



## Advanced T20v2 CW Trainer



Many Years ago, when I learned Morse there was very popular electronic tutor called the Datong D70. The T20v2 is a modern version with many more features.

This is new version of the T20 Morse tutor project, after many requests it now has even more features.

Now the T20v2 will support BOTH Paddle and Straight keys in practice mode (Iambic A or B) and an additional fixed low level SINEWAVE output is

provided. This output can be connected to a PC for use in a number of ways.

The first is when its used with a software package such as CWGet, FLdigi etc you can check your own sending in practice mode, this way you can see how good (or Bad!) your sending really is. Another useful use for this output is to use the practice oscillator over Zoom or other internet streaming type services. This feature works with either a Paddle or Straight key.

The kit is easy to build and due to coming with pre-punched front and back panels a better finished product is assured.

Based on my design for the FISTS CW Club this tutor offers a wide range of features that you will find hard to beat. The tutor modes are:

Random Letters,  
Random Numbers and  
Mixed Modes

Random Prosigns,  
Random Callsigns,  
Random common words and abbreviations,  
Contest mode (More on that later)  
And even a practice oscillator and 10 Minute session timer.

The tutor is very simple to use, no pages of menus to navigate your way around, just one push button that changes the mode and 3 knobs, one for character speed, one for the gap between characters and finally a volume control.



Learning the code can be hard and you do need to stick to it, but don't spend too long per session, it's not beneficial. I suggest keeping to a 10 min session once a day, every day. To help you know when a session is up the tutor will illuminate a Green LED for 10 secs every 10 Minutes. This is a sign that you may need to take a break.

Now a note about the contest mode, ok what is contest mode? Well the tutor will send a typical contest type 'Over'. It will send a random callsign followed by a three digit serial number, finally a short random message ending such as 'GD DX', a 4 digit locator (Not necessarily the one for the callsign !), RST Report, or 'QRZ' etc.

That's all well and good but to add to the realism as much as possible the pitch between overs and also the speed will change randomly if you select the 'ACM' (Advanced Contest Mode) on the tutor's board (a two pin jumper enables it). You may want to start with the standard contest mode but you can change to ACM at anytime. ( I activate it all the time on mine and now the default setting for the T20)

The tutor will generate code from about 11 to nearly 30 wpm, if this gets too tame for you then you can push the tutor up to about 50WPM, another jumper on the main PCB selects this 'Hyper' mode.

In addition The user can now change the pitch of the tutor, hold the mode button in while turning on the power will allow the pitch to be changed, just hold the mode button in and adjust the Gap Control to adjust the tutors pitch, Once happy release the mode button and the new pitch value will be stored in the T20's EEPROM.

To select practice mode plug either a straight or Paddle key in, while the tutor is turned off, now either press and hold the left hand paddle or hold down the straight key, turn on the tutor and it will enter Practice mode. The T20 will now work as a practice oscillator for your key type. (Straight or Paddle keys) in Paddle key mode you will be in Iambic B mode by default but there is an Iambic A/B jumper on the main board so you can change between A or B modes. One more feature, if you are left handed (or just prefer it) you can set the paddle to reverse so the Dit is on the right and the Dah the left, on the PCB is a jumper marked DEV1, the latest software will reverse the paddle if this jumper is removed, the standard config for right handed use is with this jumper fitted.



**How to build the T20v2 First Read ALL the following instructions BEFORE you start.**

Let's start. Check you have all the parts before you start.

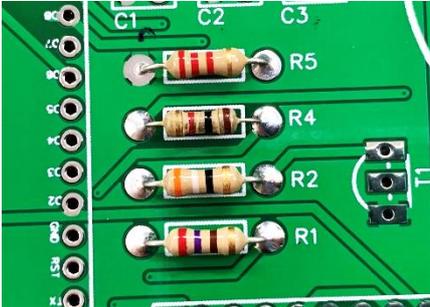
- T20v2 PCB
- Hammond case
- Front and Back Punched/Screen Printed Panels
- 4 x Stick on feet
- 2 x 15 way Socket Strips
- DC Power Socket
- 3 x 3.5mm PCB Sockets
- PCB 8 Ohm Speaker
- 9V Battery Clip
- 4 x PCB fixing Screws
- D1 1N4001( other 1N400x diodes may be provided)
- R1 270 Ohm ¼ watt Resistor
- R2 39 Ohm ¼ watt Resistor
- R3 10K Resistor Network
- R4 1K ¼ watt Resistor
- R5 2k2 ¼ watt Resistor
- R6, R7, R8 10K ¼ watt Resistor
- R9 1k8 ¼ watt Resistor
- R10, R11 3k9 ¼ watt Resistor
- C1, C2, C3 0.022uF disk Capacitor (Marked 223)
- C4 0.1uF disk Capacitor (Marked 104)
- T1 2N2222 (OR 2N2222A)
- U1 Pre-Programmed NANO Module
- 2 x 10K potentiometer
- 1 x 10K potentiometer with integrated switch
- 1 x Push Button
- 3 x Control Knobs
- 1 x 3mm Dual Colour LED
- 4 x 2.54mm jumpers
- 4 x 2.54mm 2 Pin Headers
- 2 x 2 way terminal blocks
- 2 x Foam tape lengths

***Prep step, and you would thank me for this if you had the problem later, find the speaker, put a bit of tape over the holes. This speaker has a magnet inside and having used a number of these I find it attracts just about ever off cut of wire in the workshop. The wire ALWAYS seems to get stuck inside and will cause a buzz on every dit or dah it produces later. Save yourself a lot of problems and take my suggestion seriously !***



The build of the Morse Tutor is straight forward and shouldn't present much in the way of problems.

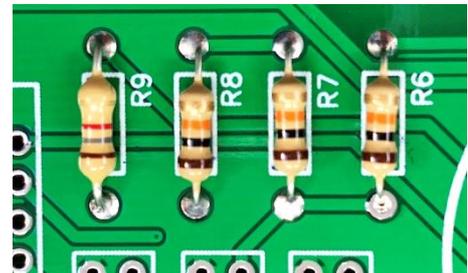
Ok lets get on with the build. First let's fit the resistors; R1, R2, R4, and R5



R1 is 270 Ohm (first two bands Red and Violet) ,  
R2 is 39 Ohm (be careful it can be mistaken for R10 & R11 as they look similar but the 39 Ohm resistor has only 4 bands Orange, White, Black, Gold)  
R4 is 1K (first two bands Brown and Black), and R5 is 2K2 (first two bands Red and Red).  
Resistors can be fitted either way round.

Next fit the second bank of resistors.

R6, R7, and R8 are all 10K (first two bands Brown and Black)  
R9 is 1K8 (first two bands Brown and Gray)  
Be sure to fit them in the right place.

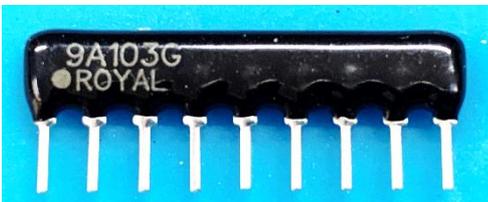


The next resistors are R10 and R11 both these are 3K9  
(bands Orange, White, Black, Brown, Brown)



Be careful, these can be mistaken for the 39 Ohm resistor, the first different you will see if you look at both is that these resistors have 5 bands , the 39 Ohm resistor has only 4 bands.

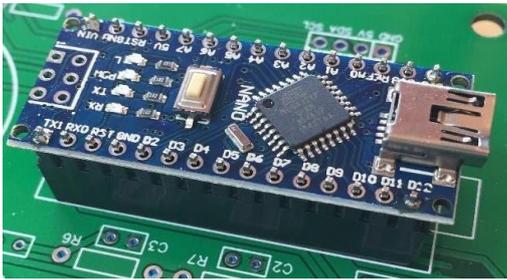
The last 'resistor' is R3, this is a block of resistors in one moulded lump!



This **MUST** be fitted the correct way. Look at the picture here and look at the resistor provided. You will see that on one side of the network there is some I.D. writing and a dot.

The side with these markings **MUST** be facing the front of the board, the 'Dot' should be next to the R3 mark on the board.





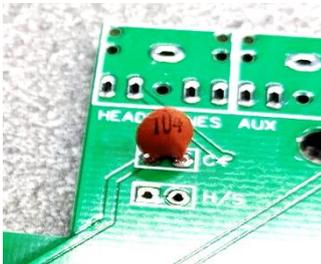
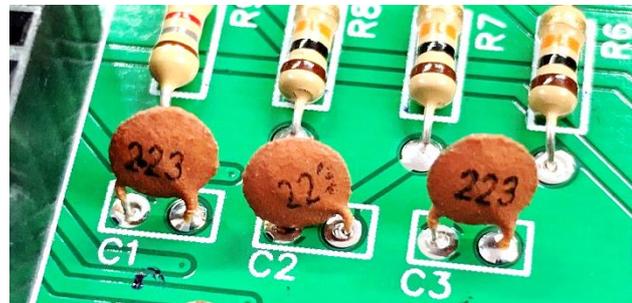
Next find your T20 Nano Module and its 2 x 15 way pin header's, Carefully push the socket strips onto the Nano's pins, put the Nano with its sockets in place on the PCB, make sure you are fitting it the right way round (look at the outline on the PCB), solder the two strips into place. (Note the picture here is the MK1 T20 but the idea is just the same.)

Just solder the 4 corner pins first and check the socket is sitting flush before soldering all the pins on top of the chip and under the board. You could just solder the two socket strips without the Nano being plugged in but this way make's sure the angle between the PCB and the sockets is right. You can unplug the Nano now if you wish. You did check you soldered all the pins!

Next fit the 4 capacitors .

C1, C2, and C3 are all the same value, 22nf (or also called 0.022uF) . They will be marked 223 on one side.

C4 is a 100nf (0.1uf) and will be marked 104 on one side



All the capacitors can be fitted either way round but I suggest fitting them so that the value is shown all on the same side. This makes it easier for fault finding should you need to.



Next we will fit the semiconductors, one diode and one transistor.

First we will fit D1, this is just a DC blocking diode. The part number of which will be 1N4001 or any 4000 sequence number between 1 and 7. (E.g. could be 1N4007)

Next we will fit the transistor, again the exact device number is not important it does need to be a GP NPN device, the normally supplied device will be a 2N2222.

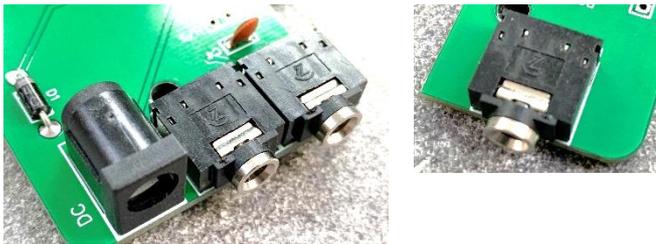




The transistor MUST be fitted as shown. The shape of the device is also shown on the PCB so make sure you

fit it as the printing on the board.

Now we can fit the sockets on the rear edge of the board. Start with the three stereo jack sockets. They will only fit one way round but make sure no legs are folded under when you push them through the board. When fitted move onto fitting the DC power socket.

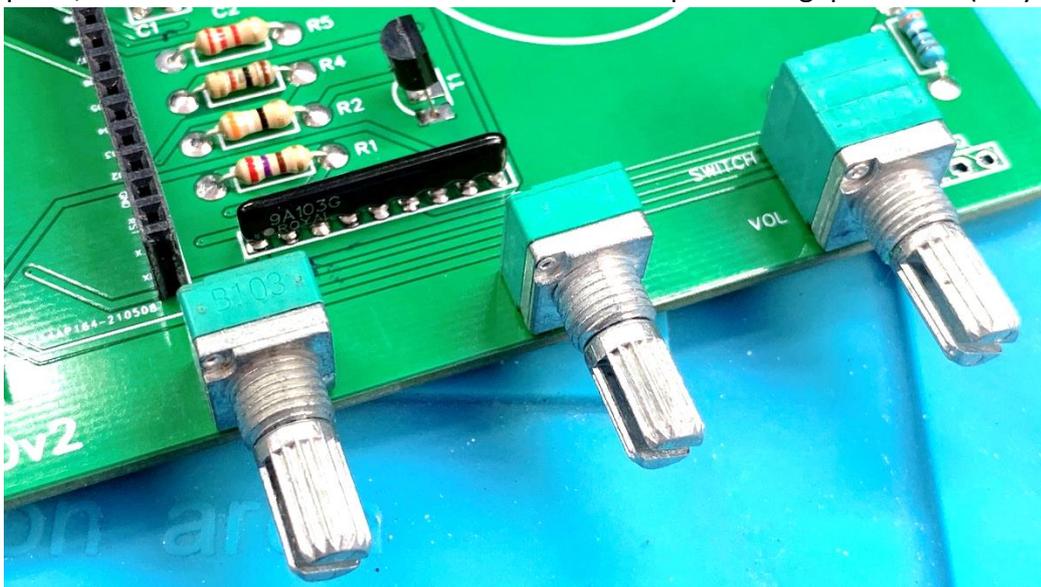


Now we can fit the three controls, Volume, Speed, and Gap. We must do a small modification to these controls first.

Each of the controls have a small metal tab that sticks out just under the shaft. We are not using this and we need to snap these off before fitting the controls. They snap off very easily. I use an old pair of cutters, hold the tag between the cutters blades and snap the tag off, you will not need to cut it and they snap without much effort. Do this for all three controls.

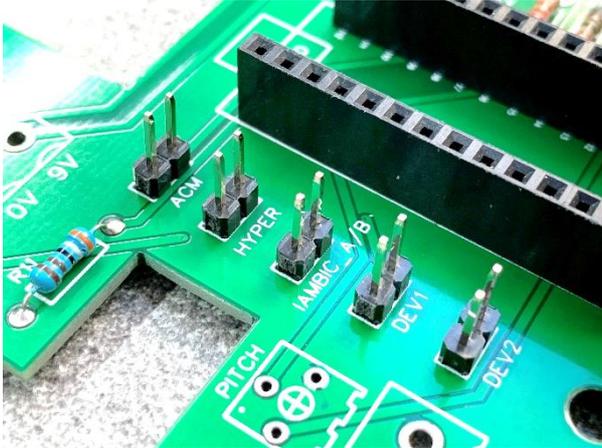


Now fit all three controls, the volume control also has a built in on/off switch and will only fit in one place, either of the other two can be used for the speed and gap controls (they are the same value)





Next we can fit the user option header pins, these pin will allow you to change certain features of the T20.

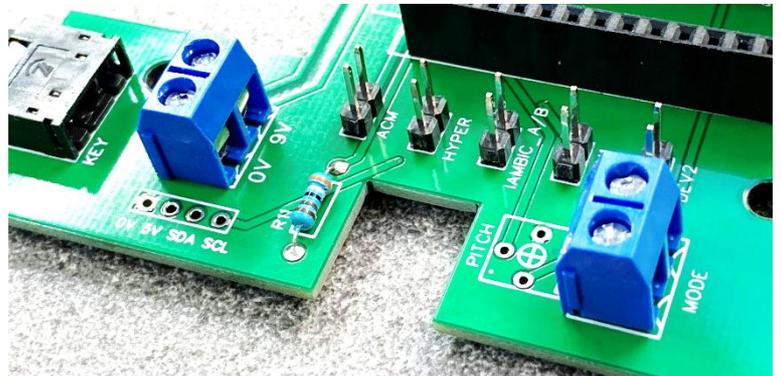


There are 6 pairs of header pins for you to fit, don't forget the one just behind the headphone socket.

We will fit the jumpers on these pins later and it will be up to you what options you want to set (don't worry I will give you a default setup If you're not sure about things)

Next fit the two blue two-way terminal blocks.

Make sure you fit these so that the open terminals are pointing towards the front of the board as shown here. *A tip, before you fit the main PCB into the case I suggest that you unscrew these terminals and put the tip of a small screw driver into the terminals opening, give it a little 'waggle' to open the terminal ready for the wire later.*



Now we can fit the speaker, leave the tape on that you put on earlier for now, I bet your work bench still has off cuts on it!

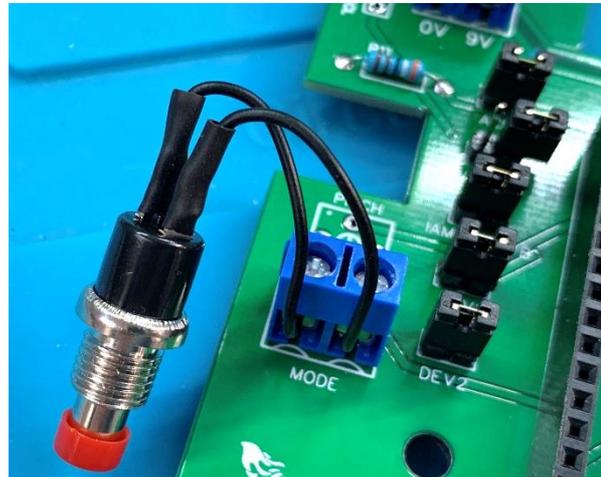
The speaker has a Positive marking near one pin, make sure that this pin is inserted where indicated on the PCB.



Now we can set the jumpers to the standard default configuration, you can change this if you wish but this is a good starting point for most people. (See the picture below)

Standard Jumper Settings:-

ACM :- ON  
HYPER : OFF  
IAMBIC A/B : ON  
DEV1 : ON  
DEV2 : ON  
H/S : OFF



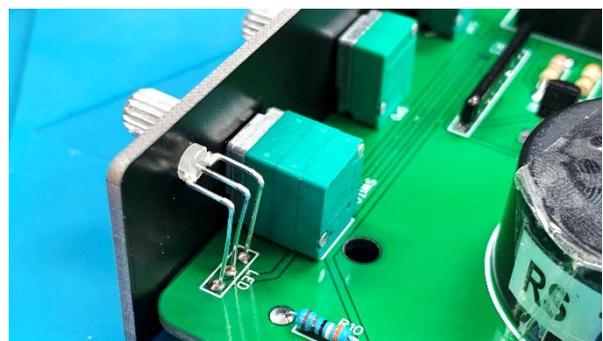
The jumper marked H/S is below the headphone socket, this selects external Headphones or external Speaker. If the jumper is fitted the socket marked headphones IS set for headphones, if you leave it off then you can use an external speaker with the T20, the jumper just bypasses an audio limiting resistor. Many people leave this ON but if you do be careful if you use headphones as it will be VERY loud at full volume. (That's why I default

Now lets wire the little push button mode switch, you should have a small length of wire and a inch or so of heat shrink. Attach the wire to this switch and I suggest (you don't have too) using the heat shrink to make a nice job of it. Leave about 50mm of wire on each pin and wire them into the front terminal block marked MODE.

Just behind the mode terminal block you will see a space for a pitch control, this is no longer needed as this is set in the software and the user can change it when they wish at anytime. (see user guide for full details)

Now things are getting interesting, find the front plate and the LED, do not fit the LED just yet. Remove the nuts and washers from the controls if you haven't already and pop the front panel over the controls, finger tighten the washers and nuts to hold the panel in place. Now look at the LED. You will see that the LED has 3 legs of different lengths, the shortest leg should be on the side nearest to the edge of the PCB. Push the led into the holes on the PCB and BEFORE soldering bend it so it protrudes though the front panel as shown below.

Now find the case and put one half which will be the bottom case in front of you and put the rear panel into the edge furthest away from you. Drop the PCB and front plate into this part of the case.





**Before** fitting the switch use the four small PCB mounting screws to fit the PCB into the case, check the positioning of the board from the rear to get the jack sockets lined up with the rear panel holes. Once happy put the spring washer on the button and push it through the front panel, carefully tighten the button with the supplied nut.

Now you will also have two lengths of foam tape, one will be wider than the other. Cut the length to

fit the cut-out in the PCB for the battery and stick the foam pad to the bottom of the case.

Now trim the battery clip leads to about 60mm and fit them to the rear terminal block, be careful that you put the wires in the right holes, the red is positive.



The battery can be fitted now. Find the top section of the case and the second foam pad, this is a little smaller than bottom strip. Look carefully at the bottom section of the case. You will notice that the two sides are different, one has a groove and the other a small protruding edge. Do a dry run and see which way round the top case section will fit. It will only go on correctly one way. When you are sure you know which way round the top fits stick the second foam pad on the case above the battery position.

Now remove the tape that you put onto the speaker! Tighten the nuts on the three controls. I have a nice nut spinner I use for this but you can do it with a normal spanner/pliers or even to be honest you can make sure that they are tight with your fingers, the PCB will hold them in place really. Fit the top case and turn over the unit. Fit the two long case screws and the supplied four rubber feet.

Now make sure all the controls are turned fully anti clockwise, fit the 3 control knobs so that the pointer is positioned just pointing at the '-' marks on the front panels. Now the knobs may be loose or very tight to push on. The shafts of the three controls have a long slot in them, they can be 'adjusted' to make the knobs fit nice. Be careful doing this as they can be snapped if you go at it with too much effort, use the tip of a wide screw driver if you need to tighten the knobs fitting and apply just a little pressure to open the shaft, if the knob is too tight then just a little squeeze of the shaft will do it for you, Do not go mad with this stage the smallest change will make a big difference.



Now we should be ready to test things. Set the speed control to about halfway, the gap control fully anticlockwise. Turn the volume control clockwise and you will hear a click and a second or so later the LED will light up. It will light green for a couple of seconds and then go red. You will also now be hearing the sweet sound of Morse.

Adjust the volume to suit. Press and release the mode button and the tutor will move to the next mode.

Now for full details of how to use the tutor read the T20V2 user guide. This is available on the web sites instructions page should you ever need a new copy.

I hope you have enjoyed building the T20 and I hope it helps you learn and improve your code. Any problems get in touch

[sales@kanga-products.co.uk](mailto:sales@kanga-products.co.uk)

73 Paul MOBMM



## T20v2 user Guide

### Modes: 7

- 1:- Random Letters (In 5 figure groups)
- 2:- Random Numbers (In 5 figure groups)
- 3:- Random Mix of Letters, Numbers (5 figure groups)
- 4:- Random Prosigns
- 5:- International Callsigns,
- 6:- Common Words and abbreviations.
- 7:- Contest mode, In this mode the pitch and the speed change by approx. +/- 15% to add to the realism and to make things less tiring for longer sessions.

### Controls:

Adjustable Volume

Adjustable Speed (approx. 8 to 30 WPM) Adjustable Gap (approx. upto 4 seconds)

### Practice Oscillator Modes:- Straight Key/Iambic A or B

Straight Key Input for use as a practice oscillator (3.5mm mono plug on key needed) and now a Iambic Paddle key practice oscillator (user selectable Iambic A or B , and Left/right handed paddle via jumpers on main board), of course the paddle key needs a stereo plug!

### Automatic 10 Minute session timer LED

### Aux output

Low Level fixed sine wave output for connecting to a PC running decoding software or for use over Zoom etc.

### External Connections:

DC Power (2.1mm Power Socket centre positive)

(7 to 15V although the tutor normally runs from a standard PP3 internal 9v battery) external 10v PSU is a good choice if using external power but make sure its regulated

Headphones / Speaker out socket (3.5mm mono or stereo) (Internal Speaker included)



## Using the T20

The T20 is refreshingly simple to use, no menus!

Turn the power/Volume control to start the tutor and that's it your away, adjust the gap and speed control to your preference and start improving your code speed. To change modes press and release the mode push button and you will hear a higher pitch Morse letter. L for Letters Mode, N for numbers mode, P for Prosigns, M for Mixed, C for Callsign modes, & CT for ConTest Mode.

The internal battery is a standard PP3 9v type and to replace it remove the two screws holding the case together and lift of the lid.

### To use the tutor as practice oscillator

To increase the tutor value it can also act as useful Practice Oscillator.

To use this feature plug your key into the rear connector, **hold the key down and turn on the tutor**. The microcontroller looks at the key input at power on and will detect the key now. It will automatically switch to straight key oscillator mode. If you're using a paddle then hold the **left** hand paddle when turning on the unit and it will start up in Iambic practice oscillator mode, the speed control on the front of the tutor will adjust the Iambic speed. There is also a jumper on the main board that will allow Iambic A or B modes (B jumper on by default) and another marked DEV1 that selects left or right hand paddle.

Word of warning....

The tutor uses an internal 30mm PCB speaker, this is great for normal personal use but some people would like to use headphones, if you do use headphones be careful with the use of the volume control. It can be very loud. There is a jumper on the main board marked H/S (headphones/Speaker), with the jumper off the volume level is limited to protect your hearing. Put the jumper on if you intend to use an external speaker.

**Changing the pitch of the tutor** is very simple. Turn it off, press and HOLD the mode push button while turning on the tutor. Do not release the button. You will now here a steady tone. Adjust the GAP control to change the pitch of the tone. When happy release the push button and the new tone will be saved and used from now on. You can change the pitch at any time you wish.

### Tips for improving your code speed.

It's very easy to fall into a common trap that can cause you problems with listening to real life Morse. Do not try to count Dits and Dah's to work out the letters. Start to learn the 'sound' of the letters from day one. Set the speed control to a realistic speed (I find setting the SPD control at the 12 O'clock position is about right to start with, about 14 WPM), adjust the GAP control to give you more thinking time. This way you will learn the characters at the right sound and although it may seem hard at first it will be easier when you listen on air (which is the point of learning the code isn't it). Spend about 10 minutes a session listening to code, much more than this isn't helpful. Take a break between sessions and you will come back fresh and ready to learn. The T20v2 has a 'Running' LED, This LED is also used as the session timer indicator, ever 10Mins the LED will change to bright green and remain so for



about 10 seconds, this is an indication that it's time to take a break, spending too much time in one session is not going to help. A couple of sessions a day would be great and will really help you learning of the code.

**Future expansion.**

There is an unused jumper, an internal trimmer position, and an I2C connection point on the main board to allow for future software upgrades. These are not being used in this current release.

Above all, enjoy it and enjoy using the T20v2 tutor. Good luck with learning Morse.

73 Paul M0BMM Kanga-products



## Morse Code

A	• —	N	— •
B	— • • •	O	— — —
C	— • — •	P	• — — •
D	— • •	Q	— — • —
E	•	R	• — •
F	• • — •	S	• • •
G	— — •	T	—
H	• • • •	U	• • —
I	• •	V	• • • —
J	• — — —	W	• — —
K	— • —	X	— • • —
L	• — • •	Y	— • — —
M	— —	Z	— — • •

### Numbers

1	• — — — —
2	• • — — —
3	• • • — —
4	• • • • —
5	• • • • •
6	— • • • •
7	— — • • •
8	— — — • •
9	— — — — •
0	— — — — —

### Prosigns

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