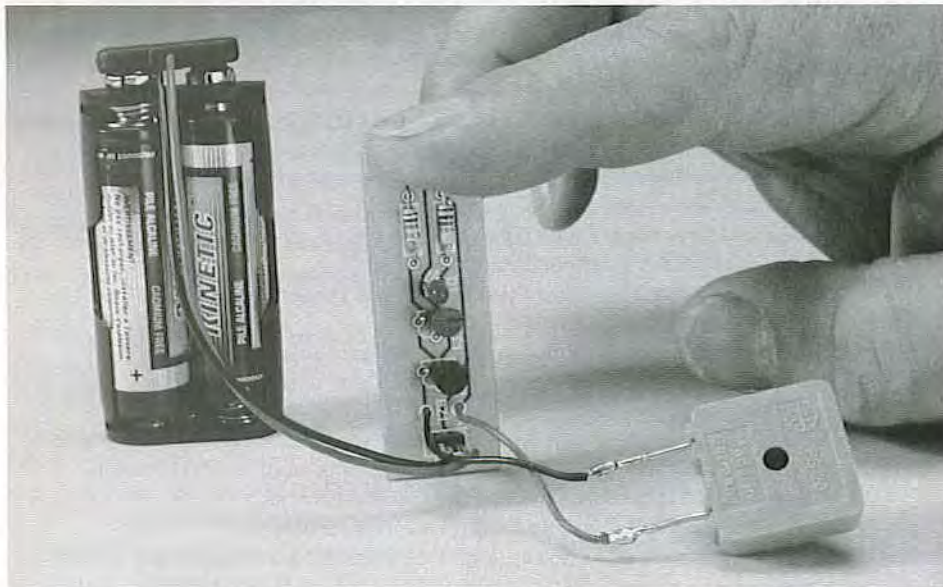


Voltage & Continuity Tester

for direct and alternating voltages up to 60 V

Design by B. Kainka

Unless it reaches really high levels, what we refer to as 'voltage' is totally invisible, so test and measurement equipment is a must in every electronics lab. However, in many cases you'll just want to know if a voltage is present at or not a certain point. The tester described as this month's Mini Project is an unusual one because it can work with just one test lead — all you have to do is use the single probe to touch the point you want to check.



So where's the other test lead connected to, after all, a voltage always exists between two points? The answer is: the voltage is measured against 'ground' connected to the metal enclosure of the test instrument. In this way, it is defined by the person holding the test probe in his/her hand. With each voltage test, a safe current of just a few microamperes flows through the person's body. The tester will amplify this current to a level where it can be indicated by an LED.

Construction and principle

The narrow PCB (Figure 1) has been designed to fit into a metal tube together with two miniature batteries. If you do not object to a slightly larger construction, you may want to use two AA (penlight) batteries. The diameter of the metal tube depends on the width of the battery holder

used for the project. The isolated probe tip is then mounted at the front side of the tube. A so-called low-current LED should be used to ensure as little power as possible is wasted in the indication, yet making it sufficiently bright. An on/off switch is not required because the tester does not consume power when it is not used. Thanks to their low self-discharge current, a pair of alkaline batteries should last for many years.

The tester's principle of operation should be familiar to most of you, as it is also used for those screwdriver-type voltage testers you can use to check if the 230-VAC voltage is present on the 'L' (live) line of a mains socket. Most of these tools contain a small glow lamp and series resistor. A metal cap at the end of the screwdriver handle acts as the ground terminal, establishing the connection with the user's body. Unfortunately, glow discharge lamps do not work at voltages below about 100 V.

With electrical safety in mind, **the instrument described in this article must never be connected to a mains voltage or any point that can be expected to be directly con-**

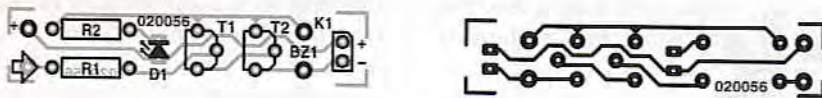


Figure 1. The narrow board and the two miniature batteries together fit into a metal tube to make a probe-like enclosure for the tester.

connected to mains supply. For this purpose, use approved testers only, for example the screwdriver type described above.

The tester described in this article is intended for low voltages up to 60 V. As a bonus, it will also function as a continuity tester and an audio signal tracer.

The circuit

The circuit diagram in Figure 2 shows a simple Darlington amplifier based around two BC548C transistors. Each of these offers a current gain of at least 420 times, so the Darlington configuration is good for a gain of 420^2 or about 170,000 times! The maximum collector current is reached at just 1 mA already. Consequently an input current of less than 0.01 mA or 10 nanoamperes is sufficient to make the LED light. An added passive piezo sounder (transducer) enables the circuit to act as a tracer for audio signals. When an alternating voltage is applied to the input, the LED will also light and the signal is audible through the transducer.

In practice, there are two ways of defining the ground connection:

Ground (case) to negative battery terminal

The tester is suitable as a 'voltage present' indicator for input voltages from +1 V, which makes it ideal for faultfinding in circuits. Simply hold the tester in one hand and use the other to touch the ground rail of the circuit under investigation. By touching the measurement point with the probe tip, you can find out for sure if a voltage greater than about 1 Volt is present. Our little instrument is also suitable for use as a simple battery tester or polarity tester simply by moving the free hand to the other battery terminal. Besides, alternating voltages with a peak level greater than 1 V are reliably indicated as well as reproduced by the piezo sounder.

Ground (case) to positive battery terminal

The test instrument is tuned into a continuity tester, where 'continuity' should be taken to mean 'very high impedance connection'. A connec-

tion with a resistance as high as 1 MΩ is already seen as an electrical conductor! Also, small capacitances with just a few 100 pF may be tested by noticing their charge and leakage currents. The use of the tester can be extended to burnt out bulbs and fuses, where it is especially convenient because you only have to touch the 'other connection'.

The circuit diagram shows a changeover switch (a small slide or rocker switch) that allows you to select between the above two modes of operation. When only one mode is required or envisaged, the switch is superfluous and the metal case of the instrument is connected directly to the desired battery terminal of the equipment under test.

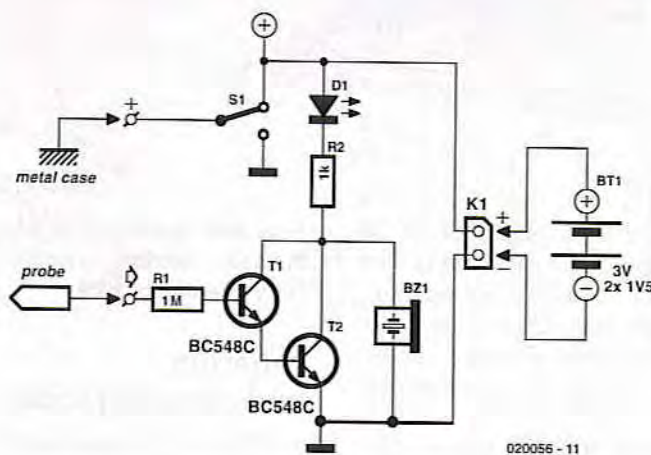
More applications

The extreme sensitivity of the tester opens up possibilities for rather special applications. For example, the tester may be used as a locating aid for mains wiring in conduit buried in walls. At just a few centimetres distance from the invisible Live (L) wire, sufficient capacitive coupling is obtained to make the LED light up.

The little instrument is also great for proving the presence of static charges. Simply hold the tester in your hand at some distance from your body, and walk over a synthetic carpet wearing shoes with rubber soles. The LED will light brightly with each step.

Other applications will exist for the instrument and we leave it up to your imagination to find out. If you do, tell us about it!

(020056-1)



020056 - 11

COMPONENTS LIST

Resistors:

- R1 = 1MΩ
- R2 = 1kΩ

Semiconductors:

- D1 = LED, low current, red
- T1, T2 = BC547C, BC548C or BC549C

Miscellaneous:

- BZ1 = miniature piezo transducer (passive)
- K1 = 2-way pinheader, lead pitch 2.5mm (0.1 in) or two solder pins
- S1 = single-pole changeover switch (optional, see text)
- Battery holder for two LR03 (AAA) or LR6 (AA) batteries
- Enclosure: suitable metal tube (see text)
- PCB, available from **The PCBShop**

Figure 2. The circuit consists essentially of a Darlington stage with very high current gain.

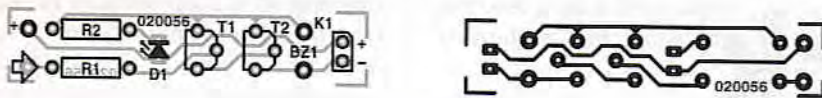


Figure 1. The narrow board and the two miniature batteries together fit into a metal tube to make a probe-like enclosure for the tester.

connected to mains supply. For this purpose, use approved testers only, for example the screwdriver type described above.

The tester described in this article is intended for low voltages up to 60 V. As a bonus, it will also function as a continuity tester and an audio signal tracer.

The circuit

The circuit diagram in Figure 2 shows a simple Darlington amplifier based around two BC548C transistors. Each of these offers a current gain of at least 420 times, so the Darlington configuration is good for a gain of 420^2 or about 170,000 times! The maximum collector current is reached at just 1 mA already. Consequently an input current of less than 0.01 mA or 10 nanoamperes is sufficient to make the LED light. An added passive piezo sounder (transducer) enables the circuit to act as a tracer for audio signals. When an alternating voltage is applied to the input, the LED will also light and the signal is audible through the transducer.

In practice, there are two ways of defining the ground connection:

Ground (case) to negative battery terminal

The tester is suitable as a 'voltage present' indicator for input voltages from +1 V, which makes it ideal for faultfinding in circuits. Simply hold the tester in one hand and use the other to touch the ground rail of the circuit under investigation. By touching the measurement point with the probe tip, you can find out for sure if a voltage greater than about 1 Volt is present. Our little instrument is also suitable for use as a simple battery tester or polarity tester simply by moving the free hand to the other battery terminal. Besides, alternating voltages with a peak level greater than 1 V are reliably indicated as well as reproduced by the piezo sounder.

Ground (case) to positive battery terminal

The test instrument is tuned into a continuity tester, where 'continuity' should be taken to mean 'very high impedance connection'. A connec-

tion with a resistance as high as 1 MΩ is already seen as an electrical conductor! Also, small capacitances with just a few 100 pF may be tested by noticing their charge and leakage currents. The use of the tester can be extended to burnt out bulbs and fuses, where it is especially convenient because you only have to touch the 'other connection'.

The circuit diagram shows a changeover switch (a small slide or rocker switch) that allows you to select between the above two modes of operation. When only one mode is required or envisaged, the switch is superfluous and the metal case of the instrument is connected directly to the desired battery terminal of the equipment under test.

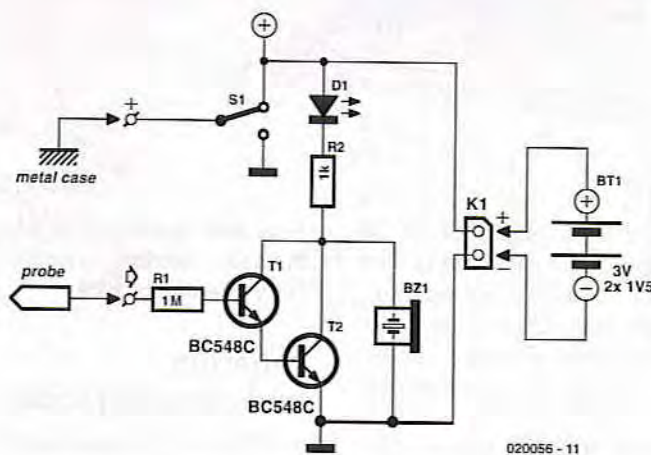
More applications

The extreme sensitivity of the tester opens up possibilities for rather special applications. For example, the tester may be used as a locating aid for mains wiring in conduit buried in walls. At just a few centimetres distance from the invisible Live (L) wire, sufficient capacitive coupling is obtained to make the LED light up.

The little instrument is also great for proving the presence of static charges. Simply hold the tester in your hand at some distance from your body, and walk over a synthetic carpet wearing shoes with rubber soles. The LED will light brightly with each step.

Other applications will exist for the instrument and we leave it up to your imagination to find out. If you do, tell us about it!

(020056-1)



020056 - 11

Figure 2. The circuit consists essentially of a Darlington stage with very high current gain.

COMPONENTS LIST

Resistors:

- R1 = 1MΩ
- R2 = 1kΩ

Semiconductors:

- D1 = LED, low current, red
- T1, T2 = BC547C, BC548C or BC549C

Miscellaneous:

- BZ1 = miniature piezo transducer (passive)
- K1 = 2-way pinheader, lead pitch 2.5mm (0.1 in) or two solder pins
- S1 = single-pole changeover switch (optional, see text)
- Battery holder for two LR03 (AAA) or LR6 (AA) batteries
- Enclosure: suitable metal tube (see text)
- PCB, available from **The PCBShop**