

1<sup>st</sup> Edition

# ANALOG SIGNAL CHAIN

*Product Guide*



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Industrial and Medical Solutions Group
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# Analog Signal Chain

## Message from the Senior Vice President, Industrial and Medical Solutions Group

In a world experiencing challenging transitions in multiple arenas—energy, healthcare, industry, finance, and security, to name a few—Maxim Integrated’s Industrial and Medical Solutions Group offers superior signal chain solutions that are innovative, accurate, and cost-effective.

We’re able to deliver these superior solutions because Maxim Integrated has developed a wide range of advanced, flexible, and affordable building blocks—ADCs, DACs, multiplexers, amplifiers, and more—that empower customers to meet their toughest challenges.

At Maxim Integrated, we partner closely with customers to understand their needs, and then develop an appropriate, holistic solution. As a result of this collaboration and customization, we’re able to assemble smaller chips and systems that deliver better performance with fewer components and use less power at a lower cost.

Maxim Integrated recognizes that most customers want to buy from fewer suppliers, suppliers whose products deliver more functionality with ready-made components as well as customizable flexibility for unique applications.

Some key areas that Maxim Integrated’s Industrial and Medical Solutions Group is currently focusing on include:

- Increasing integration
- Enhancing accuracy with precise measurement at the lowest power levels in the industry
- Strengthening security with less vulnerable all-in-one chips
- Developing analog front end (AFE) reference designs for easy prototyping and faster time-to-market with proven circuits and solutions

Maxim Integrated isn’t just focused on integration at the chip level, but also at the company level. This integration is delivered through coordination between our solutions, training, technical support, and customer service—all of which are designed to help you achieve your goals.

From building blocks to building relationships, Maxim Integrated’s Industrial and Medical Solutions Group is ready to assist you. As you review the pages of this guide, remember that we are committed to answering your questions, collaborating with you to develop the solutions you seek, and working together to meet your most complex challenges.

Thank you for considering Maxim Integrated. We’re looking forward to working with you in 2013 and beyond.

Sincerely,

A handwritten signature in black ink that reads "Chris".

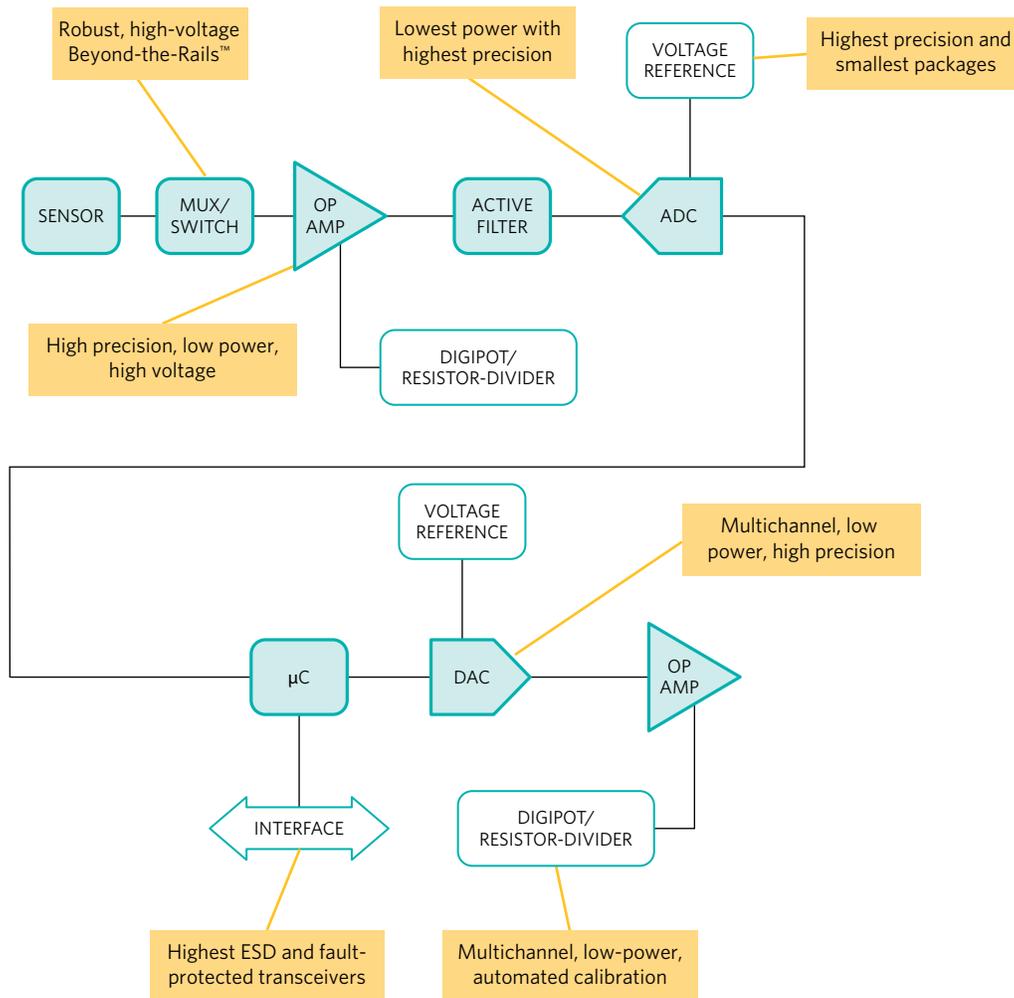
**Chris Neil**

*SVP, Industrial and Medical Solutions Group*

# High-Performance Analog

## Better Designs Start with Better Analog Building Blocks

For over 20 years Maxim Integrated has been designing robust, extended-temperature-grade ICs for industrial and medical applications. We have the best product for your design, from a single analog IC to a complete analog signal chain. This product guide offers best-in-class products for key design challenges and provides examples on how to optimize your signal chain designs using our innovative technologies in analog integration.



# Best-in-Class Signal Chain Solutions

## Lowest Power Signal Solutions

Consume less power and extend operating life with our low-power (operating and standby) and low-voltage solutions.

### Multiplexer

| Resolution    | Part                | Benefits                              |
|---------------|---------------------|---------------------------------------|
| 12-bit        | MAX4691-<br>MAX4694 | Low-voltage multiplexers and switches |
| 16-bit        |                     |                                       |
| 18- to 24-bit |                     |                                       |

### Amplifier

| Resolution    | Part     | Benefits                    |
|---------------|----------|-----------------------------|
| 12-bit        | MAX44264 | Op amp consumes only 750nA. |
| 16-bit        | MAX44265 | Op amp consumes only 4µA.   |
| 18- to 24-bit |          |                             |

### ADC

| Resolution    | Part     | Benefits   |
|---------------|----------|--|
| 12-bit        | MAX11665 | Low-power consumption at 8µA/ksps  |
| 16-bit        | MAX11100 | High-precision and low-power consumption                                     |
| 18- to 24-bit | MAX11200 | Ultra-low-power (< 300µA active current), high-resolution, serial output ADC |

### Reference

| Resolution    | Part    | Benefits  |
|---------------|---------|---|
| 12-bit        | MAX6029 | Low power, high accuracy, and small size                |
| 16-bit        | MAX6133 | Voltage reference has 3ppm/°C drift.                    |
| 18- to 24-bit | MAX6325 | Extremely low, 0.5ppm/°C (typ) temperature coefficients |

### DAC

| Resolution    | Part                | Benefits  |
|---------------|---------------------|---|
| 12-bit        | MAX5531,<br>MAX5535 | Industry's lowest power, single- and dual-channel 12-bit DACs |
| 16-bit        | MAX5214,<br>MAX5216 | Lowest power 14- and 16-bit DACs                              |
| 18- to 24-bit | MAX5318             | ±2 LSB INL (max) accuracy and ±1 LSB DNL (max)                |

### Current-Sense Amplifier

| Resolution    | Part    | Benefits                                  |
|---------------|---------|---|
| 12-bit        | MAX9928 | -0.1V to +28V supply, consumes only 20µA. |
| 16-bit        |         |   |
| 18- to 24-bit |         |   |

# Best-in-Class Signal Chain Solutions (cont.)

## Highest Performance Signal Solutions

For the highest precision, our signal chain solutions deliver industry-leading specifications covering initial accuracy, long term stability/drift, low noise, and consistency over the full industrial temperature range.

### Multiplexer

| Resolution    | Part     | Benefits  |
|---------------|----------|---|
| 12-bit        | MAX14778 | Industry's first $\pm 25V$ above- and below-the-rails multiplexer |
| 16-bit        |          |   |
| 18- to 24-bit |          |   |

### Amplifier

| Resolution    | Part                  | Benefits   |
|---------------|-----------------------|--|
| 12-bit        | MAX44246              | Fast settling time and low distortion  |
| 16-bit        |                       |  |
| 18- to 24-bit | MAX44250-<br>MAX44252 | High-voltage (2.7V to 20V) capability; industry's lowest noise, precision amps |

### ADC

| Resolution    | Part                  | Benefits   |
|---------------|-----------------------|--|
| 12-bit        | MAX11131,<br>MAX11331 | 8/10/12 bits, 4/8/16 channels, and 500k/1M/3Msps         |
| 16-bit        | MAX11166              | 16-bit, true bipolar input range                         |
| 18- to 24-bit | MAX11040K             | 24-bit, 4-channel, simultaneous-sampling delta-sigma ADC |

### Reference

| Resolution    | Part    | Benefits  |
|---------------|---------|---|
| 12-bit        | MAX6225 | Ultra-low drift, low noise (< 1 ppm/°C)   |
| 16-bit        |         |   |
| 18- to 24-bit | MAX6325 | Ultra-low drift, low noise (< 0.5ppm/°C); ideal for high-resolution systems up to 18 bits |

### DAC

| Resolution    | Part    | Benefits  |
|---------------|---------|---|
| 12-bit        | MAX5705 | Ultra-small, single-channel, 12-bit buffered output voltage DAC |
| 16-bit        | MAX5316 | Most accurate 16-bit buffered DAC available                     |
| 18- to 24-bit | MAX5318 | Most accurate 18-bit buffered DAC available                     |

### Current-Sense Amplifier

| Resolution    | Part    | Benefits                                  |
|---------------|---------|---|
| 12-bit        | MAX9643 | Outstanding 50 $\mu V$ $V_{OS}$ precision |
| 16-bit        |         |   |
| 18- to 24-bit |         |   |

# Best-in-Class Signal Chain Solutions *(cont.)*

## Bipolar/High-Voltage Signal Solutions

Many industrial systems work at higher operating voltages or require bipolar signal ranges. Our solutions include unique Beyond-the-Rails products to make designing easy, while improving system performance and lowering total implementation cost.

### Multiplexer

| Resolution    | Part     | Benefits   |
|---------------|----------|--|
| 12-bit        | MAX14752 | 8-channel/dual 4-channel<br>72V analog multiplexer |
| 16-bit        |          |  |
| 18- to 24-bit |          |  |

### Amplifier

| Resolution    | Part                  | Benefits  |
|---------------|-----------------------|---|
| 12-bit        | MAX44246,<br>MAX44248 | 2.7V to 36V supply<br>voltage; precision,<br>low-noise amplifiers                 |
| 16-bit        |                       |   |
| 18- to 24-bit | MAX9632,<br>MAX9633   | Fast-settling, high-voltage<br>op amps are ideal for 18-bit<br>SAR ADC front-end. |

### ADC

| Resolution | Part     | Benefits  |
|------------|----------|---|
| 12-bit     | MAX1272  | Software-programmable<br>analog inputs accept input<br>voltage ranges up to $\pm 10V$ .         |
| 16-bit     | MAX1300  | 4 and 8 channels,<br>single-ended or differential<br>input ranges with an<br>internal reference |
|            | MAX11166 | Industry's smallest, true<br>bipolar $\pm 5V$ , 16-bit ADC                                      |

### Reference

| Resolution    | Part                | Benefits   |
|---------------|---------------------|--|
| 12-bit        | MAX6035             | Extremely low-power<br>consumption and<br>small size |
| 16-bit        | MAX6173-<br>MAX6177 | Wide operating range:<br>2.7V to 40V input voltages  |
| 18- to 24-bit | MAX6325             | Best performance<br>(e.g., 1ppm/ $^{\circ}C$ tempco) |

### DAC

| Resolution | Part    | Benefits  |
|------------|---------|---|
| 12-bit     | MAX531  | Complete 12-bit DAC;<br>single-supply or bipolar<br>operation |
| 16-bit     | MAX5732 | Smallest and most<br>accurate 32-channel, 16-bit<br>DAC       |

### Current-Sense Amplifier

| Resolution    | Part                | Benefits  |
|---------------|---------------------|---|
| 12-bit        | MAX9611,<br>MAX9612 | High-side CSAs with<br>integrated 12-bit ADC and<br>op amp/comparator |
| 16-bit        | MAX4080,<br>MAX4081 | 0.1% accuracy with<br>operation up to 76V                             |
| 18- to 24-bit |                     |   |

# Best-in-Class Signal Chain Solutions (cont.)

## Smallest Size Signal Solutions

For space-constrained systems in industrial, consumer, computing, and medical applications, we offer the smallest and thinnest packages in the industry.

### Multiplexer

| Resolution    | Part      | Benefits   |
|---------------|-----------|--|
| 12-bit        | MAX14589E | High-density, $\pm 5V$ -capable DPDT analog switch |
| 16-bit        |           |  |
| 18- to 24-bit |           |  |

### Amplifier

| Resolution    | Part                | Benefits   |
|---------------|---------------------|--|
| 12-bit        | MAX44281            | Industry's first op amp in a 0.9mm x 0.9mm, 4-bump WLP       |
| 16-bit        | MAX9617-<br>MAX9620 | Low-power, zero-drift op amps in space-saving 2mm x 2mm SC70 |
| 18- to 24-bit |                     |  |

### ADC

| Resolution    | Part     | Benefits  |
|---------------|----------|---|
| 12-bit        | MAX11108 | Fast 3Msps, 12-bit, ADC in tiny 1.6mm x 2.1mm, 10-pin VQFN                |
| 16-bit        | MAX11100 | High precision in 12-bump WLP   |
| 18- to 24-bit | MAX11202 | 24-bit resolution at $< 1mW$ in space-saving 10-pin $\mu MAX^{\circledR}$ |

### Reference

| Resolution    | Part    | Benefits   |
|---------------|---------|--|
| 12-bit        | MAX6023 | Industry's smallest $V_{REF}$ (1.5mm <sup>2</sup> ) with 30ppm/ $^{\circ}C$ tempco |
| 16-bit        | MAX6070 | Most accurate reference (7ppm/ $^{\circ}C$ tempco) in a SOT23 package              |
| 18- to 24-bit | MAX6325 | Best performance (1ppm/ $^{\circ}C$ tempco)  |

### DAC

| Resolution | Part                | Benefits                          |
|------------|---------------------|-----------------------------------|
| 12-bit     | MAX5715,<br>MAX5725 | Industry's smallest complete DACs |
| 16-bit     | MAX5134             | Industry's smallest 16-bit DAC    |

### Current-Sense Amplifier

| Resolution    | Part    | Benefits   |
|---------------|---------|--|
| 12-bit        | MAX9643 | Industry's smallest current-sense amp, 1mm x 1mm 4-bump UCSP <sup>™</sup> /SOT23 |
| 16-bit        |         |  |
| 18- to 24-bit |         |  |

# High-Performance Switches and Multiplexers

Maxim Integrated has the industry's broadest portfolio of analog switches and multiplexers, which allows our customers to select products based on their key specifications, such as voltage range,  $R_{ON}$ , leakage, bandwidth, and switch/mux configuration. With a focus on robust high-voltage and flexible Beyond-the-Rails products, our parts help reduce external circuitry and simplify your system designs.

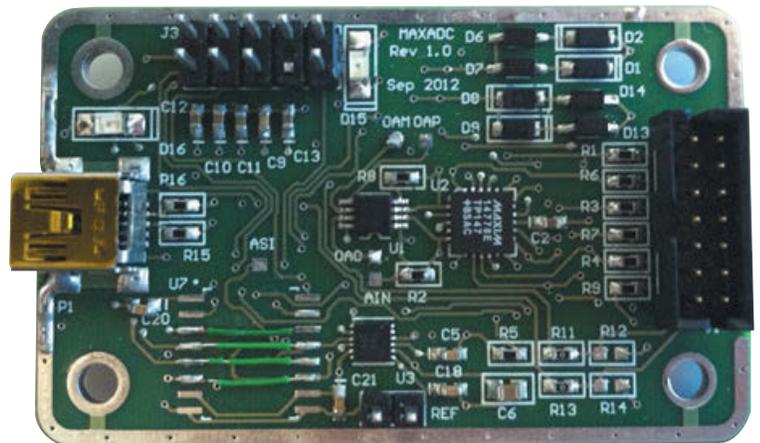
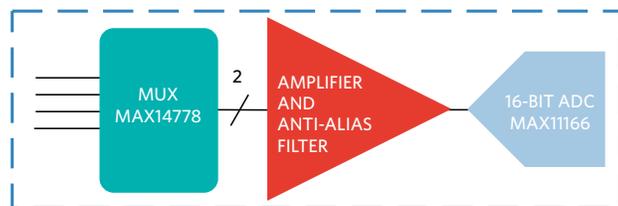
| Part                | Benefits                                 | Features   |
|---------------------|--|--|
| MAX14778            | Beyond-the-Rails, single 3V to 5V supply | $\pm 25V$ , 2 4:1, $1.5\Omega R_{ON}$  |
| MAX14759–MAX14764   | Beyond-the-Rails, single 3V to 5V supply | $\pm 25V$ , SPST, 2 SPST, SPDT, $2\Omega R_{ON}$                             |
| MAX14589E/MAX14594E | Beyond-the-Rails, 1.6V to 5.5V supply    | $\pm 5V$ , 2 DPDT, $0.38\Omega R_{ON}$                                       |
| MAX14752            | Robust 72V signal                        | $72V/\pm 36V$ supply, 2 4:1, $60\Omega R_{ON}$ , $30m\Omega R_{ON}$ flatness |
| MAX14757            | Robust 70V signal                        | $70V/\pm 36V$ supply, 4 SPST, $10\Omega R_{ON}$                              |

Our Beyond-the-Rails switches and multiplexers simplify power supplies. Integrated bias circuitry enables switching bipolar signals up to  $\pm 25V$ , while operating from a low-voltage (3.0V to 5.5V) single supply. This technology is ideal for applications such as audio and data multiplexing, interface termination, switching, PhotoMOS<sup>®</sup> switch replacement, industrial measurement, and instrumentation systems.

## Benefits

- Simplifies power supplies
- Robust bipolar signal range (up to  $\pm 25V$ )
- Single 3V supply
- Low and flat  $R_{ON}$
- Full family of configurations
- Robust ESD

## Beyond-the-Rails Building Blocks



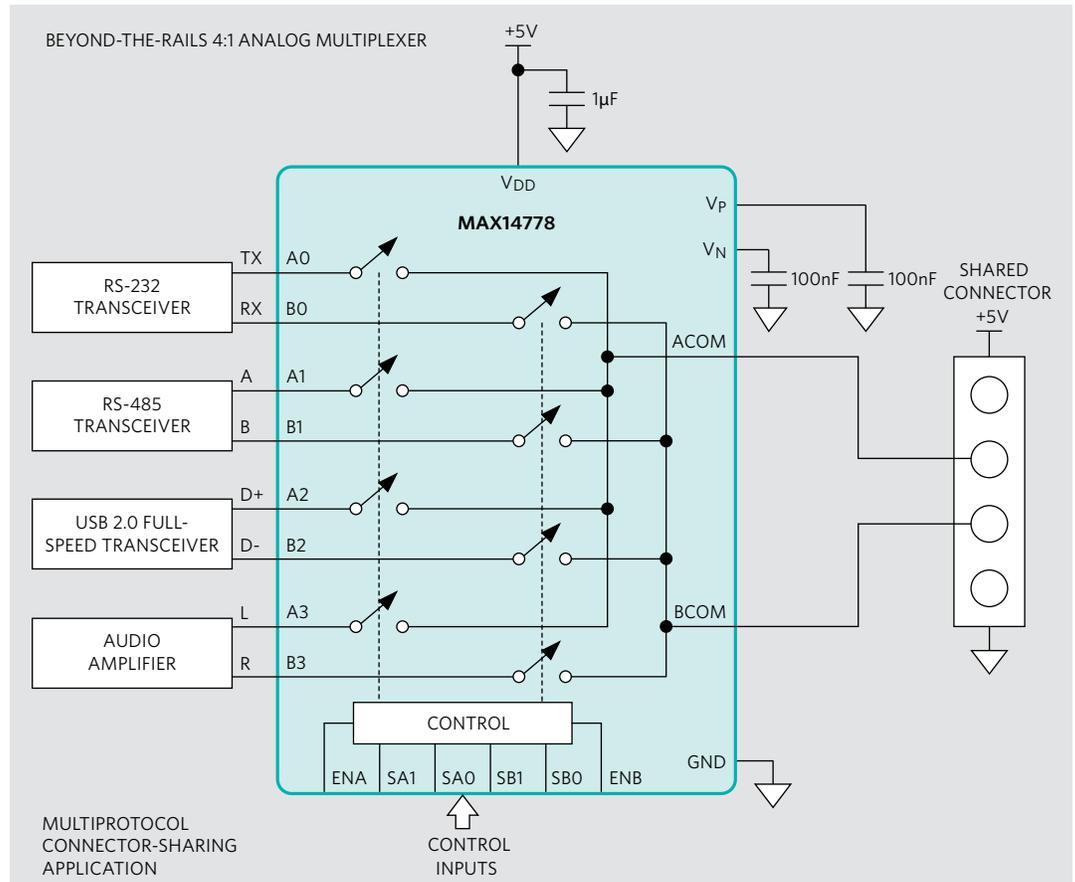
For our complete portfolio of Beyond-the-Rails switches and multiplexers, go to [www.maximintegrated.com/beyond-the-rails-portfolio](http://www.maximintegrated.com/beyond-the-rails-portfolio).

# High-Performance Switches and Multiplexers (cont.)

## Industry's First Beyond-the-Rails Multiplexer

### Benefits: MAX14778

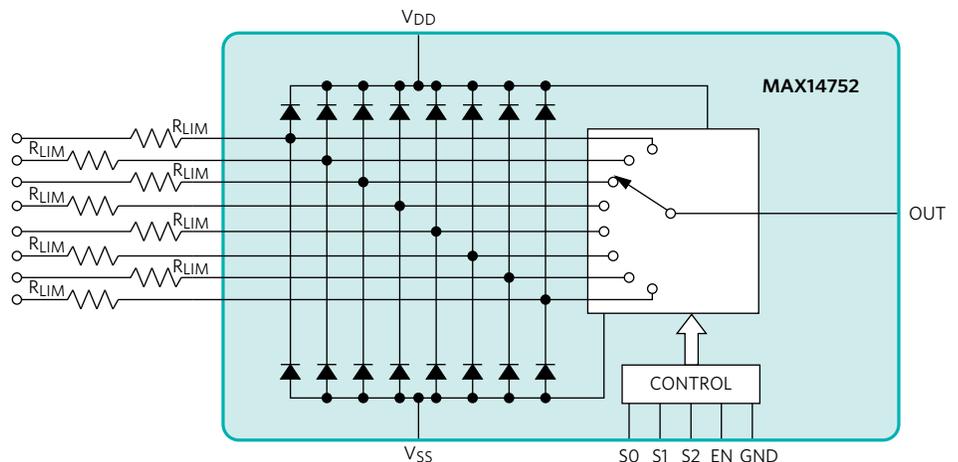
- Robust  $\pm 25V$  bipolar signal range protects against input spikes
- Single 3V to 5V supply simplifies power supplies
- Highly accurate flat  $1.5\Omega$   $R_{ON}$
- Full-speed USB bandwidth
- Robust  $\pm 6kV$  ESD



## Robust 70V Multiplexer Eliminates External Overvoltage Protection

### Benefits: MAX14752

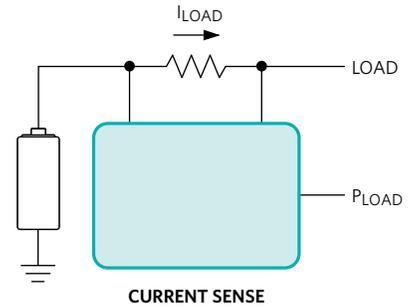
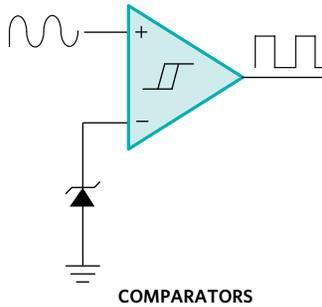
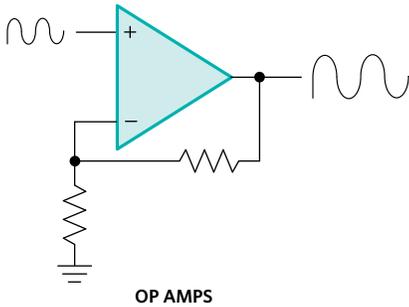
- High 72V voltage supply eliminates OVP diodes and opto relays
- $30m\Omega$  (typ)  $R_{ON}$  flatness reduces calibration needs
- Device enable (EN) defines voltage logic level of channel-select inputs



For our complete portfolio of multiplexers and switches, go to [www.maximintegrated.com/switch-mux-portfolio](http://www.maximintegrated.com/switch-mux-portfolio).

# Amplifiers and Comparators

Maxim Integrated has the widest selection of amplifiers and comparators for signal conditioning. Offering high bandwidth and minimal current consumption, our products achieve the industry's best speed-to-power ratios. Miniature packaging technology enables a variety of amplifiers and comparators in ultra-small footprints.



| HIGH PERFORMANCE  | HIGH VOLTAGE   | LOW POWER  | CMOS INPUTS   |
|---|--|--|---|
| <ul style="list-style-type: none"> <li>• <math>V_{OS} &lt; 10\mu V</math></li> <li>• Low-drift TC <math>V_{OS} &lt; 50nV/^\circ C</math></li> <li>• Low noise <math>&lt; 10nV/\sqrt{Hz}</math></li> </ul> | <ul style="list-style-type: none"> <li>• Supply voltage up to 38V</li> <li>• <math>\pm 4kV</math> to <math>\pm 8kV</math> ESD</li> </ul> | <ul style="list-style-type: none"> <li>• <math>&lt; 10\mu A</math> quiescent current</li> <li>• Shutdown capability</li> <li>• Small WLP, <math>\mu DFN</math>, and SC70 packages</li> </ul> | <ul style="list-style-type: none"> <li>• Low-bias current <math>&lt; 1pA</math></li> <li>• Current noise <math>&lt; 1pA/\sqrt{Hz}</math></li> </ul> |

## Op Amps

| Part                    | No. of Op Amp/Pkg | Rail-to-Rail | Supply Voltage (V) | Supply Current/Op Amp ( $\mu A$ , max) | $V_{OS}$ ( $\mu V$ , max) | Input $I_{BIAS}$ (nA, max) | Unity GBW (MHz, typ) | Slew Rate ( $V/\mu s$ , typ) | $e_N$ ( $nV/\sqrt{Hz}$ ) | Operating Temp ( $^\circ C$ ) | Smallest Package |
|-------------------------|-------------------|--------------|--------------------|--|---------------------------|----------------------------|----------------------|------------------------------|--------------------------|-------------------------------|------------------|
| <b>High Performance</b> |                   |              |                    |  |                           |                            |                      |                              |                          |                               |                  |
| MAX44250/1/2            | 1, 2, 4           | O            | 2.7 to 20          | 1550                                   | 6                         | 1.3                        | 10                   | 8                            | 5.9                      | -40 to +85                    | 8-SOT23          |
| MAX9632                 | 1                 | O            | 4.5 to 36          | 6500                                   | 125                       | 180                        | 55                   | 30                           | 0.94                     | -40 to +85                    | 8-TDFN           |
| <b>High Voltage</b>     |                   |              |                    |  |                           |                            |                      |                              |                          |                               |                  |
| MAX44246                | 2                 | O            | 2.7 to 36          | 1100                                   | 5                         | 0.6                        | 5                    | 3.8                          | 9                        | -40 to +85                    | 8- $\mu$ MAX     |
| MAX44248                | 2                 | O            | 2.7 to 36          | 120                                    | 7.5                       | 0.3                        | 1                    | 0.7                          | 50                       | -40 to +85                    | 8- $\mu$ MAX     |
| <b>CMOS Inputs</b>      |                   |              |                    |  |                           |                            |                      |                              |                          |                               |                  |
| MAX9636/7/8             | 1, 2              | I/O          | 2.1 to 5.5         | 55                                     | 2200                      | 0.0008                     | 1.5                  | 0.9                          | 38                       | -40 to +85                    | 6-SC70           |
| MAX44260/1/3            | 1, 2              | I/O          | 1.7 to 5.5         | 1200                                   | 50                        | 0.005                      | 15                   | 7                            | 12.7                     | -40 to +85                    | 6-UTLGA          |
| <b>Low Power</b>        |                   |              |                    |  |                           |                            |                      |                              |                          |                               |                  |
| MAX44264                | 1                 | O            | 1.8 to 5.5         | 1.2                                    | 7000                      | 1.5                        | 0.009                | 0.002                        | 120                      | -55 to +125                   | 6-WLP            |
| MAX44265                | 1                 | I/O          | 1.8 to 5.5         | 5                                      | 1000                      | 0.01                       | 0.2                  | 0.1                          | 400                      | -55 to +125                   | 6-WLP            |

For our complete portfolio of amplifiers, go to [www.maximintegrated.com/amplifier-portfolio](http://www.maximintegrated.com/amplifier-portfolio).

# Amplifiers and Comparators (cont.)

## Current-Sense Amplifiers

| Part                              | Features                             | Input Voltage (V) | Supply Current ( $\mu$ A) | $V_{OS}$ at +25°C ( $\mu$ V, max) | Gain (V/V)        | Gain Accuracy +25°C (% , max) | Bandwidth (kHz) | Operating Temp (°C) | Smallest Package |
|-----------------------------------|--------------------------------------|-------------------|---------------------------|-----------------------------------|-------------------|-------------------------------|-----------------|---------------------|------------------|
| <b>High Voltage and Precision</b> |                                      |                   |                           |                                   |                   |                               |                 |                     |                  |
| MAX9922/3                         | Ultra-precision CSAs                 | 1.9 to 28         | 700                       | 10                                | Adj, 25, 100, 250 | 0.4                           | 10, 50, 1000    | -55 to +125         | 10- $\mu$ MAX    |
| MAX9643                           | Wide input, precision CSA            | -0.1 to +60       | 1000                      | 50                                | 2.5, 10           | 0.5                           | 10,000          | -40 to +85          | 8-TDFN           |
| MAX4080                           | High-voltage CSA                     | 4.5 to 76         | 75                        | 600                               | 5, 20, 60         | 0.6                           | 250             | -40 to +85          | 8- $\mu$ MAX     |
| <b>Low Power</b>                  |                                      |                   |                           |                                   |                   |                               |                 |                     |                  |
| MAX9634                           | Precision CSA                        | 1.6 to 28         | 1                         | 250                               | 25, 50, 100, 200  | 0.5                           | 15, 30, 60, 125 | -55 to +125         | 4-UCSP           |
| MAX9928/9                         | SIGN output, current output          | -0.1 to +28       | 20                        | 400                               | Adj, 20, 50       | 1                             | 150             | -40 to +85          | 6-UCSP           |
| <b>Multifunction</b>              |                                      |                   |                           |                                   |                   |                               |                 |                     |                  |
| MAX9611/2                         | CSA + 12-bit ADC + op amp/comparator | 0 to 60           | 1600                      | 300                               | Adj               | 0.5                           | 4000            | -40 to +85          | 10- $\mu$ MAX    |

For our complete portfolio of amplifiers, go to [www.maximintegrated.com/amplifier-portfolio](http://www.maximintegrated.com/amplifier-portfolio).

## Comparators

| Part                          | No. of Comparators | Propagation Delay (ns, typ)  | Supply Voltage (V) | $I_{CC}$ per Comp ( $\mu$ A, typ) | $V_{OS}$ (mV, typ) | $V_{OS}$ (mV, max) | Logic Output             | Operating Temp (°C) | Smallest Package |
|-------------------------------|--------------------|------------------------------|--------------------|-----------------------------------|--------------------|--------------------|--------------------------|---------------------|------------------|
| <b>High Speed</b>             |                    |                              |                    |                                   |                    |                    |                          |                     |                  |
| MAX9600/1/2                   | 2, 4               | 0.5                          | 8.3 to 10.5        | 12,000                            | 1                  | 5                  | ECL/PECL                 | -55 to +125         | 20-TSSOP         |
| MAX999                        | 1, 2, 4            | 4.5                          | 2.7 to 5.5         | 6500                              | 0.5                | 1.5                | Push-pull                | -55 to +125         | 5-SOT23          |
| <b>Low Power, Ultra Small</b> |                    |                              |                    |                                   |                    |                    |                          |                     |                  |
| MAX9060/1                     | 1                  | 25,000                       | 0.9 to 5.5         | 0.35                              | 1.3                | 9                  | Open drain               | -55 to +125         | 4-UCSP           |
| MAX44269                      | 2                  | 13,000                       | 1.8 to 5.5         | 0.85                              | 0.15               | 5                  | Open drain               | -55 to +125         | 9-WLP            |
| <b>Integrated Reference</b>   |                    |                              |                    |                                   |                    |                    |                          |                     |                  |
| MAX9062-<br>MAX9064           | 1                  | 15,000<br>(0.2V threshold)   | 1 to 5.5           | 1.1                               | —                  | —                  | Open drain/<br>push-pull | -55 to +125         | 4-UCSP           |
| MAX44268                      | 2                  | 14,000<br>(1.236V threshold) | 1.8 to 5.5         | 1.15                              | 0.15               | 5                  | Open drain               | -55 to +125         | 9-WLP            |
| MAX9025,<br>MAX9026           | 1                  | 20,000<br>(1.236V threshold) | 1.8 to 5.5         | 1.7                               | 0.3                | 5                  | Open drain/<br>push-pull | -55 to +125         | 6-UCSP           |

For our complete portfolio of comparators, go to [www.maximintegrated.com/comparator-portfolio](http://www.maximintegrated.com/comparator-portfolio).

# Analog-to-Digital Converters

Maxim Integrated has the largest ADC product offering with over 500 ADCs that provide industry-leading performance and features. From ultra-high precise delta-sigma converters at 24-bit resolution, to SAR converters providing the unmatched combination of high precision at fast sample rate and low power, to exceedingly fast pipeline and flash architectures offering multigigabit sample rate ADCs. Whatever your need to bridge the gap between real-world signals and digital data, Maxim Integrated has the ADC to provide the solution.

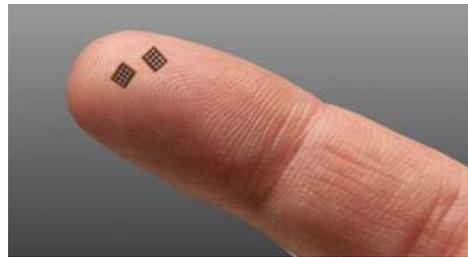
## 16-Bit SAR ADCs

For your most challenging designs, we now offer innovative 14- and 16-bit SAR ADCs. We also offer hundreds of 12-bit parts to meet nearly every application need.

### Smallest 16-Bit SAR ADC

#### Benefits: MAX11100

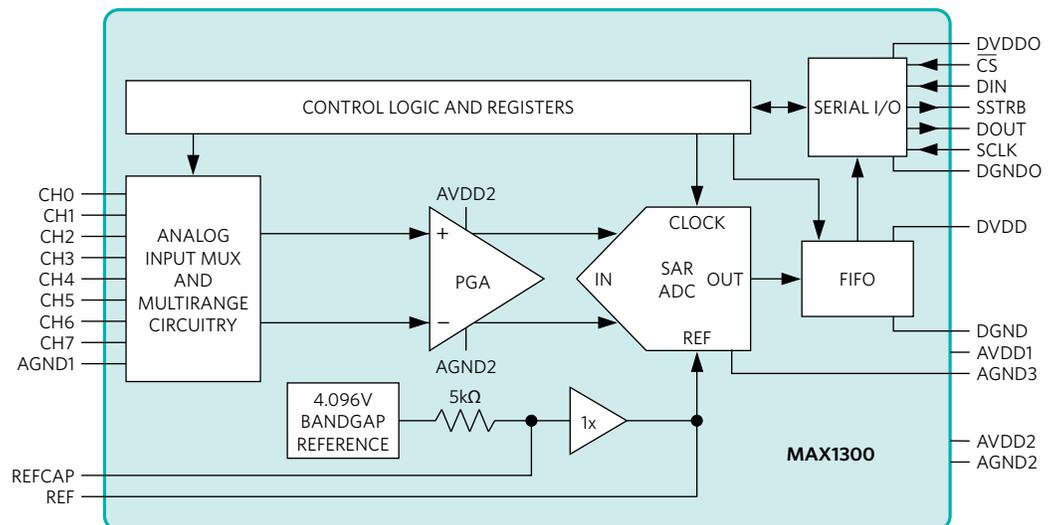
- Space-saving: 1.6mm x 2.2mm
- Ultra-low power, 130 $\mu$ A at 10ksps—ideal for portable or loop-powered systems; maximum sample rate 200ksps consumes only 2.5mA
- 3V, 5V, and 14-bit options



### Most Flexible 16-Bit SAR ADC

#### Benefits: MAX1300

- Programmable per input pin up to  $3 \times V_{REF}$ , simplifies design
- Programmable per pin, single-ended or differential inputs provides flexibility
- Integrated PGA and voltage reference for high integration and reduced bill of materials



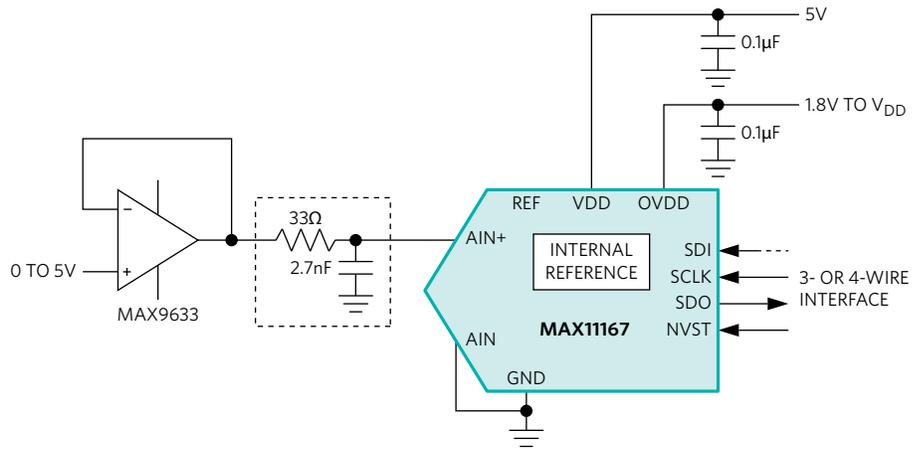
# Analog-to-Digital Converters (cont.)

## 16-Bit SAR ADCs (cont.)

### Most Integrated 1-Channel, 16-Bit SAR ADC

**Benefits: MAX11167**

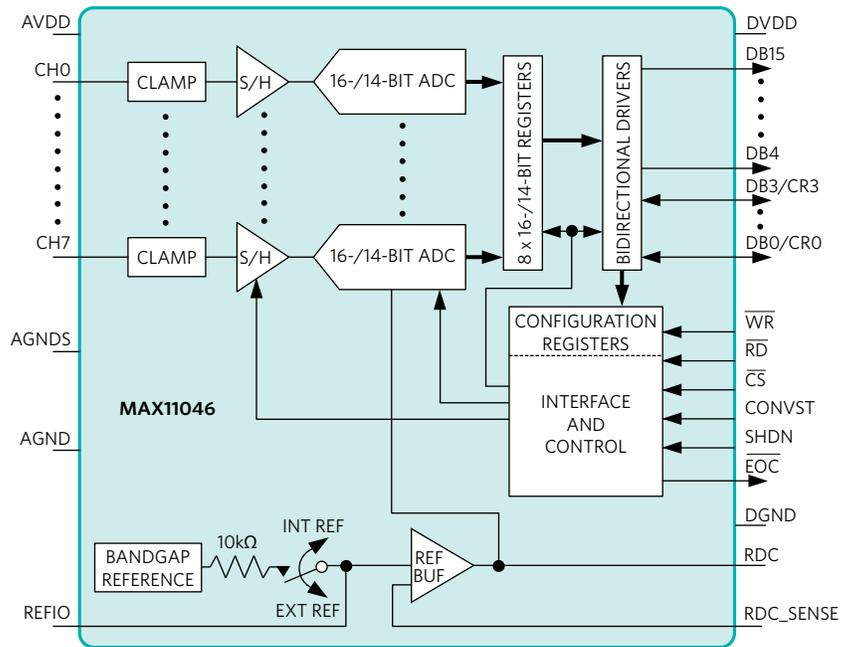
- Industry's only 12-pin, 16-bit bipolar part saves space
- Beyond-the-Rails 16-bit bipolar part simplifies system design;  $\pm 5V$  input support with a single 5V supply
- Integrated reference reduces bill of material costs
- 0 to 5V unipolar 16-bit version is also available



### 8-Channel, Simultaneous-Sampling, 16-Bit SAR ADC

**Benefits: MAX11046**

- Up to 8-channel simultaneous sampling in 8mm x 8mm provides high integration and saves space
- Beyond-the-Rails inputs simplify design by supporting  $\pm 5V$  from a single 5V supply
- World-class SNR (92.3dB) at 250ksps per channel



# Analog-to-Digital Converters (cont.)

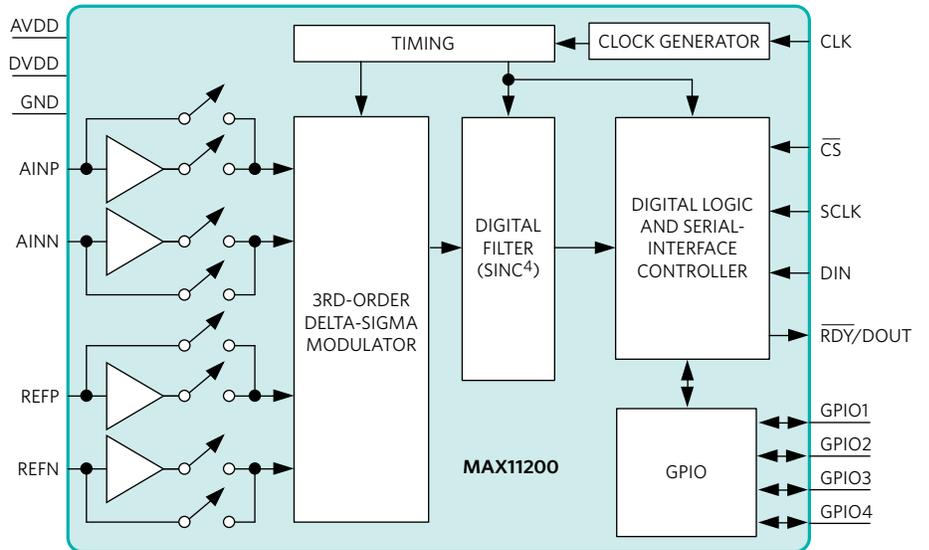
## 24-Bit, Delta-Sigma ADCs

Our lineup of high-performance delta-sigma ADCs offers high integration, industry-leading noise-free resolution, and world-class power specifications.

### Ultra-Low-Power, High-Performance, 24-Bit Delta-Sigma ADC

**Benefits: MAX11200**

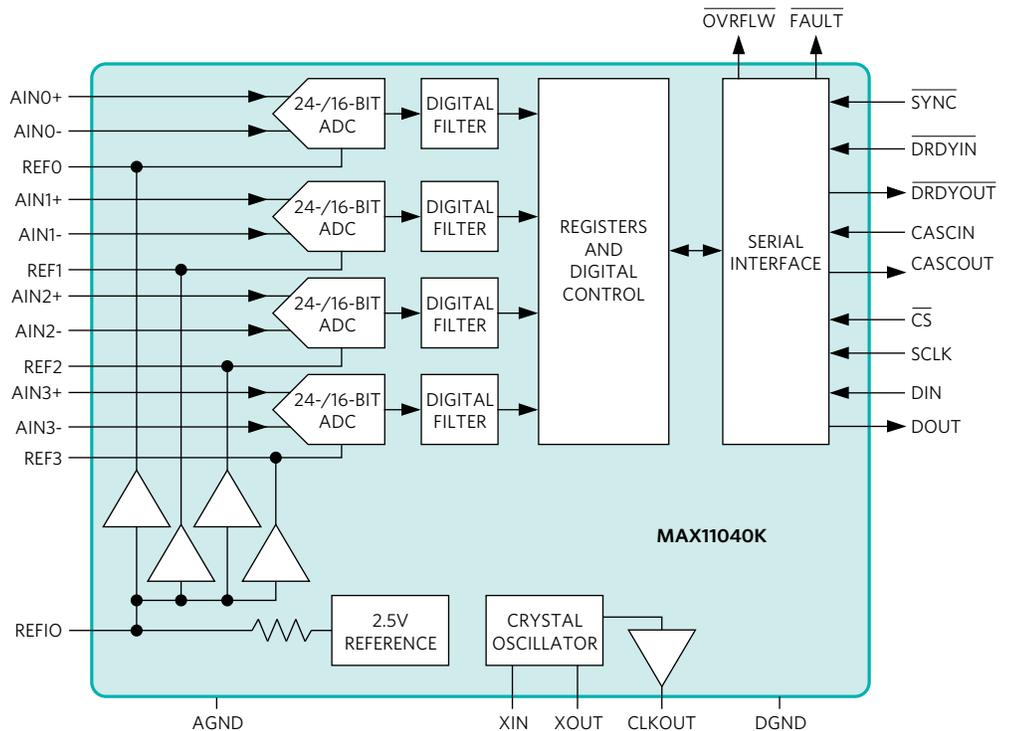
- Ultra-low-power (< 300µA), high-precision, 24-bit delta-sigma enables loop-powered sensor applications
- Integrated GPIO allows for simplified isolation schemes and easy external mux control
- Buffer input and differential reference for high-impedance sensors and radiometric resistive bridge applications



### 4-Channel, Simultaneous-Sampling, 24-Bit Delta-Sigma ADC

**Benefits: MAX11040K**

- Per-channel programmable-phase delay simplifies system
- ±6V overvoltage protection and 2.5V V<sub>REF</sub> offer high integration, reducing system bill of material
- Sync pin and daisy-chain SPI interface allow up to 32 channels of simultaneous sampling
- ±2.5V Beyond-the-Rails inputs off of a positive 3V supply



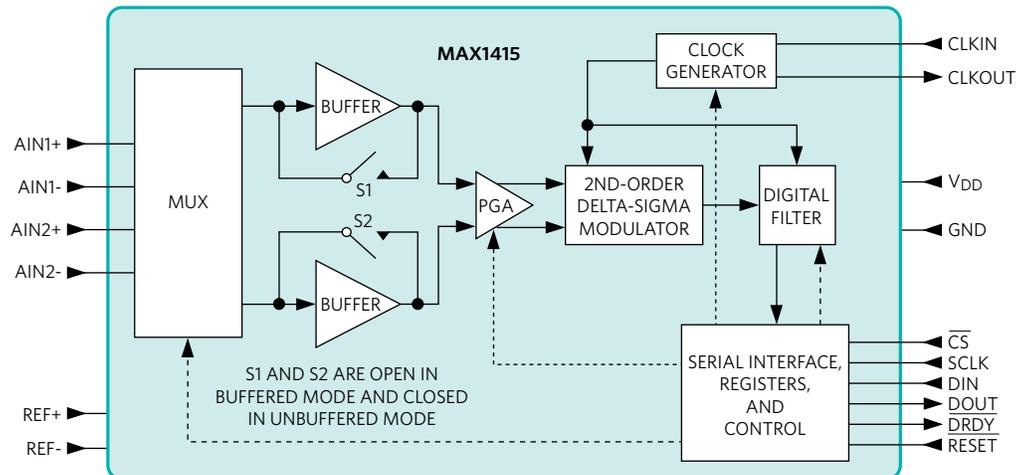
# Analog-to-Digital Converters (cont.)

## 24-Bit, Delta-Sigma ADCs (cont.)

### High-Integration, 16-Bit, Delta-Sigma ADC

#### Benefits: MAX1415

- Integrated PGA (1 to 128 gain) simplifies system design
- Pin-to-pin upgrade of AD7705; better linearity and integrated clock generator to reduce bill of materials
- Supports bipolar inputs from single positive supply rail



For our complete portfolio of ADCs, go to [www.maximintegrated.com/adc-portfolio](http://www.maximintegrated.com/adc-portfolio).

# Digital-to-Analog Converters

Maxim Integrated offers over 600 comprehensive DAC products with resolutions from 6 to 18 bits and sampling rates up to 5Gbps. For precision DACs, we have the industry's first true 18-bit DAC with  $\pm 1$  LSB DNL and also the industry's first 1.8V supply DAC.

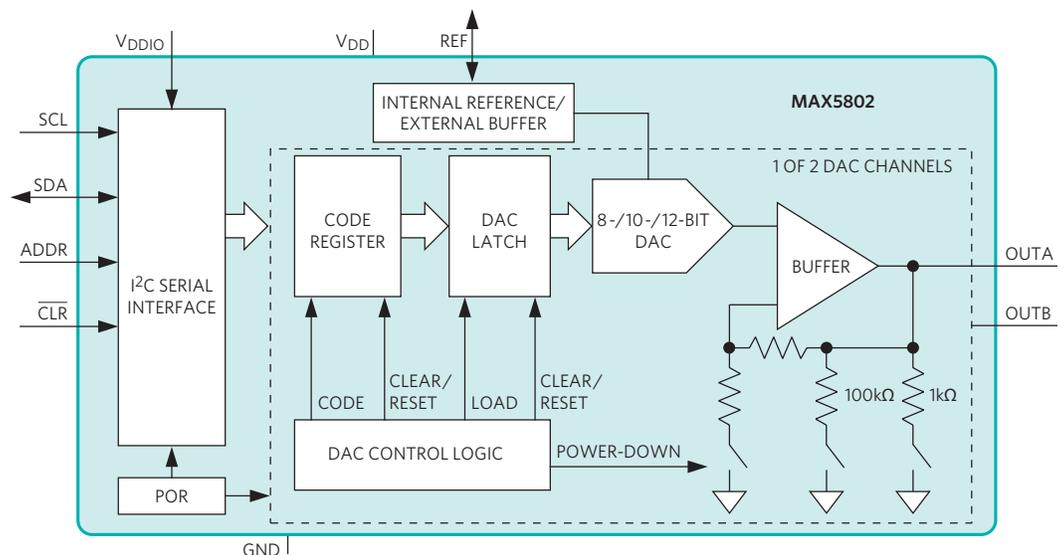
## Complete DAC Family with Internal Reference and Output Buffer

| Part            | No. of Channels | Interface        | Package         |
|-----------------|-----------------|------------------|-----------------|
| MAX5725/24*/23* | 8               | SPI              | TSSOP, WLP      |
| MAX5825/24*/23* | 8               | I <sup>2</sup> C | TSSOP, WLP      |
| MAX5715/14*/13* | 4               | SPI              | TSSOP, WLP      |
| MAX5815/14*/13* | 4               | I <sup>2</sup> C | TSSOP, WLP      |
| MAX5702/01*/00* | 2               | SPI              | $\mu$ MAX, TDFN |
| MAX5802/01*/00* | 2               | I <sup>2</sup> C | $\mu$ MAX, TDFN |
| MAX5705/04*/03* | 1               | SPI              | $\mu$ MAX, TDFN |
| MAX5805/04*/03* | 1               | I <sup>2</sup> C | $\mu$ MAX, TDFN |

### Ultra-Small, 2-Channel, 12-Bit DACs with SPI or I<sup>2</sup>C Interface

**Benefits:** MAX5702, MAX5802

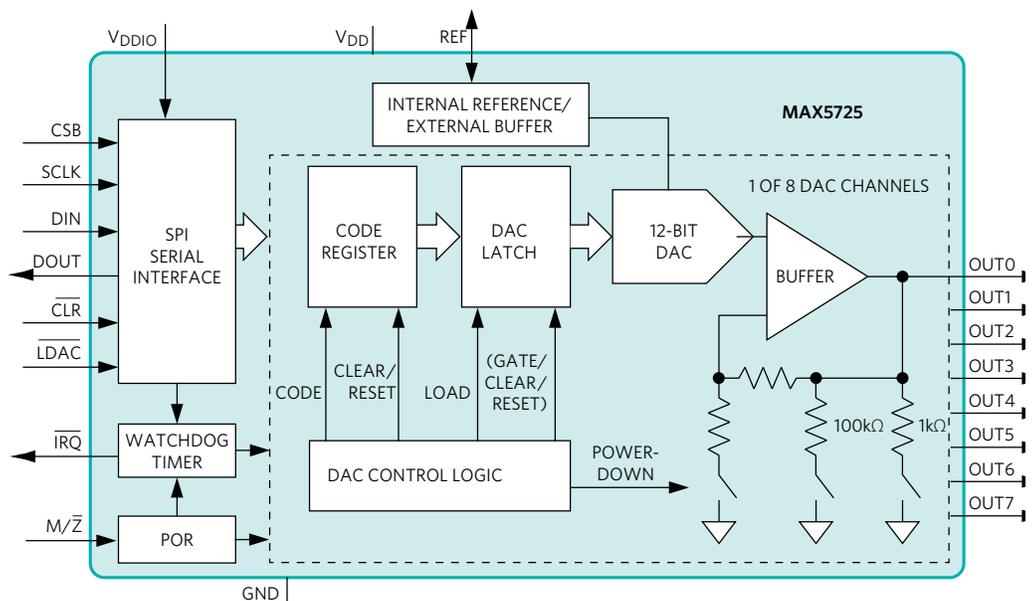
- Independent digital I/O supply: 1.8V to 5V
- Internal 10ppm (max) reference with selectable voltages: 2.048V, 2.5V, or 4.096V
- Packages: leaded 10-pin  $\mu$ MAX or leadless 10-pin TDFN



### Ultra-Small, Octal-Channel, 12-Bit Buffered Output DACs with Internal Reference

**Benefits:** MAX5725, MAX5825

- Small footprint in a WLP package (2.5mm x 2.5mm) saves board space and cost
- Three internal voltage references: 2.048V, 2.500V, or 4.096V
- Integrated watchdog programmable timer
- Independent 1.8V to 5.5V digital I/O power supply

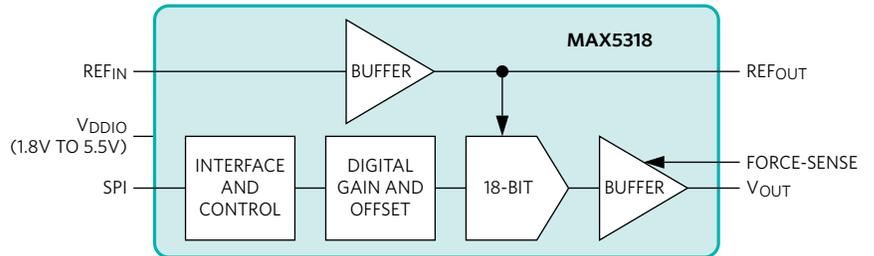


# Digital-to-Analog Converters (cont.)

## Industry's Most Integrated 18-Bit Low-Power DAC

**Benefits: MAX5318**

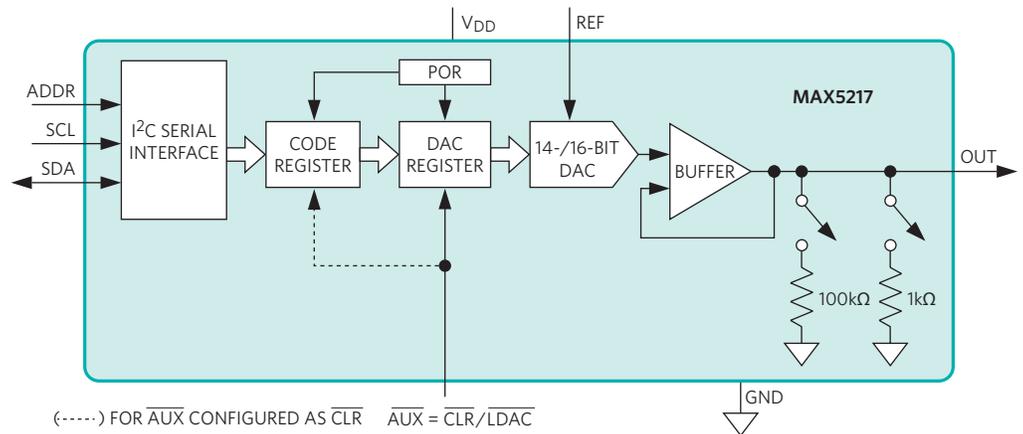
- Internal output and reference buffer
- Digital gain and offset adjustments
- $\pm 2$  LSB INL over all codes and temperatures
- Separate digital I/O voltage: 1.8V to 5.5V
- Force-sense on output for precision control
- Low drift:  $< 0.1\text{ppm}/^\circ\text{C}$



## Best INL in Ultra-Low Power Space

**Benefits: MAX5216, MAX5217**

- Low power consumption  $80\mu\text{A}$  (max)
- Accuracy:  $\pm 1.2$  LSB INL (typ), 4 LSB (max)
- Choice of serial interface: SPI (MAX5216), I<sup>2</sup>C (MAX5217)
- Lowest 10Hz noise:  $3.5\mu\text{V}_{\text{p-p}}$



For our complete portfolio of DACs, go to [www.maximintegrated.com/dac-portfolio](http://www.maximintegrated.com/dac-portfolio).

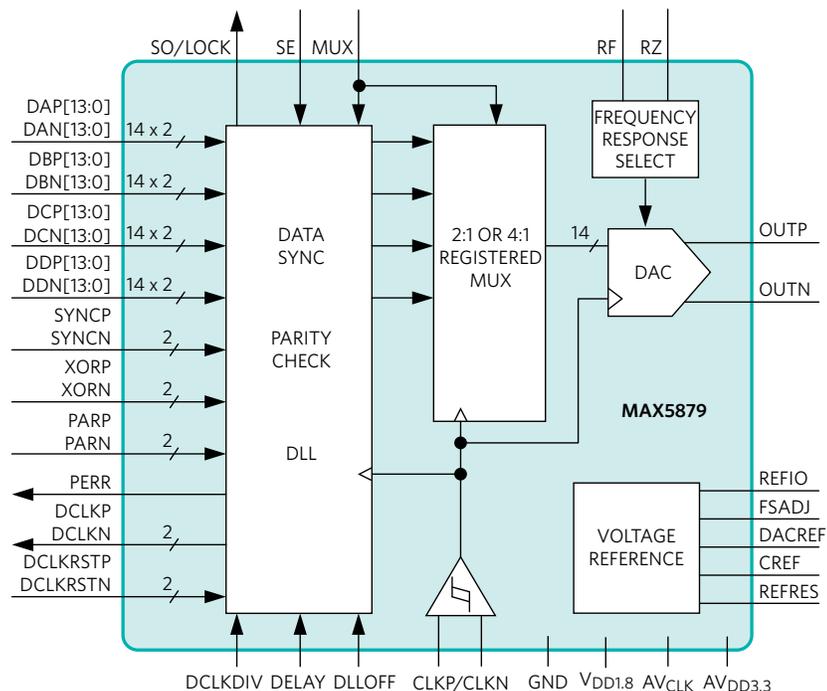
# High-Speed Data Converters

Maxim has an extensive lineup of high-speed DACs and ADCs to meet your design’s demanding requirements for dynamic performance and power dissipation. Data converters are offered in single-/dual-/quad-/octal-channel and analog front end (AFE) formats, giving you options for higher levels of integration and a lower solution cost. Maxim also offers direct RF-synthesis DACs and direct RF-sampling ADCs that can eliminate intermediate RF upconversion and downconversion stages, reducing system cost and complexity.

## High-Speed DACs and ADCs

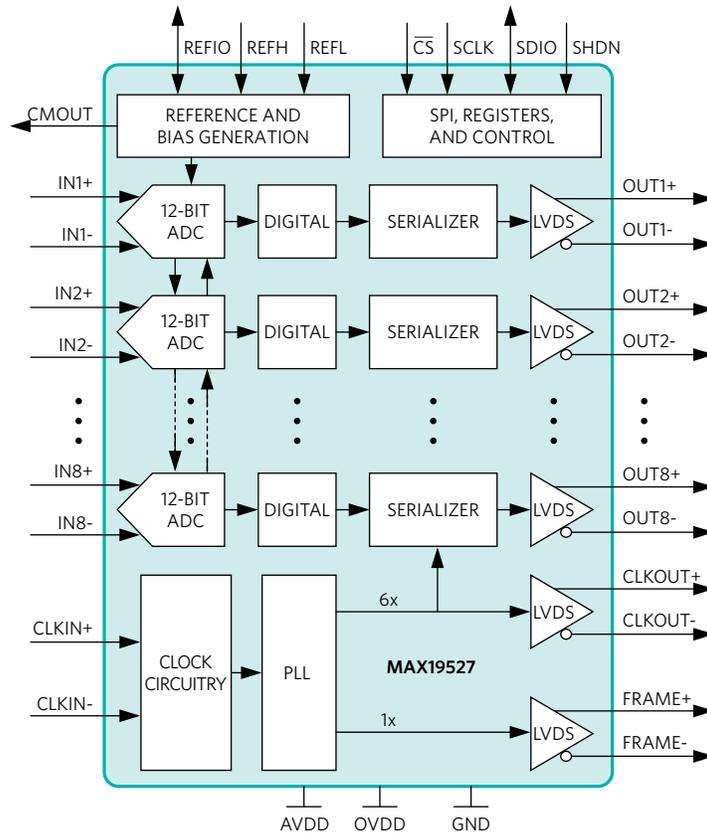
| Part               | Description  | Features  | Benefits   |
|--------------------|--|---|--|
| MAX5879            | 14-bit, 2.3Gsp/s RF DAC                            | 2:1 or 4:1 multiplexed LVDS inputs                                      | Optimizes pin count or timing margin.  |
|                    |  | Delayed-lock loop (DLL)   | Ensures data synchronization between the FPGA and the DAC.   |
|                    |  | Parity check and error flag   | More easily ensures data integrity.  |
|                    |  | Data scrambling   | Whitens spectral content to eliminate data-dependent spurs.  |
|                    |  | SDR, DDR data interface   | Increased flexibility to interface with broader set of FPGAs   |
| MAX109             | 8-bit, 2.2Gsp/s RF ADC                             | 1:4 demultiplexed LVDS outputs  | Increased timing margin  |
|                    |  | SDR, DDR, QDR data interface  | Increased flexibility to interface with broader set of FPGAs   |
| MAX19527           | Octal, 12-bit, 50Msps ADC with serial LVDS outputs | Serial LVDS outputs with programmable test patterns                     | Compact ADC/FPGA interface; ensures data timing alignment.   |
|                    |  | Output drivers with programmable current drive and internal termination | Eliminates reflections to ensure data integrity (open eye diagram).  |
| MAX19517, MAX19507 | 10-/8-bit, dual 130Msps ADCs                       | Programmable data output timing; programmable internal termination      | Simplify high-speed FPGA/ADC interface; eliminate reflections to ensure data integrity (open eye diagram). |
|                    |  | Selectable data bus (dual CMOS or single multiplexed CMOS)              | Trade-off I/O and interface speed to optimize FPGA resources.  |

### 14-Bit, 2.3Gsp/s RF DAC



# High-Speed Data Converters (cont.)

*Octal, 12-Bit, 50Msps ADC with Serial LVDS Outputs*



## FPGA Support Collateral

| Part   | Description                                   | Features   |
|--------|---|--|
| DCEP   | Data converter evaluation platform            | Data source based on Xilinx® Virtex®-4 FPGA; compatible with Maxim Integrated's high-speed ADC evaluation kits |
| HSDCEP | High-speed data converter evaluation platform | Data source based on Xilinx Virtex-5 FPGA; compatible with Maxim Integrated's high-speed DACs (≥ 1.5Gsps)      |

For our complete portfolio of high-speed data converters, go to [www.maximintegrated.com/high-speed-converters](http://www.maximintegrated.com/high-speed-converters).

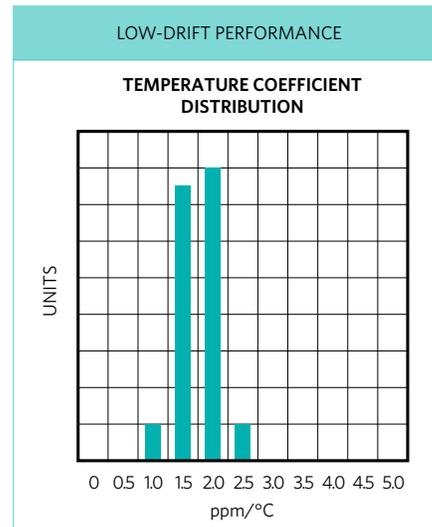
# Precision Voltage References

Maxim Integrated offers the industry's most extensive line of series and shunt voltage references, allowing customers to choose among numerous key specifications, such as accuracy, temperature coefficient, noise, and package size.

## Industry-Leading Combination of Low-Noise, Low-Drift Series Voltage Reference in SOT23

### Features: MAX6070, MAX6071

- MSOP-SO performance in SOT23, 3mm x 3mm package
  - Low temperature drift: 7ppm/°C (max)
  - Excellent long-term drift: 25ppm/1000 hours
- Low noise: 4.8μV<sub>P-P</sub> at 2.5V<sub>OUT</sub>
- 10mA source and sink
- Noise reduction filter: MAX6070
- Force-sense GND and output: MAX6071
- 30μs turn-on time to 0.01% with 0.1μF
- Drop-in upgrade to TI's REF32xx and ADI's ADR34xx with the MAX6071



## Best-in-Class Voltage References

| Part    | Benefits                              | Features   |
|---------|---------------------------------------|--|
| MAX6325 | Lowest drift                          | 1ppm/°C (max) with trim and noise reduction                                      |
| MAX6126 | Lowest noise                          | 3ppm/°C, 1.45mV <sub>P-P</sub> , 0.1Hz to 10Hz noise trim and force-sense output |
| MAX6173 | Lowest drift high voltage, in and out | 3ppm/°C, 10V or 5V output, temperature output: 1.9mV/°C                          |
| MAX6070 | Lowest drift in SOT23                 | 7ppm/°C (max) with enable and noise reduction                                    |
| MAX6023 | Smallest package footprint            | 30ppm/°C (max), 35μA quiescent current in 1.5mm <sup>2</sup> package             |
| MAX6138 | Lowest drift shunt                    | 25ppm/°C in SC70, with LM4040 pinout   |

For our complete portfolio of voltage references, go to [www.maximintegrated.com/voltage-ref-portfolio](http://www.maximintegrated.com/voltage-ref-portfolio).

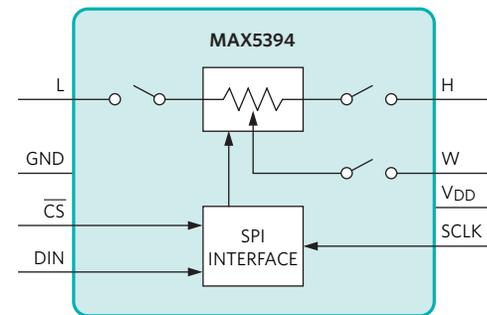
# Digital Potentiometers

Digital potentiometers perform the same function as a mechanical potentiometer or a variable resistor. These devices consist of a fixed resistor and a wiper contact with multiple tap points that are digitally controlled through a 2-wire serial interface (typically SPI). The small package size, low supply voltage, low supply current, and industrial temperature range make the devices uniquely suitable for the portable consumer market, medical and industrial applications, and the automotive market.

## 256-Tap, Volatile Digital Potentiometers

### Benefits: MAX5394, MAX5395

- Industry-leading low supply voltage: 1.7V to 5.5V extended supply range
- Ultra-low supply current ( $< 1\mu\text{A}$ )
- Minimized board space is available in a space-saving, 8-pin TDFN ( $4\text{mm}^2$ ) package
- Guaranteed performance over extended temperatures ( $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ ) enables operation in harsh environmental conditions
- Flexible design choices include an I<sup>2</sup>C (MAX5395) or SPI (MAX5394) communications interface with 10k $\Omega$ , 50k $\Omega$ , or 100k $\Omega$  end-to-end resistance options



## Best-in-Class Digital Potentiometers

| Digipot Application            | Best-in-Class Products              | Benefits  |
|--------------------------------|-------------------------------------|---|
| Nonvolatile memory             | MAX5481-MAX5484,<br>MAX5494-MAX5499 | Return wiper setting to preset condition after power-off.   |
| Volatile memory                | MAX5386-MAX5389,<br>MAX5391/MAX5393 | Operation down to 1.7V; ideal for portable battery-operated devices   |
| Bipolar                        | MAX5436-MAX5439                     | Dual- or single-supply operation  |
| Small footprint                | MAX5460-MAX5468                     | Save cost and board space, tiny $5\text{mm}^2$ SC70 package.  |
| Resistor- and voltage-dividers | MAX5430/MAX5431,<br>MAX5420/MAX5421 | Programmable gains, single- or dual-supply operation  |
| Log taper                      | DS1882                              | High design flexibility: bipolar or single supply, 1dB steps or variable, configurable nonvolatile or volatile memory |

For our complete portfolio of digital potentiometers, go to [www.maximintegrated.com/digipot-portfolio](http://www.maximintegrated.com/digipot-portfolio).

# Reference Designs

Maxim Integrated enables customers to help themselves, with an eye towards efficiency. You can search for products you need, view training videos, design with our tools, and receive samples quickly. For our technical documents and design tools, go to [www.maximintegrated.com/design](http://www.maximintegrated.com/design).

To meet the needs of industrial control and industrial automation applications, where isolation, higher resolutions, and higher voltage system solutions are often needed, Maxim Integrated provides complete subsystem signal chain reference designs. Hardware and firmware design files as well as FFTs and histograms from lab measurements are provided.

The Cupertino (MAXREFDES5#) subsystem reference design is a 16-bit high-accuracy industrial analog front end (AFE) that accepts -10V to +10V, 0 to 10V, and 4-20mA current loop signals with isolated power and data, all integrated into a small form factor. The Cupertino design integrates low-noise high-impedance analog buffers (MAX9632); a highly accurate ADC with innovative on-chip attenuation (MAX1301); an ultra-high precision 4.096V voltage reference (MAX6126); 600V<sub>RMS</sub> data isolation (MAX14850); and isolated/regulated +12V, -12V, and 5V power rails (MAX256/MAX1659). This AFE solution can be used in any application that needs high-accuracy analog-to-digital conversion, but it is mainly targeted for industrial sensors, industrial automation, process control, programmable logic controllers (PLCs), and medical applications.

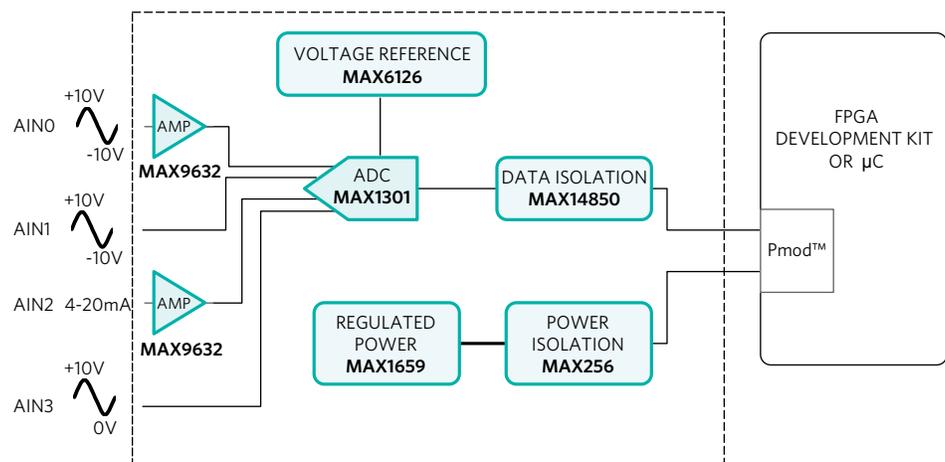
## Features

- High accuracy
- ±10V, 0 to 10V, and 4-20mA inputs
- Isolated power and data
- Small printed-circuit board (PCB) area
- Pmod™-compatible form factor

## Applications

- Industrial sensors
- Process control
- Industrial automation
- PLCs
- Medical

## The Cupertino Subsystem Design Block Diagram



For our complete portfolio of reference designs, go to [www.maximintegrated.com/reference-designs](http://www.maximintegrated.com/reference-designs).

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