Phoenix CW Trainer Key TK-20

The Phoenix CW Training key is designed to serve two purposes, the first is to act as a practice key to improve your sending. The second is to also act as a Morse tutor too.

Bespoke software allows a lot of functionality. With just two knobs and the key you can change the tutors WPM rate, the oscillators pitch, the gap between characters and of course the volume to the built in sounder.

The batteries are mounted at the rear of the key making it completely self-contained.

The key is a nice little low cost project that would be ideal for clubs running the novice train course or any buildathons. It needs both soldering and mechanical construction to finish the kit but should be well within the scope of any one that takes care and follows the instructions.

The key uses a small but powerful micro controller loaded with my own bespoke software. I don't believe that I have seen anything like this before.

The Tutor mode as 5 different modes, all random.

Random Letters
Random Numbers
Random Prosigns
Mixed mode
International Callsigns (In this mode the Pitch and speed will change by upto 15% to make this more challenging.

First let's check we have all the parts:-

Parts List

Base PCB
Key Top PCB
Flange PCB
AAA Battery Holder
2 x Control potentiometers c/w Knobs
4 x 10mm Brass standoffs
4 x 16mm Black M3 Screws
4 x Black M3 Nuts
2 x M3 Steel Nuts
1 x 14mm M3 Steel Screw
1 x 6mm M3 Steel Screw
1 x 12mm Flat Steel Washer
1 x White Insulator Washer
1 x 3mm White Spacer
1 x Black Cap
5 x M3 Fibre Washers
1 x ATTINY85 PT-20 Chip
1 x 8 pin Dip Socket
1 x Dual Colour LED
1 x Miniture Sounder
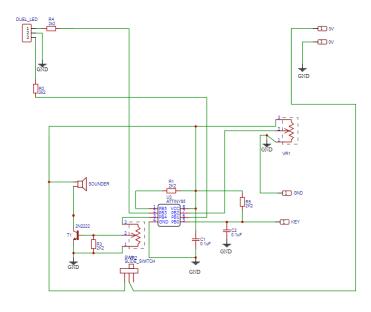1 x 2N2222 Transistor
1 x 2 way PCB Slide Switch
3 x 3k9 $\frac{1}{4}$ Watt Resistors
2 x 1k $\frac{1}{4}$ Watt Resistors
2 x 0.1uF Disk Capacitor
Sticky Pad

The Circuit

Please note the circuit and the Base PCB do not have a capacitor C2 this was removed in the prototype but unfortunately not updated on the capacitor ID's. The only two capacitors are Marked C1 and C3

C1 & C3 are both 0.1uF Disks

Building the Training Key

Building the key is straight forward and is an interesting project that combines both mechanical and electronic aspects.

Let's make a start on the Base Panel

Let's start with the IC socket, make sure you fit it as the layout on the PCB.

Next Find the little slide switch and fit that, this is a tight fit so take care not to bend any pins. You only need to solder the 3 pins in the centre, the outer metal pins are not connected and just locate the switch correctly on the board.

Now fit the resistors.

I have just made a change to these and now they are a different value than the pictures here, details of the new values are below so just follow the instructions.

The resistors can be fitted either way round. The picture above shows an earlier version.

So fit them all now R1, R3 and R5 are all 3K9 resistors, (Not as the photo above)

R2 and R4 are 1K (Not as the photo above)

Now fit the 2 small disk capacitors C1 and C3 (note: there is no C2!)

Both capacitors are 0.1uF and can be fitted either way round.

Now I suggest fitting the M3 6mm Screw at the bottom of the board, this acts as the bottom contact for the key.

Now this screw will adjust the keys gap so I will suggest to start with take the screw and put 3 or 4 fibre washers onto the shaft (I use 4) . Drop the screw through the PCB so the head

and fibre washers are on the component side, attach the screw with the M3 steel nut provided.

After you test the key you may change the number of washers to adjust the gap if you need to but I find 4 washers is about right. You will have one washer spare so put that on one side for now, don't lose it.

Now fit the two control potentiometers, they too are a tight fit so do this with care, make sure that these controls are sitting straight before you solder them as it's hard to adjust this later. Solder the 3 pins then solder the support tabs.

Next fit T1 which is a 2N2222 transistor, make sure that this is fitted as per the outline on the PCB. This MUST be fitted the correct way.

Now fit the small sounder in the centre of the board, if you look at the sounders top you will see one side as a small 'Positive' mark, this should be nearest the top of the board.

Next find the small slide switch, this is to be fitted as shown on the left hand side of the board. You will only need to solder the 3 pins for the switch the other two lugs are only to steady the switch.

Now find the battery holder and the sticky foam pad, you will only get one go at this since the foam will rip if you try to remove it later. First let's do a dry run, drop the battery holder onto the board so the pins go through the two holes. Note how it sits, we need to make sure it sits nice and square. Now remove the holder and put the double-sided pads on the bottom of the holder. Firm down and then remove the film from what will be the PCB side. CAREFULLY put the holder onto the PCB but don't press it downright away, check that it looks square as you lower it onto the board. Once down press firmly on the base of the holder to make sure the foam pads sticks to the board. Now solder the two pins on the bottom of the board, these pins are very tough and will fly off at speed when you cut them so care must be taken while doing this. Use eye protection if you have it while soldering and cutting wires. I use an old pair of cutters for these pins as they need a lot more force to cut that the other parts. A tip, don't try and cut them with the front tip of the cutters, use the bottom of the cutters which tend to be more heavy duty that the tip and less chance of damaging your nice cutters too. I have pre-cut them anyway so you may find the length is ok for you if you don't want to cut them more.

Now we will move onto the top panel, by the way I haven't forgotten the LED, don't fit that yet!

Find the following parts:-

Key top panel
The black flange disk
The plastic Knob
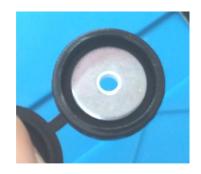3mm white Spacer
Plastic white Insulator

12mm Steel Washer
14mm Steel Screw
M3 Steel Nut
4 x 10mm Brass Standoffs
4 x 16mm Black M3 Screws
4 x Black M3 Nuts

First push the small white spacer into the hole on the large washer, its nice tight fit.

 Now put the washer with the spacer inserted into the top of the knob.

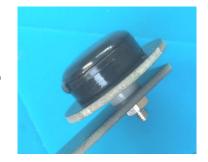This will click into place, this makes sure the knob is fitted in the centre of the flange.

Now find the steel 14mm screw and push that through the hole so the head is on top of the washer.
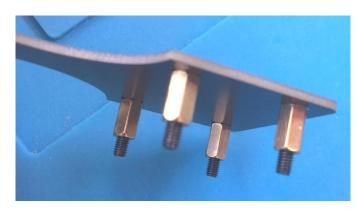
Find the flange, the 3mm white space, the Key top panel and a M3 steel nut.

Put the disk onto the screw and then the white washer, place this assembly onto the Key top panel through the hole at the end of the arm, look carefully at both sides of the key top panel and you will see that one side has a wide track running to the hole at the end of the key arm, this should be on the underside of the top panel. Make sure that the hinge part of the knob is correctly aligned. Rotate the knob and flange to get this alignment right before nipping up the screw and nut securing the knob. This screw also serves as the top 'contact' point for the key.

Find the four Brass 10mm spacers and the four black 16mm screws. Pass the screws through the top of the key panel and secure the spacers as shown.

That completes the top panel.

Now to assembly the key.

Now we need to put it all together, I haven't forgotten the LED so it's time to fit this. Push the LED though the bottom PCB, now the LED as 3 legs not two like most. That's because in fact it is two LED's in one package, a red one and a green one.

The longest leg is the centre pin, the other two legs are different lengths. See that the LED is fitted so the short leg is on the right hand side of the board (That's with the battery holder furthest away from you). If you get this wrong things will still work fine, the LED will be Green in practice mode and Red in tutor mode, Really it doesn't matter so don't worry about it too much if it turns out the other way.

Do NOT solder the LED yet!!!!!

Now if you haven't already fit the 8 pin controller chip (the brain of the project) make sure you fit this the right way round, if you look carefully on the top of the chip you will see a small dot near one pin in a corner. It's only a small dot and I must say I find it hard to see unless I have a lot of light. Make sure that the dot pin is nearest to the sounder.

With the LED just pushed into the board put the top panel on the key, you can tighten it down using the 4 Black M3 nuts. Remember that left over fibre washer ? Well we may need that to adjust the gap later if we decided to and its one of those things that you can be sure you will lose so put this washer under one of the nuts that fasten the top panel down.

Now push the led from the bottom of the back of the base PCB so that it goes as far forward though the 3mm hole on the top panel as it can. Once it's through then solder the LED legs.

Now fit the four stick on feet to the bottom of the base, the one near the battery holder pins will need to be a little further in than the others that can be fitted in each corner.

Double check the soldering at this point.

Now to test the key.

Insert the batteries, now before you do anything else look carefully at the batteries in the holder. I find that the holder since its new is a little tight and sometimes the batteries can be held in place and not pushed forward by the springs, this stops the positive tip of the battery touching the connection pad in the holder, just push each battery forward a little to make sure they are connected ok.

Now slide the power switch on.

After a second the LED will light red, this is NOT a simple power on indicator, the LED is controlled by the processor chip. When it lights Red it is in straight key mode.

Now adjust the volume and tap on the key, you should hear tone, don't worry about the pitch just yet.

If all good turn off the power switch,

Now we are going to setup the tutor WPM rate and the overall pitch.

This can be changed at any time you wish so you can change the WPM speed and pitch as you get more familiar with the Code.

To set these setting follow these instructions:-

Press and hold down the key, do not release it. While it's being held down turn on the power switch, the LED should now turn green. Carry on holding the key down, the LED will start to flash red then green and you will hear the letter 'A' in Morse code. The speed of this may be very slow or too fast, adjust the GAP/SETUP control to get a speed that you want for the tutor. (I suggest starting with around 12 WPM so set the control at the 12 O'clock position) When you're happy release the key. Now right away press the key and hold it down again.

The LED will remain Green now. Now adjust the GAP/SETUP control to set the pitch to your choice, you can set it in the range of about 400-1000Hz. Once you're happy with the pitch release the key the settings will be saved in the memory of the chip and will remain at these settings until you repeat the process. The tutor mode will begin.

You can now turn off the training key, its ready for use.

Just one point in case you find this without me telling you and you wonder whats happening.

After you set the pitch you are supposed to turn the key back off or you can just use it in tutor mode BUT if you press and hold the key down again right after you released it after setting the pitch and you hold the key down for about 4 seconds the unit will start to flash red/green and just send my callsign (M0BMN) continuously till turned off. This is just for copy protection purposes in case others copy the chip and claim it's their work!

How to use the Training Key

Now we have set the pitch and the WPM rate let's make a start using the key.

If you want to use it for sending practice it's easy, just turn on the key, the LED will light red and the key will just produce tone at the pitch you set when it's pressed.

If you want to enter tutor mode.

With the unit turned off press and hold the key down, turn on the unit and then release the key. The LED will be green and you're in tutor mode.

Adjust the volume to suit and then adjust the GAP control to a suitable setting for your abilities at this time, as you get better you may want to reset this speed but to start with give yourself as much thinking time between characters as you need. A word about the character speed (WPM rate). Do not make the mistake of setting the character speed really slow, you will start counting dots and dashes to decode the Morse, this is the wrong way to learn the code. The target is for you to be able to read the Morse you hear on air, no one send Morse at a very low character speed. To give you a good starting point I would suggest setting the speed around 12-14wpm, this should have been done in the setup stage above. That speed is found when the setup control is at about the 12 o'clock position when setting the WPM rate.

I don't expect you to jump in listening to Morse at 12-14 wpm to start with, so adjust the gap control now to give you the needed thinking time, the key will give you upto 4 seconds for this.

You can adjust this as you need to.

The key will be in Letters mode to start with. In this mode it will send random 5 character groups.

Press the key and hold it down for a second, the LED will change to red and you will hear the letter of the next mode.

'L' = Letters
'N' = Numbers
 'P' = Prosigns
'M' = Mixed
'C' =International Callsigns

In the last mode (Callsigns) the speed and the pitch will change by around 15% to make it more interesting and realistic.

As you improve you can revisit the setup and change the WPM rate as you need too.

The Training Key should provide many years of service and I hope that you find it a worthwhile project to build. Enjoy learning Morse and consider joining the best Morse Club in the world! FISTS. Take a look at the FISTS website www.fists.co.uk

73 Paul M0BMN