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STTC-P3 l Datasheet

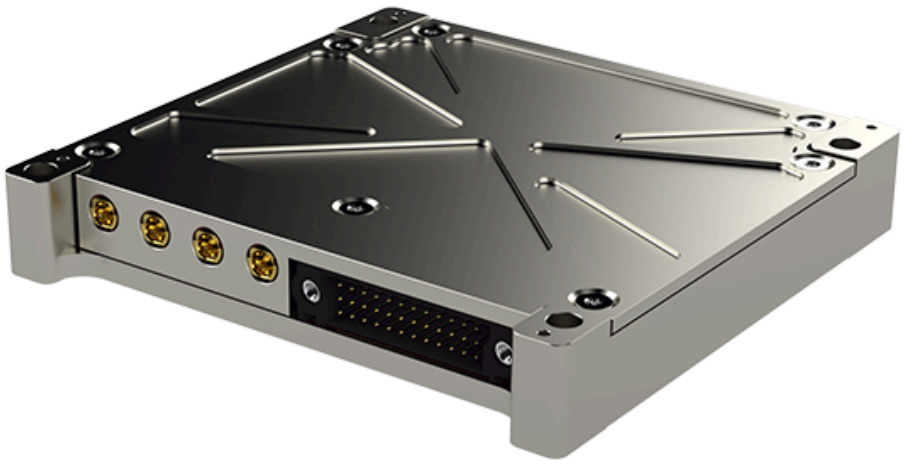
Versatile S- band transervicer module for high speed communication and ranging

STTC-P3

DATASHEET

1 FEATURES

- RF characteristics
  - Channels: 2 receive, 2 transmit
  - S-band uplink : 2025 – 2110 MHz
  - S-band downlink: 2200 - 2290 MHz
  - Tx power up to 2 Watt
  - Rx noise figure: 5 dB (TBD)
  - Full duplex
- Modem and protocol
  - CCSDS compliant (401.0-B-32 and CCSDS 131.0-B-5)
  - BPSK or OQPSK - 9600 bps to 20 Mbps
  - FEC: Convolutional Coding (K=7, r=½) and Reed Solomon (RS-223,255)
  - CCSDS Scrambling
  - Modem fully implemented in FPGA with DMA
  - CSP 1.0 and 2.0 protocol
  - 64 GB storage
- Ranging
  - CCSDS compliant (414.0-G-2)
  - Transparent PN ranging
- Interface
  - High-reliability Harwin M80 connector for power and data interface
  - CAN bus
  - LVDS, SpaceWire, RS-422, RS-485
  - Ethernet
  - 4 x 50 Ω RF connectors
- Reliability
  - Thermal heat sinking by flush-mounted PCB on 2.5mm Al
  - Radiation total dose tested EEE parts
- High-quality Enclosure
  - Min. 1.5 mm Al Shielding in all directions
  - PC-104 compatible mounting holes



2 DESCRIPTION

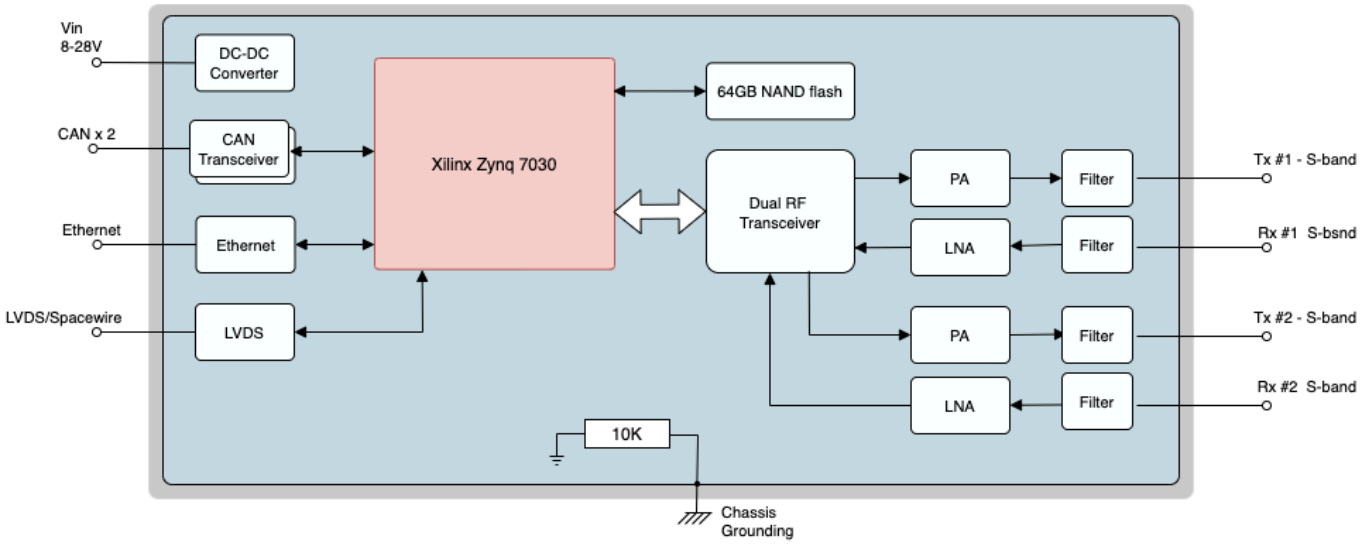
The STTC-P3 is a software defined satellite transceiver offering a versatile S-band transceiver module for high speed communication and ranging solution for both LEO and GEO missions.

The transceiver is designed to work with the latest CCSDS Cat A recommendations for high data rate transmissions and high spectral efficiency. Using constant envelope GMSK or low crest factor SRRC filtered OQPSK modulation for higher power amplifier efficiency and lower linearity requirements.

The ranging functionality supported is transparent pseudo noise ranging according to CCSDS 414.0-G2 standard where the transceiver frequency-translates the uplink ranging signal to the downlink without code acquisition (i.e., non-regenerative ranging or turnaround ranging).

The SDR is based on a powerful Xilinx Zync-7030 SoC and high performance Analog Devices SDR front-end, the AD9361.

3 FUNCTIONAL DESCRIPTION



4 CAN INTERFACE

The STTC-P3 is designed to operate as an edge-router in a CSP (Cubesat Space Protocol) network, where the internal CAN bus is meeting the external Radio interface.

5 ENCRYPTION

The radio supports shared-key encryption of the CBLK interface. The algorithm chosen is Salsa20, with an incrementing value stored in nonce to protect against replay attacks, having support for multiple independent satellites and/or ground stations. Encryption can be enabled independently for RX and TX. The radio contains up to three RX keys which are all tried when decoding a packet. The recommendation is to use one of the keys only to change other keys. All keys share the same nonce incremental counter.

5.1 ENCRYPTION CONFIGURATION

- 256 bit encryption keys (crypto_key1/2/3)
  Configure up to three keys to be used. By convention, one key should be used only when updating other keys, to minimize the risk of leaking that key.

- Select crypto key for TX (tx_encrypt)
  Set to 1, 2 or 3 to encrypt using the particular key. Decryption is always tried out using all keys.

- Enable and force decryption for RX (rx_decrypt)
  Enable decryption until the next X reboots. Should be checked and/or set periodically, to avoid decryption to be disabled in orbit.

- TX identifier (crypto_nonce_tx_group)
  Unique transmitter ID, used only when having more than one independent ground encryption node.

6 RF CONFIGURATION

The radio is configured using CSP parameters. The RF modem in the STTC is referred to as CBLK. The radio-related configuration is carried out by the following parameters.

- Radio configuration (param name: txchannel_en)
    - Bit 0: Enable transmission via TX1 (X-band if installed)
    - Bit 1: Enable transmission via TX2
- CCSDS compliant convolutional code rate (param name: tx_conv_enc_kr, rx_deconv_enc_kr)
    - 0: K=7, Rate 1/2
    - 1: K=7, Rate 2/3
    - 2: K=7, Rate 3/4
    - 3: K=7, Rate 5/6
    - 4: K=7, Rate 7/8
- Symbol rate (param name: tx_mod_symbol_rate_ndiv, rx_demod_symbol_rate_ndiv)
    - 2: 5000 ksym
    - 3: 2500 ksym
    - 4: 1250 ksym
    - 5: 625.00 ksym
    - 6: 312.50 ksym
    - 7: 156.25 ksym
    - 8: 78.125 ksym
    - 9: 39.063 ksym
    - 10: 19.531 ksym
- Modulation and filter (tx_mod_sel, rx_demod_sel)
    - 0x01: BPSK, 20% SRRC roll-off
    - 0x02: BPSK, 35% SRRC roll-off
    - 0x03: BPSK, 50% SRRC roll-off
    - 0x11: OQPSK, 20% SRRC roll-off
    - 0x12: OQPSK, 35% SRRC roll-off
    - 0x13: OQPSK, 50% SRRC roll-off
- Mode (tx_input_sel)
    - Mode 4-7 are intended for ranging sessions
    - The RX chains are still active in any mode
    - 0: Normal
    - 1: PRBS
    - 2: Carrier
    - 3: Unused
    - 4: Loopback RX1 -> TX1
    - 5: Loopback RX1 -> TX2

    - 6: Loopback RX2 -> TX1
    - 7: Loopback RX2 -> TX2

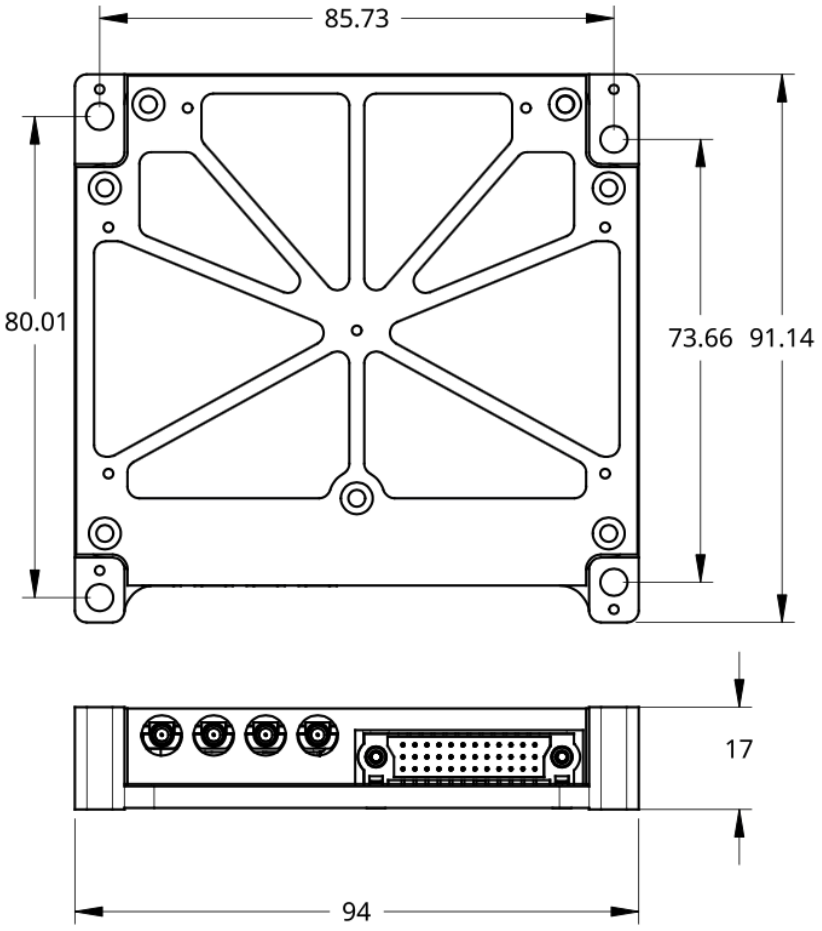
- Mode revert (tx_input_sel_revert)
    - Value in seconds before the mode reverts to 0
- TX frequency for S-band (tx_freq)
    - Unit: Hz
- TX frequency for X-band (tx_freq_x)
    - Unit: Hz
      Leave at 0 if X band if the X band HW option is not available
- RX frequency (rx_freq)
    - Unit: Hz
- TX power (tx_power_s, tx_power_x)
    - 30.000 corresponds to full output power. Halving the value corresponds to a drop of 6 dB output power
- TX training time (tx_powerup_delay)
    - Unit: ms
- TX keepalive time (tx_powerdown_delay)
    - Unit: ms

7 TELEMETRY

The radio contains a number of parameters showing health and status of the radio.

- ad_rssi [0, 1] [dBm]
    - Calibrated RSSI measurement for each receive path
- Temperature
    - s_pa_temp [deg C]
    - x_pa_temp [deg C]
    - ina_temp [0, 1] [deg C]
        - Temperature for RF and ZYNQ power supply respectively
    - ad_temp [deg C]
        - Transceiver temperature
- Power
    - current [0, 1] [mA]
        - Input current drawn for RF and ZYNQ power supply respectively
    - voltage [0, 1] [mV]
        - Input voltage for RF and ZYNQ power supply respectively
    - x_current [mA]
        - Bias current for X band PA

8 MECHANICAL DRAWINGS



Dimension Drawing

9 MASS

The weight of the STTC-P3 is 230 gram.

10 PIN-OUT

The STTC-P3 has one Harwin M83 connector with 36 pins supporting the following interfaces.

Connector type PCB: M83-LML3M7N36 (male)
Mating connector: Harwin M83-LFC1F2N36-0000-000

Pin 1 position: Top right corner, when looking into the male connector

Connector #1

- 2 x CAN
- 6 x LVDS pairs
- 1 x Ethernets
- 1 x SPI
- 1 x RS232 TTL UART
- Power 6.5V - 33.6 V unregulated

12	11	10	9	8	7	6	5	4	3	2	1
LVDS 5-P	LVDS 4-P	LVDS 3-P	LVDS 2-P	LVDS 1-P	LVDS 0-P	Vin2	Vin1	CAN H0	CAN L0	CAN H1	CAN L1
LVDS 5-N	LVDS 4-N	LVDS 3-N	LVDS 2-N	LVDS 1-N	LVDS 0-N	GND	GND	ETH A-P	ETH B-N	ETH C-P	ETH D-N
SPI SS	SPI CLK	SPI MISO	SPI MOSI	232 TX	232 RX	GND	GND	ETH A-N	ETH B-P	ETH C-N	ETH D-P
36	35	34	33	32	31	30	29	28	27	26	25