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: 400 microvolts 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 0.024 nanovolts/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

<table>
<thead>
<tr>
<th>Signal</th>
<th>Sample Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECG</td>
<td>200 Hz (1,000 Hz for HRV)</td>
</tr>
<tr>
<td>Respiration</td>
<td>50 Hz</td>
</tr>
<tr>
<td>GSR</td>
<td>50 Hz</td>
</tr>
<tr>
<td>EMG</td>
<td>1,000 Hz to 10,000 Hz</td>
</tr>
<tr>
<td>EEG</td>
<td>200 Hz</td>
</tr>
<tr>
<td>EOG</td>
<td>200 Hz</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>100 Hz</td>
</tr>
<tr>
<td>Flow rate</td>
<td>50 Hz</td>
</tr>
<tr>
<td>EGG (electrogastrogram)</td>
<td>1 Hz</td>
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</tbody>
</table>
MP36R Front Panel

- 4 analog channels
  - Built-in universal amplifiers
  - Hardware filters
**GAIN** and typical physiological signal levels

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Signal Levels</th>
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<tbody>
<tr>
<td>Heart Potential (ECG)</td>
<td>0.5-4 mV</td>
</tr>
<tr>
<td>Brain Potential (EEG)</td>
<td>5-300 µV (scalp)</td>
</tr>
<tr>
<td>Muscle Potential (EMG)</td>
<td>0.1-5 mV</td>
</tr>
<tr>
<td>Electrooculogram (EOG)</td>
<td>50-3,500 µV</td>
</tr>
<tr>
<td>Blood Pressure: direct measurement</td>
<td>10-400 mmHg Arterial</td>
</tr>
<tr>
<td></td>
<td>indirect measurement</td>
</tr>
<tr>
<td></td>
<td>25-400 mmHg Venous, 0-50 mmHg Venous</td>
</tr>
<tr>
<td>Blood Flow</td>
<td>1-300 cc/sec.</td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>2-50 breaths/min</td>
</tr>
<tr>
<td>Pneumotachography (flow rate)</td>
<td>0-600 liter/min.</td>
</tr>
<tr>
<td>Tidal Volume</td>
<td>50-1,000 ml/breath</td>
</tr>
<tr>
<td>Galvanic Skin Response</td>
<td>1-500 kΩ</td>
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<tr>
<td>Electrogastrogram (EGG)</td>
<td>10-1,000 µV</td>
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Source: Revised from Medical Engineering, C.C. Ray (ed.) Copyright 1974 by Year Book Medical Publishers, Inc. Chicago
Filters: Low pass, High Pass, Band Pass, Band Stop, Notch

- Low Pass at 5Hz
- High Pass at 5Hz
Filters: A practical Low Pass Filter example with ECG Part I

Noisy ECG data

Data after applying a low pass filter at 35Hz
Filters: A practical high pass filter example with ECG Part II

Drifting ECG data

Data after applying a high pass filter at 1Hz
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

- MP36 Menu
  - Set Up Acquisition
    - Storage Setup
    - Sample rate: Global
    - Acquisition Length
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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 |
|-----------------|-----------------|-----------------|-----------------|
| **Default**     | **Finger Displacement (inches)** | **Force (0 - 50 grams)** |
| Accelerometer (5 g's max.) | **Goniometer** | **Force (0 - 100 grams)** |
| Accelerometer (50 g’s max.) | **Goniometer (Intellitool - Flexicom)** | **Force (0 - 200 grams)** |
| Airflow (SS11L) | **Heel Toe Strike** | **Force (0 - 500 grams)** |
| Airflow (SS52L)  | **Microphone (SS17L, 5 - 200 Hz)** | **Force (0 - 1000 grams)** |
| Blood Pressure Cuff (SS10L) | **Microphone for Speech (SS62L)** | **Force (Wors FT-160)** |
| Blood Pressure Cuff (SS19L) | **MP100/150 Interface (BSL-CBL14)** | **Nerve Response (BSL CBL3, 4, 9)** |
| BNC (SS3L, -10 to +10 Volts max.) | **Psychological Response** | **Nerve Response (BSL CBL6)** |
| BNC (SS9L, -50 to +50 Volts max.) | **Pulse Plethysmograph (PPG)** | **pH (BSL-TC21)** |
| BNC (SS70L, -10 to +10 Volts max.) | **Reflex Hammer Strike** | **Pneumogram** |
| Cardiac Output - Z | **Reflex Hammer (Intellitool - Flexicom)** | **Pressure (+2.5 cm H2O)** |
| Cardiac Output - dZ/dt | **Respiration (SS58L)** | **Pressure (+12.5 cm H2O)** |
| Clench Force - kg (SS25L) | **Stethoscope (Heart Sounds)** | **Pressure (+25 cm H2O)** |
| Clench Force - lbs (SS25L) | **Stethoscope (Korotkoff Sounds)** | **Tobacco Hornworm (BSL CBL8)** |
| Clench Force - N (SS25LA) | **Stimulator-BSLSTM (0-10 Volts)** | |
| Clench Force - kgf/m^2 (SS56L) | **Stimulator-BSLSTM (0-100 Volts)** | |
| Clench Force - kpa (SS56L) | **Stroboscope Flash (TSD122)** | |
| Clench Force - psi (SS56L) | **Switch** | |
| CO2 Expired (GASSYS2) | **Temperature (deg. C)** | |
| O2 Expired (GASSYS2) | **Temperature (deg. F)** | |
| Electrocardiogram (ECG), .5 - 35 Hz | **Temperature Change (deg. C)** | |
| Electrocardiogram (ECG), .05 - 35 Hz | **Temperature Change (deg. F)** | |
| Electrocardiogram (ECG), .05 - 100 Hz, AHA | **TorsoMeter** | |
| Electrocardiogram (ECG), .05 - 150 Hz | **Airflow (small mouse)** | |
| Electrodermal Activity (EDA), 0 - 35 Hz | **Airflow (mouse)** | |
| Electrodermal Activity (EDA) Change | **Airflow (rat/guinea pig)** | |
| Electroencephalogram (EEG), 5 - 35 Hz | **Airflow (cat/rabbit)** | |
| Electroencephalogram (EEG), 5 - 100 Hz w/notch | **Airflow (small dog)** | |
| Electroencephalogram (EEG) | **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 (BSL CBL10)** | |
| 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-TC116)** | |
| Finger Displacement (cm) | **Earthworm Action Potential** | |
CALCULATION CHANNELS
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
• 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

right forearm
WHITE lead

right leg
BLACK lead
(ground)

left leg
RED lead

Lead I

Lead II

Lead III
ECG ELECTRODE PLACEMENT OPTIONS

- Right forearm (WHITE lead)
- Right leg (BLACK lead)
- Left leg (RED lead)
- Lead II Vector
EDA ELECTRODES AND GEL

- SS57 with EL507 Electrodes
- GEL101 Isotonic Gel
  Low saline content 0.5%
- EL507 EDA electrode
  Electrodes are pre-gelled
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
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

BIOPAC systems record, display and analyze data relevant to a variety of life science applications. A partial list of publications for this application is provided below. To conduct your own search for publications using the BIOPAC MP150, MP160, MP36, MP35, or MP30 systems, we recommend HighWire Press Stanford University for its ease of use and scope.
