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MIRAD microwave AG
Hofstetstrasse 6
9300 Wittenbach
Switzerland

info@mirad.ch
+41 71 352 50 80
www.mirad.ch
follow us on Linkedin

S/X Dualband Feed for 32m Goonhilly Deep Space Antenna

The UK's Goonhilly Earth Station complex has developed the capability to support lunar and deep space missions for agencies, institutions and private companies. To do this, its 30- and 32-meter antennas have been modified to be compatible with NASA (DSN) and ESA Deep Space Networks (ESTRACK). This provides cost-effective access to communications and ranging services for satellites and space missions to allow the support of scientific missions like Mars Express, INTEGRAL or Gaia.

For this reason, the "legacy" 32m Beam Waveguide (BWG) antenna (GHY-6) at the Lizard Peninsula site in England was upgraded to support future deep space communications technology. In April 2018, Goonhilly became part of a collaborative partnership for commercial lunar missions to be interoperable with ESA and NASA antenna network services. This agreement included upgrading GHY-6 to a dual-band solution that supports S- and X-band frequencies and will be used for the Lunar Pathfinder mission, which will send small landers to the lunar surface to communicate with the mother ship as a relay station to GHY-6.

Credit: https://www.goonhilly.org/ghy-6-32m-x/s-band

In this context, MIRAD was asked to support the project with a dual-band feed system to be integrated with the large BWG reflector system. The antenna refurbishment required a high gain horn with a relatively small flare angle, resulting in a mechanically massive design with a length of approximately 2.4m and an aperture diameter of approximately 1.0m. The final feed design, including the horn, has a total length of approximately 5.6m. The system provides signal transmission and reception in S-band and X-band, with the X-band additionally supporting TE21 monopulse tracking. To provide this capability the standard MIRAD TE21 monopulse X-band tracking coupler unit is connected to the horns throat in the center of the feed. Waveguide filter combined to diplexing networks in both bands provide sufficient isolation between high power transmit signals and the small level signals in the receive paths and protect the LNA from operating in saturation. After the successful design phase, the challenging manufacturing and assembly of mechanically large parts all required performance tests have been successfully passed.

The final installation of the feed system in the antenna, in conjunction with the rest of the upgrade, enabled a UK station to communicate directly with deep space missions for the first time. The 32-meter antenna was officially inaugurated on June 11, 2021.

The following key parameters represent the S/X-band feed system:

Freqeuncy Range		Polarization	Axial Ratio	Insertion Loss	Port-to-Port	Rx/Tx/Trk Isolation
S-TX:	2.025 – 2.120 GHz	Dual Circular	max. 0.8 dB	typ. 0.25 dB, max. 0.4 dB	19 dB	min. 120 dB to SRX, min. 100 dB to X-band
S-RX:	2.200 – 2.300 GHz	Dual Circular	max.0.8 dB	typ. 0.25 dB, max. 0.4 dB	19 dB	min. 90 dB to STX, min. 100 dB to X-band
X-TX:	7.145 – 7.235 GHz	Dual Circular	max. 0.5 dB	typ. 0.35 dB max. 0.35 dB	19 dB	min. 100 dB to XRX & S-band
X-RX:	8.400 – 8.500 GHz	Dual Circular	max. 0.5 dB	typ. 0.25 dB max. 0.4 dB	19 dB	min. 100 dB to XTX & S-band
X-Trk:	8.400 – 8.500 GHz	Dual Circular	max. 2.0 dB	max. 1.2dB (incl. TE21 coupling)	15 dB	Min. 100 dB to TX, min. 40 dB to RX

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