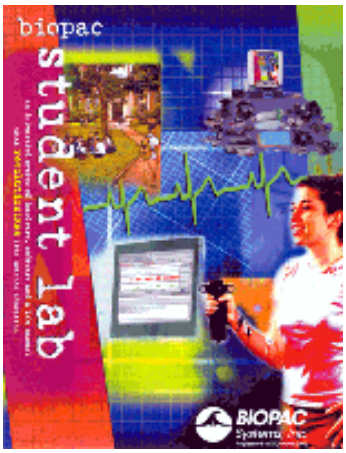
BIOPAC Systems, Inc.
Registered to ISO 9001:2008

BSL HARDWARE GUIDE



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

MP ACQUISITION UNITS

MP36/35 Four Channel Data Acquisition System
MP45 Two Channel Data Acquisition System

This document covers the following information for the MP36/MP35/MP45 Data Acquisition Systems:

The MP data acquisition unit is the heart of all Core 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 MP36/35 units, two on MP45), 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.

Symbols — MP36/35 or MP45

Symbol	Description	Explanation
	**Type BF Equipment**	Classification
	**Attention**	Consult accompanying documents
	**On** (partial)	Turns MP36/35 on assuming AC300A power adapter is powered by the mains
	**Off** (partial)	Turns MP36/35 off if but AC300A power adapter remains powered by the mains
	**Direct current**	Direct current output
	**USB**	USB port

COMPLIANCE

Safety

The MP36/35/45 satisfies the Medical Safety Test Standards affiliated with IEC60601-1. The MP36/35/45 is designated as Class I Type BF medical equipment

EMC

The MP36/35/45 satisfies the Medical Electromagnetic Compatibility (EMC) Test Standards affiliated with IEC60601-1-2.

Types of Input Devices

There are three types of devices that connect to the MP36/35 and MP45: 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.

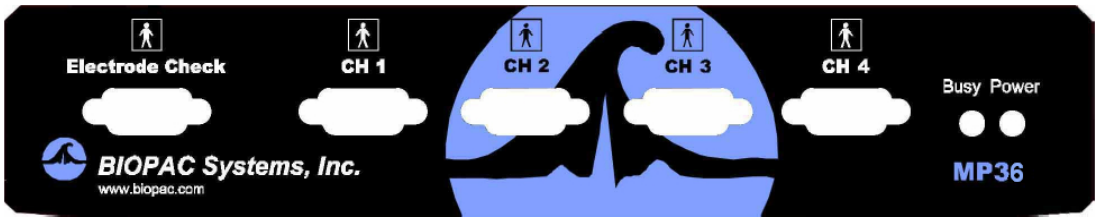
- Transducers, on the other hand, convert a physical signal into a proportional electrical signal.
- Input/Output devices (I/O for short) are specialized devices like pushbutton switches and headphones.

Simple Sensor Connectors

Regardless of the type of device connected, every sensor or I/O device connects to the MP36/35 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 MP36/35 and MP45.
- Headphones and the stimulator connect to the "Analog out" port on the back panel of the MP36/35 and to the headphone jack on the top of the MP45.
- MP36/35 only: A digital device may connect to the "I/O Port" on the back panel
- MP36/35 only: A trigger device may be connected to the "Trigger" port on the back panel.

Front Panel



Front Panel, MP36/35

The front panel of the MP36/35 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.*

MP45 is CH 1 and CH 2 only.

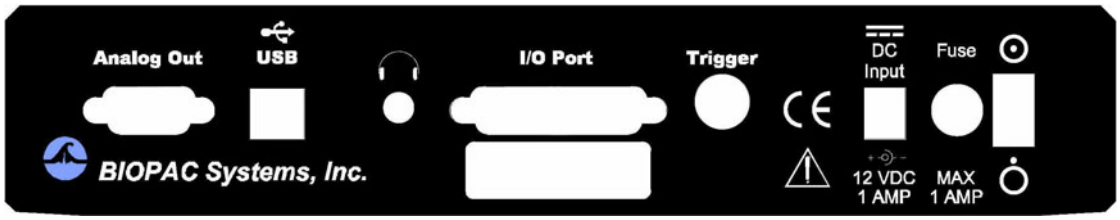
Input Ports: CH 1, CH 2, CH 3, and CH 4

- The 9-pin female analog input ports on the MP acquisition unit are referred to as Channels. There are four on the front of MP36/35 Units and two on the MP45. 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 MP36/35 is acquiring data and also during the first few seconds after the MP36/35 is powered on to indicate that a self-test is in progress. (When the MP36/35 passes the power-on test, the Busy light will turn off.)
- **Power**—status indicator is illuminated when the MP36/35 is turned on.
- **Ready**—status indicator is illuminated when the MP45 is plugged in and communicating.

Back Panel



Back Panel, MP36/35

The back panel of the MP36/35 has an analog output port, a USB 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 MP45 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 MP36/35 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 MP45.*

USB Connection

The MP36/35 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 MP36/35 to a PC or Macintosh.

The MP45 USB cable is a full-speed USB connector and should only be used to connect the MP45 to a PC or Mac USB port.

Headphone Output

- Accepts a standard (1/4" or 6.3mm) stereo headphone jack; functional for MP36 and MP45 only.

I/O Port (MP36/35 only)

- Accepts a DB 25 Female connector.
- Input/Output port used to connect digital devices to the MP36/35.

Trigger Input (MP36/35 only)

- Accepts a male BNC connector.
- Input port used to send trigger signals from another device to the MP36/35.
- 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 (MP36/35 only)

⎓ Use the DC Input to connect a battery, AC/DC converter or other power supply to the MP36/35.

- ⚠ The power supply requirements for the MP36/35 are 12 VDC @ 1 Amp. Only use the AC300A power adapter with the MP36/35. The AC300A is a 12 VDC @ 1.25 Amp power supply adapter that can connect to any mains rated as 100-250 VAC @ 50/60Hz, 40VA.
- The receptacle is configured to accept a "+" (positive) input in the center of the connector and a "-" (negative) input on the connector housing.

Fuse Holder (MP36/35 only)

The fuse holder contains a fast-blow fuse that helps protect the MP36/35 from shorts on its power, analog, and digital I/O lines. The MP36/35 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 (MP36/35 only)

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

Cleaning Procedures

Before cleaning, be sure to unplug the power supply from the MP36/35 or unplug the MP45 USB cable from the computer. To clean the MP36/35, use a damp, soft cloth. Abrasive cleaners are not recommended as they might damage the housing. Do not immerse the MP36/35 or any of its components in water (or any other fluid) or expose to extreme temperatures as this can damage the unit.

MP36/35/45 Specifications

Analog Inputs	Front panel DSUB 9f labeled "CH #"
Number of Channels:	Isolated human-safe universal input amplifiers
	MP36: 4 Channels MP45: 2 Channels
A/D Sampling Resolution:	MP36: 24-bit MP45: 16-bit
Gain Ranges:	5x to 50,000x (13 steps)
Input Voltage Range:	Adjustable from ± 200 µV to ± 2 V MP36 ± 10 V with SS70L
Signal to Noise Ratio	MP36: > 89 dB min MP45: > 75 dB min
Input Noise Voltage:	9 nV rms /sqrt (Hz) and 0.1 µV rms noise (0.1 Hz to 35 Hz) - nominal
Input Noise Current:	100 fA rms /sqrt (Hz) and 10 pA p-p noise (0.1 Hz to 10 Hz) - nominal
CMRR:	85 dB minimum
Filters:	Programmable analog and digital (IIR) filters; automatic or user-adjustable
Analog Output	 ± 1 V output Headphone jack: 3.5 mm stereo jack connection
Sample Rate:	MP36: 100,000 samples/sec each channel MP45: 48,000 samples/sec each channel
Serial Interface Type:	USB
Certification:	Complies with IEC60601-1 EMC complies with IEC60601-1-2 CE Marked
Dimensions/Weight:	MP36: 7 cm x 29 cm x 25 cm / 1.4 kg MP45: 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

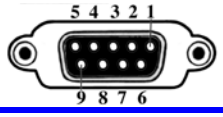
Input Triggering Options

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)
Electrode Check:	Impedance Range 0-1 MΩ (Checks Impedance between Vin+ and GND, Vin- and GND)

(See www.biopac.com for detailed specifications)

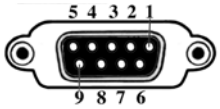
MP Unit Pin-outs

Electrode Check — MP36/35 Front
9-PIN FEMALE DSUB



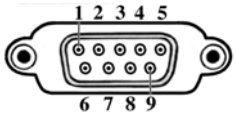
Pin		
2	Vin+	Electrode connection
3	GND	
4	Vin-	Electrode connection

MP Input — Front
CH 1, CH 2, CH 3, CH 4
9 PIN FEMALE DSUB
(1 of 4 for MP36/35 or 1 of 2 for MP45)



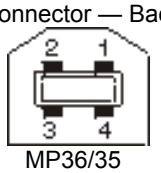
Pin	MP36 and MP35 or MP45	
1	Shield drive	Shield drive
2	Vin+	Vin+
3	GND	GND
4	Vin–	Vin–
5	Shield drive	Shield drive
6	+5 V (100 mA max aggregate)	+5 V (50 mA max)
7	ID resistor lead 1; I2C SCL	ID resistor lead 1 (+5 V)
8	ID resistor lead 2; I2C SDA	ID resistor lead 2
9	–5 V (100 mA max aggregate)	–5 V (50 mA max)

MP Analog Output — MP36/35 Back
9 PIN MALE DSUB



Pin	MP36 and MP35
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 MP35 Pulse or CH data Buffered, D.C. coupled Z out = 50 Ω Range: MP36 -10 V to +10 V MP35 0 V to +4.096 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

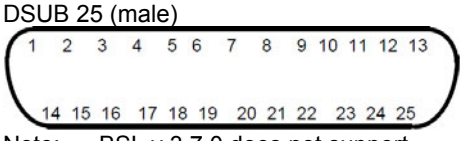
Connector — Back



MP36/35

Pin	MP36 or MP35	
1	+5	N/C
2	-Data	clock
3	Data +	RX+
4	GND	Ground
5	n/a	TX-
6	n/a	RX-
7	n/a	N/C
8	n/a	TX+

MP UNIT PIN OUTS continued
I/O Port — MP36 or MP35 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	MP36 or MP35 only			
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

NOTE: This "Core Packages" table refers to page numbering from the Biopac Student Lab Catalog. See the catalog for information contained in any of these page references.

core packages

- Packages are offered as a comprehensive building block for discipline-specific applications.
- Increase application potential by adding more hardware.

Core Package Components

BIOPAC Hardware	Part #	Page	Basic MP36	Advanced MP36	Ultimate MP36	Human MP36	Animal MP36	Biology MP36	Exercise Phys. MP36	Psychophys. MP36	Biomed. Eng. MP36	Pharm. & Tox. MP36	Intro MP45	HScS MP45
Data Acquisition Unit & Cables	ships with system	24												
BSL Software—Lessons & PRO	ships with system	2-7	x	x	x	x	x	x	x	x	x	x	x	x
Lab Manual—BSL lessons	MANBSL4/45	40	x	x	x	x	x	x	x	x	x	x	x	x
PRO Lessons—40+ experiments	on web	43-45	x	x	x	x	x	x	x	x	x	x	x	x
Electrode Lead (x2)	SS2LB	25	x	x	x	x		x	x	x	x		x	x
High-impedance Cable ±1V Input (x2)	BSLCBL8	36					x					x		
High-impedance Cable ±5V Input	BSLCBL9	36						x						
Electrodes, Disposable (100/pk)	EL503	37	x	x	x	x	x	x	x	x	x	x	x	x
Abrasive Pads (10/pk)	ELPAD	36	x	x	x	x	x	x	x	x	x	x	x	x
Airflow Transducer	SS11LA	27		x	x	x		x	x		x	x		x
Calibration Syringe—600ml	AFT6A	34		x	x	x		x	x		x	x		x
Bacterial Filters, Disposable (10/pk)	AFT1	34		x	x	x		x	x		x	x		x
Mouthpieces, Disposable (10/pk)	AFT2	34		x	x	x		x	x		x	x		x
Nose Clips, Disposable (10/pk)	AFT3	34		x	x	x		x	x		x	x		x
Electrodermal Activity (GSR) Lead	SS57L	26		x	x			x		x				
EDA (GSR) Electrodes (100/pk)	EL507	37		x	x			x		x				
Hand Switch—Pushbutton	SS10L	26		x	x			x	x	x	x			
Headphones	A: OUT1A or B: 40HP	26		A	A			A	A	A	A			B
Pulse Plethysmograph Transducer	SS4LA	26		x	x			x	x	x	x			
Respiratory Effort Transducer	SS5LB	26		x	x			x	x	x				
Temperature Transducer	SS6L	26		x	x			x	x					
Colored Paper—for L09 Polygraph	PAPER1	-		x	x			x		x				
Electrode Gel	GEL1	36			x			x						
Tape—Single-sided	TAPE1	36		x	x			x	x					
Blood Pressure Cuff Transducer	A: SS19LA or B: SS19L	27			A	A		A	A	A	A			B
Electronic Stethoscope Transducer	SS30L	28			x	x		x	x	x	x			x
Force Transducer— Variable range	SS12LA	27			x			x						
Hand Dynamometer	A: SS25LA or B: SS56L	27			A	A		A	A		A			B
Multi-Lead ECG Cable	SS29L	27			x			x						
Pressure Transducer	SS13L	27			x			x				x		
Stimulator—BSL	BSLSTMB	25			x			x				x		
Stim. Electrode—human-safe	HSTM01	28			x			x						
Stimulator—Low Voltage	SS58L	25					x							
Stim. Electrode—animal	ELSTM2	38					x	x				x		
Dissolved O_2 Probe	SS69L	31												
Dissolved O_2 Interface	BSL-TCI16	39					x	x						
Signal Processing Breadboard	SS39L	30									x			
Electrode Lead—unshielded (x2)	LEAD110	36					x					x		
Electrode Leads—shielded (x2)	LEAD110S-W & -R	36					x					x		
Force Transducer—200g	SS65L	31					x					x		
Needle Electrodes (x3)	EL452	38					x	x				x		
Nerve Chamber	NERVE2	38					x	x				x		
Nerve Cable—Recording	BSLCBL4B	39					x	x				x		
Nerve Cable—Stimulator	BSLCBL2A	39					x	x				x		
pH Interface (SS68L or other pH probe)	BSL-TCI21	39						x						
			Basic	Advanced	Ultimate	Human	Animal	Biology	Exercise Phys.	Psychophys.	Biomed. Eng.	Pharm. & Tox.	Intro MP45	HScS MP45
			8	9	9	10	12	14	16	18	20	22	8	8

See the page indicated for an overview of each discipline, including lessons the Core Package supports and suggested hardware options and potential applications.

Hardware Options

- This table only lists parts included in CORE PACKAGES.
- For a full list of hardware options, see the BSL Hardware section (pages 24-40) or check the Index (page 47).
- All parts can be ordered individually—you can add hardware options, or create your own package to suit your curriculum.

Visit www.biopac.com or contact a Biopac Student Lab Specialist to discuss your specific application needs.

NOTE: This"Lesson Hardware Guide" table refers to page numbering from the Biopac Student Lab Catalog. See the catalog for information contained in any of these page references.

lesson hardware guide

using Core Package hardware

	Page	Basic	Adv.	Ult.	Human	Animal	Biology	Psych	Ex. Phys.	BME	Pharm.	Intro MP45	HScS MP45	Hardware Used (optional)
BSL1: EMG I	43	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25, (OUT1A/40HP p26)
BSL2: EMG II	43			x	x		x		x	x			x	SS2LB p25, SS25LA p27, (OUT1A/40HP p26)
BSL3: EEG I	43	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
BSL4: EEG II	43	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
BSL5: ECG I	43	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
BSL6: ECG II	43	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB x2 p25
BSL7: ECG & Pulse	43		x	x			x	x	x	x				SS2LB p25, SS4LA p26
BSL8: Respiratory Cycle I	43		x	x			x		x					SS5LB and SS6L p26
BSL9: GSR & Polygraph	44		x	x			x	x						SS2LB p25, SS5LB and SS57L p26
BSL10: Electrooculogram (EOG) I	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB x2 p25
BSL11: Reaction Time I	44		x	x			x	x	x	x				SS10L and OUT1A p26
BSL12: Pulmonary Function I	43		x	x	x		x		x	x	x		x	SS11LA p27, AFT6A p34
BSL13: Pulmonary Function II	43		x	x	x		x		x	x	x		x	SS11LA p27, AFT6A p34
BSL14: Biofeedback	44		x	x			x	x						SS2LB p25, SS57L p26
BSL15: Aerobic Exercise Physiology	44		x	x			x		x					SS2LB p25, SS6L p26, SS11LA p27
BSL16: Systemic Blood Pressure	43			x	x		x	x	x	x			x•	SS2LB p25, SS19LA/L p27, SS30L p28
BSL17: Heart Sounds	43			x	x		x	x	x	x			x	SS2LB p25, SS30L p28
BSL20: Spinal Cord Reflexes	43													SS11LA p27, GASSYS2 and AFT6A p34
H01 12-Lead ECG	45			x			x							SS29L p27
H02 BME Compartmental Modeling	44		x	x			x	x	x	x				SS2LB p25
H03 Nerve Conduction Velocity	44			x			x							SS2LB p25, BSLSTMB p25, HSTM01 p28
H04 Blood Pressure Response to Straining Exercise	44			x	x		x	x	x	x			x	SS19LA/L p27, SS30L p28
H05 Wingate Test (WAnT)	43		x	x			x		x					SS4LA p26
H06 Finger Twitch	43			x			x							SS61L p30, BSLSTMB p25, HSTM01 p28
H07 EMG - Active Learning	43	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H08 ECG Dive Reflex - Active Learning	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H09 Auditory Evoked Potential (AEP)	44													BSLSTMB p25, OUT101 p31, BSLCBL6 p38
H10 Hemispheric EEG	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB x2 p25
H11 Mirror Test: Sensory Motor Learning & EDA	44		x	x			x	x						SS10L and SS57L p26
H12 Saccades: EOG	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H13 Tracking: EOG	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H14 Fixation I: EOG (3-lead)	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H15 Fixation II: EOG (6-lead)	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB x2 p25
H16 Reflexes & Reaction Time - Active Learning	44		x	x			x	x	x	x				SS10L and OUT1A p26
H17 Biomechanics	44													SS2LB x2 p25, SS21L p29
H18 Exercise Phys. - Continuous Noninvasive BP	43													NIBP100D p32
H19 VO_2 & RER	45													SS11LA p27, GASSYS2 and AFT6A p34
H20 BME Filtering	43	x	x	x	x	x	x	x	x	x	x	x	x	no transducers required
H21 Impedance Cardiography (Cardiac Output)	44													SS2LB p25, SS30L p28, SS31L p29
H22 Visual Evoked Response (VER)	43													SS2LB p25, TSD122 p32
H23 Signal Averaged ECG	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H24 Habituation	45		x	x			x	x						SS2LB p25, SS10L and SS57L p26
H25 BME Signal Processing I (8 circuits)	45									x				SS39L and (SS60L) p30
H26 BME Signal Processing II (ECG R-Wave Detector)	43										x			SS39L and (SS60L) p30
H27 Facial EMG	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB x2 p25, (SS10L p26)
H28 Reflex Response (patellar tendon)	43													SS2LB p25, SS36L p30, (SS20L p29)
H29 Basal Metabolic Rate	44													SS11LA p27, GASSYS2 and AFT6A p34
H30 Stroop Effect	44													SS10L p26, STP35W p32
H31 Prepulse Inhibition	44													SS2LB p25, STP35W p32, (OUT100 web)
H32 Heart Rate Variability Analysis	45	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H33 BME FFT Fast Fourier Transform	43	x	x	x	x	x	x	x	x	x	x	x	x	no transducers required
H34 Electrogastrogram from human (stomach)	45	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H35 Range of Motion: Sit & Reach	45													SS21L p29
H36 Muscular Biofeedback (auditory, visual, touch)	45		x	x			x	x	x	x			x	SS2LB p25, OUT1A/40HP p26
A01 Frog Pith & Prep	45	x	x	x	x	x	x	x	x	x	x			no transducers required
A02 Frog Gastrocnemius	45					x	x			x				SS12LA p27, STIM p25, ELSTM2 p38
A03 Frog Sciatic Nerve	45					x	x			x				STIM p25, NERVE1/2 p38, BSLCBL p39
A04 Frog Heart	45			x		x	x				x			SS12LA p27, (HDW p31)
A05 Visceral Smooth Muscle	45			x+		x+	x+				x+			SS12LA p27, (HDW p31), (ITBS100 p33)
A06 Cockroach Ventral Nerve	45					x	x				x			BSLCBL8/9 p36, EL452 x3 p38
A07 Q_{10} Principle (Dissolved O_2-Goldfish)	45					x*	x*							SS69L p31 or BSL-TCI16 p39
A08 Action Potential in Earthworm	45					x	x			x				STIM p25, NERVE1/2 p38, BSLCBL p39
A09 Properties of Turtle Heart Cardiac Muscle	45					x	x			x				SS12LA p27, STIM p25, STM2+452 p38, CBL8 p36
A11 Resting Potential - Crayfish Muscle	45					x†	x†				x†			BSLCBL8 p36, (CBL204 x2 p39)
A14 Central Pattern Generator (hornworm pupa)	45					x	x			x				BSLCBL8 p36, EL452 x3 p38
A15 Earthworm Smooth Muscle	45			x		x	x			x				SS12LA p27, (HDW p31), (ITBS100 p33)

*interface included, probe required +tissue bath required †requires Crawdad CD-ROM Lab Manual -glass microelectrode required • no ECG

NOTE: The following three pages of lesson descriptions refer to page numbering from the Biopac Student Lab Catalog. See the catalog for information contained in any of these page references.

CARDIOVASCULAR

BSL LESSON 5: ECG I

Record Lead II ECG and examine components of the ECG complex as an introduction to the electrocardiograph and the recording of the heart's electrical signal.

BSL LESSON 6: ECG II

Record ECG using bipolar Leads I and III; the software calculates Lead II to demonstrate Einthoven's law.

BSL LESSON 7: ECG & PULSE

Use a pulse plethysmogram transducer and Lead II ECG to examine the mechanical action of the heart and peripheral pulse pressure to learn how the heart pumps blood throughout the body.

BSL LESSON 16: SYSTEMIC BLOOD PRESSURE

Record arterial blood pressure using the ausculatory (cuff) technique, Korotkoff sounds using an amplified stethoscope, and ECG using Lead II.

BSL LESSON 17: HEART SOUNDS

Record ECG Lead II and place an amplified stethoscope at four different locations to listen to the sounds of the heart's valves and correlate the sounds with the cardiac cycle.

H01 12-LEAD ECG

Record a 12-lead ECG and observe changes in the frontal plane vectors throughout a cardiac cycle.

H08 ECG DIVE REFLEX ACTIVE LEARNING

Subjects immerse their face in cold water and record the change in heart rate that occurs to investigate the physiological reason for the observed response.

H21 IMPEDANCE CARDIOGRAPHY

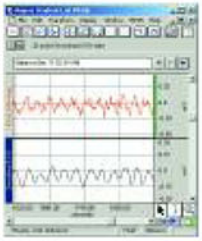
Noninvasively record and measure stroke volume and heart rate data and correlate with cardiac output.

H23 SIGNAL AVERAGED ECG

Record ECG data under different experimental conditions and perform a Signal Averaged ECG recording for each segment of data.

MUSCULAR

BSL LESSON 1: EMG I



Record maximum grip clench for the dominant and non-dominant hand to investigate the properties of skeletal muscle.

BSL LESSON 2: EMG II

Use a hand dynamometer to record maximum grip strength for both hands and explore the role of skeletal muscle in performing mechanical tasks.

H06 FINGER TWITCH HUMAN

Record the force generated from a finger twitch and measure the stimulus frequency required to induce fatigue. (Alternative to Frog Gastroc.)

H07 EMG ACTIVE LEARNING

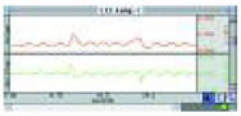
Investigate the electrical activity of different muscles as they contract with varying degrees of force and design experiments by selecting muscles to record from and creating activities those muscles will perform.

H27 FACIAL EMG

Record EMG response on the corrugator supercilii & zygomaticus major muscles.

H34 ELECTROGASTROGRAM

Record electrical activity through stomach muscles (EGG) and note the power and frequency of contractions at rest and after eating.



RESPIRATORY & PULMONARY FUNCTION

BSL LESSON 8: RESPIRATORY CYCLE I

Record chest contraction & expansion and ventilation, then correlate respiration changes with ventilation to examine the effects of cerebral influence and chemoreceptor influence on the medullary control centers.

BSL LESSON 12: PULMONARY FUNCTION I

Perform a variety of pulmonary measurements: Tidal volume, Inspiratory capacity, Expiratory capacity, Functional residual capacity, Vital capacity and Total lung capacity.

BSL LESSON 13: PULMONARY FUNCTION II

Record and analyze Forced Vital Capacity, Forced Expiratory Volume ($FEV_{1,2,3}$) and Maximal Voluntary Ventilation (MVV) to build on the principles established in Lesson 12.

H29 BASAL METABOLIC RATE

Record indirect basal metabolic rate (BMR) and post-exercise metabolic rate.

H19 VO_2 & RER

Record and measure oxygen consumption (absolute VO_2) and respiratory exchange ratio (RER) under a variety of conditions and observe the relationship between VO_2 and RER.

NEUROPHYSIOLOGY

BSL LESSON 3: EEG I

Record EEG from the occipital lobe while performing a variety of tasks to demonstrate how the brain's electrical activity varies dependent upon the task being performed.

BSL LESSON 4: EEG II

Discover how the brain constantly receives sensory input and integrates the information before processing it. The system records and displays raw EEG, alpha wave and alpha-RMS activity.

Lesson Update

See www.biopac.com for lesson additions and product updates.

CARDIO page 43 | MUSCULAR page 43 | RESP. & PULM. page 43 | NEUROPHYS. pages 43-44 | EX. PHYS. page 44 | BME page 45 | ANIMAL page 45

BSL LESSON 9: GSR & POLYGRAPH (EDA)

Record changes in respiratory rate, heart rate and electrodermal activity (skin conductance) to become familiar with the standard physiological measures recorded by a polygraph and study the effects of cognitive behavior and emotion.

BSL LESSON 10: ELECTROOCULOGRAM (EOG) I

Record horizontal and vertical eye movement to demonstrate eye fixation and tracking. Students perform a number of tasks that allow them to record the duration of saccades and fixation.

BSL LESSON 11: REACTION TIME I

Subject hears two schedules of clicks through headphones and reacts by pressing a pushbutton hand switch as quickly as possible to demonstrate the effect of learning and physiological processes on reaction times.

BSL LESSON 14: BIOFEEDBACK

Record ECG, heart rate and electrodermal activity, and try to influence heart rate and EDA (GSR) to control the position of a bar graph to demonstrate the principles of biofeedback training for relaxation purposes.

BSL LESSON 20: SPINAL CORD REFLEXES

Record and examine properties of spinal neuromuscular reflexes commonly tested in physical diagnosis.

H03 NERVE CONDUCTION VELOCITY

Record responses along the ulnar nerve of a human subject to observe the Threshold, Maximal and Supra-Maximal response levels and determine nerve conduction velocity along the ulnar nerve.

H09 AUDITORY EVOKED POTENTIAL (AEP)

Present an auditory stimulus to a human subject and record Auditory Evoked Potential.

H10 HEMISPHERIC EEG

Record EEG and study effects of sensory stimulation or change in attitude/attention on alpha rhythm, beta rhythm, and hemispheric asymmetry.

H11 MIRROR TEST: SENSORY MOTOR LEARNING & EDA

Correlate efficiency in a task requiring movement and attention focus with reticular tone (which indirectly indicates emotional fluctuations) and analyze performance over repeated trials.

H12 SACCADES: EOG

Explore applications of electrooculography and observe the constant saccade durations for a variety of given angular displacements.

H13 TRACKING: EOG

Observe tracking movements used while watching a moving object and demonstrate the difference between eye movement based on actual visual stimulation and imagined recreations.

H14 FIXATION I: EOG

Record horizontal EOG and observe Ocular Fixation while reading.

H15 FIXATION II: EOG

Record a horizontal and vertical EOG and observe spontaneous gaze changes produced when viewing an image, and then correlate results from the plot with the subject's attitude or level of interest.

H16 REFLEXES & REACTION TIME

Measure basic reflex and reaction time (visual stimulus) exercises and record reaction time to auditory stimulus. Compare reaction times from fixed interval and pseudo-random presentation to study the effects of learning and physiological processes on reaction times.

H22 VISUAL EVOKED RESPONSE

Present a visual stimulus to a human subject and record Visual Evoked Potentials (P100 test).

H24 HABITUATION

Record EDA (GSR) and Heart Rate response to repeated stimulus to demonstrate habituation and its probabilistic trend toward decreased response.

H28 REFLEX RESPONSE

Record knee and ankle reflex response with the SS36L Reflex Hammer transducer. Option: Use the SS20L Goniometer to measure angular movement in response to varying strike force.

H30 STROOP EFFECT

Record strength of interference between two associative tasks: naming and reading.

H31 PREPULSE INHIBITION

Record the startle response with and without a prepulse inhibition stimulus.

H32 HEART RATE VARIABILITY

Explore statistical measures, geometric measures, and spectral analysis in heart rate variability.

EXERCISE PHYSIOLOGY

BSL LESSON 15: AEROBIC EXERCISE PHYSIOLOGY

Record ECG, heart rate, airflow and skin temperature as the body responds to changing metabolic demands.

BSL LESSON 20: SPINAL CORD REFLEXES

Record and examine properties of spinal neuromuscular reflexes commonly tested in physical diagnosis.

H04 BLOOD PRESSURE

Record noninvasive BP with isometric or straining exercise.

H05 WINGATE TEST (WAnT)

Record the Wingate Anaerobic Test and complete calculations.

H17 BIOMECHANICS (Goniometry & EMG)

Record muscle activity from the triceps and biceps while recording angle of limb movements.

H18 EXERCISE PHYSIOLOGY (Blood Pressure)

Record Automatic Noninvasive Blood Pressure in pre- and post-exercise conditions and compare the conditions.

CARDIO page 43 | MUSCULAR page 43 | RESP. & PULM. page 43 | NEUROPHYS. pages 43-44 | EX. PHYS. page 44 | BME page 45 | ANIMAL page 45

H35 RANGE OF MOTION: SIT & REACH

Students use a goniometer to record angle of joint movement (i.e., hip, ankle etc.) during a Sit & Reach test.

H36 MUSCULAR BIOFEEDBACK

Students record EMG and use auditory and visual (bar graph) biofeedback and touch to increase muscle performance.

BME - BIOMEDICAL ENGINEERING

H02 COMPARTMENTAL MODELING

Explore Westheimer's saccadic eye movement model, which represents the eye as a 2nd order system. Record eye motion via EOG setup and compare to modeled results.

H20 FILTERING

Design and develop software-based digital filters to perform a variety of physiological signal filtering tasks. Cascade 2nd order biquads to create high order filters.

H25 SIGNAL PROCESSING BREADBOARD I (8 Circuits)

Schematic and design notes for Square Wave Oscillator, Instrumentation Amplifier, High Pass Active Filter, Active Gain Block and Low Pass Filter, Notch Filter for 60 Hz Rejection, *QRS Detection:* Band Pass Filter, *QRS Detection:* Absolute Value Circuit; *QRS Detection:* Low Pass Filter.

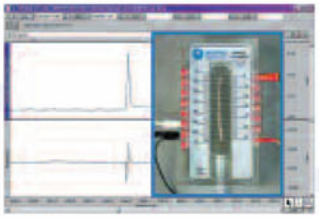
H26 SIGNAL PROCESSING BREADBOARD II (System)

Block diagram to build ECG Signal Processor with SS39L.

H33 FFT FAST FOURIER TRANSFORM

Build up a square wave from cosine components and use the FFT function to analyze the composite response.

ANIMAL

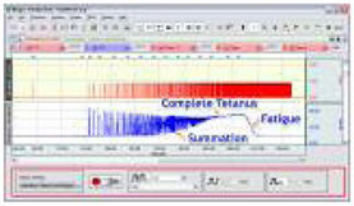


A01 FROG PITH & PREPARATION

Explanation of how to pith and prepare a frog for experiments A02, A03 and A04.

A02 FROG GASTROCNEMIUS

Directly stimulate the frog gastrocnemius muscle (or stimulate the muscle via the sciatic nerve) and record threshold voltage and contractile responses.



A03 FROG SCIATIC NERVE

Record compound action potentials of the dissected sciatic (somatic motor and sensory) nerve.

A04 FROG HEART

Record cardiac rate and contractile responses of the surgically exposed frog heart. Option: Study the effects of chronotropic and inotropic agents on the heart.

A05 VISCERAL SMOOTH MUSCLE

Study the effects of media ionic composition, temperature, and various pharmacological agents on the contraction of the visceral smooth muscle of the rabbit ileum.

A06 COCKROACH VENTRAL NERVE

Record nerve activity from the ventral nerve cord while stimulating the cerci with puffs of air.

A07 Q_{10} PRINCIPLE (Dissolved O_2 Goldfish)

Demonstrate the Q_{10} principle by measuring the metabolic rate of goldfish at two temperatures: 22° C (acclimation temperature) and 32° C (acute exposure temperature).

A08 ACTION POTENTIALS IN EARTHWORM

Use extracellular recording techniques to stimulate and record action potentials from an earthworm's nerve cord. Measure conduction velocity and refractory period, and plot a strength versus duration curve.

A09 PROPERTIES OF CARDIAC MUSCLE (Turtle Heart)

Measure the duration of systole and diastole and observe the effects of diastolic loading. Monitor the effect of vagal stimulation, temperature changes and spontaneous rhythmicity of the heart.

A11 RESTING POTENTIAL (Crayfish Muscle)

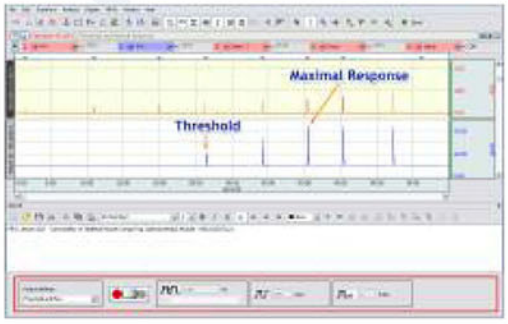
Follow BSL setup and use "Lab 4: Crayfish Muscle Resting Potential" from the Crawdad CD-ROM Lab Manual for Neurophysiology (ISBN 0-87893-947-4) to record and alter resting potential by changing external ion concentration.

A14 CENTRAL PATTERN GENERATORS

Perform extracellular recording on tobacco hornworm pupae to study central pattern generators (CPGs) and neural mechanisms.

A15 EARTHWORM SMOOTH MUSCLE

Setup earthworm gut with a force transducer and tissue bath to measure contractions and the effect of drugs.



CARDIO page 43 | MUSCULAR page 43 | RESP. & PULM. page 43 | NEUROPHYS. pages 43-44 | EX. PHYS. page 44 | BME page 45 | ANIMAL page 45

BSL STIMULATORS

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

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.

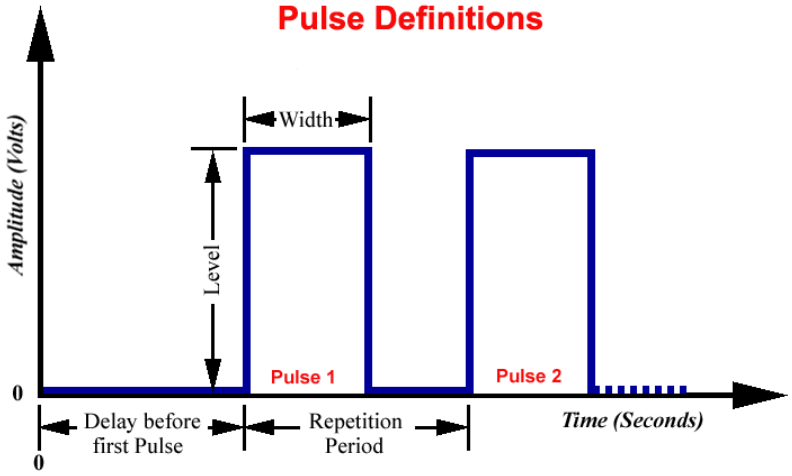
- NEVER set the BSLSTMA/B atop an MP3X
- Position the BSLSTMA/B away from the MP3X to reduce the signal distortion

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.

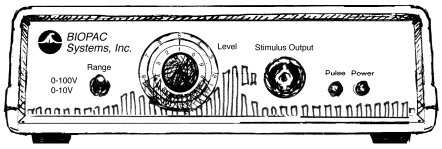
Pulse level — The amplitude of the pulse, expressed in Volts.
The output of the BSLSTM is 0 Volts when the pulse is not active.

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.

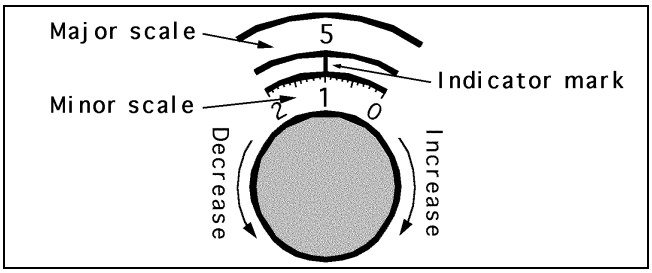
BSLSTMA/B digital display: Turn the Level control (right to increase, left to decrease) to establish the desired Level, as indicated on the digital display.

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
0-10V	Volts	Volt / 10
0-100V	Volts x 10	Volts

Turning the **Level** knob clockwise increases the voltage level, and turning it counterclockwise decreases the voltage. In the following close-up of the **Level** knob, the

level reads 5.1 Volts (Range 0-10V) or 51 Volts (Range 0-100V).
As shown in the following diagram, the indicator mark is between the two dials.



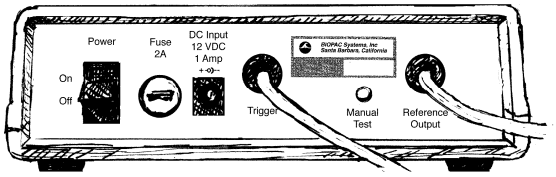
Close-up of "Level" adjustment knob

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

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

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

BACK PANEL TERMINOLOGY



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

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

DC Input — Socket for BIOPAC DC adapter.

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

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

When the **Trigger** and **Reference Output** cables are **disconnected** from the MP3X , 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 15ms and is generated each time the stimulator generates a pulse.

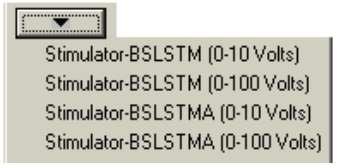
- BSLSTMA/B: Use the front panel Reference switch to select Actual or Fixed.
- BSLSTM has a fixed pulse width of 15ms, selected so that the MP30 can capture the pulse with a sample rate as low as 100 samples per second.

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.

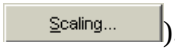
Calibration

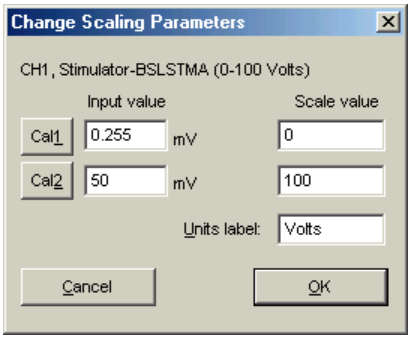
The "Reference Output" signal from the BSLSTM must be calibrated to ensure accurate results.

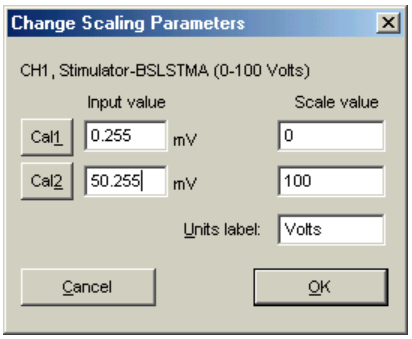
1. Choose the correct  **Preset** (via MP3X menu > Setup Channels).



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

2. With stimulator connected and ON, turn the **Level** control counter-clockwise until the display reads 0 (or as close to 0 as possible).
3. Get into the **Scaling** window for the Reference Output channel (via MP3X menu > Setup Channels >  > ).
4. Press the **Cal1** button to get the signal representing 0V out of the stimulator.

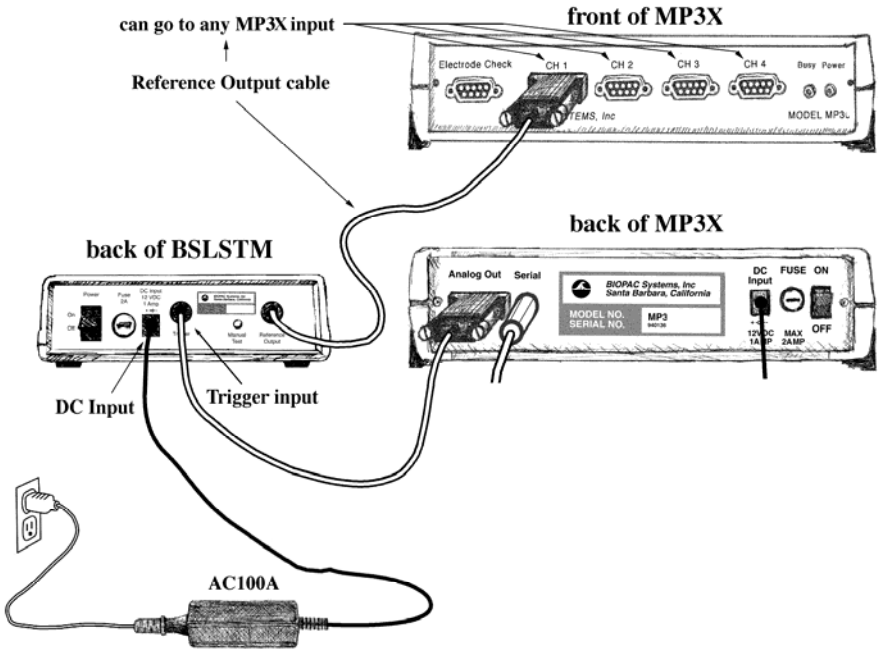




5. **Add** the Input value found with Cal1 to the Input Value displayed for Cal2.
   - For example, if "Cal1" is pressed and provides an Input Value of .255 mV, add the number .255 mV to the existing 50 mV and manually enter the total value of 50.255 mV for Cal2 Input Value.
   - *Note*: Even if the Cal1 Input Value is negative, it must still be "added" to the number for Cal2 (which essentially subtracts it) to arrive at the proper value.
6. Click **OK** to close out of the Scaling window and then close out of the Setup Channel window. The system is now ready to record.
7. *Optional*: Save the setup as a Graph Template to save these new scale settings. As long as neither the MP3X nor stimulator changes, the calibration should not need to be repeated.

CONNECTING THE BSLSTM TO THE MP3X

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



6) Plug the **Reference Output** cable (Male DB9 connector) from the back of the **BSLSTM** into an open channel input port (DB9 female connectors: CH 1, CH 2, CH 3, or CH 4) on the front of the **MP3X**.
7) Plug the 12 Volt **DC adapter** into the wall.
8) Mate the **DC output** connector on the end of the adapter cable to the **DC Input** socket on the back of the **BSLSTM**.
   - Make sure the connector is pressed in completely.
9) Plug 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 uses digital display and a keyed range switch)

Pulse width

Controlled by:	Computer, with lockable width limit
Range:	.049 – 100 milliseconds
Resolution:	2 microseconds
Accuracy:	5% (Can be improved to better than 2% using the "Correction factor" in the "Stimulator Preferences' window.)
Correction factor	Range: 0 - 150 microseconds Average value: 60 microseconds

Pulse Repetition

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

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

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

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

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

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

Initial Pulse Delay

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

Pulse level

Control:	Manual (10 turn potentiometer)
Range (selectable with *K* *Switch*):	*Range 1*: .025 - 10 Volts *Range 2*: .12 - 100 Volts Infinite (potentiometer adjustable) range
Accuracy:	5% accuracy to digital readout

Reference Output

Correlates to actual pulse output (Requires Calibration)

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

Manual Test Pulse

(Button on back panel)

Note: Will only function when "Trigger" cable is <u>not</u> connected to the MP3X.

Pulse Width:	1 millisecond

Stimulator isolation

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

Power requirements

12 Volts DC adapter (included), 1 Amp

Fuse

250V, 2A, fast blow

Fuse Dimensions:	1.25" length × .25" diameter

Module Weight

610 grams

Module Dimensions

16 cm x 16 cm x 5 cm

BSLSTM SPECIFICATIONS

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

Pulse width

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

Pulse Repetition

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

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

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

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

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

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

Initial Pulse Delay

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

Pulse level

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

Reference Output	Correlates to actual pulse output (Requires Calibration)
Pulse width:	15 millisecond fixed pulse width
Amplitude:	0 - 10 mV correlates to 0 – 10V actual output or 0 – 100V actual output
Manual Test Pulse	(Button on back panel) *Note*: Will only function when "Trigger" cable is <u>not</u> connected to the MP3X.
Pulse Width:	2.5 - 3 milliseconds
Stimulator isolation	
Volts:	2,000 Volts DC (HI POT test)
Capacitance coupling:	60pF
Power requirements	12 Volts DC adapter (included), 1 Amp
Fuse	250V, 2A, fast blow
Dimensions:	1.25" length × .25" diameter
Module Weight	610 grams
Module Dimensions	16 cm x 16 cm x 5 cm

LOW VOLTAGE STIMULATOR

OUT3

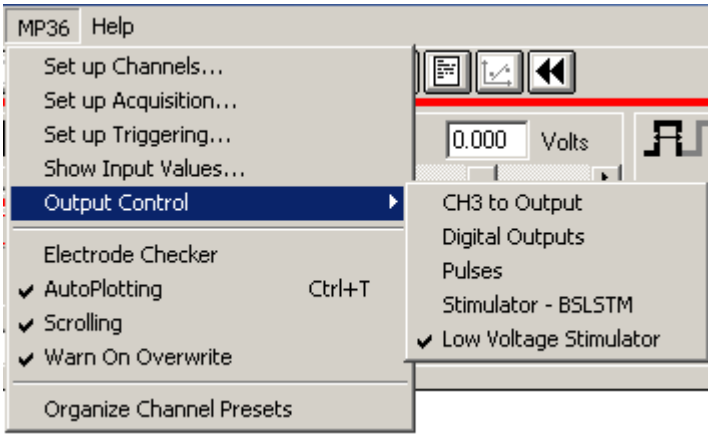
The **MP36** includes a built-in low voltage stimulator—just use the Analog Out port.

- 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

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

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!

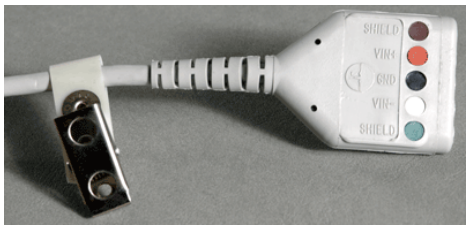
- Always set the **Level** to "0" Volts prior to connecting the stimulator electrodes to the subject.
- Increase the **Level** adjustment slowly until a response is noted.
- Never increase the **Level** more than necessary to obtain the desired response.
- The **BSLSTM** should only be used under direct 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.

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

SS1LA SHIELDED ELECTRODE ADAPTER

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



- LEAD120 for EL120 contact post electrodes or
- EL250 series reusable Ag-AgCl electrodes or
- EL450 series needle electrodes or
- LEAD110 series shielded and unshielded leads

SS1LA SPECIFICATIONS

Cable length	3-meter
Termination	standard 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.

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

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

SS3LA EDA (ELECTRODERMAL ACTIVITY) TRANSDUCER

The SS3LA transducer connects to a single MP3X input channel to record electrodermal activity (skin conductance or, with proper setup, skin resistance). Two Ag-AgCl electrodes are mounted in individual, ergonomically designed, polyurethane housings for improved contact. They attach to the fingers by a Velcro strap or can be taped to any other part of the body. The electrodes have a 6 mm contact area with a 1.6 mm cavity to accommodate electrode gel (GEL1, GEL101, or the preferred recording gel). The non-polarizable electrodes are shielded to minimize noise interference and improve recordings. These electrodes are different from standard SS2L electrodes in that they have built-in, reusable electrodes on the end, the electrodes are specially designed to fit around the tip of a person's finger, and the electrodes measure only one type of signal—the EDA.

- See the SS57L EDA (GSR) Lead for a disposable electrode option

USAGE RECOMMENDATIONS

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

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

1. Apply GEL101 to the skin at the point of electrode contact and rub it in.
2. Fill the SS3LA electrode cavity with GEL101.
3. Attach the SS3LA electrode to the subject.
4. Wait 5 minutes (minimum) before starting to record data.

Presets - BSL *PRO* software includes two EDA presets:

- Electrodermal Activity (EDA), 0 - 35 Hz; requires calibration—see details below
- Electrodermal Activity (EDA) Change; no calibration required

To calibrate the SS3LA using the Electrodermal Activity (EDA), 0 - 35 Hz preset:

1. Prepare two 1% calibration resistors; 100 kiloohm and 1 megaohm. 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. From the Scaling dialog box, set the **Cal1 Scale value** to **"1"** and click **Cal1**.
4. Repeat step 2 using the 100 kiloohm resistor.
5. From the Scaling dialog box, set the **Cal2 Scale value** to **"10"** and click **Cal2**.

Gain - verify the Gain setting of the SS3LA:

1. From the Scaling dialog box, set the **Cal1 Scale** to **"0"** and click **Cal1**.
2. Set the **Cal2 Scale** to **5Mho/V** and the **Input** voltage to **1 V**, and then close out of the Scaling dialog box.
3. Insulate a 100 kiloohm resistor and place it from electrode pad to electrode pad (resistor must be insulated from fingers).
4. Perform measurement with electrode-resistor setup.
    - BSL *PRO* should produce a reading of 10 microsiemens (older presets may use micromhos units label).

*SCR - 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.

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

SS3LA SPECIFICATIONS

Electrode Type:	Ag/AgCl, shielded	Weight:	4.5 grams
Range:	.1 – 100 μsiemens (normal human range is 1 – 20 μsiemens)	Cable Length:	2 meters
Surface Area:	6mm contact area	Connector Type:	9 Pin DIN
Gel Cavity Area	1.66 mm	Sterilizable:	Yes (contact BIOPAC)
Dimensions:	16 mm (long) × 17 mm (wide) × 8 mm (high)		

CLEANING THE SS3LA TRANSDUCER

- Do not leave GEL in the cavity after use. The electrode cavity must be left clean and dry. If GEL is left in the cavity, it will act as insulation preventing electrical contact with the skin, and the Ag-AgCl electrode disk could degrade quickly with time because the electrode surface is somewhat porous to promote good conductivity to the GEL.
- To clean the reusable SS3LA, use a cotton swab or toothbrush with tap water.
- Use any lab cleaner with pumice (such as Ajax) with a cotton swab or toothbrush to remove any dark residue from the electrode surface.
- Use Hydrogen Peroxide solution (2-3%) to brighten electrode surface (optional) or to sterilize the electrode. Do not place the electrode in solution, but simply clean the electrode surface using a cotton swab. Dry the electrode off completely before storage.

PULSE PHOTOPLETHYSMOGRAM TRANSDUCERS

- TSD200 for MP150/MP100 System
- SS4LA for MP3X and MP45 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 lead	*+VSUP*
Black lead	GND
Purple or Blue lead	INPUT

The SS4LA plugs directly into the MP3x or MP45.

CALIBRATION

The TSD200/SS4LA does not require calibration.

TSD200C PHOTOELECTRIC PULSE PLETHYSMOGRAPH 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 3-meter cable and ear clip.

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

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.
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
Interface:	PPG100C
TEL100C Compatibility:	SS4A

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

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

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

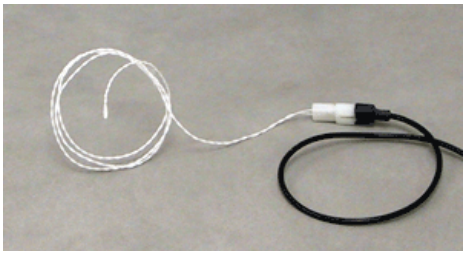
Response: T	rue DC
Circumference Range:	9 cm – 130 cm (Can be increased with a longer nylon strap)
Dimensions:	95 mm (long) × 47mm (wide) × 15mm (thick)
Weight: 9	grams
Sterilizable:	Yes (contact BIOPAC for details)
Variable Resistance Output:	50-150 K
Cable Length:	2 meters (flexible, lightweight)
Connector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

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

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

SS7L WATERPROOF PROBE

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

SS7L SPECIFICATIONS

Response time:	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
Cable:	3 meters

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

SS8L LIQUID IMMERSION PROBE

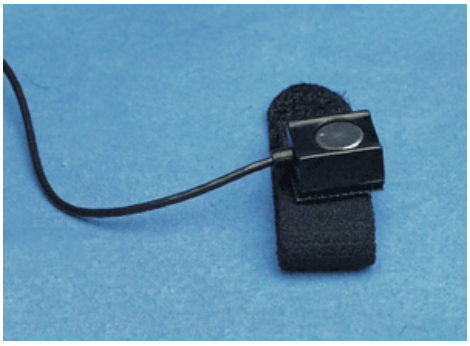
Use this stainless steel probe for dry or wet bath temperature measurements.

SS8L SPECIFICATIONS

Response time:	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:	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:	Yes (contact BIOPAC for details)

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

SS10L PUSHBUTTON HAND SWITCH

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

SS10L SPECIFICATIONS

Cable Length:	2 meters
Connector Type:	9 Pin DIN to MP36/35 front panel input

MEDIUM-FLOW PNEUMOTACH TRANSDUCER

- SS11LA for MP3X and MP45 System
- TSD117 & TSD117-MRI for MP150/MP100 System
- RX117 Replacement Airflow Head
- See also: **AFT series** of accessories for airflow and gas analysis

SS11LA needs 5-10 minutes to warm up; during this time, the baseline offset changes slightly.

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

The SS11LA/TSD117 airflow transducers include an optically clear detachable flow head (RX117) for easy cleaning and inspection. As the detachable flow head is snapped into the transducer handle, the flow head plugs directly into an integral, precision low-differential pressure transducer. Accordingly, the transducers will output an electrical signal proportional to respiratory flow. Use with the AFT22 Non-Rebreathing "T" valve for low dead space requirements.

The transducers connect to industry standard bacteriological filter AFT1 with disposable mouthpiece AFT2 or AFT13 filter and mouthpiece with AFT11H coupler. The RX117 detachable flow head can be cold sterilized, autoclaved (220° F max), or placed in a dishwasher.

- For airflow and lung volume measurements, use the airflow transducer with the AFT2 mouthpiece and the AFT1 bacterial filter.
- For measurements of expired gases, use the airflow transducer with the AFT22 non-rebreathing T valve with AFT10 facemask and the AFT15A or AFT15B mixing chambers.

All connections can be performed with AFT12 (22mm ID) tubing and AFT11 series couplers.

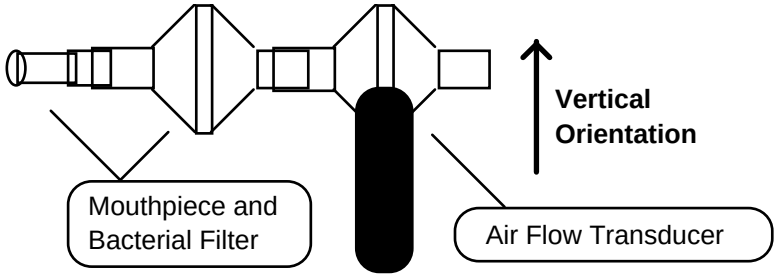
Please note the following:

a) 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.

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

Normal Measurement Connections

- SSLA plugs directly into the MP3X or MP45 unit
- TSD117 plugs directly into the DA100C amplifier module
- TSD117-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:

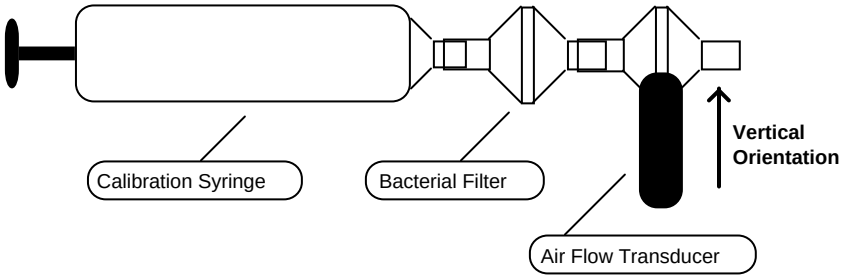
1. Breathe normally for 3 cycles (start on inspire)
2. Inspire as deeply as possible
3. Return to normal breathing for 3 cycles
4. Expire as deeply as possible
5. Return to normal breathing (end on expire)

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

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

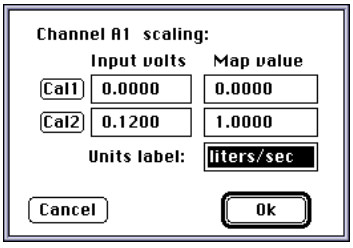
Scaling Factors for Rough Calibration of the airflow transducer

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]



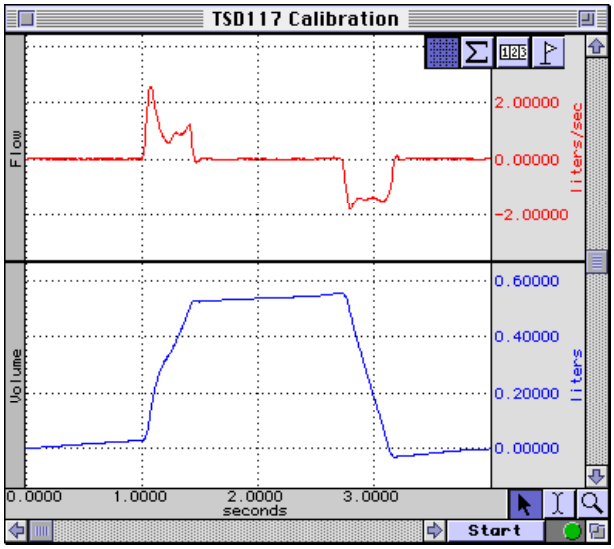
Data can now be collected directly. Prior to analyzing the data, remember that there will always be some offset recorded in the case of zero flow.

Note: With the TSD117 and MP150/100 system, it's possible to largely trim this offset out, using the ZERO potentiometer on the DA100 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 600ml-calibration syringe was used to check the rough calibration of the airflow transducer. The rough calibration indicates a syringe volume of about 550ml, 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 <<<

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.

Note: SS11LA to MP connection instructions also apply to 2-channel MP45 hardware.

SS11LA to MP3X connection

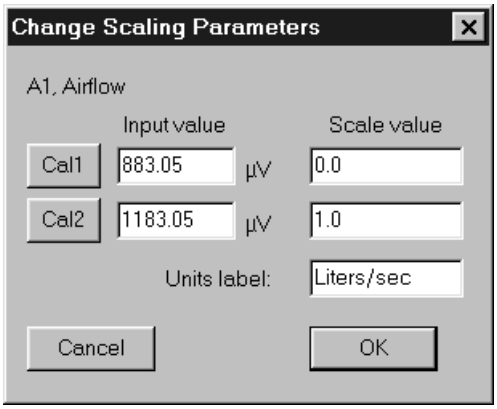
Rough Calibration (MP3X)

1. Pull down the **MP3X** menu.
2. Click **Setup channels**.
3. Select the **Analog** channel that the SS11LA transducer is plugged into and activate it by clicking in the **Acquire**, **Plot** and **Values** boxes.

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

$$60\ \mu V/[liter/sec] \cdot 5 = 300 \mu V / [liter/sec].$$

4. Pull down the **Presets** pop-up menu and select **Airflow**.
5. Click on the **View/Change Parameters** button.
6. Click on the **Scaling** button.
7. Click on **Cal1**: Leave the **Input value** reading and enter **0** for the **Scale value**.
8. For **Cal2 Input Value**, add **300µV** (or .3 mV) to the **Cal1 Input Value**. For **Cal2 Scale value**, enter **1**.
9. Click **OK** for each window to exit Channel Setup.



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

Using the Calibration Syringe

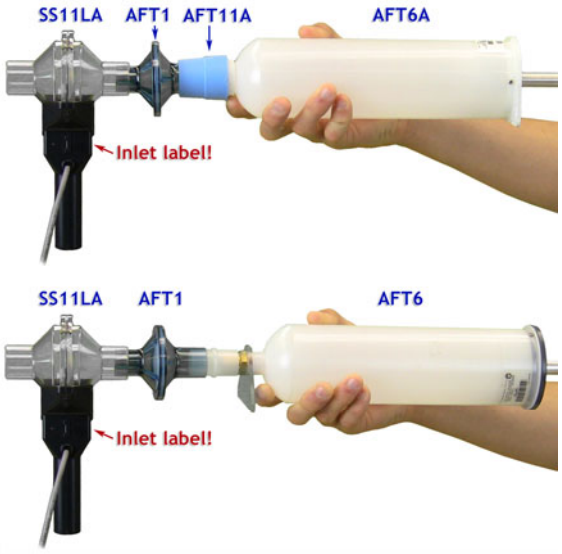
1. Place a filter onto the end of the calibration syringe.

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

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

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

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.



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.

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

Proper handling of the Calibration Syringe Assembly

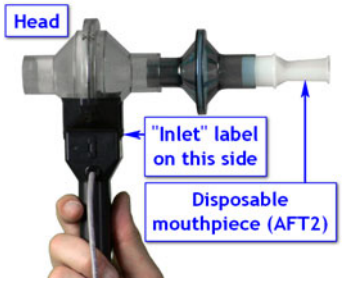
3. **Pump** the plunger several times before the recording. **Always** pull and push the plunger all the way until it stops when using the syringe. This assures that the full volume of air (0.6 liter) flows in and out of the airflow transducer.

Recording with the Airflow Transducer

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

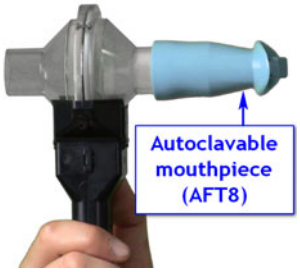
> WARNING
>
> The bacterial filter and mouthpiece are disposable and are "**one per person**" items. Please use a new disposable filter and mouthpiece each time a different person is to be breathing through the airflow transducer.

If using **SS11LA** transducer and 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."

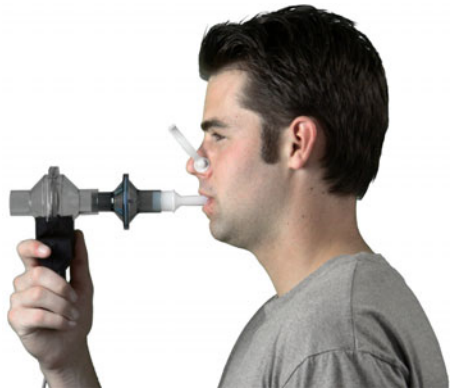


SS11LA with sterilized head

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

Hints for obtaining optimal data:

a) Keep the Airflow Transducer upright at all times.



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

c) Always use a nose clip when breathing through the airflow transducer and secure a tight seal with the mouth so that air can only escape through the airflow transducer.

d) Always begin breathing normally through the airflow transducer prior to the beginning of the recording and continue past the end of the recording.

e) If 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.

RX117 Replacement Airflow Head

The RX117 is a sterilizable airflow head for the TSD117 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 RX117 with the AFT8 sterilizable mouthpiece. (22mm ID/30mm OD). Multiple RX117 heads help eliminate equipment downtime during cleaning procedures.

Recommended sterilization: cold sterilization (i.e., Cidex®) or autoclave. If autoclaved, RX117 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 Usage Declarations for TSD117-MRI Medium Flow Pneumotach Transducer

MRI Usage: MR Conditional

Condition: The TSD117-MRI with RX117 head is used outside the bore in the MRI Chamber Room and AFT7-L tubing is connected to reach the subject.

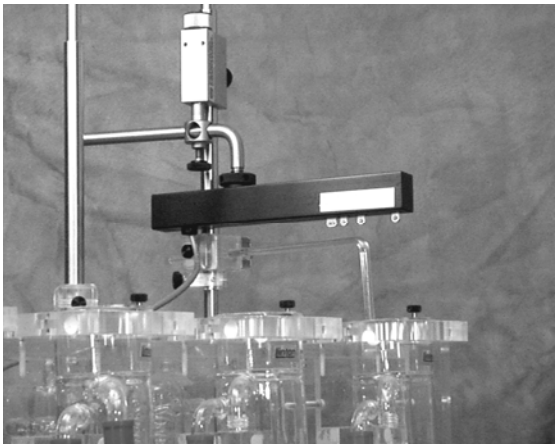
Components: Polyvinyl Chloride (PVC) Plastic, Polycarbonate Clear Plastic, Acrylonitrile Butadiene Styrene (ABS) Thermo-molded, Plastic, Polymer thick film device (rigid substrate, printed semi-conductor), Copper clad fiberglass lamination (PCB material), Stainless steel screen (type 316L), Stainless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

SS11LA & TSD117 Technical Specifications

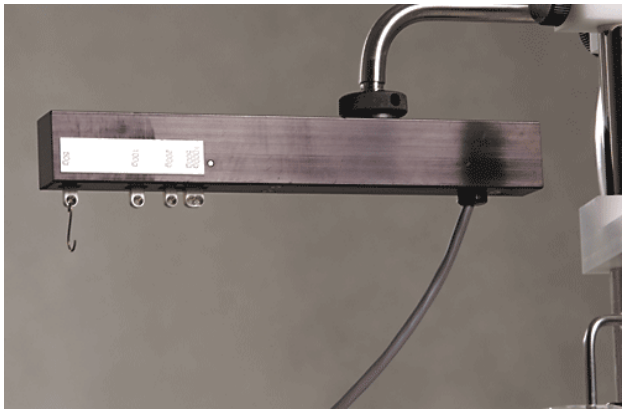
TRANSDUCER:	**TSD117**	**TSD117-MRI**	**SS11LA**
Interface:	DA100C	MECMRI-DA to DA100C	MP36/35/30/45
Flow Rate:	±300 Liters/min (±5 liters/sec)		10 liters/sec (highest linearity (±5 liters/sec)
Nominal Output:	60 µV/[liters/sec] (normalized to 1 V excitation)		60 µV/[liters/sec]
¼" 25 TPI mounting nut:	Standard camera mount		--------
Cable Length:	10 m, shielded		2 m, shielded
RX117 SPECS:			
Flow Head Construction:	Clear Acrylic		
Flow Bore (Ports):	22 mm (ID), 29 mm (OD)		
Flow Head Dimensions:	82.5 mm (diameter) x 101.5 mm (length)		
Flow Head Weight:	80 g		
Handle Weight:	85 g		
Handle Dimensions:	127 mm (length) x 23 mm (thick) x 35 mm (wide)		
Handle Construction:	Black ABS		
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 50g to 1000g. The beam and lever arm are mounted in a sealed aluminum enclosure that includes a 3/8" diameter mounting rod for holding the transducer in a large variety of orientations. The SS12LA comes equipped with a 2-meter cable and plugs directly into the MP3X module.

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

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

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

SS12LA S-hooks

SS12LA SPECIFICATIONS*

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

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

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

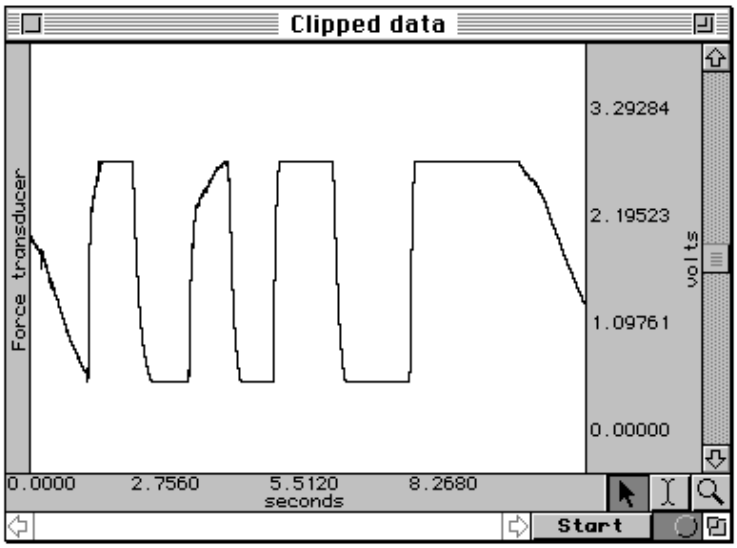
CALIBRATION

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

FORCE TRANSDUCER CALIBRATION

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

1) To find the optimal Gain setting:
   a) Start with the software Preset for the force range desired.
      - To set the Presets: MP3X menu > Setup Channels > Analog Presets > “Force (range)”
   b) Load the transducer with the maximum expected weight.
   c) Collect data for a few seconds at these settings.
   d) Inspect the sample data; 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.

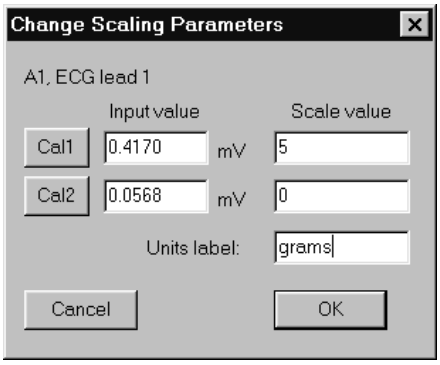
- To access the Gain setting: **MP3X** menu > **Setup Channels** > **Force** preset channel > **View/Change Parameters** icon > **Gain** pull-down menu

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.

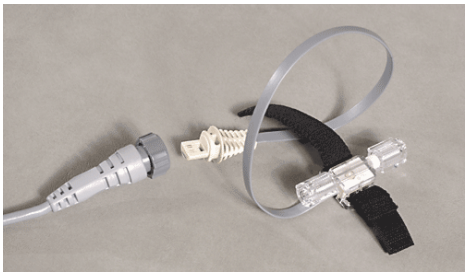
d) Remove all weight or force from the transducer.

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.

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 30cm cable that attaches to a reusable 3-meter cable that is designed to interface with the MP3X. The transducer is supplied non-sterile but can be cold sterilized.

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 = 5	1 KHz	100 (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:

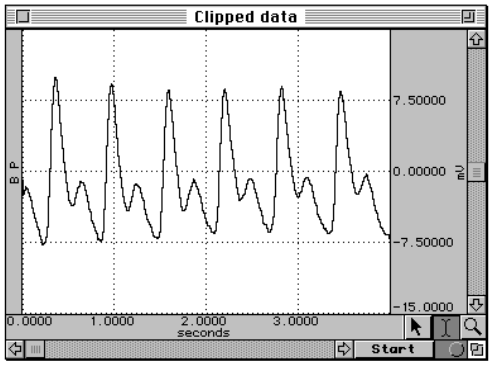
   a) Start with the software Presets (in this case, a gain of 100)
      - To set the Presets: MP3X menu > Setup channels > Analog Presets > select “Pressure”

   b) Bring the transducer to the approximate maximum and minimum expected pressures.

   c) Collect data for a few seconds at these settings.

   d) Inspect the sample data; 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 x2500) and collect new data at the lower gain setting.
      - To access the Gain setting: **MP3X** menu > **Setup channels** > **Pressure** preset channel > **View/Change Parameters** icon > **Gain** pull-down menu



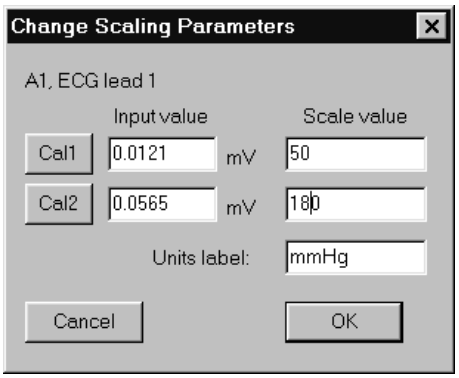
Gain set too high — Clipped *BP* data

   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 > **Setup Channels** > **Pressure** Preset channel > **View/Change Parameters** icon > **Scaling** button).



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

b) Bring the transducer to the lowest expected pressure.
c) Click on the **Cal 1** button in the Channel scaling window.
   - A voltage value will be automatically entered in the corresponding **Input value** box.
d) Bring the transducer to the highest expected pressure.
e) Click on the **Cal 2** button in the same scaling window.
   - A voltage value will be automatically entered in the corresponding **Input value** box.

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

SS13L PRESSURE TRANSDUCER SPECIFICATIONS

Operational pressure:	-50 mmHg to +300 mmHg
Overpressure:	-500 mmHg to + 4000 mmHg
Sensitivity:	25 V/VmmHg (at 5 VDC excitation)
Accuracy:	± 1.5% of reading or ± 1.0 mmHg (whichever is greater)
Operating temperature:	10° C to 40° C
Storage temperature:	-30° C to +60° C
Volume displacement:	0.04 mm per 100 mmHg
Leakage current:	10 A 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 leakage at 120 VAC/60 Hz
Defibrillation:	Withstands 5 charges of 400 joules in 5 minutes across a load
Combined effects of sensitivity, linearity and hysteresis:	1 mmHg (nominal)
Transducer cable:	30cm
Interface cable:	3 meters
Transducer dimensions:	67mm long X 25mm wide
Weight: 11.5	grams

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

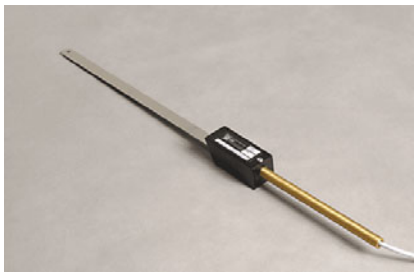
RX104A REPLACEMENT ELEMENT

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

info@biopac.com
support@biopac.com
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:	1mm to 100mm
Strain Gauge:	500 ohm silicon
Lever Length:	27cm
Support Rod Length:	15cm
Cable Length:	3 meters
Interface: MP3X	

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

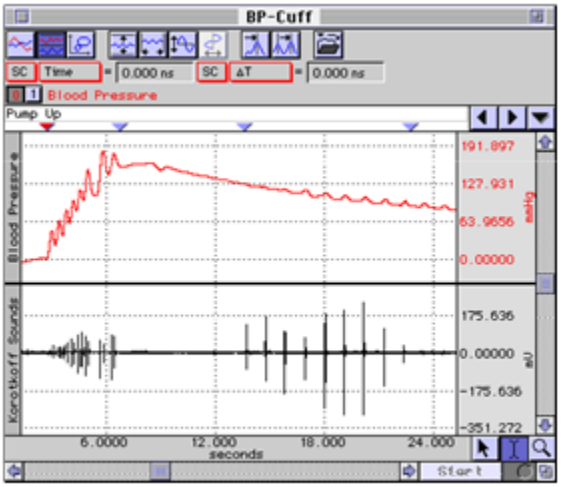
TSD108 AND SS17L PHYSIOLOGICAL SOUNDS TRANSDUCER (CONTACT MICROPHONE)

The physiological sounds transducer connects to the DA100C amplifier (TSD108) or the MP3x/4x hardware (SS17L). The transducer can be used with the Noninvasive Blood Pressure Cuff or as a stand-alone device. If used with the cuff, Korotkoff sounds can be recorded for easy determination of systolic and diastolic blood pressure. When used on its own, it can record a variety of acoustical signals, including heart sounds and sounds associated with rubbing or grinding (e.g., Bruxism). The acoustical transducer element is a Piezo-electric ceramic disk that is bonded to the interior of a circular metallic housing.

Grounding Note When using this transducer with the EBI100C module, do not connect the GROUND pin of the TSD108 to the DA100C module. Doing so will cause inaccurate impedance measures, because the TSD108 contact surface is tied to the isolated ground. An alternative is to insulate the TSD108 from the skin surface by using a latex balloon or some other non-conductive barrier. If the latter procedure is followed, the GROUND pin may be attached to the DA100 module.

- **TSD108:** Korotkoff signal is recorded by a DA100C amplifier set to AC, 5000 Hz LP and a gain of 50 to 200.
- **SS17L:** To record the Korotkoff signal, select SS17L preset from MP3x/MP4x > Set Up Channels menu.

The signal for the physiological sounds transducer is usually further conditioned by the software. In a calculation channel, the signal can be bandpass filtered from 50 to 200 Hz. The sampling rate for the entire recording needs to be about 500 Hz, assuming the physiological sounds transducer is used.



Cuff Blood Pressure Versus Korotkoff Sounds

TSD108/SS17L SPECIFICATIONS

Frequency Response:	35 Hz to 3500 Hz
Housing:	Stainless Steel
Sterilizable:	Yes (contact BIOPAC for details)
Noise:	5µV rms – (500 Hz - 3500 Hz)
Output:	2V (p-p) maximum
Weight:	9 g
Dimensions:	29 mm diameter, 6 mm thick
Cable Length:	3 m
Interface:	DA100C (TSD108), MP3x (SS17L)
Calibration:	None required
TEL100C Compatibility:	SS17

BLOOD PRESSURE CUFF AND TRANSDUCER

- TSD120 for MP150/MP100 System
- RX120 Series Cuff for TSD120
- SS19L/LA for MP3x & MP45 System

TSD120

RX120A and RX120F cuff options

BLOOD PRESSURE MEASUREMENT

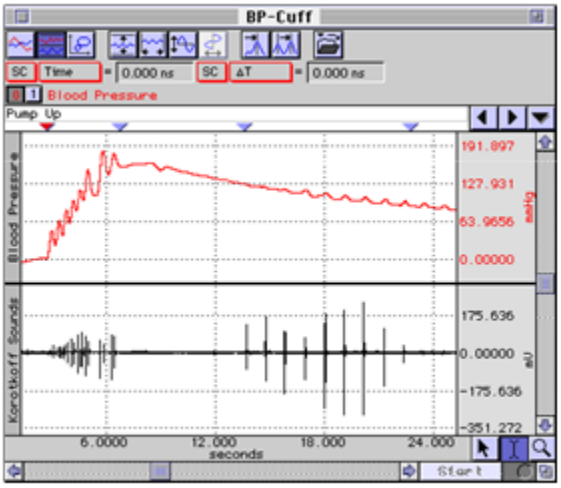
The most common form of indirect blood pressure measurement employs a pressure cuff, pump and pressure transducer. This complete assembly is commonly referred to as a *sphygmomanometer*.

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:** To record the pressure signal, Select SS19L/LA preset from the MP3x/MP4x > Set Up Channels menu.



Cuff Blood Pressure Versus Korotkoff Sounds

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.

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.

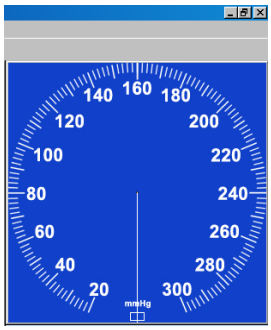
See also: DA100C Calibration options.

B) SS19L

The built-in pressure transducer of the SS19L/LA 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

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



NOTE: *The SS19LA is **not** compatible with MP45 Systems (USB chip conflict). Use SS19L with MP45 Systems.*

BSL 3.7.7

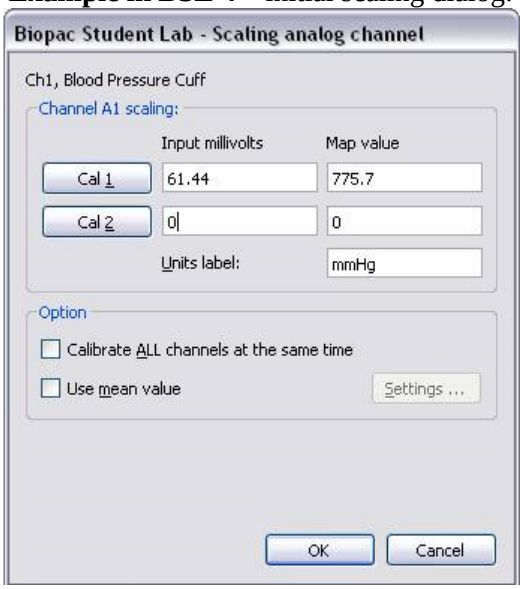
1. With **cuff deflated**, connect the SS19LA to the desired MP unit input channel.
2. Set the input channel preset to Blood Pressure Cuff SS19LA (MP > Set Up Channels > SS19LA preset)
3. Click on "View/Change Parameters" > "Scaling".
4. Click the CAL 1 button
5. Add the CAL 1 input value to the CAL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

BSL 4

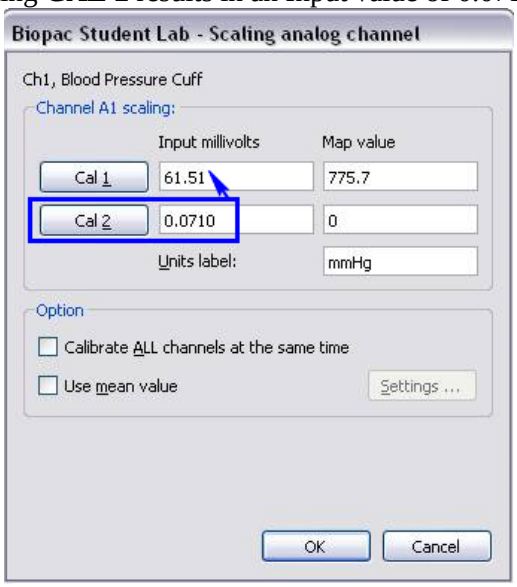
1. Repeat steps 1 and 2 from above.
2. Click "Setup" > "Scaling".
3. Click the CAL 2 button
4. Add the CAL 2 input value to the CAL 1 input value and click OK.

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

Example in BSL 4 – initial scaling dialog:



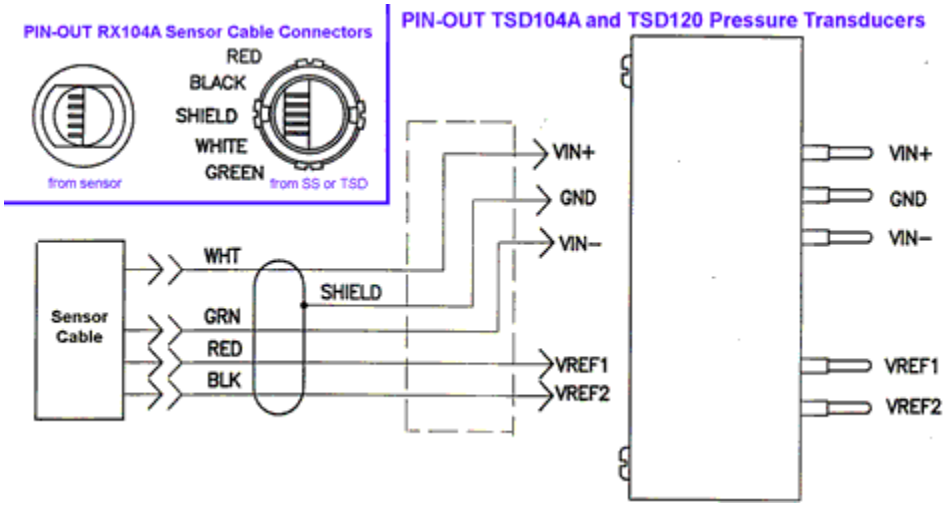
Clicking **CAL 2** results in an Input value of 0.071 mV.



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).

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 1V excitation)
Cuff circumference range:	25.4 cm to 40.6 cm (as shipped with RX120 d; cuff is switchable)
Cuff Dimensions:	14.5cm (wide) x 54cm (long)
Weight:	350 grams
Cable Length:	3 meters, shielded
Interface:	
TSD120	DA100C
SS19L/LA	MP3x/4x

Updated: 3.28.2013

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

RX120 SERIES BLOOD PRESSURE CUFFS

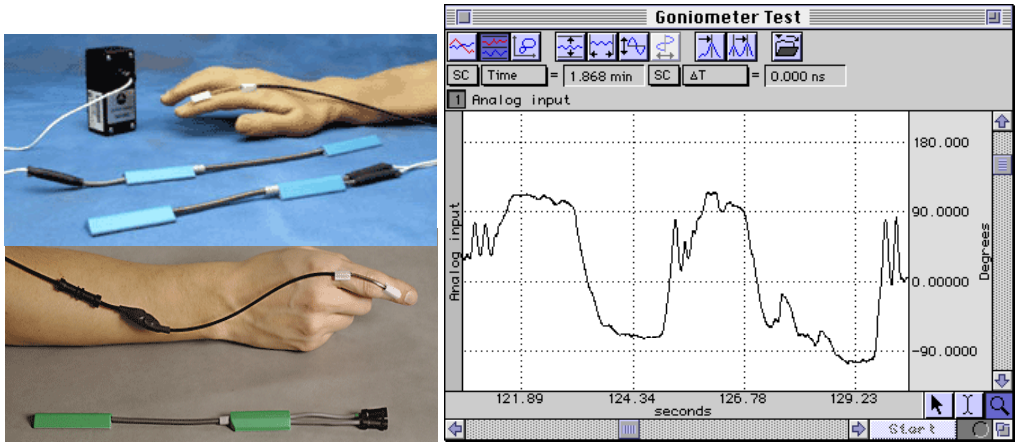
The RX120 series are optional blood pressure cuffs, of varying sizes, which can be quickly and easily swapped in and out of the noninvasive blood pressure cuff transducer. Use a single transducer and substitute one cuff for another to accommodate a wide range in limb circumferences.

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
RX120 d	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

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/MP45	TEL100C	BN-GONIO
Twin-axis Goniometer 110	TSD130A	S20L	SS20	BN-GON-110-XDCR
Twin-axis Goniometer 150	TSD130B	S21L	SS21	BN-GON-150-XDCR
Torsiometer 110	TSD130C	S22L	SS22	BN-TOR-110-XDCR
Torsiometer 150	TSD130D	S23L	SS23	BN-TOR-150-XDCR
Single-axis Goniometer 35	TSD130E	S24L	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.

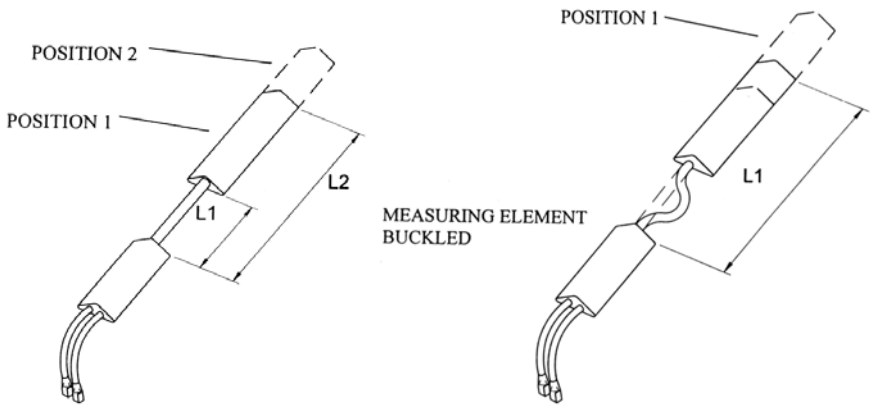
To compensate for this, all sensors are fitted with a telescopic endblock that permits changes in linear displacement between the two endblocks along axis ZZ without the measuring element becoming over-stretched or buckled.

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

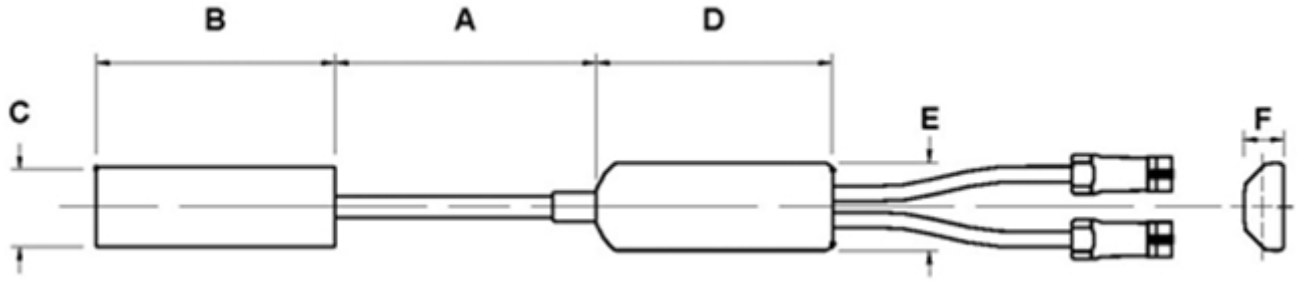
When using all goniometers and torsiometers, the minimum value of bend radius must be observed at all times, particularly when attaching and removing the sensors from the subject. Failure to do this will result in reduced unit life or failure.

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/45 analog input per rotational axis. Accordingly, the twin axis goniometers will need two DA100C amplifiers, one BN-GONIO or two MP3X/45 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/35/30/45	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	±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 m for TSD130 Series/SS20L-24L/BN-GON/BN-TOR, 1.8 m for SS20-24,				
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	700hPa to 1060hPa				
Storage	500hPa to 1060hPa				

[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.

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

OVERVIEW OF THE BIOPAC GONIOMETER SERIES

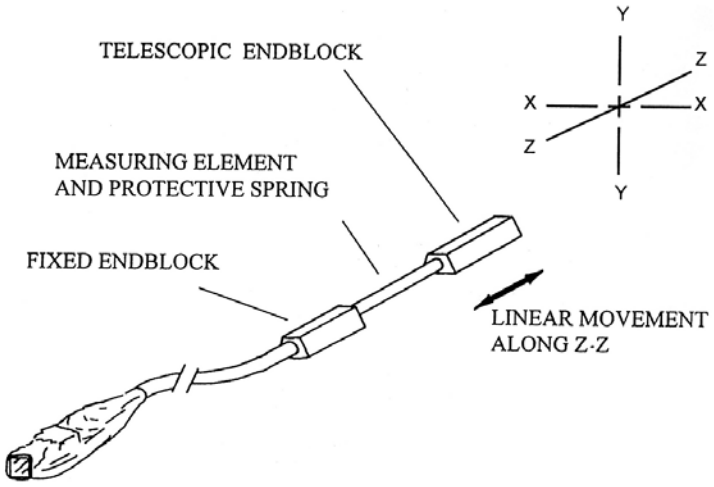
As with all measuring equipment, to correctly interpret the data, understanding the working principles (i.e., what the sensor measures) before use is helpful. BIOPAC Systems, Inc. manufactures three types of sensors:

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.

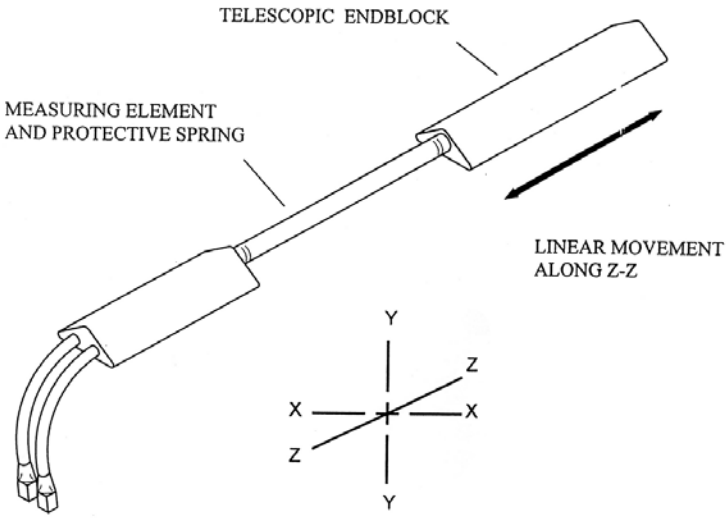
The goniometer is not designed to measure rotations about Y-Y. Any attempt to bend the unit in this way more than ± 20 from the neutral position will result in a reduction of the life of the unit or failure.



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.

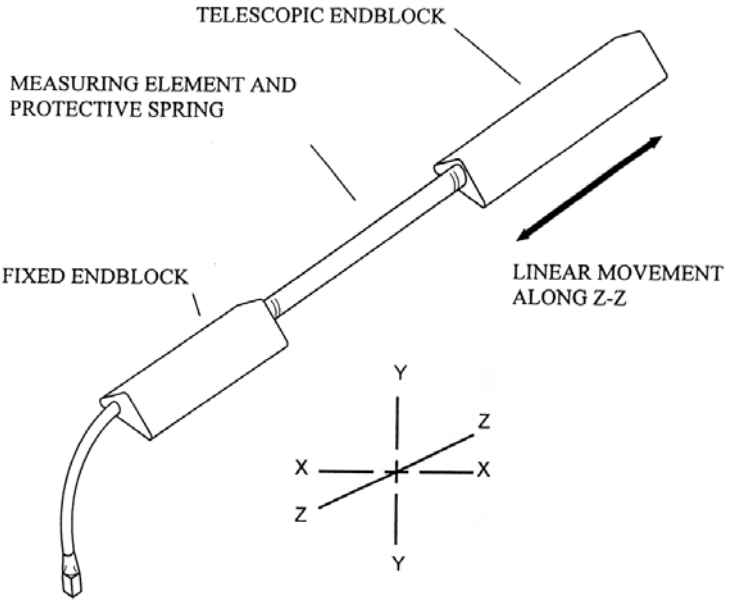
3.

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.



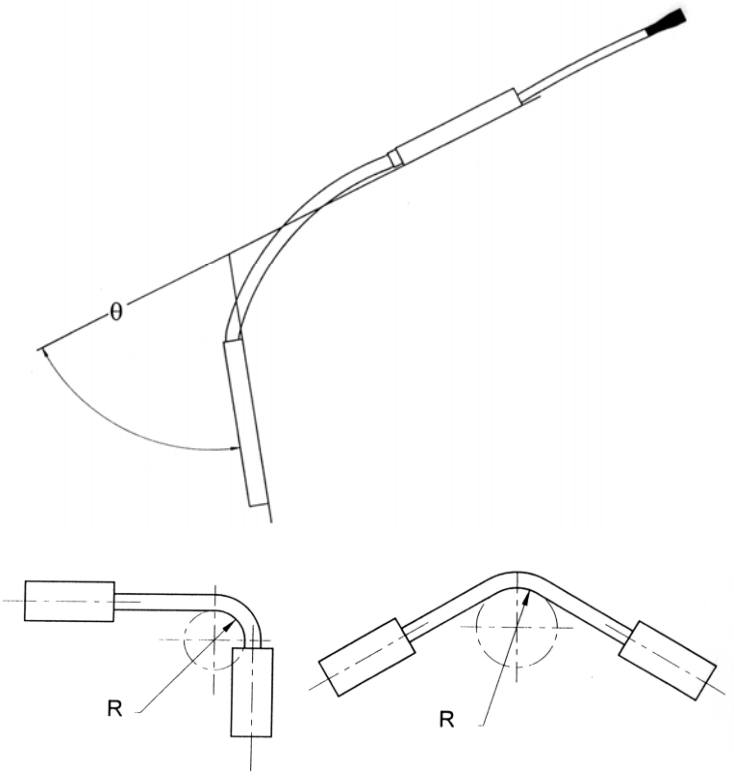
WARNING!

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.

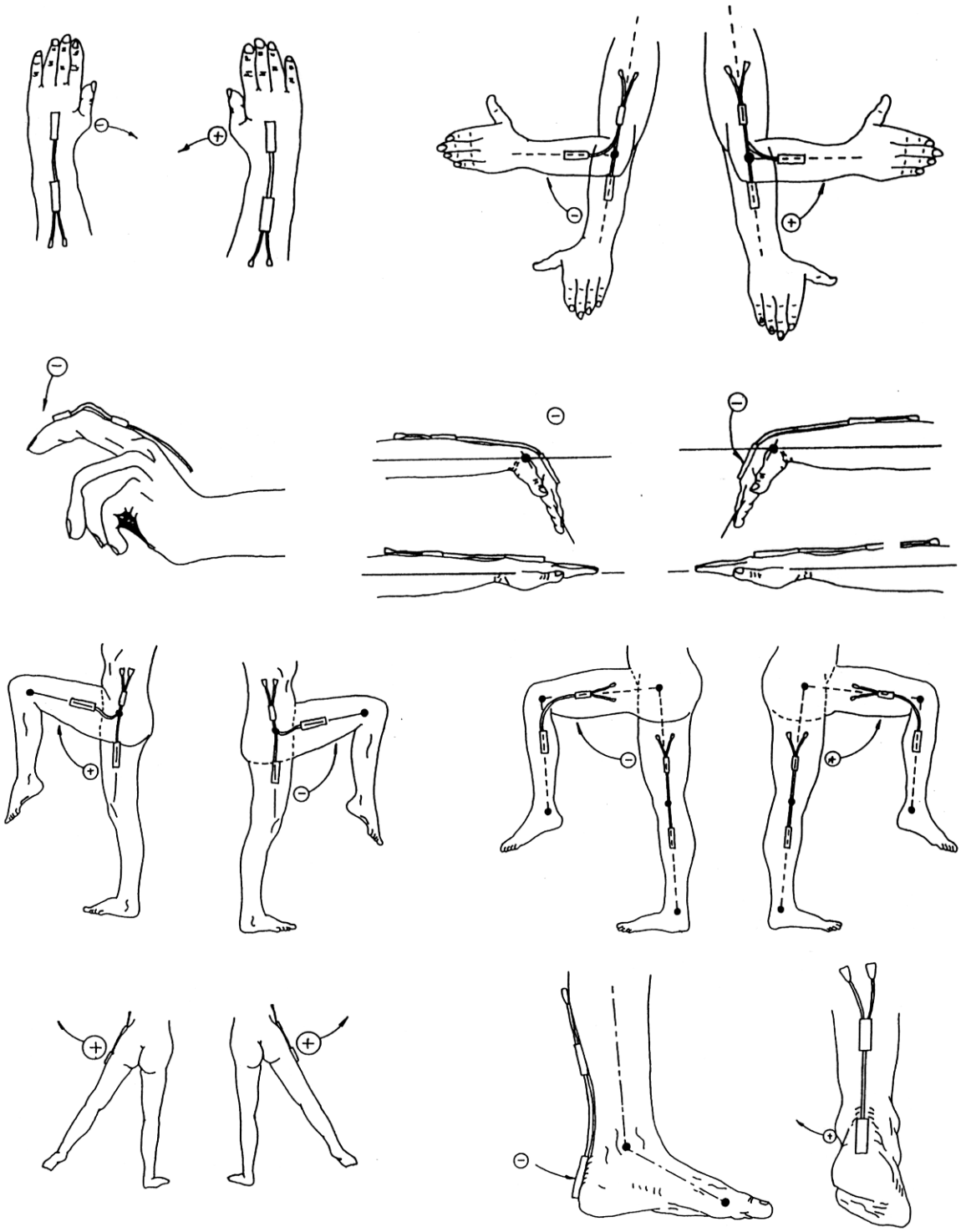
If the two ends move linearly relative to each other, within the limits of telescopic endblock, without changing the relative angles between them, then the outputs remain constant.

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

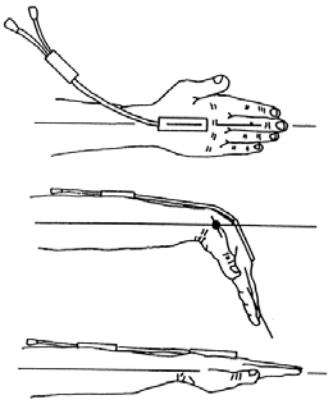
The sign convention for certain joints will differ, depending which side of the body the sensor is attached to. The following figures show sign conventions for the most common joints.



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.

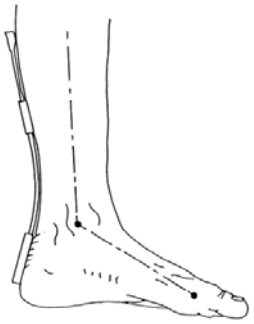


ARTICULAR COMPLEX OF THE FOOT – Goniometer TSD130A/SS20L/SS20/BN-GON-110-XDCR

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.

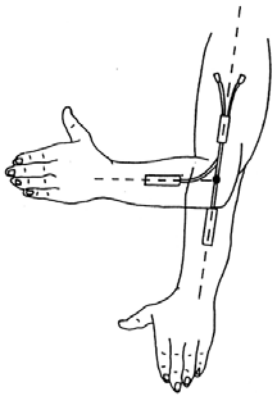
Flexion/extension of the ankle may now be monitored using the gray plug and pronation/supination using the blue marked plug.



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.

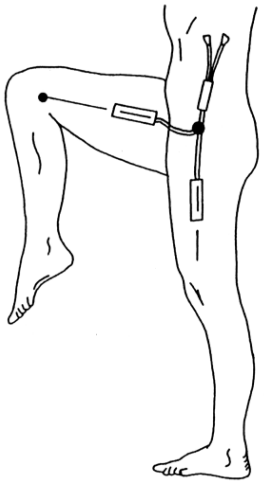
Now the elbow may be fully extended with the telescopic endblock freely sliding between Positions 1 and 2. Measurement of flexion/extension is obtained from the blue marked plug, and the gray plug is redundant. Note that the telescopic endblock is mounted on the half of the forearm nearest to the elbow 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).

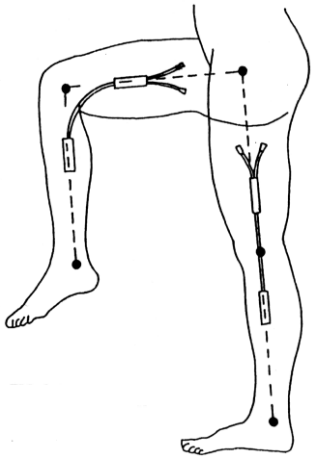
The thigh may now be flexed or extended, abducted or adducted, with the goniometer sliding freely between Positions 1 and 2. Measurements of flexion/extension are obtained from the blue marked, and abduction/adduction from the gray plug.



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.



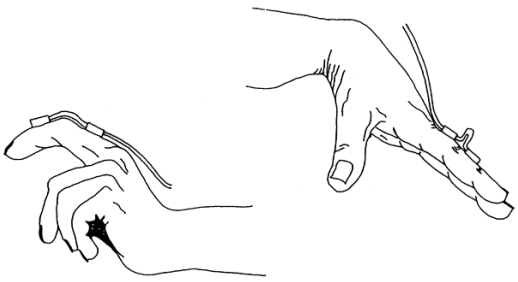
FOREARM PRONATION /SUPINATION – Torsiometer TSD130C/SS22L/SS22/BN-TOR-110-XDCR or TSD130D/SS23L/SS23/BN-TOR-150-XDCR

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.**

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

SS25LA HAND DYNAMOMETER

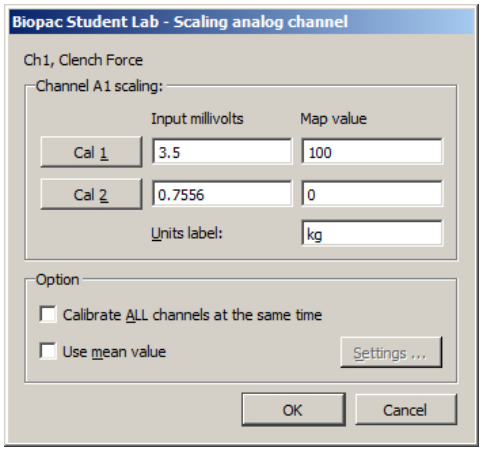
Use the hand dynamometer to measure grip force—use in isolation or combine with EMG recordings for in-depth studies of muscular activity. The lightweight, ergonomically designed transducer provides direct readings in kilograms or pounds. The simple calibration procedure makes this device easy to use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

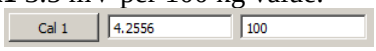
Connect the SS25LA Simple Sensor to a CH input on the front panel of an MP3X unit.

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

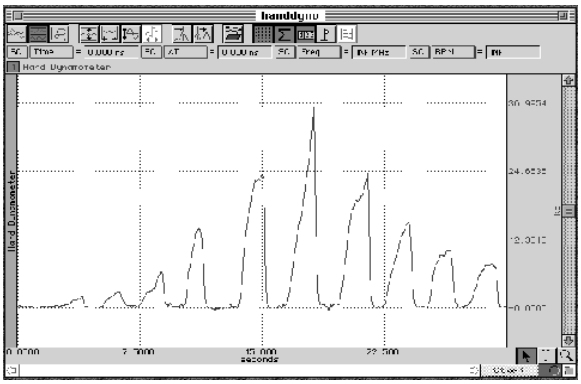
Scaling — Software Setup for the MP3X



1) Select **Set Up Channels** under the MP3X 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 on the **Setup** button.
4) Click on 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.



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.

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

SS25LA Specifications

Isometric Range:	0-90 Kg
Dimensions:	17.78 cm (long) x 5.59 cm (wide) x 2.59 cm (thick)
Nominal Output:	13.2 µV/kg for 1 V excitation Max excitation for MP36/36R is 5 V, for nominal output 66 µV/kg
Rated Output:	100 kg
Linearity:	8%
Sensitivity:	0.75 kg
Weight:	323 grams
Cable Length:	3 meters

TRI-AXIAL ACCELEROMETERS

SS26LB, TSD109C2 and TSD109C2-MRI (±5 g)
SS27L and TSD109F (±50 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. The pliable and unobtrusive design conforms readily to body contours. They come with a Velcro® strap for easy attachment.

- ±**5 g** accelerometers are optimal for measuring accelerations when performing slow movements, such as walking.
- ±**50 g** accelerometers are optimal for measuring quick movements, such as swinging a tennis racket.

Tri-axial accelerometer uses 3 channel inputs

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. 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.

MRI Use (TSD109C2): MR Conditional

Condition: Trace metallic parts do not make contact to the subject; must be used with MRI cables provided.

Equipment

- The SS26LB/SS27L accelerometers connect to the MP36/35 Data Acquisition Unit.
- The TSD109 series accelerometers connect to the HLT100C High Level Transducer module.
- The TSD109C2-MRI is intended for MRI use and ships with a longer (10 m) cable, plus an MECMRI-HLT (2 m) interface cable and filter set (MRIFIF).

Accelerometer Specifications (SSL/TSD)

	SS26LB / TSD109C2/TSD109C2-MRI	SS27L / TSD109F
Range (Output):	±5G (400 mV/G; 1 mV/G; 0 G is at 5 mV DC)	±50G (40 mV/G; 100 mV/G; 0 G is at 5 mV DC)
Noise:	0.5 mG/SQRT(Hz rms)	6.6 mG/SQRT(Hz rms)
Interface:	MP36/35 Data Acquisition Unit (SS26LB, SS27L) HLT100C High Level Transducer Module (TSD109F, TSD109C2, TSD109C2-MRI)	
Bandwidth:	DC - 500 Hz (-3dB)	
Nonlinearity:	0.2% of Full Scale	
Transverse axis sensitivity:	±2%	
Alignment error:	±1°	
Package:	Compliant silicone housing	
Dimensions:	33mm (long) x 28mm (wide, at base) x 19mm (high)	
Weight:	17 grams	
Power:	+5V @ 25 mA (via TEL100)	
Sterilizable:	Yes (contact BIOPAC for details)	
Cable length:	3 meters (10 meters for TSD109C2-MRI)	

NOTE: The SS26LA was discontinued in September of 2013.

Hardware Setup

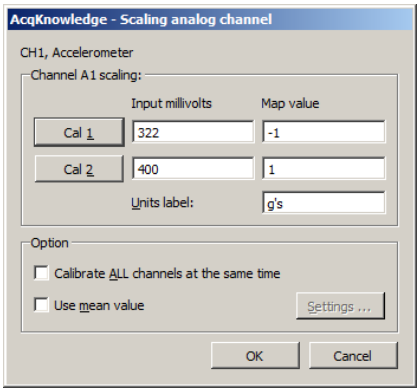
The accelerometers have three output connectors, one each for the X, Y, and Z axes. Each output connector must be connected to an **MP3X** input channel (SS26LB/SS27L,) or to the appropriate HLT100C input channel (TSD109 series). For example, connect the X-axis to channel 1, Y-axis to channel 2, and 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/SS27L:

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

b) For each channel, select the appropriate **Accelerometer Preset** (5g or 50g) from the **Preset** list.

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

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

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

TSD109 Series:

a) Select **MP150** > **Set Up Channels** > **Add New Module**.

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

c) Choose **TSD109C (5g) or TSD109F (50g)** 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:

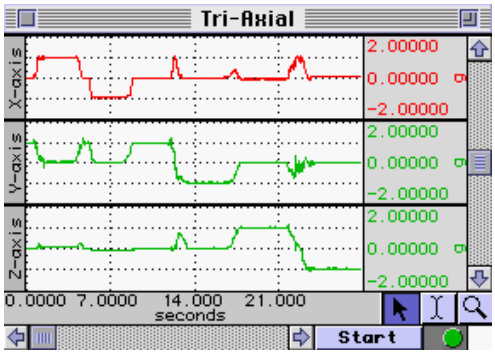
a) Start acquiring data (for the test procedure, a sample rate of 50 samples per second should be used)

b) Rotate the accelerometer 180° through each axis.

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

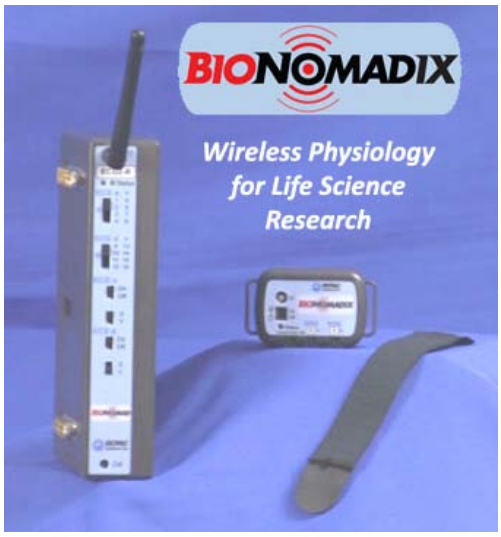
d) Repeat the calibration procedure (by rotating the transducer 180°) through each axis.

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 1g to -1g as the transducer is rotated. Likewise, Channel 2 (Y-axis) shows the same phenomenon as previously described. Finally, Channel 3 (Z-axis) has also been tested and the calibration confirmed.

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 Options:* 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)
Noise (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: *Operational Range and Characteristics*.
Operational temp:	5-45° C
Operational humidity:	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 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 Data Analysis – App Note 266

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

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 as a single channel; the heel strike generates a negative deflection and the toe strike results in a positive deflection. Two force sensitive resistors (FSR) attach to the sole of a shoe; use two transducers to record from both feet.

HEEL-TOE STRIKE SPECIFICATIONS

Nominal Output Range:	-1 to +1 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 m
Cable Length – BN-STRIKE-XDCR:	30 cm
Interface: SS28LA	MP36/35 System
TSD111A	HLT100C
SS28A	TEL100C
BN-STRIKE-XDCR	BN-STRIKE

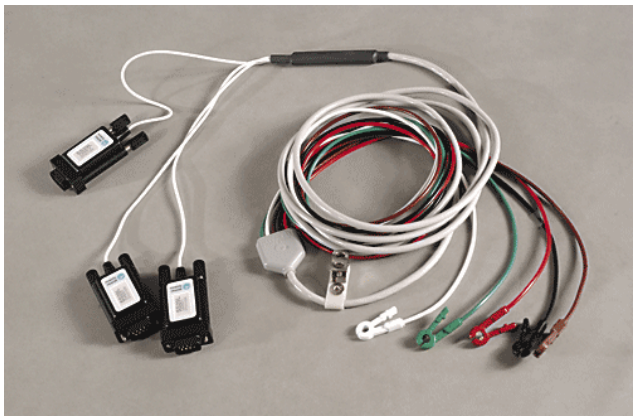
RX111 REPLACEMENT HEEL-TOE STRIKE SENSOR

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.

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

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)

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

SS30L ELECTRONIC STETHOSCOPE TRANSDUCER

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

- No calibration required, just select a **Stethoscope Preset** (Heart or Korotkoff Sounds)

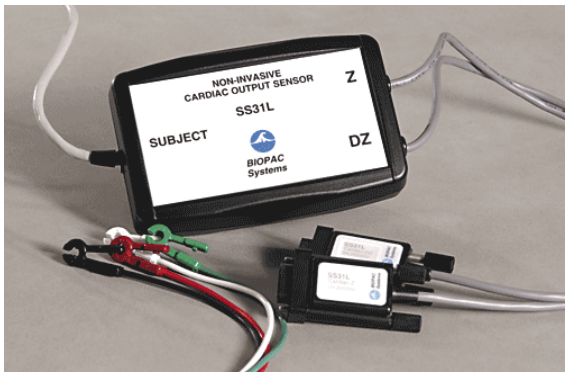
See also: Biopac Student Lab Lesson 16 Blood Pressure and Lesson 17 Heart Sounds.

SS30L SPECIFICATIONS

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

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

SS31L NONINVASIVE CARDIAC OUTPUT SENSOR



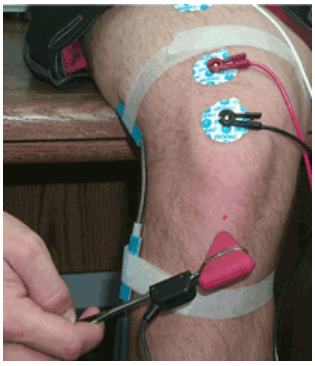
The SS31L records the parameters associated with Cardiac Output measurements. The SS31L incorporates a precision high-frequency current source, which injects a very small (400µA rms) current through the measurement tissue volume defined by the placement of a set of current source electrodes. A separate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

- Use the SS31L to measure changes in Cardiac Output under a variety of conditions: laying down, sitting up, standing up, and post-exercise.
- Use on stationary subjects; the SS31L is sensitive to motion artifact.
- See BSL *PRO* Lesson **H21 Impedance Cardiography** for sample SS31L setup and data.

Updated: 7.17.2012

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

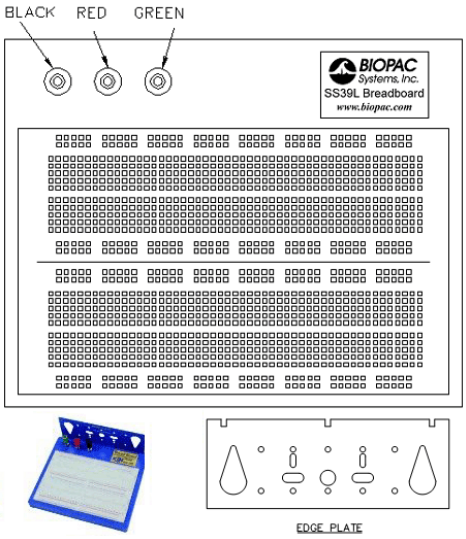
SS36L REFLEX HAMMER



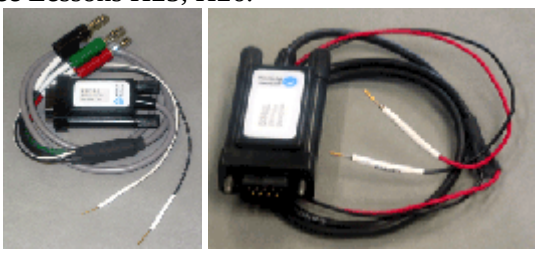
This is a classic reflex hammer with a transducer attached to perform reflex measurements. It uses a Taylor Hammer—the most common type of reflex hammer used by doctors and nurses—and incorporates electronics to record the time and the relative strength of the impact. Being able to measure the strength 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

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 and BSL *PRO* software to evaluate their designs. See Lessons H25, H26.



Circuitry Hardware

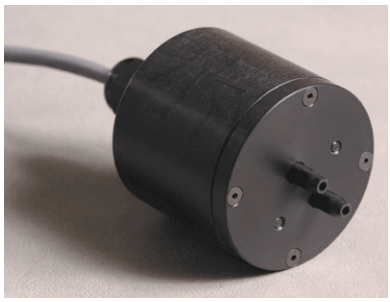
- Breadboard
- Signal/Power Cable
  - 3 x Power Plugs: Green -5 V, Black GND, Red +5 V
  - 2 x Signal Wires: White – Signal, Black – GND
  - Built-in automatically resettable fuse
- Signal Cable (SS60L)
  - 2 x Signal Wires: Red – Signal, Black – GND
- Electrode Lead Interface
  - BSL-TC122: SS2L to SS39L
- Accessory Kit (BSL-BMEACC)
  - Capacitors, diodes, resistors, jumper wires, and other circuit-building components

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

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

SS40L – 42L DIFFERENTIAL PRESSURE TRANSDUCER



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

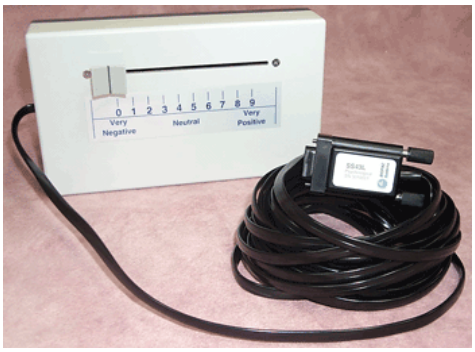
The SS40L-SS42L series differential pressure transducers are designed for low range pressure monitoring. The transducers plug directly into the MP3X general-purpose differential amplifier. The differential pressure ports are located on the front of the transducers and are easily connected to breathing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

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

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

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 MP150/MP100 SYSTEM
- SS46L-SS52L SERIES FOR MP3X AND MP45 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).
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 Usage (TSD137): MR Conditional

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

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 3mm or 4mm 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 5kg / 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).

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

TSD/RX137 & SS46L-SS52L SERIES SPECIFICATIONS

Part# *DA100C* *TSD160/SS40L* *MP36/35/30/45*	**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	±166	±583	±1565	±2666	±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):	6.0 - 7.0	6.0 - 7.0	9.0 - 10.0	10.0 - 11.0	17.0 - 22.0	14.0 - 24.6	43.0 - 45.0
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)*						

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

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.

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 10mm WG	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	550 L/min	29.5	198	230

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.

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

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

SS55L Eight-channel Marker Box

See Lessons H11, H16, H24, H27, H30.

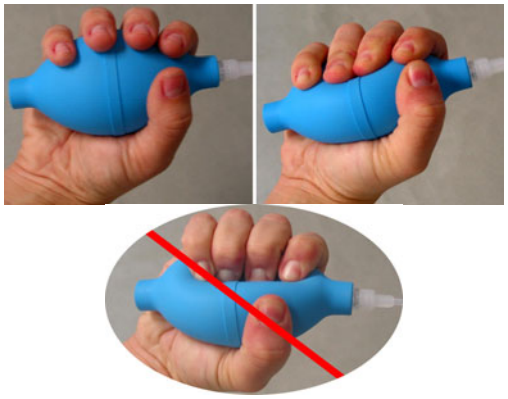
Independently mark events, or provide responses, on up to eight channels simultaneously. Assign separate digital channels as event markers for individual analog input channels. Easily customize the response scale by inserting the parameters into the scale sleeve on the front of the unit.

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

Updated: 7.1.2013

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

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

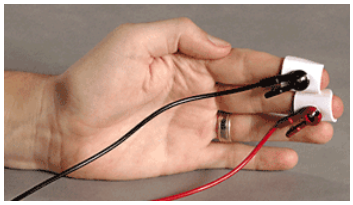
Pressure Range:	BSL: 0 to 10,546 Kgf/m^2 AcqKnowledge: 0 to 1.0546 Kg-f/cm^2	0 to 15 psi
Accuracy:	±3%	
Output:	BSL: 0.58 mV/100 Kgf/m^2 AcqKnowledge: 0.58 mV/0.01 Kg-f/cm^2	4.1 mV/psi
Bulb Diameter:	5.8 cm	
Bulb Length:	11.1 cm	
Tubing Length:	3 meters	
Weight:	108 g	

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

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

SS57L EDA LEAD FOR DISPOSABLE SETUPS



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

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

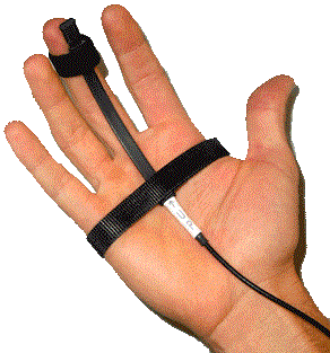
info@biopac.com
support@biopac.com
www.biopac.com

SS60L SIGNAL CABLE FOR SS39L BREADBOARD

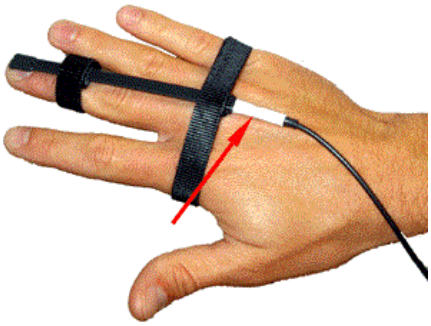
Use this signal cable to add signal inputs to the SS39L Signal Processing Breadboard, which ships with one combination power/signal cable.

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

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)

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

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.

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

SS63L – SS66L FORCE TRANSDUCER SERIES

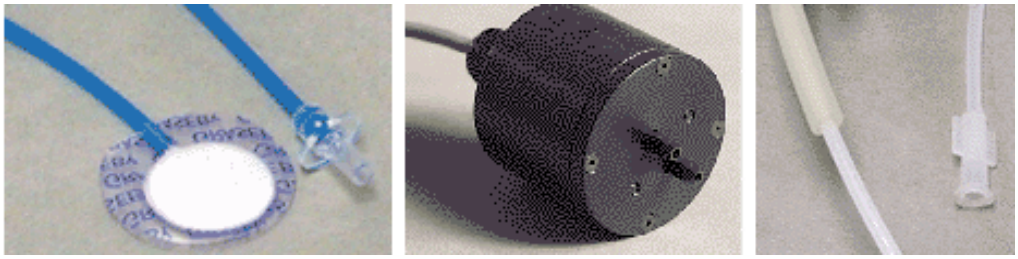
SS63L Force Transducer - 50 g
SS64L Force Transducer - 100 g
SS65L Force Transducer – 200 g
SS66L Force Transducer - 500 g

SS63L – SS66L 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

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

SS67L PRESSURE PAD/RESPIRATION TRANSDUCER



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

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.

See **RX110** for sensor specifications.

See also: MRI Compatibility Notes

RX110 PRESSURE PAD

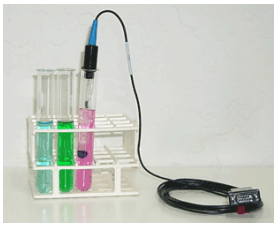
The RX110 is a self-inflating pressure pad connected to tubing terminating in a Luer male connector. The RX110 pressure pad is included with the SS67L Pressure Pad/Respiration Transducer. The RX110 sensor can be used many times, but may eventually need to be replaced because it is a sensitive pressure 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

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

SS68L PH PROBE TRANSDUCER



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

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

- A neutral buffer solution of pH 7 will read about 0mV.
- A solution with a pH of 10 will read about –15 mV.
- A solution with a pH of 3 will read about 20 mV.

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

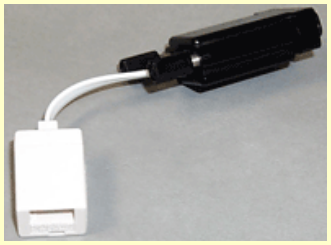
SS68L SPECIFICATIONS

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

SS69L DISSOLVED OXYGEN PROBE TRANSDUCER

SS69L Components

Order probe only as **RXPROBE02**



Order interface only as **BSL-TCI16**

The SS69L transducer measures dissolved oxygen. The SS69L includes a dissolved oxygen probe and an interface to the BSL MP36/MP35 or MP30 unit.

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

Components

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

Interface

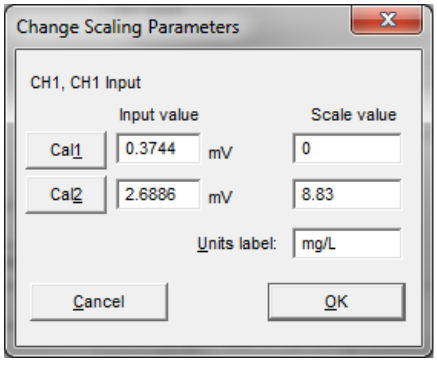
Use with BIOPAC BSL-TCI16 Transducer Connector to record with a BIOPAC data acquisition unit.

Usage

There are four steps to using the Dissolved O_2 probe:

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

1. Setup
   a. Remove and discard the blue protective cap from the tip of the probe.
   b. Unscrew the membrane cap from the tip of the probe.
   c. Use a pipette to fill the membrane cap with 1 mL of the Electrode Filling Solution.
   d. Carefully thread the membrane cap back onto the electrode.
   e. Place the probe into a beaker filled with about 100 mL of distilled water.



2. Warm-up
   a. Insert the BT connector on the RXPROBEO2 into the BSL-TCI16 transducer connector.
   b. Connect the BSL-TCI16 transducer connector to the 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.

3. Calibration — *optional*

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

a. Zero-Oxygen (CAL 1)
   i) Launch the BIOPAC software and generate the scaling dialog for the probe channel. (Select 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) When the voltage stabilizes (~1 minute), press the CAL 1 button. The Input value result should be in the 0.2 - 0.5 mV range.

b. Saturated Dissolved O_2 (CAL 2)
   i) Rinse the probe with distilled water and gently blot dry.
   ii) Unscrew the lid of the calibration bottle and slide the grommet approx. 12 mm (1/2”) onto the probe body.
   iii) Add water to the bottle to the depth of about 6 mm (1/4”) and screw the bottle into the cap. IMPORTANT: Do not touch the membrane or get it wet during this step.
   iv) Keep the probe in the position for about one minute and then press the CAL 2 button. The 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 altitude. (To calibrate and monitor using Percent Saturation, use the conversion formula on the next page.)

TABLE 1

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

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

TABLE 2

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

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

CONVERSION FORMULA FOR % SATURATION

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

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

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

Recording

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

Storage

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

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

Polishing

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

INPUT ADAPTERS

SS9LA Unisolated BNC Input Adapter
SS70L 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, 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 or MP36R and a ±10 V input range on MP35 or MP45. 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) ±10 V (MP35/MP45)

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 is not compatible with MP30 systems; contact BIOPAC for unisolated adapter options for MP30.

This cable replaces the SS9L, effective January 2014.

SS70L 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.

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.

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.

SS70L – SS71L SPECIFICATIONS

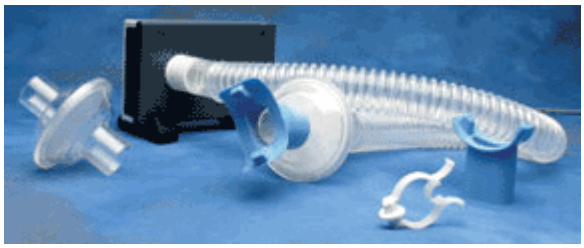
Connector type:	BNC
Signal range:	±10V

See also: Student Accessory Pack BSL-ACCPACK

AFT SERIES AIRFLOW & GAS ANALYSIS ACCESSORIES

Includes the following airflow accessories:

AFT1	AFT9	AFT11E	AFT15	AFT26
AFT2	AFT10	AFT11F	AFT20	AFT30
AFT3	AFT10S	AFT11G	AFT21	AFT31
AFT4	AFT11A	AFT11H	AFT22	AFT35
AFT6A	AFT11B	AFT11I	AFT23	
AFT7	AFT11C	AFT12	AFT24	
ATF8	AFT11D	AFT13	AFT25	



DISPOSABLE BACTERIAL FILTERS

MRI Use: MR Safe

AFT1/4/13 Bacterial Filter Components: Polycarbonate Clear Plastic

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

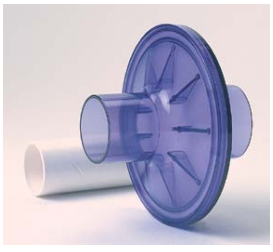
Designed to remove airborne bacteria. Pore Size: Virus Filtration Efficiency (VFE): 3.1 micron; Bacterial Filtration Efficiency (BFE): 2.8 micron. Use between the SS11LA or TSD117 and the AFT2. 22 mm ID/OD.

AFT4 Disposable Bacterial Filter

Designed to remove airborne bacteria; for use with the TSD107B, AFT4, or other 35 mm breathing circuits, connects between the AFT7 and the AFT9. (35 mm ID/35 mm OD)

AFT13 Disposable Pulmonary Function Filter and Mouthpiece *Available in packs of 10 or 250*

Eliminate cross-contamination concerns with this bacteriological filter with disposable plastic-coated paper mouthpiece to protect subjects and equipment. These exceed all recommended performance standards with 99.9% bacterial filtration efficiency and 99.9% viral filtration efficiency. They feature low resistance and minimal dead space (45 ml when measured without tube fittings). These surpass published ATS recommendations for flow resistance in pulmonary function instrumentation, which suggest resistance should be below 1.5 cm H2O/L/sec at flow rates less than 12 liters/sec. Port: 30 mm OD.



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 SS11LA or TSD117 via the AFT1.

AFT8 Autoclavable Mouthpiece *Available in Packs of 1 or 10*
30 mm ID; interfaces with the SS11LA or TSD117 and reduces the cost of disposable parts.

- RX117 Replacement Sterilizable Airflow Head**:** 22 mm ID/30 mm OD; autoclavable transducer head for the TSD117; 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 TSD117 Airflow Transducer.

CALIBRATION SYRINGES

AFT6A Calibration Syringe
0.6 liter calibration syringe. *See also*: AFT26 2.0 liter Calibration Syringe

AFT26 Calibration Syringe (2.0 liter)

The AFT26 is a 2.0 Liter Calibration Syringe for the SS11LA or TSD117 Airflow Transducer. The AFT26 Calibration Syringe is certified to have a 2-liter volume that meets or exceeds an accuracy ± 1% of the total displacement volume. The increased size and accuracy of this 2.0 liter calibration syringe provide a wider calibration range than the AFT6A for advanced studies. A coupler is included and can be reordered as AFT11I if it is inadvertently discarded when an airflow accessory is removed.

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.

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.

AFT12 Tubing (22mm)
Smooth bore tubing for use in 22mm 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, or SS11LA/TSD117 airflow transducer (via AFT11B 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

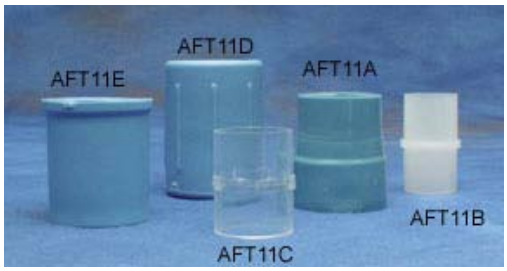
AFT25 Facemask Components: Mask: Thermoplastic Elastomer, Valve: Acetal Plastic, Acrylic Plastic,, Aluminum (nickel plated silver,) Elastomer, Nylon, Thermoplastic Polyester, Polycarbonate Plastic, Silicone Rubber, Stainless Steel, Polysulfone Plastic

Headgear: Fabric with Velcro® straps

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
AFT11B Rigid
AFT11C Rigid
AFT11D Flexible
AFT11E Flexible
AFT11F Rigid
AFT11H Flexible
AFT11I Flexible (for AFT26)

These couplers are very useful for connecting up 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.

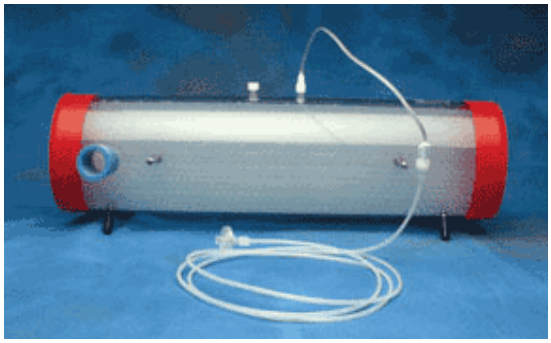
AFT11 Series Coupler Guide

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 ID	AFT11B
	22 mm OD	AFT11I
22 mm OD	22 mm ID	AFT11C
	22 mm OD	AFT11C
	25 mm ID	AFT11C
22-25 mm OD	22 mm OD	AFT11E
	25 mm ID	AFT11E

Item 1	Item 2	Coupler
25 mm ID	25 mm ID	AFT11C
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

Coupler	Size	Interface
AFT11A	25 mm OD/35 mm ID	AFT6A to AFT1
AFT11B	15 mm OD/22 mm ID	AFT10 to SS11LA
AFT11E	22 mm OD/35 mm ID	AFT7 to AFT22/25
AFT11F	35 mm OD/45 mm OD	SS52L to GASSYS2
AFT11H	35 mm OD/28.6 mm ID	AFT13 to SS11LA
AFT11I	22 mm OD/22 mm ID	AFT26 replacement coupler

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

GAS SAMPLING INTERFACE KITS

AFT20

Use to interface the CO2100C and the O2100C modules with the TSD107B or TSD117 Airflow Transducer breathing circuits.

Includes: 1.8 meters of 1.5 mm inner diameter semi-flexible polyethylene tubing with M/F Luer connector; 30cm 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

This 3.175 mm ID tubing is 10 meters long with male and female Luer lock and "Y" connector interfaces to the AFT21 T-valve, AFT25 facemask, or AFT15 mixing chamber gas sampling ports to connect them to the CO2100C module and/or the O2100C module. To use both CO2100C and O2100C modules simultaneously, a "Y" connector gas sampling interface adapter is included.

MRI Use: MR Safe

AFT31-MRI Gas Sampling Kit Components: Polyethylene, Polyvinyl Chloride Plastic, Polycarbonate Clear Plastic

ID/OD: 3.175 mm (1/8") / 6.35 mm (1/4")	Type: Crack-Resistant Polyethylene Tubing
Maximum Pressure: 358 psi @ 70° F	Material: Linear Low Density Polyethylene
Operating Temperature Range: -100° to +175° F	Wall Thickness: 1.588 (1/16")
"Y" connector: 1 x male to 2 x female	Bend Radius: 2"
Length: 10 m	Durometer: 95A (Firm)

AFT35-MRI

The Airflow Subject Interface Kit for MRI will allow two configurations with minimal clearance from mouth to fMRI cage:

Low clearance - 6 cm: use right-angle coupler with mouthpiece and noseclip

Standard clearance - 12 cm: use right-angle coupler with facemask

The AFT35-MRI assembly includes a high-flow, non-rebreathing T valve with right-angle interface to separate inspired flow from expired flow. Use assembly to perform the following airflow and lung volume tests in an fMRI:

- End Tidal CO2
- VO2 max
- Breath-by-breath Air Flow
- Breath-by-breath Volume
- Metabolic Studies

The subject breathes into a right angle port that connects to the T valve. The inspire port is directly open to the chamber room, so there is very low inspired resistance, and the T value expired port connects directly to 35 mm ID tubing (such as AFT7L).

The AFT35-MRI assembly includes a 35 mm OD T valve (AFT23), mouthpiece (AFT9), facemask with strap, noseclips, right-angle connector, and couplers.

The AFT35-MRI will connect to one or more lengths of AFT7L tubing, for ultimate connection to AFT15 Gas sampling chambers, as well as a TSD117-MRI air flow transducer.

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

AFT T-VALVES

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

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

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 cmH2O at 5 liter per minute flow, 0.65 cmH2O at 10 liter per minute. Single subject disposable item **– do not autoclave**. Includes: 22 mm OD coupler

Requires: AFT1 and AFT2 for proper operation.

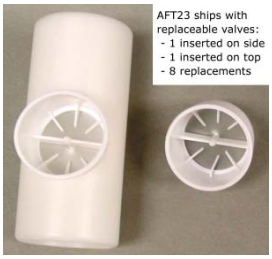
Includes: 22 mm OD coupler *Requires*: AFT1 and AFT2 for proper operation.

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 AFT13 pulmonary function filter & mouthpiece set.



MRI Use: MR Safe

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

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.*

AFT30: 1.8 m **AFT30-L**: 4 m **AFT30-XL**: 10 m

The length of tubing will add a delay of less than 50 msec to the sensing of the waveform peak.

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)			
AC137 In-line Transformer				
DA100C Amplifier	X (2)	X	X	X
TSD107B Pneumotach (High)	X (2)			X
TSD117 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 CO2 Module	X	X	X	X	X
O2100C O2 Module	X	X	X	X	X
TSD107B Pneumotach (High)	X		X		
TSD117 Pneumotach (Med.)		X		X	
TSD127 Pneumotach (Low)					X

Part Options: AFT25 = AFT21 + AFT9 + AFT3 + optional AFT24 * use 2 AFT11B and 1 AFT11C
AFT10 + AFT10S = AFT2 + AFT3 + AFT11C ** use 1 AFT11B and 1 AFT11C

See also: AFT coupler guide for additional applications.

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

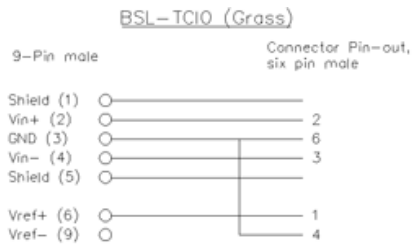
TRANSDUCER CONNECTOR INTERFACES (TCI)

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

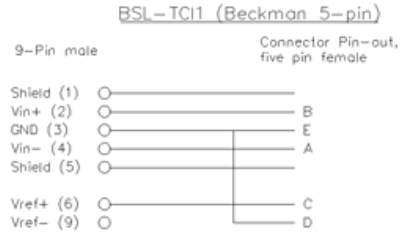
See also: SS-KIT-IN BSL/SS Custom Input Kit
SS-KIT-OUT BSL/SS Custom Output Kit

BSL-TCI PIN-OUTS

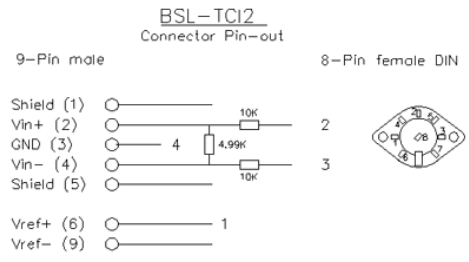
BSL-TCI0



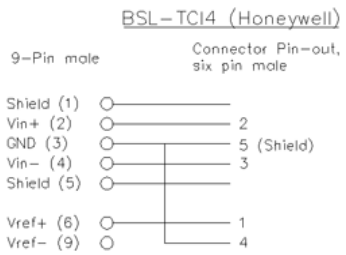
BSL-TCI1



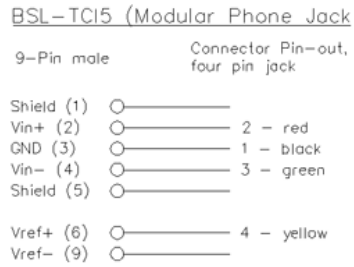
BSL-TCI2



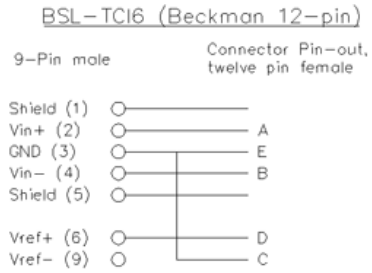
BSL-TCI4



BSL-TCI5

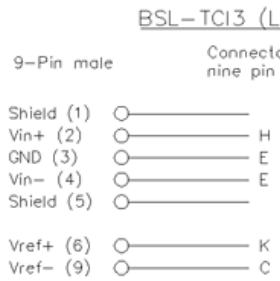


BSL-TCI6

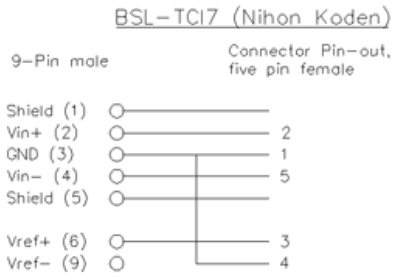


BSL-TCI PIN-OUTS

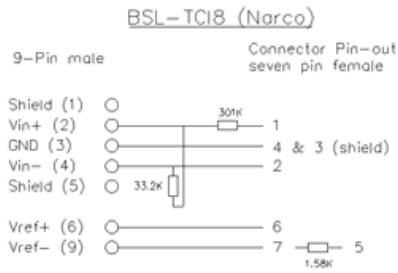
BSL-TCI3



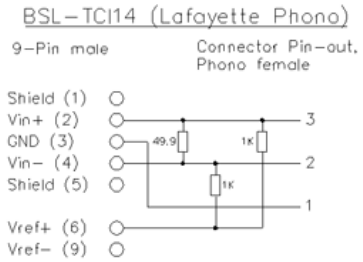
BSL-TCI7



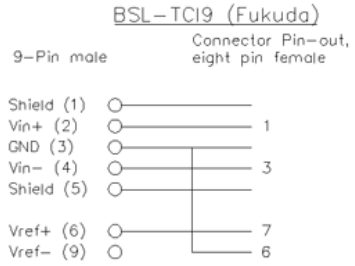
BSL-TCI8



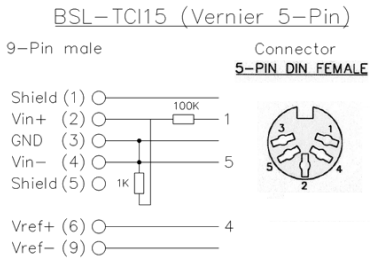
BSL-TCI14



BSL-TCI9

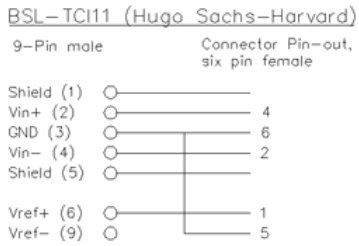


BSL-TCI15

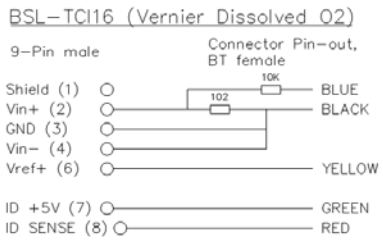


BSL-TCI10 Gould 12-pin: discontinued

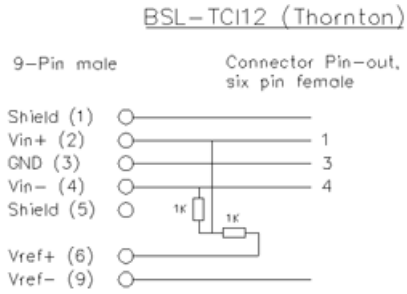
BSL-TCI11



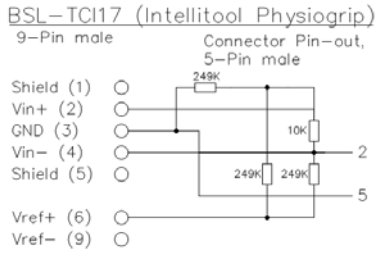
BSL-TCI16



BSL-TCI12

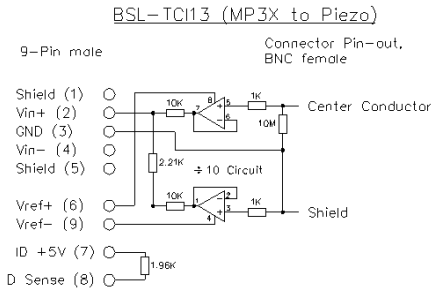


BSL-TCI17

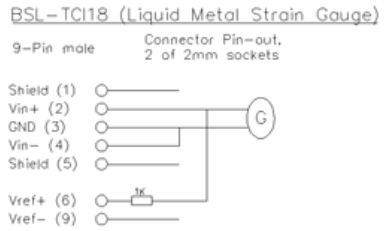


BSL-TCI PIN-OUTS

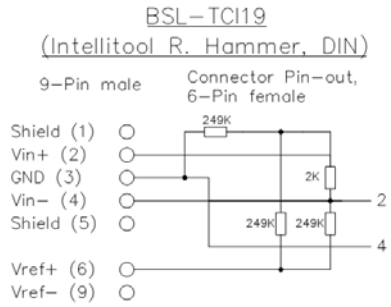
BSL-TCI13



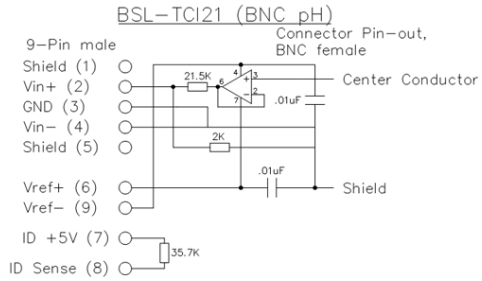
BSL-TCI18



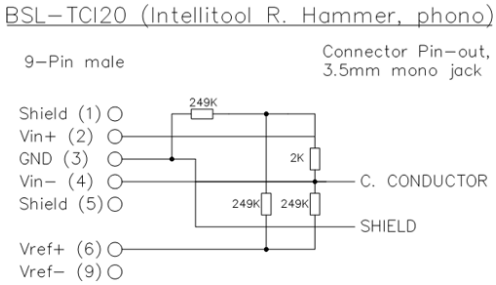
BSL-TCI19



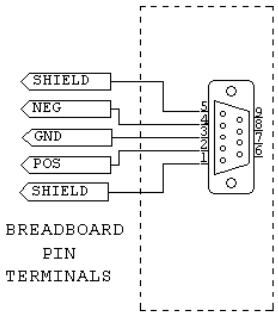
BSL-TCI21



BSL-TCI20



BSL-TCI22



BSL-TCI22 Electrode Interface

BSLCBL CABLE SERIES

BSLCBL1A: Stimulator to Nerve Chamber – Banana Plug
BSLCBL2A: Stimulator to Nerve Chamber – 2 mm Pin Plugs
BSLCBL3A: Nerve Chamber to BSL – Banana Plugs
BSLCBL4B: Nerve Chamber to BSL – 2 mm Pin Plugs
BSLCBL5: 3.5 mm Phone Plug
BSLCBL6: Stimulator to Output – 3.5 mm Mono Phone Jack
BSLCBL7: Stimulator to Electrode – BNC to 2x Alligator
BSLCBL11: Stimulator to Electrode – BNC to 2x Electronic Test Clip (spring-loaded)
BSLCBL12: Stimulator to Electrode – BNC to 2x Toothless Alligator
BSLCBL8/9: High Impedance – 1.5 mm Touchproof
BSLCBL14: 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.

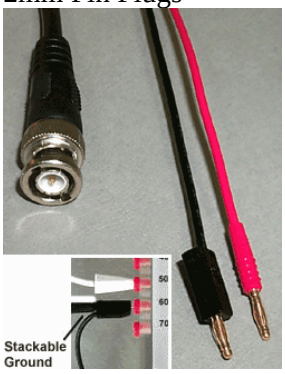
Gold-plated

Stackable ground

1.2 meter.

BSLCBL1A
Banana Plugs

BSLCBL2A
2mm Pin Plugs

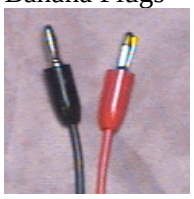


Nerve Chamber to Biopac Student Lab

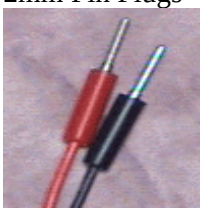
Interface nerve conduction chambers with the Biopac Student Lab System; use to record the signals coming from the nerve. A BSL DSub 9 connector interfaces with the Biopac Student Lab MP3X unit and two plugs attach to the nerve chamber.

1.2 meter

BSLCBL3A
Banana Plugs



BSLCBL4B
2mm Pin Plugs



BSLCBL3A/4B SPECS

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

3.5 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.

1.3 meter

Stimulator to Electrode

BSLCBL7,

BSLCBL11, and

BSLCBL12

BSLCBL5

3.5 mm Phone Plug

BSLCBL6

3.5 mm Mono Phone Jack

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

Use these clip leads to interface stimulating electrodes, or to connect directly with animal preparations. Each 1-meter cable has two clips And terminates with one BNC connector to interface with the BSLSTM, SS58L Stimulator, or OUT3 for MP36 low volt stimulator and silver or platinum wire electrodes.

High-impedance cables

BSLCBL8 and

BSLCBL9

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

BSLCBL8/9 Specifications

Input Range: ±70 mV, MP30: ±700	BSLCBL8: MP36/36R: ±2 V, MP35: ±1 V, MP30: MP45: ±2 V BSLCBL9: MP36/36R: ±3.8 V, MP35: ±3.8 V, mV, MP45: ±3.8 V

Input Impedance: 500mGigaOhm (Common-Mode)

Input Bias Current: 3pA Typical, 100 pA Maximum

Voltage Noise: 1.3 µV p-p

Current Noise Density: 0.01 pA /SQRT(Hz)

Cable length: 2 meters

Interface: MP3X (DSub9)

MP36/35 Input Adapter for Research Amplifiers

BSLCBL14

3.5mm phone plug adapter to MP36/35 Input (DSUB 9m)

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

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

CBL200 SERIES LEAD CONNECTOR CONVERSION CABLES

See also: Guide to *External Device Interfaces* for connections to common devices

CBL200	10 cm, 2 mm pin to 1.5 mm socket	Converts a 2 mm pin electrode or transducer lead to a Touchproof socket (1.5 mm ID), for connection to any of the 100C-series Biopotential or Transducer amplifiers or STMISO series modules. One CBL200 is required for each Touchproof socket.
CBL201	10 cm, 1.5 mm socket to 2 mm pin	Converts a Touchproof (1.5 mm ID) socket electrode or transducer lead to an old-style 2mm pin, for connection to any of the 100B-series Biopotential or Transducer amplifier modules. Also used to connect a ground electrode lead (e.g. LEAD110A) to the UIM100C module (required when using the TSD150 active electrodes). One CBL201 is required for each Touchproof socket. *For MP36/35/45 Systems* CBL201 is used to update older model SS1L Shielded Lead Adapters.
CBL202	2 mm Male pins to 6.3 mm (¼″) mono phone jack	Adapts transducers with a 6.3 mm (¼″) mono phone plug to the DA100C.
CBL203	1.5 mm Female to 6.3 mm (¼″) mono phone jack	Adapts temperature transducers with a 6.3 mm mono phone plug to the SKT100C.
CBL204	25 cm, Touchproof "Y" adapter	Connects multiple electrode sites to a single amplifier input or stimulator output. The CBL204 plugs into any 100C-series biopotential amplifier input or STMISO series output and provides two sockets to connect to electrode leads terminating in Touchproof sockets. Plug multiple CBL204s together to reference 3 or more electrode leads to the same input or output. *For MP36/35/45 Systems*, use to connect a glass microelectrode to multiple electrode sites (such as Vin- and GND from BSLCBL8/9 High-Impedance Cables).
CBL205	1.5 mm AC-Coupled electrode lead adapter	 USE CBL205 when more than one ground is required while recording electrodermal activity (e.g., galvanic skin response). One end of the adapter plugs into the ground on the amplifier and the other end accepts the electrode lead.

To record GSR with other biopotential signals (ECG, EEG, EOG, EGG, EMG, ERS), BIOPAC recommends using CBL205 connected to one ground on any of the biopotential amplifiers. The subject will be grounded through the Vin- of the GSR electrodes, but in some cases it is necessary to have more than one ground; in such cases, use CBL205 to prevent ground loops.

- For example, if—while recording a biopotential and GSR— the GSR electrode is removed during a stage of the experiment, to maintain a ground for the biopotential and avoid ground loops:
  1. Connect the Vin- lead of the GSR as ground.
  2. Connect an AC-coupled ground to the biopotential amplifier.

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

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

- Touchproof (f) electrodes
- STM200 Unipolar Pulse Stimulator Module
- MECMRI-STIMISO cable/filter system to connect to the STM200 in the MRI control room

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

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).

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

HSTM01 HANDHELD HUMAN-SAFE STIMULATING PROBE

IMPORTANT!

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

WARNING!

Even with the HSTM probe, 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.

HSTM01 SPECIFICATIONS

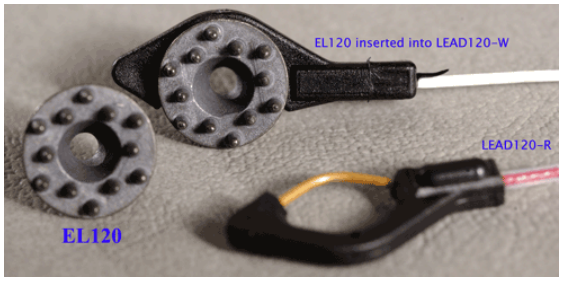
Safety Switch:	Yes
Lead Length:	3 m
Connector Type:	BNC
Interface:	BSLSTMA

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.

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

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.)

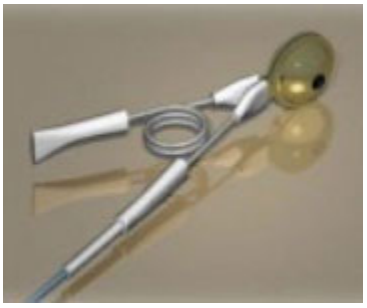
EL160 GOLD CUP

Reusable gold cup electrode with 10 mm cup diameter and 1.2 m cable.
One electrode per package.

- EL160 with black cable
- EL160-R with red cable
- EL160-W with white cable

The leadwire terminates in a standard Touchproof connector. Use with MEC Series Module Extension Cables for MP Research Systems or SS1LA Touchproof Electrode Lead Adapter for BSL Systems.

EL160-EAR – EAR CLIP ELECTRODES



This pair of gold-plated ear clip electrodes has 1.2 meter Teflon-insulated leadwires ending in standard Touchproof connectors.

EL160-EAR SPECIFICATIONS

Electrodes:	two
Material:	Au Cup (gold plated discs)
Style:	Ear Clip Electrodes
Leadwires:	1.2 meter Teflon-insulated leadwires
Connector:	leadwires terminate in standard Touchproof connectors
Non-sterile	
Reusable	

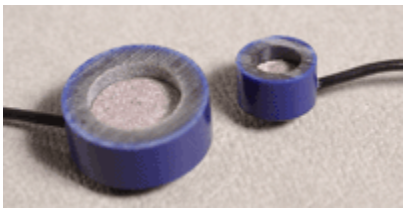
ELECTRODES

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

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. 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.

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. 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.

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. 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.

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/AgCI	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 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.

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.

√ 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.

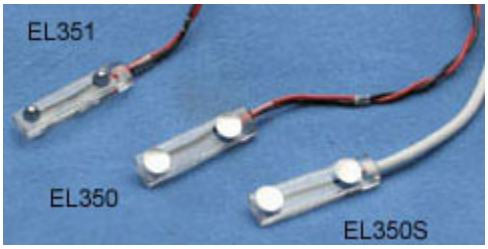
info@biopac.com
support@biopac.com
www.biopac.com

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.)

EL350 SERIES BAR LEAD ELECTRODES



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

EL350 unshielded bar lead electrode for use with the STMISO.

EL350S shielded bar lead electrode for biopotential recordings.

EL351 convex bar lead electrode for stimulating

EL350 SPECIFICATIONS

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

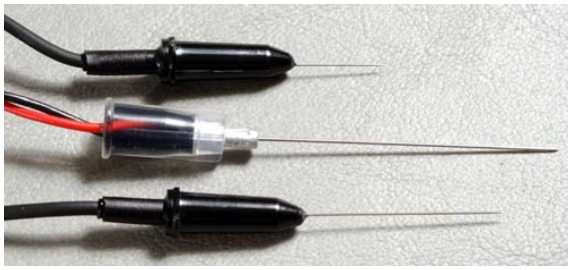
info@biopac.com
support@biopac.com
www.biopac.com

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.)

EL450 SERIES NEEDLE ELECTRODES



Use for stimulation or recording in animal subjects and tissue preparations. The 28-gauge stainless steel needles are Teflon-coated, with flexible cable terminating in 1.5 mm Touchproof connectors. 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.

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

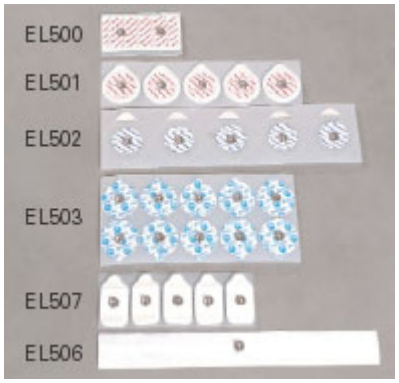
EL450 Unipolar: 2.5 cm (long) x 300µm (dia); 61 cm lead
A pair of EL450 electrodes is suitable for either recording or stimulation.

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

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

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

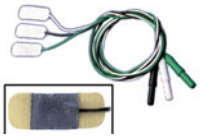
EL500 SERIES DISPOSABLE ELECTRODES




EL504


EL508


EL509


EL510

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

Part	*Ag-AgCl Adhesive/Disposable Electrode Type*
EL500	Paired electrodes: Use for general-purpose EMG measurements, nerve conduction measurements, and cardiac output. 41mm spacing (center to center) on 4mm x 82mm x 1.5mm foam
EL501	Small stress test electrodes: Use for short-term recordings where the subject may be in motion or when electrodes should be closely placed, as for multi-channel ECG, EGG, EMG or EOG. 38mm diameter mounted on 1.5mm thick foam with strong adhesive
EL502	Small pre-gelled electrodes Most appropriate for long-term biopotential measurement recording sessions, these pre-gelled electrodes have a 10 mm contact area on a 41mm (dia) backing that resists moisture. The electrodes include a hypoallergenic adhesive solid gel that adheres well to the skin but leaves no residue when removed.
EL503 **General-purpose electrode**	Ag-AgCl Adhesive/Disposable Electrode, 35mm diameter vinyl tape, 10 mm contact area, gel. These economical, pre-gelled electrodes are most suitable for short-term recordings. These electrodes have a 10 mm contact area on a 41mm (dia) backing that allows close electrode placement where necessary, with a slightly less firm adhesive for "ouchless" removal. The electrodes incorporate hypoallergenic liquid gel and are high chloride for quick, accurate readings.
EL504	Cloth base, 2.5 cm square electrodes. Particularly useful for applications on non-conforming surfaces, such as the face for EMG or fingers for nerve conduction studies. The adhesive solid gel ensures good contact, and the silver-silver chloride (Ag-AgCl) electrodes provide accurate and clear transmission of surface biopotentials. Use these comfortable and conforming electrodes in EMG, nerve conduction, ECG, sleep studies, exercise physiology, etc. The latex-free, hypoallergenic electrode adheres well and is repositionable and suitable for long term use without irritation.

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

Part	*Ag-AgCl Adhesive/Disposable Electrode Type*
EL506 **Alternative for band electrodes**	This unique disposable strip electrode is designed for bioimpedance applications. The electrode is silver laminated on medical grade cloth, with industry-standard medical grade adhesive, medium tackiness. The silver-silver chloride (Ag-AgCl) electrode provides accurate and clear transmission of surface biopotentials and is latex free. Strip length: 254mm Conductive element width: 6.35mm Adhesive width: 23.5mm Advantages of the Strip Electrode: • Combines the convenience of standard snap (spot) electrodes with the signal to noise, equipotential and current diffusion performance of band electrodes • Less obtrusive than band electrodes--easier for subjects to move and breathe • Ergonomic advantages of snap (spot) electrodes • Diffuses currents similarly to band electrodes (reduces current density) • Provides voltage measurements through a well-defined equipotential plane • Adjustable size—cut the 25cm strip to the desired size without affecting signal transmission • Snap lead connection • Peel-and-stick convenience • Disposable
EL507	Designed for electrodermal activity studies and are pre-gelled with isotonic gel. The latex-free, MRI-compatible electrodes conform and adhere well. Wet Gel: 0.5% Chloride Salt Contact area: 1 cm Size: 2.5 cm x 4.5 cm Snap: Stainless Steel Backing: Foam
EL508	These disposable, radiotranslucent electrodes are pre-gelled. Use with LEAD108. (See MRI use information for EL508 and EL509 below.)
EL509	These disposable, radiotranslucent dry electrodes have no shelf-life limitation and are ideal for EDA/GSR applications. Use with LEAD108 and electrode gel—GEL101 recommended for EDA/GSR. 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.  Circular contact area diameter: 1 cm Backing: 25 mm x 44 mm ***MRI Use:*** MR Conditional ***Condition:*** Carbon-filled plastic snap will not interfere with imaging; tested 3T-9T. ***EL508/509 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/AgCi, Reticulated foam: Polyester-polyurethane, Gel: 10% chloride-liquid gel (EL508)

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

Part	*Ag-AgCl Adhesive/Disposable Electrode Type*
EL510	EL510 is a disposable RT electrode set of three electrodes with hydrogel centers and hydrocolloid ends that terminate in Touchproof leads. Each box includes 20 sets of 3 electrodes. • Pre-wired • Safely secures to limbs without a strap that could reduce circulation. • Gentle hydrocolloid ends and hydrogel adhesives. • Long lasting and easy to use, even under high humidity. • Radiolucent materials allow for x-ray wherever they are positioned • Latex, phthalate/DEHP, BPA free.  Electrodes are 25 mm x 10 mm with a 10 mm x 10 mm gelled contact area, and the micro-lead cables are 58 cm.

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

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

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.

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

ELSTM1 UNSHIELDED STIMULATING BAR ELECTRODE

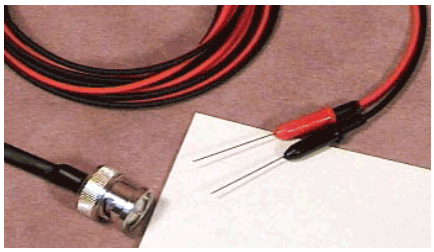
The ELSTM1 Unshielded Stimulation Bar Electrode for Research Systems has a BNC connector that will interface with either the STM200 or the STMISOLA.

ELSTM1 SPECIFICATIONS

Bar Length:	4 cm
Spacing between contacts:	3 cm
Electrode Contact Diameter:	1 cm
Cable Length:	2 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 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. Needle electrodes are shipped non-sterile, so pre-sterilization is required.



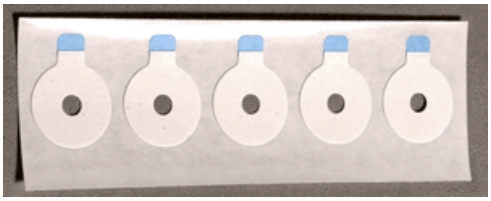
ELSTM2 SPECIFICATIONS

Needle Length:	2.5 cm
Needle Diameter:	0.3 mm
Cable length:	2.5 m
Connector type:	BNC
Interface:	BSLSTM Stimulator or SS58L for MP35 or OUT3 for MP36

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

ELECTRODE ACCESSORIES & GELS





Abrasive Pads

Before applying electrodes, abrade the skin lightly with an ELPAD (above left) 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. (Above center)

Adhesive Disks

ADD200 series double-sided adhesive collars are used to hold reusable electrodes (EL254/8RT) firmly on the skin surface. (Above right)

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

MRI Use: MR Conditional

Condition: Max MR field strength 3T

GEL100 Components:

Water, Sodium Chloride, Propylene Glycol, Mineral Oil, Glyceryl MonostearatePolyoxyethelene Stearate, Stearyl Alcohol, Calcium Chloride, Potassium Chloride, Methylparaben, Butylparaben, Propyl Paraben

GEL101 Non-irritating, isotonic gel is primarily used as a conductant for the TSD203 electrodermal response electrodes. Each tube contains 114 g (~4 ounces).

GEL101 is 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 in line with the recommendation made by Fowles (1981). Psychophysiology, 18, 232-239

MRI Use: MR Conditional

Condition: Max MR field strength 3T

GEL101 Components:

Cetyl Alcohol #697313, Glycerol Monostearate, Lanolin, USP Anhydrous, Dimenthicon Silicone TBF9-1000, Water, purified USP Sodium Chloride, Sodium Lauryl Sulfate, Sorbitol, 70 USP, Methylparaben, Propylparaben, Quaternium-15

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 all electromedical procedures. Salt-free characteristics make it particularly suitable for long-term applications. 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
- Product of choice for conductive rubber/carbon electrodes
- Product of choice 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 3T

GEL104 Salt-Free Components:

Water, Propylene Glycol, Mineral Oil, Glyceryl Monostearate, Polyoxyethelene Stearate, Stearyl Alcohol, Methylparaben, Butylparaben, Propyl Paraben

GEL102 Ten20 Conductive Gel 114 g (~4 ounces). This gel is abrasive and should be used with care not to overabrade the skin. It is not recommended for use with current inducing electrodes, such as defibrillator or neuro-stimulating equipment. Not to be used on patients with a history of skin allergies to cosmetics and lotions. Topical use only.

- ECG:Apply gel to entire electrode site with gauze pad. Rub into skin lightly. Rub off excess with clean gauze pad. Apply proper electrode gel and electrode.
- EEG:Apply gel to electrode site on scalp with cotton swab. Rub lightly. Apply electrode paste and electrode over the gel. Wash skin promptly after use.

GEL103 Tensive Adhesive Gel, 33 ml. Conductive adhesive gel. This safe, non-flammable, odorless gel is recommended for TENS, EMG, EEG, and similar protocols.

- 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

Coban Wrap

Self-adhesive Coban™ wrap can be used to hold electrodes, VMG transducers and *f*NIR sensors on a subject.

- 4 inch x 5 yard (fully stretched) (100 mm x 4.5 m)
- Latex free self-adherent wrap
- Nonsterile
- Tan

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

BSL-ACCPACK

The BSL Accessory Pack includes the consumable items to run 16 BSL Lessons.

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

60 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

ELECTRODE LEADS

LEAD108 SERIES — MRI-CONDITIONAL/RADIOTRANSLUCENT LEADS FOR EL508/EL509

Use the LEAD108 series with EL508 MRI-conditional, radiotranslucent electrodes and EL509 disposable radiotranslucent dry electrodes. All LEAD108 Series terminate in 1.5 mm female Touchproof sockets.

MRI Usage: MR Conditional

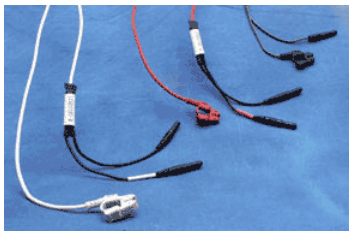
Condition: Tested 3T-9T

Lead108 Components: Polyvinyl chloride (PVC) plastic, carbon fiber leadwire, tinned copper connectors (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:	**LEAD108** 1.8 m, **LEAD108A** 3.6 m, **LEAD108B** 15 cm, **LEAD108C** 30cm

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 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)

LEAD120 LEAD FOR EL120

This 1-meter lead with 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

LEAD130 SHIELDED LEAD ASSEMBLY

LEAD130 Shielded Lead Assembly is for use with the EBI100C Electrical Bioimpedance Module or the NICO100C Noninvasive Cardiac Output Module. The shielded lead assembly terminates with an adapter that plugs into the front of the amplifier module and includes four leads:

White = I+ **Red** = Vin+ **Green** = Vin- **Black** = I- (GND)

Important Usage Notes:

- If using multiple biopotential modules, do not connect the ground (GND) for the other modules — establish one ground per subject.
- If using a GSR100C Electrodermal Response Amplifier with the EBI100C or the NICO100C, please note that the black I- (GND) connection will shunt current from the GSR100C excitation source. Accordingly, GSR100C measurement values will be shifted somewhat higher in absolute conductance, and should be used for relative measures only.

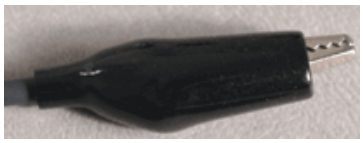
See also: EBI100C Electrical Bioimpedance Module

NICO100C Noninvasive Cardiac Output Module

EL506 Bioimpedance Strip Electrode and EL500 Series Disposable Electrodes

Application Note 215 - Noninvasive Cardiac Ouput - NICO100C and LEAD130.

LEAD140 SERIES CLIP LEADS



LEAD140 Series clip leads have a 1 m black cable and a Touchproof connector, and require the SS1LA interface.

LEAD140 Alligator clip with teeth, 40 mm: Use this fully-insulated, unshielded lead to connect fine wire electrodes, including irregular surfaces. There is ferrous metal in the clip.

LEAD141 Alligator clip with smooth (flat) clamp, 40 mm: Use this fully-insulated, unshielded lead to connect to fine wire electrodes without damage, including arbitrarily small electrode wires. There is ferrous metal in the clip.

LEAD142 Retractable clip lead with copper extension contacts, 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)

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

GASCAL CALIBRATION GAS AND GASREG REGULATOR

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

Use the single stage, non-corrosive, general-purpose GASREG regulator with the GASCAL Calibration Gas Cylinder. Single-stage pressure regulators reduce the cylinder pressure to the delivery or outlet pressure in one step, and are generally good for short duration applications.

This regulator is used to inject calibration gases into the GASSYS2 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. GASCAL is a tank containing 4% carbon dioxide, 16% oxygen and balance (80%) 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.

GASCAL Cylinder Recycling Program available.

- Call 1-800-457-0809 to receive instructions for returning a cylinder; delivery paid by sender and recycling covered by manufacturer.

GASSYS2-EA/EB AND GASSYS2-RA/RB O_2 & CO_2 GAS ANALYSIS SYSTEM

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

Modular assembly makes complete cleaning easy!

GASSYS2 modules measure expired O_2 and CO_2 concentrations. When the subject inspires, air is drawn into the GASSYS2 through an airflow transducer. The SS11 (GASSYS2 EA/EB) or TSD107B (GASSYS2 RA/RB) airflow transducer is placed on the inspiration side to eliminate any effects associated with expired air humidity. When the subject expires, air is directed to the GASSYS2 module. The GASSYS2 is designed to work with saturated expired air.

Obtain real-time Oxygen Consumption (VO_2) and Respiratory Exchange Ratio (RER) measurements using the MP System with a GASSYS2 module and some airflow accessories. The GASSYS2 connects directly to the MP36 System (GASSYS EA/EB) or via the UIM100C (GASSYS RA/RB) and requires two channels.

The non-rebreathing T-valve directs only expired air to the GASSYS2. Because only expired air is directed to the module, the system acts to average respiratory outflows. This averaging effect causes the CO_2 and O_2 concentrations to vary in accordance to the mean values resident in a few expired breaths.

Two chamber sizes are available for the GASSYS2. Each chamber assembly includes the chamber casing and rod. The chambers work exactly the same way and are interchangeable on the module base. Use the smaller chamber size for small children/medium sized animals.

5-liter chamber — included in the **GASSYS2-EA/RA**; order chamber only as **RX-GASA**

1.7-liter chamber — included in the **GASSYS2-EB/RB**; order chamber only as **RX-GASB**

The GASSYS2 also includes **AFT7** tubing, **AFT11E** Coupler, **AFT22** Non-rebreathing T-Valve, and a power supply.

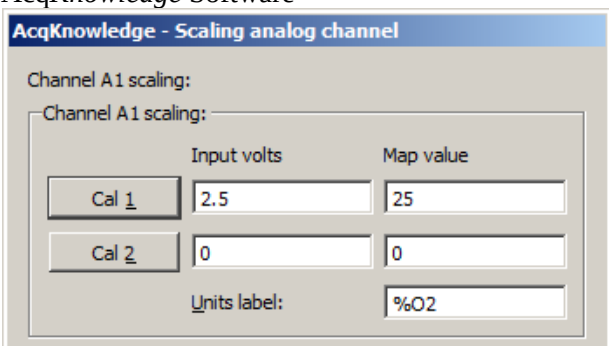
GASSYS2 Specs

O_2 sensor:	Warm-up: 10 minutes. Response time 10-90%: 30 sec. Accuracy: ±1% FSR*. Zirconia solid electrolyte with a 0.1-25% sensing range. It runs hot, which helps burn off humidity. *FSR = Full Scale Reading
Expected O_2 sensor lifespan (in years):	[5,256/(number of hours used per year)]*5 • If used for 10 hours per week or 520 total hours in a year, O_2 sensor lifespan would be [5,256/520]* 5 = 50.5 years
CO_2 sensor:	Warm-up: 2 minutes. Response time: < 120 seconds for a 90% step change. Uses a humidity-repellant (hydrophobic) membrane and has a sensing range of 0-5%. It uses non-dispersive infrared diffusion with single-beam IR and a self-calibrating algorithm. It also runs hot, which burns off humidity.
Calibration:	GASSYS2 sensors are factory calibrated prior to shipping.
Power Supply:	12 V DC @ 1 amp (AC300A) wall adapter for serial numbers ending 200 or older.

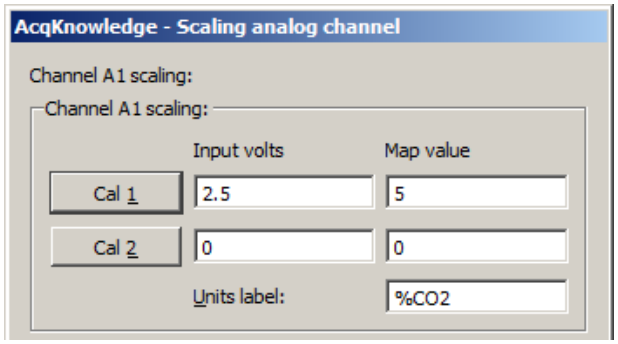
Dimensions/Weight	1.7-liter chamber	5-liter chamber
Length:	22 cm	55 cm
Height:	18 cm	18 cm
Width:	14 cm	14 cm
Weight:	1.38 kg	1.96 kg

GASSYS2 Software Scaling Defaults

Acq*Knowledge* Software

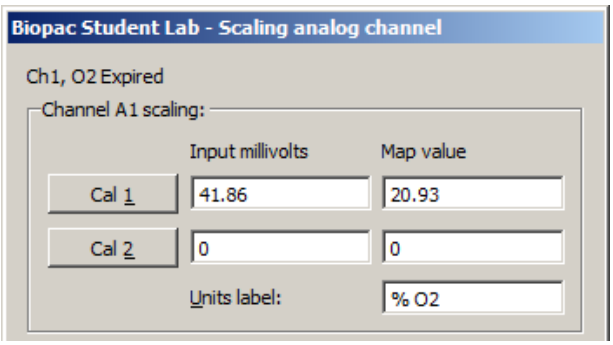


Default $\%O_2$ Scaling

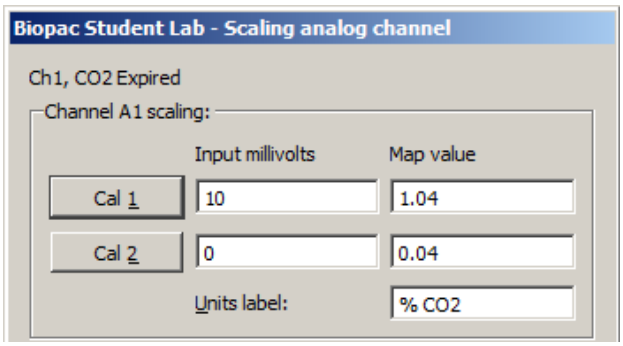


Default $\%CO_2$ Scaling

BSL *PRO* Software



Default $\%O_2$ Scaling



Default $\%CO_2$ Scaling

Calibration Procedure

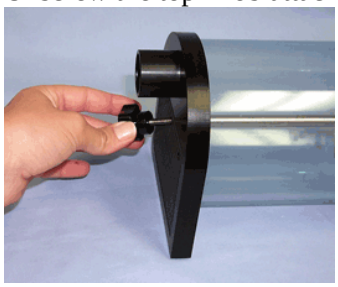
The GASSYS2 scaling parameters are factory-set to a "ballpark" default, but in order to achieve accurate measurements, these values must be re-calibrated in the Acq*Knowledge* or BSL *PRO* software using the following steps.

1. Flood the mixing chamber with fresh (ambient) air. (20.93% O_2, 0.04% CO_2) This can be accomplished by attaching the calibration syringe to the mouthpiece and cycling fresh air into the mixing chamber.
2. Monitor the gas concentration levels using Acq*Knowledge* or BSL *PRO* software. When the levels appear stabilized at ambient, obtain the first calibration point. (CAL 1)
3. Flood the chamber with the gas mixture using BIOPAC's GASCAL and GASREG. The recommended concentration is 16% O_2, 4% CO_2 and 80% nitrogen (N_2).
4. When the levels appear stabilized, obtain the second calibration point. (CAL 2)

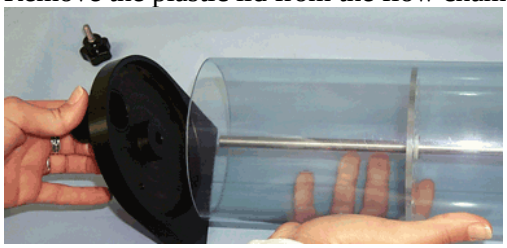
Cleaning the BIOPAC GASSYS2

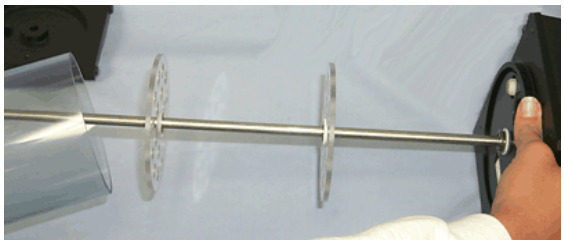
Note: Never clean the sensor base of the device. The two sensors, a screen and a copper-colored gas detector, are highly sensitive.

1) Unscrew the top knob attachment.



2) Remove the plastic lid from the flow chamber.



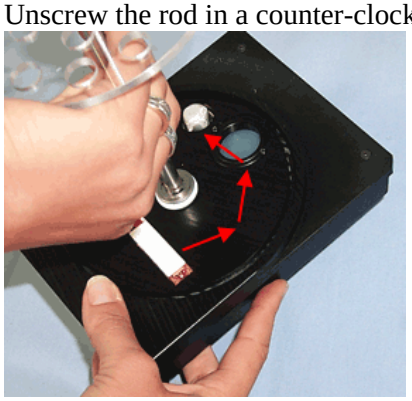


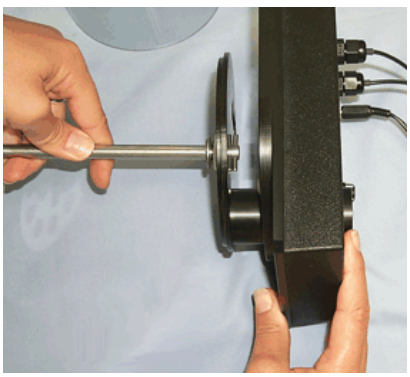
3) Gently pull the clear cylinder off the sensor base.

4) Detach the metal standing rod and its lower base attachment by holding the third of the standing rod nearest the base of the module and unscrewing the rod in a counter-clockwise motion.

   a. Depress the rod by applying pressure at the base – this unlocks the rod's position and allows movement.

   b. Unscrew the rod in a counter-clockwise motion.





5) Remove the chamber stand (gently pull back the chamber stand from the electronics base).

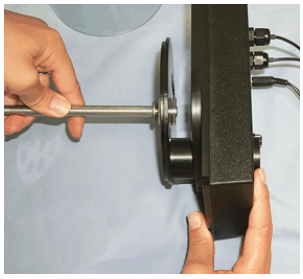
6) Clean the flow chamber with one of two methods:

   a. Use a soft cloth and Cidex Plus Sterilizing and Disinfecting Solution cleanser. Spray a light mist of Cidex cleanser on the parts of the device to be cleaned, and wipe the pieces with a dry rag. It is important never to get Cidex near the sensors of the device.

      - Other cleansers should not be substituted for Cidex – non-Cidex cleansers might damage or abrade the flow chamber pieces.

   b. Heating the components in an autoclave sterilizing oven.

7) After cleaning reattach the platformed-standing rod to the electronics base.



   a. Align the exhaust tube at the bottom of the rod stand with the exhaust port on the electronics base and insert securely.

   b. Gently ease the rod stand back into its appropriate position on the electronics base. The sensors are very delicate—slowly lower the plastic base of the standing rod to the electronics base to make sure that the openings in the standing rod base correspond with the appropriate sensors.

8) Locate the latch opening for the security screw and align it with the screw, and then press the base of the standing rod to the sensor base.

   a. Revolve the rod until the lower screw drops into its opening. When the screw meets its opening, it should drop into the hole.

   b. Depress the rod by applying pressure on the lower third of the piece and rotate it in a clockwise motion until it locks into position.

9) Ease the clear cylinder back onto the device and lay its lower edge in the track on the electronics base.

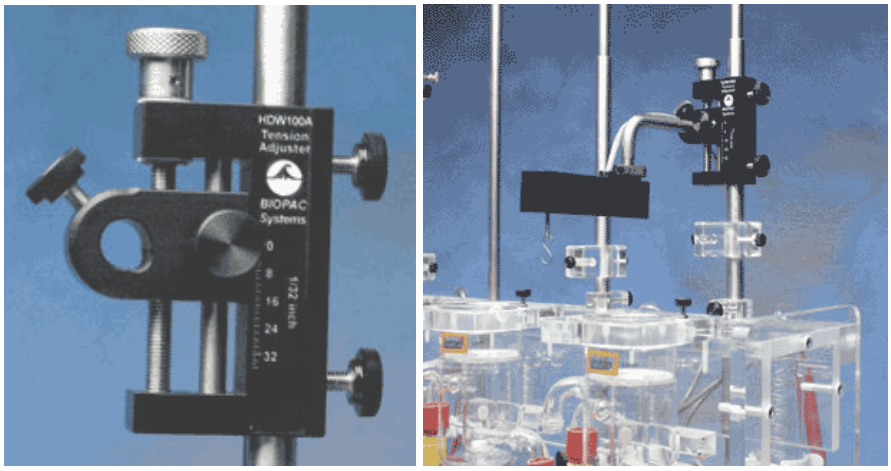
10) Re-attach the plastic top to the clear cylinder.

11) Lock the plastic top into place by screwing in the security knob.

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

TENSION ADJUSTERS

HDW100A TENSION ADJUSTER
HDW200A 3RD-PARTY TENSION ADJUSTER ADAPTER



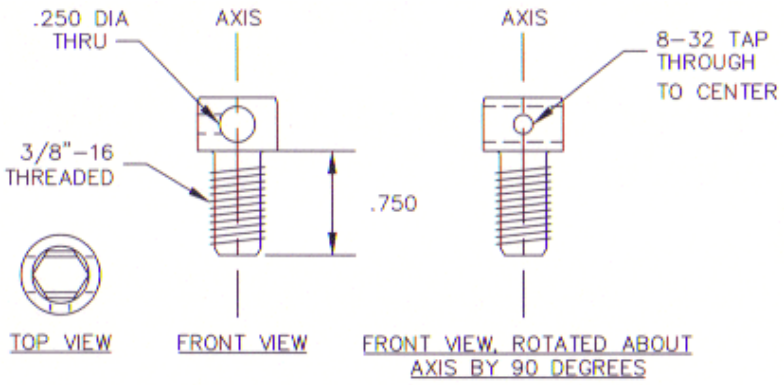
HDW100A and TSD125/SS12LA

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:	25mm
Resolution:	0.0025mm per degree rotation
Stand Clamp:	13.25mm ID
Transducer Clamp	11mm ID
Weight:	140 grams
Dimensions:	93mm (high) x 19mm (thick) x 74mm (deep)

HDW200 ADAPTER FOR 3RD-PARTY TENSION ADJUSTERS

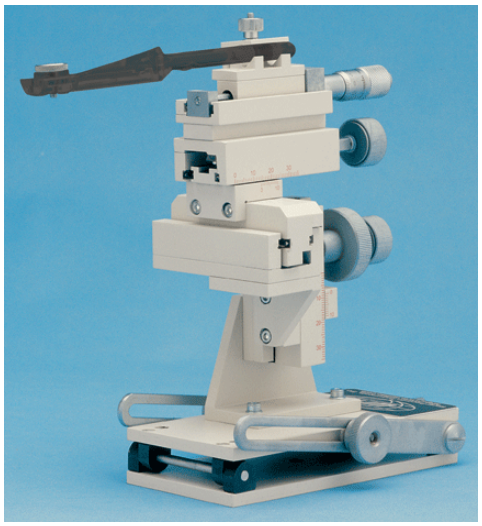


This adapter allows 3rd-party tension adjusters to interface with BIOPAC Force Transducers.

- 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.

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

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

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

NIBP100D NONINVASIVE BLOOD PRESSURE SYSTEM

The NIBP100D is a stand-alone noninvasive blood pressure monitoring system that provides a continuous, beat-to-beat, blood pressure signal recorded from the fingers of a subject. Uses a double finger cuff sensor that is comfortable for the subject to wear and easy to place on the hand– three included cuff sensors fit small to large fingers. The system outputs a continuous blood pressure waveform that is similar to a direct arterial pressure waveform. Monitor displays values for systolic, diastolic, mean blood pressure, and heart rate. Add BSL-TCI5 to use with an MP36 System.

NIBP100D System includes:

- Blood Pressure Module with external mains power and interface cables
- Finger cuff sensors (3): small 10-18 mm, medium 18-24 mm, and large 24-28 mm
- BP cuffs for calibration (4): xs 12-19 cm, small 17-25 cm, medium 23-33 cm, and large 31-40 cm
- Finger cuff sensors are a consumable item and typically last ~12 months based on 3-4 hours/week.
- Order additional finger cuffs as RXNIBPDFINGER-L, RXNIBPDFINGER-M, or RXNIBPDFINGER-S.

See also: BSL *PRO* Lesson H18 Exercise Physiology

The NIBP100D Noninvasive Blood Pressure Monitoring System is suitable for small children (~6 years) to large adults

Click the **"Resources"** tab above for the **NIBP100D User Manual** with complete specifications and **NIBP100D Calibration.**

SPECIFICATIONS

Double Cuff Finger Sensor

Finger cuff sensors are a consumable item and typically last ~12 months based on 3-4 hours/week. Order additional or replacement finger cuffs as RXNIBPDFINGER-L, RXNIBPDFINGER-M, or RXNIBPDFINGER-S.

Large 24 - 28 mm, dark red
Medium 18 - 24 mm, dark blue
Small 10 - 18 mm, light blue

Blood Pressure Cuffs (Latex free)

Child (12 – 19 cm) works starting at 20 kg (44 lbs), age 6 years
Small Adult (17 – 25 cm)
Adult (23 – 33 cm)
Large Adult (31 – 40 cm)

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

Interface

MP150/100 to DA100C via TCI105 (sold separately)

MP36 via BSL-TCI5 (sold separately)

Output

Sensor bridge voltage: 2 - 10 V (external monitor)
Sensitivity: 5 µV/V/mmHg
BP Wave Out: CNAP™ transducer cable 0.3m; connector RJ11 6P4C (e.g. Abbott IBP catheter)
Maximum delay of analog out signal: 80 msec

- Means the BP waveform may be delayed with respect to other waveforms acquired by the MP150 unit, such as ECG, by max 80 msec

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 hours (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 h if on battery-operation (fully charged battery)

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

Note—Electric and magnetic fields may interfere with the functional reliability of the device, so avoid using the CNAP™ Monitor 500 close to devices emitting powerful electromagnetic fields, e.g. x-ray equipment, diathermy applications or magnetic resonance tomographs.

Hyperbaric/Hypobaric Chamber Setup

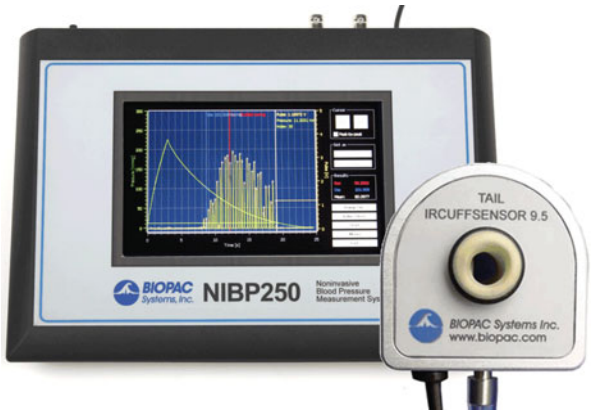
1. Cuff controller and CNAP monitor must be in the same chamber with the same"pressure" environment as both are equipped with pressure sensor for surrounding pressure.
2. Pressure must be increased / decreased continuously rather than abruptly.
3. Hypobaric: take measures against overheating of the device 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.

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

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 = 9.5mm, 100-220 g
  - RXTCUFSENSOR11 = 11 mm, 200-280 g
  - RXTCUFSENSOR13 = 13 mm, 250-350 g
- One small animal restrainer:
  - RXRESTRAINER-MICE, 10-25 g (mice)
  - RXRESTRAINER-S, 70-150 g (small rat)
  - RXRESTRAINER-M, 150-200 g (medium rat)
  - RXRESTRAINER-L, 250-350 g (large rat)
- Optional MRI-compatible 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
- 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" 800x480 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

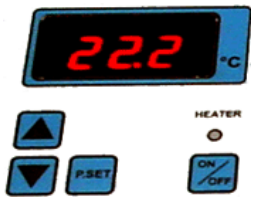
1. Connect the CBL150-Pre cable
    a. BNC to the PRESSURE output on the back panel of the unit.
    b. Other end to A1 on the front of the UIM100C unit
2. Connect the CBL150-Pls cable
    a. BNC to the PULSE output on the back panel of the unit.
    b. Other end to A2 on the front of the UIM100C unit.
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 12V 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

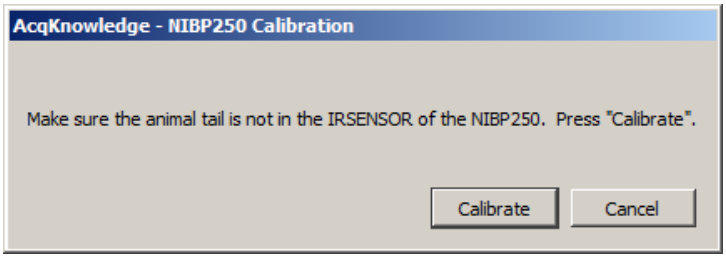


1. Turn the Animal Heating Chamber on.
2. Set the temperature value (press and hold P.Set and then press the up or down arrow to reach the desired value).
   - For accurate noninvasive blood pressure measurement, the animal or its tail should be warmed to 32°C.
3. Press the Heater button to start heating 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)

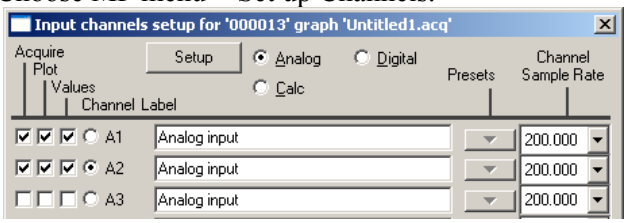
1. Launch AcqKnowledge
2. Select the "Create/Record a new experiment" option.
3. Select MP150 > Set Up Channels > "Add New Module..."
    a. From the new module list, select UIM100C-A1 (or whichever channel CBL150-PRE pressure cable is connected to) and click "Add."
    b. From the UIM100C Transducer 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.



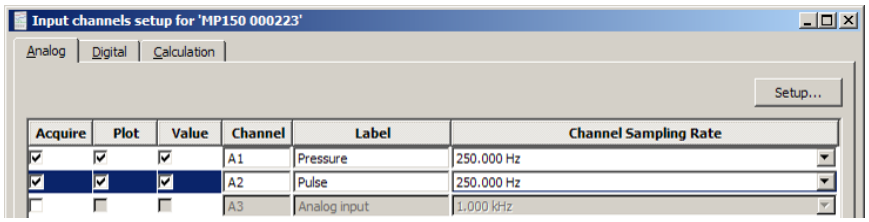
4. Repeat "Add New Module…" portion of Step 3.
    a. From the new module list, select UIM100C-A2 (or whichever channel CBL150-PLS pulse cable is connected to) and click "Add."
    b. From the UIM100C Transducer list, select "NIBP200A – Small Animal Tail BP, Pulse" or "NIBP250 – Small Animal Tail, Pulse" and click OK.

SOFTWARE SETUP (Acq*Knowledge* 4.0 and earlier)

1. Launch the BIOPAC software.
2. Choose MP menu > Set up Channels.

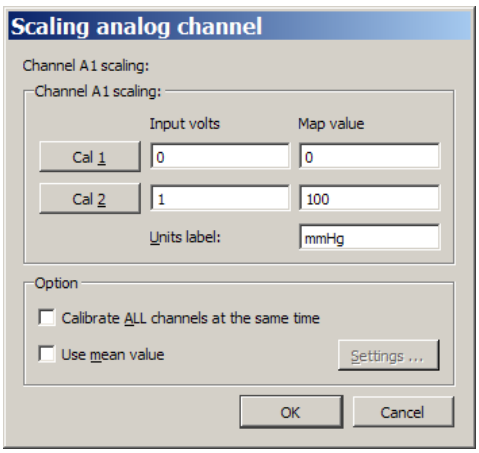


or



3. Enable analog inputs A1 and A2 to Acquire Data, Plot on Screen and Enable Value Display.
    - 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



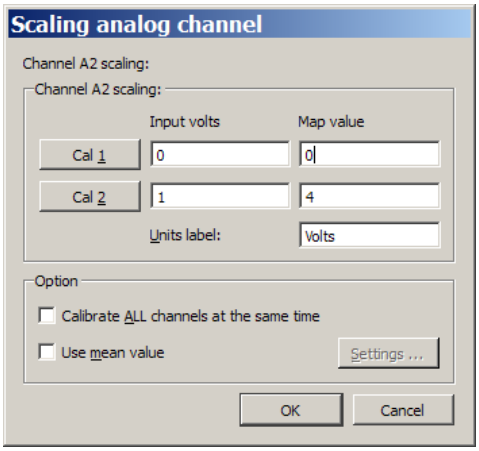
The scaling must be adjusted as the cut-off pressure switch settings are changed. If the pressure switch is set to 300 mmHg, then the settings should be:

	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:

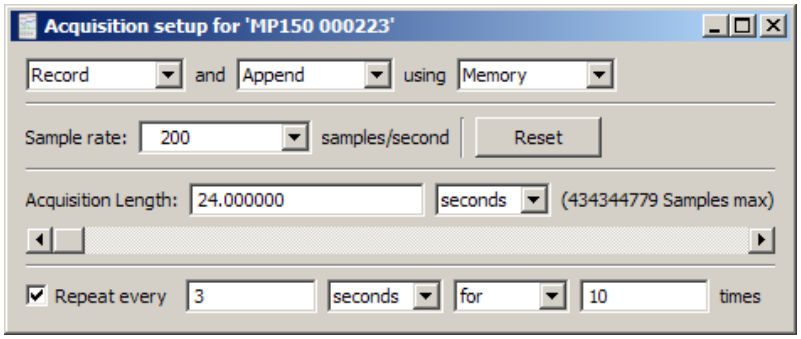
	Input volts	Scale (Map) value
Cal 1	0	0
Cal 2	1	4
	Units Label:	Volts



   c. Click OK as needed to close out of A2 setup and the Setup Channels dialog.

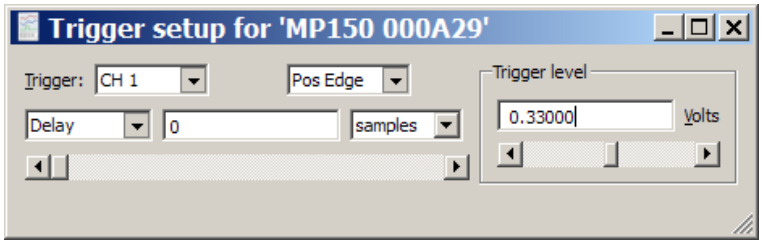
6. Choose MP menu > Set up Acquisition and establish the following settings.

Mode = Record and Append to Memory
Sample Rate = 200 samples/second
Total Length = 24 seconds
Repeat = every 3 seconds for 10 times



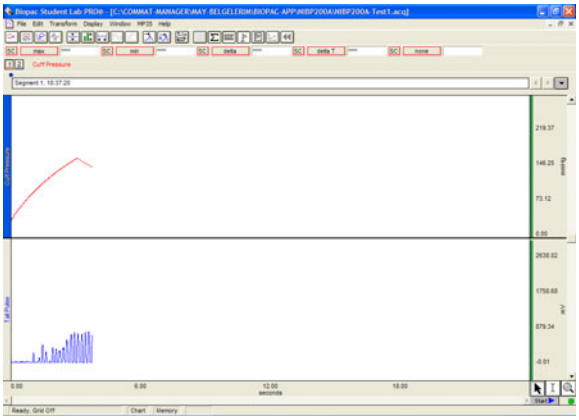
7. Close out of Set up Acquisition.
8. Choose MP menu > Setup Trigger and establish the following settings.

Source = CH 1
Pos Edge
Trigger Level = 0.33
(based on 1 V ≈ 100 mmHg)
Delay = 0



9. Close out of Set up Triggering.

RECORDING

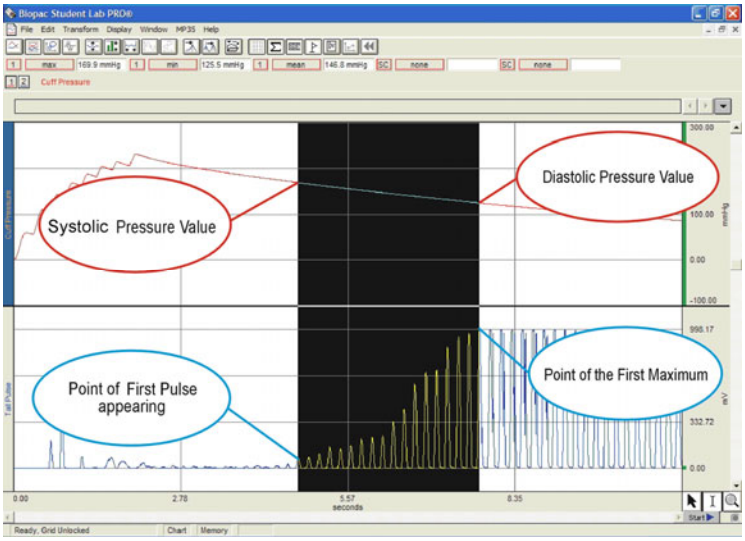


1. Confirm that the animal is ready and that the IRSENSOR is attached to the tail.
2. Click "Start" in the BIOPAC software window.
3. Press START button on the front panel of NIBP200A.
   - IRSENSOR will pump up the Cuff automatically.
   - When the Cuff Pressure on A1 reaches 30 mmHg, the cuff pressure 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

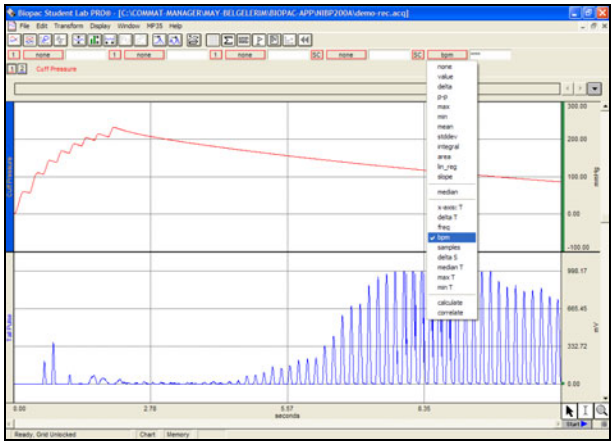
Calculation of Systolic, Diastolic and Mean.

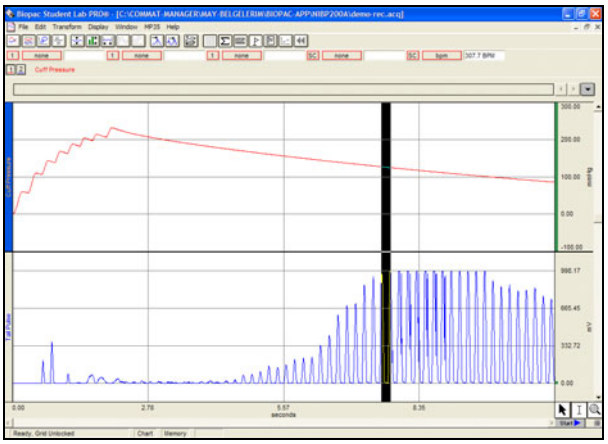


1. Click the Calculation Label.
2. Select from the list Max , Min, Mean for three different Labels.
3. Select Channel 1 as channel option.
4. Select cursor 'I' from the cursor option on the bottom right of the screen.

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.

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.

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

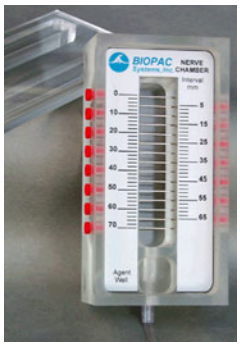
NERVE CHAMBERS: NERVE1 AND NERVE2

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

NERVE1 – WITH AGENT WELL AND LID



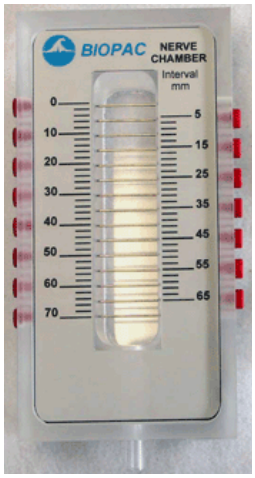
NERVE1 chamber includes:

- **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

NERVE1 chamber includes:

- **Deep Reservoir (35mL)** 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

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

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 (2mm 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 (3.5mm phone plug) into the 50 Ohm output of the STM100C.

Note: If the STM100C Stimulator is used with a Biopotential amplifier on the same nerve—which is nearly always the case—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

OUT1 High Fidelity Headphones
OUT1A Ultra-Wide Frequency Response Headphones
OUT2 BNC Output Adapter
OUT100 Monaural Headphones
OUT101 Tubephone
OUT102 Piezo Audio Transducer
OUT103 LED Cable
40HP Monaural Headphones

For OUT3, see Stimulators

OUT1 HEADPHONES

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

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

OUT1 SPECIFICATIONS

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

OUT1A

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"

See also: **SS9LA** BNC Input Adapter

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.

OUT2 SPECIFICATIONS

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

OUT100

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 meter
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

OUT101 TUBEPHONE

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.

OUT101E Replacement Foam Ear Inserts: pkg. of 50

OUT101T Replacement Plastic Tubes: pkg. of 4

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

OUT101 SPECIFICATIONS

Response:	Compares to TDH-39, 49 or 50 audiometric headphones
Acoustic signal delay:	1 msec
Dimensions:	3.8cm (wide) x 5cm (high) x 1cm (thick)
Cable termination:	6.3mm (1/4") phone plug
Cable length:	1.8 meter
Cable clip:	Yes; clip attaches to fabric or fixtures

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.

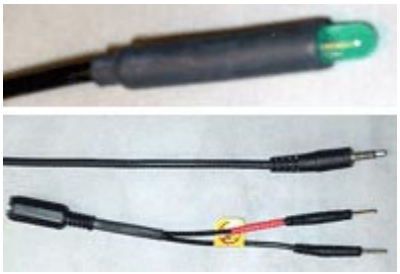
OUT102 PIEZO AUDIO TRANSDUCER

The OUT102 piezo transducer is typically connected directly to the STM100C stimulator module. When the stimulator module output rises above 1.5 volts, the piezo indicator will emit a constant audible signal (3.0 kHz @ 80 dB). Accordingly, the device 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 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. The OUT102 also connects directly to the UIM100C digital I/O ports for operation with Control Channel outputs. The OUT102 measures 2.5cm (dia) x 1cm (high) and comes equipped with a 1.8m cable terminated in a 3.5mm phone plug. An adapter is included for connecting the OUT102 to the UIM100C digital I/O ports.

OUT102 SPECIFICATIONS

Dimensions:	2.5cm (dia) x 1cm (high)
Cable Length:	1.8 meter
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

MP150 AND UIM100C SETUP

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 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.

CALIBRATION

The OUT series does not require calibration.

40HP MONAURAL HEADPHONES

These monaural headphones are used with Biopac Science Lab MP40 and Biopac Student Lab MP45 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

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

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 units have standard IEC power input plugs and operate over mains power ratings of 100-240 VAC, 50-60 Hz. Each includes a USA or EURO power cord. (ACCORD US/EURO, ACCORD-HUS Hospital Grade)

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.
AC150A	+12 volt, 4.17 amp	Connects the MP150 System to the AC mains wall outlet. One supply is included with each MP150 Starter system.
AC300A	+12 volt, 1.25 amp	Connects the MP or GASSYSTEM2 to mains wall outlet. One supply is included with MP36/35 system, MP100 or GASSYSTEM2.

See also: IPS100C Isolated Power Supply

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

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).

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

BAT100A BATTERY PACK SPECIFICATIONS

Battery

Chemistry: LiFePO	^{4} (Lithium Iron Phosphate)
Output Capacity:	12V @ 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)	14cm (high) x 19cm (wide) x 14cm (deep)

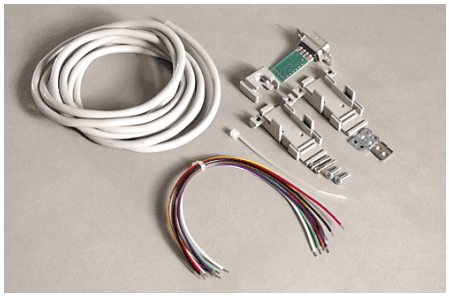
Battery Charger (For BAT100A only)

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:	3.8cm (high) x 6.4cm (wide) x 15cm (long)

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

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. 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**.

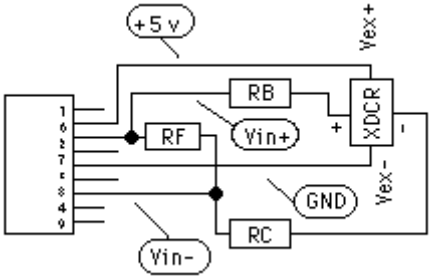
   The bridge circuit should be designed so no more than 5mA are used to power the bridge. If the bridge takes more than 5mA, try reducing the voltage across the bridge by using series resistors or other kinds of regulators.

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

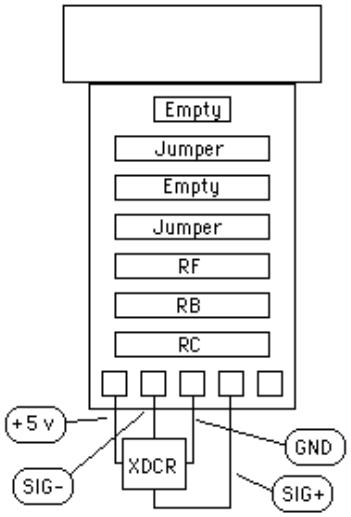
   The signal input (conditioned by the bridge) should provide a signal no greater than ±50 mV between pins 2 and 4 on the 9 Pin D Male connector. If this voltage exceeds 50 mV (of either polarity), the input amplifier stages will saturate.

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

9 Pin D Male connector pin-outs



Schematic



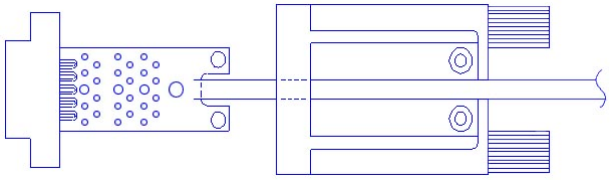
Printed circuit board layout

Updated: 3.28.2013

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

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:

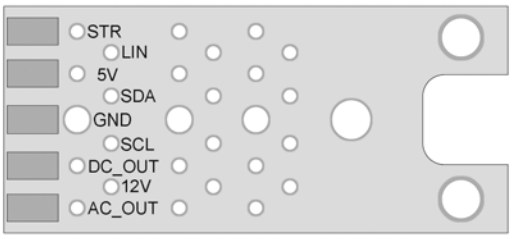
1. Synchronizing 3rd party equipment to the MP3X's start of acquisition.
2. Listening to pulses ("clicks") or tones with headphones which can be used for reaction time studies.
3. Controlling audio or visual stimulus device (Audio tone, LED or Strobe flash, etc.).
4. Listening to input signals such as EMG via headphones or an audio amp./speaker.

Typical Analog Out connections include:

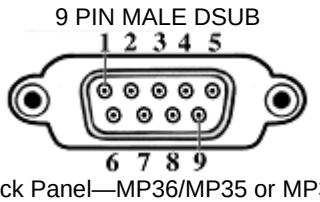
Analog Out Function	MP36/MP35 and MP30
Listening to pulses ("Clicks") via headphones or audio amp./speakers	Headphone "+": pin 1 Headphones "-": pin 3
Headphones for listening to analog signals (EMG, etc)	Headphone "+": pin 1 Headphones "-": pin 3
Driving output LED's • To limit LED current, put resistor 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/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* software, which is described in the BSL *PRO* manual.

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/MP35 or MP30

ANALOG OUT PORT

Updated: 3.28.2013

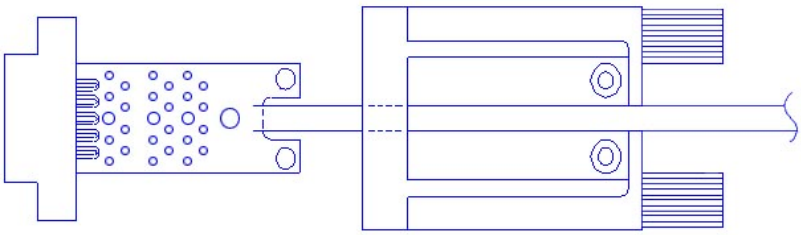
SS-KIT-OUT SPECIFICATIONS

PIN	LABEL on PCB	PIN FUNCTION MP36/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/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* software and check the Help > About Biopac Student Lab 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.

STIMULUS PRESENTATION

STP35W SUPERLAB SYSTEM FOR MP36/35

See STP30W to use with a BSL MP30

STP35W Components

SuperLab Software
Digital I/O Card
STP35 Interface Cable
Support Pack for Digital I/O Card
Six-button Response 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 MP36/35 System for data synchronization and collection purposes.

For performing accurate (1 ms resolution) reaction time measurements, the STP35W includes a six-pushbutton response box. For measuring physiological responses to stimuli, the STP35W includes an optically isolated interface, permitting up to three synchronization signals (input) between the STP35W and the MP36/35 System.

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

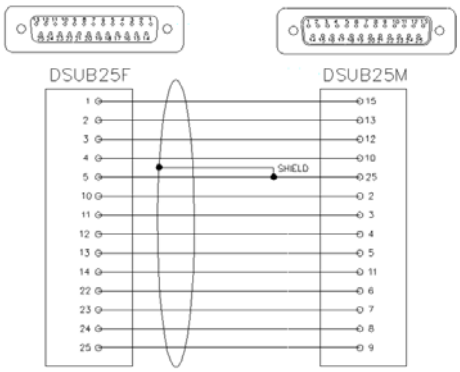
- See BSL *PRO* Lesson H30 Stroop Effect for details of the classic psychology experiment and a sample of how SuperLab works with the BSL System.

NOTE: Second PC required. The synchronization signal(s) coming from the STP35W can be directed to a BSL MP36/35 System running on a PC or a Macintosh, but it's not possible to run the STP35W on the same computer as the BSL MP36/35 System. The STP35W requires that the SuperLab software and a Digital I/O card (PCI slot required) be placed on a second computer.

STP35 MP36/35 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 MP36/35 unit.

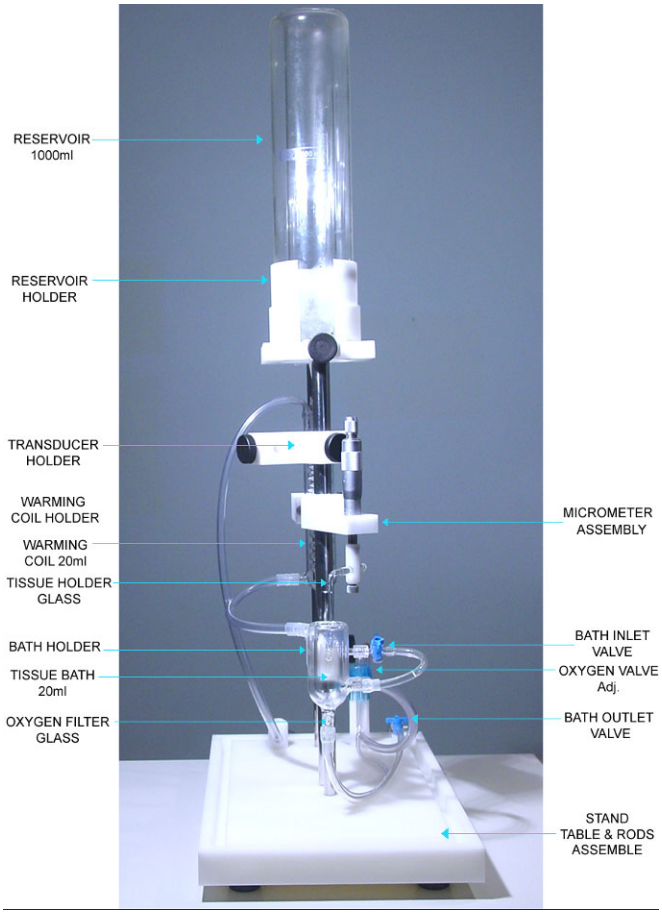
STP35A MP36/35 TO PARALLEL

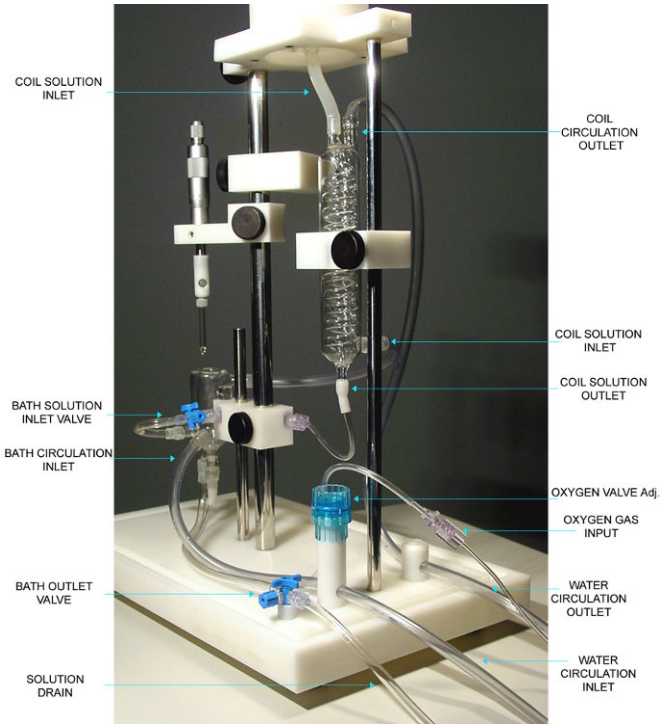


MP36 or MP35 to E-Prime, Direct RT, MediaLab, Inquisit, and other systems that connect via the parallel port.

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

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
- 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 TSD125 Force Transducer (specify TSD125 model C, D, E or F)

See also: BIOPAC Circulators, or use an existing system.

TISSUE BATH ACCESSORIES / REORDER PARTS

Tissue Holders

Tissue Clips

Warming Coil

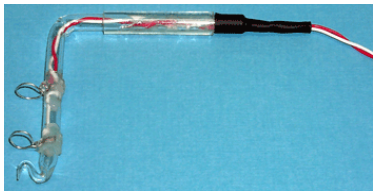
Oxygen Filter

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)
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)

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

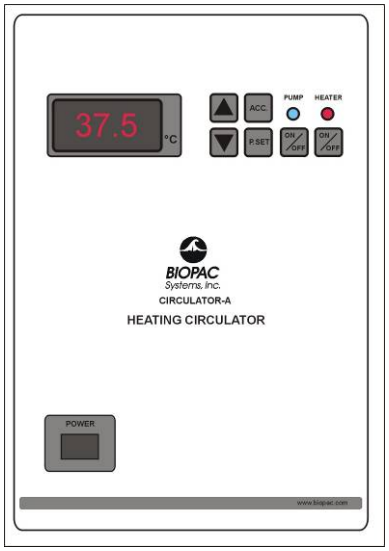
1 x Power Supply – 110V/60 Hz or 220V/50 Hz

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 30^0C to 45^0C 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^{0}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

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