



FRONTGRADE

ADVANCED PRODUCT BRIEF

Frontgrade RPS-9X

Frontgrade Reprogrammable Processor System 9-slot eXtensible

8/23/2024

Version #: 1.0.3

Introduction

The Frontgrade™ Reprogrammable Processing System™ 9-slot eXtensible (RPS-9X) includes the Reprogrammable Processing Module (RPM) with an AMD/Xilinx® XQR-Grade VC1902 System-on-Chip (SoC) with dual A72 ARM cores (up to 1.7 GHz) and dual Cortex-R5 cores for up to 3 instances across Slot 1 to Slot 3. Programmable logic may be implemented by the end user to allow high-throughput SpaceWire and Ethernet data switching. The compact 160mm 3U design with a customizable mezzanine allows for tailoring I/O to meet program requirements. Provides high speed data at up to 10 Gbps between processors and the 8-port Ethernet I/O module in Slot 4. An analog RF input can sample to 10.25 Gbps of raw digitized data in Slot 5 to the RPM in Slot 2 for signal processing and converted analog output to RF downlink. The optional RPM in Slot 3 can provide additional I/Os to a spare I/O module slot in Slot 6. The development dongle is available to access the I/O on each RPM using JTAG, UART, or 1000Base-T Ethernet for software development.

Reprogrammable Processing Module: RPM

Features

Processing / Data Rates / Connectivity:

- Processor: Versal® VC1902 System-on-Chip (SoC) with dual A72 ARM™ cores (up to 1.7 GHz) and dual Cortex-R5® cores (up to 750 MHz)
- Volatile Memory: 16 GB DDR4 memory
- Non-Volatile Boot Memory: 8 Gbits QSPI memory
- Non-Volatile Storage: 1Tb maximum of raw data storage in SLC mode

When Configured With The RPS™ Mezzanine Card In Any RPM Slot:

- Three 100Base-TX and one 1000Base-T ports
- One SpaceWire port of up to 200 Mbps per port and two RS422 UARTs up to 115.2 kbps
- Discrete IOs: 1x LVDS inputs, 2x LVDS pulse output, 1x LVDS SPI, 1x LVTTTL/LVCMOS input, 1x LVTTTL/LVCMOS output
- For each RPM front panel, two SGMII Current Model Logic (CML) channels at 1.25 Gbauds per second per channel
- Slot 4 Ethernet I/O module offers up to eight 1000/2.5G/5G/10GBase-T ports (same data rate for every four ports)
- Slot 5 one Analog RF input with a 12-bit ADC and one Analog RF output with a 16-bit DAC

Mass / Volume / Thermal:

- Mass: less than 10 kg (estimated)
- Dimensions: 13.75" (L) x 8.25" (W) x 4.2" (H), ICD including mounting hole pattern
- Maximum operating temperature mounted on a regulated thermal interface: 52°C
- Maximum power consumption: 300W with 288W output for all slots including the two RPMs (80W maximum for each Versal SoC 0.8 Vdc core voltage depending on the dynamic power utilization for all cards as a system)

Operational Life/Reliability and Performance (With Two RpmS):

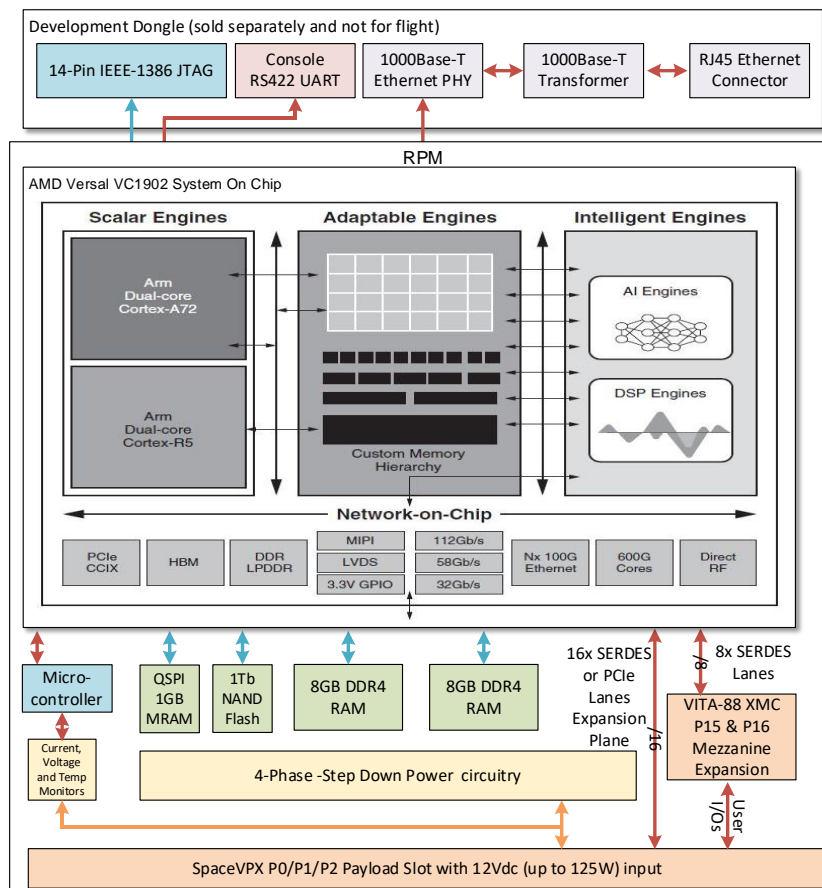
- System reliability over 0.87
- System SEU rate: No more than one per 10 months for typical LEO Missions
- TID of 25 krad(Si) or 100 krad(Si) optional assuming 100 mils of shielding with 6061-T6 Aluminum
- Level-2 parts pedigree per EEE-INST-002 and PEM-INST-001 is available

Development Environment:

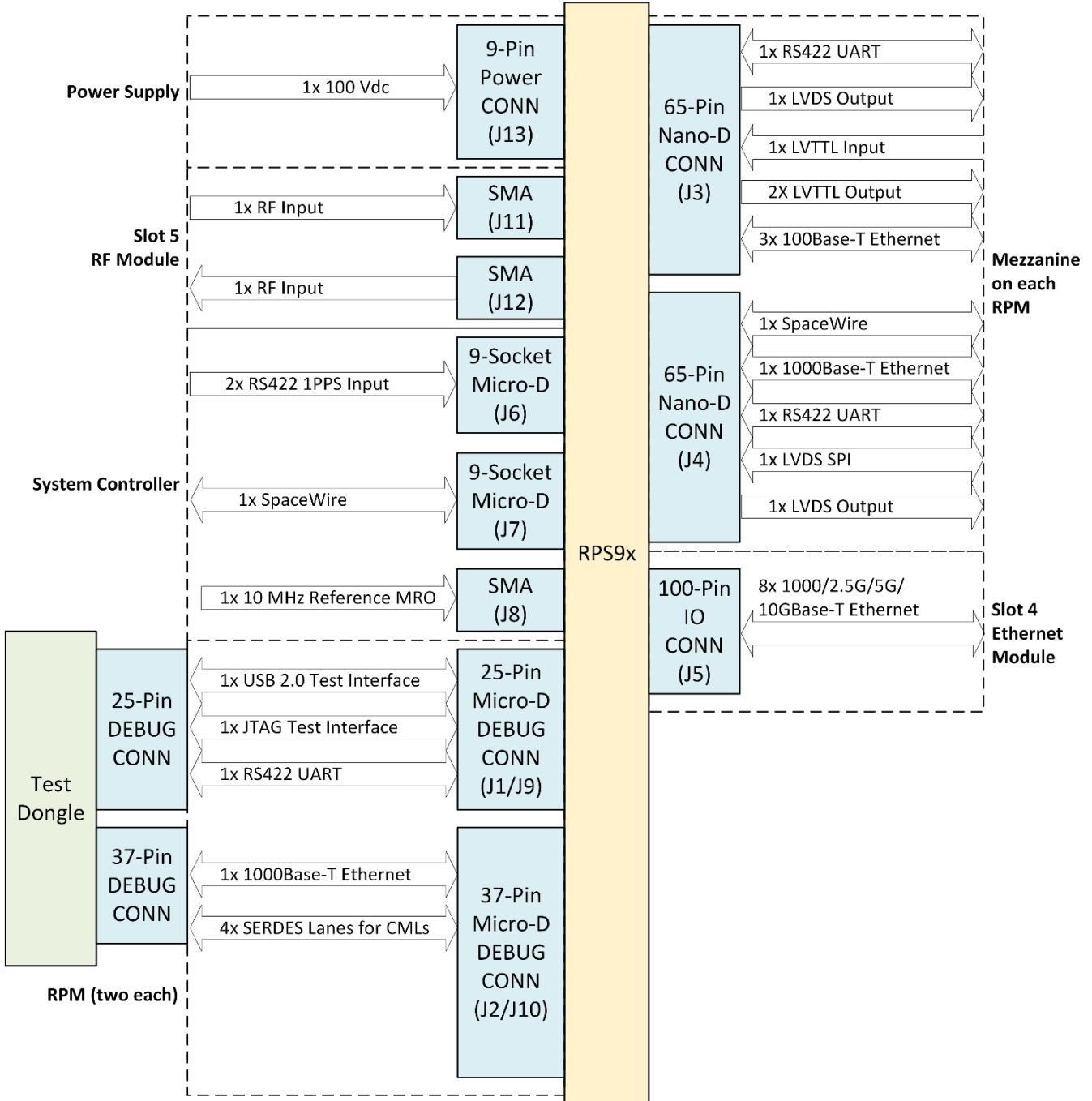
- Separate development dongle for interface with SmartLynq+ System Debugger
- Vivado® 2023.2 development environment with Petalinux Linux Support Package (LSP)



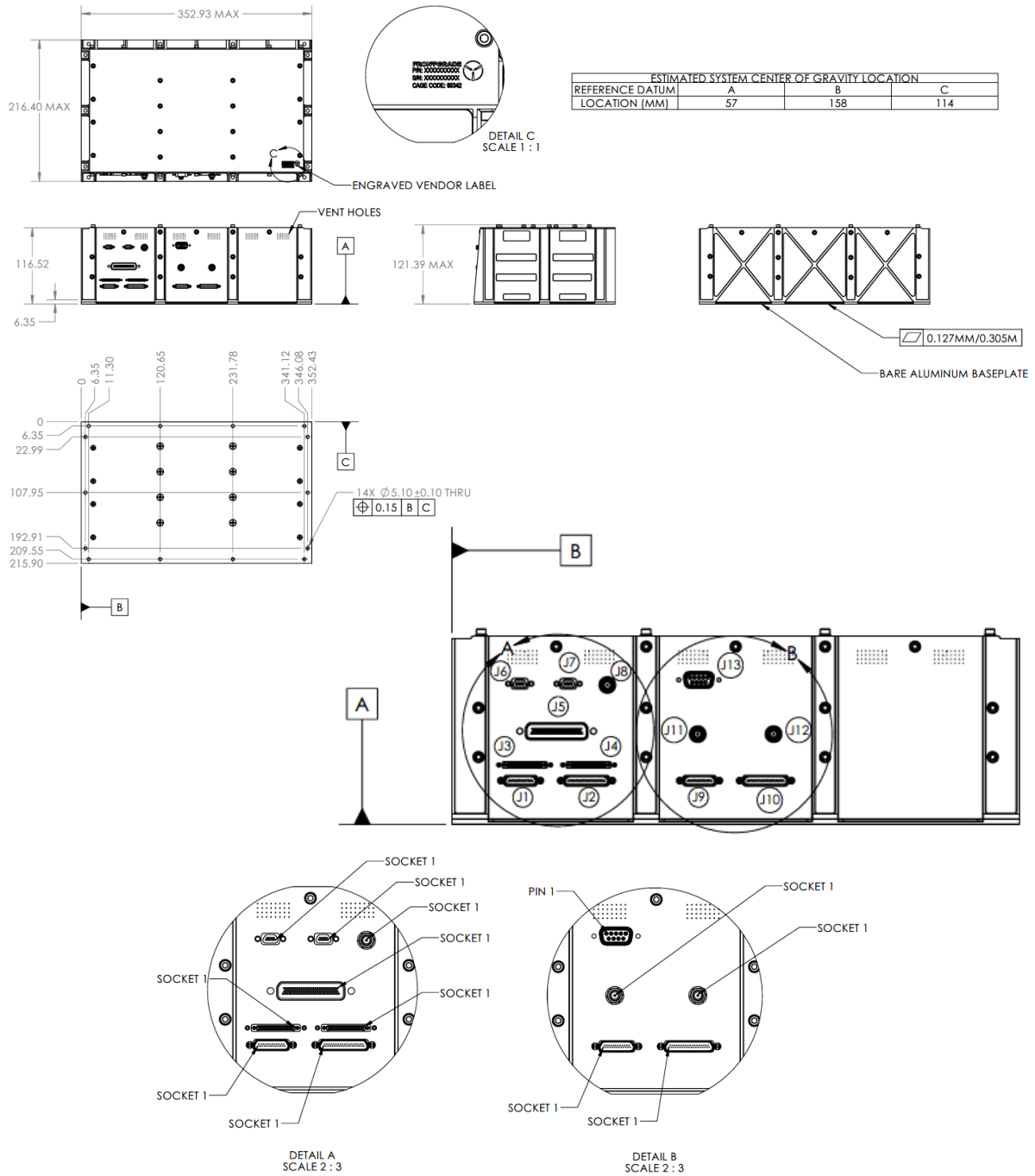
Frontgrade RPS-9X System Iso View (Top) and RPM Block Diagram (Bottom)



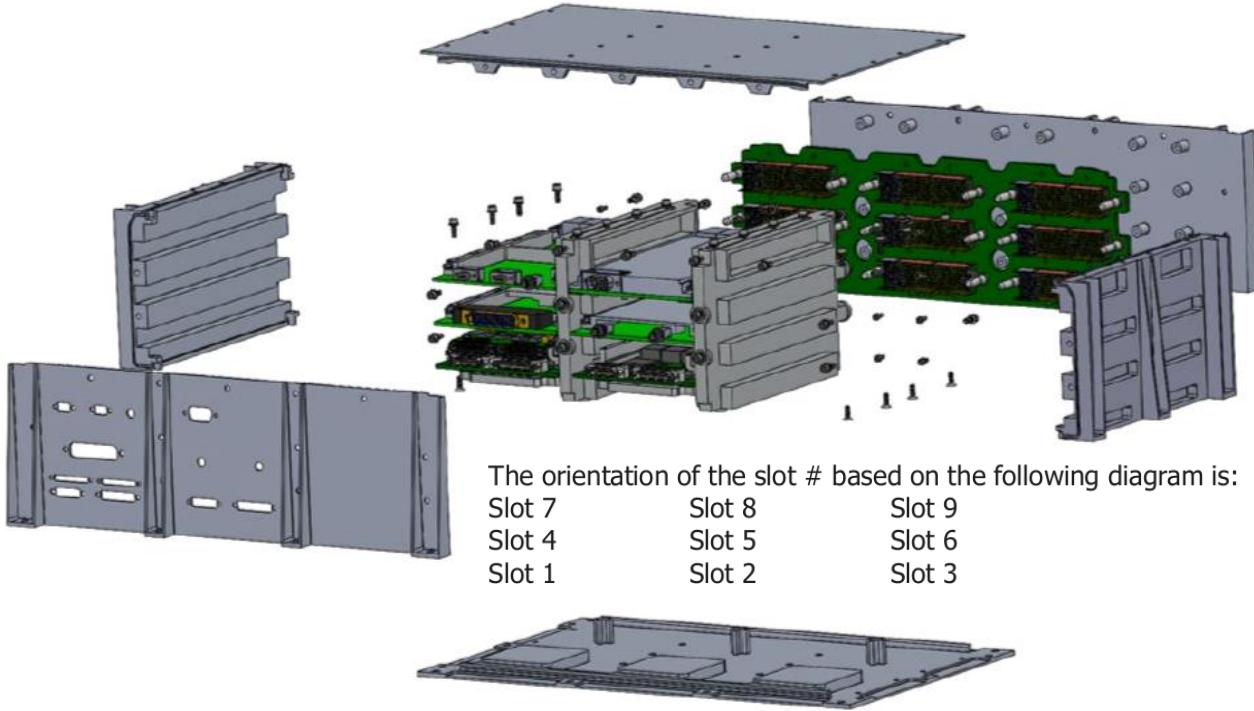
RPS-9X External Interface Diagram with Two RPMs



RPS Physical Dimensions and External Connector Summary



RPS-9X Exploded View and Default Card Slot Configuration with two RPMs



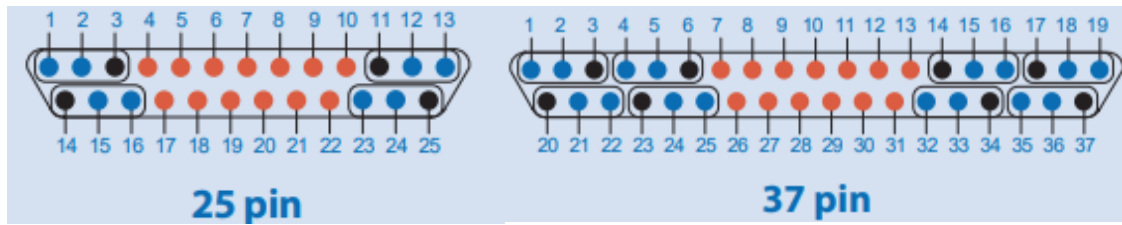
The orientation of the slot # based on the following diagram is:

Slot 7	Slot 8	Slot 9
Slot 4	Slot 5	Slot 6
Slot 1	Slot 2	Slot 3

J1 (Slot 1) and J9 (Slot 2) RPM Front-Panel Development Connector

J1 Socket	25-Pin Connector for USB, JTAG, RS422 Signal Assignment Flight Connector Part Number: GHSM2R-25SHBRR3-.140-186
1	DBG_SERDES_0_TX0_P
2	DBG_SERDES_0_TX0_N
3	GND
4	VERSAL_JTAG_CLK
5	VERSAL_JTAG_TMS
6	VERSAL_JTAG_TDO
7	VERSAL_JTAG_TDI
8	GND
9	JTAGOVERRIDE
10	N/C
11	GND
12	DBG_SERDES_0_TX1_N
13	DBG_SERDES_0_TX1_P
14	GND
15	DBG_SERDES_0_RX0_N

J1 Socket	25-Pin Connector for USB, JTAG, RS422 Signal Assignment Flight Connector Part Number: GHSM2R-25SHBRR3-.140-186
16	DBG_SERDES_0_RX0_P
17	N/C
18	GND
19	VERSAL_UART0_TX_P
20	VERSAL_UART0_TX_N
21	VERSAL_UART0_RX_P
22	VERSAL_UART0_RX_N
23	DBG_SERDES_0_RX1_P
24	DBG_SERDES_0_RX1_N
25	GND



J1/J9 and J2/J10 Connector Pin Orientation for the 25-Pin and 37-Pin RPS Front Panel Connectors (View from the Front of the Card)

J2 (Slot 1) and J10 (Slot 2) RPM Front-Panel Development Connector

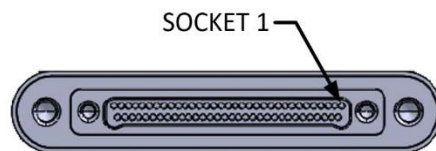
J2 Socket	37-Pin Connector for SERDES and 1000BASE-T Flight Connector Part Number: GHSM2R-37SHBRR3-.140-186
1	FRONT_SERDES_TX0_P
2	FRONT_SERDES_TX0_N
3	GND
4	FRONT_SERDES_TX2_P
5	FRONT_SERDES_TX2_N
6	GND
7	RGMII_PS0_TX0
8	RGMII_PS0_TX1
9	RGMII_PS0_TX2
10	RGMII_PS0_TX3
11	RGMII_PS0_TX_CLK
12	RGMII_PS0_TX_CTL
13	RGMII_PS0_RX0
14	GND
15	FRONT_SERDES_RX0_N

J2 Socket	37-Pin Connector for SERDES and 100BASE-T Flight Connector Part Number: GHSM2R-37SHBRR3-.140-186	
16	FRONT_SERDES_RX0_P	
17	GND	
18	FRONT_SERDES_RX2_N	
19	FRONT_SERDES_RX2_P	
20	GND	
21	FRONT_SERDES_TX1_N	
22	FRONT_SERDES_TX1_P	
23	GND	
24	FRONT_SERDES_TX3_N	
25	FRONT_SERDES_TX3_P	
26	RGMII_PS0_RX1	
27	RGMII_PS0_RX2	
28	RGMII_PS0_RX3	
29	RGMII_PS0_RX_CLK	
30	RGMII_PS0_RX_CTL	
31	GND	
32	FRONT_SERDES_RX1_N	
33	FRONT_SERDES_RX1_P	
34	GND	
35	FRONT_SERDES_RX3_N	
36	FRONT_SERDES_RX3_P	
37	GND	

J3 Slot-1 Mezzanine Front Panel Connector (Slot 2 Mezzanine is Not Populated By Default)

J3 Mezzanine Socket	65 PinRS422, LVDS, LVCMOS, 100BASE-T Signal Assignments Flight Connector Part Number: 891-028-65SS-BRT3T-02-186		
1	GND	34	GND
2	Ethernet Port 2	35	GND
3	Ethernet Port 2	36	Ethernet Port 1
4	Ethernet Port 2	37	Ethernet Port 1
5	Ethernet Port 2	38	GND
6	GND	39	Ethernet Port 1
7	GND	40	Ethernet Port 1
8	N/A	41	GND
9	N/A	42	N/A
10	N/A	43	N/A
11	N/A	44	N/A
12	GND	45	N/A
13	GND	46	N/A

J3 Mezzanine Socket	65 Pin RS422, LVDS, LVC MOS, 100BASE-T Signal Assignments Flight Connector Part Number: 891-028-65SS-BRT3T-02-186		
14	Ethernet Port 3	47	N/A
15	Ethernet Port 3	48	LVDS 1
16	Ethernet Port 3	49	LVDS 1
17	Ethernet Port 3	50	GND
18	GND	51	GND
19	N/A	52	LV TTL 1
20	N/A	53	N/A
21	N/A	54	LV TTL 2
22	N/A	55	GND
23	GND	56	LV TTL 3
24	N/A	57	N/A
25	N/A	58	UART2
26	GND	59	N/A
27	N/A	60	UART2
28	GND	61	GND
29	GND	62	UART2
30	N/A	63	GND
31	N/A	64	UART2
32	N/A	65	GND
33	N/A		GND



J3 and J4 Connector Pin Orientation for the 65-Pin Front Panel Mezzanine Connectors (View from the Front of the Card)

J4 Slot-1 Mezzanine Front Panel Connector (Slot 2 Mezzanine is Not Populated By Default)

J4 Mezzanine Socket	65 Pin SpaceWire, RS422, UART, 1000BASE-T Signal Assignment Flight Connector Part Number: 891-028-65SS-BRT3T-02-186		
1	GND	34	GND
2	GND	35	SpaceWire 1
3	Ethernet Port 4	36	SpaceWire 1
4	Ethernet Port 4	37	SpaceWire 1
5	Ethernet Port 4	38	SpaceWire 1

J4 Mezzanine Socket	65 Pin SpaceWire, RS422, UART, 1000BASE-T Signal Assignment Flight Connector Part Number: 891-028-65SS-BRT3T-02-186		
6	Ethernet Port 4	39	GND
7	GND	40	GND
8	GND	41	SpaceWire 1
9	Ethernet Port 4	42	SpaceWire 1
10	Ethernet Port 4	43	SpaceWire 1
11	Ethernet Port 4	44	SpaceWire 1
12	Ethernet Port 4	45	GND
13	GND	46	N/A
14	MISO_P	47	N/A
15	MISO_N	48	N/A
16	GND	49	N/A
17	LVDS_OUT2_N	50	GND
18	LVDS_OUT2_P	51	GND
19	GND	52	N/A
20	N/A	53	N/A
21	N/A	54	GND
22	MOSI_P	55	N/A
23	MOSI_N	56	N/A
24	GND	57	GND
25	N/A	58	UART 1
26	N/A	59	GND
27	SS_N	60	UART 1
28	SS_P	61	GND
29	GND	62	UART 1
30	N/A	63	GND
31	N/A	64	UART 1
32	SCLK_P	65	GND
33	SCLK_N		GND

J13 Power Connector

J13 Power Socket	9-Pin Connector for Power Input and Return Flight Connector Part Number: 280-028P1S9MEGPA-186	
1	100V_IN	
2	100V_IN	
3	FENCE	
4	FENCE	
5	100V_RTN	

J13 Power Socket		9-Pin Connector for Power Input and Return Flight Connector Part Number: 280-028P1S9MEGPA-186	
6		100V_IN	
7		FENCE	
8		100V_RTN	
9		100V_RTN	

J5 Slot-4 Ethernet I/O Front Panel Connector

J4 Mezzanine Socket		100-Pin 8-Port Ethernet I/O Signal Assignment Flight Connector Part Number: MWDM2L-100SBRR3-.140-186			
1	PHY2_P1_XFMR.MX1_P	35	GND	69	GND
2	PHY2_P1_XFMR.MX1_N	36	GND	70	GND
3	PHY2_P1_XFMR.MX2_P	37	PHY2_P0_XFMR.MX4_N	71	PHY1_P0_XFMR.MX2_P
4	PHY2_P1_XFMR.MX3_P	38	GND	72	GND
5	PHY2_P1_XFMR.MX3_N	39	GND	73	GND
6	PHY2_P1_XFMR.MX4_P	40	PHY1_P3_XFMR.MX1_N	74	PHY1_P0_XFMR.MX4_P
7	PHY2_P0_XFMR.MX1_P	41	GND	75	GND
8	PHY2_P0_XFMR.MX1_N	42	GND	76	PHY2_P3_XFMR.MX1_P
9	PHY2_P0_XFMR.MX2_P	43	PHY1_P3_XFMR.MX3_N	77	PHY2_P3_XFMR.MX1_N
10	PHY2_P0_XFMR.MX3_P	44	GND	78	PHY2_P3_XFMR.MX2_N
11	PHY2_P0_XFMR.MX3_N	45	GND	79	PHY2_P3_XFMR.MX3_P
12	PHY2_P0_XFMR.MX4_P	46	PHY1_P1_XFMR.MX1_N	80	PHY2_P3_XFMR.MX3_N
13	GND	47	GND	81	PHY2_P3_XFMR.MX4_N
14	GND	48	GND	82	PHY2_P2_XFMR.MX1_P
15	PHY1_P3_XFMR.MX1_P	49	PHY1_P1_XFMR.MX3_N	83	PHY2_P2_XFMR.MX1_N
16	PHY1_P3_XFMR.MX2_P	50	GND	84	PHY2_P2_XFMR.MX2_N
17	PHY1_P3_XFMR.MX2_N	51	GND	85	PHY2_P2_XFMR.MX3_P
18	PHY1_P3_XFMR.MX3_P	52	GND	86	PHY2_P2_XFMR.MX3_N
19	PHY1_P3_XFMR.MX4_P	53	GND	87	PHY2_P2_XFMR.MX4_N
20	PHY1_P3_XFMR.MX4_N	54	PHY2_P3_XFMR.MX2_P	88	PHY1_P2_XFMR.MX1_P
21	PHY1_P1_XFMR.MX1_P	55	GND	89	PHY1_P2_XFMR.MX1_N
22	PHY1_P1_XFMR.MX2_P	56	GND	90	PHY1_P2_XFMR.MX2_N
23	PHY1_P1_XFMR.MX2_N	57	PHY2_P3_XFMR.MX4_P	91	PHY1_P2_XFMR.MX3_P
24	PHY1_P1_XFMR.MX3_P	58	GND	92	PHY1_P2_XFMR.MX3_N
25	PHY1_P1_XFMR.MX4_P	59	GND	93	PHY1_P2_XFMR.MX4_N
26	PHY1_P1_XFMR.MX4_N	60	PHY2_P2_XFMR.MX2_P	94	PHY1_P0_XFMR.MX1_P
27	GND	61	GND	95	PHY1_P0_XFMR.MX1_N
28	PHY2_P1_XFMR.MX2_N	62	GND	96	PHY1_P0_XFMR.MX2_N

J4 Mezzanine Socket		100-Pin 8-Port Ethernet I/O Signal Assignment Flight Connector Part Number: MWDM2L-100SBRR3-.140-186			
29	GND	63	PHY2_P2_XFMR.MX4_P	97	PHY1_P0_XFMR.MX3_P
30	GND	64	GND	98	PHY1_P0_XFMR.MX3_N
31	PHY2_P1_XFMR.MX4_N	65	GND	99	PHY1_P0_XFMR.MX4_N
32	GND	66	PHY1_P2_XFMR.MX2_P	100	GND
33	GND	67	GND		
34	PHY2_P0_XFMR.MX2_N	68	GND		

J6 and J7 Slot 7 System Controller Redundant 1PPS and SpaceWire Front Panel Connectors

J6	Redundant 1PPS Input Connector Flight Part Number: MWDM2L-9SCBRR3-.110-186	J7	SpaceWire Connector Flight Part Number: MWDM2L-9SCBRR3-.110-186
1	N/C	1	Din_P
2	N/C	2	Sin_P
3	N/C	3	Ground
4	N/C	4	Sout_N
5	Ground	5	Dout_N
6	1PPS1_RxD_P	6	Din_N
7	1PPS1_RxD_N	7	Sin_N
8	1PPS2_RxD_P	8	Sout_P
9	1PPS2_RxD_N	9	Dout_P

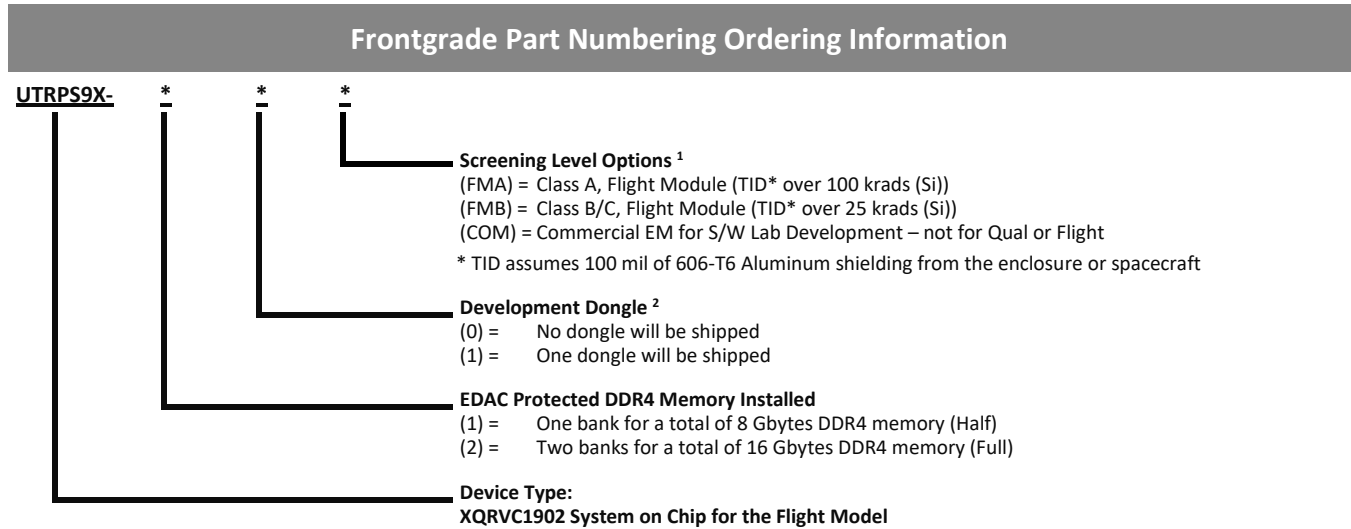
J8 Slot-7 Mission Reference Oscillator RF Input Front Panel Connectors

J11		SMA RF Input Connector Flight Part Number: 142-0711-531	
center1	MRO RF Input		
Shield2	GND		

J11 and J12 Slot-5 RF Input and Output Front Panel Connectors

J11	SMA RF Input Connector Flight Part Number: 142-0711-531	J12	SMA RF Output Connector Flight Part Number: 142-0711-531
center1	RF Input	center1	RF Output
Shield2	GND	Shield2	GND

Ordering Information



Notes:

1. Screening Level Options (FMA, FMB, or COM) must be specified.
2. Linux Support Package will be offered separately with the Frontgrade Software License Agreement.

Revision History

Date	Revision #	Author	Change Description	Page #
2/22/24	1.0.0	Anthony L	First release in Frontgrade Template and descriptions updated	All
2/28/24	1.0.1	Anthony L	Updated with higher resolution connector diagrams	7
3/4/24	1.0.2	Anthony L	Table formats are updated; no change to contents	All
8/23/24	1.0.3	TLM	Removed Export Controlled statement pursuant to Global Trade Compliance content review and approval and replaced with unlimited distribution statement	14

Datasheet Definitions

	Definition
Advanced Datasheet	Frontgrade reserves the right to make changes to any products and services described herein at any time without notice. The product is still in the development stage and the datasheet is subject to change . Specifications can be TBD and the part package and pinout are not final .
Preliminary Datasheet	Frontgrade reserves the right to make changes to any products and services described herein at any time without notice. The product is in the characterization stage and prototypes are available.
Datasheet	Product is in production and any changes to the product and services described herein will follow a formal customer notification process for form, fit or function changes.

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