# Component Tester

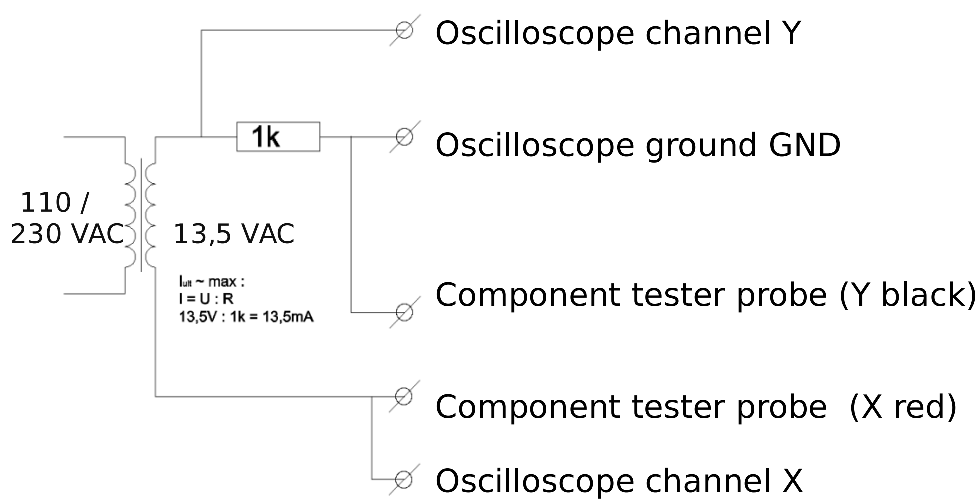
A component tester is used to test if components are working correctly in circuit. This is very nice if you do electronic repairs. You can test components directly on a soldered PCB.

You can see if components work correctly by comparing them with the same component on a working PCB, or the more difficult way- by analyzing the characteristics.

This document describes how you can make your own component tester, if your oscilloscope does not have one.

## The necessary ingredients

- Oscilloscope with 2 channels, X-Y function, Channel Invert function
- 1k resistor
- 12 to 15 volt transformer




Connect the diagram above, set your oscilloscope to use X-Y function and invert channel Y. You can now use 'Component tester probe'-connections to test your components. On the following pages you can find some theory that can help you understand, the pages are from the Hameg HM504 user manual.


Last updated: June 13th 2009 – ing. Barry de Graaff B. Eng (Electronic Engineering)
This is a re-release of the document Componententester DEFINITIEF-Model.dwg (rev. may 2002)

reality, other deviations such as unavoidable offset voltages must be taken into account, which may cause a display deviating from 0 Volt without signal applied at the input.
The display shows the arithmetic (linear) mean value. The DC content is displayed if DC or AC superimposed DC voltages are applied. In case of square wave voltages, the mean value depends on the pulse duty factor.

# Component Tester

## General

**The instrument specific information regarding the control and terminals are part of item [37] in section "Controls and Readout".**

The instrument has a built in electronic Component Tester, which is used for instant display of a test pattern to indicate whether or not components are faulty. It can be used for quick checks of semiconductors (e.g. diodes and transistors), resistors, capacitors, and inductors. Certain tests can also be made to integrated circuits. All these components can be tested individually, or in circuit provided that it is unpowered.

The test principle is fascinatingly simple. A built in generator provides a sine voltage, which is applied across the component under test and a built in fixed resistor. The sine voltage across the test object is used for the horizontal deflection, and the voltage drop across the resistor (i.e. current through test object) is used for Y deflection of the oscilloscope. The test pattern shows the current/voltage characteristic of the test object.

The measurement range of the component tester is limited and depends on the maximum test voltage and current (please note data sheet). The impedance of the component under test is limited to a range from approx. 20 Ohm to 4.7 kOhm. Below and above these values, the test pattern shows only short circuit or open circuit. For the interpretation of the displayed test pattern, these limits should always be born in mind. However, most electronic components can normally be tested without any restriction.

## Using the Component Tester

After the component tester is switched on, the Y amplifier and the time base generator are inoperative. A shortened horizontal trace will be observed. It is not necessary to disconnect scope input cables unless in circuit measurements are to be carried out. For the component connection, two simple test leads with 4 mm Ø banana plugs, and test prods, alligator clips or sprung hooks, are required. *The test leads are connected as described in section "Controls and Readout".*

## Test Procedure

**Caution!**

**Do not test any component in live circuitry, remove all grounds, power and signals connected to the component under test. Set up Component Tester as stated. Connect test leads across component to be tested. Observe oscilloscope display. – *Only discharged capacitors should be tested!***

## Test Pattern Displays

The following "Test patterns" show typical patterns displayed by the various components under test.

- Open circuit is indicated by a straight horizontal line.
- Short circuit is shown by a straight vertical line.

## Testing Resistors

If the test object has a linear ohmic resistance, both deflecting voltages are in the same phase. The test pattern expected from a resistor is therefore a sloping straight line. The angle of slope is determined by the value of the resistor under test. With high values of resistance, the slope will tend towards the horizontal axis, and with low values, the slope will move towards the vertical axis. Values of resistance from 20 Ohm to 4.7 kOhm can be approximately evaluated. The determination of actual values will come with experience, or by direct comparison with a component of known value.

## Testing Capacitors and Inductors

Capacitors and inductors cause a phase difference between current and voltage, and therefore between the X and Y deflection, giving an ellipse shaped display. The position and opening width of the ellipse will vary according to the impedance value (at 50Hz) of the component under test.

- A horizontal ellipse indicates a high impedance or a relatively small capacitance or a relatively high inductance.
- A vertical ellipse indicates a low impedance or a relatively large capacitance or a relatively small inductance.
- A sloping ellipse means that the component has a considerable ohmic resistance in addition to its reactance.

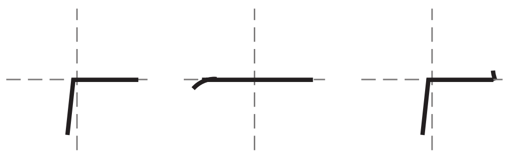
The values of capacitance of normal or electrolytic capacitors from 0.1µF to 1000µF can be displayed and approximate values obtained. More precise measurement can be obtained in a smaller range by comparing the capacitor under test with a capacitor of known value. Inductive components (coils, transformers) can also be tested. The determination of the value of inductance needs some experience, because inductors have usually a higher ohmic series resistance. However, the impedance value (at 50 Hz) of an inductor in the range from 20 Ohm to 4.7 kOhm can easily be obtained or compared.

## Testing Semiconductors

Most semiconductor devices, such as diodes, Z-diodes, transistors and FETs can be tested. The test pattern displays vary according to the component type as shown in the figures below. The main characteristic displayed during semiconductor testing is the voltage dependent knee caused by the junction changing from the conducting state to the non conducting state. It should be noted that both the forward and reverse characteristic are displayed simultaneously. This is a two terminal test, therefore testing of transistor amplification is not possible, but testing of a single junction is easily and quickly possible. Since the test voltage applied is only very low, all sections of most semiconductors can be tested without damage. However, checking the breakdown or reverse voltage of high voltage semiconductors is not possible. More important is testing components for open or short circuit, which from experience is most frequently needed.

## Testing Diodes

Diodes normally show at least their knee in the forward characteristic. This is not valid for some high voltage diode types, because they contain a series connection of several diodes.



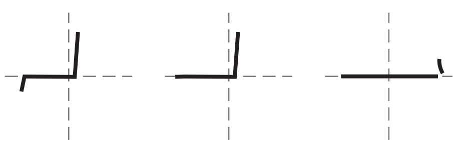
| | Normal Diode | Highvolt.-Diode | Z-Diode 6.8V |
|---|---|---|---|
| *Type:* | ***Normal Diode*** | ***Highvolt.-Diode*** | ***Z-Diode 6.8V*** |
| *Terminals:* | *Cathode-Anode* | *Cathode-Anode* | *Cathode-Anode* |
| *Connections:* | *(CT-GD)* | *(CT-GD)* | *(CT-GD)* |

Possibly only a small portion of the knee is visible. Zener diodes always show their forward knee and, depending on the test voltage, their zener breakdown forms a second knee in the opposite direction. If the breakdown voltage is higher than the positive or negative voltage peak of the test voltage, it can not be displayed.

The polarity of an unknown diode can be identified by comparison with a known diode.

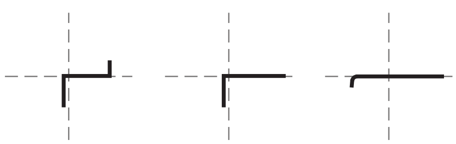
## Testing Transistors

Three different tests can be made to transistors: base-emitter, base-collector and emitter-collector. The resulting test patterns are shown below. The basic equivalent circuit of a transistor is a Z-diode between base and emitter and a normal diode with reverse polarity between base and collector in series connection. There are three different test patterns:



***N-P-N Transistor***

| | | | |
|---|---|---|---|
| *Terminals:* | *B-E* | *B-C* | *E-C* |
| *Connections:* | *(CT-GD)* | *(CT-GD)* | *(CT-GD)* |



***P-N-P Transistor***

| | | | |
|---|---|---|---|
| *Terminals:* | *B-E* | *B-C* | *E-C* |
| *Connections:* | *(CT-GD)* | *(CT-GD)* | *(CT-GD)* |

For a transistor the figures b-e and b-c are important. The figure e-c can vary; but a vertical line only shows short circuit condition.

These transistor test patterns are valid in most cases, but there are exceptions to the rule (e.g. Darlington, FETs). With the **COMPONENT TESTER**, the distinction between a P-N-P to an N-P-N transistor is discernible. In case of doubt, comparison with a known type is helpful. It should be noted that the same socket connection (**CT** or ground) for the same terminal is then absolutely necessary. A connection inversion effects a rotation of the test pattern by 180 degrees about the centre point of the scope graticule.

**Pay attention to the usual caution with single MOS components relating to static discharge or frictional electricity!**

## In-Circuit Tests

**Caution!**
**During in circuit tests make sure the circuit is dead. No power from mains/line or battery and no signal inputs are permitted. Remove all ground connections including Safety Earth (pull out power plug from outlet). Remove all measuring cables including probes between oscilloscope and circuit under test. Otherwise both COMPONENT TESTER leads are not isolated against the circuit under test.**

In-Circuit tests are possible in many cases. However, they are not well defined. Complex displays may be caused by a shunt connection of real or complex impedance, especially if they are of relatively low impedance at 50Hz, to the component under test, often results differ greatly when compared with single components. In case of doubt, one component terminal should be unsoldered. This terminal should then not be connected to the ground socket avoiding hum distortion of the test pattern.

Another way is a test pattern comparison to an identical circuit which is known to be operational (likewise without power and any external connections). Using the test prods, identical test points in each circuit can be checked, and a defect can be determined quickly and easily. Possibly the device under test itself may contain a reference circuit (e.g. a second stereo channel, push-pull amplifier, symmetrical bridge circuit), which is not defective and can therefore be used for comparison.