Overview

The DesignKits contain everything that you need to construct and test medium size circuits. They include:

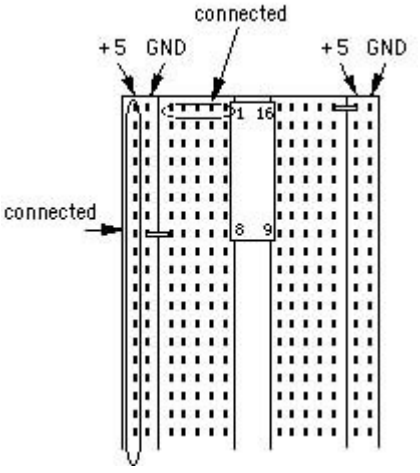
- A solderless breadboard (protoboard)
- Power supply
- Logic probe
- Clock generator (pulser)
- Box of pre-cut wires
- Wire stripper/cutter
- Some standard TTL chips and PLDs
- Switches, LEDs, resistors

You will be provided with other devices throughout the quarter and will add these to the list provided in your Design Kit. Accidents do happen, so we will replace a certain number of damaged chips (if there is a reasonable explanation for the damage). However, you will be held responsible for the cost of the chips if there is repeated and/or careless damage.

Your DesignKit contains a pair of long nose pliers. Please be very careful with these to avoid damaging the tip. You will find these invaluable for inserting and removing wires in crowded protoboards. They are also useful for straightening hook-up wire and bent pins on the chips. You may want to buy a small screwdriver. The screwdriver is an acceptable tool for carefully removing chips from the protoboard. (There is also a less effective chip puller in the DesignKit.)

Breadboarding Techniques

The protoboard in the DesignKit is comprised of several sections as shown in the figure on the next page. Power and ground have been pre-wired into the boards from the power supply connector and assigned to the vertical busses marked in Black/Green (GND) and Red (+5v.) Terminals in the protoboard are connected internally as shown in the figure. The kit includes some wire that has been pre-stripped and bent so that it can be easily inserted in the protoboard. If you need wire of a different length, use the wire stripper to cut and strip the wire. But first adjust the stripper so that it cuts the insulation without nicking the wire itself. The protoboard terminals are designed for wire of size #22-26. Inserting anything larger than size #22 wire will damage the terminal. Always straighten out bent wires and pins before inserting them into the board. You will also notice that new IC chips have pins splayed out for use in automatic insertion machines. You will have to carefully bend them together a bit before inserting the chips into the board (use pliers or the table top).



Before doing any work on the protoboard such as wiring and inserting/removing chips, be sure the power is OFF. That it, 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. To be sure, you should measure the resistance between power and ground to check for a short circuit.

Wiring Guidelines

- Arrange the IC chips on the protoboard so that only short wire connections are needed.
- Try to avoid a jungle of wires (guaranteed to save you lots of time and trouble later).
- Try to maintain a low wiring profile so that you can reach the pins of the chips and so the chips can be replaced if necessary. The best connections are those that lie flat on the board and do not cross over any chips.

Using the Logic Probe

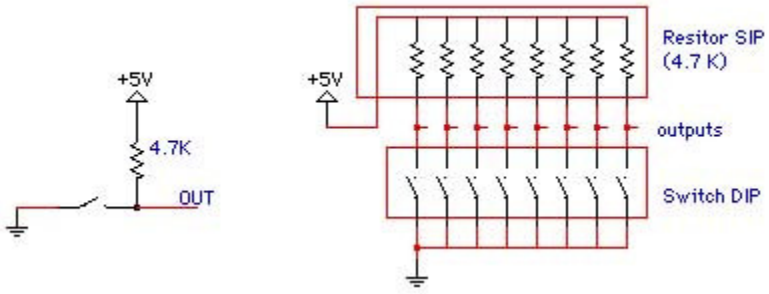
The logic probe provides a very convenient way to check the value of any signal in your circuit. The probe has two lights, HI and LO, which indicate the value of the signal. The logic probe responds to the input voltage in two ways depending on whether CMOS or TTL is selected. We will use the TTL setting which lights the LO light for voltages <0.8v. and lights the HI light for voltages >2.4v. If neither light is lit, then the signal is floating (i.e., not being driven) or has an illegal value somewhere between 0.8v and 2.4v.

The logic probe is also used to "catch pulses". If the PULSE MEMORY switch is placed in the MEM position, the PULSE indicator will turn on as soon as a transition, high or low, occurs on the input. This convenient for determining if a signal changes when the change happens too fast to be visible. This is useful for detecting glitches and whether a wire is stuck at a fixed value or is, in fact, changing on occasion.

Using the Switch Paks

You will be using switches to generate inputs for the circuits you test and LEDs to display the outputs. You may want to reserve part of your protoboard for a set of switches and lights which you can use for the rest of the quarter. The simplest switch is the the single-pole, single- throw switch shown in the figure below. To use the switch to generate a 1 or 0, we must connect it as shown. Note that this configuration generates a 0 when the switch is connected.

We will be using switches that come in packs of 8 and resistors that come in packs of 8. These can be easily connected as shown in the following picture to give 8 separate switches. First measure the resistance of the resistors in the resistor PAK to figure out which is pin 1 (common) and then connect the switches as shown. Choose an place like the first strip where you can leave these switches for the entire quarter.



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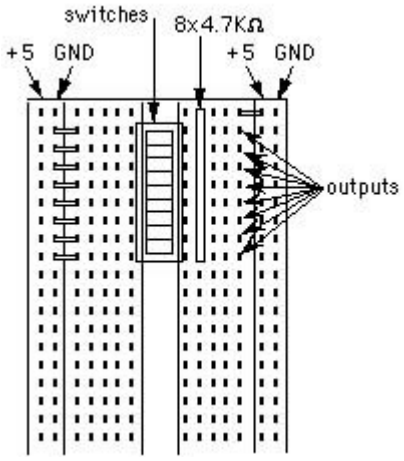
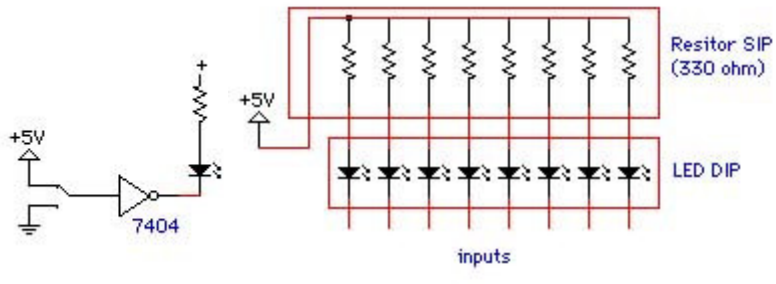


Light-Emitting Diodes (LED)

LEDs convert electrical current to light. They can be used as simple optical output devices. The circuit below shows one of many ways that a TTL gate can drive an LED. The resistor is used to limit the current flowing through the LED. An unprotected LED connected between ground and +5V will burn out. The resistor also protects the output circuitry of the TTL gate.

The LED is a diode, and thus its two connections are electrically different. How can you tell them apart? Here are some hints; they do not always work, though. The longer lead of the LED is the cathode, i.e., the wire that goes to the lower voltage. If the plastic housing is not circular, the flat part corresponds to the cathode (the flat part in the symbol). You can prepare a simple "LED test station" on your superstrip, using a 330 ohm resistor connected to +5V and a grounded pin next to it. In this set-up, you can easily test any LED both ways and determine which lead is the cathode.

We also have LED's in paks of 8 or 12. The next figure shows how they look internally and how to connect them up conveniently on your protoboard. First measure the resistance of the resistors in the resistor PAK, then construct the LED circuit shown in figure using the LED Pak. Choose an place like the first strip where you can leave these switches for the entire quarter. You will want to install a 74LS05 or 74LS04 inverter chip (or perhaps a 74LS240 buffer chip) in order to have active high inputs to the LEDs. (For clarity, the connections between the inverter outputs and the LEDs are not shown in the figure.)



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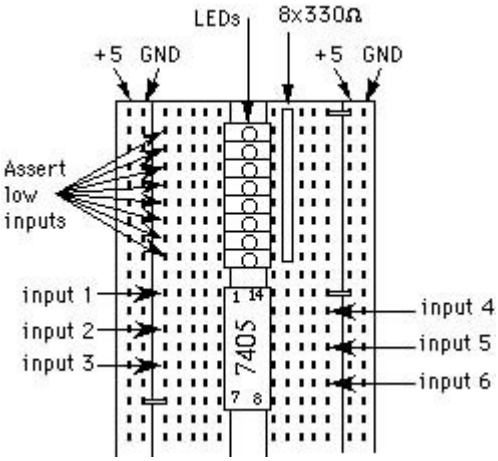

Clock Generator

Each kit contains a clock generator. Its red and black clips should be connected to power and ground. The tip is the clock output. Since the output is open collector (meaning the output will be pulled down for a `0', but left floating for a `1') you need to connect a 1K Ohm pull up resistor to the output. Connections to the output of the clock generator are made by placing the small rubber tube on the tip. This tube serves as a sleeve and a wire can be inserted in the sleeve.