CUBESPACE

Interface Control Document

CubeMag CM & CMC

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1.04	J. Miller	17/02/2025	Removed environmental test Specifications. Common ICD format update.

Reference Documents

The following documents are referenced in this document.

[RD1] CS-DEV.PD.CM-01 CubeMag Product Description Ver.1.01 or later

[RD2] CS-DEV.UM.CM-01 CubeMag User Manual Ver.1.02 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

List of Acronyms/Abbreviations

ADCS	Attitude Determination and Control System
CAN	Controller Area Network
COM	Centre of Mass
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
I2C	Inter-Integrated Circuit
ID	Identification
MCU	Microcontroller Unit
OBC	On-board Computer
PCB	Printed Circuit Board
TC	Telecommand
TCTLM	Telecommand and Telemetry (protocol)
TLM	Telemetry
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 CubeMag. 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 CubeMag 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

CubeProduct	Version	Notes
CubeMag Deployable	M2.1E4.2	--
CubeMag Compact	M2.0E4.3	--

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 bitrate(s)	1 Mbit/s
Supported protocol(s)	CubeSpace CAN Protocol, CubeSat Space Protocol (CSP)
Default CAN Address	4 (configurable)
CAN Termination	2 kΩ

2.1.2 UART and RS485 Characteristics

If necessary, RS485 can be chosen instead of UART when placing the order. In this case UART will be unavailable, and the ability to upgrade or reflash the software bootloader will be lost.

Table 3: UART/RS485 Characteristics

Parameter	Value
Maximum supported Baud rate	921600 (configurable)
Data bits	8
Parity	None
Stop bits	1
Default RS485 Address	1 (configurable)
RS485 Termination	1 kΩ

2.1.3 I2C Characteristics

I2C communication with the CubeMag is provided as a custom option for the CubeMag Compact only. The CubeMag is always configured as a slave on the I2C bus and cannot initiate communications by itself. It is important to note that the master that communicates with the CubeMag must support clock stretching. The relevant I2C details for the CubeMag are given in Table 4.

Table 4: I2C Bus Characteristics

Parameter	Value
Maximum supported bitrate	1 Mbit/s (I2C Fast Mode Plus)

Parameter	Value
Addressing mode	7-bit configurable slave address
Clock stretching	Yes (master must support clock stretching)
Repeated-start support	Not supported
Default Address	0x50 (Configurable)

2.2 Boot Line

CubeMag implements a boot line for accessing the MCU's low-level ROM bootloader. The boot line must be pulled high prior to power-on to access the ROM bootloader. It is used by CubeSpace to initially flash the CubeSpace software bootloader to the MCU, thereafter the software bootloader is used for uploading flight software. The client can leave this pin 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.

If necessary, RS485 can be chosen instead of UART when placing the order. In this case UART will be unavailable, and the ability to upgrade or reflash the software bootloader will be lost.

2.3 Power Interface

The typical power characteristics given in Table 5. Table 6 are independent of the satellite's size or control mode being used.

Table 5: External Power Supply Requirements

External Power	CubeMag Deployable	CubeMag Compact
Supply voltage [V]	3.3	
Peak power [mW]	230	
Average power [mW]	50	50
Deployment power [mW]	2350	N/A

Table 6: Power Consumption on 3.3 V Line

CubeMag Variant	3.3 V rail					Notes
	Avg. Current (mA)	Avg. Power (mW)	Max Current (mA)	Max Power (mW)	Inrush (mA – µs)	
CubeMag Deployable	15	50	70	230	230-100	Excluding deployment current.
CubeMag Compact	15	50	70	230	230-100	

2.3.1 Enable line.

CubeMag 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. For more information, refer to

Table 11.

2.3.2 3.3 V Power Switch

CubeMag implements an input power switch 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.

2.3.3 Client ADCS/OBC Power Protection Requirements

It is recommended that the client ADCS/OBC implements voltage monitoring on the 3.3 V line to CubeMag to ensure that it is always within the range specified in Table 5. It is also recommended that the client ADCS/OBC implements current limiting on the 3.3 V line to CubeMag to mitigate the effects of a latch-up in the case of a fault.

2.3.4 Power and Signal Ground

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

2.4 Header Pinout and Electrical Characteristics

2.4.1 CubeMag Deployable

The CubeMag deployable is supplied with a 50mm harness soldered into the CubeMag deployable PCB as shown in Figure 1. The connector on this harness is referred to the header in Table 7. A second open ended inline harness with the mating housing is used to connect this harness to the CubeComputer (or client ADCS / OBC) sub-system. The pin location of the inline harness is shown in Figure 2, with the pin definition listed in Table 8.

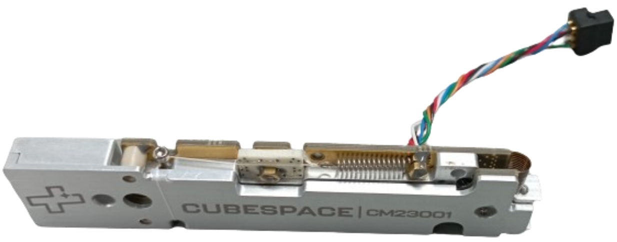

Figure 1: CubeMag with 50mm Loom

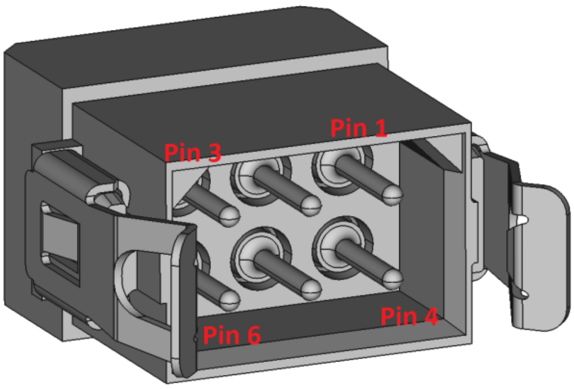

Figure 2: Harwin M80-8120605 Pin Definition

Table 7: CubeMag Deployable Header Part Details

Part	Description	Part Number
Header	Harwin Datamate L-Tek Female	M80-1030698S
Mating housing	Harwin Datamate L-Tek Male	M80-8120605
Housing terminal	Harwin Datamate L-Tek Male Crimp Contact	M80-0410005

Table 8: CubeMag Deployable Header Pinout and Electrical Characteristics

Pin #	Pin Name	Pin Description	IO Type	Voltage range [V]
1.	Enable	Toggle power on Active-high	Input	0 to 3.4
2.	3V3	Supply voltage for the digital electronics	Power	3.2 to 3.4
3.	CAN_P	High level CAN bus line (default)	Bidirectional	0 to 3.4
	RS485A	RS485 A (alternative)	Bidirectional	
	UART_TX	UART data transmit line (alternative)	Output	
4.	GND	Signal and power ground	Power	0
5.	BOOT	Toggle ROM bootloader on startup Active-high Leave disconnected if unused.	Input	0 to 3.4
6.[1]	CAN_N	Low level CAN bus line (default)	Bidirectional	0 to 3.4
	RS485B	RS485 B (alternative)	Bidirectional	
	UART_RX	UART data receive line (alternative)	Input	

2.4.2 CubeMag Compact

Table 9: CubeMag Compact Part 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

Table 10: CubeMag Compact 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.	I2C_DA	I2C data line	Serial data	2.7 to 5.5

[1] CubeMag Deployable must be configured for either CAN, RS485/RS422 or UART.

Pin #	Pin Name	Pin Description	IO Type	Voltage range [V]
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	Differential	0 to 3.4
6.	CAN_N	Low level CAN bus line	Differential	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	Signal and power ground	Power	0
9.	I2C_CLK	I2C clock line	Serial Clock	2.7 to 5.5V
10.	Enable	Toggle power on Active-high	Input	0 to 3.4

2.5 Harness Details

A standalone CubeMag 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 11. 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 11: Harness Details

Harness	Std. Length [mm]	No. Wires	Wire Gauge (AWG)	Wire Mass (g/m)	Housing Mass (mg)	Terminal Mass [mg]	Total[2] Mass [g]
CubeMag Deployable Loom	50	6	26	1.96	467	55.8	1.39
CubeMag Deployable	400	6	26	1.96	287	56.3	5.33
CubeMag Compact	400	10	26	1.96	198.8	35.4	8.39

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

3. Mechanical Interface

The base and hinging arm which enclose the magnetometer devices are manufactured from aluminium (6082-T6) and treated with a chromate conversion coating.

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.

3.1 CubeMag Deployable

The CubeMag Deployable consists of a base which is mounted on the outside of the satellite, an arm which deploys to 90 degrees when released, and a wire hold-down-and-release mechanism. The CubeMag Deployable has a primary magnetometer in the head of the deployment arm, and a secondary magnetometer on the base. Outer Dimensions

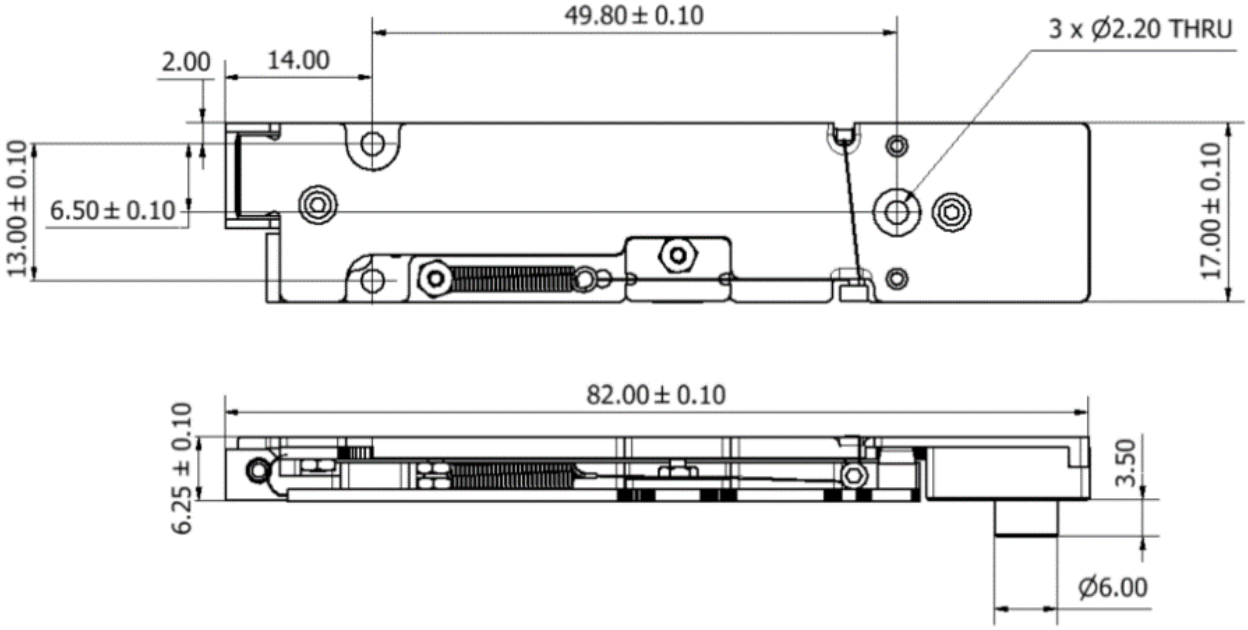

Figure 3: Indicative Dimensions of CubeMag Deployable in the Stowed State

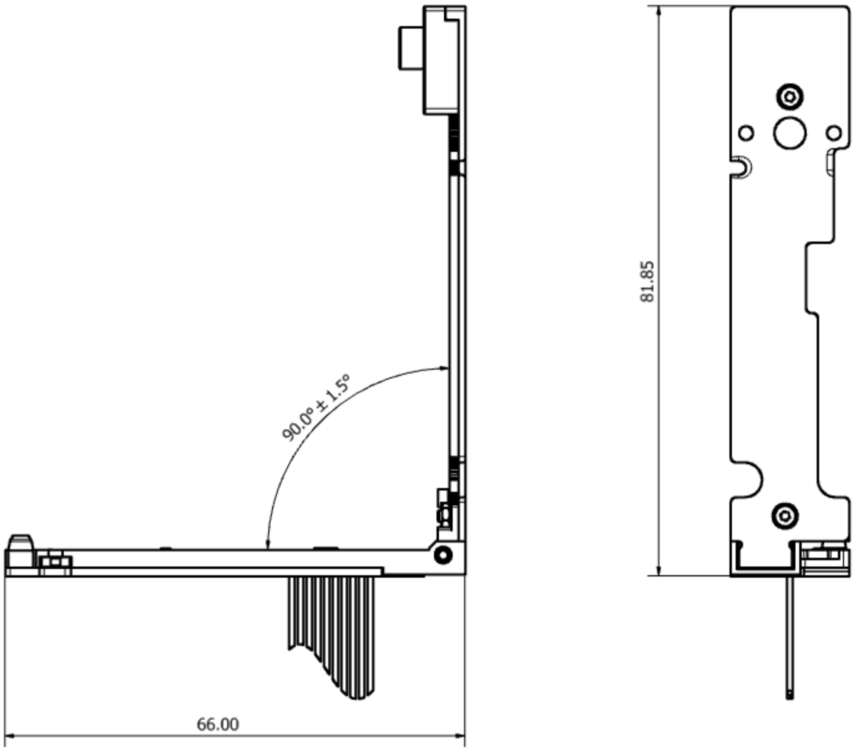

Figure 4: Indicative Dimensions of CubeMag Deployable in the Deployed State

3.1.1 Mounting Definition

The CubeMag Deployable is mounted in the stowed state as shown in Figure 3. Once deployed the CubeMag boom rotates 90° as shown in Figure 4.

The deployable magnetometer is designed to mount to an external surface of the satellite. The magnetometer should not be placed in close proximity of any part of the satellite that may cause significant disturbances. See [RD1] for more details.

The hole placement and panel cut-outs required for mounting of the magnetometer are shown in Figure 5. The dashed line represents the area the magnetometer will occupy, when in the stowed state, and must not be impinged upon.

Mounting of the deployable magnetometer is performed by way of three (3) non-ferrous M2 screws (refer to Figure 5 for screw hole locations) that pass through the magnetometer and thread into the panel onto which the magnetometer is mounted. Alternatively, the screws may pass through both the magnetometer and mounting panel and then secured with nuts on the inside of the panel.

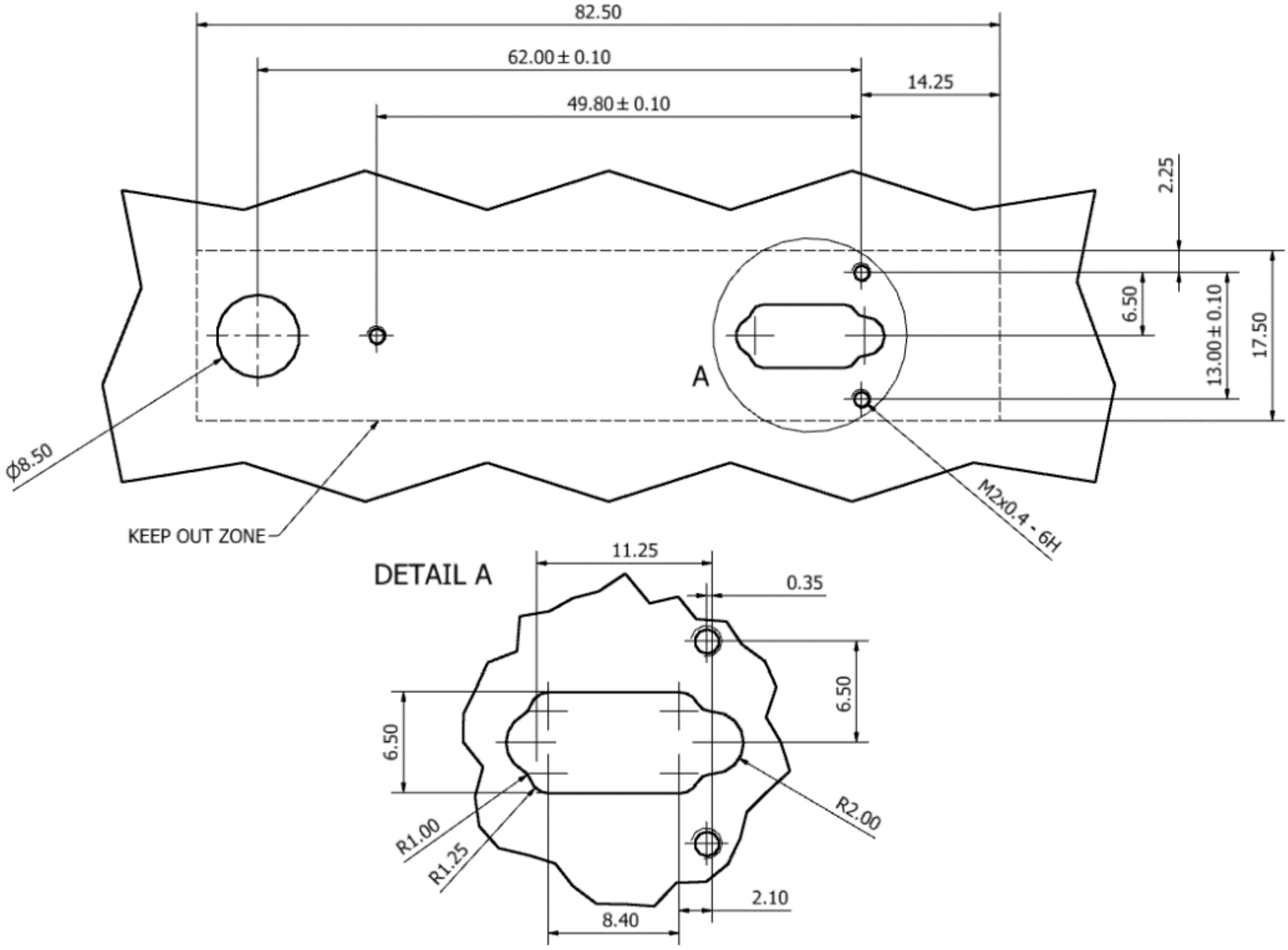

Figure 5: Panel Cut-Outs Required to Mount CubeMag Deployable

3.1.2 Mass, COM and Inertia

Table 12: CubeMag Deployable Mass

CubeMag Variant/Model	Mass (g)[3]	Notes
Deployable	16 ±5%	Measured

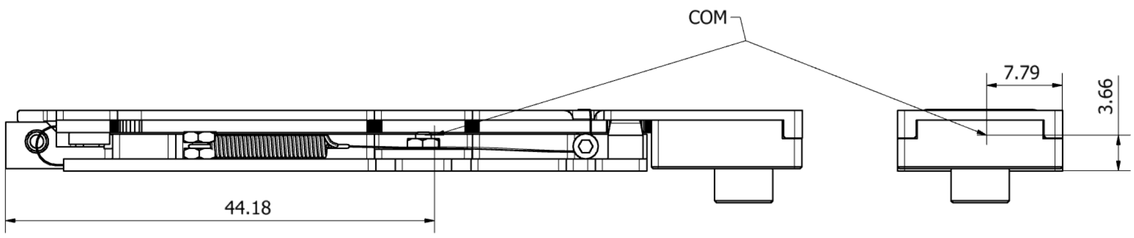

Figure 6: COM Position of CubeMag Deployable in the Stowed State

[3] This is the mass of CubeMag only, without harnessing.

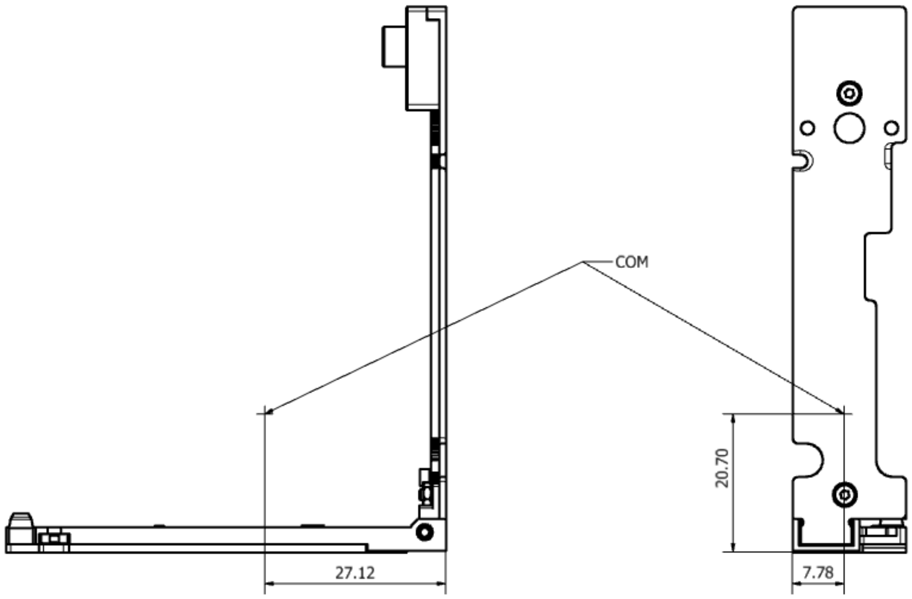

Figure 7: COM Position of CubeMag Deployable in the Deployed State

The moments of inertia (MoI) of CubeMag Deployable about its CoM are presented in Table 13 for the stowed and deployed state, using the coordinate system definition shown in Figure 8.

Table 13: CubeMag Deployable Moments of Inertia

Axis	Stowed state	Deployed state
I_{xx} (gmm^2)	316 ± 10 %	12810 ± 10 %
I_{yy} (gmm^2)	8310 ± 10 %	11800 ± 10 %
I_{zz} (gmm^2)	8070 ± 10 %	23880 ± 10 %

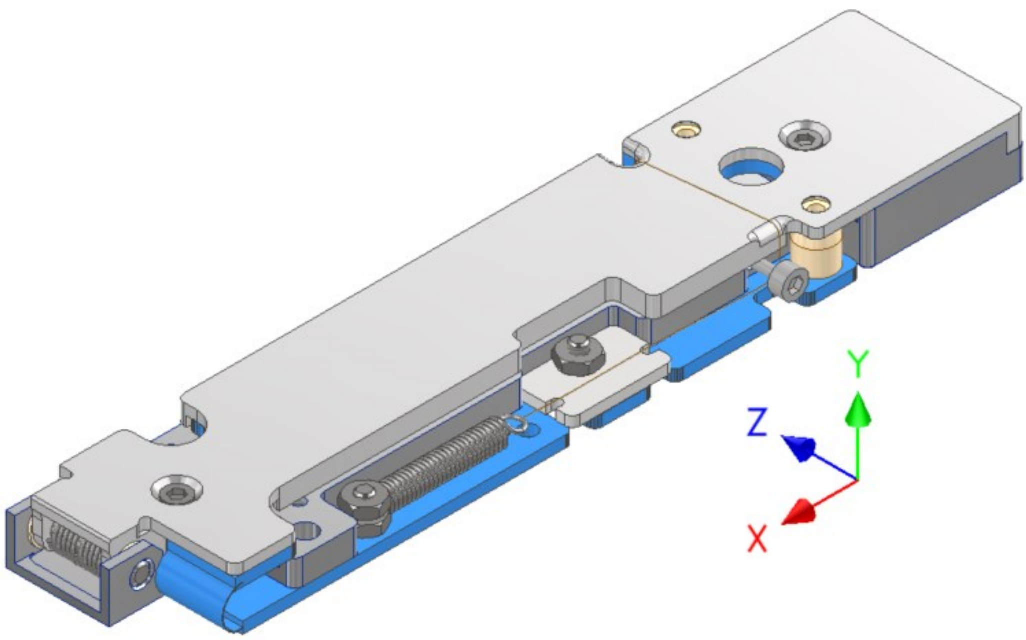

Figure 8: CubeMag Deployable Inertial Reference Frame

3.1.3 Measurement Coordinate System Definition

The CubeMag Deployable returns the magnetic field as a calibrated measurement[4] via telemetry. This calibrated measurement reference frame is the same for both the primary and secondary magnetometer and is deemed the coordinate system definition of the CubeMag deployable. The reference frame for the primary magnetometer is also the same whether the magnetometer is stowed or deployed. To achieve this, the magnetometer automatically senses whether it is deployed or not and transforms the measurements accordingly.

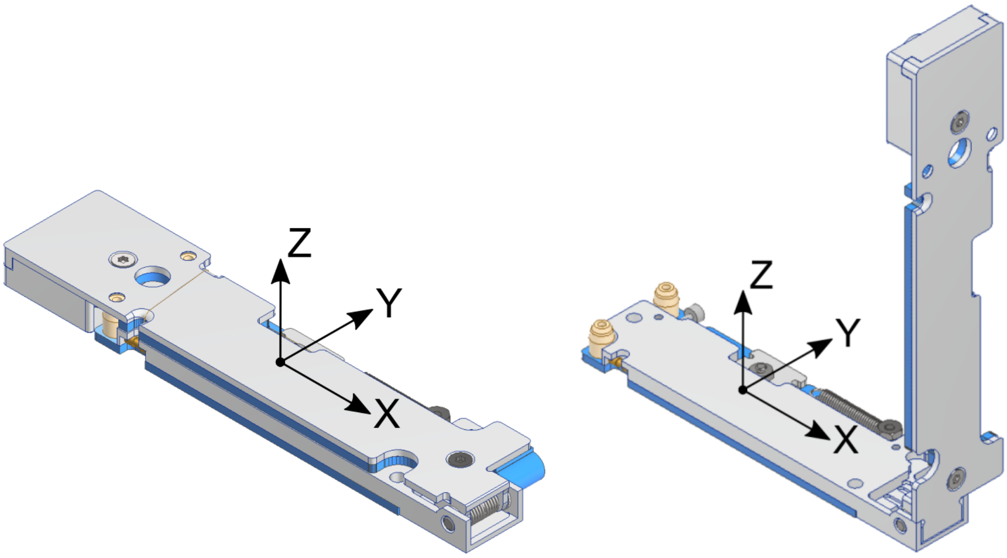

Figure 9: CubeMag Deployable Measurement Coordinate Reference Frame

3.2 CubeMag Compact

CubeMag Compact is fully enclosed in an aluminium enclosure (6082-T6), treated with a chromate conversion coating.

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.

[4] The CubeMag has a Telemetry Message (TLM) for calibrated measurements and a TLM for raw measurements. Only the calibrated measurements TLM follows the reference frame shown in Figure 9.

3.2.1 Outer Dimensions

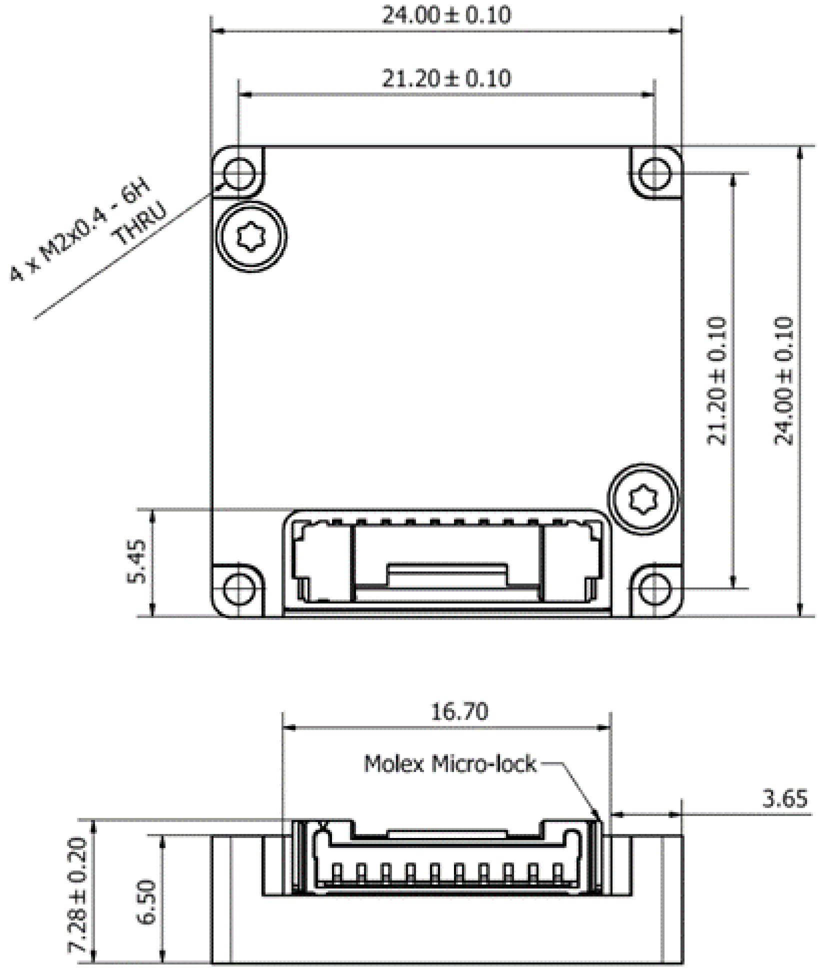

Figure 10: Indicative Dimensions of CubeMag Compact

3.2.2 Mounting Definition

The CubeMag Compact has four (4) M2x0.4mm threaded mounting holes as shown in Figure 10. Non-ferrous screws should be used for securing this CubeProduct. This redundant magnetometer can be mounted with either the top or bottom face against the mounting surface. Regardless of the mounting orientation utilised, sufficient space should be allowed around the Molex connector to ensure easy and reliable connection.

The CubeMag Compact is designed to mount to an external surface of the satellite. The magnetometer should not be placed in close proximity of any other part of the satellite that causes significant disturbances. See [RD1] for more details.

3.2.3 Mass, COM and Inertia

Table 14: CubeMag Compact Mass

CubeMag Variant/Model	Mass (g)[5]	Notes
Compact	6 ±5%	Measured

[5] This is the mass of CubeMag only, without harnessing.

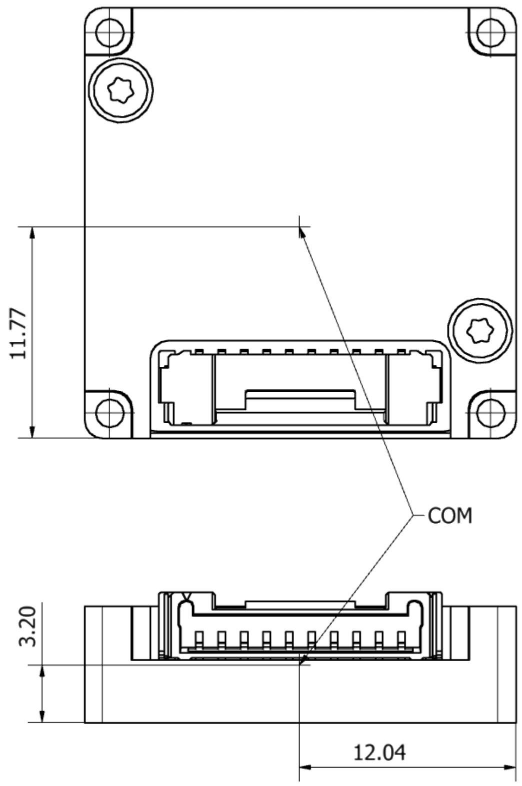

Figure 11: COM Position of CubeMag Compact

The moments of inertia (MoI) of CubeMag Compact about the COM position are presented in Table 15, the axes reference for the inertias provided is shown in Figure 12.

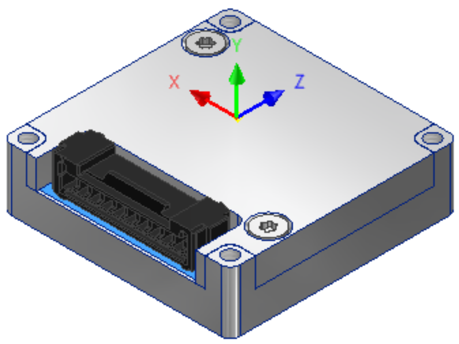

Figure 12: CubeMag Compact Inertial Reference Frame

Table 15: CubeMag Compact Moments of Inertia (MOI)

Axis	Value [gmm²]
I_{xx} (gmm²)	134 ± 10 %
I_{yy} (gmm²)	212 ± 10 %
I_{zz} (gmm²)	122 ± 10 %

3.2.4 Measurement Coordinate System Definition

The coordinate system of the CubeMag Compact is defined and shown in Figure 13. The CubeMag Compact has a TLM for calibrated measurements and a TLM for raw measurements. Only the calibrated measurements TLM follows the reference frame shown in Figure 13.

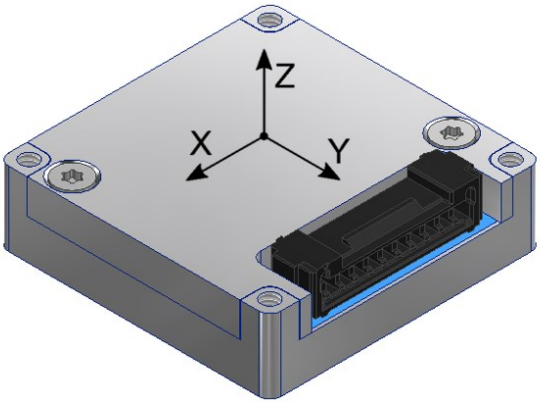

Figure 13: CubeMag Compact Measurement Coordinate System Definition

4. Software Interface

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

5. EMI / EMC

5.1 Potential RF emitter list

Table 16: Potential Emitters

CubeMag Variant	Component	Emitter type	Frequency	Frequency stability
CubeMag Deployable	MCU	Crystal	24 MHz	± 50 ppm
	Comms UART	UART	0.92MHz	± 50 ppm
	Redundant Mag	I2C	100 kHz	± 50 ppm
	Magnetometer	SPI	370 kHz	± 50 ppm
	Temperature sensor	I2C	100 kHz	± 50 ppm
	Comms CAN	CAN	500 kHz	± 50 ppm
CubeMag Compact	Comms UART	UART	0.92MHz	± 50 ppm
	Comms CAN	I2C	500 kHz	± 50 ppm
	Red Mag	I2C	100 kHz	± 50 ppm
	MCU	Crystal	24 MHz	± 50 ppm

5.2 EMI/EMC Cleanliness

5.2.1 Grounding

The enclosure and mechanical parts of CubeMag are connected to the power and signal ground through a filter designed to minimise EMI, as illustrated in Figure 14. The enclosure of CubeMag can be grounded by the user if desired.

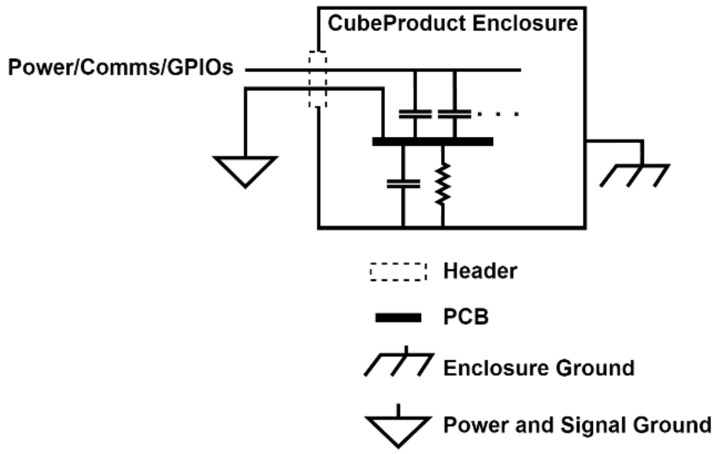

Figure 14: Generic Grounding Diagram

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 enclosures are directly connected to the ground introduces the risk that shorts could occur during satellite integration.

In some cases a customer might require the enclosure of CubeMag 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.

5.2.2 Shielding

Shielding of CubeMag 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 5.2.1

5.2.3 Filtering and Suppression

The following noise filtering strategies are implemented on CubeMag:

- All pins that are externally exposed through headers are filtered by way of 100 pF decoupling capacitor to power and signal ground as shown in Figure 14.
- 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 CubeMag.
- Common-mode filtering on the CAN communication interface to CubeMag.