

Small Deep-Space Transponder (SDST)

Reliable X-Band and Ka-Band Deep Space Transmission



NASA's Deep Space Network DSN compatible

Radiation and SEU Tolerant

MIL-STD-1553 Interfaces – Standard and Low Power

Option for Ka-Band downlink (independent of X-band functionality)

Overview

The Small Deep Space Transponder (SDST), developed by General Dynamics and NASA's Jet Propulsion Laboratory, is a spacecraft terminal for X-Band and Ka-Band telecommunications with the NASA Deep Space Network (DSN). Making extensive use of MMICs, multi-chip modules, and a new signal processing ASIC, the SDST's flexible design provides the capability to meet the telecommunication needs of nearly every deep space mission.

The SDST has two configurations. The X/X configuration consists of an X-band receiver and an X-band 880F1 exciter. The X/X/Ka configuration consists of an X-band receiver, an X-band 880F1 exciter and an X-band 840F1 exciter. The 840F1 exciter drives an external x4, X-to-Ka-band multiplier mounted to the user's Ka-band power amplifier, allowing interconnection by coaxial cable rather than waveguide.

The SDST is designed for use with our 15 watt X-band Solid State Power Amplifier (SSPA) and other customer supplied X and Ka-band power amplifiers. The 15 watt X-band SSPA is designed to supply telemetry signals that can be connected directly to the SDST to make a complete transmitter/receiver with a single MIL-STD-1553B data interface.

Currently flying on multiple deep-space missions totaling > 1,000,000 in-flight operational hours: Deep Space 1, Mars Odyssey, Spitzer Space Telescope, Mars Rovers: Spirit, Opportunity, Curiosity; Deep Impact, Messenger, STEREO, Mars Reconnaissance Orbiter, Phoenix, Dawn, Kepler, Juno, MAVEN, InSight, and OSIRIS-REx. Future missions include: Mars 2020 Rover, Lucy and Psyche.

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Performance Characteristics

Features

- Deep-Space Network Compatible
- Redundant I/O for Cross-Strapping
- X-Band Receiver, X and Ka-Band Exciters
- 2.1 dB Typical Noise Figure @25°C
- -158 dBm Typical Sensitivity @ 25°C
- Temp Compensated Receiver VCO
- Low Exciter Spurious, Phase Noise, and Allan Deviation
- Radio Science Mode (using USO Input)
- 6 ns Typical Ranging Delay Variation
- 30 Mbps Max TLM Symbol Rate
- 0.5 ns Typical Carrier Delay Variation
- MIL-STD-1553 Interface – Standard and Low Power
- External Power Converter Synchronization Capability
- Operates Under Launch Environments
- Radiation and SEU Resistant
- Internal Telemetry Modulation Encoder
- Internal Command Detector with External Baseband Input
- Mounting in Either of Two Axes
- Firmware Options:
 - Carrier Tracking Loop Bandwidth
 - Command Detector Subcarrier Frequencies and Data Rates
 - Custom Command/Telemetry Interface Format
 - Custom POR state

Transponder

- X-Band UL Freq Range (Fixed Channel): 7.145 -7.235 GHz
- X-Band DL Freq Range (Fixed Channel): 8.400 -8.500 GHz
- X-Band TX/RX Ratio: 880/749
- Ka-Band DL Freq Range (Fixed Channel): 31.800- 32.300 GHz
- Ka-Band TX/X-Band RX Ratio: 3360/749
- Carrier Delay Variation: < 3 ns p-p
- Ranging Delay Variation: < 15 ns p-p

X-Band Receiver

- Noise Figure: < 2.5 dB @25°C; < 3.2 dB over temp, aging, radiation
- Carrier Tracking Signal Range: -70 to -158 dBm (to -60 dBm nom)
- Carrier Loop Threshold BW (2-sided): 20 Hz or 50Hz (others avail)
- Carrier Loop Damping Factor: 0.5 @ 0 dB loop S/N (Type 1, second order loop)
- Tracking Range: ±200 kHz minimum
- Command Subcarrier Frequency: 16 kHz
- Command Subcarrier/Tone Mod Index: 0.5 -1.5 radians peak
- Command Data Rates: 7.8125 - 4000 bps (2n steps, PM/PSK, NRZ)
- Ranging Uplink Carrier Suppression: 0 to 5 dB (sine wave)
- Ranging Filter Type: 15th order finite impulse response filter
- Ranging Filter 3 dB BW: 1500 kHz nom (other options available)
- Temperature Stability: ±3 ppm (-20 to +60°C)

Exciters (Independent X- and Ka-Band)

- X-Band 880F1 Output Power: +13 dBm +2.5 dB, -1.5 dB (5 watt PA optional)
- X-Band 840F1 Output Power (to external X4 Multiplier): +23.5 dBm±2.5 dB
- X4 Multiplier Input Power: +18 dBm +3 dB, -0 dB
- X4 Multiplier Output Power (3360F1): -1 dBm minimum
- X-Band Phase Noise, Aux Osc Mode (add 12 dB for Ka-Band):
 - -20 dBc/Hz (1 Hz offset) maximum
 - -75 dBc/Hz (100 Hz - 100kHz offset) maximum
- Frequency Stability, 0 to 50°C: ± 5.0 ppm maximum
- X-Band Spurious & Harmonic Outputs: < -50 dBc
- Phase Modulator Linearity: < 10% variation from straight-line to 2.5 radians pk

- TLM Modulation Modes: Subcarrier, BPSK (to 15 Mbps), QPSK (to 30 Mbps) upgradeable to 100 Mbps
- TLM Encoding: Convolutional 15-1/2, 15- 1/4, 15-1/6, 7-1/2; Manchester. Bypass mode available for customer external encoders.
- TLM Subcarrier: 2 kHz to 18 MHz square or sine wave
- TLM Phase Deviation: 0° to 135° peak minimum
- Ranging Modulation Index: 4.375, 8.75, 17.5, 35, and 70° peak
- Differential One-way Ranging Tones (coherent w/downlink carrier):
 - X-Band 880F1: 19.2 MHz
 - Ka-Band 3360F1: 19.2 MHz and 76.8 MHz

General

- Mass: 7.0 lbs (3.2 kg) maximum
- Input Supply Voltage: 22 to 36 VDC, or ±11 to ±18 VDC
- Input Supply Power:
 - Receiver Only: 12.5 W nominal
 - Receiver + X-Band Exciter: 15.8 W nominal
 - Receiver + X and Ka-Band Exciters: 19.5 W nominal
- Envelope Size: 7.13" L x 6.55" W x 4.50" H
- External Synch (optional) Frequency: 125 kHz nominal
- Radiation Total Dose: 50 krad (Si) (part level), 100 krad optional
- Operating Temperature: -40 to +60° C

GENERAL DYNAMICS

Mission Systems

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D-SDST-4-0919
PRI-1908-0057