

# Extending the *denseDAC*<sup>™</sup> Multichannel D/As

*denseDAC* multichannel D/As are Analog Devices digital-to-analog converters with 8 to 40 channels, offering 12-bit to 16-bit resolution.

## Key Features

- High density of D/A channels
- Uncompromised performance in a small footprint
- User-programmable flexible features

## Key Applications

### Application Needs *denseDAC* Solution

#### Industrial/Instrumentation

- |                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>PLC I/O</b>                    | <b>AD5362</b>                    |
| • High resolution . . . . .       | 16-bit monotonic                 |
| • System calibration . . . . .    | Offset and gain registers        |
| • Flexible output range . . . . . | ±10 V, ±5 V, 0 to 5 V,<br>o 10 V |
| • Small footprint . . . . .       | 8 mm × 8 mm LFCSP                |

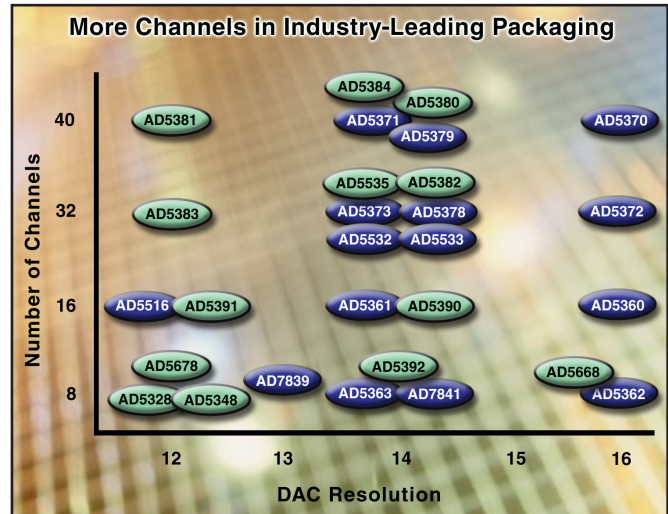
- |                                  |                              |
|----------------------------------|------------------------------|
| <b>Instrumentation</b>           | <b>AD5360</b>                |
| • High precision . . . . .       | ±4 LSB integral nonlinearity |
| • High channel count . . . . .   | 16 channels                  |
| • Bipolar output range . . . . . | ±10 V (20 V span)            |

#### Automatic Test Equipment

- |                                   |                           |
|-----------------------------------|---------------------------|
| <b>Pin Electronics</b>            | <b>AD5370</b>             |
| • High integration . . . . .      | 40 DACs in 64-lead LFCSP  |
| • System calibration . . . . .    | Offset and gain registers |
| • Group addressing . . . . .      | 5 groups × 8 channels     |
| • Remote ground sensing . . . . . | 5 DUT ground pins         |
| • Flexible output range . . . . . | -4 V to +8 V typ          |
| • LVDS option . . . . .           | AD5371                    |

#### Optical Communications

- |   |                              |
|---|------------------------------|
| <b>VOA</b>                              | <b>AD5382</b>                |
| • High integration . . . . .            | 32 DACs in 100-lead LQFP     |
| • On-chip low drift reference . . . . . | 10 ppm/°C max (1.25 V/2.5 V) |
| • System calibration . . . . .          | Offset and gain registers    |
| • Channel measurement . . . . .         | Channel monitor              |
| • Flexible interface . . . . .          | SPI <sup>®</sup> /parallel   |
| <b>MEMS Optical Switch</b>              | <b>AD5535</b>                |
| • High channel count . . . . .          | 32 channels                  |
| • High resolution . . . . .             | 14 bits, monotonic           |
| • High output voltage . . . . .         | 200 V max                    |



■ Bipolar ■ Unipolar

## Overview

Analog Devices has extended its range of high density, high performance, multichannel DACs—the *denseDAC* family—by offering new, bipolar, 8-channel to 40-channel, 16-bit and 14-bit DACs. The patented *iCMOS*<sup>™</sup> industrial manufacturing process enables the combination of up to 40 channels, high resolution, and ±10 V output range, in a compact footprint, packed with a range of new integrated programmable features.

But did you know the range of applications that these flexible parts can support and enhance? ADI engineers have found innovative ways to optimize for target application areas, addressing the needs of ATE, optical communications and networking, industrial, and precision instrumentation applications. Products are designed with your system needs in mind, so the *denseDAC* family is certain to have a solution that matches your requirements.

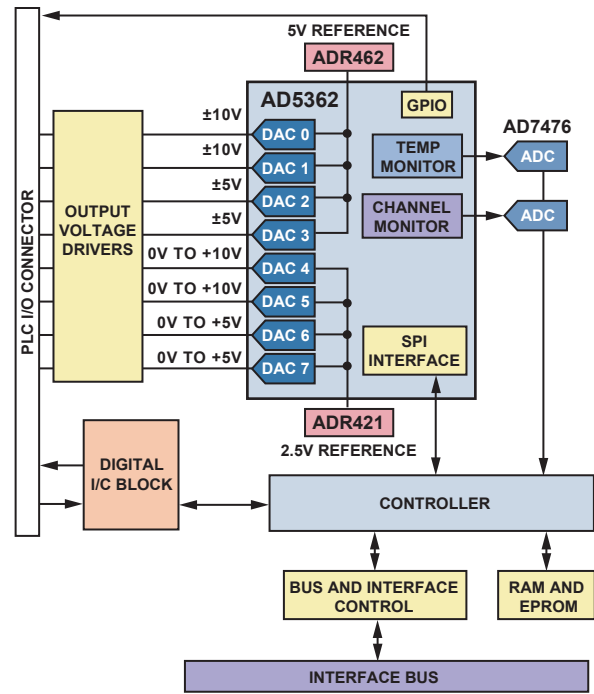


## AD5362 in PLC Applications

PLC applications will benefit from the precision, integration, and flexibility offered by the *denseDAC* family, more specifically the AD5362. With eight channels and 16-bit monotonic performance, this  $\pm 10$  V DAC in 8 mm  $\times$  8 mm LFCSP also integrates user-programmable offset and gain registers per channel, and user-selectable output voltages. The programmable output span of 20 V provides greater freedom to customize products, without the need for complex external analog circuitry. The AD5362 also includes a temperature sensor, a thermal monitor mode, a voltage monitor multiplexer, and a power-down mode—all of which are advantageous in system monitoring. The other members of this family are pin-compatible solutions, allowing higher channel or lower resolution upgrade path with no design change.

### AD5362 Key Features

- 8-channel, 16-bit, bipolar DAC
- System calibration function allowing user-programmable offset and gain
- SPI interface with readback and data error checking feature

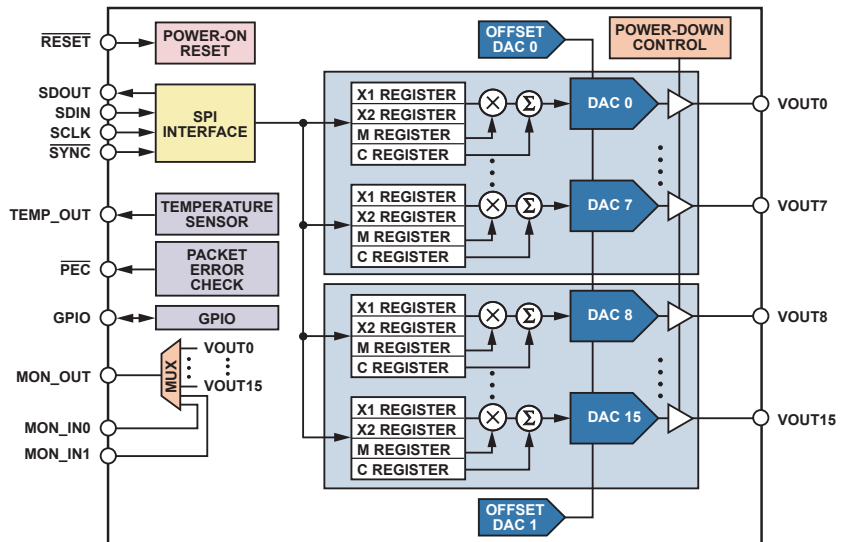


## AD5360 in Instrumentation Applications

The AD5360 is a highly integrated, 16-channel,  $\pm 10$  V, serial input, voltage output DAC. It provides industrial and instrumentation system designers the flexibility, functionality, and space efficiency that are key to implementing voltage level setting, closed-loop control, and coarse/fine tune circuits. It combines 16-bit resolution,  $\pm 4$  LSB INL, user-programmable offset and gain registers per channel, and user-selectable output voltage ranges in 8 mm  $\times$  8 mm LFCSP footprint. Additional features include SPI with readback and PEC, temperature sensor, toggle mode, and power-down mode. These devices enable the integration of greater functionality into smaller board space, which is particularly important in precision instrumentation applications such as oscilloscopes, data generators, and medical equipment.

### AD5360 Key Features

- 16-channel, 16-bit, bipolar DAC
- $\pm 4$  LSB integral nonlinearity
- $\pm 10$  V output voltage range
- System calibration function allowing user-programmable offset and gain
- Channel grouping (2 of 8) and group addressing capability

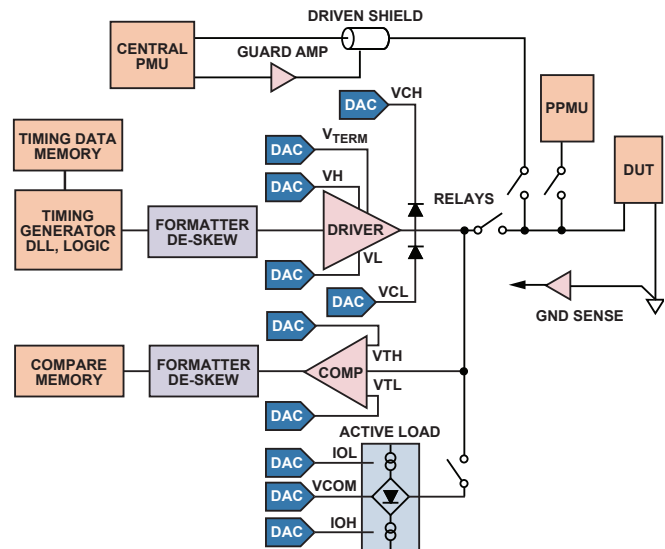


## AD5370 in ATE Applications

In ATE applications several DACs are required to control pin drivers, comparators, PMUs, and signal timing. Traditionally, sample-and-hold devices were used. However, DACs have several advantages: no refreshing is required, there is no droop, pedestal error is eliminated, and there is no need for external filtering to remove glitches. The AD5370 is a 40-channel DAC offering 16-bit DNL and 14-bit INL, in 9 mm × 9 mm LFCSP, thereby providing the channel density and performance required by high precision ATE pin electronics.

### AD5370 Key Features

- 40-channel, 16-bit DAC, in 9 mm × 9 mm LFCSP
- User-programmable offset and gain registers for system calibration
- Output voltage range: -4 V to +8 V typ
- 2  $V_{REF}$  pins and 2 offset DACs to set different output voltage ranges
- Remote ground sensing
- Greater addressing flexibility—5 groups of 8 DACs
- SPI interface with readback



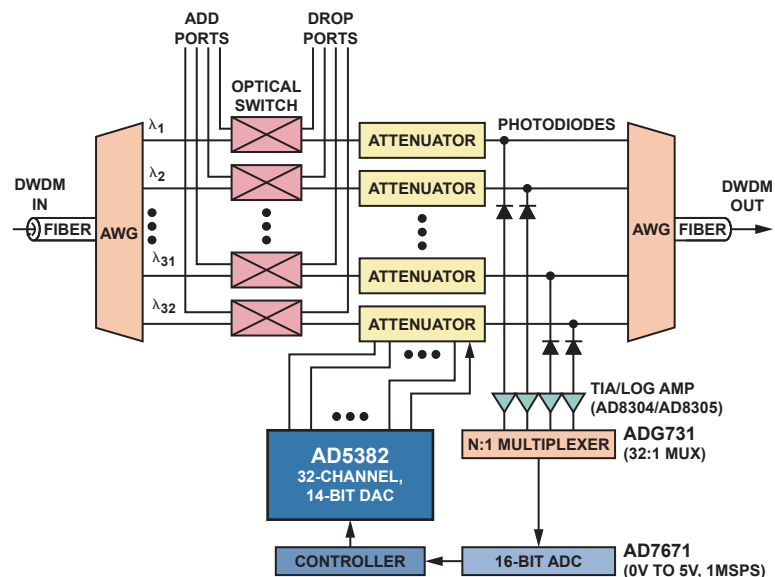
NOTES  
1. EACH AD5370 SUPPORTS 4 DCL CHANNELS.

## AD5382 in an Optical Attenuator Application (OADM System)

The AD5382, with its 32-channel, 14-bit monotonic performance and high level of integration, is ideally suited for optical applications. In optical attenuator applications, such as dynamic gain equalizers, variable optical attenuators (VOA), and optical add-drop multiplexers (OADM), each wavelength is individually extracted using an arrayed wave guide (AWG). Its power is monitored using a photodiode, transimpedance amplifier, and an ADC in a closed-loop control system. Here the AD5382 controls the optical attenuator for each wavelength, ensuring that power is equalized in all wavelengths before being multiplexed onto the fiber. This prevents information loss and saturation from occurring at amplification stages farther along the fiber.

### AD5382 Key Features

- Guaranteed monotonic to 14 bits
- $INL = \pm 4$  LSB
- System calibration function allows user-programmable offset and gain
- On-chip 1.25 V/2.5 V reference with 10 ppm/°C tempco
- On-chip output amplifiers with rail-to-rail operation
- Low power (300  $\mu$ A/channel)





## denseDAC Selection Table

Part Number	Number of Channels	Resolution (Bits)	Max Output Voltage (V)	Package	Interface	Additional Features	Price @ 1k' (\$U.S.)
<b>denseDACs with Bipolar Outputs</b>							
AD5370	40	16	±10	64-lead LFCSP/64-lead LQFP	SPI	Offset and gain registers	62.90
AD5371	40	14	±10	100-lead CSPBGA/80-lead LQFP	SPI/LVDS	Offset and gain registers	58.50
AD5379	40	14	±8.75	108-lead CSPBGA	Parallel/SPI	Offset and gain registers	59.75
AD5372	32	16	±10	56-lead LFCSP/64-lead LQFP	SPI	Offset and gain registers	52.90
AD5373	32	14	±10	56-lead LFCSP/64-lead LQFP	SPI	Offset and gain registers	47.50
AD5378	32	14	±8.75	108-lead CSPBGA	Parallel/SPI	Offset and gain registers	44.95
AD5532	32	14	±5, ±10	74-lead CSPBGA	SPI	Offset DAC	49.95
AD5532B	32	14	±5	74-lead CSPBGA	SPI	Offset DAC	54.95
AD5533	32	14	±5	74-lead CSPBGA	Parallel/SPI	Infinite SHA, offset DAC	43.75
AD5533B	32	14	±5	74-lead CSPBGA	Parallel/SPI	Infinite SHA, offset DAC	47.65
AD5532HS	32	14	±2.5	74-lead CSPBGA	SPI	High speed interface	49.95
AD5360	16	16	±10	56-lead LFCSP/52-lead LQFP	SPI	Offset and gain registers	29.90
AD5361	16	14	±10	56-lead LFCSP/52-lead LQFP	SPI	Offset and gain registers	27.50
AD5516	16	12	±2.5, ±5, ±10	74-lead CSPBGA	SPI	Increment/decrement mode	26.85
AD5362	8	16	±10	56-lead LFCSP/52-lead LQFP	SPI	Offset and gain registers	23.90
AD5363	8	14	±10	56-lead LFCSP/52-lead LQFP	SPI	Offset and gain registers	19.50
AD7841	8	14	±10	44-lead MQFP	Parallel	3 V <sub>REF</sub> pins	28.65
AD7839	8	13	±10	44-lead MQFP	Parallel	3 V <sub>REF</sub> pins	27.50
<b>denseDACs with Unipolar Outputs</b>							
AD5380	40	14	5	100-lead LQFP	Parallel/SPI/I <sup>2</sup> C <sup>®</sup>	Low drift on-chip reference	49.50
AD5384	40	14	5	100-lead CSPBGA	SPI/I <sup>2</sup> C	Low drift on-chip reference	49.50
AD5381	40	12	5	100-lead LQFP	Parallel/SPI/I <sup>2</sup> C	Low drift on-chip reference	39.50
AD5535	32	14	200	124-lead CSPBGA	SPI	On-chip temp sensor	135.00
AD5382	32	14	5	100-lead LQFP	Parallel/SPI/I <sup>2</sup> C	Low drift on-chip reference	42.50
AD5383	32	12	5	100-lead LQFP	Parallel/SPI/I <sup>2</sup> C	Low drift on-chip reference	34.50
AD5390	16	14	5	64-lead LFCSP/52-lead LQFP	SPI/I <sup>2</sup> C	Low drift on-chip reference	23.90
AD5391	16	12	5	64-lead LFCSP/52-lead LQFP	SPI/I <sup>2</sup> C	Low drift on-chip reference	19.90
AD5668	8	16	5	16-lead TSSOP	SPI	Low drift on-chip reference	13.95
AD5678	8	16/12	5	14-lead TSSOP/16-lead TSSOP	SPI	Low drift on-chip reference	10.50
AD5392	8	14	5	64-lead LFCSP/52-lead LQFP	SPI/I <sup>2</sup> C	Low drift on-chip reference	14.90
AD5328	8	12	5	16-lead TSSOP	SPI	LDAC pin	6.95
AD5348	8	12	5	40-lead LFCSP/38-lead TSSOP	Parallel	LDAC and CLR pins	8.41

<sup>1</sup>1k unit lowest grade pricing.



10 mm × 10 mm  
100-lead CSPBGA package



8 mm × 8 mm  
56-lead CSPBGA package

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## Evaluation Boards

Evaluation boards are available for *denseDAC* products. These are complete self-contained evaluation tools for precision converters. These boards essentially allow development engineers to evaluate the features, functions, and performance of the devices to determine suitability for end user applications. Evaluation boards interface directly to the PC and come with a suite of software designed to allow simple control of all programmable functions.

For more information, visit [www.analog.com/denseDAC](http://www.analog.com/denseDAC).