# Builder's Notes: Pocket FT8

**I was building the "Pocket FT8" transceiver by Charles Hill W5BAA during 2021.**

Project announcement: https://wsjtx.groups.io/g/main/message/28645
Project description and files: https://github.com/Rotron/Pocket-FT8
Hackaday article: The Simplest FT8 Transceiver You'll Ever Build
Project Manual ver.1.0

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## Building the "Pocket FT8"

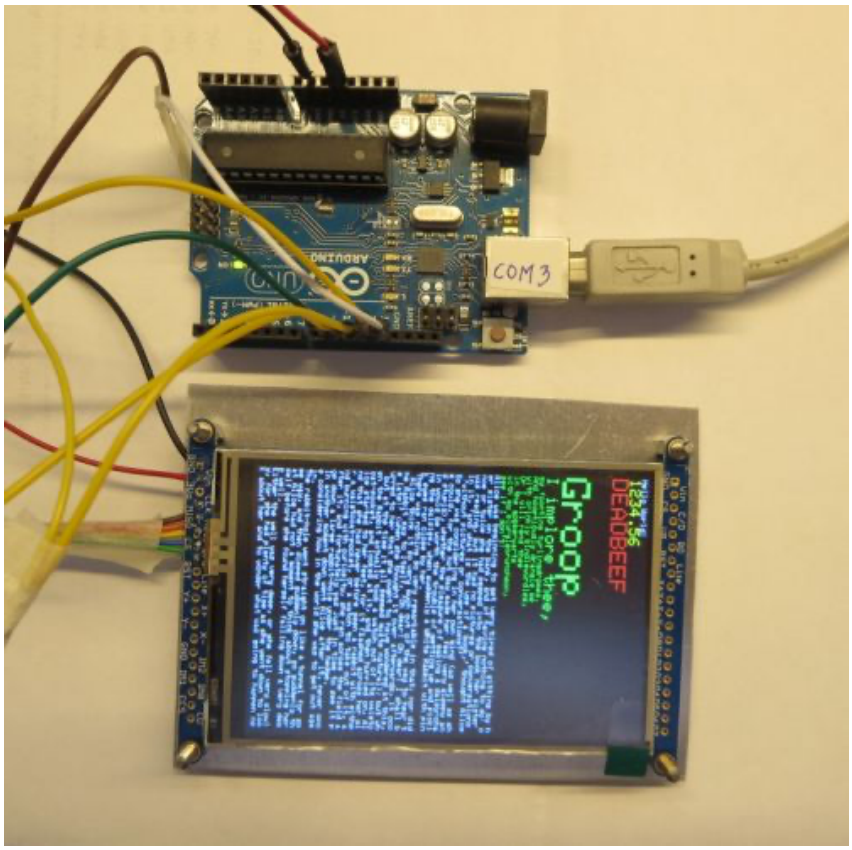


*Fig. 1. Testing the Touch Screen.*

**You can enlarge a picture by clicking on it**

**Touch Screen**
The Adafruit Touch Screen was purchased from Digi-Key (part number 1528-1470-ND). The screen is described by Adafruit.

**Testing the screen with UNO**
I used Arduino UNO for testing the touch screen. The test procedure is described in Adafruit 3.5" Color 320x480 TFT Touchscreen Breakout pages 23-27. The sketch uploaded to Arduino UNO (graphictest.ino) draws graphics and text on the screen. Figure 1 shows text with different fonts.

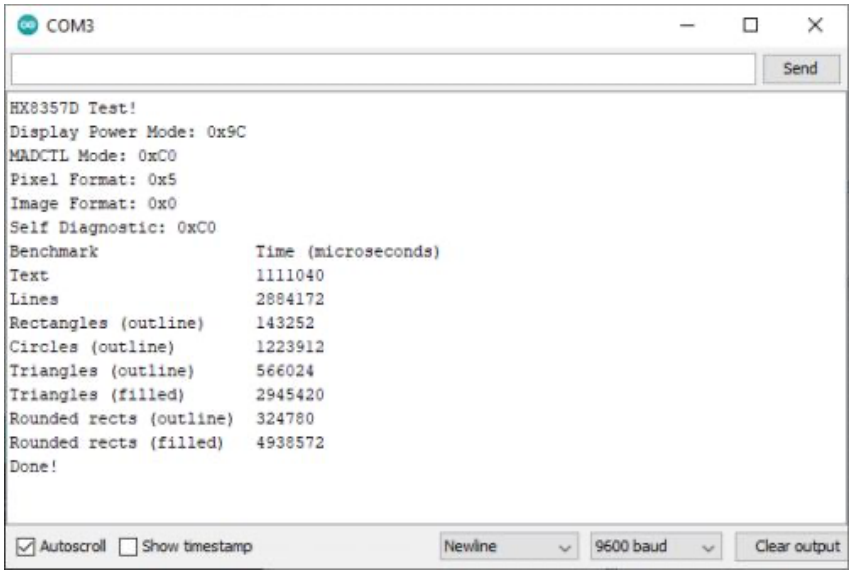


*Fig. 2. Screen measurements.*

**Screen parameters**

The UNO measures different screen parameters and sends them to the IDE via the serial interface. Figure 2 is a screen-dump from IDE showing the measurement results.

**Screen connections**
The touch screen is supplied with 3.3 V DC and is connected to Teensy 3.6 and the MCP3422.

Please note, that two of the wires on page 3 in the Project Manual 1.0 are wrongly connected. Touch screen MOSI must be connected to Teensy pin 11, and Touch screen MISO to Teensy pin 12. Thank you to HB9TVK Peter for this information.

The right connections are shown in the wiring diagram (figure 13).

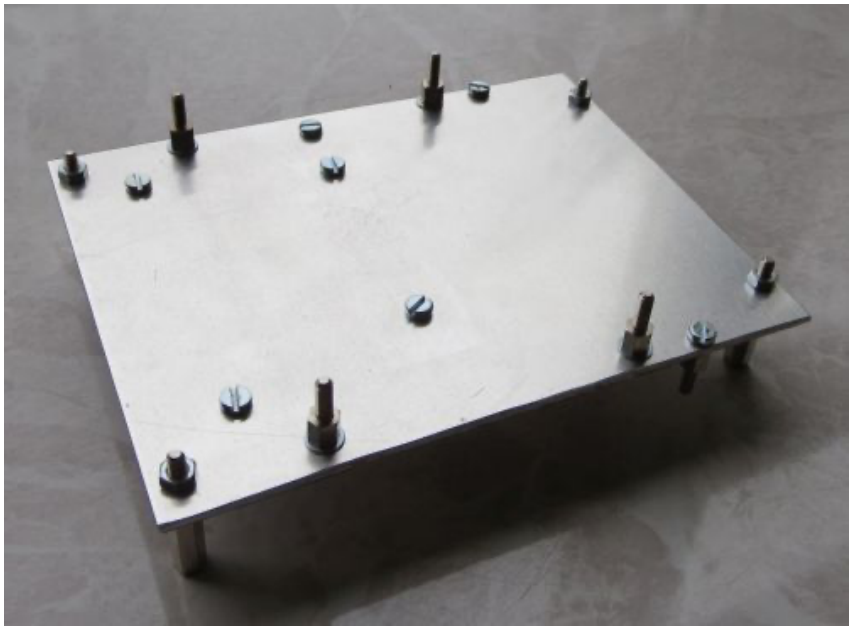

*Fig 3. Chassis (screen side).*

**Chassis**
The touch screen and the three circuit boards are mounted on an alu-sheet measuring 127 mm x 100 mm x 2 mm.

Figure 3 shows the side where the touch screen will be mounted. The 4 stand-offs under the sheet serve as feet.

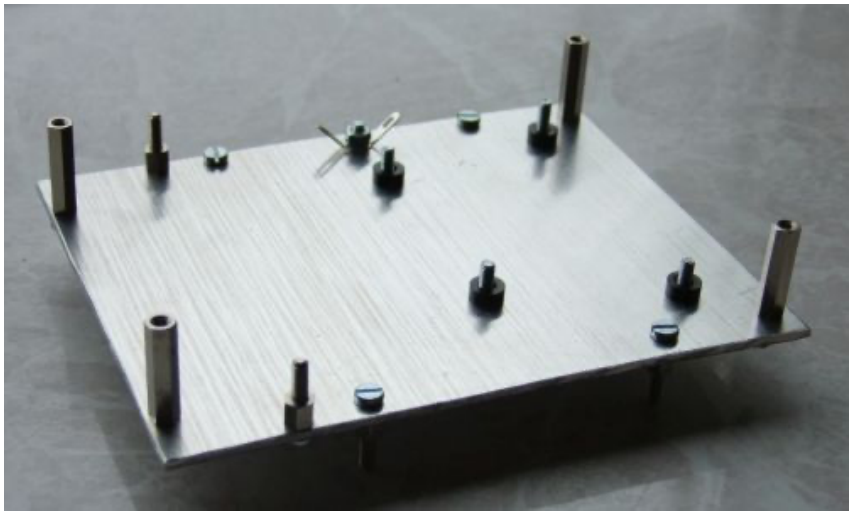

*Fig 4. Chassis (board side).*

Figure 4: Three circuit boards will be mounted on this side of the sheet.

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**Receiver board; components**
Please refer to circuit diagram in the project manual page 3. The receiver was built on a piece of Veroboard measuring 45 mm x 100 mm. The component names are shown on this sketch which also shows a label change at Teensy pin 39.

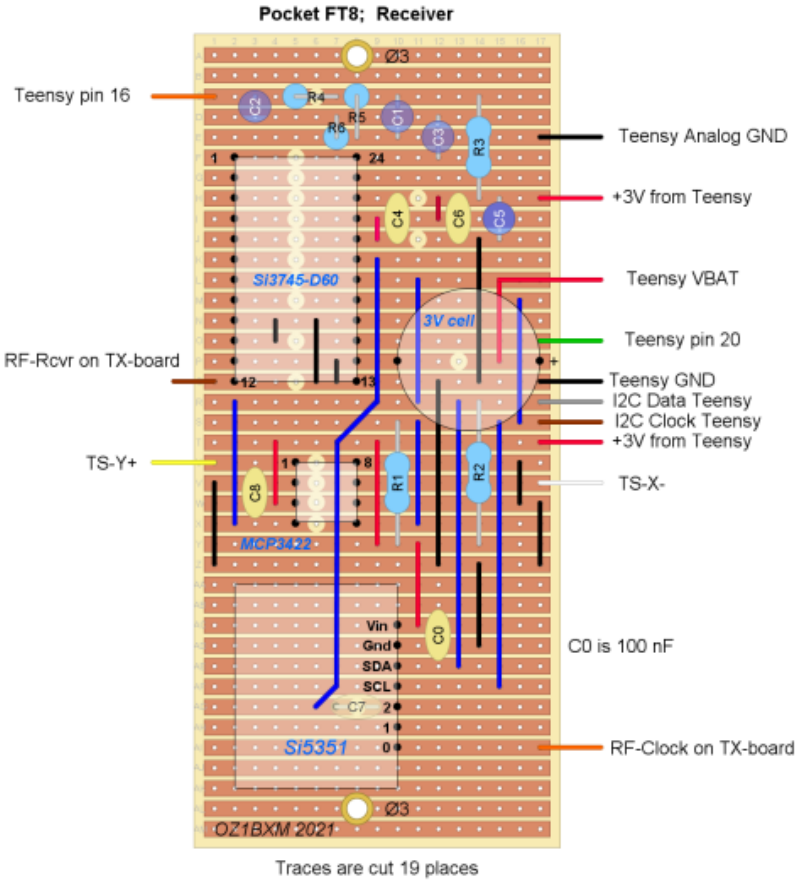


*Fig. 5.Components on the receiver board.*

Don't forget to cut the traces 19 different places, and drill two holes each 3 mm diameter.

Si3745 comes in a 24-pin SSOP housing (0.65 mm pitch) and is converted to 2.54 mm pitch using an SSOP-24 adapter. My adapter is from RoarKit (sold by sheffield_nikki on ebay.com). Soldering instructions are here. Pin 10 and 11 are grounded as recommended in the data sheet page 21.

MCP3422 in a SOIC-8 house has 1.27 mm pitch and is converted to 2.54 mm pitch using an adapter with 8 pins. Soldering instructions are here.

Si5351 comes with a 2.54 mm pitch break-out board.

The decoupling capacitor C0 100 nF was added.

The round 3 V lithium cell (CR2032) is fitted last. It powers the RTC on Teensy.

**Receiver board; photo**

Figure 6 shows the receiver board. The Si3745, Si5351, MCP3422, and the battery are not fitted yet.

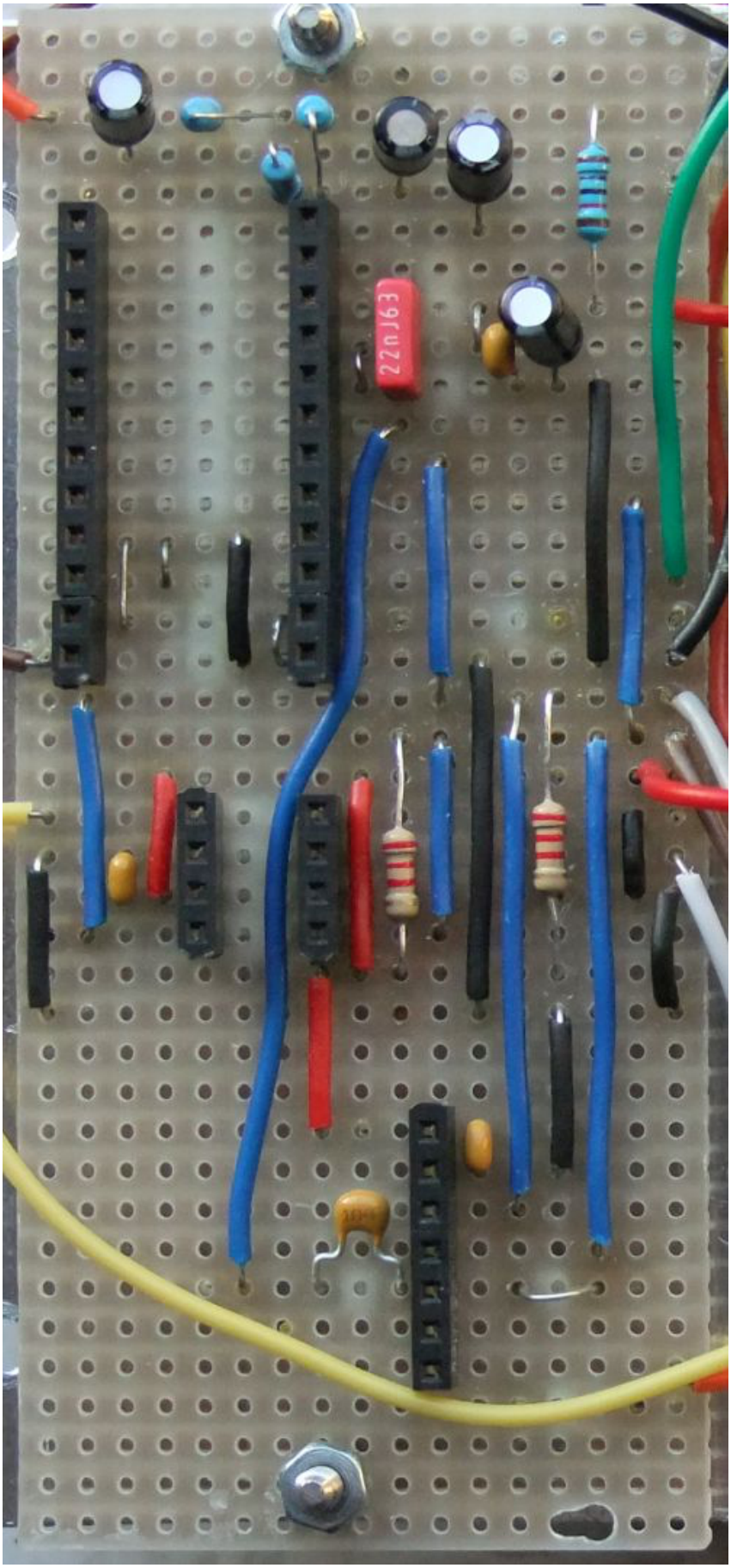


*Fig 6. Receiver board without ICs and battery.*

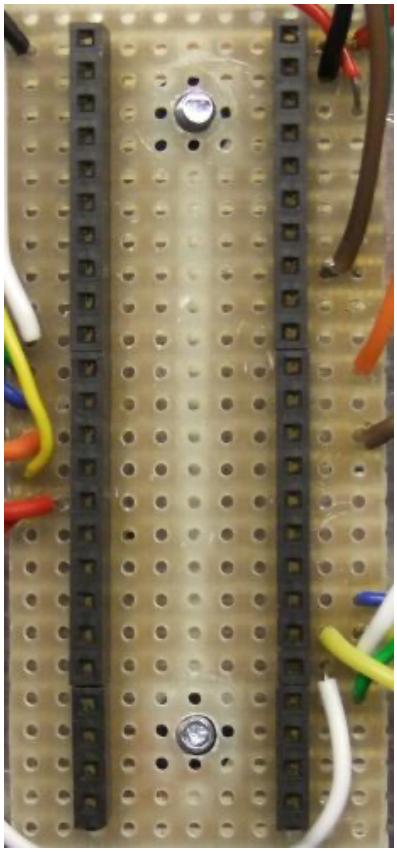

*Fig. 7. Veroboard for Teensy.*

**Teensy 3.6 board**
Teensy 3.6 is fitted on a piece of Veroboard using sockets. The Veroboard measures 68 mm x 30 mm.

Teensy 3.6 product page
Teensy 3.6 pin-out card (front side)
Teensy 3.6 pin-out card (back side)

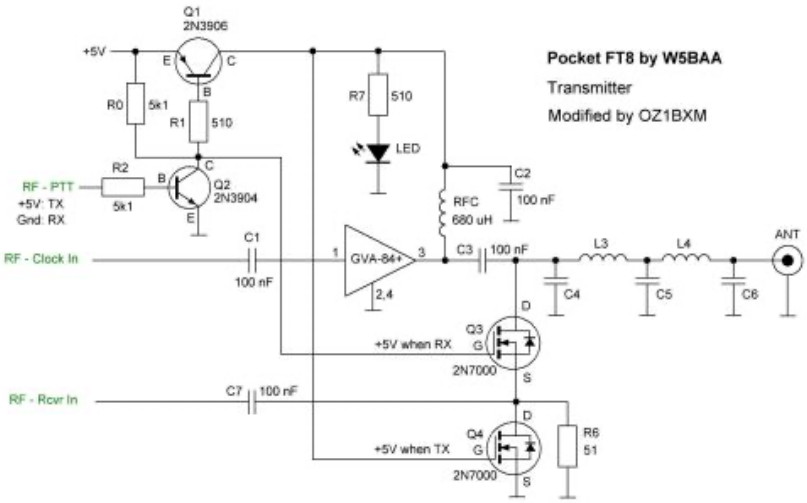


*Fig. 8. Transmitter circuit diagram.*

**Transmitter circuit diagram**
Receive: Q3 is on; Q4 is off. The signal from the antenna runs through the LPF and Q3 and is terminated by R6. The signal goes to the receiver via C7.

Transmit: Q3 is off; Q4 is on. The transmit signal from GVA-84+ flows through the LPF to the antenna. Q3 is off and prevents the strong RF signal from reaching the receiver. Q4 conducts and puts "RF - Rcvr In" to ground for receiver protection.

I've modified the transmitter as shown in figure 8. Please refer to original diagram in the project manual page 4. R0 was added to allow current into Q2. R2 was added to limit the Q2 base current when RF-PTT is high. The resistor in Q3's gate was removed (it had no function). Same destiny for the resistor in the gate of Q4.

The input low-pass filter was removed. The low-pass filter following GVA-84+ should be sufficient for removing transmitter harmonics. The output transformer T1 was removed and replaced by the application circuit from the GVA-84+ data sheet page 4. RFC was changed from a core-wound choke to a standard choke. It must be the upright type (see this photo) as this type can carry more current. R7 and LED are optional. I've added the LED to indicate when PTT is activated.

**Component values for 18 MHz**
L3, L4: 0.5 uH. Make 10 turns 0.5 mm wire on Amidon T37-2 core. Picture of this inductor.
C4, C6: 75 pF
C5: 242 pF

**Transmitter board lay-out**

The transmitter is buildt on a piece of Veroboard measuring 74 mm x 30 mm (figure 9).

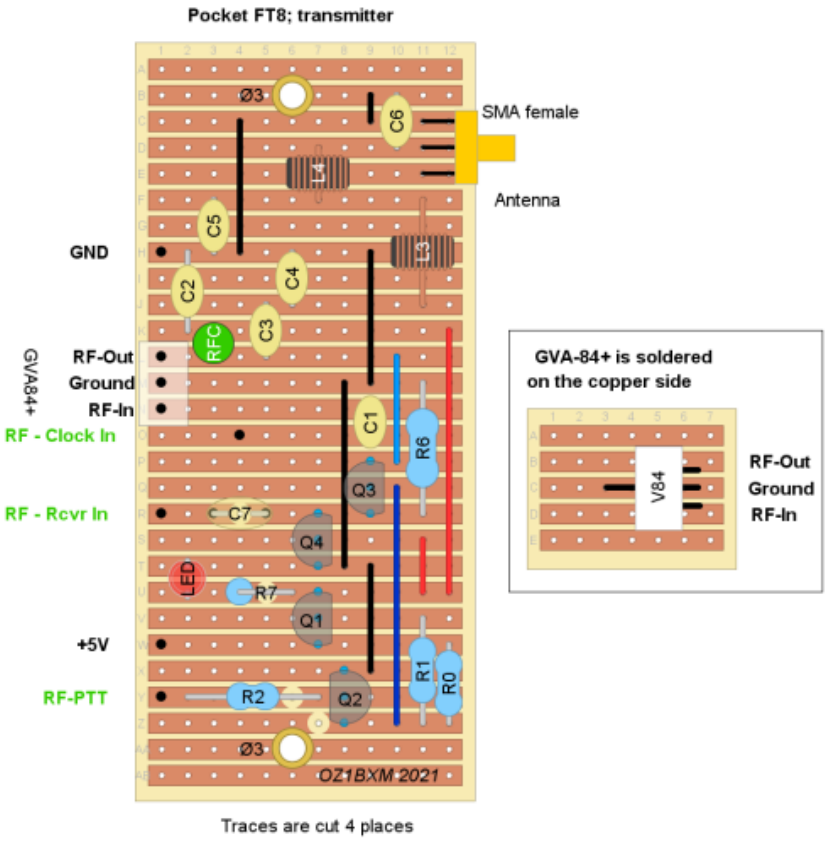


*Fig. 9. Component placement, transmitter.*

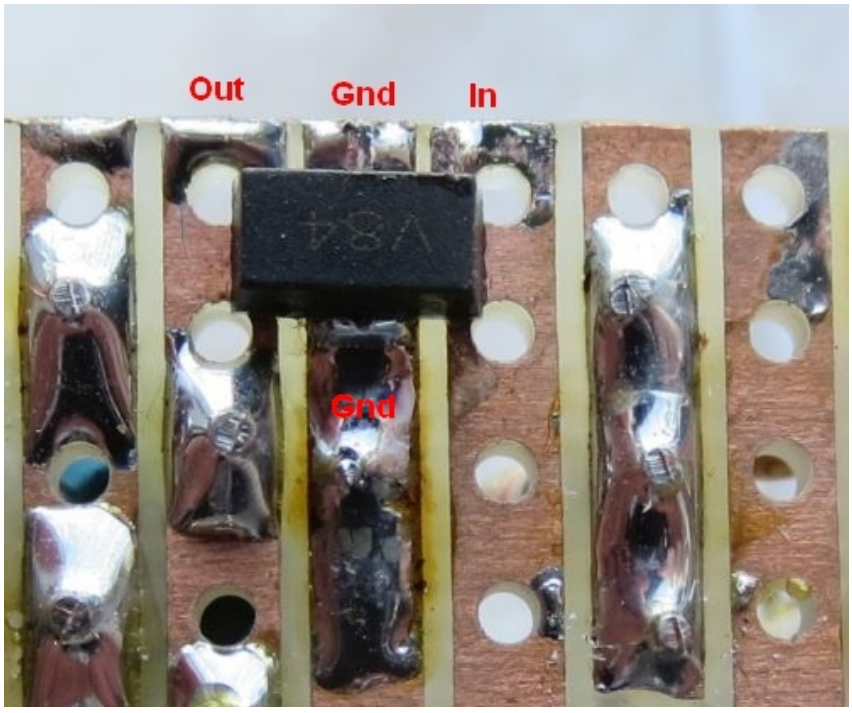


*Fig. 10. Soldering GVA-84+ on the copper side.*

**GVA-84+**
The amplifier GVA-84+ is a surface mount component. It is placed on the copper side of the board and soldered 4 places.

**Transmitter board**
RF output from the transmitter was measured using a low-price meter from China. The output was 50 mW at 18 MHz.

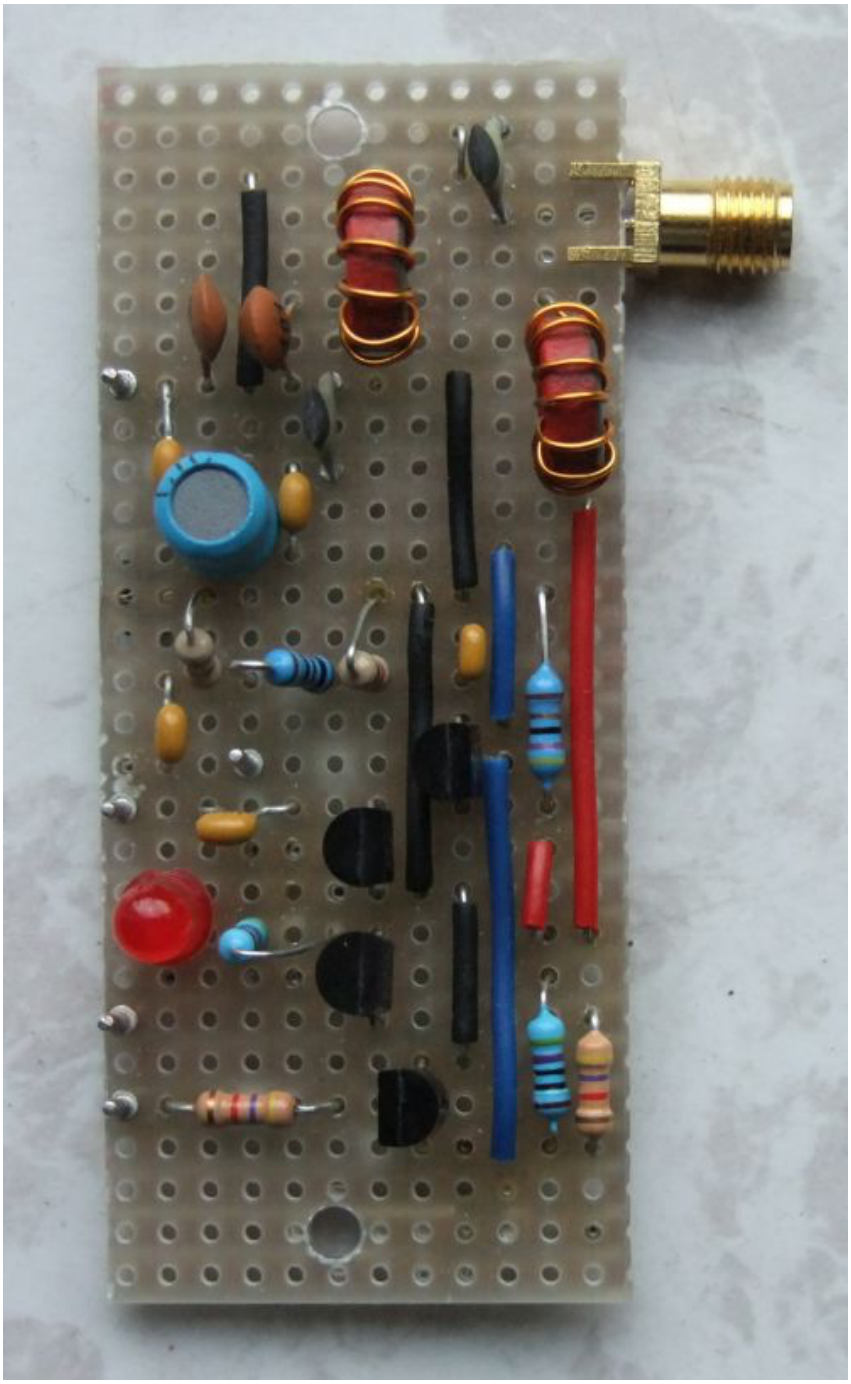

*Fig. 11. Transmitter board.*

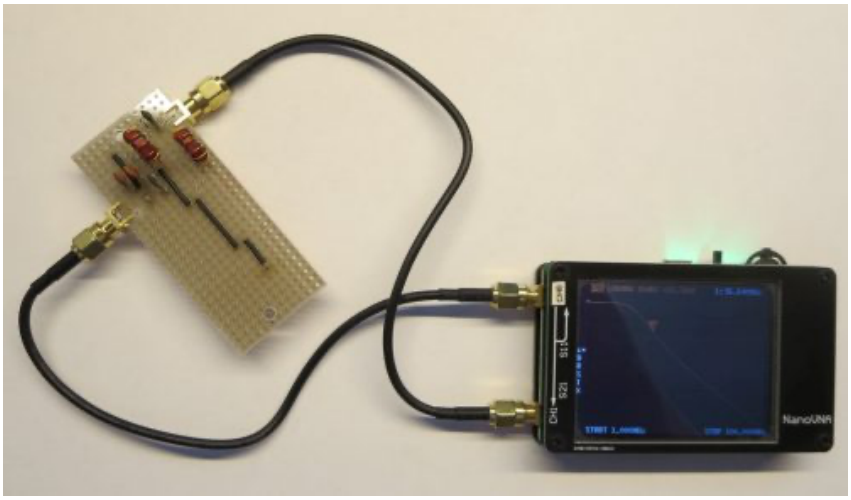


*Fig. 12. Measuring the Low Pass Filter.*

**Measuring the Low Pass Filter**
The low pass filter comprises L3, L4, C4, C5, and C6. I measured the frequency response of the filter using NanoVNA.

Start freq: 1 MHz; Stop freq: 100 MHz
Gain at 18 MHz: -0.78 dB
Gain at 36 MHz: -17.7 dB
Gain at 54 MHz: -33.6 dB
Gain at 72 MHz: -47.6 dB

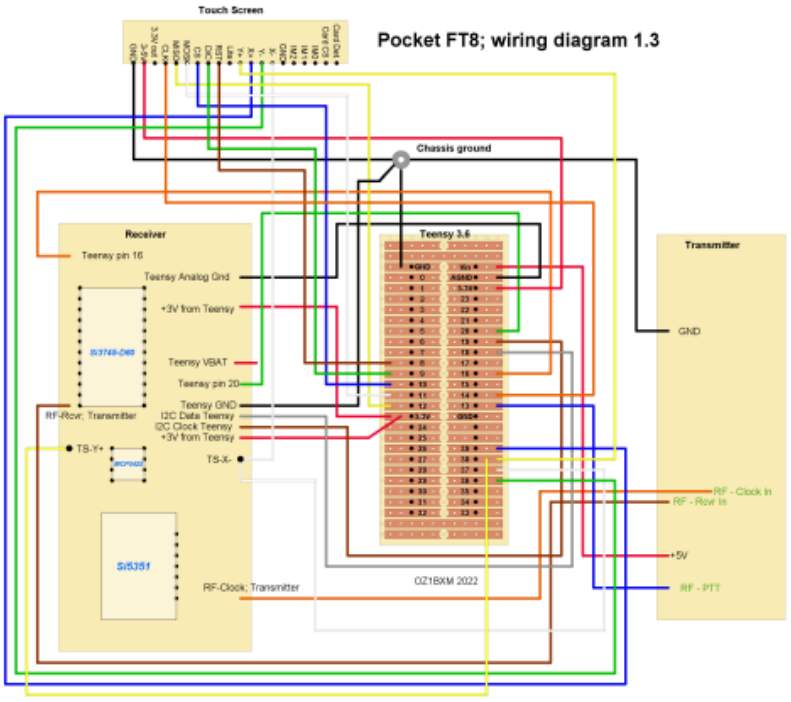


*Fig. 13. Wiring diagram (ver. 1.3).*

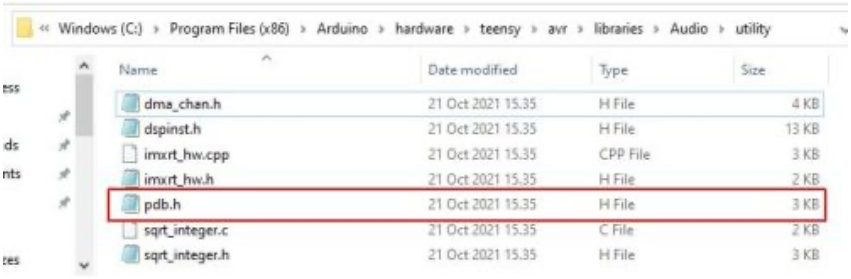


*Fig. 14. Pdb.h file.*

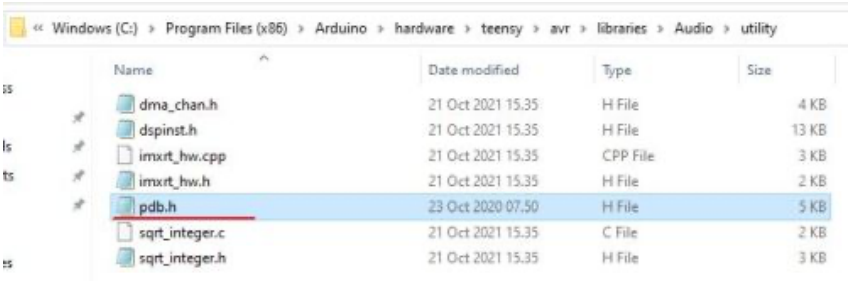


*Fig. 15. The new pdb.h file.*

**Wiring diagram**
The boards are wired together using insolated wire in different colors as shown in figure 13. HB9TVK Peter told me, that MISO and MOSI are reversed in the original diagram in the Project Manual 1.0. MOSI should connect to Teensy pin 11, and MISO to Teensy pin 12.

**Load Teensy software into Arduino IDE**
Follow the Project Manual page 5 (Building the Firmware).

The instructions https://www.pjrc.com/teensy/td_download.html will guide you, and soon Teensyduino is installed with a lot of new libraries. Win 10 advice: Run the installation file as Administrator.

The file pdb.h in the "utility" folder (high-lighted in figure 14) must be replaced by the one in the "Pocket_FT8_Publish" folder.

The new pdb.h is shown in figure 15. The new size is 5 kb and the date is 23-Oct-2020.

**Arduino IDE detects Teensy 3.6**
Figure 16 shows Arduino IDE > Tools when Teensy 3.6 is connected to the PC and properly detected.

If the Board string is different from "Teensy 3.6", you can select it here:
Tools > Board > Teensyduino > Teensy 3.6

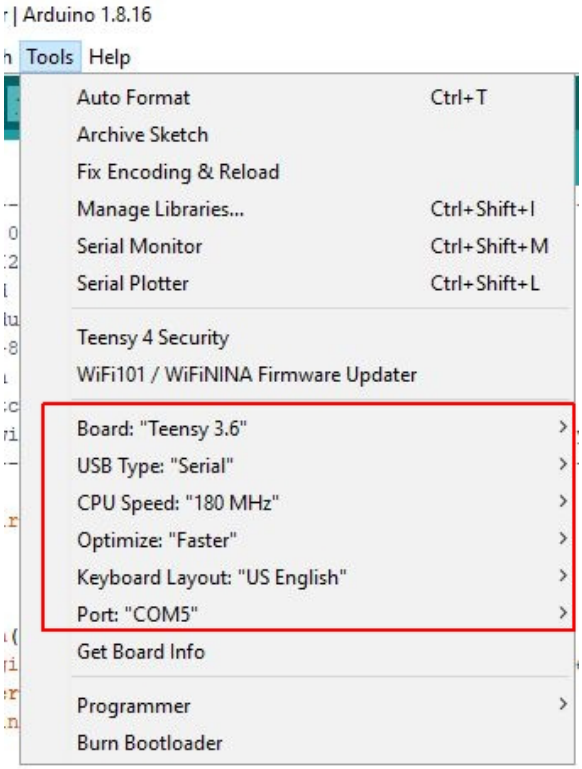


*Fig. 16. Teensy 3.6 is detected by Arduino IDE.*

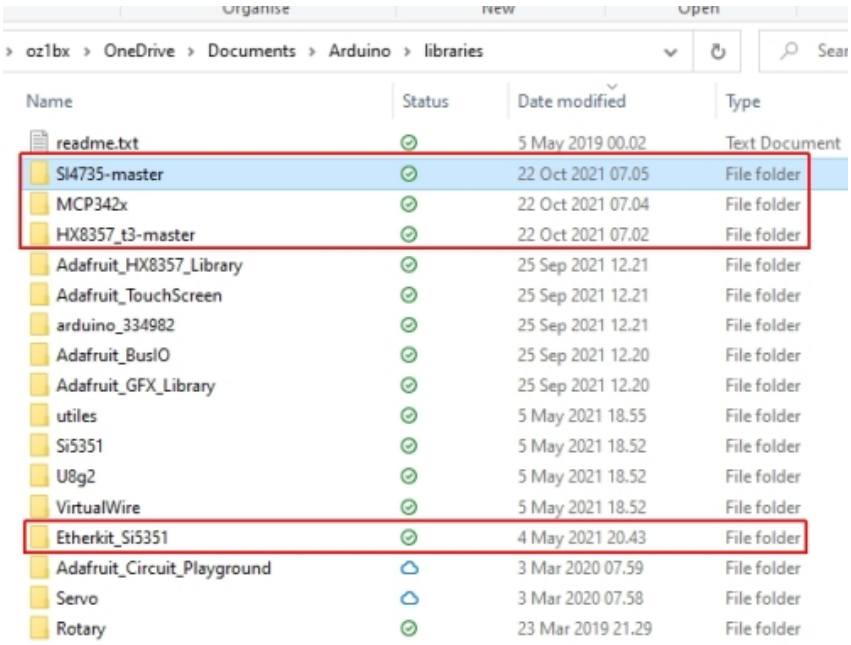


*Fig. 17. New libraries.*

**Install remaining libraries**
How to install additional libraries: https://www.arduino.cc/en/guide/libraries

Disconnect Teensy from the PC. Close Arduino IDE and restart the PC. Open Arduino IDE and install the remaining libraries:

- Etherkit_Si5351
- MCP342X
- HX8357_t3-master
- Si4735-master

The new libraries should be installed in the sketchbook folder. Open this folder by selecting:
Arduino IDE > Sketch > Show sketch folder.

Copy the four new library folders to the "libraries" folder inside your sketchbook as shown in figure 17.

Verify that the new libraries are available in the list that pops up when you select Sketch > Include library.
The Etherkit_Si5351 library is displayed as "Etherkit Si5351"
The MCP342X library is displayed as "MCP342x"
The HX8357_t3-master is displayed as "HX8357_t3"
The Si4735-master library is displayed as "PU2CLR SI4735"

The new libraries can also be verified in the Library Manager (select Type = Installed).

**Reduce SPI clock speed**
HB9TVK Peter recommends reduce the SPI clock speed from 30 MHz to 25 MHz for better stability. HB9TVK has experienced erratic display behavior at 30 MHz. He says the display still works ok at 25 MHz.

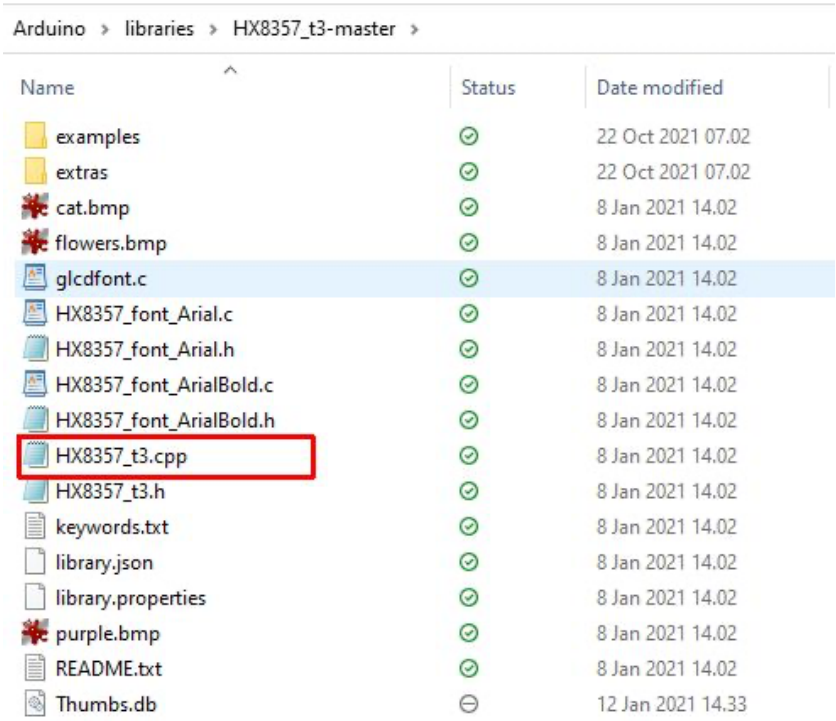


*Fig. 18. HX8357_t3.cpp.*

Find the HX8357_t3-master folder as shown in figure 18.
Open file HX8357_t3.cpp and go to line 56: #define SPICLOCK 30000000
Change line 56 like this: #define SPICLOCK 25000000

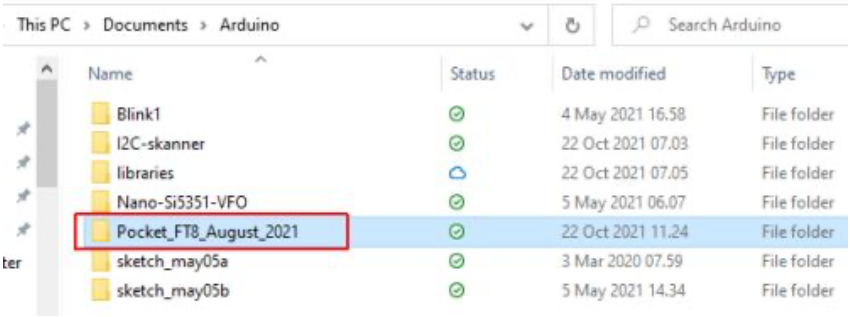


*Fig. 19. This folder contains the main software.*

**Set ham call and locator, compile and upload**
Copy the folder "Pocket_FT8_August_2021" to the sketchbook folder as shown in figure 19.

Open the file Pocket_FT8_August_2021.ino and insert your ham call and your locator:

```
char Station_Call[] = "OZ1BXM"; //six character call sign + /0
char Locator[] = "JO46"; // four character locator  + /0
```

Save the file and press Verify to compile. Observe, that IDE selects the proper libraries. If IDE selects a "wrong" library, the "wrong" library must be moved outside the library folder, or renamed.

Upload the compiled file to Teensy 3.6.

**Project status**
I have received valuable info regarding the display problem from HB9TVK Peter

**The project stopped May 2022.**

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Written by OZ1BXM Lars Petersen oz1bxm@pobox.com. Latest revision: 10-Aug-2022.