



# FMC3 Functional Specification

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## **Abstract**

FMC3 is a 4-channel 16-bit 10Ms/s DAC card in FMC (FPGA Mezzanine Card [1]) form-factor. This document describes the hardware only. Another functional specification is dedicated to the HDL related to the FMC3 card (see *FMC3 HDL functional specification*).

## History of versions

Version	Date	Author(s)	Changes
1.0	10-26-2009	mcattin	Initial release

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## 1 Features

- 4 single-ended analog output channels
- Output voltage range : +/-10V (50 ohms)
- 16-bit DACs
- Up to 10MS/s
- 1 external clock input (single-ended)
- 1 start input (TTL)
- 1 pause input (TTL)
- Each channel can store up to 32 waveform.
- Memory/channel is determined by FMC carrier [3] [2].
- Analog outputs auto-calibration.
- $I^2C$  EEPROM to store IPMI information and DACs calibration factors

## 2 General description

An FMC3 is a mezzanine card in FMC format, containing four identical analog output channels. Each channel has a 10MS/s 16-bit DAC with an output range of +/-10V. In addition, the card has two trigger inputs (start and pause) and one external clock input. These inputs are common to the four analog channels.

## 3 Clock input

The FMC3 card has an external clock input. It is compatible with many different electrical standards, like TTL, LVTTTL, PECL, sine-wave, etc...

External clock input features:

- 50 ohms terminated
- 100Hz to 10MHz
- 0.6Vpp to 1Vpp (max. 10Vpp)

Nevertheless, the external clock input doesn't have to be used, as DACs clock can be provided by the FMC carrier card [3] [2].

## 4 Trigger inputs

The FMC3 has two trigger inputs. A start and pause input. They can be used in many different ways. For further information see the *FMC3 HDL functional specification*.

All trigger inputs are TTL compliant with an internal 50 ohms termination.

## 5 Analog outputs

Table 2 lists expected FMC3 analog outputs characteristics. These are taken from a National Instruments PCI analog output card [4].

Table 2: Analog outputs characteristics

Range	$\pm 10\text{V}$
INL <sup>1</sup>	$\pm 2.2$ LSB max.
DNL <sup>1</sup>	$\pm 1.0$ LSB max.
Monotonicity <sup>1</sup>	16 bits
Offset error <sup>1</sup>	$\pm 168\mu\text{V}$ max
Gain error <sup>1</sup>	$\pm 30\text{ppm}$ of output max
Offset temperature coefficient	$\pm 35\mu\text{V}/^\circ\text{C}$
Gain temperature coefficient	$\pm 6.5\text{ppm}/^\circ\text{C}$
Onboard calibration reference	
Level	5.000V
Temperature coefficient	$\pm 0.6\text{ppm}/^\circ\text{C}$
Long-term stability	$\pm 15\text{ppm}/1000\text{h}$
Slew rate	$> 15\text{V}/\mu\text{s}$
Noise	$80\mu\text{V}$ , DC to 5MHz
Channel crosstalk	-95dB
Settling time	25ns to $\pm 1$ LSB accuracy
Total harmonic distortion	-90dB typ (generating a 10V, 1000 points, 7.5kHz sinewave, summing 9 harmonics)

## 6 Auto-calibration

Analog output channels can be auto-calibrated via an on-board ADC. Calibration information is then stored in the on-board EEPROM.

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<sup>1</sup>Measured after calibration

## 7 Physical description

Figure 1 shows the standard single width FMC board shape. The FMC3 card is connected to its carrier through a high-pin count connector from Samtec (see FMC standard [1] for further details), also visible in figure 1.

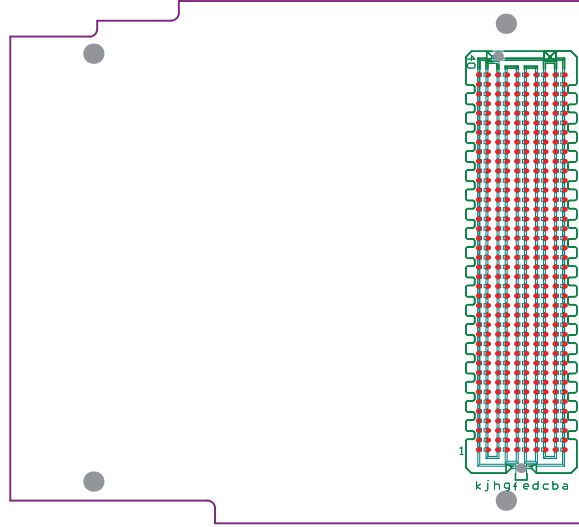


Figure 1: FMC single width board shape (scale 1:1)

## References

- [1] ANSI/VITA. American national standard for fpga mezzanine card (fmc) standard ansi/vita 57.1-2008, 2008.
- [2] CERN. PCIe FMC carrier OHR project, 2009.
- [3] CERN. VME FMC carrier OHR project, 2009.
- [4] National Instruments. NI 6731/6733 Specifications, 2007.