Lab 1 – Lab Orientation

CSE 2441 – Introduction to Digital Logic

Fall 2020

Instructor – Bill Carroll, Professor of CSE

Lab Orientation

- Policies and procedures
- Safety considerations
- Lab resources
- BitBox checkout
- This week's assignment
- Using The BitBoard
- Using solderless breadboards
- Using the DMM

Policies and Procedures

- Lab assignments
  - Mondays – assignment posted on Canvas
  - Tuesdays – assignment previewed in class
  - Tuesdays/Wednesdays/Thursdays (4:00 to 6:00 PM) – virtual lab help sessions on Teams
  - Fridays
    - Labs (ERB 126-127) open for help and consultation (9-12, 2-5)
    - Virtual help sessions available on Teams (9-12, 2-5)
  - Sundays – lab reports due (11:59 PM)
- Lab reports (Lab 1)
  - Assignment number and name
  - Student name, ID, email
  - Date and time submitted
  - Assignment purpose
  - Circuit diagrams
  - Truth tables with I/O voltages as experimentally observed
  - Vcc and GND voltages as experimentally observed
  - Logic equations for each gate studied
  - Photos with captions
- Lab grading
  - Labs 1 through 12 – 100 points each
  - Lab grade = average of Labs 1 through 12
  - Lab grade is 20% of course grade
  - Must complete all labs to earn a C or better in the course
  - Late penalty – 20 points per day

Safety/Operational Considerations

1. General
   - **Clean the surface of your workbench before beginning your work!**
   - ERB 126-127 are shared by several computer engineering courses.
   - Students can only be in the lab when a lab instructor, faculty member, or staff member is present.
   - Food and drinks are not allowed in the lab at any time.
   - Keep the lab neat and tidy at all times.
   - Pick up loose wire or parts when leaving.
   - Store backpacks and similar items in the bench pedestal so as not to create a trip hazard.
   - Notify the lab instructor or faculty/staff member of any observed safety or operational issue.
2. Electrical hazards
   - The 5-volt DC power used in this lab does not pose a danger. However, it is good practice to turn off power when wiring circuits. This provides you with extra protection and also protects the equipment and components.
   - The 120-volt AC power used for computers and other equipment is a lethal voltage level, so please plug and unplug power cords with care. Never use equipment with a damaged power cord or plug.
3. Computers
   - Do not install or uninstall any software on the lab computers without approval of the faculty or staff member in charge of the lab.
   - Do not remove any hardware or cables from lab computers or monitors without approval of the faculty or staff member in charge of the lab.
4. Other lab equipment
   - Do not use, handle, or move equipment that is not used in CSE 2441.
   - Soldering is not used in CSE 2441. So please don't use the soldering equipment or tables.

Laboratory Resources

1. The BitBoard – The BitBoard accommodates the assembly and implementation of small digital logic circuits. It consists of a solder-less breadboard that can be connected to a DE1 or similar device for power and input/output. See Figure 1. A BitBoard will be checked out to you for use during the semester. ***You will be required to return the BitBoard at the end of the semester.*** More details on The BitBoard can be found on page 4.

2. Altera DE1 Development and Education Board – The DE1 accommodates the implementation and test of small to complex digital logic circuits utilizing the Altera Cyclone II field programmable gate array (FPGA) and supporting devices. See Figure 2. The DE1 can also be used to provide power and I/O for The BitBoard. A DE1 will be checked out to you for the semester. ***You will be required to return the DE1 at the end of the semester.***

3. Parts – You will be provided a collection of commonly used integrated circuits (ICs) and jumper wire. ***You will be required to return the ICs at the end of the semester.*** Additional parts will be available in the lab as needed. Please see the ***Appendix*** for more details on IC nomenclature and package layout for some of the ICs available in the lab.

4. Tools – digital multimeters (DMMs), wire strippers, IC pullers, logic probes, etc. are available in the lab. DMMs are also included in the BitBox lab kit this semester and must be returned at the end of the semester.

5. Lab PCs – each lab bench is equipped with a Windows-based personal computer loaded with standard Windows and Office application software. A CAD software tool-set for analyzing and designing field programmable gate arrays (FPGAs) is also installed.

Laboratory Resources (con't)

6. Computer Login – Login to the lab PCs using your UTA netID and password.

7. CAD Software – Intel FPGA (Altera) Quartus II (v13.0sp1) Web-Edition is installed on lab PCs in 126 and 127 ERB. You are ***expected*** to download the software from Intel FPGA to your own laptop or home PC. The web-edition is free. **DO NOT download versions later than v13.0sp1!!** Later versions are not compatible with the DE1 technology. Quartus is Intel FPGA's industry standard computer-aided-design (CAD) software for design capture, simulation, and implementation of digital logic circuits.

8. Printer – an HP M651 color laser printer is available in the lab for printing designs and simulation results. The printer is networked to lab machines but is not accessible remotely or wirelessly.

9. File storage – User files on the lab PCs are not saved from session to session, so you need to set up a directory on the J: drive, e.g., MyCSE2441Labs, or use a usb drive to store your design files for the semester.

10. Lab stewardship – the laboratory equipment, software, and facilities are here for your educational use and are maintained on a regular basis by the CSE Technical Staff. It is your responsibility to treat the equipment with care so that it is available the next time you or someone else needs it.

BitBox Check Out

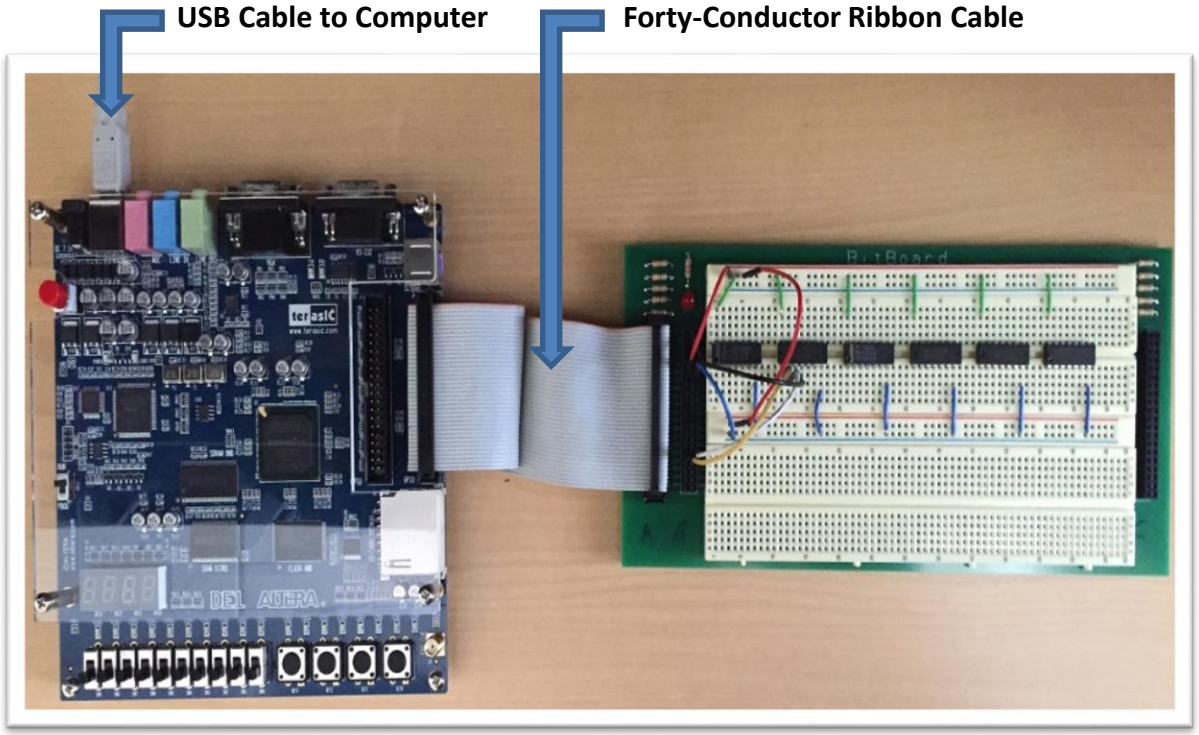
- The BitBox contents
  - The BitBoard
  - DE1 Development and Education Board
  - Twenty-seven integrated circuits (ICs)
  - Jumper wire kit
  - DT-182 dmm
- Inspect your kit
- Review the terms and conditions
- Sign and return the check out form

This Week's Assignment

- Become familiar with The BitBoard and the DE1
- Experimentally derive truth tables for basic gates – NOT, AND, OR, NAND, NOR, XOR. Note that each chip contains multiple gates but only one is needed for this experiment.
  - ✓ Use DE1 switch SW1 for input A and SW0 for input B.
  - ✓ Use LEDR0 for output Y.
  - ✓ Observe the logical values (1 or 0) of each input and output.
  - ✓ Write the logic equation for each gate.
  - ✓ Measure the voltage levels of each input and output.
  - ✓ Measure the voltage levels of Vcc and GND.
  - ✓ Record observations in a truth table.

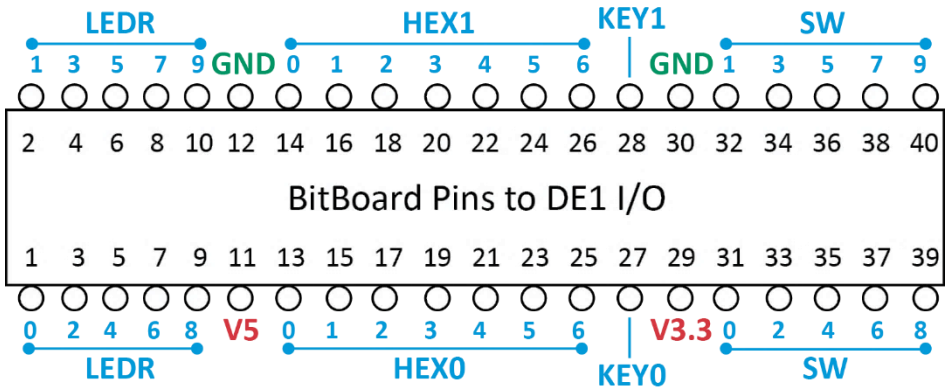
A	*B*	*Y*	V_A	V_B	V_Y
0	0				
0	1				
1	0				
1	1				

Using the DE1 with The BitBoard



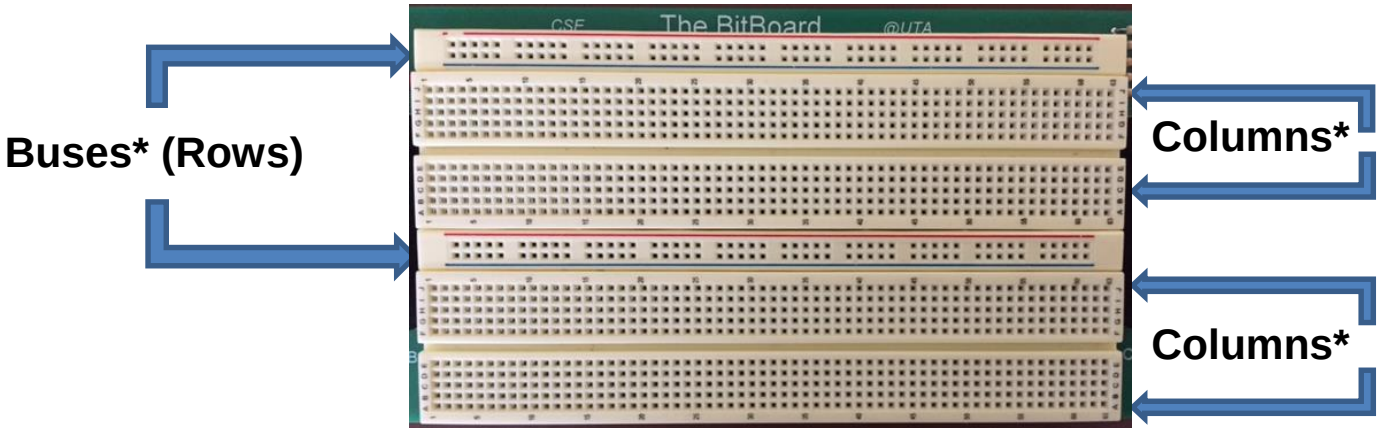
DE1 Connected to The BitBoard

Using The BitBoard



Mapping of The BitBoard Pins to the DE1 Switches and LEDs.

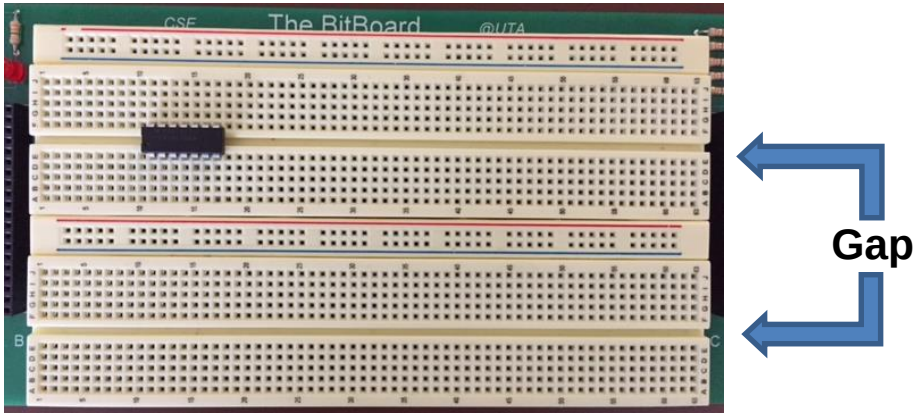
Using Solderless Breadboards



*** Electrically common**

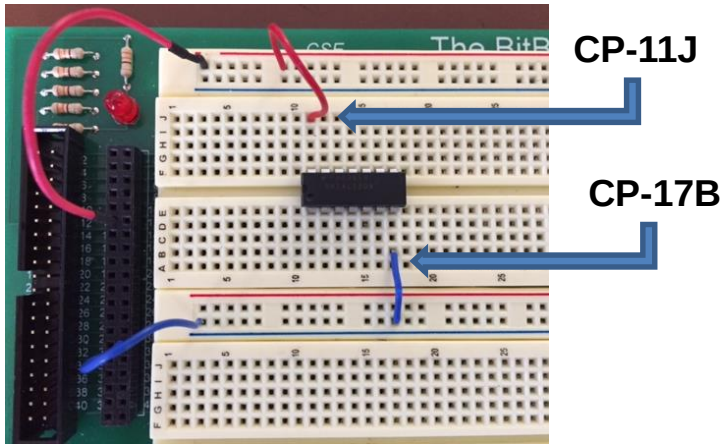
Solderless Breadboard Organization

Using Solderless Breadboards



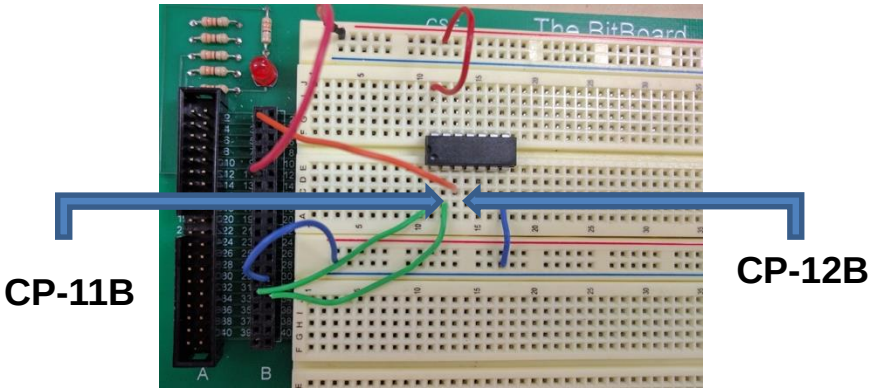
Chip Placement

Using Solderless Breadboards



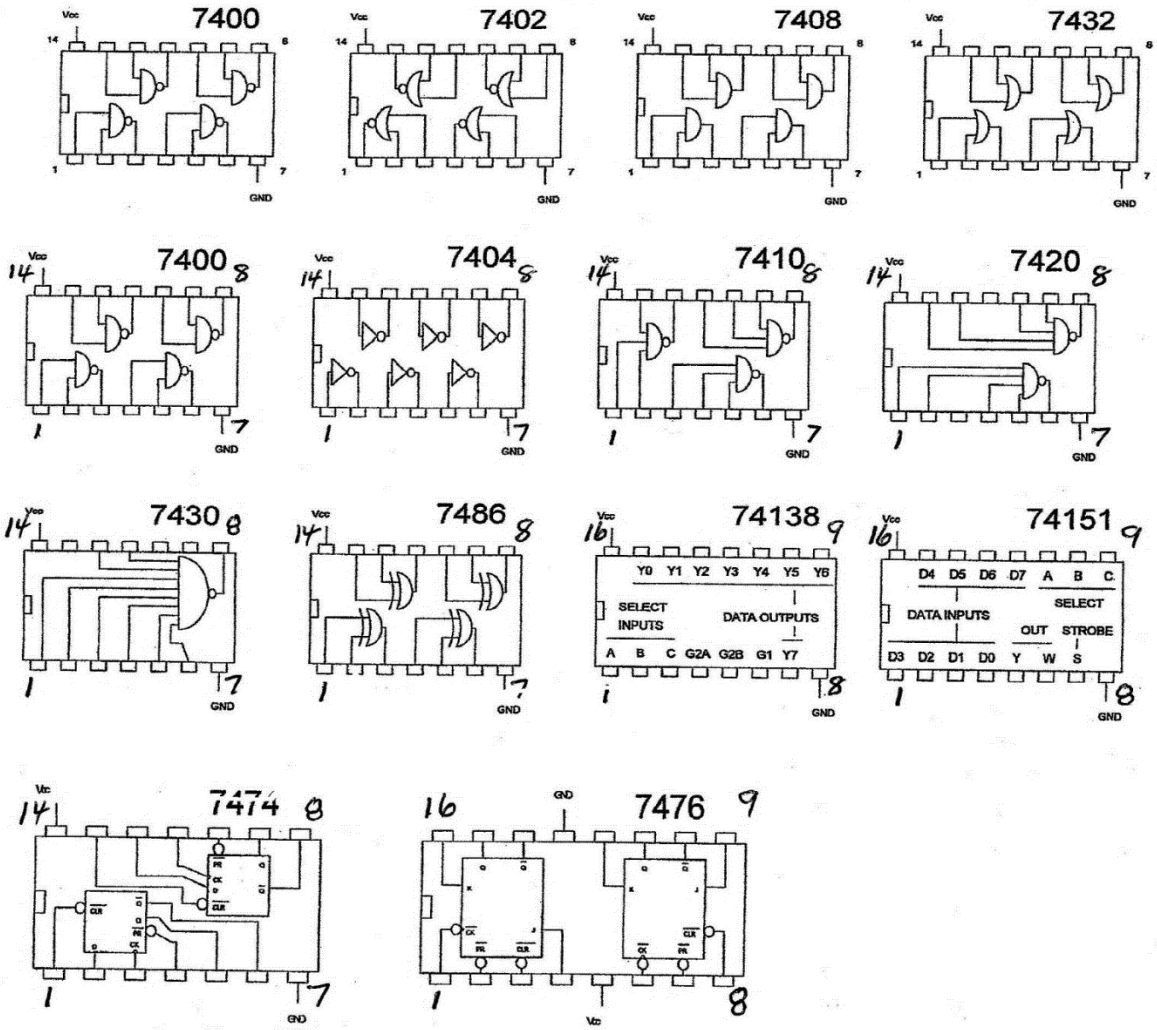
Making Connections

Using The BitBoard

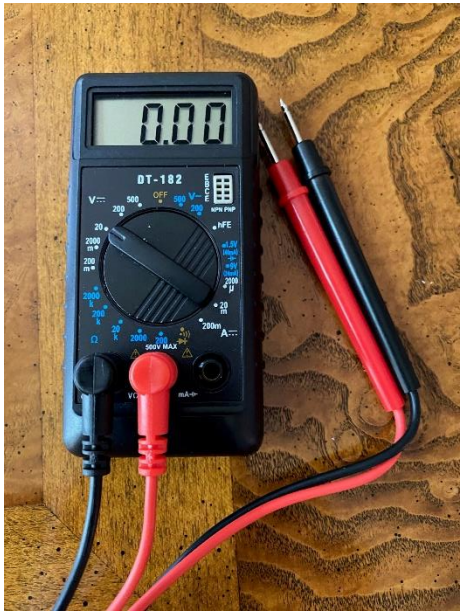


Connecting a NAND Gate

Integrated Circuit (IC) Layout and Pin Out



Using the Digital MultiMeter (DMM)



Measuring DC Voltage – First, select the smallest voltage range that is larger than the voltage to be measured. This is typically 20-volts for logic circuits and devices as shown above. Next, connect the black test lead to *ground* of the circuit or device to be measured. Connect the red lead to the terminal to be measured. The voltage of the terminal, relative to ground, will be shown on the DMM display.

Measuring AC Voltage – Select the appropriate range (500-volts or 200-volts)**.** Connect the test leads as described above. The voltage read will be RMS.

Measuring DC Current – Select the appropriate current range and connect the test leads as above. Note that when using the 10-amp range, the red lead must be connected to the 10A terminal of the DMM.

Measuring Resistance – Select the appropriate range and connect the test leads as described previously.

The DMM can also be used to test diodes and transistors and as a square-wave generator. However, these features will not be described in this guide.

POWER OFF – Be sure to place the selector switch in the **OFF** position when not using the DMM in order to preserve battery life.