

# CTR2-Mini — A Radio Controller on a Budget

This miniature radio controller comes in a small package, is inexpensive and easy to build, and looks professional.

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In the September/October 2021 and January/February 2022 issues of *QEX*, I presented the CTR2, a complex station control system that required two integrated development environments (Arduino IDE and Nextion Editor) to load the programs. Using that project as a basis, I designed a simpler, smaller radio controller that almost anyone can build. Aptly named the CTR2-Mini, or just “the Mini,” this project incorporates many of the features of the CTR2 into a smaller, professional-looking package with fewer parts.

## Overview

The CTR2-Mini is a radio controller that does a lot. The Wio Terminal from Seeed Studio is a development module selected to provide the simple user interface, which has a color display. With the proper adapters, the Wio Terminal connects to a wide variety of radio computer-aided transceiver (CAT) ports and allows you to control frequency, mode, and RIT changes. In addition, it provides 100 favorite frequency memories, a built-in memory keyer, and support for 16 radio profiles. It also has built-in Wi-Fi and Bluetooth™. While the color display doesn't support touch tuning like the CTR2, it is large and bright enough to make operating a lot more enjoyable for radios with small monochrome displays, such as the Yaesu FT-817 and the QRP Labs QCX transceiver.

An optional remote keypad can be added that provides a push-to-talk (PTT) button and five programmable function keys. The Mini emulates a Kenwood TS-2000 radio on its USB serial port. This allows third-party apps to control the radio connected to the Mini.

CAT5 cable is used to connect the Mini to the radio I/O

module. The radio I/O module has two 1/8-inch stereo jacks; **C** connects to your radio's CAT port and **K** connects to the PTT and key inputs. Simple adapter cables must be built to adapt the 1/8-inch jacks on the radio I/O to the connections on your radio. Schematics of adapter cables for various radios can be found on my website at <https://ctr2.lynovation.com/ctr2-mini-radio-wiring-diagrams> (see Figures 1 and 2).

One side benefit of using CAT5 to connect the radio I/O is that it allows one Mini to control several radios by using a manual RJ45 switch. Figure 3 shows this configuration.

To substantially reduce cost and complexity, audio management and automatic radio and RF switching



Figure 1 — The CTR2-Mini is ready for connection to a Yaesu FTDX101.

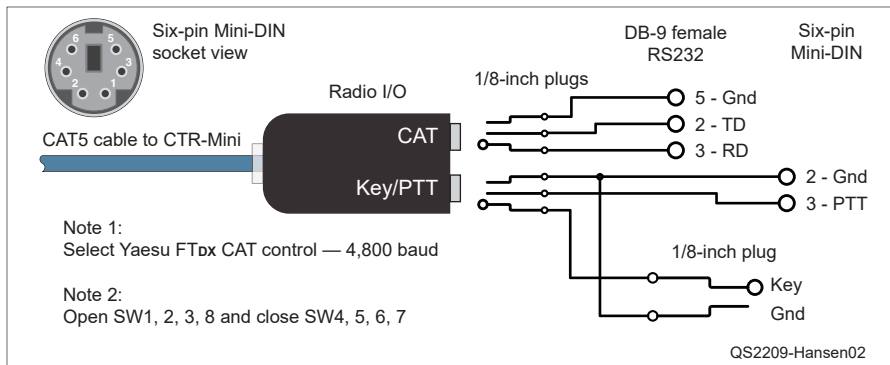


Figure 2 — The CTR2-Mini uses a cable adapter for the Yaesu FTDX101.

menu gives you control over many of the parameters on this radio. CAT control is done using the FlexRadio API over Wi-Fi. The Mini can create slices and panadapters, or it can connect to existing slices. It also allows you to run your Flex radio without SmartSDR. The Mini also supports direct CW keying of the Flex over the IP network, allowing you to operate CW from anywhere.

were not included in the Mini's design. For more information on the Mini, visit my YouTube channel at <https://youtube.com/lynovation>.

### Advantages

The Mini solves space constraints in your shack by putting the things you do most on a physical knob right next to your most-used equipment, such as the monitor, the mouse, and the keyboard or key.

Perhaps the Mini's biggest benefit is that every radio it controls looks and works the same. When using one Mini to control multiple radios, each radio can have its own configuration for frequency lists, message buffers, etc., or all radios can share the same settings. The buttons on the optional keypad can be assigned to send CW message buffers or open setting windows for RIT, CW speed, etc.

The Mini also includes enhanced support for FlexRadio's FLEX-6000 series. A special FLEX-6000

The Mini also supports the Icom PCR-1000 wideband receiver in case you have one of those gathering dust and in need of a user interface.

### User Interface

The user interface is based on the three buttons on the top of the Wio Terminal and a rotary encoder. The Mini's controls have multiple uses, depending on what mode you're in and how long you press them. Short-press functions are shown on labels directly under the buttons. Long-press functions are intuitive and easy to remember. When a menu is opened, the **UP/DOWN** navigation buttons have two labels showing their short- and long-press functions.

The user interface has two modes, Home and Menu. In the Home mode (see Figure 4), turning the encoder steps the frequency digit, shown as red, and turning the encoder while pressing it down changes which digit is stepped.

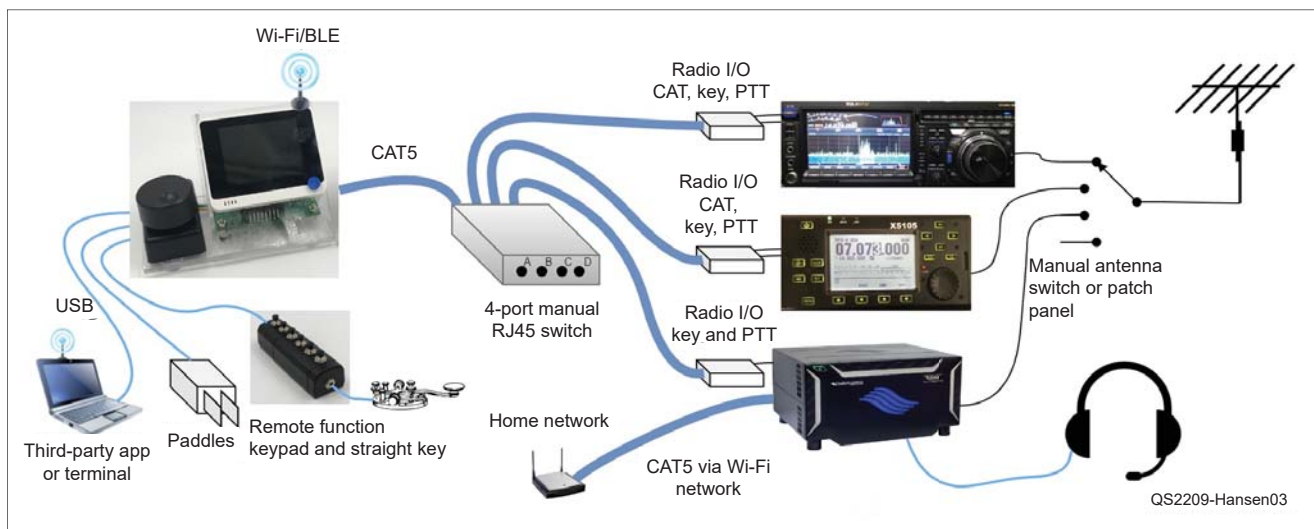


Figure 3 — The CTR2-Mini has multiple radio functions.



Figure 4 — The CTR2-Mini's home page.



Figure 5 — The CTR2-Mini's main menu.

To open Menu mode, push and release (short-press) the encoder or five-way switch. The main menu (see Figure 5) contains the most-used options and several submenus. Rotate the encoder and press to select an option.

### How It Works

The Wio Terminal is an integrated development module based on the SAMD51 microcontroller, running at 200 MHz. The Mini's hardware plugs into its 40-pin general-purpose input/output (GPIO) bus and is powered by the Wio Terminal.

The Mini consists of several small boards (see Figure 6) that can be obtained from me with pre-populated surface-mounted components. Gerber files to build the boards yourself, along with complete schematics and an assembly manual, can be downloaded from the QST in Depth web page at [www.arrl.org/qst-in-depth](http://www.arrl.org/qst-in-depth) or from my website at <https://ctr2.lynovation.com>.

The Wio GPIO interconnect board plugs into the GPIO bus on the back of the Wio Terminal and routes the required signals to the Mini's main board using a short 16-conductor ribbon cable. The main board converts the I/O from the Wio Terminal into signals that can interface to the CAT, key, and PTT signals of your radio. It also provides a sidetone oscillator for code practice.

The encoder/speaker board provides a mounting location for the rotary encoder and sidetone speaker.

The radio I/O module connects the main board to the radio using a CAT5 cable. One radio I/O module is required for each radio when controlling multiple radios.

### Circuits

The 16-pin ribbon cable from the Wio interconnect board plugs into J1 on the main board. A Darlington transistor array provides line drivers to interface the +3.3 V logic pins on the Wio Terminal to the +5 V levels used on the radio I/O interface. Both normal and inverted data signals are sent to, and received from, the radio I/O module.

The last two drivers of the Darlington array provide solid-state control of the key and PTT outputs to the radio I/O module. These outputs can switch up to +50 V at 500 mA. Reed relays can be installed on the main board to provide dry-contact outputs for tube rigs. These relays can switch up to 200 V of either polarity at 500 mA.

One 1/8-inch stereo phone jack provides a connection for your paddles. A second 1/8-inch jack is used to connect the remote function keypad, a PTT switch, or a straight key. This input is sampled by an analog/digital converter (ADC). The remote keypad uses a resistance ladder that presents a different voltage level to the input, depending on which button is pressed. The Mini recognizes 0 V as a PTT or key-down input and responds accordingly.

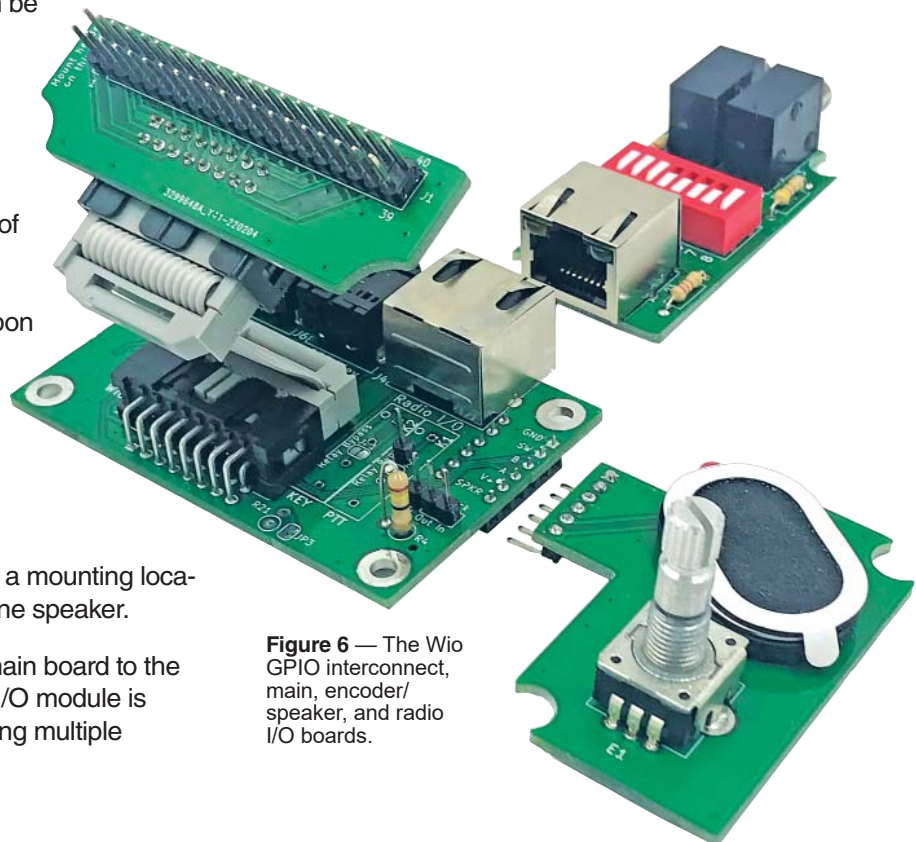


Figure 6 — The Wio GPIO interconnect, main, encoder/speaker, and radio I/O boards.

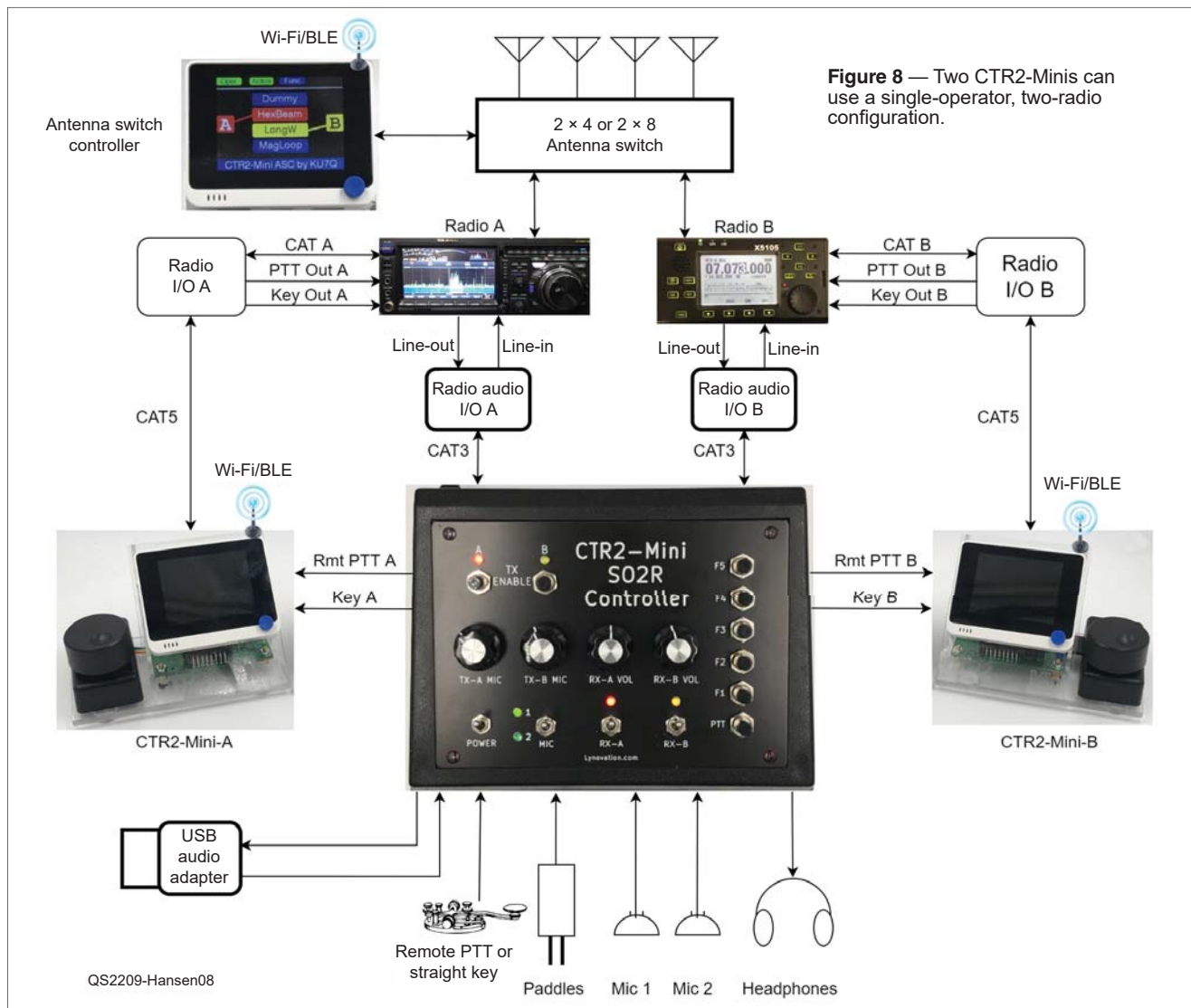
A Darlington transistor provides a simple amplifier for the 1 kHz square wave sidetone signal on Pin 18 of the Wio GPIO to drive a miniature 8 Ω speaker. A 1/8-inch mono phone jack can be added to connect headphones. You'll need a 10K potentiometer in-line to reduce the level. Sidetone can be turned off in the **KEYER** menu. The sidetone speaker and the rotary encoder connect to a six-pin socket that mounts on the bottom of the main board (see Figures 6 and 7).

The radio I/O board provides the interface connections to your radio. It contains an RJ45 connector, an eight-position DIP switch, two 1/8-inch phone jacks, and a few through-hole

resistors (see Figure 6). The DIP switch allows you to configure the CAT data polarity for your radio's CAT port. Normal, inverted (RS-232), and Icom CI-V modes are supported.



**Figure 7** — The encoder can be mounted to the left or right of the display.



**Figure 8** — Two CTR2-Minis can use a single-operator, two-radio configuration.

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## Make the Wio into a Mini

Seeed Studio made making the Wio into a Mini extremely easy, but before you can load the Mini's firmware, you'll need to perform a one-time upgrade to your Mini. As supplied, the Wio comes with old firmware. The upgrade replaces it with new eRPC firmware that supports 5 GHz Wi-Fi and BLE, both of which are used by the Mini's firmware.

To upload the Mini's program to the Wio, slide the power switch down past the ON position twice in rapid succession. This puts the Wio into programming mode, where it will emulate a flash drive on your PC. Navigate to the Arduino drive and replace the **CURRENT.UF2** file in that folder with the **CURRENT.UF2** file, which can be downloaded from my website.

## Advanced Station Control

The Mini can be used as a building block in a more advanced station control system, including audio or RF routing hardware. An optional single-operator, two-radio (SO2R) configuration and a dual-port antenna switch controller allow you to share your microphone,

headset, and key with two Minis and their associated radios (see Figure 8). The antenna switch controller can be remotely controlled by either Mini. These options are beyond the scope of this article, but they are discussed in detail at <https://ctr2.lynovation.com>.

## Conclusion

The CTR2-Mini is a simple project to duplicate, though it may be an intimidating build. It may stretch some limits and abilities, but the rewards are well worth the effort.

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All photos by the author.

Amateur Extra-class licensee Lynn Hansen, KU7Q, was first licensed in 1971. Now retired from a 40-year career in electric utility communications, where he was one of three operations managers over a seven-state communication network, Lynn lives in Lava Hot Springs, Idaho, and considers himself a lifelong learner who is always stretching to the next goal. He can be reached at [lynn@lynovation.com](mailto:lynn@lynovation.com).

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