

LEGS

Lunar Exploration Ground Sites



Expanding our capacity to bring more data home from the Moon.

With a new era of lunar exploration on the horizon, NASA’s Space Communications and Navigation (SCaN) division is partnering with industry to build a global network of state-of-the-art ground stations, known as **LEGS (Lunar Exploration Ground Sites)**. LEGS will increase the Near Space Network’s capacity to send and receive data by providing **high-availability, direct-to-Earth communications coverage for missions operating between 36,000 kilometers and 2 million kilometers from Earth**. Owned and operated by industry, the ground stations will be distributed across the world to service NASA missions alongside the growing community of lunar customers.



LEGS ground system performance characteristics are provided in the below tables:

Radio Freq. (RF) Band	Forward	Return
	Freq. Range	Freq. Range
X-Band	7145 – 7235 MHz ⁸	8400 – 8500 MHz
Ka-Band	22.55 – 23.15 GHz	25.5 – 27.0 GHz

RF Performance Criterion	Radio Freq. Performance (Forward)	
	X-Band	Ka-band
EIRP (min) ³	86 dBW	89 dBW
Forward Distortions ²	1 dB max	1 dB max
Carrier Modulations ¹	Direct PCM/PM, PCM/PM/PSK, OQSK, BPSK, Filtered OQPSK, Filtered BPSK, GMSK	Filtered OQPSK, Filtered BPSK, OQPSK, BPSK, QPSK, GMSK
FEC ^{1,6}	LDPC (¹ / ₂ , ² / ₃ , ⁴ / ₅ , ⁷ / ₈), uncoded	
Max Data Rate ^{1,4}	10 Msps	50 Msps

RF Performance Criterion	Radio Freq. Performance (Return)	
	X-Band	Ka-band
G/T (min) ³	39 dB/°K	47.5 dB/°K
Implementation Loss ²	2 dB max	2 dB max
Demodulation ¹	Direct PCM/PM, PCM/PM/PSK, BPSK, QPSK, OQPSK, Filtered BPSK, Filtered OQPSK, GMSK	BPSK, QPSK, OQPSK, Filtered BPSK, Filtered OQPSK, GMSK, 8PSK
FEC ^{1,6}	LDPC (¹ / ₂ , ² / ₃ , ⁴ / ₅ , ⁷ / ₈) uncoded	
Max Data Rate ^{1,4}	20 Msps	200 Msps

NOTES:

- ¹ Additional modulations, coding schemes, and data rates may be defined. Availability of data rates is dependent upon required spectrum authorization.
- ² GSFC CLASS link calculations use a 3dB implementation loss of which the receive system is allocated 2dB and the transmit system distortions are allocated 1dB.
- ³ Performance data is preliminary pending finalization of system requirements, and may vary across facilities and apertures.
- ⁴ Max Symbol Rates provided are based on uncoded OQPSK and includes encapsulation protocol overhead. For the uncoded case, this is equivalent to Rcs of CCSDS 401x0B31
- ⁵ BiPhase available with Direct PCM / PM / PSK
- ⁶ NRZ-L Symbol formatting required with LDPC codes.
- ⁷ Autotrack Accuracy specified is when winds are less than or equal to 45 mph at the antenna. Accuracy is ≤ 0.02 BRE for winds between 45 and 65 mph.
- ⁸ Antenna supports deep-space spectrum allocation. Lunar missions are restricted to a subset of this allocation.

LEGS Antenna Information	
Function	Performance
Antenna Diameter	20 - meter
Polarizations	Tx: RHC or LHC Rx: RHC or LHC
Antenna Travel Range ³	±300° Azimuth 0 to 90° Elevation
Tracking Rate ³	At least 1°/s
Autotrack Accuracy (all bands) ^{3,7}	≤0.01 deg Beam Radial Error (BRE)

Services Information	
Function	Performance
Services	TT&C, CCSDS Forward & Return data, Tracking (Radiometric & antenna auto-track angles)
Radiometric Tracking (X-band only)	Pseudo-Noise (PN) Ranging (CCSDS 414.1-B-2), 1-Way and 2-Way Doppler
Timing Reference ³	< 1.0 x 10 ⁻¹² short term stability Within ±5.0 x 10 ⁻¹³ freq. accuracy