Laboratory No. 1

Measurements Using The NI Elvis-II+$^{+}$ Test Instrument

Purpose:

Explore the measurement capabilities of the National Instruments Elvis-II+ test instrument. This equipment will form the test platform of all the labs associated with ECSE-331. The student will need to fully understand its measurement capabilities. The laboratory equipment is located in ENGTR Rm 5060.

Equipment Required:

1. NI Elvis-II^{+} test instrument
2. PC with ELVIS-II^{+} software installed.
3. Components:
    a. 2 x 10 kΩ, ¼ W resistors,
    b. 1 x 1 μF capacitor.

Description of the NI Elvis-II+ Test Instrument:

The National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS-II^{+}) is a hands-on design and prototyping platform that integrates the 12 most commonly used instruments – including oscilloscope, digital multi-meter, function generator, bode analyzer, and more. It connects to a PC through a USB connection, providing quick and easy acquisition and display of measurements. An illustration of a typical test set-up is shown in Fig. 1.

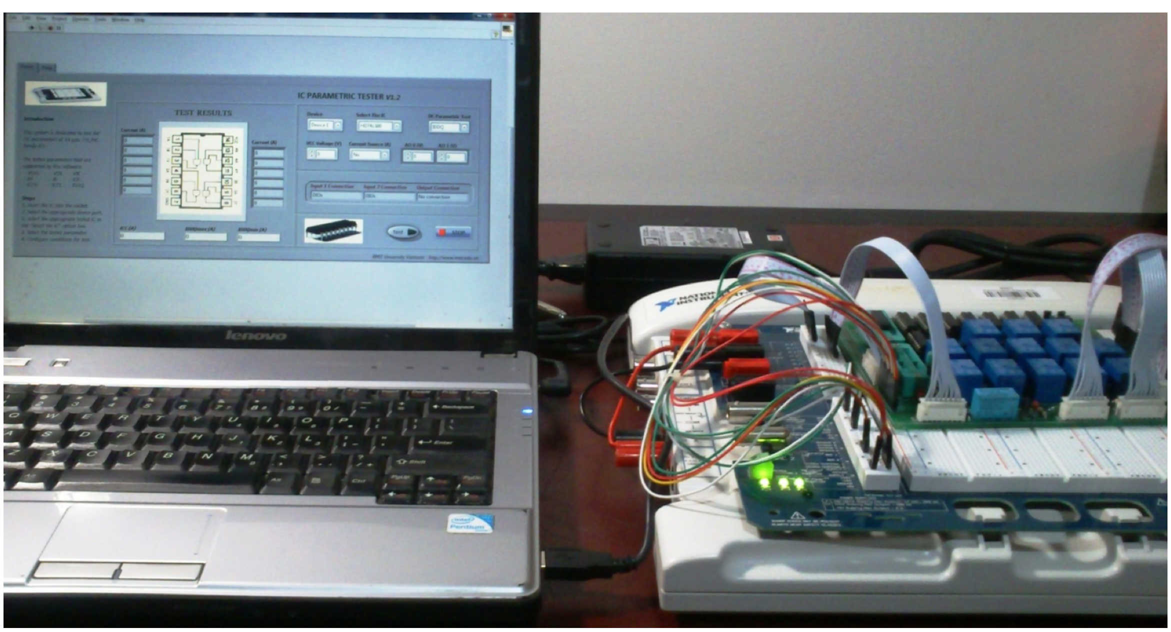
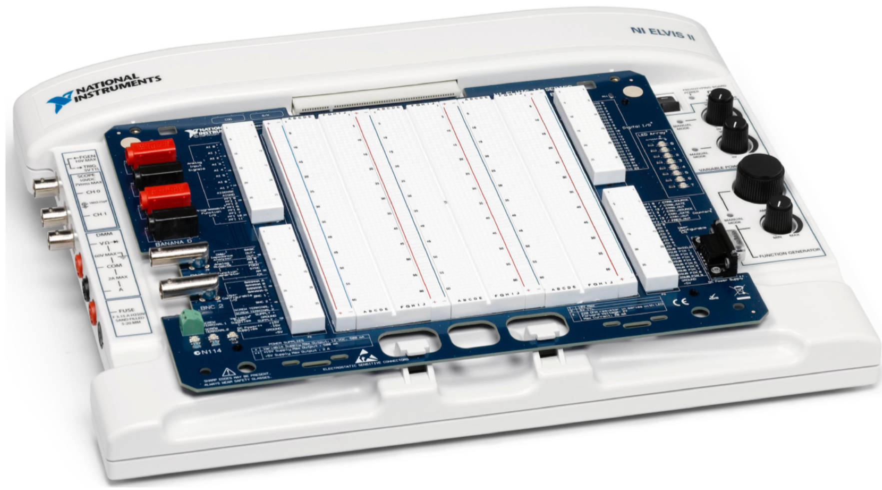
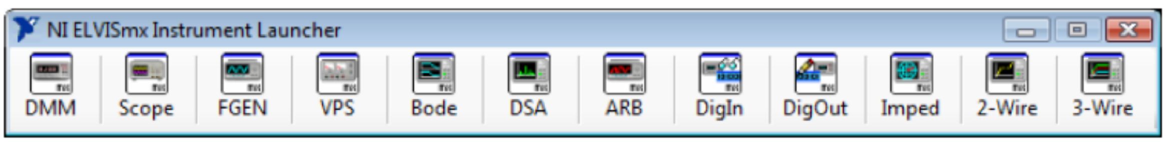


Figure 1: Typical test-set up using the Elvis-II^{+} Test Instrument.



(a)



(b)

Figure 2: (a) Elvis-II$^+$ instrumentation hardware with prototyping board, and (b) menu for various virtual instrument.

The National Instruments Educational Laboratory Virtual Instrumentation Suite consists of two main components:

1. The bench-top workstation (NI ELVIS-II$^+$), which provides instrumentation hardware and associated connectors, knobs, and LEDs as shown in Fig. 2(a). A prototyping board (breadboard) sits on top of the workstation, plugged into the NI ELVIS-II$^+$ platform, and offers hardware workspace for building circuits and interfacing experiments.
2. NI ELVIS-II$^+$ software, which includes soft front panel (SFP) instruments. Fig. 2(b) illustrates the PC screen view of the oscilloscope interface.

The Elvis-II$^+$ prototype board consists of 5 separate areas: four small prototype areas on the peripheral of the board, and a much larger central prototype area. The boards on the peripheral are used to interface to the internal data acquisition board of the Elvis-II$^+$ system. There are marking along the perimeter of the board indicating the connection. A zoomed in image of the prototyping area is shown in Fig. 3. Note that the markings are not readable from this image; the student should look at the workstation directly.

For instance, the ***upper left-hand board*** is used to interface to the Analog Input (AI) signals (AI0+/–, AI1+/–, ……, AI7+/–, AISENSE, and AIGND; essentially, the analog-to-digital converter of the data acquisition system. Signals applied to AI0+/–, and AI1+/– can then be routed for display using the virtual oscilloscope. Also, this area is used to interface to the Programmable function I/O lines (PFI0 to PFI11); these are often used for synchronization of several instruments.

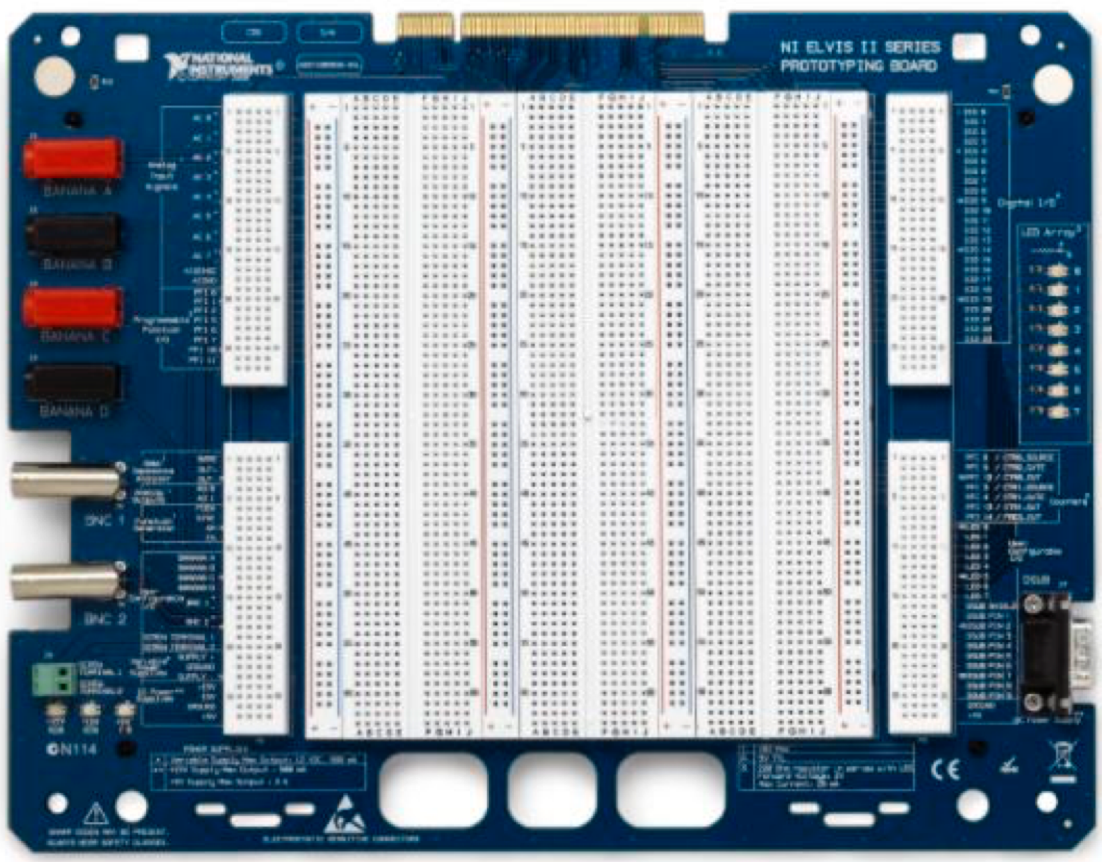


Figure 3: Highlighting the Elvis-II^{+} prototyping area.

The ***lower left-hand side board*** is used to access the digital multi-meter (DMM) and impedance analyzers (BASE, DUT+, DUT-). It also connects to the analog output lines (AO0 and AO1) belong to the digital-to-analog converter of the data acquisition board. Note that it is a differential output. In addition, the function generator lines (FGEN, SYNC, AM, and FM) belonging to the Function Generator board are available here. Power supply connections to ±15 V, +5 V and ground are found at the bottom portion of this section. The ±15 V power supply is rated for a maximum load current of 500 mA. The +5 V power supply can supply a maximum current level of 2 A. Two ±12 V variable power supplies are also available.

The ***upper right-hand side board*** provides connections to the digital input/output lines from the internal data acquisition board (DIO lines 0 to 23).

The ***lower right-hand side board*** provides access to the PFI lines for counter and synchronization of DIO tasks belong to the data acquisition board.

The ***center portion of the board*** is made up of a general-purpose prototyping area where different components can be inserted into the board and connected using various shared nodes. Rows (defined horizontally) consisting of 5 holes are connected inside the board. These are used to connect multiple components together by sharing a common node. Four column areas are marked with the +\– sign. The holes in this column are all connected. These areas should be reserved for the power distribution network. The positive column should be reserved for positive supply voltages, and the negative column should be reserved for negative voltage supplies, or ground.

Additionally, the ***NI ELVIS II workstation*** (outside of the prototyping area) is populated on its left side with BNC type I/O terminals for the Function Generator (FGEN), the 100 MS/sec Oscilloscope (Scope), and digital multi-meter (DMM). On the right side, the workstation has two knobs for manual voltage setting in [0 - +12 V] or [–12 - 0 V], and another set of two knobs for the Function Generator frequency and amplitude settings.

It is recommended that the student accesses the NI Elvis-II$^+$ user manual through the course web site or through the world-wide web. This manual will provide greater detail into the operation of the Elvis-II$^+$ workstation.

Write-Up Requirements:

A good laboratory report should contain a **brief** description of what the experiment was about, including circuit diagrams, and what you did, your data, your results, and anything else called for in the assignment, such as questions inserted in the laboratory. Answers to these questions require observations that need to be made at the time you do the experiment.

While not explicitly spelled out in any one laboratory, the use of SPICE should be used by the student to predicted the experimental outcomes. SPICE results should be compared to that obtained by measurement, and any differences explained or justified.

The laboratory report should be written using the IEEE paper style consisting of a double-column single-space format, and must adhere to the following:

1. Title page - Title of the assignment/project, authors' name, and course name.
2. Abstract - Abstract of the assignment/project report.
3. Introduction
4. Main body of the assignment/project report including figures.
6. Conclusions
7. References
8. Appendices

Procedure:

I. DC Measurements – Using the DMM Feature

With the power to the ELVIS-II$^+$ unit turned off, connect the USB cable between the unit and your PC. Turn the power to the unit ON (the power switch is on the back of the unit). The USB ACTIVE (orange) LED turns ON. In a moment, the ACTIVATE LED turns OFF and the USB READY (orange) LED turns ON. On your PC, click on the NI ELVISmx Instrument launcher (found under:

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All Programs>>National Instruments>>NI ELVISmx
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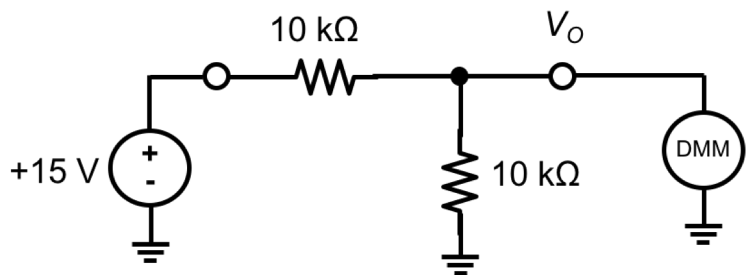
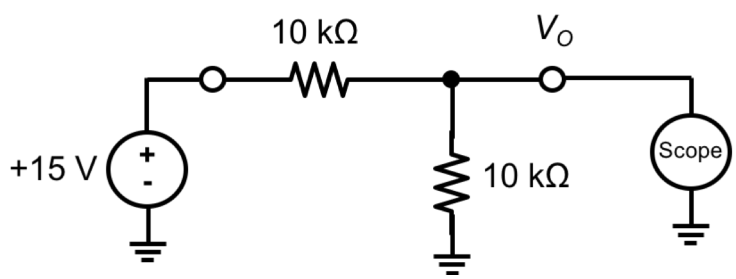
The instrument launcher should then display on the screen (see Fig. 2(b)).



(a)



(b)

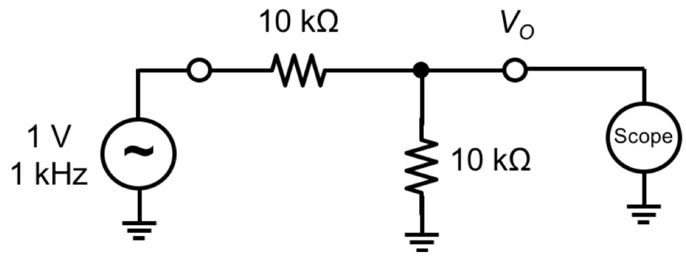
Figure 4: Voltage-divider circuit set-up and connections to Elvis-II+ test station: (a) measurement made by DMM, and (b) oscilloscope.

To exercise the Elvis-II$^+$ workstation, consider creating a voltage divider circuit involving two 10-kΩ resistors. Place these on the central prototyping area of the workstation. Place one end of each resistor into a common row so that they share a common node. The shared node will be designated as the output. This will be your output node. Connect one of the unconnected ends to the +15 V power supply and the other end to GND. Next, connect the terminals of the digital multi-meter (DMM) as shown in Fig. 4(a). *Confirm that the voltage at this node is indeed close to its expected level.*

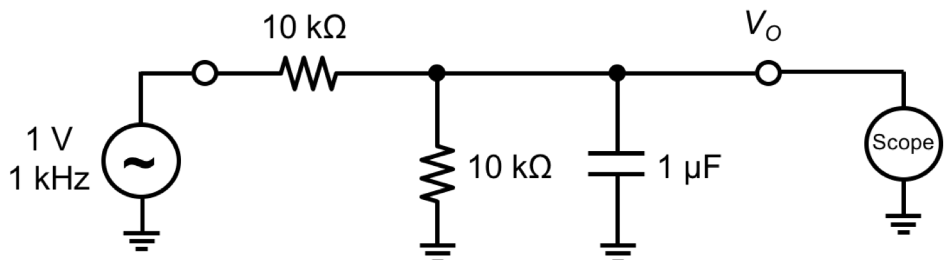
Now replace the DMM with an oscilloscope as shown in Fig. 4(b) and display the output signal. *Capture the signal that you see and verify that the average value of this signal is indeed in agreement with that identified by the DMM. What is the peak-to-peak value of the signal seen by the scope? What is the cause of this signal?*

II. AC Measurements – Using the Function Generator and Oscilloscope Features

Turn the power off to the prototyping station. Remove the +15 V power connection to the voltage divider and replace it with a 1 V peak, 1 kHz sinusoidal signal as shown in Fig. 5. This will require the student to launch the function generator through the instrument launcher. The power to the station should be turned back on and the signal at the output node should be observed with the oscilloscope. Verify that the frequency of the signal generator is indeed set to 1 kHz. *What is the amplitude of the output signal?*



(a)



(b)

Figure 5: Voltage-divider circuit set-up with 1 V peak, 1 kHz sinusoidal signal. Output is measured using an oscilloscope.

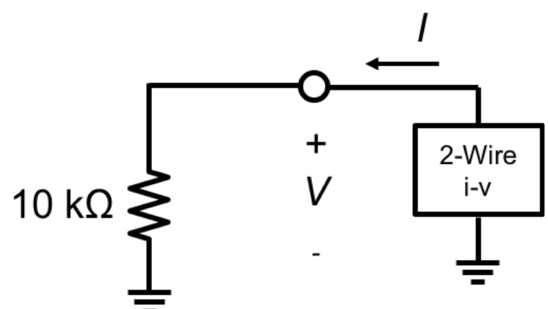


Figure 6: Measure the i-v transfer characteristic of the 10-kΩ resistor using the 2-wire i-v analyzer.

Next, place a 1 μF capacitor across the grounded 10-kΩ resistor and measure the amplitude of the signal at the output. What is the gain of the circuit at 1 kHz? Change the frequency of the sinusoidal generator to 2 kHz, and determine the gain of the circuit at this frequency. Repeat at frequencies of 3 kHz, 4 kHz and 5 kHz. *In your report, provide a plot of the circuit gain as a function of frequency.*

Return to the function generator instrument panel and change the sinusoidal signal to a square wave signal. Set the levels so that it swings between 0 and 5 V. The frequency of the generator should be set to 1 kHz. Capture both the input and the output signal on the oscilloscope. Display 4 or 5 periods of the output signal and provide a plot in your final report. Using the oscilloscope time-base control on the instrument panel, zoom in and identify the time constant associated with the output signal. Provide this value in your report.

III. AC Measurements – Using the Bode Analyzer

Repeat part II but this time use the Bode Analyzer instead of the function generator and the Scope. How do your results compare to those found previously in part II.

IV. DC Transfer Curve Measurements – Using the 2-Wire i-v Analyzer

Turn the power off to the prototyping station. Using one of the 10 kΩ resistors, connect it to the port of the 2-wire i-v analyzer. Sweep the voltage across the resistor from -2 V to 2 V and plot the i-v characteristics of the resistor. *What is the slope of this curve? At what point does it intercept the i-v axis?*

This concludes this lab.