Laboratory Goals

- Familiarize students with lab policies and expectations
- Outline basic laboratory safety for electronics
- Familiarize students with laboratory layout and equipment

Pre-lab reading

- None

Equipment needed

- Lab notebook
- Pen

1. Laboratory Safety

You must be aware of safety concerns while working in the ECE lab. These include electrical shock, electrical fires, and explosion. ***These hazards can cause serious injury, and possibly death.***

If an injury occurs, immediately notify your T.A. and seek medical attention.

Below, is a list of the most likely safety issues found in the lab. For your own safety, read and understand each one of them:

Shock hazards

The circuits you will be constructing are typically low-voltage DC circuits, with low voltage AC inputs. But they still present shock hazards. Do not touch the circuit wiring while power is applied to it. Carefully attach test leads to the circuit to avoid shorts. Make sure before you apply power to a circuit, all connections are correct, and no shorted wires exist.

The greatest shock hazard exists when you are using the AC transformers. These are plugged into the 120VAC wall outlets and produce a stepped-down AC voltage. While this secondary voltage is usually much less than 120VAC, there is likely high current available across the output terminals. Be careful not to touch or short these output terminals while the transformer is plugged in.

Fire/smoke

Excessive current flowing through a component can cause a smoke or fire hazard. ***If you see or smell smoke, immediately turn off the power to the circuit.*** Locate the problem before applying power to the circuit again. Ask your T.A. for help finding the problem. Before applying power to a circuit, double-check your circuit for wiring or design errors. Make sure that the components you are using can handle the designed current and voltage.

The following example shows how excessive current can cause problems: Applying 12VDC to a ½-Watt, 50-Ohm resistor is a bad idea! Why? 12V/50 Ohms = 240mA. And 12V x 240mA = 2.88 Watts. This resistor is designed to dissipate .5 Watt of power. And 2.88 Watts >> .5 Watts. The excess current will cause the resistor to overheat, smoke, and possibly cause a fire.

Explosion hazards

Electrolytic capacitors can explode if their voltage limits are exceeded, or if they relate to reverse polarity. (Electrolytic capacitors always have a black band with "– "Marks on them to indicate the negative connection. They are also marked with the maximum DC voltage they can handle.) Ask your T.A. to show you some electrolytic capacitors, and a ceramic disc capacitor--note the different look of each.

2. Laboratory Orientation

The ECE 321 laboratory is designed for students to perform the lab assignments. Each student uses an assigned workstation and matching equipment cabinet. Each workstation consists of:

- A digital oscilloscope for capturing waveforms
- A digital multimeter for measuring resistance, AC or DC voltages, and current
- A function generator to create sine, square, or triangle waveforms of desired amplitude
- A DC power supply to power your lab projects
- A PC with software tools such as PSPICE and LabVIEW, and Microsoft applications

Learning how to use the equipment is outlined in later labs. And you can always ask your T.A. for specific help. Lastly, you can get more information on the equipment from the user's manuals, located in the lab locker #10, on the north wall.

Each of the six equipment cabinets contain:

- Test leads with different ends, which allow you to connect your circuits to test equipment
- A digital multimeter for measuring resistance, AC or DC voltages, and current
- Transformers, analog meters, variable transformers, and other equipment used in the lab projects

While you may not use all the equipment during the semester, you need to be familiar with its name and function.

The equipment in each cabinet must be returned to its labeled location in the cabinet after each lab is completed. If any equipment is damaged or missing, please report it.

Two other cabinets are in the lab: One containing ¼ and ½-Watt resistors, and another containing assorted capacitors (both electrolytic and ceramic disc). These parts are available as needed to complete the lab experiments. Keep the components that you take from these cabinets and add them to your lab parts kit. If you can't find the component you need, ask your T.A. for help.

<u>Clean up</u>

Before leaving the lab, take a few minutes to make sure all equipment and test leads are returned to your cabinet, and then lock it. Return the cabinet key to your T.A. Pick up any loose parts on the workstation table, and wipe off any eraser shavings, or other debris with a paper towel. Dispose of the paper towel and debris in the wastebasket.

Place any waste printer paper that you generate in the blue recycling bin. (Only printer paper is to be put in the recycling bin. Other waste goes to the regular wastebasket)

<u>Report writing</u>

After completing the assignment, most of the labs require a report to summarize your work. These reports must be detailed enough so that a technical person could use them to duplicate your experiment. (An example of a typical report is found on your lab webpage).

Keeping a neat lab notebook makes your report writing easier. Record the procedures used, and the results of your experiments. Make sure to create accurate drawings of waveforms, circuit schematics, and data tables. Enumerate all the pages on your lab notebook and make an index of the notes at the beginning of the notebook. Remember to clearly write the date and time for each measurement. Don't leave the lab without getting your lab notebook signed by the TA.

3. Lab Assignment

Inventory

Unlock your assigned equipment cabinet and create an inventory list of the equipment. (Each student records the information in his or her lab notebook.) Ask the T.A. to show you each of the different connector types found on the test leads before you begin.

Use the following table as a guideline for your lab notebook:

Quantity	Manufacturer	Description	Model Number	Serial Number
1	Simpson	Analog multimeter	206	xxx-xxxx
2	Not Available	Test leads, banana/quick clip, 3 ft, red	None	None
2	Not Available	Test leads, banana/banana, 2 ft, black	None	None
2	Not Available	Test leads, BNC/quick clip, 3 ft, black	None	None
1	Not Available	Test leads, BNC/BNC, 3 ft, black		

Create a similar table for the equipment found at your workstation. Record the information in your lab notebook.

When you are finished with the inventory, close and lock the equipment cabinet, and return the key to the T.A. Clean up your workstation. Finally, have your T.A. sign your lab notebook with the inventory.

NI-ELVIS II+

The major device that you will use in this lab is the NI ELVIS Series II workstation. The workstation consists of a prototyping board and several other features that are essential for laboratory experiments conducted in the ECE department.

Each of the different features of the NI ELVIS will be explained in detail throughout all the laboratory. However, for introductory purposes we will proceed to identify some of the main components of this versatile workstation. Take a moment to locate each one of them in your workstation.

Most features are explained below in Tables 1 and 2:

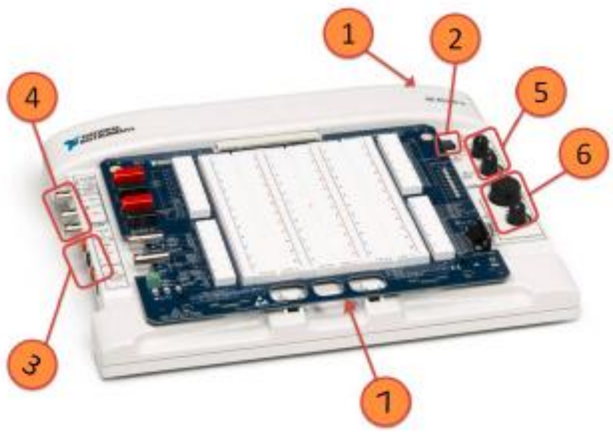
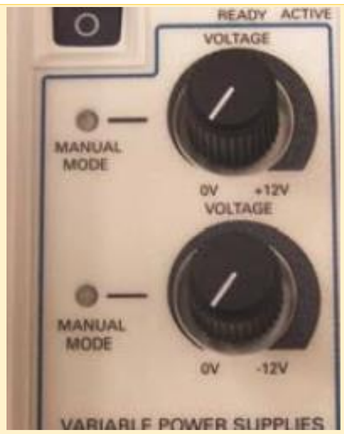
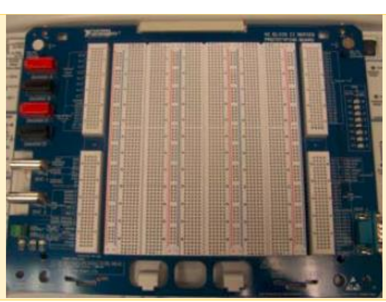


Figure 1. Isometric View of NI ELVIS II workstation with Prototyping Board

TABLE I. WORKSTATION FEATURES

1 **Workstation Power Switch**		– **Located in the rear of the workstation** – **Powers the NI ELVIS II+**
2 **Prototyping Board Power Switch**		– Controls power to *NI ELVIS Series II* prototyping board. – The power LED lights up when the switch is turned ON. – The Ready switch should be green or yellow when connected to host.
3 **Digital Multimeter (DMM) Connectors**		– ***Voltage, Resistance, and Diode Banana Jack (red):*** The positive input for digital multimeter in voltage resistance and diode measurements. – ***Common Banana Jack (black):*** The common reference connection for digital multimeter voltage, current, resistance, and diode measurements. – ***Current Banana Jack (red):*** The positive input for digital multimeter current measurements.

TABLE I. WORKSTATION FEATURES (cont'd)

4 **Oscilloscope Connectors and Function Generator Outputs/Digital Trigger Input**		***Oscilloscope (Scope) Connectors (Input)*** – ***CH 0 BNC Connector:*** The input for channel 0 of the oscilloscope. – ***CH 1 BNC Connector:*** The input for channel 1 of the oscilloscope. ***FGEN/Trigger Connector*** Optional output of the function generator or a digital trigger input.
5 **Variable Power Supply Manual Controls**		This allows you to adjust the voltage for two variable power supplies. – ***Supply+*** which can supply between 0 and +12V – ***Supply–*** can which supply between 0 and -12V – Knobs active only when the associated power supply is in manual mode. – LED lights up next to each knob lights up when associated power supply is in manual mode.
6 **Function Generator Manual Control**		These knobs allow the user to manually adjust the frequency and amplitude for a function generator output waveform. The *Manual Mode* LED lights up when the function generator is in manual mode. Instructions on how to use the function generator to input a waveform and to adjust its frequency and amplitude are explained later.
7 **ELVIS II Series Prototyping Board**		Provides an area for building circuitry and has necessary connections to access signals for common applications

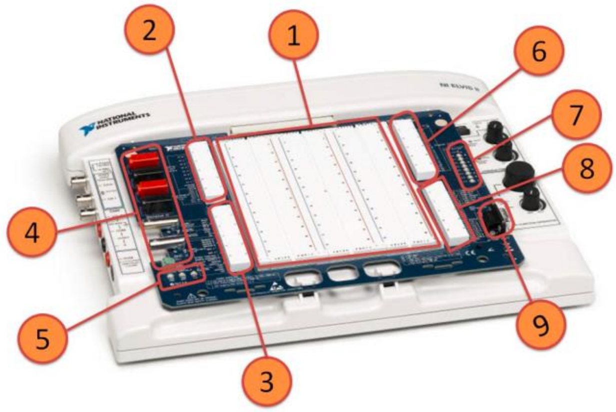


Figure 2. NI ELVIS II Series Prototyping Board

TABLE II. SIGNAL DESCRIPTIONS ON NI ELVIS II PROTOTYPING BOARD.

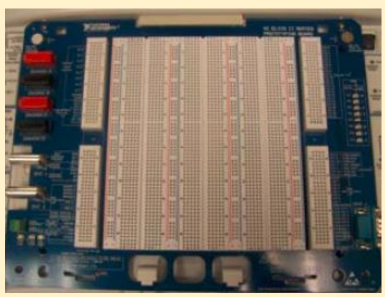
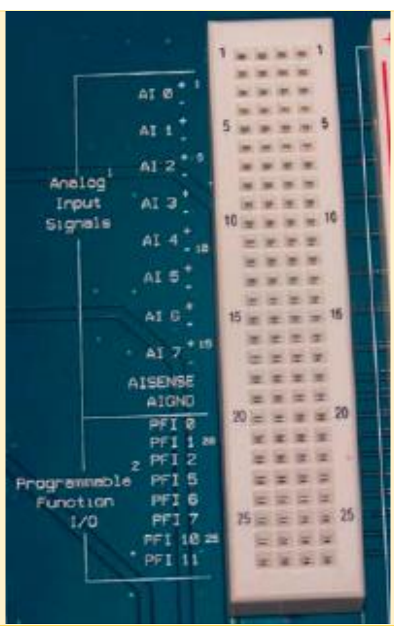
1 **Breadboard**		– This is the work area on which most circuits are built. – Figure 3 shows how the terminals are internally connected. – The horizontal connections labeled “+” and “-” and colored red and blue are called buses and are typically used for power and ground signals. – The vertical contacts are used for the actual building of circuits
2 **Analog Input (AI) and Programmable Functions Interface (PFI) signal rows**		**Analog Inputs** There are 8 analog input channels labeled AI<0…7>±. Connect positive end of the signal to be measured to the positive “+” pin socket and the negative end of the signal to the negative “-” pin socket of the input channel. These channels are mostly used as inputs for the oscilloscope discussed later. **Programmable Functions I/O** – These lines labeled <0…2>, <5…7> and <10…11> are used for static digital input output or timing signals. **AI SENSE and AI GND (INPUT)** – These pin sockets are used in cases where the signal to be measured has a different ground potential from the workstation.

TABLE II. (Cont'd)

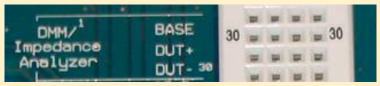
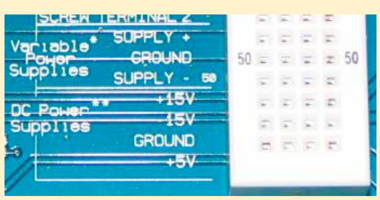
3 **Digital Multimeter (DMM) and Impedance Analyzer**		**DMM/Impedance Analyzer (INPUT)** – **BASE:** excitation terminal used as base terminal in 3-wire voltage/current analyzer of a bipolar junction transistor discussed later. – **DUT+:** excitation for capacitance and inductance measurements, impedance analyzer, 2-wire voltage/current analyzer and collector terminal for a bipolar junction transistor for 3-wire voltage/current analyzer. All of which are discussed later. – **DUT-:** virtual ground for capacitance and inductance measurements, impedance analyzer, 2-wire voltage/current analyzer and emitter terminal for a bipolar junction transistor for 3-wire voltage/current analyzer.
Analog Output (AO)		**Analog Outputs** There are 2 analog output channels labeled AO<0…1>±. These channels are used as outputs for the arbitrary waveform generator.
User Configurable Input/Output		**User Configurable I/O** – BANANA <A…D>: Connects to the banana jacks AD (see feature 4). – BNC <1…2>±: Positive lines connect to center pins of the BNC connectors (see feature 4). Negative lines connect to shells of the BNC connectors. – SCREW TERMINAL <1…2>: connects to the screw terminals (see feature 4).
Function Generator (FGEN)		**Function Generator** – FGEN (Output): the output of the function generator – SYNC (Output): 5V TTL signal synchronized to the FGEN signal. This signal is most used as a trigger signal for the oscilloscope (see feature 4 in Table 1). – AM (Input): Analog input used to modulate the amplitude of the FGEN signal. – FM (Input): Analog input used to modulate the frequency of FGEN signal.
Power Supplies		**Variable Power Supplies (OUTPUT)** – SUPPLY+: Positive variable power supply output (see feature 5 in Table 1). Can supply between 0 and +12V. – GROUND: Ground (all signals referenced to ground). – SUPPLY-: Negative variable power supply output (see feature 5 in Table 1). Can supply between 0 and -12V. **DC Power Supplies (OUTPUT)** – +15V fixed power supply. – -15V fixed power supply. – GROUND: Ground. – +5V fixed power supply

TABLE II. (Cont'd)

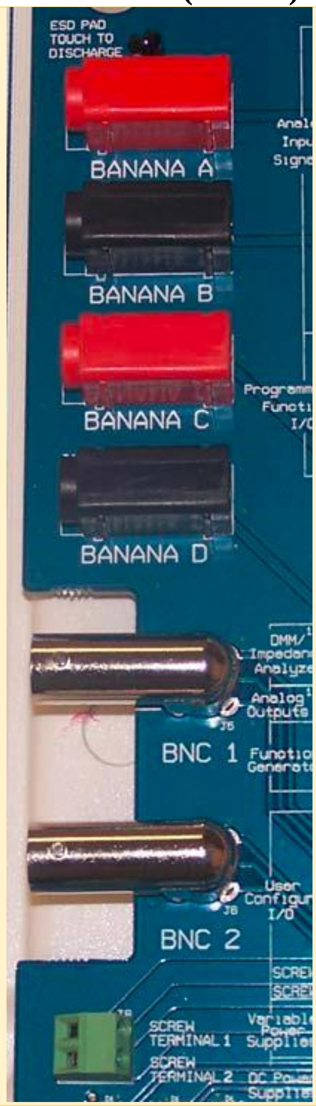
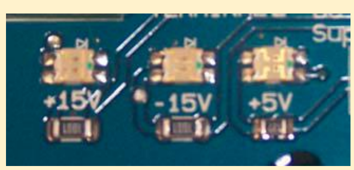
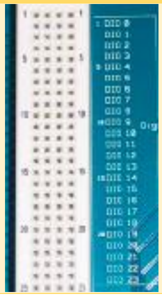
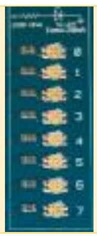
4 **User-Configurable Screw Terminals, BNC connectors and Banana jack connectors**	 	– **Banana <A…D> Jacks**: connected to BANANA <A…D> signal rows (see feature 3). – **BNC <1…2> Connectors**: connected to BNC <1…2>± signal rows (see feature 3). – **SCREW TERMINAL** <1…2>: connects to the screw terminal signal rows (see feature 3).
5 **DC power supply indicators**	 	– ±15V and +5V power supply indicators: These indicators should be lit to when the prototyping board power is enabled. – If these indicators are not lit, then there is a possible short circuit. Turn off prototyping board and check connections. – Turning the board power switch on and off should reset the current limiters.

TABLE II. (Cont'd)

6 **Digital input/output signal rows**		**DIO <0…23> (INPUT/OUTPUT)** Digital I/O lines that are used to read or write digital data (0 or 5V). These lines are programmed to be inputs oroutputs using soft front panels (SFPs) discussed later.
7 **User-Configurable LEDs**		**User-Configurable LEDs (OUTPUT)** These LEDs act as displays for digital outputs (i.e. 0 or 5V). See feature 8 for further insight.
8 **Counter/Timer User-Configurable Input/Output DC Power Supply**		**Counter/Timer (INPUT/OUTPUT)** – PFI8/CTRO_SOURCE: Counter 0 Source – PFI9/CTRO_GATE: Counter 0 Gate – PFI12/CTRO_OUT: Counter 0 Out – PFI3/CTR1_SOURCE: Counter 1 Source – PFI4/CTR1_GATE: Counter 1 Gate – PFI13/CTR1_OUT: Counter 1 Out – PFI14/FREQ_OUT: Frequency Out **LED<0…7> (INPUT)** – Input pin sockets for user-configurable LEDs (see feature 7). **DSUB SHIELD (INPUT/OUTPUT)** – Connects to shield of DSUB connector (see feature 9). **DSUB PIN<1…9> (INPUT/OUTPUT)** – Connects to pins <1…9> of DSUB connector (see feature 9). **DC Power Supply (OUTPUT)** – Ground – +5V fixed power supply
9 **User-Configurable DSUB connector**		**DSUB Connector (I/O)** Connected to DSUB PIN <1…9> and DSUB SHIELD signal rows (see feature 8).

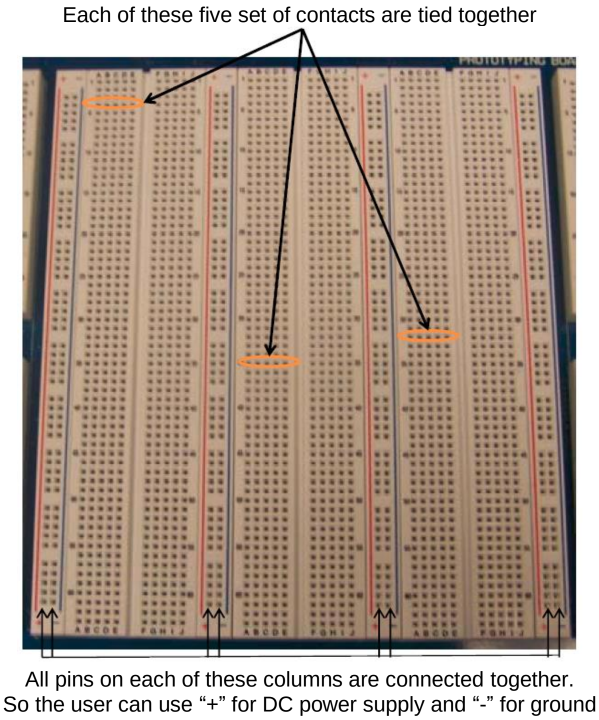


Figure 3. Breadboard connections

Post-Lab Reading

In our next laboratory experiments we will begin to build and study circuits using the NI-ELVIS II+ breadboard and features learned today. Please take a moment to read the Reference Document "Introduction to Breadboarding" from the lab website. Then answer these questions:

- How does a solder-less breadboard work?
- What are the breadboard's bus lines used for?
- Explain wire color coding and other breadboard wiring techniques.
- What things can be done to minimize parasitic effects?
- What can be done to reduce unwanted noise from the power supply?

Remember to clean up your station and getting your lab notebook signed before leaving the laboratory.