MORSE PRACTICE OSCILLATOR

With Sine Wave output and low level key clicks

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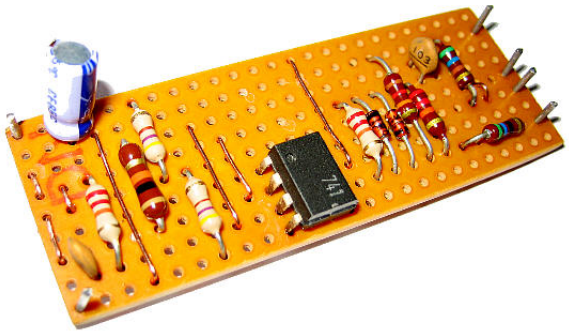
STRIPBOARD PROJECTS

No: 003

Many simple Morse practice oscillators produce an audio output of poor wave shape with loud "key clicks" that often add to the difficulty of learning Morse code. This simple design is different as it produces a cleaner sounding sine wave audio output with only a hint of "key clicks". These features produce a more realistic sound resembling that produced by a radio receiver which makes the learning process that little bit easier …

The well known Wein Bridge oscillator is used in this design because it readily produces stable sine waves and is easily implemented using just one low cost industry standard Operational Amplifier, the type 741. BiFET types such as the LF351 & TL081 should also work if substituted but this has not been tried.



The Wein Bridge type of oscillator is also commonly used in analogue audio signal generators (Bench Test Equipment) and technical information as to the principle of operation is available in many standard text books so will not be discussed further.

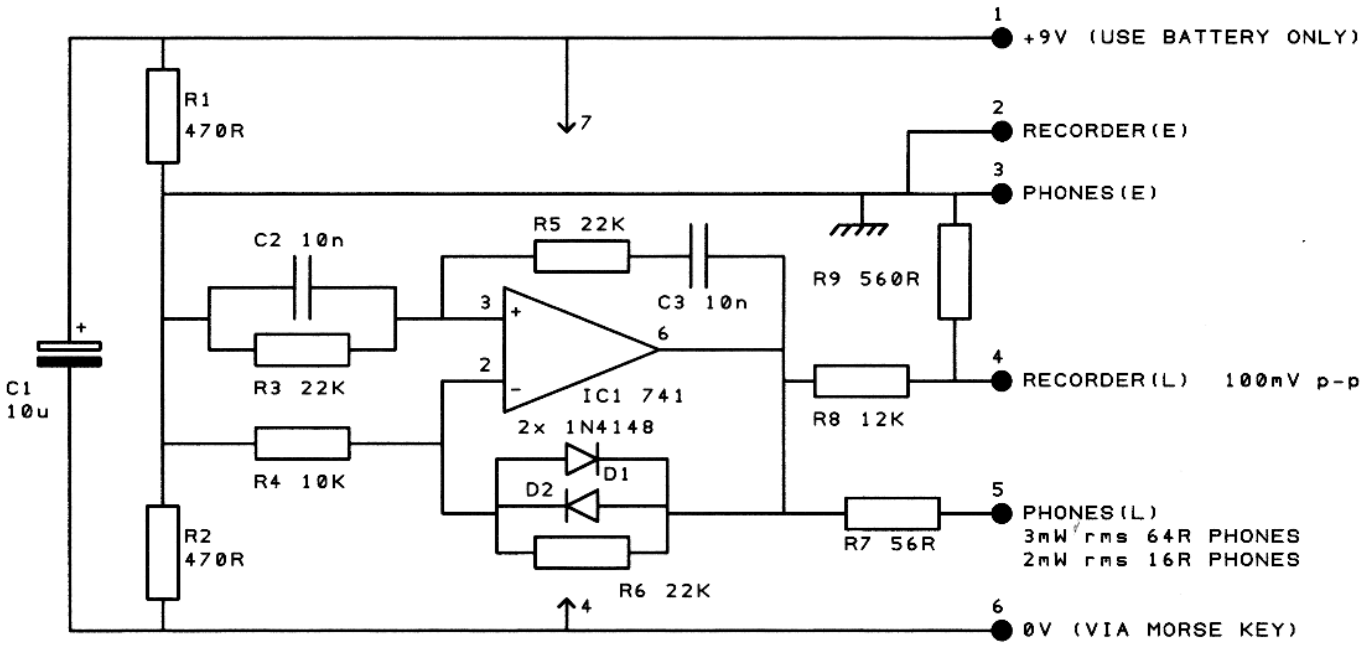
An oscillator based upon the Wein Bridge only produces low distortion sine waves if circuit losses are exactly balanced. To achieve balance, the gain of the amplifier within the oscillator has to be automatically adjusted such that the gain exactly equals the losses within the overall circuit. This may be done by using:-

(I) a sensitive and specially produced PTC resistor (hard to find these days)
(II) an AGC loop using an FET and signal rectifier system (a modern solution but uses quite a few components)
(III) an incandescent lamp (easy to find and cheap but not so good as a PTC)
(IV) silicon signal diodes acting as voltage controlled resistors (does not give the best possible wave shape due inherent non-linearity)

Methods (I) and (ii) are commonly used in high quality audio oscillators, method (iii) is often used in lower performance audio oscillators whilst method (iv) works best for a "keyed" audio oscillator like the one described here. The term "keyed" simply means that the power supply is applied via a Morse Key and is thus switched on and off in time with the Morse characters. The Morse Key is effectively the on-off switch and the battery does not supply any energy until the Morse Key is pressed. This keying method gives a very long battery life, even from a PP3 sized battery.

In order to keep the circuit as simple as possible, no additional audio amplification is provided and in most cases it won't be needed. If "walkman" style 32 ohm headphones are used, the volume should be comfortable and constant even with falling battery voltage. Hi-Fi headphones are often 8 ohm impedance but should still give a useable results albeit at slightly lower volume. For both types, the earpieces are best connected in series.

Schematic Circuit Diagram



Circuit Notes: The values of R8 and R9 determine the output signal level for a recorder such as Cassette, MP3 or PC line-in. Their values are not too critical (R8 not less than 4k7) but the ones shown gave an output level of 100mV p-p sine-wave. The output frequency may be calculated from $\mathbf{F=(2\pi RC)^{-1}}$ Hz where R=R3=R5 and C=C2=C3. The values shown give a calculated output frequency of 723 Hz but due to wide capacitor component tolerances, the prototype gave an output of 800 Hz. Any frequency between 650 and 800 Hz should prove to be acceptable. **The ratio R4:R6 is fairly critical** and should ideally be 2.2 so it is best to use 1% resistors. If 5% types are used measure them on a digital meter and calculate the ratio (divide R6 by R4) to ensure that it is in the range 2.15 to 2.25. These resistors set the initial gain of IC1 to, ideally, 3.2.

Component List (example supplier given, others offering similar parts may be used)

Ident	Description	Suppliers Order Code	Supplier	Supplier Web Address	Cost
IC1	LM741 Operational Amplifier	82-0458			25p
D1	1N4148 Silicon signal diode	47-3308			4p
D2	1N4148 Silicon signal diode	47-3308			4p
R1	470 ohms 5% watt Carbon Film	62-0362 (Box of 100)			0.6p
R2	470 ohms 5% watt Carbon Film	62-0362 (Box of 100)			0.6p
R3	22k ohms 5% watt Carbon Film	62-0402 (Box of 100)			0.6p
R4	10k ohms 1% watt Metal Film	62-0897 (Box of 100)			1.2p
R5	22k ohms 5% watt Carbon Film	62-0402 (Box of 100)			0.6p
R6	22k ohms 1% watt Metal Film	62-0922 (Box of 100)			1.2p
R7	56 ohms 5% watt Carbon Film	62-0340 (Box of 100)			0.6p
R8	12k ohms 5% watt Carbon Film	62-0396 (Box of 100)			0.6p
R9	560 ohms 5% watt Carbon Film	62-0364 (Box of 100)			0.6p
C1	10uF 25v Radial Electrolytic	11-0220	Rapid Electronics	http://www.rapidelectronics.co.uk/	3p
C2	10nF Disc Ceramic 10% 100v	08-1000			9p
C3	10nF Disc Ceramic 10% 100v	08-1000			9p
PCB	9 tracks x 25 holes Stripboard	34-0500			19p
T1-T6	6 off 1mm PCB Terminal Pins	34-0610 (Box of 100)			3p
JK1	3.5mm stereo socket (Phones)	20-0155			16p
JK2	**2.5mm** mono socket (Key)	20-0130			11p
JK3	3.5mm stereo socket (Recorder)	20-0155			16p
Plug	2.5mm mono plug (Key)	20-0100			15p
Plug	3.5mm stereo plug (Recorder)	20-0125			22p
Misc	PP3 pre wired battery clip	18-0150			7p
Misc	PP3 9 volt battery	18-0120			55p
Misc	Plastic Case with battery box 105(L) x 61(W) x 28(H) mm	30-0270			225p

Building Cost Circuit Board only

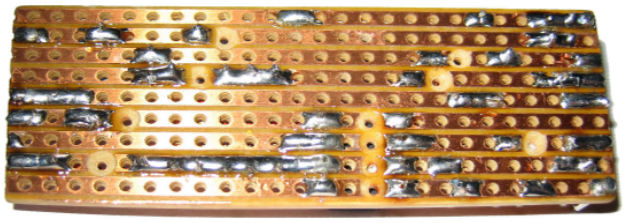
£0.83 + VAT

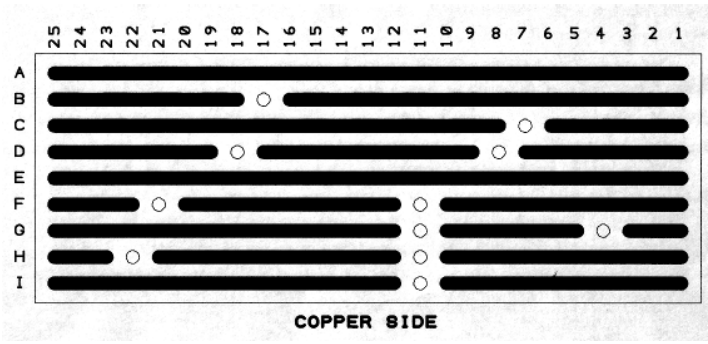
Building Cost to completion (less Phones)

£4.50 + VAT

Construction

1. First of all, the stripboard tracks are cut in the places shown here using either a specialist track cutter or a hand held 3mm drill bit. Just twist the drill bit until the track is broken cleanly.

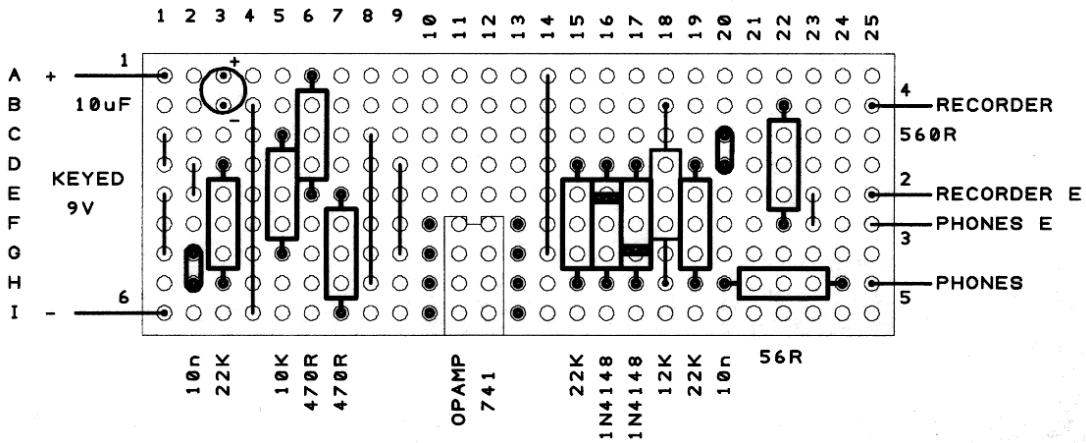




2. The next stage is to insert the terminals, wire links and components. **Do not touch the copper tracks with fingers, they must be kept clean and grease free until all soldering is completed.** Trim the leads and solder them into position in a methodical order as recommended below.

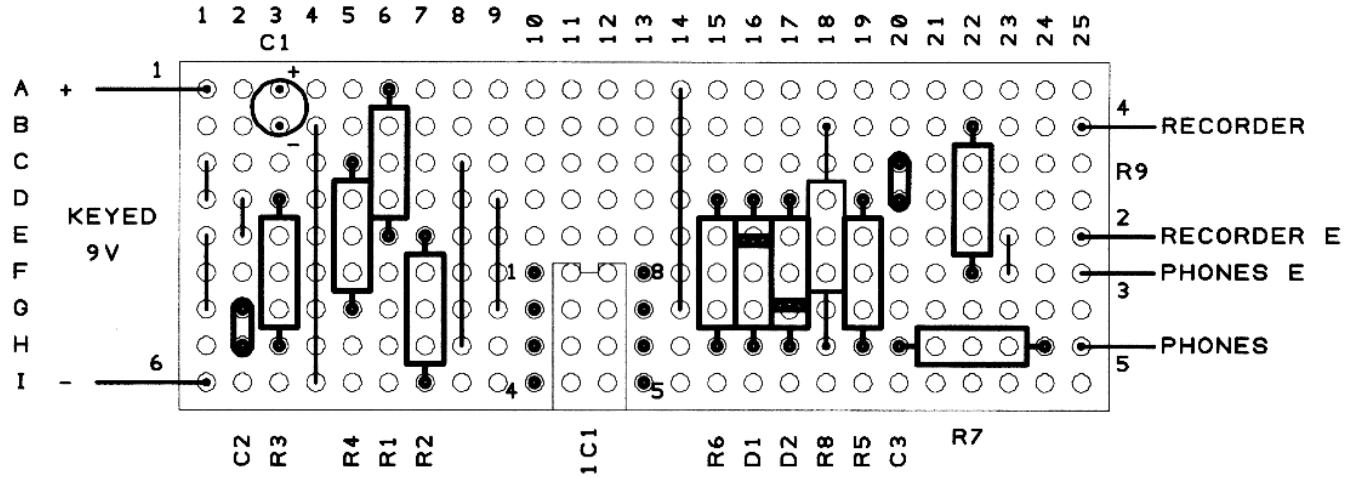
Fit the terminal pins first, then the wire links, resistors, capacitors, diodes and IC. Terminal pins should be gently hammered home before soldering to the tracks.

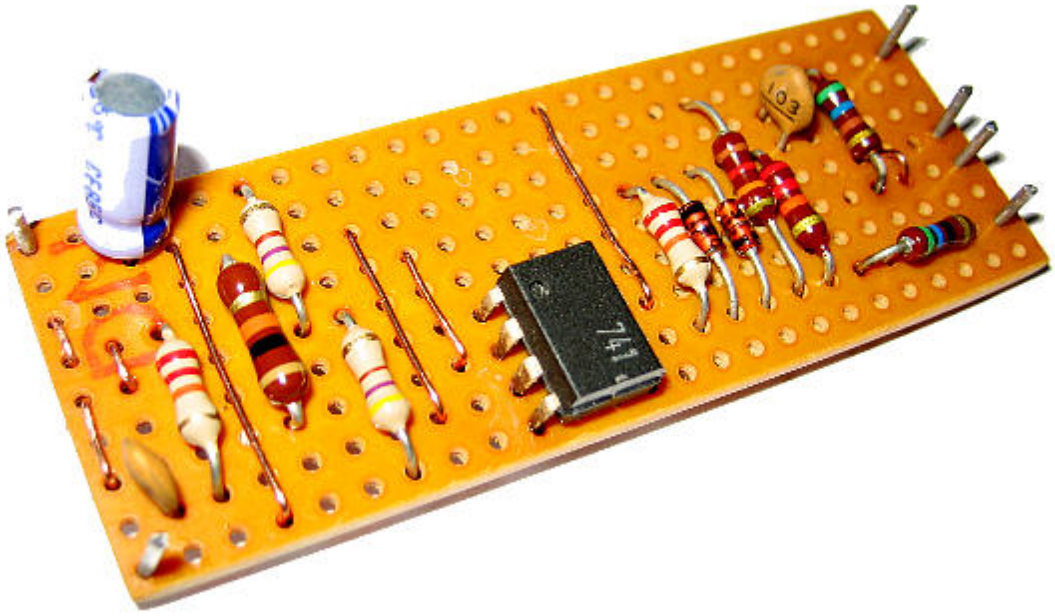
The orientation of the 10uF capacitor. two diodes and the IC are critical. The cathode of each diode is indicated by a black band and the longer lead of the electrolytic capacitor indicates +ve.



Wire links can be made from resistor lead off-cuts or 0.56mm (24 swg) diameter tinned copper wire. They should be **pre-formed** to fit the holes in the board exactly using long nosed pliers. Bend the protruding copper wires from the wire links and components slightly (about 45 degrees) on the copper side to prevent them dropping out of the board whilst soldering. Always look out for solder bridges between tracks as they can easily occur if too much solder is applied or too large a soldering iron tip is used. Remove solder bridges as they occur using a solder sucker or desoldering braid. Do not over heat the components particularly the semiconductors IC1, D! & D2.

The location of specific components for fault finding or modification purposes is given below.





Displaying your Morse Code on a PC screen

If you are learning to send Morse Code without an experienced partner, then it is recommended to display your Morse Code on a PC Computer screen by connecting the **RECORD** output to the **LINE IN** on the PC Sound Card. Software to do this (Shareware) is available from:

http://www.softwarevault.com/Download/CwGet-morse-decoder-Download

Choice of Connectors

The connectors for Morse Key, Phones and Recorder may be selected to suit local needs, however, a 3.5mm stereo jack socket is recommended for use with readily available 32 ohm stereo headphones, either "in-ear" or "headband types". This allows two ways of connection according to how much audio volume is required.

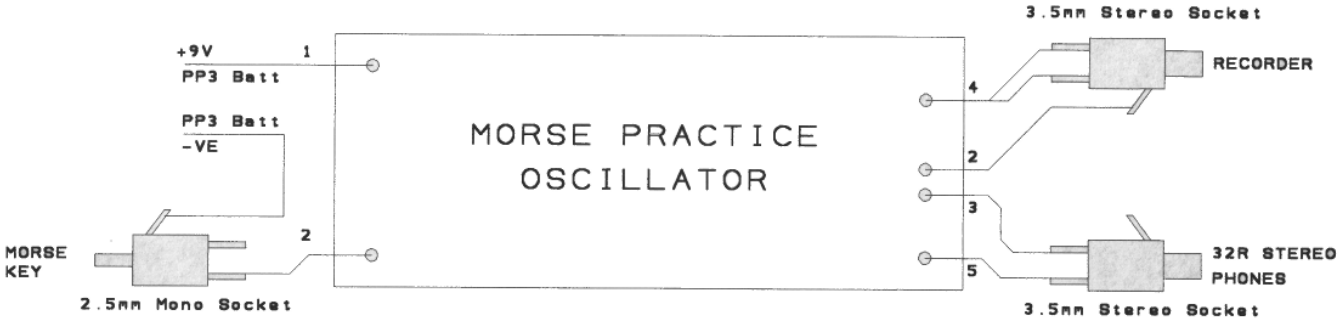
- ✓ For maximum volume (about 3mW of audio), wire the earpieces in series to give 64 ohms impedance. To do this, connect terminals 3 & 5 on the Morse Oscillator PCB to the Tip and Ring solder tags on the jack socket. The diagram on the next page shows this connection method.
- ✓ For lesser volume (about 2mW or audio), wire the earpieces in parallel to give 16 ohms impedance. To do this, connect terminal 3 to the sleeve and terminal 5 to both the tip and ring solder tags on the jack socket. A 16 ohm load may cause slight distortion of the output wave.
- ✓ For use with 8 ohm stereo hi-fi headphones, these normally come with a ¼ inch stereo jack plug with a 3.5mm adaptor and therefore a matching ¼ inch jack socket may not be needed. It is best to wire these 8 ohm earpieces in series to give 16 ohms. To do this, connect terminals 3 & 5 on the Morse Oscillator PCB to the Tip and Ring solder tags on the jack socket.

Morse Key connection

Use a PP3 battery and pre wired battery clip. Connect the front contact of the Morse Key to the tip of a 2.5mm plug and the centre Key contact to the sleeve of the plug. Wire the socket as shown in the diagram below which connects the –ve of the battery (black) to the sleeve contact of the 2.5mm mono socket. The Morse Key now acts as an on-off switch and no current is drawn from the battery in the "Key Up" condition.

Wiring to the PCB

The diagram below shows the wiring to the PCB if the recommended jack sockets shown in the component list are used.



WARNING

This project should always be battery operated, even during the testing stage. The battery supply MUST be floating, i.e. not connected to Chassis or Earth or any other metallic object. The whole unit should ideally be fitted inside an insulating plastic case for maximum safety.

There are two reasons for this:

- Firstly, you should never trust any mains operated power supply as safe when using headphones as a fault could so easily cause fatal injury.
- Secondly, both connections on each of the Recorder and Phones audio outputs float at around half battery voltage. If a power supply were to be used that had the negative lead internally connected to the mains earth as some do, then it is possible that connection to other mains operated test equipment would cause a short circuit via the Test Probe's earth clip.

Battery operation is best for this equipment. It ensures safe operation and trouble free connection to other equipment.

The current drawn by this Morse Practice Oscillator is only about 11mA (Key down only) so even a small PP3 battery will have an extremely long service life and there is no need for a mains operated supply to be used.

Morse key suppliers

Morse keys can be difficult to source at a low price these days. There are three kinds or Morse Key in common us:-

- Hand Key (up and down movements)
- Electronic Key (side to side movements)
- Electromechanical BUG key (side to side movements)

The last two generate perfectly timed Morse characters at high speed when operated by an experienced user. The technique used to operate these keys is a new skill in itself and beginners are urged to learn using the Hand Key first.

The following UK web sites may be of assistance in locating a commercially produced Morse key. One of the cheapest available from a supplier seems to be the TK as used by the Soviet Army. At the time of writing, the TK costs around £35 inc. VAT. Many second hand bargains are available from classified advertisements and Internet auction sites. **Morse keys with in-built "key click" filters are not required for this project and may even stop it working properly.**

http://www.mlands.co.uk/acatalog/Morse_Keys.html

Don't forget Ebay, Morse Keys can be found on this link:

http://search.ebay.co.uk/morse-key

Compare what you have just constructed with this historical photograph showing a Morse practice oscillator that uses a VALVE running from large LT and HT batteries. Transistors were not invented until 1948 and would have been ideal for a project like this.

Also shown is a hand Morse Key and high impedance "wireless" headphones, typically 2000 ohms per earpiece wired in series and extremely sensitive. Quite rare today unless discovered second hand.