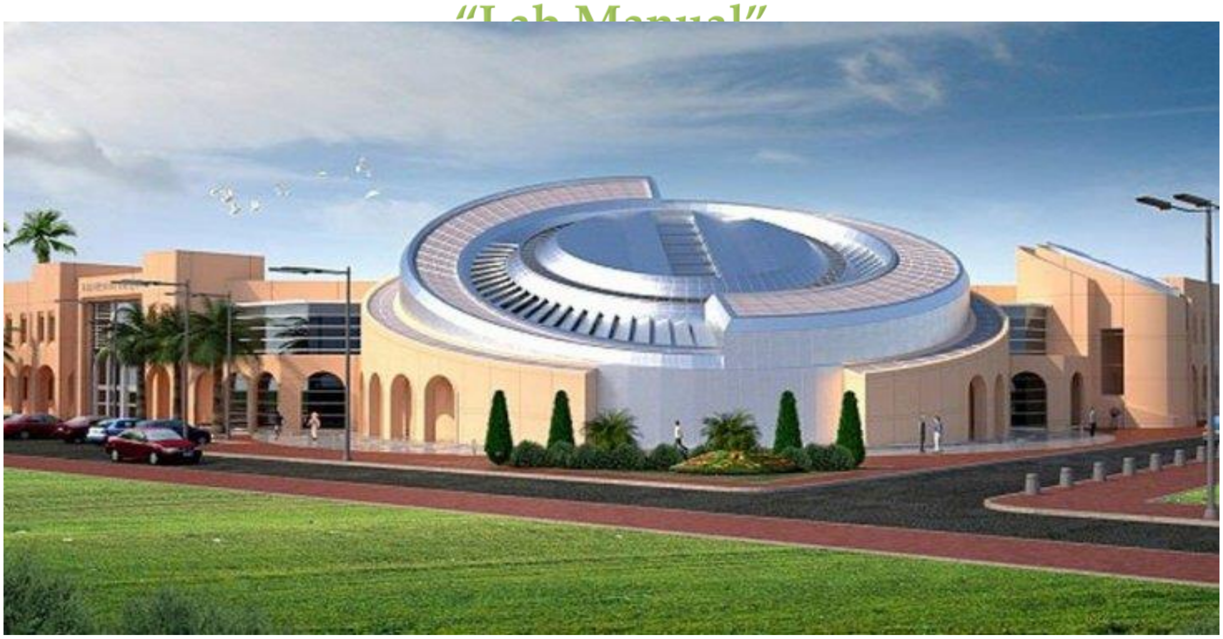
KING FAISAL UNIVERSITY

College Of Engineering

DEPARTMENT OF BIOMEDICAL ENGINEERING

BME 411: BIOMEDICAL INSTRUMENTATION-I

“Lab Manual”



Prepared By: Dr.Preethika Immaculate Britto

Major Topics covered and schedule in weeks:

Topic	Week #	Courses Covered
Introduction to Data Acquisition	1	BME 410
Introduction to NI Elvis & NI MyDaq	2	BME 410
Pulse measurement using reflectance plethysmography	3,4	BME 410
Circulation measurement using Sphygmomanometer and plethysmograph	5,6	BME 410
Heart sounds measurement using Auscultation technique	7	BME 410
Respiration rate measurement Displacement Pneumography	8,9	BME 410
Heart rate measurement using Telemetry	10,11	BME 410
Measurement of ECG using 3-Lead technique	12,13	BME 410
Measurement of EEG using 3-Electrode technique	14	BME 410
Final Exam	15	

Specific Outcomes of Instruction (Lab Learning Outcomes):

1. . Describe and define the basic medical terms and physical values that can be handled by medical instrumentation. (1)
2. . Apply measurement methods and implementation of electrical and nonelectrical modules in medical instrumentation (2, 6)
3. . Demonstrate the capability to construct and verify small electronic circuit modules and function for biomedical instrumentation. (1, 7)
4. . Demonstrate a detailed understanding of the measuring of basic medical parameters; calculate basic parameters of the equipment for using in electro diagnostic and electro therapy. (1,2, 6, 7)
5. . Analyze the operations and features of problem and service procedures for biomedical equipment. (2, 6, 7)
6. . Apply an effective scientific written communication skill of experimental findings. (3, 5)

Student Outcomes (SO) Addressed by the Lab:

z	Outcome Description General Engineering Student Outcomes	Contribution
1.	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	H
2.	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	H
3.	an ability to communicate effectively with a range of audiences	H
4.	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5.	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	L
6.	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	H
7.	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	H

Table of Content

The laboratory and workshop are another means besides lecture room to add knowledge and trained the students in skill. In the laboratories, students can acquire hands-on knowledge such as:

- How to use equipment like meter, signal generator, oscilloscopes, and others.
- How to build and fix the electric and electronic circuits.
- How to apply the theory that was learned during lecture.
- How to analyze the output from the experiments.
- Providing basic for academic research.

PROPER DRESS CODE IN THE LABORATORY

- The dress code is must, Always Display your student ID.
- Wear suitable shoes, slippers or anything similar are not allowed.

THE RULES DURING LABORATORY HOURS

- Keep the bag at the provided place.
- Experiments must be completed in 3 hours during the laboratory session.
- Forbid make noisy or interfere another student.
- No eating and drinking inside the laboratory.
- Request the supervisor or technician to check the circuits' connections before switching on the power supply. Wrong connections can damage equipment/devices.
- Lab reports must be submitted right on time.
- Data acquired by other students are not allowed and will be penalized heavily.
- Data acquired must approved by laboratory supervisor (signed).
- Do not do any walking around to other students' table. Please consult the supervisor/technicians available for any problem/questions.
- Get permission from laboratory supervisor/technician before leaving the lab.
- Switch off the hand-phone during laboratory sessions.
- For current and high voltage laboratory, student must wear the rubber shoe and forbid to wear jewel or any of metal for evade short circuit.
- Bring or take out the laboratory tools without permission is forbidden.
- The replacement laboratory only can be done with permission laboratory coordinator.

- After completing the experiment, students must tidy the table, chair and equipment before leaving the laboratory.
- All students must obey all the instruction given by laboratory supervisor and technician during experiment in the laboratory.

SAFETY

Safety is always an important topic whenever laboratory work is being considered, and it is certainly true in the case of BME 411 lab. Safety is important. The experiments in the laboratory use low voltages and low currents. However, the lab equipment is powered by the 110V, 60Hz, line voltage.

- Be careful with the line voltages.
- Do not touch exposed prongs on the equipment plugs when connecting the equipment to the lines.
- Take care when using power supplies, which may be low voltage but can supply currents in the ampere range. Shorting such, a supply can lead to a serious burn as high currents arc and can ignite flammable material. This is precisely why a car battery needs to be treated with respect.
- The hundreds of amps a battery can supply are enough to cause serious burns.
- The equipment is heavy enough to be generally stable on the bench. Be sure to keep the equipment away from the edges of the benches to avoid having a piece of equipment fall off the bench.
- Besides endangering people who might be struck, falling equipment endangers everyone in vicinity by stressing the power cords, possibly causing a line short or live fault on the equipment, not to mention damage to the expensive lab equipment.
- In general, electronic equipment does not survive harsh treatment.
- The capacitors furnished in your lab kits are electrolytic capacitors with positive and negative terminals. Always connect the positively marked terminal to the most positive terminal in your circuit. An excess negative voltage applied to these capacitors can cause the device to overheat and explode.

Experiment 1: Introduction to Data Acquisition

I. Objective:

Data Acquisition Fundamentals

This section features fundamental data acquisition concepts to get you up to speed on the topics that you will encounter in specifications documents and shows you how to get the results you need from your experiments.

II. Test Standard:

EEE C37.14-1979 - IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures

III. Theory:

What Is Data Acquisition?

Data acquisition (DAQ) is the process of measuring an electrical or physical phenomenon such as voltage, current, temperature, pressure, or sound with a computer. A DAQ system consists of sensors, DAQ measurement hardware, and a computer with programmable software. Compared with traditional measurement systems, PC-based DAQ systems exploit the processing power, productivity, display, and connectivity capabilities of industry-standard computers to provide a more powerful, flexible, and cost-effective measurement solution.

Figure :1 Data Acquisition system

What is a Sensor?

The measurement of a physical phenomenon, such as the temperature of a room, the intensity of a light source, or the force applied to an object, begins with a sensor. A sensor, also called a transducer, converts a physical phenomenon into a measurable electrical signal. Depending on the type of sensor, its electrical output can be a voltage, current, resistance, or another electrical attribute that varies over time. Some sensors require additional components to properly produce a signal that can accurately and safely be read by a DAQ device

What Is a DAQ Device?

DAQ hardware acts as the interface between a computer and signals from the outside world. It primarily functions as a device that digitizes incoming analog signals so that a computer can interpret them.

The three key components of a DAQ device used for measuring a signal are the signal conditioning circuitry, analog-to-digital converter (ADC), and computer bus. Many DAQ devices include other functions for automating measurement systems and processes. For example, digital-to-analog converters (DACs) output analog signals, digital I/O lines input and output digital signals and counters/timers count and generate digital pulses.

Signal Conditioning

Signals from sensors or the outside world can be noisy or too dangerous to measure directly. Signal conditioning circuitry manipulates a signal into a form that is suitable for input into an ADC. This circuitry can include amplification, attenuation, filtering, and isolation. Some DAQ devices include built-in signal conditioning designed for measuring specific types of sensors.

Analog-to-Digital Converter (ADC)

Analog signals from sensors must be converted into digital signals before they are manipulated by digital equipment such as a computer. An ADC is a chip that provides a digital representation of an analog signal at an instant in time. In practice, analog signals continuously vary over time, and an ADC takes periodic “samples” of the signal at a predefined rate. These samples are transferred to a computer over a computer bus where the original signal is reconstructed from the samples in software.

Computer Bus

Industry-grade DAQ devices connect to a computer through a slot or port. The computer bus serves as the communication interface between the DAQ device and computer for passing instructions and measured data. DAQ devices are offered on the most common computer buses including USB, PCI, PCI Express, and Ethernet.

What is a Computer’s Role in DAQ?

A computer with programmable software controls the operation of the DAQ device and is used for processing, visualizing, and storing measurement data. Different types of computers are used in different types of applications. A desktop may be used in a lab for its processing power, a laptop may be used in the field for its portability, or an industrial computer may be used in a manufacturing plant for its ruggedness.

Driver Software

Driver software provides application software the ability to interact with a DAQ device. It simplifies communication with the DAQ device by abstracting low-level hardware commands and register-level programming. Typically, DAQ driver software exposes an application-programming interface (API) that is used within a programming environment to build application software. For almost all NI DAQ devices, NI-DAQmx is the hardware driver. As mentioned below, NI offers development environments that can make driver calls into NI-DAQmx, but other text-based environments can also access the hardware driver.

Application Software

Application software facilitates the interaction between the computer and user for acquiring, analyzing, and presenting measurement data. It is either a prebuilt application with predefined functionality or a programming environment for building applications with custom functionality. Custom applications are often used to automate multiple functions of a DAQ device, perform signal-processing algorithms, and display custom user interfaces.

References:

LabVIEW manual

Experiment 2: Introduction to NI ELVIS II & NI my DAQ

I. Objective:

LabVIEW (short for Laboratory Virtual Instrumentation Engineering Workbench) is a platform and development environment for a visual programming language from National Instruments.

II. Test Standard:

EEE C37.14-1979 - IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures

III. Theory:

What is LabVIEW?

LabVIEW (short for Laboratory Virtual Instrumentation Engineering Workbench) is a platform and development environment for a visual programming language from National Instruments. The graphical language is named “G". LabVIEW is commonly used for data acquisition, instrument control, and industrial automation on a variety of platforms including Microsoft Windows, various flavors of UNIX, Linux, and Mac OS. One benefit of LabVIEW over other development environments is the extensive support for accessing instrumentation hardware. Drivers and abstraction layers for many different types of instruments and buses are included or are available for inclusion. These present themselves as graphical nodes. The abstraction layers offer standard software interfaces to communicate with hardware devices.

The provided driver interfaces save program development time. Many libraries with a large number of functions for data acquisition, signal generation, mathematics, statistics, signal conditioning, analysis, etc., along with numerous graphical interface elements are provided in several LabVIEW package options. Another benefit of the LabVIEW environment is the platform independent nature of the Gcode (LabVIEW programming language), which is (with the exception of a few platform-specific functions) portable between the different LabVIEW systems for different operating systems (Windows, MacOSX and Linux).

NI ELVIS –II

The NI Engineering Laboratory Virtual Instrumentation Suite (NI ELVIS) II is a modular engineering educational laboratory device developed specifically for academia. With its hands-on approach, educators can help students learn practical, experimental skills.

NI ELVIS II features one compact form factor integrated with 12 of the most commonly used instruments in the laboratory, including an oscilloscope, digital multimeter, function generator, variable power supply, and Bode analyzer. You can connect the PC to these various measurements through USB plug-and-play capabilities and build circuits on a detachable protoboard

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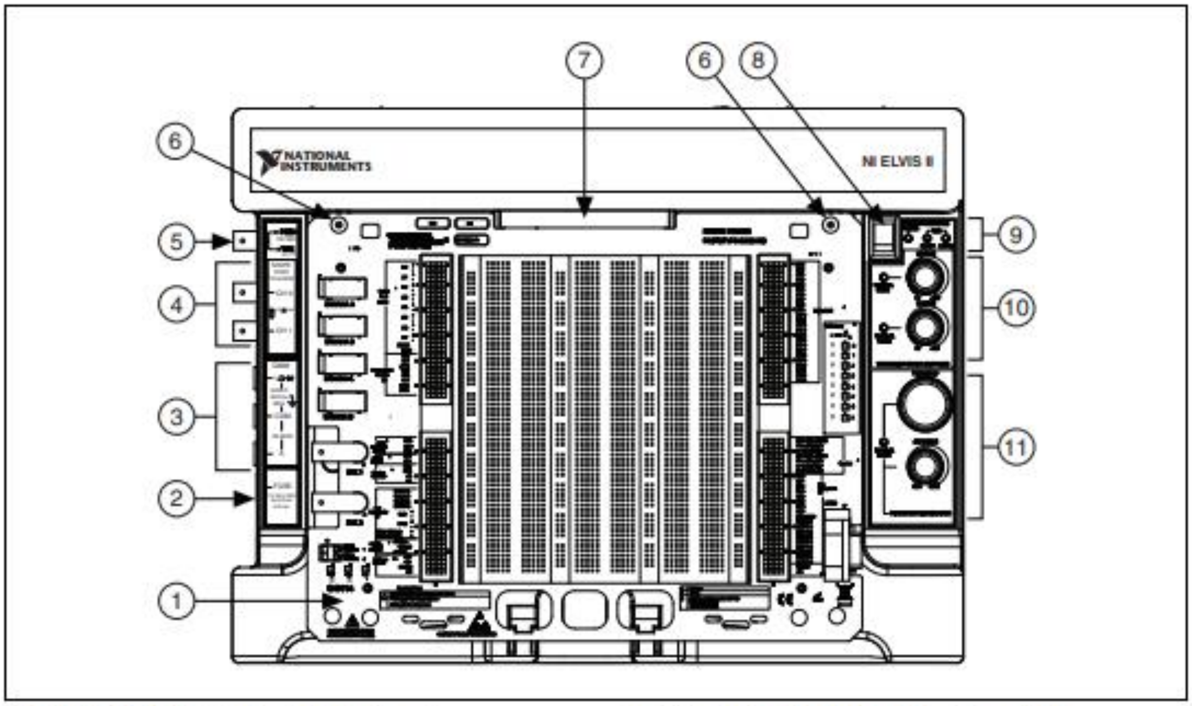


1	NI ELVIS II Series Prototyping Board	6	Prototyping Board Mounting Screw Holes
2	DMM Fuse	7	Prototyping Board Connector
3	DMM Connectors	8	Prototyping Board Power Switch
4	Oscilloscope Connectors	9	Status LEDs
5	Function Generator Output/Digital Trigger Input Connector	10	Variable Power Supplies Manual Controls
		11	Function Generator Manual Controls

The workstation has the following indicators, controls, and connectors:

USB LEDs – Ready—indicates that the NI ELVIS II Series hardware is properly configured and ready to communicate with the host computer.

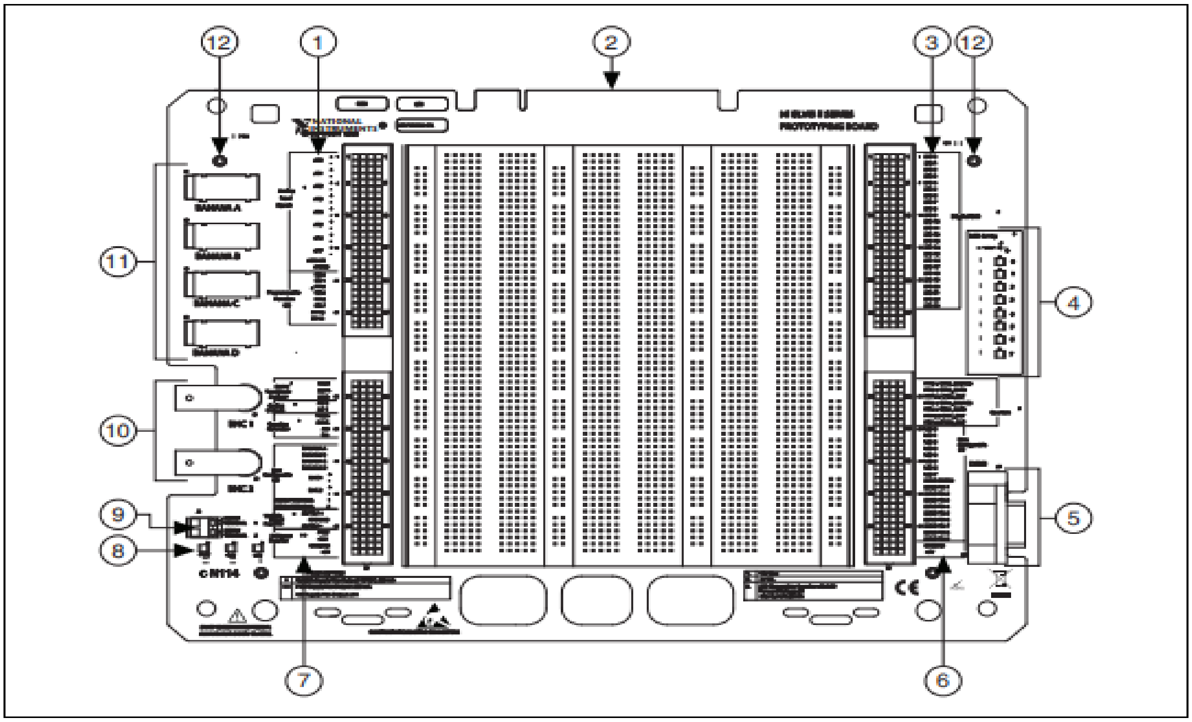
–Active—Indicates activity on the USB connection to the host computer.

ACTIVE LED	READY LED	Description
Off		Main power is off.
Yellow	Off	No connection to the host computer is detected. Make sure NI-DAQmx driver software is loaded and the USB cable is connected.
Off	Green	Connected to a full speed USB host.
Off	Yellow	Connected to a high speed USB host.
Green	Green or Yellow	Communicating with host.

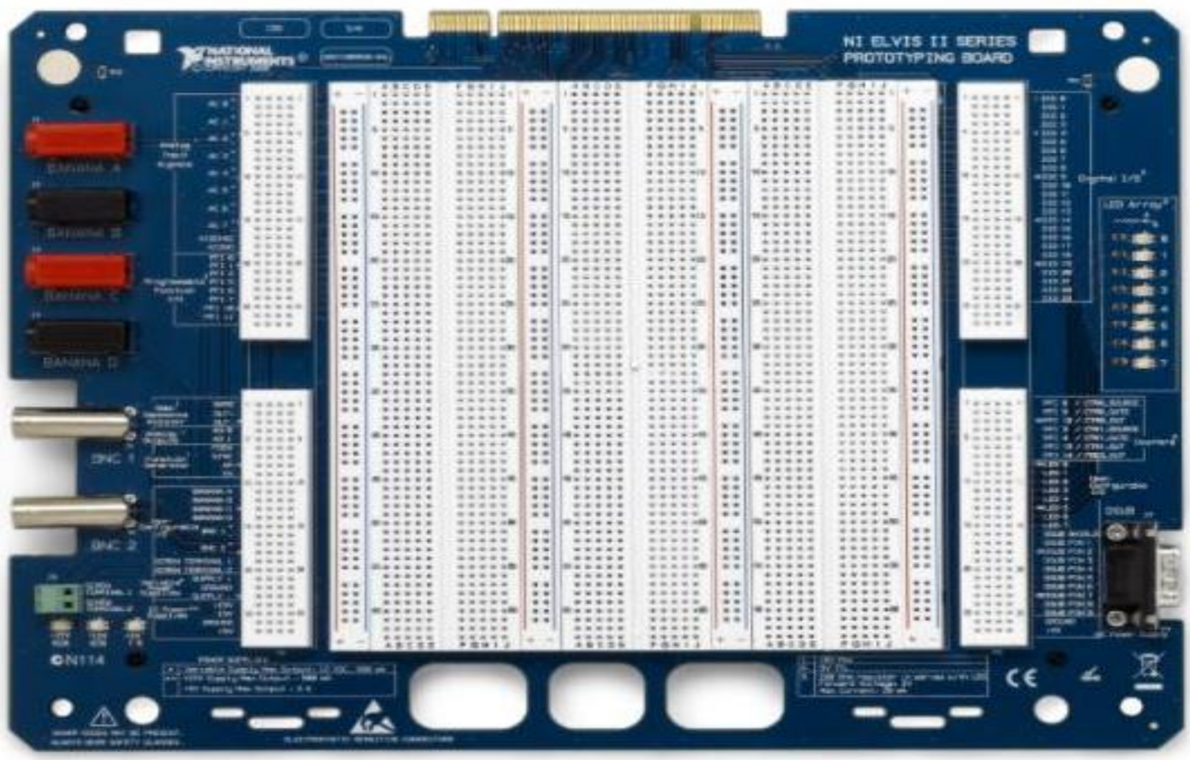
The NI ELVIS II Series Prototyping Board

The NI ELVIS II Series Prototyping Board connects to the workstation. The prototyping board provides an area for building electronic circuitry and has the necessary connections to access signals for common applications. You can use multiple prototyping boards interchangeably with the workstation.

The prototyping board exposes all the signal terminals of the NI ELVIS II Series for use through the distribution strips on either side of the breadboard area. Each signal has a row, and the rows are grouped by function.

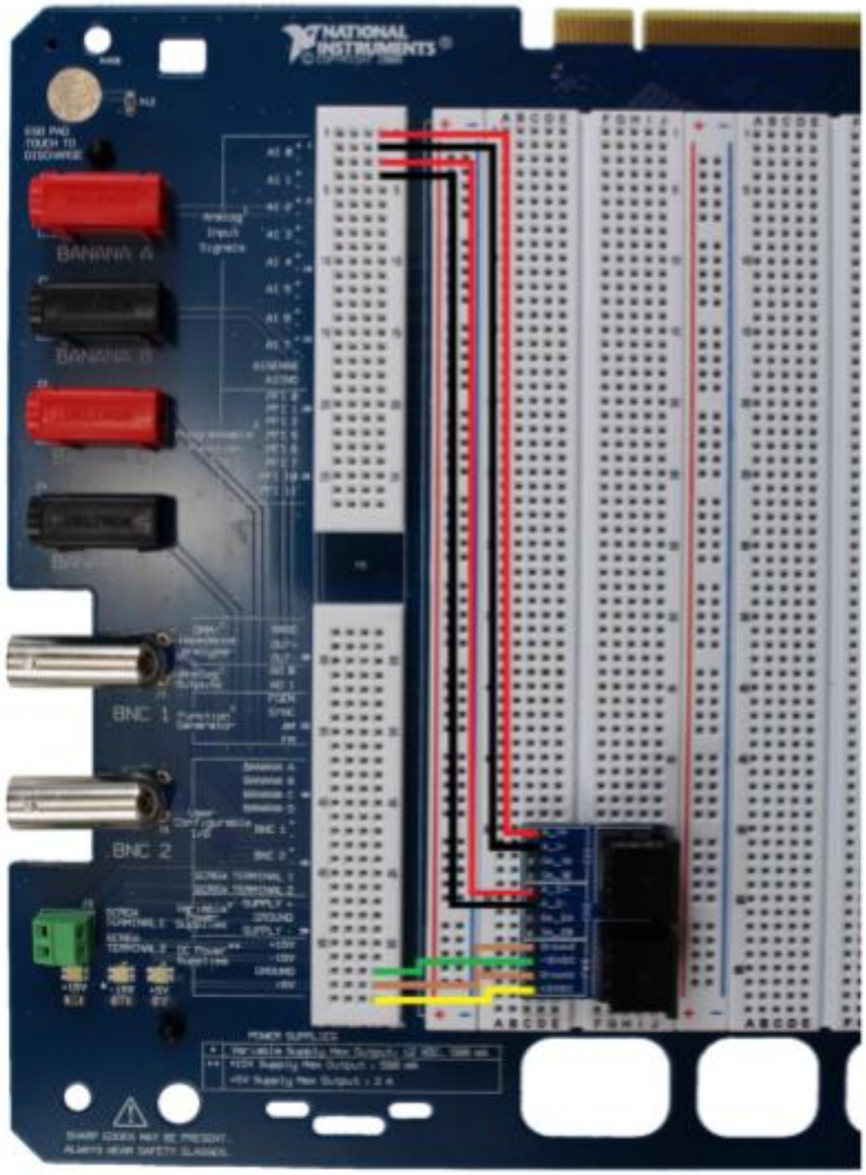


1 AI and PFI Signal Rows
2 Workstation Interface Connector
3 DIO Signal Rows
4 User Configurable LEDs
5 User Configurable D-SUB Connector
6 Counter/Timer, User-Configurable I/O, and DC Power Supply Signal Rows
7 DMM, AO, Function Generator, User-Configurable I/O, Variable Power Supplies, and DC Power Supplies Signal Rows
8 DC Power Supply Indicators
9 User-Configurable Screw Terminals
10 User Configurable BNC Connectors
11 User Configurable Banana Jack Connectors
12 Screw Positions for Locking



If using the NI ELVIS II+, connect the sensor adapter to the ELVIS topboard. In order to power the sensor adapter board, connect the two ground pins on the sensor adapter board to the ground pin on the ELVIS topboard (brown wires). Connect the -15VDC pin on the sensor adapter board to the -15 V DC power supply on the ELVIS topboard (green wire). Connect the +5 VDC pin on the sensor adapter board to the 5 V DC power supply on the ELVIS topboard (yellow wire).

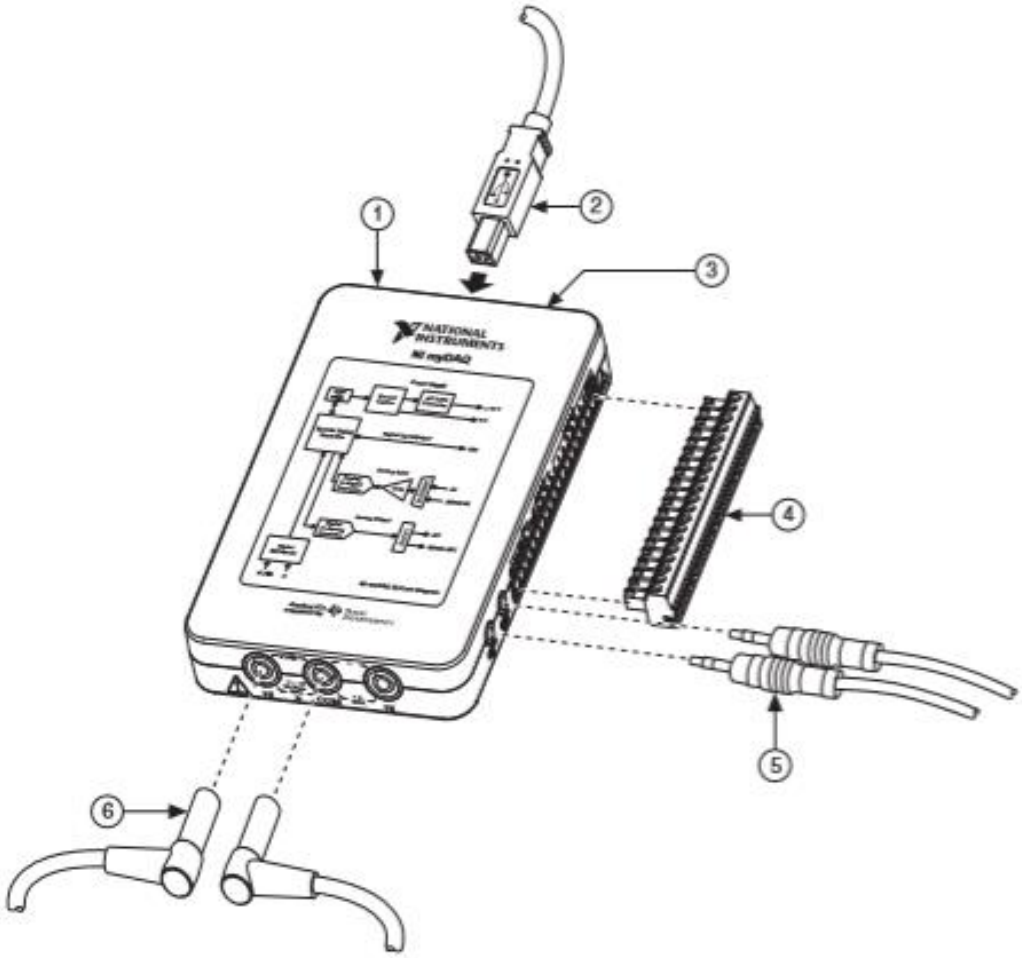
In order to take measurements using the sensor adapter board with your ELVIS, connect the A_1+ and A_1- pins on the sensor adapter board to the AI 0+ and AI 0- pins on the ELVIS topboard (red and black wires). Next, connect A_2+ and A_2- on the sensor adapter board to AI 1+ and AI 1- on the ELVIS topboard (red and black wires). This will connect channel 1 and channel 2 on the sensor adapter board to AI 0 and AI 1 on the ELVIS topboard, respectively.



NI myDAQ

NI myDAQ is a low-cost portable data acquisition (DAQ) device that uses NI LabVIEW-based software instruments, allowing students to measure and analyze real-world signals. NI myDAQ is ideal for exploring electronics and taking sensor measurements. Combined with NI LabVIEW on the PC, one can analyze and process acquired signals and control simple processes anytime, anywhere

There are two analog input channels on NI myDAQ. These channels can be configured as either general-purpose high-impedance differential voltage input or audio input. The analog inputs are multiplexed; meaning a single analog-to-digital converter (ADC) is used to sample both channels. In general-purpose mode, you can measure up to ±10 V signals. In audio mode, the two channels represent left and right stereo line level inputs. Analog inputs can be measured at up to 200 kS/s per channel, so they are useful for waveform acquisition. Analog inputs are used in the NIELVISmx Oscilloscope, Dynamic Signal Analyzer, and Bode Analyzer instruments.



1	NI myDAQ	4	20-Position Screw Terminal Connector
2	USB Cable	5	Audio Cable
3	LED	6	DMM Banana Cable

If using the myDAQ, connect the iWorx myDAQ adapter to the myDAQ device and then connect the respective sensor for each lab to Channel 1 of the adapter. When you are using two sensors, you can use Channel 1 and Channel 2 at the same time. Be sure to select the channel that you want to read in the LabVIEW software program.

Sensor adaptors

Adaptor for Elvis

Adaptor for MyDaq

Experiment 3: Pulse measurement using reflectance plethysmography

I. Objective:

- Heart rate refers to the speed of the heartbeat, specifically the number of heartbeats per unit of time.
- Heart rate varies based on the needs of the body at any given time.
- A normal resting heartbeat for a human adult ranges between 60 and 100 beats per minute (BPM).
- A lower resting heart rate generally implies better health.

II. Test Standard:

EEE C37.14-1979 - IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures

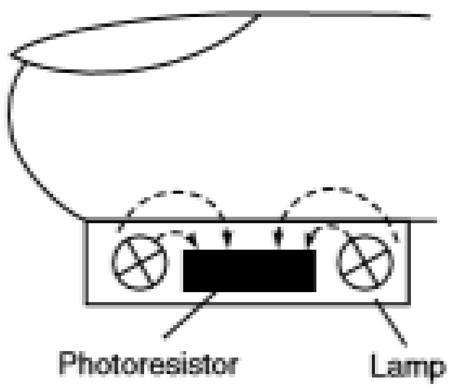
III. Theory:

PTN-104 Pulse Plethysmograph

The PTN-104 plethysmograph, with MINI DIN 7 connector, is a sensitive, rugged, nonmagnetic accelerometer, ideal for classroom use. The pulse sensor, the PTN-104 produces a signal from which rates and relative pressure information can be computed. The real-time integral of this signal is identical to volume pulse signals recorded with more expensive infrared pulse plethysmographs.

Reflectance method

The arrangement used in the reflectance method of photoelectric plethysmography is as follows. The photoresistor, in this case, is placed adjacent to the exciter lamp. Part of the light rays emitted by the LED is reflected and scattered from the skin and the tissues and falls on the photoresistor. The quantity of light reflected is determined by the blood saturation of the capillaries and, therefore, the voltage drop across the photoresistor, connected as a voltage divider, will vary in proportion to the volume changes of the blood vessels.



Reflectance method

PTN-104 Pulse Plethysmograph

IV. Apparatus:

- Bioinstrumentation Sensor - iWorx PTN-104 pulse sensor
- LabVIEW – Software
- NI MYDAQ

V. Procedure:

- Connect and calibrate your hardware system.
- Start LabVIEW. Then navigate to and launch the iWorx-Pulse VI that is located in the Labs & Examples project (.lvproj).
- Click the Run button to run the LabVIEW Pulse VI.
- Click Set Up to display the setup instructions.
- Follow the instructions for the pulse sensor to set up and calibrate the pulse sensor.
- Secure the pulse sensor (plethysmograph) on the volar surface (where the fingerprints are located) of the left middle finger.
- Wrap the Velcro strap around the end of the finger to attach the unit firmly in place.

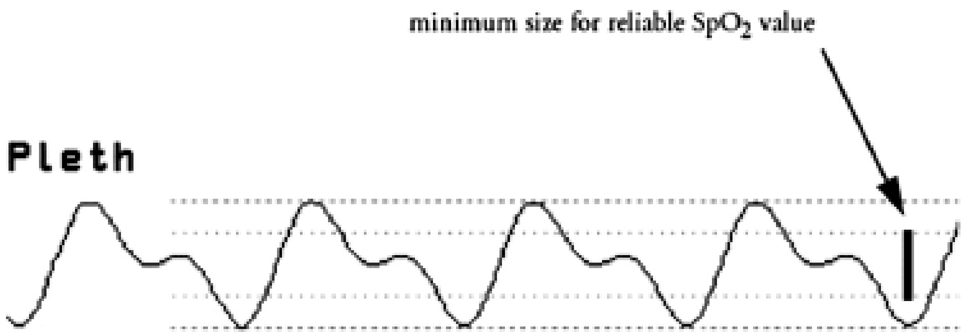
VI. Experimental Work:

<u>Measure Resting Heart Rate</u>

- Ensure the subject has been sitting still for 5 to 10 minutes prior to taking a measurement.
- While the subject remains completely still, with the pulse sensor attached, run the iWorx Pulse VI and record the subject's pulse until the pulse signal crosses the entire chart.

- Click Snapshot and save the data to a convenient location on disk. Make sure to give the file a helpful name such as Resting HR.
- Record the respective values.
- Do the required calculations

Model waveform



Tabulation

No	Amplitude	Time period

References:

LabVIEW manual

Experiment 4: Circulation measurement using Sphygmomanometer and plethysmograph.

I. Objective:

In this lab, use the iWorx pulse and blood pressure sensors to observe how the heart responds to the increased demand for oxygen to the muscles during exercise. Measure and analyze the heart rate and blood pressure of a human subject at rest and directly after exercise to gather the data you need to determine target heart rate and exercise efficiency, as well as to analyze the effects of factors that can influence heart rate and blood pressure

II. Test Standard:

EEE C37.14-1979 - IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures

III. Theory:

Knowing your heart rate and blood pressure before, during, and after exercise can help you become aware of your cardiovascular health so you can make safe changes to gain optimal health benefits from exercise. It also helps you detect changes in your heartbeat and blood pressure so you can act if something is wrong. Arrhythmias, palpitations, and ectopic heartbeats are irregular heartbeat rhythms that indicate a serious heart condition and should be addressed by a doctor right away. Blood pressure that rises too high or does not return to normal after exercise also indicates a serious problem that needs to be addressed.

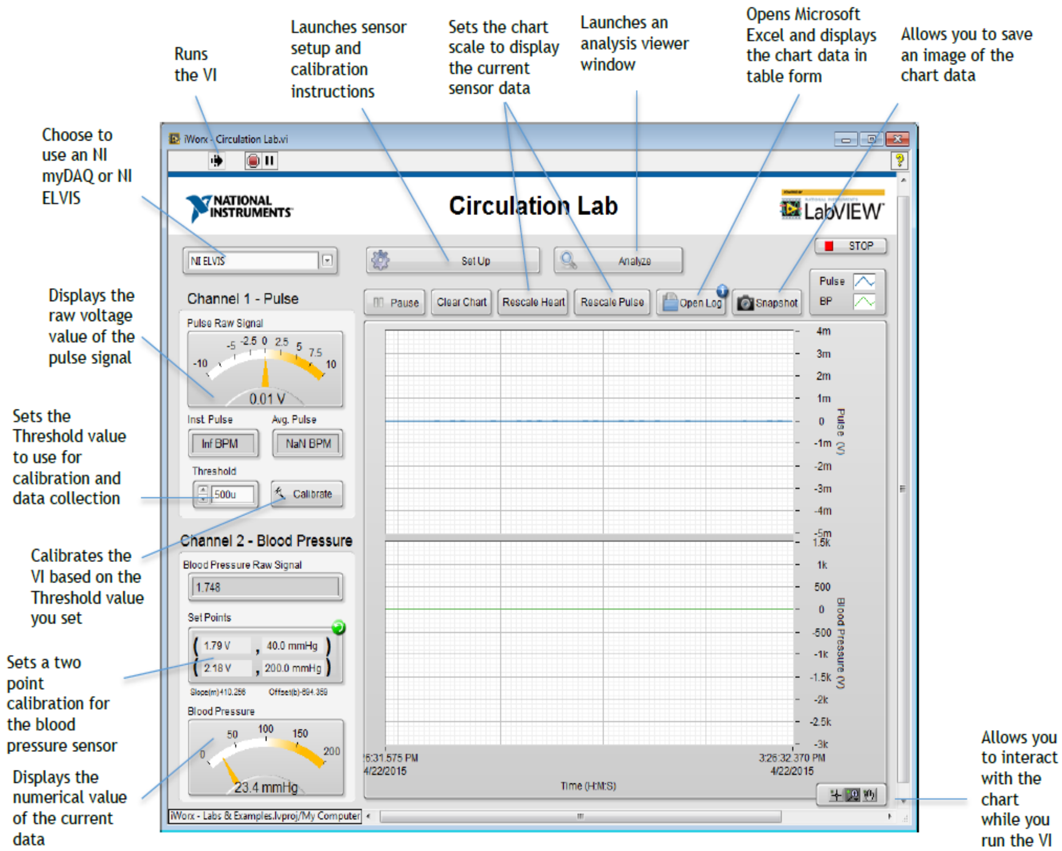
There is no correlation between heart rate (pulse) and blood pressure. Blood pressure is the force of the blood against the walls of arteries, and heart rate is the number of times your heart beats per minute. A rise in heart rate during exercise does not indicate a rise in blood pressure because healthy blood vessels dilate (get larger) to allow more blood to flow through. This is why you must take separate and specific measurements for pulse and then blood pressure.

Heart rate refers to the speed of the heartbeat, specifically the number of heartbeats per unit of time. Heart rate varies based on the needs of the body at any given time. A normal resting heartbeat for a human adult ranges between 60 and 100 beats per minute (BPM). A lower resting heart rate generally implies better health.

As stated above, blood pressure refers to the force of the blood against the walls of arteries. When the heart pumps blood into the arteries, there is a sudden increase in pressure in the arteries. The highest level of pressure that occurs immediately after the ventricles contract is known as the systolic blood pressure (top number in the reading). The pressure in the arteries slowly declines as the heart relaxes. The lowest level of pressure that occurs just prior to the next contraction of the ventricles is known as the diastolic blood pressure (bottom number in the reading). A normal blood pressure reading for a human adult ranges between 90/50 mmHg and 130/80 mmHg. Keep in mind that many factors can influence both heart rate and blood pressure including:

- Activity level
- Fitness level
- Air temperature
- Body position (standing up or lying down, for example)
- Emotions
- Body size
- Medications

Example VI Explanation



In LabVIEW, you can select <Ctrl-E> to view the block diagram, or code, of the lab VI and the annotations that explain how it works.

Precautions

- Know what you are doing ahead of time.
- Do not leave the pressure cuff inflated for any prolonged period (>20 seconds).
- Wait at least one minute before repeating measurements. Always deflate the cuff completely. The subject should flex and extend their fingers between experiments to maintain blood flow.
- This experiment should be conducted on healthy individuals who do not have a personal or family history of cardiovascular or respiratory problems.

Calibration

- Connect and calibrate your hardware system.
- Before you begin this section, instruct the subject to:

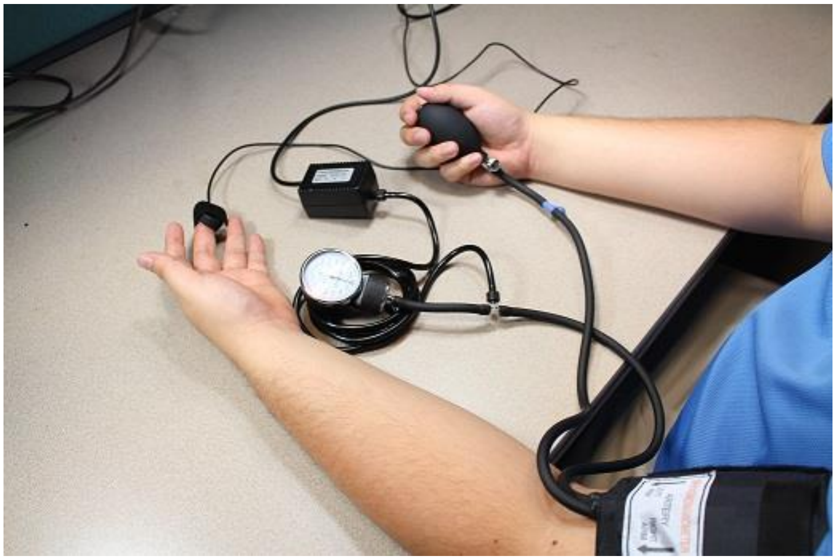
- Lie down or sit still and quiet and breathe normally for 5 to 10 minutes to reach a resting heart rate.
- Remain completely still until the calibration and resting heart rate measurement is complete.

IV. Apparatus:

- iWorx PTN-104 pulse sensor – Connect to channel 1 of the iWorx sensor adapter.
- iWorx BP-200 blood pressure sensor connected to the GPSN-100 pressure sensor and A-BT-100 tubing – Connect to channel 2 of the iWorx sensor adapter.

V. Procedure:

- Start LabVIEW. Then navigate to and launch the **iWorx-Circulation VI** (.vi) that is located in the **Labs & Examples** project (.lvproj).
- Refer to the screenshot at the beginning of this lab for an explanation of the front panel, or user interface, of the lab VI. In LabVIEW, you can select <Ctrl-E> to view the block diagram, or code, of the lab VI and the annotations that explain how it works.
- Click the **Run** button to run the LabVIEW Circulation Lab VI.
- Click **Set Up** to display the setup instructions.
- Follow the instructions that appear to set up and calibrate the blood pressure sensor.
- Place the blood pressure cuff around the upper portion of the left arm, approximately 2 cm above the elbow. The two rubber hoses from the cuff should be positioned over the brachial artery (biceps muscle) and not under the arm.
- Follow the instructions for the pulse sensor to set up and calibrate the pulse sensor.
- Secure the pulse sensor (plethysmograph) on the volar surface (where the fingerprints are located) of the left middle finger. Wrap the Velcro strap around the end of the finger to attach the unit firmly in place.



Measure Resting Heart Rate

- Ensure the subject has been lying or sitting still for 5 to 10 minutes prior to taking a measurement.
- While the subject remains completely still, with the pulse sensor attached, run the iWorx Circulation Lab VI and record the subject's pulse until the pulse signal crosses the entire chart.
- Click **Snapshot** and save the data to a convenient location on disk. Make sure to give the file a helpful name such as *Resting HR*.
- Click **Analyze** to launch the Analysis window.
- View and interact with the data through the Analysis window to understand the signal you are recording. Adjust the cursors on the chart to analyze specific parts of the signal.
- Record the respective values in **Table 1**.

VI. Experimental Work:

Calculate Target Heart Rate

To maximize the health benefits of cardiovascular activity, you need to exercise within the zone of your target heart rate. A person's target heart rate for cardiovascular exercise is generally 60 percent to 80 percent of his or her maximum heart rate. However, there are various heart rate zones defined based on their benefits. Complete the chart to determine the target heart rate of the test subject.

- **Max heart rate**—Subtract age from 220. Max heart rate = __________ example: 220 – age 40 = 180 BPM
- **Heart rate reserve**—Subtract resting heart rate from max heart rate.
  - Heart rate reserve = __________ example: 180 max BPM – 63 resting BPM = 117 bmp
- **Lower heart rate limit**—multiply heart rate reserve by .6 to determine 60% of heart rate reserve and then add resting heart rate.
  - Lower target heart rate limit = __________ example: (117 x .6) + 63 resting = 133 lower limit BPM
- **Upper heart rate limit**—multiply heart rate reserve by .8 to determine 80% of heart rate reserve and then add resting heart rate.
  - Upper target heart rate limit = __________ example: (117 x .8) + 63 resting = 157 upper limit BPM
- **Target heart rate**—Average the lower and upper limit heart rates to find the target heart rate.
  - Target heart rate = ___________________ example: (133 + 157) / 2 = 145 BPM
- **Record the data**—Record the respective values

Measure Blood Pressure

Caution: Read through all the steps before you begin, to ensure the safety of the test subject. Ensure the subject has been lying still for 5 to 10 minutes prior to taking the initial measurement.

Systolic and Diastolic Pressure

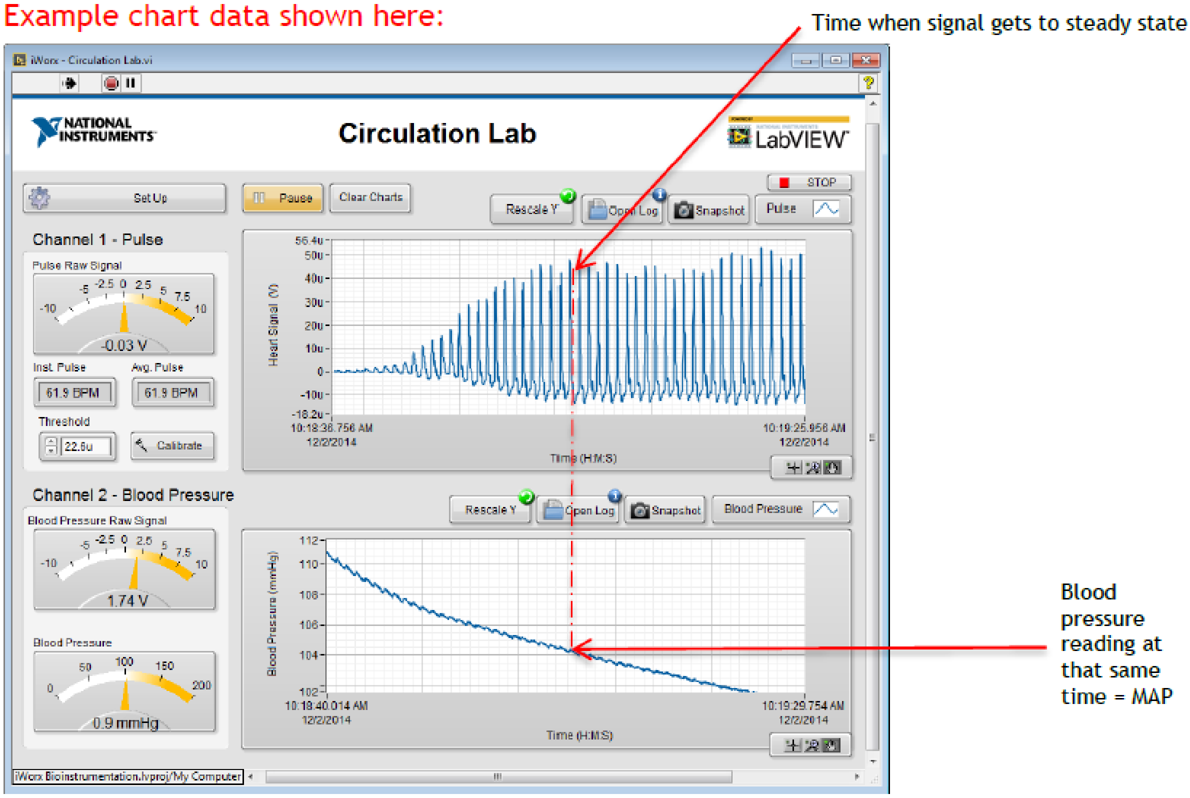
To determine systolic and diastolic pressure, utilize the following equation for **mean arterial pressure**.

- ***Mean arterial pressure*** **(MAP)** is a useful measure of the adequacy of tissue perfusion (amount of blood available to the tissue being measured). This is not a simple average of systolic and diastolic blood pressures because diastole continues for twice as long as systole. MAP can be reasonably approximated using the equation: $(systole+2(diastole))3=MAP$
- MAP is directly proportional to cardiac output and inversely proportional to total peripheral resistance, where:
- ***Cardiac output*** is the amount of blood pumped out of the heart with each beat (called the *stroke volume*) multiplied by the number of beats per minute.

- ***Total peripheral resistance*** depends on the blood viscosity, length of the arterial system, diameter and elasticity of the blood vessels, and pressure entering versus leaving the arterial system (systolic pressure minus the pressure in the venous system).
- While the subject remains completely still, place the blood pressure cuff around the upper portion of the left arm, just above the elbow. Ensure the pulse sensor is secure on the volar surface of the left middle finger. Wrap the Velcro strap around the end of the finger to attach the unit firmly in place.
- Run the LabVIEW Circulation Lab VI.
- Close the airflow valve on the bulb by turning the screw clockwise.
- While watching the pulse graph, inflate the pressure cuff slowly until you can no longer see the pulse data in the pulse graph. Record the Blood Pressure reading here: ______________
- This reading is the systolic pressure (the force of the blood against the artery walls as the heart beats).
- Deflate the cuff to 120 mmHg and then very slowly continue to deflate the cuff further until the **Pulse** data gets to a steady state.
- Immediately click **Snapshot** to record the data.
- Record the **Blood Pressure** data at the same point in the chart as the point when the pulse reached its steady state. Record the blood pressure here: ______________

This reading is the Mean Arterial Pressure (MAP).

Example chart data shown here:



- Insert the systolic and MAP measurements in the equation below and solve for diastolic pressure (D).
- Example equation: $(123+2(diasDtole))3=105$ D=96
- This the diastolic pressure (the blood pressure between heartbeats).
- Deflate the pressure cuff completely. Pause the LabVIEW Circulation Lab VI. The subject should remain lying or sitting down between measurements and exercises.

Caution: If you need to retake the measurement, do not re-inflate the cuff right away. Wait at least one minute before repeating the measurement.

Analyze the Effects of Exercise on Blood Pressure and Pulse

- Complete the steps below and record the data in Table 1.
- Reposition the blood pressure cuff around the upper portion of the left arm, just above the elbow. Reposition the pulse plethysmograph on the volar surface of the distal segment of the left middle finger. Wrap the Velcro strap around the end of the finger to attach the unit firmly in place.

- Use the same procedures outlined above to record the subject’s blood pressures from his or her upper left arm.
- After recording the subject’s resting blood pressure, remove the blood pressure cuff and pulse plethysmograph from the subject. Leave these devices connected to the iWorx sensor adapter.
- Instruct the subject to exercise vigorously enough to elevate his or her heart rate. Approximately two minutes of walking up and down stairs or doing jumping jacks are suitable exercises.
- Immediately after exercising, the subject should sit in a chair. Other members of the group should attach the pulse plethysmograph and blood pressure cuff to the subject as done in previous steps.
- Run the LabVIEW Circulation Lab VI inflate the cuff and click **Snapshot** to record the data needed to determine the subject’s blood pressure immediately after exercising. Name the file something helpful such as *BP and HR after Exercise 1*. After the data is recorded:
- Deflate the blood pressure completely.
- Monitor the subject’s heart rate by continuing to observe the data in the LabVIEW Circulation VI.
- Every 30 seconds after the beginning of the recovery period, inflate the blood pressure cuff and observe the subject’s blood pressure and pulse. The readings should begin to decrease.
- Continue to observe the subject’s blood pressure and pulse until the readings are similar to the resting pressure and pulse.

➢ Click **Snapshot** to record the new resting blood pressure and resting pulse. Name the file something helpful, such as Resting BP and HR 2.

➢ Click Exit to stop the LabVIEW Circulation Lab VI.

➢ Use the data that you collected to complete Table 1. Use the information in Table 2 to determine the blood pressure class.

Table 1. Heart Rate and Blood Pressure Data

Subject Name or ID: ________________________	Resting Heart Rate: __________		
	Heart Rate (BPM)	Systolic Pressure (mmHg or kPa)	Diastolic Pressure (mmHg or kPa)
At Rest			
End of Exercise 1			
End of Recovery 1			
End of Exercise 2			
End of Recovery 2			

References:

LabVIEW manual

Experiment. 5 Heart sounds measurement using Auscultation technique.

I. Objective:

To record the heart sounds from different points around the chest of a resting subject

II. Test Standard:

EEE C37.14-1979 - IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures

III. Theory:

A Phonocardiogram or PCG is a plot of high fidelity recording of the sounds and murmurs made by the heart with the help of the machine called phonocardiograph, or "Recording of the sounds made by the heart during a cardiac cycle". The sounds are thought to result from vibrations created by closure of the heart valves. There are at least two: the first when the atrioventricular valves close at the beginning of systole and the second when the aortic valve closes at the end of systole. It allows the detection of sub audible sounds and murmurs and makes a permanent record of these events. In contrast, the ordinary stethoscope cannot detect such sounds or murmurs, and provides no record of their occurrence. The ability to quantitate the sounds made by the heart provides information not readily available from more sophisticated tests and provides vital information about the effects of certain cardiac drugs upon the heart. It is also an effective method for tracking the progress of the patient's disease.

Heart sounds are classified into four groups based on their mechanism of origin, they are

1. Valve closure sound

2. Ventricular filling sound

3. Valve opening sounds and

4. Extra cardiac sounds

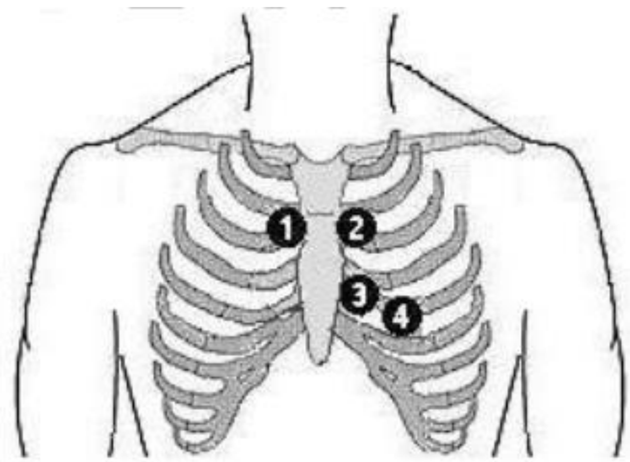


Figure HH-8-L1: Positions of the auscultation areas on the chest: 1-Aortic, 2-Pulmonic, 3-Tricuspid, 4-Mitral.

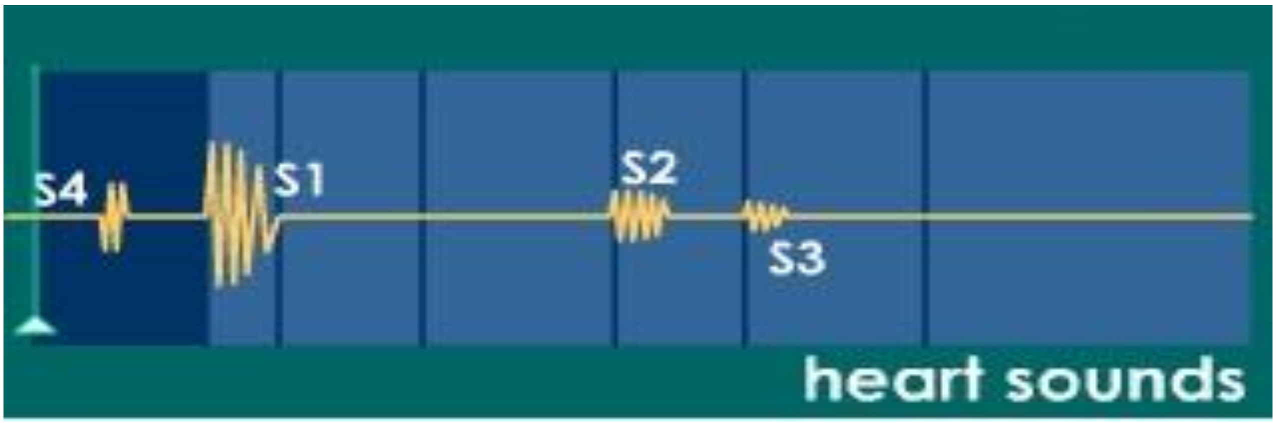
1. Aortic, which is located in the second intercostal space at the right sternal margin, at this location, the systolic murmurs of aortic stenosis and increased aortic valve flow are the loudest.
2. Pulmonic, which is located in the second intercostal space at the left sternal border, at this location, the systolic murmur of pulmonic stenosis and the diastolic murmur of pulmonic regurgitation are the loudest.
3. Tricuspid, which is located at the lower left sternal border. At this location, the diastolic murmur of tricuspid stenosis is the loudest.
4. Mitral, which is usually located in the fifth intercostal space, at the apex beat. At this location, the systolic murmur of mitral regurgitation, and the diastolic murmurs of mitral stenosis and increased valvular flow, are the loudest.

Overview

The HSM-300 is a simple device, which converts the sound waves, created by the heart valves opening and closing, into voltages, which can be recorded and displayed. A piezo-electric sensor mounted on the side of the HSM-300 picks up the vibrations that are created by the heart sounds. The piezo crystals on the sensor convert the changes in pressure created by the vibrations into voltages. These voltages are usually recorded along with the ECG of the subject to identify the specific heart sounds that occur during ventricular contraction and relaxation.

How It Works

The sensing element of the HSM-300 is placed on the chest of the subject at one of the four prescribed auscultation areas. These areas are located over the sections of the heart and large vessels containing the valves that create the heart sounds that can be heard with a stethoscope. The sensor of the HSM-300 picks up the low frequency sound waves of the heart sounds and converts these waves into voltages that can be seen on a computer screen. The output of the HSM-300 is amplified so that the recorded waves are about 1V in amplitude.



- The two major audible heart sounds in a normal cardiac cycle are the first and second heart sound, *S1* and *S2*
- S1 occurs at the onset of the ventricular contraction during the closure of the AV-valves. It contains a series of low frequency vibrations and is usually the longest and loudest heart sound. The audible sub-components of S1 are those associated with the closure of each of the two AV-valves.
- S2 is heard at the end of the ventricular systole, during the closure of the semilunar valves. Typically, its frequency is higher than S1, and its duration is shorter. It has aortic and pulmonary sub-components.
- A third low-frequency sound (*S3, ventricular gallop*) may be heard at the beginning of the diastole, during the rapid filling of the ventricles. A fourth heart sound (*S4, atrial gallop*) may be heard in late diastole during atrial contraction.
- Opening snaps of the mitral valve or ejection sound of the blood in the aorta may be heard in case of valve disease (stenosis, regurgitation)

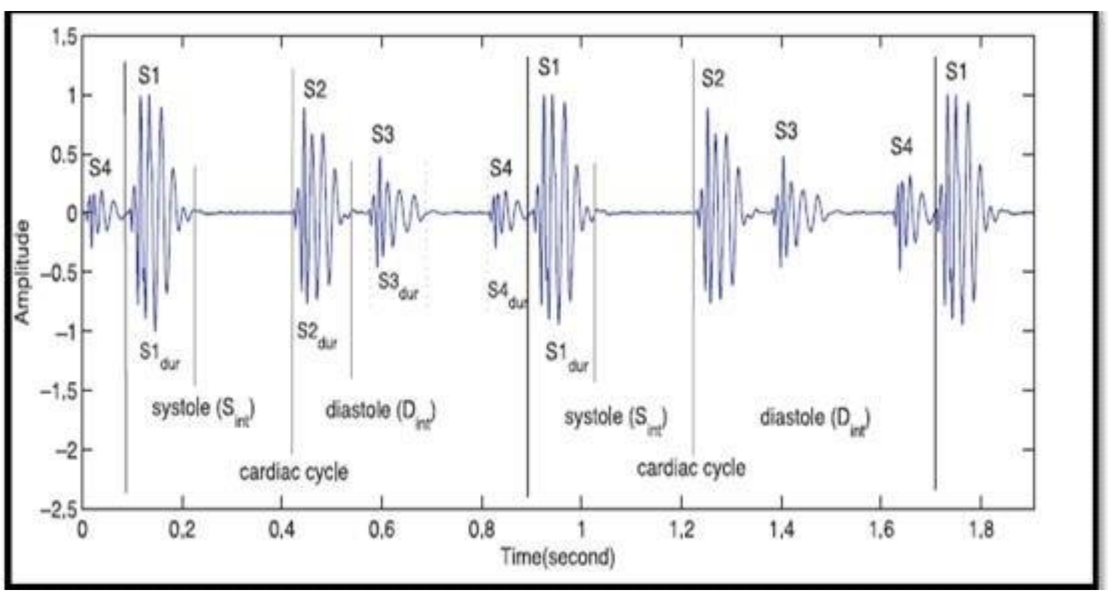
- Murmurs are high frequency, noise-like sounds that are heard between the two major heart sounds during systole or diastole. They can be innocent but can also indicate certain cardiovascular defects.

IV. Apparatus:

- HSM-300
- NI MyDaq
- SPN-304 flow head
- LabVIEW interface

V. Procedure:

- Place the SPN-304 in the Heart Sounds mode, using the switch.
- Connect the HSMN-304 to the white connector of the SPN-304. Optionally, Plug the Red input of the SPN-304 using the RED blocking cap.
- Open Heartsounds.vi interface
- Calibrate the sensor.
- Measure S1, S2, S3 and S4
- Plot them



VI. Experimental Work:

Tabulation

Resting	Sounds	Amplitude	Time period
	S1		
	S2		
	S3		
	S4		

Observation:

References:

LabVIEW manual

Experiment. 6 Respiration rate measurement Displacement Pneumography

I. Objective:

To plot the respiration rate graph for the subject.

II. Test Standard:

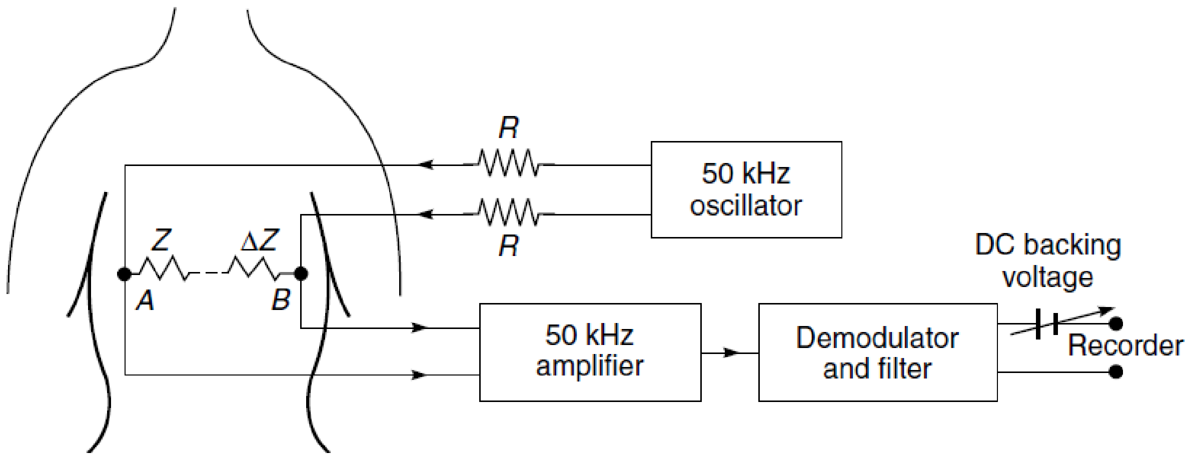
EEE C37.14-1979 - IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures

III. Theory:

The primary functions of the respiratory system are to supply oxygen and remove carbon dioxide from the tissues. The action of breathing is controlled by a muscular action causing the volume of the lung to increase and decrease to affect a precise and sensitive control of the tension of carbon dioxide in the arterial blood. Under normal circumstances, this is rhythmic action with the result that the respiration rate provides a fairly good idea about the relative respiratory activity. Several techniques have been developed for the measurement of the respiration rate. The choice of a method depends mostly upon the ease of application of the transducer and them acceptance by the subject under test.

Impedance pneumography

This is an indirect technique for the measurement of respiration rate. Using externally applied electrodes on the thorax, the impedance pneumograph measures rate through the relationship between respiratory depth and thoracic impedance change. Impedance method for measuring respiration rate consists in passing a high frequency current through the appropriately placed electrodes on the surface of the body and detecting the modulated signal. The signal is modulated by changes in the body impedance, accompanying the respiratory cycle. The electrode used for impedance pneumograph are of the self-adhesive type. Contact with the skin is made the electrode cream layer for minimizing motion artefacts. The electrodes, when the skin is properly prepared, offer an impedance of 150 to 200 W. The change in impedance corresponding to each respiratory cycle is of the order of 1% of the base impedance.



IV. Apparatus:

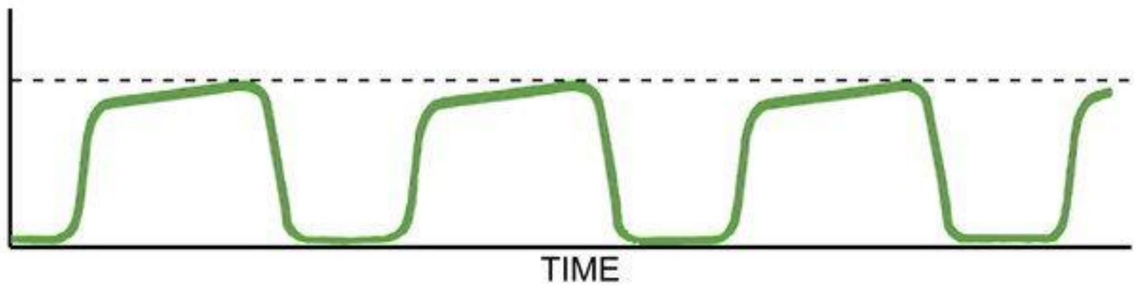
- The RMN-204- Respiration Monitor
- LabVIEW interface
- NI MYDAQ

V. Procedure:

- Take the RMN-204 and hold the belt up, it should be orientated so that the pouch velcroed to the belt is facing the subject.
- Place the sensor so that it is resting on the subjects' sternum and wrap the belt around the subject.
- The belt should be tight enough to resist falling, but not so tight as to restrict the subjects' ability to breathe comfortably.
- Plug the IX-ELVIS board into the National Instrument ELVIS platform.
- Connect the power supply to the ELVIS platform and connect to the computer via a USB cable.
- Ensure both switches are in the on position.
- Connect the MINIDIN7 connector of the RMN-204 to the MyDAQ .
- Open the recording software, select the channel that the RMN-204 is plugged into and ensure the range is set to +/-5V.
- Record and monitor the subjects breathing. As the subject breathes in the voltage should rise, and as the subject breathes out the voltage should fall.
- Clear the chart and breathe in and exhale 3 times, so three peaks are shown on the chart.

- Press the Calibrate button to set the threshold limits.

Model graph



VI. Experimental Work:

Tabulation

Respiration rate	Amplitude(v)	Time period(s)

Observation

References:

LabVIEW manual

Experiment. 7 Heart rate measurement using Telemetry.

I. Objective:

To plot the Heart Rate graph for the subject.

II. Test Standard:

EEE C37.14-1979 - IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures

III. Theory:

The heart rate meters, which are a part of the patient monitoring systems, are usually of the average reading type. They work based on converting each R wave of the ECG into a pulse of fixed amplitude and duration and then determining the average current from these pulses. They incorporate specially designed frequency to a voltage converter circuit to display the average heart rate in terms of beats per minute.

Sensor setup

With the PHRMN100, the voltage changes that take place during an electrocardiogram are picked up by two electrodes on the inside of a band around the subject's chest. The transmitter connected to the electrodes transforms these voltages into simple coded signals. The transmitter broadcasts the coded signals to a receiver that is connected to the data recording system. Since the frequency of the coded signals from the transmitter correspond to the heart rate of the subject, a periodic rate function in the recording software is used to convert the frequency of the coded signals into a display of the subject's heart rate. This technology enables relatively noise-free heart rate determination to be made from resting or exercising subjects.

IV. Apparatus:

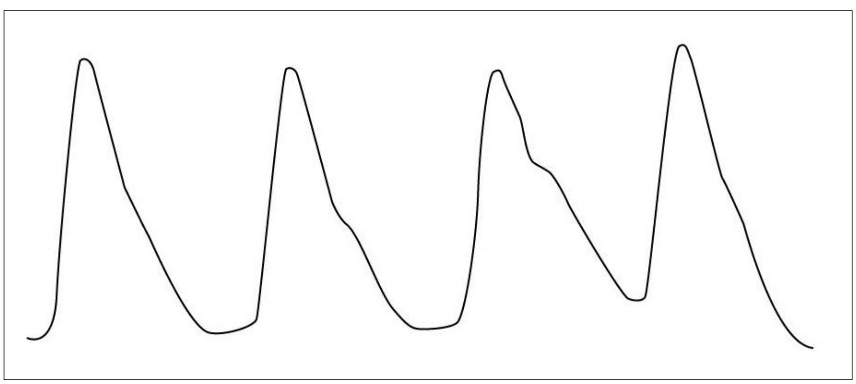
- LabVIEW interface
- NI MYDAQ
- PHRMN-100 Polar Heart Rate Monitor

V. Procedure:

- Detach the WearLink™ coded transmitter from the sensor band.

- Moisten the electrode areas of the sensor band under warm running water. Make sure these areas are well moistened.
- Adjust the length of the sensor band to fit snugly and comfortably around the chest of the subject. Secure the sensor band around the subject's chest so that the electrodes are just below the chest muscles.
- Attach the transmitter to the sensor. The PolarTM logo should be upright. Adjust the sensor band so that the transmitter is in the center of the chest.
- Check that the wet electrode areas of the sensor band are firmly against the subject's skin.
- Set up the receiver so that it is no more than 1 meter away from the transmitter. Use the supplied extension cable if necessary.
- Connect the power supply to the MYDAQ and connect to the computer via a USB cable. Ensure both switches are in the on position.
- Connect the MINIDIN7 connector of the PHRMN-100 to the MYDAQ.
- Open the recording software, select the channel that the PHRMN100 is plugged into and ensure the range is set to +/-5V.
- Press record. Once you see the heart signal on the waveform chart, press the Calibrate button to automatically set the threshold.

Model waveform:



VI. Experimental Work:

Heart rate	Amplitude	
	Time period	

Heart rate ___________________________________

Observation:

References:

LabVIEW manual

Experiment. 8 Measurement of ECG using 3-Lead technique.

I. Objective:

To measure the amplitude and time period of ECG of a resting subject

II. Test Standard:

EEE C37.14-1979 - IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures

III. Theory:

The cardiac cycle involves the sequential contractions of the atria and the ventricles, which are triggered by action potentials in the myocardial cells. The combined electrical activity of the myocardial cells produces electrical currents that spread through the body fluids. These currents are large and detectable by recording through electrodes placed on the skin. The regular pattern of signals produced by the heart is called the electrocardiogram or ECG.

The components of the ECG are correlated to electrical activity in the atria and ventricles such that:

- Atrial depolarization produces the P wave.
- Atrial repolarization and ventricular depolarization produce the QRS complex.
- Ventricular repolarization produces the T wave.

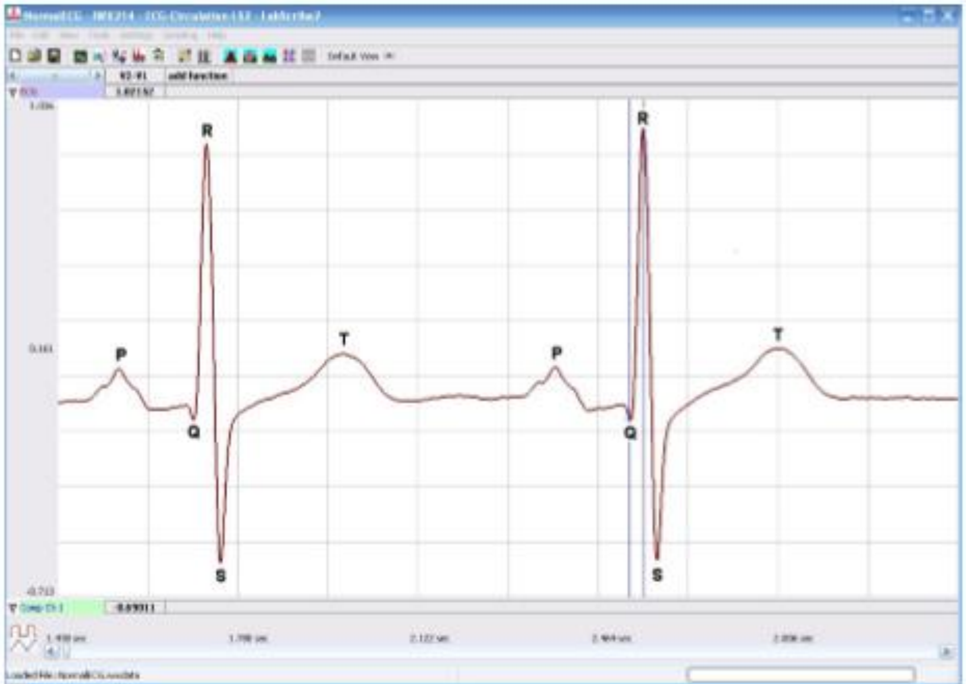


Figure 1: ECG recording displayed in the Main window with labels showing the P, QRS, and T waves

IV. Apparatus:

- C-ISO-256
- NI ELVIS Board
- LabScribe Interface
- IX-ELADP
- ECG electrodes

V. Procedure:

IX-ELVIS Setup

1. Place the IX-ELVIS unit on the bench, close to the computer.
2. Connect the IX-ELVIS to the computer with the supplied USB cable.
3. Insert the power plug into the rear of the IX-ELVIS and plug the transformer into the electrical outlet.
4. Turn on the power switches on the rear and on the upper right side of the top of the unit and confirm that the LEDs are illuminated.

5. Connect the sensor adapter to the ELVIS top board.
6. In order to power the sensor adapter board, connect the two ground pins on the sensor adapter board to the ground pin on the ELVIS topboard (brown wires).
7. Connect the -15VDC pin on the sensor adapter board to the -15 V DC power supply on the ELVIS topboard (green wire).
8. Connect the +5 VDC pin on the sensor adapter board to the 5 V DC power supply on the ELVIS topboard (yellow wire).
9. In order to take measurements using the sensor adapter board with your ELVIS, connect the A_1+ and A_1- pins on the sensor adapter board to the AI 0+ and AI 0- pins on the ELVIS topboard (red and black wires).
10. Next, connect A_2+ and A_2- on the sensor adapter board to AI 1+ and AI 1- on the ELVIS topboard (red and black wires).
11. This will connect channel 1 and channel 2 on the sensor adapter board to AI 0 and AI 1 on the ELVIS topboard, respectively

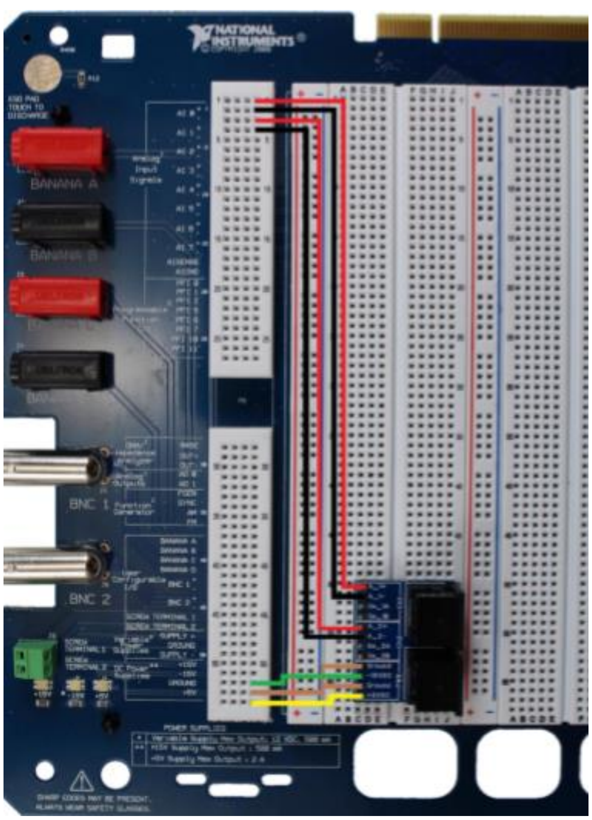


Figure 2: NI elvis II with connections

Start the Software

1. Click on the LabScribe icon on the Desktop, or click the Windows Start menu, click Programs and open the iWorx folder and select LabScribe.
2. When the program opens, select Load Group from the Settings menu.
3. When the dialog box appears, select ELVISNI.iwxgrp and then click OK.
4. Click on the Settings menu again and select the ECGHeartSounds-LS2 settings file from the Cardiac Physiology folder.
5. After a short time, LabScribe will appear on the computer screen as configured by the ECGHeartSounds-LS2 settings.
6. The settings used to configure the LabScribe software and the IX-ELVIS for this experiment are programmed on the Preferences Dialog window, which can be viewed by selecting Preferences from the Edit menu on the LabScribe Main window.

ECG Electrodes Setup

1. Locate the electrode lead wires, Insert the connectors on the red, black, and green electrode lead wires into the matching sockets of Channel 1 of the IX-ELVIS
2. Instruct the subject to remove all jewelry from their wrists and ankles
3. Remove a disposable ECG electrode from its plastic shield, and apply the electrode to the scrubbed area on the wrist.
4. Repeat for the inside of the left wrist and the inside of the right ankle.
5. Snap the lead wires onto the electrodes, so that:
    1. The red (+1) lead is attached to the left wrist,
    2. The black (-1) lead is connected to the right wrist,
    3. The green (C or ground) lead is connected to the right leg.
6. Instruct the subject to sit quietly with their hands in their lap. If the subject moves, the ECG trace will move off the top or bottom of the screen. If the subject moves any muscles in the arms or upper body, electromyograms (EMGs) from the muscles will appear on the ECG recording as noise.

The ECG electrode leads connected to disposable electrodes

The ECG in a Resting Subject

1. Click on the Record button, located on the upper right side of the LabScribe Main window. The signal should begin scrolling across the screen.

(Note: If the user clicks the Record button and there is no communication between the IX ELVIS and computer, an error window will appear in the center of the Main window. Make sure the IX-ELVIS is turned on and connected to the USB port of the computer. Click OK and select the Find Hardware function from the LabScribe Tools menu.)

2. Click on the AutoScale button at the upper margin of the ECG channel.
3. If the signal on the ECG channel is upside down when compared to trace, click on the downward arrow to the left of the channel title and select the Invert function. The trace should now look similar to the one in the figure.
4. If a larger signal is required, the electrodes should be moved from the wrists to the skin just below each clavicle.
5. When you have a suitable trace, type “<Subject’s Name> Resting ECG” in the Mark box to the right of the Mark button. Press the Enter key on the keyboard to attach the comment to the data. Record for a minute or two.
6. Click Stop to halt recording.

7. Select Save As in the File menu and type a name for the file. Choose a destination on the computer in which to save the file. Designate the file type as *.iwxdata.
8. Click on the Save button to save the data file.

Analysis

1. Scroll through the recording and find a section of data with four to six good ECG cycles in succession.
2. Use the Display Time icons to adjust the Display Time of the Main window to show at least four complete ECG cycles on the Main window.
3. Four adjacent ECG cycles can also be selected by:
    a. Placing the cursors on either side of a group of four complete ECG cycles; and
    b. Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the segment with the four selected ECG cycles to the width of the Main window.
4. Click on the Analysis window icon in the toolbar or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window

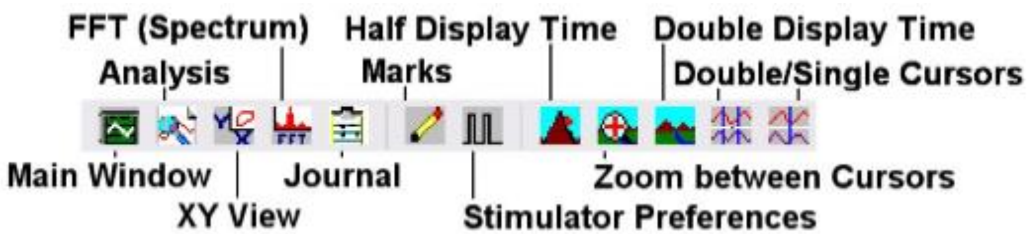


Figure 4: The LabScribe toolbar

5. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The names of the mathematical functions used in the analysis, V2-V1 and T2-T1, appear in this table. The values for V2-V1 and T2-T1 from each channel are seen in the table across the top margin of each channel.
6. Once the cursors are placed in the correct positions for determining the amplitudes and the beat period on each ECG cycle, the values of these amplitudes and the time interval can be recorded in LabScribe by typing their names and values directly into the Journal, or on a separate data table.
7. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the parameters from the recording to the Journal.
8. To use these functions:

a. Place the cursors at the locations used to measure the amplitudes and period of the ECG cycle.
b. Transfer the names of the mathematical functions used to determine the amplitudes and time interval to the Journal using the Add Title to Journal function in the ECG Channel pulldown menu.
c. Transfer the values for the amplitudes and beat period to the Journal using the Add Ch. Data to Journal function in the ECG Channel pull-down menu.

9. Use the mouse to click on and drag the cursors to specific points on the ECG recording to measure the following.
    a. The R wave amplitude: To measure the R wave amplitude, place one cursor on the Q wave that precedes the R wave and the second cursor on the peak of the R wave. The value for V2-V1 on the ECG channel is this amplitude. Measure the amplitudes of two additional R
    b. The P wave amplitude: To measure the P wave amplitude, place one cursor on the baseline that precedes the P wave and the second cursor on the peak of the P wave. The value for V2V1 on the ECG channel is this amplitude. Measure the amplitudes of two additional P waves.
    c. The T wave amplitude: To measure the T wave amplitude, place one cursor on the baseline that precedes a P wave and the second cursor on the peak of the T wave that is in the same cycle as that P wave. The value for V2-V1 on the ECG channel is this amplitude. Measure the amplitudes of two additional T waves
    d. The beat period, which is the time interval between two adjacent R waves: To measure the beat period, place one cursor on the peak of an R wave and the second cursor on the peak of the adjacent R wave. The value for T2-T1 on the ECG channel is the beat period. Measure the beat period for two additional pairs of R waves.
10. Calculate the following values and type your results into the Journal, or on a separate data sheet:
    a. The average amplitudes of the P wave, the R wave, and the T wave.
    b. The average beat period, in seconds/beat.

c. The heart rate, which is expressed in beats per minute and calculated from the average beat period by using the following equation.

Heart Rate (beats/minute) = 60 seconds/minute / # seconds/beat

Figure 5: ECG recording displayed in the Analysis window. Lines and labels were added to indicate the locations where cursors should be placed to measure the amplitudes of R (Q-R), P (Baseline-P), and T (Baseline-T) waves.

VI. Experimental Work:

Tabulation

	Amplitude	Average	Time period
P wave			

R wave			
T wave			
Beat period			

Heart rate =

Observations

References:

LabVIEW manual

Experiment. -9 Measurement of EEG using 3-Electrode technique.

I. Objective:

- Learn to collect EEG signals from the left and right cerebral hemispheres.
- learn to recognize common EEG artifacts caused by movements such as eye blinks, facial muscle contractions, and head movement.
- learn to recognize and analyze Alpha and Beta EEG patterns associated with closed and open eye conditions.

II. Test Standard:

EEE C37.14-1979 - IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures

III. Theory:

The EEG is a continuous recording of waves of varying frequency and amplitude. The number of wave cycles or peaks that occurs in an EEG pattern in a set period of time is its frequency. One EEG wave cycle occurring in a second of time is known as a Hertz (Hz). The amplitude of the EEG pattern is the strength of the pattern in terms of microvolts of electrical energy. There are four basic EEG frequency patterns as follows: Beta (14-30 Hz), Alpha (8-13 Hz), Theta (4-7 Hz), and Delta (1-3 Hz). In general, the amplitude of the EEG increases as the frequency decreases.

IV. Apparatus:

- Computer
- IX-ELVIS
- USB cable
- Power supply
- Red, black, and green EEG leads.
- EEG electrodes

V. Procedure:

<u>IX-ELVIS Setup</u>

1. Place the IX-ELVIS unit on the bench, close to the computer.

2. Connect the IX-ELVIS to the computer with the supplied USB cable.
3. Insert the power plug into the rear of the IX-ELVIS and plug the transformer into the electrical outlet.
4. Turn on the power switches on the rear and on the upper right side of the top of the unit and confirm that the LEDs are illuminated.

Start the Software

1. Click on the LabScribe shortcut on the computer's desktop to open the program. Select LabScribe from the iWorx submenu. The LabScribe Main window will appear as the program opens.
2. On the Main window, pull down the Settings menu and select Load Group.
3. Locate the folder that contains the settings group, ELVISNI.iwxgrp. Select this group and click Open.
4. Pull down the Settings menu again. Select the EEGActivity-LS2 settings file.
5. After a short time, LabScribe will appear on the computer screen as configured by the EEGActivity-LS2 settings
6. The settings used to configure the LabScribe software and the IX-ELVIS for this experiment are programmed on the Preferences Dialog window which can be viewed by selecting Preferences from the Edit menu on the LabScribe Main window

EEG Cable Setup

1. Locate the red, black, and green EEG electrode lead wires
2. After the electrodes are secured in position, the red, black, and green EEG lead wires will be plugged into the respective sockets of Channel 1 of the IX-ELVIS
3. Select one person from your group to be the subject in this experiment
4. Use alcohol swabs to clean the skin where the electrodes will be placed. Three electrodes will be placed on the head:
   - One is high on the forehead, to the left or right of the centerline.
   - One about two inches above the right ear, on the right temporal lobe.
   - One on the parietal-occipital area, two inches to the right of the midline.
5. Once the electrodes are in place, plug the three electrode lead wires into Channel 1 of the IX ELVIS.

a. The lead from the electrode over the left temporal lobe is connected to the red or +1 input. (This will be switched to the right after all exercises have been completed).
b. The lead from the electrode over the left parietal-occipital area is connected to the black or -1 input. (This will be switched to the right after all exercises have been completed).
c. The lead from the ground electrode on the forehead is connected to the green or C input.

6. The electrodes need to have as little hair as possible under their centers.
7. Remove the plastic protective covering from the disposable electrodes before applying the electrodes to the proper location
8. Once the electrodes are in place, plug the three electrode lead wires into the IX-ELVIS
9. The lead wire for the ground electrode should not hang down in the person's eyes. Drape it loosely over the top of the subject's head. This lead can be secured under a headband.
10. Drape the leads for the other electrodes over the subject's shoulder to the lead pedestal which hangs freely down the subject's back and over the chair. There should be no tension on the electrodes.
11. The subject should sit quietly with their hands in their lap

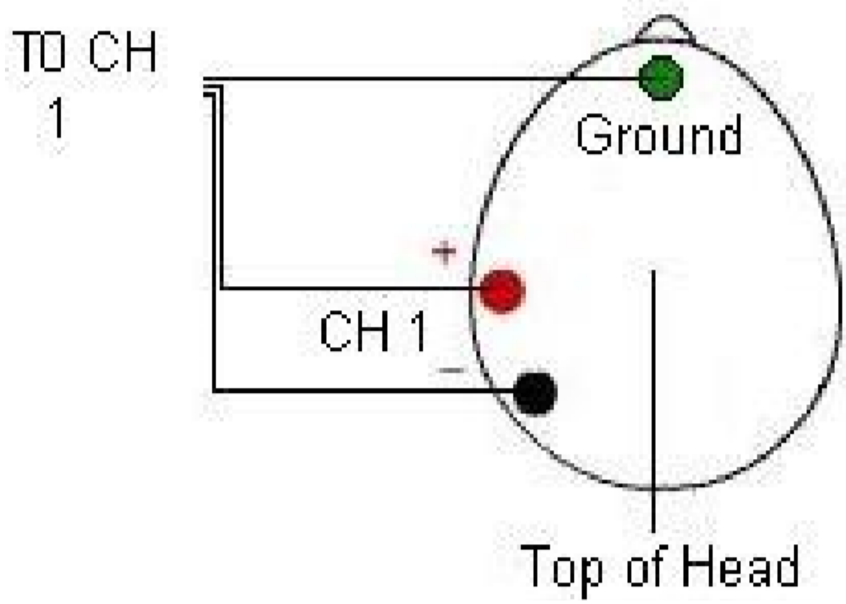


Figure:1 The equipment used to measure the EEG from a subject.

VI. Experimental Work:

Exercise 1: Common EEG Artifact

1. Ask the subject to sit quietly and not move unless told to do so, and to keep his or her eyes open during this phase of the experiment.
2. Click on the Record button, located on the upper right side of the LabScribe Main window (Figure PP-1-L1). The signal should begin scrolling across the screen.

   Note: If the user clicks the Record button and there is no communication between the IX-ELVIS and computer, an error window will appear in the center of the Main window. Make sure the IX-ELVIS is turned on and connected to the USB port of the computer. Click OK and select the Find Hardware function from the LabScribe Tools menu.
3. Click on the AutoScale buttons at the upper margin of all the channels. Your recording should look like Figure 2
4. Type "<Subject's Name>-Resting EEG" in the Mark box to the right of the Mark button. Press the Enter key on the keyboard to attach the comment to the data. Continue recording.
5. Instruct the subject to blink his or her eyes when asked, during the next thirty seconds of the recording. Type "B" for Blink in the Mark box before each time the subject is asked to blink. Press the Enter key on the keyboard to mark the recording when each blink occurs.
6. Instruct the subject to contract his or her facial muscles by frowning or smiling when asked, during the next thirty seconds of the recording. Type "F" for Frown or "S" for Smile in the Mark box before each time the subject is asked to do so. Press the Enter key on the keyboard to mark the recording when each frown or smile occurs.
7. Instruct the subject to rotate or tilt his or her head when asked, during the final thirty seconds of the recording. Type "R" for Rotate or "T" for Tilt in the Mark box before each time the subject is asked to do so. Press the Enter key on the keyboard to mark the recording when each rotation or tilt occurs.
8. Click Stop to halt recording.
9. Select Save As in the File menu, type a name for the file. Choose a destination on the computer in which to save the file. Designate the file type as *.iwxdata. Click on the Save button to save the data file

Data Analysis

1. Scroll through the recording using the scroll bar at the bottom of the Main window. Stop at marks (vertical lines in the EEG record) where you have entered comments.
2. Notice that movement of any kind will cause artifacts in the EEG record.
3. Actual variations in waking brain activity are potentials with amplitudes that are significantly lower than the amplitudes of artifacts.

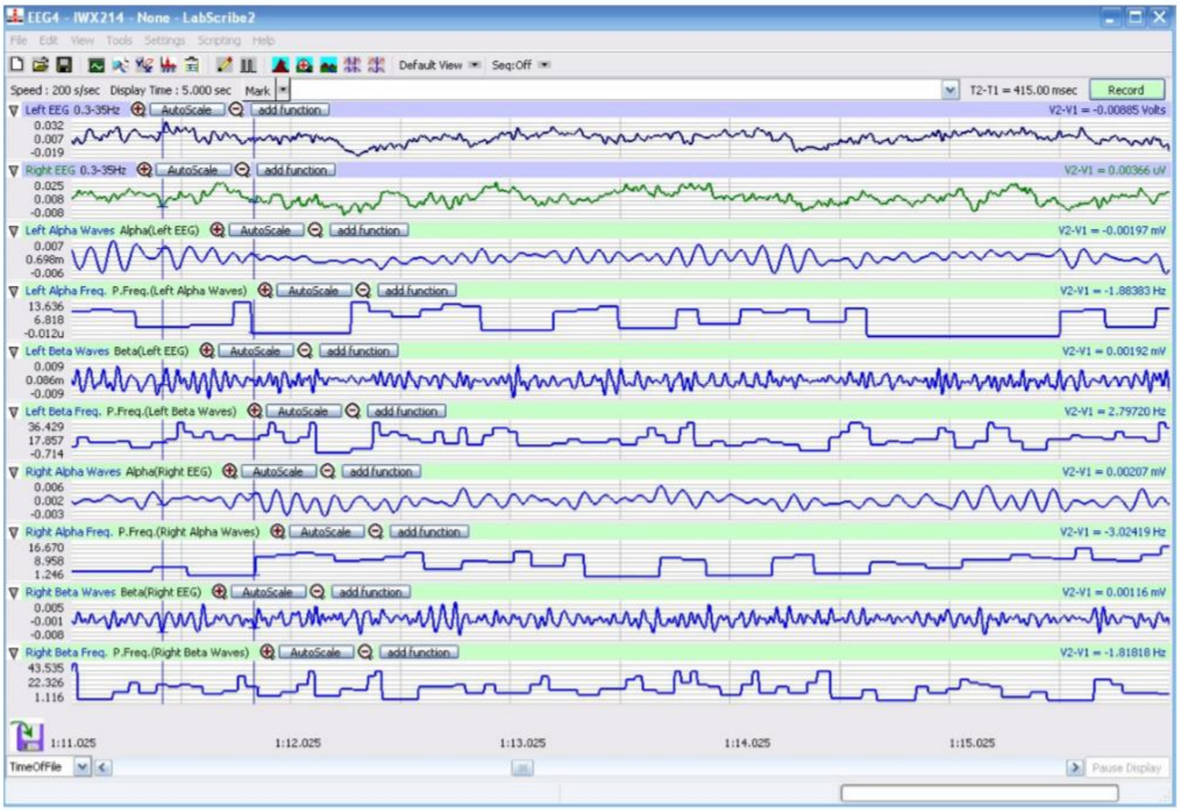


Figure: 2 EEG recording showing both the right and left hemispheres at the same time

Exercise 2: Alpha and Beta EEG Patterns

1. Instruct the subject that he or she needs to avoid any movement other than opening or closing his or her eyes when asked. The subject should have his or her eyes open at the beginning of the recording.
2. Click Record, and then click the AutoScale buttons for all six channels. You should observe an EEG recording similar to the two topmost traces in Figure

3. Type “O” for Eyes Open in the Mark box to the right of the Mark button. Press the Enter key on the keyboard to mark the recording. Record for twenty seconds.
4. While the subject has his or her eyes open, type “C” for Eyes Closed in the Mark box. Press the Enter key on the keyboard to mark the recording as you instruct the subject to close his or her eyes. Record the subject’s EEG pattern with his or her eyes closed for twenty seconds.
5. Continue to record the subject’s EEG pattern for a total of 2 minutes as the subject alternates having his or her eyes open or closed for twenty second periods. Mark the recording with an O or a C each time the subject opens or closes his or her eyes.
6. Click Stop to halt recording.
7. Select Save in the File menu

Data Analysis

1. Scroll through the data recorded in this exercise and find an artifact-free section of data recorded while the subject’s eyes were open.
2. Use the Display Time icons in the LabScribe toolbar (Figure 3) to adjust the Display Time of the Main window to show a ten second artifact-free section of data on the Main window. This section of data can also be selected by:
    a. Placing the cursors on either side of the data recorded while the subject’s eyes were open, and
    b. Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the period to the width of the Main window.
3. Click on the Analysis window icon in the toolbar or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window
4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The names of the mathematical function used in the analysis, Max-Min and Mean appears in this table. The values for Max-Min and Mean on each channel are seen in the table across the top margin of that channel.
5. Once the cursors are placed in the correct positions for determining the difference between the maximum and minimum amplitudes and the mean frequency of the waves in a ten-second section of data, the values of these parameters can be recorded in the on-line notebook of LabScribe by typing their names and values directly into the Journal, and on Table PP-1-L1.

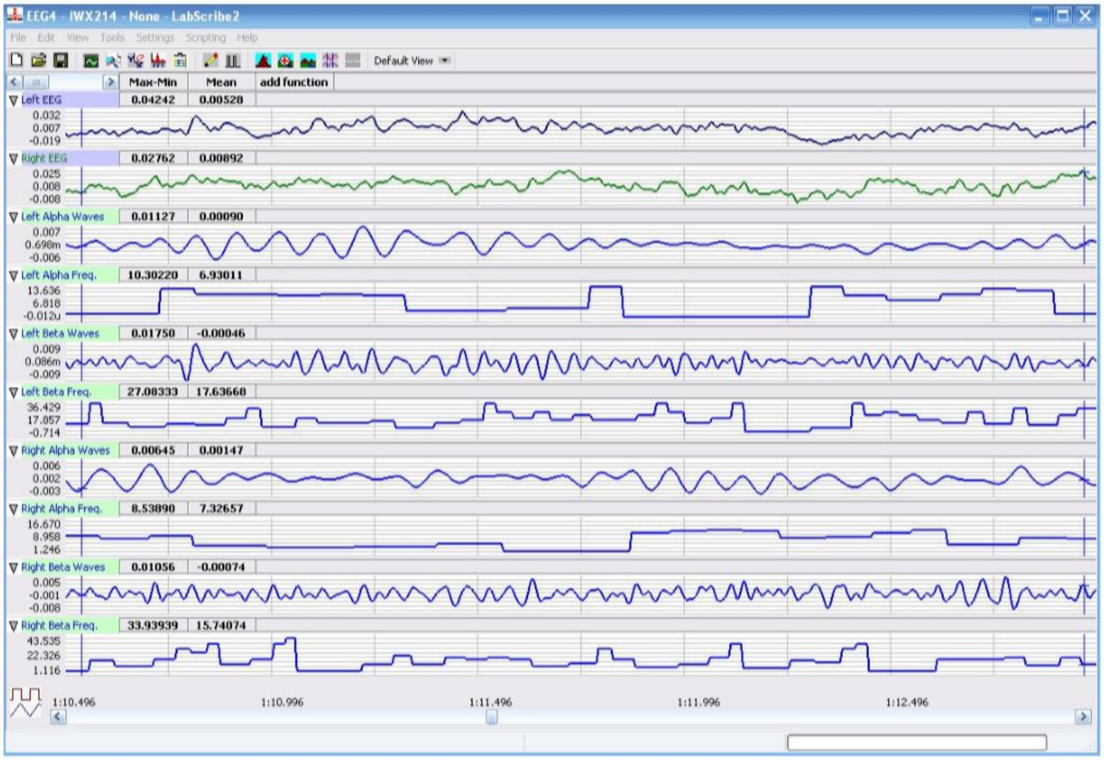


Figure 3: Recording of EEG from the left and right temporal regions of the brain displayed on the Analysis window. The complete EEG signal is displayed in the uppermost channel. The Alpha and Beta waves derived from the complete EEG signals and the frequencies of those waves from each temporal region are displayed on the lower channels

6. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the means into the Journal.
7. To use these functions:
    a. Place the cursors at the locations used to measure the values for the parameters of the EEG waves in the selected region of data.
    b. Transfer the name of the mathematical function used to determine the values of the parameters to the Journal using the Add Title to Journal function in the pull-down menu of any channel.
    c. Transfer the values of the parameters of the EEG waves to the Journal using the Add Ch. Data to Journal function in the Left EEG Channel pull-down menu.

8. Use the mouse to click on and drag a cursor to each margin of the data displayed on the Analysis window. The values for the following parameters should be recorded:
    a. The differences between the maximum and minimum wave amplitudes (Max-Min) of the waves displayed on the Left Alpha, Left Beta, Right Alpha, and Right Beta Wave channels.
    b. The mean frequency (Mean) of the waves displayed on the Left Alpha, Left Beta, Right Alpha, and Right Beta Frequency channels.
9. After recording the values return to the Main window. Scroll through the recording and find an artifact-free section of data recorded while the subject's eyes were closed.
10. Repeat Steps on an artifact-free section of data recorded while the subject's eyes

Tabulation

	Max-Min Amplitude(mV)		Mean Frequency(Hz)	
	Eyes open	Eyes Closed	Eyes open	Eyes Closed
Alpha waves				
Beta waves				

Observations

References:

LabVIEW manual