BMT-010

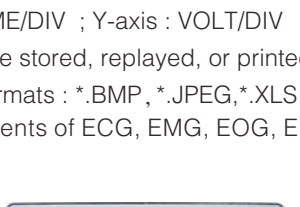
Biomedical Measurement Training System

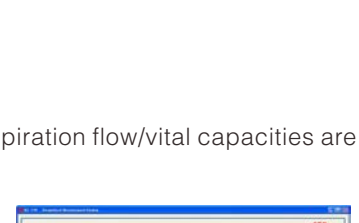
The Biomedical Measurement Training System provides a platform for students to learn how to extract various body signals using bio-electronics sensors. There are a total of 12 modules covering a variety of topics, including: Electrocardiogram (ECG), Electromyogram (EMG), Electrooculogram (EOG), Electroencephalogram (EEG), Blood pressure (BP), Photoplethysmogram (PPG), Respiratory ventilation detection, Pulse meter measurement, Body impedance detection, Doppler ultrasound blood velocity measurement, and Respiration flow/vital capacity meter measurement.

Through the system, students can construct a circuit to process and convert signals into readable forms for further observation and analysis. Also, hands-on practices and experiments allow students to understand the characteristics of various bio-electronics sensors and transducers.

Features

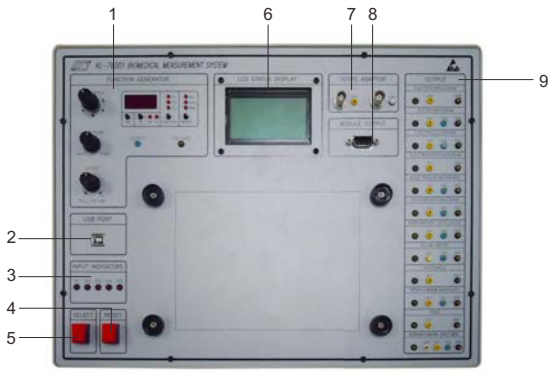
1. There are test points for adjustment of frequency bandwidth and amplifier gain, allowing students to learn the relationship between a circuit and a corresponding signal on each processing stage.
2. The system consists of several bio-electronics sensors and transducers, including pressure transducers, infrared photocouplers, strain gauges, temperature sensors, surface electrodes, dual element transducers, and pneumotach transducers.
3. Display and storage of signals
   The main unit of the system has a 128 x 64 LCD graphic display to show the real-time physiological parameters. Physiological signals can be displayed on a digital storage oscilloscope (DSO).
4. With embedded 10-bit A/D converters (2.4 Kbits/s), physiological signals can be converted to digital forms and transmitted to computers in real-time via a USB port.
5. Graphic user interface software
   a. Communication port : USB
   b. Physiological signal can be analyzed after connection
   c. Easy operation
   d. X-axis : TIME/DIV ; Y-axis : VOLT/DIV
   e. Data can be stored, replayed, or printed
   f. Storage formats : *.BMP, *.JPEG,*.XLS
   g. Measurements of ECG, EMG, EOG, EEG, blood pressure, respiration flow/vital capacities are available for analysis.





Specifications

Main Unit



KL-76001

1. Function Generator
   a. Output Waveform : Sine, Square, and Triangle.
   b. Frequency Range: 0.01 Hz ~ 1MHz, continuously adjustable
   c. Amplitude Range : 50 mVpp ~ 18 Vpp (open circuit)
   d. DC Offset : - 10V to + 10V
   e. Display : 4-digit,7-segment display
2. Interface Port
   USB Interface : Type B
3. Input Indicators
   IN1、IN2、IN3、IN4、IN5 LEDs, indicating the corresponding connection for students when conducting experiments of ECG, EMG, EOG, EEG and body impedance.
4. Reset Switch
   for MCU reset
5. Select Switch
   for selection of the modules
6. LCD Status Display
   a. Display the output frequency of the function generator
   b. Display the module selected
   c. Display Heart Rates (KL-75006), Respiration (KL-75007), Pulse Rates (KL-75008) and Doppler Ultrasound Blood(KL-75010).
7. BNC Adaptor Connector
   for 2mm sockets / BNC sockets
8. Module Output
   DB9 connector
9. Output
   a. Electrocardiogram (ECG) : 1 output
   b. Electromyogram (EMG) : 2 outputs
   c. Electrooculogram (EOG) : 2 outputs
   d. Electroencephalogram (EEG) : 1 output
   e. Blood pressure measurement : 2 outputs
   f. Photoplethysmogram : 2 outputs
   g. Respiratory ventilation : 2 outputs
   h. Pulse meter : 2 outputs
   i. Impedance : 1 output
   j. Doppler Ultrasound Blood Velocity : 2 outputs
   k. TENS : 1 output
   l. Respiration Flow/Vital Capacity Meter : 2 outputs

Module Units

Electrocardiogram ECG Module

Feature:

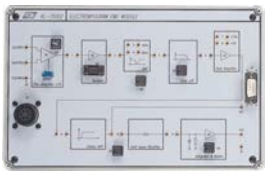
Understand the potential phenomenon when the heart beats. This measurement module uses 6 limb leads to detect the electrocardiogram. With the explicit experimental procedure, students can easily learn how to design the Wilson network and the isolated circuits.

Specifications	List of Experiments	Equipment Required
1. Limb lead inputs 2. Limb electrode 3. 6 limb leads : Lead I, Lead II, Lead III, aV R, aV L, aV F 4. Isolation circuit 5. Gain : 100~5000 6. Band-pass filter : 0.1~100 Hz 7. 1 output ECG signal	1. HPF Characteristic Experiment 2. Amplifier Experiment 3. LPF Characteristic Experiment 4. BRF Characteristic Experiment 5. ECG Simulator Experiment (Optional) 6. ECG Experiment	1. Main Unit 2. Electrocardiogram Module 3. Digital Storage Oscilloscope (Option) 4. Lead Clamp - ⑥ 5. Electrode Lead - ⑰ 6. 5-Conductor Electrode Cable - ⑱ 7. Alcohol Prep. Pad - ⑪ 8. Trimmer 9. Connection Leads - ⑳ 10. 2mm Bridging Plug - ㉑ 11. 2mm Terminal - ㉒ 12. KL-79106 ECG Simulator (Option)

Electromyogram EMG Module

Feature:

Understand the electrical activity of muscle under the isotonic and isometric conditions and simultaneously detect the amount of muscle force. From the measured waveform, students can realize the motion function made by the specific skeletal muscle.

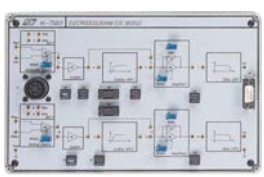


Specifications	List of Experiments	Equipment Required
1. Surface electrode 2. Gain : x 1000, x 2000 3. Isolation circuit 4. Band-pass filter : 100 ~1000 Hz 5. 2 outputs a. Electromyogram signal b. Muscle force signal	1. BRF Characteristic Experiment 2. LPF Characteristic Experiment 3. Gain Amplifier Experiment 4. HPF Characteristic Experiment 5. Half-Wave Rectifier Characteristic Experiment 6. Integrator Characteristic Experiment 7. EMG Experiment	1. Main Unit 2. Electromy ogram Module 3. Digital Storage Oscilloscope (Option) 4. Body Surface Electrodes - ⑧ 5. Electrode Lead -⑰ 6. 5-Conductor Electrode Cable - ⑱ 7. Alcohol Prep. Pad - ⑪ 8. Dumbbell - ① 9. Trimmer 10. Connection Leads - ⑳ 11. 2mm Bridging Plug - ㉑ 12. 2mm Terminal - ㉒

Electrooculogram EOG Module

Feature:

Have a thorough grasp of the electrical activity of the eye muscle under eye movements. Two kinds of electrical signals from horizontal and vertical movements of the eyeball are detected and processed in the module.

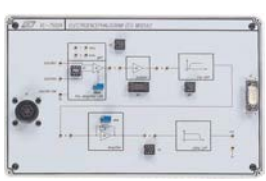


Specifications	List of Experiments	Equipment Required
1. Surface electrode 2. Gain : 5~3000 3. Isolation circuit 4. Band-pass filter : 0.05~30 Hz 5. 2 outputs a. Horizontal signal b. Vertical signal	1. Horizontal & Vertical Electro Circuit Calibration Experiment 2. BRF Characteristic Experiment 3. HPF Characteristic Experiment 4. Amplifier Experiment 5. LPF Characteristic Experiment 6. EOG Experiment	1. Main Unit 2. Electrooculogram Module 3. Digital Storage Oscilloscope (Option) 4. Bo dy Surface Electrodes - ⑧ 5. Electrode Lead -⑰ 6. 5-Conductor Electrode Cable -⑱ 7. Alcohol Prep. Pad - ⑪ 8. Trimmer 9. Connection Leads - ⑳ 10. 2mm Bridging Plug - ㉑ 11. 2mm Terminal - ㉒

Electroencephalogram EEG Module

Feature:

Understand the electrical activity of the brain. In the experimental procedure, the α-wave will be evoked when the eyes open and close. Because the EEG signal is very weak, this module implements a high gain amplifier and filters to reduce noise.

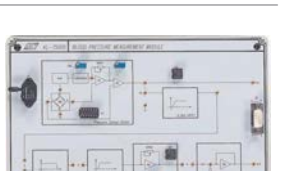


Specifications	List of Experiments	Equipment Required
1. EEG electrode 2. Gain : 50~5000 3. Isolation circuit 4. Band-pass filter : 1~20 Hz 5. 1 output EEG signal	1. Pre-Amplifier Calibration Experiment 2. BRF Characteristic Experiment 3. HPF Characteristic Experiment 4. Amplifier Experiment 5. LPF Characteristic Experiment 6. EEG Experiment	1. Main Unit 2. Electroencephalogram Module 3. Digital Storage Oscilloscope (Option) 4. EEG Electrode -⑯ 5. 5-Conductor Electrode Cable - ⑱ 6. Alcohol Prep. Pad -⑪ 7. Electrical Conductivity Jelly - ② 8. Medical Tape - ⑩ 9. Elastic Head Bandage - ⑨ 10. Trimmer 11. Connection Leads -⑳ 12. 2mm Bridging Plug - ㉑ 13. 2mm Terminal - ㉒ 14. EEG Simulator (Option)

Blood Pressure Measurement Module

Feature:

Realize how to measure the blood pressure noninvasively and compare the accuracy between the measurement from the auscultator and from the oscilloscope. In this experiment, students know the way to calibrate the pressure transducer directly and indirectly.

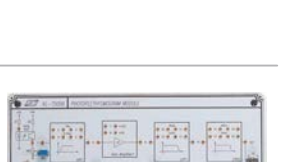


Specifications	List of Experiments	Equipment Required
1. Pressure transducer: a. Differential pressure model b. Pressure range : 0~5 psid c. Accuracy : 0.5 % d. Input impedance : 5KΩ 2. Pressure calibration circuit 3. Gain amplifier : 20~800 4. Band-pass filter : 0.3~3 Hz 5. 2 outputs a. Cuff pressure signal b. Oscillometric pulse signal	1. Pressure Sensor Calibration Experiment 2. HPF1 Characteristic Experiment 3. LPF Characteristic Experiment 4. HPF2 & Amplifier Characteristic Experiment 5. Rectifier Characteristic Experiment 6. Auscultatory Blood Pressure measurement Experiment 7. Oscillometric Blood Pressure Measurement Experiment	1. Main Unit 2. Blood Pressure Measurement Module 3. Digital Storage Oscilloscope (Option) 4. Mechanical Sphygmomanometer - ④ 5. Trimmer 6. Connection Leads - ⑳ 7. 2mm Bridging Plug - ㉑ 8. 2mm Terminal - ㉒

Photoplethysmogram Module

Feature:

Understand how to use the noninvasive method and configure the circuit to detect and process the Plethysmogram. The volume change in blood capillary is detectable by an infrared photocoupler.

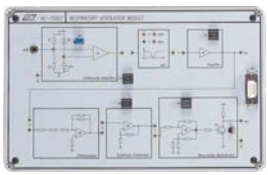


Specifications	List of Experiments	Equipment Required
1. Infrared light-emitting diode a. Rated forward current IF = 60 mA b. Rated reverse voltage VR = 4 V c. Peak wavelength λp = 880 nm d. Δθ = ±53 deg 2. Phototransistor a. Rated C-E voltage VCEO = 20 V b. Rated collector power Pc = 75 mW c. Peak wavelength λp = 800 nm d. Δθ = ±50 deg. 3. Gain : x 50~500, x 100~1000 4. Band-pass filter : 0.3~40 Hz 5. 2 outputs a. Plethysmogram signal b. Heart rate pulse	1. Infrared Photocoupler Calibration Experiment 2. HPF Characteristic Experiment 3. Gain Amplifier Experiment 4. 4th-order LPF Characteristic Experiment 5. Differentiator Experiment 6. Amplifier Experiment 7. Comparator Experiment 8. Monostable Multivibrator Experiment 9. Photoplethysmogram Measurement Experiment	1. Main Unit 2. Photoplethysmogram Module 3. Digital Storage Oscilloscope (Option) 4. Infrared Photocoupler Sensor - ⑬ 5. Trimmer 6. Connection Leads - ⑳ 7. 2mm Bridging Plug - ㉑ 8. 2mm Terminal - ㉒

Respiratory Ventilation Module

Feature:

After practicing using temperature sensors and configuring circuits, users can understand how to detect and process respiratory signals including stop breathing capacity, over-respiration, and respiratory rate.

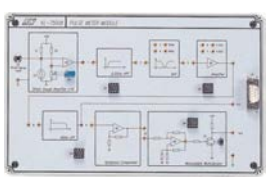


Specifications	List of Experiments	Equipment Required
1. Temperature sensor a. Thermister : 5KΩ (at 25°C) b. Tolerance : ± 5% 2. With temperature compensation circuit 3. Gain : 20 4. 2 outputs a. Pneumograph signal b. Respiratory rate pulse	1. Differential Amplifier Calibration Experiment 2. BRF Characteristic Experiment 3. Amplifier Experiment 4. Differentiator Experiment 5. Hysteresis Comparator Experiment 6. Monostable Multivibrator Experiment 7. Respiratory Ventilation Detection Experiment	1. Main Unit 2. Respiratory Ventilation Module 3. Digital Storage Oscilloscope (Option) 4. Temperature Sensor Mask - ⑦ 5. Trimmer 6. Alcohol Prep. Pad - ⑪ 7. Connection Leads - ⑳ 8. 2mm Bridging Plug - ㉑ 9. 2mm Terminal - ㉒

Pulse Meter Module

Feature:

Understand how to use the strain gauge and configure the circuit to detect and process the waveforms of the radial pulse and learn the characteristics the vascular under various transmural pressure conditions.



Specifications	List of Experiments	Equipment Required
1. Strain gauge 5 mm grid, 120Ω 2. Gain : x 2500, x 5000 3. Band-pass filter : 0.05 ~ 40 Hz 4. 2 outputs a. Pulse wave b. Heart rate pulse	1. Strain Gauge Amplifier Calibration Experiment 2. HPF Characteristic Experiment 3. BRF Characteristic Experiment 4. Gain Amplifier Experiment 5. LPF Characteristic Experiment 6. Hysteresis Comparator Experiment 7. Monostable Multivibrator Experiment 8. Pulse Meter Experiment 9. Arterial Vessel Experiment	1. Main Unit 2. Pulse Meter Module 3. Digital Storage Oscilloscope (Option) 4. Strain Gauge Tie - ⑫ 5. Wrist-type Cuff - ⑤ 6. Mechanical Sphygmomanometer - ④ 7. Trimmer 8. Connection Leads - ⑳ 9. 2mm Bridging Plug - ㉑ 10. 2mm Terminal - ㉒

Impedance Module (People with cardiac pacemaker must avoid using this module)

Feature:

Realize how to detect the body impedance. When students Inject a constant alternating current to the body and the alternating current passes through the chest, a change of body impedance will be detected when the chamber volume of both the ventricle and atrium is changed.

Specifications	List of Experiments	Equipment Required
1. Band-pass filter : 0.1~10Hz 2. Sine wave generator circuit : 50 KHz 3. Surface electrode 4. Isolation circuit 5. Gain : x 1250, x 2500 6. With overcurrent protection and reset circuits 7. 1 output Body impedance signal	1. Pre-Amplifier Calibration Experiment 2. BRF Characteristic Experiment 3. Wien-Bridge Oscillator Experiment 4. HPF Characteristic Experiment 5. Demodulator Experiment 6. Gain Amplifier Experiment 7. LPF Characteristic Experiment 8. Impedance Detection Experiment	1. Main Unit 2. Impedance Module 3. Digital Storage Oscilloscope (Option) 4. Body Surface Electrodes - ⑧ 5. Electrode Lead - ⑰ 6. 5-Conductor Electrode Cable - ⑱ 7. Alcohol Prep. Pad - ⑪ 8. Trimmer 9. Connection Leads - ⑳ 10. 2mm Bridging Plug - ㉑ 11. 2mm Terminal - ㉒

Doppler Ultrasound Blood Velocity Module

Feature:

Understand the operating principles of ultrasonic sensors, how the ultrasound probe measures the velocity of blood flow, and the fundamental circuit theory of the ultrasound probe.

Specifications	List of Experiments	Equipment Required
1. Dual Element Transducer Frequency : 5MHz 2. Gain : 16~100 3. Band-pass filter : 1~40Hz 4. 2 Outputs a. Plethysmogram signal b. Heart rate pulse	1. OSC Experiment 2. Pre-Amplifier Experiment 3. Demodulation Experiment 4. HPF Characteristic Experiment 5. Amplifier Experiment 6. LPF Characteristic Experiment 7. Comparator Experiment 8. Monostable Multivibrator Experiment	1. Main Unit 2. Doppler ultrasound blood velocity module 3. Digital Storage Oscilloscope (Option) 4. Dual Element Transducers Sensor - ㉓ 5. Trimmer 6. Alcohol Prep. Pad - ⑪ 7. Connection Leads - ⑳ 8. 2mm Bridging Plug - ㉑ 9. 2mm Terminal - ㉒ 10. Electrical conductivity jelly - ②

TENS Module (People with cardiac pacemaker must avoid using this module)

Feature:

Understand the fundamental circuit theory of the transcutaneous electrical nerve stimulation (TENS) and the physiological responses of muscles which are stimulated by different frequencies and amplitudes.

Specifications	List of Experiments	Equipment Required
1. Electrode lead 2. 1 Output 555 Timer-Astable signal a. Frequency Adjust : 25~115Hz b. Duty Cycle : 91~98%	1. 555 Timer-Astable Experiment 2. Transistor Switch Circuit Experiment 3. Transistor Bias Circuit Experiment	1. Main Unit 2. TENS module 3. Digital Storage Oscilloscope (Option) 4. Body surface electrodes - ⑭ 5. Electrode lead (for KL-75011) - ⑮ 6. Connection Leads - ⑳ 7. 2mm Bridging Plug - ㉑ 8. 2mm Terminal - ㉒

Respiration Flow / Vital Capacity Meter Module

Feature:

Understand the respiratory parameters (including the respiratory volume and respiratory flow) and the measurement of the basic circuit.

Specifications	List of Experiments	Equipment Required
1. Pneumotach transducer a. Excitation voltage : 6V b. Flow range: 2-35 L/min c. Resolution : 700P/L d. Maximum operation pressure : 25 Bar 2. 2 Outputs a. Respiration flow signal b. Counting pulse	1. Hall & Differential Experiment 2. Frequency to Voltage Experiment 3. Comparator Experiment 4. AND Gate Experiment 5. Decade Counter Experiment 6. Decoder Experiment 7. 7-Segment Experiment	1. Main Unit 2. Respiration flow/Vital capacity meter module 3. Digital Storage Oscilloscope (Option) 4. Respiration transducer - ⑲ 5. Trimmer 6. Connection Leads - ⑳ 7. 2mm Bridging Plug - ㉑ 8. 2mm Terminal - ㉒

The Features of the Experiment Modules

1. All terminals on the module are connectable with 2mm plugs.
2. Circuit symbols, blocks, and components are printed on the surface of each module.
3. Modules are secured in plastic housings.
4. Dimension : 255x165x30mm ± 10%
5. Comprehensive experiment and instructor's manuals are provided.

Digital Storage Oscilloscope

ECG simulator
(Pathological Signals

EEG simulator

Accessories

Optional Accessories

1. Digital Storage Oscilloscope (DSO)
2. KL-79106 ECG simulator
3. EEG simulator

Consumables

1. Electrical conductivity jelly
2. Body surface electrode
3. Alcohol prep pad
4. Elastic head bandage
5. Temperature sensor mask
6. Medical tape
7. Body surface electrode

Standard Accessories

① Dumbbell
② Electrical conductivity jelly
③ Accessory box
④ Mechanical sphygmomanometer
⑤ Wrist-type cuff
⑥ Lead clamp
⑦ Temperature sensor mask
⑧ Body surface electrodes
⑨ Elastic head bandage
⑩ Medical tape
⑪ Alcohol prep pad

- Strain gauge tie
- Infrared photocoupler sensor
- Body surface electrode
- Electrode lead
- EEG electrode
- Electrode lead
- 5-conductor electrode cable
- Respiration transducer
- Connection leads

㉑ 2mm bridging plug
㉒ 2mm terminal
㉓ Dual Element transducer