

The Kent 24GHz WebSDR

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Early Days

The 24GHz pioneers had their first QSOs over the North Sea in the mid-1990s. The first recorded crossing of the North Sea on 24.192 GHz was by the late Simon Freeman G3LQR from his home QTH in Suffolk on 23/03/1995 at 22:00. He made his QSO with PA0EHG by Tropo. The first G-ON QSO was a month later between Sam G4DDK near Felixstowe and ON6UG/P via Tropo 24.192. The current UK DX record still stands at 408km between G4EAT JO01HR and PA0BAT JO31FX CW & SSB 17th February 2008.

There has been a steady decline in activity on 24GHz in East Anglia over the last 20 years or so and I've been QRV on the band from home since April 2007, covering the period in question, but have made just 58 QSOs in total with 14 different stations in 5 squares with an ODX of 190km. I live in a poor QTH for the high GHz bands, some 75km from the nearest sea coast but just 4m ASL, surrounded on most sides by trees and line of sight in most directions out to just 20km. One of the frustrations of this is that you miss out on some interesting propagation that is only ever available to well sited and / or coastal stations.

Three things have happened recently that are changing things here in the East.

- Recent availability of inexpensive surplus equipment for the 24GHz band.
- Led by PA0HME's work on the WaveLab modules, there is renewed interest in the low countries and particularly interest in the path over the North Sea.
- The "24GHz North Sea Activity Group" on Telegram [2] has piqued interest of a number of stations in Suffolk, Essex and Kent

Back in the August 2024 RadCom GHz Bands column I reported on some large scale 24GHz North Sea tests with a group of Dutch, Belgian and UK Amateurs setting up 24GHz activity around the North Sea coast.

24GHz is NOT like the lower bands, "misty scatter" discovered by Simon G3LQR seems counter intuitive because atmospheric gas loss plays a far more important role than on the other GHz bands. In particular, water vapour, is a propagation killer, especially for over-sea paths. This all makes the North Sea path, difficult, making it a challenge worth pursuing.

The East Coast 24GHz WebSDR

The idea of building a 24GHz Web SDR to be placed somewhere on the East coast of England came to me when I first discovered the availability of free WebSDR software around 2020 and had some surplus 24GHz parts looking for a project. I experimented with a number of freeware programs and computer platforms, helped in the early days by a number of people, notably Phil Crump M0DNY, but finally settled upon OpenWebRX. [3] I also inherited a very nice commercial 90-degree sector antenna for 24GHz from the Estate of John G4EAT, and I already had all the components to make a 24GHz downconverter.

Project aims

The aim is firstly to study North Sea propagation by enabling 24/7/365 logging of any beacon in range of the WebSDR and secondly provide a reliable site to allow stations to test out their 24GHz systems.

Site requirements

I was particularly interested in studying trans - North Sea propagation, so the search for a site on the East Coast began. The initial plan was to set up on the Essex coast but after a long wait, nothing had come of the site we were pursuing. Then a chance chat with Phil G0JBA got me an introduction to Matt M0LMK and his Thanet Radio Infrastructure group (TRIG) [4] who were very keen to site the WebSDR on their site at Invicta house in Margate, (Figure 1) the home of GB3EK and other repeaters. A few exchanges of email and I realised that the site was almost perfect for what I needed! (Apart from the almost 3-hour drive from the Fen Edge to Margate!). For this reason, I needed the system to be reliable and have secure online ssh access to the WebSDR computer for software maintenance from home, and the ability to cycle the mains power to the unit remotely if necessary. Invicta House a 45m high apartment block on a hill overlooking the coast at 40m ASL. Room for an antenna and plenty of equipment space, 24/7 high speed broadband internet access. No public access.



Figure 1 Invicta House, Margate (Google Earth)

Something to monitor

Looking at the beaconsport.uk records for 24GHz beacons within the beamwidth of my antenna and sensible range of the site at JO01QJ81 produces the following list .

Call	Loc	MGM?	QRB from J01QJ81 (km)	QTF from J01QJ81 (degrees)
PI7ALK	JO22IP61	A1A	266	57
PI7ATV	JO22MA62	A1A	261	73
PA3GCO	JO21EU	PI4	211	74
PE1LXX	JO21PQ06	A1A	268	81
PE9GHZ	JO11WM58	F1A	172	83
ON0HVL	JO10KS58	A1A	123	122
GB3PKT	JO01MT22	JT4G	54	331 (out of main beam)

This is a perfect spread of beacons within the antenna plus a reliable 24/7 reference source (GB3PKT) to check everything is working.

Project pilot phase

The GB3PKT beacon at JO01MT22 is 12 m ASL was built by me and operates on 24.048945GHz. It has a GPS disciplined oscillator and outputs 7 W ERP to an omnidirectional slot antenna. Transmissions alternate each minute between WSJT-X's JT4G sub-mode and a carrier with CW identification. The pilot feasibility study was to monitor this beacon over the 54 km test path over the Thames Estuary, the path glancing the sea surface. The first phase SDR receiver used a masthead down-converter to a 400 MHz IF and connects to a Raspberry Pi3 controlled SDR running OpenWebRX. The pilot SDR, was an RTL-dongle. Gwyn G3ZIL from the RSGB Propagation Studies Committee [5] and HamSci [6] wrote monitoring code for the feasibility study. HamSCI's upper atmosphere and space physics focus has drawn on ionospheric measurements by radio amateurs using protocols including WSPR, precision measurements of standard frequency transmitters WWV and CHU and systematic information gathering into accessible databases. Gwyn adapted these techniques for the pilot system for monitoring tropospheric propagation on 24 GHz. The data monitoring software, based on early WsprDaemon, uses WSJT-X wav files. It logs the basic data of callsign, SNR and frequency from JT4G and signal and noise levels from carrier-only transmissions. SNR derived from carrier measurements shows greater resolution and dynamic range than from JT4G. Measurements of frequency with lower scatter are obtained from cross correlating the JT4G signal with its sync vector, finding the peaks via continuous wavelet transform then interpolation. Marine environmental data that may influence propagation was collected from a moored Lightship, including air and sea temperature, relative and absolute humidity and wave height. Rain rate is from a shore station near the transmitter. Radio and environmental data go to a Timescale database with a Grafana dashboard for visualisation. Although the distance separating environment and radio measurements preclude accurate assessments, encouraging semi-quantitative effects on propagation were observed. These included signal drop out at absolute humidity above 8 g/m³; increased variance of frequency with wave heights above 1 m; signal level reducing gradually by 8 dB during the passage of a cold front with a band of rain up to 1 mm/hour.

First Setback

The pilot ran from July to October 2024, but during the period we noticed that the on-site 70cm repeaters were breaking in to the 400MHz IF and overloading the RTL SDR. At this point we decided that in the next phase we needed to improve the indoor unit receiver with an IF filter and upgrade the SDR hardware. Our hand was further forced in October when suddenly, during a storm, the receiver failed completely, and no further signals were seen from GB3PKT.

Pilot phase results

- GB3PKT beacon at Clacton was receivable 24/7 over the 54 km sea path.

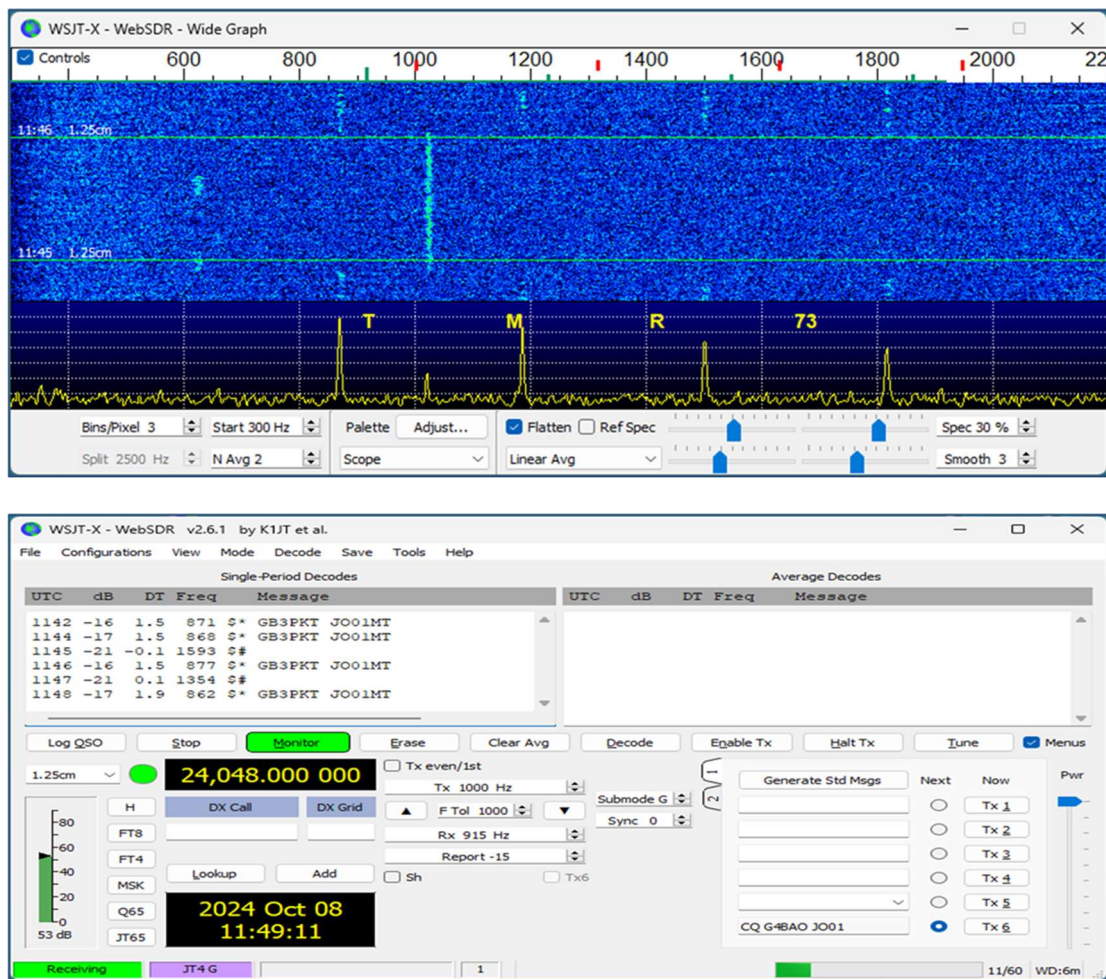
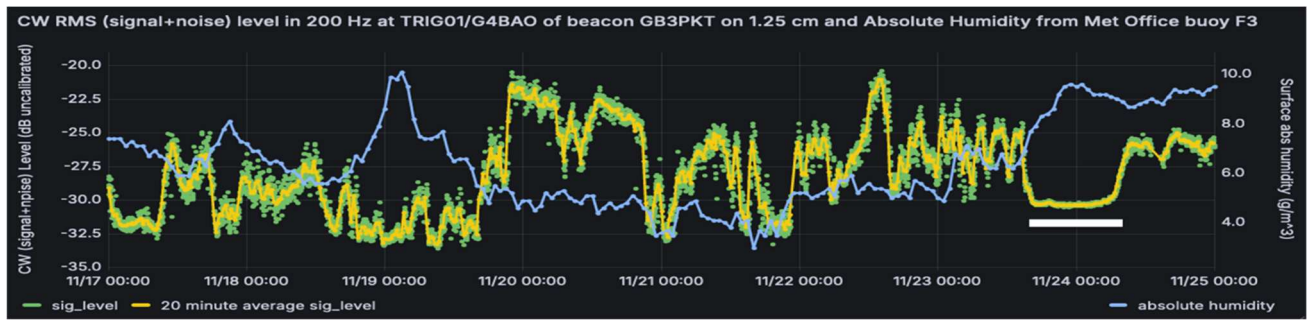


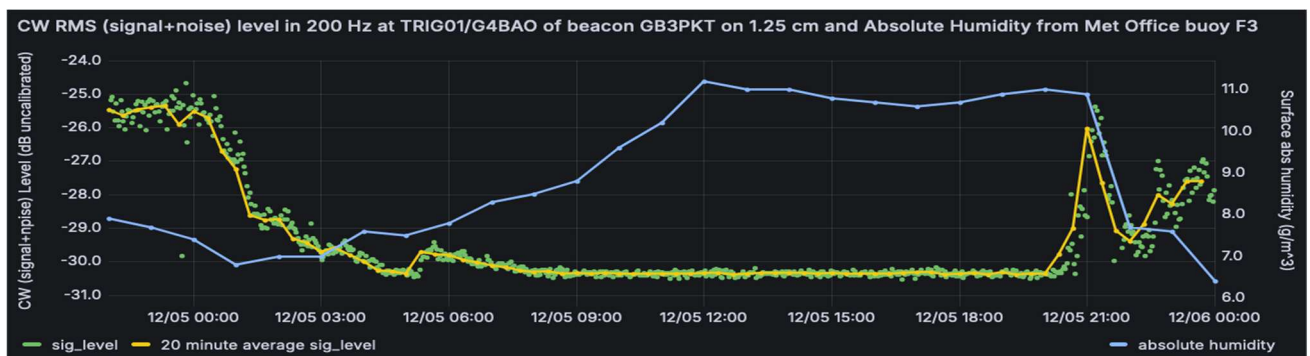
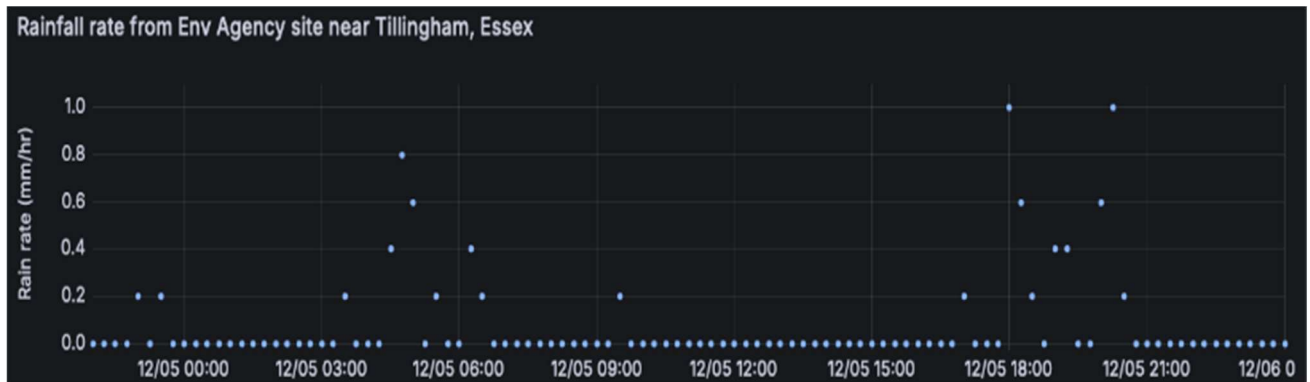
Figure 2 GB3PKT during the Feasibility Study

In relation to weather related phenomena, encouraging semi-quantitative effects on propagation have been observed. These include:

- Signal drop out (Yellow line below) at absolute humidity above 8 g/m³ (blue line) during the period shown with a white bar.



- Signal level reducing gradually during the passage of a cold front followed by a band of rain up to 1 mm/hour and the associated rise in absolute humidity. Signal recovered as absolute humidity fell.



Main Phase 1

Rebuild Part 1 - Indoor Unit Hardware description

Based on the results of the pilot, the indoor unit was improved with the addition of an IF filter consisting of a PMR base station duplexer configured as a 400MHz low pass filter with >70dB loss above 430MHz. The OpenWebRX Software was moved to a Raspberry Pi5 and the RTLSDR replaced by an Airspy R2 with modified software to allow it to be locked to the same Leo Bodnar GPSDO at 123.16667MHz used as the 24GHz Downconverter LO.

As before the 12V DC supply, 123.16667MHz LO drive and 400MHz IF signal are all multiplexed to/from the outdoor downconverter via a single coaxial cable. The Leo Bodnar unit has a GPS connection to external GPS antenna.

I decided to modify the firmware of the Airspy R2 to use the same external LO reference 123.16667MHz as the Downconverter. All the code for the Airspy is open Source and available on GitHub.

One interesting issue with the R2 was resolved in the process. As both the Leo Bodnar GPSDO reference and the Airspy are powered from Raspberry Pi USB ports, at switch on they both get power almost simultaneously. The upshot of this is that the Airspy is ready a short while before the Leo Bodnar produces output, and defaults to its internal 10MHz reference not the external GPSDO. As it's impossible to separately control the USB power outputs from individual ports on the Pi I had to put a USB power switch between the PI and the Airspy controlled by GP105 and write a CRON routine to delay the application of power to it until the GPSDO was ready. This meant that it always locks to the external reference on power up.

We visited the site again in May 2025 and installed the rebuilt indoor unit, but on arrival it was clear that there were more serious issues to deal with. The coax to the outdoor unit was dripping water and Fig 3 shows why, once we stripped back the coax a little.



Figure 3 The coaxial cable damage

We removed the outdoor unit from the mast, opened it up and found that at some point it had been one- quarter full of water! Figure 4 shows the serious corrosion.



Figure 4 The inside of the box after its soaking

Nothing more to do then. than to take it home and rebuild it in a new box. In the meantime, the indoor unit was left in situ and running without a downconverter. No signs of any IF interference were seen with the improved receiver.

Rebuild part 2 - Outdoor masthead Unit

I managed to rescue some of the 24GHz Downconverter parts. The LO multiplier unit was intact, as was the antenna and 24GHz image filter. These only needing a clean-up. The LNA was beyond economic repair so that had to be replaced. An EME – grade LNA was sourced, a completely new enclosure was built and much more care taken over waterproofing with a proper “waveguide-through-box” from a professional microwave link and the addition of a breather plug and sealed grommet for the coaxial feed.

Results

The rebuilt WebSDR was returned to service in July 2025 and is currently operating very successfully. So far, we are seeing much improved JT4G signals from GB3PKT, compared to the Pilot study results (see Fig 2). It now averages around -8dB JT, occasionally dropping out to almost zero We have also seen PI4 Decodes from the Rotterdam beacon PA3GCO and at one point, 599 RS signals from the Flanders beacon, ON0HVL, which at the time of writing is running into a 30cm dish pointed at the Web SDR.

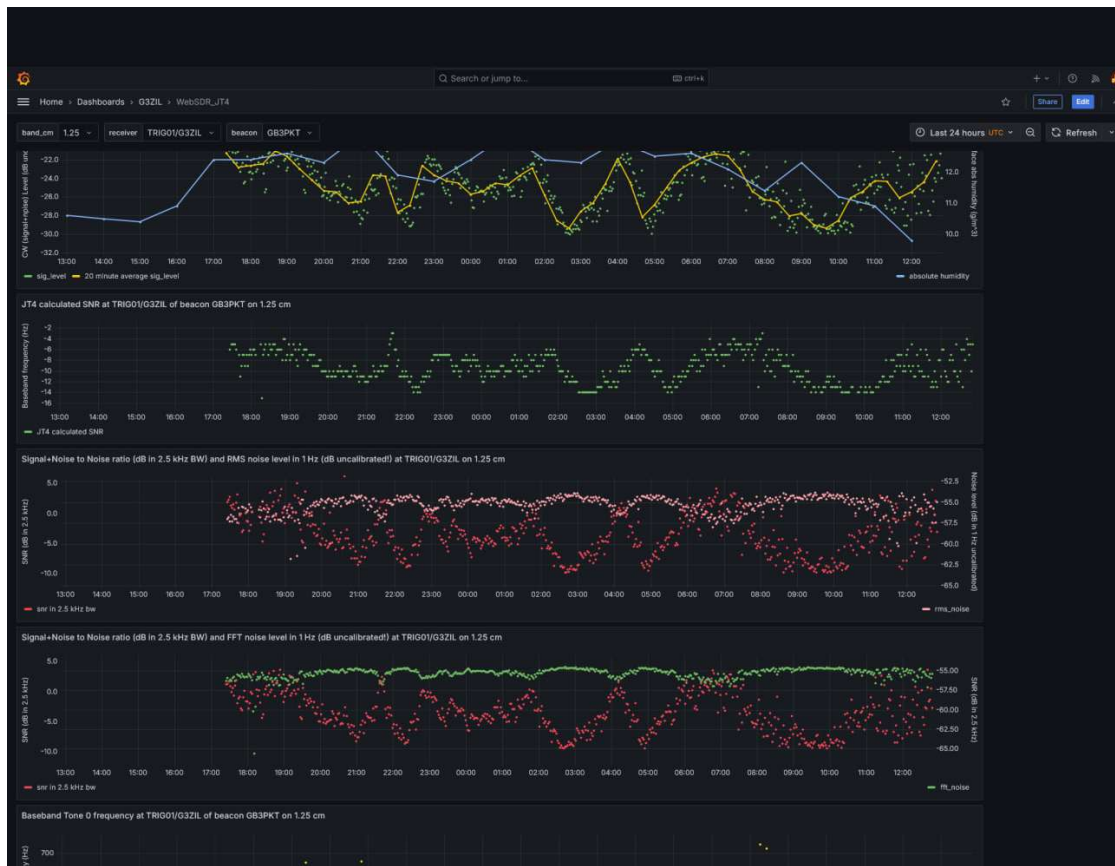


Figure 5 Some output from the Grafana database



Figure 6 The outdoor unit just below the 3element 70cm Yagi

Next – main phase 2

Main Phase 2 of the project is to continue monitoring GB3PKT with the existing software and write software to allow monitoring for the PI4 signal from PA3GCO. Next stage will be to work out a means to simultaneously monitor any signal within

the frequency range of the WebSDR. For this we will be looking into running the KA9Q radio SDR toolkit on the Raspberry PI 5

Final thoughts

24GHz is one of the few areas of amateur propagation investigation still left open to us. Contacts within Ofcom tell me that they still seem to think there is much to learn about 24GHz and above. Stations living near the coast or at least within the maritime influence, could contribute quite a lot. For example, the effect of all those offshore wind generators on 24GHz is worthy of investigation and Nick G4OGI has made a good start on this.

24GHz sea path propagation research was the main reason (apart from the fact I had all the parts in my junk box!) that I chose 24GHz not 10GHz for the Kent WebSDR. We know what 10GHz does, pretty much, but since the early pioneering days, little further has been done on the 24GHz North Sea path.

Activity is building on the band with the availability of cheap surplus, we have a real opportunity window here.

Acknowledgements

Thanks go to the following people who have helped make this happen.

- Gwyn G3ZIL for the logging software
- The RSGB Propagation Studies Committee, membership of which enabled me to meet G3ZIL
- The UK Microwave Group for help in funding the Project
- The members of the 24GHz North Sea activity group on Telegram for encouragement and testing assistance.
- Last but very much NOT least, the team at Thanet Radio Infrastructure Group for allowing me to use the site and doing the “ladder work” and Network infrastructure on the install namely: M0LMK, M5AAD (who took the photo below) and G0JBA



Figure 7 L-R G0JBA, G4BAO, M0LMK on the roof of Invicta House – Photo M5AAD

References

1. URL for the Kent 24GHz WebSDR: <http://trig01.ddns.net:8073>
2. Telegram:- <https://telegram.org/>
3. OpenwebRX: - <https://www.openwebrx.de/>
4. Thanet radio Infrastructure group: - <https://www.trig.org.uk/>
5. PSC: - <https://rsgb.org/main/about-us/committees/propagation-studies-committee/>
6. HamSci: - <https://hamsci.org/>

Appendix 1 – The WebSDR hardware

Outdoor unit (ODU)

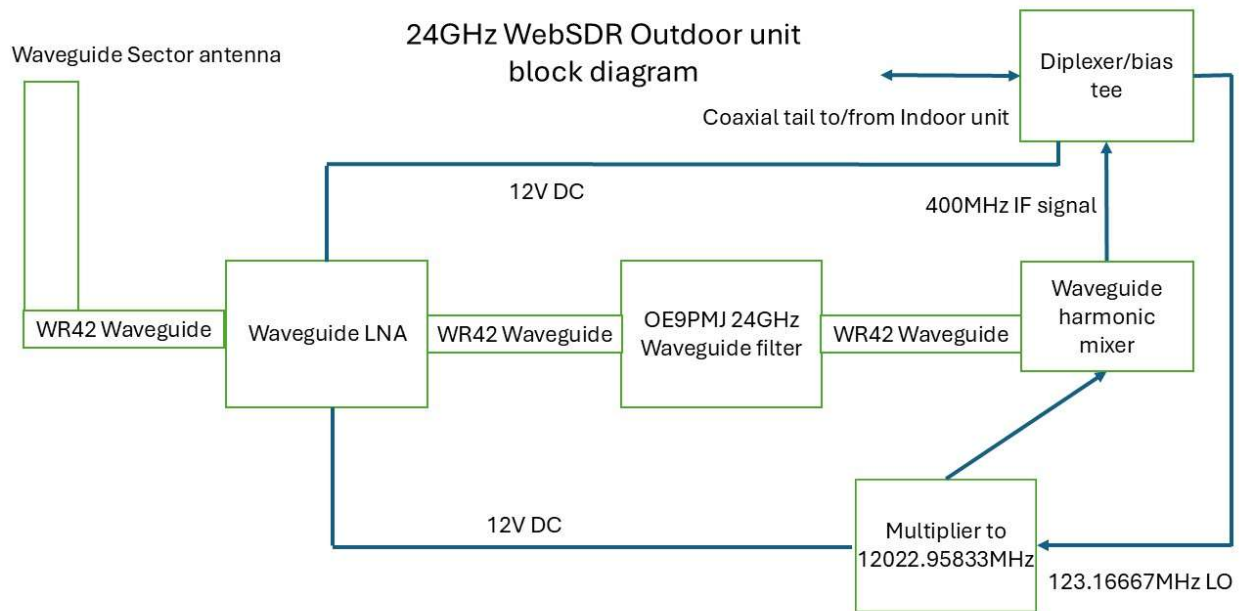


Figure 8 Outdoor unit block diagram



Figure 9 Outdoor unit hardware

ODU Parts list

- 24GHz waveguide preamp Kuhne MKU-LNA2423 RX2
- OE9PMJ design Kuhne MKU BPF 24-3-WR42, 24 GHz bandpass image filter
- MARKI MICROWAVE M97143 WR34 Waveguide harmonic Mixer
- Kuhne 12GHz Multiplier to 11824MHz (1/2 LO)
- Antenna - commercial dual polarisation 90-degree waveguide sector antenna (uses Horizontal connection)

Indoor unit (IDU)

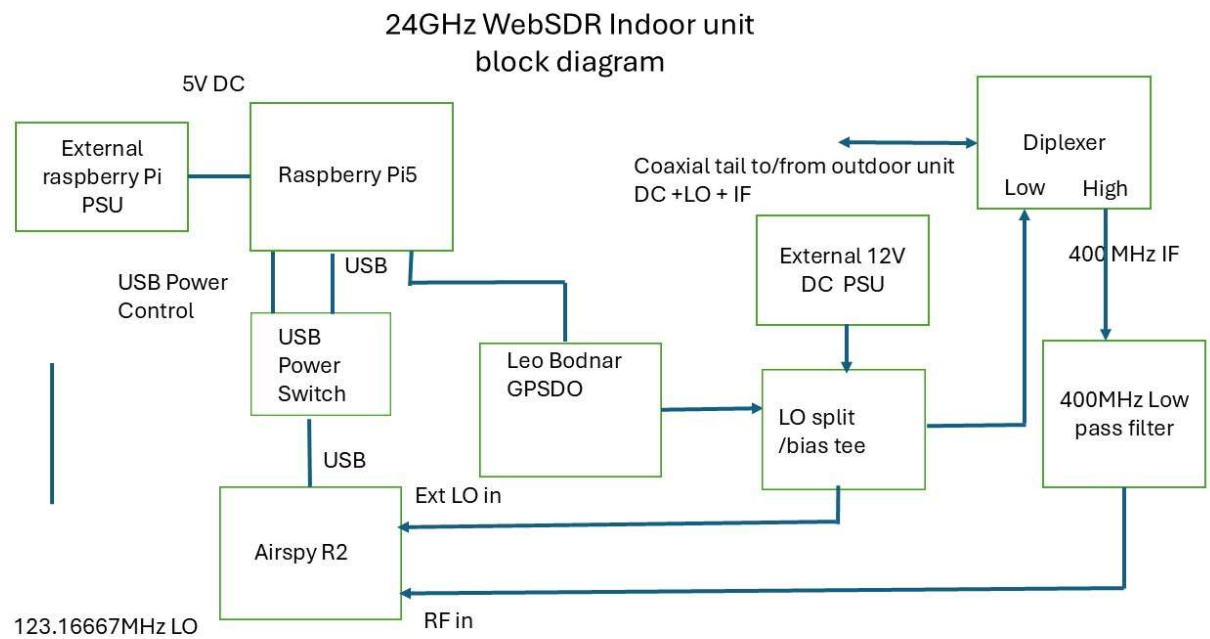


Figure 10 Indoor unit Block Diagram

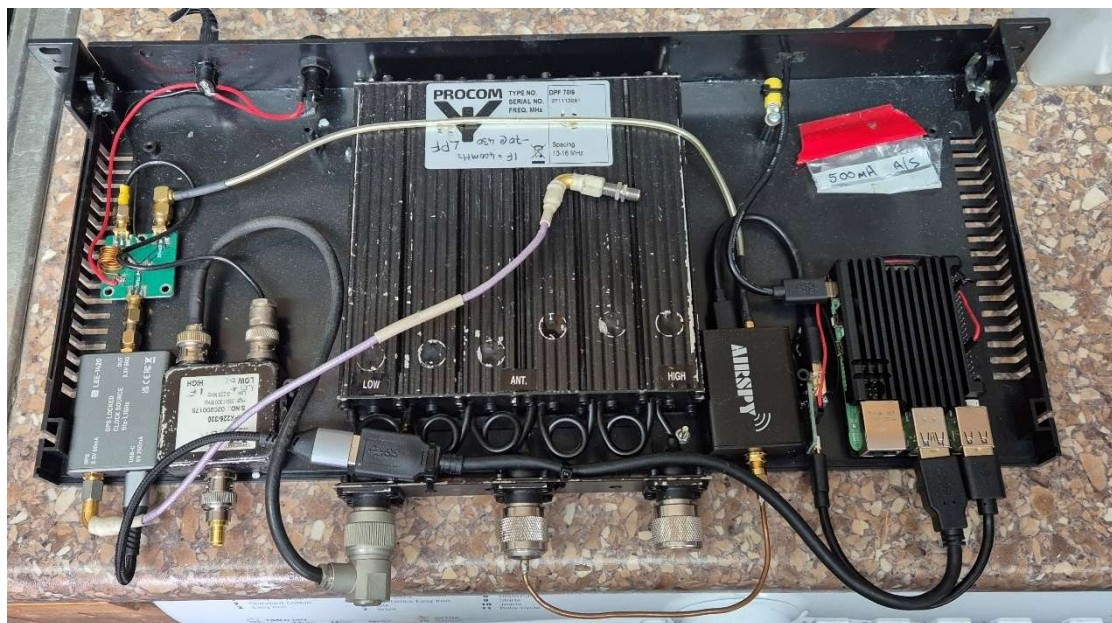


Figure 11 Indoor unit hardware

IDU Parts list

- Leo Bodnar LBE140 GPSDO
- Procom DPF70-6 Duplexer (LPF)
- Procom DPX225/330 duplexer
- Airspy R2 with modified firmware
- Raspberry PI5 4GB with PSU
- USB power control Switch
- LO resistive RF splitter and bias tee
- 12v DC unregulated linear PSU