DE1-SoC Overview for CSE369

Laboratory Design Kits

You are responsible for your lab kit and we expect that you will return the kit in good working order with all pieces intact. **Please make sure all of the following are present in your kit when you first receive it:**

- The Altera/Terasic DE1-SoC Development Board (the "DE1") with UW Proto board and white solder-less breadboard attached on the top (*Figure 1*).
- A black power cord for powering the DE1.
- A grey USB cable (Type-A to Type-B male-to-male) for hooking the DE1 to a host computer.
- A breakout board with 4 LED arrays (the "LED Board").

For the final project, if you determine that you need additional chips, switches, lights, or other devices, you can purchase them at the ECE store or online (*e.g.*, DigiKey Electronics).

We are aware that accidents can happen and device pins may be weakened from years of use. Typically, minor damage (*e.g.*, blown fuse, pin breakage) will be replaced at no penalty; however, you will have to pay for replacements in cases of gross negligence. Take care not to short-circuit ("short out") your board by connecting Ground to Power, which can quickly burn all the board components, including the board itself. Finally, be careful not to snap off wires or pins inside the I/O connectors or the holes in the solder-less breadboard.).

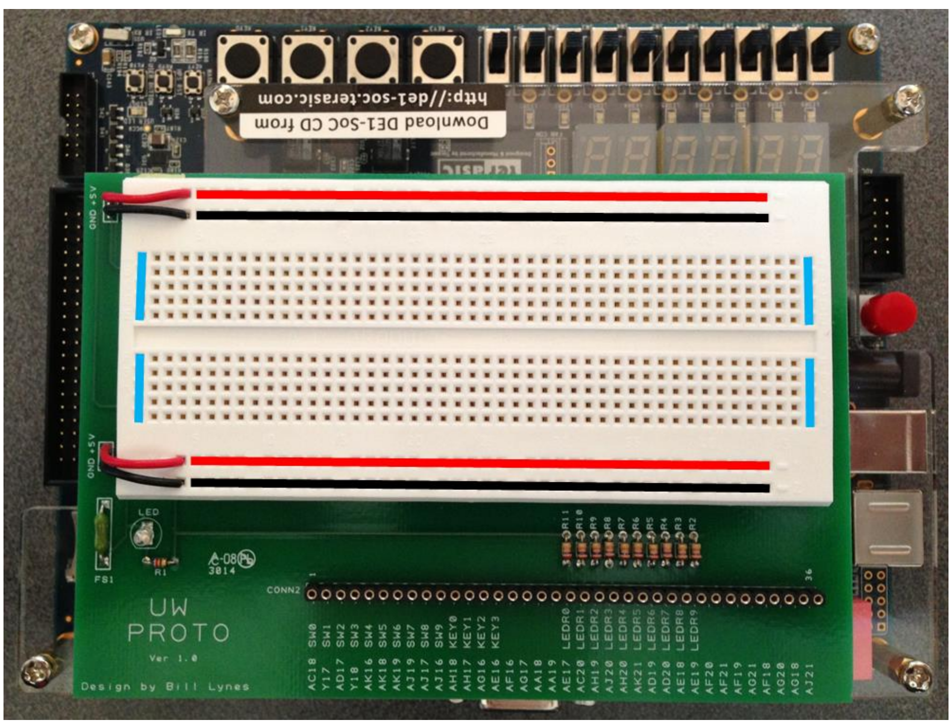

Figure 1: *Solder-less breadboard (white) and prototyping board (green) sit on top of the DE1-SoC. Internal breadboard connections are shown in* ***red*** *(VDD),* ***black*** *(Ground), and* ***blue****.*

Altera/Terasic DE1-SoC Development Board

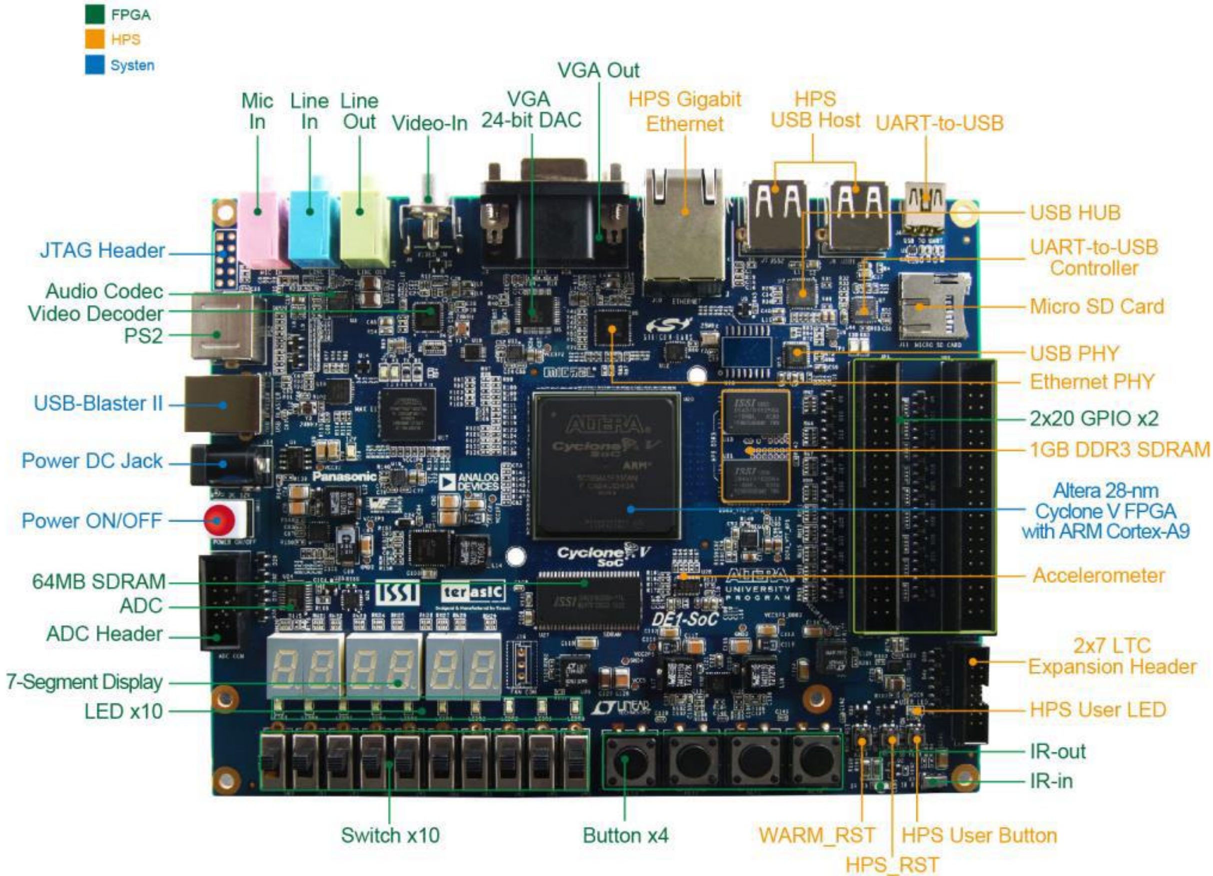

Figure 2: *Diagram of the major components of the DE1-SoC development board.*

Figure 2 highlights most of the major components of the DE1. You will program the FPGA in the center of the board to interface directly with the board devices. Think of the FPGA as a universal logic unit that all the devices can talk to.

The Field Programmable Gate Array (FPGA)

The FPGA is a large array of logical elements with reprogrammable connections. This means the FPGA can be used to build many different kinds of hardware all on the same chip!

If you look at the lights when you turn on the board, you will see that it has a premade display running. This is a program that we have written and programmed into your DE1's non-volatile memory. This means that this startup program is loaded *every* time the board is turned on, regardless of whether you reprogrammed the FPGA previously.

Basic Inputs and Outputs

The main inputs that we will use in this class are switches and pushbuttons and the main outputs are LEDs and 7-segment displays. All of these can be seen at the top of *Figure 1* and near the bottom edge of *Figure 2*. In our SystemVerilog code, we use the following special variable names to refer to these I/O devices: **`SW`** for the switches, **`KEY`** for the pushbuttons, **`LEDR`** for the LEDs, and **`HEX`** for the 7-segment displays.

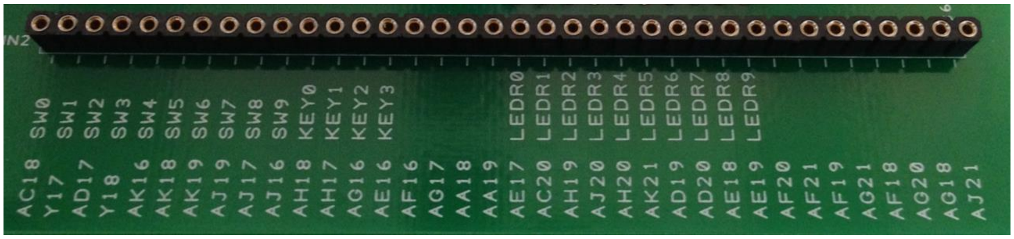

Figure 3: *Close-up image of the general-purpose input/output (GPIO) pin connections on the prototyping board.*

The UW prototyping board also provides connectors for a bank of the DE1's GPIO pins (*Figure 3*). Each hole connection also maps to a preprogrammed functionality, as indicated in white text on the prototyping board, including the switches, pushbuttons, and LEDs.

For example, if you hooked up the hole labeled "`AJ16 SW9`" to the hole labeled "`AE19 LEDR9`" with a wire, I would be controlling the red LED labeled `LEDR9` on the DE1 with the switch labeled `SW9`.

> Using the LEDRs as ***logic probes*** can be very helpful as you develop your circuits – you can find the value is of a given 1-bit signal by hooking it up to an unused LEDR to get a realtime view!

Powering and Connecting Your Board

Power the board by plugging the black power cord into an outlet and into the "Power DC Jack" socket just above the red on/off button. There is a fuse (`FS1`) and an indicator light (the blue `LED`) on your prototyping board. If you do accidentally wire up GND to VDD, you will mostly likely blow the fuse and the LED light will go off.

Connect the grey USB cable to "USB-Blaster II" socket on the board and to a USB port on the computer you're using with Quartus installed. For instructions on how to program your board, see the Quartus Tutorial document.

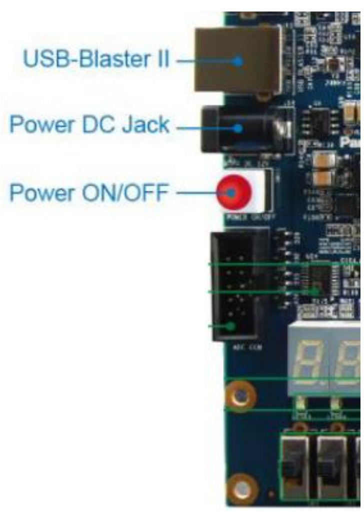

Figure 4: *Power and computer connectors on the side of the DE1.*

Figure 5: *Fuse and blue LED (unlit) found in a corner of the UW prototyping board.*

The Solder-Less Breadboard

Depending on when you take CSE369, you may or may not be required to use the solder-less breadboard. Feel free to skip this section unless needed, but you will have the option of using this during your project to connect other circuit components.

The white solder-less breadboard attached to your DE1 is for building off-board circuits and connecting additional components (*Figure 1*). Notice the red and black wires going to rows at the top and bottom of the board. The **red** wires denote VDD (+5 Volts) and the **black** wires denotes Ground (0 Volts).

Never directly connect these two rows together in any way!!!

You should have both a VDD and Ground at the top of your board and a set at the bottom. Even though there are horizontal spaces between the holes in each row, all of the holes are connected to each other. This means you have "rails" of VDD (**red** lines in *Figure 1*) and Ground (**black** lines) both at the top and bottom of your board.

Between the two sets of rails are two 48-column grids of holes separated by an indented divider. All 5 holes in one column are connected to each other (vertical **blue** lines in *Figure 1*); however, the column on the top of the divider is not connected to the column below the divider.

All of these connections are underneath the board so you cannot see them. If you connect VDD into one of the five holes in a column, all five holes now have VDD running across them.

Wiring your Solder-less Breadboard

Wires should be inserted as perpendicular as possible to the breadboard and should slide in and out with just a little force. If you find that there is a lot of resistance in either direction, first review the wiring guidelines below, and if that doesn't work, then please talk to the TAs.

Do not try to force anything larger than stripped wires into the holes, because this could damage the breadboard (at great cost).

Before doing any work on the breadboard such as wiring and inserting/removing chips, be sure the power is OFF. That is, unplug the power connector while you are constructing the circuit. After you have finished wiring up your design and before you turn on the power, double check the power and ground connections.

Wiring Guidelines

Wiring your circuit together can often feel tedious, especially in the beginning. However, if you are patient and wire your circuit nicely, you will find that you will spend a lot less time tracking down wiring errors. To aid you in this, here are a few tips to consider while wiring up your circuit. If anything is unclear, ask your TA for an example.

- *Strip your wires carefully.* This means that when you put the wire in your breadboard, there should not be any uninsulated wire visible and the wire should not crunch against the bottom of the board.
- *Your wires should always be nice and straight.* There should be no twists or kinks in them, as they can cause your board to short out when you insert them in your breadboard.

- *Arrange the chips on the breadboard so that you only need to use short wire connections.* Put tightly connected chips closer together. Chips will only fit with one set of pins on one side of the center divider and another set of pins on the other side of the divider.
- *Do not make a jungle of wires.* Long, looping wires that go way into the air are easy to pull out accidentally. These are hard bugs to find later when the circuit does not work as intended.
- *Try to maintain a low wiring profile* so that you can reach the pins of the chips if necessary. The best connections are those that lie flat on the board. Try to avoid crossing wires *over* any chips so that you can easily remove and replace them.