

## Introduction:

This kit is a Code Practice Oscillator with wave shaping. It uses a near sine wave oscillator (Twin-T) which feeds an LM-386 audio amplifier for speaker or headphone output. The frequency of the tone is variable via a potentiometer. The tone is keyed with a 2n7000 MOSFET which shapes the resulting Morse code elements with a ramp up/down of the tone. Hopefully, the result is a CPO which is more pleasing to the ear than the normal square wave type of kits.

## General notes on building the Shaped CPO kit

Q1 (2n7000) is an n-channel MOSFET transistor. This means that it should be handled as little as possible to prevent static damage. The builder should use a grounding strap and anti-static mat if available or at the very least, work on a grounded metal surface and be sure to touch ground prior to touching this part.

One decision the builder should make before starting construction of the Shaped CPO kit is how the project will be mounted in the case. The Shaped CPO kit was designed with a candy tin in mind as the case but any case could be used with suitable modification during the build of the kit. If the candy tin approach is not used, the builder will probably want to put only one of the 3.5 mm connectors on the board and mount the other somewhere else on the case and use wires to connect this second connector to the CPO circuit board. A drilling template for a candy tin is included with the circuit board. I use a 1/4 inch hand paper punch and the "armstrong" method to punch the holes along the side of the tin for the input and output jacks along with the holes needed for the pot and optional power switch. I use an awl to punch the hole in the bottom of the tin for the mounting hole.

The pads and traces are small and delicate - a small tipped, low power (25 watts or less) soldering iron should be used.

## Building the Shaped CPO

Step 1) Get the parts together: All of the board mounted components have been supplied but you will still have to provide off-board items to fully implement the kit. These items are mentioned at the end of the kit parts list

Step 2) Identify and orient the components: Most of the components should be fairly easy to identify and place - see the parts list and the parts placement diagram for descriptions. The orientation of the capacitors: C5, C6 and C7 are especially important since they are polarized (electrolytic) capacitors. C5 is a small yellow cap, the + side is marked on the slightly bumped out side of the cap. C6 and C7 are black electrolytic caps with white negative side (-) stripes. Be sure to match these polarity marks with the ones on the parts placement diagram and in the building procedure to follow.

step 3) Form the leads, place and solder the components on the main circuit board: Use the parts placement diagram for information on the placement and orientation of the parts. Clip the leads of the parts after soldering.

- a) 8 pin DIP socket - place it at the inside corner of the board with the notch pointing down and solder in place.
- b) J1, the 3.5 mm connector - place J1 to the left of the 8 pin socket. Solder all 5 connections of J1 in place.
- c) J2, the 3.5 mm connector - place J2 at the top right of the board. Solder all 5 connections of J2 in place.
- d) R2 and R3, 18 k ohm resistors (brown, gray, orange, gold). Place R2 and R3 as shown on the parts placement diagram, near the mounting hole of the circuit board and solder in place.
- e) R6, 2 k ohm resistor (red, black, red, gold). Place R6 as shown on the parts placement diagram, along the top right edge of the circuit board and solder in place.
- f) R8, 10 k ohm resistor (brown, black, orange, gold). Place R8 as shown on the parts placement diagram, along the top left edge of the circuit board and solder in place.
- g) C5, 2.2 uF yellow Tantalum capacitor. Place C5 as shown on the parts placement diagram, at the right center of the circuit board with the positive, bumped out side towards the gnd legend of the circuit board and solder in place.
- h) C6, 100 uF black electrolytic capacitor. Place C6 as shown on the parts placement diagram, at the top of the cutout area of the circuit board with the negative stripe to the left side of the circuit board and solder in place.
- fi) C7, 4.7 uF black electrolytic capacitor. Place C7 as shown on the parts placement diagram, at the right center of the circuit board with the negative stripe to the left side of the circuit board (away from the right edge) and solder in place.
- j) R7, 20 k ohm trimmer (blue pot) resistor marked 24. Place R7 as shown on the parts placement diagram just below the J2 connector on the top edge of the board with the flat edge of R7 oriented to the right of the board and solder in place.

## Building and Operating: Shaped CPO kit from Jackson Harbor Press

- k) R4, 10 k ohm trimmer (blue pot) resistor marked 14Z. Place R4 as shown on the parts placement diagram at the outside corner of the circuit board with the flat edge of R4 oriented to the right of the board and solder in place.
- l) Q1, 2n7000 transistor (remember that this part is static sensitive) . Place Q1 as shown on the parts placement diagram just to the right of the 8 pin socket with the flat edge of Q1 oriented to the left side of the board and solder in place.
- m) C1, .047 uF dark red polyester capacitor marked 473. Place C1 as shown on the parts placement diagram, just below the 8 pin socket and solder in place
- n) C4, .047 uF dark red polyester capacitor marked 473. Place C4 as shown on the parts placement diagram, to the right of J1 on the left side of the board and solder in place
- o) Q2, MPSA42 transistor (on the taped cardboard) . Place Q2 as shown on the parts placement diagram just below R2 and R3 at the bottom edge of the board with the flat edge of Q2 oriented to the top edge of the board and solder in place.
- p) C2 and C3, .018 uF dark red polyester capacitor marked 183. Place C2 as shown on the parts placement diagram, just below Q2 (yes the spacing is too tight), place C3 just below C2 and solder both in place
- q) R1, 4.7 k ohm resistors (yellow, purple, red, gold). Place R1 as shown on the parts placement diagram, on the BOTTOM of the circuit board, solder one end to pin 6 of the 8 pin socket and solder the other end to the collector of Q2, be careful not to short R1 to any other traces on the bottom of the board.
- r) Place a short jumper wire as shown on the parts placement diagram, on the BOTTOM of the circuit board, solder between two terminals of J2 at the top edge of the board.
- s) Solder the 9V battery snap (or other power input connector to the ground and +Vin holes on the left side of the board, don't forget to add a power switch if necessary in series with the positive lead.
- t) R5, external (off board) 100 k ohm audio taper pot. Solder three wires as shown on the parts placement diagram to the three pads on the bottom edge of the board

Step 4) Check the board: Before proceeding, take the time to check the top (mostly) and the bottom of the board for solder bridges. Use the parts placement and bottom view diagrams as a guide to visually check for these shorts. It may help to clean the flux from the board and then use a strong light in conjunction with a magnifying glass to see these problems. Also, double check the orientation of the critical components such as U1, the transistors and the electrolytic caps C7, C6 and C5. After you are convinced that the board is OK, form the leads of U1 (the LM386 8 pin DIP audio amplifier IC) and insert it into the 8 pin socket with pin 1 oriented towards the bottom edge of the board. Connect the board to a 9V battery using a VOM to measure the current used, current should be about 5 mA with no speaker or key connected, if it's much larger, or if it's too low (should be at least a few ma) power down and re-check the board for shorts and polarity problems.

### Operation:

Connect a speaker to J1 and a keyer or key to J2. With the key down, R4 should be adjusted for the desired tone frequency. The duty cycle pot (R7) can be most easily adjusted using an oscilloscope and keying the shaped CPO with a keyer set to send a string of high speed dits. R7 is then adjusted for a "square" wave train. Alternatively, R7 can be adjusted by ear so that the wave train is roughly even.

R5 (volume control) should be adjusted for a comfortable volume, note that at high volume levels, the waveform will be distorted. Using a higher supply voltage, +Vin, (but don't go higher than about 14 volts) will allow a higher volume level than a 9 volt battery.

### Modification ideas:

- 1) an ON/OFF switch: especially if you are using a 9V battery as a power source, it won't last long connected to the Shaped CPO. One other idea would be to use a battery saver circuit such as the kit of the same name from Jackson Harbor Press.
- 2) an internal speaker can be connected to the pads located to left of the output jack. When an external speaker is connected, the jack will turn off the internal speaker.
- 3) a headphone jack can be connected to the same pads mentioned in mod 2. Use a series resistor (I use 160 ohms, the value isn't critical) to "knock down" any noise and backwave.

Please feel free to email with any questions, comments, suggestion or problems with this kit. My email address is:

Building and Operating: Shaped CPO kit from Jackson Harbor Press

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Thanks for choosing the Shaped CPO kit and  
Best Regards,

Chuck Olson, WB9KZY

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List of parts included with the Shaped CPO kit

Ref	designation	Description
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C1,C4		.047 uF dark red polyester capacitor, .2" lead space
C2,C3		.018 uF dark red polyester capacitor, .2" lead space
C5		2.2 uF yellow Tantalum capacitor, .1" lead space
C6		100 uF electrolytic capacitor
C7		4.7 uF electrolytic capacitor
J1		stereo 3.5 mm speaker jack
J2		3.5 mm key jack
R1		4.7 k ohm, yellow, purple, red, gold resistor
R2, R3		18 k ohm, brown, gray, orange, gold resistor
R4	14Z	10 k ohm trimmer resistor
R6		2 k ohm, red, black, red, gold resistor
R7	24	20 k ohm trimmer resistor
R8		10 k ohm, brown, black, orange, gold resistor
Q1	2n7000	2n7000 MOSFET transistor, TO-92 package
Q2	MPSA42	MPSA42 NPN transistor, TO-92 package
U1	LM386	8 pin DIP,National audio amplifier IC
		8 pin DIP machine pin socket
		circuit board

Items you may need to provide to complete the Shaped CPO kit

R5		100 k ohm audio taper potentiometer
		knob for R5
		earphone jack (optional)
		series resistor for earphone jack (optional - see text)
		internal/external speaker and/or earphone
		Metal case (an Altoids candy tin is fine)
		4-40 sized mounting hardware
		input power jack (9V battery snap connector OR other power connector)
		SPST power switch (optional)
		solder, wire,