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RESEARCH

WWW.BIOPAC.COM



BIOPAC Systems, Inc.

Training Seminar



- About BIOPAC
- Hardware Setup
- Software Setup
- Subject Preparation
- Data Acquisition Demonstration
- Data Analysis
- Application Notes and Other Resources
- Question and Answer Session



MP36R





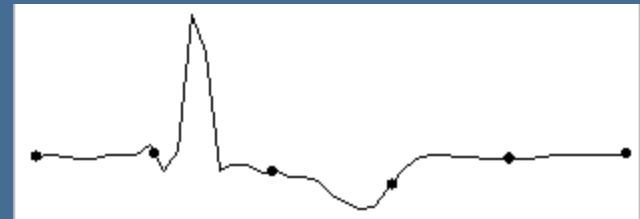
MP36

- **A/D Conversion**
 - Range of the MP36 system: 400microvolts to 4.0 Volts p-p;
 - A/D resolution: 24 bit
 - Dual A/D converters: Reduce Channel/Channel timing latency
16,777,216 levels or 2.8 microvolts/bit resolution at a gain of 5
and 0.024nanovolts/bit at a gain of 50,000
 - Minimum change that can be detected is 30 uvolts. If the signal is not strong, it must be amplified.
- **Sample Rate**
 - 4 channels @ 100K samples/second

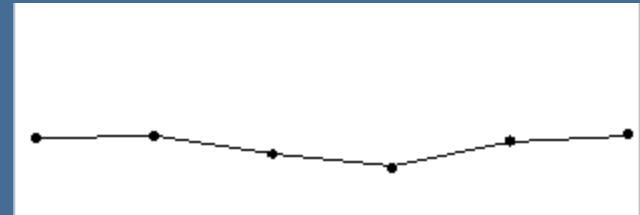


Sampling Rate

ECG waveform sampled with relatively few samples per second. The black dots are the sample points.



Above waveform as it would look if plotted.



Representation of the same ECG waveform sampled at a relatively higher sampling rate.





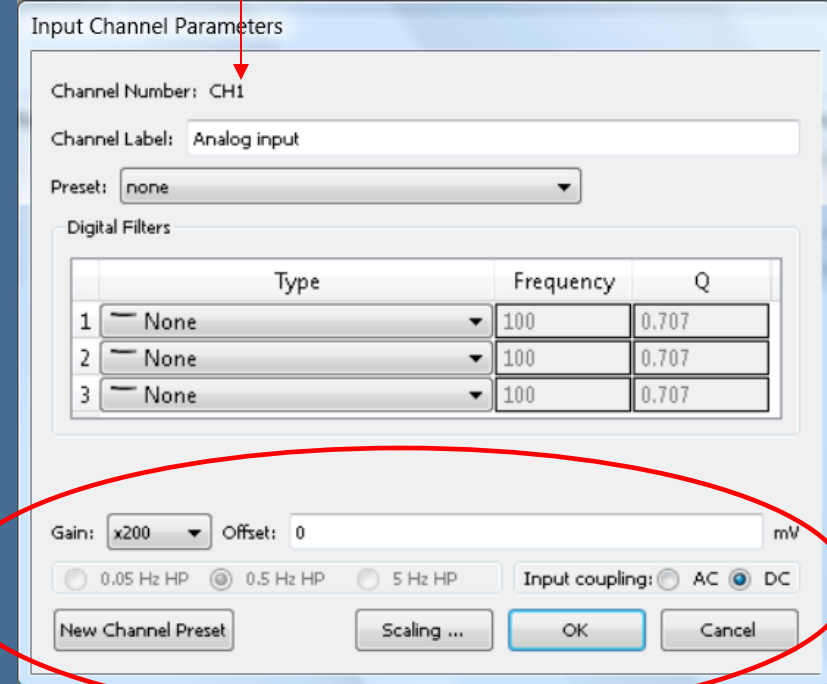
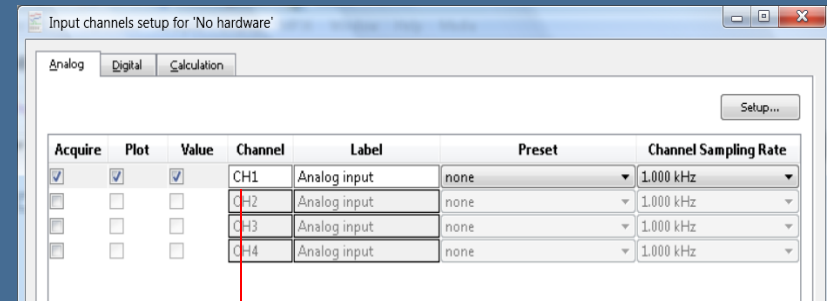
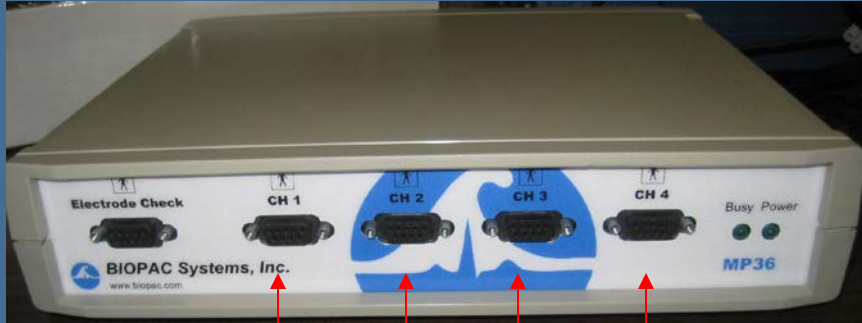
Sampling Rate

Recommended sample rates for physiological signals

ECG	200 Hz (1,000 Hz for HRV)
Respiration	50 Hz
GSR	50 Hz
EMG	1,000 Hz to 10,000 Hz
EEG	200 Hz
EOG	200 Hz
Blood pressure	100 Hz
Flow rate	50 Hz
EKG (electrogastrogram)	1 Hz



MP36R Front Panel



- 4 analog channels
 - Built-in universal amplifiers
 - Hardware filters

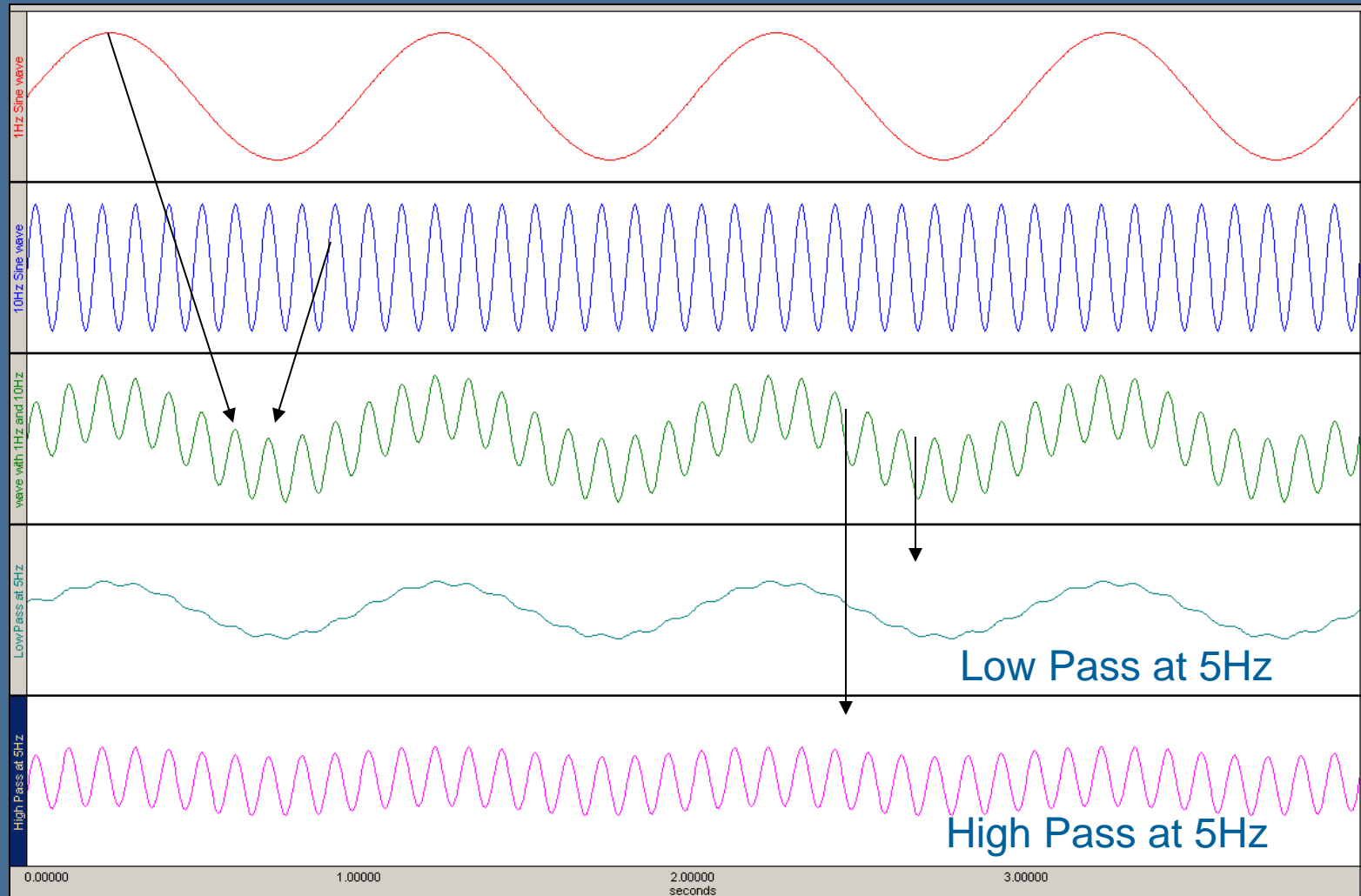


GAIN and typical physiological signal levels

Heart Potential (ECG)	0.5-4 mV
Brain Potential (EEG)	5-300 μ V (scalp)
Muscle Potential (EMG)	0.1-5 mV
Electrooculogram (EOG)	50-3,500 μ V
Blood Pressure: direct measurement indirect measurement	10-400 mmHg Arterial 25-400 mmHg Venous, 0-50 mmHg Venous
Blood Flow	1-300 cc/sec.
Respiratory Rate	2-50 breaths/min
Pneumotachography (flow rate)	0-600 liter/min.
Tidal Volume	50-1,000 ml/breath
Galvanic Skin Response	1-500 k Ω
Electrogastrogram (EGG)	10-1,000 μ V

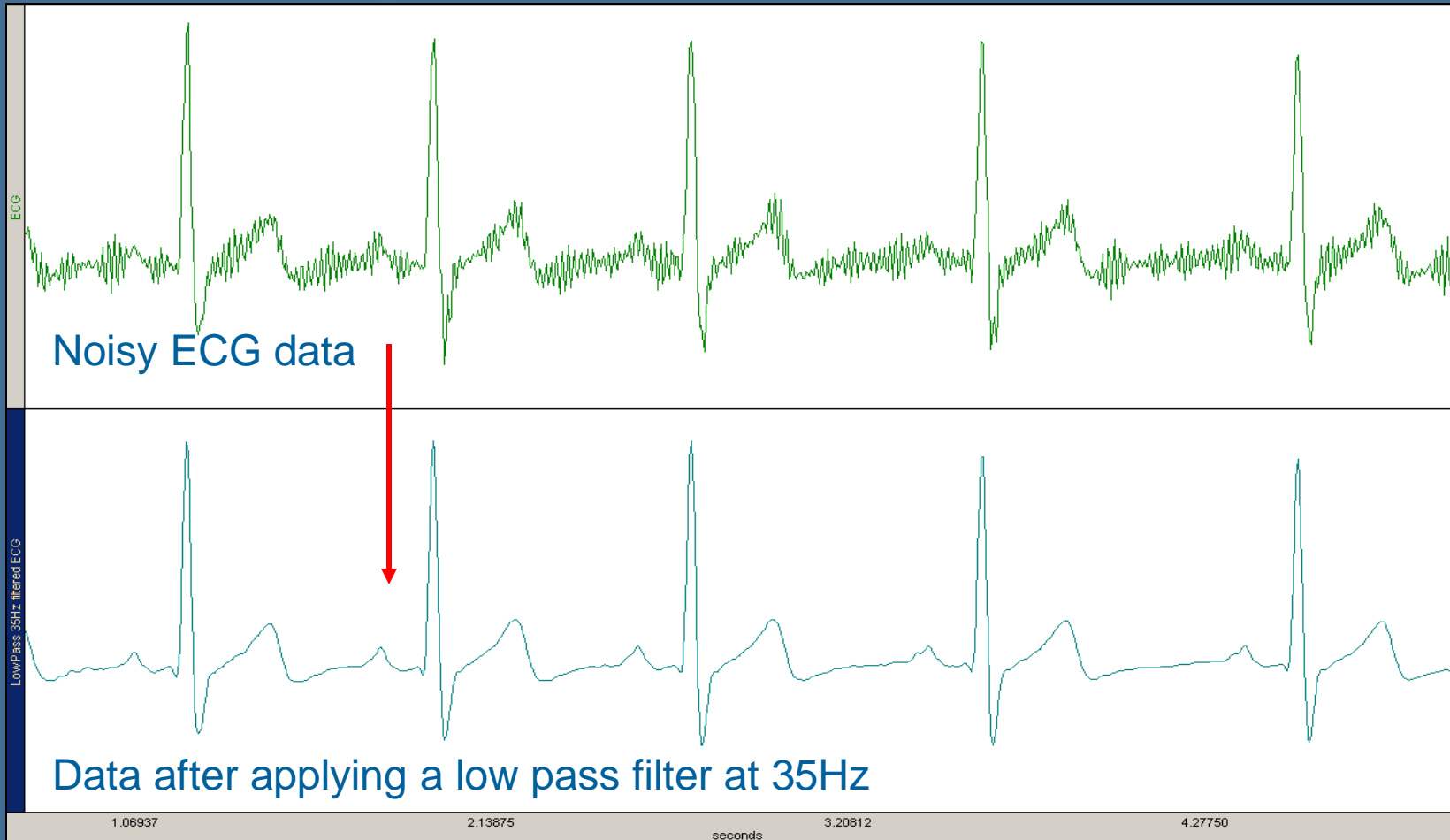


Filters: Low pass, High Pass, Band Pass, Band Stop, Notch





Filters: A practical Low Pass Filter example with ECG Part I





Filters: A practical high pass filter example with ECG Part II

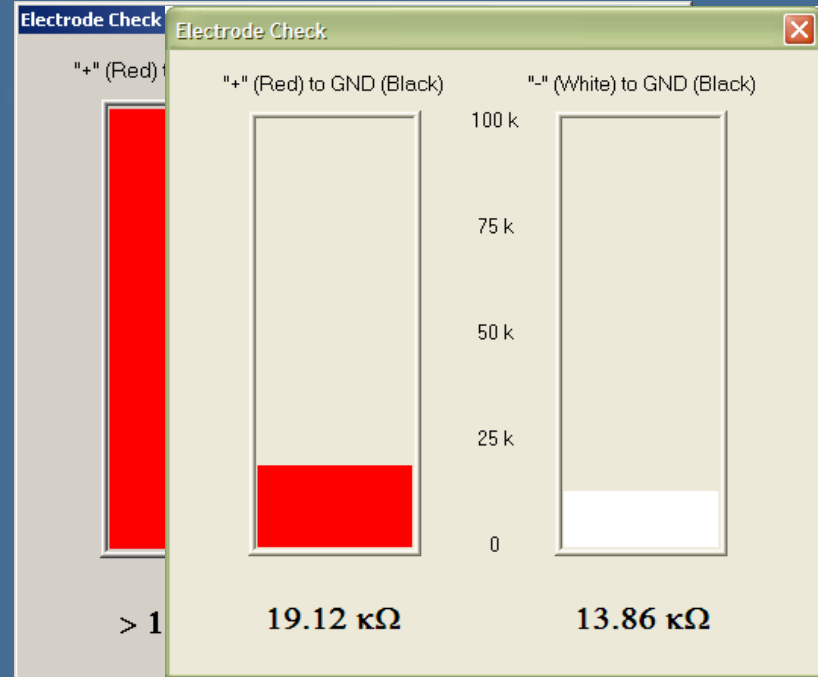




MP36R Front Panel



- Electrode check channel
 - Impedance Checker
- Status indicators
 - Busy status indicator is
 - Activated when the MP36 is acquiring data
 - Activated during self test (first few seconds after MP36 is turned on.
 - Power status indicator is illuminated when the MP36 is turned on.





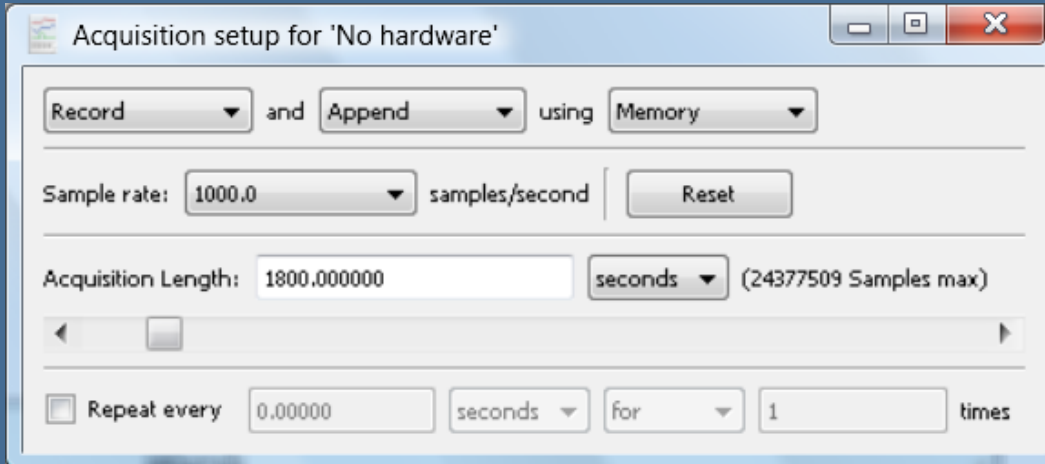
MP36 Back Panel



- Analog Out
 - Allows signals to be sent out to headphones, stimulator, etc.
- USB connection
 - Interface connection to computer.
- Headphone connection.
 - Connects a 3.5mm Stereo headphone.
- I/O Port
 - Accepts a DB 25 Female connector.
 - Input/Output port used to connect digital devices to the MP36.
- Trigger Input
 - Accepts a male BNC connector.
 - Input port used to send trigger signals from another device to the MP36.



Software Setup *Prior to Acquisition*



Acquisition setup for 'No hardware'

Record and Append using Memory

Sample rate: 1000.0 samples/second | Reset

Acquisition Length: 1800.000000 seconds (24377509 Samples max)

Repeat every 0.00000 seconds for 1 times

- **MP36 Menu**
 - **Set Up Acquisition**
 - Storage Setup
 - Sample rate: Global
 - Acquisition Length



Sampling Rate

Recommended sample rates for physiological signals

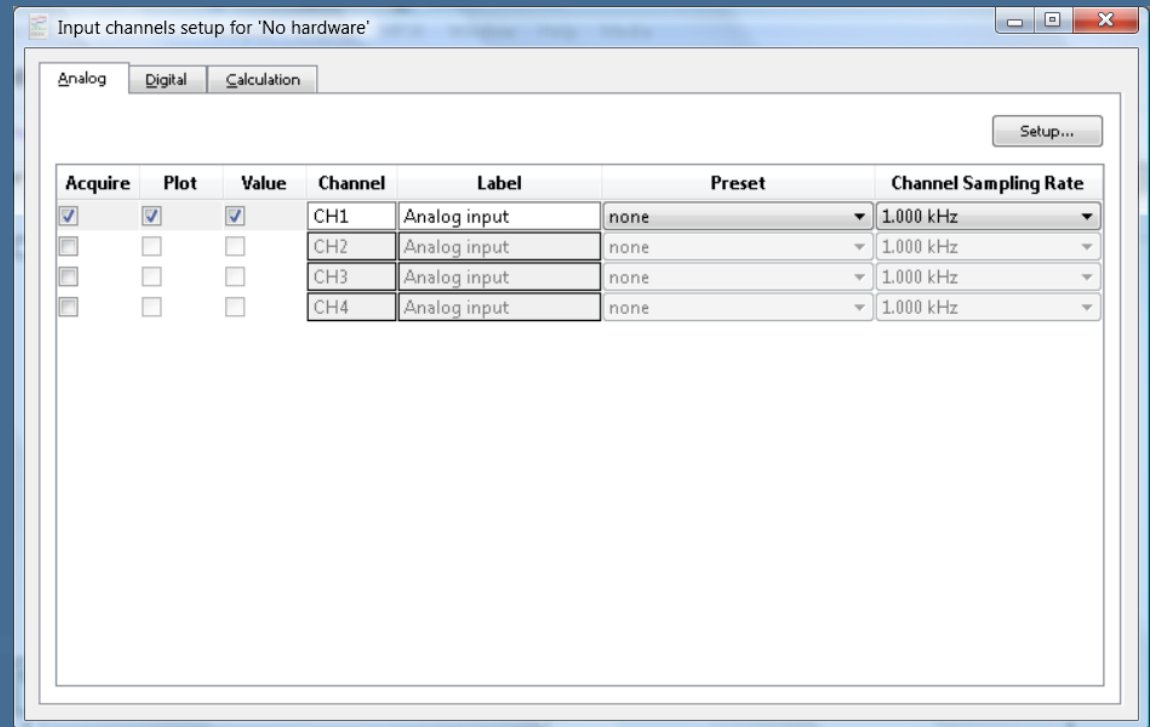
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EEG	200 Hz
EOG	200 Hz
Blood pressure	100 Hz
Flow rate	50 Hz
EKG (electrogastrogram)	1 Hz



Software Setup

Prior to Acquisition

- MP36>Set up Channels Menu
 - 4 Analog Input
 - 8 Digital input
 - 16 Calculation
 - Up to 256 when using metachannels





PRESETS

<input checked="" type="checkbox"/> none	Finger Displacement (inches)	Force (0 - 50 grams)
Default	Goniometer	Force (0 - 100 grams)
Accelerometer (5 g's max.)	Goniometer (Inteltool - Flexicomp)	Force (0 - 200 grams)
Accelerometer (50 g's max.)	Heel Toe Strike	Force (0 - 500 grams)
Airflow (SS11LA)	Microphone (SS17L, .5 - 200 Hz)	Force (0 - 1000 grams)
Airflow (SS52L)	Microphone for Speech (SS62L)	Force (iWorx FT-100)
Blood Pressure Cuff (SS19L)	MP100/150 Interface (BSLCBL14)	Nerve Response (BSLCBL3,4,9)
Blood Pressure Cuff (SS19LA)	Psychological Response	Nerve Response (BSLCBL8)
BNC (SS9L, -10 to +10 Volts max.)	Pulse Plethysmograph (PPG)	pH (BSL-TCI21)
BNC (SS9L, -50 to +50 Volts max.)	Reflex Hammer Strike	Pneumogram
BNC (SS70L, -10 to +10 Volts max.)	Reflex Hammer (Inteltool - Flexicomp)	Pressure (+-2.5 cm H2O)
Cardiac Output - Z	Respiration (SS5LB)	Pressure (+-12.5 cm H2O)
Cardiac Output - dZ/dt	Stethoscope (Heart Sounds)	Pressure (+-25 cm H2O)
Clench Force - kg (SS25LA)	Stethoscope (Korotkoff Sounds)	Tobacco Hornworm (BSLCBL8)
Clench Force - lbs (SS25LA)	Stimulator-BSLSTM (0-10 Volts)	
Clench Force - N (SS25LA)	Stimulator-BSLSTM (0-100 Volts)	
Clench Force - kgf/m ² (SS56L)	Stroboscope Flash (TSD122)	
Clench Force - kpa (SS56L)	Switch	
Clench Force - psi (SS56L)	Temperature (deg. C)	
CO2 Expired (GASSYS2)	Temperature (deg. F)	
O2 Expired (GASSYS2)	Temperature Change (deg. C)	
Electrocardiogram (ECG), .5 - 35 Hz	Temperature Change (deg. F)	
Electrocardiogram (ECG), .05 - 35 Hz	Torsiometer	
Electrocardiogram (ECG), .05 - 100 Hz, AHA	Airflow (small mouse)	
Electrocardiogram (ECG), .05 - 150 Hz	Airflow (mouse)	
Electrodermal Activity (EDA), 0 - 35 Hz	Airflow (rat/guinea pig)	
Electrodermal Activity (EDA) Change	Airflow (cat/rabbit)	
Electroencephalogram (EEG), .5 - 35 Hz	Airflow (small dog)	
Electroencephalogram (EEG), .5 - 100 Hz w/notch	Airflow (medium dog)	
Electrogastrogram (EGG)	Airflow (large dog)	
Electromyogram (EMG), 5 - 250 Hz w/notch	Blood Pressure (Arterial)	
Electromyogram (EMG), 5 - 500 Hz	Circuit Probe (Breadboard)	
Electromyogram (EMG), 5 - 1000 Hz	Current Monitor (BSLCBL10)	
Electromyogram (EMG), 30 - 250 Hz w/notch	Displacement (cm)	
Electromyogram (EMG), 30 - 500 Hz	Displacement (inches)	
Electromyogram (EMG), 30 - 1000 Hz	Displacement (AD Inst. DT-475)	
Electrooculogram (EOG), .05 - 35 Hz	Dissolved O2 (BSL-TCI16)	
Finger Displacement (cm)	Earthworm Action Potential	



CALCULATION CHANNELS

Online Transformation - Integrate

Destination: C1, Integrate setup Volts

Label:

Source channel: mV

Preset:

Option

Average over samples Reset via channel Timed reset

Control Channel:

Reset thresholds

LOW mV

HIGH mV

Reset trigger

Positive Mean subtraction

Negative Output reset events

Max cycle period sec



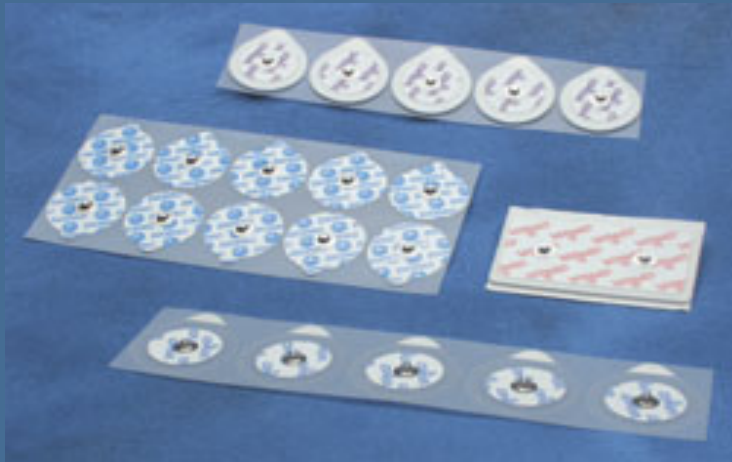
Input Devices



- Electrodes
 - attach to the surface of the skin and pick up electrical signals in the body.
- Transducers
 - convert a physical signal into a proportional electrical signal.
- Input/Output devices (I/O)
 - specialized devices like pushbutton switches and headphones.



Electrodes, Leads, and Gels





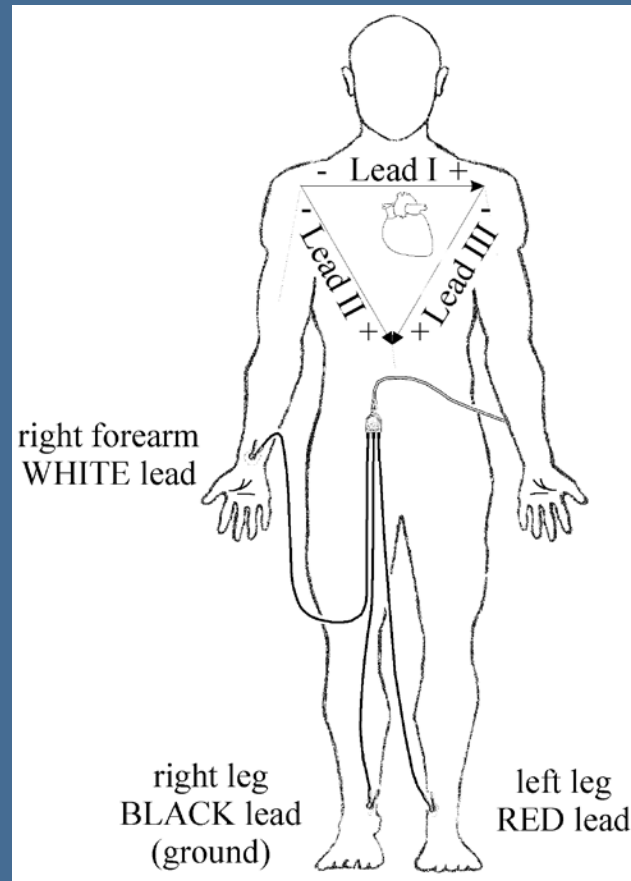
ELECTRODES AND GEL FOR ECG



- EL503 general purpose electrode
Electrodes are pre-gelled
If crystallized apply a small amount of gel
- GEL100 general purpose gel
7% saline content



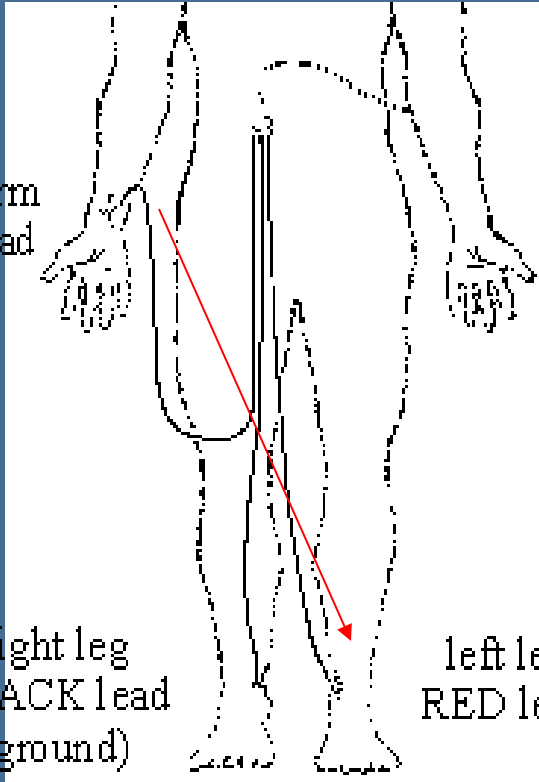
EINTHOVEN'S TRIANGLE





ECG ELECTRODE PLACEMENT OPTIONS

right forearm
WHITE lead



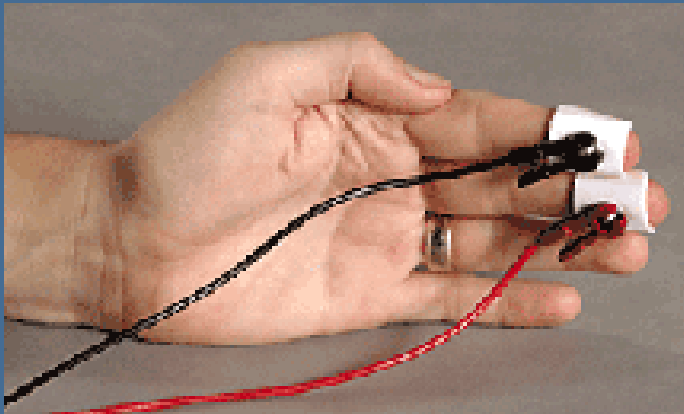
right leg
BLACK lead
(ground)

left leg
RED lead





EDA ELECTRODES AND GEL



- SS57 with EL507 Electrodes



- EL507 EDA electrode
Electrodes are pre-gelled



- GEL101 Isotonic Gel
Low saline content 0.5%



Subject Preparation

- Abrade the skin (ELPADs)
 - Not for GSR
- Electrode Gel
- Wait 5 minutes for best results
- Minimal movement
 - Use tape to provide leads strain relief
- One ground per subject!





Software Features

The screenshot shows the AcqKnowledge software interface with the following labeled components:

- MENU**: Points to the menu bar (File, Edit, Transform, Analysis, Display, MP150, Window, Help, Media).
- TOOLBARS**: Points to the toolbar containing various icons for file operations and analysis.
- HARDWARE**: Points to the 'Connect to:' dropdown menu showing 'MP150 000198'.
- MEASUREMENTS**: Points to the measurement configuration row with dropdowns for 'SC', 'Time', 'Delta T', 'Freq', 'BPM', and 'Min'.
- CHANNELS & LABEL**: Points to the 'Channel 0' label.
- EVENTS (LABELS & TOOLS)**: Points to the horizontal bar above the graph area.
- GRAPH WINDOW**: Points to the main plotting area.
- HOR. SCALE & SCROLL**: Points to the horizontal axis with time markers (0.00, 2.00, 4.00, 6.00 seconds).
- VERT. SCALE & SCROLL**: Points to the vertical axis scroll bar.
- CURSOR TOOLS**: Points to the bottom toolbar containing icons for cursor selection and zooming.
- START**: Points to the 'Start' button in the bottom toolbar.

drag-and-drop menu bars



Transform Analysis Display M

- Recently Used ▶
- Digital Filters ▶
- Fourier Linear Combiners ▶
- Math Functions ▶
- Template Functions ▶
- Integral
- Derivative...
- Integrate...
- Smoothing...
- Difference...
- Resample Waveform...
- Resample Graph...
- Expression...
- Delay...
- Rescale...
- Waveform Math...

Specialized Analysis package included

- Detect and Classify Heartbeats
- Locate ECG Complex Boundaries
- Heart Rate Variability...
- Gastric Wave Analysis...
- Gastric Wave Coupling...
- Chaos ▶
- Correlation Coefficient
- Electrodermal Activity ▶
- Electroencephalography ▶
- Electromyography ▶
- Ensemble Average
- Epoch Analysis
- Hemodynamic ▶
- Impedance Cardiography ▶
- Magnetic Resonance Imaging ▶
- Neurophysiology ▶
- Principal Component Denoising
- Remove Trend
- Respiration ▶
- Spectral Subtraction
- Stim-Response ▶
- Waterfall Plot
- Wavelet Denoising

Analysis Display MP150 Window Help

- Histogram...
- Autoregressive Modeling...
- Nonlinear Modeling...
- Power Spectral Density
- AR Time-Frequency Analysis...
- FFT...
- DWT...
- Principal Component Analysis...
- Independent Component Analysis...
- Find Cycle... Ctrl+F
- Find Next Cycle Ctrl+E
- Find All Cycles Ctrl+R
- Find Rate...

Data Analysis

- Transform and Analysis Menus
 - All post-acquisition processes
 - Offline filtering
 - Waveform math
 - Fast-Fourier Transform
 - Automated analysis
 - ‘Find Rate’ functions
 - ‘Find Cycle/Peak’ functions
 - Specialized Analysis Package
 - AcqKnowledge 4 Windows
 - AcqKnowledge 3.9 Mac
- Always duplicate waveform!!



Hints for minimizing data error

- Subject should remain as relaxed as possible
- Subject must avoid excessive extraneous movement
- Press ESC to add a marker every time you give the subject an instruction
- Add text to describe all interventions
- During comparative data analysis, ensure that all scales are the same for every channel
- Remove all jewelry or other metal objects
- Check all cable connections
- RECORD BASELINE PERIOD!

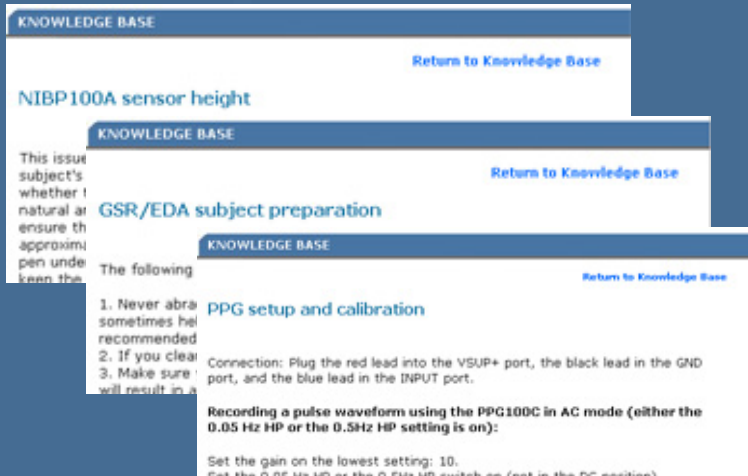


Online Resources

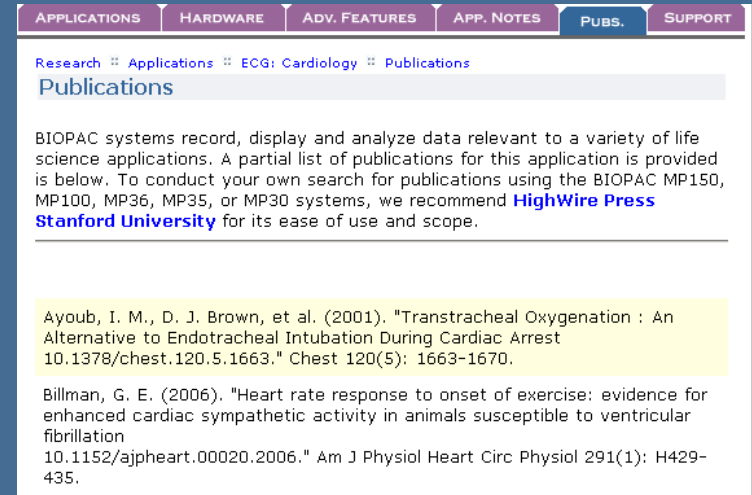
- Application notes



- Knowledge base



- Publications



- Product Resources tab

