

CFT1 5-Band QRP CW Field Transceiver

By KM4CFT

Owner's Manual





In memory of Sherwin "Steve" Kayne.

My grandfather played a vital role in making me the person I am today and without his support I would have never pursued STEM and Amateur Radio. Although he never was licensed, he was a true elmer.

"The price of success is hard work, dedication to the job at hand, and the determination that whether we win or lose, we have applied the best of ourselves to the task at hand."

- Vince Lombardi

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Overview

The CFT1 is a 5 Band, Compact Portable QRP CW Field Transceiver. It operates on the 40m, 30m, 20m, 17m, and 15m amateur radio bands. It features a ~5 watt class-D transmitter, message memory playback, iambic keyer (with paddle reverse), among other useful features.

The CFT1 was created by Jonathan, KM4CFT (age 25) with the field operator in mind, specifically for use in both Parks on the Air (POTA) and Summits on the Air (SOTA).

Front Panel and External Connections



The external connections were laid out to make portable operation comfortable and easy for the operator by putting the less used connections farther away and the more used closer to the operator.

- **EXTERNAL:**

- **DC Power In** – connect your external power source here. The CFT1 uses a 5.5mm OD x 2.1mm ID barrel connector with the center pin being positive. It can accept 8-14 VDC, and a supply current of 2A.
- **Antenna Port** – connect an external antenna or a tuner to this port. It is a standard BNC connection used in most QRP applications.
- **Power Switch** – turns on or off the power. The upper position turns the transceiver on.
- **Headphone Connector** – audio output. Puts audio on both sides of the headset. Uses a 3.5mm connector.
- **Paddle Connector** – connect your CW paddle here. Uses a 3.5mm audio connector. Tip is dit while Ring is dah. Plugging a mono cable in during power up will put the radio in *Straight Mono* mode.

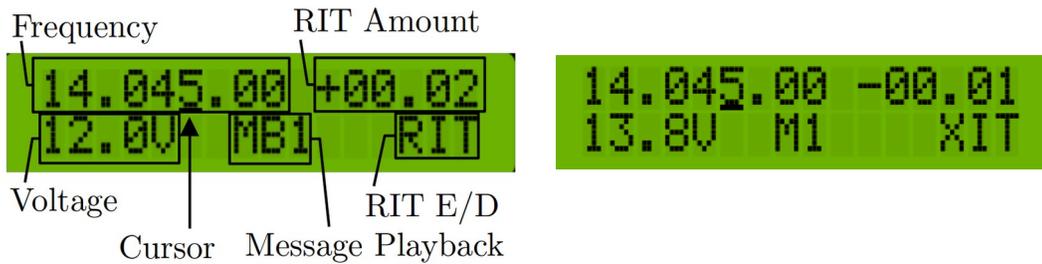
- **FRONT PANEL:**
 - **LCD Panel** – the main display.
 - **Volume Knob** – rotating the knob clockwise increases the volume, counterclockwise decreases the volume.
 - **MENU/BACK Button** – allows you to enter the settings menu. Also serves as a back button.
 - **M1-M4 Buttons** – allows for message memory or message beacon playback. A short press will playback the message while a long press will enable beacon playback (message repeat).
 - **BAND/XIT Button** – short pressing this button will cycle through the 5 bands on the transceiver (40m, 30m, 20m, 17m, 15m) while long pressing enables or disables XIT.
 - **TX LED** – when lit, the CFT1 is transmitting.
 - **VFO Encoder Knob** – changes the frequency. Also serves as a select button as well as the adjustment control. On the main display, short pressing the encoder will change the tuning rate while long pressing enables or disables RIT.

Operator Pro-Tip: Transmitter Incremental Tuning (XIT)!

Trying to work a pileup or a DX Station? Using XIT, or transmitter incremental tuning will give your station the edge over others! By using XIT, you are slightly adjusting your transmit frequency so that your tone will differ from everyone else and will be easier for the DX station to hear you.

It is considered good practice to avoid zero-beating a DXer when they have many stations calling them!

Main Display



- **Frequency** – shows the current frequency you are tuned to. You can change the frequency by rotating the VFO knob, and it will change depending on the cursor position.
- **Cursor** – shows what rate the frequency can be changed. Short-pressing the VFO knob will change this value by 10 kHz, 1 kHz, 500 Hz, 100 Hz, 10 Hz and RIT/XIT amount (if enabled).
- **RIT/XIT E/D** – shows if Receiver Incremental Tuning (RIT)/Transmitter Incremental Tuning (XIT) is enabled or disabled. A long press of the VFO knob will enable or disable RIT, and a long press of the Band Button will enable or disable XIT.
- **RIT/XIT Amount** – shows the RIT/XIT amount in kHz. This can be adjusted when the cursor is set to RIT/XIT, in which you will see a “>” to the left of the RIT/XIT E/D indicator.
- **Voltage** – displays the voltage seen at the input of the system.
- **Message Playback** – this will indicate that either message playback “M#” or message beacon playback “MB#” is engaged. Message playback is invoked with a short press of one of the four message buttons while beacon playback is invoked with a long press. Short pressing any of the front panel buttons or tapping the paddle during playback will cause the message to halt.

CW Practice Mode

The CFT1 has built-in out of band transmit protection to prevent the operator from operating illegally. If the transceiver is tuned to a frequency that is not within the amateur radio band plan, transmit will be disabled and the keyer will function as a CW practice keyer.

Settings

The Settings can be easily accessed by pressing the MENU button on the main display. Settings are ordered by how often the field operator is expected to want to change them on the fly, so things like keyer speed and paddle mode are in the front.

You can cycle through the settings by rotating the VFO knob. To change a setting, simply press in the VFO knob. When this happens, a “>” will appear to indicate you are editing the value. When you are done, you can confirm by either pressing the VFO knob again or the MENU button (except for message memory edit which will only confirm by pressing MENU)

While in the menu, you can still send CW and use the message playback buttons by pressing the M1-M4 buttons. This can be useful if you like to change the keyer speed or another menu item while in the middle of a QSO (for example, slowing down for a slower operator). However, beacon mode is disabled and you will not be able to perform any actions while playback is in progress.

Exit the settings menu by pressing the MENU button.

CW Speed



```
CW Speed:
>10 WPM
```

This is the most commonly changed setting. You can adjust your CW Keyer Speed with this. The number is the value in words per minute (WPM), and is based off the word “PARIS”. (RANGE: 5-50 WPM) (DEFAULT: 10)

Keyer Mode



```
Keyer Mode:  
>IAMBIC B
```

This changes the mode of the paddle and can be changed to the following values:

- **STRAIGHT MONO** – Straight Key with a Mono Jack. This will only respond to the *tip* connection. If you insert a mono cable into the radio at power on, it will be changed to this mode regardless of what you have the keyer mode set to.
- **STRAIGHT STEREO** – Straight Key with a Stereo Jack. Unlike with mono, this will respond to both the *tip* and *ring* connections. This is great if you want to use an iambic paddle as a sideswiper/cootie or if you simply want to key down for tuning an antenna.
- **IAMBIC A** – this mode only looks at the current state of the keyer and will automatically send a dit or dah depending on which one is pressed. This is used on the Yaesu FT-450D radio and isn't as common.
- **IAMBIC B** – this mode is the more popular iambic mode. Unlike Iambic A, this one looks at the opposing lever and if it sees that both sides have been pressed while sending it will add a dit or dah to the next character. This is what is used on most ICOM and Yaesu radios.

(DEFAULT: STRAIGHT STEREO)

CW Pitch



```
CW Pitch:  
>700 Hz
```

This sets the sidetone pitch value in Hz. When adjusted, this also will change the BFO offset to match. This means that if you set your sidetone to 700 Hz, stations that zero-beat you will sound like 700 Hz. (RANGE: 300-900Hz) (DEFAULT: 700)

Paddle Direction



```
Paddle Direction  
>NORMAL
```

This sets the direction of the paddle. With a properly wired CW paddle, the left paddle is connected to the tip and sends a dit while the right is connected to the ring and sends a dah. In NORMAL mode, this is how it should behave. If however you prefer to send the other way and/or your paddle is wired differently you can change this to REVERSE.

(DEFAULT: NORMAL)

CW Messages



```
Message 1:  
CQ CQ CQ DE CFT1
```

This allows you to enter in your four CW message values. Just like the other menus, a short press of the VFO knob will allow you to edit this. If you want to restart from scratch, long press the VFO knob and it will clear the message. Each character starts with a space and rotating the knob will cycle through the numbers followed by the letters and finally special characters. Each message memory can store a maximum of 50 characters. Once you find the letter you are looking for, short-press the VFO knob to enter the value.

If you wish to enter in a prosign (like BT, AR, SK, etc) insert a “}” between the two characters and there won’t be a character space (three dits) between the two characters (i.e. “S}K” will send the <SK> prosign)

Once you have fully entered your message, press the MENU button to exit out of message edit.

Beacon Interval



```
Beacon Interval:  
>4 sec
```

If you activate CW beacon mode (by long pressing one of the message playback buttons) this value sets the amount of pause time between each message playback in seconds.

(RANGE: 1-30 seconds) (DEFAULT: 4)

Beacon Timeout



```
Beacon Timeout:  
>10 times
```

When beacon mode is activated (by long pressing one of the message playback buttons) this value sets how many times the message will be played before beacon mode is finished. Setting this to 0 will disable timeout (repeating indefinitely). (RANGE: 0-99 repeats) (DEFAULT: 10)

Backlight



```
Backlight:  
>ON
```

This turns on or off the LCD Backlight. Turning off the backlight will decrease the current draw of the radio by ~20mA, so it is useful for conserving battery life. (DEFAULT: ON)

Calibration Menu



Cal Menu

This menu should only be entered if you know what you are doing. Ideally, this will only be adjusted during the first tune up procedure.

10 MHz Reference



10 MHz Ref:
>-18420 1 Hz

This menu calibrates the 10 MHz reference value that the si5351a IC chip uses for the VFO, BFO and PA oscillator. The number shown is a calibration factor value and is an offset from 10 MHz in tenths of a Hz.

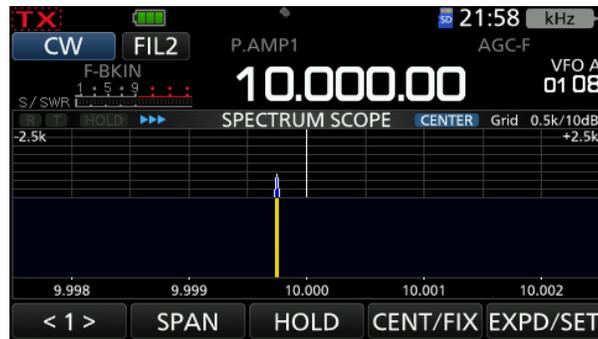
Short pressing the VFO knob will change this by 100 Hz, while long pressing will change it by 1 Hz.

When you enter this mode, the VFO will attempt to output 10 MHz. You can use a frequency counter or another radio to help calibrate it to be actually 10 MHz. It is recommended that you place your antenna near the bottom-right side of the radio since that is closest to the OSC0 signal you are calibrating.

CALIBRATION PROCEDURE:

To perform this calibration, you will need either a frequency counter or another receiver. It is preferable to have a receiver with a spectrum display so you can see where the frequency is. This will be shown using an IC-705 but an inexpensive option that would also work well is an RTL SDR which can be purchased inexpensively for about \$20.

First, enter the calibration menu and select the “10 MHz Ref” adjustment. Place the antenna of your receiver near the bottom-right of the CFT1 for best reception.



In the above image, you can see that the reference signal is *lower* than we want. In this situation, we want to *decrease* the reference value. If the reference was higher than we want, we would want to increase the reference value. Once we get this as close as possible, press the VFO knob to confirm, then long-press the VFO knob again to go into 1 Hz adjustment and then we can fine tune to 10 MHz.

Some radios have a “spot” feature that lets you play a sidetone while receiving. This can be particularly helpful with fine tuning the 10 MHz reference since it allows you to “zero-beat” your received signal and essentially getting the si5351 within 1 Hz of 10 MHz. A good technique to do this without a spot feature is to use a smartphone or computer to playback a tone (I recommend 700 Hz). They can be found easily on YouTube if you cannot find an online tool.

Once you are done calibrating this, it is recommended you power cycle the radio after exiting the CAL Menu.

IF



This changes the Intermediate Frequency value in Hz. Being a superheterodyne transceiver, there is a 4.914 MHz crystal filter that the signal passes through. These filters can vary slightly in their cutoff points, so you can use this to fine tune where the center frequency is (or at one of the peaks of the ripples in the passband) (DEFAULT: 4914850)

CALIBRATION PROCEDURE:

To perform this calibration you will need some kind of RF signal generator, such as a TinySA. You could also theoretically use another QRP radio transmitting into a dummy load.

(You can also tune to WWV and use it if you have an HF antenna that can receive it) If you have an RF source, set the output level to -90 dBm or lower. On the main screen, long-press the VFO knob to enable RIT. Try adjusting the RIT amount to see if you can achieve a louder sound. If you do, then that amount will tell you approximately where that peak is. For example, a peak at -0.03 would indicate that the IF should be *decreased* by 30 Hz. Disable RIT and enter the IF menu and adjust accordingly. You might need to experiment a little to find the peak since RIT only tunes in increments of 10 Hz.

BFO Offset



```
BFO Offset:  
>0 Hz
```

When sending and receiving, stations should appear to have the same sidetone frequency if they are zero beating each other. If for some reason this isn't the case (or want your Sidetone and zero-beat to differ), the BFO offset lets you fine tune this in Hz. This setting is almost never needed to be changed since the sent and received tones are usually within a few Hz of each other. (DEFAULT: 0)

PA Oscillator

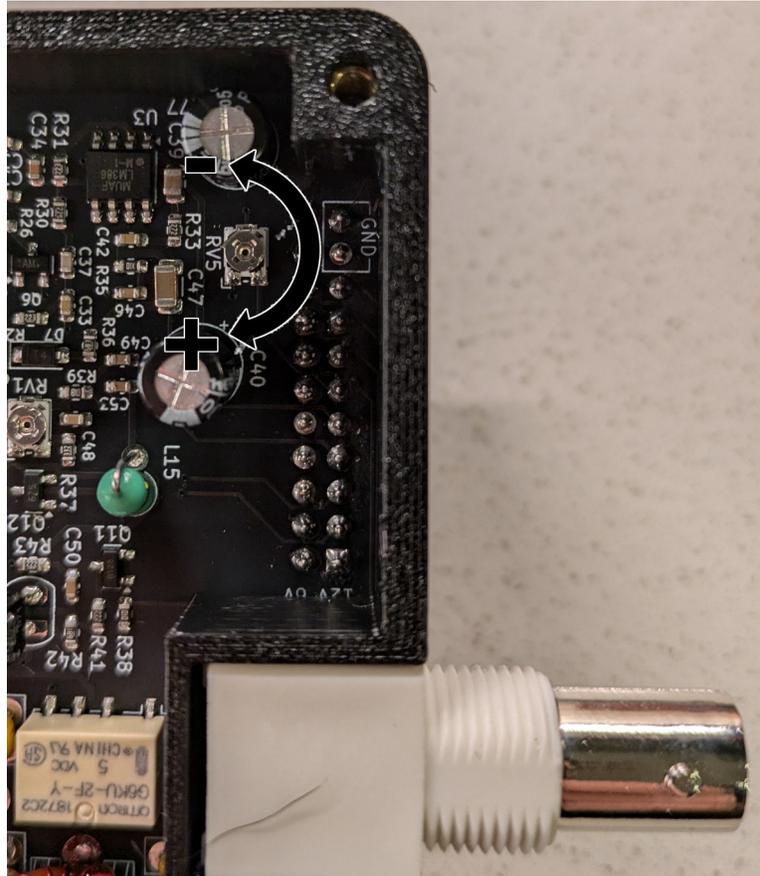


```
PA OSC:  
>Enable
```

During initial calibration, it is important that the drive level is properly set to the IRF510 Final MOSFET. The CFT1 uses a class D amplifier so ideally while transmitting we want the IRF510 going between the “off” state and the saturation state. To prevent the oscillator from influencing the drive level, this setting will allow you to temporarily disable the oscillator while setting the drive level seen at the gate of the IRF510 to 2-2.5v. (The IRF510 starts conducting between 3 and 4 volts) This setting is not remembered by the CFT1 and will reset to “Enable” after a power cycle. *See the assembly manual for the tuning procedure.* (DEFAULT: Enable)

Sidetone Volume Adjustment

By default the sidetone volume is set to maximum. If you find that the volume is too high, it can be adjusted by opening up the back plate and turning trimpot RV5 counterclockwise.

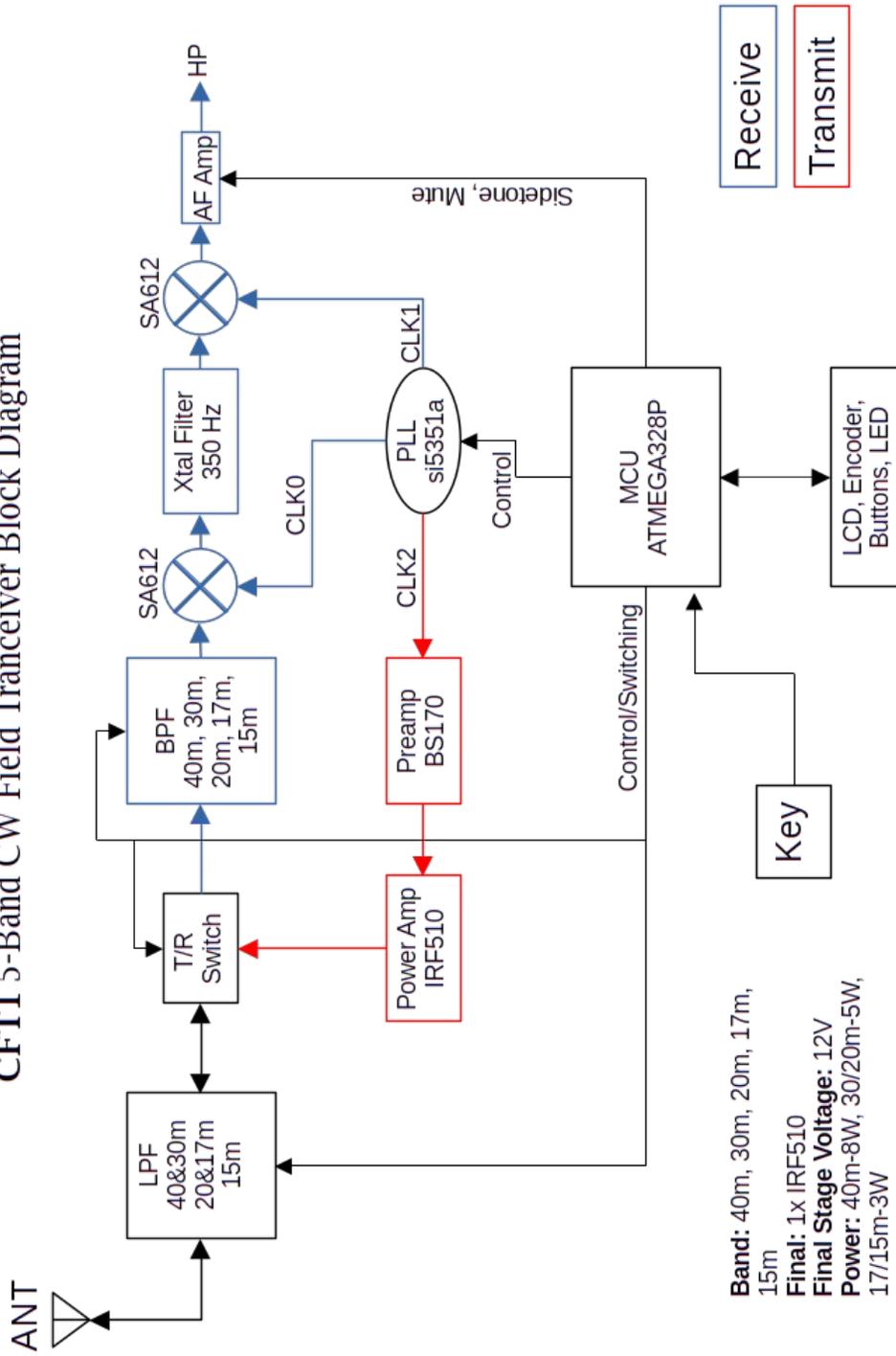


Specifications

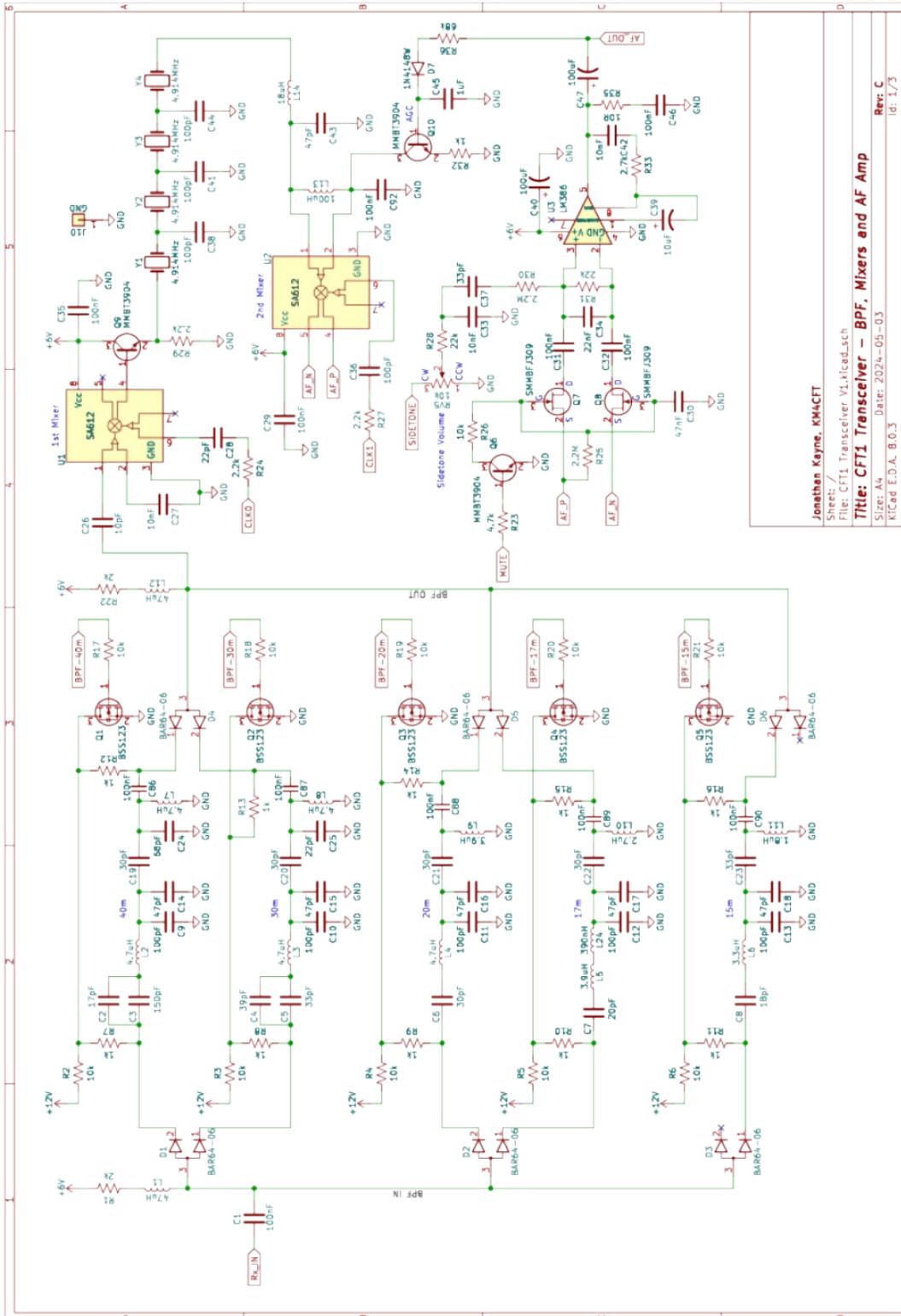
- **General:**
 - **Frequency Range** – (40m – 15m Amateur Radio Bands)
 - Rx: 6.900-8.600 MHz, 9.300-11.800 MHz, 13.500-16.000 MHz, 17.000-20.000 MHz, 20.000-24.000 MHz
 - Tx: 7.000-7.300 MHz, 10.100-10.150 MHz, 14.000-14.350 MHz, 18.068-18.168 MHz, 21.000-21.450 MHz
 - **Antenna Input** – 50Ω, BNC
 - **Voltage and Current** – 8-14V, Receive 80-100 mA (60-80mA with LCD Backlight off), Transmit 600-1500 mA. (800mA typ.) 2.5A Over Current Protection, Reverse Polarity Protection
 - **Size and Weight** –
 - Chassis: 70x100x36mm (2.77x3.94x1.43”)
 - Inc. Knobs and Connectors: 70x125x52mm (2.77x4.92x2.06”)
 - 218g (0.48 lbs)
- **Receiver:**
 - **Sensitivity** – -125 to -135 dBm
 - **Crystal Filter** – 300-400 Hz, 4.914.850 MHz CF typ.
- **Transmitter:**
 - **Output Power** – 40m: 8W, 30m: 5W, 20m: 5W, 17m: 3W, 15m: 3W (12V)
 - **Transmit Features** – Built-in Keyer (5-50 WPM), Full Break-in, MOSFET T/R Switching, 4 CW Messages of 50 characters each, Message repeat, XIT
 - **Sidetone** – 300-900 Hz, adjustable

Block Diagram

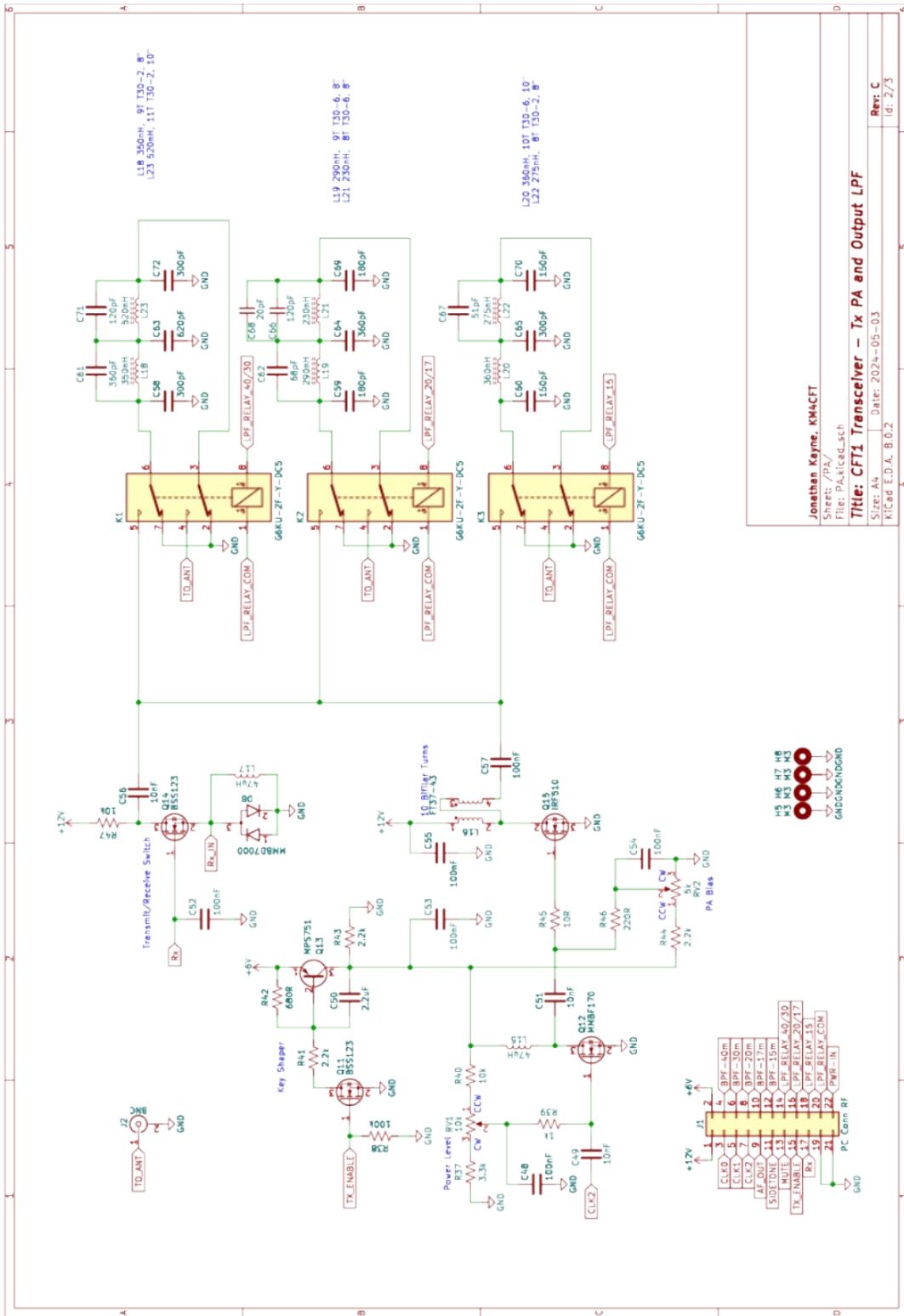
CFT1 5-Band CW Field Transceiver Block Diagram



Schematics



Jonathan Kynze, KM4CT
 Sheet: 7
 File: CFT1 Transceiver V1.kicad.sch
Title: CFT1 Transceiver – BPF, Mixers and AF Amp
 Size: AA Date: 2024-05-03
 KiCad E.D.A. B.O.3 ID: 173



Jonathon Kayne, KM4CFT
 Sheet: /PA/
 File: PA_kicad.sch
Title: CFT1 Transceiver - Tx PA and Output LPF
 Size: A4 Date: 2024-05-03
 Kicad E.D.A. 8.0.2

Rev: C
 16: 2/3

