

24-BIT ANALOG-TO-DIGITAL CONVERTER

Check for Samples: ADS1243-HT

FEATURES

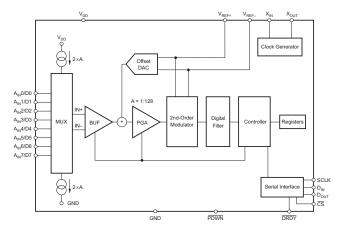
- 24-Bits No Missing Codes
- Simultaneous 50-Hz and 60-Hz Rejection (-90 dB Minimum)
- 0.0025% INL
- PGA Gains From 1 to 128
- Single-Cycle Settling
- Programmable Data Output Rates
- External Differential Reference of 0.1 V to 5 V
- On-Chip Calibration
- SPI™ Compatible
- 2.7 V to 5.25 V Supply Range
- 600-µW Power Consumption
- Up to Eight Input Channels
- Up to Eight Data I/O

APPLICATIONS

- Down-Hole Drilling
- · High Temperature Environments
- Vibration/Modal Analysis
- Multi-Channel Data Acquisition
- Acoustics/Dynamic Strain Gauges
- Pressure Sensors

SUPPORTS EXTREME TEMPERATURE APPLICATIONS

- Controlled Baseline
- One Assembly/Test Site
- One Fabrication Site
- Available in Extreme (–55°C/210°C)
 Temperature Range⁽¹⁾
- · Extended Product Life Cycle
- Extended Product-Change Notification
- Product Traceability
- Texas Instruments' high temperature products utilize highly optimized silicon (die) solutions with design and process enhancements to maximize performance over extended temperatures. All devices are characterized and qualified for 1000 hours of continuous operating life at maximum rated temperatures.



(1) Custom temperature ranges available

DESCRIPTION

The ADS1243 is a precision, wide dynamic range, delta-sigma, analog-to-digital (A/D) converter with 24-bit resolution operating from 2.7-V to 5.25-V supplies. This delta-sigma, A/D converter provides up to 24 bits of no missing code performance and effective resolution of 21 bits.

The input channels are multiplexed. Internal buffering can be selected to provide a very high input impedance for direct connection to transducers or low-level voltage signals. Burnout current sources are provided that allow for the detection of an open or shorted sensor. An 8-bit digital-to-analog converter (DAC) provides an offset correction with a range of 50% of the FSR (Full-Scale Range).

ATA.

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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The Programmable Gain Amplifier (PGA) provides selectable gains of 1 to 128 with an effective resolution of 19 bits at a gain of 128. The A/D conversion is accomplished with a second-order delta-sigma modulator and programmable FIR filter that provides a simultaneous 50-Hz and 60-Hz notch. The reference input is differential and can be used for ratiometric conversion.

The serial interface is SPI compatible. Up to eight bits of data I/O are also provided that can be used for input or output. The ADS1243 is designed for high-resolution measurement applications in smart transmitters, industrial process control, weight scales, chromatography and portable instrumentation.

ORDERING INFORMATION⁽¹⁾

T _A	PACKAGE	ORDERABLE PART NUMBER	TOP-SIDE MARKING
FF°C +- 040°C	JD	ADS1243SJD	ADS1243SJD
–55°C to 210°C	KGD	ADS1243SKGD1	NA

⁽¹⁾ For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI Web site at www.ti.com.

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted) (1)

	VALUE	UNIT
V _{DD} to GND	-0.3 to 6	V
Input Current	100, Momentary	mA
Input Current	10, Continuous	mA
A _{IN}	GND – 0.5 to V_{DD} + 0.5	V
Digital Input Voltage to GND	$-0.3V$ to $V_{DD} + 0.3$	V
Digital Output Voltage to GND	$-0.3V$ to $V_{DD} + 0.3$	V
Maximum Junction Temperature	215	°C
Operating Temperature Range	–55 to 210	°C
Storage Temperature Range	-65 to 100	°C

⁽¹⁾ Stresses above those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. Exposure to absolute maximum conditions for extended periods may affect device reliability.

THERMAL CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted)

	3 1 3 1	,				
	PARAMETER		MIN	TYP	MAX	UNIT
θ_{JC}	Junction-to-case thermal resistance	HKJ package			8.1	°C/W

DIGITAL CHARACTERISTICS

V_{DD} 2.7 V to 5.25 V

PARAMETER		TEST COMPITIONS	$T_A = -55^{\circ}C$ to 125°C			T _A = 210°C			LINUT
		TEST CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
Digital Input/Output									
Logic Family				CMOS			CMOS		
	V _{IH}		0.8 ● VDD		V_{DD}	0.8 • VDD		V_{DD}	V
Logio Lovol	V _{IL} (1)		GND		0.2 • VDD	GND		0.2 • VDD	V
Logic Level	V_{OH}	$I_{OH} = 1 \text{ mA}$	$V_{DD} - 0.4$			$V_{DD} - 0.4$			V
	V_{OL}	$I_{OL} = 1 \text{ mA}$	GND		GND + 0.4	GND		GND + 0.4	V
Innut Lookogo	I _{IH}	$V_I = V_{DD}$			10			10	μΑ
Input Leakage	I _{IL}	V _I = 0	-10			-10			μΑ
Master Clock Rate: fosc			1		5	1		5	MHz

(1) V_{IL} for X_{IN} is GND to GND + 0.05 V.

DIGITAL CHARACTERISTICS (continued)

 $V_{DD} \ 2.7 \ V$ to $5.25 \ V$

PARAMETER	TEST CONDITIONS	T _A = -5	$T_A = -55^{\circ}C$ to 125°C			T _A = 210°C			
PARAMETER	TEST CONDITIONS	MIN TYP MA			MIN	TYP	MAX	UNIT	
Master Clock Period: tosc	1/f _{OSC}	200		1000	200		1000	ns	

ELECTRICAL CHARACTERISTICS: V_{DD} = 5 V

All specifications V_{DD} = 5 V, f_{MOD} = 19.2 kHz, PGA = 1, Buffer ON, f_{DATA} = 15 Hz, V_{REF} = (REF IN+) – (REF IN-) = 2.5 V, unless otherwise specified.

		TEST SOMBITIONS	T _A =	-55°C to 125	°C		T _A = 210°C		
PAR	RAMETER	TEST CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
ANALOG II	NPUT (A _{IN} 0 – A _{IN} 7	7)	1						
A	* D	Buffer OFF	GND - 0.1		V _{DD} + 0.1	GND - 0.1		V _{DD} + 0.1	V
Analog Inpu	ut Range	Buffer ON	GND + 0.05		V _{DD} – 1.5	GND + 0.05		V _{DD} – 1.5	V
Full-Scale Input Range		(ln+) – (ln–), See Block Diagram, RANGE = 0			±V _{REF} /PGA			±V _{REF} /PGA	٧
		RANGE = 1			±V _{REF} / (2 • PGA)			±V _{REF} / (2 • PGA)	V
D''' '' '		Buffer OFF		5/PGA			12/PGA		ΜΩ
Differential Input Impedance		Buffer ON		5			8		GΩ
	$f_{DATA} = 3.75 \text{ Hz}$	-3 dB		1.65					Hz
Bandwidth	f _{DATA} = 7.50 Hz	-3 dB		3.44					Hz
	f _{DATA} = 15 Hz	–3 dB		14.6					Hz
Programma Amplifier	able Gain	User-Selectable Gain Ranges	1		128	1		128	
Input Capac	citance			9			25		pF
Input Leakage Current		Modulator OFF, T = 25°C		5			6		pA
Burnout Cu	rrent Sources			2					μΑ
OFFSET D	AC		1						
		RANGE = 0		±V _{REF} / (2 ● PGA)			±V _{REF} / (2 ● PGA)		V
Offset DAC	Range	RANGE = 1		±V _{REF} / (4 ● PGA)			±V _{REF} / (4 ● PGA)		V
Offset DAC	Monotonicity		8			8			Bits
Offset DAC	Gain Error			±10			±15		%
Offset DAC	Gain Error Drift			1			2.2		ppm/°C
SYSTEM P	ERFORMANCE		-						
Resolution		No Missing Codes	24			24			Bits
Integral Nor	nlinearity	End Point Fit			±0.0015			±0.0018	% of FS
Offset Error	_r (1)			7.5			15		ppm of FS
Offset Drift ⁽	(1)			0.02			0.04		ppm of FS/°C
Gain Error ⁽¹	1)			0.005			0.100		%
Gain Error I	Drift ⁽¹⁾			0.5			1.118		ppm°°C
		at DC	100			94			dB
Common-M	lode Rejection	f _{CM} = 60 Hz, f _{DATA} = 15 Hz		130			100		dB
		f _{CM} = 50 Hz, f _{DATA} = 15 Hz		120			100		dB
		f _{SIG} = 50 Hz, f _{DATA} = 15 Hz		100			95		dB
Normal-Mod	de Rejection	f _{SIG} = 60 Hz, f _{DATA} = 15 Hz		100			95		dB
Output Nois	se		See Tvr	oical Characte	ristics				

Product Folder Link(s): ADS1243-HT

ISTRUMENTS

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ELECTRICAL CHARACTERISTICS: V_{DD} = 5 V (continued)

All specifications V_{DD} = 5 V, f_{MOD} = 19.2 kHz, PGA = 1, Buffer ON, f_{DATA} = 15 Hz, V_{REF} = (REF IN+) – (REF IN–) = 2.5 V, unless otherwise specified.

DADAMETER	TEST COMPITIONS	T _A = -	55°C to 125°C		T _A	= 210°C		UNIT
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
Power-Supply Rejection	at DC, dB = -20 log($\Delta V_{OUT} / V_{DD}$) ⁽²⁾	80	95		79	95		dB
VOLTAGE REFERENCE IN	IPUT			·				
Reference Input Range	REF IN+, REF IN-	0		V_{DD}	0		V_{DD}	V
V_{REF}	V _{REF} ≡ (REF IN+) – (REF IN–), RANGE = 0	0.1	2.5	2.6	0.1	2.5	2.6	٧
	RANGE = 1	0.1		V_{DD}	0.1		V_{DD}	V
Common-Mode Rejection	at DC		120			98		dB
Common-Mode Rejection	f _{VREFCM} = 60 Hz, f _{DATA} = 15 Hz		120			95		dB
Bias Current ⁽³⁾	V _{REF} = 2.5 V		1.3			10		μA
POWER-SUPPLY REQUIRE	EMENTS			·			<u>.</u>	
Power-Supply Voltage	V _{DD}	4.75		5.25	4.75		5.25	V
	PGA = 1, Buffer OFF		240	375		250	480	μA
	PGA = 128, Buffer OFF		450	800		630	940	μA
	PGA = 1, Buffer ON		290	425		350	585	μA
Current	PGA = 128, Buffer ON		960	1400		1200	2050	μA
	SLEEP Mode		60			80		μA
	Read Data Continuous Mode		230			350		μA
	PDWN		0.5			10		nA
Power Dissipation	PGA = 1, Buffer OFF		1.2	1.9		1.3	2.52	mW

ELECTRICAL CHARACTERISTICS: V_{DD} = 3 V

All specifications V_{DD} = 3 V, f_{MOD} = 19.2 kHz, PGA = 1, Buffer ON, f_{DATA} = 15 Hz, V_{RFF} = (REF IN+) – (REF IN-) = 1.25 V, unless otherwise specified.

		TEST CONDITIONS	$T_{A} = -5$	5°C to 125	°C		T _A = 210°C		
PAR	RAMETER	TEST CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
ANALOG I	NPUT (A _{IN} 0 – A _{IN} 7	7)							
Analog Input Range		Buffer OFF	GND - 0.1		V _{DD} + 0.1	GND - 0.1		V _{DD} + 0.1	V
		Buffer ON	GND + 0.05		V _{DD} – 1.5	GND + 0.05		V _{DD} – 1.5	V
Full-Scale Input Voltage Range		(ln+) – (ln–), See Block Diagram, RANGE = 0			±V _{REF} / PGA			±V _{REF} / PGA	V
		RANGE = 1			±V _{REF} / (2 • PGA)			±V _{REF} / (2 • PGA)	V
Input Impedance		Buffer OFF		5/PGA			10/PGA		ΜΩ
		Buffer ON		5			8		GΩ
	$f_{DATA} = 3.75 \text{ Hz}$	-3 dB		1.65					Hz
Bandwidth	$f_{DATA} = 7.50 \text{ Hz}$	–3 dB		3.44					Hz
	f _{DATA} = 15 Hz	-3 dB		14.6					Hz
Programma Amplifier	able Gain	User-Selectable Gain Ranges	1		128	1		128	
Input Capa	citance			9			25		pF
Input Leaka	age Current	Modulator OFF, T = 25°C		5			6		pА
Burnout Cu	rrent Sources			2					μΑ
OFFSET D	AC								
Offact DAC	Pongo	RANGE = 0	(2	±V _{REF} / • PGA)			±V _{REF} / (2 • PGA)		V
Offset DAC	Range	RANGE = 1	(4	±V _{REF} / • PGA)			±V _{REF} / (4 ● PGA)		V

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 $[\]begin{array}{ll} \hbox{(2)} & \Delta V_{OUT} \text{ is a change in digital result.} \\ \hbox{(3)} & 12\text{-pF switched capacitor at } f_{SAMP} \text{ clock frequency.} \\ \end{array}$

ELECTRICAL CHARACTERISTICS: V_{DD} = 3 V (continued)

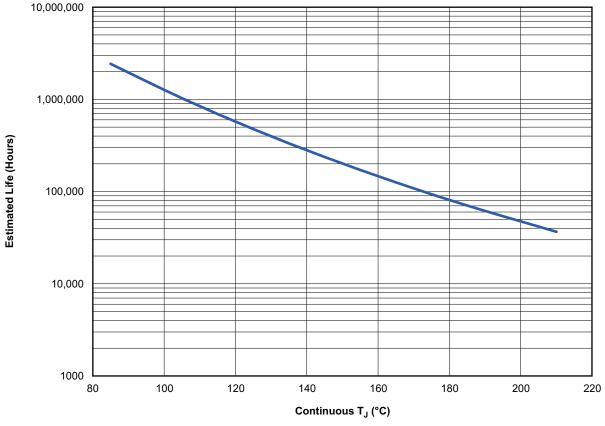
All specifications $V_{DD}=3$ V, $f_{MOD}=19.2$ kHz, PGA = 1, Buffer ON, $f_{DATA}=15$ Hz, $V_{REF}\equiv (REF\ IN+)-(REF\ IN-)=1.25$ V, unless otherwise specified.

PARAMETER	TEST CONDITIONS	T _A = -	-55°C to 125°	С	T	= 210°C		UNIT
TANAMETER	TEST CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
Offset DAC Monotonicity		8			8			Bits
Offset DAC Gain Error			±10			±12		%
Offset DAC Gain Error Drift			1			2		ppm/°C
SYSTEM PERFORMANCE								
Resolution	No Missing Codes	24			24			Bits
Integral Nonlinearity	End Point Fit			±0.0015			±0.0025	% of FS
Offset Error ⁽¹⁾			75			40		ppm of FS
Offset Drift ⁽¹⁾			0.02			0.20		ppm of FS/°C
Gain Error ⁽¹⁾			0.005			0.1		%
Gain Error Drift ⁽¹⁾			0.5			1.118		ppm/°C
	at DC	100			87			dB
Common-Mode Rejection	f _{CM} = 60 Hz, f _{DATA} = 15 Hz		130			98		dB
	f _{CM} = 50 Hz, f _{DATA} = 15 Hz		120			95		dB
Normal Made Dejection	f _{SIG} = 50 Hz, f _{DATA} = 15 Hz		100			90		dB
Normal-Mode Rejection	$f_{SIG} = 60 \text{ Hz}, f_{DATA} = 15 \text{ Hz}$		100			90		dB
Output Noise		See Typi	cal Characteri	stics				
Power-Supply Rejection	at DC, dB = $-20 \log(\Delta V_{OUT} / V_{DD})^{(2)}$	80	95		75	90		dB
VOLTAGE REFERENCE IN	PUT							
Reference Input Range	REF IN+, REF IN-	0		V_{DD}	0		V_{DD}	V
V_{REF}	V _{REF} ≡ (REF IN+) – (REF IN–), RANGE = 0	0.1	1.25	1.30	0.1	1.25	1.30	V
KEI	RANGE = 1	0.1		V _{DD}	0.1		2.6	V
Common-Mode Rejection	at DC		120			95		dB
Common-Mode Rejection	$f_{VREFCM} = 60 \text{ Hz},$ $f_{DATA} = 15 \text{ Hz}$		120			93		dB
Bias Current ⁽³⁾	V _{REF} = 1.25 V		1.3			8		μA
POWER-SUPPLY REQUIRE	EMENTS							
Power-Supply Voltage	V_{DD}	2.7		3.3	2.7		3.3	V
	PGA = 1, Buffer OFF		190	375		200	480	μΑ
	PGA = 128, Buffer OFF		460	700		600	940	μΑ
	PGA = 1, Buffer ON		240	375		350	585	μA
Current	PGA = 128, Buffer ON		870	1325		1200	1800	μA
	SLEEP Mode		75			110		μA
	Read Data Continuous Mode		113			250		μA
	PDWN = 0		0.5			7.5		nA
Power Dissipation	PGA = 1, Buffer OFF		0.6	1.2		0.66	1.58	mW

Calibration can minimize these errors.

 ⁽²⁾ ΔV_{OUT} is a change in digital result.
 (3) 12-pF switched capacitor at f_{SAMP} clock frequency.





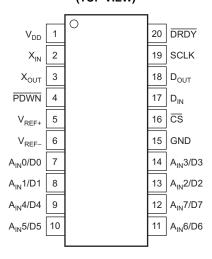
- (1) See data sheet for absolute maximum and minimum recommended operating conditions.
- (2) Silicon operating life design goal is 10 years at 105°C junction temperature (does not include package interconnect life).
- (3) The predicted operating lifetime vs. junction temperature is based on reliability modeling using electromigration as the dominant failure mechanism affecting device wearout for the specific device process and design characteristics.

Figure 1. ADS1243-HT Operating Life Derating Chart



PIN CONFIGURATION

CDIP PACKAGE (TOP VIEW)



PIN ASSIGNMENTS

PIN#	NAME	DESCRIPTION
1	V_{DD}	Power Supply
2	X _{IN}	Clock Input
3	X _{OUT}	Clock Output, used with crystal or ceramic resonator.
4	PDWN	Active LOW. Power Down. The power down function shuts down the analog and digital circuits.
5	V_{REF+}	Positive Differential Reference Input
6	V_{REF-}	Negative Differential Reference Input
7	A _{IN} 0/D0	Analog Input 0/Data I/O 0
8	A _{IN} 1/D1	Analog Input 1/Data I/O 1
9	A _{IN} 4/D4	Analog Input 4/Data I/O 4
10	A _{IN} 5/D5	Analog Input 5/Data I/O 5
11	A _{IN} 6/D6	Analog Input 6/Data I/O 6
12	A _{IN} 7/D7	Analog Input 7/Data I/O 7
13	A _{IN} 2/D2	Analog Input 2/Data I/O 2
14	A _{IN} 3/D3	Analog Input 3/Data I/O 3
15	GND	Ground
16	CS	Active LOW, Chip Select
17	D _{IN}	Serial Data Input, Schmitt Trigger
18	D _{OUT}	Serial Data Output
19	SCLK	Serial Clock, Schmitt Trigger
20	DRDY	Active LOW, Data Ready



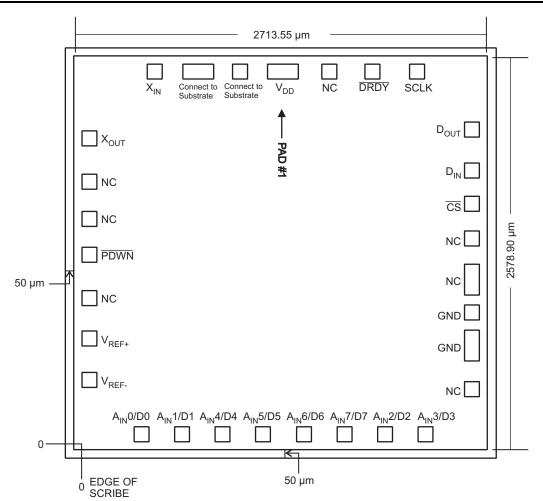
BARE DIE INFORMATION

DIE THICKNI	ESS	BACKSIDE FINISH	BACKSIDE POTENTIAL	BOND PAD METALLIZATION COMPOSITION
15 mils		Silicon with backgrind	GND	AlCu

Table 1. Bond Pad Coordinates in Microns⁽¹⁾

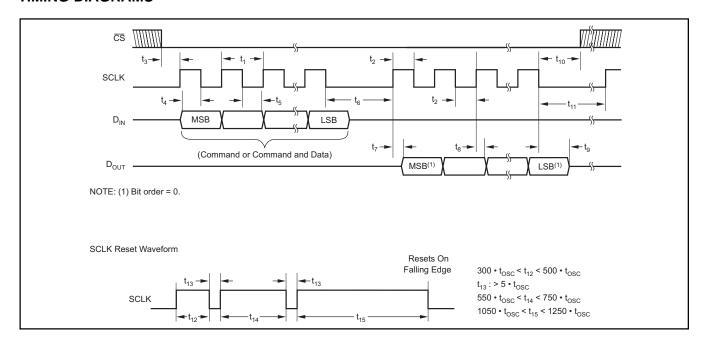
DISCRIPTION	PAD NUMBER	X MIN	Y MIN	X MAX	Y MAX
V_{DD}	1	1268.55	2471.55	1478.15	2572.55
Connect to substrate	2	1030.45	2471.55	1132.45	2572.55
Connect to substrate	3	692.45	2471.55	902.05	2572.55
X _{IN}	4	450.05	2471.55	552.05	2572.55
X _{OUT}	5	6.45	2016.65	107.45	2118.65
NC	6	6.45	1721.75	107.45	1823.75
NC	7	6.45	1468.60	107.45	1570.60
PDWN	8	6.45	1224.80	107.45	1326.80
NC	9	6.45	929.95	107.45	1031.95
V_{REF+}	10	6.45	655.20	107.45	757.20
V _{REF} -	11	6.45	373.25	107.45	475.25
A _{IN} 0/D0	12	361.15	3.55	462.15	105.55
A _{IN} 1/D1	13	636.45	3.55	737.45	105.55
A _{IN} 4/D4	14	911.70	3.55	1012.70	105.55
A _{IN} 5/D5	15	1186.85	3.55	1287.85	105.55
A _{IN} 6/D6	16	1466.25	3.55	1567.25	105.55
A _{IN} 7/D7	17	1742.50	3.55	1843.50	105.55
A _{IN} 2/D2	18	2017.60	3.55	2118.60	105.55
A _{IN} 3/D3	19	2292.75	3.55	2393.75	105.55
NC	20	2608.70	310.50	2709.70	412.50
GND	21	2608.75	553.25	2709.75	762.85
GND	22	2608.70	832.20	2709.70	934.20
NC	23	2608.75	1001.60	2709.75	1211.20
NC	24	2608.70	1335.65	2709.70	1437.65
CS	25	2608.70	1571.45	2709.70	1673.45
D _{IN}	26	2608.70	1797.90	2709.70	1899.90
D _{OUT}	27	2608.70	2076.55	2709.70	2178.55
SCLK	28	2234.80	2471.55	2336.80	2572.55
DRDY	29	1931.10	2471.55	2033.10	2572.55
NC	30	1637.90	2471.55	1739.90	2572.55

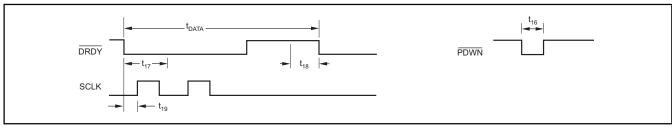
⁽¹⁾ For signal descriptions see the Pin Assignments table.





TIMING DIAGRAMS





TIMING REQUIREMENTS

PARAMETER	TEST CONDITIONS		MIN	MAX	UNIT
	OOLIK Desired		4		t _{OSC} Periods
t ₁	SCLK Period			3	DRDY Periods
t ₂	SCLK Pulse Width, HIGH and LOW		200		ns
t ₃	CS low to first SCLK Edge; Setup Time(1)		0		ns
t ₄	D _{IN} Valid to SCLK Edge; Setup Time		50		ns
t ₅	Valid D _{IN} to SCLK Edge; Hold Time		50		ns
t ₆	Delay between last SCLK edge for D _{IN} and first SCLK edge for D _{OUT} : RDATA, RDATAC, RREG, WREG		50		t _{OSC} Periods
t ₇ (2)	SCLK Edge to Valid New D _{OUT}			50	ns
t ₈ (2)	SCLK Edge to D _{OUT} , Hold Time		0		ns
t ₉	Last SCLK Edge to D _{OUT} Tri-State NOTE: DOUT goes tri-state immediately when CS goes HIGH.		6	10	t _{OSC} Periods
	OC LOW time attentional COLIC adma	Read from the device	0		t _{OSC} Periods
t ₁₀	CS LOW time after final SCLK edge.	Write to the device	8		t _{OSC} Periods
		RREG, WREG, DSYNC, SLEEP, RDATA, RDATAC, STOPC	4		t _{OSC} Periods
t ₁₁	Final SCLK edge of one command until first edge SCLK of next command:	SELFGCAL, SELFOCAL, SYSOCAL, SYSGCAL	2		DRDY Periods
		SELFCAL	4		DRDY Periods
		RESET (also SCLK Reset)	16		t _{OSC} Periods
t ₁₆	Pulse Width		4		t _{OSC} Periods
t ₁₇	Allowed analog input change for next valid conversion.			5000	t _{OSC} Periods
t ₁₈	DOR update, DOR data not valid.		4		t _{OSC} Periods
•	First SCLK after DRDV good LOW.	RDATAC Mode	10		t _{OSC} Periods
t ₁₉	First SCLK after DRDY goes LOW:	Any other mode	0		t _{OSC} Periods

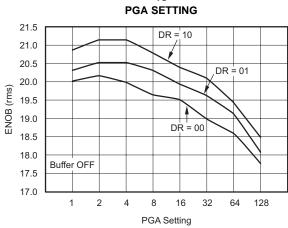
⁽¹⁾ $\overline{\text{CS}}$ may be tied LOW. (2) Load = 20 pF|| 10 k Ω to GND.



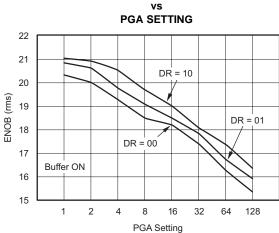
TYPICAL CHARACTERISTICS

All specifications V_{DD} = 5 V, f_{OSC} = 2.4576 MHz, PGA = 1, f_{DATA} = 15 Hz, and V_{REF} \equiv (REF IN+) – (REF IN-) = 2.5 V, unless otherwise specified.

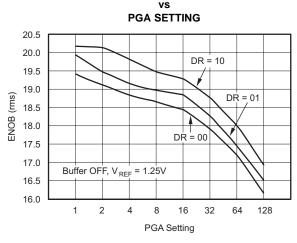
EFFECTIVE NUMBER OF BITS VS DOA SETTING



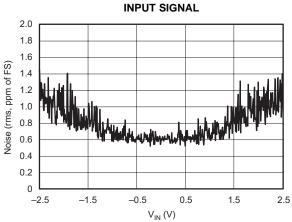
EFFECTIVE NUMBER OF BITS



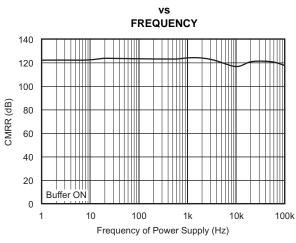
EFFECTIVE NUMBER OF BITS



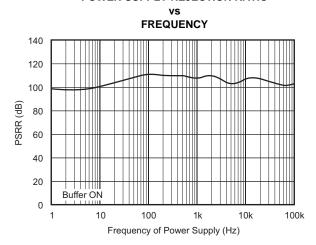
NOISE vs



COMMON-MODE REJECTION RATIO

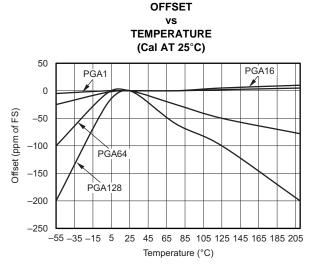


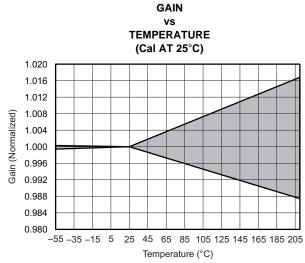
POWER SUPPLY REJECTION RATIO



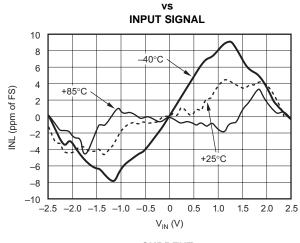
TYPICAL CHARACTERISTICS (continued)

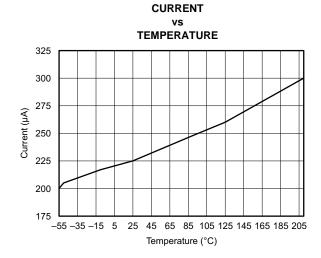
All specifications V_{DD} = 5 V, f_{OSC} = 2.4576 MHz, PGA = 1, f_{DATA} = 15 Hz, and V_{REF} \equiv (REF IN+) – (REF IN-) = 2.5 V, unless otherwise specified.

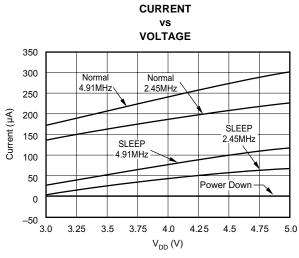


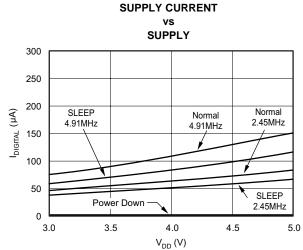


INTEGRAL NONLINEARITY





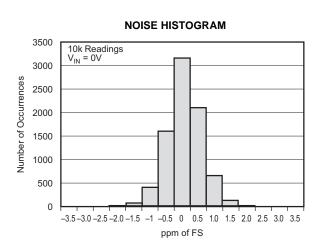


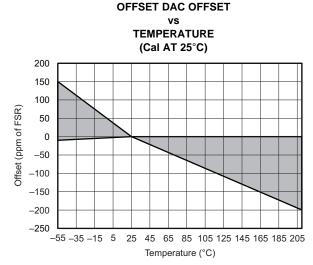


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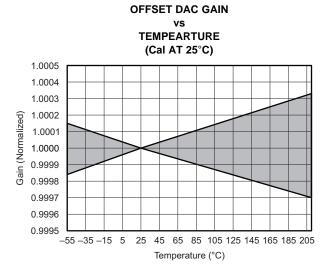
TYPICAL CHARACTERISTICS (continued)

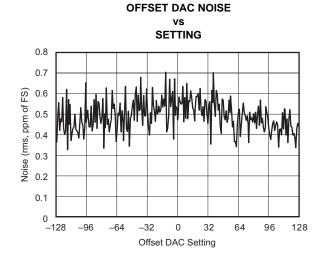
All specifications V_{DD} = 5 V, f_{OSC} = 2.4576 MHz, PGA = 1, f_{DATA} = 15 Hz, and V_{REF} \equiv (REF IN+) – (REF IN-) = 2.5 V, unless otherwise specified.





NSTRUMENTS





OVERVIEW

INPUT MULTIPLEXER

The input multiplexer provides for any combination of differential inputs to be selected on any of the input channels, as shown in Figure 2. For example, if $A_{IN}0$ is selected as the positive differential input channel, any other channel can be selected as the negative terminal for the differential input channel. With this method, it is possible to have up to seven single-ended input channels or four independent differential input channels for the ADS1243.

The ADS1243 features a single-cycle settling digital filter that provides valid data on the first conversion after a new channel selection. In order to minimize the settling error, synchronize MUX changes to the conversion beginning, which is indicated by the <u>falling</u> edge of DRDY. In other words, issuing a MUX change through the WREG command immediately after DRDY goes LOW minimizes the settling error. Increasing the time between the conversion beginning (DRDY goes LOW) and the MUX change command (t_{DELAY}) results in a settling error in the conversion data, as shown in Figure 3.

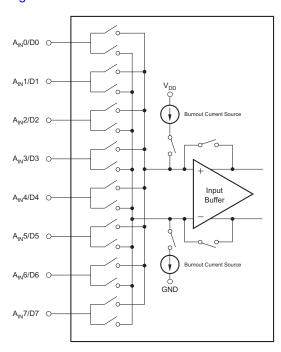


Figure 2. Input Multiplexer Configuration



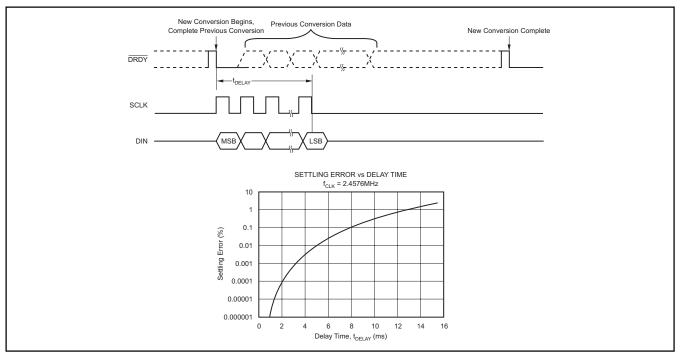


Figure 3. Input Multiplexer Configuration

BURNOUT CURRENT SOURCES

The Burnout Current Sources can be used to detect sensor short-circuit or open-circuit conditions. Setting the Burnout Current Sources (BOCS) bit in the SETUP register activates two 2µA current sources called burnout current sources. One of the current sources is connected to the converter's negative input and the other is connected to the converter's positive input.

Figure 4 shows the situation for an open-circuit sensor. This is a potential failure mode for many kinds of remotely connected sensors. The current source on the positive input acts as a pull-up, causing the positive input to go to the positive analog supply, and the current source on the negative input acts as a pull-down, causing the negative input to go to ground. The ADS1243 therefore outputs full-scale (7FFFFF Hex).

Figure 5 shows a short-circuited sensor. Since the inputs are shorted and at the same potential, the ADS1243 signal outputs are approximately zero. (Note that the code for shorted inputs is not exactly zero due to internal series resistance, low-level noise and other error sources.)

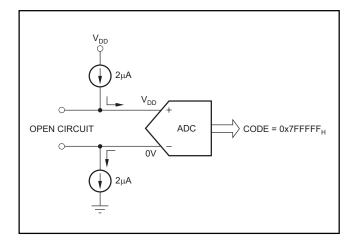


Figure 4. Burnout Detection While Sensor is Open-Circuited.

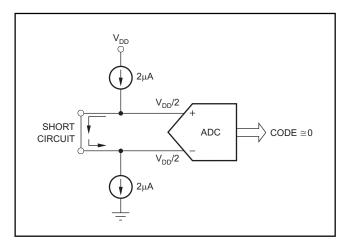


Figure 5. Burnout Detection While Sensor is Short-Circuited.

INPUT BUFFER

The input impedance of ADS1243 without the buffer enabled is approximately $5M\Omega/PGA$. For systems requiring very high input impedance, the ADS1243 provides a chopper-stabilized differential FET-input voltage buffer. When activated, the buffer raises the ADS1243 input impedance to approximately $5G\Omega$.

The buffer's input range is approximately 50mV to $V_{DD}-1.5\text{ V}$. The buffer's linearity will degrade beyond this range. Differential signals should be adjusted so that both signals are within the buffer's input range.

The buffer can be enabled using the BUFEN pin or the BUFEN bit in the ACR register. The buffer is on when the BUFEN pin is high and the BUFEN bit is set to one. If the BUFEN pin is low, the buffer is disabled. If the BUFEN bit is set to zero, the buffer is also disabled.

The buffer draws additional current when activated. The current required by the buffer depends on the PGA setting. When the PGA is set to 1, the buffer uses approximately 50 μ A; when the PGA is set to 128, the buffer uses approximately 500 μ A.

PGA

The Programmable Gain Amplifier (PGA) can be set to gains of 1, 2, 4, 8, 16, 32, 64, or 128. Using the PGA can improve the effective resolution of the A/D converter. For instance, with a PGA of 1 on a 5-V full-scale signal, the A/D converter can resolve down to 1 μ V. With a PGA of 128 and a full-scale signal of 39 mV, the A/D converter can resolve down to 75 nV. V_{DD} current increases with PGA settings higher than 4.

OFFSET DAC

The input to the PGA can be shifted by half the full-scale input range of the PGA using the Offset DAC (ODAC) register. The ODAC register is an 8-bit value; the MSB is the sign and the seven LSBs provide the magnitude of the offset. Using the offset DAC does not reduce the performance of the A/D converter. For more details on the ODAC in the ADS1243, please refer to TI application report SBAA077 (available through the TI website).

MODULATOR

The modulator is a single-loop second-order system. The modulator runs at a clock speed (f_{MOD}) that is derived from the external clock (f_{OSC}). The frequency division is determined by the SPEED bit in the SETUP register, as shown in Table 2.

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Table 2. Output Configuration

	SPEED			1st NOTCH		
†osc	BIT	f _{MOD}	00	01	10	FREQUENCY
0.4570 MH-	0	19,200 Hz	15 Hz	7.5 Hz	3.75 Hz	50/60 Hz
2.4576 MHz	1	9,600 Hz	7.5 Hz	3.75 Hz	1.875 Hz	25/30 Hz
4.0450 MH-	0	38,400 Hz	30 Hz	15 Hz	7.5 Hz	100/120 Hz
4.9152 MHz	1	19,200 Hz	15 Hz	7.5 Hz	3.75 Hz	50/60 Hz

CALIBRATION

The offset and gain errors can be minimized with calibration. The ADS1243 supports both self and system calibration.

Self-calibration of the ADS1243 corrects internal offset and gain errors and is handled by three commands: SELFCAL, SELFGAL, and SELFOCAL. The SELFCAL command performs both an offset and gain calibration. SELFGCAL performs a gain calibration and SELFOCAL performs an offset calibration, each of which takes two t_{DATA} periods to complete. During self-calibration, the ADC inputs are disconnected internally from the input pins. The PGA must be set to 1 prior to issuing a SELFCAL or SELFGCAL command. Any PGA is allowed when issuing a SELFOCAL command. For example, if using PGA = 64, first set PGA = 1 and issue SELFGCAL. Afterwards, set PGA = 64 and issue SELFOCAL. For operation with a reference voltage greater than $(V_{DD} - 1.5)$ volts, the buffer must also be turned off during gain self-calibration to avoid exceeding the buffer input range.

System calibration corrects both internal and external offset and gain errors. While performing system calibration, the appropriate signal must be applied to the inputs. The system offset calibration command (SYSOCAL) requires a zero input differential signal (see Table 5). It then computes the offset that nullifies the offset in the system. The system gain calibration command (SYSGCAL) requires a positive full-scale input signal. It then computes a value to nullify the gain error in the system. Each of these calibrations takes two t_{DATA} periods to complete. System gain calibration is recommended for the best gain calibration at higher PGAs.

Calibration should be performed after power on, a change in temperature, or a change of the PGA. The RANGE bit (ACR bit 2) must be zero during calibration.

Calibration removes the effects of the ODAC; therefore, disable the ODAC during calibration, and enable again after calibration is complete.

At the completion of calibration, the \overline{DRDY} signal goes low, indicating the calibration is finished. The first data after calibration should be discarded since it may be corrupt from calibration data remaining in the filter. The second data is always valid.

EXTERNAL VOLTAGE REFERENCE

The ADS1243 requires an external voltage reference. The selection for the voltage reference value is made through the ACR register.

The external voltage reference is differential and is represented by the voltage difference between the pins: $+V_{REF}$ and $-V_{REF}$. The absolute voltage on either pin, $+V_{REF}$ or $-V_{REF}$, can range from GND to V_{DD} . However, the following limitations apply:

- For V_{DD} = 5 V and RANGE = 0 in the ACR, the differential V_{REF} must not exceed 2.5 V.
- For V_{DD} = 5 V and RANGE = 1 in the ACR, the differential V_{REF} must not exceed 5 V.
- For V_{DD} = 3 V and RANGE = 0 in the ACR, the differential V_{RFF} must not exceed 1.25 V.
- For V_{DD} = 3 V and RANGE = 1 in the ACR, the differential V_{REF} must not exceed 2.5 V.

CLOCK GENERATOR

The clock source for ADS1243 can be provided from a crystal, oscillator, or external clock. When the clock source is a crystal, external capacitors must be provided to ensure start-up and stable clock frequency. This is shown in both Figure 6 and Table 3. X_{OUT} is only for use with external crystals and it should not be used as a clock driver for external circuitry.

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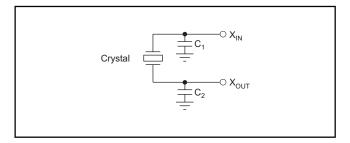


Figure 6. Crystal Connection.

Table 3. Recommended Crystals

CLOCK SOURCE	FREQUENCY	C ₁	C ₂	PART NUMBER	
Crystal	2.4576	0-20 pF	0-20 pF	ECS, ECSD 2.45 - 32	
Crystal	4.9152	0-20 pF	0-20 pF	ECS, ECSL 4.91	
Crystal	4.9152	0-20 pF	0-20 pF	ECS, ECSD 4.91	
Crystal	4.9152	0-20 pF	0-20 pF	CTS, MP 042 4M9182	

DIGITAL FILTER

The ADS1243 has a 1279 tap linear phase Finite Impulse Response (FIR) digital filter that a user can configure for various output data rates. When a 2.4576-MHz crystal is used, the device can be programmed for an output data rate of 15 Hz, 7.5 Hz, or 3.75 Hz. Under these conditions, the digital filter rejects both 50Hz and 60Hz interference. Figure 7 shows the digital filter frequency response for data output rates of 15 Hz, 7.5 Hz, and 3.75 Hz.

If a different data output rate is desired, a different crystal frequency can be used. However, the rejection frequencies shift accordingly. For example, a 3.6864-MHz master clock with the default register condition has:

(3.6864 MHz/2.4576 MHz) • 15 Hz = 22.5 Hz data output rate

and the first and second notch is:

1.5 • (50 Hz and 60 Hz) = 75 Hz and 90 Hz



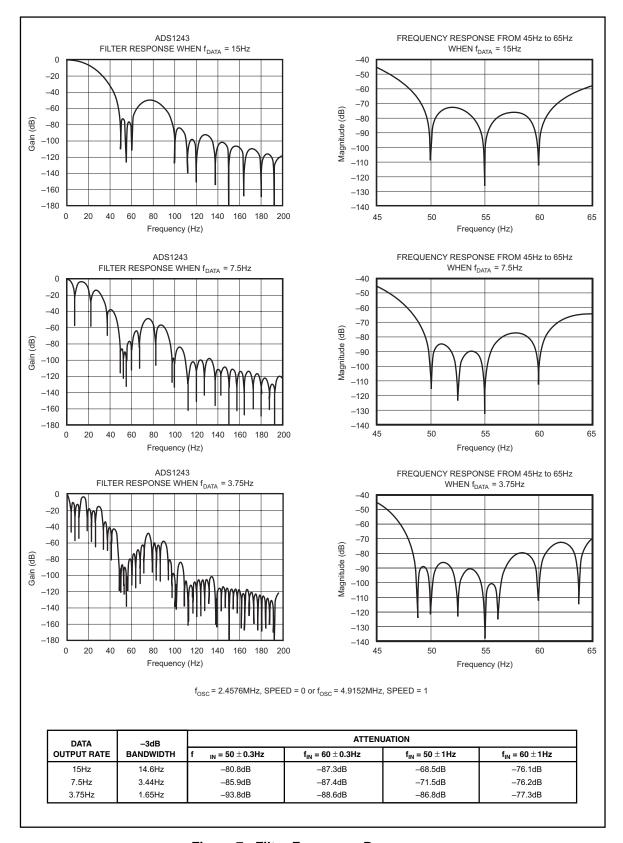


Figure 7. Filter Frequency Responses

DATA I/O INTERFACE

The ADS1243 has eight pins that serve a dual purpose as both analog inputs and data I/O. These pins are configured through the IOCON, DIR, and DIO registers and can be individually configured as either analog inputs or data I/O. See Figure 8 for the equivalent schematic of an Analog/Data I/O pin.

The IOCON register defines the pin as either an analog input or data I/O. The power-up state is an analog input. If the pin is configured as an analog input in the IOCON register, the DIR and DIO registers have no effect on the state of the pin.

If the pin is configured as data I/O in the IOCON register, then DIR and DIO are used to control the state of the pin. The DIR register controls the direction of the data pin, either as an input or output. If the pin is configured as an input in the DIR register, then the corresponding DIO register bit reflects the state of the pin. Make sure the pin is driven to a logic one or zero when configured as an input to prevent excess current dissipation. If the pin is configured as an output in the DIR register, then the corresponding DIO register bit value determines the state of the output pin $(0 = \text{GND}, 1 = \text{V}_{\text{DD}})$.

It is still possible to perform A/D conversions on a pin configured as data I/O. This may be useful as a test mode, where the data I/O pin is driven and an A/D conversion is done on the pin.

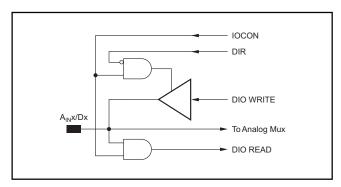


Figure 8. Analog/Data Interface Pin

SERIAL PERIPHERAL INTERFACE

The Serial Peripheral Interface (SPI) allows a controller to communicate synchronously with the ADS1243. The ADS1243 operates in slave-only mode. The serial interface is a standard four-wire SPI ($\overline{\text{CS}}$, SCLK, D_{IN} and D_{OUT}) interface.

Chip Select (CS)

The chip select (\overline{CS}) input must be externally asserted before communicating with the ADS1243. \overline{CS} must stay LOW for the duration of the communication. Whenever \overline{CS} goes HIGH, the serial interface is reset. \overline{CS} may be hard-wired LOW.

Serial Clock (SCLK)

The serial clock (SCLK) features a Schmitt-triggered input and is used to clock D_{IN} and D_{OUT} data. Make <u>sure to</u> have a clean SCLK to prevent accidental double-shifting of the data. If SCLK is not toggled within three DRDY pulses, the serial interface resets on the next SCLK pulse and starts a new communication cycle. A special pattern on SCLK resets the entire chip; see the RESET section for additional information.

Data Input (D_{IN}) and Data Output (D_{OUT})

The data input (D_{IN}) and data output (D_{OUT}) receive and send data from the ADS1243. D_{OUT} is high impedance when not in use to allow D_{IN} and D_{OUT} to be connected together and driven by a bidirectional bus. Note: the Read Data Continuous Mode (RDATAC) command should not be issued when D_{IN} and D_{OUT} are connected. While in RDATAC mode, D_{IN} looks for the STOPC or RESET command. If either of these 8-bit bytes appear on D_{OUT} (which is connected to D_{IN}), the RDATAC mode ends.

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DATA READY (DRDY) PIN

The DRDY line is used as a status signal to indicate when data is ready to be read from the internal data register. DRDY goes LOW when a new data word is available in the DOR register. It is reset HIGH when a read operation from the data register is complete. It also goes HIGH prior to the updating of the output register to indicate when not to read from the device to ensure that a data read is not attempted while the register is being updated.

The status of \overline{DRDY} can also be obtained by interrogating bit 7 of the ACR register (address 2_H). The serial interface can operate in 3-wire mode by tying the \overline{CS} input LOW. In this case, the SCLK, D_{IN} , and D_{OUT} lines are used to communicate with the ADS1243. This scheme is suitable for interfacing to microcontrollers. If \overline{CS} is required as a decoding signal, it can be generated from a port bit of the microcontroller.

DSYNC OPERATION

Synchronization can be achieved through the DSYNC command. When the DSYNC command is sent, the digital filter is reset on the edge of the last SCLK of the DSYNC command. The modulator is held in RESET until the next edge of SCLK is detected. Synchronization occurs on the next rising edge of the system clock after the first SCLK following the DSYNC command.

POWER-UP—SUPPLY VOLTAGE RAMP RATE

The power-on reset circuitry was designed to accommodate digital supply ramp rates as slow as 1 V/10 ms. To ensure proper operation, the power supply should ramp monotonically.

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ADS1243 REGISTERS

The operation of the device is set up through individual registers. Collectively, the registers contain all the information needed to configure the part, such as data format, multiplexer settings, calibration settings, data rate, etc. The 16 registers are shown in Table 4.

Table 4. Registers

ADDRESS	REGISTER	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0	
00 _H	SETUP	ID	ID	ID	ID	BOCS	PGA2	PGA1	PGA0	
01 _H	MUX	PSEL3	PSEL2	PSEL1	PSEL0	NSEL3	NSEL2	NSEL1	NSEL0	
02 _H	ACR	DRDY	U/B	SPEED	BUFEN	BIT ORDER	RANGE	DR1	DR0	
03 _H	ODAC	SIGN	OSET6	OSET5	OSET4	OSET3	OSET2	OSET1	OSET0	
04 _H	DIO	DIO_7	DIO_6	DIO_5	DIO_4	DIO_3	DIO_2	DIO_1	DIO_0	
05 _H	DIR	DIR_7	DIR_6	DIR_5	DIR_4	DIR_3	DIR_2	DIR_1	DIR_0	
06 _H	IOCON	107	106	105	104	IO3	IO2	IO1	100	
07 _H	OCR0	OCR07	OCR06	OCR05	OCR04	OCR03	OCR02	OCR01	OCR00	
08 _H	OCR1	OCR15	OCR14	OCR13	OCR12	OCR11	OCR10	OCR09	OCR08	
09 _H	OCR2	OCR23	OCR22	OCR21	OCR20	OCR19	OCR18	OCR17	OCR16	
0A _H	FSR0	FSR07	FSR06	FSR05	FSR04	FSR03	FSR02	FSR01	FSR00	
0B _H	FSR1	FSR15	FSR14	FSR13	FSR12	FSR11	FSR10	FSR09	FSR08	
0C _H	FSR2	FSR23	FSR22	FSR21	FSR20	FSR19	FSR18	FSR17	FSR16	
0D _H	DOR2	DOR23	DOR22	DOR21	DOR20	DOR19	DOR18	DOR17	DOR16	
0E _H	DOR1	DOR15	DOR14	DOR13	DOR12	DOR11	DOR10	DOR09	DOR08	
0F _H	DOR0	DOR07	DOR16	FSR21	DOR04	DOR03	DOR02	DOR01	DOR00	

DETAILED REGISTER DEFINITIONS

Setup

(Address 00_H) Setup Register

Reset Value = iiii0000

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
ID	ID	ID	ID	BOCS	PGA2	PGA1	PGA0

bit 7–4 Factory Programmed Bits

bit 3 BOCS: Burnout Current Source

0 = Disabled (default)

1 = Enabled

bit 2-0 PGA2: PGA1: PGA0: Programmable Gain Amplifier

Gain Selection 000 = 1 (default)

000 = 1

010 = 4

011 = 8

100 = 16

101 = 32

110 = 64

111 = 128



MUX

(Address 01_H) Multiplexer Control Register

Reset Value = 01_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
PSEL3	PSEL2	PSEL1	PSEL0	NSEL3	NSEL2	NSEL1	NSEL0

bit 7–4 PSEL3: PSEL1: PSEL0: Positive Channel

Select

 $0000 = A_{IN}0$ (default)

 $0001 = A_{IN}1$

 $0010 = A_{IN}2$

 $0011 = A_{IN}3$

0011 - 74100

 $0100 = A_{IN}4$

 $0101 = A_{IN}5$ $0110 = A_{IN}6$

 $0111 = A_{IN}7$

1111 = Reserved

bit 3-0 NSEL3: NSEL2: NSEL1: NSEL0: Negative Channel

Select

 $0000 = A_{IN}0$

 $0001 = A_{IN}1$ (default)

 $0010 = A_{IN}2$

 $0011 = A_{IN}3$

 $0100 = A_{IN}4$

 $0101 = A_{IN}5$

 $0110 = A_{IN}6$

 $0111 = A_{IN}7$

1111 = Reserved

ACR

(Address 02_H) Analog Control Register

Reset Value = X0_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
DRDY	U/B	SPEED	BUFEN	BIT ORDER	RANGE	DR1	DR0

bit 7 DRDY: Data Ready (Read Only)

This bit duplicates the state of the $\overline{\text{DRDY}}$ pin.

bit 6 U/B: Data Format

0 = Bipolar (default)

1 = Unipolar

U/B	ANALOG INPUT	DIGITAL OUTPUT (Hex)
	+FSR	0x7FFFFF
0	Zero	0x000000
	–FSR	0x800000
	+FSR	0xFFFFF
1	Zero	0x000000
	–FSR	0x000000

bit 5 SPEED: Modulator Clock Speed

 $0 = f_{MOD} = f_{OSC}/128$ (default)

 $1 = f_{MOD} = f_{OSC}/256$

bit 4 BUFEN: Buffer Enable

0 = Buffer Disabled (default)

1 = Buffer Enabled

bit 3 BIT ORDER: Data Output Bit Order

0 = Most Significant Bit Transmitted First (default)

1 = Least Significant Bit Transmitted First Data is always shifted in or out MSB first.

bit 2 RANGE: Range Select

0 = Full-Scale Input Range equal to $\pm V_{REF}$ (default). 1 = Full-Scale Input Range equal to $\pm 1/2$ V_{REF} NOTE: This allows reference voltages as high as V_{DD}, but even with a 5V reference voltage the calibration must be performed with this bit set to 0.

bit 1-0 DR1: DR0: Data Rate

 $(f_{OSC} = 2.4576MHz, SPEED = 0)$

00 = 15 Hz (default)

01 = 7.5 Hz

10 = 3.75 Hz

11 = Reserved

ODAC

(Address 03) Offset DAC

Reset Value = 00_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
SIGN	OSET6	OSET5	OSET4	OSET3	OSET2	OSET1	OSET0

bit 7 Sign

0 = Positive

1 = Negative

Offset =
$$\frac{V_{REF}}{2 \cdot PGA} \cdot \left(\frac{OSET [6:0]}{127}\right) RANGE = 0$$

Offset =
$$\frac{V_{REF}}{4 \cdot PGA} \cdot \left(\frac{OSET[6:0]}{127}\right) RANGE = 1$$

NOTE: The offset DAC must be enabled after calibration or the calibration nullifies the effects.

DIO

(Address 04_H) Data I/O

Reset Value = 00_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
DIO 7	DIO 6	DIO 5	DIO 4	DIO 3	DIO 2	DIO 1	DIO 0

If the IOCON register is configured for data, a value written to this register appears on the data I/O pins if the pin is configured as an output in the DIR register. Reading this register returns the value of the data I/O pins.

TEXAS INSTRUMENTS

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DIR

(Address 05_H) Direction Control for Data I/O

Reset Value = FF_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
DIR7	DIR6	DIR5	DIR4	DIR3	DIR2	DIR1	DIR0

Each bit controls whether the corresponding data I/O pin is an output (= 0) or input (= 1). The default power-up state is as inputs.

IOCON

(Address 06_H) I/O Configuration Register

Reset Value = 00_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
107	106	IO5	IO4	IO3	IO2	IO1	IO0

bit 7-0 IO

IO7: IO0: Data I/O Configuration

0 = Analog (default)

1 = Data

Configuring the pin as a data I/O pin allows it to be controlled through the DIO and DIR registers.

ORC0

(Address 07_H) Offset Calibration Coefficient

(Least Significant Byte)

Reset Value = 00_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	
OCR07	OCR06	OCR05	OCR04	OCR03	OCR02	OCR01	OCR00	1

OCR1

(Address 08_H) Offset Calibration Coefficient

(Middle Byte)

Reset Value = 00_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
OCR15	OCR14	OCR13	OCR12	OCR11	OCR10	OCR09	OCR08

OCR2

(Address $09_{\rm H}$) Offset Calibration Coefficient

(Most Significant Byte)

Reset Value = 00_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
OCR23	OCR22	OCR21	OCR20	OCR19	OCR18	OCR17	OCR16

FSR0

(Address 0A_H) Full-Scale Register

(Least Significant Byte)

Reset Value = 59_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
FSR07	FSR06	FSR05	FSR04	FSR03	FSR02	FSR01	FSR00

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FSR1

(Address 0B_H) Full-Scale Register

(Middle Byte)

Reset Value = 55_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
FSR15	FSR14	FSR13	FSR12	FSR11	FSR10	FSR09	FSR08

FSR2

(Address 0C_H) Full-Scale Register

(Most Significant Byte)

Reset Value = 55_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
FSR23	FSR22	FSR21	FSR20	FSR19	FSR18	FSR17	FSR16

DOR₂

(Address $0D_H$) Data Output Register

(Most Significant Byte) (Read Only)

Reset Value = 00_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
DOR23	DOR22	DOR21	DOR20	DOR19	DOR18	DOR17	DOR16

DOR1

(Address $0E_H$) Data Output Register

(Middle Byte) (Read Only)

Reset Value = 00_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
DOR15	DOR14	DOR13	DOR12	DOR11	DOR10	DOR09	DOR08

DOR₀

(Address $0F_H$) Data Output Register

(Least Significant Byte) (Read Only)

Reset Value = 00_H

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	
DOR07	DOR06	DOR05	DOR04	DOR03	DOR02	DOR01	DOR00	

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ADS1243 CONTROL COMMAND DEFINITIONS

The commands listed in Table IV control the operations of ADS1243. Some of the commands are stand-alone commands (for example, RESET) while others require additional bytes (for example, WREG requires the count and data bytes).

Operands:

- n = count (0 to 127)
- r = register (0 to 15)
- x = don't care

Table 5. Command Summary

COMMANDS	DESCRIPTION	OP CODE	2nd COMMAND BYTE
	Read Data	0000 0001 (01 _H)	_
	Read Data Continuously	0000 0011 (03 _H)	_
	Stop Read Data Continuously	0000 1111 (0F _H)	_
RDATA RDATAC	Read from REG "rrrr"	0001 rrrr (1x _H)	xxxx_nnnn (# of regs-1)
STOPC RREG	Write to REG "rrrr"	0101 rrrr (5x _H)	xxxx_nnnn (# of regs-1)
WREG SELFCAL SELFOCAL	Offset and Gain Self Cal	1111 0000 (F0 _H)	_
SELFOCAL	Self Offset Cal	1111 0001 (F1 _H)	_
SYSOCAL	Self Gain Cal	1111 0010 (F2 _H)	_
SYSGCAL WAKEUP	Sys Offset Cal	1111 0011 (F3 _H)	_
DSYNC SLEEP	Sys GainCal	1111 0100 (F4 _H)	_
RESET	Wakup from SLEEP Mode	1111 1011 (FB _H)	_
	Sync DRDY	1111 1100 (FC _H)	_
	Put in SLEEP Mode	1111 1101 (FD _H)	_
	Reset to Power-Up Values	1111 1110 (FE _H)	_
NOTE: The received	d data format is always MSB first; the data	out format is set by the BIT ORDER bit	t in the ACR register.

RDATA-Read Data

Description: Read the most recent conversion result from the Data Output Register (DOR). This is a

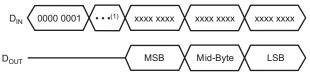
24-bit value.

Operands: None

Bytes: 1

Encoding: 0000 0001

Data Transfer Sequence:



(1) For wait time, refer to timing specification.

RDATAC-Read Data Continuous

Description: Read Data Continuous mode enables the continuous output of new data on each DRDY. This

> command eliminates the need to send the Read Data Command on each DRDY. This mode may be terminated by either the STOPC command or the RESET command. Wait at least 10

f_{OSC} after DRDY falls before reading.

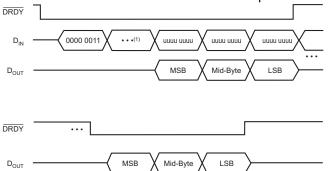
Operands: None Bytes: 1

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Encoding: 0000 0011

Data Transfer Command terminated when "uuuu uuuu" equals STOPC or RESET.

Sequence:



(1)For wait time, refer to timing specification.

STOPC–Stop Continuous

Ends the continuous data output mode. Issue after DRDY goes LOW. **Description:**

Operands: None

Bytes: 1

Encoding: 0000 1111

 $\overline{\mathsf{DRDY}}$

Data Transfer Sequence:

XXX 0000 1111

RREG-Read from Registers

Description: Output the data from up to 16 registers starting with the register address specified as part of

the instruction. The number of registers read will be one plus the second byte count. If the

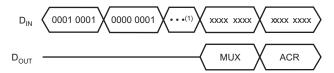
count exceeds the remaining registers, the addresses wrap back to the beginning.

Operands: r, n Bytes:

Encoding: 0001 rrrr xxxx nnnn

Data Transfer Read Two Registers Starting from Register 01_H (MUX)

Sequence:



⁽¹⁾For wait time, refer to timing specification.

WREG-Write to Registers

Description: Write to the registers starting with the register address specified as part of the instruction. The

number of registers that will be written is one plus the value of the second byte.

Operands: r, n Bytes: 2

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Encoding: 0101 rrrr xxxx nnnn

Data Transfer Write Two Registers Starting from 04_H (DIO)

Sequence:



SELFCAL-Offset and Gain Self Calibration

Description: Starts the process of self calibration. The Offset Calibration Register (OCR) and the Full-Scale

Register (FSR) are updated with new values after this operation.

Operands: None Bytes: 1

Encoding: 1111 0000

Data Transfer Sequence: 1111 0000

SELFOCAL-Offset Self Calibration

Description: Starts the process of self-calibration for offset. The Offset Calibration Register (OCR) is

updated after this operation.

Operands: None Bytes: 1

Encoding: 1111 0001

Data Transfer Sequence: 1111 0001

SELFGCAL-Gain Self Calibration

Description: Starts the process of self-calibration for gain. The Full-Scale Register (FSR) is updated with

new values after this operation.

Operands: None Bytes: 1

Encoding: 1111 0010

Data Transfer
Sequence: 1111 0010

SYSOCAL-System Offset Calibration

Description: Initiates a system offset calibration. The input should be set to 0V, and the ADS1243

computes the OCR value that compensates for offset errors. The Offset Calibration Register (OCR) is updated after this operation. The user must apply a zero input signal to the

(OCR) is updated after this operation. The user must apply a zero input signal to the appropriate analog inputs. The OCR register is automatically updated afterwards.

Operands: None Bytes: 1

Encoding: 1111 0011

Data Transfer
Sequence: D_{IN} (1111 0011)

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SYSGCAL-System Gain Calibration

Description: Starts the system gain calibration process. For a system gain calibration, the input should be

> set to the reference voltage and the ADS1243 computes the FSR value that will compensate for gain errors. The FSR is updated after this operation. To initiate a system gain calibration, the user must apply a full-scale input signal to the appropriate analog inputs. FCR register is

updated automatically.

Operands: None Bytes: 1

Encoding: 1111 0100

Data Transfer Sequence:

1111 0100

WAKEUP

Description: Wakes the ADS1243 from SLEEP mode.

Operands: None Bytes: 1

Encoding: 1111 1011 **Data Transfer**

Sequence:

1111 1011

DSYNC-Sync DRDY

Description: Synchronizes the ADS1243 to an external event.

Operands: None Bytes: 1

Encoding: 1111 1100 **Data Transfer** 1111 1100 Sequence:

SLEEP-Sleep Mode

Description: Puts the ADS1243 into a low power sleep mode. To exit sleep mode, issue the WAKEUP

command.

Operands: None Bytes:

Encoding: 1111 1101 **Data Transfer** 1111 1101

Sequence:

RESET-Reset to Default Values

Description: Restore the registers to their power-up values. This command stops the Read Continuous

mode.

Operands: None

Bytes: 1



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Encoding: 1111 1110

Data Transfer Sequence:

D_{IN} (1111 1110)

APPLICATION INFORMATION

GENERAL-PURPOSE WEIGHT SCALE

Figure 9 shows a typical schematic of a general-purpose weight scale application using the ADS1243. In this example, the internal PGA is set to either 64 or 128 (depending on the maximum output voltage of the load cell) so that the load cell output can be directly applied to the differential inputs of ADS1243.

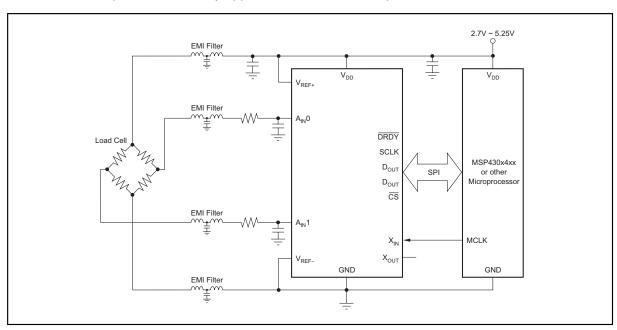


Figure 9. Schematic of a General-Purpose Weight Scale.

HIGH PRECISION WEIGHT SCALE

Figure 10 shows the typical schematic of a high-precision weight scale application using the ADS1243. The front-end differential amplifier helps maximize the dynamic range.



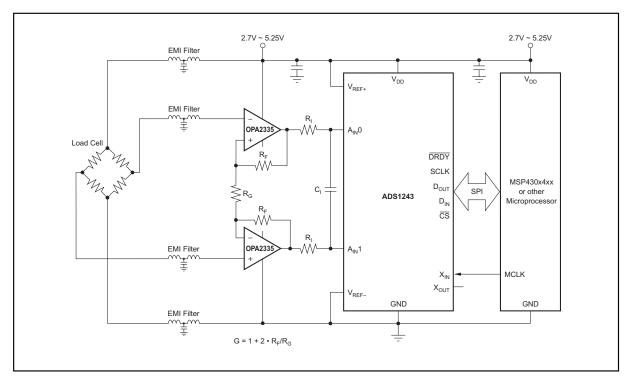


Figure 10. Block Diagram for a High-Precision Weight Scale.

DEFINITION OF TERMS

An attempt has been made to be consistent with the terminology used in this data sheet. In that regard, the definition of each term is given as follows:

Analog Input Voltage – the voltage at any one analog input relative to GND.

Analog Input Differential Voltage –given by the following equation: (IN+) – (IN–). Thus, a positive digital output is produced whenever the analog input differential voltage is positive, while a negative digital output is produced whenever the differential is negative.

For example, when the converter is configured with a 2.5-V reference and placed in a gain setting of 1, the positive full-scale output is produced when the analog input differential is 2.5 V. The negative full-scale output is produced when the differential is -2.5 V. In each case, the actual input voltages must remain within the GND to V_{DD} range.

Conversion Cycle –the term conversion cycle usually refers to a discrete A/D conversion operation, such as that performed by a successive approximation converter. As used here, a conversion cycle refers to the t_{DATA} time period.

Data Rate – The rate at which conversions are completed. See definition for f_{DATA}.

$$\begin{split} f_{\text{DATA}} &= \frac{f_{\text{OSC}}}{128 \, \bullet \, 2^{\text{SPEED}} \, \bullet \, 1280 \, \bullet \, 2^{\text{DR}}} \\ &\text{SPEED} = 0,1 \\ &\text{DR} = 0,1,2 \end{split}$$

fosc –the frequency of the crystal oscillator or CMOS compatible input signal at the X_{IN} input of the ADS1243.

 f_{MOD} – the frequency or speed at which the modulator of the ADS1243 is running. This depends on the SPEED bit as given by the following equation:

$$f_{MOD} = \frac{f_{osc}}{mfactor} = \frac{f_{osc}}{128 \cdot 2^{SPEED}}$$

PGA SETTING	SAMPLING FREQUENCY
1, 2, 4, 8	$f_{SAMP} = \frac{f_{OSC}}{mfactor}$
16	$f_{SAMP} = \frac{f_{OSC^{\bullet}2}}{mfactor}$
32	$f_{SAMP} = \frac{f_{OSC} \cdot 4}{mfactor}$
64, 128	$f_{SAMP} = \frac{f_{OSC^{\bullet} 8}}{mfactor}$

 f_{SAMP} – the frequency, or switching speed, of the input sampling capacitor. The value is given by one of the following equations:

 f_{DATA} – the frequency of the digital output data produced by the ADS1243, f_{DATA} is also referred to as the Data Rate.

Full-Scale Range (FSR) – as with most A/D converters, the full-scale range of the ADS1243 is defined as the input, that produces the positive full-scale digital output minus the input, that produces the negative full-scale digital output.

For example, when the converter is configured with a 2.5-V reference and is placed in a gain setting of 2, the full-scale range is: [1.25 V (positive full-scale) minus –1.25 V (negative full-scale)] = 2.5 V.

Least Significant Bit (LSB) Weight – this is the theoretical amount of voltage that the differential voltage at the analog input has to change in order to observe a change in the output data of one least significant bit. It is computed as follows:

STRUMENTS .

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LSBWeight =
$$\frac{\text{Full-Scale Range}}{2^{N} - 1}$$

where N is the number of bits in the digital output.

 $\ensuremath{t_{\text{DATA}}}$ – the inverse of fDATA, or the period between each data output.

Table 6. Full-Scale Range versus PGA Setting

	5V SI	JPPLY ANALOG INI	G INPUT ⁽¹⁾ GENERAL EQUATIONS				
GAIN SETTING	FULL-SCALE DIFFERENT INPUT VOLTAGE		PGA OFFSET FULL-SCALE RANGE RANGE		DIFFERENTIAL INPUT VOLTAGES ⁽²⁾	PGA SHIFT RANGE	
1 5 V		±2.5 V	±1.25 V	RANGE = 0			
2	2.5 V	±1.25 V	±0.625 V	V	$\pm V_{REF}$	$\pm V_{REF}$	
4	1.25 V	±0.625 V	±312.5 mV	V _{REF}			
8	0.625 V	±312.5 mV	±156.25 mV	PGA	2•PGA	4∙PGA	
16	312.5 mV	±156.25 mV	±78.125 mV				
32	156.25 mV	±78.125 mV	±39.0625 mV				
64	78.125 mV	±39.0625 mV	±19.531 mV		RANGE = 1		
128	39.0625 mV	±19.531 mV	±9.766 mV				

⁽¹⁾ With a 2.5-V reference.

⁽²⁾ Refer to electrical specification for analog input voltage range.

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PACKAGING INFORMATION

Orderable part number	Status (1)	Material type	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material	MSL rating/ Peak reflow	Op temp (°C)	Part marking (6)
ADS1243SJD	Active	Production	CDIP SB (JD) 20	19 TUBE	Yes	AU	N/A for Pkg Type	-55 to 210	ADS1243SJD
ADS1243SKGD1	Active	Production	XCEPT (KGD) 0	121 TUBE	Yes	Call TI	N/A for Pkg Type	-55 to 210	

⁽¹⁾ Status: For more details on status, see our product life cycle.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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OTHER QUALIFIED VERSIONS OF ADS1243-HT:

Catalog: ADS1243

⁽²⁾ Material type: When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ RoHS values: Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

⁽⁴⁾ Lead finish/Ball material: Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ MSL rating/Peak reflow: The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ Part marking: There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.



PACKAGE OPTION ADDENDUM

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NOTE: Qualified Version Definitions:

 $_{\bullet}$ Catalog - TI's standard catalog product

PACKAGE MATERIALS INFORMATION

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TUBE



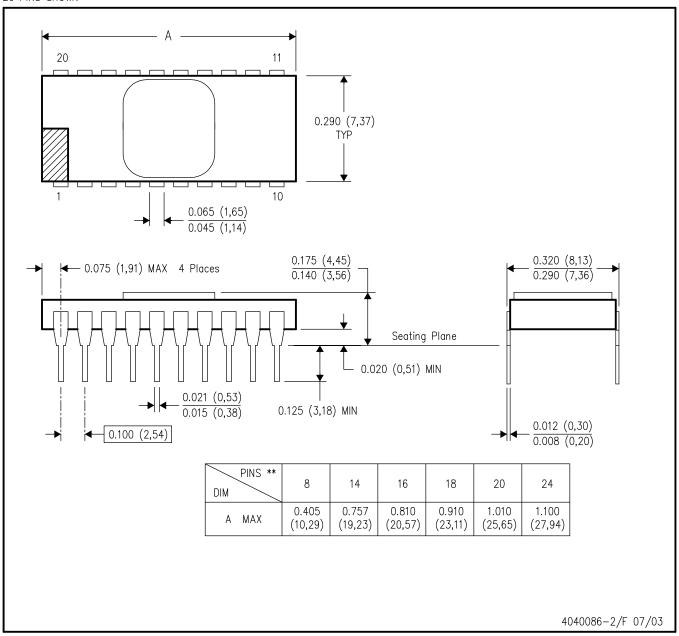
*All dimensions are nominal

Device		Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
	ADS1243SJD	JD	CDIP SB	20	19	506.98	15.24	12290	NA

JD (R-CDIP-T**)

CERAMIC SIDE-BRAZE DUAL-IN-LINE PACKAGE

20 PINS SHOWN



NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. This package is hermetically sealed with a metal lid.
- D. The terminals are gold plated.
- E. Falls within MIL STD 1835 CDIP2 T8, T14, T16, T18, T20 and T24 respectively.



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