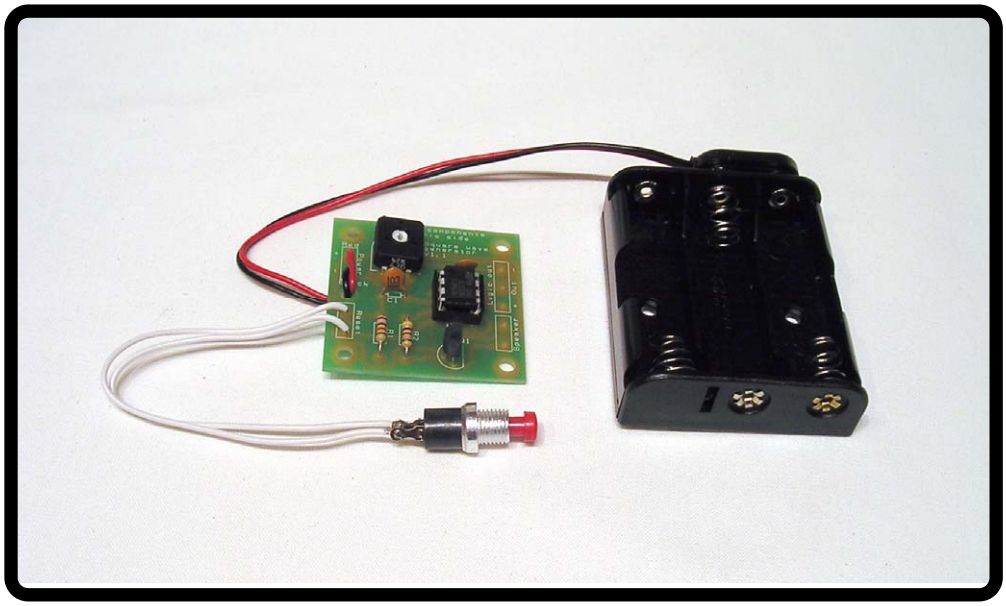
Square wave generator



Build Instructions

Issue 1.1

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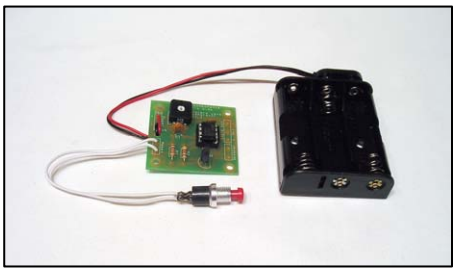
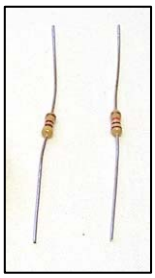


Before you put any components in the board or pick up the soldering iron, just take a look at the Printed Circuit Board (PCB). The components go in the side with the writing on and the solder goes on the side with the tracks and silver pads.

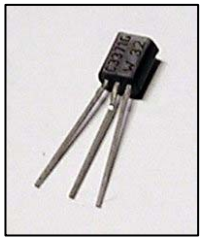
You will find it easiest to start with the small components and work up to the taller larger ones. If you've not soldered before get your soldering checked after you have done the first few joints.

Step 1
Start with the two resistors (shown right):
R1 is a 10KΩ (brown, black, orange coloured bands)
R2 is a 3.3KΩ (orange, orange, red coloured bands)



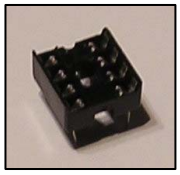
The text on the PCB shows where R1 and R2 should go. It doesn't matter which way around the resistors go into the board.

Step 2
Place the two 10nF capacitors (shown left) in to the board where it is labeled C1 and C2. It does not matter which way around the devices are fitted.



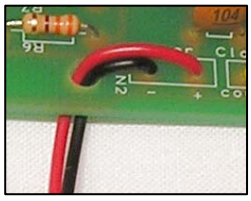
Step 3
Place the BC547 transistor (shown right) in to the board where it is labeled Q1. Make sure the device is the correct way around. The shape of the device should match the outline on the PCB.

Step 4
The 47KΩ variable potentiometers (pictured left) should be soldered into R3 on the PCB. The legs on the device should be matched with the holes on the PCB.



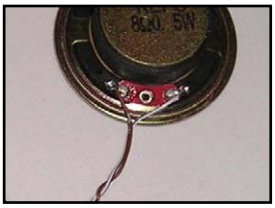
Step 5
Solder the integrated Circuit (IC) holder (shown right) in to U1. When putting it into the board, be sure to get it the right way around. The notch on the IC holder should line up with the notch on the lines marked on the PCB.

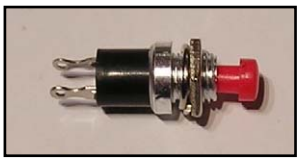
Step 6
Now you must attach the battery clip (shown left). Start by feeding the leads through the strain relief hole between the power & reset connections. The wire should be fed in from the rear of the board (see below & left).



The leads should be connected to the 'power' terminals. The red lead should be soldered to the '+' terminal (also marked with text 'red') and the black lead should be soldered to the '-' terminal (also marked with the text 'black').

Step 7 (only if fitting a speaker)
To connect the speaker to you need to cut two pieces of wire to the desired length. Strip both ends and solder them into 'Speaker' and the other end to the tabs on the speaker. The wires can go either way around.





Step 8
Cut and strip two pieces of wire to the required length for connecting to the switch (shown left). Solder one end of each wire to each of the terminals on the switch and the other end to the terminals labeled 'Reset'. It does not matter which wire goes to which terminal.

Step 9
The IC can now be put into the holder ensuring the notch on the chip lines up with the notch on the holder.

Using the logic output

The square wave generator board can be used to drive logic instead of a speaker. When the logic output is to be used the speaker doesn't need to be present and connections to the 'logic out' can be made as follows:

+	This is the positive power
-	This is 0 volts
Out	This is the logic level output

Checking Your PCB

Check the following before you power up the unit:

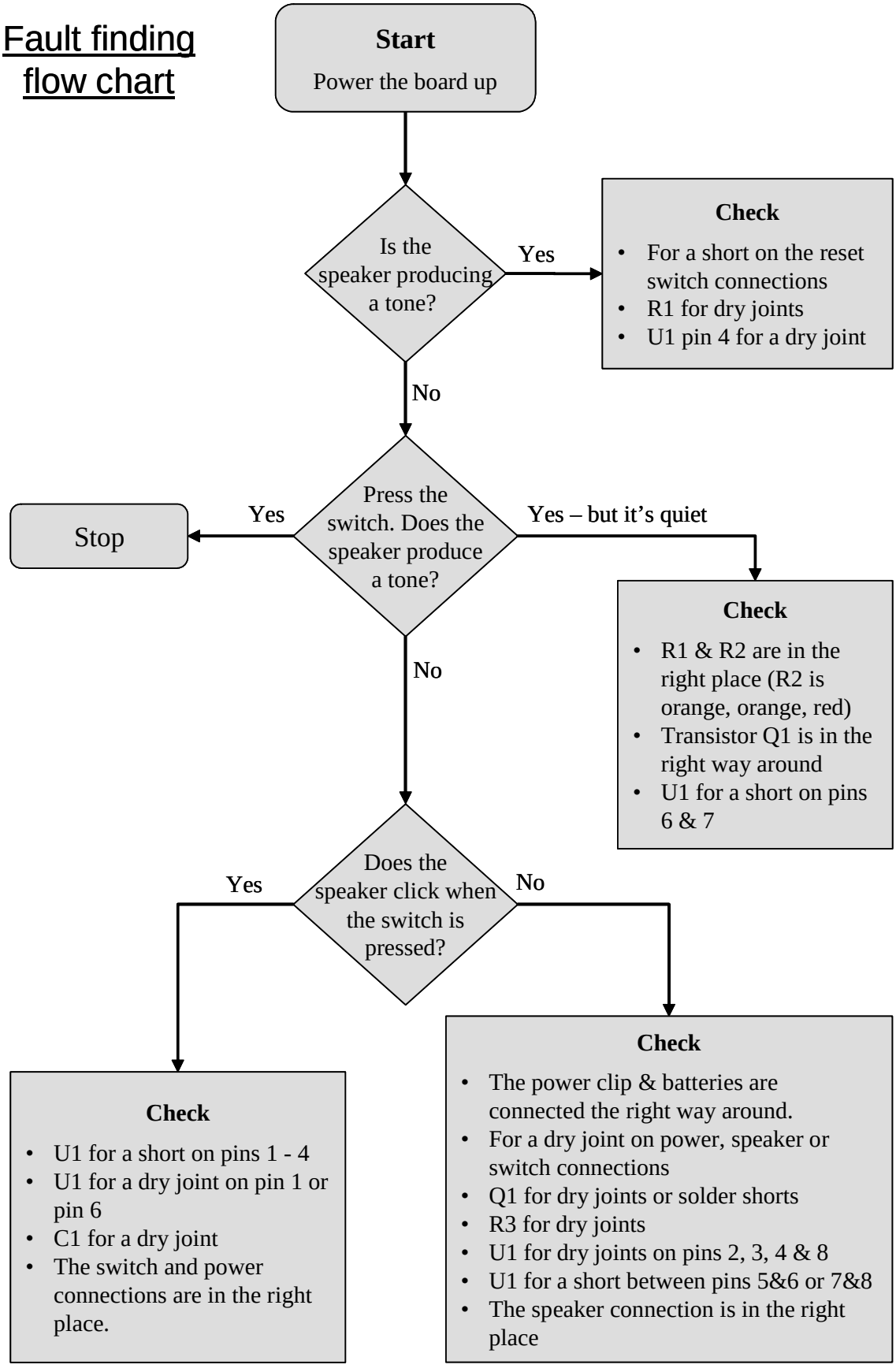
Check the bottom of the board to ensure that:

- All holes (except the large mounting holes) are filled with the lead of a component.
- All these leads are soldered.
- Pins next to each other are not soldered together.

Check the top of the board to ensure that:

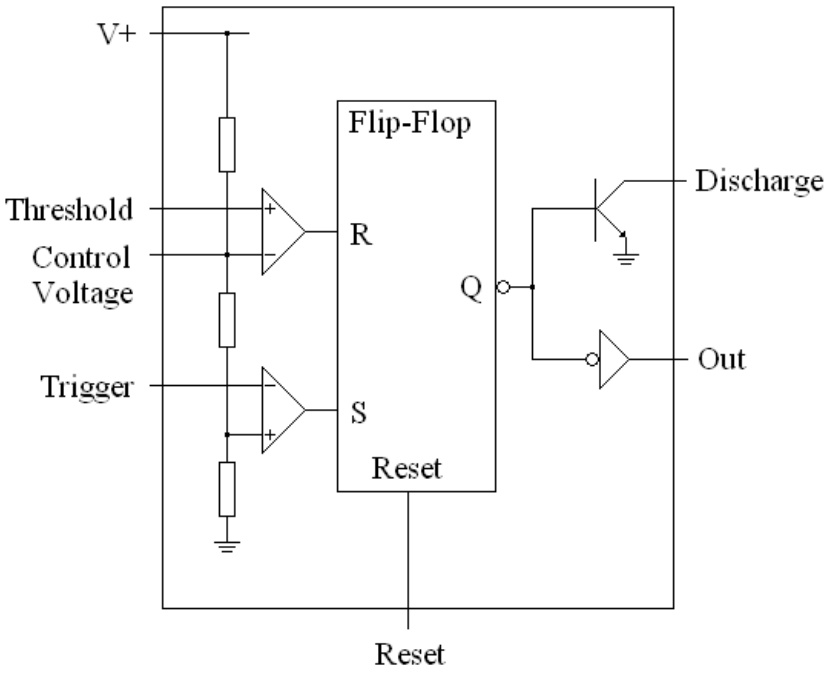
- The notch on the 555 IC matches the outline on the PCB.
- The shape of the transistor matches the outline on the PCB.
- The resistor bands on R1 are brown, black and orange.
- All the connecting leads are connected to the right part and that the power connection is the right way around.

Fault finding flow chart



Please note: This fault finding diagram is based upon using an 8Ω speaker to test the circuit. Alternatively an oscilloscope connected to the logic output could be used.

The 555 IC



Operating Overview

The 555 timer is a simple integrated circuit. By taking the trigger signal from high to low the flip-flop is set. This causes the output to go high and the discharge pin to be released from Gnd (0V). The releasing of the discharge pin from Gnd causes an external capacitor to begin charging.

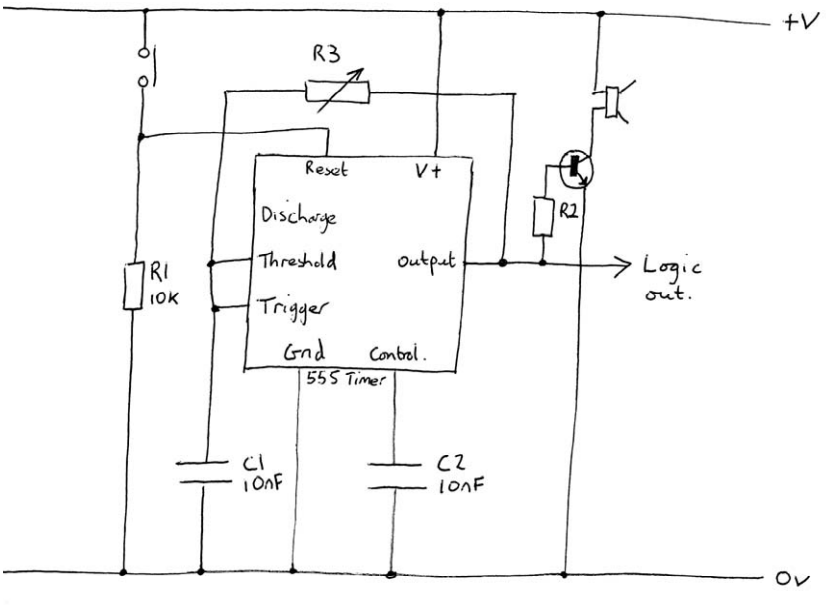
When the capacitor is charged the voltage across it increases. This results in the voltage on the threshold pin increasing. When this is high enough it will result in the threshold pin to causing the flip-flop to reset.

This causes the output to go low and the discharge pin is also taken back to Gnd. This discharges the external capacitor ready for the next time the device is triggered.

Pin Descriptions

V+	=	Supply voltage.
GND	=	Gnd (0V) connection for supply voltage.
Threshold	=	Active high input pin that is used to monitor the charging of the timing capacitor.
Control Voltage	=	Used to adjust the threshold voltage if required. This should be left disconnected if the function is not required. A 0.01uF capacitor to Gnd can be used in electrically noisy circuits.
Trigger	=	Active low trigger input that start the timer.
Discharge	=	Output pin that is used to discharge the timing capacitor.
Out	=	Timer output pin.
Reset	=	Active low reset pin. Normally connected to V+ if the reset function is not required.

How the square wave generator works



555 timer

The 555 timer needs to be configured as an astable timer (it outputs a continuous alternating signal). In this configuration the 555 timer re-triggers itself after each cycle which results in the continuous alternating signal.

The frequency of the output frequency is determined by the time taken to charge the 10nF capacitor C1. This capacitor charges through the 47K variable resistor R3. When the output of the circuit (pin 3) goes high C1 begins to charge until the voltage across it is high enough to activate the threshold input. This causes the output to go low and the capacitor now starts to discharge through R3. This continues until the voltage across C1 is low enough to activate the (active low) trigger input. The output now goes high and the process is repeated.

The minimum 555 output frequency is determined as follows:

$$f = \frac{1.44}{R3 \times C1} \quad f = \frac{1.49}{47K \times 10nF}$$ Hence f is approx. 3.2KHz.

The output signal is used to switch the transistor. The transistor is used as it allows larger loads (ie the speaker) to be driven than the 555 timer output could drive on its own.

The reset line is active low, this means that to the hold the timer in reset so that the timer stops the reset line is taken low and in normal operation it is taken high. This is implemented with the 10K pull down resistor R1and the push to make switch between the reset pin and the supply line. When this buttons is pressed the circuit operates and the tone is generated, when it is released the circuit is held in reset and no tone is generated.

The capacitor C2 on the control voltage (CV) pin is present for improved noise immunity.