

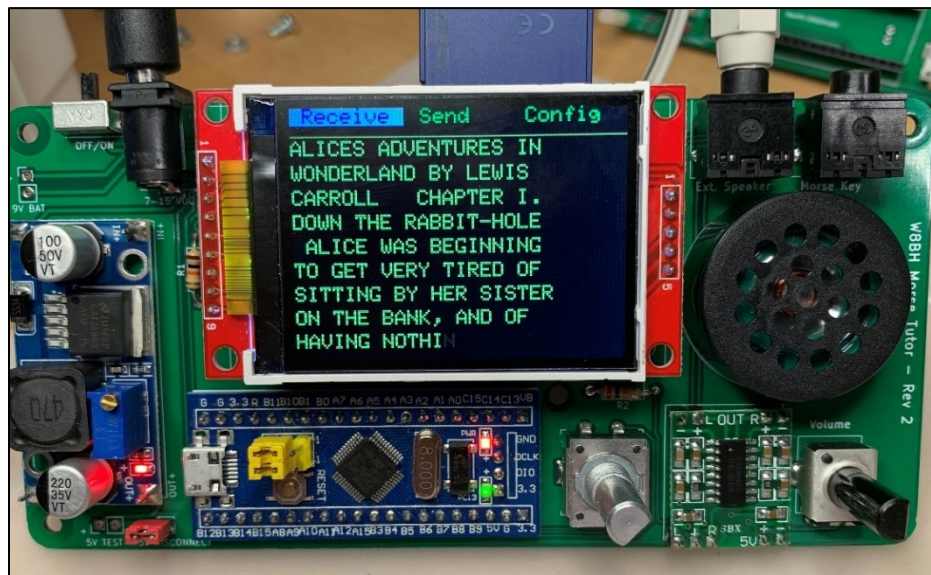
# Morse Code Tutor - From the ground up.

## Part 10: User Guide

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The [W8BH Morse Tutor](#) is a self-contained device for learning Morse code that you build yourself. It was inspired by the talk “Morse Code Tutor” that Jack Purdum W8TEE gave at FDIM 2019. The previous parts of this tutorial cover its coding and construction. This document is a user guide for the finished device.



The device consists of a single circuit board which contains a microcontroller, LCD display, speaker, and supporting components. It requires 7-15 VDC input @ 150 mA via a DC barrel connector (2.1mm, center-pin positive). You will need to supply a matching power adapter or other power supply. There are 1/8" stereo jacks for external speaker output and Morse paddle input. There is also a standard-size SD card connector for playing text files. There are two shafted components: the rotary encoder for feature selection and a potentiometer for volume control.

Currently there are two board designs. The first design uses the “Blue Pill” STM32 microcontroller. The second design uses the ESP32 microcontroller. The feature set for both boards is nearly the same, except that the ESP32 has a built-in WiFi radio that can be used for communication between two nearby Morse Tutor boards (see Two-Way Communication, below).

Please review the Hardware Connections and Quick-Start instructions on the next two pages. The remainder of the guide explains each feature in more detail.

## HARDWARE CONNECTIONS

### Power

The Power input connector is a barrel jack on the top side of the PCB. It accepts standard 2.1 mm ID/5.5 mm OD plugs with (+) DC voltage on the center pin. Choose a DC power adapter with 7V to 15V output. For example, Adafruit sells a [9V, 1000 mA supply](#) for \$7 which works very well.



A 9V battery may also be used instead, however do not expect it to last more than an hour or two. The Morse Tutor draws about 150 mA current.

### Morse Key

A jack labelled “Morse Key” on the top side of the PCB is the point of connection for your key, bug, or paddles. It will accept an 1/8” or 3.5mm stereo (TRS) audio plug. For a straight key or bug, connect one wire to the plug “Tip” and one wire to the “Sleeve”. For paddles, the common paddle connection (or base) should connect to “Sleeve”, the dit-paddle should be connected to “Tip”, and the dah-paddle should be connected to “Ring”.

Regarding prewired TRS audio cables, red is usually “Ring”, and black or bare-wire is usually “Sleeve”. The remaining wire, which may be just about any color, is Tip. Unfortunately, there is no standard. TRRS cables have an additional ring on their plug and should be avoided.



### External Speaker

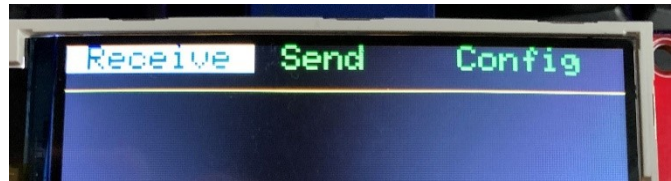
A jack labelled “Ext Speaker” on the top side of the PCB is the point of connection for an external audio speaker. When an 1/8” mono or stereo plug is inserted into this jack, audio from the device is shunted from the built-in speaker to the external speaker. The external speaker should be connected to the “Tip” and “Sleeve” contacts of the plug. Audio output is mono. The on-board amplifier is capable of providing room-filling sound with a suitable speaker. A 3W, 8-ohm speaker is recommended. A single, non-powered computer speaker also works well. Do not use a powered speaker.

## QUICK-START GUIDE

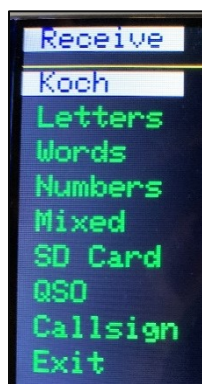
1. TURN IT ON To operate the unit, apply suitable power via the barrel connector. Turn on the switch in the top-left corner of the board. You should hear the Morse letter 'R' through the on-board speaker. Adjust the volume as needed. The screen should light up and display a welcome message within a few seconds. You will see a three-item menu at the top of the display.
2. CHECK OUT THE MENU. The various functions and features of the Morse Tutor are selected using the rotary encoder. Turning the shaft clockwise will scroll the top menu to the right, and will scroll vertical menus downward. Turning the shaft counterclockwise scrolls the menus in the opposite direction. The current menu selection is highlighted. Pressing the encoder button on a top menu selection will show the corresponding drop-down menu. Press the encoder button on a drop-down menu to select the highlighted item. See the next page for a description of the menus.
3. TRY SOMETHING. For example, to listen to random words in Morse code, go to the Receive Menu and select Words. To quit, press the encoder button.
4. CONFIGURE IT. Go to the third choice in the top menu, 'Config'. Here you will find options for setting the code speed, changing the pitch of the audio output, configuring your key/paddle, and entering your callsign. The default configuration is a speed of 13 WPM at 1200 Hz pitch using paddles in iambic Mode B. Each of the configuration settings is explained below.
5. USE IT. If you are a beginner, try starting with the Koch lessons. These are the first item in the Receive menu. After the Koch lessons you can do the remaining exercises in any order. We all learn in different ways, so the Morse Tutor gives you several different options for sending and receiving practice. Receiving exercises include Koch method, Letters, Numbers, Mixed, Words, SD Card, QSO. Sending exercises include Practice, Copy One, Copy Two, Head Copy, and Two-way. The next page will give you a brief overview of these features.

## MENUS

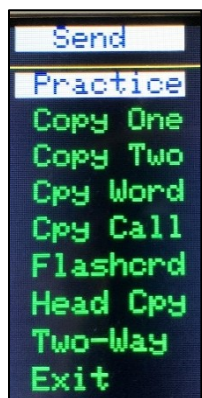
The menu consists of a 3-item, horizontal bar on top of the display. The current item, "Receive" is highlighted in white. Use the rotatory encoder to move between the three choices.



Press the encoder button down to select an item and a vertical drop-down menu will appear. Again, use the rotary encoder to move between the choices, and press the encoder button to make your selection.

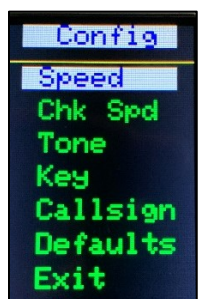


**The Receive Menu** contains choices associated with receiving, or listening to Morse Code. "Koch" is a series of lessons meant for the beginner. "Letters", "Words", "Numbers" let you listen to characters of those types. You can pause or change the speed while you listen. "Mixed" presents random characters that include all of the above. "SD Card" lets you listen to text files stored on an SD card. "QSO" lets you listen to a typical code transmission that a ham might send on the air. "Callsign" lets you practice listening to random US callsigns.



**The Send Menu** contains choices that pertain to using your key to send Morse code. Beginners can start with "Copy One": listen to a random character, then try to send it with your key. "Copy Two" does the same thing, but for two characters at a time. As you get better sending, try "Copy Word" and "Copy Call". "Flashcard" is more of a listening exercise, where you listen to a character and say it before the answer is given on screen. Flashcards is meant to get you prepared for the challenging "Head Copy", in which you must listen to the word being sent (no screen prompts) and send it back. Each of the exercises shows your score. See how well you can do!

Finally, the ultimate test is a two-way conversation. Use this feature for wireless communication between two units (ESP32 only).

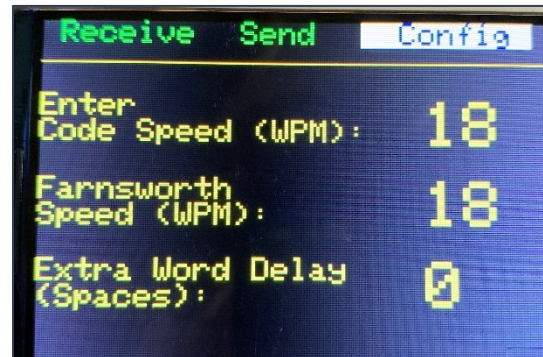


Use options in **the Configuration Menu** to tailor the device to your needs. "Speed" contains several options that control the rate at which Morse Code is sent and received. "Check Speed" accurately measures Morse Code speed using the options you selected. Use "Key" to select the type of key you are using and the keyer mode. "Callsign" lets you customize the startup screen with your callsign. Finally, "Defaults" removes your customizations and returns the device back to its original configuration.

## CODE SPEED

Menu: Config -> Speed

There are three settings for speed: code speed, Farnsworth speed, and word spacing. Code speed is the most basic setting, and determines how fast each character is sent. The default is 13 WPM, but you want to learn faster code than that, right? Try setting it to a higher value!



Next is Farnsworth speed. The Farnsworth method uses a fast character speed, but increases the space between characters to reduce the overall speed. For example, if you want to be able to copy 30 WPM code, try setting the code (character) speed at 30 WPM, but reduce the Farnsworth speed to 15 WPM. The characters will still be sent at 30 WPM, but the increased space between characters will reduce the overall speed to 15 WPM. Once you master code at this level, gradually increase the Farnsworth speed until it matches the code speed. You cannot set a Farnsworth speed faster than the code speed.

The last speed setting is word spacing. Once you master the sound of each character, try mastering the sounds of words. The idea is similar to the Farnsworth method: Set your target code speed, but with added space between each word. Try 5-10 spaces to start. Each unit corresponds to one word-space (7 dit-spaces). As you master the words, reduce the word spaces to 0 (normal spacing).

Example 1: You are just starting to learn Morse Code. You would like to eventually be able to copy 20 WPM. Try this: Code Speed = 20 and Farnsworth Speed = 13 WPM.

Example 2: You are at 20 WPM and want to run with the big guys at the bottom of the band. You want head-copy. Try this: Code Speed = 35 WPM. Farnsworth = 35 WPM. Word Spaces = 10. Too fast? OK, try something less aggressive. You decide.

No matter what settings you use, you can check your overall speed with the Speed Check function (Menu: Config -> Spd Chk). It will measure the amount of time required to send the word 'PARIS', using the settings you've chosen, and display the result in WPM.



## PITCH

Menu: Config -> pitch.

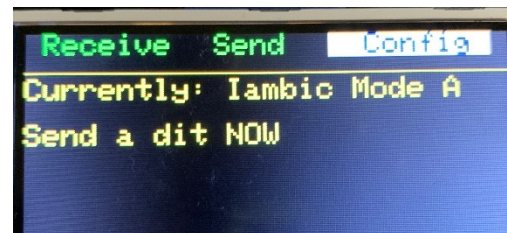
There is no correct pitch. Some like 600 Hz tones, others like 400 Hz, other like 1200 Hz. It depends on user preference as well as the characteristics of the speaker/headphones being used. Use this setting to change the frequency of the speaker tones. Turn the encoder counter-clockwise to decrease the frequency and clockwise to increase the frequency. Press the encoder button to save and quit.



## KEY

Menu: Config -> key

Use this function to select straight key vs paddle input. Connect your key via the jack marked 'Morse Key' using a 1/8" or 3.5 mm stereo plug using the instructions provided on page 2. Don't worry if you get the connections reversed: you can use this function to configure them correctly.



The current key mode is displayed when you first enter the function. If you are satisfied with this setting, press the encoder button to exit.

To change your settings, send a dit when instructed. Send another dit if using a straight key, or a dah if using paddles. Finally, if using paddles, send another dit for Iambic A or a dah for Iambic B. That's it: you key is now configured for use.

## CALLSIGN

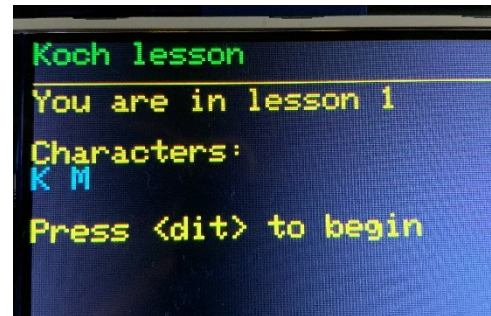
Menu: Config -> Callsign

Use this function to enter your callsign. The callsign you enter is displayed on screen when you power-on the device. Your callsign is also used the QSO feature.

## KOCH METHOD

Menu: Receive -> Koch

If you are learning code for the first time, consider trying the Koch method. This method was invented by Ludwig Koch in the 1930's as a rapid way to learn Morse code. To use it, try setting your code speed at 20 WPM and the Farnsworth speed at 13 WPM or more. The method consists of a series of lessons. The first lesson teaches you to recognize just two characters: K and M. Each lesson introduces a new character. There is a nice write-up on the method at <https://www.qsl.net/n1irz/finley.morse.html>



Start the lesson, and as you hear each character, write it down. Concentrate on the sounds. Don't watch the screen. A full screen of characters will be sent. When it is done, compare your list to what is on the screen and grade yourself. A successful practice session is a score of 90% or greater.

The key to this method is grading yourself. Don't skip it. If you score 90% on two or more consecutive sessions, advance to the next lesson. Otherwise repeat the session until you do. There is no shame in repeating!



At the end of each session you have several choices. To quit, press the encoder button and your current lesson level will be saved. To repeat the lesson, press the dah paddle. To advance to the next lesson, press dit.

Finally, at the start of each lesson, you can rotate the encoder knob counter-clockwise if you wish to return to a previous lesson.

## LETTERS

Menu: Receive -> Letters

Random letters are presented to you in blocks of five characters, similar to the final Koch lesson, but there is no scoring (Hurray!) and no lesson 'end'.



Receive	Send	Config
HIMFU	OKLFM	XBEZX
ISQNH	BKQOR	GVEQO
JZBYB	TUXLU	TBCIA
IGWNO	OWTYZ	

For the LETTER lesson, and all other receiving lessons, you can listen as long as you like. To pause, send a 'dit'. Send another 'dit' to resume. You can also speed up or slow down the code speed while the lesson is playing by turning the rotary encoder. Press the encoder button to quit.

## NUMBERS

Menu: Receive -> Numbers

Random numbers are presented to you in blocks of five characters. You can pause, resume, speed up, and slow down the lesson. See LETTERS, above.



Receive	Send	Config
43869	03703	37928
41185	56149	92366
81128	99525	71841
239		

## MIXED

Menu: Receive -> Mixed

Random letters, numbers, and punctuation marks are presented to you in blocks of five characters. You can pause, resume, speed up, and slow down the lesson - see LETTERS, above.



Receive	Send	Config
@K<5N	9PPUH	0A@45
D5WWE	3;7@5	C6PJI
P097S	NJBNN	LDRJ9
7TH=K	Z88K	

## QSO

Menu: Receive -> QSO

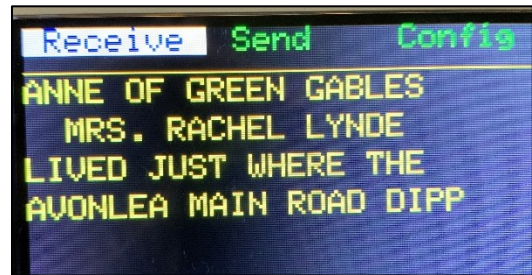
You will listen to the first part of a typical CW transmission, as if another ham has just answered your CQ. The practice includes an RST report, name, and QTH. You can pause, resume, speed up, and slow down the lesson - see LETTERS, above.



## SD CARD

Menu: Receive -> SD Card

Listen to text on an SD card. To use this function, format a standard-sized SD card and load it with a text file that you want to hear. This file could be a W1AW broadcast, a CW lesson from another source, a news article, your favorite novel, etc. The file should only contain straight ASCII text (UTF-8 is also OK, but non-ASCII text, special symbols, punctuation, and diacritical marks will be ignored). The name of your file should be in DOS 8.3 format, such as "EXAMPLE.TXT". Specifically, do not use a filename longer than 8 characters with a 3-character extension; these will cause errors.



Put the text file(s) into the root directory of your SD card. Files in other directories will be ignored. The Morse Tutor will recognize the first 20 files in the root directory.

The function starts by displaying a list of the files it finds on the SD card. You will see a blank (or nearly blank) screen if the Tutor cannot read the card.

Use the rotary encoder to scroll through the list. Press the encoder button to start the selected file. You can pause, resume, speed up, and slow down the playback - see LETTERS, above.

If you are using paddles, you can also 'skip forward' while listening to text: squeeze the paddles together, a break character will sound, and the Tutor will skip the next 250 characters.

## SENDING PRACTICE

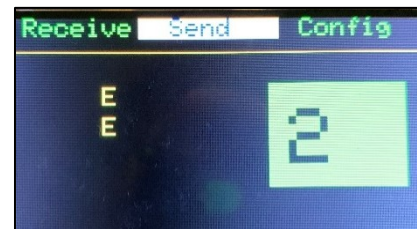
Menu: Send -> Practice

Use this function to practice sending Morse Code. There are no rules here: use your paddles or straight key and starting sending. The built-in decoder will read your input and attempt to convert it to text. Use the displayed text as an indication of your sending accuracy. If the decoded text does not seem correct, make sure the code speed setting *approximately* matches your sending speed.

## COPY ONE CHARACTER

Menu: Send -> Copy One

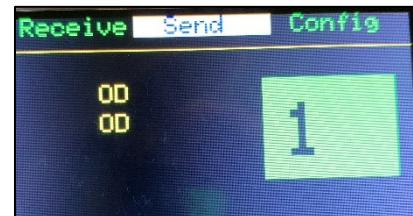
The Tutor will prompt you with a random character and wait for you to repeat it. If you repeat the character accurately, your 'score' increases by one. Miss a character and your score is reset to zero. See how high you can go. I thought I was doing well at 30 until my friend got a score of 110. After you master "Copy One", try "Copy Two" below.



## COPY TWO CHARACTERS

Menu: Send -> Copy two

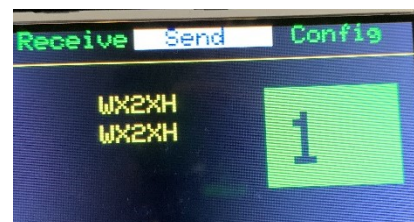
The Tutor will prompt you with two random characters and wait for you to repeat them. If you repeat both characters accurately, your 'score' increases by one. Miss a character and your score is reset to zero. See how high you can go.



## COPY WORDS

### COPY CALLSIGNS

These features prompt you with words and callsigns, but otherwise work the same as Copy One, above.



## HEAD COPY

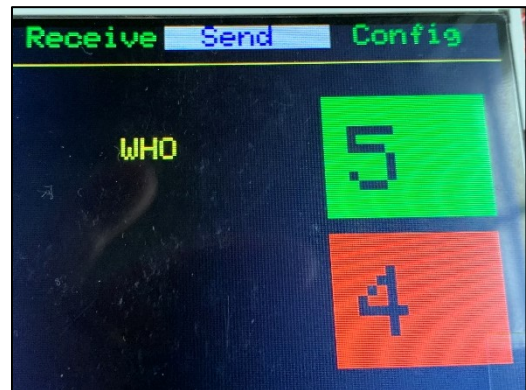
Menu: Send -> Head Cpy

Head Copy is a challenging and fun way to test your Morse code skills!

In this exercise, the Tutor sends random words in Morse *but does not display them on screen.*

You must listen carefully, recognize the word, then resend the word with your key.

Correct answers are scored in green, and incorrect answers are scored in red.



The current word will repeat until you get it right. So, if you missed it and you want to hear it again, send a 'dit' (E) – or anything else. If you can't get the word and want to move on, send the break character (\_...\_)

This exercise requires both listening comprehension and sending ability. Don't be discouraged if your "red score" is higher than your "green score". Over time you will see your score slowly improve.

Head Copy is designed to emphasize listening, not seeing. The scores, while still displayed, are accompanied by "hit" and "miss" tones. Try not to look at the screen. You will hear if you got the answer right.

Easter Egg feature: you can use the same scoring method on Copy One, Copy Two, etc. For example, when selecting Copy One, keep the encoder button pressed for more than a second. The first item sent will be a practice character that doesn't count. Subsequent items will be invisible and will use the green/red scoring method.

## TWO-WAY COMMUNICATION

Menu: Send -> Two Way

Use this function to have a real, wireless QSO between two Morse Tutor devices. It uses the WiFi radio in the ESP32 module to wirelessly transmit and receive. This function is only available on the ESP32 version of Morse Tutor.

The units must be located near each other. The range is similar to other WiFi devices: a few rooms away, or upstairs-downstairs, or inside-house-to-back-yard. Units separated by multiple walls and/or more than 100' will not reliably connect. The units do not require an existing WiFi router. They do not use or need an internet connection.

Place the two units in a suitable location. The first unit to start Two-Way will search for another unit. If it doesn't find any it creates its own "WiFi access point". I think of this as a base station. A small gray square in the right-upper corner of the display indicates the unit has established itself as an access point and is waiting for another unit to connect.

When the second unit joins, it establishes a connection with the first unit. On successful connection, a small green square will appear in the upper-right corner of the screen on both units. This indicator will stay green for the life of the connection. The indicator will turn red when the connection is lost.

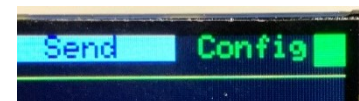
You can begin your QSO when the indicator has turned green. Communication is full duplex so both units will simultaneously send and receive.

Text that you send will be appear in white, while text that you received will be in green. The units do not need to be at the same code speed.

Note: the current software gets "confused" if you restart this feature out of order. In other words, if you stop and then restart a session between two units, please start the units in the same order as was used previously.



*Waiting for connection*



*Connection established*



*Connection Lost*

## KOCH WORKSHEET

Letters: \_\_\_\_\_

[illegible]

Letters: \_\_\_\_\_