

# CTR2-Duo

## Hardware Manual

### v1.01



Last Revision: **April 15, 2026**

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Version: **v1.01**

**Revised sections for this version are highlighted in yellow**

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## Introduction

**CTR2-Duo** (referred to as the **Duo** in this document) is the descendant of a long line of microcontroller-based radio controllers from [Lynovation](#). If you're interested in its background, you can read the QEX and QST articles about the **CTR** series [here](#).

At the start of 2026, the dual-encoder **CTR2-Flex** hardware was rebranded to **CTR2-Duo**. This was done to eliminate the confusion over the **CTR2-Flex** hardware and the **CTR2-Flex** firmware naming convention. This manual can be used for the dual-encoder **CTR2-Flex** hardware unit.

The **Duo's** hardware is based on the M5-Dial from M5Stack. This is a rugged, commercial touchscreen controller. The **Duo** is similar in design to the **CTR2-Uno** (aka **Uno**) and **CTR2-Quad** (aka **Quad**) controllers, and is available in either a 3D printed enclosure, or a commercial, molded, CNC milled, New Age enclosure. Like the **Uno** and the **Quad**, it can run either **CTR2-Flex** or **CTR2-Dial** firmware. You can find the operation manuals for the **Flex** and **Dial** firmware [here](#) and [here](#).

**CTR2-Duo** hardware has the following features:

- Color touchscreen user interface
- Runs either **CTR2-Flex** or **CTR2-Dial** firmware (both are included in the **CTR2-Flex** firmware package).
- Two knobs (encoders). Both knobs use detent (bumpy) style encoders. Both knobs are programmable to any of the *Dial* functions. Push-and-turn operation is not supported.
- Both knobs have dual-function pushbuttons that can be programmed to operate two button commands.
- A single 3.5mm stereo input jack that can be set for either for a CW paddle or straight-key/PTT input from the *Settings* menu.
- A volume control and speaker for CW sidetone for the internal keyer in **CTR2-Flex** firmware.

**CTR2-Flex** firmware creates a custom WiFi controller specifically designed for the Flex 6000 and 8000 SDR radios. It is based on the popular **CTR2-Micro** controller's firmware. It utilizes the Flex Network API to monitor and control the Flex radio over an IP network connection. In addition, it provides real-time CW keying and PTT control over the network.

Because the Flex API is a two-way protocol, unlike **CTR2-Dial**, **CTR2-Flex** is aware of the radio's operating state (frequency, mode, band, etc.) A [Dashboard](#) display provides easy access to many of the radio's functions.



## 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. 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.

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:me@qrz.com).

## 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 kits.
- I make no warranty that the firmware provided will perform up to your expectations or be suitable for your application. A lot of compromises had to be made to fit the small display so review this manual to be sure you're comfortable with the user interface.
- Software bugs are a fact of life and I try to find and correct all bug reports to the best of my ability ASAP.
- CTR2-Flex requires a license key to be fully functional. License keys can be purchased separately if you build your own unit. They are included with any purchase of a CTR2-Dial or CTR2-Flex product from [Lynovation.com](http://Lynovation.com).
- License keys are tied to your call sign. This allows you to use the same key on as many devices as you own. You are not allowed to include your license key on units you build to sell or give to others. They will need to purchase their own key.

## Change Log

### v1.01: April 15, 2026

- Added additional information and warning about the [Paddle/Key/PTT jack's function](#)
- Updated [Appendix A](#) to include ESPConnect as the preferred firmware update method

### v1.00.00: January 12, 2026

- Separated the original **CTR2-Flex** hardware into separate devices, **CTR2-Uno** and **CTR2-Duo**, and created separate hardware manuals for each of them.
- Added **CTR2-Quad** to the Lynovation product suite and created a manual for it.
- **CTR2-Flex** and **CTR2-Dial** now identify firmware products. They are described in separate manuals.

Changes to previous versions of this manual can be found [here](#).

## System Overview

**CTR2-Duo** hardware utilizes the M5Dial from M5Stack. M5Dial is small controller based on the ESP32-S3 processor and includes a 1.28" round display and an integrated encoder. It can be powered from a USB connection, an external 6-to-36-volt battery, or from a 3.7-volt Lithium battery. The current version of the **Duo** uses USB for power. The user can upgrade their unit to use these other power sources if desired.

The **Duo** is available in either a commercial, molded, CNC milled New Age enclosure (shown on the left) or a 3D printed enclosure (shown on the right).



The **Duo's** hardware is similar to the **Uno** and **Quad** in that it provides physical knobs, and supports CW paddle, straight-key, and PTT inputs. It also provides a speaker with a **volume control** to provide a useable sidetone for CW operation when running **CTR2-Flex** firmware.

Like the **Uno**, the **Duo** provides a single 3.5mm stereo jack that can be software configured to be either a CW paddle or key/PTT input jack.

**CAUTION: This jack is for paddle, key, and PTT inputs only. It is not designed for output. Do not connect this jack to your radio as this may damage the unit.**

## Two Firmwares

As mentioned previously, two versions of firmware are available.

**CTR2-Flex** firmware is great for controlling your Flex 6000/8000 series radio locally running any version of SmartSDR (or even without the SmartSDR user interface). However, since it doesn't support SmartLink, it presents challenges for remote operation.

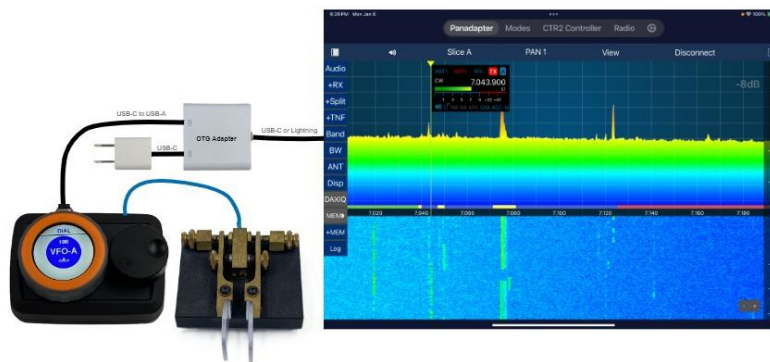
**CTR2-Dial** firmware on the other hand, uses MIDI commands over Bluetooth or USB to control a 3<sup>rd</sup> party app such as SmartSDR for iOS/macOS, SDR-Control, FT-Control, TS-Control, K4-Control, Thetis, SDR-Console, and many other apps that support MIDI control of their functions

You can switch between the two firmwares in the *Settings* menu without re-flashing your unit.

## Power Options

The **Duo** hardware 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), directly from a newer iOS device with a USB-C cable, a 5-volt cell phone charger, a USB battery pack, an external 6-to-36 VDC power source, or even an internal 3.7-volt lithium battery pack.

In the photo below, an **Uno** is shown connected to an OTG adapter on an iPad running SmartSDR for iOS. (a **Duo** or **Quad** can also be used.) This adapter has a USB-C power port and a Lightning connector that plugs into the iPad. The phone charger plugged into the OTG adapter is optional and powers both the iPad and **CTR2** unit when plugged in. For extended battery operation, a 20,000 mA USB battery can be used to power both the **CTR2** unit and the iPad. You can power the **CTR2** unit directly from the iPad or iPhone through the OTG adapter without an external power supply. When running **CTR2-Flex** firmware, both the **CTR2** unit and the iPad must be connected to the same network your radio is on.



The green power jack on the back of the M5Dial allows you power the unit from an external 6-to-36 VDC power supply. This connector is provided with assembled **Duo** units but no external power jack is provided.

**CAUTION: If you power your CTR2-Flex from an external power supply (+6 to +36 volts into the green connector on the back of the M5Dial), DO NOT connect the CTR2-Duo to a USB connector on your computer at the same time. Your external power supply's ground may not be at the same potential as the computer's USB ground and the voltage difference may damage your computer.**

### *Using a 3.7-volt Lithium Battery*

The M5Dial also has a 1.25mm two-pin connector under the STAMP-S3 processor that is used to connect a single cell 3.7-volt lithium battery. The M5Dial will charge the battery (at around 100 milliamps) so a battery of at least 1000 mAH should be used. The STAMP-S3 processor must be removed to access this connector and it can be very difficult to replace the processor when you're done. This is a user modification. I do not sell battery equipped **Duo** units, although Neil, G7UFO does in [his shop](#).

**NOTE:** The M5Dial doesn't have the hardware required to monitor the 3.7-volt battery's state of charge so you essentially have to "run it till it drops".

**NOTE:** When powering the unit using a 3.7-volt lithium battery you must press and hold the M5 button for at least 10 seconds to wake the unit up when using the sleep timers or power off option in the [Settings](#) menu.

**CAUTION:** If you choose to connect a 3.7-volt battery to your M5Dial you **MUST** verify the battery connector is wired correctly! There is no standard for the + and – power leads on these batteries and there is no reverse polarity protection on the M5Dial. If you connect the battery in reverse, you will probably destroy the M5Dial. For more information see this post:

<https://github.com/m5stack/M5Dial/issues/14>

## Appendix A: Installing or Updating CTR2-Flex Firmware

**CTR2-Flex** firmware is pre-installed on assembled **CTR2** units supplied with the M5Dial controller. If you're using your own hardware, you'll need to install the firmware yourself.

Starting with v2.00.00, **CTR2-Dial** firmware became part of the **CTR2-Flex** firmware package. As of v2.03.05, **CTR2-Flex/Dial** firmware is now 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**. Instructions for switching between the two firmwares can be found [here](#).

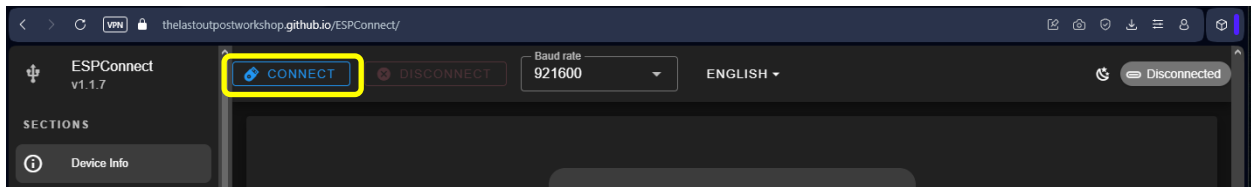
Before you begin, download the latest **CTR2-Flex/CTR2-Dial** firmware from my [web site](#). Unzip the firmware distribution zip file into a folder.

### Installing Firmware using ESPConnect (New Method)

By far, the easiest, and recommended method to install or update firmware on an ESP32 process is with [ESPConnect](#), an open source ESP32 management project.

**ESPConnect** is a browser-based tool that must be opened on a Chromium-based browser that supports Web Serial, such as Chrome, Edge, Brave, or Opera. It will run on a Windows PC or an Apple Mac. Unfortunately, Linux doesn't support Web Serial in any browser.

To start, open **ESPConnect** here: <https://thelastoutpostworkshop.github.io/ESPConnect/>



Next, plug your **CTR2** unit into a USB port on your computer.

**NOTE:** Do not connect it to an unpowered USB hub.

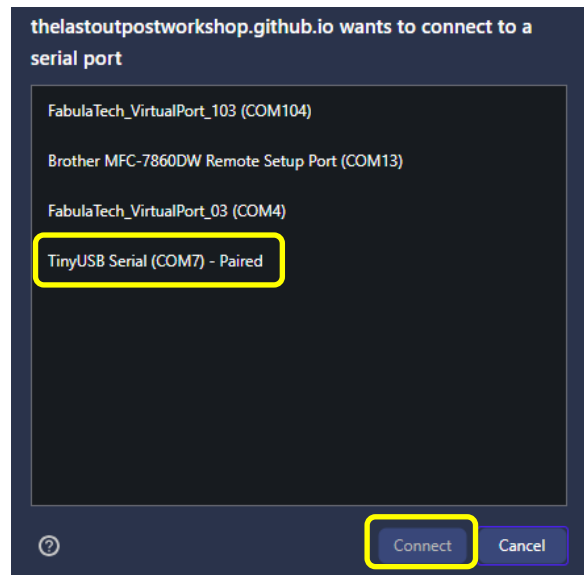
Click the **Connect** button.

A device list will pop up showing the available USB devices on your computer.

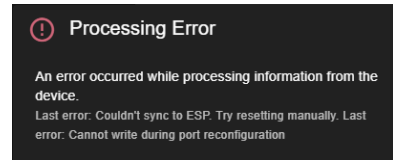
On a Windows PCs, all **CTR2** units will be shown as a **TinyUSB Serial** device, as shown here.

On Macs, **CTR2** units based on the M5Dial will be listed as an **M5STACK\_DIAL** device.

Select the **CTR2** device and click the **Connect** button.



A popup warning will appear telling you that an error occurred. Some errors may tell you to press the BOOT button on the processor to put it into bootloader mode. You do not need to do this.



This is the normal response when trying to connect to a **Tiny USB serial** device.

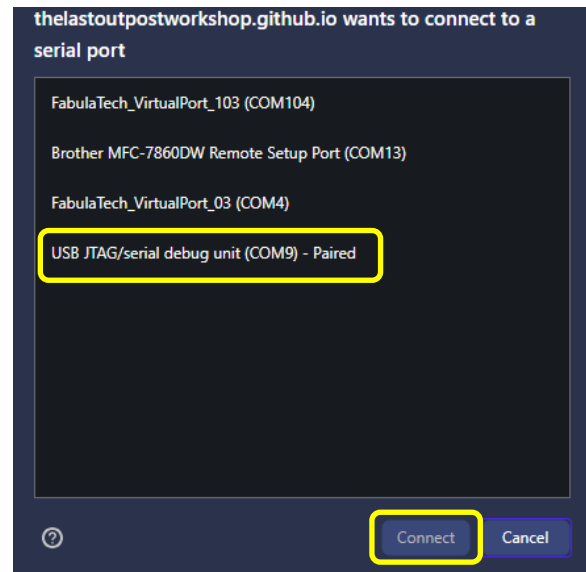
Click the **Connect** button on the home page again.

This time, the **TinyUSB serial** (or **M5STACK\_DIAL** on Macs) will not be shown on the list. Instead, a new device, **USB JTAG/serial debug unit** will be shown (on both PCs and the Mac).

This is the bootloader port and the unit is now ready to program.

Select the **USB JTAG/serial debug unit** device then click **Connect**.

**NOTE:** Apparently, not all ESP32-S3 processors will enable the **USB JTAG** port automatically. If your's doesn't, you'll need to open the enclosure and press the **Programming** button on the back of the M5Dial.



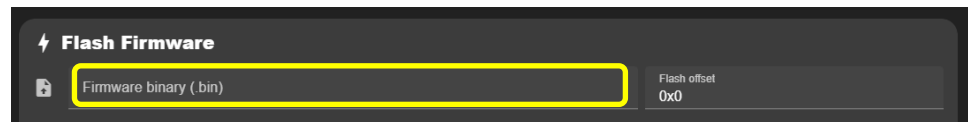
Once you're connected to your **CTR2** unit, the left menu items on the page will be enabled.

**<<< WARNING >>>**

**ESPConnect** is a powerful device editor. Many of the functions can cause problems with **CTR2** firmware if you change them. If you don't know what a function does, **DON'T CHANGE IT!**

Click on the **Flash Tools** menu item and scroll down to the **Flash Firmware** section.

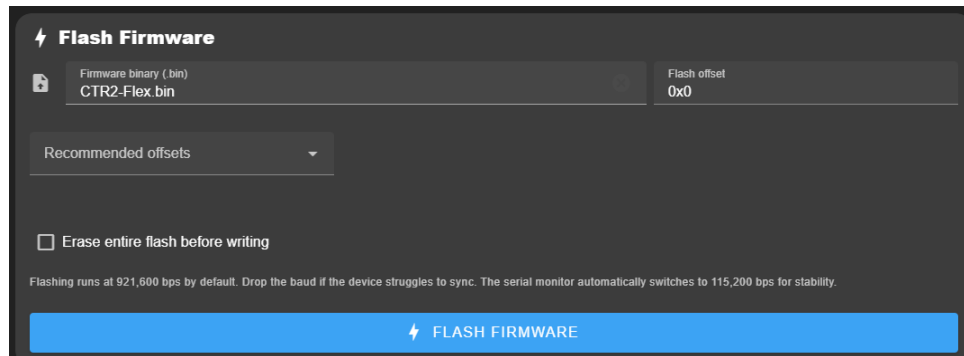
Click the **Firmware binary (.bin)** text box.



A file navigation screen will appear. Navigate to where you unzipped the firmware zip file from the [firmware update page](#) and click on the **CTR2-Flex.bin** file.

Your display should now look like this:

Leave the **Flash offset** set to **0x0** and uncheck the **Erase entire flash before writing** checkbox.



Click the **FLASH FIRMWARE** button to start the flash process.

Once the process completes, cycle the power on your **CTR2** unit. The version # will be displayed when the unit boots. The version # should match the version # from the firmware zip file.

This completes the firmware update process.

## Installing Firmware using EspressIF Flash Download Tool (Old Method)

The EspressIF Flash Download Tool is the original flash tool provided by the makers of ESP32 micro controllers. It's geared for developers and many find it difficult to use.

This section will describe the process of using this tool to update your M5Dial. I highly recommend using [ESPConnect, described above](#), instead.

You must force the M5Dial into programming mode before you can flash firmware to it. To do this, follow this procedure

- 1) Open the enclosure and locate the back of the M5Dial
  - a. On 3D printed enclosures remove the four screws holding the base to the shell with a 2mm Allen wrench
  - b. On the New Age enclosure remove the four rubber feet on the bottom by pulling them off then remove the four Phillips screws under the feet
- 2) Press and hold the **DOWNLOAD (BTN)** button on the M5Dial then apply power to CTR2-Flex. The display will be blank when the unit boots into programming mode. If the unit is already powered up, press and hold the **DOWNLOAD** button then press and release the **RESET** button. You should hear a beep from your computer as it registers the new USB COM port and the display will be blank.

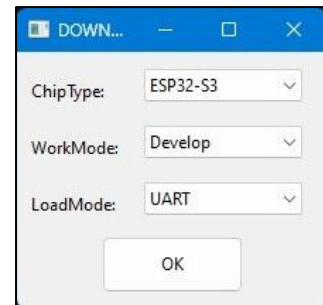
**NOTE:** If you have problems getting the **DOWNLOAD** button to work its lever may have slipped off the button on the board. Remove the label and flick the lever back onto the button. Thanks Joe, KO8V for the tip!



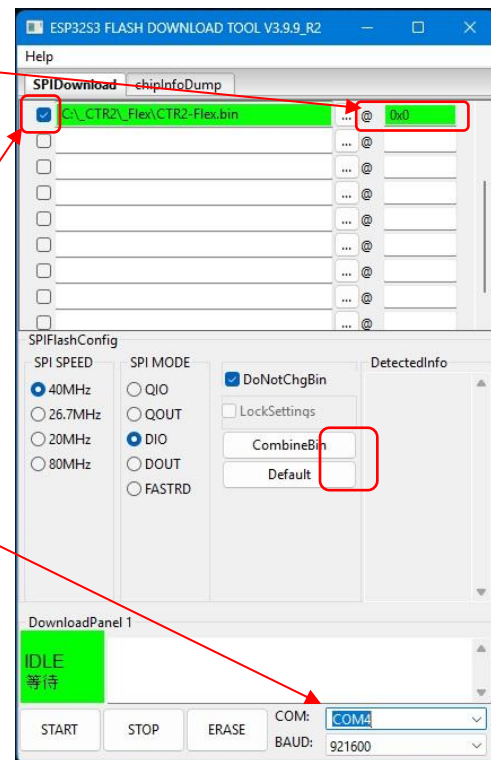
- 3) You can now use the procedure below with EspressIF Flash Download tool (on Windows) or [run the script \(on Linux and Mac\)](#) with the new COM port to flash the new firmware to the M5Dial.
- 4) Once the download completes, cycle the power on the unit to start the new firmware.

Now that you have the M5Dial in programming mode, follow these steps to install or update to the latest **CTR2-Flex/CTR2-Dial** firmware:

1. Download and unzip the latest **CTR2-Flex** firmware from [my web site](#). Unzip that file into a different folder than where you store other Lynovation firmware update files.
2. Download and open the [EspressIF Flash Downloader Tool](#). When it starts, select the **ESP32-S3 Chip Type**. Leave **WorkMode** set to *Develop* and **LoadMode** set to *UART*.



3. Map the **CTR2-Flex.bin** file that you unzipped from the **CTR2-Flex\_v2.xx.xx** firmware distribution file into the downloader tool and set the offset address to **0x0**.
4. Select the checkbox on the left of the **CTR2-Flex.bin** filename as shown.
5. Set the **COM:** port to the port assigned to **CTR2-Flex** 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.

6. On new installs, click the **ERASE** button to clear the factory demo from the M5Dial's memory.

**NOTE:** If you erase the memory after running the **CTR2-Flex** firmware you will need to [re-enter your call sign and registration key](#), re-select the number of knobs on your unit, and re-enter your WiFi and radio settings the next time you start **CTR2-Flex**. If you previously [exported](#) your settings, you can restore them using the [Import Settings](#) option in the **Settings** menu.

7. Click the **START** button to download the firmware.
8. Once the download is complete, cycle the power on the unit to start the new CTR2-Flex firmware.

**NOTE:** The ESP32-S3 processor will revert back to its operating COM port after the reboot.

## Installing using Linux or Mac

Mac users should use the [new method using ESPConnect](#), described above. Linux users have no other option, other than to follow the procedure below.

A script file is 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**.

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.

To use the script file:

- 1) Force the M5Dial into programming mode as described above.
- 2) Edit the COM port in the script to the programming port. This port will be different than the operating COM port.
- 3) Edit the path to the .BIN file in the script.
- 4) Run the script.

## Appendix B: Power Requirements

The approximate current on the **Duo's** USB connection is shown below for various configurations. These values will give you a rough idea of how long the unit can run on a small 3.7-volt battery.

WiFi Mode	Backlight	Current
On	High	170 mA
	Medium 2	152 mA
	Medium 1	133 mA
	Low	115 mA
Off	High	121 mA
	Medium 2	105 mA
	Medium 1	82 mA
	Low	70 mA

## Appendix C: Change Log

Changes applied to older firmware versions are documented here.