http://www.cubesatkit.com/

CubeSat Kit™
Flight Motherboard

Hardware Revision: D

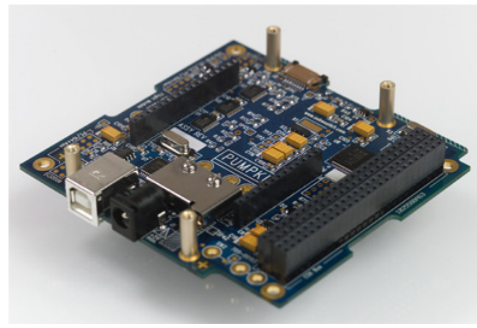
Single Board Computer Motherboard for Harsh Environments

Applications

- CubeSat nanosatellite C&DH, COM, mass storage and battery / power switching
- General-purpose low-power computing in a PC/104-size form factor
- Remote sensing for harsh environments

Features

- Open architecture – accepts pluggable Flight Processor Modules
- Compatible with a wide range of supply and I/O voltages
- Extremely low (<10µA) quiescent current
- Integrated peripherals:
  - I2C real-time clock
  - 3V Lithium backup battery
  - USB 2.0 device interface for pre-launch communications, battery charging and power
  - MMC/SD Card socket for mass storage (32MB – 2GB)
- Support for a wide range of transceivers
- Stackable 104-pin CubeSat Kit Bus connectors includes complete Flight Processor's I/O space, user-assignable signals and more
- Extensible to multiprocessor architectures, with Flight Processor reset / NMI pin on bus
- Direct wiring for 10A Remove-Before-Flight and Deployment switches
- Comprehensive overcurrent, overvoltage & undervoltage (reset) protection
- Independent latchup (device overcurrent) protection on critical subsystems
- Bus override for critical power and data/control paths
- Power consumption can be monitored externally
- Wiring-free module interconnect scheme
- PC/104-size footprint, with +5V and GND on PC/104 J1/J2 connectors
- 6-layer gold-plated blue-soldermask PCB with dual ground planes for enhanced signal integrity
- Compatible with Pumpkin's Salvo™ RTOS and HCC-Embedded's EFFS-THIN SD Card file FAT file system for ease of programming
- Backwards compatible with CubeSat Kit Rev. A through Rev. C FM430 Flight Modules

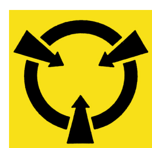


ORDERING INFORMATION

Pumpkin P/N 710-00484

Option Code	FPM Connector Height	CubeSat Kit Bus Connector[1]
/00 (standard)	+6mm	non-stackthrough
/10	+6mm	stackthrough

Contact factory for availability of optional configurations.
Option code /00 shown.



CAUTION

Electrostatic Sensitive Devices

Handle with Care

[1] Stackthrough connectors are used in CubeSat Kit configurations where the FMB is not in Slot 0.

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OPERATIONAL DESCRIPTION

The CubeSat Kit Flight Motherboard (FMB) is the fourth generation of Pumpkin's line of single-board computers (SBCs) designed for use in the CubeSat Kit and elsewhere.

Unlike earlier Pumpkin SBCs like the FM430 Flight Module[2], the FMB does not have a permanently soldered Flight Processor (FP).[3] Instead, it has a socket to accommodate a lightweight pluggable Flight Processor Module (FPM). FPMs can be sourced from Pumpkin, third parties or can be created by the end-user of a CubeSat Kit. Thus, a wide range of potential Flight Processors (e.g. MSP430, 8051, AVR®, PICmicro®, ARM®, x86, FPGA, ASIC, etc.) can be mated to the FMB via a suitable FPM.

The FMB has a flexible power scheme that permits the use of FPMs with different power and I/O requirements. All of the FMB's on-board peripheral I/O (RTC, MHX interface, USB & SD Card) is level-shifted and zero-power-isolated to interface with FPMs at any I/O voltage, from +2V to +5V.

The FMB provides the FPM socket with all of the CubeSat Kit Bus Connector I/O and power signals, as well as some dedicated and special-purpose FMB signals.[4]

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Units
Operating temperature [5]	T_A	-40 to +85	ºC
Voltage on **+5V_USB** bus			
Voltage on **+5V_SYS** bus			
Voltage on **PWR_MHX** bus		-0.3 to +6	V
Voltage on **VCC_SYS** bus			
Voltage on local **VCC** bus			
Voltage on **–FAULT** open-collector output		-0.3 to +6	V
Voltage on any I/O pin		-0.3 to (**VCC** + 0.3)	V
Voltage on local **VCC_SD** bus		-0.3 to +3.6	V
Voltage on **VBACKUP** bus		-0.3 to +3.6	V
Voltage at external +5V power connector [6]		-20 to +20	V
DC current through any pin of Flight Processor Module Connector	I_{PIN1_MAX}	1.2	A
DC current through any pin of CubeSat Kit Bus Connector	I_{PIN2_MAX}	3	A
DC current through external +5V power connector [7]	I_{EXT_MAX}	4	A
DC current through Remove-Before-Flight or Deployment Switches [8]	I_{SW_MAX}	10	A

[2] The FM430 was based on TI's MSP430 16-bit RISC microcontroller.
[3] The Flight Processor was previously referred to in Pumpkin literature as the Flight MCU.
[4] The only signals from the CubeSat Kit Bus Connector that are not presented at the Flight Processor Module Connector are the **S0**-**S5** signals (Remove-Before-Flight and Deployment Switches) and direct MHX interface signals (e.g., **-RTS_MHX**, etc.).
[5] Does not include any SD card fitted to the FMB. Typical commercial SD card operating temperatures are –20ºC to + 65ºC.
[6] Voltages between 0V and +5.5V are passed through to +5V_SYS on the CubeSat Kit Bus.
[7] Limited by a fast-blo 4A fuse.
[8] Make only. Not rated for repetitive make and break cycles of dc current.

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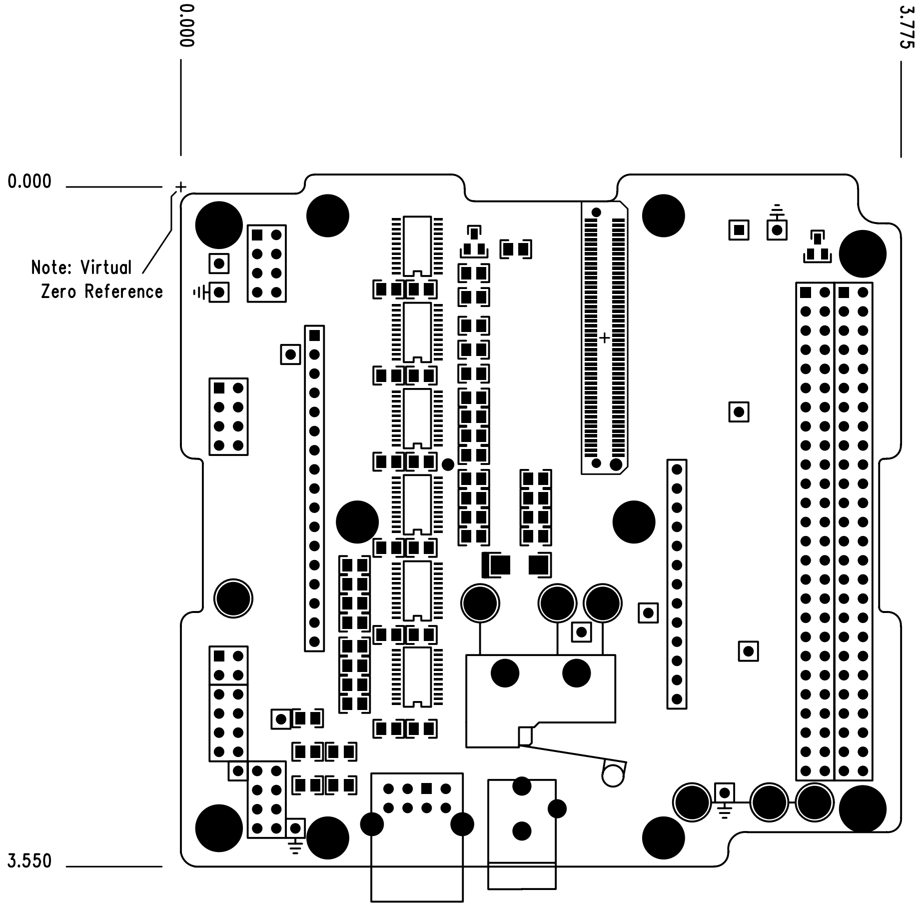
PHYSICAL CHARACTERISTICS

Parameter	Conditions / Notes	Symbol	Min	Typ	Max	Units
Mass [9]	With standoff and fastener hardware to accept a short Flight Processor Module (e.g., FPM A1) mounted 9mm above the FMB			77		g
	With FPM A1 mounted using abovementioned hardware [10]			88		
	With FPM A1 mounted using abovementioned hardware, 10mm CubeSat Kit Bus Connector extenders and 15.5mm standoffs for MHX transceiver			103		
Height of components above PCB	Without FPM, MHX transceiver or 10mm CubeSat Kit Bus Connector extenders fitted				11.4	mm
	With FPM fitted, and without MHX transceiver or 10mm CubeSat Kit Bus Connector extenders fitted				12.5	
	With MHX transceiver and 10mm CubeSat Kit Bus Connector extender fitted				24.5	
Height of components below PCB					3.5	mm
PCB width	Corner hole pattern matches PC/104			96		mm
PCB length				90		mm
PCB thickness				1.6		mm
Mating external power jack dimensions	Outer diameter				5.5	mm
	Internal diameter		2.1			
CubeSat Kit Bus Connector terminal pitch	Horizontal or vertical distance to nearest terminal			2.54		mm
Switch terminal hole diameter	For C, NO & NC switch terminals [11]			2.54		mm
Coin cell battery dimensions	Diameter			12		mm
	Height		2.0	2.5	2.5	mm

[9] With Remove-Before-Flight Switch and cover fitted. No SD Card in socket.
[10] Flight Processor Modules are not included with each Flight Motherboard, and must be purchased separately. Data supplied as an example only.
[11] Common, Normally Open and Normally Closed.

SIMPLIFIED MECHANICAL LAYOUT [12]



[12] Dimensions in inches.

ELECTRICAL CHARACTERISTICS

(T = 25ºC, +5V bus = +5V unless otherwise noted)

Parameter	Conditions / Notes	Symbol	Min	Typ	Max	Units
Operating Voltage	I/O voltage for all on-board peripherals. Individual peripherals may require higher supply voltages, e.g. +3.3V for SD Card	V_{OP}	2		5	V
Maximum external dc voltage	External dc voltage increased until protection circuitry forces disconnect	V_{EXT_TRIP}			5.5	V
Backup battery voltage	Feeds **VBACKUP** through **R20** (4.7kΩ).	V_{BT1}		3.0		V
Voltage drop from external dc power connector to **+5V_SYS** [13]	I_{IN} = 5mA	V_{EXT_DROP}			10	mV
	I_{IN} = 4A			400		
Operating current	Typical operation	I_{OP}		500		µA
	All control outputs inactive, Flight Processor asleep	I_{SLEEP}		5	10	µA
RTC crystal frequency	No external capacitors	f_{CLK_RTC}		32.768 ± 0.001		kHz
USB bus current [14]	Powered over USB	I_{USB_MAX}			500	mA
Overcurrent trip point for SD Card socket	Set by **R61**	I_{TRIP_SD}		170		mA
Overcurrent trip point for MHX transceiver socket	Set by **R23**	I_{TRIP_MHX}		2400		mA
Time to switch between **+5V_SYS** and **+5V_USB** power sources	Automatic				1	µs
Data rate through any on-board isolator (**U1**-**U3**, **U16**-**U18**)	May be reduced by non-zero inline resistors (e.g., **R9**-**R12**, **R59**) where fitted due to parasitic capacitance		50			MHz

USB DEVICE CHARACTERISTICS

Parameter	Conditions / Notes	Value
Speed [15]	USB 2.0 compatible	Low Speed (1.5Mbps) Full Speed (12Mbps)
Vendor ID (VID)		0403
Product ID (PID)		F020
Reported options	Unique serial number	/0F30
Reported serial number	Format: PUdddddd	unique to each unit
Required driver	See CubeSat Kit website	provided by Pumpkin

[13] Measured at +5V system test point **TP9**. External +5V passes through a fuse and an active overvoltage protection circuit before reaching system +5V. FMB PCB is implemented with 2oz copper to minimize resistance of power traces.
[14] The FMB's USB interface is configured at the factory to report a maximum current of 500mA for a bus-powered device to any attached USB host.
[15] Actual throughput is dependent on coding in and configuration of Flight Processor, and is often much lower.

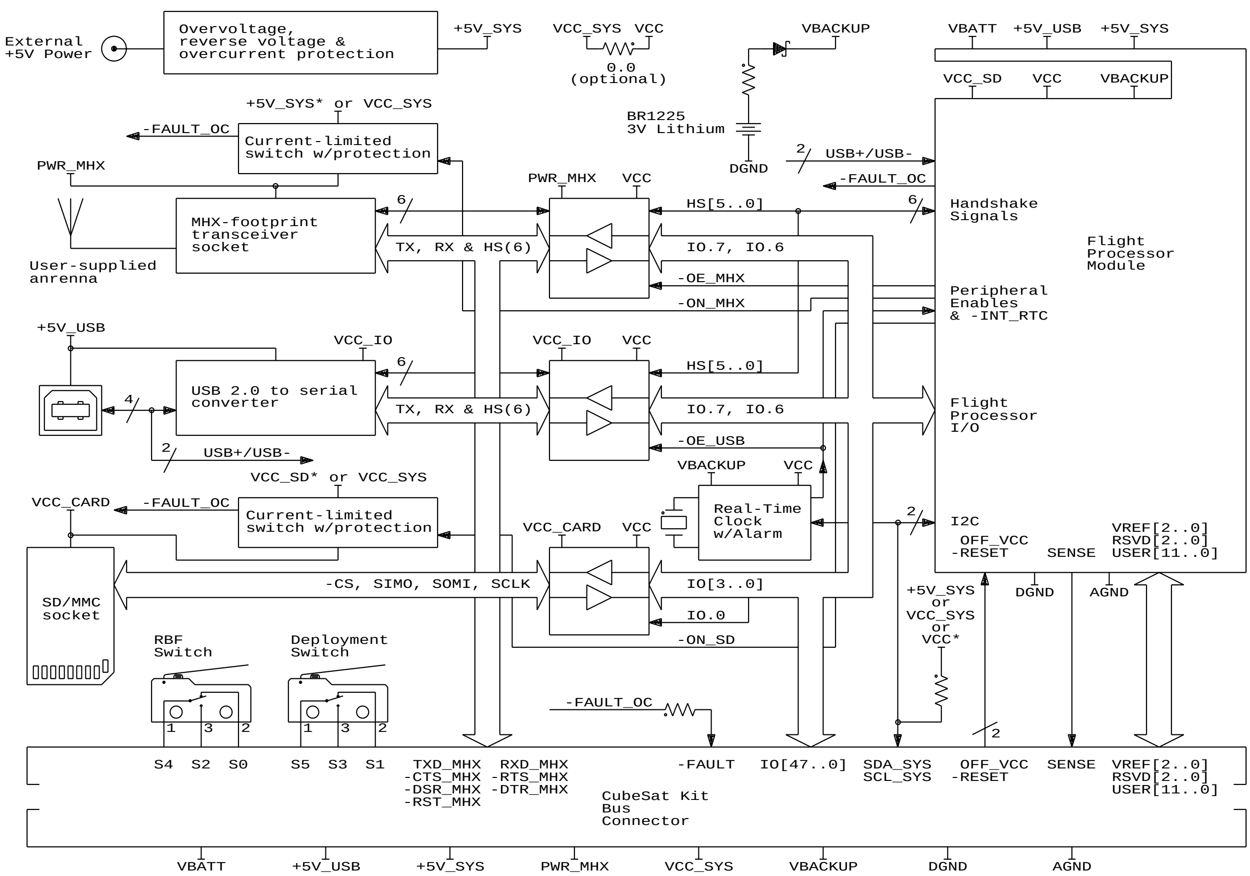
Backup Battery

The Flight Motherboard has a replaceable BR1225 3V Lithium coin cell to serve as a backup battery for real-time clocks and other components requiring battery backup of volatile information.

Battery BT1 is held in place by a coin cell battery holder in one corner of the underside of the FMB. The all-metal battery holder is oriented in such a way that once installed onto a CubeSat Kit Base Plate, the battery cannot slide out of its battery holder and is thereby physically restrained along five of six axes. However, since the battery has a conductive outer shell, excessive movement of the battery along its insertion / removal axis could result in a short if it were to contact the Base Plate. Therefore insulating Kapton tape should be applied to the battery and battery holder as shown below.

Alternately, the customer can feed **VBACKUP** on the CubeSat Kit bus via their own backup battery.

BLOCK DIAGRAM



*: Default configuration, selectable
via 0 Ohm resistors / jumpers.

Flight Processor Module PIN DESCRIPTIONS

The Flight Processor Module Connector **`H10`** connects the Flight Processor Module[16] to resources on the Flight Motherboard and to the CubeSat Kit Bus Connector.

Those signals that are connected directly between the Flight Processor Module Connector and the CubeSat Kit Bus Connectors are tagged under the CSKB label below. Signals marked with an '*' are associated with dedicated peripherals on the FMB. They may also be used with off-board peripherals through the proper use of FMB peripheral enables and FMB power control.

To/From Flight MCU on Processor Module

H10
LSS-150-02-L-DV

<->	IO.23	1	2	IO.47	<->
<->	IO.22	3	4	IO.46	<->
<->	IO.21	5	6	IO.45	<->
<->	IO.20	7	8	IO.44	<->
<->	IO.19	9	10	IO.43	<->
<->	IO.18	11	12	IO.42	<->
<->	IO.17	13	14	IO.41	<->
<->	IO.16	15	16	IO.40	<->
<->	IO.15	17	18	IO.39	<->
<->	IO.14	19	20	IO.38	<->
<->	IO.13	21	22	IO.37	<->
<->	IO.12	23	24	IO.36	<->
<->	IO.11	25	26	IO.35	<->
<->	IO.10	27	28	IO.34	<->
<->	IO.9	29	30	IO.33	<->
<->	IO.8	31	32	IO.32	<->
<->	IO.7 *	33	34	IO.31	<->
<->	IO.6 *	35	36	IO.30	<->
<->	IO.5	37	38	IO.29	<->
<->	IO.4	39	40	IO.28	<->
<->	IO.3 *	41	42	IO.27	<->
<->	IO.2 *	43	44	IO.26	<->
<->	IO.1 *	45	46	IO.25	<->
<->	IO.0 *	47	48	IO.24	<->
	+5V_USB	49	50	+5V_USB	
	+5V_SYS	51	52	+5V_SYS	
	VCC_SD	53	54	VCC_SD	
	VCC	55	56	VCC	
	DGND	57	58	DGND	
	AGND	59	60	AGND	
	VBATT	61	62	VBATT	
	VBACKUP	63	64	VBACKUP	
	VREF0	65	66	-FAULT_OC	-->
	VREF1	67	68	SENSE	-->
	VREF2	69	70	-RESET	<--
	RSVD0	71	72	OFF_VCC	<--
	RSVD1	73	74	SDA_SYS	<->
	RSVD2	75	76	SCL_SYS	-->
-->	USBDP/CB4	77	78	USER0	
-->	USBDM/CB2	79	80	USER1	
<--	-ON_SD	81	82	USER2	
<--	-ON_MHX	83	84	USER3	
<--	-OE_MHX	85	86	USER4	
<->	-OE_USB/-INT	87	88	USER5	
-->	HS0	89	90	USER6	
-->	HS1	91	92	USER7	
-->	HS2	93	94	USER8	
<--	HS3	95	96	USER9	
<--	HS4	97	98	USER10	
<--	HS5	99	100	USER11	

Flight Processor Module PIN DESCRIPTIONS – I/O

Name	Pin	I/O	CSKB	Description
`IO.0`	H10.47	I/O	•	**`-CS_SD`**. Controls SD Card interface. *Normally configured as an output from Flight Processor.*
`IO.1`	H10.45	I/O	•	**`SIMO`**. SPI master data out. *Normally configured as an output from Flight Processor.*
`IO.2`	H10.43	I/O	•	**`SOMI`**. SPI master data in. *Normally configured as an input to Flight Processor.*
`IO.3`	H10.41	I/O	•	**`SCLK`**. SPI clock. *Normally configured as an output from Flight Processor.*
`IO.4`	H10.39	I/O	•	**`TX0D`**. Tx0 data out. *Often configured as an output from Flight Processor.*
`IO.5`	H10.37	I/O	•	**`RX0D`**. Rx0 data in. *Often configured as an input to Flight Processor.*

[16] Not included. Flight Processor Modules are purchased separately from Flight Motherboards.

IO.6	H10.35	I/O	•	**TX1D**. Tx1 data out to MHX transceiver or USB. *Normally configured as an output from Flight Processor.*
IO.7	H10.33	I/O	•	**RX1D**. Rx1 data in from MHX transceiver or USB. *Normally configured as an input to Flight Processor.*
IO.8	H10.31	I/O	•	General-purpose I/O.
IO.9	H10.29	I/O	•	General-purpose I/O.
IO.10	H10.27	I/O	•	General-purpose I/O.
IO.11	H10.25	I/O	•	General-purpose I/O.
IO.12	H10.23	I/O	•	General-purpose I/O.
IO.13	H10.21	I/O	•	General-purpose I/O.
IO.14	H10.19	I/O	•	General-purpose I/O.
IO.15	H10.17	I/O	•	General-purpose I/O.
IO.16	H10.15	I/O	•	General-purpose I/O.
IO.17	H10.13	I/O	•	General-purpose I/O.
IO.18	H10.11	I/O	•	General-purpose I/O.
IO.19	H10.9	I/O	•	General-purpose I/O.
IO.20	H10.7	I/O	•	General-purpose I/O.
IO.21	H10.5	I/O	•	General-purpose I/O.
IO.22	H10.3	I/O	•	General-purpose I/O.
IO.23	H10.1	I/O	•	General-purpose I/O.
IO.24	H10.48	I/O	•	General-purpose I/O.
IO.25	H10.46	I/O	•	General-purpose I/O.
IO.26	H10.44	I/O	•	General-purpose I/O.
IO.27	H10.42	I/O	•	General-purpose I/O.
IO.28	H10.40	I/O	•	General-purpose I/O.
IO.29	H10.38	I/O	•	General-purpose I/O.
IO.30	H10.36	I/O	•	General-purpose I/O.
IO.31	H10.34	I/O	•	General-purpose I/O.
IO.32	H10.32	I/O	•	General-purpose I/O.
IO.33	H10.30	I/O	•	General-purpose I/O.
IO.34	H10.28	I/O	•	General-purpose I/O.
IO.35	H10.26	I/O	•	General-purpose I/O.
IO.36	H10.24	I/O	•	General-purpose I/O.
IO.37	H10.22	I/O	•	General-purpose I/O.
IO.38	H10.20	I/O	•	General-purpose I/O.
IO.39	H10.18	I/O	•	General-purpose I/O.
IO.40	H10.16	I/O	•	General-purpose I/O.
IO.41	H10.14	I/O	•	General-purpose I/O.
IO.42	H10.12	I/O	•	General-purpose I/O.
IO.43	H10.10	I/O	•	General-purpose I/O.
IO.44	H10.8	I/O	•	General-purpose I/O.
IO.45	H10.6	I/O	•	General-purpose I/O.
IO.46	H10.4	I/O	•	General-purpose I/O.
IO.47	H10.2	I/O	•	General-purpose I/O.

Flight Processor Module PIN DESCRIPTIONS – Power

Name	Pin	I/O	CSKB	Description
+5V_USB	H10.49 H10.50	–	•	+5V USB power. From USB host. Powers on-board USB-to-serial converter and FPM.
+5V_SYS	H10.51 H10.52	–	•	+5V system power. From EPS or external +5V connector. Powers some on-board peripherals and FPM.
VCC_SD	H10.53 H10.54	–		SD Card power. Nominally +3.3V. Sourced from FPM or from **VCC_SYS** via **R58**.
VCC	H10.55 H10.56	–		FMB power and I/O level. From +2V to +5V. Sourced from FPM or from **VCC_SYS** via **R68**.
DGND	H10.57 H10.58	–	•	Digital ground.

AGND	H10.59 H10.60	–	•	Analog ground.
VBATT	H10.61 H10.62	–	•	Battery voltage. EPS-dependent. Typically +7V to +10V.
VBACKUP	H10.63 H10.64	–	•	Battery backup voltage (e.g. for RTC's). From FMB's 3V Lithium battery **BT1**.

Flight Processor Module PIN DESCRIPTIONS – Analog References

Name	Pin	I/O	CSKB	Description
VREF0	H10.65	I/O	•	General-purpose I/O. Intended for analog voltage references.
VREF1	H10.67	I/O	•	General-purpose I/O. Intended for analog voltage references.
VREF2	H10.69	I/O	•	General-purpose I/O. Intended for analog voltage references.

Flight Processor Module PIN DESCRIPTIONS – Reserved

Name	Pin	I/O	CSKB	Description
RSVD0	H10.71	–	•	Reserved for future use.
RSVD1	H10.73	–	•	Reserved for future use.
RSVD2	H10.75	–	•	Reserved for future use.

Flight Processor Module PIN DESCRIPTIONS – FMB-Specific

Name	Pin	I/O	CSKB	Description
CB4	H10.77	I		Configurable CBUS4 signal from FT232R USB chip **U7**.
USBDP				When **U7** is not fitted and **R56** is fitted, provides the '+' half of the USB differential signal pair from **J3** to the Flight Processor.
CB2	H10.79	I		Configurable CBUS2 signal from FT232R USB chip **U7**.
USBDM				When **U7** is not fitted and **R57** is fitted, provides the '-' half of the USB differential signal pair from **J3** to the Flight Processor.
-ON_SD	H10.81	O		Control signal for SD Card power. Active LOW, pulled high on FMB. When active, enables **VCC_CARD** on FMB, thereby powering SC Card socket and SD Card level translators / isolators **U17** & **U18**.
-ON_MHX	H10.83	O		Control signal for MHX socket power. Active LOW, pulled high on FMB. When active, enables **PWR_MHX** on FMB, thereby powering MHX socket and MHX level translators / isolators **U2** & **U3**.
-OE_MHX	H10.85	O		Control signal for MHX interface. Active LOW, pulled high on FMB. When active, enables signals to pass through MHX level translators / isolators **U2** & **U3**.
-OE_USB	H10.87	O		Control signal for USB interface. Active LOW, pulled high on FMB. When active, enables signals to pass through USB level translators / isolators **U1** & **U16**.
-INT		I		Output from RTC's –IRQ open-collector output. When properly configured, can be used to interrupt Flight Processor via RTC.
HS0	H10.89	I		Handshake signal. –RTS (USB) or –CTS (MHX).
HS1	H10.91	I		Handshake signal. –DTR (USB) or –DSR (MHX).
HS2	H10.93	I		Handshake signal. –PWE (USB) or –DCD (MHX).
HS3	H10.95	O		Handshake signal. –CTS (USB) or –RTS (MHX).
HS4	H10.97	O		Handshake signal. –RI (USB) or –DTR (MHX).
HS5	H10.99	O		Handshake (reset) signal. –RST (USB) or –RST (MHX).

Flight Processor Module PIN DESCRIPTIONS – Control & Status

Name	Pin	I/O	CSKB	Description
-FAULT_OC	H10.66	O		Open-collector output from FPM's latchup prevention overcurrent switch. Active LOW. Wire-ORed to –FAULT_OC on FMB.
SENSE	H10.68	O	•	Can be used to measure FPM's current consumption. The current used by the FPM from a single source is (source – **SENSE**) / 75mΩ. Depends on FPM implementation.
-RESET	H10.70	I	•	Reset signal to FPM's reset supervisor. Active LOW.
OFF_VCC	H10.72	I	•	Control signal to FPM's power circuit(s). Active HIGH.

Flight Processor Module PIN DESCRIPTIONS – I2C Bus

Name	Pin	I/O	CSKB	Description
SDA_SYS	H10.74	I/O	•	I2C data.
SCL_SYS	H10.76	O	•	I2C clock.

Flight Processor Module PIN DESCRIPTIONS – User-defined

Name	Pin	I/O	CSKB	Description
USER0	H10.78	I/O	•	User-defined.
USER1	H10.80	I/O	•	User-defined.
USER2	H10.82	I/O	•	User-defined.
USER3	H10.84	I/O	•	User-defined.
USER4	H10.86	I/O	•	User-defined.
USER5	H10.88	I/O	•	User-defined.
USER6	H10.90	I/O	•	User-defined.
USER7	H10.92	I/O	•	User-defined.
USER8	H10.94	I/O	•	User-defined.
USER9	H10.96	I/O	•	User-defined.
USER10	H10.98	I/O	•	User-defined.
USER11	H10.100	I/O	•	User-defined.

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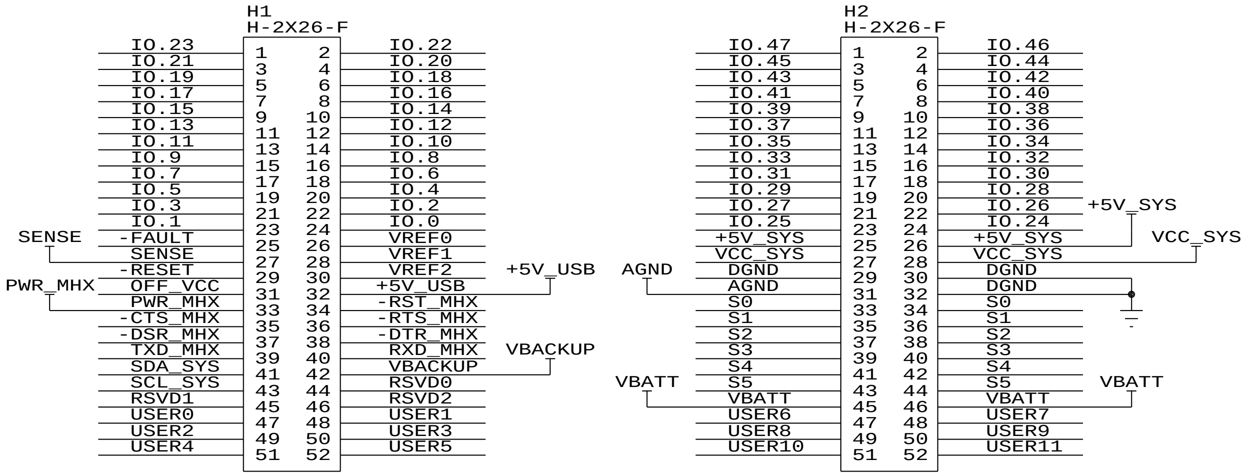
CubeSat Kit Bus PIN DESCRIPTIONS [17]

Those signals that are connected directly between the CubeSat Kit Bus Connectors and the Flight Processor Module Connector are tagged under the FPM label below.

CubeSat Kit Bus Connectors



CubeSat Kit Bus PIN DESCRIPTIONS – I/O

Name	Pin	I/O	FPM	Description
IO.0	H1.24	I/O	•	**-CS_SD**. Controls SD Card interface. *Normally configured as an output from Flight Processor.*
IO.1	H1.23	I/O	•	**SIMO**. SPI master data out. *Normally configured as an output from Flight Processor.*
IO.2	H1.22	I/O	•	**SOMI**. SPI master data in. *Normally configured as an input to Flight Processor.*
IO.3	H1.21	I/O	•	**SCLK**. SPI clock. *Normally configured as an output from Flight Processor.*
IO.4	H1.20	I/O	•	**TX0D**. Tx0 data out. *Often configured as an output from Flight Processor.*
IO.5	H1.19	I/O	•	**RX0D**. Rx0 data in. *Often configured as an input to Flight Processor.*
IO.6	H1.18	I/O	•	**TX1D**. Tx1 data out to MHX transceiver or USB. *Normally configured as an output from Flight Processor.*
IO.7	H1.17	I/O	•	**RX1D**. Rx1 data in from MHX transceiver or USB. *Normally configured as an input to Flight Processor.*
IO.8	H1.16	I/O	•	General-purpose I/O.
IO.9	H1.15	I/O	•	General-purpose I/O.
IO.10	H1.14	I/O	•	General-purpose I/O.
IO.11	H1.13	I/O	•	General-purpose I/O.
IO.12	H1.12	I/O	•	General-purpose I/O.
IO.13	H1.11	I/O	•	General-purpose I/O.
IO.14	H1.10	I/O	•	General-purpose I/O.
IO.15	H1.9	I/O	•	General-purpose I/O.
IO.16	H1.8	I/O	•	General-purpose I/O.
IO.17	H1.7	I/O	•	General-purpose I/O.
IO.18	H1.6	I/O	•	General-purpose I/O.
IO.19	H1.5	I/O	•	General-purpose I/O.
IO.20	H1.4	I/O	•	General-purpose I/O.

[17] The fact that the CubeSat Kit Bus has 104 pins (like PC/104) is purely coincidental – the original CubeSat Kit Bus used in the Rev A and Rev B FM430 had only 80 pins.

IO.21	H1.3	I/O	•	General-purpose I/O.
IO.22	H1.2	I/O	•	General-purpose I/O.
IO.23	H1.1	I/O	•	General-purpose I/O.
IO.24	H2.24	I/O	•	General-purpose I/O.
IO.25	H2.23	I/O	•	General-purpose I/O.
IO.26	H2.22	I/O	•	General-purpose I/O.
IO.27	H2.21	I/O	•	General-purpose I/O.
IO.28	H2.20	I/O	•	General-purpose I/O.
IO.29	H2.19	I/O	•	General-purpose I/O.
IO.30	H2.18	I/O	•	General-purpose I/O.
IO.31	H2.17	I/O	•	General-purpose I/O.
IO.32	H2.16	I/O	•	General-purpose I/O.
IO.33	H2.15	I/O	•	General-purpose I/O.
IO.34	H2.14	I/O	•	General-purpose I/O.
IO.35	H2.13	I/O	•	General-purpose I/O.
IO.36	H2.12	I/O	•	General-purpose I/O.
IO.37	H2.11	I/O	•	General-purpose I/O.
IO.38	H2.10	I/O	•	General-purpose I/O.
IO.39	H2.9	I/O	•	General-purpose I/O.
IO.40	H2.8	I/O	•	General-purpose I/O.
IO.41	H2.7	I/O	•	General-purpose I/O.
IO.42	H2.6	I/O	•	General-purpose I/O.
IO.43	H2.5	I/O	•	General-purpose I/O.
IO.44	H2.4	I/O	•	General-purpose I/O.
IO.45	H2.3	I/O	•	General-purpose I/O.
IO.46	H2.2	I/O	•	General-purpose I/O.
IO.47	H2.1	I/O	•	General-purpose I/O.

CubeSat Kit Bus PIN DESCRIPTIONS – Analog References

Name	Pin	I/O	FPM	Description
VREF0	H1.26	I/O	•	General-purpose I/O. Intended for analog voltage references.
VREF1	H1.30	I/O	•	General-purpose I/O. Intended for analog voltage references.
VREF2	H1.28	I/O	•	General-purpose I/O. Intended for analog voltage references.

CubeSat Kit Bus PIN DESCRIPTIONS – I2C Bus

Name	Pin	I/O	FPM	Description
SDA_SYS	H1.41	I/O	•	I2C data.
SCL_SYS	H1.43	O	•	I2C clock.

CubeSat Kit Bus PIN DESCRIPTIONS – Control & Status

Name	Pin	I/O	FPM	Description
-FAULT	H1.25	O	•	Open-collector output. Active LOW. Active when an overcurrent fault condition is detected by any of the FMB's or FPM's latchup prevention overcurrent switches. With series 4.7kΩ resistor. Normally pulled up externally to **VCC_SYS** or **+5V_SYS**.
SENSE	H1.27	O	•	n be used to measure FPM's current consumption. The current used by the FPM from a single source is (source – **SENSE**) / 75mΩ. Depends on FPM implementation.
-RESET	H1.29	I	•	Reset signal to FPM's reset supervisor. Active LOW.
OFF_VCC	H1.31	I	•	Control signal to FPM's power circuit(s). Active HIGH.

CubeSat Kit Bus PIN DESCRIPTIONS – RBF and Launch Switches

Name	Pin	I/O	FPM	Description
S0	H2.33 H2.34	–		Switch terminal. Normally connected to RBF Switch normally closed (NC) terminal.
S1	H2.35 H2.36	–		Switch terminal. Normally connected to Deployment Switch normally closed (NC) terminal.
S2	H2.37 H2.38	–		Switch terminal. Normally connected to RBF Switch normally open (NO) terminal.
S3	H2.39 H2.40	–		Switch terminal. Normally connected to Deployment Switch normally open (NO) terminal.
S4	H2.41 H2.42	–		Switch terminal. Normally connected to RBF Switch common (C) terminal.
S5	H2.43 H2.44	–		Switch terminal. Normally connected to Deployment Switch common (C) terminal.

CubeSat Kit Bus PIN DESCRIPTIONS – Power

Name	Pin	I/O	FPM	Description
VBATT	H2.45 H2.46	–	•	Battery voltage. EPS-dependent. Typically +7V to +10V.
+5V_USB	H1.32	–	•	+5V USB power. From USB host.
+5V_SYS	H2.25 H2.26	–	•	+5V system power. From EPS or external +5V connector.
PWR_MHX	H1.33	–	•	MHX transceiver power. Derived from **+5V_SYS** or **VCC_SYS** system power. Under FPM control. The current used by the MHX transceiver is (**+5V_SYS** – **PWR_MHX**) / 75mΩ or (**VCC_SYS** – **PWR_MHX**) / 75mΩ, depending on the source of MHX power. Can be overridden by feeding **+5V_SYS** or **VCC_SYS** directly into **PWR_MHX**.
VBACKUP	H1.42	–	•	Battery backup voltage (e.g. for RTC's). From FMB's 3V Lithium battery **BT1**.
VCC_SYS	H2.27 H2.28	–	•	VCC system power. Normally generated by EPS. Not normally connected to FMB's local VCC.
AGND	H2.31	–	•	Analog ground.
DGND	H2.29 H2.30 H2.32	–	•	Digital ground.

CubeSat Kit Bus PIN DESCRIPTIONS – Transceiver Interface

Name	Pin	I/O	FPM	Description
-RST_MHX	H1.34	I		Reset input to transceiver. Active LOW.
-CTS_MHX	H1.35	O		Clear-to-send output from transceiver. Active LOW.
-RTS_MHX	H1.36	I		Request-To-Send input to transceiver. Active LOW.
-DSR_MHX	H1.37	O		Data Set Ready output from transceiver. Active LOW.
-DTR_MHX	H1.38	I		Data Transmit Ready input to transceiver. Active LOW.
TXD_MHX	H1.39	I		Transmit data input to transceiver. Idles HIGH.
RXD_MHX	H1.40	O		Receive data output from transceiver. Idles HIGH.

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CubeSat Kit Bus PIN DESCRIPTIONS – User-defined

Name	Pin	I/O	FPM	Description
USER0	H1.47	I/O	•	User-defined.
USER1	H1.48	I/O	•	User-defined.
USER2	H1.49	I/O	•	User-defined.
USER3	H1.50	I/O	•	User-defined.
USER4	H1.51	I/O	•	User-defined.
USER5	H1.52	I/O	•	User-defined.
USER6	H2.47	I/O	•	User-defined.
USER7	H2.48	I/O	•	User-defined.
USER8	H2.49	I/O	•	User-defined.
USER9	H2.50	I/O	•	User-defined.
USER10	H2.51	I/O	•	User-defined.
USER11	H2.52	I/O	•	User-defined.

CubeSat Kit Bus PIN DESCRIPTIONS – Reserved

Name	Pin	I/O	FPM	Description
RSVD0	H1.44	–	•	Reserved for future use.
RSVD1	H1.45	–	•	Reserved for future use.
RSVD2	H1.46	–	•	Reserved for future use.

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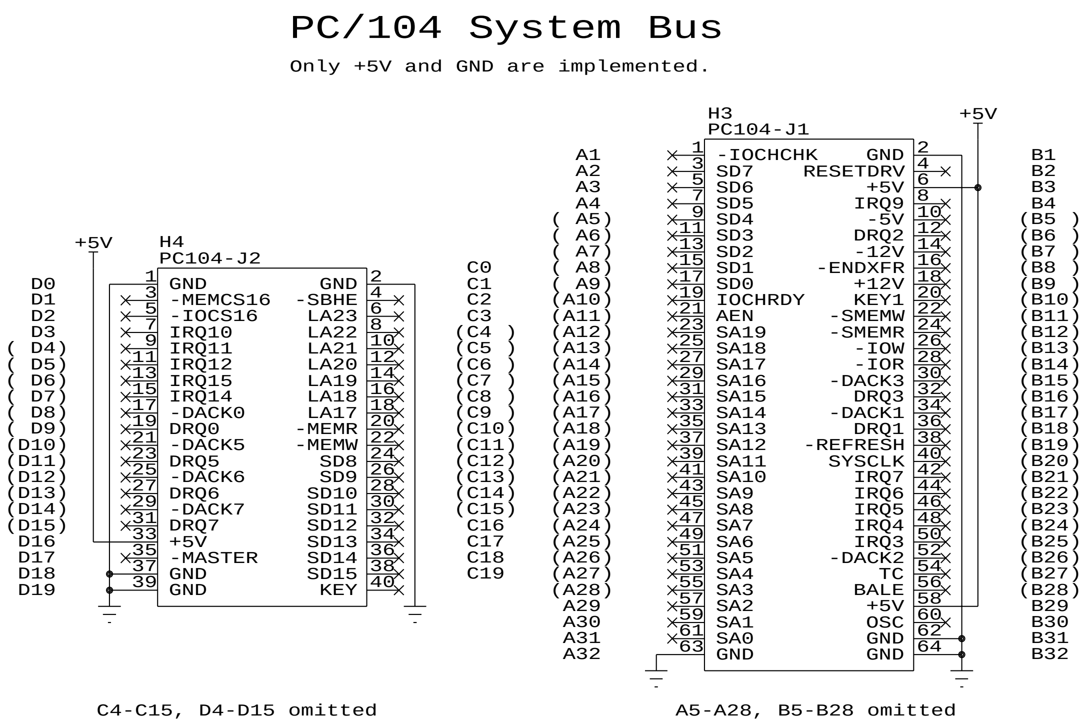
PC/104 System Bus PIN DESCRIPTIONS



The FMB implements a subset of the PC/104 specification in the form of two connectors that provide only +5V and GND for PC/104 modules. Only a total of 32 pins are implemented, 16 on **J1** and 16 on **J2**. By adding up to 4 8-pin connectors to the FMB, PC/104 modules can be plugged directly into the FMB to obtain +5V power and GND. No other connections between the PC/104 bus and the CubeSat Kit Bus are provided.

CONNECTORS

Item	Description	Source	Part Number	Application
1	52-pin non-stackthrough	Samtec[18]	ESQ-126-37-G-D	CubeSat Kit Bus connector for non-stackthrough applications (e.g., FMB option /00).
2	52-pin stackthrough	Samtec	ESQ-126-39-G-D	CubeSat Kit Bus connector for stackthrough applications (e.g., FMB option /10).
3	52-pin	Samtec	SSQ-126-22-G-D	CubeSat Kit Bus connector 10mm extension.
4	8-pin non-stackthrough	Samtec	ESQ-104-37-G-D	CubeSat Kit PC/104 power connector for non-stackthrough applications.
5	8-pin stackthrough	Samtec	ESQ-104-39-G-D	CubeSat Kit PC/104 power connector for stackthrough applications.
6	8-pin	Samtec	SSQ-104-22-G-D	CubeSat Kit PC/104 power connector 10mm extension.
7	100-pin, hermaphroditic	Samtec	LSS-150-02-L-DV	Flight Processor Module Connector (standard)

Items 1-6: Non-stackthrough connectors are normally fitted only to an FMB and form an endpoint to the CubeSat Kit Bus connector stack. Stackthrough connectors are normally fitted to all other modules (e.g. EPS modules). The normal stacking height is 15mm between modules. The 10mm extension can be used to increase this distance, e.g. to 25mm. 8-pin connectors are used to provide +5V and GND (only) to PC/104 modules.

[18] http://www.samtec.com/, 1-800-SAMTEC9.

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This connector information is provided for reference only.

REPLACEMENT FUSES

The overcurrent fuse **F1** protects only against overcurrent conditions drawing too much current from the external +5V dc supply. It is soldered in place. The replacement fuse is LittleFuse 0451004.MRL, 4A, 125V, fast-acting Nano SMF Fuse, and is available e.g. through Digi-Key®. Should replacement be required, it should be replaced by the factory or by a qualified electronics technician.

BACKWARDS COMPATIBILITY

Please note the following when replacing a Rev C FM430 with a Rev D FMB:

- **H8**: The RSSI breakout connector for the MHX transceiver is no longer supported and is not present on the FMB.

Users with older (i.e., Rev A or Rev B) FM430s should consult the FM430 Rev C datasheet for issues concerning backwards compatibility.

MHX WIRELESS TRANSCEIVER COMPATIBILITY

The FMB is designed to interface directly to Microhard Corporation's[19] line of MHX OEM wireless transceiver modules, and any other footprint-compatible transceivers. The mechanical interface is through four M2.5 F/F threaded standoffs at a prescribed height of 15.5mm above the FMB PCB. The electrical interface is through the FMB's **H5** connectors, which connect the MHX module to the FMB via the MHX pins 1-17 and 21-33 only.[20] Because of minor physical differences between the earlier (e.g., MHX-2400) and later (e.g., MHX-2420) Microhard transceivers, the FMB as supplied from the factory supports only later transceivers. The FMB uses a high-side switch capable of supplying currents to the transceiver greatly in excess of the Rev A through Rev C's 1.2A.

[19] http://www.microhardcorp.com/.

[20] These pins were originally No Connect (NC) on the MHX-2400 and similar modules. Later versions use these pins. The functionality of most of these additional pins is not required to operate these newer MHX modules (e.g,. MHX-2420), and hence they are backwards-compatible with the earlier MHX modules.

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