# BUILD A SQUARKER
## TO SET TWO-STROKE MAGNETO IGNITION TIMING
**By Bruce Pierson**


If you have ever needed to set the ignition timing on a two-stroke magneto engine, you may have had difficulty in knowing exactly when the points open. It's not something that you can easily measure, because the resistance of the coil in the magneto is quite low and there is very little difference in the resistance across the points when the points are open as compared to when they are closed.

This handy device, known as a “Squarker”, solves that problem, because it is able to detect very slight changes in resistance, down to less than one ohm. I constructed my first Squarker around 40 years ago, when I was working as a motorcycle mechanic. I still have this original unit and I have used it from time to time over the years since leaving the motorcycle trade. So, why is it called a Squarker, you ask? Just listen to it in operation and you will have the answer.

Recently, I was working on my chainsaw and I experienced an issue with it, in that it would not start after I had fitted new points in it. I suspected that the points were not making proper contact when closed, so I dug out my old squarker to check if this was the case. I hadn't used it for a long time and it didn't have a battery in it, so I fitted a new battery and I ascertained that the points were not making proper contact when closed, as I had suspected. A quick file with a points file and resetting the points gap fixed the issue and the saw was running well again.

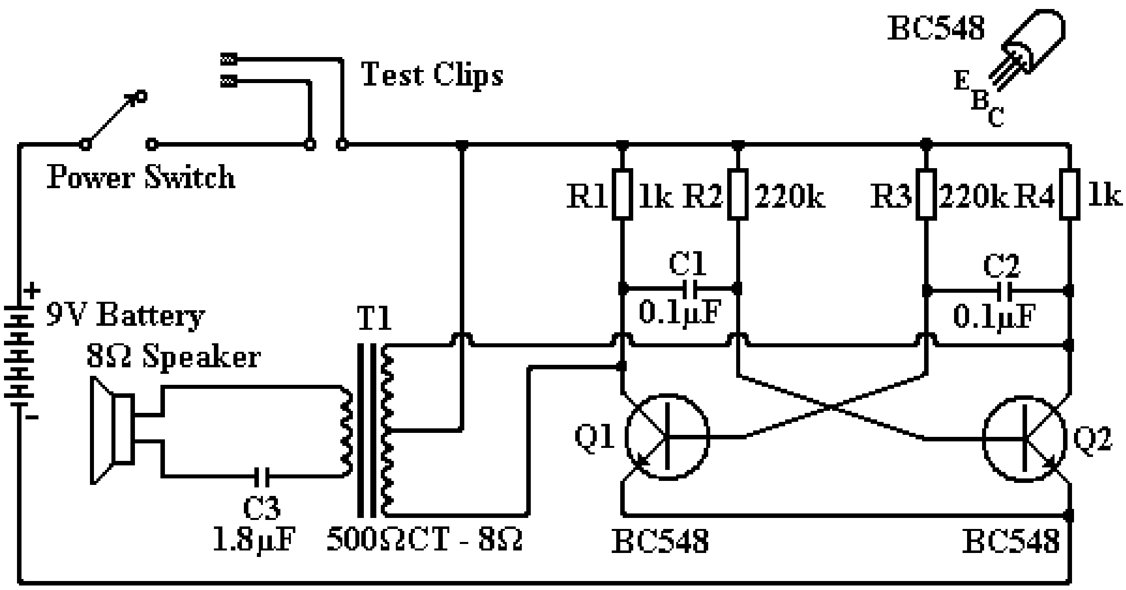
This started me thinking that the Squarker would make a good project, because it uses readily obtainable components and would be relatively simple to construct, while having multiple uses. I opened the old squarker again and studied the construction. I was not exactly sure how I had constructed this unit, because it had been assembled on four tag strips, with point-to-point wiring, which was the standard of the day.

I started by drawing out the components as they were laid out. This proved rather difficult, due to the way the unit was constructed, but with the aid of a small mirror, I managed to make a drawing of all the components and how they were connected. At this point, I had to enlist the assistance of my son, who does Year 12 Physics, to help me re-draw the circuit into a more readable state.

There was also the issue of trying to identify the two transistors that were used in the original circuit, as they appeared to be pre-historic types with no visible identification on them. I established that they were NPN types and I worked out the connections for them. Having the circuit in a more readable state, I established that the two transistors were configured as an astable multivibrator, driving a mini speaker transformer into an eight ohm speaker.

The next step was to attempt to rough up a replica of the Squarker, using modern components, to establish the workability of the circuit. Having constructed a rough replica of the circuit, I could not get it to function. So, I had a good look at the circuit as we had drawn it and then I re-designed the circuit and re-built it, with a bit of trial and error to fine tune the components for the best performance.

The next step was to design a printed circuit board for the construction of a modern version of the old Squarker. With the new circuit drawn out, I designed the new PCB to suit a small jiffy box, which would house the PCB, battery, switch and a small 40mm 8 ohm speaker. A larger box could have been used, so that an old 57mm computer speaker could have been utilised, as was the case with the original unit, but I wanted to make the new Squarker more compact than the original design, which had been housed in an old front door alarm box at the time I had constructed it.



## HOW IT WORKS

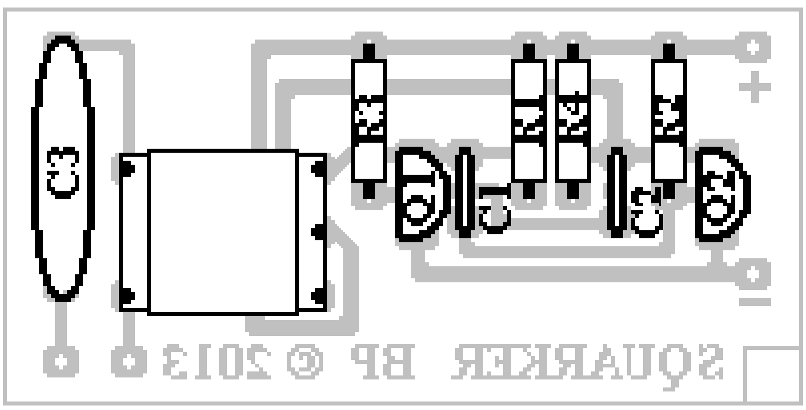
The circuit design is relatively straight-forward, being an astable multivibrator composed of transistors Q1 and Q2 and associated capacitors and resistors. This drives a mini speaker transformer into an 8 ohm speaker, via a 1.8µF greencap. This capacitor is necessary in order to prevent the formation of a DC short-circuit, which prevents the unit from operating.

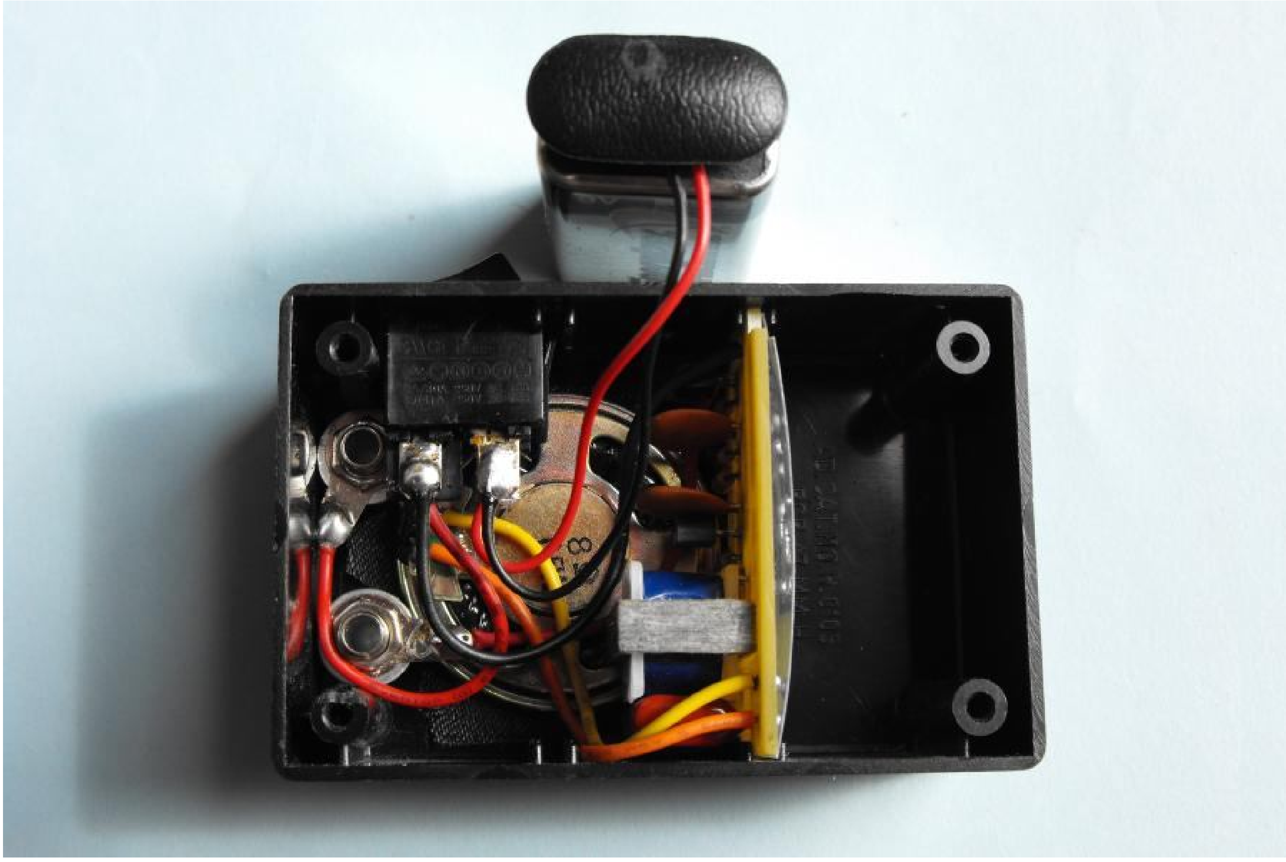
This value was chosen by trial and error  to give the highest volume from the speaker. Values higher than this tend to reduce the volume, due to the short-circuit effect mentioned above. A lower value capacitor can be used, with a corresponding reduction in volume from the speaker. The original Squarker used a 0.1µF ceramic capacitor. Any value between 0.1µF and 1.8µF would be acceptable, but the lower values do tend to lower the volume substantially.

Power is supplied from a 9V battery, via a power switch. Two test leads are connected in series with the positive supply and these leads are fitted with small alligator clips. The clips are connected across the points of the engine being tuned. As the flywheel is turned and the points open and close, the tone of the Squarker changes, giving a clear audible indication of exactly when the points open. This then enables accurate timing of the engine by the use of the timing marks.

## CONSTRUCTION

All the components, with the exception of the speaker, power switch and test lead sockets, are mounted on a small PCB, measuring 50mm x 25mm, which is the correct size to fit a small UB5 jiffy box. The jiffy box has a series of holes drilled in it to accommodate the power switch, test lead sockets and the speaker grille. The speaker has a black cloth between it and the front panel. It is held in place with a couple of small spots of contact adhesive. The audio transformer is off centre on the PCB and the PCB must be fitted with the audio transformer closest to the opening of the box to clear the speaker. Note that one corner of the PCB must be cut out to accommodate the battery cables. The battery snap needs to be the type that has the wires through the centre of the snap, not at the end. Some modification is required to the Jiffy Box in order to accommodate the battery without spreading the sides of the box. A sharp knife can be used to form a slight hollow for the battery snap and to remove a thin layer at the other end of the battery section. Note that the 1.8µF Greencap needs to be mounted slightly above the PCB in order to clear the PCB slot in the Jiffy Box.





The componentry inside the jiffy box is quite a compact fit and must be assembled in the correct order. First, prepare the jiffy box by drilling the required holes. Start with the two banana sockets. Select a drill bit that will neatly fit the inside of the banana socket without damaging it. Push each banana socket in turn into the corner of the box and drill through it onto a block of wood. These holes are then reamed to size with a tapered reamer or filed to size with a round file and the banana sockets fitted.

Next, place the 40mm slimline speaker in the bottom of the box and push it hard against the banana sockets and being sure that it is centred in the box, mark around it with a pencil. Mark the required speaker pattern and drill with a small sized drill. The hole for the switch can then be made by marking it out and then drilling and filing to the correct size,  allowing adequate clearance to the banana socket on that side.

At this point, the speaker can be glued in and left to dry. Next, take the lugs off the banana sockets and solder wires to them. This prevents melting the sockets, which would happen if the lugs were soldered while still on the sockets. Connect all the wiring to the PCB and file the soldering on the back of the PCB flat, to around 1mm thick. Install the PCB and place the sheet of insulating plastic behind it to prevent the PCB shorting on the battery. Then solder the wires to the switch and install it. I used a DPST switch because it made terminating the battery leads easy, but a SPST switch is all that is required.

I made up a set of leads from an old set of multimeter leads that had failed at the probe ends. I just replaced the faulty probes with small alligator clips, which would be used to clip onto the points. A further set of leads with probes is also useful for using the squarker for other purposes.

## OTHER USES

The Squarker has other uses besides setting ignition timing. It can be used to test diodes. Connect the test clips to the diode. The Squarker will either sound or not sound. Reverse the clips. If the diode is good, the Squarker will sound one way and not the other way. Both ways equals a short-circuit. No sound indicates an open-circuit. LEDs can also be tested with the Squarker. The LED will light and the Squarker will sound when the leads are connected one way and nothing will happen when connected the other way. If nothing happens both ways or the squarker sounds both ways, then the LED is faulty. The Squarker can also test speakers, which will emit a sound if they are in working order.

The Squarker can also be used as a continuity tester. The unique properties of the Squarker being very sensitive to slight changes in resistance will enable the user to identify poor connections which may be causing electrical problems in low voltage wiring. Needless to say, all power must be OFF when conducting tests of this nature, to avoid damage to the Squarker. The Squarker must not be used on electronic equipment, which could be severely damaged by the voltage present in this unit.

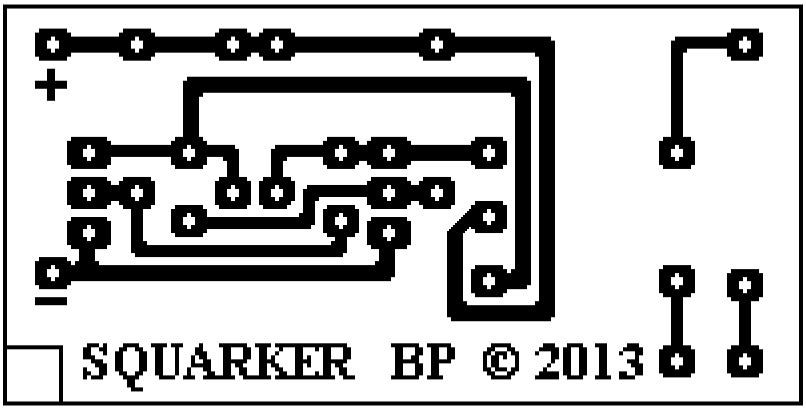
## POWER CONSUMPTION

The Squarker draws around 20mA when fitted with a fresh 9V battery. This current draw reduces to around 10mA as the battery runs down, with a corresponding reduction in the volume from the speaker. Once the battery voltage drops below a usable level, a fresh battery will need to be fitted. Due to the nature of the circuit, no Power LED has been fitted, as this would draw a similar current to the circuit, thus flattening the battery at a much faster rate. With the power switch on and the test leads open-circuited, the unit does not draw any power from the battery, so even if the power switch is accidentally left on, provided that the test clips are not touching, then no power will be drawn from the battery.

## PARTS LIST

1 PCB measuring 50mm x 25mm
1 UB5 Jiffy Box - Altronics Catalogue Number: H0205
1 9V Battery
1 9V Battery Snap - Type with the wires running through the centre of the snap
1 Power Switch - Rocker Type - Rectangular
1 Set Test leads - Banana Plug to Alligator Clips (optional - extra set with probes)
1 Mini Audio Transformer 500Ω CT to 8Ω - Altronics Catalogue Number: M0226
2 BC548 Transistors
2 0.1µF Ceramic Capacitors
1 1.8µF Greencap Capacitor
2 1k .25W Resistors
2 220k .25W Resistors
1 Slimline 40mm 8Ω Speaker (Available on eBay)
1 sheet insulating plastic the same size as the PCB

The PCB pattern has been produced at double actual size and can be reversed using a graphics program for use with the Toner Transfer method of etching. Just remember to set your printer to print 50% of actual size, to get the correct sized result. The square section in the bottom left-hand corner of the PCB must be cut out, in order to provide access for the battery cables.




## COMPARING THE OLD AND THE NEW

After constructing my new Squarker, I compared it with the old one that I had constructed around 40 years earlier. While both units do the same thing, the new one is smaller, has fewer components, is more easily constructed, is around four times louder and a little more sensitive than the old one. The extra volume from the speaker does come at the cost of a higher battery drain, as the old squarker only draws around half the current that the new one does.