Decoding satellite telemetry

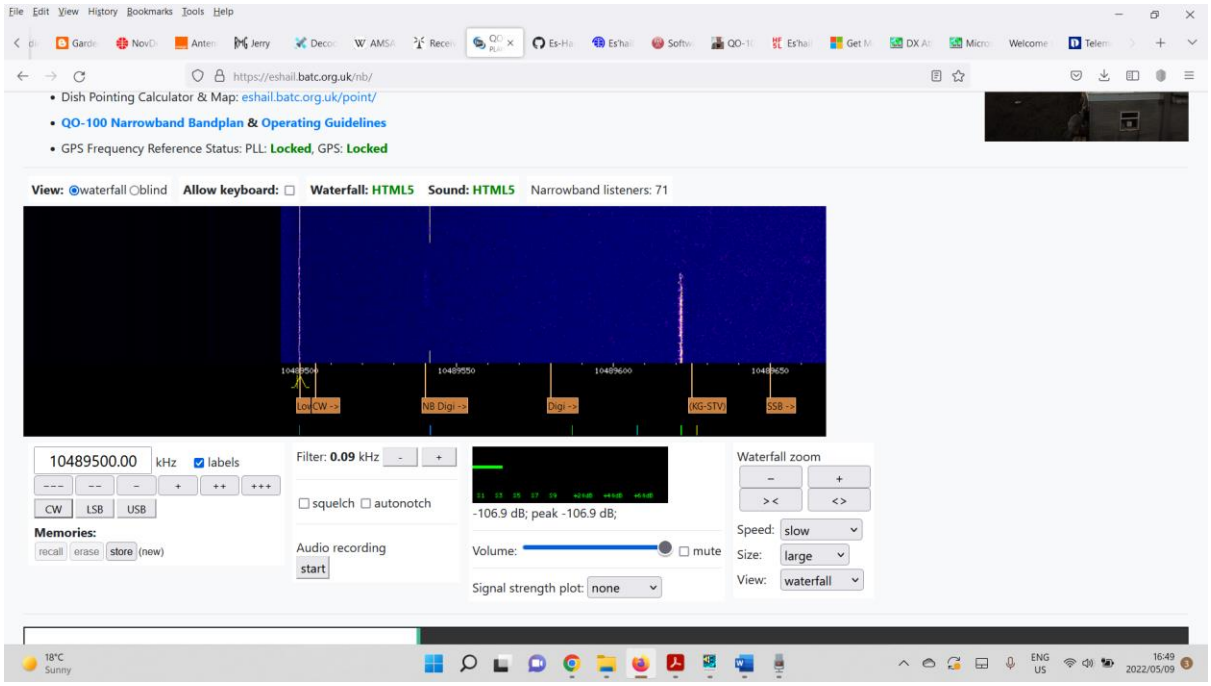
I was intrigued to see the 'Decoding telemetry from satellites' competition (https://www.hamsatsa.co.za/2022/04/16/decoding-telemetry-from-satellites-competition/) come up, linked with the very helpful satellite manual that ZR6TG has put together (http://www.satellitemanual.com/telemetry.html). I have yet to complete a satellite QSO (although I've been able to listen in to some), and the only data I've downloaded from the birds was some SSTV footage from the ISS last December. This looked to be just the inspiration I needed to nudge me along.

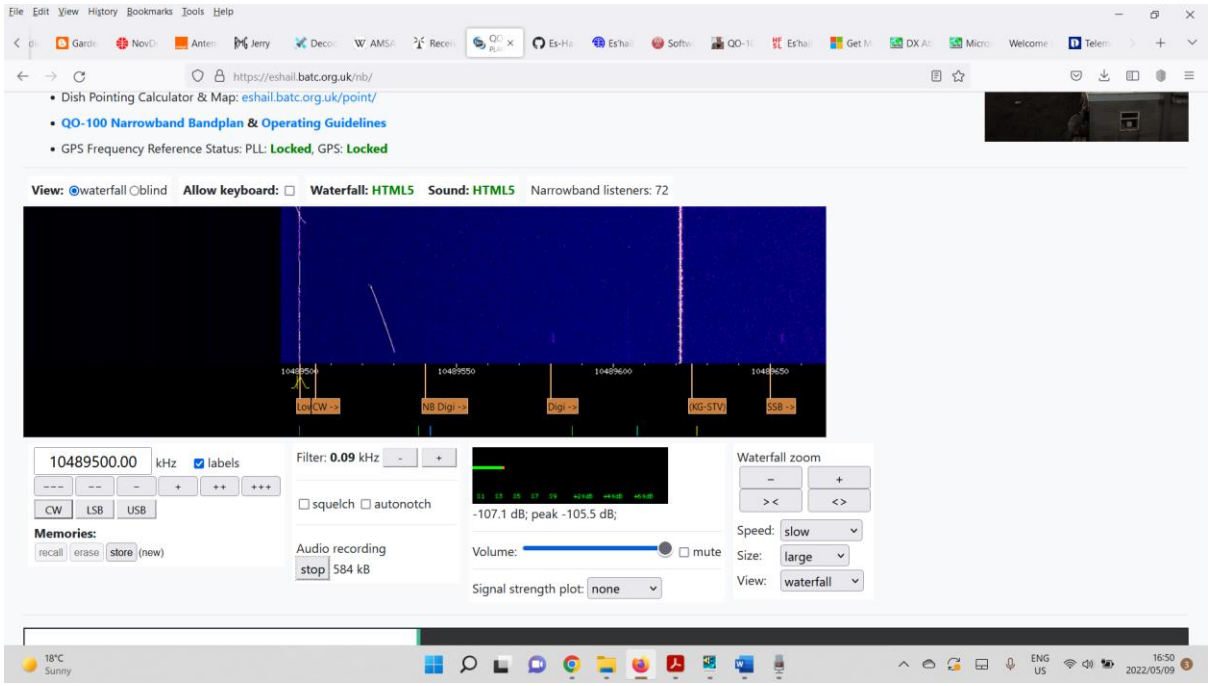
The competition found me at a busy time, and I didn't think that I'd be able to construct an antenna and get an SDR up and running. I therefore gave some thought as to practical options that might work for me.

I recalled logging onto a WebSDR last year and listening to a conversation (in Afrikaans, as it happened) taking place through the Es-Hail (QO-100) satellite. The competition calls for amateurs to 'receive and decode telemetry from any amateur satellite in orbit', and a WebSDR should enable me to do just that. A quick search on http://websdr.org/ got me to the Qatar-OSCAR 100 Narrowband WebSDR (https://eshail.batc.org.uk/nb/). A helpful article on Radio Club HF5L's website (https://hf5l.pl/en/eshail-2-or-qo-100-for-beginners/) confirmed that there were CW beacons on 10 489.500 MHz and 10 490.00 MHz.

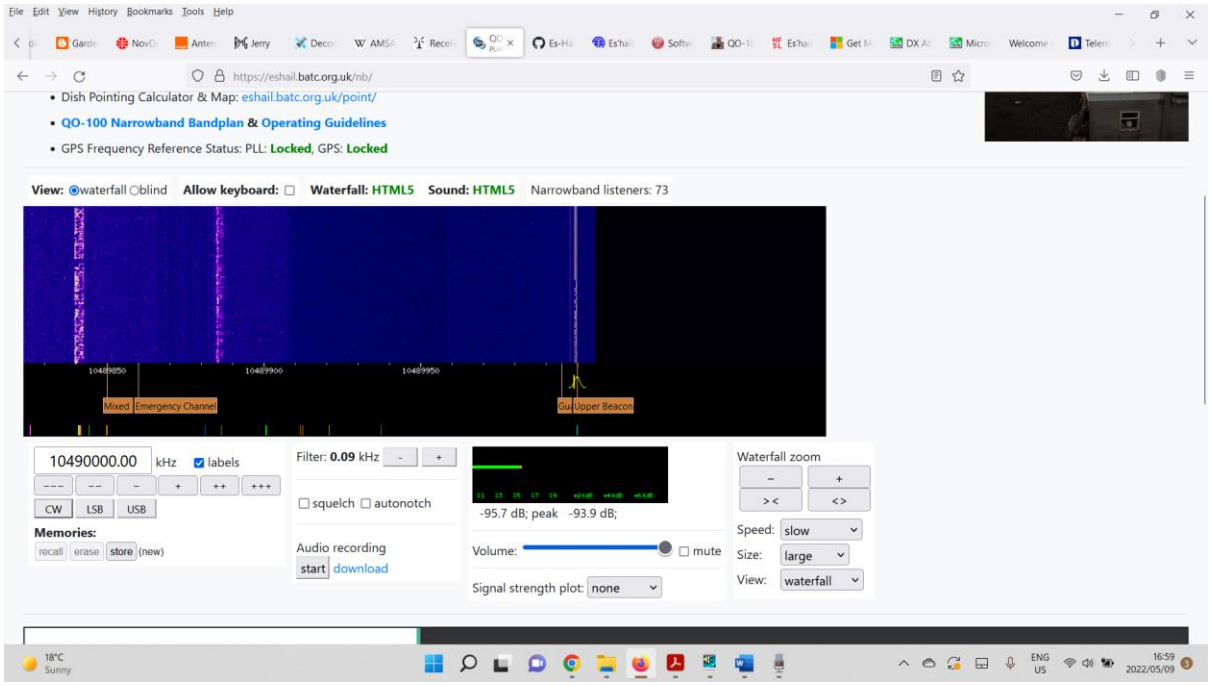
I wasn't entirely as to whether obtaining and decoding these transmissions would fall into the scope of the contest. They certainly are transmissions, in fact retransmissions, since they are generated at the Es-Hail control centre, but these CW transmissions are in Morse *code*, after all. Also, they're referred to as telemetry beacons in a very interesting article on Github (https://github.com/happysat/Es-Hail-2-Oscar-100/blob/main/README.md#Telemetry_beacon_). In any event, I would try.

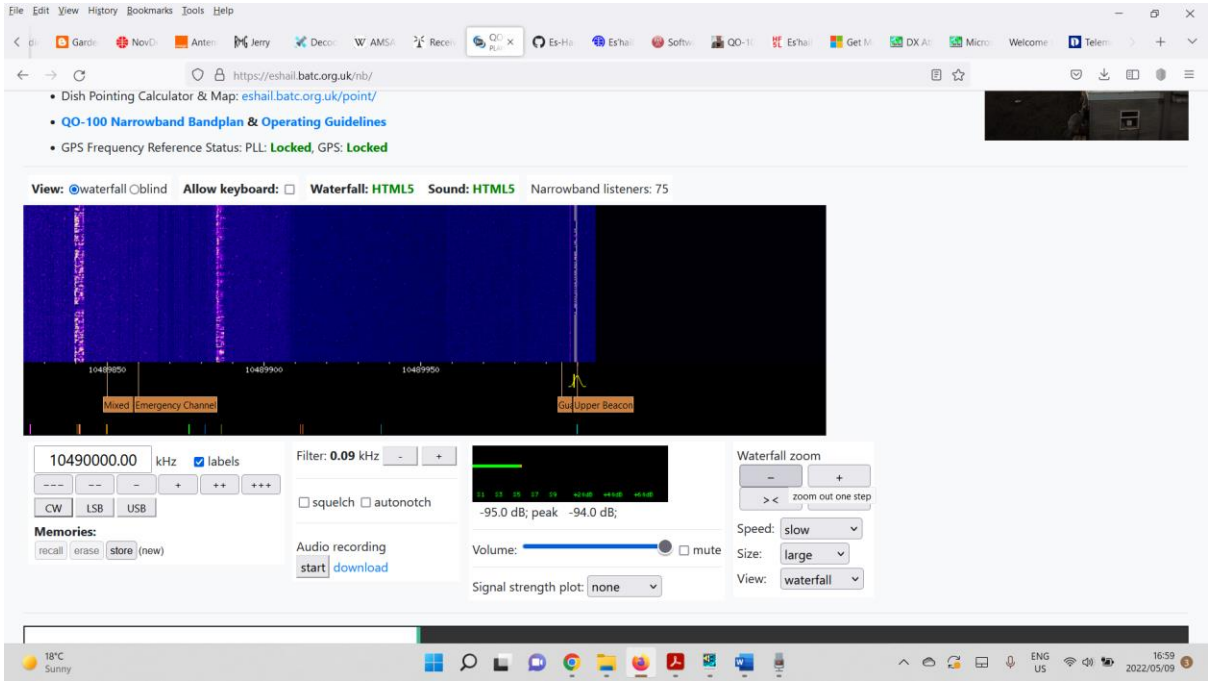
So, I set the controls on the WebSDR to listen to the lower beacon (see screen shots below), and made recordings of the transmitted code. Recording using the laptop microphone resulted in an overly soft result; using a mobile phone provided a better result, and the best was that obtainable directly from the WebSDR itself (not surprisingly).





I then re-tuned to the upper beacon, and repeated the exercise (see screenshots below).

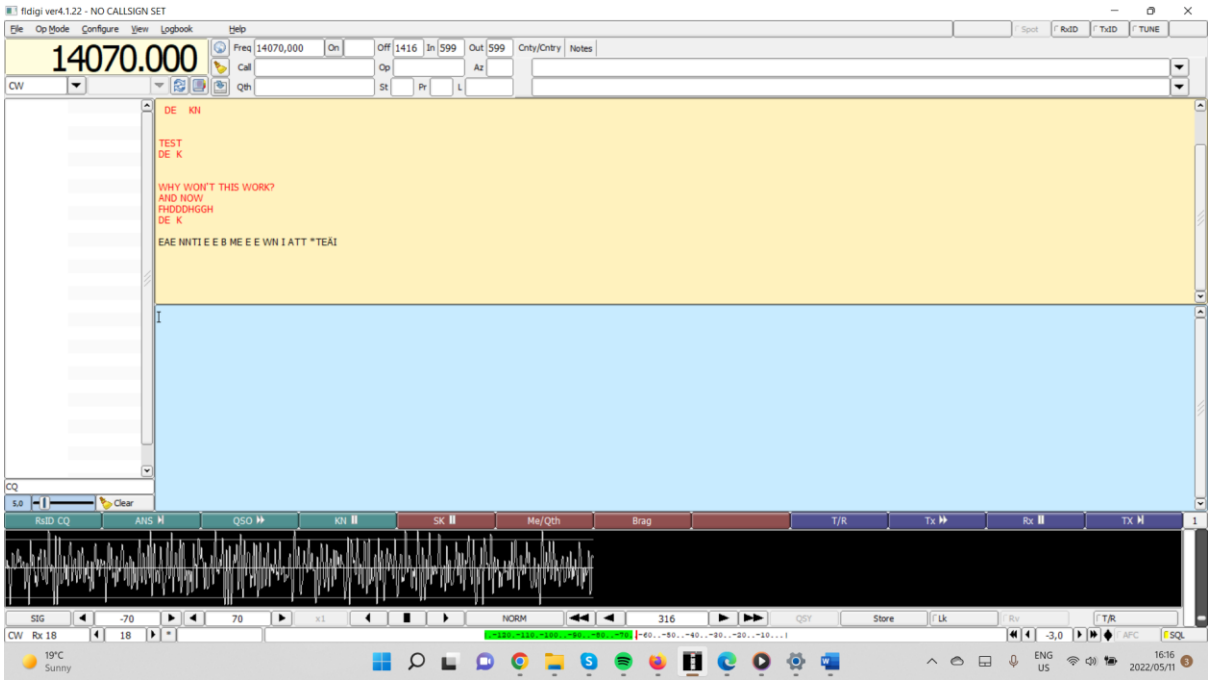




Now that I had the audio files, it was time to attempt to decode them. Not being Morse proficient (and with no chance of becoming so before the end of the contest) I went looking for a software decoding option. I'd heard of CW Skimmer, so downloaded (http://www.dxatlas.com/CwSkimmer/) and installed it. After some playing it became clear to me that it was designed for higher purposes than just decoding audio files, so I looked for alternatives. Next it was the turn of MRP40 (http://www.polar-electric.com/Morse/MRP40-EN/LoadPRM-EN.html), but that again seemed unnecessarily complicated for my intended use.

The Github site already mentioned had a link to fldigi (https://sourceforge.net/projects/fldigi/files/fldigi/), so I thought I would try that next, and hope for a more user-friendly experience. Installation was quick, and there's a beginner's guide at https://www.sbarcnm.org/documents/fldigi%20beginner%27s%20guide.pdf , with more comprehensive information available at http://www.w1hkj.com/FldigiHelp/ .

I quickly worked out how to generate Morse code using the program, but getting it to decode my audio files proved a little more problematic. Frustration ensued, as I could get the programme to 'listen to' the beacons (see screen shot below), but no decoding was taking place. Or if it was, I couldn't find it.

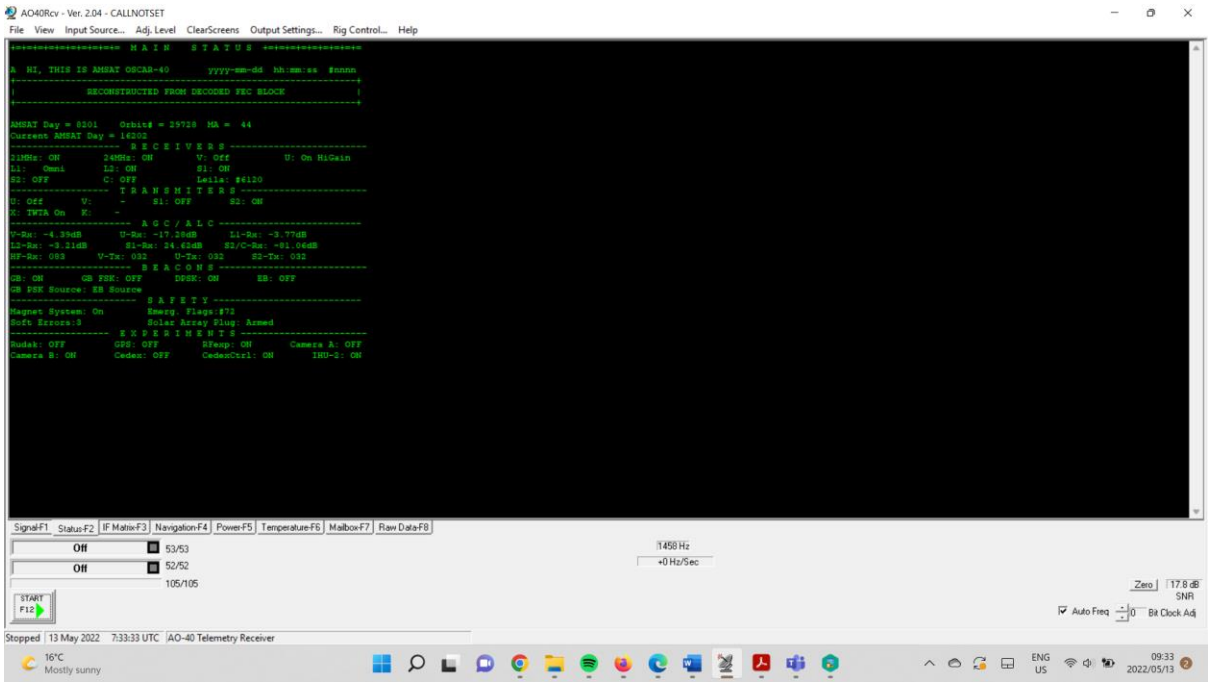


I even sent a recording of the transmissions to a local Elmer who had been very helpful to me in the past, but he told me that his Morse wasn't yet up to the task.

Time to try something else. Like the middle beacon, transmitting telemetry using PSK. This is transmitted on 10 489.750 MHz (https://www.sdr-radio.com/EsHail-2), no longer on 10 489.800 MHz (https://www.dk3wn.info/wp/satelliten/qo-100/).

I downloaded AO40Rcv (http://www.moetronix.com/ae4jy/ao40rcv.htm), downloaded some audio files of the telemetry beacon from the WebSDR, and got to work.

This worked well, and I was amazed at how much data was readily available from the beacon. Reports were available on the satellite's status:



Navigation indicators:

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+=+=+=+=+=+=+=+=+=+=  N A V I G A T I O N  +=+=+=+=+=+=+=+=+=+=

---------------------- S T A B I L I T Y --------------------------
SEU Sensor Mode: Spin     Magnet Sys: OFF
Magnet Pwr: OFF      M-SOLL: 105
------------------ E A R T H   S E N S O R S ----------------------
Sensitivity:600.00 mV    Pointing: Side
Edge: Positive    Lock Range: 116
ES-R Upper--> MA:110 Orbit:121(mod256)
ES-R Lower--> MA:032 Orbit:111(mod256)
ES1 spin Cnt: 104   Update Flag1 101
ES2 spin Cnt: 114   Update Flag2 032
--------------- S P I N   S U N    S E N S O R S ------------------
SS1 cnt:108     SS2 cnt:032     Threshold: 1.80 V
SS-Flags: 111   Spin Count Raw: 114  SEU: 26.69  RPM
Sun Angle: 33.54  deg.
-------------- 3 - A X I S   S U N   S E N S O R S ---------------
Omni Up-X: 82.79 deg.      Up-Y: 82.79 deg.
Omni Down-X: 82.79 deg.    Down-Y: 82.79 deg.
U//D Z:  Below Y-X Plane
------ E L E C T R O N I C   P R O P U L S I O N   U N I T--------
                  Configuration: #75
Tank Pressure:   1.36 Bar.        Motor Pressure:   4.63 Bar.
Motor Voltage:-223.98 V       Motor Current:   3.36 A
Set Current:   6.57 A   Flow(analog): 100   Flow Rate: 32
--------------- R E A C T I O N   W H E E L S ------------------
Wheel 1 Power: OFF        Speed: -443.14 RPM
Wheel 2 Power: OFF        Speed: -565.61 RPM
Wheel 3 Power: ON         Speed: -107.23 RPM    Sync: NO
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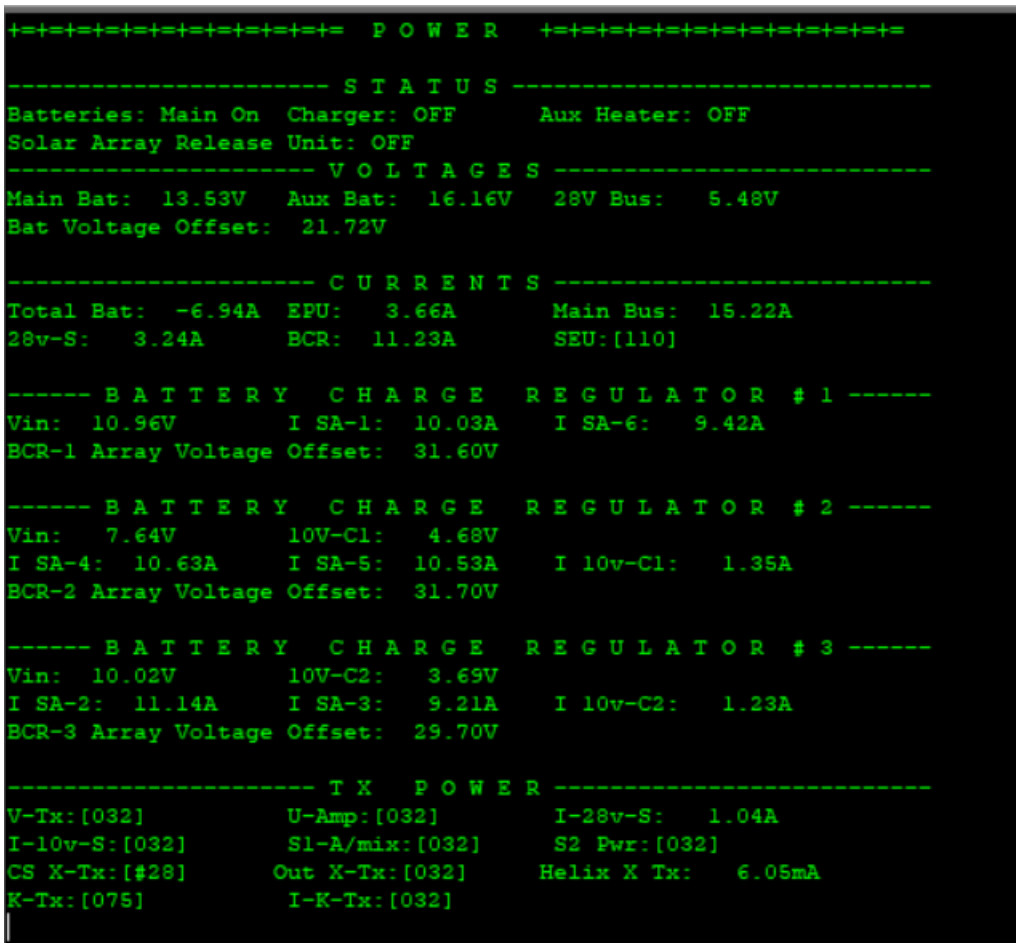
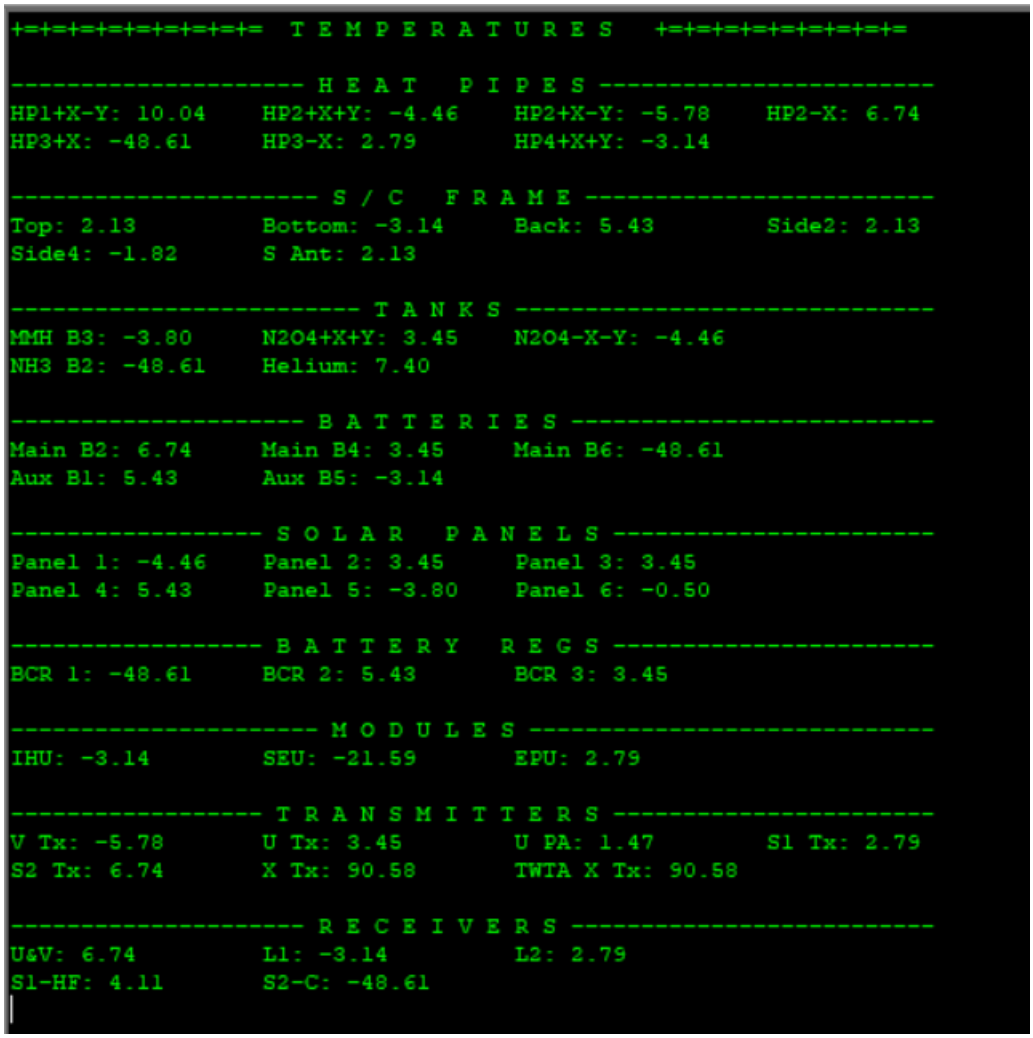
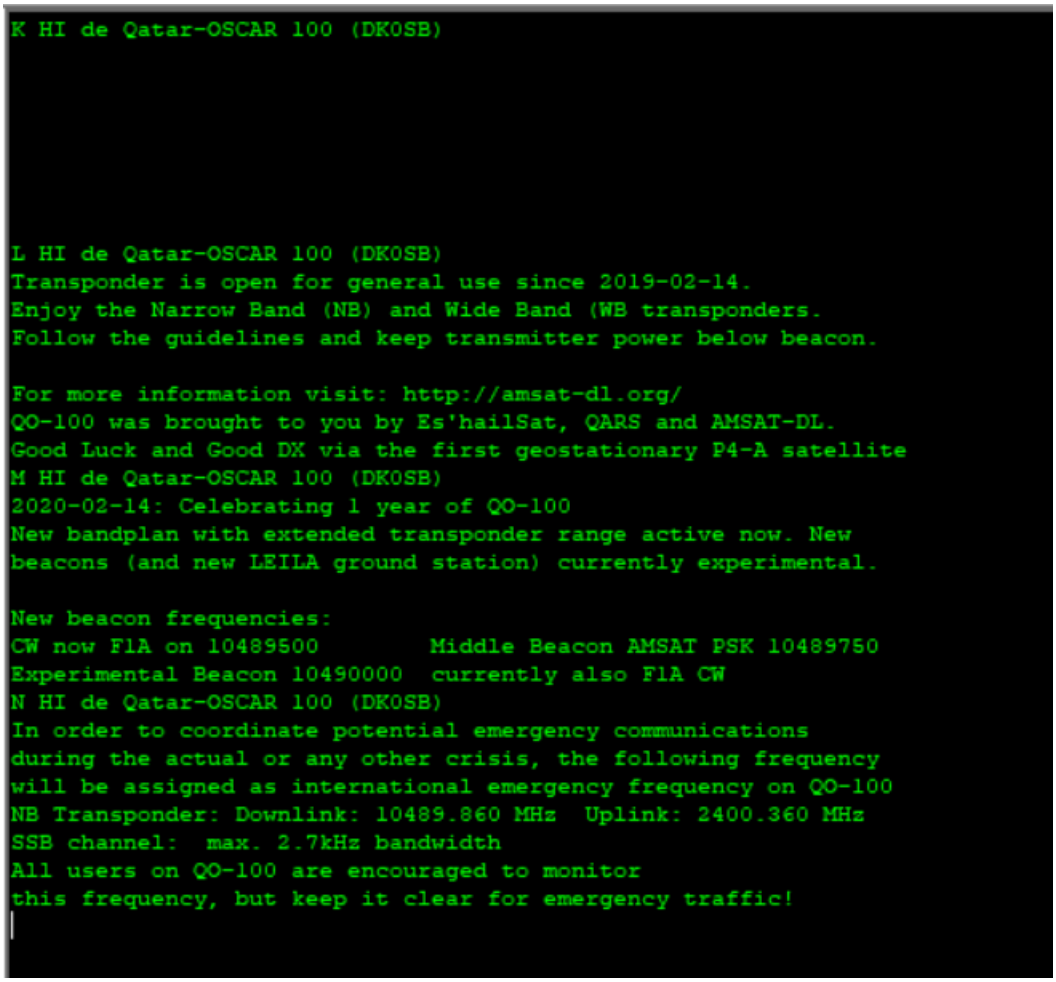
Power status:



Temperatures:



& even a message from the control centre:

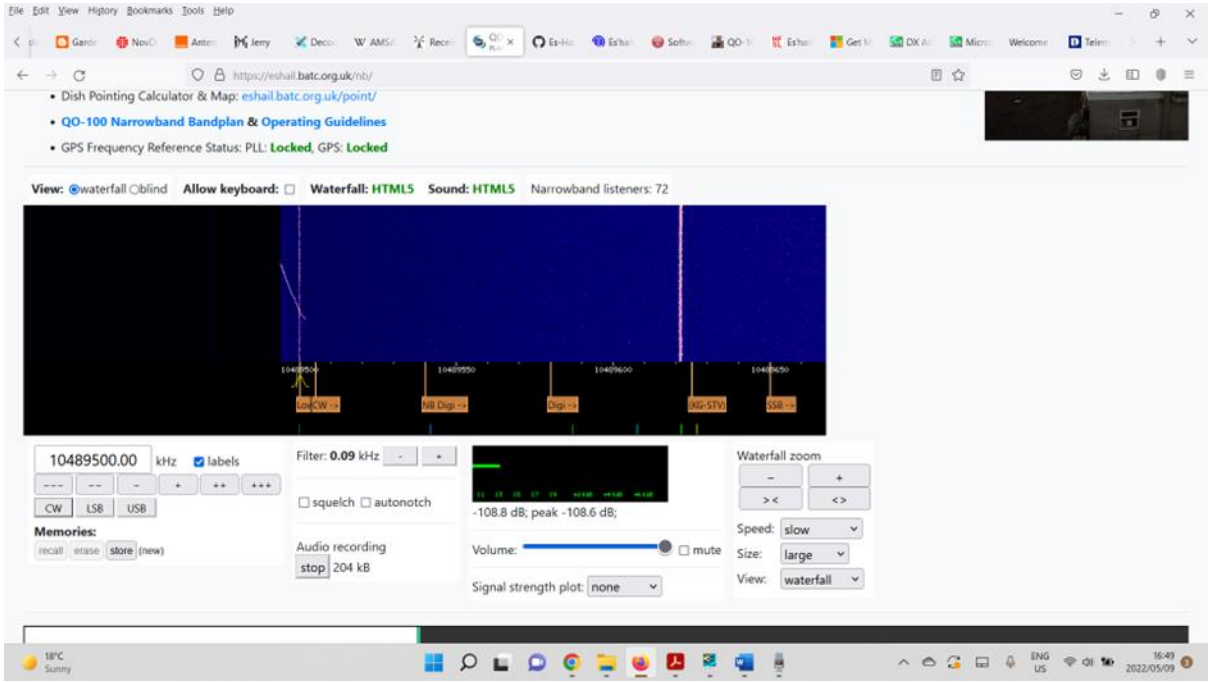


What's next? Perhaps time to start looking at setting up my own QO-100 station (https://hf5l.pl/en/eshail-2-or-qo-100-for-beginners/)? Or perhaps I'll build a turnstile or egg-beater antenna and start hunting for more telemetry, this time without needing a WebSDR. I'll decide next week!

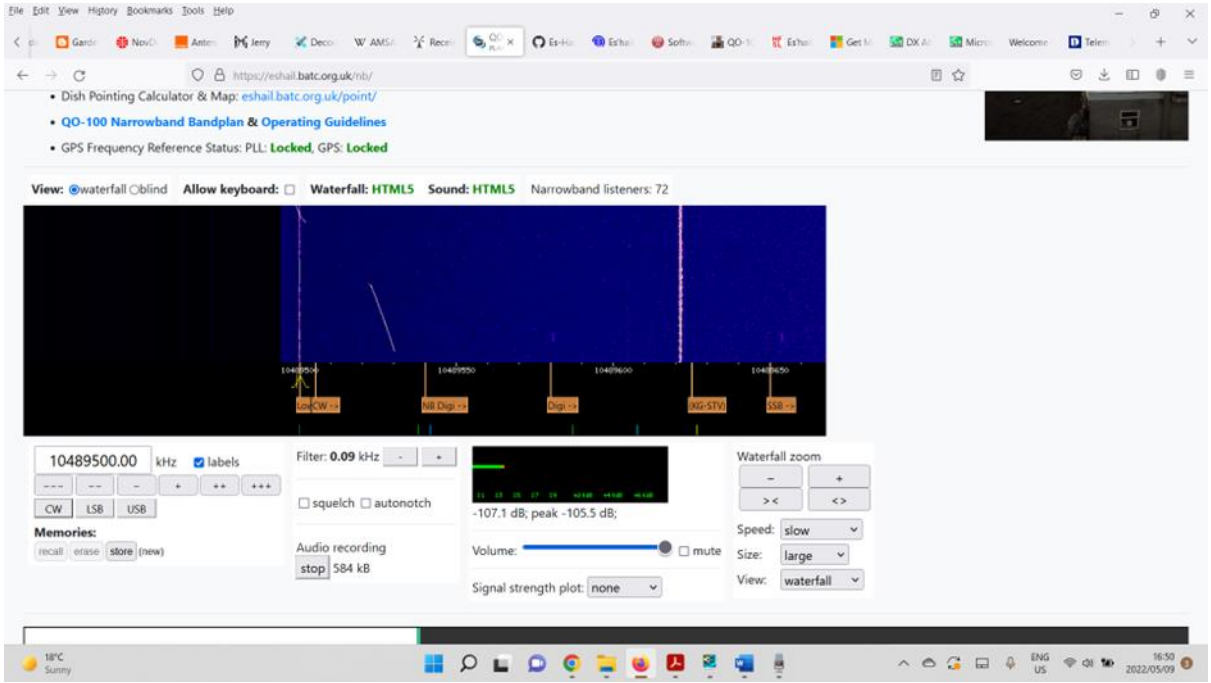
Gary Cundill
ZS1GAR

Annexure: an interesting phenomenon

While listening to the beacon, I suddenly heard a whistle, rapidly changing in tone. The time corresponded to the slanted line that can be seen on the waterfall below.



I later saw a similar slanted line (see below) on the waterfall, although I didn't hear anything as it didn't cross the frequency I was listening to.



I wonder what would generate such a transmission?