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Product Information Sheet

PDAC4000

4000 MSPS Waveform Generator



FEATURES

- 4 16-bit DAC Outputs at 1000 MSPS
- 512 Megabytes DDR RAM
- Modular Plug-in for PMP1000 Base Board
- Easy Interface to DSP Functionality
- Wide Selection of Output Filters
- Based on Analog Devices AD9779
- Interpolation at 2, 4, or 8x Data Rate
- Digital Quadrature Modulator
- User Specified Analog Output Filters

APPLICATIONS

- Waveform Generation or Playback
- Digital Quadrature Frequency Up Conversion
- Radar
- Video
- Communications
- Ultrasound
- Automated Testing

OVERVIEW

The PDAC4000 is a very high speed, four channel Digital to Analog Conversion (DAC) board which may be used as an Arbitrary Waveform Generator, a waveform playback device, or for generating multiple communication frequency bands. Output waveforms may be “single shot” or “continuously looped”. The DAC4000 is a daughter card that plugs into a PMP1000 base board and takes advantage of its data interfaces and programmability.

The PDAC4000 can accurately produce output signal frequencies up to 400 MHz. Each 16-bit converter can output up to 1000 megasamples per second. On-board there is a total of 512 megabytes of SDRAM.

Data samples may be supplied to the DACs via the on-board memory, or via the Signatec Auxiliary Bus (SAB) or PCI-X bus on the PMP1000. Waveforms captured with either Signatec's 8-bit PDA1000 or 14-bit PDA14 boards may be played back at the same clock rate at which they were acquired or at other programmable clock rates.

The DAC clock source may be selected as either the 1000 MHz or 800 MHz VCXO oscillator or from the external clock input. Any of the three clock sources can be divided by any integer from 1 to 32 times a second integer from 1 to 32 for a total divider range of 2 to 1024. The VCXO oscillators have extremely low jitter and can be synchronized to an external reference input or to the internal TCXO reference. The internal reference is accurate to better than 3ppm.

The PDAC4000 can be programmed to generate continuous, repetitive waveforms by utilizing data “looping” whereby the designated amount of data is played repeatedly without gaps in the waveform.

The PDAC4000 is ideal for playing back extremely long waveforms, such as those previously captured with a Signatec Waveform Recording system. This is particularly useful in testing a system’s response to previously recorded real world signals. In such an operation the data is supplied from the high-speed data storage system via the PCI-X bus and the PMP1000’s on-board RAM is utilized as a very large FIFO. The PDAC4000’s own on-board RAM would not be used in this implementation.

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HARDWARE DESCRIPTION

The PDAC4000 is a daughter-card that installs onto a PMP1000 platform as shown in figure 1 on the following page. Figures 2 and 3 show details on the main components of the PDAC4000 and also data flow.

Data flows into the PDAC4000 from the two 32-bit data ports of the PMP1000 data path switch. This data can either be loaded into RAM or routed directly to the DAC.

Since the PDAC4000 is installed in a base PMP1000 platform, the details of PMP1000 operation should be explored via the PMP1000 data sheet and operator's manual.

PDAC4000 operation can be controlled via a PC-based program or a PMP1000 program.

Operating Modes

The PDAC4000 has 6 operating modes:

- Power-down Mode
- Load SDRAM from PCI-X
- Load SDRAM from SAB
- RAM Playback
- PCI-X Playback
- SAB Playback

Power-down Mode

Power-down mode minimizes power usage. When the host computer is powered up the PDAC4000 is in the Power-down mode.

Loading Data

Data can be loaded into SDRAM from either the SAB or the PCI-X bus. This is done in order to prepare the board to be used in RAM Playback mode. When data is placed into RAM, the data length is stored as an ending address.

Single Shot Operation

When Single Shot operation is selected, a single trigger, from either the external trigger input or via software, causes a waveform to be generated starting at RAM address 0 and continuing until the programmed ending address is reached. At that point the address is reset to 0 and another trigger can be issued to repeat the process. The board can also be placed into a free run mode whereby the ending address is ignored and the DAC will continue to output a waveform until a software stop command is issued.

Waveform Looping

When the waveform data source is the on-board RAM, repeating waveforms can be generated by activating the "continuous looping" feature. In this mode the start of the waveform will be at address 0 and the "looping address" is the ending address.

When using externally supplied data via either the SAB or PCI buses, the external data source must supply the looping feature.

PCI-X / SAB Playback Modes

Data may be supplied to the DAC as a stream via the PCI-X or SAB buses (on the PMP1000 platform). Playback works particularly well via the PCI bus where the PMP1000's on-board SDRAM is utilized as a very large FIFO. This is especially useful since PCI data may be interrupted for substantial time periods to accommodate various computer requirements.

Clock Generation

The DAC clock can be derived from on-board 800 MHz or 1000 MHz VCXO oscillators or from an externally supplied clock. If either of the internal oscillators is selected, their outputs will be synchronized to the internal or external reference clock via a phase lock loop. In this case the DAC clocking frequency will have the same accuracy as the reference clock. The internal reference accuracy is better than 3ppm. The external reference clock frequency must satisfy the equation:

$f_{ref} = f_{vcxo} * R/N$ where R and N are any 13 bit integer.

The DAC sampling clock frequency can be set to:

$f_{DAC} = f_{VCXO} / (a * b)$ where a and b are 5 bit integer values.

When the external clock is used, its frequency should be substituted for f_{vcxo} in the above equation.

The use of inter-sample interpolation allows the DAC sample rate to be 2, 4, or 8 times the input date rate. This allows unwanted sampling "images" and artifacts to be separated in frequency from the desired spectrum and therefore more easily filtered from the analog output.

It is important to note that although the DAC can output a maximum rate of 1000 MSPS simultaneously on all four channels, the maximum input rate to the DAC is limited to 300 MSPS per channel. Data cannot be interleaved between channels to increase the input rate into the DAC.

Interpolation Filters / Digital Quadrature Modulator

When interpolation is activated, the DAC samples at a multiple of the actual input data rate. The multiple can be selected as 2, 4, or 8. In this mode, interpolated values are inserted between the real data values. In the 8x mode, 7 interpolated values are inserted between each real value.

A range of interpolation filters allows for the creation of multiple frequency bands throughout the Nyquist range of the DAC sampling frequency. The output signal bandwidth, however, cannot exceed the Nyquist limit of the actual input data rate.

The Digital Quadrature Modulator allows the output signal to be shifted into one of the frequency bands defined by the interpolation filtering.

For more details on interpolation/modulation please refer to the AD9779 data sheet.

Data Multiplexers / Data Formats

The PDAC4000 employs a 4:1 (x16 bits) multiplexer for each DAC channel. Their purpose is to provide compatibility with any data format that is based on 16-bit entities.

Bit shifters are supplied to re-package 12 or 14-bit data so that the MSBs of the DAC inputs contain the data with the LSBs set to zero.

Eight bit data is expanded to 16 bits by the 8-bit expander. The lower 8 bits are set to 0.

Output Amplitude and Offset

The full scale output voltage (with 50 ohm termination) may be set from 400 mV p-p to 2.0 V p-p with 8-bit resolution. An offset DAC allows for shifting the output signal from + full scale to - full scale with 12 bit resolution.

Filter Selection

The PDAC4000 is available with optional analog output low pass filters, or with no output filters. The filters are third order with either a Chebyshev or Transitional filter response characteristic available. Depending on the characteristics of a particular application, output filters can play an important role in rejecting unwanted effects such as sampling artifacts, distortion, and noise.

The Chebyshev has the steepest roll off characteristic and is a good choice for frequency domain applications. For time domain applications the Chebyshev response will exhibit about a 10% overshoot with ringing for fast signal edges. For time domain applications the transitional filter may be more appropriate since it has a much better behaved fast pulse response, but it's stopband rolloff is not as steep.

When ordering, the user may select one of the "standard" low pass filter cutoff frequencies or optionally specify the desired non-standard cutoff frequency. All band pass filters are non-standard, requiring both the low and high end cutoff to be specified.

More details on filter cutoff limitations will be forthcoming.

External Trigger

An external trigger input is provided. The proper signal edge will activate the output from the DAC. This allows the output waveform to be synchronized with an external event.

Other DAC5687 Features

The PDAC4000 is built around a pair of Analog Devices AD9779 Digital-to-Analog Converters. This device has many advanced features, many of which have been discussed in this data sheet. However, it is beyond the scope of this data sheet to itemize all the features. The PDAC4000 does support most its features and the user should refer to the AD9779 data sheet for more details.

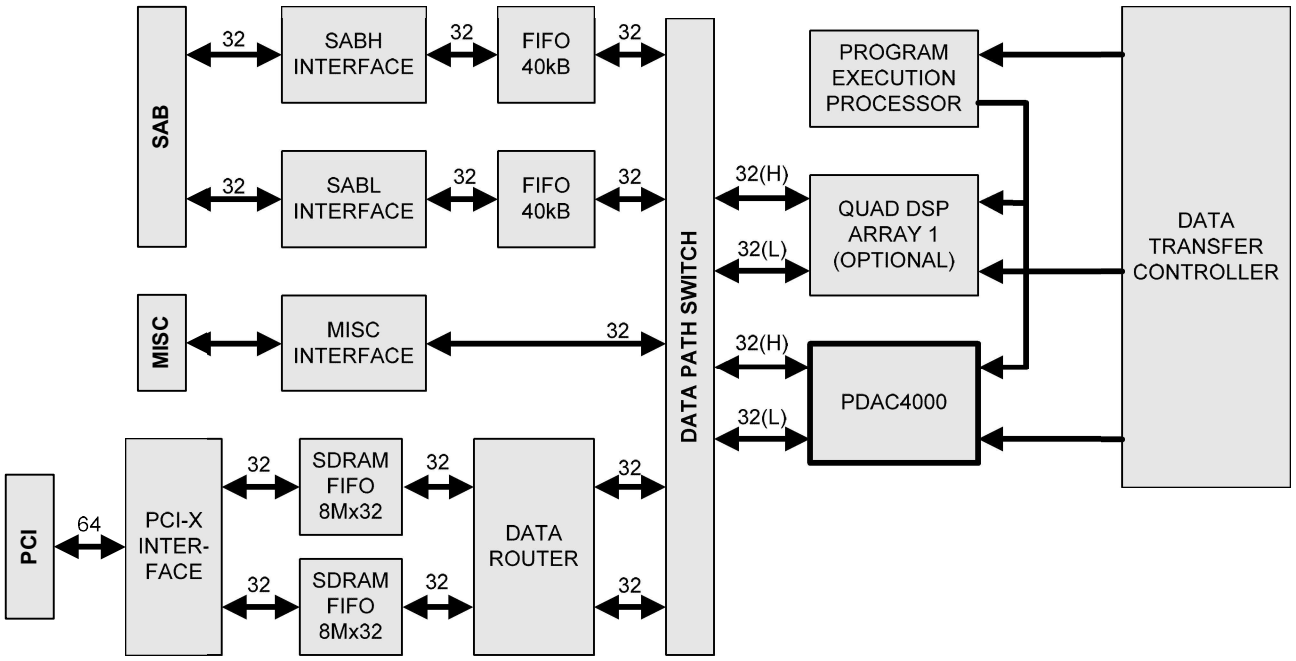


Figure 1 – PDAC4000 Installed on PMP1000 Platform

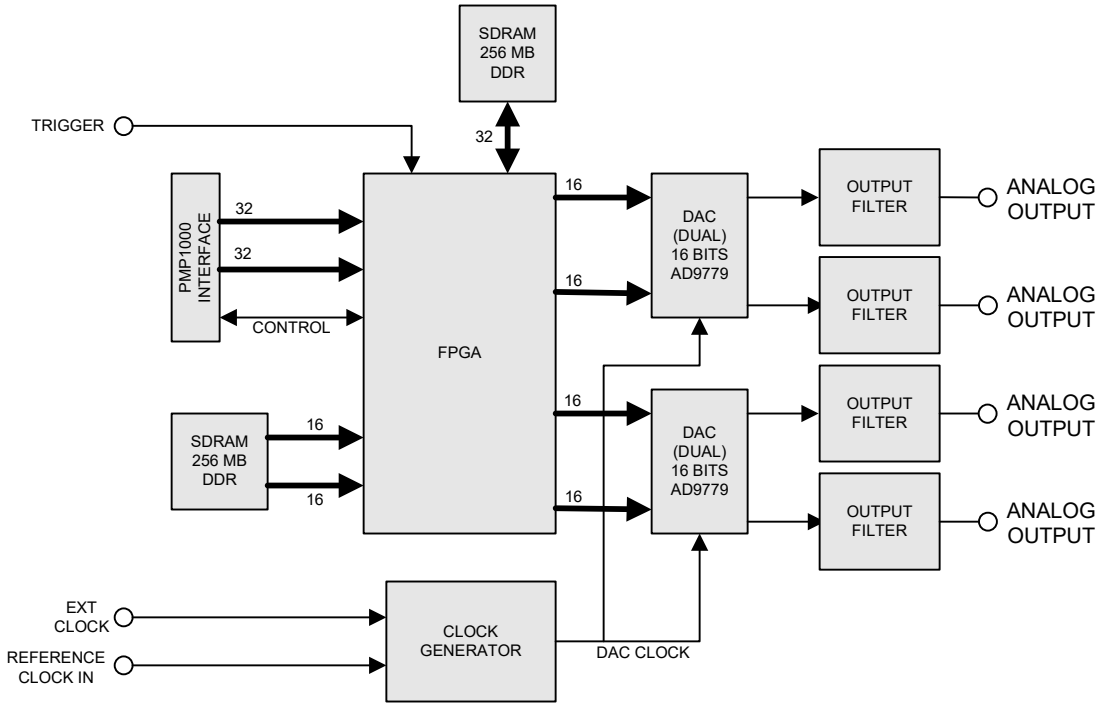


Figure 2 – PDAC4000 Block Diagram

PDAC4000 SPECIFICATIONS AND ORDERING INFORMATION

Input Signals
External Trigger
External Clock
Reference Clock

Output Signals
DAC Channel 1 ("I1")
DAC Channel 2 ("Q1")
DAC Channel 3 ("I2")
DAC Channel 4 ("Q2")
Clock Out
Digital I/O

Connectors
MMCX (9 total)

Analog Outputs
F.S. Voltage Ranges : 400mVp-p to 2.0Vp-p (DC Coupled)
Impedance : designed for 50 ohm load
Bandwidth : up to 125 MHz, but determined by selected filter
Coupling : DC / AC

External Trigger
Trigger Level : TTL (.8v - Low, 2V-Hi)
Coupling : DC

External Clock
Signal Type : sine or square wave
Impedance : 50 ohms to ground
Frequency : 16 MHz to 1000 MHz
Amplitude : 100 mV p-p to 2.0V p-p
Coupling : AC

Reference Clock
Signal Type : sine or square wave
Impedance : 50 ohms to ground
Frequency : $f_{ref} = f_{vcxo} * R/N$ where R and N are any 13 bit integer; f_{ref} (max) = 100MHz
Amplitude : 100 mV p-p to 2.0V p-p
Coupling : AC

DC Offset Voltage
Control : 12 bit DAC
Range : ±1/2 of full scale setting

AC Performance (fdac=1000MHz)
SFDR, fig=100MHz : 80dB
SNR, fsig=100MHz : TBD dB

Trigger Modes
Single Shot: single start trigger runs memory data once
Continuous: single start trigger runs looped memory data

DAC Memory
512 MBytes DDR SDRAM

Data Rates

Maximum Rates
The following maximum data rates at various points in the data flow could dictate perform limits for various utilizations.
Input 32-bit Ports : 500+ MB/s (single port) / 1.0+ GB/s (2 ports)
SDRAM : 1.3 GB/sec
Input Data Rate to each DAC : 300 MSPS
DAC Output Rate : 1000 MSPS (with interpolation)

Minimum Rates
Input Rate to DAC : 16 MSPS per channel

Signatec Auxiliary Bus (SAB)
Data Transfer Modes : 64-bit or 32-bit
Data Transfer Rates : 62.5 MHz maximum
Data Direction : Input only

Power Requirements
25 W maximum

Absolute Maximum Ratings
Trigger Input : ±5 volts
Clock Input : 5 volts peak to peak
Ambient Temperature : 0 to 70°C / 0 to 50°C for specified performance

Ordering Information
PDAC4000-AC : PDAC4000 AC coupled with no output filters
PDAC4000-DC : PDAC4000 DC coupled with no output filters

-T-X : Add to end of desired PDAC4000 part number above to add a L.P. Transitional filters
-C-X : Add to end of desired PDAC4000 part number above to add a L.P. Chebyshev filters

-QDA : Add to end of desired PDAC4000 part number above to add a PMP1000-QDA DSP module.

-Module : For existing PMP1000 customers, add to end of desired PDAC4000 part number above to specify only the PDAC400 module.

NOTES:
X = Low Pass Cutoff Frequency in MHz.
Standard Low Pass Filters: TBD

SAB Cables
Refer to the "SAB Cable Assembly Ordering Guide" to select and order the appropriate cable assemblies.

Coax Cables
The PDAC4000 is shipped with two, four foot coaxial cables with BNC connectors on the user end. Additional cables may be purchased separately.

Documentation & Accessories
The PDAC4000 is supplied with a comprehensive Operators Manual that thoroughly describes the operation of the hardware and the software, as well as appropriate software disks.

Customer Support
Customer Support and Software Updates can be obtained from the Signatec Web Site at www.signatec.com.

Product Warranty
All Signatec products carry a full 3-year warranty. During the warranty period, Signatec will repair or replace any defective product at no cost to the customer. This warranty does not cover customer misuse or abuse of the products or physical damage not reported within 15 days of the time of shipment by Signatec.

Notes:
Signatec reserves the right to make changes in this specification at any time without notice. The information furnished herein is believed to be accurate, however no responsibility is assumed for its use.

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