

# SpaceCube v2.0 Hybrid Data Processing System

## Features

- Flexible flight data processing system
- In-flight reconfigurable
- 3U modular form factor, 4 slots
- Supports up to 6 defense-grade and/or space-grade Xilinx Virtex 5 FPGAs
- Suite of mission-unique interface cards
- Applicable to all mission classes



SpaceCube v2.0 Pictured with 1 Power Card, 2 Processor Cards, 1 Digital I/O Card

## Description

SpaceCube is a cross-cutting, in-flight reconfigurable Field Programmable Gate Array (FPGA) based on-board hybrid data processing system developed at the NASA Goddard Space Flight Center. The goal of the SpaceCube program, which started in 2005, is to provide 10x to 100x improvements in on-board computing capability while lowering relative power consumption and cost. The SpaceCube v2.0 base system is comprised of a power card, processor card, backplane card, and chassis. Two additional slots are available for more processor cards or mission-unique interface cards, and the chassis is easily scalable to support larger configurations.

## Applications

- Real-Time instrument processing
- Autonomous Operations / Robotic Servicing
- Mission-critical computing
- Real-time Event / Feature Detection
- Gigabit interfacing
- On-board classification
- Intelligent data compression
- Real-time situational awareness
- Data volume reduction
- Inter-platform collaboration
- High speed data routing
- Multi-processor computing
- Adaptive processing applications

## Specifications

|                     |   |
|---------------------|---|
| Size                | 25 x 20 x 15 cm   |
| Weight              | 4.5 kg (base system)  |
| Power               | < 20W (base system)   |
| Temp                | -35C to +55C  |
| Standard Interfaces | RS422, LVDS, SpaceWire, SerDes, LVCMOS/LVTTL, 10/100 Ethernet, JTAG |
| FPGAs Supported     | XQR5VFX130-CN1752<br>XC5VFX130T-FF1738 (contains 2 PowerPC 440)     |
| Radiation           | TID > 50KRad (w/o shielding)<br>SEL immune, SEE tolerant            |

## Flight Heritage

- Restore-L Payload Control Computer (2021)
- Robotic Refueling Mission 3 (current)
- Raven AR&D Instrument (current)
- ISE 2.0 (2013-15)
- NavCube on STP-H6 (2019)
- 7 earlier version SpaceCube payloads totaling 12 years of operation

## Contact Information

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## Processor Card Features

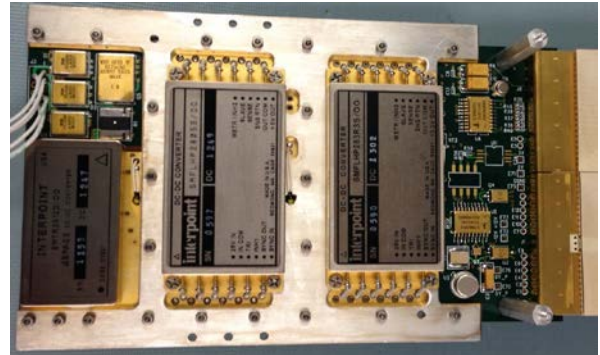
- 2x Xilinx Virtex 5 FPGAs, 8W/ea. allocation
- 1x system controller FPGA
- 4x 512MB DDR1
- 2x 4GB NAND Flash
- 1x 16MB SRAM with EDAC
- External Interfaces: 4x SerDes, 88 GPIO or 44 LVDS, 8x RS422 or LVDS
- Debug: 4x UART, 10/100 Ethernet, JTAG
- 16-ch Housekeeping A/D



- IPC 6012B Class 3/A
- Optional heat sink (if necessary)

## Power Card Features

- 28V +/- 6V, triple redundant inputs
- Configurable in-rush limiter, default < 7A
- EMI filtering
- 5.0V: 80W 3.3V: 53W +/- 12V: 30W
- Power On Reset generation
- Power Loss Warning signal, default < 22.4V
- Redundant input current sensors
- 4x Temperature monitors
- Supports doubling 5.0V or 3.3V power service
- Supports master/slave ganging of two cards



- > 1Mohm primary/secondary isolation
- Integrated heat sink

## Catalogue of Interface Cards

| Card                       | Function   | Power | Interfaces   |
|----------------------------|--|-------|--|
| Basic I/O Card (Restore-L) | Configurable RS422/LVDS buffers, RS485 bus support                               | < 3W  | 40x LVDS/422 inputs, 8x RS485<br>8x LVDS/422 outputs                           |
| Digital Card (RRM3)        | Standard interfaces to ISS<br>Wireless Ethernet interfacing<br>Discrete services | < 4W  | 2x 10BASE-T Ethernet<br>1553 A/B, 10x discrete outputs<br>14x RS422/LVDS pairs |
| Analog Card (RRM3)         | 15-bit A/D conversion, up to 200KHz<br>5KHz sample rate for 40 channels          | < 4W  | 31x 4-Wire, 16x 2-wire sensors<br>28x analog inputs                            |
| GPS RF Card (NavCube)      | Required card for NavCube<br>Weak signal GPS receiver, L1/L2C                    | < 4W  | 2x SMA female  |
| Digitizer Card (Kodiak)    | 1.524 GHz high-speed ADC, 12-bit<br>Required card for Kodiak Lidar               | < 9W  | 2x ADC inputs  |
| Front End Interface Card   | Interface/Telemetry circuits<br>Required card for Kodiak Lidar                   | < 1W  | 2x RS485; PPS in/out<br>5V, +/-12V out   |
| Laser Card (Kodiak)        | Fiber laser ranging assembly<br>Required card for Kodiak Lidar                   | < 20W | Laser/seed fiber optic<br>Laser status input, GSE                              |
| Waveform Generator Card    | 2-channel D/A, 14-bit 160MSPS, 1553<br>Ideal for radar transmitter               | < 12W | 2x analog out, 1x clock in<br>1553, LVDS/422, discrete                         |
| Digital Receiver Card      | 4-channel A/D, 14-bit 160MSPS<br>Ideal for digitizing reflected radar signals    | < 12W | 4x analog in, 1x clock in<br>8x LVDS/422                                       |