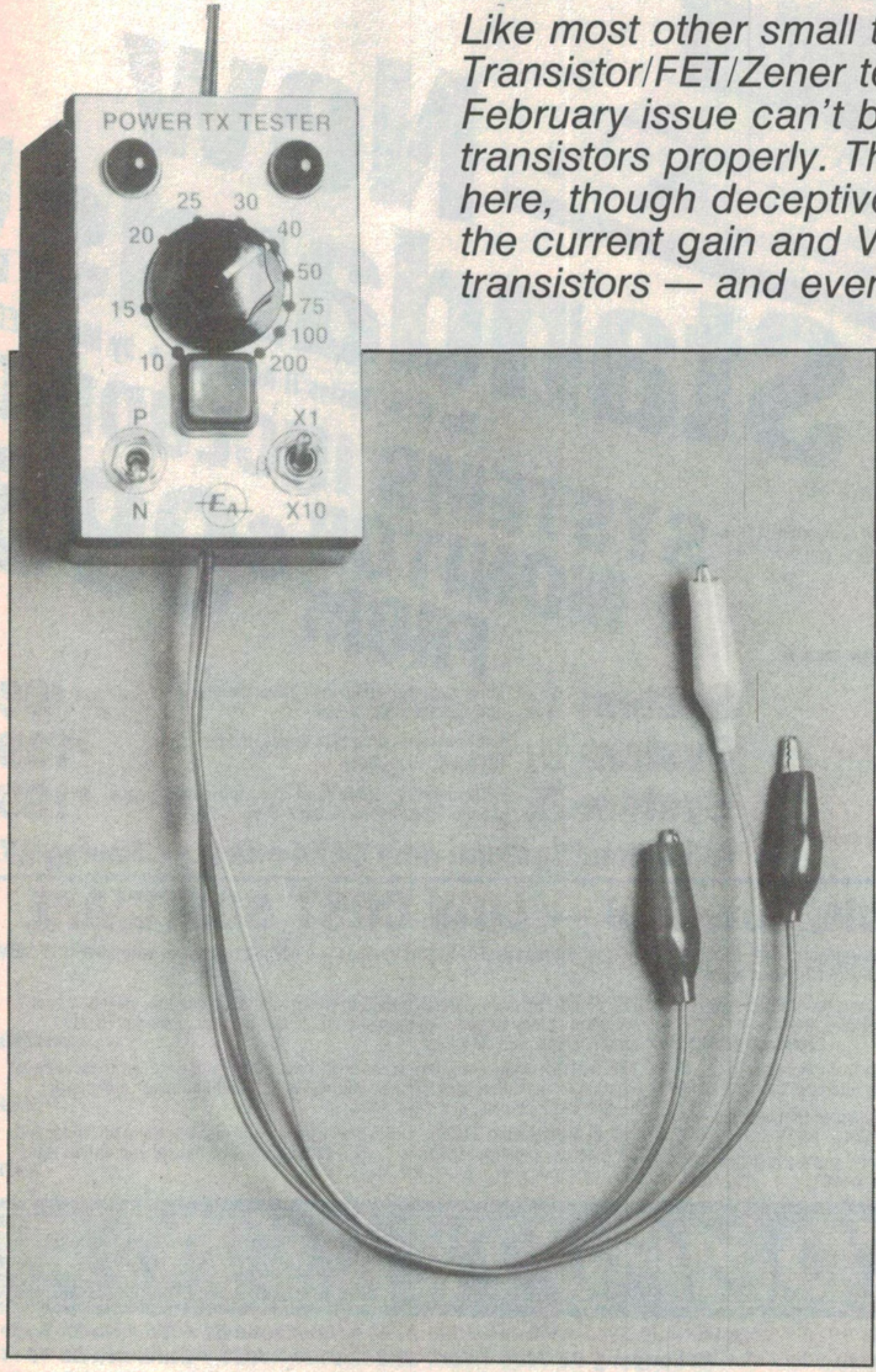
Construction project:

Simple tester for power transistors

Like most other small transistor testers, the Transistor/FET/Zener tester described in our February issue can't be used to check power transistors properly. The tester presented here, though deceptively simple, can evaluate the current gain and Vbe of all popular power transistors — and even power Darlingtons.



by PHIL ALLISON

For the purpose of this article, a power transistor is any bipolar transistor with a continuous collector current rating of at least one amp — although RF types have not been tried. If a transistor has a rating below this, then DO NOT attempt to test it with this tester, as damage is likely.

Now a power transistor (particularly a silicon device) is designed to work at higher current levels, and usually has little or no current gain β or h_{FE} at the low current levels employed by most transistor testers — including the earlier *EA* designs and the one described in the February 1988 issue. As a result, if you try to test them on this kind of tester, you'll get erroneous readings: the device will seem to have much lower gain than its real performance at working current levels.

The tester design presented here operates at a nominal 0.6 amps of collector current, and so eliminates this problem. As a bonus, it provides for testing of a power transistor's Vbe (base—emitter voltage), under the correct conditions of constant Ice (collector—emitter current). You can thus use it for correct matching of devices for parallel operation. It will even allow you to match power Darlington devices.

Because the tester is not likely to be needed all that often in most workshops, I have not included a dedicated power supply. Instead it is designed to

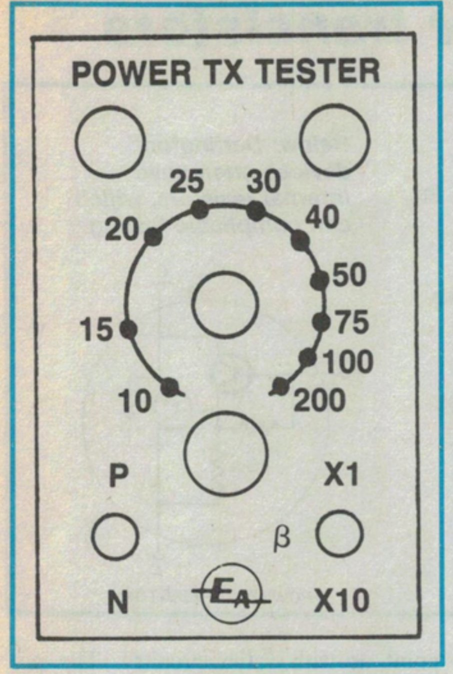


Fig.3: The panel artwork for the original tester, showing the current gain measurement scale.

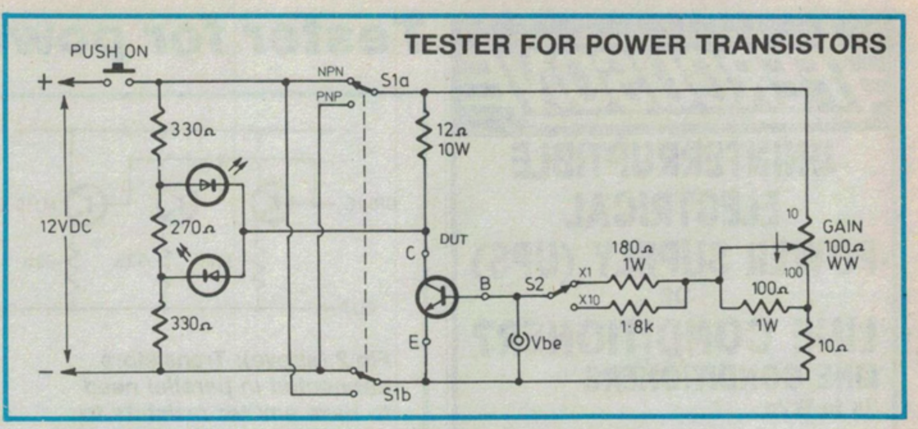


Fig.1: The circuit for the tester is deceptively simple.

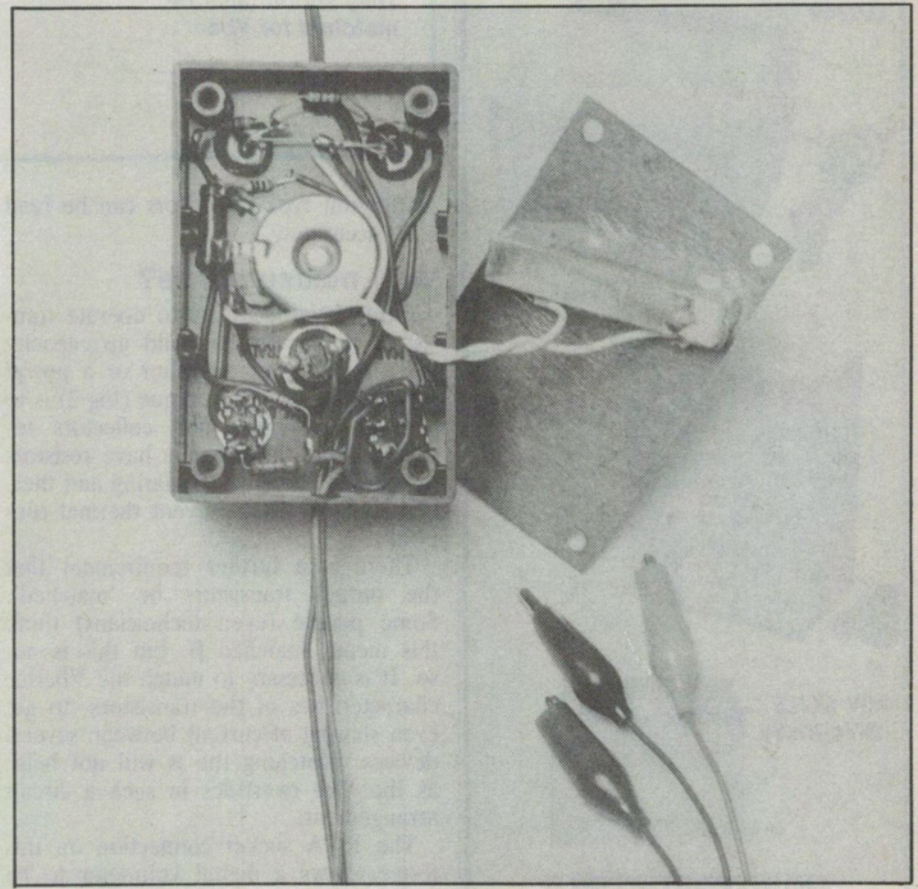
use an external 12V DC power supply. A variable regulated bench supply with a rating of one amp or more would be ideal, and most readers with a need for this project are likely to have such a supply. However a 12V plug-pak would also suffice, or even a 12V battery, rechargeable or otherwise.

Principle of operation

The idea behind the design was to test a transistor at a fairly high current, and to measure the base current needed to achieve this current. The ratio of these two is then the β of hFE.

A simple means of setting the collector current to a known value and varying the base current so as to indicate β was devised on paper, tried and optimised. As I have an aversion to unnecessarily complex or expensive gadgets to perform simple tasks, a method of setting the current which does not use a moving coil meter seemed preferable.

Two LEDs can be used as shown in the circuit as a sensitive null detector, to set the collector voltage to a particular value. When the voltage at the collector of the Device Under Test (DUT) is equal to one half the supply, then the voltage across each LED is barely sufficient for it to light. When both LEDs are out, this indicates that correct 'null' has been achieved. If a known supply voltage and collector load resistor are employed then a known current has



Inside the author's prototype tester. The 12-ohm power resistor is cemented to the rear panel, to assist in heat dissipation. No PCB is needed.

been set — in this case 600 milliamps. If a pot is used to vary the base current, then it can be calibrated in terms of the current gain of the DUT once the LEDs are nulled out.

The condition of half supply at the collector is enough to null the LEDs and give a correct reading, so the actual supply voltage is not critical. However the design is optimised for 12 volts DC where the LED sensitivity is best and

Parts List

1 case, as desired
1 DPDT miniature toggle switch
1 SPDT miniature toggle switch
1 pushbutton switch
2 LEDs, preferably 'jumbo' size
1 100Ω wirewound pot
1 knob, to suit
Test leads and clips
Resistors ¼W type:
1×10Ω, 1×270Ω,
2×330Ω,1×1.8k
1 12Ω 10W resistor
1 100Ω 1W resistor
1 100Ω 1W resistor

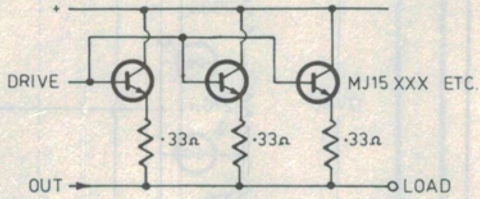
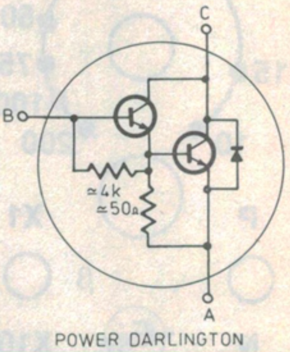


Fig.2 (above): Transistors connected in parallel need to have emitter resistors to ensure current sharing. They should also be matched for Vbe.

Below: Darlington devices often have internal resistors, which can complicate testing.



Darlington type transistors can be read most accurately.

Why measure Vbe?

Often it is necessary to operate transistors in parallel to build up capacity for a high power amplifier or a power supply. The usual technique (Fig.2) is to connect the bases and collectors together while the emitters have resistors in series to aid current sharing and thermal stability (i.e., prevent thermal runaway).

There is a further requirement that the output transistors be 'matched'. Some people (even technicians) think this means matched β, but this is not so. It is necessary to match the Vbe/Ice characteristics of the transistors, to get even sharing of current between several devices. Matching the β will not help, as the Vbe overrides in such a circuit arrangement.

The RCA socket connection on this tester allows a digital voltmeter to be connected to the B-E junction, to check the Vbe when the Ice is 0.6 amp.

Note: Keep the reading brief, as device heating affects the Vbe at the rate of 2mV per degree C, as the temperature of the chip rises.

Note also that most power transistors have some form of 'date code' stamped on them indicating the batch which they came from. Generally speaking devices with the same date code have very similar Vbe/Ice characteristics, so this is usually a good starting place for device matching.

Construction details

There is no PCB specified as all components can be easily wired point to point as with valve circuitry. The pot and switches provide sufficient points to anchor components. I used 'jumbo' LEDs supplied by Davred Electronics of York Street in Sydney, because their size and brightness suited the design well.

Calibration procedure

If the design is followed exactly, the scale shown (Fig.3) will probably suffice. But if you wish, a simple calibration can be done by inserting a current meter in series with the base connection of a good transistor, and read the current for various settings of the pot. If the current is 60mA then this equates to a gain of 10, if 6mA then 100 and all points in between. This assumes that the tester is connected to a supply of very close to 12V, of course.

How to use it

To test a transistor for β it is only necessary to connect the clips to the correct leads and select S2 for appropriate polarity (NPN/PNP). Then while holding the 'ON' button down, rotate the pot to null out the two LEDs.

If no null occurs on the X10 range, switch down to the X1 and try again. If there's still no success, check the connections and polarity. If you still can't get a null the device is probably faulty.

Once a null is found simply read the β from the scale around the pot.

Testing Vbe

To test Vbe connect a DVM to the RCA socket and after setting the tester to null the LEDs, read the DVM. A reading of 0.6 to 0.75 volts is to be expected.