This user manual details the applications, features and operation of EnduroSat's UHF Antenna II module. Please read carefully the manual before unpacking the antenna in order to ensure safe and proper use.

Figure 1: EnduroSat's UHF Antenna II
(with EnduroSat's 1U Solar Panel mounted - sold seperately)

1 CHANGE LOG

<table>
<thead>
<tr>
<th>Date</th>
<th>Version</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>22/Nov/2017</td>
<td>Rev 1</td>
<td>Document created</td>
</tr>
<tr>
<td>01/Feb/2018</td>
<td>Rev 1.2</td>
<td>Radiation testing details added, Minor text enhancements</td>
</tr>
<tr>
<td>22/Feb/2018</td>
<td>Rev 1.3</td>
<td>Detailed left/right-hand circular polarizations directions and interface connector pinout</td>
</tr>
<tr>
<td>23/Nov/2018</td>
<td>Rev 1.4</td>
<td>Added radiation patterns for 1U, 2U, and 3U body. Technical writing enhancements</td>
</tr>
</tbody>
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## ACRONYMS LIST

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>LHCP</td>
<td>Left Hand Circular Polarization</td>
</tr>
<tr>
<td>RHCP</td>
<td>Right Hand Circular Polarization</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency</td>
</tr>
<tr>
<td>UHF</td>
<td>Ultra-High Frequency</td>
</tr>
<tr>
<td>PCB</td>
<td>Printed Circuit Board</td>
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3 OVERVIEW

The **UHF Antenna II** module is designed to cover the amateur satellite band 435-438 MHz. The antenna is circularly polarized, and uses a burn wire mechanism with feedback for the deployment of the antenna rods. The module has an internal microcontroller to control and monitor the release of the antenna rods. Communication to the module is via an I²C interface.

The module uses a triple redundant system to ensure deployment of the antenna rods. The burn wire mechanism has double redundancy. In addition, the microcontroller can be bypassed to control the burn resistors directly via general purpose inputs on the module interface.

4 HIGHLIGHTED FEATURES

- UHF band for amateur satellite communications (435 – 438 MHz)
- Compatible with EnduroSat's Solar Panels
- Circularly polarized
- Weight: 85 g
- Gain > 0dBi*
- Max. RF output power: 3.5W
- Supply voltage for deployment: 5V
- Interface: I²C
- Triple Redundant System
- Burn wire mechanism with feedback for deployment (dual redundancy)
- Direct control of the burn resistors (third redundancy mechanism)

*from simulation

5 FUNCTIONAL DESCRIPTION

The feed network for the RF part of the antenna is realized using strip lines. Each rod is fed with a 90 degree phase shift so that the antenna has a circular polarization. The antenna has a through hole for connecting it to EnduroSat’s 1U Solar Panel Z.

6 HARDWARE LAYOUT

Figure 2 depicts the bottom side of the antenna. All the dimensions are in mm. It uses up to 8 bolts for mounting to the satellite body (minimum 4 required: in this configuration, the bolts must be installed in the proper locations as shown in Figure 4). There is an opening in the PCB, through which an EnduroSat solar panel can be connected. The right angle MCX connector, used for connecting the antenna to the communication module, is located next to the opening.

The thickness of the antenna and the height of the connector are shown in Figure 3. The overall thickness (and weight) of the antenna depends on the top cover. It can be a solar panel, a top cover or another module. Figure 3 shows the thickness of the whole antenna with a top cover of 1.6 mm.
Figure 2: Physical Layout Bottom Side (dimensions in mm)

Figure 3: Side View (dimensions in mm)
7 CHARACTERISTICS

7.1 Frequency

Figure 5 shows the measured return loss of the UHF antenna.
7.2 **Polarization**
RHCP or LHCP depending on the antenna and satellite orientation.

7.3 **Connectors**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>C1</td>
<td>MCX right angle (straight MCX or SMA upon request)</td>
</tr>
<tr>
<td>C2</td>
<td>Six pin Molex Pico-Lock™ 504050-0691</td>
</tr>
</tbody>
</table>

If the MCX connector cannot be accessed due to an obstruction between it and the structure of the satellite, then a U.FL connector on the internal side can be accessed by disassembling the top cover of the antenna.
7.4 **Antenna Gain**

The following figures depict the simulated radiation pattern of the antenna and when mounted on 1U,2U,3U.

![Figure 7: Radiation pattern of the antenna (free space)](image URL)
Figure 8: Radiation pattern when mounted on a 1U structure

Figure 9: Radiation pattern when mounted on a 2U structure
In the above figures the antenna is positioned at the origin of the coordinate system and the satellite is along the z axis in the positive direction.

8 ELECTRICAL CHARACTERISTIC

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
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</thead>
<tbody>
<tr>
<td>Supply Voltage [V]</td>
<td></td>
<td>4.8</td>
<td>5</td>
<td>2*</td>
</tr>
<tr>
<td>Current Consumption [mA]</td>
<td>Idle mode</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Primary burn resistor</td>
<td>250</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Primary and back-up burn resistor</td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All primary burning resistors (pin 5 activated)</td>
<td>1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All back-up burn resistors (pin 6 activated)</td>
<td>1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burn Resistors Voltage Activation [V]</td>
<td>Logical level threshold for direct activation of all burn</td>
<td>1.5</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>resistors (primary = pin 2, or back-up = pin 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Peak current consumption during I2C communication with 4.7 kOhm pull-up resistors
9 DEPLOYMENT MECHANISM

The deployment mechanism uses burn resistors to melt a nylon wire and release the doors holding the antenna rods as well as feedback switches to indicate successful deployment.

For redundancy purposes, each antenna rod deployment mechanism has two independent circuits of burn resistors and two independent deployment feedback switches. The module uses a six pin Molex Pico-Lock™ connector with an I2C interface for providing control and status of the antenna deployment, via an internal microcontroller.

For redundancy purposes, the microcontroller can also be bypassed to directly control the burn resistors via general purpose inputs on the six pin Molex Pico-Lock™ connector.

In order to avoid significant voltage drops (on the +5V power supply bus) caused by the currents required to heat up the burn resistors, then the length of cables to the module should be minimized. The recommended gauge of cable is AWG 24.

10 MATERIALS

The frame and doors, used for holding the rolled up antenna rods, are made of hard anodized aluminum which prevents a short circuit between the frame and the antenna rods. Rods are made from Shape Memory Alloy (SMA) with super elastic properties to ensure a straight shape after release. The PCB is made from FR-4.

11 MECHANICAL AND ENVIRONMENTAL TEST

A full campaign of tests at qualification level were performed on the qualification engineering model. Qualification test levels and duration follow the ESA standard ECSS-E-ST-10-03C and GEVS: GSFC-STD-7000A. Tests performed:

- Thermal Cycling
- Thermal Vacuum
- Random Vibration
- Sinusoidal Vibration
- Pyroshock Test
- Total Ionizing Dose > 40 kRad
12 INCLUDED IN THE SHIPMENT

EnduroSat provides along with the UHF antenna:

- 2 x 50 Ohm Coaxial cables with selectable lengths and connectors
- Power and command cable (PTFE Material Jacket, 24AWG), connector MOLEX 504051-0601
- USB stick with user manual

Customized cables and connectors can be provided upon request.

13 HANDLING AND STORAGE

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

- Handle using PVC, latex, cotton (lint free) or nylon gloves
- The environment where UHF antenna module 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 deterioration, the UHF antenna must be stored in a controlled environment, i.e. the temperature and humidity levels shall be maintained in the proper ranges:
  - Ideal storage temperature range: 15ºC to 27ºC
  - Ideal storage humidity range: 30% to 60% relative humidity (RH)
14 WARNINGS

This product uses very fragile components. Observe precautions for handling.

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.