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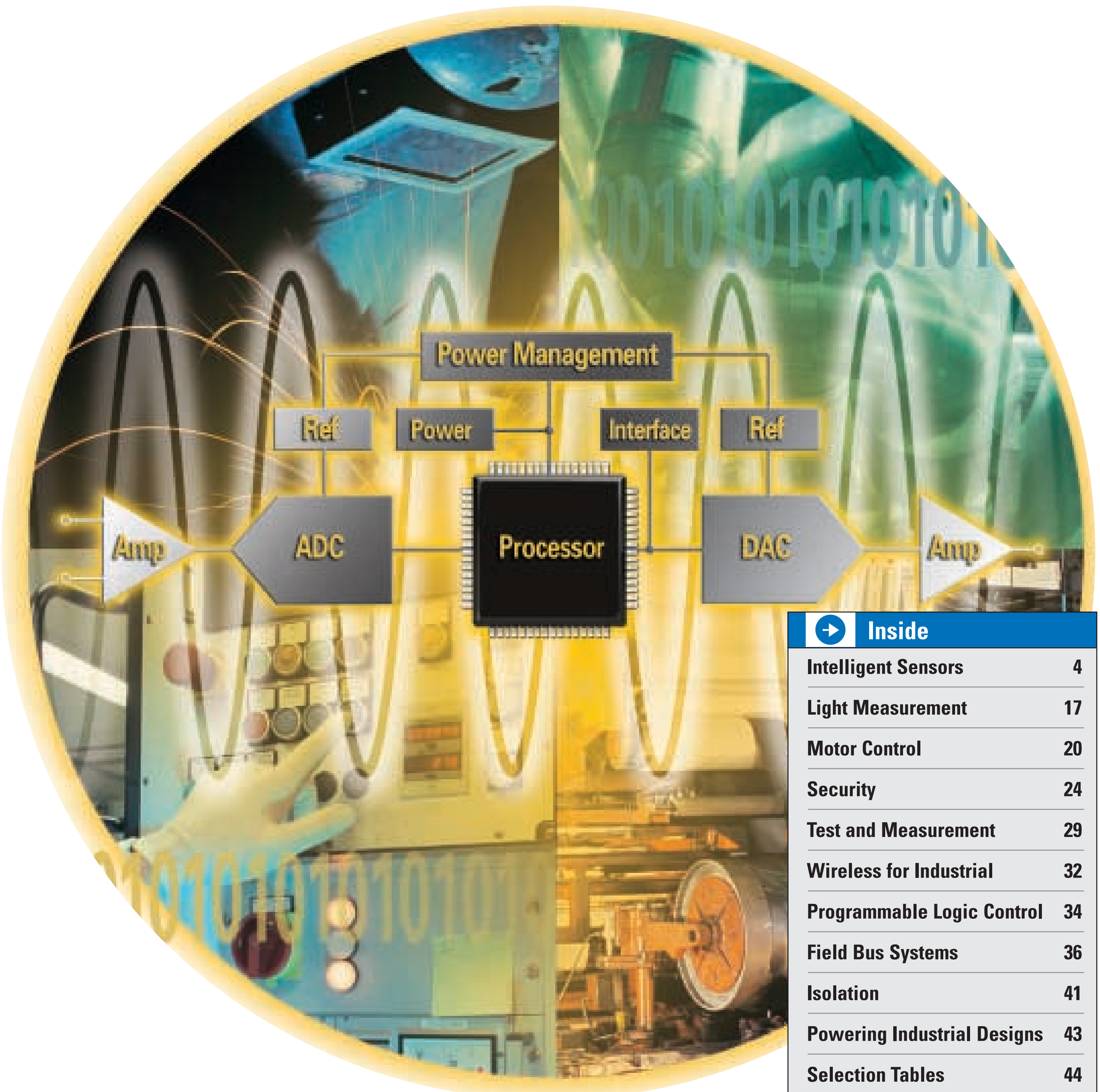
Industrial Solutions Guide

Amplifiers, Data Converters, Digital Signal Processors, Digital Temperature Sensors, Interface, Microcontrollers, Power Controllers, Power Management

1Q 2005



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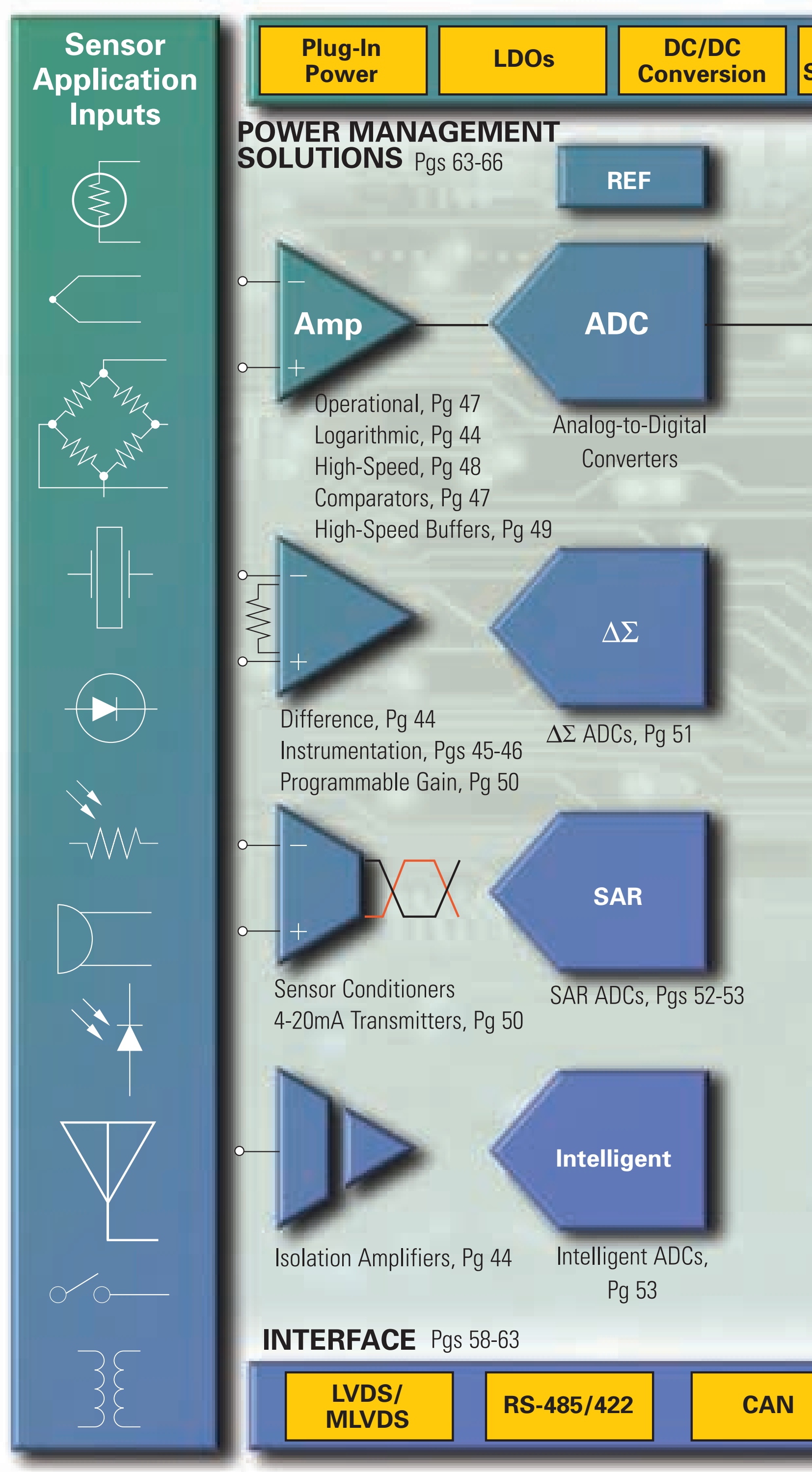
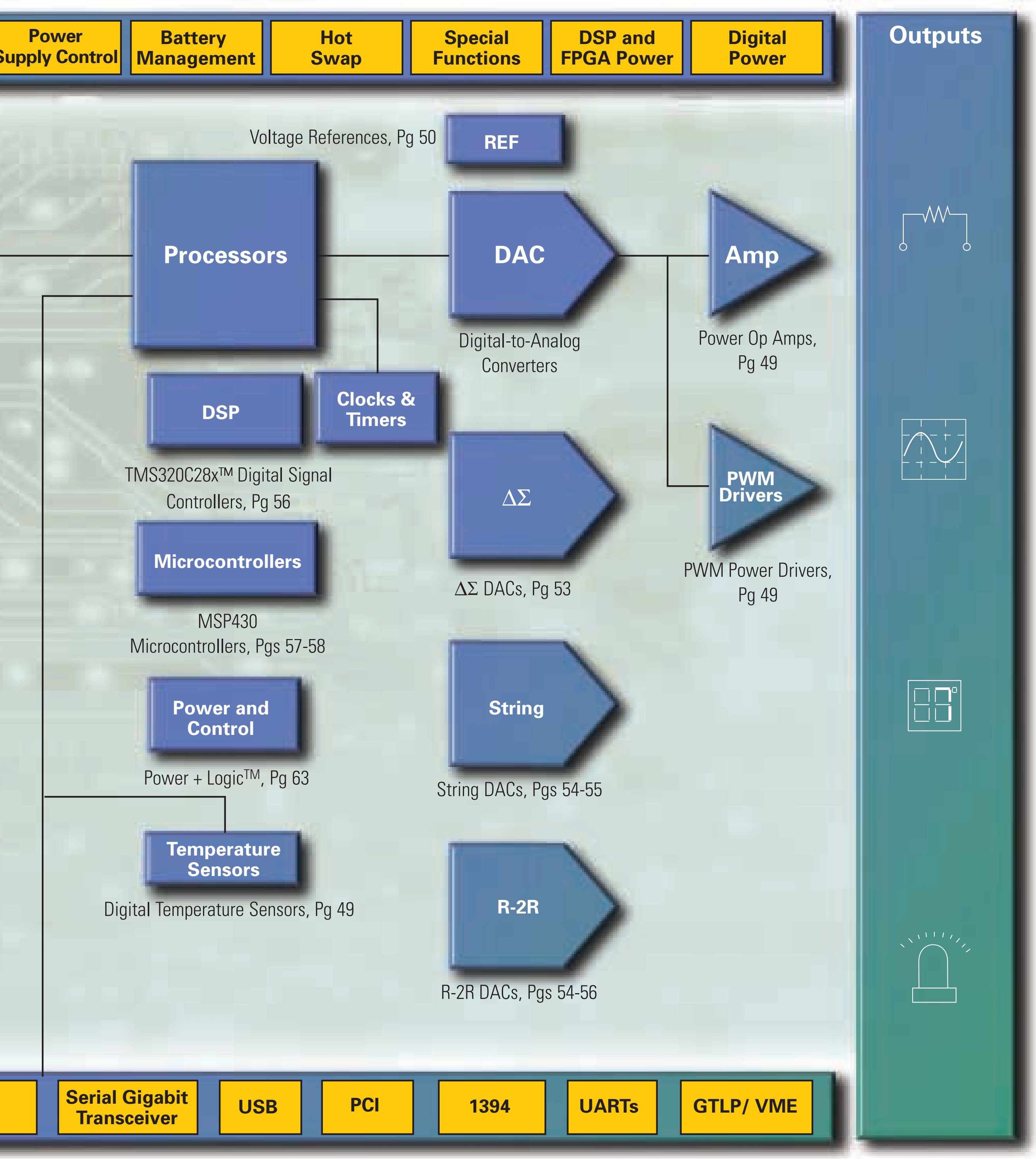


Complete Industrial Solutions from TI



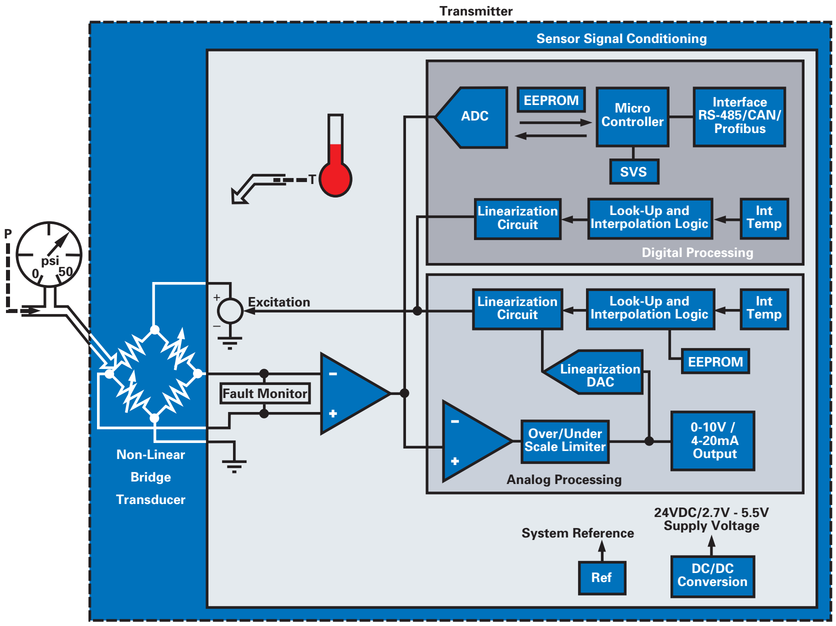
Pressure

Pressure sensors convert a physical value–weight, tire pressure, level, force, and flow–into a differential signal in the mV/V range and are referred to as metal thick-film, ceramic or piezo-resistive. The majority of designers use the cost-effective piezo-sensors (25mbar – 25bar). However, these are very nonlinear, temperature dependent and have large offset and offset drift. Plus, they require attention to electronic calibration and compensation.

The block diagram (at right) shows the functional block diagram of a pressure signal conditioning system.

Sensor Signal Conditioning — performs all necessary functions to calibrate, compensate for temperature variance, scale, and linearize the sensor signal.

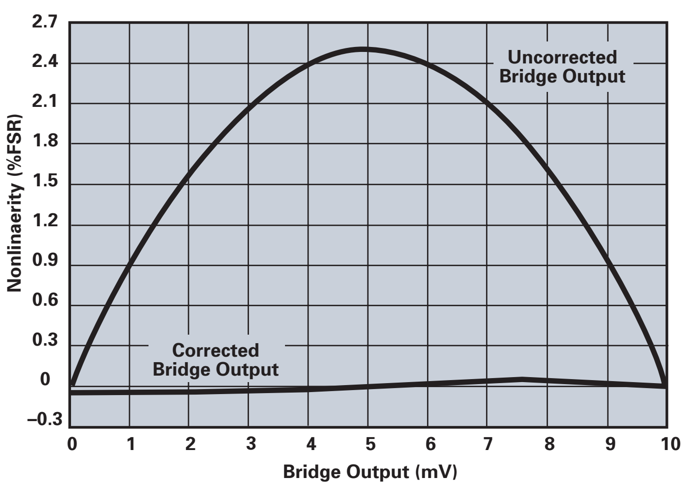
Analog/Digital Processing — there are two ways to convert and linearize the sensor signal. The analog technique results in an analog solution and provides an analog output. This technique is cheap and fast, but limited to a maximum of 11- to 16-bit resolution. Digital is more precise, up to 24 bits, and provides a digital output at moderate speed.



Pressure system functional block diagram

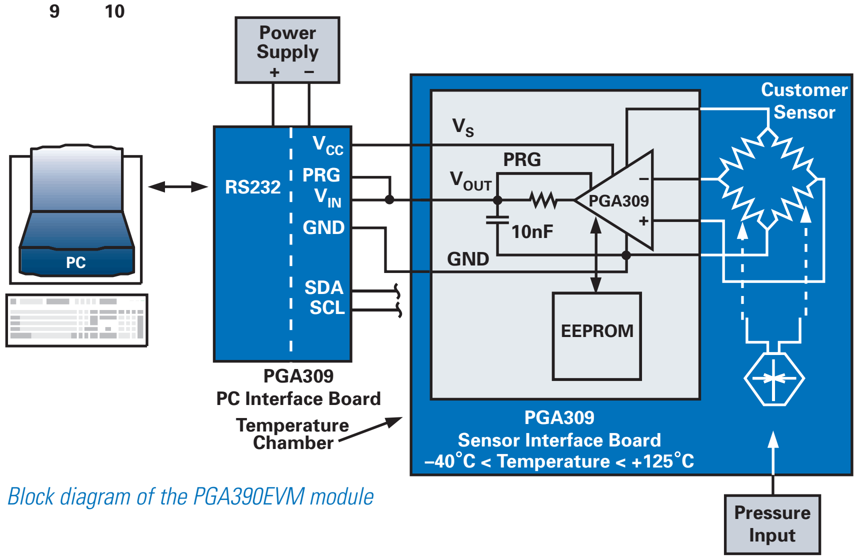
Calibration parameters are stored in an external nonvolatile memory to eliminate manual trimming and achieve long-term stability. An evaluation module, PGA309EVM (see below) includes software and calibration sheet for easy evaluation of your sensor + PGA309 combination.

The highly integrated, CMOS PGA309, available in TSSOP-16, is tailored for bridge pressure sensors and adds to TI's portfolio of highly flexible, lowest noise amplifier and instrumentation amplifier solutions that also include the OPAx227, OPAx132, OPA335, OPA735, INA326, INA327, INA118 and INA122.



PGA309 bridge pressure nonlinearity correction

The bridge excitation linearization circuit is optimized for bridge pressure nonlinearities with a parabolic shape (see above). The linearization circuit is digitally programmable, but the pure analog signal conditioning side is handled by the same process as in TI's well-known 4-20mA transmitters, such as XTR105, XTR106 or XTR108. The heart of the PGA309 is a precision, low-drift programmable gain instrumentation amplifier using an auto-zero technique and includes a programmable fault monitor and over/underscale limiter. It also offers a digital temperature compensation circuit. Calibration is carried out either via a one-wire digital serial interface or through a two-wire industry-standard connection.



Block diagram of the PGA390EVM module

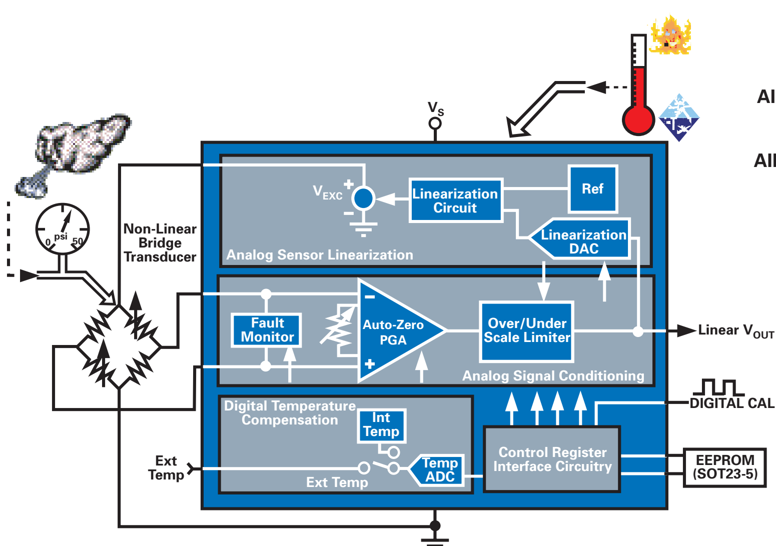
Complete Voltage-Output, Programmable Bridge Sensor Signal Conditioner
PGA309

Get samples, datasheets, EVMs and app reports at:
www.ti.com/sc/device/PGA309

Real-world sensors have span and offset errors, ever changing over temperature. In addition, many bridge pressure sensors have a nonlinear output with applied pressure. The sensor conditioner, PGA309 is an ideal choice in combination with low-cost piezo resistive or ceramic thin-film pressure sensors.

Key Features
- Ratiometric or absolute voltage output
- Digitally calibrated via single-wire or two-wire interface
- Eliminates potentiometer and trimming
- Low, time-stable total adjusted error
- +2.7V to +5.5V operation
- Packaging: small TSSOP-16

Applications
- Bridge sensors
- Remote 4-20mA transmitters
- Strain, load, weight scales
- Automotive sensors



PGA309 functional block diagram

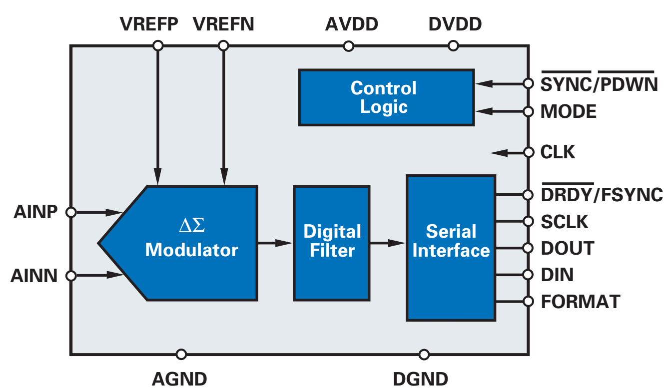
24-Bit, ΔΣ ADC with Excellent AC and DC Performance
ADS1271

Get samples, datasheets, EVMs and app reports at: **www.ti.com/ADS1271**

The ADS1271 is a 24-bit, delta-sigma ADC with up to 105kSPS data rate. It offers the unique combination of excellent DC accuracy and outstanding AC performance. The high-order, chopper-stabilized modulator achieves very low drift with low in-band noise. The onboard decimation filter suppresses modulator and signal out-of-band noise. The ADS1271 provides a usable signal bandwidth up to 90% of the Nyquist rate with only 0.005dB of ripple.

Key Features
- AC performance: 109dB SNR (52kSPS); 105dB THD
- DC accuracy: 1.8mV/°C offset drift; 2ppm/°C gain drift
- High resolution: 109dB SNR
- Low power: 40mW dissipation

Applications
- Ideal for vibration/modal analysis, acoustics, dynamic strain gauges and pressure sensors



ADS1271 functional block diagram

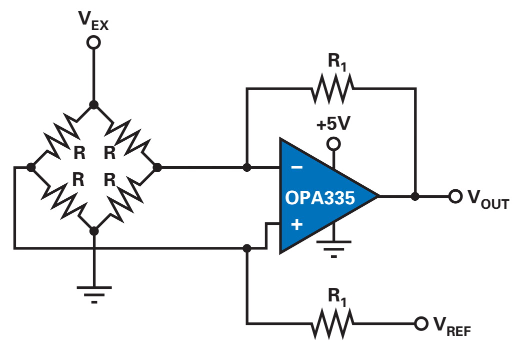
Pressure

Zero-Drift, Low Offset, Single-Supply Op Amps
OPA334/OPA335

Get samples, datasheets, EVMs and app reports at:
www.ti.com/sc/device/OPA334, www.ti.com/sc/device/OPA335

The OPA334 and OPA335 CMOS op amps use auto-zeroing techniques to simultaneously provide very low offset voltage and near-zero drift over time and temperature. These high-precision amps offer high input impedance and rail-to-rail output swing.

Key Features
- Low offset voltage: 5µV (max)
- Zero drift: 0.05µV/°C (max)
- Quiescent current: 285µA
- Packaging: SOT23-5, SOT23-6, SO-8, MSOP-10 (dual)



OPA335 –5V supply bridge amplifier

Device Recommendations

Device	Description	Key Features	Benefits	Other TI Solutions
Power Management Products				
DCP12405	1W/5V DC/DC converter	Miniature 24V DC/DC converter with 1500V galvanic isolation, integrated 5V LDO	Fully integrated DC/DC converter in a miniature package, high isolation and regulated output, smallest height in the industry	TPS54xx SWIFT™ family, highest efficiency DC/DC converter w/integrated FET
TPS71501	LDO: 24V/1.2V – 15V	Adjustable LDO, ultra-low quiescent current 3.5µA to 50mA	Excellent for low-power applications up to 1.2V	LM317, lowest cost LDO with 37V input
Data Converters				
ADS1256	24-bit ADC	24-bit ADC, filters, PGA, digital I/O, sensor excitation, GP I/Os	Highest resolution (25.4-bit ENOB) and lowest input reference noise in the industry – up to 30kSPS	ADS1218, core of MSC121x family with additional Flash
MSC121x	8051-based MCU with ADS1218 ΔΣ converter including Flash memory	24-bit ADC, filters, PGA, digital I/O, sensor excitation, burn-out current sources, offset DACs, 4 x 16-bit DACs, temperature sensor	Lowest noise and highest integration in the market, includes all necessary external circuitry — all-in-one solution	MSC1200, low-cost version without DACs
ADS1271	24-bit, 105kSPS ADC	Low offset drift: <1µV/°C, passband ripple <±0.005dB, THD <–109dB	24-bit ADC with DC accuracy plus AC performance at highest speed up to 105kSPS	PCM4202, PCM4204
References				
REF3125/30/33/40	References	Small package, high initial accuracy, low drift	15ppm/°C stable reference for precise data conversion	REF30xx with max. 50ppm/°C drift
Amplifiers				
OPA335	Zero-drift op amp	CMOS 0.05µV/°C drift, 5µV offset, RRIO at 3.3VDC, single supply	Best long-term stability for industrial use, single supply, best in class, automotive temp range	OPA735, 12V version with improved noise and drift
INA326	High-precision instrumentation amp	Single supply 30nV/√Hz noise, RRIO, CMOS	Lowest noise in the industry and best long-term stability, no need for dual supply	INA337, automotive temp range, –40°C to +125°C
XTR115	4-20mA transmitter including sensor excitation	Includes all functions to generate 4-20mA output signal and bridge excitation	Lowest cost all-in-one solution (<$1) up to 36V supply voltage, no need for DC/DC converter	XTR110 is intended for 3-wire output
PGA309	Programmable pressure sensor conditioner	Includes sensor excitation, linearization and temperature-compensated conditioning, ADC, DAC, temp sensor	Fully integrated sensor conditioning system on a chip (SOC), small package, only 16-bit ASSP on the market	XTR108, similar but is targeted for PT100, temp sensors included, 4-20mA transceiver
TMP121	Digital temp sensor	Integrated temp sensor, ΔΣ ADC and SPI interface to convert valve temp into digital code	High resolution and accuracy, extended industrial temperature range, SOT-23 package	TMP175 (SMB-bus interface)
Interface				
SN65HVD1176	PROFIBUS transceiver	Interfaces PROFIBUS fieldbus to system controller	Optimized for PROFIBUS, up to 160 users per bus, up to 40Mbps, benchmarked by Siemans as reference device	SN65HVD485E, low-cost version
SN65HVD251	CAN-bus transceiver	Interfaces CAN fieldbus to system controller	Improved drop-in replacement for PCA82C251, tolerates ±200V transients	SNHVD233 (3.3V version)
Processor				
MSP430F1121	18-bit MCU with Flash	Low-power MCU, lowest power in industry, 6µs wake-up	Reduces heat in sensor system, reduces cost of power source and increases lifetime	MSP430Cxx without Flash , even lower power

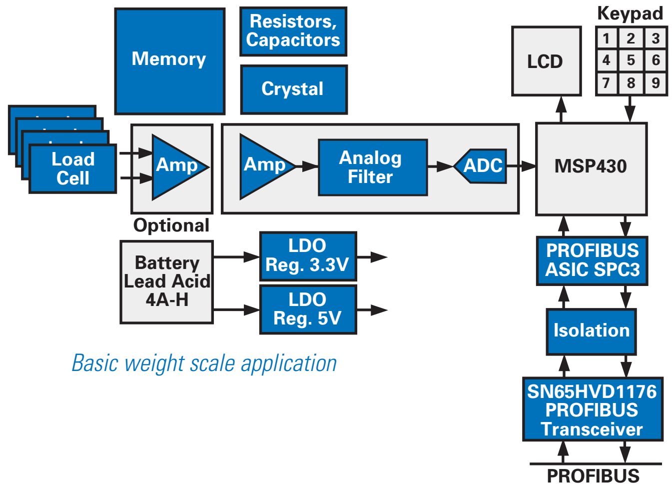
Weight Scales

Electronic weight scales are found in many industrial applications in some shape or form and are ubiquitous in today's food industry. Manufacturers of electronic weight scales traditionally choose proprietary ASICs to tailor the performance of their analog front end for highest accuracy and stability. The diagram at right shows an approach using standard products offering up to 25.4 effective number of bits (ENOB) or 23 noise-free bits of resolution.

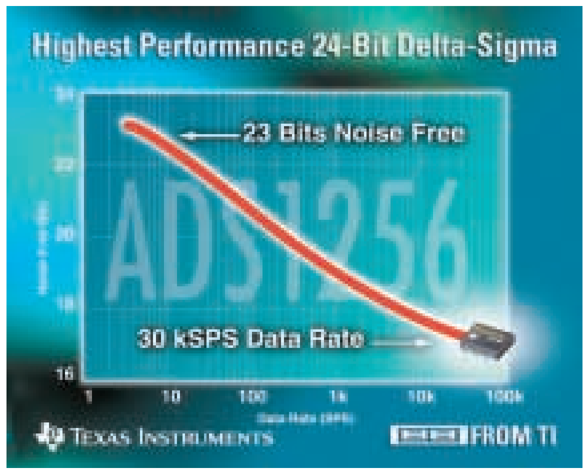
A major challenge in designing weight scales is the sampling of multiple load cells while offering extremely low input referred noise (RTI). The ADS1256 and ADS1232 guarantee input referred noise of 30nV/√Hz and 50nV/√Hz, respectively, and at the lowest cost. Another important factor is the analog circuitry's long-term stability with regard to offset drift and gain. Here the accuracy of the amplified input signal, either single-ended or differential, must be guaranteed over years of operation. Auto-zero amplifiers, such as the OPA335 and the INA326 instrumentation amplifier, meet these stringent requirements by achieving offset drifts of 0.05μV/°C (OPA335) and 0.4μV/°C (INA326).

For an easy-to-use solution, the MSC1210 family offers a complete data acquisition system on a chip comprised of:

- An optimized 8051 core, (3-times faster than standard version at same power)
- A 24-bit, ΔΣ ADC with 22 ENOBs, and 75nV/√Hz (RTI)
- A PGA with gain steps from 0 – 128
- 2kB Boot ROM and up to 32kB Flash memory



Basic weight scale application

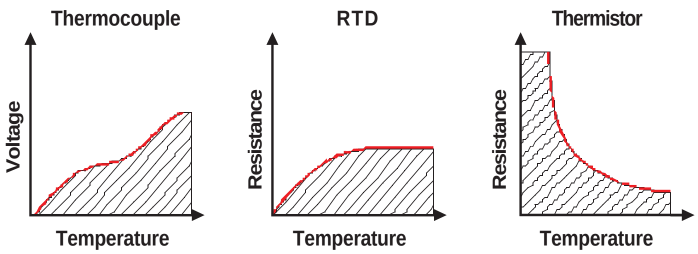


Device Recommendations

Device	Description	Key Features	Benefits	Other TI Solutions
Power Management Products				
TPS76301	Low-power 150-mA, low-dropout (LDO) linear regulator	Regulates 6V to 3.3V and 5V	Small package	TPS76333
Amplifiers				
OPA335	Zero drift op amp	0.05μV/°C drift, 5μV offset, RRIO at 3.3VDC single supply	Best long-term stability for industrial use, no need for dual supply, best in class, automotive temp range	OPA735, 12V version of OPA335
INA326	High-precision instrumentation amp	30nV/√Hz noise, RRIO, single supply	Lowest noise in industry and best long-term stability, no need for dual supply	INA337, automotive temp range –40°C to +125°C
Data Converters				
ADS1256	24-bit, 30kSPS ΔΣ ADC w/ multiplexer	Very low noise, 24-bit resolution, input reference noise 30nV	Integrated, small package, easy to use	MSC1210
ADS1232	24-bit, 240SPS cost-effective ΔΣ ADC	Very low noise 24-bit resolution, input reference noise, cont. time PGA	Best price/performance ratio for weight scale applications	ADS1243
Interface				
SN65HVD1176	PROFIBUS RS-485	Optimized for PROFIBUS, 2.1V min., V_{OD} low bus cap.	Improved signal fidelity and enhanced transmission reliability	SN65HVD05
SN65HVD251	CAN-bus transceiver	Interfaces CAN fieldbus to system controller	Improved drop-in replacement for PCA82C251, tolerates ±200V transients	SNHVD233
Processor				
MSP430F413	MSP430	16-bit ultra-low-power microcontroller, 8kB Flash, 256 RAM, comparator, 96 segment LCD	Low-power, integrated LCD driver and flash	MSP430F417

Temperature

Temperature is the most frequently measured physical parameter and can be measured using a diverse array of sensors. All of them infer temperature by sensing some change in a physical characteristic. Three of the most common types are Thermocouples, Resistance Temperature Detectors (RTDs), and NTC-Thermistors.



Common types of thermocouples, RTDs and NTC-thermistors

Thermocouples consist of two dissimilar metal wires welded together to form two junctions. Temperature differences between the junctions cause a thermoelectric potential (i.e. a voltage) between the two wires. By holding the reference junction at a known temperature and measuring this voltage, the temperature of the sensing junction can be deduced. Thermocouples have very large operating temperature ranges and the advantage of very small size. However, they have the disadvantages of small output voltages, noise susceptibility from the wire loop, and relatively high drift.

Resistance Temperature Detectors (RTDs) are wire winding or thin-film serpentines that exhibit changes in resistance with changes in temperature. While metals such as copper, nickel and nickel-iron are often used, the most linear, repeatable and stable RTDs are constructed from platinum. Platinum RTDs, due to their linearity and unmatched long-term stability, are firmly established as the international temperature reference transfer standard. Thin-film platinum RTDs offer performance matching for all but reference grade wire-wounds at improved cost, size and convenience. Early thin-film platinum RTDs suffered from drift, because their higher surface-to-volume ratio made them more sensitive to contamination. Improved film isolation and packaging have since eliminated these problems making thin-film platinum RTDs the first choice over wire-wounds and NTC thermistors.

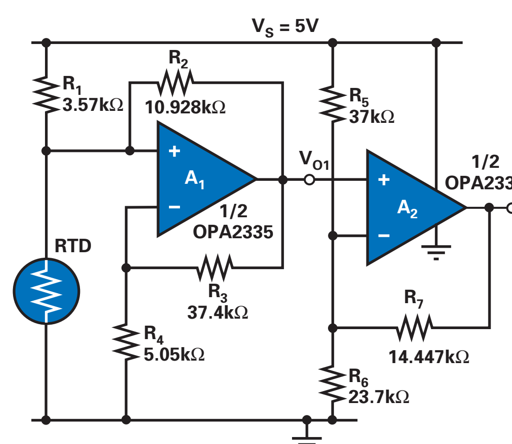
NTC Thermistors are composed of metal oxide ceramics, are low cost, and the most sensitive temperature sensors. They are also the most nonlinear and have a negative temperature coefficient. Thermistors are offered in a wide variety of sizes, base resistance values, and Resistance vs. Temperature (R-T) curves are available to facilitate both packaging and output linearization schemes. Often two thermistors are combined to achieve a more linear output. Common thermistors have interchangeabilities of 10% to 20%. Tight 1% interchangeabilities are available but at costs often higher than platinum RTDs. Common thermistors exhibit good resistance stability when operated within restricted temperature ranges and moderate stability (2%/1000 hr at 125°C) when operated at wider ranges.

Comparison of Temperature Sensor Attributes

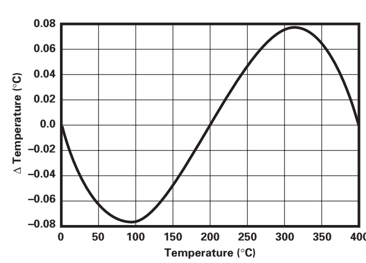
Criteria	Thermocouple	RTD	Thermistor
Cost-OEM quality	Low	High	Low
Temperature range	Very wide –450°F to +4200°F	Wide –400°F to +1200°F	Short to medium –100°F to +500°F
Interchangeability	Good	Excellent	Poor to fair
Long-term stability	Poor to fair	Good	Poor
Accuracy	Medium	High	Medium
Repeatability	Poor to fair	Excellent	Fair to good
Sensitivity (output)	Low	Medium	Very high
Response	Medium to fast	Medium	Medium to fast
Linearity	Fair	Good	Poor
Self heating	No	Very low to low	High
Point (end) sensitive	Excellent	Fair	Good
Lead effect	High	Medium	Low
Size/packaging	Small to large	Medium to small	Small to medium

Low-Cost PT100 Linearization Circuit for 0°C to 400°C

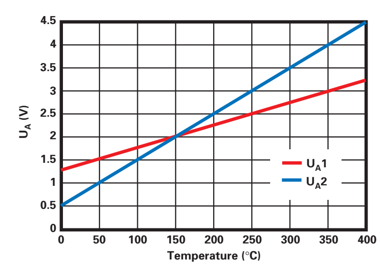
A low-cost RTD measurement circuit with linearization is achieved with just one dual operational amplifier, OPA2335, and seven resistors. The first stage linearizes a PT100 sensor over a temperature range from 0°C to 400°C, yielding a maximum temperature error of ±0.08°C. R_1 defines the initial excitation current of the RTD. R_3 and R_4 set the gain of the linearization stage to ensure the input of A_1 stays within its common-mode range. Rising temperature increases V_{01}. A fraction of V_{01} is fed back to the input via R_2 for linearization. Resistors, R_1 – R_4, are calculated so that the maximum excitation current through the RTD is close to 100Ω to avoid measurement errors through self-heating.



OPA2335 PT100 linearization circuit



Δ temp vs. temp



U_A vs. temp

The second stage performs offset and gain adjustment. Here the linear slope of V_{01} is readjusted to provide a V_{02} slope of 10mV/°C within an output range of 0.5V to 4.5V.

Temperature Measurement of a Remote 3-Wire RTD via a 4-20mA Current Loop

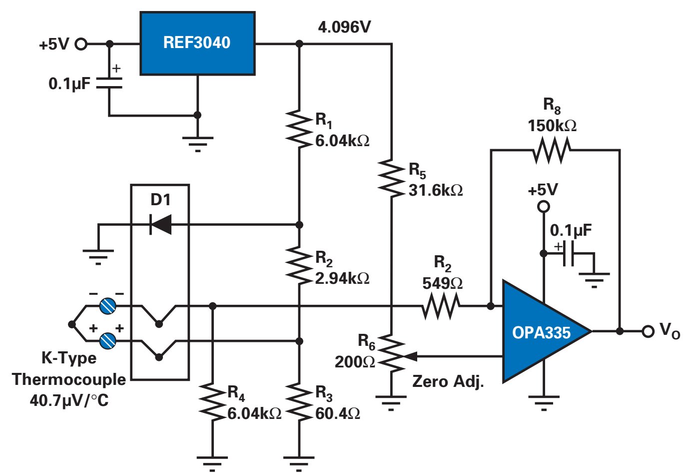
This circuit measures the temperature of a remote 3-wire RTD using the 4-20mA current transmitter, XTR112. The device provides two matched current sources for RTD excitation and line-resistance compensation. Internal linearization circuitry provides 2nd-order correction to the RTD, thus achieving a 40:1 improvement in linearity. I_{R1} is the excitation for the RTD. I_{R2} is the compensation current flowing through R_Z and R_{LINE1}. By choosing the value of R_Z to be equal to the RTD resistance at minimum temperature, the internal instrumentation amplifier (INA) only measures the temperature dependent difference in RTD resistance.

R_{CM} is used to provide an additional voltage drop to bias the inputs of the XTR112 within the common-mode input range. The 0.01µF bypass capacitor minimizes common-mode noise. R_G sets the gain of the INA. For 2nd-order linearization, a fraction of the INA output voltage is fed back via the resistors, R_{LIN1} and R_{LIN2}. Internally, the output voltage is converted into a current and then added to the return current, I_{RET}, to yield an output current of $I_O = 4mA + V_{IN} \bullet 40/R_G$.

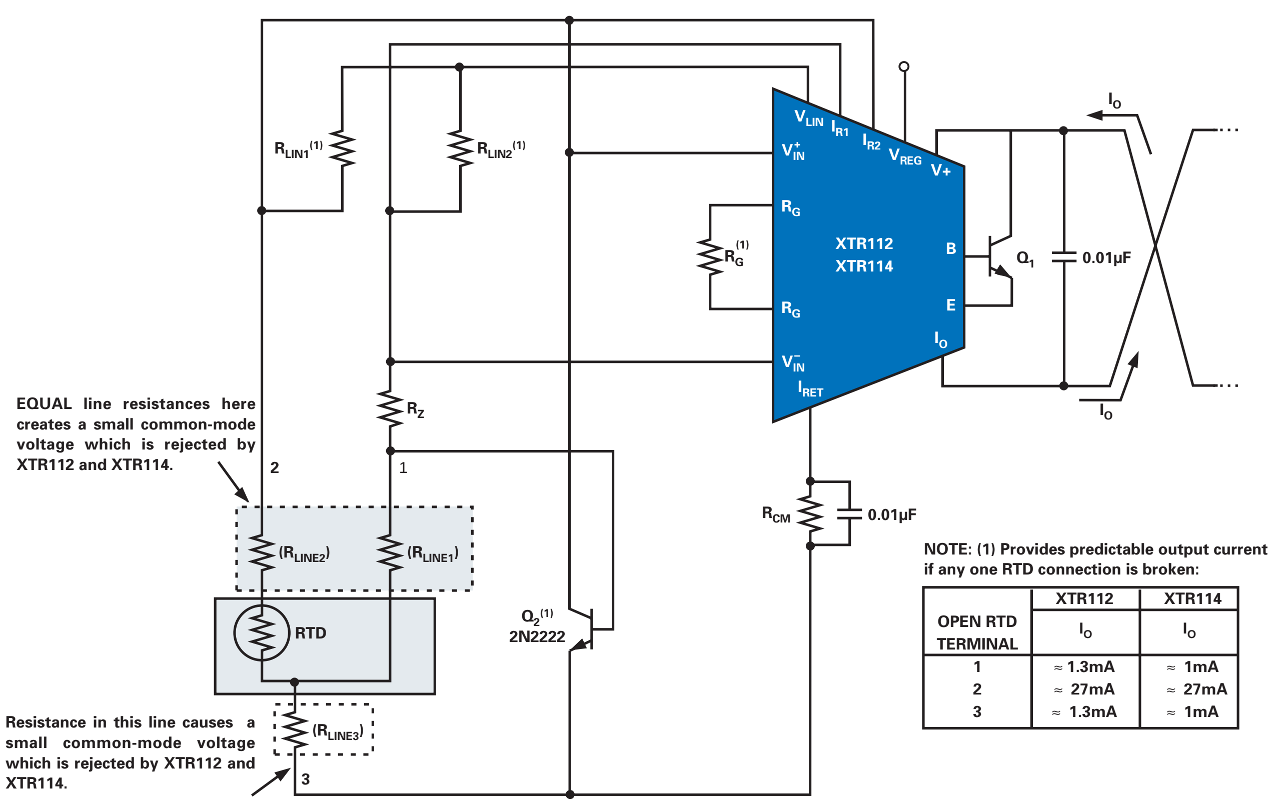
On the current-loop side, transistor, Q_1, conducts the majority of the signal-dependent 4-20mA loop current. This isolates most of the power dissipation from the internal precision circuitry of the XTR112, maintaining excellent accuracy. For detailed information on the calculation of the resistor values for various temperature ranges, refer to the XTR112 data sheet.

Temperature Measurement with a K-Type Thermocouple Using Wired Cold-Junction Compensation (CJC)

This thermocouple measurement circuit uses the auto-zero, single-supply amplifier, OPA335. A precision voltage reference, REF3040, provides the 4.096V bridge supply. The forward voltage of diode, D_1, has a negative temperature coefficient of –2mV/°C, and provides the cold-junction compensation via the resistor network R_1 to R_3. The zero-



OPA335 temperature measurement circuit



OPEN RTD TERMINAL	XTR112 I_O	XTR114 I_O
1	≈ 1.3mA	≈ 1mA
2	≈ 27mA	≈ 27mA
3	≈ 1.3mA	≈ 1mA

Temperature measurement of a remotely located RTD

Temperature

adjustment for a defined minimum temperature is achieved via R_6, while R_7 and R_8 set the gain for the output amplifier. The OPA335 provides a high DC open-loop gain of A_{OL} = 130dB, allowing 16-bit+ accuracy at high gain in low-voltage applications. The auto-zero operation removes the 1/f noise and provides an initial offset of 5µV (max) as well as an extremely low offset drift over temperature of 0.05µV/°C (max). Thus the OPA335 ideally suits single-supply, precision applications where high accuracy, low drift and low noise are imperative.

Autonomous Temperature Measurement System for Multiple Thermocouples Using MSC1200

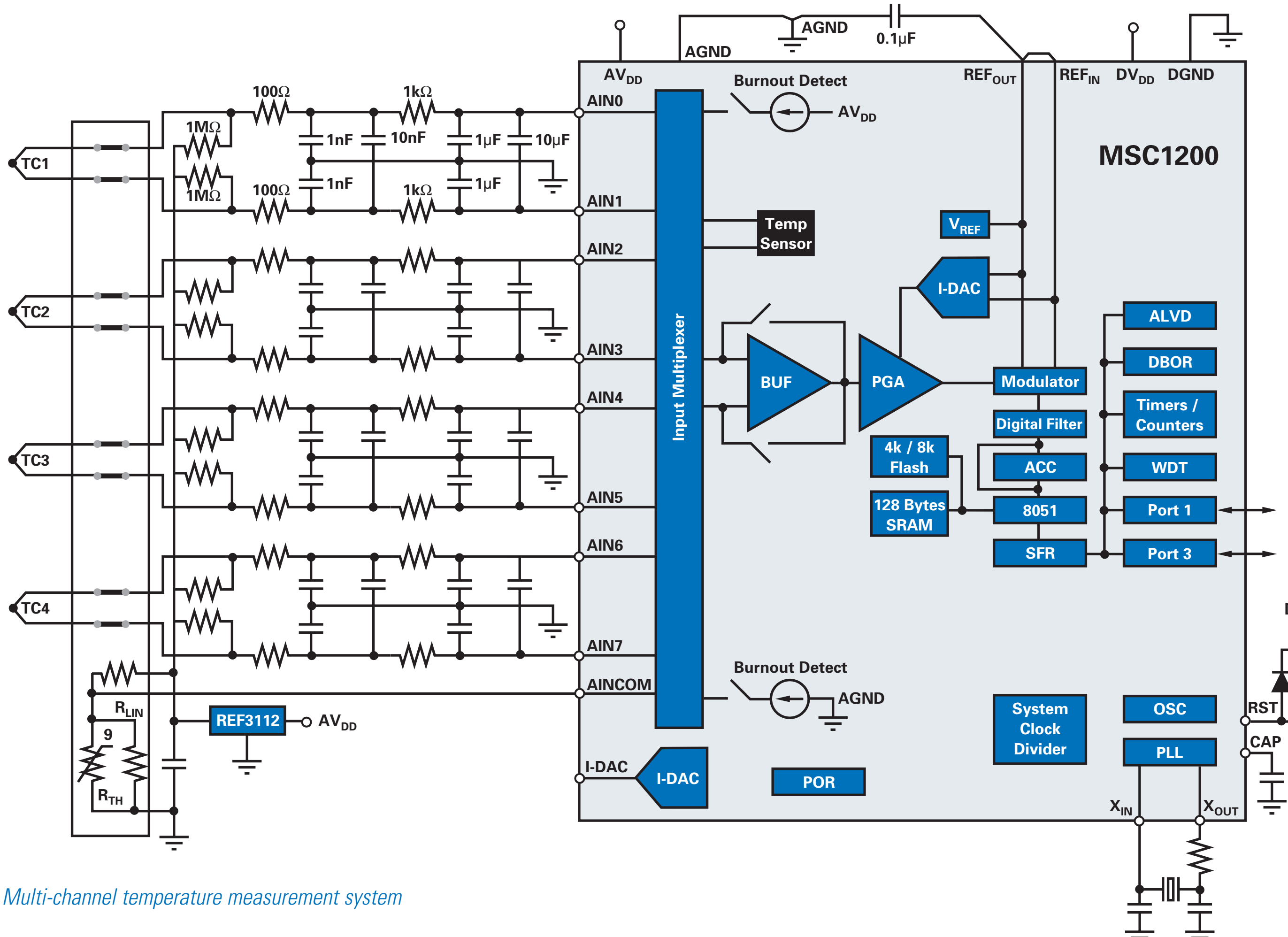
This temperature measurement system measures the differential output voltage of four different types of thermocouples, (T_{C1}–T_{C4}), and one reference temperature using the mixed-signal controller, MSC1200. The MSC1200 incorporates a ΔΣ ADC with 22-bits of effective resolution, with a versatile input multiplexer, a selectable input buffer, and a programmable gain amplifier (PGA) with gain adjustments from 1 to 128. The device includes on-chip Flash and SRAM memory and an improved 8051-CPU, running 3-times faster than the initial standard version at the same power consumption. An on-chip current digital-to-analog converter, (I-DAC), provides excitation current to the RTDs and thermistors.

Integrated Current Sources Allow for Sensor Burn-Out Detection

In the case of remotely located thermocouples, input RC low-pass filters remove differential and common-mode noise, which might have been picked up by the thermocouple leads running through a noisy environment. For the various types of thermocouples, different PGA settings may be required to reduce the analog input impedance. Low input impedance can cause compensation current to flow through a thermocouple. These currents disturb electron density (which the Seebeck effect is based on) thus generating wrong thermo-EMF readings at the thermocouple output. To provide consistently high input impedance of some GW, the input buffer must be enabled. This however reduces the input common-mode range to 50mV above analog ground and 1.5V below the positive analog supply. To ensure that the thermocouple signals are within that range, each input is biased via a 10k to 100kΩ resistor. The bias voltage is provided by the precision voltage reference circuit, REF3112, which has an initial error of 0.2% and a temperature drift of 15ppm/°C.

Cold-Junction Compensation

Cold-junction compensation (CJC) is performed by reading the output voltage across a linearized thermistor circuit via A_{INCOM}.



Multi-channel temperature measurement system

The versatility of the input mux allows assigning the positive and negative inputs of the buffer to any of the analog input pins. Thus, to measure the reference temperature differentially, one buffer input is connected to A_{INCOM}, while the other input is connected to the "low-end" input of any of the thermocouples (A_{IN}1, 3, 5 or 7). However, once an input has been selected, all subsequent differential measurements of the reference temperature should be made against the same "low-end" input. If the MSC1200 is close to the isothermal block, and based on the required accuracy, the on-chip temperature sensor could be used for CJC.

Constant Temperature Control for Thermoelectric Coolers with INA330

The INA330 is a precision amplifier designed for thermoelectric cooler (TEC) control in optical networking and medical analysis applications. It is optimized for use in 10kΩ thermistor-based temperature controllers. The INA330 provides thermistor excitation and generates an output voltage proportional to the difference in resistances applied to the inputs. It uses only one precision resistor plus the thermistor, thus providing an alternative to the traditional bridge circuit. This new topology eliminates the need for two precision resistors while maintaining excellent accuracy for temperature control applications. The INA330 offers excellent long-term stability, and very low 1/f noise throughout the life of the product. The low offset results in a 0.009°C temperature error from –40°C to +85°C.

An excitation voltage applied to the inputs, V_1 and V_2, creates the currents, I_1 and I_2, flowing through the thermistor (R_{THERM}) and the precision resistor (R_{SET}). An on-chip current-conveyor circuit produces the output current, $I_O = I_1 - I_2$. The output current, flowing through the external gain-setting resistor (R_G) is buffered internally and appears at the V_O pin. Any bias voltage applied to the other side of R_G adds to the output voltage, so that $V_O = I_O \cdot R_G + V_{ADJUST}$. This output voltage feeds a PID controller, which provides the input voltage to a TEC driver in bridge-tied-load configuration. The two operational amplifiers (OPA569) are CMOS, single-supply power amplifiers capable of driving load currents of up to 2A at 3V supply.

In this application, the temperature to be controlled is set by the DAC. If the temperature of the TEC rises above the set temperature, TEC current flows in one direction for cooling. If the temperature falls below the set-point, the current direction is reversed and the TEC heats. The dotted line indicates closed-loop thermal feedback from the TEC to the thermistor, which it is mechanically mounted to, but electrically isolated from.

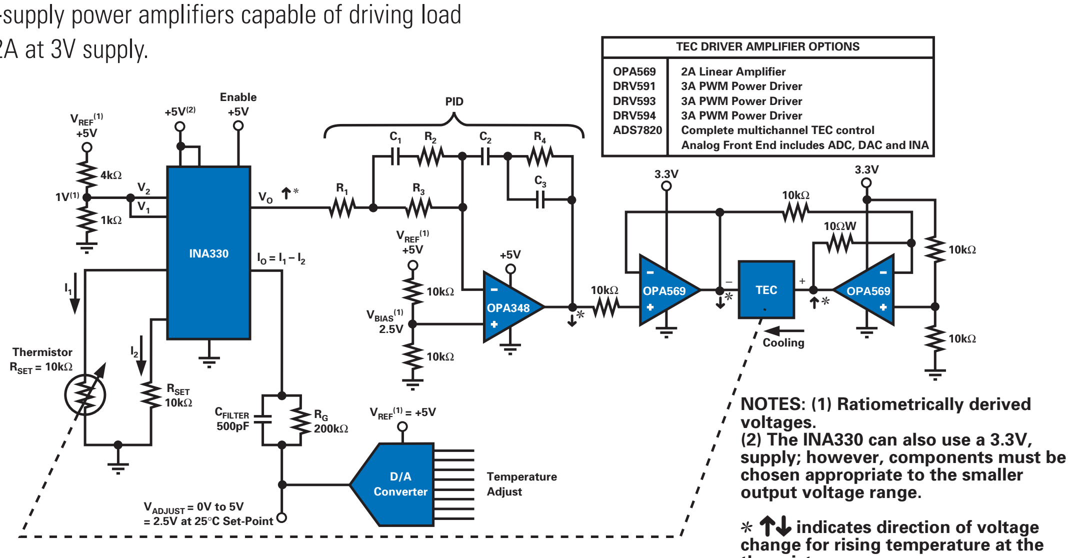
Constant Temperature Control for Thermoelectric Coolers with INA326

The INA326 is a high-performance, low-cost, precision instrumentation amplifier with rail-to-rail input and output. It's a true single-supply instrumentation amplifier with very low DC errors and input common-mode ranges that extend beyond the positive and negative rail. These features make it suitable for general-purpose to high-accuracy applications.

Excellent long-term stability and very low 1/f noise assure low offset voltage and drift. The INA326 is a two-stage amplifier with each gain stage set by R_1 and R_2, respectively. Overall gain is described by the equation: $G = 2 \cdot R_2 / R_1$.

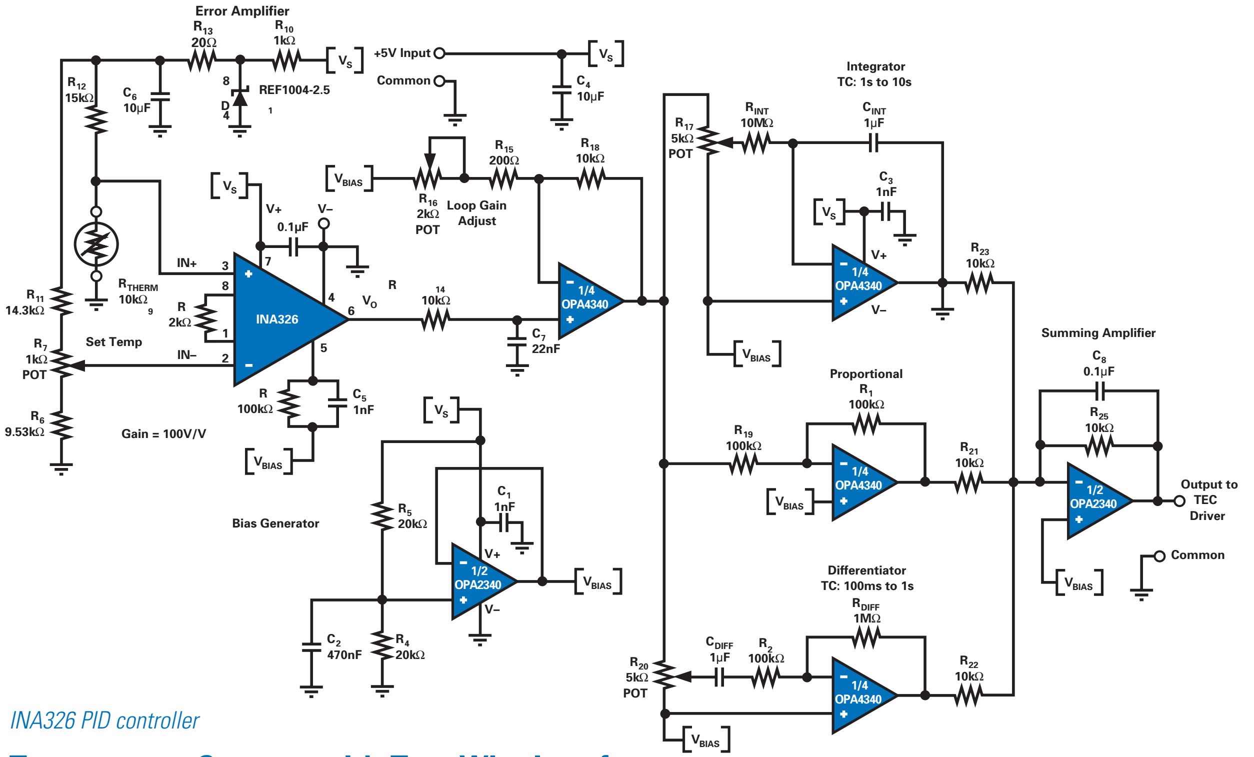
The INA326 measures the difference between the voltage of the temperature set-point (R_7), and the voltage across the thermistor (R_{THERM}). The differential input voltage is amplified by a factor of 100 ($G = 2 \cdot 100k\Omega / 2k\Omega$) and fed, via an RC-lowpass filter into the PID controller. R_{14}, C_7 is an output filter that minimizes auto-correction circuitry noise.

The PID controller shown uses separate adjustment stages, allowing for optimized adjustment of controller parameters to the closed-loop system. Once these parameters have been determined, the existing circuitry consisting of five op amps for PID, summing and loop-gain adjustment can be converted into a single amplifier PID controller.



INA330 in TEC application

Temperature



INA326 PID controller

Digital Temperature Sensors with Two-Wire Interface

TMP75/TMP175

Get samples, datasheets and app reports at:

www.ti.com/sc/device/TMP75, www.ti.com/sc/device/TMP175

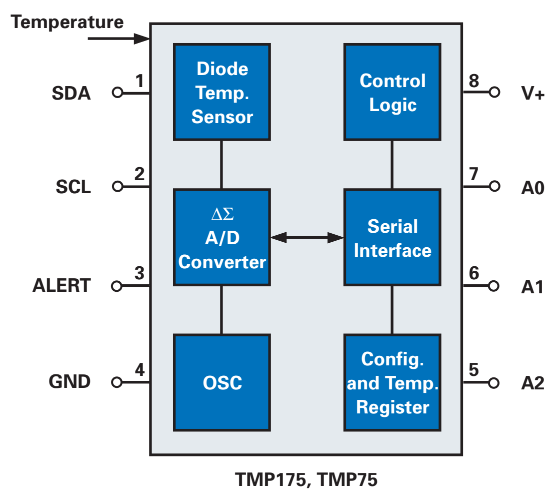
The TMP75 and TMP175 are two-wire, serial output temperature sensors. The devices require no external components and are capable of reading temperatures with a resolution of 0.0625°C. The two-wire interface is SMBus compatible, which allows the TMP175 to have up to 27 devices on one bus and the TMP75 eight devices. Both feature SMBus alert functions and are ideal for extended temperature measurements found in industrial environments.

Key Features

- 27 addresses (TMP175)
- 8 addresses (TMP75)
- Digital output: two-wire serial interface
- Resolution: 9- to 12-bits, user selectable
- Accuracy:
  ±1.5°C (max) from –25°C to +85°C
  ±2.0°C (max) from –40°C to +125°C
- Low quiescent current: 50µA, 0.1µA standby
- Wide supply range: 2.7V to 5.5V
- Packaging: SO-8

Applications

- Power-supply temperature monitoring
- Computer peripheral thermal protection
- Thermostat controls
- Environmental monitoring and HVAC



TMP75/175 functional block diagram

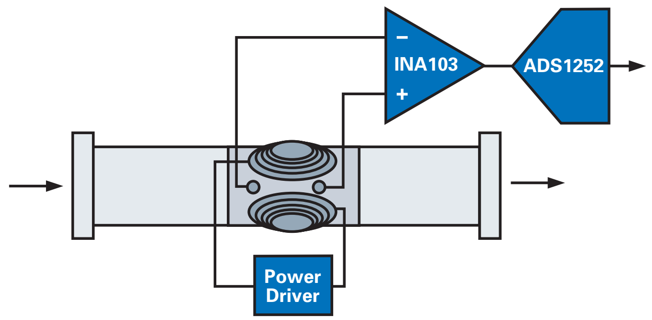
Flow Metering

The application requirements of flow measurement in industrial settings varies from low cost to very high precision and fast flow metering found in petrochemical and pharmaceutical plants. This section contains explanations of the most common techniques and offers various solutions for overcoming flow measurement obstacles.

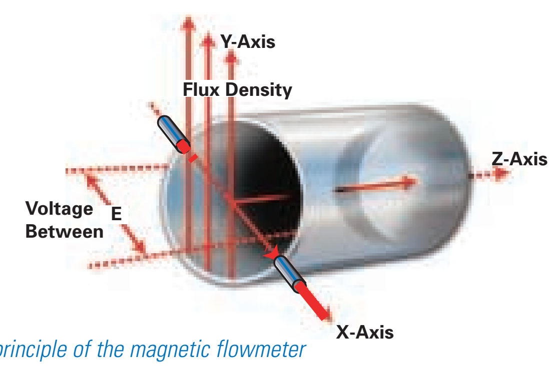
The Magnetic-Inductive Flowmeter

The magnetic-inductive flowmeter consists of a non-ferromagnetic tube wrapped with a magnetic coil. Electrodes in the tube's inner isolated surface are in contact with the liquid (must be conductive) that flows through the tube.

The coils around the pipe generate a magnetic field within the tube. The magnetic field inducts a voltage in the liquid, which is proportional to the speed of the liquid in the tube. This voltage is measured via the electrodes. As the measured voltage is very low, precise low-noise instrumentation amplifiers, such as the INA103, options are needed at the amplifier front end. Usually the voltage is digitized with precision ΔΣ ADCs such as the ADS1252.



The magnetic-inductive flowmeter



The principle of the magnetic flowmeter

The Coriolis Flowmeter

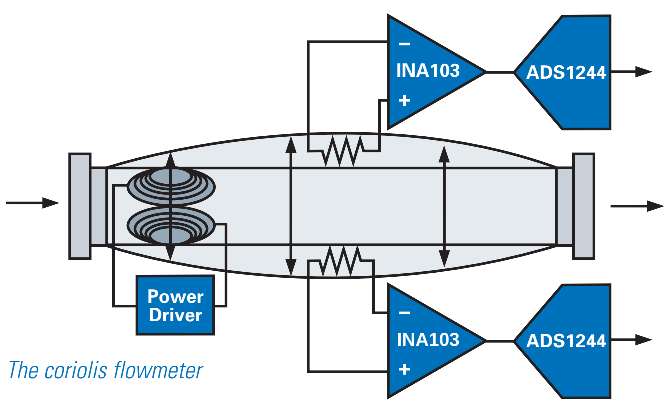
The coriolis flowmeter consists of a tube, which is forced into oscillation by a low-frequency power driver. Liquid particles flowing through the tube are deviated by the mechanical oscillation of the tube. These deviations are different in their signs, depending on their distance to the position of the power source. Close to the power source, the particles of the liquid are accelerated. In the area of the mechanical sensors the particles are decelerated. In the coriolis flow meter, the mechanical forces (which are decelerating) are measured/detected by inductive sensor systems. The very low resulting voltages are amplified by precision amplifiers and then digitized. The phase difference between the basic oscillation of the tube and the resulting inductive sensor signal describes the amount of mass-flow in the tube.

As the detected voltages are very low, a low-noise precision amplifier in the sensor front-end is required. For digitizing the measurement signal, a 2-channel precision ADC (ΔΣ) is needed as the phase-accuracy between the two channels has a direct impact on the measurements' accuracy.

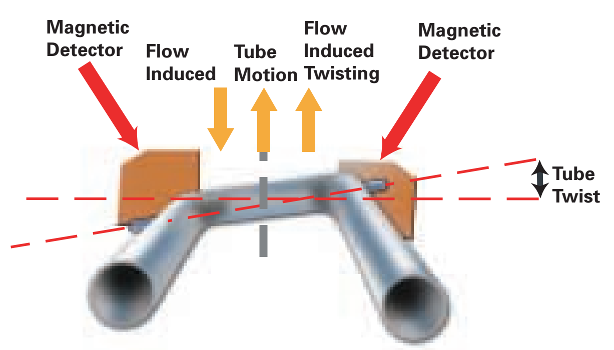
Differences Between the Two Measurement Techniques

The magnetic inductive system can only measure the liquid's speed through the tube. As the diameter of the tube is known, the volume of flow can be calculated. The liquid must have minimal electrical resistance. Non-conductive liquids can't be measured.

The coriolis technique makes it possible to actually measure the amount of mass flowing through the tube. This technique is more expensive.



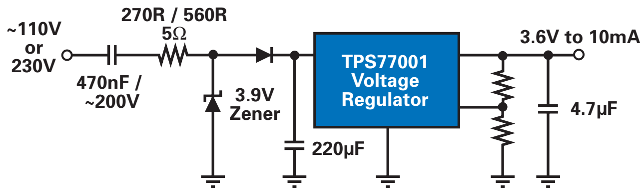
The coriolis flowmeter



Operational principle of a coriolis mass flowmeter

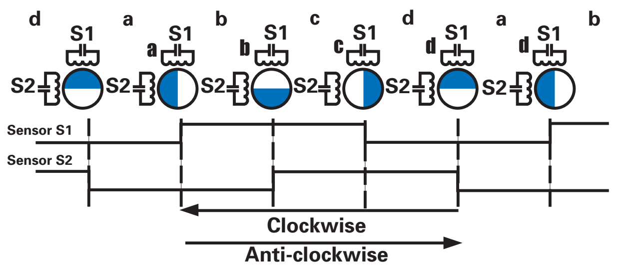
Flow Metering

Low-Cost Method:



TPS7701 functional block diagram

- Ultra-low-power MSP430 requires <10mA for the complete metering application
- No power transformers required for power supply management
- Simple capacitor-tapped power supply coupled with an LDO

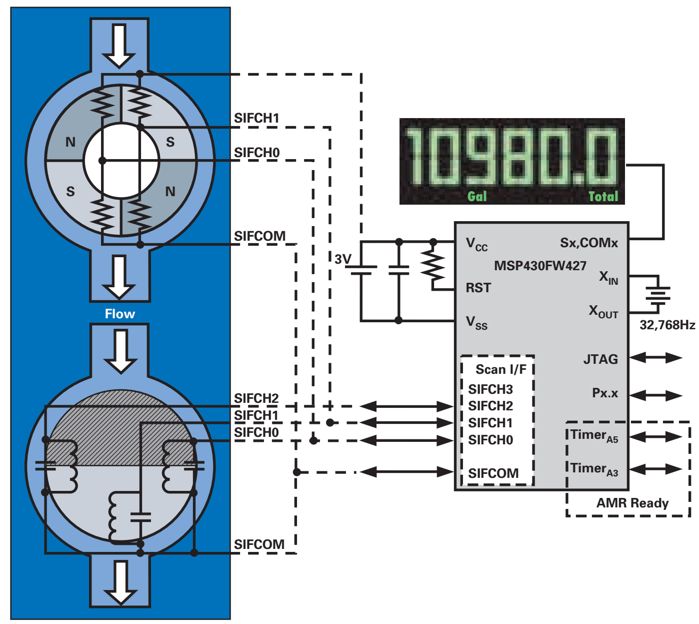


Quadrature decoding, detect rotation, direction error detection

Quadrature decoding example: Generation of input signal with the two LC-type sensors S1 and S2 used. If the previous position of the damped plate is known, together with the current state, the rotation as well as the direction of rotation can be detected. For the digital signals, a "0" means the sensor is above the undamped part of the plate and "1" means it is above the damped area, the metal part. Additional sensors can be used for redundancy, but two sensors are sufficient to detect rotation and direction.

- Two LC sensors or one GMR sensor are used (S1, S2)
- State machine in scan I/F enable to detect rotation, error and distortion

High-Precision Method:



MSP430FW427 single-chip flow meter

- Small battery meets life-cycle of 2 calibration periods due to scan I/F
- Various sensors and physical conditions are handled
- Performance for additional functions e.g. automatic meter reading at low power

Device Recommendations

Device	Description	Key Features	Benefits	Other TI Solutions
Reference				
REF3140	Voltage Reference	Drift = 20ppm/°C 4.097V, 0.2%	Very low drift, tiny package	REF02, REF102
Isolation Products				
DCV010515D	Dual Converter	Isolation converter, $+5V_{IN}$, $\pm 15V_{OUT}$	Low noise, small board data	DCP10515
DCV0105052D	Dual Converter	Isolation converter, $+5V_{IN}$, $\pm 5V_{OUT}$	Low noise, small board data	DCP10505
Power Management Product				
TPS54110	SWIFT™ Buck Controller	Adjustable output (0.9V-3.3V), 1.5A	Very easy to use, flexible output	TPS64200
Data Converters				
ADS8321	16-bit, 100ksps	Power = 2mW, 8-pin, SFDR = 86dB	Excellent performance	ADS8320, ADS8325
ADS1251	24-bit, 20ksps	Power = 155mW, SFDR = 100dB	Only 7.5mW, single 5V supply	ADS1252
MSC121x	24-bit ADC, MCU, REF DAC, PGA	8051 MCU with integrated 24-bit up to 1kSPS ADC, 16-DAC and precision reference, eight inputs and PGA	Cost effective and highest integration all in a single-chip solution	MSC1212, MSC1200

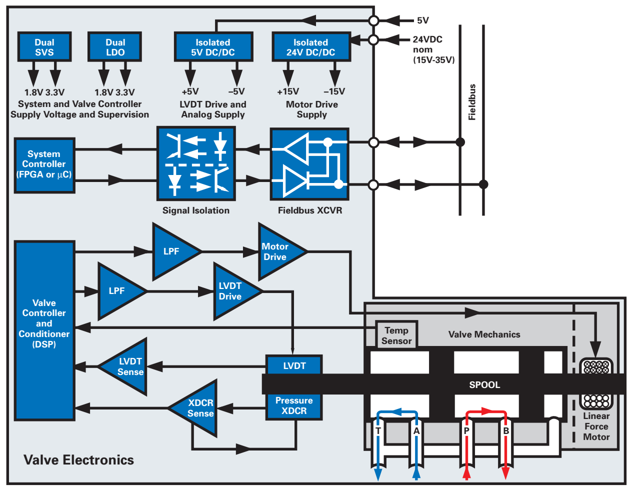
Linear Voltage Differential Transformer

Hydraulic valves are used to direct the flow of liquid mediums, most commonly oil, from input ports to output ports. The direction of flow is determined by the position of a spool, which is driven by a linear force motor. The valve electronic is split into three core-subsystems:

Power Conversion — provides galvanic isolation between the valve power and the external fieldbus and auxiliary 24V supplies. It also provides regulated supply voltages to the individual functional blocks.

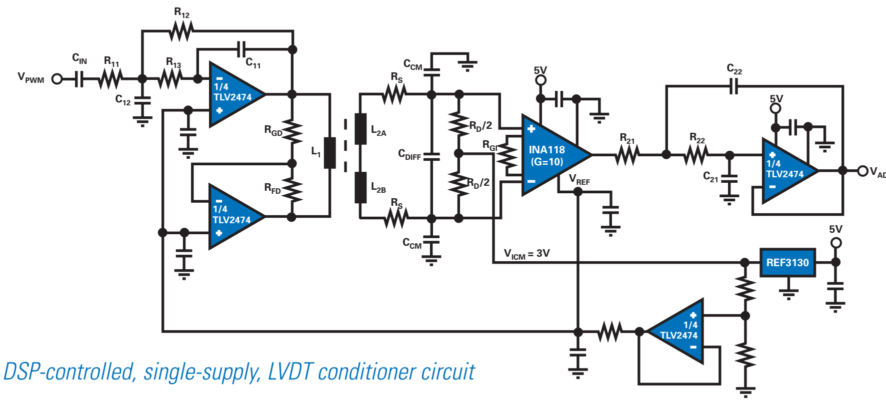
Fieldbus Interface and Control — provides galvanic isolation between the system controller and the fieldbus signals. The system controller translates the incoming data from the fieldbus into valve commands for the DSP, and vice versa, it translates the valve data from the DSP into fieldbus signals.

Valve Control — performs spool positioning, pressure and temperature measurement. It also indicates alarm conditions.



Basic hydraulic valve diagram

The valve controller receives a position command from the fieldbus via the system controller and drives the linear force motor until the output signal of the position sensor (LVDT = Linear Variable Differential Transformer) equals the input value of the position command. At the same time, pressure and temperature are monitored. An alarm condition is indicated if one of these sensors exceeds a pre-determined safety value.



DSP-controlled, single-supply, LVDT conditioner circuit

Device Recommendations

Device	Description	Key Features	Benefits	Other TI Solutions
Power Management Products				
UCC3823	PWM Controller	Universal PWM controller for 24V, isolated boost converter to drive motor control	Lowest cost, small package	UCC3813, TL5001
DCR010505	1W/5V DC/DC Converter	Miniature 5V DC/DC converter with 100V galvanic isolation, integrated 5V LDO	Fully integrated DC/DC converter in miniature package, high isolation and regulated output	DCP020505 (2W, unregulated)
TPS70751	Dual LDO: 3.3V/1.8V	Two regulated output voltages for DSP split-supply systems with power-up sequencing, 250mA output current	Industry's most integrated supply systems, with power good indicator, UVL and thermal shutdown	TPS70851, TPS70251
TPS3305-18	Dual SVS: 3.3V/1.8V	Dual supervisory circuit for DSP and processor supplies including POR generator	Requires no external capacitors, temp-compensated V_{REF}, small package	TPS3306-18, TPS3806I33
Amplifiers				
OPA4345	Quad, low-power op amp	Used as active low-pass filter to convert PWM into analog signal	Low power, low offset, small package, low cost	OPA4340, OPA4346
TLV2472	Dual, single-supply, high O/P drive	Drives LVDT sensor with ±25mA	No cross-over distortion in BTL configuration, lowest supply voltage, drives up to ±35mA	TLC074, TLC084
INA118	Single/dual supply inst. amp	Senses LVDT output with high linearity	High linearity at lowest supply voltage	INA128
OPA544	Power amplifier	Drives linear force motor (±10V/1A)	Class AB amp with current limit and thermal shutdown	OPA548, OPA549, OPA569
PGA309	Programmable pressure sensor conditioner	Includes sensor excitation, linearization and temperature-compensated conditioning	Fully integrated sensor conditioning system on a chip (SOC), small package	—
TMP121	Digital temp sensor	Integrates diode temp sensor, ΔΣ ADC and SPI interface to convert valve temp into digital code for the DSP	High resolution and accuracy, extended industrial temp range, ultra small package	TMP175 (SMBus interface)
Interface				
SN65HVD1176	PROFIBUS transceiver	Interfaces PROFIBUS fieldbus to system controller	Optimized for bus, up to 160 users per bus, up to 40Mbps, benchmarked by Siemens as reference device	SN65HVD485E
SN65HVD251	CAN-bus transceiver	Interfaces CAN fieldbus to system controller	Improved drop-in replacement for PCA82C251, tolerates ±200V transients	SNHVD233 (3.3V version)

Current Measurement

Current is one of the most common values measured in industrial applications. The Motor Control chapter (pages 20-23) describes precise current measurement using delta-sigma modulators and precision SAR ADCs that also require galvanic isolation. Another approach to directly measuring current uses instrumentation amplifiers which allow direct shunt measurements with common-mode voltages up to 60V.

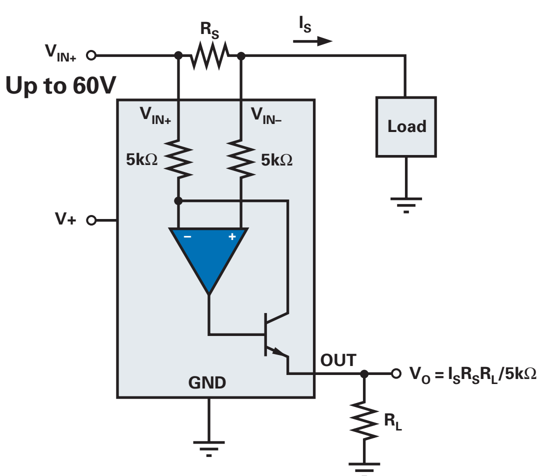
High-Side Current Shunt Monitors
INA138/INA168/INA170

Get samples and datasheets at: **www.ti.com/sc/device/INA138**, **www.ti.com/sc/device/INA168**, **www.ti.com/sc/device/INA170**

The INA138 and INA168 are high-side, unipolar, current shunt monitors with low quiescent current and are available in SOT23-5 packaging. Input common-mode and power supply voltages are independent and can range from 2.7V to 36V (IN138) or to 60V (INA168). The devices convert a differential input voltage to a current output. The current is converted back to a voltage with an external load resistor that sets any gain from 1 to over 100.

Key Features
- Wide supply range
  - INA138: 2.7V to 36V
  - INA168: 2.7V to 60V
- Unidirectional current: INA138/9, INA168/9
- Bidirectional current: INA170
- Low quiescent current: 25µA
- Independent supply and common-mode voltages
- Wide temp range: –40°C to +125°C
- Packaging: SOT23-5

Applications
- Current shunt measurement in automotive, telephones, computers
- Portable and battery-backup systems
- Power management
- Precision current source



INA138/INA168 functional block diagram

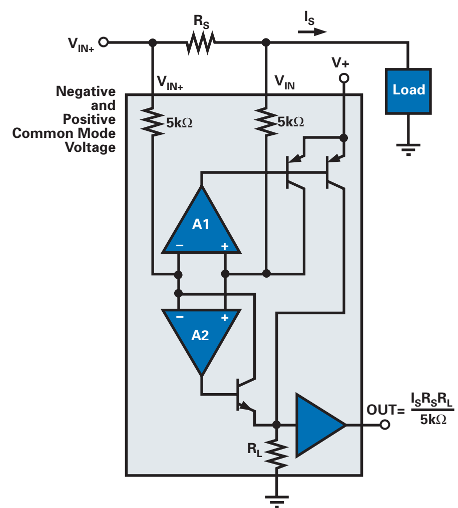
Current Shunt Monitor with –16V to +36V Common-Mode Range
INA193/INA194/INA195/INA196/INA197/INA198

Get samples and datasheets at: **www.ti.com/sc/device/PARTnumber**
Replace **PARTnumber** with **INA193**, **INA194**, **INA195**, **INA196**, **INA197** or **INA198**

The INA193-INA198 family of current shunt monitors with voltage output can sense drops across shunts at common-mode voltages from –16V to +36V, independent of the supply voltage. The devices are available with three output voltage scales: 20V/V, 50V/V and 100V/V. The 400kHz bandwidth simplifies use in current control loops.

Key Features
- Common-mode voltage range: –16V to 36V (80V in development)
- High accuracy: ±3% over temp
- Bandwidth: up to 400kHz
- Quiescent current: 250µA
- Three transfer functions available: 20V/V, 50V/V, 100V/V
- Packaging: SOT23

Applications
- Current shunt measurement in automotive, telephones, computers
- Portable and battery-backup systems
- Power management
- Use in PWM current control loops
- 16-bit, 1 channel, ±250mV input range: ADS1202
- 16-bit, 1 channel, ±250mV input range: ADS1203
- 16-bit, 4 channels, 0 to 5V input range: ADS1204



INA19x functional block diagram

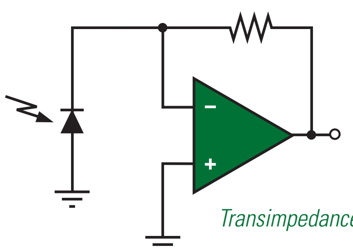
Measurement of Photodiode Currents

Photometric measurements for industrial, test, analytical, laboratory, photographic, and general light detection have many similar requirements to those in high-speed optical communications systems. Best results depend on how the photodiode is used and the amplifier techniques that follow it.

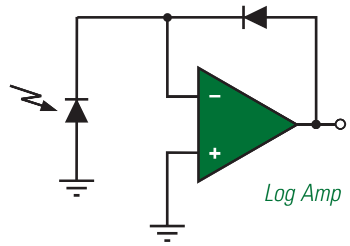
Many light sources produce slow variations but often have wide dynamic range up to 8 decades or 160dB. In contrast, fiber optic transmission systems have high bandwidth and also wide variation in optical power level. There are many ways to optimally configure a photodiode circuit.

A common technique utilizes a transimpedance amplifier in which a short circuit is forced across the photodiode. This keeps the photodiode's dark current and the associated noise and temperature drift low but results in higher photodiode capacitance. Therefore, the zero-bias technique is used for relatively slow systems where optical power levels vary from very tiny to very large. For faster systems, a reverse-biased photodiode circuit is commonly used. This results in smaller photodiode capacitance but dark current, temperature drift and noise are increased. To keep errors to a minimum, the bias voltage must be very clean; meaning low noise and good temperature stability.
In certain very fast systems that use an avalanche photodiode with a large active optical light gathering area, reverse bias is mandatory.

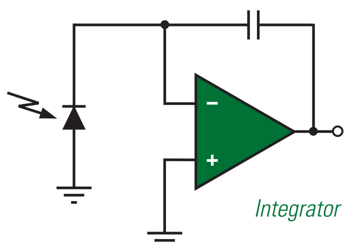
In addition to diode-biasing, different types of transimpedance circuits are employed. One is an op amp with a resistor in the feedback loop. This produces a linear, continuous response of output voltage to input current. Spike transitions will occur, however, if the feedback resistor is switched to other values to change the gain during signal acquisition.



Another approach is the logarithmic amplifier with a diode in the op amp's feedback loop. This produces a continuous non-linear response of output voltage to input current. It has the unique ability to apply high gain to low-level signals, while providing low gain to high-level signals. It's like a smooth automatic gain circuit without switching transitions that does not disrupt the signal at any time.



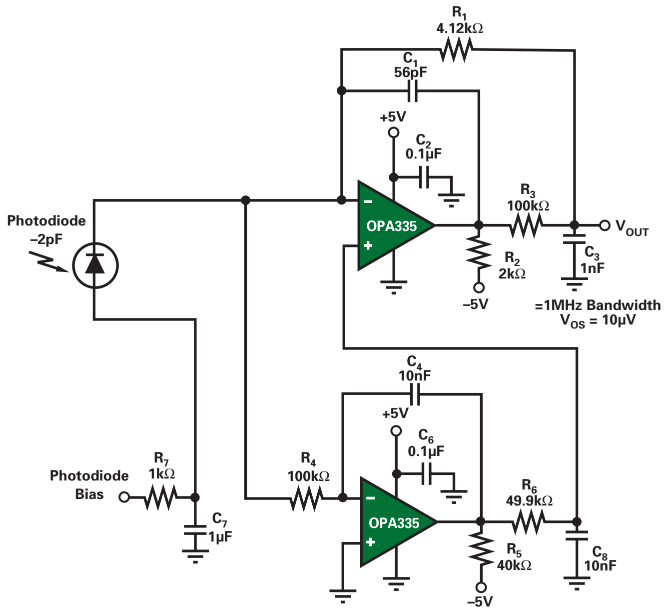
Yet another approach is the switched integrator with a capacitor in the feedback loop. It has the advantage of integrating the noise and allowing easy ability to change gain by simply altering the time allowed for the capacitor to charge. Output voltage depends on how long the capacitor is allowed to charge. In fact it is easy to change the gain by simply changing the charging time. The switched integrator configuration is used as an analog front end in the direct digital converter (DDC) where the analog output voltage is directly converted into a high-resolution digital word on the same chip.



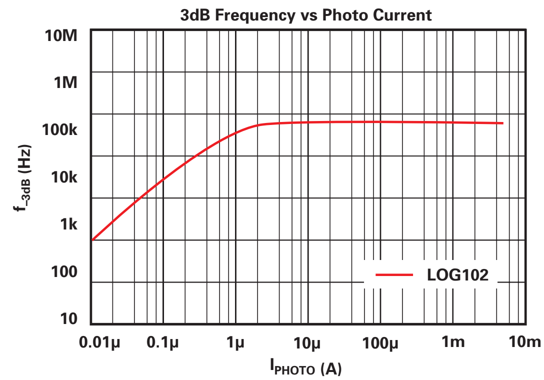
Measurements of Photodiode Currents: Light Measurement and Laser Control

The linear transimpedance amplifier finds its use in wide bandwidth applications with up to five decades of dynamic input range. Wideband amplifiers, such as the OPA353, have the necessary gain bandwidth to provide high transimpedance gain. This type of amplifier, however, lacks the DC-precision for wider dynamic input range at low input currents. To improve the DC-parameters, an auto-zero amplifier, such as the OPA335, is implemented in a composite configuration. While the wideband amplifier provides the current-to-voltage conversion in the signal path, the auto-zero amplifier compensates its offset. Thus the composite amplifier provides wide bandwidth at high transimpedance gain over a dynamic input range of five decades. The design of a composite transimpedance amplifier requires serious effort in stability calculations. To shorten the design time of photodiode front ends, Texas Instruments has developed a new, wideband transimpedance amplifier, the OPA380, with a bandwidth of 1MHz at 120dB transimpedance gain. Its dynamic input range extends over 5 decades and allows for current measurement down to 5nA.

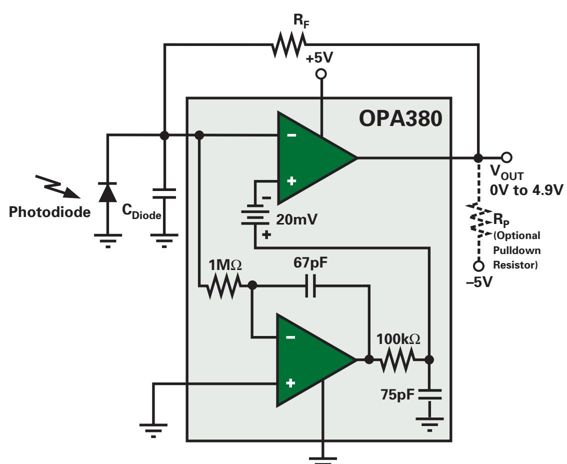
Photodiodes



OPA335 in wideband photodiode application



3dB frequency vs. photo current



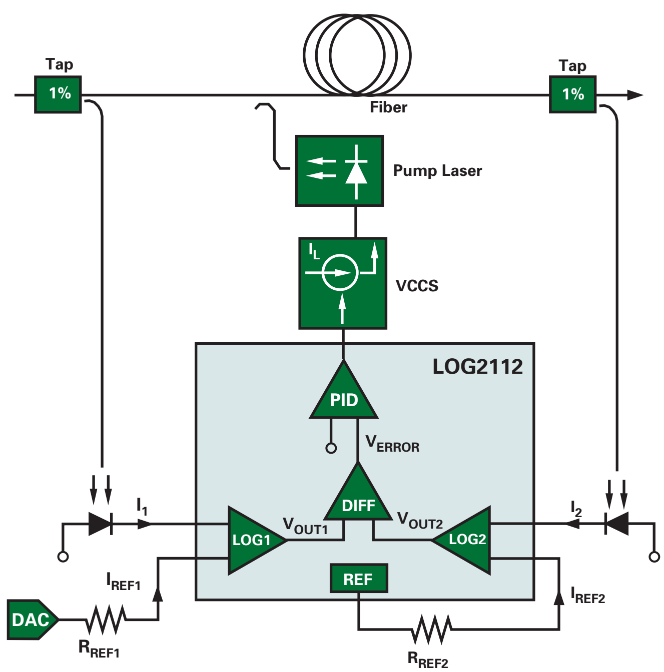
OPA380 offers 1MHz BW and allows current measurement down to 5nA

Logarithmic amplifiers provide the widest dynamic input range of up to 7-8 decades. Their 3dB bandwidth, however, decreases linearly with decreasing input current (see Output Power Circuit pg. 19). While linear transimpedance amplifiers measure the absolute value of an input current, and convert it into an output voltage via a feedback resistor, ($V_{OUT} = I_{IN} \cdot R_F$), logarithmic amplifiers provide the logarithmic ratio of two input currents in the form of an output voltage ($V_{OUT} = \log I_1/I_2$). Usually I_1 represents the current to be measured, and I_2 is a reference current. The logarithmic comparison of two input currents offers the benefit of measuring the input and output quantity of a physical transmission system, be it of optical, electrical, or mechanical nature.

Constant Gain Control and Gain Adjustment of an Optical Amplifier

Load variations in the transmission fiber cause transients of optical power at the amplifier's output. To minimize these transients, optical gain control is achieved by two log amps measuring the optical amplifier's input and output power. A difference amplifier subtracts the output signals of both log amps and applies an error voltage to the following PID-controller. The controller output adjusts a voltage-controlled current source (VCCS), which then drives the actual pump laser. The amplifier operates at the desired optical gain, when the error voltage at the PID output is zero.

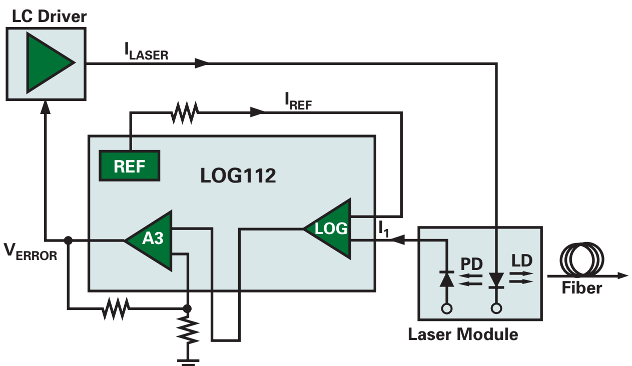
Gain setting is achieved by varying the reference current of Log_1. Again, a variation in V_{OUT1} translates into a new power level at the pump laser output until the error voltage at the PID output is zero.



Current measurement using log amps

Controlling the Optical Output Power of a Laser Diode

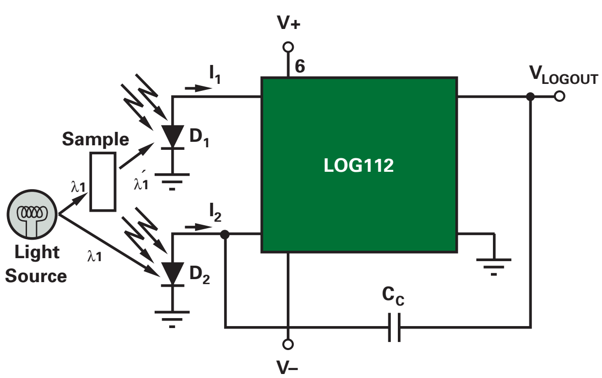
With the diode's output power decreasing over its lifetime, a control loop is required to keep the output power constant. In the feedback path, a fraction of the output signal (1%) is fed back via a photodiode and converted into electrical current. The laser is calibrated by making the reference current, I_{REF}, equal to the photo current, I_1. This allows the detection of minute changes in photo current. Deviations between reference and photo current are converted into an error signal and applied to the bias input of the laser diode driver. The driver then increases the bias current of the laser diode until the error signal diminishes to zero.



Output power circuit for a laser diode

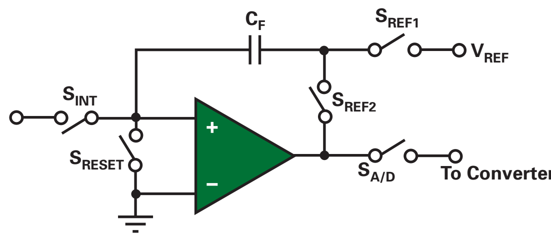
Absorbance Measurement

In the case of an absorbance measurement, a light source provides input to two photodiodes, D_1 and D_2. D_2 receives light directly from the source, resulting in a current, I_2. D_1 receives a reduced optical signal which has passed through a material sample with an absorbance coefficient, α, thus yielding a current of $I_1 = I_2 \bullet \alpha$. The amplifier, performing the logarithmic ratio of I_1/I_2, then provides an output of $V_{OUT} = \log I_1/I_2 = \log I_2 \bullet \alpha/I_2 = \log \alpha$. Thus, V_{OUT} is a direct indication for α.



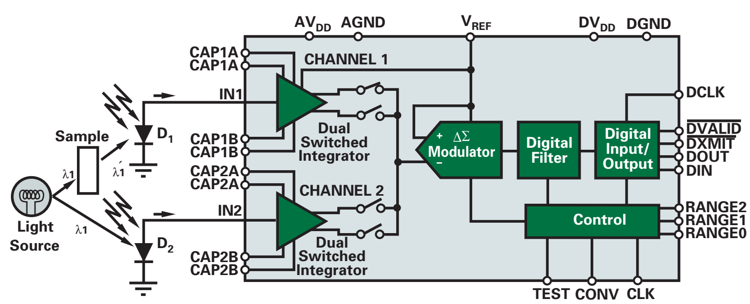
Absorbance measurement circuit

Switched integrating amplifiers allow current detection down to fA levels. Because of their mode of operation, their figures of merit are full-scale charge (Q_{FS}) and integration time (T_{INT}), rather than input current in nA and bandwidth in kHz. Switched integrators work on the principle that a reference voltage charges the feedback capacitor of an inverting amplifier from one side; then, the opposite side of the capacitor is connected to the amplifier input for the duration of T_{INT} to receive the input charge. After the integration phase, the remaining output voltage is available for further analog-to-digital conversion.



Configuration of the front end integrators of the DDC112

For highest accuracy, the Texas Instruments DDC112 switched integrator device combines a dual integrator and a 20-bit, $\Delta\Sigma$ ADC with digital interface for microcontroller and DSP control. An extensive control interface allows variation of the full-scale range from a minimum 47.5pC to a maximum 1000pC, and the integration time from T_{INT} = 50µs (non-continuous mode) to 1s (continuous mode). Typical applications are direct photo-sensor digitization, CT scanner, DAS, infrared pyrometer, liquid/gas chromatography and blood analysis.

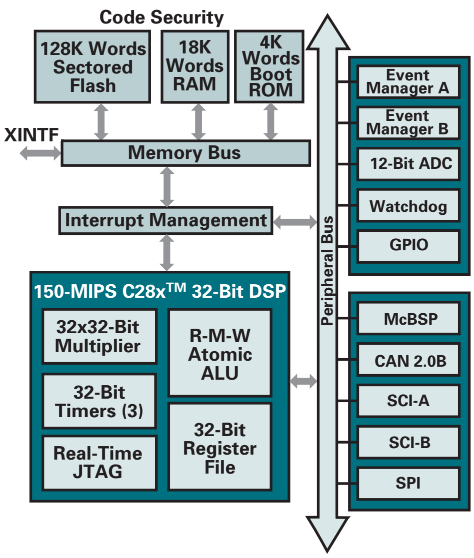


DDC112 functional block diagram

Asynchronous, DC and Servo Motors

Digital Motor Control

Today's motor control applications challenge electronic circuitry to achieve the highest efficiency, lowest power consumption and highest precision control. There are several motor types in which digital and analog solutions are increasing performance in motor control applications. Synchronous motors are also described as BLDC (Brushless DC) or PMSM (Permanent Magnet Synchronous Motors). The only difference between them is the shape of the induced voltage, resulting from two different manners of wiring the stator coils. The back-emf is trapezoidal in the BLDC motor, and sinusoidal in the PMSM motor. Digital techniques addressed by the C2000™ DSP controller make it possible to choose the correct control technique for each motor type. Processing power can extract the best performance from the machine and reduce system costs. Options include using sensorless techniques to reduce sensor cost, or even eliminate it; additionally, complex algorithms can help simplify the mechanical drive train design, also lowering system cost.



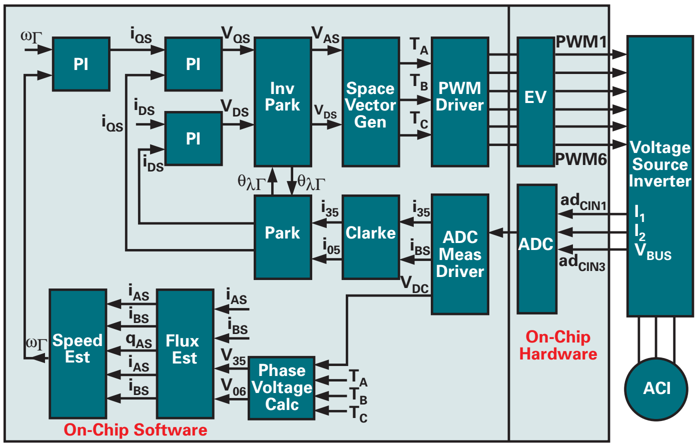
TMS320F2812 block diagram

For asynchronous motors, speed regulation is a typical concern. Three phase inverters with a 6 PWM scheme are widely used for variable-speed drive applications. Depending on the application, a simple V/Hz open-loop (scalar) control where no feedback is required can be applied, or a vector control in which current, voltage and speed information is needed.

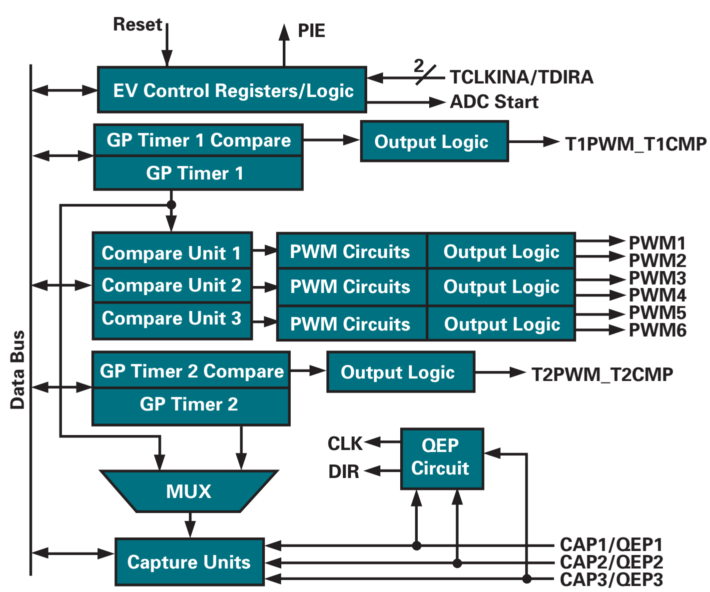
Scalar Control: (V/Hz)

- Simple to implement: only three sine waves feeding the motor are required
- Position information not required (optional)
  - Doesn't deliver good dynamic performance
  - Torque delivery not optimized for all speeds

Vector control, also called Field Oriented Control, allows designers to fulfill all of the "ideal" control requirements. Having information on all system parameters, such as phase current and bus voltage, allows delivery of the appropriate power at the right moment thanks to real-time control made possible by DSP integration and MIPS availability.



Vector control functional block diagram

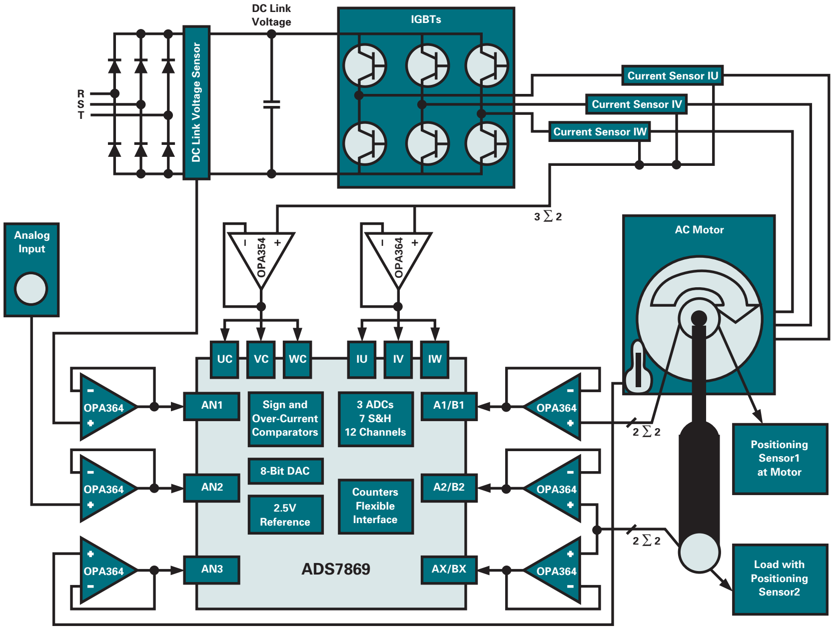


TMS320F2810 event manager block diagram

Asynchronous, DC and Servo Motors

Servo Motor Control Application and Featured Products

The figure at right is an example of a typical motor control circuit. The IU, IV and IW channels measure the motor's currents. The motor's position/speed and load are measured simultaneously by Ax, Bx, etc. using resolver or analog encoder sensors. Simultaneously sampling at least two currents or all three currents is important to achieving maximum accuracy in motor positioning. Good linearity and low offset of the ADC is mandatory. Channel A_{N1} measures the differential DC link voltage. Fast sampling in the range of 2µs or less per channel guarantees fast leakage current detection for IGBT control. A_{N3} measures the motor's temperature. The level input of the window comparators are connected to an 8-bit DAC for control purpose.



Servo motor control functional block diagram

Current Shunt Modulator
ADS1203

Get samples, datasheets and EVMs at: **www.ti.com/sc/device/ADS1203**

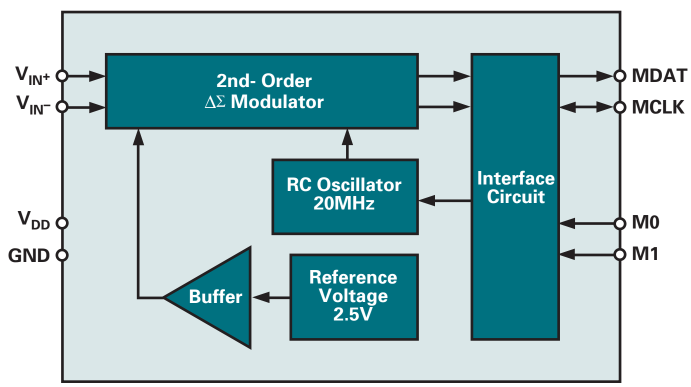
The ADS1203 is a delta-sigma modulator with 95dB dynamic range, operating from a single +5V supply. The differential inputs are ideal for direct connection to transducers or low-level signals. It is available in an 8-lead TSSOP package. A 16-pin QFN (3x3) package will be available 1Q05.

Key Features

- Resolution: 16-bits
- Input range : ±250mV
- Linearity: ±1LSB (typ)
- Internal 2.5V reference

Family Members:

- 16-bit, 1 channel, ±250mV input range: ADS1202
- 16-bit, 1 channel, ±250mV input range: ADS1203
- 16-bit, 4 channels, 0 to 5V input range: ADS1204
- INA139, high-side current-shunt monitor (diff. amplifier), up to 36V common-mode input
- INA169, high-side current-shunt monitor (diff. amplifier), up to 60V common-mode input



ADS1203 functional block diagram

Asynchronous, DC and Servo Motors

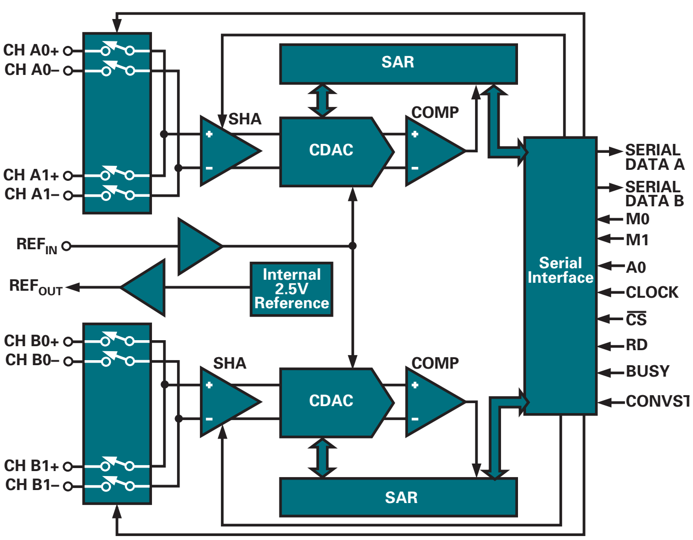
2+2 Channel Simultaneous Sampling, 16-Bit ADC
ADS8361

Get samples, datasheets and EVMs at: **www.ti.com/sc/device/ADS8361**

The ADS8361 is a 16-bit, 500kSPS ADC with four fully differential input channels grouped into two pairs for high-speed, simultaneous signal acquisition. The device offers a high-speed, dual serial interface and is available in an SSOP-24 package and specified over the –40°C to +85°C operating range.

Key Features
- 4 fully differential input channels
- 2µs throughput per channel
- INL: ±3 LSB (typ)
- Power consumption: 150mW
- Internal 2.5V reference
- Supply voltage: 2.7V to 5.5V
- Pin-compatible upgrade to ADS7861 (12- to 16-bit)

Family Member
- 12-bit, 2x2 channel, serial interface: ADS7861
- 12-bit, 2x2 channel, parallel interface: ADS7862
- 12-bit, 3x2 channel, parallel interface: ADS7864
- 16-bit, 2x2 channel, serial interface: ADS8361
- 16-bit, 6x1 channel, parallel interface: ADS8364



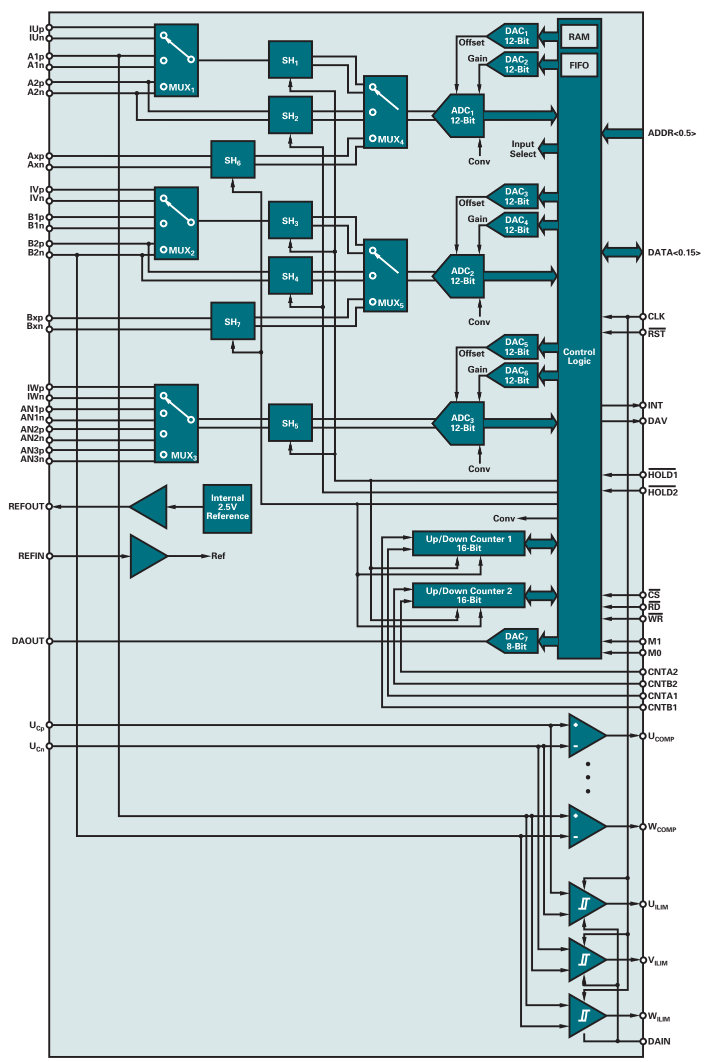
ADS8361 functional block diagram

Complete Analog Front End
ADS7869

Get samples, datasheets and EVMs at: **www.ti.com/sc/device/ADS7869**

The ADS7869 is the next-generation successor of the well known VECANA01 analog front end and includes three ADCs with a total of seven S/H capacitors and 12 fully differential input channels. There are four sign comparators connected to four input channels. The device offers a very flexible digital interface, featuring 3 different modes, starting from serial SPI, adjustable parallel up to the VECANA01-compatible mode. For position sensor analysis, two up-down counters are added on the silicon. This feature ensures that the analog input of the encoder is held at the same point of time as the counter value.

Key Features
- Resolution: 12-bits
- Sampling rate: 1MSPS
- INL: ±1 LSB (typ)
- 2 up-down counter modules on-chip
- Power consumption: 250mW
- Packaging: TQFP-100

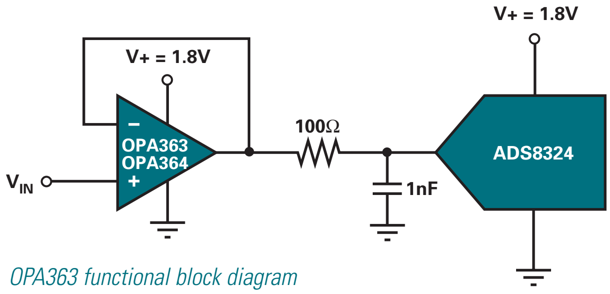


ADS7869 functional block diagram

1.8V, 7MHz, 90dB CMRR Rail-to-Rail I/O Op Amps
OPA363/OPA364

Get samples, datasheets and EVMs at: **www.ti.com/sc/device/OPA363**, **www.ti.com/sc/device/OPA364**

The OPA363 and OPA364 families are high-performance CMOS op amps optimized for very low voltage, single-supply operation. Designed to operate on single supplies from 1.8V (±0.9V) to 5.5V (±2.25V), these amps are ideal for sensor amplification and signal conditioning in battery-powered systems. They are optimized for driving medium speed A/D converters (up to 100kHz) and offer excellent CMRR without the crossover associated with traditional complimentary input stages. The input common mode range includes both the negative and positive supplies and the output voltage swing is within 10mV of the rails. All versions are specified for operation from –40°C to +125°C.



OPA363 functional block diagram

Key Features
- Slew rate: 5V/µs
- Low offset: 500µV (max)
- Quiescent current: 750µA/channel (max)
- Available in single, dual and quad
- Packaging: SOT23-5, SO-8, MSOP-8, TSSOP-14, SO-14

Applications:
- Signal conditioning
- Data acquisition
- Process control
- Test equipment
- Active filters

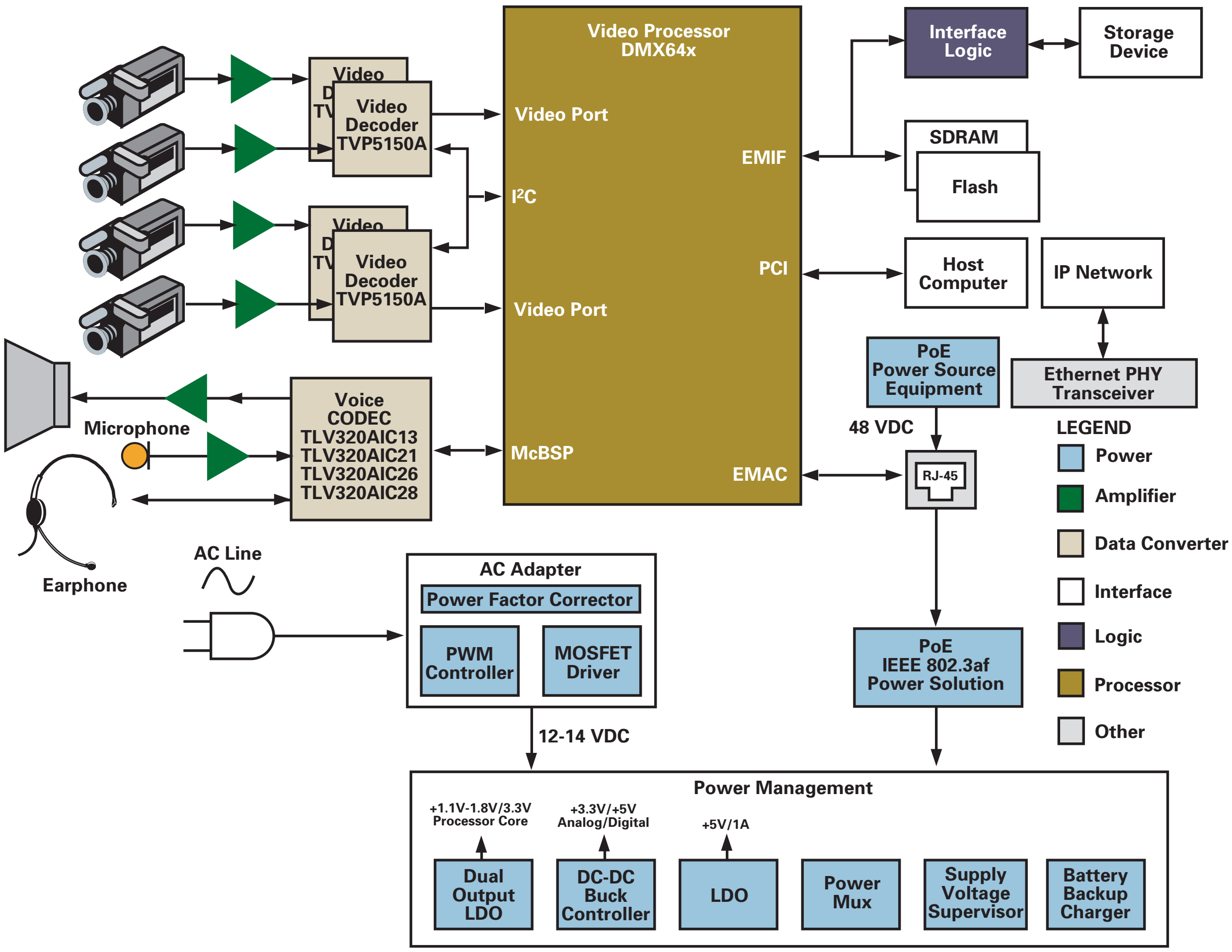
Device Recommendations

Device	Description	Key Features	Benefits	Other TI Solutions
Amplifiers				
OPA335	Zero-drift op amp	0.05µV/°C drift, 5µV offset, RRIO at 3.3VDC, single supply	Best long-term stability for industrial use, no need for dual supply, best in class, automotive temp range	OPA735, 12V version with improved noise and drift
INA326	High-precision instrumentation amp	30nV/√Hz noise, RRIO, single supply	Lowest noise in the industry and best long-term stability, no need for dual supply	INA337, automotive temp range, –40°C to +125°C
TMP121	Digital temp sensor	Integrated diode temp sensor, ΔΣ ADC and SPI interface to convert valve temp into digital code or the DSP	High resolution and accuracy, extended industrial temperature range, ultra small package	TMP175 (SMB-bus interface)
OPA227	Low noise amp	V_N = 3nV, CMRR > 120dB, V_S = 5 to 36V	Very low noise, small package	OPA350, OPA725
Interface				
SN65HVD1176	PROFIBUS transceiver	Interfaces PROFIBUS fieldbus to system controller	Optimized for PROFIBUS, up to 160 users per bus, up to 40Mbps, benchmarked by Siemans as reference device	SN65HVD485E, low-cost version
SN65HVD251	CAN-bus transceiver	Interfaces CAN-fieldbus to system controller	Improved drop-in replacement for PCA82C251, tolerates ±200V transients	SNHVD233 (3.3V version)
Power Management Products				
REF3140	Voltage reference	Drift = 20ppm/°C, 4.097V, 0.2%	Very low drift, tiny package	REF02, REF102
DCV010505D	Dual converter	Isolation converter, +5V_{IN}, ±5V_{OUT}	Low noise, small board area	DCP010505
TPS54110	SWIFT™ buck converter	Adjustable output (0.9V to 3.3V), 1.5A	Very easy to use, flexible output	TPS64200
Data Converters				
ADS1206	V/F Converter	0-5V input, 1-4MHz output	Low cost direct DC-Link current measurement	INA19x, INA138
DAC7731	16-bit, 5µs settling time	Output = ±10V, INL = 0.0015%	Small package	DAC7741
Other				
FilterPro™	Free design software	Design low pass filters, quick, easy	Free, www.ti.com	—

Surveillance Cameras, Glass Breakage and Smoke Detectors

Surveillance IP Video Node Basics

Digital video surveillance systems include embedded image capture capabilities which allow video images or extracted information to be compressed, stored or transmitted over communication networks or digital data links. The TVP51xx video decoder family offers a high-performance, low-cost analog video interface supporting PAL/NTSC/SECAM video systems. Fast lock times and superior analog processing capabilities make them an ideal fit for any kind of streaming video applications. A typical audio subsystem consists of an audio codec and an audio amplifier. The TPA3007D1, based on the patented filter-free modulation scheme, is a high-efficiency, state-of-the-art, Class-D audio amplifier. TI's video surveillance solutions are primarily based on the high-performance TMS320DM64x digital media processors, which have on-chip video ports for easy connection to video devices. The DM64x devices are capable of handling both video and audio encode/decode for IP-based video surveillance applications. Cost-competitive video compression/decompression algorithms are available from TI or through our partner network for JPEG, MPEG2, MPEG4, H.264, and more. Audio compression/decompression algorithms are also available.



IP Video Node block diagram

Surveillance Cameras, Glass Breakage and Smoke Detectors

High-Performance Digital Signal Processors
TMS320DM64x

Get samples, datasheets and app reports at: **www.ti.com/dm64x**

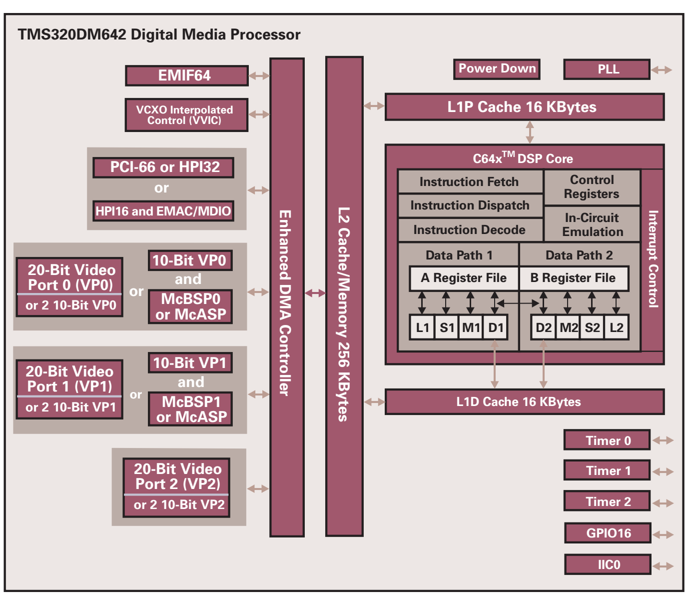
TI's video surveillance solutions are primarily based on the high-performance DM64x DSP-based digital media processors. The DM64x digital media processors have on-chip video ports for easy connection to video devices and are capable of handling both video and audio encode/decode for IP-based video surveillance applications. The single programmable digital media processor is a cost-effective solution because the need for external PCI or EMAC is eliminated.

Key Features

- Performance up to 5760 MIPS performance at 720MHz
- Multiple input/output glueless interfaces for common video and audio formats
- Performance real-time video encoding, decoding, or transcoding
- Three dual-channel video ports support simultaneous video input and output
- Advanced connectivity with 10/100 Ethernet MAC and 66MHz PCI
- Ready-to-use application software such as MPEG-4, MPEG-2, MPEG-1, WMV9, H.26L, H.263, H.261, M-JPEG, JPEG2000, JPEG, H.264 and more.

Applications

- Network camera-based surveillance and IP video nodes
- Video-on-demand set-top boxes, personal video recorders and digital media centers
- Statistical multiplexer and broadcast encoders
- IP-based video conferencing and IP-based videophones



TMS320DM642 digital media processor block diagram

High-Performance Digital Signal Processors
TMS320C6414T and TMS320C6415T

Get samples, datasheets and app reports at: **www.ti.com/sc/device/TMS320C6414**

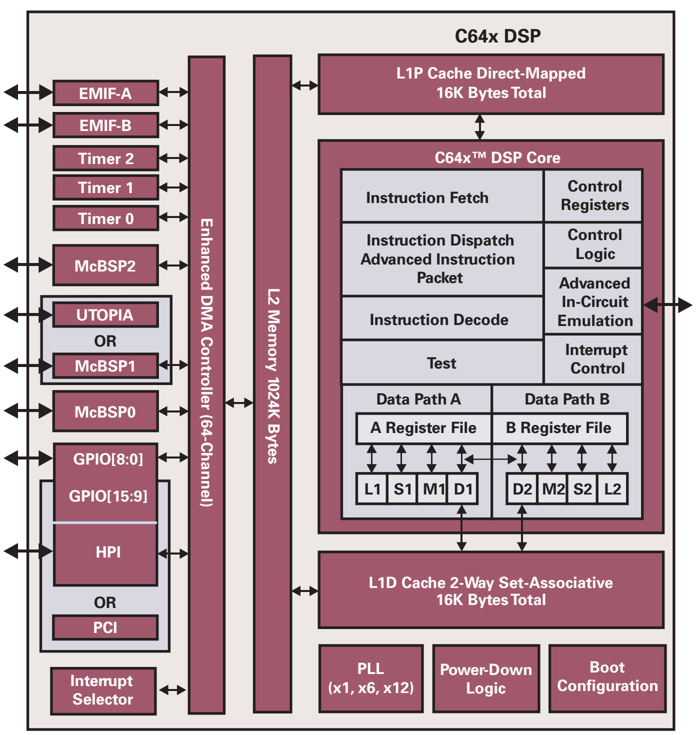
TMS320C64x™ DSPs offer the highest level of performance to meet the demands of the digital age. At clock rates up to 1GHz, the C64x™ DSPs can process information at a rate of more than 8000 MIPS. TI's C64x DSPs are backed by an extensive selection of optimized algorithms and industry-leading development tools.

Key Features

- Highest in-class performance with production class devices available up to 1GHz
- TMS320C64x DSPs are 100% code-compatible with TMS320C6000™ DSPs
- C64x DSPs offer up to 8000 MIPS with costs as low as $20.00
- Advanced C Compiler and Assembly optimize maximize efficiency and performance
- Packaging: 23-/27-mm BGA options

Applications

- Statistical multiplexers
- Broadcast encoders
- Video conferencing
- Video surveillance



TMS320C6415T DSP block diagram

Surveillance Cameras, Glass Breakage and Smoke Detectors

Device Recommendations

Device	Description	Key Features	Benefits
Amplifiers			
TLV246x	Op amp	Ideal for audio amplification, low power consumption	Cost-effective solution with low noise and small SOT-23 package
TPA3007D1	Class-D audio amp	6.5W into an 8Ω load from 12V supply, 3rd generation modulation technique, short circuit protected	Replaces large LC filter with small Ferrite Bead Filter, no heatsink required, improved efficiency, improved SNR
Data Converters			
TVP5146	NTSC/PAL/SECAM 4x 10-bit digital video decoder w/Macrovision	Quad, 30MSPS, 10-bit ADC, supports component YPrPb/RGB, programmable video output format, certified Macrovision copy protection detection, built-in video processing, VBI data processor, I^2C interface	10 video inputs, SCART support, includes a 5-line adaptive comb filter for best-in-class Y/C separation, 4 10-bit, 30MSPS ADCs for superior noise performance
TVP5150A	8-bit video decoder (PAL, NTSC, SECAM)	Single 8-bit ADC, composite and S-video support, built-in video processing, I^2C interface	2 video inputs, 4-line adaptive comb filter, fast lock times, extremely low power, low cost
TLV320AIC12	Dual-channel voice codec	Programmable sampling rate up to: max 26kSPS w/ on-chip IIR/FIR filter, max 104kSPS w/ IIR/FIR bypassed, built-in amps for microphones/speakers	Directly connect to McBSP w/o logic, interface with multiple analog I/Os DSP software, analog/digital PGA to increase performance
Processor			
TMS320DM642	Video processor	Ability to perform video/audio encode on multiple channels, direct I/F to NTSC/PAL decoder through video ports/audio through McBSP	Cost effective with single programmable DSP, no need for external PCI or EMAC, eliminates the need for external FPGA
Power Management Products			
TPS2383	Power sourcing equipment power managers (PSEPM)	Internal PD detection signature output, internal PD classification output, programmable inrush current limit, 0.3Ω low-side FET input, internal thermal protection and UVLO compliant to the PoE IEEE 802.3af standard	Individually manage power for up to 8 ethernet ports, all operations of the TPS2383A are controlled through register read and write operations over a standard (slave) I^2C serial interface
UCC1809/ 2809/3809	Current mode PWM controller	Programmable soft start with active low shutdown	Anti-cross conduction circuitry, allows the output to sink current by allowing the synchronous rectifier to turn on w/o the switch node collapsing
TPS2370	Power interface switch	All detection, classification, inrush current limiting and switch FET control necessary for compliance with IEEE 802.3af standard	Low-input voltages (1.8V to 10V), draws >12µA, allowing accurate sensing of the external 24.9-kΩ discovery resistor
TPS76850	Fast-transient-response 1-A LDO	Low drop-out = 230mV at 1A, 2% tolerance, open drain power good, thermal shutdown protection	Designed to have a fast transient response and be stable with 10µF low ESR cap at low cost
TPS70148	Dual-output LDO for DSP systems	1.2V/1.5V/1.8V/2.5V/3.3V options for dual-output voltages, selectable power-up sequence for DSP appilcations, power-on reset with delay, power good, two manual reset, thermal shutdown	Complete power management solution designed for TMS320™ DSP family, easy programmability, differentiated features: accuracy, fast, transient response, SVS supervisory, reset and enable pins
TPS5130	Triple sync buck controller with LDO	3 independent step-down DC/DCs and 1 LDO, 1.1V-28V input range, 0.9V to 5.5V output range, sync for high efficiency, auto PWM/SKIP overvoltage/current protection, short-circuit protection	On-chip sync rectifier drives less expensive N-Ch MOSFET, allows smaller input cap to reduce cost, resistor-less current protection reduces external part count

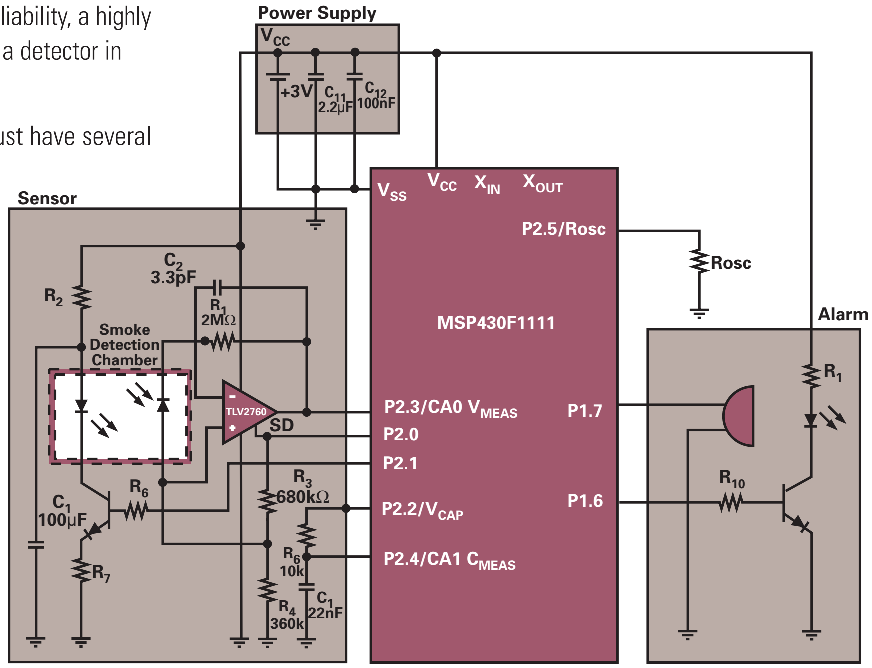
Surveillance Cameras, Glass Breakage and Smoke Detectors

Smoke Detector

Smoke detection is a critical application, not only because life can depend on the reliability of the sensor but also because false alarms can be quite costly. There are several ways to detect smoke, but optical detection is the most common. In order to achieve high reliability, a highly integrated solution is desirable. Due to laws that require a detector in every room (e.g. in hotels) cost is also a decisive factor.

In order to achieve low maintenance costs, batteries must have several years of life which require a pulsed application with fast wake-up time, fast processing time and exceptionally low stand-by current. This makes the mixed-signal processor, MSP430, an ideal choice for this application.

The figure at right, shows the heart of a smoke detector. A pulsed IR-transmitter and IR-receiver are located in a non-reflective measurement chamber which has to be protected against outside light, only light from the IR-transmitter, which is reflected by the smoke, can reach the IR-receiver. Two subsequent measurements are performed. The first measures the surrounding light when the IR-transmitter is switched off; the second measures reflected light when the IR-transmitter is switched on. This differential measurement method requires not only a high dynamic range linearity sensor and circuitry, but also a high linearity of the system.



Smoke detector block diagram

Device Recommendations

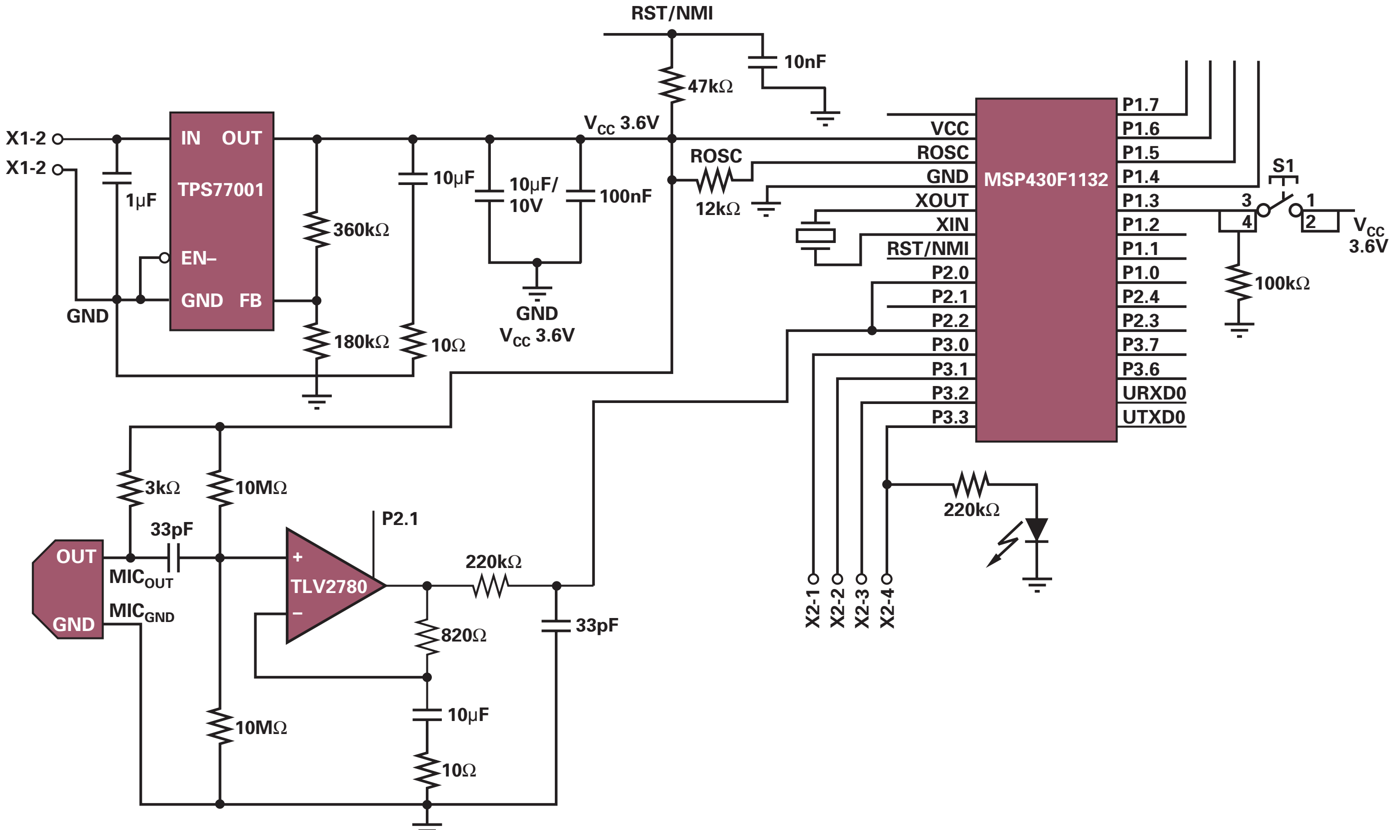
Device Type	Recommended Device	Device Characteristics
Microcontroller	MSP430F1111	1.8V to 3.6V lowest power microcontroller with analog comparator for dual slope A/D conversion
Operational Amplifiers	OPAx340	Fast RRIO transimpedance amplifier with trimmed offset voltage
	OPAx336	Low offset, low drift RRO amplifier with only 32µA quiescent current
	OPAx381	Fast, zero drift transimpedance amplifier with <1mA quiescent current
	TLV247x	Fast, lowest drift 0.4µV/°C, general-purpose amplifier with shutdown
	TLV276x	Medium speed, 1.8V RRIO amplifier with shutdown and fast turn on/off time
	TLV224x	1µA, 5kHz, RRIO nanopower operational amplifier
	OPAx379	1.8V, 2µA, 100kHz, RRIO nanopower operational amplifier

*Preview devices appear in **bold blue**.*

Surveillance Cameras, Glass Breakage and Smoke Detectors

Glass Breakage Detector

The typical acoustic glass breakage sensor works by using a microphone to measure the sound spectrum of pressure differences in the glass. The first signal wave represents the vibration caused by an object hitting the glass. This frequency is in the 200kHz range. The second signal, in the 5kHz frequency range, occurs when the glass breaks. The figure shows an implementation using a low dropout regulator, an amplifier and the MSP430 microntroller with an onboard ADC. A fast rail-to-rail amplifier is needed to boost the transducer signal to the ADC input voltage range. All following stages are integrated into the MSP430 signal controller.



Glass breakage detector block diagram

Device Recommendations

Device Type	Recommended Device	Device Characteristics
Microcontroller	MSP430F1132	1.8V to 3.6V lowest power microcontroller with integrated 10-bit, 200kSPS ADC
Operational Amplifiers	TLV278x	Fast 8MHz GBW, 4.3V/μs SR, 1.8V, RRIO operational amplifier with shutdown
	OPAx363	Fast 7MHz GBW, 6V/μs SR, 1.8V, RRIO amplifier with excellent input linearity and shutdown
Voltage Regulator	TPS77001	Adjustable, 50mA output current voltage regulator with low dropout and low quiescent current
Data Converter	ADS7866	Lower power family at 8-, 10-, 12-bit >200kSPS, 1.2V to 3.6V ADC

*Preview devices appear in **bold blue**.*

Electronic E-Meter

Electronic E-Meter

Industry's First Single-Chip IC for Electronic Energy Meters

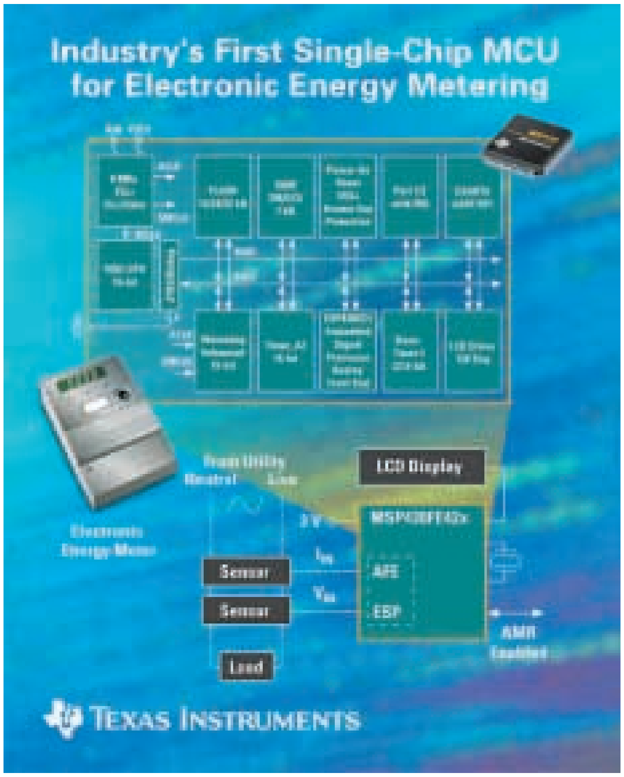
- Single-chip solution for electronic e-meter application
- Single supplier solution
- Analog Front End (AFE) with coprocessor integrated in the ESP430CE1 module.
- Ultra-low-power MSP430FE42x for extremely long life cycles
- Main CPU can run mainly for communication like ripple control, tariff switching or sleep
- Provides shunts, current transformers (CT) and di/dt sensors like Rogowski coils

Calculated Results:

- Active, reactive, apparent power
- Software programmable metering start current
- Status
- Waveform samples
- Power factor
- DC removal
- Mains period
- RMS, peak values (current/voltage)
- Temperature
- Line cycle counter
- Automatic voltage drop detection – level select by software
- Tamper detection for single phase, 2-wire metering

Next-Generation Electronic E-Meter

The MSP430FE42x is designed to meet the requirements of next generation electronic e-meters including the ability to meet different international standards such as IEC62053-21/22/23 (Europe) and ANSI C12.XX (US). High integration provides for an easy-to-use solution with the smallest size and lowest cost.



Device Recommendations

Device	Description	Key Features	Benefits	Other TI Solutions
Interface				
SN65HVD3082E	5-V, half-duplex RS-485 transceiver	Ideal for metering applications, low power consumption and slew-rate control	Cost-effective solution with low-power and slew-rate control	SN65HVD3085E
SN65LBC184	5-V, half-duplex RS-485 transceiver	Ideal for metering applications, integrated transient voltage protection and slew-rate control	Integrated Transient Voltage Protection for highest reliability	SN65LBC182
Data Converter				
ADS8364	6Ch, 16-bit, 250kHz SAR	High-speed simultanous sampling ADC for security power metering	Fastest control loop to secure circuit braker shut off	ADS1204
Op Amp				
OPA363	Rail-to-rail, 1.8V, high CMRR	Low noise , no crossover distortion at low power and high GBW 7MHz	Ideal for driving high speed and precision 16-bit ADCs	OPA2822, OPA350
Microcontrollers				
MSP430F42x	Ultra-low-power, 16-bit RISC CPU	Single-chip IC for Electronic E-meter	Easily integrated solution in a small package and lowest cost	MSP430FE425 MSP430FE27

Scientific Instrumentation

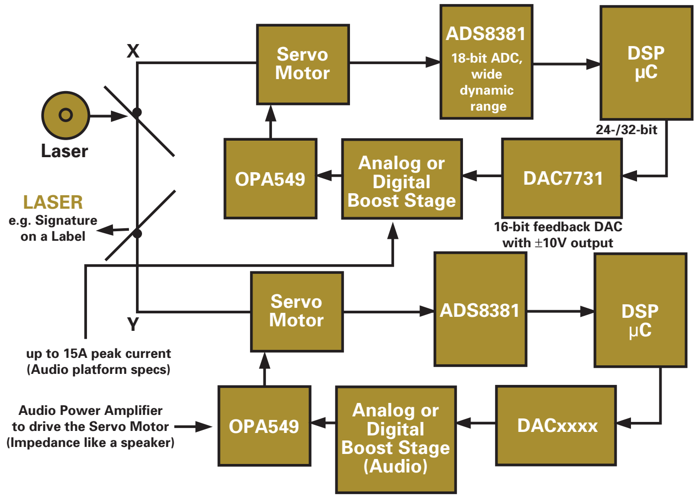
In today's industrial scientific instrumentation applications, such as gas/liquid chromatography, mass spectrometry and vibration analysis, the analog signal requires processing with maximum resolution at the highest speed while achieving optimum signal-to-noise ratio, lowest ripple and THD. For automatic test equipment (ATE) an excellent DNL and INL are also expected.

In gas chromatography applications, an ADC converts the signal and separates the desired frequency product from the mixture. Combining high resolution (16- to 18-bit range) with the highest speed (MHz range) while achieving high SNR is the major challenge.

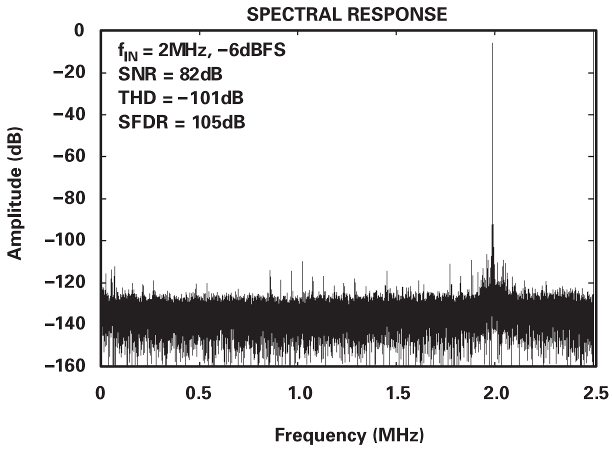
The ADS160x family of 16-bit, 5MSPS, delta-sigma ADCs was developed for applications based on a newly patented Adaptively Randomized DWA (Data Weighted Averaging) Algorithm architecture and works up to 5MHz (10MHz in 2x mode) bandwidth while achieving SFDR above 100dB.

For mass spectrometry application an unprecedented 0.0025% ripple can be expected.

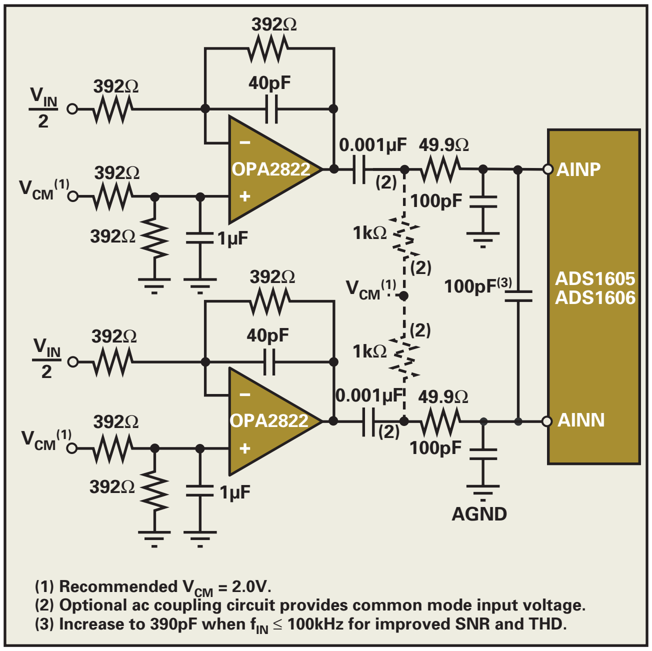
In applications such as mirror positioning for precision laser beam control, a very fast, high-resolution control loop is needed to achieve maximum accuracy and throughput. The ADC needs to have the lowest latency at maximum resolution to position the laser. The application below shows the ADS8381 (18-bit, 500kHz) – one of the fastest SAR ADCs available – with 112dB SFDR and 18-bits NMC.



DWF1-364838 laser mirror positioning application, test and working principle: 1 mirror for 1 direction



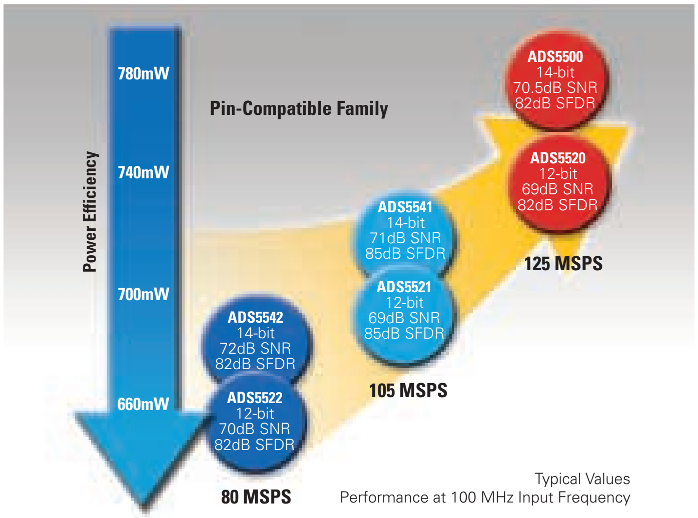
ADS160x typical spectral response



Recommended high-speed ADC driver circuit using OPA2822

High-Speed Signal Analysis

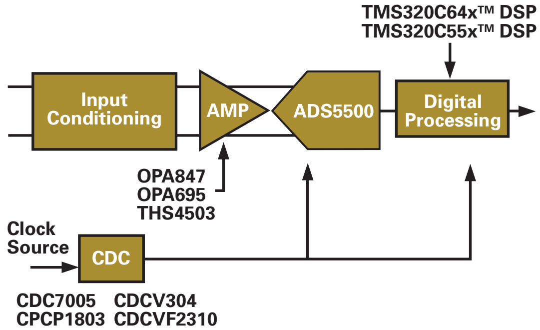
High-speed test and measurement applications are characterized by the need for high SNR, high sampling rate and other high-speed characteristics as determined by the system designer. Input signals may be large bandwidth and thus the input bandwidth of the ADC becomes critical (the ADS5500 family delivers 750MHz BW). At the same time, to support input frequencies higher than 1/2 the ADC's sampling rate, undersampling is often applied, requiring the converter to perform well (SNR/SFDR) at these high input frequencies. The ADS5500 operates well beyond 200MHz. Peripheral functions also have a dramatic impact on signal chain performance. The amplifier driving the ADC has a direct impact on SNR/SFDR, thus it must be chosen carefully to maintain specified system performance (OPA69x/OPA84x single-ended, THS450x/THS430x differential and THS900x for driving transformers are very good choices). Additionally, ADC performance is critically impacted by clock jitter; thus, a low-jitter clock source, such as the CDC7005, can provide an ideal solution.



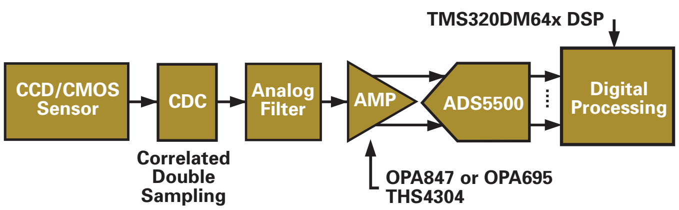
ADS55xx family has performance flexibility

ADS5500 in Video and Imaging Application (High-End Camera, Video Inspection, Motion Control, Security Camera)

The ADS5500's 14-bit resolution provides higher SNR to process high-quality images accurately, and simplifies the analog input circuitry by reducing the need for programmable gain amplifiers. Also, its high sample rate allows designers to scan images faster or oversample the input signal, which simplifies analog filter design and lowers system cost. The ADS5500's low power dissipation extends battery life in portable systems and provides cost savings due to the lower power supply and system thermal management requirements.



ADS5500 in test and measurement applications



ADS5500 in video and imaging applications

High-Performance ADCs

Device	Bits	MSPS	SNR (dB)	SFDR (dB)	Power (mW)
ADS5500	14	125	70.5	82	780
ADS5541	14	105	71	85	710
ADS5542	14	80	72	82	670
ADS5520	12	125	69	82	740
ADS5521	12	105	69	85	700
ADS5522	12	80	70	82	660

Additional Products

TI Solution	Device	Device Characteristics
Operational Amplifier	OPA695	Ultra-wideband (1.4GHz), current-feedback, 2500 V/µs slew rate (G=+2)
Operational Amplifier	THS9000	50 to 350MHz cascadeable op amp optimized for high IF frequencies
Digital-to-Analog Converter	DAC5686	Dual-channel 16-bit, 500MSPS with selectable 2x to 16x interpolation CommsDAC™
Digital Up/Down Converter	GC5016	Wideband, quad, channels independently configurable, low power
Clock Distribution Circuit	CDC7005	Low-phase noise, low-skew clock synthesizer and jitter cleaner, 3.3V supply
Digital Signal Processors	TMS320C64x™ TMS320C55x™	16-bit, fixed-point DSPs, up to 1GHz clock rates and 8 GigaMACs of performance, with the industry's best power consumption benchmarks
Digital Signal Processor	TMS320C67x™	32-bit DSPs with up to 1GFLOPS of floating-point processing performance

RF Applications

Industrial applications have had to wait many years for the availability of effective wireless solutions to overcome shop floor communications obstacles such as expensive cables and wiring costs. To date, efforts to simplify industrial interface has met with little success especially with more recent demands for lower power and overall system costs in applications such as metering, security systems, fire detectors and HVAC systems.

In response to these market demands, TI has introduced a multiband radio frequency (RF) transceiver, TRF6903, and transmitter, TRF4903. These devices can wirelessly transmit and/or receive up to 64kbps of data for the 315, 433, 868, and 915MHz industrial, scientific and medical (ISM) bands. The devices can interface easily to a baseband processor such as TI's MSP430. A synchronized data clock, provided by the TRF6903 and TRF4903, is programmable for most common data rates, eases baseband processing and reduces code complexity. The devices work exceptionally well with various MSP430 microprocessor family members and has complete EVM kits and software available.

The TRF6903 and TRF4903 are also single-chip solutions for low-cost multiband Frequency Shift Keying (FSK) or On/Off Keying (OOK) devices used to establish a frequency-programmable, half-duplex, bidirectional RF link. The devices operate down to 2.2V and are designed for low power consumption with a 0.6µA standby current.

For frequency hopping systems, these devices are the fastest and most efficient hoppers available. The TRF6903 and TRF4903 require no calibration when switching to a new frequency which makes them highly efficient at high data rates.

Features:

- Transceiver (TRF6903) and Transmitter (TRF4903) available
- 315, 433, 868 and 915MHz operation
- Apt for frequency hopping protocols
- Clock recovery with training recognition
- Standby current: 0.6µA (typ)
- 2.2V to 3.6V operation
- Output power: +8dBm (typ)
- FSK/OOK modes of operation
- Data rates up to 64kbps
- Industrial temperature range: –40°C to 85°C

Tools Available:

- Free samples
- Evaluation modules at $149 each
  - MSP-TRF6903-DEMO: Two boards equipped with TRF6903 and MSP430F449
  - MSP-TRF4903-DEMO: Two boards equipped with TRF4903 and MSP430F449.

The EVM kits for the TRF6903 and TRF4903 are used to demonstrate a bidirectional RF link between the two boards and for prototyping by downloading new software code to the MSP430F449 using a JTAG connector. The schematic and board layouts can be used as a reference design if desired. A user's guide is included.

System Design Software

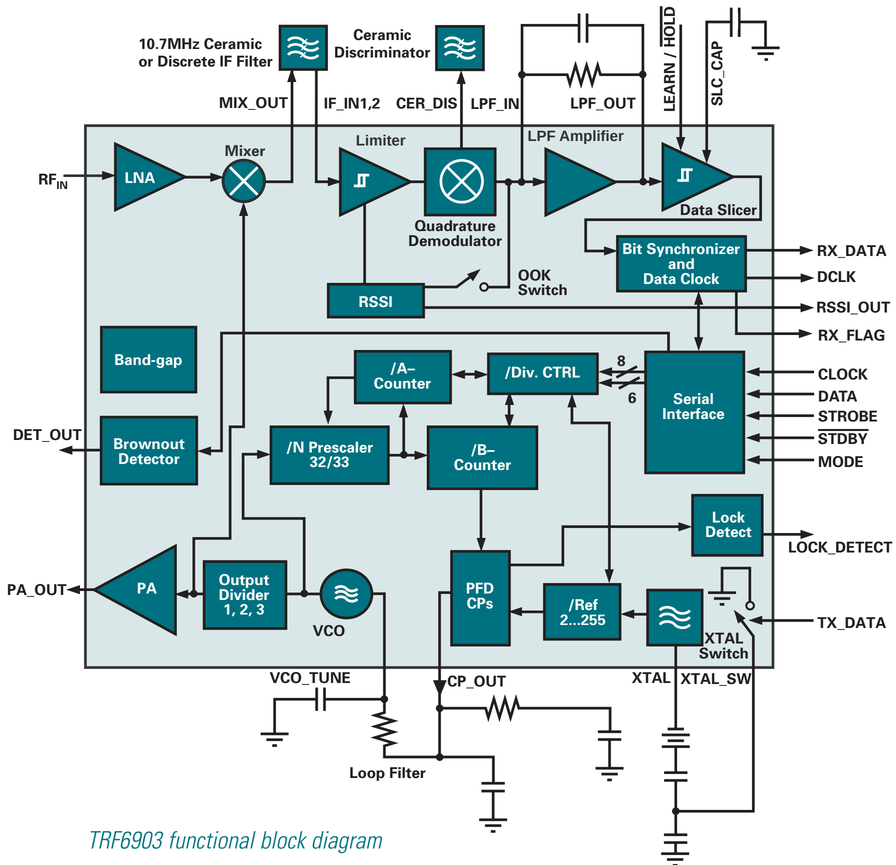
EasyRF™ tools for TRF6903: Calculates values for PLL filter, LNA, PA matching, crystal switch caps, IF matching and S/H capacitors.

EasyRF™ for TRF4903: Calculates values for PLL filter, PA matching, and crystal switch caps.

TRF6903 wireless connection for 315, 433, 868, and 915MHz operation

To download these tools or for further information on ISM RF, please visit www.ti.com/ismrf

RF Applications



TRF6903 functional block diagram

Wireless Communication Devices for Industrial Applications

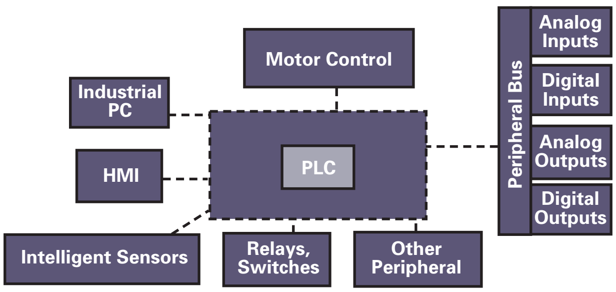
Device	Description	Frequency (MHz) Min	Frequency (MHz) Max	Standards Supported	Output Power (dBm)	Operating Voltage (V) Min	Operating Voltage (V) Max	Current (µA)	Package	Price
TRF6903	RF Transceiver	315	915	FSK, OOK	8	2.2	3.6	0.6	PQFP-48	$2.85
TRF6901	RF Transceiver	860	930	FSK, OOK	8	1.8	3.6	0.6	PQFP-48	$2.70
TRF6900A	RF Transceiver	850	950	FSK, Narrow-band FM	5	2.2	3.6	0.5	PQFP-48	$3.20
TRF5901	RF Transceiver	902	928	FSK, Narrow-band FM	5	3	3.6	0.5	PQFP-48	$3.20
TRF4903	RF Transmitter	315	915	FSK, OOK	8	2.2	3.6	0.6	TSSOP-24	$2.00
TRF4900	RF Transmitter	850	950	FSK, Narrow-band FM	7	2.2	3.3	0.5	TSSOP-24	$1.90
TRF4400	RF Transmitter	420	450	FSK, Narrow-band FM	7	2.2	3.6	0.5	TSSOP-24	$1.90

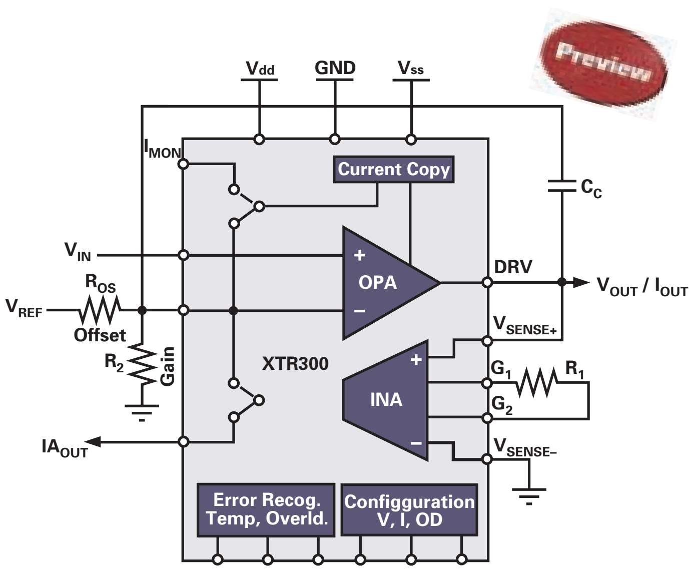
Input/Output Cards, Internal Communication/Interface/Isolation, Core Logic

Programmable Logic Controls (PLC) are widely used in industrial applications primarily in the areas of factory and process automation. PLC systems consist of different subsystems realized either as complete integrated systems or as base unit plus plug-in cards/ modules for different options.

Industrial Analog I/Os

PLCs and field extension modules control large numbers of electronic actuator, such as motors, solenoids and electronic ballasts. Due to the wide range of actuator and their different performance requirements, the XTR300 provides signals in the form of drive voltage or current with large voltage offset compliance. Typical voltage ranges are ±5V, ±10V, while current ranges include ±20mA, ±10mA, as well as 0-20mA and 4-20mA.





XTR300 functional block diagram

In addition to these common ranges, many proprietary signal interfaces exist, which all have one problem in common; tailoring the electronic drive's design to match the required actuator's input.

To ease this design task, TI has developed an industrial analog current/voltage output driver, the XTR300. This device provides an operational amplifier working as a signal driver in the forward direction, and an instrumentation amplifier in the feedback loop.

Digital control sets the XTR300 into voltage-output or current-output mode. Error flags indicate over-temperature, load-error, and common-mode error.

For most applications the setting of just two resistor values (R_1 and R_2), as well as the selection between current or voltage mode is sufficient to accommodate a wide range of output signals of up to ±25mA or ±17.5V.

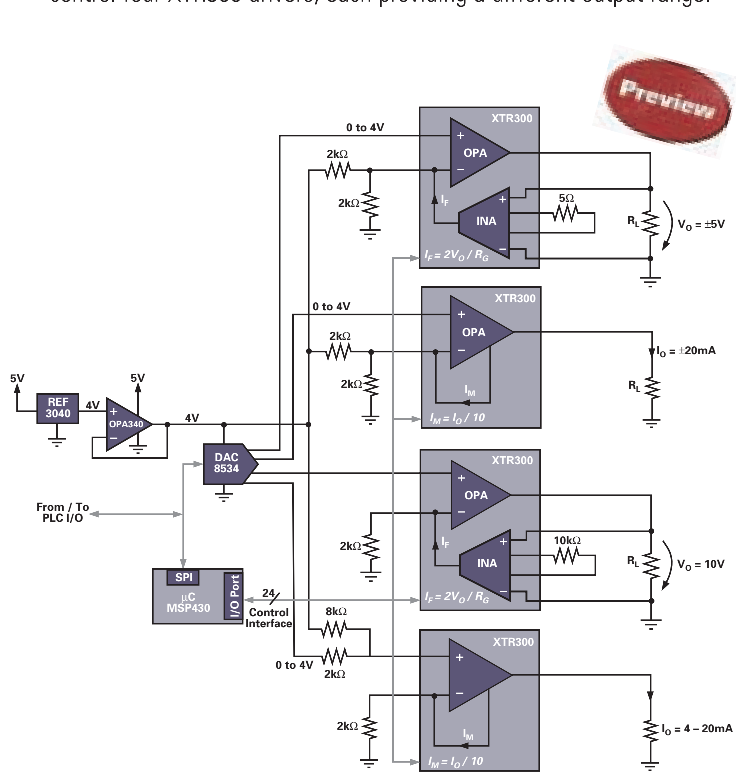
For more exotic output ranges, modification of the reference voltage, V_{REF}, and the gain resistor, R_{OS}, is possible.

The figure to the right shows a typical application for a single-channel output of ±10V or ±20mA, depending on the XTR300's digital control for either voltage or current mode.

A reference voltage is applied to the control DAC, DAC8531, and to the XTR300. The microcontroller performs device configuration, error monitoring and also provides the DAC input code. The analog output of the DAC8531 feeds the input of the XTR300, which then drives the load behind the terminal connector.

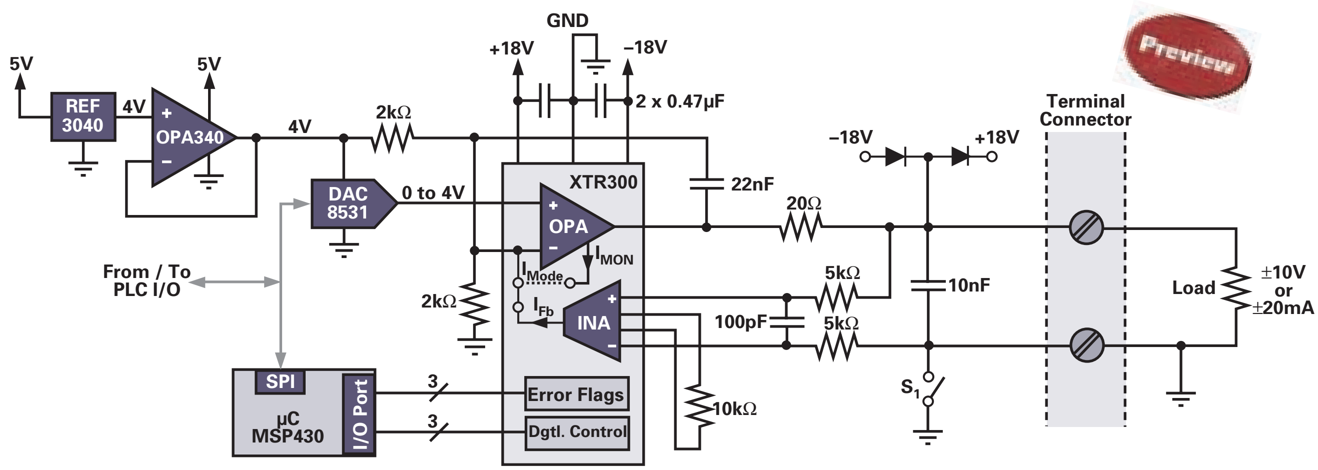
For a floating load, switch S_1 provides the option for establishing ground referred input signals to the instrumentation amplifier. The LC and RC networks perform RF- and LF-noise rejection.

The multi-channel driver shown below uses a quad DAC, DAC8534, to control four XTR300 drivers, each providing a different output range.



Quad-channel drive with 4 x XTR300

Input/Output Cards, Internal Communication/Interface/Isolation, Core Logic



Single-channel drive with XTR300, V_{IN} = 0 – 4V, V_{OUT} = ±10V or I_{OUT} = ±20mA

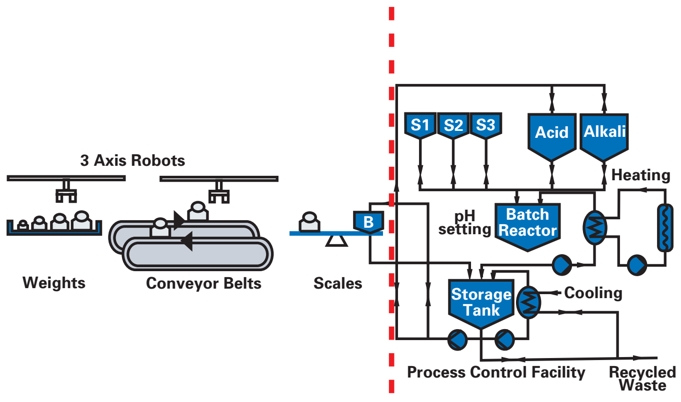
Device Recommendations

Device	Description	Key Features	Benefits	Other TI Solutions
Power Management Products				
REF3140	Voltage reference	Drift = 20ppm/°C, 4.097V, 0.2%	Very low drift, tiny package	REF02, REF102
DCV010515D	Dual converter	Isolation converter, $+5V_{IN}$, $\pm15V_{OUT}$	Low noise, small board area	DCP010515
DCV010505D	Dual converter	Isolation converter, $+5V_{IN}$, $\pm5V_{OUT}$	Low noise, small board area	DCP010505
TPS54110	SWIFT™ buck converter	Adjustable output (0.9V – 3.3V), 1.5A	Very easy to use, flexible output	TPS64200
Amplifiers				
INA118	Instrumentation amp	Gain = 1 to 1000, CMRR > 110dB, 8-pin	Very low power	INA128
ISO124	Isolation amp	Isolation = 2400V, Output = ±10V	No external components required	ISO122
PGA204	Prog. gain INA	Gain of 1, 10, 100, 1000, precision	Small package	PGA203
OPA227	Low noise amp	V_N = 3nV, CMRR > 120dB, V_S = 5–36V	Very low noise, small package	OPA350, OPA725
DRV591	PWM driver	±3A max, high efficiency, tiny package	Single 5V supply, tiny package	DRV104
OPA569	Linear power amp	2.4A, RRO 200mV to rail, thermal protection	Single 5V, tiny package, complete solution	OPA549
XTR300	I/O Driver	±10V, ±20mA, Input/Output	Multipurpose I/O driver for all industrial I/O voltage currents	—
Data Converters				
ADS8325	16-bit, 100kSPS ADC	Power = 2mW, 8-pin, SFDR = 86dB, power = 82mW	Single 5V supply, power only 2mW, single 5V supply for bipolar	ADS8320
ADS7809	16-bit, 100kSPS ADC	Power = 2mW, 8-pin, SFDR = 86dB, bipoloar (±10V), power = 82mW	Single 5V supply, power only 2mW, single 5V supply for bipolar	ADS7805, ADS8321 ADS8509, ADS8505
ADS8402	16-bit, 1.25MSPS ADC	Power = 2mW, 8pin, SFDR = 86dB, bipoloar (±10V), power = 82mW	Single 5V supply, power only 2mW, single 5V supply for bipolar	ADS8412
ADS1251	24-bit, 20kSPS ADC	Power = 155mW, 8-pin, SFDR = 100dB, power = 7.5mW, INL = 0.0015%	Excellent performance, only 7.5mW, single 5V supply	ADS1252
DAC7731	16-bit, 5μs settling time	Output = ±10V, INL = 0.0015%	Small package	DAC7741
DAC7631	16-bit, 10μs settling time	Power < 2mW, output = ±2.5V	Single 5V, small package	DAC7641
DAC8534	Quad, 16-bit DAC	Low power, 16-bit swing DAC	Excellent price/performance ratio	DAC8532
Interface				
PCI2050B	PCI-PCI bridge	66MHz, 32-bit	—	PCI2250
SN65HVD24	RS-485	Failsafe, extended common mode, RX EQ	Only RX with EQ in industry	SN65HVD23
SN65MLVD200A	M-LVDS transceiver	100Mbps, 8-pin package	First M-LVDS complete transceiver	SN65MLVD202A
SN65HVD485E	Half-duplex transceiver	5V supply, MSOP-8, 10Mbps	Thermal shutdown protection, low supply current	—
TLK2201	Gigabit Ethernet TRX	10-bit interface, 1 – 1.6Gbps serial	Power < 200mW	TLK1501, TLK1201
Other				
UAF42	Active filter	Low-, high- or band-pass filter	Fully integrated active filter	RC Filter
MPC50x	Analog mux	Analog input = ±15V	—	—
FilterPro™	Free design software	Design low pass filters, quick, easy	Free, www.ti.com	—

*Preview devices are listed in **bold blue**.*

Factory Communications

Industrial Automation is the computerization of manufacturing and process steps, which workers can't carry out as fast, as precise or as often as a machine. Traditionally Industrial Automation has been separated into two major categories: Factory Automation and Process Automation.



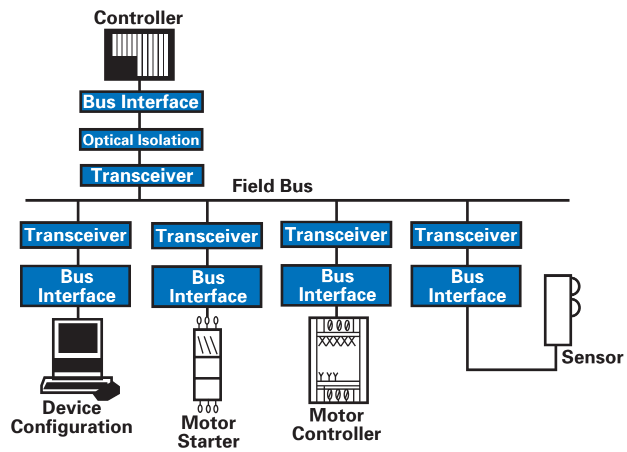
Factory Automation *Process Automation*

Factory Automation *senses and drives physical quantities such as pressure, temperature, flow, force vibration, mass and density. Applications typically require 10-12 bits of resolution and communicate at rates between 50 and 400kbps. However, there are several technologies that communicate at much faster signaling rates, such as PROFIBUS DP running at 12Mbps.*

Process Automation *performs compositional measurements such as conductivity, pH and chemical analysis in addition to physical quantities as in Factory Automation. Applications typically require 16 bits of resolution and communication rates between 10 and 50kbps.*

Nodes in Industrial Automation environments are grouped into three distinct families: controllers, sensors and actuator. As the name suggests, controllers are used to manage variables such as temperature based on pre-determined values and information provided by sensors. If the difference between a pre-determined and sensed value exceeds a certain limit, the controller tries to manipulate the variable through an actuator such as a cooler. The number of nodes and the distance separating these nodes can vary greatly, which creates the need for specialized communications called industrial networks.

In the 1940s, process instrumentation used 3 to 15psi pressure signals for monitoring control devices. By the 1960s, the first standardized communication method was introduced—the 4-20mA technique of pure analog current-loop signaling. By the nature of the technology, every node requires its own set of cabling between the controller and itself, which creates a maze of cables, yet it is still used extensively in industrial networks. In the 1970s, industrial applications began using PLCs (programmable logic controllers) and digital computers. By the mid 1980s, industry's quest for a standardized all-digital field-bus became a reality. However, major industrial companies and countries, mainly Germany, France and the US, did not let go of their de facto standards, so multiple competing standards came into use such as PROFIBUS, InterBus, DeviceNet and others. These field-buses are simply all-digital, serial, two-way communication systems that serve as a Local Area Networks (LAN) for factory/plant instrumentation monitoring and device control.



Process automation system

Requirements in Industrial Environments:

Many hazards threaten the various electrical devices and it is difficult to encase or protect interface cabling. Both device and network must be able to maintain operation even under the most undesirable conditions. Common hazards include:

- Power surges (e.g. of nearby motors)
- Ground potential differences (e.g. due to equalizing currents)
- Electrostatic Discharge (ESD)
- Excessive number of nodes (e.g. in flow control many sensors and actuator)
- Long cable lengths in large factories

In order to maintain operation under such circumstances, devices need the following properties:

- Immunity to power surges (transient suppression)
- Wide common-mode range
- High ESD protection
- Low unit load, allowing for many nodes
- High output drive, high sensitivity, receiver equalization, pre-emphasis

Download the *Interface Selection Guide at:*
interface.ti.com

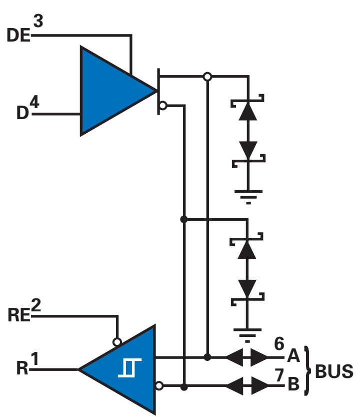
5V, RS-485 Transceivers with Integrated Transient Suppression
SN65LBC184/SN65LBC182

Get samples, datasheets and app reports at:
www.ti.com/sc/device/SN65LBC184,
www.ti.com/sc/device/SN65LBC182

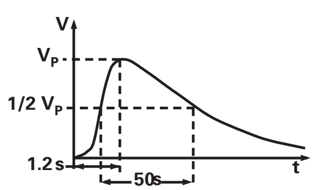
The SN65LBC184 differential data line transceiver is available in the trade-standard footprint of the SN75176 with built-in protection against high-energy noise transients. This feature provides a substantial increase in reliability for better immunity to noise surges coupled to the data cable over most existing devices. Use of these circuits provides a reliable low-cost, direct-coupled (with no isolation transformer) data line interface without requiring any external components. The SN65LBC184 can withstand over-voltage transients of 400-W peak (typical). The conventional combination wave called out in IEC 61000-4-5 simulates the over-voltage transient and models a unidirectional surge caused by inductive switching and secondary lightning transients.

Key Features (LBC184)

- Integrated transient voltage suppression
- Standard RS-485 common-mode voltage range: –7V to 12V
- JEDEC & IEC ESD protection:
  - ±30kV IEC 61000-4-2, contact discharge
  - ±15 kV IEC 61000-4-2, air-gap discharge
  - ±15kV EIA/JEDEC, human body model
- Up to 128 nodes on a bus (1/4 unit-load)



Functional logic diagram (positive logic)



Surge waveform combination wave

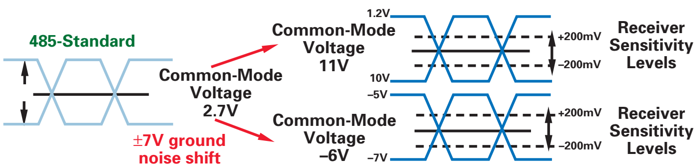
Extended Common Mode Transceivers with Optional Receiver Equalization
SN65HVD2x

Get samples, datasheets and app reports at: **www.ti.com/hvd2x**

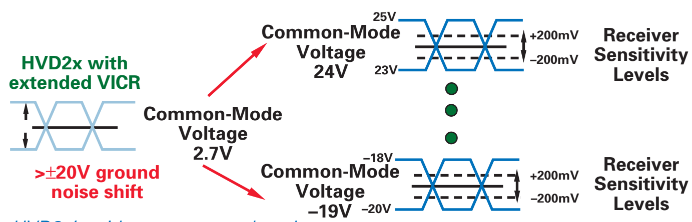
The SN65HVD2x device series offers a very wide input voltage operating range. The RS-485 standard requires functionality at DC-levels at the receiver input between –7V and +12V (±7V plus swing of up to 5V). These devices nearly triple this requirement and are fully functional between –20V and +25V, while surviving ±27V and transients up to 60V.

Key Features

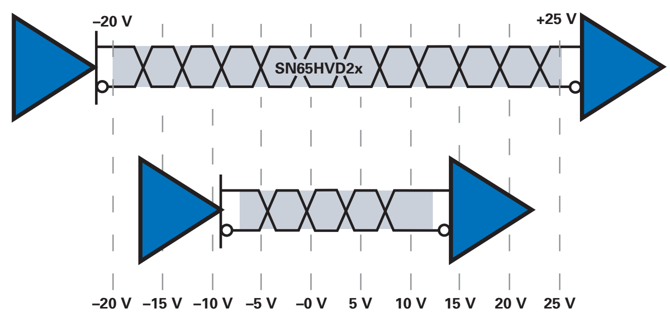
- Common-mode voltage range (–20V to +25V) more than doubles TIA/EIA-485 requirement
- Best in class ESD protection in the industry: 16kV HBM
- Up to 256 nodes on a bus (HVD21, 22 and 24) (1/8 unit-load)
- Optional receiver equalization (HVD23 and HVD24)



RS-485 standard operation



HVD2x's wide common-mode voltage range



SN65HVD2x extended common-mode voltage range

Device Recommendations

Numbers	Cable Length and Signaling Rate	Number of Nodes
SN65HVD20	Up to 50m at 25Mbps	Up to 64
SN65HVD21	Up to 150m at 5Mbps (with slew rate limit)	Up to 256
SN65HVD22	Up to 1200m at 500kbps (with slew rate limit)	Up to 256
SN65HVD23	Up to 160m at 25Mbps (with receiver equalization)	Up to 64
SN65HVD24	Up to 500m at 3Mbps (with receiver equalization)	Up to 256

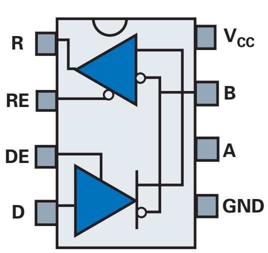
Factory Communications

PROFIBUS Transceiver
SN65HVD1176

Get samples, datasheets and app reports at:
www.ti.com/sc/device/SN65HVD1176

PROFIBUS is the most frequently used process-automation bus in Europe, and is growing in use in other regions. Despite this fact, the selection of suitable transceivers is very limited. In fact, for many years, TI's SN65ALS1176 has been the only device approved by the PROFIBUS User Organization. The reason for this is that a high output drive is required (minimum 2.1V differential) and at the same time, the bus-capacitance must not exceed 10pF. These requirements actually oppose each other and the combination is hard to achieve. The SN65HVD1176 fulfills all PROFIBUS requirements, plus offers very good noise rejection to common-mode noise and has significantly improved timing parameters.

Key Features
- Standard RS-485 common-mode voltage range: –7V to 12V
- High ESD protection of 10kV HBM
- Up to 160 nodes on a bus (1/5 unit-load)
- High output drive: differential output exceeds 2.1V



HVD1176 functional block diagram

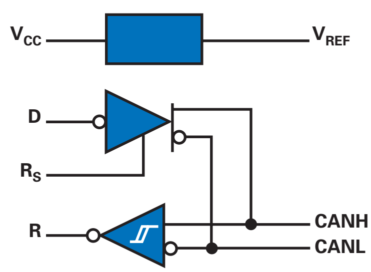
3.3V and 5V CAN Transceivers
SN65HVD23x/SN65HVD251

Get samples, datasheets, EVMs and app reports at:
www.ti.com/sc/device/PARTnumber
Replace **PARTnumber** with **SN65HVD230**, **SN65HVD231**, **SN65HVD232**, **SN65HVD233**, **SN65HVD234**, **SN65HVD235** or **SN65HVD251**

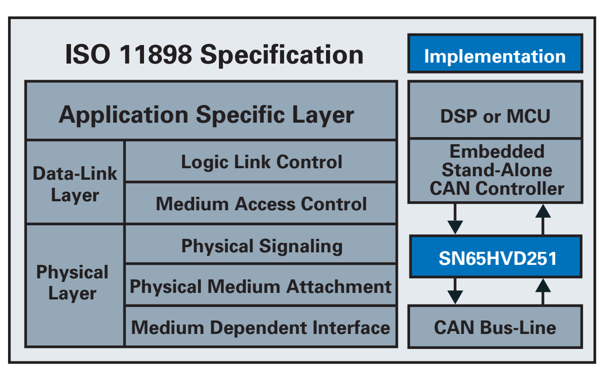
The SN65HVD251 (5V) and SN65HVD23x (3.3V) families of CAN transceivers are intended for use in harsh environment applications. They feature cross-wire, loss-of-ground, over-voltage and over-temperature protection, and wide common-mode range and can withstand common-mode transients of ±200V. The SN65HVD230/1/2 operate over a –2V to 7V CMR on the bus, and can withstand common-mode transients of ±25V; SN65HVD233/4/5 and SN65HVD251, operate over a –7V to 12V CMR and will withstand transients of ±100V and ±50V, respectively.

Key Features for SN65HVD251
- Drop-in improved replacements for the PCA82C250 and PCA82C251
- Bus-fault protection of ±36V
- Bus-pin ESD protection exceeds 14kV HBM
- High input impedance allows up to 120 SN65HVD251 nodes
- Meets or exceeds the requirements of ISO 11898

Applications
- CAN data buses
  - DeviceNet™ data buses
  - Smart distributed systems (SDS)
- SAE J1939 standard data bus interface
- NMEA 2000 standard data bus interface
- ISO 11783 standard data bus interface



Functional diagram (positive logic)



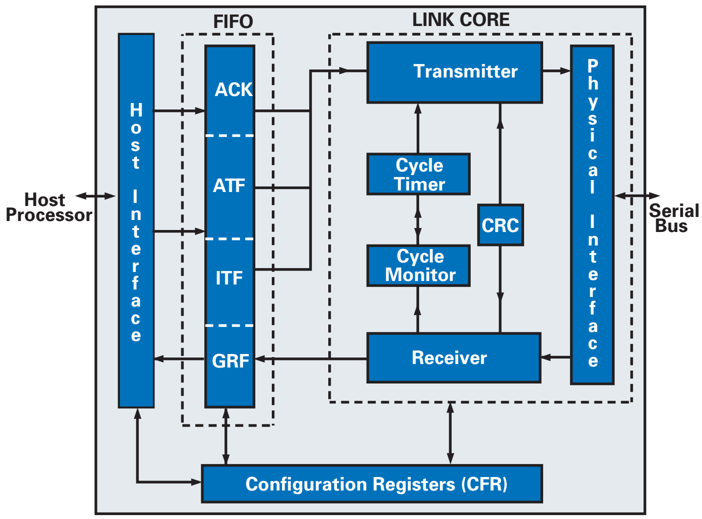
High-Performance 1394-1995 Link Layer for Industrial and Bridge Applications
TSB42AC3

Get samples, datasheets, EVMs and app reports at:
www.ti.com/sc/device/TSB42AC3

The TSB42AC3 is a 1394-1995 general-purpose link layer ideal for a wide range of applications. The TSB42AC3 provides a high-performance interface with the capability of transferring data between the 32-bit host controller and the 1394 PHY-link interface. The 1394 PHY-link interface provides the connection to the 1394 physical layer device (PHY). The LLC provides the control for transmitting and receiving 1394 packet data between the FIFO and PHY-link interface at rates of 50 (backplane only), 100, 200, and 400Mbit/s.

Key Features
- Generic 32-bit, 50-MHz host bus interface
- Programmable 10K byte total for asynchronous, isochronous and general FIFO
- Separate ACK FIFO register decreases SCK-tracking burden on the host
- Additional programmable status output to pins
- Completely software compatible with the TSB12LV01B
- IEEE 1149.1 JTAG interface to support board level scan testing

Applications
- Motor/motion/process control
- Industrial imaging



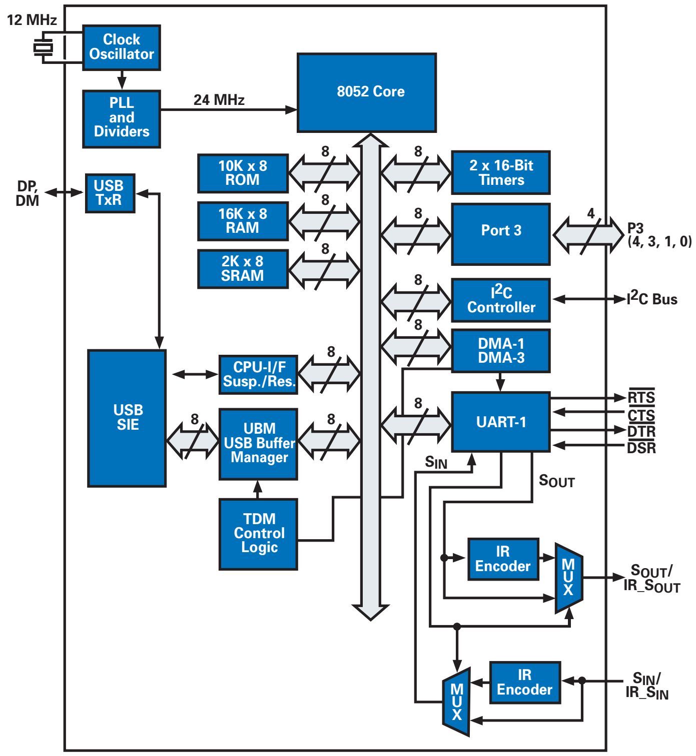
TSB42AC3 functional block diagram

USB-to-Serial Bridge
TUSB3410

Get samples, datasheets, EVMs and app reports at:
www.ti.com/sc/device/TUSB3410

The TUSB3410 provides an easy way to move your UART device to a fast, flexible USB interface by bridging between a USB port and an enhanced UART serial port. The TUSB3410 contains all the necessary logic to communicate with the host computer using the USB bus. The TUSB3410 can be used to build an interface between a legacy serial peripheral device and a PC with USB ports, such as a legacy-free PC. An evaluation module can jump-start your USB development, or you can use it as a complete USB-to-RS-232 converter.

Key Features
- Built-in, two-channel DMA controller for USB/UART bulk I/O
- Enhanced UART features including programmable software/ hardware flow control and automatic RS-485-bus transceiver control, with and without echo



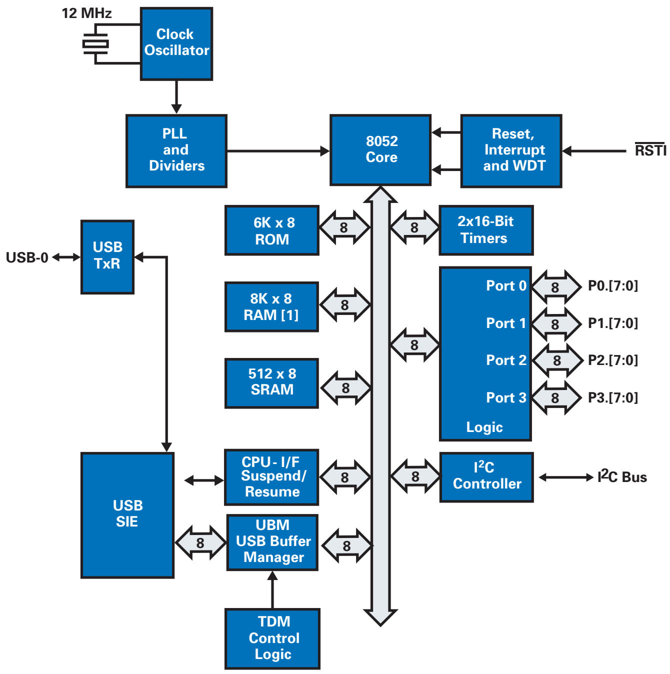
The TUSB3410 can support a total of three input and three output (interrupt, bulk) endpoints

USB-Based Controller with MCU GPIO
TUSB3210

Get samples, datasheets, EVMs and app reports at:
www.ti.com/sc/device/TUSB3210

The TUSB3210 is a USB-based controller with a general-purpose, industry-standard 8052 MCU and a 32 GPIO. It contains 8K x 8 RAM space for application development. The TUSB3210 is programmable, making it flexible enough to use for a variety of general USB I/O applications

Key Features
- Supports 12Mbps USB data rate (full speed)
- Supports USB suspend/resume and remote wake-up operation
- Integrated 8052 microcontroller



TUSB3210 functional block diagram

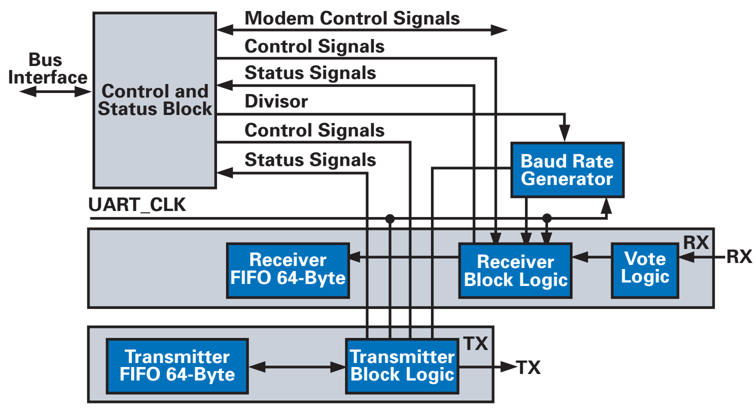
Quad UART with 64-Byte FIFO
TL16C754B

Get samples, datasheets and app reports at:
www.ti.com/sc/device/TL16C754B

Texas Instruments' wide portfolio of space-saving, performance-enhancing UARTs are pin-for-pin compatible with many leading UART manufactures' devices.

Key Features
- 3.3V and 5V operating voltages available
- 64-byte programmable trigger-level FIFO buffering
- Up to 3.2Mbps data transfer rate

Applications
- Industrial automation controls
- Base stations
- Cell phones
- PCs



TL16C754B functional block diagram

Digital Coupler and Isolation Amplifiers

There are many applications where it is desirable, even essential, that a sensor have a direct (galvanic) electrical connection with the system to which it is supplying data in order to avoid either dangerous voltages or currents from one half of the system from damaging the other half, or breaking an intractable ground loop. Such a system is said to be "isolated", and the area which passes a signal without galvanic connections is known as an "isolation barrier".

Isolation barrier protection works in both directions, and may be needed in either half of the system, sometimes both. Common applications requiring isolation protection are those where sensors may accidentally encounter high voltages, and the system it is driving must be protected. Or a sensor may need to be isolated from accidental high voltages arising downstream in order to protect its environment: examples include prevention of explosive gas ignition caused by sparks at sensor locations or protecting patients from electric shock by ECG, EEG and EMG test and monitoring equipment. The ECG application may require isolation barriers in both directions: the patient must be protected from the very high voltages (>7.5kV) applied by the defibrillator, and the technician handling the device must be protected from unexpected feedback.

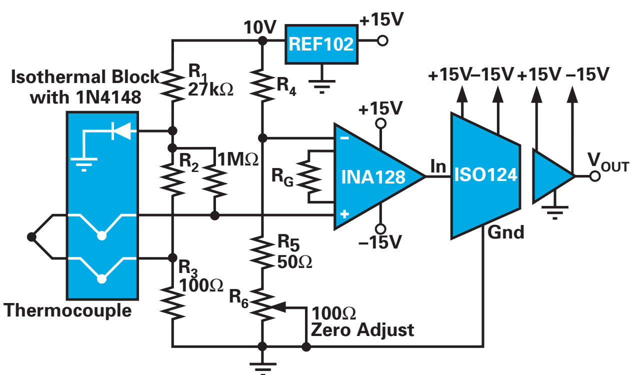
Applications for Isolation Amplifiers

- Sensor is at a high potential relative to other circuitry (or may become so under fault conditions)
- Sensor may not carry dangerous voltages, irrespective of faults in other circuitry (e.g. patient monitoring and intrinsically safe equipment for use with explosive gases)
- To break ground loops

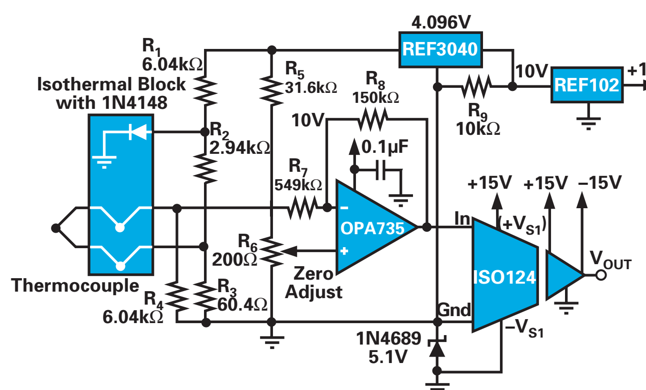
Isolation Amplifier Design

Obstacles in isolation amplifier design include offset, drift, gain accuracy, and nonlinearity or distortion. The high-performance isolation amplifier applies either linear optocouplers (LOCs), or modulators with digital capacitive isolation, either of which is implemented differentially to increase linearity over a large signal range. Isolation amps use dual-feedback circuit topology to significantly reduce distortion.

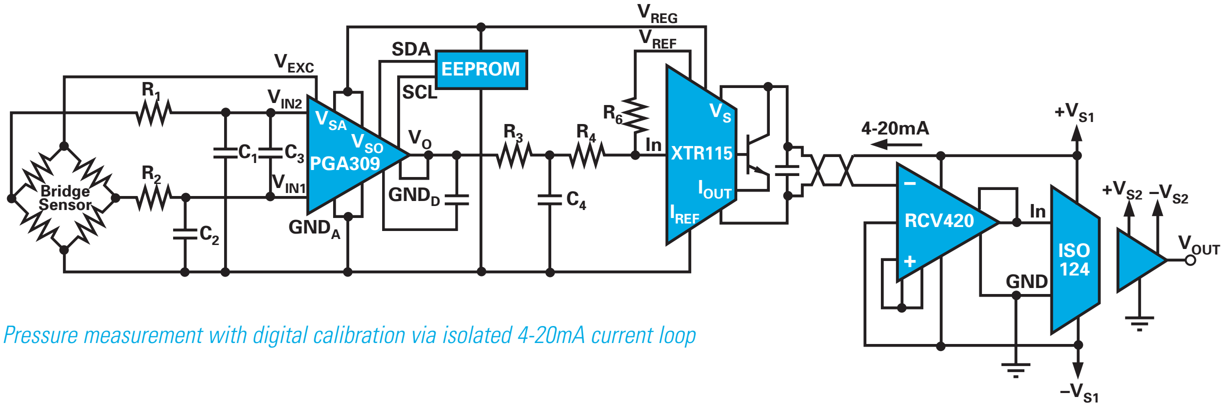
While feedback across the barrier corrects for these errors, it only does so as long as the circuit on each side of the barrier is an exact match. This is difficult to achieve as the circuits are not on the same piece of silicon. In integrated circuit isolation amplifiers, the output and feedback demodulator are made from "adjacent" die from the same silicon wafer, allowing for better matching than discrete designs.



Isolated temperature measurement with dual supplies



Isolated temperature measurement with single supply



Pressure measurement with digital calibration via isolated 4-20mA current loop

Digital Coupler and Isolation Amplifiers

Galvanic Isolation Solutions

System designers must contend with poor power quality, ground faults, and lightning strikes interfering with or disrupting system performance. Additionally, the distance between the nodes on a network can be substantial and often AC outlets from different ground domains power the nodes. The potential difference between these ground domains may include a dc bias, 50 or 60Hz AC harmonics, and various transient noise components.

If these grounds are connected together by a cable logic ground or shielding, a ground loop can exist and current will flow into the cable. Ground-loop currents can have severe effects on a network, including the degradation of data, excessive EMI, component damage, and when the potential difference is large enough, a human electrical hazard.

New magnetic field isolation techniques not only retain old problems like high power consumption, no fail-safe output and a restricted operating temperature range, but also introduce a whole new set of problems associated with susceptibility to external magnetic fields.

TI isolation solutions are designed to eliminate problems associated with existing isolation technologies. Problems such as high power consumption, no fail-safe output, low signaling rates and high pulse-width distortion are common. When using optocouplers, the low efficiency with which the electro-optical conversion occurs is especially problematic as the amount of current required to turn on the phototransistor increases with the age of the part. This is due to the LED's reduction of light emission over time and which is accelerated by high operating temperatures.

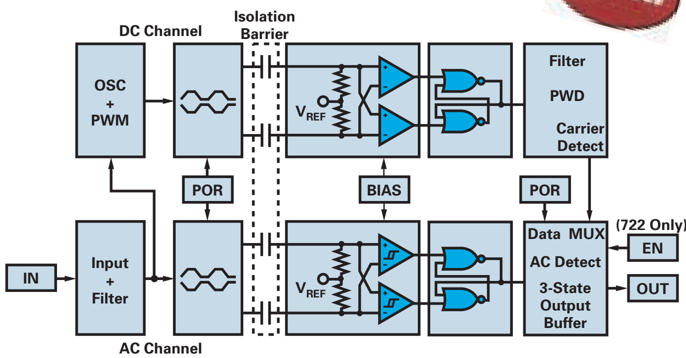
The soon to be released (2Q 2005) ISO721 and ISO722 provide isolation solutions solving all of these problems. Other isolation products currently in development at TI include multi-channel isolators, isolated CAN and RS-485 transceivers, isolated op amps, isolated data converters and an isolated gate controller interface.

3.3V High-Speed Digital Isolators
ISO721/ISO722

The ISO721 digital isolator is a logic input and output buffer separated by a silicon oxide (SiO_2) insulation barrier that provides galvanic isolation of up to 4000V. Used in conjunction with isolated power supplies, the device prevents noise currents on a data bus or other circuits from entering the local ground and interfering with or damaging sensitive circuitry.

A binary input signal is conditioned, translated to a balanced signal, then differentiated by the capacitive isolation barrier. Across the isolation barrier, a differential comparator receives the logic transition information, then sets or resets a flip-flop and the output circuit accordingly. A periodic update pulse is sent across the barrier to ensure the proper dc level of the output. If this dc-refresh pulse is not received for more than 4µs, the input is assumed to be unpowered or not functional, and the fail-safe circuit drives the output to a logic high state.

Key Features
- 4000V isolation
- Fail-safe output
- Signaling rate up to 100Mbps
- UL 1577, IEC 60747-5-2 (VDE 0884, Rev. 2), IEC 61010-1 and CSA Approved
- 25kV/µs transient immunity



ISO721 functional block diagram
Product release scheduled for 2Q 2005

How to Power Your Industrial Application

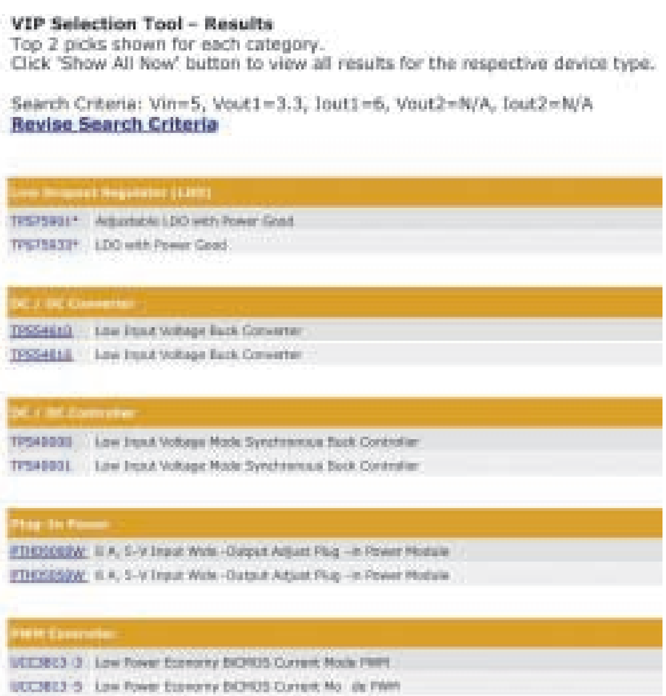
TI offers extensive online information on powering industrial designs.

(1) Controllers for Typical Industrial Power Supplies

The TPS40054/55/57 and TPS40060/61 are families of synchronous buck controllers with input voltage ranges of 8V - 40V and 10V - 55V, respectively. Learn more about these products at:
www.ti.com/sc/device/tps40054

(2) Controllers for Very Economical Power Supply Design

The TL5001 and TL5001A offer an industrial input voltage range from 3.6V to 40V. Their flexible PWM control architecture allows cost-optimized power supplies for a variety of industrial control solutions. More details at:
www.ti.com/sc/device/tl5001 and www.ti.com/sc/device/tl5001a



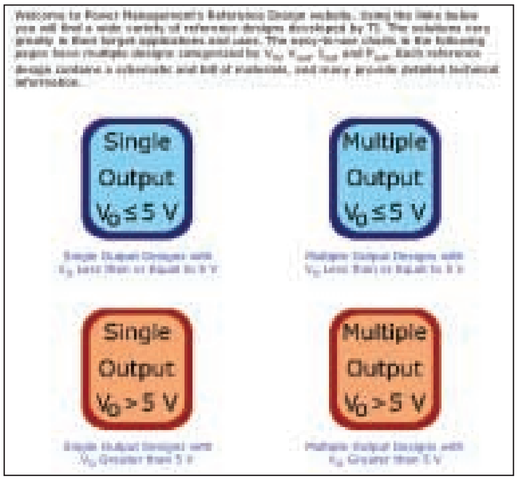
Example:	**Results in Top Recommendations for:**
1. Enter your Voltage In (V)	• LDOs
2. Enter your Voltage Out (V)	• DC/DC Converters
3. Enter your Current Out (A)	• DC/DC Controllers
4. Select Search Devices	• Plug-In Modules
	• PWM Controllers

(3) Select an Appropriate Device Using TI's VIP Tool

Visit power.ti.com, click on the "VIP Selection Tool" button and enter the desired input and output voltage(s). This tool provides recommendations from our many product portfolios, including DC/DC controllers, DC/DC converters, low-dropout linear regulators, PWM controllers and complete module solutions.

(4) Reference Design Resources

Our reference design home page features solutions including schematics and detailed bills of materials. Go to power.ti.com, select "Design Resources" and then "Reference Designs."



(5) Not Sure Which Architecture Will Fit?

The Power Supply Topology poster, available at: http://focus.ti.com/lit/ml/sluw001/sluw001.pdf, provides typical power supply devices for each topology. The Power Management Applications Solutions brochure, available at: http://focus.ti.com/lit/ml/slub007/slub007.pdf, lists relevant application notes.

(6) Power Management Selection Guide

This guide provides an overview of TI's extensive power supply product portfolio. You can download the guide at: http://power.ti.com/selectionguide

(7) Powering Xilinx and Altera FPGAs

Texas Instruments offers a variety of ready-to-use solutions to power core and I/O voltages for Altera® and Xilinx® FPGAs. Web pages for Altera (www.ti.com/alterafpga) and Xilinx (www.ti.com/xilinxfpga) feature Power Management Reference Guides, along with downloadable schematics and bills of material for each design.

Amplifiers

Difference Amplifiers Selection Guide

Device	Description	Spec Temp Range	Ch.	Gain	Offset (µV) (max)	Offset Drift (µV/°C) (max)	CMRR (dB) (min)	BW (MHz) (typ)	Output Voltage Swing (V) (min)	Power Supply (V)	I_Q (mA) (max)	Package(s)	Price[1]
General Purpose													
INA132	Micropower, high-precision	I[2]	1, 2	1	250	5	76	0.3	(V+) – 1 to (V–) + 0.5	+2.7 to +36	0.185	DIP, SO	$1.05
INA133	High-precision, fast	I[2]	1, 2	1	450	5	80	1.5	(V+) – 1.5 to (V–) + 1	±2.25 to ±18	1.2	SOIC-8/-14	$1.05
INA143	High-precision, G = 10 or 1/10	I[2]	1, 2	10, 1/10	250	3	86	0.15	(V+) – 1 to (V–) + 0.5	±2.25 to ±18	1.2	SOIC-8/-14	$1.05
INA145	Resistor programmable gain	I[2]	1, 2	1-1000	1000	103	76	0.5	(V+) – 1 to (V–) + 0.5	±1.35 to ±18	0.7	SOIC-8	$1.50
INA152	Micropower, high-precision	I[2]	1	1	750	5	86	0.7	(V+) – 0.2 to (V–) + 0.2	+2.7 to +20	0.65	MSOP-8	$1.20
INA154	High-speed, precision, G = 1	I[2]	1	1	750	20	80	3.1	(V+) – 2 to (V–) + 2	±4 to ±18	2.9	SOIC-8	$1.05
INA157	High-speed, G = 2 or 1/2	I[2]	1	2, 1/2	500	20	86	4	(V+) – 2 to (V–) + 2	±4 to ±18	2.9	SOIC-8	$1.05
Audio													
INA134	Low distortion: 0.0005%	I[2]	1, 2	1	1000	2[3]	74	3.1	(V+) – 2 to (V–) + 2	±4 to ±18	—	SOIC-8/-14	$1.05
INA137	Low distortion, G = 1/2 or 2	I[2]	1, 2	2, 1/2	1000	2[3]	74	4	(V+) – 2 to (V–) + 2	±4 to ±18	2.9	SOIC-8/-14	$1.05
High Common-Mode Voltage													
INA117	±200-V CM range	I[2]	1	1	1000	20	86	0.2	(V+) – 5 to (V–) + 5	±5 to ±18	—	SOIC-8	$2.70
INA146	±100-V CM range, prog. gain	I[2]	1	0.1-100	5000	100[3]	70	0.55	(V+) – 1 to (V–) + 0.1 5	±1.35 to ±18	0.7	SOIC-8	$1.70
INA148	±200-V CM range, 1MΩ input	I[2]	1	1	5000	100[3]	70	0.1	(V+) – 1 to (V–) + 0.2 5	±1.35 to ±18	0.3	SOIC-8	$2.10
High-Side Current Shunt Monitors													
INA138	36V max	EI[4]	1	200µA/V	1000	1[3]	100	0.8	0 to (V+) – 0.8	+2.7 to 36	0.045	SOT23-5	$0.99
INA139	High-speed, 40V max	EI[4]	1	1-100	1000	1	100	4.4	0 to (V+) – 0.9	+2.7 to 40	0.125	SOT23-5	$0.99
INA168	60V max	EI[4]	1	200µA/V	1000	1[3]	100	0.8	0 to (V+) – 0.8	+2.7 to 60	0.045	SOT23-5	$1.25
INA169	High-speed, 60V max	EI[4]	1	1-100	1000	1	100	4.4	0 to (V+) – 0.9	+2.7 to 60	0.125	SOT23-5	$1.25
INA19x	–16V to 36V CM range	EI[4]	1	20, 50, 100V/V	2000	1	100	0.4	0.4 (V+) – 0.1	+2.7 to 13.5	0.9	SOT23-5	$0.80
INA170	High-side, bi-directional	I[2]	1	1-100	1000	1	100	0.4	0 to (V+) – 0.9	+2.7 to 60	0.125	MSOP-8	$1.25

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]I = –40°C to +85°C. [3]Denotes single supply. [4]EI = –40°C to +125°C. *For complete product listing visit amplifier.ti.com*

Logarithmic Amplifiers Selection Guide

Device	Spec[2] Temp Range	Scale Factor (V/decade)	Input Current Range (nA) (min)	Input Current Range (mA) (max)	Conformity Error (Initial 5 Decades) (%) (max)	Conformity Error (Initial 5 Decades) (%/°C) (typ/temp)	Offset Voltage (Input Amplifiers) (mV) (max)	V_S (V) (min)	V_S (V) (max)	I_Q Per Ch. (mA) (max)	Reference Type	Auxiliary Op Amps	Package(s)	Price[1]
LOG101	C3	1	0.1	3.5	0.2	0.0001	1.5	±4.5	±18	1.5	External	—	SO-8	$6.95
LOG102	C	1	1	1	0.3	0.0002	1.5	±4.5	±18	2	External	2	SO-14	$7.25
LOG104	C3	0.5	0.1	3.5	0.2	0.0001	1.5	±4.5	±18	1.5	External	—	SO-8	$6.95
LOG112	C3	0.5	0.1	3.5	0.2	0.00001	1.5	±4.5	±18	1.75	2.5V Internal	1	SO-14	$7.90
LOG2112[3]	C3	0.5	0.1	3.5	0.2	0.00001	1.5	±4.5	±18	1.75	2.5V Internal	1	SO-16	$11.35
LOG114	C3	0.375	0.1	3.5	0.2	0.001	4	±2.25	±5	15	2.5V Internal	2	QFN-16	TBD

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]C = 0°C to 70°C; C3 = –5°C to 75°C. [3]Dual LOG112. *Preview devices appear in* ***bold blue***.

Isolation Amplifiers Selection Guide

Device	Description	Spec[2] Temp Range	Isolation Voltage Cont Peak (DC) (V)	Isolation Voltage Pulse/ Test Peak (V)	Isolation Mode Rejection DC (dB) (typ)	Gain Nonlinearity (%) (max)	Input Offset Voltage Drift (±µV/°C) (max)	Small-Signal Bandwidth (kHz) (typ)	Package(s)	Price[1]
ISO120	1500-Vrms isolation, buffer	WI	2121	2500	160	0.01	150	60	DIP-24	$68.20
ISO121	3500-Vrms isolation, buffer	I2	4950	5600	—	0.01	—	60	CERDIP-16	$66.35
ISO122	1500-Vrms isolation, buffer	I2	2121	2400	160	0.02	200	50	DIP-16, SOIC-28	$9.40
ISO124	1500-Vrms isolation, buffer	I2	2121	2400	140	0.01	—	50	DIP-16, SOIC-28	$7.20
Digital Couplers										
ISO150	Dual, bi-directional digital coupler	I	1500	2400	—	—	—	—	DIP-12, SO-12	$7.47

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]WI = –55°C to +125°C; I2 = –25°C to +85°C; I = –40°C to +85°C.

Single-Supply Instrumentation Amplifiers Selection Guide

Device	Description	Spec[2] Temp Range	Gain	Non Linearity (%) (max)	Input Bias Current (nA) (max)	Offset at G = 100 (µV) (max)	Offset Drift (µV/°C) (max)	CMRR at G = 100 (dB) (min)	BW at G = 100 (kHz) (min)	Noise at 1kHz (nV/√Hz) (typ)	Power Supply (V)	I_Q per Amp (mA) (max)	Package(s)	Price[1]
Single-Supply, Low Power IQ < 525µA per Instrumentation Amp														
INA321	RRO, SHDN, low offset, gain error	WI	5 to 10000	0.01	0.01	1000	7[3]	90	50	100	2.7 to 5.5	0.06	MSOP-8	$1.10
INA2321	Dual INA321	WI	5 to 10000	0.01	0.01	1000	7[3]	90	50	100	2.7 to 5.5	0.06	TSSOP-14	$1.75
INA322	RRO, SHDN, low cost	WI	5 to 10000	0.01	0.01	10000	7	60	50	100	2.7 to 5.5	0.06	MSOP-8	$0.95
INA2322	Dual INA322	WI	5 to 10000	0.01	0.01	10000	7	60	50	100	2.7 to 5.5	0.06	TSSOP-14	$1.50
INA122	Micropower, RRO, CM to ground	I	5 to 10000	0.012	25	250	3	90	5	60	2.2 to 36	0.085	SOIC-8	$2.10
INA332	RRO, wide BW, SHDN	WI	5 to 1000	0.01	0.01	10000	7[3]	60	500	100	2.7 to 5.5	0.1	MSOP-8	$0.85
INA2332	Dual INA332	WI	5 to 1000	0.01	0.01	10000	7[3]	60	500	100	2.7 to 5.5	0.1	MSOP-8	$1.35
INA126	Micropower, < 1V V_{SAT}, low cost	I	5 to 10000	0.012	25	250	3	83	9	35	2.7 to 36	0.2	SO/MSOP-8	$1.05
INA2126	Dual INA126	I	5 to 10000	0.012	25	250	3	83	9	35	2.7 to 36	0.2	SO/MSOP-16	$1.70
INA118	Precision, low drift, low power[4]	I	1 to 10000	0.002	5	55	0.7	107	70	10	2.7 to 36	0.385	SOIC-8	$4.15
INA331	RRO, Wide BW, SHDN	WI	5 to 1000	0.01	0.01	500	5[3]	90	2000	46	2.7 to 5.5	0.5	MSOP-8	$1.10
INA2331	Dual INA331	WI	5 to 1000	0.01	0.01	1000	5[3]	80	2000	46	2.7 to 5.5	0.5	TSSOP-14	$1.80
INA125	Internal Ref, sleep mode[4]	I	4 to 10000	0.01	25	250	2	100	4.5	38	2.7 to 36	0.525	SOIC-16	$2.05
Single-Supply, Low Input Bias Current I_B < 100pA														
INA155	Low offset, RRO, SR = 6.5V/µs	WI	10, 50	0.015	0.01	1000	5[3]	86	110	40	2.7 to 5.5	2.1	MSOP-8	$1.10
INA156	Low offset, RRO, low cost, SR = 6.5V/µs	WI	10, 50	0.015	0.01	8000	5[3]	86	110	40	2.7 to 5.5	2.1	SOIC-8, MSOP-8	$0.95
INA321	RRO, SHDN, low offset, gain error	WI	5 to 10000	0.01	0.01	1000	7[3]	90	50	100	2.7 to 5.5	0.06	MSOP-8	$1.10
INA2321	Dual INA321	WI	5 to 10000	0.01	0.01	1000	7[3]	90	50	100	2.7 to 5.5	0.06	TSSOP-14	$1.75
INA322	RRO, SHDN, low cost	WI	5 to 10000	0.01	0.01	10000	7	60	50	100	2.7 to 5.5	0.06	MSOP-8	$0.95
INA2322	Dual INA322	WI	5 to 10000	0.01	0.01	10000	7	60	50	100	2.7 to 5.5	0.06	TSSOP-14	$1.50
INA331	RRO, wide BW, SHDN	WI	5 to 1000	0.01	0.01	500	5[3]	90	2000	46	2.7 to 5.5	0.5	MSOP-8	$1.10
INA2331	Dual INA331	WI	5 to 1000	0.01	0.01	1000	5[3]	80	2000	46	2.7 to 5.5	0.5	TSSOP-14	$1.80
INA332	RRO, wide BW, SHDN	WI	5 to 1000	0.01	0.01	10000	7[3]	60	500	100	2.7 to 5.5	0.1	MSOP-8	$0.88
INA2332	Dual INA332	WI	5 to 1000	0.01	0.01	10000	7[3]	60	500	100	2.7 to 5.5	0.1	TSSOP-14	$1.35
Single-Supply, Precision V_{OS} < 300µA, Low V_{OS} Drift														
INA118	Precision, low drift, low power[4]	I	1 to 10000	0.002	5	55	0.7	107	70	10	2.7 to 36	0.385	SOIC-8	$4.15
INA326	RRIO, auto zero, CM > supply, low drift	I	0.1 to 10000	0.01	2	100	0.4	100	1	33	2.7 to 5.5	3.4	MSOP-8	$1.80
INA327	RRIO, auto zero, SHDN, CM > supply, low drift	I	0.1 to 10000	0.01	2	100	0.4	100	1	33	2.7 to 5.5	3.4	MSOP-10	$1.95
INA337	RRIO, auto zero, low drift, CM > supply	EI	0.1 to 10000	0.01	2	100	0.4	106	1	33	2.7 to 5.5	3.4	MSOP-8	$1.80
INA338	RRIO, auto zero, low drift, CM > supply, SHDN	EI	0.1 to 10000	0.01	2	100	0.4	106	1	33	2.7 to 5.5	3.4	MSOP-10	$1.95
INA122	Micropower, RRO, CM to ground	I	5 to 10000	0.012	25	250	3	90	5	60	2.2 to 36	0.085	SOIC-8	$2.10
INA125	Internal ref, sleep mode[4]	I	4 to 10000	0.01	25	250	2	100	4.5	38	2.7 to 36	0.525	SOIC-16	$2.05
INA126	Micropower, < 1V V_{SAT}, low cost	I	5 to 10000	0.012	25	250	3	83	9	35	2.7 to 36	0.2	SO/MSOP-8	$1.05
INA2126	Dual INA126	I	5 to 10000	0.012	25	250	3	83	9	35	2.7 to 36	0.2	SO/MSOP-16	$1.70
Signal Amplifiers for Temperature Control				**I_B (nA)**		**Temp Error[5]**			**1/F Noise**					
INA330	Optimized for precision 10K thermistor applications	I	—	—	0.2[3]	—	0.009°C[3]	—	1	0.0001 °C pp	2.7 to 5.5	3.6	MSOP-10	$1.55

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]WI = –55°C to +125°C; I = –40°C to +85°C; EI = –40°C to +125°C. [3]Typical. [4]Internal +40-V input protection. [5]–40°C to +85°C.

Amplifiers

Dual-Supply Instrumentation Amplifiers Selection Guide

Device	Description	Spec[2] Temp Range	Gain	Non Linearity (%) (max)	Input Bias Current (nA) (max)	Offset at G = 100 (µV) (max)	Offset Drift (µV/°C) (max)	CMRR at G = 100 (dB) (min)	BW at G = 100 (kHz) (min)	Noise at 1kHz (nV/√Hz) (typ)	Power Supply (V)	I_Q per Amp (mA) (max)	Package(s)	Price[1]
Dual-Supply, Low Power I_Q < 850µA per Instrumentation Amp														
INA122	Micropower, RRO, CM to ground	I	5 to 10000	0.012	25	250	3	90	5	60	±1.3 to ±18	0.085	DIP-8, SOIC-8	$2.10
INA126[3]	Micropower, < 1V V_{SAT}, low cost	I	5 to 10000	0.012	25	250	3	83	9	35	±1.35 to ±18	0.2	DIP/SO/MSOP-8	$1.05
INA118	Precision, low drift	I	1 to 10000	0.002	5	55	0.7	107	70	10	±1.35 to ±18[4]	0.385	SOIC-8	$4.15
INA121	Low bias, precision	I	1 to 10000	0.005	0.05	500	5	100	50	20	±2.25 to ±18[4]	0.525	SO-8	$2.50
INA125	Internal ref, sleep mode[4]	I	4 to 10000	0.01	25	250	2	100	4.5	38	±1.35 to ±18	0.525	SOIC-16	$2.05
INA128[3]	Precision, low noise, low drift[4]	I	1 to 10000	0.002	5	60	0.7	120	200	8	±2.25 to ±18	0.8	SOIC-8	$3.05
INA129	Precision, low noise, low drift AD620 second source[4]	I	1 to 10000	0.002	5	60	0.7	120	200	8	±2.25 to +18	0.8	SOIC-8	$3.05
INA141[3]	Precision, low noise, low drift, pin compatible with AD6212[4]	I	10, 100	0.002	5	50	0.7	110	200	8	±2.25 to +18	0.8	SOIC-8	$3.05
Dual-Supply, Low Input Bias Current I_B < 100pA														
INA110	Fast settle, low noise, wide BW	C	1,10,100, 200, 500	0.01	0.05	280	2.5	106	470	10	±6 to ±18	4.5	CDIP-16	$7.00
INA121	Precision	I	1 to 10000	0.005	0.05	500	5	100	50	20	±2.25 to ±18[4]	0.525	SO-8	$2.50
INA111	Fast settle, low noise, wide BW	I	1 to 10000	0.005	0.02	520	6	106	450	10	±6 to ±18	4.5	SO-16	$4.20
INA116	Ultra low I_B 3 fA (typ), with buffered guard drive pins[4]	I	1 to 10000	0.01	0.0001	5000	40	80	70	28	±4.5 to ±18	1.4	SO-16	$4.20
Dual-Supply, Precision V_{OS} < 300µA, Low V_{OS} Drift														
INA114	Precision, low drift[4]	I	1 to 10000	0.002	2	50	0.25	110	10	11	±2.25 to ±18	3	SO-16	$4.20
INA115	Precision, low drift, with gain sense pins[4]	I	1 to 10000	0.002	2	50	0.25	120	10	11	±2.25 to ±18	3	SO-16	$4.20
INA131	Low noise, low drift[4]	I	100	0.002	2	50	0.25	110	70	12	±2.25 to ±18	3		$3.80
INA141[3]	Precision, low noise, pin com. w/AD6212	I	10, 100	0.002	5	50	0.7	110	200	8	±2.25 to ±18[4]	0.8	SOIC-8	$3.55
INA118	Precision, low drift	I	1 to 10000	0.002	5	55	0.7	107	70	10	±1.35 to ±18[4]	0.385	SOIC-8	$4.15
INA128[3]	Precision, low noise, low drift[4]	I	1 to 10000	0.002	5	60	0.7	120	200	8	±2.25 to ±18	0.8	SOIC-8	$3.05
INA129	Precision, low noise, low drift, AD620 second source[4]	I	1 to 10000	0.002	5	60	0.7	120	200	8	±2.25 to ±18	0.8	SOIC-8	$3.05
INA122	Micropower, RRO, CM to ground	I	5 to 10000	0.012	25	250	3	90	5	60	±1.3 to ±18	0.085	SOIC-8	$2.10
INA125	Internal ref, sleep mode[4]	I	4 to 10000	0.01	25	250	2	100	4.5	38	±1.35 to ±18	0.525	SOIC-16	$2.05
INA126[3]	Micropower, < 1V V_{SAT}, low cost	I	5 to 10000	0.012	25	250	3	83	9	35	±1.35 to ±18	0.2	SO/MSOP-8	$1.05
INA101	Low noise, wide BW, gain sense pins	C	1 to 10000	0.007	30	259	23	100	25000	13	±5 to ±18	8.5	TO-100, CDIP-14, PDIP-14, SO-16	$7.90
INA110	Fast settle, low noise, low bias, wide BW	C	1,10,100, 200, 500	0.01	0.05	280	2.5	106	470	10	±6 to ±18	4.5	CDIP-16	$7.00
Dual-Supply, Lowest Noise														
INA103	Precision, fast settle, low drift, audio, mic pre amp, THD+N = 0.0009%	C	1, 100	0.0006[5]	12000	255	1.2[5]	100	800	1	±9 to ±25	13	SO-16	$5.00
INA163	Precision, fast settle, low drift, audio, mic pre amp, THD+N = 0.002%	I	1 to 10000	0.0006[5]	12000	300	1.2[5]	100	800	1	±4.5 to ±18	12	SOIC-14	$2.50
INA166	Precision, fast settle, low drift, audio, mic pre amp, THD+N = 0.09%	I	2000	0.005	12000	300	2.5[5]	100	450	1.3	±4.5 to ±18	12	SO-14 Narrow	$5.95
INA217	Precision, low drift, audio, mic pre amp, THD+N = 0.09%, SSM2017 replacement	I	1 to 10000	0.0006[5]	12000	300	1.2[5]	–100	800	1.3	±4.5 to ±18	12	SO-16	$2.50

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]I = –40°C to +85°C; C = 0°C to 70°C. [3]Parts also available in dual version. [4]Internal +40-V input protection. [5]Typical.

Operational Amplifiers Selection Guide

Device	Description	Spec[2] Temp Range	S, D, T, Q[3]	Offset (mV) (max)	Drift (µV/°C) (typ)	I_B (pA) (max)	Noise 1kHz (nV/√Hz)	GBW (MHz) (typ)	SR (V/µs) (typ)	V_{IN} Low (min)	V_{IN} High (max)	V_{OUT} Low	V_{OUT} High	V_{SUP}	I_Q / Amp (mA) (max)	Price[1]
Bipolar Input—Low Offset, Low Drift																
OPA234	SS, gen. purpose	I	S, D, Q	0.1	0.5	25 nA	25	0.35	0.2	–0.1	4	0.1	4	2.7 to 36	0.3	$1.30
OPA241	SS	I	S, D, Q	0.25	0.4	20 nA	45	0.035	0.01	–0.2	4	0.1	4.9	2.7 to 36	0.03	$1.15
OPA227	Low noise/G>5	I	S, D, Q	0.075	0.1	10 nA	3	1	1	–13	13	–13	13	±2.5 to ±18	3.8	$1.65
OPA277	Lowest offset /drift	I	S, D, Q	0.02	0.1	1 nA	8	1	0.8	–13	13	–14.5	13.8	±2 to ±18	0.825	$0.85
TLC220x	SS, low noise	I	S, D	0.2	0.5	10	8	1.8	2.5	0	2.7	0.05	4.7	4.6 to 16	1.5	$1.75
FET-Input—Low Noise, Wide Bandwidth																
OPA130	Low power, FET	I	S, D, Q	1	2	20	16	1	2	—	—	—	—	±2.5 to ±18	0.65	$1.40
OPA132	THD = 0.00008%	I	S, D, Q	0.5	2	50	8	8	20	–12.5	12.5	–14.5	13.8	±2.5 to ±18	4.8	$1.45
OPA627	Very low-noise	I2	S	0.5	2.5	10	5.6	16	55	–11	11	–11.5	11.5	±4.5 to ±18	7.5	$12.25
CMOS—Low Input Bias Current (I_B), Rail-to-Rail In and Out																
OPA336	RRO, SOT23	I	S, D, Q	0.125	1.5	10	40	0.1	0.03	–0.2	4	0.1	4.9	2.3 to 5.5	0.032	$0.40
OPA340	RRIO, SOT23	I	S, D, Q	0.5	2.5	10	25	5.5	6	–0.3	5.3	0.005	4.995	2.5 to 5.5	0.95	$0.80
OPA350	RRIO, MSOP	I	S, D, Q	0.5	4	10	8	38	22	–0.1	5.1	0.05	4.95	2.5 to 5.5	7.5	$1.30
OPA355	High-speed, RRO	EI	S, D, T	9	7	50	5.8	200	300	–0.2	4	0.3	5.2	2.5 to 5.5	11	$1.90
OPA364	1.8V, high CMRR, SS	EI	S, D, Q	0.5	2	10	17	7	5	–0.1	5.6	0.02	5.48	1.8 to 5.5	0.75	$0.60
OPA725/6	Low-noise, high-speed	EI	S,D	3	4	200	15	20	30	0	9	0.15	11.525	4 to 12	6.2	$0.90
OPA727	e-Trim™, precision	I	S	1.5	0.3	100	6	20	30	-0.1	8.5	0.1	7	4to 12	4.3	$1.45
OPA734/5	0.05µV/°C (max)	I	S,D	0.005	0.05	200	150	1.6	1.5	-0.1	10.5	0.05	11.95	2.7 to 12	0.75	$1.25
OPA703/4	RRIO, SOT23/G>5	I	S, D, Q	0.75	4	10	45	1/3	0.6	–0.3	12.3	0.045	11.95	4 to 12	0.2	$1.30
OPA743	RRIO, SOT23	I	S, D, Q	1.5	8	10	30	7	10	–0.3	12.3	0.075	11.925	3.5 to 12	1.5	$0.95
TLC081x	Low cost, SS, SHDN	EI	S, D, Q	1	1.2	50	8.5	10	16	0	3.5	0.25	4.1	4.5 to 16	2.5	$0.50
TLC2252	Dual, RRO, low power	EI, WI	D, Q	1.5	05	6	19	0.2	0.12	—	—	—	—	4.4 to 16	0.0625	$0.65
TLC2272	Dual, RRIO	E, WI	D, Q	9.5	2	1	9	2.18	3.6	—	—	—	—	4.4 to 16	1.5	$0.65
TLV240x	SS, RRIO, SOT23	EI	S, D, Q	1.2	3	300	500	0.005	0.002	–0.1	10	0.15	4.95	2.5 to 16	0.95µA	$0.80
TLV276x	SS, SOT23, SHDN	EI	S, D, Q	3.5	9	15	95	0.5	0.2	0	3.6	0.02	3.58	1.8 to 3.6	0.028	$0.65
Auto-Zero Autocalibration—Highest Precision, Lowest Drift																
TLC450x	SS, auto cal	EI	S, D	0.05	1	50	12	4.7	2.5	0	2.7	0.1	4.9	4 to 6	1.5	$1.35
OPA335	Auto zero, SS	EI	S, D	0.005	0.02	200	—	2	1.6	–0.1	3.5	0.1	4.9	2.7 to 5.5	0.3	$1.90
OPA380	Transimpedance amp.	EI	S,D	0.0025	0.1	50	200	90	80	0	3.7	0.12	4.9	2.7 to 5.5	9.5	$1.95
OPA381	Low power	EI	S	0.0025	0.03	50	10	18	12	—	—	—	—	2.7 to 5.5	1	$1.45

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]I = –40°C to +85°C; I2 = –25°C to +85°C; EI = –40°C to +125°C, WI = –55°C to +125°C. [3]S = single; D = dual; T = triple; Q = quad.

Comparators Selection Guide

Device	Description	Ch.	I_Q Per Ch. (mA), (max)	Output Current (mA) (min)	t_{RESP} Low-to-High (µs)	V_S (V) (min)	V_S (V) (max)	V_{OS} (25°C) (mV) (max)	Output type	Package(s)	Price[1]
Low Power I_Q <0.5mA											
TLV370x	Nanopower, push-pull, RRIO	1, 2, 4	0.0008	—	36	2.5	16	5	Push-Pull	MSOP, PDIP, SOIC, SOT23, TSSOP	$0.60
TLV349x	Low voltage, speed/power	1, 2	0.0012	—	<0.1	1.8	5.5	15	Push-Pull	SOT23, SOIC, TSSOP	$0.42
Combination Comparators and Op Amps											
TLV230x	Sub-micropower, RRIO	2	0.0017	—	55	2.5	16	5	Open Drain/Collector	MSOP, PDIP, SOIC, TSSOP	$0.90
TLV270x	Sub-micropower, RRIO	2, 4	0.0019	—	36	2.5	16	5	Push-Pull	MSOP, PDIP, SOIC, TSSOP	$0.90
Comparator and Voltage Reference											
TLV3011	Micropower with built-in 1.242V	1	0.003	5	<7	1.8	5.5	15	Push-Pull	SC70, SOT23	$0.75
TLV3012	Nanopower, Push-Pull	1	0.005	0.5	6	1.8	5.5	12	Push-Pull	SC70-6, SOT23	$0.75

[1]Suggested resale price in U.S. dollars in quantities of 1,000.

Amplifiers

High-Speed Amplifiers Selection Guide

Device	Ch.	SHDN	Supply Voltage (V)	A_{CL} (min)	BW at A_{CL} (MHz) (typ)	BW G = +2 (MHz) (typ)	GBW Product (MHz) (typ)	Slew Rate (V/µs)	Settling Time 0.1% (ns) (typ)	THD 2Vpp G = 1.1MHz (dB) (typ)	Differential Gain (%)	Differential Phase (°)	V_N (nV/√Hz) (typ)	V_{OS} (mV) (max)	Package(s)	Price[1]
Fully Dfferential																
THS4120/21	1	Y	3	1	100	—	—	55	60	–75	—	—	5.4	8	SOIC, MSOP PowerPAD™	$1.90
THS4130/31	1	Y	5, ±5, ±15	1	150	90	90	52	78	–97	—	—	1.3	2	SOIC, MSOP PowerPAD	$3.50
THS4140/41	1	Y	5, ±5, ±15	1	160	—	—	450	96	–79	—	—	6.5	7	SOIC, MSO, PowerPAD	$3.40
THS4150/51	1	Y	5, ±5, ±15	1	150	81	100	650	53	–84	—	—	7.6	7	SOIC, MSOP PowerPAD	$4.70
THS4500/01	1	Y	5, ±5	1	370	175	300	2800	6.3	–100	—	—	7	7	SOIC, MSO, PowerPAD, Leadless MSOP PowerPAD	$3.65
THS4502/03	1	Y	5, ±5	1	370	175	300	2800	6.3	–100	—	—	6	7	SOIC, MSOP PowerPAD, Leadless MSOP PowerPAD	$4.00
THS4504/05	1	Y	5, ±5	1	260	110	210	1800	20	–100	—	—	8	7	SOIC, MSOP PowerPAD, Leadless	$1.75
OPA692	1	Y	5, ±5	1	280	225	—	2000	8	–93	0.07	0.02	1.7	2.5	SOT23, SOIC	$1.45
CMOS Amplifiers																
OPA354	1	—	2.5 to 5.5	1	250	90	100	150	30	—	0.02	0.09	6.5	8	SOT23, SOIC PowerPAD	$0.75
OPA2354	2	—	2.5 to 5.5	1	250	90	100	150	30	—	0.02	0.09	6.5	8	SOIC PowerPAD, MSOP	$1.20
OPA4354	4	—	2.5 to 5.5	1	250	90	100	150	30	—	0.02	0.09	6.5	8	SOIC, TSSOP	$1.80
OPA355	1	Y	2.5 to 5.5	1	450	100	200	300	30	—	0.02	0.05	5.8	9	SOT23, SOIC	$0.90
OPA2355	2	Y	2.5 to 5.5	1	450	100	200	300	30	—	0.02	0.05	5.8	9	MSOP	$1.50
OPA3355	3	Y	2.5 to 5.5	1	450	100	200	300	30	—	0.02	0.05	5.8	9	SOIC	$1.90
OPA356	1	—	2.5 to 5.5	1	450	100	200	300	30	—	0.02	0.05	5.8	9	SOT23, SOIC	$0.90
OPA2356	2	—	2.5 to 5.5	1	450	100	200	300	30	—	0.02	0.05	5.8	9	SOIC, MSOP	$1.50
OPA357	1	Y	2.5 to 5.5	1	250	90	100	150	30	—	0.02	0.09	6.5	8	SOT23, SOIC PowerPAD	$0.75
OPA2357	2	Y	2.5 to 5.5	1	250	90	100	150	30	—	0.02	0.09	6.5	8	MSOP	$1.20
FET-Input																
OPA655	1	—	±5	1	400	185	240	290	8	–100	0.01	0.01	6	2	SOIC	$9.70
OPA656	1	—	±5	1	500	200	230	290	—	–80	0.02	0.05	7	1.8	SOT23, SOIC	$3.35
OPA657	1	—	±5	7	350	300	1600	700	10	–80	—	—	4.8	1.8	SOT23, SOIC	$3.80
THS4601	1	—	±5, ±15	1	440	95	180	100	135	–76	0.02	0.08	5.4	4	SOIC	$9.95
Voltage Feedback																
OPA2822	2	—	5, ±5	1	400	200	240	170	32	–86	0.02	0.03	2	1.2	SOIC, MSOP	$2.30
OPA686	1	—	±5	7	425	—	1600	600	16	–82	0.02	0.02	1.3	1	SOT23, SOIC	$2.95
OPA842	1	—	±5	1	400	56	200	400	15	—	0.003	0.008	2.7	1.2	SOT23, SO	$1.55
OPA843	1	—	±5	3	500	65	800	1000	7.5	—	0.001	0.012	2		SOT23, SO	$1.60
OPA846	1	—	±5	7	500	—	1750	625	15	—	0.02	0.02	1.2	0.5	SOT23, SOIC	$1.70
OPA847	1	—	±5	12	600	—	3900	950	20	—	—	—	0.85	0.5	SOT23, SOIC	$2.00
THS4021	1	—	±5, ±15	10	350	—	1600	470	40	–68	0.02	0.08	1.5	2	SOIC, MSOP PowerPAD	$2.20
THS4022	2	—	±5, ±15	10	350	—	1600	470	40	–68	0.02	0.08	1.5	2	SOIC, MSOP PowerPAD	$3.65
THS4031	1	—	±5, ±15	2	100	100	200	100	60	–72	0.015	0.025	1.6	2	SOIC, MSOP PowerPAD	$2.00
THS4032	2	—	±5, ±15	2	100	100	200	100	60	–72	0.015	0.025	1.6	2	SOIC, MSOP PowerPAD	$3.35
THS4271/75	1	Y	5, ±5, 15	1	1400	390	400	1000	25	–110	0.007	0.004	3	10	SOIC, MSOP PowerPAD	$2.85
Voltage-Limiting Amplifiers																
OPA698	1	N	5, ±5	1	450	215	250	1100	—	–93	0.012	0.008	5.6	5	SOIC	$2.00
OPA699	1	N	5, ±5	4	260	—	1000	1400	—	—	0.012	0.008	4.1	5	SOIC	$2.05
Current Feedback																
OPA691	1, 2, 3	Y	5, ±5	1	280	255	—	2100	8	–93	0.07	0.02	1.7	2.5	SOT23, SOIC	$1.55
OPA684	1, 2, 3, 4	Y	5, ±5	1	210	160	—	820	—	–77	0.04	0.02	3.7	.35	SOT23, SOIC	$1.35
OPA683	1, 2	Y	5, ±5	1	200	150	—	540	—	–84	0.06	0.03	4.4	3.5	SOT23, SOIC	$1.20
OPA658	1, 2	N	±	1	900	680	—	1700	11.2	–70	0.025	0.02	2.7	5.5	SOT23, SOIC	$1.55
THS3091	1	Y	±5, ±15	1	235	210	—	5000	42	–72	0.013	0.02	2	3	SOIC, SOIC PowerPAD	$3.60

[1] *Suggested resale price in U.S. dollars in quantities of 1,000.*

High-Speed Buffer Amplifiers Selection Guide

Device	Spec[2] Temp Range	V_S ±15 (V)	V_S ±5 (V)	V_S 5 (V)	A_{CL} Min Stable Gain (V/V)	BW at ACL (MHz)	Slew Rate (V/µs)	Settling Time 0.01% (ns) (typ)	I_Q (mA) (typ)	THD (FC = 1MHz) (dB) (typ)	Diff Gain (%)	Diff Phase (°)	V_{OS} (mV) max	I_B (µA) max	Package(s)	Price[1]
THS3201	1	N	±5, ±15	1	1200	1000	—	9000	10	–65	0.02	0.01	6.8	4	SOIC, MSOP PowerPAD™	$1.60
BUF634	I	Yes	Yes	Yes	1	180	2000	200	250	—	0.4	0.1	100	20	DIP, SOIC, TO220-5, DDPak-5	$3.05
OPA633	C	Yes	Yes	—	1	260	2500	50	100	—	—	0.1	15	35	DIP	$5.45

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]I = –40°C to +85°C; C = 0°C to 70°C. For a complete product listing visit amplifier.ti.com

PWM Power Drivers Selection Guide

Device	Temp Range[2]	Output Current (A) (min)	Saturation Voltage (V) (max)	I_Q (mA) (max)	V_S (V) (min)	V_S (V) (max)	Duty Cycle (%) (min)	Duty Cycle (%) (max)	Package(s)	Price[1]
Single Switch										
DRV101	I	1.9	1	5	9	60	10	90	TO-220, DDPAK	$3.85
DRV102	WI	2	2.2	9	8	60	10	90	TO-220, DDPAK	$3.85
DRV103	I	3	0.6	0.8	8	32	10	90	SO-8, SO-8 PowerPAD™	$1.60
DRV104	I	1.5	0.6	1	8	32	10	90	14-lead PowerPAD	$1.60

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]I = –40°C to +85°C; WI = –55°C to +125°C.

Power Operational Amplifiers Selection Guide

Device	Spec[2] Temp Range	I_{OUT} (A)	V_S (V)	Bandwidth (MHz)	Slew Rate (V/µs)	I_Q (mA) (max)	V_{OS} (mV) (max)	V_O Drift (µV/°C) (max)	I_B (nA) (max)	Package(s)	Price[1]
OPA445/B	I2	0.015	10 to 40	2	15	4.7	5-3	10	0.05	TO-99, DIP-8, SO-8	$4.75
OPA452	EI	0.05	20 to 80	1.8	7.2	5.5	3	5	0.1	TO220-7, DDPak-7	$2.55
OPA453	EI	0.05	20 to 80	7.5	23	5.5	3	5	0.1	TO220-7, DDPak-7	$2.55
OPA541	I2	10	±10 to ±40	full power 55kHz	10	20	1	30	0.05	TO-3, ZIP	$11.10
OPA544	I	2	20 to 70	1.4	8	12	5	10	0.1	TO220-5, DDPak-5	$6.88
OPA2544	I	2	20 to 70	1.4	8	12	5	10	0.1	ZIP11	$12.00
OPA547	I	0.5	8 to 60	1	6	10	5	25	500	TO220-7, DDPak-7	$4.35
OPA548	I	3	8 to 60	1	10	17	10	30	500	TO220-7, DDPak-7	$6.00
OPA549	I	8	8 to 60	0.9	9	26	5	20	500	ZIP11	$12.00
OPA551	EI	0.2	8 to 60	3	15	7	3	7	0.1	DIP-8, SO-8, DDPak-7	$2.40
OPA552	EI	0.2	8 to 60	12	24	7	3	7	0.1	DIP-8, SO-8, DDPak-7	$1.75
OPA561	EI	1.2	7 to 16	17	50	50	20	50	0.1	HTSSOP-20	$2.65
OPA569	I	2	2.7 to 5.5	1.2	1.2	6	2	1.3 (typ)	10 µA	SO-20 PowerPAD	$3.10
TLV411x	EI	0.3	2.5 to 6	2.7	1.6	1	3.5	3	0.05	PDIP, MSOP, SOIC	$0.75

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]I2 = –25°C to +85°C; I = –40°C to +85°C; EI = –40°C to +125°C. For a complete product listing visit amplifier.ti.com

Digital Temperature Sensors Selection Guide

Device	Supply Voltage (V)	Interface	–25°C to 85°C Accuracy (˚C max)[2]	Quiescent Current (µA) max	Resolution (Bits)	Programmable Temp Alert	Max Operating Temp (°C)	Package	Price[1]
TMP100	2.7 to 5.5	2-wire	±2	45	9 to 12	—	150	SOT23	$0.75
TMP101	2.7 to 5.5	2-wire	±2	45	9 to 12	✓	150	SOT23	$0.80
TMP121	2.7 to 5.5	SPI	±1.5	50	12	—	150	SOT23	$0.90
TMP122	2.7 to 5.5	SPI	±1.5	50	9 to 12	✓	150	SOT23	$0.99
TMP123	2.7 to 5.5	SPI	±1.5	50	12	—	150	SOT23	$0.90
TMP124	2.7 to 5.5	SPI	±1.5	50	12	—	150	SO-8	$0.70
TMP75	2.7 to 5.5	2-wire	±1.5	50	12	✓	127	SO-8	$0.70
TMP175	2.7 to 5.5	2-wire	±1.5	50	12	✓	127	SO-8	$0.85

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]All digital temp sensors have a ±0.5°C typical accuracy. New products are listed in **bold red**.

Amplifiers/Voltage References

4-20mA Transmitters and Receivers Selection Guide

Device	Description	Sensor Excitation	Loop Voltage (V)	Full-Scale Input Range	Output Range (mA)	Additional Power Available (V at mA)	Package(s)	Price[1]
2-Wire General Purpose								
XTR101	IA with current excitation	Two 1mA	11.6 to 40	5mV to 1V	4-20	—	DIP-14, SOIC-16	$8.70
XTR115	I_{IN} to I_{OUT} converter, external resistor scales V_{IN} to I_{IN}	V_{REF} = 2.5V	7.5 to 36	40µA to 200µA	4-20	—	SOIC-8	$1.05
XTR116	I_{IN} to I_{OUT} converter, external resistor scales V_{IN} to I_{IN}	V_{REF} = 4.096V	7.5 to 36	40µA to 200µA	4-20	—	SOIC-8	$1.05
3-Wire General Purpose								
XTR110	Selectable input/output ranges	V_{REF} = 10V	13.5 to 40	0V to 5V, 0V to 10V	4-20, 0-20, 5-25	—	DIP-16	$7.10
4-20mA Current Loop Receiver								
RCV420	4-20mA input, 0V to 5V output, 1.5V loop drop	V_{REF} = 10V	+11.5/–5 to ±18	4-20mA	0V to 5V	—	DIP-16	$3.55
2-Wire RTD Conditioner with Linearization								
XTR105	100Ω RTD conditioner	Two 800µA	7.5 to 36	5mV to 1V	4-20	5.1 at 1	DIP-14, SOIC-14	$4.00
XTR112	High-resistance RTD conditioner	Two 250µA	7.5 to 36	5mV to 1V	4-20	5.1 at 1	DIP-14, SOIC-14	$4.00
XTR114	High-resistance RTD conditioner	Two 100µA	7.5 to 36	5mV to 1V	4-20	5.1 at 1	DIP-14, SOIC-14	$4.00
2-Wire Bridge Sensor Conditioner with Linearization								
XTR106	Bridge conditioner	5V and 2.5V	7.5 to 36	5mV to 1V	4-20	5.1 at 1	DIP-14, SOIC-14	$4.00
2-Wire RTD Conditioner with Digital Calibration for Linearization, Span and Offset								
XTR108	100Ω to 1kΩ RTD conditioner, 6-channel input Mux, extra op amp can convert to voltage sensor excitation, calibration stored in external EEPROM	Two 500µA	7.5 to 24	5mV to 320mV	4-20	5.1 at 2.1	SSOP-24	$3.35
Bridge Conditioner with Digital Calibration for Linearization, Span and Offset over Temperature								
PGA309	Complete digitally calibrated bridge sensor conditioner, voltage output, calibration stored in external EEPROM, one-wire/two-wire interface	V_{EXC} = V_S, 2.5V, 4.096V	2.7V to 5.5V	1mV/V to 245mV/V	0.1V to 4.9V at V_S=+5V	—	TSSOP-16	$3.40

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red**.*

Voltage References Selection Guide

Device	Description	Output (V)	Initial Accuracy (%) max	Drift (ppm/°C) max	Long-Term Stability (ppm/1000hr) (typ)	Noise 0.1 to 10Hz (µVp-p) (typ)	I_Q max (mA)	Temperature Range (°C)	Output Current (mA)	Package(s)	Price[1]
REF1112	Nanopower 1.25V shunt	1.25	0.2	30	60	25	0.0012	–40 to +125	1A to 5mA	SOT-23	$0.85
REF31xx	Precision, micropower	1.25, 2.048, 2.5 3.0, 3.3, 4.096	0.2	15	24	15 to 30	0.1	–40 to +125	±10	SOT23-3	$1.10
REF30xx	Micropower, bandgap	1.25, 2.048, 2.5, 3.0, 3.3, 4.096	0.2	50	24	20 to 45	0.05	–40 to +125	25	SOT23-3	$0.60
REF02B	Low drift, low noise, buried zener	5	0.13	10	50	4	1.4	–25 to +85	+21, –0.5	PDIP-8, SOIC-8	$2.65
REF102A	Low drift, low noise, buried zener	10	0.1	10	20	5	1.4	–25 to +85	+10, –5	PDIP-8, SOIC-8	$1.75
REF102B	Low drift, low noise, buried zener	10	0.05	5	20	5	1.4	–25 to +85	+10, –5	PDIP-8, SOIC-8	$4.40
REF102C	Ultra-low drift, low noise, buried zener	10	0.025	2.5	20	5	1.4	–25 to +85	+10, –5	PDIP-8, SOIC-8	$5.10
Current References											
REF200	Dual current reference with current mirror	Two 100µA	±1µA	25 (typ)	—	1µAp-p	—	–25 to +85	50µA to 400µA3	PDIP-8, SOIC-8	$2.60

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red**.*

ΔΣ ADCs Selection Guide

Device	Res. (Bits)	Sample Rate (kSPS)	Number of Input Channels	Interface	Input Voltage (V)	V_{REF}	Linearity (%)	NMC (Bits)	Power (mW)	Package(s)	Price[1]
ADS1271	24	105	1 Diff	Serial, SPI	±2.5	Ext	0.0015	24	50 - 100	TSSOP-16	$5.90
ADS1252	24	41	1 SE / 1 Diff	Serial	±5	Ext	0.0015	24	40	SOIC-8	$5.60
ADS1255	24	30	2 SE / 1 Diff	Serial, SPI	PGA (1-64), ±5V	Ext	0.0010	24	35	SSOP-20	$8.25
ADS1256	24	30	8 SE / 4 Diff	Serial, SPI	PGA (1-64), ±5V	Ext	0.0010	24	35	SSOP-28	$8.95
ADS1251	24	20	1 SE / 1 Diff	Serial	±5	Ext	0.0015	24	7.5	SOIC-8	$5.60
ADS1254	24	20	4 SE / 4 Diff	Serial	±5	Ext	0.0015	24	4	SSOP-20	$6.70
ADS1210	24	16	1 SE / 1 Diff	Serial, SPI	PGA (1-16), ±5	Int / Ext	0.0015	24	27.5	PDIP-18, SOIC-18	$10.25
ADS1211	24	16	4 SE / 4 Diff	Serial, SPI	PGA (1-16), ±5	Int / Ext	0.0015	24	27.5	PDIP-24, SOIC-24, SSOP-28	$10.90
ADS1216	24	0.78	8 SE / 8 Diff	Serial, SPI	PGA (1-128), ±2.5	Int / Ext	0.0015	24	0.6	TQFP-48	$5.00
ADS1217	24	0.78	8 SE / 8 Diff	Serial, SPI	PGA (1-128), ±5	Int / Ext	0.0012	24	0.8	TQFP-48	$5.00
ADS1224	24	0.24	4 SE / 4 Diff	Serial	±5	Ext	0.0015	24	0.5	TSSOP-20	$3.25
ADS1244	24	0.015	1 SE / 1 Diff	Serial	±5	Ext	0.0008	24	0.3	MSOP-10	$2.95
ADS1245	24	0.015	1 SE / 1 Diff	Serial	±2.5	Ext	0.0015	24	0.5	MSOP-10	$3.10
ADS1242	24	0.015	4 SE / 2 Diff	Serial, SPI	PGA (1-128), ±2.5	Ext	0.0015	24	0.6	TSSOP-16	$3.60
ADS1243	24	0.015	8 SE / 4 Diff	Serial, SPI	PGA (1-128), ±2.5	Ext	0.0015	24	0.6	TSSOP-20	$3.95
ADS1212	22	6.25	1 SE / 1 Diff	Serial, SPI	PGA (1-16), ±5	Int / Ext	0.0015	22	1.4	PDIP-18, SOIC-18	$7.70
ADS1213	22	6.25	4 SE / 4 Diff	Serial, SPI	PGA (1-16), ±5	Int / Ext	0.0015	22	1.4	PDIP-24, SOIC-24, SSOP-28	$9.00
DDC112	20	3	2 SE, 1 IN	Serial	50-1000pC	Ext	0.025	20	80	SOIC-28, TQFP-32	$12.10
DDC114	20	2.5	4SE, 1 IN	Serial	50-350pC	Ext	0.025	20	50	QFN-48	$18.00
ADS1625	18	1.25MSPS	1 Diff	P18	±3.75	Int/ Ext	0.0015	18	520	TQFP-64	$37.60
ADS1626	18	1.25MSPS	1 Diff	P18 w/ FIFO	±3.75	Int/ Ext	0.0015	18	520	TQFP-64	$37.60
ADS1202	16	10MHz Clock	1 SE / 1 Diff	Modulator	±0.3	Int / Ext	0.018	16	30	TSSOP-8	$3.10
ADS1203	16	10MHz Clock	1 SE / 1 Diff	Modulator	±0.3	Int / Ext	0.003	16	30	TSSOP-8, QFN 3 x 3	$3.10
ADS1204	16	10MHZ Clock	4 SE	Modulator	±2.5	Int / Ext	0.003	16	60	QFN 5 x 5	$4.15
ADS1605	16	5MSPS	1 Diff	P16	±3.75	Int/ Ext	0.0015	16	560	TQFP-64	$32.05
ADS1606	16	5MSPS	1 Diff	P16 w/ FIFO	±3.75	Int/ Ext	0.0015	16	560	TQFP-64	$33.75
ADS1602	16	2.5MSPS	1 Diff	Serial	±3	Int/ Ext	0.0015	16	550	TQFP-48	$23.00
ADS1601	16	1.25MSPS	1 Diff	Serial	±3	Int/ Ext	0.0015	16	350	TQFP-48	$14.00
ADS1100	16	0.128	1 SE / 1 Diff	Serial, I^2C	PGA (1-8), V_{DD}	Ext	0.0125	16	0.3	SOT23-6	$1.80
ADS1110	16	0.24	1 SE / 1 Diff	Serial, I^2C	PGA (1-8), ±2.048	Int	0.01	16	0.7	SOT23-6	$1.95
ADS1112	16	0.24	3 SE / 2 Diff	Serial, I^2C	PGA (1-8), ±2.048	Int	0.01	16	0.7	MSOP-10, SON-10	$2.65

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red**. Preview products are listed in **bold blue**.*

Data Converters

SAR ADCs Selection Guide

Device	Res. (Bits)	Sample Rate (kSPS)	Number of Input Channels	Interface	Input Voltage (V)	V_{REF}	Linearity (%)	NMC	SINAD (dB)	Power (mW)	Package(s)	Price[1]
ADS8380	18	580	1 SE	Serial, SPI	V_{REF}	Int / Ext	0.0018	18	90	100	QFN-6 x 6	$17.33
ADS8382	18	580	1 Diff	Serial, SPI	±V_{REF} (4.1V) at 1⁄2 V_{REF}	Int / Ext	0.0018	18	95	100	QFN-6 x 6	$18.16
ADS8381	18	580	1 SE	P8 / P16 / P18	V_{REF}	Ext	0.0018	18	88	100	TQFP-48	$16.65
ADS8383	18	500	1 SE	P8 / P16 / P18	(V_{REF}) +4.1V	Ext	0.006	18	85	110	TQFP-48	$15.75
ADS8411	16	2000	1 SE	P8 / P16	(V_{REF}) +4.1V	Int	0.00375	16	87	155	TQFP-48	$22.00
ADS8412	16	2000	1 Diff	P8 / P16	±V_{REF} (4.1V) at 1⁄2 V_{REF}	Int	0.00375	16	90	155	TQFP-48	$23.05
ADS8401	16	1250	1 SE	P8 / P16	+4, V_{REF}	Int	0.00375	16	85	155	TQFP-48	$12.55
ADS8402	16	1250	1 Diff	P8 / P16	±V_{REF} (4.1V) at 1⁄2 V_{REF}	Int	0.00375	16	88	155	TQFP-48	$13.15
ADS8371	16	750	1 SE	P8 / P16	+4.2V (V_{REF})	Ext	0.003	16	87	110	TQFP-48	$12.00
ADS8323	16	500	1 Diff	P8 / P16	±2.5V at 2.5	Int / Ext	0.009	15	83	85	TQFP-32	$7.10
ADS8361	16	500	2 x 2 Diff	Serial, SPI	±2.5V at +2.5	Int / Ext	0.00375	14	83	150	SSOP-24	$10.35
ADS8342	16	250	4 Diff	P8 / P16	±2.5	Ext	0.006	16	85	200	TQFP-48	$11.30
ADS7815	16	250	1 SE	P16	±2.5	Int / Ext	0.006	15	84	200	SOIC-28	$21.30
ADS8364	16	250	1 x 6 Diff	P16	±2.5V at +2.5	Int / Ext	0.0045	14	82.5	413	TQFP-64	$18.10
TLC4545	16	200	1 Diff	Serial, SPI	V_{REF}	Ext	0.0045	16	84.5	17.5	SOIC-8, VSSOP-8	$6.85
ADS7805	16	100	1 SE	P8 / P16	±10	Int / Ext	0.0045	16	86	81.5	PDIP-28, SOIC-28	$21.80
ADS8320	16	100	1 Diff	Serial, SPI	V_{REF}	Ext	0.012	15	84	1.95	VSSOP-8	$5.15
ADS8321	16	100	1 Diff	Serial, SPI	±V_{REF} at +V_{REF}	Ext	0.012	15	84	5.5	VSSOP-8	$5.15
ADS8325	16	100	1 Diff	Serial, SPI	V_{REF}	Ext	0.006	16	91	2.25	VSSOP-8, QFN-8	$5.90
ADS8343	16	100	4 SE / 2 Diff	Serial, SPI	±V_{REF} at +V_{REF}	Ext	0.006	15	86	3.6	SSOP-16	$7.45
ADS8345	16	100	8 SE / 4 Diff	Serial, SPI	±V_{REF} at +V_{REF}	Ext	0.006	15	85	3.6	SSOP-20	$8.00
ADS7807	16	40	1 SE	Serial, SPI / P8	4, 5, ±10	Int / Ext	0.0022	16	88	28	PDIP-28, SOIC-28	$27.40
ADS7813	16	40	1 SE	Serial, SPI	+4, 10, ±3.3, 5, 10	Int / Ext	0.003	16	89	35	PDIP-16, SOIC-16	$21.30
ADS7825	16	40	4 SE	Serial, SPI / P8	±10	Int / Ext	0.003	16	83	50	PDIP-28, SOIC-28	$29.55
ADS7891	14	3000	1 SE	P8 / P14	2.5	Int	0.009	14	78	90	TQFP-48	$10.50
ADS7890	14	1250	1 SE	Serial, SPI	2.5	Int	0.009	14	78	90	TQFP-48	$10.50
TLC3541	14	200	1 SE	Serial, SPI	V_{REF}	Ext	0.006	14	81.5	17.5	SOIC-8, VSSOP-8	$5.00
TLC3544	14	200	4 SE / 2 Diff	Serial, SPI	4	Int / Ext	0.006	14	81	20	SOIC-20, TSSOP-20	$6.00
TLC3548	14	200	8 SE / 4 Diff	Serial, SPI	4	Int / Ext	0.006	14	81	20	SOIC-24, TSSOP-24	$6.40
TLC3574	14	200	4 SE	Serial, SPI	±10	Ext	0.006	14	79	29	SOIC-24, TSSOP-24	$6.85
TLC3578	14	200	8 SE	Serial, SPI	±10	Ext	0.006	14	79	29	SOIC-24, TSSOP-24	$8.65
ADS8324	14	50	1 Diff	Serial, SPI	±V_{REF} at +V_{REF}	Ext	0.012	14	78	2.5	VSSOP-8	$4.15
ADS7871	14	40	8 SE / 4 Diff	Serial, SPI	PGA (1, 2, 4, 8, 10, 16, 20)	Int	0.03	13	—	6	SSOP-28	$5.00
ADS7881	12	4000	1 SE	P8 / P12	2.5	Int	0.024	12	71.5	110	TQFP-48	$7.35
ADS7869	12	1000	12 Diff	Serial, SPI / P12	±2.5 at +2.5	Int / Ext	0.048	11	71	250	TQFP-100	$14.60
ADS7886	12	1000	1 SE	Serial, SPI	V_{DD} (2.5V to 5.25V)	Ext	0.024	12	70	11	SOT23-6, SC-70	$2.35
ADS7810	12	800	1 SE	P12	±10	Int / Ext	0.018	12	71	225	SOIC-28	$27.80
ADS7818	12	500	1 Diff	Serial, SPI	5	Int	0.024	12	70	11	PDIP-8, VSSOP-8	$2.50
ADS7835	12	500	1 Diff	Serial, SPI	±2.5	Int	0.024	12	72	17.5	VSSOP-8	$2.75
ADS7852	12	500	8 SE	P12	5	Int / Ext	0.024	12	72	13	TQFP-32	$3.40
ADS7861	12	500	2 x 2 Diff	Serial, SPI	±2.5 at +2.5	Int / Ext	0.024	12	70	25	SSOP-24	$4.05
ADS7862	12	500	2 x 2 Diff	P12	±2.5 at +2.5	Int / Ext	0.024	12	71	25	TQFP-32	$5.70
ADS7864	12	500	3 x 2 Diff	P12	±2.5 at +2.5	Int / Ext	0.024	12	71	52.5	TQFP-48	$6.65
TLC2551	12	400	1 SE	Serial, SPI	V_{REF}	Ext	0.024	12	72	15	SOIC-8, VSSOP-8	$3.95
TLC2552	12	400	2 SE	Serial, SPI	V_{REF}	Ext	0.024	12	72	15	SOIC-8, VSSOP-8	$3.95
TLC2554	12	400	4 SE	Serial, SPI	4	Int / Ext	0.024	12	71	9.5	SOIC-16, TSSOP-16	$5.30
TLC2558	12	400	8 SE	Serial, SPI	4	Int / Ext	0.024	12	71	9.5	SOIC-20, TSSOP-20	$5.30
ADS7800	12	333	1 SE	P8 / P12	±5, 10	Int	0.012	12	72	135	CDIP SB-24, PDIP-24	$30.50
ADS7866	12	200	1 SE	Serial, SPI	V_{DD} (1.2V to 3.6V)	Ext	0.024	12	70	0.25	SOT23-6, QFN-2 x 2	$2.15
ADS7816	12	200	1 Diff	Serial, SPI	V_{REF}	Ext	0.024	12	72	1.9	PDIP-8, SOIC-8, VSSOP-8	$1.95

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

New products are listed in ***bold red***. *Preview products are listed in* ***bold blue***.

SAR ADCs Selection Guide (Continued)

Device	Res. (Bits)	Sample Rate (kSPS)	Number of Input Channels	Interface	Input Voltage (V)	V_{REF}	Linearity (%)	NMC	SINAD (dB)	Power (mW)	Package(s)	Price[1]
ADS7841	12	200	4 SE / 2 Diff	Serial, SPI	V_{REF}	Ext	0.024	12	72	0.84	SSOP-16	$2.50
ADS7842	12	200	4 SE	P12	V_{REF}	Ext	0.024	12	72	0.84	SSOP-28	$3.10
ADS7844	12	200	8 SE / 4 Diff	Serial, SPI	V_{REF}	Ext	0.024	12	72	0.84	SSOP-20	$2.90
TLC2574	12	200	4 SE	Serial, SPI	±10	Ext	0.024	12	79	29	SOIC-20, TSSOP-20	$5.30
TLC2578	12	200	8 SE	Serial, SPI	±10	Ext	0.024	12	79	29	SOIC-24, TSSOP-24	$5.80
TLV2541	12	200	1 SE	Serial, SPI	V_{REF}	Ext	0.024	12	72	2.8	SOIC-8, VSSOP-8	$3.85
TLV2542	12	200	2 SE	Serial, SPI	V_{REF}	Ext	0.024	12	72	2.8	SOIC-8, VSSOP-8	$3.85
TLV2544	12	200	4 SE	Serial, SPI	+2, 4	Int / Ext	0.024	12	70	3.3	SOIC-16, TSSOP-16	$4.20
TLV2548	12	200	8 SE	Serial, SPI	+2, 4	Int / Ext	0.024	12	70	3.3	SOIC-20, TSSOP-20	$4.85
TLV2556	12	200	11 SE	Serial, SPI	V_{REF}	Int / Ext	0.024	12	—	2.43	SOIC-20, TSSOP-20	$3.55
ADS7829	12	125	1 Diff	Serial, SPI	V_{REF}	Ext	0.018	12	71	0.6	QFN-8	$1.50
AMC7820	12	100	8 DAS	Serial, SPI	5	Int	0.024	12	72 (typ)	40	TQFP-48	$9.60
ADS7804	12	100	1 SE	P8 / P16	±10	Int / Ext	0.011	12	72	81.5	PDIP-28, SOIC-28	$14.05
ADS7808	12	100	1 SE	Serial, SPI	+4, 10 , ±3.3, 5, 10	Int / Ext	0.011	12	73	81.5	SOIC-20	$10.85
ADS7822	12	75	1 Diff	Serial, SPI	V_{REF}	Ext	0.018	12	71	0.6	PDIP-8, SOIC-8, VSSOP-8	$1.55
ADS7823	12	50	1 SE	Serial, I^2C	V_{REF}	Ext	0.024	12	71	0.75	VSSOP-8	$2.85
ADS7828	12	50	8 SE / 4 Diff	Serial, I^2C	V_{REF}	Int / Ext	0.024	12	71	0.675	TSSOP-16	$3.35
ADS7870	12	50	8 SE	Serial, SPI	PGA(1, 2, 4, 8, 10, 16, 20)	Int	0.06	12	72	4.6	SSOP-28	$4.15
ADS7806	12	40	1 SE	Serial, SPI / P8	+4, 5, ±10	Int / Ext	0.011	12	73	28	PDIP-28, SOIC-28	$12.75
ADS7812	12	40	1 SE	Serial, SPI	+4, 10, ±3.3, 5, 10	Int / Ext	0.012	12	74	35	PDIP-16, SOIC-16	$11.80
ADS7824	12	40	4 SE	Serial, SPI / P8	±10	Int / Ext	0.012	12	73	50	PDIP-28, SOIC-28	$13.10
TLV1570	10	1250	8 SE	Serial, SPI	2V, V_{REF}	Int / Ext	0.1	10	60	9	SOIC-20, TSSOP-20	$3.80
TLV1572	10	1250	1 SE	Serial, SPI	V_{REF}	Ext	0.1	10	60	8.1	SOIC-8	$3.30
TLV1578	10	1250	8 SE	Serial, SPI	V_{REF}	Ext	0.1	10	60	12	TSSOP-32	$3.85
ADS7887	10	1000	1 SE	Serial, SPI	V_{DD} (2.5V to 5.25V)	Ext	0.05	10	61	11	SOT23-6, SC-70	$1.55
TLC1514	10	400	4 SE / 3 Diff	Serial, SPI	+5.5 ($V_{REF} = V_{DD}$)	Int / Ext	0.012	10	60	10	SOIC-16, TSSOP-16	$2.90
TLC1518	10	400	8 SE / 7 Diff	Serial, SPI	+5.5 ($V_{REF} = V_{DD}$)	Int / Ext	0.012	10	60	10	SOIC-20, TSSOP-20	$3.45

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

*Preview products are listed in **bold blue**.*

8051-Based Intelligent ΔΣ ADCs Selection Guide

Device	ADC Res. (Bits)	Sample Rate (kSPS)	Number of Input Channels	Input Voltage (V)	V_{REF}	CPU Core	Program Memory (kB)	Program Memory Type	SRAM (kB)	Power (mW/V)	DAC Output (Bits)	Price[1]
MSC1200Y3	24	1	8 Diff / 8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	0.1	3 / 2.7-5.25	8-bit IDAC	$6.45
MSC1201Y3	24	1	6 Diff / 6 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	0.1	3 / 2.7-5.25	8-bit IDAC	$5.95
MSC1210Y5	24	1	8 Diff / 8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4 / 2.7-5.25	16-bit PWM	$12.00
MSC1211Y2	24	1	8 Diff / 8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	1.2	4 / 2.7-5.25	4 x 16-bit I / VDAC	$17.50
MSC1211Y5	24	1	8 Diff / 8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4 / 2.7-5.25	4 x 16-bit I / VDAC	$20.95
MSC1213Y2	24	1	8 Diff / 8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	1.2	4 / 2.7-5.25	2 x 16-bit I / VDAC	$12.65
MSC1213Y5	24	1	8 Diff / 8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4 / 2.7-5.25	2 x 16-bit I / VDAC	$15.95
MSC1202Y3	16	2	6 Diff / 6 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	0.2	3 / 2.7-5.25	8-bit IDAC	$4.95

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red**. Preview products are listed in **bold blue**.*

ΔΣ DACs Selection Guide

Device	Res. (Bits)	Settling Time (ms)	Number of Output DACs	Interface	Output (V)	V_{REF}	Linearity (%)	Monotonicity (Bits)	Power (mW)	Package	Price[1]
DAC1220	20	10	1	Serial, SPI	5	Ext	0.0015	20	2.5	SSOP-16	$6.65
DAC1221	16	2	1	Serial, SPI	2.5	Ext	0.0015	16	1.2	SSOP-16	$5.25

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

Data Converters

String and R-2R DACs Selection Guide

Device	Architecture	Res. (Bits)	Settling Time (µs)	# of Output DACs	Interface	Output (V)	V_{REF}	Linearity (%)	Mono-tonic (Bits)	Supply Voltage (V)	Power (mW) (typ)	Package(s)	Price[1]
DAC7654	R-2R	16	12	4	Serial, SPI	±2.5	Int	0.0015	16	±14.25 to 15.75	18	LQFP-64	$21.80
DAC7664	R-2R	16	12	4	P16	±2.5	Int	0.0015	16	±14.25 to 15.75	18	LQFP-64	$20.75
DAC7634	R-2R	16	10	4	Serial, SPI	$+V_{REF}$, $\pm V_{REF}$	Ext	0.0015	15	±4.75 to 5.25	7.5	SSOP-48	$19.95
DAC7641	R-2R	16	10	1	P16	$+V_{REF}$, $\pm V_{REF}$	Ext	0.0015	15	±4.75 to 5.25	1.8	TQFP-32	$6.30
DAC7642	R-2R	16	10	2	P16	$+V_{REF}$, $\pm V_{REF}$	Ext	0.0015	15	±4.75 to 5.25	2.5	LQFP-32	$10.55
DAC7644	R-2R	16	10	4	P16	$+V_{REF}$, $\pm V_{REF}$	Ext	0.0015	15	±4.75 to 5.25	7.5	SSOP-48	$19.95
DAC7734	R-2R	16	10	4	Serial, SPI	$+V_{REF}$, $\pm V_{REF}$	Ext	0.0015	16	±14.75 to 15.75	50	SSOP-48	$31.45
DAC712	R-2R	16	10	1	P16	±10	Int	0.003	15	±11.4 to 16.5	525	PDIP-28, SOIC-28	$14.50
DAC714	R-2R	16	10	1	Serial, SPI	±10	Int	0.0015	16	±11.4 to 16.5	525	PDIP-16, SOIC-16	$14.50
DAC7631	R-2R	16	10	1	Serial, SPI	$+V_{REF}$, $\pm V_{REF}$	Ext	0.0015	15	±4.75 to 5.25	1.8	SSOP-20	$5.85
DAC7632	R-2R	16	10	2	Serial, SPI	$+V_{REF}$, $\pm V_{REF}$	Ext	0.0015	15	±14.25 to 15.75	2.5	LQFP-32	$10.45
DAC7744	R-2R	16	10	4	P16	$+V_{REF}$, $\pm V_{REF}$	Ext	0.0015	16	+2.7 to 5.5	50	SSOP-48	$31.45
DAC8501	String	16	10	1	Serial, SPI	V_{REF} / MDAC	Ext	0.0987	16	+2.7 to 5.5	0.72	VSSOP-8	$3.00
DAC8531	String	16	10	1	Serial, SPI	$+V_{REF}$	Ext	0.0987	16	+2.7 to 5.5	0.72	VSSOP-8, QFN 3 x 3	$3.00
DAC8532	String	16	10	2	Serial, SPI	$+V_{REF}$	Ext	0.0987	16	2.75 to 5.25	1.35	VSSOP-8	$5.35
DAC8544	String	16	10	4	Parallel	$+V_{REF}$	Ext	0.0987	16	+2.7 to 5.5	2	QFN 5 x 5	$9.75
DAC8534	String	16	10	4	Serial, SPI	$+V_{REF}$	Ext	0.0987	16	+2.7 to 5.5	0.42	VTSSOP-16	$9.75
DAC8541	String	16	10	1	P16	$+V_{REF}$	Ext	0.096	16	+2.7 to 5.5	0.72	TQFP-32	$3.00
DAC8571	String	16	10	1	Serial, I^2C	$+V_{REF}$	Ext	0.0987	16	+2.7 to 5.5	0.42	VSSOP-8	$2.95
DAC8574	String	16	10	4	Serial, I^2C	$+V_{REF}$	Ext	0.0987	16	+2.7 to 5.5	2.7	TSSOP-16	$10.25
DAC7731	R-2R	16	5	1	Serial, SPI	+10, ±10	Int / Ext	0.0015	16	±14.25 to 15.75	100	SSOP-24	$8.20
DAC7741	R-2R	16	5	1	P16	+10, ±10	Int / Ext	0.0015	16	±14.25 to 15.75	100	LQFP-48	$8.30
DAC8581	String	16	1	1	Serial, SPI	$+V_{REF}$	Ext	0.0987	16	2.75 to 5.25	60	TSSOP-16	$3.25
DAC8811	R-2R	16	0.5	1	Serial, SPI	$\pm V_{REF}$ / MDAC	Ext	0.0015	16	2.75 to 5.25	0.05	VSSOP-8	$8.50
DAC8812	R-2R	16	0.5	2	Serial, SPI	$\pm V_{REF}$ / MDAC	Ext	0.0015	16	2.75 to 5.25	0.05	TSSOP-16	$10.15
DAC8814	R-2R	16	0.5	4	Serial, SPI	$\pm V_{REF}$ / MDAC	Ext	0.0015	16	2.75 to 5.25	0.05	SSOP-28	$26.35
DAC8821	R-2R	16	0.5	1	P16	$\pm V_{REF}$ / MDAC	Ext	0.0015	16	2.75 to 5.25	0.05	TSSOP-28	$12.50
DAC8830	R-2R	16	0.5	1	Serial, SPI	$+V_{REF}$	Ext	0.0015	16	2.75 to 5.25	0.05	SOIC-8	$9.35
DAC8831	R-2R	16	0.5	1	Serial, SPI	$+V_{REF}$	Ext	0.0015	16	2.75 to 5.25	0.05	SOIC-14	$9.35
DAC8802	R-2R	14	0.5	2	Serial, SPI	$\pm V_{REF}$ / MDAC	Ext	0.0061	14	2.75 to 5.25	0.05	TSSOP-16	$7.25
DAC8803	R-2R	14	0.5	4	Serial, SPI	$\pm V_{REF}$ / MDAC	Ext	0.0061	14	2.75 to 5.25	0.05	SSOP-28	$16.95
DAC8804	R-2R	14	0.5	1	P16	$\pm V_{REF}$ / MDAC	Ext	0.0061	14	2.75 to 5.25	0.05	TSSOP-28	$7.15
DAC8801	R-2R	14	0.5	1	Serial, SPI	$\pm V_{REF}$ / MDAC	Ext	0.0061	14	2.75 to 5.25	0.3	MSOP-8	$5.50
DAC7513	String	12	10	1	Serial, SPI	$+V_{REF}$	Ext	0.38	12	+2.7 to 5.5	0.3	VSSOP-8, SSOP-8	$1.45
DAC7571	String	12	10	1	Serial, I^2C	$+V_{REF}$	Ext	0.096	12	+2.7 to 5.5	0.85	SOP-6, SSOP-16	$1.55
DAC7574	String	12	10	4	Serial, I^2C	$+V_{REF}$	Ext	0.096	12	+2.7 to 5.5	0.85	MSOP-10	$6.15
DAC7611	R-2R	12	10	1	Serial, SPI	4.096	Int	0.012	12	+4.75 to 5.25	5	PDIP-8, SOIC-8	$2.55
DAC7612	R-2R	12	10	2	Serial, SPI	4.096	Int	0.012	12	+4.75 to 5.5	3.5	SOIC-8	$2.70
DAC7613	R-2R	12	10	1	P12	$+V_{REF}$, $\pm V_{REF}$	Ext	0.012	12	+4.75 to 5.5	1.8	SSOP-24	$2.50
DAC7616	R-2R	12	10	4	Serial, SPI	$+V_{REF}$, $\pm V_{REF}$	Ext	0.012	12	3 to 3.6	2.4	SOIC-16, SSOP-20	$5.40
DAC7621	R-2R	12	10	1	P12	4.096	Int	0.012	12	+4.75 to 5.25	2.5	SSOP-20	$2.75
DAC7625	R-2R	12	10	4	P12	$+V_{REF}$, $\pm V_{REF}$	Ext	0.012	12	+4.75 to 5.25	15	PDIP-28, SOIC-28	$10.25
DAC7715	R-2R	12	10	4	Serial, SPI	$+V_{REF}$, $\pm V_{REF}$	Ext	0.012	12	±14.25 to 15.75	45	SOIC-16	$11.45
DAC7725	R-2R	12	10	4	P12	$+V_{REF}$, $\pm V_{REF}$	Ext	0.012	12	±14.25 to 15.75	45	PLCC-28, SOIC-28	$11.85
DAC7554	R-2R	12	5	4	Serial, SPI	$+V_{REF}$	Ext	0.012	12	2.75 to 5.25	1	MSOP-10	$6.20
DAC813	R-2R	12	4	1	P12	+10, ±5, 10	Int / Ext	0.006	12	+11.4 to 16.5	270	PDIP-28, SOIC-28	$12.60
TLV5614	String	12	3	4	Serial, SPI	$+V_{REF}$	Ext	0.1	12	+2.7 to 5.5	3.6	SOIC-16, TSSOP-16	$7.45
TLV5616	String	12	3	1	Serial, SPI	$+V_{REF}$	Ext	0.1	12	+2.7 to 5.5	0.9	VSSOP-8, PDIP-8, SOIC-8	$2.60
TLV5618A	String	12	2.5	2	Serial, SPI	$+V_{REF}$	Ext	0.08	12	+2.7 to 5.5	1.8	CDIP-8, PDIP-8, SOIC-8, LCCC-20	$4.75

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.* *New products are listed in* ***bold red****. Preview devices appear in* ***bold blue****.*

String and R-2R DACs Selection Guide (Continued)

Device	Architecture	Res. (Bits)	Settling Time (μs)	# of Output DACs	Interface	Output (V)	V_{REF}	Linearity (%)	Monotonic (Bits)	Supply Voltage (V)	Power (mW) (typ)	Package(s)	Price[1]
DAC7541	R-2R	12	1	1	P12	$\pm V_{REF}$, MDAC	Ext	0.012	12	+5 to 16	30	PDIP-18, SOP-18	$6.70
TLV5619	String	12	1	1	P12	$+V_{REF}$	Ext	0.08	12	+2.7 to 5.5	4.3	SOIC-20, TSSOP-20	$2.60
TLV5630	String	12	1	8	Serial, SPI	$+V_{REF}$	Int / Ext	0.4	12	+2.7 to 5.5	18	SOIC-20, TSSOP-20	$8.85
TLV5636	String	12	1	1	Serial, SPI	+2, 4	Int / Ext	0.1	12	+2.7 to 5.5	4.5	SOIC-8, VSSOP-8	$3.65
TLV5638	String	12	1	2	Serial, SPI	+2, 4	Int / Ext	0.1	12	+2.7 to 5.5	4.5	SOIC-8, CDIP-8, LCCC-20	$3.25
TLV5639	String	12	1	1	P12	+2, 4	Int / Ext	0.1	12	+2.7 to 5.5	2.7	SOIC-20, TSSOP-20	$3.45
DAC7800	R-2R	12	0.8	2	Serial, SPI	1mA	Ext	0.012	12	+4.5 to 5.5	1	PDIP-16, SOIC-16	$13.55
DAC7802	R-2R	12	0.8	2	P12	1mA	Ext	0.012	12	+4.5 to 5.5	1	PDIP-24, SOIC-24	$14.00
DAC7811	R-2R	12	0.5	1	Serial, SPI	$\pm V_{REF}$ / MDAC	Ext	0.0244	12	2.75 to 5.25	0.05	MSOP-10	$3.15
DAC6571	String	10	9	1	Serial, I^2C	V_{DD}	Ext	0.195	10	2.75 to 5.25	0.5	SOP-6	$1.40
DAC6574	String	10	9	4	Serial, I^2C	$+V_{REF}$	Ext	0.195	10	2.7 to 5.5	1.5	VSSOP-10	$3.05
TLV5604	String	10	3	4	Serial, SPI	$+V_{REF}$	Ext	0.05	10	2.7 to 5.5	3	SOIC-16, TSSOP-16	$3.70
TLV5606	String	10	3	1	Serial, SPI	$+V_{REF}$	Ext	0.15	10	2.7 to 5.5	0.9	SOIC-8, VSSOP-8	$1.30
TLV5617A	String	10	2.5	2	Serial, SPI	$+V_{REF}$	Ext	0.1	10	2.7 to 5.5	1.8	SOIC-8	$2.25
TLV5608	String	10	1	8	Serial, SPI	$+V_{REF}$	Ext	0.4	10	2.7 to 5.5	18	SOIC-20, TSSOP-20	$4.90
TLV5631	String	10	1	8	Serial, SPI	$+V_{REF}$	Int / Ext	0.4	10	2.7 to 5.5	18	SOIC-20, TSSOP-20	$5.60
TLV5637	String	10	0.8	2	Serial, SPI	+2, 4	Int / Ext	0.1	10	2.7 to 5.25	4.2	SOIC-8	$3.20
TLC5620	String	8	10	4	Serial, SPI	$+V_{REF}$	Ext	0.4	8	+4.75 to 5.25	8	PDIP-14, SOIC-14	$1.50
TLC5628	String	8	10	8	Serial, SPI	$+V_{REF}$	Ext	0.4	8	+2.7 to 5.25	15	PDIP-16, SOIC-16	$2.45
TLV5620	R-2R	8	10	4	Serial, SPI	$+V_{REF}$	Ext	0.2	8	+2.7 to 5.5	6	PDIP-14, SOIC-14	$1.00
TLV5621	R-2R	8	10	4	Serial, SPI	$+V_{REF}$	Ext	0.4	8	+2.7 to 5.5	3.6	SOIC-14	$1.65
TLV5628	String	8	10	8	Serial, SPI	$+V_{REF}$	Ext	0.4	8	+2.7 to 5.5	12	PDIP-16, SOIC-16	$2.20
DAC5571	String	8	8	1	Serial, I^2C	V_{DD}	Int	0.195	8	2.75 to 5.25	0.5	SOP-6	$0.90
DAC5574	String	8	8	4	Serial, I^2C	$+V_{REF}$	Ext	0.195	8	2.7 to 5.5	1.5	VSSOP-10	$2.55
TLC7226	R-2R	8	5	4	P8	$\pm V_{REF}$	Ext	0.4	8	+11.4 to 16.5	90	PDIP-20, SOIC-20	$2.15
TLV5623	String	8	3	1	Serial, SPI	$+V_{REF}$	Ext	0.2	8	+2.7 to 5.5	2.1	SOIC-8, VSSOP-8	$0.99
TLV5625	String	8	3	2	Serial, SPI	$+V_{REF}$	Ext	0.2	8	+2.7 to 5.5	2.4	SOIC-8	$1.70
TLV5627	String	8	2.5	4	Serial, SPI	$+V_{REF}$	Ext	0.2	8	+2.7 to 5.5	3	SOIC-16, TSSOP-16	$2.05
TLV5624	String	8	1	1	Serial, SPI	+2, 4	Int / Ext	0.2	8	+2.7 to 5.5	0.9	SOIC-8, VSSOP-8	$1.60
TLV5632	String	8	1	8	Serial, SPI	+2, 4	Int / Ext	0.4	8	+2.7 to 5.5	18	SOIC-20, TSSOP-20	$3.35
TLV5626	String	8	0.8	2	Serial, SPI	+2, 4	Int / Ext	0.4	8	+2.7 to 5.5	4.2	SOIC-8	$1.90
TLC7524	R-2R	8	0.1	1	P8	1mA	Ext	0.2	8	+4.75 to 5.25	5	PDIP-16, PLCC-20, SOIC-16, TSSOP-16	$1.45
TLC7528	R-2R	8	0.1	2	P8	1mA	Ext	0.2	8	+4.75 to 5.25	7.5	PDIP-20, PLCC-20, SOIC-20, TSSOP-20	$1.55

[1]Suggested resale price in U.S. dollars in quantities of 1,000.

*Preview products are listed in **bold blue**.*

Data Converters/Digital Signal Controllers

High-Speed DACs Selection Guide

Device	Res. (Bits)	Supply (V)	Update Rate (MSPS)	Settling Time (ns)	Number of DACs	Power Typ (mW)	DNL max (±LSB)	INL max (±LSB)	Package(s)	Price[1]
DAC904	14	3.0 to 5.0	165	30	1	170	1.75	2.5	28-SOP, 28-TSSOP	\$6.25
THS5671A	14	3.0 to 5.0	125	35	1	175	3.5	7	28-SOP, 28-TSSOP	\$8.00
DAC902	12	3.0 to 5.0	165	30	1	170	1.75	2.5	28-SOP, 28-TSSOP	\$6.25
THS5661A	12	3.0 to 5.0	125	35	1	175	2.0	4	28-SOP, 28-TSSOP	\$6.25
DAC900	10	3.0 to 5.0	165	30	1	170	0.5	1	28-SOP, 28-TSSOP	\$4.25
THS5651A	10	3.0 to 5.0	125	35	1	175	0.5	1	28-SOP, 28-TSSOP	\$4.25
DAC2904	14	3.3 to 5.0	125	30	2	310	—	—	48-TQFP	\$20.19
DAC2902	12	3.3 to 5.0	125	30	2	310	2.5	3	48-TQFP	\$15.41
DAC2900	10	3.3 to 5.0	125	30	2	310	1	1	48-TQFP	\$9.19
DAC5662	12	3.0 to 3.6	200	20	2	330	2	2	48-TQFP	\$10.70
DAC5672	14	3.0 to 3.6	200	20	2	330	3	4	48-TQFP	\$13.25
DAC5675	14	3	400	5	1	820	2	4	48-HTQFP	\$29.75
DAC5686	14	1.8/3.3	500	12	2	400	TBD	TBD	100-HTQFP	\$42.00
DAC2932	12	2.7 to 3.3	40	25	2	29	0.5	2	48-TQFP	\$7.95
DAC5674	12	1.8/3.3	400	20	1	420	2	3.5	48-HTQFP	\$21.00

[1]Suggested resale price in U.S. dollars in quantities of 1,000.

TMS320C28x™ Digital Signal Controllers

Device[5]	MIPS	Boot ROM[7] (words)	RAM (16-bit words[7])	Flash/ ROM[5] (16-bit words[7])	Timers	CAP/ QEP	# PWM Channels	A/D[2] Chs/ Conversion Time (ns)	EMIF	WD Timer	CommPorts Other	SPI	SCI	CAN	I/O Pins	Core Voltage (V)	Package	Price[1]
Flash Devices																		
TMS320**F2801**-PZA/Q[5]	100	4K	6K	16K	9	2/1	6 + 2[8]	16 ch/160	—	Y	I^2C	2	1	1	32	1.8	100-LQFP	\$5.79[4]
TMS320**F2801**-GGMA/Q[5]	100	4K	6K	16K	9	2/1	6 + 2[8]	16 ch/160	—	Y	I^2C	2	1	1	32	1.8	100-BGA[6]	\$5.79[4]
TMS320**F2806**-PZA/Q[5]	100	4K	10K	32K	15	4/2	12 + 4[8]	16 ch/160	—	Y	I^2C	4	2	1	32	1.8	100-LQFP	\$8.69[4]
TMS320**F2806**-GGMA/Q[5]	100	4K	10K	32K	15	4/2	12 + 4[8]	16 ch/160	—	Y	I^2C	4	2	1	32	1.8	100-BGA[6]	\$8.69[4]
TMS320**F2808**-PZA/Q[5]	100	4K	18K	64K	15	4/2	12 + 4[8]	16 ch/160	—	Y	I^2C	4	2	2	32	1.8	100-BGA[6]	\$11.52[4]
TMS320**F2808**-GGMA/Q[5]	100	4K	18K	64K	15	4/2	12 + 4[8]	16 ch/160	—	Y	I^2C	4	2	2	32	1.8	100-BGA[6]	\$11.52[4]
TMS320**F2810**-PBKA/Q[5]	150	4K	18K	64K	7	6/2	16	16 ch/80	—	Y	McBSP	1	2	1	56	1.9	128-LQFP	\$14.53
TMS320**F2811**-PBKA/Q[5]	150	4K	18K	128K	7	6/2	16	16 ch /80	—	Y	McBSP	1	2	1	56	1.9	128-LQFP	\$15.50
TMS320**F2812**-GHHA/Q[5]	150	4K	18K	128K	7	6/2	16	16 ch /80	Y	Y	McBSP	1	2	1	56	1.9	179-BGA[6]	\$16.47
TMS320**F2812**-PGFA/Q[5]	150	4K	18K	128K	7	6/2	16	16 ch/80	Y	Y	McBSP	1	2	1	56	1.9	176-LQFP	\$16.47
RAM-Only Devices																		
TMS320**F2811**-PBKA/Q[5]	150	4K	20K	—	7	6/2	16	16 ch/160	—	Y	McBSP	1	2	1	56	1.9	128-LQFP	\$9.11
TMS320**F2812**-GHHA/Q[5]	150	4K	20K	—	7	6/2	16	16 ch/160	Y	Y	McBSP	1	2	1	56	1.9	179-BGA[6]	\$10.63
TMS320**F2811**-PGFA/Q[5]	150	4K	20K	—	7	6/2	16	16 ch/160	Y	Y	McBSP	1	2	1	56	1.9	128-LQFP	\$10.63
ROM-Based Devices																		
TMS320**C2810**-PBKA/Q[5]	150	4K	18K	64K	7	6/2	16	16 ch/80	—	Y	McBSP	1	2	1	56	1.9	128-LQFP	\$7.05[3]
TMS320**C2811**-PBKA/Q[5]	150	4K	18K	128K	7	6/2	16	16 ch/80	—	Y	McBSP	1	2	1	56	1.9	128-LQFP	\$8.22[3]
TMS320**C2812**-GHHA/Q[5]	150	4K	18K	128K	7	6/2	16	16 ch/80	Y	Y	McBSP	1	2	1	56	1.9	179-BGA[6]	\$9.59[3]
TMS320**C2812**-PGFA/Q[5]	150	4K	18K	128K	7	6/2	16	16 ch/80	Y	Y	McBSP	1	2	1	56	1.9	176-LQFP	\$9.59[3]

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]Dual sample/hold. *New products are listed in **bold red**.*
[3]Minimum volumes for C281x devices are 10 KU with NRE of \$11,000. [4]Production scheduled for 3Q05. [5]A = –40° to 85°C; Q = –40 to 125°C (10% adder), Q100 qualified.
[6]PB-free packages available. [7]1 word = 2 bytes. [8]CAP can be used to generate PWM. Note: Enhanced plastic and Military DSP versions are available for selected DSPs.

MSP430 Ultra-Low-Power Microcontrollers Selection Guide

Device	Prgm. (kB)	SRAM	I/O	DMA	LCD 8-Bit Timer	Watch-dog 16-Bit	Timer[2] A	Timer[2] B	USART	I^2C	SVS	BOR	MPY	Comp A	Temp Sensor	ADC Ch/Res	DAC Ch/Res	Package(s)	Price[1]
Flash Based F1xx Family (V_{CC} 1.8V to 3.6V)																			
MSP430F1101A	1	128	14	—	—	✓	3	—	—	—	—	—	—	✓	—	Slope	—	20-SOIC, 20-TSSOP 20-TVSOP, 24-QFN	$0.99
MSP430C1101	1	128	14	—	—	✓	3	—	—	—	—	—	—	✓	—	Slope	—	20-SOP, 20-TSSOP, 24-QFN	$0.60
MSP430F1111A	2	128	14	—	—	✓	3	—	—	—	—	—	—	✓	—	Slope	—	20-SOIC, 20-TSSOP 20-TVSOP, 24-QFN	$1.35
MSP430C1111	2	128	14	—	—	✓	3	—	—	—	—	—	—	✓	—	Slope	—	20-SOP, 20-TSSOP, 24-QFN	$1.10
MSP430F1121A	4	256	14	—	—	✓	3	—	—	—	—	—	—	✓	—	Slope	—	20-SOIC, 20-TSSOP 20-TVSOP, 24-QFN	$1.70
MSP430C1121	4	256	14	—	—	✓	3	—	—	—	—	—	—	✓	—	Slope	—	20-SOP, 20-TSSOP, 24-QFN	$1.35
MSP430F1122	4	256	14	—	—	✓	3	—	—	—	—	✓	—	—	✓	5 / 10	—	20-SOIC, 20-TSSOP, 32-QFN	$2.00
MSP430F1132	8	256	14	—	—	✓	3	—	—	—	—	✓	—	—	✓	5 / 10	—	20-SOIC, 20-TSSOP, 32-QFN	$2.25
MSP430F122	4	256	22	—	—	✓	3	—	—	—	—	—	—	✓	—	Slope	—	28-SOIC, 28-TSSOP, 32-QFN	$2.15
MSP430F123	8	256	22	—	—	✓	3	—	—	—	—	—	—	✓	—	Slope	—	28-SOIC, 28-TSSOP, 32-QFN	$2.30
MSP430F1222	4	256	22	—	—	✓	3	—	1	—	—	✓	—	—	✓	8 / 10	—	28-SOIC, 28-TSSOP, 32-QFN	$2.40
MSP430F1232	8	256	22	—	—	✓	3	—	1	—	—	✓	—	—	✓	8 / 10	—	28-SOIC, 28-TSSOP, 32-QFN	$2.50
MSP430F133	8	256	48	—	—	✓	3	3	1	—	—	—	—	✓	✓	8 / 12	—	64-LQFP, 64-TQFP, 64-QFN	$3.00
MSP430C1331	8	256	48	—	—	✓	3	3	1	—	—	—	—	✓	—	Slope	—	64-TQFP, 64-QFN	$2.00
MSP430F135	16	512	48	—	—	✓	3	3	1	—	—	—	—	✓	✓	8 / 12	—	64-LQFP, 64-TQFP, 64-QFN	$3.60
MSP430C1351	16	512	48	—	—	✓	3	3	1	—	—	—	—	✓	—	Slope	—	64-TQFP, 64-QFN	$2.30
MSP430F147	32	1024	48	—	—	✓	3	7	2	—	—	—	✓	✓	✓	8 / 12	—	64-LQFP, 64-TQFP, 64-QFN	$5.05
MSP430F1471	32	1024	48	—	—	✓	3	7	2	—	—	—	✓	✓	—	Slope	—	64-LQFP, 64-QFN	$4.60
MSP430F148	48	2048	48	—	—	✓	3	7	2	—	—	—	✓	✓	✓	8 / 12	—	64-LQFP, 64-TQFP, 64-QFN	$5.75
MSP430F1481	48	2048	48	—	—	✓	3	7	2	—	—	—	✓	✓	—	Slope	—	64-LQFP, 64-QFN	$5.30
MSP430F149	60	2048	48	—	—	✓	3	7	2	—	—	—	✓	✓	✓	8 / 12	—	64-LQFP, 64-TQFP, 64-QFN	$6.05
MSP430F1491	60	2048	48	—	—	✓	3	7	2	—	—	—	✓	✓	—	Slope	—	64-LQFP, 64-QFN	$5.60
MSP430F155	16	512	48	✓	—	✓	3	3	1	✓	✓	✓	—	✓	✓	8 / 12	2 / 12	64-LQFP	$4.95
MSP430F156	24	1024	48	✓	—	✓	3	3	1	✓	✓	✓	—	✓	✓	8 / 12	2 / 12	64-LQFP	$5.55
MSP430F157	32	1024	48	✓	—	✓	3	3	1	✓	✓	✓	—	✓	✓	8 / 12	2 / 12	64-LQFP	$5.85
MSP430F167	32	1024	48	✓	—	✓	3	7	2	✓	✓	✓	✓	✓	✓	8 / 12	2 / 12	64-LQFP	$6.75
MSP430F168	48	2048	48	✓	—	✓	3	7	2	✓	✓	✓	✓	✓	✓	8 / 12	2 / 12	64-LQFP	$7.45
MSP430F169	60	2048	48	✓	—	✓	3	7	2	✓	✓	✓	✓	✓	✓	8 / 12	2 / 12	64-LQFP	$7.95
MSP430F1610	32	5120	48	✓	—	✓	3	7	2	✓	✓	✓	✓	✓	✓	8 / 12	2 / 12	64-LQFP	$8.25
MSP430F1611	48	10240	48	✓	—	✓	3	7	2	✓	✓	✓	✓	✓	✓	8 / 12	2 / 12	64-LQFP	$8.65
MSP430F1612	55	5120	48	✓	—	✓	3	7	2	✓	✓	✓	✓	✓	✓	8 / 12	2 / 12	64-LQFP	$8.95
Flash-ROM-Based F4xx Family with LCD Driver (V_{CC} 1.8V - 3.6V)																			
MSP430F412	4	256	48	—	96	✓	3	—	—	—	✓	✓	—	✓	—	Slope	—	64-LQFP, 64-QFN	$2.60
MSP430C412	4	256	48	—	96	✓	3	—	—	—	✓	✓	—	✓	—	Slope	—	64-LQFP, 64-QFN	$2.90
MSP430F413	8	256	48	—	96	✓	3	—	—	—	✓	✓	—	✓	—	Slope	—	64-LQFP, 64-QFN	$2.95
MSP430F413	8	256	48	—	96	✓	3	—	—	—	✓	✓	—	✓	—	Slope	—	64-LQFP, 64-QFN	$2.10
MSP430F415	16	512	48	—	96	✓	3,5	—	—	—	✓	✓	—	✓	—	Slope	—	64-LQFP	$3.40
MSP430F417	32	1024	48	—	96	✓	3,5	—	—	—	✓	✓	—	✓	—	Slope	—	64-LQFP	$3.90
MSP430FW423	8	256	48	—	96	✓	3,5	—	—	—	✓	✓	—	✓	—	Slope	—	64-LQFP, 64-QFN	$3.75
MSP430FW425	16	512	48	—	96	✓	3,5	—	—	—	✓	✓	—	✓	—	Slope	—	64-LQFP	$4.05
MSP430FW427	32	1024	48	—	96	✓	3,5	—	—	—	✓	✓	—	✓	—	Slope	—	64-LQFP	$4.45
MSP430F423	8	256	14	—	128	✓	3	—	1	—	✓	✓	✓	—	✓	3 / 16	—	64-LQFP	$4.50
MSP430F425	16	512	14	—	128	✓	3	—	1	—	✓	✓	✓	—	✓	3 / 16	—	64-LQFP	$4.95
MSP430F427	32	1024	14	—	128	✓	3	—	1	—	✓	✓	✓	—	✓	3 / 16	—	64-LQFP	$5.40
MSP430FE423	8	256	14	—	128	✓	3	—	1	—	✓	✓	—	—	✓	3 / 16	—	64-LQFP	$4.85
MSP430FE425	16	512	14	—	128	✓	3	—	1	—	✓	✓	—	—	✓	3 / 16	—	64-LQFP	$5.45

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]Number of capture/compare registers.

Microcontrollers/Interface

MSP430 Ultra-Low-Power Microcontrollers Selection Guide (Continued)

Device	Prgm. (kB)	SRAM	I/O	DMA	LCD 8-Bit Timer	Watch-dog 16-Bit	Timer[2] A	Timer[2] B	USART	I^2C	SVS	BOR	MPY	Comp A	Temp Sensor	ADC Ch/Res	DAC Ch/Res	Package(s)	Price[1]
Flash-ROM-Based F4xx Family with LCD Driver (V_{CC} 1.8V - 3.6V) (Continued)																			
MSP430FE427	32	1024	14	—	128	✓	3	—	1	—	✓	✓	—	—	✓	3 / 16	—	64-LQFP	$5.95
MSP430F4250	16	256	32	—	56	✓	3	—	—	—	✓	✓	—	—	—	16	12	—	$3.95
MSP430F4260	24	256	32	—	56	✓	3	—	—	—	✓	✓	—	—	—	16	12	—	$4.25
MSP430F4270	32	256	32	—	56	✓	3	—	—	—	✓	✓	—	—	—	16	12	—	$4.55
MSP430F435	16	512	48	—	128/160	✓	3	3	1	—	✓	✓	—	✓	✓	8 / 12	—	80-LQFP, 100-LQFP	$4.45
MSP430F436	24	1024	48	—	128/160	✓	3	3	1	—	✓	✓	—	✓	✓	8 / 12	—	80-LQFP, 100-LQFP	$4.70
MSP430F437	32	1024	48	—	128/160	✓	3	3	1	—	✓	✓	—	✓	✓	8 / 12	—	80-LQFP, 100-LQFP	$4.90
MSP430FG437	32	1024	48	✓	128	✓	3	3	1	—	✓	✓	—	✓	✓	12 / 12	2 / 12	80-LQFP	$6.50
MSP430FG438	48	2048	48	✓	128	✓	3	3	1	—	✓	✓	—	✓	✓	12 / 12	2 / 12	80-LQFP	$7.35
MSP430FG439	60	2048	48	✓	128	✓	3	3	1	—	✓	✓	—	✓	✓	12 / 12	2 / 12	80-LQFP	$7.95
MSP430F447	32	1024	48	—	160	✓	3	7	2	—	✓	✓	✓	✓	✓	8 / 12	—	100-LQFP	$5.75
MSP430F448	48	2048	48	—	160	✓	3	7	2	—	✓	✓	✓	✓	✓	8 / 12	—	100-LQFP	$6.50
MSP430F449	60	2048	48	—	160	✓	3	7	2	—	✓	✓	✓	✓	✓	8 / 12	—	100-LQFP	$7.05
MSP430F4618	116	8192	80	✓	160	✓	3	7	2	—	✓	✓	✓	✓	✓	8 / 12	2 / 12	100-LQFP	$9.95
MSP430F4619	120	4096	80	✓	160	✓	3	7	2	—	✓	✓	✓	✓	✓	8 / 12	2 / 12	100-LQFP	$9.75
Flash-ROM-Based F4xx Family with 16 MIPS (V_{CC} 1.8-3.6V)																			
MSP430F2101	1	128	14	—	—	✓	3	—	—	—	—	—	—	✓[3]	—	Slope	—	20-TVSOP, 20-SOP, 20-TSSOP, 24-QFN	$0.99
MSP430F2111	2	128	14	—	—	✓	3	—	—	—	—	—	—	✓[3]	—	Slope	—	20-TVSOP, 20-SOP, 20-TSSOP, 24-QFN	$1.35
MSP430F2121	4	256	14	—	—	✓	3	—	—	—	—	—	—	✓[3]	—	Slope	—	20-TVSOP, 20-SOP, 20-TSSOP, 24-QFN	$1.70
MSP430F2131	8	256	14	—	—	✓	3	—	—	—	—	—	—	✓[3]	—	Slope	—	20-TVSOP, 20-SOP, 20-TSSOP, 24-QFN	$2.05

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]Number of capture/compare registers. [3]Multiplied comparator. *Preview products appear in **bold blue**.*

CAN Selection Guide

Supply Voltage (V)	Device	Description	Transient Pulse Protection (V)	I_{CC} max (mA)	ESD (kV)	Bus Fault Protection (V)	Footprint	Temp Range (°C)	Package(s)	Price[1]
5	SN65HVD251	Standby mode, improved drop-in replacement for PCA82C250 & PCA82C251	–200 to 200	65	14	±36	PCA82C250	–40 to 125	8-PDIP, 8-SOIC	$0.90
	SN65HVD1040	Improved drop-in replacement for TJA1040	–200 to 200	70	6	–27 to 40	TJA1040	–40 to 125	8-SOIC	—
	SN65HVD1039	Same as HVD1040 without dominant time out mode	–200 to 2000	70	6	–27 to 40	TJA1040	–40 to125	8-SOIC	—
	SN65HVD1050	Improved drop-in replacement for TJA1050	–200 to 200	70	6	–27 to 40	TJA1050	–40 to 125	8-SOIC	—
	SN65HVD1049	Same as HVD1050 without dominant time out mode	–200 to 200	70	6	–27 to 40	TJA1050	–40 to 125	8-SOIC	—
	SN65HVD1040v33	TJA1040 with 3 V MCU I/Os	±200	70	6	–27 to 40	TJA1040	–40 to 125	8-SOIC	—
	SN65HVD1050v33	TJA1050 with 3 V MCU I/Os	±200	70	6	–27 to 40	TJA1050	–40 to 125	8-SOIC	—
	SN65LBC031	500Kbps	–150 to 100	20	2	–5 to 20	SN75LBC031	–40 to 125	8-SOIC	$1.50
3.3	SN65HVD230	Standby mode	–25 to 25	17	16	–4 to 16	PCA82C250	–40 to 85	8-SOIC	$1.35
	SN65HVD231	Sleep mode	–25 to 25	17	16	–4 to 16	PCA82C250	–40 to 85	8-SOIC	$1.35
	SN65HVD232	Cost effective	–25 to 25	17	16	–4 to 16	SN65HVD232	–40 to 85	8-SOIC	$1.30
	SN65HVD230Q	Automotive temp, standby mode	–25 to 25	17	15	–7 to 16	PCA82C250	–40 to 125	8-SOIC	$1.55
	SN65HVD231Q	Automotive temp, sleep mode	–25 to 25	17	15	–7 to 16	PCA82C250	–40 to 125	8-SOIC	$1.55
	SN65HVD232Q	Automotive temp, cost effective	–25 to 25	17	15	–7 to 16	SN65HVD232	–40 to 125	8-SOIC	$1.50
	SN65HVD233	Standby mode, diagnostic loop-back	–100 to 100	6	16	±36	—	–40 to 125	8-SOIC	$1.50
	SN65HVD234	Standby mode, sleep mode	–100 to 100	6	16	±36	—	–40 to 125	8-SOIC	$1.45
	SN65HVD235	Standby mode, autobaud loop-back	–100 to 100	6	16	±36	—	–40 to 125	8-SOIC	$1.50

[1]Suggested resale price in U.S. dollars in quantities of 1,000. All devices have a signaling rate of 1Mbps except LBC031. *Preview products appear in **bold blue**.*

USB Hub Controllers Selection Guide

Device	Speed	Ports	I^2C	Voltage (V)	Package	Description	Price[1]
TUSB2036	Full (1.1)	2	No	3.3	32-LQFP	2/3-port hub for USB with optional serial EEPROM interface	$1.15
TUSB2046B	Full (1.1)	4	No	3.3	32-LQFP	4-port hub for USB with optional serial EEPROM interface supporting Windows® 95/DOS mode	$1.20
TUSB2077A	Full (1.1)	7	No	3.3	48-LQFP	7-port USB hub with optional serial EEPROM interface	$1.95
TUSB2136	Full (1.1)	2	Yes	3.3	64-LQFP	2-port hub with integrated general-purpose function controller	$3.25
TUSB5052	Full (1.1)	5	Yes	3.3	100-LQFP	5-port hub with integrated bridge to two serial ports	$5.10

[1]Suggested resale price in U.S. dollars in quantities of 1,000.

RS-485 Selection Guide

	Temperature Prefix[2]	Device	Description	No. of Tx/Rx	Supply Voltage (V)	Signaling Rate (Mbps)	ESD (kV)	Fail-Safe	Nodes	Footprint	Package(s)	Price[1]
Half-Duplex	SN65, SN75	HVD12	3.3V transceiver — 1Mbps	1/1	3.3	1	16	Short, Open	256	SN75176	8-PDIP, 8-SOIC	$1.75
Half-Duplex	SN65, SN75	HVD11	3.3V transceiver — 10Mbps	1/1	3.3	10	16	Short, Open	256	SN75176	8-PDIP, 8-SOIC	$1.80
Half-Duplex	SN65, SN75	HVD10	3.3V transceiver — 25Mbps	1/1	3.3	25	16	Short, Open	64	SN75176	8-PDIP, 8-SOIC	$1.85
Half-Duplex	SN65, SN75	HVD08	Wide supply range: 3 to 5.5V	1/1	3.3 to 5	10	16	Short, Open	256	SN75176	8-PDIP, 8-SOIC	$1.90
Half-Duplex	SN65, SN75	HVD3082E	Low power, fail-safe, high ESD	1/1	5	0.2	15	Short, Open	256	SN75176	8-PDIP, 8-SOIC, 8-MSOP	$0.90
Half-Duplex	**SN65, SN75**	HVD3085E	Low power, fail-safe & high ESD	1/1	5	1	15	Short, Open	256	SN75176	8-PDIP, 8-SOIC, 8-MSOP	$0.90
Half-Duplex	SN65, SN75	HVD3088E	Low power, fail-safe & high ESD	1/1	5	10	15	Short, Open	256	SN75176	8-PDIP, 8-SOIC, 8-MSOP	$1.00
Half-Duplex	SN65	HVD485E	Half duplex transceiver	1/1	5	10	15	Open	64	SN5176	8-PDIP, 8-SOIC, 8-MSOP	$0.70
Half-Duplex	SN65, SN75	HVD1176	PROFIBUS transceiver, EN 50170	1/1	5	40	10	Short, Open, Idle	160	SN75176	8-SOIC	$1.55
Half-Duplex	SN65	HVD22	–20V to 25V common mode, 0.5Mbps	1/1	5	0.5	16	Short, Open	256	SN75176	8-PDIP, 8-SOIC	$1.65
Half-Duplex	SN65	HVD21	–20V to 25V common mode, 5Mbps	1/1	5	5	16	Short, Open	256	SN75176	8-PDIP, 8-SOIC	$1.65
Half-Duplex	SN65	HVD20	–20V to 25V common mode, 25Mbps	1/1	5	25	16	Short, Open	64	SN75176	8PDIP, 8-SOIC	$1.65
Half-Duplex	SN65	HVD23	Receiver equalization, –20V to 25V Common mode, 25Mbps	1/1	5	25	16	Short, Open	64	SN75176	8-PDIP, 8-SOIC	$1.80
Half-Duplex	SN65	HVD24	Receiver equalization, –20V to 25V common mode, 3Mbps	1/1	5	3	16	Short, Open	256	SN75176	8-PDIP, 8-SOIC	$1.80
Half-Duplex	SN65, SN75	HVD07	High output transceiver — 1Mbps	1/1	5	1	16	Short, Open	256	SN75176	8-PDIP, 8-SOIC	$1.50
Half-Duplex	SN65, SN75	HVD06	High output transceiver — 1Mbps	1/1	5	10	16	Short, Open	256	SN75176	8-PDIP, 8-SOIC	$1.55
Half-Duplex	SN65, SN75	HVD05	High output transceiver — 40Mbps	1/1	5	40	16	Short, Open	64	SN75176	8-PDIP, 8-SOIC	$1.60
Half-Duplex	SN55, SN65, SN75	LBC176	Low power, –40˚C to +125˚C	1/1	5	10	2	Open	32	SN75176	8-PDIP, 8-SOIC	$0.90
Half-Duplex	SN65, SN75	LBC176A	Low power, high ESD	1/1	5	30	12	Open	32	SN75176	8-PDIP, 8-SOIC	$1.20
Half-Duplex	SN65	LBC176A-EP	Low power, high ESD, controlled fab & A/T	1/1	5	30	12	Open	32	SN75176	8-SOIC	$3.51
Half-Duplex	SN65, SN75	LBC184	Integrated transient protection, IEC 61000-4-2/5	1/1	5	0.25	15	Open	128	SN75176	8-PDIP, 8-SOIC	$1.30
Half-Duplex	SN65, SN75	LBC182	Similar to LBC184 without integrated transient protection	1/1	5	0.25	15	Open	128	SN75176	8-PDIP, 8-SOIC	$1.05
Half-Duplex	SN65, SN75	ALS176	Skew: 15ns	1/1	5	35	2	Open	32	SN75176	8-SOIC	$0.72
Half-Duplex	SN75	ALS176A	Skew: 7.5ns	1/1	5	35	2	Open	32	SN75176	8-PDIP, 8-SOIC	$1.08
Half-Duplex	SN75	ALS176B	Skew: 5ns	1/1	5	35	2	Open	32	SN75176	8-PDIP, 8-SOIC	$0.72
Half-Duplex	SN75	176A	Cost effective	1/1	5	10	2	None	32	SN75176	8-PDIP, 8-SOIC	$0.27
Half-Duplex	SN65, SN75	176B	Cost effective	1/1	5	10	2	None	32	SN75176	8-PDIP, 8-SOIC, 8-SOP	$0.36
Full-Duplex	SN65, SN75	LBC179A	High signaling rate, high ESD w/o enable	1/1	5	30	10	Open	32	SN75179	8-PDIP, 8-SOIC	$1.10
Full-Duplex	SN65, SN75	LBC180A	High signaling rate, high ESD w/ enable	1/1	5	30	10	Open	32	SN75180	14-PDIP, 14-SOIC	$1.35
Full-Duplex	SN65, SN75	LBC180	Lower power, with enable	1/1	5	10	2	Open	32	SN75LBC180	14-PDIP, 14-SOIC	$1.05
Full-Duplex	SN65, SN75	LBC179	Low power, without enable	1/1	5	10	2	Open	32	SN75179	8-PDIP, 8-SOIC	$0.85
Full-Duplex	SN75	ALS181	–12V to 12V common mode, with enable	1/1	5	10	2	None	32	SN75ALS180	14-PDIP, 14-SOP	$1.62
Full-Duplex	SN65, SN75	ALS180	High signaling rate, with enable	1/1	5	25	2	Open	32	SN75ALS180	14-SOIC	$1.48
Full-Duplex	SN75	178B	Without enables	1/1	5	10	2	None	32	SN75176	8-PDIP, 8-SOP	$1.35
Full-Duplex	SN75	179B	Without enables	1/1	5	10	2	None	32	SN75179	8-PDIP, 8-SOIC, 8-SOP	$0.68

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]Available in Commercial (SN75) and Military (SN55) Temperature options in addition to Industrail Temperature (SN65).

*Preview prodcuts appear in **bold blue**.*

Interface

RS-485 Selection Guide (Continued)

	Temperature Prefix[2]	Device	Description	No. of Tx/Rx	Supply Voltage (V)	Signaling Rate (Mbps)	ESD (kV)	Fail-Safe	Nodes	Footprint	Package(s)	Price[1]
Dual	SN75	ALS171	FAST-20 SCSI, skew: 10ns	3/3	5	20	2	Open	32	SN75ALS171	20-SOIC	$5.40
Dual	SN75	ALS1177	Driver & receiver pair, common enable	2/2	5	10	2	Open	32	MC34050	16-PDIP, 16-SOP	$3.24
Dual	SN75	ALS1178	Driver & receiver pair, driver enable	2/2	5	10	2	Open	32	MC34051	16-PDIP, 16-SOP	$3.24
Dual	SN75	1177	Driver & receiver pair, common enable	2/2	5	10	2	N/A	32	MC34050	16-PDIP, 16-SOP	$2.43
Triple	SN75	1178	Driver & receiver pair, driver enable	2/2	5	10	2	Open	32	MC34051	16-PDIP, 16-SOP	$2.43
Triple	SN75, SN65	LBC170	FAST-20 SCSI, skew: 3ns	3/3	5	30	12	Open	32	SN75ALS170	20-SOIC, 16-SSOP	$3.54
Triple	SN75, SN65	LBC171	FAST-20 SCSI, skew: 3ns	3/3	5	30	12	Open	32	SN75ALS171	20-SOIC, 20-SSOP	$3.54
Triple	SN75	ALS170A	FAST-20 SCSI, skew: 5ns	3/3	5	20	2	Open	32	SN75ALS170	20-SOIC	$4.77
Triple	SN75	ALS171A	FAST-20 SCSI, skew: 5ns	3/3	5	20	2	Open	32	SN75ALS171	20-SOIC	$4.54
Triple	SN75	ALS170	FAST-20 SCSI, skew: 10ns	3/3	5	20	2	Open	32	SN75ALS170	20-SOIC	$4.77
Quad-Drivers	SN55, SN65, SN75	LBC172	Low power	4/0	5	10	2	N/A	32	AM26LS31	16-PDIP, 20-SOIC	$1.65
Quad-Drivers	SN55, SN65, SN75	LBC174	Low power	4/0	5	10	2	N/A	32	MC3487	16-PDIP, 20-SOIC	$1.75
Quad-Drivers	SN65, SN75	LBC172A	High signaling rate, high ESD	4/0	5	30	13	N/A	32	AM26LS31	16-PDIP, 16-SOIC, 20-SOIC	$2.25
Quad-Drivers	SN65, SN75	LBC174A	High signaling rRate, high ESD	4/0	5	30	13	N/A	32	MC3487	16-PDIP, 16-SOIC, 20-SOIC	$2.35
Quad-Drivers	SN75	ALS172A	High signaling rate	4/0	5	20	2	N/A	32	AM26LS31	16-PDIP, 20-SOIC	$2.61
Quad-Drivers	SN75	ALS174A	High signaling rate	4/0	5	20	2	N/A	32	MC3487	16-PDIP, 20-SOIC	$1.13
Quad-Drivers	SN75	172	Cost effective	4/0	5	4	2	N/A	32	AM26LS31	16-PDIP, 20-SOIC	$0.97
Quad-Drivers	SN75	174	Cost effective	4/0	5	4	2	N/A	32	MC3487	16-PDIP, 20-SOIC	$0.63
Quad-Receivers	SN55, SN65, SN75	LBC173	Low power	0/4	5	10	2	Open	32	AM26LS32	16-PDIP, 16-SOIC	$1.05
Quad-Receivers	SN55, SN65, SN75	LBC175	Low power	0/4	5	10	2	Open	32	MC3486	16-PDIP, 16-SOIC, 20-SOIC	$1.00
Quad-Receivers	SN65, SN75	LBC173A	High signaling rate, high ESD, low power	0/4	5	50	6	Short, Open	32	AM26LS32	16-PDIP, 16-SOIC	$1.40
Quad-Receivers	SN65, SN75	LBC175A	High signaling rate, high ESD, low power	0/4	5	50	6	Short, Open	32	MC3486	16-PDIP, 16-SOIC	$1.30
Quad-Receivers	SN75	ALS173	Low power	0/4	5	10	2	Open	32	AM26LS32	16-PDIP, 16-SOP	$2.61
Quad-Receivers	SN75	ALS175	Low power	0/4	5	10	2	Open	32	MC3486	16-PDIP, 16-SOP	$2.29
Quad-Receivers	SN55, SN75	173	Cost effective	0/4	5	10	2	Open	32	AM26LS32	16-PDIP, 16-SOIC, 16-SOP, 20-LCCC,16-CDIP	$0.99
Quad-Receivers	SN65, SN75	175	Cost effective	0/4	5	10	2	None	32	MC3486	16-PDIP, 16-SOIC, 16-SOP	$0.45

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]Available in Commercial (SN75) and Military (SN55) Temperature options in addition to Industrial Temperature (SN65).

RS-232 Selection Guide

Device	Description	Drivers per Pkg.	Receivers per Pkg.	Supply Voltage(s) (V)	I_{CC} (mA) (max)	Footprint	Package(s)	Price[1]
TL145406	Triple RS-232 drivers/receivers	3	3	±12, 5	20	MC14506	PDIP, SOIC	$0.94
GD75232	Multiple RS-232 drivers and receivers	3	5	±12, 5	20	GD75232	PDIP, SOIC, SSOP, TSSOP	$0.22
MAX3243	3V to 5.5V multichannel RS-232 line driver/receiver with ±15kV ESD (HBM) protection	3	5	3.3, 5	1	MAX3243	SOIC, SSOP, TSSOP	$0.99
MAX202	5V dual RS-232 line driver/receiver with ±15kV ESD protection	2	2	5	15	MAX202	SOIC, TSSOP	$0.58
MAX207	5V multichannel RS-232 line driver/receiver with ±15kV ESD protection	5	3	5	20	MAX207	SOIC, SSOP	$1.08
MAX211	5V multichannel RS-232 line driver/receiver with ±15kV ESD protection	4	5	5	20	MAX211	SOIC, SSOP	$1.08
MAX222	5V dual RS-232 line driver/receiver with ±15kV ESD protection	2	2	5	10	MAX222	SOIC	$1.26
SN65C3243	3V to 5.5V multichannel RS-232 line driver/receiver	3	5	3.3 or 5	1	MAX3234	SOIC, SSOP, TSSOP	$3.46
SN75185	Multiple RS-232 drivers and receivers	3	5	±12, 5	30	SN75185	PDIP, SOIC	$0.43

[1]Suggested resale price in U.S. dollars in quantities of 1,000.

*New products appear in **bold red**.*

RS-232 Selection Guide (Continued)

Device	Description	Drivers per Pkg.	Receivers per Pkg.	Supply Voltage(s) (V)	I_{CC} max (mA)	Footprint	Package(s)	Price[1]
SN75C185	Low-power multiple drivers and receivers	3	5	±12, 5	0.75	SN75C185	PDIP, SOIC	$0.90
SN75C3234	3V to 5.5V multichannel RS-232 line driver/receiver	3	5	3.3 to 5	1	MAX3243	SOIC, SSOP, TSSOP	$2.02
SN75LBC187	Multichannel EIA-232 driver/receiver with charge pump	3	5	5	30	SN75LBC187	SSOP	$3.60
SN75LP1185	Low-power multiple RS-232 drivers and receivers	3	5	5, ±12	1	SN75LP185	PDIP, SOIC, SSOP	$1.53
SN75LPE185	Low-power multiple drivers and receivers	3	5	5, ±12	1	SN75LP185	PDIP, SOIC, SSOP, TSSOP	$1.62
SN75LV4737A	3V to 5.5V multichannel RS-232 line driver/receiver	3	5	3 or 5	1	MAX3243	SOIC, SSOP, TSSOP	$2.61
LT1030	Quad low-power line driver	4	0	±5	1	LT1030	PDIP, SOIC	$0.81
MC1488	Quad line driver	4	0	±9	25	MC1488	PDIP	$0.20
SN55188	Quad line driver	4	0	±9		MC1488	CDIP, CFP, LCCC	$1.97
SN75188	Quad line driver	4	0	±9	25	MC1488	PDIP, SOIC, SOP	$0.18
SN75C188	Quad low-power line driver	4	0	±12	0.16	MC1488	PDIP, SOIC, SOP, SSOP	$0.31
SN75C198	Quad low-power line drivers	4	0	±12	0.32	—	PDIP, SOIC	$2.25
SN75154	Quad differential line receiver	4	4	5 or 12	35	SN75154	PDIP, SOIC, SOP	$0.41
SN75C1154	Quad low-power drivers/receivers	4	4	±12, 5	—	—	PDIP, SOIC, SOP	$0.76
SN75LBC241	Low-power LinBiCMOS™ multiple drivers and receivers	4	5	5	8	MAX241	SOIC	$1.73
GD75323	Multiple RS-232 drivers and receivers	5	3	±12, 5	32	GD75323	SOIC	$0.22
MAX3238	3V to 5.5V multichannel RS-232 line driver/receiver	5	3	3.3, 5	2	MAX3238	SSOP, TSSOP	$1.13
SN65C3238	3V to 5.5V multichannel RS-232 line driver/receiver	5	3	3.3 or 5	2	MAX3238	SOIC, SSOP, TSSOP	$3.24
SN75196	Multiple RS-232 driver and receiver	5	3	±12, 5	20	SN75196	PDIP, SOIC	$0.41
SN75C3238	3V to 5.5V multichannel RS-232 line driver/receiver	5	3	3.3 or 5	2	MAX3238	SOIC, SSOP, TSSOP	$2.81
SN75LP196	Low-power multiple RS-232 drivers and receivers	5	3	5, ±12	1	SN75LP185	PDIP, SOIC, SSOP, TSSOP	$1.53
SN65C23243	3V to 5.5V dual RS-232 port	6	10	3.3, 5	0.02	—	SSOP, TSSOP	$4.32
SN752232	Dual RS-232 port	6	10	5	±50	—	SSOP, TSSOP	$0.81
SN75C23243	3V to 5.5V dual RS-232 port	6	10	3.3, 5	0.02	—	SSOP, TSSOP	$3.42
UC5171	Octal line driver with TTL mode selection	8	0	±9 to ±15	42	—	PLCC	$6.33
UC5172	Octal line driver with long line drive	8	0	±9 to ±15	25	—	PDIP, PLCC	$3.25

[1]Suggested resale price in U.S. dollars in quantities of 1,000.

1394b Media Summary

Device	Reach	s100	s200	s400	s800	s1600	s3200
UTP-5	100m	X	—	—	—	—	—
POF/HPCF	100m	X	X	X	X	X	—
50µm GOF	100m	—	—	X	X	X	X
STP (beta)	4.5m	—	—	X	X	X	X
STP (DS)	4.5m	X	X	X	—	—	—

Higher speeds and greater distances provide increased versatility for industrial and automated systems requiring high bandwidth real-time data.

1394 Link-Layer Controllers Selection Guide

Device	Supply Voltage (V)	Speed Max (Mbps)	FIFO (kb)	Package	Description	Price[1]
TSB12C01A	5	100	2	100-LQFP	High-performance 5V link layer with 32-bit host I/F, 2K FIFOs	$11.75
TSB12LV01B	3.3	400	2	100-TQFP	High-performance 1394 3.3V link layer for telecom, embedded & industrial app., 32-bit I/F, 2kb FIFO	$8.90
TSB12LV21B	3.3	400	4	176-LQFP	PCILynx™ - PCI to 1394 3.3V link layer with 32-bit PCI I/F, 4K FIFOs	$9.60
TSB12LV26	3.3	400	9	100-TQFP	OHCI-Lynx™ PCI-based IEEE 1394 host controller	$3.95
TSB12LV32	3.3	400	4	100-LQFP	General-purpose link layer controller (GP2Lynx)	$5.15
TSB42AA4	3.3	400	8	128-TQFP	1394 link layer controller with DTCP content protection for consumer electronics applications	$9.20
TSB42AB4	3.3	400	8	128-TQFP	1394 link layer controller for consumer electronics applications - no content protection	$10.95
TSB42AC3	3.3	400	10	100-TQFP	High-performance link layer with 32-bit I/F. May be cycle master; has 10KB FIFO and JTAG support. PHY-link timing compliant with 1394a-2000 for industrial and bridge applications.	$6.50
TSB82AA2	3.3	800	11	144-LQFP	High-performance 1394b 3.3V OHCI 1.1+ compliant link layer controller	$7.80

[1]Suggested resale price in U.S. dollars in quantities of 1,000.

Interface

1394 Integrated Devices Selection Guide

Device	Supply Voltage (V)	Speed Max (Mbps)	FIFO (kb)	Package(s)	Description	Price[1]
TSB43AA22	3.3	400	8	128-TQFP	1394a serial layer controller + 400Mbps, 2-port physical layer	$7.20
TSB43AA82A	3.3	400	4.7	144-LQFP	2-port high performance integrated physical and link layer chip for PC peripherals	$8.30
TSB43AB21A	3.3	400	9	128-TQFP	OHCI 1.1, 1394a link layer controller integrated with 1394a, 400Mbps, 1-port physical layer (PHY)	$4.35
TSB43AB22A	3.3	400	9	128-TQFP	OHCI 1.1, 1394a link layer controller integrated with 1394a, 400Mbps, 2-port physical layer (PHY)	$4.55
TSB43AB23	3.3	400	9	144-LQFP, 128- TQFP	OHCI 1.1, 1394a link layer controller integrated with a 1394a, 400Mbps, 3-port physical layer (PHY)	$4.90
TSB43CA42	3.3	400	16	176-LQFP	iceLynx micro 2-port IEEE 1394a-2000 CES	$10.60
TSB43CA43A	3.3	400	16.5	176-LQFP	iceLynx micro-5C with streaming audio and content protection	$12.60
TSB43CB43A	3.3	400	16.5	176-LQFP	iceLynx micro with streaming audio	$11.40

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

1394 Physical-Layer Controllers Selection Guide

Device	Supply Voltage (V)	Speed Max (Mbps)	FIFO (kb)	Package(s)	Description	Price[1]
TSB14AA1A	3.3	100	1	48-TQFP	IEEE 1394-1995, 3.3V, 1-port, 50/100Mbps, backplane PHY	$5.90
TSB14C01A	5	100	1	64-LQFP	IEEE 1394-1995, 5V, 1-Port, 50/100Mbps backplane physical layer controller	$5.45
TSB17BA1	3.3	100	1	24-TSSOP	1394b-2002 compliant Cat5 cable transceiver for up to 100 meters	$2.50
TSB41AB1	3.3	400	1	48-HTQFP, 64-HTQFP	IEEE 1394a one-port cable transceiver/arbiter	$1.50
TSB41AB2	3.3	400	2	64-HTQFP	IEEE 1394a two-port cable transceiver/arbiter	$1.85
TSB41AB3A	3.3	400	3	80-HTQFP	IEEE 1394a three-port cable transceiver/arbiter	$3.00
TSB41BA3A	3.3	400	3	80-HTQFP	1394b-2002 3-port physical layer device	$6.50
TSB41LV04A	3.3	400	4	80-HTQFP	IEEE 1394a four-port cable transceiver/arbiter	$6.50
TSB41LV06A	3.3	400	6	100-HTQFP	IEEE 1394a six-port cable transceiver/arbiter	$6.40
TSB81BA3	1.8, 3.3	800	3	80-HTQFP	IEEE P1394b s800 three-port cable transceiver/arbiter	$7.80

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

UARTs Selection Guide

Device	Channels	FIFOs (bytes)	Baud Rate max (Mbps)	Voltage (V)	Package(s)	Description	Price[1]
TL16C450	1	0	0.256	5	40-PDIP, 44-PLCC	Single UART without FIFO	$1.50
TL16C451	1	0	0.256	5	68-PLCC	Single UART with parallel port and without FIFO	$2.50
TL16C452	2	0	0.256	5	68-PLCC	Dual UART with parallel port and without FIFO	$2.55
TL16C550C	1	16	1	5, 3.3	48-LQFP, 40-PDIP, 44-PLCC, 48-TQFP	Single UART with 16-byte FIFOs and auto flow control	$1.75
TL16C550D	1	16	1	5, 3.3, 2.5	48-LQFP, 48-TQFP, 32-QFN	Single UART with 16-byte FIFOs and auto flow control	$1.75
TL16C552/552A	2	16	1	5	68-PLCC	Dual UART with 16-byte FIFOs and parallel port	$3.90 /$3.85
TL16C554/554A	4	16	1	5	80-LQFP, 68-PLCC	Quad UART with 16-byte FIFOs	$6.05/$6.00
TL16C750	1	16 or 64	1	5, 3.3	64-LQFP, 44-PLCC	Single UART with 64-byte FIFOs, auto flow control, low-power modes	$3.70
TL16C752B	2	64	3	3.3	48-LQFP	Dual UART with 64-byte FIFO	$3.10
TL16C754B	4	64	5V-3, 3.3V-2	5, 3.3	80-LQFP, 68-PLCC	Quad UART with 64-byte FIFO	$8.35
TL16PC564B/BLV	1	64	1	5, 3.3	100-BGA, 100-LQFP	Single UART with 64-byte FIFOs, PCMCIA interface	$5.90/$3.10
TL16PIR552	2	16	1	5	80-QFP	Dual UART with 16-byte FIFOs, selectable IR and 1284 modes	$6.10
TIR1000	0	None	0.115	2.7 to 5.5	8-OP, 8-TSSOP	Standalone IrDA encoder and decoder	$1.15
TUSB3410	0	None	0.922	3.3	32-LQFP	RS232/IrDA serial-to-USB converter	$2.50

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

USB Peripherals Selection Guide

Device	Speed	Voltage (V)	Remote Wakeup	Package	Description	Price[1]
TUSB3210	Full	3.3	Yes	64-LQFP	USB full-speed general-purpose device controller	$2.50
TUSB3410	Full	3.3	Yes	32-LQFP	RS232/IrDA serial-to-USB converter	$2.25
TUSB6250	Full, high	3.3	Yes	80-TQFP	USB 2.0 high-speed ATA/ATAPI bridge solution	$2.80

[1]*Suggested resale price in U.S. dollars in quantities of 1,000.*

PCI Bridges Selection Guide

Device	Intel Compatible Part Number	Speed (MHz)	Expansion Interface (bits)	Hot Swap	MicroStar BGA™ Packaging	Voltage(s) (V)	Package(s)	Description	Price[1]
HPC3130		33	32		No	3.3	128-LQFP, 120-QFP	Hot plug controller	$10.95
HPC3130A		66	64		No	3.3	128-LQFP, 144-LQFP, 120-QFP	Hot plug controller	$10.95
PCI2040				Friendly	Yes	3.3, 5	144-BGA, 144-LQFP	PCI-to-DSP bridge controller, compliant to compact PCI hot swap specification 1.0	$10.55
PCI2060		66	32	Friendly	Yes	3.3, 5	257-BGA	Asynchronous 32-bit, 66MHz PCI-to-PCI bridge	$9.50
PCI2050B	21150bc	66	32	Friendly	Yes	3.3, 5	257-BGA, 208-LQFP, 208-QFP	PCI-to-PCI bridge	$9.50
PCI2250	21152ab	33	32	Friendly	No	3.3, 5	176-LQFP, 160-QFP	32-bit, 33MHz PCI-to-PCI bridge, compact PCI hot-swap friendly, 4-master	$6.10

[1]Suggested resale price in U.S. dollars in quantities of 1,000.

PCI CardBus Controllers Selection Guide

Device	Voltage (V)	D3 Cold Wake	Integrated 1394	Integrated ZV	Package(s)	Description	Price[1]
PCI1510	3.3	Yes	No	No	144-BGA, 144-LQFP	Single slot PC CardBus controller	$3.60
PCI1520	3.3	Yes	No	No	209-BGA, 208-LQFP	PC card controller	$4.35
PCI1620	1.8, 3.3, 5	Yes	No	No	209-BGA, 208-LQFP	PC card, flash media, and smart card controller	$7.35
PCI4510	3.3	Yes	Yes	No	209-BGA, 208-LQFP	PC card and integrated 1394a-2000 OHCI two-port-PHY/link-layer controller	$8.00
PCI4520	3.3	Yes	Yes	No	257-BGA	Two slot PC card and integrated 1394a-2000 OHCI two-port-PHY/link-layer controller	$9.15
PCI6420	3.3	Yes	No	No	288-BGA	Integrated 2-slot PC card & dedicated flash media controller	$9.50
PCI6620	3.3	Yes	No	No	288-BGA	Integrated 2-slot PC card with smart card & dedicated flash media controller	$10.50
PCI7410	3.3	Yes	Yes	No	209-BGA, 208-LQFP	PC Card, flash media, integrated 1394a-2000 OHCI 2-Port PHY/link-layer controller	$11.00
PCI7420	3.3	Yes	Yes	No	288-BGA	Integrated 2-slot PC Card, dedicated flash media socket & 1394a-2000 OHCI 2-Port-PHY/link-layer controller	$12.00
PCI7510	3.3	Yes	Yes	No	209-BGA, 208-LQFP	Integrated PC Card, smart card and 1394 controller	$11.00
PCI7610	3.3	Yes	Yes	No	209-BGA, 208-LQFP	Integrated PC Card, smart card, flash media ,1394a-2000 OHCI 2-Port-PHY/ link-layer controller	$12.00
PCI7620	3.3	Yes	Yes	No	288-BGA	Integrated 2-slot PC card with smart card, flash media, 1394a-2000 OHCI 2-Port-PHY/link-layer controller	$13.00

[1]Suggested resale price in U.S. dollars in quantities of 1,000.

Power+ Logic™: 8-Bit Devices with Integrated Control Logic and FETs (T_C = –40°C to +125°C)

Device	Description	V_{DS} max (V)	I_{CC} typ (µA)	I_O (A)	I_{PEAK} (A)	$r_{DS(on)}$ typ (Ω)	E_{AS} max (mJ)	t_{PLH} typ (ns)	ESD max (kV)	Package(s)
TPIC6259	Addressable latch	45	15	0.25	0.75	1.3	75	625	3	20/SOP (DW), DIP (N)
TPIC6273	D-Type latch	45	15	0.25	0.75	1.3	75	625	3	20/SOP (DW), DIP (N)
TPIC6595	Shift register	45	15	0.25	0.75	1.3	75	650	3	20/SOP (DW), DIP (N)
TPIC6596	Shift register	45	15	0.25	0.75	1.3	75	650	3	20/SOP (DW), DIP (N)
TPIC6A259[1]	Addressable latch	50	500	0.35	1.1	1	75	125	2.5	20/DIP (NE), 24/SOP (DW)
TPIC6A595[1]	Shift register	50	500	0.35	1.1	1	75	125	2.5	20/DIP (NE), 24/SOP (DW)
TPIC6A596[1]	Shift register	50	500	0.35	1.1	1	75	125	2.5	20/DIP (NE), 24/SOP (DW)
TPIC6B259[2]	Addressable latch	50	20	0.15	0.5	5	30	150	2.5	20/SOP (DW), DIP (N)
TPIC6B273[2]	D-type latch	50	20	0.15	0.5	5	30	150	2.5	20/SOP (DW), DIP (N)
TPIC6B595[2]	Shift register	50	20	0.15	0.5	5	30	150	2.5	20/SOP (DW), DIP (N)
TPIC6B596[2]	Shift register	50	20	0.15	0.5	5	30	150	2.5	20/SOP (DW), DIP (N)
TPIC6C595[2]	Shift register	33	20	0.1	0.25	7	30	80	2.5	16/SOP (D), DIP (N)
TPIC6C596[2]	Shift register	33	20	0.1	0.25	7	30	80	2.5	16/SOP (D), DIP (N)

[1]Short-circuit and current-limit protection. [2]Current-limit capability.

Power Management

PWM Power Supply Control (Single Output) Selection Guide

Device	Typical Power Level (W)	Max Practical Frequency	Start-Up Current	Operating Current	Supply Voltage (V)	UVLO: On/Off (V)	V_{REF} (V)	V_{REF} Tol. (%)	Max Duty Cycle (%)	E/A	Voltage Feed-Forward	Internal Drive (Sink/Source) (A)	Package(s)	Price[1]
Peak Current Mode Controllers														
UCC38C40	10 to 250	1MHz	50µA	2.3mA	6.6 to 20	7.0/6.6	5	2	100	Yes	Yes	1/1	SOIC-8, PDIP-8, MSOP-8	$0.95
UCC38C41	10 to 250	1MHz	50µA	2.3mA	6.6 to 20	7.0/6.6	5	2	50	Yes	Yes	1/1	SOIC-8, PDIP-8, MSOP-8	$0.95
UCC38C42	10 to 250	1MHz	50µA	2.3mA	9 to 20	14.5/9	5	2	100	Yes	Yes	1/1	SOIC-8, PDIP-8, MSOP-8	$0.95
UCC38C43	10 to 250	1MHz	50µA	2.3mA	7.6 to 20	8.4/7.6	5	2	100	Yes	Yes	1/1	SOIC-8, PDIP-8, MSOP-8	$0.95
UCC38C44	10 to 250	1MHz	50µA	2.3mA	9 to 20	14.5/9	5	2	50	Yes	Yes	1/1	SOIC-8, PDIP-8, MSOP-8	$0.95
UCC38C45	10 to 250	1MHz	50µA	2.3mA	7.6 to 20	8.4/7.6	5	2	50	Yes	Yes	1/1	SOIC-8, PDIP-8, MSOP-8	$0.95

[1]Suggested resale price in U.S. dollars in quantities of 1,000.

Switching DC/DC Controllers Selection Guide

Device	V_{IN} (V)	V_O (V) (max)	V_O (V) (min)	V_{REF} Tol (%)	Driver Current (A)	Output Current (A)[2]	Multiple Outputs	Frequency (kHz)	Protection[3]				Application[4]					Light Load Efficeint	Price[1]
									OCP	OVP	UVLO	PG	Source Only	Source/ Sink	Prebias Operation	PGD	DDR		
General-Purpose DC/DC Controllers																			
TPS40007	2.25 to 5.5	4	0.7	1.5	1	15	No	300	✓		✓			✓	✓	✓		✓	$0.99
TPS40021	2.25 to 5.5	4	0.7	1	2	25	No	Program up to 1MHz	✓		✓	✓		✓		✓		✓	$1.15
TPS40057	8 to 40	35	0.7	1	1	20	No	Program up to 1MHz	✓		✓				✓			✓	$1.35
TPS40061	10 to 55	40	0.7	1	1	10	No	Program up to 1MHz	✓		✓			✓					$1.40
TPS40071	4.25 to 28	23	0.7	1	1	20	No	Program up to 1MHz	✓		✓	✓		✓		✓			$1.35
TPS51020	4.25 to 28	24	0.85	1	2	20	2	450	✓	✓	✓	✓					✓	✓	$3.15
DC/DC Controllers with Light Load Efficiency													**Comments**						
TPS51116	3 to 28	3.4	1.5	1	0.8	10	1 + 2	Up to 500	✓	✓	✓	✓	Sync switcher w/3A tracking LDO				✓	✓	$1.20
Other Typology DC/DC Controllers													**Comments**						
TPS6420x	1.8 to 6.5	6.5	1.2	—	—	3	No	—	✓		✓		Simple, hysteretic high-efficiency controller in SOT-23						$0.55
UC3572	4.75 to 30	0	–48	2	0.5	5	No	300	✓		✓		Simple inverting PWM controller						$1.05

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]Current levels of this magnitude can be supported. *New prodcuts are listed in **bold red**.*
[3]OCP = over-current protection, OVP = over-voltage protection, UVLO = under-voltage lockout, PG = power good. [4]The controller of choice for most applications will be the source/sink version, which has two-quadrant operation and will source or sink output current. PGD = Predictive Gate Drive™ technology included; DDR = supports DDR memory.

DC/DC Converter (Integrated FETs) Selection Guide

Device	V_{IN} (V)	Output Current (A)	V_{OUT} (V)	Package(s)	Price[1]
Buck (Step Down)					
TPS62040/2/3/4/6	2.5 to 6.0	1.2	Adj. 1.5, 1.6, 1.8, 3.3	MSOP-10, QFN-10	$2.20
TPS62200/1/2/3/4/5/6	2.5 to 6.0	0.3	Adj.,1.5, 1.8, 3.3, 1.6, 2.5, 2.6	SOT 23-5	$1.35
TPS62000/1/2/3/4/5/6/7/8	2.0 to 5.5	0.6	Adj., 0.9, 1.0,1.2, 1.5, 1.8, 2.5, 3.3, 1.9	MSOP-10	$1.60
TPS62051/2/3/4/5	2.7 to 10	0.8	Adj., 1.5, 1.8, 3.3	MSOP-10	$1.85
TPS54310/1/2/3/4/5/6	3.0 to 6.0	3	Adj., 0.9, 1.2, 1.5, 1.8, 2.5, 3.3	HTSSOP-20	$2.95
TPS54610/1/2/3/4/5/6	3.0 to 6.0	6	Adj., 0.9, 1.2, 1.5, 1.8, 2.5, 3.3	HTSSOP-28	$3.90
TPS54810	4.0 to 6.0	8	Adj. to 0.9	HTSSOP-28	$4.20
TPS54910	3.0 to 4.0	9	Adj. to 0.9	HTSSOP-28	$4.40
Inverter					
TPS6755	2.7 to 9.0	0.2	Adj. from -1.25 to - 9.3	SOIC-8	$1.25
TL497A	4.5 to 12	0.5	Adj. from -1.2 to -25	TSSOP-14	$0.86

[1]Suggested resale price in U.S. dollars in quantities of 1,000.

Low Dropout Regulators (LDOs) Selection Guide

Device	I_O (mA)	V_{DO} @ I_O (mV)	I_q (µA)	Output Options: Voltage (V)	Output Options: Adj.	Min V_{IN}	Max V_{IN}	Accuracy (%)	SC70	SOT23	MSOP	SO8	SOT223	TO220	QFN	DDPAK	Features[2]	CO[3]	Comments	Price[1]
Positive Voltage, Single Output Devices																				
TPS797xx	10	105	1.2	1.8, 3.0, 3.3	—	1.8	5.5	4	✓								PG	0.47µF C	MSP430; lowest Iq	$0.34
TPS715xx/A	50	415	3.2	2.5, 3.0, 3.3, 5	1.2 - 15	2.5	24	4	✓						✓			0.47µF C	V_{IN} up to 24V	$0.34
TPS722xx	50	50	80	1.5, 1.6, 1.8	1.2 - 2.5	1.8	5.5	3		✓							/EN, BP	0.1µF C	Low noise, V_{IN} down to 1.8V	$0.41
REG101	100	60	400	2.5, 2.8, 2.85, 3.0, 3.3, 5	2.5 - 5.5	2.6	10	1.5		✓		✓					EN, BP	No Cap	Low noise	$0.95
TPS792xx	100	38	185	2.5, 2.8, 3.0	1.2 - 5.5	2.7	5.5	2		✓							EN	1µF C	RF low noise, high PSRR	$0.40
TPS731xx	150	30	400	1.5, 1.8, 2.5, 3.0, 3.3, 5.0, EEProm[4]	1.2 - 5.5	1.7	5.5	1		✓							EN, BP	No Cap	Reverse leakage protection	$0.45
TPS771xx	150	75	90	1.5, 1.8, 2.7, 2.8, 3.3, 5	1.5 - 5.5	2.7	10	2				✓					/EN, SVS	10µF C	Low noise	$0.60
TPS732xx	250	40	400	1.5, 1.8, 2.5, 3.0 3.3, 5.0, EEProm[4]	1.2- 5.5	1.7	5.5	1		✓			✓				EN, BP	No Cap	Reverse leakage protection	$0.65
TPS794xx	250	145	172	1.8, 2.5, 2.8, 3.0, 3.3	1.2 - 5.5	2.7	5.5	2			✓		✓				EN, BP	2.2µF C	RF low noise, high PSRR	$0.65
REG102	250	150	400	2.5, 2.8, 2.85, 3.0, 3.3, 5	2.5 - 5.5	1.8	10	2		✓		✓	✓				EN, BP	No Cap	Capacitor free, DMOS	$1.05
TPS736xx	400	75	300	1.5, 1.8, 2.5, 3.0 3.3, EEProm[4]	1.2 - 5.5	1.7	5.5	1		✓			✓		✓		EN, BP	No Cap	Reverse leakage protection	$0.85
TPS795xx	500	105	265	1.6, 1.8, 2.5, 3.0, 3.3	1.2 - 5.5	2.7	5.5	3					✓				EN, BP	2.2µF C	RF low noise, high PSRR	$1.05
REG103	500	115	500	2.5, 2.7, 3.0, 3.3, 5	2.5 - 5.5	2.1	15	2				✓	✓			✓	EN, PG	No Cap	Capacitor free, DMOS	$2.50
TPS777xx	750	260	85	1.5, 1.8, 2.5, 3.3	1.5 - 5.5	2.7	10	2			✓		✓				/EN,SVS	10µF T	Fast transient response	$1.05
TPS725xx	1000	170	75	1.5, 1.6, 1.8, 2.5	1.2 - 5.5	1.8	6	2				✓	✓			✓	EN, SVS	No Cap	V_{IN} down to 1.8V, low noise	$1.10
TPS786xx	1500	390	310	1.8, 2.5, 2.8, 3.0, 3.3	1.2 - 5.5	2.7	5.5	3					✓			✓	EN, BP	1µF C	RF low noise, high PSRR	$1.35
UCCx83-x	3000	400	400	3.3, 5	1.2 - 8.5	1.8	9	2.5						✓		✓	EN	22µF T	Reverse leakage protection	$2.57
UCx85-x	5000	350	8mA	1.5, 2.1, 2.5	1.2 - 6	1.7	7.5	1						✓		✓		100µF T	Fast LDO with reverse leak.	$3.00
Negative Voltage, Single-Output Devices																				
TPS723xx	200	280	130	–2.5	–1.2 - –9	–10	–2.7	2		✓							EN, BP	2.2µF C	Low noise, high PSRR	$1.05
UCC384-x	500	150	200	–12.0, –5.0	–1.25 - –1	–15	–3.5	3				✓					/EN	4.7µF T	Duty cycled short	$1.86

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]PG = Power Good; EN = Active High Enable; /EN = Active Low Enable; SVS Supply Voltage Supervisor; BP = Bypass Pin for noise reduction capacitor. [3]C = Ceramic; T = Tantalum; No Cap = Capacitor Free LDO. [4]TI's TPS73xxx series of LDOs are EEProm programmable at the factory, allowing production of custom fixed voltages (as well as custom current limits), minimum quantities apply. Please contact TI.

Dual-Output LDOs Selection Guide

Device	I_{O1} (mA)	I_{O2} (mA)	V_{DO1} @ I_{O1} (mV)	V_{DO2} @ I_{O2} (mV)	I_Q @ I_O (µA)	Output Options: Voltage (V)	Output Options: Adj.	Accuracy (%)	PWP Package	Min V_O	Max V_O	/EN	PG	SVS	Seq	Low Noise	Min V_{IN}	Max V_{IN}	CO[2]	Description	Price[1]
TPS707xx	250	150	83	—	95	3.3/2.5, 3.3/1.8, 3.3/1.5, 3.3/1.2	✓	2	✓	1.2	5	✓	✓	✓	✓	✓	2.7	5.5	10µF T	Dual-output LDO with sequencing	$1.20
TPS708xx	250	150	83	—	95	3.3/2.5, 3.3/1.8, 3.3/1.5, 3.3/1.2	✓	2	✓	1.2	5	✓	✓	✓		✓	2.7	5.5	10µF T	Dual-output LDO with independent enable	$1.20
TPS701xx	500	250	170	—	95	3.3/2.5, 3.3/1.8, 3.3/1.5, 3.3/1.2	✓	2	✓	1.2	5	✓	✓	✓	✓	✓	2.7	5.5	10µF T	Dual-output LDO with sequencing	$1.50
TPS702xx	500	250	170	—	95	3.3/2.5, 3.3/1.8, 3.3/1.5, 3.3/1.2	✓	2	✓	1.2	5	✓	✓	✓		✓	2.7	5.5	10µF T	Dual-output LDO with independent enable	$1.50
TPS767D3xx	1000	1000	230	—	170	3.3/2.5 3.3/1.8	✓	2	✓	1.2	5	✓		✓			2.7	10	10µF T	Dual-output FAST LDO with integrated SVS	$2.00
TPPM0110	1500	300	1000	2500	1000	3.3/1.8		2		1.8	3.3						4.7	5.3	100µF T	Outputs track within 2V	$1.60
TPPM0111	1500	300	1000	2800	1000	3.3/1.5		2		1.5	3.3						4.7	5.3	100µF T	Outputs track within 2V	$1.60
TPS703xx	2000	1000	160	—	185	3.3/2.5, 3.3/1.8, 3.3/1.5, 3.3/1.2	✓	2	✓	1.2	5	✓	✓	✓	✓	✓	2.7	5.5	22µF T	Dual-output LDO with sequencing	$2.35
TPS704xx	2000	1000	160	—	185	3.3/2.5, 3.3/1.8, 3.3/1.5, 3.3/1.2	✓	2	✓	1.2	5	✓	✓	✓		✓	2.7	5.5	22µF T	Dual-output LDO with independent enable	$2.35

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]T = Tanalum.

Power Management

Plug-In Power Solutions Selection Guide

Device	Input Bus Voltage (V)	Description	P_{OUT} or I_{OUT}	Isolated Outputs	V_O Range (V)	V_O Adjustable	Price[1]
Non-Isolated Single Positive Output							
PT5040	5	1A, 5V-input step-up ISR	1A	No	8 to 18	No	$9.50
PT5070	12	7- to 16V-input 2A 12V output step-up/down converter	2A	No	12	Yes	$21.16
PT5100	Wide input	1A wide-input positive step-down ISR	1A	No	3.3 to 15	No	$7.33
PT5400	3.3/5	3.3V/5V-input 6-A adjustable SWIFT™ ISR	6A	No	1.0 to 3.6	Yes	$11.82
PT5500	3.3/5	3.3V/5V-input 3-A adjustable ISR	3A	No	1.0 to 3.6	Yes	$10.80
PT5520	3.3/5	3.3V/5V-input 1.5-A adjustable ISR	1.5A	No	1.0 to 3.6	Yes	$9.77
PT6100	Wide input	1A wide-input adjustable step-down ISR	1A	No	1.9 to 22	Yes	$7.54
PT6210	Wide input	2A wide-input adjustable step-down ISR	2A	No	1.9 to 22	Yes	$10.58
PT6300	Wide input	3A wide-input adjustable step-down ISR	3A	No	1.9 to 22	Yes	$11.88
PT6340	12	12V-input 6-A adjustable ISR	6A	No	1.5 to 5	Yes	$18.08
PT6520	3.3/5	3.3V/5V-input 8-A adjustable ISR with short-circuit protection	8A	No	1.5 to 3.7	Yes	$18.99
PT6620	12	6A, 12V-input adjustable ISR	6A	No	1.6 to 10	Yes	$18.99
PT6650	24	5A, 24V-input adjustable ISR	5A	No	1.8 to 17	Yes	$18.99
PT6670	3.3	3.3V-input 20W boost ISR	20W	No	3.8 to 12.8	Yes	$18.99
PT6700	5	1.3- to 3.5-$_{OUT}$ 5V input 13-A programmable ISR	13A	No	1.3 to 3.5	5-bit programmable	$21.16
PT6720	12	12V-input 13A programmable ISR	14A	No	1.3 to 3.5, 5	5-bit programmable	$21.16
PT6880	24	5A, 18- to 36V-input adjustable ISR	5A	No	1.8 to 17	Yes	$18.99
PT78HT200	Wide input	$5V_{OUT}$ 2A wide-input positive step-down ISR	2A	No	3.3 to 6.5	No	$10.80
PT78ST100	Wide input	1.5A wide-input positive step-down ISR	1.5A	No	3.3 to 15	No	$8.63
PT78ST200	Wide input	2A wide-input positive step-down ISR	2A	No	12	No	$10.80
Non-Isolated Single Negative Output							
PT5020	5	1A, 5V-input positive-to-negative ISR	–1A	No	–1.7 to –15	No	$9.50
PT6640	12	12V-input 24W adjustable plus-to-minus voltage converter	24W	No	–1.8 to –17	Yes	$18.99
PT6910	3.3/5	3.3V/5V-input 12W adjustable plus-to-minus voltage converter	12W	No	–1.2 to –6.5	Yes	$26.26
PT78NR100	Wide input	1A wide-input plus-to-minus voltage ISR	–1A	No	–3.0 to –15	No	$8.63
PT78NR200	Wide input	2A wide-input plus-to-minus voltage ISR	–2A	No	–5.2 to –15	No	$16.28
PT79SR100	Wide input	1.5A wide-input negative step-down ISR	–1.5A	No	–5 to –15	No	$10.80
Non-Isolated Multiple Output							
PT5060	5	5- to ±12/$15V_{OUT}$ 9W dual output adjustable ISR	9W	No	±8 to ±20	Yes	$10.80
PT6935	5	35W, 5V input adjustable dual output ISR	35W	No	1.3 to 3.6	Yes	$27.37
Isolated Single Output							
DCP01_B	5, 24	1W unregulated isolated DC/DC converter with sychronization	1W	Yes	5, 12, 15	No	$5.01
DCP02	5, 12, 24	2W unregulated isolated DC/DC converter with sychronization	2W	Yes	3.3, 5, 7, 9, 12, 15	No	$6.50
DCR01	5, 12, 24	1W regulated isolated DC/DC converter with sychronization	1W	Yes	3.3, 5	No	$5.60
DCR02	12, 24	2W regulated isolated DC/DC converter with sychronization	2W	Yes	5	No	$6.85
DCV01	5, 24	1W unregulated isolated DC/DC converter with 1500V isolation	1W	Yes	5, 12, 15	No	$8.00
PT4140	24	20W, 24V input isolated DC/DC converter	20W	Yes	1.7 to 16.5	Yes	$32.45
PT4240	24	10W, 24V input isolated DC/DC converter	10W	Yes	1.5 to 12	Yes	$26.00
PT4580	24	30W, 24V input isolated DC/DC converter	30W	Yes	1.8 to 15	Yes	$38.52
Isolated Multiple Output							
DCP01_DB	5, 15, 24	1W unregulated dual isolated DC/DC converter with sychronization	1W	Yes	±5, ±12, ±15	No	$5.51
DCP02_D	5, 15, 24	2W unregulated dual isolated DC/DC converter with sychronization	2W	Yes	±5, ±12, ±15	No	$6.50
DCV01_D	5, 15, 24	1W unregulated dual isolated DC/DC converter with 1500V isolation	1W	Yes	±5, ±12, ±15	No	$8.50
PT4680	24	20A, 24V-input dual isolated DC/DC converter	20A	Yes	1.5 to 5	Yes	$99.20

[1]Suggested resale price in U.S. dollars in quantities of 1,000. [2]T = Tanalum.

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Increasing INA117 Differential Input Range	sboa001
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