xScape100 Optical Front-End

Interface Control Document

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Controlled document note: It is the user's responsibility to verify that the version of any printed documentation matches the configuration controlled version.

Document History

Revision	Date	Details
1	2019-04-25	First formal release of document
2	2019-07-30	Updated: Table 3-2, Figure 3-3, Figure 4-2, Figure 4-3. Updated Section 4.2.2.
3	2019-07-30	Updated document number

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List of Abbreviations

Abbreviation	Description
AIT	Assembly, Integration and Testing
CVCM	Collected Volatile Condensable Material
FFD	Flange Focal Distance
ISO	International Organization for Standardization
OFE	Optical Front-End
TML	Total Mass Loss

1. Introduction

1.1 Identification

Item Description: xScape100 Optical Front-End

Simera Item Number: SS100-027898

1.2 Intended Use

This document describes the interfaces and environmental conditions of the xScape100 Optical Front-End.

1.3 Context and Summary

The xScape100 Optical Front-End is an optical system 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 xScape100 Optical Front-End can also be used as part of larger satellite systems.

This Interface Control Document identifies, defines and describes the interfaces between the xScape100 Optical Front-End and the surrounding satellite components, as well as between the xScape100 Optical Front-End and its environment.

2. Applicable Documents

Table 2-1 lists documents that are applicable, to the extent stated herein. In the event of conflict between the contents of the applicable documents and this document, the applicable documents shall take precedence.

Table 2-1: Applicable Documents

Ref. #	Doc No [Revision/Date]	Document Title
[1]	https://outgassing.nasa.gov/ [Accessed: 24/10/2018]	Outgassing Data for Selecting Spacecraft Materials [Online]

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 xScape100 Optical Front-End captures electromagnetic radiation and focuses the radiation on its image plane. The xScape100 Optical Front-End typically forms part of the payload subsystem of a satellite and is shown in the context of a typical CubeSat diagram in Figure 3-1 below.

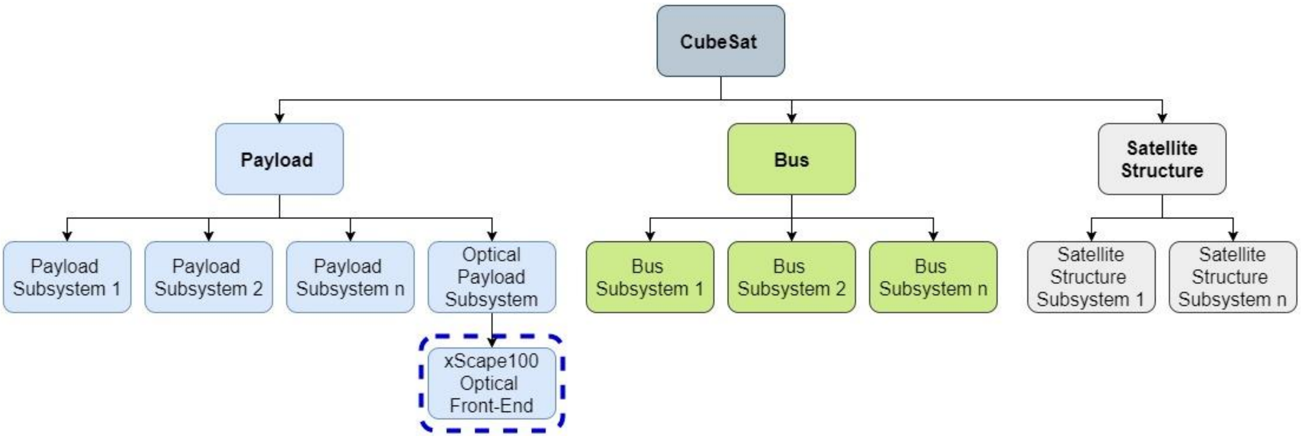

Figure 3-1: Typical CubeSat System Diagram

3.1 Physical Description

The xScape100 Optical Front-End consists of several mechanical and optical components. Table 3-1 provides a functional description of the Optical Front-End and some select mechanical components.

Table 3-1: System and Component Functional Description

ID	Optical Front-End/Components	Primary Functions
1	xScape100 Optical Front-End	Focuses the collected electromagnetic radiation onto an imaging plane
1.1	Main Body Lower	Provides the mechanical mounting interface which acts as main structural support for the Optical Front-End.
1.2	Focal Plane Component	Provides the mechanical interface which acts as main structural support for mounting of the sensor mechanics.

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

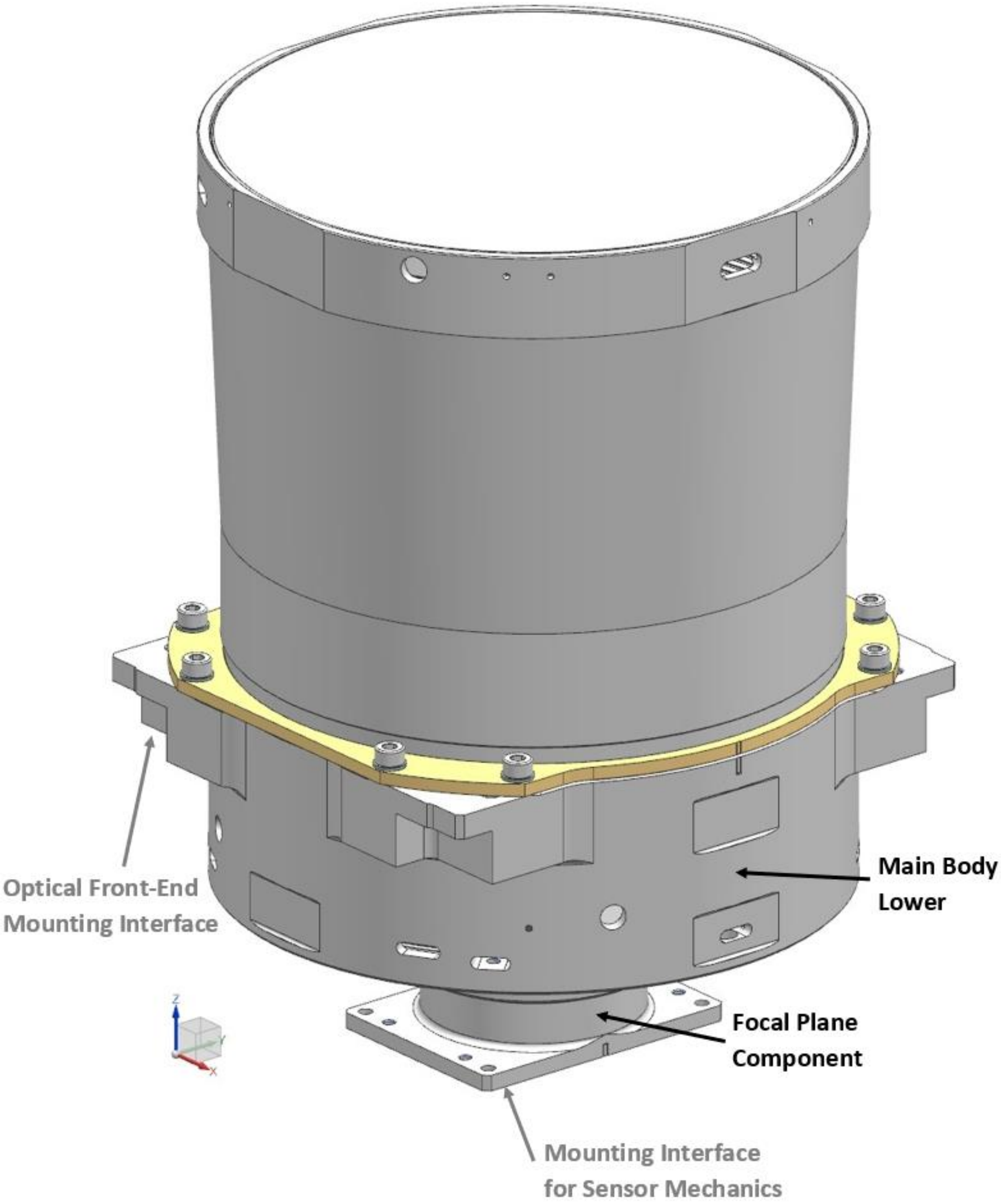

Figure 3-2: xScape100 Optical Front-End with Axis Definition

3.2 Physical Properties

The physical properties of the xScape100 Optical Front-End (OFE) 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. Figure 3-3 presents the envelope dimensions of the OFE and indicates the position of the centre of mass relative to the OFE's mounting points.

Table 3-2: Physical Properties

Property	Unit	Value
Mass	kg	0.94 (± 3%)
Moments of Inertia		
I_{xx}	kg.m^2	2.90E-03 (± 3%)
I_{yy}	kg.m^2	2.87E-03 (± 3%)
I_{zz}	kg.m^2	1.37E-03 (± 3%)
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	21 (± 1) See Figure 3-3

Table 3-3 provides the first ten natural frequencies of the OFE when it is rigidly constrained at its four mounting points which is shown in Figure 4-2.

Table 3-3: First Ten Natural Frequencies of the OFE

Mode Number	Frequency [Hz]
1	891
2	1013
3	1549
4	1556
5	1558
6	1897
7	1941
8	2166
9	2242
10	2460

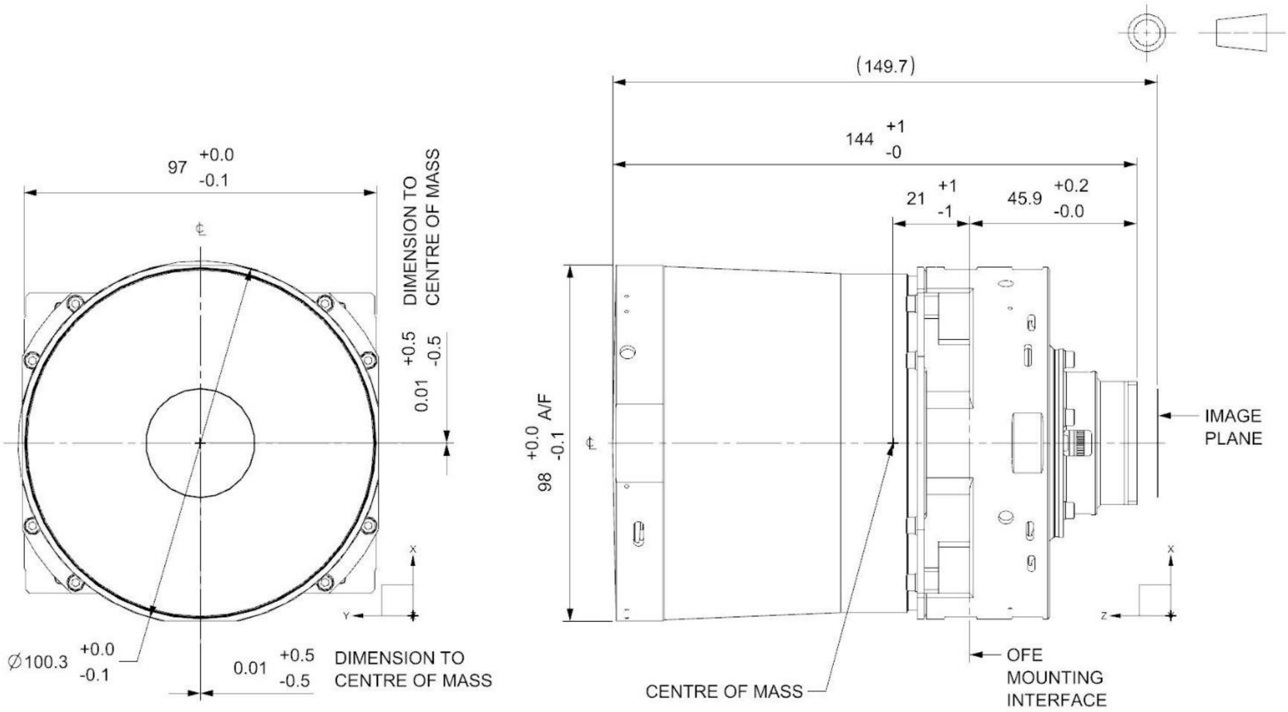

Figure 3-3: Centre of Mass Position

4. Description of System Interfaces

4.1 Interface Identification and Definition

The various interfaces between the OFE and the satellite components, as well as between the OFE 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 OFE and as such also includes the imaging sensor, as well as the satellite structure.

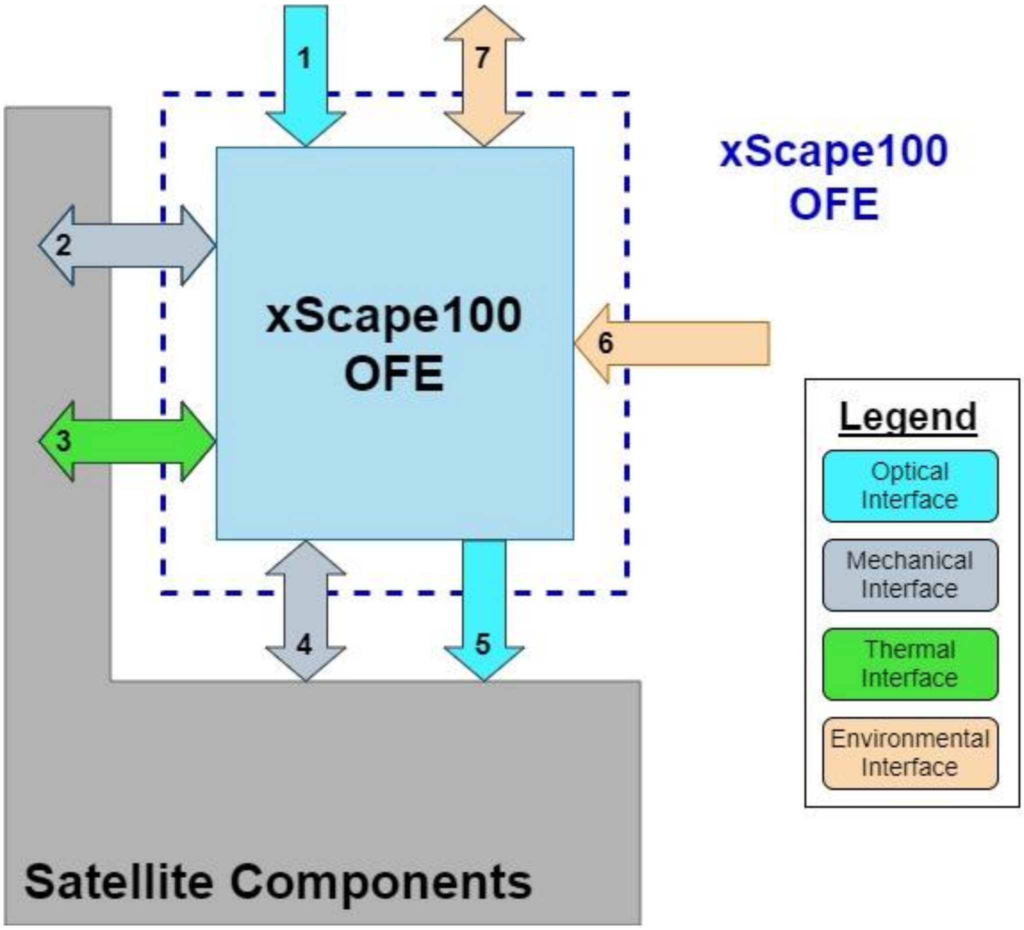

Figure 4-1: Interface Identification Diagram

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 Table 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	Mechanical	xScape100 OFE	Satellite Components
5	Optical	xScape100 OFE	Satellite Components
6	Environmental (Cosmic Radiation)	Environment	xScape100 OFE
7	Environmental (Thermal Radiation)	xScape100 OFE	Environment

4.2 Optical Interfaces

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.

4.2.2 Interface 5: xScape100 OFE to Satellite Components

The xScape100 OFE has an optical interface with a Flange Focal Distance (FFD) of 5.69 mm (± 0.3 mm) and an image circle diameter of 30 mm. The collected electromagnetic radiation passes via this interface and is focussed onto the image plane. Refer to Figure 4-2 for the position of the image plane relative to the OFE.

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 OFE.

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 or smoother 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 interfaces 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.

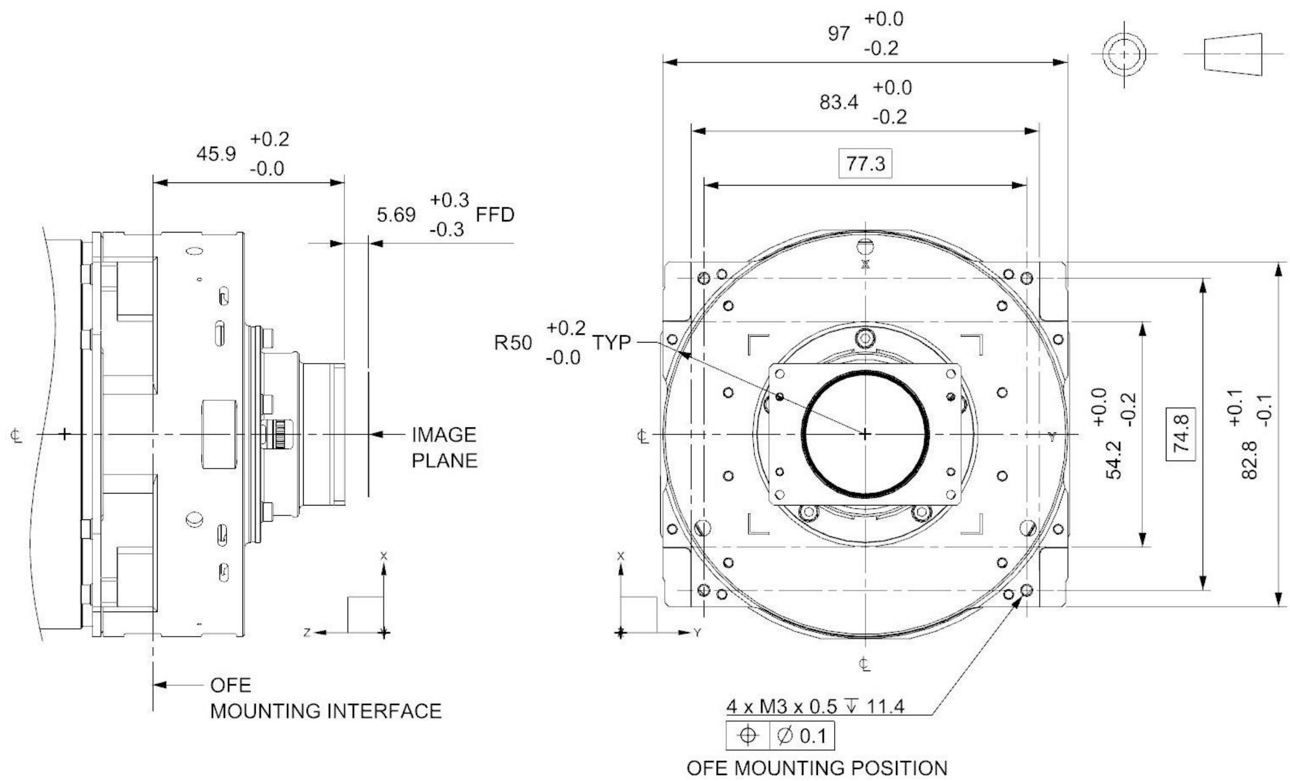

Figure 4-2: OFE Mounting Interface Details

The specifications of the OFE's mounting interface are provided 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 4: xScape100 OFE to Satellite Components

The OFE offers a mechanical interface for mounting of the sensor mechanics. The sensor mechanics shall be secured to the OFE via the four through holes with a diameter of 2.2 mm and spacing as shown in Figure 4-3. The sensor support mechanics shall be manufactured using grade 5 (Ti-6Al-4V) titanium to ensure athermal behaviour of the OFE over the operating temperature range specified in section 5.4.2.

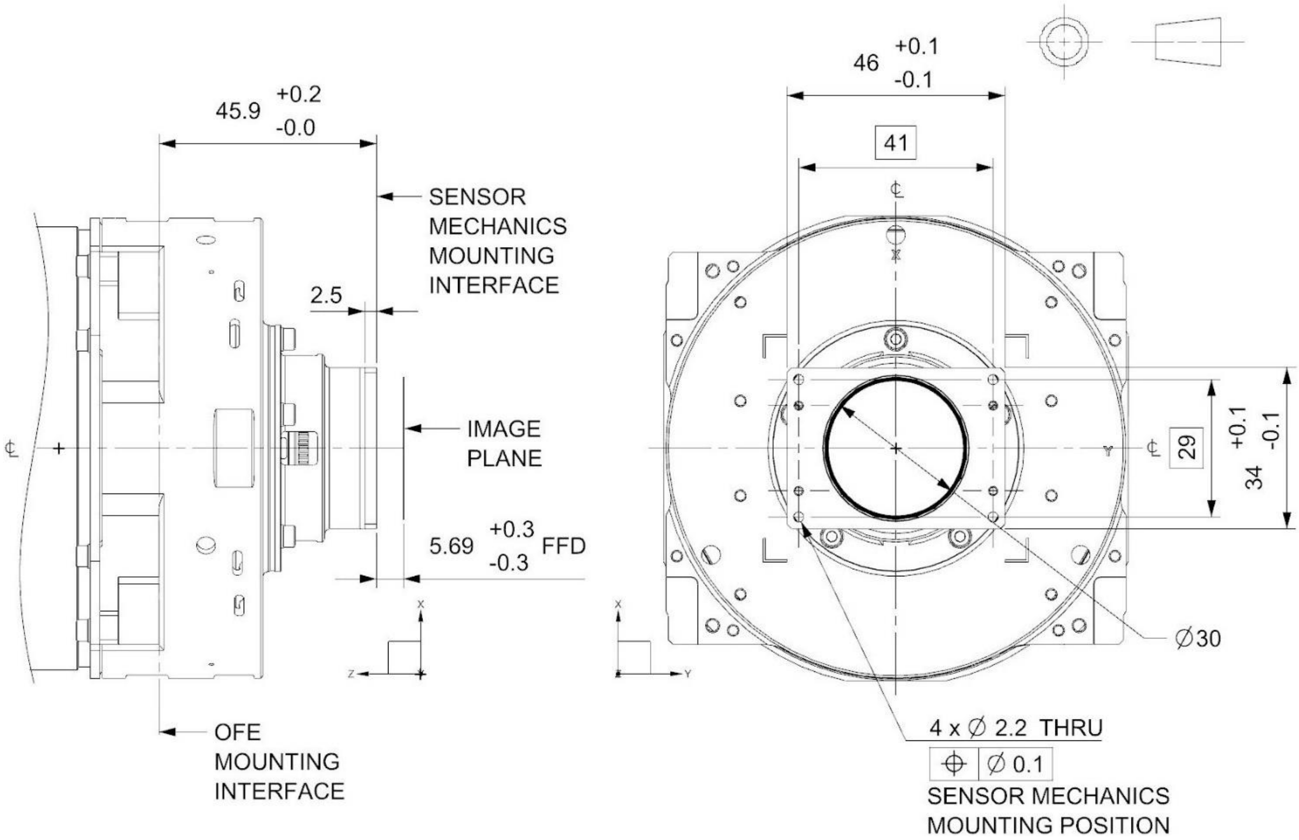

Figure 4-3: Mechanical Interface to Sensor Mechanics

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.

4.5 Environmental Interfaces

4.5.1 Cosmic Radiation Interfaces

4.5.1.1 Interface 6: Environment to OFE

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

4.5.2 Thermal Radiation Interface

4.5.2.1 Interface 7: OFE to Environment

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

5. Environmental Requirements

5.1 Transportation

5.1.1 Temperature

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

During transportation and in a non-operating condition the minimum temperature of the OFE 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 OFE to less than 5 g in all directions.

5.1.4 Shock

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

5.1.5 Cleanliness

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

5.2 Storage

During storage it is assumed that the OFE will not be in motion, therefore vibration and shock loading conditions are not relevant. During storage the following conditions shall 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 OFE shall be kept in an environment with a cleanliness of 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 shall be performed in an ISO class 8 cleanroom, as per ISO 14644-1:2015 standards, or better. 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 OFE assembly to less than 5 g in all directions.

5.3.2 Shock

All handling operations shall limit shock exposure to the complete OFE 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 OFE 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 OFE 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 OFE, 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.

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