Elementary Electronics

5 One transistor projects

by ROSS TESTER

The circuits below have one thing in common — they each work from only one transistor. And the transistor is the cheapest part — in fact, it is free.

By courtesy of Fairchild Australia Pty. Ltd., we are giving away 4000 transistors to our readers. This offer is especially intended for younger readers, but we are quite happy to give away a transistor to anyone who sends in the coupon on page 75.

Since our supply is limited, it is a good idea to post your coupon as soon as possible — and be sure to enclose a stamped, self-addressed envelope.

We designed these circuits around the free Fairchild transistors, but the coupon entitles you to only one transistor. So it is more than likely that many of our readers will want to obtain other types of transistors to build the other projects.

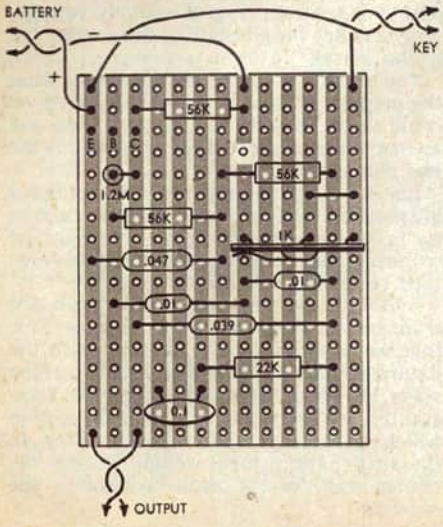
All of the circuits shown should work quite satisfactorily with the Fairchild 2N3638A transistor, which the free one is roughly similar to. Other types of PNP silicon transistors may also work.

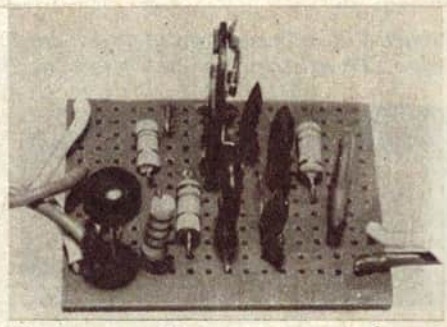
Code Oscillator

Have you ever listened to a short wave receiver and heard long strings of dots and dashes, and wondered what they meant?

The oscillator described here will help you learn the Morse code, if you have the patience to learn. By connecting a key to the circuit, you can "transmit" Morse to a friend, and he can do the same thing back to you. This way, you will be able to master the code.

There are four main requirements for a practice oscillator of this type. These are: It must be free from "clicks" and "chirps"; it must be stable in frequency; it must be easy or pleasant to listen to; and, preferably, the pitch should be variable.





Basic oscillator mounted on Veroboard.

Considering the simplicity of this circuit, the oscillator is surprisingly good in all these respects. There are no chirps (that is, a slight change in frequency as the key is pressed), very light key clicks, the tone is quite pleasant (not unlike a flute or clarinet), and the frequency is very stable over quite long periods.

Basically, the oscillator is a "twin T" network. It gets this name from the appearance of the two T-shaped networks which determine the oscillator's frequency. With the twin T, the frequency can be varied easily in one of two ways, by varying the capacitor at the junction of the two resistors, or by varying the resistance at the junction of the two capacitors.

We have chosen to vary the resistance, because this is the easiest to do. While it is possible to vary the capacitance by substituting individual fixed capacitors, this is not very practical. It is far easier to change the resistance by means of a variable resistor. If you wish, you could experiment with different values of resistors and capacitors in the legs of the "T" sections.

The variable resistor we used was a small preset potentiometer, but you could use an ordinary variable pot if you wished. The difference is that the preset pot may be mounted on the Veroboard with the other components, and adjusted with a screwdriver. The ordinary variable may be attached to connecting leads and is varied in the same way as a volume control on an amplifier.

By varying the pot, you will be able to change the pitch of the oscillator, to find the pitch which is most pleasant for you.

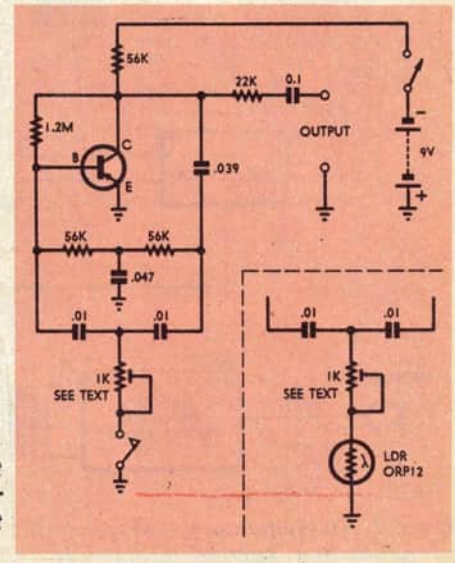
To use this oscillator, you will need to feed it into an amplifier, either into a "Pickup" or "Aux. Input" channel. Or you may care to construct a simple audio amplifier from one of those featured in the March, 1970 issue. (Reprint 1 / XA / 10.)

A code key is connected between the pot and the positive supply rail, and it is this key which is used to make your dots and dashes. We would suggest that you try to obtain a proper key (possibly from disposals sources) as a good key is of prime importance if you are to develop a good "hand" for sending Morse code.

The easiest way to mount the oscillator components is on a piece of Veroboard. If you follow the diagrams, there should be no problem. Note that there is a break in the copper pattern at one point. It is easy to do this with a ⅛in. twist drill. Simply hold the drill in your hand, put the point into the hole to be broken, and turn the drill a couple of times. This will cleanly break the copper pattern around the hole.

When soldering components, especially transistors and diodes, take care that you do not overheat components. It is best to "pre-tin" the components before soldering them to Veroboard. Be sure to use a heat sink (such as a pair of pliers) on the leads to prevent heat damage when soldering.

We do have another couple of uses for the code oscillator. The next project shows you how to modify it slightly, but another idea, which we are still working on, will be presented soon — possibly next month. We think you will find our new ideas interesting, so when you have finished experimenting with the oscillator, don't pull it to pieces — wait and see what else you can do with it.



At left is oscillator component layout; at right is code oscillator circuit with substitute LDR circuit for light control.

Light Controlled Oscillator

The code oscillator circuit can be quite easily modified to make the oscillator light controlled. In other words, the oscillator will not function without light, but when light is present, will vary its pitch according to the intensity of light.

To make the oscillator light sensitive, all we do is remove the key and substitute a light dependent resistor (LDR).

The resistance of an LDR varies in proportion to the amount of light striking it. This resistance varies, typically, from tens of megohms in complete darkness down to a few hundred ohms in very bright light.

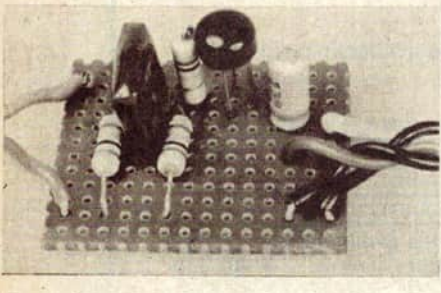
In low light the LDR resistance is too high for the oscillator to function. Once the light increases, however, the resistance lowers, and the oscillator will turn on. More light will cause the tone of the oscillator to increase in pitch — and vice versa.

By waving your hands above the LDR (and hence interrupting the light) the oscillator pitch will vary, not unlike the weird "space music" one often hears in TV science fiction.

What can one use a light sensitive oscillator for?

One use which we can immediately think of for such a device as this is for a party game — trying to find a candle or light bulb in a darkened room while blindfolded. Armed with this oscillator connected to a small amplifier, all one would need to do is to walk around the room a few times, holding the LDR in front of you. As you approach the light, the oscillator would lessen in pitch, but if you turned away, it would stop altogether. It shouldn't take too long to find the light source.

Impedance Matching Stage



Impedance matching stage mounted on Veroboard.

In audio work, a problem which faces some of us from time to time is the matching of a high impedance source to a lower impedance input. The "emitter follower" circuit described here will help match these different impedances.

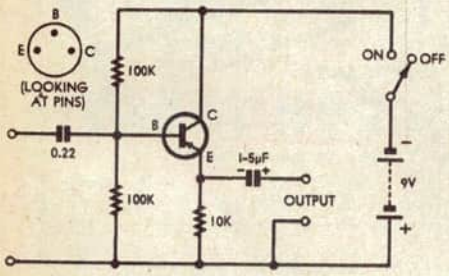
Some possible uses for a circuit such as this include: matching a high impedance

microphone to an amplifier with a lower impedance input; feeding a microphone signal into a long length of cable so that the high frequency component of the signal will not be attenuated by the capacitance of the cable; and coupling a piece of equipment with a high impedance output (such as a tape recorder) to a low impedance input on an amplifier.

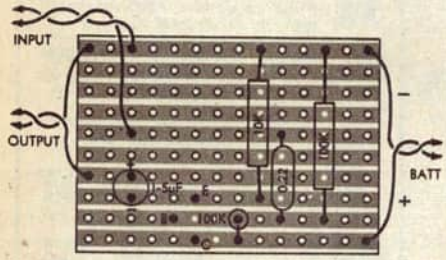
The input impedance of this circuit would be approximately 50K, for all load input impedances of about 5K or over. Most amplifier inputs would fall into this category.

You may wonder why we have called the circuit an "emitter follower". It is given this name because the waveform at the output (the emitter) follows the waveform at the input. The circuit does not invert the signal, as other types of circuits do.

The voltage gain of this circuit is less than unity (we get less signal voltage out than we put in) but this does not mean that the transistor is not amplifying the signal. What it does mean is that we are using the amplification to achieve another purpose; a change in impedance. Instead of a voltage



Circuit for impedance matching stage.



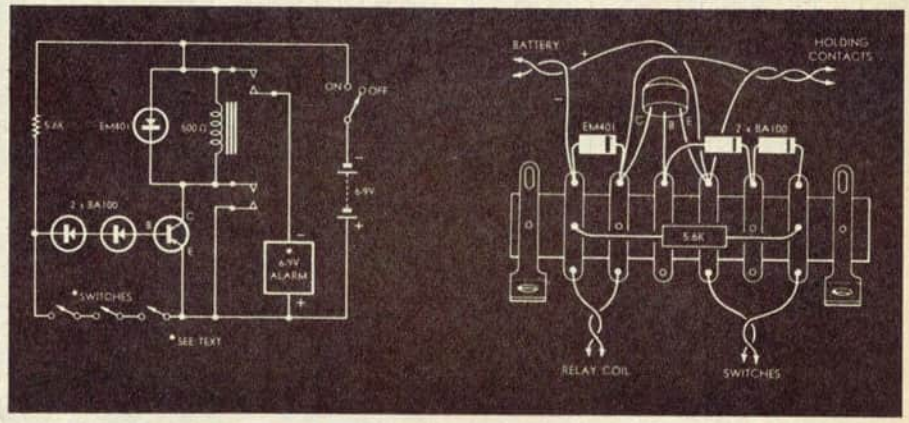
Wiring layout for impedance matching stage.

increase, we accept a slight voltage decrease, but across a very much lower impedance. This, in fact, represents a form of amplification — power amplification.

Therefore, there must be a sufficiently high level of signal available from the source to ignore the lack of gain. The signal is applied to the base via a 0.22uF capacitor, and extracted via a low value electrolytic. We used a 1uF, but anything up to about 5uF would suffice.

Layout is not critical. We have built it up on a piece of scrap Veroboard, but it could be built on tagstrips if you so desire.

Follow our diagrams, and you should have no trouble duplicating the prototype. To check that the circuit is operating correctly place a multimeter in series with the supply battery — taking care of the polarity of the meter. The circuit should draw approximately 0.4-0.5mA if it is operating properly.



Circuit for burglar alarm.

Wiring layout for burglar alarm.

Burglar Alarm

This burglar alarm circuit, while very simple, is extremely reliable and economical. You can protect your home and property against intruders with a device such as this — and the circuit described here, in its simplest form, will cost you less than two dollars — (even less if you can "scrounge" an old relay).

The circuit is simple. The door and window switches bias the transistor "off" while they are closed. But as soon as one or more of these switches is opened, the transistor is biased "on", and the relay is energised. This closes the relay contacts and starts the alarm.

Note that one set of contacts (known as "holding" contacts) bypass the transistor and hold the relay on, even if the switch is closed and the transistor is turned off. This will keep the alarm on until someone investigates and turns it off, and would also discourage the intruder from having another try.

Until the alarm operates, the circuit draws very little current. From Ohm's law we can work out that nine volts across a 5.6K resistor involves a current flow of only 1.6 milliamps. (There should be no appreciable leakage through the transistor and relay). So the life of the battery should almost be equal to its "shelf life".

Naturally, the alarm itself will draw a far greater current — particularly if it is a large bell, for example. So you might give consideration to using a separate power source for the alarm. This could be a much larger battery, possibly re-chargeable, which would be sure of making the "alarm" function reliable at all times.

Note that if you do use another battery, you should not connect the alarm contacts on the relay to the circuit battery, as we have shown. Instead, you should use the contacts as a switch in the external circuit.

The relay you use should have a coil resistance of approximately 500 ohms. This is the value we used, although slightly lower and higher coil resistances should work. Do not use a relay with too high a resistance, however, as the relay will not energise, or one with too low a resistance, which may endanger the transistor by allowing too heavy a current to flow through it.

The relay should have at least two sets of normally open contacts. And, depending on the current drawn by your alarm, these contacts may have to be quite large. If there are more than two sets of contacts on your relay, some may be wired in parallel to give a higher current-handling capability.

The EM401 diode in parallel with the relay coil is used to suppress transient voltages generated when the coil circuit is opened. You may remember from the article on the electromagnet in the November, 1971 issue that a collapsing magnetic field generates

quite high transient voltages in the coil — high enough, in fact, to destroy the transistor were it not for this diode.

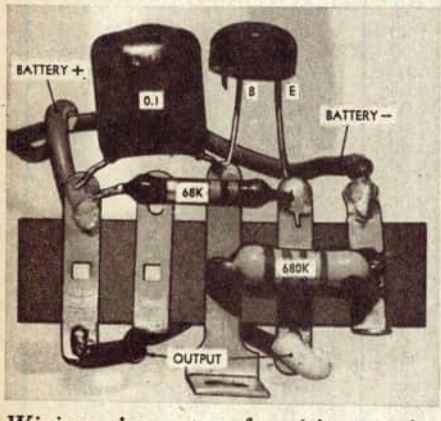
The two BA100 diodes in series effectively increase the reverse base-emitter breakdown voltage of the transistor. This is more or less for the same reason as the other diode — only this time it is used to protect against transient voltages generated by the bell or buzzer used as the alarm itself.

The buzzer or bell used as the alarm device can take many forms. It may be a large bell mounted on the wall of the house, or a small buzzer or bell to give warning to a specific person. A localised "quiet" warning has one decided advantage — the first the intruder knows about the burglar alarm could be when the gentleman in blue taps him on the shoulder!

Or you may like to use a device such as the solid state "Sonalert", marketed by Plessey Ducon Pty. Ltd. This little device gives a loud whistle, but draws only a few milliamps of current. The cost of this device is about six dollars. If you do use something like this, take care with the polarity. We have marked a plus and minus on the circuit for this purpose. Ordinary bells and buzzers are not polarised.

The choice of door and window switches is largely left up to you. However, we would consider a "dry reed" switch and associated magnet to be one of the best types of switch. For a full article on actually installing a burglar alarm in your home, the one we published in September, 1967, will give you all the information you should need. Copies of this article are available through the information service for fifty cents (reprint 3 / MS / 14).

White Noise Generator



Wiring layout of white noise generator mounted on a tagstrip.

Our last circuit is rather a novel one. You will notice that only two connections to the transistor are made. In other words, we are using the device not as a transistor, but as a diode. Also, you may notice that the connections to the diode are reverse to what one would normally expect for a PNP transistor. Therefore, we are using a reverse-biased base-emitter junction. Why?

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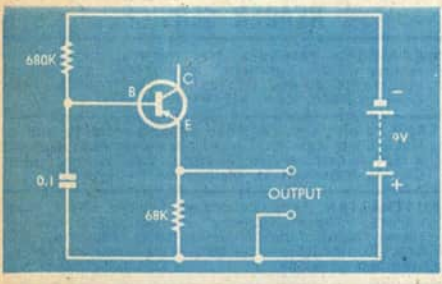
The answer is — to make noise! But why should we want to make noise — isn't there enough of that around already?

The noise we are trying to make is rather special. It is known as "white noise", which may be defined as sound within the audio spectrum which is completely random in frequency and amplitude. The name is borrowed from white light, which is also random mixture of frequencies and amplitudes within the visible spectrum.

White noise has a unique property. It is able, to some extent, to mask sound by increasing the "ambient" noise level to which the ear becomes accustomed. In other words, the ear's sensitivity is



Circuit for white noise generator.

decreased. The end result is that you become less conscious of all but the louder sounds.

For this reason, some modern city office blocks now use white noise to help staff concentrate. It helps to lessen the noise of typewriters, of traffic in the street outside, of the person on the phone near you, and so on. By the same effect, we reasoned that white noise will help you study, or to concentrate on precision tasks.

Don't get us wrong — white noise will not blanket out sound, so if this is what you are looking for, you will be disappointed. But it will help reduce the distraction caused by the TV set in the next room, or the baby screaming next door. The secret is to have the white noise generator going, and then try to forget about it. After 15 minutes or so you should have achieved this and have improved your concentration.

We have mounted the generator on a piece of tagstrip, but it may be constructed any way you like. The layout is not at all critical. And the voltage to run the generator is not critical, either. It may be anything from nine to 25 or so. Once you get above 15 volts, though, change the 680K resistor to one megohm.

As with the tone oscillator, you will need to run the noise generator through an amplifer. The amplifier should have a high sensitivity input such as the input used for electro-magnetic pick-ups.

If you find that you cannot get any white noise output from your loud speakers, it is probably because your amplifier is not sensitive enough for the circuit as shown. In this case, swap the transistor for a BC108 and reverse the battery connections. Our free transistors will give approximately ten millivolts of white noise A BC108 will give approximately 60 millivolts of white noise, which should be enough to drive most audio amplifiers.