The Pocket FT8 Revisited Transceiver

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***Abstract*—Pocket FT8 Revisited is a derivative of Charles Hill’s (W5BAA) Pocket FT8 Transceiver. This document describes how to operate the little rig plus a few hints for modifying it in your own application.**

***Index Terms*—Amateur Radio, Digital Signal Processing, DSP, FT8, Homebrew, SDR, Software Defined Radio, Teensy, Si4735, Si5351, Transceiver, WSJTX.**

# I. INTRODUCTION

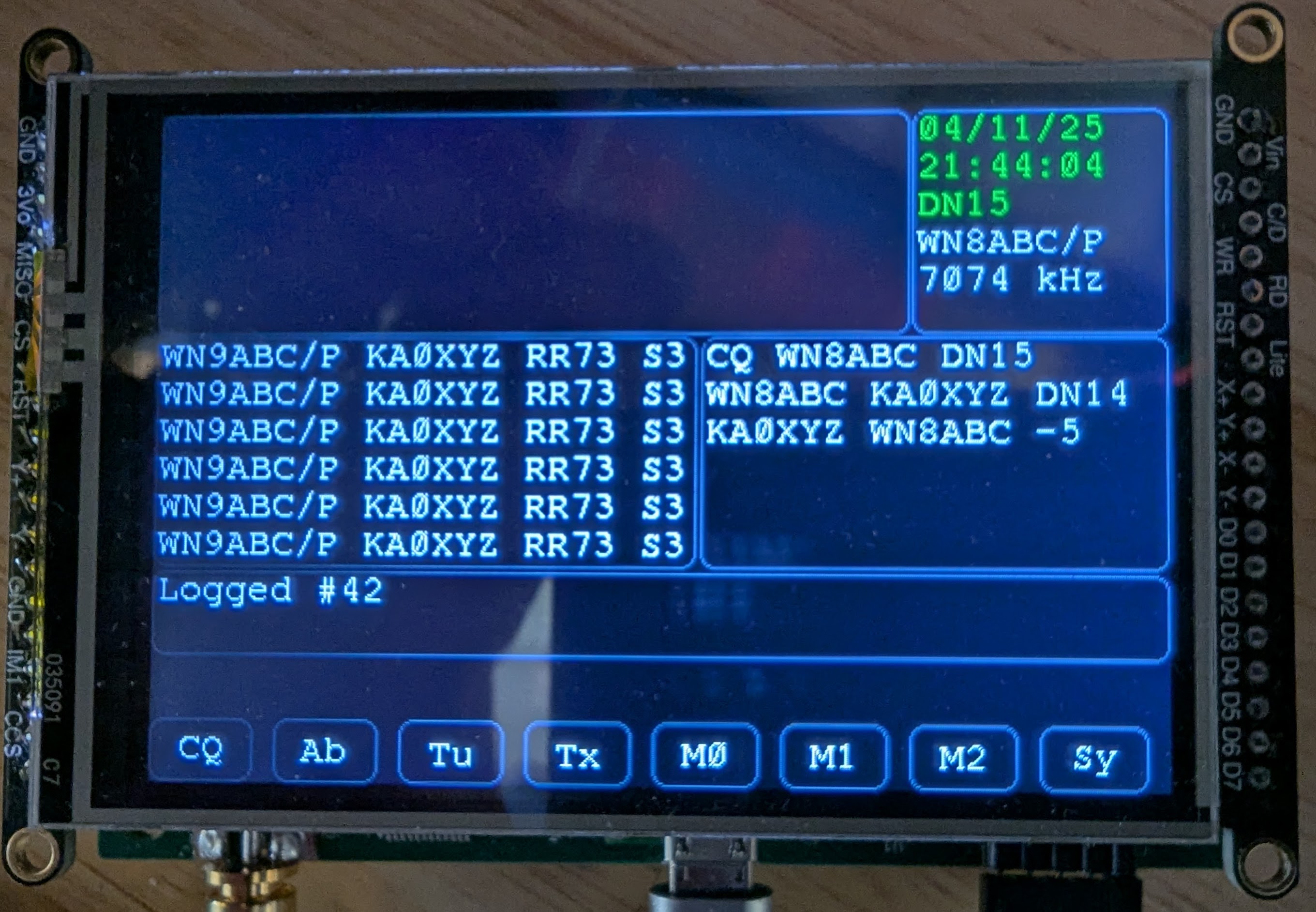
The Pocket FT8 Revisited is a single-band, amateur radio transceiver. Features include:

* 4.0 X 2.8", 4-layer board
* Single-band operation
* FT8 modulation
* 275 mW RF output
* 480x320 TFT touchscreen display
* 600 mHz Teensy 4.1 MCU
* Auto-logging to SD ADIF file
* JSON configuration file
* “RoboOp” sequenced QSO
* TCXO clock
* GPS disciplined date, time and grid square
* Operation from a single 5V power brick

To use this radio, you will need an SD card, suitable antenna, feed-line, 5 V power brick, and USB power cable. You may prefer to use a stylus with the resistive touchscreen. No computer, tablet or phone are required to make contacts.

The Pocket FT8 Revisited is not a kit. If you’re looking for a Heathkit-like experience, consider one of the products from QRP Labs or the DXFT8. On the other hand, this rig, both the hardware and the firmware, are fully open source. You can use or improve the KiCad schematics and board design, or the PlatformIO firmware and tests with few restrictions beyond your project must too remain open source (and that only in a single library). That said, I sometimes have a limited supply of extra boards.

# II. User Interface Overview

The user interface (UI) includes five panels and a row of menu buttons. The upper-left panel provides a waterfall display of received signal strengths, and is used to change the FT8 offset frequency. The upper-right panel reports the station’s status including the current date and time, four character Maidenhead grid square locator, callsign, carrier frequency, and the rig’s current activity (e.g. RECEIVE, TUNE, TRANSMIT…). The middle-left panel reports the first 6 messages decoded during the previous FT8 interval. The middle-right panel reports messages, including CQs, received by this station. The lower panel displays error and informative messages about the station’s activities.  **Fig. 1.** Pocket FT8 Revisited

The menu buttons appear in a bottom row and control the typical functions of an FT8 rig.

## A. Waterfall Panel

The waterfall provides an interactive display of FT8 activity above the carrier frequency. Brighter pixels indicate stronger signals while darker pixels reflect weaker signals. The vertical red line indicates your chosen transmitter offset frequency (from the carrier), and can be adjusted by touching the panel. You may wish to choose an offset in a quiet region of the band so your QRPP transmissions will not be buried beneath those of other stations.

## B. Station Status Panel

When a GPS fix is available, the GPS-disciplined date and time are displayed in UTC with green text. When a GPS is not available, or when a satellite fix cannot be obtained, the date and time values are retrieved from the battery-backed Real Time Clock (RTC) and displayed with yellow text.

Likewise, when a GPS fix is available, the four-character Maidenhead grid square locator is displayed with green text. When a GPS fix is not available, the rig uses the locator provided by the SD configuration file, if that’s available.

Note that the GPS, while highly desirable, is optional. The rig will “make the best of it” when a GPS fix cannot be obtained. In particular, if a GPS fix has been previously obtained, the previously disciplined, battery-backed RTC will likely be reasonably accurate.

The station’s callsign and carrier frequency are obtained from the SD configuration file.

## C. The Decoded Messages Panel

The receiver displays its decoded messages in the middle-left panel. Due to the constrained screen space and the conflicting desire to report as much as possible about each signal, the display differs from the familiar. Space limits the display to only 6 messages. The Received Signal Level (RSL) appears as S1, S2, S3, etc. rather than the FT8 decibel convention in order to fit the signal report into two characters rather than three (e.g. -13).

The panel is refreshed following each FT8 time interval.

## D. The Station Messages Panel

Signals of interest to the local station (those addressed to the local station or general CQ broadcasts) appear in the station messages panel. These messages scroll such that the oldest displayed message always appears at the top. Most messages appear in white text, but repeated transmissions appear in yellow (to save screen space).

## E. The Application Messages Panel

The Application Messages panel displays error and informative messages about the rigs activities. Most are self-explanatory, but a few deserve further explanation:

* FATAL: You \*must\* copy AudioStream6400.h to .../teensy/hardware/avr/1.59.0/cores/teensy4/AudioStream.h: The firmware has been rebuilt with the wrong version of Teensy’s AudioStream.h header file. You’ll find the correct version in the Extras folder named, AudioStream6400.h, and this must be renamed and copied into the ...cores/teensy4 folder before the rebuilding the firmware. This error is fatal.
* ERROR: Unable to access SD card: The SD storage disk containing your config.json file (and space for the ADIF log) is not accessible in the Teensy SD slot. Verify you didn’t insert the card in the Adafruit display board’s socket as that’s the wrong location. The rig continues to boot up but many features are inoperable as the station’s callsign is unknown without the config file.

## E. The Menu Buttons

* CQ: Pressing the CQ button instructs the rig to begin calling CQ in the next available FT8 timeslot (e.g. 0, 15, 30 or 45 seconds past the minute). If a response is received, RoboOp attempts to engage the responder in a sequenced FT8 QSO, and returns to listening when the QSO completes. If nothing is heard, the rig repeats the CQ message until the attempt times-out. Pressing the CQ button while the rig is already transmitting CQs immediately terminates the CQ activity.
* AB: Abort whatever transmission is in progress.
* TU: Tune. Pressing the TU button during a tuning activity ends the transmission. The tune RF output appears at the configured carrier frequency.
* TX: Instructs RoboOp to respond to the first station it hears calling CQ. If successful, RoboOp engages in a standard, sequenced FT8 QSO and then returns to listening. RoboOp repeatedly attempts to contact the heard station until a time-out occurs. You can abort RoboOp’s pursuit of a contact by pressing TX again, or by pressing the AB (abort) button. By default, RoboOp will not engage a station that’s already in the log; this can be changed in the configuration file.
* M0: Not implemented.
* M1: Not implemented.
* M2: Not implemented.
* Sy: Not implemented.

V. Conclusion

A conclusion section is not required. Although a conclusion may review the main points of the article, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

# Appendix

Appendixes, if needed, appear before the acknowledgment.

# References and Footnotes

## A. References

## B. Footnotes

Number footnotes separately in superscripts (Insert | Footnote).[[2]](#footnote-3) Place the actual footnote at the bottom of the column in which it is cited; do not put footnotes in the reference list (endnotes). Use letters for table footnotes (see Table I).

## 

# Acknowledgment

Pocket FT8 Revisited is a derivative of Charles Hill’s (W5BAA) Pocket FT8 project with important contributions from Ricardo Caritti (the Si4735 library), Karlis Goba (YL3JG, the FT8 library), Barb (WB2CBA, the SN74ACT244 PA), and many other widely available Adafruit, Arduino and PJRC libraries. Charles and Barb continue their work on the DXFT8 project, another Pocket FT8 derivative. I am indebted to tips from now-forgotten mentors for getting the best phase noise performance from the Si5351 clock, optimizing the sensitivity of the Si4735 receiver, combined RF/AF/digital PCB design, and getting the most out of the Teensy 4.1 MCU.

Back in the 60s, the ARRL Handbook published an amazing receiver, the Junior Miser’s Dream, that accomplished so much (for its day) with so little (if only I could have afforded that Eddystone dial;). Its focused design guided my engineering career, ever drawing me away from unbridled complexity. The Pocket FT8 and its derivatives echo the goal of doing so much with so little in our modern world. May you too stand on shoulders of giants.

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2. W.-K. Chen, *Linear Networks and Systems.* Belmont, CA, USA: Wadsworth, 1993, pp. 123–135.
3. Philip B. Kurland and Ralph Lerner, eds., *The Founders’ Constitution.* Chicago, IL, USA: Univ. of Chicago Press, 1987, Accessed on: Feb. 28, 2010, [Online]. Available: http://press-pubs.uchicago.edu/founders/

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3. R. J. Hijmans and J. van Etten, “Raster: Geographic analysis and modeling with raster data,” R Package Version 2.0-12, Jan. 12, 2012. [Online]. Available: http://CRAN.R-project.org/package=raster

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2. D. Ebehard and E. Voges, “Digital single sideband detection for interferometric sensors,” presented at the 2nd Int. Conf. Optical Fiber Sensors*,* Stuttgart, Germany, Jan. 2-5, 1984.
3. PROCESS Corporation, Boston, MA, USA. Intranets: Internet technologies deployed behind the firewall for corporate productivity. Presented at INET96 Annual Meeting. [Online]. Available: http://home.process.com/Intranets/wp2.htp

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1. U.S. Department of Health and Human Services, Aug. 2013, “Treatment Episode Dataset: Discharges (TEDS-D): Concatenated, 2006 to 2009,” U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Office of Applied Studies, doi: 10.3886/ICPSR30122.v2.

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   Jim Conrad, KQ7B, is retired from the computer industry with his wife on their little farm near Grangeville, Idaho (e-mail: [conr2286@gmail.com](mailto:conr2286@gmail.com)). The many surrounding SOTA and POTA sites were an inspiration for this project. [↑](#footnote-ref-2)
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