Operator's Manual for the mcHF transceiver

Updated for firmware version 0.0.211
Prepared by C. Turner, KA7OEI

Preface:

This manual is for the mcHF transceiver, the original design by Chris Atanassov, M0NKA, as an open-source SDR (Software Defined Radio), both in terms of Software and Hardware. As such, the features of this transceiver will continue to evolve and this manual is intended to provide a reference source.

Front Panel controls:

Figure 1: *Front panel controls of the mcHF transceiver*

All of the controls are defined in software, but for the purpose of simplicity they are typically defined as follows:

- **Power** – This turns the transceiver on, but it is also used to turn the transceiver off *and save configuration and frequency mode/memories.* A brief press of this button will also select the brightness of the LCD backlight. *Please read notes about the backlight and the possibility of its injection of a tone into the receiver when a "dim" mode is selected.*
- **BND-, BND+** – These buttons select the next lower/higher amateur band. When the lowest/highest band is reached it "wraps around" to the highest/lowest band.
- **STEP-, STEP+** – This sets the tuning step size in steps that include 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, and 100 kHz. The function of these buttons may be swapped via a menu setting. Pressing-and-holding of one of these buttons will temporarily change the step size to facilitate tuning. Pressing-and-holding both of these buttons simultaneously will toggle "frequency lock" on and off, with "on" being indicated by the main frequency readout being displayed in grey.
- **FREQ ENC** – This is used to tune the transceiver's operating frequency, the tuning steps being set by the **STEP-** and **STEP+** buttons.
- **ENC1**, **M1** – Rotary encoder **ENC1** is typically used to adjust the volume, but its function may be changed using button **M1** to adjust the sidetone gain.
- **ENC2, M2** – Rotary encoder **ENC2** is typically used to adjust the RF gain, but its function may be changed using button **M2** to adjust the action of the DSP Noise Reduction or Noise Blanker strength. In the **Menu** mode it is used to select the item to be adjusted. Pressing-and-holding

button **M2** when in normal (non-menu) receive mode will switch between the right-hand function adjusting the DSP Noise Reduction or the Noise Blanker "strength."

- **ENC3, M3** – Rotary encoder **ENC3** is typically used as an RIT (Receiver Incremental Tuning) but its function may be changed using button **M3** to adjust the sending speed (in Words Per Minute) in the CW mode, or to adjust the Microphone or Line-In gain in voice mode. In the **Menu** mode it is used to modify the item selected, or button **M3** may be pressed-and-held to select whether Microphone-In or Line-Input mode is active and to be adjusted.
- **G1** – This button is used to select the operating mode of the transceiver (CW, USB, LSB, etc.) Pressing this button cycles through the available modes.
- **G2** – This button is used to control the DSP audio filter mode. Pressing-and-holding will turn DSP on/off while preserving the current settings.
- **G3** – This button is used to set the transmit power level *(FULL, 5 Watts, 2 Watts, 1 Watt, 0.5 watts, and back to FULL.)*
- **G4** – This button is used to select the audio passband filter of the receiver.

Buttons **F1-F5** are "soft" buttons located under the display, the functions of which change depending on mode, indicated on the LCD itself and will be discussed in more detail later in this document.
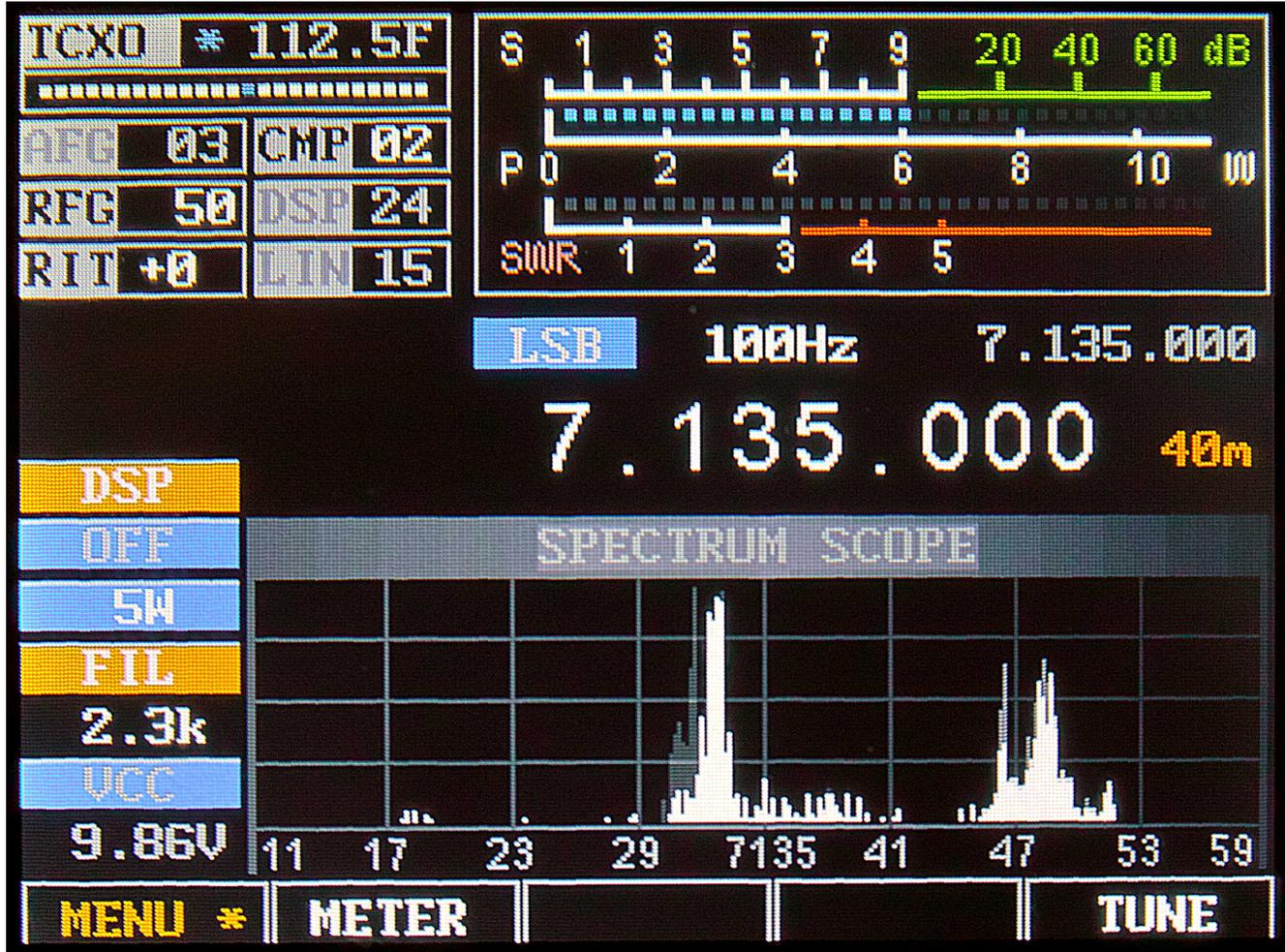

Figure 2: Main display of the mcHF transceiver.

Also on the front panel are two LEDs, **LD1** on the left and **LD2** on the right. **LD1**, which is typically green, is illuminated on receive and **LD2** which is typically red is illuminated on transmit.
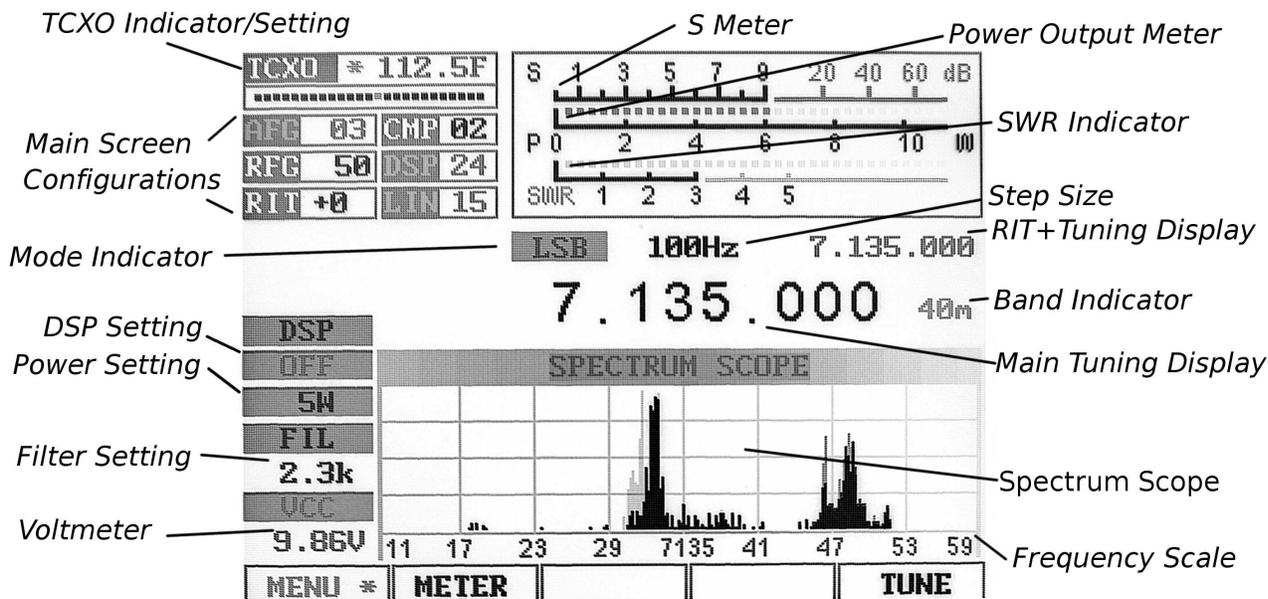
Main display:

Figure 3: The main screen (annotated)

On the main display, just above the Spectrum Scope, there are a number of indicators:

- **Main Frequency:** The main frequency display *ALWAYS* shows the **transmit** frequency. If this display is **grey** rather than white, the "Frequency Lock" *(toggled by pressing-and-holding both the STEP- and STEP+ buttons simultaneously, or configured in the menu)* is active. If this display is **yellow**, a transverter offset has been configured.

- **RIT+Tuning Display:** Above and to the right of the main frequency display is a smaller display that is offset from the main display if the **RIT** is set to something other than zero.

- **Band Display:** To the right of the main display is an indicator of the amateur band in which the current frequency is tuned. If the current frequency is outside an amateur band it will display "Gen" (e.g. "General Coverage"). In **Figures 2 and 3** the band is set to 40 meters.

- **Mode Indicator:** Above the "10's" digit of the main frequency display is the current mode displayed on a blue background. In **Figures 2 and 3** the mode is set to LSB.

- **Step Size Indicator:** Above the center of the main frequency display, between the Mode Indicator and the "Sub" Frequency display is the setting of the current step size. In **Figures 2 and 3** the step size is set to 1 kHz. Optionally, a "marker" may be activated that puts a line under the digit indicating the currently-selected step size *(see the menu item "Step Size Marker")*.

Along the top there are a number of additional indicators:

- **TCXO Mode/Display:** In the top-left corner the "TCXO" box indicates whether the TCXO (Temperature-Compensated Xtal Oscillator) is active or not. The TCXO is used to read the temperature of the Si570 synthesizer (U8 on the RF board) and apply a compensation to it to keep on frequency. When it is active the bar graph below the temperature display will display white dots with a blue marker that moves about but when set to "Off", the bar graph will be grayed out.   If set to "Stop" the temperature display will be replaced with "STOPPED". In **Figures 2 and 3** the TCXO is set to ON and displaying a temperature of 112.5F, but this may be set to display the temperature in Centigrade.

- **S-Meter:** This S-meter is nominally calibrated so that S-9 equals 50 microvolts into a 50 ohm load with each S-unit representing 6 dB. Practically speaking, the usable range of the S-meter ranges from about S-3 to something a bit higher than "40 over" which, if you were "run the numbers" about matches the dynamic range of the receiver! The bottom half of the S-Meter's graticule ("S0-S9") is normally white in color, but if the receiver's A/D converter experiences an overload condition, it will turn red. On bands with strong signals it is normal for this to momentarily flash red as the internal gain control adjusts itself. In **Figures 2 and 3** the S-meter is displaying a signal level of S-9.

- **PO:** The S-Meter scale, when in transmit mode, also indicates the output power from the transmitter.

- **Multi-function meter:** Below the S-Meter and Power Output meter is a multi-function meter that, using button **F2**, may be used to select one of three modes: **SWR**, **AUDIO**, and **ALC**.
    - **SWR:** As of this firmware version, the SWR meter is non-functional.
    - **AUD**io**:** This indicates, in dB, the relative audio level being applied to the MIC/Line input.
    - **ALC:** This indicates, in dB, the amount of gain *reduction* that the ALC is applying while in transmit mode.

Along the left-hand edge there are a few more indicators, starting from the ***bottom***-left corner:

- **VCC:** Below this is a voltmeter that indicates the current supply voltage. Below 9.50 volts, the digits are displayed in red indicating that the voltage may be too low for the transceiver to operate properly. ***Note that below 10.5 volts, attempting to obtain more than 3-5 watts of "clean", distortion-free RF output from the transceiver may not be possible, particularly on the higher bands!*** In **Figures 2 and 3** the voltmeter is indicating 9.86 volts.

- **FIL:** Below this is the current filter bandwidth setting, selectable by using button **G4**. In **Figures 2 and 3** the bandwidth is shown being set to 2.3 kHz.

- **Power Output Setting:** Just above the **FIL** icon is the currently-selected output power setting, selectable using button **G3**. In **Figures 2 and 3** the power is shown being set to 5 watts.

- **DSP Setting:** Just above the **Power Output Setting** is the indicator of the DSP mode. The modes available are: **"OFF"**, **"NR"** *(Noise Reduction)***, "NOTCH"**, and **"NR+NOT"** *(Noise Reduction and Notch)*.

Spectrum display:

Below the frequency readout is a spectrum display that shows signals that are on either side of the current tuned frequency. Along the bottom of the spectrum display is a frequency scale that shows the frequency scaling of the graticules rounded to the nearest kHz.

At the moment the vertical scaling of the spectrum scope is variable, being dynamically scaled such that the signals within the passband fit vertically. This scaling is fairly slow, using a sort of "AGC" (Automatic Gain Control) to prevent extremely rapid fluctuation. If a very large change in signal dynamics occurs, such as that which might occur of a band is changed, it may take several seconds for the Spectrum Scope to "catch up" and recover.

The vertical scale is also non-linear *(but not logarithmic)* to allow a much wider dynamic range of signals than would be possible were linear vertical scaling used.

An adjustable "smoothing" filter is available that dramatically improves the visibility of rapidly-changing signals that may be adjusted using the setting "**Spec. Scope Filter**".

In the menu system, the range of the Spectrum Scope may be set to span either +/- 24 kHz or +/- 12 kHz, with the scope's AGC operating *only* on signals within the displayed span – see the setting "**Spec. 2x magnify**" for more information.

Connectors:

On the right-hand side of the transceiver on the UI board are four 3.5mm three-conductor connectors. Starting from the top these connectors are:

- **Line Out (J1).** This is a receive audio output that is fixed level *(unaffected by the volume control)* that may be used to supply audio to a computer for "sound card" (digital) modes. ***This connector also carries the audio being transmitted.***

- **Line In (J2).** This input may come from a computer for "sound card" (digital) for transmitting. Its use must be selected in the menu for it to be used.

- **Microphone/PTT (J3).** This connector has both a microphone connector with bias voltage *(if R68 is installed)* for powering an electret microphone and a PTT (Push-to-Talk) line that is shorted to ground to key the radio. While the PTT line is always active, the microphone must be selected as the active audio input from the menu for it to be used. *(Note that this is also the "Dah" line, which is also used for keying in CW "straight key" mode.)*

- **Speaker/Phones (J4).** This jack feeds and external speaker/headphones, disconnecting the internal speaker when something is plugged into it.
    - **Warning:** There is no limiting resistor in series with this audio connection, so you must remember to turn down the volume before plugging in headphones.

On the RF board, along the right side, there are three connectors. Starting from the top these connectors are:

- **Power connector (J1).** This is a coaxial power connector, 5.5mm O.D., 2.1mm I.D., that supplies power to the transceiver. The outer shell is negative and the inner conductor is positive.

- **Paddle (J2).** This connects to either a set of Morse paddles or a straight key. The outer conductor ("ring") is typically the "Dah" while the tip is the "Dit" when in Iambic mode. In "Straight Key" mode only the outer conductor ("ring") is used. *(The "Dah" line is the same as the "PTT" line.)*

- **Accessory (J3).** This is used for interfacing with an external device and may be used for keying the transmitter and/or determining when the transmitter is keyed. The "tip" of this jack is the "PTT"/"Dah" line and may be used when interfacing the transceiver to a computer when operating a digital mode. The outer conductor ("ring") is grounded when the transceiver is in transmit mode and this may be used to key an external amplifier or TR switch.

On the left-hand side of the UI board are two USB connectors.

- The upper, "A" type (full-sized) USB connector is a USB host port that may have future use for storage of data/audio files and/or interface devices such as keyboards and wireless devices.

- The lower "mini" USB host port is primarily used for programming firmware into the transceiver.

Finally, the sole connector on the left-hand side of the RF board is the BNC-type antenna connector, the nominal impedance being 50 ohms.

Operational modes:

Receive mode:

After powering up, the mcHF transceiver will revert to receive mode on the last frequency, in the mode and using the audio bandpass filter that was in use when it was last powered down ***using the POWER button***. In this mode **LD1**, the left-hand LED *(typically green)* is illuminated.

By default, **ENC1** controls the volume, **ENC2** the RF Gain and **ENC3** controls the RIT.

Transmit mode:

When in transmit mode LD2 *(typically red)* the right-hand LED is illuminated. In transmit mode most of the controls are frozen, this being done to prevent the change of frequency, filter type and mode during mid-transmission.

TUNE mode:

Tune mode may be entered by pressing the button located below the **TUNE** icon on the screen *(e.g. button F5)* at any time and in this mode a carrier is generated, along with an audible sidetone in the speaker, the amplitude being set by the "Sidetone Gain" (**STG**) setting. The output power may

adjusted during transmit by pressing the button **G3** to cycle through the settings. The **TUNE** label on the LCD will turn red while **TUNE** mode is active.

Always have a suitable load connected to the transmitter (matched antenna or dummy load) <u>before</u> entering TUNE mode or <u>ANY</u> transmit mode.

Pressing the **TUNE** button again will exit.

Notes:

- When in **TUNE** mode audio being input to the Microphone and LINE inputs will be ignored.

- When **TUNE** is activated in SSB mode, the frequency offset from the display frequency and the sidetone frequency *(e.g. the tone emitted from the speaker)* will always be 750 Hz.

- When **TUNE** is activated in CW mode the frequency offset from the display frequency and the sidetone frequency will be that configured as the sidetone frequency in the menu.

- Pressing-and-holding the **TUNE** button will toggle the **Transmit Disable** function. If this is activated the **TUNE** indicator above button **F5** will be displayed in grey and pressing it will have no effect. *The "Transmit Disable" function may also be enabled/disabled in the configuration menu.*

MENU mode:

Pressing the **MENU** button *(e.g. button F1)* will enter the main menu system by which many parameters of the transceiver may be configured: These parameters will be discussed in detail later. Pressing-and-holding this button will save all settings to EEPROM.

Upon entering the **MENU** mode several of the "soft" buttons along the bottom of the screen will change their function:

- **EXIT** (button **F1**) – This exits the menu system, returning to the main display. Pressing-and-holding this button will save all settings to EEPROM.

- **DEFLT** (button **F2**) – This button resets the currently-selected item to its default setting.

- **PREV** (button **F3**) – This button goes backwards one screen or six menu items. Pressing-and-holding this button will jump to the beginning of the menu, or to the end of the menu if already at the beginning.

- **NEXT** (button **F4**) – This button goes forwards one screen or six menu items. Pressing-and-holding this button will jump to the end of the menu, or to the beginning of the menu if already at the end.

- The **TUNE** mode remains present while in the **MENU** system at button **F5**.

Note: If an item has been changed in the menu system that may need to be saved to EEPROM using the **POWER** button, the **MENU** indicator will be orange and be followed by an asterisk (e.g. "MENU *")

Configurable options on the main screen:

In the upper left corner there are a number of items on the main screen that are configurable using the buttons and/or encoders.

- **AFG** - "AF Gain" (a.k.a. "Volume Control"). This is used to adjust the audio level feeding the speaker/headphone jack using encoder **ENC1**. Button **M1** may be used to select whether this encoder adjusts **AFG** or **STG** *(see below)* with the "un-selected" item being "grayed" out. **AFG** *(e.g. the "Volume control)* is ***always*** enabled when in **Menu** mode.

- **STG** - "Sidetone Gain" ***while in CW mode***. This is used to adjust the level of the sidetone that is heard during keying while in CW mode and while in TUNE mode using encoder **ENC1**. Button **M1** may be used to select whether this encoder adjusts **STG** or **AFG** with the "un-selected" item being "grayed" out. Sidetone Gain is also adjustable from the main menu. ***When not in CW mode this is replaced with "CMP".***

- **CMP** - "TX Compression Level" ***while not in CW mode.*** This is used to adjust the amount of audio compression when in voice mode. ***When in CW mode this is replaced with "STG"***.

- **RFG** - "RF Gain". This control, as the setting is decreased, causes an increased deflection in

the S-Meter and a commensurate decrease in the receiver sensitivity. This functions in exactly the same way as the "RF Gain" control on a traditional analog receiver and is typically used to limit the receiver sensitivity on a noisy band. Button **M2** may be used to select whether this encoder adjusts **RFG** or **NB** *(see below)* with the "un-selected" item being "grayed" out. This parameter may also be adjusted from the main menu.

- **DSP** – This adjust the "strength" of the DSP noise reduction, when enabled.   Pressing-and-holding button **M2** will select between this parameter or "**NB**" *(Noise Blanker adjust)* being visible.

- **NB** - "Noise Blanker". This control adjusts the "strength" of the noise blanker, with "0" being "disabled." This is a "pulse" type noise blanker operating on the wideband input prior to filtering in the DSP input. As the noise blanker strength is increased, the color of the number changes to warn the user that the higher numbers are more likely to cause degradation of the receive audio. Button **M2** may be used to select whether this encoder adjusts **NB** or **RFG** with the "un-selected" item being "grayed" out. Pressing-and-holding button **M2** will select between this parameter or "**DSP**" being visible.

- **RIT** - "Receive Incremental Tuning". This offsets the receiver, in 20 Hz steps, to allow the transmit frequency to be different from that of the receiver with the actual receive frequency being shown on the "sub" frequency display above and to the right of the main frequency display. Button **M3** may be used to select whether this encoder adjusts **RIT** or **WPM** *(see below)* with the "un-selected" item being "grayed" out.

- **WPM** - "Words Per Minute" ***while in CW mode***. This adjusts the Morse sending rate in "Words Per Minute" when using Iambic mode keying. Button **M3** may be used to select whether this encoder adjusts **WPM** or **RIT** *(see below)* with the "un-selected" item being "grayed" out. The Morse WPM setting may is also adjustable from the main menu. ***When <u>not</u> in CW mode this is replaced with "MIC" or "LIN"***.

- **MIC** or **LIN** - "Microphone Gain" or "Line Input Gain" ***when <u>not</u> in CW mode***. This adjusts the Microphone (or Line Input) gain, depending on which is enabled. ***When in CW mode this is replaced with "WPM"***. Pressing-and-holding button **M3** will select Microphone or Line-Input modes. ***Note that if this is changed during transmitting, one must briefly unkey for the change of inputs to take effect.***

Automatic switching of on-screen items when going from receive to transmit:

Using the item in the "Configuration Menu" labeled "**O/S Menu SW on TX**" and setting it to **ON** several of the on-screen items will change automatically when going from receive to transmit and back again when returning to receive. These include:

- **AFG** to **STG** (in CW mode) or **CMP** (in voice mode)

- **RIT** to **WPM** (in CW mode) or **MIC** or **LIN** (in voice mode)

This automatic switching facilitates the adjustment of the relevant parameters when in transmit mode

without having to pause and press the **M1** and/or **M3** buttons to switch the functions of the relevant knobs.

Note that if you already had selected an alternate function while in receive *(e.g. "CMP")* it will "remember" and return to that setting after you have been in transmit and again turned to receive.

Setting the parameter " **O/S Menu SW on TX**" to **OFF** prevents the above parameters from changing when going between receive and transmit.

DSP (Digital Signal Processing) Noise Reduction and Automatic Notch Filter:

Button **G2** is used to enable/disable the DSP function, providing the following settings:

- **OFF** – DSP Functions are turned off

- **NR** – Noise Reduction only

- **NOTCH** – Automatic Notch Filter only

- **NR+NOT** – Noise Reduction and Notch Filter

Pressing-and-holding button **G2** will "save" the currently-selected DSP mode, if on, and turn it off. Pressing-and-holding this button again will restore the mode(s) that had been configured when it had been turned off.

The "strength" of this filter may be adjusted using the menu item #10, "DSP NR Strength" - but be very careful with this as it easy to go overboard with this setting. If it is set too high, the artifacts caused by the noise reduction *(e.g. "hollow" or "watery" sound)* can be *worse* than the interference than you are trying to remove!

The "strength" may also be set using button **M2** and **ENC2** without having to enter the menu system. To do this:

- Enable DSP "NR" mode by pressing button **G2**.

- Press button **M2** so that the highlighting changes from **RFG** to **DSP** on the screen.
    - If "**NB**" is displayed instead, press-and-hold button **M2** to change it.

- With **DSP** highlighted, **ENC2** will now allow adjustment of the DSP noise reduction "strength".

- You will note that the number denoting DSP "strength" is greyed out when DSP is turned off and cannot be (accidentally!) adjusted.

IMPORTANT OPERATIONAL NOTES related to DSP and the noise blanker:

• All DSP functions are disabled until a few seconds after the radio boots up.

• The notch filter is automatically turned off in CW mode. It cannot be selected when in CW mode. The reason for this is that the notch filter would "kill" CW signals!

• ALWAYS turn all DSP modes off when you are using any "sound card" modes such as PSK31, RTTY, SSTV or any other digital modes. ***DSP is <u>NOT</u> compatible with these modes!***

• The noise blanker is disabled in the 10 kHz bandwidth mode.

• The noise blanker is disabled in AM mode.

• Enabling the noise blanker *and* DSP can cause the user interface of the mcHF to slow down significantly! What this means is that the response to button-presses and the updates of the spectrum scope can be significantly slower. *(You have been warned!)*

There are additional "advanced" configuration settings related to the DSP modes available: See the items in the menu system and the section on "Advanced DSP Settings" later in this manual.

Tips to minimize processor loading when using DSP:

• The DSP Noise Reduction and the Automatic Notch Filter ("Notch") are *separate* functions that operate independently. Because of this, operating on "**NR+NOT**" mode takes more processor "horsepower" than either "**NR**" or "**NOTCH**" alone.

• The noise blanker takes about as much processor power as both the DSP NR *and* "Notch" put together which is why turning on the noise blanker in addition to DSP can significantly slow down the transceiver's response – and also why the noise blanker is disabled in AM mode and when set to 10 kHz – both of which take more processor power in their own right!

• When DSP NR is active, the parameter "**DSP NR FFT NumTaps**" can significantly change processor loading: The higher this value, the more loading. If you need to have DSP turned on, but you find the user interface to be operating too slowly, try setting this to a lower value: This can decrease the "quality" of the noise reduction somewhat, but it will free some processor power.

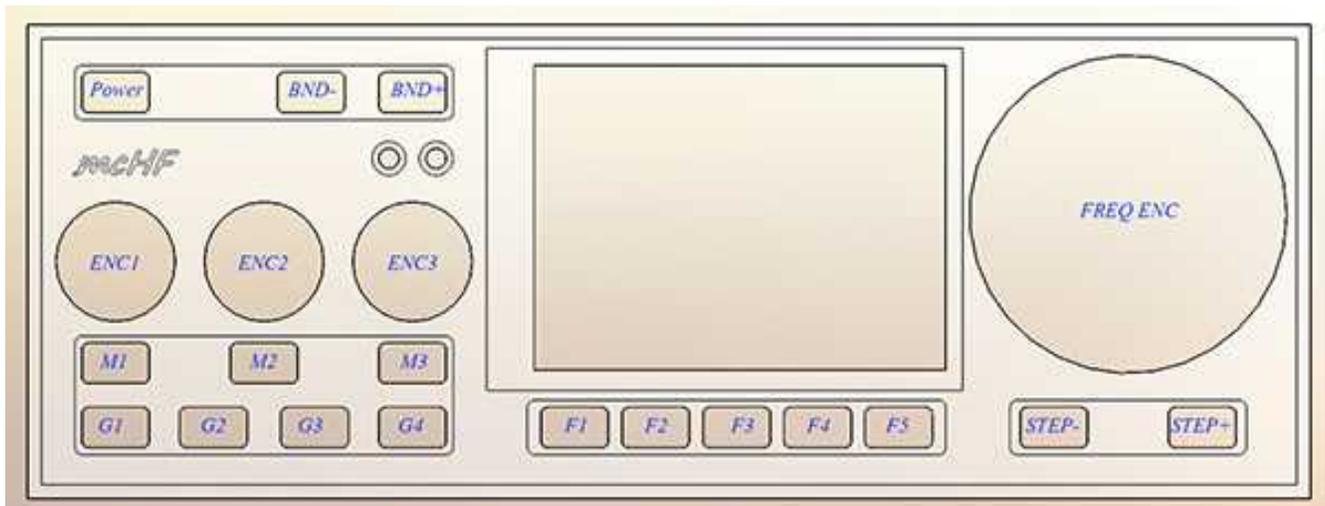# Using the mcHF transciever – brief overview:

Figure 4: *Front panel controls of the mcHF transceiver*

To turn on the transceiver, press the **POWER** button briefly and the display should light up, go through its attribution and boot-up screen and display the frequency and spectrum display. In this state:

Receive:

- Adjust volume using the **ENC1** control.
- Tune the frequency using **FREQ ENC** knob. Select the step size using the **STEP-** and **STEP+** buttons.
    - Pressing-and-holding the **STEP-** or **STEP+** button will *temporarily* decrease/increase the step size while tuning, the step size display changing colour while this is in effect.
    - Pressing-and-holding both the **STEP-** and **STEP+** buttons at the same time will enable/disable the "Frequency Lock" mode. The main frequency display will turn grey when "Frequency Lock" is enabled. *The **RIT** is still enabled when the frequency is locked.*
- Change the band using the **BND-** and **BND+** buttons.
- Change the mode *(USB, LSB, CW, etc.)* using button **G1.**
- Button **G4** selects the receiver bandwidth.
- Pressing button **G2** will select the mode of DSP noise reduction.
    - **Pressing and holding** button **G2** will turn DSP off, saving the current settings while pressing and holding again will restore the last-used mode. The available DSP modes are:
        - **NR** = Noise reduction only
        - **NOTCH** = Automatic notch (tone) filter only
        - **NR+NOT** = Both Noise reduction *and* Automatic notch filter.
- If **RIT** is desired, use **ENC3** to shift the receive frequency: The *small* frequency display will show **actual** receive frequency display when **RIT** is set to non-zero, but the large display will show the **transmit** frequency.

Transmit:

Set the receive frequency and mode, setting the desired output power using button **G3**. *Note that it is recommended that for voice modes that "full" power <u>not</u> be used unless you have carefully configured for clean, linear output power.*

Initial SSB transmit audio set-up:

- Preferably, connect the mcHF transceiver to a 50 ohm dummy load capable of handling at least 10 watts. Alternatively, you may tune to a **clear** frequency while connected to an antenna with a *known-good* 50 ohm match.
- Use button **G1** to select LSB or USB mode as desired.
- Press button **F2** to select the **AUD**io meter.
- For testing, press button **G3** to select the 0.5 watt setting: The power setting does not matter for this configuration.
- Connect the microphone to connector **J3**: This is is the one just above the speaker connector on the right side of the UI board, below and to the right of the **FREQ ENC** control. The mcHF is typically used with an electret-type microphone element and power for the microphone element is supplied by the radio.
- Press button **M3** to switch from **RIT** to **MIC**. If the box to the right-hand side of **RIT** shows "**LIN"** which indicates that line-input mode is active, press-and-hold button **M3** to change it to **MIC.** Press button **M3** as necessary to highlight **MIC** on the display: This allows the adjustment of the microphone gain.
- Now, key the radio using the Push-to-Talk (PTT) button on the microphone: The spectrum display should freeze.
- **Speak normally** into the microphone. You should see the indicator on the **AUD**io meter bounce upwards. While speaking, adjust the **ENC3**, which adjust the **MIC** parameter, so that the **AUD**io meter indication peaks up to +4 or so *(in the red)* on peaks. Occasional, higher, higher peaks are permissible, but avoid settings that cause full-scale indications which could imply distortion.
- Release the PTT button and press button **F2** to select the **ALC** meter.
- Press button **M1** to highlight the **CMP** on the display: This will allow the adjustment of the compression level of the speech processor.
- Press the PTT button and speak normally again. You should see the **ALC** meter indicate upwards on voice peaks occasionally: If it does not, increase the **MIC**rophone gain slightly.
- Adjusting **CMP** to a higher value will increase the aggressiveness of the speech processor: A value of **2** is a nice, modest value and a value of 12, while very "punchy" and can be used to maximize "talk power" will sound very "processed" and is likely to be unpleasant for normal, casual QSOs. *The value of "SV" will select custom settings – see the menu for additional information.*
- Once you have configured the settings to your satisfaction, press-and-hold button **F1** to store them in memory.

Using the mcHF with computer "Sound Card" modes via the Line-Input and Line-Output connections:

The mcHF may be connected to a computer, tablet or smart phone via audio cables and the PTT line on the Microphone cable to allow modes such as SSTV, PSK31, WSPR or other digital "Sound Card" mode. To do this, configure the transceiver as follows:

- Using button **G1**, select **USB** mode: All digital modes are operated using USB, ***regardless of band.*** In this way the audio frequency of the digital signal may be added to the frequency display to calculate the ***actual*** transmit/receive frequency.
- Set **RIT** to zero using **ENC3:** Press button **M3** as necessary to highlight **RIT** to allow adjustment. When using a digital mode the RIT ***MUST*** be disabled or else you will have difficulty making contacts!
- Set **CMP** to zero using **ENC1:** Press button **M1** as necessary to highlight **CMP** to allow adjustment. When using a digital mode, the audio compressor must be set to ***MINIMUM*** or else it may degrade the digital signal!
- Before connecting the external device *(Computer, tablet, phone)* set the audio output level to mid-scale. Also set the audio input gain to approximately mid-scale as well.
- For receive, one may use any of the available receive audio filters, but it is recommended that the 10 kHz filter ***not*** be used! If narrow (300Hz, 500Hz or 1.8 kHz) filters are used, one may shift the center frequency of that filter in the menu to suit the passband for that mode, but be aware that it is possible to run ***too narrow*** a filter for some of the "wider" digital modes! In the vast majority of cases the 2.3kHz filter will be adequate.

Connect the Line-Input jack (J2) of the mcHF to the audio output of the device you are using to generate the audio and connect the Line-Output jack (J1) of the mcHF to the audio input of that same device.

To key the transceiver, you will need also to connect a cable the Microphone jack *(J3 on the UI board)* or the Key jack *(J2 on the RF board)* and the PTT/Key line on either of those jacks *(the "ring")* would be grounded to key the transceiver: Typical rig-computer interfaces will easily accommodate this connection.

- Preferably, connect the mcHF transceiver to a 50 ohm dummy load capable of handling at least 10 watts. Alternatively, you may tune to a **clear** frequency while connected to an antenna with a ***known-good*** 50 ohm match.
- Using button **M3**, select **LIN** mode. You may need to press-and-hold this button to change from **MIC** to **LIN**. Press button **M3** as necessary to highlight **LIN**.
- Using button **F2** select the **AUD**io meter.
- Using button **G3** set the mcHF to 0.5 watts for this setup.
- Using the program running on the external device, key the computer using the selected mode. If the program has a "test" mode, use it for this.
- Adjust the **LIN** setting via **ENC3** for a reading on the **AUD**io meter of +2 to +4.
- ***Make sure that you have set "CMP" to 0 as noted above!***
- Un-key the transceiver.
- Make a note of the settings that you have used for future reference.

- Find a signal on the bands representative of the mode and adjust the audio input level of the external device for approximately "mid-scale". ***The Line Output level on the mcHF on this version of firmware is fixed.***
- It should be noted the the **LINE OUT** jack will contain the *transmit* audio. This is an artifact of the hardware configuration.
- Once you have configured the settings to your satisfaction, press-and-hold button **F1** to store them in memory.

TUNE mode:

The **TUNE** button may be used to send an unmodulated (CW) carrier for brief testing, such as checking the RF power output or the VSWR/matching. The **TUNE** function is also used for initial adjustment of various parameters *(TX Gain, Phase)* as described elsewhere in detail.

The operation of the **TUNE** mode is very simple:

- Press the **TUNE** button: The mcHF transmits and the indicator turns red.
- Press the **TUNE** button again: The mcHF stops transmitting and the indicator turns white.

Comments about the TUNE mode:

- When set to CW mode, when **TUNE** is activated the mcHF will produce a carrier *above* the dial frequency by the amount of the setting of the **"CW Side/Off Freq"** (e.g. sidetone frequency).
- When set to SSB mode, when **TUNE** is activated the mcHF will produce a carrier that is offset from the dial frequency by 750 Hz – the same as the audible sidetone. This carrier will be below the dial frequency in LSB mode and above it in USB mode.
- Pressing-and-holding the **TUNE** button will toggle the **TRANSMIT DISABLE** function. If this mode is on, the **TUNE** indicator will turn grey and all transmit capabilities of the mcHF will be disabled. *This is the same as the parameter "**Transmit Disable**" in the configuration menu.*

Configuration of the mcHF for CW operation:

- Connect a key or paddle to jack **J2** on the RF board: This is the connector next to the DC power input.

For connecting a paddle for Iambic keying:

- The **TIP** of the connector is **DIT**.
- The **RING** of the connector is **DAH.**

For connecting a straight key, mechanical semi-automatic key *(e.g. a "bug")* or an external keyer/computer:

- The **RING** of the connector keys.

   Note that the DAH/Straight Key connection is the same as the "PTT" line on the Microphone connector.

Now, press the **MENU** button (**F1**) and use the **NEXT** and **PREV** buttons (**F4** and **F3**, respectively) to navigate to the screen containing the menu item "**CW Keyer Mode**", noting the setting to the right of it. The three possible settings are:

- **IAM_A** – Iambic mode "A". Using paddles, alternate dots and dashes are sent with both paddles are depressed, stopping with the last dot or dash that was sent while the appropriate paddle was depressed.
- **IAM_B** – Iambic mode "B". The same as mode "A" except that keying continues by sending one more element – a dot if the paddles were released during a dash and vice-versa.
- **STR_K** – Straight Key. This would be used for a straight key, a "bug"or external keyer/computer.

Additional items on this menu *(you may need to scroll to another screen using ENC2)* include:

- **CW Paddle Reverse** – This reverses the DIT and DAH positions of the paddle, affecting ***ONLY*** the IAMBIC modes when using the built-in keyer.
- **CW TX->RX Delay** – This sets the delay, after the last CW element, before the transceiver returns to receive mode.
- **CW Side/Off Freq** – This sets the offset frequency and sidetone in CW operation, adjustable in 10 Hz steps. Because CW mode ***always*** occurs in USB mode, the actual CW transmit carrier frequency is that of the display frequency ***plus*** this offset frequency. Likewise, if the pitch of a receive signal is matched to that of the transmit sidetone the transmit frequency of your signal and that of the other station will be the same.
    - **Note:** If the sidetone frequency is adjusted, the center frequencies of the 300 Hz and 500 Hz filters should be adjusted to compensate to keep the frequencies within the center of the filter passband!
- The parameters **CW Keyer Speed** and **CW Sidetone Gain** are adjustable from the main display and will be discussed shortly.

To configure for CW operation:

- Press button **G1** to select the CW mode.
- Press button **G4** to select the desired receive audio bandwidth.
- Press button **G3** to set the power to 0.5 watts: The power has little effect on this adjustment.
- Press button **M3** to highlight the **WPM** parameter: Use **ENC3** to set the desired sending speed in words-per-minute. ***This parameter has no effect if set to straight-key mode.***
- Press button **M1** to highlight the **STG** parameter: **ENC1** is used to adjust this parameter.
- Press the paddle/key to cause the mcHF to transmit: Use **ENC1** to adjust the volume of the sidetone. *Note that the volume control ("**AFG**") setting has no effect on the level of the sidetone.*
- *Once you have configured the settings to your satisfaction, press-and-hold button **F1** to store them in memory.*

Miscellaneous notes and tips:

- The DSP "NR" (Noise Reduction) mode may be used to advantage when in CW mode, but note that the DSP "NOTCH" mode is always disabled because it would "kill" CW signals!
- CW mode is always in USB: The actual transmit carrier frequency is precisely that of the dial frequency *plus* the **"CW Side/Off Freq"** menu setting.
- The sidetone frequency is *exactly* that of the amount of transmit offset from the dial frequency.
- If the parameter **"CW Side/Off Freq"** is changed - which changes the sidetone/offset frequency - remember to change the the center frequencies of the 300Hz and 500Hz filters so that the center of your receive filter passband will match your transmit frequency. If you do not do this a station that returns to you *on your frequency* may do so outside the passband of your receive filter!
- There is a slight interaction between the power setting, the perceived loudness of the sidetone gain and the sidetone gain setting. This is a known issue, but it has not been a cause of complaints.

The configuration menu system:

The configuration menu may be entered by pressing the **MENU** button (**F1**).

When in the menu system, it may be navigated using the following encoders and buttons:

- **ENC2** – Selects the individual menu item.
- **ENC3** – Adjusts the selected menu item
- **Button F1** – Exits the menu system, returning to the main transceiver display. Pressing-and-holding will save settings to EEPROM.
- **Button F2** – Resets the currently-selected item to its default setting.
- **Button F3** – Goes backwards in the menu system by 6 items (one screen). Pressing-and-holding this button will jump to the beginning of the menu, or to the end of the menu if already at the beginning.
- **Button F4** – Goes forwards in the menu system by 6 items (one screen). Pressing-and-holding this button will jump to the end of the menu, or to the beginning of the menu if already at the end.
- **Button F5** – Enters/Exits **TUNE** mode. Pressing-and-holding this button will also toggle "Transmit Disable". The "**TUNE**" indicator will turn grey indicating that the transmitter is disabled.

Important Notes:

- When in **MENU** mode **ENC1** is *always* configured as **AFG** (e.g. the volume control.)
- Whenever a menu item is changed the warning "Save settings using POWER OFF!" will appear along the bottom of the screen to warn you that any changes that you may have made will *NOT* be saved unless you power down the transceiver using the POWER button.
- If you have made any changes while in the **MENU** system, when you exit the **MENU** system the label above button **F1** will be orange and display "**MENU ***" to warn you that you should power down using the **POWER** button to save any changes that you might have made.

There are two separate menus within the menu configuration system:

- The **MAIN** menu. These are the more commonly-adjusted items with the labels in YELLOW.
- The **CONFIGURATION** menu. These are less-frequently adjusted items used for calibrating the radio's hardware with the labels in CYAN *(e.g. light blue.)*

The **CONFIGURATION** menu is hidden unless it is enabled by activating it by setting the last item in the main menu to **ON**.

Note:

> *All menu items are numbered, but the numbers are omitted here to simplify maintenance of this document as these number occasionally change as features are added/modified.*

Main Menu configuration items:

Important Note:

If, when the a menu item is changed, it will be necessary to turn off the transceiver using the **POWER** button to save the changes to the EEPROM.

Alternatively, button **F1** may be pressed-and-held to cause a save of all settings to occur.

These items are listed in the order that they appear in the menu system.

DSP-related items:

- **DSP NR Strength** – This adjusts the aggressiveness of the DSP noise reduction, with 0 being "weak" and higher numbers correlating to "stronger" DSP noise reduction effects. The relative effects of this parameter are affected by the "advanced" parameters – *see the "DSP Related Items" section.* This is the same as the "**DSP**" parameter controlled by **ENC2** on the main screen.

Filter-related items.

- **300Hz Center Freq.** - This sets the center frequency of the 300 Hz CW filter, the options being 500, 550, 600, 650, 700, 750, 800, 850 and 900 Hz. A final option is "Off" which eliminates this filter from the selection when button **G4** is pressed. The settings will be displayed in white if this filter is currently selected.
- **500Hz Center Freq.** - This sets the center frequency of the 500 Hz CW filter, the options being 550, 650, 750, 850 and 950 Hz. A final option is "Off" which eliminates this filter from the selection when button **G4** is pressed. The settings will be displayed in white if this filter is currently selected.
- **1.8k Center Freq. -** This sets the center frequency of the 1.8 kHz "narrow" SSB filter, the options being 1125, 1275, 1427, 1575 and 1725 Hz. A final option is "Off" which eliminates this filter from selection when button **G4** is pressed. The settings will be displayed in white if this filter is currently selected.
- **2.3k Center Freq. -** This sets the center frequency of the 2.3 kHz SSB filter, the options being 1262, 1412, 1562 and 1712 Hz. The settings will be displayed in white if this filter is currently selected. *This filter cannot be disabled.*
- **3.6k Filter. -** This enables/disables the filter and when set to "Off", this filter will be eliminated from selection when button **G4** is pressed. The settings will be displayed in white if this filter is currently selected.
- **10k Filter. -** This enables/disables the filter and when set to "Off", this filter will be eliminated from selection when button **G4** is pressed. The settings will be displayed in white if this filter is currently selected.
- **Wide Filt in CW mode** – When ON, the "Wide" SSB filters (3.6 kHz and 10 kHz) will be available for selection when in CW mode.
- **CW Filt in SSB mode** – When ON, the "Narrow" CW filters (300 Hz and 500 Hz) will be available for selection when in SSB mode.
- **AM mode disable -** When ON, the AM mode will be eliminated from selection when the **G1**

button is pressed.

AGC and other receiver-related items:

- **AGC Mode -** The selections are **SLOW, MED**ium, **FAST, CUSTOM** and **MANUAL**. These related to the "decay" speed (e.g. "hang") of the receive AGC. When in **MANUAL** mode the AGC is disabled and the audio gain is set to maximum – *see "RF Gain", below.* <u>WARNING:</u> **Reduce volume level before setting this to MANUAL!**
- **RF Gain -** This is the same as the "**RFG**" (RF Gain) control from the main menu and in this context it is used in conjunction with the **MANUAL** AGC mode.
- **Cust AGC (+=Slower) -** When **AGC Mode** is set to **CUSTOM** this sets the decay rate with a higher setting setting a slower decay. A setting of "12" is equal to the "**MED**" AGC setting. Values lower than 3 are displayed in RED to warn the user that the decay rate of the AGC is likely to be extremely fast, that the resulting audio is likely to be unpleasant and that a bit overshoot/undershoot is possible on the tail end of a signal. This parameter is displayed in orange if **CUSTOM** AGC mode is not selected.
- **RX Codec Gain -** Normally set to **AUTO**, this determines whether or not the A/D input gain on the Codec is automatically controlled based on the input signal levels. If the input levels start to approach full-scale, the gain of the coded is automatically reduced, but if these level have not been attained for a while, the gain is gradually increased again. If this is set to anything other than **AUTO** there is the risk of significantly reducing the dynamic range *(e.g. performance)* of the receiver. When not in **AUTO** mode, the settings range from 8, which is "maximum" gain and the highest susceptibility to overload to 0 which is the lowest receiver sensitivity. *Settings other than **AUTO** are indicated in **RED** to warn the user of likely receiver degradation.*
- **RX NB Setting -** This is the same as the "**NB**" setting on the main screen. This adjusts the "strength" of the noise blanker, with "0" being off.
  - **The noise blanker takes a significant amount of processor horsepower, so some "slowing" of responses should be expected when it is active, particularly if DSP is turned on at the same time!**
  - **The noise blanker is disabled in AM mode or if the 10 kHz bandwidth is selected.**

Transmit Audio related items:

- **Mic/Line Select -** This selects whether the Microphone or the LINE input is to be used for transmit audio in the SSB mode. This is the same function as pressing-and-holding button **M3** when in a voice mode.
- **Mic Input Gain -** This is used to adjust the microphone input gain to adjust the drive in SSB mode. It is recommended that the **AUD**io meter be used, setting this parameter for audio peaks above "0dB". *This setting cannot be adjusted if the **MIC** input is not selected.*
- **Line Input Gain -** This is used to adjust the line input gain to adjust the drive in SSB mode. It is recommended that the **AUD**io meter be used, setting this parameter for audio peaks above "0dB". *This setting cannot be adjusted if the **LINE** input is not selected.*
- **ALC Release Time -** This adjusts the release (decay) time of the ALC. A value of 10 is offers modest compression while values of 5 or lower offer fairly aggressive compression. ***See the section about the adjustment of the ALC/Compressor.*** This setting will be displayed in RED and not adjustable unless "TX Audio Compress" is set to "SV".
- **TX PRE ALC Gain -** This is a post-filter, pre-ALC gain setting in the TX audio path where a

setting of 1 is unity. This is increased from unity to increase the amount of ALC action (compression). ***See the section about the adjustment of the ALC/Compressor.*** This setting will be displayed in RED and not adjustable unless "TX Audio Compress" is set to "SV".

- **TX Audio Compress -** This is the same as the "**CMP**" setting on the main screen and it adjusts the amount of compression of the transmitted audio signal. This parameter dynamically adjusts both "**ALC Release Time**" and "**TX PRE ALC Gain**" to provide a configuration that will result in a small amount of compression for low values or "heavy" compression for high values. When set to "**SV**" *(which would be setting "13")* the "**ALC Release Time**" and "**TX PRE ALC Gain**" parameters, above, are available for adjustment to provide "custom" processor settings. The "**ALC Release Time**" and "**TX PRE ALC Gain**" settings forced by this parameter are ***not*** saved to EEPROM and the user-configurable settings in "SV" mode are preserved.

CW related items:

- **CW Keyer Mode -** This selects from Iambic-B, Iambic-A and Straight Key modes.
- **CW Keyer Speed -** This allows the adjustment of CW keyer speed, when in Iambic mode, from 5 to 48 words per minute. This is the same as the **WPM** item on the main display screen.
- **CW Sidetone Gain -** This adjusts the sidetone volume in CW mode as well as in the TUNE mode. This is the same as the **STG** item on the main display screen.
- **CW Side/Off Freq -** This adjusts the CW sidetone and TX/RX offset frequency in 10 Hz steps from 400 to 1000 Hz.
    - It should be noted that the CW transmit carrier frequency is always ***higher*** in frequency by ***this*** amount and it ***exactly*** matches the sidetone frequency which is to say that if you match the pitch of the other station's receive signal with the pitch of the sidetone, both with be transmitting on the same frequency.
    - When adjusting the sidetone, always take care to be sure that the center frequency 300 Hz and/or 500 Hz filter that you use matches the sidetone or else the stations that reply to you may do so outside the filter's passband!
- **CW Paddle Reverse -** This swaps the Dit and Dah position of the paddles.
    - Note that if this is turned ON, the "ring" contact of the paddle jack is still the "PTT" line as before.
- **CW TX->RX Delay -** This sets the Transmit-to-Receive turnaround time. **Note:** If you experience a problem with the CW key "hanging" occasionally during CW operation *(e.g. it goes "dead" for a second or two and then recovers)* you may wish to increase this time slightly. There ***may*** still be a lingering bug that may show up if the TX->RX turnaround time is set too short, but it is believed that this has been fixed.

TCXO Related items:

- **TCXO Off/On/Stop -** When set to **OFF** the TCXO is read every second or so and the temperature is displayed, but the frequency is not corrected based on the temperature. When set to **ON**, temperature-related frequency corrections are applied to minimize frequency drift. When set to **STOP** the temperature sensor is ***not*** polled and "STOPPED" is displayed in lieu of the temperature. The "STOP" setting may be used by those who experience the one-second "TICK" sound on higher bands (e.g. 15 meters and up) who have not performed the modification to prevent this.
- **TCXO Temp. (C/F) -** This selects either Centigrade or Fahrenheit display of the TCXO

temperature.

Spectrum Scope related items:

- **Spec. Scope Speed -** This selects the update rate of the spectrum scope, or it may be set to **OFF** which disables the spectrum scope entirely. The **OFF** setting may be used to reduce the "helicopter" sound that may be heard under low-signal conditions.
    - **Note:** The "helicopter" sound may be significantly reduced by placing an **insulated** metal shield between the RF and UI boards.
- **Spec. Scope Filter -** This adjusts the "smoothing" of the spectrum scope display. **Note:** If your board uses an LCD with an SPI interface a smoothing setting of 1 or 2 is recommended.
- **Spec. Trace Colour -** This sets the color of the spectrum trace.
- **Spec. Grid Colour -** This sets the color of the background grid of the spectrum scope.
- **Spec. Scale Colour -** This sets the color of the frequency scale along the bottom of the spectrum scope.
- **Spec. 2x magnify -** When set to **ON** this changes the span of the spectrum scope from its normal +/- 24 kHz to +/- 12kHz. It does not increase the resolution, but rather the thickness of the lines are doubled.
- **Spec. AGC Adj. -** This adjusts the AGC response rate of the spectrum scope. The default setting of 10 yields the same response as the the previous "fixed" setting of earlier firmware.
- **Spec. Rescale Adj. -** This adjust the rate at which the signals displayed on the spectrum scope are rescaled. The default setting of 10 yields the same response as the previous "fixed" setting of earlier firmware.

Configuration Menu:

The final item of the main menu item is "Configuration Menu". When set to **ON** the "Configuration" menu is enabled.

General radio setup related items:

- **Step Size Marker -** When set to ON a line below the appropriate digit of the main frequency display indicates the selected step size.
- **Step Button Swap -** When ON, the STEPM **(Step-)** and STEPP **(Step+)** buttons are swapped. The intent of this is so that the position of the **Step Size Marker** moves to the left/right in conjunction with the left/right step size button when this setting is on.
- **Transmit Disable -** When ON, all transmit functions are disabled. This may also be toggled by pressing-and-holding the **TUNE** button. An indication of **Transmit Disable** being active is the **TUNE** button's text being displayed in grey.
- **O/S Menu SW on TX -** ("On-Screen Menu Switch on Transmit") When ON several of the receive-specific adjustments ("**AFG**" and "**RIT**") are switched to transmit-specific adjustments, such as "**STG**" and "**WPM**" in CW mode and "**CMP**" and **"MIC"** or **"LIN"** in voice modes, respectively. This allows more convenient access to these parameters when in transmit mode.

Receiver related items:

- **Max Volume -** This sets the maximum permitted setting of the **AFG** ("volume control"), setting the maximum "safe" level. This is most useful to those who exclusively use headphones.
- **Max RX Gain (0=Max) -** This sets the "maximum" gain of the receiver/AGC system. The default of "3" is a compromise of stability in preventing feedback at normal volume levels with no antenna connected. This setting can be used to prevent the receiver's gain from getting too high under no-signal conditions, particularly if all of the various modifications have *not* yet been done to prevent feedback.

CAT related items:

- **CAT mode -** This enables the CAT mode which is based on a USB driver that allows remote control of the transceiver. *This setting is **NOT** saved in EEPROM.* The CAT mode is in development and has limited capabilities.
  - **NOTE:** If you have the USB programming cable connected and enter CAT mode, it is likely that the transceiver will crash! If you have programmed the transceiver you must first disconnect the transceiver for 10-15 seconds before reconnecting it and enabling CAT mode.
  - EEPROM save *may* not work reliably if CAT mode has been enabled/disabled since the last power-up.

Frequency related items:

- **Freq. Calibrate -** This adjusts the frequency calibration of the transceiver in Hz, referenced to 14.000 MHz.

I/Q Gain and Phase related items:

Notes:

- **Please read the procedure for calibration of the RX IQ gain and phase balance for more detailed information.** This procedure may be found elsewhere in this document.
- You must be in the appropriate mode (e.g. LSB, USB, RX, TX) in order to adjust the relevant item. If the item is available to be adjusted, its parameter will be displayed in white.

- **LSB RX IQ Bal.** - This adjusts the IQ Gain balance in LSB RX mode.
- **LSB RX IQ Phase.** - This adjusts the IQ Phase balance in LSB RX mode.
- **USB/CW RX IQ Bal.** - This adjusts the IQ Gain balance in USB/CW RX mode.
- **USB RX IQ Phase.** - This adjusts the IQ Phase balance in USB RX mode.
- **AM RX IQ Bal.** - This adjust the IQ Gain balance in AM RX mode.
- **LSB TX IQ Bal.** - This adjusts the IQ Gain balance in LSB TX mode.
- **LSB TX IQ Phase.** - This adjusts the IQ Phase balance in LSB TX mode.
- **USB/CW TX IQ Bal.** - This adjusts the IQ Gain balance in USB/CW TX mode.
- **USB TX IQ Phase.** - This adjusts the IQ Phase balance in USB RTX mode.

PA bias adjustment related items:

- **CW PA Bias (If >0) -** If this setting is greater than zero, it is sets the applied PA bias during transmit when in CW mode. If this value is zero the setting of "**PA Bias**" (see below) is used.
- **PA Bias -** This is the setting applied to the final transistors during transmit. If the value of "**CW PA Bias**" is set to a value of zero, this value is used during CW transmit.
  - The signal gain of FET power transistors will vary with their bias. If you set the PA bias in CW lower than that in SSB mode, you can expect that the RF power output will be **LOWER**. The converse will be true if the PA bias is set higher (e.g. higher power output.

Note:

- It is not possible to enter CW transmit mode without RF drive being present. If it is desired that the PA bias current be measured for CW transmit, it is necessary that the bias first be set in SSB mode, *NOT* in **TUNE** mode, by keying the PTT with no audio and then noting the numerical value at the desired PA current. Once this value has been obtained, it may be applied to the **CW PA Bias** setting.

Power Meter related items:

- **FWD PWR Cal. Factor -** This calibrates the forward power meter indicator (the "PO" scale). A value of "100" represents a multiplication factor of 1.00.

Transverter related items:

- **XVTR Offs/Mult -** This is a transverter multiplication factor that can range from **OFF** to **1-10**. When this parameter is set to something other than OFF, the multiplication factor and the offset (below) is applied and the digits of the main frequency are displayed in **YELLOW.**
- **XVTR Offset (Hz) -** This is the frequency offset that is applied to the transverter multiplication factor.

The above offsets the display as follows:

Displayed Frequency = (Tuned Frequency * XVTR Mult) + XVTR Offset

5 Watt Power calibration items:

- **80m 5W PWR Adjust -** This adjusts the drive level so that 5 watts may be obtained on this band.
- **60m 5W PWR Adjust -** This adjusts the drive level so that 5 watts may be obtained on this band.
- **40m 5W PWR Adjust -** This adjusts the drive level so that 5 watts may be obtained on this band.
- **30m 5W PWR Adjust -** This adjusts the drive level so that 5 watts may be obtained on this band.
- **20m 5W PWR Adjust -** This adjusts the drive level so that 5 watts may be obtained on this

band.
- **17m 5W PWR Adjust -** This adjusts the drive level so that 5 watts may be obtained on this band.
- **15m 5W PWR Adjust -** This adjusts the drive level so that 5 watts may be obtained on this band.
- **12m 5W PWR Adjust -** This adjusts the drive level so that 5 watts may be obtained on this band.
- **10m 5W PWR Adjust -** This adjusts the drive level so that 5 watts may be obtained on this band.

Important notes on the 5 watt power adjustment settings:

- **If you see the settings for the 5 watt power adjust defaulting to ZERO, first POWER OFF the radio using the POWER button to initialize the memory-save locations.**

- The 2 watt, 1 watt and 0.5 watt levels are based on proportional scaling of the 5 watt settings.

- You **must** be set to the band being adjusted!

- You **must** be set to the "5 watt" mode for the specific band being adjusted.

- While you may get 5 watts in TUNE or CW mode, your *measured* output power may be lower in SSB mode owing to the peak-average nature of SSB. *Unless* you have a peak-reading SSB power meter, *do not* trust it to properly read the power output when in SSB! Also, remember that the adjustment of the **Mic Gain** (or Line Gain) settings will affect your output power when in SSB.

- If *both* the band **and** 5 watt mode are not set properly, the band will be "oranged out" and you will not be able to adjust it – this being done to prevent accidental adjustment of the wrong parameter.

- **NOTE** that unless your final/driver amplifier is appropriately modified, you may not be able to get full 5 watts on some of the higher bands (e.g. 15 meters and above.) *Please follow the discussions on the Yahoo Group and check the "mcHF board modifications" document for updates on this topic.*

"FULL" Power calibration items:

- **80m FULL PWR Adjust -** This adjusts the drive level so that "full" linear power may be obtained on this band.
- **60m FULL PWR Adjust -** This adjusts the drive level so that "full" linear power may be obtained on this band.
- **40m FULL PWR Adjust -** This adjusts the drive level so that "full" linear power may be obtained on this band.
- **30m FULL PWR Adjust -** This adjusts the drive level so that "full" linear power may be obtained on this band.

- **20m FULL PWR Adjust -** This adjusts the drive level so that "full" linear power may be obtained on this band.
- **17m FULL PWR Adjust -** This adjusts the drive level so that "full" linear power may be obtained on this band.
- **15m FULL PWR Adjust -** This adjusts the drive level so that "full" linear power may be obtained on this band.
- **12m FULL PWR Adjust -** This adjusts the drive level so that "full" linear power may be obtained on this band.
- **10m FULL PWR Adjust -** This adjusts the drive level so that "full" linear power may be obtained on this band.

Important notes on the "FULL" power adjustment settings – <u>PLEASE READ CAREFULLY</u>:

- **If you see the settings for the "FULL" power adjust defaulting to ZERO, first POWER OFF the radio using the POWER button to initialize the memory-save locations.**

- The "FULL" power setting has NO effect on any other power setting.

- You **<u>must</u>** be set to the band being adjusted!

- You **<u>must</u>** be set to the "FULL" mode for the specific band being adjusted.

- While you may a certain power output in TUNE or CW mode, your *measured* output power may be lower in SSB mode owing to the peak-average nature of SSB. *Unless* you have a peak-reading SSB power meter, *do not* trust it to properly read the power output when in SSB! Also, remember that the adjustment of the **Mic Gain** (or Line Gain) settings will affect your output power when in SSB.

- If *both* the band **and** FULL power mode are not set properly, the band will be "oranged out" and you will not be able to adjust it – this being done to prevent accidental adjustment of the wrong parameter.

- Note that "officially" the mcHF transceiver is just a 5 watt radio, but work is being done to derive modifications to *safely* increase the output power.

- It is recommended that you do *NOT* increase the output power above 10 watts unless you have verified that you have provided adequate heat sinking of the final power transistors.

- Because the gain of the circuitry decreases with increasing frequency, you should expect that the maximum power will *decrease* on the higher bands! *This is <u>not</u> a malfunction, but the reality of semiconductor physics!*

- If the output power is set too high, nonlinearity may result, causing key clicks on CW and "splatter" on SSB, so please take care when adjusting the "FULL" power parameters!

- *Please follow the discussions on the Yahoo Group and check the "mcHF board modifications" document for updates on the topic of improving the power amplifier of this*

radio!

DSP related items:

- **DSP NR BufLen** – This is the length of the De-Correlation delay buffer. In order for the DSP to tell a voice signal from noise, it must have a sample of each, but given the absence of a separate noise source, we have to "simulate" one by delaying the original signal to "de-correlate" it. If we delay it too little, it will resemble the voice too much and be ineffective. If we increase the delay, we can improve the performance but if we delay too much we end up with an "echo" type effect and a sluggish response.
    - **This value must always be <u>larger</u> than "DSP NR FFT NumTaps", below. If this rule is violated, the number will turn RED and DSP NR operation will become ineffective.**
- **DSP NR FFT NumTaps** – This is the number of taps in the FIR (filter) comprising the DSP noise reduction filter. A smaller number of taps implies a more agile filter, but also one that is less accurate while a larger number of taps is more precise and potentially slower to respond: A more "precise" filter may also reduce the actual performance in that the automatic calculation of the filter's parameters – which are, by their nature, imprecise, may "miss the mark". <u>***A higher number will increase processor loading and slow the user-interface response.***</u>
    - **This value must always be lower than "DSP NR BufLen", above.   If this rule is violated, the number will turn RED and DSP NR operation will become ineffective.**
- **DSP NR Post-AGC** – This determines whether the DSP noise reduction will take place ***before*** the audio filtering and AGC or ***after*** the audio filtering and AGC. The net effect will be the same, but there will be important differences as perceived by the user:
    - **"NO": DSP Noise reduction takes place *before* filtering/AGC** – The operation of the DSP noise reduction **will** affect the S-meter reading. Because the noise reduction occurs prior to the AGC, the "quieting" caused by the noise reduction will be compensated by the AGC and the perceived "quieting" effect caused by the noise reduction will be reduced. **Note that this can give the <u>*impression*</u> that the noise reduction is less effective than it actually is!**
    - **"YES": DSP Noise reduction takes place *after* filtering/AGC** – The operation of the DSP noise reduction ***does not*** affect the S-meter reading. If very "heavy" noise reduction is occurring, this can cause the perceived audio level to drop, requiring that one "rides" the volume control, particularly if there are weaker signals, buried in the noise, amongst strong – a situation that can exaggerate the volume differences! **Be careful if you are wearing headphones when using this setting!**
- **DSP Notch ConvRate** – This adjusts the convergence factor ("mu") of the filter and will have an effect on how quickly it "attacks" a CW note. Because of the nature of the filter, this parameter's effects aren't as obvious as those of the "Strength" adjustment of the noise reduction filter.
- **DSP Notch BufLen** – This is the length of the De-Correlation delay buffer. In order for the DSP to tell a voice signal from noise, it must have a sample of each, but given the absence of a noise source, we can "simulate" one by delaying the original signal to "de-correlate" it. If we delay it too little, it will resemble the voice too much and be ineffective and start to affect voice. If it is increased, the notch becomes more accurate, but it can slow down and, for a number of reasons, actually lose effectiveness.

Notes about adjustment of DSP-related values, above:

DSP Noise Reduction parameters:

The DSP Noise Reduction is active in either the DSP **NR** or **NR+NOT** mode and it performs noise reduction be detecting the coherent (e.g. non-random) properties of the human voice and quickly adapting a filter to pass those frequencies and blocking the other frequencies.

The "strength" of this filter may be adjusted using the menu item #10, "**DSP NR Strength**" - but be very careful with this as it easy to go overboard with this setting. If it is set too high, the artifacts caused by the noise reduction *(e.g. a "hollow" or "watery" sound)* can be ***worse*** than the interference than you are trying to remove!

The default setting is a good place to start, and carefully increase experimentally on signals of varying quality to get a "feel" the effects.

It should be noted that "**DSP NR BufLen**" and "**DSP NR FFT NumTaps**" will also interact with the efficacy of the **"DSP NR Strength"** setting, sometimes making a particular "strength" setting weaker, sometimes making it "stronger.

Again: Remember that the "DEFLT" button will restore the settings to usable defaults!

DSP Automatic Notch Filter parameters:

The DSP Notch filter is an "Automatic" notch filter that will immediately "seek and destroy" any CW (continuous) carrier that it finds, but it should have a minimal effect on the normal human voice. It is active in the "**NOTCH**" and "**NR+NOT**" modes, but it is ***always disabled*** when in the CW mode as it would make such operation impossible.

The notch filter operates within the signal path ***prior*** to the AGC and the **DSP NR** operation, so a strong "tune up" signal will not cause the S-meter to deflect when the notch filter is active, but note that the codec AGC is still active and the receiver may still desense if this signal is very strong and cause the lower half of the S-meter to flash red.

Also note that the presence of a strong carrier may also cause some "intermodulation" distortion – both from mixing products within the transceiver's analog circuitry, but also due to the dynamic limitations of the A/D converter as well as artifacts in the mathematical calculations being carried out in the SDR itself!

Note:

- The notch filter may be useful in AM mode to eliminate the "tweet" that appears when tuned very close to the center frequency. If you are listening to a shortwave broadcast station, note that the automatic notch may occasionally "attack" music with interesting results!

There are some known problems. The DSP (especially the noise reduction) tends to crash occasionally:

- Occasionally, the receiver audio will suddenly cut out when in Noise reduction and/or Notch mode, but it will work again when DSP is turned off. The cause of this is currently unknown and the only known "fix" (for now) is to turn the mcHF off and then back on again!

- If, when you turn on the mcHF there is no audio in one or more DSP mode, turn the mcHF off and back on again. Again, the cause of this is currently unknown and the only known "fix" is to turn the mcHF off and then back on again!

- If there is no audio when you turn the mcHF on, adjust the volume control: If "touching" the volume control fixes it, let me know.   This is not DSP-related, actually, but I thought that I'd mention it, just in case.

Important Note:

If, when the a menu item is changed, it will be necessary to turn off the transceiver using the POWER button to save the changes to the EEPROM.

Alternatively, button F1 may be pressed-and-held to cause a save of all settings to occur.

Approximate specifications of the mcHF transceiver:

The following specifications are for a transceiver that has been modified according to the "mchf_board_modifications_xxxx" file that may be found in the FILES section of the YAHOO mcHF Yahoo group.

Because this is a software-defined radio and due to ongoing modifications/improvements of the software and hardware, the specifications continue to improve!

- **Receiver sensitivity for 10dB S/N:** Better than -108 dBm in a 2.3 kHz bandwidth, better than -120 dBm in a 300 Hz bandwidth *if the recommended modifications are performed.*

- **Frequency coverage:** 80, 60, 40, 30, 20, 17, 15, 12 and 10 meter amateur bands, transmit. Receive: 3.5-30 MHz nominal, 1.8-32 MHz at reduced specifications.

- **Large-signal handling capability:** Continuous "Clip Warning" occurs above approximately -28 dBm and actual A/D clipping and distortion occurs at and above approximately -18 dBm.

- **Transmitter power output:** 5 Watts, typical, linear. *Modifications may be made to increase this: Follow the discussions in the Yahoo group.*

- **Frequency stability:** +/- 30 Hz at 14 MHz over the range of 10 to 35 C, ambient with the transceiver in the case or better with the TCXO active. *(It can be much better than this.)*

- **Available TX/RX modes in this firmware version:** CW, USB, LSB. Limited AM receive capability.

- **Available audio filter bandwidths in this firmware version:** 300 Hz, 500 Hz, 1.8 kHz, 2.3 kHz, 3.6 kHz, 10 kHz. *All filters software-defined: Additional bandwidths could be made available.*

- **DSP Filtering Capability:** Noise reduction and Automatic Notch Filter

- **S-Meter calibration:** Nominal S-9 = -73dBm (50.2uV @ 50 ohms) with each "S" unit representing 6 dB. Units above S-9 are in dB units, as noted.

- **External audio input/output connections:** "Line In" and "Line Out" audio ports, and a "PTT" (Push-to-Talk) are provided via 3.5mm connectors to allow the connection to an external device. With these connectors it is possible to interface with an external device *(a computer or tablet/smart phone)* and operate "Sound Card" modes with the mcHF such as SSTV, PSK31, WSPR and other analog/digital modes.

- **Current consumption:** Receive: Unmodified, approx. 410mA on 40 meters and below at 13.0 volts, approx. 440 mA on 10 meters, minimum volume, maximum display brightness. Minimum LCD brightness can reduce this by 40-60mA and a modification to the PA drivers can reduce this by a further 50-80 mA. Power off: 3-5 mA if the PA driver modification is performed.

The ALC (Automatic Level Control)

This module requires a bit of explanation, so please read the following section <u>very</u> carefully!

Prior to the addition of the ALC the **POWER** adjustment on the mcHF was somewhat irrelevant when in a voice mode as it only added effective attenuation in the audio path. If one adjusted the audio to 5 watts PEP when in the 5 watt mode, it was possible to switch to the 1 watt mode and readjust the audio gain to again achieve 5 watts as there was nothing within the code to set levels!

What is more significant is that there was nothing in the code to prevent the overdriving of the final amplifier stage, even if it had been set up properly for a "clean" 5 watts as there was no way to be sure, without using an external RF power meter, that the transmitter audio drive was properly set.

This was been changed in version code 0.0.207: **It is no longer possible to obtain a higher PEP power at a given power setting than a steady carrier in CW or TUNE mode! Unless you have a true peak-reading RF power meter, you <u>will</u> read a lower RF output power in SSB mode than in CW mode.**

Please re-read the above paragraph at least once to be sure that you understand it!

How the ALC works:

All modern SSB transceivers have a form of ALC which monitors the transmit power level and if it exceeds the set power level, it is cut back to prevent overdriving of the finals. In this way the *maximum* output power may be set for a mode that has intrinsically varying power levels.

With the ALC the PEP power from the transmitter should not exceed the carrier level observed in TUNE mode, no matter the audio drive level.

In order for the ALC to work there must be at least a *minimum* audio level to drive it and to provide for this the **F2** button has been repurposed to change the (former) **SWR** meter to one of three modes:

- The **SWR** meter. *This still does not work... yet...*

- The **AUD**io meter. This shows the audio level from -20dB to +12dB, with 0 dB being "nominal". It is acceptable for audio to occasionally peak at +6 to +10dB.

- The **ALC** meter. This shows the amount of ALC action, from 0 to 34 dB – *more on this below.*

Adjusting for the proper audio level when in SSB transmit mode:

- Speak normally if using the Microphone input, or set the nominal input level if you are using the LINE Input mode.

- Use button **F2** to select the **AUD**io meter.

- Use button **M1** (below **ENC1**, the left-hand encoder) to select the on screen **CMP** setting and use that encoder to adjust it to a setting of 1.

- Use button **M3** (below **ENC3**, the right-hand encoder) to select the on-screen **MIC** (or **LIN**) setting and use that encoder to adjust it, or you may go into the Menu mode and adjust the "**Mic Input Gain**" (or "Line Input Gain" as appropriate).

- While speaking normally, adjust the gain so that the audio meter peaks up to "0" (zero) to +6 on the audio meter. It is fine for it to occasionally peak higher than this.

- Now use button **F2** to select the **ALC** meter.

- Use button **M1** (below **ENC1**, the left-hand encoder) to select the on screen **CMP** setting and use that encoder to adjust it, or you may go into the Menu mode and adjust the "**TX Compress Level**".

- Adjust this setting for an upwards indication of the **ALC** indicator. ***See below for a discussion of this setting.***

Using the ALC to control transmit power, or as a speech processor:

There are two ways to adjust the speech processor/compressor settings:

- Using the "**CMP**" *numerical* settings *(which is the same as the "TX Audio Compress" menu parameter)*

- Setting the "**CMP**" *(or the "TX Audio Compress")* setting to "**SV**" and independently adjusting the "**ALC Release Time**" and "**TX PRE ALC Gain**" settings.

Using numerical settings for CMP:

When using the numerical settings for the **CMP** setting *(also the "TX Audio Compress" parameter)* the "**ALC Release Time**" and "**TX PRE ALC Gain**" settings are automatically adjusted to provide "compression" settings that become "stronger" with an increasing number.

"Manually" adjusting parameters when "CMP" is set to "SV":

When the "**CMP**" *(or the "TX Audio Compress" parameter)* are set to "**SV**" the parameters "**ALC Release Time**" and "**TX PRE ALC Gain**" may be manually adjusted as desired to provide a custom compressor setting.

This ALC system has been designed to be flexible and be usable both as a "standard" ALC used to set the SSB transmit power ***and*** as a highly-effective compressor-type speech processor. To operate the the ALC in this way requires attention to two separate parameters as described below.

SSB operation with minimal speech compression:

- Set the Microphone/Line gain as described in the previous section *(e.g. around "0" on the AUDio meter with occasional peaks to +6 to +10.)*

- In the menu system, set the parameter **ALC Release Time** to the default setting of **10**.

- While speaking normally adjust the **TX PRE ALC Gain** parameter for a peak reading on the **ALC** meter of 4-6 dB.

- Setting **ALC Release Time** to a higher value will reduce the compression even more.

SSB operation with maximum speech compression:

- Set the Microphone/Line gain as described in the previous section *(e.g. around "0" on the AUDio meter with occasional peaks to +6 to +10.)*

- In the menu system, set the parameter **ALC Release Time** to the default setting of **3 or lower**.

- While speaking normally, adjust the **TX PRE ALC Gain** parameter for a peak reading on the **ALC** meter of 8-16 dB.

- Setting **ALC Release Time** to a lower value and the **TX PRE ALC Gain** to a higher value will increase the compression even more.

Explanation of the parameters and meters:

- **Mic Input Gain/Line Input Gain:** These operate directly on the microphone and line inputs in the way that you would expect. These parameters display as **MIC** or **LIN** on the main display, respectively.

- **Audio meter:** This displays the audio level, in deciBels, on the selected audio input, with "0" being the level that will *just* achieve 100% power at the bottom of the ALC threshold. The level displayed is *NOT* filtered in any way and signals outside the frequency range that would be transmitted (e.g. <200 Hz, >3500 Hz) will register.

- **TX PRE ALC Gain:** This is a variable audio gain *after* audio filtering in the transmit bandpass, *after* the audio metering, above, but *before* the ALC circuit.

- **ALC Meter:** This indicates the amount of gain *reduction* in deciBels that the ALC is providing to the audio path. The ALC is in the audio path *after* transmit audio filtering so it will not respond to audio that is outside the frequency range that will be transmitted. The ALC can only *reduce* gain *(by up to 40 dB)* but it can <u>never</u> increase it and it will settle to unity under no-signal conditions.

- **ALC Release Time:** This sets the time, after audio has dropped below the current threshold, that the ALC will take to release and reduce attenuation. When set to the default setting of 10, the ALC will have only a modest effect on the transmitted audio, taking several seconds for the

ALC to completely recover from a voice peak while setting it to the maximum value if 20, the effect is almost that of disabling the ALC entirely in terms of added compression in that the gain recovery rate is approximately 1dB/second. Low values (below 5) will "follow" audio very quickly and offer effectively very high compression rate.

Warnings:

- Do not set the Mic/Line gain such that the peak audio level on the **AUD**io meter regularly peaks much above 4 to 8B, although occasional peaks to +10 are fine. Avoid settings that "peg" the meter as this could result clipping and audio distortion.
    - If the RF amplifier is working properly and not being overdriven, input audio clipping should not cause "splattering" on the transmitted signal, only "bad" sounding audio.

- Frequent, very high indications on the **ALC** meter *(e.g. >12dB)* can cause annoying "pumping" of background noise on transmit audio, which is to say that during periods of silence in the voice, sounds in the background may rise up and become an annoyance to those listening to the transmission on the air. A "fast" ALC release time *(e.g. low number)* can make this effect worse.

- The use of a speech compressor/processor can significantly increase the heat dissipation of the final transistors: Please be aware of this while transmitting, making sure that your finals are adequately heat-sinked!

- If the mcHF is being operated from lower than normal supply voltage the RF amplifier may be unable to output a normal amount of power. In severe cases, operating under these conditions may result in distortion and/or "splattering" which can cause interference on the bands.

- If operating at "**FULL**" power, splattering may result unless you had carefully adjusted the "**FULL Power**" configuration settings such that the obtained power level was within the linear range.
    - **If the "FULL" power setting was simply adjusted for maximum power output you may expect that transmissions at this power setting may sound somewhat distorted and could cause a degree of "splattering".**

SSB operation and proper adjustment of the "5W PWR Adjust" and "FULL PWR Adjust" parameters":

If you get reports of "splattering" when you operate on SSB, first check the **AUD**io meter to make sure that it is not "buried" in the red, then check the **ALC** meter to verify that the **CMP** ("TX Compress Level") is not set such that this meter indicates excessive deflection in the red zone (e.g. continuous excursions above 12-16dB).   If you have appropriately adjusted the microphone/line and ALC settings, but are still getting reports of splattering, do the following:

- If you are on "**FULL**" power, set the power to **5 Watts.**
- If you are running **5 Watts**, set the power to a lower setting.
- If you are still getting reports of splattering, verify that the **PA Bias** is properly set.

If reducing power "cleans up" the splattering problem, your final power amplifier may not be able to output the expected amount of power on the current amateur band and this could be for a number of reasons:

- **The power supply voltage is low.** If you are operating the radio on a voltage lower than 12.5 volts, it may not be able to output power level that you request so a lower power level should be selected if you operate at that voltage.

- **There may be a problem with the low-pass filter on that band.** You should compare the output power on that band with that of other bands and if it is markedly lower, re-check – and readjust, if necessary – the values of the toroidal inductors in that band's low-pass filters.

- If you get reports of splatter on "**FULL**" power but not on other power settings, you should reduce the "FULL PWR Adjust" for that band in the "Adjustment Menu" for that band, or remember to *not* operate SSB at the "**FULL**" power setting. Remember: It is possible to get quite a bit of RF output from the final transistors, but if it is *Linear* and "clean" power that you want – necessary for SSB operation – you will need to operate at a lower power than this "maximum" output!

- If the **PA Bias** was never set properly your RF amplier, nonlinear operation may result. In order to set the **PA Bias** do the following steps:
    - Adjust the radio's power supply for 12.5-14.0 volts.
    - Insert an ammeter so that you can measure its current consumption. This meter should be capable of reading up to 3 amps with a resolution of better than 0.1 amps.
    - Connect the radio to a dummy load.
    - Turn on the radio and select USB or LSB.
    - Go to the adjustment menu and set the **PA Bias** to **0** (zero).
    - Key the radio *__with no audio__* and note the current.
    - With the radio keyed, adjust the **PA Bias** so that the current increases by 0.1 to 0.3 amps.
    - Unkey the radio.
    - Use the **POWER** button to save the new **PA Bias** setting.

REMEMBER:

If your RF power meter does not have a good "Peak" reading function specifically designed to read PEP on SSB signals *(many do not!)* it will always give a false "low" power reading on SSB, which is to say that your power on voice *peaks* may be where it should be, but your meter will be reading a much lower pseudo-average!

Amplitude Modulation (AM) mode reception:

The mcHF is capable of AM reception, but its operation requires some explanation due to the quirk common to many SDRs.

The "Zero-Hertz" hole problem:

This (and all "sound-card") type SDRs have a "hole" at zero Hertz – right in the middle of the display. This is the inevitable result of AC coupling to the A/D converter (codec) and cannot easily be helped without added design complication.

What this means is that if you tune in an AM signal "dead center" its carrier will fall into this "hole" and disappear which effectively turns it into a ***double sideband with no carrier*** – which is to say, it is ***no longer AM!*** **If an AM signal is tuned dead-center, it will sound terribly distorted – much like an SSB signal tuned on an AM receiver!**

The cure for this is simple: **Do NOT tune the AM signal so that the carrier is "dead center"**. It is necessary only to offset-tune by a few hundred Hertz, but ***it is*** necessary to do this!

A recommended modification for mcHF Board version 0.4 (and possibly earlier) if you are interested in AM reception:

As noted in the modification file it is recommended that capacitors **C71** and **C73** (on the outputs of U16 of the RF board) be removed and replaced with jumpers or zero-ohm resistors: Their DC-blocking function is provided by capacitors C26 and C31 on the UI board and the removal of C71 and C73 will extend the low-frequency response of the receiver and reduce the width of this "hole" significantly. It also has the side-effect of potentially improving the low-frequency opposite sideband rejection as it is one-fewer component in the audio path to have its value change with temperature and cause a phase/amplitude shift.

How the demodulation in version 0.0.208 is different from that in earlier version :

In versions prior, the ***pre-demodulation*** bandwidth was fixed at 10 kHz, which meant that all signals within +/10kHz would hit the demodulator. Because the demodulator is, by its nature, a non-linear "device" it would mix and cause distortion should any other signal within that +/-10kHz passband also be intercepted. The selectable audio filter was applied ***after*** the demodulation, but if there was an extraneous signal within the +/-10kHz passband, the damage was already done!

In this version the filtering when in AM mode has been re-done: The Hilbert transformers, which have a bandpass response, are replaced with low-pass filters *(e.g. response to DC)* that have their low-pass cut-off frequency selected according to the desired bandwidth. Post-detection, there is additional audio filtering applied to reduce the wideband noise that inevitably results with envelope detection of weak signals.

The AM bandwidth filtering operates as follows. ***The bandwidths noted below are <u>always</u> available in AM, regardless of menu settings***:

- **10 kHz:** Pre-detection bandwidth: +/-10kHz; Post-detection bandwidth: 10 kHz.
- **3.6 kHz:** Pre-detection bandwidth: +/-3.6 kHz; Post-detection bandwidth: 3.6 kHz.
- **2.3 kHz:** Pre-detection bandwidth: +/-2.0 kHz; Post-detection bandwidth: 2.3 kHz (300-2600Hz, adjustable).
- **1.8 kHz:** Pre-detection bandwidth: +/-2.0 kHz; Post-detection bandwidth: 1.8 kHz (500-2300Hz, adjustable).

Some explanation is required for the **1.8 kHz** and **2.3 kHz** modes as you'll note that the bandwidth appears to be a bit on the narrow side to accommodate the sidebands that extend out beyond the filter (e.g. greater than the +/-2kHz bandwidth).

The 1.8 kHz and 2.3 kHz filters are the same as those used for SSB and the center frequencies of these filters may be adjusted in the menu as desired.

Because it is always necessary to off-center tune an AM signal, one of the two sidebands (upper or lower) may be encompassed in the narrower bandwidth. This "quirk" may also be used to advantage in the presence of QRM (interference) by selectively tuning for one sideband or the other, moving away from the source of the interference.

Known issues with AM demodulation:

- **Remember:** AM signals *must* be off-tuned to avoid placing the carrier in the dead center! An offset of a few hundred Hz is typically adequate.

- There is a known issue in which a weak heterodyne *("tweet")* can be heard at frequencies close to the center frequency. This is caused by the inexact 90 degree phase shift in the receive system: For the time-being, off-tune the carrier until it disappears *or* you may try turning on the DSP notch filter, or adjust the parameter "**AM RX IQ Bal.**" to minimize it.

Comments on adjusting the AM RX IQ Balance:

This adjusts the receiver I/Q amplitude balance when in AM mode and is used to minimize the low-level "tweet" *(e.g. tone)* that can be heard when an AM signal is tuned in slightly off frequency to avoid the "zero Hertz" hole.

This frequency of this "tweet" is twice the offset from the carrier frequency, which is to say that if you tune 500 Hz off from the AM carrier, you will hear a 1000 Hz tone. To null this tone it is recommended that you tune in a strong carrier, offset it by 500 Hz and then adjust this parameter to minimize the amplitude of this tone.

This adjustment is unlikely to completely eliminate this "tweet", but it can significantly reduce it. Note also that the efficacy of this reduction changes with audio frequency in that the optimal null for a 400 Hz "tweet" tone *(e.g. 200 Hz offset from the carrier frequency)* will be different from that of a 1000 Hz "tweet" tone.

Recommended procedure for adjusting RX IQ gain and phase adjustments:

1. Set the mcHF to LSB mode

2. Set the AGC to FAST mode so that the receiver recovers more quickly from the "clicks" that occur during the phase adjustments.

3. Tune in a strong, constant signal. This could be a shortwave broadcast station or a signal generator. The

4. Tune the mcHF dial frequency 1 kHz above the carrier frequency to obtain a strong 1kHz audio note.

5. Now tune the mcHF dial frequency 2 kHz lower (e.g. 1kHz below) the carrier frequency. You should be able to hear the same 1 kHz audio note, but much more weakly.

6. If you can *NOT* hear this note, re-check the frequency. If the frequency is correct and you cannot hear the "leakage", either the test signal is not strong/clear enough or your opposite sideband attenuation is sufficient and you should proceed to adjusting the USB gain/phase adjustments.

7. If you hear the "leakage", adjust the **LSB RX IQ Bal.** to minimize it.

8. Once minimized using the **RX IQ Bal.**, adjust the **RX IQ Phase** to further minimize the "leakage". Note that adjusting the phase will cause "clicking" which may upset the AGC/S-meter briefly.

9. Once the LSB leakage has been minimized, repeat the above procedure in USB mode, but tuning below in step 4 and above in step 5.

NOTE for CW operators who use "lower" CW sidetone frequencies:

If you use the mcHF primarily for CW, use rather low frequency CW notes and sidetone frequencies *(400-550 Hz)* and notice "leakage" from the opposite sideband after following the above procedure, you may choose to perform the above procedure at the approximate frequency CW sidetone frequency rather than 1000 Hz. This is because of the way the Hibert Transformer works and the fact that lower frequencies (<500 Hz) can have poorer opposite-sideband rejection.

If you choose a different, lower sidetone frequency note that you may sacrifice opposite sideband rejection at higher frequencies, particularly if you null it at too-low a frequency! You should carefully choose your "alternate" frequency as to provide a good compromise good opposite sideband rejection at the desired frequency and higher frequencies (e.g. 750 Hz and up).

Recommended procedure for adjusting TX IQ gain and phase adjustments:

1. **<u>Loosely</u>** couple your transmitter to a receiver that is connected to a computer running a program with a waterfall display. Do NOT connect the mcHF transmitter to your receiver, but ***connect it to a dummy load*** and place an antenna coupling from your computer-connected receiver near-ish the mcHF's RF output so that it gets adequate signal. A program such as **Spectran** is recommended. *(The **Spectrum Lab** program will also work, but is more complicated to use.)*

2. Switch to LSB mode on the mcHF.

3. Set the mcHF to 1 Watt mode.

4. Switch to **<u>USB</u>** mode on the computer-connected receiver. *(Yes, USB.)*

5. Tune both the mcHF and the computer-connected receiver to the same frequency.

6. Press TUNE mode. You will hear a 750 Hz tone from the mcHF and see it on the waterfall display, see a signal 750 Hz below the mcHF dial display frequency. ***Note: You'll have to do some simple math to figure out where these frequency components will land on the waterfall!***

7. If you adjust the **LSB TX IQ Bal.** you should see the signal 750 Hz above the mcHF dial display frequency go up and down. Null this upper frequency as much as possible.

8. **Note:** Unless the IQ Gain balance is nulled as much as possible, nulling of the Phase adjustment will ***not*** be possible.

9. Once the best nulling is obtained with the **LSB TX IQ Bal.**, adjust the **LSB TX IQ Phase.** It will "click" on each adjustment, so wait for the waterfall screen to clear after each adjustment.

10. Once the best phase null is obtained, go back and forth between the gain and phase for the best null.

11. Press **TUNE** again to exit TUNE mode.

12. Switch the mcHF to **USB** mode.

13. Switch the computer-connected receiver in **LSB** mode, but this time null out the 750 Hz tone BELOW the mcHF dial frequency, having done the math to figure out where the frequency components will land!

When you are done write down the phase and gain settings, then power off using the **POWER** button to save the settings. Power up again and return to the menu to verify that they were saved.

Operational notes, quirks, and known bugs:

- CW mode operates in USB: The transmitted frequency is the dial frequency ***PLUS*** the sidetone frequency while the transmit frequency of the *other* station could be determined by zero-beating.

- In the presence of a strong signal, the lower portion of the S-meter *(that which is normally white that indicates S0-S9)* will turn red to indicate the possibility of overload of the A/D converter. This turning red briefly is normal in the process of the codec gain automatically adjusting. *For more information see the menu item **"RX Codec Gain".***

- In the sudden presence of a strong, steady signal, a "Tick-tick" sound may be heard for a few seconds, accompanied by the lower portion ("S0-S9") of the S-Meter turning red. This sound is the result of the automatic gain adjustment of the A/D converter in the codec being quickly adjusted to prevent overload, with the "tick" sounds being due to the large step sizes of the gain reduction. In normal operation, in the presence of modulation *(e.g. audio)* rather than a steady carrier this artifact is inaudible.

- When the transceiver is powered up one of the pieces of information that is displayed is the interface mode of the LCD. The desired mode is "**Parallel**", which is obtained with UI board revisions 0.3 and later with appropriately-jumpered HY-28B LCD displays. If you have have a version 0.3 board and this newer display, but the startup message indicates that the LCD interface mode is **SPI**, you may consider ***CAREFULLY*** removing the LCD and properly setting its jumpers to achieve parallel mode.

- If you have an older LCD and/or board that runs in SPI mode you may wish to change the parameter "**Spec. Scope Filter**" to 1 or 2 to reduce its strength and speed the response to changing signals.

- If you experience a one-second "Tick" sound on higher bands (15, 12, 10 meters) you may wish to perform the modification that suppresses this problems. Prior to making these modifications, this "tick" sound may be suppressed by setting the menu parameter "**TCXO Off/On/Stop**" to "Stop". Note that this will halt polling of the temperature sensor, disabling the temperature display and the ability of the temperature drift of the synthesizer to be compensated for temperature change. ***These modifications may be found in the "KA7OEI" folder on the Yahoo group.***

- There ***may*** be a lingering bug in the CW mode in which the transceiver momentarily "hangs" on rare occasions, particularly when going quickly from TX, to RX and then back to TX again. It is believed that this bug has been fixed, but if it does occur, increase the length of the "**CW TX->RX Delay**" parameter slightly.

- If the various modifications to improve receiver performance have been performed *(e.g. the "U3a" mod, a separate regulator for the MCU, the 4.7 ohm resistor in the 8 volt supply for the audio amplifier, the resistor/filter for the LCD supply, etc.)* the receiver sensitivity will increase to the point that EMI from the LCD's data bus can get into the receiver. When the spectrum scope display is updated, this can cause a "Helicopter"-like sound which may be significantly reduced by placing a metal shield between the UI and RF boards. This shield may be any type of metal, but it must be insulated on both sides to prevent its shorting components. *This shield need not be grounded to effect significant improvement in receiver performance.* This effect is

less apparent with the LCD operating in SPI mode.

- Starting with version 0.0.211, the "build" number ("211" for example) is stored in the EEPROM and compared upon boot-up. If this is different, it is assumed that a new version of firmware has been loaded and new EEPROM variables are automatically initialized. Note that this is triggered ONLY if the build number of the loaded firmware is different from what was previously loaded into the radio.

- If, for some reason, the communications with the Si570 and/or temperature sensor is lost – something that would often cause red digits and "pausing" of the spectrum scope and the user interface – it was observed that the only way to restore communications was to power-cycle the unit.
  - Now, this loss of communications is detected and the serial bus to these devices is reset. When this happens, a message will appear along with an audible disruption as the Si570 is reset.
  - It is believed that this function will detect if the temperature sensor is NOT installed, but this is not known for absolute certainty! If you do not have the temperature sensor installed, go into the menu, set the "**TCXO Off/On/Stop**" setting to **STOP** – which should stop the automatic resetting due to the lack of the sensor – and let me know about this.

[End of document]