



ANALOG-TO-DIGITAL CONVERTER AND DRIVER ICs

Industry's Fastest 16-Bit ADC Samples at 250 MSPS, Enabling Higher Intermediate Frequency Plans in Instrumentation and Communications Applications

Solution

The AD9467 16-bit analog-to-digital converter provides a new level of signal processing performance for test and measurement instrumentation, defense electronics, medical imaging, and communications applications, where high resolution over a wide bandwidth is needed. This data converter achieves a high SFDR (spurious-free dynamic range) of up to 90 dBFS with up to 300 MHz analog input and SNR (signal-to-noise ratio) performance of 76.4 dBFS. The device's superior level of dynamic performance coupled with its low 60 femtosecond rms (root mean square) jitter helps lower the signal chain bill of materials component count by allowing engineers to increase system performance at higher intermediate frequencies, thereby reducing the number of signal downconversion stages.

AD9467 Features

- 16-bit resolution with high signal bandwidths up to 300 MHz enables advanced signal acquisition subsystems in common radio platforms, radar systems, and spectrum analysis
- High dynamic range over broad signal bandwidth enables software-defined radios for use with multiple standards, such as LTE/W-CDMA, MC-GSM (Class-1), and CDMA
- Programmable full-scale input range allows trade-off between SNR and SFDR, enabling the design of more sensitive radar systems with the ability to acquire and track smaller targets with better accuracy, as shown in the following table:

Input Range (V p-p)	SNR (dBFS)	SFDR (dBFS)	Analog Input (MHz)	Sample Rate (MSPS)
2.5	75.1	90	300	250
2.0	74	95	170	250
2.5	76	100	100	160

Pricing:

- AD9467-250—\$119.85

Recommended Complementary Components

- Amplifier: ADL5562 3.3 GHz ultralow distortion RF/IF differential amplifier; ADL5202/ADL5201 digital variable gain amplifiers
- Clock: AD9523/AD9524 clock generators

250 MSPS 16-Bit ADC

ANALOG DEVICES

AD9467

Superior SFDR Performance for IF Sampling Applications

76dBFS SNR, 90dBc SFDR with 100MHz A_{in} at 250MSPS

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Visit our new website for data sheets, samples, and additional resources.



Precision Analog-to-Digital Converters Achieve New Level of Noise Performance and Low Power Operation in Portable Industrial and Medical Equipment

Portable instrumentation, industrial process controls, medical monitoring devices, and other applications increasingly demand reliable, space-constrained, highly accurate signal conversion on a diminishing power budget.

Solution

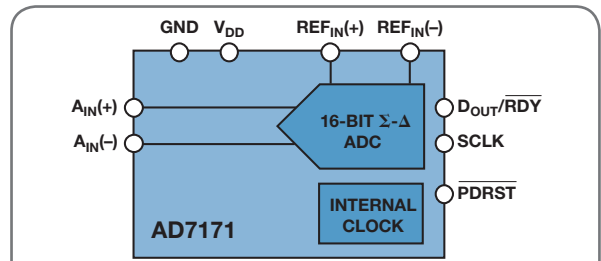
The AD7170 and AD7171 are 12-bit and 16-bit, respectively, small package devices that achieve new levels of noise performance and low power operation for portable industrial and medical instrumentation equipment. Both devices have a 125 Hz output data rate and generate less noise than competing converters while consuming 25% less current. They contain a precision Σ - Δ ADC core with an on-chip oscillator and consume only 110 μ A of power. These devices are particularly suitable for portable or battery-operated products where the lowest possible power is a requirement. These ADCs also have a power-down mode in which the devices consume 5 μ A, thus increasing the battery life of the product. The AD7170 and AD7171 operate with a power supply from 2.7 V to 5.25 V and are available in 10-lead LFCSP.

AD7170/AD7171 Features

- RMS noise: 6.9 μ V
- INL: ± 0.1 LSB at 12 bits (AD7170), ± 0.4 LSB at 16 bits (AD7171)
- Power consumption: 110 μ A (5 μ A in power-down mode)
- 3 mm \times 3 mm, 10-lead LFCSP
- Pricing:
 - AD7170—\$0.95
 - AD7171—\$1.15

Recommended Complementary Components

- Amplifier: ADA4940 differential ADC driver (see below for information on the ADA4940)
- Digital isolator: ADuM1201 2-channel; ADuM1301 3-channel



Applications

- Weigh scales
- Industrial process control
- Pressure measurement
- Portable instrumentation

Extremely Low Power ADC Driver for High Resolution, Low Power ADCs with Sampling Rates Up to 3 MSPS

Data converter technology has continued to steadily advance in noise and distortion performance while simultaneously lowering power requirements. A challenge faced by many designers today is finding a driver amplifier that is capable of matching the ENOB of the ADC at correspondingly low power.

Solution

The ADA4940 differential ADC driver can operate with a range of 3 V to 10 V supplies and consumes less than 5 mW at its lowest supply voltage. It features excellent performance from dc to 2 MHz, including very low distortion and low noise, making it ideal to drive low power, 16-bit to 18-bit ADCs with sampling rates up to 3 MSPS. The ADA4940's adjustable output common-mode voltage, along with its rail-to-rail output, allows it to match the input common-mode voltage of multiple ADCs, even those with 1.8 V supplies, taking full advantage of the ADC's input range.

ADA4940 Features

- Very low quiescent current: 1.25 mA
- Low input voltage noise: 4 nV/ $\sqrt{\text{Hz}}$
- Extremely low harmonic distortion: -96 dB SFDR @ 1 MHz
- Externally adjustable gain
- Adjustable common-mode voltage: 0.8 V to 4.3 V
- Flexible power supply operation: 3 V to 10 V
- Pricing:
 - ADA4940-1—\$1.89
 - ADA4940-2—\$2.89

Recommended Complementary Components

- ADC: AD7983 16-bit/1.33 MSPS PuLSAR[®]; AD7985 16-bit/2.5 MSPS PuLSAR; AD7170/AD7171 12-/16-bit low power Σ - Δ ADCs

Note: This product is in sampling stage, with full production at a later date. Samples can be obtained by visiting the product page at www.analog.com/ADA4940.



Web-Based Tools

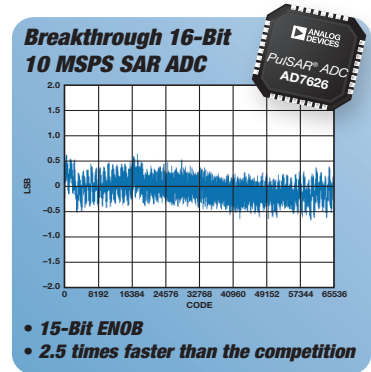
ADI Diff Amp Calculator™ design tool simulates differential amplifier performance: www.analog.com/diffampcalculator

Breakthrough 16-Bit, 10 MSPS SAR ADC Delivers on Speed, Precision, Power, Package Size, and Price

The ability to process information at higher speeds while preserving data integrity is a key requirement in today's most advanced industrial and medical systems. From factory automation systems that boost productivity to sensitive medical imaging equipment that quickly and noninvasively scans patients, virtually all manufacturers want to push the speed barrier while holding a firm line on data accuracy.

Solution

The AD7626 PulSAR ADC achieves industry-leading 16-bit data capture performance, with best-in-class 15-bit ENOB (effective number of bits) and 10 MSPS (million samples per second) throughput, which is 2.5 times faster than other SAR ADCs. Unlike other ADCs, which operate at much lower speeds or reach higher sample rates by increasing power consumption and trading off ac and dc performance, the AD7626 PulSAR ADC has a 92 dB SNR (signal-to-noise ratio) that is 8 dB (1.3 bits) better than any ADC, regardless of architecture. Available in a compact 5 mm × 5 mm QFN (quad flat no-lead) package that is 70% smaller than competing offerings, it consumes just 130 mW of power. The AD7626 also uses a self-clocked low voltage differential serial (LVDS) bus that provides a very low noise interface and reduces the number of external components required to address board-level noise concerns. The AD7625 is a pin-compatible 6 MSPS solution, adding to a large family of PulSAR ADCs, with speed options ranging from 1 MSPS to 10 MSPS and dynamic range of 16 bits to 18 bits.



AD7626 Features

- INL: ± 1 LSB typ, ± 2 LSB max
- DNL: ± 0.3 LSB typ, ± 1 LSB max
- Differential input range: ± 4.096 V
- Pricing:
 - AD7626—\$34.95
 - AD7625—\$29.95

Applications

- High speed data acquisition
- Digital imaging systems
- Telecommunications receivers

Recommended Complementary Components

- Amplifier: ADA4899-1 for low noise, low distortion, high speed; ADA4932-1 for high frequency input drive
- Voltage reference: ADR434 XFET[®] reference with current sink/source

Reference Circuits

Circuits from the Lab™

Single-Ended-to-Differential High Speed Drive Circuit for 16-Bit, 10 MSPS AD7626 ADC
www.analog.com/CN0105

Attenuating Differential Amplifier Drives 18-Bit, 2 MSPS SAR ADC with ± 10 V Inputs

In industrial, instrumentation, and medical applications, engineers face a common problem where high voltage signals (for example, ± 10 V, ± 5 V) have to interface with precision low voltage ADCs.

Solution

Now system designers can use a single part with selectable attenuating gains and level-shifting to drive low voltage, high precision differential input SAR ADCs in high voltage applications, saving board space and system power with ease of use. The AD8475 offers precision gains of 0.4 and 0.8, for differential inputs up to ± 10 V. A high impedance input sets the output common-mode voltage. Impressive performance specifications, such as 10 nV/ $\sqrt{\text{Hz}}$ output noise, 150 MHz bandwidth, and a 50 V/ μs slew rate, make the AD8475 capable of driving 18-bit ADCs up to 2 MSPS. With low distortion (112 dB THD + N), the AD8475 is also suitable for driving high speed Σ - Δ ADCs.

AD8475 Features

- Flexible gains and level shifting
- Robust overvoltage protection up to ± 15 ($V_s = +5$ V)
- Power supply: 3 V to 10 V or ± 1.5 V to ± 5 V
- Differential output designed for modern ADCs
- Suited for driving 18 bits for up to 4 MSPS converter
- 3 mm × 3 mm, 16-lead LFCSP; 10-lead MSOP
- Pricing:
 - AD8475—\$2.60

Recommended Complementary Components

- ADC: AD7986 18-bit/2 MSPS PulSAR ADC with true differential input; AD7622 16-bit/2 MSPS differential ADC; AD7982 18-bit/1 MSPS PulSAR ADC

Reference Circuits

Circuits from the Lab™

Precision Single-Supply Differential ADC Driver for Industrial-Level Signals
www.analog.com/CN0180

Multichannel Simultaneous Sampling ADC Simplifies the Implementation of Power-Line Monitoring Solutions

Designers of multichannel current and voltage monitoring systems deal with a complex host of circuit design challenges, such as dual supply requirements, limited analog input range, input impedance dependent on sampling speed, robustness to overvoltage events on the analog inputs, and increased costs associated with expensive discrete components.

Solution

The AD7606 is a fully integrated multichannel data acquisition solution with $\pm 10\text{ V}$ and $\pm 5\text{ V}$ analog inputs, operating from a single 5 V supply. Each ADC channel incorporates $\pm 16.5\text{ V}$ analog input clamps for protection, second-order antialiasing filter, and input buffer. The complete signal chain achieves 16 bits no missing codes and maintains this performance in noisy power supply conditions due to on-chip power supply regulators powering the high performance ADC.

The AD7606 provides a simplified solution to monitoring and measuring the current and voltage in the three phases and neutral within substation automation equipment with its eight simultaneously sampling channels. The AD7606 can be connected directly to PT and CT transformer outputs. It eliminates the need for external input buffers and antialiasing filters and requires a low number of decoupling capacitors, which results in a considerable saving in BOM, PCB area, and associated manufacturing costs.

The AD7606 also incorporates a back-end digital filter, which can be used to lower the in-band noise and increase the effective number of bits of the complete data acquisition system. This feature enables the same ADC channel to be used for monitoring and measurement by dynamically switching on the digital filter to achieve increased resolution when in measurement mode and switching off the digital filter when in monitoring mode.

The 16-bit AD7606 is available in 8-, 6-, and 4-channel versions. The AD7607 is the 14-bit version.

AD7606/AD7607 Features

- 8/6/4 simultaneously sampled inputs
- True bipolar analog input ranges: $\pm 10\text{ V}$, $\pm 5\text{ V}$
- On-chip 2nd AA filter, input buffer, and reference
- Single 5 V analog supply, 1.8 V to 5 V interface logic levels
- $1\text{ M}\Omega$ analog input impedance, independent of sample rate
- $\pm 16.5\text{ kV}$ analog input clamp protection, 7 kV HBM ESD
- 200 kSPS for all 8 channels
- Low power: 100 mW @ 200 kSPS
- 0.01% gain and offset error
- Price:
 - AD7606—\$16.70
 - AD7607—\$13.50

Applications

- Power-line monitoring and protection systems
- Instrumentation and control systems
- Multiaxis positioning systems
- Data acquisition systems (DAS)

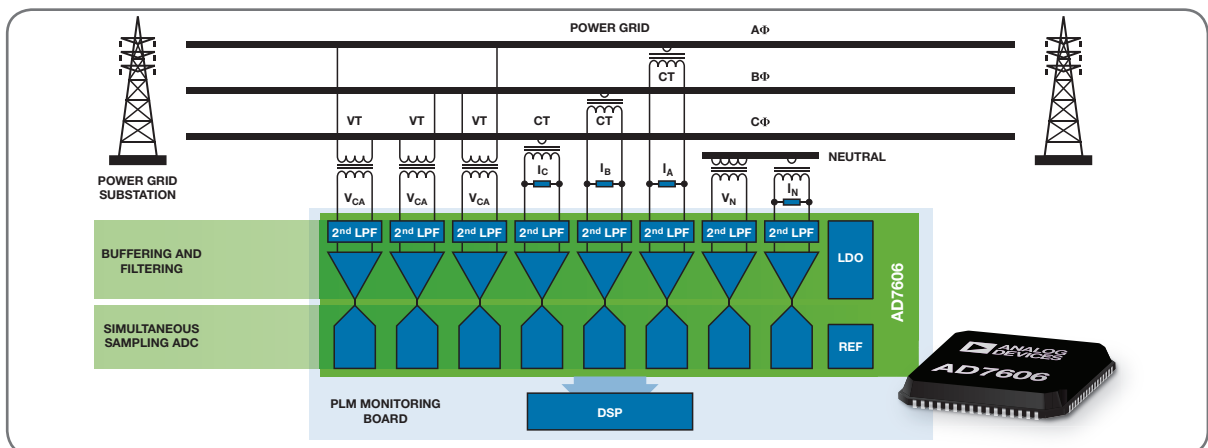
Recommended Complementary Components

- Precision voltage reference: ADR421 2.5 V XFET
- Digital isolator: ADuM1402 4-channel; ADuM5402 4-channel with dc-to-dc converter

Reference Circuits

Circuits from the Lab™

Layout Considerations for an Expandable Multichannel Simultaneous Sampling Data Acquisition System (DAS) Based on the AD7606 16-Bit, 8-Channel DAS
www.analog.com/CN0148



Analog Devices received multiple awards at the 2010 EDN China Innovation Awards ceremony. The event honors outstanding products that have shaped the electronics industry throughout the year. The AD7606 captured best product award.

Digital IF Variable Gain Amplifiers Provide Board, Power, and Component Savings Over Discrete AGC Within Communications Systems

Within digital communications systems, variable gain is used at multiple points in the signal chain and serves multiple purposes. The most obvious use is in the receive path where gain is adjusted to optimize the signal level as the power level into the antenna varies. While low signal levels at the antenna generally demand high gain, variable gain is also used to reduce signal levels—for example, when handling a large unwanted blocking signal, the gain must change dynamically and quickly, often referred to as an automatic gain control (AGC) circuit.

The digital variable gain amplifier (DVGA) is an optimal choice for AGC. The DVGA may also be used to adjust or compensate for receiver variations. These variations may be due to part-to-part component variations, gain drift vs. temperature, or gain variations vs. frequency.

Solution

The ADL5201 single channel and ADL5202 dual channel are IF digitally controlled VGAs with a fully differential input and output. The differential signal path provides excellent common-mode rejection with low second-order distortion and is ideally suited to drive low noise, highly linear signals into IF sampling ADCs.

The ADL5201 and ADL5202 supports a highly flexible digital interface allowing parallel, serial, and gain step up/down over a 31.5 dB range with 0.5 dB step. Compared to discrete designs the ADL5201/ADL5202 highly linear differential ADC drive reduces component count and power consumption for driving high IF sampling ADC in digital communications.



ADL5201/ADL5202 Features

- Gain control range: 11.5 dB to 20 dB with 0.5 dB step
- Low noise 6 dB noise figure @ maximum gain
- OIP3 of 48 dBm at 200 MHz
- -3 dB bandwidth: 700 MHz
- Multiple control interface options: parallel 6-bit control interface, serial peripheral interface, gain step up/down interface
- Low power mode and power-down control
- Single 5 V supply operation
- Pricing:
 - ADL5201—\$7.21
 - ADL5202—\$10.41

Note: These products are in sampling stage, with full production at a later date. Samples can be obtained by visiting the product page at www.analog.com/ADL5201 or www.analog.com/ADL5202.

Recommended Complementary Components

- Mixer: ADL5356/ADL5358 passive mixers; ADL5801/ADL5802 active mixers
- ADC: AD9467 16-bit/250 MSPS wideband ADC



Web-Based Tools

Simulate PLL performance of ADI's ADF series of PLLs
www.analog.com/ADIsimPLL

3.3 GHz Ultralow Distortion RF/IF Differential Amplifier Drives a Wide Variety of Wideband ADCs

The ADL5562 is a high performance differential amplifier optimized for RF and IF applications. This amplifier offers low noise of 2.1 nV/√Hz and excellent distortion performance over a wide frequency range, making it an ideal driver for high speed 8-bit to 16-bit ADCs. The ADL5562 provides three gain levels of 6 dB, 12 dB, and 15.5 dB through a pin-strappable configuration. For the single-ended input configuration, the gains are reduced to 5.6 dB, 11.1 dB, and 14.1 dB. Using an external series input resistor expands the amplifier gain flexibility and allows for any gain selection from 0 dB to 15.5 dB. The ADL5562 is supplied in a compact 3 mm × 3 mm, 16-lead LFCSP package and operates over the temperature range of -40°C to +85°C.

ADL5562 Features

- -3 dB bandwidth of 3.3 GHz (AV = 6 dB)
- Low noise input stage: 2.1 nV/√Hz RTI @ AV = 12 dB
- IMD3 of -94 dBc at 250 MHz center
- Pricing:
 - ADL5201—\$7.21

Recommended Complementary Components

- ADC: AD9467 16-bit/250 MSPS wideband; AD9644 14-bit/80 MSPS dual ADC with JESD204A-compliant output

Selection Guide

PuSAR ADCs

Part Number	Resolution (Bits)	Sample Rate (MSPS)	INL (ppm)	SNR Typ (dB)	Power (mW)	Package	Price (\$U.S.)
AD7626	16	10	30	92	140	32-lead LFCSP	34.95
AD7625	16	6	30	92	120	32-lead LFCSP	29.95
AD7621	16	3	30	90	86	48-lead LFCSP, 48-lead LQFP	30.31
AD7985	16	2.5	22	91.5	11	20-lead LFCSP	26.40
AD7986	18	2	9.4	97	15	20-lead LFCSP	29.95
AD7984	18	1.33	8.4	98.5	10.5	10-lead LFCSP, 10-lead MSOP	27.95
AD7643	18	1.25	13	93.5	62	48-lead LFCSP, 48-lead LQFP	29.95
AD7982	18	1	7.5	95.5	7	10-lead LFCSP, 10-lead MSOP	23.00

Multichannel SAR ADCs

Part Number	Resolution (Bits)	Sample Rate (MSPS)	No. of Channels	Data Bus Interface	Supply Range (V)	Power (mW)	Temperature Sensor	Package	Price (\$U.S.)
AD7298	12	1000	8	Serial	2.8 to 3.6 (1.65 to 3.6 logic)	17.4	Yes	20-lead LFCSP	3.90
AD7298-1	12	1000	8	Serial	2.8 to 3.6 (1.65 to 3.6 logic)	17.4	No	20-lead LFCSP	2.55
AD7291	12	22	8	I ² C	2.8 to 3.6 (1.65 to 3.6 logic)	7.8	Yes	20-lead LFCSP	3.90

Σ-Δ ADCs

Part Number	Resolution (Bits)	Channels Differential/ Pseudo Differential	Noise (rms)	PGA	On-Chip Clock	Package	Price (\$U.S.)
AD7190	24	2/4	8.5 nV	Yes	Yes	24-lead TSSOP	5.90
AD7191	24	2/4	15 nV	Yes	Yes	24-lead TSSOP	3.80
AD7192	24	2/4	11 nV	Yes	Yes	24-lead TSSOP	4.90
AD7193	24	4/8	11 nV	Yes	Yes	28-lead TSSOP	5.40
AD7194	24	8/16	11 nV	Yes	Yes	32-lead LFCSP	6.40
AD7195	24	2/4	8.5 nV	Yes	Yes	32-lead LFCSP	7.50
AD7170	16	1/0	11.5 μV	No	Yes	10-lead LFCSP	1.15
AD7171	12	1/0	11.5 μV	No	Yes	10-lead LFCSP	0.95

Simultaneous Sampling ADCs

Part Number	Resolution (Bits)	Sample Rate (MSPS)	No. of Channels	Analog Input Range (V)	DNL (LSB)	INL (LSB)	SNR (dB)	Package	Price (\$U.S.)
AD7606	16	200	8	±5, ±10	±0.99	±2	88.5	64-lead LQFP	16.70
AD7606-6	16	250	6	±5, ±10	±0.99	±2	88.5	64-lead LQFP	13.60
AD7606-4	16	250	4	±5, ±10	±0.99	±2	88.5	64-lead LQFP	11.10
AD7607	14	200	8	±5, ±10	±0.5	±1	84.5	64-lead LQFP	13.50

High Speed, Low Power ADCs

Part Number	Resolution (Bits)	No. of Channels	Sample Rate (MSPS)	Power Consumption (mW/Channel)	Price (\$U.S.)
AD9239	12	4	170/210/250	285/324/382	101.15/121.55/169.15
AD9641		2	80	238	26.35
AD9251	14	2	20/40/65/80	33/45/63/73	18.50/23.89/35.00/37.50
AD9644		2	80	212	37.50
AD9266	16	1	20/40/65/80	57/73/98/113	28.00/35.00/43.33/48.33
AD9467		1	200/250	1260/1330	100.30/119.85
AD9650	16	2	25/65/80/105	119/198/261/328	53.00/98.52/114.92/135.15
AD9269		2	20/40/65/80	44/60/85/100	49.00/59.50/73.66/84.09

All prices shown are in 1000 quantity.

ADC Driver Amplifier ICs

Part Number	-3 dB BW (MHz)	Minimum Gain (A _{OL})	Voltage Supply (V)	Supply Current (mA)	Slew Rate (V/μs)	Distortion 2nd (dBc)	Distortion 3rd (dBc)	Frequency (MHz)	Package	Price (\$U.S.)
AD8132	350	1	±5	10.7	1200	-96	-102	1	8-lead MSOP, 8-lead SOIC	1.67
AD8137	110	1	±6	3.6	450	-90	-90	0.5	8-lead SOIC	1.10
AD8138	320	1	±5	20	1500	-94	-114	5	8-lead MSOP, 8-lead SOIC	3.75
AD8139	410	1	5 to 12	24.5	800	-90	-110	5	8-lead LFCSP, 8-lead SOIC	3.75
ADA4922-1	38	1	±12	9.4	730	-99	-100	0.1	8-lead LFCSP, 8-lead SOIC	3.63
ADA4927-1/ ADA4927-2	2300	1	4.5 to 11	22.1	5000	-87	-89	100	16-lead LFCSP, 24-lead LFCSP	3.79/6.29
ADA4930-1/ ADA4930-2	1350	1	3.3 to 5.25	35	3400	-73	-75	70	16-lead LFCSP, 24-lead LFCSP	3.79/6.29
ADA4932-1/ ADA4932-2	560	1	3 to 11	9.6	410	-72	-80	50	16-lead LFCSP, 24-lead LFCSP	2.95/5.29
ADA4937-1/ ADA4937-2	1900	1	3 to 5.25	39.5	6000	-77	-84	100	16-lead LFCSP, 24-lead LFCSP	3.79
ADA4938-1/ ADA4938-2	1000	1	4.5 to 11	40	4700	-82	-82	50	16-lead LFCSP, 24-lead LFCSP	3.79/5.69
ADA4939-1/ ADA4939-2	1400	2	3 to 5	37.7	6800	-77	-95	100	16-lead LFCSP	3.79/5.69
ADA4940-1/ ADA4940-2	200	1	3 to 10	1.25	50	-108	-103	1	8-lead SOIC, 16-lead LFCSP, 24-lead LFCSP	1.89/2.89
ADA4941-1	30	2	2.7 to 12	2.3	22	-75	-71	1	8-lead LFCSP, 8-lead SOIC	2.42
ADA4950-1/ ADA4950-2	750	1	3 to 11	9.5	2900	-80	-84	50	16-lead LFCSP, 24-lead LFCSP	2.99/5.29
ADA4960-1	5000	6	4.5 to 5.5	60	8700	-73	-72	250	16-lead LFCSP	6.95
AD8475	150	0.4, 0.8 (fixed)	3 to 10	3	50	-110	-96	1	10-lead MSOP, 16-lead LFCSP	2.60
AD8275	15	0.2 (fixed)	3.3 to 15	1.9	25	-106	-106	1 kHz	8-lead MSOP	1.60

ADC Clock Generators and Buffers

Part Number	Description	Number of References	Number of Outputs	Max Output (MHz)	Jitter (ps)	Price (\$U.S.)
AD9523-1	Clock generator	14	Configurable	1000	0.124	9.76
ADCLK944	Buffer	1	4 LVPECL	7000	0.050	6.00
ADCLK925	Buffer	1	2 ECL	6000	0.06	5.95
ADCLK914	Buffer	1	1 HVDS	6000	0.11	6.95
ADCLK946	Buffer	1	6 LVPECL	4800	0.075	6.25
ADCLK954	Buffer	2	12 LVPECL	4800	0.075	6.95

Power Management ICs

Part Number	Description	Input Voltage Range (V)	Output Voltage Range (V)	Maximum Output Current (mA)	Quiescent Current (mA)	Maximum Shutdown Current (μA)	Package	Price (\$U.S.)
ADP123	Low quiescent current, low noise LDO	2.3 to 5.5	0.8 to 5.0	300	0.17	1	5-lead TSOT	0.34
ADP125	Low quiescent current, low noise LDO	2.3 to 5.5	0.8 to 5.0	500	0.21	1	8-lead MSOP	0.42
ADP150	Ultralow noise, high PSRR LDO	2.2 to 5.5	1.8 to 3.3	150	0.22	1	5-lead TSOT	0.31
ADP3336	12 V input, low noise LDO	2.6 to 12	1.8 to 5.0	500	10	1	8-lead MSOP	1.46
ADP2114	Low noise, synchronous buck regulator	2.75 to 5.5	0.6 to 3.3	2000 + 2000	1.7	10	32-lead LFCSP	2.50
ADP2116	Low noise, synchronous buck regulator	2.75 to 5.5	0.8 to 3.3	2000 + 2000	1.7	10	32 lead-LFCSP	3.17

All prices shown are in 1000 quantity.

16-Bit Dual ADC Uses Half the Power of Competing Data Converters, While Achieving Best Noise Performance in Its Class

Many higher resolution, high speed ADC devices offer great improvements in linearity and distortion and lower power dissipation. However, in some applications, the primary specifications of merit are broadband noise and signal-to-noise ratio (SNR). This requires a class of high speed ADC products that focuses on noise performance over distortion.

Solution

In an effort to address customer needs in instrumentation, medical imaging, and other applications that require emphasis on increased SNR performance, Analog Devices has developed the AD9650 dual, 16-bit, 105 MSPS ADC. This device delivers an industry-best 82 dBFS SNR over the Nyquist bandwidth and a 90 dBc SFDR when measured at 30 MHz A_{in} frequency.

The AD9650's dual ADC core features a multistage, differential pipelined architecture with integrated output error correction logic. Each ADC features wide bandwidth and differential sample-and-hold analog input amplifiers and accommodates input frequencies of up to 300 MHz. The dual ADC cores also share an integrated precision voltage reference, which eases design considerations.

In the medical imaging arena, designers are constantly striving for higher resolution image capture that improves patient diagnostics. The AD9650 enables achievement of that goal by allowing medical equipment designers to increase imaging channel densities while still maintaining system critical low noise and power requirements.

With the unique mixture of high input sensitivity, low power consumption, dual-channel design, and small package form factor, the AD9650 is ideally suited to solve a number of customer design problems in high speed data acquisition, medical imaging, electronic test equipment, and numerous other applications.

Available in a compact 9 mm × 9 mm LFCSP package, the AD9650 consumes just 328 mW/channel when operating at the full sampling rate of 105 MSPS, and power is correspondingly reduced when the device samples at lower speeds.

AD9650 Features

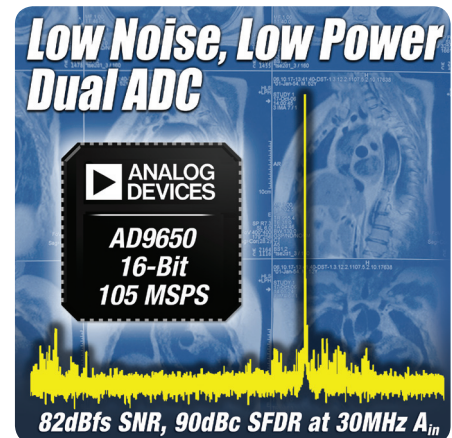
- SNR: 82 dBFS @ 30 MHz input and 105 MSPS data rate; 83 dBFS @ 9.7 MHz input and 25 MSPS data rate
- SFDR: 90 dBc @ 30 MHz input and 105 MSPS data rate; 95 dBc @ 9.7 MHz input and 25 MSPS data rate
- 1.8 V analog supply operation
- Low power: 328 mW per channel @ 105 MSPS; 119 mW per channel @ 25 MSPS
- Pricing:
 - AD9650-105—\$159.00

Applications

- Industrial instrumentation
- MRI and ultrasound equipment
- Chemical and spectrum analysis
- Direct conversion receivers
- Multimode digital receivers
- General-purpose software radios

Recommended Complementary Components

- Amplifier: ADL5562 RF/IF differential amp; ADA4937-2 differential ADC driver; AD8372 programmable VGA
- Clock: AD9510 clock distribution IC, AD9520 clock generator



Web-Based Tools

Design and Simulation Tools Library
www.analog.com/tools

Smallest 8-Channel SAR ADC with Integrated Reference and Temperature Sensor

Data acquisition system engineers often require multichannel data acquisition with added temperature sensing in cost- and/or space-constrained applications. Moreover, as processor interface voltages continue to decrease, digital interfaces must accommodate ever decreasing voltages, often requiring the use of an external level shifter.

Solution

The AD7298 and AD7291 are 8-channel, 12-bit SAR ADCs ideally suited to monitoring variables in a variety of systems, including telecommunications and process and industrial control. In a 4 mm × 4 mm LFCSP, these devices offer more functionality per mm² of package area than any similar converters on the market. They feature a 2.5 V, 12 ppm/°C internal reference and an on-board band gap temperature sensor that digitizes temperature with a resolution of 0.25°C and ±1°C accuracy. A digital interface voltage range of 1.65 V to 3.6 V allows flexibility in terms of direct processor interface without the need for external level shifter. The AD7298 operates with an SPI-compatible interface. The AD7291 operates with an I²C interface and has the added benefit of alert functionality, again minimizing processor interaction and system power dissipation. The AD7298-1 is a 10-bit pin for pin compatible variant of the AD7298, without an internal temperature sensor. Operating with a temperature range of -40°C to +125°C, operation is guaranteed in a wide range of operating environments.

AD7298/AD7291 Features

- 1°C internal temperature-to-digital sensor
- 1.65 V to 3.6 V digital interface voltage
- 4 mm × 4 mm, 20-lead LFCSP
- Pricing:
 - AD7298—\$3.90
 - AD7291—\$3.90
 - AD7298-1—\$2.55

Applications

- Multichannel data acquisition systems
- Telecommunications equipment monitoring
- Instrumentation and control

Recommended Complementary Components

- Amplifier: AD8066 FastFET® op amp
- Voltage reference: AD780 2.5 V/3 V band gap
- Digital Isolator: ADuM140x 4-channel

AC Excitation Σ - Δ ADC Offers Precision with Low Temperature Drift

Measuring small signal levels with precision requires a very accurate 24-bit ADC. For slow moving signals such as pressure and weight a Σ - Δ ADC is often used. However, as temperature increases the temperature drift of the bridge sensor itself becomes a significant issue resulting in loss of accuracy for the system.

Solution

The AD7195 overcomes this issue by having on-chip ac excitation outputs to control the bridge sensor drivers. The ac excitation signal alternates the external reference polarity to effectively chop the bridge, minimizing dc-induced offset from the bridge. The AD7195 features a low noise PGA enabling up to 22.5 noise free bits resolution with a gain of 128. Combined with the ac excitation, this delivers a low drift, high precision system solution.

AD7195 Features

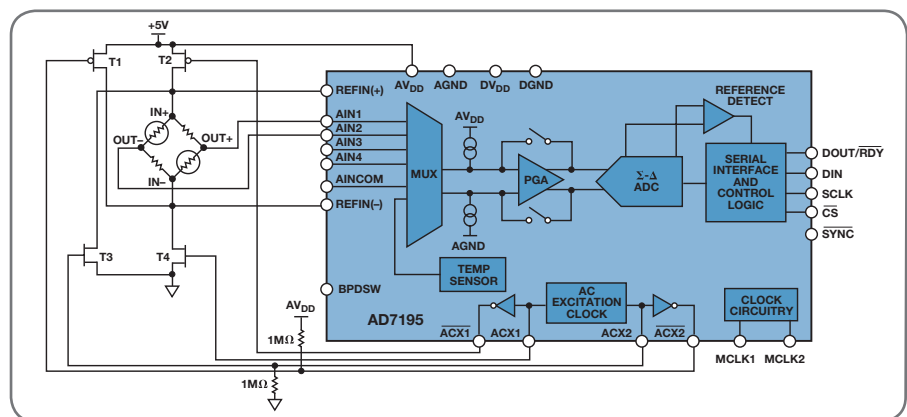
- AC excitation signals
- Channel sequencer
- Fast settling digital filter
- Low noise PGA
- Pricing:
 - AD7195—\$7.50

Applications

- Weigh scales
- Strain gage transducers
- Pressure measurement

Recommended Complementary Components

- Digital isolator: ADuM140x 4-channel; ADuM540x 4-channel with dc-to-dc converter
- Power: ADP3303 low dropout linear regulator



Reference Circuits

Circuits from the Lab™

Precision Weigh Scale Design Using a 24-Bit Sigma-Delta ADC with Internal PGA and AC Excitation
www.analog.com/CN0155

High Speed 8-Bit Analog-to-Digital Converters Feature Low Power and Low Noise for Handheld Instrumentation Applications

The AD9286 8-bit high speed analog-to-digital converter uses a pipelined architecture to achieve an industry-best power consumption of 310 mW at 500 MSPS, which is 40% less power than competitive components. This device utilizes two time-interleaved, low power, 250 MSPS ADC cores to achieve the ultimate sample rate of 500 MSPS. A single 500 MHz input clock is presented to the converter, and all interleave clocking is managed internally. Via SPI control, the user has the ability to finely correct for sample-time skew mismatches between the two analog-to-digital cores to optimize performance. No external interleaving algorithm is required. The AD9284 features two ADC cores operating independently to provide the industry's first dual, 8-bit, 250 MSPS pipelined analog-to-digital converter.

Both converters operate on a single 1.8 V supply, feature low SNR (signal-to-noise ratio) of 49.3 dBFS, and allow for a wide dynamic signal range with SFDR (spurious-free dynamic range) performance of 65 dBc. Applications for these components include battery-powered instrumentation, handheld scope meters, digital oscilloscopes, and communications receivers. The devices are available in a Pb-free, 48-lead LFCSP and are specified to operate over the industrial temperature range of -40°C to $+85^{\circ}\text{C}$.

AD9286 (Single) Features

- SNR: 49.3 dBFS to 200 MHz input @ 500 MSPS
- SFDR: 65 dBc to 200 MHz input @ 500 MSPS
- Low power: 310 mW @ 500 MSPS
- Pricing: \$36.00

AD9284 (Dual) Features

- SNR: 49.3 dBFS to 200 MHz input @ 250 MSPS
- SFDR: 65 dBc to 200 MHz input @ 250 MSPS
- Low power: 155 mW per channel @ 250 MSPS
- Pricing: \$24.00

Recommended Complementary Components

- Amplifier: ADA4960 ADC driver
- Clock: AD9516 clock generator



Multioption Clock Distribution Function, with Serial On-Chip PLLs, Delivers <math><200\text{ fs}</math> RMS Jitter to Enhance Data Converter SNR Performance

The AD9523 is designed to support the clocking requirements for data conversion stages in long-term evolution (LTE) and multicarrier GSM base station, medical instrumentation, ATE, and other wireless transceiver systems. It relies on an external VCXO to provide the oscillator source for a jitter cleanup PLL to achieve the restrictive low phase noise requirements necessary for acceptable data converter SNR performance.

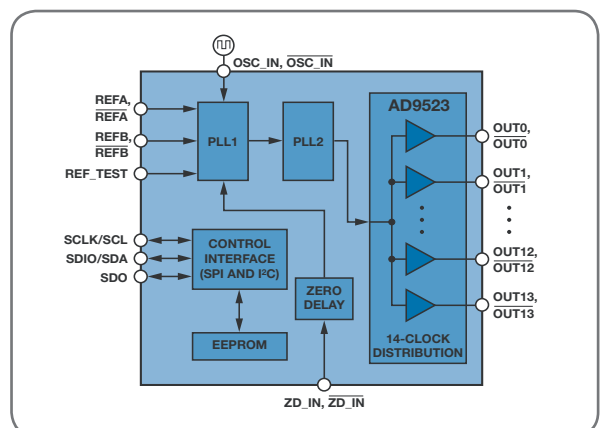
The input receivers, oscillator inputs, and zero-delay receiver support both single-ended and differential operation. When connected to a recovered system reference clock and a VCXO, the device generates 14 low noise outputs with a range of 1 MHz to 1 GHz and one dedicated buffered output from the input PLL (PLL1). The frequency and phase of one clock output relative to another clock output can be varied by means of a divider phase select function that serves as a jitter-free coarse timing adjustment in increments that are equal to the period of the signal coming out of the VCO.

AD9523 Features

- Output frequency: $<1\text{ MHz}$ to 1 GHz
- Absolute output jitter: $<200\text{ fs}$ at 122.88 MHz; integration range: 12 kHz to 20 MHz
- 14 outputs: configurable LVPECL, LVDS, HSTL, and LVCMOS
- Distribution phase noise floor: -160 dBc/Hz
- Pricing:
 - AD9523—\$9.27

Recommended Complementary Components

- ADC: AD9467 16-bit/250 MSPS; AD9650 dual 16-bit/105 MSPS



ADC Families with I²C-Compatible Interface Target Data Acquisition Applications

Solution

The AD7998 is one member of a large family of 8-bit to 12-bit SAR ADCs with a full I²C- and SMBus-compatible interface. The family includes 2-/4-/8-channel versions, in 10-lead MSOP, 16-lead TSSOP, and 20-lead TSSOP package options. With this family, monitoring can be done with only minimal processor supervision, thus minimizing system power dissipation, as the programmable on-chip threshold registers interrupt only when an input exceeds the limit. Also in this family are the AD7991, AD7995, and AD7999. In 8-lead SOT-23, the AD7991 is the industry's smallest 4-channel, 12-bit ADC with I²C-compatible interface. The AD7995 and AD7999 8-bit/10-bit pin-compatible solutions, respectively, are also available. Analog Devices' multichannel I²C ADCs are unmatched in their ability to deliver the combination of low power, small footprint, and low cost requirements that today's I²C system monitors demand.

AD799x Features

- Specified for VDD of 2.7 V to 5.5 V
- I²C-compatible interface
- On-chip channel sequencer
- Shutdown mode: 1 μ A max

Applications

- Multichannel data acquisition systems
- Telecommunications equipment monitoring
- Instrumentation and control

Recommended Complementary Components

- Amplifier: AD8599 dual low noise op amp
- Digital isolator: ADuM1250, ADuM1251, ADuM2250, ADuM2251 dual I²C isolators

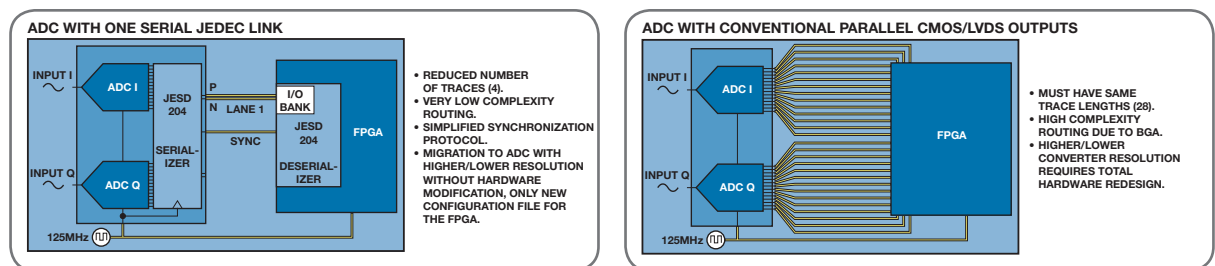
8-Bit to 12-Bit I²C Precision ADCs

Part Number	Resolution (Bits)	Sample Rate (kSPS)	Channels	Power (mW)	Package	Price
AD7991	12	140	4	0.3 max	8-lead SOT-23	3.22
AD7992	12	188	2	0.495 max	10-lead MSOP	3.04
AD7994	12	188	4	0.495 max	16-lead TSSOP	3.29
AD7998	12	188	8	0.495 max	20-lead TSSOP	3.54
AD7993	10	188	4	0.495 max	16-lead TSSOP	1.91
AD7995	10	140	4	0.3 max	8-lead SOT-23	1.80
AD7997	10	188	8	0.495 max	20-lead TSSOP	2.13
AD7999	8	140	4	0.3 max	8-lead SOT-23	1.35

Note: See Page 12 for related Circuits from the Lab reference circuit.

High Speed Serial ADC Interface Improves Signal Integrity and Simplifies Printed Circuit Board Layout in Communications Systems

The JESD204A industry serial interface standard reduces the number of data inputs/outputs between data converters and other devices, such as FPGAs (field-programmable gate arrays). Fewer interconnects simplifies layout and allows smaller form factor realization without impacting overall system performance. These attributes are important for a range of high speed ADC applications, including portable instrumentation, ultrasound equipment, radar, wireless infrastructure (GSM, EDGE, W-CDMA, LTE, CDMA2000, WiMAX, TD-SCDMA), and software-defined radios.



At 70 MHz A_{IN} and 80 MSPS, the dual-channel AD9644 achieves an SNR (signal-to-noise ratio) of 73.7 dBFS and an SFDR (spurious-free dynamic range) of 92 dBc. Its JESD204A coded data rate supports up to 1.6 Gbps per link, and the device offers two output modes supporting a dedicated data link per ADC channel or a single shared data link for both ADC channels. The AD9644 is available in 48-lead LFCSP (7 mm × 7 mm) and is specified over the industrial temperature range of -40°C to +85°C. A single-channel version, the AD9641, is also available in 32-lead LFCSP (5 mm × 5 mm) and also operates over the industrial temperature range.

AD9641/AD9644 Features

- 14-bit resolution/80 MSPS sample rates
- Two configurable JESD204A-compliant serial outputs
- 73.7 dBFS SNR/92 dBc SFDR at 70 MHz A_{IN} and 80 MSPS
- Low power: 212 mW/channel at 80 MSPS
- Pricing:
 - AD9641—\$26.35
 - AD9644—\$37.50

Recommended Complementary Components

- Amplifier: ADL5562 differential amp; ADA4937-2 differential amp; AD8372 dual VGA
- Clock: AD9510 clock distribution IC; AD9520 clock generator

Reference Circuits Enable Quick and Easy System Integration

**Circuits
from the Lab™**

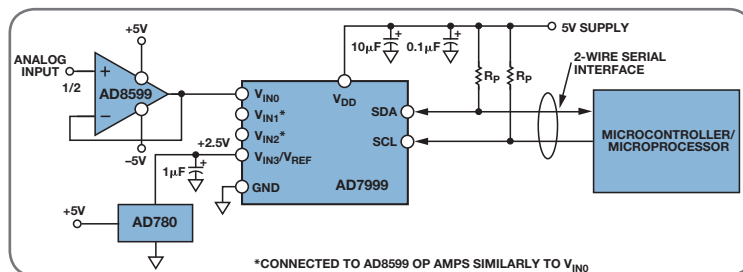
Analog Devices' Circuits from the Lab™ reference circuits address common design challenges and have been engineered for quick and easy system integration. They are designed to help engineers manage the increased time pressure they face to complete designs by providing tested building blocks that are easy to understand and integrate into a design.

Circuit note documentation describes the circuit's function and benefits, the theory of operation, test data, and design/layout guidelines. Newer circuits also contain schematic files, PCB layout files, a bill of materials, and a device driver (when applicable). Learn more at www.analog.com/circuits.

Featured Circuits from the Lab

Circuit Note CN-0045, Using the AD8599 Op Amp as an Ultralow Distortion Driver for the AD7999 4-Channel, 8-Bit ADC

This circuit provides an ultralow distortion driver circuit for the AD7999 8-bit, 4-channel ADC, which is designed to achieve optimum ac and dc performance. The circuit uses the ultralow distortion, ultralow noise AD8599 dual-supply op amp and ultrahigh precision AD780 band gap voltage



reference to ensure that the maximum AD7999 performance is achieved by providing a low impedance driver with adequate settling time and a highly accurate reference voltage.

It is always recommended to buffer analog input signals before applying them to ADCs with switched capacitor inputs such as the AD7999. This is particularly important in applications where the signal source has high source impedance and where low distortion and high signal-to-noise-ratio is important. This circuit shows how the AD8599, an ideal choice for high accuracy designs, can be used to buffer the analog input channels. Read more at www.analog.com/CN0045.



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