BSL HARDWARE GUIDE

An integrated system of hardware, software and a lab manual that revolutionizes life science education

BSL MP36 4-channel System

BSL MP45
2-channel
System

BSL System Accessories

BIOPAC® Systems, Inc.
Registered to ISO 9001:2015

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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 diagnosis, mitigation, treatment, cure, or prevention of disease.

The MP data acquisition unit is an electrically isolated data acquisition system, designed for biophysical measurements.

Exercise extreme caution when applying electrodes and taking bioelectric measurements while using the hardware 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.

Extreme caution is also required when performing general stimulation (electrical or otherwise) on a subject. Stimulation currents should not be allowed to pass through the heart. Keep stimulation electrodes far from the heart and located close together on the same side of the subject's body.

It is very important (in case of equipment failure) that significant currents are not allowed to pass through the heart. If electrocautery or defibrillation equipment is used, it is recommended that all BIOPAC Systems, Inc. instrumentation be disconnected from the Subject.

CLEANING & DISINFECTING BIOPAC COMPONENTS

The following disinfectants are recommended for LIQUID "COLD" sterilization of BIOPAC transducers:

- **Cidex® / Cidex® OPA** Disinfectant Solution, Johnson & Johnson
- **Perform®** Powder Disinfectant Concentrate, Schülke & Mayr
- **Terralin®**, Liquid Disinfectant Concentrate, Schülke & Mayr

> Always follow the manufacturer's directions.

Recommended gas based method:

- Low temperature, **Ethylene Oxide (EtO)** gas sterilization

AFT Series

- All AFT components, with the exception of filters, will hold up to liquid and gas sterilization as specified in this document.

AFT25 Facemask

- See detailed guide shipped with the product; also available at www.biopac.com.

EL250 Series Electrodes

- Store electrodes in clean, dry area.
- After use, clean electrode with cold to tepid water
- DO NOT use hot water.
- Cotton swabs are suggested.
- Let the electrode dry completely before storing it.
- DO NOT allow the electrodes to come in contact with each other during storage.
- Electrodes may form a brown coating if they have not been used regularly. To remove the coating, gently polish the surface of the electrode element with non-metallic material or wipe it with mild ammonium hydroxide. Rinse with water and store the electrode in a clean, dry container.

Warning! Use of a Waterpik® or similar jet will drastically shorten the life of these electrodes and is not recommended.

GASSYS2

- See detailed guide shipped with the product; also available at www.biopac.com.

Probes

- Immersion temperature probes can be cleaned using standard liquid disinfectant methods, with direct immersion for the recommended period.
- Non-immersion probes can be wiped down with liquid disinfectant, alcohol, or sterilized using Ethylene oxide (EtO).

RX137 Series Airflow Heads

- Thorough cleaning retains precise measurements. Disinfecting is only useful on a previously cleaned apparatus. Using a gas for disinfecting does not provide cleaning. An appropriate disinfectant solution can clean and disinfect simultaneously.
    1. Immerse the apparatus in the liquid. It can be completely immersed since the electrical part is waterproof; a 30- to 60-minute bath is usually sufficient to detach or dissolve the dirt.
    2. Rinse under a strong tap.
    3. Rinse with distilled or demineralized water.
    4. Use air or another compressed gas to dry the apparatus. Blow through the screen and in each pressure tube; a pressure of 5 to 6 bars is acceptable.
    5. Finish drying with atmospheric air or with a warm blow dryer (hair dryer).

WARNING!

Do not use organic solvents	Dilute the disinfectant (as for hand washing)
Do not heat the apparatus above 50º C	Never touch the screen with a tool

- Examples of liquids that may be used: Cidex® / Cidex OPA®, Glutaral, Glutaraldéhyde
- Example of gas that may be used: Ethylene oxide (EtO) gas sterilization

TSD130 Series Goniometers & Torsiometers

- Important: Disconnect sensors from instrumentation before cleaning or disinfecting.
- Cleaning: Wipe the sensors with a damp cloth, or a cloth moistened with soapy water. Do not use solvents, strong alkaline or acidic materials to clean the sensors.
- Disinfection: Wipe the sensors with a cloth moistened with disinfectant.

See detailed cleaning procedures for LDF and TSD140 series in LDF section.

BIOPAC Data Acquisition Units, Amplifiers or Accessory Modules

Clean BIOPAC module surfaces using any the following methods:

- Wipe lightly with a dry, lint-free cloth.
- Wipe lightly with a soft cloth dampened with a commercial, non-abrasive cleaner.
- Use a low-pressure air line to blow dust free, or carefully clean with a suitable vacuum cleaner.

To disinfect the module, wipe the surface with a soft cloth dampened with a solution of 70% alcohol in water.

WARNING! Do not spray, pour or spill any liquid on the module, including its connectors, switches or openings.

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MP ACQUISITION UNITS

MP36 Four Channel Data Acquisition System
MP46 Two Channel Data Acquisition System

Symbols – page 1
Compliance/Safety – page 1
Input devices/Sensor Connections – pages 1-2
Front and Back Panels – pages 2-4
Hardware Filters – page 4
Specifications – page 5
Pin-Out Diagrams – page 6

NOTE: Biopac Student Lab and BSL *PRO* software is not yet compatible with macOS 11 Big Sur--check compatibility.

The MP data acquisition unit is the heart of all BSL System packages. The MP Unit has an internal microprocessor to control data acquisition and communication with the computer. The MP Unit takes incoming signals and converts them into digital signals that can be processed with the computer. There are analog input channels (four on MP36 units, two on MP46), one of which can be used as a trigger input. The MP Unit must be connected to the computer and electrodes, transducers, and/or I/O devices must be connected to the MP Unit. Users are suggested to take a few minutes to become familiar with the MP Unit prior to making any connections.

MP46 units with current software are available to MP45 users via an upgrade program. Please contact your BIOPAC sales representative about MP46U-M (Mac upgrade) or MP46U-W (Windows upgrade).

Symbols — MP36 or MP46

Symbol	Description	Explanation
	Type BF Equipment	Classification
	Attention	Consult accompanying documents
	On (partial)	Turns MP36 on assuming AC300A power adapter is powered by the mains
	Off (partial)	Turns MP36 off if but AC300A power adapter remains powered by the mains
	Direct current	Direct current output
	USB	USB port

COMPLIANCE

Safety

The MP36/46 satisfies the Medical Safety Test Standards affiliated with IEC 60601-1. The MP36/46 is designated as Class I Type BF medical equipment

EMC

The MP36/46 satisfies the Medical Electromagnetic Compatibility (EMC) Test Standards affiliated with IEC 60601-1-2.

Types of Input Devices

There are three types of devices that connect to the MP36 and MP46: 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 MP36 using a "Simple Sensor" connector. Simple Sensor connectors are designed to plug only one way into the MP unit—no need 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 MP36 and MP46.
- Headphones and the stimulator connect to the "Analog out" port on the back panel of the MP36 and to the headphone jack on the top of the MP46.
- MP36 only: A digital device may connect to the "I/O Port" on the back panel
- MP36 only: A trigger device may be connected to the "Trigger" port on the back panel.

Front Panel

Front Panel, MP36

The front panel of the MP36 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. *The MP45 does not have an Electrode Check port. Use BIOPAC's* EL-CHECK *standalone electrode impedance checker to measure electrode/skin contact.*

MP46 is
CH 1 and CH 2 only.

Input Ports: CH 1, CH 2, CH 3, and CH 4

- The 9-pin female analog input ports on the MP acquisition unit are referred to as Channels. There are four on the front of MP36 Units and two on the MP46. The Biopac Student Lab Lessons software will always check to see that the proper sensors are connected to the appropriate channel.

Status Indicators

- **Busy**—indicator is activated when the MP36 is acquiring data and also during the first few seconds after the MP36 is powered on to indicate that a self-test is in progress. (When the MP36 passes the power-on test, the Busy light will turn off.)
- **Power**—status indicator is illuminated when the MP36 is turned on.
- **Ready**—status indicator is illuminated when the MP46 is plugged in and communicating.

Back Panel

Back Panel, MP36

The back panel of the MP36 has an analog output port, a USB port, a headphone port, an I/O Port, a Trigger Port, a DC input, a fuse holder, a power switch, and the unit's serial number.

The back panel of the MP46 has a USB cable and headphone port.

Analog Out Port – Low Voltage Stimulator

There is one 9-pin male "D" analog output port on the back of the MP36 that allows signals to be amplified and sent out to devices such as headphones. On the MP36, Analog Out is built-in low voltage stimulator.
Not available for MP46.

USB Connection

The MP36 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 MP36 to a PC or Mac.

The MP46 USB cable is a full-speed USB connector and should only be used to connect the MP46 to a PC or Mac USB port.

Headphone Output

- Accepts a standard (1/8" or 3.5 mm) stereo headphone jack.

I/O Port (MP36 only)

- Accepts a DB 25 Female connector.
- Input/Output port used to connect digital devices to the MP36.

I/O PORT (MP46 Only)

- Accepts BN-SMART-IOCBL TTL interface cable
- 1 meter cable connects to the small I/O port on the MP46 and terminates in a male DSub25 connector.

Trigger Input (MP36 only)

- Accepts a male BNC connector.
- Input port used to send trigger signals from another device to the MP36.
- MP system external trigger inputs are TTL compatible—this means that one needs to send the external trigger input 0 volts for a TTL low and 5 volts for a TTL high.

  The external trigger inputs are equipped with internal pull-up resistors—this means that they automatically sit at TTL high, if left unattached.

  - This is a common and helpful implementation, because all one requires to implement an external trigger is to pull the external trigger input low.
  - This implementation is typically performed with an external switch placed between the external trigger input and ground.

- When the switch is closed the external trigger input is pulled to TTL low.
- When the switch is opened the external trigger input is pulled back (by the internal pull-up resistor) to TTL high.

To sync several MP systems together, so that one external trigger can start all the MP systems simultaneously:

1. Connect all the MP systems grounds together.
2. Connect all the MP systems external trigger inputs together.
3. Place a switch between any MP system external trigger input and ground.

When the switch is pressed, all the MP systems that are connected together will be triggered simultaneously.

DC Input (MP36 only)

⎓ Use the DC Input to connect a battery, AC/DC converter or other power supply to the MP36.

- ⚠ The power supply requirements for the MP36 are 12 VDC @ 1 Amp. Only use the AC300A power adapter with the MP36. 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, 40 VA.
- 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 (MP36 only)

The fuse holder contains a fast-blow fuse that helps protect the MP36 from shorts on its power, analog, and digital I/O lines. The MP36 uses a 1.0 amp fast-blow fuse.

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

Power Switch (MP36 only)

- ⊙ ON position — powers up the MP Unit ○ OFF position — cuts the flow of power

Fixed Hardware Low Pass Filters

To provide for anti-aliasing for the digital IIR filters and to reduce high frequency noise, the MP unit employs a low pass filter. These filtering options are incorporated into each MP unit channel:

MP36: Low pass filter is set at approximately 20 KHz

MP45: Low pass filter is set at approximately 8 KHz

Fixed Hardware High Pass Filters

To accommodate the DC offsets associated with a range of biopotential and transducer signals, the MP unit employs a switchable bank of single pole high pass filters. These filtering options are incorporated into each MP unit channel:

MP36/46: High pass filter option of DC (HP filter off), 0.05Hz, 0.5Hz and 5 Hz.

Cleaning Procedures

Before cleaning, be sure to unplug the power supply from the MP36 or unplug the MP46 USB cable from the computer. To clean the MP36, use a damp, soft cloth. Abrasive cleaners are not recommended as they might damage the housing. Do not immerse the MP36 or any of its components in water (or any other fluid) or expose to extreme temperatures as this can damage the unit.

MP36/46 Specifications

Analog Inputs	Front panel DSUB 9f labeled “CH #”	
Number of Channels:	Isolated human-safe universal input amplifiers	
	MP36: 4 Channels MP46: 2 Channels	
A/D Sampling Resolution:	MP36: 24-bit MP46: 16-bit	
Gain Ranges:	MP36: 5x to 50,000x (13 steps) MP46: 10x to 20000x (11 steps)	
Input Voltage Range:	MP36: Adjustable from ± 200 µV to ± 2 V MP46: Adjustable from ± 500 µV to ± 1 V MP36/46 ± 10 V with SS70LA	
Signal to Noise Ratio	MP36: > 89 dB min MP46: > 65 dB min at 20000x gain	
Input Noise Voltage:	MP36: 0.1 µV rms noise (0.1 Hz to 35 Hz) – nominal MP46: 0.3 µV rms noise (0.1 Hz to 35 Hz) - nominal	
Input Noise Current:	2.1 pA rms (0.1 Hz to 10 Hz) - nominal	
CMRR:	85 dB minimum	
Software Filters:	Three programmable digital (IIR) filters; automatic or user-adjustable	
Hardware Filters:	Low pass – 20 KHz (MP36); none (MP46) High pass – DC, 0.05 Hz, 0.5 Hz, 5 Hz (MP36/46)	
Channel-to-Channel Latency:	None: Channels are sampled simultaneously	
Analog Output		± 0.5 V output Headphone jack (MP36/46): 3.5 mm stereo jack connection
Sample Rate:	MP36: 100,000 samples/sec each channel MP46: 20,000 samples/sec each channel	
Serial Interface Type:	USB 2.0 full speed	
Certification:	Complies with IEC 60601-1 EMC complies with IEC 60601-1-2 CE Marked	
Dimensions/Weight:	MP36: 7 cm x 29 cm x 25 cm / 1.4 kg MP46: 3 cm x 18 cm x 10 cm / 0.3 kg	
Additional Specs MP36 Only		
Analog Output:	Back panel DUSB 9m labeled “Analog Out”	
Voltage Output:	Range -10 V to +10 V Resolution: 16-bits	
Pulse Output:	Width: variable, 50 µsec – 100 msec Repetition: variable. 100 µsec – 5 seconds	
Pulse Level:	Adjustable from -10 V to +10 V With BSLSTMB Stimulator: 0 – 100 V	
Electrode Check:	Impedance Range 0-1 MΩ (Checks Impedance between Vin+ and GND, Vin- and GND)	
Input Triggering Options (MP36 only)		
External Trigger:	Back panel BNC labeled “Trigger” TTL positive or negative edge	
Analog Trigger:	Any Input channel (front panel “CH1 – CH4”)	
Digital Trigger:	Any of the eight input lines (back panel DSUB 25m)	
Additional Specs		
Operating Temperature Range:	0 – 70 deg C	
Storage Temperature Range:	-10 – 70 deg C	
Operating / Storage Humidity Range:	0 – 95% (non-condensing)	
Operating / Storage Pressure Range:	0 – 300 kPA	

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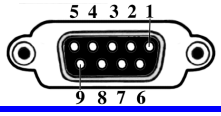
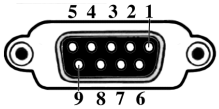
MP Unit Pin-outs

Electrode Check — MP36 Front Panel
9-PIN FEMALE DSUB



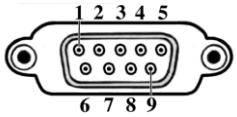
Pin		
2	Vin+	Electrode connection
3	GND	
4	Vin-	Electrode connection

MP 45/46 Input — Front
CH 1, CH 2, CH 3, CH 4
9 PIN FEMALE DSUB
(1 of 4 for MP36 or 1 of 2 for MP45)



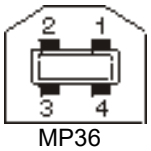
Pin	
1	Shield drive
2	Vin+
3	GND
4	Vin–
5	Shield drive
6	+5 V (50mA totally for 2 channels)
7	ID resistor lead 1; I2C SCL
8	ID resistor lead 2; I2C SDA
9	–5 V (50mA totally for 2 channels)

MP Analog Output — MP36 Back
9 PIN MALE DSUB



Pin	
1	Buffered analog or pulse output A.C. coupled (1,000 uF) Analog range: +/- 2.048 V Pulse range: 0 to 2.048 V
2	MP36 Low voltage stimulator Buffered, D.C. coupled Z out = 50 Ω Range: MP36 -10 V to +10 V
3	GND
4	+5 V (100mA max.)
5	Buffered pulse output Z out = 1 kΩ Range: 0 to 5 V
6	+12 V (100 mA max)
7	I2C SCL – Do not connect
8	I2C SDA
9	Monitor – Do not connect

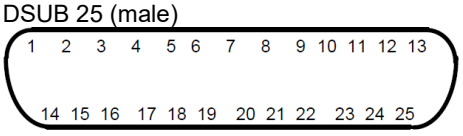
Connector — Back



MP36

Pin	
1	+5
2	-Data
3	Data +
4	GND
5	n/a
6	n/a
7	n/a
8	n/a

MP UNIT PIN OUTS continued
I/O Port — MP36 Back
DSUB 25 (male)



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

† Digital Input are 0-5 V with 100 K ohm pullups to 5 V on board

Pin		Pin	
1	Digital Output 1 0-5 V 8 ma	14	Digital Output 5
2	Digital Output 2 0-5 V 8 ma	15	Digital Output 6
3	Digital Output 3 0-5 V 8 ma	16	Digital Output 7
4	Digital Output 4 0-5 V 8 ma	17	Digital Output 8
5	GND Unisolated	18	Analog Input, Right 1 VRMS, centered at 0 V
6	GND Unisolated		
7	RS-232-RX	19	Analog Input, Left 1 VRMS, centered at 0 V
8	+5 V Unisolated/fused		
9	I2C-SDA 3.3. V	20	RS-232-TX 0-5 V
10	Digital Input 1† 0-5 V	21	I2C-SCL 3.3 V
11	Digital Input 2† 0-5 V	22	Digital Input 5
12	Digital Input 3† 0-5 V	23	Digital Input 6
13	Digital Input 4† 0-5 V	24	Digital Input 7
		25	Digital Input 8

BSL STIMULATORS

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

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

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

BSLSTMB

BSLSTMA

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

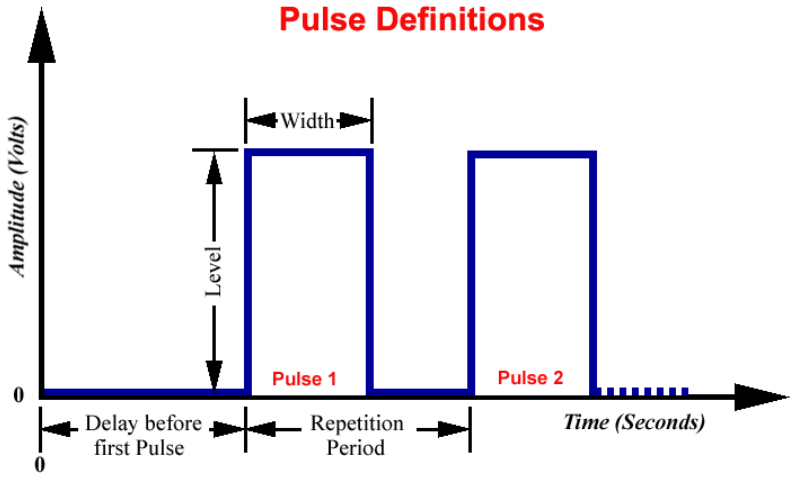
- NEVER set the BSLSTMA/B atop an MP3X
- Position the BSLSTMA/B away from the MP3X to reduce the signal distortion

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

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

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

STIMULATOR PULSE DEFINITIONS



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

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

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

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

Also called —
Pulse frequency
Repetition rate
Events per second

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

Pulse Repetition — Use when referring to either Pulse rate or Pulse period.

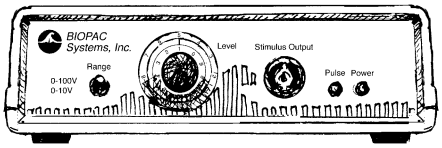
Pulse level — The amplitude of the pulse, expressed in Volts.
The output of the BSLSTM is 0 Volts when the pulse is not active.

Number of pulses — The number of successive pulses that will be sent out at the selected Pulse Width, Pulse Rate, or Pulse Period, and Pulse Level.

FRONT PANEL TERMINOLOGY

BSLSTMA/B — Digital Display & Keyed Switch

BSLSTM — Dial Reading & Flip Switch



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

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

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

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

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

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

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

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

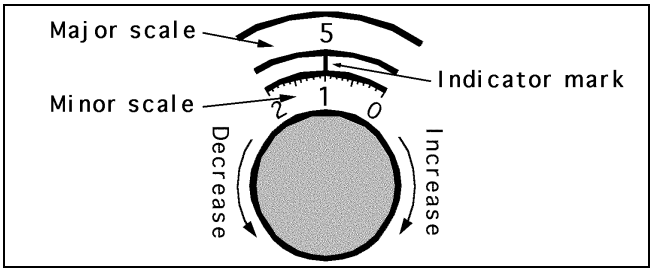
BSLSTMA/B digital display: Turn the Level control (right to increase, left to decrease) to establish the desired Level, as indicated on the digital display.

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

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

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

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



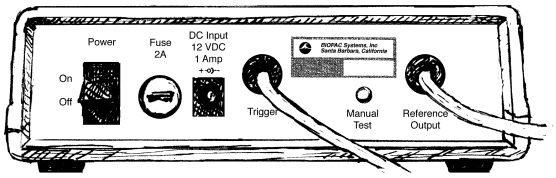
Close-up of "Level" adjustment knob

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

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

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

BACK PANEL TERMINOLOGY



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

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

DC Input — Socket for BIOPAC DC adapter.

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

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

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

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

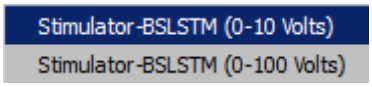
- BSLSTMA/B: Use the front panel Reference switch to select Actual or Fixed.
- BSLSTM has a fixed pulse width of 15 ms, selected so that the MP30 can capture the pulse with a sample rate as low as 100 samples per second.

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

Calibration

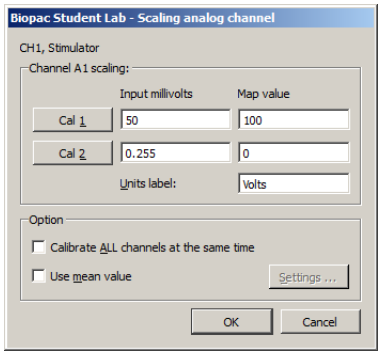
The "Reference Output" signal from the BSLSTM must be calibrated to ensure accurate results.

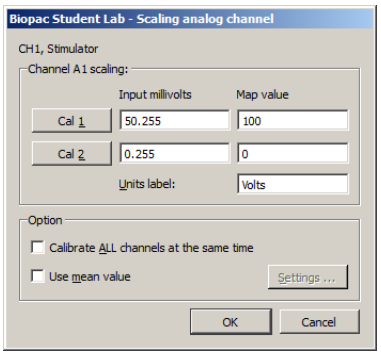
1. Choose the correct **Preset** (via MP3X menu > Set Up Data Acquisition > Channels).



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

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



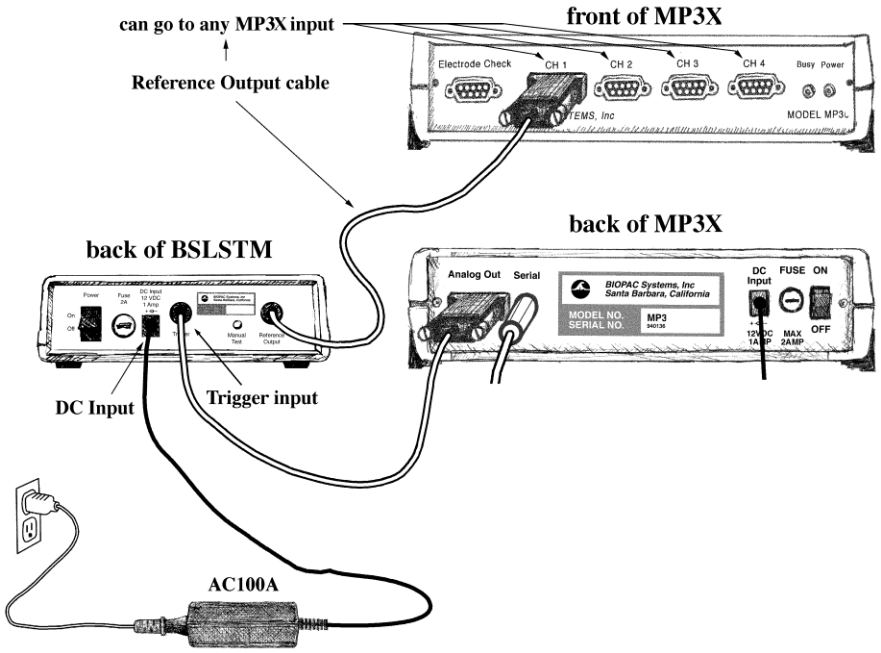


5. **Add** the Input value found in Cal 2 to the Input Value displayed for Cal 1.
   - For example, if "Cal 2" is pressed and provides an Input Value of .255 V, add the number .255 V to the existing 50 V and manually enter the total value of 50.255 V for Cal 1 Input Value.
   - *Note*: Even if the Cal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

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

CONNECTING THE BSLSTM TO THE MP3X

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



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

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

Pulse width

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

Pulse Repetition

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

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

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

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

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

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

Initial Pulse Delay

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

Pulse level

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

Reference Output

Correlates to actual pulse output (Requires Calibration)

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

Manual Test Pulse

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

Pulse Width:	1 millisecond

Stimulator isolation

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

Power requirements

12 Volts DC adapter (included), 1 Amp

Fuse

250 V, 2 A, fast blow

Fuse Dimensions:	1.25" length × .25" diameter

Module Weight

610 grams

Module Dimensions

16 cm x 16 cm x 5 cm

BSLSTM SPECIFICATIONS

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

Pulse width

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

Pulse Repetition

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

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

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

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

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

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

Initial Pulse Delay

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

Pulse level

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

Reference Output

Correlates to actual pulse output (Requires Calibration)

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

Manual Test Pulse

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

Pulse Width:	2.5 - 3 milliseconds

Stimulator isolation

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

Capacitance coupling:

60 pF

Power requirements

12 Volts DC adapter (included), 1 Amp

Fuse

250 V, 2 A, fast blow

Dimensions:	1.25" length × .25" diameter

Module Weight

610 grams

Module Dimensions

16 cm x 16 cm x 5 cm

LOW VOLTAGE STIMULATOR

OUT3

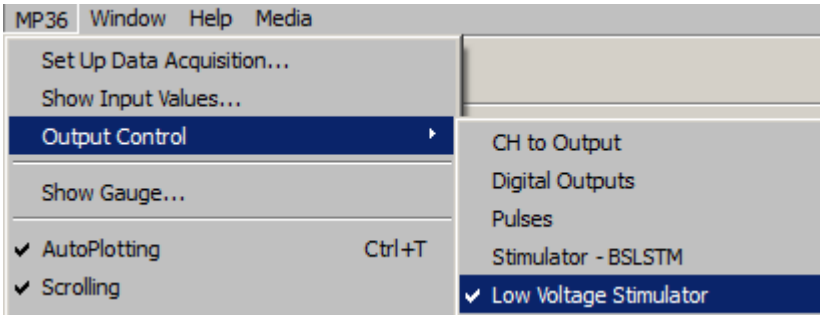
The **MP36** includes a built-in low voltage stimulator—just use the Analog Out port.

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

SS58L

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

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



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

STIMULATOR ELECTRODE GUIDELINES

— *PLEASE READ* —

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

The BSLSTM can output lethal levels of energy!

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

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

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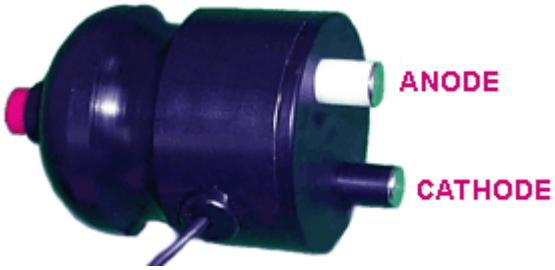
STMHUM HUMAN-SAFE STIMULATOR – DB9



Human stimulation with a superior degree of safety and comfort

The STMHUM is a direct, human-safe stimulator that provides pulse output in the range of 0-100 V. The maximum width pulse that can be generated is limited to 1 msec by hardware, ensuring the STMHUM meets all stimulator safety standards.

The ergonomic design allows the user to focus on the electrode placement instead of worrying about holding the electrode.

- Subjects depress the red safety switch to allow the software-controlled stimulus presentation through
- To stop the stimulus, Subjects simply remove their thumb from the switch and the electrode shuts off.

Cable terminates in a DB9 connector to interface the "Analog out" port on MP36 and MP36R units; not compatible with MP35 or MP30 units. Requires software versions BSL 4.1.1 or Acq*Knowledge* 4.4.1 or higher.

The STMHUM eliminates the need for an external stimulator—use as a cost-effective alternative for the HSTM01+BSLSTMB/A hardware combination.

BIOPAC software provides an output control panel that allows for the voltage to be specified directly along with pulse frequencies. Set parameters using MP Menu > Output Control > Human Stimulator – STMHUM:

IMPORTANT! Refer to the Stimulation Safety Notes beginning on the next page.

STMHUM SPECIFICATIONS

Stimulus Type:	Voltage
Stimulus Pulse Width:	50 µsec to 1 msec
Step Up Voltage Ratio:	1:10
Maximum output voltage:	100 V
Safety Switch:	Yes (pushbutton)
Isolation Capacitance:	100 pF
Isolation Voltage:	1500 V
Power output:	Watt (instantaneous max.) = (100 V x 100 V)/500 Ohms = 20 Watts
	Joules (Watts x Seconds) = 20 Watts x 0.001 seconds = 0.020 Joules = 20 mJ
Stimulating Electrodes:	*Material*: Stainless steel; *Diameter*: 8 mm; *Spacing*: 2.54 cm
Dimensions:	*Height* (electrode bottom to button top): 7.7 cm; *Diameter*: 4.5 cm; *Weight:* 170 G
Cable:	*Length*: 3 m (10'); *Connector*: DB9 male
Interface:	MP36 or MP36R Analog Out port (DB9 female)

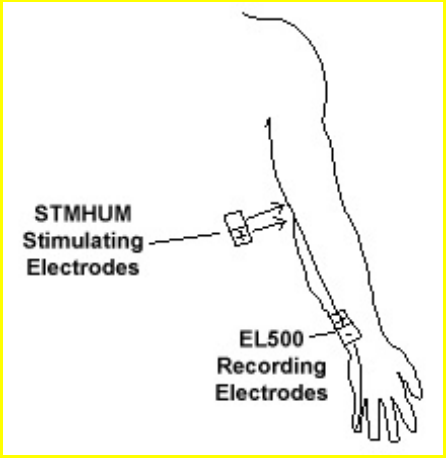
IMPORTANT SAFETY NOTES!

When using the STMHUM, it is possible to generate voltages as high as 100 V p-p. These voltages are potentially dangerous, especially if the stimulator's high voltage outputs are connected across the subject's heart. Across the heart means that the heart is potentially in the electrical path from lead to lead. This situation occurs when the stimulation electrodes are placed on opposite sides of the subject's body.

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

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

Example of correct stimulation electrode placement:



STIMULATION SAFETY

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

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

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

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

STMHUM units employ stimulus isolation transformers that limit the output pulse width to 1 ms maximum, under 500 ohm load conditions. In addition, the highest available output voltage is 100 V pk-pk under open circuit conditions.

For the pulse energy calculation for STMHUM:

Joules = Watts x Seconds
Watt (instantaneous max.) = (100 V x 100 V)/500 Ohms = 20 Watts
Joules (Watts x Seconds) = 20 Watts x 0.001 seconds = 0.020 Joules = 20 mJ

Accordingly, the highest possible energy output using the STMHUM is **20 mJ**, considerably **less than the 300 mJ maximum** as specified by IEC 60601-2-10:2015.

CAUTIONS FOR USE!

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

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

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

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

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

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

2) **Always start the stimulation process with the stimulator control set the LOWEST possible level**. The "Pulses" output control panel in the BIOPAC software is used to control the STMHUM. Set to the 0% level, prior to the onset of the stimulation protocol. During the protocol, increase the stimulus intensity by increasing the Level in small increments Stop increasing the intensity at the first sign of subject discomfort.

IMPORTANT NOTES!

A) It takes as little as **15 micro-amps** directed across the heart to instigate ventricular fibrillation. This situation can be readily achieved by using sub-surface stimulation needle electrodes that insert directly into the heart. It is considerably more difficult to achieve ventricular fibrillation on the same heart using surface electrodes, but it is possible to do so, evidenced by the performance of cardiac defibrillation units used in hospitals or by paramedics.

B) **Qualified experienced professionals** should supervise any protocols where electrical stimulation is applied to human subjects. Electrical stimulation protocols are not simple. Please contact BIOPAC Systems for any questions regarding the use of BIOPAC's stimulation units or accessories.

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STMISOLA LINEAR ISOLATED STIMULATOR

The Constant Current and Constant Voltage Isolated Linear Stimulator (STMISOLA) will connect to any analog output signal drive (±10 V input) and provides considerable flexibility in stimulation protocols:

- **Voltage and current stimulator (unipolar or bipolar)**—

  The STMISOLA connects directly to the STM100C (OUTPUT 50 Ω port) or the AMI100D/HLT100C/UIM100C (Analog Output 0 or 1 port) associated with the MP160/150 system.

  Interface STMISOLA to MP36R or MP36R Analog Out port; the DSUB9 to 3.5 mm mono jack allows the MP36R/MP36 to be used with the STMISOLA for arbitrary stimulus output. Works with Acq*Knowledge* 4.4.2 or above (MP36R) or BSL 4.1.2 or above (MP36).

  Linear stimulator—the STMISOLA can be used to generate stimulation signals that can have arbitrary waveshape. Typically, stimulators can only generate simple unipolar or bipolar pulses. The STMISOLA, however, can output unipolar or bipolar arbitrary waves such as pulse (single or train), square, sine, triangle, exponentially decaying, modulated envelopes, and fully user-specified types.

The STMISOLA can output either voltage or current waveforms.

- **Voltage (V) mode**—the STMISOLA multiplies the Control Input Voltage by a factor of 20, to present that amplified signal at the STMISOLA output.
  - In the case of a maximum ±10 V input control signal, the STMISOLA will output a ±200 V signal, with an output of either 100 ohms or 1 K ohms. These output impedance settings will act to limit the available output current.
- **Current (I) mode**—two settings.

The STMISOLA provides two options for output current mode.

1) High current mode (Zout switch set to 100 ohms), provides a gain factor of 10 ma/volt.
2) Low current mode (Zout switch set to 1 K ohms), provides a gain factor of 1 ma/volt. Low current mode permits much improved control for currents less than 10 ma.

The STMISOLA multiplies the Control Voltage by the factor indicated (K in ma/V) to present that associated output current at the STMISOLA output.

In the case of a maximum ±10 V Control Input Voltage, for:

- Zout = 100 ohms, K=10 ma/V: the STMISOLA will output ±100 ma
- Zout = 1000 ohms, K=1 ma/V: the STMISOLA will output ±10 ma
- In both cases, the voltage compliance is ±200 V.

There are two basic **stimulation modes** for the STMISOLA:

- Voltage
- Current

In voltage mode, the STMISOLA has two different output impedance (Zout) settings (100 ohms and 1 K ohms). Depending on the setting, the output voltage (Vout) on the electrode impedance load (Ze) will be subject to the following formula:

- Vout = [Ze/(Ze+Zout)] * Vc * 20
- Where: Vc is the input control voltage

In current mode, electrode load impedance does not impact STMISOLA gain accuracy. The STMISOLA will simply output the specified current (subject to the applied control voltage), despite the electrode load impedance, up to the point of maximum voltage compliance (+/- 200 volts).

Isolation characteristics—The STMISOLA isolates the Control Input Voltage from the stimulus output to 1500 VDC HiPot and approximately 1000 pF of coupling capacitance.

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

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

Power ON Safety—when you Power ON the STMISOLA, you must also hold Reset for at least 3 seconds. This forces the unit into an "operational but no output state" and protects the subject if accidentally connected to electrodes on power up.

Operating Details

→ Review Important Notes and Safety Notes before operating the STMISOLA

Important Notes

A) **The Current Feedback Monitor Cable (CBLCFMA) is recommended** for use with any voltage stimulator; to isolate CBLCFMA output, use INISOA and AMI100D/HLT100C. Always make sure to place the electrodes on the participant at least 10 minutes before starting any electrical stimulation. Use a CBLCFMA to monitor and record the actual current delivered to the participant at ALL times. A large enough change in current delivered to the participant will alter the subjective perception of the stimulation. Thus, an unpleasant shock may become painful if more current starts being delivered or become ineffectual if less current is being delivered than during threshold identification. Changes in the levels of delivered current are due to changes in impedance. Changes in impedance could be due to a number of factors: gel saturating the skin over time; gel drying up – over longer period of times; hydration level of participant; sweating; decoupling of electrodes and skin due to motion artifacts; etc.

B) In Current (I) Mode stimulation, if the output has a load (typically high impedance) that induces railing for the specific output current, the STMISOLA will immediately go into “Protect” mode. In the case of an unloaded output, this state will happen as soon as the STMISOLA is placed into Current (I) Mode stimulation. This happens because an “unloaded” STMISOLA output simply means that an arbitrarily high resistance load is attached to the STMISOLA. To correctly operate in Current (I) Mode stimulation, the proper load must be placed between stimulation electrodes and then “Reset” pushbutton must be pressed to 3 seconds to activate the unit.

C) In either stimulation mode (V or I), the output level (OL) will directly be a function of the applied Control Input Voltage (CIV). The conversion ratios are as follows:

Voltage (V) Mode:	CIV (volts)*20 (volts/volts) = OL (volts)
Current (I) Modes:	Zout = 100 ohms: CIV (volts)*10 (ma/volts) = OL (ma)
	Zout = 1 K ohms: CIV (volts)*1 (ma/volts) = OL (ma)

D) When an output waveform is present, the output waveform indicator—**red** LED just above BNC output connector —will glow. Waveform output level indication can be observed as an increasing intensity of this red LED. This output waveform indicator is designed to provide a visual indication of output, even if the wave duration is extremely short, so it may be possible that this indicator shows a waveform output for some brief period of time after the output wave has already passed.

Safety Notes

1. Never place the stimulation electrodes so that it’s possible for stimulation current to pass through the subject’s heart. This can happen if electrodes are placed so that the leads “straddle” to the left and right sides of the subject’s body. Place the stimulation electrodes close together on the SAME (left or right) side of the subject’s body appendage. Only place stimulation electrodes so they are on the appendage of interest. For example, for left leg stimulation, only place stimulation electrodes on the left leg and on NO other location on the body.

2. Do not power ON or OFF the STMISOLA unit while electrodes attached to the subject. Always be sure to place the STMISOLA in VOLTAGE mode, with zero volts applied to input, before attaching/removing electrodes to/from the subject. Zero volts is automatically applied to the STMISOLA input if the STMISOLA input cable is unplugged from any signal source.
3. For MRI Applications, when possibly considering the use of the STMISOLA for associated electrical stimulation of human subjects, please refer to BIOPAC Application Note 257 for context, warnings and details.
4. It is ideal to use the STM100C for stimulation control, because it permits manual control of the stimulation level. To use the STM100C:
   - Plug the Control Input Voltage line for the STMISOLA into the 50 ohm output of the STM100C.
   - Before stimulation begins, turn the Output Level Control knob to 0%.
   - Initiate stimulation in the Acq*Knowledge* software (see Application Note AH162).
   - After stimulation is initiated, slowly turn the STM100C Output Level Control to the desired level.
   - When the stimulation session is ended, turn the STM100C Output Level Control back to 0%.
5. **Do not remove electrodes** while in current (I) mode; it's possible for subjects to receive a shock if they remove electrodes while the STMISOLA is in current (I) mode because the STMISOLA responds to the impedance increase and causes the current source to swing to a positive or negative rail.

STMISOLA: Additional Notes Regarding Use of Current Mode Output

Current Mode stimulus output can appear to demonstrate non-intuitive behavior. This behavior is very different than Voltage Mode stimulus output.

The STMISOLA is a voltage-controlled stimulation system. In the case of Current Mode output, options exist to map the stimulus output current to the input control voltage. These two options are:

Option 1

+10 V input control voltage maps to +100 ma stimulus output current

-10 V input control voltage maps to -100 ma stimulus output current

Option 2

+10 V input control voltage maps to +10 ma stimulus output current

-10 V input control voltage maps to -10 ma stimulus output current

For both Option 1 or 2, the behavior is essentially the same, even though the stimulus output current range is different. When the input control voltage is close to 0 V, the stimulus output current is also proportionally close to 0 ma.

IMPORTANT NOTE:

When attempting to set the input control voltage to zero volts, the resulting voltage will most certainly never be exactly zero volts. Instead of zero, the input voltage will simply be close to zero, perhaps on the order of +0.001 V or -0.00001 V.

So, if the input control voltage is non-zero, the current output will also be non-zero!

Example A:

A non-zero input control voltage of 0.001 V will result in a non-zero stimulus output current of 0.001ma, assuming STMISOLA is set to Option 2. If the STMISOLA stimulus output is connected to an infinite (or very large) impedance, the STMISOLA will attempt to drive 0.001 ma through this very large impedance. Assuming the large impedance is 200 Mohm, then:

0.001 ma x 200,000,000 ohms = 200 V (estimate)

Accordingly, in practical operation, if the STMISOLA is used in current mode and is attached to electrodes that are making intermittent contact to the tissue of the subject, intermittent shocks may be felt by subject, even if 0 V is applied to the input control voltage. This is because the STMISOLA will drive directly to the compliance voltage limit and start to behave as a voltage stimulator.

Intermittent contact with electrodes will result in intermittent +/- 200 V shocks being applied to the subject. These possible transient shocks may be felt, but only when skin electrodes dislodge and reconnect to the subject's tissue.

This possible +/- 200 V stimulus will be present on STMISOLA output leads at the point when the electrodes reconnect with the tissue, assuming the electrodes had dislodged previously. At the point of reconnect, the voltage level falls back below the compliance threshold and the errant stimulus goes away, but this process takes a few microseconds. If transient connects and reconnects happen over a period of time, many bursts of voltage will impact the electrode sites.

This potential safety issue can be mitigated through a couple of methods:

1. Employ a bipolar voltage clamp across the stimulus output current leads.
2. Employ an added parallel resistance across the stimulus output current leads.

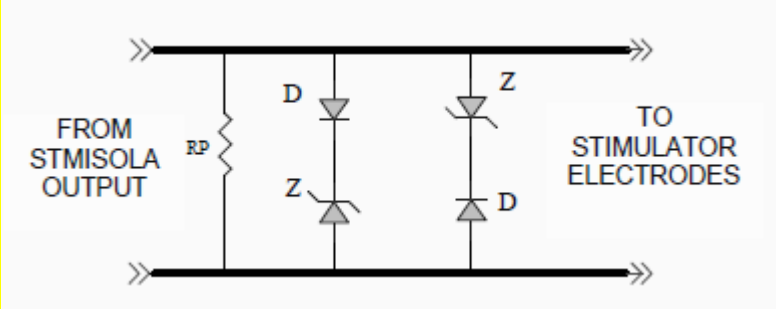
In method 1, the bipolar voltage clamp simply limits the compliance voltage to a deemed safe level.

Two, oppositely directed, diode and Zener diode series circuits are used to define the voltage clamp maximum value, assuming the stimulus electrodes may become dislodged.

In method 2, the maximum load impedance will be dictated by the chosen added parallel resistance.

Also, these two methods can be used together, for additional safety consideration.

Components and Connections:



Choose:

Rp: Resistor; should have value much larger than resistance through intended load (e.g., subject).

Z: Zener diode; breakdown voltage should be equal to desired voltage limit.

D = Switching signal diode (suggest 1N4148 TYP)

Example B:

Using the Example A, also assume that a parallel resistance of 1 Mohm is employed across the stimulus output current leads. Accordingly, the reference equation becomes:

0.001 ma x 1,000,000 ohms = 1 V (estimate)

In this case, the maximum stimulus voltage received by the subject, in the event of sporadic electrode contact, would be on the order of 1 V, instead of 200 V. Alternatively, if the parallel loading represented by the additional 1 Mohm resistance is not desired, a voltage clamp could be used to limit the maximum output voltage level in the event of sporadic electrode contact.

The STMISOLA has the capability of acting as a nearly ideal current stimulator, with very high performance. Adding a parallel resistance or a voltage clamp reduces performance from ideal, but enhances safety. Please contact BIOPAC Systems, Inc. at www.biopac.com for more information.

Operating Procedure

→ Review Important Notes and Safety Notes before operating the STMISOLA

The included 3.5 mm mono splitter (3.5 mm male mono phone plug to two 3.5 mm female mono sockets) and one CBL100 (3.5 mm mono male to 3.5 mm mono male cable) permit the analog drive signal to be directed to two locations. The drive signal – usually from DA0 or DA1 – is typically directed to the splitter cable. One socket output of the splitter cable is directed to the STMISOLA input.

The other socket output of the splitter cable is looped back to drive an available MP input, via CBL100, through the UIM100C or AMI100D/HLT100C (CBL122 adapter required for AMI100D/HLT100C). In this manner, during acquisition, the stimulus level and timing will be indicated on the recording.

1. Plug AC300 into back of STMISOLA unit.
2. Connect Control Input (3.5 mm male phono plug) to output: AMI100D/HLT100C/UIM100C (Analog Out 0 or 1) or STM100C (50 ohms) or MP36 Analog Out (via OUT5 adapter) or external signal generator.
3. **Before powering ON the STMISOLA** (turning from OFF to ON), make sure that stimulation electrodes are not attached to the subject.
4. Power ON STMISOLA.
   - Note that "Protect" red LED on front panel is ON, when STMISOLA is powered ON.
5. Set "Output Mode" switch to **V** for Voltage stimulation.
6. Press "Reset" pushbutton switch for 3 seconds to enable STMISOLA.
7. Make sure that STMISOLA input voltage is Zero volts.
8. Connect electrodes to subject and then to STMISOLA output.
9. Place STMISOLA in Current (I) mode, if desired.
   - Note that if output is unloaded and if STMISOLA is in Current (I) Mode, then the "Protect" light will stay ON, thus activating shutdown protection (see Important Note A).
10. Send Control Voltage (STMISOLA input) to affect desired wave output (see Acq*Knowledge* Software Guide or BIOPAC Application Notes AH162 and AS200).
11. When stimulation session is ended, place STMISOLA in Voltage (V) Mode and make sure that STMISOLA unit input control voltage is Zero volts.
12. **Before powering OFF the STMISOLA** (turning from ON to OFF), remove stimulation leads and/or electrodes from subject.

    WARNING: Do not remove electrodes while in current (I) mode; it's possible for subjects to receive a shock if they remove electrodes while the STMISOLA is in current (I) mode because the STMISOLA responds to the impedance increase and causes the current source to swing to a positive or negative rail.
13. Power OFF STMISOLA after making sure that stimulation electrodes are not attached to the subject.

STMISOLA Specifications

The STMISOLA is a linear, isolated, constant voltage or constant current stimulator. The STMISOLA has one output voltage mode and two output current modes. The output voltage mode multiplies the input control voltage (±10 V) by a factor of 20 to the output. When operating in output current mode, there are two options: Low current mode (Zout=1 K ohm) and High current mode (Zout = 100 ohms). In Low current mode there is a 1:1 relationship between the input control voltage (in volts) and output current (in ma). In High current mode there is a 1:10 relationship between the input control voltage (in volts) and output current (in ma). The Zout selector switch determines the output impedance of the STMISOLA is voltage mode (100 ohms or 1 K ohms). The Zout selector switch determines the output current range (±100 ma for Zout = 100 ohms) or (±10 ma for Zout = 1 K ohms). The Zout switch has different operation, depending on output mode of STMISOLA. In Voltage output mode, the Zout setting simply specifies the output impedance of the STMISOLA. In Current output mode, the Zout setting determines the gain factor (K) which sets the desired current range, either +/- 100 ma or +/-10 ma.

The STMISOLA is also well-suited for transcranial direct current stimulation (tDCS). tDCS is a form of neuro-stimulation which employs the use of low level (typically under 10 ma) constant, unipolar, direct current.

The STMISOLA will support arbitrarily long, constant, non-varying, direct output currents, so long as the associated voltage compliance is 100 VDC or less. The tDCS level is adjusted by holding a stable voltage to the control voltage input of the STMISOLA. This control voltage can be set in Acq*Knowledge*, to be output to STMISOLA via analog output, or can be provided by any 3rd party power supply or signal generator.

Control Voltage Input: ±10 V maximum input

Control Voltage Impedance: 1 Mohm

Control Voltage Input Interface: Male 3.5 mm mono phone plug

Isolation: Control Voltage Ground to Isolated Output Ground: 1000 pF at 1500 VDC HiPot

Isolated Output Ground to Mains Ground: 2000 pF at 1500 VDC HiPot

OUTPUT:

Stimulation Voltage (V) Mode: ±200 V with:

Zout = 100 ohms: ±100 ma compliance; Output Impedance = 100 ohms

Zout = 1 Kohm: ±10 ma compliance; Output Impedance = 1000 ohms

Current (I) Mode: ±200 V compliance; Output Impedance - 1 Gohm

Zout = 100 ohms: ±100 ma

Zout = 1 K ohm: ±10 ma

Input to Output Ratio:

Voltage (V) Mode:

±10 V DC input creates output of ±200 VDC (1:20 ratio - V/V) for Zout either 100 ohms or 1 K ohms

Current (I) Mode:

±10 V DC input creates output of:

Zout = 100 ohms ±100 mA (1:10 ratio - V/ma)

Zout = 1 K ohms ±10 mA (1:1 ratio - V/ma)

Rise Time Measurement Setup:

Load: 1 K ohm

Input Control Signal: 0-1 Volt (1 µsec rise time or less)

Current Monitor: CBLCFMA Current Monitor (in series with stimulus output current)

Rise Times (10%-90% stimulus output current amplitude levels indicate rise time)

1) Voltage mode (Zout = 100 ohms or 1 K ohms): 10 µsec nominal

2) Current mode (Zout = 100 ohms – 15 µsec nominal, Zout = 1 K ohms – 10 µsec nominal

Max output pulse width: Less than 100 VDC (voltage output or compliance level) – arbitrarily long

More than 100 VDC (voltage output or compliance level) – 100 ms typical

Max sine frequency: 30 kHz (-3 dB)

Input Control Voltage: ±10 V max

Physical Interface: 3.5 mm male mono phone plug

Compatibility MP: UIM100C (Analog Out 0 or 1), AMI100D or HLT100C (Analog Out 0 or 1 via CBL122 cable adapter), STM100C (50 ohm output), Generic signal generator w/ ±10 V output range

Voltage or Current output noise (rms): nominally +/-0.02% of Full Scale Range (FSR)

Accuracy: Voltage or Current output (Zout is 100 ohms or 1 K ohms): ± 1%

Linearity: ± 0.1%

Output Pulse Duration: Output or current compliance voltage (Vout < 100 V) - fully arbitrary, no limit to wave (pulse) duration, subject to user-supplied control voltage signal drive

Output or current compliance voltage (Vout > 100 V) : 100 msec typical and limiting to 20 ms at 100 ma current output

Current Limiting: ±350 ma (short circuit)

Voltage Limiting: ±210 V (nominal)

Reset Push Button: Required with each power ON – push in for 3 seconds to Reset

Manual Test Voltage Output Pulse: 100 V for 2 msec

Current Output Pulse:

Zout = 100 ohms: 50 ma for 2 msec

Zout = 1 K ohms: 5 ma for 2 msec

Full Scale Range:

Voltage mode: ±200 V (Zout = 100 ohms or 1 K ohms)

Current mode:

±100 ma (Zout = 100 ohms)

±10 ma (Zout – 1 K ohms)

Output Indicator: ON for P-P amplitudes > 1% FSR

Fuse: 2 amp fast blow

Power Adapter: 12 VDC at 1 amp (AC300A)

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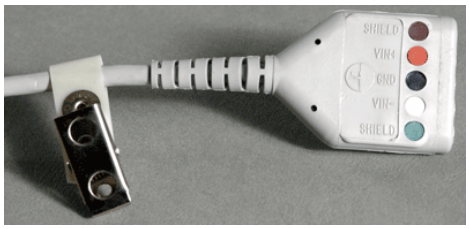
SS1LA SHIELDED ELECTRODE ADAPTER



The fully-shielded electrode interface cable permits high resolution recording of biopotential signals. The 3-meter adapter cable accepts standard 1.5 mm female Touchproof connectors. Use this lead adapter with:

- LEAD120 and EL120 Contact Post Electrodes
- LEAD110 Series and
    - EL160 Series Reusable Gold Cup Electrodes
    - EL250 Series Reusable Ag-Agcl Electrodes
    - EL350 Series Bar Electrodes
    - EL450 Series Needle Electrodes
- LEAD140 Series Clip Leads

To use disposable electrodes, connect 2 x LEAD110S-R/W shielded electrode leads to the VIN+ and VIN- inputs, and 1 x LEAD110 unshielded lead to the ground input. The LEAD110 series electrode leads will interface with any BIOPAC disposable electrode.

SS1LA SPECIFICATIONS

Cable length	3-meter
Termination	standard 1.5 mm female Touchproof connectors

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

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SS2L ELECTRODE LEAD SET

- "SS2L" is used to reference SS2L, SS2LA, or SS2LB lead sets;
- SS2LB is recognized by current release BSL Lessons.

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/4X unit. Depending on where electrodes are placed, they can 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/4X 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 and SS2LA are discontinued products. SS2LB is the current product offering.

SS2L SPECIFICATIONS

Cable Length:	2 meters
Connector Type:	9 Pin DIN

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SS3LA ELECTRODERMAL ACTIVITY (EDA) TRANSDUCER WITH REUSABLE ELECTRODES

The SS3LA transducer connects to a single MP3X/45 input channel to record electrodermal activity (changes in skin conductance) or, with modified setup, skin resistance*. The SS3LA operates by applying a fixed voltage (0.5 Volts DC) across the two electrodes and then detects the minute current flowing between the electrodes. Because the voltage (V) is fixed, from Ohms Law, the conductance (G) will be proportional to the current (I): G = I/V = I/0.5 V. Circuitry in the SS3LA then converts the detected current to a voltage so it can be measured by the MP device. The software performs the necessary scaling and units conversion. Two reusable Ag-AgCl electrodes are mounted in individual, ergonomically designed, polyurethane housings for improved contact, attachable to the fingers by a Velcro strap. The electrodes have a 6 mm contact area with a 1.6 mm cavity to accommodate isotonic electrode gel (GEL101A or equivalent). The non-polarizable electrodes are shielded to minimize noise interference and improve recordings.

- See the SS57L EDA Lead for a disposable electrode option

USAGE RECOMMENDATIONS

Presets - BSL *PRO* (and Acq*Knowledge* software for MP36R) includes the following EDA presets:

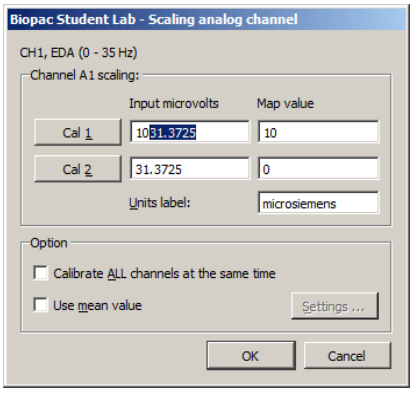
- Electrodermal Activity (EDA), 0-35 Hz; requires calibration—see details below
- Electrodermal Activity (EDA) Change; no calibration required (BSL *PRO* 4.0.3 and earlier only)

To navigate to the presets in the software, choose **MP** > **Set Up Data Acquisition** (BSL 4.1) or **Set Up Channels** (BSL 4.0.3 or earlier) > **Channels** > and select the desired EDA preset from the **Preset** pop-up menu.

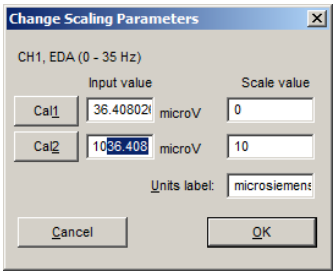
Single-point Calibration for (EDA) 0-35 Hz Preset

The following single-point calibration will yield very good results and is easy to perform:

1. Disconnect the electrodes.
2. Click "Setup" > "Scaling" button in the software's EDA preset dialog.
3. Click the **Cal 2** button.
4. Add the new **Cal 2** value to the default **Cal 1** value (example below left, 1000 + 31.3725 = 1031.3725). If the new **Cal 2** value is negative, then subtract that value from **Cal 1**.



BSL 4.x and AcqKnowledge 4.x EDA Scaling Dialog



*Note that **Cal 1** and **Cal 2** values are reversed in software versions BSL 3.7.x and earlier.*

BSL 3.7.x EDA Scaling Dialog

Two-point Calibration for (EDA) 0-35 Hz Preset

Two-point calibration offers the advantage of greater accuracy, but is a more complex procedure. To perform:

1. Prepare two 1% calibration resistors: 100 kiloohm (10 microsiemens) and 1 megaohm (1 microsiemen). Insulate the resistor using clear tape such that when held, the fingers will not directly contact the resistor leads.
2. Place the 1 megaohm resistor such that one resistor lead contacts one electrode pad and the other resistor lead contacts the opposite electrode pad.

3. Click "Setup" > "Scaling" button in the software's EDA preset setup dialog.
4. In the Scaling dialog box, set the **Cal 1 Scale value** to **"1"** and click **Cal 1**.
5. Repeat Step 2 using the 100 kiloohm resistor.
6. In the Scaling dialog box, set the **Cal 2 Scale value** to **"10"** and click **Cal 2**.

If the file is now saved as a template (*.gtl), the calibration values will be maintained as long as the transducer is matched to the software each time it is used.

Verify - check the accuracy of the SS3LA:

1. Click **Start** to begin a recording.
2. Place an insulated 100 kiloohm resistor (10 microsiemens) across the electrode pads (resistor must be insulated from fingers).
3. Click **Stop**.
4. Check the EDA value when the resistor was placed across the electrodes using measurements.
    - The software should produce a reading of 10 microsiemens (μsiemens).

Setup - There must be good electrical connections between the skin and the electrodes for EDA to work properly.

Gel - When using GEL101A isotonic gel it is important that the gel has a chance to be absorbed and make good contact before recording begins. Accordingly:

1. Apply GEL101A to the skin at the point of electrode contact and rub it in.
2. Fill the SS3LA electrode cavity with GEL101A.
3. Attach the SS3LA electrode to the subject.
4. Wait 5 minutes (minimum) before starting to record data.

*Measuring skin resistance - Use an Expression calculation channel to take reciprocal of conductance, and then apply proper scaling.

Tip

To detect a good signal, subjects should 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.

CLEANING THE SS3LA TRANSDUCER

- The GEL should be immediately cleaned off the electrodes after each use. Dried gel will act as insulator preventing electrical contact with the skin, and the Ag-AgCl electrode disk could degrade quickly with time because of the porous electrode surface.
- To clean the electrodes, wet a cotton swab or toothbrush with water and remove the electrode gel. Always dry the electrodes after cleaning.
- If needed, use Hydrogen Peroxide solution (2-3%) to brighten electrode surface (optional) or to sterilize the electrode. Do not place the electrode in solution, but rather use a cotton swab or toothbrush. Dry the electrodes after cleaning.
- If a dark residue remains after the above cleaning methods are used, then a cleaner with pumice (such as Ajax) can be used on the wetted cotton swab or toothbrush.
- **Warning!** Use of a Waterpik® or similar jet will drastically shorten the life of these electrodes and is not recommended.

SS3LA SPECIFICATIONS

Electrode Type:	Ag/AgCl, shielded		
Excitation:	0.5 V DC	Weight:	4.5 grams
Range:	0.1-100 μsiemens (normal human range is 1-20 μsiemens)	Cable Length:	2 meters
Surface Area:	6 mm contact area	Connector Type:	9 Pin DIN

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Gel Cavity Area	1.66 mm	Sterilizable:	Yes (contact BIOPAC)
Dimensions:	16 mm (long) × 17 mm (wide) × 8 mm (high)		

PULSE PHOTOPLETHYSMOGRAM TRANSDUCERS

- TSD200 for MP160/MP150 System
- SS4LA for MP3X and MP4X System

The TSD200/SS4LA consist of a matched infrared emitter and photo diode, which transmits changes in blood density (caused by varying blood pressure) in specific body locations. When the TSD200 is attached to the skin, the infrared light is modulated by blood pulsing through the tissue below. The modulated, reflected light results in small changes in the resistance of the photo resistor, which yields a proportional change in voltage output.

The TSD200/SS4LA includes a shielded 2-meter cable and a stretchable Velcro® strap for easy attachment to the fingers, or it can be taped to other body parts. The TSD200/SS4LA can also be placed on other body locations by employing ADD208 adhesive disks to hold the transducer in place. Use the TSD200C ear clip transducer for easy attachment to the ear.

Place the transducer around the finger and adjust the Velcro® closure to provide only slight tension. Blood density readings can vary considerably depending on transducer location and tension changes.

The TSD200 connects to the PPG100C as follows (See also: PPG100C for a diagram):

TSD200 Lead	PPG100C	
Red connector	VIN+/+VSUP	(may also be black connector with red shrink wrap)
Black connector	GND	
White connector	VIN-/INPUT	(may also be black connector with blue shrink wrap)

The SS4LA plugs directly into the MP3x or MP4x.

CALIBRATION

The TSD200/SS4LA does not require calibration.

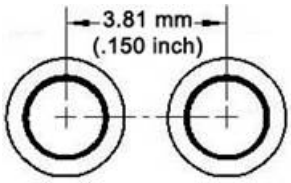
TSD200C PULSE PHOTOPLETHYSMOGRAM WITH EARCLIP

The photodetector operates via incident photons, from an IR transmitter, impacting an IR detector. The incident photons result in a proportional passage of electrons in the detector. The IR detector operates like a photon-controlled current source. The transducer incorporates an appropriate clipping range, with linearity insured for arbitrarily low levels of reflected light. For the expected magnitude of incident infrared light, the photodetector operates in a linear fashion. Situations have not been encountered where the detector is operating non-linearly (near saturation).

The TSD200C transducer operates with the PPG100C amplifier to record the pulse pressure waveform. The TSD200C consists of a matched infrared emitter and photo diode, which transmits changes in infrared reflectance resulting from varying blood flow. The ergonomic housing design improves contact with the subject and helps reduce motion artifact. The TSD200C is primarily designed for ear attachment and comes with a shielded 2-meter cable and ear clip.

TSD200/200C/SS4LA SPECIFICATIONS

Emitter/Detector Wavelength:	860 nm ± 60 nm
Optical Low Pass Filter Cutoff Wavelength:	800 nm
Note	The operational range of the emitter and detector fall within the wavelength range of 800 nm to 920 nm. The filter is placed over the receiver; the filter of 800 nm is an optical lowpass, so wavelengths longer than 800 nm will pass thru.
Emitter/Detector Spacing:	3.81 mm (.150 inch) – center to center



Nominal Output:	20 mV (peak-peak)
Power:	6 VDC Excitation @ 5 mA
Sterilizable:	Yes (Contact BIOPAC for details)
Weight:	4.5 g
Dimensions (L x W x H):	16 mm x 17 mm x 8 mm
Attachment:	Velcro strap
Cable:	3 m, shielded (TSD200, SS4LA), 2 m, shielded (TSD200C)
Interface:	PPG100C
TEL100C Compatibility:	SS4A

NOTE THE TSD200A EAR CLIP TRANSDUCER WAS DISCONTINUED IN AUGUST OF 2008.

OXYSSH-SYS HUMAN OXIMETRY (SpO_2) SYSTEM

This Human Pulse Oximetry System includes everything required to record SpO_2, Heart Rate, and Pulse with an MP36R Research System or MP36, MP35, MP46, or MP45* Education System.

Human SpO_2 System components:

OXYSSH Oximeter module for MP3X/4X

BSLCBL15 Pulse cable for OXYSS

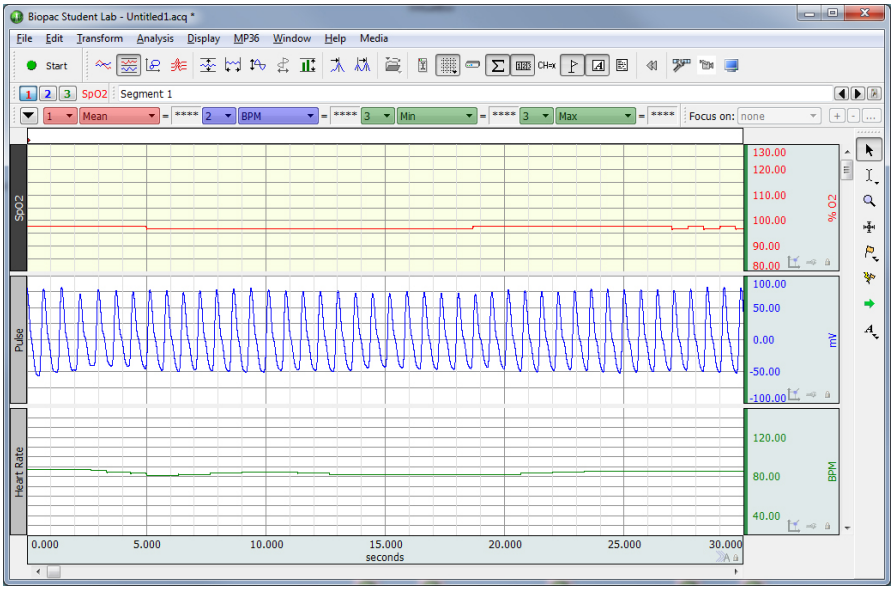
BSLCBL16 Rate cable for OXYSS

TSD124A SPO_2 Finger Transducer*

To access optional auxiliary Status output, add the BSLCBL14A adapter.

Power is via the MP input, so no external power supply is required.

* The Oximeter module also accepts optional Ear Clip Transducer (TSD124B) and Flex Wrap Transducer (TSD124C). The Human SpO_2 Transducers (TSD124A/B/C) output SpO_2 via a 1.8 m (6') cable terminated in a DB9 Male connector for an MP device analog CH input.



There are three auxiliary outputs (3.5 mm stereo jacks):

PULSE BSLCBL15 (uncalibrated) output cable is 3.5 mm male mono phone plug with 1.8 m (6') cable to DB9 Male; attenuates by 5 and employs 3.32 K Ohm resistor.

RATE BSLCBL16 output cable is 3.5 mm male mono phone plug with 1.8 m (6') cable to DB9 Male; attenuates by 5 and employs 7.62 K Ohm resistor.

STATUS BSLCBL14 add-on required for optional output , which is 3.5 mm male mono phone plug with 3 m (10') cable to DB9 Male; attenuates by 10, which translates 10 V to 1 V.

* When used with the MP46/45 two-channel system, only one of the three auxiliary outputs can be used in conjunction with the SpO_2 output.

OXYSSH-SYS Specifications

Outputs:	SpO_2 OXYSSH	Pulse BSLCBL15	Rate BSLCBL16	Status BSLCBL14 add-on
Range	0 – 100 % O_2	+- 250 mV	18 – 321 BPM	0 – 200 mV
Averaging:	4-beat average*	No	4-beat average*	No
Accuracy:	+- 2 digits for 70 – 100 %O_2	N/A	+- 3 digits, no motion, +- 5 digits with motion	+- 5 mV
Update Rate (samples/sec)	3	75	3	75

Measurement Wavelengths and Output Power:

Red:	660 nanometers @ 0.8 mV maximum average
Infrared:	910 namometers @ 1.2 mW maximum average
Finger transducer placement:	index, middle or ring fingers
Subject weight requirement**:	> 30 Kg (66 Lbs)
Operating Temperature Range:	0- 40 deg. C (32 – 104 deg. F)
Operating Humidity Range:	10 – 90% non-condensing
Weight:	366 grams (excluding BSLCBL14 cable)
Size of OXYSSH module:	9.5 cm x 6.5 cm x 3 cm
Length of MP interface cables:	1.8 m
Length of finger transducer cable:	1 m

Notes:

* SpO_2 and Rate outputs use 4-beat average values that are updated on every pulse beat.

**Subject weight requirement is based on the design of the Adult finger clip transducer that is included with the OXYSSY-SYS.

Status Indicators:

The OXYSSH outputs status information in two ways: (1) via LEDs on the OXYSSH module and (2) via output voltage levels on Status auxiliary output. A green blinking LED indicates the pulse oximeter is working properly and detecting SpO_2. An Orange blinking LED indicates an error condition (i.e., finger is not detected,) or the level of perfusion may be too low to measure SpO_2. If the status is indicating low perfusion, see Appendix 2: Troubleshooting. The blink pattern of the LEDs (number of blinks in quick succession) provides more detailed information as shown in the following table:

OXYSSH Status condition	Green LED	Orange LED	Status Output
High Perfusion: working with amplitude of high signal quality	1 blink	Off	210 mV
Medium Perfusion: working with amplitude of moderate signal quality	2 blinks	Off	185 mV
Low Perfusion: working with amplitude of low signal quality	3 blinks	Off	170 mV
Sensor Alarm Error: finger transducer is providing an unusable signal	Off	1 blink	< 5mV
Out of Track Error: an absence of consecutive good pulse signals	Off	2 blinks	< 5 mV
Artifact Error: a detected pulse beat didn't match the current pulse interval	Off	2 blinks	13 mV
Sensor Disconnect Error – finger transducer is not connected to OXYSSH module or sensor is inoperable	Off	3 blinks	< 5 mV

Note: The stated output voltages are approximate and can vary by as much as +- 5mV when the OXYSSH is working (Green LED blinking) and +- 2 mV when there is an error condition.

OXYSSH Setup and Calibration

Setup:

1. Turn OFF MP unit. If using the MP46/45, it must be turned OFF by disconnecting the USB cable from the computer.
2. OXYSSH Connections:
   a. Plug the TSD124A Finger clip transducer into the "Transducer" input on the OXYSSH.
   b. Plug the 3.5 mm phone plug on the "Pulse"-BSLCBL15 cable into OXYSSH output labeled "Aux. - Pulse".
   c. Plug the 3.5 mm phone plug on the "Rate"-BSLCBL16 cable into the output labeled "Aux. - Rate".
   d. If monitoring "Status", plug the 3.5 mm phone plug on the optional BSLCBL14 into the output labeled Aux. – Status.

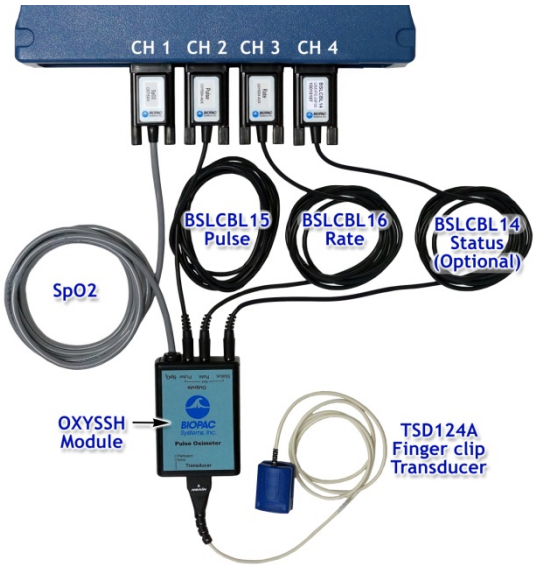


Figure 1

3. MP connections:*
   a. Plug in the "SpO2" cable into CH 1.
   b. Plug the "Pulse"-BSLCBL15 cable into CH 2.
   c. Plug the "Rate"-BSLCBL16 cable into CH 3.
   d. Plug the BSLCBL14 (Status) cable into CH 4 (Optional).

Note* The MP46/45 (not shown) is a two channel device, so only one of the auxiliary outputs can be used.

4. Turn ON the MP unit. If using the MP46/45, plug the USB cable into the computer.

Connecting TSD124A Finger Clip Transducer to Subject:

To obtain optimal pulse oximeter data, the finger clip transducer must be positioned at or near heart level and the **Subject** must be seated, relaxed and fingers should be warm. The finger transducer can be placed on the index, middle or ring finger. Make sure that the side of the clip displaying the finger graphic is properly oriented. The hand should be positioned so that there is no additional pressure placed on the transducer, and motion artifact should be minimized. Two recommended positions are:

- Hand resting in lap with palm facing up.
- Arm resting on arm rest with palm facing up.

Although it is possible to record pulse oximetry data during exercise, it is not recommended as it is difficult to control motion artifact. For resting vs. exercise comparisons, consider taking recordings only in the resting and post exercise state. After recording the "at rest" portion, click **Stop**. The **Subject** can then remove the finger clip transducer and begin exercising. Immediately after stopping exercise, the **Subject** must quickly return to a seated and relaxed position, reapply the finger transducer, and continue the recording.

Calibration:

If using BSL 4.1.3 or higher, or Acq*Knowledge* 5.0.x or higher with MP36R, OXYSSH SpO_2 calibration prompts will appear automatically after clicking the BSL or Acq*Knowledge* graph's "**Start**" button. Follow the prompts to complete OXYSSH SpO_2 calibration.

If using BSL 4.0.1-4.1.2, or Acq*Knowledge* 4.4.x with MP36R, follow the steps below. If using software prior to BSL 4.0, it will be necessary to manually setup all channel parameters referencing Appendix 1 and then proceed starting at Step 4. (Acq*Knowledge* versions prior to 4.1 do not offer MP36R support.)

1. After launching the software, choose "**Create/Record a new experiment**" from the Startup dialog and click "**OK**" to display the "**Data Acquisition Settings**" dialog. Alternately, if the software is already running, select "**Set Up Data Acquisition**" from the MP menu.
2. From the **Channels > Preset** pop-up menu list, choose the correct preset for each of the four channels as shown below.

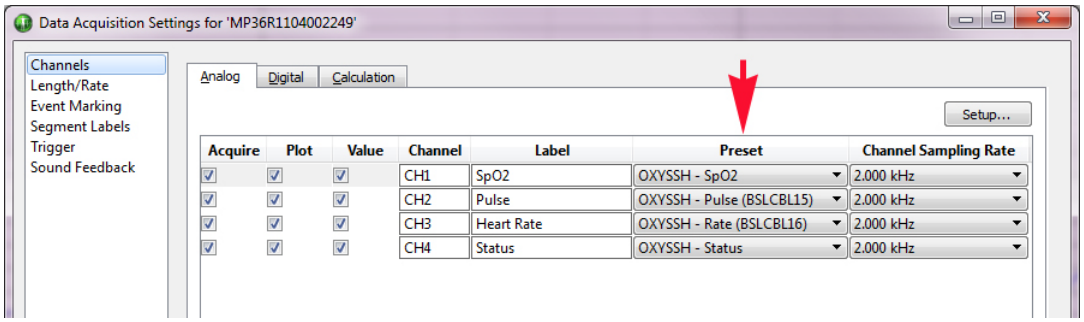


Figure 2

3. Exit the "**Data Acquisition Settings**" dialog using the "**Close**" button.
4. Click "**Start**" followed by "**Stop**" to record a small amount of data, which sets up the graph display.
5. Instruct the **Subject** to remove finger from the finger clip transducer.
6. Using the arrow selection tool, click the wrench button in the units (% O2) region of **CH 1** (SpO2) as shown in Figure 3 to display the Scaling dialog shown in Figure 4.
7. Click "**Cal 2**" to update the "**Input millivolts**" value and make sure the corresponding "**Map value**" is **127** % O2.
8. Click "**OK**" to close the dialog.

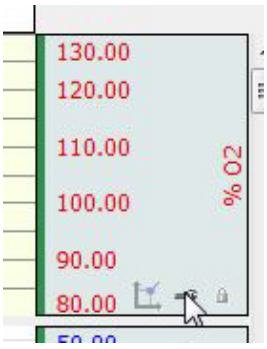


Figure 3

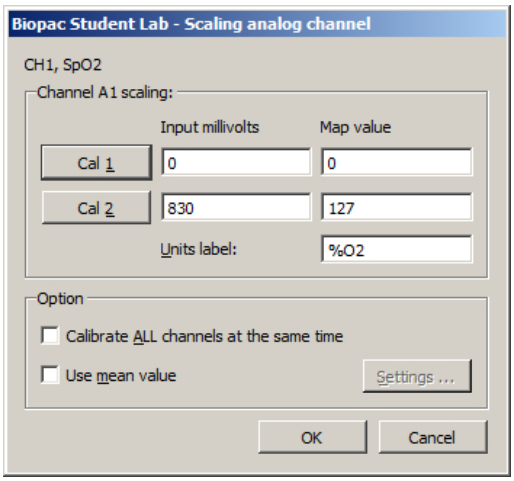


Figure 4

9. It may be useful to enable **textual value display** in order to show the numerical values for SpO_2 during the recording. This option is not available in software prior to BSL 4.0. To enable, position the arrow cursor over the numerical values in the vertical scale region and click the mouse button. The dialog shown in Figure 5 will appear. Check the "**Show textual value display**" box and click "**OK**" to close the dialog.

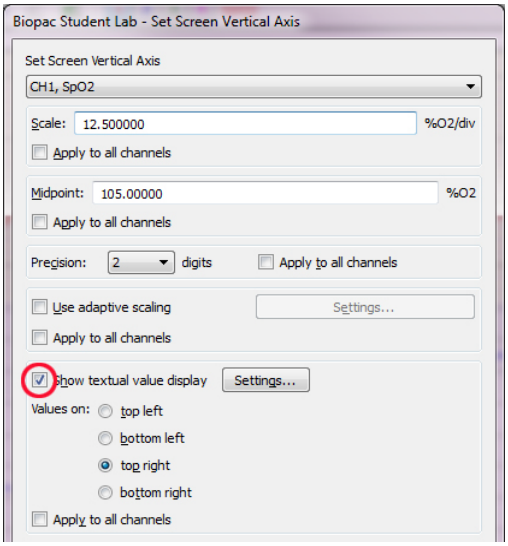


Figure 5

10. Click the wrench button in the units (BPM) region of **CH 3** (Heart Rate) to display the Scaling dialog shown in Figure 6.
11. Click "**Cal 2**" and make sure the corresponding "**Map value**" is **511** BPM.
12. Click "*OK*" to close the dialog.
13. Enable the "**Show textual value display**" option for CH 3.

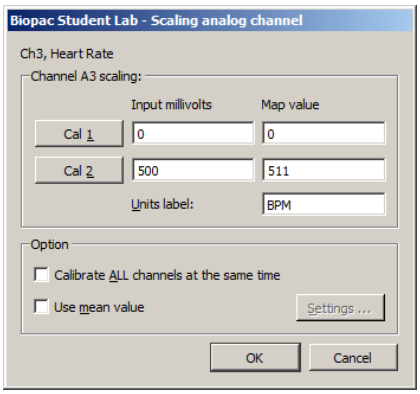


Figure 6

Recording

1. **Subject** attaches the finger clip transducer to index finger and gets into a seated and in a relaxed position.
2. Click "**Start**" to begin the recording. The recording should resemble data shown in Figure 7.

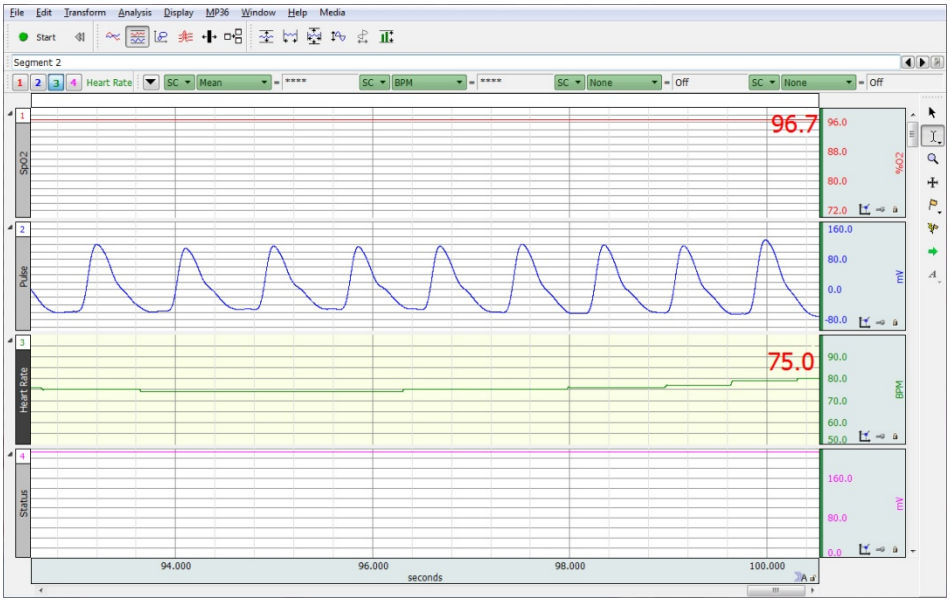


Figure 7

Appendix 1: Channel Settings

CH 1, "SpO2":

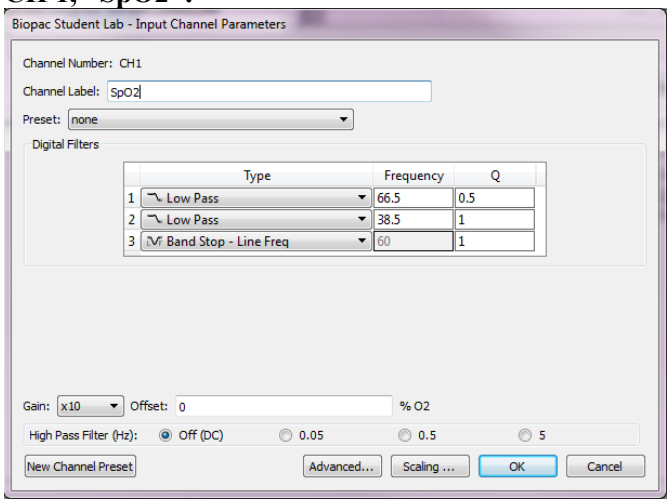


Figure 8

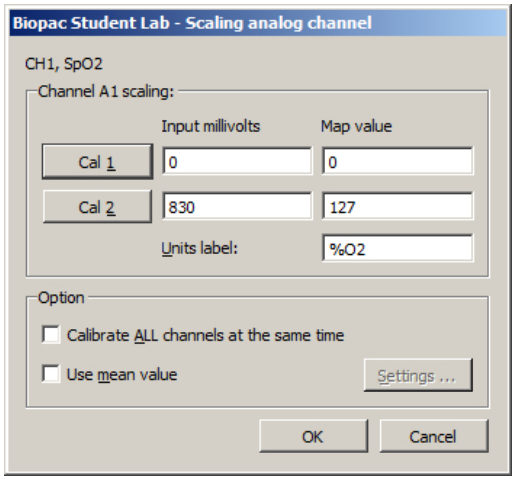


Figure 9

CH 2, "Pulse":

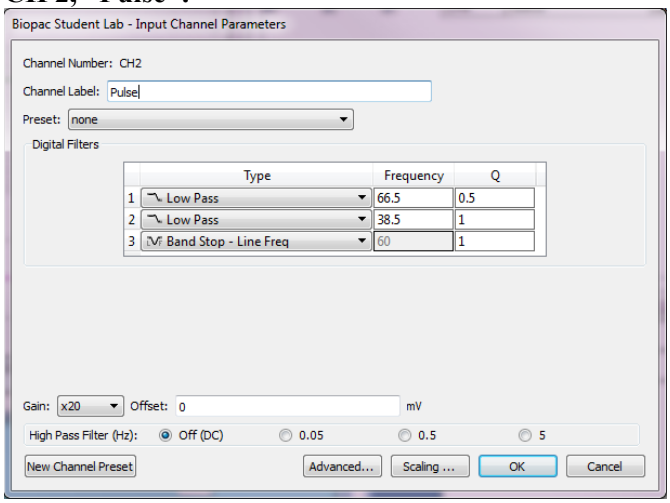


Figure 10

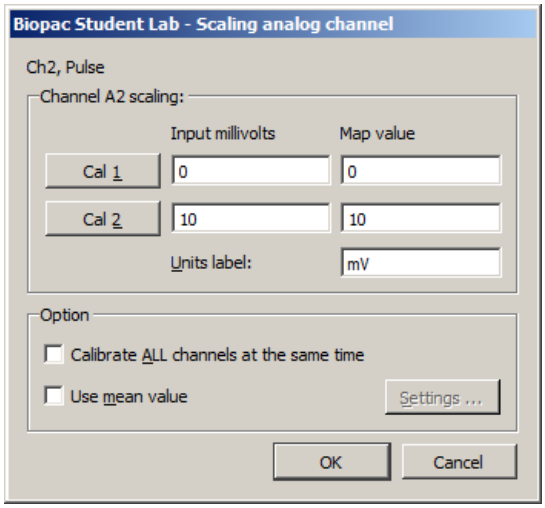


Figure 11

Ch 3, "Rate":

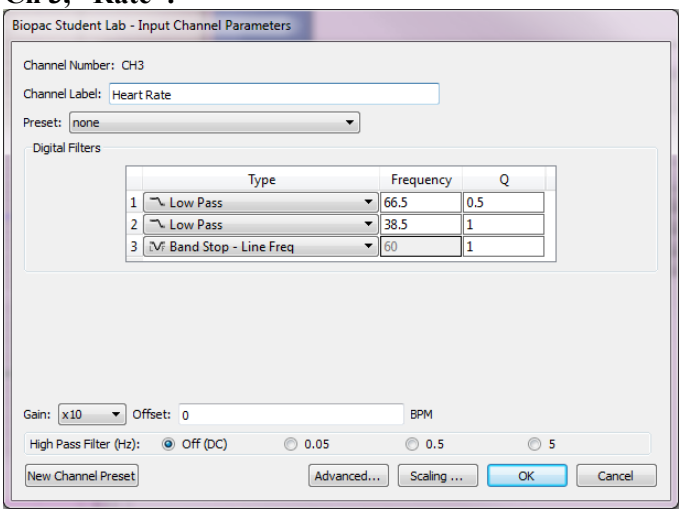


Figure 12

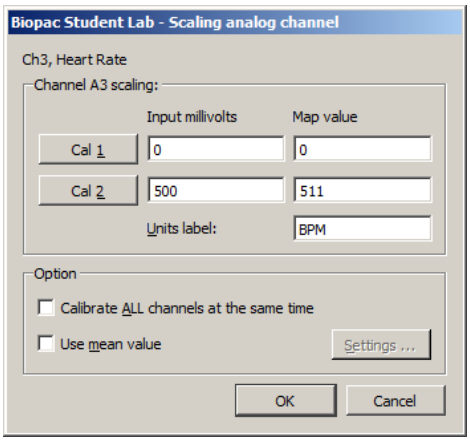


Figure 13

Ch 4, "Status":

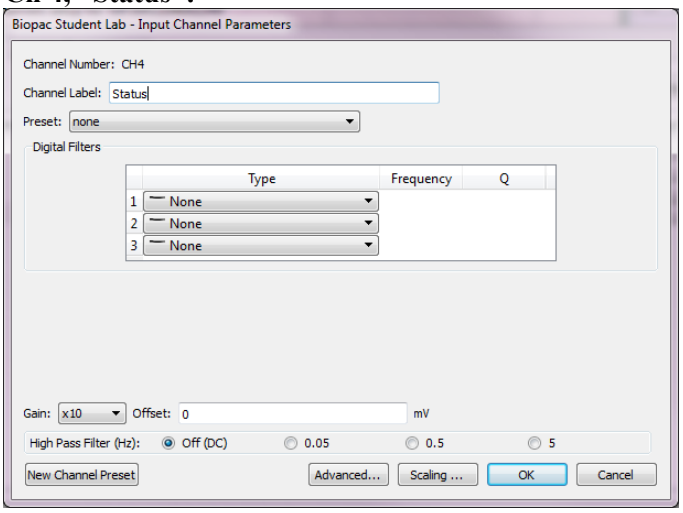


Figure 14

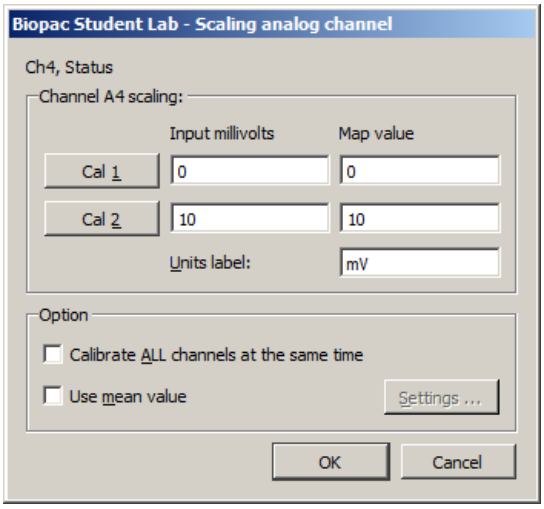


Figure 15

Appendix 2: Troubleshooting

If the status is indicating low perfusion:

- Reposition the finger transducer or place it on an alternate finger.
- Ensure that recording finger is warm. Lower body temperature will give poor readings.
- Make sure the finger transducer is not positioned above heart level.
- Reduce the amount of ambient light around the finger transducer.
- Remove any nail polish.

If the status is indicating an error condition:

- Make sure the finger transducer is plugged all the way into the OXYSSH module.
- Make sure the finger is placed all the way into the finger transducer.
- Turn the MP unit off and then back on.

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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:	9 cm – 130 cm (Can be increased with a longer nylon strap)
Interface:	MP36/35/30/45
Dimensions:	95 mm (long) × 47mm (wide) × 15mm (thick)
Weight:	9 grams
Sterilizable:	Yes (contact BIOPAC for details)
Cable Length:	2 meters (flexible, lightweight)
Connector Type:	9 Pin DIN

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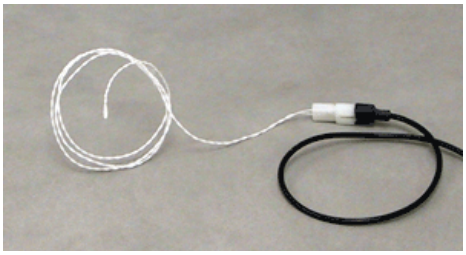
TEMPERATURE TRANSDUCERS

SS6L: Fast Response
SS7L: Waterproof Probe
SS8L: Liquid Immersion Probe
SS18L Digit Surface

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).

RX202A Sensor (white) shown at right with transducer connector (black); ships as sensor only.

This is a replacement sensor for

- TSD202A for MP research systems
- SS6L for BSL education systems
- SS6 for telemetry/wireless systems

The sensor snaps onto the "SS" transducer connector for connection to a BIOPAC data acquisition system.

SS6L SPECIFICATIONS

Response time (in stirred oil bath):	0.6 sec
Nominal resistance:	2252 Ω @ 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:	No
Dimensions:	5 m x 1.7 m

SS7L WATERPROOF PROBE

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

SS7L SPECIFICATIONS

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

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SS8L LIQUID IMMERSION PROBE

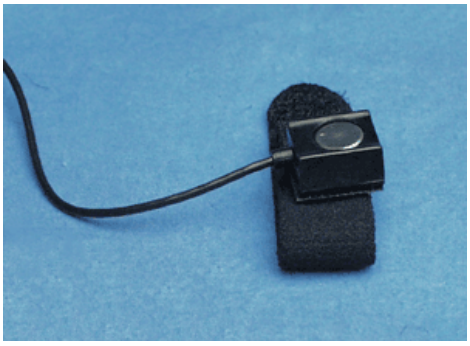
Use this stainless steel probe for dry or wet bath temperature measurements.

SS8L SPECIFICATIONS

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

SS18LA DIGIT SURFACE TEMPERATURE TRANSDUCER

The SS18LA is designed to 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.



SS18L SPECIFICATIONS

Response time (in stirred oil bath):	1.1 sec
Size	
with housing:	16 mm (long) x 17 mm (wide) x 8 mm (high)
sensor only:	10 mm sensing diameter, 1.4 mm sensor thickness
Interface:	MP3X
Nominal Resistance:	2252 ohms at 25° C (sensor only)
Maximum operating temperature:	60° C (when used with MP3X)
Accuracy and Interchangeability:	0.2° C (after calibration)
Cable Length:	3 meters
Compatibility:	YSI series 400 temperature probes (sensor only)
Sterilizable:	No

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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 SS to MP36/35 front panel input

MEDIUM-FLOW PNEUMOTACH TRANSDUCER

- SS11LB and SS11LA for MP3X and MP4X System
- TSD117A & TSD117A-MRI for MP160/150 System
- TSD117B for MP160/150 System
- RX117A-MRI Replacement Airflow Head
- See also: **AFT series** of accessories for airflow and gas analysis

The SS11LB handheld airflow transducer is intended for human use and can be used to perform a variety of tests relating to airflow and lung volume. The transducer is factory-calibrated to measure airflows ranging from -10 to +10 liters/second within +/-5%. The transducer has a removable head (RX117A-MRI) for sterilization and replacement.

The SS11LB transducer incorporates the following improvements over the earlier-model SS11LA:

- No calibration syringe is required.
- Airflow measurement is much less susceptible to changes in transducer orientation.
- New tiered airflow head design allows for direct connection to multiple standard pulmonary ID/OD hoses and components without the need for couplers.
- Flow correction that was previously only included in lessons (via syringe) is now in Lessons and BSL *PRO* analog preset.

Use standard disposable mouthpieces with disposable bacterial filters, or use an autoclavable mouthpiece, depending on budget and/or lab preference. Direct connection to AFT36 35 mm Filtered mouthpiece. The SS11LB can also be used with the AFT22 Non-Rebreathing T-valve for low dead space requirements, and to monitor expiration and inspiration signals separately.

NOTE: SS11LB is compatible with BSL 4.1.1 and above or Acq*Knowledge* 4.4.2 and above. For earlier BSL and Acq*Knowledge* software versions, use SS11LA. (See page 2.)

FLOWCAL Optional SS11LB Calibration/Validation Kit

To perform an optional SS11LB user calibration, use the FLOWCAL Kit.

This kit consists of a calibrated 3-Liter calibration syringe (AFT27) plus coupler (AFT11D) that connects the syringe to the SS11LB. Download the free graph template file and FLOWCAL procedure from the BIOPAC FLOWCAL page.

Users wishing to perform an accurate validation should also have equipment that can measure humidity, temperature, and pressure of the lab environment.

The SS11LB is factory-calibrated for use when directly connected to a mouthpiece. If the flow transducer is connected to a hose, facemask, or other tubing it should be recalibrated with those attachments by using the syringe and this kit.

SS11LA Medium Flow Pneumotach Transducer

Older model SS11LA with RX117 is available for systems running BSL 4.1.0 and below or Acq*Knowledge* 4.4.1 and below (software upgrade recommended), and is the shipping airflow transducer model for Chinese, Italian, and Russian BSL 3.7 Systems. Use AFT1 Filter + AFT2 mouthpiece with SS11LA flow head RX117. See page 5 for SS11LA connection and calibration instructions.

TSD117A Medium Flow Pneumotach Transducer

The TSD117A is intended for human use and can be used to perform a variety of tests relating to air flow, lung volume and expired gas analysis. The new tiered flow head allows for direct connection to multiple standard pulmonary ID/OD hoses and components without the need for couplers. The flow head is removable, for easy cleaning and sterilization or replacement (RX117A-MRI). The TSD117A interfaces with the DA100C general-purpose transducer amplifier. The TSD117A is intended for human use.

Replaces older model TSD117/RX117.

TSD117B Medium Flow Pneumotach Transducer

The TSD117B is similar to the TSD117A, but output and scaling are distinct. The TSD117B is intended for human use and can also be used to test ventilator circuits.

TSD117A-MRI Medium Flow Pneumotach Transducer

The TSD117A-MRI is designed for use in the MRI environment and interfaces with the MECMRI-DA to the DA100C general-purpose transducer amplifier. Includes RX117A-MRI removable flow head.

Replaces older model TSD117-MRI/RX117-MRI.

The TSD117A-MRI terminates in a DSUB9 and requires MECMRI-DA for proper operation.

MRI Use: MR Conditional to 3T

Note: Conductive parts of transducer are electrically and thermally isolated from subject. The TSD117-MRI is used outside the bore in the MRI Chamber Room and AFT7-L tubing is connected to reach the subject using AFT35-MRI non-rebreathing T-valve.

Components: Polyvinyl Chloride (PVC) Plastic, Polycarbonate Clear Plastic, Acrylonitrile Butadiene Styrene (ABS) Thermo-molded, Plastic, Polymer thick film device (rigid substrate, printed semi-conductor), Copper clad fiberglass lamination (PCB material), Stainless steel screen (type 316L), Stainless steel machine screws/nuts, tinned copper wire, Silicone elastomer, PVDF (Kynar®) heat shrink tubing

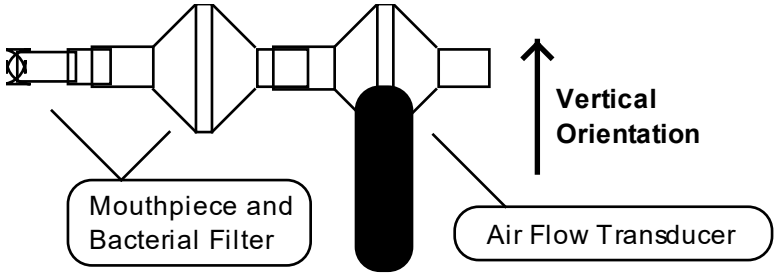
Please note the following for all airflow transducers:

a) The bacterial filter and mouthpiece are disposable and are "one per person" items. Use a new disposable filter and mouthpiece each time a different person is to be breathing through the airflow transducer.

b) For more effective calibration, use a bacterial filter between the calibration syringe and the airflow transducer.

Normal Measurement Connections

- SS11LA/SS11LB plugs directly into the MP3X or MP4X unit
- TSD117A/TSD117B plugs directly into the DA100C amplifier module
- TSD117A-MRI plugs into MECMRI-DA cable to DA100C amplifier module



For the most accurate lung volume recording, be sure to use a noseclip to prevent airflow through the nose. Also, be sure not to remove the airflow transducer assembly from the mouth during the recording. All air leaving or entering the lungs must pass through the airflow transducer during the lung volume measurement.

Use the following measurement procedure for determining lung volume:

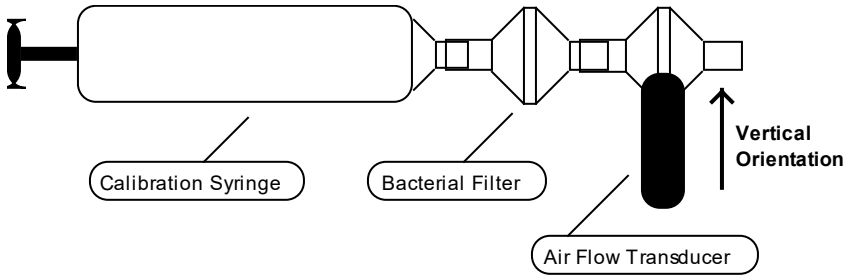
1. Breathe normally for 3 cycles (start on inspire)
2. Inspire as deeply as possible
3. Return to normal breathing for 3 cycles
4. Expire as deeply as possible
5. Return to normal breathing (end on expire)

Data Processing

When integrating the collected data to determine lung volume, it's important to integrate from the starting point of the first inspire, to the end point of the last expire. Before integration, the mean of the selected (airflow) data must be determined and then subtracted from the record. This process insures that the integral will have the same starting and ending point.

Calibration for Medium-Flow Pneumotachs

1. Syringe Calibration



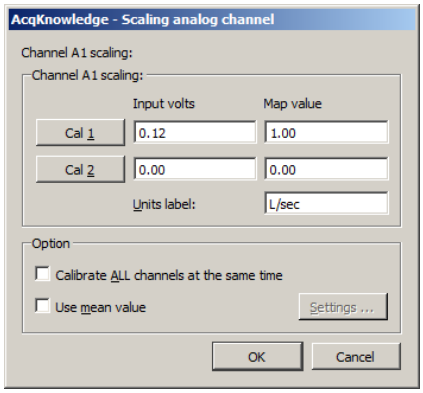
After the calibration process, please remove the calibration syringe and attach a new bacterial filter and mouthpiece to the airflow transducer.

It's very important that each individual use his/her own mouthpiece and bacterial filter.

Place the narrow end of the bacterial filter and mouthpiece assembly into either side of the airflow transducer. Airflow data can now be recorded. For best results, hold the airflow transducer vertically.

2. Mathematical Calibration (TSD117A/B and TSD117-MRI)

The transducer can be roughly calibrated without using the calibration syringe. Using the transducer's nominal output of 60 µV per liter/sec (normalized to 1 volt excitation), the following calibration factors can be entered in the software Scaling window.



Scaling Factors for Rough Calibration of the airflow transducer

The following equation illustrates why 0.12 volts maps to 1.00 liter/sec:

Calibration Constant • Amp Gain • Amp Excitation = Scale Factor

Thus

60 µV/[liter/sec] • 1000 • 2 Volts = 0.12 V / [liter/sec]

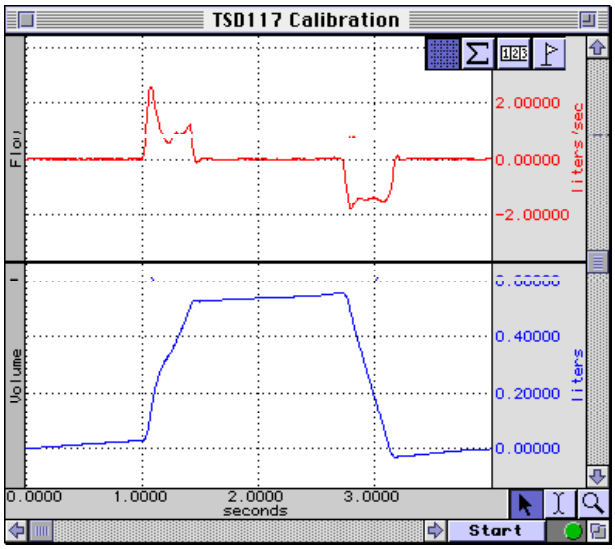
Data can now be collected directly. Prior to analyzing the data, remember that there will always be some offset recorded in the case of zero flow.

Note: With the TSD117A/B and MP160/150 system, it's possible to largely trim this offset out, using the ZERO potentiometer on the DA100C amplifier, but some residual will always remain.

To remove residual offset after the flow data has been collected, select a portion of the baseline (zero flow reading) and calculate the mean value using the popup measurements. Subtract this mean value from the raw data to obtain a mean corrected flow signal.

Now, the integral of the mean can be calculated as shown in this graph →

In this case, a 600 ml-calibration syringe was used to check the rough calibration of the airflow transducer. The rough calibration indicates a syringe volume of about 550 ml, so this method may only be expected to be accurate within ±10% of the real reading.



Flow Measurement and Volume Calculation

To achieve a more exact calibration, start with the above scaling factors and then boost or drop them slightly as indicated by the rough calibration. In this case, if the map value correlating to 0.12 volts were boosted about 10% to 1.10 (from 1.0 liters/sec), the resulting calibration would be fairly accurate.

See also: DA100C Calibration options.

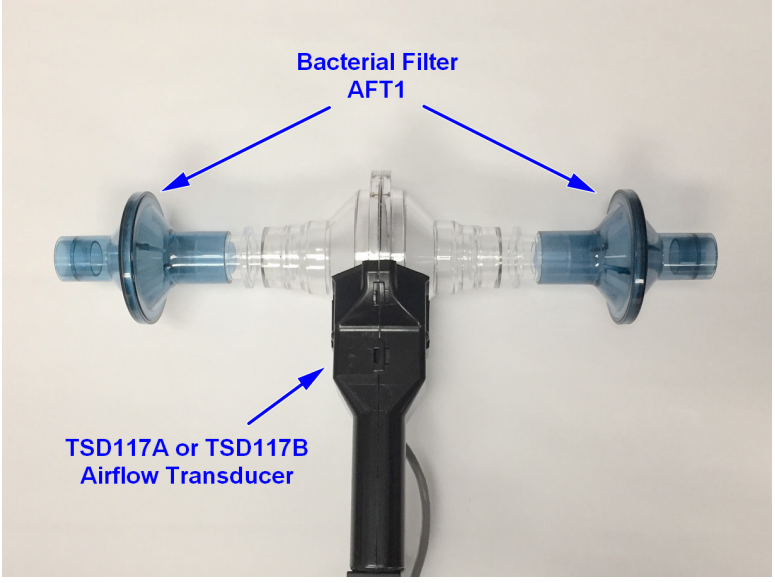
>>> All Instructions also apply to the older airflow transducer — model SS11L with non-removable head <<<

TSD117A and TSD117B Volume Calculations for use with Ventilator Setups only

When the TSD117A / TSD117B is used for volume calculations, the BIOPAC provided polynomial corrections are applied to this connection configuration.

AFT1 + AFT11B + TSD117A/B + AFT11B + AFT1

The AFT11B couplers are oriented so that the larger ID portion is inserted into the inlet and outlet ports of the TSD117A/B.



Correction polynomials are created for positive going flow and negative going flow. Accordingly, inlet/outlet orientation of the TSD117A/B is important to note.

TSD117A and TSD117B Correction Polynomials

	TSD117A	TSD117B
Positive flow, gain 200	(62.2975*(C0.0^5))-(83.9338*(C0.0^4))+(37.713*(C0.0^3))-(7.79054*(C0.0^2))+(9.95619*C0.0)	(104.885*(C0.0^5))-(79.0459*(C0.0^4))+(39.0034*(C0.0^3))-(19.8456*(C0.0^2))+(18.9708*C0.0)
Negative flow, gain 200	-160.886*C1.0^5 - 221.417*C1.0^4 - 98.8812*C1.0^3 - 14.2169*C1.0^2 + 9.04025*C1.0	485.591*C1.0^5 + 431.054*C1.0^4 + 110.998*C1.0^3 + 11.5803*C1.0^2 + 18.5883*C1.0
Positive flow, gain 1000	--	(-0.0269074*(C0.0^5))+(0.572741*(C0.0^4))-(1.40163*(C0.0^3))+(0.447*(C0.0^2))+(3.76072*C0.0)
Negative flow, gain 1000	--	-0.199265*C1.0^5 - 0.394593*C1.0^4 - 0.175574*C1.0^3 + 0.118694*C1.0^2 + 3.75985*C1.0

TSD117A/B correction curves to account for small tube interface turbulence.

Calibration, noise, and accuracy data: download TSD117B to TSI4000 flow standard (xls and txt)

The assumptions for TSD117A/B use are: TSD117A/B connected to DA100C

DA100C set to:

- Gain: 200 (TSD117A/B) and 1000 (TSD117B)
- 10Hz LP ON
- 300Hz LP ON
- DC Coupling
- VREF1 = +5V
- VEF2 = -5V

NOTE: for further accuracy, a syringe calibration is recommended to determine appropriate overall multiplicative factors for specific devices.

SS11LA To MP3X Connection

1. Make sure the BIOPAC MP3X unit is turned OFF.
   Note: 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.
4. Launch the BSL or Acq*Knowledge* software.

IMPORTANT: After launching the software, allow at least 5 minutes for the SS11LA/LB Airflow Transducer to properly warm up.

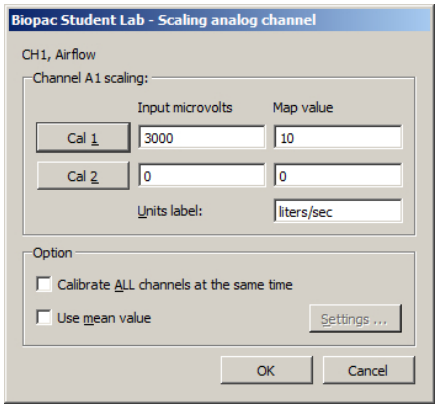
Note: SS11LA to MP connection instructions also apply to 2-channel MP46/45 hardware.

SS11LA to MP3X connection

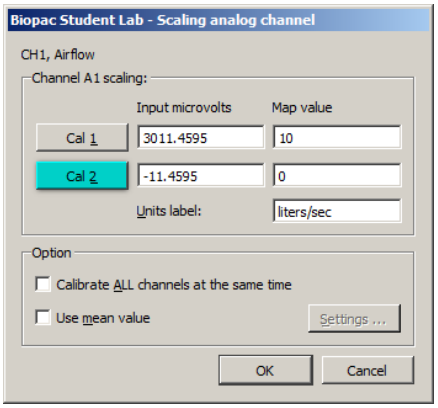
Rough Calibration (MP3X)

1. Choose the MP3X menu and select **Set Up Data Acquisition > Channels**.
2. Select the **Analog** channel that the SS11LA transducer is plugged into and activate it by checking the **Acquire**, **Plot** and **Values** boxes.
3. Click the **Preset** pop-up menu and select **Airflow (SS11LA)** from the Preset list.
4. Click the **Setup** button in upper right of Channels screen.
5. Click the **Scaling** button at bottom of Setup screen. Note the default **Cal1 Input value** is 3000 microvolts, and the **Cal1 Map value** is 10, as shown in upper right example.
6. Click **Cal2**: Note the adjusted **Input value**. (Leave the **Map value** at 0.)
7. Add the adjusted **Cal2 Input value** to the **Cal1 Input value**, as shown in lower right example.
8. Click **OK**.

The SS11LA can be roughly calibrated without using the AFT6 calibration syringe by choosing the SS11LA preset and re-scaling to account for amplifier excitation. Use the "Rough Calibration" steps shown on the left to apply this calibration method.



SS11LA Default Scaling



SS11LA Adjusted Scaling

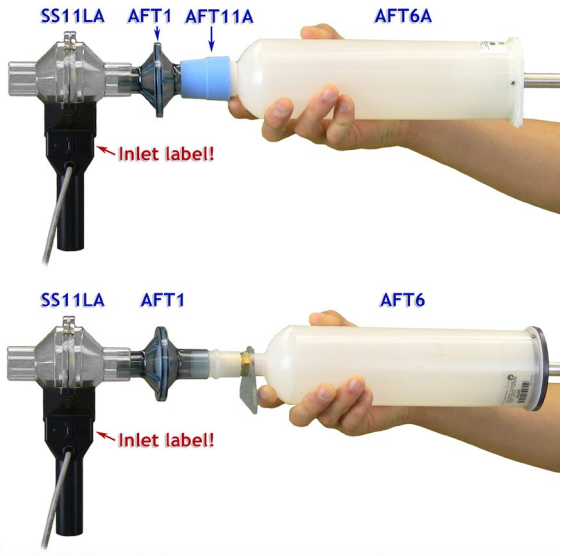
Using the Calibration Syringe

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. The filter only needs to be replaced 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

Insert syringe assembly so that the transducer cable exits on the left, as shown above.

- **If** using an older **SS11L** transducer with non-removable head, insert syringe assembly into the larger diameter port.

IMPORTANT: If the 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.

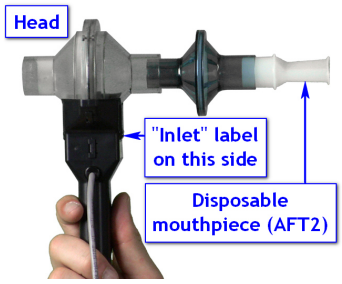
Recording with the Airflow Transducer

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.

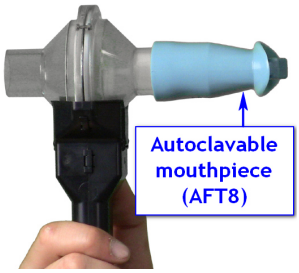
2) Breathe through the airflow transducer, following the proper procedure defined to the right.

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



SS11LA with unsterilized head

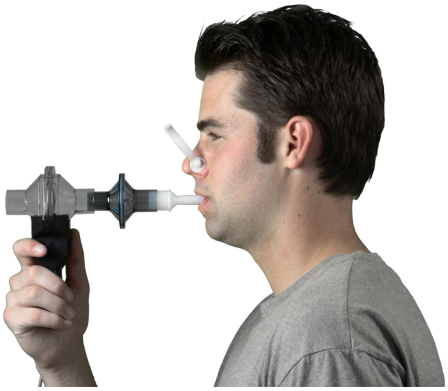
If using **SS11LA** transducer and sterilizing the head after each use, insert a disposable mouthpiece (BIOPAC AFT2) or a sterilizable mouthpiece (BIOPAC AFT8) into the airflow transducer on the side labeled "Inlet."



SS11LA with sterilized head

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 starting 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.

RX117A-MRI Replacement Airflow Head

The RX117A-MRI is a sterilizable airflow head for the TSD117A/B, TSD117A-MRI, and SS11LA pneumotach transducers. The material used in the flow head is polycarbonate and the screen is Stainless Steel. To reduce the cost of disposable items, use the RX117A-MRI with the AFT8 sterilizable mouthpiece. (22 mm ID/30 mm OD). Multiple RX117A-MRI heads help eliminate equipment downtime during cleaning procedures.

Recommended sterilization: cold sterilization (i.e., Cidex® OPA) or autoclave. If autoclaved, RX117A-MRI Airflow Heads should be cleaned at the lowest autoclave temperature setting. The life cycle will be about 10-20 cycles, depending upon temperature used.

MRI Use: MR Conditional to 3T

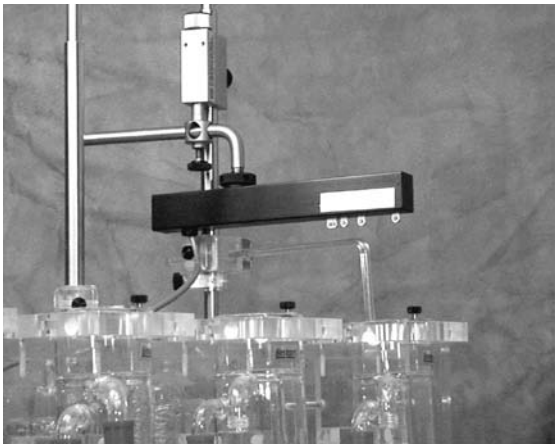
Condition: The RX117-MRI head is used with the TSD117A-MRI transducer outside the bore of the MRI Chamber Room and AFT7-L tubing is connected to the subject.

Handheld Pneumotach and Flow Head Specifications

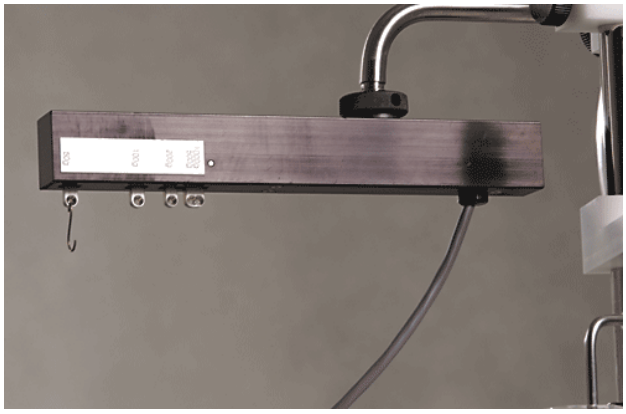
TRANSDUCER:	**TSD117A/TSD117B**	**TSD117A-MRI**	**SS11LA/SS11LB**
Interface:	DA100C	MECMRI-DA to DA100C	MP36/35/45
Cable Length:	3 m shielded	8 m, shielded	3 m, shielded
Flow Rate:	±10 liters/sec (highest linearity (±5 liters/sec)		
Nominal Output:	60 µV/[liters/sec] (normalized to 1 V excitation)		
¼" 25 TPI mounting nut:	Standard camera mount		
Handle Dimensions:	127 mm (length) x 23 mm (thick) x 35 mm (wide)		
Handle Construction:	Black ABS		
RX117A-MRI SPECS:			
Flow Head Construction:	Clear Acrylic		
Flow Bore (Ports):	Inner Diameter: 22 mm, Tiered Outer Diameter: 29 mm, 31 mm, 35 mm		
Flow Head Dimensions:	82.5 mm (diameter) x 101.5 mm (length)		
Flow Head Weight:	80 g		
Handle Weight:	85 g		
Dead Space:	93 ml		

See also: Force Transducer Tension Adjuster (HDW100A)

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 50 g to 1000 g. 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 50 g, 100 g, 200 g, 500 g and 1,000 g. The point closest to the end is the 50 g attachment point, while the point closest to the middle is the 1,000 g 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 50 g, 100 g and 200 g ranges. The larger hook is intended for the 500 g and 1000 g 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

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	1 mV/V (for 5 V excitation, output is 5 mV 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	19 mm (wide) × 25 mm (thick) × 190 mm (long)
Weight (with mounting rod)	300 g
Cable length	3 meters
Materials	Aluminum: hook rings Anodized aluminum: housing Stainless Steel: attachment arm

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

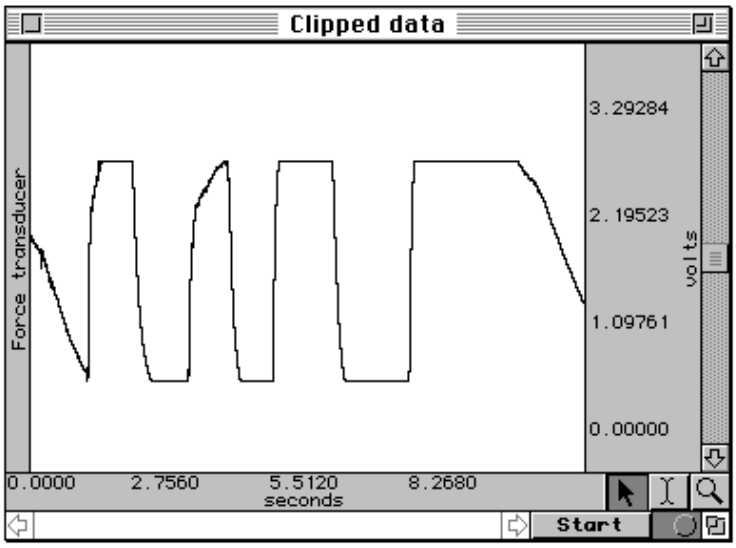
CALIBRATION

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; 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.

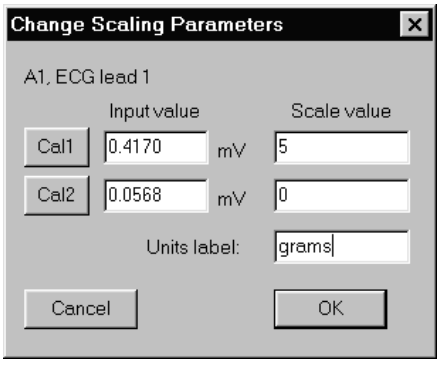
- To access the Gain setting: **MP3X** menu > **Setup Channels** > **Force** preset channel > **View/Change Parameters** icon > **Gain** pull-down menu

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

Once an optimal gain setting for the transducer has been established, this same gain setting can be used 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 an acquisition is started.

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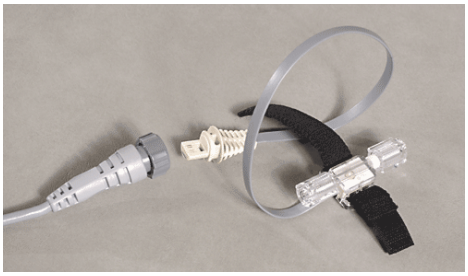
SS13L PRESSURE TRANSDUCER



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 the tubing via the standard rotating Luer-lok fittings. This assembly consists of a disposable transducer with a 30 cm 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.

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

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 = 1.0	1 KHz	1000 (preset)	DC

These settings are automatically applied when the **Pressure** preset is selected, but settings can be adjusted if 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:

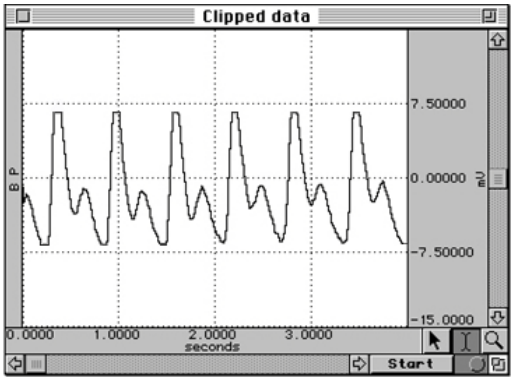
   a) Start with the software Presets (in this case, a gain of 1000)
      - To set the Presets: **MP3X** menu > **Set Up Data Acquisition** > **Channels** > **Analog Presets** > select "**Blood Pressure (Arterial)"**

   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; 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 is shown at right.

   e) If the signal is clipped, decrease the gain setting by one step (e.g., from x5000 to x2000) and collect new data at the lower gain setting.
      - To access the Gain setting: **MP3X** menu > **SetUp Data Acquisition > Channels** > **Blood Pressure (Arterial)** preset channel > **Setup** button > **Gain** pull-down menu



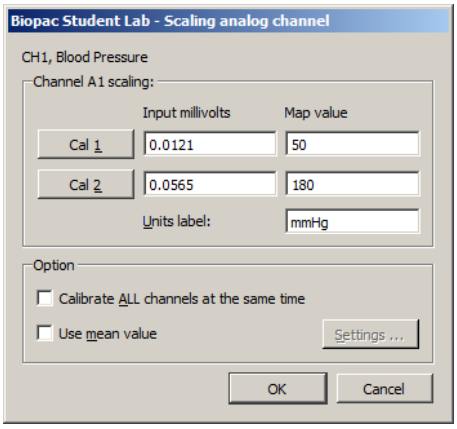
Gain set too high — Clipped *BP* data

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

   Once an optimal gain setting for the transducer has been established, this same gain setting can be used 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 > **Set Up Data Acquisition > Channels** > **Blood Pressure (Arterial)** Preset channel > **Setup** button > **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:	25 uV/mmHg (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:	10 uA RMS @ 115 VAC 50 Hz
Dynamic response:	100 Hz
Unbalance:	50 mmHg max
Connection Ports:	male Luer and female Luer (sensors shipped prior to summer 2010 were male Luer on both sides)
Eight-hour drift:	1 mmHg after 5-minute warm-up
Isolation:	<= 5 uA 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:	30 cm
Interface cable:	3 meters
Transducer dimensions:	67 mm long X 25 mm wide
Weight:	11.5 grams

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RX104A REPLACEMENT ELEMENT

RX104A is the replacement pressure-sensing element for blood pressure transducer SS13L. It does not include the Smart Sensor connector and cable.

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www.biopac.com

See also: Tension Adjuster (HDW100A)

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.

SS14L SPECIFICATIONS

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

Updated: 8.26.2014

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TSD108A AND SS17LA PHYSIOLOGICAL SOUNDS TRANSDUCER (CONTACT MICROPHONE)

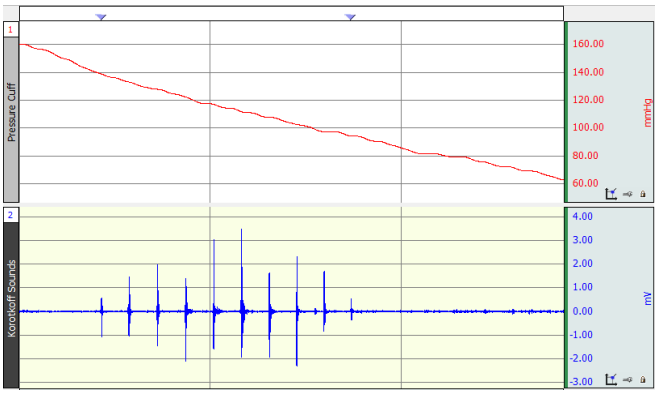
The TSD108A and SS17LA are contact acoustical transducers. The sensing element is a piezo-electric ceramic disk that's bonded to the interior of a plastic circular housing. The housing acts to focus intercepted surface pressure waves onto the piezo-electric ceramic disk to enhance both sensitivity and signal to noise ratio.

The TSD108A interfaces with the DA100C general-purpose transducer amplifier to measure a wide array of physiological sounds and pressure waves. To listen to physiological sounds, as they are recorded, pipe the TSD108A signal through the STM100C Stimulator Module to drive an audio amplifier or pair of headphones.

The SS17LA connects to a single input channel of the BSL System MP3X unit or MP45 to measure a wide array of physiological sounds and pressure waves. To listen to physiological sounds, as they are recorded, connect an audio amplifier or pair of headphones to the MP3X output.

The TSD108A and SS17LA can

- Measure heart sounds or Korotkoff sounds. For heart (including valve) sounds, the TSD108A can be secured to the respective torso location proximal to the source. When the TSD108A/SS17LA signal is recording sounds from the Brachial artery, simultaneously with the TSD120 (TSD108A) or SS19LB (SS17LA) blood pressure cuff signal, the Korotkoff sounds vividly mark the systolic and diastolic blood pressure.
- Record the sounds associated with rubbing or grinding. (e.g., Bruxism).
- Measure glottal activity and specifically record the production of both voiced and unvoiced sounds. To measure vocal cord behavior, the TSD108A/SS17LA is placed adjacent to the larynx.
- Record the specific acoustical signature associated with the contraction of muscle fibers (place adjacent to striated muscle).



Cuff blood pressure vs. Korotkoff sounds

TSD108A/SS17LA SPECIFICATIONS

Output Range:	2 µV – 200 mV
Noise:	2 µV rms (1 Hz – 1250 Hz)
Bandwidth:	1 Hz – 1250 Hz
Operating Temperature:	-40 to +85 °C
Dimensions:	26 mm diameter x 10 mm high
Interface:	

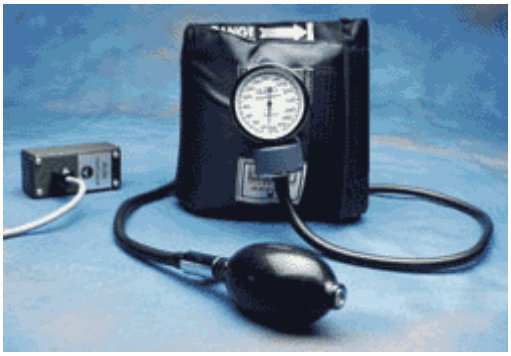
- **TSD108A:** Three (3) 2 mm pin plugs ($Vsig^+$, $Vsig^-$, GND) to DA100C
- **SS17LA:** CH input on MP3X or MP45

Cable Length:	3 meters

NOTE: The earlier-model TSD108 and SS17L contact microphones were discontinued in May of 2020.

BLOOD PRESSURE CUFF AND TRANSDUCER

- TSD120 for MP160/MP150 System
- RX120 Series Cuff for TSD120
- SS19L/LA/LB for MP3X & MP4X System
  (See table on page 4 for hardware/software compatibility)



TSD120

RX120A and RX120F cuff options

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 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.

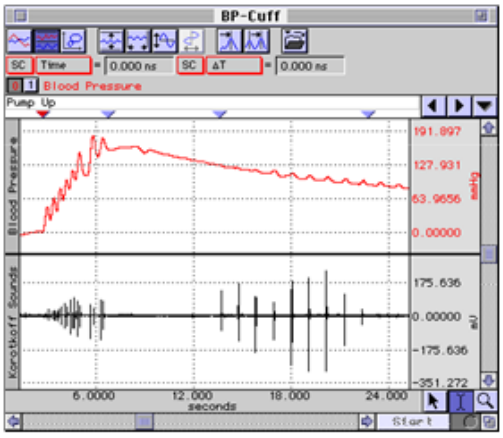
SETUP

The graph at right illustrates a typical recording using the TSD120/SS19L.

- **TSD120:** Pressure signal is recorded via a DA100C amplifier set to DC, 10Hz LP and a gain of 200.
- **SS19L/LA/LB:** To record the pressure signal, Select SS19L/LA/LB preset from the MP3x/MP4x > Set Up Channels menu.

RECORDING

As the cuff is wrapped around the upper arm of the subject, be sure to place the physiological sounds transducer **underneath** the blood pressure cuff, **directly over the brachial artery**. Transducer 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.



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.

CALIBRATION

A) TSD120

The TSD120'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. The pressure change will be noticeable 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 the pressure transducer can be calibrated using the standard procedure in the SCALING dialog (in Acq*Knowledge*). To use the cuff at a future date, simply save the calibration settings in a stored file.

See also: DA100C Calibration options.

B) SS19L

The built-in pressure transducer of the SS19L/LA/LB requires 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. 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 the pressure transducer can be calibrated 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.

C) SS19LA/LB

SS19LA/LB uses an on-screen gauge display only and does not include a physical gauge. Gauge color can be set under Lesson Preferences.

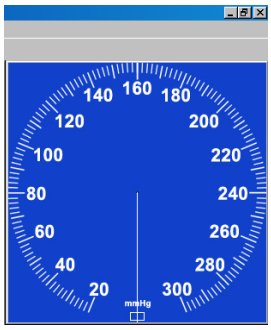
NOTE: The SS19LB is only compatible with BSL 4.1 and higher.

BSL 3.7.7

1. With **cuff deflated**, connect the SS19LA to the desired MP unit input channel.
2. Set the input channel preset to Blood Pressure Cuff SS19LA (MP > Set Up Channels > SS19LA preset)
3. Click on "View/Change Parameters" > "Scaling."
4. Click the CAL 1 button
5. Add the CAL 1 input value to the CAL 2 input value.
6. Click OK and close dialogs.

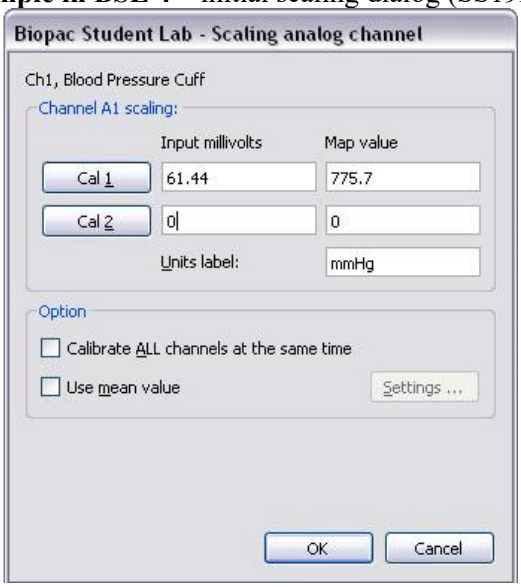
BSL 4

1. Repeat steps 1 and 2 from above.
2. Click "Setup" > "Scaling."
3. Click the CAL 2 button
4. Add the CAL 2 input value to the CAL 1 input value and click OK.

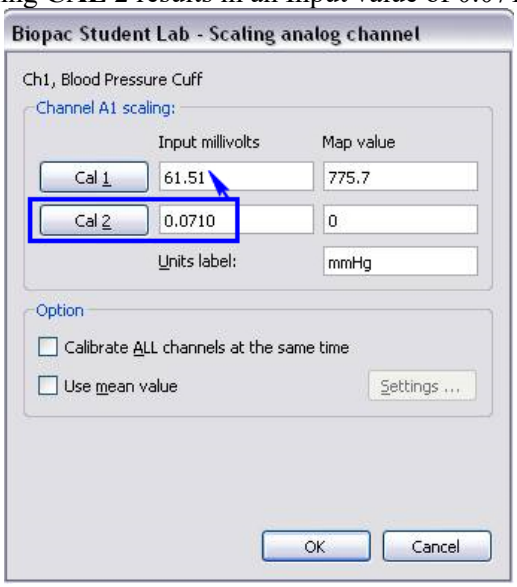


NOTE: *The SS19LA/LB is **not** compatible with MP46/45 Systems (USB chip conflict). Use SS19L with MP46/45 Systems.*

Example in BSL 4 – initial scaling dialog (SS19LA):



Clicking **CAL 2** results in an Input value of 0.071 mV.

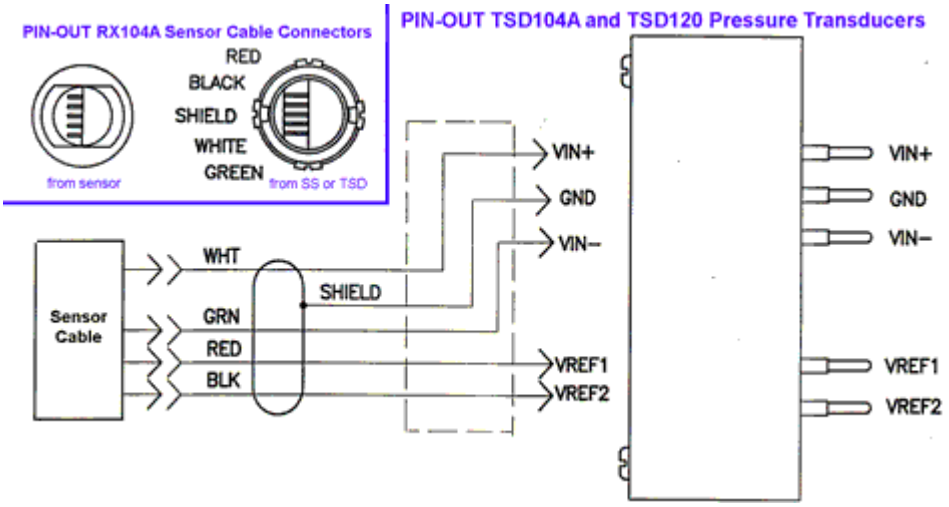


Adding 0.071 to the initial value of 61.44 results in an adjusted **CAL 1** value of 61.51 mV. (Your result may vary slightly from the example).

NOTE: For the SS19LB, the default initial scaling values are: **CAL1 = 40.96, Map value = 258.57**

IMPORTANT: CAL 1 and CAL 2 values are reversed between BSL 3.7.7 and BSL 4.

BLOOD PRESSURE CUFF SPECIFICATIONS



Pressure range:	20 mmHg to 300 mmHg
Manometer accuracy:	±3 mmHg
Output:	5 µV/mmHg (normalized to 1 V excitation)
Cuff circumference range:	25.4 cm to 40.6 cm (as shipped with RX120 d; cuff is switchable)
Cuff Dimensions:	14.5 cm (wide) x 54 cm (long)
Weight:	350 grams
Cable Length:	3 meters, shielded
Interface:	
TSD120	DA100C
SS19L/LA/LB	MP3x/4x (see following page for specific compatibility)

BLOOD PRESSURE CUFF COMPATIBILITY

Cuff	Gauge Type	MP Unit	Software
SS19LB	onscreen	MP36/MP36R	BSL 4.1 or above; Acq*Knowledge* 4.1 or above
SS19LA	onscreen	MP36/MP35	BSL 3.7.7 or above
SS19L	mechanical	MP36/MP35	BSL 3.7.3 or above
		MP46/45	BSL 3.7.5 or above

RX120 SERIES BLOOD PRESSURE CUFFS

The RX120 series are optional blood pressure cuffs, of varying sizes, which can be quickly and easily swapped in and out of the noninvasive blood pressure cuff transducer. Use a single transducer and substitute one cuff for another to accommodate a wide range in limb circumferences.

RX120 SPECIFICATIONS

Cuff	**Circumference Range** (cm)	**Width** (cm)	**Length** (cm)
RX120A	9.5-13.5	5.2	18.5
RX120B	13.0-19.0	7.5	26.1
RX120C	18.4-26.7	10.5	34.2
RX120D	25.4-40.6	14.5	54.0
RX120E	34.3-50.8	17.6	63.3
RX120F	40.6-66.0	21.0	82.5

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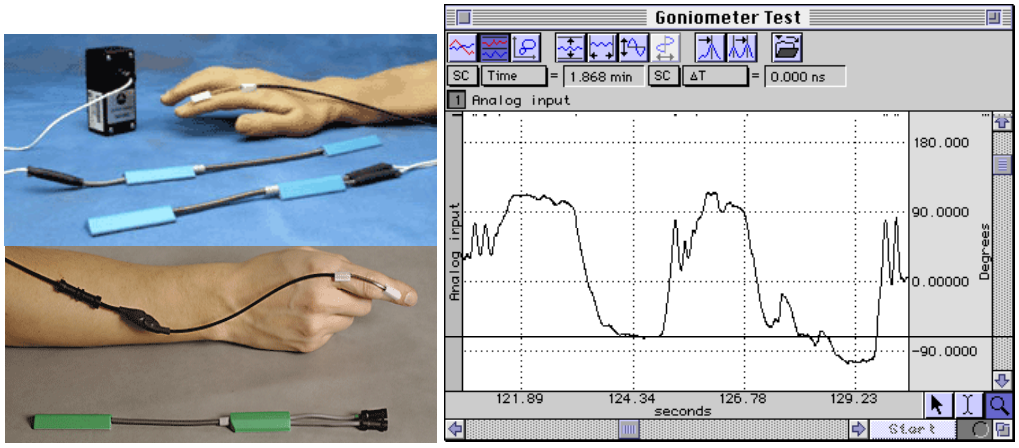
www.biopac.com

Goniometers & Torsiometers

- TSD130 Series
- SS20L-SS24L
- SS20-SS24
- BN-GON-XDCR Series
- BN-TOR-XDCR Series
- BN-GON-F-XDCR



In the example above, the TSD130A was connected directly to a DA100C amplifier, the DA100C gain was set to 1,000, and AcqKnowledge was used to calibrate the signal to provide angular measurements from approximately +90° to -90°.

Transducer	MP1XX (DA100C)	MP3X/MP4X	TEL100C	BN-GONIO
Twin-axis Goniometer 110	TSD130A	SS20L	SS20	BN-GON-110-XDCR
Twin-axis Goniometer 150	TSD130B	SS21L	SS21	BN-GON-150-XDCR
Torsiometer 110	TSD130C	SS22L	SS22	BN-TOR-110-XDCR
Torsiometer 150	TSD130D	SS23L	SS23	BN-TOR-150-XDCR
Single-axis Goniometer 35	TSD130E	SS24L	SS24	BN-GON-F-XDCR

BIOPAC Goniometers and Torsiometers are designed for the measurement of limb angular movement. Goniometers transform angular position into a proportional electrical signal. Goniometers incorporate gauge elements that measure bending strain along or around a particular axis.

BIOPAC 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). The 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. All sensors connect directly to the BIOPAC Acquisition Unit as part of an MP or BSL System. Activity data can be displayed and recorded, leaving the subject to move freely in the normal environment.

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.

Twin-axis Goniometers Dual output devices that can measure angular rotation about two orthogonal planes simultaneously. Goniometers provide outputs to simultaneously measure around two orthogonally rotational axes (e.g. wrist flexion/extension and radial/ulnar deviations).

—wrist or ankle use **TSD130A/SS20L/SS20/BN-GON-110-XDCR**

—elbow, knee or shoulder use **TSD130B/SS21L/SS21/BN-GON-150-XDCR**

Torsiometers Measure angular twisting (as on the torso, spine or neck) as opposed to bending. Torsiometers measure rotation about a single axis (e.g. forearm pronation/supination).

—neck use **TSD130C/SS22L/SS22/BN-TOR-110-XDCR**

—along the torso or spine use **TSD130D/SS23L/SS23/BN-TOR-150-XDCR**

Single-axis Goniometer Measures the angle in one plane only; designed to measure digit joint movement.

—fingers, thumb or toes use **TSD130E/SS24L/SS24/BN-GON-F-XDCR**

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.

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.** The connection lead should also be taped down near the goniometer.

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 the finger goniometer (TSD130E/SS24L/SS24/BN-GON-F-XDCR), 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.

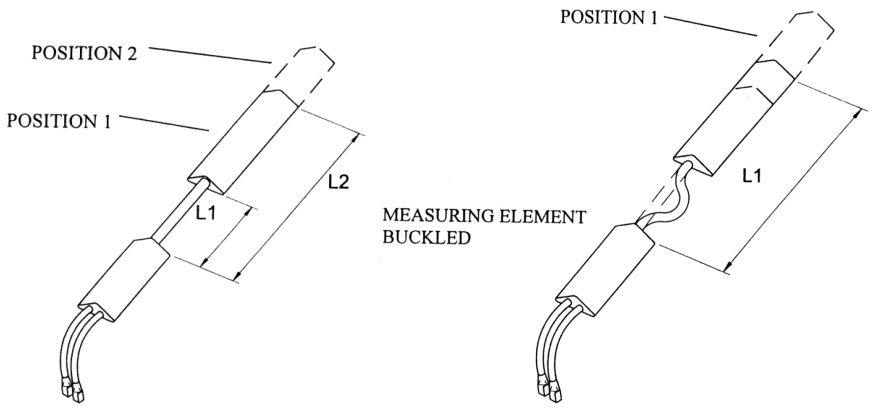
To compensate for this, all sensors are fitted with a telescopic endblock that permits changes in linear displacement between the two endblocks along axis ZZ without the measuring element becoming over-stretched or buckled.

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 goniometer and torsiometer sensors, so attachment instructions are provided for the most commonly measured joints (on page 8), 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.

WARNINGS

1. Take care to handle the goniometer and torsiometer sensors as instructed. Mishandling may result in inaccurate data, reduced equipment life, or even failure.
2. Observe the minimum bend radius value for each goniometer and torsiometer 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.
3. Never remove the goniometer from the subject by pulling on the measurement element and/or protective spring. Remove the endblocks individually and carefully, making sure not to exceed the minimum permissible bend radius, particularly where the measuring element enters the endblocks.
4. Take care when mounting goniometers to ensure that the measurement element always forms a “simple” bend shape. Accuracy will be reduced if an “oxbow” shape occurs in the element.
5. Do not bend the finger goniometer more than ±20° in the Y-Y Plane or reduced equipment life and/or failure may result.
6. Do not exceed rotations of ± 90° about ZZ. Exceeding the torsiometer range may result in a reduction of the life of the unit or failure.
7. Disconnect the transducers from the BIOPAC Acquisition Unit before cleaning or disinfecting goniometers and torsiometers.

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 returning 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.

Calibration

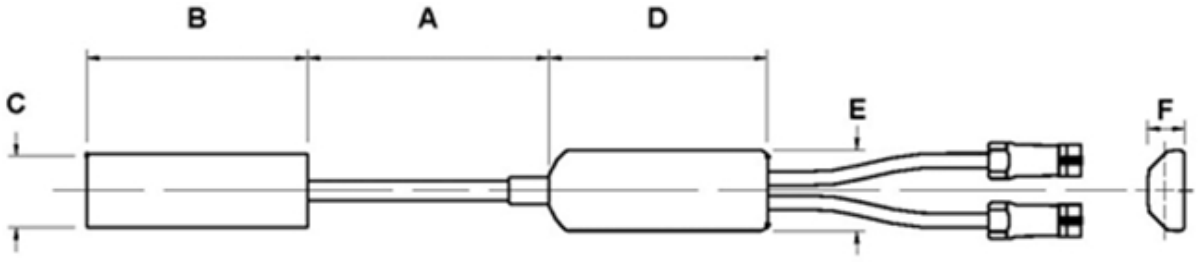
When using all goniometers and torsiometers, the minimum value of bend radius must be observed at all times, particularly when attaching and removing the sensors from the subject. Failure to do this will result in reduced unit life or failure.

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 software calibration features (under Setup Channels) to calibrate any of the BIOPAC series goniometers.

Each goniometer requires a DA100C amplifier, BN-GONIO or MP3X/4X analog input per rotational axis. Accordingly, the twin axis goniometers will need two DA100C amplifiers, one BN-GONIO or two MP3X/4X analog channels to simultaneously measure both rotational axes. The recommended excitation voltage is +5 VDC.

1. Place goniometer with care to verify that limb/joint/torso attachment will not result in over stretch at the limits of limb/joint/torso movement.
2. Put body in the first position, which brackets one end of range of movement. Press CAL 1.
3. Put body in the second position, which brackets the other end of range of movement. Press CAL 2.

Specifications



Part #					
MP1XX via DA100C	TSD130A	TSD130B	TSD130C	TSD130D	TSD130E
Telemetry TEL100C	SS20	SS21	SS22	SS23	SS24
MP36/36R/35/30/46/45	SS20L	SS21L	SS22L	SS23L	SS24L
BioNomadix via BN-GONIO	BN-GON-110-XDCR	BN-GON-150-XDCR	BN-TOR-110-XDCR	BN-TOR-150-XDCR	BN-GON-F-XDCR
Number of channels	2	2	1	1	1
Measuring range (degrees)	±150	±150	±150	±150	±150
Dimensions mm					
A. Maximum	110	150	110	170	35
A. Minimum	70	100	70	115	30
B.	60	70	60	70	18
C.	18	18	18	18	8
D.	54	54	54	54	15
E.	20	20	20	20	8
F.	9	9	9	9	5
Bend radius (mm) – min.	18	18	18	18	3
Weight (g)	23	25	22	23	8
Crosstalk[1]	±5%	±5%	N/A	N/A	N/A
Nominal Output	5 µV/degree normalized to 1 V excitation				
Temperature Zero Drift	0.15 degrees angle / °C				
Cable length	6 meters for TSD130 Series/SS20L-24L, 1.8 meters for SS20-24, 10 cm for BN-GON/BN-TOR				
Endblock height	Cable end 9.4 mm, distal end 8.2 mm				
Transducer type	Strain gauge				
Life[2]	600,000 cycles minimum				
Accuracy	±2° measured over 90° from neutral position				
Repeatability	Better than ±1°				
Analog resolution	Infinite				
Operating temp range	+0° to +40° C				
Storage temp range	-20° C to +50° C				
Operating/Storage humidity range	30% to 75%				
Atmospheric pressure range					
Operation	700 hPa to 1060 hPa				
Storage	500 hPa to 1060 hPa				

[1] Specification of crosstalk for all Biometrics twin-axis SG series of goniometers is measured over ±60°. i.e., if a joint is moved through 60° from the neutral position in one plane without movement in the orthogonal plane, then the sensor output in the orthogonal plane may change by a maximum ±3°.

[2] Life test results have been collected by cycling the sensors through movements that would happen during everyday use. For example, placing a sensor on an adult elbow and moving from the neutral position to maximum flexion and back to the neutral position, the unit will function for a minimum of 600,000 cycles.

OVERVIEW OF THE BIOPAC GONIOMETER SERIES

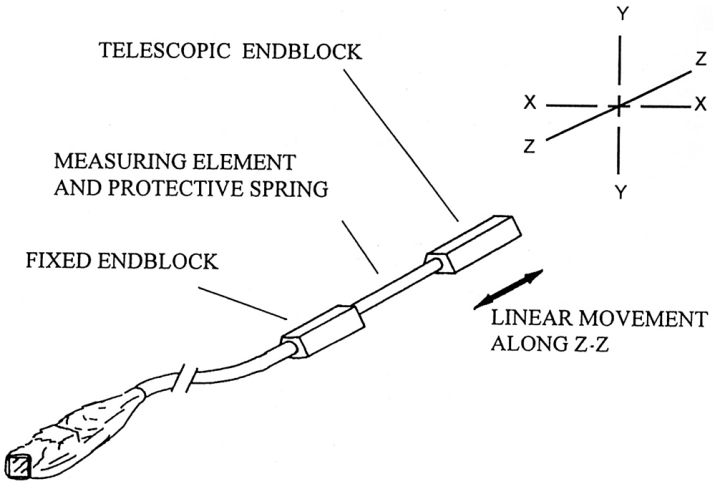
As with all measuring equipment, to correctly interpret the data, understanding the working principles (i.e., what the sensor measures) before use is helpful. BIOPAC Systems, Inc. manufactures three types of sensors:

1.

The 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.

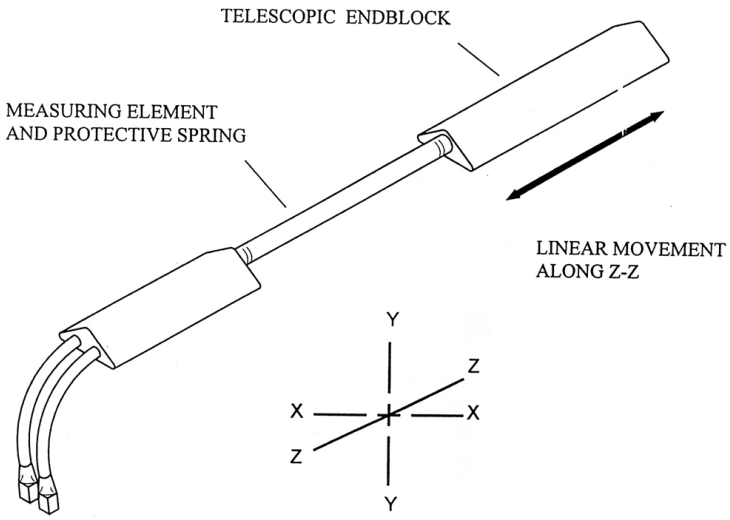
The goniometer is not designed to measure rotations about Y-Y. Any attempt to bend the unit in this way more than ± 20 from the neutral position will result in a reduction of the life of the unit or failure.



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.

The 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.

These goniometers function in the same way, and differ only in size.

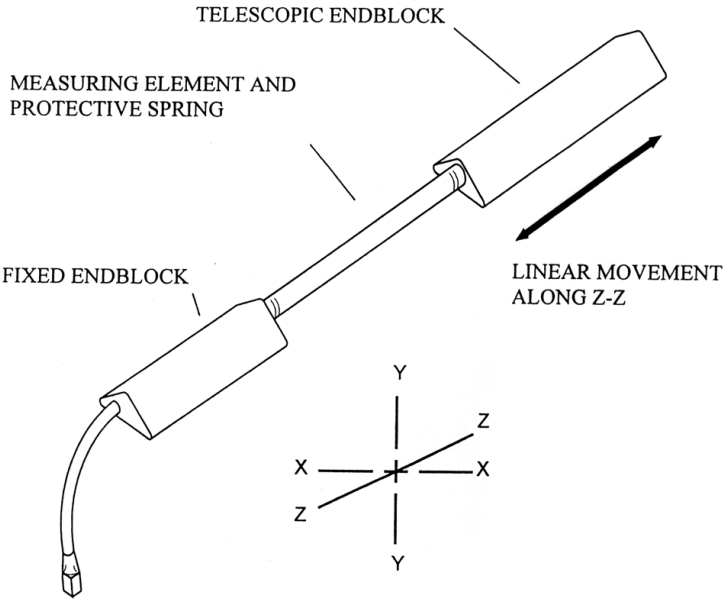
3.

The 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.



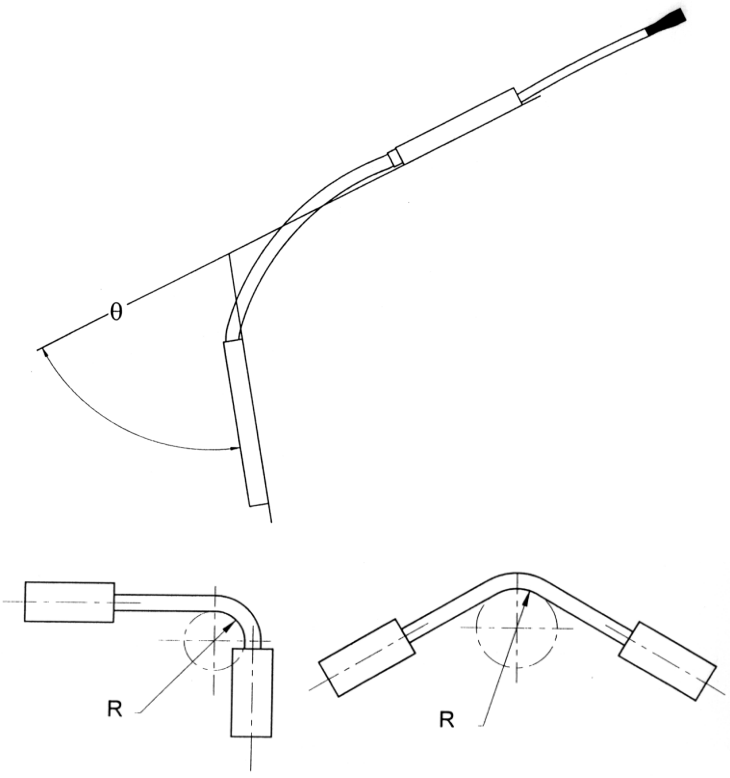
WARNING!

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.

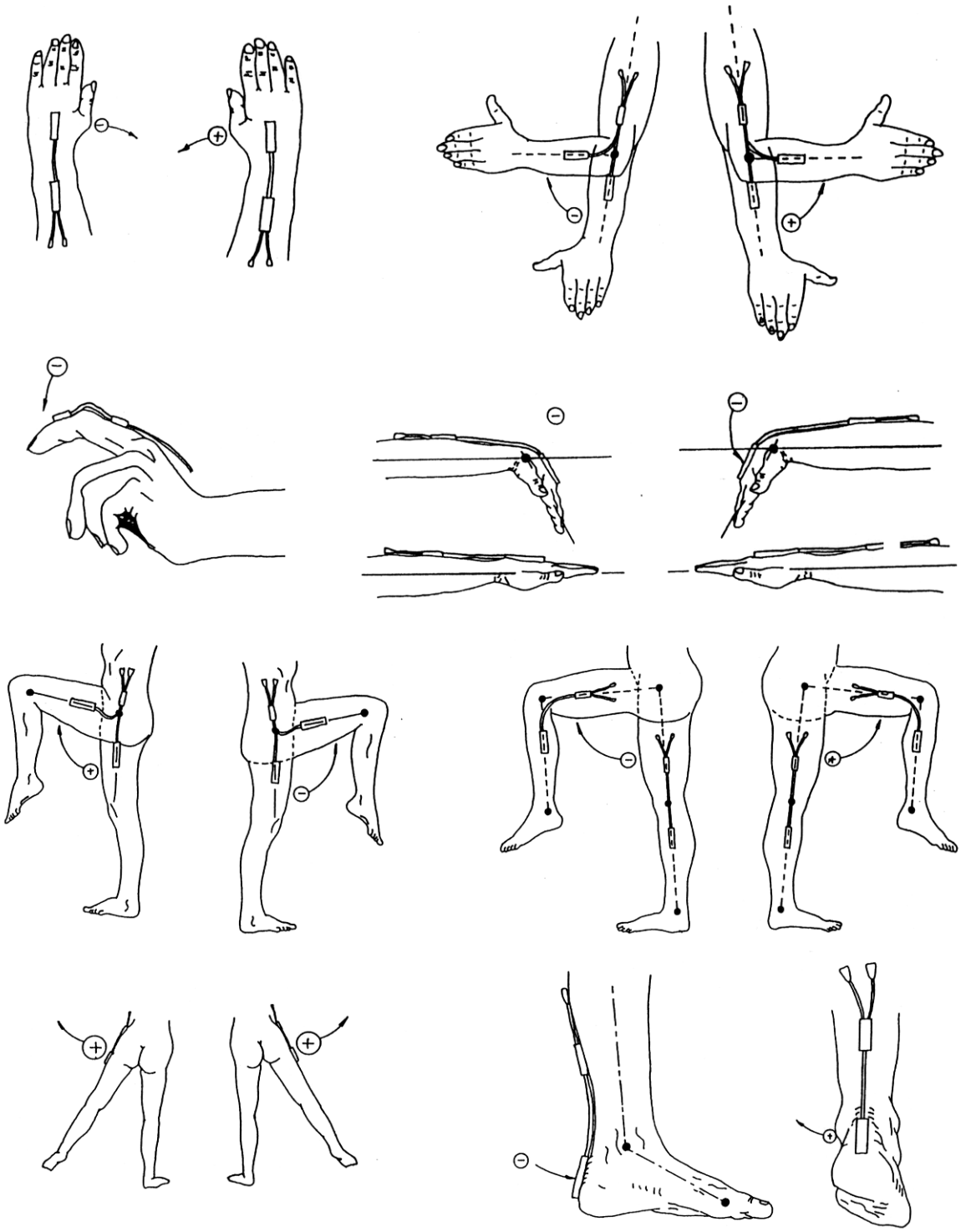
If the two ends move linearly relative to each other, within the limits of telescopic endblock, without changing the relative angles between them, then the outputs remain constant.

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.



SIGN CONVENTIONS

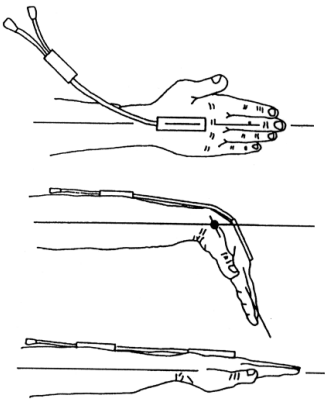
The sign convention for certain joints will differ, depending which side of the body the sensor is attached to. The following figures show sign conventions for the most common joints.



WRIST – Goniometer TSD130A/SS20L/SS20/BN-GON-110-XDCR

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 2) 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.

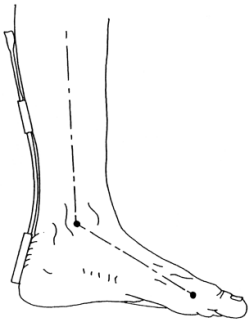


ARTICULAR COMPLEX OF THE FOOT – Goniometer TSD130A/SS20L/SS20/BN-GON-110-XDCR

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 2) so that the axes of the leg endblock are coincident.

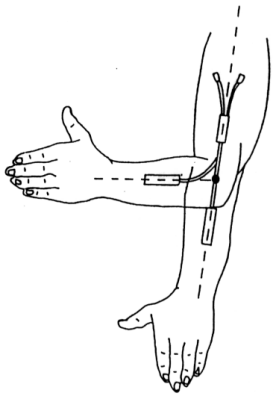
Flexion/extension of the ankle may now be monitored using the gray plug and pronation/supination using the blue marked plug.



ELBOW – Goniometer TSD130B/SS21L/SS21/BN-GON-150-XDCR

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 2) and attach the fixed endblocks to the upper arm, with the center of the endblock and the center axis of the upper arm coincident.

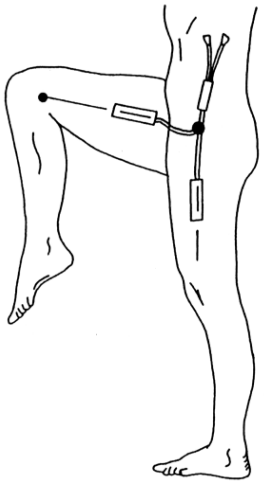
Now the elbow may be fully extended with the telescopic endblock freely sliding between Positions 1 and 2. Measurement of flexion/extension is obtained from the blue marked plug, and the gray plug is redundant. Note that the telescopic endblock is mounted on the half of the forearm nearest to the elbow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



HIP – Goniometer TSD130B/SS21L/SS21//BN-GON-150-XDCR

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 2) 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).

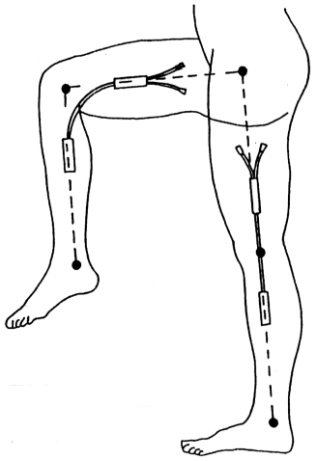
The thigh may now be flexed or extended, abducted or adducted, with the goniometer sliding freely between Positions 1 and 2. Measurements of flexion/extension are obtained from the blue marked, and abduction/adduction from the gray plug.



KNEE – Goniometer TSD130B/SS21L/SS21/BN-GON-150-XDCR

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 2) 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 – Torsiometer TSD130C/SS22L/SS22/BN-TOR-110-XDCR or TSD130D/SS23L/SS23/BN-TOR-150-XDCR

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 –Goniometer TSD130E/SS24L/SS24/BN-GON-F-XDCR

The single axis goniometer is 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 2).

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 other BIOPAC Goniometers and Torisometers, 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

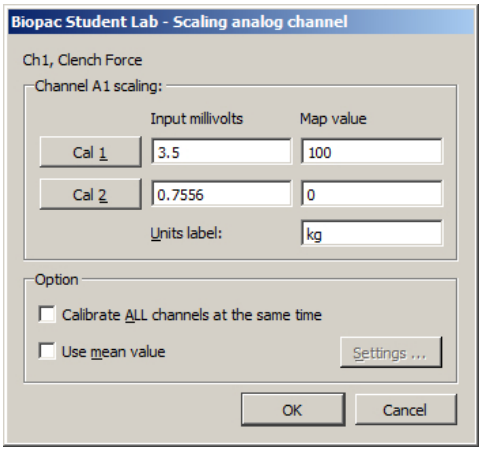
Use the hand dynamometer to measure grip force—use in isolation or combine with EMG recordings for in-depth studies of muscular activity. The lightweight, ergonomically designed transducer provides direct readings in kilograms or pounds. The simple calibration procedure makes this device easy to use for precise force measurements, and the isometric design improves experiment repeatability and accuracy. The SS25LA is a basic unit, designed for student lessons; it can also be used in the MRI, with proper module setup, since it employs plastics in the spring constant. The highest performance dynamometer is TSD121C, which employs a four terminal, laser-trimmed, Wheatstone bridge built onto metal elements.

Hardware Setup

Connect the SS25LA Simple Sensor to a CH input on the front panel of an MP3X/45 unit.

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

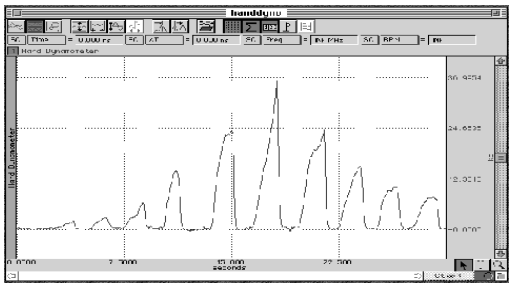
Scaling — Software Setup



1) Select **Set Up Channels** under the MP menu and enable one analog channel.
2) Select the desired **Clench Force** Preset (kg or lbs, the example to the right is shown in units of kg.)
3) Click the **Setup** button.
4) Click the **Scaling** button to activate a dialog box similar to the one shown at right.
5) In the **Map value** column, note the default scaling of "0" for **Cal2** and "100" for **Cal1**. These represent 0 and 100 kilograms, respectively.
6) Place the SS25LA on a flat surface.
7) Click the **Cal2** button to obtain an initial calibration reading. A value similar to the above example "0.7556" will appear.
8) To obtain the **Cal1** input value, add the **Cal2** input value to the default **Cal1** 3.5 mV per 100 kg value. (In this example, this value would be 0.7556 mV + 3.5 mV = 4.2556 mV.)

Note: The above instructions are for BSL 4 and higher. In BSL 3.7.7 and earlier, placement of the CAL1 and CAL2 scale values are reversed.

Optional Calibration Confirmation



a) Click "Start" to begin data acquisition.
b) Place the SS25LA 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 steps a-c as necessary.

SS25LA Specifications

Clench Force Range:	0-50 kgf
Nominal Output:	13.2 µV/kgf
Linearity:	8%
Sensitivity:	0.75 kg
Weight:	323 grams
Cable Length:	3 meters
Dimensions:	17.78 cm (long) x 5.59 cm (wide) x 2.59 cm (thick)

NOTE: See Hardware Guide Appendix for SS25LA hysteresis specification and response diagram.

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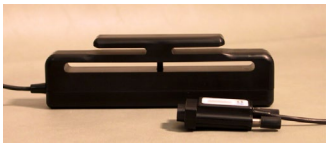
SS25LB HAND DYNAMOMETER



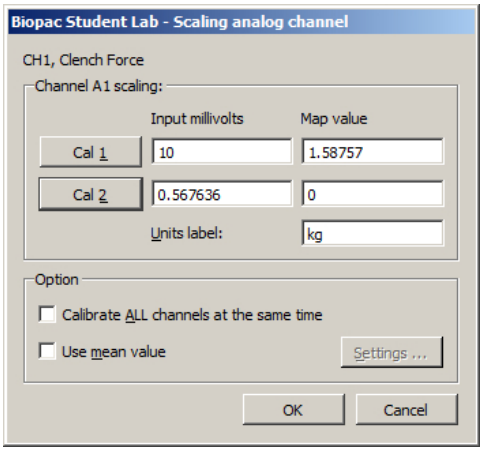
Use the hand dynamometer to measure grip force—use in isolation or combine with EMG recordings for in-depth studies of muscular activity. The lightweight, ergonomically designed transducer provides direct readings in kilograms or pounds. The simple calibration procedure makes this device easy to use for precise force measurements, and the isometric design improves experiment repeatability and accuracy. The SS25LB is a basic unit, designed for student lessons; it can also be used in the MRI, with proper module setup, since it employs plastics in the spring constant.

The highest performance dynamometer is TSD121C, which employs a four terminal, laser-trimmed, wheatstone bridge built onto metal elements.

Hardware Setup

Connect the SS25LB Simple Sensor to a CH input on the front panel of an MP36/36R/35/46/45 unit.

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

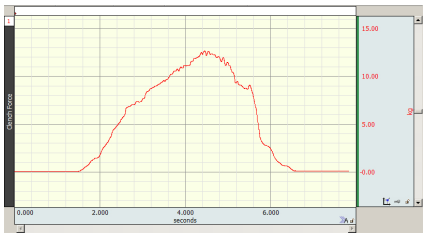


Scaling—Software Setup for the MP36/36R/35/46/45

Note: When using with Biopac Student Lab, the SS25LB is compatible with versions 4.1 and higher only.

1) Select **Set Up Data Acquisition > Channels** under the MP menu and enable one analog channel.
2) Select the desired **Clench Force (SS25LB)** Preset in units of kg, lbs, or N. (Example above is units of kg.)
3) Click the **Setup** button.
4) Click the **Scaling** button to activate a dialog box similar to the one shown at right.
5) In the **Map value** column, note the default scaling of "0" for **Cal 2** and "1.58757" for **Cal 1**. These represent 0 and 1.58757 kilograms, respectively. **The MAP values must not be altered**.
6) Place the SS25LB on a flat surface.
7) Click the **Cal 2** button to obtain an initial calibration reading. A value similar to the above example will appear.
8) To obtain the **Cal 1** input value, add the **Cal 2** input value to the default **Cal 1** 10 mV per 1.58757 kg value. (In the above example, this value would be 0.567636 mV + 10 mV = 10.567636 mV.)

Optional Calibration Confirmation



a) Make sure the SS25LB is connected to the same channel as enabled in Step 1 above.
b) Click "**Start**" to begin data acquisition.
c) Place the SS25LB on a flat surface and then place a known weight on the uppermost portion of the grip.
d) Review the data to confirm that the known weight is reflected accurately in the data (sample above).
e) Adjust the Scaling parameters and repeat steps a-c as necessary.

SS25LB Specifications

Clench Force Range:	0-50 kgf	Weight:	323 grams
Nominal Output:	6.299 mV/kgf	Cable Length:	3 meters
Linearity:	6%	Dimensions:	17.78 cm (long) x 5.59 cm (wide) x 2.59 cm (thick)
Sensitivity:	20 gf		

NOTE: See Hardware Guide Appendix for SS25LB hysteresis specification and response diagram.

TRI-AXIAL ACCELEROMETERS

TSD109A and TSD109A-MRI (±2 g)

SS26LB, TSD109C3, and TSD109C2-MRI (±5 g)

SS34L and TSD109J1 (±200 g)

BN-ACCL3

Tri-Axial Accelerometers connect directly to BIOPAC hardware and require no additional amplification. They provide three outputs, each simultaneously measuring acceleration 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.

Tri-axial accelerometer uses 3 channel inputs

- ±**2 g** accelerometers are optimal for measuring fine motor movement, ballistocardiography, tremor, respiration, and other activities requiring high resolution measurements.
- ±**5 g** accelerometers are optimal for measuring accelerations when performing slow movements, such as walking.
- ±**200 g** accelerometers are optimal for measuring quick movements, such as swinging a tennis racket or high impact events commonly encountered in exercise physiology experiments.

The transducers can be used on any part of the body or attached to external equipment. The pliable and unobtrusive design conforms readily to body contours and includes a Velcro® strap for easy attachment.

For the TSD109C2-MRI: Strap the accelerometer on finger, wrist, toe, or foot. To minimize artifact associated with cable tugging, during movement activities, tape the sensor securely in place using TAPE1. The sensor cabling can be secured to the subject via a thermally insulating sleeve, such as nylon wire loom. The loom will permit the cable to travel freely during subject motion.

The frequency response extends from DC to 500 Hz. The accelerometers are extremely accurate and can easily be calibrated by simply changing their orientation in three-dimensional space, so that gravity (G=1) acts only upon the desired axis. Trace metallic parts do not make contact to the subject; must be used with 3-axis MECMRI-9 cables provided.

MRI Use (TSD109C2-MRI and TSD109A-MRI): MR Conditional to 7T

Note: Use with provided MECMRI-9 cable and MRIRFIF filter. Conductive parts of transducer are electrically and thermally isolated from subject.

Equipment

- The SS26LB/SS34L accelerometers connect to the MP36/35 Data Acquisition Unit.
- The TSD109 series accelerometers connect to the AMI100D or HLT100C High Level Transducer module.
- The TSD109C2-MRI and TSD109A-MRI are intended for MRI use and ship with a longer (10 m) cable, plus an MECMRI-HLT/AMI (2 m) interface cable and filter set (MRIFIF).

Accelerometer Specifications (SSL/TSD)

	SS26LB / TSD109C3 / TSD109C2-MRI	SS34L / TSD109J1	TSD109A / TSD109A-MRI
Range (Output):	±5 G	±200 G	±2 G
Noise:	0.25 mG/SQRT[Hz] (rms)	4.3 mG/SQRT[Hz] (rms)	0.05 mG/SQRT[Hz] (rms)
Bandwidth:	DC-500 Hz (-3 dB)	DC-1000 Hz (-3 dB)	DC-145 Hz (-3 dB)
Nonlinearity:	±0.2% of FSR	±0.5%	±0.5%
Cross-axis Sensitivity:	±1% of FSR	±1.4%	±2%
Package Alignment Error:	±1°	N/A	N/A
Interaxis Alignment Error:	±0.1°	N/A	N/A
Supply Current:	0.5 mA	0.5 mA	0.68 mA
Supply Voltage:	+5 V (nominal)	+5 V (nominal)	3.3 V (nominal)
Supply Voltage Range:	4 V – 6 V	4 V – 6 V	2.4 V – 3.6 V
Interface:	MP36/35 Data Acquisition Unit (SS26LB, SS34L) MP160/150/AMI100D/HLT100C Module (TSD109J1, TSD109C3, TSD109C2-MRI, TSD109A, TSD109A-MRI)		
Package:	Compliant silicone housing		
Dimensions:	16 mm (L) x 17 mm (W) x 8 mm (H)		
Weight:	4.5 grams		
Sterilizable:	Yes (contact BIOPAC for details)		
Cable length:	3 meters (10 meters for TSD109C2-MRI and TSD109A-MRI)		
Operational Temp:	0-50° C		
Operational Humidity:	0-95% non-condensing		

NOTE: The SS26LA (±5 G) was discontinued in September of 2013 and the SS27L and TSD109F (±50 G) were discontinued in May of 2015.

The TSD109C2 and TSD109J were discontinued in February of 2019. Current offerings are TSD109C3 and TSD109J1 to support AMI100D and HLT100C interface module compatibility.

Gain Constant and Offset Specifications (SSL/TSD)

Type	Gain Constant	Offset @ 0 G (Typical)
SS26LB	125 mV/g	1 V
SS34L	1.6 mV/g	340 mV
TSD109C3 / TSD109C2-MRI	200 mV/g	1.5 V
TSD109J1	7 mV/g	1.45 V
TSD109A / TSD109A-MRI	660 mV/g	1.65 V

Hardware Setup

The accelerometers have three output connectors, one each for the X, Y, and Z axes. Each output connector must be connected to an **MP3X** input channel (SS26LB/SS34L,) or to the appropriate AMI100D/HLT100C input channel (TSD109 series). For example, connect the X-axis to Channel 1, Y-axis to Channel 2, and Z-axis to Channel 3.

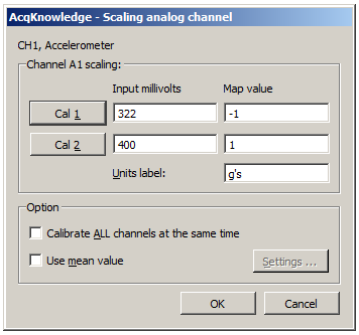
IMPORTANT

Make sure the selected channel is **not** already assigned to any other BIOPAC module; up to 5 Accelerometers can be used with a single MP System. **If contention exists, the channel data will be corrupted.**

See also: Setup notes for external devices and channel contention issues.

Software Setup

SS26LB/SS34L:



a) **Select MP3X** > **Set Up Data Acquisition > Channels** > **Setup** and enable three analog channels, one for each axis.

b) For each channel, select the appropriate **Accelerometer Preset** (5 g or 200 g) from the **Preset** list.

c) Click on **Setup** and then click on **Scaling**:

d) In the **Map value** fields, enter the scaling factors required, -1 for Cal 1 and 1 for Cal 2.

e) Enter "g" for the **Units label,** as shown. (This unit should appear by default in Accelerometer presets.)

f) Take the accelerometer and rest it in the upright position on the tabletop.

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

h) To calibrate the Y-axis, start with the transducer sitting on the table, face up, and click Cal 1. Rotate the transducer 180°, so that it is now sitting upside down, and click the Cal 2 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.

TSD109 Series:

a) Select **MP160/150** > **Set Up Data Acquisition > Channels** > **Add New Module**.

b) Choose **AMI100D** or **HLT100C-A1** from the module type list and click "Add."

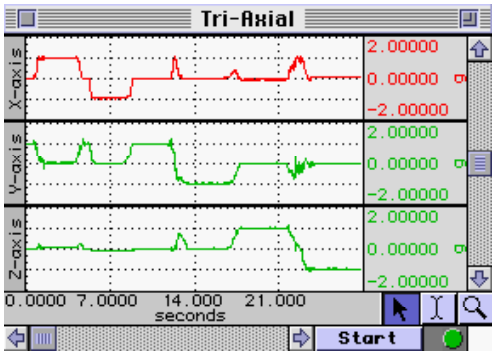
c) Choose **TSD109C (5 g), TSD109J (200 g),** or **TSD109A (2 g)** from the transducer list and click "OK."

d) Follow the onscreen calibration dialogs.

e) Repeat steps a-d for channels A2 (Y-Axis) and A3 (Z-axis).

Testing Calibration

To see if the calibration is correct:



a) Start acquiring data (for the test procedure, a sample rate of 50 samples per second should be used).

b) Rotate the accelerometer 180° through each axis.

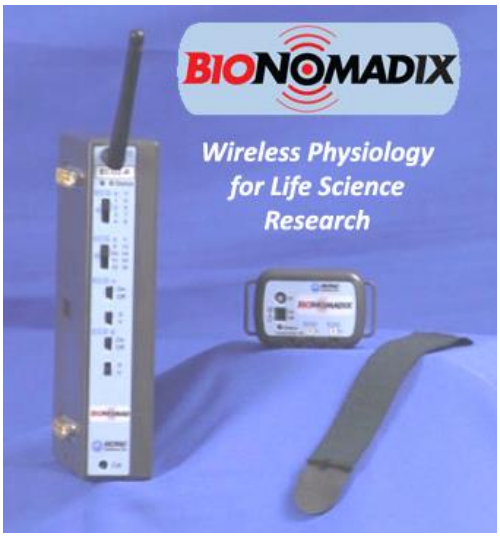
c) Set the vertical scale to 1 and the midpoint to 0 for all channels.

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 1 g to -1 g 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.

BIONOMADIX WIRELESS ACCELEROMETER



The BioNomadix wireless Tri-axial Accelerometer (BN-ACCL3) is a broad spectrum acceleration measurement system. The transmitter can be attached to any part of the subject's body to measure three-axis acceleration associated with movement in that particular location.

The system comes factory preset to support an operational range of ±16 G, with a maximum system bandwidth of 400 Hz. Ranges can be set to as low as ±2 G with bandwidths as low as 3 Hz.

The system can also be configured to act as a "tap detector," detect either single or double taps. In this mode, the system can act as an event recorder for self-report. When "double-tapped," for example, the system will output a pulse to precisely mark the time location of the observed event.

In Acceleration measurement mode, the BN-ACCL3 will output X, Y and Z acceleration values on three associated channels. The system is very well suited for mobile applications. The system can measure the acceleration of gravity (static) for tilt-sensing and can also measure very fast-changing, dynamic acceleration resulting from rapid movement or impact.

BN-ACCL3 Specifications

BioNomadix	**BN-ACCL3**
Signal type:	G (X, Y, Z)
Bandlimits *Max*: *Factory preset*: *Filter ptions* Alternative signal:	±2, ±4, ±8 or ±16 G ± 16 G at 400 Hz LP DC to 3.13 Hz LP up to 400 Hz LP (in power of 2 steps) Tap Event Mark Mode (*replaces* G)
Resolution**:**	X: 5 mg (rms), Y: 6 mg (rms), Z: 9 mg (rms) (±2 G scale at 400 Hz LP)
Signal range:	*Selectable* ±2, ±4, ±8 or ±16 G
Output Voltage range:	±10 V (receiver output)
Transmitter type & rate	Type: Ultra-low power, 2.4 GHz bi-directional digital RF transmitter Rate: 2,000 Hz (between transmitter and receiver)
Delay:	Large fixed component (12.5 ms) and small variable component (±0.5 ms)
Operational range:	10 meters (line-of-sight) typical in standard laboratory setups. See also: *perational Range and Characteristics*.
Operational temp:	5-45° C
Operational humidity:	0-95% non-condensing
Transmitter Battery: Charger:	BioNomadix transmitters use an L-ion battery: full charge takes approx. 1 hour to provide maximum operating time. A battery charger is included with each module pair. See BN-CHARGER for charge time and recharge cycle details.
Operating time:	72-90 hours
Receiver Power:	Use with an MP Research System or with isolated power supply IPS100C/D for 3rd-party data acquisition system.
Included strap:	33 cm - BN-STRAP33
Size & Weight:	Transmitter (approx.): 6 cm x 4 cm x 2 cm; 54 grams; Receiver (approx.): 4 cm x 11 cm x 19 cm; 380 grams
Input:	Attach BioNomadix transmitter to subject – no additional hardware input required; sensor is internal to transmitter.

See also: Tri-Axial Accelerometer Application Notes 141, 266 and 273 here.

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HEEL-TOE STRIKE TRANSDUCERS

SS28LA
TSD111A
SS28A
BN-STRIKE-XDCR

Use this transducer to record heel and toe strike activity as the subject walks. The heel/toe strike data is recorded on two analog channels; One channel records heel strike and the other, toe strike. Strikes are indicated by positive deflections on the graph. Two force sensitive resistors (FSR) attach to the sole of a shoe; use two transducers to record from both feet.

HEEL-TOE STRIKE SPECIFICATIONS

Nominal Output Range: (after amplification)	0 to +10 V
Nominal Contact Force:	200 g to indicate heel/toe strike
Attachment:	TAPE1, TAPE2, Vinyl Electrical or Duct Tape
FSR Dimensions:	18.3 mm (dia) x 0.36 mm (thick) and 30 cm pigtail lead
FSR Active Area:	12.7 mm (dia)
Cable Length:	7.6 meters
Cable Length – BN-STRIKE-XDCR:	30 cm
Interface: SS28LA	MP36/35 System
TSD111A	AMI100D/HLT100C/MP160/150 System
SS28A	TEL100C/MP160/150 System
BN-STRIKE-XDCR	BN-STRIKE/MP160/150 System

HEEL-TOE STRIKE CALIBRATION

BN-STRIKE, TSD111A, SS28LA or SS28A do not require calibration.

Registered impulses on each channel simply reflect the timing marks associated with heel/toe strike contact during gait. The amplitude of each impulse is indicative of force measured at the time of strike. Although this amplitude value does not have an exact linear relationship to force, it is monotonically related. As force increases, amplitude increases. If precise force measurements are required, then weights could be sequentially applied to each sensor to perform a rough calibration within a narrow operational range. Furthermore, an expression channel could be used in Acq*Knowledge* (TSD111A) or BSL *PRO* (SS28LA) software to linearize a heel/toe strike sensor over a wide operational range.

RX111 REPLACEMENT HEEL-TOE STRIKE SENSOR

Replacement strike sensor for Heel/Toe Strike transducers.

Note: Heel/Toe Strike Transducers without the "A" suffix in the part number (SS28L/TSD111) do not have a replaceable sensor. Check the part number or check the cable for a removable sensor connector before ordering this replacement.

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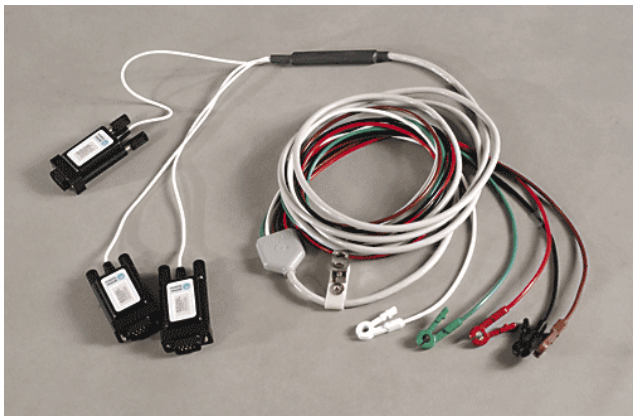
SS29L MULTI-LEAD ECG CABLE



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)

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SS30LA ELECTRONIC STETHOSCOPE TRANSDUCER

The **SS30LA** 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 **SS30LA** 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 **SS30LA** 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.

The SS30LA has the same form and function as the discontinued SS30L; the difference is an internal ID used by the BSL software.

- MP36 units are compatible with SS30L or SS30LA
- MP46 units require SS30LA

SS30LA 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

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SS31LA NONINVASIVE IMPEDANCE CARDIOGRAPHY MODULE

The SS31LA records the thoracic impedance parameters associated with Cardiac Output measurements. The SS31LA incorporates a precision high-frequency current source, which injects a very small (2 mA 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. The SS31LA outputs impedance (*Z*) and derivative of impedance (*dZ*) in real time.

- Use with a 8-spot electrode lead configuration
- Use the SS31LA 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 SS31LA is sensitive to motion artifact.
- See BSL *PRO* Lesson **H21 Impedance Cardiography** for sample SS31LA setup and data.

Specifications

Outputs:

Impedance (*Z*)	(50 mV = 100 Ω)
Derivative Impedance (*dZ*)	(5 mV or 2 ohms/sec)
Operational Frequency:	100 KHz sine wave
Current Level:	2 mA (rms)

Bandwidth: (can limit in BSL *PRO* software)

Z:	DC – 100 Hz
dZ:	DC – 100 Hz

Dimensions:	14 cm (long) x 9.1 cm (wide) x 2.9 cm (high)
Weight:	400 grams

Electrode clip connects to standard snap electrode – use with an 8-spot electrode lead configuration

Note: SS31LA replaces the SS31L, which had lead connectors designed for strip electrodes, such as EL506, which were discontinued due to manufacturing limitations.

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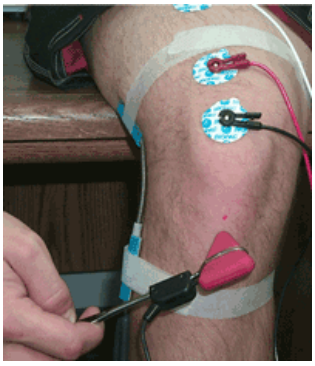
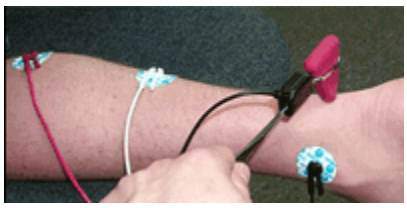
SS36L REFLEX HAMMER





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 L20, H16, H28.

Updated: 7.17.2012

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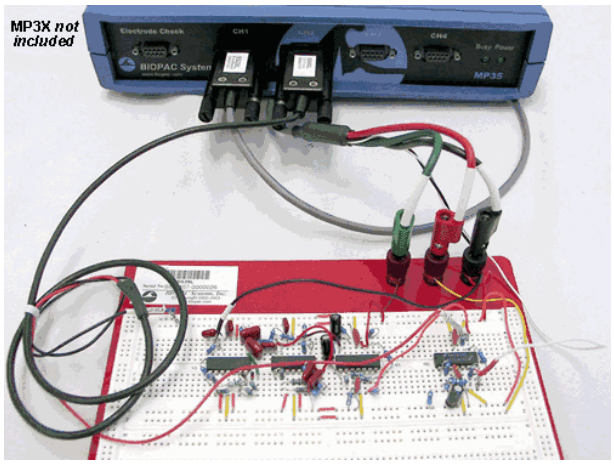
SS39L BREADBOARD

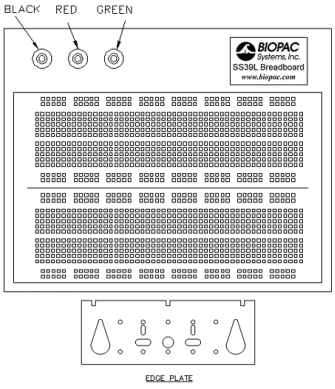


The Bioengineering Breadboard Lab consists of circuitry hardware and eight projects (with schematics and design notes) that demonstrate a very important subset of circuit design for recording and processing physiological signals. Students will use the MP36/35/46/45 and BSL *PRO* software to evaluate their designs. See Lessons H25, H26.

Project Book includes schematics for:

- Lab 1: Square Wave Oscillator
- Lab 2: Instrumentation Amplifier
- Lab 3: High Pass Active Filter
- Lab 4: Active Gain Block and Low Pass Filter
- Lab 5: Notch Filter for 50/60 Hz Rejection
- Lab 6: QRS Detection: Band Pass Filter
- Lab 7: QRS Detection: Absolute Value Circuit
- Lab 8: QRS Detection: Low Pass Filter and Overall System Test

Circuitry Hardware



- Breadboard
- Signal/Power Cable:
  - 3 x Power Plugs: Green -5 V, Black GND, Red +5 V
  - 2 x Signal Wires: White–Signal, Black–GND
  - Built-in automatically resettable fuse
- Signal Cable: 2 x Signal Wires: Red–Signal, Black–GND
- Electrode Lead Interface: enables use of SS2L Lead Assembly
- Accessory Kit: capacitors, diodes, resistors, jumper wires, and other circuit-building components

ACCESSORY OPTIONS

BSL-BMEACC BREADBOARD ACCESSORY KIT

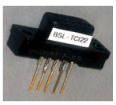
Use to add work stations for the SS39LB Breadboard. Students can build a lab and rotate the power and signal cables from the SS39LB to connect to the Biopac Student Lab software and test the design.

Includes: breadboard, capacitors, diode, ic, ic quad OP-AMP, jumper wire kit, and resistors.

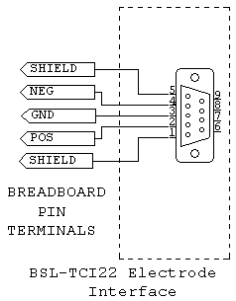
SS60LB SIGNAL CABLE FOR SS39LB BREADBOARD

Use this signal cable to add signal inputs to the SS39LB Signal Processing Breadboard, which ships with one combination power/signal cable.

BSL-TCI22 ELECTRODE LEAD INTERFACE



The electrode interface connects the SS2L Shielded Lead Assembly to the SS39LB Breadboard for circuit configurations that require electrodes. One BSL-TC122 is shipped with the SS39LB; SS2L not included.



NOTE: SS39L previously included cable SS39LA and SS60LA; current customers can use those older cables to run lesson set H25-H26 but upgrading cables to SS39LB and SS60LB is strongly recommended to run lesson set H40 EMG-Controlled Robotic Arm or future BME breadboard lessons.

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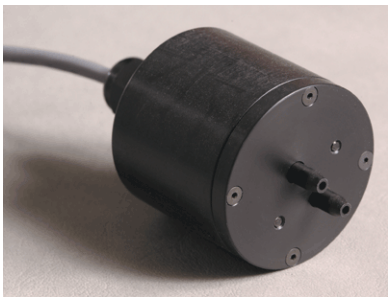
SS40L – 42L DIFFERENTIAL PRESSURE TRANSDUCER



SS40L ±2.5 cm H_2O
SS41L ±12.5 cm H_2O
SS42L ±25 cm 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 4 mm ID tubing. Included with each SS46L-SS52L.

SS40L – 42L Specifications

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

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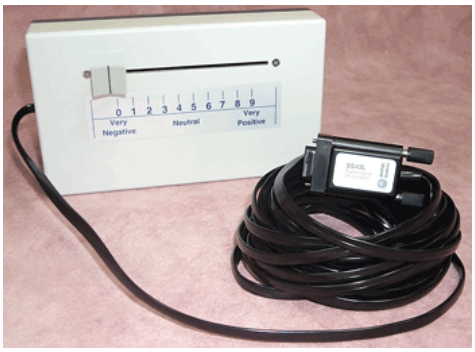
SS43L VARIABLE ASSESSMENT (PSYCH) TRANSDUCER



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 the parameters into the scale sleeve on the front of the unit.

SS43L SPECIFICATIONS

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

PNEUMOTACH AIRFLOW TRANSDUCERS

- TSD137 SERIES FOR MP160/MP150 SYSTEM
- SS46L-SS52L SERIES FOR MP3X AND MP4X SYSTEM
- RX137 SERIES REPLACEMENT FLOW HEADS

The TSD137/SS46L-SS52L series pneumotachs can be used to perform a variety of small animal and human pulmonary measurements relating to airflow, lung volume and expired gas analysis. These pneumotach transducers consist of a low flow, pneumotach airflow head (RX137B through RX137H and SS46L through SS52L) coupled to a precision, highly sensitive, differential pressure transducer (TSD160A or SS40L) via RX137 tubing. 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 RX137 series flow head. All pneumotachs are equipped with an internal heating element and AC137A 6-volt power supply.

MRI Use (TSD137): MR Conditional

Condition: Tested to 3T: Contains ferrous material – must be clamped down in the safe MRI operating area.

Components: Brass, stainless steel, copper

See also: DA100C Calibration options.

RX137 Series Replacement Airflow Heads (SHOWN ABOVE)

For TSD137 & SS46L-SS52L Series Pneumotachs

The RX137 series are airflow heads for the TSD137 and SS46L-52L series pneumotach transducers. The RX137 heads can be mixed and matched with any of the TSD137 and SS46L-SS52L series pneumotachs. Switching one head for another when using a single pneumotach can accommodate a wide range in flows. RX137 heads connect to the TSD160A or SS40L differential pressure transducer via standard 3 mm or 4 mm ID tubing. Multiple RX137 heads help eliminate equipment downtime during cleaning procedures.

Pneumotach Airflow Transducer Calibration

Connect tubing between the calibration syringe and the transducer, then follow the procedure for TSD117/SS11LA but move the calibration syringe plunger at a reduced velocity due to the very high sensitivity to flow of the TSD137/SS46L-SS52L series. Each of the TSD137/SS46L-SS52L series is factory calibrated to a known flow level, as indicated on the transducer.

Flow Head Cleaning & Disinfection

IMPORTANT:

- RX137 series airflow heads are manufactured with a very thin layer of synthetic resin, so they should **never** be cleaned with an organic solvent. We recommend cleaners such as Hydro-Merfen at the concentration used for medical material, or Gluterex.
- Before using the airflow head, be sure it is dry.
- Never heat the airflow head higher than 50 C.

1. Submerge the airflow head in a disinfectant solution for approximately one hour.
2. Rinse the airflow head with distilled or de-mineralized water.
3. Use compressed air or another compressed gas [pressure up to 5 kg / cm2 (5 bar)] to drive any remaining water out of the airflow head.
4. Allow the airflow head to dry completely in ambient air (or continue using compressed air if time requires it).

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TSD/RX137 & SS46L-SS52L Series Specifications

Part# *DA100C* *TSD160/SS40L* *MP36/35/30/46/45*	**TSD137B** **RX137B1** **SS46L**	**TSD137C** **RX137C1** **SS47L**	**TSD137D** **RX137D1** **SS48L**	**TSD137E** **RX137E1** **SS49L**	**TSD137F** **RX137F1** **SS50L**	**TSD137G** **RX137G1** **SS51L**	**TSD137H** **RX137H1** **SS52L**
Range (ml/sec):	±50	±83	±167	±583	±1667	±2667	±13333
Dead Space (cc):	0.8	0.9	2.0	4.0	18.15	13.87	80.0
Nominal Output (µV [ml/sec]):	15.40	5.78	2.10	0.924	1.155	0.4815	0.1925
Flow Ports ID/OD (mm):	2.4 - 3.9	3.76 - 5.2	6.4 - 7.9	9.5 - 15.0	19.0 - 22.0	Port 1: 15.0 - 22.0 Port 2: 13.2 - 15.0	28.6 - 35.0
RX Head Length (mm):	75	75	75	60	60	60	60
RX Head Weight (grams):	90	90	100	60	100	150	250
Approx. Size:	Mouse	Rat/Guinea Pig	Cat/Rabbit	Small Dog	Medium Dog	Large Dog	Adult Human
Approx. Weight:	50 g	350 g	750 g	5.5 kg	15 kg	25 kg	--
Nominal Output:	TSD137B, C, H = normalized to 1 V excitation TSD137D, E, F, G & SS46L-52L = normalized to 5 V excitation						
Tubing Length:	1.8 m *(to TSD160A/SS40L)*						

PNEUMOTACH 200 SERIES AIRFLOW TRANSDUCERS

These flow transducers are designed for humans and animals ranging in size from mice to medium-sized dogs. They include a detachable flow head (RX237B through H) and a differential pressure transducer (TSD160A or SS40L).

Available Flow Rates

17 ml/sec	Mouse/Rat
167 ml/sec	Cat/Rabbit
1.67 L/sec	Medium Dog
16.7 L/sec	Human

- Lightweight and robust
- Linear and direction sensitive
- Twin, non kink silicone tubing
- Economical, sensitive and robust
- Easily cleaned, disinfected or sterilized

For cleaning instructions, see the **Cleaning Guidelines**.

MRI Usage: MR Conditional

Condition: Animal use only. Contains ferrous material – must be clamped down in the safe MRI operating area.

Components: Brass, stainless steel, copper

RX237 SERIES REPLACEMENT AIRFLOW HEADS

For TSD237 and SSLA Series Pneumotachs

Detachable flow heads in are machined from acetal to give good stability with low weight and have found application in pediatrics and in the respiration measurement of animals such as dogs, cats, rats and mice.

TSD/SSLA/RX237 Series Specifications

BIOPAC Part #		Flowhead Type	Dead Space (ml)	Linear Range L/min	Approx. Flow for 10 mm H_2O	Tube (OD mm)	Length (mm)	Weight (gm)
Transducer	Flowhead							
TSD237B/SS46LA	RX237B	F1L	0.6	± 1	1.2 L/min	5	40	14
TSD237D/SS48LA	RX237D	F10L	2	± 10	12 L/min	8	54	22
TSD237F/SS50LA	RX237F	F100L	9	± 100	90 L/min	16	54	38
TSD237H	RX237H	F1000L	320	± 1000	485 L/min	29.5	198	260

Note: One of the problems historically encountered with pneumotachographs is condensation from expired air. This can be prevented by fitting a non-return valve and measuring only inspiration or alternatively by heating the flowhead, but viscosity errors may arise (from which in the first few breaths especially) preheat the inspired air most uncomfortably. In this range of flow heads, **the problem is approached from a fresh angle.** By mounting fine stainless steel gauze in plastic rings, thermal inertia is greatly reduced. The gauze therefore rapidly equilibrates in temperature with passing air and condensation is minimal.

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SS53L – SS55L DIGITAL SWITCH SERIES

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 MP36/35 only.

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: 69 mm (wide), 90 mm (long), 26 mm (high)
Cable Length: 1.8 meters
Connector Type: DSUB 25f

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 the parameters into the scale sleeve on the front of the unit.

Switch Type: Pushbutton: ON - OFF
Dimensions: 19 cm (wide), 11 cm (deep), 4 cm (high)
Cable Length: 3 meters
Connector Type: DSUB 25f

Updated: 8.26.2014

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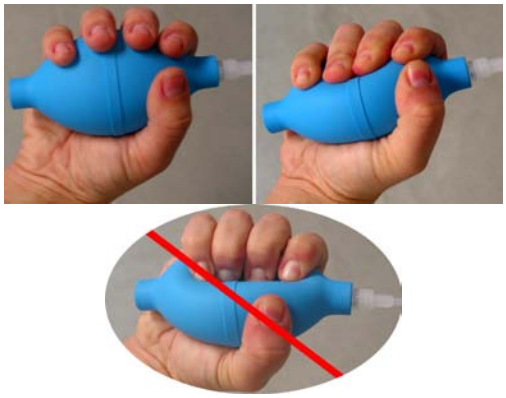
SS56L HAND CLENCH FORCE BULB



SS56L measures proportionality of bulb pressure to clench force in "kgf/m^2" units (a pressure unit). This measure is accurate for the relative measures recorded in BSL Lesson 2 Electromyography (EMG) II. SS56L is recognized by current release BSL Lessons.

Specifications

Pressure Range:	BSL: 0 to 10,546 Kgf/m^2 Acq*Knowledge*: 0 to 1.0546 Kg-f/cm^2	0 to 15 psi
Accuracy:	±3%	
Output:	BSL: 0.58 mV/100 Kgf/m^2 Acq*Knowledge*: 0.58 mV/0.01 Kg-f/cm^2	4.1 mV/psi
Bulb Diameter:	5.8 cm	
Bulb Length:	11.1 cm	
Tubing Length:	3 meters	
Weight:	108 g	

Optional BSL *PRO* Presets:

- Clench Force - kpa (SS56L) - input value 20.48 mV scales to 34.47 kpa
- Clench Force - psi (SS56L) - input value 61.44 mV scales to 15 psi

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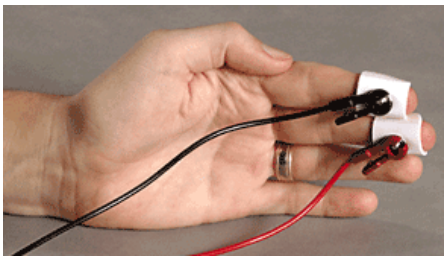
SS57LA/SS57L LEAD SET FOR ELECTRODERMAL ACTIVITY (EDA) FOR USE WITH DISPOSABLE ELECTRODES



The EDA Lead connects to a single input channel to record electrodermal activity (changes in skin conductance) or, with modified setup, skin resistance from two EL507 disposable EDA (isotonic gel) electrodes.

Two pinch leads snap to the EL507 EDA electrodes and terminate in a two-conductor shielded cable with DSub9 connector.

SS57LA EDA Lead delivers accuracy over its specified range to within 5% with no calibration required.

Biopac Student Lab Systems: requires BSL 4.1 with MP36/35/46/45.

Research Systems:

- MP36R – connect directly to a CH input
- MP160/150 – add the DA100C amplifier (set Gain: 1000 and Bandwidth: DC to 10 Hz) and the TCI114 interface

For BSL 4.1 and Acq*Knowledge* 4.4.1 and higher, the SS57LA is the recommended option.

The SS57L is suitable for BSL 3 or MP30.

For a reusable electrode option, see the SS3LA EDA Finger Transducer.

Specifications

Electrode Type:	Requires two Ag/AgCl disposable electrodes (EL507)
Excitation:	0.5 V DC
Range:	0.1-100 μsiemens (normal human range is 1-20 μsiemens)
Connector Type:	9 Pin DIN
Pinch Leads:	Red (+), Black (GND)
Weight:	4.5 grams
Cable Length:	2 meters
Accuracy:	Within 5% without calibration (SS57LA only)

Usage Recommendations (SS57L)

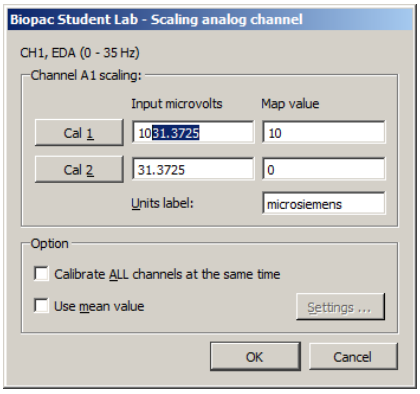
Presets - BSL *PRO* (and Acq*Knowledge* software for MP36R) includes the following EDA presets:

- Electrodermal Activity (EDA), 0-35 Hz; requires calibration—see details below
- Electrodermal Activity (EDA) Change; no calibration required (BSL *PRO* 4.0.3 and earlier only)

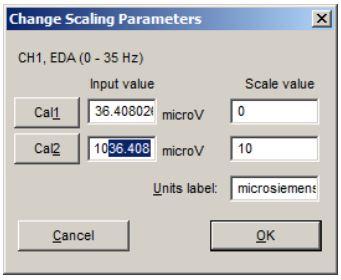
To navigate to the presets in the software, choose **MP** > **Set Up Data Acquisition** (BSL 4.1) or **Set Up Channels** (BSL 4.0.3 or earlier) > **Channels** > and select the desired EDA preset from the **Preset** pop-up menu.

Single-point Calibration for (EDA) 0-35 Hz Preset

1. Disconnect the electrodes.
2. Click "Setup" > "Scaling" button in the software's EDA preset dialog.
3. Click the **Cal 2** button.
4. Add the new **Cal 2** value to the default **Cal 1** value (example below left, 1000 + 31.3725 = 1031.3725) If the new **Cal 2** value is negative, then subtract that value from **Cal 1**.



BSL 4.x and AcqKnowledge 4.x EDA Scaling Dialog



*Note that **Cal 1** and **Cal 2** values are reversed in software versions BSL 3.7.x and earlier.*

BSL 3.7.x EDA Scaling Dialog

Setup - There must be good electrical connections between the skin and the electrodes for EDA to work properly.

Gel – It is recommended that an isotonic gel (GEL101A or equivalent) be added to the disposable electrodes to assure optimal skin contact.

1. Apply a small dot of GEL to each electrode being careful not to get any on the adhesive portion.
2. Attach the electrodes to the subject.
3. Wait 5 minutes (minimum) before starting to record data to allow the gel to penetrate the skin.

Tip

To detect a good signal, subjects should 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.

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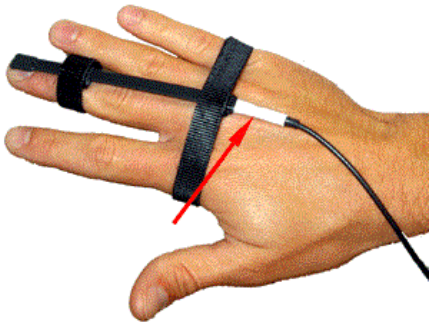
SS61L FINGER TWITCH TRANSDUCER

Palmar attachment recommended: "UP" label facing out



"UP" label toward skin for posterior (dorsal) attachment

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.

SPECIFICATIONS

Transducer Dimensions:	14.6 cm (long), 0.50 cm (wide)
Weight:	6 grams
Maximum Bend:	180° (can be fully curled)

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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 for speech frequency analysis and other acoustic studies. For use with the MP36/35 only, requires continuous high-speed sample rate.

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SS63L – SS83L FORCE TRANSDUCER SERIES

SS83L Force Transducer – 20 g
SS63L Force Transducer – 50 g
SS64L Force Transducer – 100 g
SS65L Force Transducer – 200 g
SS66L Force Transducer – 500 g

Force transducers are devices capable of transforming a force into a proportional electrical signal. The SS63L-SS83L series force transducer elements are cantilever beam load cells incorporating thin-film strain gauges. 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. Forces are transmitted back to the beam via a self-centering pull-pin to insure accurate force measurements. The cantilever beam is mounted in a sealed aluminum enclosure that includes a 3/8" diameter mounting rod for holding the transducer in a large variety of orientations.

SS63L – SS83L Specifications

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 (diameter), variable orientation
Weight:	250 g
Dimensions (L x W x Thick):	100 mm x 19 mm x 25 mm
Cable Length:	3 meters
Interface:	Dsub9 connector to MP3x/4x hardware

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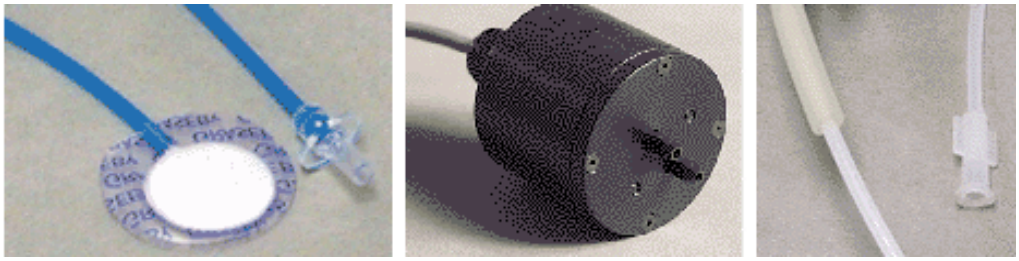
SS67L PRESSURE PAD/RESPIRATION TRANSDUCER



The SS67L consists of an RX110 pressure pad (left,) SS41L differential pressure transducer (center,) and tubing (right).

The multipurpose pressure pad/respiration 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.

RX110 PRESSURE PAD

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

RX110 SPECIFICATIONS

Sensor Pad Diameter:	20 mm
Sensor Pad Thickness:	3.18 mm
Sensor Tubing Diameter:	2.2 mm
Sensor Tubing Length:	1 m → use BIOPAC tubing M106 for extra length
Sensor Tubing ID:	1.6 mm
Tubing Termination:	Luer male

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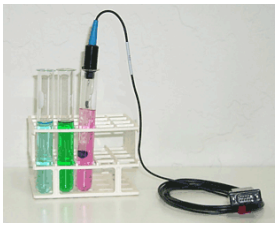
SS68L PH PROBE TRANSDUCER



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 0 mV.
- 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 MP unit.

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

SS68L SPECIFICATIONS

Type:	Double junction
Refillable:	Yes
Body:	Glass
Length:	3.25 m
Weight:	3.5 ounces
Diameter:	1.2 cm

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 MP36/MP35 Data Acquisition Unit.

The dissolved oxygen probe can be used to measure the concentration of dissolved oxygen in water samples tested in the field or in the laboratory. Use this sensor to perform a wide variety of tests or experiments to determine changes in dissolved oxygen levels, one of the primary indicators of the quality of an aquatic environment:

- Monitor dissolved oxygen in an aquarium containing different combinations of plant and animal species.
- Measure changes in dissolved oxygen concentration resulting from photosynthesis and respiration in aquatic plants.
- Use this sensor for an accurate on-site test of dissolved oxygen concentration in a stream or lake survey, in order to evaluate the capability of the water to support different types of plant and animal life.
- Measure Biological Oxygen Demand (B.O.D.) in water samples containing organic matter that consumes oxygen as it decays.
- Determine the relationship between dissolved oxygen concentration and temperature of a water sample.

See also: BSL *PRO* Lesson #A07 Fish Respiration and Q10.

Components

Dissolved O_2 probe	Sodium Sulfite calibration standard (2.0 M Na_2SO_3)
Replacement membrane cap	Dissolved O_2 electrode filling solution
Calibration bottle & pipette	Polishing strips

Interface

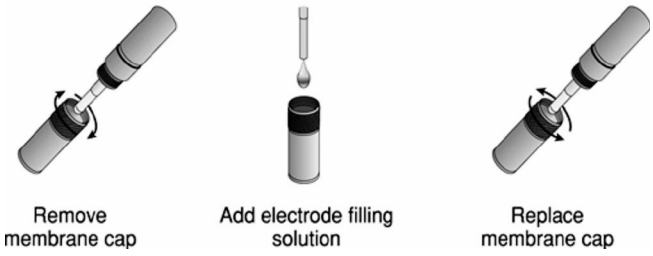
Use with BIOPAC BSL-TCI16 Transducer Connector to record with a BIOPAC MP36/35 Data Acquisition Unit.

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.



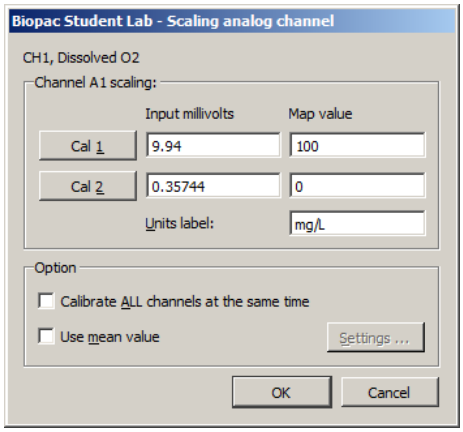
2. Warm-up
   a. Insert the BT connector on the RXPROBEO2 into the BSL-TCI16 transducer connector.
   b. Connect the BSL-TCI16 transducer connector to the MP data acquisition unit.
   c. Turn the MP unit ON and wait 10 minutes for the probe to warm up.
      - The probe must stay connected to the interface at all times to keep it warmed up. If the probe is disconnected for more than a few minutes, the warm-up routine will need to be repeated.

Calibration — *optional*

- Calibration is optional. To measure relative change, probe calibration is not essential. To improve accuracy for discrete measurements, probe calibration is recommended.

Calibration in BSL 4.x or AcqKnowledge 4.x software for MP36R:

a. First Calibration Point (Zero-Oxygen)
   i) Launch the BIOPAC software and open the scaling dialog for the probe channel.
   (MP36/35 menu > Set Up Data Acquisition > Channels > Setup > Scaling Button.)
   ii) Remove the probe from the water and place the tip of the probe into the Sodium Sulfite calibration solution as shown.



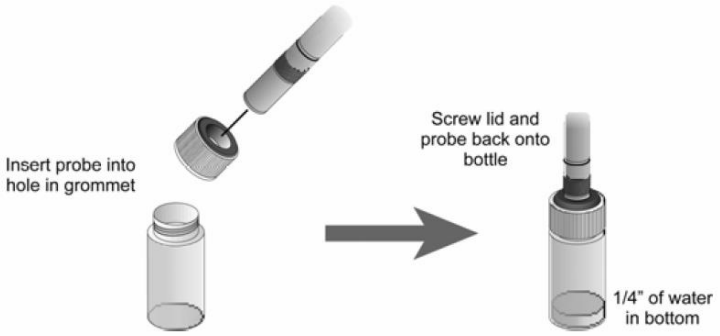
IMPORTANT: No air bubbles can be trapped below the tip of the probe or the calibration will be distorted. If the voltage does not rapidly decrease, tap the side of the bottle with the probe to dislodge any bubbles.

   iii) Wait until the voltage stabilizes (~2 minutes), and press the CAL 2 button. The Map value result should be in the 0.2 - 0.5 mV range.

b. Second Calibration Point (Saturated Dissolved O_2)
   i) Rinse the probe with distilled water and gently blot dry.
   ii) Unscrew the lid of the calibration bottle and slide the grommet approximately 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 as shown. **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 1 button. The Map 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 the current altitude. The example scaling on the previous page (9.94) is based upon an ambient temperature of 16° C and a barometric pressure of 760 mm. (To calibrate and monitor using Percent Saturation, use the conversion formula on the following page.)

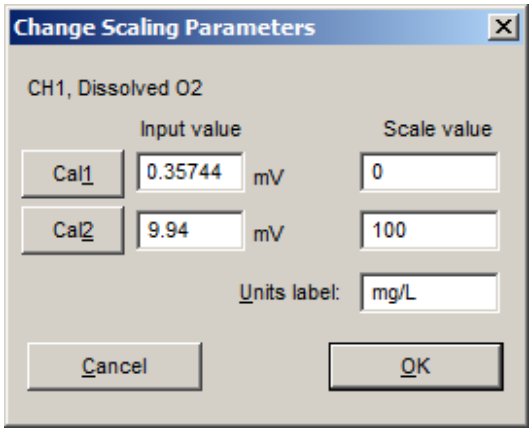
Calibration in BSL 3.7.x software:

(CAL 1 and CAL 2 values are reversed from BSL 4, uses "Scale value" instead of "Map value")

a. First Calibration Point (Zero-Oxygen)

i) Launch the BIOPAC software and generate the scaling dialog for the probe channel.

(MP menu > Set Up Channels > View/Change Parameters > Scaling Button.)



ii) Enter 0 for CAL 1 Scale 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) Wait until the voltage stabilizes (~2 minutes), press the CAL 1 button. The Input value result should be in the 0.2 - 0.5 mV range.

b. Second Calibration Point (Saturated Dissolved O_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 Input value result should be above 2 mV.

v) Enter a Saturated Dissolved O_2 value (in units of mg/L) from Table 1 as the CAL 2 scale value, based on the current barometric pressure and air pressure values. If necessary, use Table 2 to estimate the air pressure at the current altitude. The example scaling above right (9.94) is based upon an ambient temperature of 16° C and a barometric pressure of 760 mm. (To calibrate and monitor using Percent Saturation, use the conversion formula on the following page.)

Calibration and Monitoring Using Units of Percent Saturation

Instead of calibrating using units of mg/L (equal to parts per million or ppm), you may also choose to calibrate dissolved oxygen using units of % saturation. When doing a calibration for units of % saturation, the calibration point done in the sodium sulfite solution (zero oxygen) is assigned a value of 0%, and that for water-saturated air (or air-saturated water) is given a value of 100%. It must be noted, however, that 100% represents an oxygen-saturated solution only at that particular temperature, pressure, and salinity level. If you intend to compare your measured dissolved oxygen values with data collected under a different set of conditions, a preferable method would be to use units of mg/L.

To convert the $\%O_2$ to mg/L, use the following formulae:

% **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 20º C and a pressure of 740 mmHg, the corresponding Table 1 value is 8.93 mg/L, so % Saturation = (6.1 / 8.93) x 100 = 68%

BSL 4.x: Set CAL 2 Map value to 0% and CAL 1 Map value to 100% and then press the CAL 1 button to map the probe voltage, proportional to dissolved O_2 to 100%.

BSL 3.7.x: Set CAL 1 Scale value to 0% and CAL 2 Scale value to 100% and then press the CAL 2 button to map the probe voltage, proportional to dissolved O_2 to 100%. (Set units label to mg/L)

Table 1

Dissolved O_2 (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

Recording

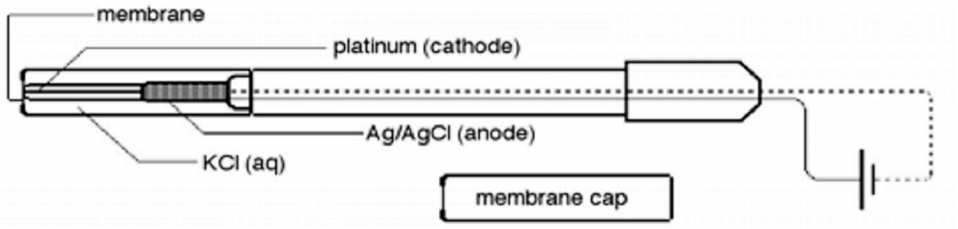
a. Place the tip of the probe into the sample to be measured. Submerge the tip about 4-6 cm (2”).

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.

c. For this O_2 measurement to be valid, the sample must be at the same pressure and temperature as calibration solution.

How the Dissolved Oxygen Probe Works

The Dissolved Oxygen Probe is a Clark-type polarographic electrode that senses the oxygen concentration in water and aqueous solutions. A platinum cathode and a silver/silver chloride reference anode in KCl electrolyte are separated from the sample by a gas-permeable plastic membrane.



A fixed voltage is applied to the platinum electrode. As oxygen diffuses through the membrane to the cathode, it is reduced:

$$1/2\ O_2 + H_2O + 2e\text{-}\ 2 \rightarrow OH^-$$

The oxidation taking place at the reference electrode (anode) is:

$$Ag + Cl\text{-} \rightarrow AgCl + e^-$$

Accordingly, a current will flow that is proportional to the rate of diffusion of oxygen, and in turn to the concentration of dissolved oxygen in the sample. This current is converted to a proportional voltage, which is amplified and read by the MP hardware and BIOPAC software.

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.

Maintaining and Replenishing the Sodium Sulfite Calibration Solution

The 2.0 M sodium sulfite ($Na2SO_3$) solution can be prepared from solid sodium sulfite crystals: Add 25.0 g of solid anhydrous sodium sulfite crystals ($Na2SO_3$) to enough distilled water to yield a final volume of 100 mL of solution. The sodium sulfite crystals do not need to be reagent grade; laboratory grade will work fine. Many high school chemistry teachers will have this compound in stock. Prepare the solution 24 hours in advance of doing the calibration to ensure that all oxygen has been depleted. If solid sodium sulfite is not available, substitute either 2.0 M sodium hydrogen sulfite solution, (sodium bisulfite, 20.8 g of $NaHSO_3$ per 100 mL of solution) or 2.0 M potassium nitrite (17.0 g of KNO_2 per 100 mL of solution).

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INPUT ADAPTERS

SS9LA Unisolated BNC Input Adapter
SS70LA Isolated BNC Input Adapter
SS71L Isolated BNC Input Adapter – MP30

See also: OUT2 BNC Output Adapter

SS9LA Unisolated BNC Input Adapter

This unisolated input adapter is for MP36, MP36R, MP35, MP46, and MP45 Systems only. Use to send signals from other devices (other chart recorders, amplifiers and signal generators) to be recorded by a Biopac Student Lab System or a Research System with Acq*Knowledge*.

SS9LA has a built-in divide by 10 attenuation which provides a ±20 V input range on MP36, MP36R, MP46, and MP45, a ±10 V input range on MP35. The 2-meter cable terminates in a male BNC for easy connections.

SS9LA Specifications

Cable length:	2 meter
Connector type:	BNC
Signal range:	±20 V (MP36/MP36R/MP46/MP45) ±10 V (MP35)

WARNING! Never connect the SS9LA BNC Input Adapter to an MP3X unit if electrodes from other channels are connected to human subjects – this may void the electrical isolation (one un-isolated channel input voids the isolation of all channel inputs).

This cable replaces the SS9L, effective January 2014.

SS70LA Isolated BNC Input Adapter for MP36/MP35

This BNC adapter is required when connecting un-isolated third party devices (i.e. amplifiers, chart recorders or signal generators), while electrodes, attached to human Subjects are connected to other input channels.

Connector Type: BNC
Signal range: ±10 V (MP36/MP36R/MP35/MP46/MP45)

This adapter replaces the SS70L, effective June 2017.

SS71L Isolated BNC Input Adapter for MP30

This BNC adapter is required when connecting un-isolated third party devices (i.e. amplifiers, chart recorders or signal generators), while electrodes, attached to human Subjects are connected to other input channels.

Connector Type: BNC
Signal range: ±10 V

WARNING! Since all MP inputs share a common isolated ground, connecting an un-isolated device to any channel voids the isolation for all channels and exposes the Subject to possible shock hazards.

SS72L MICROELECTRODE AMPLIFIER

The SS72L very high impedance (Zin), single-ended input amplifier is fully shielded and operates with glass or wire electrodes. It is suitable for intracellular or extracellular measurements. The frequency response of the SS72L ranges from DC to 3000 Hz.

The SS72L input directly supports a variety of plug-in adapters to connect to a wide range of glass or wire electrodes, and includes an adapter to connect to glass microelectrodes with 2 mm female socket connection (i.e., A-M Systems 67604x series). The adapter firmly holds the glass microelectrode, so positioning can be handled via the support rod. The Ground input is on the bottom; one alligator clip lead (LEAD140) is included as an option for GND.

The SS72L Micro Electrode Amplifier can connect to any MPXX platform:

- MP36/MP36R/MP35/MP46/MP45: Connect directly to any input channel.
- MP160/150 System: Connect via DA100C and TCI114.

Specifications

Gain:	2
Input:	Single-ended, JFET type
Input Connector:	Touchproof male socket (1.5 mm pin diameter)
Input Ground Connector:	Touchproof male socket (1.5 mm pin diameter)
Adapter:	4.8 cm long, 4.5 mm diameter, Touchproof female (1.5 mm socket) to 2 mm male pin
Offset voltage:	0.05 mV nominal
Input bias current:	0.25 pA nominal
Input voltage range:	±1 V with MP36/36R/35/46/45; ±100 mV with MP160/150 via DA100C + TCI114 *For wider input voltage range using MP160/150 System and SS72L, contact BIOPAC*
Noise voltage:	2.5 µV p-p (0.1-10 Hz)
Noise voltage density:	16 nV/sqrt (Hz)
Noise Current Density:	0.5 fA/sqrt (Hz)
Output:	Single-ended or differential
Output Connector:	Connects directly to MP36/36R/35/46/45; requires DA100C + TCI114 to MP160/150
Bandwidth	DC-3000 Hz, single poll roll-off
Shielded:	Yes, connects to MPXX ground pin
Input Impedance:	1 Gohm nominal
Power:	±5 V (from MPXX platform)
Cable Length:	3 m (10')
Dimensions:	Support Rod: 10 cm long, 0.635 cm diameter Amplifier casing (shielded): 6.91 cm long, 3.175 cm diameter

info@biopac.com
support@biopac.com
www.biopac.com

SS72L Example Setups

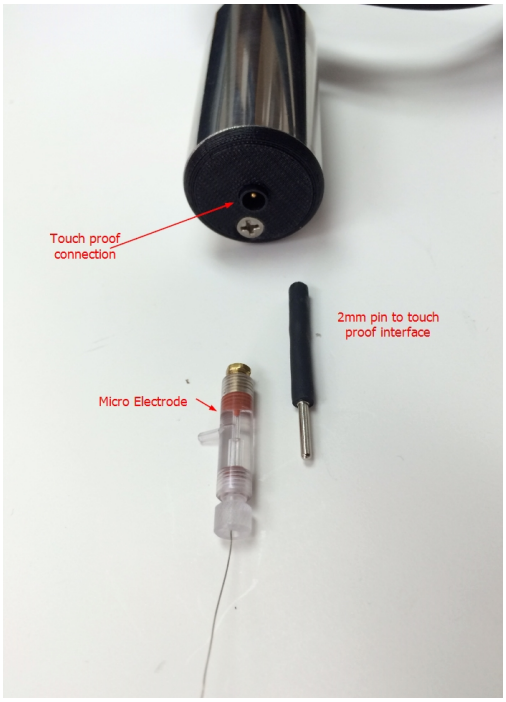


Figure 1

Figure 2

Figure 3

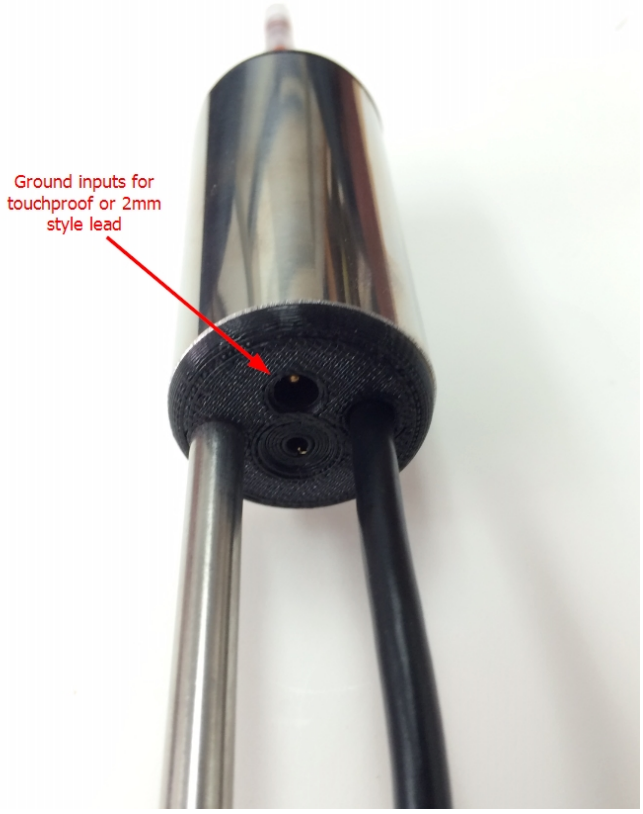
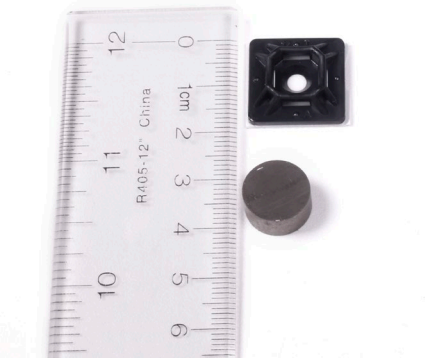


Figure 4

SS73L HALL EFFECT SWITCH TRANSDUCER ASSEMBLY

The SS73L Hall Effect Switch Transducer is used for detecting pedal or flywheel rotations on a cycle ergometer. Types of tests performed with this transducer include the Wingate Anaerobic Test (WAnT) covered in BIOPAC *PRO* lesson H05. This transducer detects the presence of a Neodymium Disc magnet (13 mm dia, 4.8 mm thick, 2.3 kg max pull) up to a distance of 18 mm.



The SS73L Hall Effect Switch Transducer is compatible with MP36, MP35, MP46, or MP45 hardware (Biopac Student Lab 4.0.1 or higher software,) or MP36R hardware (Acq*Knowledge* 4.4 or higher software).

The SS73L assembly includes an adhesive magnet, four adhesive wire tie mounts and four wire ties as shown in the above figure. The Switch Transducer has double-sided tape on the back side for mounting.

Caution: The neodymium disc magnet produces a strong magnetic field. Do not place near sensitive electronics (i.e. computers with hard drives). The magnet is shipped in protective foam with a prominent warning label.

SS73L SPECIFICATIONS

Parameter	Specification
Interfaces to:	MP36, MP36R, MP35, MP46, MP45
Input connector:	DB9 Male
Cable Length:	3 meters
Output Voltage range:	0 to 1 Volt
Signal Output Voltage Logic:	Magnet detected: 0 – 5 milliVolt Magnet not detected: 1 Volt
Supply Voltage (From MP):	+5 Volts
Supply Current:	20 mA
Attenuation:	5 dB
Frequency Response:	0 – 1.6 KHz (+- 20%)
Noise Voltage (0 – 1,000 Hz):	0.02 mV RMS
Weight:	125 grams
Size of Hall Effect Switch housing (L x W x H):	26 mm x 11 mm x 3 mm
Magnet:	Neodymium Disc. Nickel plated, 13 mm diameter, 4.8 mm thick, 2.3 kg max pull
Maximum Sensing distance using the above magnet:	18 mm

NOTE: The magnet must be oriented such that the South Pole faces the Hall Effect switch. The SS73L is not compatible with MP30 hardware.

SS73L HALL EFFECT SWITCH TRANSDUCER SETUP

The following describes the setup and use of the BIOPAC Hall Effect Switch transducer assembly (SS73L) with BSL *PRO* or Acq*Knowledge* software to count and record pedal revolutions of a cycle ergometer.

EQUIPMENT:

- BIOPAC Student Lab System:
  - MP36, MP36R, MP35, MP46, or MP45 hardware
  - Software: BSL 4.0.1 or higher or Acq*Knowledge* 4.4 or higher (Acq*Knowledge* is compatible with MP36R hardware only)
- BIOPAC Hall Effect Switch Transducer (SS73L) assembly*
- Plate loaded or pendulum balance cycle ergometer

***Note*:** The SS73L Hall Effect Switch Transducer assembly, includes a stick-on magnet, four stick-on wire tie mounts and four wire ties as shown in Figure 1. The switch has double-sided tape on the back side for mounting.

Caution: The neodymium disc magnet produces a strong magnet field. Do not place it near sensitive electronics (i.e., computer hard drives). It is shipped in protective foam.

Figure 1

HARDWARE SETUP

There are many types of cycle ergometers. Some have an exposed flywheel (Figure 2) and others conceal the flywheel with a plastic cover.

1. Locate the optimal position for attaching the Hall effect switch and the magnet on the ergometer. Placing the magnet on the flywheel is preferred because the flywheel rotates multiple times per pedal revolution and gives better pedal cadence (RPM) resolution. Find locations that meet these requirements.

If the Flywheel is exposed:

- The Hall effect switch can be securely mounted to the frame.
- The magnet can be placed on the flywheel such that it will pass by the center of the Hall effect switch (Figure 3).
- The gap between the Hall effect switch and the magnet is no more than 18 millimeters.

Figure 2

If the flywheel is concealed, or if there is no way to mount magnet on the flywheel:

- The magnet is placed on the inner side of the crank arm, held in place by the tape as well as magnet's attraction to the iron in pedal's shaft (Figure 4).
- The Hall Effect Switch can be securely mounted to the frame or chain cover such that the magnet will pass by the center of the switch (Figure 5).
- The gap between the Hall Effect Switch and the magnet is no more than 18 millimeters.

Some improvising may be necessary to meet the requirements (i.e. using spacers, etc.). The Hall Effect Switch can be held in place using the included double-sided tape, screws, or wire ties. Figure 3 shows an example of flywheel placement. Since the ergometer frame is round, a spacer/support piece was constructed out of plastic to firmly hold the switch, to align the switch and the magnet, and to keep the distance between them less than 18 mm.

Before attaching:

- Clean the mounting locations with isopropyl alcohol.
- It is important that the south pole of the magnet be facing towards the Hall Effect switch. If the magnet's polarity is reversed, the switch will not function. The south pole will be the side *opposite* the double-backed tape. If no tape is available, it is recommended to not attach the magnet until Step 8, where it can be moved back and forth near the Hall Effect switch to verify that it is detected. If the magnet is not oriented correctly, it can be difficult to remove due to the magnet's strong pull-strength.

2. Peel off the protective layer of the double-backed tape and press the Hall effect switch and the magnet into position.

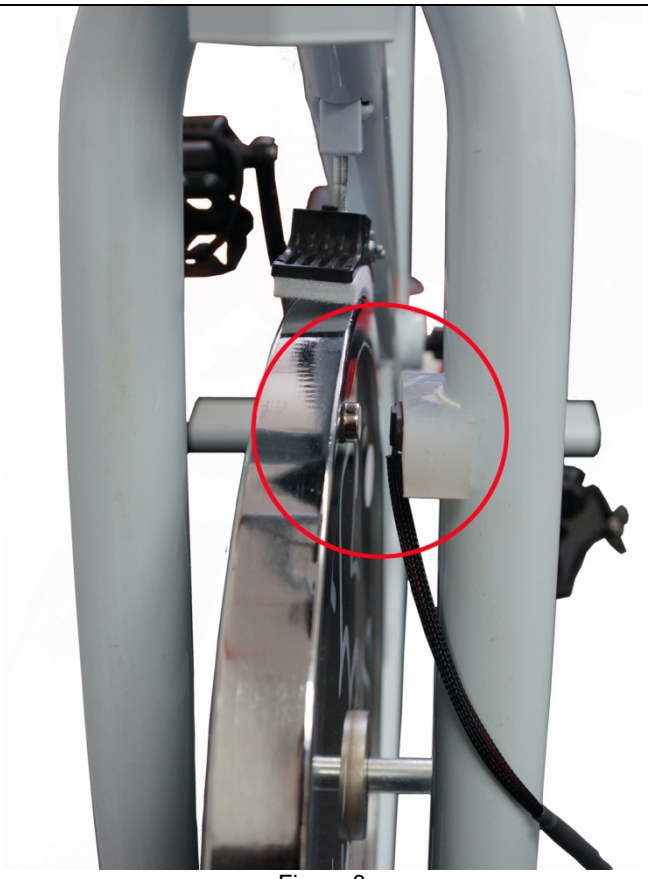


Figure 3

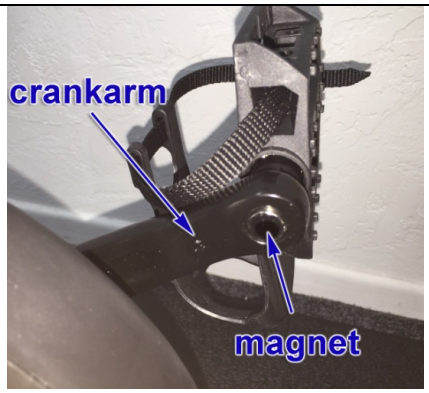


Figure 4

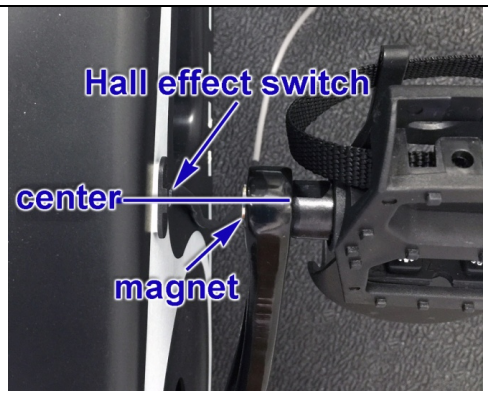


Figure 5

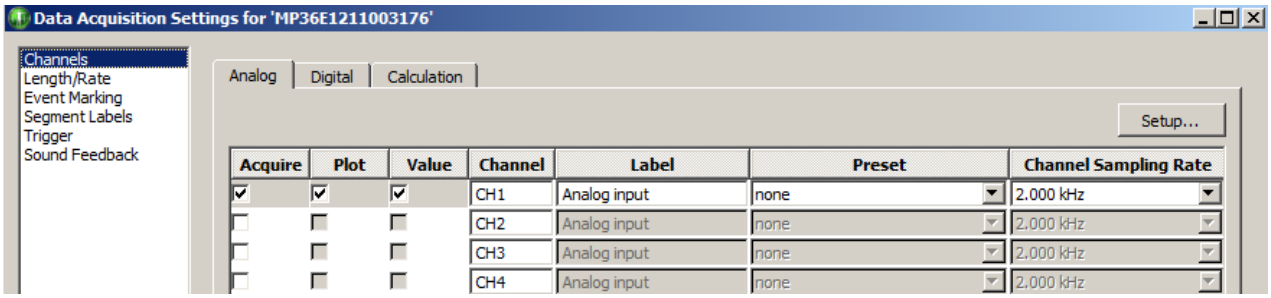
3. To protect the cable from moving parts, attach stick-on wire tie mounting plates in strategic locations and secure the cable using wire ties.
4. Determine the flywheel to pedal rotation ratio which is the precise number of rotations the flywheel makes for each rotation of the pedal (may not be an even integer): **Flywheel to pedal rotation ratio**: _____

It is assumed that the MP36/35/46/45 is connected to the host computer and that BSL *PRO* software has been installed. If using an MP36 or MP35, it should be connected to its power supply but turned OFF. If using an MP46/45, which obtains its power from the USB port, the unit will remain powered ON.

5. Plug the BIOPAC Hall Effect switch (SS73L) into an MP Input Channel (CH 1 used in examples).
6. Turn on the MP36/36R/35. Turning ON the hardware after the connections are made minimizes the chance of instrumentation errors caused by Electrostatic Discharge (ESD) during plug-in.

SOFTWARE SETUP

Launch the BSL 4 or Acq*Knowledge* 5 software and and choose "**Create/Record a new experiment**." Make sure "**Create empty graph**" is selected and click **OK**. The new empty graph will open to the following settings (CH1 enabled, "Acquire," "Plot" and "Value" checked as shown below.)



If using BSL 4.1.3 or higher or Acq*Knowledge* 5.0.3 and higher (SS73L presets established):

a. Select "**Switch, Hall Effect (SS73L)"** from the CH1 "**Preset**" menu list.

b. Click the "**Calculation**" tab, select "Acquire," "Plot," and "Value" for C1 and then select the Preset: "**Pedal Cadence (from SS73L)**."

c. Click the "**Setup**" button to open the Metachannels.

d. Select the "**C1.0**" row and then click "**Setup Subchannel**."

e. Make sure that the Source channel is set to "**Primary Source Channel: Ch 1, Hall Effect Switch**" as shown in Figure 6.

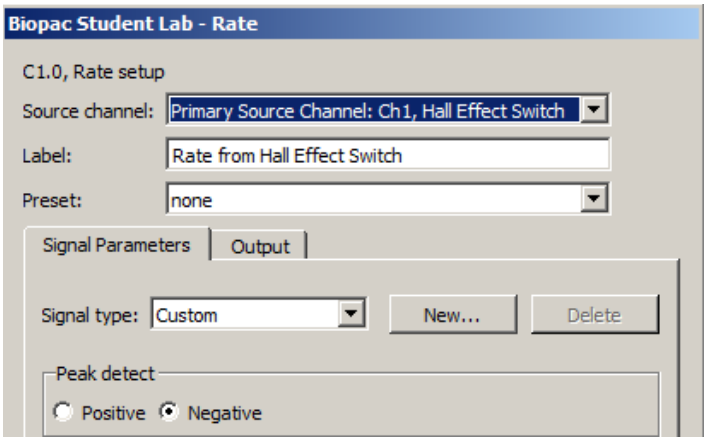


Figure 6

f. Click **OK** to close the two Metachannel Setup dialogs.

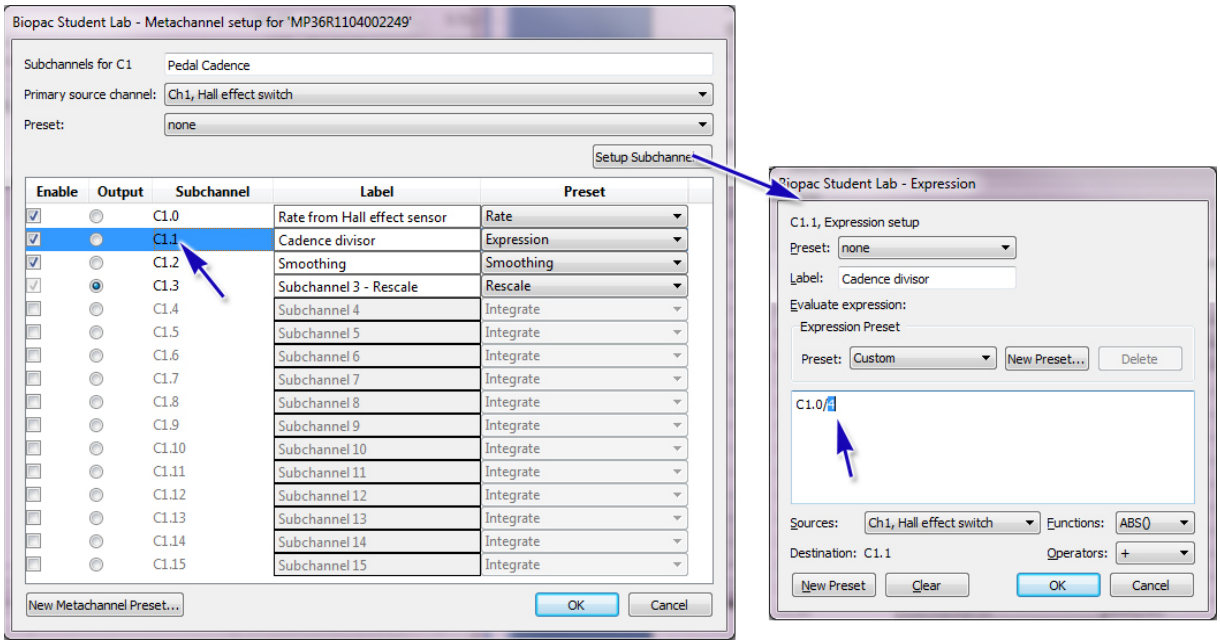
g. Select "**Length/Rate**" from the left column in Data Acquisition Settings. Verify that "Sample rate" is set to at least 2000 samples/second and adjust other parameters if necessary.

h. Close out of the Data Acquisition Settings dialog and continue to **Step 7** on following page.

If using BSL 4.1.2 or prior OR Acq*Knowledge* 5.0.2 or prior (SS73L presets NOT established):

Contact BIOPAC to obtain a pre-configured graph template for these software versions.

7. Continue to **Step 8** if magnet is located on crank arm. If the magnet is placed on the flywheel, the following changes must be made prior to recording:
   a. Enter this number into the Pedal Cadence calculation channel as follows:
      i. Select "**MP menu > Set Up Data Acquisition > Channels**."
      ii. Click the "**Calculation"** tab, select "C1" and click "**Setup**."
      iii. Select Subchannel C1.1 (Cadence Divisor) and click "**Setup Subchannel**."
      iv. Replace the default divisor, "1," with the "Flywheel to pedal rotation ratio" obtained in Step 4 on page 3. Be careful to not alter any other text in the expression.



   v. Click "OK" in the Metachannel and Calculation channel dialogs and close the "Input Channels Setup" dialog.

8. Test the setup by clicking **Start** to begin a recording and then rotate the pedals a few rotations, and then click **Stop**. The data should look similar to that in Figure 7.

   CH1 baseline level should reside at 1000 mV and negative going pulses should indicate when the magnet passed by the Hall effect switch. The pedal cadence should show changes in RPM corresponding to interval between switch pulses.

   If no pulses are seen on CH1:

   - The distance between the magnet and the Hall Effect switch is too great.
   - The magnet does not pass over the center of the Hall Effect switch.
   - The magnet polarity is incorrect and the magnet must be flipped.

   Click the Rewind button to erase the setup data.

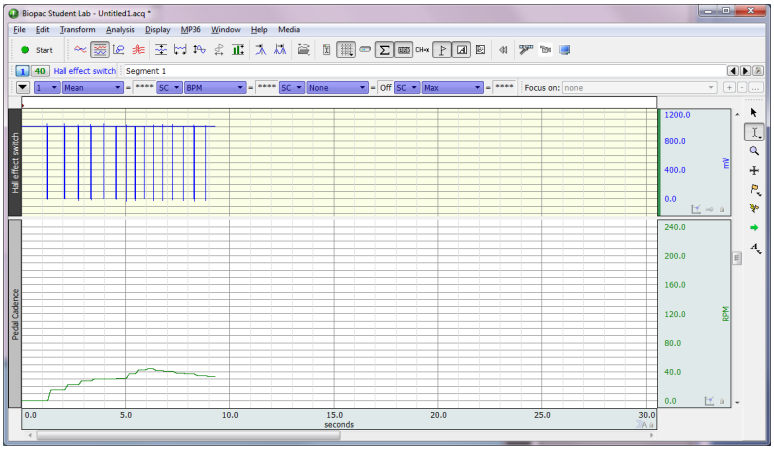
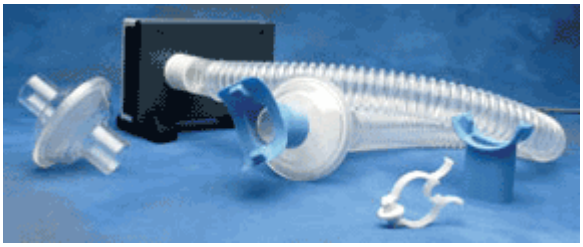


Figure 7

IMPORTANT: Save the template with the new settings so these steps do not need to be repeated. Select File > Save As and choose "Save as type: Graph Template (*.gtl)." Use a different filename so as to not overwrite the original. Organize the files so the new template will be used in the future.

AFT SERIES AIRFLOW & GAS ANALYSIS ACCESSORIES



See also: Student Accessory Packs BSL-ACCPACK and BSLACCPACK-11B

Includes the following airflow accessories:

Bacterial Filters	*Mouthpieces*	*Calibration*	*Airflow Tubing*	*Facemasks & Accessories*	*Noseclip*
AFT1 AFT4 AFT36	AFT2 ATF8 AFT9 RX-AFT35-MOUTH	AFT6A AFT16 AFT17 AFT27 AFTCAL-160	AFT7 AFT7L AFT12	AFT10 AFT10S AFT25 RX-AFT25-SMALL RX-AFT25-MEDIUM RX-AFT25-LARGE RX-AFT25-CAP	AFT3
Gas Sampling Kits	*AFT T-valves*	*Head Support*	*Gas Tubing*	*Mixing Chamber*	*Couplers*
AFT20 AFT31-MRI	AFT21 AFT22 AFT23 AFT35-MRI AFT302	AFT24	AFT30	AFT15	AFT11A AFT11B AFT11C AFT11D AFT11E AFT11F AFT11H AFT301 AFT160

DISPOSABLE BACTERIAL FILTERS

MRI Use: MR Safe

AFT1/4/36 Bacterial Filter Components: Polycarbonate Clear Plastic

AFT1 Disposable Bacterial Filter *Available in Packs of 10 or 250*

Designed to remove airborne bacteria. Pore Size: Virus Filtration Efficiency (VFE): 3.1 micron; Bacterial Filtration Efficiency (BFE): 2.8 micron. Use between any SS11L, SS11LA, SS11LB, or TSD117, or TSD117A and the AFT2. 22 mm ID/OD.

AFT4 Disposable Bacterial Filter

Designed to remove airborne bacteria; for use with the TSD107B, or other 35 mm breathing circuits, connects between the AFT7 and the AFT9. (35 mm ID/35 mm OD)

AFT36 Disposable Pulmonary Function Filter and Mouthpiece *Available in packs of 10 or 200*

This disposable bacteriological filter with integrated mouthpiece is recommended for use with the SS11LB or TSD117A airflow transducer, and attaches directly to the outside of the airflow head. Independent laboratory tests have verified 99.99% bacterial and viral filtration efficiency. This surpasses published ATS recommendations for flow resistance in pulmonary function instrumentation, which suggest resistance should be below 1.5 cm H_2O/L/sec at flow rates of 14 L/sec. Port: 35 mm OD. **NOTE:** The AFT36 is not compatible with earlier-style SS11L or SS11LA or TSD117 airflow transducers. (Use AFT1 + AFT2 instead.)

MOUTHPIECES

MRI Use: MR Safe

AFT Mouthpiece Components: Polyethylene EVA Copolymer, Thermoplastic Rubber, Polycarbonate Plastic

AFT2 Disposable Mouthpiece *Available in Packs of 10 or 250*

22 mm OD; connects to the older model SS11LA or TSD117 via the AFT1.

AFT8 Autoclavable Mouthpiece *Available in Packs of 1 or 10*

30 mm ID; interfaces with the SS11LA, SS11LB, or TSD117A and reduces the cost of disposable parts.

- RX117A-MRI Replacement Sterilizable Airflow Head**:** 22 mm ID/30 mm OD; autoclavable transducer head for the TSD117A; can be used with the AFT8 to reduce the cost of disposable items.

AFT9 Reusable Mouthpiece *Available in Packs of 1 or 10*

35 mm ID; designed to connect to the TSD107B or other 35 mm breathing circuits with the AFT7 via the AFT4. (Also connects to the AFT21 Non-rebreathing T Valve.)

NOSECLIP

MRI Use: MR Safe

AFT Noseclip Components: Thermoplastic Rubber, Polyvinyl Chloride (PVC) Plastic, Polyurethane Foam Plastic

AFT3 Disposable Noseclip *Available in Packs of 10 or 250*

Gently squeezes the nostrils shut while using the SS11LA or TSD117A Airflow Transducer.

CALIBRATION

AFT6A Calibration Syringe

0.6 liter calibration syringe. *See also*: AFT27 3.0 liter Calibration Syringe

AFT27 Calibration Syringe (3.0 liter)

The AFT27 is a 3.0 Liter Calibration Syringe for the SS11LB, SS11LA or TSD117A Airflow Transducer. The AFT27 Calibration Syringe is certified to have a 3-liter volume that meets or exceeds an accuracy ± 0.5% of the total displacement volume. The increased size and accuracy of this 3.0 liter calibration syringe provide a wider calibration range than the AFT6A for advanced studies. A coupler is included and can be reordered as AFT11D (SS11LB) if it is inadvertently discarded when an airflow accessory is removed. This adjustable aluminum calibration syringe is shipped with the volume locked to 3.0 L and BIOPAC templates and software settings are set for 3 L.

The locking collar and graduated rod allow users to select other calibration volumes, from 0.5 Liters to 3.0 Liters. The aluminum syringe has a universal connector and works with BIOPAC's AFT11D flexible coupler (35 mm OD, 35 mm OD).

NOTE The AFT27 3.0 Liter Calibration Syringe replaces the AFT26 2.0 Liter Calibration Syringe, which was discontinued in September of 2017.

AFT16 Regulator Barb Interface Kit

Use the Regulator Barb Interface Kit to interface the GASCAL+GASREG calibration gas combination to an AFT15 mixing chamber to calibrate the CO2100C carbon dioxide measurement and O2100C oxygen measurement amplifier modules.

Kit includes 2 meters of tubing that connect to the GASREG and mixing chamber along with two stoppers to seal the inlet and outlet ports of the mixing chamber.

AFT17 Regulator Barb Interface for GASSYS3

Use this Regulator Barb Interface with Luer lock to connect a regulator (such as GASREG) and GASCAL or GASCAL2 calibration gas to inject calibration gases into the RX-GAS3 Calibration Chamber to calibrate the GASSYS3 Gas Analysis System.

AFTCAL-160 Differential Pressure Manometer with NIST Calibration

Use this NIST-certified manometer to calibrate the TSD160 series of differential pressure transducers. Range ±2 psi, ±140.6 cm H2O.

The device offers 11 units of measure (user-selectable on front panel) and the differential input uses quick-disconnect fittings. Advanced features include DATA HOLD, MIN-MAX-AVG RECORD mode, ZERO/OFFSET, AUTO POWER OFF, and USB PC interface. Ships fully tested and calibrated.

This manometer is recommended for use with the TSD160 Series Differential Pressure Transducer and VVK100-SYS Ventilator Validation Kit measurement accessories. (See AFTCAL-160 technical specs on page 12.)

TUBING FOR AIRFLOW

MRI Use: MR Safe

AFT7/7L/12 Tubing Components: Polyethylene EVA Copolymer

AFT7 Smooth Bore Tubing

1 m length, 35 mm ID; connects to the TSD107B, AFT4, or other 35 mm breathing circuits.

See also: AFT part guide for additional applications. Sterilization: Cidex® / Cidex OPA® recommended

AFT7L Smooth Bore Tubing

3 m length, 35 mm ID; connects to the TSD107B, AFT4, or other 35 mm breathing circuits.

See also: AFT part guide for additional applications. Sterilization: Cidex® / Cidex OPA® recommended

AFT12 Tubing (22 mm)

Smooth bore tubing for use in 22 mm breathing circuits. (1.8 meter length, 22 mm ID)

FACEMASKS, FACEMASK ACCESSORIES

AFT10 Disposable Adult Facemask

These mouthpieces connect to 22 mm breathing circuits. Connects directly to the AFT1, AFT22 non-rebreathing T-valve, SS11LA/TSD117 airflow transducer (via AFT11B coupler) or SS11LB/TSD117A airflow transducer (via AFT11H coupler). Includes hook-ring to secure AFT10S adjustable head strap. (22 mm ID/25 mm OD)

MRI Use: MR Safe

AFT10 Facemask Components: Thermoplastic Elastomer, Polyvinyl Chloride (PVC) Plastic

AFT10S Adjustable Head Strap

This fully adjustable latex head strap holds the AFT10 disposable facemask securely to the subject's head. Use one or more straps to securely fasten the mask.

MRI Use: MR Safe

AFT10S Head Strap Components: Latex Rubber

AFT25 Facemask with Valve

This adult facemask with integral non-rebreathing T valve is a high performance, very low dead space, low airflow resistance mask and valve; suitable for high airflow 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 35 mm OD, 28 mm ID

MRI Use: MR Safe

AFT25 Facemask Components: Mask: Thermoplastic Elastomer, Valve: Acetal Plastic, Acrylic Plastic, Aluminum (nickel plated silver,) Elastomer, Nylon, Thermoplastic Polyester, Polycarbonate Plastic, Silicone Rubber, Stainless Steel, Polysulfone Plastic

Headgear: Fabric with Velcro® straps

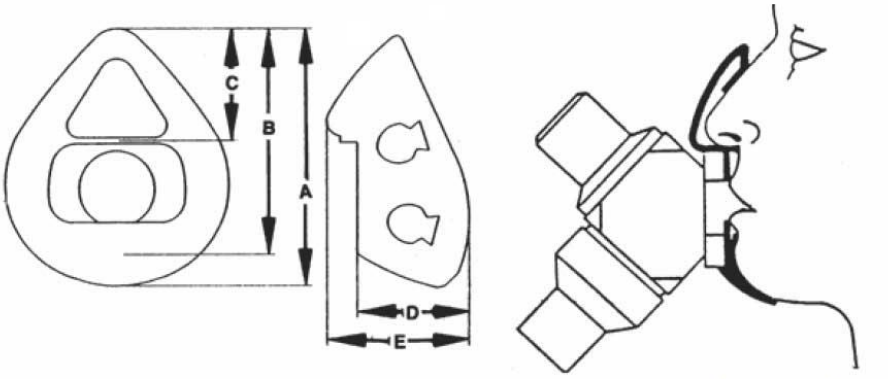
AFT25 Accessories—Masks and Cap

Airflow mask and cap accessories for the AFT25 adult facemask:

- **Masks** do not include T-valve. Available in small, medium, or large. To use, remove the valve and adapter from the original AFT25 mask and then attach them to the T-valve on the new mask via the valve adapter that is part of the AFT25 mask.

  Mask Part Numbers: **RX-AFT25-SMALL, RX-AFT25-MEDIUM, RX-AFT25-LARGE**

MOUTH BREATHING MASK FACE PIECE DIMENSIONS



Part #	Size	A Inch (mm)	B Inch (mm)	C Inch (mm)	D Inch (mm)	E Inch (mm)
RX-AFT25-LARGE	Adult Large	5.3 (134.6)	4.8 (122.7)	2.4 (61.2)	2.0 (50.8)	3.0 (74.9)
RXAFT25-MEDIUM	Adult Medium	4.9 (125.2)	4.5 (113.0)	2.2 (54.6)	2.0 (50.8)	2.7 (67.3)
RX-AFT25-SMALL	Adult Small	4.6 (117.6)	4.2 (117.6)	1.9 (47.5)	2.0 (50.8)	2.6 (66.6)

GUIDELINES FOR MASK FIT:	
Adult Large	Large Adult
Adult Medium	Large Adolescent to Medium Adult
Adult Small	9 Years to Small Adult

- **Cap** does not include mask or T-valve. Cap includes cap, straps and clips for the AFT25 mask. Design ensures the mask has a secure fit to the subject's face and head, overcoming the problem of slipping during active or long-term setups, as with exercise physiology or sleep studies. Cap fits all three mask sizes.

  Cap Part Number: **RX-AFT25-CAP**

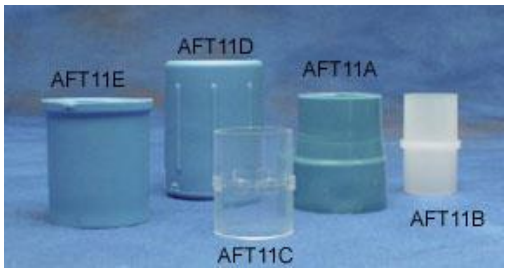
Need a complete facemask with integral non-rebreathing T-valve? See our AFT25 high performance, very low dead space, low airflow resistance mask and valve; suitable for high airflow applications (e.g., exercise physiology).

MRI Use: MR Safe (see AFT25 Specifications on previous page for components)

COUPLERS

MRI Use: MR Safe

AFT11 Series Coupler Components: Thermoplastic Rubber, Polyvinyl Chloride (PVC) Plastic, Polycarbonate Clear Plastic, Acrylonitrile Butadiene Styrene (ABS) Thermo-molded, Plastic



AFT11A Flexible **AFT11C** Rigid **AFT11E** Flexible **AFT11H** Flexible
AFT11B Rigid **AFT11D** Flexible **AFT11F** Flexible

These couplers are very useful for connecting a variety of airflow port IDs and ODs to transducers, tubing, and calibration syringes. Pick an AFT11 Series coupler that matches the port sizes to be interfaced.

AFT11 Series Coupler Guides

Coupler	Couples	Interface
AFT11A	25 mm OD/35 mm ID	AFT6A to AFT1
AFT11B	15 mm OD/22 mm ID	AFT10 to SS11LA
AFT11C	22mm OD/22 mm OD	AFT22 to AFT20
AFT11D	35 mm OD/35 mm ID	AFT27 to SS11LB
AFT11E	22 mm OD/35 mm ID	AFT7 to AFT22/25
AFT11F	35 mm OD/45 mm OD	SS52L to GASSYS3 or GASSYS2
AFT11H	35 mm OD/28.6 mm ID	AFT10 to SS11LB

Item 1	Item 2	Coupler
15 mm OD	22 mm ID	AFT11B
20 mm OD	22 mm ID	AFT11B
22 mm ID	15 mm OD	AFT11B
	20 mm OD	AFT11B
22 mm OD	22 mm OD	AFT11C
	25 mm ID	AFT11C
22-25 mm OD	22 mm OD	AFT11E
	25 mm ID	AFT11E
25 mm ID	22 mm OD	AFT11C
	25 mm ID	AFT11C

Item 1	Item 2	Coupler
25-30 mm OD	25-30 mm OD	AFT11A
	28-35 mm ID	AFT11A
28-35 mm ID	25-30 mm OD	AFT11A
	35 mm ID	AFT11A
34-37 mm ID	41-47 mm ID	AFT11F
35 mm ID	28-35 mm ID	AFT11A
	38 mm ID	AFT11E
35-38 mm ID	22-25 mm OD	AFT11E
35-38 mm OD	35-38 mm OD	AFT11D
35 mm OD	28.6 mm OD	AFT11H

Note the AFT11I coupler for connecting the AFT26 2.0 Liter Calibration Syringe to the SS11LA airflow transducer was discontinued in September of 2019. To connect an existing AFT26 syringe to the SS11LA, use the following connections:

AFT26 + AFT11D + AFT11E + AFT11B + SS11LA

AFT301 INLINE COUPLER FOR O_2 SENSOR

This inline coupler has a threaded port to fit the Galvanic Oxygen Sensor (RX301; included in TSD301) and ends that fit 22 mm smooth bore tubing (such as AFT12). The coupler is ideally suited for ventilator testing and interfaces with the patient tubing that connects to the ventilator outlet.

This inline coupler is used to ensure that the O_2 sensor is exposed to full flow in breathing or ventilator circuits, as when the TSD301 is added to the Ventilator Validation Kit (VVK100-SYS) for high-speed oxygen concentration (% Oxygen) measurements—synchronized with flow cycling.

Total length: 76.2 mm Port: M16-1 tapped hole

Ends: 31.75 mm OD Material: Delrin® Acetal Resin

AFT160 COUPLER WITH PRESSURE TAP

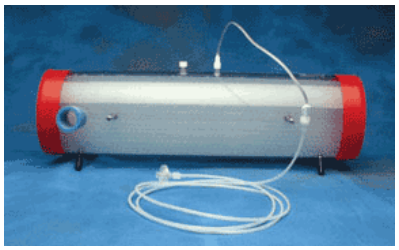
The AFT160 15 mm OD, 22 mm ID Pressure Tap coupler mates one connection with a 15 mm OD and a second connection with a 22 mm ID connection along with a 3.175 mm barb that allows the flow through the connection to be tapped for various purposes. This tap may be used to mate directly with any of the TSD160 series pressure transducers for monitoring pressure in an airflow circuit as well as other compatible amplifiers such as the O2100C and CO2100C. It is directly compatible with the Fluke lung.

This pressure tap is recommended for use with the TSD160 Series Differential Pressure Transducer and VVK100-SYS Ventilator Validation Kit measurement accessories.

AFT302 TAP INTERFACE FOR AIRFLOW OR HUMIDITY

The AFT302 allows for a tap into a standard 22 mm ID airflow circuit to use a TSD302 temperature transducer or a TSD 304 humidity sensor to modify the values directly within the airflow stream. This tap may be used to measure and properly adjust values to STPD conditions. This unit is recommended for any users who require STPD corrections using the TSD302 temperature or the TSD304 humidity sensors.

AFT15 MIXING CHAMBERS



AFT15A/B mixing chambers incorporate dual baffles and flexible connection ports capable of interfacing with 35 mm or 22 mm breathing circuits.

Two female Luer connection ports are provided between the baffles for the simultaneous monitoring of O_2 and CO_2 concentrations.

AFT15A shown with AFT20 (not included)

AFT15A — 5 Liter

Use for demanding expired gas analysis measurements (e.g. VO_2 or RER measurements).

Dimensions: 13 cm (dia) x 47 cm (long) Coupling Ports: 35 mm OD, 25 mm ID

AFT15B — 8 Liter

Use for very high volume and rate expired gas analysis measurements (e.g. VO_2 or RER measurements).

Dimensions: 13 cm (dia) x 73 cm (long) Coupling Ports: 35 mm OD, 25 mm ID

MRI Use: MR Conditional to 3T

Condition: Mixing Chambers AFT15 (5 liter) and AFT15B (8 liter) can be placed in chamber room, where gas sampling lines to CO2100C and O2100C are directed through chamber to control room waveguide parts.

AFT15/15B Mixing Chamber Components: Aluminum; Stainless Steel; Nylon plastic; Vinyl; Polypropylene; Low-density polyethylene; Butyrate.

GAS SAMPLING INTERFACE KITS

AFT20

Use to interface the CO2100C and the O2100C modules with the TSD107B or TSD117A Airflow Transducer breathing circuits.

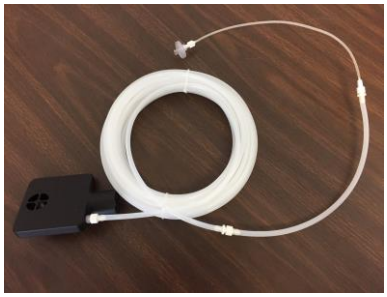
Includes: 1.8 meters of 1.5 mm inner diameter semi-flexible polyethylene tubing with M/F Luer connector; 30 cm Nafion® water vapor permeable tubing with M/F Luer connector; 5 micron filter with M/F Luer connector; M/F Luer to female Luer "Y" connector.

The AFT20 connects the CO2100C or O2100C directly to the sampling port of a mixing chamber. The AFT20 also permits sampling connections to the Non-rebreathing "T" Valves (AFT21 or AFT22).

MRI Use: MR Safe

AFT20 Gas Sampling Kit Components: Tubing: 1.8 m of 1.5 mm diameter polyethylene tubing with M/F Luer; Tubing: 30 cm Nafion® water vapor permeable tubing with M/F Luer connector; Y-connector: Acrylonitrile butadiene styrene (ABS) polycarbonate

AFT31-MRI



(L) AFT31-MRI components – (R) connected to AFT35-MRI mouthpiece

This 3.175 mm ID tubing is 10 meters long with male and female Luer locks for direct connection with the AFT35-MRI T-valve gas sampling port, CO2100C module, and/or O2100C module. To use both CO2100C and O2100C modules simultaneously, a "Y" connector gas sampling interface adapter is included, along with two Nafion® Drying Tubes and two 17 mm 45 micron Hydrophobic Filters to prevent moisture buildup.

Notes:

- The 3.175 mm polyethylene plastic tubing can be cleaned with isopropyl alcohol. Isopropyl alcohol is not recommended for sterilization.
- Hydrophobic filters and Nafion® Drying Tubes are used to keep gas samples clean and dry as they enter the sensing chambers of oxygen and carbon dioxide modules. Nafion® tubing should be replaced when tubing becomes discolored, and filters should be replaced monthly.
    - Replacement Drying Tubes and Hydrophobic Filters are available in packs of 10. When reordering, request RX-AFT20-NAFION and RX-AFT20-FILTER.
- Humidity effects of tubing, filters, and module setup are discussed in the O2100C-CO2100C spec sheet for Gas Concentration Measurement Modules.

MRI Use: MR Safe

AFT31-MRI Gas Sampling Kit Components: Polyethylene, Polyvinyl Chloride Plastic, Polycarbonate Clear Plastic, Nafion® water vapor permeable tubing, hydrophobic filter

ID/OD: 3.175 mm (1/8") / 6.35 mm (1/4")	Type: Crack-Resistant Polyethylene Tubing
Maximum Pressure: 358 psi @ 21° C	Material: Linear Low Density Polyethylene
Operating Temperature Range: -73° to +79° C	Wall Thickness: 1.588 mm (1/16")
"Y" connector: 1 x male to 2 x female	Bend Radius: 51 mm (2")
Length: 10 m	Durometer: 95A (Firm)

AFT T-VALVES

AFT21 Non-Rebreathing "T" Valve: Female, 35 mm

AFT22 (top left), **AFT21** (top right)
AFT20 (bottom)

High performance, very low dead space, low airflow resistance valve, suitable for high airflow applications (e.g. exercise physiology). The non-rebreathing "T" valve incorporates a Female Luer connector gas sampling port for interfacing with the AFT20. All ports are 35 mm OD, 30 mm ID.

Includes: 35 mm OD coupler

Requires: AFT4, AFT7, and AFT9 for proper operation.

AFT22 Non-Rebreathing "T" Valve: Male, 22 mm

Very low dead space valve, suitable for low to medium airflow applications. The non-rebreathing "T" valve incorporates a Male Luer connector gas sampling port for interfacing with the AFT20. Coupler ports are 22 mm OD fittings. Common port incorporates a 15 mm ID connection. Dead space 20 cc. Resistance: 0.29 cmH_2O at 5 liter per minute flow, 0.65 cmH_2O at 10 liter per minute. Single subject disposable item **– do not autoclave**. Includes: 22 mm OD coupler

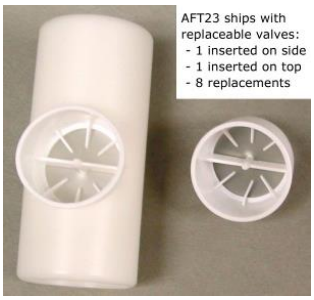
Requires: AFT1 and AFT2 for proper operation.

Includes: 22 mm OD coupler *Requires*: AFT1 and AFT2 for proper operation.

MRI Use: MR Safe

AFT21/22 T-Valve Components: Acrylic Plastic, Elasotomer, Polycarbonate Clear Plastic

AFT23 Non-Rebreathing T-Valve, 35 mm



The AFT23 is a disposable paper mouthpiece featuring a one-way valve for pulmonary function measurements (expiratory only). It provides low air resistance, adds cross-contamination protection, and is strong and durable. It ships with eight extra valves. Mouthpiece OD: 35 mm. Fits AFT1 + AFT2 pulmonary function filter & mouthpiece set.

MRI Use: MR Safe

AFT23 T-Valve Components: Acrylic Plastic, Elasotomer, Paper

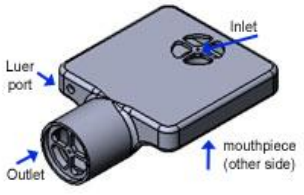
AFT35-MRI

The AFT35-MRI is a low-profile mouthpiece and non-rebreathing T-valve assembly specifically designed to fit inside an fMRI head coil.

NOTE: Although fit is fine with 32 channel head coils, a shortening (cut via snips) of the flexible snorkel mouthpiece may be required to encourage a better fit for 20 and 64 channel head coils.

Use the AFT35-MRI to perform the following airflow and lung volume tests:

- End Tidal CO_2
- VO_2 max
- Breath-by-breath Air Flow
- Breath-by-breath Volume
- Metabolic Studies



The assembly includes a female Luer lock connection for direct connection to AFT31-MRI gas sampling tubing for CO_2 and O_2 gas analysis. The Luer port has a removable male Luer sealing cap for when gas sampling is not used.

The AFT35-MRI also interfaces with AFT7/7-L tubing, via the AFT11A coupler, for operation with the TSD117A-MRI ±300 L/min airflow transducer. Extra mouthpiece included.

For the AFT31-MRI, 3.175 mm ID tubing at 10 meters, the gas sensing delay will be approximately 47.1 seconds, assuming 100 ml/min total gas sampling flow rate. This delay includes 0.6 seconds additional, due to gas module internal sampling and 30 cm NAFION tubing.

Low clearance – only 25 mm between subject and coil

Dimensions: 25 mm breathing port height (excluding mouthpiece) x 35 mm outlet port diameter x 83 mm wide x 115 mm long

Deadspace: 88 ml

Sterilization: Cidex® / Cidex OPA® recommended

RX-AFT35-MOUTH

The RX-AFT35-MOUTH is a low profile liquid silicone mouthpiece replacement for the AFT35-MRI non-rebreathing T-valve assembly.

MRI Use: MR Safe

AFT35-MRI Sample Setups

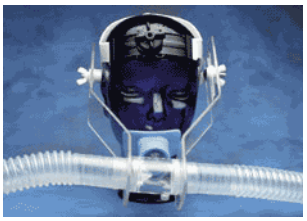
Perform a variety of tests. Place transducer outside the bore in the MRI Chamber Room and run tubing to connect to the subject and breathing accessories; place amp in Control Room.

- **End Tidal CO_2:** CO2100C amp + AFT31-MRI tubing + AFT35-MRI airflow interface
- **Airflow & Lung Volume:** DA100C amp + MECMRI-DA cable/filter set + TSD117A-MRI transducer + AFT1 filter + AFT7L tubing + AFT11A coupler +AFT35-MRI
- **Airflow & Lung Volume with End Tidal CO_2:** DA100C + MECMRI-DA + TSD117A-MRI + AFT1 filter + AFT7L tubing + AFT11A + AFT35-MRI + AFT31-MRI + CO2100C
- **Metabolic:** DA100C + MECMRI-DA + TSD117A-MRI + AFT1 filter + 2 x AFT11A + 2 x AFT7L + AFT35-MRI + AFT31-MRI + AFT15A/B + CO2100C and/or O2100C

MRI Use: MR Safe

AFT35-MRI Components: Polyvinyl Chloride (PVC) plastic, Polyethylene EVA Copolymer, Thermoplastic Rubber, Polycarbonate Plastic, Acrylic Plastic, Elasotomer, Paper, Latex Rubber, Polyurethane Foam Plastic, Acrylonitrile Butadiene Styrene (ABS) Thermo-molded

AFT24 Head Support



The AFT24 head support is used when breathing directly into the AFT21 non-rebreathing T valve for exercise physiology measurements. The AFT21 is secured directly in front of the subject and minimizes the strain associated with the weight of valves and tubing.

TUBING FOR GAS SAMPLING

AFT30 Series Tubing and M/F Luer Locks

Use this semi-flexible 1.5 mm tubing with male and female Luer locks to interface with the RX110 self-inflating pressure pad, TSD114 response/hand force pump bulb, or gas sampling ports on AFT15 mixing chambers, CO2100C module, or O2100C module. *See AFT31-MRI for gas sampling in the MRI.*

Assuming a gas sampling module (CO2100C/O2100C) flow rate of 100 ml/min, the following approximate delays will be introduced as a function of tubing length:

AFT30: 1.8 m length, 1.5 mm ID – 2.5 seconds*

AFT30-L: 4 m length, 1.5 mm ID – 4.8 seconds*

AFT30-XL: 10 m length, 1.5 mm ID – 11.1 seconds*

*These delays include 0.6 seconds additional – due to gas sampling module internal tubing and 30 cm NAFION tubing.

MRI Use: MR Safe

AFT30 Series Gas Sampling Kit Components: 1.5 mm diameter polyethylene tubing with M/F Luer

Part Summary for Typical Airflow / Gas Analysis Applications

Pulmonary Function

Part #	**High Flow** *Exercising human*	**Med. Flow** *Resting human*	**Low Flow** *Child, Pig, Dog*	**Very Low Flow** *Small Animals*
AFT2 Mouthpiece		X		
AFT3 Noseclip	X	X		
AFT6A Calibration Syringe	X	X	X	
AFT7/7L Tubing	X (2)			
AFT9 Mouthpiece	X			
AFT21 T Valve	X			
AFT24 Head Support	X (optional)			
AFT36 Mouthpiece	X			
AC137 In-line Transformer				
DA100C Amplifier	X (2)	X	X	X
TSD107B Pneumotach (High)	X (2)			X
TSD117A Pneumotach (Med.)		X		
TSD127 Pneumotach (Low)			X	
TSD137 A-E Pneumotachs (Very Low)				X (by size)

Part Options: AFT25 = AFT21 + AFT9 + AFT3 + optional AFT24
AFT2 + AFT3 = AFT0 + AFT11B

Exercise Physiology

Part #	**Mixed Expiratory Gases**		**Breath-by-Breath**		
	High Flow *Exercising human*	Med. Flow *Resting human*	High Flow *Exercising human*	Med. Flow *Resting human*	Low Flow *Dog*
AFT6A Calibration Syringe	X	X	X	X	X
AFT7 Tubing	X (2)		X		
AFT10 Facemask		X		X	
AFT10S Head Strap		X		X	
AFT11 Series Couplers		X (3)*		X	X (2)**
AFT12 Tubing		X (2)		X	
AFT15A Mixing Chamber	X	X			

AFT20 Interface Kit	X (2)	X (2)	X (2)	X	X (2)
AFT22 T Valve		X		X	X
AFT25 Facemask w/Valve	X		X		
DA100C Amplifier	X	X	X	X	X
CO2100C CO_2 Module	X	X	X	X	X
O2100C O_2 Module	X	X	X	X	X
TSD107B Pneumotach (High)	X		X		
TSD117A Pneumotach (Med.)		X		X	
TSD127 Pneumotach (Low)					X

Part Options: AFT25 = AFT21 + AFT9 + AFT3 + optional AFT24
AFT10 + AFT10S = AFT2 + AFT3 + AFT11C

* use 2 AFT11B and 1 AFT11C
** use 1 AFT11B and 1 AFT11C

See also: AFT coupler guide for additional applications.

AFT Series Cleaning & Disinfection

All AFT components, with the exception of filters, will hold up to liquid and gas sterilization as specified in this document.

The following disinfectants are recommended for LIQUID "COLD" sterilization of BIOPAC transducers:

- **Cidex® / Cidex® OPA** Disinfectant Solution, Johnson & Johnson
- **Perform®** Powder Disinfectant Concentrate, Schülke & Mayr
- **Terralin®**, Liquid Disinfectant Concentrate, Schülke & Mayr

Always follow the manufacturer's directions.

Recommended gas-based method:

- Low temperature, **Ethylene Oxide (EtO)** gas sterilization

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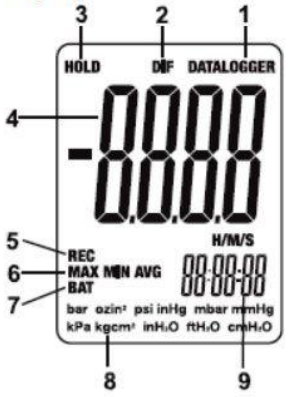
AFTCAL-160 Technical Info and Specifications

Display



1. USB data output active
2. Differential Pressure Mode
3. Data Hold Mode
4. Primary display
5. Record Mode
6. MAX/MIN/AVG indicators
7. Low Battery Indicator
8. Pressure unit of measure
9. Elapsed Timer

Meter Description

1. P1 input
2. AC adaptor jack
3. P2 Input
4. LCD Display – Indicates the measurement data, unit of measure, elapsed timer, and function symbols as described in this manual
5. USB PC interface jack (3.5mm) – For use with data acquisition software
6. UNIT button – Press to select the unit of measure
7. DIF button– Press to display differential pressure. Also used to OFFSET the displayed readings.
8. RECORD button– Press to access the MIN/MAX/AVG recording mode
9. HOLD / ZERO button– Press to freeze the displayed reading. Also used to zero the display (press and hold until display shows all zeroes).
10. BACKLIGHT button – Press to switch the display backlight ON. The backlight will automatically turn OFF after 40 seconds.
11. POWER button – Press to turn the meter ON or OFF
12. Battery compartment (on rear)

Specifications	Range	Resolution	Basic Accuracy
inH_2O	55.40 inH_2O	0.01 inH_2O	±0.3 FS
psi	2 psi	0.001 psi	±0.3 FS
mbar	137.8 mbar	0.1 mbar	±0.3 FS
kPa	13.78 kPa	0.01 kPa	±0.3 FS
inHg	4.072 inHg	0.001 inHg	±0.3 FS
mmHg	103.4 mmHg	0.1 mmHg	±0.3 FS
$Ozin^2$	32 $ozin^2$	0.01 $ozin^2$	±0.3 FS
ftH_20	4.616 ftH_20	0.001 ftH_20	±0.3 FS
cmH_2O	140 cmH_2O	0.1 cmH_2O	±0.3 FS
$Kgcm_2$	0.140 $kgcm_2$	0.001 $kgcm_2$	±0.3 FS
bar	0.137 bar	0.001 bar	±0.3 FS
Dimensions/Weight	210 mm x 75 mm x 50 mm (8.2” x 9” x 1.9”), 280 g (9.8 oz)		

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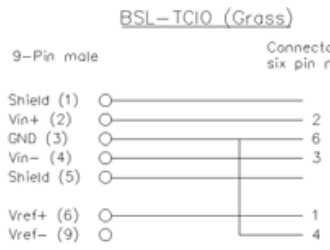
TRANSDUCER CONNECTOR INTERFACES (TCI)

BSL-TCI0 Interface Grass
BSL-TCI1 Interface Beckman 5 pin
BSL-TCI2 Interface WPI
BSL-TCI3 Interface Lafayette
BSL-TCI4 Interface Honeywell
BSL-TCI5 Interface Mod Phone
BSL-TCI6 Interface Beckman
BSL-TCI7 Interface Nihon Koden
BSL-TCI8 Interface Narco 7
BSL-TCI9 Interface Fukuda
BSL-TCI10 Interface Gould: *discontinued*
BSL-TCI11 Interface Hugo Sachs
BSL-TCI12 Interface Thornton
BSL-TCI13 Interface MP30 to Piezo
BSL-TCI14 Interface 1/4 phono
BSL-TCI15 Interface 5-pin DIN Vernier
BSL-TCI16 Interface BT connector, Vernier
BSL-TCI17 Interface 5-pin Intellitool
BSL-TCI18 Interface 2 mm Hg Strain
BSL-TCI19 Interface 6-pin Intellitool
BSL-TCI20 Interface 3.5 mm Intellitool
BSL-TCI21 Interface BNC pH probe
BSL-TCI22 Interface SS2L to SS39L

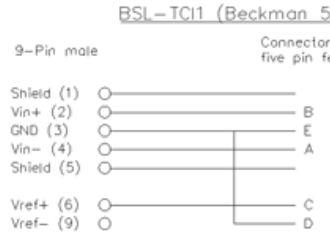
See also: SS-KIT-IN BSL/SS Custom Input Kit
SS-KIT-OUT BSL/SS Custom Output Kit

BSL-TCI PIN-OUTS

BSL-TCI0



BSL-TCI1



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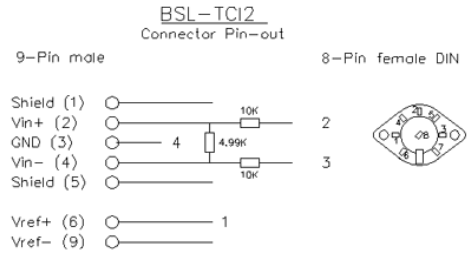
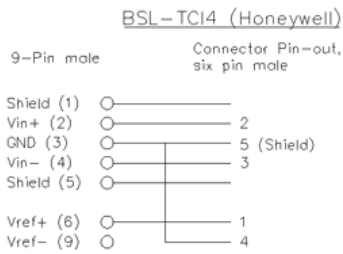
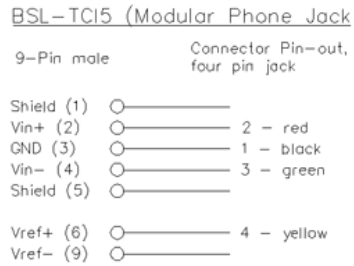


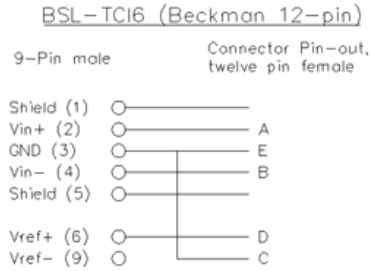
BSL-TCI4



BSL-TCI5



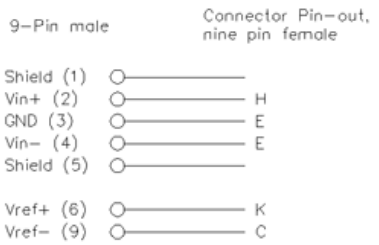
BSL-TCI6



BSL-TCI PIN-OUTS

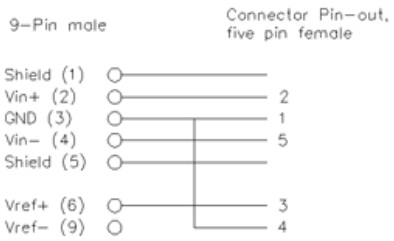
BSL-TCI3

BSL-TCI3 (Lafayette)



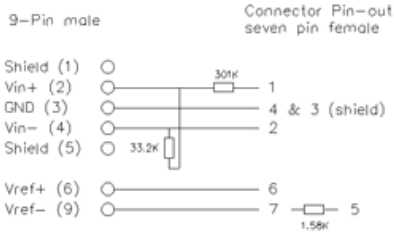
BSL-TCI7

BSL-TCI7 (Nihon Koden)



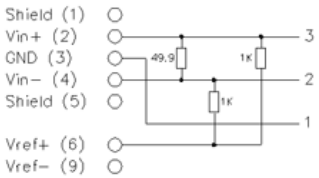
BSL-TCI8

BSL-TCI8 (Narco)



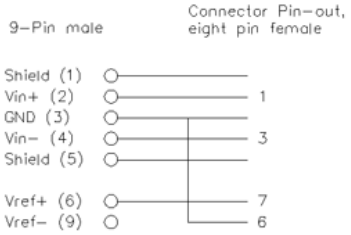
BSL-TCI14

BSL-TCI14 (Lafayette Phono)



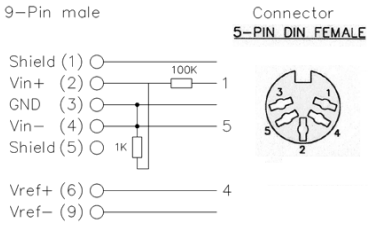
BSL-TCI9

BSL-TCI9 (Fukuda)



BSL-TCI15

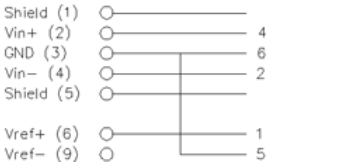
BSL-TCI15 (Vernier 5-Pin)



BSL-TCI10 Gould 12-pin: discontinued

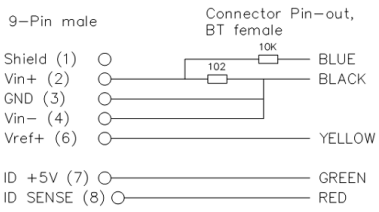
BSL-TCI11

BSL-TCI11 (Hugo Sachs-Harvard)



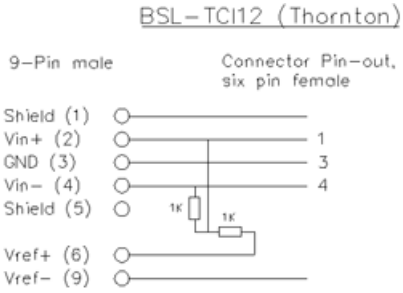
BSL-TCI16

BSL-TCI16 (Vernier Dissolved O2)



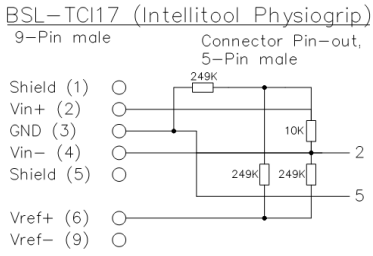
BSL-TCI12

BSL-TCI12 (Thornton)



BSL-TCI17

BSL-TCI17 (Intellitool Physiogrip)



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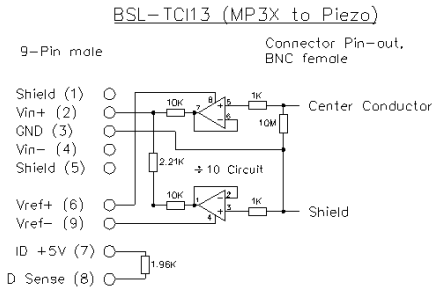
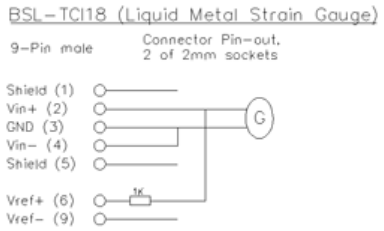
BSL-TCI PIN-OUTS

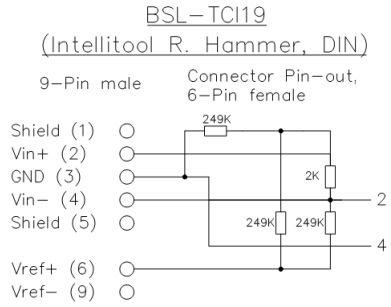
BSL-TCI13



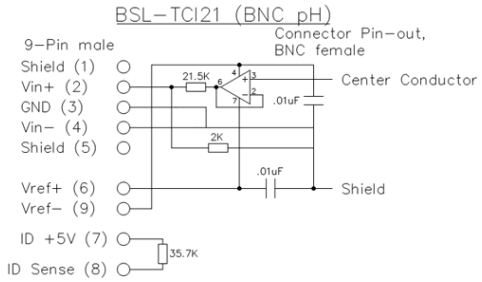
BSL-TCI18



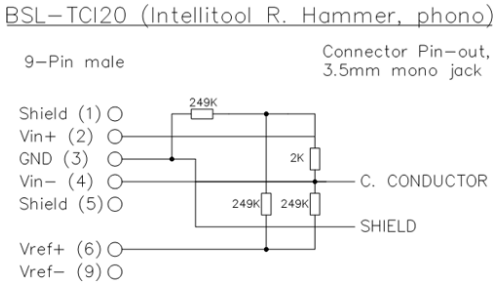
BSL-TCI19



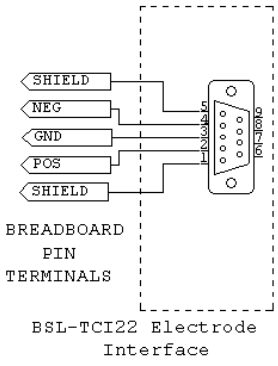
BSL-TCI21



BSL-TCI20



BSL-TCI22



BSL-TCI22 Electrode Interface

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INTERFACE SS2L TO BSL-BBOARD (BSL-TCI25)

Use the BSL-TCI25 interface cable to bring an analog signal from an SS2L series electrode lead set to a BSL Breadboard for circuit processing. One end has 3 x 25 cm wires with bare end labeled white VIN–, red VIN+ and black GND to interface with the breadboard; the other end terminates in a dSUB9 connector that attaches to an analog input on the MP36/5 unit.

BSL-TCI25 is used in BSL *PRO* Lesson H40: EMG-Controlled Robotic Arm and will be incorporated in future lessons.

Functionally, the BSL-TCI25 plays a similar role to the BSL-TCI22 adapter used in H25-26 (ECG Breadboard Lessons), but the added cable length reduces strain on the connector and allows the subject to use a greater range of movement when controlling the robotic arm.

TRANSDUCER ACCESSORY "TA" PACKS

The following "TA' Packs are suggested transducer accessories for any core package to increase the application potential of your lab. Each "TA" Pack allows you to perform the additional lessons listed—or create your own experiments. All items can be ordered individually.

Human Physiology TA—BSLHPY-TA

Includes this hardware

- Stimulation Electrode for Humans STMHUM
- Finger Twitch Transducer SS61L
- Reflex Hammer Transducer SS36L

Adds these lessons

- BSL L20 Spinal Cord Reflexes
- H03 Nerve Conduction Study
- H06 Finger Twitch
- H28 Reflex Response (patellar tendon)

Exercise Physiology TA—BSLEXP-TA

Includes this hardware

- GASSYS3 CO_2 & O_2 Gas Analysis Module (includes GASSYSMAIN 5-liter mixing chamber, AC power adapter, and options of US, EU, or China power cord)
- GASKIT3 Calibration Kit (includes RX3 Calibration Chamber, AFT27 Cal Syringe, AFT11D Coupler, AFT17 Regulator Barb Interface)
- AFT25 Facemask with integral non-rebreathing T-valve
- AFT7-L Smooth Bore Tubing x 2
- SS29L Multi-lead ECG Cable 12-lead
- SS31LA Impedance Cardiography Sensor (includes module with 4 x CBL204 Touchproof Y-adapter and 8 x LEAD110 Unshielded Lead)

Adds these lessons

- H01 12-Lead ECG
- H19 VO_2 & RER
- H29 Basal Metabolic Rate

Biomechanics TA—BSLEXM-TA

Includes this hardware

- Reflex Hammer Transducer SS36L
- Goniometer (twin-axis) SS21L
- Stimulation Electrode for Humans STMHUM
- Heel-Toe Strike Transducer SS28LA

Adds these lessons

- BSL L20 Spinal Cord Reflexes
- H03 Nerve Conduction Study
- H06 Finger Twitch
- H28 Reflex Response (patellar tendon)

Psychophysiology TA—BSLPSY-TA

Includes this hardware

- SuperLab Stimulus Presentation Pkg STP35W
- EL500-6 Disposable Snap Electrodes (150 pk)
- SS31LA Impedance Cardiography Sensor (includes module with 4 x CBL204 Touchproof Y-adapter and 8 x LEAD110 Unshielded Lead)

Adds these lessons

- H30 Stroop Effect
- H31 Pre-pulse Inhibition

Biomedical Engineering TA—BSLBME-TA

Includes this hardware

- Stimulation—choose items based on the lab's MP unit:
  - MP36: STMHUM or MP35: BSLSTMB + HSTM01 or MP30: BSLSTMBA + HSTMO1
- Impedance: SS31LA Impedance Cardiography Sensor with 4 x CBL204 Touchproof Y-adapter and 8 x LEAD110 Unshielded Lead and EL500-6 paired electrodes

Adds these lessons

- H03 Nerve Conduction Study
- H21 Impedance Cardiography

Pharmacology & Toxicology TA—BSLPHA-TA

Includes this hardware

- Tissue Bath Station

Adds these lessons

- A05 Visceral Smooth Muscle

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ROBOTIC ARM LAB SET (BSLBME-ROBOT-HW)

This kit includes all required hardware for building the EMG-Controlled Robotic Arm using BSL *PRO* Lesson H40 (set of 10 labs) and an existing MP36/35 Data Acquisition System with BSL Software (version 4.1.0 or higher).

- BSL-BBOARD BSL Breadboard
- BSL-GRIPKIT BSL Robot Gripper and Servos
- BSL-DEV-S BSL Development Board with Shield
    - TOOL1 Mini Screwdriver
- BSL-TCI25 (x 2) SS2L to Breadboard Interface Cable
- BSL-BMEACC1 BSL Breadboard H40 Accessories
- BSL-CLAMPSTAND Lab Ring Stand and Clamp
- EL504 Disp. Cloth electrode (2 packs of 30)
- WRAP1 Self-adhering wrap (7.5 cm x 4.5 m) Latex Free
- SS39LB Breadboard Signal & Power Cable High Z
- SS60LB Breadboard Inputs Cable High Z

Note: If your lab already has a BSL BME System or SS60LB Input Cable and SS39LB Signal & Power Cable, you can use the BSLBME-ROBOT-TA Accessories kit instead—it includes all of the components in BSLBME-ROBOT-HW except SS39LB and SS60LB. It can be used to add additional workstations…students build their own breadboard and then use shared SS39LB and SS60LB cables to power and test their build.

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ROBOTIC ARM LAB SET (BSLBME-ROBOT-TA)

This accessories kit provides additional hardware required for use with an existing BSL BME System to build the EMG-Controlled Robotic Arm using BSL *PRO* Lesson H40 (set of 10 labs) and an MP36/35 Data Acquisition System with BSL Software (version 4.1.0 or higher) for labs that also have SS39LB and SS60LB cables. BSLBME-ROBOT-TA includes all of the components in BSLBME-ROBOT-HW except SS39LB Signal & Power Cable and SS60LB Input Cable. It can be used to add additional workstations…students build their own breadboard and then use shared SS39LB and SS60LB cables to power and test their build.

- BSL-BBOARD BSL Breadboard
- BSL-GRIPKIT BSL Robot Gripper and Servos
- BSL-DEV-S BSL Development Board with Shield
    - TOOL1 Mini Screwdriver
- BSL-TCI25 (x 2) SS2L to Breadboard Interface Cable
- BSL-BMEACC1 BSL Breadboard H40 Accessories
- BSL-CLAMPSTAND Lab Ring Stand and Clamp
- EL504 Disp. Cloth electrode (2 packs of 30)
- WRAP1 Self-adhering wrap (7.5 cm x 4.5 m) Latex Free

Note: If your lab already does not already have a BSL BME System or SS39LB Signal & Power Cable and SS60LB Input Cable, you need the BSLBME-ROBOT-HW kit instead.

Updated: 8.28.2020

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ROBOTIC ARM LAB BME SYSTEM ADD-ON (BSLBME-ARM-TA)

BSL-GRIPKIT

BSL-DEV-S

BSL-CLAMPSTAND

If your lab has a BSL BME System (including MP36/35 Data Acquisition System and BSL Software version 4.1.0 or higher) or an SS39L Signal & Power Cable, you can add BSLBME-ROBOT-TA to be able to build the EMG-Controlled Robotic Arm using BSL *PRO* Lesson H40 (set of 10 labs).

Includes:

- BSL-GRIPKIT
- BSL-DEV-
- BSL-CLAMPSTAND

Note: These components are included in the BSLBME-ROBOT-TA kit. If your lab does not already have a BSL BME System or SS39LB Signal & Power Cable and SS60LB Input Cable, you need the BSLBME-ROBOT-HW kit instead.

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BSL ROBOT GRIPPER AND SERVOS (BSL-GRIPKIT)

This Robot Gripper with 2 x Robot Servos is used for the EMG-Controlled Robotic Arm created with BSL *PRO* Lesson Set H40 (10 labs).

- The two Servo motors are used in tandem to perform "twist" and "grasp" movements to manipulate objects with the gripper.
- The potentiometer is used to optimize robotic control for each student's unique EMG output. The potentiometer is easily accessed since the circuit board is separate from the motor.
- The servos can control the gripper to open to 3.3 cm (1.3″) from closed and can rotate the gripper approximately 180 degrees. A Phillips screwdriver is required for assembly. It also includes two clamp cushions that adhere to the inner sides of the gripper.
- Both motors use Pulse Width Control.
- The output shaft is supported on the bottom and top with bronze bushings and the potentiometer is indirect drive.

BSL-GRIPKIT is included in BSLBME-ROBOT-HW, BSLBME-ROBOT-TA, and BSL-BME-ARM-TA.

Servo Specifications:

Control System:	+Pulse Width Control 1500 usec Neutral
Required Pulse:	3-5 V Peak to Peak Square Wave
Operating Voltage:	4.8-6.0 V
Operating Temperature Range:	-20 to +60 Degree C
Operating Speed (4.8 V):	0.21 sec/60° at no load
Operating Speed (6.0 V):	0.16 sec/60° at no load
Stall Torque (4.8 V):	45.82 oz/in. (3.3 kg/cm)
Stall Torque (6.0 V):	56.93 oz/in. (4.1 kg/cm)
Operating Angle:	45° one side pulse traveling 400 usec
360 Modifiable:	Yes
Direction:	Clockwise/Pulse Traveling 1500 to 1900 usec
Current Drain (4.8 V):	8 mA/idle and 150 mA no load operating
Current Drain (6.0 V):	8.8 mA/idle and 180 mA no load operating
Dead Band Width:	8 usec
Motor Type:	3 Pole Ferrite
Potentiometer Drive:	Indirect Drive
Bearing Type:	Dual Oilite Bushing
Gear Type:	Nylon
Connector Wire Length:	11.81" (300 mm=11.81 in)
Dimensions:	See Schematics
Weight:	1.6 oz (45.5 g)

Gripper Specifications:

Max clamp width:	3.3 cm (1.3")
Size:	57 x 65 x 30 mm (2.24"x 2.56"x 1.18")
Weight:	25 g

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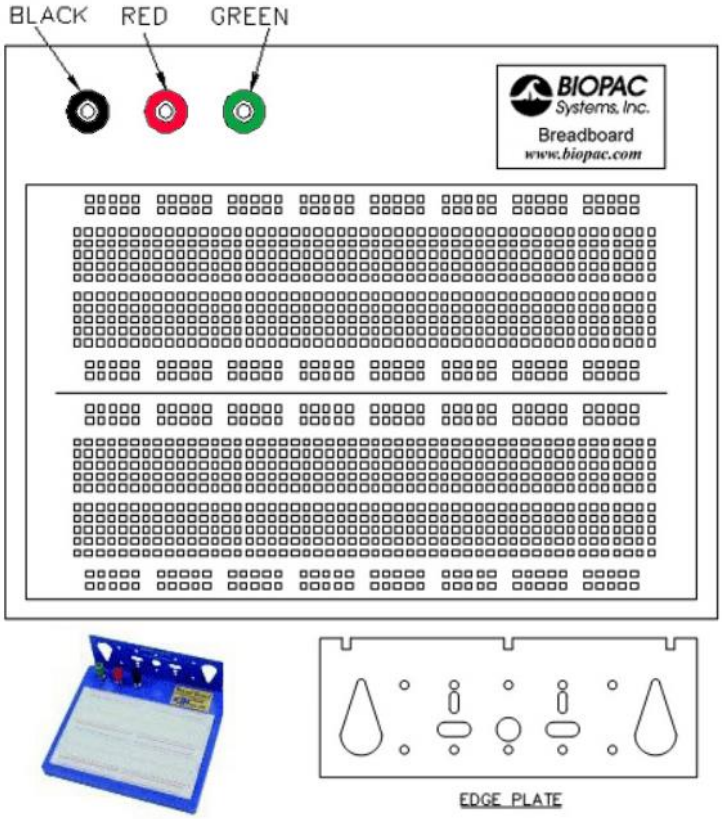
BSL BREADBOARD (BSL-BBOARD)



This breadboard is required for BSL *PRO* Biomedical Engineering Lessons, such as ECG Signal Processor Lesson Set H25-H26 and H40 EMG-Controlled Robotic Arm Lesson Set H40.

The breadboard is included in: BSL BME Systems, BSLBME-ROBOT-HW, and BSLBME-ROBOT-TA.

It is now offered separately from the BSL-BMEACC kit to allow instructors or students to replenish consumables (resistors, capacitors, ICs, and wire kit) without requiring an extra breadboard.

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BSL BREADBOARD H40 ACCESSORIES (BSL-BMEACC1)

This Breadboard Accessories Kit includes two jumper wire kits and all required capacitors, resistors, integrated chips, trimmers, and diodes for EMG-Controlled Robotic Arm using BSL *PRO* Lesson H40 (set of 10 labs). BIOPAC recommends purchasing a new BSL-BMEACC1 kit each time lesson set H40 is instructed since students cut and manipulate the wires and other various components.

Important! BSL Breadboard Accessory Kits are *not interchangeable*. BSL-BMEACC1 kit is compatible with the H40 Robotic Arm lab set and BSL-BMEACC must be used for the H25-26 QRS detector lab set.

Jumper wire kit x 2
Capacitors 10 µF Aluminum Electrolytic, 35 V 20%
Capacitor Ceramic 10000 PF 100 V 10% Radial
Multilayer Ceramic Capacitors MLCC – Leaded 4700 pF 50 V C0G 5%
Capacitor Film, 10000 PF 50 VDC Radial
Cap Film .22 uF 2% 63 V
Cap Film 0.47 UF 63 VDC Radial
Capacitor 50V 1uF Axial Ceramic C0G
Diode Small Signal Fast 100V 200 MA DO35
IC OPAMP GP 4 Circuit 14DIP
IC OPAMP QUAD 0-70DEG C 14-DIP
Resistor 19.6 K OHM 1/4W 1% Axial
Resistor Metal Film 1.00 KOHM 1/4W 1%
Resistor Metal Film – Through Hole 200 Kohms 1% 50PPM
Resistor 100 KOHM 1/4W 0.1% Axial
Resistor 2 KOHM 1/2W 1% Axial
Trimmer Potentiometer 100 KOHM 0.5 W TH
Resistor 10 KOHM 1/4W 0.1% Axial
Resistor 11.3 KOHM 1/4W 1% Axial
Resistor 22.6 KOHM 1/4W 1% Axial
Resistor Metal Film 100 KOHM 1/4W 1%
Resistor 46.4 KOHM 1/4W 1% Axial
Resistor , 10 KΩ 1% Metal Film, TH
Resistor 24.3 K OHM 1/4W 1% Axial
Resistor 11 KOHM 1/4W 1% Axial
Resistor 45.3 KOHM 1/4W 1% Axial
Resistor 4.99 K OHM METAL FILM .50W 1%
Resistor 237 KΩ 1/4W 1% Axial
Resistor 2 KOHM 1/4W 5% Axial
Resistor 12.1 KOHM 1/4W 1% Axial
Resistor 24.9 KOHM 1/4W 1% Axial
Resistor 14.3K OHM 1/4W 1% Axial
Resistor 1/4W 1% 28.7K

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BSL FNIR ACCESSORIES (BSL-FNIRACC)

The BSL fNIRS Accessory Pack provides items used in lesson F01: The fNIRS System and Oxygenation Changes Measured on the Forearm.

BSL-FNIRACC includes:

- 1 x Occlusion Band (39 cm)—Quick Release
- 1 x Hand Grip Exerciser—Tension Rating: 15 Kg (33 lbs)
- 1 x Coban Wrap (10 cm x 4.5 m)—Latex Free

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CLAMPSTAND FOR ROBOTICS (BSL-CLAMPSTAND)

This lab ring and clampstand can be used when building the EMG-powered robotic arm in the BSL *PRO* H40 Lesson Set. The base of the robotic arm consists of one lab ring stand and clamp, which holds two servo motors and a gripper (BSL-GRIPKIT) in place. The stand is a cast iron support ring stand with acid resistant finish. The platform is 20 cm x 30 cm (5" x 8") and the rod is 51 cm (20") tall. The clamp is a 3-prong finger style rubber-coated laboratory stand clip made of alloy steel.

One BSL-CLAMPSTAND is included in BSLBME-ARM-TA and BSL BME Systems. It may also be purchased separately.

The clamp is a 3-prong finger style rubber-coated laboratory stand clip made of alloy steel. BSL-CLAMPSTAND is included in BSLEMG-TA and BSLBME-W/M. It may also be purchased separately.

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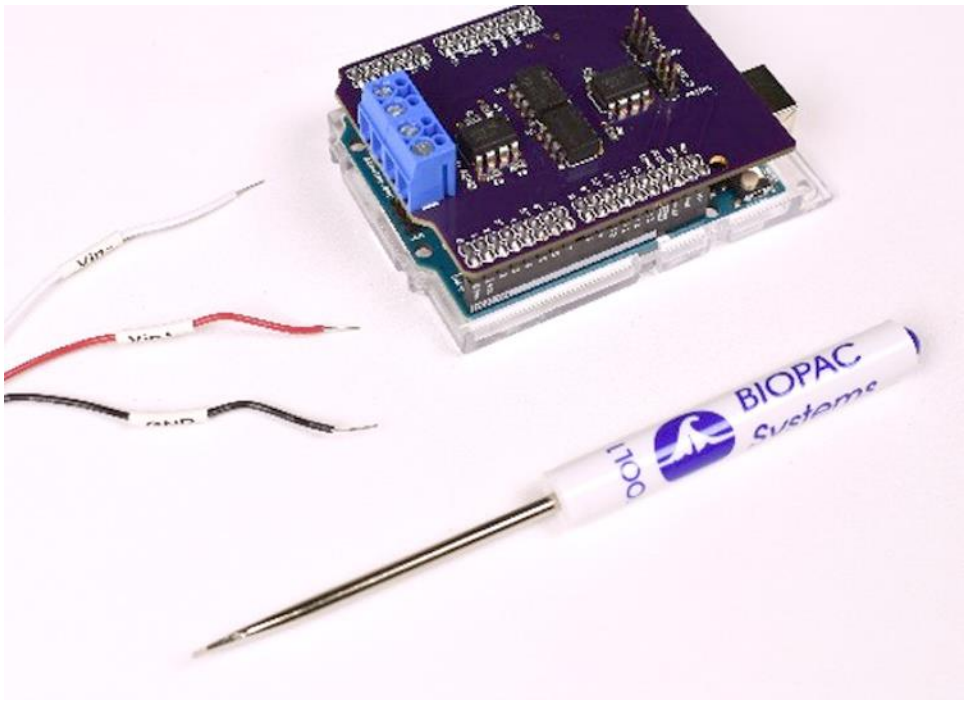
BSL DEVELOPMENT BOARD (BSL-DEV-S)



This Development Board with Shield is required for the overall system test in Lab 10 of the H40 EMG-Controlled Robotic Arm Lesson Set; a script and instructions for running the BSL-DEV-S are included in the lesson journal and lab protocol. The Development Board converts both EMG analog signals to PWM (pulse width modulation) digital signal, which drives each Servo motor. The shield provides optical isolation.

BSL-DEV-S includes a USB cable (CBLUSB) to provide power and for programming the development board.

The development board is a derived from Arduino but is not connected to Arduino; any tech support request must be directed to BIOPAC Support.

One BSL-DEV-S is included in BSLBME-ROBOT-HW and BSLBME-ROBOT-TA.

BSLCBL CABLE SERIES

BSLCBL1A: Stimulator to Nerve Chamber – Standard Banana Plug
BSLCBL2A: Stimulator to Nerve Chamber – 2 mm Pin (Mini-Banana) Plugs
BSLCBL3A: Nerve Chamber to BSL – Standard Banana Plugs
BSLCBL4B: Nerve Chamber to BSL – 2 mm Pin (Mini-Banana) Plugs
BSLCBL5: 3.5 mm Phone Plug
BSLCBL6: Stimulator to Output – 3.5 mm Mono Male Phone Plug
BSLCBL7: Stimulator to Electrode – BNC to 2x Alligator Clip
BSLCBL11: Stimulator to Electrode – BNC to 2x Electronic Test Clip (spring-loaded)
BSLCBL12: Stimulator to Electrode – BNC to 2x Toothless Alligator Clip
BSLCBL8/9: High Impedance – 1.5 mm Touchproof
BSLCBL14A: MP36/35 Input Adapter for Research Amplifiers

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

Length: 1.2 meters

Pin Plugs: 2 mm (OD)

Standard Banana Plugs: 4 mm (OD)

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.

Length: 1.2 meters

BSLCBL3A/4B Specs

Gain: 1/10 (divide by 10)

Input Impedance (single-ended and common-mode): 5e11 Ohms (500 GigaOhms)

Common-Mode Rejection: 90 dB Typical

Input Bias Current: 3 pA Typical, 100 pA

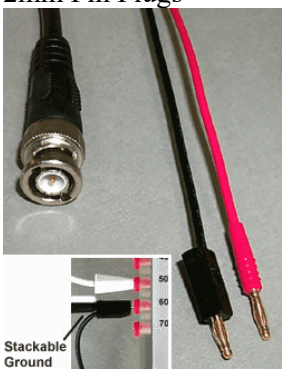
Maximum Voltage Noise: 1.3 µV p-p (0.1-10 Hz)

Voltage Noise Density: 36 nV /SQRT(Hz)

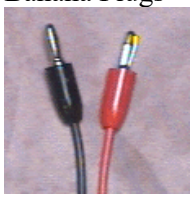
Current Noise Density: 0.01 pA /SQRT(Hz)

BSLCBL1A
Banana Plugs

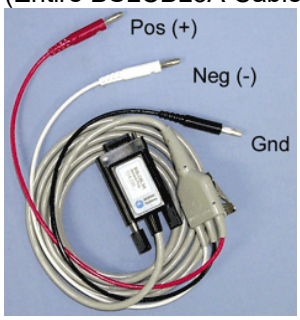
BSLCBL2A
2mm Pin Plugs



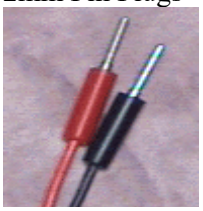
BSLCBL3A
Banana Plugs



(Entire BSLCBL3A Cable)



BSLCBL4B
2mm Pin Plugs



(Entire BSLCBL4B Cable)

3.5 mm Phone Plug Adapter

Use BSLSBL5, 1.7 meters (included with TSD122). The cable has a built-in attenuation of 1/200, which translates 10 V to 50 mV.

Stimulator to Output

Use BSLCBL6 to interface the BSL Stimulator with 3.5 mm Mono Phone Jack outputs, like the OUT100 Headphones or the OUT101 Tubephone set for auditory stimulation. Required for Auditory Evoked Response experiments. Use with OUT3 for MP36 built-in low voltage stim.

Length: 1.3 meters

BSLCBL5

3.5 mm Phone Plug

BSLCBL6

3.5 mm Mono Phone Jack

Stimulator to Electrode

BSLCBL7,

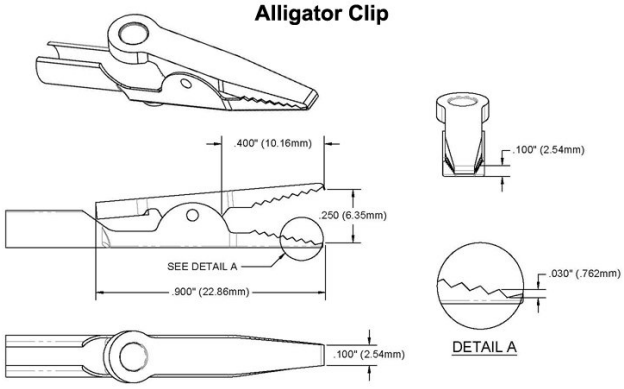
BSLCBL11, and

BSLCBL12

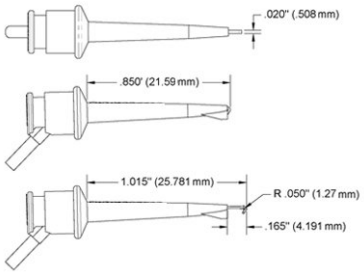
BSLCBL7 - BNC to 2x Alligator Clip
BSLCBL11 - BNC to 2x Electronic Test Clip (spring-loaded)
BSLCBL12 - BNC to 2x Toothless Alligator Clip

Use these special electrode lead clips 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 BSLSTM, SS58L Stimulator, or OUT3 for MP36 low volt stimulator and silver or platinum wire electrodes.

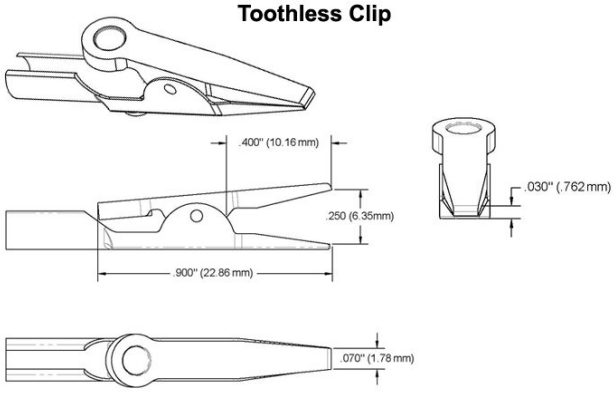
Alligator Clip



Retractable Clip



Toothless Clip



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 1.5 mm Touchproof electrode connectors to interface reusable electrodes (EL250, EL350, and EL450 series).

IMPORTANT: A ground connection, to the measurement point, is required when using BSLCBL8 or BSLCBL9. This connection is mandatory to allow the internal cable amplifiers to receive the required bias current. The ground connection is made from the center pin of the electrode lead attachment junction at the end of the cable to the preparation/animal/nerve under study.

Typically, a LEAD140 series lead, EL450 series needle electrode or LEAD110 series clip lead is used to establish this ground connection.

BSLCBL8/9 Specifications

Input Range:	BSLCBL8: MP36/36R: ±2 V, MP35: ±1 V, MP30: ±70 mV, MP46/45: ±2 V
	BSLCBL9: MP36/36R: ±3.8 V, MP35: ±3.8 V, MP30: ±700 mV, MP46/45: ±3.8 V

Input Impedance: 500 GigaOhm (Single-ended & Common-Mode)
Input Bias Current: 3 pA Typical, 100 pA Maximum
Maximum Voltage Noise: 1.3 µV p-p (0.1-10 Hz)
Voltage Noise Density: 36 nV /SQRT(Hz)
Current Noise Density: 0.01 pA /SQRT(Hz)
Cable length: 2 meters
Interface: MP3X (DSUB 9)
Gain: BSLCBL8 (Gain = 1), BSLCBL9 (Gain = 1/10)

MP36/35 Input Adapter for Research Amplifiers
BSLCBL14A

3.5 mm male phone plug adapter with built-in attenuation.

Provides a divide by 10 attenuation to scale the ±10 V signal range of BIOPAC's 100 series modules to the ±2 V (MP36) or ±1 V (MP35) device input ranges.

Interface with MP3X, MP4x or BIOPAC 100 series amplifiers through a connection to either the UIM100 or the IPS100C Isolated Power Supply. (Not compatible with MP30.)

CBL200 SERIES LEAD CONNECTOR CONVERSION CABLES

See also: Guide to *External Device Interfaces* for connections to common devices

CBL200 CBL200 consists of a 2 mm female socket leading to a 1.5 mm female Touchproof socket. This 10 cm extension is required when converting an old-style 2 mm pin electrode or transducer lead to a 1.5 mm Touchproof socket for connection to any of the 100C-series Biopotential or Transducer amplifiers or STMISO series modules. One CBL200 is required for each old-style 2 mm pin.

CBL201 CBL201 is a 2 mm male pin leading to a 1.5 mm male Touchproof pin and is 10 cm long. Use CBL201 to:

- Connect a female socket 1.5 mm Touchproof electrode lead to the DA100C amplifier.
- Connect a ground electrode lead (e.g. LEAD110A) to the UIM100C module—required when using the TSD150 active electrodes.
- Convert a 1.5 mm Touchproof female socket electrode or transducer lead to an old-style 2 mm pin, for connection to any of the 100B-series Biopotential or Transducer amplifier modules.

One CBL201 is required for each 1.5 mm Touchproof socket. *For MP36/35/46/45 Systems* CBL201 is used to update older model SS1L Shielded Lead Adapters.

CBL202 CBL202 consists of a female mono 6.3 mm (¼") phone socket leading to two 2 mm male pins. This multi-purpose adapter is 10 cm long and can be used to:

- Connect a 6.3 mm male mono phone cable to the digital I/O lines on the UIM100C.
- Connect microphones or signal sources that terminate in a 6.3 mm male mono phone plug to the DA100C.
- Connect the STM100C to nerve conduction chambers (CBL105 required).

CBL203 CBL203 consists of a female mono 6.3 mm (¼") phone socket leading to two female 1.5 mm Touchproof sockets and is 10 cm long.

CBL203 is primarily designed to connect YSI 400 series biomedical temperature probes to the SKT100C temperature amplifier, but it can also be used to connect male mono 6.3 mm (¼") phone plug terminated cables or transducers to 100C-series Biopotential or Transducer amplifiers.

- Blue heat shrink = tip of ¼" mono connector, Black = sleeve of ¼" mono connector.
- Connect to SKT100C Vin+ and Vin– ports (either socket to either port); thermistors do not make electrical contact so GND is not required for safety.
    - If using a 3rd-party probe with metal casing, the ground lead from the probe can be connected to SKT100C GND.

CBL204

CBL204 consists of a single female 1.5 mm Touchproof socket leading to two male 1.5 mm Touchproof pins and is 25 cm long.

CBL204 plugs into any 100C series Biopotential amplifier input or STMISO series stimulator output and provides two sockets to connect to electrode leads terminating in a 1.5 mm Touchproof "Y" electrode lead adapter.

This 1.5 mm Touchproof "Y" electrode lead adapter is required when multiple electrode sites are to be connected to a single amplifier input or stimulator output.

Multiple CBL204s can be plugged together to reference three or more electrode leads to the same input or output.

CBL204-MRI

This "Y" cable is functionally identical to the CBL204 but designed for use in the MRI environment when referencing two or more electrodes to a single biopotential amplifier input. Primarily used for NICO (noninvasive cardiac output) measurements in the MRI. Two 1.5 mm Touchproof male inputs to one 1.5 mm Touchproof female input, cable length 5 cm.

MRI Use: MR Conditional to 9T

Components: Carbon composition, tin plated and gold plated brass connectors

- For two or more amplifier inputs to one electrode, use JUMP100C-MRI; two 1.5 mm Touchproof female to one 1.5 mm Touchproof male—MRI equivalent of JUMP100C.

CBL205

CBL205 is a 1.5 mm Touchproof male to female 1.5 mm AC-coupled electrode lead adapter and is 10 cm long. One end of the adapter plugs into the ground on the biopotential amplifier and the other end accepts the electrode lead. (LEAD110)

Use CBL205 when more than one ground is required while recording EDA (electrodermal activity) and other biopotential(s).

CBL205-MRI

CBL205-MRI is functionally identical to CBL205 but designed for recording in the MRI or fMRI environment.

- MR Safe carbon composite construction
- 16.5 cm long with 7.6 mm diameter
- Plugs into LEAD108B/C

CBL205/CBL205-MRI: To record EDA with other biopotential signals (ECG, EEG, EOG, EGG, EMG, ERS), BIOPAC recommends using CBL205/CBL205-MRI connected to one ground on any of the biopotential amplifiers. The subject will be grounded through the Vin- of the EDA electrodes, but in some cases, it is necessary to have more than one ground; in such cases, use an AC-coupled lead adapter (CBL205/CBL205-MRI) to prevent galvanic ground loops.

For example, if—while recording a biopotential and EDA—the EDA electrode is removed during a stage of the experiment, you will want to maintain ground for the biopotential. To always have a ground and no ground loops: connect the Vin- lead of the EDA as ground and connect an AC-coupled ground to the biopotential amplifier GND.

Safety Note—If using any two EDA100C modules at the same time on the same MP System, ground loops can be a problem due to non-isolation between module excitation currents. A solution is to record with one module connected to a separate IPS100C/D and AMI100D/HLT100C, and the remaining module to the MP System. Use OUTISO signal isolators to connect the first module outputs (via AMI100D/HLT100C) to the UIM100C on the MP System side.

CBL206

Lead junction TPF to 4X TPM. Reference four electrodes from one. Connect via the MEC110C to the NICO100C and EBI100C cardiac output amplifier modules.

CBL207 1 m, BNC (m) to 2 x 1.5 mm TP (m).

Use with:

- 1.5 mm Touchproof (f) electrodes
- STM200 Unipolar Pulse Stimulator Module
- MECMRI-STIMISO cable/filter system to connect to STM200 in the MRI control room

CBL229 ~3 cm, RJ11 to Touchproof female socket adapter

Allows a ground lead (such as LEAD110 or LEAD110A) to be connected to the subject if active electrodes TSD150A or TSD150B are being used when no other wired ground is present.

Safety Note—This adapter is required if only active electrodes are being used and no other wired signals are being recorded; if there is another C-series biopotential amplifier that has a ground connection to the subject, this adapter is not required.

CBL231-MRI

This adapter is an MR Safe carbon composite radio translucent electrode lead that connects a non-ferrous 2 mm pin to a Touchproof 1.5 mm female connector, 46 cm (18”) long.

Use for tDCS systems in an fMRI environment or connecting other MR Safe electrodes and cables that use a 2 mm socket interface.

MR Conditional: Use during fMRI or MRI scanning sequences (including multi-band) up to 7T.

CBL237

The **Smart Amp Output "Y" Adapter** allows for the signals from a 100D-Series Smart Amplifier connected to either an AMI100D or an IPS100D to be sent to other equipment. An RJ12 cable plugs into either the AMI100D or IPS100D, the Smart Amplifier to one port of the adapter, and either an OUTISOA for connecting signals to mains powered equipment or another cable if Unisolated connections are needed (such as CBL123).

Works with 100D-Series Smart Amplifiers, 100C-Series Amplifiers, BioNomadix Receivers, STP100C Isolated Digital Interface, or the STM100C Stimulator Module as part of an MP160 Research System.

Important: Only one Smart Amplifier should be connected to the adapter at a time. Connecting more than one Smart Amplifier to a single channel input is not supported.

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CBLUSB

USB CABLE

2.5 meter replacement USB cable connects the MP3X to a USB port. Includes and provides EMI protection to maintain BSL Systems certified safety rating (CE, EMC).

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EXTENSION CABLES

CBLEXT Serial Extension Cable

Use this 3.6 meter extension cable to increase the distance between the MP100 or MP30 and your computer. The CBLEXT is used to extend the length of CBLSERA (use only one CBLEXT per MP100 or MP30 System).

CBLHLT1 Phono Plug Extension Cable

Use this 7.6 meter extension cable with phono connectors for

- AMI100D/HLT100C high level transducer module.
- NIBP100D Noninvasive Blood Pressure System (cable included) between the TCI105 and NIBP100D connector.

OXY100E-200 EXT Pulse Oximeter Extension Cable

Use this 3 meter extension cable to increase the distance between SpO_2 transducers (TSD124 Series *human* or TSD270 Series *veterinary*) and an OXY100E or OXY200E SpO_2 Amplifier.

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HSTM01 HANDHELD HUMAN-SAFE STIMULATING PROBE

IMPORTANT!

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

WARNING!

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

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/B.

HSTM01 SPECIFICATIONS

Safety Switch:	Yes (Push button)
Lead Length:	3 meters
Connector Type:	BNC Male
Interface:	BSLSTMA/B

Stimulating Electrodes:

Material: Stainless	steel
Diameter: 8	mm
Spacing: 2.54	cm
Max Pulse Width:	1000 µsec
Min Pulse Width:	100 µsec

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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.)

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 the ground; a generic electrode can be used for ground.
- Requires one LEAD120 per electrode.

IMPORTANT: GEL should immediately be cleaned off the electrodes after each use. Dried gel will act as an insulator decreasing electrical contact with the skin, and the Ag-AgCl electrode disk could degrade quickly with time because of the porous electrode surface.

To clean the electrodes

1. Wet a cotton swab or toothbrush with water and remove the electrode gel.
   - If needed, use Hydrogen Peroxide solution (2-3%) to brighten electrode surface (optional) or to sterilize the electrode; do not place the electrode in solution, but rather use a cotton swab or toothbrush.
2. Always dry the electrodes after cleaning.
3. If a dark residue remains after the above cleaning methods are used, then a cleaner with pumice can be used on the wetted cotton swab or toothbrush.

Warning! Use of a Waterpik® or similar jet will drastically shorten the life of these electrodes and is not recommended.

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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.)

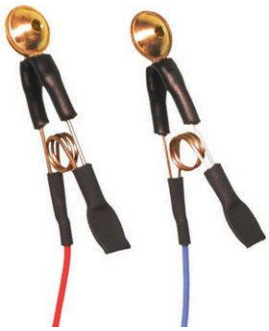
EL160 Gold Cup

Reusable gold cup electrode with 10 mm cup diameter and 1.2 m cable. One electrode per package.

- EL160 with green cable
- EL160-R with red cable
- EL160-W with white cable

The leadwire terminates in a standard 1.5 mm Touchproof connector. Use with MEC Series Module Extension Cables for MP160/150 Systems or SS1LA 1.5 mm Touchproof Electrode Lead Adapter for MP3X Systems.

EL160-Ear – Ear Clip Electrodes



This pair of gold-plated ear clip electrodes has 1.5 m silicone-insulated leadwires ending in standard 1.5 mm Touchproof connectors.

Use with MEC Series Module Extension Cables for MP Research Systems or SS1LA 1.5 mm Touchproof Electrode Lead Adapter for BSL Systems.

Before use, check the electrode for damage and excessive wear. If in doubt, replace it.

Also available as individual standard gold cup electrodes: EL160 with green cable, EL160-R with red cable, and EL160-W with white cable.

Please do not use these electrodes unless you have been trained in the proper use and placement of these devices.

Cleaning Earclips and Surface Electrodes

After each use clean with warm water and a mild detergent. Use a soft cloth or Q-tip. Then disinfect with 70% alcohol or a water based disinfectant. Do not soak in water for prolonged periods, it causes deterioration of the electrode.

EL160-Ear Specifications

Electrodes:	two
Material:	Au Cup (gold plated discs)
Style:	Ear Clip Electrodes
Leadwires:	1.5 meter silicone-insulated leadwires
Connector:	leadwires terminate in standard 1.5 mm Touchproof connectors
Non-sterile	
Reusable	

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ELECTRODES

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

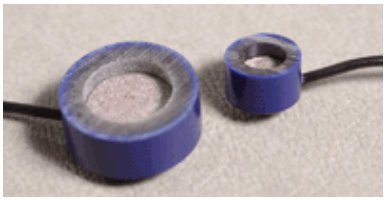
1) Electrode site is dry and free of excessive hair.
2) Electrode is not placed over scar tissue or on an area of established erythema or with a lesion of any kind.
3) Skin is properly prepared. (Prepare the skin at the electrode site. Use the ELPAD to lightly abrade the skin surface. Use a brisk dry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

EL250 Series Reusable Ag-AgCI Electrodes

EL250 Series reusable electrodes incorporate a variety of features which improve biopotential recordings.

- Non-polarizable
- Sintered to increase electrode/electrolyte contact area
- Does not require chloriding
- Reusable via resurfacing
- High stability recordings, to DC, when used with chloride salt gel electrolyte
- Electrolyte gel cavity reduces artifact due to electrolyte/electrode motion and minimizes electrolyte dissipation/drying over long term recordings

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 1.5 mm female Touchproof sockets for direct connection to the SS1L shielded electrode lead adapter (MP3x System), or the MEC110C (MP160/150 System). Use shielded electrode leads for minimal interference. The unshielded electrode leads work best as ground electrodes. Typically, one biopotential input requires 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 m lead terminated with a 1.5 mm female Touchproof socket for connection to the SS1L (MP3x System), or the MEC110C (MP160/150 System).

EL254S Ag-AgCl Shielded Electrode, 7.2 mm diameter housing, 4 mm contact area, includes 1 meter lead terminated with two 1.5 mm female Touchproof sockets for connection to the SS1L (MP3x System), or the MEC110C (MP160/150 System). 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 1.5 mm female Touchproof socket for connection to the SS1L (MP3x System), or the MEC110C (MP160/150 System).

EL258S Ag-AgCl Shielded Electrode, 12.5 mm diameter housing, 8 mm contact area, includes 1 meter lead terminated with two 1.5 mm female Touchproof sockets for connection to the SS1L (MP3x System), or the MEC110C (MP160/150 System). The gray lead plug is for the electrode contact; the black lead pin plug is for the lead shield.

EL258H Features a 2 mm gel injection hole, useful for EEG monitoring; use as both recording and reference electrodes. 12.5 mm diameter housing, 8 mm contact area, 1 m lead terminated with 1.5 mm female Touchproof socket for connection to the SS1L (MP3x System), or the MEC110C (MP160/150 System).

EL250 Series Radiotranslucent Ag-AgCI Recording Electrodes (Animals Only)

MRI Use: MR Conditional (tested to 9T)

Condition: For use with animals only, due to possible heating hazards associated with incomplete filling of gel reservoir with electrode gel.

EL254RT/258RT Components:

Electrode: Ag/AgCl	Lead wire: Carbon
Enclosure: Epoxy	Wire insulation: PVC

EL254RT Silver-silver chloride (Ag-AgC1) electrodes provide accurate and clear transmission of surface biopotentials. Reusable electrodes are permanently connected to robust and pliable leadwires. The leadwires terminate in standard 1.5 mm Touchproof connectors for interfacing to 100C series Biopotential modules or extension cables. 7.2 mm diameter housing, 4 mm contact area, includes 1.5 m lead terminated with a 1.5 mm female Touchproof socket for connection to the SS1L (MP3x System), or the MEC110C (MP160/150 System).

EL258RT As described above for EL254RT but with larger dimensions. 12.5 mm diameter housing, 8 mm contact area, includes 1.5 m lead terminated with 1.5 mm female Touchproof socket for connection to the SS1L (MP3x System), or the MEC110C (MP160/150 System).

√ All EL250 Series electrodes require adhesive disks (ADD200 series) and recording gel (GEL1 or the 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.

IMPORTANT: GEL should immediately be cleaned off the electrodes after each use. Dried gel will act as an insulator decreasing electrical contact with the skin, and the Ag-AgCl electrode disk could degrade quickly with time because of the porous electrode surface.

To clean the electrodes

1. Wet a cotton swab or toothbrush with water and remove the electrode gel.

- If needed, use Hydrogen Peroxide solution (2-3%) to brighten electrode surface (optional) or to sterilize the electrode; do not place the electrode in solution, but rather use a cotton swab or toothbrush.

2. Always dry the electrodes after cleaning.
3. If a dark residue remains after the above cleaning methods are used, then a cleaner with pumice can be used on the wetted cotton swab or toothbrush.

Warning! Use of a Waterpik® or similar jet will drastically shorten the life of these electrodes and is not recommended.

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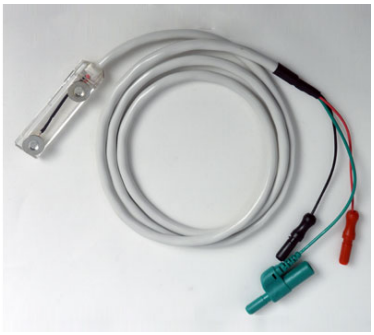
EL350 SERIES BAR LEAD ELECTRODES

EL350



EL350S

EL351

Bar lead electrodes are recommended when applying a stimulus or recording a signal during nerve conduction, somatosensory or muscle twitch recordings with human subjects. All bar electrodes are nonferrous and consist of two tin electrodes placed 30 mm apart in a watertight acrylic bar; leads terminate in standard 1.5 mm Touchproof connectors. The bar configuration permits easy electrode placement without disturbing electrode- to-electrode spacing.

EL350 **concave** unshielded bar lead electrode for use with the STMISO

EL350S **concave** shielded bar lead electrode for biopotential recordings

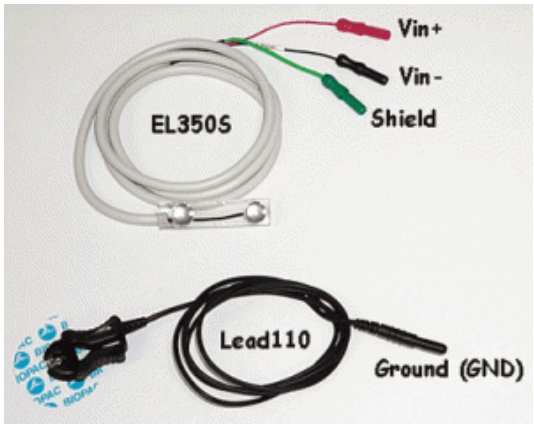
EL351 **convex** bar lead electrode for stimulating

Use with MP160/150 System for recording or stimulation:

- Direct connection to any 100C-series Biopotential amplifier, STMISOLA stimulator, or STMISOC/D/E stimulus isolation adapters
- Interface via CBL201 1.5 mm Touchproof to 2 mm pin cable holder to 100A/100B-series amplifiers or STMISOA/B

Use with MP36 or MP36R

- Recording: interface via SS1LA
- Stimulation: interface via CBL207 1.5 mm Touchproof to BNC cable to STM200 or BSLSTMB Stimulators



When using bar electrodes for signal recording, a single ground lead (LEAD110 with EL503) is required.

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

1. Electrode site is clean 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.)
4. Apply a small amount of isotonic or hypotonic gel to the skin at the electrode sites. BIOPAC GEL100 or GEL101A is recommended.

EL350 SERIES SPECIFICATIONS

Electrode spacing:	30 mm	
Lead length:	EL350 and EL351: 61 cm	EL350S: 91 cm
Connector type:	1.5 mm TouchProof	

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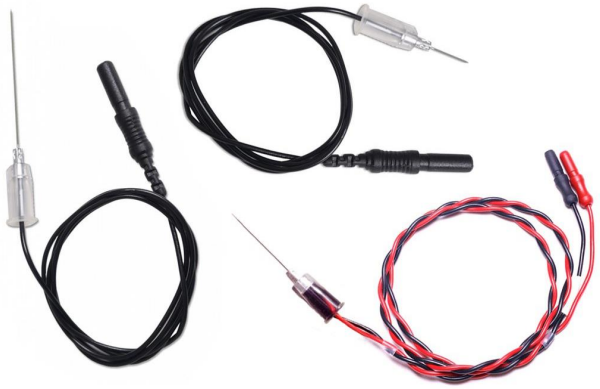
EL450 SERIES NEEDLE ELECTRODES



EL450 Series (L to R): EL450, EL452, EL451

Unipolar and Concentric Bipolar Needle Electrodes

Use these stainless steel needle electrodes for stimulation or recording in animal subjects and tissue preparations.

EL450 37 mm x 26g Teflon coated unipolar needle electrode with 61 cm lead

EL451 25 mm x 30g Teflon coated concentric bipolar electrode with 91 cm lead

- Disposable PTFE coated stainless steel needle electrodes have a super-flexible PVC insulated leadwire ending with a standard touch proof connector.
- Teflon coated needle electrodes are fully insulated, with a clear Teflon overcoat, except for the conductive needle tip. The coating prevents the needle from making contact with the subject except at the very tip of the needle, which is exposed.
- For applications that require better contact between the electrode and the subject to record a good signal, abrade the needle to remove the Teflon coating.

EL452 12 mm x 28g unipolar needle electrode with 61 cm lead

- Disposable uncoated (no Teflon) stainless steel ground reference needle electrodes have a super-flexible PVC insulated leadwire ending with a standard touch proof connector.

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

Suggested Use

- When recording from a single site (e.g., studies of individual muscle fibers), use one EL451 electrode plus one EL452 ground electrode.
- For general-purpose recording (e.g., ECG), use a pair of EL450 or EL452 electrodes, plus one EL452 ground electrode.
- For stimulation, use a pair of EL450 or EL452 electrodes.

Interface Notes

Research System Users: CBL201 is required for connection to older model 100A/100B-series amplifiers or STMISOA/B.

Education System Users: Use SS1LA, BSLCBL8, or BSLCBL9 to interface the MP3X data acquisition unit.

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EL500 SERIES – DISPOSABLE ELECTRODES

Usage Descriptions - 500 Series Disposable Ag/AgCl electrodes:

EL500: Dual high adhesion, high conductivity, low artifact, biopotential electrodes

EL501: High adhesion, high conductivity, low artifact, biopotential electrode

EL502: Long-term recording, high adhesion, low artifact, biopotential electrode

EL503: General purpose, economical, high conductivity, biopotential electrode

EL504: Long-term recording, moderate adhesion, high compliance, low artifact, gentle, biopotential electrode

EL506: Strip electrodes discontinued in December 2018. Replaced with EL516 or EL526.

EL507: Electrodermal activity measurement electrode*

EL508: MR Conditional electrode for general-purpose use – use only with LEAD108 series leads

EL509: MR Conditional electrode for electrodermal activity measurement – use only with LEAD108 series leads

EL510: MR Conditional electrode and lead set for general-purpose use

EL512: Small (2.54 cm) electrode, easy on the skin for infant applications

EL513: Disposable cloth electrode designed for recording EMG or ECG for sleep and facial applications

EL516: Disposable carbon film strip electrodes, high conductivity, bioimpedance electrode

EL526: MR Conditional electrode for bioimpedance – MR Conditional only with MECMRI Extension Cables

The EL500 Series disposable, Ag/AgCl 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 time use only.

Use the EL500 series electrodes with a wide range of BIOPAC electrode leads and cables, such as SS1L, SS1LA, SS2L, SS2LA, SS2LB, LEAD108 series, Lead 110 series, Lead 110S series or any BIOPAC lead or electrode lead cable assembly indicated for use with snap electrodes.

Electrode Properties – Electrolyte Gel and Chloride Salt Concentration

For electrode gels (electrolytes), the higher the chloride salt content, the more conductive the electrode. Higher salt content, pre-gelled, surface electrodes are useful for making fast, high quality measurements of biopotentials, once the electrodes are applied to the skin surface. In addition, wet (liquid) gels further accelerate this process because the electrolyte migrates into the skin surface layers more easily and rapidly. High conductivity electrodes generally have reduced artifact, due to the low generated impedance between electrode and skin surface.

As the chloride salt content of the electrolyte drops, the less conductive the electrode. As the chloride content drops to 10% or less, then the electrode can be increasingly employed for long-term recording (greater than 2 hours), with reduced chance for skin irritation. In addition, hydrogels are gentler on the skin than wet (liquid) gels of the same salt concentration. Hydrogel based electrolytes will not migrate into the skin surface as easily or rapidly as with wet gels.

For Electrodermal activity measurements it's important to use an electrode with similar (isotonic) chloride salt content as per the skin surface, so as not to hypersaturate or hyposaturate the eccrine glands.

The impedance of the electrode/skin junction is highly dependent on the electrolyte type and the chloride salt concentration. For example, a hydrogel electrode with 4% chloride concentration will have about 10x higher impedance than a wet liquid gel electrode with 10% chloride concentration, after first application to the skin.

Electrode Properties – Backing Adhesive

The 500 series disposable electrodes come with a range of adhesive qualities. All electrodes are designed to adhere well to skin surfaces, but the adhesion characteristics can be grouped depending on the application.

The three adhesive groups are identified as follows:

Group 1: strong adhesive

Group 2: moderate adhesive, high tack

Group 3: moderate adhesive, low tack

Strong adhesive electrodes are best for biopotential measurements when the subject is moving. Moderate adhesive electrodes are optimal for long-term recordings. Lower tack electrodes can be repositioned and are best suited for delicate skin surfaces.

Skin Preparation

For highest electrode to skin conductivity, the skin should be lightly abraded with a gentle abrasive wipe, such as BIOPAC's ELPAD*. An alcohol wipe is not recommended, to improve conductivity, as this will only serve to dry out the skin surface. Lightly abrading the top layer of the epidermis will effectively remove dead skin cells and prepare the skin site to establish a high conductivity path, once the gelled electrode is applied.

After application, the electrode can be verified for robust galvanic connection to the skin via impedance checking. BIOPAC's EL-CHECK can be used to measure the impedance between any two applied surface electrodes. Because each electrode/electrolyte junction forms a half-cell, impedance measurements are more accurately measured at some frequency resident in the band of biopotentials. EL-CHECK operates by injecting a 3.5 uA rms constant current of 25 Hz through the electrodes undergoing impedance check. The complete series impedance loop, including both electrodes/skin junction and coupling body impedance, is reported. Ideally, the reading should be 10,000 ohms or less (approximately 5000 ohms per electrode). In practice, BIOPAC biopotential amplifiers are very tolerant of electrode/skin impedances, even higher than 50,000 ohms. However, the highest quality recordings will always be accompanied by electrode/skin impedance junctions of 10,000 ohms or less.

***IMPORTANT:** **Do not abrade the skin** when using EL507 electrodes for electrodermal activity. Learn more about EDA Subject Prep.

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Electrode Chloride Salt Content and Adhesive Backing

Disposable Electrode Ag/AgCi	Chloride Salt %	Electrode Backing Adhesive
EL500	10% (wet gel)	Strong
EL501	10% (wet gel)	Strong
EL502	4% (hydrogel)	Moderate, high tack
EL503	7% (wet gel)	Moderate, high tack
EL504	4% (hydrogel)	Moderate, low tack
EL507	0.5% (wet gel)	Strong
EL508	10% (wet gel)	Moderate, high tack
EL509	n/a: dry electrode – use any gel	Strong
EL510	4% (hydrogel)	Moderate, low tack
EL512	n/a: dry strip electrode – use GEL 100 or 101	Moderate, low tack
EL513	4% (hydrogel)	Moderate, low tack
EL516	4% (hydrogel)	Moderate, low tack
EL526	4% (hydrogel)	Moderate, low tack

Wet (liquid) electrolyte

The chloride salt content in WET gel electrodes from BIOPAC varies:

- 10% is used for short term applications such as resting ECG or stress test
- 7% is a more universal gel and can be used short term for most subjects, though some react long term
- 4% is a long-term, monitoring gel used for more than 24 hours
- 0.5% in electrodermal activity (EDA) electrodes

Hydrogel (solid) electrolyte

The chloride salt content in all hydrogel, solid electrolyte, electrodes from BIOPAC is 4%. This universal gel can be used short and long term, and is suitable for adult and infants.

Duration

BIOPAC does not recommend for applications running more than 24 hours.

Irritation Factors

Possible skin irritation can result from the gel or the adhesive on the tape backing of the electrode. To reduce the potential for skin irritation, choose an electrode which has lower electrolyte chloride content, reduced tape backing skin adhesion and electrolyte is hydrogel-based. Overall, the least impactful skin electrodes are the EL504, EL510, EL512 and EL513.

Note About 2% of the population will react to any adhesives and gels put on a skin, regardless of composition or concentration. Internal body fluids are about 0.9% chloride salt. Skin sweat is typically 0.1% to 0.4% chloride salt.

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PART	Electrode Description
EL500 Dual Electrodes	Paired, pre-gelled, electrodes: The fixed spacing between the contacts of these dual electrodes are useful for general-purpose EMG measurements, electrical stimulation, bioimpedance and cardiac output studies. Hypo-allergenic, wet liquid gel electrolyte (10% chloride salt). These electrodes incorporate a gel cavity (16 mm diameter, 1.5 mm deep) situated between electrode and skin surfaces that helps reduce motion artifact. Dual Ag/AgCl electrode conductors: 11 mm diameter, 95 mm^2 conductive contact area, 41 mm spacing (center to center) mounted on 41 mm x 82 mm, moisture resistant, latex free, 1.5 mm thick foam tape with strong adhesive.
EL501 Stress Test Electrodes	Small stress test, pre-gelled, 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. Hypo-allergenic wet liquid gel electrolyte (10% chloride salt). These electrodes incorporate a gel cavity (16 mm diameter, 1.5 mm deep) situated between electrode and skin surfaces that helps reduce motion artifact. Single Ag/AgCl electrode conductor: 11 mm diameter, 95 mm^2 conductive contact area, mounted on 40 mm diameter, moisture resistant, latex free, 1.5 mm thick foam tape with strong adhesive.
EL502 Long-term Recording Electrodes	Small, pre-gelled, electrodes. Most appropriate for long-term (> 2 hours) biopotential measurements. Hypo-allergenic, hydrogel, solid, electrolyte (4% chloride salt) that adheres well to skin, but leaves no residue when removed. Single Ag/AgCl electrode conductor: 11 mm diameter, 95 mm^2 conductive contact area mounted on 41 mm diameter, moisture resistant, latex free, vinyl backing tape (0.12 mm thick) with moderately strong adhesive. The hydrogel base also lends these electrodes to electrical stimulation studies, such as for nerve conduction velocity or tDCS.
EL503 **General-purpose electrode**	Small, pre-gelled, electrodes: These economical electrodes are most suitable for general purpose, short-term recordings. The small diameter permits relatively closely-spaced biopotential recording. Hypo-allergenic wet liquid gel electrolyte (7% chloride salt). Single Ag/AgCl electrode conductor: 11 mm diameter, 95 mm^2 conductive contact area mounted on 35 mm diameter, moisture resistant, latex free, vinyl backing tape (0.12 mm thick) with moderately strong adhesive.

PART	Electrode Description
EL504 High Flexibility Electrodes	Small, pre-gelled, electrodes. Most appropriate for long-term (greater than 2 hours) biopotential measurements. Hypo-allergenic, hydrogel, solid, electrolyte (4% chloride salt) that adheres well to skin, but leaves no residue when removed. Single Ag/AgCl electrode conductor: 11 mm diameter, 95 mm^2 conductive contact area mounted on a cloth-based, 2.5 cm x 2.5 cm porous, latex free, backing fabric tape (0.2 mm thick). Particularly useful for applications on non-conforming surfaces, such as the face for EMG or fingers for nerve conduction studies. The electrodes are very comfortable and conform easily to a great variety of skin surfaces. These are optimal electrodes for facial EMG recording, due to gentle adhesion, high flexibility, cloth base and low potential for skin irritation. These electrodes are useful for general ECG, EMG and sleep studies. The hydrogel base also lends these electrodes to electrical stimulation studies, such as for nerve conduction velocity or tDCS. These latex-free, hypo-allergenic, electrodes adhere well to the skin, can be repositioned and are suitable for long term use with minimal irritation.
EL507 EDA Electrodes	Designed for electrodermal activity (EDA) measurements and are pre-gelled with isotonic gel. Isotonic gel is recommended for EDA measurements to establish physiological ionic equivalency to the skin surface. The electrodes conform and adhere well to a variety of skin surfaces. Typically, they are applied around fingers to create a firm bond. Also, these electrodes are very suitable for attachment to the palm of hand, wrist, toes or sole of foot. These electrodes incorporate a gel cavity (16 mm diameter, 1.5 mm deep) situated between electrode and skin surfaces that helps to stabilize measurements and reduce motion artifact. Wet Gel: 0.5% chloride salt (isotonic,) Electrode Contact Diameter: 11 mm, Electrode Contact Area: 95 mm^2, Size: 27 mm x 36 mm, Backing: 1.5 mm thick foam, latex free
EL508 MRI General-Purpose Electrodes	These disposable, radio-translucent electrodes are pre-gelled. Use with LEAD108 series. ***MRI Use:*** MR Conditional ***Condition:*** Up to 7T, any scanning sequence. Up to 9T on animals. Use with LEAD108 series only. Electrode contact type: Ag/AgCl laminated on carbon composition plastic snap, Wet Gel: 10% chloride salt, Electrode Contact Diameter: 11 mm, Electrode Contact Area: 95 mm^2, Vinyl Tape Backing: 41 mm diameter, 0.12 mm thick, latex free ***EL508 Components:*** Substrate: Tape with medical grade adhesive, Label: Bi-Oriented Polypropylene (BOPP) or Vinyl, Stud: 40% Carbon-filled ABS plastic, Eyelet: 20% glass-filled ABS plastic coated with Ag/AgCl, Reticulated foam: Polyester-polyurethane, Gel: 10% chloride salt wet liquid gel electrolyte

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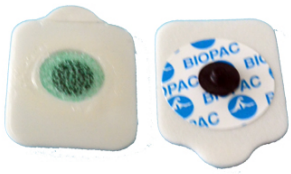
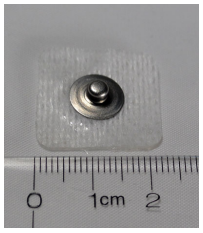
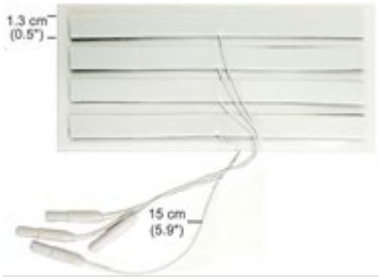
PART	Electrode Description
EL509 MRI EDA Electrodes	These disposable, radio-translucent, dry electrodes have a very long shelf-life and are ideal for electrodermal activity (EDA) measurements. They are content and dimensionally equivalent to the EL507 series electrodes, but with carbon composition snap and gel-free. Use with LEAD108 and isotonic electrode gel - GEL101A recommended for EDA. Isotonic gel is recommended for EDA measurements to establish physiological ionic equivalency to the skin surface. The electrodes conform and adhere well to a variety of skin surfaces. Typically, they are applied around fingers to create a firm bond. Also, these electrodes are very suitable for attachment to the palm of hand, wrist, toes or sole of foot. These electrodes incorporate a gel cavity (16 mm diameter, 1.5 mm deep) situated between electrode and skin surfaces that helps to stabilize measurements and reduce motion artifact. ***MRI Use:*** MR Conditional ***Condition:*** Up to 7T, any scanning sequence. Up to 9T on animals. Use with LEAD108 series only. Electrode contact type: Ag/AgCl laminated on carbon composition plastic snap, Electrode Contact Diameter: 11 mm, Electrode Contact Area: 95 mm^2, Size: 27 mm x 36 mm, Backing: 1.5 mm thick foam, latex free To add gel: 1. Fill back cavity (adhesive side) with gel. 2. Add a drop of gel to the sponge pad. 3. Place the sponge pad into the cavity. 4. Press firmly to clear air pockets.  ***EL509 Components:*** Substrate: Tape with medical grade adhesive, Label: Bi-Oriented Polypropylene (BOPP) or Vinyl, Stud: 40% Carbon-filled ABS plastic, Eyelet: 20% glass-filled ABS plastic coated with Ag/AgCl, Reticulated foam: Polyester-polyurethane, Gel: none; add BIOPAC GEL101A at time of application.
EL510 MRI X-ray Electrodes	EL510 is a disposable, radio-translucent, set of three electrodes with hydrogel (4% chloride salt) electrolyte centers and hydrocolloid ends that terminate in 1.5 mm Touchproof leads. Each box includes 20 sets of 3 electrodes. Electrodes are 25 mm x 10 mm with a 10 mm x 10 mm, gelled, contact area. The thin, flexible, carbon composition leads are 58 cm long. ***MRI Use:*** MR Conditional ***Condition:*** Tested up to 3T, any scanning sequence, radiolucent head • Pre-wired, carbon composition leads • Ag/AgCl contact type • Safely secures to limbs without a strap that could reduce circulation. • Gentle hydrogel centers and hydrocolloid ends adhesives • Long lasting and easy to use, even under high humidity • Radio-translucent materials allow for X-ray passage • Latex, phthalate/DEHP, BPA free

PART	Electrode Description
EL512 Disposable Dry Infant Electrode	Small round dry electrode (2.54 cm; 1″) that is easy on the skin for infant applications. Add gel before recording, such as GEL100 or GEL101A. Foam backing with standard snap for lead connection; use with any pinch lead connector, such as LEAD110 series, LEAD108, or BN-LEAD series. Available in packs of 100 (order EL512) or 1000 (order EL512-10).
EL513 Disposable Cloth Facial Electrode	Disposable cloth electrodes designed for recording EMG or ECG for sleep and facial applications. • 10 mm contact area on 2 cm x 2 cm backing • Front has standard snap for lead connection (Use with LEAD110 or BN-LEAD series) • Back has conductive adhesive solid gel that tolerates repositioning for proper placement  The non-woven cloth base of the electrode is extremely conforming to contours of the face and very comfortable. Available packs of 60 (order EL513) or 600 (order EL513-10).
EL516 Disposable Strip Electrodes	Pack of four carbon film strip electrodes (10 cm; 4” x 1.3 cm; 0.5”) with fabric backing for comfort & conformity and snap fit for BIOPAC electrode leads. Add hydrogel before recording for a conductive medium. Available in packs of 4 (order EL516) or 80 (order EL516-20).
EL526 Bioimpedance Strip Electrodes	Pack of four strip electrodes with TP leads attached, intended for bioimpedance applications. Each electrode is 16.5 cm x 1.3 cm (6.5″ x 0.5″) with four 15 cm lead cables that terminate in 1.5 mm Touch Proof sockets. The electrode is foam backed and uses hydrogel to adhere the electrode to the participant and provide a conductive medium. The electrode is carbon fiber with carbon fiber electrode leads and is considered MR Conditional when used with MECMRI series MRI Extension Cables. *Cannot be used with LEAD108 leads.  ***MRI Use:*** MR Conditional ***Condition:*** Use with MECMRI series MRI Extension Cables. Available in packs of 4 (order EL526)

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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.)

EL650 SERIES REUSABLE SNAP ELECTRODES

EL650 Series reusable snap electrodes incorporate a variety of features which improve biopotential recordings.

- Non-polarizable
- Sintered to increase electrode/electrolyte contact area
- Does not require chloriding
- Reusable via resurfacing
- High stability recordings, to DC, when used with chloride salt gel electrolyte
- Electrolyte gel cavity reduces artifact due to electrolyte/electrode motion and minimizes electrolyte dissipation/drying over long term recordings

EL654 This is a reusable Ag-AgCl snap electrode with a 4 mm diameter.

EL658 This is a reusable Ag-AgCl snap electrode with a 8 mm diameter.

Use with ADD204 adhesive collars and interface with LEAD110S Series snap electrode leads or BioNomadix electrode lead sets.

EL654/658 SPECIFICATIONS

Sensor diameter: 4 mm Ag-AgCl (EL654,) 8 mm Ag-AgCl (EL658)

Housing diameter: 13 mm

Overall height: 6 mm (EL654,) 8 mm (EL658)

Gel cavity: 2 mm deep

Snap: 1 mm thick Ag-AgCl sintered sensor element mounted in an epoxy housing; all parts are firmly encapsulated with epoxy, resulting in a tough, durable waterproof assembly

How to Clean Reusable Electrodes

1. Do not leave GEL in the cavity after use. If GEL is left in cavity, the Ag-AgCl electrode disk could degrade quickly with time because the electrode surface is somewhat porous to promote good conductivity to the GEL.
2. To clean the reusable electrode, use a cotton swab or toothbrush with tap water.
3. Use any lab cleaner with pumice (such as Ajax) with cotton swab or toothbrush to remove any dark residue from electrode surface.
4. Use Hydrogen Peroxide solution (2-3%) to brighten electrode surface (optional) or to sterilize electrode. Do not place the electrode in solution, but simply clean the electrode surface using a cotton swab.
5. Dry electrode off completely before storage.

Warning! Use of a Waterpik® or similar jet will drastically shorten the life of electrodes and is not recommended.

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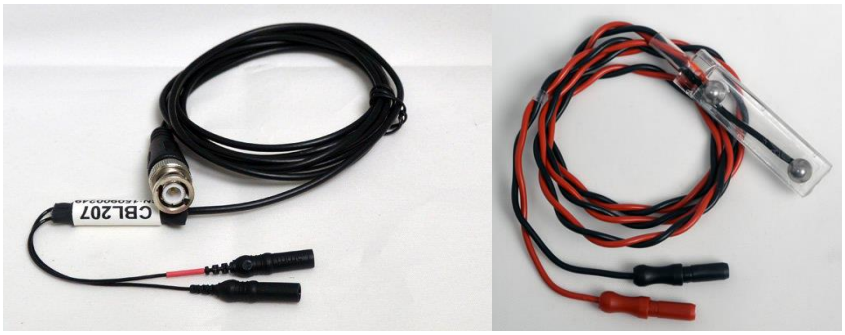
ELSTM1 UNSHIELDED STIMULATING BAR ELECTRODE AND CABLE KIT

The ELSTM1 is a stimulation electrode and BNC cable kit for MP160/150 Research Systems that will interface with either the STM200 or the STMISOLA. The kit is comprised of the BIOPAC CBL207 cable (BNC male to 2 x 1.5 mm Touchproof male connectors) and the EL351 Unshielded Stimulation Bar Lead Electrode (2 x 1.5 mm Touchproof female connectors).



ELSTM1 SPECIFICATIONS

Bar length (EL351):	4 cm
Spacing between contacts:	3 cm
Electrode contact diameter:	1 cm
Lead length (EL351):	61 cm
Cable length (CBL207):	1 m

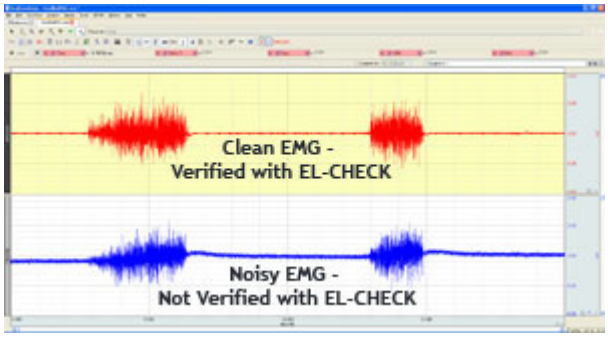
ELSTM2 UNSHIELDED NEEDLE ELECTRODES

Recommended for use when applying a stimulus to animal subjects and tissue preparations. The dual stainless steel needles are Teflon coated. The coating prevents the needle from contacting the subject except at the very tip of the needle, which is exposed. For applications that require better contact between the electrode and the subject to record a good signal, abrade the needle to remove the Teflon coating. Needle electrodes are shipped non-sterile, so pre-sterilization is required.

ELSTM2 SPECIFICATIONS

Needle Length:	2.5 cm
Needle Diameter:	0.3 mm
Cable length:	3.7 m
Connector type:	BNC
Interface:	BSLSTM Stimulator or SS58L for MP35 or OUT3 for MP36

EL-CHECK – ELECTRODE IMPEDANCE CHECKER



BIOPAC EL-CHECK video tutorial!

Use EL-CHECK to determine electrode/surface contact impedances. Measurements are selectable to a standard three-point contact (Vin+ to GND, Vin- to GND and Vin+ to Vin-). Electrode impedance range from < 5 kΩ to > 50 kΩ is indicated in seven levels. EL-CHECK accepts standard 1.5 mm Touchproof and BioNomadix connectors.
EL-CHECK will support over 50,000 10-second measurements with a single 9-volt battery.

The EL-CHECK is suitable for measuring electrode contact impedance for all surface biopotential measurements, including ECG, EEG, EGG, EMG, EOG, Bioimpedance and Impedance Cardiography. The EL-CHECK permits simultaneous connection of up to three electrode leads, for quick impedance checking between any two electrodes in the three connected leads (Active or Vin+) and (Reference or Vin-) and GND.

To test the impedance between any two electrode leads:

1. Insert the leads into the appropriate connectors on the front panel of the EL-CHECK.
2. Switch the selector knob to the corresponding position, and then press and hold the "Test" button.

Green, Yellow, Orange and/or Red LEDs will illuminate to indicate the measured electrode impedance.
The EL-CHECK is only active when the "Test" button is pressed.

For best biopotential measurement results, the impedance between any two electrode leads should be less than 5 kΩ. To obtain electrode lead-to-lead impedances of less than 5 kΩ, it's advisable to lightly abrade the skin with an abrasive pad, such as BIOPAC's ELPAD, and then apply a well-gelled (not dry) surface electrode. Dried-out surface electrodes can sometimes be rejuvenated by applying a small amount of BIOPAC's electrode gel to the contact pad of the electrode.

Specifications

Test Frequency:	25 Hz
Test Current:	3.5 µA rms (10 µA peak-peak: constant current)
Electrode Impedance Range Indicators:	< 5 kΩ, 5k-10 kΩ,10 to 20 kΩ, 20k-30 kΩ, 30k-40 kΩ, 40-50 kΩ, > 50 kΩ
Lead Compatibility:	Standard female touchproof (1.5 mm) electrode leads, all BIOPAC electrodes and leads that terminate in female 1.5 mm touchproof sockets, all BN- EL and BN-Adapt series.
Testing Configurations Switch Selectable:	Active (Vin+) to Reference (Vin-), Active (Vin+) to Ground (GND), Reference (Vin-) to Ground (GND)
Power:	One 9 V Alkaline battery, ~50,000 impedance tests possible per battery
Dimensions:	14 cm long x 8 cm wide x 2.2 cm high
Weight:	132 grams

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ELECTRODE ACCESSORIES & GELS

Abrasive Pads

Before applying electrodes, abrade the skin lightly with an ELPAD to remove non-conductive skin cells and sensitize skin for optimal adhesion. Each ELPAD package contains 10 abrasive pads.

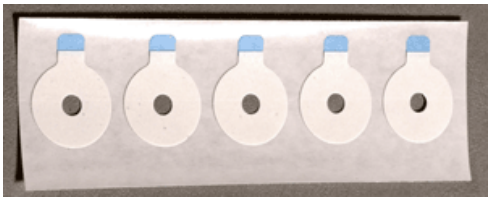
Adhesive

Use adhesive tape for attaching Active Electrodes and other devices. Use the preferred tape or BIOPAC's adhesive tape: **TAPE1** single-sided; **TAPE2** double-sided.

MRI Use: MR Safe

TAPE1 Components:

3M hypoallergenic surgical tape – Acrylic adhesive



Adhesive Disks

ADD200 series double-sided adhesive collars are used to hold reusable electrodes (EL254/8RT) firmly on the skin surface.

ADD204 19 mm outside diameter, use with EL254 and EL254S

ADD208 22 mm outside diameter, use with EL258 and EL258S

MRI Use: MR Safe

ADD204/208 Adhesive Disks Components:

Disks: 3M hypoallergenic medical tape – Acrylic polymer

Electrode Gels

GEL1 & GEL100 Non-irritating, hypo-allergenic gel used as a conductant with the EL250 series reusable electrodes. GEL1 = 50 g; GEL100 = 250 g. 5% NaCl (salt) content. 0.85 molar NaCl

MRI Use: MR Conditional

Condition: Max MR field strength 7T

MRI Notes When using with EL250 series electrodes, it's important to completely fill the EL250 series gel reservoir. Incomplete filling of reservoir may result in localized heating of gel at the electrode site.

GEL100 Components:

Water, Sodium Chloride, Propylene Glycol, Mineral Oil, Glyceryl Monostearate Polyoxyethelene Stearate, Stearyl Alcohol, Calcium Chloride, Potassium Chloride, Methylparaben, Butylparaben, Propyl Paraben

GEL101A Non-irritating, isotonic gel is primarily used as a conductant for electrodermal response recording. Use with TSD203 EDA transducer, SS3LA EDA transducer, EL507 EDA electrodes, EL509 dry electrodes, etc. Each bottle contains 114 g (~4 ounces).

Consists of 0.5% Saline in a neutral base and is the appropriate GEL to use for GSR, EDA, EDR, SCR, and SCL. This electrode paste has an approximate molarity of 0.05M NaCl and is 0.5% Saline; the Saline concentration is adjusted to obtain a final paste molarity of 0.05M NaCl. This particular molarity is recommended by Fowles (1981). Psychophysiology, 18, 232-239

MRI Use: MR Conditional

Condition: Max MR field strength 7T

GEL101A Components:

Distilled water, sodium chloride, Unibase™ cream base (water fatty acids, alcohols, esters, nonionic emulsifiers, glidant)

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GEL102 Ten20 Conductive Gel 114 g (~4 ounces). Ten20 is a conductive and adhesive paste specifically formulated for use with reusable (non-disposable) electrodes. Ten20 contains the right balance of adhesiveness and conductivity, enabling electrodes to remain in place while allowing the transmittance of electrical signals. Ten20 is a uniquely washable and non-drying formula.

Do not use too much paste—the size of the area of the paste becomes the effective size of the electrode; this can reduce interelectrode distances and potential differences measured. Wash skin promptly after use. 12.5% NaCl content, 2.15 molar NaCl

GEL103 Tensive Adhesive Gel, 33 ml. Conductive adhesive gel. This safe, non-flammable, odorless gel is recommended for TENs or ECG to adhere non-adhesive electrodes to the skin.

- Eliminates tape and tape irritation
- Conductive immediately, no need to wait
- Non-flammable, no solvent odor
- Best adhesive gel available
- Hypoallergenic, bacteriostatic, non-irritating
- Water soluble, easily removed with water

GEL104 Electrode Gel - salt free - 250 g (8.5 oz). **SPECTRA 360®** electrode gel. The only salt-free and chloride-free electrically conductive gel, recommended for many biopotential measurements. Salt-free characteristics make it particularly suitable for electrical stimulation and long-term applications. However, it is not recommended for DC measures, such as EDA, ECG, EOG or slow potentials. Spectra 360 differs significantly from all other electrically conductive media...it works by wetting the skin, thereby reducing skin resistance.

- Salt-free, no sodium ion transfer
- Non-irritating, hypoallergenic, bacteriostatic
- Can be used with carbon compositing flexible electrodes
- Can be used for ECG and TENS
- Non-gritty STAY-WET® formula allows for prolonged use without re-application

MRI Use: MR Conditional

Condition: Max MR field strength 7T

GEL104 Salt-Free Components:

Water, Propylene Glycol, Mineral Oil, Glyceryl Monostearate, Polyoxyethelene Stearate, Stearyl Alcohol, Methylparaben, Butylparaben, Propyl Paraben

ELPREP Skin Preparation Gel 114 grams (~4 oz). Designed for EEG, ECG, EMG, EOG, Cardiac Output and Bioimpedance measurements. This gel is abrasive and should be used with care not to overabrade the skin. It is not recommended for use with electrodes attached to conventional electrical stimulation equipment, such as voltage or current stimulators. Not to be used on subjects with a history of skin allergies to cosmetics and lotions. Topical use only.

Prepare skin and apply small amount to appropriate electrode site by squeezing near tube opening. Gently rub gel into the skin surface. Apply small amount to disc electrode and press into the paste that has been applied to the scalp or other skin surface. Clean with warm water.

Coban Wrap

Self-adhesive Coban™ wrap can be used to hold electrodes, VMG transducers and *f*NIR sensors on a subject.

- 3 inch x 5 yard (fully stretched) (75 mm x 4.5 m)
- Latex free self-adherent wrap
- Nonsterile
- Tan

BSL-ACCPACK

The BSL Accessory Pack includes the consumable items to run 17 BSL Lessons. School bookstores can purchase the BSL Accessory Packs and sell them to students. Includes:

100 x EL503 Disposable Electrodes
10 x EL507 Disposable EDA (GSR) Electrodes (ten electrodes total)
1 x AFT1 Disposable Bacterial Filter
1 x AFT2 Disposable Mouthpiece
1 x AFT3 Noseclip
8 x ELPAD Abrasive Pads

BSL-ACCPACK-11B

The BSL Accessory Pack 11B includes the consumable items to run 17 BSL Lessons. This pack includes the AFT36 combination bacterial filter/mouthpiece optimized for the newer-model SS11LB airflow transducer. Includes:

100 x EL503 Disposable Electrodes
10 x EL507 Disposable EDA (GSR) Electrodes (ten electrodes total)
1 x AFT36 Disposable Bacterial Filter with Integrated Mouthpiece
1 x AFT3 Noseclip
8 x ELPAD Abrasive Pads

NOTE: BSL-ACCPACK-11B is not compatible with earlier-model SS11L or SS11LA airflow transducers or software versions earlier than BSL 4.1.1. If using earlier airflow transducers or software, order BSL-ACCPACK.

Alcohol Prep Pad Wipes (ALCPAD, ALCPAD-10)

These Disposable Wipe Prep Pads are sterile, 2-ply non-woven sponge pads saturated with Isopropyl Alcohol and sealed in individual airtight foil packets.

- Affordable
- Convenient Individual Packaging
- 2-Ply Enhances Strength for Cleaning & Disinfecting
- Airtight Poly-Lined Foil Pouches Minimized Dry Pads
- Active Ingredient: Isopropyl Alcohol
- Saturation Level: 70%
- Latex-Free
- Sterile

Quantity options: pack of 200 (order ALCPAD) or pack of 2000 (order ALCPAD-10)

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ELECTRODE LEADS

LEAD108 SERIES — MR CONDITIONAL/RADIOTRANSLUCENT LEADS FOR EL508/EL509

Use the LEAD108 Series with EL508 MR Conditional, radiotranslucent electrodes and EL509 disposable radiotranslucent dry electrodes.

All LEAD108 Series terminate in 1.5 mm female Touchproof sockets.

MRI Lead Guidelines

For MRI use, shorter leads are better...specifically, keeping lead lengths much shorter than the wavelength of the Larmor frequency (42.6 MHz/T) is critical. For a 3T machine, this is the speed of light divided by (42.6*3*1E6) or 2.34 meters. As field strengths increase, then lead lengths should continue to shorten. To record ECG, or any other biopotential signal, in MRI, short leads such as LEAD108B (15 cm) and LEAD108C (30 cm) are recommended; do not use 2-meter or 1-meter leads for biopotential signals in MRI.

- *Recommended reading*: Thoralf Niendorf, Lukas Winter and Tobias Frauenrath (2012). **Electrocardiogram in an MRI Environment: Clinical Needs, Practical Considerations, Safety Implications, Technical Solutions and Future Directions** , Advances in Electrocardiograms - Methods and Analysis, PhD. Richard Millis (Ed.), ISBN: 978-953-307-923-3, InTech, DOI: 10.5772/24340.

See BIOPAC MRI Guidelines for additional details.

MRI Usage: MR Conditional to 9T

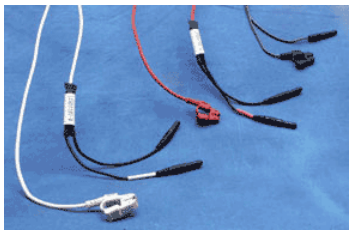
Condition: Up to 9T, any scanning sequence, use with EL508 or EL509 MRI/RT electrodes only.

Lead108 Components: Polyvinyl chloride (PVC) plastic, carbon fiber leadwire, tinned copper connectors (1.5 mm female Touchproof socket), electrode clip (carbon filled ABS plastic)

SPECIFICATIONS

Construction:	Carbon fiber leadwire and electrode snap
Leadwire Diameter:	1.5 mm
Leadwire Resistance:	156 Ohms/meter
Leadwire Length:	**LEAD108B** 15 cm, **LEAD108C** 30 cm

LEAD110 SERIES — ELECTRODE LEADS



The LEAD110 Series, for use with disposable and other snap connector electrodes, are pinch leads for easy connection between the EL500-series snap electrodes and any BIOPAC biopotential amplifier or the GND terminal on the back of the UIM100C. Leads are 1.9 mm in diameter and terminate in standard 1.5 mm Touchproof connector and connect to BIOPAC modules or to a Modular Extension Cable (MEC series).

LEAD	TYPE	LENGTH	USAGE NOTE
LEAD110	Unshielded	1 m	Works best as a ground electrode
LEAD110A	Unshielded	3 m	Works best with ground or reference electrodes
LEAD110S-R	Shielded; red	1 m	Use with recording electrodes for minimal noise interference. White lead plug is for electrode contact; black lead pin plug is for lead shield.
LEAD110S-W	Shielded; white	1 m	Use with recording electrodes for minimal noise interference. White lead plug is for electrode contact; black lead pin plug is for lead shield.

See also: TSD155C Multi-lead ECG Cable

WT100C Wilson Terminal (virtual reference)

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LEAD115 LIGHTER LEAD SERIES

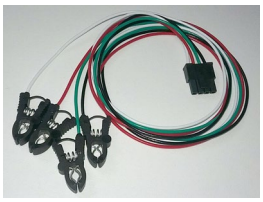
New series of unshielded 1-meter electrode leads with thin cable; suitable for facial EMG and other areas where lighter, shorter lead cables are required. Use for female Touchproof connectors to pinch clip connectors—connect electrodes to either a C-series amplifier or an MEC. The pinch connectors are light-weight and the lead cable tinsel wire is 1.27 mm diameter.

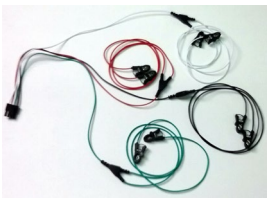
LEAD115 (black), LEAD115-R (red), LEAD115-W (white)

LEAD120 LEAD FOR EL120

This 1-meter lead with 1.5 mm Touchproof connector works exclusively with the reusable EL120 electrode. Snap the electrode into place and then plug the lead in with the Touchproof connector. White—LEAD120-W Red—LEAD120-R

LEAD131, LEAD132





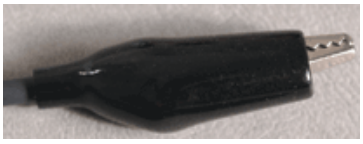
Use these electrode lead sets with D-series Smart Amplifiers EBI100D and NICO100D for impedance measurements.

LEAD131 has four (4) 50 cm clip leads, White I+, Red Vin+, Green VIN-, Black I-. Use for tetrapolar electrode configurations.

LEAD132 has eight (8) 64 cm clip leads (4 x 25 cm wires each split to 2 x 35 cm leads): Use for spot electrode configurations.

LEAD131 and LEAD132 electrode leads are only compatible with EBI100D and NICO100D amplifiers.

LEAD140 SERIES SPECIAL ELECTRODE LEAD CLIPS



LEAD140 Series Special Electrode Lead Clips have a 1 m black cable, a 1.5 mm touchproof connector, a 40 mm alligator clip, and require the SS1LA interface. These lead clips that can be used for either recording or stimulation. They are useful for attaching BIOPAC amplifiers to a variety of unusual electrode types, ranging from bare wires, needles, unusual junctions, etc.

LEAD140 Alligator clip with teeth, length 40 mm: Use this fully insulated, unshielded lead to connect fine wire electrodes, including irregular surfaces. There is ferrous metal in the clip.

LEAD142 Retractable minigrabber clip lead with copper extension contacts, length 40 mm, extension length 3.5 mm: Use this unshielded lead to connect to fine wire electrodes up to 1 mm diameter. There is non-ferrous copper alloy in the clip.

MRI Usage: MR Conditional

Condition: Tested 3T-9T (LEAD142 only)

See the following page for diagrams of LEAD140 Series clamping width, length, and height dimensions.

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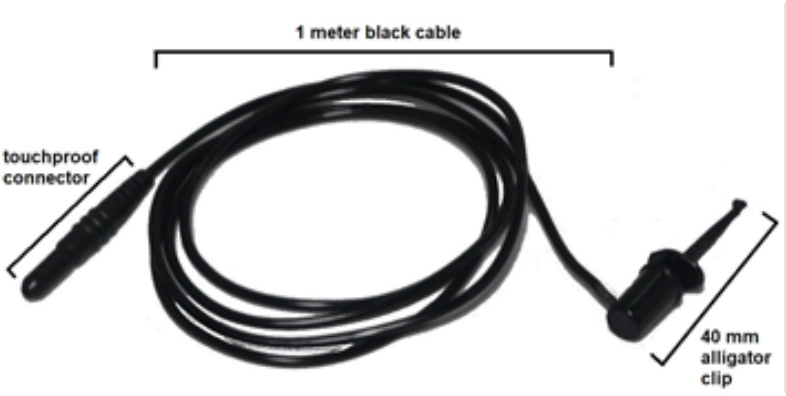
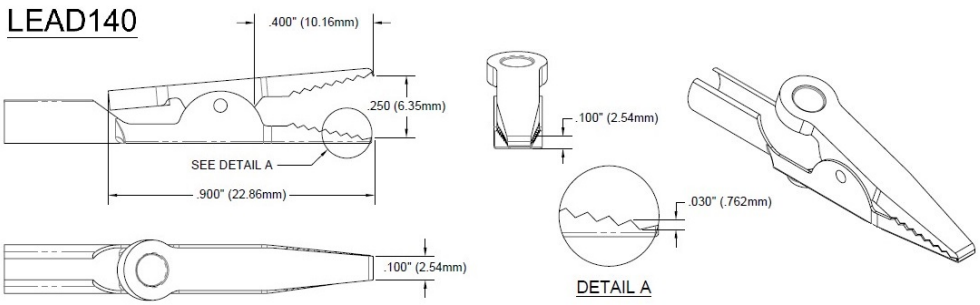
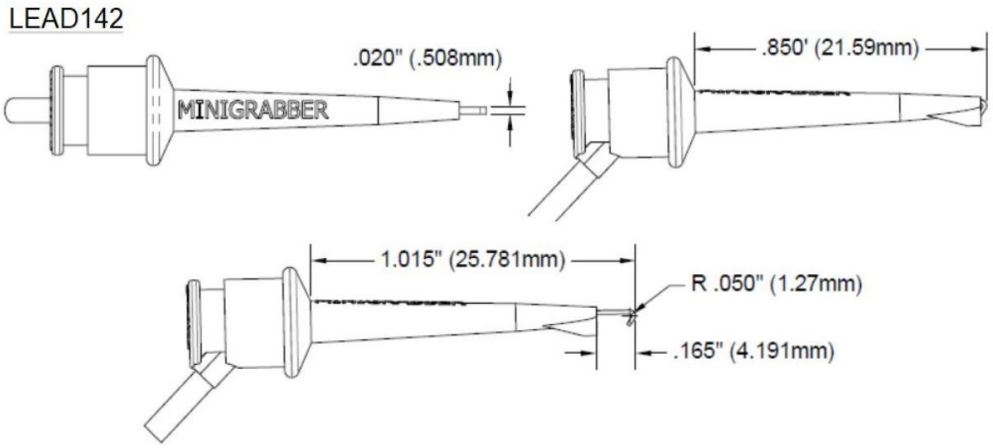
LEAD140 SERIES DIMENSIONAL DIAGRAMS







GASSYS3 O_2 & CO_2 GAS ANALYSIS SYSTEM

Flexible Data Display & Reporting - VO_2, VCO_2, RER, RMR, EE, REE

GASSYS3 Gas Analysis System—paired with the BIOPAC MP36 unit, SS11LB airflow transducer, and accessories—provides a lower-cost, compact, simpler, solution suitable for both education and research physiology applications. Obtain quality metabolic data, such as Volume of Oxygen Consumed ($\dot{V}O_2$), Volume of Carbon Dioxide eliminated ($\dot{V}CO_2$), Respiratory Exchange Ratio (RER), Energy Expenditure (EE, REE) and Resting Metabolic Rate (RMR) from Subjects at rest or during exercise.

GASSYS3 solves a myriad of challenges traditional methods of obtaining metabolic data often present, including high cost, extensive, complex and costly calibration requirements, and difficult operation.

- O_2 and CO_2 sensors
- 5-Liter Mixing Chamber
- Relative Humidity Sensors—ambient and chamber
- Temperature Sensors—ambient and chamber
- Barometric Sensor—ambient
- Fits Standard 35 mm Tubing
- Small and Compact Unit
- Automated Setup and Analysis
- Requires Less Frequent Gas Calibration

The BIOPAC GASSYS3 provides detailed insights on human subjects' responses in a variety of research applications, such as exercise physiology, sports science, biomedical engineering, psychophysiology, and many product development and consumer neuroscience applications.

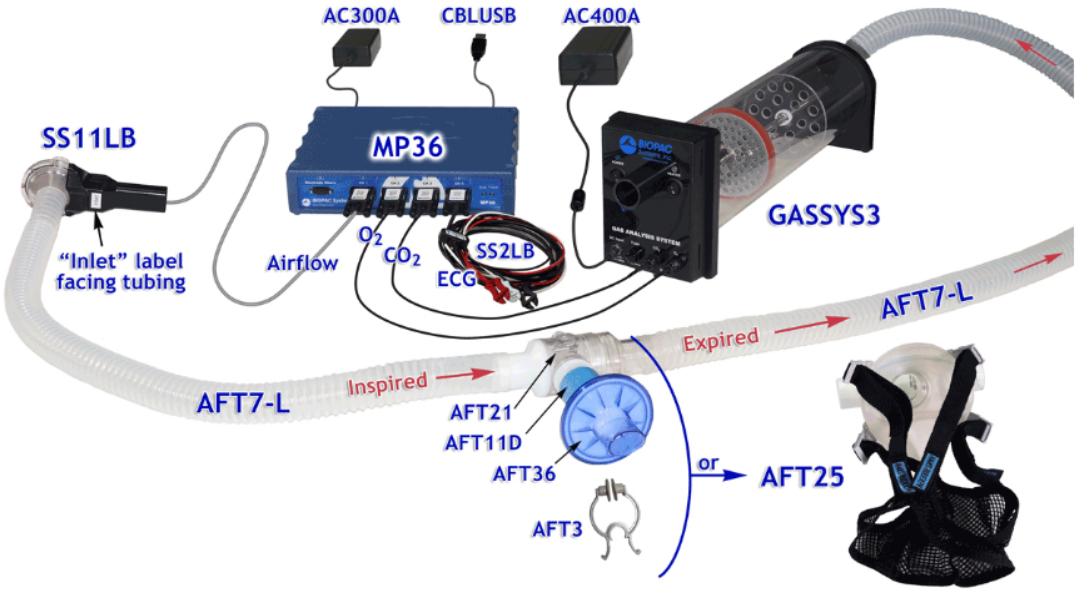
- CO_2 sensor range extended from 5% to 10%, important for VO_2 Max measurements.
- Integrated heater lowers the relative humidity to prevent condensation from forming in and around the sensors.
- Integrated environmental sensors for both ambient and chamber air. These sensors are read in serially by the MP36 (under software control) and are used to adjust measurements based on changes in temperature, relative humidity, and barometric pressure.
- Small blower inside chamber, which helps mix the air, improves CO_2 sensor response time and helps prevent condensation inside the CO_2 sensor.
- Sealed Chamber prevents ambient air from corrupting the chamber air between expired air cycles.
- New design results in less air restriction.
- Auto-voltage calibration and memory circuitry added to the O_2 and CO_2 circuits to improve accuracy.

Measure Expired O_2 and CO_2 Concentrations

Required Equipment

- **GASSYS3** with included Power Supply (12V, 5A) with choice of cord (US, EU, China)
  - *optional*: Calibration Kit GASKIT3
- **MP36** with BSL 4.1.3 or above OR **MP36R** with Acq*Knowledge* 5.0.3 or above; not compatible with MP46/45.
- **Airflow Transducer** SS11B
- **T-Valve**
  - *option 1*: high flow T-valve (AFT21 35 mm OD) + Disposable filter with mouthpiece (AFT36) + Disposable Nose Clip (AFT 3).
  - *option 2*: Facemask with integrated T-valve (AFT25) + Syringe coupler, 35 mm to 25 mm (AFT11A).
  - *option 3*: low flow non-rebreathing T-valve (AFT22) + smooth bore tubing (AFT7-L) + flexible coupler (AFT11E).
- **Calibration syringe**—required to flush the chamber during setup if not performing gas calibration.
  - *option 1*: AFT27 3 L calibration syringe or equivalent 2, 3, 5- or 7-liter syringe.
  - *option 2*: soon to be released GASKIT3 calibration kit, which will include an AFT27.
- **Airflow & Gas Analysis Accessories**
  Choose AFT Series tubing, couplers, etc. accessories to suit your protocol.

Setup



GASSYS3 Example Setup

Notes

- The non-rebreathing "T" valve directs only expired air to the GASSYS3. The mixing chamber inside the GASSYS3 averages respiratory outflows. This averaging effect causes the CO_2 and O_2 concentrations to vary in accordance with the mean values resident in multiple expired breaths.
  - For resting measurements, the airflow transducer can be placed on the output port of the GASSYS3.
  - For exercise measurements, the airflow transducer is placed on the inspired side of the T-valve to reduce the chance of condensation affecting airflow accuracy. The transducer should be held securely (i.e., stabilized on a tripod) to reduce vibration.

- When the subject inspires, air will be drawn into the GASSYS3 through the SS11LB air flow transducer, which is placed on the inspiration side to eliminate any effects associated with expired air humidity.
- When the subject expires, air will be directed to the GASSYS3 module, which is designed to work with saturated expired air.

Recording Procedure

See BSL *PRO* Lesson procedures:

- H19 VO2 & RER
- H29 Basal Metabolic Rate

Citations

These Gas Analysis System Citations used BIOPAC's previous Gas Analysis System GASSYS2—the new GASSYS3 can be used in place of the older GASSYS2 for these and other protocols.

Cleaning the BIOPAC GASSYS3

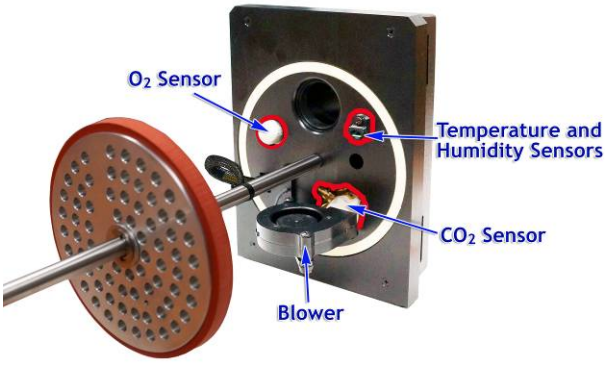
Note

Since the GASSYS3 processes only expired air, it is not necessary to clean using strong disinfectants such as Cidex OP. It is recommended to use 60-75% Isopropyl Alcohol in water.

- Never let isopropyl alcohol get on any of the sensors.

1) Unscrew (counterclockwise) the knob on the Inlet side (see below left figure).

2) Carefully pull the Inlet Plate away from the mixing chamber. It may be necessary to gently wiggle the plate side-to-side to remove it.
3) Gently pull the clear cylinder away from the Outlet/Sensor Plate. Be careful not to rotate the cylinder, as this can damage the cable.
4) Clean the clear cylinder, the support rod, and the heater plate with isopropyl alcohol and a soft cloth. Use swabs dipped in alcohol around the sensors and in the holes of the heater. It is important to avoid getting alcohol on the O_2, CO_2, and Temperature/Humidity sensors, as this can cause damage. For a margin of safety, note that the red areas in the below figure should not be cleaned.



5) Reassemble the system in the reverse order. Please note the following:
   a. The clear cylinder should fit snugly over the heater gasket. It may be necessary to slightly squeeze the cylinder, forcing it round, for it to begin to slide over the gasket. Push the cylinder slowly to prevent damaging the gasket. Do not allow the cylinder to rotate to avoid damaging the cable.
   b. Both inlet and exhaust plates have a recessed circular area containing a gasket that must seal with the clear cylinder. It may be necessary to squeeze the cylinder, to make sure it seats into each recessed area correctly.
   c. Once the clear cylinder is in place, insert the knob and begin slowly tightening (clockwise). As the knob is tightened, make sure that the cylinder does not come out of place on either end. Tighten the knob until snug.

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GASCAL CALIBRATION GAS

GASREG REGULATOR

GASCAL and GASCAL2

Composition: GASCAL: 4% Carbon Dioxide, 16% Oxygen, balance Nitrogen
GASCAL2: 8% Carbon Dioxide, 21% Oxygen, balance Nitrogen

Cylinder Type:	ED
Valve Connection:	CGA-973 works with GASREG regulator
Accuracy:	±0.03% absolute
Stability Guaranteed:	3 years
Cylinder Pressure:	2200 psig
Gas Volume:	560 liters
Cylinder Recycling:	Cylinder Recycling Program available. Contact support@biopac.com to receive instructions for returning a cylinder; delivery paid by sender and recycling covered by manufacturer.

GASREG

Use the non-corrosive, two stage regulator with flow control with the GASCAL Calibration Gas Cylinder.

This regulator is used to inject calibration gases into the GASSYS2/GASSYS3 or AFT15 chambers to create the secondary calibration points for a proper gas calibration of O2 and CO2 sensors.

- The initial case (for the primary calibration points) is the chamber flooded with ambient air (20.95% Oxygen, 0.04% Carbon Dioxide and balance Nitrogen).
- The secondary case (for the secondary calibration points) is using the GASCAL with GASREG to inject a calibrated gas mixture into the chamber.
- The chamber will be flooded with this mixture from GASCAL or GASCAL2.

GASCAL is a tank containing 4% carbon dioxide, 16% oxygen and balance (80%) nitrogen.

GASCAL2 is a tank containing 8% carbon dioxide, 21% oxygen and balance (71%) nitrogen.

Use 3.2 mm ID tubing to run from GASREG output to the chamber and seal the 3.2 mm ID tube to the input port of the chamber, during calibration.

Wait for the chamber to be flooded, typically about 1-2 minutes.

Put regulator at 10 psi and open up the flow valve.

After flooding, then largely close the flow valve, but keep some small flow during the calibration of secondary point, to maintain positive pressure in the chamber.

The chamber needs to be flooded prior to attempting to calibrate for secondary points.

After secondary calibration, shut down the tank by closing the main valve.

See also: AFT16 Regulator Barb Interface Kit for interfacing the GASCAL+GASREG combination to an AFT15 mixing chamber to calibrate the O2100C or CO2100C amplifier modules.

AFT17 Regulator Barb Interface to inject calibration gases into the RX-GAS3 Calibration Chamber to calibrate the GASSYS3 Gas Analysis System.

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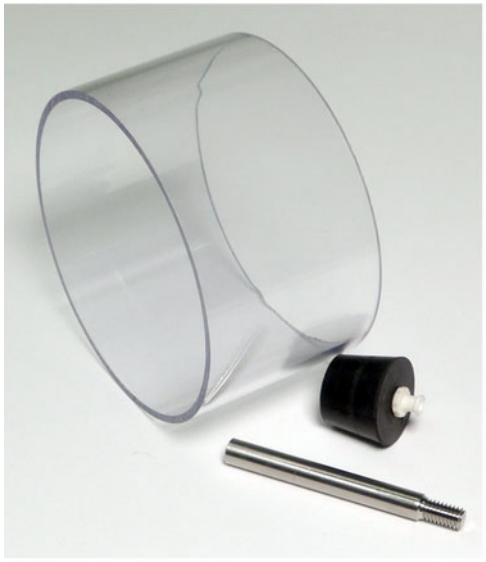
GASKIT3 CALIBRATION KIT FOR GASSYS3



This gas and airflow calibration kit works with the GASSYSTEM3 Gas Analysis System. It includes hardware interface items; it does not include gas cylinder(s) or regulator.

This calibration kit includes:

- Syringe and Coupler: AFT27 + AFT11D
- Calibration Chamber for GASSYS3: RX-GAS3
- Regulator Barb Interface/tubing to connect a regulator to the calibration chamber: AFT17

See also: GASCAL (4% CO_2, 16% O_2), GASCAL2 (8% CO_2, 21% O_2), GASREG regulator

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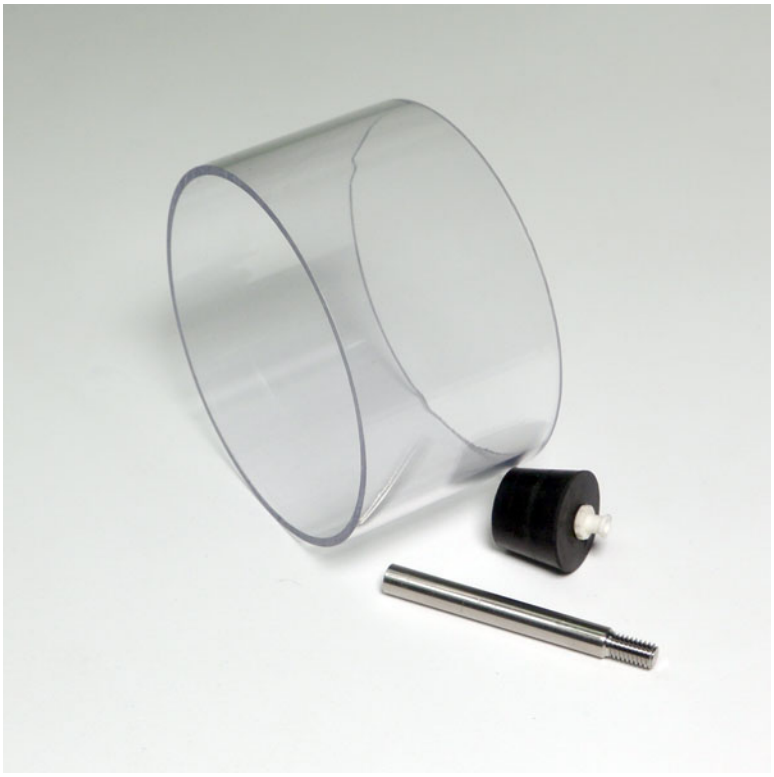
RX-GAS3 CALIBRATION CHAMBER FOR GASSYS3



This is a short chamber that is used when performing calibration of the GASSYS3 Gas Analysis module. The large chamber and rod are replaced with a shorter chamber and rod. Using the included stopper on the inlet of the GASSYS3, calibration gases may then be injected into the calibration chamber using the AFT17 + GASREG + GASCAL/GASCAL2. After calibration, the larger chamber is used.

The stopper includes a standard female Luer lock connector to interface to other equipment as well.

RX-GAS3 connected to MP36

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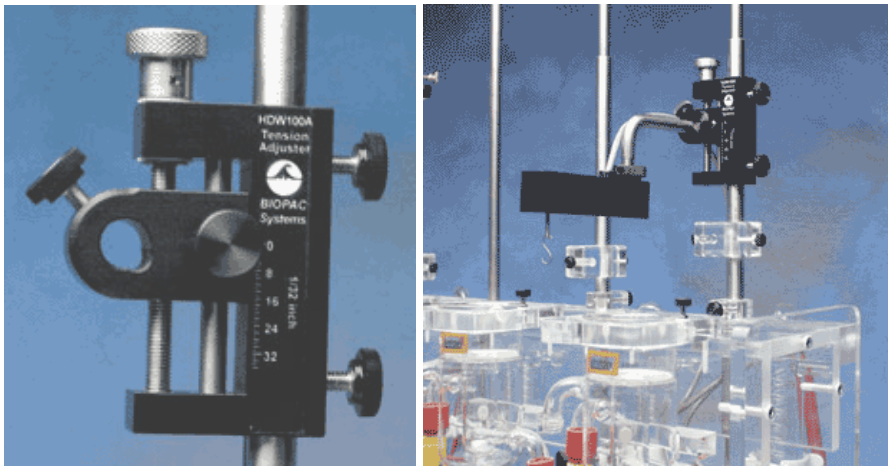
RX-GAS3-GASKET FOR GASSYS3

The RX-GAS3-GASKET is a set of endcap replacement gaskets for the GASSYS3 Gas Analysis Module. Over time the gaskets of the chamber for the GASSYS3 may deform and no longer make an airtight seal. This gasket set may be used to replace worn gaskets to maintain an airtight seal for the GASSYS3.

TENSION ADJUSTERS

HDW100A TENSION ADJUSTER
HDW200A 3RD-PARTY TENSION ADJUSTER ADAPTER



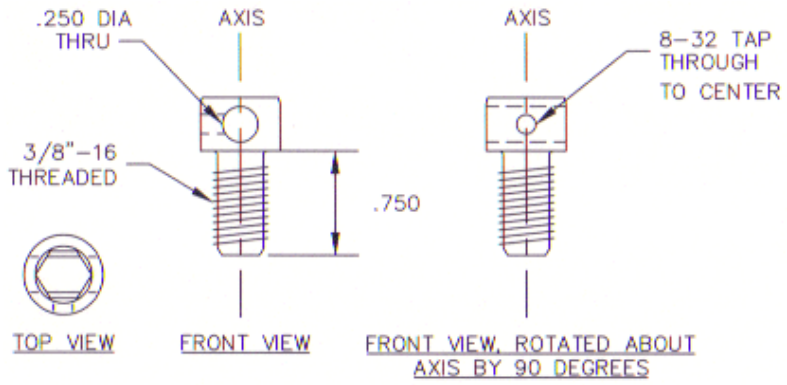
HDW100A and TSD125/SS12LA

The HDW100A tension adjuster operates with the TSD105A, TSD125, SS12LA force transducers and SS14L displacement transducer. The rugged design and stability of the 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.

HDW100A SPECIFICATIONS

Travel Range:	25 mm
Resolution:	0.0025 mm per degree rotation
Stand Clamp:	13.25 mm ID
Transducer Clamp	11 mm ID
Weight:	140 grams
Dimensions:	93 mm (high) x 19 mm (thick) x 74 mm (deep)

HDW200 ADAPTER FOR 3RD-PARTY TENSION ADJUSTERS



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, such as “riser” style tension adjusters from Lafayette and Wards.

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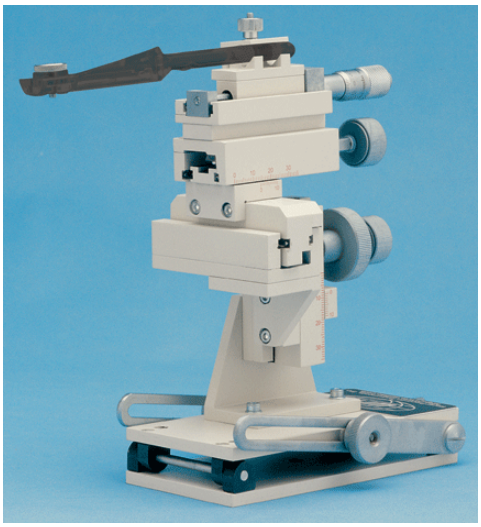
MICROMANIPULATOR



This manual micromanipulator is a reliable, durable, and economical solution for high-precision experiments.

- Vernier scales allow readings to 0.1 mm
- X-axis fine control allows readings to 10 µm
- Includes tilting base
- Includes standard 12 mm clamp
- Includes 14 cm electrode holder
- All control knobs project to the rear, so units can be tightly grouped.

Control	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
Weight:	1.4 kg (3 lbs.)	

Specify left- or right-handed unit when ordering.

MANIPULATOR-R Right-handed
MANIPULATOR-L Left-handed

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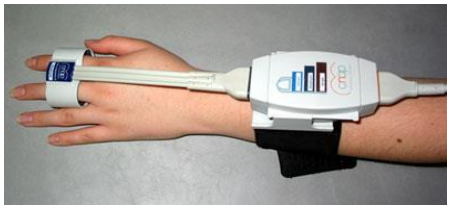
NIBP100D NONINVASIVE BLOOD PRESSURE MONITORING SYSTEM



The NIBP100D Noninvasive Blood Pressure Monitoring System is suitable for small children (~4-5 years) to large adults

- **Accurate noninvasive blood pressure values**
- **Comfortable for subjects to wear**
- **Real-time, continuous, noninvasive blood pressure**
- **Easy to use**

The NIBP100D noninvasive blood pressure system provides a continuous, beat-to-beat, blood pressure signal recorded from the fingers of a subject. The system outputs a continuous blood pressure waveform that is similar to a direct arterial pressure waveform. The monitor displays values for systolic, diastolic, mean blood pressure, and heart rate.

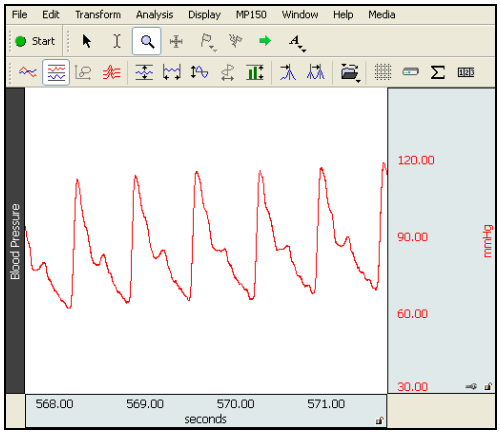
The noninvasive blood pressure (NIBP) monitoring system uses a double finger cuff that is comfortable for the subject to wear and easy to place on the hand. The cuffs (included with system) come in three sizes to accommodate children through large adults.

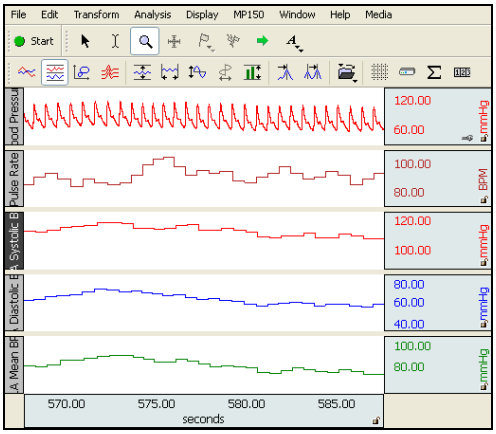
The NIBP100D interfaces with an MP160/150 Data Acquisition System (or third-party data acquisition system), via a DA100C and TCI105 Interface Connector. It is also compatible with the MP36/36R/35/45 Data Acquisition System via a BSL-TCI5 transducer and CBLHLT1 cable. The Acq*Knowledge* or BSL *PRO* software displays the blood pressure signal, plus systolic, diastolic, mean blood pressure and heart rate. It will also provide a detailed beat-to-beat analysis of the blood pressure signal.

The NIBP100D is calibrated using a standard blood pressure cuff that is placed around the subject's upper arm. The unit automatically takes a blood pressure measurement from the subject and uses the value for calibration purposes. During the calibration process the system locates the pulse at the finger and performs a partial occlusion. It will switch from one finger to the next during the course of the recording to relieve the pressure from the occluded finger. The interval between finger rotations is user-selectable and can be as long as 60 minutes. During the rotation, the system takes another calibration reading to ensure that values are accurate.

The system is very user friendly and the initial setup and calibration period takes less than three minutes—that time includes placing the cuff around the upper arm and the sensor on the fingers. Placing the finger sensor is as simple as sliding the subject's fingers through the two cuffs.

The system employs a vascular unloading technique to measure blood pressure at the fingers. A refined version of the Penáz' principle is used to deliver a continuous noninvasive blood pressure signal. The method is based on concentrically interlocking control loops for accurate long-term readings of finger blood pressure.





HYPERBARIC/HYPOBARIC CHAMBER SETUP

1. Cuff controller and CNAP monitor must be in the same chamber with the same"pressure" environment as both are equipped with pressure sensor for surrounding pressure.
2. Pressure must be increased / decreased continuously rather than abruptly.
3. Hypobaric: take measures against overheating of the device as conventional cooling is limited (dim CNAP display low; do not restrict airflow through case).
4. No draught on cuff.
5. Hand on heart level in steady position.

SPECIFICATIONS

*For complete specifications, see the **NIBP100D User Manual** online under the product page "Support" tab.*

Components

- **Double-Cuff Finger Sensors** – one each size
  - **L** 24 - 28 mm dark red, **M** 18 - 24 mm Dark blue, **S** 10 - 18 mm Light blue
  - Finger cuff sensors are a consumable item and typically last ~12 months based on 3-4 hours/week.
- **Blood Pressure Cuffs** — one each size, latex-free
  - **Child** (12 – 19 cm), **Small Adult** (17 – 25 cm), **Adult** (23 – 33 cm), **Large Adult** (31 – 40 cm)
- **NIBP100D Monitor**
  - Dimensions 280 x 270 x 250 mm (11 x 10.6 x 9.8 in.)
  - Weight 7.5 Kg (16.6 lbs) including components and accessories necessary for operability of device
  - Battery Sealed lead gel, operating time = 2 hrs (fully charged battery, normal conditions)

Electrical properties

- Nominal voltage: 18 VDC ±10%
- Nominal current: 3 A
- Operability: No time-limit if powered by external mains adapter, at least 2 hrs if on battery-operation (fully charged battery)

NIBP100D continuous noninvasive arterial pressure

- Parameter classification
  - Sys, Dia, Mean [mmHg]
  - Pulse [bpm]
- Measuring range
  - Sys: 40 - 250 mmHg (5.3 – 33.3 kPa)
  - Dia: 30 - 210 mmHg (4 - 28 kPa)
  - Mean: 35 - 230 mmHg (4 – 30.6 kPa)
  - Heart rate indication range 20-200 bpm
  - Accuracy ±5 mmHg (0.6 kPa)
- Display resolution 1 mmHg (0.1 kPa)
- Inflation pressure
  - Typ.: 120 mmHg (16 kPa)
  - Min.: 30 mmHg (4 kPa)
  - Max.: 300 ±10 mmHg (41.3 kPa ±1.3 kPa)
- Excess pressure limit
  - 300 ±10 mmHg (40 kPa ±1.3 kPa)
  - Response time: < 3 sec.
  - Deflation time: < 15 sec
  - Protection against electric shock: Type BF

Output

- Sensor bridge voltage: 2 – 10 V (external monitor)
- Sensitivity: 5 µV/V/mmHg
- BP Wave Out: CNAP™ transducer cable 0.3 m; connector RJ11 6P4C (e.g. Abbott IBP catheter)
- Delay of analog out signal: 50 msec (fixed)

Interface

- To DA100C via TCI105 (sold separately)

External mains adapter

- Nominal voltage: 100 – 240 VAC
- Power frequency: ~50/60 Hz
- Power output: 18 V, 3.3 A
- Safety class: Class II with functional earth
- Earth leakage current: < 500 µA

Standards

- EN 60601-1+A1+A2+A12+A13: 1996
- EN 60601-1-2: 2003
- EN 60601-1-4:1996 +A1: 1999
- EN 60601-1-6: 2004
- EN 60601-1-8:2004+A1: 2006
- EN 60601-2-30: 2000
- EN 1060-1: 1995
- EN 1060-3:1997+A1: 2005
- ANSI/AAMI SP10: 2002

CE

Note: Electric and magnetic fields may interfere with the functional reliability of the device, so avoid using the NIBP100D CNAP™ Monitor 500 close to devices emitting powerful electromagnetic fields, e.g. x-ray equipment, diathermy applications or magnetic resonance tomographs.

O-RING KIT FOR NIBP100D – RXNIBP100D-KIT

This O-ring repair kit for the NIBP100D Noninvasive Blood Pressure Monitor (CNAP® Monitor 500) allows the user to replace the O-rings on the main unit, sensor cable and sensor.

Kit includes 50+ O-rings, a repair tool, and lubricant.

1. O-RING LUBRICATION

O-rings are used for leak-proof distribution of air throughout the CNAP® hardware. The O-ring bushings of the CNAP® finger cuff and the CNAP® cable (Figure 1) need to be lubricated regularly (every 1 2 months) in order to assure a free moving connection and avoid air leakage.

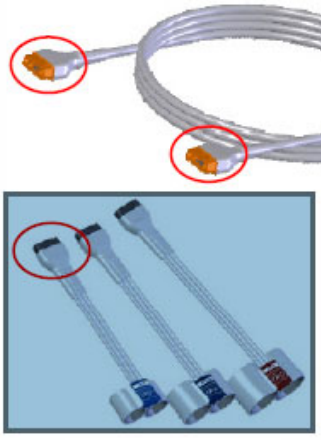


Figure 1

CNAP™ Error Codes associated with air leakage:
CNAP Fault Initial Pressure. Technical description: Self-Test Manifold Pump Does Not Reach Minimum Pressure Threshold
CNAP Fault Pump/Tubing/Valve Leaky. Technical description: Self-Test Manifold Pump/Tubing/Inlet Valve Leakage

Lubricate the O-ring bushings (air connectors) of CNAP® Monitor 500 with O-lube.

a. Apply a small amount of O-lube to a Q-tip. (Figures 2-4). Avoid applying too much O-lube on the Q-tip (as in Figure 2) by distributing excess lube on the back of your hand (Figure 3). Figure 4 depicts the proper amount of lube.

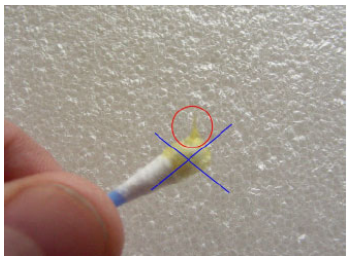


Figure 2

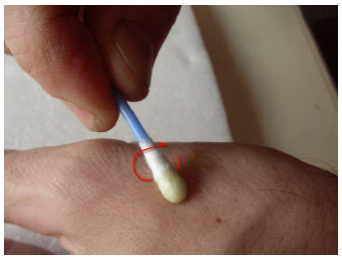


Figure 3

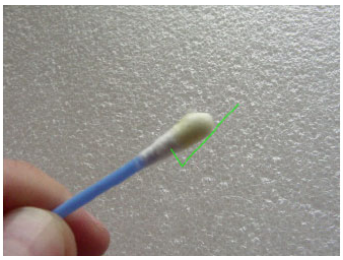


Figure 4

b. Apply O-lube into each of the two bushings (lateral holes used for air supply) of the CNAP® finger cuff and the CNAP® cable (both ends) as shown in Figures 5 and 6.

IMPORTANT: The electrical connections in the middle of the connector must not come in contact with the O-lube.

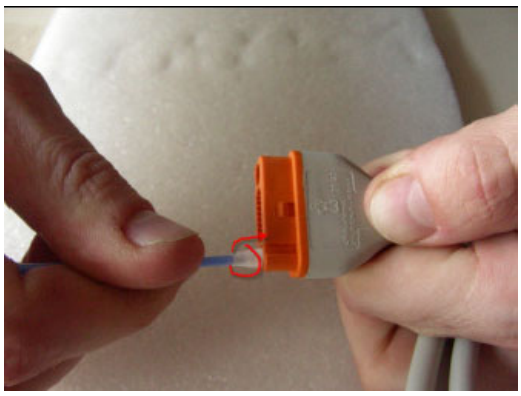


Figure 5

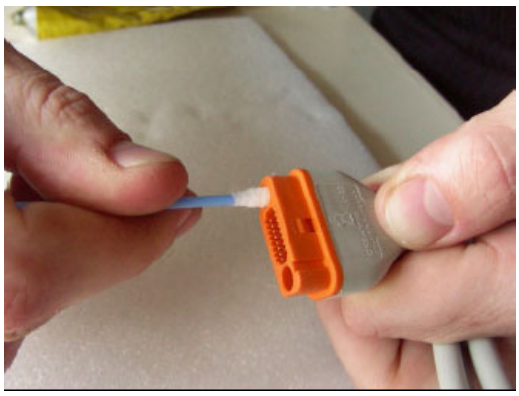


Figure 6

c. Start the NIBP100D CNAP® Monitor and CNAP® hardware (CNAP® controller, CNAP® finger cuff and CNAP® cable). If the status message "CNAP initializing" is displayed upon startup, the connection is working properly. Otherwise, repeat Steps b and c.

2. O-RING INSTALLATION

O-rings are used in the CNAP® controller (four O-rings) and CNAP® cable port (two O-rings) to distribute leak-proof air throughout the CNAP® hardware.

How to change the O-rings (air connectors) on the NIBP100D CNAP® Monitor 500

a. Remove the four red O-rings from the CNAP® controller. (Two O-rings for each connector, see Figures 7 and 8.)

Figure 7

Figure 8

b. Slide/roll O-ring onto the provided O-ring mounting tool (O-ring at the end of the conus, as shown in Figures 9 and 10).

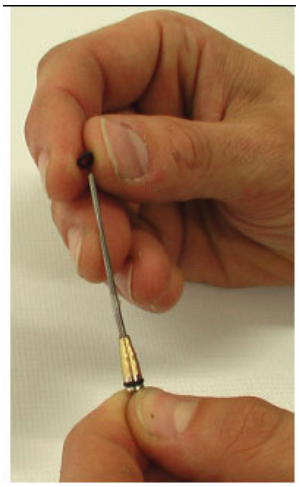


Figure 9

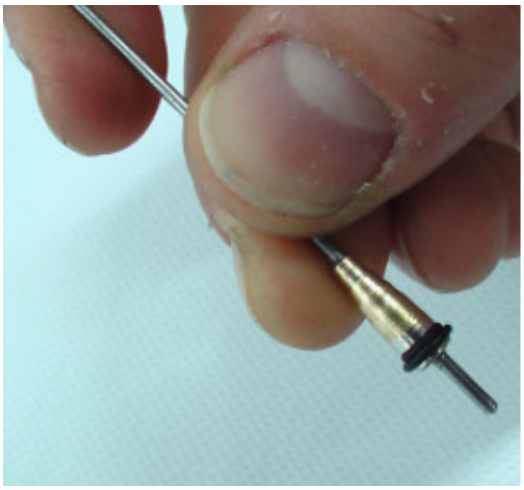


Figure 10

c. Attach the O-ring mounting tool to one of the O-ring carriers (as shown in Figure 11). Then use the green O-ring plug socket to slide the O-ring onto the O-ring carrier (Figure 12). Make sure that the O-ring sits in position on the O-ring carrier.

Figure 11

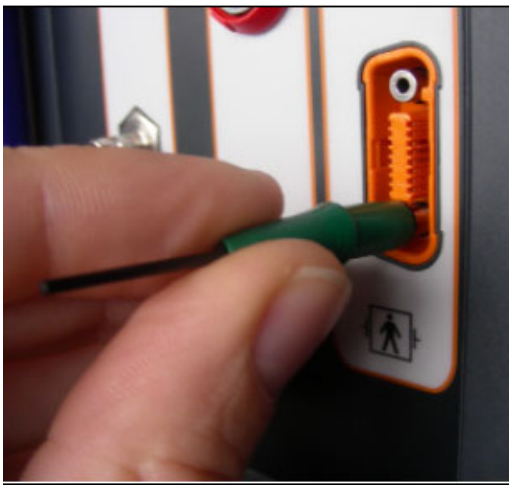


Figure 12

d. Remove the O-ring plug socket and O-ring mounting tool.

e. Repeat Steps a-d for all four O-rings of the CNAP® controller and the two O-rings of the cable port on the NIBP100D CNAP® Monitor 500.

f. Lubricate all O-ring bushings as described in Section 1.

info@biopac.com
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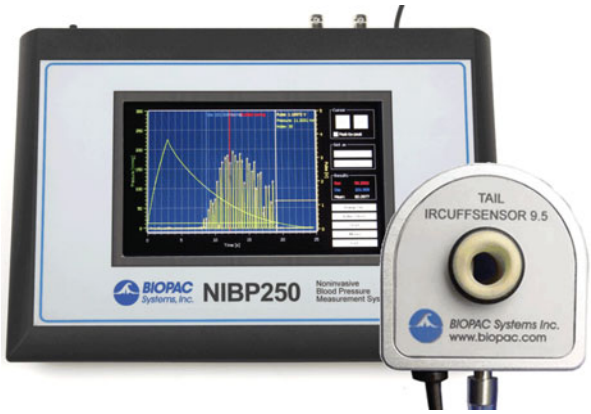
NON-INVASIVE SMALL ANIMAL TAIL BLOOD PRESSURE SYSTEMS

NIBP250 Blood Pressure Amplifier

NIBP200A Blood Pressure System



NIBP Amplifiers with built-in pump automatically inflate the tail cuff to occlude the vessel in the tail of a rat or similar small animal, and then slowly deflate the cuff when the inflation point is reached, providing a linear drop in pressure. A single control starts both the inflation and deflation cycles, making the system very operator-friendly. Amplifiers have two analog outputs for pressure and pulse waveforms, plus gain adjustment to amplify or attenuate the pulse signal. Systolic, diastolic, and mean BP values.

- **NIBP250** Touchscreen LCD controls and displays data for local analysis and storage. Use as a stand-alone system or interface to BIOPAC or third-party A/D hardware. USB 1.1 compatible flash memory port and SD card slot.
- **NIBP200A** Amplifier for use with Tail Cuff Sensor.

Systems include:

- Amplifier order NIBP250 or NIBP200A
- One tail cuff sensor (request size):

  RXTCUFSENSOR9.5 = 9.5 mm, 100-220 g
  RXTCUFSENSOR11 = 11 mm, 200-280 g
  RXTCUFSENSOR13 = 13 mm, 250-350 g
- One small animal restrainer:

  RXRESTRAINER-S, 70-150 g (small rat)
  RXRESTRAINER-M, 150-200 g (medium rat)
  RXRESTRAINER-L, 250-350 g (large rat)
- Optional MRI-conditional sensors available – add to an existing NIBP200A system

  RXCUFSEN9.5-MRI = 9.5 mm, 100-220 g
  RXCUFSEN11-MRI = 11 mm, 200-280 g
  RXCUFSEN13-MRI = 13 mm, 250-350 g

  MRI Use: MR Conditional

  Condition: Animal use only; tested to MR field strength 3T

  RXTCUFSENSOR 9.5/11/13 Components—MRI chamber room components only:

  Sensor Housing: Delrin®
  SensorType: Infrared
  Sensor Tubing: Latex
  Cable: Dual Fiber Optical Cable
  Air Line: Tygon® Tubing

- Analog outputs: pressure 0-3 V DC, Pulse 0-4 V DC
- Output cables: pressure cable and pulse cable
- Interface cables: to BIOPAC or third-party A/D hardware
- User's Manual

Optional Tail Heater: TAILHEATA 110 V or TAILHEATB 220 V

SPECIFICATIONS

Cut-off Pressure Range:	100 – 300 mmHg (adjustable by 1mmHg steps)
Pressure Accuracy:	300 mmHg Full Scale 1%
Pressure Sensitivity:	0.1 mmHg
Pressure Signal output:	300 mmHg/3 Volt DC
Pulse Gain Levels:	x1, x2, x4, x5, x8, x16, x32 (adjustable)
Pulse Signal Output:	0 – 4 Volt DC
Pulse Display:	Pulse intensity is displayed on A2, derived from plethysmographic measure The tail sensor detects blood flow and pulse intensity is increased or decreased, depending on the flow ratio.
LCD Display:	7" 800 x 480 TFT (NIBP250)
User Interface:	Resistive Touch Panel (NIBP250)
Analog outputs:	Two BNC connectors for uncalibrated pressure and pulse signals
Triggers:	Two BNC connectors for TTL Compatible trigger in and out signals
Power Supply:	12 Volt 2 Amp – External

NIBP200A/NIBP250 SYSTEM CONNECTIONS

NIBP200A Front Panel

NIBP200A Rear Panel

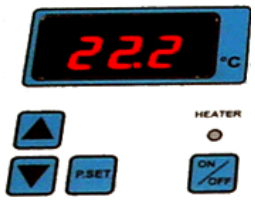
1. Connect the CBL150-PRE cable (or CBL35-PRE cable for MP36/35 hardware).
    a. BNC to the PRESSURE output on the back panel of the unit.
    b. Other end to A1 on the front of the AMI100D/HLT100C/UIM100C (or CH 1 of the MP36/35 unit).
2. Connect the CBL150-PLS cable (or CBL35-PLS for MP36/35 hardware).
    a. BNC to the PULSE output on the back panel of the unit.
    b. Other end to A2 on the front of the AMI100D/HLT100C/UIM100C unit (or CH 2 of the MP36/35 unit).
3. Connect the IRSENSOR.
    a. Black cord to the sensor input on the front panel of the NIBP200A (back panel on NIBP250).
    b. Tubing in the cuff on the front panel of the NIBP200A (back panel on NIBP250).
4. Connect the power.
    a. AC300 adapter to the 12 V DC input on the back panel of the NIBP200A.
    b. AC300 to Mains power.
5. Switch the POWER on.

ANIMAL PREPARATION

Optional Heating Chamber

Restrainer Animal Holders

Tail Cuff/Sensor

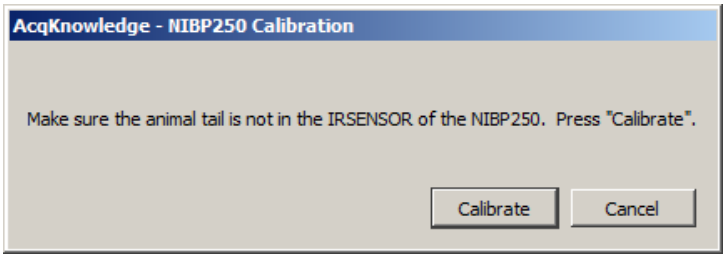


1. Turn the Animal Heating Chamber on.
2. Set the temperature value (press and hold P.Set and then press the up or down arrow to reach the desired value).
   - For accurate noninvasive blood pressure measurement, the animal or its tail should be warmed to 32° C.
3. Press the Heater button to start heating 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, to condition the animal, put the animal inside the holder several times a day and repeat the heating each time.*

SOFTWARE SETUP (Acq*Knowledge* 4.1 and higher)

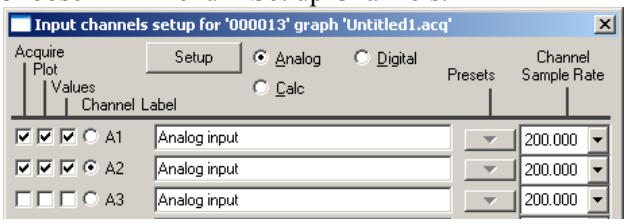
1. Launch Acq*Knowledge* 4.x.
2. Select the "Create/Record a new experiment" option.
3. Select "MP160/150 > Set Up Data Acquisition > Channels > "Add New Module..."
    a. From the new module list, select AMI100D-HLT100C-A1 (MP160) or UIM100C-A1(MP150), (or whichever channel CBL150-PRE pressure cable is connected to) and click "Add."
    b. From the AMI100D/HLT100C (MP160) or UIM100C (MP150) Transducer list, select "NIBP200A – Small Animal Tail BP, Pressure" or "NIBP250 – Small Animal Tail BP, Pressure" and click OK.
    c. Click "Calibrate" in the resulting Calibration dialog.



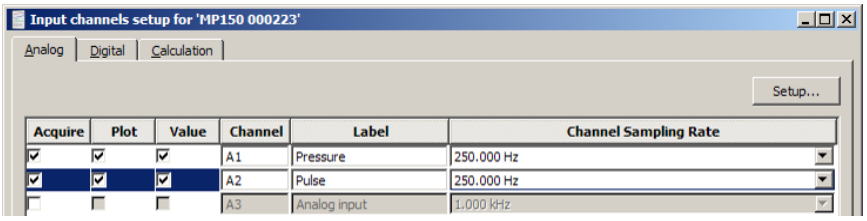
4. Repeat "Add New Module…" portion of Step 3.
    a. From the new module list, select AMI100D-HLT100C-A2 (MP160) or UIM100C-A2 (MP150) (or whichever channel CBL150-PLS pulse cable is connected to) and click "Add."
    b. From the AMI100D/HLT100C (MP160) or UIM100C (MP150) Transducer list, select "NIBP200A – Small Animal Tail BP, Pulse" or "NIBP250 – Small Animal Tail, Pulse" and click OK.

SOFTWARE SETUP (Acq*Knowledge* 4.0 and earlier)

1. Launch the BIOPAC software.
2. Choose "MP menu > Set up Channels."



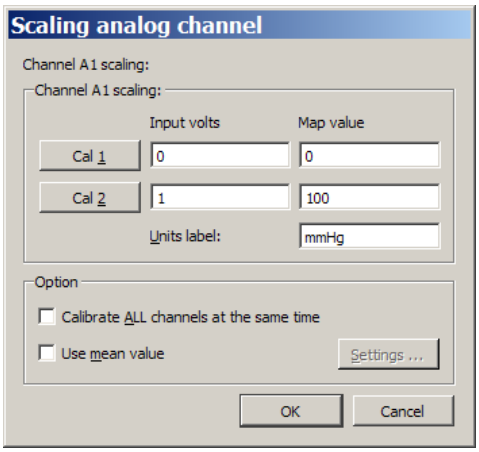
or



3. Enable analog inputs A1 and A2 and select the Acquire, Plot and Value options.
    - If desired, enter channel Labels: A1 Pressure and A2 Pulse.

4. Calibrate for the pressure measurement of IRSENSOR.
   a. Select A1 (Pressure) and click Setup and establish these settings:

	Input volts	Scale (Map) value
Cal 1	0	0
Cal 2	1	100
Units	**Label:**	mmHg



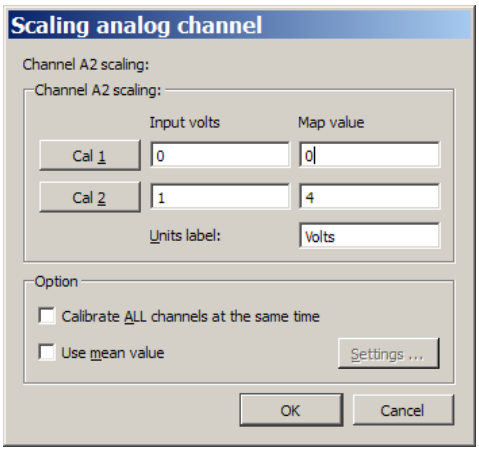
The scaling must be adjusted as the cut-off pressure switch settings are changed. If the pressure switch is set to 300 mmHg, then the settings should be:

	Input volts	Scale (Map) value
Cal 1	0	0
Cal 2	3	300
Units	**Label:**	mmHg

   b. Click OK as needed to close out of A1 setup.

5. Calibrate for the pulse measurement of IRSENSOR.
   a. Ensure that the tail is not inside the IRSENSOR and it is empty, and the sensor resides freely.
   b. Select A2 (Pulse) and click Setup and establish these settings:

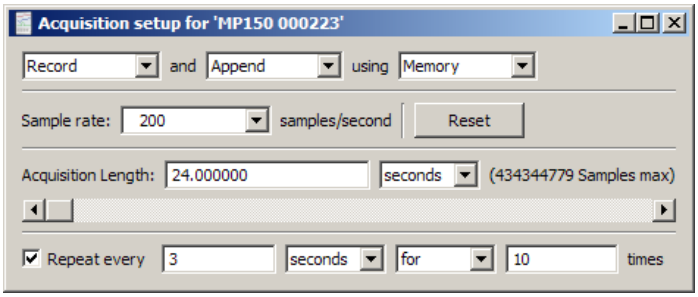
	Input volts	Scale (Map) value
Cal 1	0	0
Cal 2	1	4
Units	**Label:**	Volts



   c. Click OK as needed to close out of A2 setup and the Setup Channels dialog.

6. Choose "MP menu > Set up Acquisition" and establish the following settings:

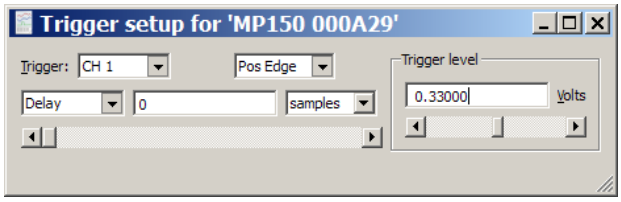
   Mode = Record and Append to Memory
   Sample Rate = 200 samples/second
   Total Length = 24 seconds
   Repeat = every 3 seconds for 10 times



7. Exit Set up Acquisition dialog.

8. Choose "MP menu > Setup Trigger" and establish the following settings:

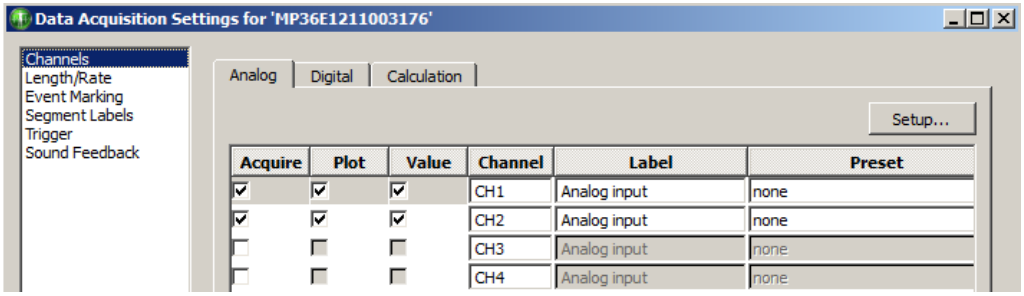
   Trigger = CH 1, Pos Edge
   Trigger Level = 0.33 Volts
   (based on 1 V ≈ 100 mmHg)
   Delay = 0 samples



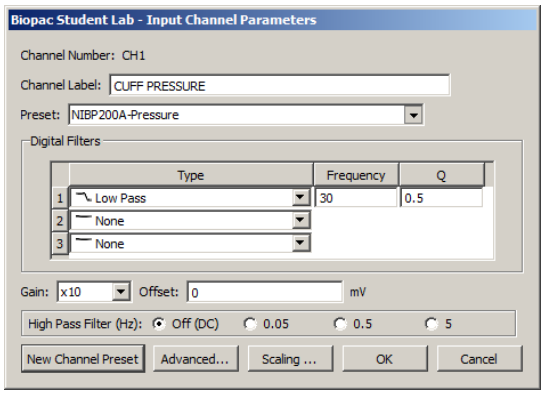
9. Close out of Triggering dialog.

SOFTWARE SETUP for Acq*Knowledge* 4.x or BSL 4.x with MP3x Hardware

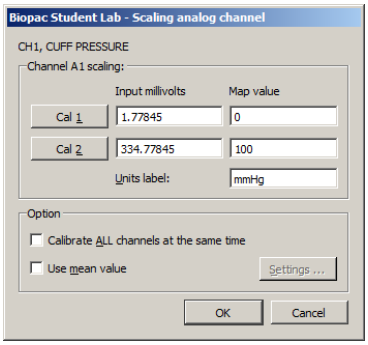
1. Launch the software.
2. Select the "Create/Record a new experiment" option.
3. If necessary, choose "MP3x > Set up Data Acquisition > Channels."
4. Enable analog inputs CH1 and CH2 and select the Acquire, Plot and Value options.



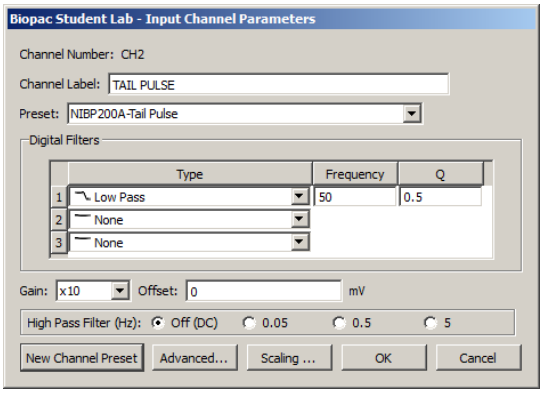
5. Select CH1 and click "Setup.".
6. Click "New Channel Preset," enter "NIBP200A-Pressure" and click OK.
7. Establish the following settings:
   - Channel Preset = NIBP200A-Pressure
   - Channel Label = CUFF PRESSURE
   - Gain = x10
   - Input Coupling = DC
   - Filter = 1
   - Type = Low Pass
   - Frequency = 30
   - Q = 0.5



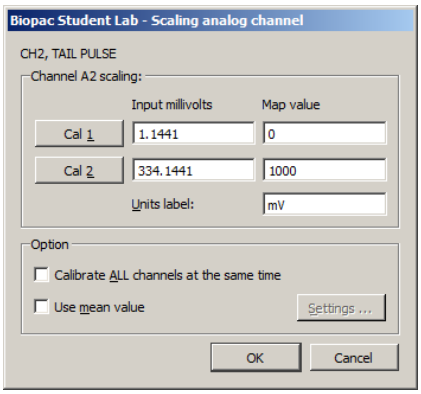
8. Calibrate for the pressure measurement of IRSENSOR.
   a. Click "Scaling" button and establish the following settings:
      Map values
         Cal1 = 0
         Cal2 = 100
      Units label = mmHg
   b. Click the Cal 1 button.
   c. Add "333" to the Cal 1 Input value, and enter the result in Cal 2 Input value (Cal 2 = Cal 1 + 333)
   d. Click OK as needed to exit the CH1 "Scaling" and Input "Channel" setup dialogs.



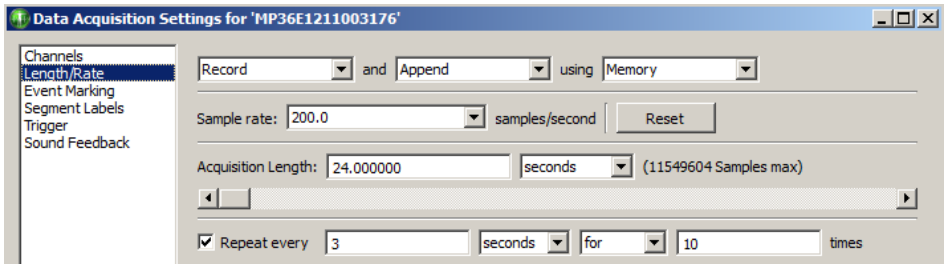
9. Select CH2 and click "Setup."
10. Click "New Channel Preset," enter "NIBP200A-Tail Pulse" and click OK.
11. Establish the following settings:
    - Channel Preset = NIBP200A-Tail Pulse
    - Channel Label = TAIL PULSE
    - Gain = x10
    - Input Coupling = DC
    - Filter = 1
    - Type = Low Pass
    - Frequency = 50
    - Q = 0.5



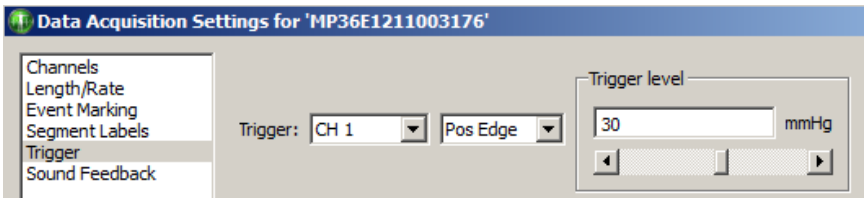
12. Calibrate for the pulse measurement of IRSENSOR.
    a. Ensure that the tail is not inside the IRSENSOR, and that the sensor resides freely.
    b. Click "Scaling" button and establish the following settings:
        Map values
            Cal 1 = 0
            Cal 2 = 1000
        Units label = mV
    c. Click the Cal 1 button.
    d. Add "333" to the Cal 1 Input value and enter the result in Cal 2 Input value (Cal 2 = Cal 1 + 333)
    e. Click OK as needed to exit the CH2 "Scaling" and "Input Channel" setup dialogs.



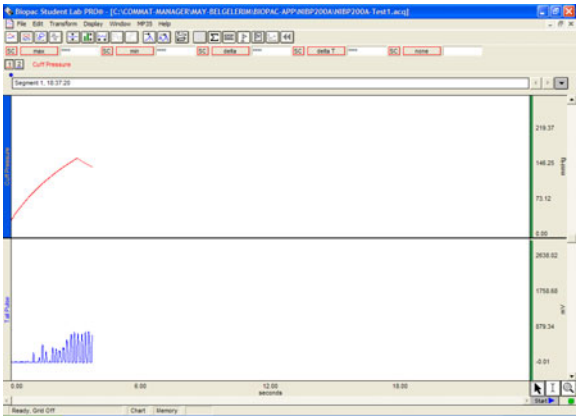
13. Choose "MP3x > Set Up Data Acquisition > Length/Rate" and establish the following settings:
    - Mode = Record and Append using Memory
    - Sample Rate = 200 samples/second
    - Acquisition Length = 24 seconds
    - Repeat = every 3 seconds for 10 times



14. Choose "Trigger" and establish the following settings.
    Trigger = CH 1, Pos Edge
    Trigger Level = 30 mmHg
15. Exit the Data Acquisition Settings dialog.



RECORDING

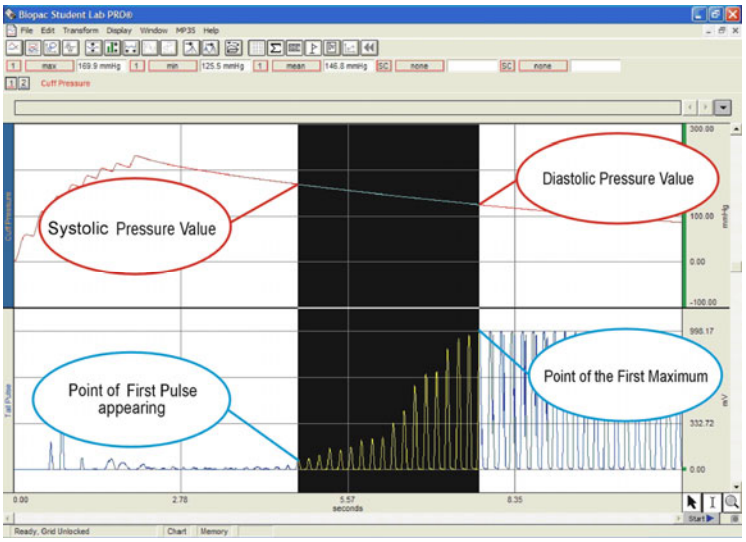


1. Confirm that the animal is ready and that the IRSENSOR is attached to the tail.
2. Click “Start” in the BIOPAC software window.
3. Press START button on the front panel of NIBP200A.
   - IRSENSOR will pump up the Cuff automatically.
   - When the Cuff Pressure on A1 reaches 30 mmHg, the cuff pressure 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 done.

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

NIBP200A 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 measurements.

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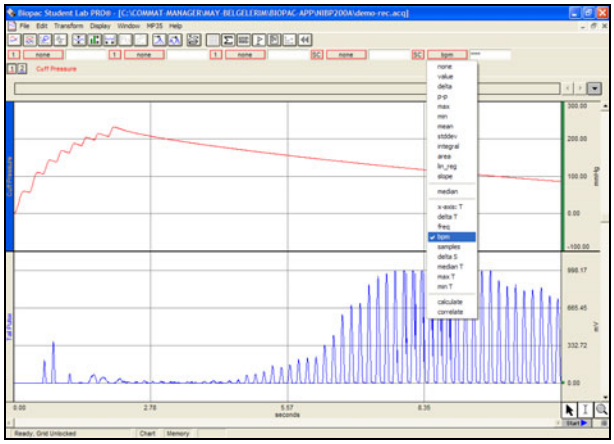
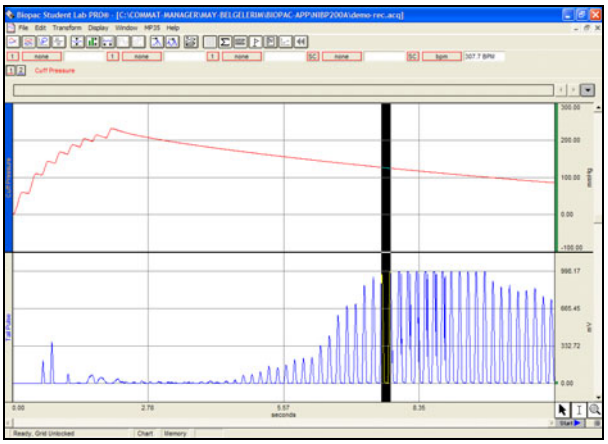
Calculation of BPM Heart





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.

NIBP250 QUICK GUIDE

PREPARE

- With unit turned off, attach the sensor and cuff connectors.
- Turn on unit and wait for the Main Screen to appear.
- Prepare the animal and attach sensor-cuff to tail.

ACQUIRE

- When preparation is complete: Press the “Start” button on the Main Screen. The button label changes to “Stop” and you can halt the acquisition at any time.
- When the acquisition starts, the unit automatically closes the leakage valve and begins inflating the cuff.
- After pressure reaches the maximum level, the pump stops and opens the leakage valve to release the pressure.
- After the pressure is fully released, the acquisition stops.

NIBP250 ANALYSIS

The NIBP250’s automated peak detection system marks the peak of each pulse with a white cross, and is enabled by selecting the "Peak by peak" option on the Main Screen. This feature makes it easier to identify the individual pulses. To determine the systolic and diastolic values:

1. Select the "Peak by peak" box on the main screen.
2. Use the right (or left) cursor button to locate the first pulse's white cross and press the "Systolic" button. (You may also place the cursor using the touch screen.) The system will record and display the systolic blood pressure value.
3. Use the cursor button (or touch screen) to move to the pulse with the highest peak and then press the "Diastolic" button. The system will record and display the diastolic blood pressure value..

You may change your cursor peak positions at anytime during the analysis.

After measurement is complete, press the Save button under “Results.” An automatically generated result code will be displayed at the top of the results section.

For analysis in BIOPAC Acq*Knowledge* or BSL *PRO* software, see previous page for NIBP200A.

SAVE RESULTS

- Previously saved results can be displayed by pressing the "Load" button under "Results."
- Placing the cursor on a desired measurement and pressing OK will load the recorded pressure, pulse curves and previously calculated results.
- After loading is complete, you can easily evaluate the results and re-analyze any measurements.

TURN OFF

- Before turning off the unit, be sure that the current measurement was saved.
- Power off the unit by switching the power button on the back

TROUBLESHOOTING

Tail Pulse signals are not regular.

- The animal may be under stress, resulting in excessive tail movement. Remove the animal from the RESTRAINER holder until it calms down before continuing with the experiment.
- The tail may not be sufficiently warmed or cooled down. Put the animal in the Tail Heater Chamber and repeat the heating process. Make sure the tail temperature is 32° C.
- Tail Cuff sizing may be incorrect. Check Table 5 on the following page for sizing descriptions.
- Tail Cuff Sensor position may be incorrect. Try re-attaching the sensor in a different location on the tail. The optimal location is between the mid-point of tail and base of tail (spinal column).

Compressor is working continuously.

- Immediately turn off the NIBP system.
- Remove the Tubing from the Cuff connector on the panel of NIBP system
- Turn the system back on.
- Close the air outlet by pressing the finger on the Cuff output and press the "Start" button. The compressor will work for a few seconds and stop (please inform BIOPAC if the Compressor does not stop). The pressure chart should be viewable on the screen.
- If the Compressor stops automatically, it means that the system is working normally.

There is leakage in the tubing connections and Cuff of the IRSENSOR.

- Make sure the tubing is securely attached.

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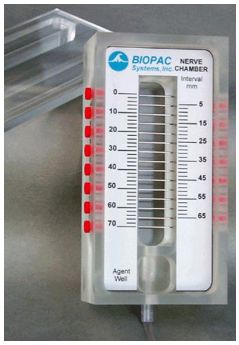
NERVE CHAMBERS: NERVE1 AND NERVE2

These 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 2 mm pin plugs.

NERVE1 and NERVE2 Comparison

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

NERVE1 – WITH AGENT WELL AND LID



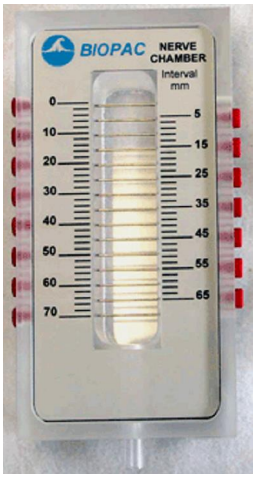
NERVE1 chamber includes:

- **Deep Reservoir** (35 mL) for containing Ringers or other solutions
- **Drain (with valve & hose)** to facilitate extended viability of the preparation
- **Agent Well** for adding compounds (such as ether or dry ice)
- **Lid** to enclose the preparation when the protocol requires it.

NERVE2 – STANDARD NERVE CHAMBER

NERVE2 chamber includes:

- **Deep Reservoir** (35 mL) for containing Ringers or other solutions.
- **Drain (with valve & hose)** to facilitate extended viability of your preparation.



NERVE2

NERVE CHAMBER SPECIFICATIONS (NERVE1/NERVE2)

Pins: 15, stainless steel
Spacing: 5 mm
Sockets: accepts 2 mm pin plugs
Reservoir: holds 35 mL (or use drain/valve)
Dimensions: 4.5 cm x 7 cm x 14 cm (H x W x L)
Agent well: *(NERVE1 only)* 1.4 cm x 2 cm x 2 cm (H x W x L)
Lid: *(NERVE1 only)* 50 mm thick

Related components:

- STM100C Stimulator Module
- STMISO Series Stimulator Modules
- MCE100C Micro-electrode Amplifier
- ERS100C Evoked Response Amplifier
- EMG100C Electromyogram Amplifier

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NERVE CHAMBER CONNECTIONS

To connect the Nerve Chamber to MP-series Biopotential amplifiers (MCE100C, ERS100C, or EMG100C), use three JUMP100 connectors and three CBL200 adapter cables. Optionally, for additional lead length, use one MEC110C extension cable.

1. Plug the three JUMP100s into the desired points of the Nerve Chamber.
2. Connect the free ends of the JUMP100s to the mating ends of the CBL200s.
3. Then connect the free ends of the CBL200s to the Biopotential amplifier inputs. For additional lead length, plug the MEC110C into the Biopotential amplifier and plug the free ends of the CBL200s into the free end of the MEC110C.

To connect the Nerve Chamber to the STM100C Stimulator, use one CBL106 and one CBL102.

1. Plug the red and black leads (2 mm pins) of the CBL106 into the desired points of the Nerve Chamber.
2. Connect the free end (Female BNC) of the CBL106 to the mating end (Male BNC) of the CBL102.
3. Then insert the free end of the CBL102 (3.5 mm phone plug) into the 50 Ohm output of the STM100C.

Note: If the STM100C Stimulator is used with a Biopotential amplifier on the same nerveð which is nearly always the caseð make sure that the black lead of the CBL106 (stimulation negative) is connected to the same pin as the ground lead going to the Biopotential amplifier. This is easy to do because the design of the JUMP100 allows stacking connections.

OUT SERIES

Headphones

OUT1 High Fidelity Headphones

OUT1A Ultra-Wide Frequency Response Headphones

OUT100 Monaural Headphone

40HP Monaural Headphones

LED

OUT4 Visual Stimulus: Controllable LED

OUT103 LED Cable

OUT2 BNC Output Adapter

OUT3 *for TTL pulses only—see Stimulators*

OUT5 *see STMISOLA*

OUT101 Tubephone

OUT01E Foam Ear Inserts:

OUT101R Plastic Tubes

OUT102 Piezo Audio Transducer

OUT6 DSUB9 to RJ11 Output Adapter

OUT1 HIGH-FIDELITY 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)

OUT1A WIDE-FREQUENCY RESPONSE HEADPHONES

These ultra-wide frequency response headphones connect directly to the headphone port on the MP36 or MP36R data acquisition unit.

Features of these multi-purpose headphones include:

- High dynamic range
- High-resolution capsule
- 1/8" connector plus 1/4" adapter included
- Single-sided cord
- Oval-shaped ear cups
- Comfortable headband
- High-quality components and exceptionally rugged construction

OUT1A SPECIFICATIONS

Connector: 1/8" TRS connector plus 1/4" TRS adapter

Interface: MP36 or MP36R (not compatible with other MP units)

Frequency response: 20 Hz - 20 kHz

Max. power handling: 100 mW

Impedance: 32 Ohm

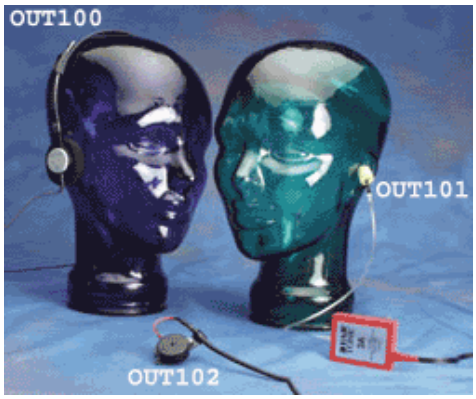
Sensitivity: 105 dB @ 1 kHz

Cord length: 2 meters

Dimensions: 11-3/4" x 9-3/4" x 8-1/4"

OUT100 MONAURAL HEADPHONES

These monaural headphones can be used with the STM100C stimulator module to deliver a tone signal while recording data for startle response or other stimulus-response studies. The headphones can also be used to listen to raw signals (such as EMG), piped through the STM100C from an amplifier output. The OUT100 is a wide response, high efficiency headphone, weighing 85 grams and is equipped with a 1.8 meter cord terminated in a 6.3 mm (1/4") phone plug.



OUT100 SPECIFICATIONS

Weight:	85 grams
Connector Type:	6.3 mm (1/4")
Cable length:	1.8 meters
Speaker:	28 mm dia 32 ohm dynamic Mylaar
Impedance:	16 Ohm @ 1.0 kHz
Power Handling:	100 mW max
Frequency response:	20 Hz - 20 kHz
Average SPL:	108 dB ± 4 dB
Adapter (included):	1/4" mono adapter plug

40HP MONAURAL HEADPHONES

These monaural headphones are used with Biopac Science Lab MP40 and Biopac Student Lab MP46/45 for stimulus response experiments and to listen to EMG signals. The 40HP is a wide-response, high-efficiency headphone.

40HP SPECIFICATIONS

Cable Length:	5 meters
Connector Type:	3.5 mm phone plug

OUT2 BNC (M) 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.

See also: **SS9LA** BNC Input Adapter

OUT2 SPECIFICATIONS

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

OUT4 VISUAL STIMULUS: CONTROLLABLE LED

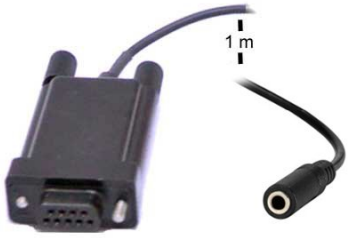
The OUT4 is a controllable high-brightness LED output device mounted on an angled stand intended to provide a good viewing angle for subjects. Use OUT4 for visual stimulus presentation in Biopac Student Lab Lesson 11A Reaction Time - Visual Stimulus, Visual Evoked Potential experiments, and more. Set LED intensity via Use MP Menu > Output Control > Visual Stim Controllable LED - OUT4; set flash rate/sequence via MP Menu > Output Control > Pulse Sequence.

OUT4 SPECIFICATIONS

LED:	White, Relative Luminous Intensity up to ~5000 mcd, adjustable
Interface:	MP36 or MP35 “Analog Out” port* (Pulse Out 0-5 V)
Cable:	2 meters

* OUT4 is not compatible with a) Research System MP36R at this time because Acq*Knowledge* 4.4 and below does not include the required output control, b) with MP46/45, c) with MP30 except if used in place of SS10L in BSL Lesson 11.

OUT5 STMISOLA INTERFACE FOR MP36/36R



This DSUB9 to 3.5 mm mono jack interface allows the MP36/36R to be used with the STMISOLA isolated linear stimulator for arbitrary stimulus output (range -10 V to +10 V). The 1 m interface connects the MP36/36R Analog Out and the STMISOLA 3.5 mm mono plug/cable.

Compatible with:

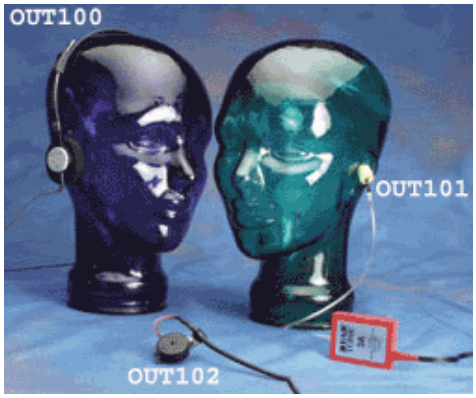
- MP36 with BSL 4.1.2 and above
- MP36R with Acq*Knowledge* 4.4.2 and above

OUT6 DSUB9 TO RJ11 OUTPUT ADAPTER

Use this DSUB9 to RJ11 jack Output Adapter to map the analog output of an MP36 or MP36R to an RJ jack; allows stimulators designed with AMI/HLT-compatible connections to be connected to MP36/36R units. Control the STMTHERM, or other stimulators that have RJ11 input cables.

OUT101 TUBEPHONE

- **OUT101E** Replacement Foam Ear Inserts: pkg. of 50
- **OUT101T** Replacement Plastic Tubes: pkg. of 4



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

Use the OUT101 tubephone 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.

MP36 and MP36R interface options:

- BSL System stimulator (model BSLSTM): use BSLCBL6 and Radio Shack P/N 274-047 ¼" to 1/8" phono adapter
- BSL MP36 data acquisition unit Analog Out port: use OUT3 plus BSLCBL6 and Radio Shack P/N 274-047 ¼" to 1/8" phono adapter
- MP36 headphone port: use Radio Shack P/N 274-047 ¼" to 1/8" phono adapter; note—volume may not reach the same levels as the Analog Out port

Calibration for Auditory Brainstem Response Studies

To calibrate the OUT101 Tubephone, use an Etymotic ER-7C Probe Microphone—this microphone provides a calibrated output voltage which is a function of applied Sound Pressure Level (SPL). The sensitivity is 50 mV/Pascal (-46 dB re: 1 V/uBar): 0 dB SPL = 0 dBuV. Place the Probe Microphone insert tube in the auditory canal prior to the insertion of the OUT101 foam tip.

The OUT101 Tubephone sound delivery tube and the Probe Microphone sound input tube will then be exposed to the same auditory chamber. Accordingly, the SPL is recorded, via the Probe Microphone, simultaneously with applied auditory stimulus from the OUT101 Tubephone.

OUT101 SPECIFICATIONS

Response:	Compares to TDH-39, 49 or 50 audiometric headphones
Acoustic signal delay:	1 msec
Dimensions:	3.8 cm (wide) x 5 cm (high) x 1 cm (thick)
Cable termination:	6.3 mm (1/4") phone plug
Cable length:	1.8 meters
Cable clip:	Yes; clip attaches to fabric or fixtures

OUT102 PIEZO AUDIO TRANSDUCER

The OUT102 piezo transducer is very useful for providing an audible stimulus, or alarm, when a physiological signal passes a certain threshold. As such, the OUT102 makes an excellent audible BPM indicator for ECG, blood pressure, or respiration signals. The device can also be used to indicate when temperature or other slowly moving variable (e.g., electrodermal response) passes a certain threshold.

The following interface cables are included with the OUT102:

- 1 x 3.5 mm cable (CBL100) for connecting the OUT102 to a Digital I/O port on the UIM100C rear panel for operation with Control Channel outputs
- 1 x Y-Splitter (CBL212) to permit the MP System to sample the drive waveform from stimulus presentation setups; permits recording of the drive waveform timing and amplitude
- 2 x Unisolated RJ11 to 3.5 mm Jack (CBL122)

The OUT102 Piezo transducer may be connected directly to the STM100C stimulator module 50 ohm output. When the stimulator module output rises above 1.5 volts, the Piezo indicator will emit a constant audible signal (3.0 kHz @ 80 dB).

The threshold for the OUT102 is determined by adjusting the amplitude control on the STM100C module. The specific Biopotential or Transducer amplifier signal monitored can be recorded while simultaneously directed through the STM100C module. To operate as described here, the source amplifier needs to be set to CH16, STM100C is set to CH16 input, and source signal must be able to reach at least +1.5 V of amplitude. Source signal gain can typically be sufficiently adjusted by using the gain switch on the source amplifier module. STM100C amplitude control can be used to attenuate the source signal, as required, to help activate the Piezo transducer on only the desired source signal portions.

The OUT102 also connects directly to the UIM100C digital I/O ports for operation with Control Channel outputs. An adapter is included for connecting the OUT102 to the UIM100C digital I/O ports.

The included splitter (CBL212 3.5 mm male mono phone plug to two 3.5 mm female mono sockets) and connector cable (CBL100 3.5 mm mono male to 3.5 mm mono male) permit the analog drive signal to be directed to two locations. The drive signal—usually from DA0 or DA1—is typically directed to the splitter cable. One socket output of the CBL212 splitter cable is directed to the OUT102 input. The other socket output of the CBL212 splitter cable is looped back to drive an available MP input, via CBL100, through the UIM100C. In this manner, during acquisition, the stimulus level and timing will be indicated on the recording.

OUT102 SPECIFICATIONS

Dimensions (case):	50.29 mm (W) x 65.41 mm (L) x 45.15 mm (H)
Cable Length:	1.8 meters
Connector Type:	3.5 mm phone plug + adapter for the UIM100C digital I/O ports

OUT103 LED CABLE

Use this LED cable to synchronize a light flash. The 3 meter cable makes it easy to use the LED for a variety of protocols. Terminates for connection to Analog OUT 0/1 and includes adapter for connection to Digital I/O. **Media synchronization** - Windows only - Acq*Knowledge* 4.1 and above.

The included 3.5 mm mono splitter (3.5 mm male mono phone plug to two 3.5 mm female mono sockets) and one CBL100 (3.5 mm mono male to 3.5 mm mono male cable) permit the analog drive signal to be directed to two locations. The drive signal – usually from DA0 or DA1 – is typically directed to the splitter cable. One socket output of the splitter cable is directed to the OUT103 input. The other socket output of the splitter cable is looped back to drive an available MP input, via CBL100, through the UIM100C. In this manner, during acquisition, the stimulus level and timing will be indicated on the recording.

Option 1: MP150 and UIM100C setup using an Analog Output

a. Connect the OUT103's 3.5 mm phone plug from the LED to one of the arms of the included Y-cable.

b. Connect the included CBL100 to the other arm of the Y-cable.

c. Connect the stem of the Y-cable to one of the two Analog Output connections near the bottom of the front face of the UIM100C.

d. Connect the other end of the CBL100 to an otherwise unused Analog Channel also on the front face of the UIM100C.

e. Use "MP160/150 > Set Up Channels..." (in Acq*Knowledge* 4.4, choose "Channels" in the left pane after choosing "MP160/150 > Set Up Data Acquisition...") and acquire and plot the analog channel to which the CBL100 is connected.

f. Use "MP160/150 > Set Up Stimulator..." (in Acq*Knowledge* 4.4, choose "Stimulator" in the left pane after choosing "MP160/150 > Set Up Data Acquisition...") to send 5 volt pulses through the Analog Output.

Option 1: MP160 and AMI100D/HLT100C setup using an Analog Output

a. Connect the OUT103's 3.5 mm phone plug from the LED to one of the arms of the included Y-cable.

b. Connect the included CBL100 to the other arm of the Y-cable.

c. Connect the stem of the Y-cable to a CBL122 connected to one of the two Analog Output connections near the bottom of the front face of the AMI100D/HLT100C.

d. Connect the other end of the CBL100 to a CBL122 connected to an otherwise unused Analog Channel also on the front face of the AMI100D/HLT100C.

e. Use "MP160 > Set Up Channels..." (in Acq*Knowledge* 5, choose "Channels" in the left pane after choosing "MP160 > Set Up Data Acquisition...") and acquire and plot the analog channel to which the CBL100 is connected.

f. Use "MP160 > Set Up Stimulator..." (in Acq*Knowledge* 5, choose "Stimulator" in the left pane after choosing "MP160 > Set Up Data Acquisition...") to send 5 volt pulses through the Analog Output.

Option 2: MP150 and UIM100C setup using a Digital I/O Channel

a. Connect the OUT103 2 mm pin adapter to the 3.5 mm plug on the OUT103 cable.

b. Connect the red OUT103 2 mm pin to a Digital I/O channel on the rear of the UIM100C and the black pin to GND D on the rear of the UIM100C.

c. Use MP150 > Set Up Channels to acquire and plot the Digital I/O channel the OUT103 is connected to.

d. Set MP150 > Show Manual Control

- Set for 'Output.'

- Enable the 'Set immediately' option.
- Click the Digital I/O channel the OUT103 was connected to toggle between 0 and 1.

If necessary, click the 'Set' button to update the manual control and output a digital pulse.

MP36R setup - additional items required

a. Connect an OUT3 (BNC adapter) to the 'Analog Out' port on the rear of the MP36R.

b. Connect a BSLCBL6 (interface cable: BNC to 3.5 mm) to the OUT3.

c. Connect the OUT103 3.5 mm plug to the BSLCBL6 3.5 mm socket.

d. Set MP36 > Output Control 'Low Voltage Stim' option

- Set Pulse width to 100 msec.
- Set Pulse level to 5 volts – set Reference Channel to any digital channel.
- Click the D'ON' button to output a digital pulse.

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STMTHERM THERMAL STIMULATOR

STMTHERM Thermal Stimulator Unit (SCU) and TSD191 Transducer Probe (Thermode)

The STMTHERM is a thermal stimulator that can deliver a range of hot and cold temperature stimulation to a subject, and can be used to identify participant thermoreceptor response thresholds for a variety of applications. The STMTHERM consists of two parts, the Stimulator Unit (SCU) and the included TSD191 Thermal Stimulation Transducer (Thermode).

The TSD191 has a 30 mm x 30 mm contact area and includes a hook-and-loop strap to hold it in place. The STMTHERM is an "open-loop" thermal stimulator, so there is no temperature feedback incorporated into the design. Accordingly, the STMTHERM behaves similarly to a conventional voltage stimulator where the electrical applied stimulus is a function of drive level and associated loading. In the context of the STMTHERM, the thermal stimulus temperature at the Thermode contact area is impacted by the heat-carrying capacity of the stimulus area.

In order to obtain an accurate measure of the specific stimulus temperature at the stimulus area, BIOPAC recommends use of the SKT100C Skin Temperature Amplifier Module and TSD202A Temperature Transducer, where the TSD202A is placed between the Thermode and the stimulus area.

The STMTHERM is controlled via a voltage signal (Peltier thermoelectric method) and the Thermode temperature can be increased or decreased in a linear or step-change fashion. The STMTHERM also has two manual pushbutton test modes that deliver a five-second step increase or decrease, respectively, to the present stimulus temperature.

The analog control input signal range is ±10 volts, where negative voltages lower the temperature of the Thermode and positive voltages increase the temperature of the Thermode. An LED indicator on the front of the SCU turns red when the Thermode is being heated and blue when it is being cooled. The intensity of the LED indicates the relative amount of heating/cooling being applied via the control voltage.

The SCU interfaces directly to one of the AMI100D or HLT100C analog output ports for MP160 Systems, an HLT100C-MP150 analog output port for MP150 Systems, or with added OUT6 for MP36/MP36R Systems. The SCU can be controlled using Acq*Knowledge* software "Stimulator Setup" or "Manual Control" features.

Output interface: Use the Thermode (TSD191) to deliver temperature stimuli to participants. The transducer has a thermal stimulation area of 30 mm x 30 mm and includes a three-meter cable. The transducer incorporates a heat sink and cooling fan. Proper operation of the TSD191 requires that the fan airflow not be obstructed.

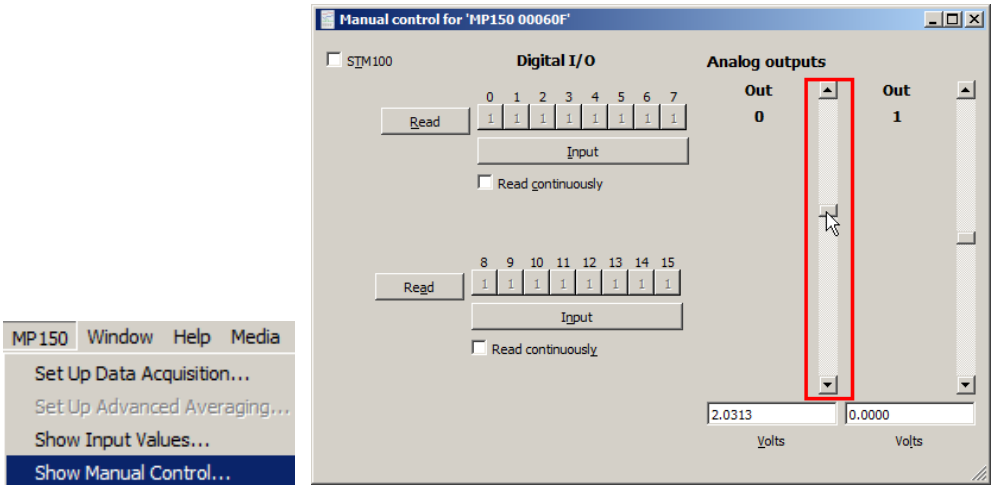
WARNING: When applying thermal stimulus to skin, DO NOT set the STMTHERM control voltages at the -10 V or +10 V limits for longer than 5 seconds.

STMTHERM THERMAL STIMULATOR Specifications

(Includes Stimulator Control Unit (SCU) & TSD191 Thermal Stimulation Transducer (Thermode)

SCU Weight		470 grams
Dimensions		Enclosure: 15.4 cm (wide) x 15.8 cm (deep) x 4.8 cm (high)
Cable	**MP160**	to AMI100D or HLT100D, 6-pin, RJ11, 2 meters long
	MP150	to HLT100C-MP150 via RJ11
	MP36/36R	via OUT6 (DSUB9 to RJ11) adapter
Control		- via Acq*Knowledge* arbitrary waveform stimulator window or external voltage source (range ±10 V) - via "HOT PULSE" and "COLD PULSE" manual pushbuttons (each generates a 5 second thermal stimulus at 50% of maximum level; equivalent to ±5 V fixed-step control voltage drive)
Fuse		3.5 amps
Power Supply		AC400 (12 V @ 5 amps)
Control Voltage Range		±10 V (via HLT100D, AMI100D, MP36/36R, Acq*Knowledge* or external voltage source)
Operation		Voltage controlled thermal stimulation (Peltier thermoelectric)
Dynamic Range		±10 V (20 V p-p) maps to 67.5° C p-p unloaded
Max Rate of Change		For 20 V p-p input, ΔT/°sec max is 7.6° C/sec

The STMTHERM can be easily controlled via the **Manual Control** window in Acq*Knowledge* software (MP1xx menu > Show Manual Control).



Acq*Knowledge* Manual Control Window

Adjust the vertical voltage slider to change the stimulus temperature. Up to two STMTHERM Systems can be used with a single MP160/150 System.

Characteristic Voltage vs. Temperature Curves

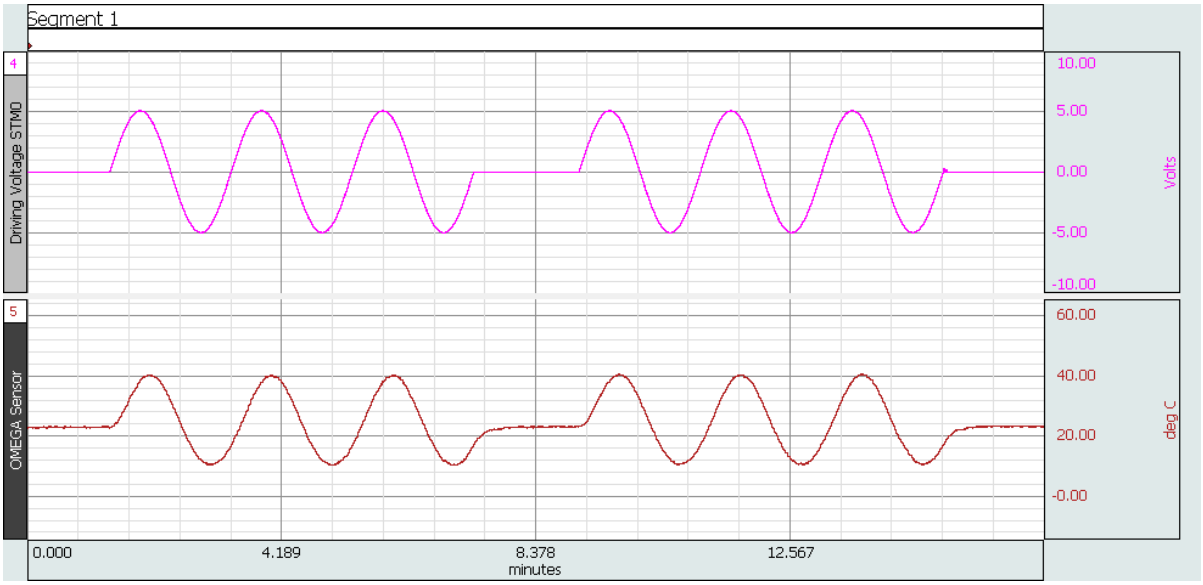


Figure 1: STMTHERM driven by a sine wave (top trace) with voltage limits of +/- 5 V and frequency of 0.008333 Hz. Peak thermal signal (bottom trace) = 40.3 ºC; minimum signal = 10.3º C. Delay between drive signal and thermal response ~ 9 – 10 sec.

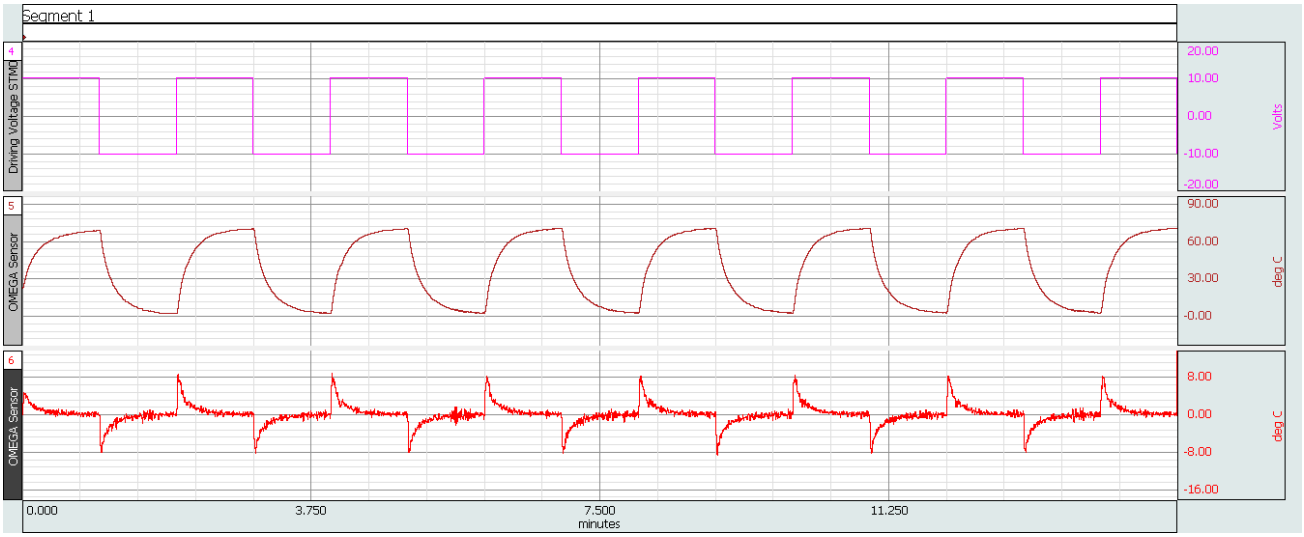


Figure 2: Unloaded response (no skin contact, using non-contact thermal imager) of the STMTHERM to +/- 10 V stimulus waveform for High Temperature Range. **Stimulus cycle is 1 minute +10V, 1 minute -10 V.**

The **peak derivative of the response is ~ 7.6 (°C/sec)** and the **output temperature swing Δ = 67.51 (°C)**.

Top curve: stimulus, middle curve: response, bottom curve: derivative of response.

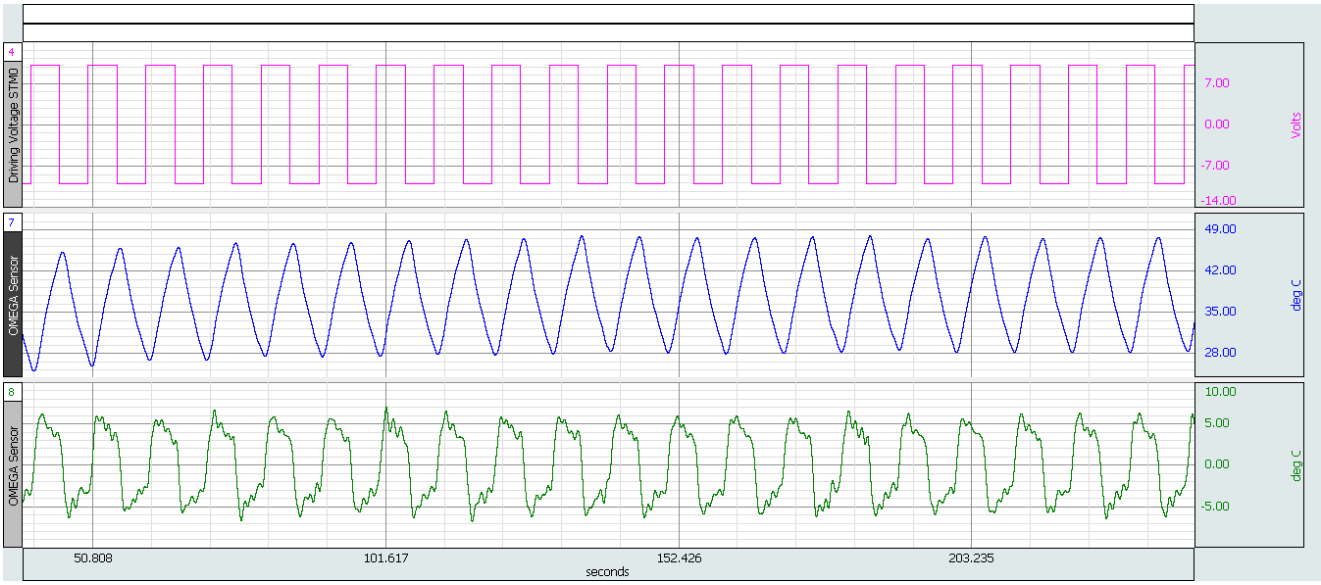


Figure 3: Unloaded response (no skin contact, using non-contact thermal imager) of the STMTHERM to +/- 10 V stimulus waveform for High Temperature Range. **Stimulus cycle is 5 sec +10 V, 5 sec -10 V.**

The **average derivative of the response is ~ 4.3 (°C/sec)** and the **output temperature swing Δ = 19.84 (°C)**.

Top curve: stimulus, middle curve: response, bottom curve: derivative of response.

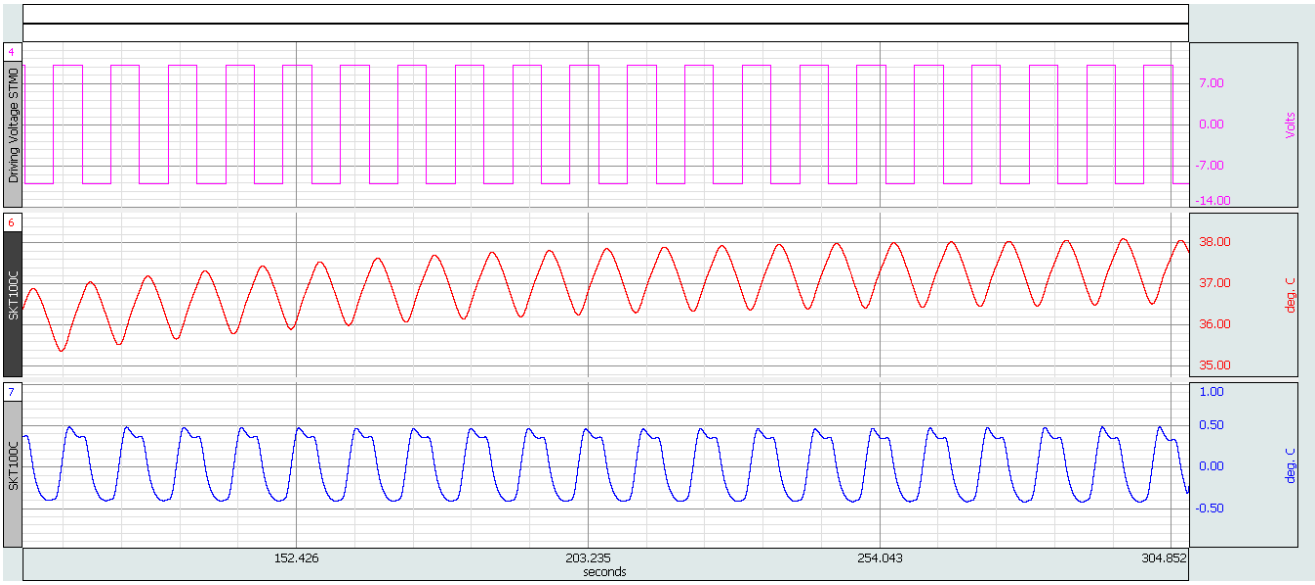


Figure 4: Loaded response (skin contact using TSD202A thermistor) of the STMTHERM to +/- 10 V stimulus waveform for High Temperature Range. **Stimulus cycle is 5 sec +10 V, 5 sec -10 V.**

The **average derivative of the response is ~ 0.393 (°C/sec)** and the **output temperature swing Δ = 1.64 (°C)**.

Top curve: stimulus, middle curve: response, bottom curve: derivative of response.

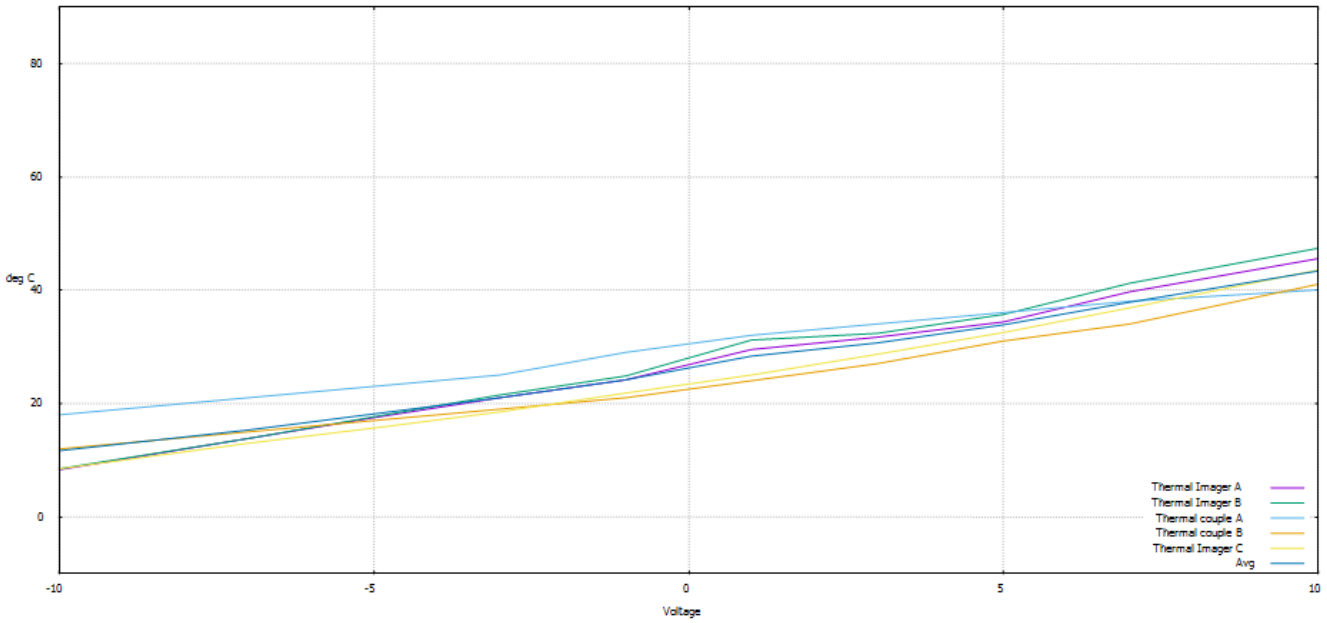


Figure 5: STMTHERM Temperature Curves (Low Temperature Range)
Measured Performance Unloaded

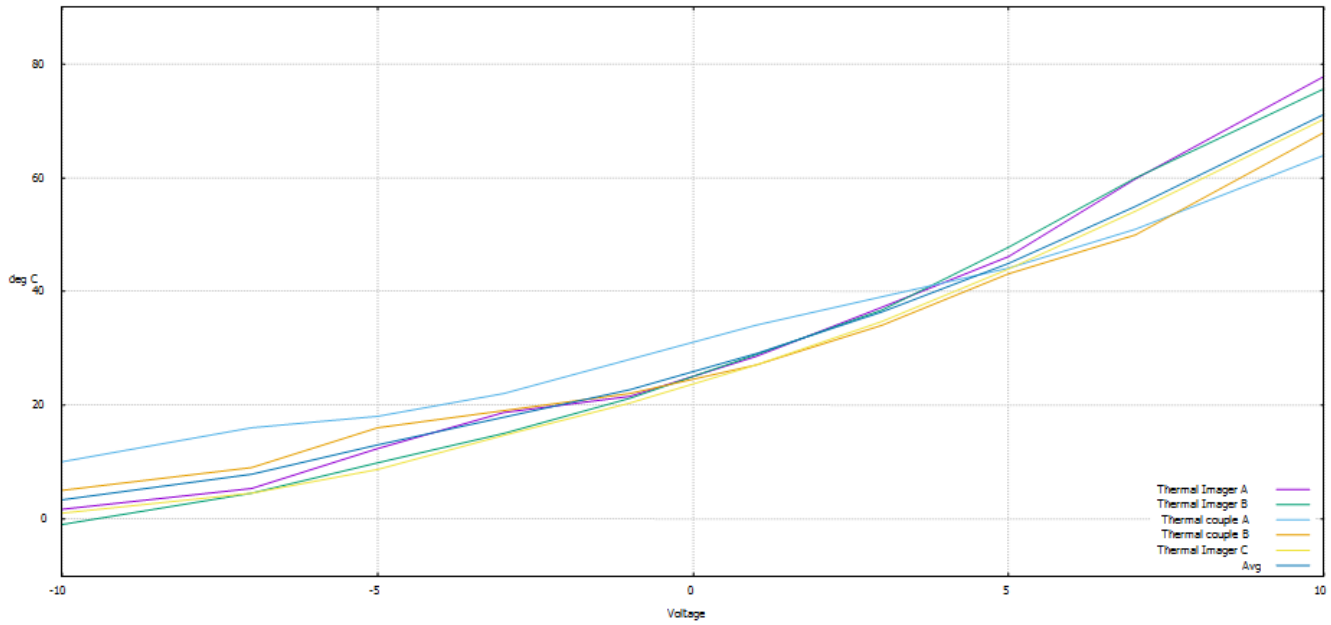


Figure 6: STMTHERM Temperature Curves (High Temperature Range)
Measured Performance Unloaded

Temperature Curve Legend

Thermal Imager A	Ryobi IR non-contact temperature probe
Thermal Imager B	FLIR IR imager
Thermocouple A	Thermocouple probe (Fluke meter) – Trial 1
Thermocouple B	Thermocouple probe (Fluke meter) – Trial 2
Thermal Imager C	OMEGA OS35 IR non-contact temperature probe

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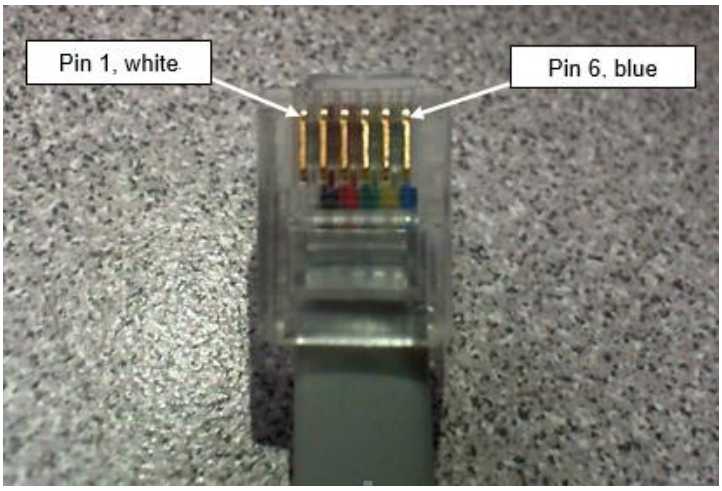
STMTHERM RJ11 Pin-Outs



STMTHERM RJ11 connector (tab is underneath the pins):

Pin 1	White
Pin 2	Black → Signal ground
Pin 3	Red
Pin 4	Green → Vc input (+/-10 V control voltage range)
Pin 5	Yellow
Pin 6	Blue

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IN-LINE POWER SUPPLIES

AC150A Power Supply

AC137A Power Supply

All AC series in-line power supplies are CE marked for the EC Low Voltage Directive and EMC Directive, and all have UL and TUV approval. The AC150A has standard IEC power input plugs and operate over mains power ratings of 100-240 VAC, 50-60 Hz. AC150A includes a USA, EURO, or Chinese power cord. (ACCORD US/EURO/CN).

AC101A	±12 volt, +5 volt, 1 amp	Connects the LDF100C to the AC mains wall outlet. One supply is included with each LDF100C module.
AC137A	+6 volt, 1.5 amp	Powers the heating element for any of the TSD137 series pneumotachs. The AC137A has fixed built-in USA-style power prongs and does not need a power adapter cord for USA operation. Interchangeable prongs are included for international use.
AC150A	+12 volt, 3.4 amp	Connects the MP160/150 System or GASSYSTEM2 to the AC mains wall outlet. One supply is included with each MP160/150 Starter system or GASSYSTEM2.
AC300A	+12 volt, 1.25 amp	Connects the MP to mains wall outlet. One supply is included with each MP36/35 system.

See also: IPS100C Isolated Power Supply

NOTE: The older style AC137A with the ACCORD US/EURO power cord was discontinued in October of 2017.

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BAT100A RECHARGEABLE BATTERY PACK

BAT100A with Recharger

The BAT100A is a high energy density and lightweight battery pack designed to operate MP150 or MP3X Systems. A universal input voltage 3 amp battery charger is also included. The battery pack is lightweight and comes with a supplied carrying case with integral shoulder strap. The carrying case holds battery pack, charger and all associated cords.

The BAT100A chemistry is Lithium Iron Phosphate (LiFePO4). A key advantage over other lithium-ion batteries is the superior thermal and chemical stability, which provides better safety characteristics than other lithium-ion batteries with different cathode materials. Due to the significantly stronger bonds between oxygen atoms in the phosphate, oxygen is not readily released, and as a result, lithium iron phosphate cells are virtually incombustible in the event of mishandling during charge or discharge, and can handle high temperatures without decomposing. Ships as USA or EURO version based on delivery address.

BAT100A replaces BAT100 effective June 2011.

Operation

1. Only charge the BAT100A (12 V @ 15 AH LiFePO4) using the included charger.
2. Discontinue use of the BAT100A when the performance of the MP System begins to deteriorate.

Charging the Battery Pack

1. When the BAT100A is being charged, the charger will indicate a RED charging LED.
2. When the BAT100A is fully charged, the charger will indicate a GREEN charging LED.

Storage

1. Store the Battery Pack in a fully charged condition.
2. Store the Battery Pack in a cool place (normal room temperature or lower).

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BAT100A BATTERY PACK SPECIFICATIONS

Battery

Chemistry:	$LiFePO^4$ (Lithium Iron Phosphate)
Output Capacity:	12 V @ 15 amp-hours
Working Output Voltage Range:	13.2 V – 12 V
Output Connector:	DC Barrel Plug (5.5 mm OD, 2.1 mm ID – Center positive)
Operating Time:	MP3X with 4 sensors: 26 hours nominal MP150 with 4 modules: 16 hours nominal
Charge Time:	5 hours (nominal)
Recharge Cycles: (number of cycles to 80% of original capacity): 1500 (typical minimum)	
Operating Temperature Range:	0° C to 45° C
Storage Temperature Range:	-20° C to 60° C
Weight:	2.45 kg
Dimensions: (includes carrying case)	14 cm (high) x 19 cm (wide) x 14 cm (deep)

Battery Charger (For BAT100A only)

Maximum Nominal Charge Voltage:	14.4 V @ 3.0 amps (Charges at 3 amps to 14.4 V, then potentiostatic at 14.4 V until current is less than 0.5 amps)
Input:	120/240 VAC @ 50/60 Hz (USA or EURO power cord)
Output Connector:	DC Barrel Socket (5.5 mm OD, 2.1 mm ID – Center positive)
Operating Temperature Range:	0° C to 45° C
Storage Temperature Range:	-20° C to 60° C
Weight:	285 grams
Dimensions:	3.8 cm (high) x 6.4 cm (wide) x 15 cm (long)

See also: **TCI series** of available interfaces

SS-KIT-IN TRANSDUCER CONNECTOR INTERFACE KIT – INPUT

This kit is for users who wish to adapt their own transducers to the Biopac Student Lab *PRO* System or Acq*Knowledge* System with MP36R. The kit comes with a Smart Sensor connector, cable and components to properly interface with the transducers. The kit will allow quarter, half or full bridge transducers (pressure, force, strain, acceleration, sound, etc.) to be connected to the system.

SS-KIT-IN COMMENTS AND SUGGESTIONS

1) **Be careful of consumption**.

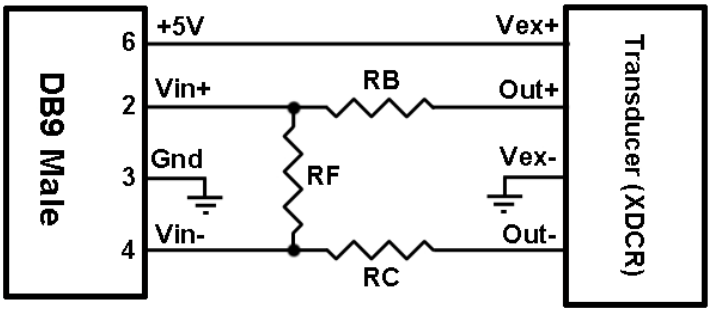
   The bridge circuit should be designed so no more than 5mA are used to power the bridge. If the bridge takes more than 5mA, try reducing the voltage across the bridge by using series resistors or other kinds of regulators.

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

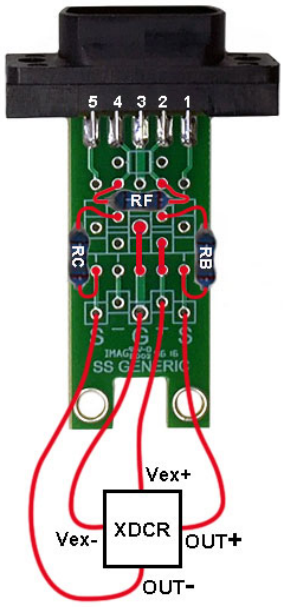
   Resistors RB, RC, and RF are used to reduce the output of the transducer to provide a signal no greater than ±2 V (MP36/45), ±V (MP35) or ±50 mV (MP30) between pins 2 and 4 on the 9 pin D-Sub (DB) Male connector. If the voltage is exceeded (of either polarity), the input amplifier stages will saturate.

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



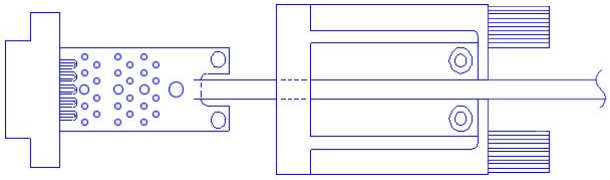
Schematic



Printed circuit board layout

SS-KIT-OUT Transducer Connector Interface Kit - Output

SS-KIT-OUT GUIDE



The SS-KIT-OUT allows custom cables to be made that connect to pins on the Analog Out port. Typical uses are:

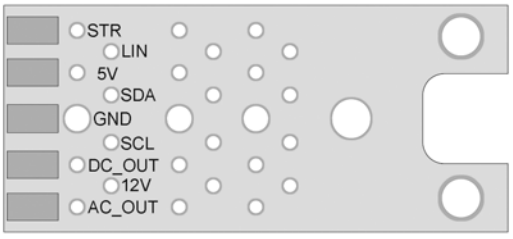
1. Synchronizing 3rd party equipment to the MP3X's start of acquisition.
2. Listening to pulses ("clicks") or tones with headphones which can be used for reaction time studies.
3. Controlling audio or visual stimulus device (Audio tone, LED or Strobe flash, etc.).
4. Listening to input signals such as EMG via headphones or an audio amp./speaker.

Typical Analog Out connections include:

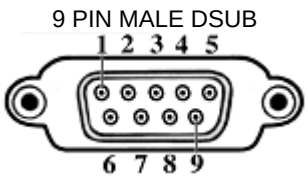
Analog Out Function	MP36/MP36R/MP35 and MP30
Listening to pulses ("Clicks") via headphones or audio amp./speakers	Headphone "+": pin 1 Headphones "-": pin 3
Headphones for listening to analog signals (EMG, etc)	Headphone "+": pin 1 Headphones "-": pin 3
Driving output LED's • To limit LED current, put resistor in series with pin 2.	"+": pin 2 "-": pin 3
Synchronizing to 3rd party equipment	Out "+": pin 5 Out "-": pin 3

The "Analog Out" port on the back panel of the MP36/MP36R/MP35 or MP30 (MP3X) can output pulses (digital) or analog voltage levels, or it can pipe out analog signals from one of the input channels. The port is controlled through one of the Output Control Panels in the Biopac Student Lab (BSL) *PRO* or Acq*Knowledge* software, which is described in the BSL *PRO* and Acq*Knowledge* manuals.

The following diagrams and table show the pin-outs of the "Analog Out" port on the back of the MP3X and the Printed Circuit Board (PCB) layout of the SS-KIT-OUT. Each pin is accessible on the PCB and can be located by the label shown in the table.



SS-KIT-OUT PCB



Back Panel—MP36/MP36R/MP35 or MP30

ANALOG OUT PORT

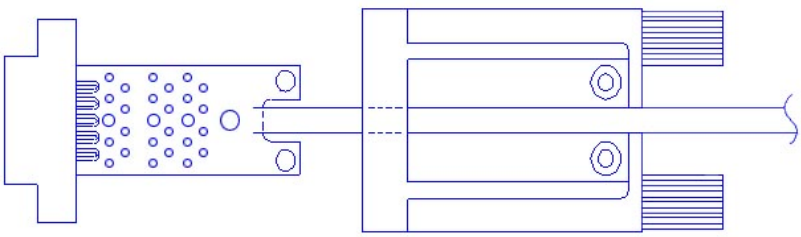
SS-KIT-OUT SPECIFICATIONS

PIN	LABEL on PCB	PIN FUNCTION MP36/MP36 R/MP35	MP30
1	AC_OUT	Buffered analog or pulse output A.C. coupled (1,000 uF) Analog range: +/- 2.048 V Pulse range: 0 to 2.048V	Buffered analog or pulse output A.C. coupled (2,200 uF) Analog range: +/- 2.5 V Pulse range: 0 to 2.5V
2	DC_OUT	Buffered analog or pulse output D.C. coupled Z out = 50 Ω Range: 0 to 4.096 V	Buffered analog or pulse output D.C. coupled Z out = 50 Ω Range: 0 to 5 V
3	GND	Ground	Ground
4	5V	+5 V (100mA max.)	+7.5 V (100 mA max.)
5	STR	Buffered pulse output Z out = 1 kΩ Range: 0 to 5 V	Un-buffered analog or pulse output (D.C. coupled) Z out = 1 kΩ Range: 0 to 5 V
6	12V	+12 V (100 mA max)	Not used
7	SCL	I^2C SCL **Do not connect!**	Not used
8	SDA	I^2C SDA **Do not connect!**	Not used
9	LIN	Monitor **Do not connect!**	Not Used

Notes Pins 1 and 2 — For the MP36/MP36R/MP35, pins 1 and 2 can output analog or pulses when using MP3X firmware revision 1.26.037.030 or greater. When run under previous firmware, pins 1 and 2 can only be used for analog output. To identify the firmware revision, launch the BSL *PRO* or Acq*Knowledge* software and check the Help > About dialog. See the Support section at www.biopac.com for upgrade information.

Pins 3, 4 and 6 — The Power supply pins (3, 4 and 6) can be used for external circuits as long as the load current does not exceed 100 mV.

ASSEMBLY NOTES



The PCB assembly fits into the thumb screw housing as shown. Two screws attach the PCB to the housing and hold the strain relief in place. The strain relief is used to prevent the cable and attached wires from pulling off the SS-KIT-OUT PCB. It is a good idea to place the strain relief over the cable prior to soldering the wires to the PCB so that it only has to be slid on a small distance. If the strain relief fits too tightly around the cable, use water to wet the cable, allowing the strain relief to slide. Place the strain relief such that the case cover pinches and holds the cable. The stick on panel is used to cover the screws and protect the label.

STP35W SUPERLAB SYSTEM FOR MP36R/MP36/MP35

STP35W Components

SuperLab Software
STP35B Interface Cable
Six-button Response Box
Pushbutton 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 MP36R/MP36/MP35 System for data synchronization and collection purposes. The STP35W system includes:

- **SuperLab** – present visual stimuli on a computer screen, or auditory stimuli via headphones or speakers, and simultaneously (1 ms resolution) send trigger signals for data synchronization and collection purposes to an MP36/35 BSL System or MP36R Research System.
- **Interface** – use the included STP35B for MP36/36R/35 to parallel port connections
- **Response Box** – Use the six-pushbutton response box for performing accurate (1 ms resolution) reaction time measurements.

NOTE: Second PC required. The synchronization signal(s) coming from the **STP35W** can be directed to a BIOPAC System running on a PC or a Mac, but it's not possible to run the **STP35W** on the same computer as the BSL MP36/35 System or MP36R Research System. Mac OS X setups require a StimTracker (STK100).

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.

STP35 MP36R/MP36/MP35 TO SUPERLAB

For users who already have SuperLab and an MP3X unit, the STP35 Interface Cable can be used to connect the two systems. The STP35 cable interfaces with the I/O port of the rear of the MP36R/MP36/MP35 unit.

STP35B MP36R/MP36/MP35 TO PARALLEL

MP36R/MP36 or MP35 to E-Prime, Direct RT, MediaLab, Inquisit, and other systems that connect via the parallel port.

EPM100W STIMULUS PRESENTATION SYSTEMS WITH E-PRIME 3

These stimulus presentation packages include E-Prime experiment generator and an isolated digital interface (STP100C) with parallel port cable (CBL110C).

E-Prime provides experiment generation and millisecond precision data collection through data handling and processing. E-Prime is a powerful suite of applications combining precise millisecond timing, a user-friendly environment, and the flexibility to create simple to complex experiments for both advanced and novice users.

- EPM100W includes E-Prime 3.0
- EPM100 – E-Prime 3.0 software only

Use the Acq*Knowledge* Digital inputs to stim events tool to automatically score and label digital event marks from the E-Prime presentation. The digital channels are interpreted as a binary number. Each stimulus event placed into the graph has the corresponding number included with its label. This allows further analysis to distinguish between different types of stimulus events for automated event related analysis.

NEW WITH E-PRIME 3.0

- Support for tablets and touchscreens
- SlideButton sub-object for an area of response collection without using script
- SlideChoice sub-object to design multiple choice surveys, recognitions, recalls
- SlideSlider sub-object to design scales and sliders
- Slide Layout Templates for quick design
- Improved interface with tabbed workspace and easier access to windows
- Find and replace properties in an experiment
- Run an experiment in a floating window for quicker inspection and debugging
- Run desired List rows at runtime with Interactive order selection
- Interactively run List rows for debugging purposes
- Create conditional Task Events using subroutines in User Script
- Improved Audio/Video playback and load times
- Start an experiment from any List object
- Play movie and audio files in additional formats
- Online Experiment Library
- E-Prime Command Reference and online documentation
- New experiment design templates
- Access Full and User Script in the Structure window
- Automatically generate text data files upon completion of experiment
- Save a definition of columns of interest in E-DataAid
- Correct, Incorrect, Omission Task Events
- Check for Update checks web and prompts when updates are available

The E-Prime suite of applications includes:

- E-Studio – Drag and drop graphical interface for experiment design.
- E-Basic – Underlying scripting language of E-Prime (nearly identical to Visual Basic for Applications™).
- E-Run – Once experiment design is complete, a single mouse click generates it into an E-Basic script. E-Run then affords you the millisecond precision of stimulus presentation, synchronizations, and data collection.
- E-Merge – Quickly and easily combines your single session data files for group analysis.
- E-DataAid – Data management utility that allows you to filter, edit, analyze, and export your data.
- E-Recovery – Recovers data files in the event of early terminated experiments, or lost or corrupted files.

INTERFACE TO BIOPAC

Research Systems: MP160 or MP150 System—Use the Isolated Digital Interface (STP100C) to safely isolate digital inputs (in the range of 0-3.3 V or 0-5.0 V) and outputs; STP100C includes CBL110C, a 3-meter DB25 M/F ribbon cable to interface with E-Prime via the printer port.

Education Systems: MP36 or MP35 System—Use the STP35A DB25 M/F 3-meter ribbon cable to interface the computer printer port to the I/O Port on the back panel of the MP unit.

SYSTEM REQUIREMENTS

For E-Prime system requirements see:

- Current release E-Prime 3
- Legacy versions E-Prime 1 and E-Prime 2

See also: STP100C, STMEPM

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TSD122 SERIES STROBOSCOPE

The TSD122 Stroboscope connects directly to the UIM100C or STM100C for Visual Evoked Response applications. This battery-operated device will provide 360,000 flashes between charges. The unit will go from zero to a maximum of 12,000 flashes per minute. It has external TTL synchronization and Trigger facilities for interfacing with the MP System and other equipment.

The TSD122 can be used for:

- Single pass or averaging type visual evoked response applications.
- Synchronize the stroboscope to an averaging pass.
- Trigger the stroboscope during acquisition or during an averaging pass.
- Trigger an acquisition or an averaging pass with the stroboscope.
- Use a digital input to acquire the signal synchronized with the stroboscope.
- Use an analog input to acquire the signal synchronized with the stroboscope.

The TSD122 connects to the AMI100D or HLT100C via the CBL122 (3.5 mm to RJ11) cable adapter.

The TSD122 can also be used to trigger the MP System, via the External Trigger terminal block (on the back of the UIM100C).

TSD122A Stroboscope 120 V/60Hz

To use the TSD122 Stroboscope with a BSL or MP36R unit, order as TSD122C (includes BSLCBL5); see BSL *PRO* Lesson H22 Visual Evoked Potentials for setup guidelines.

TSD122C Stroboscope 120 V/60Hz

TSD122 SPECIFICATIONS

Display:	Digital LCD
Battery:	Built-in, rechargeable
Battery Life:	60 hours at 100 strobes/sec (360,000 strobes between charges)
Flash duration:	30 µsec
Flash energy:	180 mJoule
External TTL:	Sync/Trigger
Weight:	1.1 kg
Body Dimensions:	9.3 cm (wide) 9 cm (high) x 23 cm (long)
Reflector Housing:	12.2 cm (dia)
Handle:	10.8 cm (long)
I/O Ports:	TTL (Sync input and output)—3.5 mm phone jacks
Cables:	CBL102, CBL122, and CBL106 or BSLCBL5
Interface:	AMI100D, HLT100C, UIM100C or MP36R STM100C (triggered)

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USB-TTL INTERFACE

USB-TTL Interface is a USB module which provides 16 TTL I/O lines that can have up to millisecond accuracy. It may be used to replace parallel port interfaces, which are no longer common on computers. This interface may be used for custom programming or for sending/receiving information from E-Prime, SuperLab, or other stimulus presentation programs.

USB TTL Module: Millisecond accurate* event marking across up to 16 I/O lines.

Gender Changer: Use to connect the USB-TTL to an STP100C for MP160/150 System, directly to I/O Port on MP36/36R, or other 25-pin male device.

USB Lead: Use to connect the USB-TTL Module to the Host PC.

Key features:

- 16 Digital +5 V TTL Lines
  - 8 TTL Input
  - 8 TTL Output
- TTL Input Lines configured as an 8 bit port
- TTL Output Lines configured as an 8 bit port
- Change detection on TTL Input lines
- TTL Input to 2 hex bytes conversion representing 255 possible states
- Event marking: 2 hex bytes to TTL Output across 8 bit port representing 255 possible states
- TTL Output lines automatically latch once set
- Works out of the box with PCs/Macs/Linux—fully plug in & play
- Appears as a Virtual Com Port (VCP)
- Compatible with all Psychology experiment generators, e.g., E-Prime, SuperLab, Presentation, Inquisit, DMDX, ERTS, DirectRT, PsyScope, PsychoPy, OpenSesame, etc.
- Works with any software that can access a standard serial port
- Comes complete with timing validation software which checks round trip timing on your PC
- Fully documented API complete with examples
- Small and unobtrusive—Dimensions (WxHxD): 67.1 mm x 28.2 mm x 67.1 mm
- LED indicators for Input (green) and Output (red)
- Full-speed USB 2.0 (compatible with USB 3.0)
- Scans for TTL I/O changes 109,000 times each second
- Millisecond accurate TTL event marking*
- Utilizes The Black Box Toolkit technology

*Accuracy may be limited by PC and experiment generation software selected for stimulus presentation.

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STM-CHRONOS

A Multifunctional Response and Stimulus Device

Chronos is a powerful new USB-based response and stimulus device. Chronos allows the accurate collection and verification of tactile, auditory, visual, and analog responses along with the precise source of audio and generic analog output timing. The Chronos graphical user interface allows for user-friendly implementation of the system's wide range of features.

Chronos features millisecond accuracy and consistent sound output latencies across machines. Chronos includes 16 digital inputs and 16 digital outputs, eliminating the need for a parallel port. All responses collected are synchronous to the E-Prime time domain. Multiple Chronos devices can be connected to a single PC using E-Prime 3 or 2 Professional. Chronos also introduces a large set of Task Events to facilitate the design of basic to complex experiments without the use of script (E-Prime 3 or 2 Professional).

Response Features

Keys

- 5 buttons
- 16 digital inputs
- Voice key
- n-key rollover
- Programmable debounce intervals

Audio Recording

- Stream and save vocal responses
- Start recording at object onset OR when speaking begins

Voice

- Sound-activated response (voice key)
- Condenser or dynamicmicrophone compatible
- Configurable audio input gain
- Configurable threshold settings for incoming audio responses and recording
- Detect sound to silence (offset threshold/post-silence interval)

Analog Input

- 3 Analog Inputs (plus Photo Sensor) with configurable onset and offset thresholds

Stimulus Presentation Features

LEDs

- 5 LEDs with programmable RGB color values (>4,000 colors per LED)
- Assign color values as response mapping verification, stimuli, or as feedback based on accuracy

Audio Output

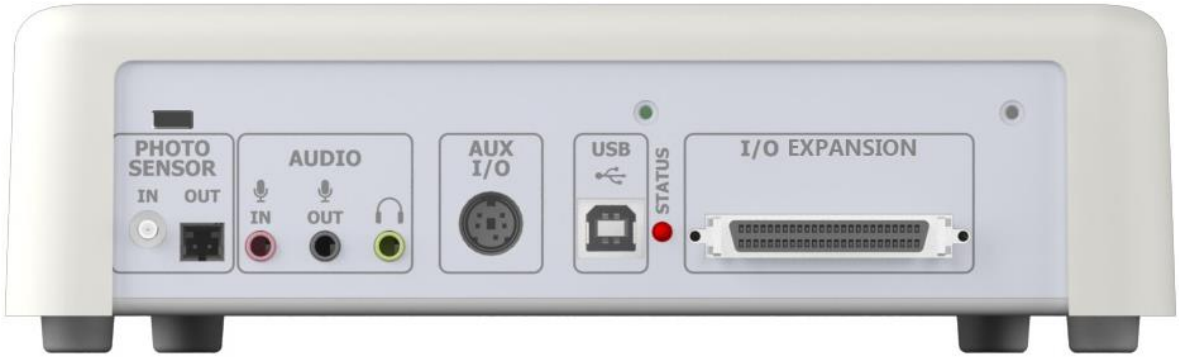
- Present auditory stimuli with accurate and precise sound output latencies of 1 ms (Mix Mode 1) or a fixed latency of 6 ms (Mix Mode 2) across different machine hardware
- Configurable onset and offset output thresholds per channel

Analog Output

- 4 Analog Outputs
- Generate sine, saw tooth, square, triangle, and custom waveforms

Pulse Generator

- Generate square waveforms of configurable frequency



Chronos Console

Chronos Photosensor

Chronos Microphone

Chronos USB Cable

Chronos I/O Expander

STM-CHRONOS Systems Include:

- Chronos Console (20.32 cm x 16.51 cm x 6.03 cm)
- Microphone (10.16 cm x 24.77 cm)
- Photo Sensor
  - The Photo Sensor accessory can be used on CRT, LCD, and projection displays to detect stimulus onset events, refreshes, and measure rise and fall times
  - High speed photodiode adapted to human eye sensitivity
- USB cable (1.8 m)
- BIOPAC Interface Cable—choose for Smart Center, MP36/36R, or STP100C
  - **STM-CHRONOS-1** Chronos with Smart Center cable (HDMI I/O to 8 tinned wires)
  - **STM-CHRONOS-2** Chronos with MP36/36R cable (DSUB25 to 8 tinned wires)
  - **STM-CHRONOS-3** Chronos with STP100C cable (DSUB25 to 8 tinned wires)
- Auxiliary I/O breakout cable assembly
  - 2 digital inputs, 2 digital outputs, 1 power (5 V), 1 digital ground, 1 analog input, and 1 analog ground
- I/O Expander
  - Provides access to 16 digital inputs, 16 digital outputs, 1 pulse generator, digital powers and grounds, 3 analog inputs, 4 analog outputs, analog grounds
- Demonstration Equipment
- Samples and Tutorials
- Kensington® lock support (lock not included)

System Requirements

- Windows 8.1/8, 64-bit, Windows 7, 64 & 32-bit
- Pentium-compatible Dual-Core or Multi-Core processor, 2 Ghz
- 2 GB RAM
- USB 2.0, 3.0, or powered hub port
- E-Prime 3 or 2 Standard/Professional

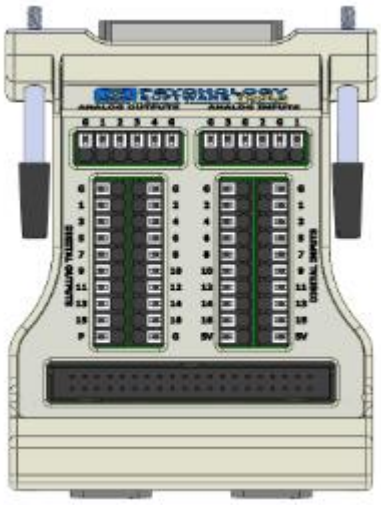
Auxiliary I/O Breakout Cable Information

The Auxiliary I/O Breakout cable enables connection of up to two digital inputs, two digital outputs, and one analog input. The table below specifies the corresponding function and wire colors. Note that the outputs are zero-based while the inputs are one-based.

Pin	Color	Function	Description	Response Mapping (Pseudo Button)
1	Light Blue	+5V	+5V	n/a
2	Light Green	OUT14 (base 0)	Digital Output	n/a
3	Purple	OUT15	Digital Output	n/a
4	White	Digital Ground	Digital Ground	n/a
5	Orange	Analog Ground	Analog Ground	n/a
6	Yellow	IN16 (base 1)	Digital Input	G
7	Brown	IN15 (base 1)	Digital Input	F
8	Red	ADC1	Analog Input	9

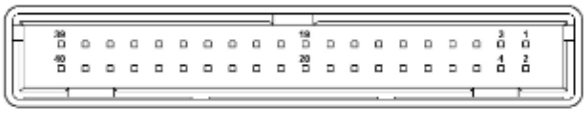
I/O Expander Pin Assignments

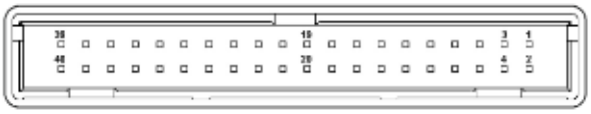
The I/O Expander Connector is used to facilitate communication with a variety of devices. The image below shows the location on the Push-in Terminal Block for the 16 digital outputs, 16 digital inputs, one pulse generator (see block labeled "P"), four analog outputs and three analog inputs. Note when using E-Prime, that the outputs are zero-based while the inputs are one-based. For example, digital output 7 is referenced in E-Basic script as Chronos.DigitalOut.SetBit 6. Users who purchase the Custom Expansion Kit may also communicate with the I/O external interfaces.



I/O Expander 40-pin Header Pin Assignments

Users who purchase the Custom Expansion Kit may also communicate with the I/O Expander. In addition to the Push-in Terminal Blocks, the 40-pin header on the IO Expander can be used to connect Chronos digital inputs 1-16 and digital outputs 1-16 directly to the Custom Expansion Kit using the kit's included ribbon cable. This enables the 16 inputs and outputs to be configured with the LEDs and switches that can be ordered with the kit.





I/O Expander 40 Pin Assignments (1-20)	
PIN NUMBER	**DESCRIPTION**
1	5V @ 150 mA
2	Ground
3	Digital Input 1
4	Digital Input 2
5	Digital Input 3
6	Digital Input 4
7	Digital Input 5
8	Digital Input 6
9	Digital Input 7
10	Digital Input 8
11	Digital Input 9
12	Digital Input 10
13	Digital Input 11
14	Digital Input 12
15	Digital Input 13
16	Digital Input 14
17	Digital Input 15
18	Digital Input 16
19	5V @ 150 mA
20	Ground

I/O Expander 40 Pin Assignments (21-40)	
PIN NUMBER	**DESCRIPTION**
21	Ground
22	Ground
23	Digital Out 1
24	Digital Out 2
25	Digital Out 3
26	Digital Out 4
27	Digital Out 5
28	Digital Out 6
29	Digital Out 7
30	Digital Out 8
31	Digital Out 9
32	Digital Out 10
33	Digital Out 11
34	Digital Out 12
35	Digital Out 13
36	Digital Out 14
37	Digital Out 15
38	Digital Out 16
39	Ground
40	Ground

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M-PODS AND C-PODS

Map any Input Signal to any Output Pin—Event Markers sent USB

STM-M-POD-IO for MP36/36R Systems

STM-M-POD-STP for STP100C and MP160 Systems

STM-M-POD-IO

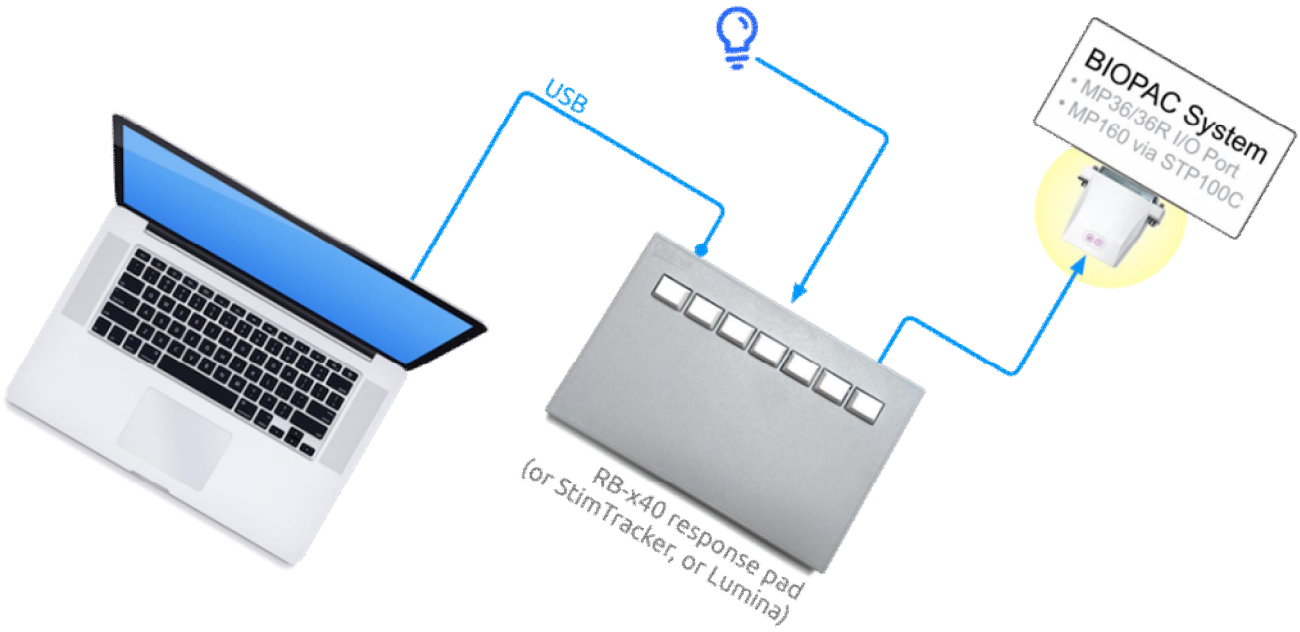
STM-M-POD-STP

Use m–pod to map any input signal to any output pin, or combine any number of input signals to a single output pin and build your very own custom output table. With its speedy microprocessor, this translation power adds a minuscule 50 µs delay.

Use m-pods to get all, or only, the desired signals. In some experiments, it may be appropriate to mark the onset of participants' key presses. In others, these markers get in the way and it may be preferable to have more data bits available for markers sent via USB. Or even a mix of both.

No more fussing over the right connector size, gender, and pin assignments—just choose the m-pod for the specific interface and enjoy instant compatibility:

- interface directly to the I/O port on MP36 and MP36R units, or
- interface to an STP100C for MP160 Systems



Updated: 1.15.2018

Easily Send Event Markers from Computer to Recording Devices—Affordable Jitter-Free Precision

STM-C-POD-IO for MP36/36R Systems

STM-C-POD-STP for STP100C and MP160 Systems

STM-C-POD-IO

STM-C-POD-STP

Send event markers via USB with high precision. c-pods simplify connection & timing details and deliver guaranteed jitter-free performance.

- Asynchronous Output
- Scheduler
- Pattern Generation
- Mixed output
- 32-bit microprocessor
- Interface directly to I/O port on MP36 and MP36R units, or to an STP100C for MP160 Systems.

Asynchronous Output

With traditional I/O cards, software programs used for sending pulses need to wait for the duration of the pulse before work can resume. Imagine sending a postcard to a friend and then not being able to do anything else until that postcard is delivered. It's a lot of wasted time. This is synchronous delivery.

c–pod can deliver signals asynchronously—an application sends a command that includes the pulse duration and then resumes working, e.g. to present a stimulus or look for participant response. c–pod takes care of completing the pulse delivery.

Scheduler

c–pod takes the idea of asynchronous output a step further. Instead of delivering a pulse now, why not deliver it later? Better yet, why not deliver multiple pulses later?

This is a useful feature that answers the following question: when presenting a movie or sound, how can I mark certain points precisely during playback?

With the scheduling feature, it's possible to preload c–pod with a list of times for pulse delivery, the length of the pulse, and the output line(s) that it should be delivered on. A subsequent command can be sent at the onset of the movie or sound to start executing the schedule.

Pattern Generation

c–pod can function as a pattern generator as well, sending periodic pulses out on a user-defined output line, or even pulses of different periods on multiple output lines. This is useful for applications requiring strobing, or where the intensity of light or a motor is controlled using pulse width modulation (PWM).

Mixed Output

And more: the features described above are not mutually exclusive. For example, while a schedule is being executed on output lines 1, 2, and 3, an async pulse command can be sent at any time on the remaining lines 4 through 8.

Similarly, while a pattern is being generated on some lines, an asynchronous pulse command can be sent on the remaining lines. c–pod will not skip a beat.

32-Bit Microprocessor

Inside the c-pod is a computer with a speedy 32-bit engine, humming with useful, well-polished software.

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	c–pod	m–pod *+ using an existing response pad*	StimTracker
Send Pulses Asynchronously	✓	✓	✓
Signal / Pattern Generator	✓	✓	No
Pulse Scheduler Feature	✓	✓	No
Marks Onset of Participant Key Presses	No	✓	No
Marks Onset of Visual Stimuli	No	✓	✓
Marks Onset Of Auditory Stimuli	No	No	✓
Marks Onset of External TTL Input	No	No	✓
Voice Key	No	No	✓
Number of Simultaneous Outputs	1	1	2

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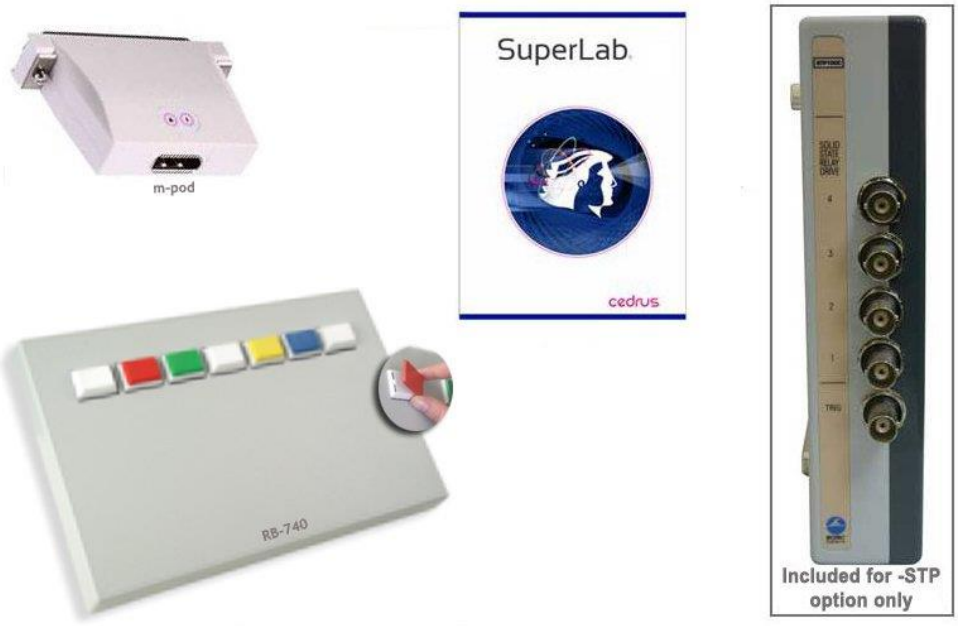
M-POD EVENT PRESENTATION & MARKING SYSTEMS

STM-M-POD-SYS-IO (for MP36/36R Systems)
STM-M-POD-SYS-STP (for MP160 Systems)



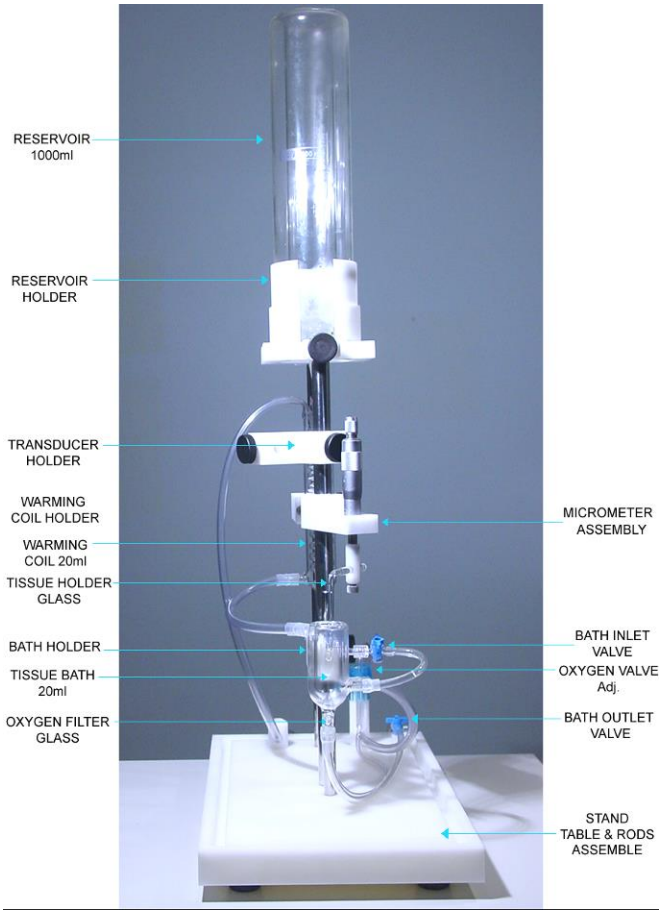
These Event Presentation & Marking Systems include m-pod, SuperLab Pro Stimulus Presentation Software, Response Pad (RB-740), and BIOPAC interface cable (option to interface MP160 System also includes Isloated Digital Interface STP100C).

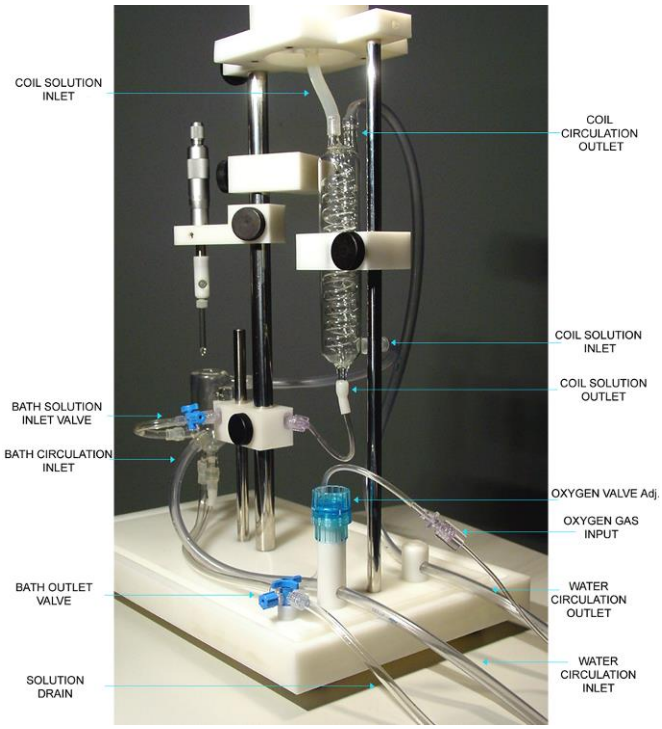
SuperLab offers a host of powerful features, including

- Playing movies
- Stimulus lists
- Support for JPEG, GIF, PNG, and TIFF files
- Built-in support for RSVP and self-paced reading
- Improved support for fMRI and EEG/ERP
- Trial variables
- Conditional branching (if/then/else)
- Multiple input devices in the same experiment
- Unicode application that handles Japanese, Chinese, and other international fonts just as easily as it handles English fonts.

See also: Product description and specs for m-pod, StimTracker, SuperLab, and STP100C.

TISSUE BATH 1, 2, 4, 8 TISSUE BATH STATIONS





The Tissue Bath Station is completely modular, and can be purchased 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 the tissue bath to be lowered 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 the experiment. The unique design makes it easy to add or remove stations to provide the optimal solution for the requirements.

When a system is ordered, the size of the tissue bath and heating coil must be specified.

Each **Tissue Bath** station includes:

1 Reservoir (specify 400 ml warming reservoir or 1000 ml reservoir)
1 Reservoir Holder
1 Transducer Holder
1 Warming Coil Holder
1 Warming Coil (specify 5 ml, 10 ml, 20 ml, or 30 ml 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 5 ml, 10 ml, 20 ml size)
1 Oxygen Filter (glass)
1 Micrometer Assembly
1 Mount Accessories Kit
1 Base Station with Support Rods
1 For MP160/MP150 System with DA100C, TSD125 Force Transducer (specify TSD125 model C, D, E or F)
1 For MP36/MP35 System, SS83L Force Transducer

See also: BIOPAC Circulators, or use an existing system.

TISSUE BATH ACCESSORIES / REORDER PARTS

Tissue Holders

Tissue Clips

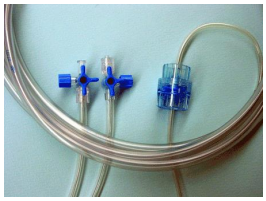
Warming Coil

Oxygen Filter

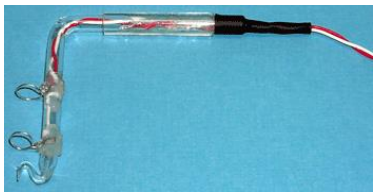
Tissue Bath

Reservoir

Mount Accessories



Field Stimulation Electrode



RXHOLDER-S	Tissue Holder (stainless steel)
RXHOLDER-G	Tissue Holder (glass)
RXHOLDER-TR	Triangle Tissue Holder (stainless)
RXCLIP	Tissue Clip (stainless steel)
RXCLIP-TRI	Triangle Tissue Clip for Rings (stainless steel)
RXWARMING	Replacement Warming Reservoir 400 ml

RXCOIL	Warming Coil
RXO2FILTER	Oxygen Filter (glass)
RXBATH	Tissue Bath (5 ml, 10 ml, 20 ml, 30 ml)
RXRESERVOIR	Reservoir 1000ml
RXMOUNT	Mount Accessories Kit
STIMHOLDER	Field Stimulation Electrode for use with STM100C
BSLSTIMHLD	Field Stimulation Electrode with BNC cable termination for use with BSL Stimulator

TISSUE BATH ACCESSORIES SPECIFICATIONS

1 x Tissue Holder—stainless steel; 15 mm high x 9 mm wide; reorder as RXHOLDER-TR

1 x Tissue Holder—glass; 67.46 mm high x 57.85 mm wide; reorder as RXHOLDER-G;

1 x Tissue Holder —stainless steel; 77.34 mm high x 55.06 mm wide; reorder as RXHOLDER-S

2 x Tissue Clip—stainless steel; 15 mm high x 5 mm wide: reorder as RXCLIP

2 x Triangle Tissue Clip—stainless steel; 15 mm high x 12 mm wide; reorder as RXCLIP-TRI

1 x Replacement Warming Reservoir 400 ml: reorder as RXWARMING

1 x Integrated heater—1,600 ml volume, programmable temp. 20° - 44° C

1 x Circulator pump—15 W; 500 ml/min

1 x Warming Coil; reorder as RXCOIL

1 x Oxygen Filter; reorder as RX02FILTER

1 x Bath —reorder as RXBATH5 (5 ml,) RXBATH10 (10 ml,) RXBATH20 (20 ml), RXBATH30 (30 ml)

1 x Reservoir—1000 ml; reorder as RXRESERVOIR

Mount Accessories Kit; reorder as RXMOUNT

Field Stimulation Electrode; reorder as STIMHOLDER for STM100C, BSLSTIMHLD for BSL Stimulator

1 x Micrometer-transducer assembly

1 x 3 way Rotary Valve

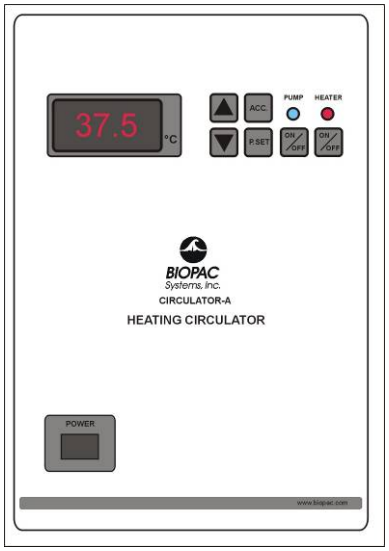
1 x Power Supply – 110V/60 Hz or 220V/50 Hz

CIRCULATOR A/B HEATING 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

CIRCULATOR SETUP AND USAGE GUIDE

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

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

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

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.
   - A buzzer sound warning will be emitted if there is not enough water in the bath when the Circulator is powered on. 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° C 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.

TROUBLESHOOTING

- **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

Dimensions:	40 cm (L) x 20 cm (W) x 29 cm (H)
Temperature Range:	30° C to 44° C
Reading Sensitivity:	0.1° C
Display:	3 digit (LED Display)
Water Bath Volume:	4.5 liters (Stainless Steel)
Circulation Flow:	2 liter/min.
Heater Resistance:	1000 Watt
Circulation Pump:	110 V 100 W Plastic Head
Supply Voltage:	
CIRCULATA:	110 Volt 60 Hz (1000 Watt)
CIRCULATB:	220 V 50 Hz (1100 Watt)
Inlet/Outlet	OD 8.5 mm, ID 6.3 mm Tubing
Temperature Offset Range:	0° C to 1.2° C
Acceleration Levels:	0 to 5

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APPENDIX

HYSTERESIS SPECIFICATION FOR HAND DYNAMOMETERS

Devices affected: TSD121B-MRI, SS25LA, SS25LB

Specification: Hysteresis: Nominal Test Case - For an applied force (~FSR/2 = 27.2155 kgf) over 4 seconds, the residual force (hysteresis) ≤ 1.3%. FSR for this device = 50 kgf.

Error = (residual/applied force) * 100

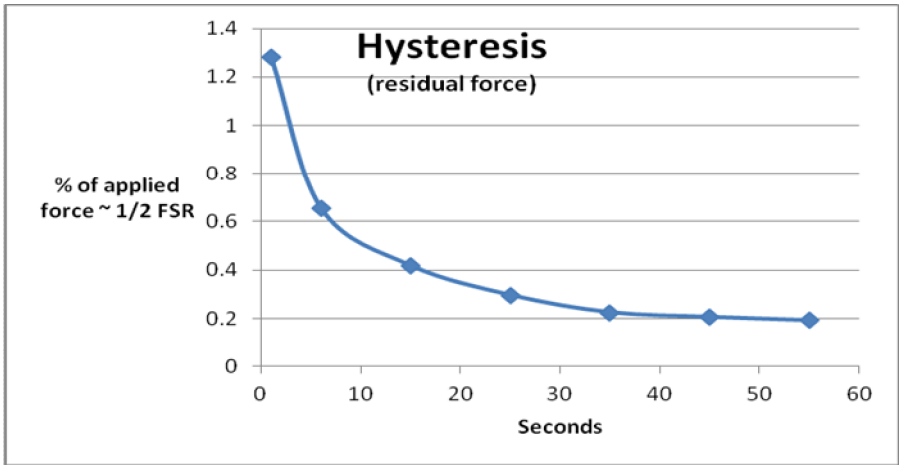

Figure 1: Residual force (hysteresis) due to viscoelasticity after application of force ~ ½ FSR (27.2155 kgf).

Figure 2: Delrin handle within the test fixture. Red arrow indicates placement of applied force which is at a single point; not distributed across the handle.

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LIMITED WARRANTY

BIOPAC Systems, Inc. guarantees its equipment against all defects in materials and workmanship to the original purchaser for a period of 12 months from the date of shipment unless otherwise stated below; effective 1-1-2015, BIOPAC MP36 units are guaranteed against defects in materials and workmanship to the original purchaser for a period of 60 months (5 years) from the date of shipment.

If BIOPAC Systems, Inc. receives notice of such defects during the warranty period, BIOPAC Systems, Inc. will at its option, either repair or replace the hardware products that prove to be defective in materials or workmanship. This warranty applies only if your BIOPAC Systems, Inc. product fails to function properly under normal use and within the manufacturer's specifications. This warranty does not apply if, in the sole opinion of BIOPAC Systems, Inc., your BIOPAC Systems, Inc. product has been damaged by alteration, accident, abuse, misuse, neglect, improper packing, shipping, modification or servicing, by any party other than BIOPAC Systems, Inc. If a problem arises, please contact us for authorization before returning an item.

Any returns should be supported by a Return Mail Authorization (RMA) number issued by BIOPAC Systems, Inc. BIOPAC Systems, Inc. reserves the right to refuse to accept delivery of any shipment containing any shipping carton which does not have the RMA number(s) displayed on the outside. The Buyer will prepay transportation charges to the BIOPAC Systems, Inc. designated site. The warranty period for repairs and for used equipment purchased from BIOPAC is 90 days.

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