OL-SDR project

Lucca – 14 marzo 2025

I2SUH Mauro

OL-SDR Project History

- On-going Community Project
- To develop a HAM radio RTX based on SDR technology
- Kicked-off in 2019
- Impacted by component shortage during Covid
- HW, firmware and software has been extensively redesigned since then

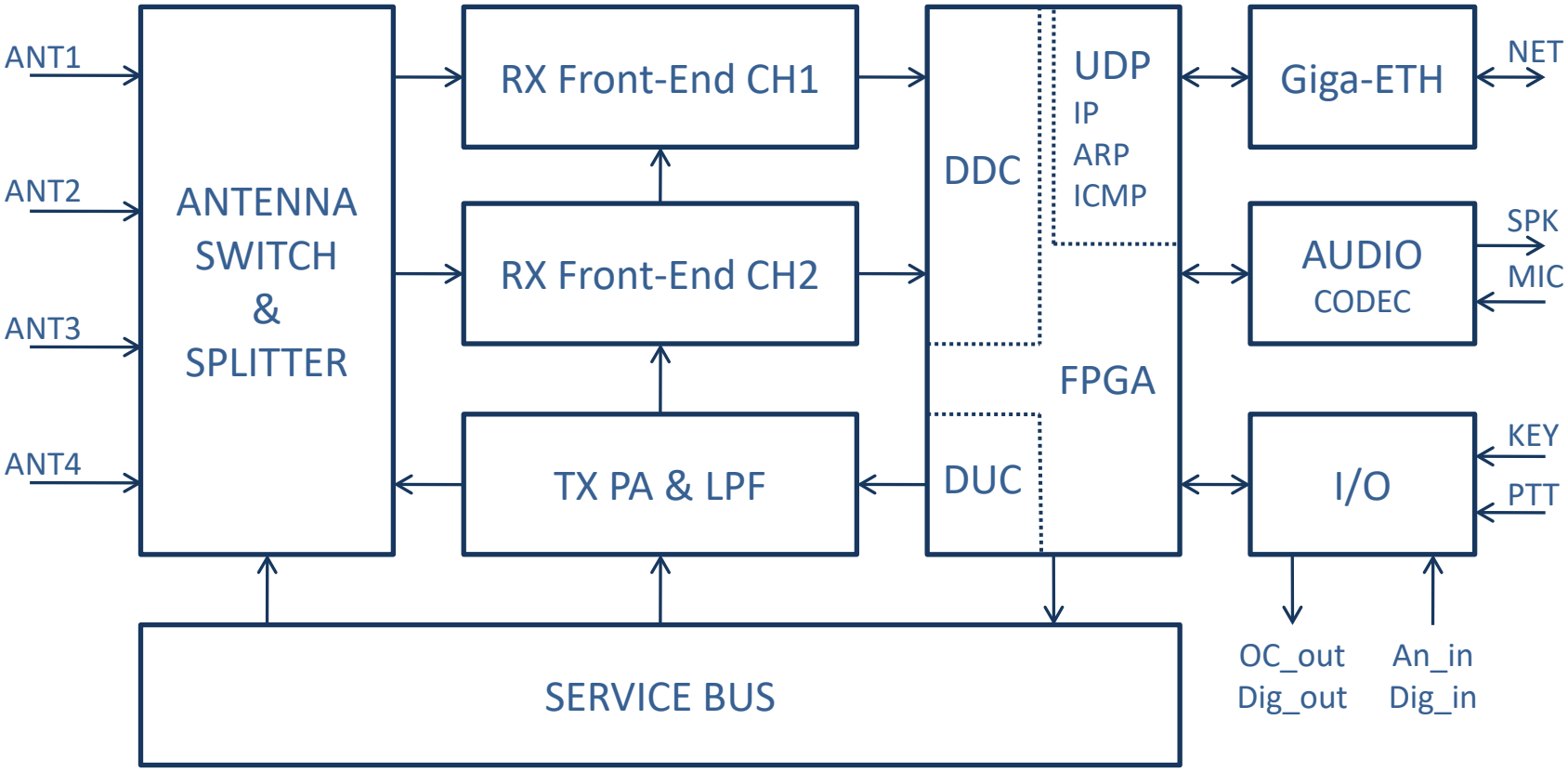
OL-SDR Project Overview

- Direct sampling SDR with 15Wrms or 300Wrms output power from 160m to 6m
- 2 direct sampling rx channels
- 16 bit RX ADC
- 16 bit TX DAC
- 4 fully indipendent SW RX, each one with sub-rx
- Visible RX spectrum up to 1.5MHz
- Wideband full-spectrum overview window
- Ultra-low noise master oscillator (122.88MHz)
- Very stable reference oscillator (10MHz)
- GigaEthernet to allow hw installation away from PC
- Adaptive MOSFET protection base on SWR and temperature
- Complete set of functionalities to reduce needs of external boxes
- Easy-to-use ergonomic user interface
- Support for OTRSP protocol (SO2R) and MTTQ protocol
- Look Ahead VOX, to preserve first syllable
- Look Ahead ALC, to avoid PA overdriving
- Clean TX spectrum using Pre-Distorsion (PureSignal) technology
- Build using WDSP library by Dott. Warren Pratt NR0V

OL-SDR Target Specification

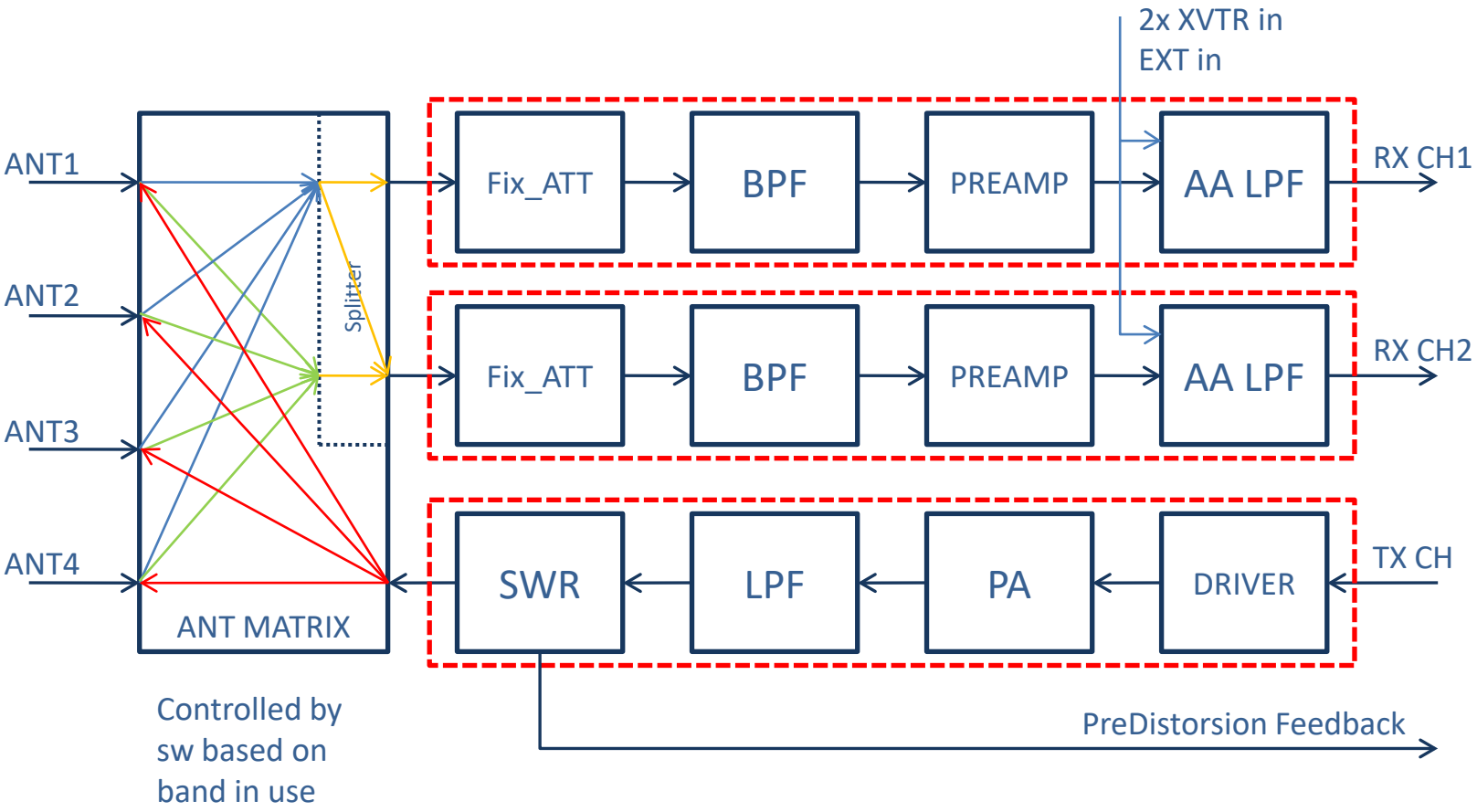
- 100KHz - 55MHz continuous coverage
- Noise Floor: -130 dBm (0.07 uV @2.4 KHz di banda)
- Noise Figure: 12 dB
- RMDR (Reciprocal Mixing Noise): 107 dB (@2.4KHz di banda)
- Ultra-low noise LVPECL differential Master Clock:
  - @10KHz: -155 dBc/Hz
  - Ultimate: -162 dBc/Hz
- Reference TCXO: <50 ppb over 0°-70°C temperature range (<0.7Hz@14MHz)
- 10MHz input for GPS reference clock
- TX output power: 15Wrms (10W on 6m) or 300Wrms (275W on 10m and 6m)
- HiFi audio amplifier: 7+7Wrms
- Availability of digital and analog input and output
  - 8 Open Collector Output to directly control external devices (i.e. relays)
  - 8 Digital LVCMOS Output (3.3V or 5V settable)
  - 8 Analog Input (max 3.3V)
  - 8 Digital Input/Output (3.3V or 5V settable)

HW Architecture



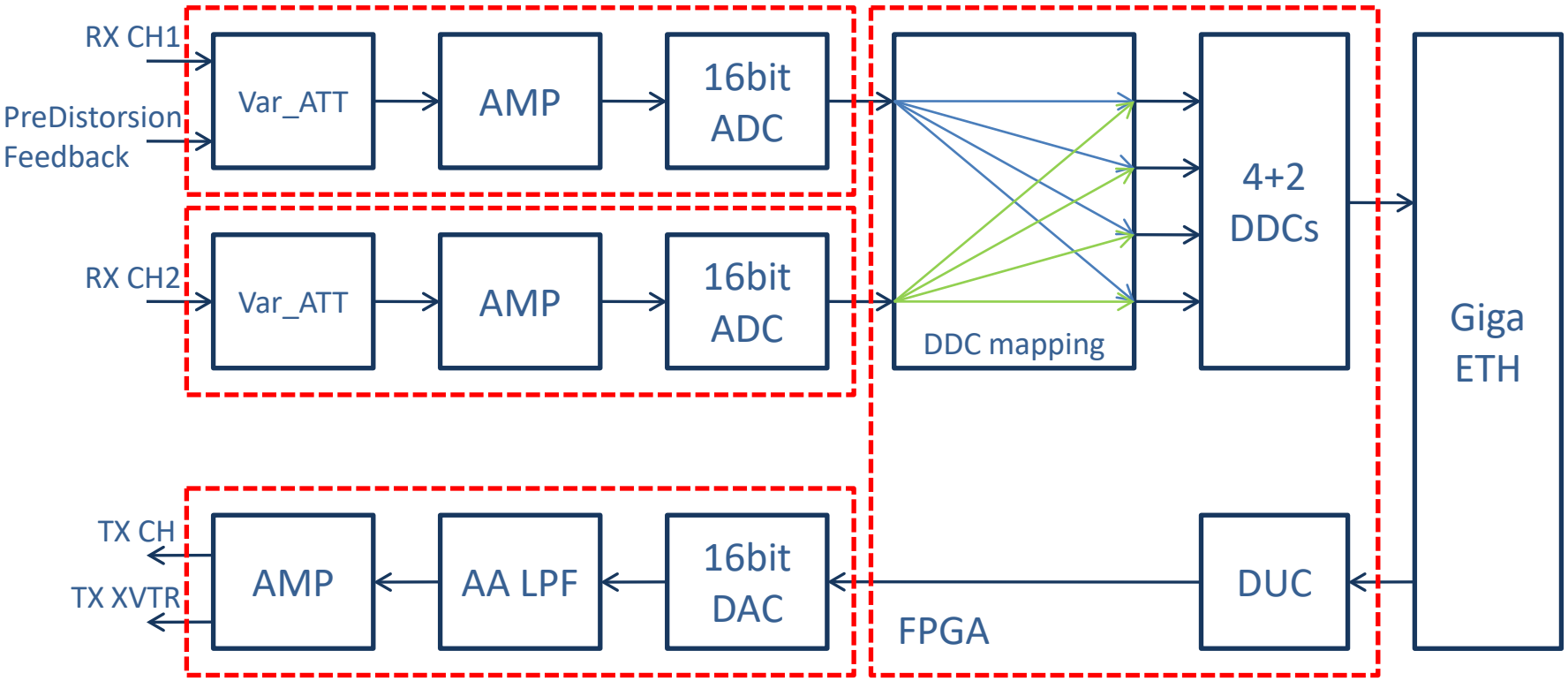
DDC = Digital Down Converter
DUC = Digital Up Converter

RX and TX Filter Boards



AA LPF = Anti Aliasing Low Pass Filter

SDR Board



AA LPF = Anti Aliasing Low Pass Filter
DDC = Digital Down Converter
DUC = Digital Up Converter

Each DDC sends a stream to peer RX in OL-Master sw

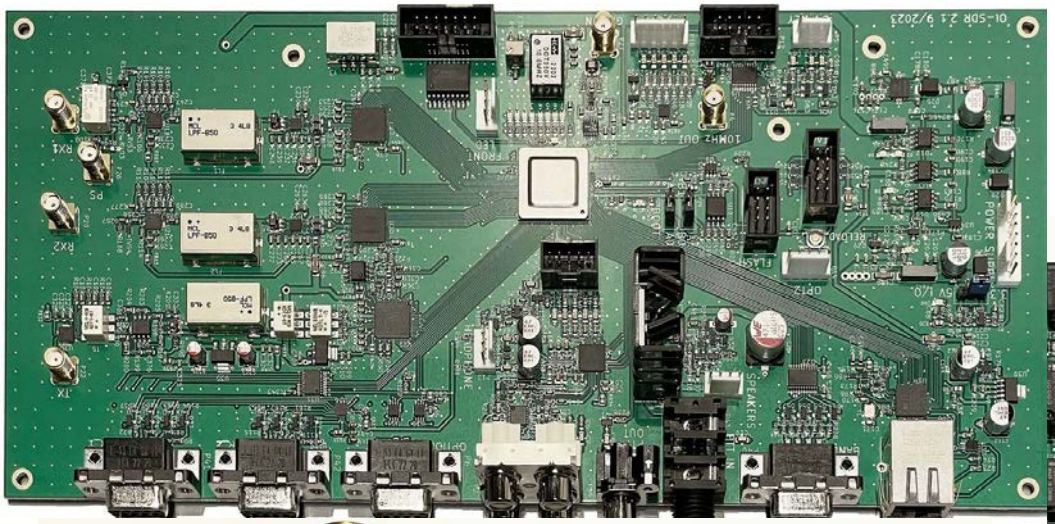
Front Panel

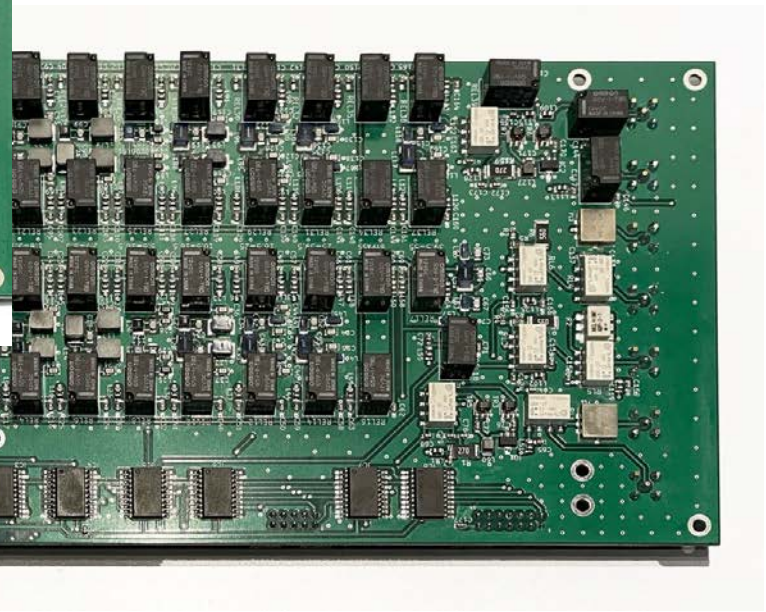

OLITER
made in ITALY
KEY
PHONES
TX
OL-SD20A
HF/50MHz - 2 CHANNELS TRANSCEIVER

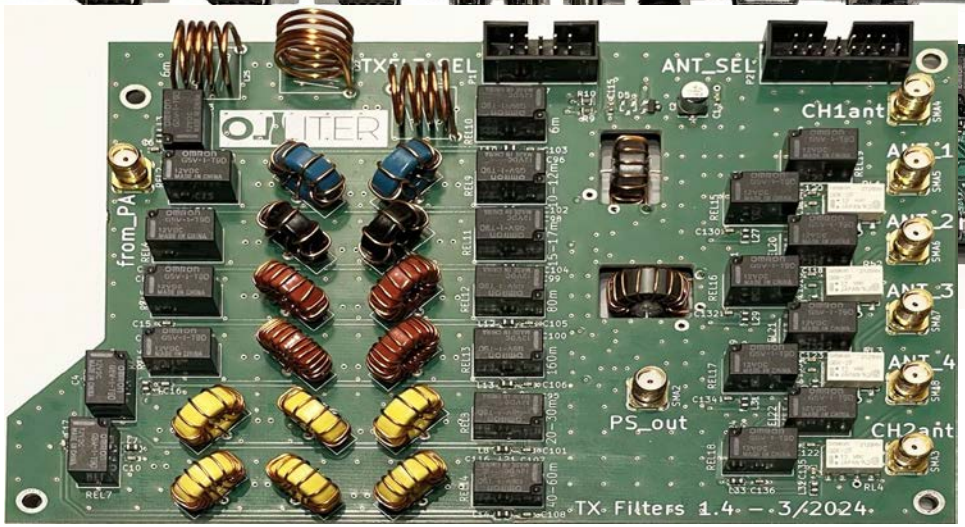
Rear Panel


RX
RX
PS IN
GPS IN
XVTR1
XVTR2
PS OUT
EXT IN
10 Mhz
TX
TX
OUT
OPEN COLLECTOR
SPEAKER
PUSH
DO NOT GROUND
INT. SPK
EXT. SPK
9-13.8 VDC IN
SERIAL NO. 240010F
OLLITER
OL-SD100A HF/50Mhz
4-CHANNELS SDR TRANSCEIVER
OLLITER LABORATORY, SAgl SWITZERLAND
ANT 1
ANT 2
ANT 3
ANT 4
LINE
L
OUT
IN
R
XVTR1
XVTR2
ACC
PTT OUT
PTT IN
PA BAND
ETHERNET

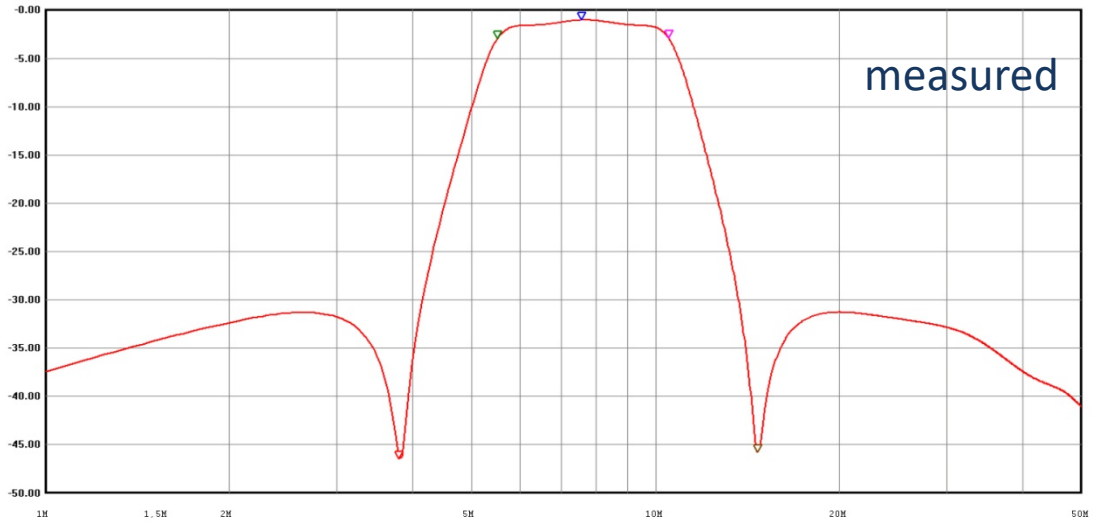
Boards

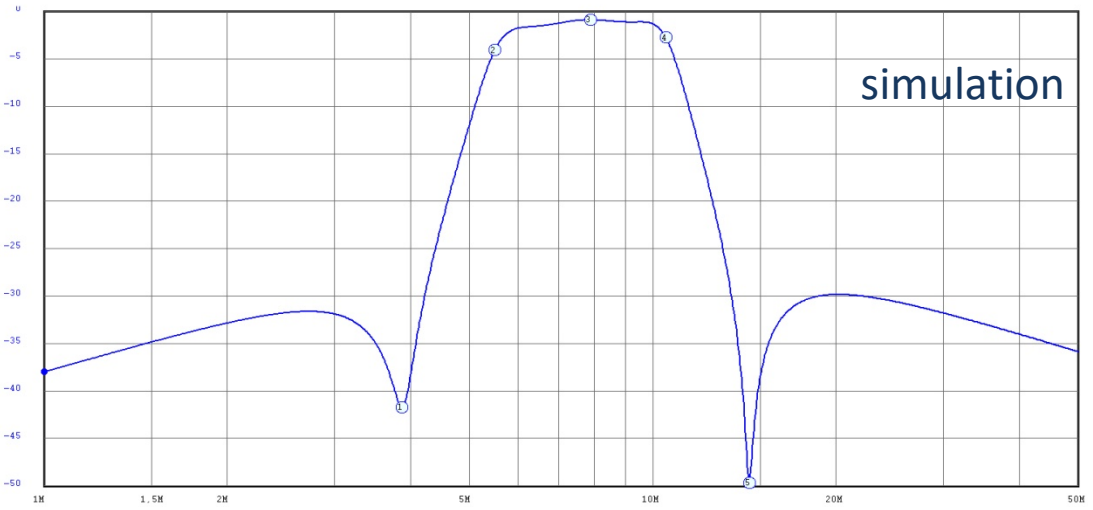





ANT_SEL
CH1ant
ANT_1
ANT_2
ANT_3
ANT_4
CH2ant
PS_out
from_PA
TX Filters 1.4 – 3/2024

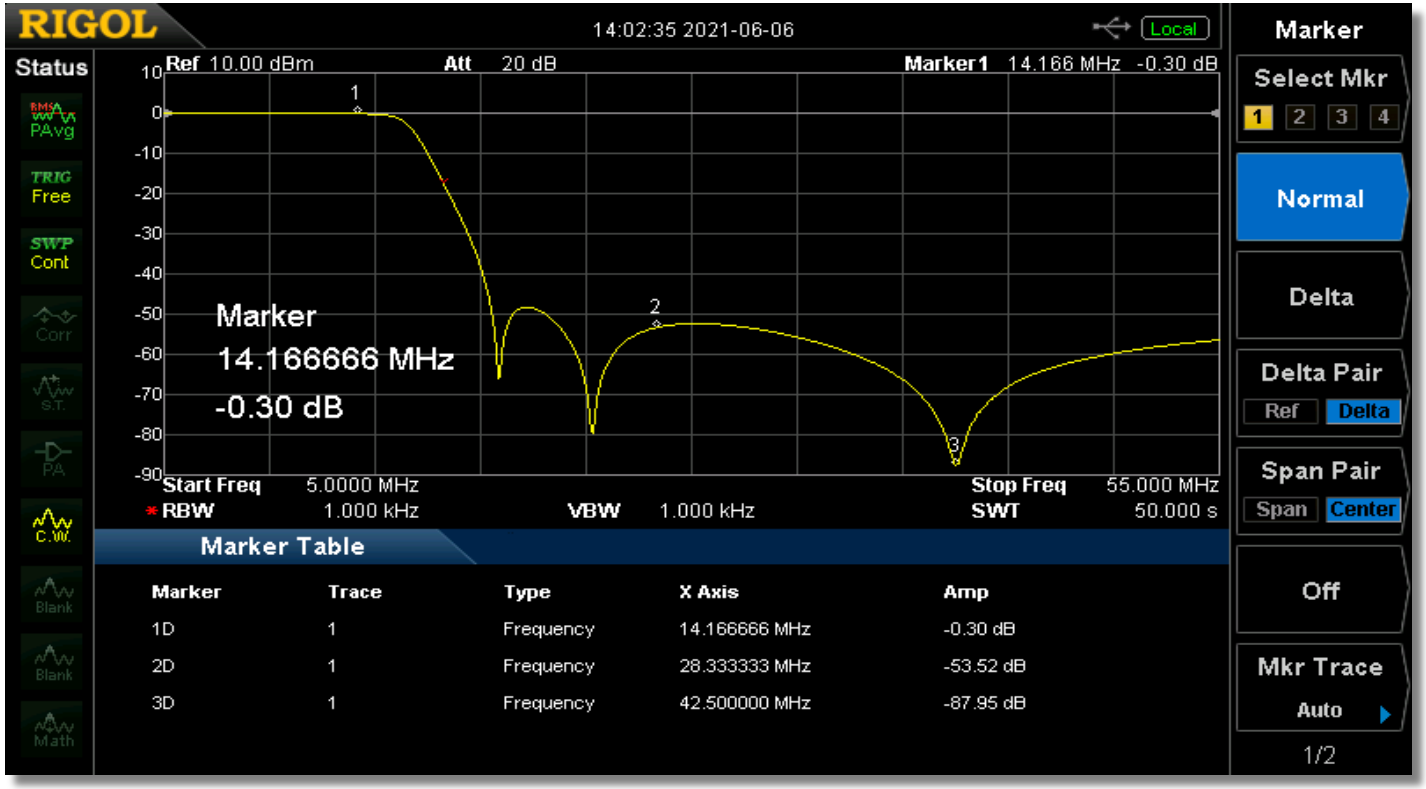
RX BandPass Filter Example





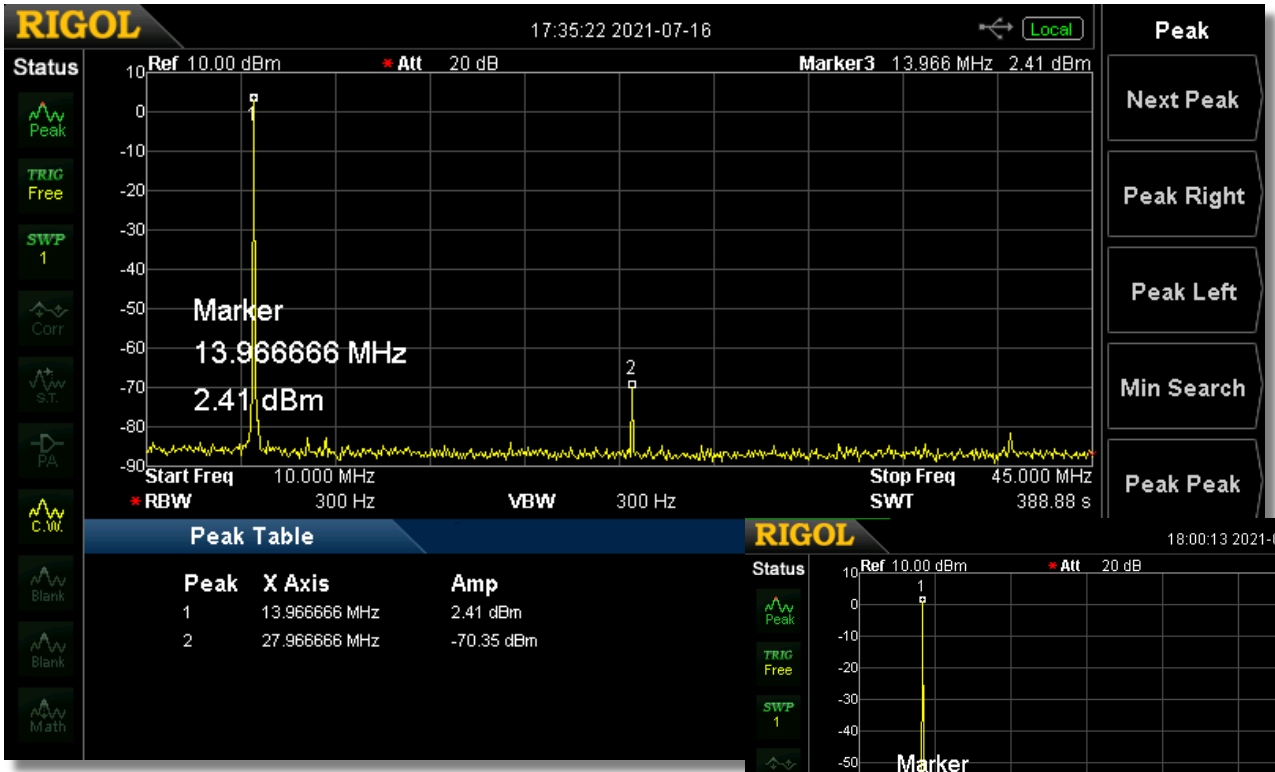
- insertion loss <1.5dB (including relay's)
- stop-band attenuation >30dB
- "zero's" inserted on adiacent contest bands to increase IMD tolerance
- monotonic slope after zero's
- high Q smd inductor
- careful design
- filter bypass available for special needs/situations

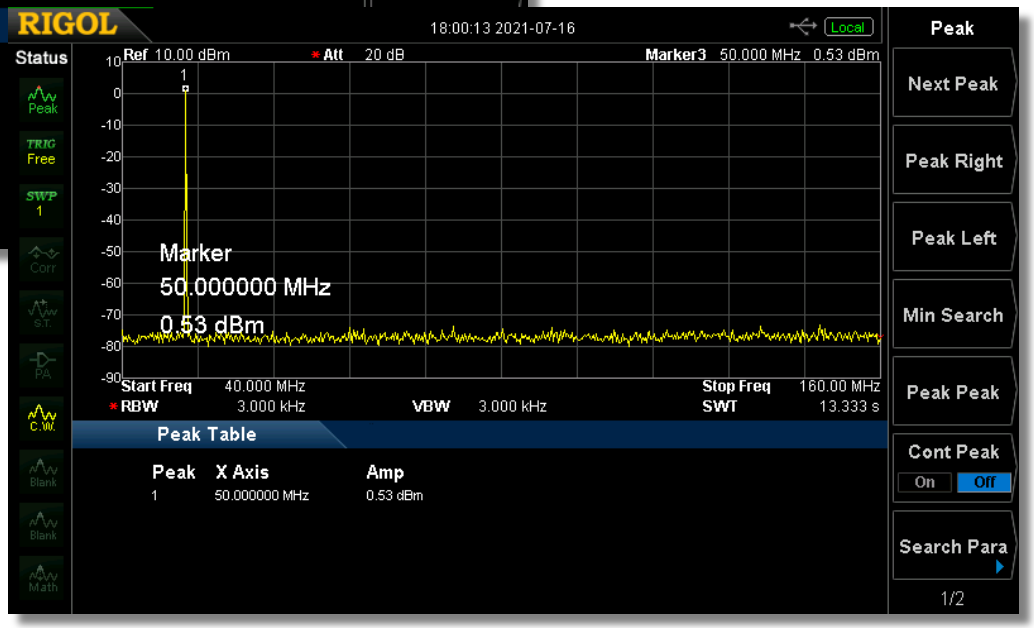
TX LowPass Filter Example



- Insertion loss <0.5dB (SDR20A) or <0.2dB (SDR300A) including RTX relay's, antenna matrix and SWR bridge
- Stop-band attenuation >50dB
- "zero" inserted around 3rd harmonic to improve response on classic bands
- Very low harmonic emission

TX Spectrum





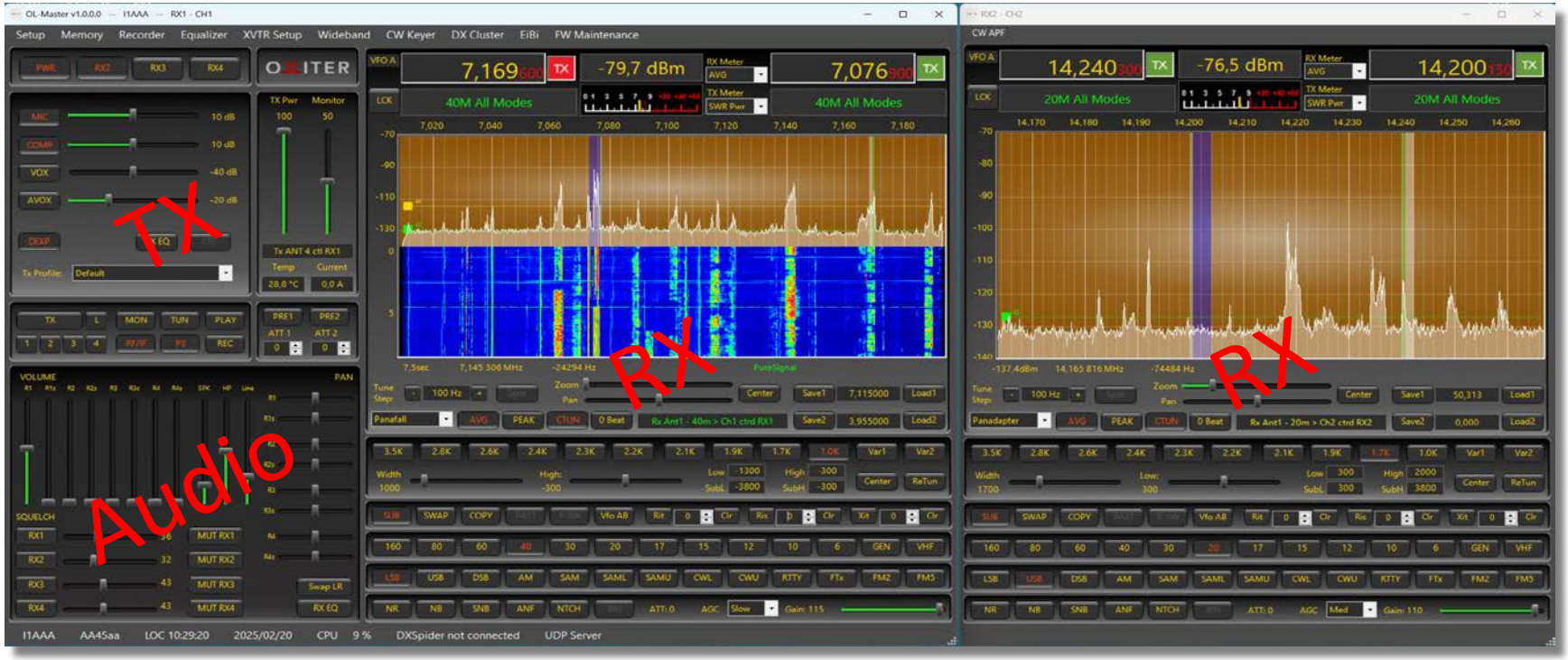
Where is the 3rd harmonic?

Very low harmonic emission: well below 5uW @ 15W out

OL-Master

- 4 full-featured indipendent Receivers with one sub-Receiver each
- Wideband Panadapter
- **And a lot more….**

OL-Master



- 4 full-featured indipendent Receivers with one sub-Receiver each
- Each Receiver can be connected to HW Channel 1 or HW Channel 2
- Each RX or sub-RX VFO can be selected as TX VFO
- “One Function, One Click” approach for fast action and easy operation
- Primary functions directly available in each window, based on frequency of use

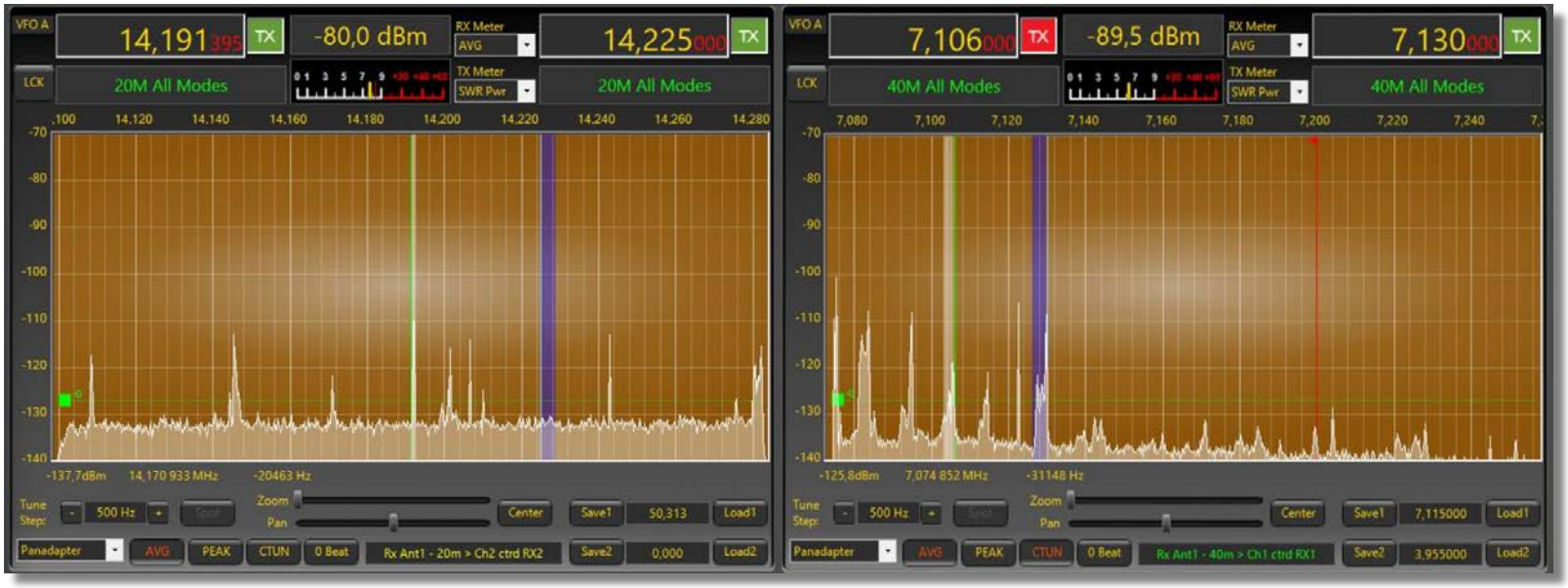
OL-Master Key Points

- 10 pre-defined band-pass filters, based on mode in use
- 2 custom band-pass filters plus manual setting (slider or drag)
- Additional low frequency narrow BPF for digital tones and cw
- 8 channels audio mixer, with individual panning, mute and squelch
- Indipendent volume control for Speakers, Headphone and Output Line
- Full control of antennas, digital outputs and Open Collector outputs
- Noise Reduction, Noise Blanker, Spectral Noise Blanker, Automatic Notch Filter
- Unlimited number of multiple persistent Notch Filters
- Country Band Plan info box (implemented with CSV customizable files)
- 4 + 1 Virtual Audio Cable to distribute audio & I/Q to other applications
- 4 CAT connections to external app (i.e. N1MM, WSJT, CW Skimmer, Fldigi, HRD, ….)

OL-Master Key Points

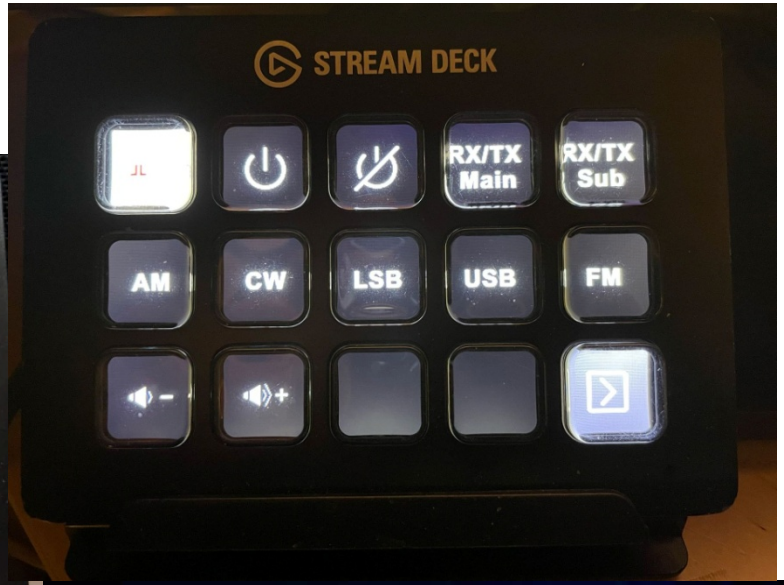
- OTRSP (Open Two Radio Switching Protocol) native protocol support (SO2R)
- MTTQ (Message Queuing Telemetry Transport) protocol
- UDP server to transmit streams
- External accessories support (Keyboards and Rotary controls)
- 10 bands RX and TX Equaliser
- Classic and CFC TX Compressor
- CW generation at firmware level
  - No latency on local monitor
  - Optimally shaped transition for glitch free transmission
- “Look Ahead” ALC & VOX
- Multiple tuning styles
- Customizable interface colors and skins to match user’s taste
- Automatic backup of last 10 Configuration DB and Memory DB
- Easy-to-Use, Ergonomic user interface

Multiple Tuning Style



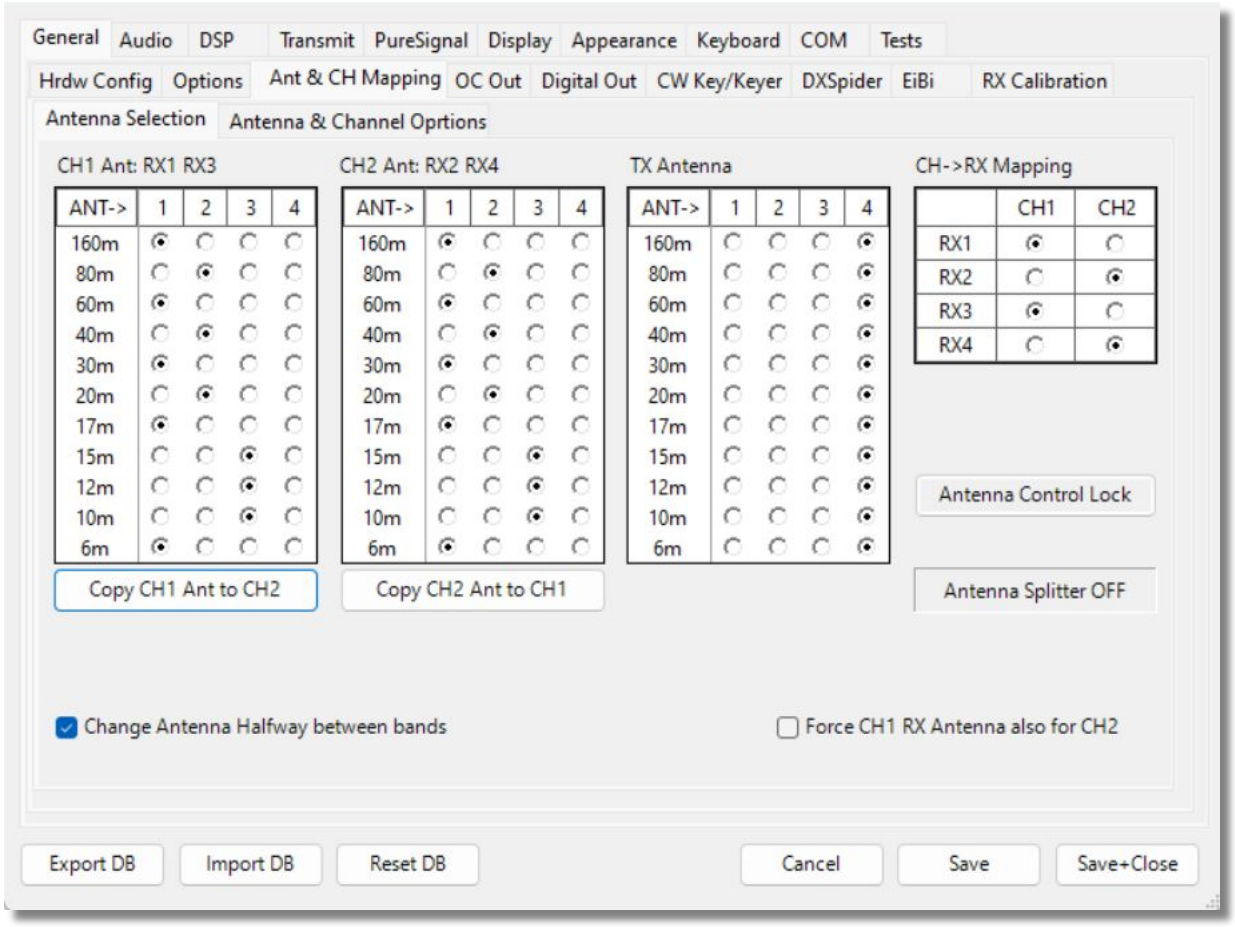
- Keep tuned station at panadapter center, drag panadapter to tune (or Double-Click)
- Keep panadapter fixed, “Click2Tune” at mouse position (Ctrl+Click to SubRX)
- Drag tune cursor on fixed panadapter (Ctrl+Drag on SubRX)
  - if at panadapter limit, optionally scroll panadapter
- Mouse wheel to tune, while on panadapter (Ctrl+Wheel to SubRX) or frequency display
- Selectable mouse wheel tune step
- Optionally “snap to step” on mouse click
- Direct frequency input on display (Esc, digits, Enter)
- Filters and vertical scale can be moved and adjusted with mouse drag

External Controls



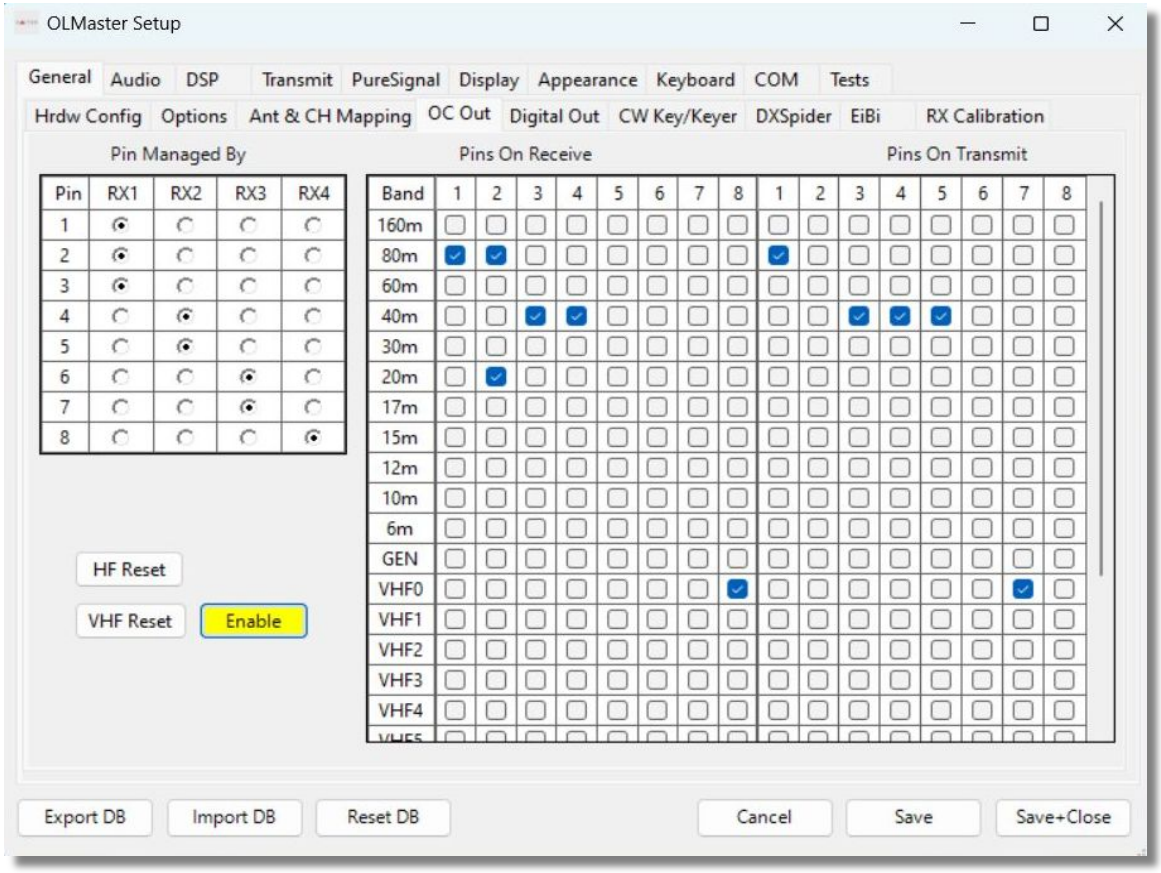
- Native support of selected external USB control devices
- Customizable functions
- Tuning knob, Fine tuning, Volume
- Band, mode and filters switching, RX/TX, …….

CH/RX and Antenna Mapping



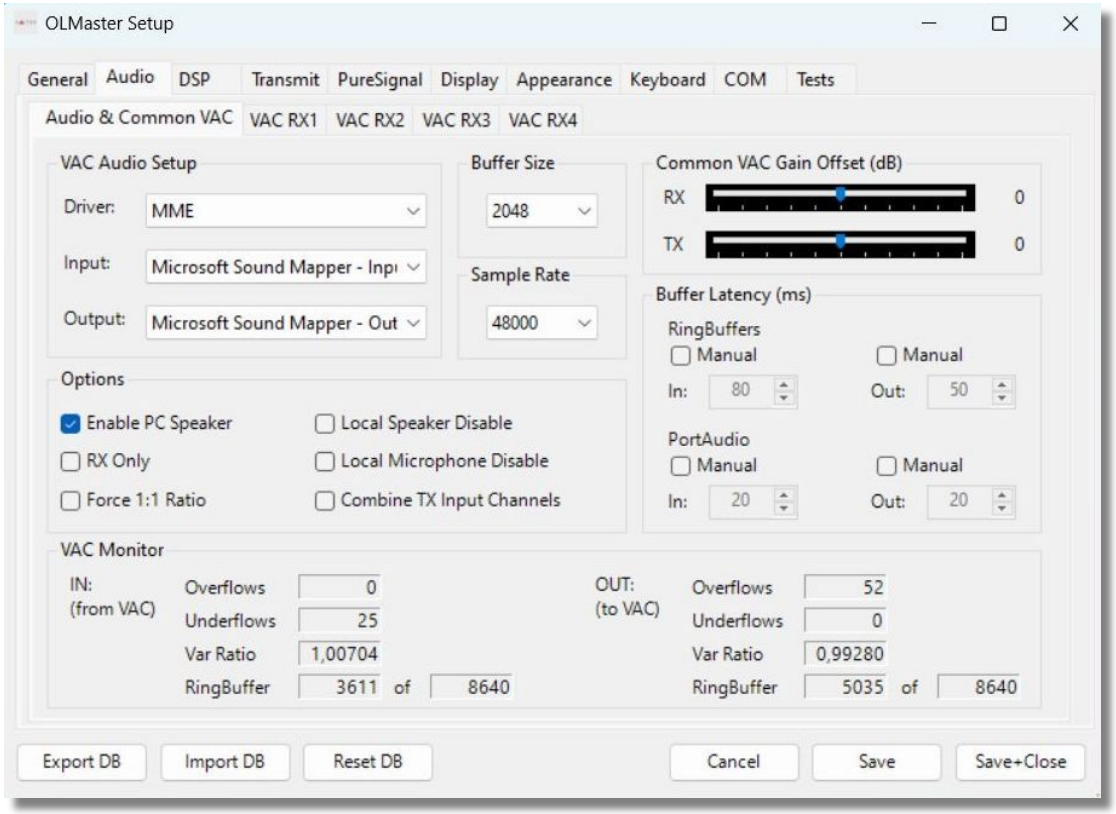
Full control on antenna mapping by band and by RX/TX

Open Collector Mapping



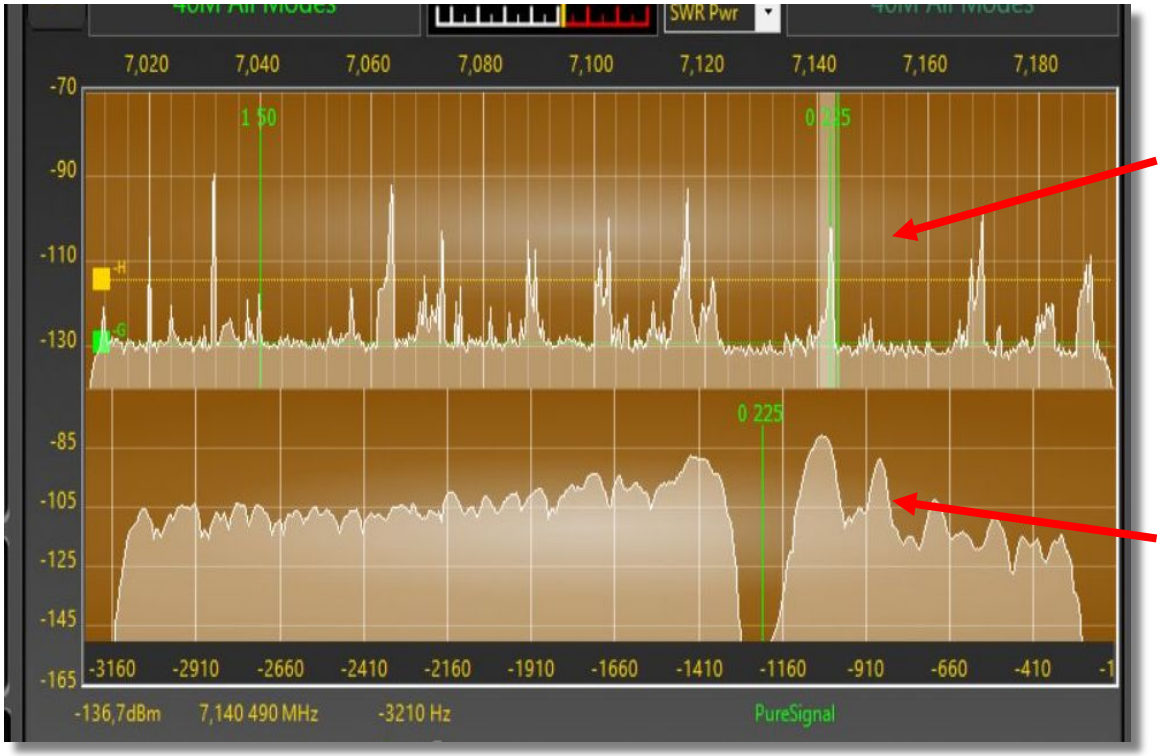
- Full control on external devices by band and by RX/TX
- Alternatively OC can be driven by OTRSP commands (SO2R)
- Same setup on Digital Output

Virtual Audio Cable Configuration



- 1 Common VAC for mixed audio
  - For SDR installed away from PC (i.e. attic, antenna proximity, …)
- 4 indipendent VACs, Dedicated to each RX, to interface external applications
- I/Q samples direct output on Dedicated VAC

Multiple Notch Filter

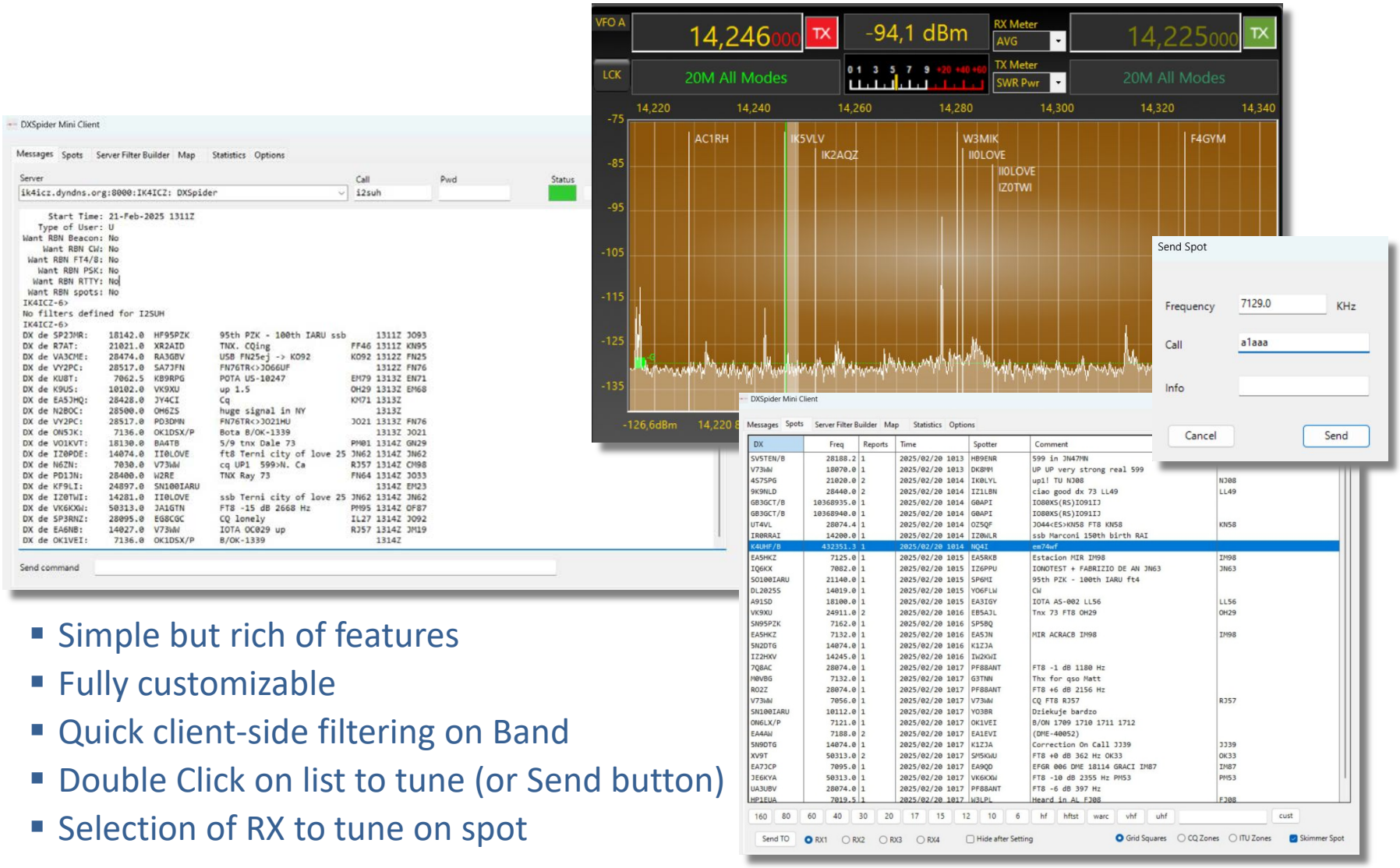


After antenna, but before processing

After processing

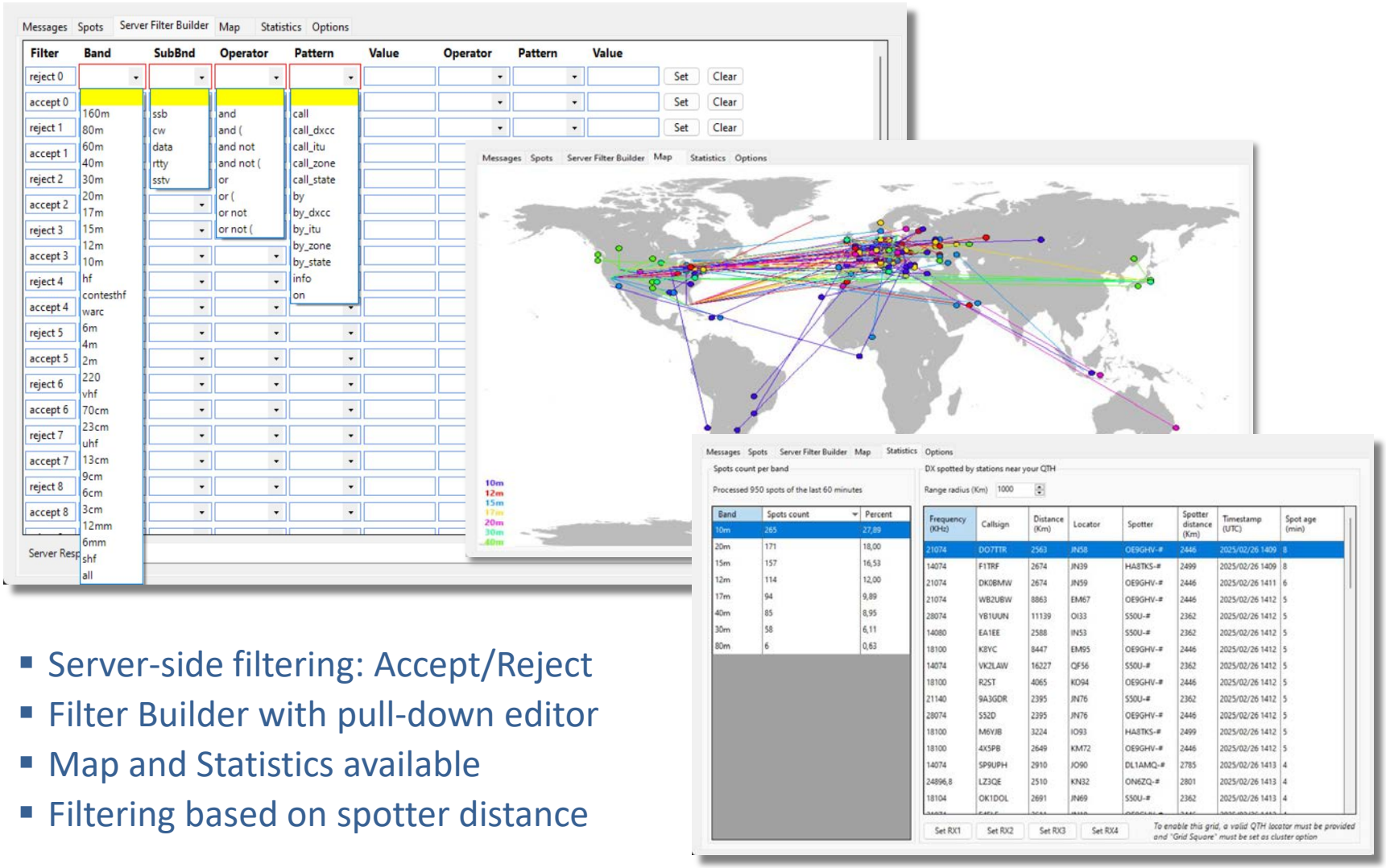
- Mouse Right Click to create/enable/disable
- Mouse Double Right Click to delete
- Mouse Wheel to control notch bandwidth
- Can be defined/managed in both panadapter and spectrum windows
- Persistent, if out of received spectrum or after power-off

DXSpider Mini Client



- Simple but rich of features
- Fully customizable
- Quick client-side filtering on Band
- Double Click on list to tune (or Send button)
- Selection of RX to tune on spot

DXSpider Mini Client



- Server-side filtering: Accept/Reject
- Filter Builder with pull-down editor
- Map and Statistics available
- Filtering based on spotter distance

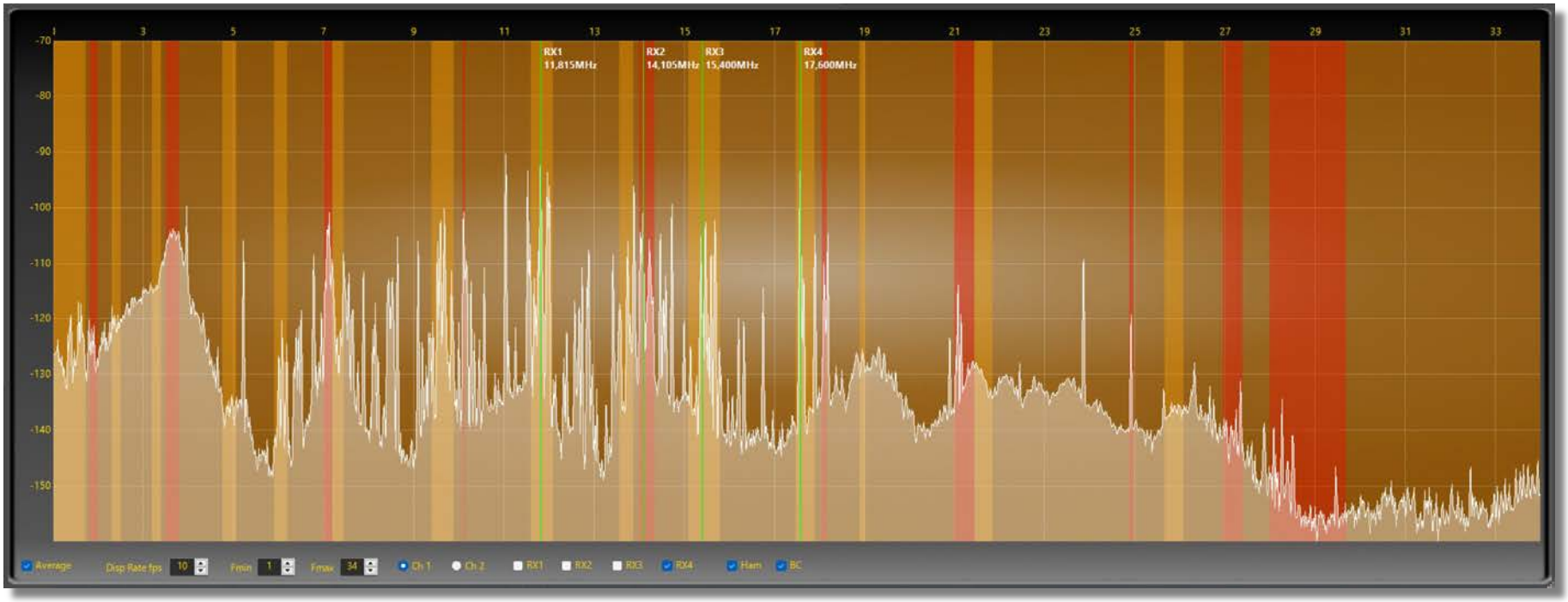
EiBi Client

- Comprehensive Broadcast and Utilities database
- Easy full filtering
- Single Click quick filters
- Automatic update from EiBi server (@ OL-Master start)
- On-the-fly display (Alt+Mouse Move)
- Immediate tuning from Panadapter
- Immediate tuning from List (Double Left Click or Set Btn)

CW Keyer

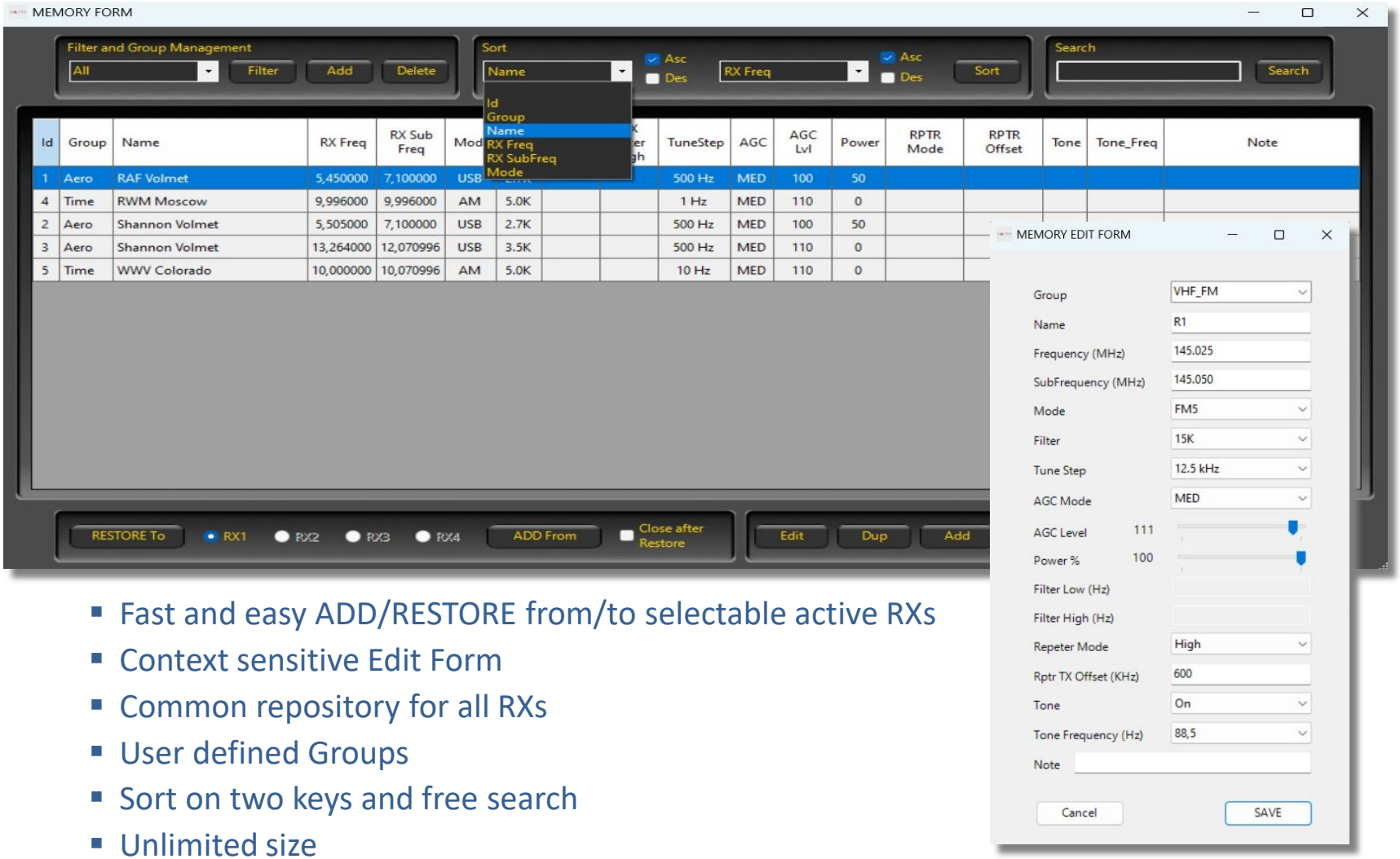
- Automatic switch to CW on opening
- Easy to use
- 24 macros available
- QSO counter that increments at # in text (i.e. at qso end)
- Insert DX call at #C in text, DX OM name at #N in macro, RST at #R
- CW parameters directly on Main Panel

Wideband Panadapter



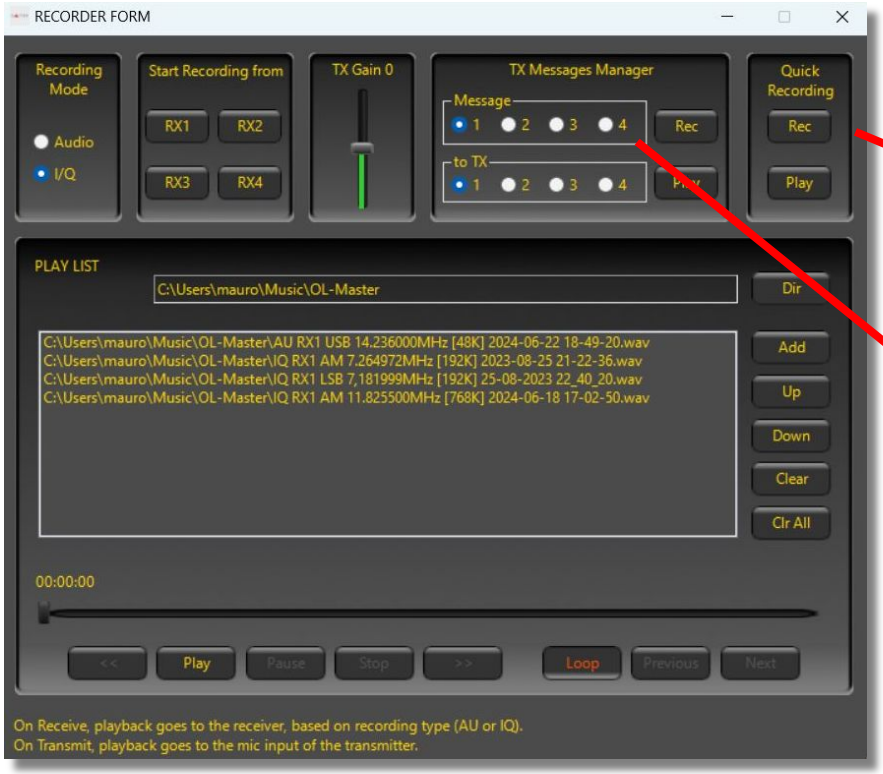
- Quick perception of propagation (and band noise…..)
- Selectable Fmin and Fmax
- Ham Band and Broadcast Band (based on selected Country Band Plan)
- Double Click to tune the selected RXs

Memory Organization



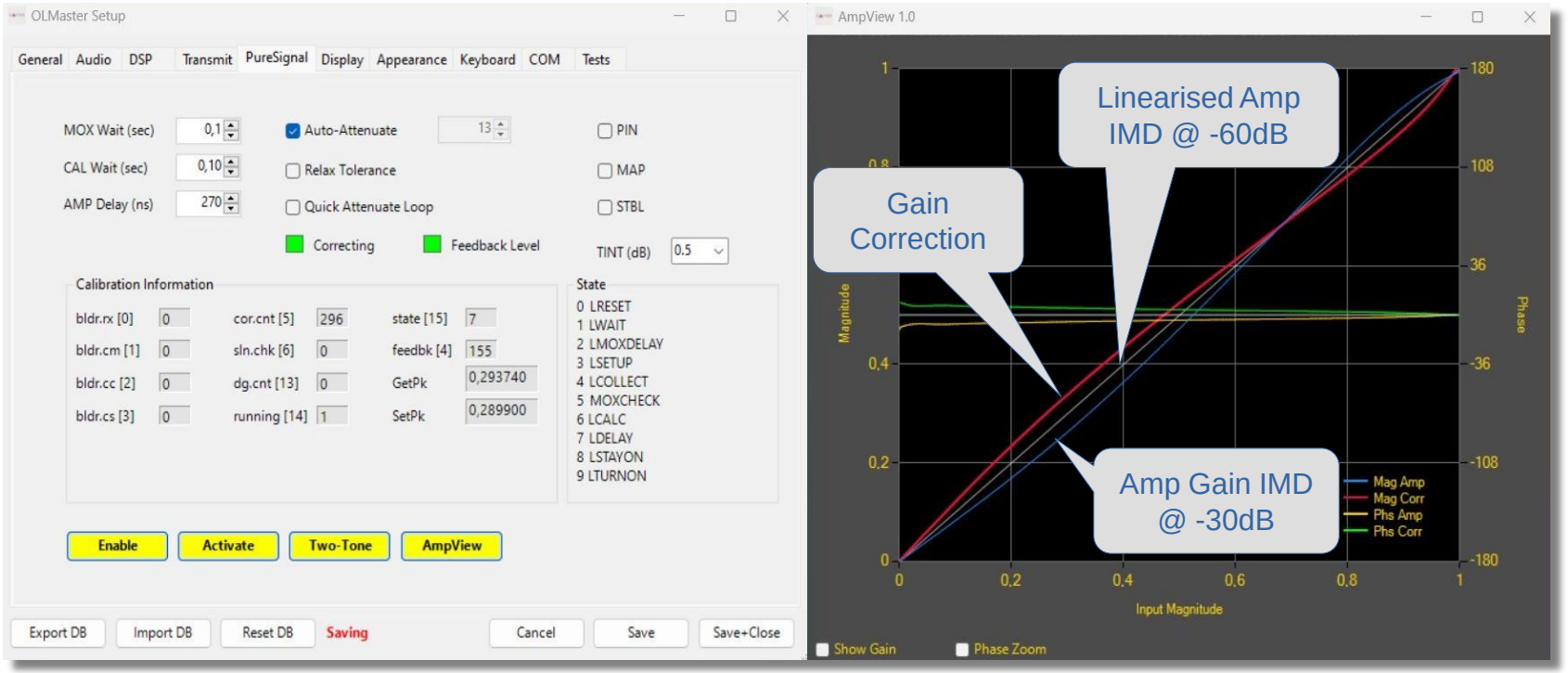
- Fast and easy ADD/RESTORE from/to selectable active RXs
- Context sensitive Edit Form
- Common repository for all RXs
- User defined Groups
- Sort on two keys and free search
- Unlimited size

Recorder



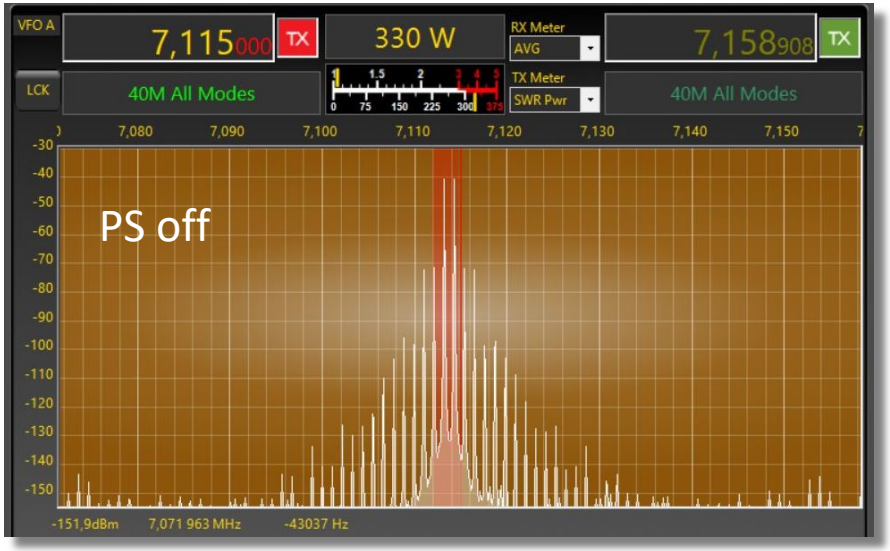
- Record/Play Audio or RAW IQ data, extended WAV format
- Simultaneous recording from selected RXs
- Unlimited recording time (670MByte/h audio recording, 11GB/h IQ recording @ 768KHz)
- During RAW IQ playback, possibility to tune (CTUN) different frequency/mode/filter
- 4 TX message per each RX windows
- Quick Recorder/Player for RX1 (accesible also from Main Window)

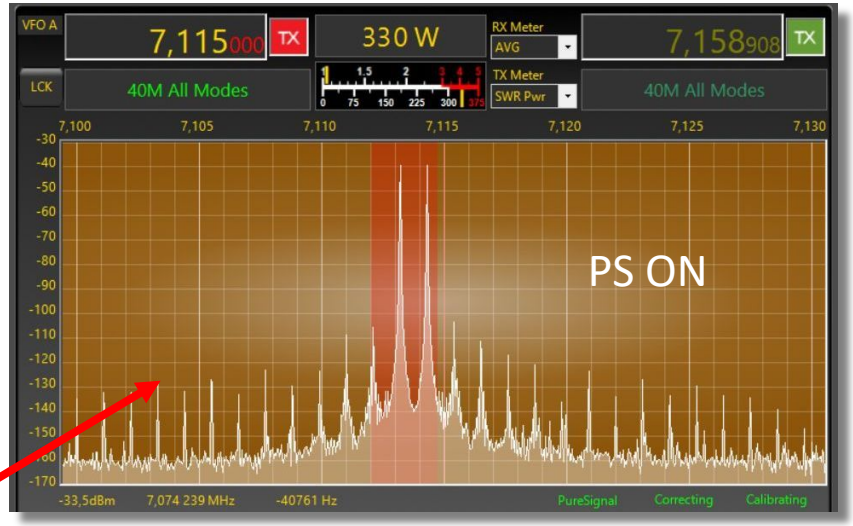
Pre-Distorsion - PureSignal

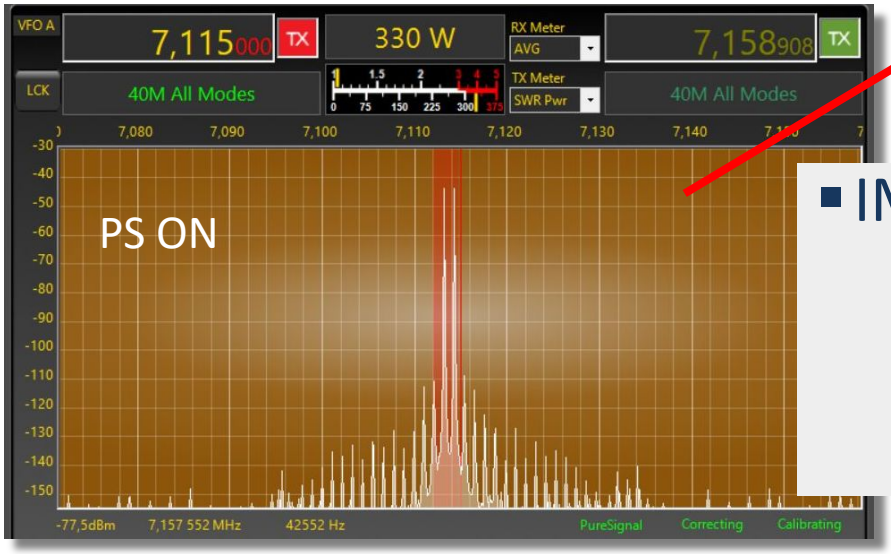


- Improve amplifier linearity through signal pre-distorsion
- IMD can be improved by more than 20dB
- Clean TX spectrum
- Avoid disturbing nearby stations
- Designed by Dott. Warren Pratt, NR0V

PureSignal Measurements

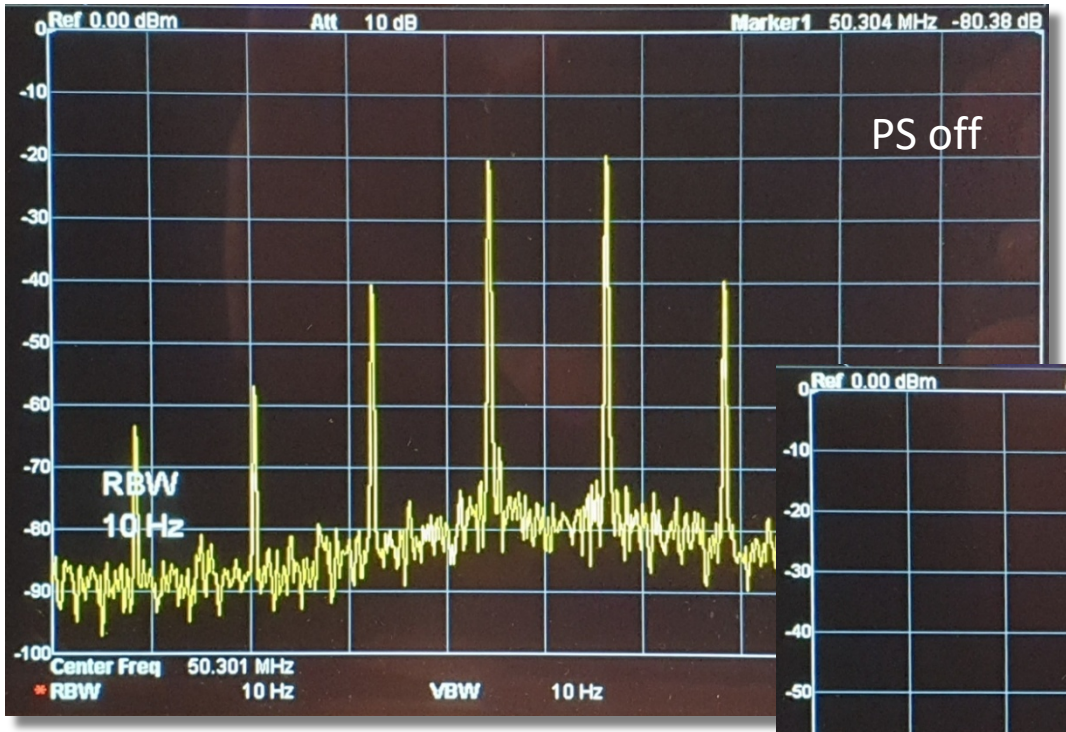




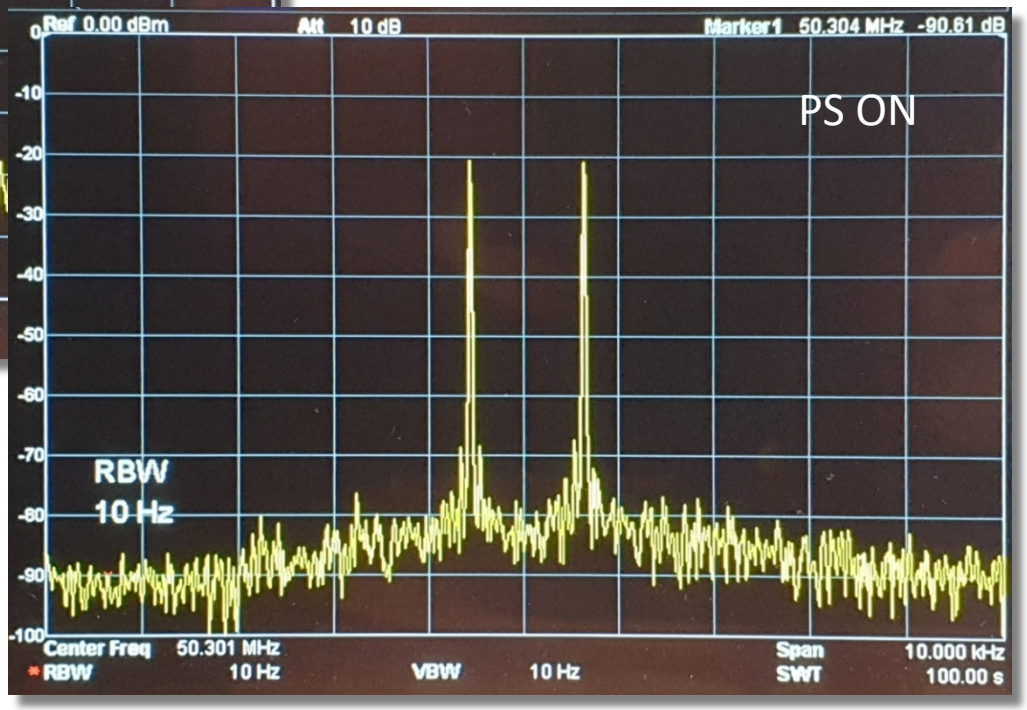


- IMD @ 300W out
  - PS off: -30dB (300mW)
  - PS ON: -60dB (300uW)
  - Floor: < -110dB (3nW)

PureSignal Measurements

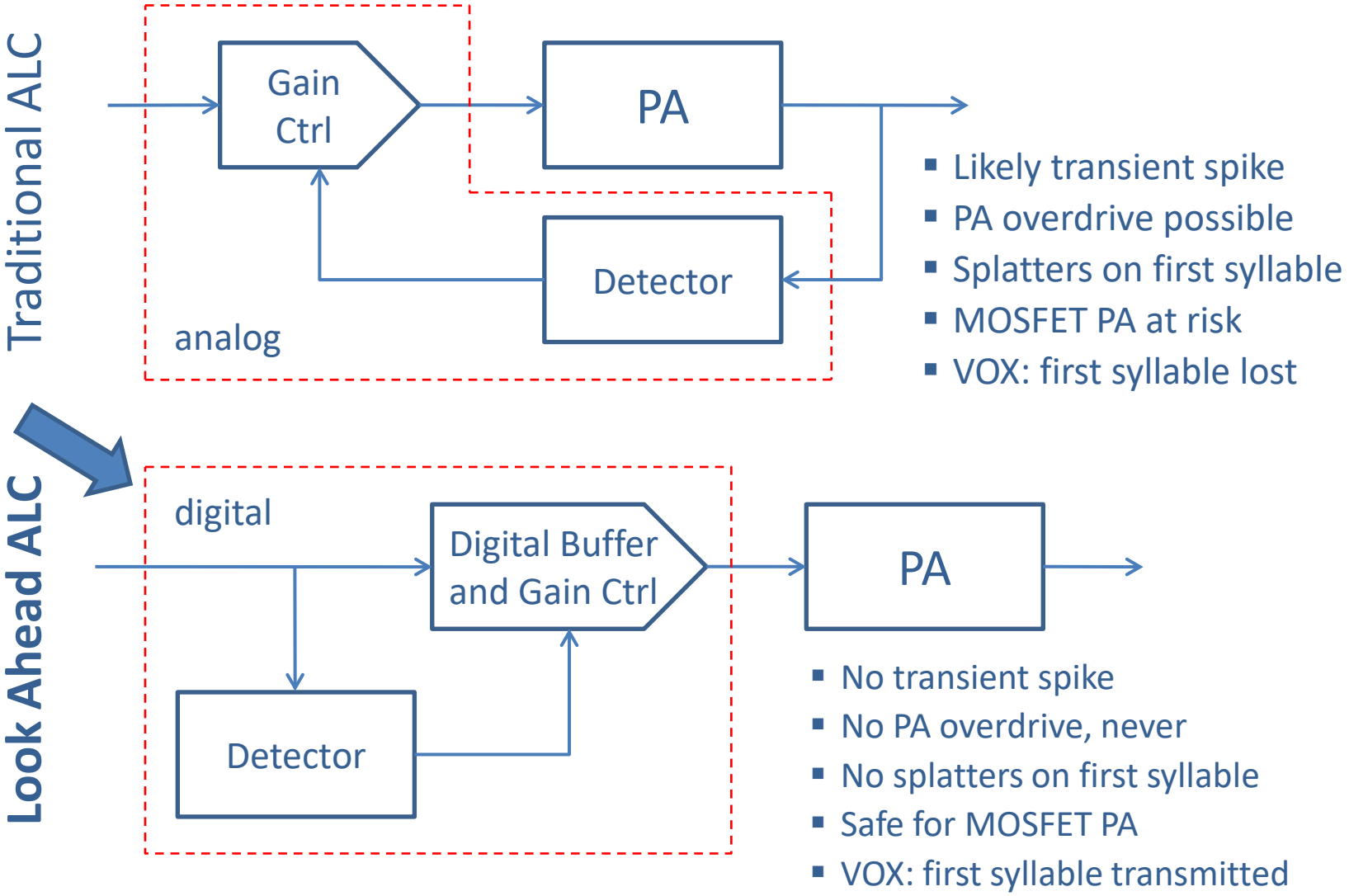


Bias adjusted (reduced) @15W
to get IMD visible @ -20dB

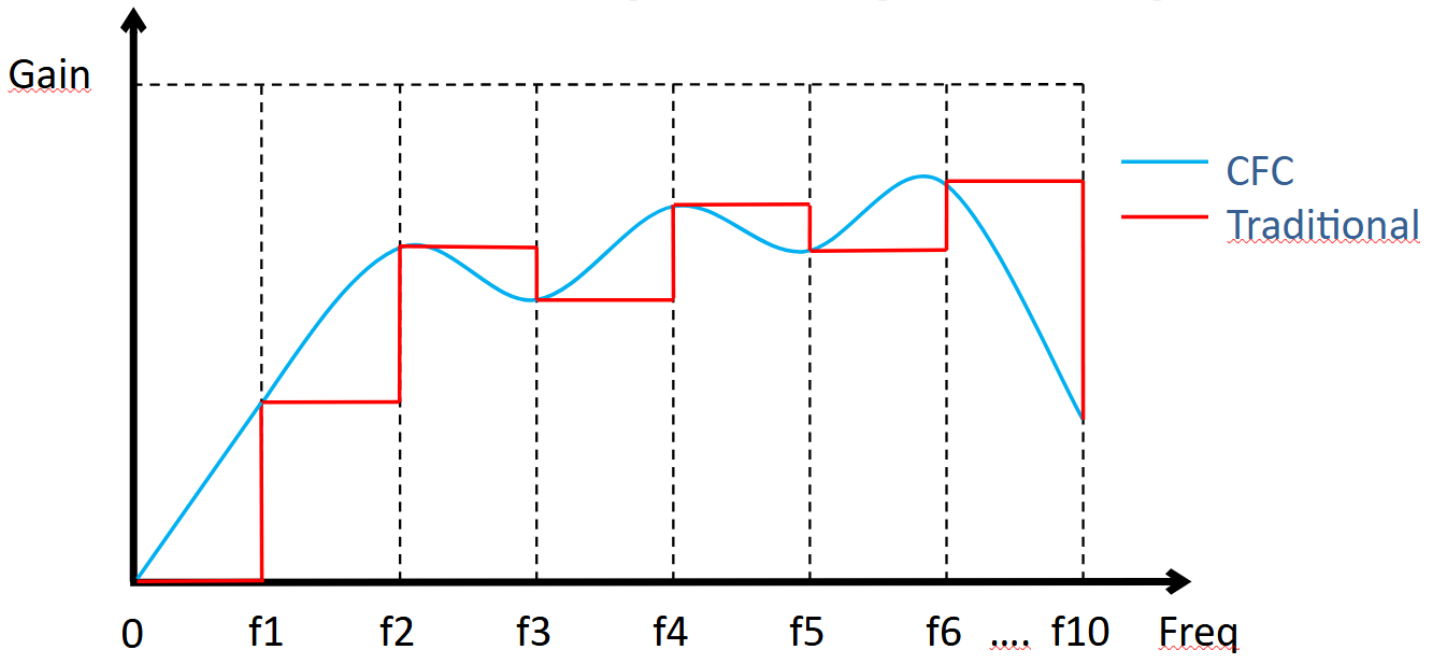


But PureSignal does a great job
even @ 50MHz!

ALC and VOX Look Ahead



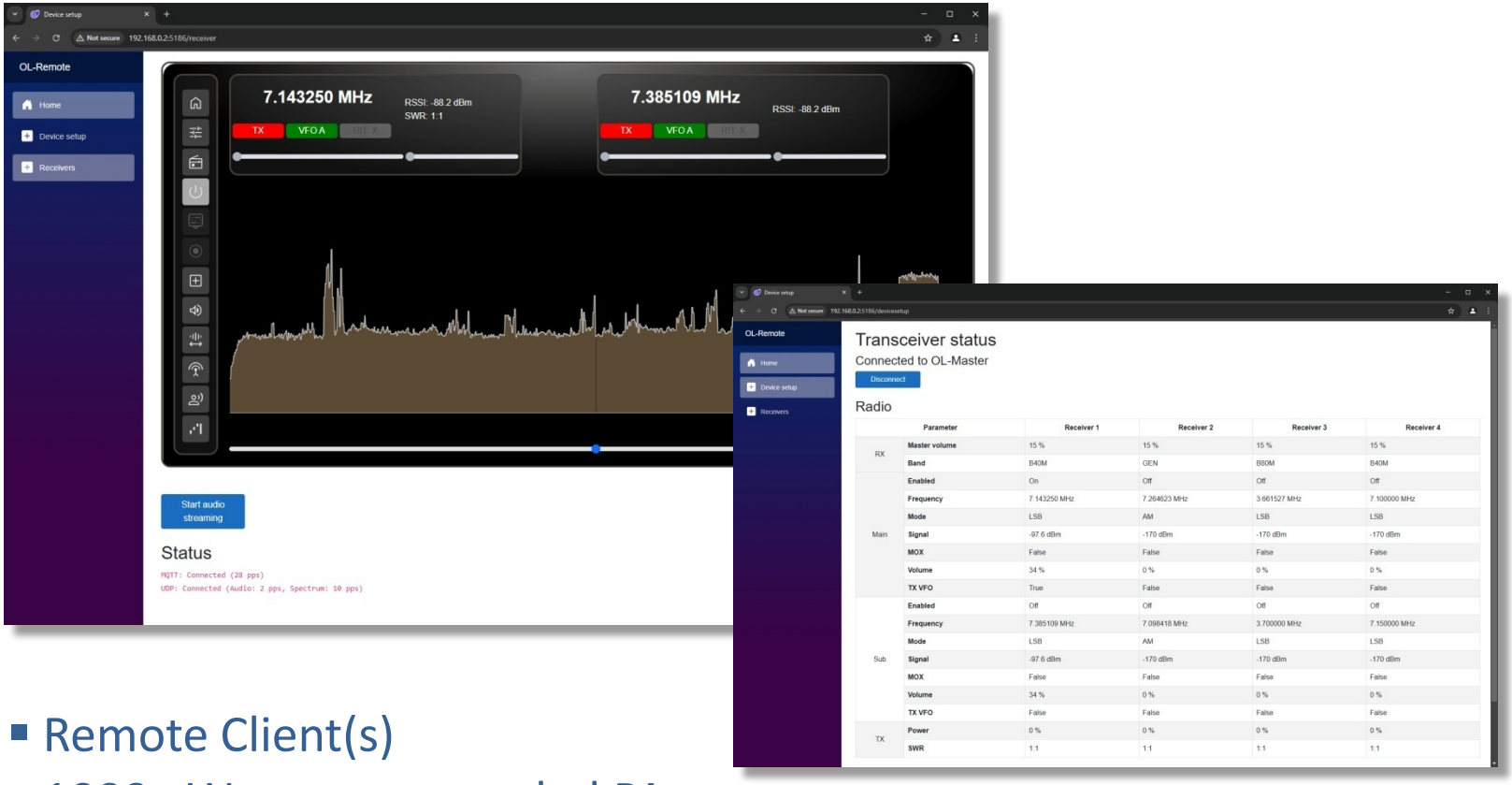
Continuous Frequency Compressor



No step change of gain -> Optimal compression with no artifacts

- Total control on band frequencies and compression level
- Compression level interpolated between bands
- Efficient increase of average power and intelligibility without artifacts
- Designed by Dott. Warren Pratt NR0V

What Next



- Remote Client(s)
- 1000+ Wrms water cooled PA
- SWL RX only version?
- ……..

Thank you for your time

www.olliter.com