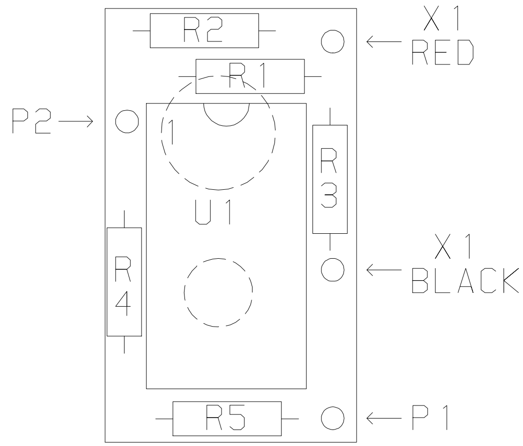
Specifications

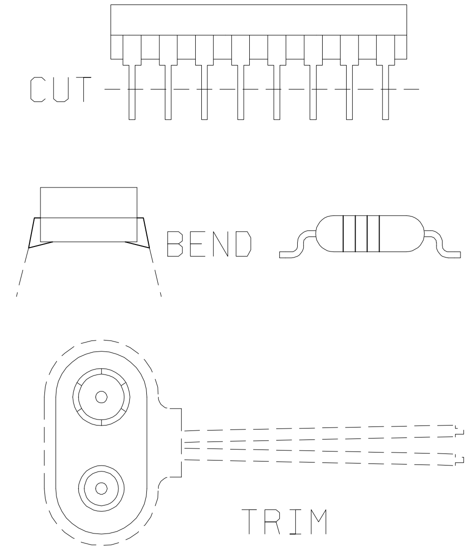
OPEN CIRCUIT VOLTAGE:	250MV MAXIMUM.
SHORT CIRCUIT CURRENT:	1MA MAXIMUM.
THRESHHOLD RESISTANCE:	100 OHMS TYPICAL.
PITCH OF TONE:	ABOUT 4KHZ.
SIZE:	1.3"W X .75"T X 2.7"L IN OPTIONAL CASE.
BATTERY LIFE:	OVER 2 YEARS IDLING. (LIMITED BY SHELF OF THE BATTERY).

Parts List

U1	CA3096CE
R1	820K OHMS 1/4W 5%
R2	2.2K OHMS 1/4W 5%
R3	12K OHMS 1/4W 5%
R4	1MEG OHM 1/4W 5%
R5	51 OHM 1/4W 5%
X1	PIEZO TRANSDUCER PKM35-4A0
--	FOAM TAPE
J1	9-VOLT BATTERY CONNECTOR
B1	9-VOLT CARBON ZINC BATTERY (NOT INCLUDED)
--	BICYCLE PATCH KIT REMA TIP TOP NO. 21 (NOT INCLUDED)



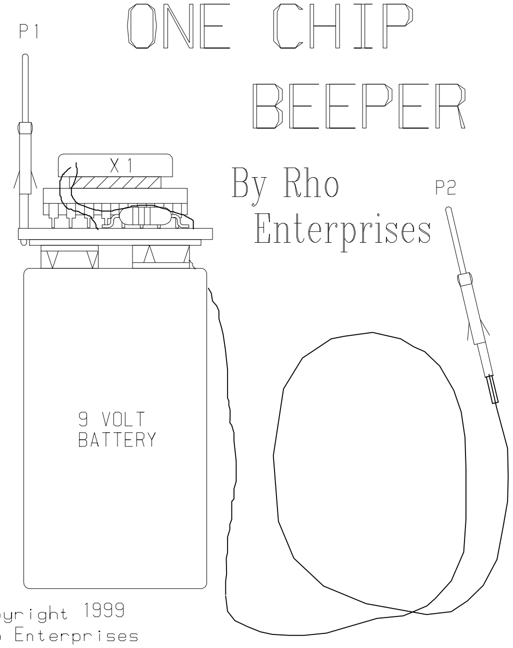
Parts Placement

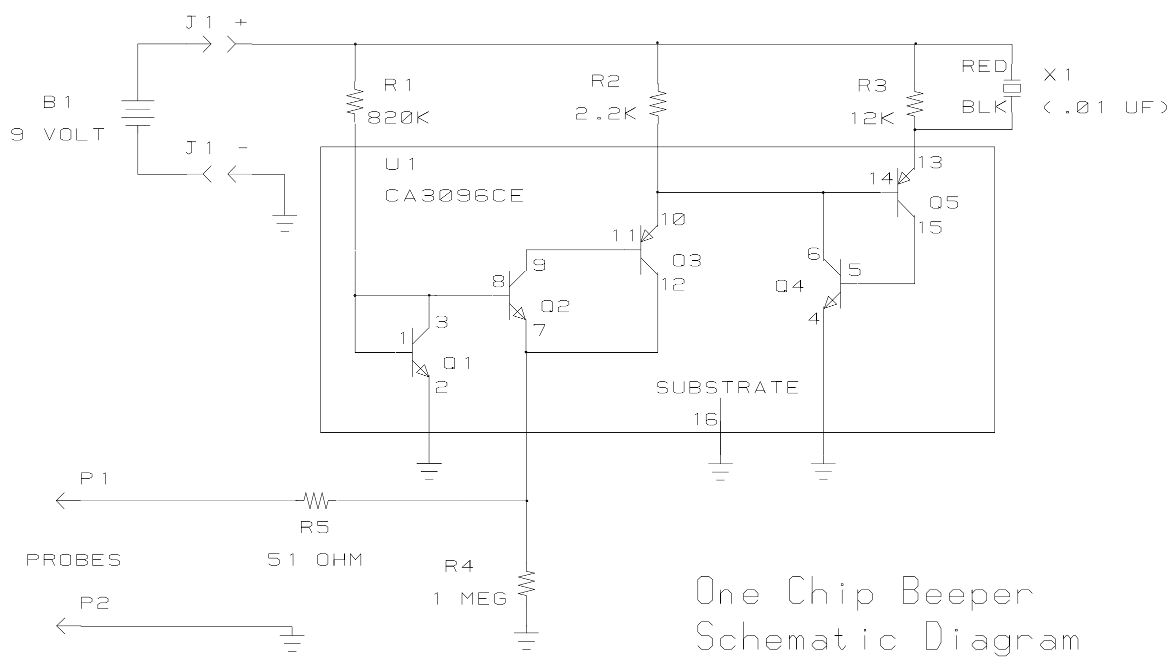


Component Preparation

ONE CHIP BEEPER

By Rho Enterprises





One Chip Beeper Schematic Diagram

Description and operation

The One Chip Beeper is an audible continuity tester. It works well in circuits that already have components installed because only wires and low value resistors will cause a tone. The One Chip Beeper will not turn on diode junctions or damage sensitive circuits. The one piece construction is compact and easy to use.

No power switch is needed due to its very low power consumption. Use any 9 volt battery. An inexpensive carbon/ zinc battery will last almost forever.

Capacitors will cause the beeper to click or momentarily beep depending on their value. A click can sometimes be heard when touching unconnected long wires in cables.

The beeper can stop working if a small voltage is applied to the probes. This can be caused by measuring an electrolytic capacitor first in one polarity -- charging it -- and then measuring in the other polarity. If this should happen, the beeper is not damaged. Unplug the board from the battery and then plug it back on. The beeper will now work again.

To prevent permanently damaging the beeper, the circuit being tested should not have power applied.

How it works

U1 is a transistor array that has three NPN transistors and two PNP transistors (Q1 through Q5).

Resistor R1 supplies current to transistors Q1 and Q2. With the probes open, the current in Q1 is much greater than in Q2. The higher current in the Q1 base/emitter junction causes it to drop a larger voltage than Q2's base/ emitter junction. This difference shows up as about .2 volts on pin 7 of U1. This is the maximum voltage that will appear on the probes.

NPN transistor Q2 and PNP transistor Q3 form a ‘‘complementary’’ Darlington amplifier. With only a small amount of current flowing through Q2 and Q3, R2 drops a small voltage. Q5 is held off under these conditions and so is Q4 since they are in series.

When probes P1 and P2 are shorted together, some current from R1 flows into the base of Q2 and is amplified by Q3. Now a higher current flows through R2 causing the voltage on the base of Q5 to drop. When the voltage across R2 increases beyond about .6 volts, Q5 turns on. As Q5 conducts it causes Q4 to conduct, which causes Q5 to conduct even harder. Q4 and Q5 will continue this way until both transistors are turned on all the way (saturated) and are dropping only about one volt total from the emitter of Q5 to ground.

Transducer X1's capacitance is quickly charged by Q4 and Q5 switching to ground. As X1 charges up, the current keeping Q4 and Q5 on decreases until their currents can no longer feed on each other and both Q4 and Q5 turn off. Resistor R3 does not supply enough current to keep Q4 and Q5 on but will discharge X1 back toward +9 volts. As the transducer voltage approaches +9 volts the voltage is again enough to turn on Q5 (and Q4) and the cycle starts again. As long as the probes are shorted together, the transducer capacitance will be charged and discharged at a rate determined by R3's resistance and X1's capacitance causing X1 to emit a tone.

The 51 ohm resistor (R5) gives some protection against accidentally using the beeper in a powered circuit. The high valued resistor (R4) provides a path for the small leakage currents of Q2 and Q3.

Construction

The entire circuit is built on a printed circuit board the size of the end of the battery. To do this, many of the parts must be surface mounted. Because of the unusual nature of the construction, the following instructions are more detailed than might be expected.

Start by converting the standard components to work as surface mount parts. Bend and trim the resistors (R1, R2, R3, R4 and R5) and IC (U1) leads as shown in the drawings. Save the cut off resistor leads for later use.

The battery connector is not surface mounted, but takes special preparation as well. Cut the plastic covering from the back and sides of the battery clip. Trim the plastic that remains under the battery snaps to be the size of the insulator that holds the snaps together. Unsolder the leads from the rivets that hold the snaps to the insulator. Clean off any excess solder that remains on the rivets.

First mount the battery connector. Take two of the cuts off resistor leads and fold them tightly in half. These wires go into the holes near the center of the board with the large pads. Push each wire through its hole from the foil side of the board leaving the the end of the fold just 3/64 inch above the board. Solder the wires to their pads.

Place the battery connector over the wires from the non-foil side of the board. The large snap connects to the pad marked with the plus symbol. Spread the folds apart to hold the snaps in place and solder the wires to the rivets. Be careful not to get any solder on the contact surfaces of the snaps. Trim the wires to allow mating of the snaps to those that are on the battery.

Next mount U1 to the foil side of the circuit board with pin 1 toward the end of the board with the plus sign. The IC should mount flat without rocking. If it rocks any, trim a little off the wires that hold the battery connector in place. Solder U1 in place using as little solder as possible to minimize the chances of solder bridges to the traces under U1. At this point you may want to test for shorts to the hidden traces using an ohmmeter.

Mount the resistors in place on the foil side of the board according to the parts placement drawing. Bend another resistor lead in half and push it through the board from the non-foil side in the hole for P1. Solder a male connector pin to this wire and its pad. The pin should stand straight up on the circuit board.

Use a piece of double sided foam tape to attach the transducer (X1) to the top of U1. Cut and strip the leads of X1 to leave some slack when reaching to their holes. Solder the leads of X1 to the foil side of the circuit board by leaving a little uninsulated wire exposed on the foil side. The parts placement diagram shows where to connect the red and black wires of the transducer.

Crimp or solder the second male connector pin to one end of the 22ga wire and use the heat shrink tubing for strain relief. Solder the other end of the wire into the hole for P1, inserting it from the non-foil side of the board. Use the female connector pins as probe extensions by soldering a wire to each of them. Choose a wire thin enough to reach the contacts in an IC socket.

Testing

Snap the assembled beeper onto a 9 volt battery. It should look like the drawing on the front page. Touching the probes together should cause a tone. If you don't hear a tone, the most likely mistake is a solder bridge between the leads of U1, or worse, a bridge from a pin of U1 to a trace under U1. Use solder wicking braid to remove the excess solder and try again.

Packaging it up

By putting the beeper board on the end of the battery, you don't absolutely need a case. If you want to put the beeper into a case, I suggest using the box that bicycle patches come in. Drill holes in one end for probe P1 and the sound from the transducer. Drill a hole in the other end for the wire of probe P2. You may need to trim the ridge from the lid of the case to allow the lid to close tightly with the battery installed. Use some pieces of foam tape to keep the battery from sliding around in the case.