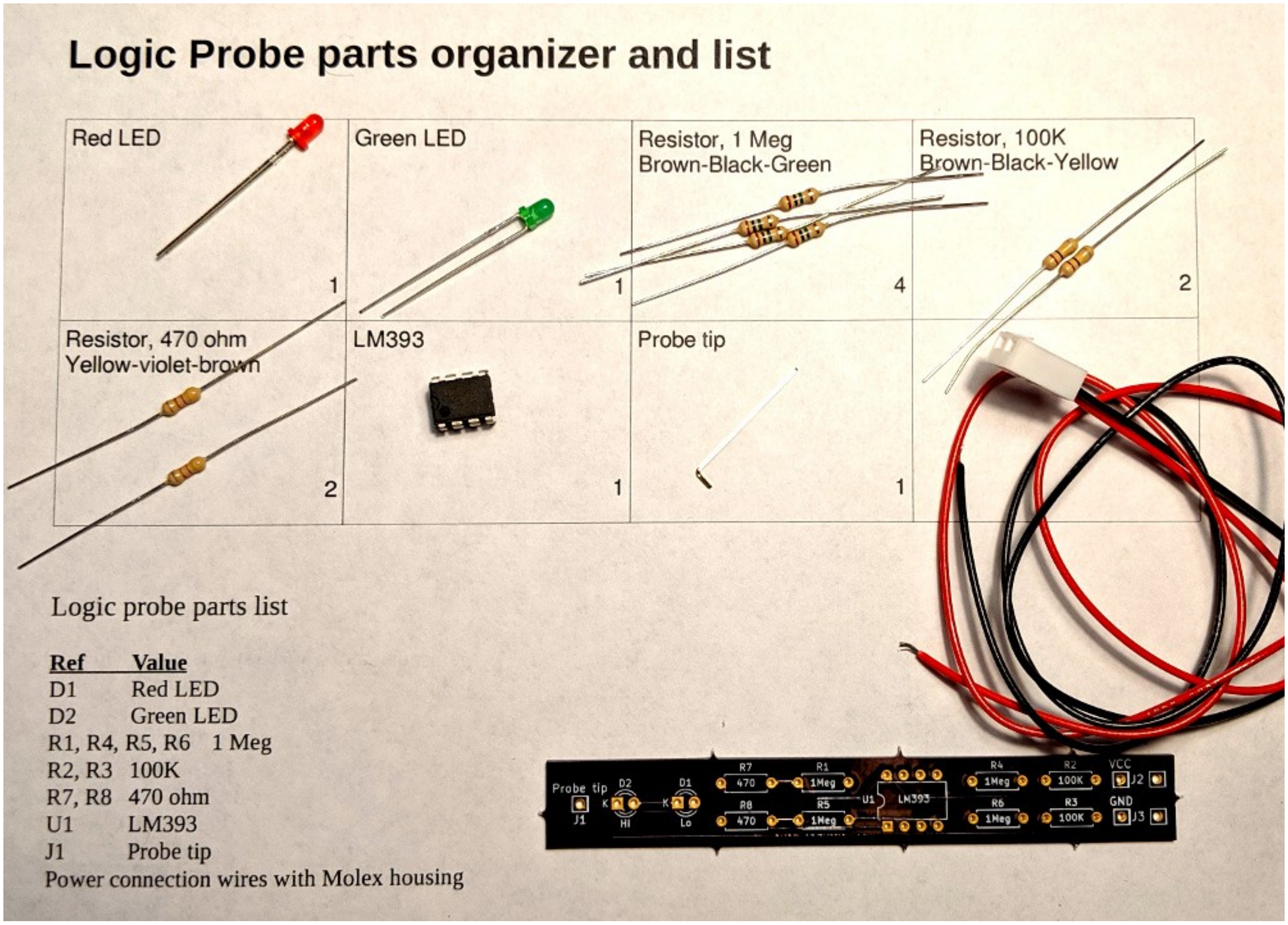
Logic Probe Kit Instructions

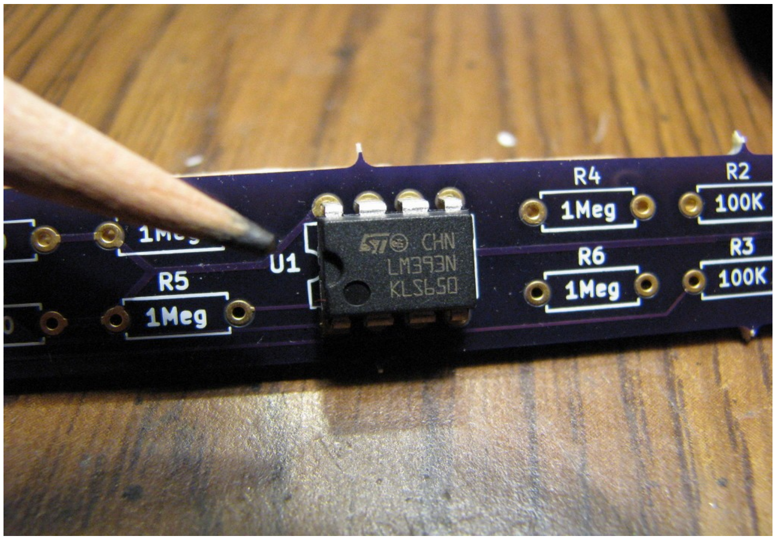
This is a simple kit, so these are simple instructions. For soldering tips see the CPUville instruction manuals for the more complex kits. The logic probe circuit board is small and lightweight, so clamping it in some type of vise appropriate for circuit boards is recommended, to avoid pushing it around when the soldering iron is applied.

Print out the Logic Probe Parts Organizer and place the parts on it, to make sure you have all the parts and to become familiar with them:



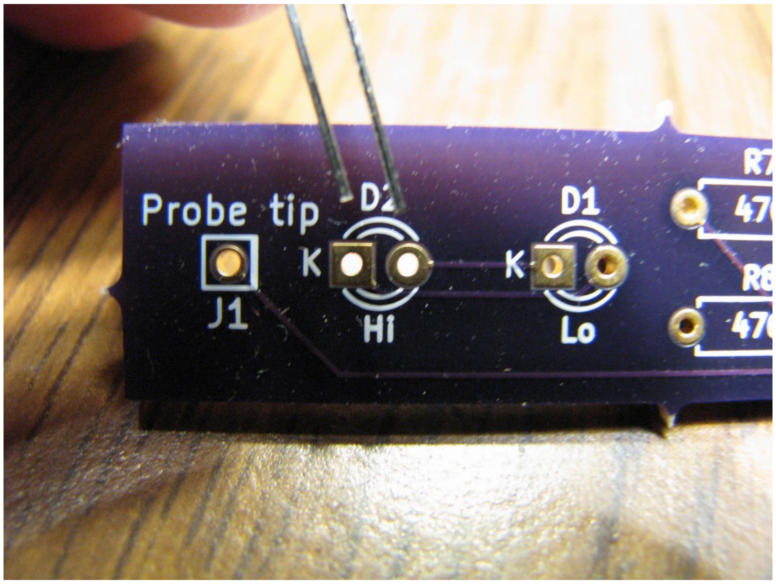
1. Place the resistors and solder them first.

2. Solder the LM393 comparator IC next. The small cut-out should be oriented to the left:

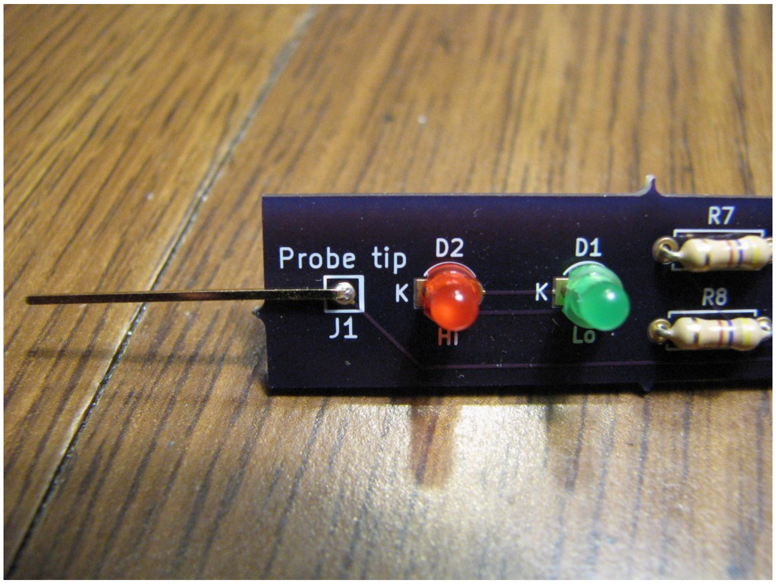


3. Solder the probe tip to the front of the board.

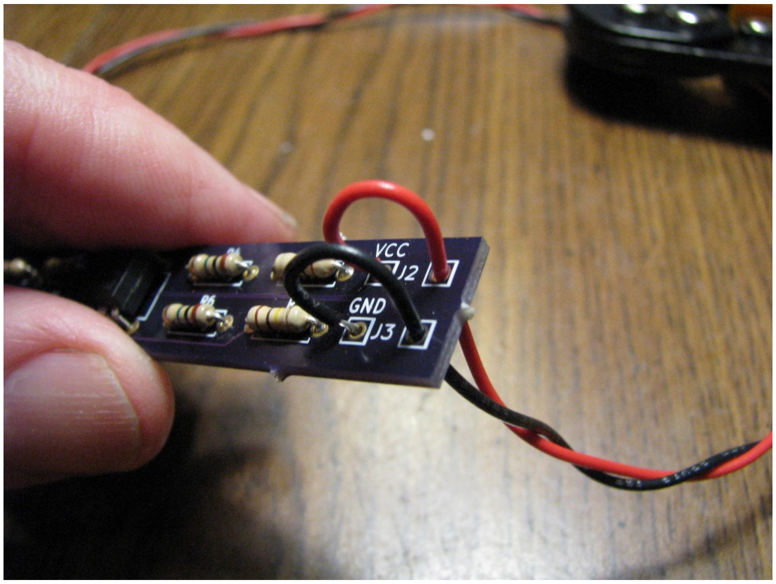
4. Solder the LEDs in place. The shorter lead (cathode) should be oriented to the left, going in the hole marked “K”:



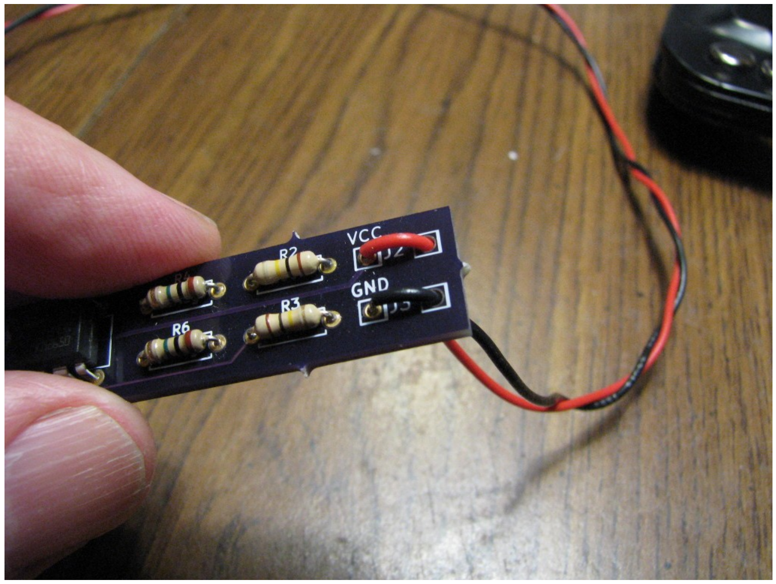
The red LED goes in the footprint labeled “Hi”, and the green LED goes in the footprint labeled “Lo”:



5. Insert the wires through the unplated holes, then solder in place. The red wire goes in the hole marked “VCC”, and the black wire in the hole marked “GND”:

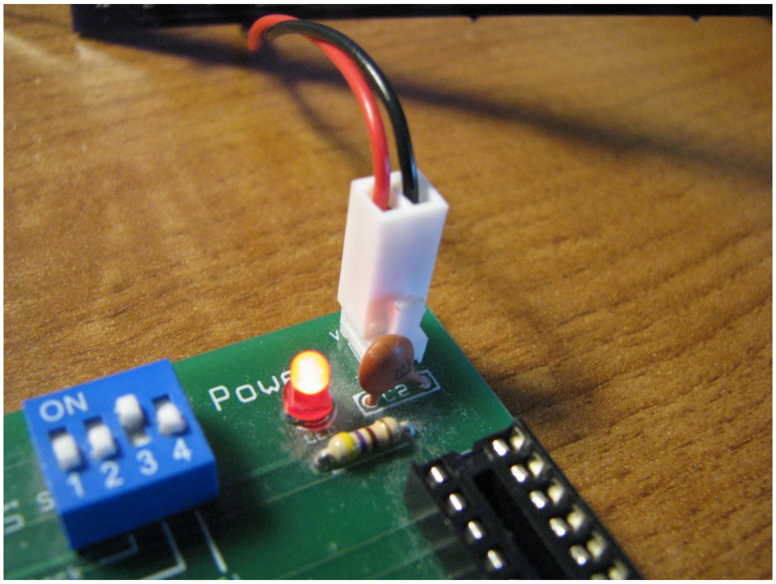


After the wires are soldered pull the wires back through the unplated holes. This scheme provides some strain relief for the wires and their solder joints:


VCC
R2
GND
R3
R6

Using the Logic Probe

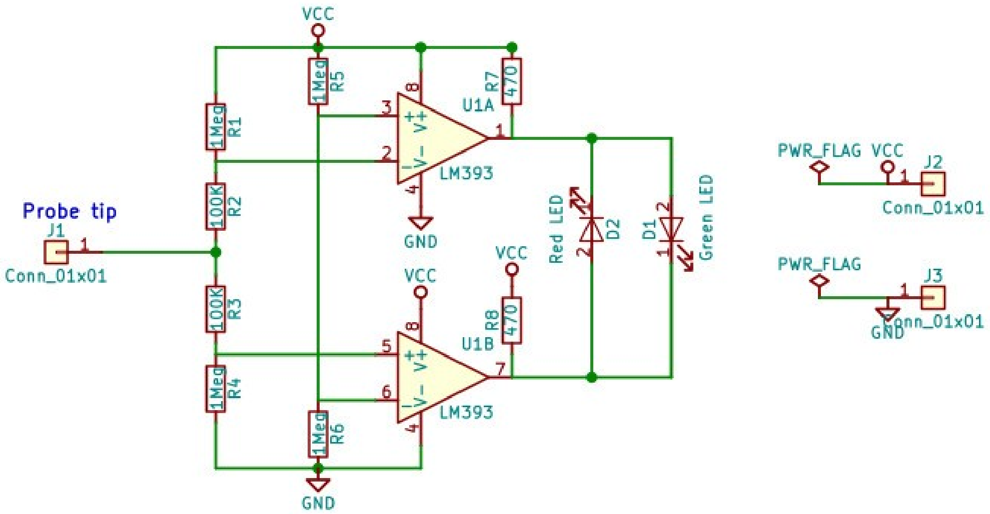
Connect the logic probe to the auxiliary power connector on the circuit board of the Original or Single-board Z80 computer. The red wire (VCC) should be on the left, with the black wire (GND) on the right:



The logic probe LEDs will show four different conditions. When not touching a pin, or when touching a disconnected pin, both LEDs will be off. This is the "dead" signal. When touching a pin that that is at +5V, the red "Hi" LED will light, and when touching a grounded pin the green "Lo" LED will light. Finally, when touching a pin that is cycling, both LEDs will be dimly lit.[1] The probe draws very little current, so its use will not disturb a running system, if one takes care not to short two adjacent pins by a slip of the probe tip. The probe is very sensitive, and touching the probe tip or the back of the circuit board with your fingers will cause the LEDs to light. Holding it by the edges will prevent this. If holding it this way is difficult, one may wrap the board in insulating material, such as electrical tape.

1 Experience shows that the cycling of the fast clock oscillator is hard to detect with this simple probe. However, the address, data, and control signals cycling can be detected.

Logic Probe Schematic and Explanation



The logic probe is not a digital device. It is an analog device. It uses comparators, which are essentially one-bit analog-to-digital converters. The comparators have internal open-collector output transistors. When this transistor is on, the output goes to ground, and when it is off, the output will be pulled up to +5V by the 470 ohm resistor. These pull-up resistors also serve as current-limiting resistors for the output LEDs.

The input resistor chains connected between Vcc and ground act as voltage dividers. When Vcc is +5V, the voltage at comparator input pins 3 and 6 is half the total voltage drop of the resistor chain, or 2.5 V. This voltage serves as a reference voltage for the two comparators. In the upper comparator, this reference is applied to the non-inverting input (pin 3, +), and in the lower comparator it is applied to the inverting input (pin 6, -). When the voltage on the non-inverting input of the comparator is greater than the inverting input, the output transistor of that compatator will be off. If the non-inverting voltage is lower than the inverting voltage, the comparator output transistor will be on, and the output will be connected to ground.

When the probe is not touching anything, the voltage at the probe connection, which is halfway through the other resistor chain, will also be 2.5V. The voltage **drop** from Vcc to pin 2 will be 1/1.1 x 2.5 = 2.27, so the **voltage** on pin 2 will be 5 – 2.27 = 2.73 V. Similarly, the voltage **drop** from the probe connection to pin 5 will be 0.1/1.1 x 2.5 = 0.23, so the **voltage** at pin 5 will be 2.5 – 0.23 = 2.27 V. So when the probe tip is not touching anything, the voltage of the non-inverting input on of the top comparator will be lower than the inverting input, and the output transistor will be on, and the output voltage will be close to ground. Similarly, the non-inverting input of the lower comparator will also be lower than the inverting input. Both comparator outputs will be close to ground, and no current will flow between them, and neither LED will light up. When the probe touches a +5V signal, the voltage drop across the two resistors on top of the chain is now 0, and the inverting input voltage on the top comparitor will be +5V. The top comparator will still be on (output close to ground) because the non-inverting voltage, which is fixed at 2.5V, will be lower than than the inverting voltage, which is now +5V. However, for the bottom comparator, the voltage drop from the probe connection to ground across the 100K and 1 Meg resistors will now be +5V. The voltage drop from the probe connection to pin 5 will be 0.1/1.1 x 5 = 0.45, and the voltage at the non-inverting input will be 5 – 0.45 = 4.55V. This is higher than the inverting input voltage, which is fixed at 2.5V, so this comparator output transistor will be off. Now, current will flow through the bottom 470 ohm resistor through the red LED into the top comparitor, and the LED will light. Current is unable to light the green LED because in this situation it is backward. When the probe tip touches 0V, the situation is reversed, and the green LED lights.

Logic Probe parts organizer and list

Red LED 1	Green LED 1	Resistor, 1 Meg Brown-Black-Green 4	Resistor, 100K Brown-Black-Yellow 2
Resistor, 470 ohm Yellow-violet-brown 2	LM393 1	Probe tip 1	

Logic probe parts list

Ref	Value
D1	Red LED
D2	Green LED
R1, R4, R5, R6	1 Meg
R2, R3	100K
R7, R8	470 ohm
U1	LM393
J1	Probe tip

Power connection wires with Molex housing