Pocket Money Kit of the Month May 2020

No 5 – Logic probe

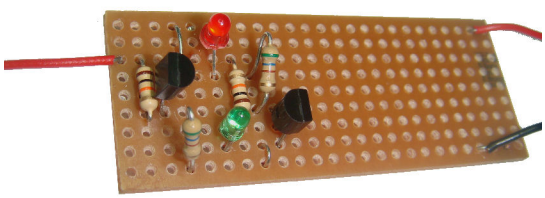
Many enthusiasts own multimeters, which are extremely useful tools for testing and fault-finding on layouts and on electronic modules. The ability to read different voltage levels helps trace bad joints, etc.

But, when dealing with modules that work on digital inputs and outputs, you only want to know whether a particular point in your circuit is at +5v or at 0v.
These circuits act like electric switches where much of the operation only works with ONs and OFFs, sometimes also called HIGHs and LOWs.
Examples uses of a logic probe are to:

- Check the supply pins of a chip. Is it getting both the +5v and the 0v?
- Check the output from a track detector – is it changing when a loco passes?
- Check the input to a circuit that is coming from a switch – is it going from +5v to 0v, or 0v to 5v, when the switch is operated?
- Check whether the inputs and outputs of CBUS and other digital modules are producing the expected results.

The internal circuits in lots of electronic modules work on 5v, even when the they are connected to a 12v or other voltage supply. This project is for a very useful tool that tells you whether a point in the circuit is at +5v or at 0v.

You could ask why not just use a multimeter? You could connect the -ve lead of your meter to the 0v line of your module. Then you could tap various parts of the circuit with the other lead. If you have +5v on that point, you will get a reading. But – and here is the catch – if you do not get a reading, it does not mean that you have 0v at that point. You might just have a broken wire that is not connected to anything. To check for connections to 0v, you would have to connect the meter's +ve lead to the 5v line and then test with the other lead's probe. You would have to reverse your meter connections every time you wanted to check for +5v or 0v.

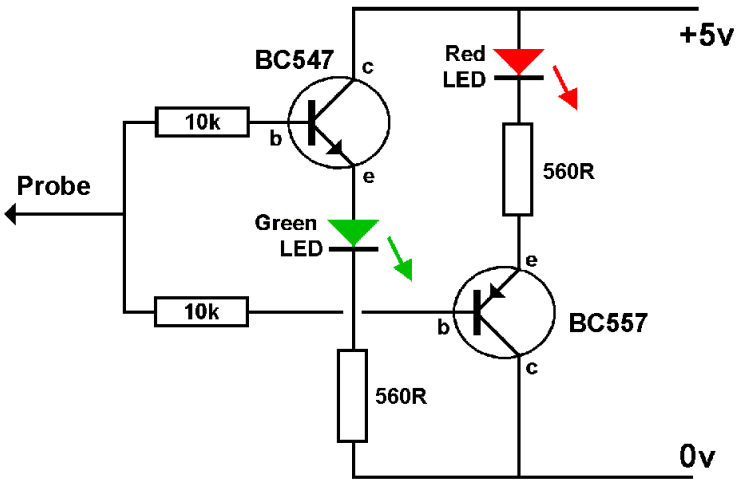


That is where a logic tester is handy. This, project, like the commercial versions, works by connecting the unit to the +5v and 0v of the module you are checking. Then you touch any point in the circuit. If +5v is on that point, a green LED lights up. If there is 0v at that point, the red LED lights up. All other voltages, or points not connected to anything, either keep the LEDs unlit or dimly lit.

Fancier commercial versions of our little tester are available - but they are about 20 times more expensive.

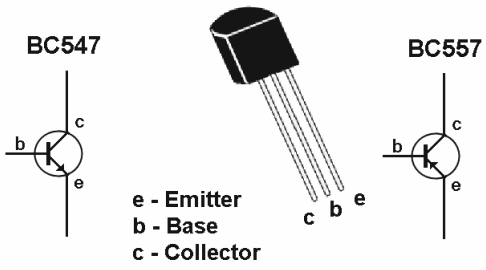
How it works

Here is the circuit diagram for the logic tester.
It uses just eight components.
It is really just two almost identical sections; one to light the red LED and one to light the green LED.
It uses a transistor to light each LED.
A transistor is a small semiconductor device that was originally mainly used as an amplifier, like those used in an old transistor radio.
Depending on the voltage fed to them, they can also act like a switch, as in this project.



In normal operation, a small increase in current through the transistor's base results in a larger current through its collector. The total resistance of the LED and resistor means that there is a maximum current that can flow through the emitter/collector. When this point is reached, increasing the base current has no further effect. The transistor is said to be in *'saturation'*. The 10k resistors limit the base current to be sufficient to switch the transistor fully saturated.

The two transistors use different semiconductor layers in their construction. This means that the BC547 allows current to flow from its collector to emitter when its base is at a higher voltage than its emitter. The BC557 allows current to flow from its emitter to collector when its base is at a lower voltage than its emitter. That's why the red LED lights on 0V while the green LED lights on 5V.



The kit is available at all West of Scotland activities (for 55p) or can be purchased from the national MERG website as PMP 5.