VITA 57.1 FMC and VITA 57.4 FMC+ Extender Cards

Application Note

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VITA 57.1 FMC and VITA 57.4 FMC+ Extender Cards

For VITA 57 Applications

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Change History

Revision #	Reason	Author	Date
01	Initial Release	Matt Burns	09/27/2019
02	Added VITA 57.1 FMC Extender Info	Matt Burns	05/10/2024

1 Abstract

FPGA carrier card developers require easy-to-use options to confirm the operation of the VITA 57.1 FMC and/or VITA 57.4 FMC+ expansion connector typically found on these platforms. In some cases, the mating height of the standard FMC/FMC+ connectors may prevent fully leveraging the connectivity options of all FMC/FMC+ modules.

The VITA 57.1 FMC+ Extender Card (REF-228680-01) and the VITA 57.4 FMC+ Extender Card (REF-212564-01) have been designed for placement between FPGA Carrier Cards and FMC Modules or FMC+ Modules. This increased space can be used for additional I/O expansion during development. The FMC Extender Card and the FMC+ Extender Card also provide a cost-effective option for extending the life of the FPGA Carrier Card HPC and/or HSPC connectors used as test platforms. They are ideal for benchtop testing, system debugging, probing, or FPGA development.

The cards provide FPGA designers easy to use options for testing low-speed interfaces and high-speed multi-gigabit transceivers on any FPGA development board or FPGA carrier card. They can run system data or BER testing on all channels in parallel. This makes evaluation and development with an FPGA much easier.

This paper will explore the following details of the FMC Extender Card and FMC+ Extender Card:

- Mechanical dimensions and assembly features
- Connector pin assignments and block diagrams
- Qualification testing set-up and test results

2 Mechanical Dimensions

The FMC Extender Card provides a variant of the mechanical dimensions of an FMC card defined within ANSI/VITA 57.1-2010 Section 3. The electromechanical interface between the mating HPC connectors conforms to ANSI/VITA 57.1-2010 Section 3. Specific mechanical dimensions of the card are highlighted below.

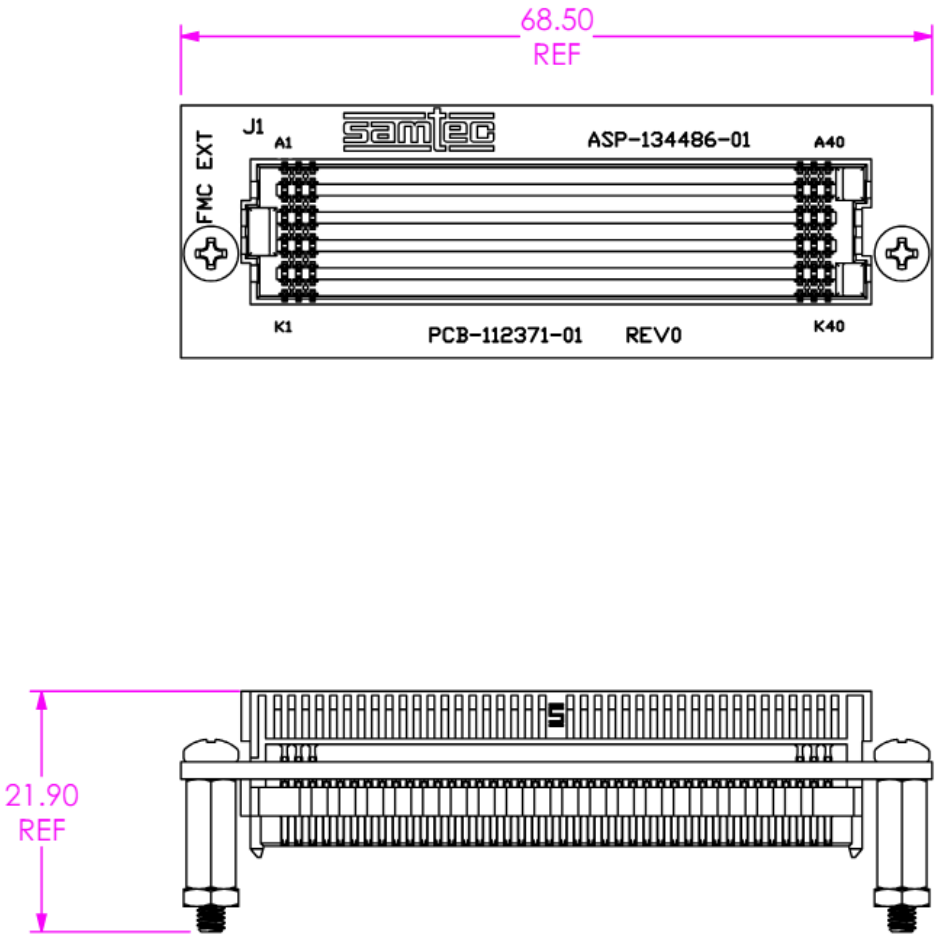


Figure 1 - Mechanical Dimensions for FMC Extender Card (in millimeters)

The FMC+ Extender Card provides a variant of the mechanical dimensions of an FMC+ card defined within ANSI/VITA 57.4-2019 Section 3. The electromechanical interface between the mating HSPC connectors conforms to ANSI/VITA 57.4-2019 Section 3. Specific mechanical dimensions of the card are highlighted below.

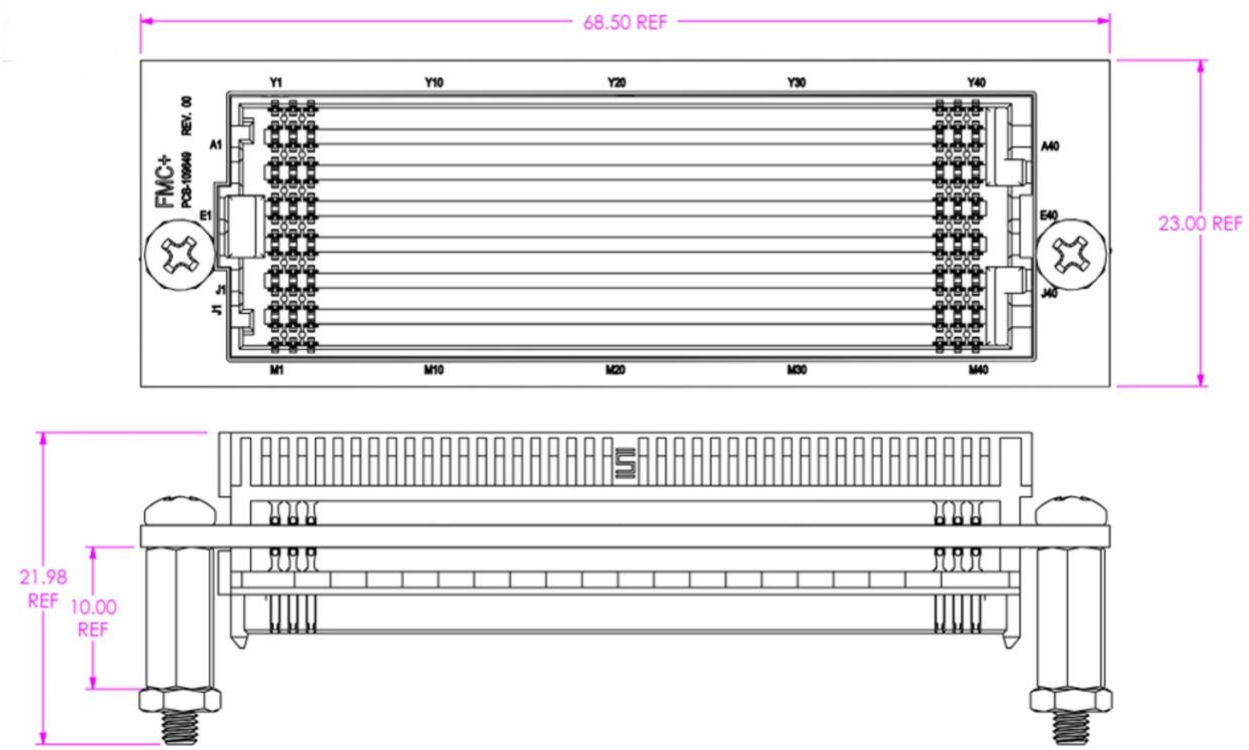


Figure 2 - Mechanical Dimensions for FMC+ Extender Card (in millimeters)

3 Mechanical Design Features

Since many of the applications that involve VITA 57.1 and VITA 57.4 systems are on highly populated PCBs with sensitive components, it is important to have an easy way to access the FPGA carrier. The FMC Extender Card and the FMC+ Extender Card provides several mechanical features that ease mating and unmating.

FMC Extender Card and FMC+ Loopback Card features:

- The FMC Extender Card and FMC+ Loopback Card have been designed to work in conjunction with the Micro Jack Screw Standoff (JSOM).
- Use JSOMs to carefully mate and unmate the FMC Extender Card of the FMC+ Loopback Card to the FPGA carrier to avoid damages.
- An Allen-key unscrews and expands the jack screw, dividing the PCBs in a steady, even motion until the mezzanine is safely separated from its host.

4 Connector Pin Assignments

The FMC Extender Card conforms to the Connector Pin Assignments of the HPC connector as defined within ANSI/VITA 57.1-2010 Section 5. The FMC Extender Card provides direct pass-through connectivity for all 400 pins from the HPC male to HPC female connectors. Specific pin assignments are highlighted below.

	K	J	H	G	F	E	D	C	B	A
1	VREF_B_M2C	GND	VREF_A_M2C	GND	PG_M2C	GND	PG_C2M	GND	CLK_DIR	GND
2	GND	CLK3_BIDIR_P	PRSNT_M2C_L	CLK1_M2C_P	GND	HA01_P_CC	GND	DP0_C2M_P	GND	DP1_M2C_P
3	GND	CLK3_BIDIR_N	GND	CLK1_M2C_N	GND	HA01_N_CC	GND	DP0_C2M_N	GND	DP1_M2C_N
4	CLK2_BIDIR_P	GND	CLK0_M2C_P	GND	HA00_P_CC	GND	GBTCLK0_M2C_P	GND	DP9_M2C_P	GND
5	CLK2_BIDIR_N	GND	CLK0_M2C_N	GND	HA00_N_CC	GND	GBTCLK0_M2C_N	GND	DP9_M2C_N	GND
6	GND	HA03_P	GND	LA00_P_CC	GND	HA05_P	GND	DP0_M2C_P	GND	DP2_M2C_P
7	HA02_P	HA03_N	LA02_P	LA00_N_CC	HA04_P	HA05_N	GND	DP0_M2C_N	GND	DP2_M2C_N
8	HA02_N	GND	LA02_N	GND	HA04_N	GND	LA01_P_CC	GND	DP8_M2C_P	GND
9	GND	HA07_P	GND	LA03_P	GND	HA09_P	LA01_N_CC	GND	DP8_M2C_N	GND
10	HA06_P	HA07_N	LA04_P	LA03_N	HA08_P	HA09_N	GND	LA06_P	GND	DP3_M2C_P
11	HA06_N	GND	LA04_N	GND	HA08_N	GND	LA05_P	LA06_N	GND	DP3_M2C_N
12	GND	HA11_P	GND	LA08_P	GND	HA13_P	LA05_N	GND	DP7_M2C_P	GND
13	HA10_P	HA11_N	LA07_P	LA08_N	HA12_P	HA13_N	GND	GND	DP7_M2C_N	GND
14	HA10_N	GND	LA07_N	GND	HA12_N	GND	LA09_P	LA10_P	GND	DP4_M2C_P
15	GND	HA14_P	GND	LA12_P	GND	HA16_P	LA09_N	LA10_N	GND	DP4_M2C_N
16	HA17_P_CC	HA14_N	LA11_P	LA12_N	HA15_P	HA16_N	GND	GND	DP6_M2C_P	GND
17	HA17_N_CC	GND	LA11_N	GND	HA15_N	GND	LA13_P	GND	DP6_M2C_N	GND
18	GND	HA18_P	GND	LA16_P	GND	HA20_P	LA13_N	LA14_P	GND	DP5_M2C_P
19	HA21_P	HA18_N	LA15_P	LA16_N	HA19_P	HA20_N	GND	LA14_N	GND	DP5_M2C_N
20	HA21_N	GND	LA15_N	GND	HA19_N	GND	LA17_P_CC	GND	GBTCLK1_M2C_P	GND
21	GND	HA22_P	GND	LA20_P	GND	HB03_P	LA17_N_CC	GND	GBTCLK1_M2C_N	GND
22	HA23_P	HA22_N	LA19_P	LA20_N	HB02_P	HB03_N	GND	LA18_P_CC	GND	DP1_C2M_P
23	HA23_N	GND	LA19_N	GND	HB02_N	GND	LA23_P	LA18_N_CC	GND	DP1_C2M_N
24	GND	HB01_P	GND	LA22_P	GND	HB05_P	LA23_N	GND	DP9_C2M_P	GND
25	HB00_P_CC	HB01_N	LA21_P	LA22_N	HB04_P	HB05_N	GND	GND	DP9_C2M_N	GND
26	HB00_N_CC	GND	LA21_N	GND	HB04_N	GND	LA26_P	LA27_P	GND	DP2_C2M_P
27	GND	HB07_P	GND	LA25_P	GND	HB09_P	LA26_N	LA27_N	GND	DP2_C2M_N
28	HB06_P_CC	HB07_N	LA24_P	LA25_N	HB08_P	HB09_N	GND	GND	DP8_C2M_P	GND
29	HB06_N_CC	GND	LA24_N	GND	HB08_N	GND	TCK	GND	DP8_C2M_N	GND
30	GND	HB11_P	GND	LA29_P	GND	HB13_P	TDI	SCL	GND	DP3_C2M_P
31	HB10_P	HB11_N	LA28_P	LA29_N	HB12_P	HB13_N	TDO	SDA	GND	DP3_C2M_N
32	HB10_N	GND	LA28_N	GND	HB12_N	GND	3P3VAUX	GND	DP7_C2M_P	GND
33	GND	HB15_P	GND	LA31_P	GND	HB19_P	TMS	GND	DP7_C2M_N	GND
34	HB14_P	HB15_N	LA30_P	LA31_N	HB16_P	HB19_N	TRST_L	GA0	GND	DP4_C2M_P
35	HB14_N	GND	LA30_N	GND	HB16_N	GND	GA1	12P0V	GND	DP4_C2M_N
36	GND	HB18_P	GND	LA33_P	GND	HB21_P	3P3V	GND	DP6_C2M_P	GND
37	HB17_P_CC	HB18_N	LA32_P	LA33_N	HB20_P	HB21_N	GND	12P0V	DP6_C2M_N	GND
38	HB17_N_CC	GND	LA32_N	GND	HB20_N	GND	3P3V	GND	GND	DP5_C2M_P
39	GND	VIO_B_M2C	GND	VADJ	GND	VADJ	GND	3P3V	GND	DP5_C2M_N
40	VIO_B_M2C	GND	VADJ	GND	VADJ	GND	3P3V	GND	RES0	GND
			LPC Connector	LPC Connector			LPC Connector	LPC Connector		

Figure 3 - HPC Connector Pin Assignments

The FMC+ Extender Card conforms to the Connector Pin Assignments of the HSPC connector as defined within ANSI/VITA 57.4-2019 Section 5. The FMC+ Extender Card provides direct pass-through connectivity for all 560 pins from the HSPC male to HSPC female connectors. Specific pin assignments are highlighted below.

14 x 40	M	L	K	J	H	G	F	E	D	C	B	A	Z	Y
1	GND	RES1	VREF_B_M2C	GND	VREF_A_M2C	GND	PG_M2C	GND	PG_C2M	GND	CLK_DIR	GND	HSPC_PRSNT_M2C_L	GND
2	DP23_M2C_P	GND	GND	CLK3_BIDIR_P	PRSNT_M2C_L	CLK1_M2C_P	GND	HA01_P_CC	GND	DP0_C2M_P	GND	DP1_M2C_P	GND	DP23_C2M_P
3	DP23_M2C_N	GND	GND	CLK3_BIDIR_N	GND	CLK1_M2C_N	GND	HA01_N_CC	GND	DP0_C2M_N	GND	DP1_M2C_N	GND	DP23_C2M_N
4	GND	GBTCLK4_M2C_P	CLK2_BIDIR_P	GND	CLK0_M2C_P	GND	HA00_P_CC	GND	GBTCLK0_M2C_P	GND	DP9_M2C_P	GND	DP22_C2M_P	GND
5	GND	GBTCLK4_M2C_N	CLK2_BIDIR_N	GND	CLK0_M2C_N	GND	HA00_N_CC	GND	GBTCLK0_M2C_N	GND	DP9_M2C_N	GND	DP22_C2M_N	GND
6	DP22_M2C_P	GND	GND	HA03_P	GND	LA00_P_CC	GND	HA05_P	GND	DP0_M2C_P	GND	DP2_M2C_P	GND	DP21_C2M_P
7	DP22_M2C_N	GND	HA02_P	HA03_N	LA02_P	LA00_N_CC	HA04_P	HA05_N	GND	DP0_M2C_N	GND	DP2_M2C_N	GND	DP21_C2M_N
8	GND	GBTCLK3_M2C_P	HA02_N	GND	LA02_N	GND	HA04_N	GND	LA01_P_CC	GND	DP8_M2C_P	GND	DP20_C2M_P	GND
9	GND	GBTCLK3_M2C_N	GND	HA07_P	GND	LA03_P	GND	HA09_P	LA01_N_CC	GND	DP8_M2C_N	GND	DP20_C2M_N	GND
10	DP21_M2C_P	GND	HA06_P	HA07_N	LA04_P	LA03_N	HA08_P	HA09_N	GND	LA06_P	GND	DP3_M2C_P	GND	DP10_M2C_P
11	DP21_M2C_N	GND	HA06_N	GND	LA04_N	GND	HA08_N	GND	LA05_P	LA06_N	GND	DP3_M2C_N	GND	DP10_M2C_N
12	GND	GBTCLK2_M2C_P	GND	HA11_P	GND	LA08_P	GND	HA13_P	LA05_N	GND	DP7_M2C_P	GND	DP11_M2C_P	GND
13	GND	GBTCLK2_M2C_N	HA10_P	HA11_N	LA07_P	LA08_N	HA12_P	HA13_N	GND	GND	DP7_M2C_N	GND	DP11_M2C_N	GND
14	DP20_M2C_P	GND	HA10_N	GND	LA07_N	GND	HA12_N	GND	LA09_P	LA10_P	GND	DP4_M2C_P	GND	DP12_M2C_P
15	DP20_M2C_N	GND	GND	HA14_P	GND	LA12_P	GND	HA16_P	LA09_N	LA10_N	GND	DP4_M2C_N	GND	DP12_M2C_N
16	GND	SYNC_C2M_P	HA17_P_CC	HA14_N	LA11_P	LA12_N	HA15_P	HA16_N	GND	GND	DP6_M2C_P	GND	DP13_M2C_P	GND
17	GND	SYNC_C2M_N	HA17_N_CC	GND	LA11_N	GND	HA15_N	GND	LA13_P	GND	DP6_M2C_N	GND	DP13_M2C_N	GND
18	DP14_C2M_P	GND	GND	HA18_P	GND	LA16_P	GND	HA20_P	LA13_N	LA14_P	GND	DP5_M2C_P	GND	DP14_M2C_P
19	DP14_C2M_N	GND	HA21_P	HA18_N	LA15_P	LA16_N	HA19_P	HA20_N	GND	LA14_N	GND	DP5_M2C_N	GND	DP14_M2C_N
20	GND	REFCLK_C2M_P	HA21_N	GND	LA15_N	GND	HA19_N	GND	LA17_P_CC	GND	GBTCLK1_M2C_P	GND	GBTCLK5_M2C_P	GND
21	GND	REFCLK_C2M_N	GND	HA22_P	GND	LA20_P	GND	HB03_P	LA17_N_CC	GND	GBTCLK1_M2C_N	GND	GBTCLK5_M2C_N	GND
22	DP15_C2M_P	GND	HA23_P	HA22_N	LA19_P	LA20_N	HB02_P	HB03_N	GND	LA18_P_CC	GND	DP1_C2M_P	GND	DP15_M2C_P
23	DP15_C2M_N	GND	HA23_N	GND	LA19_N	GND	HB02_N	GND	LA23_P	LA18_N_CC	GND	DP1_C2M_N	GND	DP15_M2C_N
24	GND	REFCLK_M2C_P	GND	HB01_P	GND	LA22_P	GND	HB05_P	LA23_N	GND	DP9_C2M_P	GND	DP10_C2M_P	GND
25	GND	REFCLK_M2C_N	HB00_P_CC	HB01_N	LA21_P	LA22_N	HB04_P	HB05_N	GND	GND	DP9_C2M_N	GND	DP10_C2M_N	GND
26	DP16_C2M_P	GND	HB00_N_CC	GND	LA21_N	GND	HB04_N	GND	LA26_P	LA27_P	GND	DP2_C2M_P	GND	DP11_C2M_P
27	DP16_C2M_N	GND	GND	HB07_P	GND	LA25_P	GND	HB09_P	LA26_N	LA27_N	GND	DP2_C2M_N	GND	DP11_C2M_N
28	GND	SYNC_M2C_P	HB06_P_CC	HB07_N	LA24_P	LA25_N	HB08_P	HB09_N	GND	GND	DP8_C2M_P	GND	DP12_C2M_P	GND
29	GND	SYNC_M2C_N	HB06_N_CC	GND	LA24_N	GND	HB08_N	GND	TCK	GND	DP8_C2M_N	GND	DP12_C2M_N	GND
30	DP17_C2M_P	GND	GND	HB11_P	GND	LA29_P	GND	HB13_P	TDI	SCL	GND	DP3_C2M_P	GND	DP13_C2M_P
31	DP17_C2M_N	GND	HB10_P	HB11_N	LA28_P	LA29_N	HB12_P	HB13_N	TDO	SDA	GND	DP3_C2M_N	GND	DP13_C2M_N
32	GND	RES2	HB10_N	GND	LA28_N	GND	HB12_N	GND	3P3VAUX	GND	DP7_C2M_P	GND	DP16_M2C_P	GND
33	GND	RES3	GND	HB15_P	GND	LA31_P	GND	HB19_P	TMS	GND	DP7_C2M_N	GND	DP16_M2C_N	GND
34	DP18_C2M_P	GND	HB14_P	HB15_N	LA30_P	LA31_N	HB16_P	HB19_N	TRST_L	GA0	GND	DP4_C2M_P	GND	DP17_M2C_P
35	DP18_C2M_N	GND	HB14_N	GND	LA30_N	GND	HB16_N	GND	GA1	12P0V	GND	DP4_C2M_N	GND	DP17_M2C_N
36	GND	12P0V	GND	HB18_P	GND	LA33_P	GND	HB21_P	3P3V	GND	DP6_C2M_P	GND	DP18_M2C_P	GND
37	GND	12P0V	HB17_P_CC	HB18_N	LA32_P	LA33_N	HB20_P	HB21_N	GND	12P0V	DP6_C2M_N	GND	DP18_M2C_N	GND
38	DP19_C2M_P	GND	HB17_N_CC	GND	LA32_N	GND	HB20_N	GND	3P3V	GND	GND	DP5_C2M_P	GND	DP19_M2C_P
39	DP19_C2M_N	GND	GND	VIO_B_M2C	GND	VADJ	GND	VADJ	GND	3P3V	GND	DP5_C2M_N	GND	DP19_M2C_N
40	GND	12P0V	VIO_B_M2C	GND	VADJ	GND	VADJ	GND	3P3V	GND	RES0	GND	3P3V	GND

Figure 4 - HSPC Connector Pin Assignments

5 Block Diagrams

The FMC Extender Card and the FMC+ Extender Card provide basic throughput functionality for testing general FPGA carrier cards that contain the HPC and/or HSPC interface. Signals routed include:

- Gigabit data signals (multi-gigabit transceivers; MGTs)
- Gigabit reference clocks
- Control lines including JTAG (including IPMI support), I2C, addressing, and reserved signals
- All required power rails, sequencing, and control lines

Specific high-level signal routing for both cards are highlighted below.

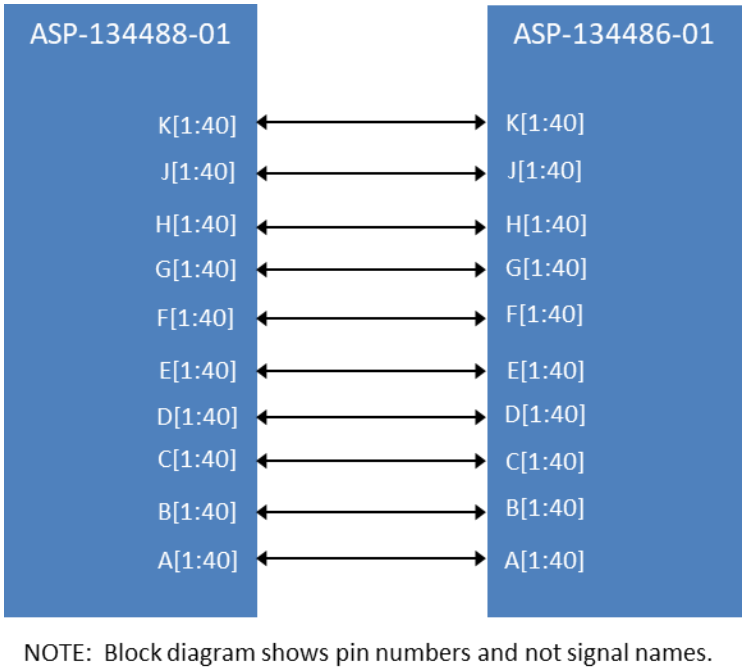
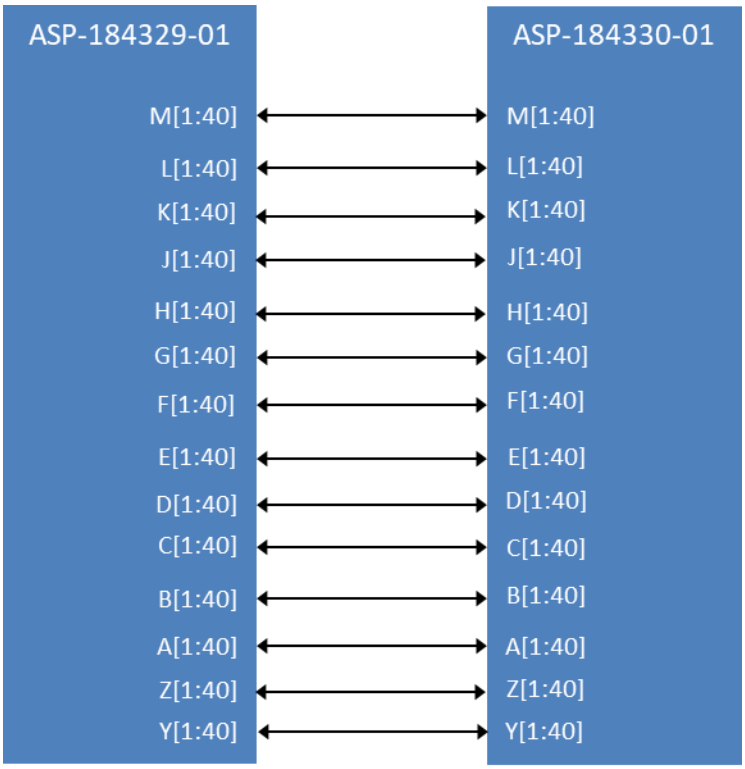


Figure 5 - FMC Extender Card Block Diagram



NOTE: Block diagram shows pin numbers and not signal names.

Figure 6 - FMC+ Extender Card Block Diagram

Additional signal routing and circuitry details are contained in the schematics for the FMC Extender and the FMC+ Extender. Schematics are available from Samtec under NDA. Please e-mail KitsAndBoards@samtec.com for more details.

6 Testing the FMC Extender and FMC+ Extender Cards

The FMC Extender Card and the FMC+ Extender Card have been designed to test low-speed signals and high-speed multi-gigabit transceivers (MGTs) on any FPGA development board or FPGA carrier card with the FMC or the FMC+ interface.

The design for the FMC Extender Card and the FMC+ Extender Card follows the same design rules, PCB material, and other standard design practices. The PCB design of the two cards is essentially identical, except for the additional signal rows on the FMC+ Extender Cards. For testing purposes, the results contained below are assumed similar for both options.

6.1 *Test Setup*

General functional testing of power, control, and low-speed signal are assumed with a successful power-up of the card. Key testing results are focused on verifying full-speed operation of the MGTs routed via the HSPC connectors.

To determine electrical performance of the FMC+ Extender Card, a Xilinx VCU118 was used as the FMC+ carrier along with the Samtec HSPC Loopback Card.

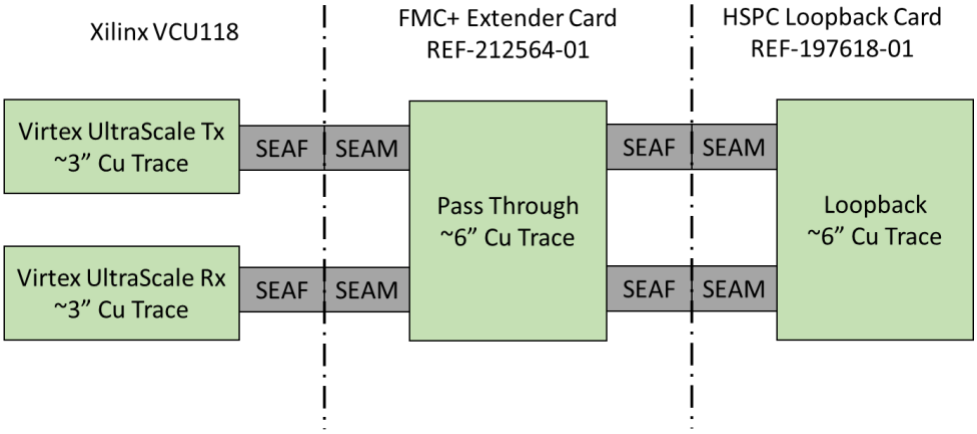


Figure 7 – FMC+ Extender Card Test Setup Using the HSPC Loopback Card

6.2 *Testing Results*

The Test Setup ran over 24 channels and was found to be error free for over 15 hours of testing with a BER < 5.4e-14. The resulting data is shown in Figure 8 and Figure 9.

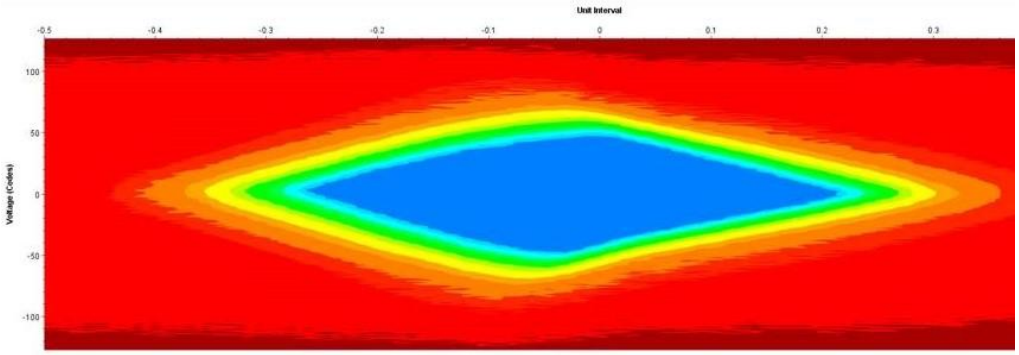


Figure 8 – Eye Diagram for Test Setup 1

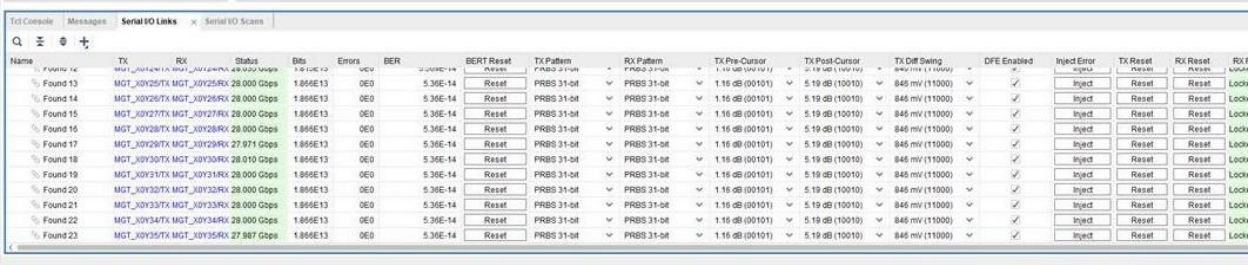


Figure 9 – Channel Results for Test Setup 1

7 Conclusions

FPGA carrier card developers require easy-to-use options to confirm the operation of the VITA 57.1 FMC or VITA 57.4 FMC+ expansion connector typically found on these platforms. In some cases, the mating height of the standard FMC/FMC+ connectors may prevent fully leveraging the connectivity options of all FMC/FMC+ modules.

The VITA 57.1 FMC+ Extender Card (REF-228680-01) and the VITA 57.4 FMC+ Extender Card (REF-212564-01) have been designed for placement between FPGA Carrier Cards and FMC/FMC+ Modules. This increased space can be used for additional I/O expansion during development. The FMC Extender card and the FMC+ Extender Card also provide cost-effective options for extending the life of the FPGA Carrier Card HPC and/or HSPC connectors used as test platforms. It is ideal for benchtop testing, system debugging, probing, or FPGA development.

The card provides FPGA designers an easy-to-use option for testing low-speed interfaces and high-speed MGTs on any FPGA development board or FPGA carrier card. It can run system data or BER testing on all channels in parallel. This makes evaluation and development with an FPGA much easier.

The FMC Extender Cards and the FMC+ Extender Cards have been tested on numerous, popular FPGA evaluation kits and carrier cards. Data rates on the MGTs have been confirmed to 28 Gbps and beyond.

Additional details on can be found at www.samtec.com/kits.