CubeADCS Gen 1

CubeADCS GEN 1 Hardware Configuration Sheet

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Revision History

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7.3	Marisa du Plessis	All	2022/11/29	Updated HW config sheet

Reference Documents

[1] CubeADCS – ICD [7.4]

List of Acronyms/Abbreviations

ACP	ADCS Control Program
ADCS	Attitude Determination and Control System
CAN	Controller Area Network
CSS	Coarse Sun Sensor
I2C	Inter-Integrated Circuit
OBC	On-board Computer
PCB	Printed Circuit Board
SBC	Satellite Body Coordinate
UART	Universal Asynchronous Receiver/Transmitter

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CubeADCS Hardware Configuration

CubeSpace aims to simplify the complicated task of integrating an ADCS into your satellite design. Our systems are therefore highly configurable, and this document allows you to customise your CubeADCS unit to meet your requirements. If additional customisation is required, please contact CubeSpace directly at info@cubespace.co.za.

The CubeADCS 3-Axis bundle is an integrated collection of CubeSpace ADCS components which provides the necessary actuators and sensors for a nanosatellite to achieve a stabilised attitude with 3-axis control.

Figure 1 provides a high-level system diagram of the complete standard CubeADCS 3-Axis solution.

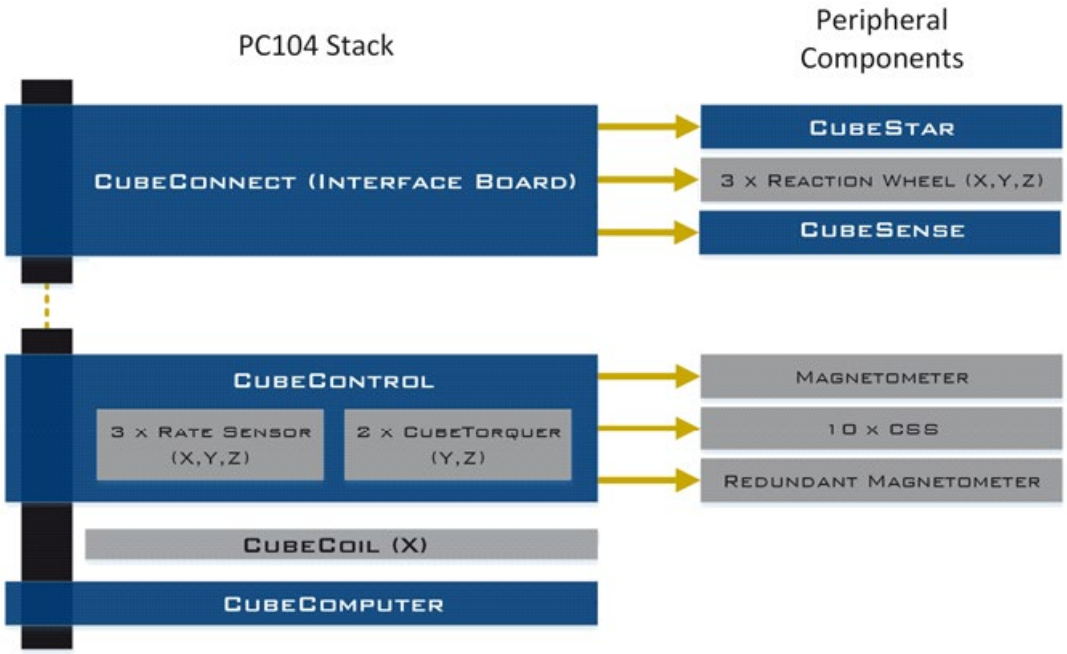


Figure 1: System Diagram of CubeADCS 3-Axis Solution

Please complete all the relevant sections below to configure the CubeADCS unit.

Note: The harness lengths specified in this document will have a minimum acceptable length not shorter than 2% of the specified length and a maximum acceptable length not longer than 10% of the specified length. The harness lengths provided in this document refers to the inside length of the harnesses, thus excluding the connectors.

1 PC104 Bus Configuration

The options in this section will determine the pin configuration of the main PC104 bus. The pin description of the PC104 bus, as used by the CubeADCS 3-Axis unit, is shown in Figure 2.

H2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52
	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51
H1	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52
	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51

PC104 Interface Pins					
External Communication					
	H1	1	CANL	CAN Bus Low	*Option*
	H1	3	CANH	CAN High Low	*Option*
	H1	41	I2C_SDA_SYS	System I2C Data for CubeComputer	*Required*
	H1	43	I2C_SCL_SYS	System I2C Clock for CubeComputer	*Required*
	H1	17, 18, 19, 20	UART_1	Usable Pins for UART_1 (Rx or Tx)	*Option*
	H2	21, 22			
	H1	33, 35, 39, 40	UART_2	Usable Pins for UART_2 (Rx or Tx)	*Option*
External Power					
	H2	29, 30, 32	GND	Ground Connection for All Modules	*Required*
	H2	45 and 46	V_Bat	Battery Voltage Bus	*Required*
	H2	25 and 26	5V_Main	Main 5 V Supply	*Option*
	H2	27 and 28	3V3_Main	Main 3.3 V Supply	*Option*
	H1	47, 49, 51	5V_S1/S2/S3	Switched 5 V Supply Options	*Option*
	H1	48, 50, 52	3V3_S1/S2/S3	Switched 3.3 V Supply Options	*Option*
Internal (ADCS Only)					
	H1	2, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16	ENABLE	Usable Pins for Enable Lines for CubeADCS Nodes	*Option*
	H2	15, 17, 18, 19, 20			
	H1	21	I2C_SCL_ADCS	Internal I2C clock line for ADCS modules	*Required*
	H1	23	I2C_SDA_ADCS	Internal I2C data line for ADCS modules	*Required*

Figure 2: PC104 Bus Pin Description

The CubeADCS bundle requires pins on the PC104 header to enable/disable its various subcomponents. Throughout the document, the locations these lines will occupy on the PC104 header can be customised and selected.

Note: The relevant enable pins *only* need to be selected for components that are part of the CubeADCS solution. Once the enable lines have been selected, the relevant PC104 locations should be reserved for the CubeADCS only, i.e., no other components on the satellite should make use of them.

1.1 Power Supply

1.1.1 CubeADCS

The CubeADCS unit requires 3.3 V, 5 V, and the battery voltage to operate. Although CubeComputer forms a part of the CubeADCS, it is not necessarily powered by the same power rail as the rest of the unit, as selected in Option 1 and Option 2.

Please select the 3.3 V and 5 V supplies for the ADCS bundle, CubeWheels and CubeComputer on the PC104 header, in Option 1 to Option 4.

Option 1: CubeADCS 3.3 V Supply

	H2-27,28	H1-48	H1-50	H1-52
3.3 V Supply Pin(s)	☑	☐	☐	☐

Option 2: CubeADCS 5 V Supply

	H2-25,26	H1-47	H1-49	H1-51
5 V Supply Pin(s)	☑	☐	☐	☐

The gains of the speed controller on the MCU of the CubeWheel units are dependent on the battery bus voltage of the satellite. Please specify the expected nominal battery voltage, within a range of 6.5 V to 16 V, as specified in **Ref [1]**. *(Standard option: 8.0 V)*

Option 3: Nominal Battery Voltage

	Nominal Voltage
Raw Battery Voltage	8.0

1.1.2 CubeComputer

Option 4 allows the user to power the CubeComputer from a different rail than the rest of the CubeADCS, by selecting enable pins that differ from the selection made in Option 1. If the same selection is made in both Option 1 and Option 4, CubeComputer and CubeADCS will be powered from the same power rail. Please select the 3.3 V supply for CubeComputer.

Option 4: CubeComputer 3.3 V Supply

	H2-27,28	H1-48	H1-50	H1-52
3.3 V Supply Pin(s)	☑	☐	☐	☐

1.2 Communication

1.2.1 UART

The CubeADCS bundle has two UART buses, designated as UART 1 and UART 2, which can be used to interface with the bundle. Both buses can be routed to the PC104 header, where UART 1 is accessible from the debug header on CubeComputer by default. Please select to which PC104 pins the UART must be connected, if any. *(Standard option: None)*

Option 5: UART 1

	H1-17	H1-18	H1-19	H1-20	H2-21	H2-22	None
UART 1 TX	○	○	○	○	○	○	◉
UART 1 RX	○	○	○	○	○	○	◉

Option 6: UART 2

	H1-33	H1-35	H1-39	H1-40	None
UART 2 TX	○	○	○	○	◉
UART 2 RX	○	○	○	○	◉

1.2.2 CAN

CubeComputer contains optional CAN electronics which allows the user to interface with the CubeADCS unit via a CAN bus. If the CAN interface is not required, CubeComputer's power consumption can be reduced slightly by leaving the CAN electronics unpopulated. Please indicate whether the CAN bus will be required. *(Standard option: No)*

Option 7: CubeComputer CAN Bus

	Yes	No
CAN Controller and Transceiver	○	◉

In the case where a CAN controller and transceiver is required, please specify if a termination resistor is required and what the resistance of this resistor should be

Option 8: CAN Termination Resistor

	120 Ω	Other (Specify)	No Resistor
CAN Termination Resistor	○	ohm	◉

2 CubeConnect Configuration

2.1 CubeConnect Selection

The CubeWheels, CubeSenses and CubeStar need to be connected to the PC104 header to communicate with the CubeComputer. To do this CubeSpace provides the user with a CubeConnect interface PCB forming part of the CubeADCS stack-up. The CubeConnect comes in two forms. The standard CubeConnect and the more compact micro CubeConnect.

The standard CubeConnect can also be used as a mounting platform for 3 CubeWheel Small units as shown in Figure 8 (3-Axis configuration) and Figure 9 (Y-momentum configuration) to integrate into the CubeADCS unit's form factor. Figure 3 shows the standard CubeConnect without any CubeWheel Small units mounted.

Note: Only the CubeWheel small unit sizes can physically be mounted to the standard CubeConnect.

There are 6 optional harness lengths that can be selected for CubeWheel Small units that are not mounted on the standard CubeConnect. These 6 options are also available for the CubeWheel Small+ units selected with a standard CubeConnect. The harness lengths for CubeWheel Medium and Large units are limited to 2 options when the standard CubeConnect is selected. The harness lengths for CubeWheel Small units that are mounted on the standard CubeConnect are fixed and cannot be selected.

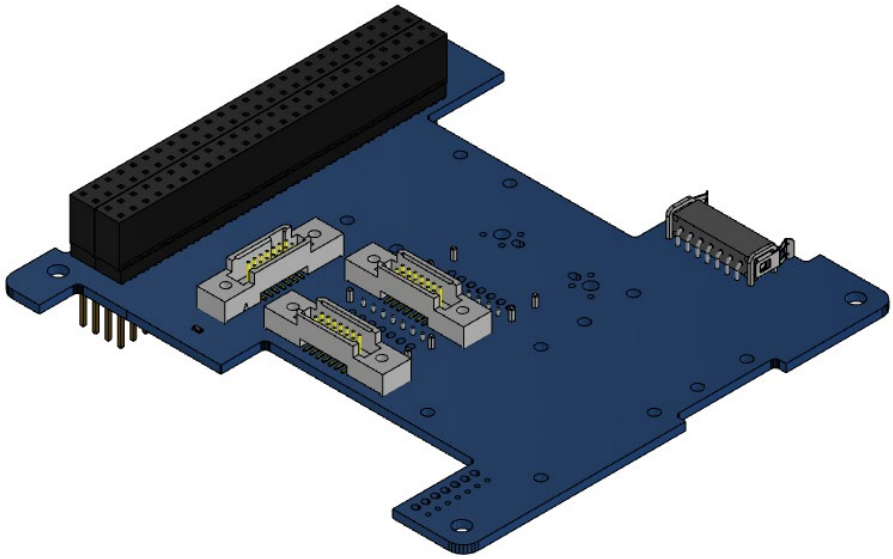


Figure 3: Standard CubeConnect without Mounted Small Wheels

The micro CubeConnect shown in Figure 4 is a small PCB housing the PC104 header. The micro-CubeConnect allows for the harness length to be customizable for any CubeWheel.

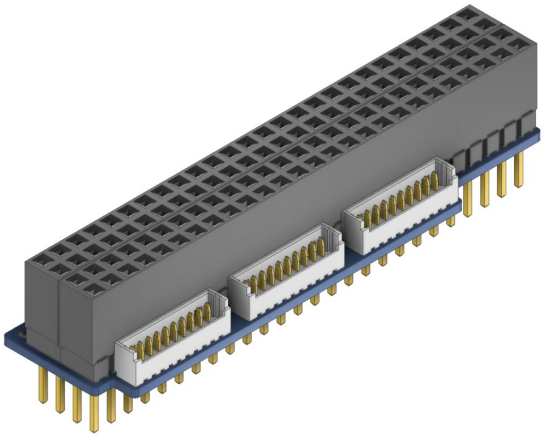


Figure 4: Micro CubeConnect

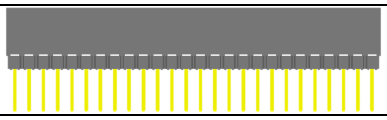
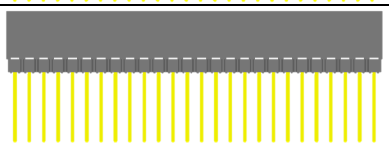
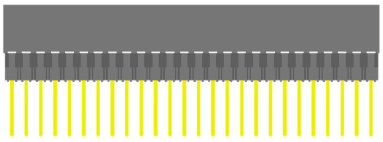
Indicate your CubeConnect selection in Option 9, below.

Option 9: CubeConnect Selection

	Selection
CubeConnect Option	Micro

Indicate the PC104 header selection to be used on for the CubeConnect selected in Option 10.

Option 10: CubeConnect PC104 Header

Samtec Header Model	Image	Pin Length above PCB (mm)	Pin Length Below PCB (mm)	✓
SSQ-126-23-G-D		8.51	8.4	○
SSQ-126-04-G-D		8.51	13.23	○
ESQ-126-38-G-D		11.05	5.76	◉
ESQ-126-39-G-D		11.05	10.59	○
ESQ-126-49-G-D		13.59	8.05	○

2.2 Sensor Configuration

The CubeSense Sun, CubeSense Nadir and CubeStar sensors connect to the CubeComputer via the CubeConnect interface board (see Figure 1).

The CubeConnect PCB has three headers located at specific locations. The location of the headers (referred to as CN1, CN2 and CN3) on the standard and micro CubeConnect respectively, is shown in Figure 5 and Figure 6. The sensor selection in Option 11 thus simply refers to the physical location of the header connecting the specific sensor to the board.

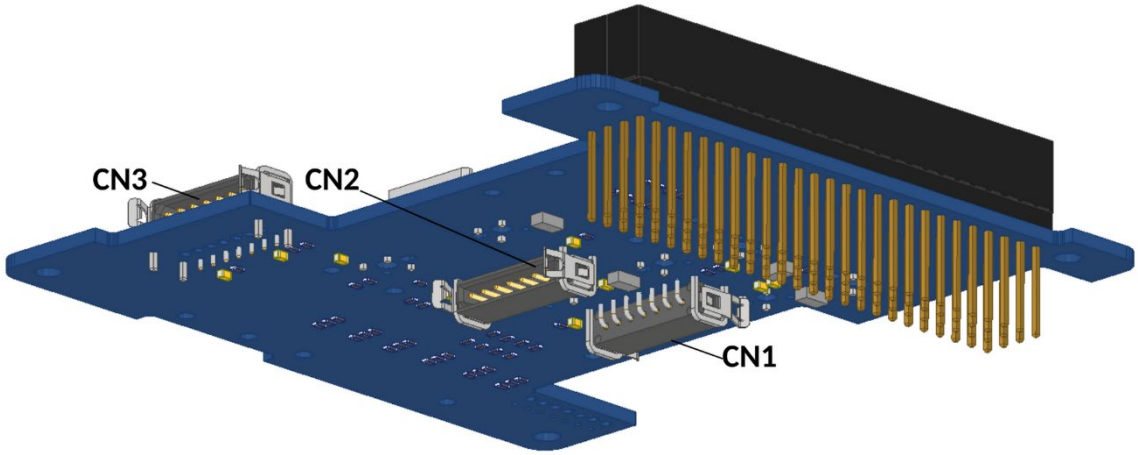


Figure 5: Standard-CubeConnect Sensor Headers

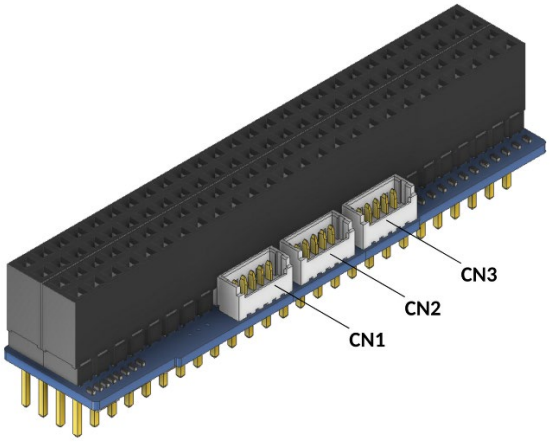


Figure 6: Micro-CubeConnect Sensor Headers

As mentioned in Section 1, the CubeADCS bundle requires pins on the PC104 header to enable/disable its various subcomponents. The locations of the respective enable pins on the PC104 header can be specified in Option 11.

An 8-way harness is used to connect CubeSense to the CubeConnect. Please indicate the desired CubeSense harness length. A 7-way harness connects CubeStar to CubeConnect via a HARWIN M80-8760722 L-Tek SIL connector set. The harness lengths are to be specified in Option 11.

The software configuration of each sensor refers to the naming used in the ACP. Figure 7 shows an example of how the software configuration is used for naming in the CubeSupport software program.

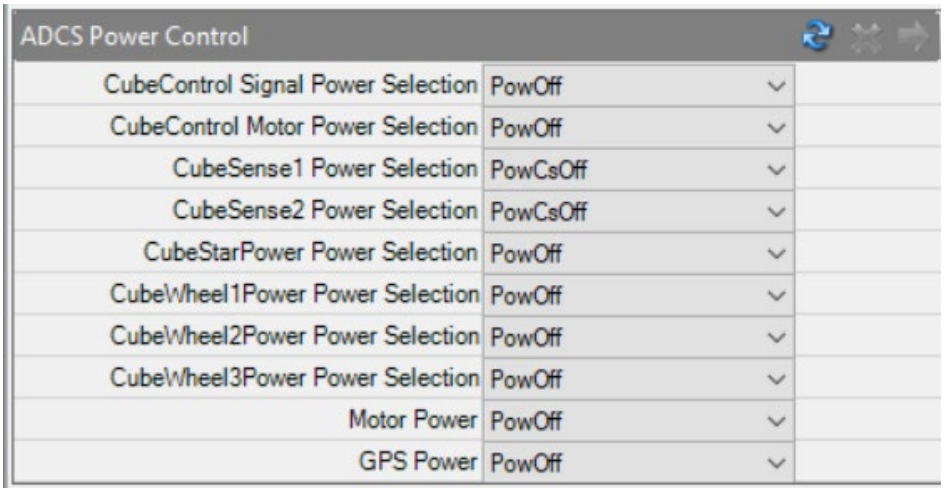


Figure 7: CubeSupport Sensor Naming Conventions

Use Option 11 as a guideline to configure the sensors that form part of this order. **Only configure the sensors that are part of the CubeADCS solution provided to you by CubeSpace.**

Option 11: CubeConnect Sensor Configuration

Header	Sensor	Configuration	PC104 Enable	Harness Length
CN1	Sun	CubeSense1	H2-20	150 mm
CN2	Nadir	CubeSense2	H1-16	250 mm
CN3	N/A	N/A	N/A	N/A

Note: **The user is responsible for** mounting the CubeSense Sun, CubeSense Nadir and CubeStar against the satellite's side-panel. If a CubeStar forms part of the CubeADCS solution, the user is responsible for sending the mounting transformation matrix for the CubeStar relative to the satellite body coordinate frame (SBC) to CubeSpace one month prior to the delivery date.

2.3 3-Axis Reaction Wheel Configuration

This section is only applicable if a 3-Axis System is included as the CubeADCS solution.

2.3.1 CubeWheel Enable Pins

Please select the locations of the enable pins for the CubeWheel(s) on the PC104 header.

Option 12: CubeWheel Enable Pin Locations on PC104

Component	Enable Pin
CubeWheel 1	H1-5
CubeWheel 2	H1-7
CubeWheel 3	H1-9

2.3.2 CubeWheel Small Mounting

If you have selected to make use of the Standard-CubeConnect and you are using small CubeWheels you have the option to have the wheel(s) mounted to your CubeConnect or not. The mounting configuration for the 3-Axis CubeADCS solution can be seen in Figure 8.

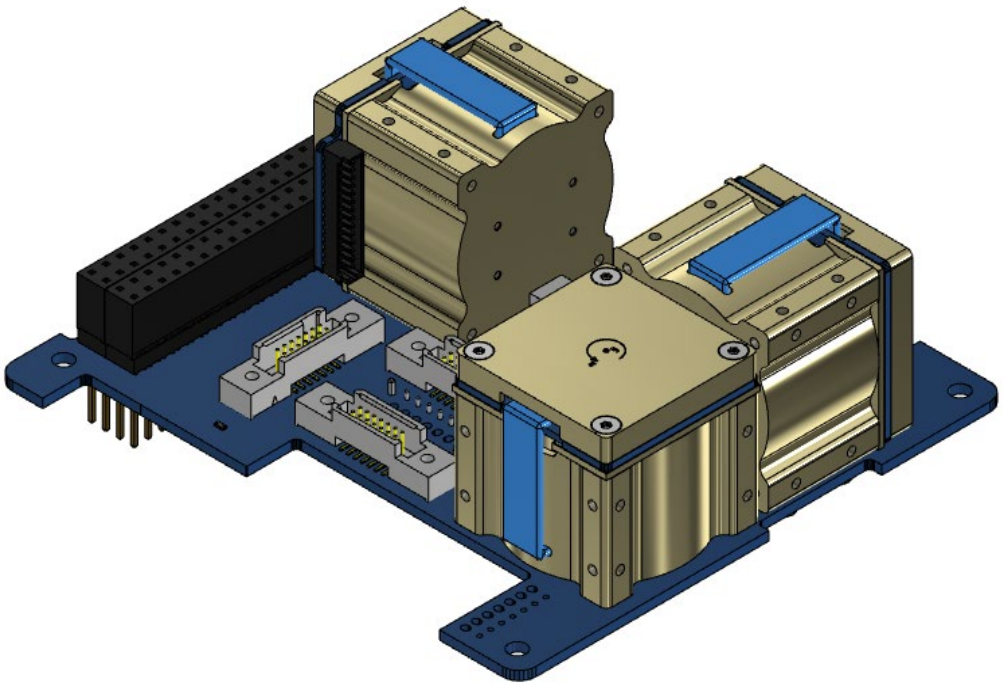


Figure 8: Standard CubeConnect with Mounted Small Wheels

This option is only available if you are making use of small CubeWheels with a Standard-CubeConnect.

Option 13: CubeWheel Small Mounting Configuration

	Selection
CubeWheel Small Mounting Configuration	Loose

2.3.3 CubeWheel Harness Lengths

If you have selected to use a CubeConnect Micro or loose small CubeWheels provided with a standard CubeConnect please provide the desired length of the harness between the CubeConnect and the CubeWheel.

If you have selected to use a Standard CubeConnect with medium or large CubeWheels then a harness can be provided with a length of either 230mm or 400mm.

Option 14: CubeWheel Small Harness Length

	Harness Length
CubeWheel 1 Harness Length	230 mm
CubeWheel 2 Harness Length	230 mm
CubeWheel 3 Harness Length	230 mm

2.4 Y-Momentum Reaction Wheel Configuration

This section is only applicable if a Y-Momentum System is included as the CubeADCS solution.

2.4.1 CubeWheel Enable Pin

Please select the locations of the enable pins for the CubeWheel(s) on the PC104 header.

Option 15: CubeWheel Enable Pin Locations on PC104

Component	Enable Pin
CubeWheel 2	N/A

2.4.2 CubeWheel Small Mounting

This section is only applicable if a small CubeWheel has been selected for Y-Momentum control.

In the case where a standard CubeConnect as a small wheel is selected, you have the option to mount Reaction Wheel 2 on CubeConnect. The mounting configuration for the 3-Axis CubeADCS solution can be seen in Figure 9. Select the small wheel mounting configuration in Option 16.

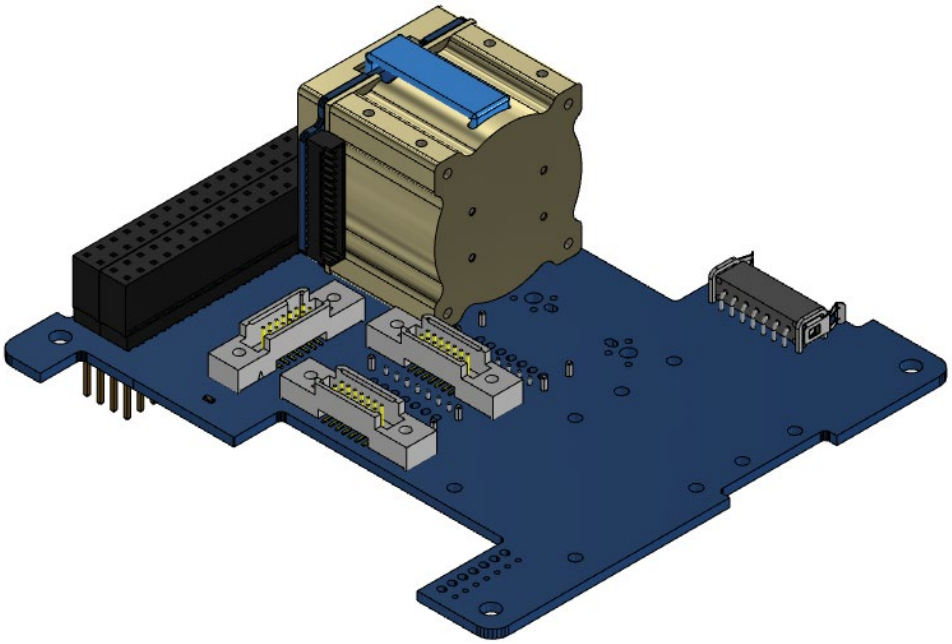


Figure 9: Standard CubeConnect with Mounted Small Wheel

This option is only available if you are making use of small CubeWheels with a Standard-CubeConnect.

Option 16: CubeWheel Small Mounting Configuration

	Selection
CubeWheel Small Mounting Configuration	N/A

2.4.3 CubeWheel Harness Length

If you have selected to use a micro CubeConnect or a loose small CubeWheel provided with a standard CubeConnect please provide the desired length of the harness between the CubeConnect and the CubeWheel.

If you have selected to use a Standard CubeConnect with a medium or large CubeWheel then a harness can be provided with a length of either 230mm or 400mm.

Option 17: CubeWheel Harness Length

	Standard Length
CubeWheel 2 Harness Length	N/A

3 CubeControl Configuration

3.1 CubeControl Enable Lines

Please select the locations of the enable pins for the CubeControl on the PC104 header.

Component	Enable Pin
CubeControl Common	H1-4
CubeControl Motor	H1-6
CubeControl Signal	H1-8

3.2 Course Sun Sensors

CubeControl interfaces with a Coarse Sun sensor (CSS) array consisting of up to ten photodiode sensors. These sensors are connected to CubeControl through a Molex PicoBlade 2-way in-line connector (L1).

There are two main configurations in which these CSS photodiodes can be attached to the satellite:

1. **Default option** – the photodiodes are individually soldered onto small 10x4.5mm PCBs (see Figure 10) which include PicoBlade connectors on a harness (L2). The photodiode PCBs are then typically epoxied onto the satellite's side-panel. An example of this configuration is shown in Figure 11.

Figure 10: Photodiode Soldered onto Small PCB

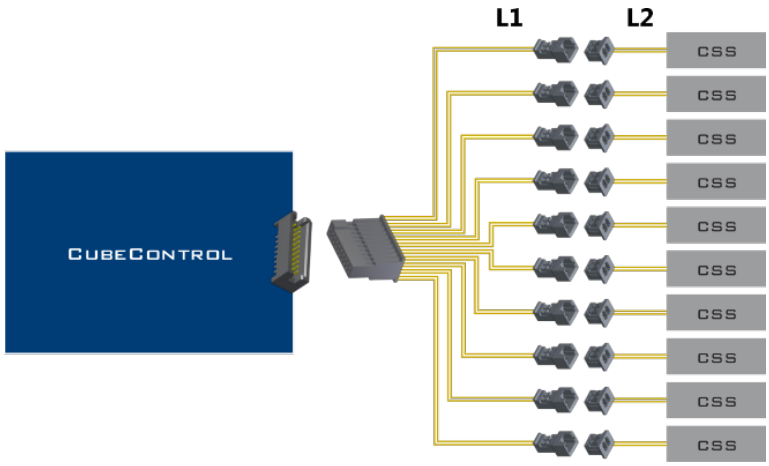


Figure 11: Coarse Sun Sensor Wiring for Option 1 (Default Assembly)

2. **Self-assembly option** - only the photodiodes, PicoBlade connectors and harness L1 (360 mm, uncrimped) are supplied, for own assembly by the user. This smaller-sized configuration is useful if the solar-panels have dedicated pads for photodiodes. An example of this configuration can be seen in Figure 12.

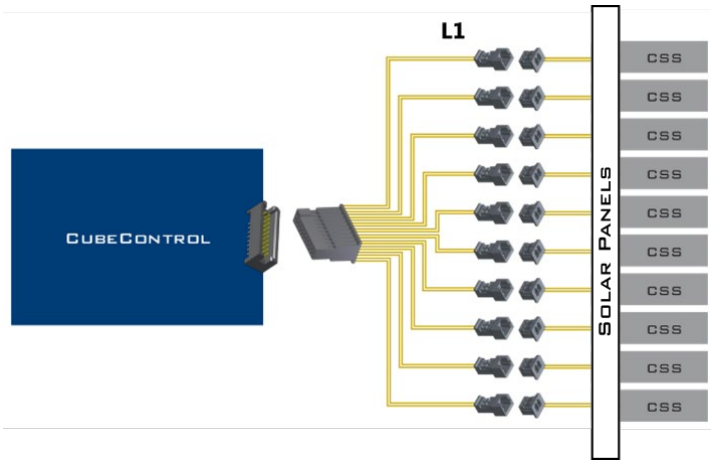


Figure 12: Coarse Sun Sensor Wiring for Option 2 (Self-assembly)

L1 harness length is configurable with a standard length of 300 mm and a maximum length of 350 mm. L2 harness length is provided in a standard length of 50 mm.

Please choose the desired CSS configuration, as well is the L1 harness length.

Option 18: Coarse Sun Sensor Configuration

	Selection
Coarse Sun Sensor Configuration	Default

Option 19 is only applicable if CSS Configuration Option 1 (Default) is selected.

Option 19: Coarse Sun Sensor L1 Configuration

	Harness Length
Coarse Sun Sensors	200

3.3 Primary Magnetometer

CubeControl interfaces with the external magnetometer using an Omnetics Nano Circular 11-way in-line connector set. The harness is terminated in an 11-way Molex PicoBlade female connector. An illustration of the magnetometer connection can be seen in Figure 13.

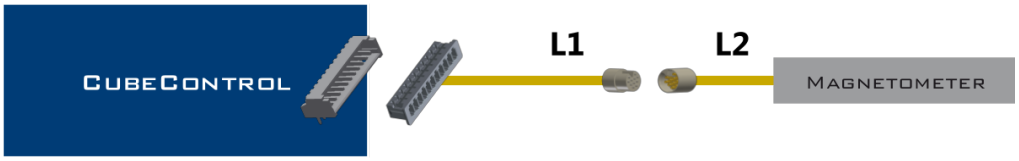


Figure 13: Magnetometer Wiring Diagram

The length of the harness on CubeControl's side of the in-line connector (L1 in Figure 13) can be configured. The length of L2 is 50 mm. Please indicate the desired magnetometer harness length.

Option 20: Primary Magnetometer Harness Length

	Harness Length
Magnetometer	150

3.4 Redundant Magnetometer

This section is only applicable if an optional redundant magnetometer is included in the ADCS solution.

CubeControl can interface with a second (redundant), non-deployable magnetometer. The redundant magnetometer, which is not supplied with the CubeADCS bundle by default, is connected to CubeControl by a 6-way wire harness.

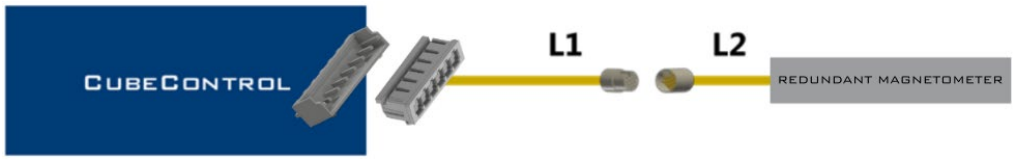


Figure 14: Redundant Magnetometer Wiring Diagram

The length of the harness on CubeControl's side of the in-line connector (L1 in Figure 14) can be configured. The length of L2 is 50 mm. Please indicate the desired redundant magnetometer harness length in Option 21.

Option 21: Redundant Magnetometer Harness Length

	Harness Length
Redundant Magnetometer	N/A

3.5 Magnetic Torquers

This section is only applicable if an upgrade to Medium or Large torquers (refer to CubeSpace quotation and/or simulation report) is included in the CubeADCS solution.

CubeControl can interface with three magnetic torquers. Depending on the size of the magnetic torquers (i.e., the magnetic dipole moment), the torquers can be mounted either in the CubeADCS stack, or separately from the CubeADCS stack (**which the user is responsible for**).

If CubeTorquer Small and CubeCoil are used, they are mounted on the CubeADCS stack by CubeSpace (no user mounting is required). However, if Medium or Large CubeTorquer rods are used, they are supplied standalone and require separate mounting within the satellite.

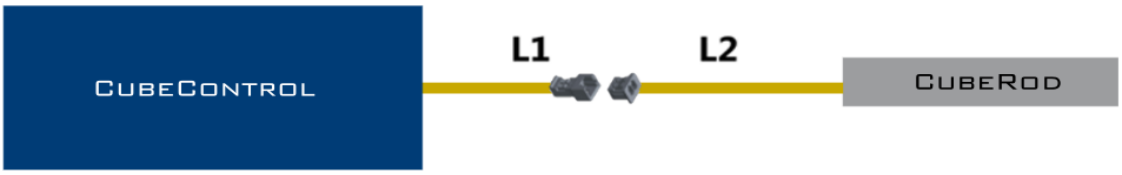


Figure 15: CubeRod Medium and Large Wiring Diagram

The length of the harness on CubeTorquer's side of the in-line connector (L2 in Figure 15) can be configured. The length of L1 is 50 mm. Please indicate the desired harness length in Option 22.

Option 22: Medium/Large CubeTorquer Rods Length

	Harness Length
Medium/Large CubeTorquer	N/A

4 Grounding Configuration

4.1.1 CubeADCS Assembly Grounding

The standard CubeSat mounting holes on the corners of the CubeADCS stack can be connected to ground if required. Please select whether to ground the mounting holes of the bundle. If you have selected small CubeWheels mounted on a Standard CubeConnect, the grounding option selected here should coincide with the CubeWheel housings grounding option selected in Section 6.4. *(Standard option: Not connected)*

Option 23: CubeADCS Mounting Holes Grounding

	Grounded	Not Connected
CubeADCS Mounting Holes	○	◉

4.1.2 CubeWheel Housings Grounding

The Aluminium housings of the CubeWheels can be connected to ground if required. Please select whether the housings should be grounded. If you have selected small CubeWheels mounted on a Standard CubeConnect, the grounding option selected here should coincide with the mounting hole grounding option selected in Section 8. *(Standard option: Not connected)*

Option 24: CubeWheel Housing Grounding

	Grounded	Not Connected
CubeWheel Housings	○	◉

Declaration

I, _____, hereby declare that I am a legal representative of _____.

Signature	Date