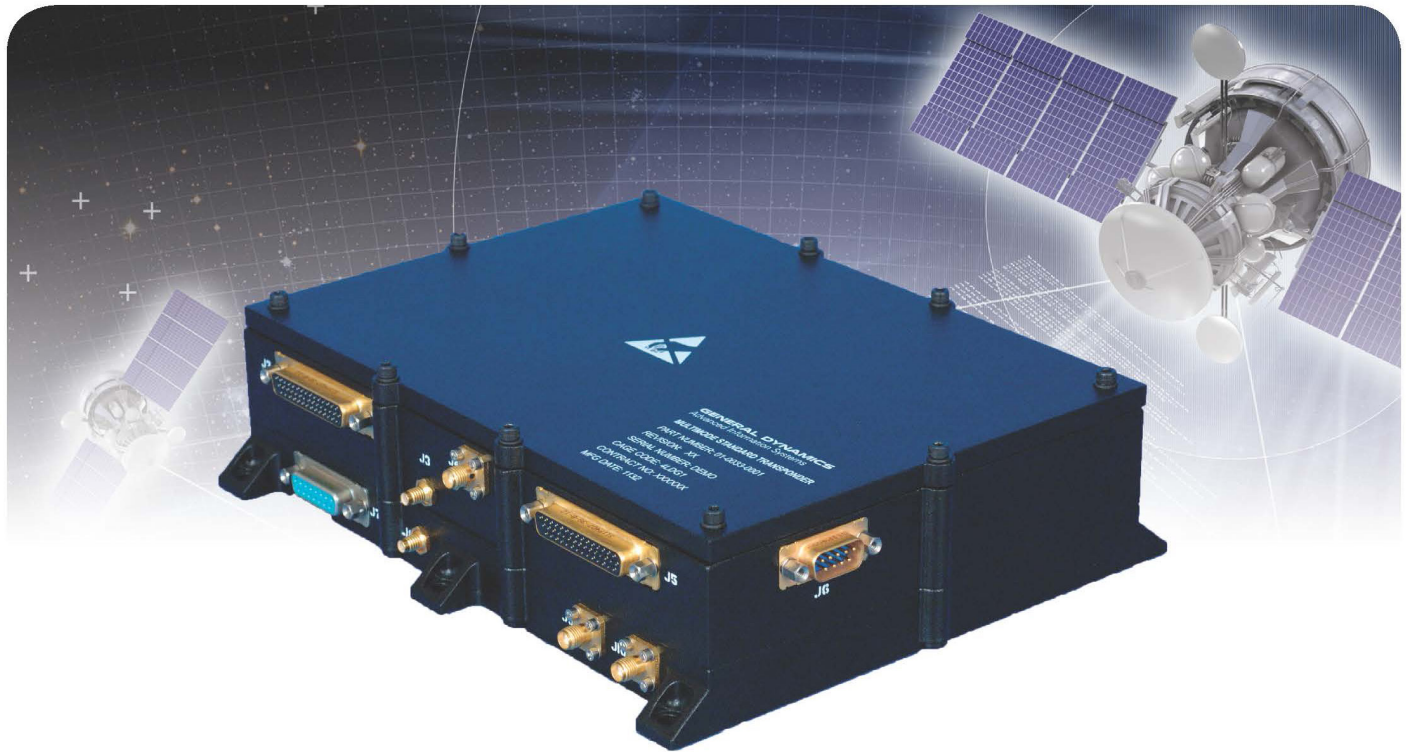# Space Qualified Multi-Mode Standard Transponder (MST)

Affordable, compact S-Band transponder

Mission ready: Five different MST models support a wide range of customer requirements

Secure: Compatible with commercial and NSA certified encryption products

Flexible: Customer specific requirements and options are available

Proven: Providing reliable earth-to-space craft and spacecraft-to-spacecraft communications for more than 50 years

Overview

The Multi-Mode Standard Transponder (MST) provides compatibility with a variety of government and commercial telemetry and command formats in a single unit at an affordable price.

Available receive modes include NASA's Tracking and Data Relay Satellite System (TDRSS), NASA's traditional Spaceflight Tracking and Data Network (STDN) ground network format, Air Force Satellite Control Network (AFSCN) Space-Ground Link System (SGLS) and Unified S-Band (USB), and a direct carrier BPSK mode compatible with commercial services and the NASA Ground Network (GN). Available transmit modes include PN spread modes compatible with the NASA TDRSS in addition to OQPSK/SQPSK, QPSK, BPSK and linear phase modulation modes.

In addition to telemetry and command applications, a pair (or more) of transponders can be configured for proximity link or crosslink applications. Operating modes are configured at manufacture via firmware. Customization is available for unique applications.

Space Qualified Multi-Mode Standard Transponder (MST)

Available Models

Model #	Mode	Telemetry Data Rates	Command Data Rate	Ranging	Encryption/ Decryption	Modulation	FEC
MST-100	DSN/STDN/ USB	1k – 512k bps uncoded	1, 2, 4 kbps standard	Turn-around tone ranging and coherent Doppler turnaround	Decryption interface (e.g. MCU-110), Barker word detect	Rx: BPSK direct on carrier or on a 16 kHz subcarrier Tx: BPSK or 1.7 MHz Subcarrier	Tx: R=1/2, K=7 Convolutional Encoding
MST-200	TDRSS/NEN	18 – 300 kbps SS-SQPN	Up to 300 kbps SQPN, higher rates in unspread mode	PN ranging (regenerative) and coherent Doppler turnaround	Decryption interface (e.g. MCU-110), Barker word detect	Rx: SS-UQPSK (TDRSS), BPSK Tx: SQPN, OQPSK (unspread), BPSK	Tx: R=1/2, K=7 Convolutional Encoding Rx: R=1/2, K=7 Viterbi Decoding
MST-300	SGLS/AFSCN	1k – 128k bps uncoded subcarrier 1k – 512k bps uncoded direct carrier	1 kbps or 2 kbps standard	AFSCN PN ranging and coherent Doppler turnaround	Decryption interface (e.g. MCU-110), Barker word detect or Ternary (1/0/S) tone operation	Rx: AM/FSK or BPSK Tx: 1.024 or 1.7 MHz subcarrier or direct BPSK	Tx: R=1/2, K=7 Convolutional Encoding
MST-400	BPSK/NEN	1k – 1.6M bps BPSK direct carrier, 500k – 8M bps OQPSK/QPSK	2, 32 or 64 Kbps standard, other rates available	Coherent Doppler turnaround available	Decryption interface (e.g. MCU-110), Barker word detect	Rx and Tx: BPSK	Tx: R=1/2, K=7 Convolutional Encoding Rx: NRZ M- to -L
MST-500	SGLS + USB	1k – 128k bps uncoded subcarrier 1k – 512k bps uncoded direct carrier	1 or 2 Kbps on subcarrier, higher rates on direct BPSK	Tone and PN, coherent Doppler turnaround	Decryption interface (e.g. MCU-110), Barker word detect or Ternary (1/0/S) tone operation	Combines MST-100, MST-300, and BPSK modulations	Tx: R=1/2 R=1/2, K=7 Convolutional Encoding

Note: Multiple modes can be combined in a custom configuration up to the available processing resources; additional interface types, data rates and other specialized features can be implemented subject to the same processing resource constraints.

Interface

- RF connectors are SMA-F

- Non-RF connectors are sub-miniature D

- Digital interfaces are differential RS-422 compatible line drivers and receivers (LVDS interfaces are also optionally available)

- Mode control via RS-422 UART at user-specified baud rate

- DC power (> 1 megohm isolated)
    - 21 - 36 VDC
    - < 10 Watts receive-only mode
    - 44 - 46 Watts full duplex

- Analog telemetry
    - Voltage Monitor
    - Temperature Monitors (passive thermistors)
    - RF Output Power Monitor

- Digital telemetry via RS-422 UART at user-specified baud rate
    - Receiver Frequency Offset
    - Lock and Configuration Status
    - Receiver AGC

- Redundant command data interfaces (data, clock and lock status)

- Redundant I and Q transmit data inputs (selectable via command)

- Hard-line baseband command interface for spacecraft checkout

- Redundant long code epoch output for time transfer on TDRSS units

Receiver Features

- Operating modes include:
    - TDRSS
    - Direct Carrier BPSK
    - BPSK Modulated Command Subcarrier Linearly Phase Modulated on the Carrier
    - SGLS/AFSCN including Ternary FSK
    - Multiple Mode Operation Available in a Single Unit

- Noise Figure: <2.5 dB ambient; 2.8 dB hot

- Frequency Stability: < 0.5 ppm, 0 to +50º C

- Operating Frequency: USB = 2025 to 2120 MHz, SGLS = 1760 to 1840 MHz

- Acquisition:
    - TDRSS: Doppler Compensated
    - GN: Ground Sweep or Autoacquisition

Transmitter Features

- PN Spread Modes are Compatible with TDRSS

- BPSK, QPSK, Linear Modulation and Subcarrier Modulation Modes

- Frequency Stability: < 0.5 ppm,0 to +50º C

- Operating Frequency: 2200 to 2300 MHz

- Digital Filtering for Spectral Containment

Physical/Environmental

- Size: 9.40" x 7.30" x 2.30" (2 Module Integrated Unit)

- Weight: < 6.0 lbs (2 Module Integrated Unit, including optional 8W PA)

- EMI/ EMC: MIL-STD-461C

- Radiation: 100 kRad

- Vibration: 25 Grms

- Shock: 3000 G peak, 1300 Hz

- Temperature: -34º C to +71º C

Technical Specifications

- Many parameters can be easily customized with only a firmware change including:
    - Operating Frequency
    - Data Rate
    - Subcarrier Frequency
    - Serial Mode Control Commands
    - Modulation Index

- The transponder can be supplied with or without the integrated 8W PA, and also as two separate, stand-alone units for remote mounting of the PA.

- The transponder can be supplied with an integrated diplexer

- Optional interface to standard cryptographic equipment (e.g. or MCU-110)

- The transponder can also be configured for Proximity Link or Crosslink applications.

- Further customization is available, please contact us to discuss your unique requirements.

Space Qualified Multi-Mode Standard Transponder (MST)

50+ Years of Space Communications Success

General Dynamics has over 50 years of experience designing and manufacturing high reliability space electronics for NASA and the Department of Defense. From the S-Band transponders used by the Apollo astronauts who landed on the moon and communicated back down to earth, to the X-Band system for the Mars Exploration Rovers. Our proven space electronics provide reliable Earth-to-spacecraft and spacecraft-to-spacecraft communications.

General Dynamics supplies the tracking, telemetry and control (TT&C), precision navigation and timing, and crosslink equipment for missions of human space flight, near-Earth observation, lunar and deep space exploration.

Our flight-proven subsystem components make us a trusted leader in complex space communications and data handling electronics, miniaturized power components and on-board software processes.are development. We comply with CMMI level-3 systems and embedded software processes.
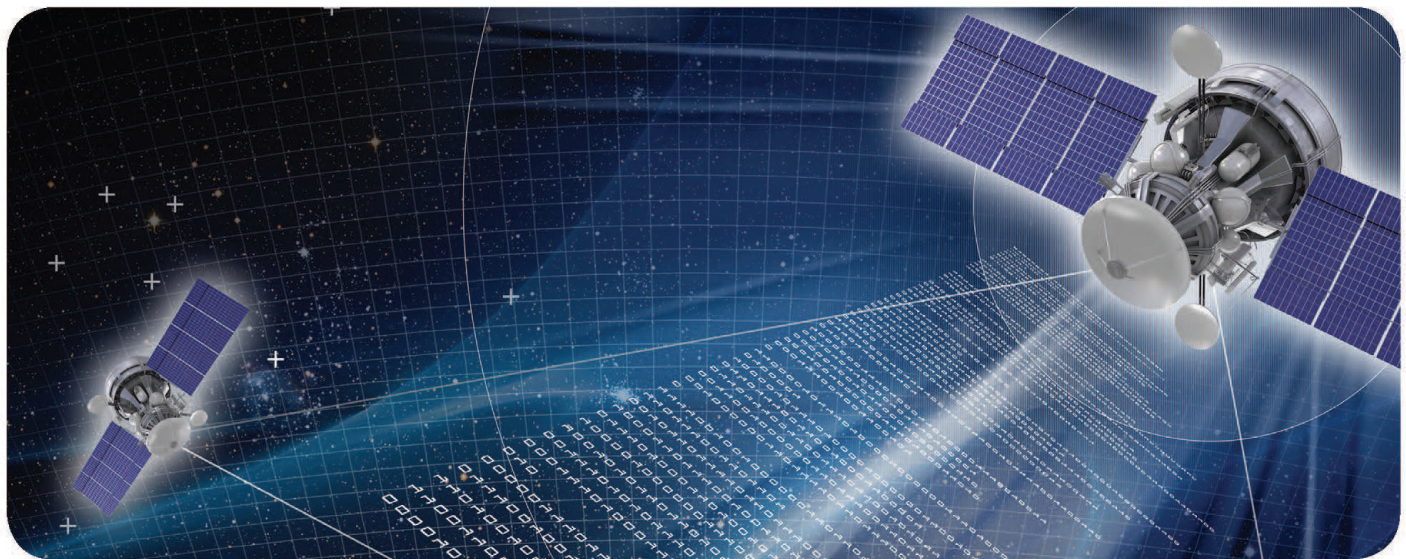
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