

PRECISION ADC SELECTOR GUIDE

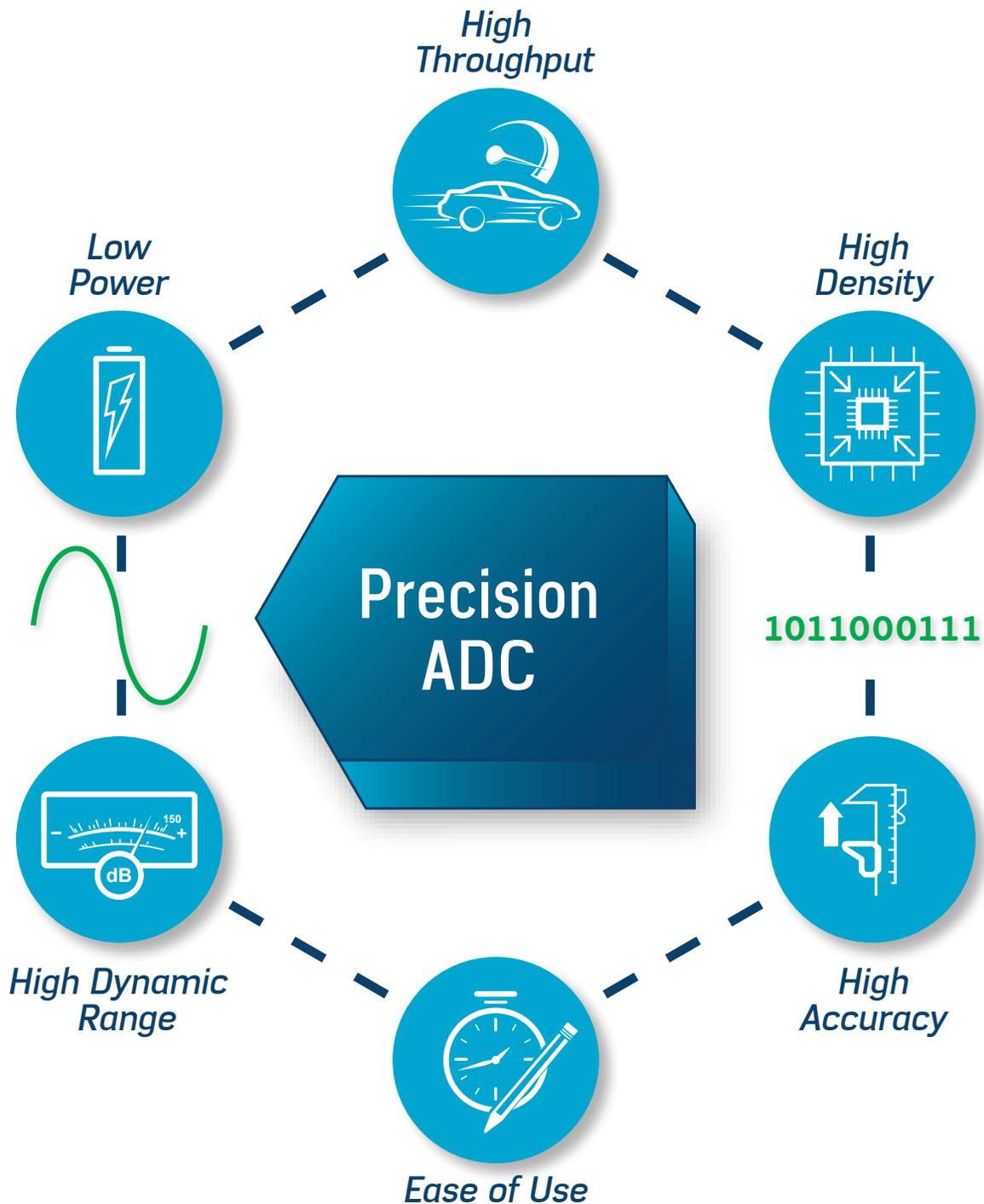


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Introduction

This ADC selector guide is designed as a pre-selection tool to facilitate selection of a short list of possible products. A detailed data sheet review should be performed before ultimately selecting the right ADC for the application.

ADC Input Types..... Page 3

This section describes the common terms used to categorize the various signal types that an ADC can accept at its inputs. The signal type has implications on the selection of an amplifier to drive the ADC.

Single Channel SAR ADCs Page 5

Analog Devices' single channel successive approximation register (SAR) ADC portfolio offers sample rates up to 15Msps with no latency operation. Resolutions include high accuracy 20-bit and 24-bit ADCs at sample rates up to 2Msps, to general purpose 12-bit and 14-bit ADCs with a wide selection of parallel and serial interfaces. The high resolution devices offer excellent DC performance including outstanding INL of up to 0.5ppm and better than 100dB SNR. Many of these devices offer power saving features such as digital gain compression which allows the device to be driven by a single supply ADC driver, while also offering longer acquisition times to enable pairing with slower speed ADC drivers to save power and cost.

µModule® Data Acquisition Systems Page 6

Data acquisition µModules incorporate more of the signal chain in one device. More of the signal chain is guaranteed to data sheet limits which reduces system level performance variations in manufacturing and also reduces the need for costly system level calibration in manufacturing. These products also enable higher system density, reduce time to market for system level designers and simplify the BOM management by reducing the number of components on the PCB.

Simultaneous Sampling ADCs Page 7

Simultaneous sampling enables multiple analog signals to be sampled at the same instant in time. This is particularly useful in power measurement applications, multiphase DC to AC inverter control applications and applications that measure phase differences between analog signals. In some devices a dedicated ADC is used for each channel, or multiple sample and hold circuits may be employed with a single ADC to acquire all the inputs. The latter helps to lower the power consumption and reduce the package footprint.

Many devices offer independently configurable SoftSpan™ inputs that can be software configured on a conversion-by-conversion basis to accept high voltage true bipolar or unipolar input signals with widely varying common mode ranges.

Isolated Sigma Delta Modulators Page 8

Isolated Sigma Delta modulators are suited to applications that require precision measurement of current and voltage in high voltage applications where galvanic isolation is required between the high voltage electronics and the low voltage control loop electronics. These ADCs integrate Analog Devices' iCoupler® digital isolation technology.

MUXed Input SAR ADCs..... Page 9

Multiplexed Input SAR ADCs enable system monitoring of a variety of signal sources often with on-the-fly flexibility to configure the order in which channels are sampled. These products are also used in control loops where multiple parameters are measured to optimize the control algorithm. The sample rate per channel is dependent on the core ADC sample rate and the number of channels sampled. Some devices incorporate programmable sequencers, temperature sensors, PGAs, as well as configurable SoftSpan input ranges.

Wideband Oversampled ADCs (FIR Filter)..... Page 10

High dynamic range, 24-bit and 32-bit Sigma Delta and Oversampled SAR ADCs with integrated digital filters target applications with signal bandwidths as high as 1MHz and where the magnitude of the signal can vary from µVolts to Volts. Configurable digital filters enable the system designer to optimize system signal bandwidth to trade off speed vs. dynamic range, while relaxing the anti-aliasing filter requirements at the input to the ADC to significantly reduce system complexity. This also unburdens the processor from the filtering task, allowing it to access the ADC output at a reduced data rate and lower the interface power consumption.

Narrowband Oversampling ADCs..... Page 11

This ultrahigh precision, low bandwidth ADC portfolio includes Sigma Delta and Oversampled SAR architectures. It focuses on DC accuracy, low offset and gain drifts, and linearity, and delivers ultralow noise options with greater than 25 NFB (noise free bits) of performance for digitizing low frequency analog signals. The Sigma Deltas deliver the highest degree of signal chain integration, offering a palette of integrated functions for sensor interfacing such as PGAs or rail-to-rail input buffers, cross point MUX and sensor excitation.

SYMBOL KEY	
~	Identifies ADCs that are optimized to maintain SINAD performance at high input signal frequencies within the Nyquist bandwidth of the ADC.
▶	Buffered Input: Identifies ADCs that incorporate buffers on the analog inputs. These ADCs offer substantial space and cost savings by eliminating front-end signal conditioning circuitry normally required to drive unbuffered switched-capacitor ADC inputs.
✦	PGA Input: Identifies ADCs that incorporate a PGA (programmable gain instrumentation amplifier) on the analog inputs. The high input impedance and programmable signal scaling functionality enable direct interface to sensor outputs.
⚡	Resistive Input: Identifies ADCs that have a resistive input structure on the analog inputs. This input structure type enables true bipolar analog input signals to be connected directly to an ADC that operates off a single unipolar supply rail. These ADCs are ideally suited for direct connection to low output impedance sensors such as current transformers and voltage transformers and eliminate the need for front-end signal conditioning circuitry normally required to drive the ADC.

COLOR KEY	
	Suggested Part for that given cell. The ADCs are categorized by resolution, sampling rate and input channel count.
	Indicates that the ADC is Higher Performance versus a similar product in same cell.
	Indicates that the ADC enables a Smaller Solution size versus a similar product in same cell. The ADC may have a smaller package footprint or integrate additional functionality such as a voltage reference, reference buffer, input buffers or PGA.
	Indicates that the ADC enables Lower Power versus a similar product in same cell. The ADC may have lower power consumption at the component level or may enable lower power at the signal chain level due to its ease of use features.

ADC Input Types

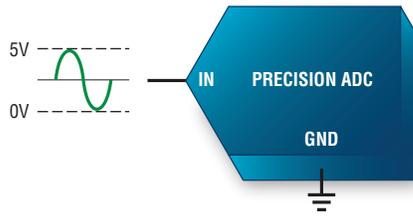


Figure 1a. Single-Ended Unipolar

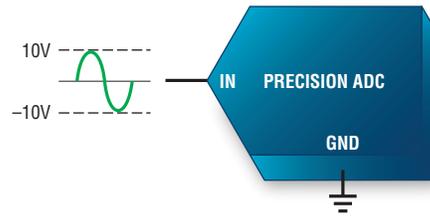


Figure 1b. Single-Ended True Bipolar

Single-Ended Inputs

An ADC with single-ended inputs digitizes the analog input voltage relative to ground. Single-ended inputs simplify ADC driver requirements, reduce complexity and lower power dissipation in the signal chain. Single-ended inputs can either be unipolar or bipolar, where the analog input on a single-ended unipolar ADC swings only above GND (0V to V_{FS} , where V_{FS} is the full-scale input voltage that is determined by a reference voltage) (Figure 1a) and the analog input on a single-ended bipolar ADC also called true bipolar, swings above or below GND ($\pm V_{FS}$) (Figure 1b).

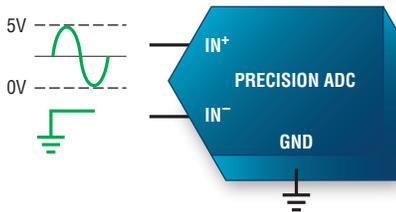


Figure 2a. Pseudo-Differential Unipolar

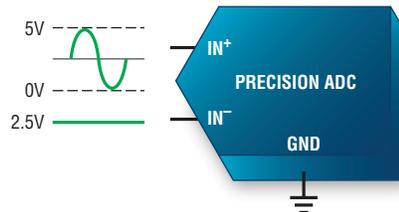


Figure 2b. Pseudo-Differential Bipolar

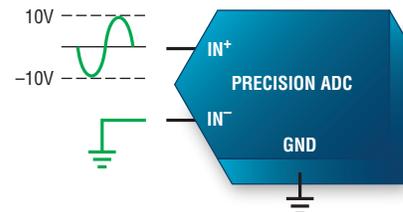


Figure 2c. Pseudo-Differential True Bipolar

Pseudo-Differential Inputs

An ADC with pseudo-differential inputs digitizes the differential analog input voltage ($IN^+ - IN^-$) over a limited range. The IN^+ input has the actual analog input signal, while the IN^- input has a restricted range.

A pseudo-differential unipolar ADC digitizes the differential analog input voltage ($IN^+ - IN^-$) over a span of 0V to V_{FS} . In this range, a single-ended unipolar input signal, driven on the IN^+ pin, is measured with respect to the signal ground reference level, driven on the IN^- pin. The IN^+ pin is allowed to swing from GND to V_{FS} , while the IN^- pin is restricted to around $GND \pm 100mV$ (Figure 2a).

A pseudo-differential bipolar ADC digitizes the differential analog input voltage ($IN^+ - IN^-$) over a span of $\pm V_{FS}/2$. In this range, a single-ended bipolar input signal, driven on the IN^+ pin, is measured with respect to the signal mid-scale reference level, driven on the IN^- pin. The IN^+ pin is allowed to swing from GND to V_{FS} , while the IN^- pin is restricted to around $V_{FS}/2 \pm 100mV$ (Figure 2b).

A pseudo-differential true bipolar ADC digitizes the differential analog input voltage ($IN^+ - IN^-$) over a span of $\pm V_{FS}$. In this range, a true bipolar input signal, driven on the IN^+ pin, is measured with respect to the signal ground reference level, driven on the IN^- pin. The IN^+ pin is allowed to swing above or below GND to $\pm V_{FS}$, while the IN^- pin is restricted to around $GND \pm 100mV$ (Figure 2c).

Pseudo-differential inputs help separate signal ground from the ADC ground, allowing small common mode voltages to be cancelled. They also allow single-ended input signals that are referenced to ADC ground. Pseudo-differential ADCs are ideal for applications that require DC common mode voltage rejection, for single-ended input signals and for applications that do not want the complexity of differential drivers. Pseudo-differential inputs simplify the ADC driver requirement, reduce complexity and lower power dissipation in the signal chain.

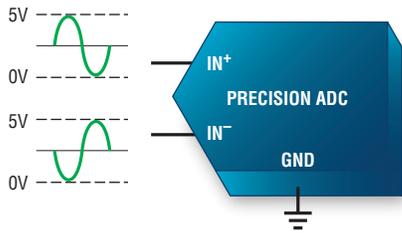


Figure 3a. Fully Differential

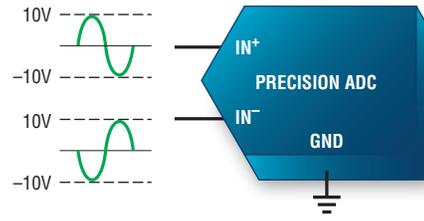


Figure 3b. Fully Differential True Bipolar

Fully Differential Inputs

An ADC with fully differential inputs digitizes the differential analog input voltage ($IN^+ - IN^-$) over a span of $\pm V_{FS}$. In this range, the IN^+ and IN^- pins should be driven 180° out-of-phase with respect to each other, centered on a fixed common mode voltage, for example, $V_{REF}/2 \pm 50mV$. In most fully differential ADCs, both the IN^+ and IN^- pins are allowed to swing from GND to V_{FS} (Figure 3a), while in fully differential true bipolar ADCs, both the IN^+ and IN^- pins are allowed to swing above or below GND to $\pm V_{FS}$ (Figure 3b).

Fully differential inputs offer wider dynamic range and better SNR performance over single-ended or pseudo-differential inputs. Fully differential ADCs are ideal for applications that require the highest performance.

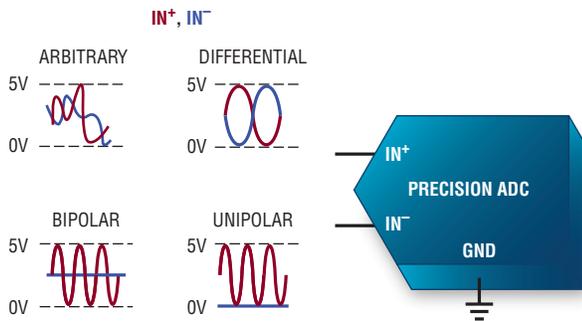


Figure 4a. Differential with Wide Input Common Mode

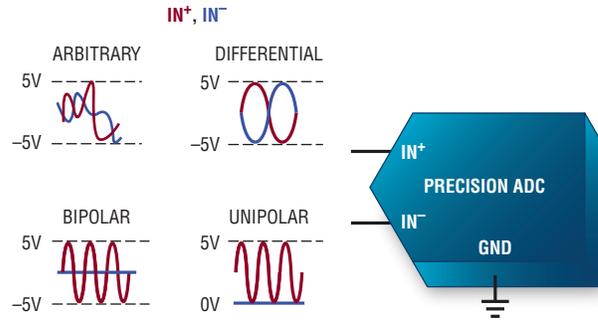


Figure 4b. Differential True Bipolar

Differential Inputs with Wide Input Common Mode

An ADC with differential inputs digitizes the voltage difference between the IN^+ and IN^- pins while supporting a wide common mode input range. The analog input signals on IN^+ and IN^- can have an arbitrary relationship to each other. In most differential ADCs, both IN^+ and IN^- remain between GND and V_{FS} (Figure 4a), while in differential true bipolar ADCs, both the IN^+ and IN^- pins are allowed to swing above or below GND to $\pm V_{FS}$ (Figure 4b). Differential inputs are ideal for applications that require a wide dynamic range with high common mode rejection. Being one of the most flexible ADC input types, an ADC with differential inputs can also digitize other types of analog input signals such as single-ended unipolar, pseudo-differential unipolar/bipolar and fully differential.

Precision ADC Selector Guide

Single Channel SAR ADCs

		Input Type	≤200ksps	≤250ksps	≤500ksps	≤1Msps	≤1.8Msps	≤2Msps	≤6Msps	≤10Msps	≤15Msps
RESOLUTION	24-Bit	Fully Differential						LTC 2380-24			
		Pseudo-Differential				LTC 2368-24					
	20-Bit	Fully Differential		LTC 2376-20	LTC 2377-20	LTC 2378-20	AD [~] 4020				
		Fully Differential	AD 7989-1	LTC 2376-18 AD 7691	LTC 2377-18 AD [~] 4011	LTC 2378-18 AD [~] 4007	LTC 2379-18 AD 7984	AD [~] 4003 AD 7986	LTC [~] 2385-18 AD [~] 7960	LTC [~] 2386-18	LTC [~] 2387-18
	18-Bit	Fully Differential ±10V True Bipolar		LTC [~] 2336-18	LTC [~] 2337-18	LTC [~] 2338-18					
		Pseudo-Differential		LTC 2364-18	LTC 2367-18	LTC 2368-18	LTC 2369-18	LTC 2389-18			
		Pseudo-Differential ±10V True Bipolar		LTC [~] 2326-18	LTC [~] 2327-18	LTC [~] 2328-18					
	16-Bit	Fully Differential		LTC 2376-16 AD 7687	LTC 2377-16	LTC 2378-16 AD [~] 4005		LTC 2380-16 AD [~] 4001 LTC [~] 2310-16	LTC [~] 2385-16 AD [~] 7961 LTC [~] 2311-16	LTC [~] 2386-16 AD [~] 7626	LTC [~] 2387-16
		Fully Differential ±2.5V True Bipolar		LTC 1603	LTC 1604 LTC 1608						
		Pseudo-Differential Unipolar	AD 7683 AD 7988-1	LTC 2364-16 AD 7685 AD 7694	LTC 2367-16 AD 7686 AD 7988-5	LTC 2368-16 AD 7981 AD [~] 4004	AD 7983	LTC 2370-16 AD [~] 4000	AD 7985		
		Pseudo-Differential True Bipolar		LTC [~] 2326-16	LTC [~] 2327-16	LTC [~] 2328-16					
		Single-Ended ±10V True Bipolar	LTC [~] 1605 LTC [~] 1609	LTC [~] 1606							

[~] Improved SINAD at High F_{IN}
[~] Resistive Input

 Suggested Part

 Higher Performance

 Lower Power

 Smaller Solution

Single Channel SAR ADCs (Continued)

		Input Type	≤100ksps	≤250ksps	≤500ksps	≤1.5Mps	≤3Mps	≤6Mps
14-Bit	RESOLUTION	Differential with Wide Input Common Mode					LTC 1403A LTC 2310-14	LTC 2355-14 LTC 2356-14 LTC 2311-14
		Fully Differential ±10V True Bipolar			AD 7899	AD 7951		
		Pseudo-Differential		AD 7942	AD 7946		AD 7944 LTC 1403A LTC 2310-14	LTC 2355-14 LTC 2356-14 LTC 2311-14
		Pseudo-Differential ±10V True Bipolar				AD 7951		
		Single-Ended Unipolar	AD 7940		LTC 2312-14	AD 7485	AD 7484 LTC 2313-14	LTC 2314-14
		Single-Ended ±10V True Bipolar		AD 7894				
12-Bit	RESOLUTION	Fully Differential			AD 7452	AD 7450A		
		Differential with Wide Input Common Mode					LTC 1403 LTC 2310-12	LTC 2355-12 LTC 2356-12 LTC 2311-12
		Pseudo-Differential	AD 7457 LTC 2301*	LTC 1860	AD 7453 LTC 2302	AD 7472	LTC 1403 LTC 2310-12	LTC 2355-12 LTC 2356-12 LTC 2311-12
		Single-Ended Unipolar	AD 7466		LTC 2312-12	AD 7091 AD 7091R	AD 7274 AD 7276 AD 7482 LTC 2313-12	LTC 2315-12
		Single-Ended ±10V True Bipolar	AD 7893	AD 7895 AD 7898				

~ Improved SINAD at High F_{IN}

* I²C

 Suggested Part

 Higher Performance

 Lower Power

µModule Data Acquisition Systems

Resolution	Input Type	Max Output Data Rate	
		≤500ksps	≤1Mps
16-Bit	Pseudo-Differential	ADAQ 7988	ADAQ 7980

Simultaneous Sampling ADCs (High Resolution)

		Input Type	Channels	≤200 ksp/s/ch	≤400 ksp/s/ch	≤700 ksp/s/ch	≤1 Msps/ch	≤2 Msps/ch	≤5 Msps/ch
24-Bit	Fully Differential/ Pseudo-Differential	8		AD ^{PGIA} 7779	AD ^{PGIA} 7770	AD ^{PGIA} 7771	AD 7768		
		4				AD 7768-4			
18-Bit	Differential with Wide Input Common Mode	2					LTC 2341-18		
		4				LTC 2344-18			
		8			LTC 2345-18				
	Differential ±10V True Bipolar	2					LTC 2353-18		
		4					LTC 2357-18		
		8		AD ^{Resistive} 7609	LTC 2358-18	LTC 2348-18			
Pseudo-Differential True Bipolar	8		AD ^{Resistive} 7608						
16-Bit	Fully Differential	2					AD 7903		
	Differential with Wide Input Common Mode	2				LTC 2341-16		LTC [∨] 2321-16	LTC [∨] 2323-16
		4				LTC 2344-16		LTC [∨] 2324-16	LTC [∨] 2325-16
		8		LTC 2345-16		AD 7761		LTC [∨] 2320-16	
	Differential ±10V True Bipolar	2					LTC 2353-16		
		4					LTC 2357-16		
		8		LTC 2348-16	LTC 2358-16				
	Pseudo-Differential Single-Ended	2					LTC 2341-16	AD 7902	
		4					LTC 2344-16		
		8			LTC 2345-16				
	Pseudo-Differential ±10V True Bipolar	4			AD ^{Resistive} 7606-4		AD ^{Resistive} 7605-4		
		6			AD ^{Resistive} 7606-6		AD 7656A/-1		
8			ADAS ^{PGIA} 3023	AD ^{Resistive} 7606	LTC 2358-16	LTC 2348-16			

∨ Improved SINAD at High F_{IN}
^{Resistive} Resistive Input

▶ Buffered Input
 ▲ PGIA Input

▣ Suggested Part

▣ Smaller Solution

Simultaneous Sampling ADCs (Continued)

		Input Type	Channels	<150ksps/ch	≤400ksps/ch	≤1Msps/ch	≤2Msps/ch	≤5Msps/ch
RESOLUTION	14-Bit	Fully Differential	2			AD 7264		
		Differential with Wide Input Common Mode	2				LTC 1407A, LTC 2321-14	LTC 2323-14, AD 7357
			4				LTC 2324-14	LTC 2325-14
			6	LTC 1408	LTC 2351-14			
			8				LTC 2320-14	
		Pseudo-Differential ±10V True Bipolar	6			AD 7657		
	8		AD 7607					
	12-Bit	Fully Differential	2			AD 7265, AD 7262	AD 7266	
		Differential with Wide Input Common Mode	2				LTC 1407, LTC 2321-12	LTC 2323-12, AD 7352, AD 7356
			4				LTC 2324-12	LTC 2325-12
6			LTC 1408-12	LTC 2351-12				
8						LTC 2320-12		
Pseudo-Differential ±10V True Bipolar		6			AD 7658			

PGIA Input
 Improved SINAD at High F_{IN}
 Resistive Input
 Suggested Part
 Higher Performance
 Lower Power

Isolated Sigma Delta Modulators

Channels	Interface	Integrated	Isolated Working Voltage V _{RMS}	
			400V _{RMS}	884V _{RMS}
1	CMOS	Clock	AD 7400A	AD 7402
			AD 7401A	AD 7403
	LVDS		AD 7405	
2	SPI	isoPower	ADE 7912	
	CMOS		ADE 7932	
3	SPI	isoPower	ADE 7913	
	CMOS		ADE 7933	

±250mV Analog Input Range
 ±500mV, ±31.25mV Analog Input Range

MUXed Input SAR ADCs

		Input Type	Channels	≤250ksps	≤500ksps	≤1Msps	≤1.6Msps
18-Bit	Fully Differential	8			LTC 2372-18	LTC 2373-18	
	Fully Differential ±10V True Bipolar	8				LTC 2333-18 LTC 2335-18	
	Pseudo-Differential	8			LTC 2372-18		
	Pseudo-Differential ±10V True Bipolar	8				LTC 2333-16	
16-Bit	Fully Differential	8			LTC 2372-16	LTC 2373-16	LTC 2374-16
	Fully Differential ±10V True Bipolar	8	LTC [Ⓜ] 1856 LTC [Ⓜ] 1859			LTC 2333-16 LTC 2335-16	
	Pseudo-Differential	2	LTC 1865				
		4	AD 7682				
		8	LTC 1867 AD 7689	LTC 2372-16 AD 7699	LTC 2373-16 ADAS [Ⓜ] 3022		
	Pseudo Differential ±10V True Bipolar	8	LTC [Ⓜ] 1856 LTC [Ⓜ] 1859			LTC 2333-16 ADAS [Ⓜ] 3022	
16					AD [Ⓜ] 7616		
14-Bit	Fully Differential	4	LTC [Ⓜ] 1855 LTC [Ⓜ] 1858				
	Pseudo-Differential	8	AD 7949				
	Pseudo-Differential ±10V True Bipolar	8	LTC [Ⓜ] 1855 LTC [Ⓜ] 1858				

[Ⓜ] Resistive Input
 ▶ Buffered Input
 ⚡ PGIA Input

 Suggested Part
  Higher Performance
  Lower Power
  Smaller Solution

MUXed Input SAR ADCs (Continued)

		Input Type	Channels	≤250ksps	≤500ksps	≤1Msps	≤1.6Msps
RESOLUTION	12-Bit	Fully Differential	4		LTC 1853		LTC 1851
		Fully Differential ±10V True Bipolar	4	LTC [™] 1854, LTC [™] 1857			
		Pseudo-Differential	2	AD 7921, LTC* 2305, LTC 1861	LTC 2306	AD 7922, AD 7091R-2	
			4	AD* 7091R-5, AD 7923	AD 7934-6	AD 7924, AD 7091R-4	AD 7934
			8	LTC 1863, AD 7927, LTC* 2309, AD* 7998	LTC 2308, AD 7938-6, LTC 1853	AD 7091R-8	LTC 1851, AD 7938
		16			AD 7490		
	Pseudo-Differential ±10V True Bipolar	2		AD 7321	AD 7322		
		4		AD 7323	AD 7324		
		8	LTC [™] 1854, LTC [™] 1857		AD 7329, AD 7328		
	10-Bit	Single-Ended Unipolar	2	AD 7911		AD 7912	
4			AD* 7995		AD 7914	AD 7933	
8			AD* 7997		AD 7918	AD 7939	

* I²C Interface



Suggested Part



Smaller Solution



Higher Performance



Lower Power

Wideband Oversampled ADCs (FIR Filter)

		Input Type	Digital Filter Bandwidth (-3dB Point)						
			≤5kHz	≤12.5kHz	≤25kHz	≤50kHz	≤125kHz	≤250kHz	≤1MHz
RESOLUTION	32-Bit	Fully Differential	LTC 2508-32					LTC 2500-32	
	24-Bit	Fully Differential		AD 7767-2, AD 7766-2	AD 7767-1, AD 7766-1	AD 7767, AD 7766, AD 7765	AD 7764	AD 7762, AD 7763, LTC 2512-24	AD 7760

▶ Buffered Input

Narrowband Oversampling ADCs

	Input Type	Channels	Output Data Rate							
			≤0.05kpsps	≤0.5kpsps	≤ 5kpsps	≤20kpsps	≤50kpsps	≤250kpsps	≤2Msps	
RESOLUTION 32-Bit	Fully Differential/ Pseudo-Differential	2/4				AD 7177-2				
	Fully Differential	1	LTC 2400 LTC 2484 LTC * 2485		LTC 2440				LTC 2380-24	
	Pseudo-Differential	1							LTC 2368-24	
	Fully Differential/ Pseudo-Differential	1/1			AD 7797					
		2/2			AD 7191					
		2/4			AD 7190 AD 7192 AD 7195		AD 7172-2	AD 7175-2 AD 7176-2		
		3/3		AD 7793 AD 7799						
		4/7 or 8			AD 7193	AD 7124-4	AD 7172-4			
		6/6		AD 7794						
		8/15 or 16			AD 7194	AD 7124-8	AD 7173-8	AD 7175-8		
	Fully Differential/ Single-Ended	2/4	LTC 2492 LTC * 2493				LTC 2442			
		4/8				LTC 2444 LTC 2445 LTC 2446 LTC 2447				
		8/16	LTC 2498 LTC * 2499				LTC 2448 LTC 2449			

Buffered Input
 PGIA Input
 * I²C Interface

Suggested Part

Narrowband Oversampling ADCs (Continued)

	Input Type	Channels	Output Data Rate		
			≤0.05ksps	≤0.5ksps	≤5ksps
16-Bit	Fully Differential	1			
	Fully Differential/ Pseudo-Differential	1/1			
		3/3			
		6/6			
	Fully Differential/ Single-Ended	2/4			
8/16					
Single-Ended	1				

Buffered Input
 PGIA Input
 * I²C Interface

Suggested Part

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