# SIMERA SENSE

# HyperScape100

## Interface Control Document

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# Document History

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| 1 | 2019-08-20 | First release of document |

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# List of Abbreviations

| Abbreviation | Description |
|---|---|
| AIT | Assembly, Integration and Testing |
| BOL | Beginning of Life |
| CE | Control Electronics |
| CVCM | Collected Volatile Condensable Material |
| DC | Direct Current |
| FPGA | Field Programmable Gate Array |
| IO | Input/Output |
| ISO | International Organization for Standardization |
| LVDS | Low Voltage Differential Signalling |
| MSB | Most Significant Bit |
| NC | Not Connected |
| OFE | Optical Front-End |
| PCB | Printed Circuit Board |
| SPI | Serial Peripheral Interface |
| TML | Total Mass Loss |

# 1. Introduction

## 1.1 Identification

Item Description: HyperScape100

Simera Item Number: SS100-034647

## 1.2 Intended Use

This document describes the interfaces and environmental conditions of the HyperScape100 Imager.

## 1.3 Context and Summary

The HyperScape100 is an electro-optical imaging system employing a CMOSIS CMV12000 sensor utilizing a linear variable filter. The HyperScape100 is produced by Simera Sense and is intended for earth observation applications. It is primarily designed to be implemented as part of an optical payload in a CubeSat. Its compact form factor allows for direct implementation into a 3U CubeSat structure; however, the HyperScape100 can also be used as part of larger satellite systems.

This Interface Control Document identifies, defines and describes the interfaces between the HyperScape100 and the surrounding satellite components, as well as between the HyperScape100 and its environment.

## 2. Referenced Documents

Table 2-1 lists documents that are referenced in this document. In the event of conflict between the contents of the reference documents and this document, this document shall take precedence.

**Table 2-1: Referenced Documents**

| Ref. # | Reference |
|---|---|
| [1] | Outgassing Data for Selecting Spacecraft Materials. [Online]. Available: https://outgassing.nasa.gov/ [2018, October 24] |
| [2] | NXP I2C-bus specification and User Manual. [Online]. Available: https://www.nxp.com/docs/en/user-guide/UM10204.pdf [2018, October 24] |

For undated references, the latest released version of the reference document applies. For dated references, subsequent versions of the document do not apply. It is best practice to always refer to the latest released version. Unless otherwise stated, web links referenced above were last accessed at the release date of the current version of this document.

## 3. System Description and Context

The HyperScape100 captures electromagnetic radiation, focuses the radiation on a sensor and converts the focused electromagnetic radiation into electrical signals. The HyperScape100 typically forms part of the payload of a satellite and is shown in the context of a typical CubeSat diagram in Figure 3-1 below.
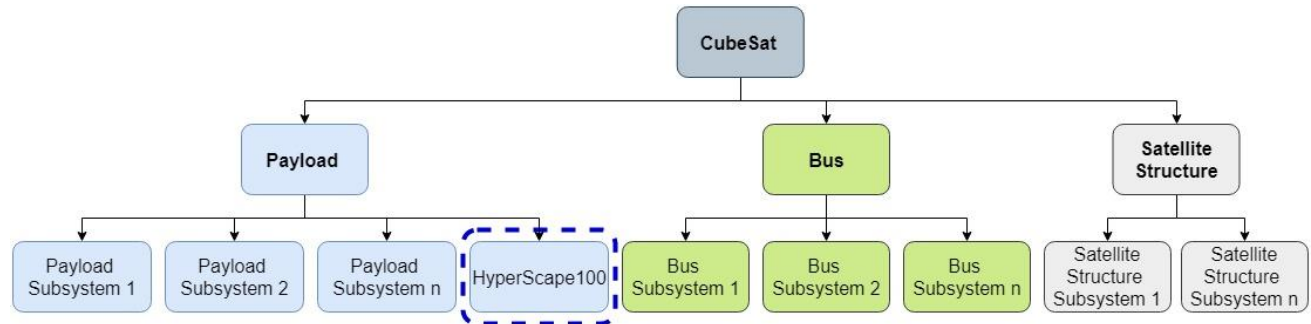


**Figure 3-1: Typical CubeSat System Diagram**

### 3.1 Physical Description

The HyperScape100, hereafter referred to as the "Imager", consists of several subassemblies which comprises of the xScape100 Optical Front-End (OFE), the HyperScape100 Sensor Unit and the HyperScape100 Control Electronics. Table 3-1 provides a functional description of the Imager and its components

**Table 3-1 System and Component Functional Description**

| ID | Imager/Component | Primary Function |
|----|------------------|------------------|
| 1 | HyperScape100 | Collects electromagnetic radiation and converts it into electrical signals |
| 1.1 | xScape100 OFE | Focuses the collected electromagnetic radiation onto an imaging sensor |
| 1.2 | HyperScape100 Sensor Unit | Positions the sensor on the focal plane and converts the focused electromagnetic radiation into electrical signals |
| 1.3 | HyperScape100 Control Electronics | Powers and drives the sensor unit, as well as provides storage space for the captured images |

Figure 3-2 illustrates the physical system subassemblies and provides the axis definition.
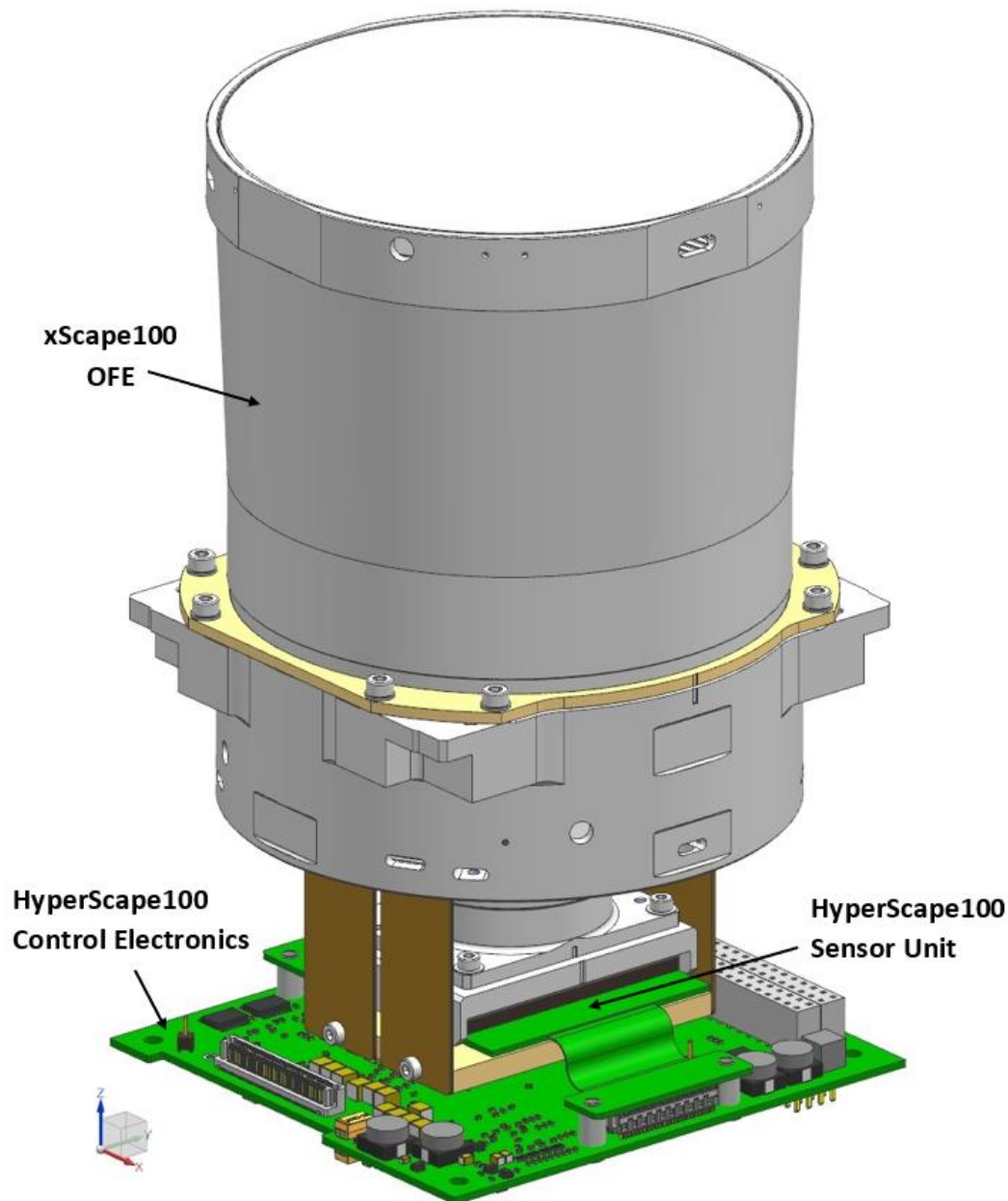


**Figure 3-2: HyperScape100 with Axis Definition**

## 3.2 Physical Properties

The physical properties of the Imager are presented in Table 3-2. The reference axis system used to define the moments of inertia and centre of mass position is located at the geometric centre of the OFE's mounting points which is shown in Figure 4-2.

**Table 3-2: Physical Properties**

| Property | Unit | Value |
|---|---|---|
| Mass | kg | 1.14 (± 5%) |
| Moments of Inertia | | |
| $I_{xx}$ | kg.m$^2$ | 3.70E-03 (± 5%) |
| $I_{yy}$ | kg.m$^2$ | 3.65E-03 (± 5%) |
| $I_{zz}$ | kg.m$^2$ | 1.55E-03 (± 5%) |
| Centre of Mass | | |
| x | mm | < 0.5 (± 0.5) See Figure 3-3 |
| y | mm | < 0.5 (± 0.5) See Figure 3-3 |
| z | mm | 7 (± 1) See Figure 3-3 |

Table 3-3 provides the natural frequencies of the Imager (from 0 - 2000 Hz) when it is rigidly constrained at its four mounting points which is shown in Figure 4-2.

**Table 3-3: Natural Frequencies of the Imager from 0 – 2000 Hz**

| Mode Number | Frequency [Hz] |
|---|---|
| 1 | 684 |
| 2 | 705 |
| 3 | 800 |
| 4 | 854 |
| 5 | 891 |
| 6 | 996 |
| 7 | 1020 |
| 8 | 1072 |
| 9 | 1157 |
| 10 | 1587 |
| 11 | 1691 |
| 12 | 1718 |
| 13 | 1820 |
| 14 | 1839 |
| 15 | 1855 |
| 16 | 1933 |
| 17 | 1947 |
| 18 | 1997 |

Figure 3-3 presents the envelope dimensions of the Imager and indicates the position of the centre of mass relative to the OFE's mounting points.
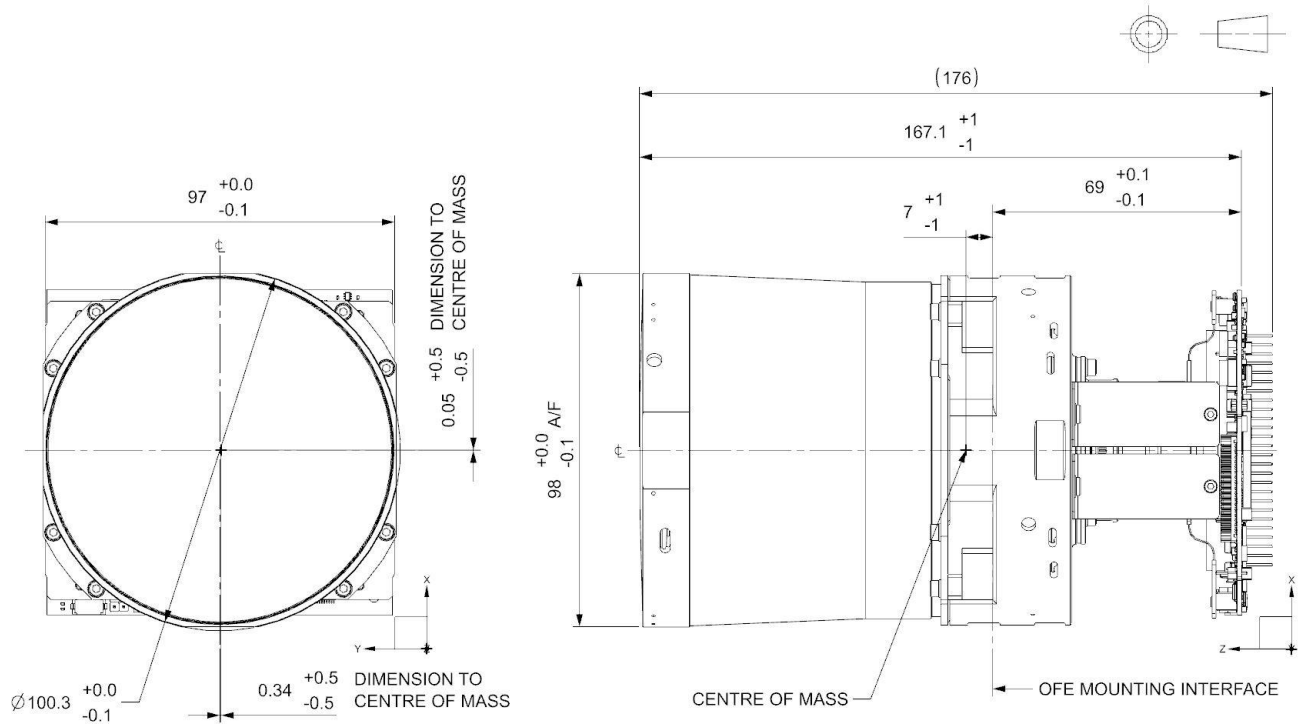


**Figure 3-3: Centre of Mass Position**

# 4. Description of System Interfaces

## 4.1 Interface Identification and Definition

The various interfaces between the Imager and the satellite components, as well as between the Imager and its environment, are shown graphically in Figure 4-1 below. The satellite components are herein defined as being all components which do not form part of the Imager and as such includes the satellite structure.

Note: For analysis purposes it is assumed that there is no thermal interface via the wiring harnesses.
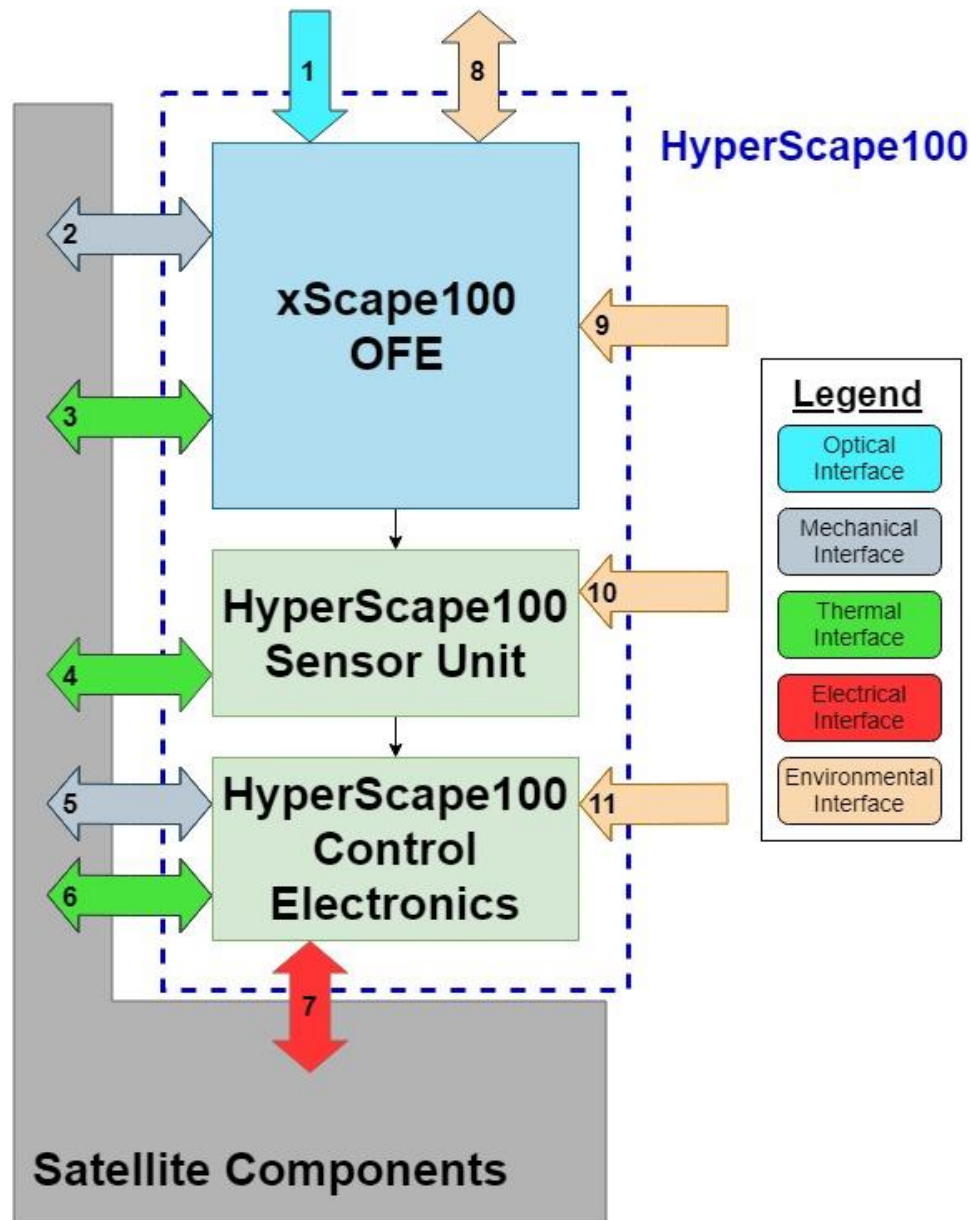


**Figure 4-1: Interface Identification Diagram**

The interfaces identified in Figure 4-1, are defined in Table 4-1 below. The descriptions of the interfaces are presented in the subsections following Figure 4-1.

**Table 4-1: Interface Definition**

| Interface Number | Interface Type | Interface From | Interface To |
|---|---|---|---|
| 1 | Optical | Target in View | xScape100 OFE |
| 2 | Mechanical | xScape100 OFE | Satellite Components |
| 3 | Thermal | xScape100 OFE | Satellite Components |
| 4 | Thermal | HyperScape100 Sensor Unit | Satellite Components |
| 5 | Mechanical | HyperScape100 Control Electronics | Satellite Components |
| 6 | Thermal | HyperScape100 Control Electronics | Satellite Components |
| 7 | Electrical (Power and Control) | Satellite Components | HyperScape100 Control Electronics |
| 8 | Environmental (Thermal Radiation) | xScape100 OFE | Environment |
| 9 | Environmental (Cosmic Radiation) | Environment | xScape100 OFE |
| 10 | Environmental (Cosmic Radiation) | Environment | HyperScape100 Sensor Unit |
| 11 | Environmental (Cosmic Radiation) | Environment | HyperScape100 Control Electronics |

## 4.2 Optical Interface

### 4.2.1 Interface 1: Target in View to xScape100 OFE

The xScape100 OFE has an optical interface at its front aperture with a diameter 95 mm and a full field of view of 2.96 degrees. The function of this interface is to enable the collection of electromagnetic radiation by the OFE. This optical interface shall remain unobscured during imaging to ensure optimal performance of the Imager.

## 4.3 Mechanical Interfaces

### 4.3.1 Interface 2: xScape100 OFE to Satellite Components

The OFE interfaces mechanically with the satellite structure via four threaded mounting points which are located on the OFE. The function of this interface is to secure the OFE to the applicable satellite components and act as the main structural support for the Imager.

The mating interface which is bolted to the OFE shall have four through holes with a diameter of 3.4 mm or larger. These through holes shall be spaced to match the hole spacing of the four M3 threaded holes (as shown in Figure 4-2) exactly and shall have a positional tolerance of 0.1 mm. In addition, all interfaces which mate directly to the mounting interface of the OFE shall have a flatness tolerance of 50 μm or smaller and shall have a N7 surface finish (this is equivalent to a surface finish with an average roughness of $R_a$ = 1.6 μm).

Caution shall be exercised during the assembly of any mechanics to the mounting interface of the OFE. Any mechanics which must be mounted to the OFE, shall first be secured to the OFE's mounting interface, only then shall the mechanics be joined to the rest of the satellite structure. This shall be done to ensure that the mounting surfaces of the OFE remain coplanar in the z-direction. Figure 4-2 provides the dimensions of the OFE's mounting interface.
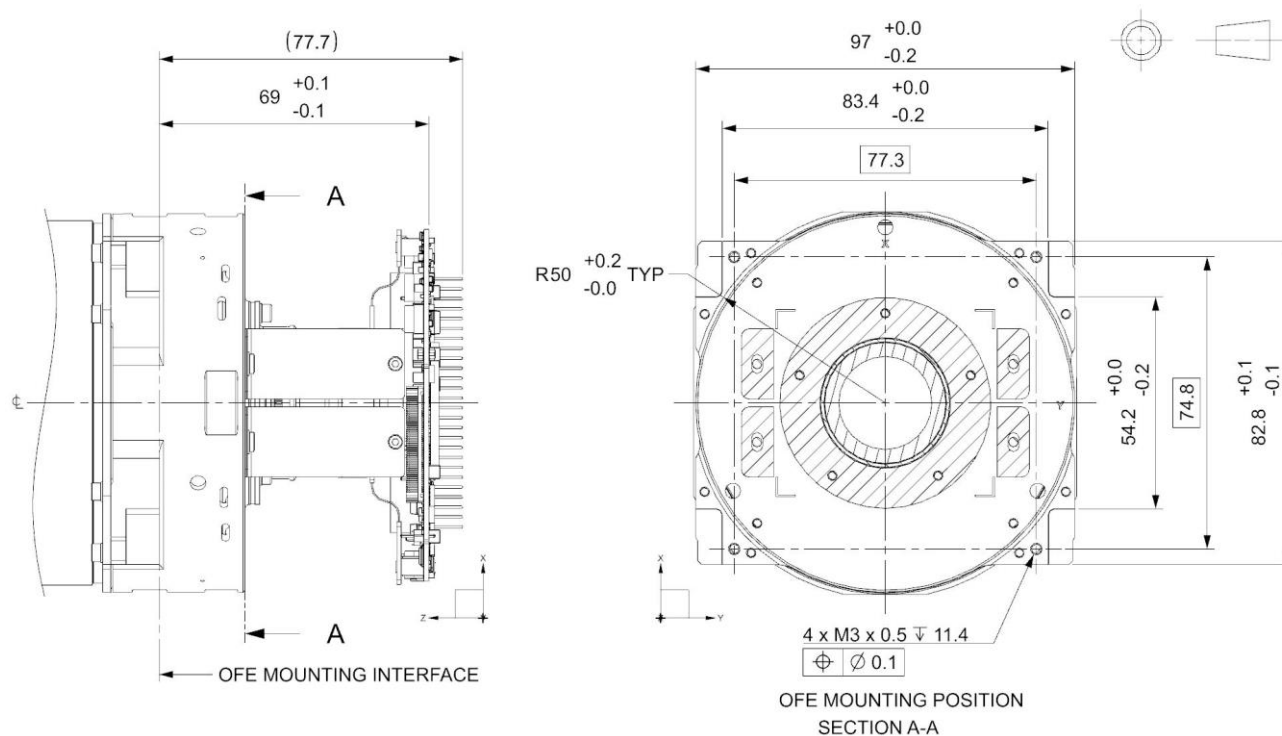


**Figure 4-2: OFE Mounting Interface Dimensions**

The details of the mounting interface are specified in Table 4-2 below.

**Table 4-2: OFE Mounting Interface Specifications**

| Description | Value |
|---|---|
| Interface Material | Titanium Grade 5 (Ti-6Al-4V) |
| Interface Surface Finish | Bare Ti-6Al-4V, N7 surface finish |
| Flatness | <20 μm |
| Number of Mounting Locations | 4 |
| Thread Specification | M3 x 0.5 (see Figure 4-2) |
| Depth of Thread Supplied in OFE | 11.4 mm |
| Fastener Torque (for stainless steel A4-70 fastener material). All fasteners shall be staked using Scotch Weld EC2216 adhesive or equivalent. | 1 Nm |

### 4.3.2 Interface 5: HyperScape100 Control Electronics to Satellite Components

The HyperScape100 Control Electronics (CE) interfaces mechanically with the satellite components through the four mounting holes located on the edges of the printed circuit board (PCB). These four mounting holes are through holes in the PCB and their spacing conforms to the PC-104 standard. The function of this interface is to secure the PCB to the applicable satellite component and act as main structural support for the CE. Figure 4-3 displays the dimensions of the CE PCB, as well as the height of the components on both sides of the PCB.
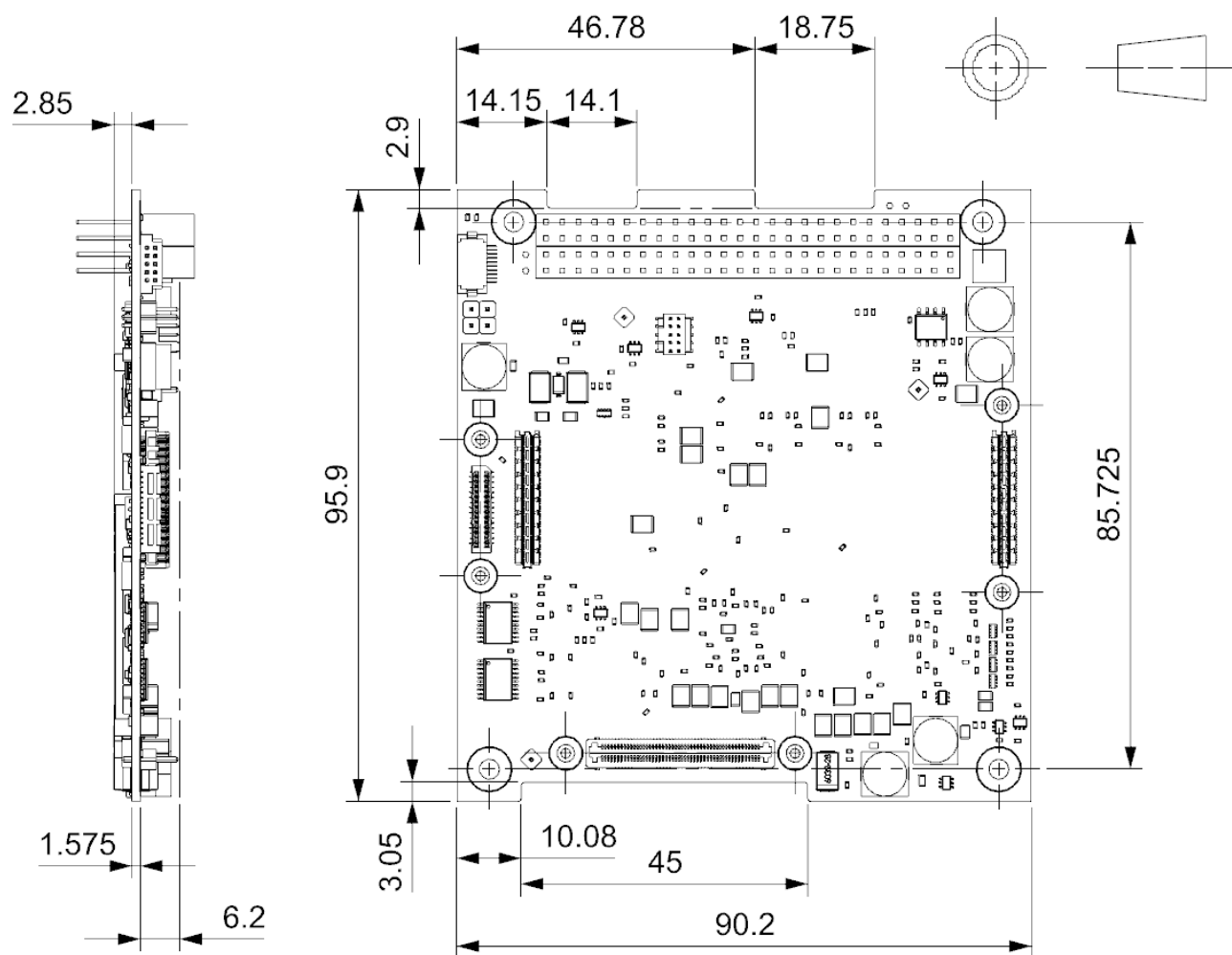
**Figure 4-3: CE Mechanical Drawing**

In Figure 4-4 below, the mounting details of the CE, as well as of the high-speed connector on the CE PCB are shown in more detail.
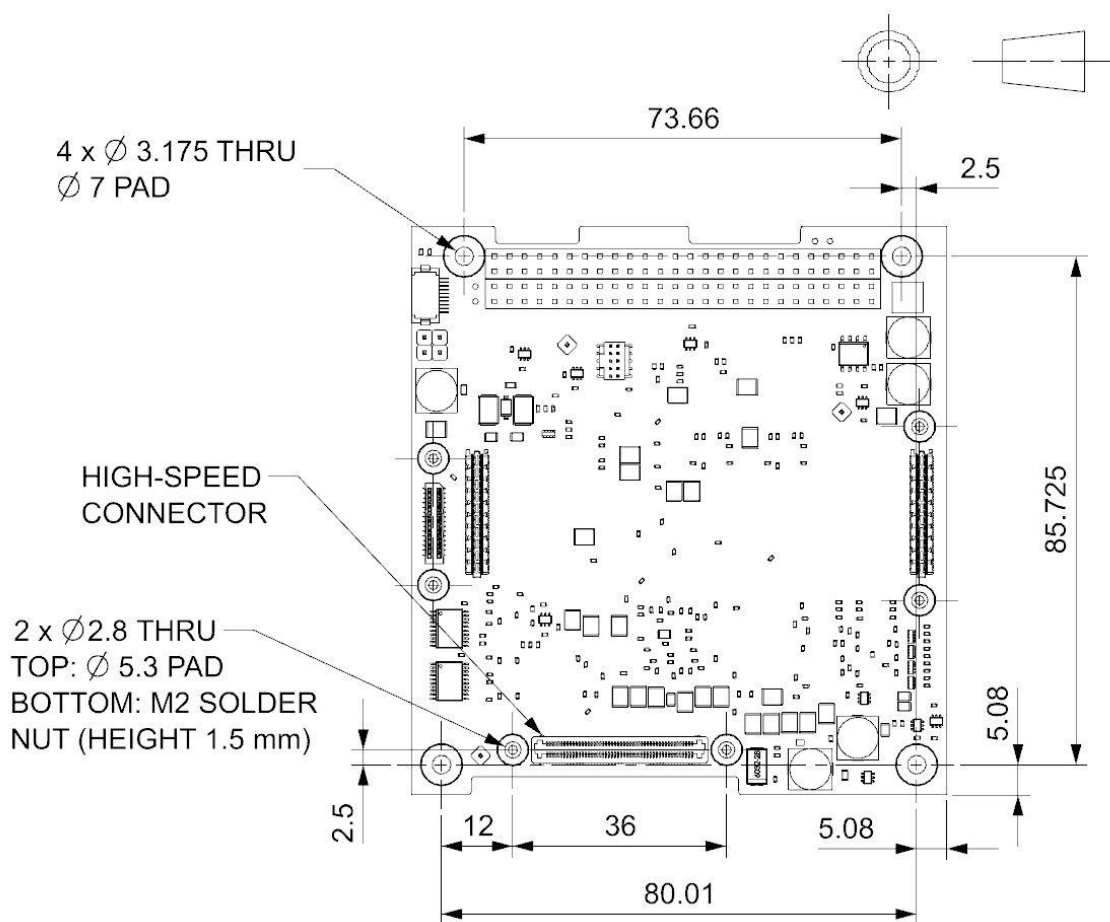
**Figure 4-4: CE and High-Speed Connector Mounting Hole Details**

Figure 4-5 shows the mounting position of the CE relative to the OFE.
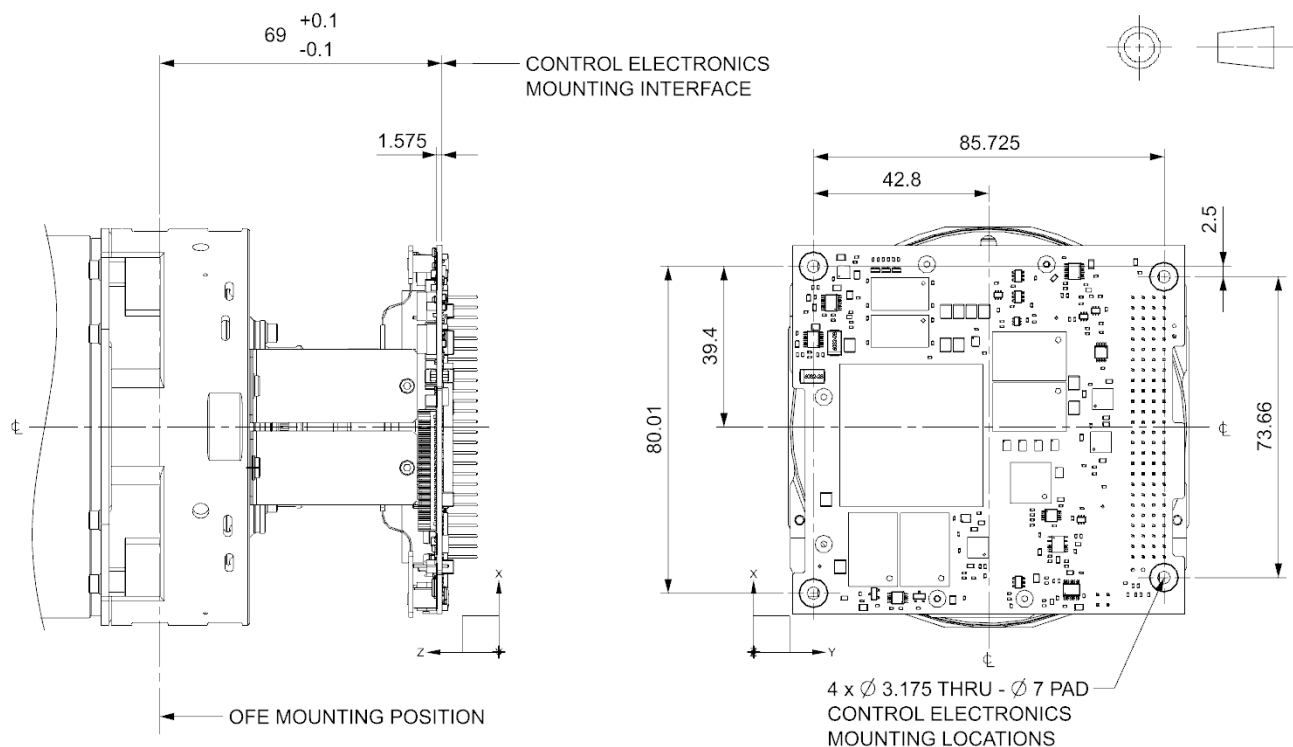


**Figure 4-5: CE Mounting Position Relative to OFE**

## 4.4 Thermal Interfaces

### 4.4.1 Interface 3: xScape100 OFE to Satellite Components

The mounting interface between the OFE and applicable satellite components facilitates heat transfer through thermal conduction between the OFE and the satellite components. In addition, thermal energy is also exchanged (by means of radiation) between the OFE and the surrounding satellite components. No specific requirement is placed on the amount of energy transmitted via conduction and radiation.

### 4.4.2 Interface 4: HyperScape100 Sensor Unit to Satellite Components

Thermal energy is exchanged by means of radiation between the HyperScape100 Sensor Unit and the surrounding satellite components. No specific requirement is placed on the amount of energy transmitted via radiation.

### 4.4.3 Interface 6: HyperScape100 Control Electronics to Satellite Components

The mounting points of the CE facilitates heat transfer through thermal conduction between the CE and the surrounding satellite components. In addition, thermal energy is also exchanged (by means of radiation) between the CE and the surrounding satellite components. No specific requirement is placed on the amount of energy transmitted via conduction and radiation.

## 4.5 Electrical Interfaces

### 4.5.1 Interface 7: Satellite Components to HyperScape100 Control Electronics

This interface consists of a single or of multiple electrical connector(s) to act as interface between the CE and the applicable satellite component(s). The function of this interface is to transmit power, control and data to and from the CE.

#### 4.5.1.1 PC-104 Interface

The CE supports a CubeSat Kit Bus compatible PC-104 header and its pin description is given in Figure 4-6.

**H1**

| | | | Pin | Pin | | | |
|---|---|---|---|---|---|---|---|
| | CANL * | IO0 | 1 | 2 | IO1 | | |
| | CANH * | IO2 | 3 | 4 | IO3 | PowerCtrl | LVDS6- |
| LVDS6+ | PowerCtrl | IO4 | 5 | 6 | IO4 | PowerCtrl | LVDS6+ |
| LVDS7+ | PowerCtrl | IO5 | 7 | 8 | IO5 | PowerCtrl | LVDS7+ |
| LVDS7- | PowerCtrl | IO6 | 9 | 10 | IO6 | PowerCtrl | LVDS7- |
| LVDS3- | PowerCtrl | IO7 | 11 | 12 | NC | | |
| LVDS3+ | PowerCtrl | IO8 | 13 | 14 | IO8 | PowerCtrl | LVDS3+ |
| | PowerCtrl | IO9 | 15 | 16 | IO9 | PowerCtrl | |
| | | IO10 | 17 | 18 | IO10 | | |
| | | IO11 | 19 | 20 | IO11 | | |
| | SCL | IO12 | 21 | 22 | IO12 | | |
| | SDA | IO13 | 23 | 24 | IO13 | | |
| | | NC | 25 | 26 | NC | | |
| | | NC | 27 | 28 | NC | | |
| LVDS5- | | IO14 | 29 | 30 | IO15 | | |
| | | IO16 | 31 | 32 | IO17 | LVDS5+ | |
| | | IO18 | 33 | 34 | NC | | |
| LVDS2- | | IO19 | 35 | 36 | NC | | |
| | | NC | 37 | 38 | NC | | |
| LVDS2+ | | IO20 | 39 | 40 | IO21 | | |
| | SDA | IO22 | 41 | 42 | NC | | |
| | SCL | IO23 | 43 | 44 | NC | | |
| | | NC | 45 | 46 | NC | | |
| | | 5V | 47 | 48 | NC | | |
| | | 5V | 49 | 50 | NC | | |
| | | 5V | 51 | 52 | NC | | |

**H2**

| | | | Pin | Pin | | | |
|---|---|---|---|---|---|---|---|
| | | NC | 1 | 2 | NC | | |
| | | NC | 3 | 4 | NC | | |
| | | NC | 5 | 6 | NC | | |
| | | NC | 7 | 8 | NC | | |
| | | NC | 9 | 10 | NC | | |
| | | NC | 11 | 12 | NC | | |
| | | 5V | 13 | 14 | NC | | |
| | | 5V | 15 | 16 | 5V | | |
| LVDS4- | PowerCtrl | IO24 | 17 | 18 | IO24 | PowerCtrl | LVDS4- |
| LVDS4+ | PowerCtrl | IO25 | 19 | 20 | IO25 | PowerCtrl | LVDS4+ |
| | | IO26 | 21 | 22 | IO26 | | |
| | | NC | 23 | 24 | NC | | |
| | | 5V | 25 | 26 | 5V | | |
| | | NC | 27 | 28 | NC | | |
| | | GND | 29 | 30 | GND | | |
| | | NC | 31 | 32 | GND | | |
| | | NC | 33 | 34 | NC | | |
| | | NC | 35 | 36 | NC | | |
| | | NC | 37 | 38 | NC | | |
| | | NC | 39 | 40 | NC | | |
| | | NC | 41 | 42 | NC | | |
| | | NC | 43 | 44 | NC | | |
| | | NC | 45 | 46 | NC | | |
| LVDS1- | RS422 A RX | IO27 | 47 | 48 | IO28 | RS422 A TX | |
| | RS422 B RX | IO29 | 49 | 50 | IO30 | RS422 B TX | LVDS1+ |
| | | NC | 51 | 52 | NC | | |

**Figure 4-6: CubeSat Kit Bus Compatible PC-104 Header Schematic**

The pins labelled '*NC*' are not connected on the CE. The rest of the pins are not connected by default and are configured through the product configuration sheet if and how they are connected. All pins labelled 'IOn' can be routed directly to a 3.3 V FPGA IO bank if their secondary function is not used. Those labelled 'LVDSn±' are routed differentially and can therefore be used as LVDS pairs. The 'IOn' pins can be used for SPI interfaces, or high speed LVDS point-to-point interfaces, or hard telecommands.

### 4.5.1.2 Power Interface

The CE requires a Direct Current (DC) supply regulated at 5 V ± 10% at a current of at least 1.5 A. The nominal Beginning of Life (BOL) DC current consumption for the different modes in the operational state is given in Table 4-3.

**Table 4-3: Imager BOL Power Consumption**

| Operational Mode | Imager Current Consumption at 5 V nominal supply voltage | Imager Power Consumption |
|---|---|---|
| Idle Mode | 500 mA | 2.5 W |
| Imaging Mode | 1200 mA | 6.0 W |
| Readout Mode | 500 mA | 2.5 W |

The 5 V supply must be supplied by one, or a combination, of H1.47, H1.49, H1.51, H2.13, H2.15, H2.16, H2.25, and H2.26, depending on the selections made in the product configuration sheet. The ground connection is made by one, or a combination, of H2.29, H2.30, and H2.32.

The CE has an optional power switch onboard that can be used to switch power to the Imager on. This may be used if the 5 V supplied to the CE is not switched. If this power switch is selected in the product configuration sheet, its control line "PowerCtrl" can be routed to one, or a combination, of H1.4, H1.5, H1.6, H1.7, H1.8, H1.9, H1.10, H1.11, H1.13, H1.14, H1.15, H1.16, H2.17, H2.18, H2.19 or H2.20, depending on the selections made in the product configuration sheet. The "PowerCtrl" control signal is active high. To turn on the CE, the "PowerCtrl" control signal must be driven high by applying a voltage between 2.5 V and 5.0 V for at least 100 ms.

The "PowerCtrl" signal may optionally be used to power the CE off (as well as on). If this option is selected the Imager can be turned off by driving "PowerCtrl" low to between 0 V and 0.5 V for at least 100 ms. This option can be enabled in the product configuration sheet. If this option is selected, the CE will power-cycle itself in the event of a radiation induced overcurrent condition.

The "PowerCtrl" signal may optionally be latched onboard the CE. If this option is enabled, the "PowerCtrl" signal may be deasserted after the CE has switched on which enables the CE to turn the Imager completely off in the event of a radiation induced overcurrent condition. This option can be enabled in the product configuration sheet. An unused "IOn" signal may be used as feedback and will be driven high when the imager is powered on and pulled to GND when the imager is turned off.

### 4.5.1.3 Control Interface

This interface is used to control the CE and receive telemetry from the CE. The control interface can be I$^2$C or SPI and provides access to 32-bit registers. As such the control interface transfers are always 4 bytes long. The paragraphs that follow provide more information on the physical interface layers.

**I$^2$C Interface**

The CE implements an I$^2$C slave interface. Refer to [2] for the I$^2$C-bus specification. The CE supports Standard-mode and Fast-mode as defined in [2]. Depending on the selections made in the product configuration sheet, the I$^2$C Interface can operate at either 3.3 V or 5 V voltage levels and supports 7-bit slave addressing. Each transfer always contains 4 data bytes.

The SCL signal can be routed to either H1.21 or H1.43 and the SDA signal to either H1.23 or H1.41 depending on the selections made in the product configuration sheet. The SCL and SDA signals can optionally be pulled up to the bus voltage (3.3 V or 5 V as configured) if enabled in the product configuration sheet.

The I$^2$C slave address is taken from the product configuration sheet.

**SPI Interface**

The CE implements a 3.3 V logic compatible SPI slave interface which consists of four signals. These four signals can be routed to any open "IOn" pin on the PC-104 Interface as defined in 4.5.1.1. The four SPI signals are:

- nSEL – Active low select signal generated by the master to select the slave interface. When not active (high) the SPI interface is not selected and placed in its reset state. All communication is initiated by the master first driving this nSEL signal low. It is kept low for the duration of the communication. It has a weak (± 20 kΩ) pullup resistor to 3.3 V.

- MOSI - Master Out Slave In signal is the data output of the master. It has a weak (± 20 kΩ) configurable pullup/pulldown resistor to 3.3 V/GND.

- MISO – Master In Slave Out is the data output of the slave. It has a weak (± 20 kΩ) pullup resistor to 3.3 V.

- SCK – The serial clock signal driven by the master. It has a weak (± 20 kΩ) pulldown resistor to GND. The maximum clock rate is 10 MHz.

The SPI interface conforms to the SPI standard "00" (clock polarity '0', clock phase '0'). As such the values on the MOSI and MISO lines are valid at the rising edge of SCK and remain valid until the next SCK shift edge. Refer to Figure 4-7 for the timing diagram.
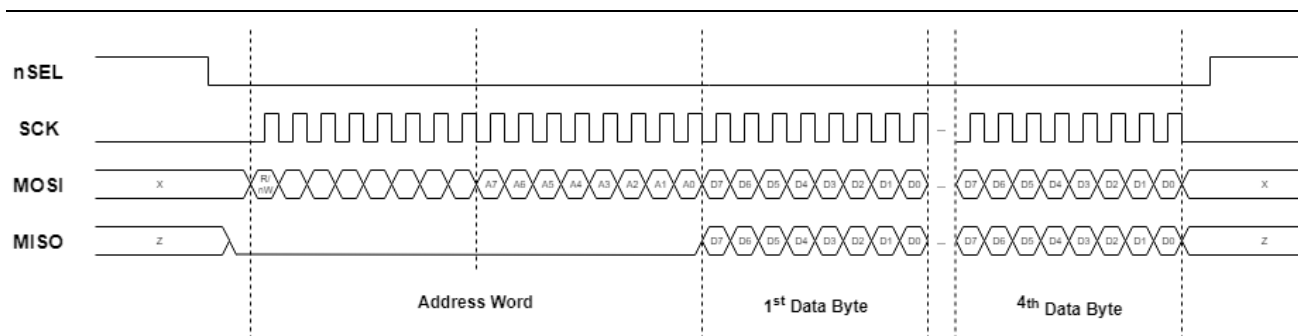
**Figure 4-7: SPI Interface Timing Diagram**

A transfer is initiated by the Address Word (16 bits) which specifies a read or write action as well as the register address. The CE echo's the received action and command bits on its MISO output while the master outputs them on the MOSI line. One or more bytes of data follows the command byte during which the CE MISO output may toggle depending on the action and command.

#### 4.5.1.3.2 Connector Details

Two Samtec SSQ/ESQ Series connectors are used, one each for H1 and H2. The PC-104 connector is optional, and its fitment and choice of connector depends on the selections made in the product configuration sheet. Instead of fitting the connectors, wires may be soldered directly into the pads instead with adjacent pads used as strain relief.

#### 4.5.1.4 High-Speed Data Interface

The CE provides a half-duplex bi-directional high-speed data interface consisting of up to eight LVDS pairs. The LVDS pairs are all bi-directional and are organised as shown in Table 4-4.

**Table 4-4: High-Speed Data Interface Signal Assignment**

| Pair No. | Name | Description |
|---|---|---|
| 1 | Clock | Clock to which data is synchronised |
| 2 | D0 | Data Lane 0 |
| 3 | D1 | Data Lane 1 (optional) |
| 4 | D2 | Data Lane 2 (optional) |
| 5 | D3 | Data Lane 3 (optional) |
| 6 | Sync/Valid | Signals first bit in transfer. Byte invalid if not asserted. |
| 7 | Flow Control | Return line to throttle data transfer (optional) |
| 8 | Reserved | |

The optional additional data lanes D1 to D3 allow faster transmission or they may be repurposed to implement full duplex communication. Data is transmitted most significant bit (MSB) first. The signal timing diagram is shown in Figure 4-8.
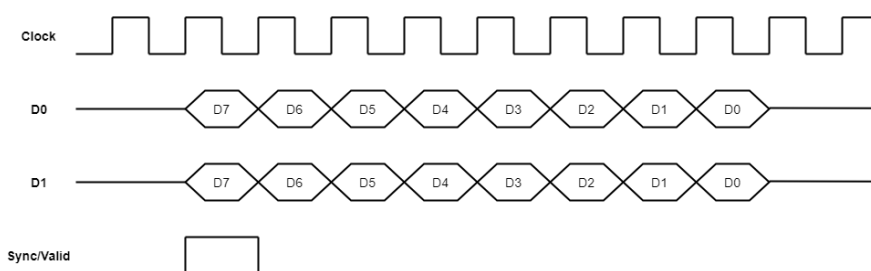
**Figure 4-8: High-Speed Data Interface Timing Diagram**

Transfers are always done in full bytes. The Sync/Valid signal indicates the MSB of the transfer. If it is not asserted at the beginning of the next byte, that transfer is deemed invalid and the byte transferred should be discarded. When multiple lanes are used, each lane transfers a full byte at the same time. The Sync/Valid signal is therefore applicable to all lanes.

The flow control signal is optional and can be used to throttle the data rate.

#### 4.5.1.4.1 Connector Details

A Samtec LSHM-150-03.0-L-DV-A-N connector is used. A rendering of the connector is shown in Figure 4-9.
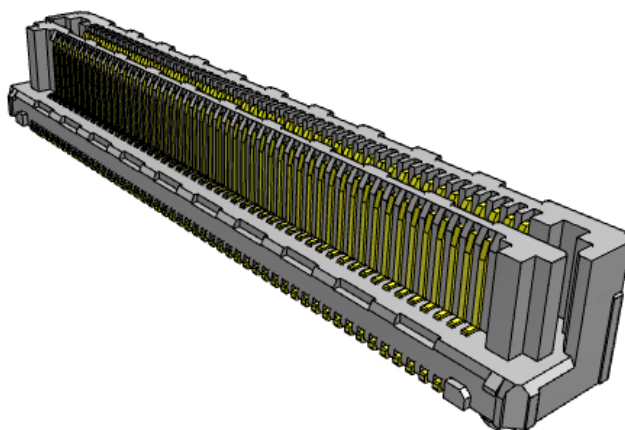


**Figure 4-9: High-Speed Data Connector**

The CE PCB has mounting holes either side of this connector that can be used to fasten the mating circuit to the CE. Details of the mounting holes are shown in Figure 4-4. The connector pinout is shown in Table 4-5. Do not connect to the pins labelled "Reserved". Pin 1 is located as per the recommended PCB layout prescribed by Samtec.

**Table 4-5: High-Speed Data Connector Pinout**

| Pin No. | Signal | | Pin No. | Signal |
|---|---|---|---|---|
| 1 | GND | | 2 | GND |
| 3 | Reserved | | 4 | Reserved |
| 5 | Reserved | | 6 | Reserved |
| 7 | GND | | 8 | GND |
| 9 | Reserved | | 10 | Reserved |
| 11 | Reserved | | 12 | Reserved |
| 13 | GND | | 14 | GND |
| 15 | Reserved | | 16 | Reserved |
| 17 | Reserved | | 18 | Reserved |
| 19 | GND | | 20 | GND |
| 21 | Reserved | | 22 | Reserved |
| 23 | Reserved | | 24 | Reserved |
| 25 | GND | | 26 | GND |
| 27 | Reserved | | 28 | Reserved |
| 29 | Reserved | | 30 | Reserved |
| 31 | GND | | 32 | GND |
| 33 | Reserved | | 34 | Reserved |
| 35 | Reserved | | 36 | Reserved |
| 37 | GND | | 38 | GND |
| 39 | Reserved | | 40 | Reserved |
| 41 | Reserved | | 42 | Reserved |
| 43 | GND | | 44 | GND |
| 45 | Reserved | | 46 | Reserved |
| 47 | Reserved | | 48 | Reserved |
| 49 | GND | | 50 | GND |
| 51 | Reserved | | 52 | Reserved |
| 53 | Reserved | | 54 | Reserved |
| 55 | GND | | 56 | GND |
| 57 | IO | | 58 | Pair0+ |
| 59 | Reserved | | 60 | Pair0- |
| 61 | GND | | 62 | GND |
| 63 | PairAux+ | | 64 | Pair1+ |
| 65 | PairAux- | | 66 | Pair1- |
| 67 | GND | | 68 | GND |
| 69 | Pair2+ | | 70 | Pair3+ |
| 71 | Pair2- | | 72 | Pair3- |
| 73 | GND | | 74 | GND |
| 75 | Pair4+ | | 76 | Pair5+ |
| 77 | Pair4- | | 78 | Pair5- |
| 79 | GND | | 80 | GND |
| 81 | Pair6+ | | 82 | Pair7+ |
| 83 | Pair6- | | 84 | Pair7- |

| Pin No. | Signal | | Pin No. | Signal |
|---------|--------|---|---------|--------|
| 85 | GND | | 86 | GND |
| 87 | GND | | 88 | GND |
| 89 | GND | | 90 | GND |
| 91 | Reserved | | 92 | Reserved |
| 93 | GND | | 94 | GND |
| 95 | Reserved | | 96 | Reserved |
| 97 | GND | | 98 | GND |
| 99 | Reserved | | 100 | Reserved |

#### 4.5.1.5   Earth Strap

All mounting holes on the CE are connected to each other and to GND through a single 22 ohm resistor to facilitate earth strapping.

## 4.6   Environmental Interfaces

### 4.6.1   Thermal Radiation Interface

#### 4.6.1.1   Interface 8: xScape100 OFE to Environment

The front aperture of the OFE exchanges heat through thermal radiation with the space environment at the aperture. The function of this interface is to transmit thermal energy between the OFE and the space environment by means of radiation.

### 4.6.2   Cosmic Radiation Interfaces

#### 4.6.2.1   Interface 9: Environment to xScape100 OFE

There is an interface between the space environment and the OFE through which cosmic radiation is transmitted to the OFE.

#### 4.6.2.2   Interface 10: Environment to HyperScape100 Sensor Unit

There is an interface between the space environment and the HyperScape100 Sensor Unit through which cosmic radiation is transmitted to the sensor unit.

#### 4.6.2.3   Interface 11: Environment to HyperScape100 Control Electronics

There is an interface between the space environment and the CE through which cosmic radiation is transmitted to the CE.

## 5. Environmental Requirements

### 5.1 Transportation

#### 5.1.1 Temperature

During transportation and in a non-operating condition the maximum temperature of the Imager assembly shall not exceed 50 degrees Celsius.

During transportation and in a non-operating condition the minimum temperature of the Imager assembly shall not be less than -10 degrees Celsius.

#### 5.1.2 Humidity

The humidity during transportation shall be less than 60%, non-condensing.

#### 5.1.3 Vibration

All handling operations shall limit static accelerations to the complete Imager assembly to less than 5 g in all directions.

#### 5.1.4 Shock

All handling operations shall limit shock exposure to the complete Imager assembly to less than 5 g maximum.

#### 5.1.5 Cleanliness

During transportation the Imager shall be kept in an environment with a cleanliness of at least International Organization for Standardization (ISO) level 8 as per ISO 14644-1:2015 standards.

### 5.2 Storage

During storage it will be assumed that the Imager will not be in motion, therefore vibration and shock loading conditions are not relevant. During storage the following conditions must be adhered to:

#### 5.2.1 Temperature

During prolonged storage and in a non-operating condition the maximum temperature shall not exceed 30 degrees Celsius.

During prolonged storage and in a non-operating condition the minimum temperature shall not be less than 10 degrees Celsius.

#### 5.2.2 Humidity

The humidity during prolonged storage shall be between 30% and 60%, non-condensing.

#### 5.2.3 Cleanliness

During prolonged storage the Imager shall be kept in an environment with a cleanliness of at least ISO level 8, as per ISO 14644-1:2015 standards, or better.

## 5.3 Assembly, Integration and Testing

All Assembly, Integration and Testing (AIT) procedures must be performed in an ISO class 8 cleanroom, as per ISO 14644-1:2015 standards, or equivalent. In addition, during AIT the following conditions shall always be adhered to:

### 5.3.1 Vibration

All handling operations shall limit static accelerations to the complete Imager assembly to less than 5 g in all directions.

### 5.3.2 Shock

All handling operations shall limit shock exposure to the complete Imager assembly to less than 5 g maximum.

### 5.3.3 Mechanical Interface with OFE

During all assembly and integration procedures, all mechanical mating interfaces with the OFE shall cause zero relative displacement (in the x and y directions) between any of the OFE's four mounting points.

## 5.4 In-Orbit

### 5.4.1 Survivable Temperature

In order to ensure survival, the maximum temperature of the Imager shall not be greater than 65 degrees Celsius and the minimum temperature shall not be less than -25 degrees Celsius.

### 5.4.2 Operating Temperature

During operation the maximum temperature of the Imager shall not exceed 50 degrees Celsius and the minimum temperature shall not be less than -10 degrees Celsius.

### 5.4.3 Operating Temperature Gradients

During operation the maximum axial temperature gradient over the OFE shall not be greater than 3 degrees Celsius.

During operation the maximum transverse temperature gradient over the OFE shall not be greater than 2 degrees Celsius.

### 5.4.4 Outgassing of Satellite Components

Material used in satellite components, which are near the Imager, shall have a maximum Total Mass Loss (TML) of less than 1.0% and a maximum Collected Volatile Condensable Material (CVCM) of less than 0.10%. Refer to [1] for a list of material TML and CVCM data.

## Contact Us

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