GNSS IF Recorder Pelican Case
21 December 2020 Recordings
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Seven GPS L1 recordings were taken using the GNSS IF Recorder pelican case shown in Figures 1 and 2 below. The recording antennas were located at approximately Lat +34.684101, Long -86.809860 with clear skies and 50 degs F. Record location is shown in Figure 3 below. Recording started at 3:22 PM and ended at 6:15 PM. Figure 4 shows GPS and Galileo satellite positions on 21 Dec 2020, 3:22 PM and Figure 5 shows satellite positions at 6:15 PM.

The first recording in file "Ubox_ANN_MB_record1_21Dec2020_322PM.dat" was taken with a Ubox ANN-MB series precision GNSS active antenna attached to the GNSS IF Recorder pelican case (GNSS-IFR). Figure 6 shows the Ubox ANN-MB series GNSS antenna. Although the ANN-MB GNSS active antenna covers GPS L1/L2 and Galileo E5b, recordings are restricted to GPS L1 due to the limit of a single RF rotary joint. This recording was taken to insure that the GNSS-IFR was operating properly before the following measurements were taken with the Haigh-Farr 8310-3MD and 15370_REV0 wrap-around antennas. The GPS L1 RF chain gain for this first recording is as follows: Ubox active antenna (RHCP, +31.4 dB gain, 2.8 dB NF) followed by 6.5 dB cable loss followed by a LNA (+30 dB, 1 dB NF) followed a splitter (3.5 dB loss) by the MAX2771 LNA2 (18 dB gain, 0.9 dB NF) followed by a GPS L1 bandpass cavity filter (0.75 dB loss) followed by the MAX2771 (5th order polyphase filter BW = 2.5 MHz and PGA = 55 dB).

All following recordings involve the Haigh-Farr 8310-3MD and 15370-REV0 wrap-around antennas rotated from 0 to 7 Hz with the rotation assembly shown in Figures 7, 8, 9, and 10. Although the rotation assembly was designed for 0 to 20 Hz rotation rates, it was found that after everything was completed the nylon chain becomes unstable above rotation rates of 7 Hz. A rotation rate of 7 Hz served my purposes and, consequently, there was no need to invest more time and funds to redesign with a rubber belt. The rotation profile starts at 0 Hz for several seconds followed by 1 Hz increments for 5 second intervals to 7 Hz followed by 1 Hz decrements for 5 second intervals to 1 Hz. The rotation rate profile repeats over and over until recording is stopped. All of the IF recordings have the rotation rate set to 0 Hz for several seconds before ending.

Figures 11 and 12 show the test setup on 21 Dec 2020. Both Haigh-Farr antennas were rotated parallel to the ground to simulate a level missile flight. The axial rotation axis of both antennas was along a line north to south.

File "Haigh-Farr_8310_3MD_30db_record2_21Dec2020_421PM.dat" involves the 8310-3MD antenna which includes RHCP GPS L1 and S-band linear patch antennas. Figure 13 shows S-parameters for an 8310-3MD and Figure 14 shows the roll gain profile at theta = 90 degrees. For all of the 8310-3MD recordings, one of the RHCP GPS L1 patch antennas was pointed directly up. The GPS L1 chain gain for this recording is as follows: Haigh-Farr 8310-3MD wrap-around antenna (RHCP, -3 to -5 dB gain) followed by a rotary joint (0.3 dB loss) followed by a LNA (+30 db gain, 1 dB NF) followed 1 dB cable loss followed by LNA (+30 dB, 1 dB NF) followed by a splitter (3.5 dB loss) followed by the MAX2771 LNA2 (18 dB gain, 0.9 dB NF) followed by a GPS L1 bandpass cavity filter (0.75 dB loss) followed by the MAX2771 (5th order polyphase filter BW = 2.5 MHz and PGA = 55 dB).

File "Haigh_Farr_8310_3MD_0db_record3_21Dec2020_442PM.dat" involves the 8310-3MD antenna. The GPS L1 chain gain for this recording is as follows: Haigh-Farr 8310-3MD wrap-around antenna (RHCP, -3 to -5 dB gain) followed by a rotary joint (0.3 dB loss) followed 1 dB cable loss followed by a LNA (+30 dB, 1 dB NF) followed a splitter (3.5 dB loss) followed by the MAX2771 LNA2 (18 dB gain, 0.9 dB NF) followed by a GPS L1 bandpass cavity filter (0.75 dB loss) followed by the MAX2771 (5th order polyphase filter BW = 2.5 MHz and PGA = 55 dB).

File "Haigh_Farr_8310_3MD_20db_record4_21Dec2020_502PM.dat" involves the 8310-3MD antenna. The GPS L1 chain gain for this recording is as follows: Haigh-Farr 8310-3MD wrap-around antenna (RHCP, -3 to -5 dB gain) followed by a rotary joint (0.3 dB loss) followed by a LNA (+20 dB gain, NF = 1 dB) followed by 1 dB cable loss followed by a LNA (+30 dB, 1 dB NF) followed a splitter (3.5 dB loss) followed by the MAX2771 LNA2 (18 dB gain, 0.9 dB NF) followed by a GPS L1 bandpass cavity filter (0.75 dB loss) followed by the MAX2771 (5th order polyphase filter BW = 2.5 MHz and PGA = 55 dB).

File "Haigh_Farr_15370_REV0_20dB_record5_21Dec2020_532PM.dat" involves the Haigh-Farr 15370-REV0 wrap-around antenna which includes GPS L1, GPS L2, and S-band all with linear polarizations. I've been unable

to get Haigh-Farr to provide an antenna radiation pattern as of this writing. The GPS L1 chain gain for this recording is as follows: Haigh-Farr 15370-REV0 wrap-around antenna (Linear, SWAG -6 to -8 dB gain) followed by a rotary joint (0.3 dB loss) followed by a LNA (+20 dB gain, NF = 1 dB) followed by 1 dB cable loss followed by a LNA (+30 dB, 1 dB NF) followed a splitter (3.5 dB loss) followed by the MAX2771 LNA2 (18 dB gain, 0.9 dB NF) followed by a GPS L1 bandpass cavity filter (0.75 dB loss) followed by the MAX2771 (5th order polyphase filter BW = 2.5 MHz and PGA = 55 dB).

File "Haigh_Farr_15370_REV0_30dB_record6_21Dec2020_548PM.dat" involves the Haigh-Farr 15370-REV0 wrap-around antenna. The GPS L1 chain gain for this recording is as follows: Haigh-Farr 15370-REV0 wrap-around antenna (Linear, SWAG -6 to -8 dB gain) followed by a rotary joint (0.3 dB loss) followed by a LNA (+30 dB gain, NF = 1 dB) followed by 1 dB cable loss followed by a LNA (+30 dB, 1 dB NF) followed a splitter (3.5 dB loss) followed by the MAX2771 LNA2 (18 dB gain, 0.9 dB NF) followed by a GPS L1 bandpass cavity filter (0.75 dB loss) followed by the MAX2771 (5th order polyphase filter BW = 2.5 MHz and PGA = 55 dB).

File "Haigh_Farr_15370_REV0_0dB_record7_21Dec2020_608PM.dat" involves the Haigh-Farr 15370-REV0 wrap-around antenna. The GPS L1 chain gain for this recording is as follows: Haigh-Farr 15370-REV0 wrap-around antenna (Linear, SWAG -6 to -8 dB gain) followed by a rotary joint (0.3 dB loss) followed by 1 dB cable loss followed by a LNA (+30 dB, 1 dB NF) followed a splitter (3.5 dB loss) followed by the MAX2771 LNA2 (18 dB gain, 0.9 dB NF) followed by a GPS L1 bandpass cavity filter (0.75 dB loss) followed by the MAX2771 (5th order polyphase filter BW = 2.5 MHz and PGA = 55 dB).

All recorded GPS L1 IF files follow the format described in file "GNSS_IF_Recorder_File_Format_ICD". All recorded files were found to have no block or checksum errors during each record session.

Figure 1. GNSS IF Recorder pelican case (outside view)

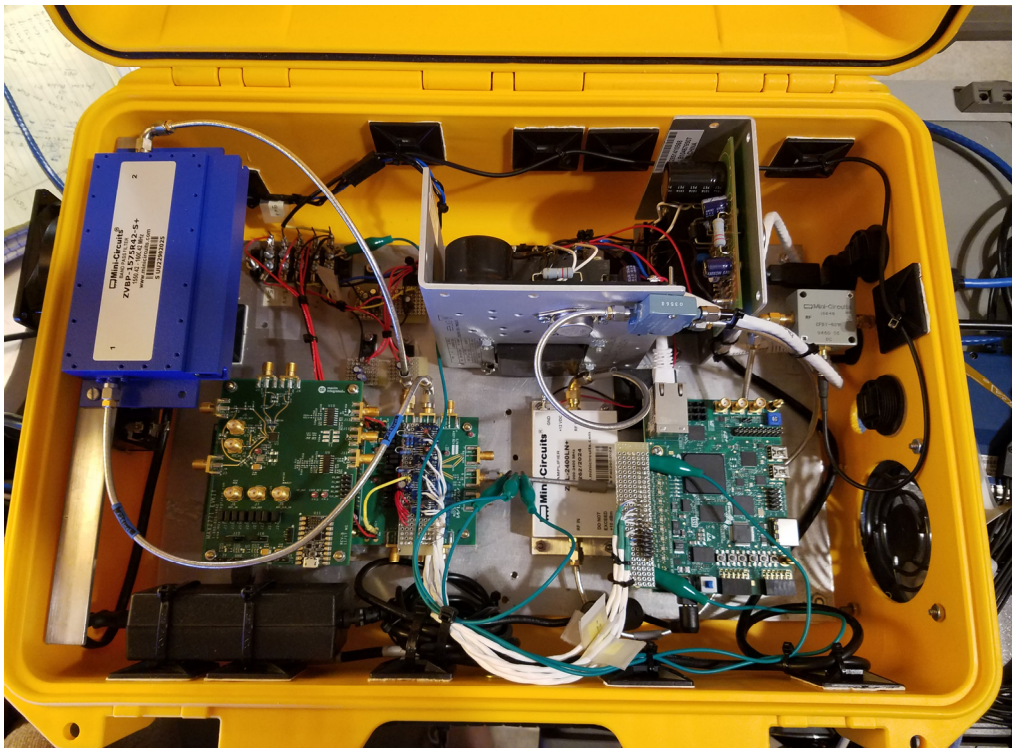
Figure 2. GNSS IF Recorder pelican case (inside view)


Figure 3. Record Location - 28840 Hardiman Rd, Madison, Al 35758 - 21 Dec 2020

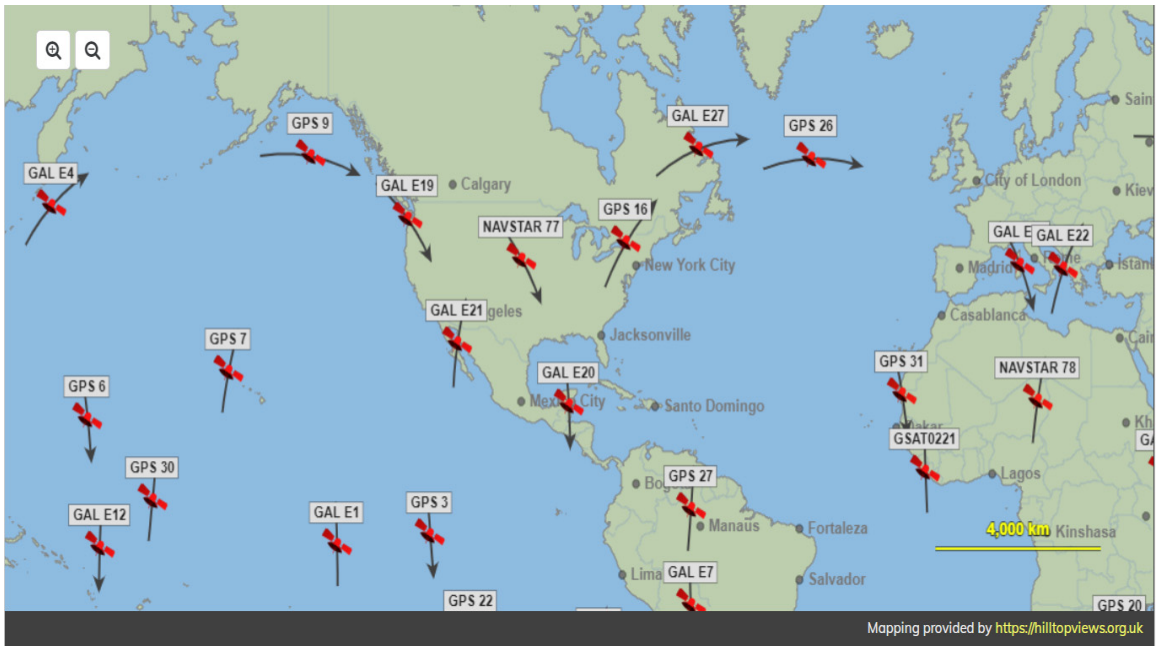


Figure 4. GPS and Galileo satellite positions on 21 Dec 2020 at 3:22 PM

Figure 5. GPS and Galileo satellite positions on 21 Dec 2020 at 6:15 PM

Figure 6. Ubox ANN-MB series precision GNSS active antenna

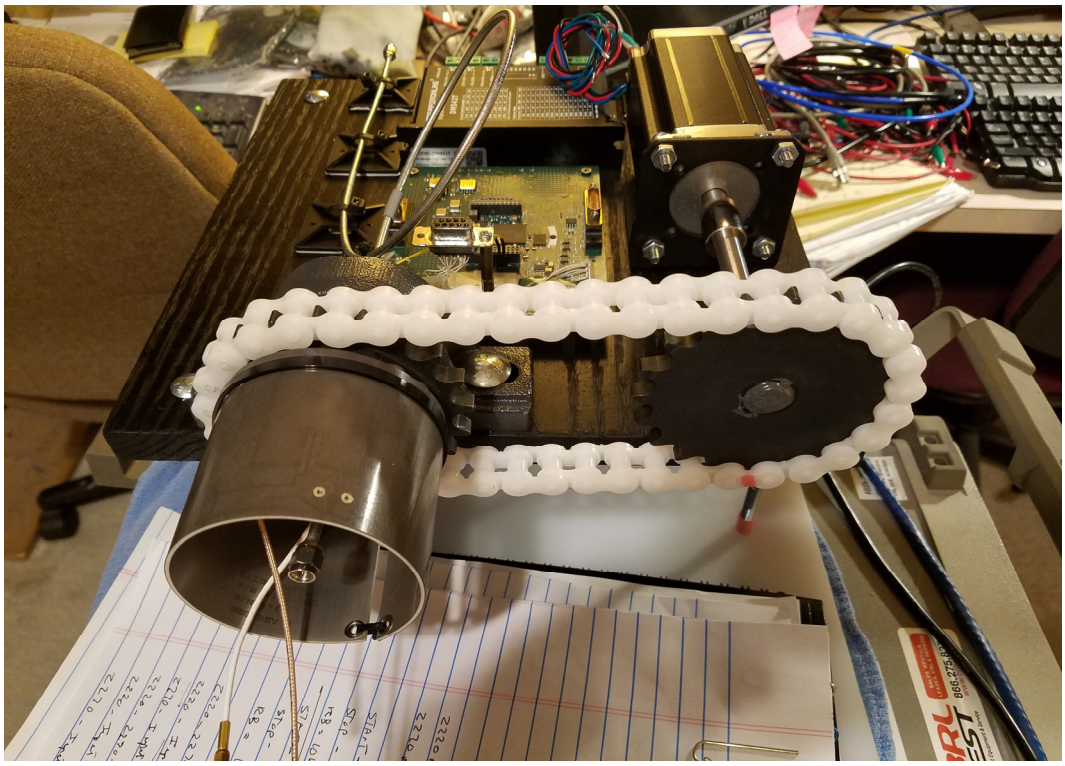

Figure 7. Haigh-Farr antenna rotation assembly

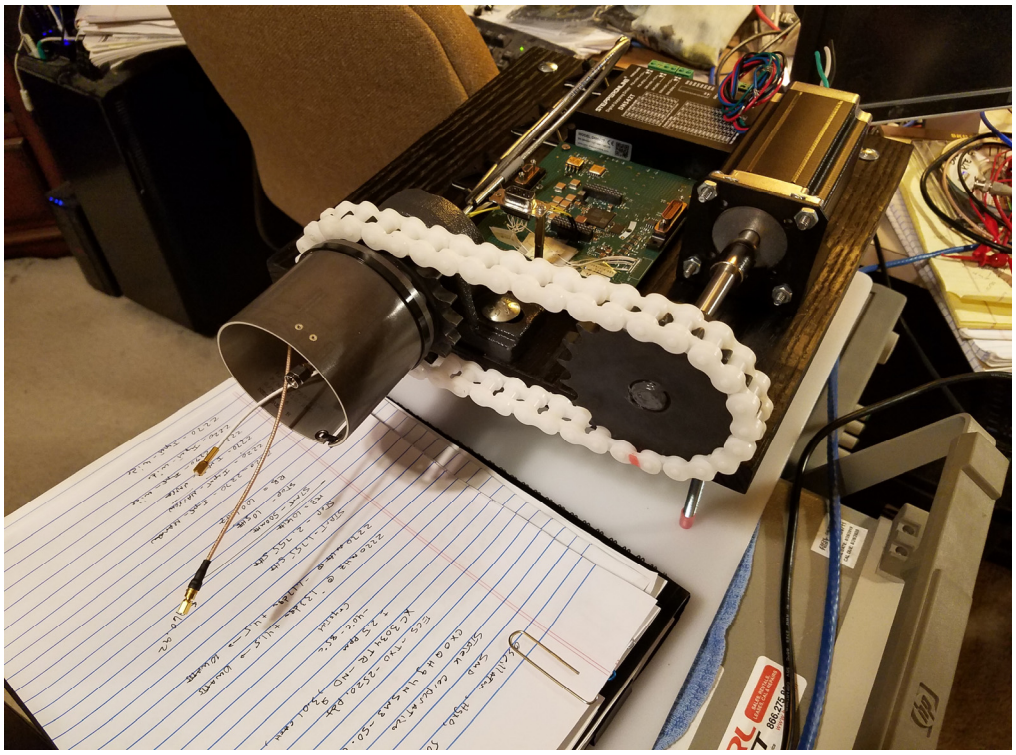

Figure 8. Haigh-Farr antenna rotation assembly

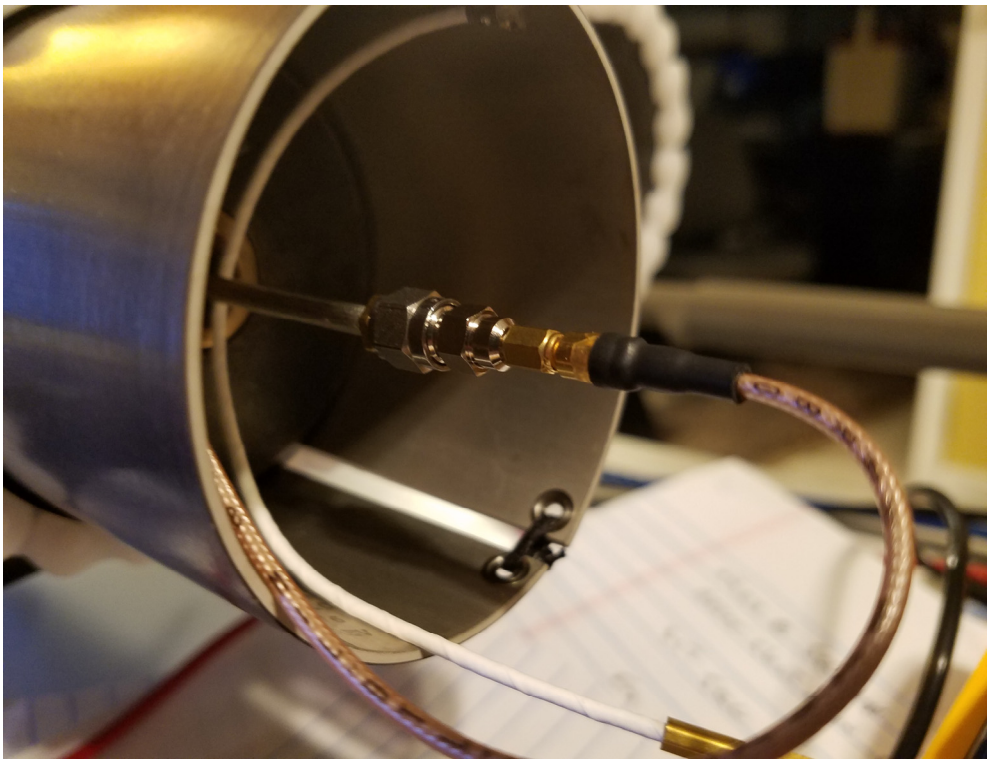

Figure 9. Haigh-Farr antenna rotation assembly

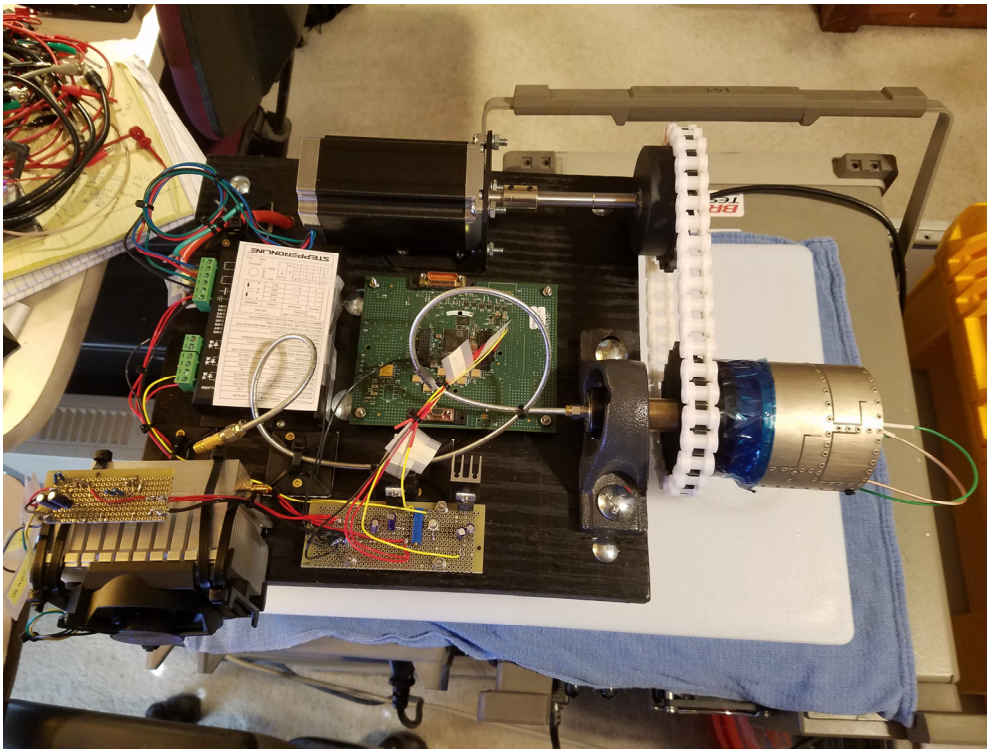

Figure 10. Haigh-Farr antenna rotation assembly

Figure 11. Test setup on 21 Dec 2020

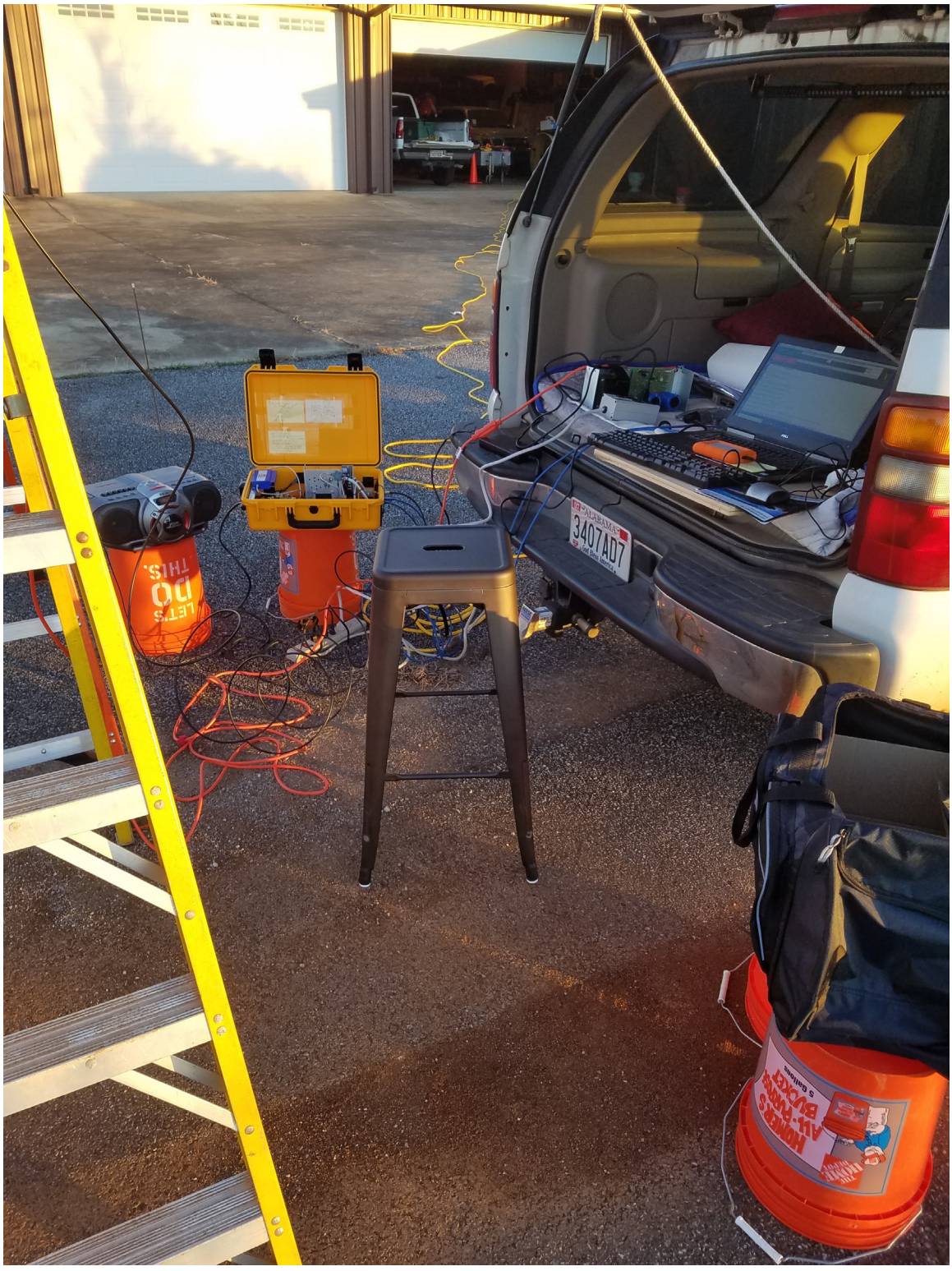

Figure 12. Test setup on 21 Dec 2020

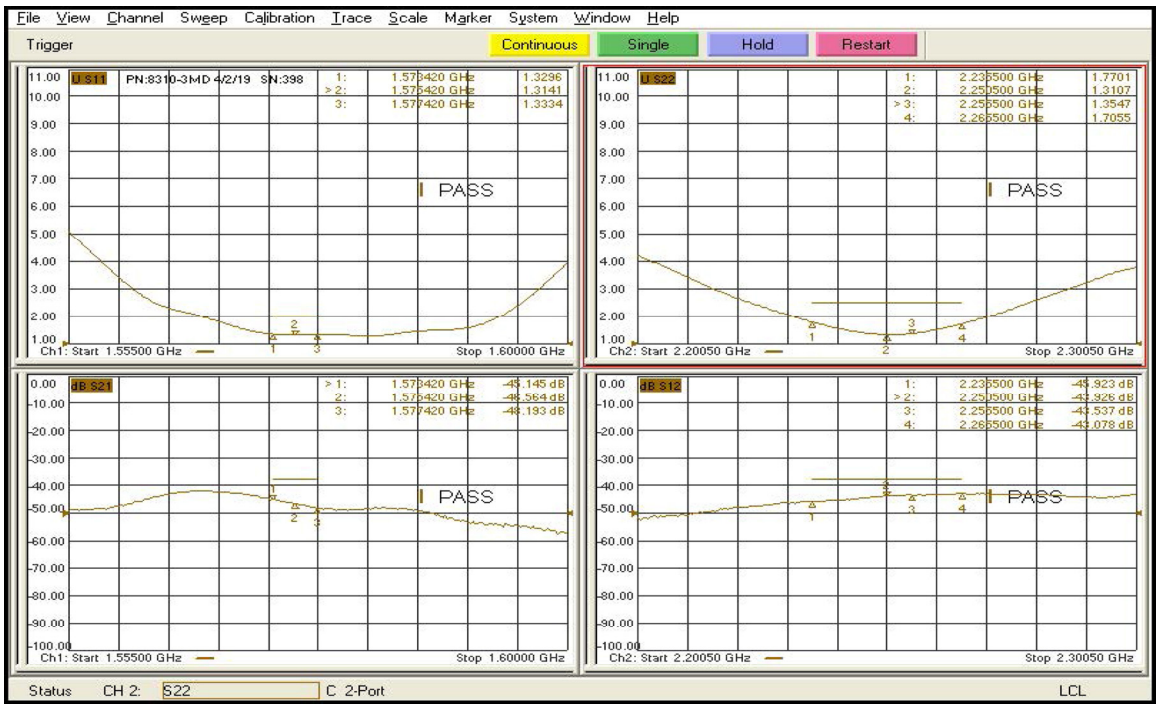


Figure 13. S-Parameters for a Haigh-Farr 8310-3MD antenna

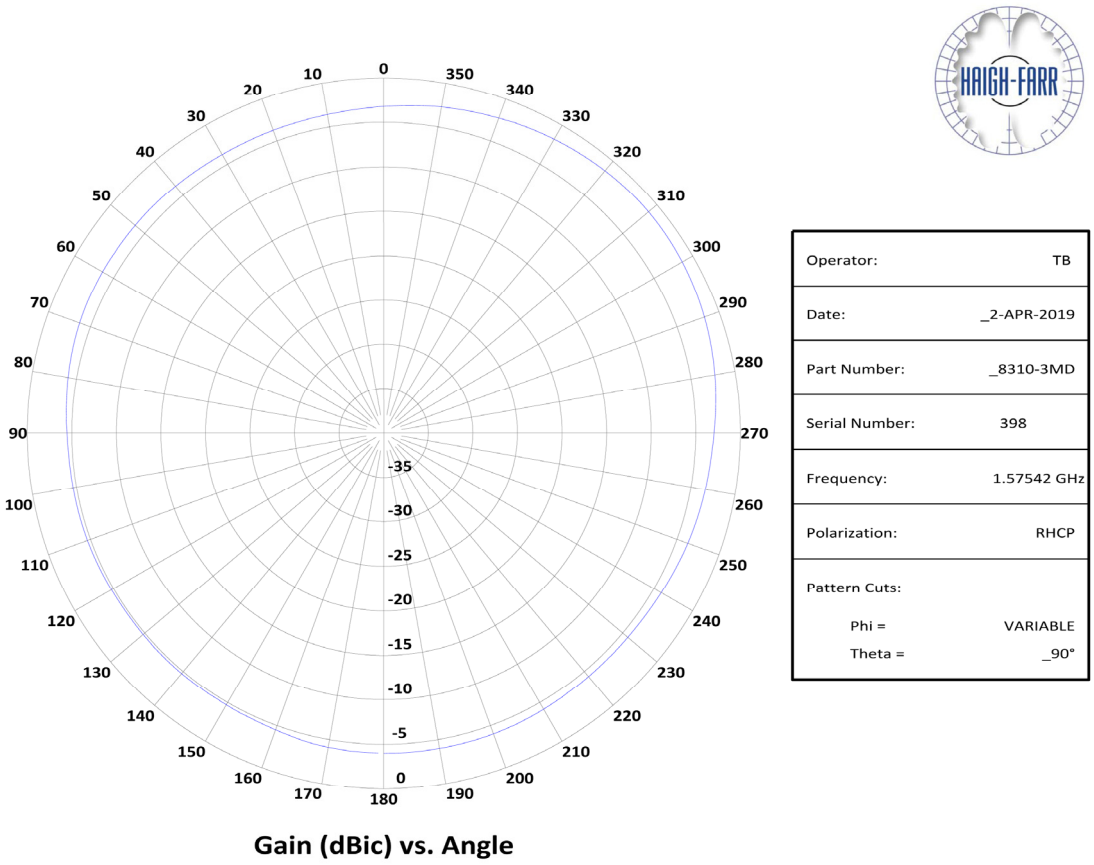


Figure 14. Haigh-Farr 8310-3MD roll gain profile at theta = 90 degs