



Intro to Lab Equipment and Procedures

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EECS: 1100 Digital Logic Design
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Lab Assignment #1

1. Objectives

- becoming familiar with the Lab environment,
- becoming familiar with the protoboards for building physical logic circuits,
- becoming familiar with the Power Supply and the Function Generator,
- becoming familiar with the Agilent 54645D Mixed-Signal Oscilloscope,
- becoming familiar with the Agilent's BenchLink software tool for transferring data from the Agilent 54645D Mixed-Signal Oscilloscope to a computer,
- becoming familiar with the Dell GxaEM computer system,
- becoming familiar with the integrated circuit components,
- becoming familiar with the difference in properties of the analog and digital channels of the Agilent 54645D Mixed-Signal Oscilloscope,
- learning the process of preparing the *computer generated* Lab Reports.
- Overall, becoming familiar and proficient with lab tools will save you a lot of time and frustration in the lab. The extra time you spend in this lab will save you time in future labs.

2. Prelab Assignment

2.1 INTRODUCTION TO THE AGILENT'S MIXED-SIGNAL OSCILLOSCOPE

Download from the Educator's Corner web site, preferably to a hard copy, and become familiar with the short Oscilloscope Tutorial document which describes the controls and operational modes of the Agilent 54645D Mixed Signal Oscilloscope that will be used in sections 4.2 and 4.3 of this assignment, and in all future Lab experiments throughout the semester.

2.2 INTRODUCTION TO THE AGILENT'S SOFTWARE TOOL BENCHLINK

Download from the Educator's Corner web site, preferably to a hard copy, and become familiar with the short BenchLink Tutorial document which describes the procedures that will be used in sections 4.2 and 4.3 of this assignment. The effort invested in learning how to use BenchLink will pay off here and in future Labs that you will take later on in the course of your studies.

2.3 INTRODUCTION TO THE AGILENT'S FUNCTION GENERATOR

Download from the Educator's Corner web site, preferably to a hard copy, and become familiar with the short Function Generator Tutorial document which describes the controls and operation modes of the Agilent 33120A function generator that will be used in sections 4.2 and 4.3 of this assignment, and in all future Lab experiments.



2.4 INTRODUCTION TO THE LAB REPORT GUIDELINES

Download from the Educator's Corner web site, preferably to a hard copy, and make yourself familiar with the short Lab Report Guidelines document which describes the composition and formats of the Lab Reports.

Equipment and Circuit Components

3.1 EQUIPMENT

- Proto board Global PB-104,
- Agilent E3631A DC power supply,
- Function generator: Agilent 33120A,
- Mixed-Signal oscilloscope Agilent 54645D,
- Dell GxaEM computer system.

3.2 CIRCUIT COMPONENTS

- integrated circuit 7404, hex inverter (1)

4. Lab Assignment

4.1 INSPECTION OF THE LAB EQUIPMENT

Objective: Gain acquaintance with the external characteristics of the Lab equipment.

Inspect the front panels of the power supply, function generator and the oscilloscope to see what functions they provide.

Have a look at the backplane of the oscilloscope to discover the presence of the Agilent 54652B RS-232 Interface module which provides: hard copy, full remote control and non-volatile trace memory. While there, notice the connection from the oscilloscope to the Dell computer, which allows the downloading to computer's memory of all measurement data previously stored in the non-volatile trace memory of the module.

Notice at the back of the computer the connection to the College of Engineering computer network. In our case, the data from the oscilloscope will be downloaded to a computer file which can be further transferred to student accounts for later processing in the course of preparation of a Lab Report. Additional feature is that the College of Engineering application server will provide access to Agilent's software package BENCHLINK, which runs on the Agilent 54645D mixed signal oscilloscope, making the oscilloscopes functions applicable to the downloaded measurement data while working outside the Digital Logic Design Lab on a computer connected to the College's network.



4.2 USING THE OSCILLOSCOPE FOR VISUALIZATION OF SIGNAL WAVEFORMS

Objective: Learn the basic function of the Agilent 54645D oscilloscope's dials and soft keys, and gain an understanding of the difference between the waveform displays by the *analog* and *digital* channels.

4.2.1 Connect to one set of interconnected pin-holes of the protoboard:

- output of the function generator, Agilent 33120A
- probes of both analog channels, A1 and A2 of the Mixed-Signal oscilloscope Agilent 54645D,
- probes of the digital channels D0 and D1 of the Mixed-Signal oscilloscope Agilent 54645D.

4.2.2 Connect to another set of interconnected pin-holes of the protoboard:

- ground terminal of the function generator,
- ground terminals of the Mixed-Signal oscilloscope Agilent 54645D,

4.2.3 On the front panel of the function generator:

- attach the connection cable (only temporarily, for Section 4.2 experiments and never again in the whole semester!) to the signal outlet/jack marked Output,
- select the square waveform,
- adjust the frequency of the signal to 1MHz,
- adjust the signal amplitude knob to the midway position,
- turn on the power.

4.2.4 On the front panel of the Mixed-Signal oscilloscope Agilent 54645D:

- set the threshold level of the digital channels to *TTL*,
- turn on the digital channels D0 and D1, and the analog channels A1 and A2,
- set the triggering mode to *Normal*,
- hit the key *Autoscale*.
- hit the key *Single*.

Varying the time resolution of the oscilloscope, observe and compare the waveforms of the same signal, as displayed differently by analog and digital channels of the oscilloscope. What is the main difference?

4.2.5 Change the signal of the function generator to the saw-tooth form, hit the key *Single*, and observe the difference between the waveforms displayed by analog and digital channels of the oscilloscope.

4.2.6 Turn off the channels A2 and D1, and save the Screen Image of the waveforms of the channels A1 and D0 to a file named I1_426.tif (.pcx) on the Dell GxaEM computer system. (Alternatively, use the Screen Capture tool.)



- Hint#1:** For instruction on how to download the *Screen Image and Waveform Data* from the oscilloscope's memory to files on Dell GxaEM computer system, consult the *Agilent's BenchLink Application Tutorial*.
- 4.2.7 Change the signal of the function generator to the sinusoidal form and observe the difference between the waveforms displayed by analog channel A1 and digital channel D0 of the oscilloscope. Save the Screen Image of the waveforms of the channels A1 and D0 to the *Trace 1* memory of the oscilloscope, and save the Screen Image of the waveforms of the channels A1 and D0 to a file named I1_427.tif (.pcx) on the Dell GxaEM computer system. Save the Waveform Data of the channels A1 and D0 to a file named L1_427.WFX on Dell GxaEM computer system.
 - 4.2.8 Change the trigger threshold level of the digital channels from TTL to CMOS, hit the key *Single*; then recall the display of *Trace 1* waveforms that were saved in the experiment 4.2.7. Observe and describe in one sentence the difference between the current (displayed brighter) and the *Trace 1* (displayed dimmed) waveforms. Save the Screen Image of the waveforms of the channels A1 and D0 to a file named I1_428.tif (.pcx) on Dell GxaEM computer system. (Alternatively, use the Screen Capture tool.)
 - 4.2.9 Hit the key *Cursors* and view the cursor functions in the softkey menu. Use cursors to measure the period and amplitude of the waveforms. Read the numeric display of the measurement data.

4.3 USING THE INTEGRATED CIRCUIT COMPONENT 7404 - HEX INVERTER

Objective: Learn how to connect power, ground and signals to integrated circuit components. Meet the simplest logic circuit gate - the inverter.

- 4.3.1 On the front panel of the function generator:
 - detach the connection cable from the signal outlet/jack marked **Output**,
 - attach the connection cable to the signal outlet/jack marked **TTL/CMOS** (where it will stay for the rest of the semester to save the IC components from being damaged),
 - select the square waveform,
 - adjust the frequency of the signal to 1MHz,
 - turn on the power.
- 4.3.2 Insert the 7404 integrated circuit (**IC**) component into the protoboard.
- 4.3.3 Connect to the power rails of the protoboard to the ground and +5V terminals of the power supply.
- 4.3.4 Connect the GND and V CC terminals of the IC 7404 to the corresponding power and ground rails of the protoboard.
- 4.3.5 Connect to the input pin of a selected inverter of the 7404:
 - the output of the function generator, Agilent 33120A
 - the probe of the analog channel A1 of the Mixed-Signal oscilloscope Agilent 54645D,
 - the probe of the digital channel D0 of the Mixed-Signal oscilloscope Agilent 54645D,
- 4.3.6 Connect to the output pin of the same selected inverter of the 7404:
 - the probe of the analog channel A2 of the Mixed-Signal oscilloscope,
 - the probe of the digital channel D1 of the Mixed-Signal oscilloscope,



4.3.7 On the front panel of the Mixed-Signal oscilloscope:

- set the threshold level of digital channels to *TTL*,
- set the triggering mode to *Normal*,
- hit the key *Single*.

Observe and compare the waveforms of the signals at the input and output of the inverter gate. Explain the characteristics of their relationship. Save the currently displayed Screen Image to a file named I1_437.tif (.pcx) on Dell GxaEM computer system. (Alternatively, use the Screen Capture tool.)

4.3.8 Save the Waveform Data of the channels A1,A2,D0, and D1 to a file named I1_438.WFX on Dell GxaEM computer system. Use the commands of the BenchLink application on Dell GxaEM computer system to manipulate the display of the transferred Waveform Data stored in file named I1_438.WFX, and use the cursors to measure the period of the input signal and the time delay between the input and output signals.

4.4 TRANSFER OF CAPTURED WAVEFORMS.

Transfer (ftp) the files I1_*.tif from the Dell GxaEM computer system to your personal College of Engineering computer account for further processing.

5. Postlab Assignment

5.1 USING THE BENCHLINK TOOL TO MANIPULATE WAVEFORMS

5.1.1 In your personal College of Engineering computer account:

- use the network version of the BenchLink/Scope to open the measurement data file I1_427.WFX that you have transferred to your account,
- use the BenchLink cursors to measure the level of the analog voltage that the Agilent 54645D considers to be the TTL logic threshold voltage,

Hint#2: Place the time cursors t1 and t2 on the positive and negative edge respectively of the digital channel waveform; then place the voltage cursors V1 and V2 at the intersections of the time cursors and the analog channel waveforms.

5.1.2 In your personal College of Engineering computer account:

- use the network version of the BenchLink/Scope to open the measurement data files I1_438.WFX that you have transferred to your account,
- use the BenchLink tool commands to adjust the time resolution of measurement data file waveforms, so that an accurate measurement of the time delay of the inverter gate can be accomplished; then use the time cursors t1 and t2 to determine the propagation time delay of the inverter.

5.2 IMPORTING THE WAVEFORMS

Use a word processor of your preference to import into your Lab report all I1_*.tif graphic files as Figures.



6. Lab Report

To be considered complete, the Lab report #1 must contain the following,

1. Cover sheet - Lab style, filled out (the template to be used is available for downloading at the EECS1100 course web site,
2. Wave forms observed, and answers to the questions asked under 4.2 through 4.3 and 5.1.
3. A report on items not already included under 1. and 2. above, which includes:
 - a discussion of the insights gained through the conducted experiments,
 - textual description and graphical/ tabular illustration of the design procedure(s),
 - description of implemented testing procedures,
 - conclusions reached as a result of performing the lab experiment,
 - comments and suggestions that might lead to easier and/or deeper understanding of the topics covered by the assignment.