RS-918SSB HF SDR Transceiver

FEBRUARY 15, 2018

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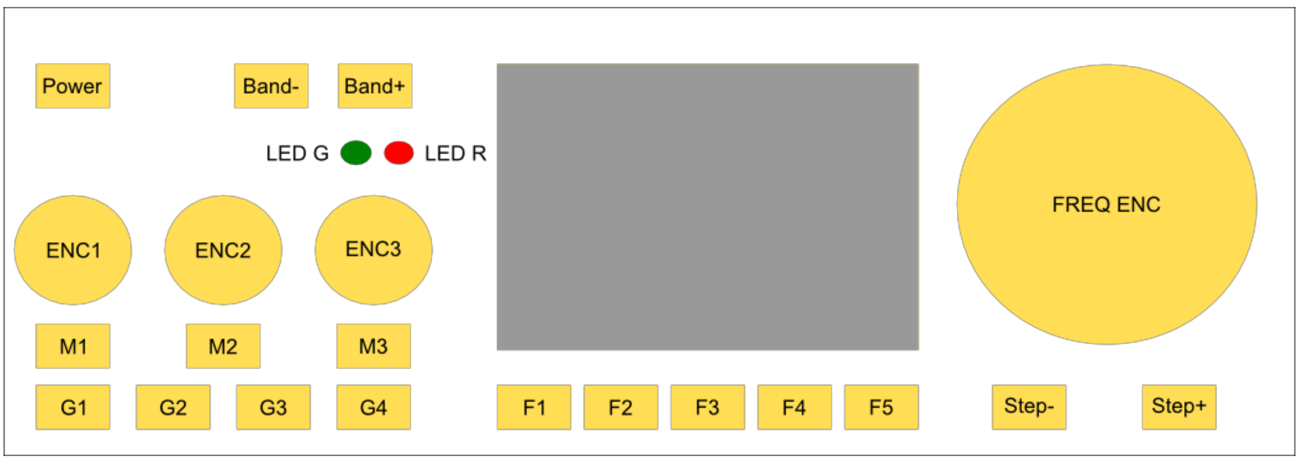
Operating Manual

There is another project which provides operating manual on gitbook started by Marc, EA3HZZ. You can access this project here. Contributors / collaborators are welcome as in github, too :)

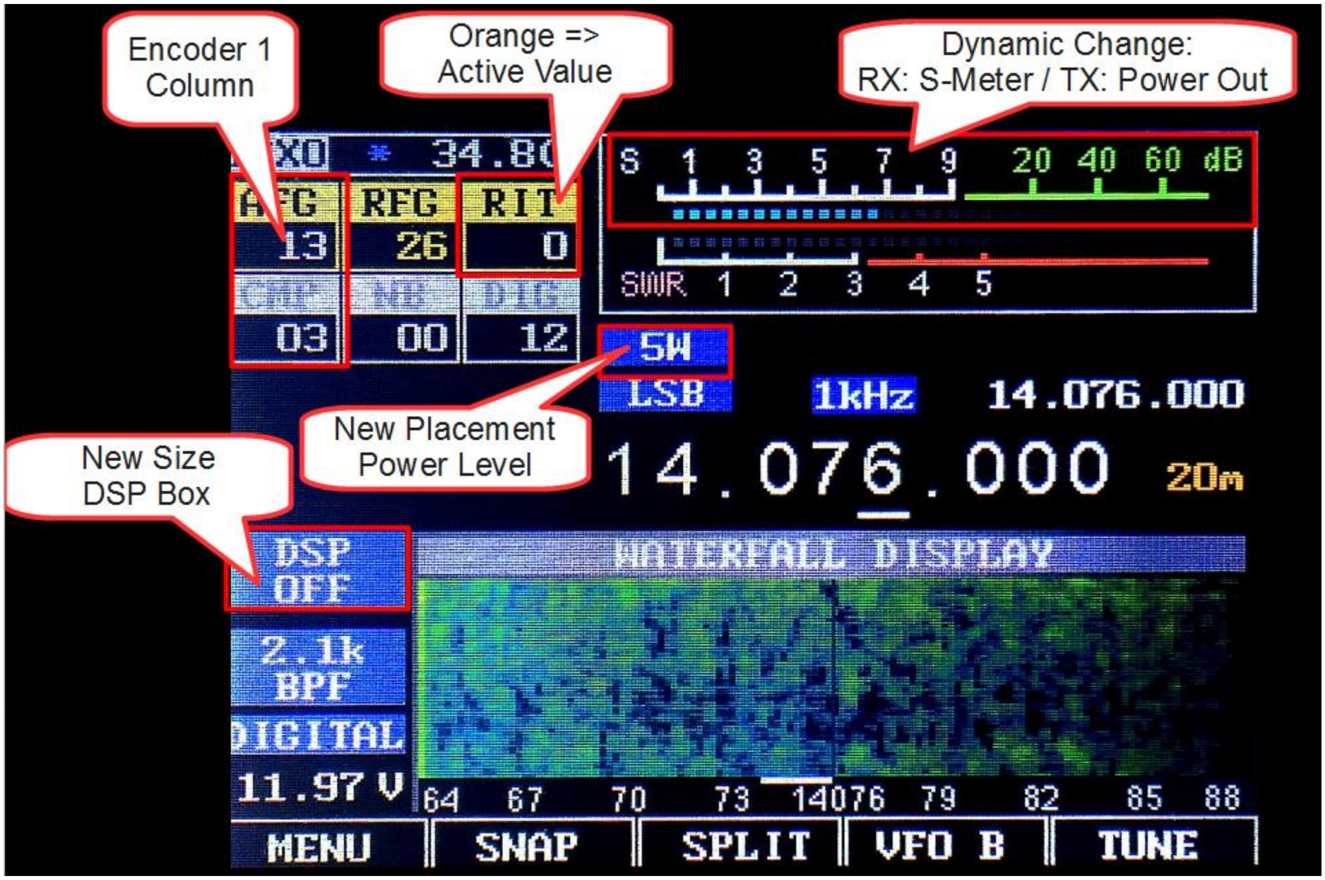
If not mentioned otherwise, the information below applies to the newest daily build. So sometimes there may be some differences if you use older firmware releases.

mcHF UI Element Naming Convention



Please note, that in mcHF related context are also sometimes other names being used for buttons. Names with starting with capital "S" are the names in the schematic and found on the PCB. We do not use these here and do not recommend to use them anywhere.

mcHF Basic Screen Layout



Filter Box

Shows the name of the currently selected RX (!) audio filter. Top line is the upper frequency, lower line the characteristic parameter:

- BPF -> ~300 - upper frequency
- LPF -> 0 - upper frequency
- otherwise width (300/500 -> for narrow CW filters) or center frequency (for narrow SSB filters) is shown

LCD Touchscreen Functions

Where	Short Press	Long Press	When	Comment
"<" Waterfall/Scope bar	Waterfall/Scope magnification reduced		RX, TX	Works also in big size mode with no bar shown
">" Waterfall/Scope bar	Waterfall/Scope magnification increased		RX, TX	Works also in big size mode with no bar shown
Left side Waterfall/Scope bar	Toggle Waterfall/Scope/Dual	Toggle normal/big size mode visual for spectrum (i.e. (no) title bar)	RX, TX	Works also in big size mode with no bar shown
Lower part Waterfall/Scope	Tune to the tapped frequency		RX	Not if tuning frequency is locked, in AM and SAM 5khz grid is used
Signal Meter	Show next measurement		RX, TX	AUD, SWR, ALC
Frequency display (three least significant digits)	Frequency set to KHz Boundary		RX	

Where	Short Press	Long Press	When	Comment
MODE Button Label	Toggle Menu Mode		RX	Short Press Button F1
Audio Signal Box	Next audio source		RX, TX	See Encoder 3 & M3
TX Power Box	Next TX power level		RX, TX	Short Press Button G3
DSP Box	Restart Codec I2S Stream		RX	Use if you have "twin peaks syndrome"
Left of Band Name	Next lower band		RX	
Right of Band Name	Next higher band		RX	
Tune Step Size Box	Toggle Dynamic Tuning		RX	Blue box -> dynamic tuning active
Frequency ruler	Tune to the tapped frequency	Set new Scope/Waterfall size ratio	RX	

Extra Touch Actions

You can get a preview how it looks if mcHF selects new bands provided by future expansion PCBs if you touch "40" of S-Meter (rf-bands-mod) or "60" of S-Meter (vhf/uhf-bands-mod) on touchscreen when you are in hardware-menu (touching toggles pcb present or not "hard-coded").

Key Press Map

Based on the current active-devel firmware

Name of Key(s)	When	Short Press	Long Press	Comment
Power		Dim LCD	Power On / Save Config and Power down	
Power + BAND+		-	Power down without saving config	
Power + BAND-	LCD Auto Blank! = OFF	-	Toggles "Blank LCD" permanently	
Power + BAND-	Bootloader DF8OE, mcHF is off	-	Update firmware from USB pendrive	See this page
BAND-		Next Lower Band	-	
BAND+		Next Higher Band	-	

Name of Key(s)	When	Short Press	Long Press	Comment
M1		Select Encoder 1 Value	-	
M2	No Menu	Select Encoder 2 Value	long press: toggle between Noise Blanker & AGC mode	
M2	Menu Mode	Select Encoder 2 Value (no change via Encoder 2 possible)	long press: toggle between Noise Blanker & AGC mode	
M3	No Menu	Encoder 3 Value	Switch Line in Channel	See below for explanation of line in channel labels
M3	Menu Mode	Select Encoder 3 Value (no change via Encoder 3 possible)	Switch Line in Channel	
G1		Changes (De)Modulation Mode	Switches to alternate mode, see below	

Name of Key(s)	When	Short Press	Long Press	Comment
G2		Changes DSP Modes	DSP Off	
G3		Switches Power Levels	-	
G4		Switches Predefined Filters	Enables Filter Selection by Encoder 3	
G4	Encoder 3 Filter Selection Active	Disables Encoder 3 Filter Selection	-	
F1		Toggles Menu Mode	Save Config to EEPROM	
F2	No Menu	Snap Carrier	Change Meter (SWR, ALC, AUD)	
F2	Menu	Prev Menu Page	First Menu Page	
F3	No Menu	Toggles Split Mode	Toggles Memory Mode	
F3	Memory Mode	Toggles Waterfall/Scope	Switch to Memory Mode	Memory Mode not implemented

Name of Key(s)	When	Short Press	Long Press	Comment
F3	Menu	Next Menu Page	Last Menu Page	
F4	No Menu	Toggle VFO A/B	Copy active VFO Freq to inactive VFO	
F4	Menu Mode	Reset Menu Item Value to Default	-	
F5		Start/Stop Tune	Disable/Enable TX	
STEP-		Decrease Tuning Step	Temporarily Enable Smaller Step	
STEP+		Increase Tuning Step	Temporarily Enable Larger Step	
STEP- + STEP+		(Un)Lock Frequency Change		
BAND- + BAND+		Toggle Scope/Waterfall		
POWER + BAND-	Autodimm Active	Turn Display On/Off		

Name of Key(s)	When	Short Press	Long Press	Comment
F1+F3+F5	Splash screen	Ask for Reset to Default Config		
F2+F4	Splash screen	Ask for Reset to VFOs to default		
Any Button	Splash screen	Button and Touchscreen Test		
Touchscreen	Splash screen		Touchscreen Calibration	

Encoder 1 & M1 Button

M1 is used to select the following settings/values with a short press. Change these values using Encoder 1. The actively controlled value is typically indicated using a yellow box background.

Label	Name	When	Comment
AFG	AF Gain	RX	Audio Volume for Speaker or Headphone
STG	Side tone Gain	TX in CW	Controls volume of control tone if in CW mode
CMP	Audio Compressor	TX in Voice	Controls the strength of the audio compressor (0 -> lowest)

Encoder 2 & M2 Button

M2 is used to select the following settings/values with a short press. Change these values using Encoder 2. The actively controlled value is typically indicated using a yellow box background.

In Menu Mode Encoder 2 is used to select items or sub menus. Use Encoder 3 to change or hide/show sub menus. M2 keeps its original function.

Label	Name	When	Comment
AGC	AGC thresh	RX	
NB/AGC	Noise Blanker or AGC mode	RX	
PEAK	Peak Filter	RX	
NOTCH	Notch Filter	RX	
NR	Noise Reduction	RX	
BAS	Bass	RX, TX	RX and TX have independent settings
TRB	Treble	RX, TX	RX and TX have independent settings

Encoder 3 & M3 Button

M3 is used to select the following settings/values with a short press. Change these values using Encoder 3. The actively controlled value is typically indicated using a yellow box background.

In Menu Mode Encoder 3 is used to show/hide sub menus and to change menu item values. M3 keeps its original function.

Label	Name	When	Comment
RIT	RIT	RX	RX frequency deviation (20Hz steps)
MIC	TX Microphone Signal	TX	Microphone jack
L>L	TX Left Line IN Signal	TX	Line IN jack, left channel
L>R	TX Right Line IN Signal	TX	Line IN jack, right channel
DIG	TX USB Audio Signal	TX	USB Speaker, 48kHz stereo, but only left channel is used
DIQ	TX USB IQ Signal	TX	48Khz IQ Baseband Signal e.g. from HDSDR. Do not send normal audio, USB Audio sent to PC is also IQ
WPM	Words Per Minute	TX in CW	CW Keyer Setting

G1 - Mode Switch (>= 1.3.1)

A short press cycles through all enabled (de)modulation modes (SSB, CW, AM, FM, SAM, DIG).

Each band has at least one mode which is always available. For all HF bands at least one SSB mode, for 10m: in addition to SSB also FM if USB/LSB Autos elect is on (!).

Which SSB bands are in the "short press" list depends on the setting of USB/LSB Autos elect in the menu. If off, both modes are there, if on, depending on the band's frequency either USB or LSB.

A long press toggles to the alternative mode for the currently selected mode (Mode1 -> Mode2 and Mode2 -> Mode1):

Mode1	Mode2	Mode3	Mode4
LSB	USB	-	-
AM	SAM	SAM-L	SAM-U
SAM	SAM-L	SAM-U	AM
CW-L	CW-U	-	-
DI-L	DI-U	-	-
FM-W	FM-N	-	-

Color and Blink Codes of the LEDs Explained

State	Green Led	Red Led
Boot	Steady	Steady
RX	Steady	Off (or Blinking if CW Decoder on and carrier detected)
TX	Off	Steady
Low Battery Voltage (only if shutdown enabled)	Blinking	*
RX with CW Decoder on	*	On when CW carrier

'*' == not related to other led's state, can be any state (On, Off, Blinking)

Frequency Display Explained

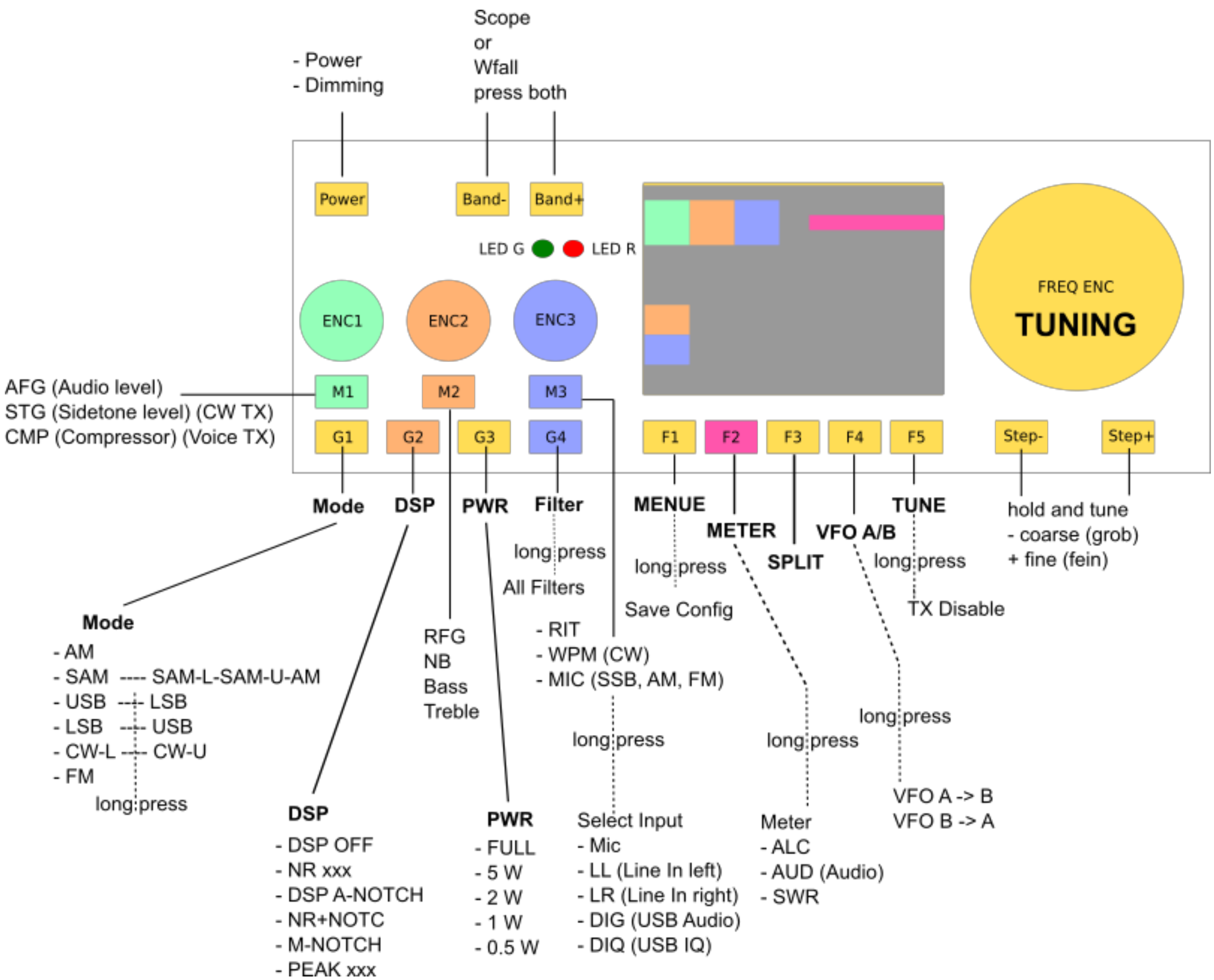
The frequency display operates in two modes, normal mode and split mode.

Color Codes of the Main Display

Digit Color	Meaning
White	Normal operation, device tuned to frequency
Yellow	Outside specifications of the local oscillator chip Si570, but still usable frequency
Orange	Non-tunable frequency, transmit disabled, LO operates at last valid frequency
Red	Communication to local oscillator not working, probably I2C issue or RF / Si570 board connection faulty

UHSDR Quick Operating Guide

This document is useful if you are looking for a very simple guide how to operate the mcHF:



The Chinese translate at here

Also available as PDF and SVG. The SVG is the source document and is maintained using Inkscape.

This image shown above is part of the Github source and always shows the current development version from the active-devel branch (our main development branch).

Each release will contain the matching document in its zip/tar source code archive (from version 1.5.5). See the releases.

Operating Manual Menu

Menu Entries Explained

Can't see the menu entry you are looking for? Document it for your fellow mcHF users! But since the table is generated automatically, do this by changing this file in the source code or requesting a change if you fear to break something.

In general, the entries will cover the newest version of the software, comments will make sure if there are important differences to older version.

How to Operate the Menu

To select the item to change or a sub menu, use Encoder 2. To change a value or fold/unfold a sub menu, use Encoder 3. There is no "OK" etc. to confirm a setting, it takes effect immediately unless documented otherwise in the menu item help. See below for the link to the item help.

The menu items typically change settings of the mcHF. To store configuration changes permanently, press and hold the "Menu" button until the message "Saving ..." appears. Settings are also stored if you turn off the machine by press and hold of "Power Off". To prevent saving changes at power off you can turn off by press and hold of "Band+" and "Power Off" together (or you simply cut the power). See Operating Manual.

Not automatically saving changes permanently makes it easy to try out changes or new firmware without losing a working configuration accidentally.

Menu Overview (Automatically Generated)

Since Xmas 2016 there is an automatic generated manual regarding menu items. Because of it may change recently please follow this link: Here you'll find the most recent menu item overview for the last daily build

uhsdr firmware v.. - UI Menu Overview

generated at 2018-02-10T09:41:57 by "./ui_menu_structure_mdtable.py"

Standard Menu (MENU_BASE)

LABEL (NR)	DESCRIPTION
LSB/USB Auto Select (MENU_SSB_AUTO_MODE_SELECT)	If enabled, the appropriate sideband mode for SSB and FreeDV is chosen as default for each band by its frequency.
Digital Modes (MENU_DIGI_DISABLE)	Disable appearance of digital modes when pressing Mode button
CW Mode (MENU_CW_DISABLE)	Disable appearance of CW mode when pressing Mode button
AM Mode (MENU_AM_DISABLE)	Disable appearance of AM mode when pressing Mode button
SyncAM Mode (MENU_DEMOD_SAM)	Disable appearance of SyncAM modes when pressing Mode button
SAM PLL locking range (MENU_SAM_PLL_LOCKING_RANGE)	SAM PLL Locking Range in Hz: this determines how far up and down from the carrier frequency of an AM station we can off tune the receiver, so that the PLL will still lock to the carrier.
SAM PLL step response (MENU_SAM_PLL_STEP_RESPONSE)	Step response = Zeta = damping factor of the SAM PLL. Sets the

LABEL (NR)	DESCRIPTION
	stability and transient response of the PLL. Larger values give faster lock even if you are off tune, but PLL is also more sensitive.
SAM PLL bandwidth in Hz (MENU_SAM_PLL_BANDWIDTH)	Bandwidth of the PLL loop = OmegaN in Hz: smaller bandwidth = more stable lock. FAST LOCK SAM PLL - set Step response and PLL bandwidth to large values [e.g. 80 / 350]; DX (SLOW & STABLE) SAM PLL - set Step response and PLL bandwidth to small values [eg. 30 / 100].
SAM Fade Leveler (MENU_SAM_FADE_LEVELER)	Fade leveler (in AM/SAM mode) ON/OFF. Fade leveler is helpful in situations with very fast QSB of the carrier ´flutter´. It is designed to remove the rapidly changing carrier and replace it with a more stable carrier. If there is no QSB on the carrier, there is no change.
FM Mode (MENU_FM_MODE_ENABLE)	Disable appearance of FM mode when pressing Mode button
FM Sub Tone Gen (MENU_FM_GEN_SUBAUDIBLE_TONE)	Enable generation of CTCSS tones during FM transmissions.

LABEL (NR)	DESCRIPTION
FM Sub Tone Dot (MENU_FM_DET_SUBAUDIBLE_TONE)	Enable detection of CTCSS tones during FM receive. RX is muted unless tone is detected.
FM Tone Burst (MENU_FM_TONE_BURST_MODE)	Enabled sending of short tone at beginning of each FM transmission. Used to open repeaters. Available frequencies are 1750 Hz and 2135 Hz.
FM Deviation (MENU_FM_DEV_MODE)	Select between normal and narrow deviation (5 and 2.5kHz) for FM RX/TX
AGC WDSP Mode (MENU_AGC_WDSP_MODE)	Choose a bundle of preset AGC parameters for the WDSP AGC: FAST / MED / SLOW / LONG / very LONG or switch OFF the AGC.
AGC WDSP Slope (MENU_AGC_WDSP_SLOPE)	Slope of the AGC is the difference between the loudest signal and the quietest signal after the AGC action has taken place. Given in db.
AGC WDSP Decay (MENU_AGC_WDSP_TAU_DECAY)	Time constant for the AGC decay (speed of recovery of the AGC gain) in milliseconds.
AGC WDSP Threshold (MENU_AGC_WDSP_THRESH)	´Threshold´ = ´Knee´ of the AGC: input signal level from which on the AGC action takes place. AGC threshold should be placed/adjusted just above the

LABEL (NR)	DESCRIPTION
	band noise for every particular RX situation to allow for optimal AGC action. The blue AGC box indicates when AGC action takes place and helps in adjusting this threshold.
AGC WDSP Hang enable (MENU_AGC_WDSP_HANG_ENABLE)	Enable/Disable Hang AGC function: If enabled: after the signal has decreased, the gain of the AGC is held constant for a certain time period (the hang time) in order to allow for speech pauses without disturbing noise because of fast acting AGC.
AGC WDSP Hang time (MENU_AGC_WDSP_HANG_TIME)	Hang AGC: hang time is the time period over which the AGC gain is held constant when in AGC Hang mode. After this period the gain is increased fast.
AGC WDSP Hang threshold (MENU_AGC_WDSP_HANG_THRESH)	´Threshold´ for the Hang AGC: Hang AGC is useful for medium to strong signals. The Hang threshold determines the signal strength a signal has to exceed for Hang AGC to take place.
AGC WDSP Hang Decay (MENU_AGC_WDSP_TAU_HANG_DECAY)	Time constant for the Hang AGC decay (speed of recovery of the AGC gain after hang time has expired) in milliseconds.

LABEL (NR)	DESCRIPTION
RX Codec Gain (MENU_CODEC_GAIN_MODE)	Sets the Codec IQ signal gain. Higher values represent higher gain. If set to AUTO the mcHF controls the gain so that the best dynamic range is used.
RX/TX Freq Xlate (MENU_RX_FREQ_CONV)	Controls offset of the receiver IQ signal base frequency from the dial frequency. Use of +/-12Khz is recommended. Switching it to OFF is not recommended as it disables certain features.
Mic Input Gain (MENU_MIC_GAIN)	Microphone gain. Also changeable via Encoder 3 if Microphone is selected as Input
Line Input Gain (MENU_LINE_GAIN)	Line IN gain. Also changeable via Encoder 3 if Line IN Left (L>L) or Line IN Right (L>R) is selected as Input
TX Audio Compress (MENU_TX_COMPRESSION_LEVEL)	Control the TX audio compressor. Higher values give more compression. Set to CUSTOM for user defined compression parameters. See below. Also changeable via Encoder 1 (CMP).
TX ALC Release Time (MENU_ALC_RELEASE)	If Audio Compressor Config is set to CUSTOM, sets the value of the Audio Compressor Release time. Otherwise shows

LABEL (NR)	DESCRIPTION
	predefined value of selected compression level.
TX ALC Input Gain (MENU_ALC_POSTFILT_GAIN)	If Audio Compressor Config is set to CUSTOM, sets the value of the ALC Input Gain. Otherwise shows predefined value of selected compression level.
RX NB Setting (MENU_NOISE_BLANKER_SETTING)	Set the Noise Blanker strength. Higher values mean more aggressive blanking. Also, changeable using Encoder 2 if Noise Blanker is active.
DSP NR Strength (MENU_DSP_NR_STRENGTH)	Set the Noise Reduction Strength. Higher values mean more aggressive noise reduction but also higher CPU load. Use with extreme care. Also, changeable using Encoder 2 if DSP is active.
TCXO Off/On/Stop (MENU_TCXO_MODE)	The software TCXO can be turned ON (set frequency is adjusted so that generated frequency matches the wanted frequency); OFF (no correction or measurement done); or STOP (no correction but measurement).
TCXO Temp. (C/F) (MENU_TCXO_C_F)	Show the measure TCXO temperature in Celsius or Fahrenheit.

LABEL (NR)	DESCRIPTION
Backup Config (MENU_BACKUP_CONFIG)	Backup your I2C Configuration to flash. If you don't have suitable I2C EEPROM installed this function is not available.
Low Voltage Shutdown (MENU_LOW_POWER_SHUTDOWN)	Shutdown automatically when supply voltage is below threshold for 60 seconds (only in RX).
Restore Config (MENU_RESTORE_CONFIG)	Restore your I2C Configuration from flash. If you don't have suitable I2C EEPROM installed this function is not available.

Configuration Menu (MENU_CONF)

LABEL (NR)	DESCRIPTION
Save Out-Of-Band Freq. (CONFIG_FREQ_MEM_LIMIT_RELAX)	Select ON to save and restore frequencies which do not fit into the band during configuration saving (Power-Off or long press on Menu button)
TX on Out-Of-Band Freq. (CONFIG_TX_OUT_ENABLE)	Permit low power transmission even if the

LABEL (NR)	DESCRIPTION
	frequency is out of the official ham bands. DO NOT USE WITH CONNECTED ANTENNA! Use a dummy load!
Transmit Disable (CONFIG_TX_DISABLE)	Disable all transmissions unconditionally. In CW you will be able to hear a side tone but no transmission is made.
Menu SW on TX disable (CONFIG_AUDIO_MAIN_SCREEN_MENU_SWITCH)	Control if the screen automatically adapts Encoder value focus when switching between RX and TX.
TX Mute Lineout (CONFIG_MUTE_LINE_OUT_TX)	During transmission with frequency translation off, line out will carry one of the two signal channels. Good for CW but not very useful

LABEL (NR)	DESCRIPTION
	otherwise. You may switch this signal off here.
TX Initial Muting Time (CONFIG_TXRX_SWITCH_AUDIO_MUTE)	When switching from RX to TX the audio and HF output will be muted for roughly VALUE ms. There are now several minimum times for muting defined in the firmware: Input from Mic: 40ms Input from Line In: 40ms Digital Inputs (CW, USB): less than 1ms. If the user defined 'TX Initial Muting Time' is set to more than zero, the maximum of both fixed input time and user defined time is used. Your microphone PTT switch is a

LABEL (NR)	DESCRIPTION
	potential source of noise if Mic is input! You need to increase the delay or change switches!
Max Volume (CONFIG_MAX_VOLUME)	Set maximum speaker headphone volume.
Lineout Gain (CONFIG_LINEOUT_GAIN)	Set the constant gain level for the analog lineout jack
Key Beep (CONFIG_BEEP_ENABLE)	If ON each keypress will generate a short beep
Beep Frequency (CONFIG_BEEP_FREQ)	Set beep frequency in Hz.
Beep Volume (CONFIG_BEEP_VOLUME)	Set beep volume.
CAT Running In Sandbox (CONFIG_CAT_IN_SANDBOX)	If On, frequency Changes made via CAT will not automatically switch bands and affect the manually

LABEL (NR)	DESCRIPTION
	selected frequencies.
CAT-DIQ-FREQ-XLAT (CONFIG_CAT_XLAT)	Select which frequency is reported via CAT Interface to the connected PC in Digital IQ Mode. If ON, it reports the displayed frequency. If OFF, it reports the center frequency, which is more useful with SDR programs.
PTT via virtual RTS (CONFIG_CAT_PTT_RTS)	The virtual serial port signal RTS can be used to switch to TX. Use with care, many CAT-able programs also set RTS to aktiv and make the TRX go to TX mode.
XVTR Offs/Mult (CONFIG_XVTR_OFFSET_MULT)	When connecting to a transverter, set this to 1 and set

LABEL (NR)	DESCRIPTION
	the XVERTER Offset to the LO Frequency of it. The mcHF frequency is multiplied by this factor before the offset is added, so anything but 1 will result in each Hz in the mcHF being displayed as 2 to 10 Hz change on display.
XVTR Offset (CONFIG_XVTR_FREQUENCY_OFFSET)	When transverter mode is enabled, this value is added to the mcHF frequency after being multiplied with the XVTR Offs/Mult. Use Step+ to set a good step width, much less turns with the dial knob if it is set to 1Mhz
Step Button Swap (CONFIG_STEP_SIZE_BUTTON_SWAP)	If ON, Step- behaves like

LABEL (NR)	DESCRIPTION
	Step+ and vice versa.
Band+/- Button Swap (CONFIG_BAND_BUTTON_SWAP)	If ON, Band- behaves like Band+ and vice versa.
RTC Start (CONFIG_RTC_START)	Start using the RTC and use the modified button layout. Will reboot your mcHF. Please use only if you completed the RTC mod otherwise you will need to disconnect battery and power and reboot to get a working mcHF. This menu is only visible if Backup RAM (VBat) was detected.
RTC Hour (CONFIG_RTC_HOUR)	Sets the Real Time Clock Hour. Needs HW Modifications.

LABEL (NR)	DESCRIPTION
RTC Min (CONFIG_RTC_MIN)	Sets the Real Time Clock Minutes. Needs HW Modifications.
RTC Seconds (CONFIG_RTC_SEC)	Sets the Real Time Clock Seconds. Needs HW Modifications.
RTC Reset (CONFIG_RTC_RESET)	Full Reset of STM32 RTC. Can be used to simulate first start with RTC mod completed
RTC Calibration (CONFIG_RTC_CALIB)	Sets the Real Time Clock Frequency calibration value in ppm. 1s/day deviation equals 11.57 ppm deviation
Voltmeter Cal. (CONFIG_VOLTMETER_CALIBRATION)	Adjusts the displayed value of the voltmeter.
Low Voltage Threshold (CONFIG_LOW_POWER_THRESHOLD)	Voltage threshold for

LABEL (NR)	DESCRIPTION
	voltage warning colors and auto shutdown.
Freq. Calibrate (CONFIG_FREQUENCY_CALIBRATE)	Adjust the frequency correction of the local oscillator. Measure TX frequency and adjust until both match. Or use receive a known reference signal and zero-beat it and then adjust. More information in the Wiki.
Pwr. Display mW (CONFIG_FWD_REV_PWR_DISP)	Shows the forward and reverse power values in mW, can be used to calibrate the SWR meter.
Pwr. Det. Null (CONFIG_RF_FWD_PWR_NULL)	Set the forward and reverse power sensors ADC zero power offset. This setting is enabled ONLY

LABEL (NR)	DESCRIPTION
	when Disp. Pwr (mW), is enabled. Needs SWR meter hardware modification to work. See Wiki Adjustment and Calibration.
SWR/PWR Meter FWD/REV Swap (CONFIG_FWD_REV_SENSE_SWAP)	Exchange the assignment of the Power/SWR FWD and REV measurement ADC. Use if your power meter does not show anything during TX.
I2C1 Bus Speed (CONFIG_I2C1_SPEED)	Sets speed of the I2C1 bus (Si570 oscillator and MCP9801 temperature sensor). Higher speeds provide quicker RX/TX switching but may also cause tuning issues (red digits). Be careful with speeds above 200 kHz.

LABEL (NR)	DESCRIPTION
I2C2 Bus Speed (CONFIG_I2C2_SPEED)	Sets speed of the I2C2 bus (Audio Codec and I2C EEPROM). Higher speeds provide quicker RX/TX switching, configuration save and power off. Speeds above 200 kHz are not recommended for unmodified mcHF. Many modified mcHF seem to run with 300kHz without problems.
RX IQ Auto Correction (CONFIG_IQ_AUTO_CORRECTION)	Receive IQ phase and amplitude imbalance can be automatically adjusted by the mcHF. Switch ON/OFF here. If OFF, it takes the following menu values for compensating the imbalance. The automatic

LABEL (NR)	DESCRIPTION
	algorithm achieves up to 60dB mirror rejection. See Wiki Adjustments and Calibration.
RX IQ Balance (80m) (CONFIG_80M_RX_IQ_GAIN_BAL)	IQ Balance Adjust for all receive if frequency translation is NOT OFF. Requires USB/LSB/CW mode to be changeable. See Wiki Adjustments and Calibration.
RX IQ Phase (80m) (CONFIG_80M_RX_IQ_PHASE_BAL)	IQ Phase Adjust for all receive if frequency translation is NOT OFF. Requires USB/LSB/CW mode to be changeable. See Wiki Adjustments and Calibration.

LABEL (NR)	DESCRIPTION
RX IQ Balance (10m) (CONFIG_10M_RX_IQ_GAIN_BAL)	IQ Balance Adjust for all receive if frequency translation is NOT OFF. Requires USB/LSB/CW mode to be changeable. See Wiki Adjustments and Calibration.
RX IQ Phase (10m) (CONFIG_10M_RX_IQ_PHASE_BAL)	IQ Phase Adjust for all receive if frequency translation is NOT OFF. Requires USB/LSB/CW mode to be changeable. See Wiki Adjustments and Calibration.
TX IQ Balance (80m) (CONFIG_80M_TX_IQ_GAIN_BAL)	IQ Phase Adjust for all transmission if frequency translation is NOT OFF. Requires USB or LSB mode to be changeable. See

LABEL (NR)	DESCRIPTION
	Wiki Adjustments and Calibration.
TX IQ Phase (80m) (CONFIG_80M_TX_IQ_PHASE_BAL)	IQ Phase Adjust for all transmission if frequency translation is NOT OFF. Requires USB or LSB mode to be changeable. See Wiki Adjustments and Calibration.
TX IQ Balance (10m) (CONFIG_10M_TX_IQ_GAIN_BAL)	IQ Phase Adjust for all transmission if frequency translation is NOT OFF. Requires USB or LSB mode to be changeable. See Wiki Adjustments and Calibration.
TX IQ Phase (10m) (CONFIG_10M_TX_IQ_PHASE_BAL)	IQ Phase Adjust for all transmission if frequency translation is NOT OFF.

LABEL (NR)	DESCRIPTION
	Requires USB or LSB mode to be changeable. See Wiki Adjustments and Calibration.
TX IQ Balance (80m, CW) (CONFIG_80M_TX_IQ_GAIN_BAL_TRANS_OFF)	IQ Balance Adjust for CW transmissions (and all transmission if frequency translation is OFF). See Wiki Adjustments and Calibration.
TX IQ Phase (80m, CW) (CONFIG_80M_TX_IQ_PHASE_BAL_TRANS_OFF)	IQ Phase Adjust for CW transmissions (and all transmission if frequency translation is OFF). See Wiki Adjustments and Calibration.
TX IQ Balance (10m, CW) (CONFIG_10M_TX_IQ_GAIN_BAL_TRANS_OFF)	IQ Balance Adjust for CW transmissions (and all transmission if frequency translation is

LABEL (NR)	DESCRIPTION
	OFF). See Wiki Adjustments and Calibration.
TX IQ Phase (10m, CW) (CONFIG_10M_TX_IQ_PHASE_BAL_TRANS_OFF)	IQ Phase Adjust for CW transmissions (and all transmission if frequency translation is OFF). See Wiki Adjustments and Calibration.
DSP NR BufLen (CONFIG_DSP_NR_DECORRELATOR_BUFFER_LENGTH)	DSP LMS noise reduction: length of the audio buffer that is used for simulation of a reference for the LMS algorithm. The longer the buffer, the better the performance, but this buffer length must always be larger than the number of taps in the FIR filter used. Thus, a larger buffer

LABEL (NR)	DESCRIPTION
	(and larger FIR filter) uses more MCU resources.
DSP NR FIR NumTaps (CONFIG_DSP_NR_FFT_NUMTAPS)	DSP LMS noise reduction: Number of taps in the DSP noise reduction FIR filter. The larger the number of taps in the filter, the better the performance, but the slower the performance of the filter and the mcHF.
DSP NR Post-AGC (CONFIG_DSP_NR_POST_AGC_SELECT)	DSP LMS noise reduction: Perform the DSP LMS noise reduction BEFORE or AFTER the AGC. NO = before AGC, YES = after AGC.
DSP Notch ConvRate (CONFIG_DSP_NOTCH_CONVERGE_RATE)	DSP LMS automatic notch filter:

LABEL (NR)	DESCRIPTION
DSP Notch BufLen(CONFIG_DSP_NOTCH_DECORRELATOR_BUFFER_LENGTH)	DSP LMS automatic notch filter: length of the audio buffer that is used for simulation of a reference for the LMS algorithm. The longer the buffer, the better -and the slower- the performance, but this buffer length must always be larger than the number of taps in the FIR filter used. Thus, a larger buffer (and larger FIR filter) uses more MCU resources.
DSP Notch FIRNumTap (CONFIG_DSP_NOTCH_FFT_NUMTAPS)	DSP LMS automatic notch filter: Number of taps in the DSP automatic notch FIR filter. The larger the number of taps in the filter, the better the performance,

LABEL (NR)	DESCRIPTION
	but the slower the performance of the filter and the mcHF.
DSP Notch ConvRate (CONFIG_DSP_NOTCH_CONVERGE_RATE)	DSP LMS automatic notch filter:
DSP Notch BufLen(CONFIG_DSP_NOTCH_DECORRELATOR_BUFFER_LENGTH)	DSP LMS automatic notch filter: length of the audio buffer that is used for simulation of a reference for the LMS algorithm. The longer the buffer, the better -and the slower- the performance, but this buffer length must always be larger than the number of taps in the FIR filter used. Thus, a larger buffer (and larger FIR filter) uses more MCU resources.

LABEL (NR)	DESCRIPTION
DSP Notch FIRNumTap (CONFIG_DSP_NOTCH_FFT_NUMTAPS)	DSP LMS automatic notch filter: Number of taps in the DSP automatic notch FIR filter. The larger the number of taps in the filter, the better the performance, but the slower the performance of the filter and the mcHF.
Reset Config EEPROM (CONFIG_RESET_SER_EEPROM)	Clear the EEPROM so that at next start all stored configuration data is reset to the values stored in Flash (see Backup/Restore) .

Display Menu (`MENU_DISPLAY`)

LABEL (NR)	DESCRIPTION
LCD Auto Blank (CONFIG_LCD_AUTO_OFF_MODE)	After x seconds LCD turns dark and LCD data sections stop. So, power

LABEL (NR)	DESCRIPTION
	consumption is decreased and RX hum is decreased, too. LCD operation starts when using any button or the touchscreen.
Step Size Marker (CONFIG_FREQ_STEP_MARKER_LINE)	If enabled, you'll see a line under the digit which is currently representing the selected tuning step size
Filter BW Display (CONFIG_DISP_FILTER_BANDWIDTH)	Color of the horizontal Filter Bandwidth indicator bar.
Spectrum Size (MENU_SPECTRUM_SIZE)	Change height of spectrum display
Spectrum Filter (MENU_SPECTRUM_FILTER_STRENGTH)	Lowpass filter for the spectrum FFT. Low values: fast and nervous spectrum; High values: slow and calm spectrum.
Spec FreqScale Colour (MENU_SPECTRUM_FREQSCALE_COLOUR)	Color of the small frequency digits under the spectrum display.
TX Carrier Colour (MENU_SPECTRUM_CENTER_LINE_COLOUR)	Color of the vertical line indicating the TX carrier frequency in the spectrum or waterfall display.
Scope Light (MENU_SCOPE_LIGHT_ENABLE)	The scope uses bars (NORMAL) or points (LIGHT)

LABEL (NR)	**DESCRIPTION**
	to represent data. LIGHT is a little less resource intensive.
Scope 1/Speed (MENU_SCOPE_SPEED)	Lower Values: Higher refresh rate. Set to 0 to disable scope.
Scope AGC Adj. (MENU_SCOPE_AGC_ADJUST)	Adjusting of scope / waterfall AGC for fitting graphs to screen
Scope Trace Colour (MENU_SCOPE_TRACE_COLOUR)	Set color of scope
Scope BW Trace Colour (MENU_SCOPE_TRACE_HL_COLOUR)	Set color of highlighted BW scope
Scope BW BCKgr Colour (MENU_SCOPE_BACKGROUND_HL_COLOUR)	Set color of highlighted BW background
Scope Grid Colour (MENU_SCOPE_GRID_COLOUR)	Set color of scope grid
Scope Div. (MENU_SCOPE_DB_DIVISION)	Set rf range for scope
Wfall 1/Speed (MENU_WFALL_SPEED)	Lower Values: Higher refresh rate. Set to 0 to disable waterfall.
Wfall Colours (MENU_WFALL_COLOR_SCHEME)	Select color scheme for waterfall display.
Wfall Step Size (MENU_WFALL_STEP_SIZE)	How many lines are moved in a single screen update

LABEL (NR)	DESCRIPTION
Wfall Contrast (MENU_WFALL_CONTRAST)	Adjust to fit your personal input level range to displayable color range for waterfall
Upper Meter Colour (MENU_METER_COLOUR_UP)	Set the color of the scale of combined S/Power-Meter
Lower Meter Colour (MENU_METER_COLOUR_DOWN)	Set the color of the scale of combined SWR/AUD/ALC-Meter
dBm display (MENU_DBM_DISPLAY)	RX signal power (measured within the filter bandwidth) can be displayed in dBm or normalized as dBm/Hz. This value is supposed to be quite accurate to +-3dB. Preferably use low spectrum display magnify settings. Accuracy is lower for very very weak and very very strong signals.
dBm calibrate (MENU_DBM_CALIBRATE)	dBm display calibration. Just an offset (in dB) that is added to the internally calculated dBm or dBm/Hz value.
Freq display font (MENU_FREQ_FONT)	Font selection for frequency display. Allows selection of old/modern fonts

LABEL (NR)	DESCRIPTION
Menu Inverse Scrolling (MENU_UI_INVERSE_SCROLLING)	Inverts Enc2/Enc3 behavior in menu up/down and show/hide UI scrolling actions, used for side-mounted encoder dials.

CW Mode Settings (`MENU_CW`)

LABEL (NR)	DESCRIPTION
CW Keyer Mode (MENU_KEYER_MODE)	Select how the mcHF interprets the connected keyer signals. Supported modes: Iambic A and B Keyer (IAM A/B), Straight Key (STR_K), and Ultimatic Keyer (ULTIM)
CW Keyer Speed (MENU_KEYER_SPEED)	Keyer Speed for the automatic keyer modes in WpM. Also changeable via Encoder 3 if in CW Mode.
CW Keyer Weight (MENU_KEYER_WEIGHT)	Keyer Dit/Pause ratio for the automatic keyer modes. Higher values increase length of dit, decreases length of pause so that the total time is still according to the set WpM value.
CW Sidetone Gain (MENU_SIDETONE_GAIN)	Audio volume for the monitor sidetone in CW TX. Also changeable via Encoder 1 if in CW Mode.

LABEL (NR)	DESCRIPTION
CW Side/Offset Freq (MENU_SIDETONE_FREQUENCY)	Sidetone Frequency (also Offset frequency, see CW Freq. Offset below)
CW Paddle Reverse (MENU_PADDLE_REVERSE)	Dit is Dah and Dah is Dit. Use if your keyer needs reverse meaning of the paddles.
CW TX->RX Delay (MENU_CW_TX_RX_DELAY)	How long to stay in CW TX mode after stop sending a signal.
CW Freq. Offset (MENU_CW_OFFSET_MODE)	TX: display is TX frequency if received frequency was zero-beated. DISP: display is RX frequency if received signal is matched to sidetone. SHIFT: LO shifts, display is RX frequency if signal is matched to sidetone.
CW LSB/USB Select (MENU_CW_AUTO_MODE_SELECT)	Set appropriate sideband mode for CW. If AUTO, sideband is chosen for bands by its frequency. A long press on Mode button gets the other sideband mode
CW decoder enable (MENU_CW_DECODER)	enable experimental CW decoding
Signal threshold (MENU_CW_DECODER_THRESH)	All signals above this threshold are interpreted as a dit or daah

LABEL (NR)	DESCRIPTION
Tune helper (MENU_CW_DECODER_SNAP_ENABLE)	graphical tune helper: adjust frequency until yellow vertical line is in center of green box --> right on CW carrier frequency
Blocksize for Goertzel (MENU_CW_DECODER_BLOCKSIZE)	How many samples are taken for the signal detection with the Goertzel algorithm?
Noise cancel (MENU_CW_DECODER_NOISECANCEL)	Enable/disable noise canceler for CW decoder
Spike cancel (MENU_CW_DECODER_SPIKECANCEL)	Enable/disable spike canceler or short cancel for CW decoder
AGC for decoder (MENU_CW_DECODER_USE_3_GOERTZEL)	Enable/disable AGC for CW decoder
show CW LED (MENU_CW_DECODER_SHOW_CW_LED)	Enable/disable LED for CW decoder

Filter Selection (`MENU_FILTER`)

LABEL (NR)	DESCRIPTION
SSB Filter 1 (MENU_FP_SSB_01)	Filter bandwidth #1 when toggling with filter select button in LSB or USB.
SSB Filter 2 (MENU_FP_SSB_02)	Filter bandwidth #2 when toggling with filter select button in LSB or USB.

LABEL (NR)	DESCRIPTION
SSB Filter 3 (MENU_FP_SSB_03)	Filter bandwidth #3 when toggling with filter select button in LSB or USB.
SSB Filter 4 (MENU_FP_SSB_04)	Filter bandwidth #4 when toggling with filter select button in LSB or USB.
CW Filter 1 (MENU_FP_CW_01)	Filter bandwidth #1 when toggling with filter select button in CW.
CW Filter 2 (MENU_FP_CW_02)	Filter bandwidth #2 when toggling with filter select button in CW.
CW Filter 3 (MENU_FP_CW_03)	Filter bandwidth #3 when toggling with filter select button in CW.
CW Filter 4 (MENU_FP_CW_04)	Filter bandwidth #4 when toggling with filter select button in CW.
AM/SAM Filter 1 (MENU_FP_AM_01)	Filter bandwidth #1 when toggling with filter select button in AM & SAM.
AM/SAM Filter 2 (MENU_FP_AM_02)	Filter bandwidth #2 when toggling with filter select button in AM & SAM.
AM/SAM Filter 3 (MENU_FP_AM_03)	Filter bandwidth #3 when toggling with filter select button in AM & SAM.
AM/SAM Filter 4 (MENU_FP_AM_04)	Filter bandwidth #4 when toggling with filter select button in AM & SAM.
AM TX Audio Filter (CONFIG_AM_TX_FILTER_DISABLE)	Select if AM-TX signal is filtered (strongly recommended to agree to regulations)

LABEL (NR)	DESCRIPTION
SSB TX Audio Filter2 (CONFIG_SSB_TX_FILTER)	Select if SSB-TX signal is filtered (strongly recommended to agree to regulations)

PA Configuration (`MENU_POW`)

LABEL (NR)	DESCRIPTION
Tune Power Level (CONFIG_TUNE_POWER_LEVEL)	Select the power level for TUNE operation. May be set using the selected power level or have a fixed power level.
Tune Tone (SSB) (CONFIG_TUNE_TONE_MODE)	Select if single tone or two tone is generated during TUNE operation. Not persistent.
CW PA Bias (If >0) (CONFIG_CW_PA_BIAS)	If set to a value above 0, this BIAS is used during CW transmission; otherwise normal BIAS is used during CW
Reduce Power on Low Bands (CONFIG_REDUCE_POWER_ON_LOW_BANDS)	If set (recommended!) frequencies below 8Mhz (40m or lower) require higher power adjust values (four times). This permits better control of generated power on these frequencies.

LABEL (NR)	DESCRIPTION
Reduce Power on High Bands (CONFIG_REDUCE_POWER_ON_HIGH_BANDS)	If set frequencies above 8Mhz (30m or higher) require higher power adjust values (four times). This permits better control of generated power on these frequencies.
PA Bias (CONFIG_PA_BIAS)	Defines the BIAS value of the PA. See Adjustment and Calibration for more information.
2200m 5W PWR Adjust (CONFIG_2200M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
630m 5W PWR Adjust (CONFIG_630M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
160m 5W PWR Adjust (CONFIG_160M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.

LABEL (NR)	DESCRIPTION
80m 5W PWR Adjust (CONFIG_80M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
60m 5W PWR Adjust (CONFIG_60M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
40m 5W PWR Adjust (CONFIG_40M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
30m 5W PWR Adjust (CONFIG_30M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
20m 5W PWR Adjust (CONFIG_20M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.

LABEL (NR)	DESCRIPTION
17m 5W PWR Adjust (CONFIG_17M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
15m 5W PWR Adjust (CONFIG_15M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
12m 5W PWR Adjust (CONFIG_12M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
10m 5W PWR Adjust (CONFIG_10M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
6m 5W PWR Adjust (CONFIG_6M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.

LABEL (NR)	DESCRIPTION
4m 5W PWR Adjust (CONFIG_4M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
2m 5W PWR Adjust (CONFIG_2M_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
70cm 5W PWR Adjust (CONFIG_70CM_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
23cm 5W PWR Adjust (CONFIG_23CM_5W_ADJUST)	Defines the internal power adjustment factor to achieve 5W power on this band. See Adjustment and Calibration for more information.
2200m Full PWR Adjust (CONFIG_2200M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment

LABEL (NR)	DESCRIPTION
	and Calibration for more information.
630m Full PWR Adjust (CONFIG_630M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment and Calibration for more information.
160m Full PWR Adjust (CONFIG_160M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment and Calibration for more information.
80m Full PWR Adjust (CONFIG_80M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment and Calibration for more information.
60m Full PWR Adjust (CONFIG_60M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment

LABEL (NR)	DESCRIPTION
	and Calibration for more information.
40m Full PWR Adjust (CONFIG_40M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment and Calibration for more information.
30m Full PWR Adjust (CONFIG_30M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment and Calibration for more information.
20m Full PWR Adjust (CONFIG_20M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment and Calibration for more information.
17m Full PWR Adjust (CONFIG_17M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment

LABEL (NR)	DESCRIPTION
	and Calibration for more information.
15m Full PWR Adjust (CONFIG_15M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment and Calibration for more information.
12m Full PWR Adjust (CONFIG_12M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment and Calibration for more information.
10m Full PWR Adjust (CONFIG_10M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment and Calibration for more information.
6m Full PWR Adjust (CONFIG_6M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment

LABEL (NR)	DESCRIPTION
	and Calibration for more information.
4m Full PWR Adjust (CONFIG_4M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment and Calibration for more information.
2m Full PWR Adjust (CONFIG_2M_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment and Calibration for more information.
70cm Full PWR Adjust (CONFIG_70CM_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment and Calibration for more information.
23cm Full PWR Adjust (CONFIG_23CM_FULL_POWER_ADJUST)	Defines the internal power adjustment factor to achieve full power on this band. Check the output signal when adjusting for full power! See Adjustment

LABEL (NR)	DESCRIPTION
	and Calibration for more information.
2200m Coupling Adj. (CONFIG_FWD_REV_COUPLING_2200M_ADJ)	Power Meter Adjustment factor for the 2200m band power values. See Wiki.
630m Coupling Adj. (CONFIG_FWD_REV_COUPLING_630M_ADJ)	Power Adjustment factor for the 630m band power values. See Wiki.
160m Coupling Adj. (CONFIG_FWD_REV_COUPLING_160M_ADJ)	Power Meter Adjustment factor for the 160m band power values. See Wiki.
80m Coupling Adj. (CONFIG_FWD_REV_COUPLING_80M_ADJ)	Power Meter Adjustment factor for the 80m band power values. See Wiki.
40m Coupling Adj. (CONFIG_FWD_REV_COUPLING_40M_ADJ)	Power Meter Adjustment factor for the 40m and 60m band power values. See Wiki.
20m Coupling Adj. (CONFIG_FWD_REV_COUPLING_20M_ADJ)	Power Meter Adjustment factor for the 20m and 30m band power values. See Wiki.
15m Coupling Adj. (CONFIG_FWD_REV_COUPLING_15M_ADJ)	Power Meter Adjustment factor for the 10m - 17m bands power values. See Wiki.

LABEL (NR)	DESCRIPTION
6m Coupling Adj. (CONFIG_FWD_REV_COUPLING_6M_ADJ)	Power Meter Adjustment factor for the 6m band power values. See Wiki.
2m Coupling Adj. (CONFIG_FWD_REV_COUPLING_2M_ADJ)	Power Meter Adjustment factor for the 2m band power values. See Wiki.
70cm Coupling Adj. (CONFIG_FWD_REV_COUPLING_70CM_ADJ)	Power Meter Adjustment factor for the 70cm band power values. See Wiki.
23cm Coupling Adj. (CONFIG_FWD_REV_COUPLING_23CM_ADJ)	Power Meter Adjustment factor for the 23cm band power values. See Wiki.

System Info (`MENU_SYSINFO`)

LABEL (NR)	DESCRIPTION
Display (INFO_DISPLAY)	Displays working mode (SPI/parallel
Disp. Controller (INFO_DISPLAY_CTRL)	identified LCD controller chip
SI570 (INFO_SI570)	Startup frequency and I2C address of local oscillator Type SI570
SI5351A (INFO_SI5351A)	Local oscillator type SI5351A detected.
EEPROM (INFO_EEPROM)	type of serial EEPROM and its capacity
Touchscreen (INFO_TP)	touchscreen state

LABEL (NR)	DESCRIPTION
CPU (INFO_CPU)	identification of fitted MCU
Flash Size (kB) (INFO_FLASH)	flash size of MCU
RAM Size (kB) (INFO_RAM)	RAM size of MCU
Firmware (INFO_FW_VERSION)	firmware version
Build (INFO_BUILD)	firmware: timestamp of building
Bootloader (INFO_BL_VERSION)	bootloader version
RF Bands Mod (INFO_RFMOD)	RF bands expansion PCB present?
V/UHF Mod (INFO_VHFUHFMOD)	VHF/UHF bands expansion PCB present?
Audio Codec Presence (INFO_CODEC)	Audio Codec I2C communication successfully tested? This is not a full test of the Audio Codec functionality, it only reports if I2C communication reported no problem talking to the codec.
Backup RAM Battery (INFO_VBAT)	Battery Support for Backup RAM present?
Real Time Clock (INFO_RTC)	Battery Supported Real Time Clock present?
FW license (INFO_LICENCE)	Display license of firmware
HW license (INFO_HWLICENCE)	Display license of hardware

Debug/Exper. Settings (MENU_DEBUG)

LABEL (NR)	DESCRIPTION
Enable Debug Info Display (MENU_DEBUG_ENABLE_INFO)	Enable debug outputs on LCD for testing purposes (touch screen coordinates, load) and audio interrupt duration indication via green led
CW Shift Keeps Signal (MENU_DEBUG_CW_OFFSET_SHIFT_KEEP_SIGNAL)	Enable automatic sidetone correction for CW OFFSET MODE = SHIFT. If you tuned in SSB to a CW signal around the sidetone frequency, you'll keep that signal when going to CW. Even if you switch from USB to CW-LSB etc.
TX Audio via USB (MENU_DEBUG_TX_AUDIO)	If enabled, send generated audio to PC during TX.
FT817 Clone Transmit (MENU_DEBUG_CLONEOUT)	Will in future send out memory data to an FT817 Clone Info (to be used with CHIRP).
FT817 Clone Receive (MENU_DEBUG_CLONEIN)	Will in future get memory data from an FT817 Clone Info (to be used with CHIRP).
Show gains (MENU_DEBUG_NR_GAIN_SHOW)	Debugging: show gains of spectral noise reduction

LABEL (NR)	DESCRIPTION
NR beta (MENU_DEBUG_NR_BETA)	time constant beta for spectral noise reduction, leave at 0.85
NR asnr (MENU_DEBUG_NR_ASNR)	Devel 2 NR: asnr
NR smooth wd. (MENU_DEBUG_NR_GAIN_SMOOTH_WIDTH)	Devel 2 NR: width of gain smoothing window
NR smooth thr. (MENU_DEBUG_NR_GAIN_SMOOTH_THRESHOLD)	Devel 2 NR: threshold for gain smoothing
STEREO Enable (MENU_DEBUG_ENABLE_STEREO)	Enable stereo demodulation modes
leaky LMS (MENU_DEBUG_LEAKY_LMS)	Use leaky LMS noise reduction instead of built-in CMSIS LMS algorithm
NR no taps (MENU_DEBUG_ANR_TAPS)	Number of taps of leaky LMS noise reduction
NR delay (MENU_DEBUG_ANR_DELAY)	Delay length of leaky LMS noise reduction
NR gain (MENU_DEBUG_ANR_GAIN)	Gain of leaky LMS noise reduction
NR leak (MENU_DEBUG_ANR_LEAK)	Leak of leaky LMS noise reduction
Si5351a PLL Reset (MENU_DEBUG_OSC_SI5351_PLLRESET)	Debug Setting: Select when the Si5351a does a PLL RESET

Adjustment and Configuration Manual

Essential Calibration and Setup Steps

Once you finished the assembly and loading the firmware, you should run through a number of important setup steps and calibrations. There are plenty more things to configure, but the ones listed here should be done initially. And in most cases, you will not have to touch these again unless you modify the hardware or the firmware improves and you are asked to re-calibrate.

1. Touchscreen Setup
2. SWR Meter Reverse/Forward Orientation
3. TX PA Calibration
4. TX/RX IQ Balance Calibration
5. SWR/Power Meter Calibration
6. Voltmeter Calibration
7. Frequency Calibration

Touchscreen Setup

If you added touchscreen connections, check if the touchscreen is working correctly using the following procedure

Skip this if you don't have the touchscreen connections fitted.

1. Touch screen at any point while simultaneously pressing the boot button to start the machine
2. Keep touch screen pressed until screen with calibration information appears
3. Follow the instructions on the following screens (which involves calibration by touching several points on the touch screen with your touch pen or fingers)
4. After the calibration procedure, enjoy the touchscreen functions!

SWR/Power Meter Reverse/Forward Orientation

If you finished the PA and you can measure HF output coming out of the mcHF in Tune mode, but SWR meter does not show a proper SWR and no power is shown on the meters of the mcHF, you most likely will have to switch the orientation of the SWR meter in software. Go to the "Configuration" menu and set "SWR/PWR Meter FWD/REV Swap" to "ON".

PA Power Calibration

What you will need:

1. Operational PTT switch connected to the microphone/ptt connector or CW paddles connected to the CW keyer port
2. An ampere meter OR a power supply with sufficiently accurate current measurement (minimum resolution 10mA)
3. A dummy load capable of handling at least 10W or more (20W or more recommended). If dummy load is not available, an alternative is an antenna (then calibration should be done only in the antenna bands and with an SWR meter to verify low SWR)
4. [Optional] HF Power Meter
5. [Optional] Oscilloscope

Basic BIAS Adjustment for mcHF RF Board (up to version 0.6)

1. [Optional] Connect dummy load or antenna. Since no actual RF is being produced if everything goes right, the mcHF doesn't have to be connected to a dummy load or antenna. But to play safe, it doesn't hurt and is required for the next calibration steps anyway.
2. Connect a microphone or cow paddles to your much.
3. Put an amperemeter in the positive power supply line (range 2A) and switch on mcHF
4. Choose mode *LSB* or *USB*, the band is *not* important.
5. Make sure nothing is connected to the extern line in port of the TRX.
6. If you use a microphone wit PTT switch, choose TX audio input to be coming from one of the "Line In" sources by long pressing M3 (multiple times). The TX audio source should show L>R (line in right channel) or L>L (line in left channel). If no microphone is connected, MIC (microphone) TX audio source will work too.
7. Enter "PA Configuration Menu", "PA Bias".
8. Setting must be "0" (if not - correct it after pressing PTT briefly).
9. Press PTT or CW paddle. It is important that *no RF is being produced*.

10. The measured current at this point is the "start mark", write it down. Be sure to have the PA Bias set to the lowest possible value.
11. Now adjust bias so that measure current is 500mA higher than this "start mark". E.g. you measure 460mA in the previous step, so the target current is around 960mA (460+500).

FAQ PA Bias

Q: I am not able to reach the 500mA increase even at PA Bias value 115. What can I do?

A: Be sure to use none-defective, genuine RD16HHF. If one of the 2 PA misfit is defective, for obvious reason, it is difficult to achieve the 500mA current increase.

Q: I checked, both MOSFETs are okay. What can I do now?

Some RD16HHF required a higher bias voltage to achieve the desired bias current. A modification to the bias voltage regulator U18 can help here. A resistor of 3k3 between pin 1 and 4 increases the bias voltage range by 0.8V. If this is still not sufficient use 2k2, which provides an increase of 1.2V. If these modifications still not get you into the 500mA, check the PA transistors again and consider replacing them.

TX: RF Power Adjustment

Before this step the PA Bias *must* be set using the previous steps.
It is mandatory to connect a dummy load or properly tuned antenna. You will need a way to measure the generated RF power. Best is to use an oscilloscope or proper RF power meter. The power meter of the UHSDR TRX can be used. But since it is not calibrated initially, it is only a rough estimation tool.

The standard mcHF supports 160m to 10m operation, although 160m transmit into an antenna without additional LPF between PA and antenna is not recommended. It is recommended to calibrate all bands from 160m to 10m.

5W Power Adjustments

The mcHF is able to produce more than 5W on most bands. However, best signal quality is achieved with 5W or less. All power levels below 5W are derived from the 5W settings, thus it is important to calibrate the 5W setting properly.

1. Choose mode LSB or USB.

2. Set "PA Configuration Menu", "Tune Tone" to "Single".
3. Set "PA Configuration Menu", "Tune Power Level" to either "5W" or to "as TX PWR" and change TX power to "5W"
4. Enter "PA Configuration Menu", "*xx*m 5W PWR Adjust" (replace *xx* with your bands 10, 12, ... ,160m). You will be able to change the value for a band only if the band is selected!
5. Press F5 - "Tune".
6. Make sure you see "5W" as power indication in the blue "TX power" box. If not, see step 3.
7. Set gain to achieve 5W of output power.
8. Press F5 - "Tune" again.

TX: Adjustment for Maximum RF Power

Procedure to setup RF power in `Full Power` menu for each frequency band you intend to use, the standard mcHF supports 160m to 10m operation, although 160m transmit without additional LPF between PA and antenna is not recommended.

1. Choose mode LSB or USB.
2. Set "PA Configuration Menu", "Tune Tone" to "Single".
3. Set "PA Configuration Menu", "Tune Power Level" to either "Full" or to "as TX PWR" and change TX power to "Full"
4. Enter "PA Configuration Menu", "*xx*m Full PWR Adjust" (replace *xx* with your bands10, 12, ... ,160m). You will be able to change the value for a band only if the band is selected!
5. Press F5 - "Tune".
6. Make sure you see "Full" as power indication in the blue "TX power" box. If not, see step 3.
7. Set the gain up to the point, where RF power stays at maximum and only DC current increases
8. Reduce the gain back to get approximately 1dB less RF power (down-to 79%). To avoid possible instability of the PA a setting power back -1.5dB (down to 70%) is recommended.

Using the integrated two-tone signal generator, you can also adjust for nice looking two tone signal with an oscilloscope instead of using the above procedure. You will have lower maximum output power settings when using this method, since it will keep you in the (more) linear range of the PA.

TX: Adjustment RF Power Meter

The RF Power Meter should be calibrated to show proper values. Calibration needs to be done for some but not all bands, the software calculates the values for other bands.

1. Choose mode LSB or USB.
2. Choose 5W power
3. Set "PA Configuration Menu", "Tune Tone" to "Single".
4. Enter "PA Configuration Menu", "*xx*m Coupling Adj." (replace *xx* with 15, 20, 40, 80 ,160). You will be able to change the value for a band only if the band is selected!
5. Press F5 - "Tune".
6. Set the coupling up to the point, where RF power meter shows roughly 5W.

TX: FM And Digital Modes

Please, keep in mind that transmitting FM or digital modes means there is a continuous carrier of a chosen power present at the RF output. It is highly advisable to have an adequate cooling of PA stage.

IQ Calibration

In the real world certain hardware-related influences affect the analog IQ signal in the mcHF. It is not perfectly symmetrical and the phase may not be exactly 90 degrees and/or the amplitudes may not be exactly equal. In the software domain we can use calibration to reduce/correct this problem. This requires careful adjustment of IQ phase and gain balance both for the RX and TX signal path. The mcHF from version 1.5.7 provides 3 groups of adjustments. 2 groups are for receive and transmission in a given translation mode. The third group is for adjustments in case of CW transmission (and all other untranslated transmission, which is not recommended). First of all, make the adjustments in USB and translate mode. When complete, continue through the adjustments for CW mode. The CW mode adjustments do not use frequency translate, these are different software parameters to USB translate mode, so follow the adjustments through to the end. For receive only, there is now [Valid from 1.5.8] the ability for an automatically adjusted IQ phase and amplitude imbalance correction (see point RX IQ adjustments).

TX IQ Adjustments [Valid from 1.5.2]

You will need a SSB receiver for 80m and 10m, or a spectrum analyzer for this frequency range. The instructions are given for a frequency translation of -12khz. If you want to use a different translation frequency, it is recommended to run the procedure in the desired translation mode. While the overall approach is the same, frequencies will change, so if in doubt, we recommend to stick to -12kHz translation.

Preparation

1. Set the frequency translation to -12khz
2. Set power to 0.5W
3. Connect dummy load or attenuator, if nothing else is available, use an antenna.
4. The mcHF is always used to **transmit** the signal **in USB mode**!
5. The second receiver is always used to **receive** the signal **in LSB mode**!

TX 80m calibration (translated mode)

1. Switch mcHF to 80m band.
2. Switch to **USB** mode. To switch to USB from LSB use a long press on the Mode button.
3. Set the mcHF frequency to 3.624.000 Hz.
4. Start "Tune". You should now be able to listen to the generated signal on a second receiver (LSB: Dial Frequency of second receiver 3.625.500, USB: 3.624.000). It should have a good strength (around S9).
5. Tune second receiver to 3.600.000 Hz, **LSB** (!!).
6. You should be able to hear a much weaker tone. Maybe you have to change the frequency of second receiver +/- 500 Hz for getting the tone in reasonable frequency. A spectrum analyzer or IQ receiver will show the weak signal around 3.599.250 Hz.
7. Enter the "Configuration Menu", go to the "TX IQ Phase (80m)" setting.
8. Now change the value so that the tone can no longer be heard or is minimal. The direction to change values depends on your mcHF, e.g. you may need to set a positive or a negative value.
9. Once you found the minimum using the "TX IQ Phase (80m)", and you still hear something, use the "TX IQ Balance (80m)" setting to further reduce the tone.
10. You may vary both settings alternatively slightly to find the best setting.

TX 10m calibration (translated mode)

You simply repeat all steps for the 80m band. Only this time in the 10m band and using the TX IQ Balance/Phase 10m settings. The initial USB frequency should be 28.124.000 Mhz (Receive for monitoring original TX signal is LSB: 28.125.500, USB: 28.124.000). The second receiver's LSB (!!) frequency for calibration purposes is 28.100.000 khz. A spectrum analyzer or IQ receiver will show the weak signal around 28.099.250 Hz.

CW TX 10m/80m calibration [from version 1.5.7]

1. Set USB mode on mcHF. (Yes!)
2. Set Frequency Translation to OFF
3. Set LSB mode on second receiver.
4. Set mcHF and second receiver to 80m: dial frequency 3624.00 kHz. Now minimize received signal using CW TX IQ/Phase settings for 80m.
5. Repeat the last step for dial frequency 28.124.00 kHz and minimize with CW TX IQ/Phase settings for 10m.
6. Restore original frequency translation mode.

Do NOT use CW for setting this because of the settings for frequency of second receiver would differ. Why make it complicate if it can be done simply?

RX IQ Adjustments [Valid from 1.5.2]

There are two ways to adjust for IQ phase and amplitude imbalances in RX:

1. Automatic IQ correction [Valid from 1.5.8]: Just go into the Configuration Menu and switch "RX IQ AUTO CORRECTION" to ON. Ready to go! No more adjustments required. This can achieve up to 65dB of mirror rejection! Thanks to Yves HB9EWY for doing a real and reliable measurement! If you believe you can do it better than 65dB with your hands on your mcHF, you will have to do the manual IQ phase and amplitude imbalance adjustment:

2. Manual IQ correction: You will need a signal generator for 80m and 10m. If you use a normal transmitter with a tune signal, use **USB** mode on that transmitter. Make sure you receive the strong main signal on the original RX frequency before searching the weak signal on the secondary frequency!

Preparation RX Manual IQ correction

1. Get the frequency translation to -12khz (after calibration you may set any value you want)

2. Connect signal generator to mcHF (maybe via attenuator regarding output of signal generator) or make sure you can receive your transmitter with sufficient but not too high signal level.
3. The mcHF is used to receive the **original signal in USB mode**, the **secondary signal in LSB mode** !
4. The signal generator is always used to **transmit** the signal carrier **at the given frequency**!

RX Manual IQ correction: 80m calibration

1. Set the signal generator to 3.601.000 Hz in the 80m band (If using a second TRX: 3.600.000 Hz in USB mode, activate Tune mode).
2. Switch mcHF to 80m band at 3.600.000 Hz.
3. Switch to **USB** mode. To switch use a long press on the Mode button.
4. You should be able to receive the generated signal with the mcHF.
5. Tune mcHF to 3.624.000 Hz.
6. Switch to **LSB** mode (!!) by a long press on the Mode button. If necessary, adjust +/- 500Hz for getting tone in reasonable frequency, if not right on spot.
7. You should be able to hear a much weaker tone.
8. Enter the "Configuration Menu", go to the "RX IQ Phase (80m)" setting.
9. Now change the value so that the tone can no longer be heard or is minimal. The direction to change values depends on your mcHF, e.g. you may need to set a positive or a negative value.
10. Once you found the minimum using the "RX IQ Phase (80m)", and you may still hear something, use the "RX IQ Balance (80m)" setting to further reduce the tone.
11. You may vary both settings alternatively slightly to find the best setting.

RX Manual IQ correction: 10m calibration

You simply repeat all steps for the 80m band. Only this time in the 10m band and using the RX IQ Balance/Phase 10m settings. The initial RX frequency should be 28.100.000 Mhz, **USB**, signal generator set to 28.101.000 Hz (TRX: 28.100.000, USB, Tune Mode). The secondary RX frequency for the mcHF is then 28.124.000 khz **LSB** (!!).

SWR/Power Meter Calibration

In order to have the SWR/Power meter to be more accurate, you may want to run the calibrations below. Default values are often good enough to start with but the mcHF can be fairly accurate if calibrated properly.

Calibrate Zero Power Offset

Preparation: You have to make the resistor-change modification to the SWR hardware circuitry. If you haven't done so, the mcHF will show a message in the boot screen.

1. You should have done at least the PA BIAS calibration.
2. Connect dummy load. Better safe than sorry.
3. In Configuration Menu set "Pwr. Display mW" to "ON"
4. Set Input to DIG, with no USB cable connected
5. Set mode to USB or LSB
6. Key the transmitter by pressing PTT
7. Adjust in Configuration menu the setting "Pwr. Det. Null" so that the displayed mW power values are flickering between 0 and 2 max. Do not go lower than necessary to achieve that.
8. In Configuration menu disable "Pwr. Display mW". It will be disabled on next boot in any case.

Calibrate Power Coupling

You will need a good power meter or oscilloscope in order to measure the true power emitted by the mcHF.

1. You should have done at least the PA BIAS calibration.
2. Connect dummy load which can handle at least 5W.
3. Set TX power to 5W.
4. In Configuration menu enable "Pwr. Display mW".
5. Set mode to USB or LSB
6. Select lowest band you want to transmit in (80m).
7. Go to the PA Calibration menu to the "80m Coupling Adj." setting.
8. Press Tune. Align as closely as possible the displayed mW value for forward power and measured power by changing the setting.
9. Repeat this for 40m (60m), 20m (30m), 15m (10m, 12m, 17m). Bands in parentheses are using the same coupling factor.

Frequency Calibration

The Si570 is fairly well calibrated, yet even 10ppm accuracy mean 100 Hz @ 10Mhz and almost 300Hz at 28Mhz. The mcHF firmware permits to fine tune the calibration. Equipment needed:

- Either an as exact and as high as possible reference frequency signal (single carrier, no modulated signal OR a strong broadcast station) (RX calibration approach)
- OR a precise frequency counter (TX calibration approach).

Preparation: Bring the mcHF up to the normal operating temperature of the TCXO (can take up to 15 minutes).

Frequency calibration can be done either in TX or in RX mode and has only to be done in one of the modes, not both! The calibration -once done and saved- is then valid for both: RX AND TX.

TX calibration approach [from firmware 1.5.8]

1. Set a "FM" mode (FM-N or FM-W)
2. Set input to DIG, do not connect USB cable. Alternatively, you may also use any other input mode, be sure to have no input signal.
3. Connect frequency counter to mcHF Antenna port (via attenuator)
4. Start "Tune"
5. Go into the configuration, item "Frequency Calib.". Now change the PPM value so that frequency counter displays frequency shown on mcHF display.
6. Save configuration by long press on "MENU" or "EXIT" button (F1)

RX calibration approach [from firmware 1.5.8]

1. Set demodulation mode to "SAM"
2. Tune into China Radio International on the 16m or 19m band (do this at daytime). You can take any other broadcast station, but China Radio International/Radio Romania Intl are well known for being exactly on the accurate frequency. Many broadcast stations are NOT on the accurate frequency, e.g. Voice of Turkey, Voice of Iran, most (if not all) Brazilian radio stations etc. Alternatively use a well-calibrated signal generator with a frequency as high as possible (28MHz).

3. Wait until the SAM demodulator has captured the carrier and the carrier frequency is displayed in the small frequency display and the small frequency display is stable
4. Go into Configuration menu to "Frequency Calib." Adjust the PPM value until the small frequency display shows exactly xxxxxx.000 Hz
5. Save configuration by long press on "MENU" or "EXIT" button (F1)

Automatic Carrier Frequency Tuning CW TUNE HELPER & SNAP MODE

CW TUNE HELPER

This works as a graphical helper to match your CW RX frequency to the frequency of your QSO partner. It matches your CW offset to your sidetone frequency and graphically shows you the difference between the two. This is called "CW SPOT" in the Elecraft KX3 and works very similar in the UHSDR software. The range of the graphical display is +-150Hz and the accuracy of determining the CW carrier frequency is +-2Hz (relatively independent of spectrum/waterfall magnify mode, however accuracy is a little better in higher magnify modes): You will probably be able to match your QSO partners´ frequency within +-5Hz in real time operation.

A small green box is displayed on the left side of the display above the DSP box: tune into a CW station and adjust your frequency, so that the little vertical yellow indicator is exactly in the center of the box --> Done!

how to use it

- enable "carrier snap" in Debug menu: entry "Do not use: cs" [only use, if you are brave ;-)]
- enable CW decoder in CW menu
- adjust CW decoder threshold, so that CW station modulates the red LED
- change Demod_mode to CW
- for highest frequency estimation accuracy: set display menu "spectrum FFT window" to "Hann"
- adjust frequency of a CW carrier to match your sidetone by graphically matching yellow mark to center of green box (above the DSP box)

How does the frequency snap mode work?

The automatic tuning process is based on determining the difference between your tuning frequency and the carrier frequency of the station you are listening to. It is based on the results of a complex FFT (which is executed on demand when you use the SNAP button, but we could also use the FFT of the spectrum display, so the data is already there and does not consume additional computing resources). The values of the complex FFT are magnitude values of signal strength for 256bins across the whole spectrum of 48000Hz. That means, one calculated value for one bin holds the average magnitude for a bin bandwidth (binBW) of 187.5Hz = 48000Hz / 256. A bin bandwidth of 187.5Hz is of course not accurate enough for precision tuning, as necessary for DSB or StereoAM listening. We would need an accuracy of a few Hz to be able to listen to a signal in these modes without annoying heterodynes or oscillations of the signal. This is achievable by inter- bin three-point quadratic interpolation! You use the magnitude values of three bins adjacent to each other and use these values to interpolate a quadratic curve (which stands on its "head") (Jacobsen & Kootsookos 2007, www.ericjacobsen.org, Thanks vladn for pointing me to this method and this and other papers!). That's all. Now you would set up a tuning process:

I used a very simple process, only two frequency steps are sufficient for very accurate tuning to the carrier:

1. determine the bin numbers, between which the maximum FFT magnitude is being searched for (bins within the passband, as I can use different USB & LSB bandwidths in DSB tuning (passband tuning) mode)
2. search for maximum FFT magnitude value in that frequency range
3. coarse tune to that bin (delta = deltabins * binBW)
4. interpolate with three-point-quadratic interpolator (equation (4) of Jacobsen & Kootsookos 2007) with the three bins in the center of my frequency
5. fine tune: set freq to that interpolation --> delta = binBW * (1.36 * (bin3 - bin1)) / (bin1 + bin2 + bin3); for maximum accuracy, this requires the FFT window type to be set to Hanning!
6. done!

I tested several formulas (e.g. Lyons (2011)): The paper by Jacobsen & Kootsookos (2007) had the final implementation formula. As I used a complex FFT library, that already calculated magnitudes, I was looking for a formula for magnitudes. Also, I wanted to use Hanning, so their equation (4) solved my problem: delta = binBW * (1.36 * (bin3 - bin1)) / (bin1 + bin2 + bin3); This is astonishingly accurate! With a fs = 48000Hz and 256point FFT I have an accuracy of 2-3Hz with strong signals, and 4-5Hz with very noisy signals. That's perfect with a binBW of 187.5Hz in my view.

With this method it was possible to implement a fine tuning graphical helper for zero beat tuning in CW. We do this by the following steps:

• we have the FFT already done for spectrum display/waterfall display

• take the bins from the display FFT and search in the bins that are in the filter passband (which is usually quite narrow in CW) for the loudest signal (do averaging over several FFT loops). Note the number of that bin

• take the signal values of that bin, the bin below and the bin above (do that several times and average to account for pauses between the dits and dahs) and calculate a three-bin quadratic interpolation to exactly determine the frequency of that signal (with the formula shown above)

• calculate the deviation of the received CW signal from Rx frequency +- CW sidetone

• show this deviation graphically inside the spectrum display or waterfall display

This method is pretty accurate to at least 5Hz in the lowest magnify mode (1x) and becomes even more accurate with higher magnify modes.

Jacobsen, & Kootsookos (2007): Fast, accurate frequency estimators. - IEEE SIGNAL PROCESSING MAGAZINE [125] MAY 2007. https://www.researchgate.net/publication/3321864_Fast_Accurate_Frequency_Estimators_DSP_Tips_Tricks

Lyons, R.S. (2011): Understanding Digital Signal Processing, Prentice-Hall, 3rd Ed.

http://www.embedded.com/design/configurable-systems/4007643/DSP-Tricks-Spectral-peak-location-algorithm

Details for programmers

How do we process for the graphical TUNE HELPER? [2017_09_15]

- Ui_Spectrum_RedrawSpectrum()
- apply window function to 256 samples for spectrum/waterfall display
- do FFT
- calculate complex magnitude values
- do scaling
- do lowpass filtering
- if(we have a valid pulse recognized by the CW_decoder routine) jump to UiSpectrum_CalculateDBm
- calculate bin bandwidth --> bin_BW

- calculate LBin and Ubin from magnify mode & frequency conversion & filterpassband
- rearrange data in sd.FFT_Samples (the buffer with the lowpass-filtered, scaled complex magnitudes from the FFT)
- jump into UiSpectrum_CalculateSnap (Lbin, Ubin, posbin, bin_BW)
- search for max magnitude value inside the passband (between Lbin and Ubin)
- maxbin is the bin number of the bin with that max magnitude
- calculate offset to Rx frequency depending on ts.cw_lsb (CW-L or CW-U)
- delta1 is first offset in steps of bin_BW
- delta2 is second offset determined by quadratic interpolation of the three bins maxbin-1, maxbin and maxbin+1 (delta2 is always < bin_BW !)
- delta = delta1 + delta2
- CW-L: delta = delta + cw_sidetone_freq;
- CW-U: delta = delta - cw_sidetone_freq;
- jump to UiSpectrum_CWSnapDisplay (delta)
- clamp data for display (display is +-140Hz at the moment)
- draw yellow indicator with accuracy of 5Hz/pixel
- done

Automatic Gain Control (AGC)

WDSP AGC

We use this AGC by Warren Pratt which is part of the WDSP library. It was implemented for the UHSDR because it has some more features that might potentially be useful in very specific RX situations.

QUICK USER GUIDE FOR THE AGC:

1. search for a free frequency --> band noise
2. use encoder 2 to adjust the AGC threshold ("AGC"), so that the white text "AGC" in the blue AGC indicator box starts to disappear
3. With button M2 toggle focus of encoder 2 to next box
4. Adjust AGC mode according to your personal preference and your band situation: OFF = AGC off

FAS = fast

MED = medium

SLO = slow

LON = long

vLO = very long

the figure is the time constant = AGC WDSP DECAY for the AGC (given in centiseconds = milliseconds*10, that decay time is the time the AGC needs to increase up to maximum sensitivity again: thus 100 means 1 second). This is predefined for the different AGC modes, but can be fine-tuned in the menu --> AGC WDSP DECAY

1. Ready!

The AGC can be very easily and quickly adjusted for any specific receive and noise situation. The WDSP AGC has double AGC detectors (one with short and one with long time constant, thus potentially better for a suppression of short noise impulses) and a hang AGC with adjustable hang time.

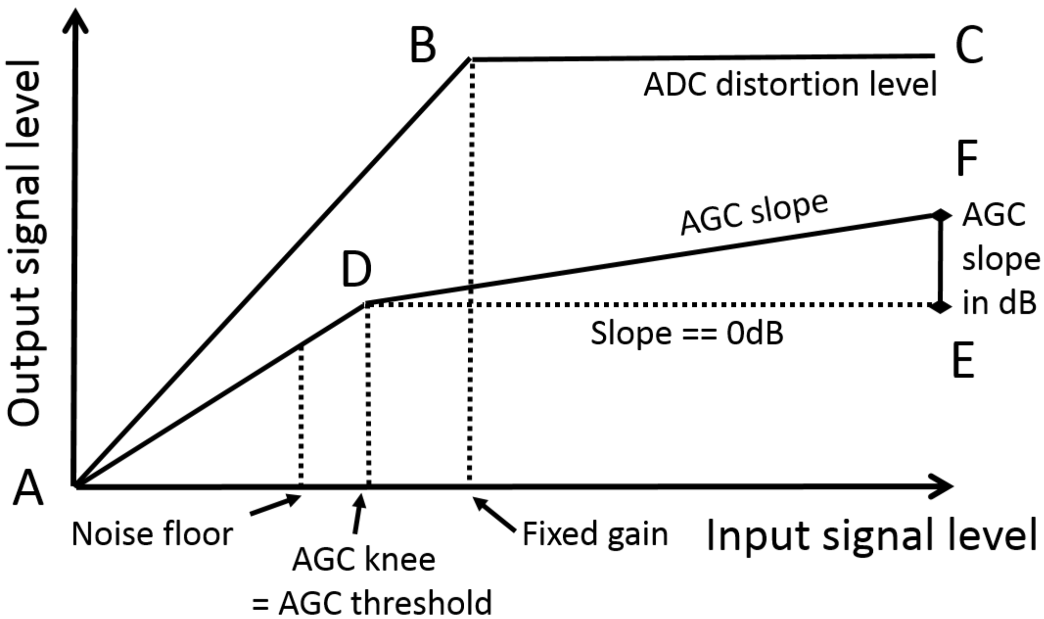


Figure 1:

Relationship between input and output signal level WITH (A-->D-->F) and WITHOUT (A-->B-->C) an automatic gain control (AGC) with an indication of some of the WDSP AGC parameters that can be controlled by the user. Inspired by a paper by Phil Harman: “A discussion on the AGC requirements of the SDR1000” (I added the relevant AGC parameters for better understanding).

If you want to know more about how your AGC works, please read this paper and use figure 1 above to understand how the AGC works: Phil Harman (VK6APH): A discussion on the Automatic Gain Control (AGC) requirements of the SDR1000.
- http://www.flexradio.com/downloads/vk6aph-agc-discussion-powersdr-pdf/

This paper is excellent, fun to read, instructive and essential for the full understanding of the functioning and the perfect adjustment for the WDSP AGC.

Because Phil has explained the AGC so well in his paper, I will now restrict myself to the explanation of the menu adjustments of the parameters implemented in the mcHF firmware and assume that the reader is well informed about how these parameters affect the AGC functioning.

AGC WDSP switch

choose between “Standard AGC” and “WDSP AGC”: please note that the S-Meter in old school style does not work when switched to “WDSP AGC”: the S-Meter is automatically switched to be based on dBm instead.

AGC WDSP Mode

choose between predefined parameter sets for the AGC. AGC DECAY is the time needed until the AGC recovers from a strong signal to achieve higher gain for a low signal.

AGC WDSP mode	Attack	Decay	Hang time	Hang enable
Fast	1ms	50ms	100ms	
Med	1ms	250ms	250ms	
Slow	1ms	500ms	1000ms	
Long	1ms	2000ms	2000ms	
Very Long	1ms	4000ms	3000ms	

AGC threshold

this is the most important WDSP AGC parameter. It determines the input signal level where the AGC knee is situated (see figure 1). AGC action only takes place for input signal levels exceeding this level. It is given as a gain figure in dB. If this threshold is too low, AGC action takes place with band noise leading to an amplification of band noise --> annoying hiss for RX. If it is set too high, AGC action starts only with very large signals and this can potentially lead to distortion in the ADC with large signals. There is an AGC indicator, a blue box right of the load indicator. If it says "AGC" the input signal level has exceeded the AGC threshold, which means AGC action is taking place. So it is very easy to adjust the AGC threshold:

- Set AGC WDSP to FAST (for faster reaction of the AGC indicator box)
- Set mcHF to a frequency without a signal (only band noise)
- Adjust AGC threshold to the point where the blue AGC box display changes between ON/OFF or a little bit lower
- Set AGC WDSP to FAST/MED/SLOW/LONG/very LONG again after your preference

AGC WDSP Slope

Indicates the output signal level difference between very low input signals and very high input signals. If set to 0dB, every signal has the same volume and the RX sounds flat. A good sounding effect can be adjusted with settings between 3 and 10dB, but that is very dependent on the hearing habits and the personal preference of the user. Experiment with this, until you achieve a pleasant and non-tiring result.

AGC Hang enable

Enable the Hang AGC which works like this: Hang is enabled when the signal level exceeds the AGC hang time threshold. When the level decreases (no more speech, for example), the hang counter is enabled and holds the AGC gain constant for the hang time, and after the hang time has expired, the gain increases quite fast (the time until maximum gain is achieved again can be adjusted with AGC HANG TIME). AGC Hang feature is nice for medium to strong SSB signals.

Hang AGC: hang threshold and hang time fully adjustable

- set AGC Hang enable to ON
- set AGC Hang time to your preferred time period (in ms)
- set AGC Hang threshold: while you are tuned to the desired signal, decrease the AGC hang threshold, until the AGC box changes its color to WHITE, decrease a little bit further --> ready!

AGC-box in a nut-shell:

- AGC-box is blue without text: AGC not working
(input signal is lower than AGC threshold)
- AGC box is blue with text "AGC": AGC is working on the signal
(input signal is higher than AGC threshold)
- AGC box is white with text "AGC": AGC is working, HANG AGC is enabled
(input signal is larger than AGC threshold AND larger than AGC HANG threshold.

If HANG AGC is not enabled, the box will always be blue.

AGC Hang threshold

for signals exceeding this level, the hang AGC is activated. For lower signals, nothing happens

Fixed gain

if the AGC WDSP Mode is “OFF”, the user-adjusted figure for “AGC threshold” is taken as the “Fixed gain” in dB. Be very careful, with large signals without AGC, it can be very very loud!

AGC Attack

This cannot be adjusted by the user and is a constant of 1 millisecond. This is desirable, because when a large signal appears, it is nice to have the AGC react very fast (1ms) in reducing the gain in order to save your ears from damage.

Digimodes

The UHSDR software supports three digimodes (FreeDV, RTTY, and CW) at the moment. Work is underway to implement some more modes.

Common for all digital modes (except for CW decoding, see below):

- Once only: enable "Digital Modes" in Standard Menu
- With touchscreen
  - touch on blue box "DIGITAL" --> changes to orange and displays the digital mode
  - to switch to other digital modes touch box again
- With menu (no touchscreen)
  - Go to "Touch via menu" Menu
  - Select desired "Digital Mode"
  - Leave menu mode
  - The blue box should show the desired digital mode.
  - Now switch to digital mode using the Mode button (G1). The blue box switches to orange and digital mode is active.

Implemented modes:

FreeDV (Rx & Tx)

How to operate

- select digital mode "FREEDV" as described above
- bla bla bla

Theory

FreeDV is a digital voice mode designed for reception and transmission of voice on the HF bands. It uses a low bitrate voice coder-decoder (Codec 2) which is in the public domain (licensed under the GNU GPL). Decoding voice is possible down to signal-noise-ratios of 4dB. We are grateful to David Rowe for writing the source code and putting it into the public domain and also for answering questions and helping with design decisions for implementation of FreeDV into the UHSDR software. More details here: http://freedv.org/tiki-index.php?page=FreeDV+Specification

RTTY (RX & TX)

How to operate

- select digital mode "RTTY" as described above
- set AGC speed to very long (very slow) or (best) switch it off completely
- change mode to RT-L (LSB aka normal polarity, Mark is the high RF frequency) or RT-U (USB aka reverse polarity, Mark is the lower RF frequency) according to desired RTTY mode
- use filter bandwidth 1.4k BPF --> do not try to use a very narrow bandwidth, this does not help the decoder, maybe it helps your ears, but the decoder needs relatively wide bandwidth to avoid distortion decoder errors
- with button M1 change orange focus to box BD
- with encoder 1 adjust baud rate (BD)
- with button M2 change orange focus to box SFT
- with encoder 2 adjust shift (SFT)
- adjust frequency until mark and space frequencies are accurately aligned with the vertical markers
- if vertical markers are invisible, change their color in Display Menu --> TX Carrier Color
- enjoy RTTY being decoded and displayed as running text

Ham RTTY:

- RTTY LSB mode = RT-L
- shift 170 Hz
- 45.45 bauds
- signals at 915 and 1085 Hz

Shipping RTTY broadcast (marine weather, warnings etc.) of the Deutscher Wetterdienst DWD:

- RTTY USB mode = RT-U
- shift 450 Hz

- 50 bauds
- signals at 915 and 1365 Hz
- try 4581.865 kHz, 7644.860 kHz, 10099.660 kHz, 11037.860 kHz or 14466.160 kHz

RTTY TX (Experimental)

Using CW Keyer Input

- Switch CW Keyer Mode (CW menu) to Iambic or Ultimate
- Set CW TX RX delay (CW menu) high enough so that RTTY keeps transmitting between your Morse letters
- As soon as you start using the keyer, your decoded Morse code will be sent out as RTTY (or idle RTTY is sent)

Using USB Keyboard Input

Simple RTTY TX via USB Keyboard now possible, most but not all USB keyboards work. Keyboard layout is QWERTY, no matter what the keyboard says.

- Switch CW Keyer Mode to Straight (disables RTTY CW Keyer Input)
- Now select desired RTTY mode
- Hit F1 on keyboard to start TX (or press PTT)
- Enter text, text is immediately sent out
- Hit F2 on keyboard to stop TX (or press Tune twice)
- You can also enter text before you press F1, it is stored and sent when you start TX.

Theory

RTTY is a simple FSK (frequency shift keying) mode which transmits digital data at relatively low speeds without error correction. We use a simple but apparently quite well working decoder based on a DSP tutorial written by Norbert, HA2NON, adapted and extended for use in the UHSDR firmware. The demodulator filters both frequencies and passes the energy difference through a simple 50Hz filter. The resulting signal is passed to a digital PLL which handles the bit decoding timing and a symbol decoder which then decodes the bitstream into RTTY characters.

A nice example for a digital mode which existed for a long, long time.

Details of the RTTY demodulation chain:

- filter the incoming audio baseband signal with two 2nd order IIR bandpass filters. The bandpass frequency for mark and space are adjusted according to the shift used for the specified RTTY mode
- the result is two narrowband signals which are now separately multiplied to calculate the magnitude squared: mark * mark and space * space
- calculate the envelope of the two signals by an exponential average with fast attack and slow decay
- calculate the noise floor level by an exponential average with fast attack and even slower decay
- "clip" by taking the smaller of the two: magnitude or envelope
- this is the "Optimal ATC" - algorithm by W7AY also implemented in FlDigi. It copes quite well with selective fading and QRM: v1 = (mclipped - noise_floor) * (mark_env - noise_floor) - (sclipped - noise_floor) * (space_env - noise_floor) - 0.25 * ((mark_env - noise_floor) * (mark_env - noise_floor) - (space_env - noise_floor) * (space_env - noise_floor));
- lowpass filter v1 with IIR filter with cutoff-frequency equal to the baud rate
- slicing: is v1 <0 --> bit is 0, if v1 > 0 --> bit is 1
- digital PLL: bit decoding timing
- symbol decoder translates bit stream into characters
- send character to print routine

CW Decoder

We know that experienced CW operators do not need this feature (and will probably also never use it ;-)), but it could be useful for beginners in CW or for refreshing your CW knowledge, or (we hope so!) could even motivate hams to learn CW from scratch!

The decoder code has been adapted from Lofturs´ implementation of an algorithm designed by Guenther (1973) (for military use on a "modern" microcomputer (modern in the seventies!), see reference below). Thanks, Loftur, for putting your code under the GNU GPL license!

Please note that the CW decoder is definitely not better than your ear-brain interface. This is also expressed by the huge amount of scientific effort still recently put into developing new algorithms to decode CW (e.g. Zhang et al. 2006, Wu et al. 2010, Wang et al. 2016 and the "Machine Learning Challenge" in 2014: http://ag1le.blogspot.de/2014/09/morse-learning-machine-challenge.html).

So, for the moment, there seems to be no better CW decoder available than your ears and brain working together (which is somehow appeasing and alarming at the same time ;-)). Or your eyes and brain when using QRSS CW modulation.

Adjustments

Use a slow or very slow AGC or no AGC in your audio path. Make sure you have tuned to the CW station properly assuring that the audio pitch of the station matches your sidetone frequency (because the CW decoder only "hears" CW signals which are on the pitch of your selected sidetone frequency).

CW decoder enable - ON/OFF

- Switches the CW decoder ON or OFF. This is possible in every mode; the decoder works on basis of the audio signal. Honestly, this is only useful, if you have a narrow filter and a one sideband mode, e.g. 300Hz/700Hz in LSB or CW-L. Do not combine this with RTTY demodulation mode, this will produce garbage ;-)

Signal threshold:

- Adjust this threshold while checking the red LED until the red LED is modulated with the rhythm of the CW signal you are listening to. This adjustment is dependent on the signal strength of your CW station and band and antenna noise. So, you would likely have to adjust this threshold when changing bands, antennas, or frequency. ATTENTION: the audio signal has to match the pitch of your CW sidetone.

Blocksize

- in order to be able to filter out and determine the real time signal strength of the CW impulses, we use the Goertzel algorithm. Similar to an FFT, we need a certain no. of samples and calculate the magnitude from the sample levels. The number of samples used for one signal magnitude value is called "Blocksize". Blocksize can be changed from 8 to 128 in steps of 8 samples.

Noise cancel ON/OFF

- a special noise canceling algorithm for the decoder.

Spike cancel OFF/SPIKE/SHORT

- yet another spike cancelling algorithm, which helps the decoder to ignore short noise impulses. Has three options: OFF/SPIKE cancelling/SHORT spikes cancelling

Use 3 Goertzels

- may come in the future, there is nothing to choose here yet

Theory

The decoder works as follows (see Guenther 1973 for details):

- collect a block of samples (with size "Blocksize")
- calculate one "optimized Goertzel" magnitude value from this block of samples [Goertzel algorithm works like an FFT, giving you the magnitude of a signal for a given frequency --> the CW sidetone frequency you are listening to]
- lowpass filter the magnitude values ("averager")
- automatic gain control for these values ("AGC")
- determine whether we have a pulse or a space by comparing the magnitude level to a "threshold"
- noise canceling: determine whether two consecutive magnitude values are the "same" (pulse/space) and accepting only when this is true
- light the red LED when we have a pulse
- shut off the red LED when we have a space
- the pulses and spaces and the time length of these pulses and spaces are stored in a ring buffer
- the ring buffer is used to INITIALIZE the decoder: a set of equations from Guenther (1973) is used to determine the speed (WPM) of the received CW message, i.e. the length of dots, dashes and inter-character and inter-word spaces. This is the essential step for decoding the message
- then the message stored in the ring buffer is being decoded by the DATA RECOGNITION routine using the timing information from the initialization --> this produces another data buffer with all the dits and dahs and spaces of the message
- the dits and dahs are then interpreted in the CHARACTER IDENTIFICATION routine, where basically a look-up-table is used to interpret the dits and dahs as characters

- the characters and the inter-character-spaces are then sent to the printer routine which prints them out on the display
- One very important addition is an error correction routine which -in the case of a sequence of dits and dahs that can not be assigned to a character in the look-up-table- tries out several possibilities to eliminate single dots in order to finally match the dit/dah sequence to existing characters in the look out table. Also the error correction tries to correct too short character spaces
- So, we are finally there: a sequence of characters and spaces which hopefully matches the transmitted CW message to a certain extent

Please note that still -in 2017!- there is no algorithm which performs better on decoding of CW signals than the human ear/brain of trained CW experts! Even highly sophisticated machine learning algorithms do not perform better than experienced CW operators.

PSK

This is under development. See discussion under #1002 and add any opinions or useful links there.

PSK demodulation works as follows:

- switch demodulation mode to PSK-U or PSK-L depending on band and/or your personal preference
- use a narrow filter that includes 1000Hz center frequency (for example the 500/950Hz filter)
- coarse tune into a PSK31, PSK63 or PSK125 transmission signal (the center frequency is 1000Hz, which is indicated by the vertical line inside the filter passband)
- press M3, so that orange "PSK" box becomes highlighted
- adjust PSK mode (31, 63, 125) with encoder 3
- fine tune with the SNAP button (only works within +-100Hz around the 1000Hz center frequency)
- perform further finetuning with 1Hz steps
- you should now see the PSK transmission text decoded in the text line

PSK transmission works as follows: Connect USB keyboard switch to digital mode PSK and type text. Use F1 and F2 to switch tx/rx. Or long press M1, while in CW mode record macro as described below, switch back to PSK mode and use TXRX to transmit. Long press TXRX switches from/to buffered/unbuffered mode. In buffered mode it returns to rx after finishing the message unless you keep typing. In unbuffered switch to rx manually.

Keyer functionality

How to operate

Currently, implemented only for CW/iambic mode, but will be used for other digital modes, too. After M1 long press function of buttons F1-F5 is changed. Use another M1 long press to return back to default functions. F1-F3 become buttons to record and play back a macro (just a text at this point). Long press on e.g. F1 enters recording mode - use iambic keyer to enter the macro. Short press on F1 while in recording saves the macro. Short press F1 will automatically send the saved macro. Touching any paddle will stop sending. Label of the button changes to the first word of the macro. F4 and F5 are currently reserved for future use.

Future improvements

- using the keyer for other digital modes (PSK, RTTY, etc.)
- radio stays in TX mode while sending the macro, it should return to RX between the symbols
- using USB keyboard to enter the macro
- currently, message is saved only in operating memory and needs to be reentered each time after powering the radio. It should be saved to EEPROM
- only cw symbols recognized are saved and sent. Non-ascii characters are not saved
- creating and sending actual macros not just static text

Resources

RTTY

the source of the RTTY algorithm used HERE

Automatic threshold correction algorithm for RTTY HERE how FlDigi does it HERE

why you need a slow or no AGC for RTTY decoding HERE

Fldigi source code: CW and RTTY decoding HERE

FREEDV

http://freedv.org/tiki-index.php

CW

Machine recognition of hand sent Morse code incl. C source, by Loftur, GNU GPL3 HERE

GUENTHER, J.A. (1973): Machine recognition of hand-sent Morse code suing the pdp-12 computer. - Air Force Institute of Technology Wright-Patterson Air Force Base, Ohio. HERE

Arduino Morse code decoder incl. C source HERE

ZHANG, R.B., HE, L.G. & X.-Y. LI (2006): Automatic detection and recognition of Morse signal in strong noise environment. HERE

WU et al. (2010): Design and Implementation of Morse Code Recognition Based on Finite State Machines. HERE

WANG et al. (2016): An Automatic Decoding Method for Morse Signal based on Clustering Algorithm. - Advances in Intelligent Information Hiding and Multimedia Signal Processing pp 235-242. HERE

PSK31

PSK31 decoding and encoding, source code under GNU GPL HERE

USB CAT and AUDIO Mode

The provided USB CAT functions (Computer Aided Tuning) in combination with the integrated USB Audio Interface enable you to:

- Use standard HAM software to control many aspects of the receiver (tuning, modes, PTT). This is enabled by an emulated serial COM port using the well-documented protocol of Yaseu FT-817 receivers.
- Streaming of the mcHF audio to your PC by use of a virtual microphone interface via USB. You can use this with any audio recording software or HAM software accepting soundcard input.
- Transmitting audio from the PC via USB to the mcHF. Use with any soundcard compatible HAM software or audio tools.
- Use the mcHF as SDR RF frontend for SDR software such as HDSDR, SDR# and others accepting sound card in- and output. That means you not only can receive IQ data but also transmit (e.g. with HDSDR). Bandwidth is limited by the A/D conversion and sample rate in the mcHF (which is 48khz/16bits per sample).

All of this requires just a single USB cable which is plugged into the Mini-USB port of the mcHF.

Provided functionalities

- USB Audio In (RX, 48kHz sample rate, both channels have same signal), default signal except in DIQ (Digital IQ) mode on mcHF
- USB IQ In (RX, 48kHz sample rate, left channel is I, right is Q), DIQ (Digital IQ) mode on mcHF required
- USB Audio Out (TX, 48kHz sample rate, left channel is used), DIG (Digital Audio) mode on mcHF required
- USB IQ Out (TX, 48kHz sample rate, left channel is I, right is Q), DIQ (Digital IQ) mode on mcHF required
- CAT control via FT-817 protocol using the virtual COM port, baud rate setting is ignored, any baud rate will work.
- USB CW Key control via DTR of virtual COM Port (DTR == 0 -> no carrier, DTR == 1 -> CW carrier, requires use of PTT via CAT), can be used in parallel to a connected CW keyer

Enabling/Disabling USB CAT/AUDIO.

USB CAT and USB AUDIO is always enabled in current firmware (2.0.0 or newer). You just need to connect PC and mcHF.

- Connect your PC to the mini-USB port.
- Linux machines will now automatically detect both the virtual com port as /dev/ttyACM? and also the audio is automatically detected. Depending on the Linux sound package you are using, you may not see the capture device (sound in) in all programs. Pulse Audio does work, ALSA seems to have trouble seeing the capture interface. This may improve in future. Make sure that not programs like "modemmanager" access your device. See FAQ below.
- Windows machines should load the audio in and out driver without problems. However, the virtual COM port needs special care on all Windows Version up to and including Windows 8.1. Windows 10 loads the right drivers automatically. All Windows version from XP on can operate the serial after installation of a "special" driver information file. See below for instructions.

Programs known to work

Programs for controlling the rig

All HAMLIB based programs should be able to control the main aspects if the FT-817 is available as choice. Baud Rate / Communication speed is not relevant. To transmit use the CAT PTT option if possible. RTS/DTR based PTT control is not supported. Please note that the FT-817 emulation is not complete. Especially programs reading and writing to EEPROM locations in order to activate certain specific FT-817 function will not be able to do so for obvious reasons. Very important EEPROM locations can be implemented if the respective functionality is present in the mcHF. Do it by yourself and contribute or ask for assistance if CAT control does not work as expected.

- Omni-rig using FT-817 protocol
- HamRadioDeluxe 5.x using FT-817 protocol
- DXLabs Suite using FT-817 protocol.

Programs used to receive/transmit digital modes

You will need to set the transmit source to "DIGITAL" in menu TX AUDIO Source (or switch TX Audio Source by long press on M3) if you plan to transmit audio from PC via USB.

- FLDigi (Linux/Windows): works as expected using HAMLIB FT-817 control
- WSJT-X (Linux/Windows): works as expected using HAMLIB FT-817 control
- MMSSTV (Windows)
- QSSTV (Linux)
- Multipsk (Windows)

Programs used to receive/transmit CW

Recent firmware got a special support for PC based CW operation if CW mode is selected on mcHF. Use FT-817 CAT for reading and setting frequencies, in CW modes you may also use the DTR signal of the CAT serial port (same port!) to send CW from the PC via mcHF (PTT has to be handled via CAT protocol). DTR Line = High will key the mcHF. You can use your keyer as well if the PC is not sending CW in the specified mode (Straight, Iambic A or B, Ultimate). If you enable "Virtual RTS" in the UHSDR menu, RTS will switch the TRX to TX and DTR will key the CW signal (only in CW mode!). As long as Virtual RTS is set, the TRX will remain in transmission mode, ready to transmit.

Most programs will be able to send CW using the SSB audio mode. In this case "manual" keying with a keyer connected to the mcHF is not possible. All CW needs to be generated as audio signal and send to the mcHF via USB.

- UCXLog: CW-Mode keying via DTR works (tested).
- FLDigi: SSB only. QSK keying via audio right channel not supported.
- N1MM / N1MM+ . You need to enable Virtual RTS in UHSDR menu, and use RTS for PTT and DTR for keying

Unsupported Programs for CW

Please note, **TR4W** (see discussion #1174) does not work with the UHSDR at the time of writing. It seems to be a bug in TR4W keyer handling. If the situation changes, we should update this statement :-)

SDR Programs for use with IQ Data

You can configure the mcHF to stream IQ data to the PC instead of processed audio (default) using the DIG IQ setting in menu 060 TX AUDIO Source. This will also automatically switch the stream from PC to mcHF to use I/Q Data. Technical parameters of the delivered/accepted IQ stream is 48khz sample rate, left channel I, right channel Q. Data is 16 bits. You may want to play with configuration menu 400 which allows you to define the communicated mcHF frequency. This is either center frequency (default setting), i.e. LO frequency. Or it is the TUNE frequency, the frequency you see in the mcHF display, this typically 6 or 12 khz off center. Some software needs the lo to be sent via cat but most software use the tune (example all logging software, cluster spotting)

- SDR# (Linux/Windows): soundcard receive (Linux needs build with MONO)
- HDSDR (Windows): soundcard receive and transmit, rig control via Omnirig
- Quisk (Linux/Windows)
- GQRX (Linux)

Installation on Windows XP - 8.1

In order to use the virtual serial port, Windows needs a driver for this interface. In fact, it needs only the information which driver to use. Windows driver download.

Windows Vista and newer

- Run the ST Virtual Com Port (VCP) driver installer. This will provide you with everything you need. Look for the file stmcdc.inf.
- Modify this file by replacing the respective part of the file with the following lines

```
[DeviceList.NT]
%DESCRIPTION%=DriverInstall,USB\VID_0483&PID_5732&MI_00

[DeviceList.NTamd64]
%DESCRIPTION%=DriverInstall,USB\VID_0483&PID_5732&MI_00
```

Run `dpinst_amd64.exe` or `dpinst_x86.exe` in the same directory and you are done.

Windows XP

You need Win XP SP3 or have to find usbser.sys. Then follow the instructions above (worked for some) or point the device directly to the usbser.sys file (worked for others).

FAQ

I can see the Speaker/Microphone device but no sound is coming from/going to the mcHF. I have used an experimental firmware with USB Audio before.

This might be caused by the sample rate change. You have to tell Windows to switch to the right sample rate (16bit stereo, 48000 Hz).

1. Right click on the loudspeaker symbol in the Windows taskbar. Select *Recording Devices*.
2. Select STM Microphone entry and click on *Properties*.
3. Click on *Advanced* tab, and set the right Default Format: 2 channel, 48000 Hz, DVD Quality
4. Repeat 1. - 3. for Playback Device, STM Speaker

When I start transmitting using CAT, TX LED goes on for a very short time and then goes off.

You are in CW-U or CW-L mode. Switch to USB or LSB. TX in CW modes is not supported yet (and not necessary with most HAM software).

Linux: I can see the /dev/ttyACM0 device, but it still does not work with the programs like fldigi.

Most likely a program like modemmanager takes control of your devices. Many Linux distributions still install modemmanager by default. You can either change the udev rules (see here). The rule for the mcHF is:

```
`ATTRS{idVendor}=="0483", ATTRS{idProduct}=="5732", ENV{ID_MM_DEVICE_IGNORE}="1"`
```

You can also uninstall the modemmanager, if it is not needed for other applications.

Another user pointed out that the Braille display driver 'brltty' might also take over control (see output of command `dmesg` and search for 'brltty' or use `dmesg | grep 'brltty'`). Unless you have a Braille display connected, you can safely uninstall this tool too.
You also need to have access to the serial port. On most Linux distributions you need to be member of group 'dialout'. Do an `ls -l /dev/ttyACM*` to find out who is allowed to access the device. Use `id` to see which groups you are member of. Use `sudo useradd -G dialout <yourusername>` to add yourself to the group dialout. Change name of group if necessary.

Audio Tx is named plughw: card=interface DEV=0 Audio RX is named plughw: card=interface DEV=1

When I use CW-L and CAT, every frequency change via CAT switches to CW-U. Why?

That is a consequence of the used FT817 CAT protocol emulation. The FT817 CAT protocol know two CW modes, CW and CW-R. On a real FT817 this is used to received CW in the two side bands and the user can control which is mapped to CW (USB by default) and CW-R (LSB by default). The mcHF maps CW to CW-USB and CW-R to CW-LSB. I.e. in order to keep the mcHF in CW-L, you have to tell your CAT program to use CW-R instead of CW. How to do that depends on the program itself.

WSJT-X sound does not work with Ubuntu/Xenial 16.04, - (fldigi works well)

Add the following two lines into /etc/pulse/default.pa and reboot:

load-module module-alsa-source device=plughw:2,1
load-module module-alsa-sink device=plughw:2,0
(Here the mcHF is my soundcard number #2)

Then in wsjtx, select:
Input: alsa_input.plughw_2_1 (Left)
Output: alsa_output.plughw_2_0 (Both)

McHF driver & Windows 8 64bit

I discovered that Windows 8 64bit (and maybe Windows 10 64bit) has the “driver signature enforcement” that permits to install only drivers with Microsoft signature. So, following the procedure in this page is not possibile if you have a operative system with 64bit. Before of trying it, you have to remove the signature enforcement, following, for example, the procedure written in this page: https://www.howtogeek.com/167723/how-to-disable-driver-signature-verification-on-64-bit-windows-8.1-so-that-you-can-install-unsigned-drivers/ Only after have removed the signature enforcement I succeded to connect the mcHF with the virtual port on the pc. Note: removing signature enforcement instead is not necessary for bootloader and firmware updating.

Hip-hop Tips and Tricks

Snap to a Frequency Step Grid:
When using SNAP to a frequency you can end up on a decimated frequency. You can return to a current frequency step grid by quick turning the frequency knob (dynamic tuning enabled).

Changing a second-line meter when in CW mode:
While being in a CW mode the F2 is for activating SNAP to carrier function but you can still change the currently used second-line meter by long-pressing F2.

Temporarily picking different built-in audio filter:
By long-pressing G4 we can temporarily jump into a list of all built-in filters. Than we can choose between them by rotating ENC3. To leave this excursion just short-press G4.

Changing TX modulation input:
By long-pressing M3 (ENC3) while in RIT mode we can cycle between possible modulation inputs, e.g. MIC, USB(DIG, I/Q), Line(L/R).

Product Description:

- HF QRP Transceiver, attach battery 12v and ANT and QSO.
- DC IN: 9-13V Max:3A
- Output POWER:10W (44dbm) MAX:15W
- Transmit: 160, 80, 60, 40, 30, 20, 17, 15, 12 and 10-meter amateur bands.
- Receive: 3.5-30 MHz nominal including general coverage, 0.8-32 MHz at reduced specifications.
- MODE: CW, LSB, USB, AM, FM (N, W), SAM, FreeDV
- Bandwidth:300Hz-10Khz Adj
- SWR: Display 1:1 to 5:1 calibrated

Sensitivity/bandwidth

Better than -108 dBm (0.89uV) in a 2.3 kHz bandwidth

Better than -120 dBm (0.22uV) in a 300 Hz bandwidth

Technical Specifications:

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, CCITT filtering, taken at 28.3 MHz:
- Frequency Translation enabled:

Better than -111 dBm (0.6uV) in a 2.3 kHz bandwidth

Better than -126 dBm (0.11uV) in a 300 Hz bandwidth

- Frequency Translation Disabled:

Better than -108 dBm (0.89uV) in a 2.3 kHz bandwidth

Better than -120 dBm (0.22uV) in a 300 Hz bandwidth

The above specifications are for a receiver on which the published sensitivity modifications are performed.

Frequency coverage:

- Transmit: 160,80,60,40,30,20,17,15,12 and 10-meter amateur bands.

- Receive: 3.5-30 MHz nominal including general coverage, 0.8-32 MHz at reduced specifications.

Note: The ability of the Si570 to tune the radio below 2.5 MHz is not guaranteed in its specifications, but most units have enough range to tune just below 1.8 Mhz. Maybe there are some small gaps where LO does not work - if it works, it works fine.

Indicator is the color of the frequency digits:

- White: fully working

- Yellow: mostly working, maybe there are some small gaps

- Red: not working

Spectral Display Modes:

- Spectrum Scope: This is a spectrum analyzer with the vertical divisions representing user definable amplitude variations of 5,7.5,10,15, 20,1 S-Unit (6dB),2 S-Units (12dB) or 3 S-Units). The baseline ("reference level") of the analyzer is automatically adjusted so that the signals within the displayed passband best-fit the dynamic range selected by the user selected dB/division. A graticule along the bottom of the display indicates the approximate frequency of the signal being displayed over a width of +/- 24 kHz. (48 kHz total.)

- Waterfall Display: As with the spectrum scope, the frequency is displayed along the "x" axis but the signal strength is implied by the displayed color. The newest signals are displayed along the bottom of the screen, but as new readings arrive, the representations of the older signals are shifted upwards giving an ephemeral time record of recent activity on nearby frequencies. There are several options for color "palettes" that range from simple grayscale to "cold-hot" to "rainbow" to represent weak to strong signals.

- There is also a "Magnify" mode for both the Spectrum Scope and Waterfall Display mode that provides 2x magnification, reducing the visible spectral width to just +/-12 kHz (24 kHz total). Both the Spectrum Scope and Waterfall Display are very highly configurable. It is possible to disable one or both spectral display modes if desired.

- 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 for signals +/- the local oscillator frequency and higher for signals outside this range.

Transmitter power output: <=10 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: CW, USB, LSB, AM (full-carrier, double-sideband), SAM (double side band reception) and FM. AM transmit and FM transmit/receive capabilities are available ONLY if the "frequency translate" is activated (highly recommended)

FM options: Carrier (ultrasonic) squelch, sub audible tone encoding and decoding, tone burst ("whistle up") generation, "narrow" (+/-2.5 kHz) and "wide" (+/-5 kHz) deviation and the selection of 7.2,10,12 or 15 kHz pre-detection receive bandwidths.

FM sensitivity for 12 dB SINAD, CCITT filtering:

7.2 kHz BW filter: -103.7 dBm (1.46uV) with 1 kHz tone at +/-1.5 kHz

10 kHz BW filter: -102.1 dBm (1.75uV) with 1 kHz tone at +/-1.5 kHz

10 kHz BW filter: -104.0 dBm (1.41uV) with 1 kHz tone at +/- 3kHz

12 kHz BW filter: -102.7 dBm (1.63uV) with 1 kHz tone at +/- 3kHz

15 kHz BW filter: -99dBm dBm (2.50uV) with 1 kHz tone at +/- 3 kHz

CW mode receive/transmit and frequency display details: Nine modes of CW display/shifting are available to emulate the various makes of radios and suit the user's taste, ranging from no shifting, display-only shifting, display and LO shifting and manual or automatic LSB/USB shifting.

In CW mode "CW-L" or "CW-U" is displayed depending on whether LSB or USB is being used for reception.

CW Speed range: 5-48 WPM.

Available audio filter bandwidths in this firmware version: 300 Hz, 500 Hz, 1.8 kHz, 2.3 kHz, 3.6 kHz, with a "wide" filter of 5, 6, 7.5 or 10 kHz being selectable in all modes except FM, where the filtering is done prior to demodulation as noted above. All filters are software defined and additional bandwidths could be made available. Filters can be used as BPF or as LPF selectable in main menu.

DSP Filtering Capability: Noise reduction and Automatic Notch Filter with adjustable parameters. Notch filtering is disabled in CW mode for (obvious reasons!) or when using a "wide" receive bandwidth. (Devel-branch: Because NR activation leads to instability of mcHF it is disabled by default. If you want to use it (and risk instabilities in various scenarios) you can activate NR in config menu "last item." Setting will NOT BE STORED and must be activated after every powering on. When NR issues are fixed and NR will be improved this function will be obsolete.)

S-Meter calibration: "Industry Standard" (IARU Region 1, Technical recommendation R.1) S-meter calibration where 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.

(devel-branch only): There is CAT function and audio-in and out also as IQ in and out via USB available. Setting of input is in main menu #60 or via long-press of M3.

Line out signal levels: Nominal 1-volt peak-peak, maximum when AGC is operating.

Line in signal levels: Nominal 0.1 -> 1.0-volt peak-peak, adjustable using the "Line Input Gain" settings.

Transmit ALC type: Look-ahead gain compressor with both pre-set and available "custom" settings.

Operating voltage range:

- 18.0 volts maximum (when capacitors C27 and tantalum parallel to C106 both fry board are 25V)

- To 11.0 volts minimum for full transmit power

- To 9.5 volts for reduced transmit power

- As low as 6.5 volts, receive-only: Only very low transmit power may be possible–distortion on peak audio (SSB, AM) may occur.

Current consumption:

1.Receive:

Unmodified, approx. 410 mA on 40 meters and below at 13.0 volts, approx. 440 mA on 10 meters, minimum volume, maximum display brightness.

The selection of minimum display brightness can reduce this by 40-60mA.

The modification to the PA drivers to switch off bias when not in TX mode can reduce this by a further 30-60 mA.

- Power off: <5 mA if the PA driver bias modification is performed. (If this modification is not performed it is recommended that power be disconnected from the transceiver as the PA driver transistors will be biased on even when the power is turned off, causing 30-60 mA of standing current.)

- With modification RF-04-: -010 from German mcHF Project Group consumption in power off is <0.5uA.

2.Transmit (At 13.0 volts power supply): At full power around 3A; At 10W around 2.5A

Packing List:

- 1 x RS-918 HF SDR Transceiver
- 1 x PL-918 DC Power Cable
- 1 x HM-918 Hand Microphone
- 1 x Wrench
- 1 x BNC To SO239 Convertor
- 1 x User Manual