DATASHEET

On-Board Computer (OBC) Type I
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This datasheet details the functions and features of EnduroSat's On-Board Computer (OBC) Type I. Please read carefully the manual before unpacking the OBC in order to ensure safe and proper use.

Figure 1: EnduroSat's On-Board Computer(OBC) Type I

1 CHANGE LOG

<table>
<thead>
<tr>
<th>Date</th>
<th>Version</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>19/07/2019</td>
<td>Rev 1</td>
<td>Initial document</td>
</tr>
<tr>
<td>18/10/2019</td>
<td>Rev 1.1</td>
<td>Minor text changes</td>
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## ACRONYMS LIST

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC</td>
<td>Analog to Digital Converter</td>
</tr>
<tr>
<td>ASIC</td>
<td>Application Specific Integrated Circuit</td>
</tr>
<tr>
<td>CAN</td>
<td>Controller Area Network</td>
</tr>
<tr>
<td>CSAC</td>
<td>Chip Scale Atomic Clock</td>
</tr>
<tr>
<td>ECSS</td>
<td>European Cooperation Space Standardization</td>
</tr>
<tr>
<td>EPS</td>
<td>Electrical Power System</td>
</tr>
<tr>
<td>ESA</td>
<td>European Space Agency</td>
</tr>
<tr>
<td>ESD</td>
<td>Electrostatic Discharge</td>
</tr>
<tr>
<td>GEVS</td>
<td>General Environmental Verification Standard.</td>
</tr>
<tr>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>I2C</td>
<td>Inter-Integrated Circuit</td>
</tr>
<tr>
<td>OBC</td>
<td>Onboard Computer</td>
</tr>
<tr>
<td>PCB</td>
<td>Printed Circuit Board</td>
</tr>
<tr>
<td>PWM</td>
<td>Pulse Width Modulation</td>
</tr>
<tr>
<td>RAM</td>
<td>Random-Access Memory</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency</td>
</tr>
<tr>
<td>SD card</td>
<td>Secure Digital Card</td>
</tr>
<tr>
<td>SPI</td>
<td>Serial Peripheral Interface</td>
</tr>
<tr>
<td>UART</td>
<td>Universal Asynchronous Receiver/Transmitter</td>
</tr>
<tr>
<td>UHF</td>
<td>Ultra-High Frequency</td>
</tr>
<tr>
<td>USART</td>
<td>Universal Synchronous Asynchronous Receiver Transmitter</td>
</tr>
<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
</tr>
<tr>
<td>VCP</td>
<td>Virtual Communication (COM) Port</td>
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</table>
3 DESCRIPTION

EnduroSat’s Onboard Computer Type I is a high-performance and low-power computing platform for nanosatellites. It is fully compatible with the CubeSat standard. It is based on an ARM Cortex M4 with a clock rate up to 180 MHz or optionally on ARM Cortex M7 processor with a clock rate up to 216 MHz.

It comes with integrated double redundancy sensors: 3-axis accelerometers and a compass. An Attitude Determination and Control System (ADCS) can be implemented using the PWM peripheral outputs for the magnetorquers, and the peripheral inputs for the sun sensors, temperature sensors and gyroscope.

The OBC has a highly flexible third-party protoboard connector for easily connecting and integrating third-party modules which may contain additional sensors and ICs such as an atomic clock or a GPS receiver for example. This connector is also ideal for fast prototyping of external modules and test-bed modules. The pins to the protoboard connector can be configured by soldering or removing zero-ohm resistors. There are mechanical mounting holes on the OBC for convenient mechanical fixing of the third-party protoboard.

4 PRODUCT PERFORMANCE AND PROPERTIES

- ARM Cortex M4/M7 processor
- Clock rate: up to 180 MHz for M4, up to 216 MHz for M7
- ARM Cortex M4: 256 kB RAM and 2 MB Flash Memory
- ARM Cortex M7: 2 MB RAM and 2 MB Flash Memory
- MicroSD card slot
- Integrated double redundancy sensors: 3-axis accelerometer and compass
- 3x PWM drivers for magnetorquers
- OBC can be easily connected with external (provided on the EnduroSat solar panels):
  - 6x analog sun sensor
  - 6x external temperature sensors
  - 3x external gyroscopes
- Interfaces: CAN (not supported by software), 2x USART, UART, 2x I2C, 2x SPI, USB (VCP)
- Real Time Clock
- Flexible clock eco-mode
- Weight: 58 g.
- 256 Mbit Serial NOR Flash Memory
- 64 Mbit Static RAM (Optional)
- Connector for antenna deployment
- Protoboard area for easy connection of payload and access to main power and communication buses.
5 ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
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<td>Supply voltage</td>
<td>V</td>
<td></td>
<td>3</td>
<td>3.3</td>
<td>3.6</td>
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<tr>
<td>Supply current</td>
<td>mA</td>
<td>STM32F427 @185Mhz</td>
<td>104</td>
<td>123</td>
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<tr>
<td></td>
<td>mA</td>
<td>STM32F427 @120Mhz</td>
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<td>72</td>
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<tr>
<td></td>
<td>mA</td>
<td>STM32F427 @60Mhz</td>
<td>30</td>
<td>38</td>
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<tr>
<td></td>
<td>mA</td>
<td>STM32F427 @16Mhz</td>
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<tr>
<td></td>
<td>µA</td>
<td>3-Axis Accelerometer – Normal Mode(^1)</td>
<td>200</td>
<td>400</td>
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<td></td>
<td>µA</td>
<td>3-Axis Accelerometer – Low Power Mode(^1)</td>
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<td>12</td>
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<tr>
<td></td>
<td>µA</td>
<td>3-Axis Accelerometer – Power Down Mode(^1)</td>
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<td>µA</td>
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<td></td>
<td>µA</td>
<td>3-Axis Digital Compass - Measurement Mode(^2) – Low Power Mode</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>µA</td>
<td>3-Axis Digital Compass - Measurement Mode(^2) – High Resolution Mode</td>
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<td></td>
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<tr>
<td></td>
<td>mA</td>
<td>Ext. 64M-bit Static RAM (Opt.), F = 18Mhz</td>
<td>45</td>
<td>55</td>
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<td></td>
<td>mA</td>
<td>Ext. 64M-bit Static RAM (Opt.), F = 1Mhz</td>
<td>7.5</td>
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<td></td>
<td>µA</td>
<td>Ext. 64M-bit Static RAM (Opt.), Stand-By Mode</td>
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<td>48</td>
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<td></td>
<td>mA</td>
<td>Ext. 1Gbit NOR Flash Memory Operational Mode @108Mhz (fast-read extended I/O)</td>
<td>4</td>
<td>15</td>
<td></td>
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<tr>
<td></td>
<td>mA</td>
<td>Ext. 1Gbit NOR Flash Memory Operational Mode @54Mhz (fast-read extended I/O)</td>
<td>6</td>
<td>6</td>
<td></td>
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<tr>
<td></td>
<td>mA</td>
<td>Ext. 1Gbit NOR Flash Memory Operational Mode @108Mhz (fast-read dual I/O)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mA</td>
<td>Ext. 1Gbit NOR Flash Memory Operational Mode @108Mhz (Operating current (fast-read quad I/O)</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>µA</td>
<td>Ext. 1Gbit NOR Flash Memory Operational Mode Stand by Mode</td>
<td>200</td>
<td></td>
<td></td>
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<tr>
<td>Bi-directional PWM Outputs</td>
<td>mA</td>
<td>@3.3V</td>
<td></td>
<td></td>
<td>3000</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>°C</td>
<td></td>
<td>-30</td>
<td>85</td>
<td></td>
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<tr>
<td>Storage Temperature</td>
<td>°C</td>
<td></td>
<td></td>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

Table 1: Electrical Characteristics

\(^1\) Current consumption is for one 3-Axis Accelerometer. The OBC has two identical sensors on the same location, but on opposite sides of the PCB.

\(^2\) Current consumption is for one 3-Axis Digital Compass. The OBC has two identical sensors on the same location, but on opposite sides of the PCB.
6 INTERFACE DIAGRAM

Figure 2: Interface Diagram
Figure 3: Peripherals of the OBC's Microcontroller

- Two 3-Axis Accelerometer (I2C)
- Two 3-Axis Digital Compass (I2C)
- Six Outputs for Sun Sensors (Analog)
- Three H-Bridges Outputs for Magnetorquers (PWM/direction)
- Six Outputs for Temperature Sensors (SPI)
- Three Outputs for Gyroscopes (SPI)
- 64-Mbit Static RAM (Opt.)
- 1-Gbit Flash Memory
- SD Card Holder
7 COMMUNICATION INTERFACES

7.1 CAN

EnduroSat's On-Board Computer (OBC) has a CAN bus interface using a 3.3V CAN transceiver.

The CAN interface of external modules should be connected to header 1, pins 1 and 3 (H1-1 and H1-3) of the PC/104 connector.

The same CAN interface can be reached from the protoboard area using the JP2 and JP14 connectors (TLE-110-01-G-DV). In this case, the zero Ohm resistors R72 and R73 should be mounted as shown in Figure 4.

Figure 4: Protoboard Connector and Zero-Ohm Resistor Jumpers

Figure 5: CAN Resistors R72 and R73
7.2 USART and UART

EnduroSat's On-Board Computer (OBC) provides two USART interfaces and one UART interface. The first USART interface (H1-33 and H1-35) is used by EnduroSat's UHF Transceiver. The second USART interface is left free for the payload (H1-19 and H1-20). If the USB peripheral is mounted (Figure ), then this interface is used for UART to USB communication (VCP).

![USB Peripheral Location](image)

Figure 6: USB Peripheral Location

Mounting zero Ohm resistors on R62 and R63 gives access to this interface through the connectors JP2 or JP14 on the protoboard area as shown in Figure 7.

![Necessary Zero Ohm resistors](image)

Figure 7: Necessary Zero Ohm resistors to connect Payload USART to Protoboard connector
For USB (VCP) R62, R63, R67 & R68 as shown on figure 8.

**Figure 8:** Necessary Zero Ohm resistors to connect Payload USART to USB (VCP) connector

For USART on “P1-USB” R82, R81 as shown on figure 9.

**Figure 9:** Necessary Zero Ohm resistors to connect Payload USART to Molex connector P1

Moreover, the same interface can be used for communication with atomic clock if it is mounted on the ProtoBoard area (Microsemi Quantum™ SA,45s CSAC). To realize the communication with the atomic clock, zero-ohm resistors – R62, R63, R64 and R65 have to be mounted as shown in Figure 10.
ON-BOARD COMPUTER (OBC) TYPE I – DATASHEET

Figure 10: Necessary Zero Ohm resistors to connect Payload USART to External Atomic clock

UART – is free for payload and it can be access through H1-39 / H1-40 (EnduroSat EPS Opt.).

7.3 SPI

Two 3.3V SPI interfaces are provided.

In the EnduroSat CubeSat platform the first SPI interface (H2-9, H2-10, H2-11, H2-15 and H2-16 of the PC104 connector) is used for the EnduroSat S-Band transceiver.

The second SPI interface (H2-47, H2-48, H2-49 and H2-50 of the PC104 connector) can be used for the payload or for generic user needs.

The second SPI interface also can be accessed through JP2 or JP14 of the ProtoBoard area mounting zero Ohm resistors R74, R75, R76 and R77 as shown in Figure 11.

Figure 11: Necessary Zero Ohm resistors to connect Payload SPI to Protoboard connector
7.4 I²C

Two 3.3V I²C interfaces are provided.

First I²C interface (H1-41 and H1-43 of the PC104 connector) can be used as main interface among all the subsystems of the satellite.

Second I²C interface (H1-21 and H1-23 of the PC104 connector) can be used for the payload and to control the deployment of the EnduroSat UHF Antenna through the connector J1 located on the ProtoBoard area. To realize the access through JP2 or JP14, zero Ohm resistors R69 and R70 and have to be mounted (Figure 12).

![Diagram of I²C interfaces](image.png)

Figure 12: Necessery Zero Ohm resistors to connect System I2C to Protoboard connector

7.5 Six General Purpose Outputs

The OBC module has five general purpose outputs. Each output can be switched between 3.1V and Ground. All outputs are protected with diodes. In this way other modules can control the same outputs (there are 10k pull-down resistors on the EnduroSat EPS Type I Module). A diode OR gate can be realized.

8 SENSORS FOR ATTITUDE DETERMINATION AND CONTROL

EnduroSat's On-Board Computer(OBC) comes with an embedded array of sensors for the attitude determination and outputs for control of the magnetorquers.

8.1 Compass

Two 3-axis digital compasses designed for low-field magnetic sensing with high-resolution are included on the OBC as peripherals. Both sensors are located at the same place, but on opposite sides of the OBC. The compass is based on magneto-resistive sensors plus an ASIC containing amplification, automatic degaussing strap drivers, offset cancellation, and a 12-bit ADC that enables 1° to 2° compass
heading accuracy. Compass utilizes Anisotropic Magneto-resistive (AMR) technology that provides advantages over other magnetic sensor technologies. These anisotropic, directional sensors feature precision in-axis sensitivity and linearity. These sensors have a solid-state construction with very low cross-axis sensitivity and are designed to measure both the direction and the magnitude of the Earth’s magnetic field, from milli-gauss to 8 gauss.

8.2 Accelerometers

Two high-performance ultra low-power 3-axis accelerometers are added as OBC peripherals. Both are placed at the same location but on opposite sides of the PCB. The accelerometers have dynamic user-selectable full-scales of ±2g/±4g/±8g and are capable of measuring accelerations with output data rates from 0.5 Hz to 1 kHz.

8.3 Sun sensors

Six analog inputs for sun sensors. The current OBC has filters and amplifiers optimized for the sun sensors on EnduroSat's Solar Panels.

8.4 Temperature sensors

Six external temperature sensors with SPI communication interface can be connected to the OBC.

8.5 Magnetorquers control

Three independent outputs for control of the magnetorquers. The control of the magnetorquers is realised using a H-Bridge with 3.3V and maximum output current of 3A.

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Parameter</th>
<th>Unit</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two 3-Axis Digital Compass</td>
<td>Measurement Range</td>
<td>gauss</td>
<td>Full scale</td>
<td>-16</td>
<td></td>
<td>+16</td>
</tr>
<tr>
<td></td>
<td>Sensitivity</td>
<td>LSb/gauss</td>
<td>±4</td>
<td>6842</td>
<td>1370</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>±8</td>
<td>3421</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>±12</td>
<td>2281</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>±16</td>
<td>1711</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two 3-Axis Accelerometer</td>
<td>Measurement range</td>
<td>±2g/±4g/±8g</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output Data Rate</td>
<td>Hz</td>
<td>0.5</td>
<td>0.5</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Parameters of the Magnetorquers
9  OBC PROTOBOARD AREA

9.1  USB interface

An additional USB interface can be provided on the ProtoBoard area. This interface gives accessibility to an external device/PC (Master device) to communicate with the OBC Microcontroller (Slave device). The OBC USB interface is based on IC FT232RL - UART to USB interface (VCP). Full driver support can be found at http://www.ftdichip.com.

EnduroSat's On-Board Computer (OBC) Type I comes with electronic components for the USB Interface already mounted on it.

The USB interface can be accessed from the PC/104 connector (Tx) H-19 and (Rx) H-20. Moreover, it can be also accessed from the 20 pin headers “JP2” on the top side of the OBC through pin 11 (Rx) and pin 12 (Tx) or “JP14” on the bottom side through pin 12 (Rx) and pin 11 (Tx). To realize the access through “JP2” and “JP14”, zero Ohm resistors R62, R63, R67 and R68 have to be mounted as shown in Figure 8.

Two types of connectors can be used to access the USB Interface: standard USB Mini B Connector (USB1) or Molex 53398-0471 (P1). When EnduroSat's Solar Panel with a Remove Before Flight (RBF) is used in the platform, then connection to it can be realized using the OBC Molex 53398-0471 and an EnduroSat 4 pin cable. In this way, when the CubeSat is fully assembled, the OBC USB interface can be accessed with EnduroSat's external USB adapter. For more information check the datasheet of a solar panel, and find a chapter with the information about “Satellite Communication Interface Connector (SCIC)”. Both USB connectors can be connected to the ProtoBoard Connectors “JP2” (DM – pin3 / DP – pin4) and “JP14” (DM – pin4 / DP – pin3) when zero Ohm resistors are mounted on R83 and R84 (Figure 13).

![Figure 13: Necessary Zero Ohm resistors to connect USB signals to Protoboard connector](image-url)
9.2 External PCB (Payload)

An external PCB (Payload) can be connected to the connector located on the ProtoBoard Area. Additional mounting holes are also provided. The ProtoBoard connector is the 20pin SAMTEC TLE-110-01-G-DV. One is on the top side (JP2) of the OBC and the other on the bottom (JP14 -Not Mounted). This allows minimization of the used space inside the satellite and easy access to different communication interfaces and power supplies. The interfaces on the ProtoBoard connectors should be chosen very carefully, because they are shared with the main PC/104 connector. All pins of the ProtoBoard connectors are separated from the rest of the OBC when zero Ohm resistors are not mounted. Each pin of the ProtoBoard connector has its own testing point located just next to it for research and development purposes. All test points are plated holes with pitch 0.1inch (2.54mm) and diameter of 0.060inch.

Figure 14: External PCB
9.3 Stripboard Grid

For developing and prototyping purposes an area of OBC is left as a stripboard grid with 11 holes on 16 strips. All holes are plated with grid spacing of 0.1inch (2.54mm) and diameter of 0.060inch. All holes in the first strip are connected to the 5V BUS, in the second strip to 3.3V BUS and the last one to GND. These power strips can be recognized by the square rings.

Figure 15: Stripboard Grid
9.4 **Atomic Clock Ready**

On the protoboard area, there are mounting holes for Quantum™ SA.45s Chip Scale Atomic Clock from Microsemi. UART interface can be connected through zero Ohm resistors. Access to other pins of the atomic clock can be realized with plated holes next to each pin.

![Figure 16: Atomic Clock Pins](image)

9.5 **SD Card Holder**

Direct access to SD Card holder is enabled through the 12 pin connector JP15 – Molex 53398-1271. The SD card is shared with the high speed data payload and the OBC to resend data if required through the RF communication module.
10 CONNECTOR PINOUT

10.1 Connector Location

Figure 17: Connector Location on Top Side
10.2 H1 & H2 Stack Connector

Figure 18: Connector Location on Bottom Side

Figure 19: Header 1 & 2 Stack connectors
### H1

<table>
<thead>
<tr>
<th>Pin</th>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1-1</td>
<td>CANL</td>
<td>CAN communication Low (3.3V)</td>
</tr>
<tr>
<td>H1-3</td>
<td>CANH</td>
<td>CAN communication High (3.3V)</td>
</tr>
<tr>
<td>H1-19</td>
<td>PAY_TX</td>
<td>USART payload transmit data</td>
</tr>
<tr>
<td>H1-20</td>
<td>PAY_RX</td>
<td>USART payload receive data</td>
</tr>
<tr>
<td>H1-21</td>
<td>PAY_SCL</td>
<td>I2C for payload</td>
</tr>
<tr>
<td>H1-23</td>
<td>PAY_SDA</td>
<td>I2C for payload</td>
</tr>
<tr>
<td>H1-33</td>
<td>UHF RX</td>
<td>USART UHF module transmit data (optional EnduroSat EPS)</td>
</tr>
<tr>
<td>H1-35</td>
<td>UHF TX</td>
<td>USART UHF module receive data (optional EnduroSat EPS)</td>
</tr>
<tr>
<td>H1-39</td>
<td>SYS_TX</td>
<td>UART transmit data</td>
</tr>
<tr>
<td>H1-40</td>
<td>SYS_RX</td>
<td>UART receive data</td>
</tr>
<tr>
<td>H1-41</td>
<td>SYS_SDA</td>
<td>I2C between sub-systems</td>
</tr>
<tr>
<td>H1-43</td>
<td>SYS_SCL</td>
<td>I2C between sub-systems</td>
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</table>

Table 3: Pinout Description of Stack Connector Header 1

### H2

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<th>Mnemonic</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>H2-3</td>
<td>OBC_OUT1</td>
<td>Universal Output 1</td>
</tr>
<tr>
<td>H2-4</td>
<td>OBC_OUT2</td>
<td>Universal Output 2</td>
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<tr>
<td>H2-5</td>
<td>OBC_OUT3</td>
<td>Universal Output 3</td>
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<tr>
<td>H2-6</td>
<td>EN_OBC</td>
<td>Enable OBC (to turn on the OBC)</td>
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<tr>
<td>H2-7</td>
<td>OBC_OUT5</td>
<td>Universal Output 5</td>
</tr>
<tr>
<td>H2-8</td>
<td>OBC_OUT6</td>
<td>Universal Output 6</td>
</tr>
<tr>
<td>H2-9</td>
<td>SPI MISO</td>
<td>SPI MISO</td>
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<tr>
<td>H2-10</td>
<td>SPI MOSI</td>
<td>SPI MOSI</td>
</tr>
<tr>
<td>H2-11</td>
<td>SPI SCK</td>
<td>SPI SCK</td>
</tr>
<tr>
<td>H2-13</td>
<td>SPI TR</td>
<td>SPI TR</td>
</tr>
<tr>
<td>H2-15</td>
<td>SPI CS</td>
<td>SPI CS</td>
</tr>
<tr>
<td>H2-16</td>
<td>SPI IRQ</td>
<td>SPI IRQ</td>
</tr>
<tr>
<td>H2-25</td>
<td>+5V</td>
<td>+5V BUS</td>
</tr>
<tr>
<td>H2-26</td>
<td>+5V</td>
<td>+5V BUS</td>
</tr>
<tr>
<td>H2-27</td>
<td>3V3</td>
<td>+3.3V BUS</td>
</tr>
<tr>
<td>H2-28</td>
<td>3V3</td>
<td>+3.3V BUS</td>
</tr>
<tr>
<td>H2-29</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>H2-30</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>H2-31</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>H2-32</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>H2-47</td>
<td>PAY_MISO</td>
<td>SPI Payload</td>
</tr>
<tr>
<td>H2-48</td>
<td>PAY_MOSI</td>
<td>SPI Payload</td>
</tr>
</tbody>
</table>
10.3 PAN1, PAN2 and PAN3

Picoblade 12 pin connectors PAN1, PAN2 and PAN3 are located on the top side of the OBC as shown in Figure 20.

![Figure 20: Picoblade 12 Pin Connectors (PAN1, PAN2, PAN3)](image)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC</td>
<td>Not connected</td>
</tr>
<tr>
<td>2</td>
<td>NC</td>
<td>Not connected</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>Vgyro</td>
<td>Power for gyroscope</td>
</tr>
<tr>
<td>5</td>
<td>SPI CS1</td>
<td>SPI chip select for gyroscope</td>
</tr>
<tr>
<td>6</td>
<td>SPI MOSI</td>
<td>SPI (for gyroscope and temperature sensor)</td>
</tr>
<tr>
<td>7</td>
<td>AGND</td>
<td>Photodiode Analog Ground</td>
</tr>
<tr>
<td>8</td>
<td>PhotoDiode</td>
<td>Photodiode signal</td>
</tr>
<tr>
<td>9</td>
<td>SPI SCK</td>
<td>SPI (for gyroscope and temperature sensor)</td>
</tr>
<tr>
<td>10</td>
<td>SPI MISO</td>
<td>SPI (for gyroscope and temperature sensor)</td>
</tr>
<tr>
<td>11</td>
<td>+3.3V</td>
<td>+3.3V BUS power supply for sensors</td>
</tr>
<tr>
<td>12</td>
<td>SPI CS2</td>
<td>SPI chip select for temperature sensor</td>
</tr>
</tbody>
</table>

Table 5: Picoblade 12 Pin Connectors (PAN1, PAN2, PAN3)
10.4 PAN4, PAN5 and PAN6

Picoblade 12 pins connectors PAN4, PAN5 and PAN6 are located on the bottom side of the OBC as shown in Figure 21.

![Picoblade 12 Pin Connectors (PAN4, PAN5, PAN6)](image)

Figure 21: Picoblade 12 Pin Connectors (PAN4, PAN5, PAN6)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PWMB</td>
<td>PWM (in/out)</td>
</tr>
<tr>
<td>2</td>
<td>PWMA</td>
<td>PWM (out/in)</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>Vgyro</td>
<td>Power for gyroscope</td>
</tr>
<tr>
<td>5</td>
<td>SPI CS1</td>
<td>SPI chip select for gyroscope</td>
</tr>
<tr>
<td>6</td>
<td>SPI MOSI</td>
<td>SPI (for gyroscope and temperature sensor)</td>
</tr>
<tr>
<td>7</td>
<td>AGND</td>
<td>Photodiode Analog Ground</td>
</tr>
<tr>
<td>8</td>
<td>PhotoDiode</td>
<td>Photodiode signal</td>
</tr>
<tr>
<td>9</td>
<td>SPI SCK</td>
<td>SPI (for gyroscope and temperature sensor)</td>
</tr>
<tr>
<td>10</td>
<td>SPI MISO</td>
<td>SPI (for gyroscope and temperature sensor)</td>
</tr>
<tr>
<td>11</td>
<td>+3.3V</td>
<td>+3.3V BUS power supply for sensors</td>
</tr>
<tr>
<td>12</td>
<td>SPI CS2</td>
<td>SPI chip select for temperature sensor</td>
</tr>
</tbody>
</table>

Table 6: Picoblade 12 Pin Connectors (PAN4, PAN5, PAN6)
## 10.5 JP2

![JP2 Interface Diagram](image)

**Table 7: JP2 Pin Description**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+5V</td>
<td>+5V BUS</td>
</tr>
<tr>
<td>2</td>
<td>+3.3V</td>
<td>+3.3V BUS</td>
</tr>
<tr>
<td>3</td>
<td>USB D-</td>
<td>USB data -</td>
</tr>
<tr>
<td>4</td>
<td>USB D+</td>
<td>USB data +</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Not connected</td>
</tr>
<tr>
<td>6</td>
<td>PAY SCL</td>
<td>I2C payload</td>
</tr>
<tr>
<td>7</td>
<td>CAN L</td>
<td>CAN Low (3.3V)</td>
</tr>
<tr>
<td>8</td>
<td>PAY SDA</td>
<td>I2C payload</td>
</tr>
<tr>
<td>9</td>
<td>CAN H</td>
<td>CAN High (3.3V)</td>
</tr>
<tr>
<td>10</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>11</td>
<td>PAY Rx</td>
<td>USART receive data</td>
</tr>
<tr>
<td>12</td>
<td>PAY Tx</td>
<td>USART transmit data</td>
</tr>
<tr>
<td>13</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>14</td>
<td>OUT1</td>
<td>Universal output 1</td>
</tr>
<tr>
<td>15</td>
<td>PAY MISO</td>
<td>SPI payload</td>
</tr>
<tr>
<td>16</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>17</td>
<td>PAY MOSI</td>
<td>SPI payload</td>
</tr>
<tr>
<td>18</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>19</td>
<td>PAY NCS</td>
<td>SPI payload</td>
</tr>
<tr>
<td>20</td>
<td>PAY SCK</td>
<td>SPI payload</td>
</tr>
</tbody>
</table>
### JP14

<table>
<thead>
<tr>
<th>Pin</th>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+3.3V</td>
<td>+3.3V BUS</td>
</tr>
<tr>
<td>2</td>
<td>+5V</td>
<td>+5V BUS</td>
</tr>
<tr>
<td>3</td>
<td>USB D+</td>
<td>USB data +</td>
</tr>
<tr>
<td>4</td>
<td>USB D-</td>
<td>USB data -</td>
</tr>
<tr>
<td>5</td>
<td>PAY SCL</td>
<td>I2C payload</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Not connected</td>
</tr>
<tr>
<td>7</td>
<td>PAY SDA</td>
<td>I2C payload</td>
</tr>
<tr>
<td>8</td>
<td>CAN L</td>
<td>CAN Low (3.3V)</td>
</tr>
<tr>
<td>9</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>10</td>
<td>CAN H</td>
<td>CAN High (3.3V)</td>
</tr>
<tr>
<td>11</td>
<td>PAY Tx</td>
<td>USART transmit data</td>
</tr>
<tr>
<td>12</td>
<td>PAY Rx</td>
<td>USART receive data</td>
</tr>
<tr>
<td>13</td>
<td>OUT1</td>
<td>Universal output 1</td>
</tr>
<tr>
<td>14</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>15</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>16</td>
<td>PAY MISO</td>
<td>SPI payload</td>
</tr>
<tr>
<td>17</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>18</td>
<td>PAY MOSI</td>
<td>SPI payload</td>
</tr>
<tr>
<td>19</td>
<td>PAY SCK</td>
<td>SPI payload</td>
</tr>
<tr>
<td>20</td>
<td>PAYNCS</td>
<td>SPI payload</td>
</tr>
</tbody>
</table>

Table 8: JP14 Pin Description

### J1

![J1 Interface Diagram](image-url)

Figure 23: J1 Interface Diagram
### J1

<table>
<thead>
<tr>
<th>Pin</th>
<th>Mnemonic / OUT1</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+5V</td>
<td>+5V BUS</td>
</tr>
<tr>
<td>2</td>
<td>Ant_SCL / OUT1</td>
<td>I2C UHF antenna / Universal output 1</td>
</tr>
<tr>
<td>3</td>
<td>Ant_SDA</td>
<td>I2C UHF antenna</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>Ground</td>
</tr>
</tbody>
</table>

Table 9: J1 Pin Description

10.8 JP15

![JP15 Connector Diagram]

**MOLEX 53398-1271**

**Figure 24: JP15 Connector**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>3</td>
<td>SD_EN</td>
<td>SD Enable</td>
</tr>
<tr>
<td>4</td>
<td>SD_D2</td>
<td>SD data 2</td>
</tr>
<tr>
<td>5</td>
<td>SD_D3</td>
<td>SD data 3</td>
</tr>
<tr>
<td>6</td>
<td>SD_CMD</td>
<td>SD command I/O</td>
</tr>
<tr>
<td>7</td>
<td>SD_DET</td>
<td>SD detect</td>
</tr>
<tr>
<td>8</td>
<td>SD_CK</td>
<td>SD clock</td>
</tr>
<tr>
<td>9</td>
<td>SD_D0</td>
<td>SD data 0</td>
</tr>
<tr>
<td>10</td>
<td>SD_D1</td>
<td>SD data 1</td>
</tr>
<tr>
<td>11</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>12</td>
<td>GND</td>
<td>Ground</td>
</tr>
</tbody>
</table>

Table 10: JP15 Pin Description
10.9 CN1

Figure 25: CN1 Connector

<table>
<thead>
<tr>
<th>Pin</th>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+3.3V</td>
<td>+3.3V BUS</td>
</tr>
<tr>
<td>2</td>
<td>NJRST</td>
<td>JTAG Test nReset</td>
</tr>
<tr>
<td>3</td>
<td>JTDI</td>
<td>JTAG Test Data Input</td>
</tr>
<tr>
<td>4</td>
<td>JTMS-SWDIO</td>
<td>JTAG Test Mode Selection / Serial Wire Data I/O</td>
</tr>
<tr>
<td>5</td>
<td>JTCK-SWCLK</td>
<td>JTAG Test Clock / Serial Wire Clock</td>
</tr>
<tr>
<td>6</td>
<td>JTDO</td>
<td>JTAG Test Data Output</td>
</tr>
<tr>
<td>7</td>
<td>NRST</td>
<td>External Reset</td>
</tr>
<tr>
<td>8</td>
<td>BOOT0</td>
<td>Boot Configuration</td>
</tr>
<tr>
<td>9</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>10</td>
<td>GND</td>
<td>Ground</td>
</tr>
</tbody>
</table>

Table 11: CN1 Pin Description

10.10 SD1

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Data2</td>
<td>Data signal 1</td>
</tr>
<tr>
<td>2</td>
<td>Data3</td>
<td>Data signal 2</td>
</tr>
<tr>
<td>3</td>
<td>CMD I/O</td>
<td>Input and output command</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>supply voltage negative</td>
</tr>
<tr>
<td>5</td>
<td>VDD</td>
<td>supply voltage positive</td>
</tr>
<tr>
<td>6</td>
<td>CLK</td>
<td>clock signal</td>
</tr>
<tr>
<td>7</td>
<td>GND</td>
<td>supply voltage negative</td>
</tr>
<tr>
<td>8</td>
<td>Data0</td>
<td>data signal 0</td>
</tr>
<tr>
<td>9</td>
<td>Data1</td>
<td>data signal 1</td>
</tr>
</tbody>
</table>

Table 12: SD1 Pin Description
Figure 26: P1 Connector

<table>
<thead>
<tr>
<th>Pin</th>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+5V</td>
<td>+5V USB</td>
</tr>
<tr>
<td>2</td>
<td>USB_DM</td>
<td>USB data -</td>
</tr>
<tr>
<td>3</td>
<td>USB_DP</td>
<td>USB data +</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>Ground</td>
</tr>
</tbody>
</table>

Table 13: P1 Pin Description
11 MECHANICAL CHARACTERISTICS

In this section, the main dimensions of the OBC are shown. All dimensions are in mm. A STEP file can be provided upon request.

Figure 27: OBC Top View

Figure 28: OBC Side View

Figure 29: OBC Side View
ON-BOARD COMPUTER (OBC) TYPE I – DATASHEET

12 ASSEMBLING
The production process follows the quality standards:

- PC-A-610E, class 3 (Acceptability of Electronic Assemblies)
- IPC-A-600 (Acceptability of Printed Boards)
- J-STD-001 (Requirements for Soldered Electrical and Electronic Assemblies)
- ISO 14644 (Cleanrooms and Associated Controlled Environments)
- IEC 61340 (Electrostatics ESD: Protection of Electronic Devices from Electrostatic Phenomena)

Conformal coating:

- Outgassing requirements: NASA SP-R-0022A

13 ENVIRONMENTAL AND MECHANICAL TESTS
A full campaign of tests at qualification level was performed on the On-Board Computer(OBC) qualification engineering model. Qualification test levels and duration follow the ESA standard ECSS-EST-10-03C and GEVS: GSFC-STD-7000A. Tests performed:

- Thermal Cycling
- Thermal Vacuum
- Random Vibration
- Sine Vibration
- Shock Test

Space qualification campaign link: https://www.endurosat.com/space-qualification/

14 HANDLING AND STORAGE
Particular attention shall be paid to the avoidance of damage to the On-Board Computer(OBC) during handling, storage and preservation. The handling of the OBC should be performed in compliance with the following instructions:

- Handle using PVC, latex, cotton (lint free) or nylon gloves.
- The environment where the On-Board Computer(OBC) module will be handled shall meet the requirements for a class 100,000 environment, free of contaminants such 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 power module 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: 15°C to 27°C
  - Ideal storage humidity range: 30% to 60% relative humidity (RH)
15 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.