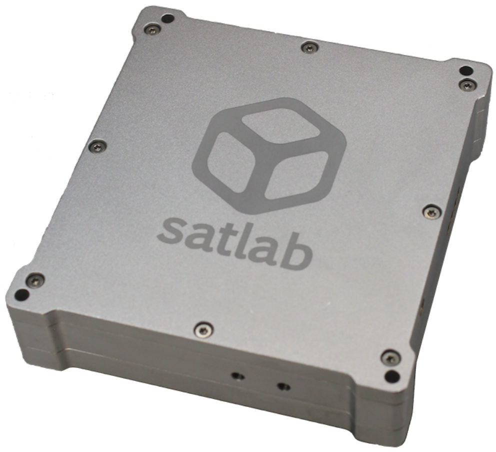
# High-Speed X-band Transmitter

## Introduction

The Satlab SRX-8 is a DVB-S2 X-band transmitter designed for high-speed data transfer at rates up to 1.4 Gbit/s while weighing just 300 g, making it ideal for downlinking large volumes of payload data from micro- and nano-satellites. The transmitter operates in the ITU Earth observation X-band with support for all DVB-S2 MODCODs, allowing simple integration with commercial ground station providers.

## Features

- Variable symbol rate up to 312.5 MBd, enabling data rates up to 1.4 Gbit/s
- Adjustable output power up to 33 dBm, with power monitoring and regulation
- Run-time configurable modulation with support for all DVB-S2 MODCODs
- Support for all DVB-S2 frame lengths, pilots, Gold sequences and roll-offs
- 1 Gb/s Ethernet and 10 Gb/s Ethernet interfaces with flow control for data transfer
- IP routing with Generic Stream Encapsulation
- CAN-bus and RS-422 interfaces using CubeSat Space Protocol (CSP) for configuration and telemetry
- FPGA configuration and logic memories protected by SECDED ECC
- PC/104 form factor aluminum enclosure
- Delivered with support library for easy integration
- Fully on-orbit software upgradable




## Key Parameters

| Parameter | Specification |
|---|---|
| Transmit frequency range | 8025 MHz to 8400 MHz |
| Transmit symbol rate | 1 MBd to 312.5 MBd |
| Transmit modulation | DVB-S2: QPSK, 8PSK, 16APSK and 32APSK |
| Transmit FEC | DVB-S2: BCH and LDPC |
| Transmit power | 27 dBm to 33 dBm |
| Transmit data rate | Up to 1.4 Gbit/s |
| Input voltage | 7.5 V to 40 V |
| Typical power consumption | TX: 27 W (312.5 MBd, 33 dBm output), idle: 4.3 W |
| Operating temperature | −40 °C to 70 °C |
| 1 Gb/s Ethernet standard | 1000BASE-T |
| 10 Gb/s Ethernet standard | 10GBASE-R (10.3125 Gbit/s CML SERDES) |
| Dimensions | 93.0 mm x 87.2 mm x 22.0 mm |
| Mass | 300 g |

## Table of Contents



# 1 Description

The Satlab SRX-8 is a DVB-S2 X-band transmitter designed for high-speed data transfer at rates up to 1.4 Gbit/s while weighing just 300 g, making it ideal for downlinking large volumes of payload data from micro- and nano-satellites. The transmitter operates in the ITU Earth observation X-band with support for all DVB-S2 MODCODs, allowing simple integration with commercial ground station providers.

The SRX-8 documentation package is composed of two documents. The datasheet **SL-PRO-DS-SRX-8** (this document) and the user manual **SL-PRO-UM-SRX-8**. The datasheet primarily focuses on the capabilities of the SRX-8 while the user manual serves as a guide on how to use the SRX-8. The datasheet contains references to the user manual throughout the document. The user manual can be found at `https://satlab.com/products/srx-8/`.

Figure 1 shows a simplified block diagram of the external connections to the SRX-8.

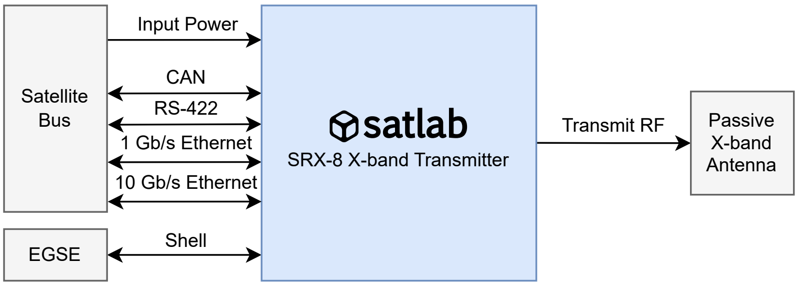



**Figure 1:** Simplified overview of the SRX-8 transmitter with external interfaces.

The SRX-8 is powered from a single 7.5 V to 40.0 V input. All onboard regulated voltages are protected against over-current.

The transmitter is controlled via CAN-bus and/or RS-422 using CubeSat Space Protocol (CSP) commands, and forwards IP packets from the Ethernet interfaces on the RF link. Both CAN and RS-422 can be enabled simultaneously, allowing one to serve as backup.

CSP is a small network-layer delivery protocol designed for CubeSats. An open source reference implementation is available on `http://www.libcsp.org`.

Satlab supplies source-level client libraries in C and Python to wrap the CSP protocol, along with example code to simplify integration even further. Documentation for the support libraries is distributed separately along with the source code.

The SRX-8 can function as a network router by forwarding IP traffic from an internal satellite network, as a transmitter of individual DVB-S2 BBFRAMEs if fine-grained control of the data link is required, or a combination thereof. The SRX-8 is capable of transmitting data with an on-orbit configurable symbol rate spanning from 1 MBd to 312.5 MBd at RF frequencies between 8.025 GHz and 8.4 GHz.

The SRX-8 monitors the output power during transmission and uses an Automatic Level Control (ALC) loop to adjust the transmit gain to achieve and maintain the target output power.

The transmitter is delivered in a milled aluminum enclosure which provides a strong mechanical interface as well as EMI shielding and thermal contact to the thermal interface. The connectors P1, P2 and P3 are high-reliability Harwin Gecko connectors. P1 and P3 are screwed, P2 is latching, P4 is a 4-port SMPM full detent connector, and the TX port is a full detent SMP connector, all with gold-plated contacts.

A serial command line shell is available through the EGSE connector (P2), which can be used for on-ground configuration, testing and performance verification.

## 2 Hardware Overview

Figure 2 shows a simplified block diagram of the transmitter with the external interfaces in gray: the RF connector for TX, the main connector P1, the EGSE connector P2, the 1 Gb/s Ethernet connector P3 and the 10 Gb/s Ethernet connector P4. The EGSE connector is used for on ground configuration and performance testing. Internally, the SRX-8 is composed of two parts, a baseband board and a Block Up Converter (BUC) board. Each board contains an MCU which ties together the functions and interfaces of each board. The baseband MCU handles configuration of the FPGA-based DVB-S2 modulator and all control plane communication. The BUC MCU is responsible for keying up the transmit chain and automatic level control (ALC) during transmission. Both MCUs also collect telemetry (TM) from their respective temperature, voltage, current and power sensors. See section 2.3 for more information.

The system includes on-board transceivers for CAN-bus, RS-422, 1 Gb/s Ethernet and 10 Gb/s Ethernet to simplify integration with different satellite buses. The 10 Gb/s Ethernet interface can be powered up/down as needed to save power when not in use.

Configuration and calibration values are stored persistently in F-RAM.

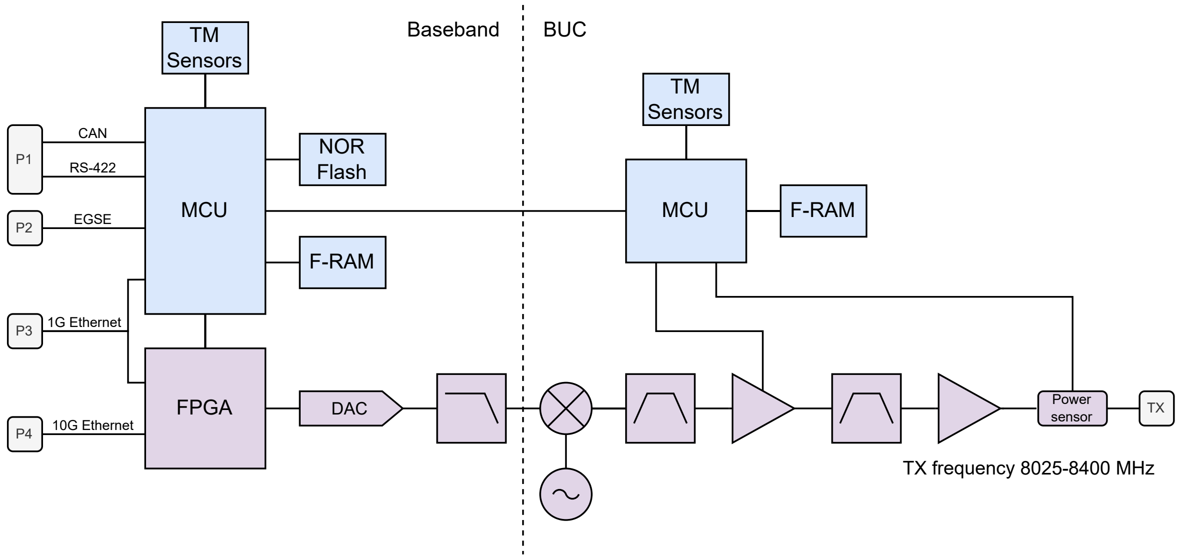



**Figure 2:** Simplified overview of the SRX-8 hardware design. Control plane modules are depicted in blue, data plane modules in purple and external interfaces in gray.

The FPGA configuration is protected against bit flips by the Xilinx Soft Error Mitigation (SEM) core [SEM]. Memories in the FPGA that are not protected by the SEM core (such as ROMs holding filter coefficients etc.) are protected by an Error-Correcting Code (ECC) similar to that of the SEM core. This Single Error Correction, Double Error Detection (SECDED) ECC is capable of correcting any single bit error and detecting any double bit errors. All types of corrected or detected bit flips are logged in telemetry.

### 2.1 RF Design

The RF section is shown in purple on figure 2. The RF path is constructed as a transmitter chain consisting of multiple filters and gain stages. A Numerically Controlled Oscillator (NCO) is used to control the TX frequency digitally. The SRX-8 includes an on-board power amplifier for simple integration with passive antennas.

RF forward and reflected power is monitored via a directional coupler and power sensors to allow the Automatic Level Control (ALC) to keep output power stable over frequency and temperature.

## 2.2 Power Domains

Figure 3 shows an overview of the SRX-8 power domains. The input buck converter generates a local 3.8 V regulated voltage from the input voltage. A 3.3 V Low-Dropout Regulator (LDO) from the input voltage is used to drive the dedicated Watchdog Timer (WDT) circuit. The WDT circuit is also used as a power on reset timer that actively discharges the internal power nets of the transmitter before starting the power-on sequence. In an over-current event, or if the baseband MCU does not reset the WDT, the power-on reset sequence, with active discharge, will be re-initiated.

A set of buck converters from 3.8 V are used to create several lower voltages for the FPGA and parts of the baseband circuit.

The BUC is supplied via the baseband module. The BUC features a WDT circuit similar to the one mounted on the baseband module. No configuration or control of the two WDTs is required from the user.

The transmitter PA is supplied from a 23 V switch-mode converter (SMPS).

Key RF components in the transmitter chain are supplied through LDOs to keep the impact of power supply noise to a minimum, but are not shown due to simplicity.

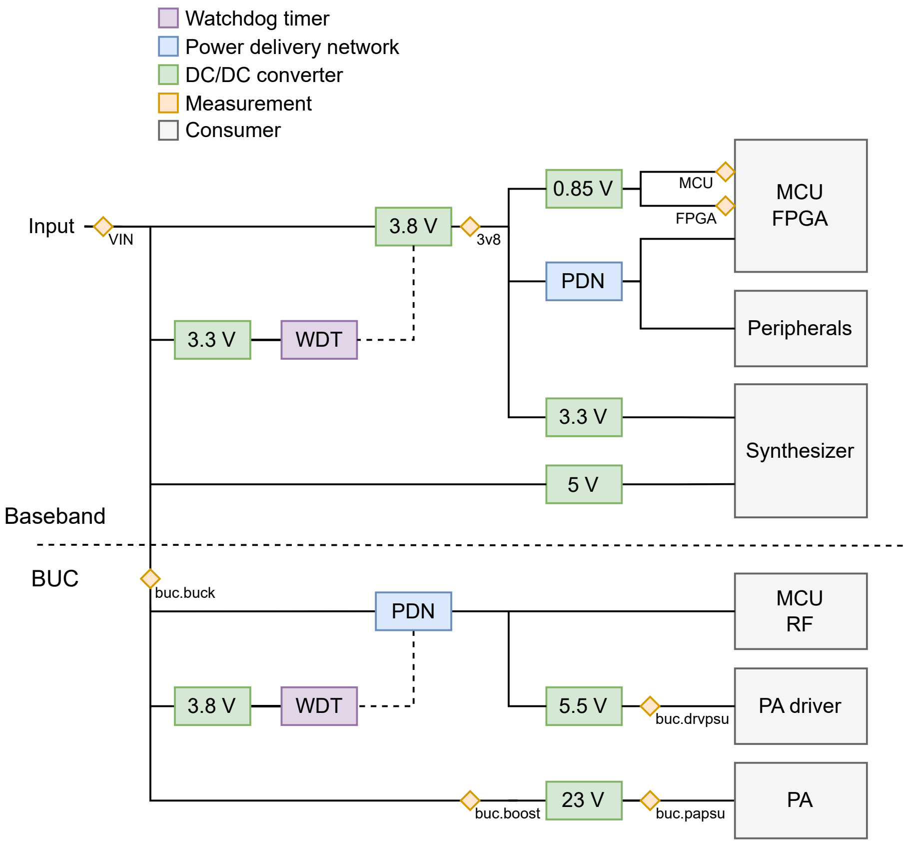



**Figure 3:** SRX-8 power domains and voltage/current measurement points. Some power domains are omitted for clarity.

## 2.3 Telemetry Sensors

Voltage, current and power is measured on the $V_{IN}$ and $V_{3.8V}$ rails on the baseband module as well as the $V_{BUC\_buck}$, $V_{BUC\_boost}$, $V_{BUC\_driver}$ and $V_{BUC\_PA}$ rails on the BUC module. All telemetry is gathered by the baseband module and can be downloaded using telemetry properties. See figure 3 for an overview of the placement of the sensors.

The SRX-8 has a combined 16 temperature sensors (8 on the baseband module and 8 on the BUC) located on-die or near key components on the PCBs. The temperature and power sensors are listed in table 1 along with their telemetry property name.

**Table 1:** Onboard telemetry sensors

| Property | Description |
|---|---|
| `tm.{volt,cur,power}.vin` | $V_{IN}$ voltage, current and power |
| `tm.{volt,cur,power}.3v8` | $V_{3.8V}$ voltage, current and power |
| `tm.volt.mcu` | $V_{MCU}$ voltage |
| `tm.volt.fpga` | $V_{FPGA}$ voltage |
| `tm.temp.vin` | $V_{IN}$ sensor temperature |
| `tm.temp.3v8` | $V_{3.8V}$ sensor temperature |
| `tm.temp.mcu` | MCU temperature |
| `tm.temp.fpga` | FPGA on-die temperature |
| `tm.temp.mem` | Memory temperature |
| `tm.temp.top` | Baseband board temperature (top) |
| `tm.temp.bot` | Baseband board temperature (bottom) |
| `tm.temp.dac` | DAC temperature |
| `tm.sem.det` | Detected bit errors |
| `tm.sem.corr` | Corrected bit errors |
| `tm.sem.uncorr` | Uncorrectable bit errors |
| `tm.sem.state` | State of SEM core |
| `tm.{volt,cur,power}.buc.buck` | $V_{BUC\_buck}$ voltage, current and power |
| `tm.{volt,cur,power}.buc.boost` | $V_{BUC\_boost}$ voltage, current and power |
| `tm.{volt,cur,power}.buc.drvpsu` | $V_{BUC\_driver}$ voltage, current and power |
| `tm.{volt,cur,power}.buc.papsu` | $V_{BUC\_PA}$ voltage, current and power |
| `tm.temp.buc.buck` | $V_{BUC\_buck}$ sensor temperature |
| `tm.temp.buc.boost` | $V_{BUC\_boost}$ sensor temperature |
| `tm.temp.buc.drvpsu` | $V_{BUC\_driver}$ sensor temperature |
| `tm.temp.buc.papsu` | $V_{BUC\_PA}$ sensor temperature |
| `tm.temp.buc.board` | BUC board temperature |
| `tm.temp.buc.drv` | BUC driver temperature |
| `tm.temp.buc.pa` | BUC power amplifier temperature (external) |
| `tm.temp.buc.padie` | BUC power amplifier temperature (internal) |

Note that the SRX-8 generates a lot of heat when transmitting. The internal PA temperature, stored in `tm.temp.buc.padie`, is expected to be well above 100 ℃ during nominal operations.

## 3 Software Overview

Figure 4 shows the main software components and packet flow in the SRX-8 transmitter. The transmitter essentially functions as a router of IP packets from the the satellite bus to the radio interface.

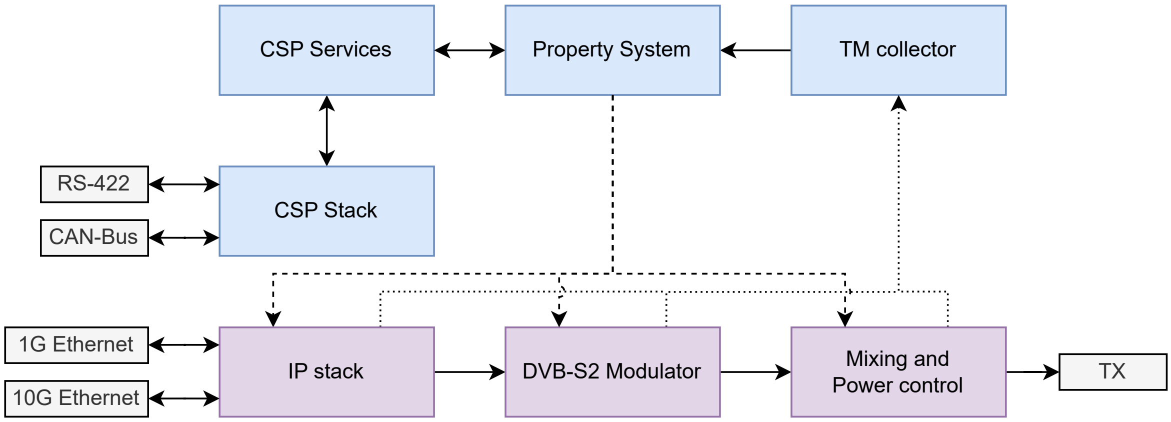



**Figure 4:** Overview of the transmitter software components and data flow. Control plane modules are depicted in blue, data path modules in purple and external interfaces in gray.

The transmitter is configured via CSP. Both the CAN-bus and RS-422 interfaces can be enabled simultaneously and used for CSP communication. Alternatively, both interfaces can be connected to the same systems and serve as backup routes using the CSP routing table. A CSP connection on CAN-bus or RS-422 is required to operate the SRX-8 transmitter.

Configuration and telemetry readout is handled through a local CSP service that interfaces with the onboard property system. See the SRX-8 user manual for more information on the property system. The TM Collector module is responsible for periodically collecting telemetry values from on-board sensors, and updating system properties accordingly.

Payload data from either of the Ethernet interfaces is modulated and framed in the FPGA before being mixed to the target RF frequency and amplified to the target output power. An ALC loop continuously monitors and adjusts the transmit gain to achieve the configured output power. It is not possible to forward data arriving at the CAN-bus or RS-422 on the radio interface.

## 3.1 DVB-S2 Modulator

Figure 5 show an overview of the components that are implemented in the FPGA. The SRX-8 is configured using properties. A full list of the SRX-8 properties and a description of their values is included in the user manual.

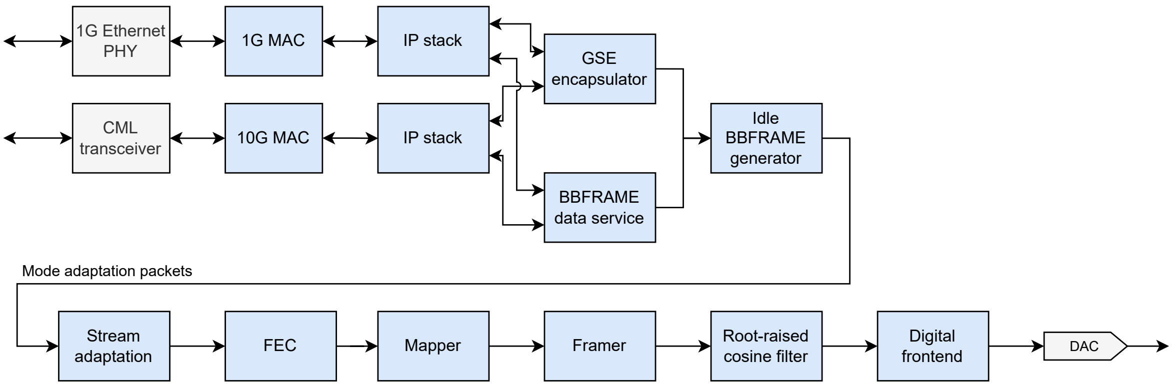



**Figure 5:** Overview of components implemented in the FPGA

The FPGA is loaded on boot by the MCU. Being an FPGA-based modem, it can be fully upgraded with the MCU firmware both during integration and on-orbit through the CSP stack. Safeguards are in place to ensure a fallback firmware is loaded if an upgrade fails. More details on this can be found in the user manual.

The modulator processes data in the following way:

- Packets are received on either of the two Ethernet interfaces.
- The destination IP destination of the packets determine if they are routed through one of the following data paths:
  - A GSE encapsulator. IP packets are encapsulated according to [ETSI GSE] which allows the SRX-8 to be used as a router that forwards IP traffic in GSE frames.
  - A BBFRAME data service, allowing frame-by-frame control of modulation and coding by accepting Mode Adaptation (MA) packets in accordance with [ETSI DVB, annex I.2].

  The SRX-8 is capable of signalling if data is supplied faster than it is able to transmit regardless of Ethernet interface and data path. See the SRX-8 user manual for more information on GSE encapsulation or the BBFRAME data service and the trade-off between these.
- If enabled, idle (empty) BBFRAMEs are inserted in the data stream if the link is not fully utilized by payload data.
- FEC is applied to the frames in accordance with [ETSI DVB, section 5.3].
- Bits are mapped to either QPSK, 8PSK, 16APSK or 32APSK symbols in accordance with [ETSI DVB, section 5.4].
- Dummy PLFRAME, header and pilot insertion is done in accordance with [ETSI DVB, section 5.5].
- The interpolated symbols are shaped with a root-raised cosine filter in accordance with [ETSI DVB, section 5.6].
- The digital frontend scales and resamples the signal to match the symbol rate.
- Samples are mixed and amplified to the target RF frequency and power.

The IP addresses used for routing are configurable through the `sys` property table.

## 3.2 Telemetry

The property system is used to read the telemetry variables from the SRX-8. Telemetry values are collected periodically and are available through the `tm` property group. Please see the user manual for more details on how to interact with the property system.

Listing 3.1 shows how the `tm show` command can be used to summarize the SRX-8 telemetry. The SRX-8 is connected to a 10 V bench supply and is transmitting idle BBFRAMEs at 33 dBm. The ambient temperature is approximately 20 ℃ and the average temperature of the SRX-8 is about 30 ℃ except for the estimated internal PA temperature which is significantly higher.

Note that the voltage and current measurements are instantaneous, while the power measurements are averaged, which is why the multiple of the voltage and current values are not exactly equal to the power measurements.

**Listing 3.1:** Output of `tm show` during transmission.

```
[srx-8] tm show
Power Rails
VIN                9971 mV    2672 mA   26648 mW   28.87 C
3V8                3793 mV    2000 mA    7587 mW   29.12 C
MCU                 847 mV
FPGA                853 mV

Temperature Sensors
VIN               28.87 C
MCU               30.70 C
FPGA              31.73 C
MEM               29.00 C
DAC               29.10 C
Top               30.31 C
Bottom            28.56 C

BUC Power Rails
Buck converter     9959 mV     282 mA    2809 mW   28.75 C
Boost converter    9943 mV    1508 mA   15003 mW   28.62 C
Driver PSU         5487 mV      67 mA     370 mW   30.37 C
PA PSU            23265 mV     619 mA   14395 mW   31.50 C

BUC Temperature Sensors
Board             28.56 C
Driver            30.25 C
PA                40.31 C
PA die           164.70 C

Transmitter
BBFRAMEs           1992 frames
GSE PDUs              0 frames
Forward power     32.99 dBm
BUC gain          48.30 %
```

## 3.3 EGSE Shell

The SRX-8 provides a serial command line shell on the RX/TX pins in the EGSE connector (see section 6.2). The serial configuration is 8N1 at 115200 baud, and the console requires an “Enter” key press to be activated.

Listing 3.2 shows the nominal output on the serial shell during boot. A number of timestamped log messages are printed during boot from various logging groups. Additional logging can be enabled at runtime using the `trace` commands. The `help` command can be used to list available commands and their usage.

The installed software version and build information is also printed in the EGSE shell during boot.

More information on how to interact with the SRX-8 using the EGSE shell can be found in the user manual.

**Listing 3.2:** Example output from EGSE shell.

```
Satlab SRX-8 bootloader v1.2.0
boot slot 0 (2 remaining attempts)

[     0.000130] system: Copyright (c) 2025 Satlab A/S <satlab@satlab.com>
[     0.008937] system: boot slot: 0 count: 1
[     0.015573] system: board serial #38123456
[     0.024415] prop: using stored sys properties
[     0.031183] prop: using stored cal properties
[     0.888294] buc: firmware version 1.0.3

Satlab SRX-8 v1.2.0

[srx-8] help
Available commands:
boot                Bootloader commands
csp                 CSP commands
echo                Display a line of text
help                Show available commands
history             Show previous commands
prop                System configuration properties
reboot              Reboot system
time                Time command execution
tm                  Telemetry commands
trace               Trace subcommands
uptime              Show system uptime
watch               Run command periodically
```

## 3.4 Software Upgrade

The SRX-8 uses two firmware images which share a common bootloader. Both firmware images can be upgraded on-orbit using CSP. The firmware images are updated using an A/B system, allowing safe firmware updates with automatic fallback to the last known good firmware image. The SRX-8 is delivered with identical firmware in the two firmware slots. Each firmware image includes the FPGA bitstream and BUC firmware.

Refer to the user manual for more information on how to upgrade and switch between firmware images.

# 4 Throughput

The channel symbol rate is configurable through the `tx.rate` property, but the information rate depends on the DVB-S2 frame format. The achievable throughput depends on whether pilots or short frames are used as well as the DVB-S2 MODCOD which dictates modulation order and FEC. The spectral efficiency is listed for all combinations of pilots, frame lengths and MODCODs in table 2.

Frame lengths, pilot insertion and MODCODs are described in greater detail in [ETSI DVB, section 5].

The 1 Gb/s Ethernet interface adheres to the 1000BASE-T standard and supports data rates up to 1000 Mbit/s, while the 10 Gb/s Ethernet interface supports data rates up to 10 000 Mbit/s. Both Ethernet interfaces can be used simultaneously. Note that the 10 Gb/s Ethernet interface is required in order to reach the maximum achievable throughput.

Both Ethernet interfaces support flow control. More information about this can be found in the SRX-8 user manual.

**Table 2:** Spectral efficiency for short and normal frames with and without pilot insertion for all MODCODs along with the maximum achievable throughput.

| MODCOD | | Spectral efficiency [(bit/s)/Hz] Short w/ pilots | Short w/o pilots | Normal w/ pilots | Normal w/o pilots | Max throughput [Mbit/s]† |
|---|---|---|---|---|---|---|
| 1 | QPSK 1/4 | 0.3575 | 0.3653 | 0.4786 | 0.4902 | 153.20 |
| 2 | QPSK 1/3 | 0.6155 | 0.6291 | 0.6408 | 0.6565 | 205.14 |
| 3 | QPSK 2/5 | 0.7446 | 0.7609 | 0.7706 | 0.7894 | 246.69 |
| 4 | QPSK 1/2 | 0.8306 | 0.8488 | 0.9653 | 0.9889 | 309.02 |
| 5 | QPSK 3/5 | 1.1317 | 1.1565 | 1.1600 | 1.1883 | 371.35 |
| 6 | QPSK 2/3 | 1.2607 | 1.2884 | 1.2908 | 1.3223 | 413.20 |
| 7 | QPSK 3/4 | 1.3897 | 1.4203 | 1.4521 | 1.4875 | 464.84 |
| 8 | QPSK 4/5 | 1.4758 | 1.5082 | 1.5494 | 1.5872 | 496.00 |
| 9 | QPSK 5/6 | 1.5618 | 1.5961 | 1.6153 | 1.6547 | 517.08 |
| 10 | QPSK 8/9 | 1.6908 | 1.7280 | 1.7244 | 1.7665 | 552.02 |
| 11 | QPSK 9/10 | N/A | N/A | 1.7461 | 1.7886 | 558.94 |
| 12 | 8PSK 3/5 | 1.6920 | 1.7253 | 1.7396 | 1.7800 | 556.25 |
| 13 | 8PSK 2/3 | 1.8850 | 1.9220 | 1.9357 | 1.9806 | 618.95 |
| 14 | 8PSK 3/4 | 2.0779 | 2.1188 | 2.1775 | 2.2281 | 696.29 |
| 15 | 8PSK 5/6 | 2.3351 | 2.3811 | 2.4223 | 2.4786 | 774.55 |
| 16 | 8PSK 8/9 | 2.5281 | 2.5778 | 2.5859 | 2.6460 | 826.88 |
| 17 | 8PSK 9/10 | N/A | N/A | 2.6184 | 2.6792 | 837.25 |
| 18 | 16APSK 2/3 | 2.5052 | 2.5488 | 2.5746 | 2.6372 | 824.13 |
| 19 | 16APSK 3/4 | 2.7616 | 2.8097 | 2.8963 | 2.9667 | 927.10 |
| 20 | 16APSK 4/5 | 2.9326 | 2.9836 | 3.0905 | 3.1656 | 989.26 |
| 21 | 16APSK 5/6 | 3.1035 | 3.1575 | 3.2219 | 3.3002 | 1031.31 |
| 22 | 16APSK 8/9 | 3.3599 | 3.4184 | 3.4395 | 3.5231 | 1100.98 |
| 23 | 16APSK 9/10 | N/A | N/A | 3.4827 | 3.5673 | 1114.79 |
| 24 | 32APSK 3/4 | 3.4192 | 3.4931 | 3.6233 | 3.7033 | 1157.28 |
| 25 | 32APSK 4/5 | 3.6308 | 3.7093 | 3.8663 | 3.9516 | 1234.87 |
| 26 | 32APSK 5/6 | 3.8425 | 3.9255 | 4.0306 | 4.1195 | 1287.36 |
| 27 | 32APSK 8/9 | 4.1599 | 4.2499 | 4.3029 | 4.3979 | 1374.33 |
| 28 | 32APSK 9/10 | N/A | N/A | 4.3569 | 4.4530 | 1391.57 |

† Normal frames w/o pilots at 312.5 MBd.

The spectral efficiencies found in table 2 can be used to calculate the resulting throughput with a given MODCOD, framing options and transmit rate. For example using MODCOD 10 with normal frames, pilots enabled and `tx.rate` set to 60 MBd yields a throughput of:

$$60\,\text{MBd} \times 1.72442 \approx 103.465\,\text{Mbit/s}$$

# 5 Electrical Specifications

All electrical parameters in all tables are specified under the following conditions, unless stated otherwise:

- Typical values are based on $T_{AMB}$=20 ℃ and $V_{IN}$=10 V, by production test and/or design characterization.
- Minimum and maximum values represent the worst conditions across supply voltage, process variation, and operating temperature.
- All values refer to levels specified on the connectors, i.e. not including cable loss.

## 5.1 Absolute Maximum Ratings

The table below lists the minimum and maximum allowable levels on the connector pins. Exceeding these may damage the product permanently.

**Table 3:** Absolute Maximum Ratings

| Parameter | Min | Max | Unit |
|---|---|---|---|
| Storage Temperature | –40 | 85 | ℃ |
| Input Voltage | –0.5 | 45 | V |
| CAN-L/H | –7 | 12 | V |
| RS-422 | –7 | 12 | V |
| 1 Gb/s Ethernet | –0.3 | 3.6 | V |
| 10 Gb/s Ethernet | –0.5 | 1.2 | V |
| EGSE-UART (TTL) | –0.5 | 5 | V |

## 5.2 Operating Conditions

Operating conditions refer to two modes defined as:

- Idle Mode: Keyed down.
- TX Mode: Keyed up, actively transmitting packets

The typical and maximum power consumption is specified with the CAN-bus, RS-422 interface and 1 Gb/s Ethernet interface enabled, the 10 Gb/s Ethernet interface is disabled.

Temperatures are measured on the primary thermal interface. For more information, refer to section 7.2.

**Table 4:** General Operating Condition

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Operational Temperature (Idle) | –40 | — | 85 | ℃ |
| Operational Temperature (TX) | –40 | — | 70 | ℃ |
| Supply Voltage | 7.5 | — | 40 | V |
| Input power (Idle) | — | 4.3 | 6.9[1] | W |
| Input power (TX, 33 dBm output power) | — | 26.6 | 32[1] | W |
| Additional input power for 10 Gb/s Ethernet (Idle) | — | 450 | 500 | mW |
| $V_{IN}$ voltage rail | 7.5 | — | 40 | V |
| $V_{3.8V}$ voltage rail | 3.75 | 3.8 | 3.85 | V |
| $V_{MCU}$ voltage rail | 0.825 | 0.85 | 0.875 | V |
| $V_{FPGA}$ voltage rail | 0.825 | 0.85 | 0.875 | V |
| $V_{BUC\_BUCK}$ voltage rail | $V_{IN}$–0.1 | — | $V_{IN}$+0.1 | V |
| $V_{BUC\_BOOST}$ voltage rail | $V_{IN}$–0.1 | — | $V_{IN}$+0.1 | V |
| $V_{BUC\_DRIVE}$ voltage rail (During TX) | 5.4 | 5.5 | 5.6 | V |
| $V_{BUC\_PA}$ voltage rail (During TX) | 22 | 23.25 | 24.5 | V |
| $V_{IN}$ input equivalent capacitance at power-on | — | 210 | — | µF |

[1] $V_{IN}$ 40 V, temperature 70 ℃

## 5.3 Transmitter

In figure 6 the typical output power spectrum is shown for overlapping 50 MBd channels spaced by 25 MHz at 33 dBm output power. Figure 7 shows the typical spectrum at 8212.5 MHz for 3 output power levels at the maximum transmit rate of 312.5 MBd along with the ITU requirements for out-of-band domain emissions [ITU-R, annex 5 section 5.2]. Both measurements are performed using a 32APSK modulated Pseudo-Random Binary Sequence (PRBS) as a data source with $\alpha$=0.2 RRC filter.

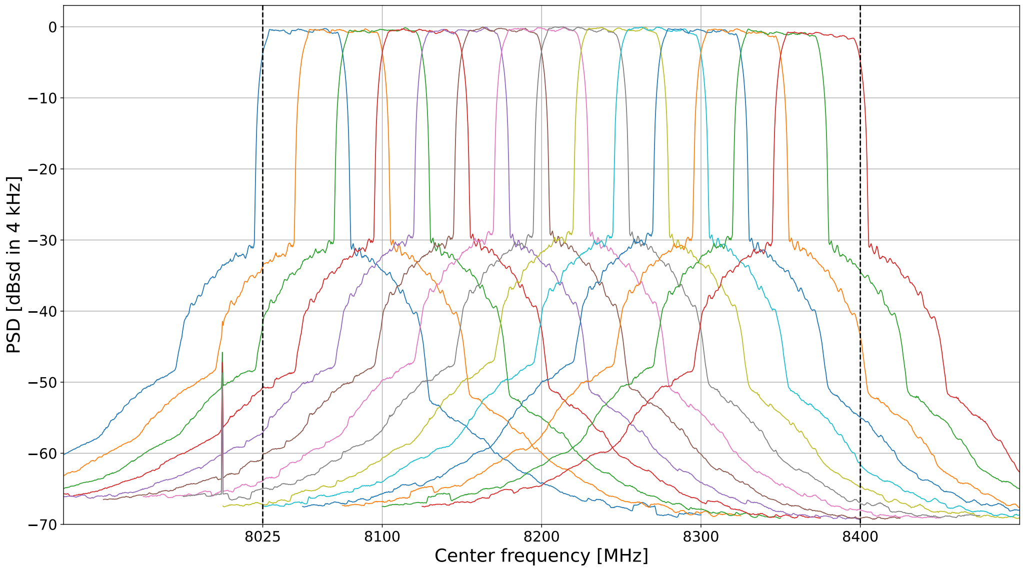



**Figure 6:** Typical transmitter power spectrum, 50 MBd 32APSK, RRC $\alpha$=0.2, 33 dBm

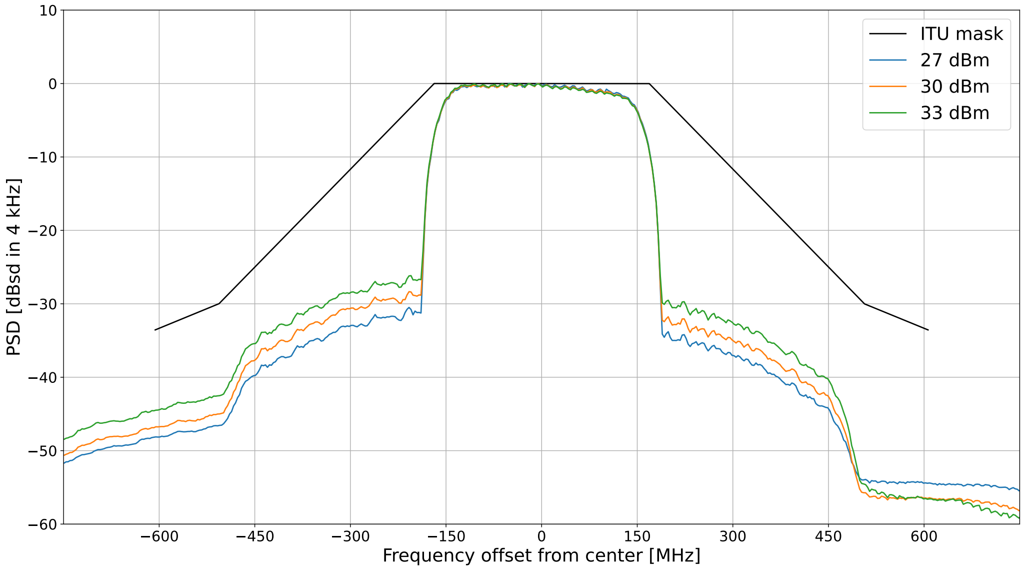



**Figure 7:** Typical transmitter power spectrum, 8212.5 MHz, 312.5 MBd 32APSK, RRC $\alpha$=0.2 along with ITU out-of-band emission limits.

Figure 8 shows the typical DC power consumption at 27, 30 and 33 dBm output power over the frequency range when transmitting 32APSK modulated BBFRAMEs at 50 MBd (TX at 20 ℃ and 7.5 V supply).

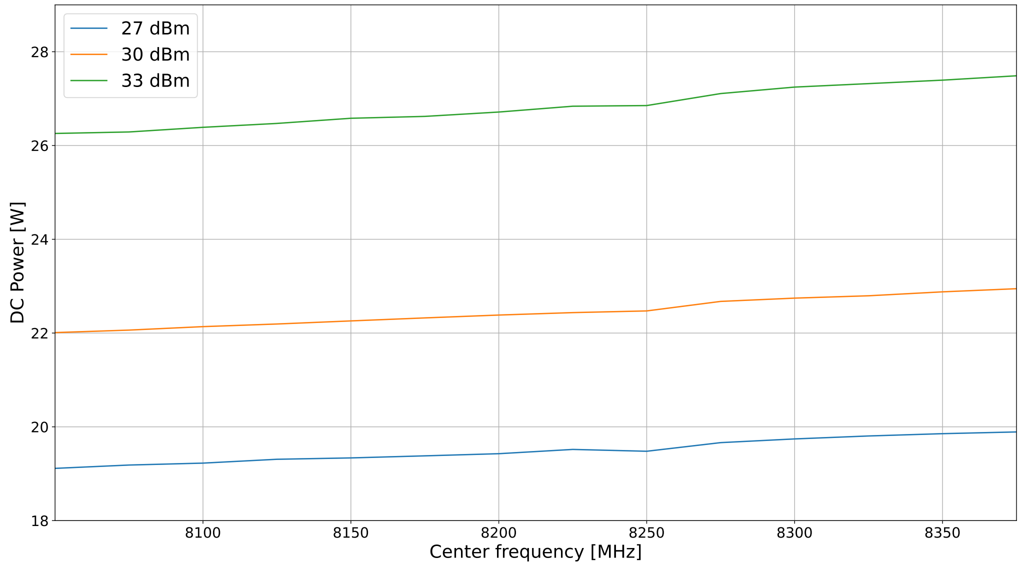



**Figure 8:** Typical DC power consumption during transmission of a 50 MBd 32APSK waveform as a function of transmit frequency and output power.

Table 5 shows the transmitter key specification.

**Table 5:** Transmitter characteristics

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Center frequency | 8025 | — | 8400 | MHz |
| Symbol rate $R_{sym}$ | 1 | — | 312.5 | MBd |
| Output power | 27 | — | 33 | dBm |
| ALC loop step size | — | <0.1 | — | dB |
| Occupied bandwidth 99.0%[1] | — | 1.07 $R_{sym}$ | — | Hz |
| Occupied bandwidth 99.9%[1] | — | 1.15 $R_{sym}$ | — | Hz |
| SFDR | 65 | — | — | dBc |
| Initial frequency error (20 ℃) | — | — | 1 | µHz/Hz |
| Frequency error (over temperature) | — | — | 0.28 | µHz/Hz |
| Frequency error (aging per year) | — | — | 1 | µHz/Hz |
| Pulse shaping | Root-raised cosine, roll-off 0.2, 0.25 or 0.35 | | | |
| Modulation | QPSK, 8PSK, 16APSK, 32APSK | | | |
| EVM (RMS, MODCOD 11, 33 dBm)[1,2] | — | 3.3 | — | % |
| EVM (RMS, MODCOD 17, 33 dBm)[1,2] | — | 3.0 | — | % |
| EVM (RMS, MODCOD 23, 33 dBm)[1,2] | — | 3.4 | — | % |
| EVM (RMS, MODCOD 28, 33 dBm)[1,2] | — | 4.3 | — | % |

[1] Pulse shaping roll-off 0.20

[2] Baud rate 312.5 MBd, center frequency 8212.5 MHz

Figure 9 shows the output constellation diagrams of the SRX-8 for all DVB-S2 modulations transmitted on a 312.5 MBd channel at 33 dBm. The transmitted signal is shaped by a $\alpha$=0.2 RRC filter.

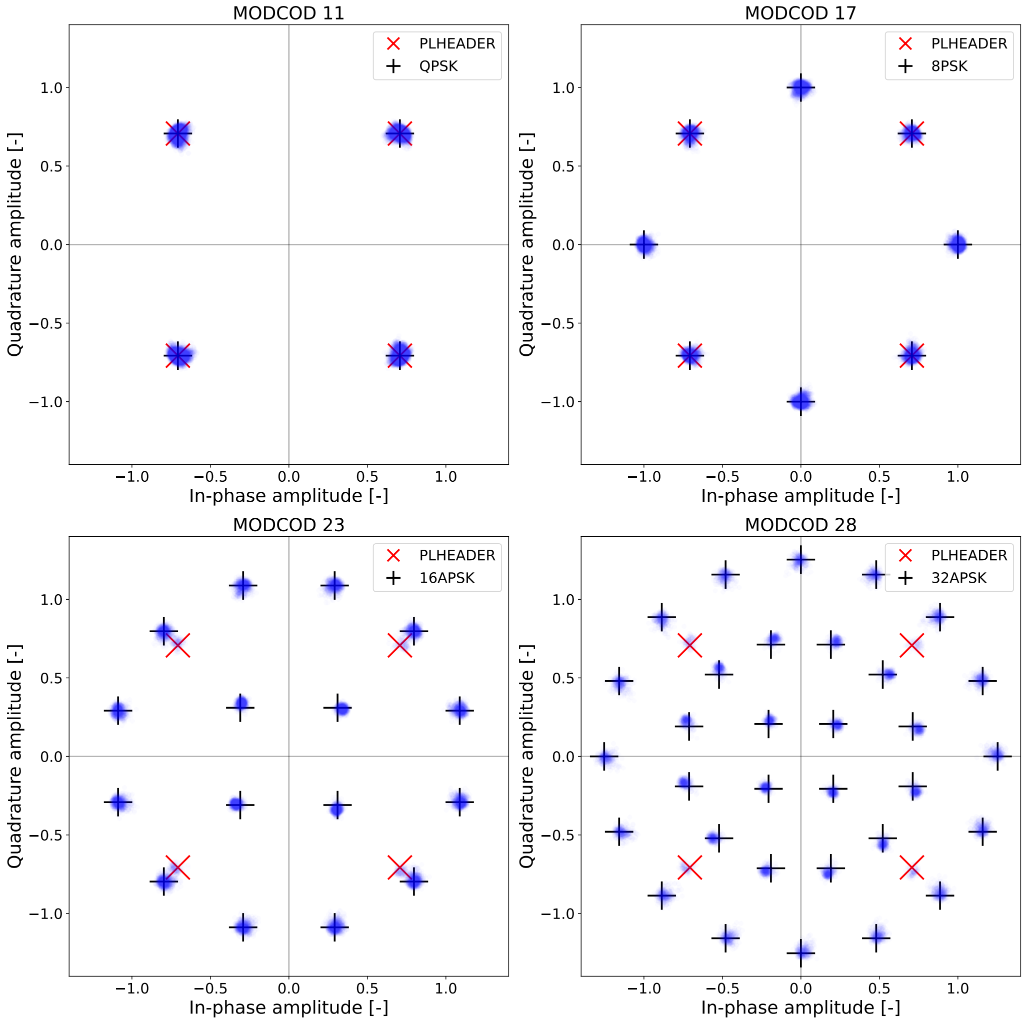



**Figure 9:** Constellation diagrams of a single DVB-S2 PLFRAME for all DVB-S2 modulations at 312.5 MBd. Demodulator equalization and I/Q compensation is enabled.

The deviation from the nominal symbols for 16APSK and 32APSK illustrates the AM/AM and AM/PM distortion caused by the power amplifier when transmitting 312.5 MBd at 33 dBm. This distortion is included in the EVM in table 5.

## 5.4 Communication Interfaces

**Table 6:** Communication Interface Specification

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| **CAN-bus** | | | | |
| Bit rate | 125 | 1000 | 1000 | kbit/s |
| Termination resistor | — | 120 | — | Ω |
| CAN-L/H | –2 | — | 7 | V |
| CAN-L/H recessive level | — | 2.3 | — | V |
| CAN-L output dominant level | 0.5 | — | 1.3 | V |
| CAN-H output dominant level | 2.4 | — | 3.35 | V |
| CAN dominant L/H difference | 1.1 | 2.0 | 3.0 | V |
| **RS-422** | | | | |
| Bit rate[1] | 9.6 | 1000 | 3125 | kbit/s |
| Receive termination resistor | — | 100 | — | Ω |
| RX differential level $\lvert RX+ - RX- \rvert$ | 0.15 | — | 6.0 | V |
| TX differential output | 2.0 | 3.0 | 3.5 | V |
| **1 Gb/s Ethernet** | | | | |
| Bit rate | 100 | 1000 | 1000 | Mbit/s |
| ETH-TX Out diff. across 100 Ω termination | 0.8 | 1.0 | 1.2 | V |
| **10 Gb/s Ethernet** | | | | |
| Bit rate | 10 000 | 10 000 | 10 000 | Mbit/s |
| Line rate[2] | 10 312.5 | 10 312.5 | 10 312.5 | Mbit/s |
| RX input common mode | — | 800 | — | mV |
| RX differential level $\lvert RX_n+ - RX_n- \rvert$ | 150 | — | 1250 | mV |
| TX output common mode | 660 | — | 800 | mV |
| TX differential level $\lvert TX_n+ - TX_n- \rvert$ | 800 | — | 1080 | mV |
| **EGSE-UART (TTL)** | | | | |
| TX output high | 2.3 | 3.3 | 3.4 | V |
| TX output low | 0.0 | — | 0.5 | V |
| RX input low | 0.0 | — | 1.2 | V |
| RX input High | 1.9 | — | 4.0 | V |

[1] Supported values respect 100 MHz/16/N where N is an integer in [2;651]
[2] 64b/66b CML

## 5.5 ESD Rating for Interfaces

**Table 7:** Communication Interface ESD Specification

| Interface | ESD level [kV] | Standard |
|---|---|---|
| CAN-bus | 12 | IEC61000-4-2 |
| RS-422 | 16 | IEC61000-4-2 |
| 1 Gb/s Ethernet | 12 | IEC61000-4-2 |
| 10 Gb/s Ethernet | 1.5 | JEDEC JEP155 |
| EGSE | 12 | IEC61000-4-2 |

# 6 Qualification

The SRX-8 has been qualified through a number of test campaigns to verify its performance over temperature, vibration and radiation. An overview of the testing performed on the SRX-8 is shown in table 8. As this list is non-exhaustive, please contact Satlab for further information if needed.

It should be noted that the levels which are listed in table 8 is a superset of the different tests the transmitter has been through during various test campaigns.

**Table 8:** Qualification Parameters

| Parameter | Value |
|---|---|
| Thermal soak (TX) | −40 ℃ to 70 ℃ |
| Vibration | 20.3 $G_{rms}$ |
| TID | 10 kRad(Si) board level |

## 6.1 Calibration and Acceptance Testing

All units are production calibrated. Calibration includes adjusting gain values for different output levels over the full TX band and temperature interval by comparing the output of the SRX-8 power sensor, shown on figure 2, with a calibrated reference power sensor.

As part of acceptance testing, each transmitter is subject to a full TX performance test over the temperature interval ranging from −30 ℃ to 70 ℃ on the primary thermal interface.

## 6.2 Connector Pinout

P1, P2 and P3 are high-reliability Harwin Gecko connectors with 1.25 mm pitch and gold-plated contacts, P1 and P3 are screwed, P2 is latching. P4 is an Ampherol SV microwave 4-port SMPM full detent male connector. P1 (G125-MH12005M4P) is the main connector for power and TMTC interfaces. P3 (G125-MH11205M4P) is used for 1 Gb/s Ethernet with the SRX-8 and P4 (9311-60039) is used for 10 Gb/s Ethernet with the SRX-8. P2 (G125-MH10605L3P) is the EGSE connector used for the serial shell for initial configuration. Typically, the P2 connector is only used for testing on ground and left unconnected in flight configuration. The P2 can be connected to another system in the spacecraft if desired, as the board includes protection against reverse supply from these pins.

The X-band transmitter is supplied with termination resistors on the CAN-bus (120 Ω) and on the RS-422 receive pair (100 Ω). The CAN-bus termination resistors can optionally be removed, see section 8 for more information. The unit has built-in magnetics on the 1 Gb/s Ethernet interface, and can be used in systems both with and without magnetics.

The coaxial TX connector is a full detent male type SMP according to MIL-STD 348B.

The P1, P2, P3 and P4 connector pinouts are shown on the next page together with the pin numbering of the male connectors. “TX” pins denote output pins from the SRX-8 and “RX” pins are inputs to the SRX-8.

All pins in P2 and P3 use TVS diodes for additional ESD suppression. The RF connector is DC grounded. However, proper care should still be observed while handling the device.

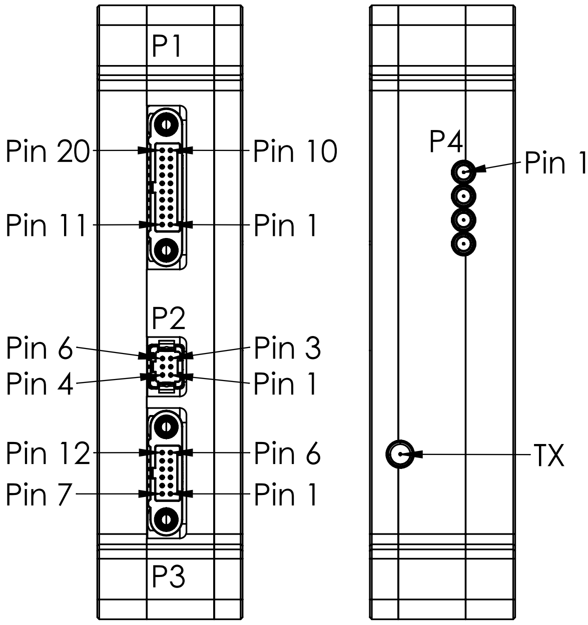
| P1 — Main Connector | | | |
|---|---|---|---|
| VIN | 20 | 10 | VIN |
| VIN | 19 | 9 | VIN |
| DNC | 18 | 8 | DNC |
| GND | 17 | 7 | GND |
| GND | 16 | 6 | GND |
| RS-422 RX- | 15 | 5 | RS-422 TX- |
| RS-422 RX+ | 14 | 4 | RS-422 TX+ |
| GND | 13 | 3 | GND |
| CAN-L | 12 | 2 | DNC |
| CAN-H | 11 | 1 | DNC |

| P2 — EGSE Connector | | | |
|---|---|---|---|
| EGSE TX | 6 | 3 | DNC |
| $V_{Target}$ (sense) | 5 | 2 | GND |
| EGSE RX | 4 | 1 | DNC |

| P3 — 1000BASE-T Connector | | | |
|---|---|---|---|
| $MDI_3$- | 12 | 6 | $MDI_2$- |
| $MDI_3$+ | 11 | 5 | $MDI_2$+ |
| GND | 10 | 4 | GND |
| GND | 9 | 3 | GND |
| $MDI_0$- | 8 | 2 | $MDI_1$- |
| $MDI_0$+ | 7 | 1 | $MDI_1$+ |

| P4 — 10GBASE-R SMPM Connector | |
|---|---|
| RX+ | 1 |
| RX- | 2 |
| TX- | 3 |
| TX+ | 4 |

DNC = Do Not Connect




**ATTENTION:** Although all external interfaces on the SRX-8 are protected against ESD, proper precautions and grounding must still be ensured when handling the device.

# 7 Mechanical Specifications

The SRX-8 transmitter is composed of a polymide (Tg >250 °C) PCB and a Rogers RO4003C PCB.

**Table 9:** Mechanical Specifications

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Mass | 295 | 300 | 305 | g |
| X-dimension | 87.10 | 87.20 | 87.30 | mm |
| Y-dimension | 92.90 | 93.00 | 93.10 | mm |
| Z-dimension | 21.80 | 22.00 | 22.20 | mm |

## 7.1 Mechanical Interface

Figure 10 shows the transceiver from the top side (Z+) and first angle projections from the connector sides (X+ and X-) and thermal interface side(Y-). Note that the four mounting holes use the PC/104 layout and are not symmetrical. CAD models are available on the Satlab website.

## 7.2 Thermal Interface

On the top projection in figure 10, two M3 attachment points are provided as the primary thermal interface. Internally the structure provides a good thermal path to these two points, and it is advised to use these for thermal interfacing. The Z+ face can be used as a secondary thermal interface while the 4 corner holes provide a tertiary thermal interface. The unit has a thermal capacity of approximately 250 J/K.

**ATTENTION:** The surface of the SRX-8 can reach more than 70 °C during transmission if no thermal sinking is performed. Ensure sufficient heat dissipation (e.g., thermal mass, heat sink, active cooling) before prolonged transmission. The user should check the value of the temperature sensors or allow for adequate time for the SRX-8 to cool before touching the device.

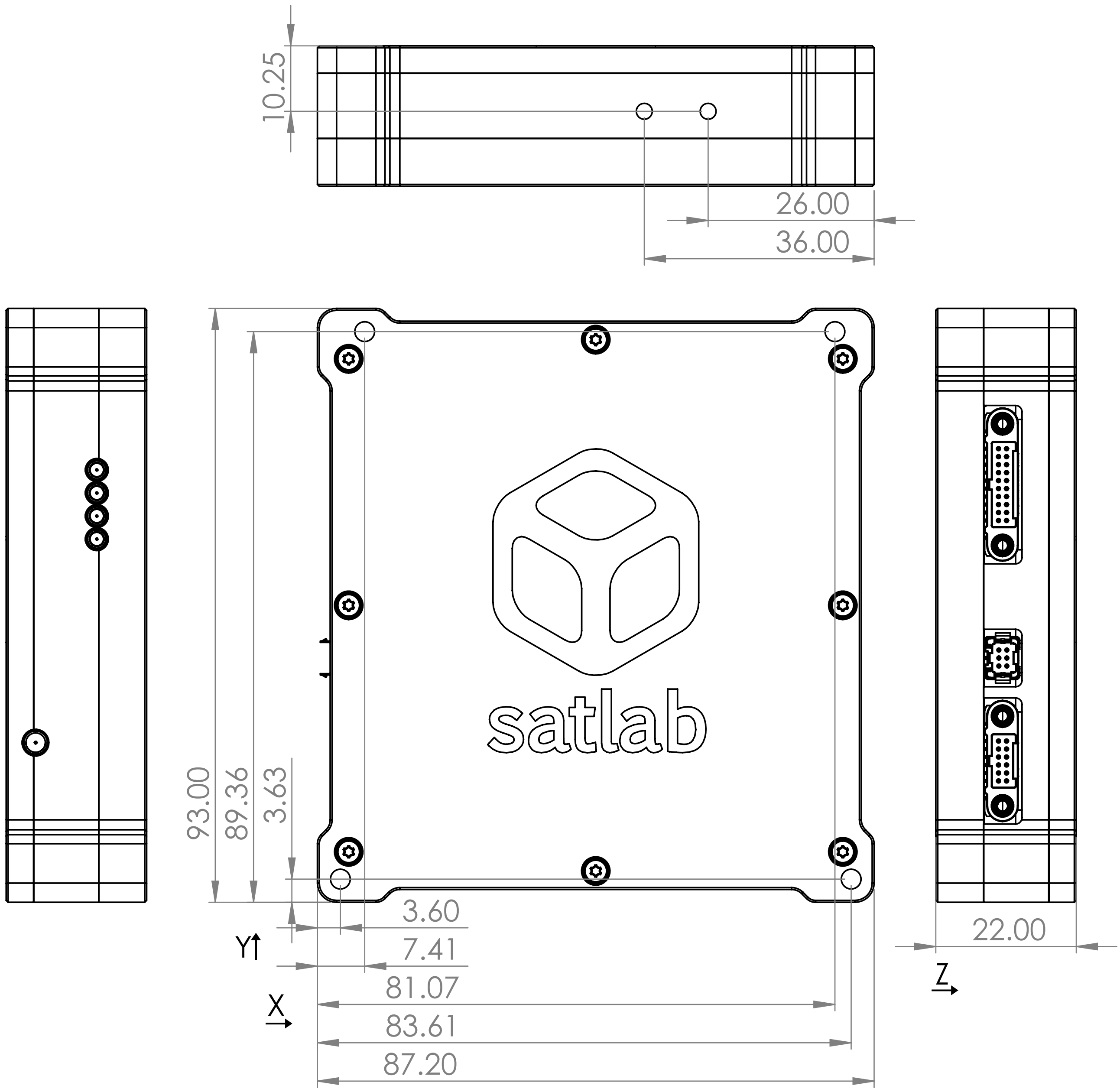



**Figure 10:** Board outline and side views showing the Z+, X+, X-, and Y- faces. All dimensions in mm with ±0.1 mm tolerance in X and Y and ±0.2 mm in Z.

## 8 Ordering Options

By default, the SRX-8 X-band transmitter is delivered with a PTFE flying leads cable for the main connector (P1) with all pins included and the connector potted. A USB EGSE adapter for SWD and serial interface is included for on-ground programming and testing on first order. For contamination control and vibration protection, the PCB is coated with *Nusil CV-1152* conformal coating. If to be omitted, this can be selected below

The aluminum enclosure is delivered with *SurTec 650 ChromitAL TCP* chromate conversion coating (MIL DTL 5541, type II).

Satlab can deliver additional and/or customized cables upon request.

| **SRX-8 Order Options** | | |
|---|---|---|
| CAN-bus termination | Do not include 120 $\Omega$ resistor | ☐ |
| Conformal Coating | Do not conformal coat PCBs | ☐ |

## 9 Customization

Customized versions of SRX-8 hardware and/or software tailored for specific customer requirements can be delivered at additional NRE cost. Please contact Satlab for more information about this option.

## 10 Revision History

The document ID of this datasheet is **SL-PRO-DS-SRX-8-1.0** and the revision number is **1.0**. The measurements and examples in this datasheet were created using version **1.2.0** of the firmware.

| Revision | Issue date | Description |
|---|---|---|
| 0.1 | 2025-04-07 | Internal pre-released version. |
| 0.2 | 2025-12-04 | External pre-released version. |
| 1.0 | 2026-02-10 | First released version. |

## 11 Disclaimer

This datasheet is subject to change without notice. All information in the document is believed to be accurate and reliable at the time of publication, but it is presented without guarantee, warranty, or responsibility of any kind, expressed or implied. It is the responsibility of the customer to validate that the product with the properties described herein is suitable for use in a particular application. All trademarks are the property of their respective owners.

## 12 References

[ETSI DVB] ETSI. *ETSI EN 302 307-1 v1.4.1 Digital Video Broadcasting (DVB) Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications*. URL: https://www.etsi.org/deliver/etsi_en/302300_302399/30230701/01.04.01_60/en_30230701v010401p.pdf.

[ETSI GSE] ETSI. *ETSI TS 102 606-1 v1.2.1 Digital Video Broadcasting (DVB); Generic Stream Encapsulation (GSE);* URL: https://www.etsi.org/deliver/etsi_ts/102600_102699/10260601/01.02.01_60/ts_10260601v010201p.pdf.

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