

# FMC-Servo

V 0.1 06/04/2015



**FMC Module with eight 16-bit, 500 kSPS A/D channels; eight 16-bit D/A channels with onboard PLL.**

## FEATURES

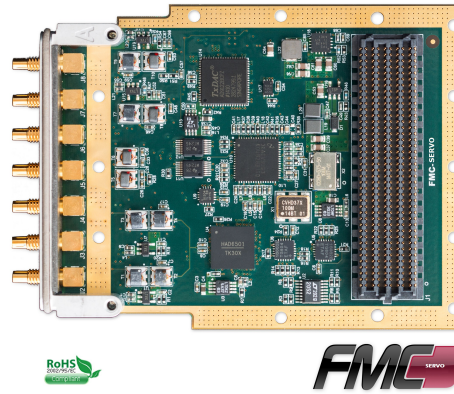
- Eight A/D Input Channels
  - 500 kSPS, 16-bit A/D
  - Differential, Gain Programmable
- Eight D/A Output Channels
  - 0.5µs Settling Time, 16-bit D/A
  - ± 10V Output Range
- Sample clocks and timing and controls
  - 10 MHz, ±250 ppb stability on-board reference.
  - Programmable PLL
  - Programmable Clock Frequency as low as 3.05 kHz
  - Integrated with FMC triggers
- FMC module, VITA 57.1
  - High Pin Count no SERDES required
  - Compatible with 2.5V VADJ
  - Power monitor and controls
- 12 W typical
- Conduction Cooling per VITA 20 subset
- Environmental ratings for -40 to 85C  
9g RMS sine, 0.1g<sup>2</sup>/Hz random vibration

## APPLICATIONS

- Industrial Instrumentation Systems
- Real-Time Control Systems
- Sensor Data Recording and Playback
- Machine Learning Systems

## SOFTWARE

- MATLAB/VHDL FrameWork Logic



## DESCRIPTION

The FMC-SERVO module features eight simultaneously sampling A/D and DACs with an FPGA computing core. Low latency SAR A/D and fast-settling DACs support real-time servo control applications. The programmable input range and high input interface directly to many sensors, while the output is capable of driving many transducers. Front panel digital IO can be also be used as PWM or process controls.

Clock and trigger controls include support for consistent servo loop timing, counted frames, software triggering and external triggering. The sample rate clock is either an external clock or on-board programmable PLL clock source

The FMC-Servo power consumption is TBD W for typical operation. The module may be conduction cooled using VITA20 standard and a heat spreading plate. Ruggedization levels for wide-temperature operation from -40 to +85C operation and 0.1 g<sup>2</sup>/Hz vibration. Conformal coating is available.

Support logic in VHDL is provided for integration with FPGA carrier cards. Specific support for Innovative carrier cards includes integration with Framework Logic tools that support VHDL and Matlab developers. The Matlab BSP supports real-time hardware-in-the-loop development using the graphical block diagram Simulink environment with Xilinx System Generator for the FMC integrated with the FPGA carrier card.

Software tools for Innovative carrier cards include host development C++ libraries and drivers for Windows and Linux, 32/64-bit including RTOS variants. Application examples demonstrating the module features are provided.

\* Sampling rates in an application depend on carrier and system design

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## FMC-Servo



This electronics assembly can be damaged by ESD. Innovative Integration recommends that all electronic assemblies and components circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

### ORDERING INFORMATION

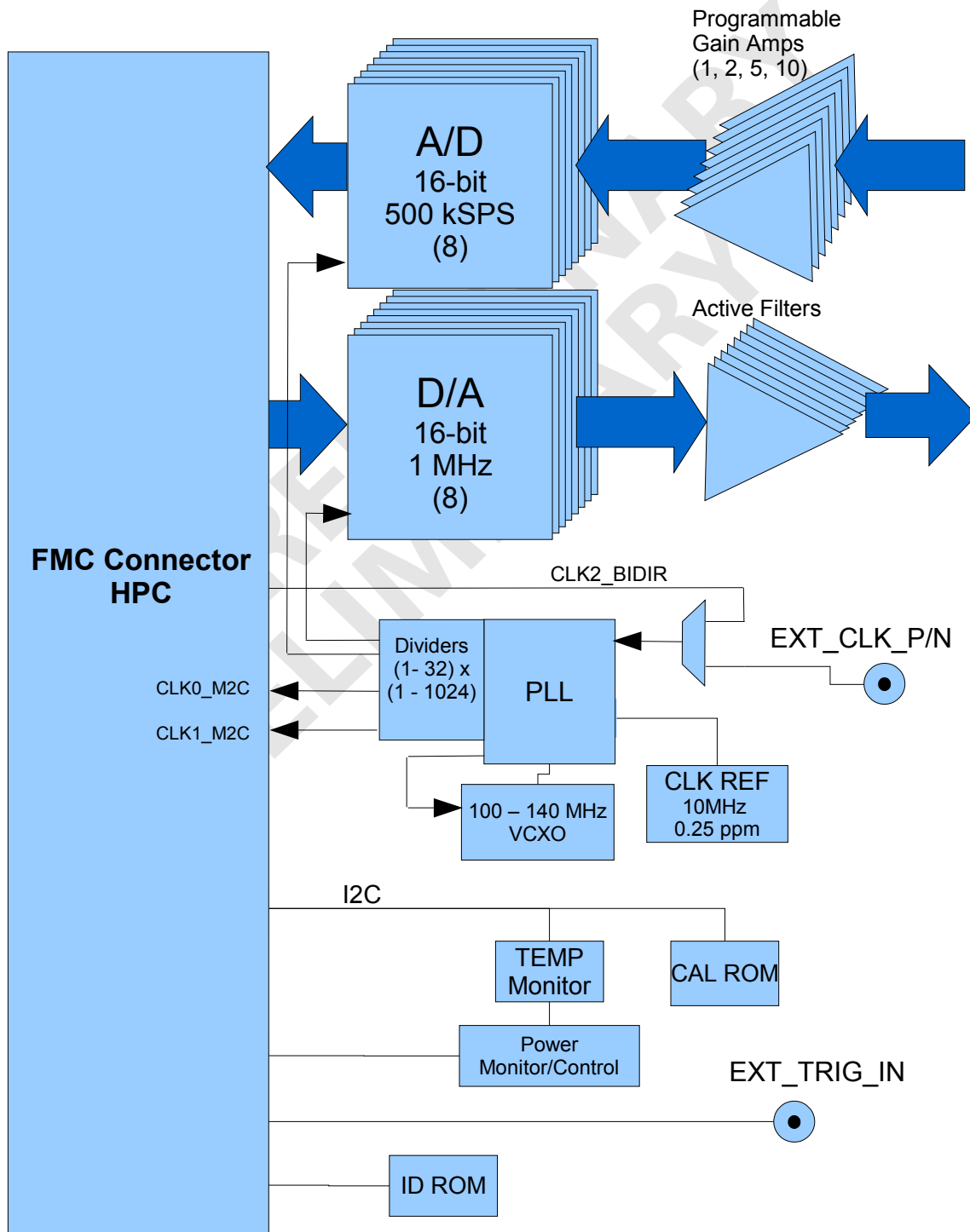
| Product                        | Part No.         | Description  |
|--------------------------------|------------------|--|
| FMC-Servo                      | 80339-<CFG>-<ER> | FMC module with eight 16-bit A/Ds (500 kSPS per channel), eight 16-bit DACs (0.5 $\mu$ s settling time), on-board PLL.<br><CFG> is configuration.<br>0: AC-coupled analog ADC inputs and DAC outputs<br>2: DC-coupled analog ADC inputs and DAC outputs<br><ER> is environmental rating L0...L4. |
| <b>Cables</b>                  |                  |  |
| TBD                            | TBD              | IO cable with XXXXXXXXXXXXX  |
| <b>Carrier Cards</b>           |                  |  |
| VPX6-COP                       | 80262            | 3U VPX FPGA co-processor card with FMC site  |
| PEX6-COP                       | 80284            | Desktop/server PCI Express FPGA co-processor card with FMC site  |
| <b>Embedded Computer Hosts</b> |                  |  |
| ePC-K7                         | 90502            | Embedded PC with support for one FMC module; COM Express Type 6 i7 CPU; RF expansion tray; Windows, Linux  |
| Mini-K7                        | 90600            | Miniature embedded PC with support for one FMC module; COM Express Type 6 Atom CPU; RF expansion tray; LCD display; Windows, Linux   |

<ER> corresponds to the [Environmental Rating, L0...L4](#).

| Physicals           |  |
|---------------------|--|
| Form Factor         | FMC VITA 57.1 single-width                                     |
| Size                | 76.5 x 69 mm<br>10 mm mounting height                          |
| Weight              | 180g (approximate, contact factory if critical to application) |
| Hazardous Materials | Lead-free and RoHS compliant                                   |

# FMC-Servo

## FMC-SERVO Simplified Block Diagram



# FMC-Servo

## J2 (SAMTEC QSE-020-01-L-D-A) Connection Detail

| Signal Name | Pin Assignment | Description   |
|-------------|----------------|---|
| ADC0        | 1              | The eight ADC channel inputs. Full-scale range is dependent on programmed gain.<br>Gain=1 ±10V<br>Gain=2 ±5V<br>Gain=5 ±2V<br>Gain=10 ±1V<br>Differential impedance > |
| ADC1        | 5              |   |
| ADC2        | 9              |   |
| ADC3        | 13             |   |
| ADC4        | 17             |   |
| ADC5        | 21             |   |
| ADC6        | 25             |   |
| ADC7        | 29             |   |
| DAC0        | 2              | The eight DAC channel outputs. Full-scale range is ±10V.  |
| DAC1        | 6              |   |
| DAC2        | 10             |   |
| DAC3        | 14             |   |
| DAC4        | 18             |   |
| DAC5        | 22             |   |
| DAC6        | 26             |   |
| DAC7        | 30             |   |
| EXT_TRIG_IN | 35             | External Trigger Input. 50 DC termination to ground.<br>Expected signal: 1.2V nominal threshold, 0 – 2.5V nominal limits.   |
| EXT_CLK_P   | 37             | External Clock Input. AC-coupled, differential termination 100 ohms.<br>Nominally LVDS levels.  |
| EXT_CLK_N   | 39             |   |

Note: 2.5 V logic inputs absolute maximum 2.8V, absolute minimum -0.3V

PRELIMINARY

## FMC-Servo

### Operating Environment Ratings

Modules rated for operating environment temperature, shock and vibration are offered. The modules are qualified for wide temperature, vibration and shock to suit a variety of applications in each of the environmental ratings L0 through L4 and 100% tested for compliance.

| Environment Rating <ER> |        | L0                                 | L1  | L2  | L3  | L4   |
|-------------------------|--------|------------------------------------|---|---|---|--|
| Environment             |        | Office, controlled lab             | Outdoor, stationary   | Industrial  | Vehicles  | Military and heavy industry  |
| Applications            |        | Lab instruments, research          | Outdoor monitoring and controls                                       | Industrial applications with moderate vibration   | Manned vehicles   | Unmanned vehicles, missiles, oil and gas exploration   |
| Cooling                 |        | Forced Air<br>2 CFM                | Forced Air<br>2 CFM   | Conduction  | Conduction  | Conduction   |
| Operating Temperature   |        | 0 to +50C                          | -40 to +85C   | -20 to +65C   | -40 to +70C   | -40 to +85C  |
| Storage Temperature     |        | -20 to +90C                        | -40 to +100C  | -40 to +100C  | -40 to +100C  | -50 to +100C   |
| Vibration               | Sine   | -                                  | -   | 2g<br>20-500 Hz   | 5g<br>20-2000 Hz  | 10g<br>20-2000 Hz  |
|                         | Random | -                                  | -   | 0.04 g <sup>2</sup> /Hz<br>20-2000 Hz   | 0.1 g <sup>2</sup> /Hz<br>20-2000 Hz  | 0.1 g <sup>2</sup> /Hz<br>20-2000 Hz   |
| Shock                   |        | -                                  | -   | 20g, 11 ms  | 30g, 11 ms  | 40g, 11 ms   |
| Humidity                |        | 0 to 95%,<br>non-condensing        | 0 to 100%   | 0 to 100%   | 0 to 100%   | 0 to 100%  |
| Conformal coating       |        |                                    | Conformal coating   | Conformal coating,<br>extended<br>temperature range<br>devices                            | Conformal coating,<br>extended<br>temperature range<br>devices,<br>Thermal conduction<br>assembly | Conformal coating,<br>extended<br>temperature range<br>devices,<br>Thermal conduction<br>assembly,<br>Epoxy bonding for<br>devices |
| Testing                 |        | Functional,<br>Temperature cycling | Functional,<br>Temperature<br>cycling,<br>Wide temperature<br>testing | Functional,<br>Temperature<br>cycling,<br>Wide temperature<br>testing<br>Vibration, Shock | Functional,<br>Temperature<br>cycling,<br>Wide temperature<br>testing<br>Vibration, Shock         | Functional,<br>Testing per MIL-<br>STD-810G for<br>vibration, shock,<br>temperature,<br>humidity                                   |

Minimum lot sizes and NRE charges may apply. Contact sales support for pricing and availability.

# FMC-Servo

## Standard Features

| Analog Inputs           |   |
|-------------------------|---|
| Inputs                  | 8   |
| Input Type              | Single ended, DC coupled  |
| Nominal Input Impedance | > 5.3 GΩ (all versions).<br>Dynamic impedance = 50 ohms (pole = 165 ns) |
| A/D Device              | Texas Instruments ADS8568 (500 kSPS, 16-bit)                            |
| Resolution              | 16-bit  |
| ADC Sample Rate         | <= 500 kSPS   |
| Input Bandwidth         | TBD kHz (-3dB, est.) (AC-Coupled)<br>250 kHz (-3dB, est.) (DC-Coupled)  |

| Analog Outputs   |   |
|------------------|---|
| Outputs          | 8   |
| Output Range     | ±10V DC-coupled into high impedance load.                           |
| Output Type      | Single ended, AC or DC coupled                                      |
| Output Impedance | 100 ohms<br>(back terminated to guard against overshoot/undershoot) |
| DAC Device       | Burr-Brown (TI) DAC8822 (x 4)                                       |
| DAC Resolution   | 16-bit  |
| DAC Update Rate  | <= 1 MHz  |

\*Possible clock and sample rates in an application can depend on hardware configuration, carrier and system design

| Clocks and Triggering |  |
|-----------------------|--|
| Clock Sources         | External, or<br>Internal, based on Analog Devices AD9510 followed by AD9508.<br>Est. Jitter < 350 fs RMS<br>VCXO: 100 – 140 MHz  |
| PLL Reference         | External or 10 MHz on-card<br>10 MHz ref is ±250 ppb -40 to +85C   |
| PLL Resolution        | ≥ 12 kHz using 10 MHz reference<br>Assumes PLL's "B" divider is configured with 8,191 divider ratio.<br>May require adjustment of on-board PLL filter and parameters. This resolution is divided by the AD9510 / AD9508 divisors to calculate resolution at clock output.<br>See "PLL Notes" below for additional information. |
| Phase Noise           | -155 dBc / Hz @ 100 kHz offset<br>(measured at reference frequency – phase noise at output will depend on PLL gain and output divisors.)   |
| Triggering            | External, software, acquire N frame<br>Decimation<br>1:1 to 1:4095 in FPGA<br>Channel Clocking<br>All channels are synchronous<br>Multi-card Synchronization<br>External triggering input is used to synchronize sample clocks or an external clock and trigger may be used.   |

## FMC-Servo

| FMC Interface     |  |
|-------------------|--|
| IO                | LA[33:0] pairs, HA[22:0] pairs, HB[12:0] pairs   |
| IO Standards      | LA: LVDS<br>HA: LVDS<br>HB : LVCMOS 1.7V to 3.3V |
| Required voltages | 3.3V, 12V<br>VADJ = 1.7 to 3.3 V                 |

\*Possible rates in an application can depend on hardware configuration, carrier and system design

| Power          |           |   |
|----------------|-----------|---|
| All DC coupled | Total     | 10.74W (including external Vadj current).                                 |
|                | 3.3V      | 30 mA (0.1 W)   |
|                | 12V       | 670 mA (8.00 W)   |
|                | 2.5V Vadj | < 1.2A (2.64 W)   |
| Heat Sinking   |           | Conduction cooling supported, system level thermal design may be required |

## FMC-Servo

### A/D ELECTRICAL CHARACTERISTICS

Over recommended operating free-air temperature range at 0°C to +60°C, unless otherwise noted.

| Parameter                             | Typ        | Units | Notes   |  |
|---------------------------------------|------------|-------|---|--|
| <b>A/D Channels</b>                   |            |       |   |  |
| Bandwidth                             | 0          | kHz   | -3dB, DC coupled inputs (includes input filtering)        |  |
| Range                                 | DC Coupled | +/-10 | V   | Absolute maximum from ground, gain setting = 1 |
| SNR                                   | 91.5       | dB    | Fin = 10 kHz, 500 kSPS                                    |  |
| THD                                   | -94        | dBc   | Fin = 10 kHz, 500 kSPS                                    |  |
| SFDR                                  | 95         | dB    | Fin = 10 kHz, 500 kSPS                                    |  |
| Offset Error (absolute value maximum) | 1          | mV    | Factory calibration, average of 64K samples after warmup. |  |
| Gain Error (absolute value maximum)   | 0.5        | %     | Factory calibration after warmup for gain setting =1.     |  |

PRELIMINARY



## FMC-Servo

### D/A ELECTRICAL CHARACTERISTICS

Over recommended operating free-air temperature range at 0°C to +60°C, unless otherwise noted.

| Parameter               | Typ    | Units   | Notes  |
|-------------------------|--------|---------|--|
| <b>DAC Channels</b>     |        |         |  |
| Analog Output Range     | +/- 10 | V       | Typical, DC Coupled  |
| Analog Output Bandwidth | 600    | kHz     | including response of output active filter<br>excluding sample-and-hold effect (sinc roll-off) |
| SFDR                    | 75     | dB      | 20 MHz sine output, 1.2 dBm, DC  |
| SNR                     | -100   | dBc     | Fout = 10 kHz, Output = 20 Vpp (excludes distortion)   |
| THD                     | -89    | dBc     | Fout = 500 kHz, Output = 2Vpp  |
| Channel Crosstalk       | <-64   | dB      | Aggressor = 500 kHz, adjacent channel.   |
| Noise floor             | -100   | dBFS    | Total noise 600 kHz BW.  |
| Gain Error              | <0.5   | % of FS | Calibrated   |
| Offset Error            | <10    | mV      | Calibrated   |

## FMC-Servo

### Notes

#### Gain Definition

FMC-Servo is specified and tested with a low source impedance (ideal voltage source or 50 ohm source impedance, both negligible compared to the input impedance of the board). The FMC-Servo nominal gain is calibrated at the 1X or 0dB setting, resulting in a full-scale output. The internal hardware (raw) gain of the FMC-Servo may be different, such as when the particular board being calibrated comes in at a gain slightly lower than unity and the ADC output is digitally corrected to achieve overall accuracy.

#### Digital Calibration Note

The FMC-Servo can be digitally calibrated for offset and gain. However if the signal is clipped (outside the A/D range) the information is lost, so the raw gain is typically designed for a signal level at the A/D that is slightly less than A/D Full Scale in the bandwidth of interest to allow the nominal input range to be measured accurately without clipping when digitally calibrated.

#### PLL Notes

The output clock is produced by an integer division  $(1\sim 32) \cdot (1\sim 1,024)$  of the VCXO output. The VCXO has a tuning range of 100 – 140 MHz. This tuning range limits the range of frequencies that can be produced by integer division. For output clock frequencies below 46.67 MHz (140 MHz / 3) some combination of VCXO frequency and division ratio can be chosen to produce any arbitrary output clock frequency because the various divider output frequency ranges overlap. For example, if the AD9510 divisor is chosen to be 32 and the AD9508 divisor is chosen to be 1024, the tuning range is 3051.758 kHz – 4272.461 kHz. The next highest range (31 x 1024) is 3150.202 kHz – 4410.282 kHz which overlaps the lower range. Table 1 shows one possible programming scheme that ensures continuous coverage between an output frequency of 3.05 kHz and 46.67 MHz.

Beyond the ability to successfully synthesize a prescribed output clock frequency as outlined above, the tuning resolution limits the ability to realize the corresponding VCO output frequency exactly. The architecture of the loop requires that the VCO frequency be a rational fraction multiple (i.e., a quotient of integers) of the input reference frequency (in this case, 10 MHz). Two issues limit the achievable resolution: (1) the precision of the rational fraction necessary to produce the necessary VCO frequency and (2) the value of the feedback divide ratio (the numerator of the rational fraction) required to produce that VCO frequency since it affects the stability parameters of the PLL. The required divide ratios are not always obvious – for example, a number of VCXO frequencies (within the tuning range) are available to produce a 501 kHz output: 100.2 MHz (501 kHz x 200), 100.7 MHz, (501 kHz x 202), etc. through 139.779 MHz (501 kHz x 279).

Of the above options, the best possible choice of VCXO frequency would be one in which the numerator and denominator of the rational fraction are the smallest possible numbers. From this standpoint 100.7 MHz (10 MHz x (501/50)) is preferable to 139.779 MHz (10 MHz x (2530/181)). With such a wide tuning range ( $\pm 16.6\%$ ) there a number of choices available which would produce the same output frequency. Also, which particular VCXO frequencies would result in the lowest possible divisors is not always obvious – 125.25 MHz (501 kHz x 250) results in even smaller divisors (10 MHz x (238/19)) than does 100.7 MHz.

## FMC-Servo

| AD9508<br>Div | AD9510<br>Div | Fmin       | Fmax       |
|---------------|---------------|------------|------------|
| 1024          | 3 - 32        | 3.05 kHz   | 45.57 kHz  |
| 96            | 3 - 32        | 45.57 kHz  | 486.11 kHz |
| 9             | 3 - 32        | 486.11 kHz | 5.185 MHz  |
| 1             | 3 - 32        | 5.185 MHz  | 46.667 MHz |

Table 1. Range of output clock frequencies showing continuous coverage in the tuning range.

## FMC-Servo

### FMC Connector Pin Assignments

| P1   | P1 Pin    | FMC-Servo |
|------|-----------|-----------|
| Pins | Name      | Net       |
| A1   | GND       | GND       |
| A2   | DP1_M2C_P | N/C       |
| A3   | DP1_M2C_N | N/C       |
| A4   | GND       | GND       |
| A5   | GND       | GND       |
| A6   | DP2_M2C_P | N/C       |
| A7   | DP2_M2C_N | N/C       |
| A8   | GND       | GND       |
| A9   | GND       | GND       |
| A10  | DP3_M2C_P | N/C       |
| A11  | DP3_M2C_N | N/C       |
| A12  | GND       | GND       |
| A13  | GND       | GND       |
| A14  | DP4_M2C_P | N/C       |
| A15  | DP4_M2C_N | N/C       |
| A16  | GND       | GND       |
| A17  | GND       | GND       |
| A18  | DP5_M2C_P | N/C       |
| A19  | DP5_M2C_N | N/C       |
| A20  | GND       | GND       |
| A21  | GND       | GND       |
| A22  | DP1_C2M_P | N/C       |
| A23  | DP1_C2M_N | N/C       |
| A24  | GND       | GND       |
| A25  | GND       | GND       |
| A26  | DP2_C2M_P | N/C       |
| A27  | DP2_C2M_N | N/C       |
| A28  | GND       | GND       |
| A29  | GND       | GND       |
| A30  | DP3_C2M_P | N/C       |
| A31  | DP3_C2M_N | N/C       |
| A32  | GND       | GND       |
| A33  | GND       | GND       |
| A34  | DP4_C2M_P | N/C       |
| A35  | DP4_C2M_N | N/C       |
| A36  | GND       | GND       |
| A37  | GND       | GND       |
| A38  | DP5_C2M_P | N/C       |
| A39  | DP5_C2M_N | N/C       |
| A40  | GND       | GND       |

|     |               |      |
|-----|---------------|------|
| B1  | CLK_DIR       | 3P3V |
| B2  | GND           | GND  |
| B3  | GND           | GND  |
| B4  | DP9_M2C_P     | N/C  |
| B5  | DP9_M2C_N     | N/C  |
| B6  | GND           | GND  |
| B7  | GND           | GND  |
| B8  | DP8_M2C_P     | N/C  |
| B9  | DP8_M2C_N     | N/C  |
| B10 | GND           | GND  |
| B11 | GND           | GND  |
| B12 | DP7_M2C_P     | N/C  |
| B13 | DP7_M2C_N     | N/C  |
| B14 | GND           | GND  |
| B15 | GND           | GND  |
| B16 | DP6_M2C_P     | N/C  |
| B17 | DP6_M2C_N     | N/C  |
| B18 | GND           | GND  |
| B19 | GND           | GND  |
| B20 | GBTCLK1_M2C_P | N/C  |
| B21 | GBTCLK1_M2C_N | N/C  |
| B22 | GND           | GND  |
| B23 | GND           | GND  |
| B24 | DP9_C2M_P     | N/C  |
| B25 | DP9_C2M_N     | N/C  |
| B26 | GND           | GND  |
| B27 | GND           | GND  |
| B28 | DP8_C2M_P     | N/C  |
| B29 | DP8_C2M_N     | N/C  |
| B30 | GND           | GND  |
| B31 | GND           | GND  |
| B32 | DP7_C2M_P     | N/C  |
| B33 | DP7_C2M_N     | N/C  |
| B34 | GND           | GND  |
| B35 | GND           | GND  |
| B36 | DP6_C2M_P     | N/C  |
| B37 | DP6_C2M_N     | N/C  |
| B38 | GND           | GND  |
| B39 | GND           | GND  |
| B40 | RES0          | N/C  |

# FMC-Servo

## FMC Connector Pin Assignments (cont.)

|     |           |              |
|-----|-----------|--------------|
| C1  | GND       | GND          |
| C2  | DPO_C2M_P | N/C          |
| C3  | DPO_C2M_N | N/C          |
| C4  | GND       | GND          |
| C5  | GND       | GND          |
| C6  | DPO_M2C_P | N/C          |
| C7  | DPO_M2C_N | N/C          |
| C8  | GND       | GND          |
| C9  | GND       | GND          |
| C10 | LA06_P    | ADC_D0       |
| C11 | LA06_N    | ADC_D1       |
| C12 | GND       | GND          |
| C13 | GND       | GND          |
| C14 | LA10_P    | ADC_D2       |
| C15 | LA10_N    | ADC_D3       |
| C16 | GND       | GND          |
| C17 | GND       | GND          |
| C18 | LA14_P    | ADC_D4       |
| C19 | LA14_N    | ADC_D5       |
| C20 | GND       | GND          |
| C21 | GND       | GND          |
| C22 | LA18_P_CC | ADC_D6       |
| C23 | LA18_N_CC | ADC_D7       |
| C24 | GND       | GND          |
| C25 | GND       | GND          |
| C26 | LA27_P    | FMC_ADC_CS_N |
| C27 | LA27_N    | FMC_ADC_RD_N |
| C28 | GND       | GND          |
| C29 | GND       | GND          |
| C30 | SCL       | FMC_SCL      |
| C31 | SDA       | FMC_SDA      |
| C32 | GND       | GND          |
| C33 | GND       | GND          |
| C34 | GA0       | FMC_G0       |
| C35 | 12P0V     | 12P0V        |
| C36 | GND       | GND          |
| C37 | 12P0V     | 12P0V        |
| C38 | GND       | GND          |
| C39 | 3P3V      | 3P3V         |
| C40 | GND       | GND          |

|     |               |                 |
|-----|---------------|-----------------|
| D1  | PG_C2M        | FMC_PG_C2M      |
| D2  | GND           | GND             |
| D3  | GND           | GND             |
| D4  | GBTCLK0_M2C_P | N/C             |
| D5  | GBTCLK0_M2C_N | N/C             |
| D6  | GND           | GND             |
| D7  | GND           | GND             |
| D8  | LA01_P_CC     | ADC_D8          |
| D9  | LA01_N_CC     | ADC_D9          |
| D10 | GND           | GND             |
| D11 | LA05_P        | ADC_D10         |
| D12 | LA05_N        | ADC_D11         |
| D13 | GND           | GND             |
| D14 | LA09_P        | ADC_D12         |
| D15 | LA09_N        | ADC_D13         |
| D16 | GND           | GND             |
| D17 | LA13_P        | ADC_D14         |
| D18 | LA13_N        | ADC_D15         |
| D19 | GND           | GND             |
| D20 | LA17_P_CC     | FMC_ADC_STBY_N  |
| D21 | LA17_N_CC     | FMC_ADC_RESET   |
| D22 | GND           | GND             |
| D23 | LA23_P        | REF_SEL         |
| D24 | LA23_N        | FMC_ADC_BUSY    |
| D25 | GND           | GND             |
| D26 | LA26_P        | FMC_ADC_GAIN_D0 |
| D27 | LA26_N        | FMC_ADC_GAIN_D1 |
| D28 | GND           | GND             |
| D29 | TCK           | N/C             |
| D30 | TDI           | N/C             |
| D31 | TDO           | N/C             |
| D32 | 3P3VAUX       | 3P3V_AUX        |
| D33 | TMS           | N/C             |
| D34 | TRST_L        | N/C             |
| D35 | GA1           | FMC_G1          |
| D36 | 3P3V          | 3P3V            |
| D37 | GND           | GND             |
| D38 | 3P3V          | 3P3V            |
| D39 | GND           | GND             |
| D40 | 3P3V          | 3P3V            |

# FMC-Servo

## FMC Connector Pin Assignments (cont.)

|     |           |      |
|-----|-----------|------|
| E1  | GND       | GND  |
| E2  | HA01_P_CC | N/C  |
| E3  | HA01_N_CC | N/C  |
| E4  | GND       | GND  |
| E5  | GND       | GND  |
| E6  | HA05_P    | N/C  |
| E7  | HA05_N    | N/C  |
| E8  | GND       | GND  |
| E9  | HA09_P    | N/C  |
| E10 | HA09_N    | N/C  |
| E11 | GND       | GND  |
| E12 | HA13_P    | N/C  |
| E13 | HA13_N    | N/C  |
| E14 | GND       | GND  |
| E15 | HA16_P    | N/C  |
| E16 | HA16_N    | N/C  |
| E17 | GND       | GND  |
| E18 | HA20_P    | N/C  |
| E19 | HA20_N    | N/C  |
| E20 | GND       | GND  |
| E21 | HB03_P    | N/C  |
| E22 | HB03_N    | N/C  |
| E23 | GND       | GND  |
| E24 | HB05_P    | N/C  |
| E25 | HB05_N    | N/C  |
| E26 | GND       | GND  |
| E27 | HB09_P    | N/C  |
| E28 | HB09_N    | N/C  |
| E29 | GND       | GND  |
| E30 | HB13_P    | N/C  |
| E31 | HB13_N    | N/C  |
| E32 | GND       | GND  |
| E33 | HB19_P    | N/C  |
| E34 | HB19_N    | N/C  |
| E35 | GND       | GND  |
| E36 | HB21_P    | N/C  |
| E37 | HB21_N    | N/C  |
| E38 | GND       | GND  |
| E39 | VADJ      | VADJ |
| E40 | GND       | GND  |

|     |           |        |
|-----|-----------|--------|
| F1  | PG_M2C    | PG_M2C |
| F2  | GND       | GND    |
| F3  | GND       | GND    |
| F4  | HA00_P_CC | N/C    |
| F5  | HA00_N_CC | N/C    |
| F6  | GND       | GND    |
| F7  | HA04_P    | N/C    |
| F8  | HA04_N    | N/C    |
| F9  | GND       | GND    |
| F10 | HA08_P    | N/C    |
| F11 | HA08_N    | N/C    |
| F12 | GND       | GND    |
| F13 | HA12_P    | N/C    |
| F14 | HA12_N    | N/C    |
| F15 | GND       | GND    |
| F16 | HA15_P    | N/C    |
| F17 | HA15_N    | N/C    |
| F18 | GND       | GND    |
| F19 | HA19_P    | N/C    |
| F20 | HA19_N    | N/C    |
| F21 | GND       | GND    |
| F22 | HB02_P    | N/C    |
| F23 | HB02_N    | N/C    |
| F24 | GND       | GND    |
| F25 | HB04_P    | N/C    |
| F26 | HB04_N    | N/C    |
| F27 | GND       | GND    |
| F28 | HB08_P    | N/C    |
| F29 | HB08_N    | N/C    |
| F30 | GND       | GND    |
| F31 | HB12_P    | N/C    |
| F32 | HB12_N    | N/C    |
| F33 | GND       | GND    |
| F34 | HB16_P    | N/C    |
| F35 | HB16_N    | N/C    |
| F36 | GND       | GND    |
| F37 | HB20_P    | N/C    |
| F38 | HB20_N    | N/C    |
| F39 | GND       | GND    |
| F40 | VADJ      | VADJ   |

# FMC-Servo

## FMC Connector Pin Assignments (cont.)

|     |            |                 |
|-----|------------|-----------------|
| G1  | GND        | GND             |
| G2  | CLK1_M2C_P | CLK1_M2C_P      |
| G3  | CLK1_M2C_N | CLK1_M2C_N      |
| G4  | GND        | GND             |
| G5  | GND        | GND             |
| G6  | LA00_P_CC  | DAC_D0          |
| G7  | LA00_N_CC  | DAC_D1          |
| G8  | GND        | GND             |
| G9  | LA03_P     | DAC_D2          |
| G10 | LA03_N     | DAC_D3          |
| G11 | GND        | GND             |
| G12 | LA08_P     | DAC_D4          |
| G13 | LA08_N     | DAC_D5          |
| G14 | GND        | GND             |
| G15 | LA12_P     | DAC_D6          |
| G16 | LA12_N     | DAC_D7          |
| G17 | GND        | GND             |
| G18 | LA16_P     | DAC_A0          |
| G19 | LA16_N     | DAC_A1          |
| G20 | GND        | GND             |
| G21 | LA20_P     | FMC_DAC_LDAC    |
| G22 | LA20_N     | DAC_RST_N       |
| G23 | GND        | GND             |
| G24 | LA22_P     | DAC_WR0         |
| G25 | LA22_N     | DAC_WR1         |
| G26 | GND        | GND             |
| G27 | LA25_P     | DAC_WR2         |
| G28 | LA25_N     | DAC_WR3         |
| G29 | GND        | GND             |
| G30 | LA29_P     | FMC_PLL_SDIO    |
| G31 | LA29_N     | FMC_PLL2_CS_N   |
| G32 | GND        | GND             |
| G33 | LA31_P     | FMC_PLL_STATUS1 |
| G34 | LA31_N     | FMC_PLL_SYNC1   |
| G35 | GND        | GND             |
| G36 | LA33_P     | N/C             |
| G37 | LA33_N     | FMC_PLL_SYNC2   |
| G38 | GND        | GND             |
| G39 | VADJ       | VADJ            |
| G40 | GND        | GND             |

|     |             |                |
|-----|-------------|----------------|
| H1  | VREF_A_M2C  | N/C            |
| H2  | PRSNT_M2C_L | GND            |
| H3  | GND         | GND            |
| H4  | CLK0_M2C_P  | CLK0_M2C_P     |
| H5  | CLK0_M2C_N  | CLK0_M2C_N     |
| H6  | GND         | GND            |
| H7  | LA02_P      | DAC_D8         |
| H8  | LA02_N      | DAC_D9         |
| H9  | GND         | GND            |
| H10 | LA04_P      | DAC_D10        |
| H11 | LA04_N      | DAC_D11        |
| H12 | GND         | GND            |
| H13 | LA07_P      | DAC_D12        |
| H14 | LA07_N      | DAC_D13        |
| H15 | GND         | GND            |
| H16 | LA11_P      | DAC_D14        |
| H17 | LA11_N      | DAC_D15        |
| H18 | GND         | GND            |
| H19 | LA15_P      | ADC_GAIN_CH0   |
| H20 | LA15_N      | ADC_GAIN_CH1   |
| H21 | GND         | GND            |
| H22 | LA19_P      | ADC_GAIN_CH2   |
| H23 | LA19_N      | ADC_GAIN_WR    |
| H24 | GND         | GND            |
| H25 | LA21_P      | ADC_SLEEP      |
| H26 | LA21_N      | DAC_CLK_SEL    |
| H27 | GND         | GND            |
| H28 | LA24_P      | FMC_PLL1_CS_N  |
| H29 | LA24_N      | FMC_PLL_SCLK   |
| H30 | GND         | GND            |
| H31 | LA28_P      | FMC_TRIGOUT_P  |
| H32 | LA28_N      | FMC_TRIGOUT_N  |
| H33 | GND         | GND            |
| H34 | LA30_P      | TRIG_SEL       |
| H35 | LA30_N      | EXT_CLK_SEL    |
| H36 | GND         | GND            |
| H37 | LA32_P      | N/C            |
| H38 | LA32_N      | FMC_TEMP_ALERT |
| H39 | GND         | GND            |
| H40 | VADJ        | VADJ           |

# FMC-Servo

## FMC Connector Pin Assignments (cont.)

|     |              |              |
|-----|--------------|--------------|
| J1  | GND          | GND          |
| J2  | CLK3_BIDIR_P | CLK3_BIDIR_P |
| J3  | CLK3_BIDIR_N | CLK3_BIDIR_N |
| J4  | GND          | GND          |
| J5  | GND          | GND          |
| J6  | HA03_P       | N/C          |
| J7  | HA03_N       | N/C          |
| J8  | GND          | GND          |
| J9  | HA07_P       | N/C          |
| J10 | HA07_N       | N/C          |
| J11 | GND          | GND          |
| J12 | HA11_P       | N/C          |
| J13 | HA11_N       | N/C          |
| J14 | GND          | GND          |
| J15 | HA14_P       | N/C          |
| J16 | HA14_N       | N/C          |
| J17 | GND          | GND          |
| J18 | HA18_P       | N/C          |
| J19 | HA18_N       | N/C          |
| J20 | GND          | GND          |
| J21 | HA22_P       | N/C          |
| J22 | HA22_N       | N/C          |
| J23 | GND          | GND          |
| J24 | HB01_P       | N/C          |
| J25 | HB01_N       | N/C          |
| J26 | GND          | GND          |
| J27 | HB07_P       | N/C          |
| J28 | HB07_N       | N/C          |
| J29 | GND          | GND          |
| J30 | HB11_P       | N/C          |
| J31 | HB11_N       | N/C          |
| J32 | GND          | GND          |
| J33 | HB15_P       | N/C          |
| J34 | HB15_N       | N/C          |
| J35 | GND          | GND          |
| J36 | HB18_P       | N/C          |
| J37 | HB18_N       | N/C          |
| J38 | GND          | GND          |
| J39 | VIO_B_M2C    | N/C          |
| J40 | GND          | GND          |

|     |              |              |
|-----|--------------|--------------|
| K1  | VREF_B_M2C   | N/C          |
| K2  | GND          | GND          |
| K3  | GND          | GND          |
| K4  | CLK2_BIDIR_P | CLK2_BIDIR_P |
| K5  | CLK2_BIDIR_N | CLK2_BIDIR_N |
| K6  | GND          | GND          |
| K7  | HA02_P       | N/C          |
| K8  | HA02_N       | N/C          |
| K9  | GND          | GND          |
| K10 | HA06_P       | N/C          |
| K11 | HA06_N       | N/C          |
| K12 | GND          | GND          |
| K13 | HA10_P       | N/C          |
| K14 | HA10_N       | N/C          |
| K15 | GND          | GND          |
| K16 | HA17_P_CC    | N/C          |
| K17 | HA17_N_CC    | N/C          |
| K18 | GND          | GND          |
| K19 | HA21_P       | N/C          |
| K20 | HA21_N       | N/C          |
| K21 | GND          | GND          |
| K22 | HA23_P       | N/C          |
| K23 | HA23_N       | N/C          |
| K24 | GND          | GND          |
| K25 | HB00_P_CC    | N/C          |
| K26 | HB00_N_CC    | N/C          |
| K27 | GND          | GND          |
| K28 | HB06_P_CC    | N/C          |
| K29 | HB06_N_CC    | N/C          |
| K30 | GND          | GND          |
| K31 | HB10_P       | N/C          |
| K32 | HB10_N       | N/C          |
| K33 | GND          | GND          |
| K34 | HB14_P       | N/C          |
| K35 | HB14_N       | N/C          |
| K36 | GND          | GND          |
| K37 | HB17_P_CC    | N/C          |
| K38 | HB17_N_CC    | N/C          |
| K39 | GND          | GND          |
| K40 | VIO_B_M2C    | VADJ         |



## FMC-Servo

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