CUBESPACE

Interface Control Document

CubeStar CT M2.1E5.3

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Revision History

Version	Authors	Date	Description
1.00	C. Leibbrandt	28/08/2023	First published version
1.01	A. Scholtz	24/02/2025	Common ICD changes implemented. New document number assigned.

Reference Documents

The following documents are referenced in this document.

[RD1] CS-DEV.PD.CT-01 CubeStar Product Description Ver.1.00 or later

[RD2] CS-DEV.UM.CT-01 CubeStar User Manual Ver.1.03 or later

[RD3] CS-DEV.ETP.CA-01 Generic Environmental Test Plan Ver.1.05 or later

[RD4] CS-DEV.FRM.CA-01 CubeProduct Firmware Reference Manual Ver 7.02 or later

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List of Acronyms/Abbreviations

ADCS	Attitude Determination and Control System
AWG	American Wire Gauge
CAN	Controller Area Network
CoM	Centre of Mass
CT	CubeStar
EM	Engineering Model
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESL	Equivalent Series Inductance
FM	Flight Model
ICD	Interface Control Document
MoI	Moments of Inertia
MCU	Microcontroller Unit
OBC	On-board Computer
PCB	Printed Circuit Board
PTFE	Polytetrafluoroethylene
QSPI	Quad Serial Peripheral Interface
RF	Radio Frequency
SPI	Serial Peripheral Interface
SRAM	Static Random-Access Memory
UART	Universal Asynchronous Receiver/Transmitter

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1. Introduction

The purpose of this document is to provide information on how to correctly interface with CubeStar. This includes communications, power requirements, mechanical mounting and axes definitions, as well as guidelines on EMI/EMC compatibility. It is assumed that the reader is already familiar with the relevant product description document [RD1]. Details regarding environmental qualification, and a declared materials list, are available to clients upon request.

CubeSpace cannot guarantee nominal operation of CubeStar if the specifications provided in this document are not adhered to.

This version of the ICD applies to the products and hardware versions described in Table 1.

Table 1: Document Applicability

Version	Notes
M2.0E5.3	Alodine conversion coating (gold) With or without the standard 120° baffle mounted
M2.1E5.3	SurTec 650 conversion coating (silver) With or without the standard 120° baffle mounted

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2. Electrical Interface

2.1 Communication Interfaces

2.1.1 CAN Characteristics

Table 2: CAN Bus Characteristics

Parameter	Value
Supported CAN standard	V2.0B
Supported bit rate	1 Mbit/s
Supported protocols	CubeSpace CAN Protocol, CubeSat Space Protocol (CSP)
Default CAN address	4 (configurable)
CAN termination	2 kΩ

2.1.2 UART and RS485 Characteristics

Table 3: UART/RS485 Characteristics

Parameter	Value
Maximum supported baud rate	921600 (configurable)
Data bits	8
Parity	None
Stop bits	1
RS485 address	1 (configurable)
RS485 termination	1 kΩ

RS485 communication can be selected as a custom option and must be specified by the client when placing the order.

When RS485 is selected, the UART interface will not be available.

2.1.3 Boot Line

CubeStar implements a boot line to enable access to the MCU's low-level ROM bootloader. It is used by CubeSpace to initially flash the CubeSpace software bootloader to the MCU, which is thereafter used for uploading flight software. This boot line pin may be left unconnected, however it is recommended to connect it to the ADCS/OBC as a recovery method in case the software bootloader needs to be updated or re-flashed.

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Due to hardware restrictions, the software bootloader cannot be upgraded or re-flashed over RS485.

2.2 Power Interface

Typical power consumption characteristics for CubeStar are independent of satellite size or the ADCS mode being used.

Table 4: Power Consumption on 3.3 V Line

Parameter	Value	Notes
Average current	50 mA	Measured over a 1-second loop.
Average power	165 mW	
Maximum current	82 mA	
Maximum power	271 mW	
Inrush current	180 mA	
Inrush current duration	1800 µs	

2.2.1 Enable Line

CubeStar implements an externally controlled enable line to power on the device. The enable line is active-high and should be controlled by the client ADCS/OBC.

2.2.2 3.3 V Power Switch

CubeStar implements an input power switch on the 3.3 V line that is enabled by pulling the enable line high. The power switch also provides a current limit of 400 mA to protect against latch-up events. Under- and overvoltage protection is also implemented, with a range of 2.5 V – 3.9 V depending on thermal conditions.

2.2.3 Client ADCS/OBC Power Protection Requirements

CubeADCS implements voltage and current monitoring on the 3.3 V line to CubeStar to ensure that the supply voltage is always within range and to mitigate the effects of latch-up in the event of a fault. If CubeStar is not used as part of a CubeADCS bundle, it is recommended that the client ADCS/OBC implements the same protections.

2.2.4 Power and Signal Ground

CubeStar does not have separate power and signal ground, all circuits share the same ground.

2.3 Header Pinout and Electrical Characteristics

Table 5: Header Details

Part	Description	Part Number
Header	Molex Micro-Lock Plus PCB Header	5055671081
Mating housing	Molex Micro-Lock Plus Receptacle Crimp Housing	5055651001
Housing terminal	Molex Micro-Lock Female Crimp Terminal	5054311100

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Table 6: Header Pinout and Electrical Characteristics

Pin #	Pin Name	Pin Description	IO Type	Voltage Range [V]
1	Boot	Toggle ROM bootloader on startup Active-high Leave disconnected if unused	Input	0 to 3.4
2	GND	Power and signal ground	Power	0
3	3V3	Supply voltage	Power	3.2 to 3.4
4	UART Tx	UART data transmit line (default)	Output	0 to 3.4
	RS485 A	RS485 A (alternative)	Bidirectional	
5	CAN P	High level CAN bus line	Bidirectional	0 to 3.4
6	CAN N	Low level CAN bus line	Bidirectional	0 to 3.4
7	UART Rx	UART data receive line (default)	Input	0 to 3.4
	RS485 B	RS485 B (alternative)	Bidirectional	
8	GND	Power and signal ground	Power	0
9	GND	Power and signal ground	Power	0
10	Enable	Toggle power on Active-high	Input	0 to 3.4

2.4 Harness Details

A standalone CubeStar will ship with two harnesses: an EM harness as part of the ground support equipment package to allow for immediate testing and health checks, and a standard FM pigtail harness that can be used by the client to assemble a flight harness. The standard FM pigtail harness specifications are described in Table 7. The standard length can be cut shorter, and longer (custom) lengths can be arranged during order placement.

The EM harness is provided as part of the ground support equipment package only and is not low-outgassing. Therefore, it is not safe for flight or for use in a vacuum.

Table 7: Harness Details

Harness	Std. Length [mm]	No. Wires	Wire Gauge [AWG]	Wire Mass [g/m]	Housing Mass [mg]	Terminal Mass [mg]	Total[1] Mass [g]
FM pigtail	400	10	26	1.96	198.8	35.434	8.4

[1] Weight of the supplied pigtail harness only, excludes ADCS/OBC mating parts.

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3. Mechanical Interface

CubeStar is fully enclosed in an aluminium enclosure (6082-T6), treated with a chromate conversion coating. The enclosure includes a M24x1.5 mm thread for the optional addition of a baffle to improve the performance of CubeStar[2]. The baffle is coated with black low-outgassing, low reflectivity and high absorptivity paint.

The dimensions given in this chapter are indicative only. The mechanical CAD files with the latest dimensions are supplied to customers and must be used for final design and fitment verification.

[2] This document only considers the standard 120° baffle. If a custom baffle is required, the relevant information can be requested from CubeSpace.

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3.1 Outer Dimensions

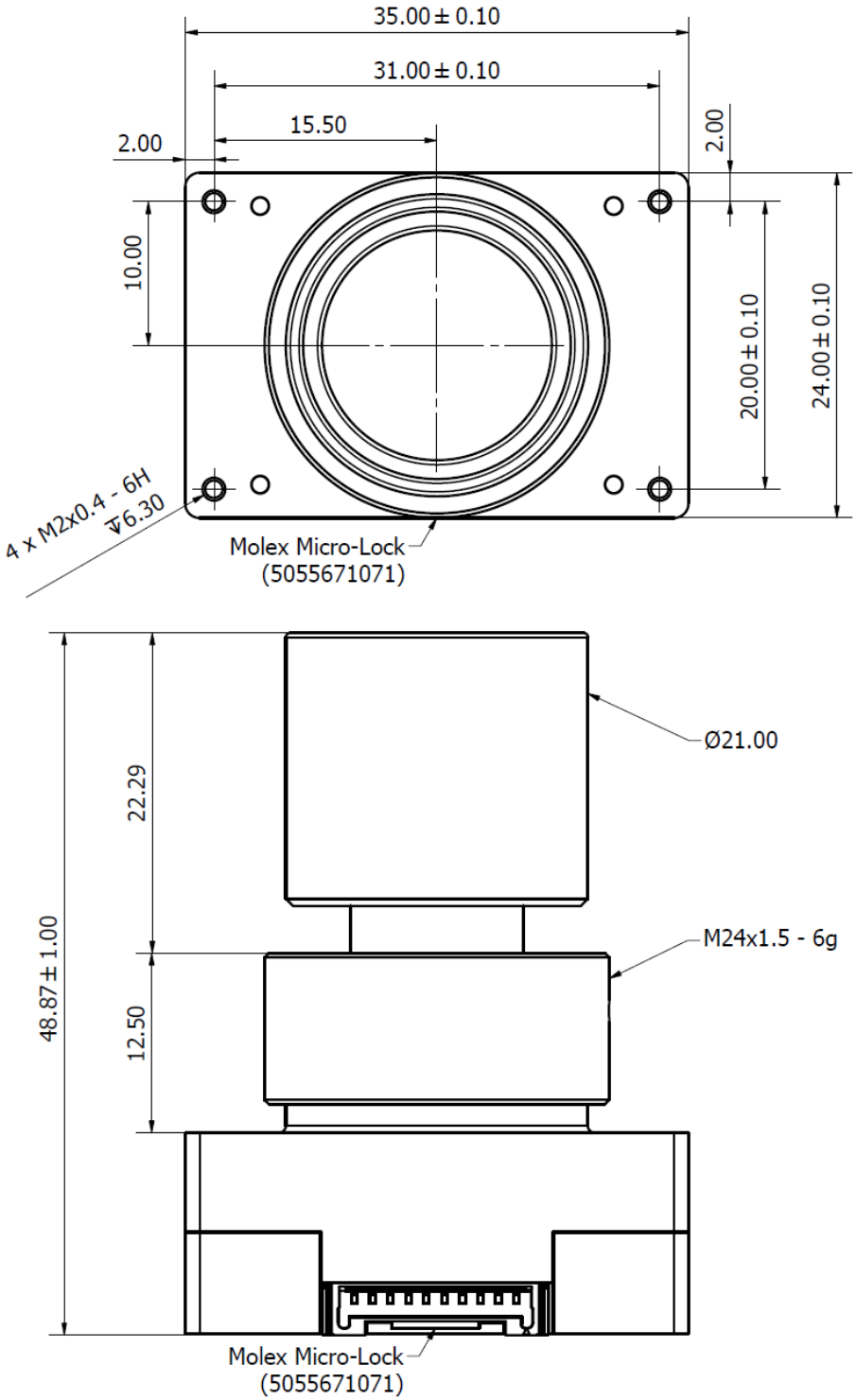

Figure 1: Indicative Dimensions of CubeStar without a Baffle

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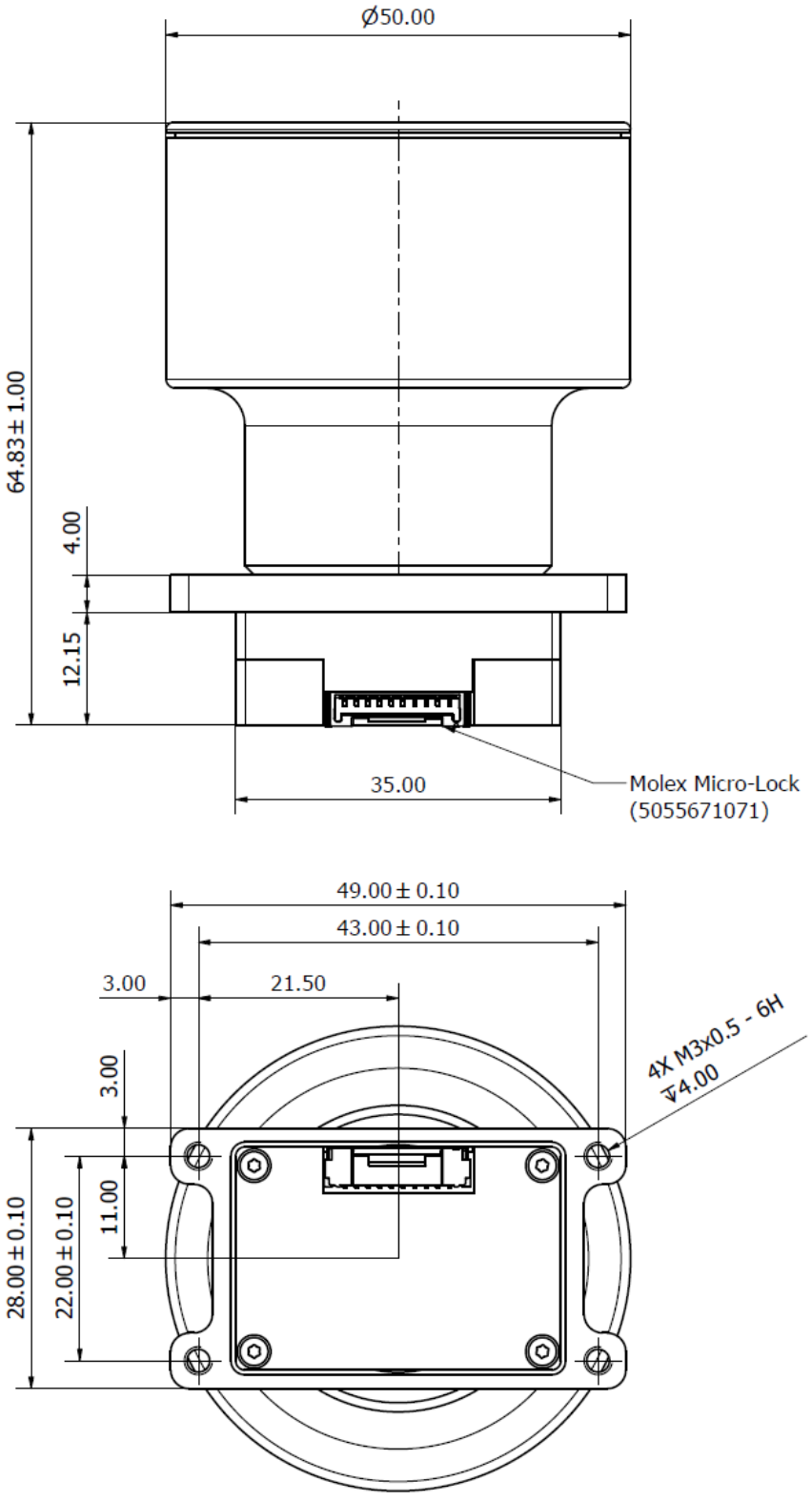

Figure 2: Indicative Dimensions of CubeStar with the Standard Baffle

3.2 Mounting Definition

Mounting of CubeStar without a baffle is performed through four blind M2x0.4 mm threaded holes as shown in Figure 1. CubeStar can only be secured/mounted via the threaded holes on the face (lens side) of the enclosure, as indicated. The lens of CubeStar is sufficiently supported by the enclosure and does not require additional external support.

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If the standard baffle is selected for inclusion with a CubeStar, the required mounting adaptor bracket will be supplied and replaces the standard mounting definition. The adaptor bracket has four M3x0.5 mm threaded holes for mounting the CubeStar with the baffle assembly, as shown in Figure 2.

3.3 Mass, CoM and Inertia

Table 8: Mass Details

Variant/Model	Mass [g]	Notes
Without Baffle	47	Excluding harness
With Standard Baffle	122	

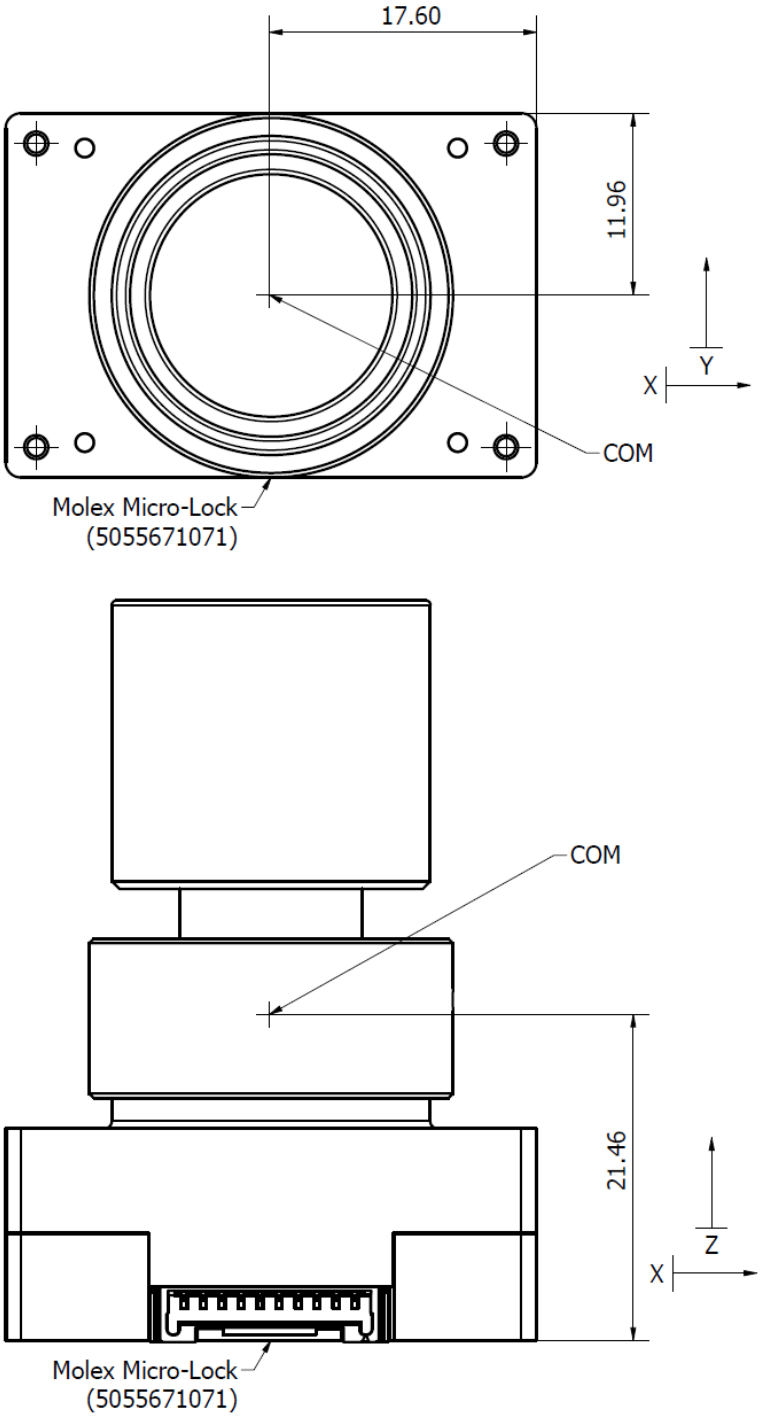

Figure 3: CoM Position of CubeStar without a Baffle

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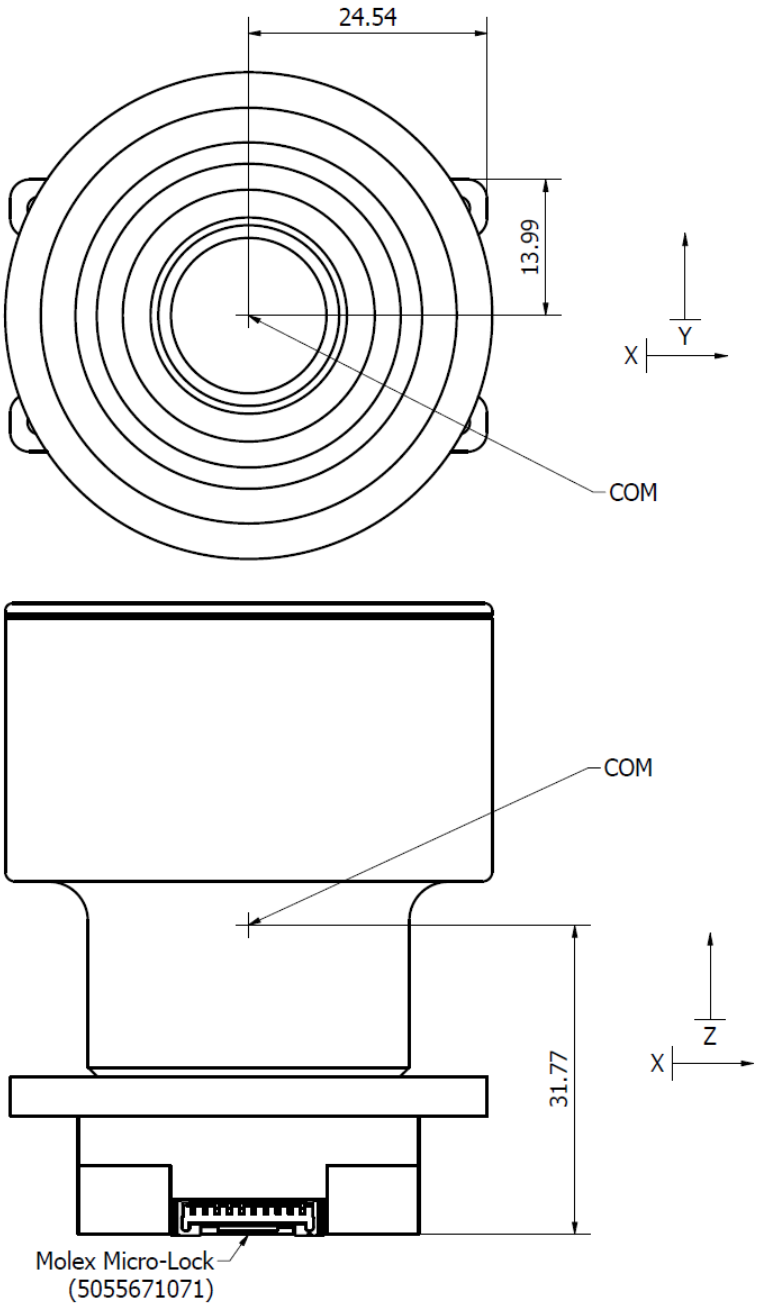

Figure 4: CoM Position of CubeStar with the Standard Baffle

The moments of inertia (MoI) of CubeStar about its CoM are presented in Table 9, using the coordinate system definition shown in Figure 3 and Figure 4. Please note the orientation of the Y-Axis with regards to the connector location.

Table 9: Moments of Inertia

Variant/Model	I_{xx} [gmm²]	I_{yy} [gmm²]	I_{zz} [gmm²]
Without Baffle	6710 ± 10 %	6548 ± 10 %	530 ± 10 %
With Standard Baffle	44556 ± 10 %	45386 ± 10 %	27350 ± 10 %

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4. Software Interface

Each CubeProduct is accompanied by a user manual [RD2] that provides details regarding telemetry exchanges using ground support equipment. For further information regarding software interfacing and control, please refer to the firmware reference manual [RD4].

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5. Measurement Coordinate System Definition

Vector and attitude outputs from CubeStar are referenced to the measurement coordinate system indicated in Figure 5. Note the orientation of the Y-Axis with regards to the connector location.

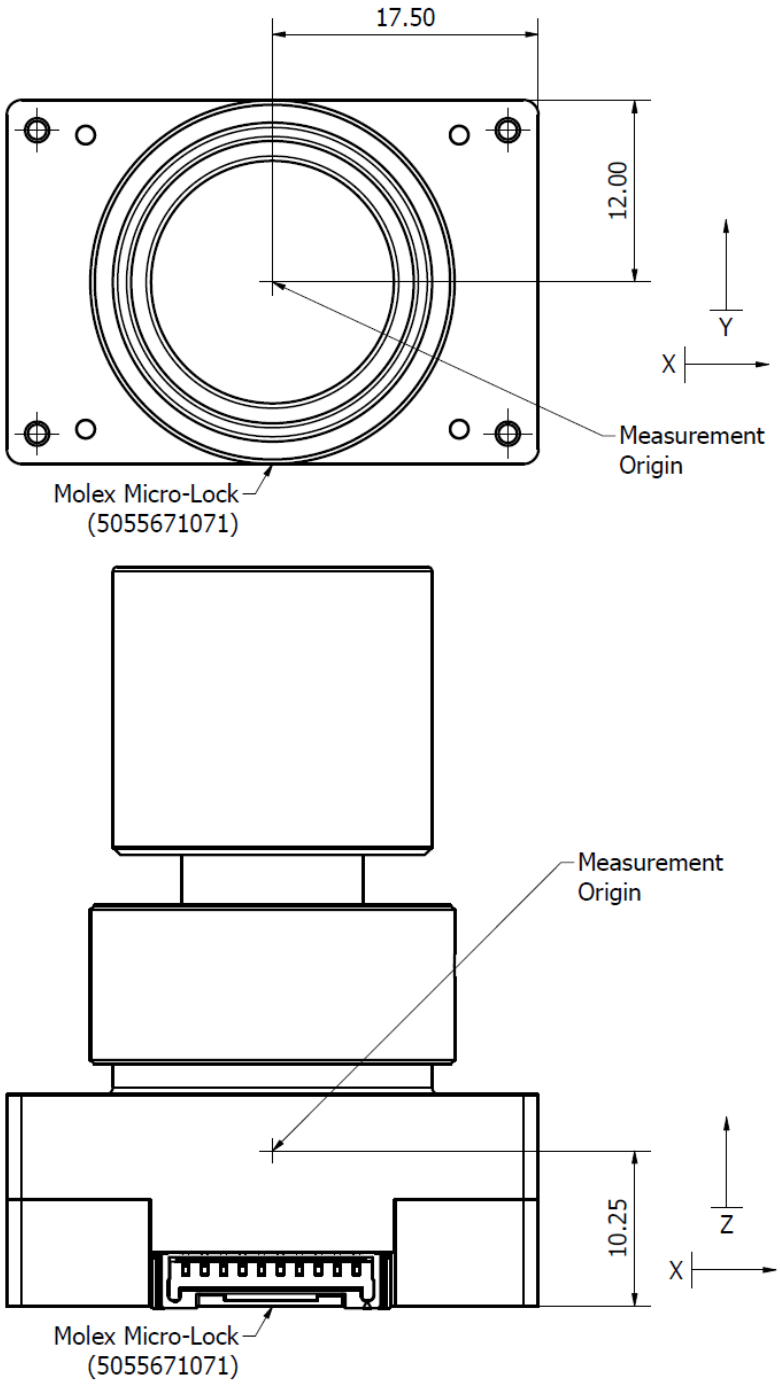

Figure 5: Measurement Coordinate System Definition

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6. EMI/EMC

6.1 Potential RF Emitters

Table 10: Potential RF Emitters

Source	Frequency [MHz]	Frequency Stability [ppm]
MCU clock	24	± 50
Image sensor clock	20	± 50

6.2 EMI/EMC Cleanliness

6.2.1 Enclosure Grounding

The enclosure and mechanical parts of CubeStar are connected to the power and signal ground through a filter designed to minimise EMI, as illustrated in Figure 6. The enclosure of CubeStar can be grounded by the user if desired.

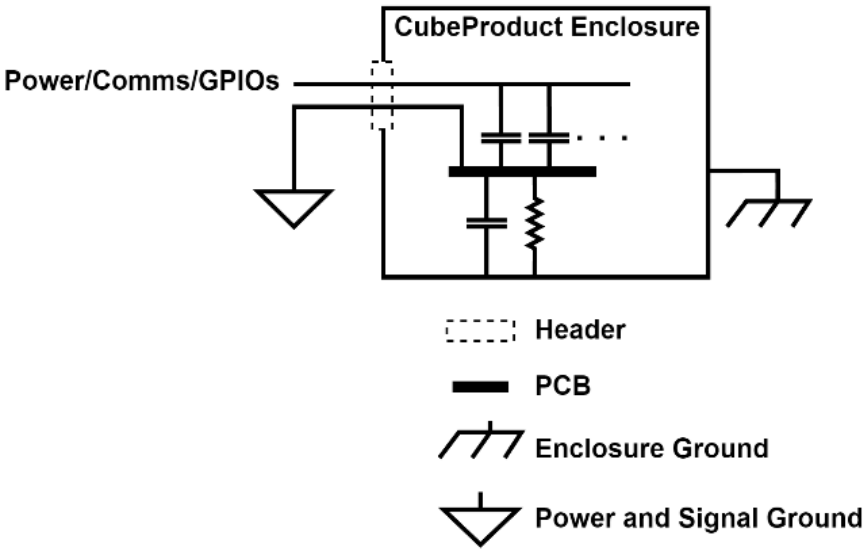

Figure 6: Enclosure Grounding

The enclosure's RC filter design consists of a high value resistor in parallel with a low ESL capacitor. This dissipates high frequency noise to ground and also conducts static buildup away from the enclosure. The commonly used alternative method where the enclosure is directly connected to the ground introduces the risk that a short circuit could occur during satellite integration.

In some cases a customer might require the enclosure of CubeStar to be completely isolated from the system ground by removing the EMI filters completely. In such a case, it should be specified as a custom option during order placement.

6.2.2 Shielding

Shielding of CubeStar electronics is accomplished by the mechanical enclosure as a Faraday cage. The enclosure makes contact to the chassis ground trace on each PCB. This chassis trace is connected to the PCB power and signal ground through the filter discussed in section 6.2.1.

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6.2.3 Filtering and Suppression

The following noise filtering strategies are implemented on CubeStar:

- All pins that are externally exposed through headers are filtered by way of 100 pF decoupling capacitors to power and signal ground as shown in Figure 6.
- RC filtering is applied on the CAN and UART communication interfaces to minimize spurious frequencies above 1 MHz.

The following noise filtering strategies are recommended for consideration on the client ADCS/OBC side:

- LC filtering on the 3.3 V supply and the boot- and enable lines to CubeStar.
- Common-mode filtering on the CAN communication interface to CubeStar.

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