Welcome to the Texas Instruments New Product Update

We will begin promptly at 1 min past the hour- thank you for your patience
Phone lines will be muted during the presentation.

We are now using web-ex VOIP audio. There is no telephone dial in.

Please post questions on the chat Web-Ex Chat
or contact your sales person or field applications engineer
Introduction to Precision ADC

What we do

• SAR and delta-sigma ADCs (up to 10 MSPS)
• Isolated amplifiers and isolated delta-sigma modulators
• Audio ADCs and codecs
• Automotive

What we will cover

Important collateral
• Fundamental knowledge
• Device-specific

How to find ADCs

Factory automation products
Collateral Update

Fundamental knowledge
Precision Labs

- Comprehensive online “classroom” – 180 videos and counting
- Ties fundamental knowledge to practical applications
- Many modules include hands-on training

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</thead>
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<td>TI Precision Labs - Multiplexers (4)</td>
</tr>
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<td>TI Precision Labs - Isolation (11)</td>
<td>TI Precision Labs - Sensors (22)</td>
</tr>
<tr>
<td>TI Precision Labs - Motor Drivers (8)</td>
<td></td>
</tr>
</tbody>
</table>

Example Video

Hardware for hands-on training

Texas Instruments
Circuit Cookbooks

- **Simulated circuits** for common applications
- System / Component tradeoffs make circuits adaptable
- # of circuits: amplifiers (64), ADCs (34), DACs (15)

**ADC Table of Contents**

- Low-power, small size, and cost optimized circuits
- Level translation input drive circuits
- Low-level sensor input circuits
- Input protection, filtering and isolation circuits
- Commonly used auxiliary circuits

**Example: High-side 3-wire RTD**
Analog Engineer’s Pocket Reference

- **Easy reference guide** for everyday analog design challenges
- Media options: hard copy via TI.com store, PDF, smart phone app

**Front Cover**

**Example: Settling time & accuracy**

**Example: Resistor coding**

**Figure 86: Settling time for RC circuit-related to ADC converters**

**Table 37: Conversion accuracy achieved after a specified time**

<table>
<thead>
<tr>
<th>Settling time in time constants ($N_{T}$)</th>
<th>Accuracy in bits ($N$)</th>
<th>Settling time in time constants ($N_{T}$)</th>
<th>Accuracy in bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.44</td>
<td>10</td>
<td>14.43</td>
</tr>
<tr>
<td>2</td>
<td>2.89</td>
<td>11</td>
<td>15.87</td>
</tr>
<tr>
<td>3</td>
<td>4.33</td>
<td>12</td>
<td>17.31</td>
</tr>
<tr>
<td>4</td>
<td>5.77</td>
<td>13</td>
<td>18.76</td>
</tr>
<tr>
<td>5</td>
<td>7.21</td>
<td>14</td>
<td>20.20</td>
</tr>
<tr>
<td>6</td>
<td>8.68</td>
<td>15</td>
<td>21.64</td>
</tr>
<tr>
<td>7</td>
<td>10.10</td>
<td>16</td>
<td>23.08</td>
</tr>
<tr>
<td>8</td>
<td>11.54</td>
<td>17</td>
<td>24.53</td>
</tr>
<tr>
<td>9</td>
<td>12.98</td>
<td>18</td>
<td>25.97</td>
</tr>
</tbody>
</table>

**Figure 1: Resistor color code examples**
Analog Engineer’s Calculator

- **Calculator** featuring many helpful ADC, Op Amp, and passive tools
- Extension of the pocket reference
- Includes cookbook links
- Downloadable, Labview-based offline tool
Collateral Update

Device-specific
E2E forum

- **Direct support** from TI’s applications team for all device-related questions
- Replies within 24 hours
- Growing list of answers to frequently asked questions (FAQs)
Device calculators

- Product-specific design calculators for integrated ADCs
- Tools and calculations to complement datasheet information
- Reduce design challenges and time to market

**ADS125H02 product folder**

**Example: CM range calculator**

![CM range calculator diagram]

**Example: Digital filter response**

![Digital filter response diagram]
Software code examples

- Releasing C Code Examples for popular products
- Designed to be part of the EVM GUI creation process
- Next: LINUX, FPGA

**Example: register read**

```c
/**
 * \fn uint8_t readSingleRegister(uint8_t addr)
 * \brief Reads contents of a single register at the specified address
 * \param addr address of the register to read
 * \return 8-bit register read result
 */
uint8_t readSingleRegister(uint8_t addr)
{
    /* Check that the register address is in range */
    assert((addr < NUM_REGISTERS));

    uint8_t DataTx[8];
    uint8_t DataRx[8] = { 0 };
    uint8_tbyterlength = 6;
    uint8_t dataPosition = 4;

    /* Build TX array */
    DataTx[8] = OPCODE_REG; (addr & 0x1F);
    DataTx[1] = ADD_Init;
    DataTx[2] = calculateCRC(DataTx[0], 8); /* Compute CRC-2 */
    DataTx[3] = 0;
    DataTx[4] = 0;
    DataTx[5] = 0;

    /* Select which /CSx pin to set low */
    bool nCS1 = (addr < 0x0Fe);
    bool nCS2 = (addr >= 0x0Fe);

    /* SPI send & receive */
    setCS(nCS1, nCS2);
    SPI_SendReceive(DataTx, DataRx,byterlength);
    setCS(HIGH, HIGH);

    /* Validate command response */
    if (validateSPI(DataT, DataR, OPCODE_REG))
    {
        /* Handle SPI error */
        handeSPIerror(DataT, DataR,byterlength,"REG");
    } else
    { /* Update register array */
        ADC_RegisterMap[addr] = DataR[dataPosition];
    }

    return DataR[dataPosition];
}
```
Three-wire PT100 RTD measurement circuit with high-side reference and two IDAC current sources

Joseph Wu, Chris Helf

Design Description

This cookbook design describes a temperature measurement for a three-wire RTD using the ACS1261. This design takes advantage of the ADS8900 ADC's differential input and current source for a PT100 type RTD with a temperature measurement range from -50°C to 85°C. Included in this design are AC/DC configuration register settings and circuit codes to customize and meet the needs of the device. This circuit can be used in applications such as analog input modules for I/O, lab instrumentation, and factory automation. For more information about using precision ADC measurements with a variety of RTD wiring configurations, see A Basic Guide to RTD Measurements.

Power Supply

<table>
<thead>
<tr>
<th><strong>AVCC</strong></th>
<th><strong>AVDD</strong></th>
<th><strong>DVEE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>5V</td>
<td>5V</td>
<td>3.3V</td>
</tr>
</tbody>
</table>

ADC Inputs

<table>
<thead>
<tr>
<th><strong>VINP</strong></th>
<th><strong>VINM</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>+Vcc</td>
<td>-Vcc</td>
</tr>
</tbody>
</table>

AINP_Current

AINM_Current

VCC_OPA

OPA625_CM

V1

ADC_INP

ADC_INM

ON this example: ADS8900 @ 1MSPS
tacq = 330ns
tconv=670nS
LSB = (5V^2) / (2^20-1) =19.0733uV
1/2_LSB = 9.53uV

ADC INP

ADC_INM

+V

Mode

U2 OPA625

- V

Mode

U3 OPA625

AINP

AINM

ADC in

- VIN

VIN

Vcm 2.5

ADC

U2

OPA625

U3

OPA625

SPICE Models

Code Examples

Related Content

Product Folders

Circuit cookbooks ➔ circuit design hub

Texas Instruments

Circuit Design Hub

SPICE Models

Code Examples

Product Folders

Related Content

EERDs, EE Pages

Design Calculators

Pre-Filtered Search
How to Find Precision ADCs
Finding TI’s Precision ADCs

“Products → Data Converters → Precision ADCs (<=10MSPS)”
Or

Find the best device for your application with 17 additional parameters

Easily search through TI’s 558 Precision ADCs
Precision ADC Hero Products
ADC types covered in this presentation

**Factory Automation**
- Low noise, 24-bit delta-sigma ADCs
- Excellent DC precision
- Features for process level (4-20mA / ±10V) and sensor (temp / pressure) inputs

**Grid Infrastructure**
- 24-bit delta-sigmas / 12-18-bit SAR
- Simultaneous sampling
- Metrology features
- ±10 V input option w/ 5 V supply

**General Purpose**
- <16-bit ADCs
- SAR and delta-sigma
- Low power, small size, low cost
- Ideal for monitoring functions (V / I / temp)
Factory Automation ADCs
ADS124S06 / ADS124S08
24-bit, 4 kSPS, 6/12-Ch ΔΣ ADC for Precision Sensor Measurement

Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>24</td>
</tr>
<tr>
<td># of Ch</td>
<td>6 / 12</td>
</tr>
<tr>
<td>Sample Rate</td>
<td>4 kSPS</td>
</tr>
<tr>
<td>Interface</td>
<td>SPI</td>
</tr>
<tr>
<td>AVDD</td>
<td>2.7 V to 5.25 V ±2.5 V</td>
</tr>
<tr>
<td>DVDD</td>
<td>2.7 V to 3.6 V</td>
</tr>
<tr>
<td>Input Type</td>
<td>Single-Ended Differential</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-50°C to +125°C</td>
</tr>
<tr>
<td>Package</td>
<td>5 mm x 5 mm (QFN-32 / TQFP-32)</td>
</tr>
</tbody>
</table>

Benefits

- **Low-noise PGA** enables precision measurements for the smallest input signals
- **Low-drift integrated voltage reference** reduces system cost and size while still offering high precision and accuracy
- **Dual, matched IDACs** can be used for RTD biasing, reducing BOM size and solution cost
- **High-accuracy oscillator** enables better 50/60 Hz rejection than competitors for noisy industrial environments

Applications

- Temperature Measurement: RTDs | Thermocouples | Thermistors
- Pressure Sensors
- Electro-Magnetic Flow Meters
- Universal PLC / DCS Analog Input Modules
- Weigh Scales

Resolution | 24
---|---
# of Ch | 6 / 12
Sample Rate | 4 kSPS
Interface | SPI
AVDD | 2.7 V to 5.25 V ±2.5 V
DVDD | 2.7 V to 3.6 V
Input Type | Single-Ended Differential
Temperature Range | -50°C to +125°C
Package | 5 mm x 5 mm (QFN-32 / TQFP-32)

Low-Noise PGA (19 nV @ G=128)

Low-Drift Reference (10 ppm/°C max)

2x Current Sources (IDACs)

High Accuracy Oscillator (1.5%)
ADS1260 / ADS1261
24-bit, 40 kSPS, 5/10-Ch ΔΣ ADC w/ Low Noise in 5 mm x 5 mm QFN

Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>24</td>
</tr>
<tr>
<td># of Ch</td>
<td>5/10</td>
</tr>
<tr>
<td>Sample Rate</td>
<td>40 kSPS</td>
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<tr>
<td>Interface</td>
<td>SPI</td>
</tr>
<tr>
<td>AVDD</td>
<td>4.75 V to 5.25 V ±2.5 V</td>
</tr>
<tr>
<td>DVDD</td>
<td>2.7 V to 5.25 V</td>
</tr>
<tr>
<td>Input Type</td>
<td>Single-Ended Differential</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-40°C to +125°C</td>
</tr>
<tr>
<td>Package</td>
<td>5 mm x 5 mm (QFN-32)</td>
</tr>
</tbody>
</table>

Benefits

- **Low-noise PGA** enables precision measurements for the smallest input signals
- **Small 5x5 mm QFN package** reduces system footprint while still providing a highly-integrated, high-performance solution
- **AC-excitation drive** for H-bridge chopping helps remove offset and offset drift errors to improve system accuracy
- **Monitoring & diagnostic** features help improve system reliability

Applications

- PLC Analog Input Modules:
  - 4-20 mA | 10 V | RTD | Thermocouple
- DAQ and Dynamic Strain Analyzers
- Gas Chromatographs / Flow Meters
- Weigh Scale / Resistive Bridge Measurements

Low-Noise PGA (6 nV\text{RMS} @ G=128, 2.5 SPS)

Small 5 mm x 5 mm QFN Package

AC Excitation (ADS1261 only)

Monitoring & Diagnostics
**ADS125H01** / **ADS125H02**

Industry's First ±20 V Input, 24-bit, 40kSPS, 1-/2-Ch ΔΣ ADC with High Input Impedance

### Features
- **Resolution**: 24
- **# of Ch**: 1 / 2
- **Sample Rate**: 40 kSPS
- **Interface**: SPI
- **CM Range**: ±15.5 V
- **HV AVDD**: ±18 V / 0 V to 36 V
- **AVDD**: 4.75 V to 5.25 V
- **DVDD**: 2.7 V to 5.25 V
- **PGA Gains**: 0.125 to 128 (binary)
- **Input Type**: Single-Ended Differential
- **Temp Range**: -40°C to +125°C
- **Package**: 5 mm x 5 mm (QFN-32)

### Benefits
- **Programmable input signal range** accepts high-voltage inputs and low-voltage inputs
- **Low noise PGA + high-resolution 24-bit ADC** suitable for direct connection to bridge / RTD / thermocouple sensors
- **Small form factor, single-chip solution** is >50% smaller than discrete devices, reducing PCB area and simplifying design
- **1-GΩ input impedance** eliminates measurement errors caused by sensor loading

### Applications
- **PLC Analog Input Modules**:
  - ±10 V / 4-20 mA
  - Thermocouple / RTD
  - Universal Input
- **High-Voltage, Precision T&M**
  - Battery Test Equipment

### Wide FS Input Signal Range:
- ±20 mV to ±20 V

### Ultra-Low Noise:
- 45 nV<sub>RMS</sub> (20 SPS)

### Small Solution Size:
- 5 mm x 5 mm QFN

### High Input Impedance:
- 1 GΩ
Grid Infrastructure ADCs
**ADS85xxx (ADS8588S family)**

14/16/18-bit, 4/6/8-Ch Sim-Sam SAR ADC w/ High Input Impedance Front End & Single Supply Operation

### Features

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>14 / 16 / 18</td>
</tr>
<tr>
<td># of Ch</td>
<td>4 / 6 / 8 (simultaneous)</td>
</tr>
<tr>
<td>Sample Rate</td>
<td>200 kSPS / 250 kSPS / 330 kSPS / 500 kSPS</td>
</tr>
<tr>
<td>Interface</td>
<td>SPI / Parallel</td>
</tr>
<tr>
<td>AVDD</td>
<td>4.75 V to 5.25 V</td>
</tr>
<tr>
<td>DVDD</td>
<td>2.3 V to AVDD</td>
</tr>
<tr>
<td>Input Type</td>
<td>Single-Ended</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-40°C to +125°C</td>
</tr>
<tr>
<td>Package</td>
<td>10 mm x 10 mm (LQFP-64)</td>
</tr>
</tbody>
</table>

### Benefits

- **A high input impedance** front end with programmable input range (unipolar/bipolar) enables direct sensor interface & simplifies design
- **3 dB** better SNR than AD7606
- 5 V single supply operation **simplifies design**
- The high speed (200 kSPS / 500 kSPS) simultaneous sampling enables **fast data acquisition** across multiple signals with **no channel-to-channel latency**

### Applications

- Protection Relays
- Test & Measurement
- Battery Test
- Industrial Automation
- Power Monitoring

### Exceptional AC & DC Performance:

- **SNR:** 101.8 dB
- **THD:** -114 dB

### Pin-Programmable Bipolar Inputs:

- ±10 V and ±5 V

### 5 V Single Supply Operation

---

**Device** | Resolution | Sample Rate | # of Ch |
---         |            |            |         |
ADS8578S   | 14         | 200 kSPS   | 8       |
ADS8584S   | 16         | 330 kSPS   | 4       |
ADS8586S   | 16         | 250 kSPS   | 6       |
ADS8588S   | 16         | 200 kSPS   | 8       |
ADS8588H   | 16         | 500 kSPS   | 8       |
ADS8598S   | 18         | 200 kSPS   | 8       |
ADS8598H   | 18         | 500 kSPS   | 8       |

---

**TI Information – Selective Disclosure**
**ADS131A02 / ADS131A04**

24-bit, 128 kSPS, 2/4-Ch ΔΣ ADC for Energy Applications with High Dynamic Range

### Features

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<thead>
<tr>
<th>Resolution</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Ch</td>
<td>2 / 4</td>
</tr>
<tr>
<td>Sample Rate</td>
<td>128 kSPS</td>
</tr>
<tr>
<td>Interface</td>
<td>SPI</td>
</tr>
<tr>
<td>AVDD</td>
<td>3.3 V to 5.5 V</td>
</tr>
<tr>
<td>DVDD</td>
<td>1.65 V to 3.6 V</td>
</tr>
<tr>
<td>Input Type</td>
<td>Single-Ended Differential</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-40°C to +125°C</td>
</tr>
<tr>
<td>Package</td>
<td>5 mm x 5 mm (TQFP-32)</td>
</tr>
</tbody>
</table>

- **High Dynamic Range:** 115 dB
- **Flexible Interface:** Daisy-Chain Capability
- **Extended Input Range:** AVSS-1.5 V to AVDD with Unipolar Supply
- **High Data Rate:** 128 kSPS

### Benefits

- **High Performance** allows solutions with high dynamic range
- Serial interface provides sync options for multiple devices
- **Extended Input Range** enables low cost solution by simplifying the front end design
- Wide bandwidth allows for harmonic analysis

### Applications

- Relay Protection & Circuit Breakers
- Power Metrology
- Portable Instrumentation/IEDs
- Battery Test

---

TI Information – Selective Disclosure
ADS131M02* / ADS131M03* / ADS131M04

Industry’s lowest power, low cost and small size

2/3/4-Ch, 24-bit, 32 kSPS, Simultaneous Sampling ADC

**Features**

<table>
<thead>
<tr>
<th>Feature</th>
<th>ADS131M02</th>
<th>ADS131M03</th>
<th>ADS131M04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>24-bit</td>
<td>24-bit</td>
<td>24-bit</td>
</tr>
<tr>
<td># of Ch</td>
<td>2 / 3 / 4</td>
<td>2 / 3 / 4</td>
<td>2 / 3 / 4</td>
</tr>
<tr>
<td>Sample Rate</td>
<td>32 kSPS</td>
<td>32 kSPS</td>
<td>32 kSPS</td>
</tr>
<tr>
<td>Gain</td>
<td>Up to 128</td>
<td>Up to 128</td>
<td>Up to 128</td>
</tr>
</tbody>
</table>
| Input Impedance     | 240 kΩ (G = 1, 2, 4)
                     | 1 MΩ (G = 8, 16, 32, 64) | 240 kΩ (G = 1, 2, 4)
                     | 1 MΩ (G = 8, 16, 32, 64) | 240 kΩ (G = 1, 2, 4)
                     | 1 MΩ (G = 8, 16, 32, 64) | 240 kΩ (G = 1, 2, 4)
| AVDD                | 2.7 V to 3.6 V | 2.7 V to 3.6 V | 2.7 V to 3.6 V |
| DVDD                | 2.7 V to 3.6 V | 2.7 V to 3.6 V | 2.7 V to 3.6 V |
| Input Type          | Single-Ended | Single-Ended | Single-Ended |
| Differential        | Differential | Differential | Differential |
| Temperature Range   | -40°C to +125°C | -40°C to +125°C | -40°C to +125°C |
| Package             | See table  | See table  | See table  |

**Benefits**

- **Low power** enables efficient energy measurements
- **High input impedance** at all gain settings enables direct sensor interface
- **ADC accuracy** exceeds requirements for Class 0.2 metering
- **Ideal features for metrology:**
  - Channel phase delay for CT or Rogowski Coil compensation
  - Fast startup ideal for circuit breakers
  - Third channel for monitoring neutral for tamper protection

**Applications**

- Energy measurement: V/I/T
  - Electricity meters: residential & commercial
  - Circuit breakers
  - Battery management

**Device**

- ADS131M02: 2-Channel, 24-bit, 32 kSPS, Simultaneous Sampling ADC
- ADS131M03: 3-Channel, 24-bit, 32 kSPS, Simultaneous Sampling ADC
- ADS131M04: 4-Channel, 24-bit, 32 kSPS, Simultaneous Sampling ADC

**Package Options**

- ADS131M02: 3 mm x 3 mm (VQFN-16) / 5 mm x 4.4 mm (TSSOP-16)
- ADS131M03: 3 mm x 3 mm (WQFN-20) / 6.5 mm x 4.4 mm (TSSOP-20)
- ADS131M04: 3 mm x 3 mm (WQFN-20) / 6.5 mm x 4.4 mm (TSSOP-20)
General Purpose ADCs (<16-bit)
General Purpose ADCs
Low Cost, Small Size, High Ch Density and Highly flexible ADCs

### Low Cost

#### Industry’s Lowest Priced ADCs

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price @ 1ku</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADS7040</td>
<td>8-bit, 1 channel SPI</td>
<td>$0.40</td>
</tr>
<tr>
<td>TLA2021</td>
<td>12-bit, 1 channel, I2C</td>
<td>$0.55</td>
</tr>
<tr>
<td>TLA2022</td>
<td>12-bit, 1 channel, PGA, I2C</td>
<td>$0.60</td>
</tr>
<tr>
<td>ADS7041</td>
<td>10-bit, 1 channel SPI</td>
<td>$0.60</td>
</tr>
<tr>
<td>TLA2024</td>
<td>12-bit, 4 channels, PGA, I2C</td>
<td>$0.65</td>
</tr>
</tbody>
</table>

### Small Size

#### Industry’s Smallest Sized ADCs

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADS111C04</td>
<td>16-bit, 4 channel, I2C</td>
</tr>
<tr>
<td>ADS7066</td>
<td>16-bit, 8 channel, SPI</td>
</tr>
<tr>
<td>ADS7042</td>
<td>12-bit, 1 channel, 1 MSPS, SPI</td>
</tr>
<tr>
<td>ADS7046</td>
<td>12-bit, 1 channel, 3 MSPS, SPI</td>
</tr>
<tr>
<td>ADS7056</td>
<td>14-bit, 1 channel, 3 MSPS, SPI</td>
</tr>
</tbody>
</table>

### High Ch Density

#### 2 Channels

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADS7142</td>
<td>(2 mm X 1.5 mm)</td>
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</table>

#### 8 Channels

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLA2528*</td>
<td>(3 mm X 3 mm)</td>
</tr>
<tr>
<td>ADS7066*</td>
<td>(1.66 mm X 1.66 mm)</td>
</tr>
</tbody>
</table>

#### 4 Channels

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADS111C04*</td>
<td>(1.38 mm X 0.94 mm)</td>
</tr>
<tr>
<td>TLA2024</td>
<td>(1.5 mm X 1.5 mm)</td>
</tr>
</tbody>
</table>

#### 16 Channels

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADS7953</td>
<td>(5 mm X 5 mm)</td>
</tr>
</tbody>
</table>

### Diversified Features

#### GPIOs

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADS7953</td>
<td>4 GPIOs</td>
</tr>
<tr>
<td>TLA7128</td>
<td>8 GPIOs</td>
</tr>
</tbody>
</table>

#### Integrated PGA

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLA2022</td>
<td>Input ranges from ±256 mV to ±6.144 V</td>
</tr>
<tr>
<td>TLA2024</td>
<td></td>
</tr>
</tbody>
</table>

#### Autonomous Monitoring

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADS7142</td>
<td>P2P compatible devices</td>
</tr>
<tr>
<td>ADS7138</td>
<td></td>
</tr>
</tbody>
</table>

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TI Information – Selective Disclosure
ADS7128 – Device Family
12-bit, 140 kSPS, 8-Ch SAR ADC w/ GPIOs

TLA2528

- Lowest Cost
  - Smallest 8 Channel ADC
  - Programmable GPIOs
  - Averaging (16 bit mode)

ADS7138 & ADS7138-Q1

- TLA2528 +
  - Autonomous Monitoring
  - CRC on Data Interface
  - -40°C to +125°C

ADS7128

- ADS7138 +
  - True RMS module
  - ZCD module
  - -40°C to +85°C

ADS7128/38 are p2p and backward compatible with TLA2528
ADS7128 – Applications

12-bit, 140 kSPS, 8-Ch SAR ADC w/ GPIOs

**Voltage Supervisor w/ Fast ALERT**
- AVDD
- VIN1, VIN2, VIN8
- LIMIT1, LIMIT2... LIMIT8
- ALERT

**Zero-Crossing-Detection for Appliances**
- Analog input
- High threshold
- Transient rejection
- Digital output

ADS7128 eliminates transients in the ZCD output caused by switching noise in the line voltage.

**Over Current / Over Voltage Protection w/ Fast Shutdown**
- VCC
- AVDD
- OV
- OC
- GPIO

**Temperature Control**
- VCC
- AVDD
- HEATING ELEMENT
- AIN
- GPIO

Temperature control loop using analog inputs and GPIO.

**ADC + IO Expander**
- AIN / GPIO
- AIN / GPIO
- AIN / GPIO
- AIN / GPIO
- AIN / GPIO
- AIN / GPIO
- i2C or SPI
- ISO
- Controller

**True Root-Mean-Square Measurement**
- AC MAINS
- AVDD
- 0.5 AVDD
- True RMS Output

RMS to digital conversion with lowest power. Competes with ADI’s RMS-DC converter.

Samples: NOW
RTM: 4Q19

TI Information – Selective Disclosure
New Product Updates now on our website!

https://training.ti.com/npu
## Upcoming Broadcasts

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
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<tbody>
<tr>
<td>12/5/2019</td>
<td>Boost Converters and Controllers</td>
</tr>
<tr>
<td>12/12/2019</td>
<td>Power over Ethernet</td>
</tr>
<tr>
<td>12/19/2019</td>
<td>Break</td>
</tr>
<tr>
<td>12/26/2019</td>
<td>Break</td>
</tr>
<tr>
<td>1/2/2020</td>
<td>Break</td>
</tr>
<tr>
<td>1/9/2020</td>
<td>SimpleLink™ wired and wireless Arm® MCUs</td>
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