SigmaXplore DAC Module User Guide

Contents

1 Introduction **2**

2 Features **2**

3 Specifications **2**

4 Board **3**

5 Performance **4**

6 Software Support **4**

7 Connecting the PMOD module **4**

1 Introduction

SigmaXplore DAC is a fully differential Delta-Sigma DAC module designed for seamless integration with any standard PMOD-compatible FPGA board. It features a multibit digital output interface that feeds a differential-to-single-ended analog reconstruction filter, providing a clean, flexible, and high-quality analog output path. The architecture supports a wide range of output topologies, including data-weighted averaging (DWA), dynamic element matching (DEM), FIR-based output, single-bit hold, and traditional single-bit operation. This versatility makes the module an ideal platform for exploring advanced DAC linearization, noise-shaping strategies, and mixed-signal design techniques.

Getting started is simple with our preconfigured HDL files and analysis scripts, allowing you to dive directly into experimentation, customization, and hands-on learning without the burden of complex setup.

2 Features

DAC

- •Fully differential architecture
- •16-bit input interface for DWA/DEM applications
- •Single-ended analog output
- •20 kHz large-signal output bandwidth
- •Fully discrete design for maximum educational value
- •3.3V to 5V Single Supply from PMOD

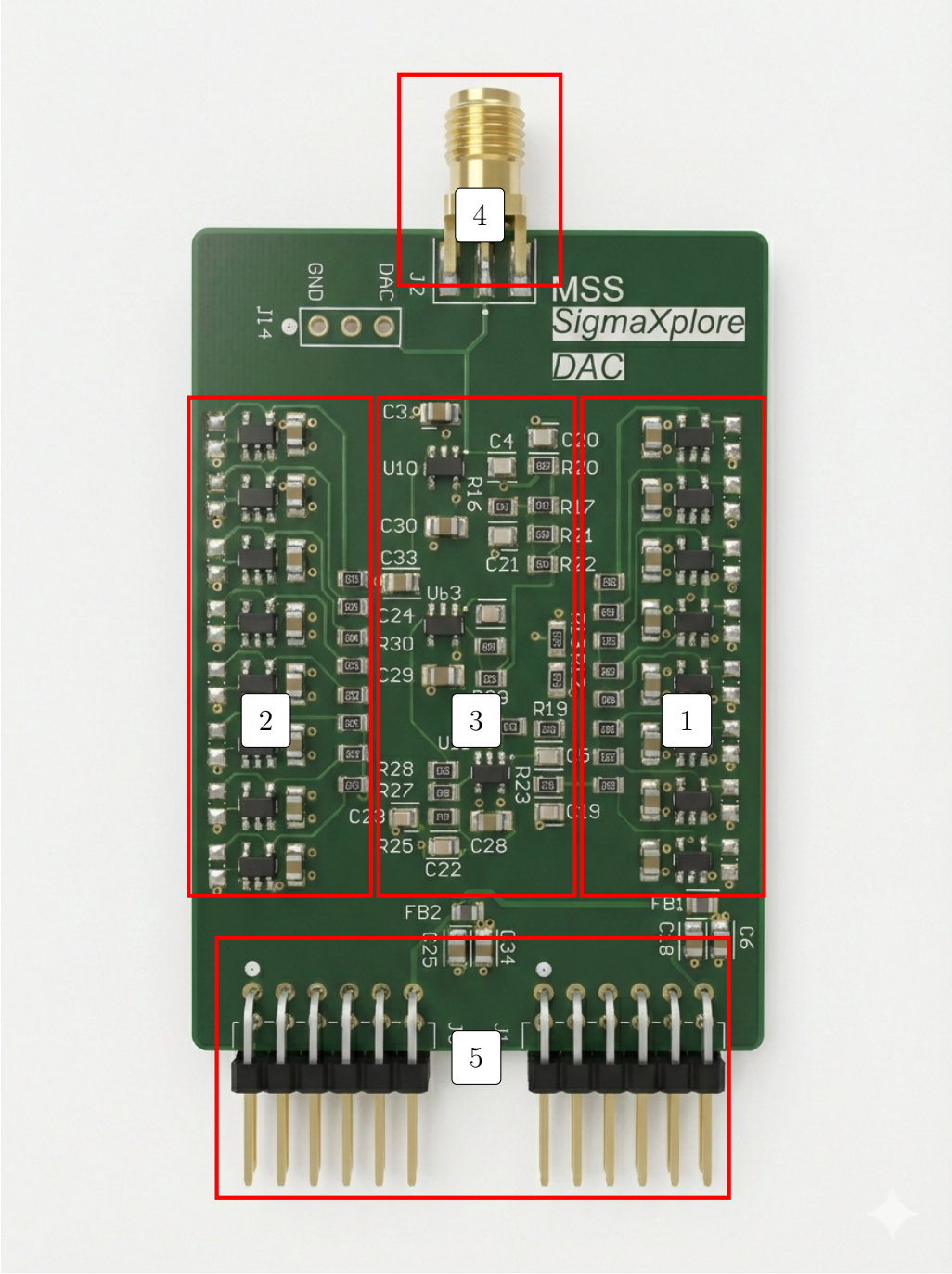
Applications

- •Professional and university-level education
- •High-performance audio systems
- •Algorithm and digital-topology development
- •High-fidelity NCO-based test-signal generation

3 Specifications

Parameter	Value	Unit
Supply Voltage	3.3	V
Supply Current	25	mA
SNR	-93	dB
Output Noise	13	uV RMS
Vout	3.25	Vpp

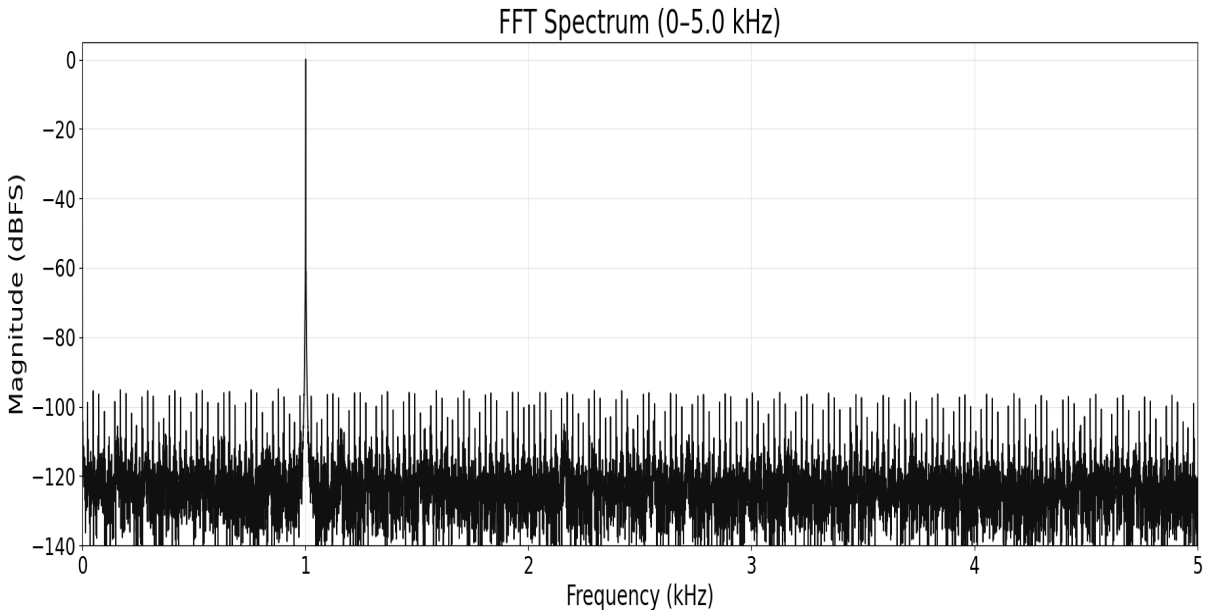
4 Board



Reference	Callout	Signal/Part	Notes
1	P-DAC	(8) DAC bits	Positive input
2	N-DAC	(8) DAC bits	Negative Input
3	Filter/Differential Driver		
4	Femal SMA output		3.25Vpp Output
5	16 Bit input and power		FPGA connection

5 Performance

Below is the measured performance of the SigmaXplore 6FD with the SigmaXplore DAC driving it with a 1kHz 1.5Vpp input. The ADC is configured for 16 bits with an OSR of 128. The 2nd order DAC is configured for 20 bits and is driven by a CORDIC NCO. The ADC resolution and sample rate are determined by the clock frequency, oversampling ratio, and number of integrator stages and can be easily modified through vivado code changes.



6 Software Support

The SigmaXplore DAC includes a compressed Vivado project that's already configured for the MOC FPGA boards, and it can be adapted to any PMOD-style FPGA board with only minor edits to the .xdc file. The design bundles a numerically controlled oscillator, a delta-sigma DAC configurable up to fourth order, and a linear DWA 16-bit differential output stage. Running the converter at 40MHz—rather than the 5MHz sweet spot of the simpler single-bit DACs—gives a substantial SFDR improvement across the band.

There's plenty of room to extend the core: adding a UART interface to set the NCO frequency, a high bit order MicroBlaze based NCO, fractional-scale NCO output, more advanced DWA or DEM calibration, or streaming WAV data from a PC over Python. You could also drop in an I^2S receiver to interface with external digital-audio sources.

7 Connecting the PMOD module

Connecting the SigmaXplore DAC is straightforward because the pins follow the PMOD standard: 0.9-inch spacing with a dual-row 12-pin, 0.1-inch header.

The module must only be inserted into a PMOD port in the correct orientation. A single-pin offset or an upside-down insertion can damage the module, since misalignment can place PMOD supply pins directly onto unprotected I/O pins. The MOC FPGA boards themselves are not at risk, but the modules can be permanently damaged if connected incorrectly. Always power down all boards when connecting or disconnecting modules.

Once aligned properly, the module can be used without concern for I/O configuration. The MOC FPGA boards follow the 200-ohm PMOD output-impedance guideline, which prevents damage from pins that might otherwise be driven incorrectly during development or testing.

The DAC output has both solder terminals and a female SMA connector. The outputs are not short circuit protected and a prolonged shorted output will result in damage to the output driver. The output can drive a 50 ohm load without problems. Please double check all connections before powering up.