JALA
„just another loop amplifier“

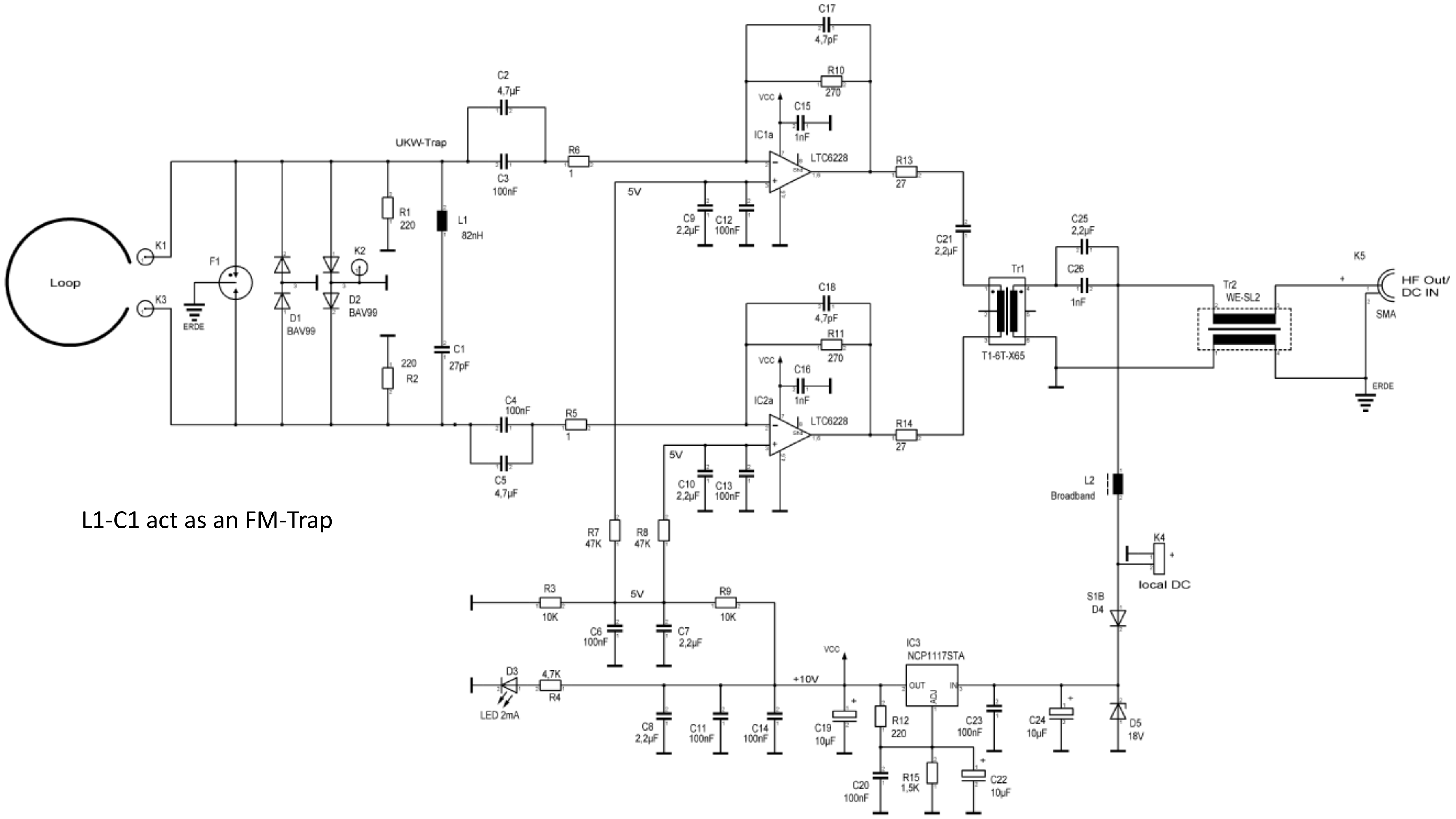
www.dl4zao.de

The objective of this small project is to practically evaluate the suitability of the LTC6228 high-speed operational amplifier as a transimpedance amplifier (current/voltage converter) for a magnetic loop active-antenna. For this purpose a "wide-aperture loop" with 20m (65 ft) circumference for VLF/LF/MW BC-DXing was built. It is planned to perform further tests with a loop amplifier optimized for a 80 cm (2.6 ft) radius loop.

The receive loop is connected to a balanced amplifier that operates in quasi-short circuit mode. The loop Inputs are directly or via a small resistor connected to the inverting inputs of the OP. A negative feedback between the output of the OP and the inverting input achieves a very small input resistance (quasi-short circuit) over a wide frequency range.

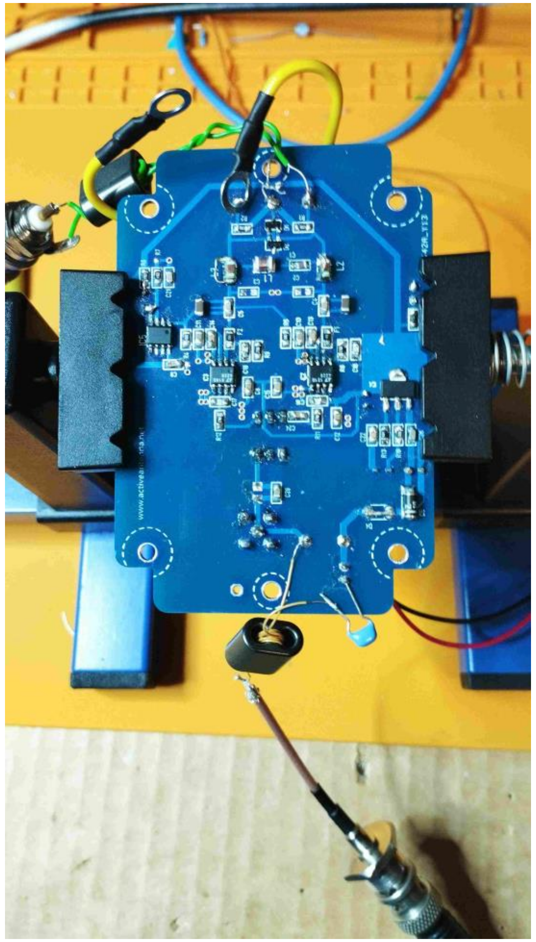
The negative feedback resistor is kept at a low value in order to keep the noise low. The frequency-dependent loop-impedance versus the negative feedback resistor determines the amplifier gain. The gain is high at low frequencies and decreases with increasing frequency.

circuit diagram

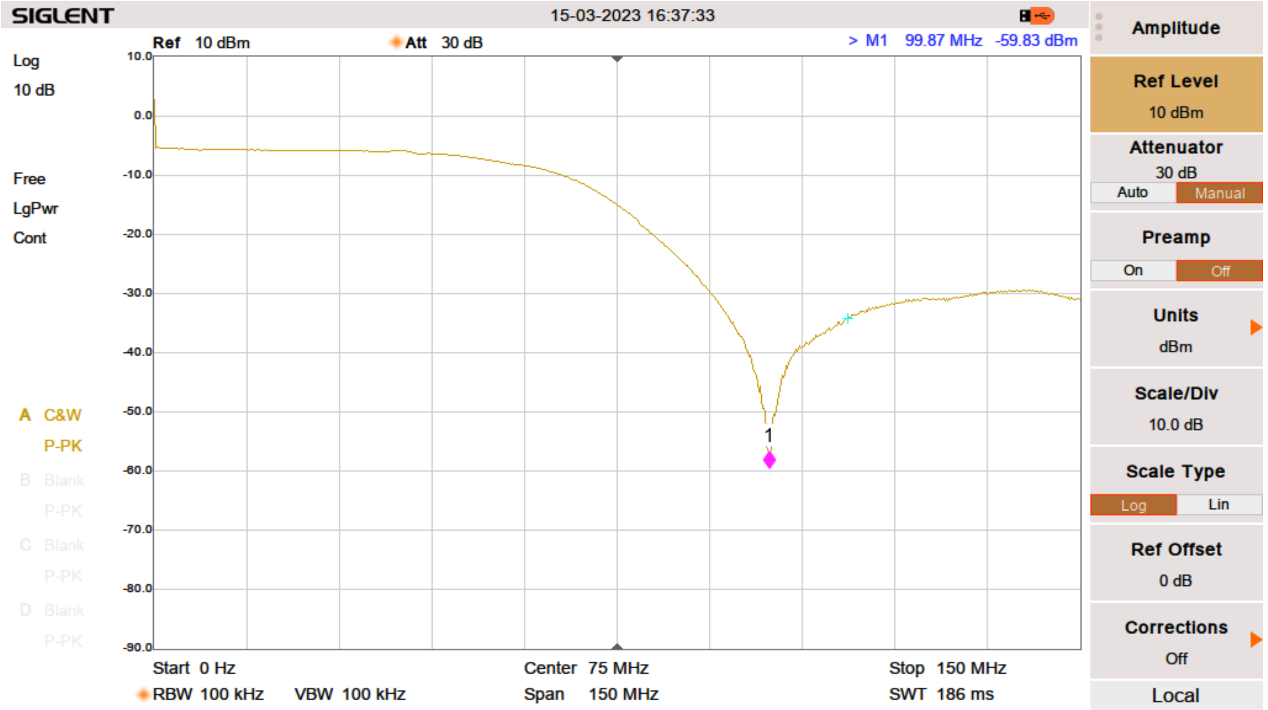


L1-C1 act as an FM-Trap

JALA Transmission characteristics

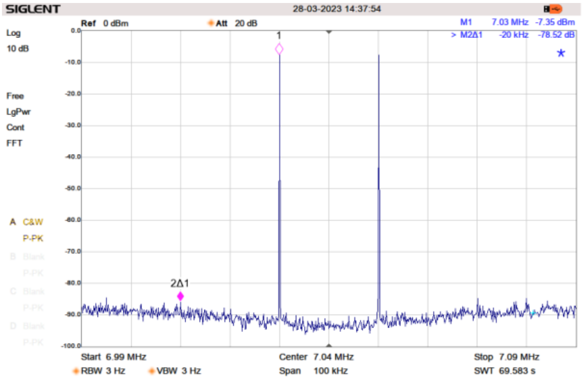


JALA PCB on the workbench



Transmission curve in a 50 Ohms environment. (Siglent Spektrum Analyzer with Tracking-Generator, fed via a ferrite symmetry transformer)

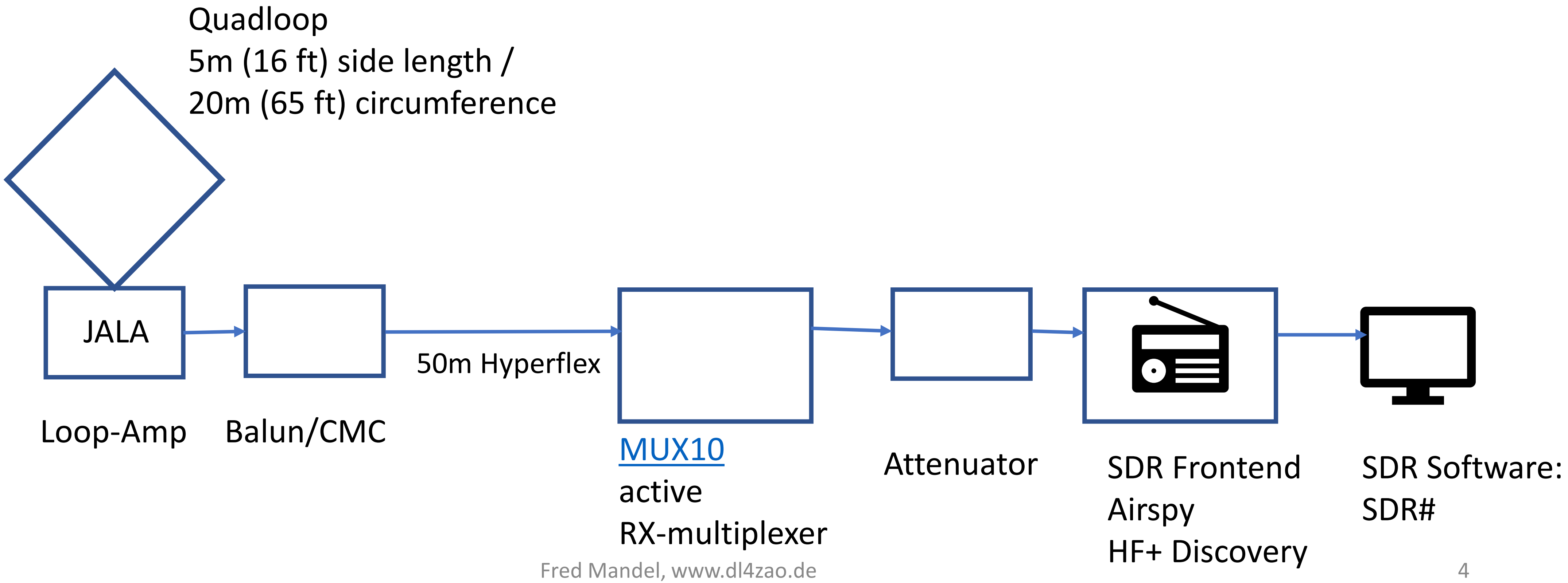
Dip at Marker 1 shows the effect of the fm-trap



2-Tone Intermodulation at 7MHz, -10 dBm Signal Input.

IM-Distance 78,5 dB at -8 dBm signal output level. This calculates to an OIP3 of 31.25 dBm.

Testsetup JALA
RX wide aperture Quadloop



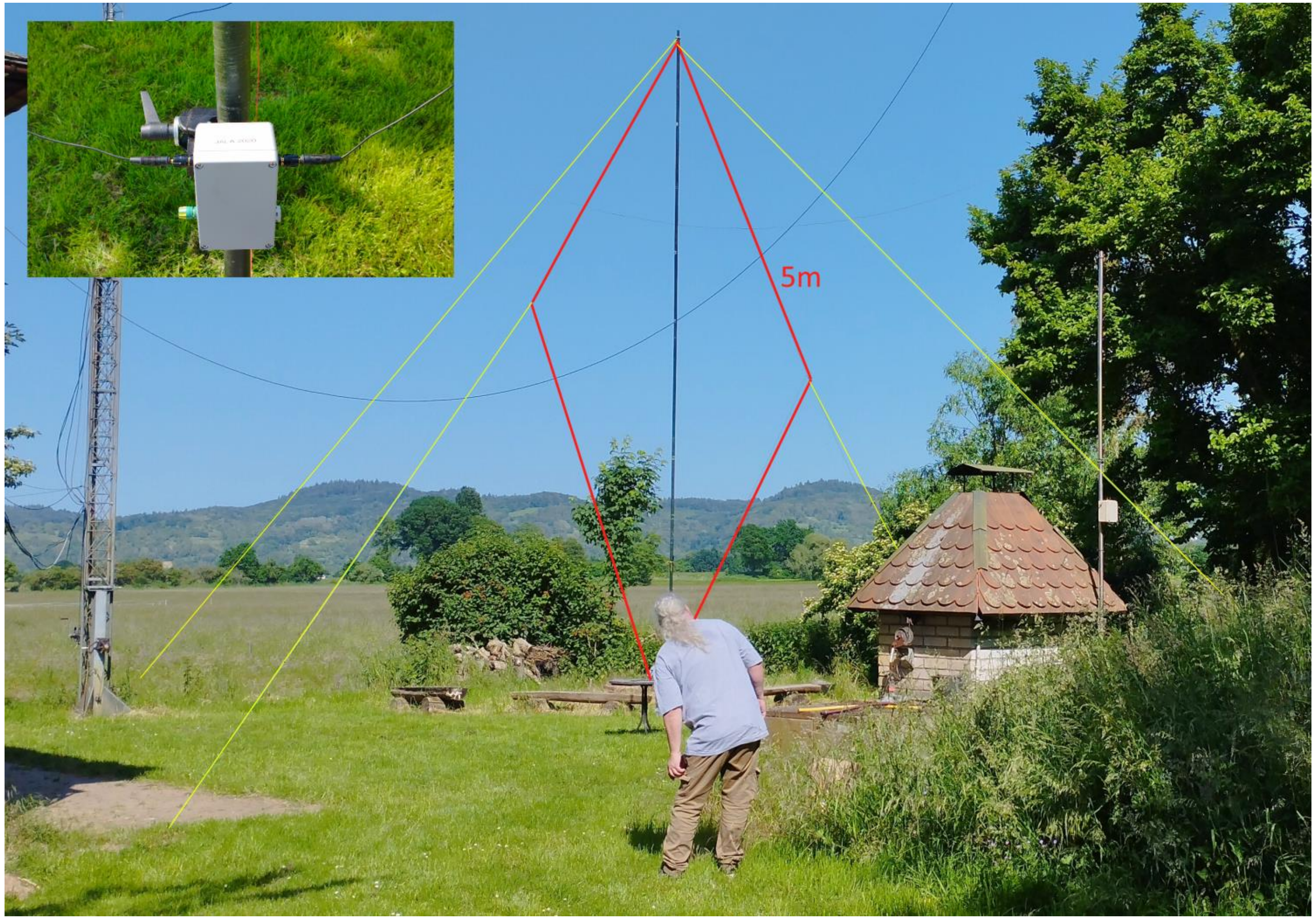
Location and Time

- Testing location was the DLØWH Clubstation property, in Southwest Germany, Grid Locator JN49HN, 2,5 km far from urban areas.
- Test took place on May 27th, 2023 at noon, during maximum daytime attenuation. On Medium Wave and the low-bands only reception of groundwave propagation seemed to be possible. The conditions on the higher shortwave band have been quite good.
- Northeast in 6 respectively 15 km distance are two large active Shortwave transmitting stations. IBB Lampertheim (former Radio Liberty) and IBB-Biblis (former Radio Free Europe). During the cold war both stations had been operated by the CIA, today the entities are financed by the US-Congress board of governors. The stations transmit programmes of Radio Farda, VoA, Radio Free Afghanistan und others. Both are multi Transmitter Stations with up to eleven 100 kW Transmitters on most of the shortwave BC-bands. It‘s high-gain curtain-antenna-arrays are beaming southeast, directly towards our test-site. The ground waves of these transmitters caused very strong signals in the loop antenna.
- The RX used was an Airspy HF+-Discovery. This small device offers an excellent sensitivity of -141 dBm/500 Hz. Because of the high receive levels on the lower bands, it was necessary to put up to 30dB attenuation before the Airspy.
- Strictly speaking, a "wide aperture loop" with a circumference of 20m can only be regarded as a "magnetic loop" broadband antenna for frequencies below 2.5 MHz. Above it behaves like an electromagnetic antenna with resonance ripples. These resonances are apparently damped and could not be recognized during reception. The setup delivered impressive signals with good SNR over the entire HF range.

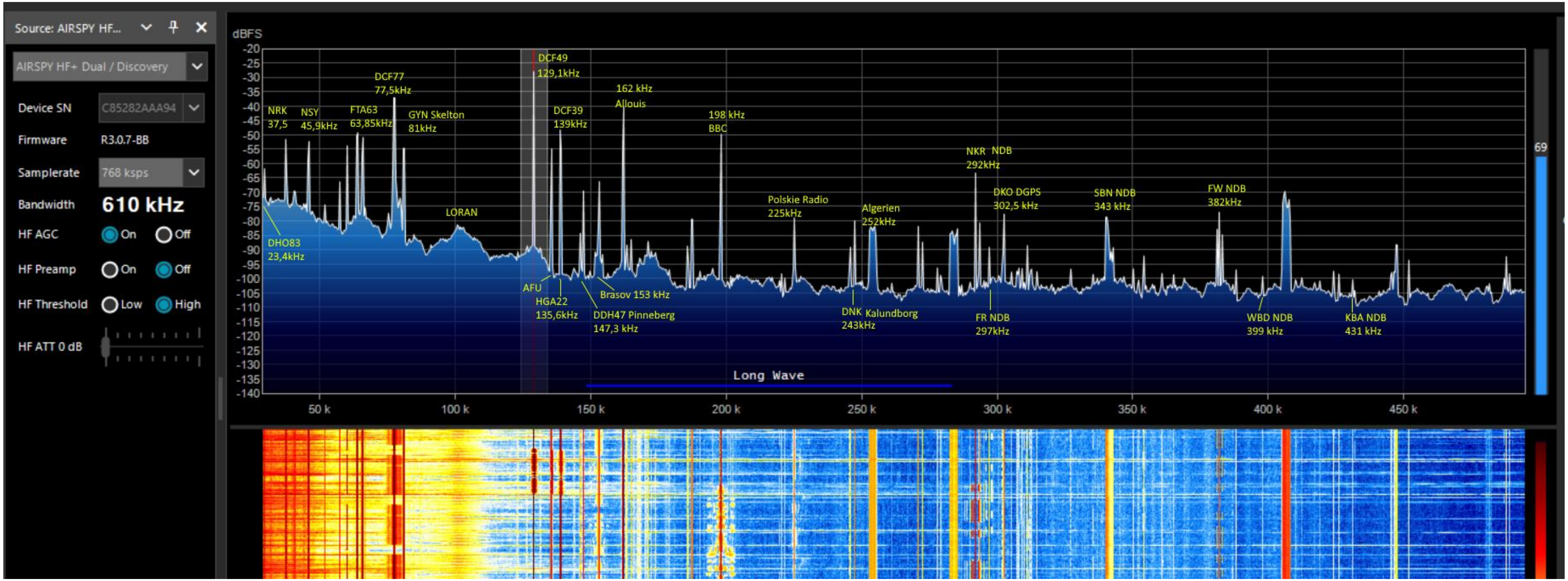
JALA at the 20m Loop

A square wire loop with 5m edge length / 20m circumference served as the receiving loop (highlighted in red)

The JALA is mounted directly under the loop and got remotely powered.



VLF 20 – 500 kHz

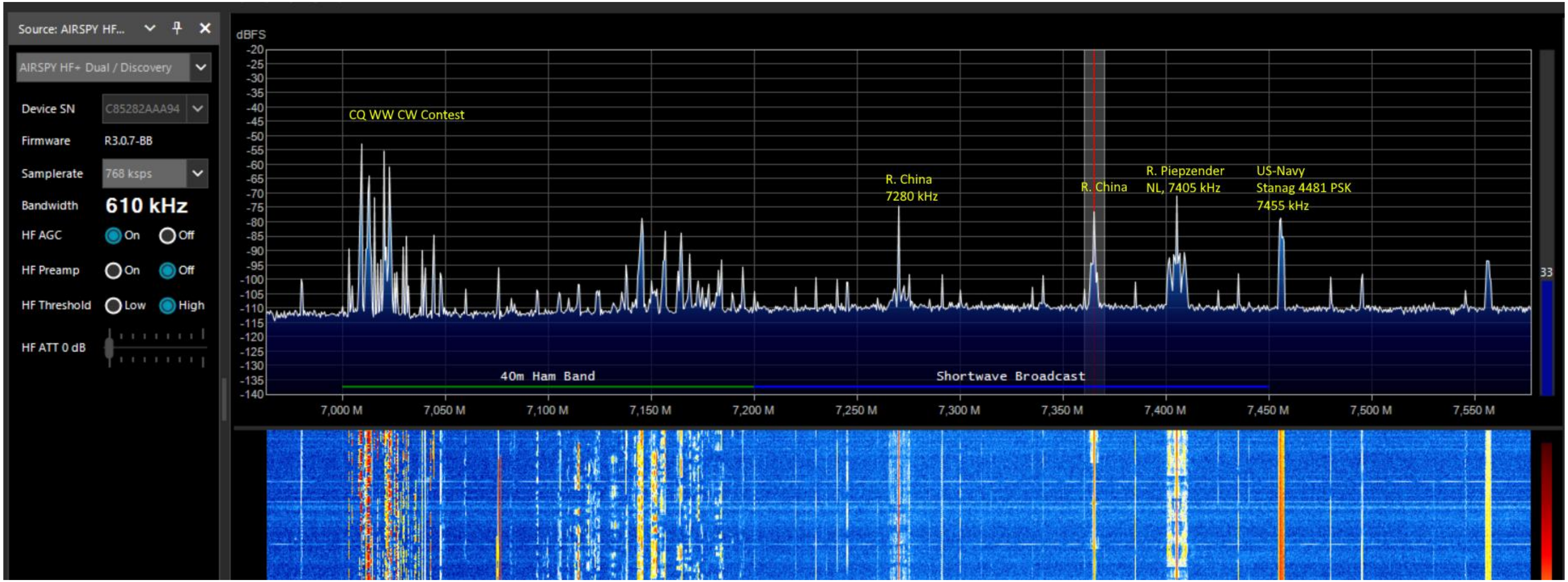


All screenshots taken on 27 May 2023 between 12 and 14 CEST, at the time of the maximum D-layer attenuation. The signals of the received longwave stations and the NDB are ground wave propagation. The noise increase below 150 kHz is partly due to external noise and partly due to very low negative feedback and the gain increase at low frequencies. This ramp can be flatted by adding small resistors in series to the loop. Because of the high signal levels, a 30dB attenuator was inserted between the active antenna and the Airspy HF+ discovery.

MW and 80/160m HAM-Bands

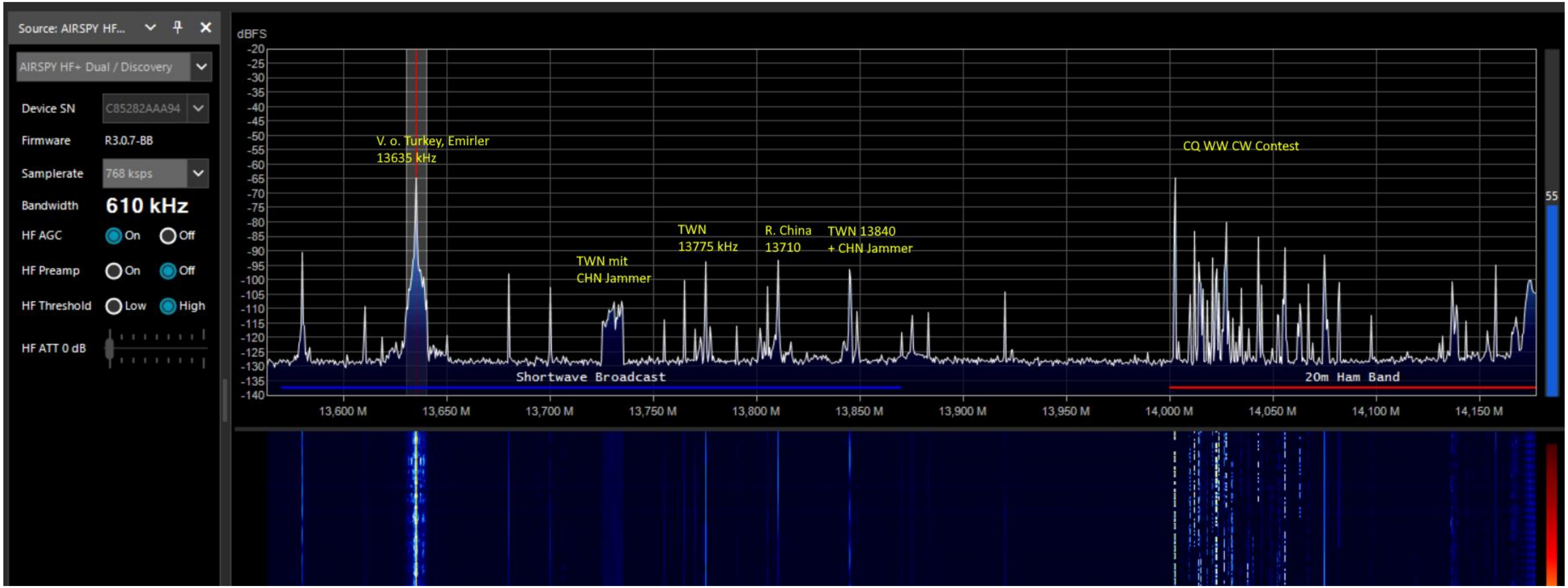
The tests took place on May 27, 2023 between 12 and 14 hrs CEST (UTC +2) at the time of the highest D-layer attenuation at noon mid summer.
Due to the high daytime attenuation, no screenshots of this frequency range were taken.

40m HAM und BC Band



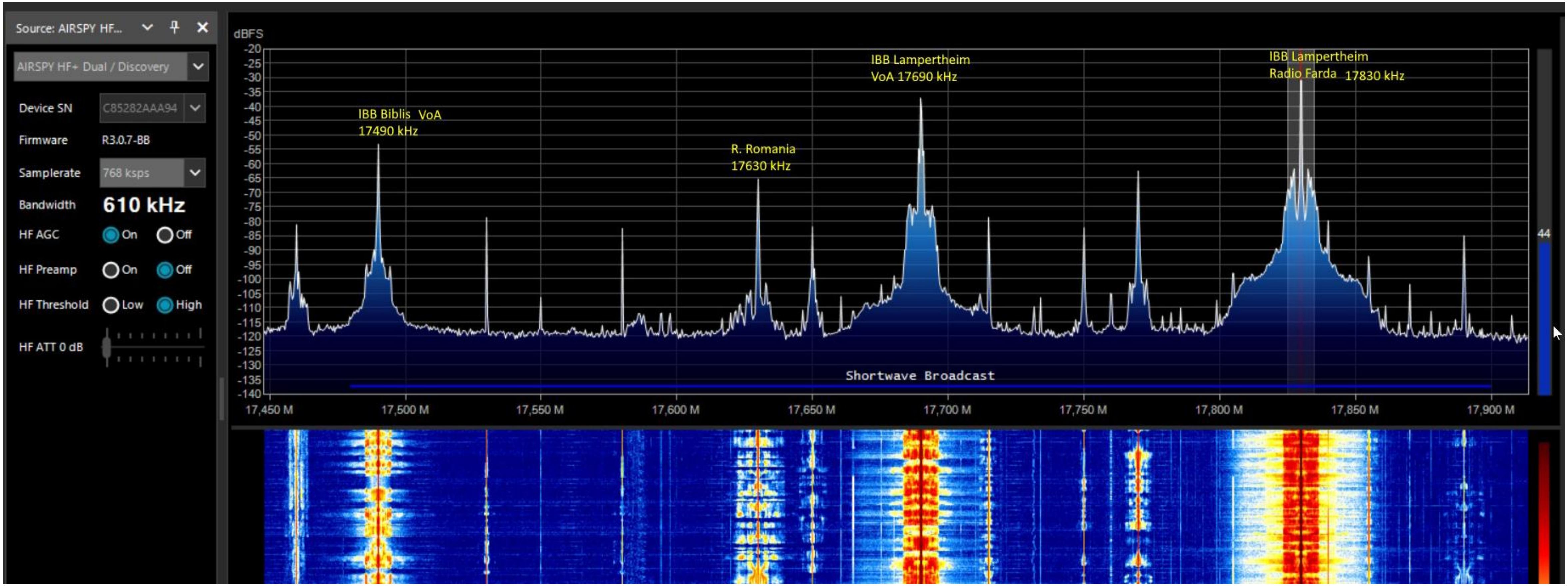
Screenshot 27.5.23, 13 hrs. CEST, 40m and with a 10dB attenuator between active antenna and Airspy HF-Discovery. At the time the CW-WW DX contest was running, the number of strong CW signals is impressive. The SNR is consistently good.

20m HAM and BC Band



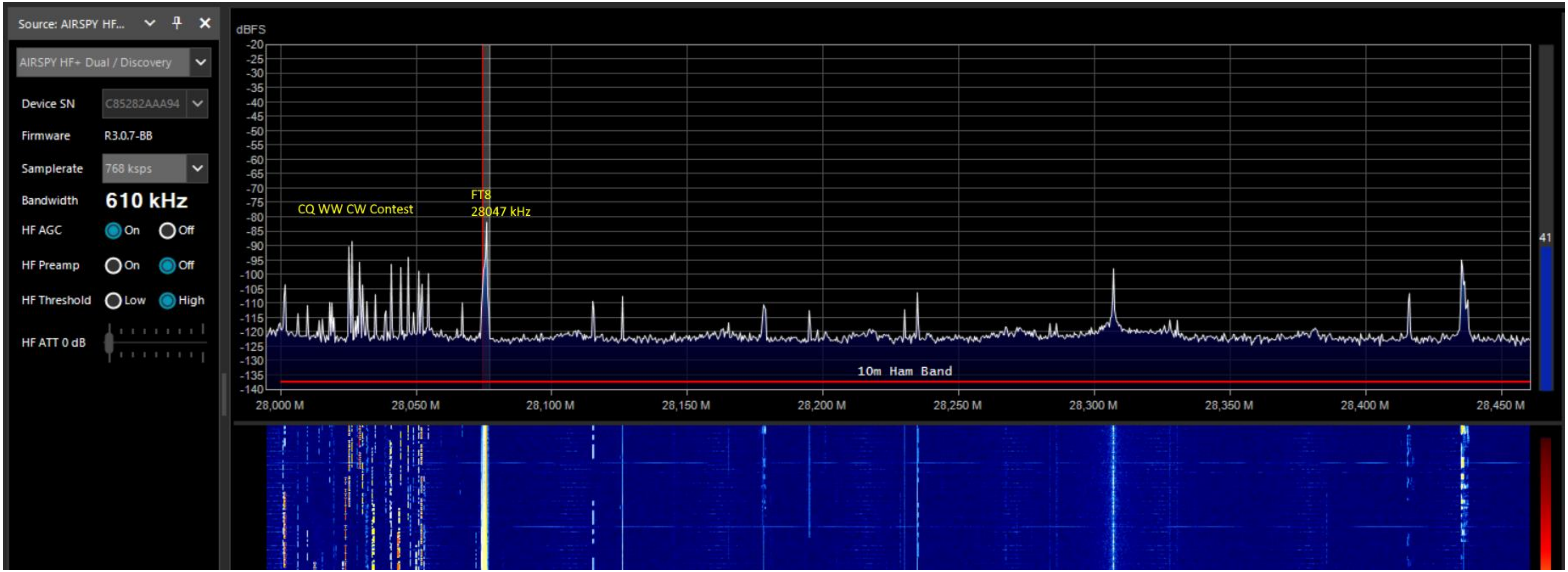
Screenshot 27.5.23, 13 hrs CEST, mit 10dB Dämpfungsglied zwischen Aktivantenne und Airspy HF+-Discovery. Although a loop with 20m circumference can no longer be called a "small magnetic loop" in this frequency range, the reception results are very good. There are no resonance ripples detectable in the noise floor. The SNR is consistently good. Strong CW Signal at 14 MHz are from CQ-WW DX Contest taking place at the same time..

16m BC Band



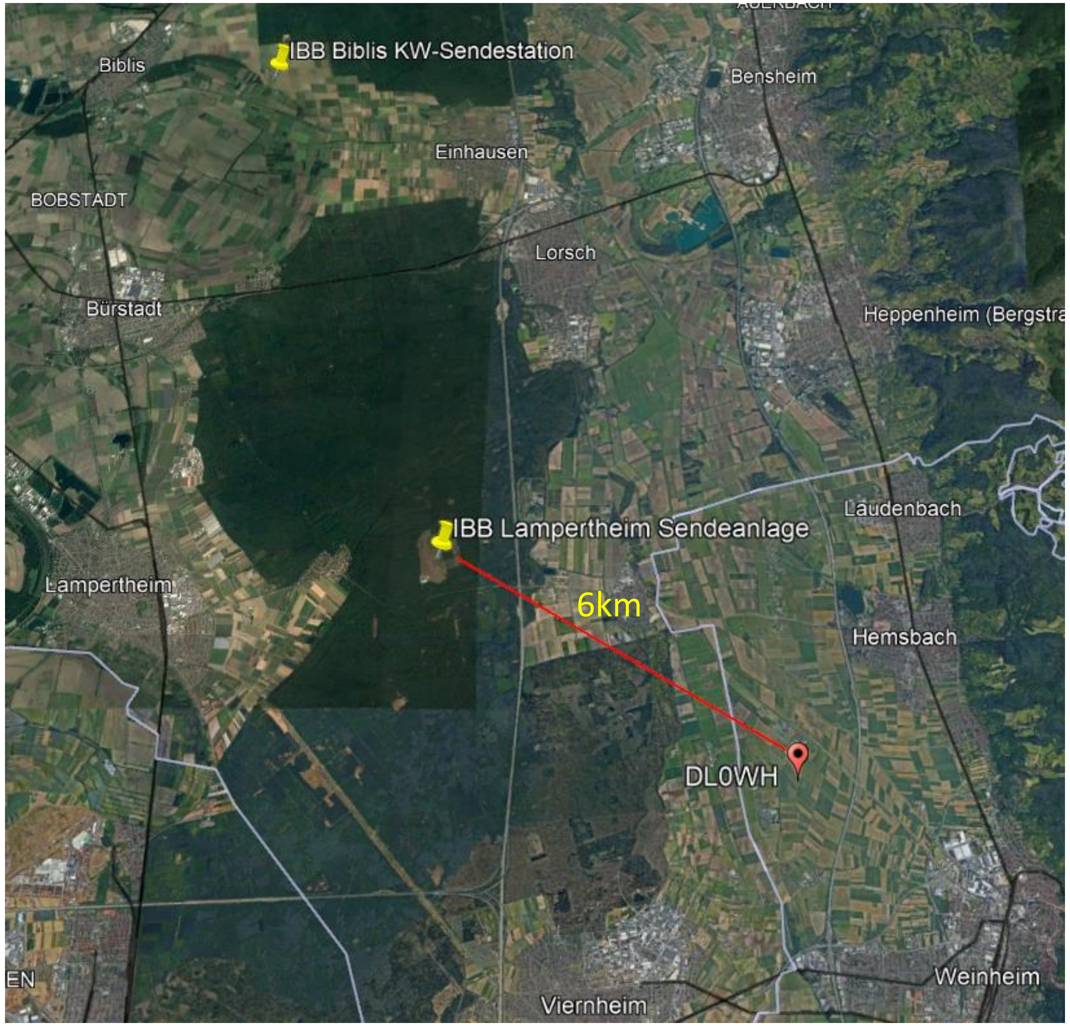
Screenshot 27.5.23, 13 Uhr CEST. Although the loop with 20m circumference in this frequency range can no longer be called a "small magnetic loop", the reception results are good. Brutally strong signals from the nearby SW transmitting stations IBB-Lampertheim (formerly Radio Liberty) and IBB-Biblis (formerly Radio Free Europe). Nevertheless, there are no intermodulation products detectable.

10m HAM Band



Screenshot 27.5.23, 14 hrs CEST, 0 dB attenuation between active-Antenna andAirspy HF+-Discovery. Although the loop with 20m circumference can no longer be called a "small magnetic loop" on 10m, the reception results are good. During testing the CW-WW DX contest was ongoing, therefore the many CW signals in the 10m band.

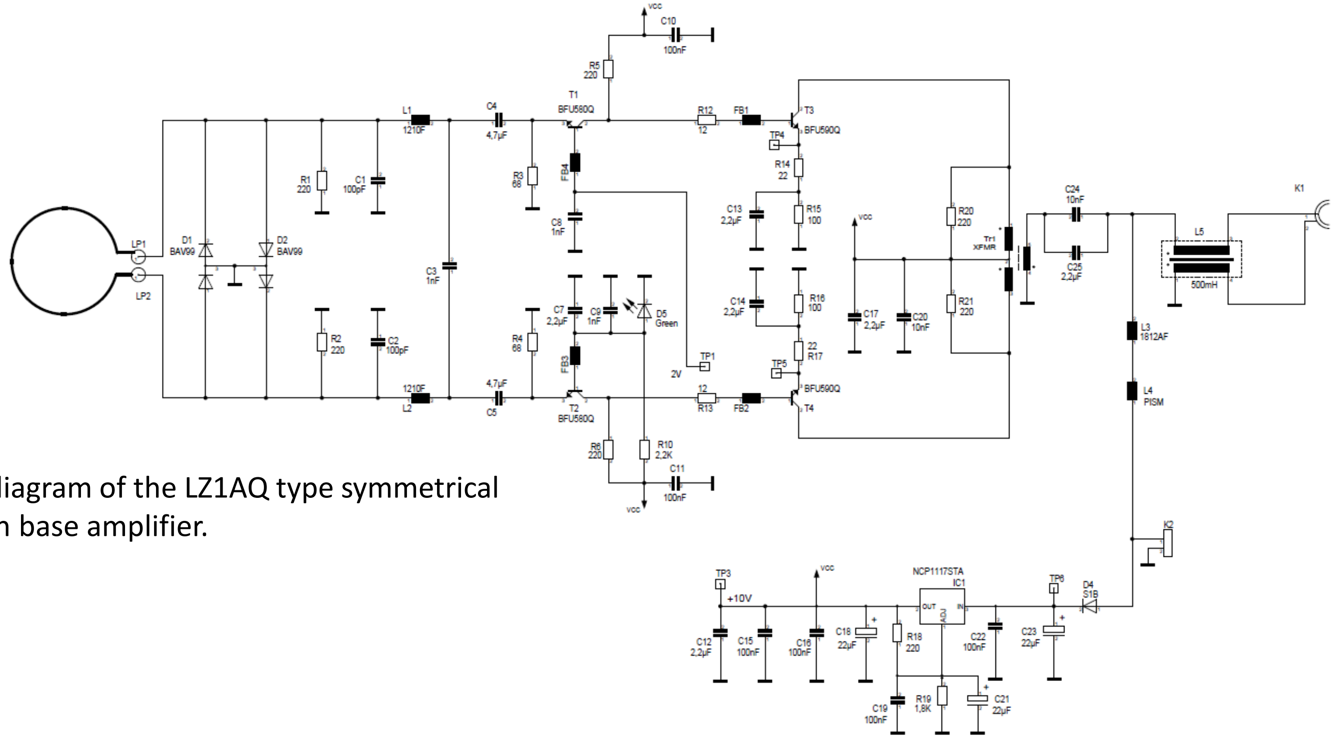
Nearby Shortwave Transmitting Stations



Map view from the test site DLØWH, QRA Grid JN49HN. Northwest in 6km distance there ist a large SW-transmitting station: IBB Lampertheim. A similar HF transmitting station IBB Biblis is 15 km northwest. Up to 21 transmitterx are working in parallel on various SW-Bands, each with 100 KW AM output power. The high-gain curtain antennas are beaming into the direction of the test site causing strong signal levels there.

Planned: comparison tests with a 80 cm loop

It is planned to perform further tests with an 80 cm radius loop later. The gain setting of the JALA will then be optimized for a smaller loop. The brand-new hi-end ELAD FDM-S3 SDR will be used as the test receiver, it is capable to cover 10MHz wide band segments. The raw I/Q data stream of the whole frequency segment can be recorded for off-line post-processing. I intend to use a same sized loop with my proven LZ1AQ type loop amplifier as reference antenna for performance comparisons.



Circuit diagram of the LZ1AQ type symmetrical common base amplifier.