

Bradford Avionics System

QUASAR TRANSPONDER

An Intelligent, Fault-Tolerant, Lightweight SmallSat Communications & Navigation Subsystem for Near Earth Orbits and Deep Space Applications



Quasar SDR Transponder

The Quasar Transponder is a complete S- and K-band communications system, built around an adaptable SDR core. It is designed for applications needing Mbps-level communications with guaranteed high availability.

MAIN FEATURES

- DSN/ESTEC or commercial networks compatible
- CCSDS compliant frequencies, modulation & encoding
- K/Ka-band operation with variable bandwidth for maintaining the BER in noisy environments
- Two-way Coherent architecture for Doppler and PN Regenerative Ranging
- Ranging delay variation <10nsec
- 16W RF K or Ka-band SSPA available
- Fire Code command decoder
- Dual simultaneous Rx inputs for multi-antennae usage
- Multi-channel architecture suitable for relay applications
- Full internal redundancy - no single-point critical failure possibility
- Low SWaP
- Competitive cost and less than 3 months' lead time

The Quasar provides telecommand, telemetry, and navigation services for small spacecrafts, including those with agile frequency needs. It can be operated either in the S- or K/Ka-band or in combinations of both enabling its primary use in beyond-LEO orbits, particularly for cislunar and inner solar system SmallSats.

The Quasar, enabled by its radiation-screened components, is designed to operate in high radiation and proton-heavy environments. Its internal redundancy enables the transponder's increased resilience against single events and other types of random failures, and it is qualified for >5 year missions.

All of this makes the Quasar the ideal candidate for high-performance yet low-cost deep space and cislunar missions as well as for Near Earth Orbit missions with size-centric, high data availability and performance dependability requirements.

INTERFACES

- Power input: 22V to 34V unregulated.
- Data interfaces:
 - single or redundant CAN, or RS485/422
 - optional Ethernet
- RF interfaces (K-band): 2x RX WR42 + 1x TX WR42
- CCSDS-compliant radio link

FREQUENCY RANGE

	Uplink (MHz)	Downlink (MHz)
K-Band (<i>Cislunar</i>)	22550-23150	25500-27000
Ka-Band (<i>Deep Space</i>)	34200-34700	31800-32300
S-Band	2025-2120	2200-2300

TECHNOLOGY READINESS

- Currently at TRL5 with FMs available by Q1 2025.



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PERFORMANCE CHARACTERISTICS RECEIVER

- Minimum Detectable Signal: - 150dBm
- Noise Figure:
 - - 1.6dB (- 125°K) at K-Band
- Demodulation: PM
- Carrier Tracking signal range: - 70 to - 150dBm
- Tracking Range: +/- 4MHz at Ka-Band
- Ranging Filter Type: Digital
- Two independent channels capable of concurrent operation, each internally redundant

TRANSMITTER

- Pout: Max 16 W (+42 dBm)
- Spurious: - 60dBc max
- Harmonics: - 40dBc max
- Phase Noise (100Hz – 1MHz): 1.5° K-Band, 1.6° Ka-Band
- Telemetry Symbol Rates (DL): up to 40Mbps
- Modulations: OQPSK, QPSK, GMSK, PM

RANGING

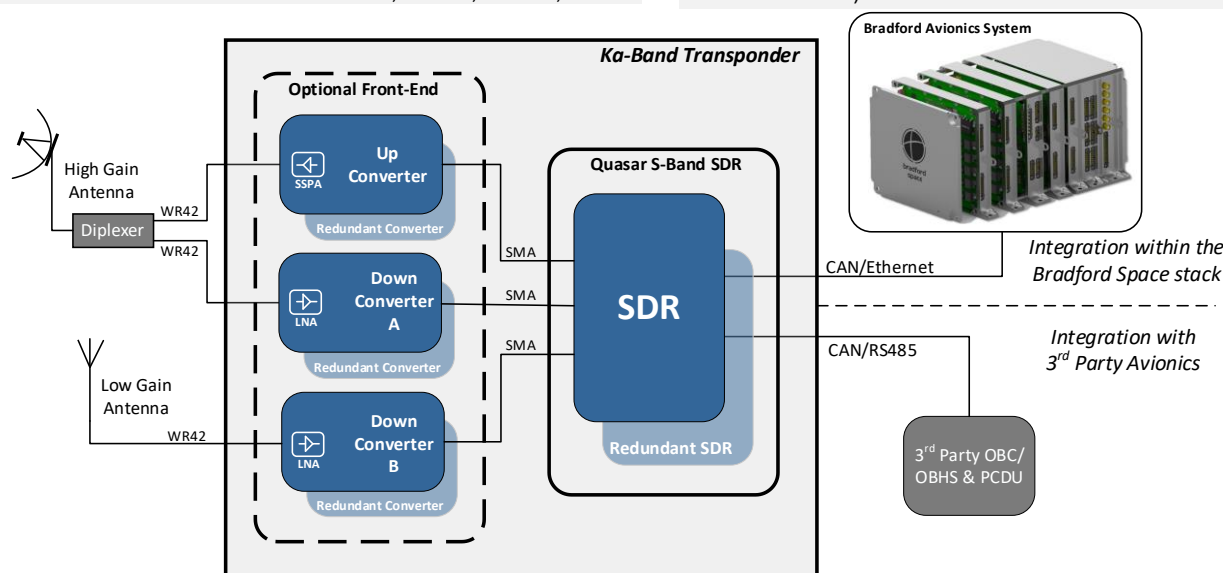
- Range: Regenerative PN
- Rate-Range: Doppler
- Bearing: D-DOR
- OCXO Allan Deviation: - 2.1x10⁻¹¹

ENVIRONMENT

- Operational temperature range: - 30°C to +60°C.
- Non-operational temperature range: - 40°C to +70°C.
- Radiation: qualified up to 30kRad total ionizing dose, and mitigations against SEEs.
- Lifetime: > 5 years.

BUDGETS

- Size: 163.5mm x 120mm x 35mm
- Mass: 0.75kg (S-Band), 2kg (K-Band with converters)
- Power:
 - Passive listening mode < 4.5W
 - Active receiving mode < 14W
 - Transmit mode < 60W transmission (K-band SSPA)



Typical Ka-Band Transponder Example Configuration

Example Transponder Configurations

Some potential configurations of the Quasar Transponder are shown below. The full amplifier set for the typical Ka-Band is designed and provided by Bradford Space. Additional amplifiers might be required for other configurations depending on the customer needs.

	Typical Ka-Band Deep-space mission with HGA + omni RX	K-Band Tx / S-Band Rx LEO Mission with high rate downlink need	S-Band Tx/Rx LEO Mission for control & medium data downlink need	Multiple Antennae
Downlink (+redundancy)	Ka-Band	K-Band	S-Band	S-Band into MGA/HGA
Uplink A (+redundancy)	Ka-Band	S-Band	S-Band	S-Band Into MGA/HGA
Uplink B (+redundancy)	S-Band	-	S-Band (with 3db gain on omni)	S-Band Into LGA