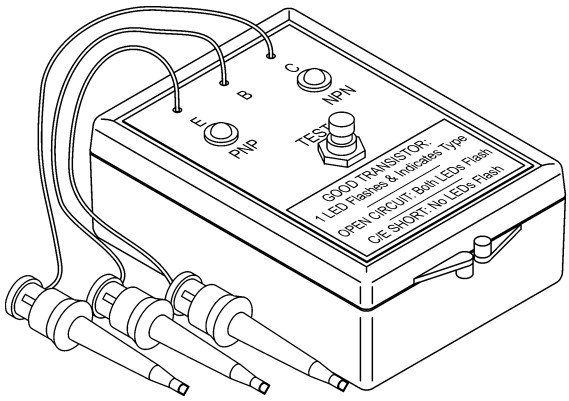
IN-CIRCUIT TRANSISTOR TESTER

CONTENTS:

DESCRIPTION

This device is used to detect a faulty transistor, within an assembled PCB. The testing can be carried out on the PCB's components, so that only the faulty transistor needs to be removed and replaced. The TRANSISTOR *T'EST'E'R* PCB and components are small enough to fit into a "slide box", making it very portable.



SECTION 1: GENERAL AND PLANNING INFORMATION

Locating a faulty transistor on a Circuit Board, crowded with soldered in place components, can be a difficult proposition. With an In-Circuit TRANSISTOR T'EST'E'R, however, the component's general quality can be determined, while avoiding damage to other components and/or the foil pattern, due to excessive soldering iron heat. The TESTER described here will indicate whether a suspect transistor is good or faulty and, as a bonus, tell you the component's type (PNP or NPN).

A pair of flashing LED's indicate the transistor's condition. One LED flashes if the transistor is a functional PNP type, while the other LED flashes if the transistor is a good NPN type. If the transistor is faulty, either both LED's will flash or neither will flash, depending on the type of failure.

SECTION 2: COMPONENTS & MATERIAL REQUIRED

2a COMPONENTS SUPPLIED

The following components are supplied in a plastic bag for the construction of one Transistor Tester.

1x PCB
1x Slide Box
1x Battery Clip
3x Test Clips
1x Push Button Switch
1x 1C Socket (Spin)
1x IC Socket (16pin)
1x IC1555 Timer
1x IC2 4027 dual JK Flip-Flop
1x l0K OhmResisistor(Rl)
1x 47K Ohm Resistor (R2)
1x 270 Ohm Resistor (R3)
1x 220 Ohm Resistor (R4)
1x 330 Ohm Resistor (R5)
2x LED holders
4x Diode 1N4148 or 1N914 (D1,D2,D3,D4)
1x Electrolytic Capacitor l^iF (Cl)
2x Light Emitting Diode (LED1,LED2)

Note: it is suggested that, before you commence construction, you check the components in your kit

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2b ADDITIONAL REQUIREMENTS

The following parts are to be supplied by the student / builder: one 9V Battery, fine electric wire (different colours). Also required are 1.5mm and 7.0mm drills.

Note: it is suggested that, before you commence construction, you check the components supplied in your kit, and ensure that you have everything else required.

SECTION 3: MAKING AND ASSEMBLING THE *TRANSISTOR TESTERER*

3.1 ASSEMBLING THE PRINTED CIRCUIT BOARD (PCB)

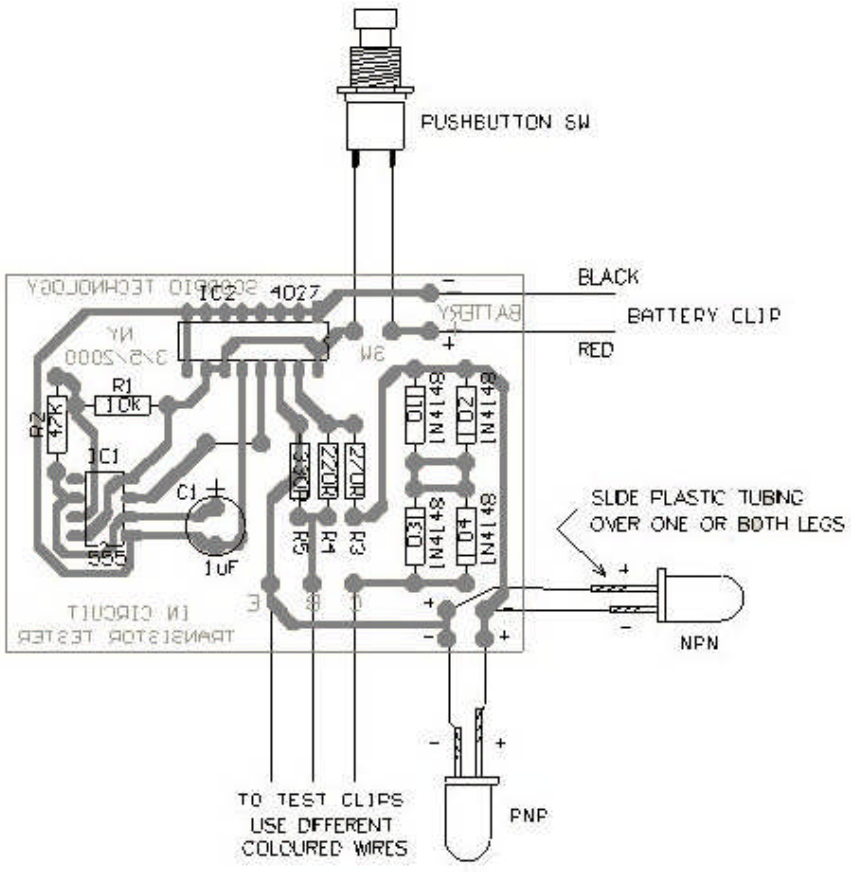
Notes:

1. Insert components onto the PCB from the non track side, with the leads coming out on the track side. Slightly bend the leads, to keep the components in place.
2. Always check to ensure that the components are oriented correctly (as per the PCB and instructions)
3. Incorrect orientation of components will cause the *TESTER*. to malfunction. It may also cause damage to some components.

Mount the resistors (Rl to R5). Use the colour coded bands to identify each resistor. Place them in the positions shown on the PCB overlay.

Rl - 10KΩ = Brown Black Orange Gold
R2 - 47KΩ = Yellow Violet Orange Gold
R3 - 270Ω = Red Violet Brown Gold
R4 - 220Ω = Red Red Brown Gold
R5 - 330Ω = Orange Orange Brown Gold

PRINTED CIRCUIT BOARD OVERLAY



Next mount the diodes (Dl to D4): these have a glass body, with a black band near one end to identify the negative end. Make sure the ends with the bands around them are placed in the same direction as shown on the diagram.

The two Integrated Circuit (1C) sockets must be inserted next. The notch at the end of the socket must be facing the same direction as shown in the overlay diagram. The electrolytic capacitor (Cl) is then inserted. The negative lead is marked with a stripe on the body and is also the longer of the two leads.

Check the components on the circuit board against the diagram. Ensure that all the components are in their proper positions and are correctly oriented.

- Solder the components in place.

- The two Integrated Circuits (1C) must be inserted into the sockets. It is important that the sockets are facing in the correct direction. The notches on the Integrated Circuits must face in the same direction as the notch on the socket, and as shown on the diagram. If available, use an 1C inserter to insert the IC2 (4027).

Warnings:

1. This 1C (4027) is a CMOS type and can easily be damaged by static electricity from your fingers. If you do not have an 1C inserter, you must first make sure that any static build up in your body is discharged. To do this you must touch the metal body of an earthed appliance immediately before handling the 1C. This should be done from the location you are working in.

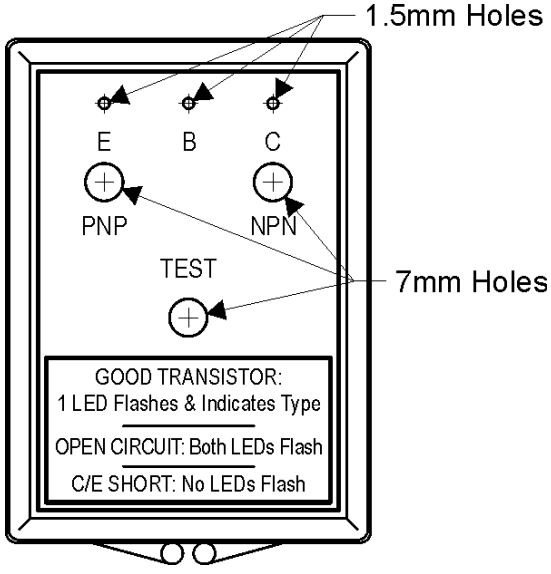
Note: walking across the room, touching the earthed appliance and walking back to your work bench will NOT work: static buildup can occur during this time.

2. If the ICs are placed the wrong way around, the IC's will be permanently damaged when the battery is connected to the circuit.

3.2 MAKING THE FRONT PANEL

- Cut three different coloured wires, each 300 mm long. Strip about 15mm of insulation from both ends of each wire, and twist the bared strands.
- Remove the top covers from the three test clips, and slide the covers onto the wires. Solder them to the test clips. Push the covers back onto the test clips.
- Cut out one of the "Front Panel" pictures (at the end of this unit). Position this Front panel on the cover of the slide box. Using a sharp scriber mark the positions for the six holes which have to be drilled in the slide box's top.

Tip: Place a piece of wood underneath the slide box lid. The wood must fit up against the inside of the lid, so when you drill the lid, it will not crack.. Drill the holes using a slow drilling speed. Clean up any burrs around the holes. Glue the cut out of the front panel in place, making sure the hole positions line up with the drilled holes. Cover the paper panel with clear contact, cut out the holes and trim to size with a sharp knife.



FRONT PANEL

3.3 ASSEMBLY TO THE FRONT PANEL

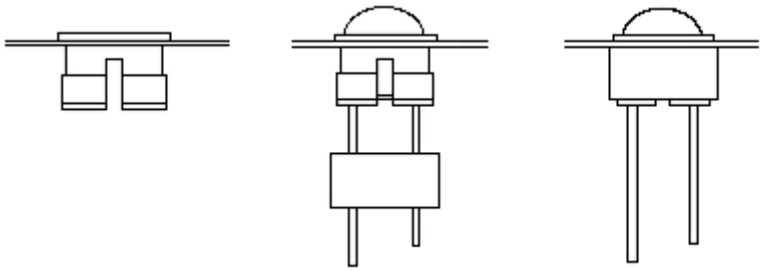
Press the LED holders into place on the cover.

Solder the wires from the PCB to the pushbutton switch. Fit the pushbutton switch into position on the cover, in the hole marked "Test".

Warning: Take care when soldering the wires to the switch's terminals - overheating can damage the switch's plastic body.

Fit the push button switch on the cover.

- Feed the test clips wires through the holes marked C, B and E (refer Front panel drawing). Pull through about 50 mm of wire and tie a knot in each wire (from underneath). This is to prevent the wires being pulled back through the holes, and stops them from being broken from the circuit board.
- Solder the test clips wires to the PCB, taking care that the wires for C, B and E go to their correct positions.
- Push the LED holders into the holes above where PNP and NPN are marked .
- Carefully push the two LED's into the LED holders. Make sure the LED's for NPN and PNP go in their correct positions.
- Push the LED's up into their holders as shown below. Slide up the ring over the LED's legs and push it up until it snaps into place
- Solder the wires from the two LED's to the PCB: the positive and negative leads must be correctly positioned



Carefully check the components, their orientation and the wiring against the layout diagram.

SECTION 4: WIRING UP *TRANSISTOR TESTER*

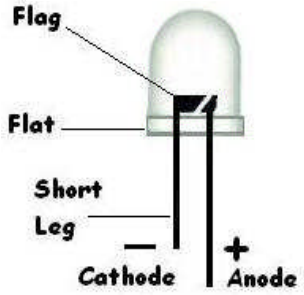
ASSEMBLING THE PCB TO THE TESTER

Tip: when working with fine multi-strand wires, the bare wires of each end should be tightly twisted together before being soldered to any component.

- Cut two wires, each no longer than 100 mm. Strip about 10 mm of the plastic insulation from both ends.
- Solder these 2 wires to the PCB for the Push Button Switch (these wires will be attached to the Switch later)
- Connect the Battery Clip to the PCB. Make sure that the Red (Positive +) and Black (Negative -) leads go to the appropriate positions on the PCB.
- Cut two Red and two Black leads, each 100 mm long. Strip about 10mm of insulation from one end of each, and about 20 mm from the other end.
- Wrap the 20mm length of one Black lead around the Negative leg of LED1. Similarly, connect one Red wire to the Positive leg of that LED.
- Repeat the above step for LED2, using the 2nd Red and Black wires.
- Solder these wires to the LEDs. Slide a short piece of 2mm plastic tubing up over at least one of the legs on each LED, to prevent the wires from touching each other and shorting out.

Note: LED's are commonly used as indicators to show whether something is turned on or adjusted properly. For example, the stereo light used on an FM radio is a LED.

LED's may use one or more of three methods to identify the negative lead. All types use method 1. However, not all LED's use methods 2 & 3. These methods are:



1. The Flag (the larger connection inside the body) identifies the negative lead. This is visible when the LED is held up to the light.

2. The shortest leg is negative

3. A flat on the ridge around the base of the LED is on the negative side.

SECTION 5: THEORY – HOW THE CIRCUIT WORKS

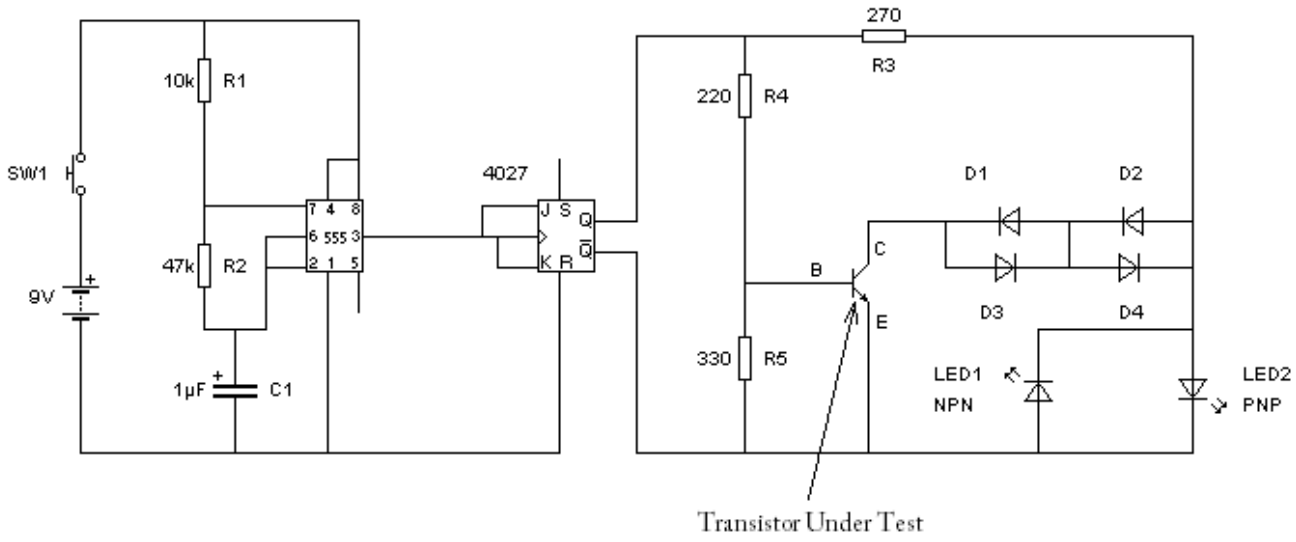
The *TESTER's* circuit (shown at the end of this section), is based on a 555 (IC1) timer operating as a 12 Hz multivibrator. The output at pin 3 drives one flip-flop of IC2. This flip-flop divides the input frequency by two, but more important, delivers complementary voltage outputs at pins 15 of 1C 1 (Q) and 14 (not-Q).

These complementary outputs are connected to indicators LED1 and LED2 via current-limiting resistor R3. The LED's are arranged so that when the polarity across the circuit is one way, only one LED will glow, and when the polarity is the reverse of that, the other LED glows. Thus, when no transistor is being tested, the LED's flash alternately. The IC2 complementary outputs are also connected to resistor network R4 and R5. The junction of these two resistors is connected to the base of the transistor being tested.

With a good transistor connected to the B, C and E (Base, Collector and Emitter) clips, when the correct voltage is applied to the three connectors, the transistor will turn on. This produces a short circuit across the LED pair. For example, when a PNP transistor is under test, during the interval when the Q output is low and the Q (not-Q) output is high, the PNP device will turn on. In this mode, LED1 is shorted, LED2 is reverse biased and, for that half cycle, neither LED will glow. On the next half cycle, the conditions of Q and not-Q are reversed with Q high and not-Q low. Under these conditions, LED1 is off because it is reverse biased, and since the PNP transistor is cut off, it does not prevent LED2 from glowing. Thus, **when testing a good PNP transistor, LED2 will flash**, and **when testing a good NPN type, LED1 will flash**.

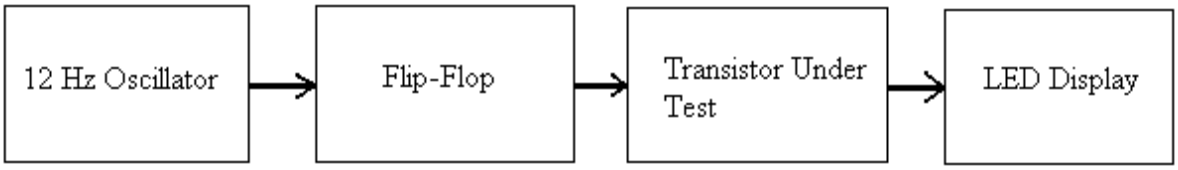
If the **transistor under test is open circuit, both LED's will flash**. If the **transistor has an internal collector-to-emitter short circuit, neither LED will flash.**

To compensate for low-valued resistors that may be present in the circuit being tested, R4 is selected to supply a large amount of base current to the transistor under test. This makes it possible to overcome in-circuit resistances across the collector-base or base-emitter junctions of as little as 40 ohms.



Diodes Dl through D4 become important if the transistor being tested has an internal short between its collector-base or base-emitter junctions. In such a case, half of the transistor acts like a diode and would normally conduct and indicate a good transistor. To overcome the possibility of this type of problem occurring, diodes Dl through D4 are added in series with the collector.

BLOCK DIAGRAM OF THE IN-CIRCUIT TRANSISTOR TESTER



SECTION 6 TESTING THE *TRANSISTOR TESTER*

5.1 TESTING THE TESTER

Rectify any faults you find. + Connect the 9 volt battery - the TESTER is now ready for testing!

Note: One of each transistor type - i.e. an NPN and a PNP - should be used to test your *T'EST'E'R*. If you have a known faulty transistor available, it also can be used.

Warning: When using the In-circuit transistor *TESTER*., power to the circuit under test must be removed. Failure to do so will either result in incorrect readings or damage to the *TESTER*.

Select the NPN transistor and connect the transistor's Collector, Base and Emitter leads to the C, B and E test clips (respectively). When the "Test" button is pressed, the NPN LED should flash on and off to indicate the NPN transistor is functioning.

Repeat the above using a PNP transistor.

If the TEST'ER is working correctly, fit the battery inside the unit and attach the lid. The *IN - CIRCUIT TRANSISTOR TESTER* is now complete, and ready for fault finding.

5.2 TROUBLESHOOTING:

i.e. WHAT DO I DO IF THE TESTER DOESN'T WORK?

Check:

- that positive (red) and negative (black) battery leads go to their correct positions on the PCB.
- if the battery has adequate charge
- if the positive and negative leads to an LED or both LED's are reversed
- that bare wire ends do not touch
- if the wiring is connected as per the PCB overlay
- that all the components are in the right positions and facing in the correct directions
- for short circuits - where solder connects across from one track to another. Note however that pins 1 through to 8 on IC2 are meant to connect to each other.
- that there are no solder bridges between the terminals.
- your soldering. Make sure there are no dry joints - the soldering may look dry or lumpy or you may notice the solder around a lead does not actually connect to the lead. This will look like a dark ring around the lead: try pulling the component up to see if the lead comes out or moves, (a magnifying glass or eye piece will help)

If you have checked all the above, there may be a faulty or damaged component. Test them individually or replace them.