Integrated Connections

The Signal Chain Guide
The Signal Chain Guide

Your Avnet team is ready to support your signal chain design requirements. As you review the innovative products featured in this guide, you can rely on Avnet to support every step of your product development process. Connect on your next design - we have assembled a library of product information, development kits and reference designs to jump start your next signal chain design project.

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Signal Chain Solutions

Specialized Design and Support
We have assembled a team of Avnet, Supplier and Partner resources to deliver a true Signal Chain Design & Support Ecosystem.

Avnet Account Managers and Field Application Engineers
Providing customers with day to day supply and design chain support for Analog and Timing Technology requirements.

Supplier Network
Avnet’s line up of supplier partners provide a full portfolio of data conversion, interface, amplifier, standard logic, clock/timing and power management devices and solutions. Avnet also has a strong portfolio for input and output products like FPGAs, DSPs, microprocessors and sensors.

Engineering to “Total Solution” Design Partners
The Avnet Technical Network connects customers to design resources with the objective of accelerating new project development. These partners offer engineering design services, software expertise, and manufacturing capabilities tied to signal chain technology and key vertical markets.

Avnet AVAIL Block Diagram APP
Your local FAE team is armed with Avnet AVAIL Block Diagram APP, an interactive engineering tool built on the Microsoft Visio platform that allows Avnet to take advantage of an elite knowledge base of engineering talent and manufacturer information to help customers develop system level block diagrams including signal chain solutions quickly and efficiently.

Analog Signal Chain

What’s Involved and What We Support:

The analog signal can be the input and/or the output interface to any design.

The analog input signal chain receives its analog signals from keyboards, pressure sensors, accelerometers, temperature sensors, microphones, voltages (i.e., batteries) and/or currents (i.e., a motor), etc.... This input signal is then conditioned or filtered via an amplifier to remove any unwanted noise or to amplify the input signal from the sensor. The signal is then converted to the digital realm through an analog-to-digital (A/D) converter. FPGAs, DSPs, and microprocessors are now able understand the digital information supplied by the A/D converter.
The opposite function is performed in the **analog output signal chain**. The digital signal from an FPGA, DSP or microprocessor is converted to an analog signal by either a digital-to-analog (D/A) converter or from an on-chip D/A on the microprocessor/DSP. This input signal is then conditioned or filtered via an amplifier to remove any unwanted noise or to amplify the signal. The analog signal is then outputted to the analog world via a speaker, motor/fan, LED or a relay.
Sensors are used to convert light, audio, sound, acceleration, touch, CCD, magnetism, pressure, dust, humidity, current, fingerprints, GPS, IR (heat), proximity, rotation, smoke, tilt and ultrasonic frequencies to an analog signal.

OP Amps (amplifiers) or filters are used to clean up and amplify a signal from the sensor output. This is typically called signal conditioning.

Analog switches/multiplexers function as an electronic switch where there are multiple inputs and one output. A processor can be used to control the multiplexer, which selects the appropriate input signal that needs to be passed through to the output of the multiplexer.

A/D converters produce a digital output, which corresponds to the value of the analog signal applied to its input and compared with a reference voltage. A/D and D/A converters perform the opposite functions.

μP (microprocessor), μC (microcontroller), DSP, or FPGA devices process and analyze the digital data outputted from the A/D converter. They can also output digital data to the D/A converter.

Voltage references provide an extremely accurate output voltage that does not change as temperature changes. Most A/D and D/A converters use them to compare a voltage to their inputs because of their accuracy.

D/A converters produce a discrete analog output value (either AC or DC) corresponding to a digital input word relative to its reference voltage. A/D and D/A converters perform the opposite functions.

FETs, IGBTs and transistors are typically used as the final output stage in power applications (i.e., motor drive and high power audio).

Output devices commonly found in the analog signal chain are speakers for sound, motors, fans, LEDs and relays.

Interface devices enable efficient and reliable communication for industrial control, networking and computing applications.

Logic and Timing Devices: clock generators, buffers, dividers, multiplexers, crystal oscillators and jitter attenuators with frequency translation.

Wireless Connectivity: RF, Wi-Fi or other wireless connection to the CPU.
Markets Served

Automotive
Motion control, radio control, driver information systems, infotainment, airbag controller, aftermarket access & diagnostics.

Commercial
Security systems, energy management, portable instruments, advertising signs, temperature sensing & PCs.

Consumer
Domestic broadband gateway, web cam, home theater in a box, set-top boxes, DSL modems, mobile phones, PDAs, digital cameras, HDTV & precision audio.

Industrial
Measurement & control, robots, process control, instrumentation, automation, data acquisition, distributed power systems, servers, remote control & security cameras.

Healthcare
Blood analyzers, portable instrumentation, ultrasound, X-ray MRI, CAT scanners, glucose meters, temperature meters & patient monitoring.
Featured Suppliers

Analog Devices, Inc. is the world leader in high performance Analog and Digital Signal Processing Solutions. For over fifty years, ADI has led the industry in innovation, performance and value. ADI continues to expand its extensive product portfolio ranging from its best in class converters and amplifier technology to the industry's broadest portfolio of advanced RF and Microwave solutions. No matter the design challenge Analog Devices will have the product and industry knowledge to help you overcome it.

IDT is the world’s leading provider of silicon timing devices (clock ICs) and offers the industry’s broadest product portfolio of clock timing solutions. IDT’s industry-leading portfolio of timing devices consists of clock generators, buffers, dividers, multiplexers, crystal oscillators and jitter attenuators with frequency translation - many with programmable capabilities for maximum flexibility. Below customers will find highlights from the buffer, PCIe clock generator, and crystal oscillator families IDT offers. For help finding or selecting other IDT timing devices contact your local Avnet salesperson.

Our broad precision analog portfolio provides a wide range of next-gen precision instrumentation, medical, communication and industrial process control applications. Intersil’s precision analog products are built on the latest technology; we offer a wide portfolio of general purpose analog building blocks targeted at precision signal chain design. With proven proprietary processes and package technologies, Intersil ships over one billion ICs per year with less than 1.2 DPPM. Our strong technology development and multi-sourcing strategy from multiple leading-edge semiconductor foundries and assembly/test partners ensures a steady product supply with reduced risk.

Microchip Technology’s broad portfolio of stand-alone analog and interface devices are engineered to meet today’s demanding design requirements addressing linear, mixed signal, power management, thermal and interface products. When combined with Microchip analog microcontrollers, this extensive portfolio can be used in many high performance design applications in the automotive, communications, consumer, computing and industrial control markets.
Featured Products
AD7768: 8-Channel, 24-Bit, Simultaneous Sampling ADC, Power Scaling, 110.8 kHz BW

The AD7768/AD7768-4 are 8-channel and 4-channel, simultaneous sampling sigma-delta (∑-Δ) analog-to-digital converters (ADCs), respectively, with a ∑-Δ modulator and digital filter per channel, enabling synchronized sampling of AC and DC signals.

The AD7768/AD7768-4 achieve 108 dB dynamic range at a maximum input bandwidth of 110.8 kHz, combined with typical performance of ±2 ppm INL, ±50 µV offset error, and ±30 ppm gain error.

The AD7768/AD7768-4 user can trade off input bandwidth, output data rate, and power dissipation, and select one of three power modes to optimize for noise targets and power consumption. The flexibility of the AD7768/AD7768-4 allows them to become reusable platforms for low power dc and high performance ac measurement modules.

Applications:
- Data acquisition systems: USB/PXI/Ethernet
- Instrumentation and industrial control loops
- High precision medical electroencephalogram (EEG)/electromyography (EMG)/electrocardiogram (ECG)
- Vibration and asset condition monitoring
- 3-phase power quality analysis
- Sonar
- Audio test and measurement

ADP7159: 2 A, Ultra-low Noise, High PSRR, Adjustable Output, RF Linear Regulator

The ADP7159 is an adjustable linear regulator that operates from 2.3 V to 5.5 V and provides up to 2 A of output current. Output voltages from 1.2 V to 3.3 V are possible depending on the model. Using an advanced proprietary architecture, the device provides high power supply rejection and ultra-low noise, achieving excellent line and load transient response with only a 10 µF ceramic output capacitor.

The ADP7159 is available in four models that optimize power dissipation and PSRR performance as a function of the input and output voltage.

Applications:
- Regulation to noise sensitive applications: phase-locked loops (PLLs), voltage controlled oscillators (VCOs), and PLLs with integrated VCOs
- Communications and infrastructure
- Backhaul and microwave links
**AD7175-2:**

24-Bit, 250 kSPS, Sigma-Delta ADC with 20 µs Settling & True Rail-to-Rail Buffers

The AD7175-2 is a low noise, fast settling, multiplexed, 2-/4-channel (fully/pseudo differential) Σ-Δ analog-to-digital converter (ADC) for low bandwidth inputs. It has a maximum channel scan rate of 50 kSPS (20 µs) for fully settled data. The output data rates range from 5 SPS to 250 kSPS.

The AD7175-2 integrates key analog and digital signal conditioning blocks to allow users to configure an individual setup for each analog input channel in use. Each feature can be user selected on a per channel basis. Integrated true rail-to-rail buffers on the analog inputs and external reference inputs provide easy to drive high impedance inputs. The precision 2.5 V low drift (2 ppm/°C) band gap internal reference (with output reference buffer) adds embedded functionality to reduce external component count.

**Applications:**
- Process control: PLC/DCS modules
- Temperature and pressure measurement
- Medical and scientific multichannel instrumentation
- Chromatography

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**AD7124-4:**

4-Channel, Low Noise, Low Power, 24-Bit, Sigma-Delta ADC with PGA and Reference

The AD7124-4 is a low power, low noise, completely integrated analog front end for high precision measurement applications. The device contains a low noise, 24-bit Σ-Δ analog-to-digital converter (ADC), and can be configured to have 4 differential inputs or 7 single-ended or pseudo differential inputs. The onchip low gain stage ensures that signals of small amplitude can be interfaced directly to the ADC.

One of the major advantages of the AD7124-4 is that it gives the user the flexibility to employ one of three integrated power modes. The current consumption, range of output data rates, and rms noise can be tailored with the power mode selected. The device also offers a multitude of filter options, ensuring that the user has the highest degree of flexibility.

**Applications:**
- Temperature measurement
- Pressure measurement
- Industrial process control
- Instrumentation Smart transmitters
- Smart transmitters
ADA4530-1: Femtoampere Input Bias Current Electrometer Amplifier

The ADA4530-1 is a femtoampere (10−15 A) level input bias current operational amplifier suitable for use as an electrometer that also includes an integrated guard buffer. It has an operating voltage range of 4.5 V to 16 V enabling it to operate in conventional 5 V and 10 V single supply systems as well as ±2.5 V and ±5 V dual supply systems.

It provides ultra-low input bias currents that are production tested at temperature to ensure the device meets its performance goals in user systems. The integrated guard buffer is provided to isolate the input pins from leakage in the printed circuit board (PCB), minimize board component count, and enable ease of system design.

Applications:

- Laboratory and analytical instrumentation: spectrophotometers, chromatographs, mass spectrometers, potentiostatic and amperostatic coulometry
- Instrumentation: picoammeters, coulombmeters
- Transimpedance amplifier (TIA) for photodiodes, ion chambers, and working electrode measurements
- High impedance buffering for chemical sensors and capacitive sensors
IDT is the world’s leading provider of silicon timing devices (clock ICs) and offers the industry’s broadest product portfolio of clock timing solutions. With the industry’s largest timing portfolio, IDT is the only “one-stop-shop” for timing solutions, offering products from full-featured system solutions to simple clock building-block devices. IDT’s industry-leading portfolio of timing devices consists of clock generators, buffers, dividers, multiplexers, crystal oscillators and jitter attenuators with frequency translation - many with programmable capabilities for maximum flexibility. Below customers will find highlights from the buffer, PCIe clock generator and crystal oscillator families IDT offers. For help finding or selecting other IDT timing devices contact your local Avnet salesperson.

Ultra-Low-Jitter Single-Ended Buffer Family

IDT’s versatile family of single-ended clock buffers delivers best-in-class jitter performance in a compact package. With the support of multiple input formats including clipped sine wave, crystal and LVCMOS, this high performance single-ended clock buffer family expands IDT’s offerings in the industrial and automotive markets. Together with small form factor and low power consumption, these devices help customers meet today’s stringent requirements. The operating temperature range from -40°C to 105°C is ideal for extended temperature applications.

LVCMOS High Performance Clock Buffers - 1.8 V to 3.3 V

**Features:**
- Very low pin-to-pin skew <50 ps
- <50 fs additive phase jitter
- \( f_{\text{max}} = 200 \text{ MHz} \)
- Integrated serial termination for 50ohm channel
- Output/Input Freq Range 0-200 MHz
- Output Banks (all products) - 1
- Core/Output Voltage (all products): 1.8, 2.5, 3.3
- Output Skew (all products): 65

**Products:**
- **5PB1102**: 1:2 LVCMOS clock buffer. Available in 8-pin DFN and TSSOP packages.
- **5PB1104**: 1:4 LVCMOS clock buffer. Available in 8-pin DFN and TSSOP packages.
- **5PB1106**: 1:6 LVCMOS clock buffer. Available in 8-pin DFN and TSSOP packages.
- **5PB1108**: 1:8 LVCMOS clock buffer. Available in 16-pin QFN and TSSOP packages.
- **5PB1110**: 1:10 LVCMOS clock buffer. Available in 12-pin QFN and TSSOP packages.
PCIExpress® (PCIe) Clock Generators

PCI Express® (PCIe®) is globally recognized as the general purpose I/O that unifies the component interconnect across many applications including desktop computing, servers, workstations, storage, networking, enterprise router, industrial test and control equipment, defense, aerospace, high-end consumer, and many more. IDT provides an extensive product portfolio that tackles design requirements needed to build an entire PCI Express network, including timing solutions, switches, signal integrity and bridges.

Features:
- PCIe Gen1, Gen2, Gen3, and Gen4
- LP-HCSL Differential Output Signaling
- Reference Output
- Spread Spectrum

Products:
- 9FGL02: 2-output 3.3V PCIe Clock Generator, SRIS-compliant, supports PCIe SRnS clocking. Available in 24-pin VFQFPN package.
- 9FGL04: 4-output 3.3V PCIe Clock Generator, SRIS-compliant, supports SRnS clocking. Available in 32-pin VFQFPN package.
- 9FGU0241: 2-output 1.5V PCIe Gen 1-2-3 Clock Generator with Zo=100Ω. The device has 2 output enables for clock management, 2 different spread spectrum levels in addition to spread off. Available in 24-pin VFQFPN package.
- 9FGU0441: 4-output 1.5V PCIe Gen 1-2-3 Clock Generator with Zo=100Ω. The device has 4 output enables for clock management, 2 different spread spectrum levels in addition to spread off. Available in 32-pin VFQFPN package.
- 9FGV0241: 2-output 1.8V PCIe Gen 1-2-3 Clock Generator with Zo=100Ω. The device has 2 output enables for clock management and supports 2 different spread spectrum levels in addition to spread off. Available in 24-pin VFQFPN package.
- 9FGV0441: 4-output 1.8V PCIe Gen 1-2-3 Clock Generator with Zo=100Ω. The device has 4 output enables for clock management and supports 2 different spread spectrum levels in addition to spread off. Available in 32-pin VFQFPN package.

XU – XL Crystal Oscillators

IDT’s crystal oscillators offer designers a flexible, reliable and economical timing solution. They are available in any frequency from 16 kHz to 1.5 GHz. IDT’s XU line features a typical jitter value of 300 fs RMS with a maximum value of 400 fs. The XL line offers an economical solution for less stringent applications with 3.2 mm x 2.5 mm, 5.0mm x 3.2 mm, and 7.0 mm x 5.0 mm packages. Check with your Avnet sales team for detailed specifications at all common frequencies.

Products:
- XLH: <1ps RMS Phase Jitter, HCMOS, 5.0 x 3.2mm Crystal Oscillators
- XUL: <400fs RMS Phase Jitter, LVDS Output Crystal Oscillators
- XUN: <400 fs RMS Phase Jitter, HCSL Output Crystal Oscillators
- XUP: <400 fs RMS Phase Jitter, LVPECL Output Crystal Oscillators
Intersil’s broad precision analog portfolio provides a wide range of next-gen precision instrumentation, medical, communication and industrial process control applications where innovation, reliability and dependability is central to the analog designs. Intersil’s precision analog products are built on the latest technology; we offer a wide portfolio of general purpose analog building blocks targeted at precision signal chain design. With proven proprietary processes and package technologies, Intersil ships over one billion ICs per year with less than 1.2 DPPM (defective parts per million). Our strong technology development and multi-sourcing strategy from multiple leading-edge semiconductor foundries and assembly/test partners ensures a steady product supply with reduced risk.

**Interface**

Intersil offers industry-leading devices to enable efficient and reliable communication for industrial control, networking and computing applications. Dual protocol transceivers, I2C Buffers, wide operating voltage range RS-232 transceivers and RS-485/422 devices with high noise immunity and ESD protection in small packages are available to support high-speed data transfer and a variety of configurations to fit your application.

### ±60V OVP, ±20V CMR, 3.3V-5V Transceiver Family

<table>
<thead>
<tr>
<th>Device</th>
<th>Speed (Mbps)</th>
<th>Duplex</th>
<th>Slew Rate Limited</th>
<th>Enable Pins</th>
<th>Cable Invert</th>
<th>Low Power SHDN</th>
<th>Packages</th>
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<tbody>
<tr>
<td>ISL32450E</td>
<td>0.25</td>
<td>Full</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>SOIC-14, MSOP-10</td>
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<tr>
<td>ISL32452E</td>
<td>0.25</td>
<td>Half</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>SOIC-14, MSOP-10</td>
</tr>
<tr>
<td>ISL32453E</td>
<td>1</td>
<td>Full</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>SOIC-14, MSOP-10</td>
</tr>
<tr>
<td>ISL32455E</td>
<td>1</td>
<td>Half</td>
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<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>SOIC-14, MSOP-10</td>
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<tr>
<td>ISL32457E</td>
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<td>Half</td>
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<td>Tx Only</td>
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<tr>
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<td>No</td>
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<tr>
<td>ISL32459E</td>
<td>20</td>
<td>Half</td>
<td>No</td>
<td>Tx Only</td>
<td>Yes</td>
<td>No</td>
<td>SOIC-8</td>
</tr>
</tbody>
</table>

**Features:**

- Fault protected RS-485 bus pins: up to ±60V
- Extended common-mode range: ±20V, larger than required for RS-485
- ±15kV HBM ESD protection on RS-485 bus pins
- Wide supply range: 3V to 5.5V
- Cable invert pin (ISL32457E and ISL32459E only) corrects for reversed cable connections while maintaining Rx full fail-safe functionality
- 1/4 unit load for up to 128 devices on the bus
- High transient overvoltage tolerance: ±80V
- Full fail-safe (open, short, terminated) RS-485 receivers
RS-485/RS-422 Fastest, Most Reliable & Smallest Transceivers

**ISL3159E/ISL3179E**
- 40Mbps Data Rate
- IEC61000 ESD Protection
- 125°C Operation
- Fast data rate of 40Mbps for high speed factory automation applications.

**ISL3259E**
- 100Mbps Data Rate
- IEC61000 ESD Protection
- Extended VOD Performance (>2.1V)
- Ultra-fast data rate of 100Mbps enables precise control of motor positioning in factory automation.

Digital Power Monitors
Intersil’s ISL2802x digital power monitor (DPM) family delivers high accuracy measurements in a wide input common mode voltage range (0V to 60V), providing designers with the high level of safety margin that is often necessary in wired, wireless and data infrastructure applications.

- The ISL28022 is a bidirectional high-side and low-side digital current sense and voltage monitor with serial interface.
- The ISL28023 is a precision DPM that integrates the analog comparators, a voltage regulator, a DAC and a low voltage auxiliary channel in a single chip.
- The ISL28025 is a high precision DPM with integrated analog comparators and an integrated voltage regulator.
Precision Instrumentation Amplifiers (programmable)

The ISL2853x and ISL2863x family of ultra-high precision instrumentation amplifiers (in-amps) feature zero-drift circuitry that provides auto offset voltage correction and noise reduction, delivering very low offset voltage drift of nV/°C and a low 1/F noise frequency corner down in the tens of mHz range. These in-amps integrate precision matched resistors for the front gain stage and the differential second stage, providing very high gain accuracy and excellent CMRR.

- Zero-drift instrumentation amplifier
- 9 pin selectable gain options: Av = 1 to 1,000
- Rail-to-rail input/output
- Single-ended output (ISL28533, ISL28534, ISL28535)
- Differential output (ISL28633, ISL28634, ISL28635)
- RFI filtered inputs improve EMI rejection
Microchip Technology's broad portfolio of stand-alone analog and interface devices are engineered to meet today's demanding design requirements addressing linear, mixed signal, power management, thermal and interface products. When combined with Microchip analog microcontrollers, this extensive portfolio can be used in many high performance design applications in the automotive, communications, consumer, computing and industrial control markets.

**Digital to Analog Converters (DACs)**

Microchip offers low power Digital to Analog converter (DAC) products in 8- to 12-bit resolution, 1 to 4 channels, I2C or SPI interface and onboard EEPROM. The unique integrated non-volatile memory option allows DAC's configuration to be saved at power down and can help reducing micro-controller overhead as well as simplify design. Small form factor options as SOT-23 and DFN (2X2) packages are available.

**Products:**

- **MCP47FEB22**: Dual Channel, 12-Bit voltage output DAC w/EEPROM with I2C
- **MCP4728**: Quad Channel, 12-Bit voltage output DAC with I2C

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**Analog to Digital Converters (ADCs)**

Microchip’s A/D converters are available in a wide range of speeds and resolutions, delivering high accuracy and low power per given sampling speed.

**Products:**

- **Pipelined A/D Converters**
  Pipelined Analog-to-Digital Converters offer 12-16-bit resolution and up to 8 Channels with sampling speeds up to 200 Msps. They exhibit very low power operation of less than 500 mW when operating at full speed. These products feature high integration of digital signal processing such as decimation filters and digital down-conversion that simplify system designs.

- **Delta-Sigma A/D Converters**
  Delta-Sigma ADC families offer 16 to 22-bits of resolution with sampling rates from 4sps to 240sps. Product features include low power operation, low output noise and choices of I2C and SPI interfaces. High integration, including on-board voltage references and PGAs, and small packaging, such as SOT-23 and DFN, allow for high density solution.

- **SAR A/D Converters**
  SAR (Successive Approximation Register) ADC offering provides a broad selection for low power applications. These devices operate with an active conversion current as low as 175 µA. The MCP30XX, MCP32XX, and MCP33XX families offer resolutions of 10-13 bits, sampling speeds of 22 ksp to 200 ksp, multiple channel inputs, and I2C or SPI interfaces.
Amplifiers

Microchip offers a broad portfolio of linear solutions featuring Operational Amplifiers (Op Amp), Instrumentation Amplifiers (INA), Comparators, Programmable Gain Amplifiers (PGAs), and DC Power/Current Sensing.

Maximize the performance of your design by using the industry's lowest power with best in class offset voltages! Combine these performance benefits with small packaging optimizes system performance in a wide variety of applications for the Consumer, Industrial, Medical and Automotive applications.

Products:
- **MCP6S2x**: programmable Gain Amplifier offer 1, 2, 6 or 8 input channels respectively and eight steps of gain. These devices are programmable over an SPI bus and thus add gain control and input channel selection to the embedded control system.
- **MCP6N16**: zero-drift instrumentation amplifier designed for single-supply operation with rail-to-rail input (no common mode crossover distortion) and output performance.
- **MCP6N11**: single instrumentation amplifier is optimized for single-supply operation with rail-to-rail input and output performance w/calibration.
- **MCP6V27**: operational amplifiers has input offset voltage correction for very low offset and offset drift. These devices have a wide bandwidth product and strongly reject switching noise.

Temperature Sensors

Microchip thermal sensors are tailored to a variety of desired tasks. Analog temperature sensors output voltage and interface well with ADCs. Digital temperature sensors, both local and remote, are I2C or SPI compatible. Temperature switches result in on/off logic control.

Products:
- **MCP9600**: fully integrated thermocouple Electromotive Force (EMF) to degree Celsius converter, with integrated Cold-Junction compensation. The MCP9600 supports 8 thermocouple types (K, J, T, N, S, E, B and R).

Current Sensors

Microchip's power monitoring ICs measure power, voltage and current, while providing the calculated power over an I2C interface. These I2C power monitors are based on the traditional high-side current sensor. The current monitors can measure voltage rails from 0V to 40V. Several of the devices also come with temperature sensors for where we see high power we need thermal management.

Products:
- **PAC1921**: power-monitoring device with a configurable analog output that can present power, current or voltage. Integration periods of 500 μs to 2.9 seconds, analog output range of 3V, 2V, 1.5V, or 1.0V.
Voltage Reference

Microchip voltage reference devices produce a fixed (constant) voltage irrespective of the loading on the device, power supply variations, temperature changes and the passage of time. Voltage references are used in with power supplies, analog-to-digital converters, digital-to-analog converters and other measurement and control systems. Voltage references vary widely in performance; a regulator for a computer power supply may only hold its value to within a few percent of the nominal value, whereas laboratory voltage standards have precisions and stability measured in parts per million.

Products:

- **MCP1501**: high-precision buffered voltage reference with an initial accuracy of 0.10% and is available in 8 voltage options. This low-drift bandgap-based reference uses chopper-based amplifiers which significantly reduces the drift and provides high current output.

- **MCP1541**: low power, high precision voltage reference. It provides a precise output voltage of 4.096V which is then compared to other voltages in the system. This voltage reference is normally used in the 3V to 5V systems, where there may be wide variations in supply voltage and a need to minimize power dissipation.

Digital Potentiometers

Microchip offers a wide variety of digital potentiometer (digipot) devices that service a broad range of applications, including but not limited to system calibration, gain and offset trimming, set-points, etc. These low-power, compact devices feature 6 to 8 bits of resolution, 1 to 4 channel counts and are available in both volatile and non-volatile memory types. Tiny packages such as SC-70 and DFN (2x3) are offered for space constraint systems. High voltage digipot devices that can support +/- 18V dual voltage operation or 10V to 36V single voltage operation are also available.

Products:

- **MCP41HV51**: single-channel, high voltage digital potentiometer (Digipot) family that supports 10V ~36V or +/-5V to +/-18V power rails.

- **MCP4261**: non-volatile, 8-bit (257 wiper steps) digital potentiometers with EEPROM and an SPI compatible interface. The MCP41/42XX family is available with end-to-end resistor values of 5KΩ, 10KΩ, 50kΩ and 100KΩ.

- **MCP4561**: single channel, non-volatile, 8-bit (257 wiper steps) digital potentiometers with EEPROM and an I2C compatible interface.
Tools & Reference Designs
Analog Devices, Inc. is a world leader in high performance Analog and Digital Signal Processing Solutions that offer a broad range of Simulation Models, Reference Designs, Evaluation Hardware & Software, and Circuit Design Tools & Calculators. No matter the design challenge Analog Devices will have the product and industry knowledge to help you overcome it.

**CN0326 – Isolated Low Power pH Monitor with Temperature Compensation**

This circuit is a completely isolated low power pH sensor signal conditioner and digitizer with automatic temperature compensation for high accuracy. The circuit gives 0.5% accurate readings for pH values from 0 to 14 with greater than 14-bits of noise-free code resolution and is suitable for a variety of industrial applications such as chemical, food processing, water, and wastewater analysis.

**CN0357 – Low Noise, Single-Supply, Toxic Gas Detector, Using an Electrochemical Sensor with Programmable Gain TIA for Rapid Prototyping**

This circuit is a single-supply, low noise, portable gas detector, using an electrochemical sensor. The Alphasense CO-AX carbon monoxide sensor is used in this example. Electrochemical sensors offer several advantages for instruments that detect or measure the concentration of many toxic gases. Most sensors are gas specific and have usable resolutions under one part per million (ppm) of gas concentration.

**CN0338 – NDIR Thermopile-Based Gas Sensing Circuit**

This circuit is a complete thermopile-based gas sensor using the nondispersive infrared (NDIR) principle. This circuit is optimized for CO2 sensing, but can also accurately measure the concentration of a large number of gases by using thermopiles with different optical filters. The printed circuit board (PCB) is designed in an Arduino shield form factor and interfaces to the EVAL-ADICUP360 Arduino-compatible platform board. The signal conditioning is implemented with the AD8629 and the ADA4528-1 low noise amplifiers and the ADuCM360 precision analog microcontroller.
CN0312 – Dual-Channel Colorimeter with Programmable Gain Transimpedance Amplifiers and Synchronous Detectors

The circuit provides an efficient solution for many chemical analysis and environmental monitoring instruments used to measure concentrations and characterize materials through absorption spectroscopy. The photodiode receiver conditioning path includes a programmable gain transimpedance amplifier for converting the diode current into a voltage and for allowing analysis of different liquids having wide variations in light absorption.

CN0363 – Dual-Channel Colorimeter with Programmable Gain Transimpedance Amplifiers and Digital Synchronous Detection

This circuit is a dual-channel colorimeter featuring a modulated light source transmitter, programmable gain transimpedance amplifiers on each channel, and a very low noise, 24-bit Σ-Δ analog-to-digital converter (ADC). The output of the ADC connects to a standard FPGA mezzanine card. The FPGA takes the sampled data from the ADC and implements a synchronous detection algorithm. By using modulated light and digital synchronous detection rather than a constant (dc) source, the system strongly rejects any noise sources at frequencies other than the modulation frequency, providing excellent accuracy.

Going Beyond Just the Silicon

Analog Devices is committed to delivering the best performing products in the industry. But even more important ADI is determined to deliver the best design experience possible by offering a variety of free online design services available 24/7. These services include ADI’s award winning suite of online design tools, EngineerZone™ our popular engineering design community and Circuits from the Lab™ Reference Designs for when you need to know it works right the first time.

Circuits from the Lab™ reference designs are built and tested bu ADI engineers with comprehensive documentation and factory-tested evaluation hardware. Visit analog.com/cftl

Engage with the Analog Devices technology experts in our online support community. Ask your tough design questions, browse FAQs or join a conversation. Visit ez.analog.com
To compliment its market-leading timing products portfolio, IDT offers development tools and reference designs used for next-generation development in areas such as 4G infrastructure, network communications, industrial automation, test and measurement, cloud datacenters and power management.

Clock Tree Design Service – Complimentary Design and Review Services
Clock tree design can be a complex task with many considerations that are often overwhelming to designers unfamiliar with clock trees and the associated “language” of timing. While clock tree tools and wizards sometimes exist to assist with simple clock tree designs, these often fall short in real-world applications; automated tools simply can’t address many of the complexities of advanced requirements like phase jitter and spread spectrum.

As the market leader in silicon timing, IDT is the only “one-stop-shop” for timing solutions, offering expertise and products from full-featured system solutions to simple clock building-block devices. Their in-house experts can assist in building a new clock tree from the ground up or evaluating and improving an existing clock tree design.

Reference Designs
Many IDT products are designed to uniquely complement semiconductor partners in their target markets and all IDT products are designed to help customers and partners achieve design success. Here’s a representative sample of IDT reference design solutions with various partners along with IDT industry-leading complementary silicon for customer designs in the application areas shown below.

- **FPGAs:** IDT products reference clocks for Altera and Xilinx FPGAs
- **Handheld / Mobile:** Timing products for NXP i.MX and IDT Atomic* Clocks
- **Server and Client-side Computing:** Clock selector guides for AMD and Intel
- **Switches and PHYs:** IDT Broadcom reference designs
- **System-on-Chip (SoC) and Embedded:** Timing solutions for Cavium processor designs and IDT Atomic* Clocks and timing solutions for NXP Processors
- **Guides:** Wireless infrastructure for RapidIO® and IDT Scheme-it online schematic and block diagramming tool

Documentation & Downloads
IDT has an extensive database of product documentation and downloadable tools including: application notes, package/pinout documents, schematics, simulation models, software, white papers and the IDT Knowledge Base Q&A library.
Intersil’s Reference Design Library contains reference designs, eval boards and demo boards for multiple applications. Reference designs provide supporting technical documentation that includes a user guide, circuit schematic, printed circuit board (PCB) layout, bill-of-materials (BOM) and Gerber files.

**ISL2802xEVKIT1Z Digital Power Monitor Evaluation Kits**
Intersil’s ISL2802x digital power monitor family delivers high accuracy measurements in a wide input common mode voltage range (0V to 60V), providing designers with a high level of safety margin that is often necessary in wired, wireless and data infrastructure applications.

**ISL28022EV1Z Digital Power Monitor 8 Site Evaluation Kit**
The Digital Power Monitor (DPM) 8 site evaluation board demonstrates the functionality and performance of the ISL28022. By design, the ISL28022 is considered a digital helper for a variety of applications ranging from energy optimization to diagnostics of complex systems. The design of the DPM evaluation board is generic such that the customer can embed the monitor into their specific application.

The DPM Evaluation kit is accompanied by a graphical user interface (GUI) that allows the user to configure the ISL28022 for monitoring bus voltage and current in a specific application. The GUI has a data save feature allowing the transfer of measurement data to another software application for analysis.

The ISL28022EV1Z evaluation board has 8 sites/channels with one microcontroller that is responsible for the data transaction and configuration for each DPM. The ISL28022 is a slave to the microcontroller via a single I²C/SMBus interface. The ISL28022 has two address pins that allow for 16 individual DPMs to be connected on a single I²C bus. The evaluation board utilizes 8 of the available 16 addresses of the ISL28022.

**ISL2853xEV2Z, ISL2863xEV2Z – 5V, Rail-Rail I/O, Zero-Drift, Programmable Gain Instrumentation Amplifiers Evaluation Boards**
The ISL2853xEV2Z and ISL2863xEV2Z boards allow simple evaluation of the ISL2853x and ISL2863x 5V zero drift programmable gain instrumentation amplifiers. The boards are designed with all necessary components to easily connect the high performance amplifier to an external signal and can operate from a single supply of +2.5V to +5.5V or dual supply of ±1.25V to ±2.75V.
Microchip provides award-winning development tool solutions to fit multiple Analog applications. Support for your Signal Chain based designs begin with free tutorials and webinars, a full range of documentation, free software downloads and evaluations and 24/7 support center.

**MCP3421EV:**
**Single Channel low-noise, high accuracy 18bit Del-Sig A/D Converter Evaluation Board**
The MCP3421 SOT23-6 Evaluation Board (P/N MCP3421EV) contains a MCP3421 18-bit Delta-Sigma Analog-to-Digital Converter (ADC). The MCP3421 is an 18-bit single channel ADC device with various options including analog input connection pads and VDD, SDA and SCL test pads. Users can connect any sensor input signal to this evaluation board and test the ADC conversion results.

**MCP4728EV:**
**Quad-Channel, 12-bit, non-volatile DAC with EEPROM Evaluation Board**
The MCP4728 Evaluation Board is a tool for quick and easy evaluation of the MCP4728 4-channel 12-bit DAC device with connection pins for the popular PICkit™ Serial Analyzer. Connect the Evaluation Board to the PICkit™ Serial Analyzer and type in the DAC input data into Graphical User Interface program. The PICkit™ Serial Analyzer will then send the user’s data to the DAC device automatically. The new DAC’s analog outputs will be available immediately at the DAC output pins.

**MCP42XXEV:**
**Dual-channel, 8-bit, non-volatile digital potentiometer with EEPROM Evaluation Board**
The MCP42XX Evaluation Board allows quick evaluation of MCP4261 Digital Potentiometer device. The board uses the TSSOP20EV Generic PCB and has been populated for the MCP4261. The 6-pin header (PICkit Serial) has been jumpered to allow the PICkit Serial to communicate with the device. Devices Supported: MCP4231, MCP4241, MCP4251, and MCP4261

**ADM00665:**
**Integrated Thermocouple Electromotive Force (EMF) to Celsius Evaluation Board**
This Evaluation Board is used to digitize the Thermocouple EMF voltage to degree Celsius with +/-1C accuracy. Users can easily evaluate the all device features using a Type K thermocouple. The device also supports Types J, T, N, E, B, S and R. Each of these types are evaluated by replacing the Type K Thermocouple connector with the corresponding connectors (not included). In addition, evaluation board connects to PC via USB interface. Temperature can be data-logged using Microchip Thermal Management Software Graphical User Interface (GUI).
ADM00640: Single, 500 kHz Zero-Drift Instrumentation Amplifier Evaluation Board
This evaluation board is designed to provide an easy and flexible platform when evaluating the performance of the MCP6N16, a Zero-Drift instrumentation amplifier. The evaluation board is populated with the MCP6N16-100, which is optimized for gains of 100V/V or higher. If one of the other gain option models is desired, exchanging the DUT and adjusting the gain setting resistors can easily be accomplished with standard soldering tools.

ADM00615: Two-Channel Temp Sensor with Resistance Error Correction Evaluation Board
This Temp Sensor Evaluation Board demonstrates all of the MCP9902 features, and allows a user to view and modify registers. A user may plot the temperature of the two temperature channels and set alert temperatures associated with those channels. LEDs indicating status information and test points are included to enable system voltages monitoring.

ADM00592: High-Side Current Sensor with Configurable Analog Output Evaluation Board
The PAC1921 is a dedicated power monitoring device with a configurable analog output. This device is unique in that all power related information is available on the 2-wire/I2C© compatible interface and power, current or voltage is available on the analog output.

TMPSNSRD-RTD2: 22-bit, Delta-Sigma A/D with 55 Hz rejection RTD Temp Sensor Evaluation Board
The RTD Reference Design demonstrates the Resistive Temperature Detector (RTD) and accurately measures temperature. This solution uses the MCP3551 22-Bit Analog to Digital Converter (ADC) to measure voltage across the RTD. The ADC and the RTD are referenced using an onboard reference voltage and the ADC inputs are directly connected to the RTD terminals.

TMPSNS-RTD1: Six Channel, Precision PGA RTD Temp Sensor Evaluation Board
The PT100 RTD Evaluation Board demonstrates how to bias a Resistive Temperature Detector (RTD) and accurately measure temperature. Up to two RTDs can be connected. The RTDs are biased using constant current source and the output voltage is scaled using a difference amplifier. In addition to the difference amplifier, a multiple input channel Programmable Gain Amplifier (PGA) MCP6S26 is used to digitally switch between RTDs and increase the scale up to 32 times.

ARD00354: 500 kHz Single INA, and 2 MHz, Single, Zero Drift Amp Wheatstone Bridge Evaluation Board
This board demonstrates the performance of Microchip’s MCP6N11 instrumentation amplifier (INA) and a traditional three op amp INA using Microchip’s MCP6V26 and MCP6V27 auto-zeroed op amps. The input signal comes from an RTD temperature sensor in a Wheatstone bridge. Real world interference is added to the bridge’s output, to provide realistic performance comparisons.
Avnet Signal Chain Solutions Line Card

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<th>Voltage Reference</th>
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## Signal Chain Products

### Amplifiers
- Analog Divider & Multiplier
- Audio Amplifier
- Comparator
- OP Amp
- SP Amplifier
- Sample and Hold
- Video Amplifier

### Discretes
- Bipolar Transistor
- Diode
- IGBT Chip
- IGBT Module
- Thyristor
- Transistor

### Logic and Timing
- Bus Exchange Switch
- Bus Switch
- Controlled Oscillators
- Crystals
- Delay Line
- Digital Synthesizers
- Logic ICs
- Oscillators
- Real Time Clock
- SMD Crystal Oscillator
- TH Crystal Oscillator
- Universal Bus Exchanger

### Power Management
- Battery Management
- Charge Pump
- Current Limit Switch
- DC to DC Controller
- DC to DC Converter
- Feedback Signal Generator
- Hot Swap Controller
- LED Driver ICs
- Linear Regulator
- Low Dropout Controller
- MOSFET and Power Drivers
- Motion Motor Control
- PWM Controllers
- Power Muxes
- Power Switch
- Supervisory Circuits
- USB Power Switch
- Voltage Reference

### Analog Switch Multiplexers

### Data Conversion
- ADC
- DAC
- Data Acquisition System
- Digital Potentiometer
- V2F and F2V

### Interface
- IR Remote Receiver
- IrDA Transceiver
- LVDS
- Termination ICs
Signal Chain Services and Support

Design Chain Solution
Customers large and small can all benefit from working with Avnet engineers through design and production. Technologies are always changing and our engineering teams stay aligned with the trends that customers are integrating into their products. Our broad supplier base and expertise allow customers to have all the options necessary to get the best products to market.

Field Application Engineers (FAEs)
• Component and technology selections
• Developing complex solutions with multiple technologies
• Guide you from design to production

Device Programming & Modifications
• Device Programming
• Customized Power Supply
• Customized Thermal Management

FPGA Design Services
• Code Development and Validation
• Vendor and 3rd Party Tools Training
• Design Workshops with Hands On Labs

Supply Chain Solutions
Our comprehensive supply chain portfolio and global scale provide you with options to maximize your supply chain and keep your products in the market longer, without disrupting production or supplies. In addition, our industry-recognized supply chain experts can help you assess your supply chain health and manage future expansion.

Inventory Management & Warehousing
• In Plant & Out Plant Stores
• Vendor Managed Inventory / Consignment
• Inventory & Order Visibility
• Inventory Replenishment

Risk & Time to Market
• Risk Mitigation
• Assurance of Supply
• Obsolescence Services

Supply Chain Assessment & Planning
• Logistical Analysis – Rapid Benefits Estimation Tool
• Global Solutions