Power switch

- ⊙ ON position — powers up the MP35/30
- ○ OFF position — cuts the flow of power to the MP35/30

CLEANING PROCEDURES

Be sure to unplug the power supply from the MP35/30 before cleaning. To clean the MP35/30, use a damp, soft cloth. Abrasive cleaners are not recommended as they might damage the housing. Do not immerse the MP35/30 or any of its components in water (or any other fluid) or expose to extreme temperatures as this can damage the unit.

SPECIFICATIONS

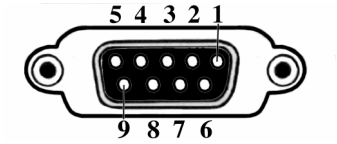
Specification	MP35 Unit	MP3X Unit
Front Panel		
ELECTRODE CHECKER Resistance Range (Vin+ and Vin- to GND)	0-100 KΩ	0-100 KΩ
ANALOG INPUTS Number of channels	4 isolated (front panel CH 1–CH 4), 2 unisolated (auxillary)	4 (front panel CH 1–CH 4)
SAMPLE RATE Maximum Minimum Trigger Input Threshold	 100K samples/second 1 samples/second Analog or digital channel Adjustable threshold; Positive or Negative Trigger	 2K s/s (8K aggregate on four ch.) 1 samples/second CH 4 input only Adjustable threshold; Positive or Negative Threshold
A/D resolution (before digital filtering)	24-bit	10-bit
Signal to noise ratio	> 90 dB (nominal)	> 90 dB
Voltage resolution Gain dependent	1.192 microvolts /bit (Gain 10) to 0.024 nanovolts /bit (Gain 50,000)	0.400 microvolts/bit (Gain 100) to 0.200 millivolts/bit (Gain 25,000)
Input voltage range (Gain dependent)	400 microvolts to 2.0 Volts p-p	4.0 millivolts to 0.2 Volts p-p
Input accuracy	±0.01% of Full Scale Range (FSR)	±0.05% FSR
Input protection; current limited	± 1 mA/V	± 1 mA/V
Maximum Input Voltage (between Vin+ and Vin-)	2V p-p	130mV p-p
Differential Input Impedance (between Vin+ and Vin-)	2 MΩ	2 MΩ
Filters (automatic or user adjustable)	3 two-pole IIR digital filters per channel	3 two-pole IIR digital filters per channel
Common Mode Input Impedance (between Vin+/Vin- and GND) DC AC (50/60 Hz)	 11 MΩ 1,000 MΩ	 11 MΩ 1,000 MΩ
Gain ranges (automatic preset or user adjustable)	10 – 50,000	100 – 50,000
Baseline adjustment (automatic or user adjustable)	Gains 10, 20, and 50: ±100mV Gains 100 to 50,000: ±10mV	±10mV all Gains
Electrode offset potential tolerance	Gains 10, 20, and 50: ±2V Gains 100, 200, 500: ±200mV Gains 1,000 to 50,000: ±80mV	±70 mV all Gains
Back Panel		
ANALOG OUTPUT Number of channels D/A resolution Accuracy Output impedance Output voltage Output drive current	 1 12 bits ±0.0125% of FSR 50Ω 0 - 4.096 V ±10 mA maximum	 1 8 bits ±0.2% of FSR 50Ω 0 - 5.000 V ±100 mA maximum

Specification	MP35 Unit	MP3X Unit
SERIAL INTERFACE Transmission type Transmission rate	 USB Type 2.0 full speed	 RS422-clocked asynchronous 524,000 bits per second (KBPS)
HEADPHONE (MP35 only)	Drives low-impedance standard stereo headphones	N/A – MP35 only
I/O PORT (MP35 only)	8 TTL compatible inputs and 8 TTL compatible outputs	N/A – MP35 only
TRIGGER (MP35 only)	TTL compatible input and synchronization port	N/A – MP35 only
DC INPUT	Power input; requires 12 VDC @ 1 Amp. Use the AC300A 12 VDC @ 1.25 Amp power supply adapter to connect to any mains rated as 100-250 VAC @ 50/60Hz, 40VA.	Power input; requires 12 VDC @ 1 Amp. Use the AC300A 12 VDC @ 1.25 Amp power supply adapter to connect to any mains rated as 100-250 VAC @ 50/60Hz, 40VA.
FUSE	1.0 amp fast-blow fuse	2.0 amp fast-blow fuse
MP UNIT Dimensions Weight	 7 cm x 29 cm x 25 cm 1.4 Kg	 7 cm x 29 cm x 25 cm 1.4 Kg

MP UNIT PIN-OUTS

Electrode Check — *Front Panel*

9-PIN FEMALE DSUB

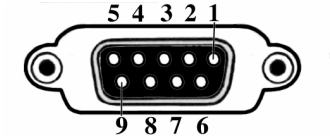


Pin	MP35 and MP3X	
2	Vin+	Electrode connection
3	GND	
4	Vin-	Electrode connection

MP Input — *Front Panel*

CH 1, CH 2, CH 3, CH 4

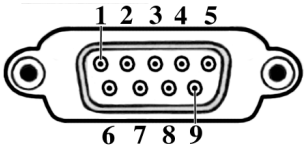
9 PIN FEMALE DSUB (1 of 4)



Pin	MP35	MP3X
1	Shield drive	Shield drive
2	Vin+	Vin+
3	GND	GND
4	Vin–	Vin–
5	Shield drive	Shield drive
6	+5 V (100 mA max aggregate)	+5 V (50 mA max)
7	ID resistor lead 1; I^2C SCL	ID resistor lead 1 (+5 V)
8	ID resistor lead 2; I^2C SDA	ID resistor lead 2
9	–5 V (100 mA max aggregate)	–5 V (50 mA max)

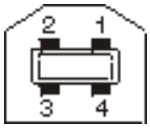
MP Analog Output — *Back Panel*

9 PIN MALE DSUB



Pin	MP35	MP3X
1	Buffered AC output Z out = 2,200 µF Cap V out range MP35: (+/- 2.0 V)	Buffered AC output Z out = 2,200 µF Cap MP3X : (+/- 2.5 V)
2	Buffered DC output Z out = 50 Ω V out range MP35: (0 to 4.096 V)	Buffered DC output Z out = 50 Ω MP3X : (0 to 5 V)
3	GND GND	
4	+5.0 V (100 mA max)	+7.5 V (100 mA max)
5	Buffered digital output Z out = 1 kΩ V out range (0 to 5 V)	Unbuffered DC output Z out = 1 kΩ V out range (0 to 5 V)
6	+12 V (100 mA max)	Not used
7	I^2C SCL	Not used
8	I^2C SDA	Not used
9	Not used	Not used

MP Serial Connector — *Back Panel*



MP35

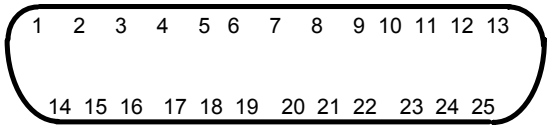
MP3X

Pin	MP35	MP3X
1	+5	Digital Output 1
2	-Data	Digital Output 2
3	Data +	Digital Output 3
4	GND	Digital Output 4
5	n/a	GND Unisolated
6	n/a	GND Unisolated
7	n/a	RS-232-RX
8	n/a	+5 V Unisolated

MP UNIT PIN OUTS *continued*

I/O Port — *MP35 Back Panel*

DSUB 25 (male)



Note: BSL v 3.7.0 does not support Pins 7, 9, 18, 19, 20 and 21.

Pin	MP35 Only
1	Digital Output 1
2	Digital Output 2
3	Digital Output 3
4	Digital Output 4
5	GND Unisolated
6	GND Unisolated
7	RS-232-RX
8	+5 V Unisolated
9	I^2C-SDA
10	Digital Input 1
11	Digital Input 2
12	Digital Input 3
13	Digital Input 4
14	Digital Output 5
15	Digital Output 6
16	Digital Output 7
17	Digital Output 8
18	Analog Input — Right
19	Analog Input — Left
20	RS-232-TX
21	I^2C-SCL
22	Digital Input 5
23	Digital Input 6
24	Digital Input 7
25	Digital Input 8

STIMULATORS

Low Voltage Stimulator – MP35 only

Use the low voltage stimulator with 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. You can monitor the output 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
- Sound output — use with headphones or speakers

Interface:	MP35 Analog Out port (unisolated)
Pulse level:	-10 V to + 10 V, software adjustable in 5 mV increments
Pulse width:	0.05-100 milliseconds
Pulse repitition:	5 seconds-0.1 millisecond (0.2-10,000 Hz)
Power:	No additional power required

BSL Stimulator

BSLSTMB

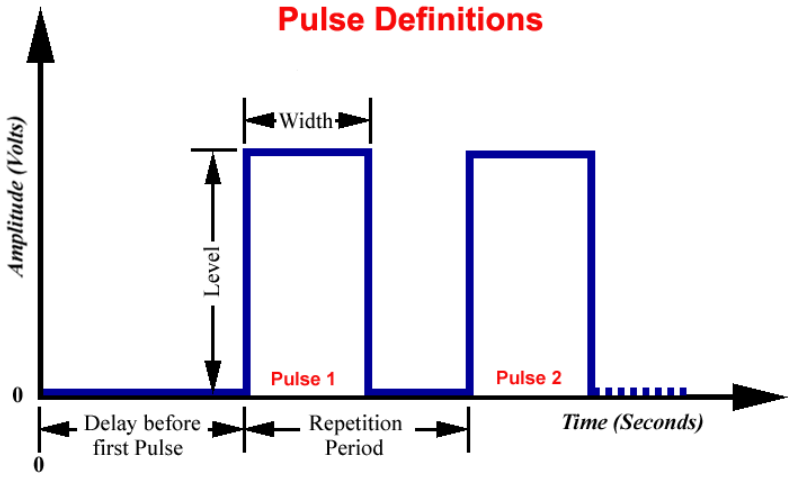
BSLSTMA

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. You can use the BSLSTM and your 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

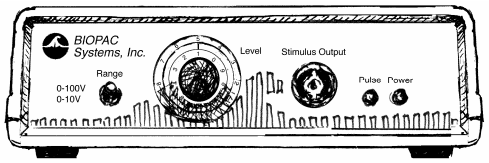


Pulse width	The time that the pulse is in the non-zero or active state.
Delay before first pulse	The initial delay from the start of acquisition to the start of the first pulse.
Repetition period	The time between pulses, as measured from the start of one pulse to the start of the next pulse. This is the inverse of the Pulse rate.
Pulse rate	The number of pulses that occur in a one-second interval, expressed in Hz.
Also called — Pulse frequency Repetition rate Events per second	The **Pulse rate** relates to the **Pulse period** as follows: **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. You can 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.

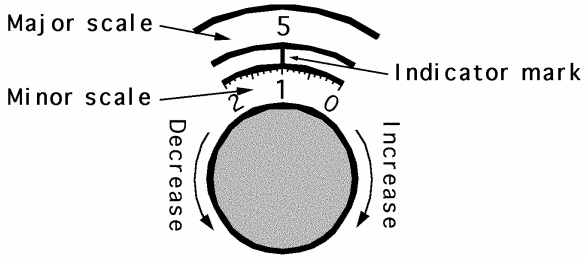
Level **Level** is used in conjunction with **Range** to set the stimulus pulse output level.

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
0-10V	Volts	Volt / 10
0-100V	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 0-10V) or 51 Volts (Range 0-100V). 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.

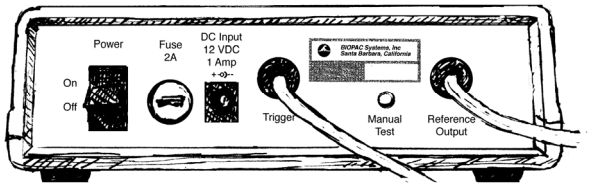
Pulse indicator LED flashes when the stimulus pulse is active: BSLSTMA/B = red. BSLSTM = green.

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 , you may use the **Manual Test** button 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 15ms 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 15ms, selected so that the MP30 can capture the pulse with a sample rate as low as 100 samples per second.

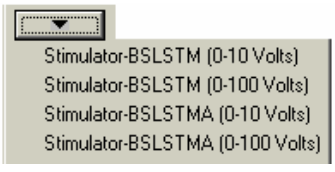
See Calibration on next page

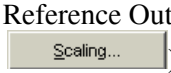
If the BSL *PRO* software has been setup correctly, the amplitude of this marker will reflect the **Level** knob setting on the BSLSTM. See the **Range switch** section for information on how this reading can be affected.

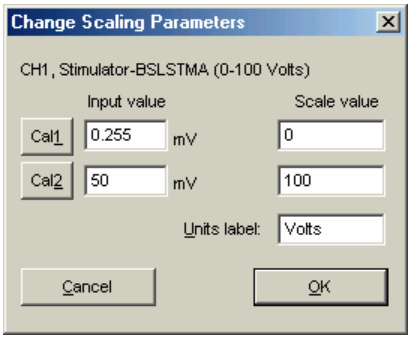
Calibration

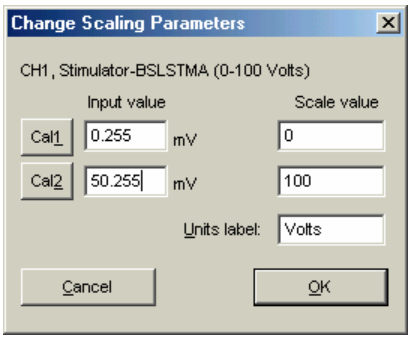
You must calibrate the "Reference Output" signal from the BSLSTM to get accurate results.

1. Choose the correct  **Preset** (via MP3X menu > Setup Channels).



   - For example, if using the BSLSTMA/B, don't choose a "BSLSTM..." Preset. Also, make sure the Preset matches the Voltage Range you will be using (0-10V, or 0-100V).
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 > Setup Channels >  > ).
4. Press the **Cal1** button to get the signal representing 0V out of the stimulator.

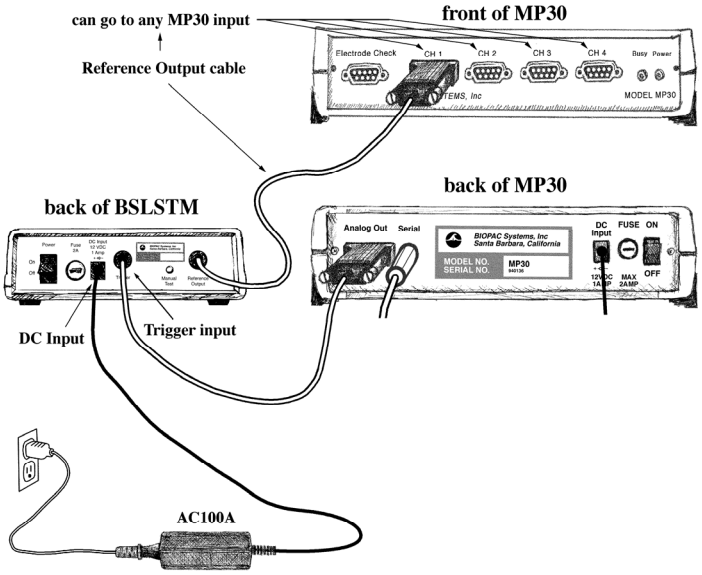




5. **Add** the Input value found with Cal1 to the Input Value displayed for Cal2.
   - For example, if you pressed "Cal1" and got an Input Value of .255 mV, you would then add the number .255 mV to the existing 50 mV and manually enter the total value of 50.255 mV for Cal2 Input Value.
   - *Note*: Even if the Cal1 Input Value is negative, you must still "add" it to the number for Cal2 (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*: You can 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.

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 **0-10V**.
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 your 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**.

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** (see page 93) 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 you are 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.

BSLSTMA/B Specification (This new unit uses digital display and a keyed range switch)

Pulse width

Controlled by:	Computer, with lockable width limit
Range:	.2 – 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
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.	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:	None or .5 - 100 milliseconds
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
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 - 10V actual output or 0 - 100V 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:	60pF
Power requirements	12 Volts DC adapter (included), 1 Amp
Fuse	250V, 2A, fast blow
Fuse Dimensions:	1.25" length × .25" diameter
Module Weight	610 grams
Module Dimensions	16 cm x 16 cm x 5 cm

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

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

Pulse width

Controlled by:	Computer, with lockable width limit
Range:	.2 – 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
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

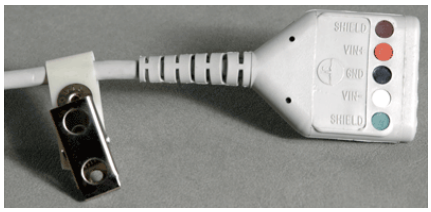
Reference Output	Correlates to actual pulse output (Requires Calibration)
Pulse width:	15 millisecond fixed pulse width
Amplitude:	0 - 10 mV correlates to 0 – 10V actual output or 0 – 100V actual output
Manual Test Pulse	(Button on back panel) *Note*: Will only function when "Trigger" cable is <u>not</u> connected to the MP3X .
Pulse Width:	2.5 - 3 milliseconds

Stimulator isolation

Volts:	2,000 Volts DC (HI POT test)
Capacitance coupling:	60pF
Power requirements	12 Volts DC adapter (included), 1 Amp
Fuse	250V, 2A, fast blow
Dimensions:	1.25" length × .25" diameter
Module Weight	610 grams
Module Dimensions	16 cm x 16 cm x 5 cm

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

SS1LA Shielded Electrode Adapter



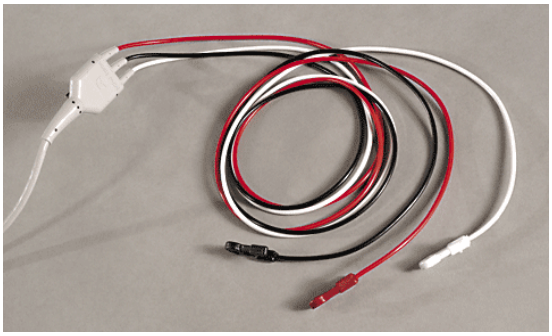
The SS1L shielded electrode lead adapter is used to interface the MP3X with reusable electrodes (such as the EL200 series). The SS1L adapter comes with a 2-meter cable and can be connected to any of the four analog ports on the front of the MP3X acquisition unit. The SS1L can be used with shielded or unshielded electrodes.

SS1LA SPECIFICATIONS

Cable length	2-meter
Connector type	9 Pin DIN

Note: The SS1L is a 3-meter electode adapter for older style 2 mm pin connections. To convert 2 mm pin connections to Touchproof 1.5 mm connections, use CBL201.

SS2L Electrode Lead Set



This fully shielded cable assembly permits high-resolution recording of biopotentials. Each lead set has three pinch leads designed to snap directly onto standard disposable electrodes (such as the EL500 series electrodes). Each pinch lead is 1 meter long and terminates in a yoke connected to a 2-meter cable.

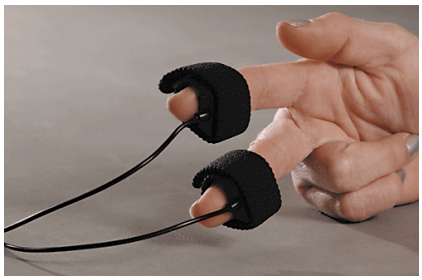
This is the general-purpose electrode cable used for almost all applications requiring the use of electrodes. These cables are used to connect the disposable electrodes that are placed on the surface of the skin to the MP3X unit. Depending on where the electrodes are placed, you can use them to measure muscle contraction, heartbeats, or even brainwaves.

One end of the SS2L cable has a Smart Sensor connector on it that connects to the MP3X and the other end splits into three smaller cables. Each end of the smaller cables is fitted with a pinch connector that clamps onto electrodes.

SS2L SPECIFICATIONS

Cable Length:	2 meters
Connector Type:	9 Pin DIN

SS3LA GSR (Galvanic Skin Response) Transducer



The SS3LA GSR transducer is designed to record galvanic skin response (GSR, also called electrodermal activity). If "galvanic" sounds familiar, it is because the phenomenon is named after Luigi Galvani, a pioneer in both electricity and physiology. GSR is basically a measure of how much you perspire, and you use electrodes to measure this since perspiration conducts electricity better than dry skin. Measuring perspiration may sound a bit unusual, but this information is useful in determining a person's overall state of physiological arousal, which, in turn, is useful in a number of contexts.

Two Ag/AgCl electrodes are mounted in individual, ergonomically designed, polyurethane housings for improved contact. They are attached to the fingers by a Velcro® strap (or can be taped to any other part of the body) and connect to a 2-meter flexible lightweight cable. Electrode gel (GEL1 or your preferred recording gel) is required for measurement so the electrodes have a 6mm contact area with a 1.6mm cavity to accommodate electrode gel. The electrodes are shielded to minimize noise interference and improve recordings.

These electrodes are different from standard SS2L electrodes in that they have built-in, reusable electrodes on the end, the electrodes are specially designed to fit around the tip of a person's finger, and the electrodes measure only one type of signal — the GSR.

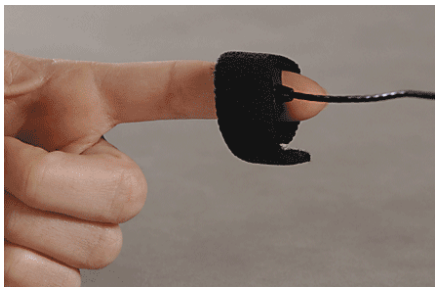
HINT

For a good signal to be picked up, it helps if the subjects have a little sweat on their hands (not a lot, but enough so that their hands are not completely smooth or cold). If subjects wash their hands just prior to the recording or if they have been sitting in a cold room, then they must do something to activate the sweat glands before beginning calibration or recording. If subjects begin with colder hands, the scale will be diminished and the signal will be easily saturated once they "warm up" during the lesson.

SS3LA SPECIFICATIONS

Electrode Type:	Ag/AgCl, shielded
Surface Area:	6mm contact area
Gel Cavity Area	1.66mm
Dimensions:	16mm (long) × 17mm (wide) × 8mm (high) [each electrode]
Weight:	4.5 grams
MRI Compatible:	Yes
Sterilizable:	Yes (contact BIOPAC for details)
Cable Length:	2 meters
Connector Type:	9 Pin DIN

SS4LA Pulse Plethysmograph Transducer



The pulse plethysmograph (pronounced “pla - thiz - mo - graf”) measures the density of blood in your fingertip. It does this by shining a light into your finger and measuring how much light gets reflected back. Since it converts a physical measure (reflected light) into an electrical signal, the SS4LA is considered a transducer.

This transducer records the pulse pressure waveform. The transducer consists of a matched infrared emitter and photo diode, which transmits changes in blood density, caused by varying blood pressure in specific body locations. A built-in two-stage IR filter and ergonomic housing reduces artifacts from ambient light and subject movement. Each transducer includes a Velcro® strip for finger attachment, or it can be taped to other body locations.

SS4LA SPECIFICATIONS

Emitter/Detector Wavelength:	860nm± 90nm
Optical Low Pass Filter Cutoff Wavelength:	800nm
Dimensions:	16mm (long) × 17mm (wide) × 8mm (high)
Transducer Weight:	4.5 grams
MRI Compatible:	Yes
Sterilizable:	Yes (contact BIOPAC for details)
Nominal Output:	20 mV (p-p)
Power:	5VDC Excitation @ 5 mA
Cable length:	2 meters (shielded, lightweight)
Connector Type:	9 Pin DIN

SS5LB Respiratory Effort Transducer

The SS5LB transducer is used to record respiration via chest or abdomen expansion and contraction. This transducer is useful for determining how deeply someone is breathing and for calculating the person’s breathing rate or respiration rate. The transducer is a strain assembly that measures the change in thoracic or abdominal circumference. The strap presents minimal resistance to movement and is extremely unobtrusive.

Due to its novel construction, the SS5LB can measure extremely slow respiration patterns with no loss in signal amplitude while maintaining excellent linearity and minimal hysteresis. The

respiratory effort transducer has a 2-meter flexible lightweight cable. The center plastic housing protects the delicate sensor within.

The transducer is attached by a fully adjustable nylon strap, which allows the transducer to fit almost any circumference.

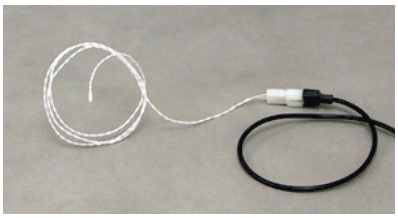
To attach the nylon belt to the transducer, thread the strap through the corresponding slots on the sensor assembly.

Place the transducer around the body at the level of maximum respiratory expansion (generally about 5cm below the armpits). At maximum expiration, adjust the strap so there is slight tension to hold the strap around the chest.

SS5LB SPECIFICATIONS

Response:	True DC
Circumference Range:	9cm - 130cm (Can be increased with a longer nylon strap)
Dimensions:	95mm (long) × 47mm (wide) × 15mm (thick)
Weight:	9 grams
MRI compatible:	Yes
Sterilizable:	Yes (contact BIOPAC for details)
Variable Resistance Output:	50-150 K
Cable Length:	2 meters (flexible, lightweight)
Connector Type:	9 Pin DIN

SS6L Temperature Transducer



The SS6L is a small fast-response thermistor used to measure small variations in temperature, either on the skin surface or in exhaled airflow. The recorded temperature changes during breathing can be used to indicate respiration rate. Attach the SS6L to the skin surface with Surgical Tape (TAPE1).

SS6L SPECIFICATIONS

Response time:	0.6 sec
Nominal resistance:	2252Ω @ 25°C
Maximum operating temperature:	100°C
Accuracy and Interchangeability:	±0.1°C
Connector Type:	9 Pin DIN
Compatibility:	YSI® series 400 temperature probes
Cable Length:	2 meters (flexible, lightweight)
Sterilizable:	Yes (contact BIOPAC for details)
Dimensions:	5m × 1.7m

SS7L Waterproof Probe

Use this vinyl probe for core (oral/rectal) temperature recordings.

Response time: 1.1 sec
Max operating temp: 60°C
Accuracy & Interchangeability: ±0.2°C
Compatibility: YSI(r) series 400
Dimensions: 9.8mm x 3.3
Cable: 3 meters

SS8L Liquid Immersion Probe

Use this stainless steel probe for dry or wet bath temperature measurements.

Response time: 3.6 sec
Max operating temp: 60°C
Accuracy & Interchangeability: ±0.2°C
Compatibility: YSI(r) series 400
Dimensions: 4mm X 115mm
Cable: 3 meters

SS9L UNISOLATED BNC Input Adapter

This adapter enables the Biopac Student Lab System to record signals from other devices (such as amplifiers, other chart recorders and signal generators). The BNC adapter can be used to measure signals as high as ±50V. The adapter cable terminates in a male BNC for easy connections.

SS9L SPECIFICATIONS

Cable length:	2 meter
Connector type:	BNC
Signal range:	±50V

See also: OUT2 BNC Output Adapter

SS10L Pushbutton Hand Switch

The SS10L pushbutton hand switch is used for remote event marking or for psychophysiological response tests. This easy to hold pushbutton switch is very rugged and reliable, and makes it simple to mark events during recording. When data from the button is displayed on the screen, it normally reads 0 Volts, and when the button is pressed it reads +5 mV.

SS10L SPECIFICATIONS

Cable Length:	2 meters
Connector Type:	9 Pin DIN

SS11LA Airflow Transducer

See page 66 for the **AFT series** of accessories for airflow and gas analysis

The SS11LA airflow transducer is designed to measure human subject respiratory, bi-directional airflow (liters/sec) and can be used to measure respiratory flow in a wide range of tests and conditions relating to airflow and lung volume. Volume measurements are obtained by integrating the airflow signal. The airflow transducer is lightweight, easily held in one hand, and has a removable head for sterilization and replacement. *For reasons of hygiene, it is important that only one person use each disposable mouthpiece and disposable filter.*

The SS11LA includes an optically clear detachable flow head (RX117) for easy cleaning and inspection. As the detachable flow head is snapped into the SS11LA handle, the flow head plugs directly into an integral, precision low-differential pressure transducer. Accordingly, the SS11LA will output an electrical signal proportional to respiratory flow. Use with the AFT22 Non-Rebreathing "T" valve for low dead space requirements.

The SS11LA connects to industry standard bacteriological filters (AFT1) and disposable mouthpieces (AFT2). The RX117 detachable flow head can be cold sterilized, autoclaved (220° F max), or placed in a dishwasher. The SS11LA plugs directly into the MP3X unit.

SS11LA SPECIFICATIONS

Flow Rate:	10 Liter/sec (highest linearity ≤ 5 Liters/sec)
Dead space:	93ml
Nominal Output:	60 µV/[liters/sec]
Detachable Flow Head	
Dimensions:	82.5mm diameter x 101.5mm length
Weight:	80 grams
Construction:	Clear acrylic
Handle	
Dimensions:	127mm (long) x 23mm (thick) x 35mm (wide)
Weight:	85 grams
Construction:	Black ABS
Cable Length:	2 meters (shielded)
Ports:	22mm ID/30mm OD
Connector Type:	9 Pin DIN
Interface:	MP3X

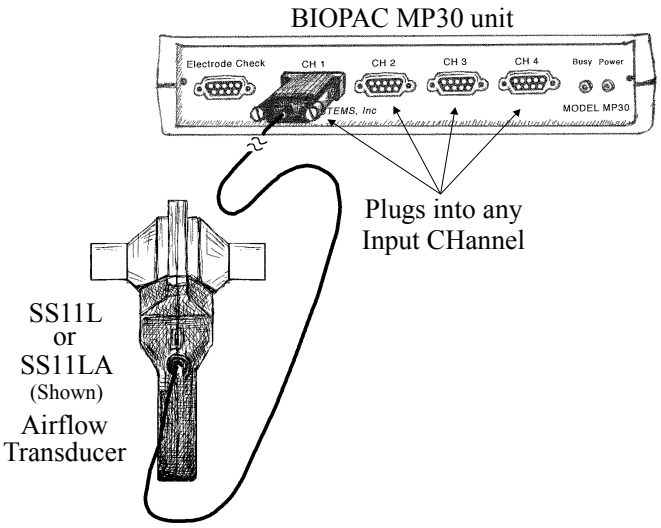
RX117 Replacement Head

Replacement sterilizable air flow head for the SS11LA Airflow Transducer.

>>> All Instructions also apply to the older airflow transducer — model SS11L <<<

SS11LA TO MP3X CONNECTION

1. Make sure the BIOPAC MP3X unit is turned OFF.
   - Note: You may turn the MP3X power off even if the software is running.
2. The airflow transducer (SS11LA) can be plugged into any input channel on the MP3X .
3. After the transducer is plugged in securely, turn the MP3X power ON.



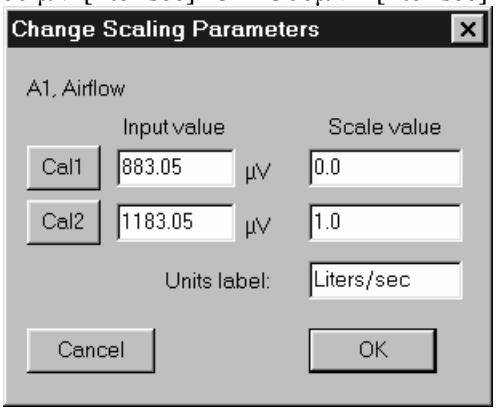
SS11LA to MP3X connection

ROUGH CALIBRATION

1. Pull down the **MP3X** menu.
2. Click **Setup channels**.
3. Select the **Analog** channel that you plugged the SS11LA transducer into and activate it by clicking in the **Acquire**, **Plot** and **Values** boxes.
4. Pull down the **Presets** pop-up menu and select **Airflow**.
5. Click on the **View/Change Parameters** button.
6. Click on the **Scaling** button.
7. Click on **Cal1**: Leave the **Input value** reading and enter **0** for the **Scale value**.
8. For **Cal2 Input Value**, add **300µV** (or .3 mV) to the **Cal1 Input Value**. For **Cal2 Scale value**, enter **1**.
9. Click **OK** for each window to exit Channel Setup.

The SS11LA can be roughly calibrated without using the AFT6 calibration syringe. The SS11LA has a nominal output of 60 µV per liter/sec, which is then scaled to account for the amplifier excitation. For the MP3X , this is factory set to 5 Volts. Therefore:

60 µV/[liter/sec] · 5 = 300µV / [liter/sec].



Note —**Add 300µV** to the Cal1 Input Value for Cal2.

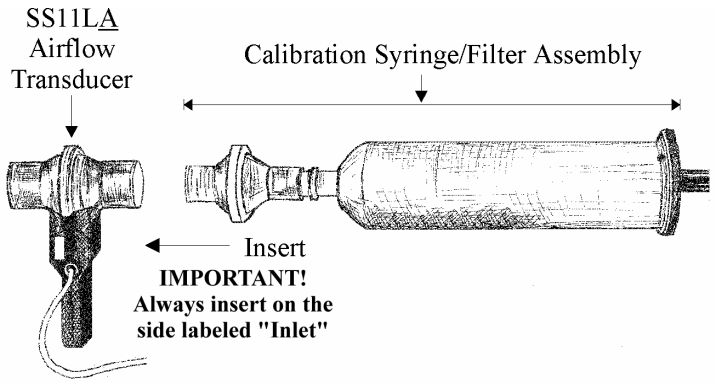
USING THE CALIBRATION SYRINGE

1. Place a filter onto the end of the calibration syringe.

The filter is necessary for calibration because it forces the air to move smoothly through the transducer. This assembly can be left connected for future use. You only need to replace the filter if the paper inside the filter tears.

2. **Insert** the Calibration Syringe/Filter Assembly into the airflow transducer.

IMPORTANT!
Always insert on the side labeled "**Inlet**."

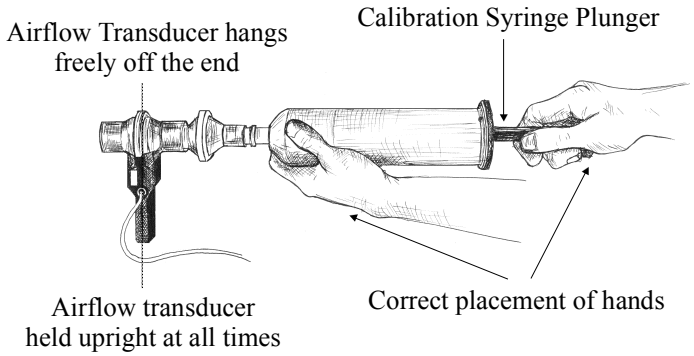


Calibration Syringe into airflow transducer

If using **SS11L** transducer with non-removable head, insert syringe assembly into the larger diameter port.
If using **SS11LA** transducer with removable, cleanable head, insert syringe assembly so that the transducer cable exits on the left, as shown in the preceding figure.
IMPORTANT: If your lab sterilizes the airflow heads after each use, make sure a clean head is installed now.

Never hold onto the airflow transducer handle when using the Calibration Syringe or the syringe tip may break.

The Airflow Transducer is sensitive to gravity so it needs to be held upright throughout the calibration and recording.



Proper handling of the Calibration Syringe Assembly

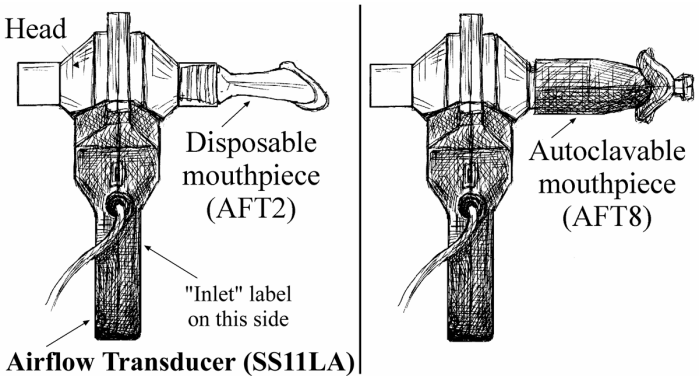
3. **Pump** the plunger several times before the recording. **Always** pull and push the plunger all the way until it stops when using the syringe. This assures that the full volume of air (0.6 liter) flows in and out of the airflow transducer.

RECORDING WITH THE AIRFLOW TRANSDUCER

1) **Attach** the appropriate filter and mouthpiece on the side labeled **Inlet**.

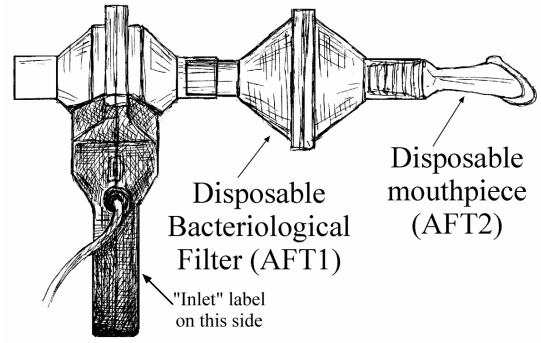
> WARNING
>
> The bacterial filter and mouthpiece are disposable and are "**one per person**" items. Please use a new disposable filter and mouthpiece each time a different person is to be breathing through the airflow transducer.

If using **SS11LA** transducer and <u>sterilizing the head</u> after each use, insert a disposable mouthpiece (BIOPAC AFT2) or a sterilizable mouthpiece (BIOPAC AFT8) into the airflow transducer on the side labeled "Inlet."



SS11LA with sterilized head

If using **SS11LA** transducer and <u>not sterilizing the head</u> after each use, insert a filter and mouthpiece into the airflow transducer on the side labeled "Inlet."

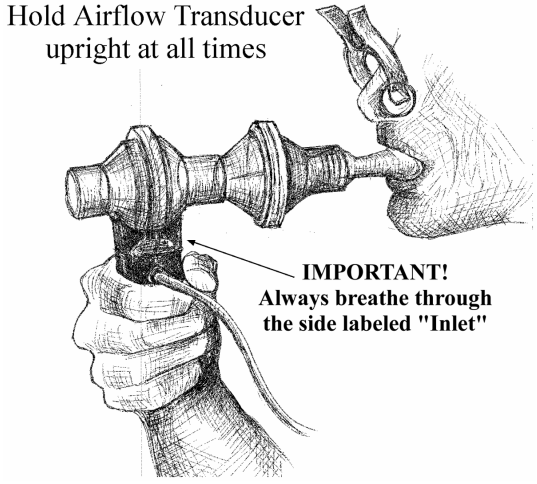


SS11LA with unsterilized head

2) Breathe through the airflow transducer, following the proper procedure defined to the right.

Hints for obtaining optimal data:

a) Keep the Airflow Transducer upright at all times.



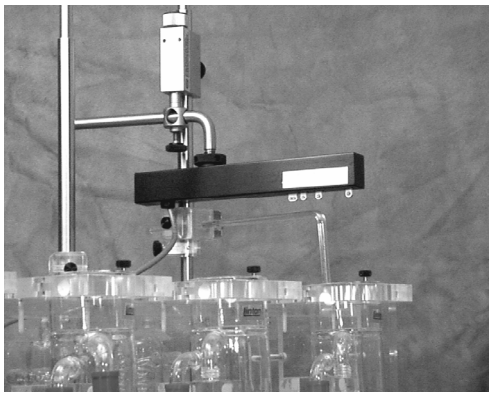
b) Always insert on and breathe through the side of the SS11LA airflow transducer labeled "Inlet."

c) Always use a nose clip when breathing through the

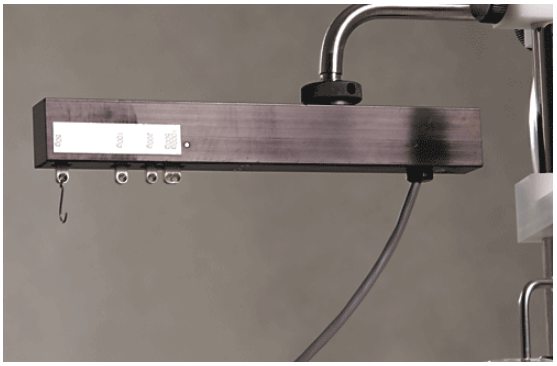
airflow transducer and secure a tight seal with the mouth so that air can only escape through the airflow transducer.

d) Always begin breathing normally through the airflow transducer prior to the beginning of the recording and continue past the end of the recording.
e) If you start the recording on an inhale, try to end on an exhale, and vice-versa. This is not absolutely critical, but will increase the accuracy of Airflow to Volume calculations.
f) The Subject must try to expand the thoracic cavity to its largest volume during maximal inspiratory efforts. (The Subject should wear loose clothing so clothing does not inhibit chest expansion.)
g) During recording of FEV, the Subject should attempt to exhale as quickly as possible into the mouthpiece.
h) During recording of MVV, the Subject should attempt to exhale and inhale as quickly and deeply as possible. Breathing rates should be faster than 60 breaths/minute or greater than 1 breath/second for the best results. The breathing needs to be maintained for 12-15 seconds.

SS12LA Variable Range Force Transducer



SS12LA Sample Setup



SS12LA Variable Range Force Transducer

Force transducers are devices capable of transforming a force into a proportional electrical signal. The SS12LA variable range force transducer element is a cantilever beam load cell incorporating a thin-film strain gauge. Because the strain elements have been photolithographically etched directly on the strain beam, these transducers are rugged while maintaining low non-linearity and hysteresis. Drift with time and temperature is also minimized, because the strain elements track extremely well, due to the deposition method and the elements' close physical proximity. The SS12LA also incorporates impact and drop shock protection to insure against rough laboratory handling.

Forces are transmitted back to the beam via a lever arm to insure accurate force measurements. Changing the attachment point changes the full scale range of the force transducer from 50g to 1000g. The beam and lever arm are mounted in a sealed aluminum enclosure that includes a 3/8" diameter mounting rod for holding the transducer in a large variety of orientations. The SS12LA comes equipped with a 2-meter cable and plugs directly into the MP3X module.

The SS12LA mounting rod can be screwed into the transducer body in three different locations, two on the top and one on the end surfaces of the transducer. The mounting rod can be placed in any angle relative to the transducer orientation. The SS12LA can be used in any axis and can be easily mounted in any standard measurement fixture, including pharmacological setups, muscle tissue baths and organ chambers.

The SS12LA has 5 different attachment points that determine the effective range of the force transducer. These ranges are 50g, 100g, 200g, 500g and 1,000g. The point closest to the end is the 50g attachment point, while the point closest to the middle is the 1,000g attachment point.

Two **S-hooks** are provided with the SS12LA; one has a .032" diameter wire and the other has a .051" diameter wire. The smaller hook is to be used for the 50g, 100g and 200g ranges. The larger hook is intended for the 500g and 1000g ranges. The larger hook is intentionally a tight fit to generate a downward pull vector. To further increase proper readings, keep the unit level and align anything that hangs off the hook straight beneath it rather than at a sideways angle.

SS12LA S-hooks

See the **Force Transducer Tension Adjuster** (HDW100A) on page 95.

SS12LA SPECIFICATIONS*

Lever Arm Position (hook ring)	Full Scale Range (FSR)	10Hz Noise	1Hz Noise
50 grams	50 grams	2.5 mg	1 mg
100 grams	100 grams	5 mg	2 mg
200 grams	200 grams	10 mg	4 mg
500 grams	500 grams	25 mg	10 mg
1000 grams	1000 grams	50 mg	20 mg

Sensitivity	1mV/V (for 5V excitation, output is 5mV at full scale)
Temperature Range	-10°C to 70°C
Thermal Zero Shift*	<±0.03% FSR/°C
Thermal Range Shift*	<0.03% Reading/°C
Excitation Voltage	5 VDC
Nonlinearity*	<±0.025% FSR*
Hysteresis*	<±0.05% FSR*
Non-repeatability*	<±0.05% FSR*
30-Minute Creep*	<±0.05% FSR*
Dimensions	19mm (wide) × 25mm (thick) × 190mm (long)
Weight (with mounting rod)	300g
Cable length	3 meters
Materials	Aluminum: hook rings Anodized aluminum: housing Stainless Steel: attachment arm

* These parameters assume the transducer is set for a 50g range. For all other range settings, force measurements from 10% to 90% full scale are linear to ±1.0%.

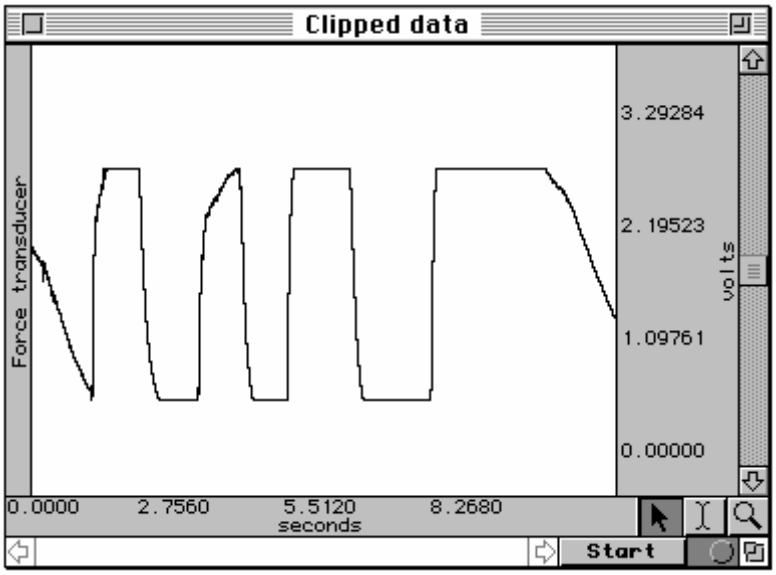
Calibration

The SS12LA is easily calibrated using weights of known mass. Ideally, calibration should be performed with weights that encompass the range of the forces expected during measurement and should cover at least 20% of the full scale range of the transducer. When calibrating for maximum range on the force transducer, use weights that correspond to 10% and 90% of the full scale range for best overall performance.

Force Transducer Calibration

Calibrating a force transducer is a two step process. The first step involves finding the optimal Gain setting for the transducer and the second step is the actual calibration.

1) To find the optimal Gain setting:
   a) Start with the software Preset for the force range desired.
      - To set the Presets: MP3X menu > Setup Channels > Analog Presets > "Force (range)"
   b) Load the transducer with the maximum expected weight.
   c) Collect data for a few seconds at these settings.
   d) Inspect the sample data. You will want to look for data that is "railed" or "clipped." This occurs when the input signal (times the gain setting) is too large relative to the maximum input range. An example of clipped data follows.



Gain set too high — Clipped* Force *data

e) If the signal is clipped, decrease the Gain setting by one step (e.g., from x5000 to x2500) and collect new data at the lower gain setting.

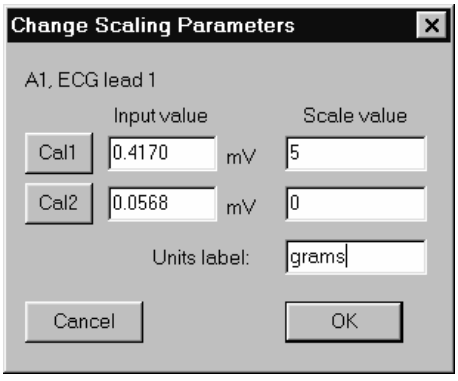
- To access the Gain setting: **MP3X** menu > **Setup Channels** > **Force** preset channel > **View/Change Parameters** icon > **Gain** pull-down menu

f) Repeat this procedure until the signal no longer appears "clipped."

Once an optimal gain setting for the transducer has been established, you should be able to use this same gain setting for other similar transducers and similar measurements.

2) The next step is to actually calibrate the transducer, which means mapping the input signal to more meaningful units (such as grams). To do this:

a) Access the Channel scaling dialog box (MP3X menu > Setup Channels > Force preset channel > View/Change Parameters icon > Scaling button).



Note:
In this sample dialog, a weight of 5 grams was placed on the transducer and the **Cal 1** button was pressed.
The transducer weight was then removed and **Cal 2** was pressed.

b) Place the maximum expected weight or force on the transducer.

c) Click on the **Cal 1** button in the Channel scaling window.

- A voltage value will be automatically entered in the corresponding **Input value** box.

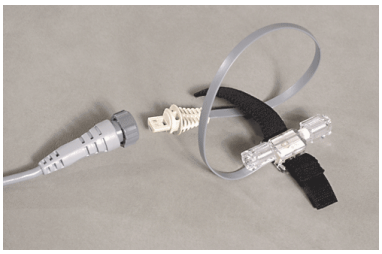
d) Remove all weight or force from the transducer.

e) Click on the **Cal 2** button in the same scaling window.

- A voltage value will be automatically entered in the corresponding **Input value** box.

The transducer will be calibrated to the set values the next time you begin an acquisition.

SS13L Pressure Transducer



***Note*: The SS13L Pressure transducer is not intended for use with humans.**

The SS13L pressure transducer is used to measure direct arterial or venous blood pressure in animals or to record pressure changes within a closed system such as an organ or tissue bath system. Connect to your tubing via the standard rotating Luer-lok fittings. This assembly consists of a disposable transducer with a 30cm cable that attaches to a reusable 3-meter cable that is designed to interface with the MP3X . The transducer is supplied non-sterile but can be cold sterilized.

Typical software settings for the blood pressure transducer are described in the table below:

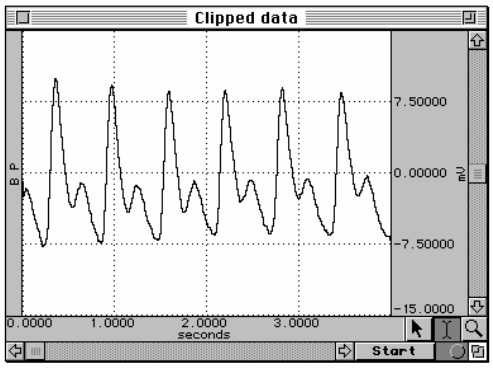
Filter 1	Filter 2	Filter 3	Hardware filter	Gain	Coupling
Low pass 66.5 Hz Q = 0.5	Low pass 38.5 Hz Q = 1.0	Band Stop 60 Hz Q = 5	1 KHz	100 (preset)	DC

These settings are automatically applied when you choose the **Pressure** preset but you can adjust them as necessary.

Pressure Transducer Calibration

Calibrating a blood pressure transducer is a two step process. The first step involves finding the optimal gain setting for the transducer and the second step is the actual calibration.

1) To find the optimal gain setting:
   a) Start with the software Presets (in this case, a gain of 100)
      - To set the Presets: MP3X menu > Setup channels > Analog Presets > select "Pressure"
   b) Bring the transducer to the approximate maximum and minimum expected pressures.
   c) Collect data for a few seconds at these settings.
   d) Inspect the sample data. You will want to look for data that is "railed" or "clipped." This occurs when the input signal (times the gain setting) is too large relative to the maximum input range. An example of clipped data follows.



Gain set too high — Clipped* BP *data

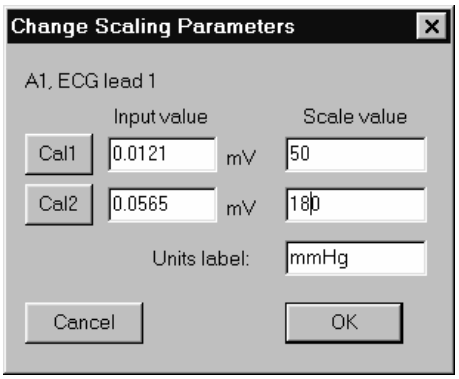
e) If the signal is clipped, decrease the gain setting by one step (e.g., from x5000 to x2500) and collect new data at the lower gain setting.
   - To access the Gain setting: **MP3X** menu **> Setup channels** > **Pressure** preset channel > **View/Change Parameters** icon > **Gain** pull-down menu

f) Repeat this procedure until the signal no longer appears "clipped."

Once an optimal gain setting for the transducer has been established, you should be able to use this same gain setting for other similar transducers and similar measurements.

2) The next step is to actually calibrate the transducer, which means mapping the input signal to more meaningful units (such as mmHg). To do this:

a) Access the Channel scaling dialog box (**MP3X** menu > **Setup Channels** > **Pressure** Preset channel > **View/Change Parameters** icon > **Scaling** button).



Note:
In this sample dialog, the transducer was brought to a pressure of 50 mmHg and the Cal 1 button was pressed.
The transducer was then brought to a pressure of 180 mmHg, and Cal 2 was pressed.

b) Bring the transducer to the lowest expected pressure.

c) Click on the **Cal 1** button in the Channel scaling window.
   - A voltage value will be automatically entered in the corresponding **Input value** box.

d) Bring the transducer to the highest expected pressure.

e) Click on the **Cal 2** button in the same scaling window.
   - A voltage value will be automatically entered in the corresponding **Input value** box.

The software will now interpolate between these two calibration points to give accurate measurements in mmHg.

SS13L PRESSURE TRANSDUCER SPECIFICATIONS

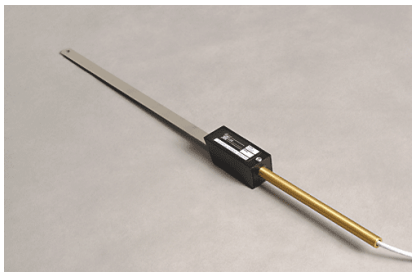
Operational pressure:	-50 mmHg to +300 mmHg
Overpressure:	-500 mmHg to + 4000 mmHg
Sensitivity:	25μV/VmmHg (at 5 VDC excitation)
Accuracy:	≤ ± 1.5% of reading or ± 1.0 mmHg (whichever is greater)
Operating temperature:	10° C to 40° C
Storage temperature:	-30° C to +60° C
Volume displacement:	0.04 mm per 100 mmHg
Leakage current:	10μA RMS @ 115 VAC 50 Hz
Dynamic response:	100 Hz
Unbalance:	50 mmHg max
Connection Ports:	Male Luer (2)
Eight-hour drift:	1 mmHg after 5-minute warm-up
Isolation:	<= 5 μA leakage at 120 VAC/60 Hz
Defibrillation:	Withstands 5 charges of 400 joules in 5 minutes across a load

Combined effects of sensitivity, linearity and hysteresis:	1 mmHg (nominal)
Transducer cable:	30cm
Interface cable:	3 meters
Transducer dimensions:	67mm long X 25mm wide
Weight:	11.5 grams

RX104A Replacement Element

The RX104A is a replacement element for the SS13L Pressure Transducer. It does not include the Smart Sensor connector and cable.

SS14L Displacement Transducer



For use in recording very slight movements in a range of physiological preparations, the SS14L incorporates a semi-isotonic strain gauge and a stainless steel lever that can be mounted in any position.

See the **Tension Adjuster** (HDW100A) on page 95.

SS14L SPECIFICATIONS

Sensitivity Range:	1mm to 100mm
Strain Gauge:	500 ohm silicon
Lever Length:	27cm
Support Rod Length:	15cm
Cable Length:	3 meters
Interface:	MP3X

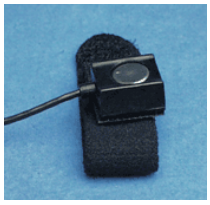
SS17L Physiological Sounds Microphone

The SS17L connects to the MP3X . The SS17L can be used with the SS19L non-invasive Blood Pressure Cuff or as a stand-alone device. If you use it with the SS19L, you can record Korotkoff sounds for easy determination of systolic and diastolic blood pressure. When used on its own, it can record a variety of acoustical signals, including heart sounds and sounds associated with ribbing or grinding (e.g., Bruxism). The acoustical transducer element is a Piezo-electric ceramic disk that is bonded to the interior of a circular metallic housing.

SS17L SPECIFICATIONS

Frequency Response:	35Hz to 3,500Hz
Housing:	Stainless Steel
Dimensions:	29mm diameter, 6mm thick
Transducer Weight:	9 grams
Sterilizable:	Yes (see BIOPAC for details)
Noise:	5 μV (RMS) (500-3,500Hz)
Output:	2V (P-P) maximum
Cable Length:	2 meters
Interface:	MP3X

SS18L Digit Temperature Probe

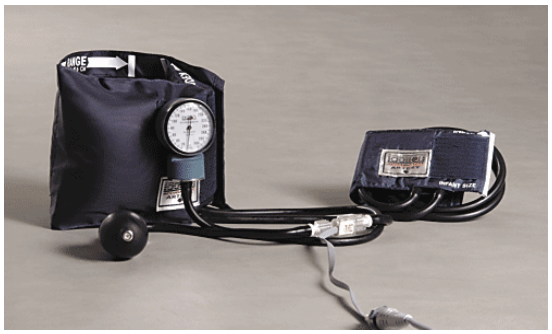


Record skin temperature of the fingers or toes. The probe contains a surface temperature sensing element encased in a polyurethane housing that conforms to curved skin surfaces and includes a Velcro strap for easy attachment.

Response time: 1.1 sec

Size: 16mm(long) x 17mm(wide) x 8mm(high)

SS19L Blood Pressure Cuff



As the cuff is wrapped around the upper arm of the subject, be sure to place the SS17L transducer **underneath** the blood pressure cuff, **directly over the brachial artery**. SS17L placement is very important to get the best possible recordings of Korotkoff sounds. Finish wrapping the cuff around the upper arm and secure it with the Velcro® seal. Now, start inflating the cuff with the pump bulb.

SS19L BLOOD PRESSURE CUFF SPECIFICATIONS

Cuff circumference range:	25.4 cm to 40.6 cm
Pressure range:	20 mmHg to 300 mmHg
Manometer accuracy:	±3 mmHg
Interface:	MP3X
Includes:	shielded 2-meter cable

CALIBRATION

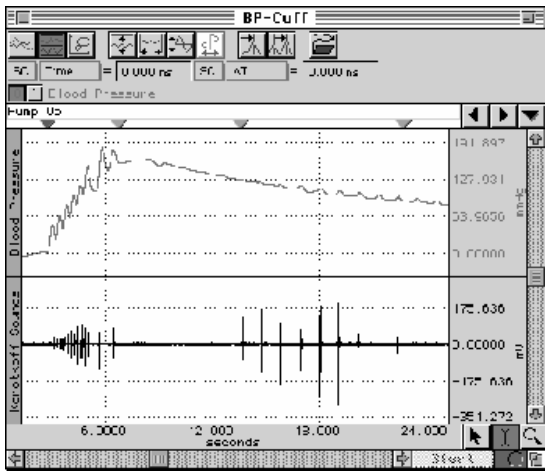
The SS19L's built-in pressure transducer will require an initial calibration prior to use. To calibrate the transducer, wrap the cuff into a roll and begin to inflate the cuff slowly with the pump bulb. You will notice the pressure change on the mechanical indicator. Set the cuff pressure to one lower pressure (typically 20 mmHg) and then one higher pressure (typically 100 mmHg). In this manner you can calibrate the pressure transducer using the standard procedure in the Scaling dialog box of the BSL *PRO* software. To use the cuff at a future date, simply save the calibration settings as a New Channel Preset or in a graph template or data file.

BLOOD PRESSURE MEASUREMENT

The most common form of indirect blood pressure measurement employs a pressure cuff, pump and pressure transducer. This complete assembly is commonly referred to as a Sphygmomanometer.

Typically, the cuff is wrapped around the upper arm and is inflated to a pressure exceeding that of the brachial artery. This amount of pressure collapses the artery and stops the flow of blood to the arm. The pressure of the cuff is slowly reduced as the pressure transducer monitors the pressure in the cuff. As the pressure drops, it will eventually match the systolic (peak) arterial pressure. At this point, the blood is able to "squirt" through the brachial artery. This squirting results in turbulence that creates the Korotkoff sounds. The Korotkoff sounds are detected using a **SS17L** physiological sounds microphone. The cuff pressure continues to drop, and the pressure eventually matches the diastolic pressure of the artery. At that point, the Korotkoff sounds stop completely, because the blood is now flowing unrestricted through the artery.

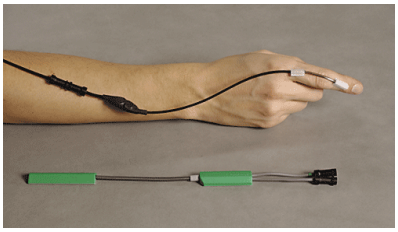
The following graph illustrates a typical recording using the SS19L and SS17L. The signal for the SS19L is usually further conditioned by the BSL *PRO* software. In a calculation channel, the SS19L signal is bandpass filtered from 50 to 200Hz. Accordingly, the sampling rate for the entire recording needs to be about 600Hz, assuming the SS17L transducer is used.



Cuff Blood Pressure versus Korotkoff Sounds

The pressure trace shows the hand pump driving the cuff pressure up to about 150 mmHg. Then the cuff pressure is slowly released by adjusting the pump bulb deflation orifice. Notice that the Korotkoff sounds begin appearing when the cuff pressure drops to about 125 mmHg (bottom trace). As the pressure continues to drop, the Korotkoff sounds eventually disappear, at about 85 mmHg. The **systolic pressure** would be identified at 125 mmHg and the **diastolic pressure** would be 85 mmHg.

SS20L - SS24L Goniometers & Torsiometers



Goniometers are devices capable of transforming angular position into a proportional electrical signal. The BIOPAC goniometers incorporate gauge elements that measure bending strain along or around a particular axis. The bending strain is proportional to the sum total angular shift along the axis. Because the bending force is extremely small, the output signal is uniquely a proportional function of the angular shift.

The BIOPAC Goniometer Series is designed for the measurement of limb angular movement.

- The single axis goniometer is designed to measure finger joint movement and will measure the angle in one plane only (e.g., thumb, toe).
- The twin axis goniometers are dual output devices and can measure angular rotation about two orthogonal planes simultaneously (e.g. wrist flexion/extension and radial/ulnar deviations).
- The torsiometers are used to measure angular twisting (as on the torso, spine or neck) as opposed to bending and they measure rotation about a single axis (e.g. forearm pronation/supination).

All the goniometers are unobtrusive and lightweight, and can be attached to the body surface using double-sided surgical tape (and can be further secured with single-sided tape). All goniometers have a telescopic endblock that compensates for changes in distance between the two mounting points as the limb moves. The gauge mechanism allows for accurate measurement of polycentric joints.

SS20L optimal for measuring angular rotation on the wrist or ankle.

SS21L commonly used to measure angular rotation on the elbow, knee and shoulder.

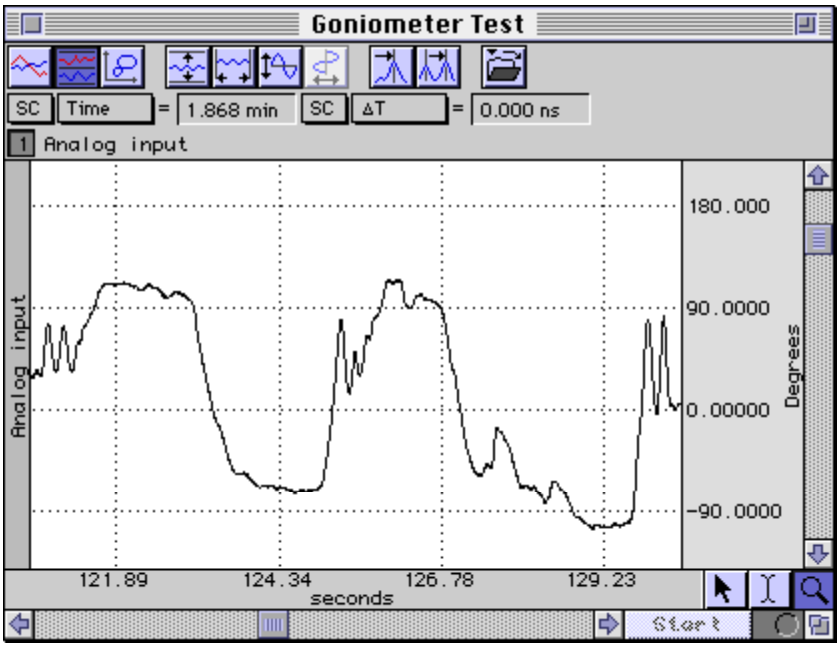
SS22L more appropriate for use on the neck.

SS23L might be best employed along the torso or spine.

SS24L placed on the fingers, thumb or toes.

Activity data can be displayed and recorded, allowing the subject to move about freely in the normal environment. The twin axis goniometers (SS20L, SS2L) come with two extension cables (one for each channel) and the single axis goniometers (SS22L, SS23L, and SS24L) come with one extension cable. Each lightweight extension cable is three meters.

The following graph illustrates standard **goniometer output**.



In this example, the SS20L was connected directly to the MP3X acquisition unit with the Gain set to 1,000, then BSL *PRO* Software was used to calibrate the signal to provide angular measurements from approximately +90° to -90°.

Each goniometer requires one channel per rotational axis. Accordingly, the twin axis goniometers will require two channels to measure both rotational axes simultaneously.

	SS20L	SS21L	SS22L	SS23L	SS24L
Type	Goniometer	Goniometer	Torsiometer	Torsiometer	Goniometer
Channels	2	2	1	1	1
Max Length	110mm	180mm	110mm	180mm	35mm
Min Length	75mm	130mm	75mm	130mm	30mm
Range	±180°	±180°	±90°	±90°	±180°
Weight	17g	19g	17g	19g	8g

OVERVIEW OF THE BIOPAC GONIOMETER SERIES

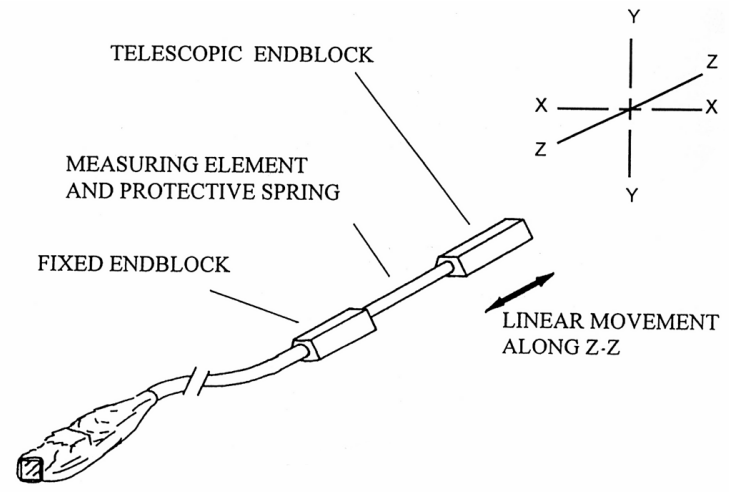
As with all measuring equipment, to correctly interpret the data, you should understand the working principles (i.e. what the sensor actually measures) before use. BIOPAC Systems, Inc. manufactures three types of sensors:

1. **Single Axis Finger Goniometer – SS24L**

   The SS24L single axis finger goniometer permits the measurement of angles in one plane.

   Angles are measured when rotating one endblock relative to the other about axis X-X.

   The goniometer is not designed to measure rotations about Y-Y. Any attempt to bend the unit in this way more than ± 20 from the neutral position will result in a reduction of the life of the unit or failure.

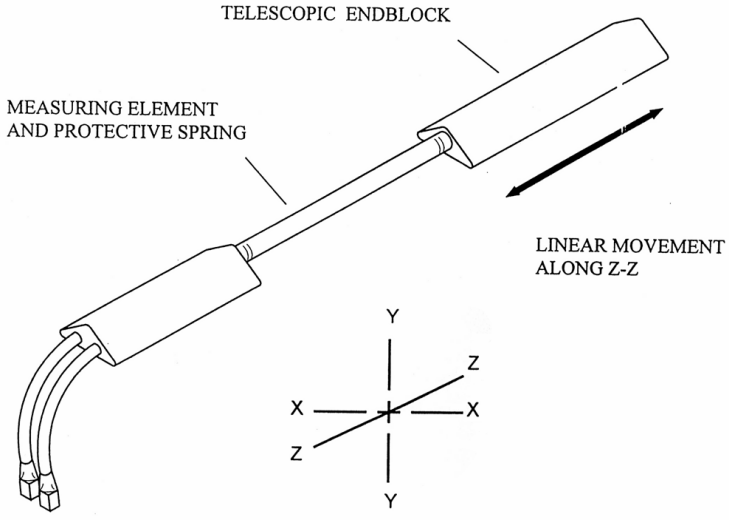


The goniometer does not measure rotations about axis Z-Z, though this movement is permitted without reduced life or damage occurring. This goniometer is designed primarily for the measurement of finger and toe flexion/extension.

2. **Twin Axis Goniometers – SS20L** and **SS21L**

   The SS20L and SS21L twin axis goniometers permit the simultaneous measurement of angles in two planes, e.g. wrist flexion / extension and radial / ulnar deviation. Rotation of one endblock relative to the other about axis X-X is measured using the gray plug. Similarly, rotation of one endblock relative to the other about axis Y-Y is measured using the blue marked plug.

   Assuming the goniometer is mounted correctly (as outlined here), the outputs of the two channels are independent of linear displacements along axis Z-Z.



It should be noted that rotation of one endblock relative to the other around axis Z-Z cannot be measured.

All SS20L and SS201L series goniometers function in the same way, and differ only in size.

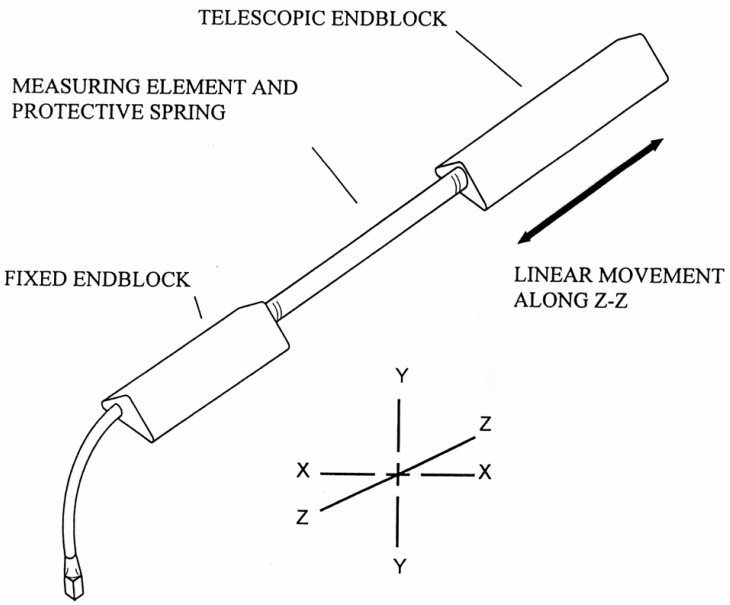
3. **Single Axis Torsiometers – SS22L** and **SS23L**

   The SS22L and SS23L single axis torsiometers permit the measurement of rotation in one plane, e.g. forearm pronation/supination.

   Axial rotation of one endblock relative to the other along axis Z-Z is measured from the gray plug.

   If the torsiometer is bent in planes X-X or Y-Y, the output remains constant.

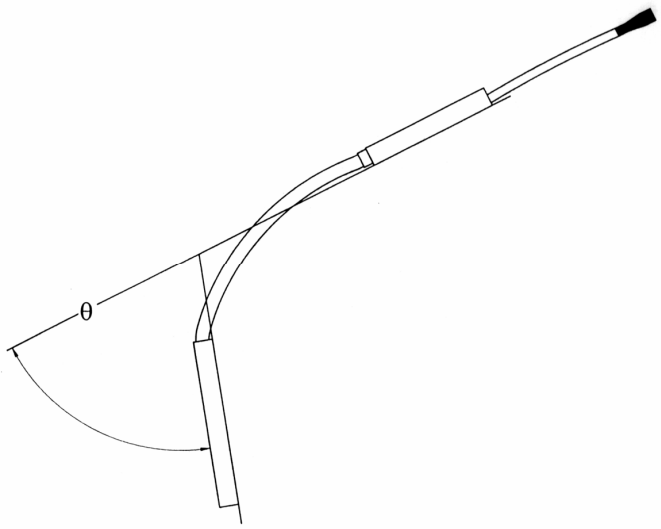
   All torsiometers function in the same way, and difference only in size.



WARNING!

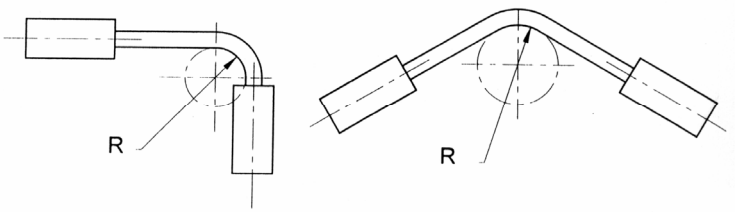
Torsiometers measure rotations about ZZ in the range ± 90°. **Exceeding the range may result in a reduction of the life of the unit or failure**.

The working mechanism is the same for all three types of sensors. There is a composite wire between the two endblocks that has a series of strain inside the protective spring gauges mounted around the circumference. As the angle between the two ends changes, the change in strain along the length of the wire is measured and this is equated to an angle. The design is such that only angular displacements are measured.



If the two ends move linearly relative to each other, within the limits of telescopic endblock, without changing the relative angles between them, then the outputs remain constant.

The amount of strain induced in the gauges is inversely proportional to the bend radius that the beam is bent around. If the stated minimum permissible bend radius is exceeded then unit life will be reduced or, in severe cases, failure may result.



When using all goniometers and torsiometers**, the minimum value of bend radius must be observed at all times**, particularly when attaching and removing the sensors from the subject. Failure to do this will result in reduced unit life or failure.

The sensors have been designed to be as light as possible and the operating force to be a minimum. This permits free movement of the joint without influence by the sensors. The sensors measure the angle subtended between the endblocks. Use the BSL *PRO* software calibration features (under **Setup Channels**) to calibrate any of the BIOPAC series goniometers.

WARNINGS

When using all goniometers and torsiometers, care should be taken so the sensors are only handled and manipulated as instructed. Mishandling may result in inaccurate data, reduced equipment life, or even failure.

When using all goniometers and torsiometers, the minimum value of bend radius must be observed at all times, particularly when attaching and removing the sensors from the subject. Failure to do this will result in reduced equipment life or failure.

Under no circumstances should the goniometer be removed from the subject by pulling on the measurement element and/or protective spring. The endblocks must be removed individually and carefully, making sure not to exceed the minimum permissible bend radius, particularly where the measuring element enters the endblocks.

When using the BIOPAC Goniometer Series, care should be taken during mounting so that the measurement element always forms a "simple" bend shape. If an "oxbow" shape occurs in the element, accuracy will be reduced.

When using the finger goniometer, the unit should not be bent more than ±20° in the Y-Y Plane. Otherwise, reduced equipment life and or failure may result.

Torsiometers measure rotations about ZZ in the range ± 90°. Exceeding the range may result in a reduction of the life of the unit or failure.

When cleaning or disinfecting goniometers and torsiometers, the transducers should be disconnected from the MP3X Acquisition Unit.

ATTACHMENT TO THE SUBJECT

Various combinations of display and recording instrumentation have been carefully developed fulfilling the requirements of specific research applications. Due to the wide range of applications, one method of attachment cannot be recommended. Experience has proven that standard medical adhesive tape is an excellent adhesion method in the majority of cases. Single-sided and double-sided medical tape (such as BIOPAC TAPE1 or TAPE2) should be used for the best results.

1. Attach pieces of double-sided tape to the underside of the goniometer endblocks.
2. Stick the tape to the subject and allow for the telescoping of the goniometer. The goniometer should be fully extended when the joint is fully flexed.
3. Press the two endblocks firmly onto the subject and ensure that the goniometer is lying over the top of the joint. When the joint is extended, the goniometer may present an "oxbow."
4. For additional security, pass a single wrap of single-sided medical tape around each endblock.
5. Secure the cable and connector leaving the goniometer with tape to ensure that they do not pull and detach the goniometer.
6. For accurate results from long recordings, employ double-sided adhesive between the endblocks and skin, and place single-sided adhesive tape over the top of the endblocks. **No tape should come into contact with the spring**. You should also tape the connection lead down near the goniometer.
7. For applications where quick or rapid movements are involved, fit a "sock" bandage over the whole sensor and interconnect lead. This does not apply to goniometer SS24L, which has a different working mechanism.

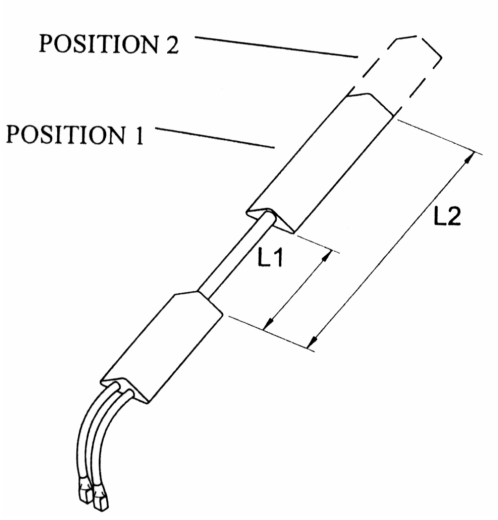
When the goniometer is mounted across the joint, the center of rotation of the sensor measuring element may not coincide with the center of rotation of the joint (for example, when measuring flexion /extension of the wrist). As the joint moves through a determined angle, the relative linear distance between the two mounting positions will change.

To compensate for this, all sensors are fitted with a telescopic endblock that permits changes in linear displacement between the two endblocks along axis ZZ without the measuring element becoming over-stretched or buckled.

In the free or unstretched position, the distance between the two endblocks is L1.

If a light force is applied, pushing the endblocks away from each other, this length will increase to a maximum of L2.

When the light force is removed, the distance between the two endblocks will automatically return to L1.

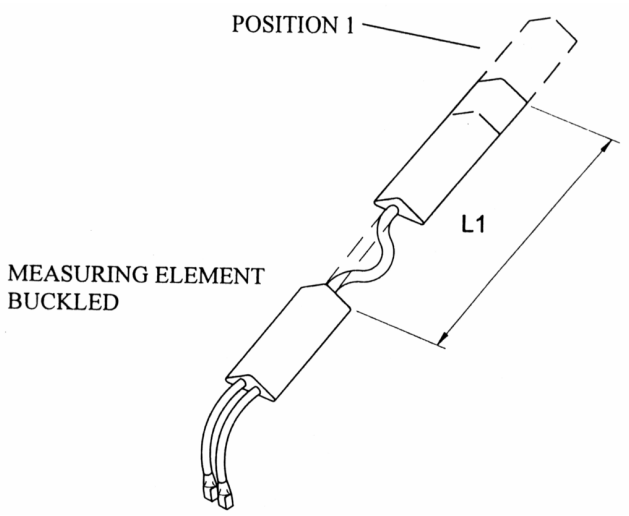


This creates several advantages: accuracy is improved; sensors can be worn comfortably and undetected under normal clothing; the tendency for the position of the sensors to move relative to the underlying skeletal structure is reduced.

If a light force is now applied, pushing the two endblocks linearly towards each other, the only way the distance L1 can decrease in length is if the measuring element buckles.

Buckling is detrimental to the accuracy of the SS20L, SS21L, SS22L and SS23L sensors, so attachment instructions are provided (on page 47) for the most commonly measured joints, to ensure that it does not occur in practice.

There is no universal rule governing which size of sensor is most suitable for a particular joint; this depends on the size of the subject.



In general, the sensor must be capable of reaching across the joint so that the two endblocks can be mounted where the least movement occurs between the skin and the underlying skeletal structure. In certain circumstances, more than one size of sensor will be appropriate.

CONNECTION TO BIOPAC SYSTEMS' INSTRUMENTATION

All sensors connect directly to the MP3X acquisition unit, as part of an MP3X System.

CLEANING AND DISINFECTION

Important: When cleaning or disinfecting, the sensors must be disconnected from all instrumentation.

Cleaning: Clean by wiping the sensors with a damp cloth, or a cloth moistened with soapy water.

No solvents, strong alkaline or acidic materials should be used to clean the sensors, or damage will result.

Disinfection: Disinfect the sensors by wiping the sensors with a cloth moistened with disinfectant.

MAINTENANCE & SERVICE

No periodic maintenance is required to ensure the correct functioning of the sensors.

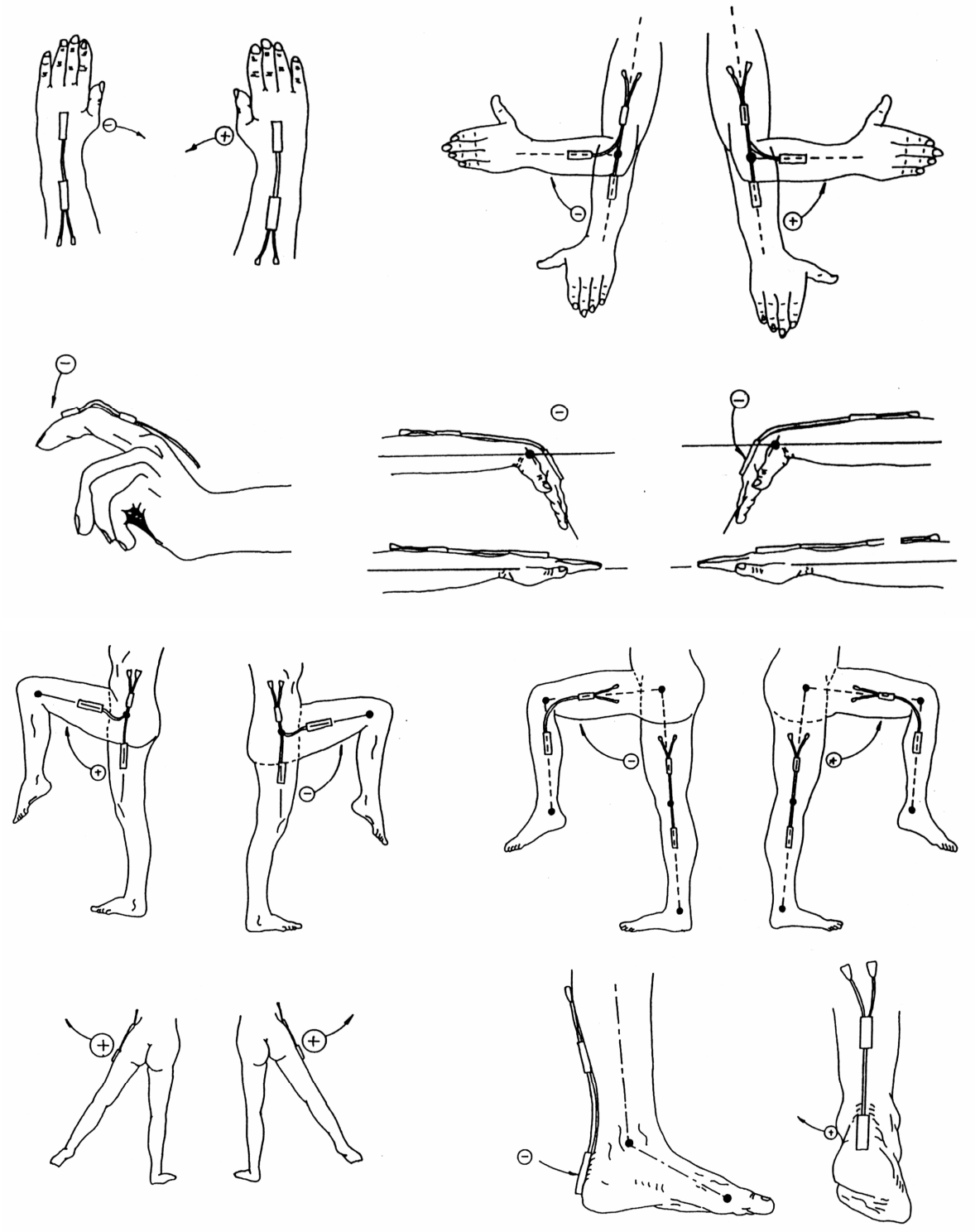
The sensors contain no user serviceable components.

If the sensor fails, it should be returned to BIOPAC Systems, Inc.

- **Please request a Return Merchandise Authorization** (RMA) number before you return the sensor and include a description of what has been observed and what instrumentation was in use at the time of sensor failure in the return package.

SIGN CONVENTIONS

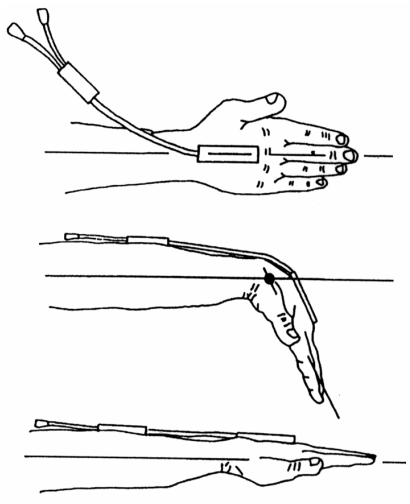
The sign convention for certain joints will differ, depending which side of the body the sensor is attached to. The following figures show sign conventions for the most common joints.



THE WRIST – SS20L Goniometer

Attach the telescopic endblock to the back of the hand, with the center axis of the hand and endblock coincident (top of figure — viewed in the frontal plane).

While fully flexing the wrist (middle and bottom of figure), extend the goniometer to Position 2 (as shown on page 44) and attach the fixed endblock to the forearm so that when viewed from the dorsal plane, the axes of the forearm and endblock are coincident. The wrist may now be flexed or extended, abducted or adducted, with the goniometer freely sliding between Positions 1 and 2. Measurement of flexion/extension is obtained from the gray plug, and abduction/adduction is obtained from the blue plug.

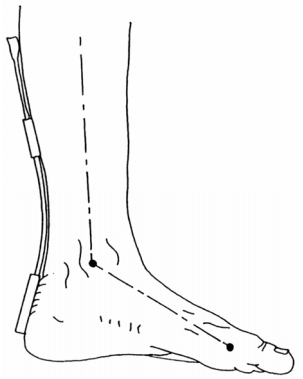


THE ARTICULAR COMPLEX OF THE FOOT – SS20L Goniometer

Attach the telescopic endblock to the back of the heel.

Extend the ankle to the maximum extension anticipated during measurement, and attach the fixed endblock to the posterior of the leg, with the goniometer in Position 1 (maximum length, as shown on page 44) so that the axes of the leg endblock are coincident.

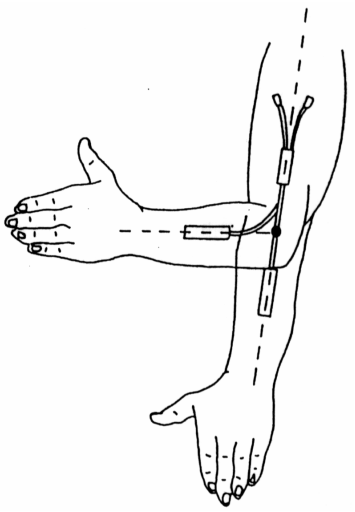
Flexion/extension of the ankle may now be monitored using the gray plug and pronation/supination using the blue marked plug.



THE ELBOW – SS21L Goniometer

Attach the telescopic endblock to the forearm with the center axis of the endblock coincident with the center axis of the forearm. With the elbow fully extended, move the goniometer to Position 2 (maximum length, as shown on page 44) and attach the fixed endblocks to the upper arm, with the center of the endblock and the center axis of the upper arm coincident.

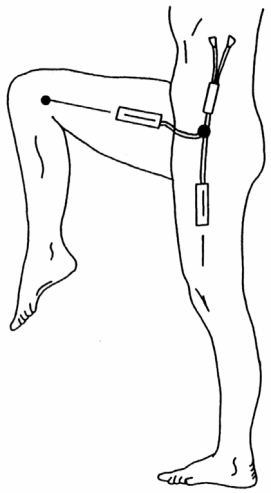
Now the elbow may be fully extended with the telescopic endblock freely sliding between Positions 1 and 2. Measurement of flexion/extension is obtained from the blue marked plug, and the gray plug is redundant. Note that the telescopic endblock is mounted on the half of the forearm nearest to the elbow joint. Movements of pronation and supination may be made and will affect the measurement of flexion/extension by a small amount.



THE HIP – SS21L Goniometer

Attach the fixed endblock to the side of the trunk in the pelvic region. With the limb in the position of reference, extend the goniometer to Position 2 (maximum length, as shown on page 44) and attach the telescopic endblock to the thigh, so that axes of the thigh and endblock coincide (when viewed in the sagittal plane, as shown).

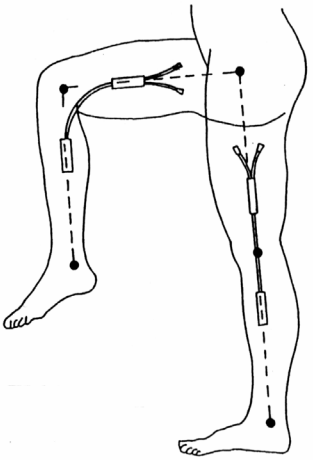
The thigh may now be flexed or extended, abducted or adducted, with the goniometer sliding freely between Positions 1 and 2. Measurements of flexion/extension are obtained from the blue marked, and abduction/adduction from the gray plug.



THE KNEE – SS21L Goniometer

Mount the telescopic endblock laterally on the leg so the axes of the leg and endblock coincide, when viewed in the sagittal plane. With the leg fully extended in the position of reference, extend the goniometer to Position 2 (maximum length, as shown on page 44) and attach the fixed endblock to the thigh so the axes of the thigh and endblock coincide.

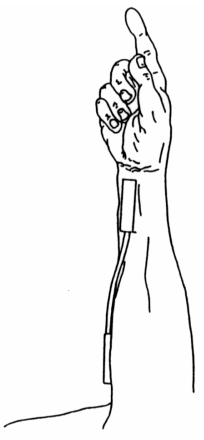
The knee may now be flexed or extended with the goniometer freely sliding between Positions 1 and 2. Measurements of flexion/extension may be monitored using the blue marked plug and varus/valgus may be monitored using the gray plug.



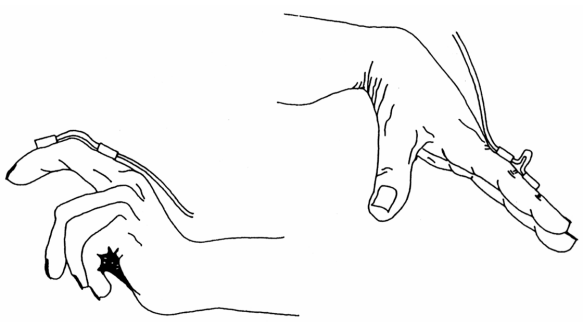
FOREARM PRONATION /SUPINATION – SS22L or **SS23L** Torsiometer

Attach the two endblocks of the torsiometer to the forearm, with the slider mechanism approximately midway between the two extremes.

Measurements of pronation/supination may now be made from the gray plug. Movements of wrist flexion/extension or radial/ulnar deviation will not affect the output.



FINGERS AND TOES – SS24L Goniometer



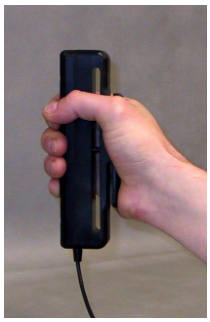
The SS24L goniometer is a single axis goniometer intended for use on fingers and toes. Angles are measured by rotating one endblock relative to the other about axis X-X (as shown on page 44).

The goniometer is not designed to measure rotations about Y-Y. **Any attempt to bend the unit in this way more than +/-20° from the neutral position will result in reduced unit life or failure**. The goniometer does not measure rotations about the axis Z-Z.

The unit is designed to fit over the joint to be measured and has extremely high flexibility to ensure the instrument does not interfere with normal joint movement. One endblock is attached either side of the joint.

Unlike the SS20L and SS21L series and "Z" series sensors, an "oxbow" shape is permitted in the measuring element. This is not detrimental to the results and does not reduce life of sensor. Care should be taken, however, **that the minimum bend radius is not exceeded**.

SS25LA Hand Dynamometer



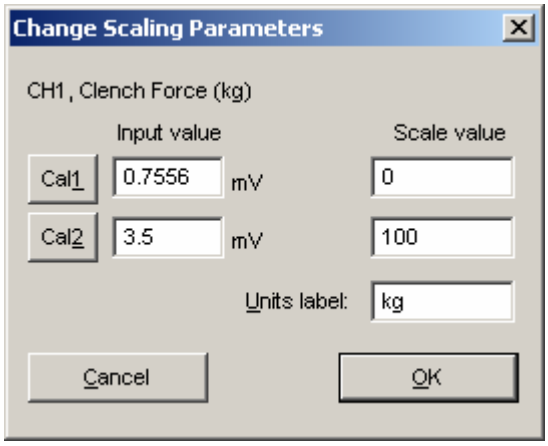
Use the hand dynamometer to measure grip force—use in isolation or combine with EMG recordings for in-depth studies of muscular activity. The lightweight, ergonomically designed transducer provides direct readings in kilograms or pounds. The simple calibration procedure makes this device easy to use for precise force measurements, and the isometric design improves experiment repeatability and accuracy.

HARDWARE SETUP

Connect the SS25LA Simple Sensor to a CH input on the front panel of an MP3X unit.

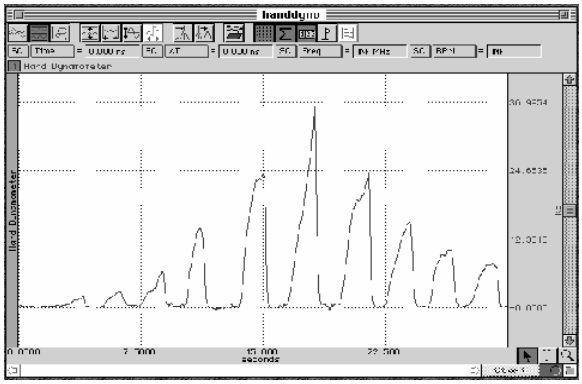
Proper grip: Place the palm across the shorter bar and wrap fingers to center the force.

SCALING — SOFTWARE SETUP FOR THE MP3X



1) Select **Setup Channels** under the MP3X menu and enable one analog channel.
2) Select the desired **Clench Force** Preset (Kg or Lbs).
3) Click on the **View/Change Parameters** button.
4) Click on the **Scaling** button to activate a dialog box similar to the one shown below:
5) In the **Scale value** column, enter the scaling factors of "0" for **Cal1** and "1" for **Cal2**. These represent 0 and 1 kilograms, respectively.
6) Take the SS25LA and rest it on the table.
7) Click on the **Cal1** button with the mouse to get a calibration reading.
8) To obtain a value for the **Cal2** box, add 3.5 mV per kg to the value from the Cal1 box.

CALIBRATION CONFIRMATION

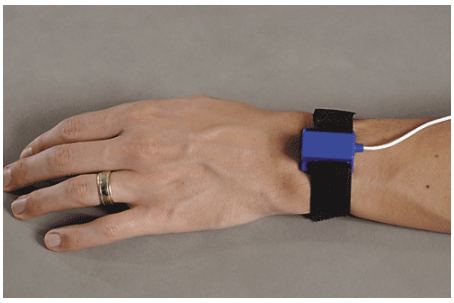


a) Click "Start" to begin data acquisition.
b) Place the hand dynamometer on a flat surface and then place a known weight on the uppermost portion of the grip.
c) Review the data to confirm that the known weight is reflected accurately in the data (sample at right).
d) Adjust the Scaling parameters and repeat until a-c as necessary.

SS25LA SPECIFICATIONS

Isometric Range:	0-90 Kg
Dimensions:	17.78 cm (long) x 5.59 cm (wide) x 2.59 cm (thick)
Nominal Output:	35 µV/kg
Weight:	323 grams
Cable Length:	3 meters

SS26L-SS27L Tri-Axial Accelerometers



Tri-axial accelerometer uses 3 channel inputs

The Tri-Axial Accelerometers connect directly to the MP3X and require no additional amplification. They provide three outputs, each simultaneously measuring accelerations in the X, Y, and Z directions. They are the same size and can be used on any part of the body or on external equipment. The pliable and unobtrusive design conforms readily to body contours. They come with a Velcro® strap for easy attachment.

- The **SS26L** is optimal for measuring accelerations when performing slow movements, such as walking.
- The **SS27L** is optimal for measuring quick movements, such as swinging a tennis racket.

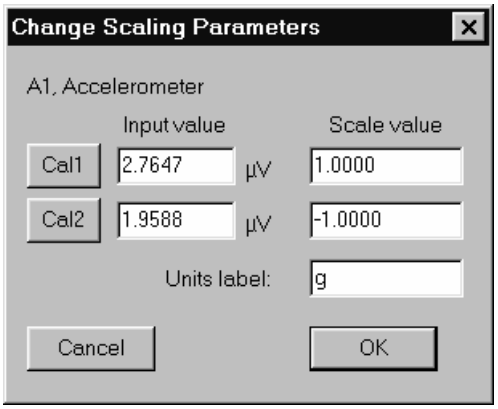
The accelerometers have a frequency response that extends from DC to 500Hz. It is extremely accurate and can be easily checked for calibration by simply changing its orientation in three-dimensional space, so that gravity (G=1) acts only upon the desired axis. One input channel is required for each output. Accordingly, you will require three input channels to measure each axis simultaneously.

ACCELEROMETER SPECIFICATIONS

Range (Output):	SS26L:	±5G (400 mV/G; 1 mV/G; 0 G is at 5 mV DC)
	SS27L:	±50G (40 mV/G; 100 mV/G; 0 G is at 5 mV DC)
Noise:	SS26L:	0.5 mG/SQRT(Hz rms)
	SS27L:	6.6 mG/SQRT(Hz rms)
Bandwidth:		DC - 500 Hz (-3dB)
Nonlinearity:		0.2% of Full Scale
Transverse axis sensitivity:		±2%
Alignment error:		±1°
Package:		Compliant silicone housing
Dimension:		33mm (long) x 28mm (wide, at base) x 19mm (high)
Weight:		17 grams
Power:		+5V @ 25 mA (via TEL100)
Sterilizable:		Yes (contact BIOPAC for details)
Cable Length:		3 meters
Interface:		MP3X Acquisition Unit

HARDWARE SETUP

The **SS26L** and the **SS27L** have three output connectors, one each for the X, Y, and Z axes. Each output connector must be connected to an **MP3X** input channel. For example the X-axis to channel 1, the Y-axis to channel 2, and the Z-axis to channel 3.



SOFTWARE SETUP

Select **Setup Channels** under the **MP3X** menu and enable three analog channels, one for each axis, with the appropriate **Accelerometer Preset** (5g or 50g).

a) Click on **View/Change Parameters** and then click on **Scaling**:

b) In the **Scale value** column, enter the scaling factors required, 1 for Cal1 and –1 for Cal2.

c) Enter "g" for the **Units label,** as shown.

d) Take the SS26L/SS27L and rest it in the upright position on the tabletop.

e) Calibrate the device by rotating it through 180° and taking a calibration reading at each point.

f) To calibrate the Y-axis, start with the transducer sitting on the table, face up, and click CAL1. Rotate the transducer 180°, so that it is now sitting upside down, and click the CAL2 button. This procedure must be followed for each axis. A label on the front of the transducer displays the X- and Y-axes. The Z-axis rotates from the end with the label and the end with the cable.

TESTING CALIBRATION

To see if the calibration is correct:

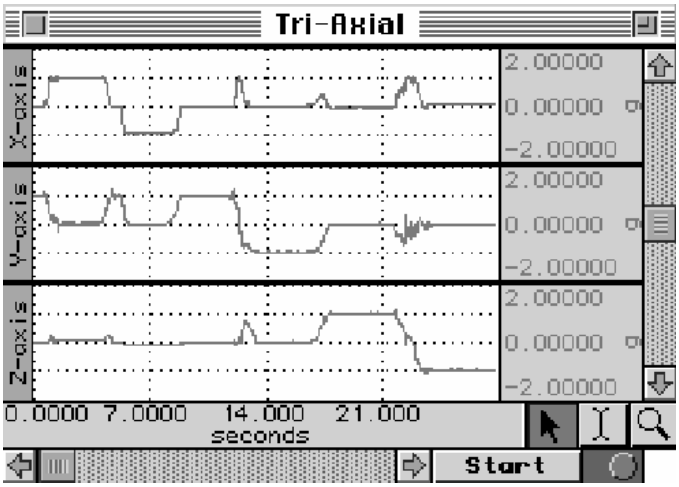
a) Start acquiring data (for the test procedure, you should use a sample rate of 50 samples per second)

b) Rotate the SS26L/SS27L 180° through each axis.

c) Set the vertical scale to 1 and the midpoint to 0 for all channels.

d) Repeat the calibration procedure (by rotating the transducer 180°) through each axis.

e) Visually confirm the correct calibration.



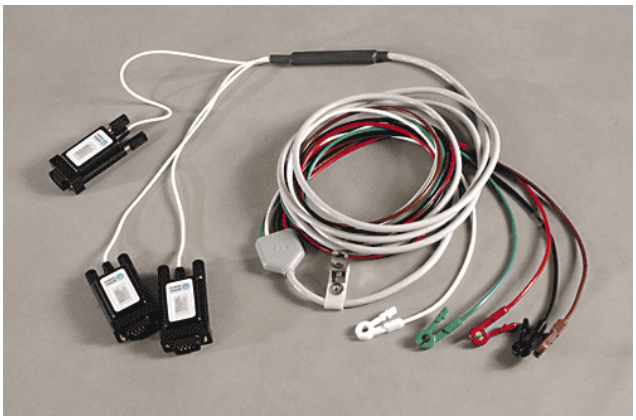
The screen shot above shows a tri-axial accelerometer being rotated through each axis. Channel 1 (X-axis) shows the signal moving from 1g to -1g as the transducer is rotated. Likewise, Channel 2 (Y-axis) shows the same phenomenon as previously described. Finally, Channel 3 (Z-axis) has also been tested and the calibration confirmed.

SS28L HEEL-TOE STRIKE

Use this transducer to record heel and toe strike activity as the subject walks. The heel/toe strike data is recorded as a single channel; the heel strike generates a negative deflection and the toe strike results in a positive deflection. Two force sensitive resistors (FSR) attach to the sole of a shoe; use two transducers to record from both feet.

Nominal Output Range: -1 to +1 V
Nominal Contact Force: 200g to indicate heel/toe strike
Attachment: TAPE1, TAPE2, Vinyl Electrical or Duct Tape
FSR Dimensions: 18.3mm (dia) x 0.36mm (thick) and 30cm pigtail lead
FSR Active Area: 12.7mm (dia)
Cable Length: 7.6 meters

SS29L Multi-Lead ECG Cable



The SS29L Multi-Lead ECG Cable permits high-resolution ECG recordings. This multi-lead set can simultaneously record Leads I, II, III, aVR, aVL, aVF, plus one precordial chest lead V(1-6). A 12-Lead ECG recording can be obtained by alternating the chest lead electrode from position V1 through V6. The cable terminates in three Smart Sensors that connect to the MP3X .

SS29L SPECIFICATIONS

Input Cable Length:	2 meters
Electrode Lead Length:	1 meter
Internal connection:	Built-in Wilson terminal
Electrode interface:	Connects to standard snap-connector disposable electrodes (EL503)

SS30L ELECTRONIC Stethoscope TRANSDUCER

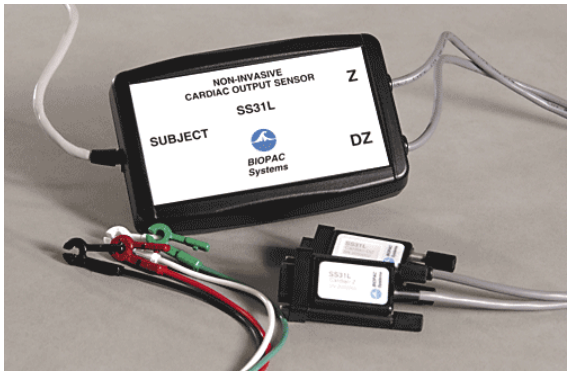
The **SS30L** stethoscope was developed to teach the standard procedure for listening to heart sounds and Korotkoff sounds with a "normal" stethoscope, and record simultaneous sound data. A microphone in the **SS30L** records sound as it is heard and the BSL software displays the sound wave during and after recording (a variety of acoustical signals can be recorded). If ECG is also recorded, the timing of the heart sounds with the ECG can be correlated. The **SS30L** can be used with the **SS19L** Blood Pressure Cuff to record Korotkoff sounds for easy determination of systolic and diastolic blood pressure. With this combination, it is easy to obtain very accurate and repeatable results — usually within 10% of those determined by direct measurement.

- No calibration required, just select a **Stethoscope Preset** (Heart or Korotkoff Sounds)
- See also: Biopac Student Lab Lesson 16 Blood Pressure and Lesson 17 Heart Sounds.

SS30L SPECIFICATIONS

Microphone Bandwidth:	20-100 Hz (does not impact acoustical bandwidth, used for data viewing)
Stethoscope Length	
From Y to acoustic sensor point:	57 cm
From Y to ears:	21 cm
Microphone Cable length:	3 meters

SS31L NONINVASIVE CARDIAC OUTPUT SENSOR

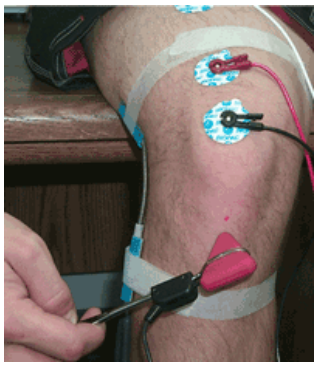


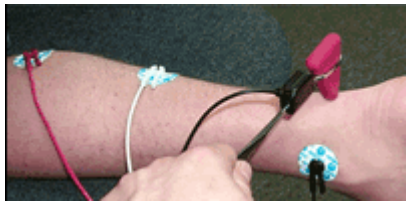
See BSL *PRO* Lesson **H21 Impedance Cardiography** for sample SS31L setup and data.

The SS31L records the parameters associated with Cardiac Output measurements. The SS31L incorporates a precision high-frequency current source, which injects a very small (400µA rms) current through the measurement tissue volume defined by the placement of a set of current source electrodes. A separate set of monitoring electrodes then measures the voltage developed across the tissue volume. Because the current is constant, the voltage measured is proportional to the characteristics of the biological impedance of the tissue volume.

- Use the SS31L to measure changes in Cardiac Output under a variety of conditions: laying down, sitting up, standing up, and post-exercise.
- Use on stationary subjects; the SS31L is sensitive to motion artifact.

SS36L Reflex Hammer





This is a classic reflex hammer with a transducer attached to perform reflex measurements. It uses a Taylor Hammer--the most common type of reflex hammer used by doctors and nurses--and incorporates electronics to record the time and the relative strength of the impact. Being able to measure the strength of impact allows students to take threshold measurements; that is, they can measure how much of an impact is needed to elicit a response. The hammer only sends a response when contact is made with the subject. See Lessons H16, H28.

SS39L Breadboard

The Bioengineering Breadboard Lab consists of circuitry hardware and eight projects (with schematics and design notes) that demonstrate a very important subset of circuit design for recording and processing physiological signals. Students will use the MP35 and BSL PRO software to evaluate their designs. See Lessons H25, H26.

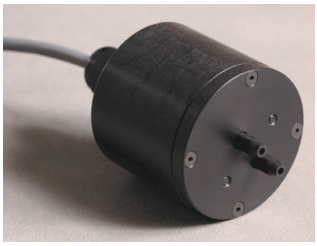
Circuitry Hardware

- Breadboard
- Breadboard to MP3X Power Cable (includes fuses with built-in,automatic reset)
- Signal Connection Cable (to record circuit performance)
- Box of resisters, diodes, etc. as required to complete projects.

Project Book includes schematics for:

1) Instrumentation Amplifier Notch
2) Active Filter: Low pass
3) Active Filter: High pass
4) Active Filter: Single Frequency Band pass
5) Active Filter: Single Frequency
6) Logarithmic Amplifier
7) Sine Wave Generator
8) Absolute Value Converter

SS40L-42L Differential Pressure Transducer



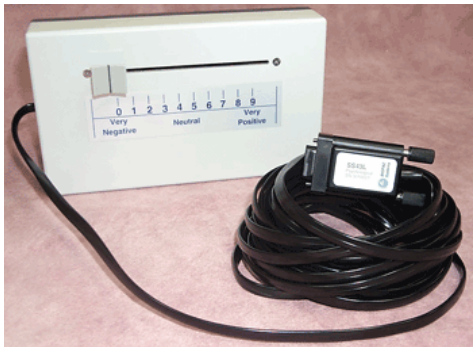
SS40L	±2.5cm H_2O
SS41L	±12.5cm H_2O
SS42L	±25cm H_2O

The SS40L-SS42L series differential pressure transducers are designed for low range pressure monitoring. The transducers plug directly into the MP3X general-purpose differential amplifier. The differential pressure ports are located on the front of the transducers and are easily connected to breathing circuits, pneumotachs or plethysmograph boxes. These transducers are very useful for interfacing a variety of small animal pneumotachs or plethysmographs to the MP System. The transducers are extremely sensitive and come in three ranges to suit a number of different applications. RX137 flow heads connect to the SS41L differential pressure transducer via standard 4mm ID tubing. Included with each SS45L-SS52L.

Voltage output (normalized to 1 volt excitation)
- SS40L: 330 µV/cm H2O
- SS41L: 130 µV/cm H2O
- SS42L: 65 µV/cm H2O

Warm-up Drift: ±50µV
Stability: ±100µV
Dynamic Response: 100Hz
Connection Ports/ID tubing Accepted: 3mm to 4.5mm
Dimensions: (high) x (wide) x (deep): 8.3cm x 3.8cm x 3.2cm
Weight: 76 grams
Operating Temperature (compensated): 0 to +50 °C

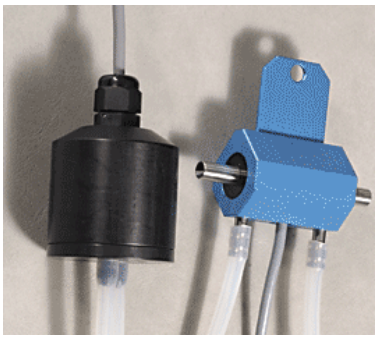
SS43L Psych Response Indicator



Use this handheld, slide control transducer to record subjective responses to a variety of different stimuli. Use multiple transducers to allow several people to simultaneously answer the same question or otherwise respond to stimuli. Easily customize the response scale by inserting your parameters into the scale sleeve on the front of the unit.

Scale Output Range: 0-5 V
Scale Resolution: Infinitely adjustable
Slide Control Length: 10 cm
Dimensions: 4cm (high) x 11cm (deep) x 19cm (wide)
Weight: 230 grams
Cable Length: 7.6 meters

SS45L – SS52L Airflow Pneumotach Transducer Series



The SS45L-SS52L series pneumotachs can perform a variety of pulmonary measurements relating to airflow, lung volume and expired gas analysis. Each transducer type consists of an airflow pneumotach head coupled to a precision, highly sensitive, differential pressure transducer. The pneumotachs will connect directly to a breathing circuit or plethysmogram chamber. For airflow and lung volume measurements, connect a short airflow cannula to the pneumotach flow head. For replacement head, see RX137A. For switchable or replacement head options, see the RX137 Series. All of the SS45L-SS52L series pneumotachs come equipped with an internal heating element that can be optionally attached to the AC137A 6-volt power supply.

Part	Replacement	Max. Range (ml/sec)	Dead Space (cc)	Output (µV/[ml/sec])	Ports ID; OD (mm)	Length (mm)	Animal Size; Weight
SS45L	RX137A	±12	0.1	25.700	1.35; 7.00	75	Small Mouse; 30 gm
SS46L	RX137B	±20	0.8	15.400	6.00; 7.00	75	Mouse; 50 gm
SS47L	RX137C	±60	0.9	5.780	6.00; 7.00	75	Rat/Guinea Pig; 350.0 gm
SS48L	RX137D	±150	2.0	2.100	9.00; 10.00	75	Cat/Rabbit; 750 gm
SS49L	RX137E	±350	4.0	0.924	10.00; 11.00	60	Small Dog; 5.5 kg
SS50L	RX137F	±1200	14.0	0.231	17.00; 19.00	60	Med. Dog; 15 kg
SS51L	RX137G	±3000	35.0	0.0963	28.00; 30.00	60	Large Dog; 25 kg
SS52L*	RX137H	±8000	80.0	0.0385	43.00; 45.00	60	Exercising Human

**Requires one coupler (AFT11F, page 35) to interface with the GAS-SYSTEM2 (page 34) and other airflow accessories.*

SS53L – SS55L Digital Switch Series

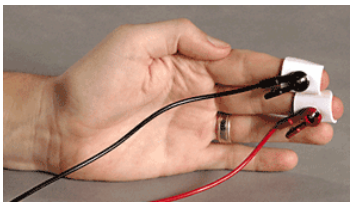
SS53L Hand switch
See Lessons H11, H16, H24, H27, H30.

SS54L Foot switch
See Lessons H11, H16, H24, H27, H30.
Switch Type: Pushbutton: ON - OFF
Dimensions: 69mm (wide), 90mm (long), 26mm (high)
Cable Length: 1.8 meters
Connector Type: 2mm pin plugs

Use for remote even marking or to externally trigger data acquisition for psychophysiological response tests Monitor switch data as a digital input channel. Connects to the digital input on the MP35 only.

SS55L Eight-channel Marker Box
See Lessons H11, H16, H24, H27, H30. Independently mark events, or provide responses, on up to eight channels simultaneously. Assign separate digital channels as event markers for individual analog input channels. Easily customize the response scale by inserting your parameters into the scale sleeve on the front of the unit.
Switch Type: Pushbutton: ON - OFF
Dimensions: 19cm (wide), 11cm (deep), 4cm (high)
Cable Length: 3 meters
Connector Type: Stripped & tinned wires

SS57L EDA Lead for Disposable Setups



Snaps to two EL507 disposable EDA (isotonic gel) electrodes. This disposable setup is an alternative to the reusable SS3LA EDA (GSR) Transducer.

Range: 0.1-100 µMho (normal human range is 1-20 µMho)
Excitation: 0.5 V DC
Pinch Leads: Red (+), Black (GND)

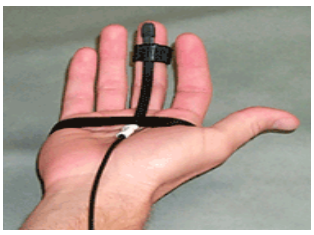
SS58L Low Voltage Stimulator

See page 13 for the Low Voltage Stimulator.

SS60L Signal Cable for SS39L Breadboard

Use this signal cable to add signal inputs to the SS39L Signal Processing Breadboard, which ships with one combination power/signal cable.

SS61L Finger Twitch Transducer



Use this transducer to record finger twitch responses from human subjects receiving electrical stimulation (using the HSTM01). The transducer conforms to the shape of the finger and attaches via a Velcro® strap and tape.

Transducer Dimensions 14.6 cm (long), 0.50 cm (wide)
Weight 6 g

SS62L Speech Frequency Microphone

Frequency Range:	60-12,000 Hz
Impedance:	600 Ohms
Type:	Cardioid
Cable:	6 meters
On/Off Switch:	none

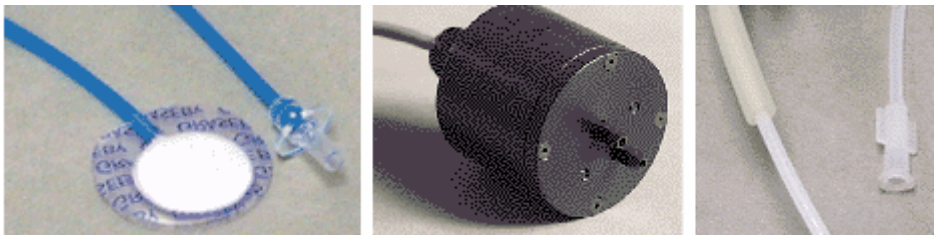
Use this precision microphone with the MP35 for speech frequency analysis and other acoustic studies for use wuith the MP35 only, requires continuous high-speed sampel rate.

SS63L- SS66L Force Transducer Series

SS63L Force Transducer - 50 g
SS64L Force Transducer - 100 g
SS65L Force Transducer – 200 g
SS66L Force Transducer - 500 g

Noise: with 10 Hz LP filter: 2.5 mg
with 1 Hz LP Filter: 1.0 mg
Temperature: -10°C to 70°C
Mounting rod: 9.5 mm (dia), variable orientation
Weight: 250 grams
Dimensions (L x W x Thick): 100 mm x 19 mm x 25 mm

SS67L Pneumogram Transducer



The SS67L consists of an SS41L differential pressure transducer, RX110 sensor, and tubing.

The multipurpose pneumogram transducer can be used to:
1.Noninvasively measure respiration -- from a small mouse to a human.
2.Measure small pressing forces (like pinching fingers together) for Parkinson's evaluations.
3.Measure human smiling (with the sensor on the cheekbone).
4.Measure pulse when placed close to the heart.
5.Measure spacing and pressure between teeth coming together.

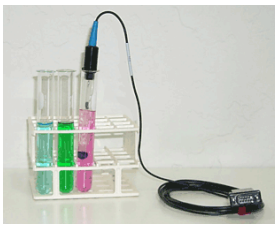
See RX110 for sensor specifications.

RX110 Replacement Sensor

The RX110 is a self-inflating pressure pad connected to tubing terminating in a Luer male connector. The RX110 sensor is included with the SS67L Pneumogram Transducer. The RX110 sensor can be used many times, but may eventually need to be replaced because it is a sensitive sensor and may become damaged with rough use. Use TAPE1 or other single-sided adhesive to affix to the subject

Sensor Pad Diameter: 20mm
Sensor Pad Thickness: 3.18mm
Sensor Tubing Diameter: 2.2mm
Sensor Tubing Length: 1m
Sensor Tubing ID: 1.6mm
Tubing Termination: Luer male
MRI Compatibility: Yes

SS68L pH Probe Transducer



The SS68L probe transducer can measure pH within the range of 0-14.

The electrode provides approximately a single digit pH value change for every 5 mV change in the electrode reading, either positive or negative depending on whether the pH is above 7 or below it.

~ A neutral buffer solution of pH 7 will read about 0mV.

~ A solution with a pH of 10 will read about –15 mV.

~ A solution with a pH of 3 will read about 20 mV.

The SS68L pH Transducer includes a double-junction pH Probe and an interface to the Biopac Student Lab MP30 unit.

- Order probe only as RXPROBE01
- To use the BSL with an existing (BNC terminated) pH probe, order the interface only as BSL-TCI21.

Type: Double junction

Refillable: Yes

Body: Glass

Weight: 3.5 ounces

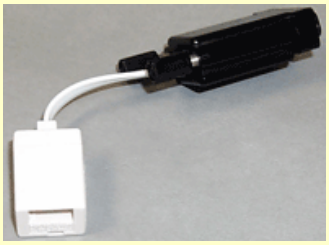
Length: 3.25m

Diameter: 1.2cm

SS69L Dissolved Oxygen Probe Transducer

SS69L Components

Order probe only as **RXPROBE02**



Order interface only as **BSL-TCI16**

The SS69L transducer measures dissolved oxygen. The SS69L includes a dissolved oxygen probe and an interface to the BSL MP35 or MP30 unit.

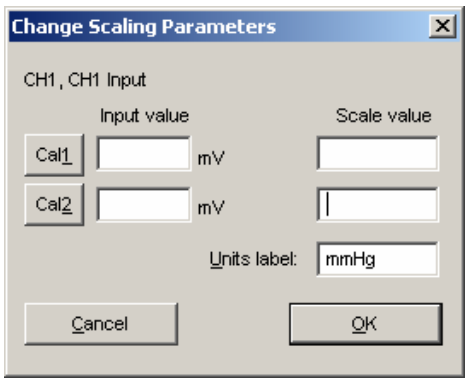
- See BSL PRO Lesson #A07 Fish Respiration and Q10.

Components	Dissolved O_2 probe	Sodium Sulfate calibration standard (2.0 M Na_2SO_3)
	Replacement membrane cap	Dissolved O_2 electrode filling solution
	Calibration bottle & pipette	Polishing strips
Interface	Use with BIOPAC BSL-TCI16 Transducer Connector to record with a BIOPAC data acquisition unit.	
Usage	There are four steps to using the Dissolved O_2 probe:	

1. Setup
2. Warm-up
3. Calibration — *optional*
4. Recording

1. Setup
   a. Remove and discard the blue protective cap from the tip of the probe.
   b. Unscrew the membrane cap from the tip of the probe.
   c. Use a pipette to fill the membrane cap with 1 mL of the Electrode Filling Solution.
   d. Carefully thread the membrane cap back onto the electrode.
   e. Place the probe into a beaker filled with about 100 mL of distilled water.
2. Warm-up
   a. Insert the BT connector on the RXPROBEO2 into the BSL-TCI16 transducer connector.
   b. Connect the BSL-TCI16 transducer connector to the MP35 or MP30 data acquisition unit.
   c. Turn the MP35 or MP30 unit ON and wait 10 minutes for the probe to warm up.
      - The probe must stay connected to the interface at all times to keep it warmed up. If the probe is disconnected for more than a few minutes, you will need to repeat the warm-up routine.
3. Calibration — *optional*
   - Calibration is optional. To measure relative change, probe calibration is not essential. To improve accuracy for discrete measurements, probe calibration is recommended.

   a. Zero-Oxygen (CAL 1)
      i) Launch the BIOPAC software and generate the scaling dialog for the probe channel. (Select MP35 or MP30 menu > Setup Channels > View/Change Parameters > Scaling Button.)
      ii) Enter 0 for CAL 1 Input value.
      iii) Remove the probe from the water and place the tip of the probe into the Sodium Sulfite calibration solution. IMPORTANT: No air bubbles can be trapped below the tip of the probe or the calibration will be distorted. If the voltage does not rapidly decrease, tap the side of the bottle with the probe to dislodge any bubbles.
      iv) When the voltage stabilizes (~1 minute), press the CAL 1 button. The Scale value result should be in the .2 - .5 mV range.



   b. Saturated Dissolved O_2 (CAL 2)
      i) Rinse the probe with distilled water and gently blot dry.
      ii) Unscrew the lid of the calibration bottle and slide the grommet approx. 12 mm (1/2") onto the probe body.

iii) Add water to the bottle to the depth of about 6 mm (1/4") and screw the bottle into the cap. IMPORTANT: Do not touch the membrane or get it wet during this step.

iv) Keep the probe in the position for about one minute and then press the CAL 2 button.The Scale value result should be above 2 mV.

v) Enter a Saturated Dissolved O_2 value (in mg/L) from Table 1, based on the current barometric pressure and air pressure values. If necessary, use Table 2 to estimate the air pressure at your altitude. [To calibrate and monitor using Percent Saturation, use the conversion formula on the next page.]

Table 1 Dissolved O2 (mg/L) in air-saturated distilled water (at various temp. & pressure)

	770 mm	760 mm	750 mm	740 mm	730 mm	720 mm	710 mm	700 mm	690 mm	680 mm	670 mm	660 mm	650 mm
0°C	14.76	14.59	14.38	14.19	13.00	13.80	13.61	13.42	13.23	13.04	12.84	12.65	12.46
1°C	14.38	14.19	14.00	13.82	13.63	13.44	13.26	13.07	12.88	12.70	12.51	12.32	12.14
2°C	14.01	13.82	13.64	13.46	13.28	13.10	12.92	12.73	12.55	12.37	12.19	12.01	11.82
3°C	13.65	13.47	13.29	13.12	12.94	12.76	12.59	12.41	12.23	12.05	11.88	11.70	11.52
4°C	13.31	13.13	12.96	12.79	12.61	12.44	12.27	12.10	11.92	11.75	11.58	11.40	11.23
5°C	12.97	12.81	12.64	12.47	12.30	12.13	11.96	11.80	11.63	11.46	11.29	11.12	10.95
6°C	12.66	12.49	12.33	12.16	12.00	11.83	11.67	11.51	11.34	11.18	11.01	10.85	10.68
7°C	12.35	12.19	12.03	11.87	11.71	11.55	11.39	11.23	11.07	10.91	10.75	10.59	10.42
8°C	12.05	11.90	11.74	11.58	11.43	11.27	11.11	10.96	10.80	10.65	10.49	10.33	10.18
9°C	11.77	11.62	11.46	11.31	11.16	11.01	10.85	10.70	10.55	10.39	10.24	10.09	9.94
10°C	11.50	11.35	11.20	11.05	10.90	10.75	10.60	10.45	10.30	10.15	10.00	9.86	9.71
11°C	11.24	11.09	10.94	10.80	10.65	10.51	10.36	10.21	10.07	9.92	9.78	9.63	9.48
12°C	10.98	10.84	10.70	10.56	10.41	10.27	10.13	9.99	9.84	9.70	9.56	9.41	9.27
13°C	10.74	10.60	10.46	10.32	10.18	10.04	9.90	9.77	9.63	9.49	9.35	9.21	9.07
14°C	10.51	10.37	10.24	10.10	9.96	9.83	9.69	9.55	9.42	9.28	9.14	9.01	8.87
15°C	10.29	10.15	10.02	9.88	9.75	9.62	9.48	9.35	9.22	9.08	8.95	8.82	8.68
16°C	10.07	9.94	9.81	9.68	9.55	9.42	9.29	9.15	9.02	8.89	8.76	8.63	8.50
17°C	9.86	9.74	9.61	9.48	9.35	9.22	9.10	8.97	8.84	8.71	8.58	8.45	8.33
18°C	9.67	9.54	9.41	9.29	9.16	9.04	8.91	8.79	8.66	8.54	8.41	8.28	8.16
19°C	9.47	9.35	9.23	9.11	8.98	8.86	8.74	8.61	8.49	8.37	8.24	8.12	8.00
20°C	9.29	9.17	9.05	8.93	8.81	8.69	8.57	8.45	8.33	8.20	8.08	7.96	7.84
21°C	9.11	9.00	8.88	8.76	8.64	8.52	8.40	8.28	8.17	8.05	7.93	7.81	7.69
22°C	8.94	8.83	8.71	8.59	8.48	8.36	8.25	8.13	8.01	7.90	7.78	7.67	7.55
23°C	8.78	8.66	8.55	8.44	8.32	8.21	8.09	7.98	7.87	7.75	7.64	7.52	7.41
24°C	8.62	8.51	8.40	8.28	8.17	8.06	7.95	7.84	7.72	7.61	7.50	7.39	7.28
25°C	8.47	8.36	8.25	8.14	8.03	7.92	7.81	7.70	7.59	7.48	7.37	7.26	7.15
26°C	8.32	8.21	8.10	7.99	7.78	7.78	7.67	7.56	7.45	7.35	7.24	7.13	7.02
27°C	8.17	8.07	7.96	7.86	7.75	7.64	7.54	7.43	7.33	7.22	7.11	7.01	6.90
28°C	8.04	7.93	7.83	7.72	7.62	7.51	7.41	7.30	7.20	7.10	6.99	6.89	6.78
29°C	7.90	7.80	7.69	7.59	7.49	7.39	7.28	7.18	7.08	6.98	6.87	6.77	6.67
30°C	7.77	7.67	7.57	7.47	7.36	7.26	7.16	7.06	6.96	6.86	6.76	6.66	6.56
31°C	7.64	7.54	7.44	7.34	7.24	7.14	7.04	6.94	6.85	6.75	6.65	6.55	6.45
32°C	7.51	7.42	7.32	7.22	7.12	7.03	6.93	6.83	6.73	6.63	6.54	6.44	6.34
33°C	7.39	7.29	7.20	7.10	7.01	6.91	6.81	6.72	6.62	6.53	6.43	6.33	6.24
34°C	7.27	7.17	7.08	6.98	6.89	6.80	6.70	6.61	6.51	6.42	6.32	6.23	6.13
35°C	7.15	7.05	6.96	6.87	6.78	6.68	6.59	6.50	6.40	6.31	6.22	6.13	6.03

Table 2 Elevation barometric pressure (based on barometric air pressure of 760 mmHg at sea level)

Elev. (feet)	Pressure (mmHg)	Elev. (feet)	Pressure (mmHg)	Elev. (feet)	Pressure (mmHg)	Elev. (feet)	Pressure (mmHg)
0	760	1500	720	3000	683	4500	647
250	753	1750	714	3250	677	4750	641
500	746	2000	708	3500	671	5000	635
750	739	2250	702	3750	665	5250	629
1000	733	2500	695	4000	659	5500	624
1250	727	2750	689	4250	653	5750	618

Conversion Formula for % Saturation

Set CAL 1 Scale to 0% and CAL 2 Scale to 100%, and then use the following formula to enter the Values:

% Saturation = (actual DO_2 result / Saturated DO_2 value from Table 1) x 100

For example, if the probe result is 6.1 mg/L at a temperature of 20ºC and a pressure of 740 mmHg, the correspondi ng Table 1 value is 8.93 mg/L, so % Saturation = (6.1 / 8.93) x 100 = 68%

4. Recording
    a. Place the tip of the probe into the sample to be measured. Submerge the tip about 4-6 cm (2”).
    b. Gently stir the probe in the sample. IMPORTANT: Keep stirring the probe in the sample—water must always be flowing past the probe tip for accurate measurements. As the probe measures the concentration of dissolved oxygen, it removes oxygen from the water at the junction of the probe membrane. If the probe is left still in calm water, reported dissolved O_2 measurements will appear to be dropping.

Storage

< 24 hours: Store the probe with the membrane end submerged in about 3 cm (1”) cm of distilled water

> 24 hours: Remove the membrane cap, rinse the inside and outside of the cap with distilled water, and then shake the membrane cap dry. Rinse the exposed anode and cathode inner elements, and then blot dry with a lab wipe. Reinstall the membrane cap loosely onto the electrode body for storage—do not tighten.

Polishing

The anode or cathode inner elements become discolored or appear corroded, use the polishing strips provided (once a year is generally sufficient). Contact BIOPAC for polishing details if necessary.

SS70L ISOLATED BNC Input Adapter

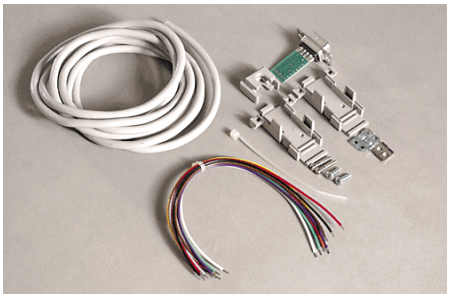
This adapter enables the Biopac Student Lab System to record signals from other devices (such as amplifiers, other chart recorders and signal generators). The BNC adapter can be used to measure signals as high as ±10V. The adapter cable terminates in a female BNC for easy connections.

SS70L SPECIFICATIONS

Connector type:	BNC
Signal range:	±10V

See also: OUT2 BNC Output Adapter

SS-KIT-IN Transducer Connector Interface Kit



See page 100 for the **TCI series** of available interfaces

This kit is for users who wish to adapt their own transducers to the Biopac Student Lab *PRO* System. The kit comes with a Smart Sensor connector, cable and components to properly interface with your transducers. The kit will allow you to connect quarter, half or full bridge transducers (pressure, force, strain, acceleration, sound, etc.) to your system.

SS-KIT-IN COMMENTS AND SUGGESTIONS

1) **Be careful of consumption**.

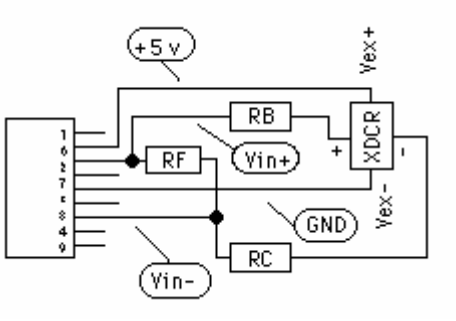
   You should be able to design your bridge circuit, so no more than 5mA are used to power the bridge. If your bridge takes more than 5mA, try reducing the voltage across the bridge by using series resistors or other kinds of regulators.

2) **Be careful of signal amplitude**.

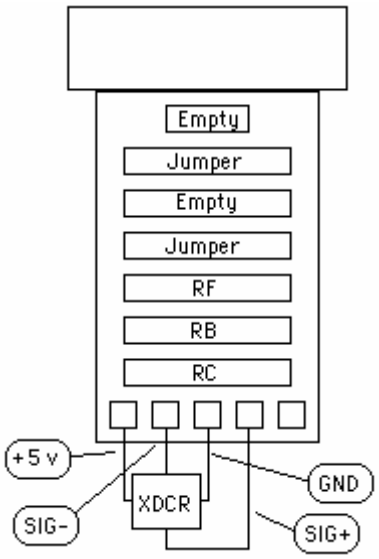
   Your signal input (conditioned by your bridge) should provide a signal no greater than ±50 mV between pins 2 and 4 on the 9 Pin D Male connector. If this voltage exceeds 50 mV (of either polarity), the input amplifier stages will saturate.

PIN	Description
1	Shield
2	Vin+
3	Ground
4	Vin-
5	Shield
6	+5 volts (ref)
7	No Connection
8	No Connection
9	-5 volts (ref)

9 Pin D Male connector pin-outs

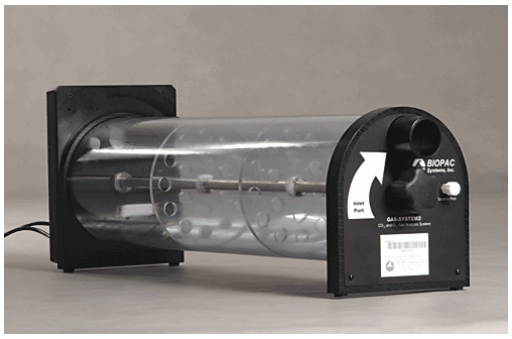


Schematic



Printed circuit board layout

GAS-SYSTEM2 CO_2 & O_2 Gas Analysis System



Modular assembly makes complete cleaning easy!

GAS-SYSTEM2-EA	Module with 5-liter chamber
RXGAS- EA	5-liter chamber/screw fixture
GAS-SYSTEM2-EB	Module with 1-liter chamber
RXGAS-EB	1-liter chamber/screw fixture

The GAS-SYSTEM2 measures expired O_2 and CO_2 concentrations. Obtain real-time Oxygen Consumption (VO_2) and Respiratory Exchange Ratio (RER) measurements using the MP3X System with the GAS-SYSTEM2 module and some airflow accessories.

When the subject inspires, air is drawn into the GAS-SYSTEM2 through the SS11LA airflow transducer. The SS11LA is placed on the inspiration side to eliminate any effects associated with expired air humidity.

When the subject expires, air is directed to the Gas-system2 module. The GAS-SYSTEM2 is designed to work with saturated expired air.

The non-rebreathing "T" valve directs only expired air to the GAS-SYSTEM2. Because only expired air is directed to the module, the system acts to average respiratory outflows. This averaging effect causes the CO_2 and O_2 concentrations to vary in accordance to the mean values resident in a few expired breaths.

The GAS-SYSTEM2 includes AFT7 tubing and an AFT22 “T” valve for a low-cost solution for Advanced System users who already have the AFT1, AFT2, AFT3. *Optional*: AFT10, AFT10S. For additional solutions, use:

- **S11LA with facemask and “T” valve**
  See AFT25, AFT7, AFT11A
- **SS11LA with large “T” valve and mouthpiece with filter**
  See AFT4, AFT9, AFT11D, AFT21, AFT7 AFT11A.
  Optional: AFT24 head support.

See page 66 for the **AFT series** of accessories for airflow and gas analysis

GAS-SYSTEM2 Specs

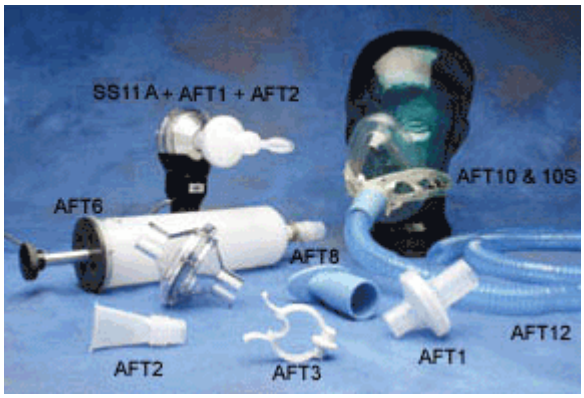
The O2 sensor is a zirconia solid electrolyte with a 0.1-25% sensing range and an estimated 5-year lifetime. It runs hot, which helps to burn off humidity. Warm-up: 10 minutes. Response time 10-90%: 30 sec. Accuracy: ±1% FSR*.

The CO2 sensor uses a humidity-repellant (hydroponic) membrane and has a sensing range of 0-5%. It uses non-dispersive infrared diffusion with single-beam IR and a self-calibrating algorithm. It also runs hot, which helps to burn off humidity. Warm-up: 2 minutes. Response time 10-90%: 45 sec. Accuracy: ±3% FSR*.

The GAS-SYSTEM2 sensors are factory calibrated prior to shipping.
The GAS-SYSTEM2 module is supplied with a 5 VDC @ 4 amp wall adapter.
*FSR = Full Scale Reading

❖ See BL *PRO* Lesson **H19 VO_2 and RER** for sample GAS-SYSTEM2 set up and data.

AIR FLOW & GAS ANALYSIS Accessories



See **BSL-ACCPACK** on page 94 for Student Accessory Pack option

AFT1 DISPOSABLE BACTERIAL FILTERS *Available in packs of 10 or 250*

This filter removes airborne bacteria. For use between the Airflow Transducer (SS11LA) and the Disposable Mouthpiece (AFT2). (22mm ID/OD).

AFT2 DISPOSABLE MOUTHPIECES *Available in packs of 10 or 250*

These mouthpieces connect to the Airflow Transducer (SS11LA) via the AFT1 Bacterial Filter. (22mm OD).

AFT3 DISPOSABLE NOSECLIPS *Available in packs of 10 or 250*

These noseclips gently squeeze the nostrils shut while using the SS11LA Airflow Transducer.

AFT4 DISPOSABLE BACTERIAL FILTER

This filter removes airborne bacteria. For use with 35mm breathing circuits; one side has a 35mm ID port, the other side has a 35mm OD port.

AFT6 CALIBRATION SYRINGE

0.6 Liter Calibration Syringe for the SS11LA Airflow Transducer.

AFT7 SMOOTH BORE TUBING (35MM)

For use with 35mm breathing circuits. (1 meter length, 35mm ID, 38mm OD)

AFT7-L For use with 35mm breathing circuits. (3 meter length, 35mm ID, 38mm OD)

AFT8 AUTOCLAVABLE MOUTHPIECE *Available in packs of 1 or 10*

30mm ID; interfaces with the SS11LA and reduces the cost of disposable parts.

AFT9 REUSABLE MOUTHPIECE *Available in packs of 1 or 10*

This mouthpiece connects to 35mm breathing circuits. Connects directly to the AFT4 bacterial filter or the AFT21 non-rebreathing T valve. (35mm ID)

AFT10 DISPOSABLE FACE MASK

This facemask connects to 22mm breathing circuits. Connects directly to the AFT1, AFT22 non-rebreathing "T" valve or TSD117 air flow transducer (via AFT11B coupler). Includes hook-ring to secure AFT10S adjustable head strap. (22mm ID/25mm OD).

AFT10S ADJUSTABLE HEAD STRAP

This fully adjustable non-latex reusable head strap holds the AFT10 disposable facemask securely to the subject's head. Use one strap to securely fasten the mask.

AFT11 FLEXIBLE COUPLERS

Useful for connecting a variety of air flow port IDs and ODs to transducers, tubing and calibration syringes.

AFT11A: Couples 25-30 mm OD to 25-30 mm OD, or 25-30 mm OD to 28-35 mm ID, or
28-35 mm ID to 35 mm ID

AFT11B: Rigid coupler. Couples 15 mm OD – 22 mm ID.

AFT11D : Couples 35-38 mm OD to 35-38 mm OD.

AFT11E: Flexible coupler. Couples 22-25 mm OD to 25-30 mm OD, 35-38 mm ID to 38 mm ID, or 35 mm OD to 38 mm ID.
Included with GAS-SYSTEM2. Use to connect AFT7 tubing to AFT22 T-Valve or AFT25 Facemask.

AFT11F: Flexible coupler. Couples 35 mm ID to 45 mm OD.Use two couplers to interface the SS52L Airflow Transducer with the GAS-SYETM and other airflow accessories.

AFT12 TUBING (22MM)

For use in 22mm breathing circuits. (1.8 meter length, 22mm ID, 25mm OD)

AFT21 NON-REBREATING "T" VALVE (35MM)

This non-rebreathing "T" valve is a high performance, very low dead space, low air flow resistance valve; suitable for high air flow applications (e.g. exercise physiology). The AFT21 incorporates a gas sampling port (female Luer) for interfacing with the AFT20 gas sampling kit. For breathing directly into the valve, use the AFT9 mouthpiece, AFT3 nose clip and (optionally) the AFT24 head support.
All ports are 35mm OD, 30mm ID.

AFT22 NON-REBREATHING "T" VALVE (22MM)

The non-rebreathing "T" valve incorporates a gas sampling port. All ports are 22mm OD. The gas sampling port is a Male Luer connector. Requires: AFT1 and AFT2 for proper operation. Includes 22mm OD coupler.

AFT24 HEAD SUPPORT

The AFT24 head support is useful for exercise physiology measurements when breathing directly into the AFT21 non-rebreathing "T" valve. The AFT21 is secured directly in front of the subject and minimizes the strain associated with the weight of valves and tubing.
Shown at right with AFT21, AFT9, and AFT7—all not included

AFT25 FACE MASK

This adult facemask with integral non-rebreathing "T" valve is a high performance, very low dead space, low air flow resistance mask and valve; suitable for high air flow applications (e.g. exercise physiology). The AFT25 incorporates two gas sampling ports (female Luer) for interfacing with the AFT20 Gas Sampling Kit.
All ports are 35mm OD, 28mm ID.

AFT26 CALIBRATION SYRINGE

The AFT26 is a 2.0 Liter Calibration Syringe for the SS11LA Airflow Transducer. The AFT26 is a more precise alternative to the AFT6 for advanced studies and increased calibration range. The AFT26 Calibration Syringe is certified to have a 2-liter volume that meets or exceeds an accuracy ± 1% of the total displacement volume.

GASCAL The Calibration Gas Cylinder is 4% Carbon Dioxide, 16% Oxygen, balance Nitrogen.
Use with BIOPAC Gas Analysis Modules *See also*: Regulator GASREG

Calibration Gas Specs

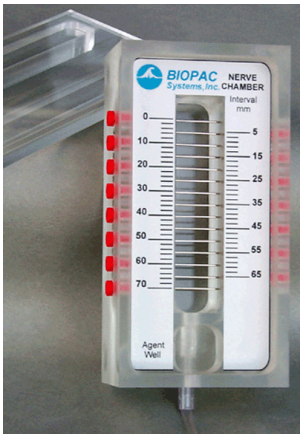
Composition:	4% Carbon Dioxide, 16% Oxygen, balance Nitrogen
Cylinder Type:	ED
Valve Connection:	CGA-973
Accuracy:	+/-0.03% absolute
Stability Guarantee:	3 years
Cylinder Pressure:	2200 psig
Gas Volume:	560 liters

Compliance: Certificates of Accuracy in compliance with specifications and cylinder labeling meet the Department of Transportation (DOT) and Occupational Safety and Health Administration (OSHA) regulations for shipments of compressed gases.

Cylinder Recycling Program available.

GASREG Use this single stage, non-corrosive, general-purpose regulator with the GASCAL Calibration Gas Cylinder.

NERVE CHAMBERS



Feature	NERVE1	NERVE2
Deep Reservoir (35mL)—contain Ringers or other solutions	x	x
Drain—facilitate extended viability of your preparation.	x	x
Agent Well—add compounds (ether, dry ice, etc.) 1.4cm x 2cm x 2cm (h x w x l)	x	x
Lid—enclose the preparation. 50mm thick	x	--
Valve & hose—flush and drain options	x	--

The acrylic, desktop Nerve Chambers have 15 stainless steel pins for recording and stimulating a variety of different nerve preparations. Each stainless steel pin is spaced 5mm apart to provide a variety of recording and stimulating configurations. The sockets accept 2mm plugs and interface with the BSLCBL2A stimulation cable and the BSLCBL4B recording cable.

Dimensions (h x w l): 4.5cm x 7cm x 14cm

See Lesson A03 Compound Action Potential: Nerve Conduction Using the Frog Sciatic Nerve.

NIBP100A Noninvasive Blood Pressure System

The NIBP100A is classified to U.S. and Canadian safety standards with respect to electric shock, fire and mechanical hazards in accordance with UL2601-1 and IEC 60601-2-30.

The sensor requires replacement every six months—use BIOPAC Part No. RXNIBPA

Specifications

Monitor	
Case:	Aluminum
Size:	5.0 (h) x 4.5 (w) x 8.5 (l) -- inches
Weight:	4.5 lbs with power cord and wrist module
Displays	
LCD:	Cold Cathode Fluorescent Backlight (CCF);
LED:	Three (3) high-intensity displays;
Electrical	
Ratings:	100-240 VAC, 50/60 Hz, 0.25 - 0.5A max
Current Leakage:	UL544
Equipment Interface	
I/O Jack:	1/4-inch standard phone jack
Data port:	25 Pin RS-232
Performance Range	Min/Max Accuracy
Systolic:	40mmHg-240mmHg+ 5mmHg/SD 8mmHg
Mean:	30mmHg-200mmHg+ 5mmHg/SD 8mmHg
Diastolic:	20mmHg-180mmHg+ 5mmHg/SD 8mmHg
Pulse:	40 bpm - 200 bpm+ 5 bpm or 10%
Trend	Updated tabular and graphical trends following each reading, up to approximately 900 readings.
Clock speed	33MHz/min; provides reliable, high-speed digital signal processing.

The noninvasive NIBP100A provides continual blood pressure measurement with accuracy comparable to an indwelling radial artery catheter. The NIBP100A is an accurate, continual, and noninvasive solution to blood pressure monitoring. Using a patented method of measuring radial artery waveforms, the NIBP100A system calculates accurate systolic, diastolic and mean pressures. The data is processed by a proprietary algorithm based on a set of coefficients derived from clinical data.

*** No complicated setup or calibration requirements! ***

The NIBP100A is easy to use. Just position the wrist sensor and make one keystroke to begin measuring arterial blood pressure. The intelligent pressure sensor in the NIBP100A applies variable pressure directly above the radial artery and as a result, a continuous sweep of approximately 15 pulse pressure waveforms is recorded.

Within 15 heartbeats, the initial measurement and waveform are displayed, and the display is continually updated every 10-15 heartbeats.

Very slight changes in blood pressure down to 40mmHg systolic are measured. Certain waveform parameters are computed in real time. In addition, the NIBP100A system provides trend lines and historical data on the graphics screen. The historical data may also be output to a standard serial port or printer.

Subjects experience minimal sensation while wearing the wrist sensor. Operation is very smooth and quiet. The wrist sensor fits adults of any size, can be worn on either wrist, and is completely latex-free.

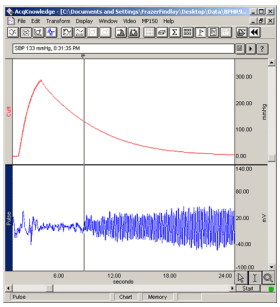
The NIBP100A also provides improved ability to obtain measurements from subjects undertaking light exercise or psych analysis conditions. The NIBP100A quickly rejects most artifact caused by arm movement and automatically initiates a new measurement when the wrist is at rest. It takes just 15 heartbeats to obtain and display a new measurement. As with an arterial line, the arterial waveform highlights artifact rejection.

RX-NIBP100A

The sensor in the NIBP100A requires replacement every six (6) months. The sensor has an internal processor that monitors the age of the sensor. The sensor starts counting after the first few uses and then automatically stops on the 6-month anniversary.

NIBP200A Small Animal Tail Noninvasive Blood Pressure System

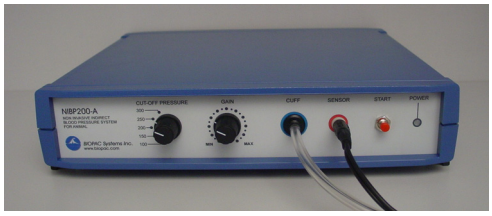
- NIBP200A1 = 110 V /60 Hz
- NIBP200A2 = 220 V /50 Hz



NIBP200A System includes:

- NIBP200A control unit
- One tail cuff sensor
  - RXTCUF9.5 =9.5 mm, 100-220 g
  - RXTCUFF-11 = 11 mm, 200-280 g
  - RXTCUFF-13 =13 mm, 250-350 g
- One small animal restrainer
  - RXRESTRAINER -L Large
  - RXRESTRAINER -M Medium
  - RXRESTRAINER -S Small
  - RXRESTR-MICE Mice

NIBP200A SYSTEM CONNECTIONS

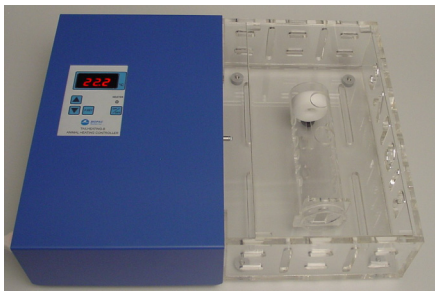


NIBP200A Front Panel

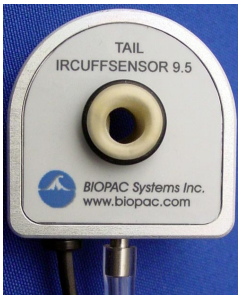
NIBP200A Rear Panel

1. Connect the CBL35-Pre cable
   a. BNC to the PRESSURE output on the back panel of the NIBP200A.
   b. other end to CH1 on the front of the MP35 unit
2. Connect the CBL35-Pls cable
   a. BNC to the PULSE output on the back panel of the NIBP200A.
   b. other end to CH2 on the front of the MP35 unit.
3. Connect the IRSENSOR
   a. Black cord to the sensor input on the front panel of the NIBP200A.
   b. tubing in the cuff on the front panel of the NIBP200A.
4. Connect the power
   a. AC100 adapter to the 12V DC input on the back panel of the NIBP200A.
   b. AC100 to Mains power.
5. Switch the POWER on.

ANIMAL PREPARATION


Animal Heating Chamber


Restrainer Animal Holders



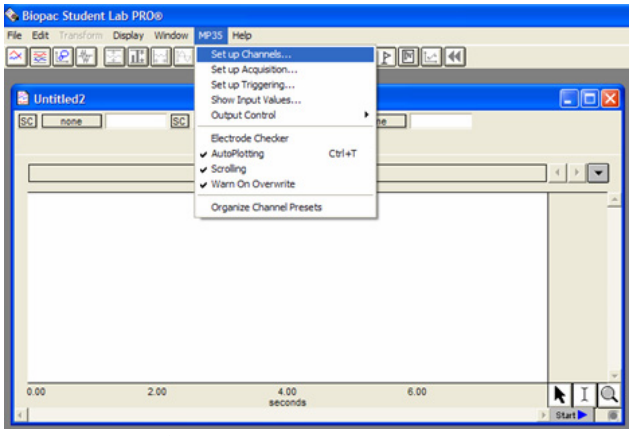
Tail Cuff/Sensor

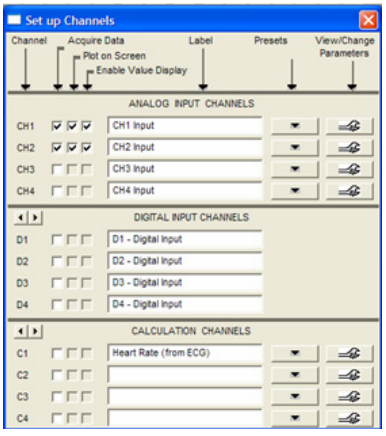
1. Turn the Animal Heating Chamber on.
2. Set the temperature value (press and hold P.Set and then press the up or down arrow to reach the desired value).
   - For accurate noninvasive blood pressure measurement, the animal or its tail should be warmed to 32°C.
3. Press the Heater button to start heating to the selected temperature value.
4. Place the animal inside the RESTRAINER "Animal Holder" (select the suitable size for the animal volume).
   - Leave the tail outside.
   - Adjust the length to obtain a position where the animal has limited movement.
5. Place the RESTRAINER (with the animal) in the heating section of the Animal Heating Chamber.
6. Wait approximately 30 minutes for the animal to reach the selected temperature.
7. Remove the RESTRAINER from the Animal Heating Chamber.
8. Connect the IRSENSOR to the tail of the animal inside the RESTRAINER.
9. Check if the sensor just fits to the tail. The sensor should be between the mid point of tail and tail end (spinal column). To achieve this, a suitable sensor should be selected.
10. Wait for the animal to relax and become inactive before starting measurements.

TIP Before starting the experiment, for conditioning the animal, you should put the animal inside the holder several times a day and repeat the heating each time.

BSL *PRO* SOFTWARE SETUP

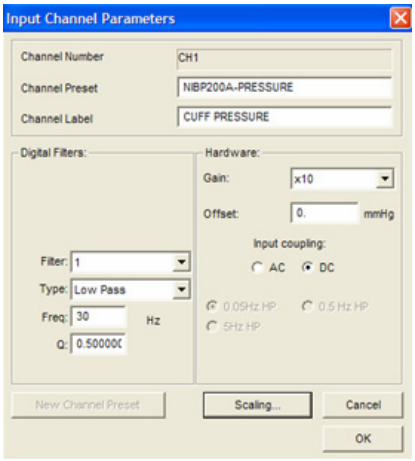
1. Launch the BSL *PRO* software.



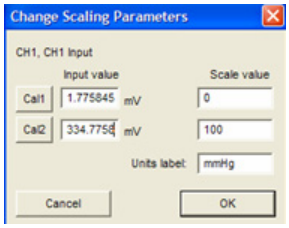


2. Choose MP35 > Set up Channels.
3. Enable analog inputs CH1 and CH2 to Acquire Data, Plot on Screen and Enable Value Display.
4. Click View/Change Parameters for CH1 and establish the following settings:

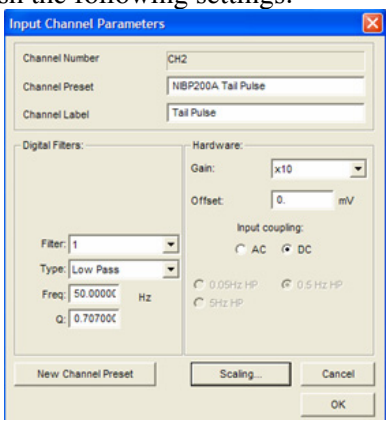
Channel Preset= NIBP200A-PRESSURE
Channel Label= CUFF PRSSUE
Gain= x10
Input coupling = DC
Filter =1
Type= Low Pass
Freq= 30
Q= 0.5



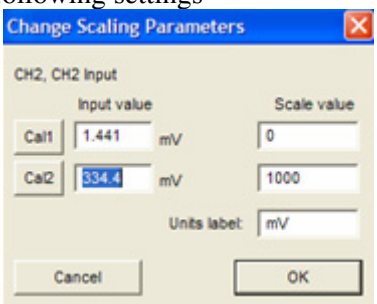
5. Calibrate for the pressure measurement of IRSENSOR.
   a. Click Scaling and establish the following settings
      Scale values
      Cal1 = 0
      Cal2 = 100
      Units Label = mmHg
   b. Click the CAL1 button successively a few times.
   c. Add 333 to the Cal1 Input value, and enter the result in Cal2 Input value (Cal2 = Cal1 + 333)
   d. Click OK as needed to close out of CH1 setup.



6. Click View/Change Parameters for CH2 and establish the following settings:
   Channel Preset= NIBP200A Tail Pulse
   Channel Label= Tail Pulse
   Gain= x10
   Input coupling = DC
   Filter =1
   Type= Low Pass
   Freq= 50
   Q= 0.5

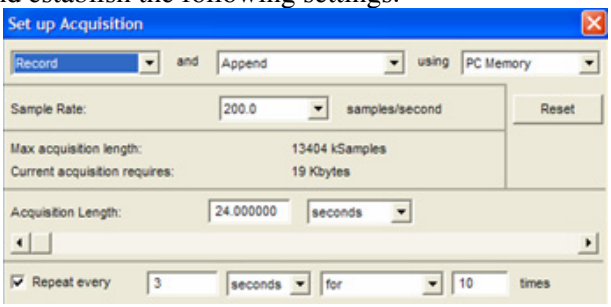


7. Calibrate for the pressure measurement of IRSENSOR.
   a. Ensure that the tail is not inside the IRSENSOR and it is empty, and the sensor resides freely.
   b. Click Scaling and establish the following settings
      Scale values
      Cal1 = 0
      Cal2 = 1000
      Units Label = mV

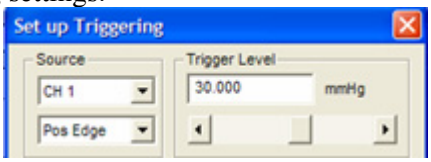


   c. Click the CAL1 button successively a few times.
   d. Add 333 to the Cal1 Input value, and enter the result in Cal2 Input value (Cal2 = Cal1 + 333)
   e. Click OK as needed to close out of CH2 setup and the Setup Channels dialog.

8. Choose MP35 > Set up Acquisition and establish the following settings.
   Mode = Record and Append using PC Memory
   Sample Rate = 200 samples/second
   Acquisition Length = 24 seconds
   Repeat = every 3 second, 10 time



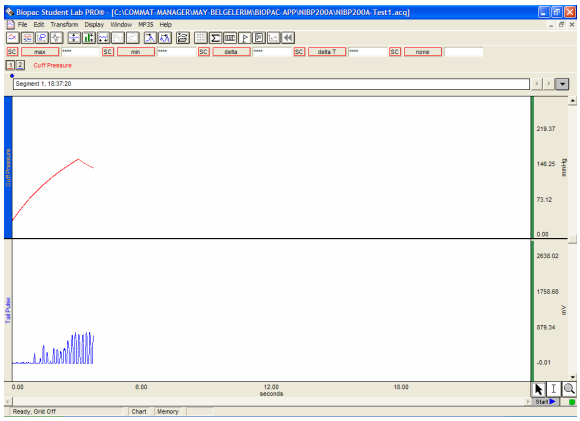
9. Close out of Set up Acquisition.
10. Choose MP35 > Setup Trigger and establish the following settings.
    Source = CH1
    Pos Edge
    Trigger Level = 30 mmHg



11. Close out of Set up Triggering.

RECORDING

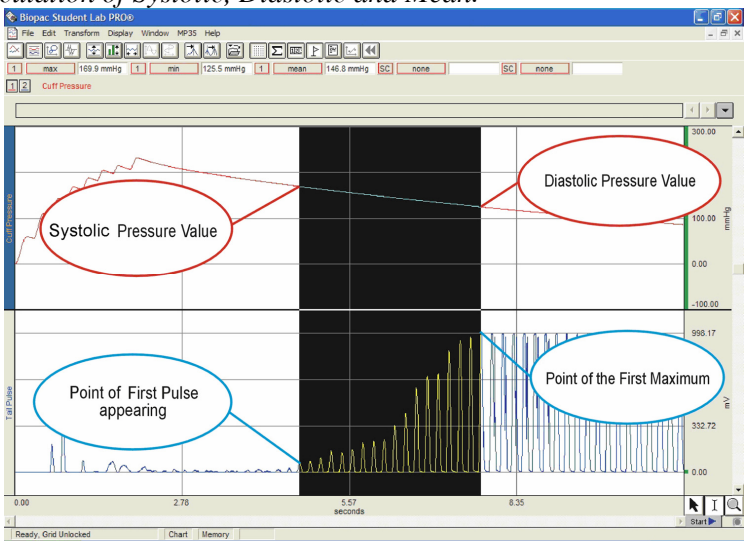
1. Check the animal is ready and IRSENSOR is attached to the tail.
2. Click “Start” in the BSL *PRO* software window.
3. Press START button on the front panel of NIBP200A.
   - IRSENOR will pump up the Cuff automatically.
   - When the Cuff Pressure on CH1 reaches 30 mmHg, the cuff pressure and tail pulse signals will be generated.
   - The recording will stop automatically after 24 seconds.
4. Press START to continue with the next measurement and repeat as necessary.
5. Choose File > Save or Save as when you are done.



TIP A generally accepted application is that for each animal, 10 measurements are recorded and mean values are calculated. In the append mode, you can make 10 consecutive measurements in the same file.

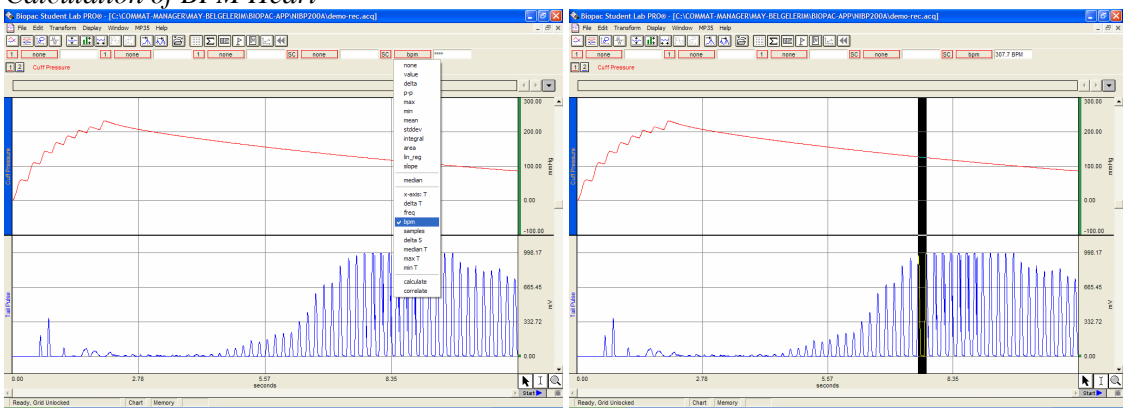
ANALYSIS

Calculation of Systolic, Diastolic and Mean.



1. Click the Calculation Label.
2. Select from the list Max , Min, Mean for three different Labels.
3. Select Channel 1 as channel option.
4. Select cursor 'I' from the cursor option on the bottom right of the screen.
5. On the graphical display, starting from the point of first pulse, select an area to the maximum.
6. Review the results for max (Systolic), min (Diastolic), and mean measurments.

Calculation of BPM Heart



1. Set a measurement for **bpm**.
2. Use the I-beam cursor to select the maximum points of the peaks of the CH2 pulse waveform.
3. Review the results for bpm (Heart Rate value) for each peak.

TROUBLESHOOTING

Tail Pulse signals are not regular.

- The animal may be under stress, restless and moves the tail steadily. Take the animal out of the holder and let it rest, and continue with the experiment.
- The tail may not be warmed enough or cooled down. Put the animal again in the Heater Chamber and heat it up again.
- Sensor dimensions may not be suitable for the tail. Select a suitable sensor.
- Position of the Sensor on the tail may not be well-matched. Take the Sensor out, put it again by trying different positions.

Compressor is working uninterruptedly.

- Close the NIBP200A system immediately.
- Take the Tubing out from the Cuff connector on the front panel of NIBP200A.
- Turn the system on again.
- Close the air outlet by pressing your finger on the Cuff output and press the Start button. The compressor will work for a few seconds and stop. (Please inform us if the Compressor is still working) You can also see the pressure chart on the screen.
- If the Compressor stops automatically, it means that the system is working normally.

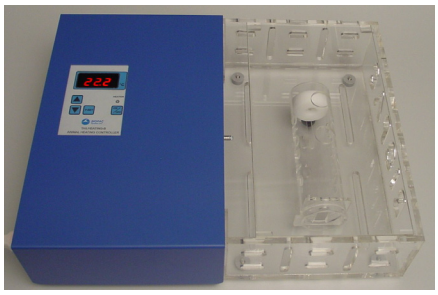
There is a leakage with the tubing connections and Cuff of the IRSENSOR.

- Check and remove the leakage.

TAILHEAT Heater for NIBP200A Small Animal Tail BP System

TAILHEATA Tail heating unit, 110 V / 60 Hz
TAILHEATB Tail heating unit, 220 V / 50 Hz

See NIBP200A for setup and usage guidelines.



OUT1 Headphones

These wide response high-fidelity headphones are used for auditory stimulus (short tones or clicks) or to listen to physiological signals (like EMG) directly. The Headphones are comfortable and lightweight (3 ounces) and include a 2-meter cable so the Subject can be seated a comfortable distance from the acquisition unit.

Unlike other Smart Sensors that connect to the MP3X , the OUT1 connects to the “Analog out” port on the back panel of the MP3X .

OUT1 SPECIFICATIONS

Cable Length:	2 meters
Connector Type:	9 Pin DIN (female)

OUT2 BNC Output Adapter

This BNC adapter is designed to output signals from the MP3X unit to other devices (such as external amplified speakers and scopes). This 2-meter adapter cable terminates in a male BNC for easy connections.

OUT2 SPECIFICATIONS

Cable Length:	2 meters
Connector Type:	BNC (male)

See also: **SS9L** BNC Input Adapter

OUT101 Tubephone

OUT101 Components: one Tubephone, plastic tube and 50 foam ear inserts

Use the OUT101 tubephone with a stimulator module to deliver clicks and tones in auditory evoked response applications (i.e. ABR).

The tubephone design consists of a monaural acoustic transducer attached to a short, flexible, plastic tube, which fits into the subject's ear with the aid of a foam tip.

Use of the tubephone reduces ambient noise and bone conduction problems, which can interfere with auditory response recordings. Furthermore, because the Tubephone provides a 1 msec acoustic signal delay (due to plastic tube), it automatically separates true response from electromagnetic artifact resulting from speaker activation.

Response: compares to TDH-39, 49 or 50 audiometric headphones
Stimulator interface: interface to BSLSTM with BSLSBL6 and Radio Shack adapter
Dimensions: 3.8cm (wide) x 5cm (high) x 1cm (thick)
Cable termination: 6.3mm (1/4") phone plug
Cable length: 1.8 meter
Cable clip: Yes; clip attaches to fabric or fixtures

Stimulus Presentation

STP35W SUPERLAB SYSTEM FOR MP35 *See STP30W to use with a BSL MP30*

STP35W Components
SuperLab Software
Digital I/O Card
STP35 Interface Cable
Support Pack for Digital I/O Card
Six-button Response BoxPushbutton
Keycap Color Kit

The STP35W is a stand-alone system that measures subject responses to visual or auditory stimuli. It can present visual stimuli on a computer screen, or auditory stimuli via headphones or speakers, and simultaneously (1ms resolution) send trigger signals to an MP35 System for data synchronization and collection purposes.

For performing accurate (1 ms resolution) reaction time measurements, the STP35W includes a six-pushbutton response box. For measuring physiological responses to stimuli, the STP35W includes an optically isolated interface, permitting up to three synchronization signals (input) between the STP35W and the MP35 System.

The SuperLab software can be used to change the placement of visual stimuli on the screen, change the screen's background color, choose from a variety of input and timing options, and provide feedback to subjects based on either response or reaction time. Different trigger channels can be paired to different visual or auditory stimuli to perform sophisticated evoked response averaging tests (e.g. P300).

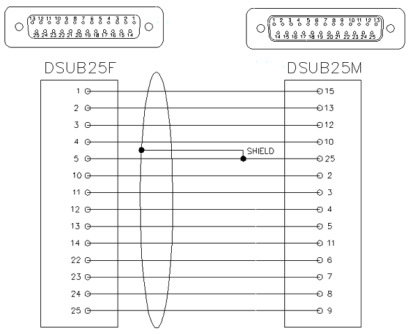
- See BSL *PRO* Lesson H30 Stroop Effect for details of the classic psychology experiment and a sample of how SuperLab works with the BSL System.

NOTE: Second PC required. The synchronization signal(s) coming from the STP35W can be directed to a BSL MP35 System running on a PC or a Macintosh, but it's not possible to run the STP35W on the same computer as the BSL MP35 System. The STP35W requires that the SuperLab software and a Digital I/O card (PCI slot required) be placed on a PC running Windows 95 or 98 or 98 SE.

STP35 MP35 TO SUPERLAB

If you already have SuperLab and an MP35 unit, you can use the STP35 Interface Cable to connect the two systems. The STP35 cable interfaces with the I/O port of the rear of the MP35 unit.

STP35A MP35 TO PARALLEL



MP35 to E-Prime, Direct RT, MediaLab, Inquisit, and other systems that connect via the parallel port.

STP30W SUPERLAB SYSTEM FOR MP30

Ships with an STP30 interface instead of an STP35 interface. See STP35W for other details.

STP30 ISOLATED DIGITAL INTERFACE FOR THE MP30

STP30 Components

Isolated interface module
3-meter ribbon cable (37 pin F/F)
SuperLab to MP30 interface cables (3)

If you already have SuperLab and the Digital I/O card with the Support Pack, you can interface to the MP30 System using the STP30 interface. The STP30 interface connects between the SuperLab Digital I/O card and the BIOPAC MP30 acquisition unit.
The STP30 system provides 3 lines for digital data inputs; all lines are optically isolated to 1500 VDC compliance.
The STP30 system can also be used to connect digital signals (TTL compatible) from any mains powered external equipment to the MP30 when the system also connects to electrodes attached to humans.

Setup:

Use the 3-meter interface cables (SS44L) to connect the STP30 to the MP30, and use the 3-meter ribbon cable (37 pin F/F) to connect SuperLab to the STP30.

1) Unscrew the pin for Ground (GND D) on the STP30.
2) Unscrew the pin(s) for Input Port 8-15 on the STP30 for the required number of SuperLab channels.
3) Plug the Ground pin from the SS44L cable into the GND D port on the STP30.
4) Plug the signal pin from the SS44L cable into Input Port(s) 8-15 on the STP30 and note the port number(s) for SuperLab programming [Input 8 - SuperLab 0, Input 9 - SuperLab 1, etc.].
5) Plug the SS44L Smart Sensor into an available MP30 channel (CH) input.
6) If you are using multiple channels for SuperLab, repeat steps 3-5 but stack the ground pins into the GND of the first SS44L cable.

TSD122C/D Stroboscope

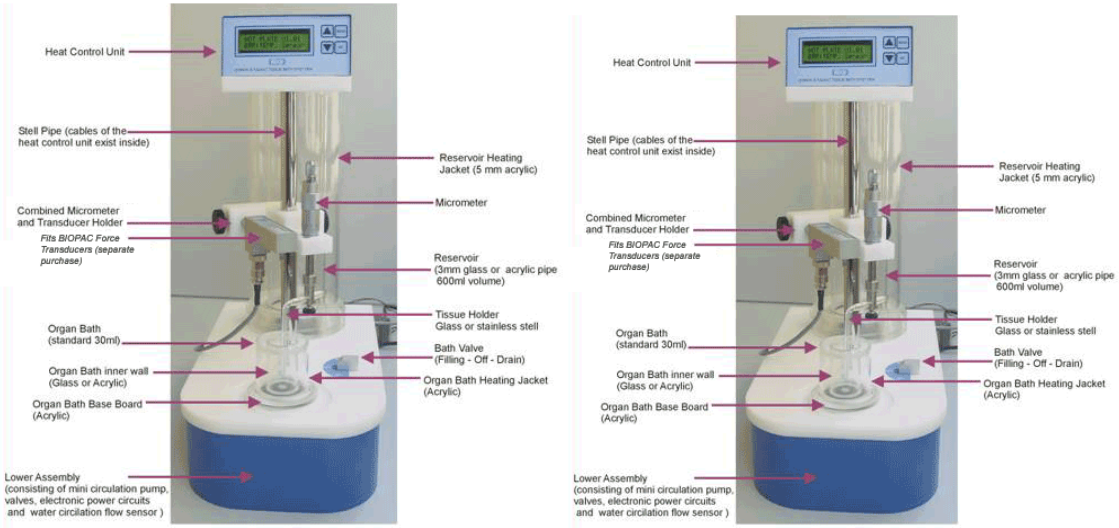
TSD122A Stroboscope 120V/60Hz

TSD122B Stroboscope 220V/50Hz

See BSL *PRO* Lesson H22 Visual Evoked Potentials for setup guidelines

Display: Digital LCD
Battery: Built-in, rechargeable
Battery Life: 60 hours at 100 strobes/sec
Flash Duration: 30µsec
Flash Energy: 180mJoule
Body Dimensions: 9.3cm (w) x 9cm (h) x 23cm (l)
I/O Ports: TTL (Sync input and output)-3.5mm phone jacks
External TTL: Sync/Trigger
Handle: 10.8cm (long)
Reflector Housing: 12.2 cm (dia)
Weight: 1.1 kg
Cables: BSLCBL5

ITBS100 Integrated Tissue Bath Station



The Integrated Tissue Bath & Heater System from BIOPAC is a modular, durable solution for your lab. Features include:

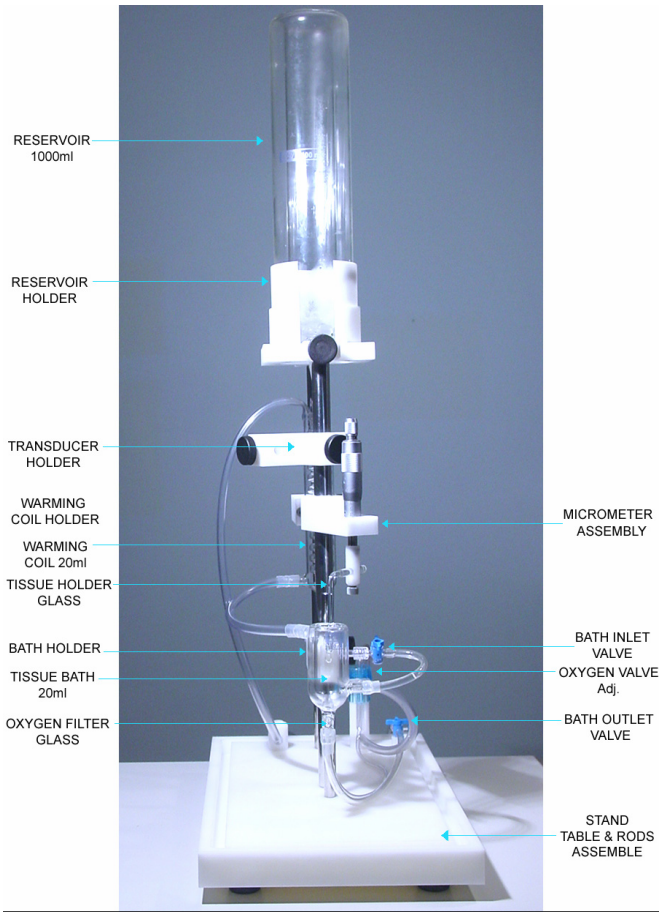
- Jacketed bath and reservoir in a range of volumes
- Integrated, programmable heating circulator
- 500 ml/min circulation flow
- Movable micrometer-transducer assembly
- User-friendly display and controls
- One-switch control of fill and drain cycle
- Microprocessor control
- Low-level alarm for water temperature
- Acrylic, robust bath
- Small dimensions, lightweight

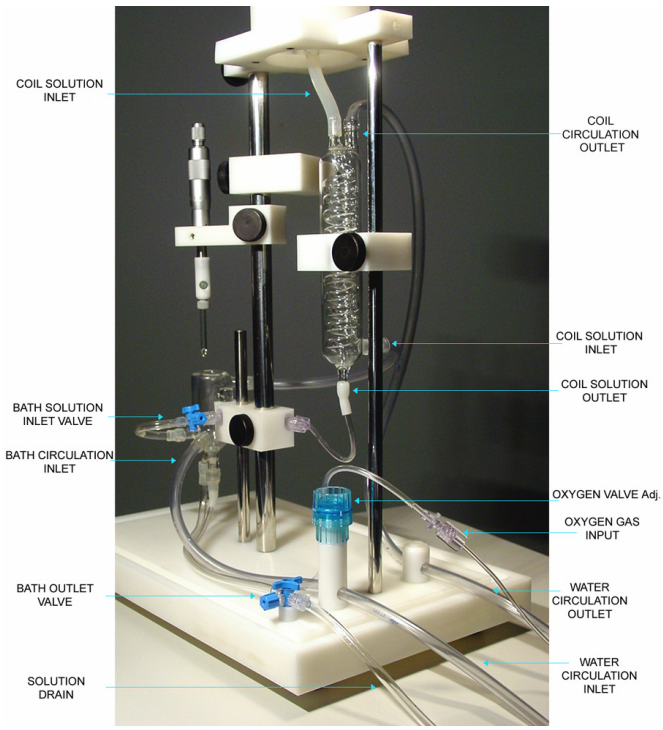
Specifications

1 x Bath	specify 20 ml, 30 ml, or 50 ml
1 x Reservoir	800 ml
1 x Integrated heater	1600 ml volume, programmable temp. 20° - 44° C
1 x Circulator pump	15 W; 500 ml/min
1 x Micrometer-transducer assembly	
2 x Triangle Tissue Clip	Stainless Steel; reorder as RXCLIP-TRI
2 x Tissue Clip	Stainless Steel ; reorder as RXCLIP
1 x Tissue Holder	Stainless Steel; reorder as RXHOLDER-S
1 x 3-way rotary valve	
1 x Power Supply	specify 110 V/60 Hz. or 220 V/50 Hz

*BIOPAC Tissue Bath Systems utilize technology from **COMMAT Ltd.** Pharmacology, Physiology and Biophysics Instrumentation (Turkey).*

TISSUEBATH1, 2, 4, 8 Tissue Bath Stations





The Tissue Bath Station is completely modular, which enables you to purchase it in multiples of one unit. The System includes all of the glassware, tubing, reservoir, tissue hooks and mounting accessories, force transducer and micrometer tension adjuster.

The ergonomic design of the station allows you to lower the tissue bath away from the tissue holder so that mounting of the tissue preparation is very easy. The taps for filling and draining the bath are mounted on the tubing to avoid the risk of accidental bath breakage. The entire station is mounted on a convenient base stand, which creates a sturdy platform for your experiment. The unique design makes it easy to add or remove stations to provide the optimal solution for your requirements.

When you order a system, you must specify the size of the tissue bath and heating coil.

Each **Tissue Bath** station includes:

- 1 Reservoir
- 1 Reservoir Holder
- 1 Transducer Holder
- 1 Warming Coil Holder
- 1 Warming Coil (specify 5ml, 10ml, 20ml, or 30ml size)
- 1 Tissue Holder (glass; left)
- 1 Tissue Holder (stainless steel; right)
- 2 Triangle Tissue Holder (stainless steel)
- 2 Tissue Clip (stainless steel)
- 1 Bath Holder
- 1 Tissue Bath (specify 5ml, 10ml, 20ml, or 30ml size)
- 1 Oxygen Filter (glass)
- 1 Micrometer Assembly
- 1 Mount Accessories Kit
- 1 Base Station with Support Rods
- 1 TSD125 Force Transducer (specify TSD125 model C, D, E or F)

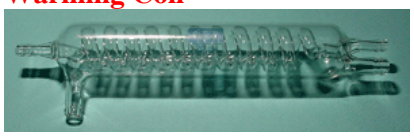
See also: BIOPAC Circulators, page 83, or you can use an existing system.

TissueBath ACCESSORIES

Tissue Holders

Tissue Clips

Warming Coil

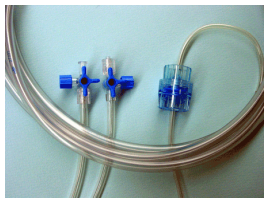


Oxygen Filter

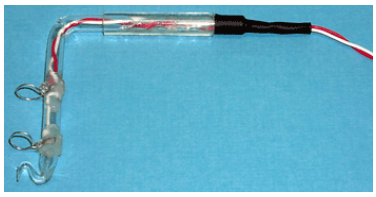
Tissue Bath

Reservoir

Mount Accessories



Field Stimulation Electrode



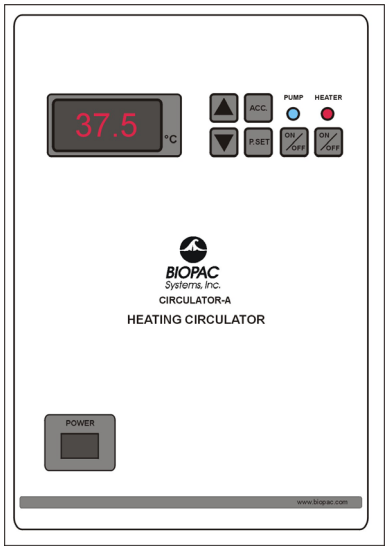
RXHOLDER-S	Tissue Holder (stainless steel)	**RXCOIL**	Warming Coil
RXHOLDER-G	Tissue Holder (glass)	**RXO2FILTER**	Oxygen Filter (glass)
RXHOLDER-T	Triangle Tissue Holder (stainless)	**RXBATH**	Tissue Bath
RXCLIP	Tissue Clip (stainless steel)	**RXRESERV**	Reservoir 1000ml
RXCLIP-TRI	Triangle Tissue Clip for Rings (stainless steel)	**RXMOUNT**	Mount Accessories Kit
		STIMHOLDER	Field Stimulation Electrode

Circulators

Heating circulators are used with Tissue Bath Stations and include a digital temperature display and the following controls:

- **Preset Temperature**
- **Power**
- **Heater**
- **Circulation**

Inlet and **Outlet** ports are on the back, along with the power cord.

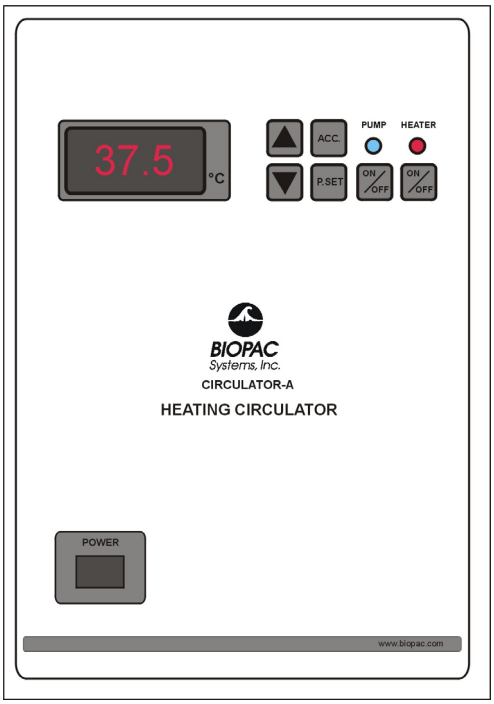


Circulator A:
110 V, 60 Hz

Circulator B:
220 V, 50 Hz

Refer to the ***Circulator Setup and Usage Guide***.

Circulator SETUP AND USAGE GUIDE



BIOPAC Heating Circulators will maintain water temperature at a preset value in the range 30^{0}C to 45^{0}C and circulate the water through tissue baths.

Heating circulators include a digital temperature display and the following controls:

Preset
Temperature
Power
Heater
Circulation

Inlet and **Outlet** ports are on the back, along with the power cord.

Circulator A:
110 V, 60 H
Circulator B:
220 V, 50 H

CALIBRATION

Although the offset value for the temperature sensor is factory-calibrated, the user can calibrate the controller's internal temperature sensor. To calibrate the sensor:

1. Install a calibrated reference thermometer in the bath.
2. Adjust the offset value to zero.
3. Adjust the preset value to an appropriate temperature.
4. Once the bath reaches the preset value and stabilizes, calculate the offset value by noting the difference between the reference thermometer value and the preset value.
5. Enter this value as an offset.

ERROR CODES

DISPLAY	INDICATION
Lo	Water in the bath is not enough or the bath is empty.
Sen	Microprocessor cannot communicate with the temperature sensor.

CIRCULATOR SETUP & USAGE GUIDELINES

1. Connect a hose from the INLET on the back of the circulator to the tissue bath OUTPUT.
   - For more than one tissue bath, connect the tissue baths serially.
2. Connect a hose from the OUTLET on the back of the circulator to the tissue bath INPUT.
3. Fill the stainless steel water bath with 4.5 liters of water.
   - You hear a buzzer sound warning if there is not enough water in the bath when you power on the Circulator. See *Error Codes* above.
4. Place the glass lid on the bath to close.
5. Plug the power cord from the back of the Circulator to a power source.
6. Press the **POWER** key to turn on the circulator.
7. To see the preset temperature value, press the **P.SET** key.
   - To change the preset temperature value, hold down the P.SET key and, at the same time, repeatedly press the UP or DOWN arrow keys to increase or decrease the preset value.
8. To see the acceleration value of the Circulator, press the **ACC** key.
   - To change the preset acceleration value, hold down the ACC key and, at the same time, repeatedly press the UP or DOWN arrow keys to increase or decrease the preset value. The higher values for acceleration indicate more rapid heating.
9. To see the offset temperature value, press the ACC and P.SET keys at the same time.
   - This is a factory-calibrated value. To calibrate the temperature sensor, see *Calibration* above.
   - All preset values are written to non-volatile memory.
10. Press the **PUMP ON/OFF** key to start the circulation pump.
    - Check that the **blue** Pump Status LED is ON. The pump should begin circulating water.
11. Check that the water goes out of the circulator and flows through the waterway of the tissue bath(s).
    - With initial setup, some air may remain in the circulator pump. See *Troubleshooting* below.
12. Press the **P.SET** button and confirm the set value of the desired temperature.
13. Press the **HEATER ON/OFF** key to turn on the heater.
    - Check that the **red** Heater Status LED is ON.
    - Check that the Heater Display LED is on to confirm that the heater inside the bath is working.
    - Circulator will maintain the preset temperature of water in the bath; variations of +/- 0.2^0C are acceptable.
14. Check the water level periodically and add water to the bath if the level drops below 4 liters.
    - **Caution**: Over time, the water level inside the bath may decrease. Do not operate the circulator with less than 4 liters of water in the bath.

15. To turn the PUMP and HEATER on and off individually, press their respective ON/OFF keys.
16. To stop operation, press ON/OFF keys.
    - Power down equipment in the following order: PUMP, HEATER, POWER.

TROUBLE SHOOTING

- **There is no water circulation or very little.**
    1. Check the hose connections and be sure they are connected to the correct positions.
    2. Check that the hoses are not bent or twisted (which might impede the flow of water).
    3. Confirm that there is at least 4 liters of water in the bath.
- **There is some air in the waterway.**

    To remove the air:

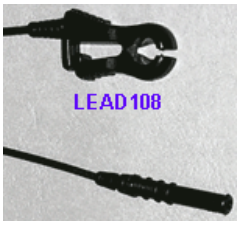
    1. Press the PUMP ON/OFF key to **OFF** stop the circulator pump.
    2. Disconnect the hose from the INPUT of tissue bath. (Leave other end connected to the Circulator OUTLET.)
    3. Put the end of the hose in a bucket to catch the water flow.
    4. Press the PUMP ON/OFF to **ON** to start the circulator pump.
    5. Operate the circulator pump for a few 1-2 second cycles.
    6. Press the PUMP ON/OFF key to **OFF** stop the circulator pump.
    7. Reconnect the hose to the INPUT of the tissue bath.
    8. Press the PUMP ON/OFF to **ON** to start the circulator pump and continue with normal operation.

TECHNICAL SPECIFICATIONS

Temperature Range:	30^0C to 44^0C
Reading Sensitivity:	0.1^0C
Display:	3 digit (LED Display)
Water Bath Volume:	4.5 liters (Stainless Steel)
Circulation Flow:	2 liter/min.
Heater Resistance:	1000 Watt
Circulation Pump:	110V 100W Plastic Head
Supply Voltage:	
CIRCULATA:	110 Volt 60 Hz (1000 Watt)
CIRCULATB:	220V 50 Hz (1100 Watt)
Inlet/Outlet	OD 8.5mm, ID 6.3mm Tubing
Temperature Offset Range:	0^0C to 1.2^0C
Acceleration Levels:	0 to 5

ELECTRODE LEADS

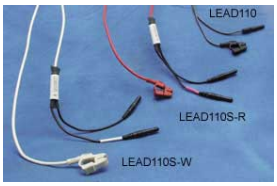
LEAD108



LEAD108 is used with EL508 MRI-compatible, radiotranslucent electrodes.
See also: MRI Compatibility Notes on page 88.

Construction: Carbon fiber leadwire and electrode snap
Leadwire Length: 1.8 meters
Leadwire Diameter: 1.5 mm
Leadwire Resistance: 156 Ohms/meter

LEAD110 Series



The LEAD110 unshielded lead works best with ground or reference electrodes like the EL500 series disposable snap electrodes. Use shielded leads with recording electrodes for minimal noise interference. Generally, for biopotential recordings, one each of: LEAD110S-W (white), LEAD110S-R (red) and LEAD110 are required. LEAD110 series electrode leads have no ferrous parts. The leads include a pinch connector for easy application and terminate in standard Touchproof connectors for interfacing to the SS1LA lead adapter.

LEAD110 unshielded lead, black, 1 m **LEAD110S-W** shielded lead, white, 1 m
LEAD110A unshielded lead, black, 3 m **LEAD110S-R** shielded lead, red, 1 m

LEAD120

This 1-meter red lead with Touchproof connector works with the reusable EL120 electrode. Snap the electrode into place and then plug the lead in with the Touchproof connector via the SS1LA adapter.
LEAD120-R red **LEAD120-W** white

LEAD140 Series

All LEAD140 series leads have 1-meter, black cables and Touchproof connectors, and interface with the SS1LA.

LEAD140 Alligator Clip Lead, with Teeth— Use this fully-insulated, unshielded alligator clip with teeth to connect fine wire electrodes, including irregular surfaces.
Length: 40mm
Clamp style: Teeth
MRI-compatible: NO (contains ferrous metal in the alligator clip)

LEAD141 Alligator Clip Lead, Toothless — Use this fully-insulated, unshielded alligator clip with smooth clamp to connect to fine wire electrodes without damage, including arbitrarily small electrode wires.
Length: 40mm
Clamp: Smooth (Flat)
MRI-compatible: NO (contains ferrous metal in the alligator clip)

LEAD142 Retractable Clip, Fine Wire Lead — Use this unshielded clip lead with copper contacts to connect to fine wire electrodes.
Length: 40mm
Extension Length: 3.5mm
Extension Contacts: Copper
Wire Size Max: 1mm diameter
MRI-compatible: YES (contains non-ferrous copper alloy in clip)

ELECTRODES

In selecting the application site for any style of electrode, care should be taken that:

1) Electrode site is dry and free of excessive hair.
2) Electrode is not placed over scar tissue or on an area of established erythema or with a lesion of any kind.
3) Skin is properly prepared. (Prepare the skin at the electrode site. Use the ELPAD to lightly abrade the skin surface. Use a brisk dry rub to prepare the application site. Avoid excessive abrasion of the skin surface.)

MRI Notes

MRI-compatibility Statement

BIOPAC defines "radiotranslucent" products as products that have no metal at all in the applied part.

- These are **best suited** for MRI applications.

BIOPAC defines "MRI-compatible" products as products that have no ferrous metal in the applied part. They may include non-ferrous metal, but are not significantly mechanically influenced by a magnetic field.

- They **may be suitable** for MRI applications.

Safety Issues

Caution is required when employing electrode leads and electrodes in an MRI environment. Under certain conditions, single fault and otherwise, low impedance conduction through the subject represents a potential hazard due to currents that may be induced in loops placed in the time-varying MRI field gradients and RF fields, and due to body movement in the static MRI field. Low impedance conduction can result in significant heating at the electrode/skin junction, because this point is often the part of the signal path with the highest impedance. Sufficient heating at the electrode/skin junction could result in burns.

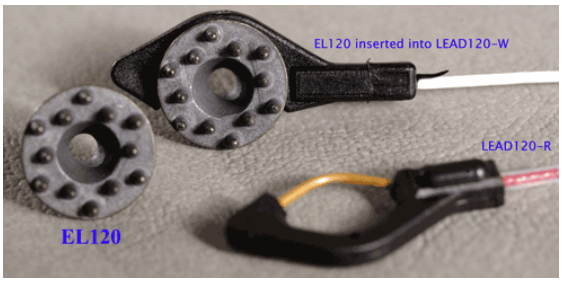
- For more information, read the paper on Methodological Issues in EEG-correlated Functional MRI Experiments from the International Journal of Bioelectromagnetism.

Important Note

BIOPAC Systems, Inc. products (including instruments, components, accessories, electrodes and electrode leads) are designed for educational and research applications. BIOPAC does not condone the use of its products for clinical medical applications.

Products provided by BIOPAC are not intended for the diagnosis, mitigation, treatment, cure or prevention of disease.

EL120



The EL120 electrode has contact posts designed to improve contact through fur or hair. The 12 posts create a 10 mm contact area. The posts are 2mm deep to push through fur/hair to provide good contact with the skin surface.

Shipped in packs of 10.

Silver-silver chloride (Ag-AgCl) electrodes provide accurate and clear transmission of surface biopotentials and are useful for recording all surface biopotentials on animals and human EEG.

Notes:

- It is not necessary to use an EL120 for your ground; you can use a generic electrode for ground.
- Requires one LEAD120 per electrode.

EL250 Series Reusable Ag-AgCl electrodes

Surface biopotentials can be accurately and clearly transmitted with silver-silver chloride electrodes. EL250 Series reusable electrodes are permanently connected to 1-meter leads and terminate in standard 2mm pin plugs for direct connection to the SS1L shielded electrode lead adapter. Use shielded electrode leads for minimal interference. The unshielded electrode leads work best as ground electrodes. Typically, for one biopotential input, you will need two shielded electrodes for signal inputs and one unshielded electrode for ground.

EL254 Ag-AgCl Unshielded Electrode, 7.2 mm diameter housing, 4 mm contact area, includes 1 meter lead terminated with a 2mm pin plug for connection to the SS1L.

EL254S Ag-AgCl Shielded Electrode, 7.2 mm diameter housing, 4 mm contact area, includes 1 meter lead terminated with two 2mm pin plugs for connection to the SS1L. The gray lead plug is for the electrode contact; the black lead pin plug is for the lead shield.

EL258 Ag-AgCl Unshielded Electrode, 12.5 mm diameter housing, 8 mm contact area, includes 1 meter lead terminated with a 2mm pin plug for connection to the SS1L.

EL258S Ag-AgCl Shielded Electrode, 12.5 mm diameter housing, 8 mm contact area, includes 1 meter lead terminated with two 2mm pin plugs for connection to the SS1L. The gray lead plug is for the electrode contact; the black lead pin plug is for the lead shield.

√ All EL250 Series electrodes require adhesive disks (ADD200 series) and recording gel (GEL1 or your preferred recording gel). See the **Electrode Accessories** section for further description.

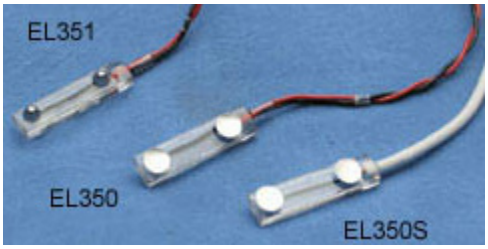
INSTRUCTIONS FOR EL250 SERIES ELECTRODES:

1) Store electrodes in clean, dry area.
2) After use, clean electrode with cold to tepid water
   a) DO NOT use hot water.
   b) Cotton swabs are suggested.
3) The electrodes should be completely dry before returning to storage.
4) DO NOT allow the electrodes to come in contact with each other during storage (adverse reaction could take place).

   - Electrodes may form a brown coating if they have not been used regularly. This should be removed by gently polishing the surface of the electrode element with non-metallic material. Wiping with mild ammonium hydroxide will also remove this coating. Rinse with water and store the electrode in a clean, dry container.

5) Remove an appropriate size electrode washer (ADD204, ADD208, or ADD212) from its waxed paper strip and carefully apply the washer to the electrode so the center hole of the washer is directly over the electrode cavity.
6) Fill the cavity with electrode gel (GEL100). No air bubbles should be present in the cavity.
7) Remove the white backing from the washer to expose the second adhesive side.
8) Place electrode on prepared skin area and smooth the washer into place.
9) Apply a few drops of electrode gel to fingertip and rub the exposed side of the adhesive washer (around the electrode) to rid its surface of adhesive quality.

EL350 Series Bar Lead Electrodes



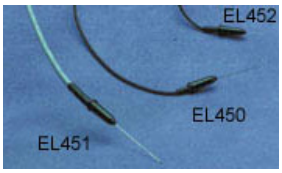
Bar lead electrodes are recommended when applying a stimulus during nerve conduction, somatosensory or muscle twitch recordings with human subjects. Two concave tin electrode disks are placed 30mm apart in a watertight acrylic bar.

- **EL350** unshielded bar lead electrode for use with the STMISO.
- **EL350S** shielded bar lead electrode for biopotential recordings.
- **EL351** convex bar lead electrode for stimulating

EL350 SPECIFICATIONS

Electrode space:	30mm
Lead length:	61cm
Connector type:	BNC
Interface:	BSLSTM Stimulator or SS58L Low Voltage Stimulator

EL450 Series Needle Electrodes



Use for stimulation or recording in animal subjects and tissue preparations. The 28-gauge stainless steel needles are Teflon-coated, with flexible cable terminating in standard 2mm pin plugs.

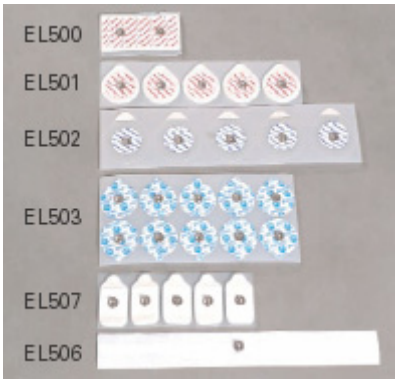
Needle electrodes are shipped non-sterile, so pre-sterilization is required.

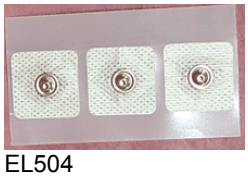
EL450 Unipolar: 2.5 cm (long) x 300µm (dia); 61 cm lead
A pair of EL450 electrodes is suitable for either recording or stimulation.

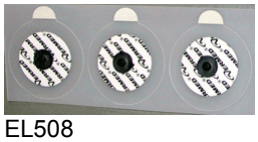
EL451 Bipolar: 3.0cm (long) x 460µm (dia); 91cm lead
Use when recording from a single site, as in studies of single muscle fibers.

EL452 Unipolar, uncoated: 1.5cm (long) x 300µm (dia); 61 cm lead

EL500 Series Disposable Electrodes




EL504

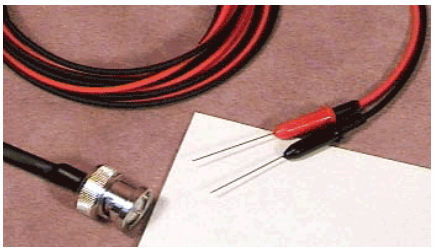

EL508

The EL500 Series snap electrodes provide the same signal transmission as BIOPAC's reusable electrodes, with added convenience and hygiene. Each peel-and-stick electrode is pre-gelled and designed for one use only. Use disposable snap electrodes with BIOPAC's SS2L electrode lead.

Part	*Ag-AgCl Adhesive/Disposable Electrode Type*
EL500	paired electrodes: Use for general-purpose EMGmeasurements, nerve conduction measurements, and cardiac output. 41mm spacing (center to center) on 4mm x 82mm x 1.5mm foam
EL501	small stress test electrodes: Use for short-term recordings where the subject may be in motion or when electrodes should be closely placed, as for multi-channel ECG, EGG, EMG or EOG. 38mm diameter mounted on 1.5mm thick foam with strong adhesive
EL502	small pre-gelled electrodes Most appropriate for long-term biopotential measurement recording sessions, these pre-gelled electrodes have a 10 mm contact area on a 41mm (dia) backing that resists moisture. The electrodes include a hypoallergenic adhesive solid gel that adheres well to the skin but leaves no residue when removed.

Part	*Ag-AgCl Adhesive/Disposable Electrode Type*
EL503 **General-purpose electrode**	Ag-AgCl Adhesive/Disposable Electrode, 35mm diameter vinyl tape, 10 mm contact area, gel. These economical, pre-gelled electrodes are most suitable for short-term recordings. These electrodes have a 10 mm contact area on a 41mm (dia) backing that allows close electrode placement where necessary, with a slightly less firm adhesive for "ouchless" removal. The electrodes incorporate hypoallergenic liquid gel and are high chloride for quick, accurate readings.
EL504	Cloth base, 2.5 cm square electrodes. Particularly useful for applications on non-conforming surfaces, such as the face for EMG or fingers for nerve conduction studies. The adhesive solid gel ensures good contact, and the silver-silver chloride (Ag-AgCl) electrodes provide accurate and clear transmission of surface biopotentials. Use these comfortable and conforming electrodes in EMG, nerve conduction, ECG, sleep studies, exercise physiology, etc. The latex-free, hypoallergenic electrode adheres well and is repositionable and suitable for long term use without irritation.
EL506 **Alternative for band electrodes**	This unique disposable strip electrode is designed for bioimpedance applications. The electrode is silver laminated on medical grade cloth, with industry-standard medical grade adhesive, medium tackiness. The silver-silver chloride (Ag-AgCl) electrode provides accurate and clear transmission of surface biopotentials and is latex free. Strip length: 254mm Conductive element width: 6.35mm Adhesive width: 23.5mm Advantages of the Strip Electrode: • Combines the convenience of standard snap (spot) electrodes with the signal to noise, equipotential and current diffusion performance of band electrodes • Less obtrusive than band electrodes--easier for subjects to move and breathe • Ergonomic advantages of snap (spot) electrodes • Diffuses currents similarly to band electrodes (reduces current density) • Provides voltage measurements through a well-defined equipotential plane • Adjustable size--cut the 25cm strip to the desired size without affecting signal transmission • Snap lead connection • Peel-and-stick convenience • Disposable
EL507	Designed for electrodermal activity studies and are pre-gelled with isotonic gel. The latex-free, MRI compatible electrodes conform and adhere well. Wet Gel: low ionic content, no chloride salt, electrically conductive ions Contact area: 1cm Size: 2.5cm x 4.5cm Clip: Stainless Steel Backing: Foam
EL508	These disposable, MRI-compatible, radiotranslucent electrodes are pre-gelled. Use with LEAD108.

ELSTM2 Unshielded needle electrodes



Recommended for use when applying a stimulus to animal subjects and tissue preparations. The dual stainless steel needles are Teflon coated. Needle electrodes are shipped non-sterile, so pre-sterilization is required.

ELSTM2 SPECIFICATIONS

Needle Length:	2.5cm
Needle Diameter:	.3mm
Cable length:	2.5 meters
Connector type:	BNC
Interface:	BSLSTM Stimulator

HSTM01 Handheld Human-Safe Stimulating Electrode

The HSTM01 handheld human-safe stimulating probe provides a superior degree of safety and comfort when using the Biopac Student Lab Stimulator for human stimulation. The ergonomic design allows the subject to focus on electrode placement instead of worrying about holding the electrode. The subject controls the stimulus presentation by activating the red safety switch. To stop the stimulus at any time, the subject simply removes his/her thumb from the switch and the electrode shuts off. The electrode is terminated in a BNC connector that interfaces with the BSLSTMA.

IMPORTANT! BIOPAC HSTM Series Probes must be used when stimulating humans. HSTM probes have current-limiting features, enhanced isolation and a user-operated "dead man" switch for optimum safety.

WARNING! Even with the HSTM probe, you must never create an electrical path across the heart (i.e. touching an active tip in each hand while the switch is engaged) and you should never use on subjects with pacemakers.

HSTM01 SPECIFICATIONS

Safety Switch:	Yes
Lead Length:	3 Meters
Connector Type:	BNC
Interface:	BSLSTMA

Electrode Accessories


BSL-ACCPACK

BSL-ACCPACK BSL ACCESSORY PACK

Make students accountable for their own lab equipment and reduce the burden on department budgets. School bookstores can purchase the BSL Accessory Packs and sell them to students. BSL Accessory Pack includes consumable items for BSL Lessons:

60 x EL503 Disposable Electrodes
1 x AFT2 Disposable Mouthpiece
1 x EL507 Disposable EDA (GSR) Electrodes (3 per strip)
1 x AFT3 Noseclip
1 x AFT1 Disposable Bacterial Filter
8 x ELPAD Abrasive Pads

GEL1 / GEL100 ELECTRODE GEL

This non-irritating, hypoallergenic gel is used as a conductant with the EL200 series reusable electrodes. GEL1 is 1 oz., GEL100 is 8 oz.

GEL101 ELECTRODE PASTE

Specially formulated with 0.5% saline in a neutral base. Unlike agar or saline pastes, this paste has a virtually unlimited shelf life. It is supplied in a 4 oz. bottle with a convenient flip-top reclosable cap. GEL101 Electrode Paste meets all of the recommended specifications for skin conductance recording. The "Unibase" material called out by Lykkenand Venables in Psychophysiology, 1971, pp. 665 - 666 no longer exists. This non-irritating, isotonic paste is primarily used as a conductant for the SS3LA Galvanic Skin Response Transducer, but can be used with any premium Ag/AgCl electrodes.

- *Usage Recommendation*: When using GEL101 it is important that the gel has a chance to be absorbed and make good contact before recording begins.

ADD200 SERIES ADHESIVE DISKS

The ADD200 series of adhesive disks are two-sided adhesive collars used to hold EL200 Series reusable electrodes in place.

ADD204 19mm outside diameter, use with EL254 and EL254S
ADD208 22mm outside diameter, use with EL258 and EL258S

ELPAD ABRASIVE PADS

Before applying electrodes, abrade the skin lightly with an ELPAD to remove non-conductive skin cells and sensitize skin for optimal adhesion.

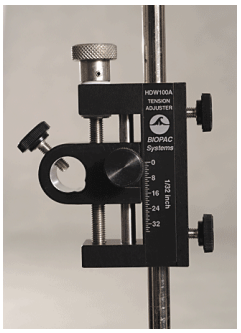
ADHESIVE TAPE

You will need adhesive tape for attaching goniometers and other devices. Use your preferred tape or BIOPAC's adhesive tape:

TAPE1 Single-sided adhesive tape for securing active electrodes, transducers, or other devices to the skin surface (9.1 meters).

TAPE2 Double-sided adhesive tape for attaching goniometers to the skin surface (25.6 meters).

HDW100A Tension Adjuster

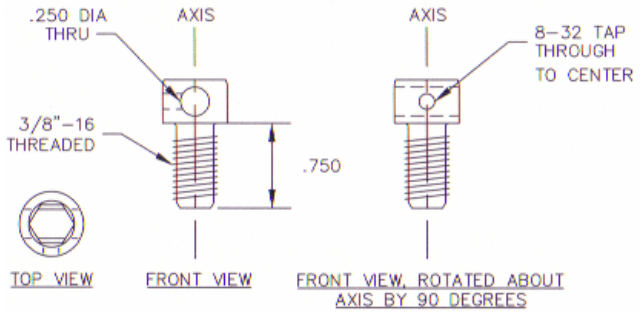


The rugged design and stability of the HDW100A tension adjuster mounting allow for fine position control. The position adjuster is located on the top for easy access and smooth operation. Vertical scales are provided for both metric and standard units. The HDW100A slides directly onto vertical rod laboratory stands and force transducers are clamped into the unit horizontally. The HDW100A operates with the SS12LA Force Transducer and the SS14L Displacement Transducer.

HDW100A Specifications

Travel Range:	25mm
Resolution:	0.0025mm per degree rotation
Stand Clamp:	14.65mm ID
Transducer Clamp	11mm ID
Weight:	140 grams
Dimensions:	93mm (high) x 19mm (thick) x 74mm (deep)

HDW200 Tension Adjuster Adapter



This adapter allows 3rd-party Tension Adjusters to interface with BIOPAC Force Transducers.

Fits any Tension Adjuster with an arm diameter of 6.35 mm (1/4") or less.

MANIPULATOR Micrcomanipulator

Travel Range:	Resolution:
X-axis Fine	10 mm 0.01 mm
X-axis	35 mm 0.1 mm
Y-axis	25 mm 0.1 mm
Z-axis	25 mm 0.1 mm

This manual micromanipulator is a reliable, durable, and economical solution for high-precision experiments. Vernier scales allow readings from 0.1 mm and X-axis fine control allows readings up to 10 µm. Includes a tilting base and ships with a standard clamp (12 mm) and electrode holder (14 cm long). All control knobs project to the rear, so units can be tightly grouped. Specify left- or right-handed when ordering.

BSLCBL Cable Series

INTERFACE CABLES

Stimulator to Nerve Chamber

Interface the BSL Stimulator with nerve conduction chambers. A BNC connector interfaces with the stimulator and two plugs attach to the nerve chamber.

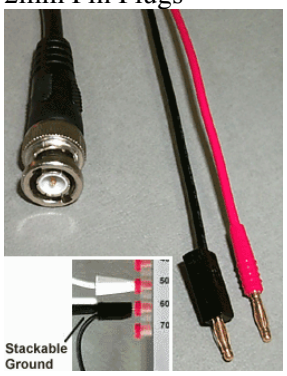
Gold-plated

Stackable ground

1.2 meter.

BSLCBL1A
Banana Plugs

BSLCBL2A
2mm Pin Plugs

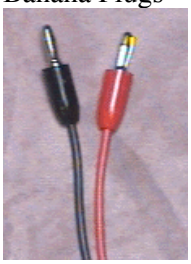


Nerve Chamber to Biopac Student Lab

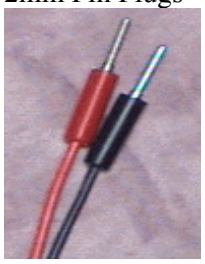
Interface nerve conduction chambers with the Biopac Student Lab System; use to record the signals coming from the nerve. A BSL DSub 9 connector interfaces with the Biopac Student Lab MP3X unit and two plugs attach to the nerve chamber.

1.2 meter

BSLCBL3A
Banana Plugs



BSLCBL4B
2mm Pin Plugs



BSLCBL3A/4B Specs

Gain: 1/10 (divide by 10)
Input Impedance (Common-Mode):
5e11 Ohms (500 GigaOhm)
Common-Mode Rejection: 90 dB Typical
Input Bias Current: 3pA Typical, 100 pA
Maximum Voltage Noise: 1.3 µV p-p
Voltage Noise Density: nV /SQRT(Hz)
Current Noise Density: 0.01 pA /SQRT(Hz)

3.5mm Phone Plug Adapter

Use BSLSBL5, 1.7 meters

Stimulator to Output

Use BSLCBL6 to interface the BSL Stimulator with 3.5mm Mono Phone Jack outputs, like the OUT100 Headphones or the OUT101 Tubephone set for auditory stimulation. Required for Auditory Evoked Response experiments.

1.3 meter

BSLCBL5

BSLCBL6
3.5mm Mono Phone Jack

Stimulator to Electrode

BSLCBL7,
BSLCBL11, and
BSLCBL12

BSLCBL7 - BNC to 2x Alligator
BSLCBL11 - BNC to 2x Electronic Test Clip (spring-loaded)
BSLCBL12 - BNC to 2x Toothless Alligator

Use these clip leads to interface stimulating electrodes, or to connect directly with animal preparations. Each 1-meter cable has two clips And terminates with one BNC connector to interface with the BSLSTM or SS58L Stimulator and silver or platinum wire electrodes.

High-impedance cables

BSLCBL8 and
BSLCBL9

These fully-shielded, high-impedance electrode interface cables permit high resolution recording of biopotential signals using reusable electrodes. The adapter terminates with standard 1.5mm Touchproof electrode connectors to interface reusable electrodes (EL250, EL350, and EL450 series).

BSLCBL8/9 Specifications

Input Range: BSLCBL8: MP35 ±1 V MP30: ±70 mV
BSLCBL9: MP35 ±10 V MP30: ±700 mV
Input Impedance: 500mGigaOhm (Common-Mode)
Input Bias Current: 3pA Typical, 100 pA Maximum
Voltage Noise: 1.3 µV p-p
Current Noise Density: 0.01 pA /SQRT(Hz)
Cable length: 2 meters
Interface: MP3X (DSub9)

Current/Voltage Drive & Monitor Cable

BSLCBL10

Use this current/voltage drive and monitor cable with an MP3X to perform ion transport experiments. This cable uses the output from the MP3X to drive a set of stimulation electrodes and also monitors the stimulation current.

The BSLCBL10 allows the MP3X to perform in a current or voltage clamping mode:

- To operate as a current clamp, the user must hold the stimulator current constant.
- To use as a voltage clamp, the user must hold the membrane voltage constant.

The cables terminate in a standard mini-grabber connector. Use with the BSLCBL8 high-impedance cable and mini-grabber leads to interface with Ag/AgCl electrodes.

The maximum recordable current is ±50µA; see the Current Measurement table below for ranges. The maximum resistance measurable at 50µA is 50KOhm.

The MP3X uses the "Manual Control" function of the BSL *PRO* software to provide the drive voltage, which eliminates the need for an additional power supply. The Manual Control function provides online control of the output voltage.

The BSLCBL10 provides an elegant solution to a somewhat complicated experiment... Typically, this experiment requires an ammeter to monitor the current, but the BIOPAC solution lets you record the current as well--this makes the experiment much

easier for students because they only have one interface to focus on.

It also simplifies setup because the equipment interface options are very limited and straightforward.

BSLCBL10 Current Measurement

Range	MP3X Gain	Resolution
0-50 µA	x200	.05 µA
0-20 µA	x500	.02 µA
0-10 µA	x1,000	.01 µA
0-5 µA	x2,000	.005 µA
0-2 µA	x5,000	.002 µA
0-1 µA	x10,000	.001 µA
Compliance:	2.5V maximum	
Resistance:	Max resistance measurable @ 50µA = 50 KOhm	
Interface:	Use with BSLCBL8 for best results	

MP35 Input Adapter for Research Amplifiers

BSLCBL14

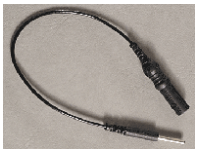
3.5mm phone plug adapter to MP35 Input (DSUB 9m)

Use to interface equipment that outputs high-level voltage signals, such as BIOPAC research amplifiers via the IPS100C Isolated Power Supply or UIM100C universal interface.

The cable has a built-in attenuation of 1/10, which translates 10 V to 1V.

CBL Cable Series

CBL201



PIN CONVERTER

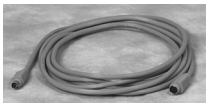
Converts 2 mm pin connection to Touchproof 1.5 mm connection. Use to update older model SS1L Shielded Lead Adapters**.**

CBL204

"Y" ADAPTER

This "Y" electrode lead adapter (25cm long) provides two Touchproof sockets and one Touchproof plug. Use to connect a glass microlectrode to multiple electrode sites (such as Vin- and GND from BSLCBL8/9 High-Impedance Cables). Connect multiple CBL204s to reference three or more electrode leads to the same input or output.

CBLEXT



SERIAL CABLE—EXTENSION

Use to increase the distance between the MP3X acquisition unit and your computer. Only one extension cable per acquisition unit is recommended. 3.6-meter

CBLSER

SERIAL CABLE—REPLACEMENT

Connects the MP3X to Mac or PC. 2.5-meter

CBLSERB

PCMCIA CABLE—REPLACEMENT

Connects the MP3X to PC Notebook via the PCMCIA card. 2-meter

CBLUSB

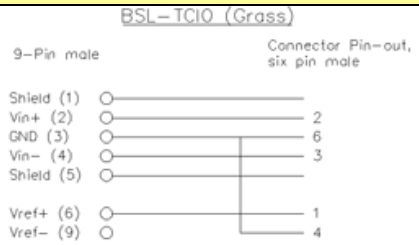
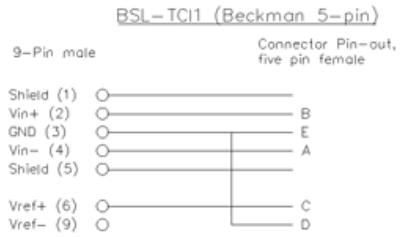
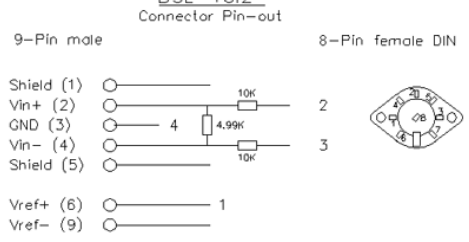
USB CABLE

2.5 meter replacement USB cable connects the MP35 to a USB port. Includes and provides EMI protection to maintain BSL Systems certified safety rating (CE, EMC).

TRANSDUCER CONNECTOR INTERFACES (TCI)

Save money and interface with your existing transducers. BSLTCI Series connectors for common transducer manufacturers are listed below-if you don't see the part you need, call BIOPAC Support or use the SS-Kit to build a custom interface.

Part #	Connector Make	Works with Transducers from...
BSL-TCI0	6-pin	Grass
BSL-TCI1	5-pin	Beckman
BSL-TCI2	8-pin	AD Instruments, iWorx, and WPI Transducers
BSL-TCI3	9-pin hexagonal	Lafayette and Narco
BSL-TCI4	6-pin	Honeywell
BSL-TCI5	4-pin phone jack	BIOPAC NIBP100 BP module
BSL-TCI6	12-pin	Beckman
BSL-TCI7	5-pin	Nihon Koden
BSL-TCI8	7-pin panel mount	Narco
BSL-TCI9	8-pin panel mount	Fukada
BSL-TCI10	12-pin panel mount	Gould
BSL-TCI11	6-pin male	Hugo Sachs and Harvard
BSL-TCI12	5-pin, 240 degrees	Thornton
BSL-TCI13	x-pin	xxxxxxxx
BSL-TCI14	1/4" phono socket	Lafayette Stereo
BSL-TCI15	5 pin DIN	Vernier
BSL-TCI16	BT Connector	BIOPAC RXPROBE02 and Vernier
BSL-TCI17	5 pin DIN	Intelitool
BSL-TCI18	2 x 2mm sockets	Liquid Metal (Mercury Strain Gauge or Indium Gallium)
BSL-TCI19	6-pin mini DIN	Intelitool
BSL-TCI20	3.5mm phono jack	Intelitool
BSL-TCI21	BNC	BIOPAC RXPROBE01 and 3rd-party pH probes

BSL-TCI Pin-outs	
BSL-TCI0	
BSL-TCI1	
BSL-TCI2	

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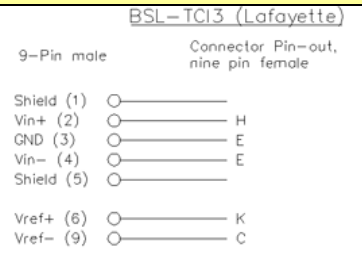
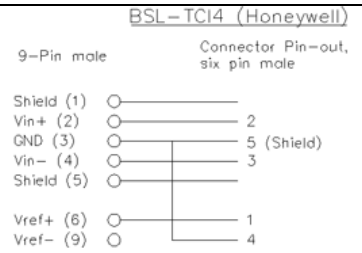
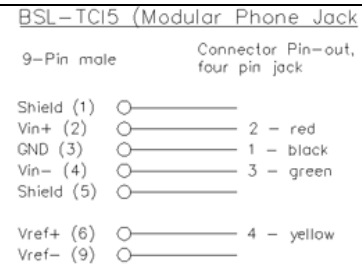
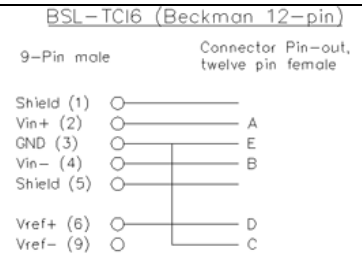
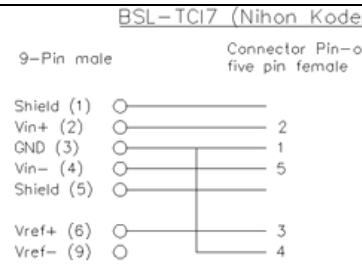
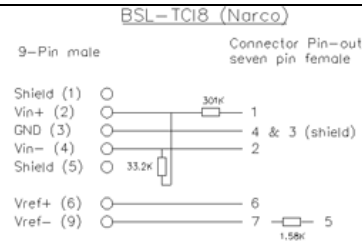
BSL-TCI3	
BSL-TCI4	
BSL-TCI5	
BSL-TCI6	
BSL-TCI7	
BSL-TCI8	

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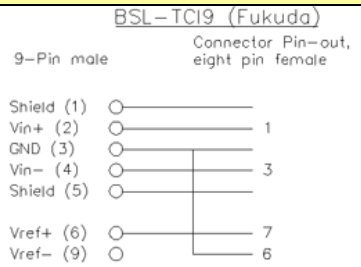
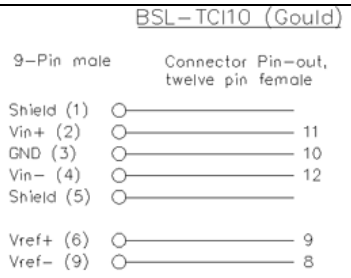
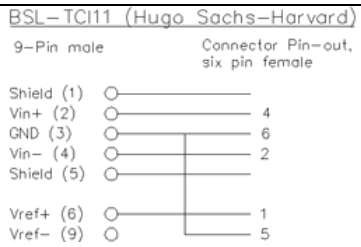
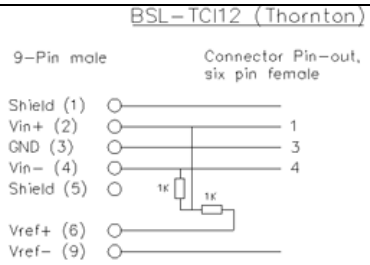
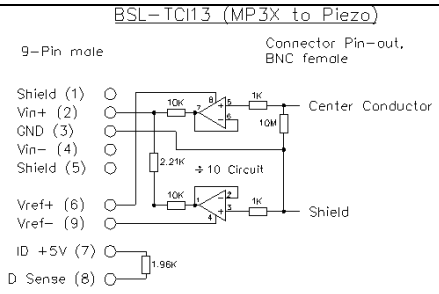
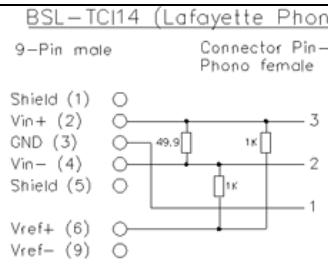
BSL-TCI9	
BSL-TCI10	
BSL-TCI11	
BSL-TCI12	
BSL-TCI13	
BSL-TCI14	

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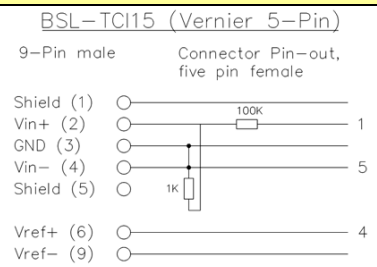
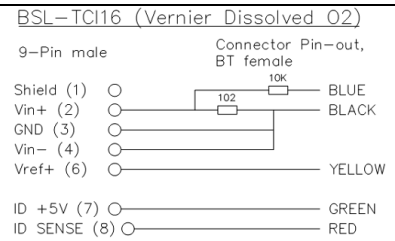
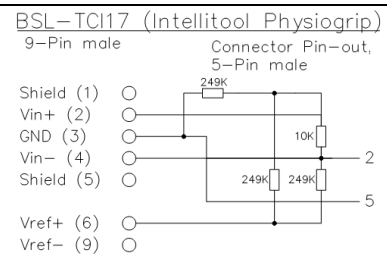
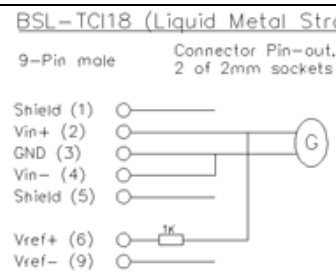
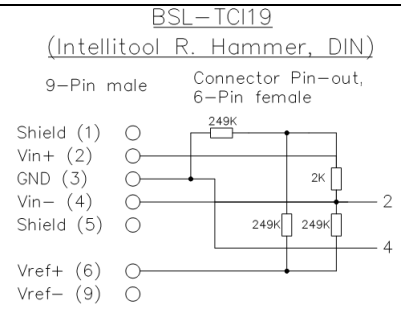
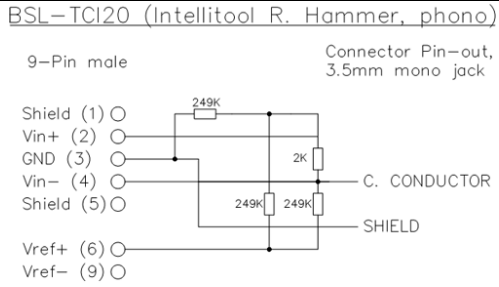
BSL-TCI15	
BSL-TCI16	
BSL-TCI17	
BSL-TCI18	
BSL-TCI19	
BSL-TCI20	

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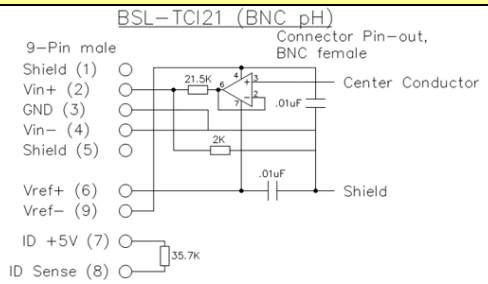
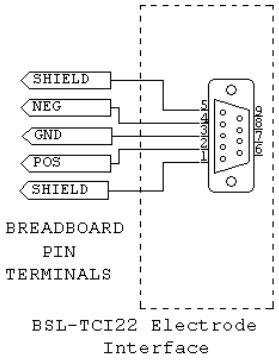
BSL-TCI21	
BSL-TCI22	

USB1M/USB1W USB ADAPTERS

USB1M and USB1W

The USB1M (for Macintosh) and USB1W (for PC) are USB adapters to interface your computer with the MP3X . They require an available USB port on your computer for proper operation, and include an integral USB cable.

AC SERIES Transformers

AC300A +12.5 V, 1.25 amp — for MP35 to mains wall outlet. Included with each BSL System. Specify power cord: ACCORD-HUS (hospital grade, USA) or ACCORD-EURO (Europe).

AC100A +12 V. 1.00 amp — for GAS-SYSTEM2 or MP30 to mains wall outlet. Specify power cord: ACCORD-US (USA) or ACCORD-EURO (Europe).

AC137A +6 V. 1.50 amp — for heating elements for SS45L-SS52L pneumotachs. Specify power cord: ACCORD-US (USA) or ACCORD-EURO (Europe).

BAT100 Battery Power Supply

Rechargeable Battery Pack (BAT100) with Recharger

The BAT100 is a sealed lead-acid rechargeable battery pack and recharger designed to operate with the MP3X. The battery pack comes in a handy carrying case equipped with a shoulder strap and includes all necessary cables. The fully charged battery pack will operate an MP3X for 12 hours minimum. The BAT100 can only be recharged when disconnected from the MP3X .

CONNECTORS

The socket on the pack and the charger connector are both standard “cigarette lighter” connections. The tip of the receptacle core is positive and the shell is negative.

CONNECTING TO THE MP3X

1) Connect the charged battery to the MP3X unit via the 1.2-meter BAT100-to-MP3X power cable.
   - The red LED on the battery cable should light, indicating that power is being supplied to the MP3X .
2) Turn on the MP3X if it is not already on.
   - The power LED should light.
3) Operate your MP3X as you normally would.

RECHARGING/STORAGE

1) Turn off the BAT100 and MP3X units if you have not already done so.
2) Remove the power cable from the BAT100.
3) Connect the BAT100 to the recharger unit via the recharger’s attached cable.
4) Plug the charger’s power cable into a mains outlet.
   - Full recharging of a completely discharged BAT100 takes 16-24 hours.
   - A shorter recharging period of 3 hours or more will allow you to “top off” a partially discharged battery or provide enough charge for shorter operating sessions.
   - Leaving the battery charger and BAT100 connected and charging for slightly longer periods than the full recharging time or charging a partially discharged battery for several hours or overnight will not adversely effect the performance of the BAT100.
   - Do not leave the battery charger plugged into the BAT100 for a significant time after the BAT100 is fully charged.
   - To optimize performance, allow the battery pack to fully discharge prior to recharging.

BAT100 BATTERY PACK SPECIFICATIONS

Capacity:	12v @ 14 AH
Weight:	5.6 kg
Charge Time:	16-24 hours
Operating Time:	24-48 hours nominal (12 hours minimum)
Recharge cycles:	500 (typical)
Output voltage:	12 V unregulated
Dimensions:	22cm × 8cm × 24cm
Shelf life:	Recharge every 6 months if stored/unused

BATTERY RECHARGER SPECIFICATIONS

Output:	12v @ 1.0 Amps
Weight:	1.8 kg
Input:	Specify USA or EURO power cord
Dimensions:	8cm × 13cm × 15cm

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