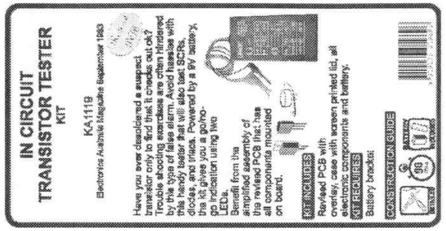
Jaycar Electronics **Specialists in electronic kits, components and products.**

Quality System Quality Endorsed Company

KA1119: KIT – TRANSISTOR TESTER

Electronics Australia Magazine September 1983

Rev 1.2A **Batch No:** 605050



Customers please note:
The PCB has been revised so that all components now mount on board.

PLEASE READ BEFORE COMMENCING CONSTRUCTION

The guarantee on this kit is limited to the replacement of faulty parts only, as we cannot guarantee the labour content you provide. Our Service Department does not do general service on simple kits and it is recommended that if a kit builder does not have enough knowledge to diagnose faults, that the project should not be started unless assistance can be obtained. Unfortunately, one small faulty solder joint or wiring mistake can take many hours to locate and at normal service rates the service charge could well be more than the total cost of the kit.
If you believe that you may have difficulty in building this kit (which is simply a complete set of separate parts made up to a list provided by the major electronics magazines) and you cannot get assistance from a friend, we suggest you return the kit to us IN ITS ORIGINAL CONDITION for a refund under our satisfaction guarantee.
Unfortunately, kits cannot be replaced under our satisfaction guarantee once construction has been commenced.

CONTACTS:

As of December 2001, Silicon Chip Magazine owns the rights to the **Electronics Australia Magazine**:
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For **quality issues** please contact the **Production Manager** at Jaycar Electronics and provide the following information:

- Product Number
- Batch No
- Details of Quality Issue

Notes and Errata (at time of print):
The project article has been updated with relevant notes and errata. It will therefore differ from the original article published in the magazine. *It is recommended to check the designers/publishers website for further notes and errata since this document was issued, before starting construction.*
None.

Possible Substitutions

Original Part	Original Part Desc	Subst Part	Subst. Part Desc.
N/A			

PARTS LIST
Please note that catalogue numbers refer to suitable products from the Jaycar product range. Quantities listed refer to the actual number of items required. When purchasing items separately, take pack quantities into account.
[1] *See section about Substitution* [2] **See section about Notes & Errata** [3] Processed Panel not part of Case listed
Catalogue numbers starting with "E" or listed as "Special Order" (incl. processed panels) are Kit specific and may not be readily available.

RESISTOR(S)

Cat.#	Qty*	Description	Component Ident And/Or Location
RR0548	1	RES 0.5W MTL 100R 1%	Brown Black Black Black Brown
RR0552	1	RES 0.5W MTL 150R 1%	Brown Green Black Black Brown
RR0564	2	RES 0.5W MTL 470R 1%	Yellow Purple Black Black Brown
RR0626	1	RES 0.5W MTL 180k 1%	Brown Grey Black Orange Brown

CAPACITOR(S)

Cat.#	Qty*	Description	Component Ident And/Or Location
RE6032	1	CAP ELECT RB 1u 63V 105C P=2mm 5x11mm	1uF / 63V
RE6070	1	CAP ELECT RB 10u 25V 105C P=2mm 5x11mm	10uF / 25V

SEMICONDUCTOR(S)

Cat.#	Qty*	Description	Component Ident And/Or Location
PI6500	2	SKT IC TIN/G 8PIN	
ZD0150	2	LED 5MM RED 10MCD	D1, D2
ZL3555	2	IC NE555 TIMER DIP8	NE555 IC1, IC2
ZR1100	4	DIODE 1N914/1N4148/BAW76 DO35	1N914/1N4148 D3-D6

HARDWARE / WIRE(S) / MISCELLANEOUS

Cat.#	Qty*	Description	Component Ident And/Or Location
EC8169	1	PCB (KA1119) NTN V2 57X70MM TRANSITOR	With OVERLAY
EF1155	1	SCREW M3X6MM POZI CSK BLK	
EH1902	1	GRMT RUB ID=6mm OD=9.5mm	
HB6013 [3]	1	ENCL JIFFY UB3 BLK 130x67x44mm	With SCREEN PRINTED LID
HM3040	2	HOOK EZ 55mm RED	
HM3041	1	HOOK EZ 55mm BLK	
HP0400	1	SCREW M3X6MM PHIL R/HD ZP	
HP0430	1	WASHER MTL M3 FLAT SLV	
HP0922	1	SPACER NYLON TAPPED HEX M3X9MM	
NS3015	1m	SOLDER 60/40 1mm	
PH9230	1	BATT SNAP 9V	
SB2344	1	BATT ZNC CHLOR 9V EXTRA/HD	
SP0711	1	SWITCH PUSH MOM MINI SPST RND BLK 125VAC	
ST0552	1	SWITCH TGL MINI DPDT ECON	
WH3010	50cm	CABLE HU RND 13x0.12mm L/D RED	
WH3011	50cm	CABLE HU RND 13x0.12mm L/D BLK	
WH3015	50cm	CABLE HU RND 13x0.12mm L/D GRN	

There is no need to unsolder suspect transistors!

BUILD AN IN-CIRCUIT TRANSISTOR TESTER

by COLIN DAWSON and revised by Jaycar Electronics P/L.

Have you ever desoldered a suspect transistor, only to find that it checks OK? Troubleshooting exercises are often hindered by this type of false alarm, but many of them could be avoided with an "in-circuit" checker such as the EA Handy Tester.

In the absence of a CRO, most hobbyists and servicemen rely on voltage measurements to locate faulty transistors. Even so, there are many situations where voltage measurements do not give a clear indication of faulty devices. Flip-flop circuits are just one example.

Another reason why voltage measurements may not be useful is that power applied to a faulty circuit may cause further damage. And while resistance measurements can be helpful in some instances, they do not always give clear cut results.

This Handy Tester overcomes these problems. It tests both NPN and PNP transistors in circuit at the press of a switch. There is no need to apply power to the circuit with the suspect components. As a bonus, the Handy Tester will test diodes and SCRs as well.

So instead of desoldering the component, all you have to do is clip three test leads to it (or two in the case of a diode). If the device checks OK, you simply unclip the test leads and move on to the next suspect. This method not only saves time but is also much kinder to printed circuit boards and components. Excessive heat can lift PCB tracks and damage components if you're not careful.

There are two LED indicators to indicate whether a component is "good" or "bad". When a good NPN transistor is tested, one LED flashes. When a good PNP device is tested, the other LED flashes. If the device is faulty, either both LEDs flash (device open circuit) or

both are extinguished (device short circuit). What could be easier?

There is no NPN/PNP switch on the Tester - it automatically indicates the polarity of the transistor under test. The front panel artwork tells you which LED should be flashing for the given transistor type and, by comparing this with the indicator, you can identify the polarity at a glance. All you have to know about a transistor is which leads are its base, collector and emitter.

Note that the tester is only supposed to indicate that the transistor action is taking place - ie, base current causes the collector-emitter path to become a low resistance in one direction. It does not give any indication of beta or high leakage in a transistor. This is not a serious limitation as most faults are of the "go/no go" type.

Diodes and SCRs are tested in similar fashion - just compare test results with the front panel artwork. In the case of diodes, only two test leads are required. The Handy Tester will then indicate whether or not the diode is working and indicate its polarity.

The principle of operation of the tester is fairly simple. The two LEDS are connected in parallel but with reverse polarity to each other. They are driven by a square wave oscillator with complementary outputs so that one LED will be on for each half cycle. The component under test is connected in parallel with the LEDs and, in the event of being forward biased or triggered, will shunt the LED current.

A good component will only conduct on positive or negative half cycles and will thus prevent one of the LEDS from illuminating.

A component which is short circuit will conduct on both positive and negative half cycles, diverting current from both LEDS. Conversely, a component which is open circuit will not conduct at all and both LEDS will flash to indicate the fault condition.

How it works

The circuit is based on one originally published in the English magazine "Television" for June 1983.

The way in which the two 555s are wired in this circuit is rather unusual. Instead of using the more familiar astable configuration, ICI has been connected to operate as a Schmitt trigger oscillator with a 2Hz output frequency. Note that the discharge pin (pin7) has not been used. Instead,, the pin3 output has been tied to pins 2 and 6 via a 180kΩ timing resistor.

Here's how it works. When power is first applied, the pin2 trigger input of ICI is held low by a 1μF capacitor and thus the pin3 output is high. The 1μF capacitor now charges via the 180kΩ resistor and, after about 0.25s, the pin6 threshold input reaches its critical value of two thirds supply (ie 2/3Vcc). ICI now toggles and the pin3 output goes low.

The 1μF capacitor now begins to discharge via the 180kΩ resistor until, after a further 0.25s, it falls to 1/3Vcc and IC1 is retriggered (pin3 high). In this way, IC1 functions as a Schmitt trigger oscillator while ever power is applied to it.

The output of IC1 is used as one of the tester outputs (E/K) and is also used to control IC2. No timing network is used with IC2 - it operates simply as an inverter. When the input signal is high, the 2/3Vcc threshold is exceeded and IC2's pin3 output goes low. Similarly, when the input signal is low, a trigger pulse is sensed and the output goes high.

In this manner, IC1 and IC2 produce complementary square wave outputs, each waveform having an amplitude of 9V RMS.

For the moment, assume that switch S2 is switched to the transistor (TR) test position. This will allow the output from IC2 to drive one side of the LEDs via a 'series 470Ω current limiting resistor. The other side of the LEDs is driven by the output of IC1, irrespective of the mode selected.

While one LED is forward biased the other will be reverse biased. Normally this is not an acceptable practice - LEDs can easily be destroyed by reverse biasing. The qualifier is that the reverse voltage becomes destructive only if it exceeds 5V. Because the typical forward voltage for a red LED is only about 1.7V, the voltage across the parallel pair can never exceed this value - regardless of the polarity.

So as long as the test terminals are open circuit, the two LEDs will flash alternately on and off. When the output of IC1 is high, LED D1 is forward biased and therefore illuminated. When the output of IC2 is high, LED D2 is illuminated.

Suppose now that we short the emitter/cathode (E/K) terminal to the collector/anode (C/A) terminal. When the output of IC1 is high, current will be diverted through diodes D5 and D6 which together have a forward voltage drop of 1.2V. This voltage is insufficient to turn on LED D1 which will thus remain off. Similarly, diodes D3 and D4 conduct when the output of IC2 goes high, thus extinguishing LED D2.

So both LEDs will remain off if there is a short circuit between the E/K and C/A terminals.

If we now connect a functioning transistor to the three test terminals, it will act as a short circuit between emitter and collector only during the half cycle for which it is forward biased. An NPN transistor is forward biased when its emitter is low and its collector and base high - ie, when the output of IC2 is high. In this condition, current will flow via diodes D3 and D4 and the collector-emitter junction of the transistor. Thus, for a good NPN transistor, only LED D1 will continue flashing.

Similarly, only LED D2 continues to flash for a good PNP transistor.

What happens if there is a base-emitter short or a base-collector short in the transistor? If this is the case, the transistor will be unable to turn on and so both LEDs will flash to indicate an open circuit between collector and emitter. What this means is that the tester is unable to identify the specific fault condition. It simply tells you whether or not the transistor is actually working.

Some readers may be wondering why two back-to-back diode pairs are used in the circuit. Why not simply use one pair? The reason is that, by using two diode pairs, the circuit is rendered less susceptible to parallel resistances in the circuit under test. A low value resistance between the E/K and C/A terminals, for example, will have less voltage across it and thus less current will be diverted through it to upset circuit operation.

Diodes and SCRs are tested in similar fashion to transistors. However, to test these components it is necessary to switch out one of the back-to-back diode pairs. The reason for this is that, if we were to simply add a test diode in series with the existing "detour" diodes, the forward voltage drop would be around 1.8V. This voltage would, in many cases, exceed the forward voltage of the LEDs and thus the LEDs could never extinguish.

This brings us to the function of S2 - the mode selector switch. When S2 is switched to the "D" position, diodes D4 and D6 are bypassed, leaving only D3 or D5 plus the test component in the detour circuit. Connecting a diode with its anode to the CIA terminal will cause it to "short out" LED D2, leaving only LED D1 to flash.

However, it doesn't really matter which way round you connect the diode. If you do connect it up with reverse polarity, LED D2 will flash on and off instead of LED D1.

An SCR will have the same effect on the circuit as a diode but it will require triggering. This is accomplished by connecting its gate to the positive supply line via a 100Ω current limiting resistor. A functional SCR connected as per the front panel diagram will cause only LED D1 to flash. Swapping the anode and cathode connections will cause LED D2 to flash instead.

A Triac is tested in the same way as an SCR with its A2 terminal connected in place of the anode and A1 in place of the cathode.

Power for the circuit is derived from a small 9V battery. Supply line filtering is provided by a 10µF electrolytic capacitor, while switch S1 switches the supply line to provide the test function.

Construction

Jaycar Electronics has revised the printed circuit board (PCB) so that all components are now mounted on it. The new PCB for this project is coded EC8169 and measures only 57x70mm. Only a few minutes work will be needed to solder the components in place, but watch the orientation - all the components except the resistors are polarised. In particular watch the orientation of the LEDs. As explained earlier in the text, unless they are wired with reverse polarity to each other, they could be damaged. Mount the base of the LEDs about 8mm above the PCB. Note that there are a few links on the PCB.

Use flexible multistrand wire for the test leads and make them at least 20cm long. We used small E-Z hooks (the ones with retracting hooks) to make the test connections – red/red (hook/wire) for the collector, red/green for the base and black/black for the emitter connection. This works quite well and is easy to remember. Secure the leads for the test clips to the PCB with the cable tie.

The Handy Tester is mounted in a small plastic utility box, measuring 112 x 62 x 31mm.

The PCB is mounted to the lid with the two switches and a 9mm standoff and washer. Five holes must be drilled in the front panel - two to mount the switches, two for the LEDs and the fifth for the remaining standoff. Countersink the hole for the standoff. The hole positions have been marked on the artwork. An additional grove must be cut into the top of the base for the test leads to exit the case. Protect the wires with a small rubber grommet.

The battery clamp is made from a small piece of scrap aluminium, secured to the case.

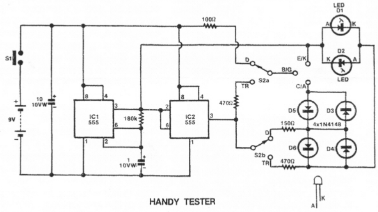
The truth-table indicating the functional state of transistors, diodes and SCRs has been screen printed on the lid for easy reference.

Check out time

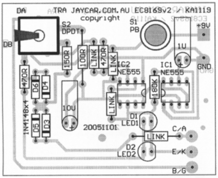
To check the Handy Tester, connect the battery and.

- Have all three test hooks disconnected.
  Depress the test switch (S1).
  The two LEDs should flash alternately.
- Now short the E/K and C/A test hooks together.
  Depress the test switch (S1).
  The two LEDs should now be extinguished.

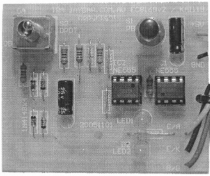
In use, the tester will give clear indications where the surrounding circuit resistances are 500Ω or more. It tends to give ambiguous readings when testing the output stages of audio amplifiers where the circuit resistances are lower than this.



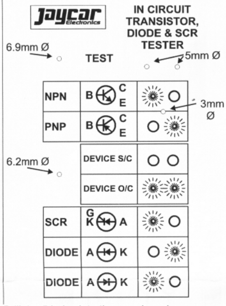
The circuit is basically a 2Hz oscillator with complementary outputs. It tests transistors, diodes and SCRs at the press of a button.



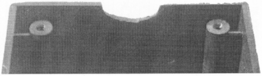
Follow this overlay to assemble the PCB.



A photo of the assembled PCB.



Drill the 5 holes into the panel as shown.

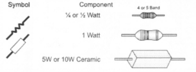


The cutout in the base for the grommet protecting the test lead wires.

COMPONENT IDENTIFICATION

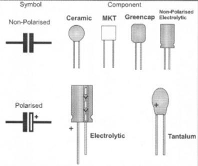
This section will help you to match some of the symbols used in schematics (electronic circuit diagrams) to the physical component used in the actual product. You will see the symbol on the left and the component on the right.

RESISTORS

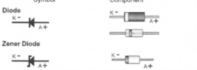


VARIABLE RESISTORS

CAPACITORS



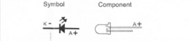
DIODE / ZENER DIODE



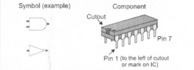
BRIDGE RECTIFIER

COMPONENT IDENTIFICATION

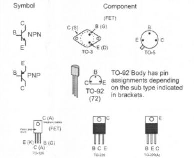
LED's



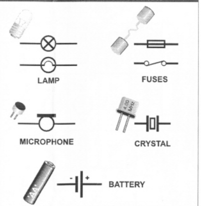
INTEGRATED CIRCUIT (IC)



TRANSISTORS

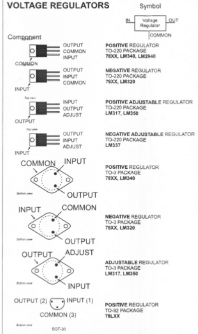


COMPONENT IDENTIFICATION



COMPONENT IDENTIFICATION

VOLTAGE REGULATORS



OHM'S LAW

The most basic law in electronics. The relationship between resistance, voltage and current is determined by Ohm's Law (*). If you know two out of the three values you can work out the third.

V= IxR
I= V/R
R= V/I

The formulas are:

V is Voltage
I is Current in Amps and
R is resistance in Ohms

Jaycar Electronics

No 1 for Kits

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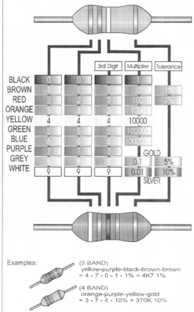
COMPONENT REFERENCE CHART

Ver 1.2 - 01.12.2004

RESISTOR COLOUR CODES



Colour	1st Digit	2nd Digit	3rd Digit	Multiplier	Tolerance
BLACK	0	0	0	1	
BROWN	1	1	1	10	1%
RED	2	2	2	100	2%
ORANGE	3	3	3	1000	
YELLOW	4	4	4	10000	
GREEN	5	5	5	100000	
BLUE	6	6	6	1000000	
PURPLE	7	7	7		
GREY	8	8	8		
WHITE	9	9	9		
GOLD				0.1	5%
SILVER				0.01	10%

Examples:

(5 BAND)
yellow-purple-black-brown-brown
= 4 - 7 - 0 - 1 - 1% = 4K7 1%

(4 BAND)
orange-purple-yellow-gold
= 3 - 7 - 4 - 10% = 370K 10%

CAPACITOR CODES

Microfarads (u)	Nanofarads (n)	Picofarads (p)	EIA code
-	-	100pF	101
-	0.22nF	220pF	221
0.001uF	1nF	1000pF	102
0.0047uF	4.7nF	4700pF	472
0.01uF	10nF	-	103
0.047uF	47nF	-	473
0.1uF	100nF	-	104
0.47uF	470nF	-	474
1uF	1000nF	-	105

ZENER DIODES (1 WATT UNLESS SPECIFIED)

Part no.	Voltage	Part no.	Voltage
1N4728	3V3	1N4744	15V
1N4729	3V6	1N4745	16V
1N4730	3V9	1N4746	18V
1N4731	4V3	1N4747	20V
1N4732	4V7	1N4748	22V
1N4733	5V1	1N4749	24V
1N4734	5V6	1N4750	27V
1N4735	6V2	1N4751	30V
1N4736	6V8	1N4752	33V
1N4737	7V5	1N4753	36V
1N4738	8V2	1N4754	39V
1N4739	9V1	1N4761	75V
1N4740	10V	1N5349B	12V 5W
1N4741	11V	1N5352N	15V 5W
1N4742	12V	1N5374	75V 5W
1N4743	13V		