Taster Receiving System for ISS HAMTV

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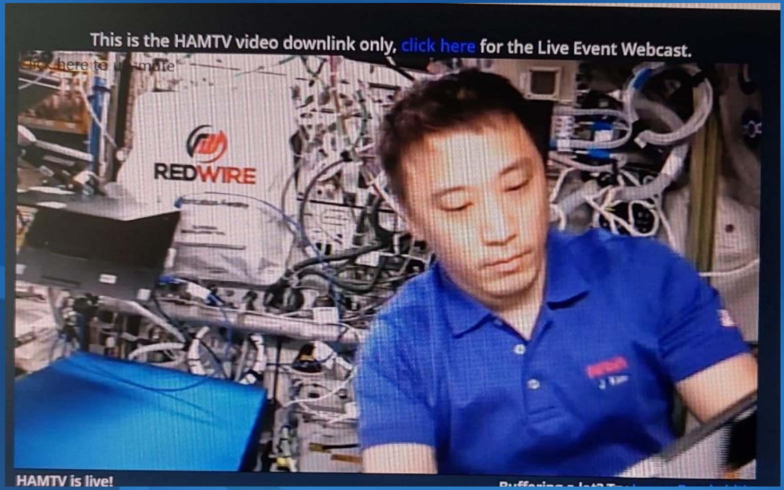
Setting the scene

This talk covers my experience receiving ISS HAMTV signals after deciding to receive them in the simplest possible way.

This involved developing a receiving system based on a fixed antenna and if all went well, consider a tracking system later.

Topics



HAMTV Downlink courtesy ARISS
18th October 2025
(https://live.ariss.org/hamtv/)

- ISS Orbit
- ISS Downlink Parameters
- Receiving System Requirements
- Considerations for a Tracking System

ISS Orbit

- The ISS is a Low Earth Orbit platform
  - Altitude about 420km
  - Orbit inclination 51.6 degrees
  - Orbit period about 91.5 minutes

Parameters vary slightly with time.

See the current TLE set at **https://live.ariss.org/tle/**

Consequences of the ISS orbit

- The ISS moves across the sky, unlike QO-100 that appears fixed
  - during sunrise and sunset ISS passes, you can easily spot it
- Depending on your home latitude,

  </= 51.6 degrees the ISS will pass at high inclination 2 – 3 times per day.

  As the latitude increases over this, the maximum elevation will decrease
- A high elevation pass is best, typically lasting 7 – 8 minutes
- This gives rise to the HAMTV merger project, which aims to stitch together **co**verage of short passes to give a longer continuous period for school linkups and similar activities.

ISS Maximum Elevation Examples

Location	Latitude (deg)	Approx. Max Elevation (deg)
London	51.5	90
Edinburgh	56	39
Belfast	54.6	51
Cardiff	51.5	90
Durham	54.7	50
Amsterdam	52.4	81

Calculations from Heavens-Above (https://www.heavens-above.com/)

ISS Orbit vs QO-100

<u>Not to Scale</u>

ISS pass information

The website Heavens-Above can provide pass information:

https://www.heavens-above.com/

Site Hosted by DLR/GSOC (German Space Agency)

- Input your location, nearest city will do
- Choose ISS, select ‘all passes’
- Produces a table of passes for the next 10 days

ISS HAMTV Downlink Parameters

- Transmit EIRP 10W
- Frequency 2395MHz, RHCP
- Symbol rate 2Ms/s, 35% roll-off
- Modulation DVB-S, QPSK, FEC ½ rate
- Video MPEG-2
- Audio MP2

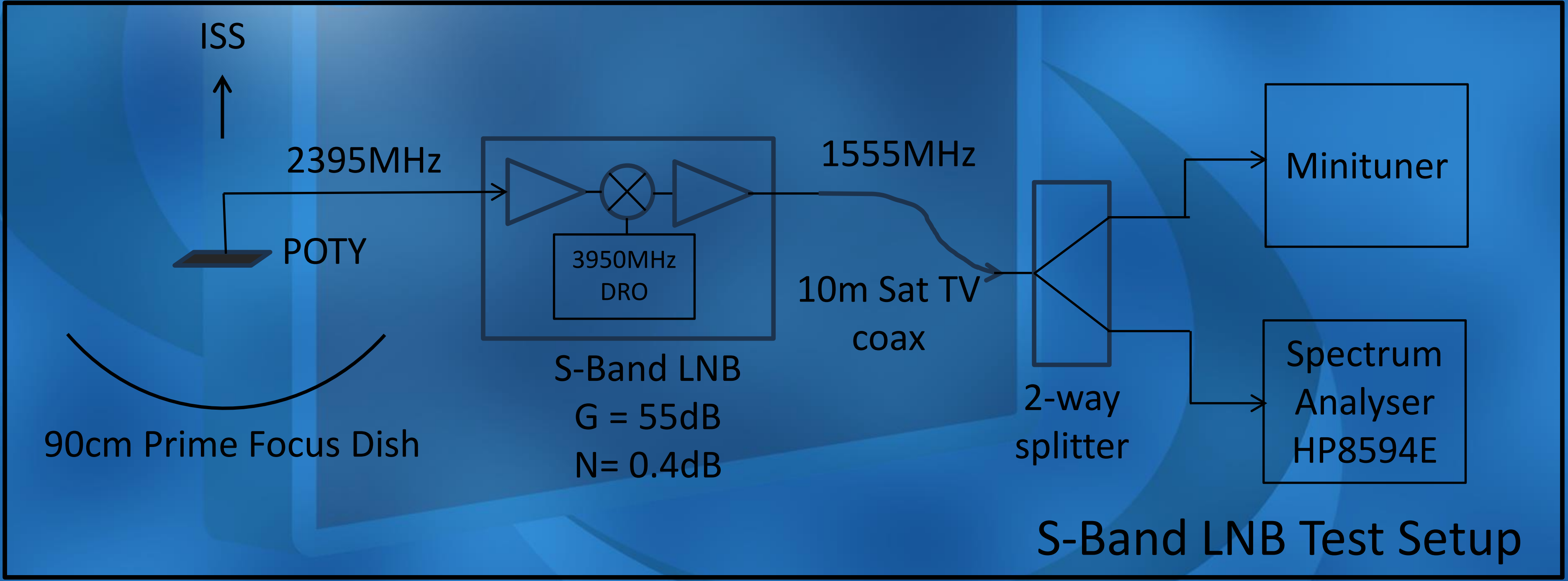
Receiving System Requirements

- Calculations indicated that a 90cm dish may provide a good C/N.
- The initial approach was to use a 90cm dish pointing directly upwards and wait for a suitable ISS pass.
- The relatively wide beamwidth of a 90cm dish at 2.4GHz (about 9.5 degrees) meant that pointing would not be too critical and reception highly probable.
- I had a 90cm dish with POTY that I'd previously used for QO-100 transmissions, which was re-used for ISS reception. Made possible as the polarisation requirement for both systems at 2.4GHz was the same (RHCP).

Reception using an S-band LNB

- An S-band LNB was connected directly to the POTY and linked back to the shack on standard satellite TV coax
- A Minituner receiver was tuned to the LNB 1555MHz IF frequency
- IF spectrum was displayed on a Spectrum Analyser

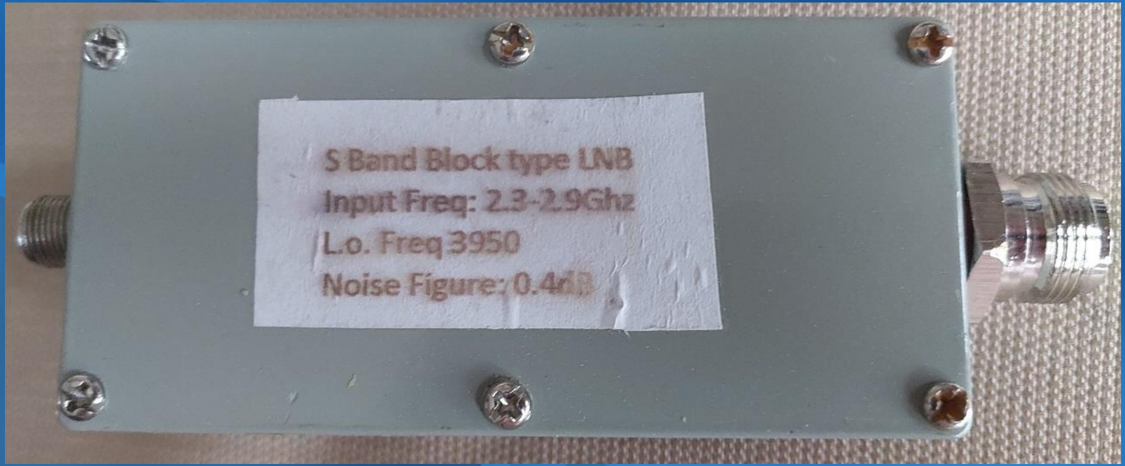
HAMTV Reception using an S-band LNB

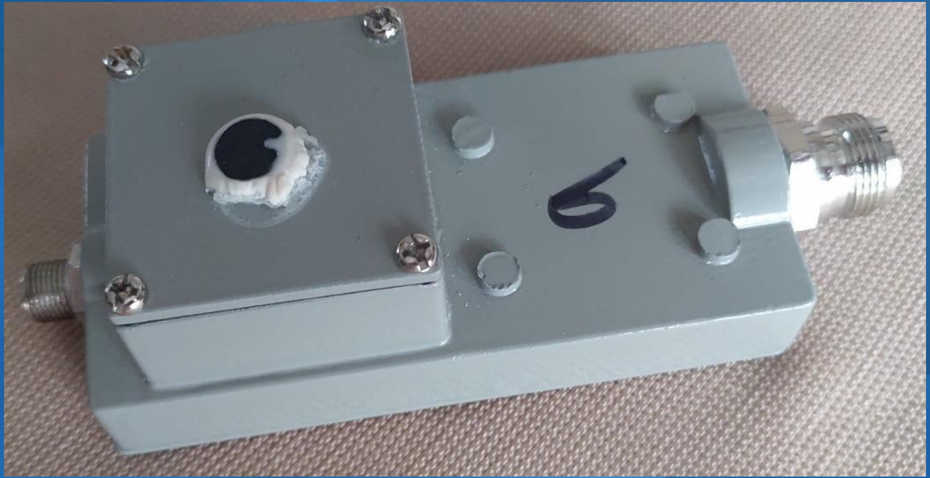


S-band LNB on 90cm Dish

S-band LNB strapped to the feed support

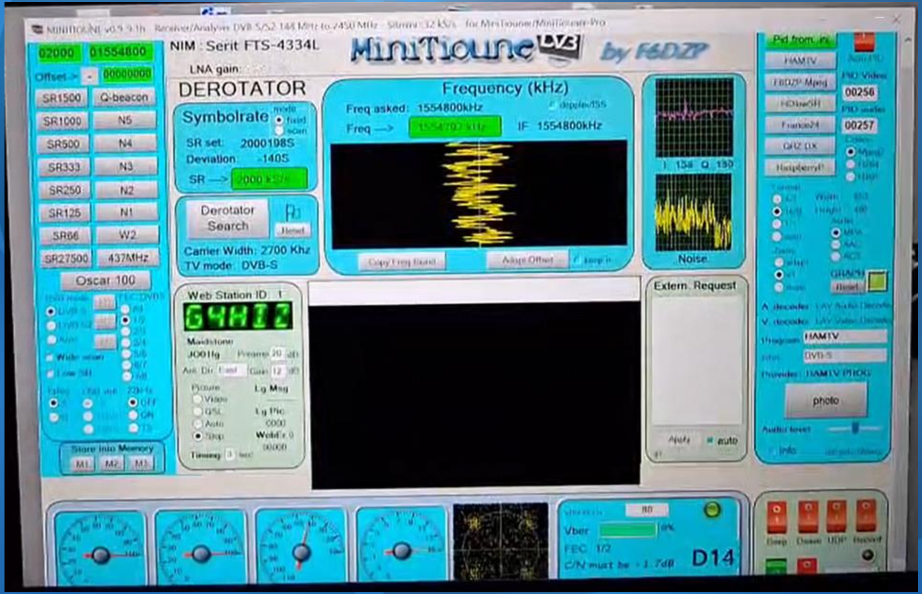
The QO-100 LNB didn’t do anything, I just didn’t want to remove it


S Band Block type LNB
Input Freq: 2.3-2.9Ghz
L.o. Freq 3950
Noise Figure: 0.4dB

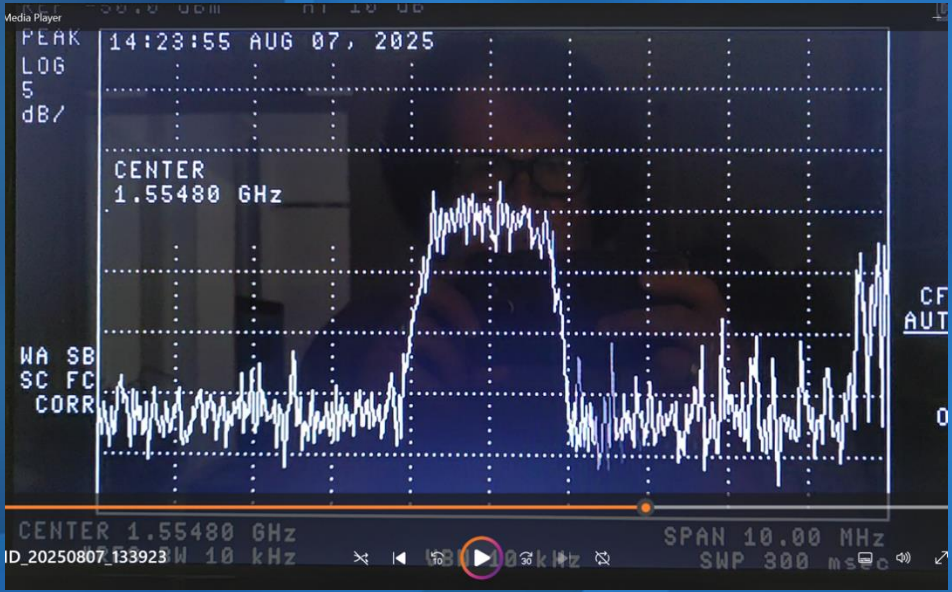


S-band LNB

S-Band LNB : Results-1



Typical black video



1.555GHz Spectrum/ 10MHz Span

S-Band LNB : Results-2

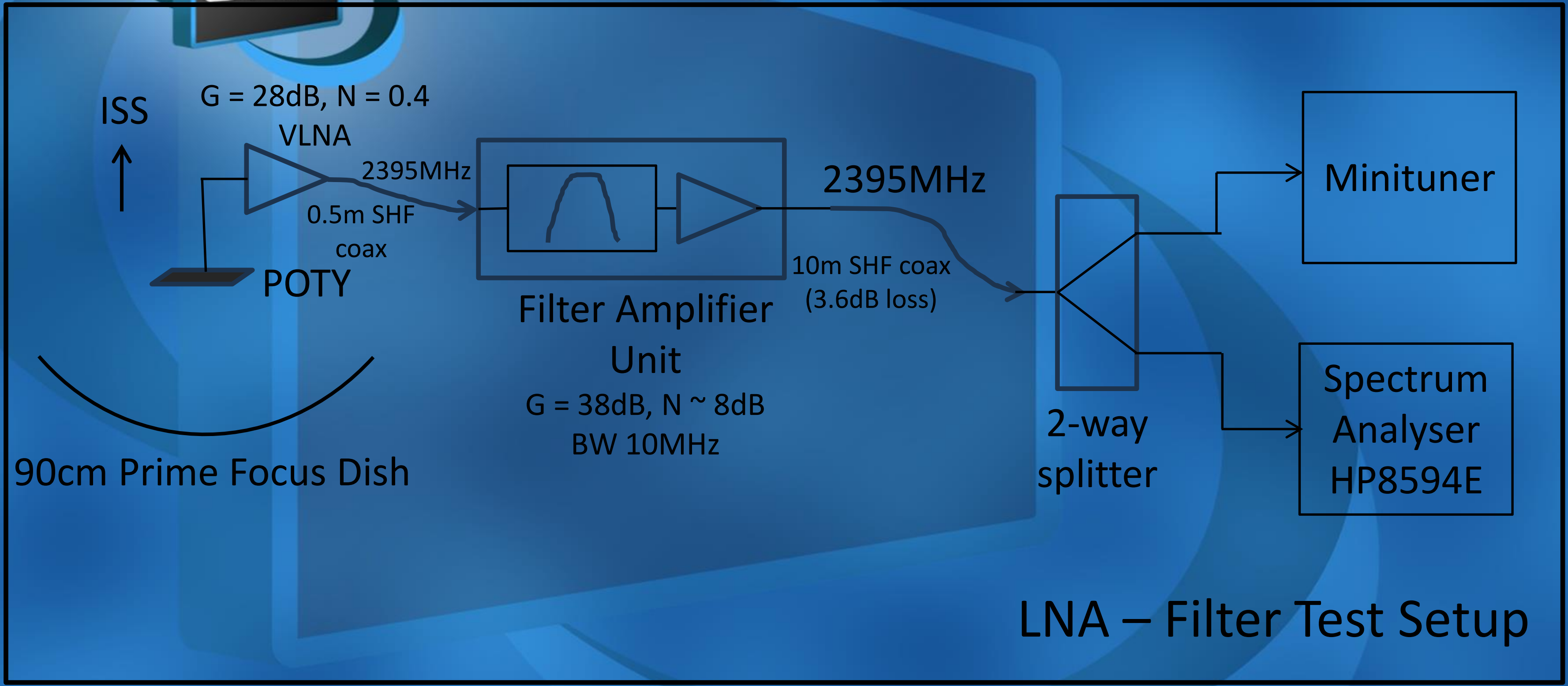
- Successfully used for observing overhead passes for the first time with peak C/N up to about 16dB.
- Black video demodulated, lasting about 18s.
- Occasional drop-outs were experienced.
- Suspected reason for drop-outs was interference due to the wide input frequency range of the LNB (2.3 to 2.9GHz) with possible candidates being Wifi and 4G
- The IF output was not very clean with additional carriers believed to be due to inter-modulation in the LNB.

Using an LNA + Filter

In order to mitigate interference issues, a new approach was adopted employing,

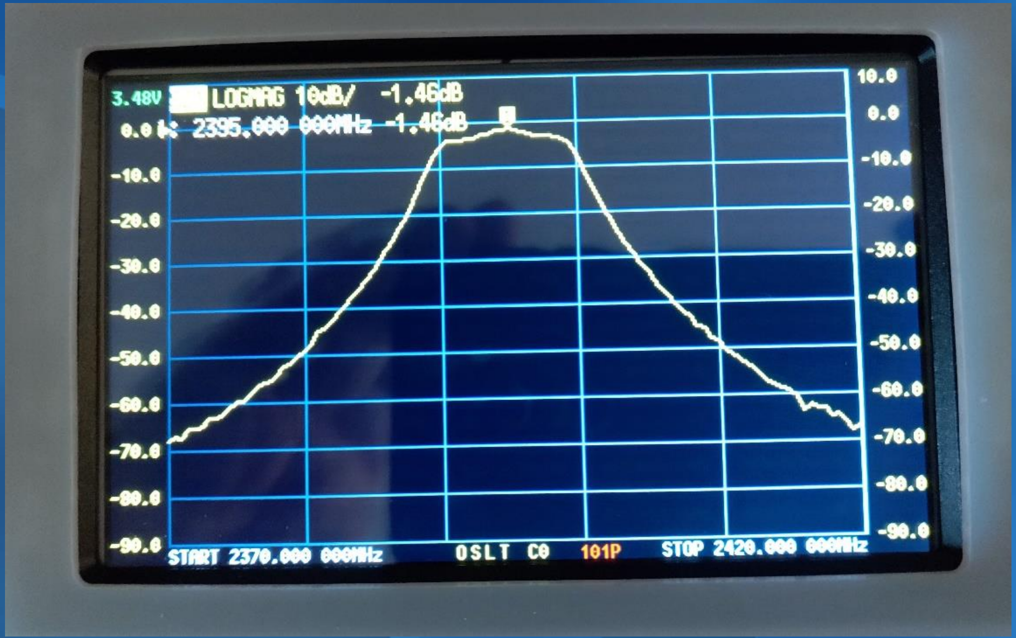
- A VLNA (G4DDK design) connected directly to the POTY
- A Bandpass filter after the LNA
- Further amplification to bring the signal level up to that required for the Minituner
- Good quality SHF coax back to the shack to minimise losses
- The Minituner receiver tuned to 2395MHz

HAMTV Reception Using LNA + Filter



2395MHz Bandpass Filter

5-pole Band-Pass Filter

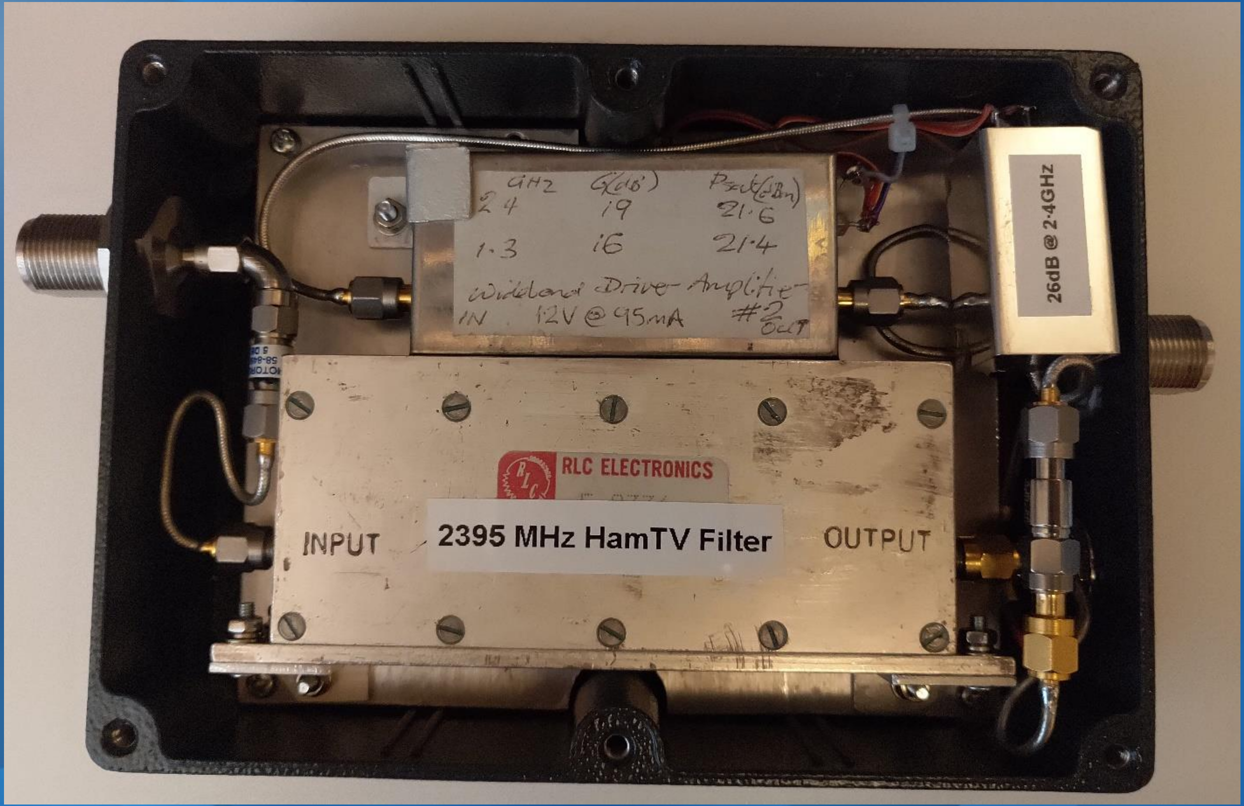


Filter aligned using Nano VNA to give 10MHz BW at 2395MHz centre frequency plus good attenuation above and below

Filter – Amplifier Unit

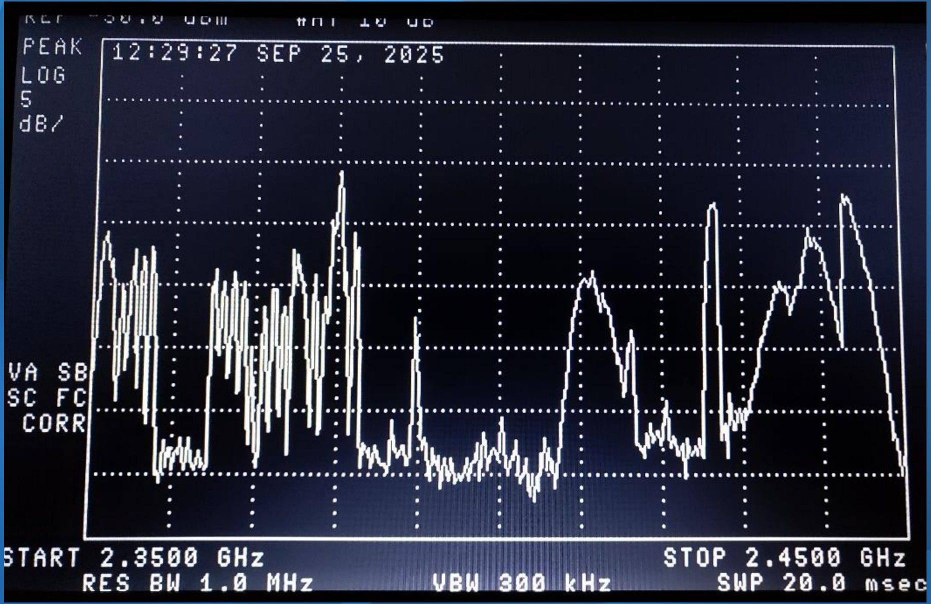
The BPF was terminated with attenuators, mainly for stability.

Two stages of RF amplification gave the unit a gain of 38dB overall.



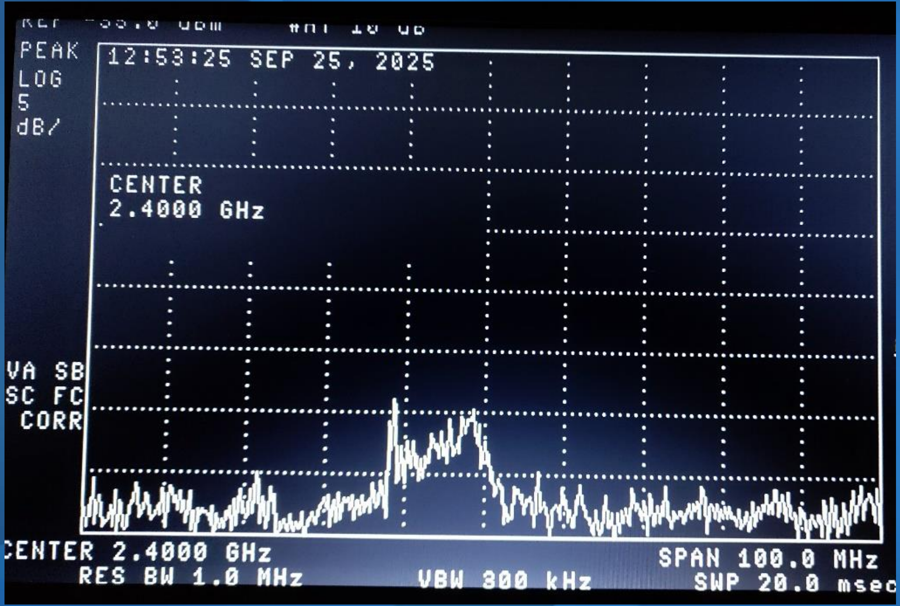
Effect of Bandpass Filter

Reference Level
-30dBm



Output of reception chain without BPF

Reference Level
-35dBm



Output of reception chain with BPF

Improved Fixed Dish Setup

Tripod allows elevation adjustment 45 – 90 degrees with all-round azimuth adjustment

Filter-Amplifier Unit strapped to dish support

High quality SHF coax connecting to receiver in shack

Filter + LNA : Results-1

- Successfully used for observing high elevation passes reliably with a good C/N.
- A Minituner was used in conjunction with a Ryde Receiver to drive a TV.
- The Ryde locked within a few seconds of the carrier being above threshold.
- Using the tripod set to the ISS max. elevation at the required azimuth, gave good repeatable results.
- During the recent HAMTV downlink of 18th October 2025, Pass 2, Colour Bars were received.

Filter + LNA : Results-2

HAMTV Reception 18th October 2025, Pass 2 (**see Video**)

(NB Spectrum Analyser clock is approx. 45 min. fast)

Conclusions on Reception Systems

- Using a fixed pointed dish provided a useful platform for investigating ISS HAMTV reception.
- Using an S-band LNB gave ‘quick and dirty’ results, but these may be degraded due to the local EM environment.
- The LNA + Filter method gave superior results at the cost of complexity but requires a suitable filter.
- For a fully tracking system, additional factors would need to be taken into account.

Considerations for a tracking system-1

Link Budget

- The ISS distance at lower elevation is greater than that for an overhead pass thus increasing the Free Space Loss at the lower elevation, which would need to be taken into account.
- Thermal noise pickup by the antenna at low elevations will be greater than when pointing straight up.
- Degradation of C/N due to local environment EM effects may vary with pointing, due to sources such as Wifi or 4G.

Considerations for a tracking system-2

Tracking System Requirements

- The antenna tracking system needs to physically handle the antenna system and track reliably.
- The tracking inaccuracy and associated loss needs to be taken into account in the LB (for the tests done, within a few degrees was adequate).

Location of Receiving System

- Ideally on top of a hill or tall building, with good all-round vision, no mobile phone masts or Wifi networks nearby, yet having a reliable high speed data connection for contribution to the HAMTV merger project.
- But any location should try!

Good luck with your system !

Questions ?