Firmware version 0.0.194

October 25, 2014

- The "RFG" control has been completely changed. Formerly, it adjusted the behavior of the Codec A/D converter gain scaling, but it now works like the "RF Gain" control on almost every HF rig you have ever seen: If set to zero, the S-meter will be "pinned" and the radio will be deaf, but if set to maximum (50) the radio will have maximum sensitivity. This control is used to set the "maximum sensitivity" of the radio and is useful on a noisy band to prevent the noise from coming up between transmission. Note that the numbers will go yellow, orange and then red as they are decreased to "warn" you that you are doing something that will "deafen" your receiver!

IMPORTANT NOTE: If, when you load this firmware, that you find your receiver to be "deaf", check the RFG setting. If it is Zero, set it 50 and all will be well - and be sure to power off using the POWER button to save the settings! ***(Don't say that I didn't warn you about this!)***

- STG Setting modified: The "STG" setting has now been modified such that the amplitude of the sidetone is now (nearly) constant, regardless of the TX power level.

- The problem with odd bleeps and blurps when using CW mode is fixed... I hope... See below about "CW TX->RX Delay". This should also reduce the problem with a "chirp" when going between RX and TX on SSB.

- The TX power coefficient for "FULL" power was reduced from 1.00 to 0.75 as it was observed that the original value was causing unconditional clipping of the TX QSD mixer, resulting in some dirty, across-the-band splattering. The peak-to-peak voltage being applied to U17's analog inputs was in excess of 7 volts, well above the "safe" limits of the device!

- The transmit filter has been replaced and it now better filters at communications bandwidth (e.g. below 3 kHz) as it should.

- A slight change was made in the way the TX IQ Gain balance works. Due to the intrinsic asymmetry in 0-90 degree Phase-Added Hilbert transformers, just one setting for one sideband does not work perfectly for the sideband the one for which the nulling was adjusted, so a work-around was added to provide an approximation for that opposite sideband. At some point separate TX IQ gain and phase adjustments for USB and LSB may be added... It is recommended that the TX IQ Gain be re-adjusted for best null with a compromise between USB and LSB.

- TCXO Button removed: The button that used to have "TCXO" on it is now blank. I haven't decided what to put there...

COMMENT on PA Bias Adjustment:

There seems to be a bit of confusion on the way that PA bias is adjusted. For now, this seems to be the best way:

First, it is strongly recommended that a resistor (1k-10k) be placed in parallel with C96 to assure that the PA Bias will adjust properly. If this is not done the bias can sometimes "run away" or simply not seem to have any effect as it is adjusted.

Second, it is strongly recommended that a tantalum capacitor of 4.7-22uF (exact value not critical) of at least 16 volts be placed across C106 to suppress spurious LF/MF oscillations.

(Both modifications are noted in the "Modifications" file in the KA7OEI filter)

When adjusting the bias, the following procedure is recommended:

- Set to 40 meters
- Set to CW mode
- Connect a watt meter
- Connect a dummy load
- Set to 1 watt mode
- Go to CAL mode
- Go to TUNE mode and adjust PA Bias for 1 watt of RF
- Exit CAL mode to save bias settings
- Exit Tune mode.

You should get about 1 watt (+/- 20%) on the other bands. If it's lower on some bands you may need to check the way the toroids for those bands were wound.

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The first thing that you will note is that button F1, which formerly said "MIC" or "LINE" (or "MB" in "CAL" mode now says "MENU" when the radio starts up. When in MENU mode the CAL button is always greyed out - and the menu button will be greyed out when in CAL mode. Other than that, the radio should function more or less normally when in MENU mode.

Pressing this button will (surprise!) enter the main configuration menu. In this mode:

- Encoder 1 (far left) is ALWAYS the volume control.
- Encoder 2 (center) selects the item to be changed. A green " < " on the far right edge of the screen indicates the item being selected.
- Encoder 3 (far right) changes the item selected. CHANGES ARE IMMEDIATE!

When in MENU mode, the indicator above button F1 changes to "EXIT" and that above button F2 changes to "DEFLT" which means "DEFAULT" - which is to say that pressing that button will reset the selected item to its DEFAULT value.

If you change ANY item, TWO things will happen:

- The bottom of the menu will display, in orange, "Save settings using POWER OFF!" which means that NONE of the changes that you will make will be saved UNLESS you turn off the radio using the POWER button! If you simply remove the power, all changes that you make will be lost.

- When you exit the menu, you will notice that the "MENU" button is will now be orange with an asterisk next to it, reminding you that you may have changed something and that if you want to save it, you will need to power down the radio using the POWER OFF button!

(Note that it detects if you changed something, but it can't detect if you changed it back to what it was and then "un-indicate" that you didn't actually made a change.)

Note that, even while in the MENU mode you CAN power off the radio at any time and save settings.

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Explanation of menu items:

The numbering of menu items are by general grouping which should be fairly self-explanatory. No doubt, things will be added as they occur to me and, possibly by request!

10 - **AGC Mode**: Slow, Medium, Fast, Custom and OFF (Default = Medium, which was the "fixed" setting in previous firmware versions.)

Slow, Medium and Fast are fairly self-explanatory, found on most other radios.

WARNING: If you select "OFF" you should turn the volume DOWN as you may get your ears blasted until you set the RF gain control (menu item #11, also adjustable from the "main" panel without going into the menu as noted above) adjusted downwards! **YOU HAVE BEEN WARNED!** *(This is one reason why the volume control is enabled when in MENU mode)*

11 - **RF Gain:** This is **exactly the same** as the now-changed "RFG" control on the main panel and it works the same way as RF gain controls on most radios. 0 = minimum sensitivity (Full-scale S-meter) and 50 = maximum sensitivity.

This may be used with the "AGC Off" mode if you wish to manually adjust the gain for some reason. It is most useful for listening to a noisy band to keep the background noise from coming up between transmissions.

In this menu the numbers do not change color as you decrease the setting and cause the receiver to go "deaf" - mainly, because I forgot in this version!

12 - **Custom AGC**: When the AGC mode is set to "Custom", this will set the "Hang" time of the AGC from very fast (0) to very slow (30). The higher values tend to make the audio sound quieter due to integration effects. Note that either extreme is likely to be unusable, but the choice is yours! The default value of 12 is equal to "Medium" AGC.

13 - **RX Codec Gain:** This is what had formerly been the "RFG" setting on the main screen. When set to Auto (recommended!) the A/D converter gain of the codec is automatically adjusted based on the signals that are present, decreasing the gain if excessively strong signals are detected. When this happens, you may occasionally see the bottom half of the S-meter, which is normally white, flash red, when an overload (or "near overload" condition is detected.

A setting of "8" is "Maximum" gain which makes the receiver VERY susceptible to overload on strong signals while a setting of "0" makes it comparatively deaf on a quiet band. If a setting OTHER than "AUTO" is selected the display is red with brackets to warn you that you probably should not be doing this!

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20 - **Mic/Line select:** This selects the Microphone or Line input for voice/data transmissions

21 - **Mic Gain:** This adjusts the Microphone gain. The default (from previous code) is 5. **BE VERY CAREFUL** as there is no easy way to tell if you are overdriving the transmitter (at least, yet...) The number displayed is that which is used to multiply the signal from the microphone, which means that a setting of 1 is 1/5 of the voltage (-14dB audio reduction) and a setting of 50 is a 20 dB increase ***as compared to the "original" setting of 5***. **It is recommended that you do NOT set this above 10 or so if you enable Mic Boost**.

22 - **Microphone Boost:** When enabled, an extra 20dB of microphone amplification is enabled. **It is recommended that you do NOT set the Mic Gain above 10 if you enable Mic Boost!** ***The "Mic Boost" function may automatically be enabled and this setting removed in a later version of firmware!***

23 - **Line Gain:** This adjusts the gain when the LINE input is used. The default gain (from previous code) is 10. **BE VERY CAREFUL** as there is no easy way to tell if you are overdriving the transmitter (at least, yet...)

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30 - **Keyer Mode:** This sets the Keyer Mode between Iambic A and B and Straight Key, the default being Iambic-B. This is the same setting as is on the main screen: It is expected that the setting on the main screen will be removed when that spaced is needed for additional features.

31 - **CW Keyer Speed:** This sets the keyer speed, the default being 20 WPM. This is the same as the "WPM" setting on the main screen. The default is 20 WPM.

32 - **CW Sidetone Volume:** This is the same as the "STG" setting on the main screen. The code has been modified so that the volume of the sidetone is more nearly constant with variations of the TX power level. The default is 5.

33 - **CW Sidetone/Offset Frequency:** This is the frequency of CW sidetone as well as the TX/RX offset - which is to say that if you were to tune a CW station's note to match that if the sidetone, your transmit frequency would be exactly the same as the other station's. The default is 750 Hz.

Currently, the range is adjustable from 600 to 900 Hz in 10 Hz steps, but **BE WARNED: The extremes of this range can put you outside the passband of the 300 Hz CW filter!**

34 - **CW Paddle Reverse:** When on, the "dit" and "dah" are reversed, the straight key is unaffected. Default = Off.

35 - **CW TX->RX Delay:** This sets the delay between the last CW element and the return back to RX mode, with the default setting of 8 which is approximately 1/2 second.

If there are continued problems with odd "squeaks" or "bloops" when going between TX and RX mode when in CW mode, try increasing this value slightly and then let me know.

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60 - **TCXO On/Off:** This turns the TCXO frequency compensation on/off, the default being "On" if the temperature sensor is present.

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70 - **Spectrum Scope Speed:** This adjusts the display rate of the spectrum scope, or disables it entirely. (Additional work needs to be done on this to make it "smoother".)

71 - **Spectrum Scope Filter:** This adjusts the "strength" of the filter used on the spectrum scope. The default is "4". A setting of "0" is similar to what was present on firmware version 0.0.181.

Those who are using LCD with and SPI interface should probably set this to 1 or 2.

72 - **Spectrum Trace Color:** You can set the trace of the spectrum scope to any of the available choices!

73 - **Spectrum Grid Color:** You can set the background grid of the spectrum scope to any of the available choices, or if you set it to "black", turn it off.

74 - **Spectrum Scale Color:** You can set the frequency scale along the bottom of the spectrum scope to any of the available choices, or you can set it to "black" to turn it off.

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Calibration Menu:

At the very end there is another setting: Menu item "00" that defaults to "Off". If this is turned on another menu system is enabled.

Currently, there is only one item in this menu:

201 - **Maximum Volume:** This sets the maximum volume that may be set, which may be useful to those that use headphones. The default of 13, it is adjustable from 8 to 14. The color of the number changes to warn you that you have "decreased" the setting to increasingly lower levels!

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To be added to the main and calibration menus:

- Per-band settings for the TX power coefficients.
- Other things...

Changes with version 0.0.191

19 October, 2014

Changes in brief:

A problem in which transmitted audio was being heard in the speaker has been fixed.

No other changes in this version.

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Changes with version 0.0.190

12 October, 2014

Changes in brief:

- TCXO - Temperature-based frequency control reworked.
- Improved reliability of saved and recalled settings in EEPROM.
- Band-Up/Down buttons now "wrap around"
- The sub-display (used for determining RX frequency when RIT is used) should no longer show an occasional spurious "10's" MHz frequency digit.
- The CALibrate display would occasionally be corrupted when changing between TX and RX.
- The handling of the input attenuator (in the A/D converter) is improved.
- RIT setting is no longer saved in EEPROM.
- The RF Bandpass/Lowpass filters are now automatically changed with tuned frequency.
- Displayed band reflects actual tuning frequency.
- Bug in TUNE mode with erratic power level in USB/LSB mode fixed
- Sidetone more consistent in TUNE/CW mode
- An *experimental*, impulse-type noise blanker has been added.

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In detail:

TXCO Frequency control improved:

Using an insulated thermal container (e.g. small cooler) I heated and cooled the transceiver while noting the frequency of the transceiver at 14.000 MHz on a GPS-locked monitor, making note of the frequency differences. It was noted that the resulting "curve" appeared to be typical of that of an AT-cut quartz crystal with a "turnover" at around 57C, according to the temperature sensor.

As of the last version (0.0.189) the general frequency calibration had been reworked such that the "reference" frequency was 14.000 MHz, and the frequency-delta information was applied here as well, using a temperature of 42-43C as a "nominal" temperature since this is approximately that at which a thermally-bonded Si570 and temperature sensor will operate in a 25C room when the transceiver is NOT in a case.

The algorithm has been rewritten to take advantage of the full, fractional-degree resolution of the temperature sensor and interpolate the temperature-frequency offset table to absolutely minimize the "jumps" as compared to the original code.

Notes:

- It is necessary that the Si570 and U10 be thermally bonded. This is done by placing a small piece of aluminium or copper across the top of the two chips and epoxying it to BOTH chips so that they are at as close to the same temperature as possible at all times.
- Not all Si570 chips are created equal. In my transceiver the temperature compensation holds the transceiver to 1-2 Hz of the correct frequency on all bands over a wide temperature range. If it turns out that there are reports that others' Si570 chips are radically different it may be necessary to add a utility where one can manually enter calibration points into EEPROM memory - a future feature, obviously!

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Improved reliability of saved and recalled settings in EEPROM:

Previously, some settings were not reliably saved/ recalled: This should be much improved now (e.g. band/mode/configuration.)

Note that the settings are saved when one properly uses the **POWER** button to shut off the radio. If you simply remove the power, most changes other than those made in the CALibrate mode *(e.g. frequency, mode, filter, power, etc.)* will be lost!

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Up/Down band buttons now "wrap" around:

On 10 meters, pressing "Band-Up" will now go to 80 meters, while on 80 meters pressing "Band-Down" will go to 10 meters.

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The sub-display (used for determining RX frequency when RIT is used) should no longer show an occasional spurious "10's" MHz frequency digit:

The small frequency display, which is used for showing the actual receive frequency when the RIT is being used, would often show a spurious "10's" of MHz digit, particularly when the transceiver was powered-up on a band below 10 MHz.

This has been fixed, I hope!

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The CALibrate display would occasionally be corrupted when changing between TX and RX:

Sometimes the numbers, particularly those related to the Frequency Calibration, would get corrupted when going between receive and transmit, when in CALibrate mode.

(Also, it now says "FreqCal" instead of "CalFreq".)

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The handling of the input attenuator (in the A/D c onverter) is improved:

If you recall, it has been recommended with the newer firmware that one REMOVES transistor Q2 as far better

dynamic range adjustment can be had by adjusting U1, the main Codec on the UI board. This change reflects a slight change in the way that dynamic is handled under large-signal conditions.

As of version 0.0.183, when there are very strong signals the lower half of the S-meter *(the portion from S0-S9)* will flash red and if the signal is not TOO strong, the gain of U1 will be adjusted internally when RFG is set to "AUT" mode: If it continually flashes red, this would be due to a very nearby transmitter, or one that comes and goes intermittently.

Remember: One may always manually adjust it, with 8 being the highest sensitivity, most susceptible to overload and 0 being least sensitive, but most resistant to overload.

This change is largely invisible to the user and is designed to make it bet ter "anticipate" a stronger signal when in "Auto" mode.

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RIT setting is no longer saved in EEPROM:

I can think of no good reason why one would want to save the RIT setting in EEPROM - can you? (If so, let me know?)

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The RF Bandpass/Lowpass filters are now automatically changed with tuned frequency:

The RF filtering (both the bandpass and lowpass) are now automatically changed as one tunes the dial frequency. The thresholds are as follows:

- Below 4.25 MHz: 80 meters
- At or above 4.25 MHz, but below 8 MHz: 40/60 meters
- At or above 8 MHz, but below 16 MHz: 20/30 meters
- At or above 16 MHz: 10/12/15/17 Meters

You will hear the relay(s) click as you pass through these frequency boundaries.

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Displayed band reflects actual tuning frequency:

The small indicator to the right of the main tuning frequency display now indicates the band. When tuning WITHIN an amateur band, it will indicate that band (e.g. 80m, 17m, etc.) but if outside that band it will indicate "Gen" for "General Coverage." The band limits are based on the largest found in the world.

It should be noted that for this and for ALL previous versions of code that if you power down on a frequency OUTSIDE an amateur band, it will revert to the lowest frequency of that band on power-up as it will have detected an "out-of-band" frequency when checking the limits. This is inherited from the original code as it had to guarantee that it started up with a valid, amateur frequency on power-up. At some point, this "gene ral coverage" frequency will become an extra "floating band" (in addition to the existing bands) in much the same way that Yaesu and Kenwood handle such things.

In other words, this transceiver has always done this, but what, exactly, it is doing is more apparent, now.

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Bug in TUNE mode with erratic power level in USB/LSB mode fixed:

I noticed, in testing, that the power level would vary when in TUNE mode when in USB/LSB with the "MIC" and "LINE" setting - an oversight when I added the facility to generate the built-in test signal to allow TX IQ Phase adjustment.

(It worked properly in CW mode, before.)

Important note:

- Make sure that you have placed a resistor of 1k-10k across C96, near U18 in the "PA Bias" section of the RF board as noted in the notes of 0.0.189 and the board modification notes.

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Sidetone more consistent in TUNE/CW mode:

The sidetone in TUNE/CW mode would sometimes be muted.

There may still be a problem with inconsistent volume/sidetone gain level to be worked out.

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*An *experimental*, impulse-type noise blanker has been added:*

You will noted that the "ATT" menu item has been changed to "NB". *Again, make sure that you have removed the JFET transistor Q2 from the RF board as it has been obsoleted by previous versions of firmware!*

This is a very simple impulse-type noise blanker, with "0" being "OFF" and "15" being maximum. You will also notice that, while adjusting, the numbers will go from yellow to red, indicative of the potential to cause signal distortion - some of which can be seen, in extreme cases, on the spectrum display. Needless to say, some settings in RED probably won't be all that useful!

Typical of this type of noise blanker, it will be affected by a strong, adjacent-frequency signal - something easily spotted on the Spectrum Scope. If the blanker is operating too aggressively you will see the noise floor on the Spectrum Scope rise up and/or signals get wider: If the effect on the received audio is objectionable, simply reduce the NB setting.

This is *NOT* a DSP noise blanker, strictly speaking, but rather a software implementation of a noise blanker that one might see on a receiver from the 80's or 90's. In testing around my shack, it does seem to work, but I don't actually have much in the way of annoying im pulse noise (fortunately for me!) to try it out on.

This noise blanker may or may not be useful to anyone and it may not even work - particularly with "version 1" of this blanker! Please let me know your observations - and whether or not it works at all for you! (This first version may be utterly useless!)

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Known issues:

- Reflectometer/SWR meter does not work, yet. This is still in the works.
- There *may* be an issue with various "strangeness" after using the TUNE/CAL mode, particularly in the USB/LSB mode. If you notice this, first save your values by exiting CAL mode and then letting me know what you did/saw: A power off-on will fix it if “strange” things occur.
- If you have been updating the radio's firmware, pressing the CAT button will crash the radio. This is "fixed" by disconne cting the USB cable for 10 seconds after programming.
- I'm sure that there are "new" bugs that I've introduced!

Changes with version 0.0.189

5 October, 2014

Changes in brief:

- Frequency, Mode and Filter now saved on a per-band basis.
- Start-of-band frequencies and sizes have been adjusted to align with Regions 1 and 2.
- The TUNE mode now works for USB/LSB without needing external audio tone generator for TX IQ Phase adjust
- Keyer mode is now saved.
- Frequency can now be calibrated.
- Tuning range extended down to 1.8 MHz and up to 32 MHz
- Tuning scope screen update function more efficient: This should slightly help those with SPI-mode displays (e.g. HY28A and/or Version 0.1 boards)
- Tuning scope smoothing filter will be less aggressive when in SPI mode: This should slightly help those with SPI-mode displays.
- PA Bias is now properly loaded on power-up and calculated differently, with wider adjustment range.
- Delay on power-down (with countdown) to assure more reliable write to EEPROM when saving settings.
- Sub-display is now properly updated when RIT is set to zero.

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Important note about saved settings:

BEFORE installing this firmware write down your TX and RX IQ gain and phase adjustments, your STG (Sidetone Gain), WPM, RFG and other settings.

To work around a "bug" in the virtual EEPROM, the addresses had to be shifted so previous settings will be disturbed!

YOU HAVE BEEN WARNED!

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Changes in detail:

Frequency, Mode and Filter now saved on a per-band basis:

For each of the nine bands the frequency, mode and filter setting is saved on each band in nonvolatile memory.

Please note that if the radio was tuned to a frequency outside an amateur band, it will be stored as the bottom frequency of the closest amateur band. In the future, there may be a "floating" general coverage band as is found in recent vintage Yaesu, Icom and other brand radios.

NOTE: Settings will not be saved if you do not use the POWER button to shut off the radio!

Comment: Default memory loaded from EEPROM (e.g. no data stored there before) will be 25 Hz from the lower band edge - this is a debug tool that I'd put there to indicate when memory was being loaded from default that I'll remove on the next release. It only shows up if there was not a frequency stored previously.

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Start-of-band frequencies and sizes have been adjusted to align with Regions 1 and 2:

All amateur bands now start on frequencies in common with Region 1 and Region 2, and the sizes of the bands are those found in Region 2, which are the largest. It is the "start + size" that sets the upper limit of the valid range used when storing memories to determine if it is within a valid amateur band.

The starting frequency and "size" of 60 meters has been set so that it should cover the frequency range over which such amateur allocations are typically found.

*** * ***

The TUNE mode now works for USB/LSB without needing external audio tone generator for TX IQ Phase adjustment:

In version 0.0.187 it was required that an external audio generator was required for TX IQ phase adjustment. Now, the transceiver will generate a tone internally, allowing TX IQ Phase adjustment.

TX IQ Phase adjustment can now be adjusted ONLY in TUNE mode when set to USB or LSB mode! The setting will be grayed out in ANY OTHER mode!

Remember: First, null out the unwanted signal using the TX IQ Gain, then use the TX IQ Phase - and then do it again a couple more times!

*** * ***

Keyer mode is now saved:

It wasn't before, but it is now!

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Frequency can now be calibrated:

When in Receive mode you will now see a "CalFreq" setting, adjustable by the far-left encoder that adjusts the calibration of the transceiver frequency. At this time, the range is +/-2000. At 14.000 MHz each step of this calibration represents 1 Hz and is proportional to the *current* operating frequency.

Note: Do Not enable the TCXO at this time!

Procedure, to be done at "nominal" room temperature:

- Tune in a known frequency reference (e.g. time station such as WWV at 10 MHz).
- Set the mode to USB.
- Now tune the frequency reference exactly 1 kHz LOW.
- Using a program such as Spectran, Argo, Spectrum lab to monitor speaker audio or using a frequency counter connected to the speaker, adjust the calibration to achieve an audio tone of exactly 1 kHz
- Press CAL to make the calibration menu disappear. This will also save the setting to memory.

The TCXO needs to be revisited - a project for a later release of the code!

*** * ***

Tuning range extended down to 1.8 MHz and up to 32 MHz:

Not much to say about this other than at the low end of the frequency range, the synthesizer ***MAY NOT LOCK RELIABLY*** and that receiver sensitivity specifications are not guaranteed.

Even if the transmitter is found to function below 75 meters (3.5 MHz) or above 10 meters (29.7 MHz) ***do not count on the spectral purity of the transmitter to be adequate for legal operation. Additionally, transmitting outside the amateur bands may cause damage to the final transistors.***

YOU HAVE BEEN WARNED!

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Tuning scope screen update function more efficient:

and

Tuning scope smoothing filter will be less aggressive when in SPI mode:

With version 0.3 boards and HY28B displays a parallel interface is used, but with HY28A displays or older boards, an SPI interface may be used - which is slower. Unfortunately, this means that the spectrum scope - which is very display-intensive - can be significantly slowed-down.

In this version I tweaked the function that updates the Spectrum Scope display so that this should speed up the display significantly: The SPI interface will still be slower than the parallel, but it should (hopefully) be a bit faster.

In the Spectrum Scope display there is also a "low pass" filter that smooths the readings. Now, when in SPI mode this filter is relaxed a bit so the display will (hopefully) respond a bit more quickly as well.

As the display becomes more "white" it (probably) slows down in SPI mode (someone could probably verify this?) One of the future enhancements will be to modify the Spectrum Scope display so that its display will be less prone to "creep up" and turn white during periods of no signal or weak signals - something that should help those with SPI interface displays.

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PA Bias is now properly loaded on power-up and calculated differently, with wider adjustment range:

It was noticed that the PA bias wasn't be loaded from EEPROM on power-up. I also noticed that the voltage range wasn't quite wide enough to go from "cut off" accommodate the entire range required.

IMPORTANT NOTE:

It is STRONGLY recommended that a resistor (1k-10k) be placed in parallel with C96 on the RF board, near U18.

What I noticed was that there is no DC loading on the output of U18 and it would tend to "float" up and not regulate properly at the intended bias voltage. What this means is that the PA transistors may not be being biased properly or, worse, they may be biased on somewhat while in receive mode!

*** * ***

Delay on power-down (with countdown) to assure more reliable write to EEPROM when saving settings:

It was noted that the EEPROM write function was not being completed fully when being powered down, so an additional delay was implemented. Additionally, a power-down message and countdown was added as well.

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Sub-display is now properly updated when RIT is set to zero:

The problem in which the sub-display - which is supposed to show the RECEIVE frequency when using RIT - is sometimes displaying garbage - is now fixed. This only happened when the RIT was set to zero.

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Known issues:

- Reflectometer/SWR meter. This is going to take a bit of work.

- Varying sidetone levels in TUNE/CW mode. The sidetone varies with power level - possibly randomly - I will need to look into this.

- After exiting TUNE mode, sometimes CW mode (maybe SSB) may not work correctly. This is an intermittent problem, but "fixed" by turning the radio off (with the power button to save values!) and then back on again. I'll try to figure out what is going on here, but the problem is easily "fixed" with the power-cycle...

- The TXCO is not properly tracking temperature, and the "steps" are too large, as noted above.

- If you have been updating the radio's firmware, pressing the CAT button will crash the radio. This is "fixed" by disconnecting the USB cable for 10 seconds after programming.

- I am sure that there are "new" bugs that I've introduced!

Changes with version 0.0.187

- The bug in which there was a disruption when the STEP+ and/or STEP- button was pressed is now fixed. There is no need to remove the capacitor(s). (Please put them back to protect against RFI/static if you removed them!)
- A minor bug in the volume control in which two of the volume settings were the same is fixed.
- Problems with the audio un-muting in CW mode after TX have been fixed (mostly.)
- RX Phase adjustment has been added.
- TX Phase adjustment has been added - but it has effect ONLY in SSB mode!
- The TX/RX calibration settings now actively change with TX/RX mode, and the TX Phase adjustment is only possible in USB or LSB mode where it has an effect!
- The CW TX and RX frequencies are now aligned with each other, and they fall within the center of the 300Hz and 500 Hz wide CW filters. (Sidetone/offset is 750 Hz - fixed, at the moment.)
- The problem with very poor opposite sideband rejection on TX has now been fixed!

* * *

Changes in detail:

Disruption when the STEP+ and/or STEP- buttons were pressed:

Previously, pressing the STEP+ and/or STEP- buttons would often (but not always) cause a "crash", squeak or other disruption, and cause the transceiver to briefly go into TX mode. The problem appears to be due to an undocumented fault with the MPU itself in which slow rise-time on some I/O pins can cause an unrelated EXTIO interrupt to occur.

Within this interrupt, the intended source of the interrupt (which was supposed to be PTT) was explicitly tested to prevent this problem from happening.

Minor bug in the Volume control:

Volume settings 10 and 11 were the same - no longer. Volume settings 11 and up are now one step louder than before, so be careful!

RX Phase adjustment:

The RX I/Q phase may now be adjusted and the setting saved, the value being adjustable from -32 to +32, representing +/- 0.5 degrees of phase adjustment.

To adjust this, tune in a clean, CW carrier on SSB for a 1000 Hz tone, then switch to the opposite sideband. FIRST adjust the RXIQ GN (gain) for minimum signal, THEN adjust the RXIQ PH (phase) to achieve a better null - and then do it again until the best null is achieved. You will note that the phase adjustment is less sensitive than the gain: This is normal.

Due to the nature of a "baseband" (low audio to 10 kHz or so) 0-90 degree Hilbert transformation filter, the amount of opposite sideband suppression will vary in the first few hundred Hz, and it is not possible to get a good null at, say, 300 Hz AND at 1 kHz: A null around 1000 Hz is suggested as that puts the adjusted null largely within the range of the low audio range where it would most likely be noticed from a station on the opposite sideband - but you can adjust it to your taste.

Comment: The scaling of the RXIQ GN (gain) has been changed so your previous setting will have to be doubled - if it was 10, it will now need to be 20. This was done because it was found that with the added phase adjustment, more granularity was needed.

TX Phase adjustment:

The TX I/Q phase may now be adjusted and the setting saved, the value being adjustable from -32 to +32, representing +/- 0.5 degrees of phase adjustment.

IMPORTANT NOTE:

TX IQ Phase may be adjusted ONLY while in transmitting in an SSB mode, because that's the ONLY time that the signal path goes through components that might require phase adjustment: You will find the adjustment of the TX IQ phase (TXIQ PH) grayed out and disabled under any other conditions.

Note that with the improved TX opposite sideband suppresssion (see below) you probably won't need to adjust this, but you will find the procedure below:

- Using a computer program such as Audacity or using an audio tone generator, produce a 750 Hz tone, feeding it to the LINE input of the transceiver and make sure that it is in LINE input (rather than MIC) mode and connect it to a dummy load capable of handling at least 10 watts. Set the mcHF transceiver to USB mode.

- Using another computer connected to another receiver, tune to the transceiver frequency - in USB mode - using a program that shows a waterfall display: Any digi-mode program will do, like Ham Radio Deluxe, DigiPan, MultiPSK.

- Couple a wire "near" the transceiver so that it will get a good signal when you key the transceiver.

- Push the TUNE button on the transceiver to enable transmit and adjust the tuning on your monitoring receiver so that it is centered in the waterfall display. You should see at least two traces: A strong one, and then a weaker one about 750 Hz lower in frequency. Place this weaker one in the center of your waterfall display.

- Adjust the TXIQ GN (gain) control and you should see a third signal appear, 750 Hz below the weaker one: This is the undesired signal that you are trying to null out. Adjust the TXIQ GN until this gets as weak as it will get.

- Press the TUNE button again to go back to receive. Now, using a microphone or Morse key, activate the PTT line with the radio in USB mode.

- If you are inputting a 750 Hz tone in the LINE input - and have it properly selected - you should see a display much like you saw in TUNE mode. If you don't see such a display, make sure that you are generating a 750 Hz tone, putting it into the LINE input at a reasonable level. If you see a lot of noise, reduce the tone level.

- Once you have a reasonable display similar to the one obtained in TUNE mode, you may now adjust the TXIQ

PH (phase) control to minimize the level of the "unwanted" signal in the way that was done in TUNE mode.

- It is recommended that you write down your settings. Press TUNE again to return to RX mode - and save your settings - when you are done.

Due to the nature of a "baseband" (low audio to 10 kHz or so) 0-90 degree Hilbert transformation filter, the amount of opposite sideband suppression will vary in the first few hundred Hz, and it is not possible to get a good null at, say, 300 Hz AND at 1 kHz: A null around 750 Hz is suggested as that puts the adjusted null largely within the range of the low audio range where it would most likely be noticed from a station on the opposite sideband - but you can adjust it to your taste

Again, if you do not have the ability to do the above procedure, simply set the TXIQ PH (phase) to ZERO and do only the first part of the adjustment using the TXIQ GN (gain) in the TUNE mode and you should get quite reasonable opposite sideband suppression.

The CW TX and RX frequencies are now aligned with each other, and they fall within the center of the 300Hz and 500 Hz wide CW filters:

Note: The CW demodulation operates using USB.

The CW TX, RX and sidetone frequencies now coincide with each other, and with the centers of the 300Hz and 500 Hz filters. Before, the offsets were 500 Hz and the "zero beat" RX and TX frequencies didn't exactly align - which meant that if you tuned into a station so that its beat note was the same as your sidetone, you would not be on the same frequency as that other station. This has been fixed, with the offset now being 750 Hz.

Note that the LO of the transceiver does NOT shift when going between SSB and CW mode in receive: The displayed frequency is that MINUS the pitch of the tone that you are hearing. In other words, if you were to zero-beat the station you were copying, the displayed frequency would be the transmitting frequency of that other station.

Problem with poor opposite sideband suppression has been fixed:

While in the process of adding the TX phase adjustment, it was noticed that the TX opposite sideband suppression was very poor at low-medium speech frequencies. This was traced to the use of the wrong Hilbert Filter in the TX SSB audio path: The filter that had been chosen was appropriate for up-converted modulation (e.g. SSB generated at, say, 5-20 kHz) and then up-converted to RF, but not for "baseband" audio that started at 300 Hz.

Because a +/- 45 degree Hilbert was chosen, this filter could not have good "near end" (e.g. near 0 or Nyquist) phase response - particularly with a limited number of taps.

Fortunately, another Transform filter - the same one that I'd reworked from the receiver - was already available as it uses a 0-90 degree "phase-added" approach which, with care, can be made to have usable response with a reasonable number of taps, allowing it to be "dropped" into place. Since it is the same transform filter as in receive, it has the same opposite-sideband rejection on transmit as it does on receive.

As described above, one can tweak the nature of the opposite sideband suppression with both the gain and phase adjustments - particularly in the "close-in" area below 500 Hz or so where the Hilbert transform's response starts to get a bit "iffy".

Changes with version 0.0.185

- An "Auto" RF gain setting.
- The Spectrum Scope has been further modified to make it faster and more responsive
- The center frequency appears below the Spectrum Scope, as do abbreviated frequency indicators under the graticules, that move when tuning frequency is changed.
- The bug that had sometimes caused the "White Screen" problem on power-up is believed be fixed.
- The voltmeter has been thoroughly debugged so that it now reads properly at all voltage.
- The voltmeter now turns red at voltages <9.50 volts to indicate a marginal power source.
- The TX IQ Gain adjustment now works.
- The virtual EEPROM can now been written to and read from reliably!
- Operational values, including current frequency, band and mode are now saved on power down/up.

* * *

In detail:

Auto RF Gain setting:

- On the RF Gain setting, there are settings 0-8 as before, but now, in lieu of "9" there is an "AUT" (for AUTO) setting. In this mode the RF gain is incrementally increased when A/D clipping is detected (e.g. the white portion of the S-meter goes red) and these are slowly relaxed only when the signals have decreased for a while. This should allow operation on a crowded band with strong stations without too much problem of A/D overload.

Spectrum Scope modifications:

There have been more extensive modification of the spectrum scope. Its display is still relative to the strongest signal within the +/- 12 kHz display range, and it is possible, under very "quiet" band conditions, for the display to go nearly "white" because of this as its AGC causes its baseline to rise upwards.

PLEASE NOTE: The spectrum scope's AGC is fairly slow, so it takes several seconds to adapt if an antenna is connected or removed!

You will also note that below the spectrum scope, aligned (mostly) with the graticules, you will see the center frequency, rounded to the nearest 1 kHz (which is why it changes at xxx.5 kHz) plus the 10's and 1's of kHz every 6 kHz on either side of the center.

LCD Initialization modification to prevent the "White Screen" on power-up:

It has been noted - and reported - that the LCD would occasionally display white when the transceiver was powered up, although it seemed to work otherwise (e.g. audio, responding to buttons, etc.)

Delays in the LCD initialization routine were doubled: I not sure which one(s) seem to have fixed the problem, but I have not seen it happen since!

Voltmeter debugged, low-voltage warning:

The voltmeter function has been reconfigured so that it should now reliably read voltages now... Really! It does update only every few seconds.

The numbers will also turn red if the voltage displays <9.50 volts, indicating that the power source is likely too low for reliable operation as this will start to reach dropout voltage for the 8 volt supply bus.

TX IQ Gain setting now works:

In addition to the RX IQ gain setting (which works, and the adjustment resolution is now finer), the TX IQ gain setting now works and you can use this to better-null the opposite sideband.

One method to do this is use the TUNE mode and press CAL while monitoring on another receiver set to USB showing a waterfall display. Tune in the main signal on the waterfall at 2300 Hz: Approximately 1000 Hz below the main signal (if you tuned it in using USB on this other receiver!) at around 300 Hz you will find a weaker signal that would be nulled using the TX IQ Gain adjustment.

Please note: While you can adjust the TX IQ Phase setting (and the RX IQ Phase setting as well) these currently do nothing!

The Virtual EEPROM now works!

I have finally gotten the Virtual EEPROM to work reliably: You can look at the code, yourself, to see what was done - although I'm not entirely sure why it made the difference. It would appear that the problem, all along, was reading from the virtual EEPROM.

Operational values are now subject to sanity checks:

With the Virtual EEPROM now working, extensive checks were now implemented to provide "sanity checks" of all parameters that were saved in the EEPROM, initializing them to reasonable defaults should they occur - very important on an EEPROM which could contain... anything! Additionally, all user-interface functions that allowed the user to change parameters were rewritten to properly trap (and fix!) invalid values.

Values saved to EEPROM:

The last-used frequency, band and mode are saved when you turn off the radio using the POWER button: If you simply disconnect the power, don't count on your frequency/band/mode being saved!

At some point in the near future there will be saved the Frequency and Mode on a per-band basis, as well as the last-used filter for the SSB and CW modes.

Now that the EEPROM is working it is now possible to work on the User Interface and add things like:

- VFO A/B
- Memory
- Split

(and many more!)

* * *

Amongst the values saved to EEPROM include:

- PA Bias
- Mic Boost setting
- TX IQ Gain Balance
- TX IQ Phase Balance (saved, but not implemented)
- RX IQ Gain Balance
- RX IQ Phase Balanced (saved, but not implemented)
- TX Audio Source (Mic/Line)
- TCXO State (on/off)
- Audio Gain (e.g. Mic. Boost)
- RF Gain (0-8/Auto)
- RIT
- RF ATTEN (deprecated and will be removed. It still supported in this code, but not for much longer: With the RF Gain code mentioned on the previous release, it is obsolete and Q2 should be removed!)
- TX power level
- Keyer Speed
- Keyer Mode
- Sidetone level

Changes with version 0.0.183

- The Spectrum Scope has been completely rewritten and should be more informative.
- The RF gain control has been implemented using different hardware, eliminating the need for Q2 entirely.
- The S-meter now indicates conventional units (6dB per S-unit, 10 dB thereafter)
- Receiver overload (A/D converter clip indicator) implemented
- Bug in display of "Cal" menu for RX settings now fixed.
- AGC has been improved.

* * *

Spectrum Scope:

- This now uses an IIR averaging filter and nonlinear display so that greater dynamics can be displayed. The averaging effectively improves the resolution and increases the persistence of the display.
- For step sizes 1 kHz and smaller, the display is not redrawn, but for step sizes larger than 1 kHz (e.g. 10kHz and up) the averaging is cleared on each step.

When signal level change radically, it may take a moment for the spectrum scope to recalibrate itself. Also, with very low signal levels (e.g. no antenna or a dead band on a very quiet antenna) you will probably see a semi-random assortment of lines.

* * *

RF Gain control:

The RF gain control is implemented using the hardware gain control of U1, the WM8731 codec. This significantly outperforms the capability of almost any practical front-end attenuator and, certainly, Q2, allowing the receiver to tolerate signals as high as -25dBm on 40 meters - the actual limit of the hardware.

The RF gain control still goes from 0 to 8 with 0 being lowest gain - and a fairly deaf receiver - to 8, the "normal" setting of previous firmware, which had been always set at "maximum" gain.

This control is helpful to prevent receiver overload - ***see the next section.***

I will probably remove the on-screen "ATT" control soon and use it for something else - probably for threshold adjustment of the experimental noise blanker.

* * *

S-meter recalibrated:

The S-meter is now calibrated to read according to the "standard" convention of:

- 6 dB per S-unit
- 10 dB per 10dB division above S-9
- 50uV (-73 dBm, 50 ohm) calibration at S-9 (with Q1 fitted)

The S-meter is now keyed from the AGC and it is also calibrated against the setting of the RFG control: As the gain of the receiver is reduced, the gain calculation of the S-meter is compensated so that a given signal level will remain constant ***as long as it is strong enough to be detected at the reduced gain level.***

IMPORTANT NOTE - Please read this and understand:

Because of the 50uV calibration at S9 and the 6dB per S-unit, you will note that you will NOT be able to get an "S-0" meter reading - at least with this version of firmware.

You must expect to see an S-3 to S7 reading from the background noise of the receiver - less if you have modified it and added some metal shielding between the UI and RF boards. You should consider this to be a tool when you work to reduce the various noises emanating from your receiver.

* * *

Receiver overload indicator:

Previously, the A/D converter was set to maximum gain, causing the receiver to be susceptible to overload at signal levels on the order of -45 to -50 dBm when preamplifier Q1 was fitted - but it was not necessarily easy to see if it was overloading, particularly if a signal doing this was outside the range of the spectrum scope.

Now, the lower portion of the S-meter (from S-1 to S-9) will turn red if the receiver's codec is overloading. If this happens, reduce the RF gain with the RF gain control to the point where it no longer flashes red.

If the receiver overload indicator flashes occasionally - on static crashes - there is probably no need for concern, but if it continually flashes, you should turn the RFGain control down a bit to avoid splattering - although you may not necessarily hear any degradation.

One of the first signs of overload is that the spectrum scope's "noise floor" will rise up. While this will happen with static crashes, too, you will soon learn to recognize when this happens because of nearby, strong signals.

* * *

RX Calibration menu display bug fixed:

This was a bug where the RX calibration menu would not always disappear properly when it was invoked.

AGC improvement:

There were some minor issues with steady-state signals on the AGC that have been fixed. The support of the Q2 RF attenuation has been removed as the addition of the manual RF gain control described above is superior. Unfortunately, using the above attenuator as part of the AGC is not practical as changing the gain settings using that hardware causes audible "clicks" to occur and test code of the AGC with it resulted in a quiet - but audible - "motorboating" as it was changed.

* * *

Outstanding issues:

- Saving data in EEPROM: This is being investigated as to why this does not work. While the adjustment of the RX phase *does* work, I would recommend leaving it at ZERO for the time being, until the saving/retrieval of that data is debugged or else you will probably get strange values (e.g. 65530 or some other large number.) I've not really spent much time in chasing down this problem, however.

- A "white screen" when powering up. This is a bug that was inherited from previous firmware and has to do with the hardware not initializing properly. If this happens to you, remove the DC power for 5 seconds and then try powering up again.

- Various beeps and clicks when going between TX and RX. Again, I have not attempted to address this issue.

Changes with version version “0.0.181_1”

1 - An AGC algorithm has been implemented. It is currently "fixed" at a "medium" decay speed. **PLEASE read the note below about increased noise and feedback if you use this firmware with AGC!**
2 - The CAL function has been modified so that there is now a gain adjustment for receive I/Q to better-balance the receiver.
3 - The tuning no longer truncates the numbers to the right of the tuning step when you increase the step size. T
4 - The spectrum scope has been de-linearized somewhat to have slightly better dynamics display on the screen.
5 - The spurious "1" that appears on the voltmeter if you power up the radio on a power supply of less than 10 volts has been fixed. (e.g. running from a 9 volt supply would display as "19.00V")

Of these, the first two require some explanation:

* * *

AGC:

There is not (yet) any menu setting for this, so the AGC is "fixed" at what sounds like a fairly good compromise set of time constants for both SSB and CW.

This AGC operates with three separate mechanisms:

1 - Via a post-filter gain control for weak/medium-strength signals.
2 - For medium-strong signals, the bias of Q2 is increased as the signal level increased to prevent overloading of the A/D converter. If Q2 is not installed, this will have no effect. This can extend the strong signal tolerance of the receiver. Because of this, the "ATT" control is no longer functional in any real way at the moment, but this could be fixed in a later version of code.
3 - For somewhat stronger signals, the pre-DSP gain is reduced (although this needs to be revised to use the CODEC's hardware gain control). The is the exact same mechanism as the "RFG" control.

The RFG control now acts in way similar to that of the "RF Gain" control on many radios in that setting this lower will reduce the level that AGC will be allowed to increase the gain of this third mechanism.

Bugs:

- There is an interaction between #2 and #3 with very strong, steady-state signals that needs to be resolved that can manifest itself as a slight, slow clicking. This only occurs with *extremely* strong signals, however.

- As the DAC that adjusts Q2 adjusts voltage, there can be a slight clicking as the D/A steps through its settings. This could probably be fixed with an additional resistor and capacitor, but if you don't have Q2 installed, you won't hear it at all - and you probably wouldn't ever hear it in normal operation, anyway.

- You WILL hear more receiver noise! Because this is an AGC, it will cause the audio gain to be cranked up and the odd noises that were there before will be even more obvious now!

- You may get speaker feedback. I had to change my 2.7 ohm resistor on the power supply line to U2 (the speaker amplifier) to 4.7 ohms. It is also recommended that the value of C32 be increased with the largest value capacitor that will fit within that footprint.

- If you didn't have a problem with TX audio getting back into the TX mixer and causing feedback before, you will likely have that problem now with the increased system gain! Please read the recent postings on how to solve that problem.

Note: There is an unrelated bug in the volume control (AFG) in that if you turn it down below 10 - and turn it back up, the volume will not actually return to its previous setting. This bug was present before, and I've not had

time to chase it down. You can work around this pressing either of the STEP buttons (press the STEP+ then the STEP-) a time or two which often resets the CODEC.

To be added:

- Menu-selectable modes for slow, medium and fast AGC action. The User Interface will need to be modified in some way for this - but I'm not sure how...

- Non-linear AGC decay to compensate for the fact that signals are logarithmic, but the gain values within the AGC control loop are not! This is not really noticeable to the user unless he/she carefully observes the reaction of the AGC's dynamics.