

ISTsat-1

A Compact ADS-B Receiver for a 1U CubeSat

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ISTSAT-1 - first nanosatellite project developed by students, professors and radioamateurs at the Instituto Superior Técnico / University of Lisbon in Portugal

Mission: test a compact ADS-B receiver and antenna

ADS-B receiver challenges:

- CP antenna with small form factor;
- High RF receiver sensitivity and reduced power consumption;





ADS-B ANTENNA

Requirements

- 1090 MHz, 16 MHz bandwidth, stable enough within 60° temperature gradient;
- Circular polarization for best match to aircraft LP antenna signals;
- Small-form factor, fitting 98×98×3 mm³ volume, without in-flight deploying parts

Solution

- Square patch with trimmed corners, probe fed, ceramic substrate ϵ_r =10.2 ;
- Co-designed with the cubesat structure and VHF/UHF antennas;

Results of integrated antenna

- Gain: 4 dBi; Axial Ratio: < 1 dB, efficiency: 80%
- System tests in roof-top show 400 km range, with 20% success message reading



The antenna is mounted at the bottom face of the cube, facing Earth. Roof-top tests show aircraft tracking up to 400 km impaired by Earth obstacles and horizon diffraction (onehour tracking period).

ADS-B RECEIVER



Requirements

- 1090 MHz, PPM modulation at 1 Mbit/s
- RF receiver sensitivity -95 dBm, SNR > 11dB
- Backend samples ADS-B signal, decodes frames and sends them to other S/C modules





- **RF frontend solution**
- Receiver with NF=1.4dB, 70 dB gain @1090 MHz and 4 MHz bandwidth. Figure shows the received Mode S 120 μ s extended squitter frame (inverted).

ADS-B board showing the RF frontend and the baseband backend

ADS-B PROCESSING CORTEX-M4 CORTEX-M0 Preambling and Buffering Decoding Filtering Phase alignment Validate Telemetry Housekeeping Telecommands Receive I2C Send I2C I2C Decoding **INCP Encoding** I2C Handler CORTEX-M0 **INCP** Decoding Integrity Check I2C Encoding Reliability Check Sampling

CONCLUSIONS

- Despite the 27.5 cm wavelength, a viable 98×98×2.5 mm³ ADS-B antenna was demonstrated, both in Lab and in system field tests.
- The ADS-B RF frontend working with the patch antenna has been demonstrated and is ready for final testing and assessment.
- Processing optimization is the final step in the development of the ADS-B receiver.