INTRODUCTION

0.1 SYSTEM INTRODUCTION

All different biomedical experiments are designed with the concept of "modules working with one main unit". The design of experiment comes from basic theories and allows users to practice hands-on measurements. The main objective of manuals is to help users to have more understanding of human physiology and biomedical measurement. Further, the present manual is a valuable reference for those who would like to learn biomedical electronics.

System Features

1. This training equipment is designed for learning basic theory and circuit design of physiological measurements. Through practical operations and verifications, students will become more familiar with biomedical transducers.

2. KL-720 contains nine measurement modules, including oscillometric blood pressure measurement, vessel volume measurement, body impedance measurement, pulse measurement, respiration frequency measurement, electroencephalogram (EEG) measurement, electrocardiogram (ECG) measurement, electromyogram (EMG) measurement and electro-oculogram (EOG) measurement.

3. Transducers used for the experiments are the piezoelectrical transducer, the photocoupler sensor, the thermal sensor, and the various surface electrodes.

4. There are several checkpoints designed on individual measurement modules. Each module allows users to conveniently change the gain and bandwidth of the measurement system, which helps students to understand the original biomedical signals and the relationship between two circuit stages.

5. There are multiple display modes for the output of signals:

   a. A 128×64 liquid crystal display (LCD) on the Main Unit can calculate and show the specific physiological variables (e.g., the heart rate and respiratory frequency) on real time.

b. The analog signal can immediately be displayed, printed out, or transferred to a computer for further processing with a digital storage oscilloscope.

c. The build-in 10-bit A/D converter can convert the analog to digital signal and transfer it to a computer through RS-232 interface. Then, the digital signal can be analyzed and stored in computer.

6. Graphic User interface (GUI) software:

a. Computer interface: RS-232C.

b. Automatic recognition of biomedical signal measurement after proper connection.

c. Easy to operate.

d. X-axis is TIME/DIV and Y-axis is VOLT/DIV.

e. Signals can be saved, read and stored. Data can be saved in the formats of .BMP, .JPEG and .XLS.

f. Analysis Software (optional) can analyze the data of ECG, EMG, EOG, EEG and blood pressure measurement offline.

0.2 SPECIFICATION

A. Specification of KL-72001 Main Unit

1. FUNCTION GENERATOR section

   a. Output Waveform: Sine, Square, Triangle

   b. Frequency range: 0.1 Hz ~ 10K Hz, 5 ranges, continuously adjustable

   c. Amplitude range: 30m Vpp ~ 18 Vpp (no load)

2. RS232 OUTPUT section

   a. Communication Protocol: 9600 bps, 2 start bits, 8 data bits, 1 stop bit

   b. DB9 Connector

3. INPUT INDICATORS section

   Input indicator LEDs used to guide the user to connect the sensor to the inputs (1N1, 1N2, 1N3, 1N4, 1N5) in ECG, EMG, EOG, EEG, and Body Impedance experiments.

4. LCD STATUS DISPLAY section

   a. Display the frequency of Function Generator

b. Display measurement modules:

ECG, EMG, EOG, EEG, BPM (Blood Pressure Measurement), PPG (Photoplethysmogram), RVR (Respiratory Ventilation), PM (Pulse Meter), IMP (Impedance).

c. Display Heart Rate (KL-75006), Respire (KL-75007), and Pulse Rate (KL-75008)

5. SCOPE ADAPTOR section

a. CH1 and CH2 inputs of oscilloscope

b. Both BNC connector and 2-mm plug provided

6. MODULE OUTPUT section

DB9 Connector

7. OUTPUT section

a.	Electrocardiogram (ECG):	1 output
b.	Electromyogram (EMG):	2 outputs
c.	Electro-oculogram (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

8. With RESET and SELECT control buttons

B. Module Specification (KL-75001 ~ KL-75009)

KL-75001: Electrocardiogram (ECG) Measurement

Objective: The module helps students to discover the electrical activity generated during the cardiac pumping cycle. The waveform related to the periodically varying potential is called electrocardiogram (ECG). The module includes Wilson network design and isolation circuit design concepts. It can be used to measure six different ECG signals.

Specification:

1. Limb lead inputs
2. Limb electrode
3. Six limb leads : Lead I, 、Lead II, 、Lead III, 、aVR, aVL, aVF
4. Isolation circuit
5. Gain:　100~5000
6. Band-Pass Filter　: 0.1~100 Hz
7. One output
   ECG signal

KL-75002: Electromyogram (EMG) Measurement

Objective: The module helps students to have an insight into the changes of electrical potential during different muscular activities, including the isotonic and isometric contractions. Besides, the module can be used to measure the force of muscle in a special condition from different testing points. This offers an opportunity to recognize an exclusive action performed by a certain skeletal muscle.

Specification:

1. Surface electrode
2. Gain　　　　　　　:　x 500,　x 1000
3. Isolation circuit
4. Band-Pass Filter　: 100 ~1000 Hz
5. Two outputs
   a. Electromyogram signal b. Muscle force signal

KL-75003: Electrooculogram (EOG) Measurement

Objective: The module helps students to learn the electrical change of the muscles which control eye-movement. In addition, we can measure the electrical potential of ocular muscle when there is horizontal or vertical eye-movement.

Specification:

    1. Surface electrode

    2. Gain   : 5~3000

    3. Isolation circuit

    4. Band-Pass Filter   : 0.05~30 Hz

    5. Two outputs

        a. Horizontal signal

        b. Vertical signal

KL-75004: Electroencephalogram (EEG) Measurement

Objective: The module helps students to be familiar with the electrical activity in human brain. The subjects electroencephalogram (EEG) as well as the effect of visual stimulation on the α wave can be measured. Because EEG signals are very weak, the module uses a high-gain amplifier to avoid the oscillation usually existing in a circuit with high amplification.

Specification:

    1. EKG electrode

    2. Gain   : 50~5000

    3. Isolation circuit

    4. Band-Pass Filter   : 1~20 Hz

    5. One output

        EEG signal

KL-75005: Oscillometric Blood Pressure Measurement

Objective: The module helps students to understand the blood pressure measurement with noninvasive methods. Here, two methods of measurement are compared: traditional stethoscope and modern oscillometric meter. Through the practical works, students can not only learn the piezoelectric characteristic of pressure sensor, but also the direct and indirect calibration methods of blood pressure.

Specification:

1. Pressure transducer:

    a. Differential Pressure Model

    b. Pressure range   : 0~5 psid

    c. Accuracy   : 0.5 %

    d. Input impedance   : 5KΩ

2. Two outputs

3. Pressure calibration circuit

4. Gain Amplifier

5. Band-Pass Filter : 0.3~3 Hz

6. Two outputs

    a. Cuff pressure signal

    b. Oscillometric pulse signal

KL-75006: Vessel Volume Measurement

Objective: The module helps students to learn how to use an infrared photo-coupler to detect the small change of diameter of artery in a finger. In other words, it's the non-invasive measurement of vessel volume. Furthermore, students can comprehend how to properly place the finger on sensor for signal detecting.

Specification:

1. Infrared Light-Emitting Diode

    a. Rated Forward Current

        I_F = 60 mA

    b. Rated Reverse Voltage

        V_R = 4 V

    c. Peak Wavelength

        λ_p = 880 nm

    d. $\Delta\theta$ = ±53 deg

2. Phototransistor

    a. Rated C-E Voltage

        V_{CEO} = 20 V

    b. Rated Collector Dissipation

        P_c = 75 mW

c. Peak Wavelength

λp = 800 nm

d. $\Delta\ \theta$ = ±50 deg.

3. Gain: x 50~500,   x 100~1000

4. Band-Pass Filter   :   0.3~40 Hz

5. Two outputs

a. Plethysmogram signal

b. Heart rate pulse

KL-75007: Respiratory Frequency Measurement

Objective: The module teaches students to apply the measurement of various respiratory activities, including breath-holding ability, excessive ventilation, and respiratory frequency measurements. In addition, students will learn how to use a thermal sensor to detect the temperature.

Specification:

1. Temperature sensor

a. Thermister :   5KΩ (at 25°C)

b. Tolerance : $\pm$ 5%

2. With Temperature Compensation Circuit

3. Gain   :   20

4. Two outputs

a. Pneumograph signal

b. Respiratory rate pulse

KL-75008: Pulse Measurement

Objective: The module helps students to learn how to use a strain gauge to sense arterial pulse. For measurement, the strain gauge needs to be appropriately placed on a superficial radial artery.

Specification:

1. Strain gauge

5 mm grid, 120 ohms

2. Gain: x 2500, x 5000

3. Band-Pass Filter   :   0.05 ~ 40 Hz

4. Two outputs

   a. Pulse wave

   b. Heart rate pulse

KL-75009: Body Impedance Measurement

(※ Caution! People with a cardiac pacemaker must avoid this experiment.)

Objective: The module teaches students how to measure body impedance. When a constant current source is sent to human body, a closed loop of current will be formed. Thus, the capacitive impedance of thoracic tissue will vary with cardiac pumping cycle or respiratory ventilation. With the module, students learn also the characteristics of body tissue impedance.

Specification:

1. Band-Pass Filter : 0.1~10Hz

2. Sine Wave Generator Circuit : 50 KHz, with fine tuning

3. Surface electrode

4. Isolation circuit

5. Gain : x 1250, x 2500

6. With over-current protection and reset circuits

7. One output

Body impedance signal

C. Module Board

1. All terminals on the module accept 2mm plugs.

2. Circuit symbols, blocks and components printed on the surface of each module.

3. Modules secured in plastic housings.

4. Dimension : 255x165x30mm ± 10%.

5. With storage cabinet for all modules to be easily stored

D. Experiment Contents

1. KL-75001 Electrocardiogram (ECG) Measurement
   (1) Measuring the Characteristics of High-Pass Filter (HPF)
   (2) Measuring the Characteristics of Amplifier
   (3) Measuring the Characteristics of Low-Pass Filter (LPF)
   (4) Measuring the Characteristics of Band-Reject Filter (BRF)
   (5) ECG Measurement using ECG Simulator
   (6) Human ECG Measurement using Oscilloscope
   (7) Human ECG Measurement using KL-720 Software

2. KL-75002 Electromyogram (EMG) Measurement
   (1) Calibrating the Pre-Amplifier Circuit
   (2) Measuring the Characteristics of Band-Reject Filter (BRF)
   (3) Measuring the Characteristics of Low-Pass Filter (LPF)
   (4) Measuring the Characteristics of Gain Amplifier
   (5) Measuring the Characteristics of High-Pass Filter (HPF)
   (6) Measuring the Characteristics of Half-Wave Rectifier
   (7) Measuring the Characteristics of Integrator
   (8) EMG Measurement using Oscilloscope
   (9) Human EMG Measurement using KL-720 software

3. KL-75003 Electro-oculogram (EOG) Measurement
   (1) Calibrating Horizontal Surface Electrode Circuit
   (2) Measuring the Characteristics of Band-Reject Filter 1 (BRF1)
   (3) Measuring the Characteristics of High-Pass Filter 1 (HPF1)
   (4) Measuring the Characteristics of Amplifier 1
   (5) Measuring the Characteristics of Low-Pass Filter 1 (LPF1)
   (6) Calibrating Vertical Surface Electrode Circuit
   (7) Measuring the Characteristics of Band-Reject Filter 2 (BRF2)
   (8) Measuring the Characteristics of High-Pass Filter 2 (HPF2)
   (9) Measuring the Characteristics of Amplifier 2
   (10) Measuring the Characteristics of Low-Pass Filter 2 (LPF2)
   (11) EOG Measurement using Oscilloscope
   (12) EOG Measurement using KL-720 Software

4. KL-75004 Electroencephalogram (EEG) Measurement

   (1) Calibrating the Pre-Amplifier Circuit

   (2) Measuring the Characteristics of Band-Reject Filter (BRF)

   (3) Measuring the Characteristics of High-Pass Filter (HPF)

   (4) Measuring the Characteristics of Amplifier

   (5) Measuring the Characteristics of Low-Pass Filter (LPF)

   (6) Human EEG Measurement using Oscilloscope

   (7) Human EEG Measurement using KL-720 Software

5. KL-75005 Oscillometric Blood Pressure Measurement

   (1) Calibrating the Pressure Sensor Driver

   (2) Measuring the Characteristics of High-Pass Filter 1 (HPF1)

   (3) Measuring the Characteristics of Low-Pass Filter (LPF)

   (4) Measuring the Characteristics of HPF2 and Amplifier

   (5) Measuring the Characteristics of Rectifier

   (6) Blood Pressure Measurement using Stethoscope

   (7) Blood Pressure Measurement using Oscillometric Sensor and Oscilloscope

   (8) Blood Pressure Measurement using Oscillometric Sensor and KL-720 Software

6. KL-75006 Vessel Volume Measurement

   (1) Calibrating KL-79102 Infrared Photocoupler Sensor

   (2) Measuring the Characteristics of High-Pass Filter (HPF)

   (3) Measuring the Characteristics of Gain Amplifier

   (4) Measuring the Characteristics of 4th-Order Low-Pass Filter

   (5) Measuring the Characteristics of Differentiator

   (6) Measuring the Characteristics of Amplifier

   (7) Measuring the Characteristics of Comparator

   (8) Measuring the Characteristics of Monostable Multivibrator

   (9) Human Vessel Volume Measurement using Oscilloscope

   (10) Human Vessel Volume Measurement using KL-720 Software

7. KL-75007 Respiratory Frequency Measurement

   (1) Calibrating the Differential Amplifier

   (2) Measuring the Characteristics of Band-Reject Filter (BRF)

   (3) Measuring the Characteristics of Amplifier

   (4) Measuring the Characteristics of Differentiator

   (5) Measuring the Characteristics of Hysteresis Comparator

   (6) Measuring the Characteristics of Monostable Multivibrator

   (7) Respiratory Frequency Measurement using Oscilloscope

   (8) Respiratory Frequency Measurement using KL-720 Software

8. KL-75008 Pulse Measurement

   (1) Calibrating the Strain Gauge Amplifier

   (2) Measuring the Characteristics of High-Pass Filter (HPF)

   (3) Measuring the Characteristics of Band-Reject Filter (BRF)

   (4) Measuring the Characteristics of Gain Amplifier

   (5) Measuring the Characteristics of Low-Pass Filter (LPF)

   (6) Measuring the Characteristics of Hysteresis Comparator

   (7) Measuring the Characteristics of Monostable Multivibrator

   (8) Pulse Measurement using Oscilloscope

   (9) Arterial Vessel Measurement using Oscilloscope

   (10) Pulse Measurement using KL-720 Software

9. KL-75009 Body Impedance Measurement

Caution! People with a cardiac pacemaker must avoid doing this experiment.

   (1) Calibrating the Pre-Amplifier

   (2) Measuring the Characteristics of Band-Reject Filter (BRF)

   (3) Measuring the Characteristics of Wien Bridge Oscillator

   (4) Measuring the Characteristics of High-Pass Filter (HPF)

   (5) Measuring the Characteristics of Demodulator

   (6) Measuring the Characteristics of Gain Amplifier

   (7) Measuring the Characteristics of Low-Pass Filter (LPF)

   (8) Body Impedance Measurement using Oscilloscope

   (9) Body Impedance Measurement using KL-720 Software

E. Equipment Required

1. Electrocardiogram (ECG) Measurement

   KL-72001 Main Unit, KL-75001 Electrocardiogram ECG Module, Digital Storage Oscilloscope, ECG Simulator, KL-79101 5-Conductor Electrode Cable, Alcohol Prep Pads, Lead Clamps, Electrode Leads, DB9 Cable, BNC Cables, RS-232 Cable, Connecting Wires, 10-mm Bridging Plugs, Trimmer.

2. Electromyogram (EMG) Measurement

   KL-72001 Main Unit, KL-75002 Electromygram EMG Module, Body Surface Electrodes, Digital Storage Oscilloscope, KL-79101 5-Conductor Electrode Cable, 5-kg Dumbbell, Alcohol Prep Pads, Electrode Leads, DB9 Cable, BNC Cables, RS-232 Cable, Connecting Wires, 10-mm Bridging Plugs, Trimmer.

3. Electro-oculogram (EOG) Measurement

   KL-72001 Main Unit, KL-75003 Electrooculogram EOG Module, Digital Storage Oscilloscope, Digital Voltmeter (DVM), KL-79101 5-Conductor Electrode Cable, Body Surface Electrodes, Alcohol Prep Pads, Electrode Leads, DB9 Cable, BNC Cables, RS-232 Cable, Connecting Wires, 10-mm Bridging Plugs, Trimmer.

4. Electroencephalogram (EEG) Measurement

   KL-72001 Main Unit, KL-75004 Electroencephalogram EEG Module, Digital Storage Oscilloscope, Digital Voltmeter (DVM), KL-79101 5-Conductor Electrode Cable, EEG Electrodes, Alcohol Prep Pads, Electrical Conductivity Jelly, Elastic Head Bandage, Medical Tape, DB9 Cable, BNC Cables, RS-232 Cable, Connecting Wires, 10-mm Bridging Plugs, Trimmer.

5. Oscillometric Blood Pressure Measurement

   KL-72001 Main Unit, KL-75005 Blood Pressure Measurement Module, Digital Storage Oscilloscope, Digital Voltmeter (DVM), Y Tube, Tube Connector, Stethoscope, Wrist - type Cuff, Hand-operated Pump, Mechanical Sphygmomanometer, PET blow bottle filled with water up to 80% of height, DB9 Cable, BNC Cables, RS-232 Cable, Connecting Wires, 10-mm Bridging Plugs, Trimmer.

6. Vessel Volume Measurement

KL-72001 Main Unit, KL-75006 Photoplethysmogram Module, Digital Storage Oscilloscope, Digital Voltmeter (DVM), KL-79102 Infrared Photocoupler Sensor, DB9 Cable, BNC Cables, RS-232 Cable, Connecting Wires, 10-mm Bridging Plugs, Trimmer.

7. Respiratory Frequency Measurement

KL-72001 Main Unit, KL-75007 Respiratory Ventilation Module, Digital Storage Oscilloscope, Digital Voltmeter (DVM), KL-79103 Temperature Sensor Mask, DB9 Cable, BNC Cables, RS-232 Cable, Connecting Wires, 10-mm Bridging Plugs, Trimmer.

8. Pulse Measurement

KL-72001 Main Unit, KL-75008 Pulse Meter Module, Digital Storage Oscilloscope, Digital Voltmeter (DVM), Mechanical Sphygmomanometer, KL-79104 Strain Gauge Tie, Y Tube, wrist - type cuff, Hand-operated Pump, DB9 Cable, BNC Cables, RS-232 Cable, Connecting Wires, 10-mm Bridging Plugs, Trimmer.

9. Body Impedance Measurement

KL-72001 Main Unit, KL-75009 Impedance Module, Digital Storage Oscilloscope, Digital Voltmeter (DVM), KL-79101 5-Conductor Electrode Cable, Body Surface Electrodes, Alcohol Prep Pads, Electrode leads, DB9 Cable, BNC Cables, RS-232 Cable, 10-mm Bridging Plugs, Trimmer.

F. Accessories

1. Standard Accessories
   a. KL-79101 5-Conductor Electrode Cable
   b. KL-79102 Infrared Photocoupler Sensor
   c. KL-79103 Temperature Sensor Mask
   d. KL-79104 Strain Gauge Tie
   e. Dumbbell (5 Kg)
   f. Mechanical Sphygmomanometer (Include Stethoscope、Tube connector、Y Tube and Hand-operated Pump)
   g. Body Surface Electrodes (100 pieces)

h.   Alcohol Prep Pads (100pcs/box)

i.   Lead Clamp (4pcs/set)

j.   Electrode Lead (5pcs/set)

k.   EEG Electrode (3pcs/set)

l.   Wrist - type Cuff

m.   DB9 Cable

n.   BNC Cable

o.   RS-232 Cable

p.   Connecting Wire (KLG-2), 30cm (6pcs/set)

q.   10-mm Bridging Plug (10pcs/set)

r.   Trimmer

s.   Testing Terminal (2∅)

t.   Installation CD

u.   Experiment Manual

2. Optional Accessories

a.   ECG Simulator

b.   Digital Storage Oscilloscope

c.   EEG Simulator

d.   RS-232C to USB Adaptor

e.   Mercury Column Sphygmomanometer

f.   Electrical Conductivity Jelly

g.   Alcohol Prep Pad

h.   Surface Electrode

i.   Elastic Head Bandage

j.   Temperature Sensor Mask

k.   Medical tape

NOTE: Since item (f) to (k) are consumables, the quantity of those items depends on personal situation.

0.3 KL-72001 MAIN UNIT INTRODUCTION AND USAGE
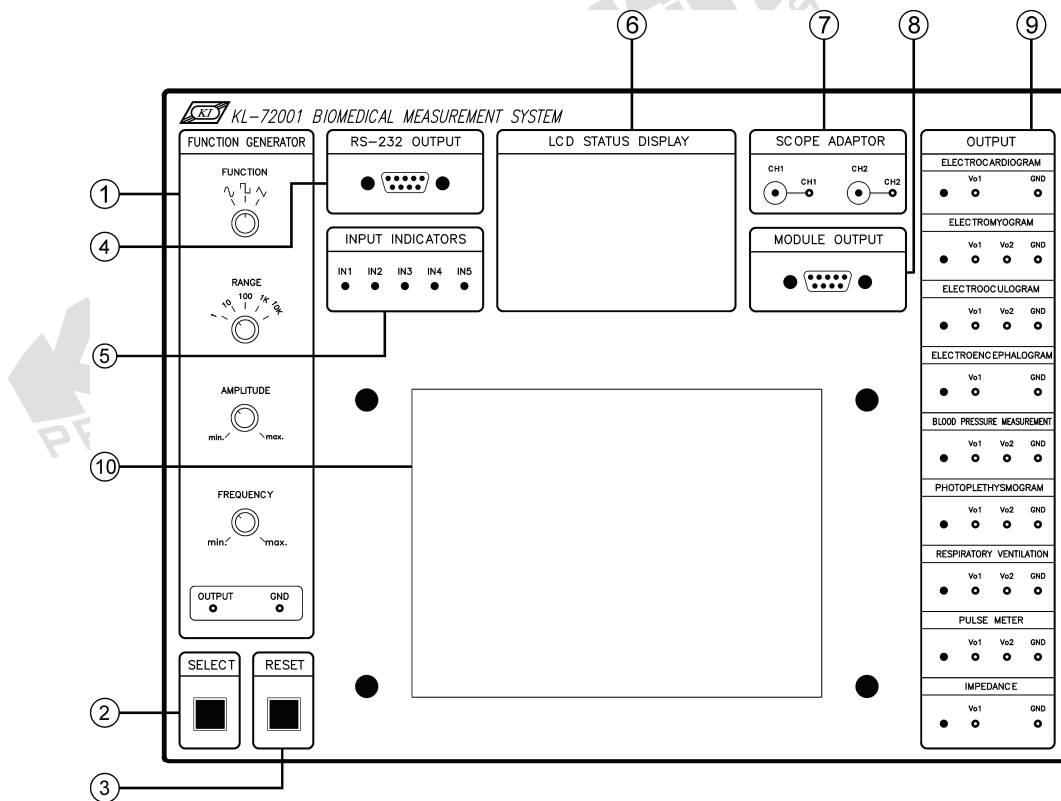
KL-72001 Main Unit including a firmware and a microprocessor is capable to convert and process the biomedical signals. The function of each section is explained as follows.

① FUNCTION GENERATOR

FUNCTION selector − selects the output waveforms: sine, square, triangle.

RANGE selector – 5 frequency ranges:

1	0.1~1 Hz
10	0.6~10 Hz
100	6~100 Hz
1K	60 Hz ~ 1 KHz
10K	575 Hz ~ 10 KHz

AMPLITUDE knob　–

This knob is used to adjust the output amplitude of function generator from 30 mVpp to 18 Vpp (no load). Adjustment in counterclockwise direction will decrease the amplitude, and that in clockwise direction will increase the amplitude.

FREQUENCY knob –

This knob is used to adjust the output frequency of function generator from 0.1Hz to 10KHz (associated with RANGE selector). Adjustment in counterclockwise direction will decrease the frequency, and that in clockwise direction will increase the frequency.

② SELECT button

This selection switch is used to indicate which input terminal should be connected. Once push SELECT button, the number of module will be shown on the LCD display. At the same time, the LED of input terminal related to the chosen module will also be on. The module will be chosen by pushing the SELECT button in the order of KL-75001, KL-75002, …, and KL-75009. For instance, if the KL-75003 EOG module is selected, those LEDs for IN1~IN5 will all be ON. It means that electrodes must connect to those input terminals (J1 of the module)

③ RESET button

This button is used to reset the oscillometric blood pressure measurement system. Details of the operation can be found in Experiment 5.

④ RS232 OUTPUT connector

This DB9 connector is used to communicate KL-72001 Main Unit with computer through RS-232 communication protocol (9600 baud, 2 start bits, 8 data bits, 1 stop bit).

⑤ INPUT INDICATORS

The five indicator LEDs are used to indicate which input signal must be connected. For example, when KL-75002 EMG Module is selected by pressing SELECT button, indicators IN1, IN2, IN5 will be on to indicate that the electrode leads must be connected to the inputs 1, 2, and 5 of KL-79101 5-conductor electrode cable. In the measurement whose inputs must be directly connected to J1 connector of the module, LEDs only indicate which input must be connected.

⑥ LCD STATUS DISPLAY

The 128 x 64 graphic LCD display shows the following information:

Lines 1 & 2 – show **"KL-72001 BIOMEDICAL MEASUREMENT SYSTEM"**

Line 3 – Blank

Line 4 – displays the name and number of the Module in use. When KL-72001 is powered up, the KL-73001 Module will be shown by default.

Lines 5 & 6 − display the required inputs for measurement.

Line 7 − displays Heart Rate (KL-75006), Respire (KL-75007), Pulse Rate (KL-75008), and SBP/DBP.

Line 8 − displays the output frequency of function generator.

⑦ SCOPE ADAPTOR

This section provides BNC connectors for the inputs of oscilloscope and 2-mm plugs for the outputs of individual modules in OUTPUT section.

⑧ MODULE OUTPUT

This connector is used for the output signals and power source of module. It is connected to the J2 connector of individual module for measurement.

⑨ OUTPUT

This section contains the output terminals of individual module areas. When a module is selected by pressing SELECT button, the LED of the related area will be on. It means that user should connect indicated output to the input of an oscilloscope.

⑩ This space is used for placing the experiment module.

0.4 MODULE USAGE (KL-75001 for example)
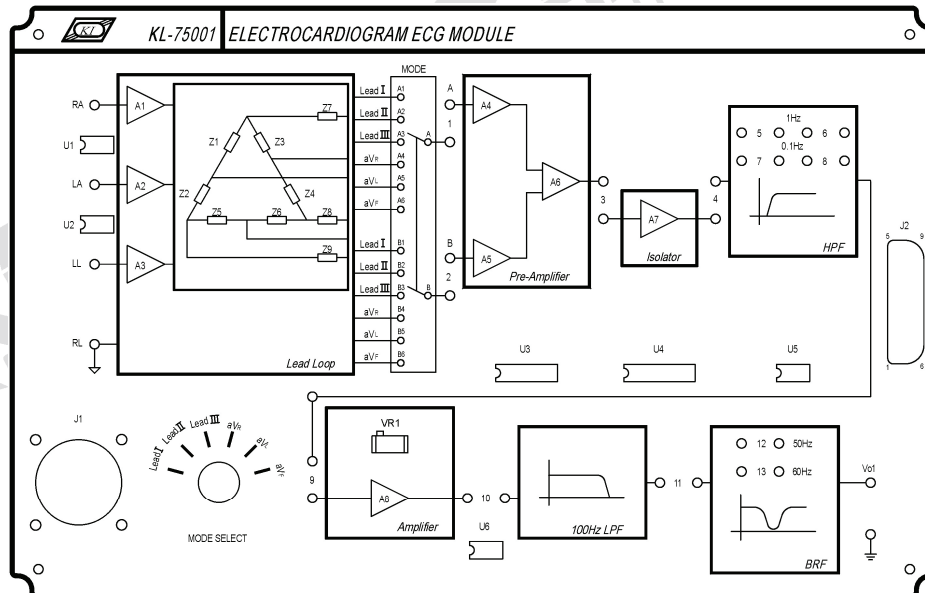
The upper figure is the front view of KL-75001 ECG Module. In the module, all circuit blocks are separated and each circuit block can be applied independently. The positions **1**, **2**, **3**, and so forth, on the module indicate where we can connect two circuit blocks. The connection can be performed with a 10-mm bridging plug or a connecting wire provided as accessory.

J1 is the input connector for the 5-conductor electrode cable. To complete ECG input connection, the module side of the 5-conductor electrode cable must connect to J1, and the lead side to the lead clamps through the electrode leads.

J2 is the module output connector. Through the connector, power and signals of the module can output to the connector of MODULE OUTPUT of KL-72001.

Here, we try to explain how to make a wire connection, taking the body ECG experiment as an example.

＊＊ Human ECG Measurement using Oscilloscope

1. Set KL-75001 ECG Module on KL-72001 Main Unit. On KL-72001 Main Unit, complete the following connections:

KL-72001 Main Unit			To	KL-72001 Main Unit		
Section	Area	Terminal		Section	Area	Terminal
OUTPUT	SCOPE ADAPTOR	CH1	→	OUTPUT	ELECTRO-CARDIOGRAM	Vo1
OUTPUT	SCOPE ADAPTOR	CH1 (BNC)	→	CH1 input of the oscilloscope		

＊＊GRAPHIC EXPLANATION＊＊

KL-72001 Main Unit			To	KL-72001 Main Unit		
Section	Area	Terminal		Section	Area	Terminal
OUTPUT	SCOPE ADAPTOR	CH1	→	OUTPUT	ELECTRO-CARDIOGRAM	Vo1
Section	Name of each section					
Area	Name of each area in section					
Terminal	Name of each terminal in area					

Connecting Wire
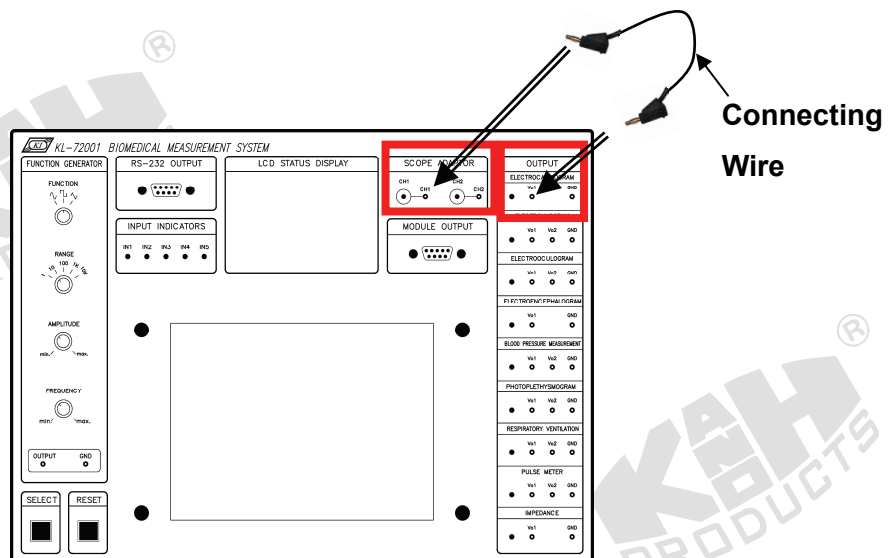
KL-72001 Main Unit				KL-72001 Main Unit		
Section	Area	Terminal	To	Section	Area	Terminal
OUTPUT	SCOPE ADAPTOR	CH1 (BNC)	→	CH1 input of the oscilloscope		

BNC Cable
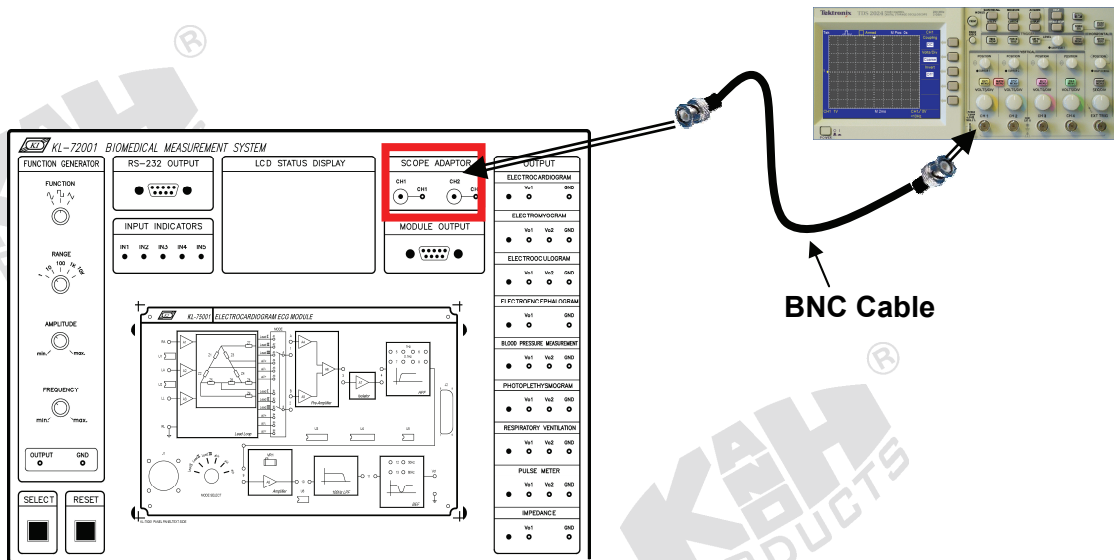
2. Complete the following connections:

KL-72001 Main Unit				KL-75001 ECG Module	
Section	Area	Terminal	To	Block	Terminal
MODULE OUTPUT	--	9-Pin	→	--	J2

＊＊GRAPHIC EXPLANATION＊＊

KL-72001 Main Unit				KL-75001 ECG Module	
（From KL-72001 Main Unit ）				（To KL-75001）	
Section	Area	Terminal	To	Block	Terminal
MODULE OUTPUT	--	9-Pin	→	--	J2
Section	Name of each section				
Area	Name of each area in section				
Terminal	Name of each terminal in area				
Block	Name of each circuit block on module				

KL-72001 Main Unit

Section : MODULE OUTPUT

Terminal : 9-Pin

KL-75001 ECG Module

Terminal : J2
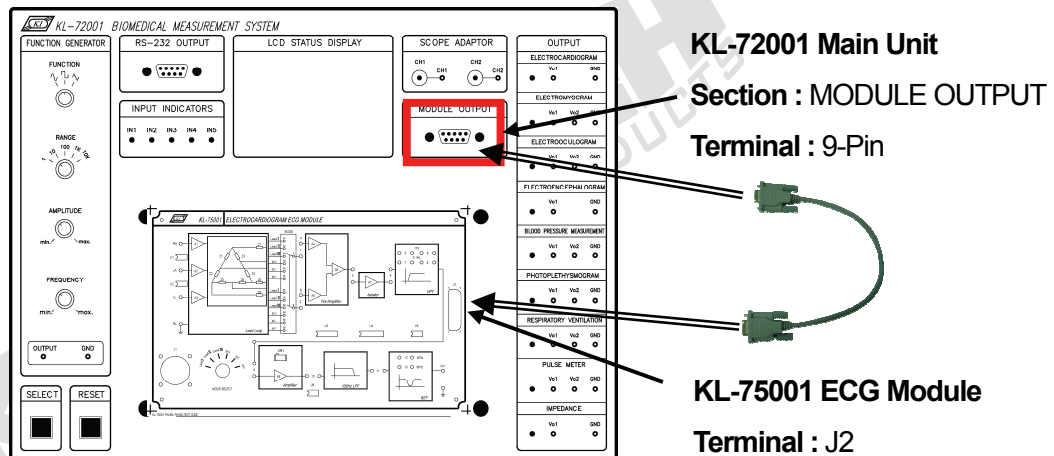
3. Insert bridging plugs in positions 1, 2, 3, 4, 5 and 6 (HPF cutoff frequency=1Hz), 9, 10, 11, and 12 or 13 (BRF center frequency 50 or 60Hz in accordance with local line frequency).

10-mm Bridging plug
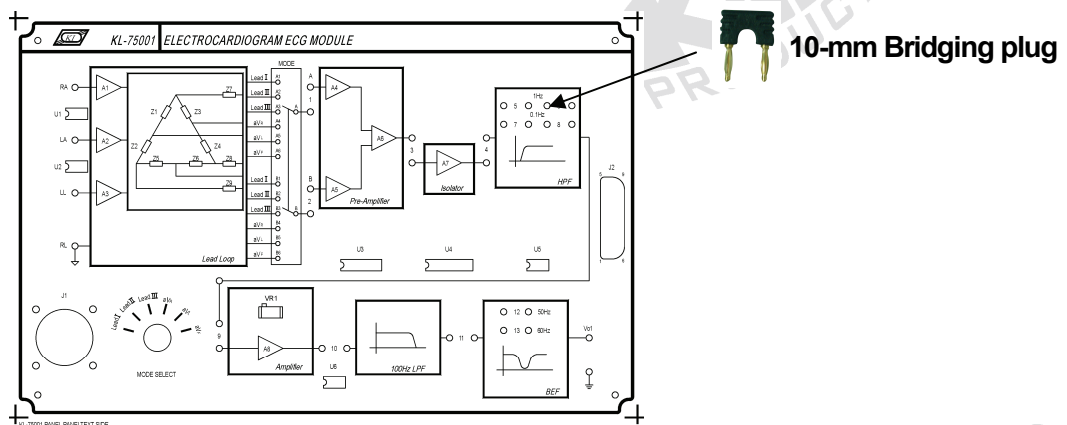
4. Wet the lead clamps and put them on the subject's forearms and lower legs as shown below. It is usually necessary to clean the clamping regions with alcohol prep pads.
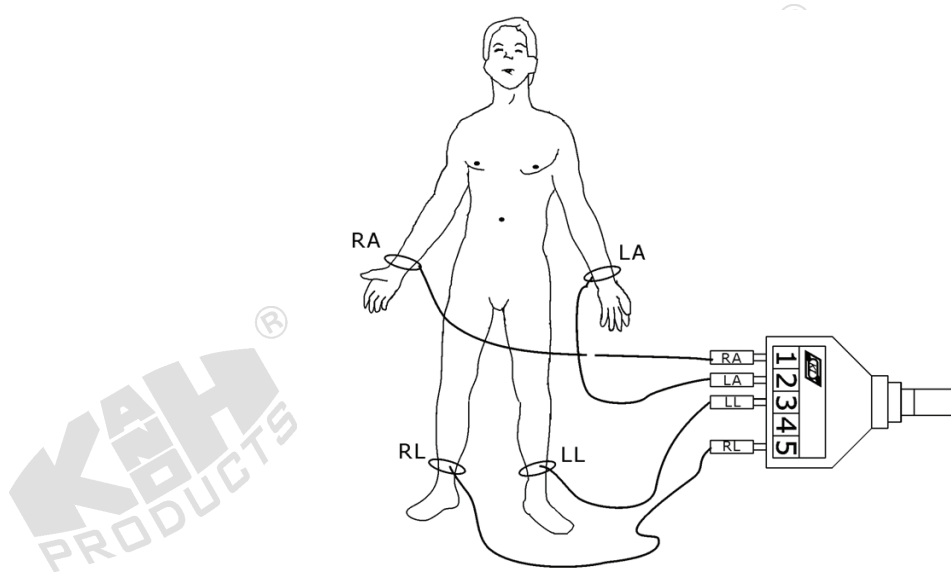
5. Connect the lead clamps to the lead side of KL-79101 5-Conductor Electrode Cable as follows: RA →1, LA→2, LL→3, and RL→5. Connect the module side of KL-79101 5-Conductor Electrode Cable to J1 connector on KL-75001 ECG Module.
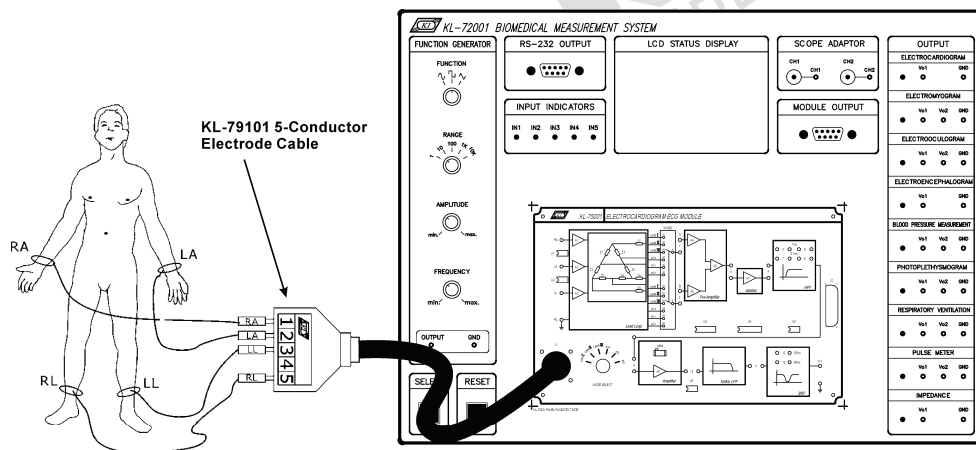
6. Turn power on. Select MODULE:KL-75001 (ECG) item from LCD display by pressing the SELECT button of KL-72001 Main Unit.

7. Set MODE SELECT switch to the Lead I position. Record the Vo1 waveform displayed on CH1 trace in Table 1.9.

8. Make sure that the Amplifier VR1 has been adjusted for maximum undistorted output amplitude. (Refer to Procedure B)

9. Repeat Step 7 for the signals Lead II, Lead III, aV_R, aV_L, and aV_F by switching MODE SELECT to the corresponding position and recording the waveform in Table 1.9.

10. Remove bridging plugs from positions 5 and 6 to positions 7 and 8. This changes the cutoff frequency of HPF from 1 Hz to 0.1 Hz. Repeat Steps 7 to 9.
11. Turn power off and disconnect circuit.

0.5 KL-720 SOFTWARE INSTALLATION AND USAGE

The current software is written by Graphic User Interface (GUI) under the LabVIEW (National Instrument) development environment. Because the software has been packaged by Builder, it can be executed without a development environment. Besides, the software is compatible with Windows NT/XP.

A. Steps for installation：

1. Insert the Installation CD into the CD Driver.
2. Files for installation will auto-run after CD insertion.
3. If it cannot auto-run, please choose an executable file, **Install**, to proceed.
4. The following picture will appear when **Install** is executed.

5. If you want to change the installation path, please push **Browse**. If your installation obeys the default path, please push **Next**.
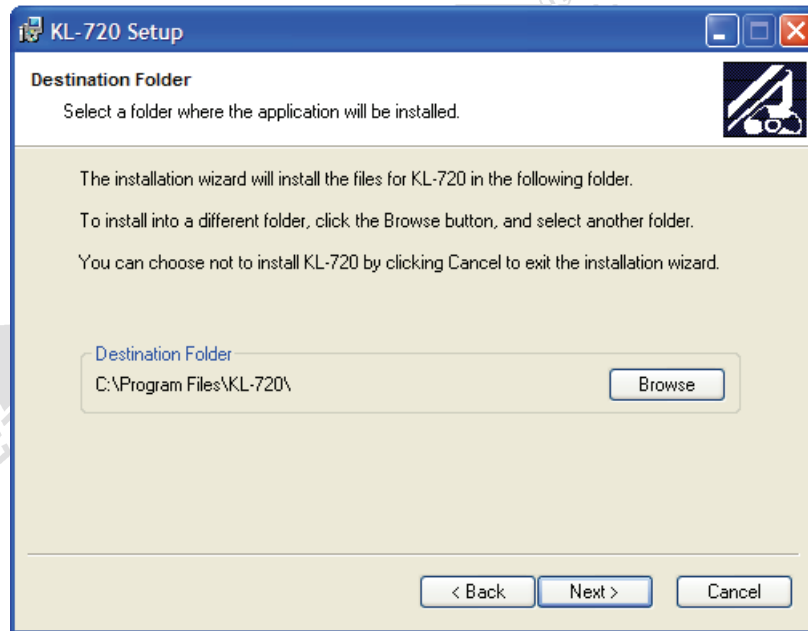
6. Push **Next** if the following picture appears.
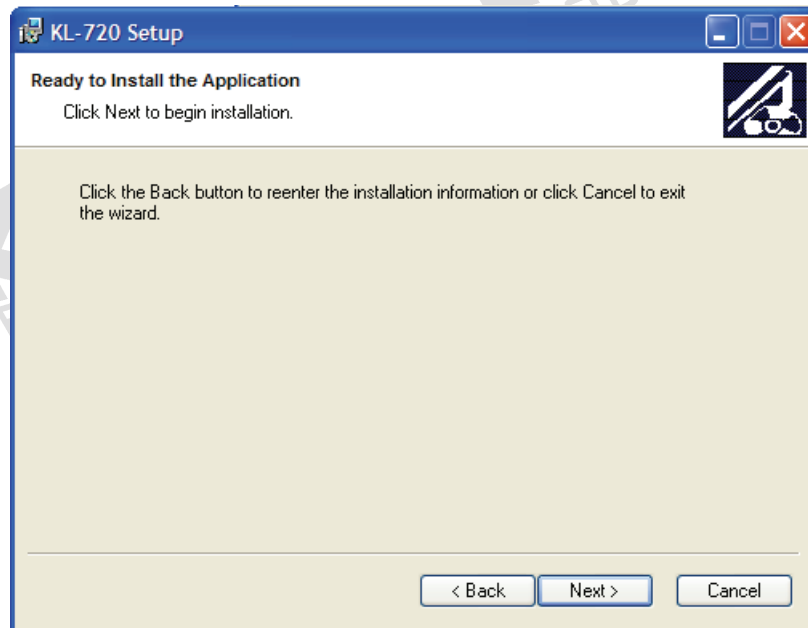
7. The following picture will appear at the end of installation. Please push **Finish** to finish the installation.
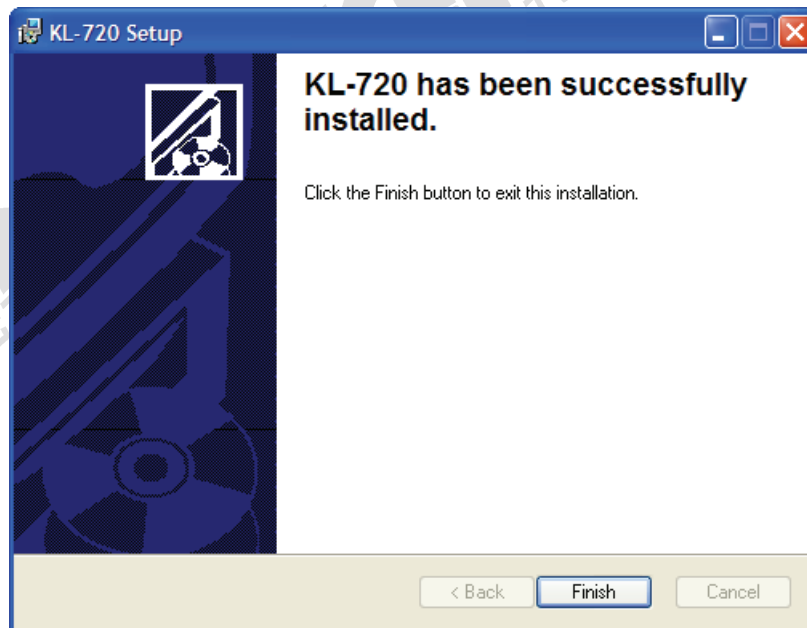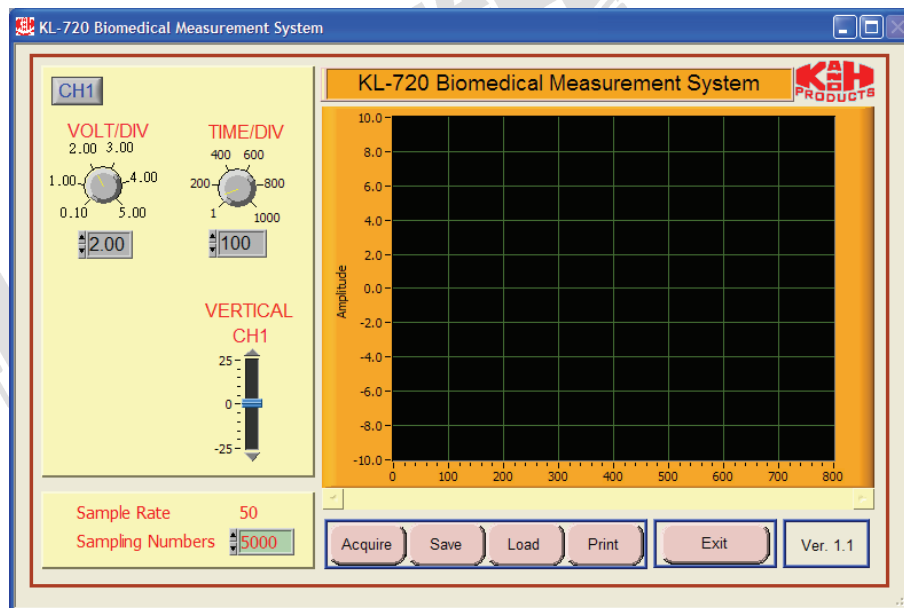

B. How to use the software

1. Go to the path : **START \ All Programs \ KL-720**, execute KL-720's icon.

2. When the following picture appears, please select a communication port. If the number of the communication port is 2, please choose **COM2**. The default port is **COM1**. Push **OK** to enter the main picture.
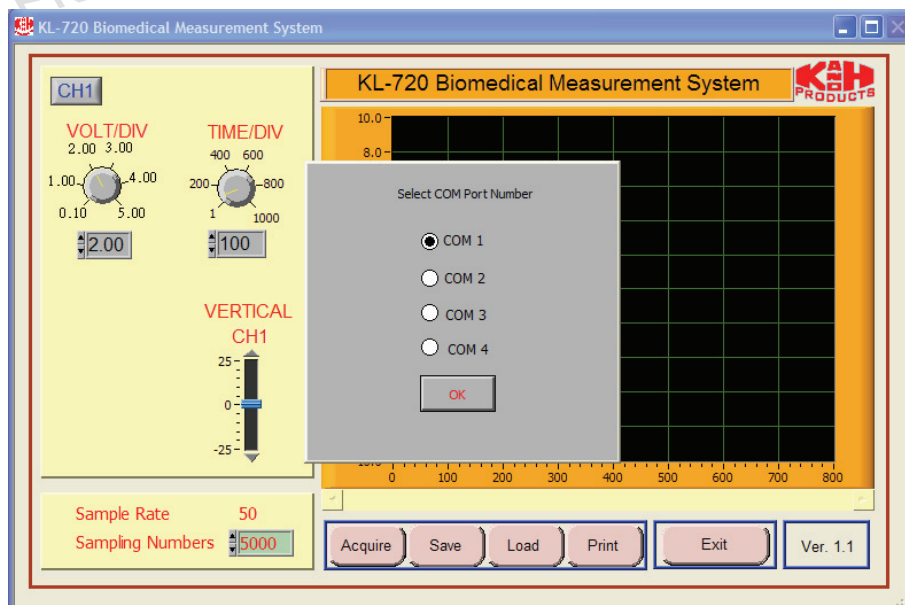
3. The main picture is shown as follows:

4. Push **Acquire** to enter the communication mode. If the communication port is incorrect or no RS-232 data is sent out by KL-72001, the communication will not be successful. Please check if the communication port is correct or check if the connection between KL-72001 and PC is properly made.
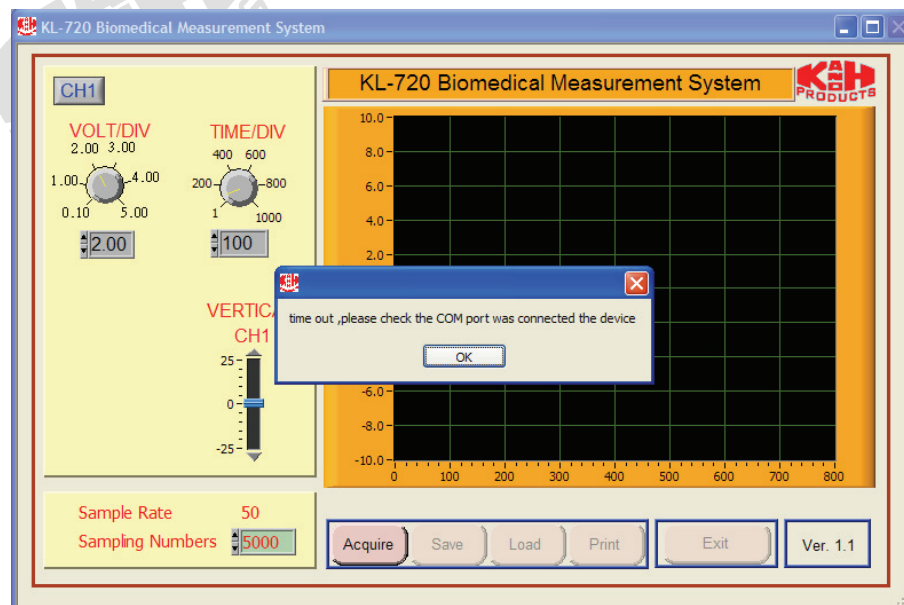
5. If the communication is done correctly, the following picture will show up (e.g., KL-75001).
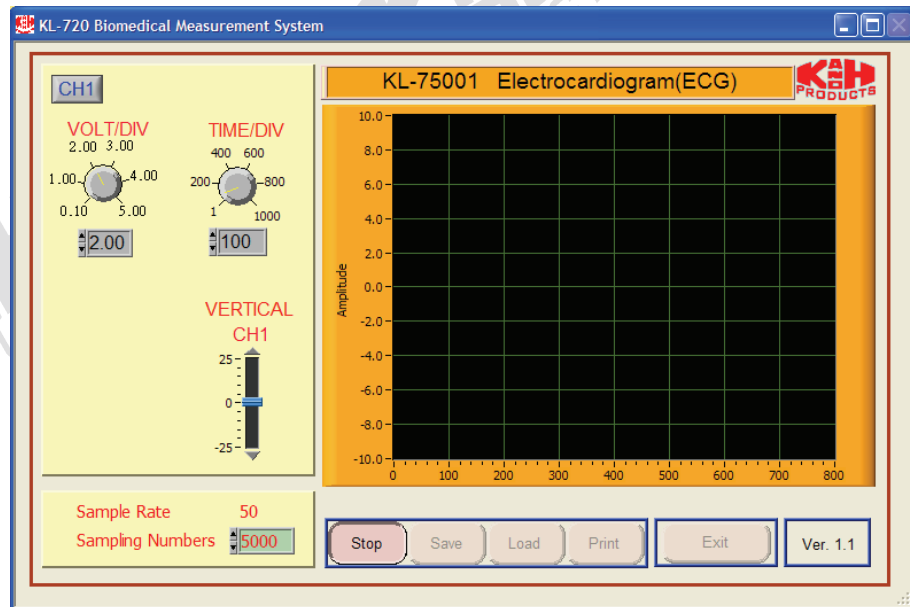
6. The function of each control is explained as follows:

Waveform Window

The window is used to display the waveform data recorded.

VOLT/DIV

Similar to the adjustment in the amplitude Y-axis of oscilloscopes. Since the amplitude of signal is different in the experiments of each module, users have to adjust this knob to change voltage amplitude per division for good observation. The smallest value for **VOLT/DIV** is 0.1 and the largest is 5. Thus, the smallest size of the voltage per division is 0.1 V and the largest size is 5 V.

TIME/DIV

Similar to the adjustment in the time X-axis of oscilloscopes. Since the amplitude of signal is different in the experiments of each module, users have to adjust this knob to change to certain time scale per division which is suitable for observation. The smallest value for **TIME/DIV** is 1 and the largest is 1000. Thus, the smallest size of the time per division is

1 and the largest size is 1000. When two channels are used, if you press the key, it will simultaneously change the time scales of CH1 and CH2.

Sampling Numbers

The button is used to limit the recording number of X-axis. The smallest recording number is 50 and the biggest,15000.

Acquire / Stop

When a module is properly connected to KL-72001, KL-72001 will automatically recognize which module being connected. Push **Acquire** button to begin registering data from KL-72001. And the data will be displayed on the waveform window. Pushing the button again will end data recording. In the mode of data recording, **Save**, **Load** and **Print** keys are inactive.

Save

The button is inactive in the mode of data recording and is available after the data recording. The files can be saved in one of formats: ***.XLS**, ***.JPG**, and ***.BMP**.

Load

The button is used to download file to program.

Print

The button is used to print out the waveform in the waveform window.

### Exit

The button is used to exit from the system.

C. Example

Human ECG Measurement using KL-720 Software

1. Set KL-75001 ECG Module on KL-72001 Main Unit. Complete the following connection:

KL-72001 Main Unit				KL-75001 ECG Module	
Section	Area	Terminal	To	Block	Terminal
MODULE OUTPUT	--	9-Pin	→	--	J2

2. Insert bridging plugs in positions 1, 2, 3, 4, 5 and 6 (HPF cutoff frequency=1Hz), 9, 10, 11, and 12 or 13 (BRF center frequency 50 or 60Hz in accordance with local line frequency).

3. Wet the lead clamps and put them on the subject's forearms and lower legs as shown below. It is usually necessary to clean the clamping regions with alcohol prep pads.
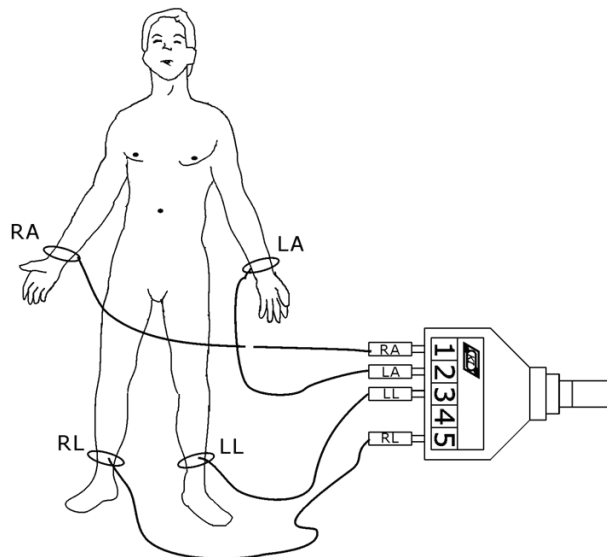

4. Connect the lead clamps to the lead side of KL-79101 5-Conductor Electrode Cable as follows: RA →1, LA→2, LL→3, and RL→5. Connect the module side of KL-79101 5-Conductor Electrode Cable to J1 connector on KL-75001 ECG Module.

5. Connect RS-232 OUTPUT connector on KL-72001 Main Unit to RS-232 port on computer using RS-232 cable.

6. Turn power on. Select MODULE:KL-75001 (ECG) item from LCD display by pressing the SELECT button located at bottom-left of KL-72001 Main Unit.

7. Set the MODE SELECT switch to the Lead I position.

8. Boot the computer.

9. Execute KL-720 program. The KL-720 Biomedical Measurement System window appears as shown below.
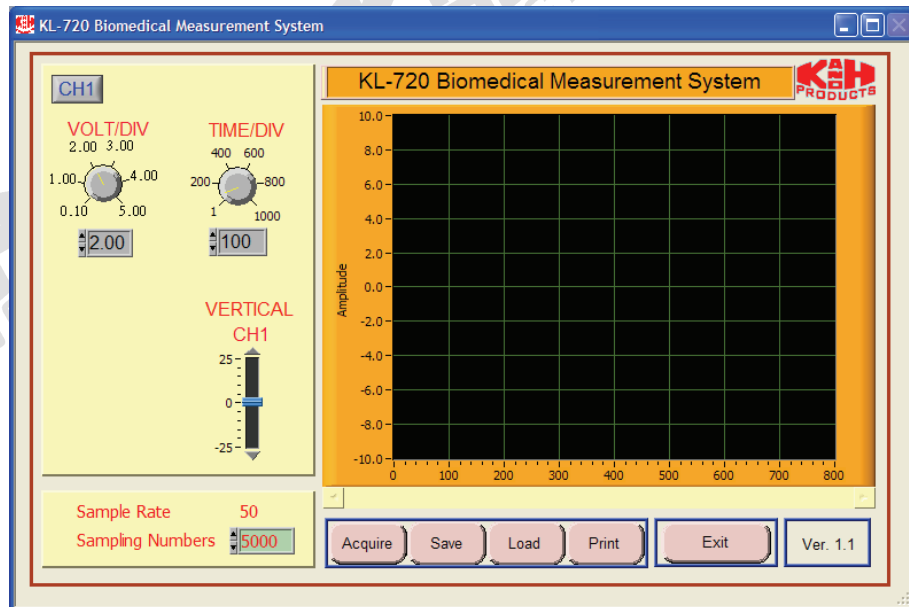

10. Click the Acquire button. The system begins to acquire the measured data via RS-232 port and shows the waveform (Lead I) on KL-75001 Electrocardiogram (ECG) waveform window as below:
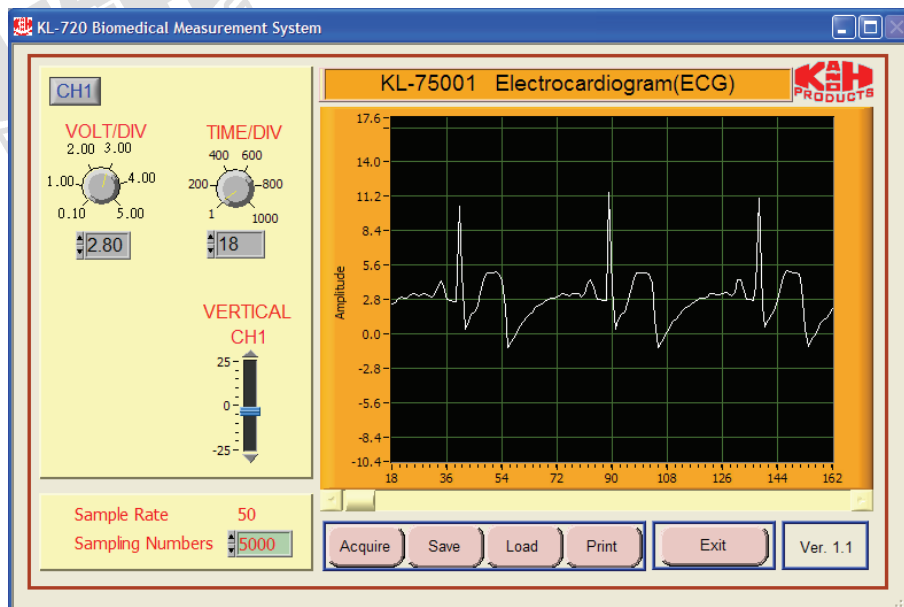
Note: If the message "time out, please check the COM port was connected the device" appears, check connection and RS-232 port.

11. Adjust VOLT/DIV and TIME/DIV knobs, so the signal can be read accurately.

12. Store the Lead I data in PC by pressing Save button and give a name to the file.
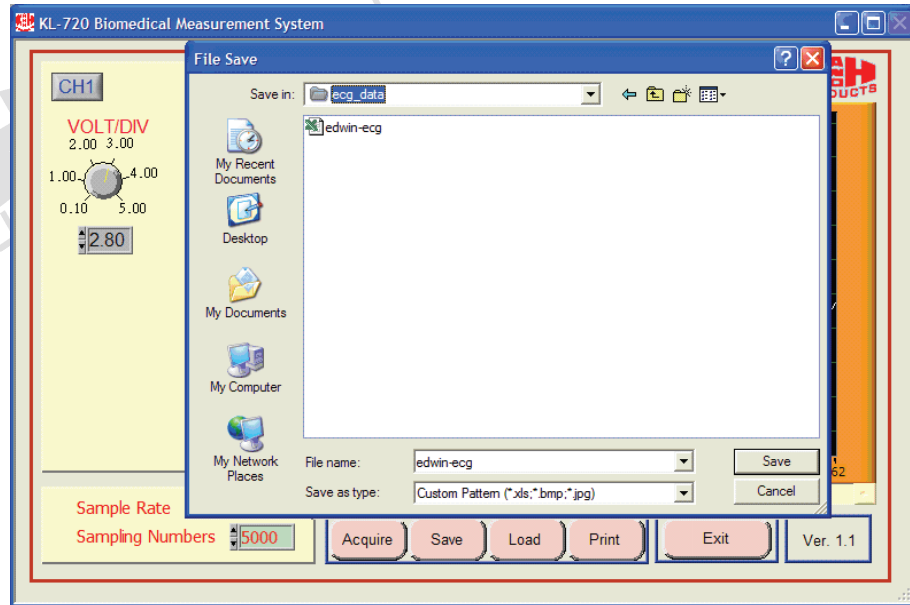
13. Switching MODE SELECT to the corresponding position and repeat Steps 10 to 12 for Lead II, Lead III, aVR, aVL, and aVF signals.

14. Remove the bridging plugs from positions 5 and 6 to positions 7 and 8. This changes the cutoff frequency of HPF from 1 Hz to 0.1 Hz.

15. Repeat Steps 10 to 13.

16. Exit KL-720 Biomedical Measurement System.