

Assembly Manual

Transistor Beta and Mosfet Tester

K-7202

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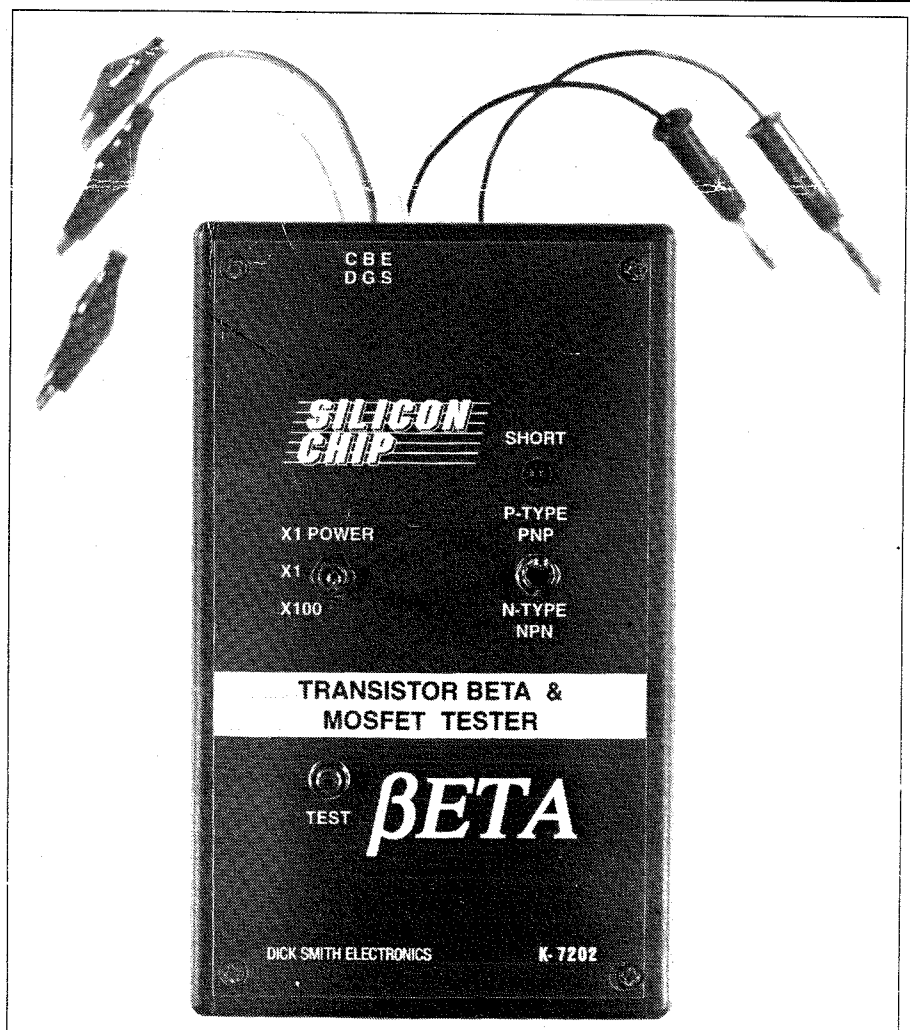
This handy test is designed to plug into a digital multimeter to provide an accurate measurement of transistor beta, to values up to 50,000 and more. You can use it to test small signal, power and Darlington transistors and, as a bonus, it will also check Mosfets.

If you need to use transistors from your junk box for your projects, it is a good idea to test them before soldering them into circuit. Actually, this is a good idea even if you have just purchased the transistors because it can stop you from soldering the wrong type into circuit. But now that many digital multimeters incorporate a simple transistor tester, why would you want to build this adaptor?

Well, there are several drawbacks to the typical "transistor test" facility in most digital multimeters. First, most will not measure transistor gains in excess of 1000. Most ordinary transistors have a beta of less than 1000 but many Darlington transistors have a beta far in excess of 1000 - up to 50,000 or more, in some cases. Also the fact that Darlington transistors have a base-emitter voltage drop of 1.2V or more and they incorporate internal base-emitter resistors means that the base current from the DMM test circuit may be less than it should be, another source of inaccuracy.

Another drawback involves power transistors. These typically require much more base current than small signal transistors and so beta tests of a power transistor using a DMM can often give misleading results.

On the other hand, many of the top brand digital multimeters do not have a transistor test facility at all and this is where the SILICON CHIP transistor



Plug this adapter into your multimeter and measure the beta of power transistors, small signal types and small signal Darlington.

Main Features

- Measures beta from 1 to over 50,000.
- Plugs into a digital multimeter for beta readings.
- Measures NPN and PNP transistors.
- Test N-type and P-type Mosfets.
- Two test base currents: 10 μ A and 1mA.
- High beta accuracy and resolution at measured current.
- Battery operated.
- Suitable for high impedance (> 10 M Ω) multimeters.
- Short indication.

tester comes into its own.

Transistor gain

You can use the tester to match transistors for gain or to decide whether an unknown device is a Darlington (very high gain) or a standard transistor. You can also find out the transistor pin-outs by trying all connection possibilities until a valid gain measurement is found. Similarly, you can determine whether the device is NPN or PNP by finding the polarity which gives a gain reading.

Mosfets are used extensively in kit set circuits these days and testing them can be difficult. With this tester, you can obtain valuable information about the condition of a Mosfet. The test is not a gm measurement but it will give a good indication of Mosfet gain.

The tester is housed in a plastic case. Three flying leads with alligator clips are clipped to the device to be tested, and two flying leads with banana plugs insert directly into the "V Ω " and "common" inputs. There are two toggle switches; one is the NPN (N-type)/PNP (P-type) switch to select the device polarity and the other is the 3-position range switch. The digital multimeter is turned on and a DC range selected, normally 2V to start. Then you press the button and the meter gives a reading. To convert the reading to beta, just take the reading in millivolts. For example, if you are on the 2V range and the reading is 0.695V or 695mV, the transistor beta is 695.

Alternatively, if the 200mV DC range has been selected and the reading is 115mV, then the beta is 115.

Power is consumed only while the Test button is pressed. If you want to hold the reading on your multimeter, press the "hold" button if it has one. That is how we stored the reading for the setup shown in the photograph accompanying this article.

Multiplier switch

The 3-position multiplier toggle switch needs some explanation. The po-

sition marked "X1 POWER" is used for testing power transistors and power Darlings. The other two settings are used for small signal transistors. The centre position marked "X1" gives a result as described; ie, the reading in mV is the beta. When on the "X100" setting, the readings are multiplied by 100 to give the actual result. This position is intended for small signal Darlington transistors which can typically have a beta of 30,000 or more.

Mosfets are measured in a similar

manner to power transistors. A good Mosfet will give a very high gain reading.

If a device being tested has a short between collector and emitter, the "Short" LED will light. The LED will also light when the wrong polarity is selected for Mosfet and Darlington transistors.

Test method

Fig. 1 shows the method of gain testing used in the circuit. The transistor under test is connected in a common emitter configuration with a 1 Ω resistor for the collector load and a 1mA current source for the base drive. A transistor with a gain of 10 will produce a 10mV drop across the resistor.

However, there are a few problems with this circuit. Firstly, for high gain transistors, a high current will be drawn from the supply and secondly, some tran-

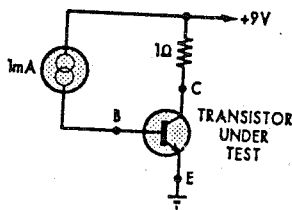


Fig. 1: This is the basic beta test set up with a fixed current supplied to the base of the transistor. If 100mV appears across the 1 Ω resistor, the collector current is 100mA and the beta is 100.

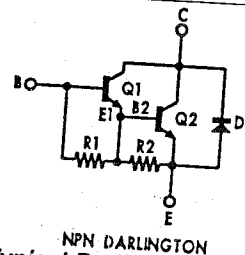


Fig. 2: Typical Darlington power transistors have internal basemitter resistors which means that a minimum base current of about 1mA is required to turn them on. Most beta testers in DMMs cannot supply this much base current.

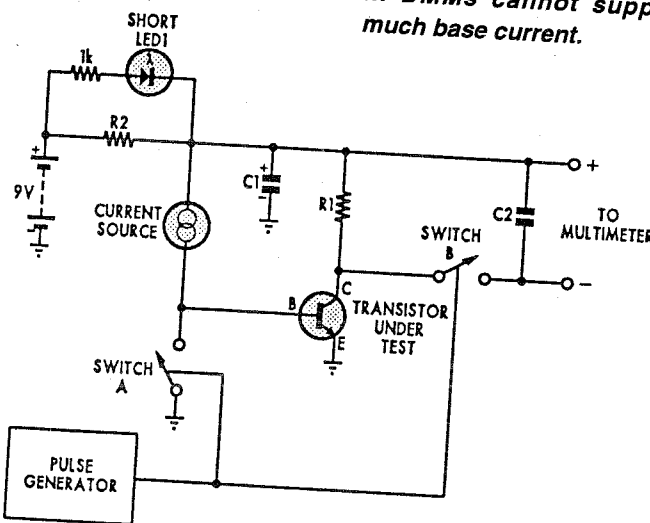


Fig. 3: This circuit shows the principle of operation of the Beta Tester. The current source is shunted to ground by switch A. When switch A opens, the current source drives the base of the transistor and a voltage proportional to the collector current is developed across R1. Switch B and capacitor C2 form a "sample and hold" circuit which stores the voltage developed across R1 so that it can be read as a DC voltage by the multimeter.

PARTS LIST

- 1 PC board, code ZA-1261 (04306951), 92 x 61mm
- 1 plastic case
- 1 front panel label
- 1 9V battery clip
- 1 SPDT momentary pushbutton switch (S1)
- 1 DPDT centre-off PC mount toggle switch (S2)
- 1 DPDT PC-mount toggle switch (S3)
- 7 PC stakes
- 2 banana plugs
- 3 crocodile clips
- 3 200mm length of hookup wire
- 2 400mm length of hookup wire
- 1 100mm length of 0.8mm diameter tinned copper wire

Semiconductors

- 1 7555, TLC555CN or LMC555CN timer (IC1)
- 1 4053 triple 2-channel demultiplexer (IC2)
- 1 LM334Z current source (REF1)
- 4 1N4148, 1N914 signal diodes (D1-D4)
- 1 3mm red LED (LED1)

Capacitors

- 2 470µF 16/25VW PC electrolytic
- 2 10µF 16/25VW PC electrolytic
- 2 0.1µF/100n/104 MKT polyester

Resistors (0.25W 1%)

- | | |
|-----------|--------|
| 1 330kΩ | 2 100Ω |
| 1 6.8kΩ | 1 68Ω |
| 2 1kΩ | 1 47Ω |
| 1 120Ω 1W | 1 1Ω |

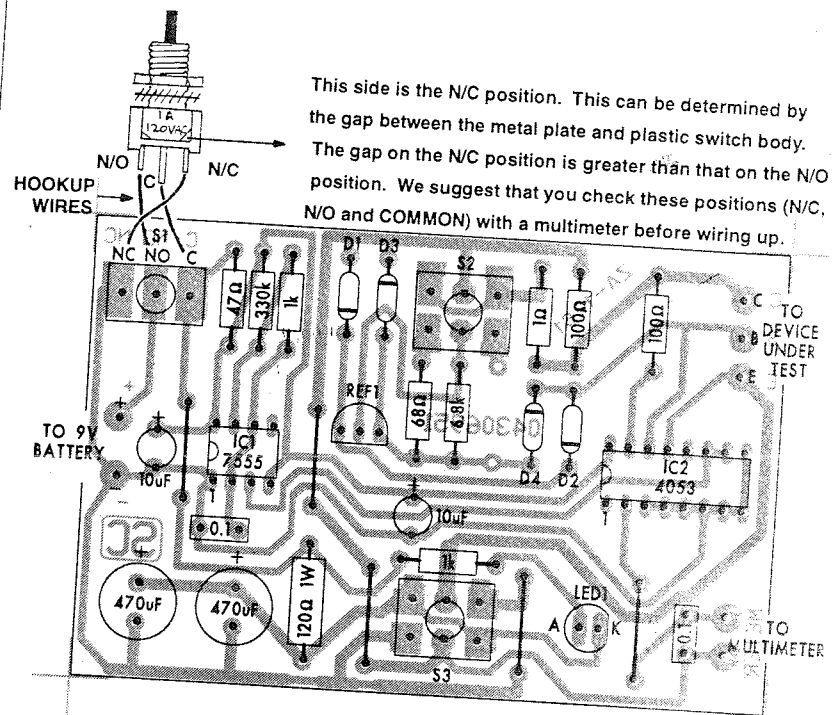


Fig. 5: Follow this parts layout diagram when installing the parts on the PC board. Note particularly the orientation of the contacts on switch S1 - see text.

Construction

The Beta Tester is housed in a plastic utility case. All the circuitry mounts on a PC board coded ZA-1261 (04306951) and measuring 92 x 61mm. This is secured to the lid by two switches.

You can begin the construction by inserting PC stakes at the external wiring points. This done, install the resistors, links and diodes, followed by the capacitors and lastly, the integrated circuits. Make sure that the semiconductors and electrolytic capacitors are correctly polarised.

All electrolytic capacitors are mounted with their bodies lying horizontal to the board (see photos). This is done so that the PC board can be mounted to the lid without interference by the two switches.

Next, the switches can be installed. Note that pushbutton switch S1 must be oriented in a particular way. You will find that from its three contacts, one is C (common), NO (normally open; ie: when not pressed) and NC (normally closed). The contact positions should match the labelling on the copper pattern side of the board (ie, NC contact toward the edge of the board). This switch is mounted by three small wire links (see Fig. 5) and as some switches do not carry any labelling, it is best that you first check switch S1 with a multimeter to

determine which terminals are NO, NC and Common. Use the centre-off switch for S2.

Finally, LED1 is inserted so that it sits at the same height as the switch bushes. Do not cut its leads to length yet, so that it can be set to the correct height in the front panel later on.

Initial tests

Attach the battery clip leads to the PC board and apply power. Connect a multimeter between the negative battery lead and pin 8 of IC1 and check that there is about +9V present when S1 is pressed. Similarly, check for a similar voltage on pin 16 of IC2. Short the E and C terminals and with S2 in the x1 power position check that LED1 lights.

Now affix the Dynamark label to the front panel and drill the holes for switches S1-S3 and LED1. One end of the case requires separate holes for the three test leads which are fitted with crocodile clips and two for the leads fitted with the banana plugs. The battery (not supplied) can be held in place with a metal clamp or with double sided tape.

Now connect up wires on the board for the base, emitter and collector test leads and for the banana plugs. Attach the PC board to the front panel by firstly placing a single nut on each switch bush about 5mm down from the top and then

transistor under test. In position 2, the "centre-off" position, the 68kΩ resistor by itself sets the base current to 10µA.

Positions 1 and 3 of S2b switch a 1Ω resistor in parallel with 100Ω, while the "centre off" position 2 leaves the 100Ω resistor by itself. Hence, for power transistors and small signal Darlingtons, the collector load resistor is 1Ω (shunted by 100Ω) while for small signal transistors the collector load is 100Ω.

Power for the circuit is derived from a 9V battery (not supplied) which is applied via pushbutton S1 to S3 via a 120Ω resistor. This supply is decoupled with two parallel 470µF capacitors which provide the peak currents required.

When S1 is open, the supply rail is discharged using the normally closed contact to prevent any voltage remaining on the circuit when the switch is released. When the switch is pressed, the 470µF capacitors are initially discharged and so LED1 lights momentarily. This provides a good indication of battery condition at the beginning of each test.

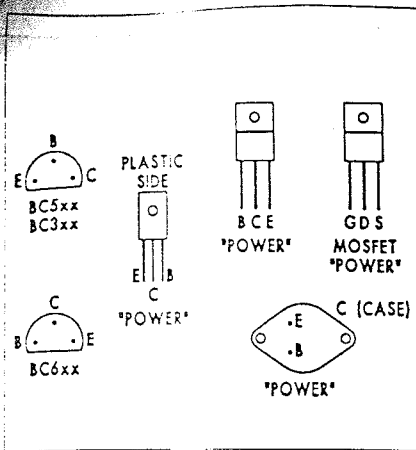


Fig. 6: Typical pin-outs for various case styles of transistor.

securing the panel with a second nut on each switch bush. The LED should be adjusted in height so that it sits correctly in the front panel hole.

Attach the meter output wires to the banana plugs and pass the B, C and E wires through the holes in the case. Terminate these wires to the alligator or easyhook clips. Fit the lid assembly into the case, attach the screws and the tester is ready for service.

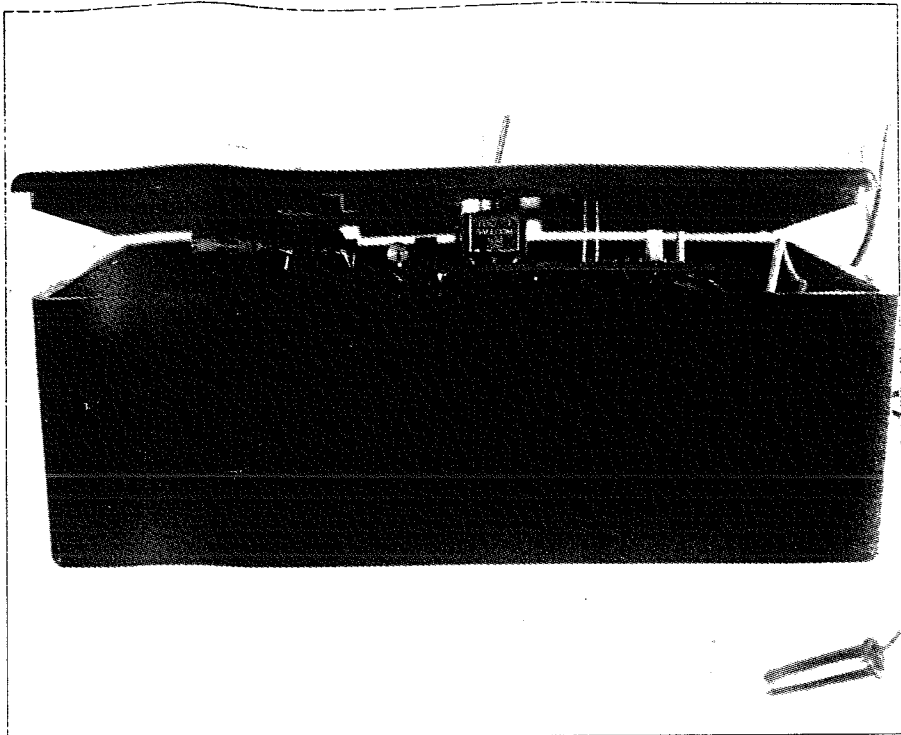
Measurements

Fig.6 shows typical pin-outs for various case styles of transistor. Use this to help with identifying the correct pin arrangement. When testing small signal transistors, use the x1 and x100 small signal setting for S2.

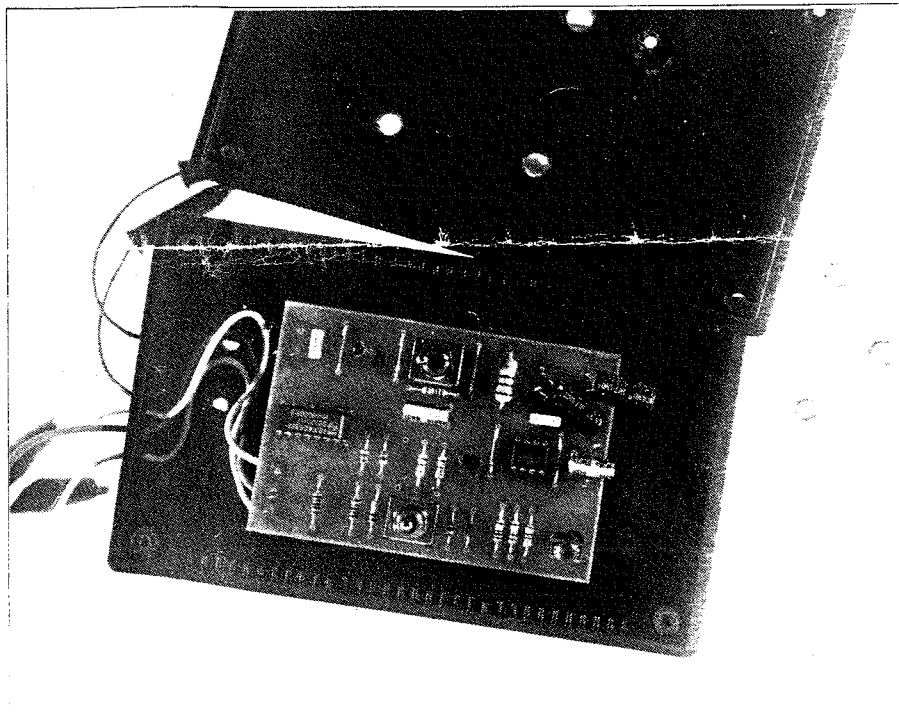
There will be some differences between readings on each range for a given device under test. This is because transistor gain varies with base current.

Mosfet "gain" values should be in the region of 1000 or more and should be tested on the x1 power position. The gate will only be pulled to about +6.5V due to the voltage drop across REF1 and the bridge rectifier which is usually not sufficient to turn a Mosfet fully on. Consequently, the Mosfet will be operating in the linear region.

Note that the polarity indication on the multimeter will differ, depending on the setting of the NPN/PNP switch (S3).



The PC board is mounted on the lid of the case and secured to it using the switch nuts. Adjust the LED leads so that it just protrudes through the lid after it is placed in position.



The PC board is attached to the lid of the case and held in place by the nuts of the switches. Note that the LED length needs to be adjusted so that the lens of the LED just protrudes from the front panel.

RESISTOR COLOUR CODES

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
<input type="checkbox"/>	1	330kΩ	orange orange yellow brown	orange orange black orange brown
<input type="checkbox"/>	1	6.8kΩ	blue grey red brown	blue grey black brown brown
<input type="checkbox"/>	2	1kΩ	brown black red brown	brown black black brown brown
<input type="checkbox"/>	1	120Ω	brown red brown brown	brown red black black brown
<input type="checkbox"/>	2	100Ω	brown black brown brown	brown black black black brown
<input type="checkbox"/>	1	68Ω	blue grey black brown	blue grey black gold brown
<input type="checkbox"/>	1	47Ω	yellow violet black brown	yellow violet black gold brown
<input type="checkbox"/>	1	1Ω	brown black gold gold	brown black black silver brown