DATASHEET

X-band Transmitter

X-BAND TRANSMITTER

DATASHEET

This Datasheet details the specifications, features, applications and operation of the EnduroSat's X-band Transmitter module.

Please contact EnduroSat if further information is needed.

Figure 1 – X-band Transmitter module

1 CHANGE LOG

Date	Version	Note
31/Jul/2018	Rev 1	Initial document.
07/11/2018	Rev 1.1	Mechanical drawings update

2 ACRONYMS LIST

16-APSK	16-Amplitude and Phase Shift Keying
8-PSK	8-Phase Shift Keying
CAN	Controller Area Network
CCSDS	Consultative Committee for Space Data Systems
DVB-S2	Digital Video Broadcasting – Second Generation
ESD	Electrostatic Discharge
ETSI	European Telecommunications Standards Institute
GEVS	General Environmental Verification Standard
GND	Ground
GS	Ground Station
HW	Hardware
I2C	Inter-Integrated Circuit
ITU	International Telecommunication Union
LEO	Low Earth Orbit
LVDS	Low Voltage Differential Signaling
OBC	On Board Computer
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
SMA	Sub-Miniature version A
SNR	Signal-to-noise ratio
SPI	Serial Peripheral Interface
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus

3 SYSTEM OVERVIEW

EnduroSat's X-Band Transmitter is a high data rate satellite module operating in the 8.025 – 8.4 GHz frequency band. This band is allocated by the ITU for Earth Exploration Satellite Services (EESS, Space-to-Earth). The transmitter is designed to work in accordance with the DVB-S2 ETSI EN 302 307 standard. Other standards are also available upon request, for example CCSDS.

The form factor of the X-band Transmitter is built around the PC-104 connector standard which is the most common for CubeSat systems.

The module has two modes of operation – *Load* mode and *Transmit* mode. In the *Load* mode the device is recording data into its internal memory (2x16GB) from the OBC or directly from a dedicated payload. It is intended for periods when the satellite is not communicating with the GS. Therefore, in this mode the module automatically switches off all unnecessary electronics and consumes less than 0.27 W. In the *Transmit* mode the device sends the loaded data through the radio channel. The optimum output power is 32 dBm and can be regulated from 27 dBm to 33 dBm with a 1 dB step. The power consumption in *Transmit* mode with 32 dBm RF output power is 12 W.

Four interfaces are available on the PC-104 connectors – I2C, CAN, UART and SPI. They are used for setting the communication parameters (e.g. operation mode, frequency, output power, symbol rate) and transferring the payload data. The RF output connector to the antenna is a 50 Ohm SMA female jack. The system has an easily accessible mini-USB connector primarily intended for setting up the module and performing tests while on the ground.

The small overall dimensions of the metallic box combined with the robust HW architecture of the X-band Transmitter makes it a perfect choice for CubeSat or nanosat LEO missions.

4 FEATURES AND BENEFITS

- Frequency Range: 8.025 to 8.4 GHz
- RF Output Power: 27 dBm to 33 dBm
- Protocol: DVB-S2 – ETSI EN 302 307-1 v1.4.1
- Modulation: QPSK, 8-PSK, 16-APSK
- Spurious Emissions: < -60 dBc
- Frequency Stability: +/- 1 ppm
- Maximum Symbol Rate: 30 Msym/s
- Interfaces: UART / I2C / CAN / SPI / LVDS
- Input Interface Connector: PC-104
- RF Connector: 50 Ohm female SMA jack
- Internal Memory with Redundancy: 2x16 GB
- Wide Power Supply Range: 10 to 24.5 V
- Low Power Consumption: 12 W at 32 dBm RF output power
- Weight: 270 g

5 RF CHARACTERISTICS

Parameter	Condition	Unit	Min	Typ	Max
Freq. Range		GHz	8.025		8.4
Freq. Tuning		kHz	1		
RF Output Power	25 °C	dBm	27	32	33
Spurious Level		dBc		60	
Symbol Rate		Msym/s	5		30
SNR	25 °C	dB	28	33	36
Output Impedance		Ohm		50	

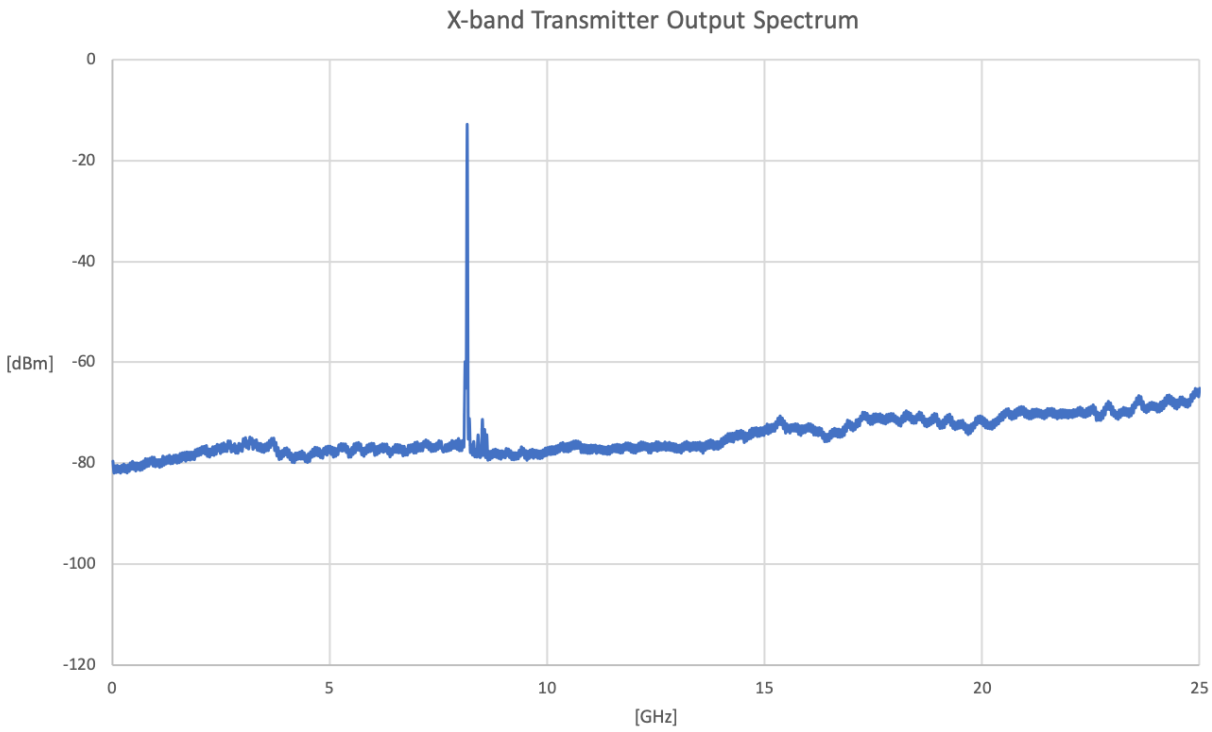


Figure 2: X-band Transmitter output spectrum – 25 GHz span, 20 MHz channel bandwidth measured with external attenuator

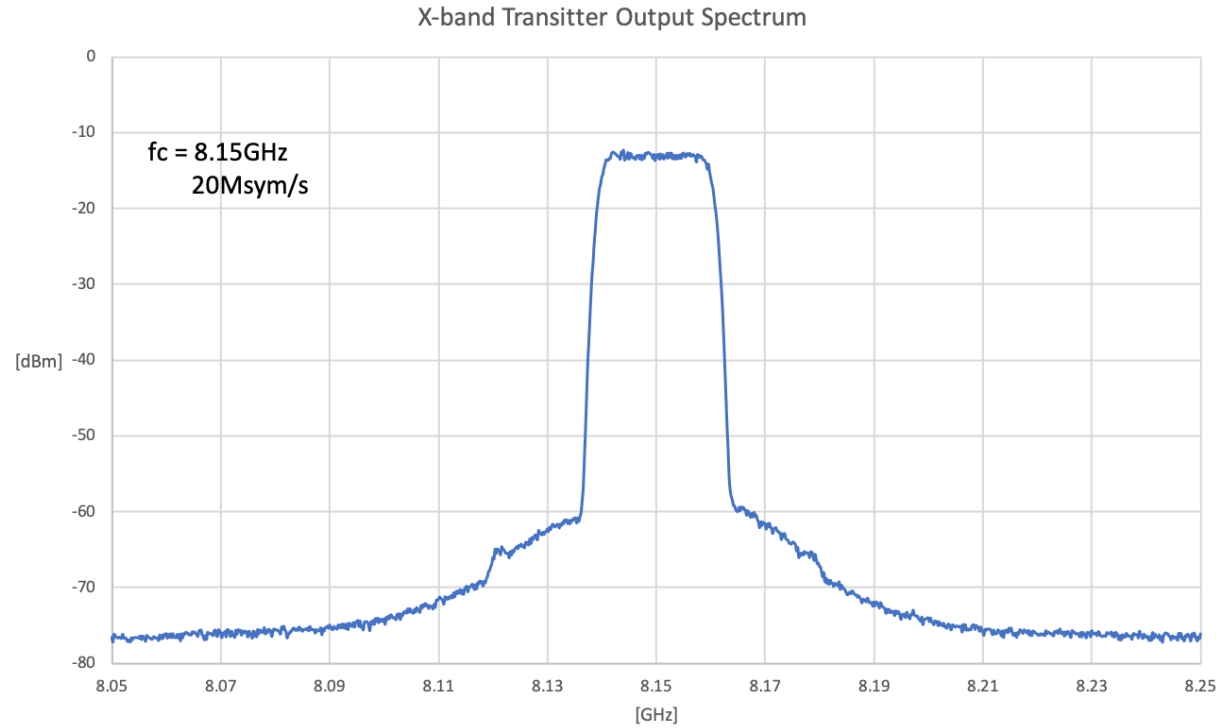


Figure 3: X-band Transmitter output spectrum – 200 MHz span, 20 MHz channel bandwidth measured with external attenuator

6 CONNECTORS

6.1 Location

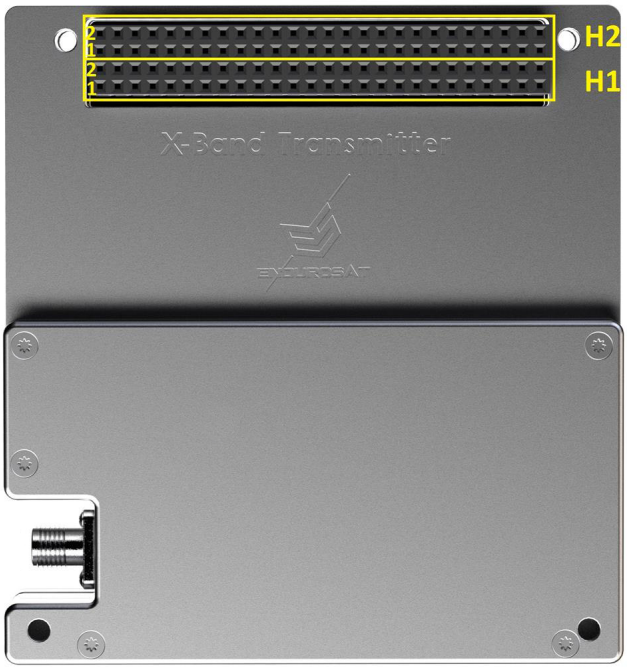


Figure 4: Main Stack Connectors

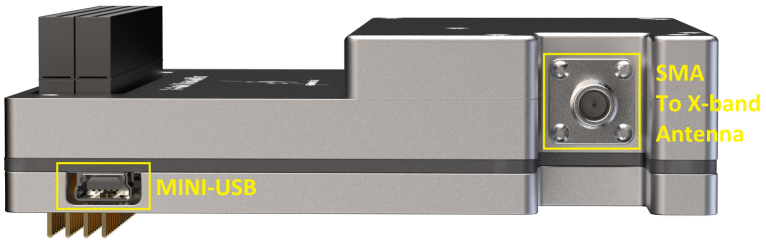


Figure 5: SMA and Mini-USB Connectors

6.2 Pinout: H1 - Stack Connector

Pin	Mnemonic	Description
H1-1	CAN L	CAN communication Low (3.3V)
H1-3	CAN H	CAN communication High (3.3V)
H1-19	TxD Payload	UART transmit data for Payload usage
H1-20	RxD Payload	UART receive data for Payload usage
H1-21	I2C SCL Payload	I2C clock for Payload usage
H1-23	I2C SDA Payload	I2C data for Payload usage
H1-39	TxD System	UART transmit data for System usage
H1-40	RxD System	UART receive data for System usage
H1-41	I2C SDA System	I2C data for System usage
H1-43	I2C SCL System	I2C clock for System usage

6.3 Pinout: H2 - Stack Connector

Pin	Mnemonic	Description
H2-3	Out1	X-band power enable
H2-23	+12V	+12V BUS Power supply
H2-24	+12V	+12V BUS Power supply
H2-29	GND	Ground
H2-30	GND	Ground
H2-31	GND	Ground
H2-32	GND	Ground
H2-45	VBatt	VBatt BUS Power supply
H2-46	VBatt	VBatt BUS Power supply
H2-47	SPI Payload	SPI – MISO for Payload usage
H2-48	SPI Payload	SPI – MOSI for Payload usage
H2-49	SPI Payload	SPI – SCK for Payload usage
H2-50	SPI Payload	SPI – NCS for Payload usage

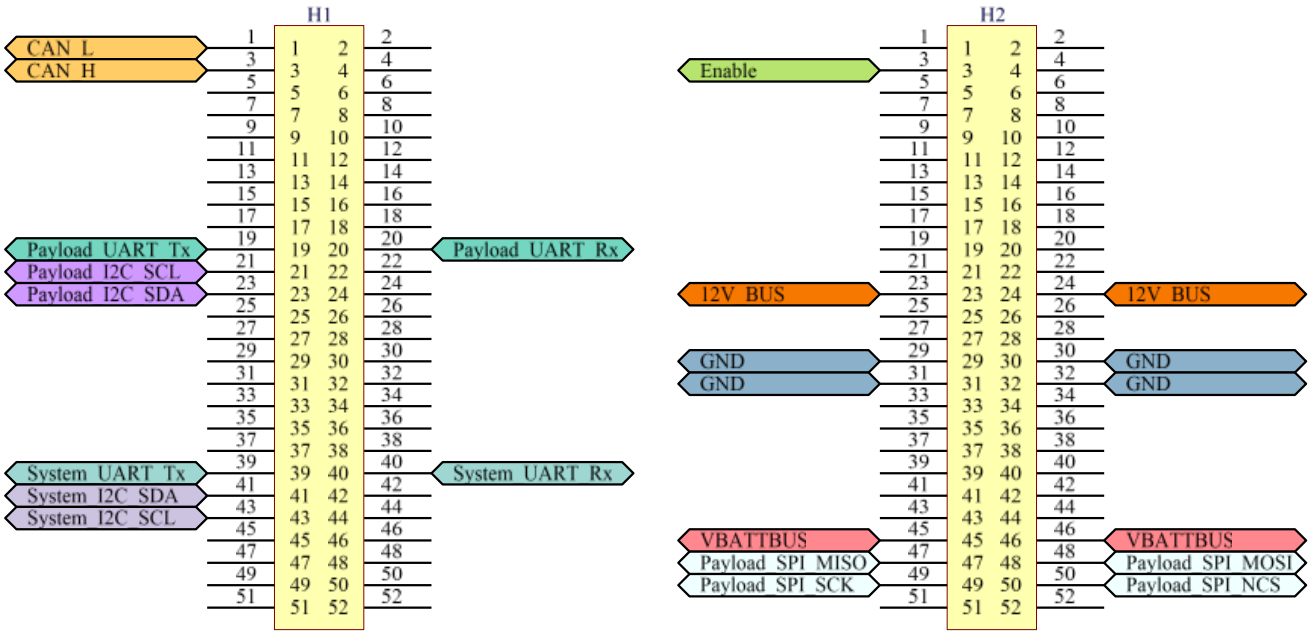


Figure 6 - Pinout of the Stack Connectors

6.4 Mini USB

The mini-B USB shown in figure 5 allows the user to easily set and test the device in laboratory conditions.

6.5 SMA Connector

The SMA connector shown in figure 5 is for the RF output signal and is a 50 Ohm female jack. It is recessed into the case to save space and its position allows easy routing of the coaxial cable within the satellite. As an option it can be purchased in a straight or right-angled configuration.

7 ELECTRICAL CHARACTERISTICS

Parameter	Condition	Min	Typ	Max
Supply Voltage [V]		10	12	24.5
Enable [V]	Logic High disables the device	1.8	3.3	5
Current Consumption [A]	Load mode		0.022	
	Transmit mode at 32 dBm RF power		1	
Operating Temperature [°C]		-30		70

8 MECHANICAL DRAWING

The following pictures show the external dimensions of the X-band Transmitter module.

STEP files can be provided upon request. All dimensions are in mm.

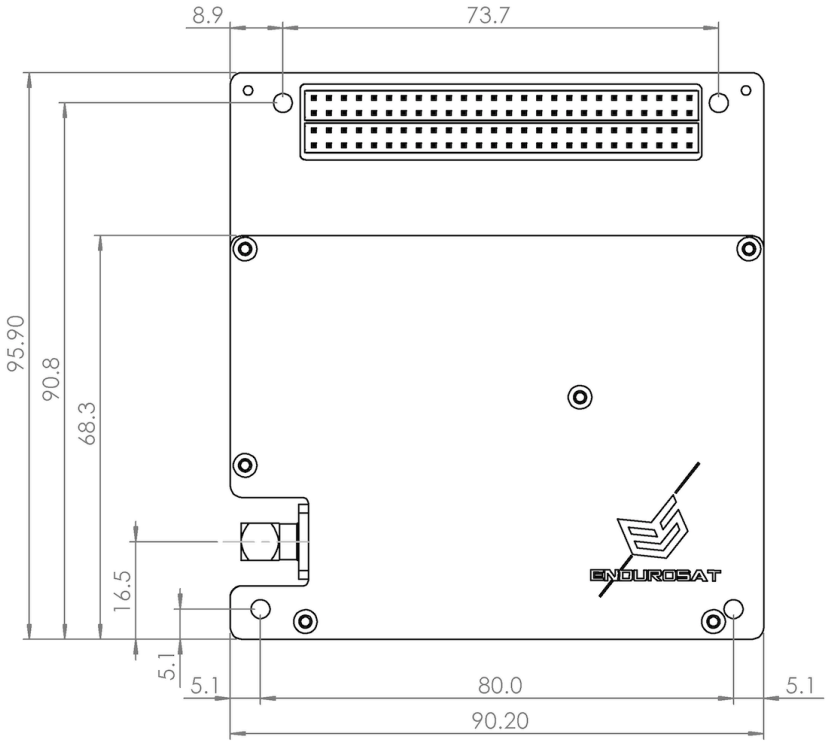


Figure 7: X-band Transmitter - top view

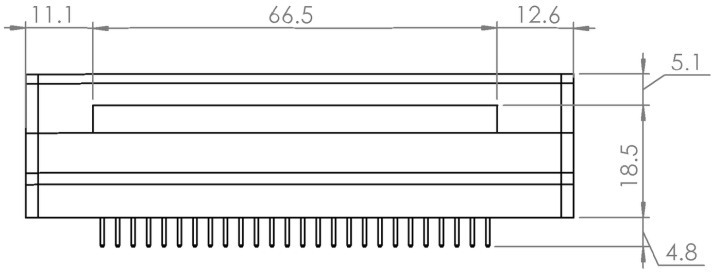


Figure 8: X-band Transmitter - side view

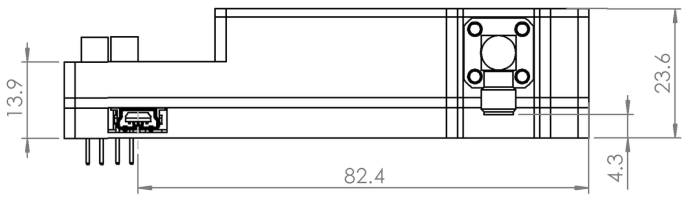


Figure 9: X-band Transmitter - side view

9 ENVIRONMENTAL AND MECHANICAL TESTING

A full campaign of tests at qualification level will be performed on the qualification engineering model. Qualification tests, levels and duration will follow the GEVS standard: GSFC-STD-7000A.

- Random Vibration
- Sinusoidal Vibration
- Pyroshock Test
- Thermal Cycling
- Thermal Vacuum
- Total Ionizing Dose

10 MATERIALS AND PROCESSES

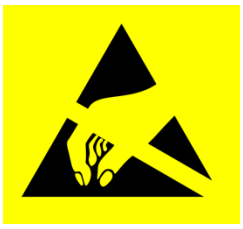
- Surface mount technology component placement
- Standard: IPC-A-610E Class 3
- Aluminum 6061 T651 box
- Visually inspected
- X-Ray checked
- Functionally verified

11 HANDLING AND STORAGE

Particular attention shall be paid to the avoidance of damage to the module during handling, storage and preservation. The handling of the module should be performed in compliance with the following instructions:

- Handle using PVC, latex, cotton (lint free) or nylon gloves.
- The environment where the device will be handled shall meet the requirements for a class environment 100,000, free of contaminants such as dust, oil, grease, fumes and smoke from any source.
- Store in such a manner as to preclude stress and prevent damage
- To prevent the deterioration, the module shall be stored in a controlled environment, i.e. the temperature and humidity levels shall be maintained within the proper ranges:
    - Ideal storage temperature range: 15 ºC to 27 ºC
    - Ideal storage humidity range: 30 % to 60 % relative humidity (RH)

12 WARNINGS



This product uses semiconductors that can be damaged by electrostatic discharge (ESD). Observe precautions for handling

Sensitive Electronic device. Do not ship or store near strong electrostatic, electromagnetic, magnetic or radioactive fields.

Communication module. Do not transmit without antenna or attenuator. Be mindful of RF interference issues.