

## TTC-2

### Dual Hot-Redundant VHF/UHF Satellite TT&C radio

For Micro- and Nano-Satellites

#### 1 Features

- 2 Half-Duplex VHF/UHF Transceivers
- 2 Microcontrollers for housekeeping and control
- Data-rate: 1200 - 19.200 kbps nominal. (up to 115.200 available upon request)
- Frequency: 130-140 and/or 420-460 MHz
- 30 dBm output power with dedicated DC-DC Regulator for high efficiency
- Noise Figure: <2 dB
- Modulation: GMSK
- Framing: HDLC
- Encoding: NRZI
- Frequency Stability:  $\pm 100$  Hz
- FEC: Convolutional Coding ( $K=7, r=1/2$ ) and Reed Solomon (RS-223,255)
- CCSDS Scrambling
- CAN bus with CSP protocol
- Optional: RS-422 with CCSDS transfer frames
- High-reliability Micro-D connectors
- Reliability
  - Thermal heat sinking by flush-mounted PCB on 2.5mm Al
  - Radiation total dose tested EEE parts
  - Vibration rated for all launch vehicles
- High-quality Enclosure
  - Min. 1.5 mm Al Shielding in all directions
  - PC-104 compatible mounting holes

#### 2 Description

The TTC-2 is a hot-redundant satellite telemetry, tracking and command (TT&C) radio with two half-duplex VHF/UHF transceiver designed to enable robust and reliable satellite communication.

The TTC-2 is intended to be used in an antenna diversity scheme, where each channel is connected to orthogonal and cross-polarized antennas. Hereby a good omnidirectional gain pattern can be achieved, which makes signal reception nearly independent of satellite attitude.

Careful receiver design provide a noise figure below 2 dB, which, combined with concatenated convolutional and Reed-Solomon decoding, ensure excellent sensitivity. Realizing that interference have proved problematic over certain regions, the TTC-2 also features a 60 dB out-of-band rejection filter.

On the transmission side, the power consumption is minimized using constant envelope GMSK modulation, whereby >50% efficiency is achieved in the PA stage. This makes the TTC-2 ideal as a low-power backup link.

Fully configurable radio beacons allow basic signal acquisition and coarse tracking of the satellite. User authentication is enabled by default, and (optional) encryption is provided as a part of the CSP protocol.

