

CTR2-MIDI

Operation Manual

v2.00.02



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Updated to firmware v2.00.02

Revised sections for this version are highlighted in yellow

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Introduction

CTR2-MIDI (called the *MIDI* in this document) is a small radio controller designed for ham operators. It utilizes dual-boot firmware similar to CTR2-Flex/CTR2-Dial.

Booting into the CTR2-MIDI firmware allows you to control MIDI enabled radio control apps using Bluetooth or USB MIDI control.

Beginning with v2.00.00 firmware, you can choose to boot into **CTR2-Flex WiFi** mode. In this mode, the controller connects directly to the network server in your Flex 6xxx/8xxx radio over WiFi allowing you to control it using the Flex API. This mode works with any version of SmartSDR, including the Windows version. It does not, however, support SmartLink for remote control. **CTR2-Flex WiFi** mode is covered in the [CTR2-MIDI Flex Mode Operation Manual](#).

CTR2-MIDI is an ideal companion for all of Marcus Roskosch's (DL8MRE) apps for [iOS and MacOS](#) and is also at home working with [Thetis](#) or Simon Brown's [SDR-Console](#) to control your Apache Labs ANAN or Hermes Lite 2 (among others) on your Windows computer. It's also a great addition for those that use [Remote Ham Radio](#).

In CTR2-MIDI mode, MIDI commands sent by the *MIDI* can be used to change frequency, mode, volume, CW speed, control the keyer and PTT, and many other functions in the app. The *MIDI* only sends commands to the app. It has no idea what the app or radio is doing. Function mapping must be done in the radio control app.

The app manages the user interface and the connection to the radio. The *MIDI* can be powered from the computer's USB port, and iOS device's accessory jack using an OTG adapter (also referred to as a Camera Adapter), a 5-volt cell phone charger, or a USB battery pack making the *MIDI* an idea companion for portable operation. You can turn the Bluetooth radio off to conserve battery power when using USB MIDI.

The *MIDI* can use USB MIDI when powered by the device running the app. If the *MIDI* is powered separately, you can use Bluetooth-LE MIDI to connect it to the app.

This photo shows the *MIDI* controlling SmartSDR for iOS while being powered by the phone though a Lightning OTG adapter. A charger or USB battery can be connected to the OTG adapter's Lightning power jack to power both devices. The Bluetooth radio can be turned off in this configuration to conserve battery power.



The *MIDI* includes the following features:

1. USB MIDI and Bluetooth-LE MIDI connections are supported.
2. Turn the Bluetooth radio off to save 50 mA of current draw for battery operation.
3. Three button/knob beep modes, off, normal, or long-press only.
4. Two proportional (speed) tuning speeds.
5. Two maps to customize the MIDI controls assigned to each **Knob** function.
6. Four knob modes control a total of 8 “Wheel” or “Slider” functions for tuning, volume control, etc. Yellow LEDs indicate the selected knob mode.
7. Six dual-mode pushbuttons. Each button can be assigned to the short-press and a long-press function.
 - a. You can enable [Extended BTN mode](#) to expand the number of buttons available from 12 to 48. In **Extended BTN mode**, each knob mode has its own set of 12 button functions that can be mapped to select modes, bands, or other app functions.
8. 3.5mm (1/8”) stereo input jack allow you to use your paddles to control the keyer, straight key, or PTT in the app (not all apps support all modes).
9. Power the *MIDI* from any USB 5-volt power source; computer USB port, cell phone charger, USB battery, or through an OTG adapter on your mobile device.
10. Firmware updating is done through the USB-C port.
11. A [Flex WiFi mode](#) that allows you to connect to a Flex radio directly, without a 3rd party app

Legal Notice

What would a manual be without a legal notice? Here goes...

- This is a hobby endeavor. Nothing is guaranteed! Use this device at your own risk!
- I will do my best to make sure you receive functioning hardware if you buy the assembled unit and will work with you if there is a problem with your unit on arrival.
- I cannot guarantee or warranty the hardware supplied in the kit.
- I make no warranty that the firmware provided for CTR2-MIDI will perform up to your expectations or be suitable for your application. Software bugs are a fact of life and I try to find and correct all bug reports to the best of my ability ASAP.

How to use this manual

This manual should be used as a reference manual. An expanded Help system if you will. Items in the Table of Contents link to their write up in the manual. The main categories have short write ups describing the functions available in that section. I’ve tried to group things logically and have added hyperlinks so you can quickly jump to other sections.

As this document evolves, sections that have changed since the last update will be **highlighted in yellow**.

The version number of this manual will follow the latest released version number of the firmware.

Feel free to contact me if you have question about a certain feature or have ideas for future improvements. I love to get feedback on my work. My email address is good on [QRZ.com](mailto:qrz@qrz.com).

Change Log

This manual covers the **CTR2-MIDI Mode** operation. For information on **CTR2-Flex WiFi Mode**, download the [CTR2-MIDI Flex Mode Operation Manual](#).

v2.00.02: December 26, 2025

- Additional debouncing refinements to minimize random code elements on paddles
- Enable red Tx LED when keying in MIDI mode, even when Bluetooth is not connected
- Additional refinements to CTR2-Flex WiFi mode – see the Operations manual for that firmware

v2.00.01: November 10, 2025

- Added paddle release debounce to fix issues with cheaper paddles adding extra code elements
- Improved keyer Bug mode so it works properly now
- The **CTR2-MIDI firmware is now distributed as a single BIN file** named **CTR2-MIDI.bin**. The instructions for flashing the single BIN file have been updated in [Appendix C](#).

v2.00.00: November 3, 2025

- Added a new option to run [CTR2-MIDI Flex WiFi mode](#), similar to the dual-boot mode in **CTR2-Flex/CTR2-Dial** firmware
 - **CTR2-MIDI Flex WiFi** mode was ported from [CTR2-Flex](#) firmware. It allows you to connect **CTR2-MIDI** directly to your Flex radio over your local WiFi network. This mode supports all versions of SmartSDR, including Windows versions. Radio control is done directly with the radio using the Flex API, not MIDI, so no 3rd party app is required for this mode. **CTR2-Flex WiFi** mode does not support SmartLink.
 - A separate operation manual for **CTR2-MIDI Flex WiFi** mode can be downloaded [here](#).
- Added [Extended BTN mode](#) – in this mode, each knob mode has 12 button functions, for a total of 48 buttons.
- Added a new [Maintenance Menu](#) that adds the ability to Export and Import settings to a file on your PC for backup.
- Added [Appendix H: Knob and Normal Button Assignment Worksheets](#) for normal BTN mode.
- Added [Appendix I: Knob and Extended Button Assignment Worksheets](#) for [Extended BTN mode](#).
- Added a new [Keywords and Definitions](#) section
- When [toggling the Bluetooth radio](#) on/off CTR2-MIDI automatically reboots. No need to power the unit down to reboot it.
- Replaced all references to the term “encoder” in this manual and in the firmware with the term “knob”.
- Replaced all references to the term “MFB” (i.e. Multi-Function Button) in this manual and in the firmware with the term “BTN”.

Changes to previous versions can be found in [Appendix J](#).

Keywords and Definitions

As many are new to the concept of controlling radios with an external controller, it will help to define many of the keywords used in this document.

Bluetooth	A wireless technology used to connect two devices together
Bluetooth MIDI	A method that sends MIDI commands to an app running on another computer using Bluetooth
BLE	Bluetooth Low Power – An advanced type of Bluetooth communication that uses less power than conventional Bluetooth
CTR2	A product line from Lynovation.com that specializes in control devices for ham radio
CTR2-MIDI	A miniature radio controller based on the ESP32-S3 microcontroller. It uses Bluetooth or USB MIDI to connect 3 rd party radio control apps that support MIDI control of their functions
<u>CTR2-Flex WiFi Mode</u>	A mode available in CTR2-MIDI firmware that uses WiFi instead of Bluetooth to connect direct to, and control a Flex radio without a 3 rd party radio control app
<u>CTR2-MIDI Mode</u>	This is the original CTR2-MIDI firmware that uses <i>Bluetooth</i> or <i>USB MIDI</i> to control a 3 rd party radio control app
<u>Extended BTN Mode</u>	When <i>enabled</i> , the 12 button functions on the unit change with each <i>Knob Mode</i> . When <i>disabled</i> , the 12 button functions in the Knob Home mode are used in all knob modes. Both yellow LEDs flash when changing knob modes when <i>enabled</i> .
<u>Extended Paddle Mode</u>	When enabled, the Paddle Input Jack can be used for straight-key and PTT switch input instead of paddle input for the internal keyer. The green LED is lit when enabled.
Knob Mode	Refers to one of four modes available on the knob control – each mode has a <i>Push</i> and a <i>Push & Turn</i> function – Knob modes are indicated by the yellow LEDs
LAN	Local Area Network – generally a wired network contained within small, localized area such as a home, office, or your radio shack – It usually incorporates WiFi to connect wireless devices to the network
MIDI	A protocol originally designed to control musical instruments - It is simple, small, and fast
MIDI Button	A MIDI command that sends an On or Off command to control a parameter in a radio control app – also referred to as a MIDI Note command since it was originally used to send musical note command to instruments
MIDI Control	A MIDI command that allows sending a value to the radio control app to change a variable parameter such as tuning, volume, etc.
Radio Control App	A 3 rd party program or application running on a computer, tablet, or phone that is used to control a radio remotely
Serial Port	A connection that sends data to, or receives data from, a remote device serially – the serial communications can travel over a physical wire (RS-232) or be embedded in a virtual connection using <i>USB</i>
Terminal	A program such as <u>Tera Term</u> or <u>Putty</u> that uses a serial port that allows you to interact with a remote device running a <i>terminal server</i>
Terminal Server	An application running on a device that allow it respond to key strokes sent from a <i>terminal</i> – generally used to create a basic user interface to control and configure a remote device
USB	Universal Serial Bus – a common interface available on all computers that enables communications between the computer and external devices
USB MIDI	A method used to send MIDI commands to an app using USB
WiFi	A wireless technology that allows remote devices to connect to a <i>LAN</i> network

Hardware

The *MIDI* uses a 60mm x 60mm x 20mm enclosure. This form factor is the perfect size for a busy operating desk or for portable operation.

As shown in the photo, the knob is the predominant feature on the face of the unit. When oriented with the USB-C connector and paddle jack as shown the two LEDs in the upper left corner show the knob mode with the lower LED having a value of 1 and the upper LED having a value of 2. Both LEDs will be off when the knob is in its **Home** mode. Short-pressing the knob steps you through knob modes **1, 2, 3**, and back to **Home**. In the photo above the knob is in mode 1.



The green LED flashes once every 5 seconds if the Bluetooth radio is turned off. It flashes once every 2 seconds when the unit is first powered up and the Bluetooth radio is turned on. It changes to two flashes every second when the unit is connected via Bluetooth-LE to the app. It is on all the time when you enter the [Extended](#) paddle mode.

The dual-function buttons (BTNs) are laid out around the circumference of the knob. BTN1 is on the upper left, just below the knob mode LEDs. The buttons are numbered counter-clockwise around the knob ending with BTN6 on the upper right. Short and long-press functions allow you to control two MIDI **Button** functions with each button.

You'll find the USB-C and 3.5mm (1/8") stereo Paddle Input jack on the top edge in the photo.

Operating Modes

CTR2-MIDI can be configured to operate in either the original **CTR2-MIDI mode** or the new **CTR2-Flex WiFi** mode. MIDI and WiFi modes cannot be used at the same time.

CTR2-MIDI mode allows you to control MIDI enabled 3rd party radio control software such as SmartSDR for iOS/macOS, or Thetis and SDR-Console for Windows, using a Bluetooth or USB MIDI connection.

CTR2-MIDI Flex WiFi mode, shorted to **CTR2-Flex WiFi** in this manual, allows you to directly control your Flex 6xxx/8xxx series radio using WiFi without the need of a 3rd party radio control app. **CTR2-Flex WiFi** mode connects directly to the network server in the radio and works with any version of SmartSDR, including the Windows versions. It does not support SmartLink. For remote operation you can switch to **CTR2-MIDI mode** and use one of Marcus' (DL8MRE) iOS/macOS radio control apps. You can download the operation manual for **CTR2-Flex WiFi** mode [here](#).

Switching Modes

To switch between **CTR2-MIDI** and **CTR2-Flex WiFi modes**, press and hold **BTN5** (middle-right button), then press and release the knob switch. The unit will power down and restart in the new mode and sound either Morse “M” (MIDI) or “F” (Flex WiFi) to indicate the new mode.

The following sections describe using CTR2-MIDI in **MIDI mode**. For information on using **CTR2-MIDI** in **CTR2-Flex WiFi mode**, refer to the [CTR2-Flex WiFi Operation](#) section.

Boot Sequence

When **CTR2-MIDI** boots into the **CTR2-MIDI mode**, a Morse **M** will be sounded to indicate the unit is in MIDI mode. If you have a [terminal](#) connected to the *MIDI*, press any key to open the **CTR2-MIDI Configuration Menu**. A Morse **F** indicates the unit is in the **CTR2-Flex WiFi** mode. See [Switching Modes](#) for information about switching between the two modes.

Connecting CTR2-MIDI to Your App

This section describes how to connect the *MIDI* to various apps. Once you are connected to the app see the [CTR2-MIDI Controls](#) section to understand how the *MIDI* controls work with the app.

NOTE: To use **USB MIDI**, you must use a **USB-C data cable**. Many USB-C cables are charge only cables and don’t have data lines for communication. If you’re using a Windows computer you should hear a beep from the computer when it registers the USB port on CTR2-Dial when you plug it in. If you don’t hear the beep, try another cable.

Remote Ham Radio

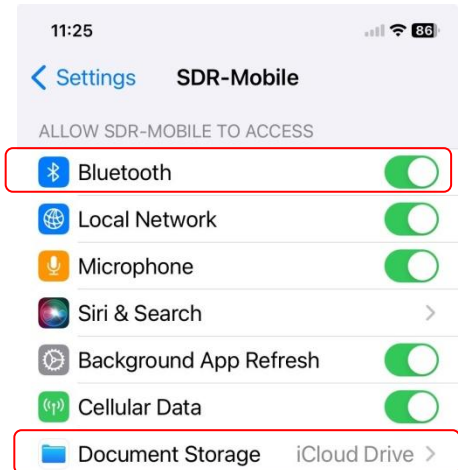
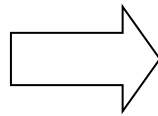
To connect the *MIDI* to [Remote Ham Radio](#) simply plug the *MIDI* into a USB port on your computer then select the **CTR2-MIDI** option in the RHR console’s **Tool** menu. The app is pre-configured for the *MIDI* so it’s plug-and-play. You can see how the *MIDI*’s controls are mapped to RHR in the [Remote Ham Radio Configuration](#) section.

NOTE: *Disable* the [Extended BTN mode](#) when using RHR.

Marcus' Apps for iOS or MacOS

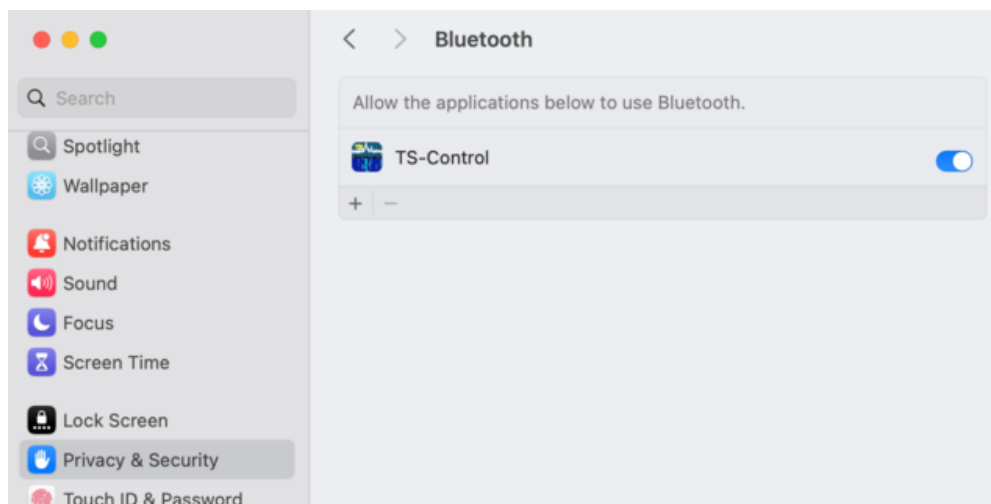
Enable Permissions

If you plan on using Bluetooth with Marcus' apps on your **iOS** device, open the app's **Settings** window and allow Marcus' apps access Bluetooth.



You can also allow the app to use your iCloud Drive to save maps in this window.

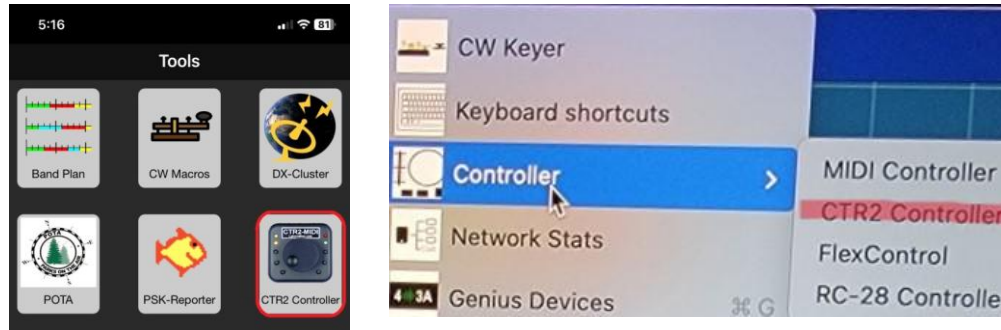
MacOS has a similar permission setting. It can be found by navigating to **Apple -> System Settings -> Privacy & Security -> Bluetooth**. The screenshot below shows the *TS-Control* app has permission to use Bluetooth.



Select the CTR2-MIDI Device

In Marcus' apps, select the **CTR2 Controller** device in the **Tools** menu (not the **CTR2 Dial Controller Tool**). The **Tools** menu will look different in each app so just look for the **CTR2 Controller**.

Here's an iOS and MacOS example of the **Tools** menu. I've highlighted the **CTR2 Controller** option in each menu...



CTR2 Controller Screen

Once you select **CTR2 Controller** from the **Tools** menu a screen like this will appear. It may look different depending on the Apple device you're using but it has basically the same information.



Make sure your *MIDI* is powered up. The green LED should be flashing once every two seconds if the Bluetooth radio is on, or once every 5 seconds if it is off.

USB Wired Connection

To use the *MIDI* with a wired USB connection on Mac's and newer iOS devices, connect the *MIDI* to your device using a USB data cable, select **XAIO_ESP32-S3** from the **Device** menu, and click the **Enabled** button. The **Status** should change to **Connected**. Press the **Edit Mapping** button and press a button or turn the knob to verify the app is receiving MIDI commands.

NOTE: To use a wired USB connection with an older iOS device (with a Lightning connector) you'll need to purchase a Lightning OTG (On The Go) adapter such as the one shown here. These are also referred to as "Camera Adapters" on Amazon. The adapter I use has two USB-A



connectors on it. It also has a Lightning port so you can connect a wall charger or battery to power your phone and *MIDI*.

Bluetooth-LE Connection

To use Bluetooth-LE MIDI, make sure the [Bluetooth radio is on](#) (green LED flashes every 2 seconds) then click the **Find CTR2 Bluetooth-LE Device** link to initiate a search for your *MIDI*. The search will fail the first time you try to access a new device. If you get a failure notice, close the failure popup notification, wait 10 seconds, then click the **Find** link again. Once it registers your *MIDI* (your *MIDI*'s device name is written on the bottom label if you bought an assembled unit) click the **Enabled** button to start the Bluetooth connection. You don't need to select the *MIDI*'s name on the **Device** list unless you have two or more *MIDI* units available. (You can only use one *MIDI* at a time but you can use a separate wired USB MIDI device such as a DJ2GO along with the *MIDI*.)

NOTE: v1.02 firmware gives you to [option of turning off the Bluetooth radio](#). If the radio is off the green LED flashes once every **5 seconds**. To turn it on press and hold BTN6 then press the knob. You should hear "BLE 1" in Morse code then the unit will start beeping once a second. Cycle power on the unit to restart it with the Bluetooth radio on.

If you can't get the app to connect to *MIDI* you probably haven't allowed the app to use Bluetooth (see [Enable Permissions](#) above). If you still can't get it to connect, download **MIDI-Wrench** or **midimitttr** for iOS or **Conji** for the Mac from the App store. They are free apps used to troubleshoot BLE MIDI issues. Connect to the *MIDI* with one of these apps first and then try to connect to the *MIDI* again in the radio control app.

MacOS Bluetooth Connection Problems

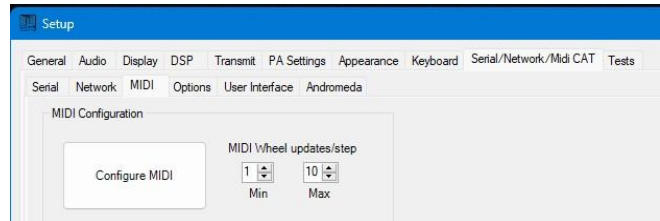
Follow these steps to connect the *Dial* to your Mac using Bluetooth:

1. Connect your *MIDI* to a USB port on your Mac.
2. In the **CTR Controller** screen, check the **Enabled** button then click **Find CTR2 Bluetooth-LE Device** at the top of the screen.
3. The Mac may report that it can't find a Bluetooth-LE device. Wait 10 seconds then click **Find CTR2 Bluetooth-LE Device** again.
4. The Mac should report that it has found a Bluetooth device named **CTR2xxxx** where xxxx is the address of your *MIDI*.
5. Select **Xiao_ESP32S3** on the **Device** list to use USB MIDI while connected to the Mac.
6. Select **CTR2xxxx** on the **Device** list to use Bluetooth MIDI.
7. You may need to change the state of the **Enabled** checkbox to get the *MIDI* to connect.
8. You can now unplug your *MIDI* from the Mac and use it remotely with Bluetooth.

Windows Applications

Thetis

Windows only supports USB MIDI connections. When you connect the *MIDI* to your Windows computer's USB port it will automatically register as a MIDI device and be assigned a virtual COM port. Windows does not support Bluetooth-LE MIDI (at least not very well).

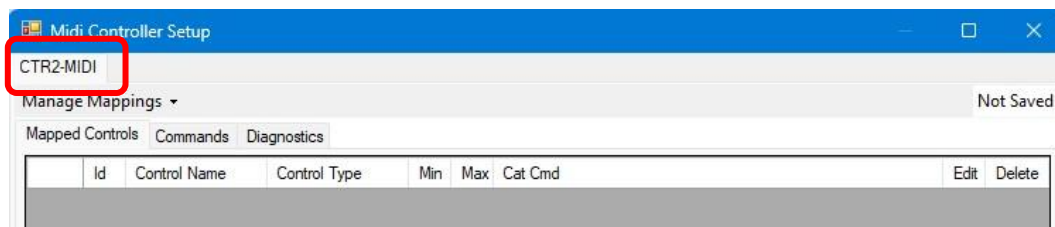


NOTE: USB MIDI requires a USB-C data cable. USB-C power cables will not work!

Most Windows apps will need to be configured (i.e. mapped). **Thetis** is used as an example here but connecting to and mapping controls in other apps should be similar. You will need to experiment with your app's mapping to determine how its map is configured.

Start by selecting the **Settings** menu on the main page in Thetis then select the **Serial/Network/MIDI CAT** tab. Click the **MIDI** tab as shown above.

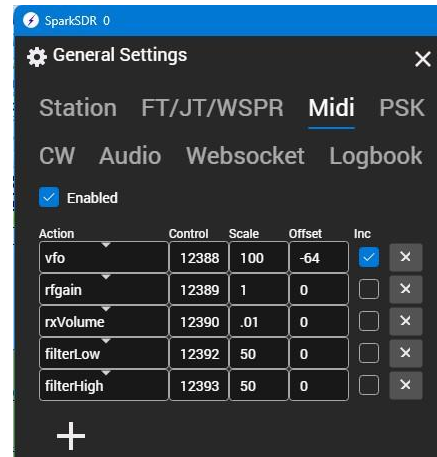
Next, click the **Configure MIDI** button to open the **Midi Controller Setup** page. The program should go through an initialization sequence and end up on this page if it finds the *MIDI* on USB. The tab at the top should be labeled **CTR2-MIDI** or possibly **ESP32S3**. If the initialization fails, double-check that you are using a USB-C data cable, not a charge cable and try again.



Additional information on mapping MIDI controls in **Thetis** can be found [here](#).

SparkSDR

SparkSDR (<https://www.sparkedr.com/>) has limited support for MIDI control. It doesn't support buttons, only the knob. To map the *MIDI's* knob functions to this program, first plug your *MIDI* into a USB port on your computer and open SparkSDR. Once you have the program running, click on the **General Settings** menu and select **Midi**. You should see **CTR2-MIDI 0** as a MIDI controller and turning the knob should display MIDI messages from the controller. To map these messages to a control in the app simply press the + icon and enter the **Control** number shown in the **Last midi message:** window in the **Control** column. Then select an **Action** and set the **Scale** and **Offset** required for that control. You may need to play with these values to get the control action you want. Check the **Inc** box if you want the value from *MIDI* to be added to the current setting of the control. This is only used with the **vfo** control. This screenshot shows the settings I use.



Flex Radio CW Zombie Mode

If you plan on using your *MIDI* with a Flex radio using remote CW keying there is an odd problem in Flex firmware where the radio can go into **CW zombie mode**. This happens occasionally when connecting and disconnecting multiple clients to the radio that send remote keying commands (at least I think that's what causes it).

In **zombie mode** the radio looks like it is transmitting CW, the light on the front panel turns red, the TX icon turns red, the MOX button turns blue *but no RF carrier is generated or displayed on the panadapter*. The only way I have found to get the radio out of zombie mode is to disconnect all clients and power cycle the radio.

BTN#+Knob Options

Now that you have the *MIDI* connected to your app, it's time to go over the various options available in the *MIDI*. The options below are accessed by pressing and holding the indicated BTN then pressing and releasing the knob switch.

Beep Mode (BTN1+Knob)

You can control when the *MIDI* beeps. Normally, it beeps whenever you press a button or the knob. This lets you know that you've changed something in the app. You may prefer the *MIDI* remains quiet all the time or only beep when you long-press a button or the knob.

To change the **Beep** mode press and hold BTN1 then press the knob. The new **Beep** mode will be announced in Morse code as follows:

- "B 0" = **Beep** mode is off. All LEDs will briefly flash when you long-press a button or the knob.
- "B 1" = **Beep** mode is normal. The *MIDI* will beep with every button or knob press.
- "B 2" = **Beep** mode is long-press. The *MIDI* will beep only when you long-press a button or the knob.

Speed Tuning Mode (BTN2+Knob)

Speed (proportional) tuning is supported when **WheelA** is selected as the MIDI control assigned to the app's tuning function. You can select from **On**, **Fast**, or turn speed tuning **Off**.

To change the Speed mode press and hold BTN2 then press the knob. The new speed mode will be announced in Morse code as follows:

- "S 0" = speed tuning is off
- "S 1" = speed tuning is set to normal speed
- "S 2" = speed tuning is set to fast speed

Knob Map (BTN3+Knob)

The *MIDI* supports two knob maps. This allows you to configure the *MIDI* for different apps depending on your needs. **Map 1** is the default and is configured to work with Marcus' iOS/macOS apps and RHR. It uses **WheelA** for tuning. **Map 2** is configured for Thetis and uses **WheelB** for VFO A and VFO B tuning control.

To change maps, press and hold BTN3 then press the knob. The new map will be announced in Morse code as follows:

- "M 1" = **Map 1** is active
- "M 2" = **Map 2** is active

Run CW Report (BTN4+Knob*)

To hear a Morse report of all of the option setting press and hold BTN4 then press the knob. You can stop the report by pressing any button.

NOTE: You can change the speed of the CW sending the report by turning the knob *while the report is running*.

* When *MIDI* firmware is running on *Micro* hardware, *long-press* **BTN1** then press the knob.

Switch Modes (BTN5+Knob*)

To switch between **CTR2-MIDI** and **CTR2-Flex WiFi** modes press and hold **BTN5** (middle-right button) then press and release the knob switch. The unit will power down and reboot into the new mode. When it boots into **CTR2-MIDI** mode, a Morse “M” will be sounded. When it boots into **CTR2-Flex WiFi** mode, a Morse “F” will be sounded. If you have a terminal connected to the unit, press any key to open the home menu. See the [CTR2-Flex WiFi Operation Manual](#) for information on this mode.

* When *MIDI* firmware is running on *Micro* hardware, *long-press* **BTN2** then press the knob.

Bluetooth Radio Power (BTN6+Knob)

You can turn off the Bluetooth radio on the *MIDI* if you are using a wired USB connection and are not running *MIDI* firmware on [Micro hardware](#). This is particularly handy when powering the *MIDI* from a battery-operated device such as an iPhone or iPad. When the radio is off the *MIDI* draws around 43 mA. When it is on the current draw is around 93 mA.

To toggle the power on the Bluetooth radio press and hold BTN6 then press the knob. The radio’s state will be announced in Morse code as follows:

- “BLE 0” = Bluetooth radio is off
- “BLE 1” = Bluetooth radio is on

NOTE: This will change to “BT0” and “BT1” in future versions of CTR2-MIDI firmware.

Once the Morse announcement completes the *MIDI* will start beeping once per second. This tells you that the *MIDI* is waiting for you to cycle the power to change the radio setting. The radio can only be enabled or disabled during the startup process.

If the Bluetooth radio is off the green LED will flash once every 5 seconds. If it is on, but not connected to your app, the green LED flashes once every 2 seconds. When connected to your app the green LED flashes twice every second.

CTR2-MIDI Controls

The *MIDI* sends MIDI commands to the app when the buttons are pressed or the knob is turned. This section will describe the various controls available.

Dual-Function Buttons (BTNs)

Buttons are laid out counter-clockwise around the knob starting with BTN1 on the upper left and ending with BTN6 on the upper right of the knob.

Buttons send the MIDI **NoteOn** command when the button is released.

Each button has two functions defined by the amount of time you hold the button down.

Short-pressing (i.e. less than 1 second) a button produces one beep (if [Beep mode](#) is set to Normal) when pressed and sends the associated MIDI **NoteOn** command when released. The MIDI **NoteOn** control # will be from 1 to 6 depending on which button was pressed.

Long-pressing a button (holding it down longer than 1 second but less than 3 seconds) produces another beep to indicate when it enters long-press mode if [Beep mode](#) is set to *Normal* or *Long-Press*. If **Beep** mode is *Off* all the LEDs will briefly flash when entering long-press mode. Upon button release the associated MIDI **NoteOn** command is sent. The **NoteOn** control will be from 11 to 16 depending on which button was pressed.

NOTE: Holding a button longer than 3 seconds cancels the button press and sounds a third low frequency beep if **Beep** mode is *Normal* or *Long-Press*. There is no indication if **Beep** mode is *Off*.

MIDI **NoteOn** commands can be mapped in the app to toggle functions such as *Band Up*, *Band Down*, *Mode Up*, *Mode Down*, etc.

NOTE: The *MIDI* does not receive updates from the controls it's mapped to in the app. If you change a value with the *MIDI*, then change it manually in the app, the next time you change it in the *MIDI* it will send the new value based on the last value the *MIDI* sent, not the value you manually set in the app.

Knob Functions

The knob has four modes. Each mode has a turn and a press and turn function for a total of eight functions. knob modes are selected by short-pressing the knob. The yellow LEDs indicate the selected mode. Both LEDs will be off in the knob's **Home** mode.

The knob can be used for tuning or changing parameters like volume, bandwidth, CW speed, etc.

WheelA, **WheelB**, and **WheelB-r** are used for tuning (depending on the app). Most other controls use **SliderA** which acts like a potentiometer. **SliderB** is used for RIT and XIT controls. It beeps at the ends of the range and it beeps and pauses when you hit the middle of the range (where RIT and XIT are off).

Although not generally used, there is a **Button** option. This can also be used for tuning if your app supports up and down buttons for frequency control.

The knob functions are covered in [Appendix A](#). You must define the MIDI control you want the *MIDI* to use for each knob function with a terminal program.









MIDI supports [two knob maps](#) so you can configure one map for RHR and Marcus' iOS/macOS apps and one map for Thetis or other Window apps. Press and hold **BTN3** then press the knob to toggle the knob map. The active knob map will be indicated by sounding either "M1" or "M2" in Morse.

NOTE: The *MIDI* always sends commands on MIDI Channel 1.

Knob Mode Indications

The *MIDI* supports four knob modes. Each mode has a *turn* and *push & turn* function. The knob mode is indicated by the yellow LEDs as shown in the table below. The *MIDI* sends the *MIDI Control Change* command (CC) # indicated in the table below for each mode.

NOTE: The function your radio control app actually executes is determined by the MIDI mapping in your app.

Knob Mode	LED	Beep Tone on Selection	MIDI Control Change
Home	 	Single high frequency beep	Knob Turn = CC 100 Push & Turn = CC 101
1	 	Single low frequency beep	Knob Turn = CC 102 Push & Turn = CC 103
2	 	Two low frequency beeps	Knob Turn = CC 104 Push & Turn = CC 105
3	 	Three low frequency beeps	Knob Turn = CC 106 Push & Turn = CC 107

Long-pressing the knob while in Mode 1, 2, or 3 will return you back to the knob **Home** mode (all LEDs off) and sounds a single high frequency beep if **Beep** mode is set to *On* or *Long-Press*. Long-pressing the knob in the knob **Home** mode toggles the **Paddle Mode**.

Paddle Input Mode

The *MIDI* has two **Paddle Modes**, *Normal* and *Extended*. These modes allow you to map different MIDI control functions to the paddle input jack depending on your needs. The **Paddle Mode** is indicated by the green LED. The table below explains the two modes.

Paddle Input	Green LED	Beep Tone On	Description
Normal Mode	○	Two tone High>Low beep	If Extended BTN mode is disabled , the left paddle controls MIDI 20 and the right paddle controls MIDI 21. If it is enabled , the left and right paddle are assigned to MIDI 96 and MIDI 97. Map these to Trigger CW Left Paddle and Trigger CW Right Paddle . Not all apps have these options.
Extended Mode	●	Two-tone Low>High beep	If Extended BTN mode is disabled , the left paddle controls MIDI 30 and the right paddle controls MIDI 31. If it is enabled , the left and right paddle are assigned to MIDI 98 and MIDI 99. You can map these to Trigger CW Straight Key and PTT Push to give you a straight key and PTT control in this mode. Or, you can map them the same as Normal mode to disable the Extended Paddle mode. Not all apps have these options.

To toggle **Paddle Mode**, long-press the knob while in the **Home** knob mode (both yellow LEDs off).

If your app doesn't support keyer or PTT input control, or you don't use them, you can map the paddle controls to other functions your app supports.

Application Mapping

CTR2-MIDI is a MIDI controller. It has no concept of radios, or how to control them. It only sends MIDI commands based on the control you execute on it. Therefore, it must be used with a 3rd party radio control app that supports MIDI control. How the *MIDI* works with your radio is determined by the MIDI mapping within that radio control app. The sections below show how several radio control apps can be mapped to the *MIDI*. You're not limited to these configurations. Feel free to develop your own mapping based on your operating style.

NOTE: The two maps that **CTR2-MIDI** supports only configure the knob control types. They do not affect the button mapping. [Extended BTN mode](#) controls how many button functions are available and their MIDI Button assignments.

Mapping for Remote Ham Radio

To use the *MIDI* with [Remote Ham Radio](#) open the **Tools** menu in the RHR console and select **CTR2-MIDI**.

The *MIDI*'s controls are pre-mapped in RHR as follows:

Keying Input

You can plug your paddles or a straight key and PTT switch into the 3.5mm jack on the *MIDI*. To use paddles, set the **Paddle Mode** to **Normal** (long-press the knob in the knob **Home** mode until the green LED turns *off*). To use your straight key and a PTT switch, wire the straight key to TIP and Shield and the PTT switch to RING and Shield of a 3.5mm plug and insert it into the 3.5mm jack on the *MIDI*. Set the **Paddle Mode** to **Extended** by long-pressing the knob while in the knob **Home** mode until the green LED turns *on*.

Knob Mode Control

To select a knob mode, short-press the knob until the yellow LEDs indicate the mode you want. The knob has a *turn* and *push & turn* function for each mode. The modes and their functions are listed below. I don't know if you can change this mapping in the program.

ENCODER ACTIONS		
LEDS	User Input	Action Taken
○	Home (turn)	Change VFO
○	Home (push & turn)	Slice Volume
○	Mode 1 (turn)	NR Level
●	Mode 1 (push & turn)	NB Level
●	Mode 2 (turn)	VOX Level
○	Mode 2 (push & turn)	*Not used*
●	Mode 3 (turn)	Keyer Speed
●	Mode 3 (push & turn)	*Not Used*

Button Controls

Each button (BTN) has two functions.

Short-press the button (< 1 second) to access the primary function.

Long-press the button (> 1 second) to access the secondary function. Thos table lists the functions available.

NOTE: Do not enable [Extended BTN mode](#) when using RHR because it changes the MIDI Button # assigned to the long-press button functions.

BUTTON ACTIONS	
User Input	Action Taken
BTN1	CW Mode
BTN1 (long-press)	Toggle NR
BTN2	SSB Mode
BTN2 (long-press)	Toggle NB
BTN3	FT8
BTN3 (long-press)	FT4
BTN4	Toggle PTT
BTN4 (long-press)	Toggle VOX
BTN5	Band Down
BTN5 (long-press)	*Not Used*
BTN6	Band Up
BTN6 (long-press)	*Not Used*

Mapping for iOS and MacOS Apps

The map on [Marcus' apps](#) is preconfigured for the *MIDI* when you select the **CTR2 Controller** device from the **Tools** menu. You can change the mapping to fit your needs.

NOTE: The example below is based on using the *MIDI* with [Extended BTN mode disabled](#). If you **enable Extended BTN mode**, you can select the **CTR2 Dial Controller** device in the **Tools** menu instead. This device is mapped to support the additional MIDI Button controls available on **CTR2-Dial** and on **CTR2-MIDI** in **Extended BTN** mode. You'll probably want to edit the MIDI map in the app to fine-tune your preferences.

The default configuration for the *MIDI*'s **Map 1** defines the first primary knob control (**CC 100**) as **WheelA**. This control is typically used for frequency control. Other knob functions are defined as MIDI **SliderA** (no center/edge beeps). You can [change these assignments](#) using a terminal program.

Editing the CTR2 Controller Map

Pressing the **Edit Mapping** button in the **CTR2 Controller** page of Marcus' app opens the **Edit CTR2 Map** page.

The map is preconfigured when you select the **CTR2 Controller** the first time as shown here. You can edit it to fit you needs.

Press a button or turn the knob to highlight its function on the map.

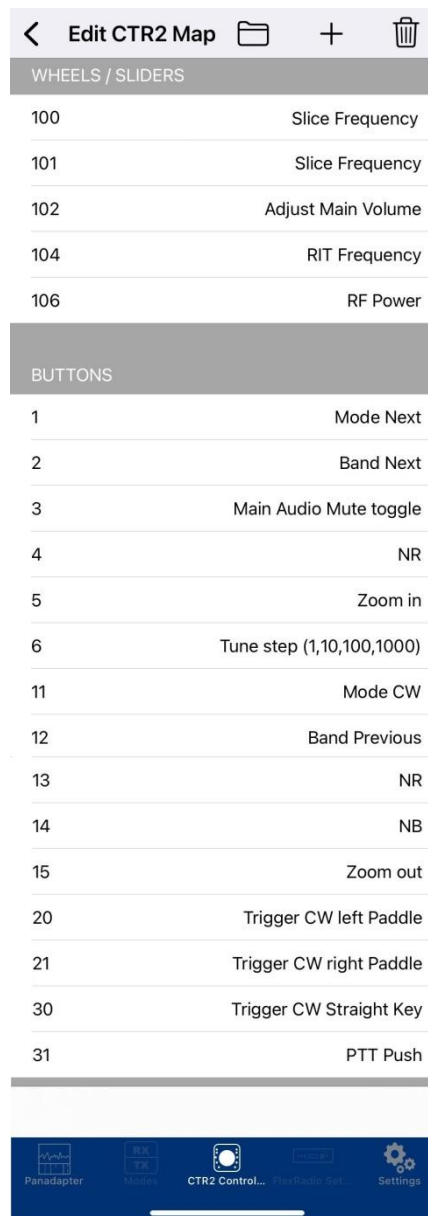
Mapping Functions to Controls

To change a mapped function press or click the control line and choose a function from the dropdown menu.

NOTE: Your *MIDI* will not be able to control your app unless functions are mapped!

Example: Short-pressing **BTN1** on the *MIDI* always sends the **Button 1** command (unless [Extended BTN mode](#) is **enabled**). This button is mapped to *Mode Next* function in SmartSDR which increments the mode on the active slice. Long-pressing **BTN1** on the *MIDI* always sends **Button 11** (again, unless **Extended BTN mode** is **enabled**). This is mapped to *Mode CW* in SmartSDR which tells it to set the radio's mode to CW.

Once you have your map configured press the folder button at the top of the display to save your map.



Using Paddles with the App's Keyer

Marcus' iOS/MacOS apps include a keyer that you can control with the paddles connected to the *MIDI*.

NOTE: If you're using Bluetooth-LE MIDI you may notice a difference in how the paddles work with the app's keyer as opposed to a hardwired paddle/keyer. The latency in the Bluetooth-LE connection causes up to 15 milliseconds of delay. This will throw your "fist" timing off, especially in Iambic modes where an extra element may be added. It may take some practice to get use to the timing change. If this is a problem for you consider using USB MIDI instead.

Follow these steps to configure the app and the *MIDI* for paddle keying:

- In the app, map **Button 20** to **Trigger CW Left Paddle** and **Button 21** to **Trigger CW Right Panel**. (Use **Button 96** and **97** if **Extended BTN mode** is *enabled*). *You* can swap this mapping if your paddles are wired backwards.
- Plug your paddles into the **Paddle In** jack on CTR2-MIDI.
- **Verify that the Paddle Mode is in *Normal mode*** on the *MIDI* (the green LED is off). To toggle this mode, long-press the knob while in the Home knob mode (both yellow LEDs off). You should hear two tones (high to low frequency) and the green LED will turn off.
NOTE: If **Paddle Mode** is in *extended* mode the green LED will be on and the paddles will control **MIDI Buttons 30 and 31** (or 98 and 99 if **Extended BTN mode** is *enabled*).
- Set the radio's mode to CW
- In SmartSDR, press the **View** menu in the Panadapter display and select **CWX Panel**. You can adjust speed and other setting here.
- In SDR-Control, select the **CW Keyer** option in the **Tools** menu to configure the keyer. DO NOT enable the MIDI device in this panel, this is done in the **CTR2-MIDI Controller** panel.
- Pressing either paddle will now activate the keyer and key the radio.

Using a Straight Key or an External PTT Switch

Straight Key Wiring

If you want to use a straight key with the *MIDI*, map **Button 30** (or 98 if **Extended BTN mode** is *enabled*) to **Trigger CW Straight Key** in the app then wire your straight key to the TIP and SHIELD of a 3.5mm (1/8") stereo jack and insert it into the **Paddle In** jack on the *MIDI*. Do not use a mono jack as the shield will ground the RING lead on the **Paddle In** jack.

PTT Switch Wiring

If you want to use an external PTT switch with the *MIDI*, map **Button 31** (or 99 if **Extended BTN mode** is *enabled*) to **PTT Push** in the app and wire your PTT switch to the RING and SHIELD of a 3.5mm (1/8") stereo jack and insert it into the **Paddle In** jack on the *MIDI*.

NOTE: You can wire your straight key and external PTT switch to the same stereo plug.

NOTE: Re-map your radio control app if you need to reverse the paddle wiring or change which jack input is used for your straight key or PTT switch.

Long-press the knob while in the Home knob mode (yellow LEDs off) to toggle the **Paddle Mode** from **Normal** to **Extended**. You should hear two tones (low to high frequency) and the green LED will light when in **Extended** paddle mode.

Mapping for Thetis

Thetis is a little different than RHR and iOS/MacOS apps in that it uses the *MIDI's* **WheelB** control instead of **WheelA** for frequency tuning. [Map 2](#) is pre-configured with **WheelB** for tuning. Press and hold BTN3 then press the knob to switch maps.

WheelB-r reverses the direction of the tuning knob and is primarily used with the PI HPSDR app.

With the **Setup** ->

Serial/Network/Midi CAT window open select the **MIDI** tab and click the **Configure MIDI** button. The program will initialize *MIDI* using USB.

NOTE: If the program doesn't initialize the *MIDI* check to make sure you are using a USB-C data cable, not a USB-C charge cable.

Mapping Controls

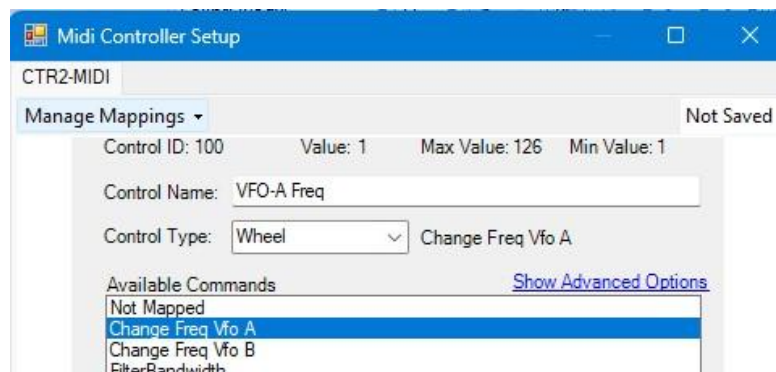
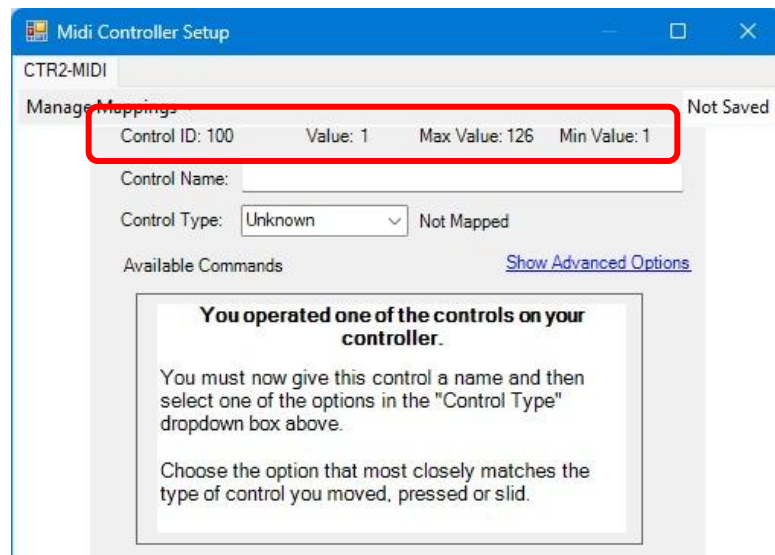
Press a button or turn the knob and the window at the left will open.

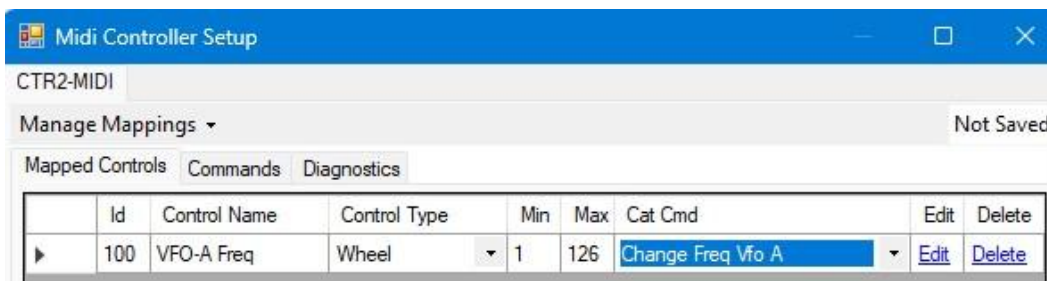
In this example I turned knob when the *MIDI* was set to the **Home** knob mode so it is controlling **Change Control (CC) 100**.

NOTE: When mapping knob controls you need to turn the knob fully CCW until you get to 1 and then fully CW until you get to 127 to set the Max and Min range values.

Next, I give the control a name. I'll call it **VFO-A Freq** and select **Change Freq VFO A** from the **Available Commands** list.

Click the **Done** and then the **Save** button to return to the **Manage Mappings** page.





You've mapped your first control! Now follow the same procedure to the other 7 knob functions and the 12 button functions.

Here's a screenshot of the mapping I currently have in Thetis. Don't be afraid to experiment with the settings so you can find the combination that works best for you.

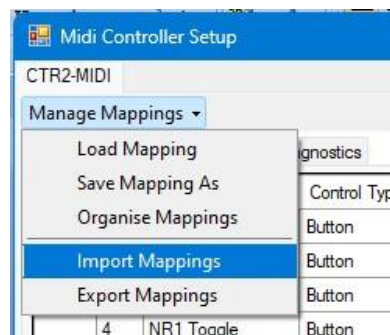
NOTE: When using the Thetis *Wheel* control type you must [set the knob type on the MIDI to WheelB](#).



When you're finished mapping controls make sure to click the **Save** button in the **Midi Controller Setup** page and **Apply** before you leave the **Setup** page so these functions will be restored the next time you run Thetis.

If you **enable** [Extended BTN mode](#) you can map additional button controls in Thetis to select specific modes, bands, and other features in the app.

Once you've completed your map you can export it to share with others. You can also import a map from someone else by clicking the **Manage Mappings** tab at the top of the **Midi Controller Setup** display. I've included a copy of my map in the firmware zip file.



Advanced Options

Operation with N1MM Logger+

You can use the *MIDI* as an interface to use N1MM's CW keyer with SmartSDR or SDR-Control for iOS. To do this, follow the instructions on the [N1MM Interfacing Basics](#) webpage to build a key interface circuit. This will require a USB serial adapter with a keying interface circuit wired to its RTS output. Connect the output of the keying interface circuit to the TIP and SHIELD of the *MIDI*'s Paddle input jack. Next, map the Left Paddle input on the *MIDI* to **Trigger CW Straight Key**. With this setup you can control your radio using the N1MM Logger+ and use keyboard keying in N1MM Logger+.

If you wire your paddle in parallel with the N1MM+ straight key you can switch between your paddles and the N1MM+ keyer by switching [Extended Paddle Mode](#) (*long-press* the knob while in the **Home** knob mode – both yellow LEDs off).

Unfortunately, this configuration does not allow N1MM Logger+ to control your radio remotely.

If you're looking to have N1MM Logger control your radio remotely you might consider using CTR2-Micro to remotely control and key your radio with SmartSDR or SDR-Control providing the user interface. Instructions for this can be found in the [CTR2-Micro Operation Manual](#) under the **Advanced Options** section.

Troubleshooting CTR2-MIDI Firmware

The table below helps you troubleshoot problems with CTR2-MIDI firmware.

Issue	Solution
I can't connect the app to the CTR2-MIDI using USB MIDI	<ol style="list-style-type: none"> 1) Make sure you are using a USB-C <u>data</u> cable. Many USB-C cables are <u>power only</u>. These will not work with USB MIDI. 2) If using a mobile device (iPhone, iPad, Android, etc) you must use an OTG adapter for your device. This adapter provides a USB connection for an external device. Newer iPhones and iPads with USB-C connectors do not required an OTG adapter.
I can't connect the app to the CTR2-MIDI BLE device	<p>Make sure the Bluetooth radio is turned on and the app has permission to use Bluetooth. The green LED will flash once every 2 seconds when the radio is on. If it's off (green LED flashes once every 5 seconds), press and hold BTN6 then press the knob to turn it on.</p> <p>Follow the instructions in the Connecting CTR2-MIDI to the App and Enable Permissions sections.</p>
I have to connect CTR2-MIDI every time I start the app.	CTR2-MIDI will stay connected the app on your iOS or Mac device with Bluetooth-LE as long as it remains powered up. If you remove power from CTR2-MIDI you'll need to open the Tools -> CTR2 Controller window and click the Find Bluetooth-LE MIDI Device button then click Enable to reconnect it to the app. When connecting with USB MIDI it should say connected even through a power cycle.
My Flex radio starts sending a string of Dits or Dahs when I select CW mode	This seems to be a bug SmartSDR v6.9.15. If you press the paddles when the app is not in CW mode but the CWX panel is open that paddle press is buffered in the app. When you change to CW mode from another mode CWX triggers the last paddle press you made and keeps sending it until you press the paddle again, turn off CW mode, or close the CWX panel. This should be fixed in the latest update of SmartSDR.
The MIDI connects to my device but does not control anything	<ol style="list-style-type: none"> 1) Verify that you have mapped each MIDI control to a function in your app. 2) Verify that you are in the correct Extended BTN mode for the mapping in your app.
Frequency tuning is not working	<ol style="list-style-type: none"> 1) Make sure you have the right knob map selected. Press and hold BTN3 then press the knob to switch maps. 2) Use WheelA for RHR and Marcus' iOS and MacOS apps. Use WheelB for Thetis and other Windows apps. WheelB-r reverses the tuning direction and is used with PI HPSDR. 3) Make sure you have the knob mode set to the mode you programmed frequency control to. I use the knob's Home mode for frequency tuning. 4) Make sure you have the correct MIDI command mapped to the frequency control in your app.
How can I tell when I'm at the center (0 Hz) when controlling RIT or XIT?	Use the SliderB control for RIT and XIT controls. This control beeps and pauses tuning for about ½ second when the control reaches its center position (64 counts) and beeps twice when reaching the upper or lower end of tuning. SliderA does not beep at center or at the edges. Its best for most other knob or dial controls.

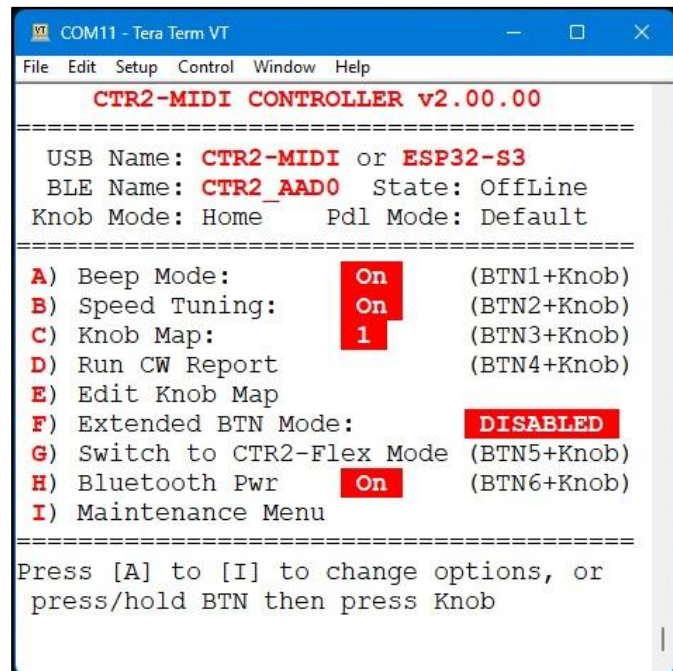
Pressing an BTN executes the wrong parameter	<ol style="list-style-type: none"> 1) Verify that the MIDI mapping is correct in the app. If it is, you may need to be recalibrate the BTN ADC counts. Connect a terminal to the unit's virtual serial port and select the Recalibrate Buttons option to start the recalibration process. 2) Verify that you are in the correct Extended BTN mode for the mapping in your app.
Speed tuning is not working	Speed sensitive tuning (tuning step changes as you tune faster) must be set to Normal or Fast in the <i>MIDI</i> 's settings. Press and hold BTN2 then press the knob to step through the speed settings. Morse output S0=Off, S1=Normal, S2=Fast. You may also have the wrong knob map selected on the <i>MIDI</i> . Press and hold BTN3 then click the knob to toggle maps.
Paddles don't key the radio	<ol style="list-style-type: none"> 1) Verify the radio is in CW mode 2) Verify the keyer is in Breakin mode and Sidetone in On in the P/CW panel 3) Verify the Paddle Mode is in Normal mode (green LED is off) 4) Verify MIDI Buttons 20 and 21 are mapped to Trigger CW Left Paddle and Trigger CW Right Paddle 5) Open the CWX Panel in the app's View menu 6) If you're using a Flex radio, cycle the power on the radio... it might be in CW Zombie mode.
Paddles are reversed	Remap MIDI Buttons 20 and 21 (or 96 and 97 if you're using the Extended BTN mode) in your app to swap Left and Right paddle assignments
No sidetone in SmartSDR when keying	Open the left pop-out window in the Panadapter display on the app and click the Audio menu. Set the Local Audio Monitor slider to 0.
Slow response or timing issues with keyer	Connecting multiple Bluetooth devices to your iOS device (i.e. CTR2-MIDI and a BT headset) may affect the app's keyer response to paddle input. consider using USB MIDI with an OTG adapter on your mobile device.

Appendix A: CTR2-MIDI Terminal Menus

This appendix is for the **CTR2-MIDI** terminal menus.

Many of the *MIDI*'s options can be changed using a "hold button and knob press" sequence. If you want to edit the knob maps, toggle [Extended BTN Mode](#), [Export](#) or [Import](#) setting files from your PC, [recalibrate](#) the buttons, or [reset](#) the *MIDI* to factory settings, you'll need to connect a terminal program such as [Putty](#) or [Tera Term](#) to the *MIDI*'s virtual USB serial port. Apple and Linux users can use the built-in terminal program on their computer. Information on connecting a terminal program can be found in [Appendix D](#), [E](#), and [F](#).

Once you connect the terminal to *MIDI* press any key on the terminal's keyboard to open the *MIDI*'s terminal display shown here.



Select an option by pressing the key associated with that option. For instance, to cycle through the **Beep** modes, press the [a] key.

The various options in the terminal **Home** menu display are described next.

Device Names

When connecting the *MIDI* to the device running the radio control app using the [USB-C connector](#) it will show up on the device using one of two device names. On Windows it shows up as **CTR2-MIDI**. On Apple iOS and MacOS devices it shows up as **XIAO_ESP32-S3**.

When you [connect to an Apple device using Bluetooth-LE MIDI](#) the *MIDI* will show up as **CTR2_** plus a four-digit hexadecimal number derived from the *MIDI*'s MAC address. This naming convention gives every *MIDI* a different Bluetooth-LE device name so you can use more than one *MIDI* on an Apple device, (but not at the same time!)

NOTE: I write the four-digit address on the bottom label of all assembled *MIDI*s.

The BLE **State** on the terminal display will show the connection status of the Bluetooth-LE MIDI connection. The green LED on the *MIDI* will flash twice once a second when the *MIDI*'s Bluetooth-LE is online. If the Bluetooth radio is turned off the status will show *BLE Off*.

NOTE: BLE MIDI is not supported on Windows.

Knob Mode

The knob mode will be shown here. You can step through the knob modes by pressing and releasing the knob. The yellow LEDs will show the selected mode.

Pdl Mode

When **Pdl mode** is set to **default**, the *MIDI* sends MIDI controls 20 and 21 for the left and right paddles (or 96 and 97 if [Extended BTN mode](#) is **enabled**). These are usually mapped to the *Trigger CW Left paddle* and *Trigger CW Right paddle* functions in the iOS/macOS apps. When the **Extended Paddle mode** is selected (by long-pressing the knob in the knob's **Home** mode – yellow LED are off) MIDI controls 30 and 31 (or 98 and 99 if [Extended BTN mode](#) is **enabled**) are sent with the left and right paddles. These can be mapped to the *Trigger CW Straight Key* and *PTT Push* functions in the SmartSDR app. **Not every app has keyer or straight key MIDI controls.**

Beep Mode

Press **A** (or press and hold **BTN1** then press the knob) to step through the **Beep** modes. When **Beep** is *off* the LEDs will momentarily flash when you press a control long enough to enter its long-press function. When **Beep** is *normal* pressing any button or the knob will sound a beep. If **Beep** is set to *Long-Press* the *MIDI* will only beep when you press a control long enough to enter its long-press function.

The selected beep mode will be sent in Morse, **B0**= Beep mode Off, **B1**= Beep mode Normal, **B2**= Beep mode Long-Press.

Speed Tuning

Press **B** (or press and hold **BTN2** then press the knob) to step through the speed (proportional) tuning settings for **WheelA**. There are three options, *Off*, *Normal*, and *Fast*. The selected tuning mode will be sent in Morse, **S0**= Speed tuning Off, **S1**= Speed tuning Normal, **S2**= Speed tuning Fast.

Knob Map

Press **C** (or press and hold **BTN3** then press the knob) to toggle between **Knob Map 1** and **Knob Map 2**.

The selected map will be sent in Morse, **M1**= Map 1 is active, **M2**= Map 2 is active.

Run CW Report

Press **D** (or press and hold **BTN4** then press the knob) to have the *MIDI* report all of the option settings in Morse code. You can press any button during the report to silence it.

The report uses the following format:

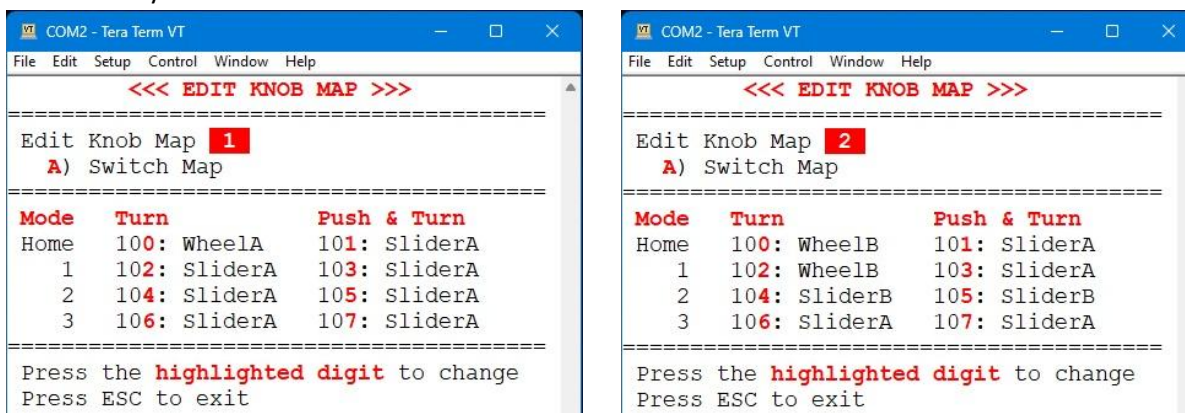
M **M** represents MIDI mode. In **CTR2-Flex WiFi** mode the report starts with **F**
B{0, 1 or 2} **Beep** mode, 0=off, 1=on, 2= Beep for long-press only
S{0, 1, or 2} **Speed Tuning** mode, 0=off, 1= normal, 2= fast
M{1 or 2} **Map #**
BT{0 or 1} **Bluetooth Radio** mode, 0=off, 1=on

Edit Knob Map

Press **E** to open the **Edit Knob Map** display. Here you can change the MIDI control type assigned for each knob function. Press the **A** key to switch between the two maps.

Knob Map 1 is typically used with RHR and Marcus' iOS/MacOS apps. **Knob Map 2** is typically used with Windows apps such as Thetis and SDR-Console.

Press the **Esc** key to exit this screen.



Four knob *Modes* with *Turn* and *Push & Turn* controls (for a total of 8 functions) are available on the knob. *Turn* mode controls are executed when you turn the knob, and are shown in the left column. They are even numbered starting at 100 (the MIDI **Control Change** command number). The *Push & Turn* controls are executed when you press and turn the knob, and are shown in the right column. They are odd numbered starting at 101.

IMPORTANT: You can only change the MIDI control type in the *MIDI* map. The actual radio parameter that each control changes must be mapped to the MIDI control # sent by the *MIDI* for each function.

Each knob function supports one of the following MIDI control types. To change the MIDI control type assigned to a knob function, press the highlighted hotkey (the red digit in the control #) on the terminal's keyboard.

- **Button** – in this mode turning the knob CCW or CW sends a MIDI **NoteOn {Button #}** for each knob tick based on the table below. There are 24 knob ticks per revolution. These commands can be used to change the frequency on iOS/macOS apps when they are mapped to the **Button Frequency Down** and **Frequency Up** in the app.

Turn	CCW Button #	CW Button #	Push & Turn	CCW Button #	CW Button #
100	40	41	101	42	43
102	44	45	103	46	47
104	48	49	105	50	51
106	52	53	107	54	55

- **SliderA** mode emulates a potentiometer. It sends a MIDI **Control Change** (aka **CC**) value for each knob tick to the app indicating the position of the slider. Turning the knob CCW decrements the count value down to 0 and turning the knob CW increments the count value up to 127. The *MIDI* remembers the last count position through power cycles. This mode is used for controls that would use physical knobs or sliders such as volume, squelch, power, etc.
- **SliderB** is similar to **SliderA** except it adds “audible detents”. The *MIDI* will beep once at the center (64 counts) and twice at the lower and upper limits of the control (0 and 127 counts). Knob changes are blocked for 600 milliseconds after the center beep to give you time to stop turning. **SliderB** is useful when using the knob for RIT and XIT tuning as the center beep indicates when RIT or XIT is turned off and the edge beeps indicate when you have reached the end of the tuning range.
- **WheelA** is similar to the **Slider** controls in that it uses a MIDI **CC** command to send a value to the app. This control has an imaginary center position at 64 counts. Turning the knob counter-clockwise sends a value below 64 for each knob tick. Turning it clockwise sends a value above 64 for each knob tick. This control is speed sensitive. Turning the knob slowly sends a value of +/- 1 count from center. Turning it moderately fast (one revolution every two seconds) sends a value of +/- 10 counts from center. Turning it fast (about 1 revolution per second) sends a value of +/- 50 counts from center. ***RHR and Marcus’ iOS/macOS apps use this scheme for frequency control and the frequency change per count depends on the Tune Step selected in the app.***
- **WheelB** is a variant of **WheelA**. Unlike **WheelA** this control has no center position, it only tells the app which direction the knob is being turned. Turning the knob counter-clockwise sends a value of 126 for each knob tick. Turning it clockwise sends a value of 1 for each tick. ***Thetis and SDR-Console use this scheme for frequency control. Frequency change per tick is based on the Tune Step set in the app.***
- **WheelB-r** is the same as **WheelB** except the tuning direction is reversed. This MIDI type is usually only used with the PI HPSDR app.

Extended BTN Mode

Press **F** to toggle the **Extended Button** mode. When **Extended BTN** mode is **disabled** the 12 MIDI Button controls remain the same for all knob modes. When **Extended BTN** mode is **enabled**, the MIDI Button control sent is determined by the current knob mode. The chart below shows the BTN# / MIDI Button assignments. The user must map the MIDI Button controls in their radio control app to execute the desired functions in the app.

WARNING: You must change the MIDI mapping in the radio control app if you change the **Extended BTN Mode**.

The following table shows the BTN and Paddle Input Jack to MIDI # assignments when **Extended BTN** mode is **disabled**. Worksheets are included in [Appendix H](#) for documenting these assignments.

BTN	Short-Press Function	Long-Press Function
1	MIDI 1	MIDI 11
2	MIDI 2	MIDI 12
3	MIDI 3	MIDI 13
4	MIDI 4	MIDI 14
5	MIDI 5	MIDI 15
6	MIDI 6	MIDI 16

Paddle Input Mode MIDI Assignments	
Normal	Extended
TIP -> MIDI 20	TIP -> MIDI 30
RING -> MIDI 21	RING -> MIDI 31

The following table shows the BTN and Paddle Input Jack to MIDI # assignments when **Extended BTN** mode is **enabled**. Worksheets are included in [Appendix I](#) for documenting these assignments.

Knob Mode	BTN	Short-Press	Long-Press	Knob Mode	BTN	Short-Press	Long-Press
Home ○ ○	1	MIDI 1	MIDI 25	2 ● ○	1	MIDI 13	MIDI 37
	2	MIDI 2	MIDI 26		2	MIDI 14	MIDI 38
	3	MIDI 3	MIDI 27		3	MIDI 15	MIDI 39
	4	MIDI 4	MIDI 28		4	MIDI 16	MIDI 40
	5	MIDI 5	MIDI 29		5	MIDI 17	MIDI 41
	6	MIDI 6	MIDI 30		6	MIDI 18	MIDI 42
1 ○ ●	1	MIDI 7	MIDI 31	3 ● ●	1	MIDI 19	MIDI 43
	2	MIDI 8	MIDI 32		2	MIDI 20	MIDI 44
	3	MIDI 9	MIDI 33		3	MIDI 21	MIDI 45
	4	MIDI 10	MIDI 34		4	MIDI 22	MIDI 46
	5	MIDI 11	MIDI 35		5	MIDI 23	MIDI 47
	6	MIDI 12	MIDI 36		6	MIDI 24	MIDI 48

In **Extended BTN** mode The Paddle Input Jack is mapped to the following MIDI #s based on the [Paddle Input Mode](#):

Paddle Input Mode MIDI Assignments	
Normal	Extended
TIP -> MIDI 96	TIP -> MIDI 98
RING -> MIDI 97	RING -> MIDI 99

Switch to CTR2-Flex Mode

Press **G** (or press and hold **BTN5** then press the knob) to switch to **CTR2-Flex WiFi** mode. An acknowledgement screen will open if you have a terminal connected and **F?** will be sent in Morse. You can press **Y** on the terminal or press the knob switch to execute the switch.

Bluetooth Pwr

Press **H** (or press and hold **BTN6** then press the knob) to toggle the Bluetooth radio's power. When powering the *MIDI* from a portable device such as an iPhone or iPad you can use USB MIDI (with the appropriate cable or OTG adapter) and turn the power off on the Bluetooth radio. This will cut the current consumption from about 93 mA to 43 mA.

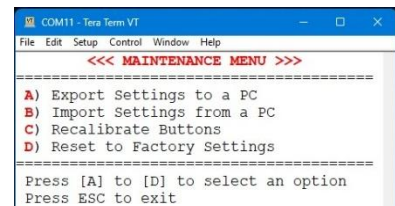
Pressing **H** will open an acknowledgment screen. If you enter **Y** the *MIDI* will send the new state of the Bluetooth radio in Morse (**BT0**=Off, **BT1**=On) then reboot.

NOTE: The Bluetooth power option is not available when **CTR2-MIDI** firmware is running on a **CTR2-Micro** hardware because the *Micro* hardware does not support USB MIDI and must use Bluetooth MIDI.

Maintenance Menu

The **Maintenance** menu is where you can backup and restore the settings on your unit, recalibrate the **BTNs**, and reset your unit to factory settings.

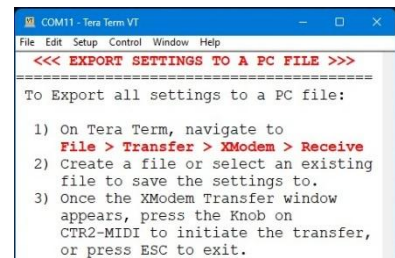
NOTE: You need to use a terminal program that supports XModem such as [Tera Term](#) to **Export** and **Import** settings files. It will be used here to explain the process.



Export Settings

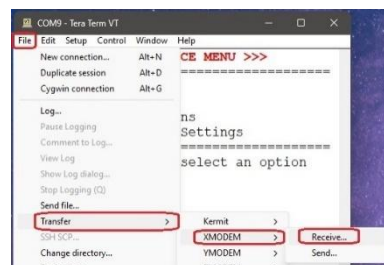
Press **A** to export the settings on your unit to a file on your computer. The terminal will display instructions on how to export your settings.

NOTE: This screen will time-out after 60 seconds if a transfer hasn't been started. You can also press any **BTN** on the unit to exit this screen.



Next, setup Tera Term to receive your data. Select **File->Transfer->XModem->Receive...** and enter the name of the settings file you wish to create. If you enter an existing file name, you'll be asked if you want to overwrite it.

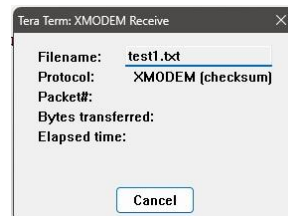
I'll create a file named *test1.txt* for this example. You can use any valid file name and extension for the file name.



NOTE: I recommend using the .txt extension since the file to be created is a text file and can be edited with a text editor.

Once you've entered the file name, the **XModem Receive** dialog box will appear. At this point, Tera Term is waiting for the unit to send its settings.

>>> Press and release the knob on the MIDI to start the transfer.



Once the transfer completes, you'll be returned to the **Maintenance** menu.

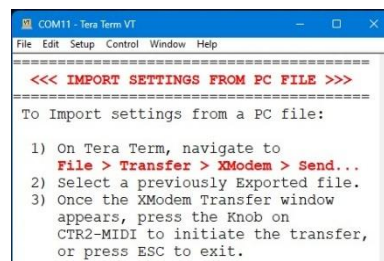
NOTE: Your WiFi and Radio IP settings are encrypted in the settings file for security.

Import Settings

Press **B** to import a previously [exported](#) settings file from your computer. This option uses **XModem Send** method to send the file.

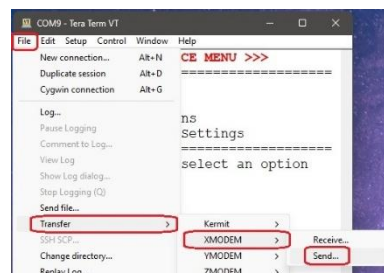
To initiate the **Import**, press **B** to start the process. The screen at the right will appear giving you instructions on how to proceed.

NOTE: This screen will time-out after 60 seconds if a transfer hasn't been started. You can also press any BTN on the unit to exit this screen.



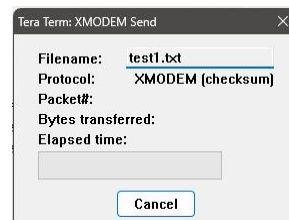
Next, select **File->Transfer->XModem->Send...** in Tera Term, then select a previously exported file from the file list to send to the *MIDI*.

In this example, I've selected a file named *test1.txt*.

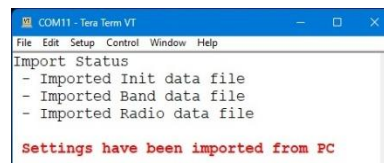


The **XModem Send** dialog box will appear indicating that Tera Term is waiting for the unit to indicate that it is ready to receive the file.

>>> Press and release the knob on the *MIDI* to initiate the transfer.



Once the transfer is complete, an **Import Status** screen will be briefly displayed indicating the status of each file imported. If any of the files indicate the import failed, try the **Import** function again.



The program will return to the **Maintenance Menu** once the transfer has completed.

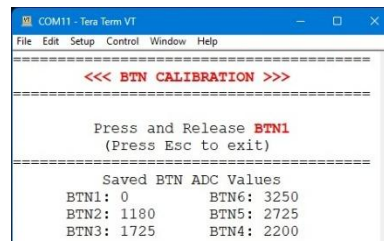
Recalibrate Buttons

Each button on the *MIDI* presents a specific voltage to the ADC (analog/digital converter) on the processor. This allows the processor to determine which button is pressed.

To ensure the highest repeatability, the buttons should be calibrated to compensate for manufacturing tolerances.

Press **C** on the **Maintenance** menu to start the calibration process.

Once the **BTN CALIBRATION** menu appears, press each button, one at a time, in sequence, starting with **BTN1** and working your way around to **BTN6**. This records the ADC values for each button. Once you've finished, the calibration screen will update and then return back to the **Maintenance** menu.



Reset to Factory Settings

Press **D** on the **Maintenance** menu to reset the unit back to factory settings. You will need to recalibrate the buttons, and re-enter your WiFi credentials, radio IP address, and call sign.

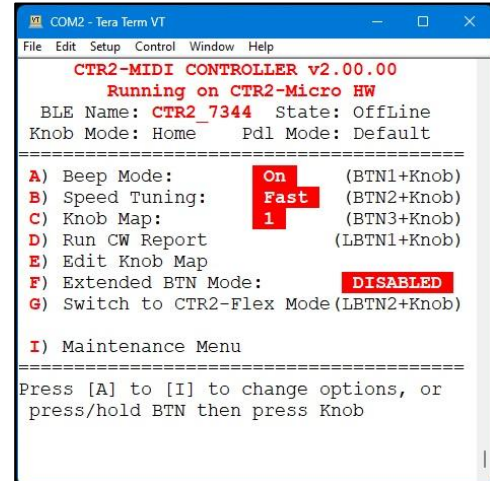
NOTE: If you don't want to lose your settings, [Export](#) them to your PC before resetting back to factory. After the reset, import them back into the *MIDI* using the [Import](#) function. You'll also want to export your settings if you plan on erasing the flash memory when updating the firmware.

Appendix B: Using CTR2-MIDI Firmware on CTR2-Micro

The CTR2-MIDI firmware can be flashed to CTR2-Micro. This gives current *Micro* users access to the *MIDI* features without having to buy new hardware.

NOTE: Because of the way the buttons are sampled on **CTR2-Micro** hardware (with the ESP32-C3 processor), you must recalibrate the buttons when switching between **CTR2-Micro** firmware and **CTR2-MIDI** firmware.

The terminal display for *MIDI* firmware running on the *Micro* is similar to the normal *MIDI* display except the **USB Name** and the Bluetooth Power option is not shown because these options are not available on the *Micro*.



There are several limitations to using the *MIDI* firmware on the *Micro*:

- **CTR2-Micro** hardware only supports Bluetooth-LE MIDI and WiFi. The ESP32-C3 processor in the *Micro* doesn't have the hardware to support USB MIDI.
- Once you have flashed the *MIDI*'s firmware on your *Micro* most of the features you use on the *Micro* will no longer be available. This includes the following:
 - WiFi is not supported in **CTR2-MIDI** firmware. To control a Flex radio over WiFi, switch to **CTR2-Flex WiFi** mode, however, CTR2-Flex WiFi mode does not support [CTR2-Voice](#)
 - Serial CAT is not supported so you can't control other radios with the *Micro*
 - The *Micro*'s keyer is not supported so you can't use a terminal as a keyboard keyer or use any CW message buffers you had set up in the *Micro*. **CTR2-Flex WiFi** mode does have a built-in keyer and has its own set of CW message buffers.
 - Physical Key and PTT Output are not supported; however, **CTR2-Flex WiFi** mode does support Key and PTT over WiFi
 - Favorite Frequency and Previous Frequency lists are not supported
 - The web browser interface is not supported
 - You must reflash the **CTR2-Micro** firmware on your *Micro* to restore its normal features
- The *Micro* only has three buttons so you can only map 6 MIDI **Buttons** in the app (or 24 if you enable [Extended Button Mode](#)).
- The *Micro* only has one LED. This LED flashes to indicate the current mode of the unit. It does not indicate long-press mode if **Beep** mode is turned *Off*.
- CW Report and Switch Mode options (**BTN4+Knob** and **BTN5+Knob**) are accessible using *long-press* **BTN1+Knob** and **BTN2+Knob** sequences.

Flashing the Firmware

To flash the *MIDI* firmware on to your *Micro*, unzip the four binary files from the *MIDI* firmware distribution zip file into a unique folder then follow the instructions in [Appendix B](#).

You will need to complete the **BTN Calibration** on the *Micro* to save the BTN ADC counts in the *MIDI*'s initialization file. This only needs to be done once.

NOTE: The *MIDI* firmware maintains its own file structure therefore the settings you had for the *Micro* firmware are not lost. Just reflash the *Micro* firmware to your *Micro* to restore your *Micro* to its normal operation – **do not Erase the flash memory** in the Flash Download tool.

Operating the *Micro* with *MIDI* Firmware

MIDI firmware can run on *Micro* hardware, with a few differences. You will need to go through the same steps to connect the *Micro* to your iPad and you will need to map the controls on the *Micro* to the app. The main difference is that you will only have 6 **MIDI Button** functions (two on each BTN) and all of the knob modes (24 if you enable [Extended BTN Mode](#)).

LED Indications

The big difference between the *MIDI* and the *Micro* is with the LED indicators (or lack thereof). The *Micro*'s status is indicated by the flash sequence of the status LED.

The table below summarizes these flash sequences and the beeps associated with them.

Knob Mode	Flash Sequence	Buzzer Tone when entering this mode	Description
Home	One long flash	One high frequency beep	Primary knob sends Control Change (CC) 100 Push and turn sends CC 101
Mode 1	One short flash	One low frequency beep	Primary knob sends CC 102 Push and turn sends CC 103
Mode 2	Two short flashes	Two low frequency beeps	Primary knob sends CC 104 Push and turn sends CC 105
Mode 3	Three short flashes	Three low frequency beeps	Primary knob sends CC 106 Push and turn sends CC 107

The **Paddle Mode** determines the rate of the LED flash.

- When **Paddle Mode** is in **Normal** mode (controlling **MIDI Buttons 20** and **21**) the LED flashes the status at 2 second intervals
- When **Paddle Mode** is in **Extended** mode (controlling **MIDI Buttons 30** and **31**) the LED flashes the status at 1 second intervals

Modified **BTN#+Knob** Functions

Since the *Micro* hardware only has three physical buttons the **BTN#+Knob** options are slightly modified.

The [BTN4+Knob](#) function to play the report or change PTT modes is accessed by *long-pressing* **BTN1+Knob**.

The [BTN5+Knob](#) function to switch modes is accessed by *long-pressing* **BTN2+Knob**.

The **BTN6+Knob** function to toggle WiFi (in Flex WiFi mode) is accessed by *long-pressing* **BTN3+Knob**.

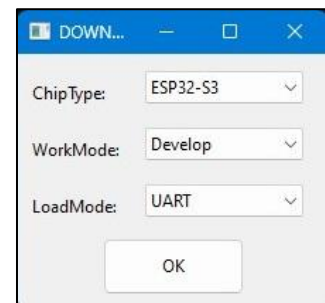
Appendix C: Installing or Updating CTR2-MIDI Firmware

As of v2.00.00, the *MIDI's* firmware is distributed as a single BIN file. This simplifies the installation process and reduces the possibilities of entering the wrong offset address for individual BIN files. The address of the single BIN file always starts at **0x0**.

Kits and assembled **CTR2-MIDIs** have the firmware already installed on them but as you might expect, changes will be made to the program over time. To install the latest MIDI firmware on your device, follow these steps:

1. Determine which version of the firmware you need for your device. If your device is a CTR2-MIDI (with six BTNs) you'll need the **S3** firmware (for the ESP32-S3). If you are running CTR2-MIDI on a CTR2-Micro (with three BTNs) you'll need the **C3** firmware (for the ESP32-C3).
2. Download and unzip the appropriate **CTR2-MIDI** firmware from [my web site](#) or the [CTR2 Group](#). Unzip it into a different folder than where you store other CTR2 firmware update files. In this example I unzipped it into my `C:_CTR2_MIDIv2\S3_Files\` folder. Your folder name will be different.
3. Download and open the [EspressIF Flash Downloader Tool](#). When it starts, select the **Chip Type** your unit is using (*ESP32-S3* for CTR2-MIDI or *ESP32-C3* for CTR2-Micro hardware). Leave **WorkMode** set to *Develop* and **LoadMode** set to *UART*.

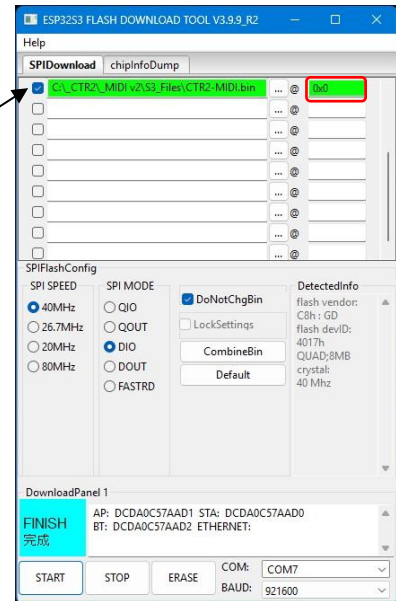
NOTE: A browser-based flash download tool is also available. See [this page](#) on my web site for more information.



- Map the **CTR2-MIDI.bin** file that you unzipped from the **CTR2-MIDI_v2.xx.xx** firmware distribution file into the downloader tool.
- Check the checkbox on the left of the **CTR2-MIDI.bin** filename as shown. This tells the program to flash this file.

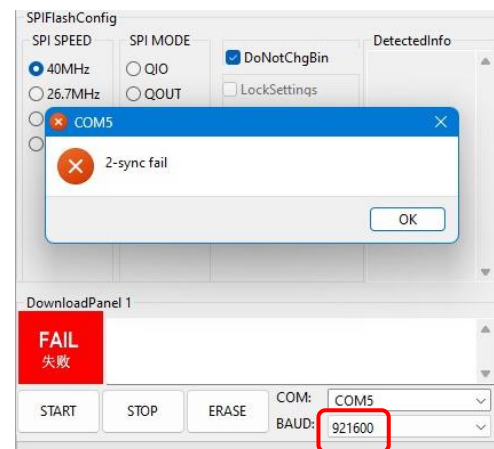
Set the **COM:** port to the port your computer assigned to **CTR2-MIDI** and set the **Baud** to **921600**.

NOTE: You must use a USB-C data cable. USB-C charge-only cables (supplied with many devices) will not work.



IMPORTANT NOTE FOR ESP32-S3

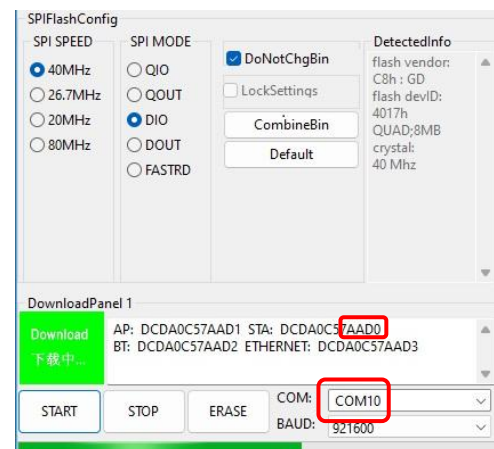
The ESP32-S3 processor in CTR2-MIDI has two USB UARTs. The first UART (COM 5 in this example, yours will be different) is active when you initially power up the unit and is the COM port you connect to with a terminal program. **When you select this port the Flash Download Tool will fail and pop up a 2-sync fail window when you press either Start or Erase.** Press **OK** to clear the alarm window.



Next, drop down the **COM:** list again. You will notice that the initial COM port (COM 5 in this example) is not on the list. You'll also notice a new COM port has been added to the list. On my computer it shows up as COM 10 (your computer will show a different port #). This is the second USB UART on the processor and is used for programming. Select this new COM port.

NOTE: If you don't see the second COM port you will need to press the **PROGRAM** button while you power up the *MIDI* to force it into program mode.

See the [Manually Switch the Processor to Program Mode](#) section for more information on this button.



NOTE: The ESP32-C3 processor in **CTR2-Micro** only has one UART so the above steps are not required. Just select the COM port for the *Micro* when flashing CTR2-MIDI firmware to it.

6. Click the **START** button to start the download.

NOTE: The unit's Bluetooth ID is based on the last four digits of the Station MAC address that is displayed in the top line of the info box once the flash process starts. In this case it is **AADO** (circled in the screenshot above). The Bluetooth ID of this unit will be **CTR2_AADO**. Your unit will have a different ID#.

7. Once the download is complete, cycle the power on the unit to start the new MIDI firmware.

NOTE: The ESP32-S3 processor will revert back to its initial COM port (COM 5 in this example) after the reboot.

NOTE: Clicking the **ERASE** button will erase the entire flash memory including the setup file. This will reset any custom MIDI control types you have selected for **CTR2-MIDI** mode, and all custom settings in **CTR2-Flex WiFi** mode. It also resets the BTN ADC values back to default values. You will need to [recalibrate](#) the buttons when you start the program and edit the maps on the *MIDI* (or [Import](#) a previously [Exported](#) settings file) to restore your custom settings. MIDI Mapping [in your app](#) is not affected.

NOTE: If you are flashing the MIDI firmware to a **CTR2-Micro** (-C3 processor) erasing the flash will also delete the configuration files used with the normal *Micro* firmware.

Installing Firmware using Linux or Mac

A script file is also supplied in the firmware update zip file. This script file can be used in a Linux or Mac environment if you don't have access to a Windows computer.

Instructions for using this script file are include in the [CTR2-Micro Operation Manual](#) in **Appendix B**.

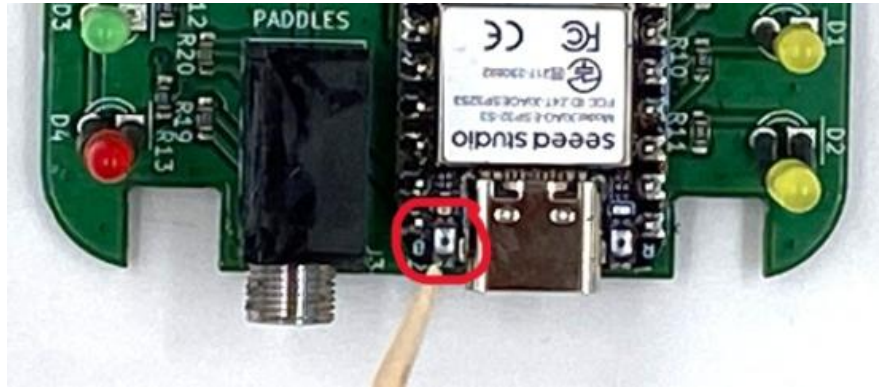
NOTE: A browser-based flash download tool is also available. See [this page](#) on my web site for more information.

The firmware that allows USB MIDI control, changes the way the virtual COM port works on the ESP32-S3. One COM port is used in the normal operating mode and another COM port is used for flashing the firmware. In order to flash new firmware to the unit you must force the ESP32-S3 to switch from the normal operating mode to programming mode.

Manually Switch the Processor to Program Mode

- 1) Power the unit off.

- 2) Press and hold the **PROGRAM** button down on the processor board then apply power to the board. Yes, it's that little black dot on the square silver pad the toothpick is pointing to in this photo!



A notch has been cut in the enclosure next to the USB-C connector to allow you to access this button without opening the enclosure.

It's still hard to do especially if your eyes aren't as good as they use to be. Insert the toothpick only about 6mm (1/4") and gently press down. You will feel a light click. If you insert the toothpick too far it will rest on the chip LED in back of the switch and will not press the button. Once you have the button pressed power up the unit. If it's in programming mode the normal LED boot sequence will not run. Use a terminal program to find the Program UARTs COM port assignment.

Once the unit is in Programming mode, edit and run the script to flash the firmware.



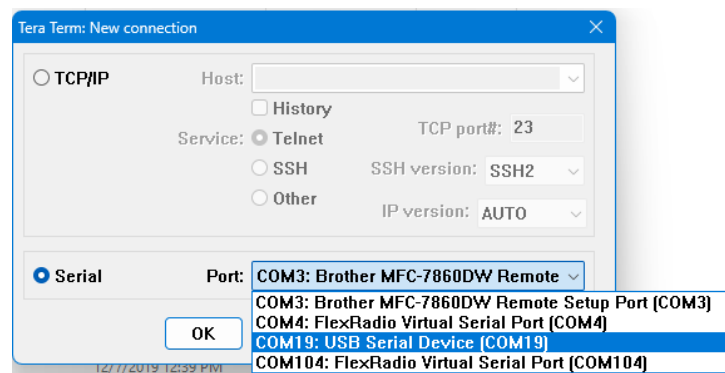
NOTE: To use the script, you must set it as an executable file and grant permission in you OS to access the **DIALOUT** group. You'll also need to edit the file to add the serial port ID and the path to the CTR2-MIDI.BIN file.

Appendix D: Configuring Tera Term

Tera Term is the simplest terminal program to get running for a serial connection.

If you search for Tera Term you will find a lot of garbage with malware attached to it. I've downloaded a clean copy of Tera Term v4.106 and posted it in the [CTR2 Group Tera Term Install File](#) section. You can download it [here](#). As far as I know, Tera Term is only available for Windows.

When you first open Tera Term you'll be presented with the **Tera Term New connection** window. Simply select the **Serial** radio button, select the COM port Window's assigned to your Micro when you plugged it in, and click the **OK** button.



Since you are connecting to a USB serial port there is no need to set the baud rate. It will run at USB speed regardless of the baud setting.

That's it! Tera Term will connect to the *MIDI*. Press any key to open the configuration display.

You can change the terminal size in the **Setup** menu. Select **Terminal...** Set the **Terminal Size** to 41 x 20. The *MIDI*'s terminal interface was designed for this size.

While in the **Terminal...** settings verify the **New-line** options are set to *CR* for both **Transmit** and **Receive** and the **Terminal ID** is set to *VT100*.

You'll probably want to change the font size and colors. These are also changed in Tera Term's **Setup** menu. Select **Display** to change the font and background colors to your liking. Select **Font** to change the font and font size. I like *Courier New, Regular, and 14-point size*. Your preferences may differ.

Once you have the program configured the way you like, select the **Setup->Save Setup...** menu and save your configuration. If you use the default file name, TERATERM.INI the program will automatically start a Telnet session using the COM port you selected above when it opens. This provides one-click access to your *MIDI*.

Appendix E: Configuring Putty

Putty is a terminal program that can be configured for a variety of needs. The *MIDI* only supports serial connections. This section describes how to configure the program to interface with the *MIDI*.

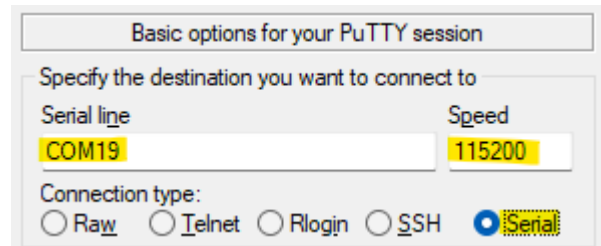
Download Putty for Windows from <https://www.putty.org/>. It's also available for Linux at <https://www.ssh.com/academy/ssh/putty/linux> and for Mac at <https://www.ssh.com/academy/ssh/putty/mac>.

You'll need to connect to the *MIDI* using its USB serial port in order to configure it.

Serial Session

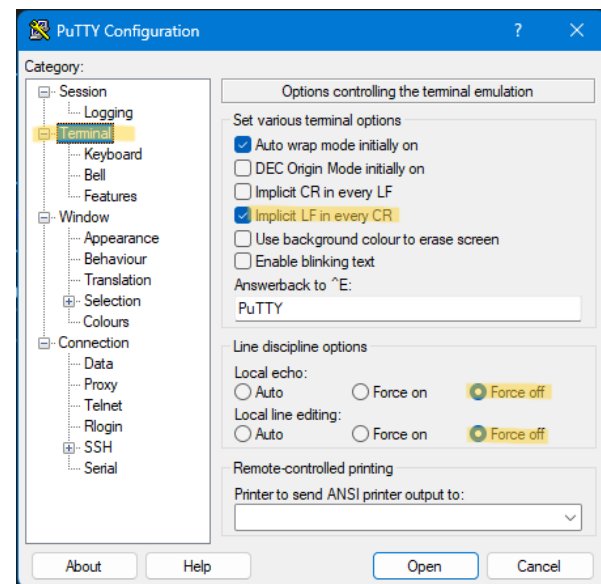
Select **Serial** then set the **Serial Line** to the COM port you found in the Device Manager and set **Speed** (Baud Rate) to 115200.

NOTE: Since this is a USB serial port the **Speed** (baud rate) doesn't matter. Data will be sent at USB speeds regardless of the **Speed** setting.



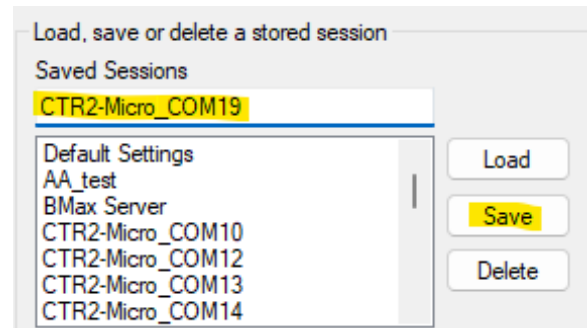
Next, select the **Terminal** item and set the **Implicit LF in Every CR** to on, and **Local Echo**, and **Local Line Editing** to **Force Off**.

You can change the window size under the **Window** item. Set the **Columns** to 41 and the **Rows** to 20.



Once this has been done, return to the **Session** menu item, enter a name for this session and click the **Save** button. This allows you to easily re-open this session with just a couple of clicks.

If you right-click on the Putty icon in the Windows toolbar the last few sessions you had open will be displayed. Just select the one you want to open it.



You can adjust the display colors on the **Windows->Colours** menu item. The Micro uses the **Bold** attribute to highlight the **hotkeys** and other items. I like to set the **Background** color to blue and the **Bold** color to yellow but you can find the colors that work for you. After you get a color combination you like return to the **Session** menu and **Save** the session.

Appendix F: Apple or Linux Terminal Programs

The Apple Mac and Linux have built-in terminal programs so there is no need to install a separate app. To connect your *MIDI* to a terminal session, use the following process.

First, list your current serial ports without the *MIDI* plugged in.

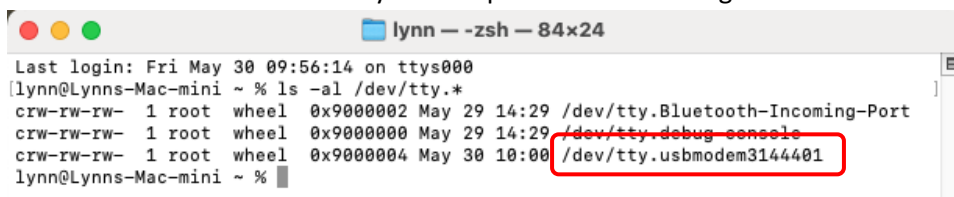
- On the Mac open **Applications/Utilities/Terminal.app**. On Linux open the terminal program supplied by your distro.
- On the Mac, enter **`ls -l /dev/tty.usb*`**, on Linux, enter **`ls /dev/tty*`** This will return a list of all known serial ports.
- Next, plug the *MIDI* into the computer's serial port and execute the command above again. This is easily done by pressing the *Up*-arrow key.
- Compare the new list with the old list. The *Flex's* serial port ID will appear on just the new list. For Mac users the serial port ID format will be **`/dev/tty.usbserialxxxxx`** where **`xxxxx`** is a unique device ID #. Linux users will see something like **`/dev/ttyACMx`** or **`/dev/ttyUSBx`**, where **`x`** is a unique # for that port.

NOTE: If a new virtual serial port is not created when you plug your Micro into your PC make sure you are using a USB-C cable that supports data. Many USB-C cables only provide power to the remote device.

Once you know the *MIDI's* USB serial port ID, write it on the label on the bottom of the unit using a fine-tipped permanent marker for future reference. Put a piece of transparent tape over the label to seal the ink so it doesn't rub off (it's not as permanent as you think). You can always remove the tape if you want to change what's written on the label.

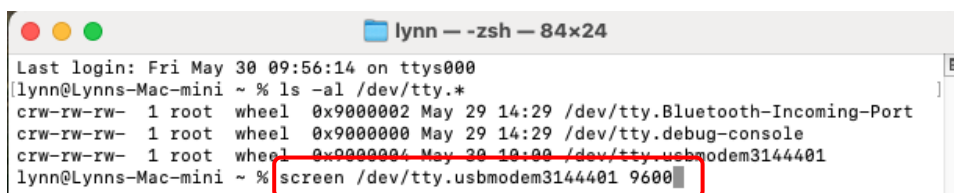
Once you have the serial port ID, enter the following: **`screen {serial port ID} 9600`**. Include the complete device description (i.e. **`/dev/ttyxxxxxx`**) for the **serial port ID**. This will open the serial port using 9600 baud in a terminal session. The following screenshots demonstrate these steps.

1. Get the list of serial devices on your computer. We're looking for the **usb** device.



```
lynn - zsh - 84x24
Last login: Fri May 30 09:56:14 on ttys000
[lynn@Lynns-Mac-mini ~ % ls -al /dev/tty.*
crw-rw-rw-  1 root  wheel  0x9000002 May 29 14:29 /dev/tty.Bluetooth-Incoming-Port
crw-rw-rw-  1 root  wheel  0x9000000 May 29 14:29 /dev/tty.debug-console
crw-rw-rw-  1 root  wheel  0x9000004 May 30 10:00 /dev/tty.usbmodem3144401
lynn@Lynns-Mac-mini ~ %
```

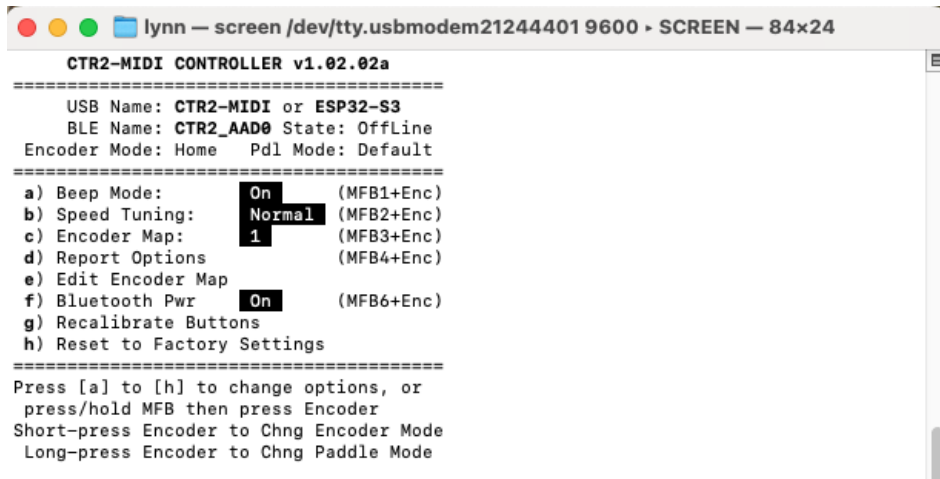
2. Open the **screen** utility using the **usbmodem3144401** device. Your USB device will have a different #.



```
lynn - zsh - 84x24
Last login: Fri May 30 09:56:14 on ttys000
[lynn@Lynns-Mac-mini ~ % ls -al /dev/tty.*
crw-rw-rw-  1 root  wheel  0x9000002 May 29 14:29 /dev/tty.Bluetooth-Incoming-Port
crw-rw-rw-  1 root  wheel  0x9000000 May 29 14:29 /dev/tty.debug-console
crw-rw-rw-  1 root  wheel  0x9000004 May 30 10:00 /dev/tty.usbmodem3144401
lynn@Lynns-Mac-mini ~ % screen /dev/tty.usbmodem3144401 9600
```

3. The Apple and Linux terminals don't offer a lot of customization, and they don't support XModem transfers for exporting and importing setting file backups.

This is the *MIDI*'s terminal display on a Mac.



```
lynn — screen /dev/tty.usbmodem21244401 9600 ▸ SCREEN — 84x24

CTR2-MIDI CONTROLLER v1.02.02a
=====
USB Name: CTR2-MIDI or ESP32-S3
BLE Name: CTR2_AAD0 State: OffLine
Encoder Mode: Home Pdl Mode: Default
=====
a) Beep Mode:      On      (MFB1+Enc)
b) Speed Tuning:   Normal   (MFB2+Enc)
c) Encoder Map:    1        (MFB3+Enc)
d) Report Options  (MFB4+Enc)
e) Edit Encoder Map
f) Bluetooth Pwr   On      (MFB6+Enc)
g) Recalibrate Buttons
h) Reset to Factory Settings
=====
Press [a] to [h] to change options, or
press/hold MFB then press Encoder
Short-press Encoder to Chng Encoder Mode
Long-press Encoder to Chng Paddle Mode
```

Appendix G: Using CTR2-MIDI with Non-MIDI Programs

MIDI is not limited to programs that support MIDI controls. Third-party MIDI translator apps such as [CoyoteMIDI](#) can receive MIDI commands from the *MIDI* and convert them to other actions such as mouse scroll or keystroke actions. MIDI translator programs are available for Windows, Mac, and Linux.

These apps allow the *MIDI* to be used as a physical tuning knob with radio control programs such as [SmartSDR for Windows](#), [wfView](#), and [WebSDR](#) that don't normally support external tuning knobs. And it doesn't stop there. These apps also allow the *MIDI* to be used with any program that accepts mouse scrolls or keystroke for control. For instance, it makes a great jog wheel for [Audacity](#).

There are a couple of drawbacks to using a translation app instead of native MIDI control. First, like your mouse or keyboard, the app you want to control must be "in focus" to receive the mouse scrolls or keystrokes from the translation app. Second, most programs don't have a lot of control functions tied to mouse scroll or keystroke actions. For instance, SmartSDR for Windows only accepts mouse scroll actions for frequency control and wfView only supports the J and K keys for frequency control.

Configuring CoyoteMIDI

This section will cover configuring CoyoteMIDI to interface with SmartSDR for Windows and wfView. The translator you choose will have a different setup procedure but they're all basically the same.

Before you start, plug the *MIDI* into a USB port on your computer. It will automatically register as a MIDI device. Make sure you are in the

Home knob mode (all yellow LEDs are OFF. If any of them are on, press and release the knob switch until they are all off. This puts the knob in its **Home** knob mode.

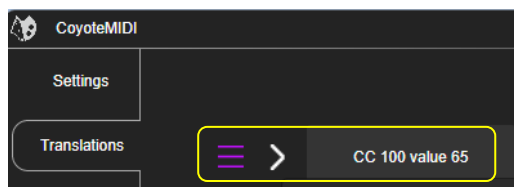
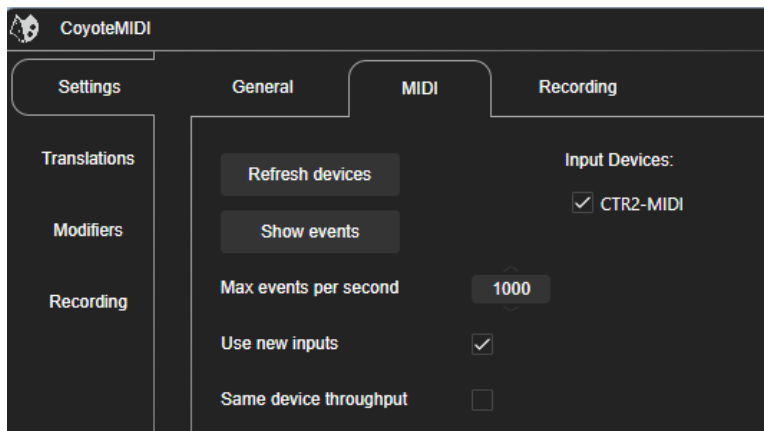
Once you've installed CoyoteMIDI open the app and navigate to the **Settings -> MIDI** tab. **CTR2-MIDI** should show up on the **Input Devices:** list. Click the checkbox to enable it.

Configure SmartSDR for Windows Frequency Control

Next, select the **Translations** tab and click the **+ Add Translation** button in the top-right corner.

The first example uses the **Home** knob mode on the *MIDI* (MIDI control #100). This mode uses the **WheelA** MIDI control where a value of 65 represents a clockwise turn and 63 represents a counter-clockwise turn of the knob.

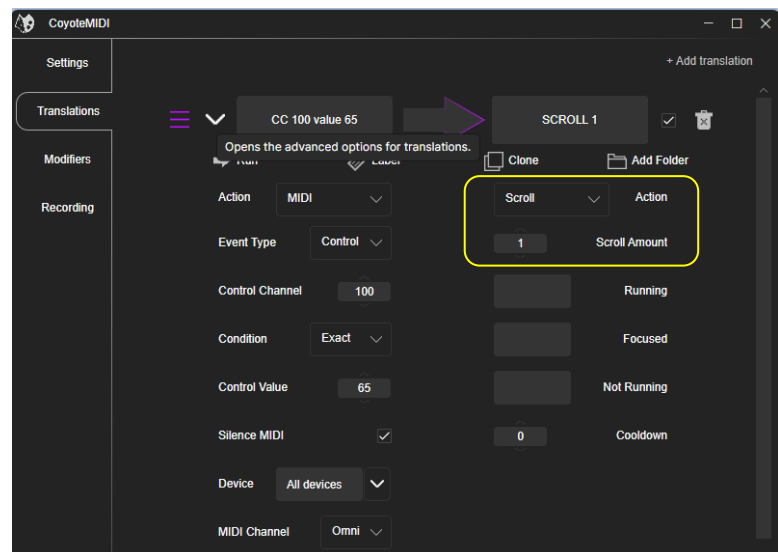
Click the box with **Click to record** then turn the knob on the *MIDI* slowly clockwise. You should see **CC 100 value 65** appear in the left box. If you don't see this, make sure all yellow LEDs are off. Hover the mouse over this entry to show the violet menu and > icons.



Click the > icon to view the details of this command. I've already set this command to be translated to the **SCROLL 1** mouse command.

The options on the left should be as shown. If not, edit them to match what's shown here.

To configure the **SCROLL 1** output, click the **Action** dropdown box and select **Scroll**. Next, set the **Scroll Amount** to **1** so each tick of the clockwise turn of the knob produces one scroll tick.



That's it. You configured your first translation. Click the **+Add Translation** button again and follow the same process to program the counter-clockwise knob turn. In this case, set the **Scroll Amount** to **-1**. This will send the reverse mouse scroll.

Now open SmartSDR for Windows and the frequency should change as you change the knob on the *MIDI*.

Configure wfView Frequency Control

You can set up translations for many other programs the same way. Next, we'll go over setting up keystroke "J" and "K" to control the frequency in wfView.

Press and release the knob on the *MIDI* to switch to **Knob Mode 1**. The bottom yellow LED should be ON and the top yellow LED should be OFF. In this mode, the knob sends MIDI control #102.

NOTE: This knob uses the **SliderA** control type. This type operates like a potentiometer and has a range of 0 to 127 counts. To use this control type, we'll look for the value increasing or decreasing to determine the direction the knob is turning. You can edit the MIDI control type in a terminal if you want to change it to **WheelA**. If you do this, follow the setting in the first example.

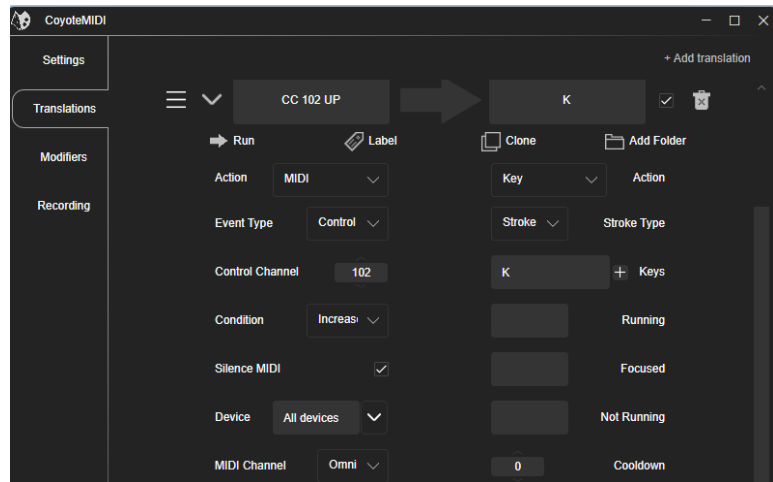
Click the **+Add Translation** button to add another translation.

Click the box that says **Click to record** then turn the knob on the *MIDI* clockwise. You should see **CC 102 value xx**, where xx is a number between 1 and 127.

Hover the mouse next to this box then click the > icon to show the details.

On the left column, click the **Condition** dropdown box and select **Increase**. This action will trigger when the MIDI value is increasing. The title in the top box will change to **CC 102 UP**.

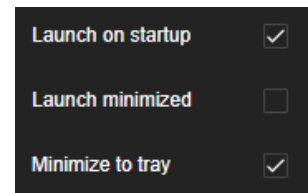
In the **Action** dropdown box in the right column select **Key** and in the **Stroke Type** select **Stroke**. Finally, in the **+ Keys** box, enter **K**. This is the key used to increment the frequency in wfView.



Next, click the **+ Add Translation** button again, click the new box showing **Click to record** and turn the *MIDI*'s knob counter-clockwise. Now, follow the same process as outlined above except select **Decrease** in the **Condition** box and enter the letter **J** in the **+ Keys** box. wfView uses the **J** key to decrement the frequency. I'm not aware of any other keystrokes wfView supports. If there are more they can easily be added.

CoyoteMIDI Startup Options

There are a couple of options in the **Settings -> General** menu that you might want to set if you regularly use the *MIDI* and CoyoteMIDI with your apps. If you select **Launch on startup** and **Minimize to tray** options CoyoteMIDI will automatically start when you boot your computer and will be available in the Windows tray if you need to change anything.



Appendix H: Knob and Normal Button Assignment Worksheet

This worksheet can be used to document the knob and button assignments when CTR2-MIDI is in *Normal* button mode. An Excel version of this worksheet is available [here](#)..

CTR2-MIDI Normal-Button Worksheet

App: _____

Use this sheet to document your radio control App's MIDI mapping

[Excel files can be found here](#)

Knob Modes: Upper # is Turn, Lower # is Push & Turn

Firmware v2.00.00

Button Modes: Upper # is Short-press, Lower # is Long-press

All Knob Modes

Button Assignments	
MIDI #	Function
1	
11	

2	
12	

3	
13	



Button Assignments	
Function	MIDI #
	6
	16

	5
	15

	4
	14

Knob Assignments			
Mode	Function	MIDI #	Ctrl Type*
Home		100	
P&T		101	

1		102	
P&T		103	

2		104	
P&T		105	

3		106	
P&T		107	

NOTE: Change App MIDI mapping when changing between Normal and Extended Button modes.

Control Types	Description
SliderA	Potentiometer type
SliderB	Centerr Beep
WheelA	VFO - SmartSDR
WheelB	VFO-Thetis
WheelB-R	VFO-PiSDR

* Set Control Type in MIDI's Map

Paddle Input Assignments	
Normal Paddle Mode	
MIDI #	Function
20	Left Paddle
21	Right Paddle
Extended Paddle Mode	
30	Staight Key
31	MOX

Appendix I: Knob and Extended Button Assignment Worksheets

Use this worksheet to record the *Extended* button assignments you have mapped in your radio control app. An Excel version of this worksheet is available [here](#).

Use this sheet to document your radio control App's MIDI mapping

Knob Modes: Upper # is Turn, Lower # is Push & Turn

Button Modes: Upper # is Short-press, Lower # is Long-press

CTR2-MIDI Extended Button Worksheet

App: _____

[Excel files can be found here](#)
Firmware v2.00.00

Knob Assignments

MIDI #

Function

100

101

Button Assignments

MIDI #

Function

1

25

2

26

3

27

Knob Assignments

MIDI #

Function

102

103

Button Assignments

MIDI #

Function

7

31

8

32

9

33

Knob #1



Knob Control Types

SliderA

SliderB

WheelA

WheelB

WheelB-R

...

Common for most

PIT, XIT

WFO in SmartSDR

WFO in Thrift

WFO in PISDR

Knob Assignments

MIDI #

Function

106

107

Button Assignments

MIDI #

Function

12

36

11

35

10

34

Knob #2



Knob Assignments

MIDI #

Function

104

105

Button Assignments

MIDI #

Function

6

30

5

29

4

28

Knob Assignments

MIDI #

Function

107

108

Button Assignments

MIDI #

Function

13

37

14

38

15

39

Knob #3



Knob Assignments

MIDI #

Function

109

110

Button Assignments

MIDI #

Function

18

42

17

41

16

40

Knob #3



Knob Assignments

MIDI #

Function

111

112

Button Assignments

MIDI #

Function

24

48

23

47

22

46

Knob #3



Knob Assignments

MIDI #

Function

113

114

Button Assignments

MIDI #

Function

25

49

24

48

23

47

Knob #3



Knob Assignments

MIDI #

Function

115

116

Button Assignments

MIDI #

Function

26

50

25

49

24

48

SmartSDR for iOS/macOS Worksheet Example

This spreadsheet shows an example of the mapping you can use in SmartSDR for iOS/macOS.

CTR2-MIDI Extended Button Worksheet

SmartSDR for iOS/macOS

Use this sheet to document your radio control app's MIDI mapping

Knob Modes: Upper # is Turn, Lower # is Push & Turn

Button Modes: Upper # is Short-press, Lower # is Long-press

Knob Assignments

MIDI #	Function
100	Slice Frequency **
101	Slice Volume

Button Assignments

MIDI #	Function
1	Mode Next
25	Mode Prev
2	Band Next
26	Band Prev
3	Main Audio Mute
27	DAX Toggle

Knob Assignments

MIDI #	Function
102	AGC-T
103	Zoom Slice

Button Assignments

MIDI #	Function
7	Mode CW
31	DigL
8	Mode LSB
32	DigH
9	Mode USB
33	SAM

Paddle Input Assignments

MIDI #	Function
96	Trigger Left Paddle
97	Trigger Right Paddle
98	Trigger Straight Key
99	MDX

Knob #1

CTR2-MIDI

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Knob Control Types

Knob Control Types	Notes
SliderA	Common for most
SliderB	PII, XIT
WheelA	WFO in SmartSDR
WheelB	WFO in Thesis
WheelB-R	WFO in PISDR
....	

Knob Assignments

MIDI #	Function
104	NR Level
105	NB Level

Button Assignments

MIDI #	Function
Tune Step	6
30	
Zoom In	5
Zoom Out	29
NR	4
NB	28

Knob Assignments

MIDI #	Function
106	CW Speed
107	PII Freq *

Button Assignments

MIDI #	Function
Mode RTTY	12
Open DX Cluster Tool	36
Mode FM	11
Open Logbook Tool	35
Mode AM	10
Open FT8 Tool	34

Knob Assignments

MIDI #	Function
19	Macro 1
43	Macro 5
20	Macro 2
44	Macro 6
21	Macro 3
45	Macro 7

Knob #2

CTR2-MIDI

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Function

Function	MIDI #
6 Meters	18
10 Meters	17
12 Meters	41
15 Meters	16
17 Meters	40

Knob Assignments

MIDI #	Function
13	80 Meters
37	160 Meters
14	40 Meters
38	60 Meters
15	20 Meters
39	30 Meters

Button Assignments

MIDI #	Function
Log QSD	24
Slice Set Tx	48
PII	23
XIT	47
Macro 4	22
Macro Stop	46

Knob #3

CTR2-MIDI

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Knob Control Types

Knob Control Types	Notes
SliderA	Common for most
SliderB	PII, XIT
WheelA	WFO in SmartSDR
WheelB	WFO in Thesis
WheelB-R	WFO in PISDR
....	

Knob Assignments

MIDI #	Function
106	CW Speed
107	PII Freq *

Button Assignments

MIDI #	Function
Mode RTTY	12
Open DX Cluster Tool	36
Mode FM	11
Open Logbook Tool	35
Mode AM	10
Open FT8 Tool	34

Knob Assignments

MIDI #	Function
19	Macro 1
43	Macro 5
20	Macro 2
44	Macro 6
21	Macro 3
45	Macro 7

Excel files can be found here

Firmware v2.00.00

CTR2-MIDI Operation Manual v2.00

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This spreadsheet shows an example of the mapping you can use in Thetis.

Thetis

Knob Modes: Upper # is Turn, Lower # is Push & Turn

[Excel files can be found here](#)
Firmware v2.00.00

1

Function	MIDI t
6 m	18
VFO Swap	42

12 m	41
15 m	16
17 m	40



Knob #2

Knob Assignments	
MIDI #	Function
106	Drive Level
107	Panadapter Zoom

Button Assignments	
MIDI #	Function
19	Macro 1
43	Macro 5

44	Macro 6
21	Macro 3
45	Macro 7



Filter wider	47
Macro 4	22
Macro 8	46

Knob #3

Notes
Common for most
PIT, XIT
WFO in SmartSDR
WFO in Thefts
WFO in PISDR

Set Control Type in MIDI's Map

Appendix J: Change Log

v1.02.01b – May 30, 2025

- Added [Appendix F](#) with information on using the **screen** command in Mac and Linux for a [terminal interface](#)
- Added a new link to download [Tera Term](#). Get it from the CTR2 Group IO File folder [here](#).

v1.02.01a – May 23, 2025

- Added a note about using a [USB-C data cable](#) for USB MIDI

v1.02.01 – May 9, 2025

- Added [Appendix G: Using CTR2-MIDI with Non-MIDI Programs](#) with examples of how to use CTR2-MIDI with programs like SmartSDR for Windows that do not support MIDI control

v1.02.01 – February 2, 2025

- Added [WheelB-r](#) to reverse dial direction for PI HPSDR app
- Added **Speed Tuning** to **WheelB** and **WheelB-r**
- Smoothed transition to speed tuning
- Changed Morse when changing Bluetooth On/Off from BLE0/1 to BT0/1
- Added additional information about [connecting CTR2-MIDI to your Mac using Bluetooth](#)
- Fixed incorrect instructions for selecting the files in EspressIF Flash Download Tool.
- Added information on mapping *MIDI* to the SparkSDR app
- Added a screenshot of the Mac Bluetooth permission screen
- Added additional information about [Enabling Permissions](#) in a Mac to use Bluetooth
- Updated the description of [wiring the straight key and PTT switch](#) to the MIDI's **Paddle In** jack
- Added a troubleshooting note about [Flex Radio Zombie mode](#) (no power out in CW mode when remote keying)

v1.02.00 – September 30, 2024

This update adds many new functions to the *MIDI*:

- [Three beep modes](#) – *Off*, *Normal*, and *Long-Press*. Press and hold **BTN1** then press the knob to step through the beep modes.
- The ability to enable or disable [speed \(proportional\) turning](#) on **WheelA** control. Press and hold **BTN2** then press the knob to step through the speed modes, *Off*, *Normal*, and *Fast*.
- Support for [two MIDI knob maps](#). Use one for iOS/Mac operations and one for Windows operations. Press and hold **BTN3** then press the knob to switch the maps.
- The ability to turn the [Bluetooth radio](#) off for battery operation. Press and hold **BTN6** then press the knob to turn the radio on or off.
- A [Reset to Factory Settings](#) option when all else fails. You must [connect a terminal](#) to the *MIDI* to reset the settings to factory.

v1.01.00f: September 3, 2024

- Added more information to [Connecting CTR2-MIDI to the App](#) section for connecting to Marcus' apps

v1.01.00e: August 20, 2024

- Updated the [Connecting CTR2-MIDI to the App](#) section to include new information on connecting to Marcus' apps
- Moved [Configuring the MIDI Firmware](#) to [Appendix A](#).

v1.01.00d: May 22, 2024

- Updated the [Installing using Linux or Mac](#) section with information about switching COM ports for flashing new firmware after v1.01.00.

v1.01.00b and v1.01.00c: May 10 and 12, 2024

- Rewrote parts in the manual to clarify the configuration requirements of the *MIDI* and the app.

v1.01.00a: May 8, 2024

- Updated the [Appendix B: Installing and Updating CTR2-MIDI Firmware](#) section to include new information about flashing firmware to the ESP32-S3 in CTR2-MIDI.

v1.01.00: April 29, 2024 – Major Update Release

- Added USB MIDI support
 - Once v1.01.00 firmware has been installed in CTR2-MIDI you'll need to follow **Step 1** in [Appendix B: Installing or Updating CTR2-MIDI Firmware](#) section for future updates.
- Select from MIDI **Button**, and two types of **Sliders** and **Wheels** for each knob function in the terminal page
- Redesigned terminal page
 - Hotkeys select the MIDI function for each knob function
 - Displays saved ADC count assigned to each BTN
 - Displays ADC count when an BTN is pressed
 - Displays MIDI channel, control, and value when a control is executed
- Added [Appendix D](#) and [E](#) with information on using Tera Term and Putty

v1.00.05 – April 7, 2024

- Added a reference to the [Conji](#) app for MacOS to help with connecting the *Midi* to a Mac computer.

v1.00.05 – March 26, 2024

- Revised button read code to reduce false triggers
- Added [Show/Hide BTN Counts](#) option in terminal set up
- Added *No Sidetone* solution to [Troubleshooting](#) table

v1.00.04 – March 23, 2024

- [Green LED now flashes](#) to indicate unit is powered up (CTR2-MIDI hardware only)

v1.00.03 – March 21, 2024

- Added additional information on importing the [.map file](#)
- Added additional information on [connecting CTR2-MIDI to the app](#)
- Added additional [troubleshooting](#) help

v1.00.03 – March 10, 2024

- Add beep types to tables
- Save knob values to initialization file

v1.00.02 – March 8, 2024

- Added [Troubleshooting](#) section

v1.00.02 – March 7, 2024

- Shortened the MIDI device name from CTR2-MIDI_xxxx to CTR2_xxxx
- Removed **Paddle PTT** mode and replaced it with **Paddle Mode**
 - When the green LED is off the paddle inputs control MIDI Buttons 20 and 21
 - When the green LED is on the paddle inputs control MIDI Buttons 30 and 31
- Removed PTT latching logic that as associated with **Paddle PTT** mode
- The red LED now lights when either paddle is pressed
- Redesigned terminal screen

v1.00.01 – March 6, 2024

- Added an option in the [terminal display](#) to enable/disable **Paddle PTT** mode
- Added BTN ADC values to the terminal display

v1.00.00m – March 3, 2024

- Beta release for interface development

v1.00.00 – December 22, 2023

- Initial release of CTR2-MIDI firmware for CTR2-Micro