

Universal Code Practice Oscillator (uCPO) with built in Morse tutor

uCPO New MK4 Specifications

Now can be used Fully as a standalone tutor
WITHOUT a Morse key.

3 Mode Processor Controlled Morse Oscillator/Tutor

Mode 1:- Straight Key Practice Oscillator

Variable Tone : 400-1000Hz
(via internal trim pot)
AutoSense Key type



Mode 2:- Iambic/bug/Sideswipe Mode

AutoSense Key type
Variable Tone : 400-1000Hz (via internal trim Pot)
Adjustable Speed 10-35wpm
User selectable Iambic A or Iambic B + dot memory

Mode 3:- Morse Tutor Mode

Built in 6 Mode Morse tutor

- 1) Random Letters
- 2) Random Numbers
- 3) Random Prosigns
- 4) Mixed Mode
- 5) International Callsigns (*Advanced mode)
- 6) Contest Mode (*Advanced Mode)
- 7) Adjustable WPM rate (10 to 30+wpm)
- 8) Adjustable Gap (Farnsworth Mode 0-3sec approx)

*Advanced modes

The two advanced modes have been designed to add a bit of realism and interest to your practice sessions, the speed of each 'over' will automatically change by upto +/- 10%. So some will be faster than your set speed and some slower, just like the real world. To make things even more realistic the user can select VariTone mode too. In this mode the pitch as well as the speed will change.

• Zoom /Decoder Output feature

Since the world has changed a lot in the past year. Many of us are now not meeting up in clubs for practice sessions and so organisations such as CWops and the CW Academy are using Zoom or Skype for remote training. The uCPO has a built in low level output socket for connecting to a PC or Mac, this output is a sinewave for a cleaner sound. This

output can also let you run decoding software on the computer to test your own sending or to show what the tutor is sending so you can check your own receiving. The uCPO also has a volume limited headphone output for personal practice too. (please note that this output is intended to be used with normal headphones, ear buds, or earphones. Not electronic Noise reduction type like the ones produced by Bose)

The uCPO is built around a clever little processor chip and offers a lot of features. With all these features being controlled by just a single knob and a straight/paddle key the initial setup can seem a little complicated the first time you try it but for many the default settings will be fine,

Default settings

Automatic Key selection

Side Tone Pitch approx 700Hz

Tutor Speed:-17 WPM

Vari-Tone for advanced Tutor modes ON

Iambic B Mode active

This is the new version 4 of the uCPO with improvements over the MK3.

Whats New with the Mk4?

The difference between the two versions is subtle but did require a new PCB to be designed.

Upto now the uCPO needed a Morse key of some kind plugged in in order to use the Morse Tutor side, well after a number of requests the uCPO now has a small push button that allows the user to enter and control the tutor side without the key.

The second change is that some users asked if the low level AUX output level could be given a little boost. The MK4 has approx an extra 6dB boost on this output.

The third change, the tutor always started in 'Letters' mode, now the tutor stores the operating mode in a EEPROM and will remember the last used mode when next turned on.

Finally a minor change was to change the on board pitch control from what was a 25 turn control to a standard single turn board mounted trimmer, this makes more sense as the pitch range is only in the order of a few hundred hertz's (400 to 1000Hz) so they was no real need for a 25 turn trimmer to start with. This makes tone adjustment easy!

SET-UP GUIDE***How to setup the uCPO options***

The instructions below sound complicated but once you have run through them a couple of times you will find you can make the changes in just a few seconds with ease.

- 1) Turn OFF the uCPO.
- 2) Press the key down or if a paddle squeeze both paddles and HOLD.(you can use the push button on the front too)
- 3) Turn on the uCPO, (Still holding the key Or the button!)
After a short delay you will hear the letter 'A' in Morse, adjust the speed control to set the tutor WPM rate.

I suggest setting the control at the 12o'Clock position which will be about 17 wpm character speed. Once you're happy with the speed release the key.

- 4) If you just wanted to change the tutor WPM rate do nothing else. Turn off the unit and then back on to use the new set speed (which will be saved for all your sessions until you change it again)

If you are doing the initial setup or want to change other features carry on and do NOT turn off the unit as above.

- 5) As soon as you release the key (or button) in step 4 hold it again, after a second or two you will hear 'VT' in Morse. This is now going to allow you to set the Vari-Tone feature ON or OFF.

If you want the Vari-Tone (VT) on continue to hold the key. After a second or two you will hear a high pitch tone (2000Hz), this tells you that VT is on. If you wanted this option off then when you hear the 'VT' Morse signal release the key and a second later you will hear a low pitch tone (1000Hz).

- 6) As soon as you hear the low or high pitch tone start hold the key again. You will now hear 'KM' for keyer mode. This mode allows you to set Iambic A or Iambic B with Dot memory. If you continue to hold the key after the KM signal you will hear another high pitch tone, this means you are in Iambic B mode, if you release the key as soon as you hear KM you will hear a low pitch tone. This means you have selected Iambic A mode.

- 7) All settings will be saved in the chip until you repeat this process again at some point in the future.
- 8) Turn off the unit and now you're ready to practice.

How to use the uCPO

The uCPO is easy to use despite having many different modes and uses.

NEW! Using the Tutor mode without a Key

With the unit turned off push and HOLD the small push button on the front of the uCPO while turning it on. Hold the button less than a second and then release. After a short pause the tutor will start, just hold the button for a second to change tutor modes. All the features detailed below in the '**Morse Tutor Mode**' section will be available to you

Straight Key Practice oscillator Mode.

Make sure you have wired your key to a 3.5mm MONO plug. Turn off the uCPO and plug the key into the front panel. Turn on the uCPO, that's it! Adjust the volume to suit. The uCPO automatically senses the straight key since it uses a MONO plug unlike the paddle key.

Paddle/Bug/ Practice Oscillator Mode.

Turn off the uCPO. Plug your key in, turn on the uCPO. Tap away. Now the speed control will be active and you can set the speed from about 10 to 35wpm, the 12o'Clock position is approx. 20 wpm.

Morse Tutor Mode.

If using a paddle key squeeze both paddles when turning on the oscillator or if using a straight key just hold it down on power up. Once turned on release the key within a second or you will enter setup mode. The tutor will now start sending 5 figure letter groups,(first time used, after that it will remember the last used mode) if you now hold the key down or hold the left hand paddle it will switch to random numbers, next press it will switch to Prosigns, then next mode which is all of the above mixed. One more press and you get a more interesting mode, Callsigns, this mode sends random international callsigns but each callsign will be sent at a slightly different speed and pitch (if VT is turned on) , just to make things a little more realistic. The next mode is typical Contest mode, a callsign followed by the standard '5NN' and then a 3 or 4 digit serial number, sometimes this serial number will use Cut numbers (instead of '0' it sends 'T' and instead of '9' it send 'N'), again with random speed and pitch like the callsign mode.

When changing modes the tutor will first send a Morse letter at a higher pitch tone that identifies the new mode ('L' = letters, 'N' = Numbers, 'P' = Prosigns, 'M' = Mixed, 'C' = Callsign, and 'CT' = Contest)

A worthwhile tip. There is no point trying to learn the code with a slow character speed, you will only need to relearn the sound of each letter again when you get on air. It's an easy mistake to learn the code with character speeds that are so slow you learn by counting the dots and dashes. This is a **mistake**. From day one learn the sound of each letter, **DO NOT** count the elements of each letter. Yes it will seem harder at first but it's not a race and the rewards are much higher. So I recommend you use a character speed of around 17 wpm which is a realistic speed used by many operators in the real world. (Start at the speed you want to get to and just increase the gap to start with) I will not be cruel and expect you to start learning Morse at such speeds so the speed control in this mode will allow you to set a gap of your choice upto 3 seconds between characters, this will make the task of learning much easier without you falling into the counting trap! In the setup guide I have explained how to set the Character speed to a suitable value.

Another new feature is the AUX output connection. This is a fixed low level **sinewave** output that can be connected to a computer for practice over the internet via Zoom etc. Another use of this output is to use it to test your sending, connected to a PC running software like CWGet, FLdigi or many others that will decode Morse. This way you can see if what you're sending makes sense, decoders typical struggle with hand sent Morse so if you can get yours decoded you know it's good!

The version 4 also gives a convenient headphone output connection point too. The volume on the headphone socket goes via a limiter to protect your hearing, it will still be more than enough ! (Read the note above about using normal headphones not electronic Noise reduction types)

The tutor functions and other features make this practice oscillator unique and exceptional value.

There is an on-board trimmer pot for pitch adjustment. With the exception of the sockets all the other controls are board mounted. The uCPO will drive a standard 8 ohm (or higher impedance) speaker.

IF making adjustment to the pitch do so while in TUTOR Mode or you will not hear the pitch change as you make adjustments. To maintain accurate Morse timings the pitch control is only read at start-up in practice oscillator modes so if you try to adjust the pitch while in these modes the trimmer control is not read until you turn the uCPO off and back on.

The power to the uCPO needs to be between 6 and 12 volts so a standard 9v battery could be used or ideally 4xAAA batteries for a long battery life.

The SPEED control will only be active in Paddle mode or to set the Gap in tutor modes.

When you want to change between the different modes of the tutor you need to press and HOLD the key (or Button) until you hear the mode Letter from the tutor. One little thing to be aware of is when in either Callsign or Contest mode and you change to the next mode the tutor will Announce the new mode Letter but may have a few letters from the last mode in its buffer that will be played before the new mode starts.

It sounds more complicated than it is, after a couple of goes you will find it very easy to change these options. You can control all of this with just a straight key after all!

The Volume control will adjust the audio level for both the internal speaker and the headphones (if used they will automatically disconnect the internal speaker) but the AUX output level will not change.

I hope you enjoy the uCPO.

Best 73 Paul MOB MN

Important Fully Boxed Kit Instructions

If you are building the uCPO full kit version in the supplied case you **MUST** follow the instructions as regards the fitting of the user adjustable controls and LED, failure to follow them will result in a poor fit to the case. Please read all these instructions before starting work.

Building the uCPO



The uCPO is built on a fairly small and busy looking PCB.

Let's check we have all the parts first;-

First a Safety Note, Using tools such as cutters and soldering irons can be dangerous, ideally wear eye protection when cutting leads and do NOT breath in Solder fumes.

Parts list.

1 x	uCPO PCB
C1, C4, C5	0.1uF Disk (marked 104)
C2, C3, C6, C7, C8	22nf Disk capacitors (marked 223)
R1,R3, R4	3K9 $\frac{1}{4}$ Watt Resistor
R2	10 Ohm $\frac{1}{4}$ Watt Resistor
R5	1K8 $\frac{1}{4}$ Watt Resistor
R6, R7, R8	10K $\frac{1}{4}$ Watt Resistor
Speed Pot	10K Potentiometer
Volume/Swt	10K Potentiometer c/w Switch
Pitch Control	10K Trimmer
U1	78L05 5V Regulator
T1	Audio Amplifier Transistor 2N2222 (or any general purpose NPN)
LED	Red 3mm "Power On" LED
IC Socket	8 Pin DIP
IC1	Attiny85 Programmed with uCPO Code
2 x Blocks	2 way Blue PCB Terminal Block
3 x	3.5mm Stereo Key Socket
1 x	Mode Push Switch
2 x	1N4148 Diodes
1 x	4 way AAA Battery Holder
1 x	8 Ohm Loudspeaker
1 x	length of Connection Cable
2 x	Knobs for controls

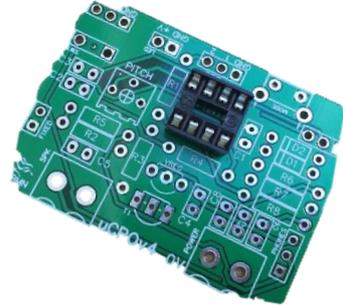
Pre-Drilled Base plate & Box c/w speaker & mounting hardware (only with full kit)

4 x Case base screws (only with full kit)

1 x Stick on Label (only with full kit)

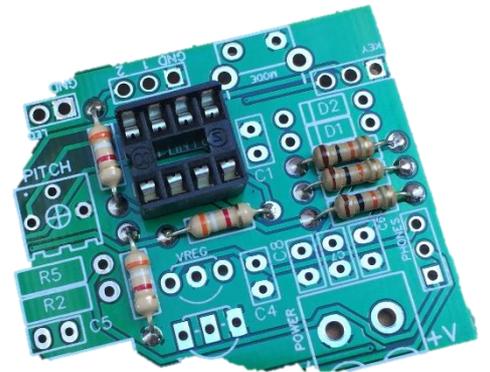
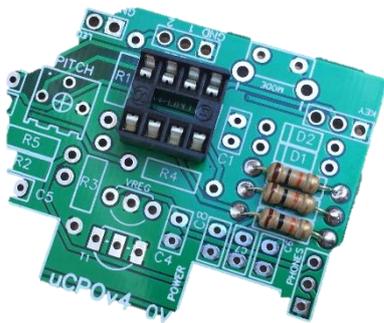
Let's make a start!

- 1) Fit the IC Socket in the middle of the board, you will note the socket as a dimple on one of the shorter sides, arrange the socket so that dimple is matched by the silk screen printing on the board.



- 2) Fit R6, R7, & R8 these are 10K resistors.

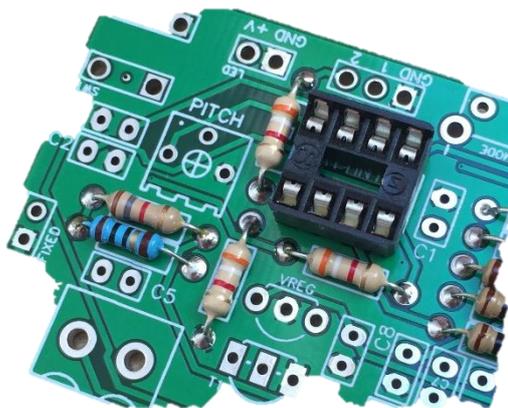
- 3) Fit R1, R3, and R4 these are 3K9 resistors



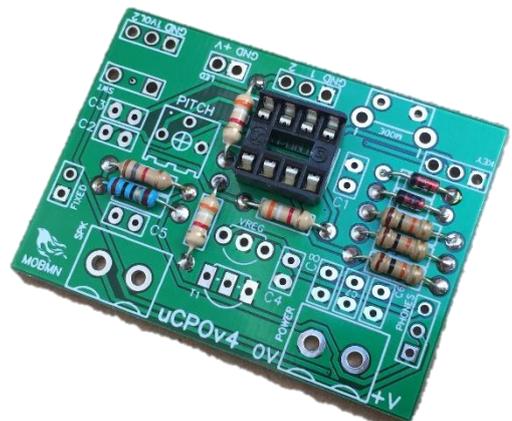
- 4) Fit the Last two resistors,

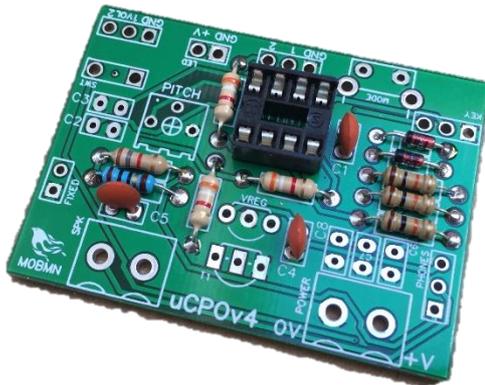
these are ; R2 which is a 10 Ohm resistor and R5 which is 1K8
Now double check that all the resistor values are correct and that you have no bad joints.

Next fit the two small glass diodes, D1 and D2, these unlike the resistors **MUST** be



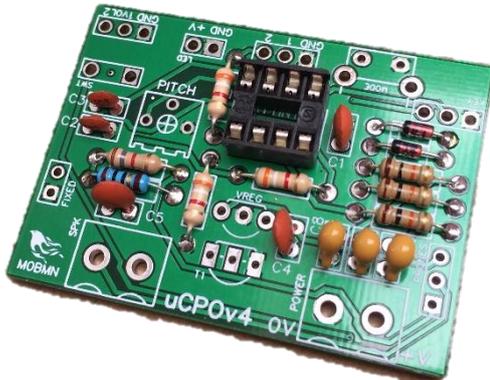
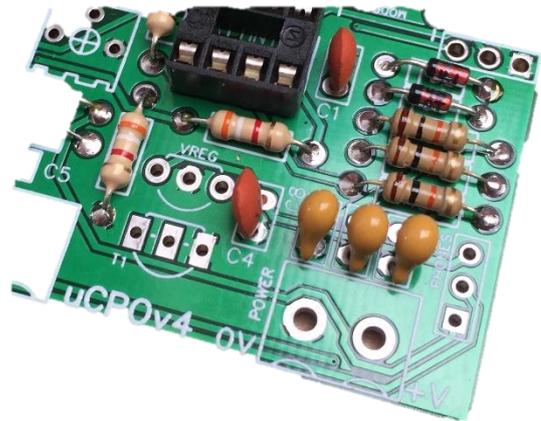
fitted the right way round, you will see that the diodes have a black band on one end. This end **MUST** be nearest to the chip socket both diodes must be fitted this way round.





5) Now we will start fitting the capacitors. Fit C1, C4 and C5. All these are 0.1uF disk capacitors and will be marked '104'. They can be fitted either way round.

6) Fit the capacitors for the Sinewave convertor circuit which are all 0.022uF capacitors, they will be small disk capacitors like you fitted before but this time marked '223'. The ones in the picture shown here are a different type than supplied in the Kit as these type have been found to be a little harder to fit due to their size.



7) Now fit C2, and C3, these are also both 0.022uF disks and will be marked '223'

Now take time to recheck your work, all the capacitors have been fitted now, makes sure all the values are correct and double check that the diodes are the right way round.

Now fit the Pitch control, this is a small blue trimmer, the only one in the kit.





8) Now the next two parts to fit can be easily misidentified so take great care with this stage.

We are going to fit the voltage regulator and the audio transistor, both look the same, a small plastic blob with 3 legs. This blob will have one flat side. Look carefully on the flat side and you will see the part type is printed on them, you first want to find the part marked 78L05, this is the voltage regulator. On the PCB the place for

this is marked 'VREG'. It's nearest to the centre of the board near to the IC socket. Do not try and push this regulator right down to the board, make sure its fitted the way the silk screen shows so the flat side is towards the IC socket and push it down so around 5mm of leg is above the board, this is not critical but dont leave it standing its full height as it will hit the speaker when fitted into the case.

9) Now fit the transistor, this should be marked 2n2222, it's a general purpose device that works well as an audio amplifier. Again leave it standing about 5mm above the board with its flat side towards the voltage regulator you previously fitted.

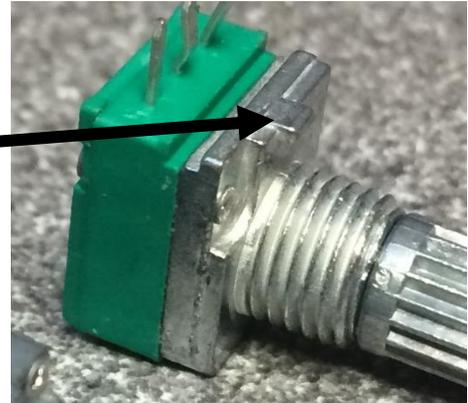


10) Fit the two 2 way blocks, these should be straight forward to fit.

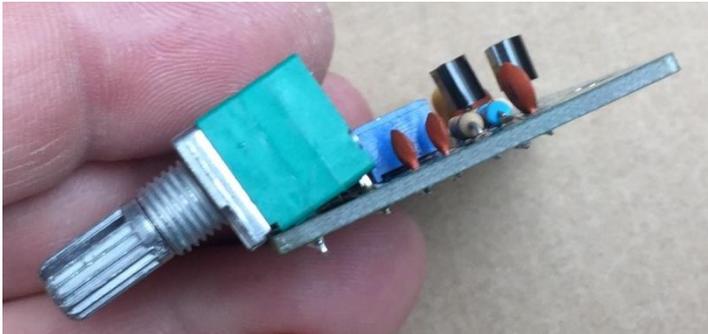
Time to take a break again and carefully check all the work you have done so far, check that all the joints are good and that you have not made any solder bridges between pins, if you have one use a magnifying glass to inspect each joint one by one. The most common reason kits don't work is poor soldering and short circuits. Make sure yours look good.

11) Now we need to fit the volume and speed controls, **THIS STEP IS CRITICAL AND MUST BE FOLLOWED**. You can't really mix these up as the volume control also has the on/off switch built in. Before you start soldering, look at the body of the two controls, if you're lucky I have already broken off the little locator tag just under the shafts.

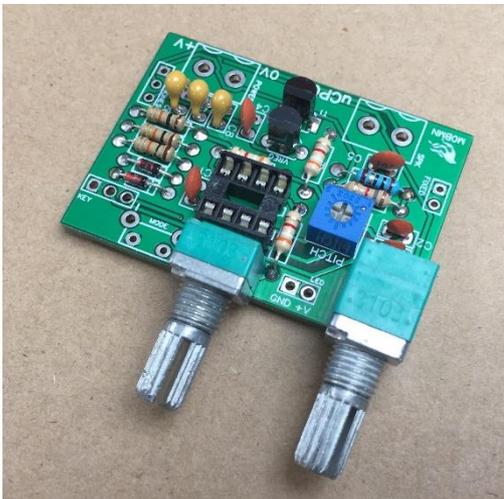
If not use cutters/pliers and snap off this tag, it comes off easy as it's only diecast aluminium. Do this to both controls. **Take care with this step or the board will not sit correctly in the case.**



READ ALL THE INSTRUCTIONS BELOW,

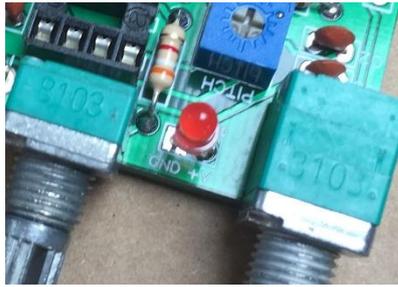


The **IMPORTANT** thing is that the control **MUST NOT** be fitted flush to the board. The case has a slight slope to the front panel, if the controls are fitted flush to the board the PCB will not sit flat in the box. Look at the picture above and you will see that the back pins are higher than the front. Push the control onto the board then push the control so that the back pins are **just** sticking out of the back of the PCB, they should just be protruding, solder tack the middle pin on the front row of terminals to hold the control in place and then double



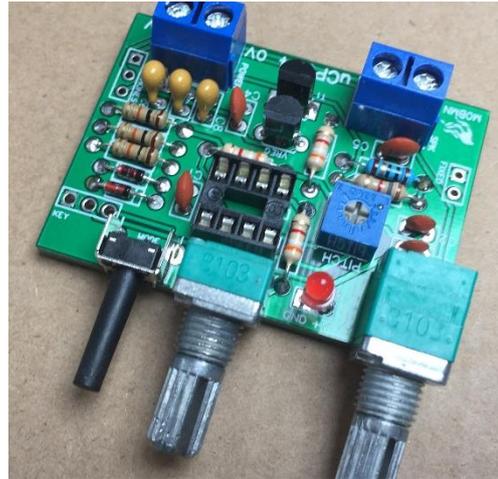
check the back pins are only just protruding and solder them in place. The most common fault with this kit is forgetting to solder the other pins of this control. Once you're happy that the control is fitted as the photo then make sure all five pins are soldered in place. Now fit the second control and angle it the same as the first. This is easier as it's just one row of pins. Make sure you solder all of them this time when happy.

Now fit the Power on led, the led as two legs, one long ,one short(er). The postion to fit the LED is between the two controls. You will see the two holes that it fits in, one hole is square one round. The long leg of the LED **MUST** go into the round hole. Push the LED in and leave it with about 5mm of leg above the board.



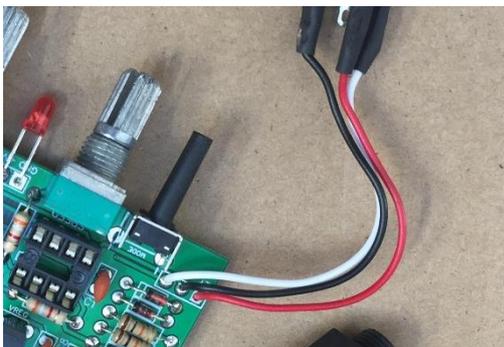
Now we need to fit the mode switch button, this should be fitted flush to the board, push the switch down inplace on the board and make sure that the pins of the switch are not folded over, check they can be seen protuding through the board before you solder them in place.

Now drop the board into the case, push it forward and make sure the LED is placed in the 3mm hole between the control holes. Carefull push the board forward, you will feel resistance to this as the LED legs will fold backwards as the board moves forward.

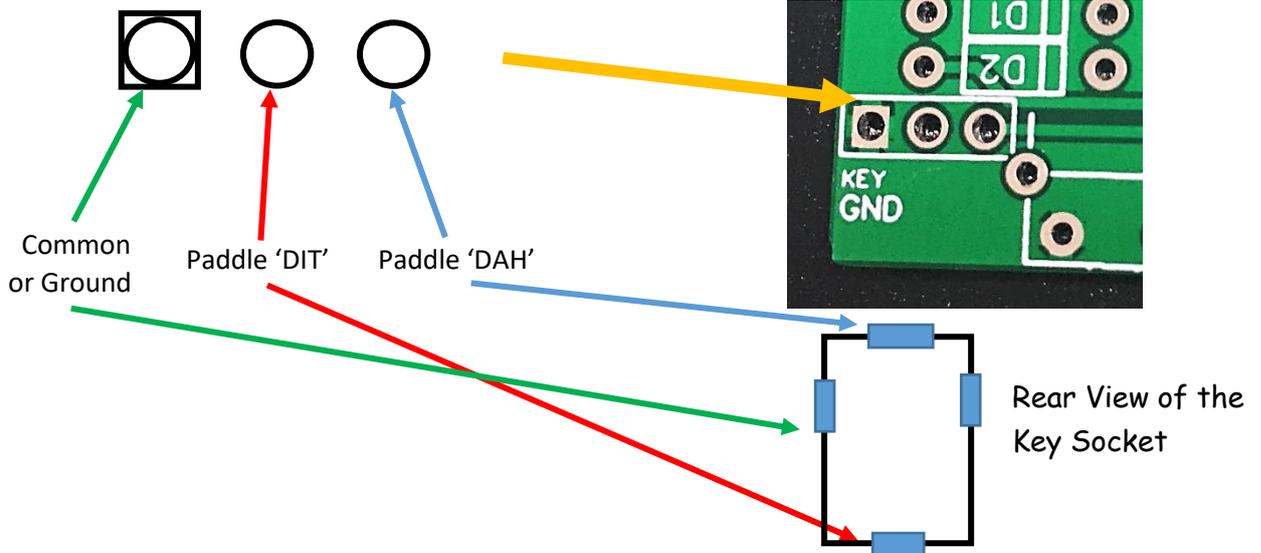


Check the board fitting, at this stage you should not have any problems, the LED legs will fold back, just make sure that they do not short on each other. Now remove the board, we have to wire the sockets.

Now we have to wire the key socket to the board. I have supplied a few short lengths of wire that can be used for this.



Next to the mode switch you will see three holes marked Key. This is the connection point for the key, the square pad is the GND or common pin for the key and the other two are the left and right paddle connection points.

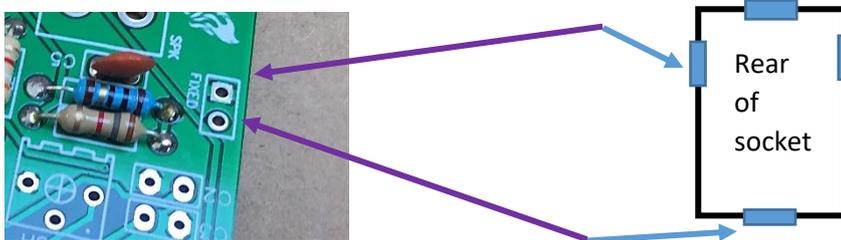


The wires to this socket do not need to be long, just about 60mm will do it nicely.

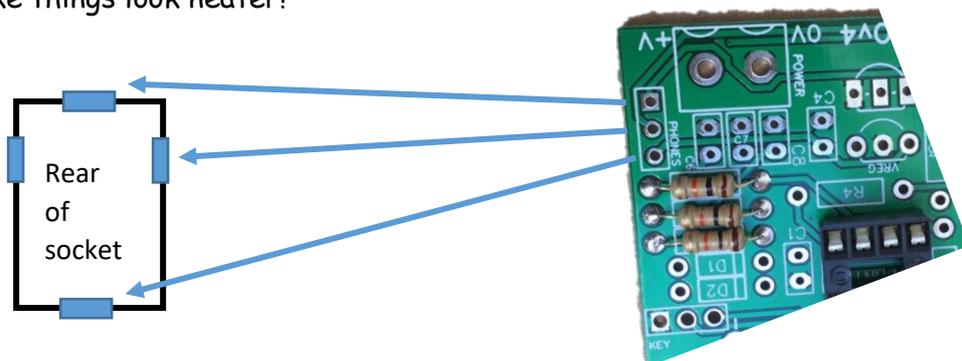
Now we can wire the AUX output and headphone socket

The AUX output is two wires that connect to one of the 3.5mm sockets, the wiring is as shown here. These wires should be about 150mm long.

Wire as shown below. (colours of wire provided may be different from shown)



Next wire the headphone socket, again leads about 150 mm long. Twist the wires together to make things look neater!



Now fit the control chip, it's a small microcontroller type chip called an ATTINY85. An amazing little high performance chip that can do a lot for its size. The chip if you look carefully, has a small dot near one pin. This dot tells you which is pin 1. The Pin 1 end of the chip should be nearest to the blue trimmer.

Now fit the PCB into the case and attach the sockets into the holes made for them.

The pictures below show the MK3 board being fitted but the instructions are just the same for the new MK4 board, the only difference is that there is an extra hole in the case that the switch protrudes through.

Fit the Key jack first BEFORE the PCB.



Once you have fitted the key jack then push the PCB in place making sure the LED (and push switch) is seated in their holes, use the washers and nuts provide to secure the board. You will have a little 'jiggle room' to make sure the switch is not trapped against the edge of its hole.

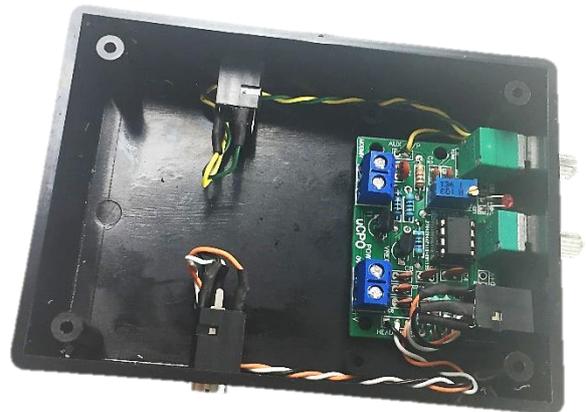
Next we need to fit the AUX and Headphone sockets.

Tuck the wires as shown.

Now connect up the battery clip and speaker as shown here, there is a foam strip provide that should be stuck either just under the battery pack or just below the speaker to stop the battery from moving around.

Finally place the back plate on the case and secure with the screws provided. You may note that the speaker is not centre on the back plate, that is to give it a couple of mm clearance from the two blue terminal blocks on the PCB, try the lid both ways to find the best fit, you may find it fits fine both ways anyway.

Now you just need to push the control knobs onto the control shafts, if the knobs seem loose you may find that the slot in the shaft of the control has been closed a little, place



the tip of a flat blade screwdriver into the slot and **very gently** re-open the slot a slight amount, be careful we don't want to break the shaft and only a tiny amount of pressure will be needed to open it the fraction we need. Finally If not already fitted apply the top panel label and the four stick on feet.

Time to test the uCPO

Turn on the uCPO by turning the volume control, you should hear a click from the control and the LED should light up, if it doesn't light up turn off the power and double check everything including the wires in the terminal block from the battery clip. If you have a test meter check that (9V is getting to the terminal block on the board). One of the most common 'faults' is that the battery clip wires are not making contact.

Hopefully you have no problems. Press the mode switch, you should hear the letter A in Morse, if you hold the switch this will keep repeating, try adjusting the speed control while doing this and try the volume control too. If all works we can move on.

Full instructions on how to setup the uCPO and how to use it are in the first 5 pages of this document, go and read them again.

The uCPO should provide many years of service and I hope that you find it a worthwhile project to build.

73 Paul

International Morse Code

- 1 dash = 3 dots.
- The space between parts of the same letter = 1 dot.
- The space between letters = 3 dots.
- The space between words = 7 dots.

A	• —	V	• • • —
B	— • • •	W	• — —
C	— • — •	X	— • • —
D	— • •	Y	— • — —
E	•	Z	— — • •
F	• • — •	.	• — • — • —
G	— — •	,	— — • • — —
H	• • • •	?	• • — — • •
I	• •	/	— • • — •
J	• — — —	@	• — — • — •
K	— • —	1	• — — — —
L	• — • •	2	• • — — —
M	— —	3	• • • — —
N	— •	4	• • • • —
O	— — —	5	• • • • •
P	• — — •	6	— • • • •
Q	— — • —	7	— — • • •
R	• — •	8	— — — • •
S	• • •	9	— — — — •
T	—	0	— — — — —
U	• • —		

Prosigns

(.)	• — • — • —
(.)	— — • • — —
(?)	• • — — • •
(/)	— • • — •
(=)	— • • • —
(AR)	• — • — •
(BK)	— • • • — • —
(CT)	— • — • —
(VA)	• • • — • —
(KN)	— • — — •