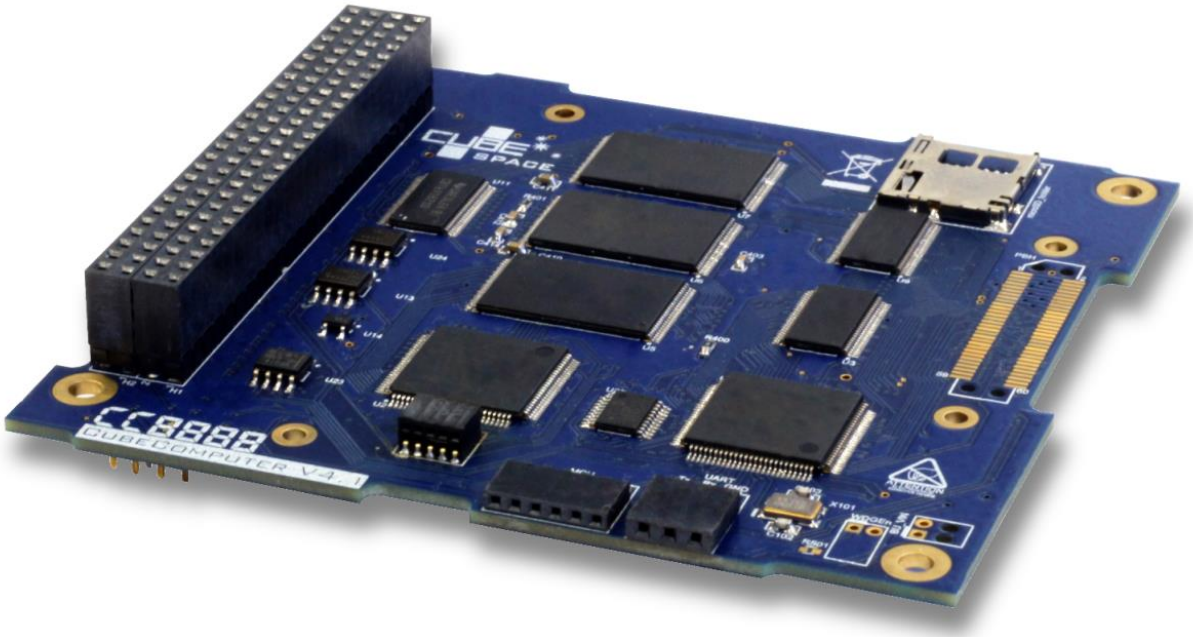
CubeComputer V4.1

General purpose on-board computer



Option Sheet

Electronic Systems Laboratory

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Table of Contents

List of Acronyms/Abbreviations

A2D	Analog-to-Digital
ADCS	Attitude and Determination Control System
CSKB	CubeSat Kit Bus
FPGA	Field Programmable Gate Array
GPIO	General Purpose Input/Output
I^2C	Inter-Integrated-Circuit
MCU	Microcontroller Unit
OBC	On-board Computer
PCB	Printed Circuit Board
RTC	Real-time Clock
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
UART	Universal Asynchronous Receiver/Transmitter
WDGEn	Watchdog Enable

1. Client Information

Company/Institution	
Name of proposed satellite	
Physical address	
Contact person	
E-mail address	
Date	

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2. Introduction

CubeSpace aims to simplify the complicated task of integrating an on-board computer (OBC) into your satellite design. Our systems are therefore highly configurable and this document allows you to customise your CubeComputer unit to meet your requirements.

If additional customisation is required, please indicate your requirements in the Additional Notes section on page 14 of this document or contact CubeSpace at info@cubespace.co.za.

The CubeComputer Datasheet is essential to understanding the various options in this document. It is recommended that the CubeComputer Datasheet should be studied before completing this document.

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3. Hardware Configuration

3.1 Power supply

CubeComputer requires a 3.3 V source on one of the PC104 pins shown in Figure 1.

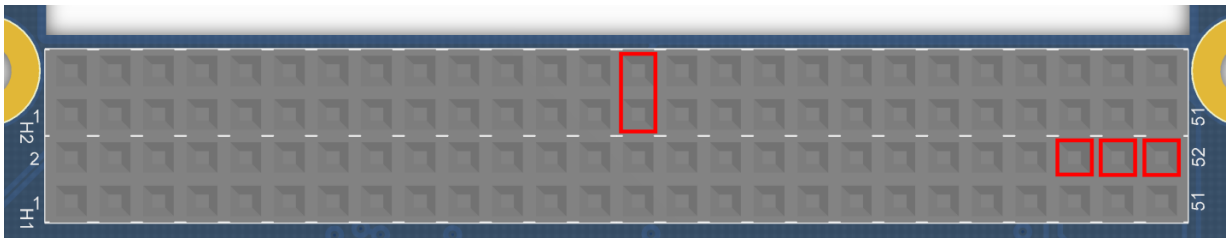

Figure 1 – Power pin positions on H1 and H2 (PC104)

Please select the source for the 3.3 V supply from the listed PC104 header pins.

Option 1 – 3.3 V supply power source selection

	H2-27,28	H1-48	H1-50	H1-52
3.3 V supply				

3.2 I²C

The MCU's secondary I²C bus can be routed to the PC104 header (H1-21,23), or it can be left unconnected. The location of the pins on H1 is shown in Figure 1.

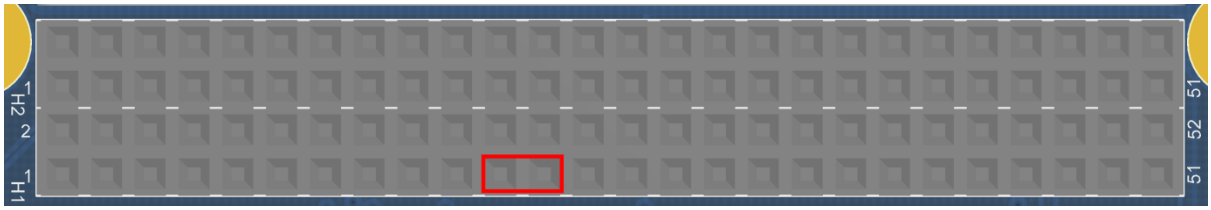

Figure 2 – Position of secondary I²C pins on H1

Please indicate the desired configuration for the secondary I²C bus.

Option 2 – Secondary I²C routing selection

	H1-21,23	Unconnected
Secondary I²C routing		

The two I²C buses on CubeComputer can be populated with bus side pull-up resistors if required. The standard value for the resistors is 1.5 kΩ. Please select or specify the required pull-up resistors for each of the two I²C buses.

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Option 3 – System I²C bus pull-up resistor value selection

	1.5 kΩ	Other (specify)	None
System I²C bus (H1-41,43)			

Option 4 – Secondary I²C bus pull-up resistor value selection

	1.5 kΩ	Other (specify)	None
Secondary I²C bus (H1-21,23)			

3.3 CAN

The CAN communication bus is optional on CubeComputer. If the CAN interface is not required, CubeComputer's power consumption can be reduced slightly by leaving the CAN electronics unpopulated. Figure 3 indicates the location of the CAN bus on the PC104 header (H1-1,3).

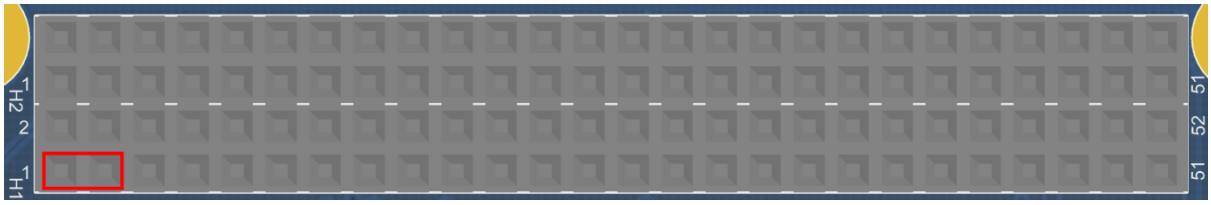

Figure 3 – Position of CAN pins on H1

Please indicate whether or not the CAN bus will be required.

Option 5 – CAN interface selection

	Yes	No
CAN electronics		

Although the CAN termination resistor has a default value of 120 Ω, an alternative value can be specified. Please select or specify the required CAN termination resistor.

Option 6 – CAN termination resistor

	120 Ω	Other (specify)	None
CAN termination resistor			

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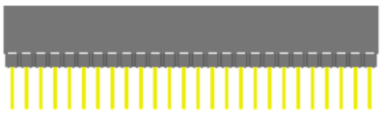
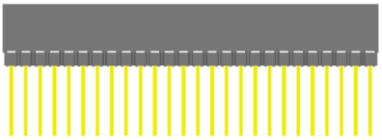
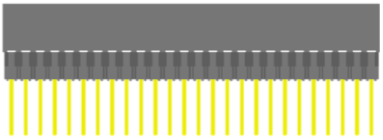
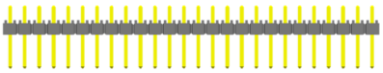
3.4 Header Configuration

3.4.1 Main PC104 header

Please select which one of the following Samtec headers should be used for the main PC104 header (H1, H2).

Option 7 – Main PC104 header selection

Samtec header model	Image	Height above PCB (mm)	Pin length below PCB (mm)	Choice (indicate with X)
SSQ-126-21-G-D		8.5	0.8	
SSQ-126-23-G-D		8.5	8.0	
SSQ-126-04-G-D		8.5	13.2	
ESQ-126-38-G-D		11.1	5.7	
ESQ-126-39-G-D		11.1	10.6	
ESQ-126-49-G-D		13.6	8.0	
TSW-126-07-G-D		3.0	4.2	

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3.4.2 Piggyback header

CubeComputer V4.1 contains a 60-pin piggyback header which can be populated with a Samtec ERF8-030-05.0-S-DV header (top and/or bottom), as shown in Figure 4, or it can be left unpopulated.

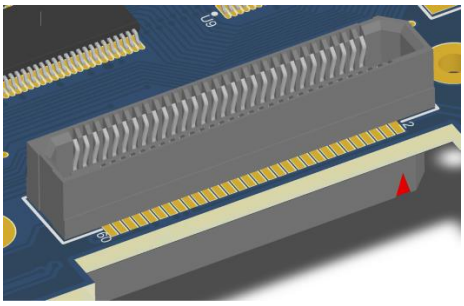

Figure 4 – Piggyback header

Please select whether or not the piggyback header must be populated.

Option 8 – Piggyback header selection

	Not populated	Top only	Bottom only	Top and bottom
Piggyback header				

3.4.3 FPGA header

The FPGA header (shown in Figure 5) is required to program CubeComputer's FPGA during assembly and testing. This header will not be used by the client and can therefore be removed before shipment if requested.

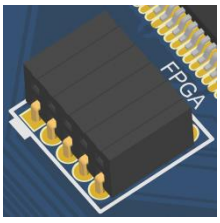

Figure 5 – FPGA header

Please indicate whether or not the FPGA header should be removed.

Option 9 – FPGA programming header selection

	Remove	Leave populated
FPGA header		

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3.4.4 BUVIN header

The EFM32GG280F1024 MCU contains a backup power domain which can be used along with the backup real time clock. The backup power domain can be powered from a backup power source though the BUVIN pin. For more information on the backup power domain, refer to the EFM32GG Reference Manual.

The BU_VIN header on CubeComputer grants direct access to the BUVIN pin (PD8, pin 54 on the MCU) and GND to allow an external power source to be attached to the pin. The BU_VIN header (Molex PicoBlade, 1.27 mm pitch, right angle, male) can be populated on the top (shown in Figure 6) or bottom of the PCB. The BUVIN pin can also be connected to the "always on" 3.3 V power supply on the PC104 header (H2-27,28; see Figure 7) through a link resistor. The BU_VIN pin can furthermore be connected to H2-42 on the PC104 header, as indicated in Figure 7.

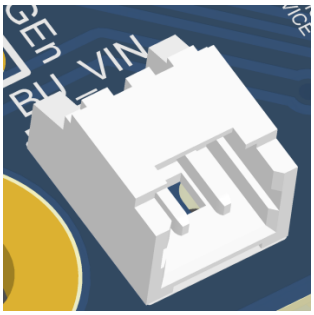

Figure 6 – BU_VIN Molex PicoBlade header

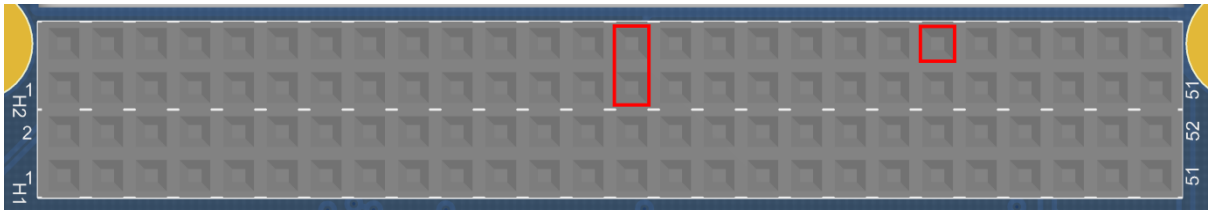

Figure 7 – BUVIN connection options on the PC104 header

Please select the desired BUVIN pin connection option(s).

Option 10 – BUVIN pin connection selection

	BU_VIN header			H2-27,28	H2-42
	Top	Bottom	None		
BUVIN pin connection					

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3.4.5 WDGE header

The Watchdog Enable (WDGEn) header can be used to permanently enable the external watchdog by placing a jumper over the header pins, as shown in Figure 8. The external watchdog can also be activated in software. The header (2 mm pitch, right angle, male) can be populated on the top or the bottom of the PCB. The watchdog can also be permanently enabled before launch by soldering one of the two link resistors (R501 on the top, R503 on the bottom) found near the header. Note that if the external watchdog is enabled, the debugging and programming of CubeComputer might be interrupted.

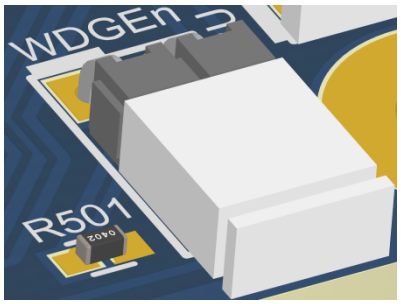

Figure 8 – Watchdog enable header

Please select whether or not the WDGEn header should be populated.

Option 11 – Watchdog enable header selection

	Populated		Not populated
	Top	Bottom	
WDGEn header			

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3.5 Additional PC104 connections

3.5.1 Analog-to-digital pins

Four analog-to-digital (A2D) pins of the MCU can be connected to specific pins on the PC104 header using link resistors. These pins can also be used as general purpose input/output (GPIO) pins or perform other functions (refer to the EFM32GG280F1024 Datasheet for more information). Please indicate the desired connection options for the A2D pins.

Option 12 – A2D pin connections to the PC104 header

MCU pin	MCU designator	PC104 pin	Connected?
50	PD4	H1-13	
51	PD5	H1-14	
52	PD6	H1-15	
53	PD7	H1-16	

3.5.2 GPIO pins

Nine GPIO pins of the MCU can be connected to specific pins on the PC104 header using link resistors. Please indicate the desired connection options for the GPIO pins.

Option 13 – GPIO pin connections to the PC104 header

MCU pin	MCU designator	PC104 pin	Connected?
21	PC3	H1-9	
26	PA7	H1-10	
		H2-15	
30	PA11	H1-5	
33	PA12	H1-8	
		H2-18	
34	PA13	H1-2	
		H2-20	
35	PA14	H1-7	
39	PB11	H1-6	
		H2-17	
40	PB12	H1-4	
		H2-19	
69	PC9	H1-11	

3.5.3 SPI

The MCU's SPI pins can be connected to specific pins on the PC104 header using link resistors. These pins can also be used as general purpose input/output (GPIO) pins or

perform other functions (refer to the EFM32GG280F1024 Datasheet for more information). Please indicate the desired connection options for the SPI pins.

Option 14 – SPI pin connections to the PC104 header

MCU pin	MCU designator	PC104 pin	Connected?
67	PE7 (SPI MOSI)	H1-31	
		H1-30	
66	PE6 (SPI MISO)	H1-30	
		H1-31	
65	PE5 (SPI CLK)	H1-29	
64	PE4 (SPI CS)	H1-32	

3.5.4 Debug UART

The Debug UART (U1) TX and RX pins can be connected to specific pins on the PC104 header using link resistors. These pins can also be used as general purpose input/output (GPIO) pins or perform other functions (refer to the EFM32GG280F1024 Datasheet for more information). Note that these connections pass through a voltage translator which acts as a protection buffer for the UART lines. Please indicate the desired connection options for the Debug UART pins.

Option 15 – Debug UART pin connections to the PC104 header

MCU pin	MCU designator	PC104 pin	Connected?
37	PB9 (Debug UART TX)	H1-17	
		H1-18	
		H1-19	
		H1-20	
		H2-21	
		H2-22	
38	PB10 (Debug UART RX)	H1-17	
		H1-18	
		H1-19	
		H1-20	
		H2-21	
		H2-22	

3.5.5 Miscellaneous UART

The Miscellaneous UART (U0) TX and RX pins can be connected to specific pins on the PC104 header using link resistors. These pins can also be used as general purpose input/output (GPIO) pins or perform other functions (refer to the EFM32GG280F1024 Datasheet for more information). Note that these connections pass through a voltage translator which acts as a

protection buffer for the UART lines. Please indicate the desired connection options for the Miscellaneous UART pins.

Option 16 – Miscellaneous UART pin connections to the PC104 header

MCU pin	MCU designator	PC104 pin	Connected?
84	PF6 (Misc. UART TX)	H1-33	
		H1-35	
		H1-39	
		H1-40	
85	PF7 (Misc. UART RX)	H1-33	
		H1-35	
		H2-39	
		H2-40	

3.6 Mounting holes

CubeComputer contains two sets of mounting holes. One set is placed on the standard CubeSat Kit Bus (CSKB) positions. The other are placed more toward the centre of the PCB to allow for the mounting of a piggyback PCB. All of these mounting holes can be connected to ground or left unconnected. Please select the desired configuration for the mounting holes.

Option 17 – Mounting hole grounding selection

	Grounded	Not connected
Main CSKB mounting holes		
Additional piggyback mounting holes		

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4. Additional Notes

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5. Terms & Conditions

The following terms and conditions are imposed on this document:

1. The "Contact Person" (listed in Section 1 of this document) must be a legal representative of the "Company/Institution" (listed in Section 1 of this document). The "Contact Person" and the "Company/Institution" will hereafter collectively be referred to as **the client**.
2. The selections made in this document will only be valid and binding after the following process has been completed:
   a. **The client** will receive an empty Option Sheet from **CubeSpace**.
   b. **The client** must send the filled and signed Option Sheet back to **CubeSpace**.
   c. After all the selected configuration options have been validated, **the client** will receive an Option Sheet Summary from **CubeSpace**, which also serves as an acknowledgement of receipt of the filled and signed Option Sheet.
   d. **The client** will receive an official quotation from **CubeSpace**.
   e. **The client** must accept the quotation received from **CubeSpace**.
   f. **The client** will receive an invoice from **CubeSpace** for the required deposit (50% of the total quotation amount).
   g. **The client** must forward the proof of payment of the required deposit to **CubeSpace**.
3. **The client** may request free-of-charge changes to certain selections made in this document within 7 (seven) days of receiving the Option Sheet Summary from **CubeSpace**.
4. Changes to the selections made in this document that are requested after 7 (seven) days of receiving the Option Sheet Summary from **CubeSpace** may result in additional costs and/or delays in delivery time.
5. Production of components will only commence once proof of payment of the required deposit has been forwarded to **CubeSpace**.
6. The standard delivery time of standalone CubeSpace components is 3 (three) months from the day on which the proof of payment of the required deposit is received by **CubeSpace**. The standard delivery time of CubeADCS bundles is 4 (four) months from the day on which the proof of payment of the required deposit is received by **CubeSpace**.
7. The aforementioned delivery time may be subject to component availability on rare occasion. **CubeSpace** retains the right to extend the delivery time by a maximum of 1 (one) month in the event of unplanned manufacturing delays. **CubeSpace** must, however, notify **the client** as soon as possible if an extension of the delivery time is expected.

Client Signature: _____

6. Declaration

I, _____, hereby declare that I am a legal representative of _____. I also declare that I have read, understand, and accept the Terms & Conditions of this document (see Section 5).

Signature	Date