High Speed, High Accuracy, 14-Bit, 16-Bit, and 18-Bit PulSAR® ADCs

At any speed, in any package size, at any price, and over a wide input voltage range, Analog Devices' industry-leading portfolio of 14-bit, 16-bit, and 18-bit SAR ADCs makes it easy to select the best converter for your application.

analog is everywhere.™

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ANALOG DEVICES

High Performance PulSAR ADCs—Uncompromised Speed of 3 MSPS

Applications requiring high performance data conversion, such as instrumentation, imaging, and vibration analysis in industrial, medical, and communications markets are driving the demand for ADC solutions that deliver greater precision and speed, at less power, that reduce overall systems cost. Analog Devices' industry-leading PulSAR family of SAR converters provides a range of solutions that addresses the needs of these markets.

Key Features

- 16-bit resolution, no missing codes
- Throughput: 3 MSPS
- 1 LSB INL/DNL typ
- S/(N+D): 90 dB typ @ 100 kHz (V_{REF} = 2.5 V)
- THD: –100 dB typ @ 100 kHz
- SPI®-/QSPI™-/MICROWIRE™-/DSP-compatible
- On-board, low drift reference with buffer and temperature sensor
- Single 2.5 V supply operation
- Power dissipation: 70 mW typ @ 3 MSPS
- 48-lead LQFP, 48-lead LFCSP

Key Benefits

- No compromises, i.e., high speed, high accuracy, low power solution
- Integrated reference
- Lower cost per channel—high speed implies fewer ADCs per channel, and high accuracy relieves expensive PGA

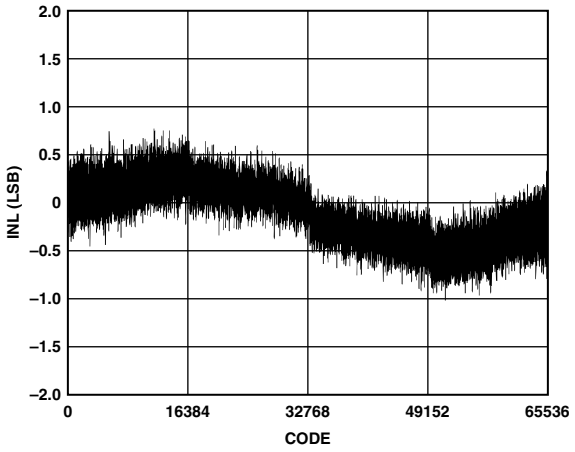
Applications

- Medical imaging
- Communications
- Data acquisition equipment
- Automatic test equipment
- Instrumentation

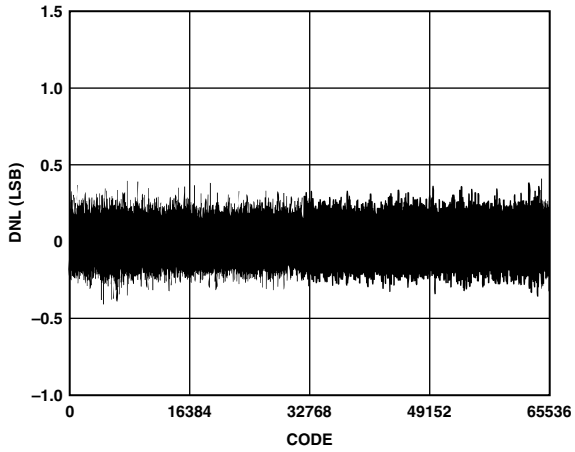
AD7621—Unequalled SAR ADC Precision and Speed

The AD7621 is a 16-bit, 3 MSPS, charge redistribution SAR, fully differential analog-to-digital converter that offers 1 LSB of INL (typ), no missing codes, plus 90 dB SNR. This combination of speed and accuracy is achieved while consuming just 70 mW at 3 MSPS. The SAR architecture ensures that there are no pipeline delays, making it ideal for multiple channel applications, therefore lowering overall cost per channel. The part contains a high speed, 16-bit sampling ADC, an internal conversion clock, an internal reference buffer, error correction circuits, and both serial and parallel system interface ports. The 16-bit accuracy decreases the need for an expensive PGA in front of the ADC, and the AD8021 is a custom-compensated operational amplifier recommended to solve any gain/bandwidth challenges.

AD7621 INL



AD7621 DNL



High Performance PulSAR ADCs—Uncompromised 18-Bit Resolution

In high speed data acquisition, medical imaging, and automatic test equipment, designers need to convert fast moving signals at the highest level of accuracy. To achieve a simpler design process, greater cost efficiencies, and improved user experience, Analog Devices' 18-bit PulSAR ADCs are the solution as they provide the necessary combination of speed, accuracy, and integration.

Key Features

- 18-bit resolution, no missing codes
- Throughput: 2 MSPS
- 2 LSB INL typ, 1 LSB DNL typ
- S/(N+D): 92.5 dB typ @ 100 kHz (V_{REF} = 2.5 V)
- THD: –101 dB typ @ 100 kHz
- SPI-/QSPI-/MICROWIRE-/DSP-compatible
- 2.048 V internal reference
- Single 2.5 V supply operation
- Power dissipation: 75 mW typ @ 2 MSPS with internal reference
- 48-lead LQFP, 48-lead LFCSP

Key Benefits

- No compromises, i.e., high speed, high accuracy, low power solution
- Integrated reference

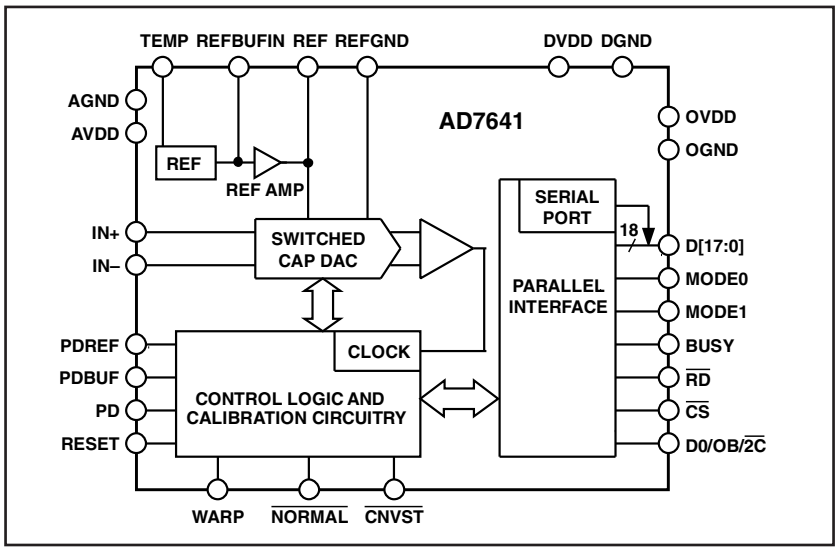
Applications

- Medical imaging
- High end data acquisition
- Automatic test equipment
- Spectrum analysis

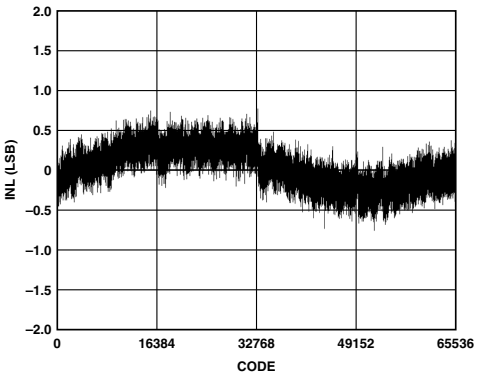
AD7641—World's Fastest SAR ADC at 18-Bits and 2 MSPS

The AD7641 has raised the top speed for 18-bit SAR ADCs to 2 MSPS. Typical INL is ±2 LSB with 18-bits no missing codes, guaranteed over temperature. The AD7641 also offers 92.5 dB of SNR and –101 dB of THD, both specified at 100 kHz. This combination of outstanding ac and dc performance supports customers' needs in converting signals at speed and with accuracy. The increase in resolution over 16-bit ADCs allows most designers to eliminate expensive programmable gain amplifiers from their systems. Other features include serial and parallel interfaces, 2.5 V internal reference, fully differential inputs, and three-way, power-down capability. The AD7641 is available in both 48-lead LQFP and 48-lead chip scale packages.

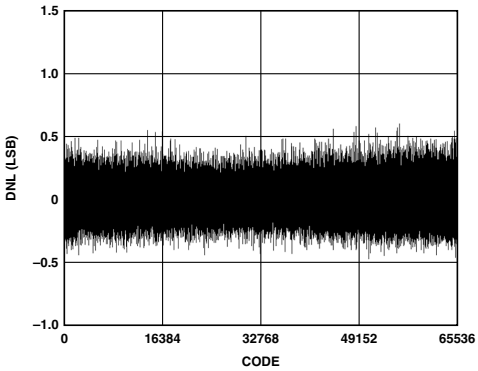
AD7641 Block Diagram



AD7641 INL



AD7641 DNL



The AD7641 allows low level signals to be converted with minimal front-end analog and filter calibration, reducing design work and cost, and dramatically improving time to market.

Now Choosing an SAR ADC Without Compromising Accuracy, Speed, or Cost Is As Simple As Choosing Analog Devices

Our portfolio of 14-bit, 16-bit, and 18-bit SAR (successive approximation register) ADCs has grown to include over 40 models—it's the largest in the industry.

The AD7621 is the fastest 16-bit SAR ADC, providing a 3 MSPS sampling rate and 2 LSB of integral nonlinearity error (INL). For applications that require more than 16-bit accuracy, we offer a new 18-bit family of ADCs with sampling rates of up to 2 MSPS (provided by the AD7641).

A new group of low power, small package converters is led by the AD7690—the smallest 18-bit ADC, in a 10-lead, 3 mm × 3 mm LFCSP package, with a sampling rate of 400 kSPS.

No matter what your ADC requirement might be—speed, accuracy, low power, small package, or the best price—Analog Devices has the perfect 14-bit, 16-bit, or 18-bit converter for you.

Features

- Low power: 1.5 mW at 2.7 V operation (AD7683)
- Input ranges:
  - Unipolar
  - Bipolar
  - True differential
- Both serial and parallel interfaces on the same ADC
  - SPI/QSPI/ MICROWIRE/DSP
- Internal conversion clock in most models

Applications

- High speed data acquisition
- Process control and industrial equipment
- CT scanners
- MRI equipment
- Test and measurement systems
- Optical networking equipment
- Battery-operated systems
- Network analyzers
- Motor control
- Scanners

Industry Firsts

- Highest resolution: 18 bits at 2 MSPS (AD7641)
- Highest accuracy: 1 LSB at 1 MSPS (AD7677)
- Smallest package: 3 mm × 3 mm LFCSP (AD7690)

Part Number	Resolution (Bits)	Sampling Rate (kHz)	Interface	Channels	Voltage Supply	Power (mW) Max	Voltage Reference
AD7641	18	2000	18P, S	1	2.5 V (3 V, 5 V logic)	100 typ	Yes
AD7643	18	1250	18P, S	1	2.5 V (3 V, 5 V logic)	100 typ	Yes
AD7674	18	800	18P, S	1	5 V (3 V, 5 V logic)	126	Buffer only
AD7634	18	670	18P, S	1	±16.5 V, (3 V, 5 V logic)	100 typ	Yes
AD7679	18	570	18P, S	1	5 V (3 V, 5 V logic)	103	Buffer only
AD7690	18	400	S	1	5 V	20	No
AD7631	18	250	18P, S	1	±16.5 V, (3 V, 5 V logic)	50 typ	Yes
AD7691	18	250	S	1	2.7 V to 5 V	12.5	No
AD7678	18	100	18P, S	1	5 V (3 V, 5 V logic)	26	Buffer only
AD7621	16	3000	16P, S	1	2.5 V (3 V, 5 V logic)	100 typ	Yes
AD7623	16	1333	16P, S	1	2.5 V (3 V, 5 V logic)	100 typ	Yes
AD7653	16	1000	16P, S	1	5 V (3 V, 5 V logic)	145	Yes
AD7667	16	1000	16P, S	1	5 V (3 V, 5 V logic)	145	Yes
AD7671	16	1000	16P, S	1	5 V (3 V, 5 V logic)	125	No
AD7677	16	1000	16P, S	1	5 V (3 V, 5 V logic)	130	No
AD7654[2]	16	1000	16P, S	4	5 V (3 V, 5 V logic)	135	No
AD7655[2]	16	1000	16P, S	4	5 V (3 V, 5 V logic)	135	No
AD7612	16	750	16P, S	1	±15 V, (3 V, 5 V logic)	165 typ	Yes
AD7650	16	570	16P, S	1	5 V (3 V, 5 V logic)	115	No
AD7664	16	570	16P, S	1	5 V (3 V, 5 V logic)	115	No
AD7665	16	570	16P, S	1	5 V (3 V, 5 V logic)	107	No
AD7652	16	500	16P, S	1	5 V (3 V, 5 V logic)	90	Yes
AD7666	16	500	16P, S	1	5 V (3 V, 5 V logic)	90	Yes
AD7676	16	500	16P, S	1	5 V (3 V, 5 V logic)	74	No
AD7686	16	500	S	1	2.7 V to 5 V	20 typ	No
AD7688	16	500	S	1	2.7 V to 5 V	44 typ	No
AD7693	16	500	S	1	5 V	20	No
AD7610	16	250	16P, S	1	±15 V, (3 V, 5 V logic)	75 typ	Yes
AD7656	16	250	16P, S	6	5 V (3 V, 5 V logic)	60 typ	Yes
AD7663	16	250	16P, S	1	5 V (3 V, 5 V logic)	41	No
AD7685	16	250	S	1	2.7 V to 5 V	15	No
AD7687	16	250	S	1	2.7 V to 5 V	20 typ	No
AD974	16	200	S	4	5 V	120	Yes
AD976A	16	200	16P	1	5 V	100	Yes
AD977A	16	200	S	1	5 V	100	Yes
AD7651	16	100	16P, S	1	5 V (3 V, 5 V logic)	45	Yes
AD7660	16	100	16P, S	1	5 V (3 V, 5 V logic)	25	No
AD7661	16	100	16P, S	1	5 V (3 V, 5 V logic)	45	Yes
AD7675	16	100	16P, S	1	5 V (3 V, 5 V logic)	25	No
AD7680	16	100	S	1	3 V to 5 V	10	No
AD7683	16	100	S	1	2.7 V to 5 V	6	No
AD7684	16	100	S	1	2.7 V to 5 V	6	No
AD7946	14	500	S	1	2.7 V to 5 V	25	No
AD7942	14	250	S	1	2.7 V to 5 V	12.5	No

[1] Input range: differential implies that +IN and –IN can vary from –0.1 to V_{DD} (or within 2 V of V_{DD}) when referred to AGND. Pseudo differential implies that the –IN input can only vary ±100 mV typically.

[2] 2 × 2 channel simultaneous sampling.

Input Range[1] (V)	No Missing Codes	DNL (LSB)	INL (LSB)	SNR (dB)	THD (dB)	Package	Price @ 1k ($U.S.)
$\pm V_{REF}$ differential	18	N/A	±3	93 typ	–100 typ	48-lead LQFP, LFCSP	32.95
$\pm V_{REF}$ differential	18	N/A	±3	93 typ	–100 typ	48-lead LQFP, LFCSP	29.95
±5 differential	18	N/A	±2.5	100	–110 typ	48-lead LQFP, LFCSP	27.95
Diff, ±10, ±20	18	–1/+1.75	±2.5	100 typ	–115 typ	48-lead LQFP, LFCSP	31.45
±5 differential	18	N/A	±2.5	100	–110 typ	48-lead LQFP, LFCSP	25.60
0 to V_{REF}	18	±1	±1.5	100 min	–125 typ	10-lead MSOP, 10-lead LFCSP	19.50
Diff, ±10, ±20	18	–1/+1.75	±2.5	100 typ	–115 typ	48-lead LQFP, LFCSP	29.45
0 to V_{REF}	18	±1	±1.5	100 min	–125 typ	10-lead MSOP, 10-lead LFCSP	14.50
±5 differential	18	N/A	±2.5	100	–110 typ	48-lead LQFP, LFCSP	19.20
$\pm V_{REF}$ differential	16	±1	±2	88	–100 typ	48-lead LQFP, LFCSP	29.95
$\pm V_{REF}$ differential	16	±1	±2	88	–100 typ	48-lead LQFP, LFCSP	24.95
0 to 2.5	15	N/A	±6	86 typ	–98 typ	48-lead LQFP, LFCSP	11.50
0 to 2.5	15	N/A	±2.5	90 typ	–100 typ	48-lead LQFP, LFCSP	23.50
±2.5, ±5, ±10, +2.5, +5, +10	16	N/A	±2.5	89	–96	48-lead LQFP, LFCSP	21.95
±2.5 @ 2.5	16	±1	±1	92	–103.5	48-lead LQFP, LFCSP	32.95
0 to 5	16	N/A	±3.5	88	–100 typ	48-lead LQFP, LFCSP	15.42
0 to 5	15	N/A	±6	86 typ	–96 typ	48-lead LQFP, LFCSP	9.45
0 to 5, 0 to 10, ±5, ±10	16	–1/+2	±1	94 typ	–115 typ	48-lead LQFP, LFCSP	29.45
0 to 2.5	15	N/A	±6	86 typ	–98 typ	48-lead LQFP, LFCSP	7.50
0 to 2.5	16	–1.0/+1.5	±2.5	90 typ	–100 typ	48-lead LQFP, LFCSP	18.65
±2.5, ±5, ±10, +2.5, +5, +10	16	N/A	±2.5	89	–100 typ	48-lead LQFP, LFCSP	19.00
0 to 2.5	15	N/A	±6	86 typ	–98 typ	48-lead LQFP, LFCSP	9.45
0 to 2.5	15	N/A	±2.5	90 typ	–100 typ	48-lead LQFP, LFCSP	18.00
±2.5 @ 2.5	16	N/A	±1	92	–103.5	48-lead LQFP, LFCSP	24.95
0 to V_{REF} (pseudo differential)	16	N/A	±2.5	92 typ	100 typ	10-lead MSOP	12.00
$\pm V_{REF}$ differential	16	N/A	±1.5	92	100 typ	10-lead MSOP	14.95
0 to V_{REF}	16	±0.5	±0.65	94 min	–116 typ	10-lead MSOP, 10-lead LFCSP	18.00
0 to 5, 0 to 10, ±5, ±10	16	–1/+2	±1	94 typ	–115 typ	48-lead LQFP, LFCSP	12.90
±5, ±10	15	N/A	±4	83	–97 typ	64-lead LQFP	17.00
±2.5, ±5, ±10, +2.5, +5, +10	16	N/A	±3	89	–100 typ	48-lead LQFP, LFCSP	12.00
0 to V_{REF} (pseudo differential)	16	N/A	±2.5	92 typ	100 typ	10-lead MSOP	8.00
$\pm V_{REF}$ differential	16	N/A	±1.5	92	100 typ	10-lead MSOP	8.95
+4, +5, ±10	15, 16	–2/+3, –1/+1.5	±3, ±2	83, 85	–90/–96	28-lead SSOP	26.40
±10	15, 16	–2/+3, –1/+1.5, 2 typ	±3, ±2, 3 typ	83, 85	–90/–96	28-lead SOIC, PDIP	20.73
±3.3, ±5, ±10, +4, +5, +10	15, 16	–2/+3, –1/+1.5, 2 typ	±3, ±2, 3 typ	83, 85	–90/–96	20-lead SSOP	20.73
0 to 2.5	15	N/A	±6	86 typ	–98 typ	48-lead LQFP, LFCSP	7.45
0 to 2.5	16	–1.0/+1.75	±3	87	–96	48-lead LQFP, LFCSP	7.91
0 to 2.5	15	N/A	±2.5	90 typ	–100 typ	48-lead LQFP, LFCSP	8.95
±2.5 @ 2.5	16	N/A	±1.5	92	–103.5	48-lead LQFP, LFCSP	12.00
0 to V_{DD}	15 @ 5 V, 16 @ 3 V	–0.9, +2.5 @ 3 V, ±2.5 @ 5 V	±4	85 @ 3 V, 84 @ 5 V	–95 typ	6-lead SOT-23	6.00
0 to V_{REF}	15, 16	N/A	±6, ±3	90, 91	–100/–106	8-lead MSOP	6.50
$\pm V_{REF}$	15, 16	N/A	±6, ±3	90, 91	–100/–106	8-lead MSOP	6.50
0 to V_{REF} (pseudo differential)	14	±0.7	±1	83	–100 typ	10-lead MSOP	7.37
0 to V_{REF} (pseudo differential)	14	±0.7	±1	83	–100 typ	10-lead MSOP	4.75

PulSAR ADCs for High Voltage Applications—*i*CMOS™ Technology

Analog Devices' industrial CMOS (*i*CMOS) manufacturing process has enabled the introduction of a wide range of high performance analog-to-digital converters, offering major advantages over traditional, power hungry, limited performance solutions. *i*CMOS ADCs address the needs of industrial, medical, and instrumentation applications by delivering products that achieve new performance standards and combine high resolution and speed, high voltage capability, flexibility, and high levels of integration.

Key Features

- 16-bit/18-bit resolution
- Multiple programmable input ranges
- Sampling rates up to 750 kSPS
- <10 ppm INL
- 100 dB SNR
- Parallel and serial interface
- 48-lead LQFP, 48-lead LFCSP

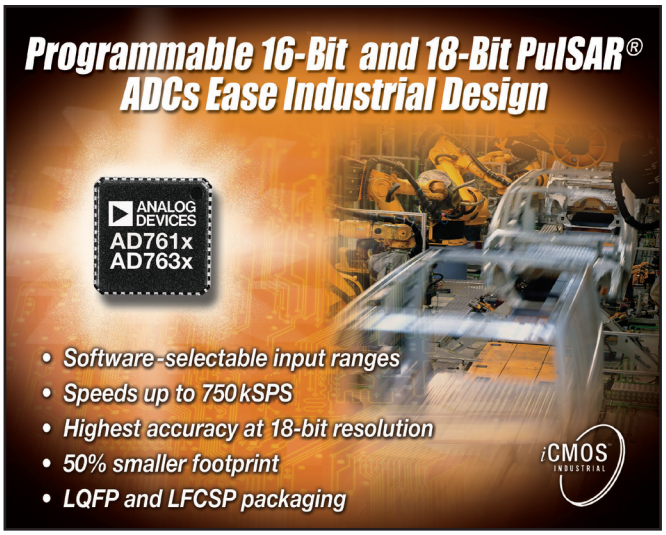
Key Benefits

- No level shifting or gain stages
- Unipolar differential
- Bipolar differential

Applications

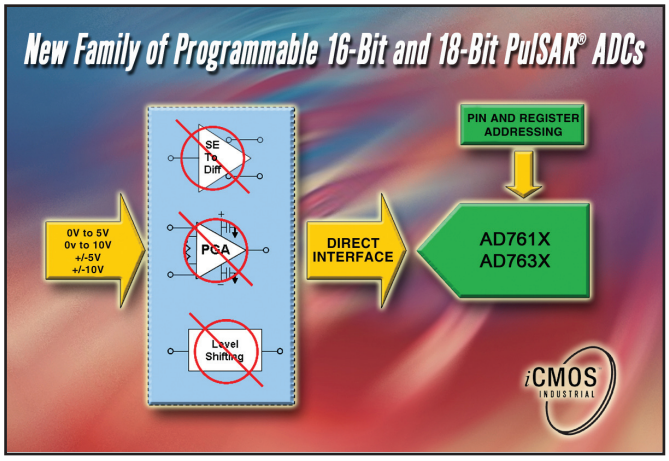
- High speed data acquisition
- Industrial process control
- Precision monitoring systems
- Programmable logic controllers
- Medical instruments

The AD7612 16-bit SAR ADC operates at speeds of 750 kSPS—up to 6× faster than competitive sampling rates. Software-selectable input ranges eliminate the need for front-end circuitry, reducing component costs and board space.



AD761x and AD763x—Unmatched Flexibility

Data acquisition systems typically utilize level shifting and gain to accommodate various bipolar and unipolar analog input ranges. This front-end signal conditioning method is both a time and cost consuming activity. The AD761x (16-bit) and AD763x (18-bit) SAR ADCs, offer sampling rates up to 750 kSPS, software-selectable unipolar input ranges of 0 V to 5 V and 0 V to 10 V, and bipolar input voltage ranges of ±5 V and ±10 V. These devices eliminate the need for front-end analog circuitry, dramatically reducing component cost and board space, while providing greater standards of performance. The software-selectable input voltage ranges allow the designer to change inputs on-the-fly, providing a more flexible solution. With both the AD761x and AD763x families of ADCs, all of the switching is done via internal registers, thus eliminating data latency. This results in faster conversion rates of up to 6× over existing designs.



Performance in a Small Package—Enabling Portable Medical Applications

Advances in integrated circuit technology have expanded the capabilities of modern medical equipment, for both patient monitoring and medical imaging. To enable these applications, Analog Devices offers a range of high precision analog components including ADCs, DACs, amplifiers, clocks, switches, and digital signal isolators that excel in all key dimensions, i.e., there is no room for trade-offs in performance and portability.

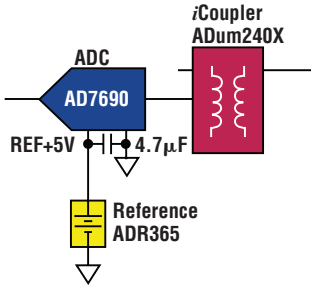
Key Features

- 18-bit resolution, no missing codes
- Throughput: 400 kSPS (AD7690), 250 kSPS (AD7691)
- Accuracy: 1 LSB typ, 1.5 LSB max
- Dynamic range: 102 dB @ 400 kSPS
- Power dissipation: 20 mW @ 400 kSPS
- 10-lead MSOP, 10-lead LFCSP

Applications

- Battery-powered equipment
- Data acquisition systems
- Digital voltage meters
- Instrumentation
- Medical instruments

AD7690 in Electrocardiogram System

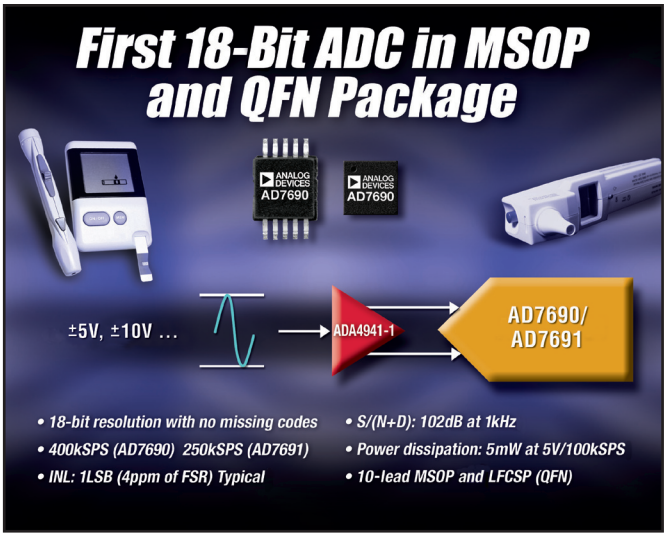


About the AD7690 18-Bit PulSAR ADC in 10-lead MSOP

The AD7690 PulSAR ADC delivers uncompromised performance in a small footprint. It is the first 18-bit ADC to fit in the 10-lead MSOP package. It is also the most linear 18-bit ADC with a 7 ppm INL maximum specification. The AD7690 is a successive approximation ADC which operates from a single 5 V power supply and has a versatile SPI serial interface port. It delivers 400 kSPS data rates and dissipates just 20 mW at its highest throughput rate. The SNR of 102 dB allows low level signals to be converted with minimal front-end analog signal conditioning, and the ADA4941-1 is a recommended single-supply differential 18-bit ADC driver. This unique combination of speed, performance, low power, and small package has been designed specifically for applications where board space is at a premium, and speed and accuracy cannot be sacrificed.

Where it matters in medical applications …

Medical diagnostics and patient monitoring systems require precision analog-to-digital conversion. The 18-bit resolution, low power, and 400 kSPS sample rate of the AD7690 meets this requirement, as the serial output is easily isolated from the rest of the system with an *i*Coupler® device. The increased demand for portability of these systems is driving the need to maintain performance at lower power and in a small footprint. Consumer medical products also require a price sensitive, off-the-shelf solution to reduce time to market. The AD7691 provides a pin-compatible 250 kSPS solution, and the AD7688 is a 16-bit pin-for-pin solution, enabling flexible system performance upgrades with minimal impact on manufacturability. The AD7690's compact 3 mm × 5 mm MSOP package, 3 mm × 3 mm LFCSP package, and low power of just 20 mW make it a natural fit for battery-powered and hand-held instrumentation applications. The device powers down at the end of each conversion, so the power scales linearly with the sampling rate, further enhancing battery life.



Recommended Voltage References and Op Amps

Take advantage of the industry's highest performing SAR ADCs using these recommended op amps and voltage references.

Voltage References

Part Number	Operating Temperature	Temperature Coefficient	Initial Accuracy	Package	Reference Voltage						
					1.225	1.250	2.048	2.500	3.000	4.096	5.000
ADR12x	–40°C to +125°C	25 ppm/°C	±0.24%	TSOT-23-6		ADR127A		ADR121A			ADR125A
		9 ppm/°C	±0.12%			ADR127B		ADR121B			ADR125B
ADR44x	–40°C to +125°C	10 ppm/°C	±0.12%	SOIC-8, MSOP-8			ADR440A	ADR441A	ADR443A	ADR444A	ADR445A
		3 ppm/°C	±0.04%				ADR440B	ADR441B	ADR443B	ADR444B	ADR445B
AD1580	–40°C to +85°C	100 ppm/°C	±10 mV	SOT-23-3, SC70-3	AD1580A						
		50 ppm/°C	±1 mV		AD1580B						

Single-Ended-to-Differential Amplifiers Optimized for Driving PulSAR Converters

Driving high resolution differential ADCs has typically required a number of external components in addition to the amplifiers. Configured as easy to use, G = +2, single-ended-to-differential amplifiers, the ADA4941-1 and ADA4922-1 require no external components to drive 16-bit to 18-bit differential PulSAR ADCs. Both devices offer high input impedance, as well as ultralow noise and distortion, which are essential for driving today's high resolution ADCs.

Part Number	–3 dB Bandwidth (MHz)	Slew Rate (V/µs)	Settling Time		Harmonic Distortion		Noise (RTO)[1] (nV/√Hz)	I_S (mA Typ)	Supply Range (V)		Price ($U.S.)[2]	Comments
			(ns)	(%)	(dBc)	Freq (kHz)			Min	Max		
ADA4922-1	38	730	580	0.01	–109	5	12	9.4	5	26	3.59	G = 2
ADA4941-1	31	24.5	610	0.005	–110	100	10.2	2.3	2.7	12	2.39	Adjustable gain; G = 2 with no external components

[1]Referred to output

[2]1k unit pricing

Operational Amplifiers for Driving PulSAR Converters

Part Number		Supply Range (V)		–3 dB Bandwidth (MHz)	Slew Rate (V/µs)	Settling Time		Harmonic Distortion		Noise (RTI)[1] (nV/√Hz)	Price ($U.S.)[2]
Single	Dual	Min	Max			(ns)	(%)	(dBc)	Freq (kHz)		
ADA4841-1	ADA4841-2	2.7	12	80	12	175	0.1	–105	100	2.1	1.59/2.29
AD8021		4.5	24	190	140	28	0.01	–84	1000	2.1	1.29
AD8610	AD8620	10	26	25	50	600	0.01	—	—	6	3.37/6.74
AD829		9	36	120	150	65	0.1	–104[3]	30	1.7	2.50

[1]Referred to input

[2]1k unit pricing

[3]THD (Total harmonic distortion)

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