

16-Bit 250-kSPS Sampling CMOS ANALOG-TO-DIGITAL CONVERTER

Check for Samples: ADS8515

FEATURES

- Standard ±10-V Input Range
- 90-dB Min SNR with 20-kHz Input
- ±2.0 LSB Max INL
- ±1 LSB Max DNL, 16 Bits, No Missing Code
- 5-V Analog Supply, Flexible I/O Supply Voltage at 1.65 V to 5.25 V
- Pin-Compatible with ADS7805/10 (Low Speed), and 12-Bit ADS7804/8504
- Uses Internal or External Reference
- Full Parallel Data Output
- 100-mW Typ Power Dissipation at 250 kSPS
- 28-Pin SSOP Package

APPLICATIONS

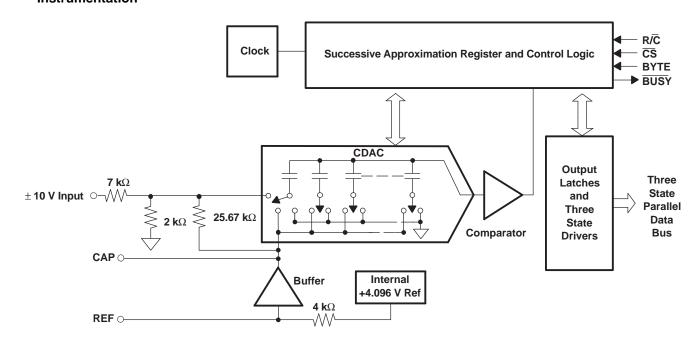
- Industrial Process Control
- Data Acquisition Systems
- Digital Signal Processing
- Medical Equipment
- Instrumentation

DESCRIPTION

The ADS8515 is a complete 16-bit sampling analog-to-digital (A/D) converter using state-of-the-art CMOS structures. It contains a complete 16-bit, capacitor-based, SAR A/D converter with sample and hold (S/H), reference, clock, interface for microprocessor use, and 3-state output drivers.

The ADS8515 is specified at a 250-kHz sampling rate over the full temperature range. Precision resistors provide an industry standard ±10-V input range, while the innovative design allows operation from a single +5-V supply, with power dissipation under 100 mW.

The ADS8515 is available in a 28-pin SSOP package and is fully specified for operation over the industrial –40°C to 85°C temperature range.



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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.





This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

PACKAGE/ORDERING INFORMATION(1)

PRODUCT	MINIMUM INL (LSB)	NO MISSING CODE	MINIMUM SINAD (dB)	SPECIFIED TEMPERATURE RANGE	PACKAGE- LEAD	PACKAGE DESIGNATOR	ORDERING NUMBER	TRANSPORT MEDIA, QTY		
ADS8515IB	. 2	46 Dito	90	-40°C to 85°C	SSOP-28	DD	ADS8515IBDB	Tube, 50		
AD20213IB	±2	±Z	16 Bits	89	09	-40°C 10 85°C	55UP-26	DB	ADS8515IBDBR	Tape and Reel, 2000
ADS8515I	. 0	16 Bits	07	-40°C to 85°C	SSOP-28	DD	ADS8515IDB	Tube, 50		
AD 505 151	±3	TO DIES	87	-40°C 10 85°C	55UP-26	DB	ADS8515IDBR	Tape and Reel, 2000		

⁽¹⁾ For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the ADS8515 product folder at www.ti.com.

ABSOLUTE MAXIMUM RATINGS(1)(2)

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

	-	ADS8515
	V _{IN}	±25V
Analog inputs	CAP	+V _{ANA} + 0.3 V to AGND2 – 0.3 V
	REF	Indefinite short to AGND2, momentary short to V _{ANA}
	DGND, AGND1, AGND2	±0.3 V
Ground voltage differences	V _{ANA}	6 V
	V _{DIG}	6 V
Digital inputs		$-0.3 \text{ V to +V}_{DIG}$ + 0.3 V
Maximum junction temperature		165°C
Internal power dissipation		825 mW

⁽¹⁾ Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) All voltage values are with respect to network ground terminal.



ELECTRICAL CHARACTERISTICS

At $T_A = -40$ °C to 85°C, $f_S = 250$ kHz, $V_{DIG} = V_{ANA} = 5$ V, and using internal reference (unless otherwise noted).

	DADAMETER	TEST CONDITIONS		ADS8515I			ADS8515IB		
	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
	Resolution				16			16	Bits
ANALOG	INPUT							·	
	Voltage range			±10			±10		V
	Impedance			8.885			8.885		kΩ
	Capacitance			75			75		pF
THROUG	SHPUT SPEED							J.	
	Conversion cycle time	Acquire and convert			4			4	μS
	Throughput rate		250			250			kHz
DC ACC									
INL	Integral linearity error		-3		3	-2		2	LSB ⁽¹⁾
DNL	Differential linearity error		-1		2	-1		1	LSB ⁽¹⁾
	No missing codes		16			16			Bits
	Transition noise ⁽²⁾			0.67			0.67		LSB
	Full-scale error ⁽³⁾ (4)	Int. Ref.	-0.5		0.5	-0.25		0.25	%FSR
	Full-scale error drift	Int. Ref.	0.0	±7	0.0	0.20	±7	0.25	ppm/°C
	Full-scale error ⁽³⁾ (4)	Ext. 4.096-V Ref.	-0.25		0.25	-0.1		0.1	%FSR
	Full-scale error drift	Ext. 4.096-V Ref.	0.20	±2	0.20	0.1	±2	0.1	ppm/°C
	Bipolar zero error ⁽³⁾	EXt. 4.000-V (Ci.	-4		4	-2		2	mV
	Bipolar zero error drift		4	±2	4	-2	±2	2	ppm/°(
	Power supply sensitivity								ррпі, с
	$(V_{DIG} = V_{ANA} = V_D)$	+4.75 V < V _D < +5.25 V	-8		8	-8		8	LSB
AC ACC	URACY							<u>'</u>	
SFDR	Spurious-free dynamic range	f _I = 20 kHz	95	102		97	102		dB ⁽⁵⁾
THD	Total harmonic distortion	f _I = 20 kHz		-100	-94		-100	-96	dB
01114.0	0. 1. (f _I = 20 kHz	87	91		89	91		dB
SINAD	Signal-to-(noise+distortion)	-60-dB Input		30			32		dB
SNR	Signal-to-noise ratio	f _I = 20 kHz	88	92		90	92		dB
	Full-power bandwidth ⁽⁶⁾			500			500		kHz
SAMPLI	NG DYNAMICS							J.	
	Aperture delay			5			5		ns
	Transient response	FS Step			2			2	μS
	Overvoltage recovery ⁽⁷⁾	'		150			150		ns
REFERE	•								
	Internal reference voltage		4.076	4.096	4.116	4.076	4.096	4.116	V
	Internal reference source current (must use external buffer)			1			1		μА
	Internal reference drift			8			8		ppm/°C
	External reference voltage range for specified linearity		3.9	4.096	4.2	3.9	4.096	4.2	V
	External reference current drain	Ext. 4.096-V Ref.			100			100	μΑ
DIGITAL	INPUTS								
	Logic levels								
V _{IL}	Low-level input voltage	V _{DIG} = 1.65 V - 5.25 V	-0.3		0.8	-0.3		0.35*V _{DIG}	V
V _{IH}	High-level input voltage	V _{DIG} = 1.65 V – 5.25 V	0.65*V _{DIG}		V _{DIG} +0.3 V	0.65*V _{DIG}		V _{DIG} +0.3 V	V
I _{IL}	Low-level input current	V _{IL} = 0 V	- 513		±10	510		±10	μА
									μА
I _{IH}	High-level input current OUTPUTS	V _{IH} = 5 V			±10			±10	

- (1) LSB means least significant bit. For the 16-bit, ± 10 -V input ADS8515, one LSB is 305 μ V.
- (2) Typical rms noise at worst case transitions and temperatures.
- (3) As measured with fixed resistors shown in Figure 22. Adjustable to zero with external potentiometer.
- (4) Full-scale error is the worst case of -full-scale or +full-scale deviation from ideal first and last code transitions, divided by the transition voltage (not divided by the full-scale range) and includes the effect of offset error.
- (5) All specifications in dB are referred to a full-scale ±10-V input.
- (6) Full-power bandwidth is defined as the full-scale input frequency at which signal-to-(noise + distortion) degrades to 60 dB, or 10 bits of accuracy.
- (7) Recovers to specified performance after 2 x FS input overvoltage.



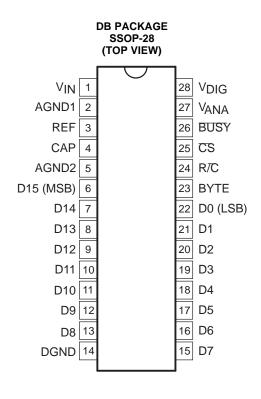
ELECTRICAL CHARACTERISTICS (continued)

At $T_A = -40$ °C to 85°C, $f_s = 250$ kHz, $V_{DIG} = V_{ANA} = 5$ V, and using internal reference (unless otherwise noted).

	24244555	TT0T 001/DIT(01/0		ADS8515I		ADS8515IB			UNIT
	PARAMETER	TEST CONDITIONS	MIN TYP		MAX	MIN	TYP MA		
	Data format (parallel 16 bits)								
	Data coding (binary twos complement)								
V _{OL}	Low-level output voltage	I _{SINK} = 1.6 mA			0.4			0.4	V
V _{OH}	High-level output voltage	I _{SOURCE} = 500 μA	0.8×V _{DIG}			0.8×V _{DIG}			V
	Leakage current	Hi-Z state, V _{OUT} = 0 V to V _{DIG}			±5			±5	μΑ
	Output capacitance	Hi-Z state			15			15	pF
DIGITA	L TIMING		•						
	Bus access timing				83			83	ns
	Bus relinquish timing				83			83	ns
POWE	R SUPPLIES								
V_{DIG}	Digital input voltage		1.65		5.25	1.65		5.25	V
V _{ANA}	Analog input voltage	Must be ≤ V _{ANA}	4.75	5	5.25	4.75	5	5.25	V
I _{DIG}	Digital input current	Wust be ≤ V _{ANA}		0.1	1		0.1	1	mA
I _{ANA}	Analog input current			20	25		20	25	mA
	Power dissipation	f _S = 250 kHz		100	125		100	125	mW
TEMPE	ERATURE RANGE								
	Specified performance		-40		+85	-40		+85	°C
	Derated performance ⁽⁸⁾		-55		+125	- 55		+125	°C
	Storage		-65		+150	-65		+150	°C
THERM	MAL RESISTANCE (Θ _{JA})								
	SSOP			67			67		°C/W

⁽⁸⁾ The internal reference may not be started correctly beyond the industrial temperature range (-40°C to +85°C); therefore, use of an external reference is recommended.

PIN CONFIGURATION



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PIN DESCRIPTIONS

PII	N	DIGITAL	
NAME	NO.	I/O	DESCRIPTION
AGND1	2		Analog ground. Used internally as ground reference point.
AGND2	5		Analog ground.
BUSY	26	0	At the start of a conversion, BUSY goes low and stays low until the conversion is completed and the digital outputs have been updated.
BYTE	23	I	Selects 8 most significant bits (low) or 8 least significant bits (high).
CAP	4		Reference buffer capacitor. 2.2-μF tantalum capacitor to ground.
CS	25	I	Internally ORed with R/\overline{C} . If R/\overline{C} low, a falling edge on \overline{CS} initiates a new conversion.
DGND	14		Digital ground.
D15 (MSB)	6	0	Data bit 15. Most significant bit (MSB) of conversion results. Hi-Z state when \overline{CS} is high, or when R/\overline{C} is low.
D14	7	0	Data bit 14. Hi-Z state when \overline{CS} is high, or when R/\overline{C} is low.
D13	8	0	Data bit 13. Hi-Z state when \overline{CS} is high, or when R/\overline{C} is low.
D12	9	0	Data bit 12. Hi-Z state when \overline{CS} is high, or when R/\overline{C} is low.
D11	10	0	Data bit 11. Hi-Z state when \overline{CS} is high, or when R/\overline{C} is low.
D10	11	0	Data bit 10. Hi-Z state when $\overline{\text{CS}}$ is high, or when $R/\overline{\text{C}}$ is low.
D9	12	0	Data bit 9. Hi-Z state when \overline{CS} is high, or when R/\overline{C} is low.
D8	13	0	Data bit 8. Hi-Z state when \overline{CS} is high, or when R/\overline{C} is low.
D7	15	0	Data bit 7. Hi-Z state when \overline{CS} is high, or when R/\overline{C} is low.
D6	16	0	Data bit 6. Hi-Z state when \overline{CS} is high, or when R/ \overline{C} is low.
D5	17	0	Data bit 5. Hi-Z state when \overline{CS} is high, or when R/\overline{C} is low.
D4	18	0	Data bit 4. Hi-Z state when $\overline{\text{CS}}$ is high, or when R/\overline{C} is low.
D3	19	0	Data bit 3. Hi-Z state when \overline{CS} is high, or when R/\overline{C} is low.
D2	20	0	Data bit 2. Hi-Z state when \overline{CS} is high, or when R/\overline{C} is low.
D1	21	0	Data bit 1. Hi-Z state when \overline{CS} is high, or when R/ \overline{C} is low.
D0 (LSB)	22	0	Data bit $\underline{0}$. Least significant bit (LSB) of conversion results. Hi-Z state when \overline{CS} is high, or when R/\overline{C} is low.
R/C	24	I	With $\overline{\text{CS}}$ low and $\overline{\text{BUSY}}$ high, a falling edge on R/ $\overline{\text{C}}$ initiates a new conversion. With $\overline{\text{CS}}$ low, a rising edge on R/ $\overline{\text{C}}$ enables the parallel output.
REF	3		Reference input/output. 2.2-μF tantalum capacitor to ground.
V _{ANA}	27		Analog supply input. Nominally +5 V. Decouple to ground with 0.1- μF ceramic and 10- μF tantalum capacitors.
V _{DIG}	28		Digital supply input. Can be connected directly to pin 27.
V _{IN}	1		Analog input. See Figure 24.



TYPICAL CHARACTERISTICS

Figure 1.

Figure 2.

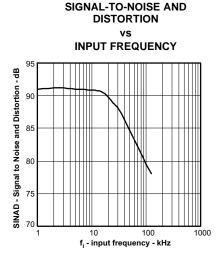


Figure 3.

SPURIOUS FREE DYNAMIC RANGE vs INPUT FREQUENCY

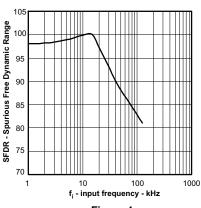


Figure 4.

SIGNAL-TO-NOISE RATIO vs FREE-AIR TEMPERATURE

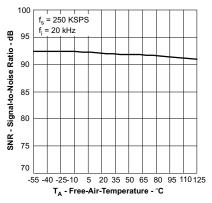


Figure 5.

SIGNAL-TO-NOISE AND DISTORTION vs FREE-AIR TEMPERATURE

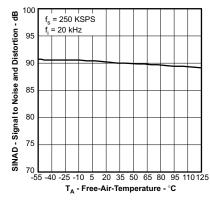


Figure 6.

SPURIOUS FREE DYNAMIC RANGE vs

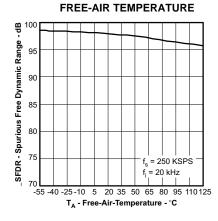


Figure 7.

TOTAL HARMONIC DISTORTION

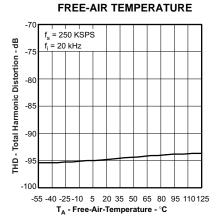


Figure 8.

INTERNAL REFERENCE VOLTAGE

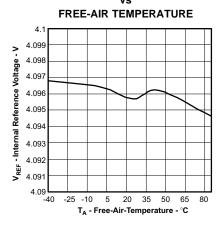
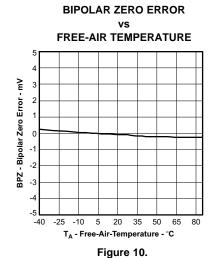


Figure 9.

NEGATIVE FULL-SCALE ERROR



TYPICAL CHARACTERISTICS (continued)



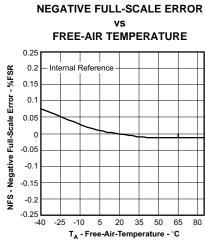


Figure 11.

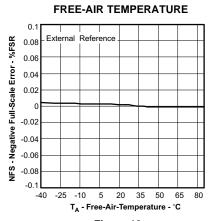


Figure 12.

POSITIVE FULL-SCALE ERROR vs FREE-AIR TEMPERATURE

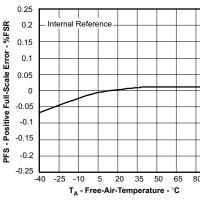


Figure 13.

POSITIVE FULL-SCALE ERROR vs FREE-AIR TEMPERATURE

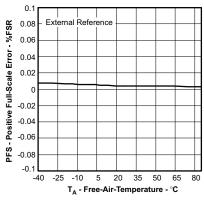
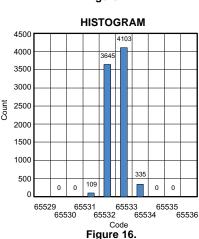


Figure 14.



SUPPLY CURRENT vs

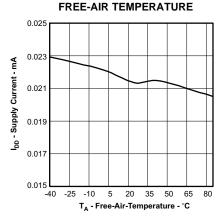


Figure 15.



TYPICAL CHARACTERISTICS (continued)

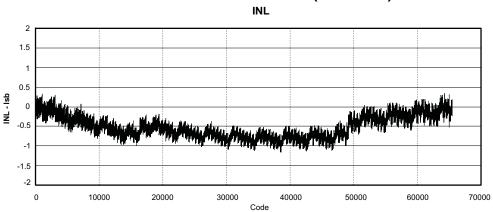


Figure 17.

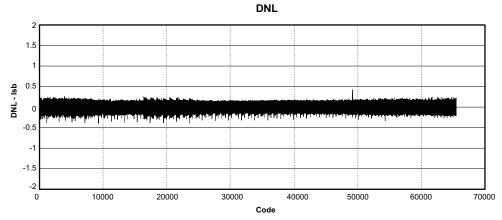


Figure 18.



BASIC OPERATION

Figure 19 shows a basic circuit to operate the A<u>DS8515</u> with a full parallel data output. Taking R/C (pin 24) low for a minimum of 40 ns initiates a conversion. BUSY (pin 26) goes low and stays low until the conversion is completed and the output registers are updated. Data are output in binary twos complement with the MSB on pin 6. BUSY going high can be used to latch the data.

The ADS8515 begins tracking the input signal at the end of the conversion. Allowing 4 μ s between convert commands assures accurate acquisition of a new signal.

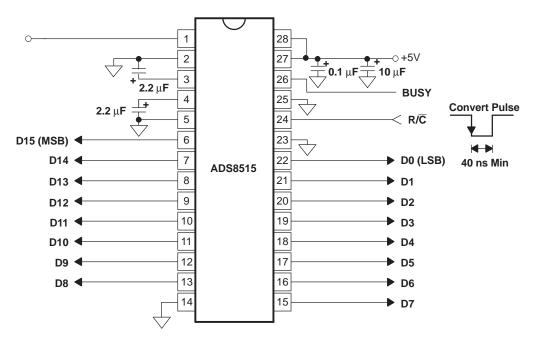


Figure 19. Basic Operation



STARTING A CONVERSION

The combination of $\overline{\text{CS}}$ (pin 25) and $R/\overline{\text{C}}$ (pin 24) held low for a minimum of 40 ns immediately puts the sample/hold of the ADS8515 in the hold state and starts conversion n. $\overline{\text{BUSY}}$ (pin 26) goes low and stays low until conversion n is completed and the internal output register has been updated.

The ADS8515 begins tracking the input signal at the end of the conversion. Allowing 4 <u>µs</u> between convert commands assures accurate acquisition of a new signal. Refer to Table 1 for a summary of CS, R/C, and BUSY states and Figure 21, Figure 22, and Figure 23 for the timing diagrams.

 $\overline{\text{CS}}$ and R/ $\overline{\text{C}}$ are internally ORed and level triggered. There is no requirement regarding which input goes low first when initiating a conversion. If, however, it is critical that $\overline{\text{CS}}$ or R/ $\overline{\text{C}}$ initiates conversion n, be sure the less critical input is low at least 10 ns prior to the initiating input.

To reduce the number of control pins, \overline{CS} can be tied low using R/ \overline{C} to control the read and convert modes. The parallel output becomes active whenever R/ \overline{C} goes high. Refer to the Reading Data section.

 $\overline{\mathsf{cs}}$ R/C BUSY **OPERATION** 1 Χ Χ None. Databus is in Hi-Z state. 0 1 Initiates conversion n. Databus remains in Hi-Z state. 0 1 1 Initiates conversion n. Databus enters Hi-Z state. 0 Conversion *n* completed. Valid data from conversion *n* on the databus. 1 1 Enables databus with valid data from conversion n. 1 1 1 0 Enables databus with valid data from conversion -1 (1). Conversion n in progress. 1 Enables databus with valid data from conversion -1 (1). Conversion n in progress. 0 0 1 New conversion initiated without acquisition of a new signal. Data is invalid. $\overline{\text{CS}}$ and/or $\overline{\text{R/C}}$ Λ 0 must be high when BUSY goes high. Χ 0 Conversion *n* in progress.

Table 1. Control Line Functions for Read and Convert

READING DATA

The ADS8515 outputs full or byte-reading parallel data in binary twos complement data output format. The parallel output is active when R/\overline{C} (pin 24) is high and \overline{CS} (pin 25) is low. Any other combination of \overline{CS} and R/\overline{C} 3-states the parallel output. Valid conversion data can be read in a full parallel, 16-bit word or two 8-bit bytes on pins 6 to 13 and pins 15 to 22. BYTE (pin 23) can be toggled to read both bytes within one conversion cycle. Refer to Table 2 for ideal output codes and Figure 20 for bit locations relative to the state of BYTE.

Table 2. Ideal Input Voltages and Output Codes

DESCRIPTION	ANALOG INDUT	DIGITAL OUTPUT BINARY TWOS COMPLEMENT				
DESCRIPTION	ANALOG INPUT	BINARY CODE	HEX CODE			
Full-scale range	±10 V					
Least significant bit (LSB)	305 μV					
Full scale (10 V – 1 LSB)	9.999695 V	0111 1111 1111 1111	7FFF			
Midscale	0 V	0000 0000 0000 0000	0000			
One LSB below midscale	–305 μV	1111 1111 1111 1111	FFFF			
-Full scale	–10 V	1000 0000 0000 0000	8000			

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⁽¹⁾ See Figure 21 and Figure 22 for constraints on data valid from conversion n-1.



PARALLEL OUTPUT (After a Conversion)

After conversion n is completed and the output registers have been updated, $\overline{\text{BUSY}}$ (pin 26) goes high. Valid data from conversion n are available on D15 to D0 (pins 6 to 13 and 15 to 22). BUSY going high can be used to latch the data. Refer to Table 3 and Figure 21, Figure 22, and Figure 23 for timing specifications.

PARALLEL OUTPUT (During a Conversion)

After conversion n has been initiated, valid data from conversion -1 can be read and are valid up to t_2 after the start of conversion n. Do not attempt to read data from t_2 after the start of conversion n until BUSY (pin 26) goes high; this may result in reading invalid data. Refer to Table 3 and Figure 21, Figure 22, and Figure 23 for timing specifications.

Note: For the best possible performance, data should not be read during a conversion. The switching noise of the asynchronous data transfer can cause digital feedthrough degrading the converter performance.

The number of control lines can be reduced by tying \overline{CS} low while using the falling edge of R/\overline{C} to initiate conversions and the rising edge of R/\overline{C} to activate the output mode of the converter. See Figure 21.

SYMBOL	DESCRIPTION	MIN	TYP	MAX	UNITS
t _{w1}	Pulse duration, convert	40			ns
t _a	Access time, data valid after R/C low		0.8	1.2	μS
t _{pd}	Propagation delay time, BUSY from R/C low		6	20	ns
t _{w2}	Pulse duration, BUSY low			2	μS
t _{d1}	Delay time, BUSY after end of conversion		5		ns
t _{d2}	Delay time, aperture		5		ns
t_{conv}	Conversion time			2	μS
t _{acq}	Acquisition time	2			μS
t _{dis}	Disable time, bus	10	15	83	ns
t _{d3}	Delay time, BUSY after data valid	35	50		ns
t_v	Valid time, previous data remains valid after R/C low	1.5	2		μS
$t_{conv} + t_{acq}$	Throughput time			4	μS
t _{su}	Setup time, R/C to CS	10			ns
t _c	Cycle time between conversions	4			μS
t _{en}	Enable time, bus	10	15	30	ns
t _{d4}	Delay time, BYTE	10	15	30	ns

Table 3. Conversion Timing

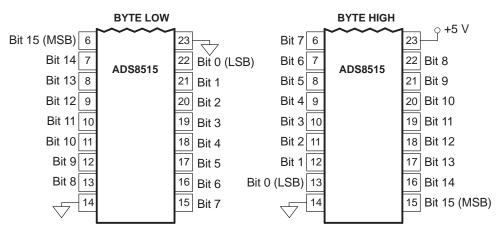


Figure 20. Bit Locations Relative to State of BYTE (Pin 23)



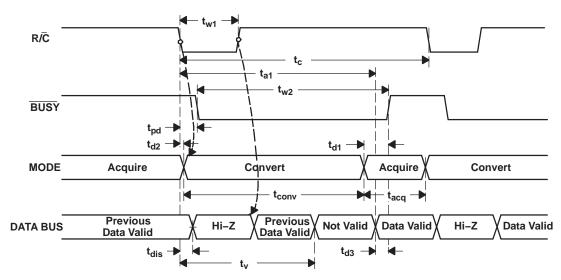


Figure 21. Conversion Timing with Outputs Enabled after Conversion (CS Tied Low)

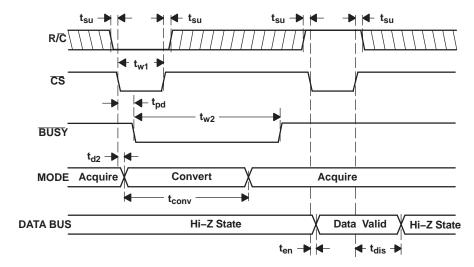


Figure 22. Using CS to Control Conversion and Read Timing

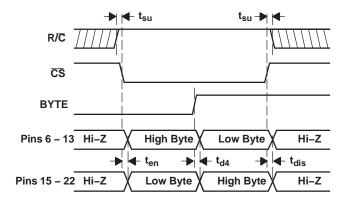


Figure 23. Using CS and BYTE to Control Data Bus

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ADC RESET

The ADC reset function of the ADS8515 can be used to terminate the current conversion cycle. Bringing R/\overline{C} low for at least 40 ns while BUSY is low will initiate the ADC reset. To initiate a new conversion, R/\overline{C} must return to the high state and remain high long enough to acquire a new sample (see Table 3, t_c) before going low to initiate the next conversion sequence. In applications that do not monitor the BUSY signal, it is recommended that the ADC reset function be implemented as part of a system initialization sequence.

INPUT RANGES

The ADS8515 offers a standard ±10-V input range. Figure 24 shows the necessary circuit connections for the ADS8515 with and without hardware trim. Offset and full-scale error specifications are tested and specified with the fixed resistors shown in Figure 25(b). Full-scale error includes offset and gain errors measured at both +FS and –FS. Adjustments for offset and gain are described in the *Calibration* section of this data sheet.

The offset and gain are adjusted internally to allow external trimming with a single supply. The external resistors compensate for this adjustment and can be left out if the offset and gain are corrected in software (refer to the *Calibration* section).

The nominal input impedance of 6.35 k Ω results from the combination of the internal resistor network shown on the front page of the product data sheet. The input resistor divider network provides inherent overvoltage protection assured to at least ± 25 V. The 1% resistors used for the external circuitry do not compromise the accuracy or drift of the converter. They have little influence relative to the internal resistors, and tighter tolerances are not required.

The input signal must be referenced to AGND1. This minimizes the ground loop problem typical to analog designs. The analog signal should be driven by a low impedance source. A typical driving circuit using an OPA627 or OPA132 is shown in Figure 24.

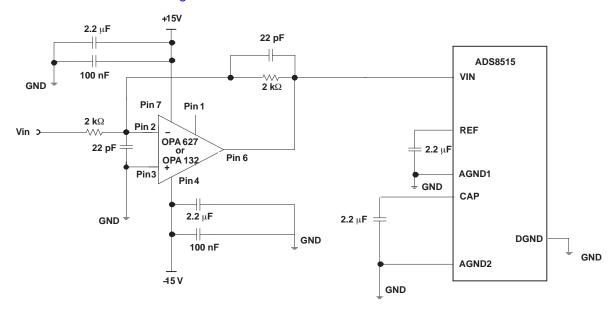


Figure 24. Typical Driving Circuit (±10 V, No Trim)



APPLICATION INFORMATION

CALIBRATION

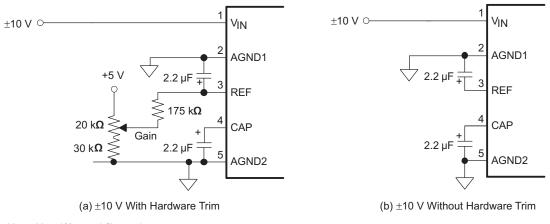
The gain of the ADS8515 can be trimmed in software. To achieve optimum performance, several iterations may be required.

Hardware Calibration

To calibrate the gain of the ADS8515, install the resistors and potentiometer as shown in Figure 25(a). The calibration range is approximately ±100 mV.

Software Calibration

The offset and gain of the ADS8515 is calibrated with software. See Figure 25(b) for the circuit connections.



Note: Use 1% metal film resistors.

Figure 25. Circuit Diagram For Software Trim

REFERENCE

The ADS8515 can operate with its internal 4.096-V reference or an external reference. By applying an external reference to pin 5, the internal reference can be bypassed. The reference voltage at REF is buffered internally with the output on CAP (pin 4).

The internal reference has an 8 ppm/°C drift (typical) and accounts for approximately 20% of the full-scale error (FSE = $\pm 0.5\%$ for low grade, $\pm 0.25\%$ for high grade).

REF

REF (pin 3) is an input for an external reference or the output for the internal 4.096-V reference. A $2.2 - \mu F$ capacitor should be connected as close to the REF pin as possible. The capacitor and the output resistance of REF create a low-pass filter to bandlimit noise on the reference. Using a smaller value capacitor introduces more noise to the reference degrading the SNR and SINAD. The REF pin should not be used to drive external ac or dc loads.

The range for the external reference is 3.9 V to 4.2 V and determines the actual LSB size. Increasing the reference voltage increases the full-scale range and the LSB size of the converter which can improve the SNR.

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CAP

CAP (pin 4) is the output of the internal reference buffer. A 2.2- μF capacitor should be placed as close to the CAP pin as possible to provide optimum switching currents for the CDAC throughout the conversion cycle and compensation for the output of the internal buffer. Using a capacitor any smaller than 1 μF can cause the output buffer to oscillate and may not have sufficient charge for the CDAC. Capacitor values larger than $2.2~\mu F$ have little affect on improving performance. The ESR (equivalent series resistance) of these compensation capacitors is also critical. Keep the total ESR under $3~\Omega$. See the *Typical Characteristics* section for how the worst case INL is affected by ESR.

The output of the buffer is capable of driving up to 2 mA of current to a dc load, but any external load from the CAP pin may degrade the linearity of the ADS8515. Using an external buffer allows the internal reference to be used for larger dc loads and ac loads. Do not attempt to directly drive an ac load with the output voltage on CAP. This causes performance degradation of the converter. The ESR (equivalent series resistance) of these compensation capacitors is also critical. Keep the total ESR under 3 Ω . See the *Typical Characteristics* section concerning how ESR affects performance.

LAYOUT

POWER

The analog power pin (V_{ANA}) and digital power pin (V_{DIG}) can be tied together from the same +5V power supply, or from two different power-supply sources. The ADS8515 uses 90% of its power from the analog circuitry, and therefore should be considered as an analog component. Care must be taken to ensure that both the analog and digital power supplies power on before any voltage is applied to the analog input pin. Failure to do so may create a latch-up condition. There is no power sequencing requirement between V_{ANA} and V_{DIG} .

GROUNDING

Three ground pins are present on the ADS8515. DGND is the digital supply ground. AGND2 is the analog supply ground. AGND1 is the ground which all analog signals internal to the A/D converter are referenced. AGND1 is more susceptible to current induced voltage drops and must have the path of least resistance back to the power supply.

All the ground pins of the A/D converter should be tied to the analog ground plane, separated from the system digital logic ground, to achieve optimum performance. Both analog and digital ground planes should be tied to the *system* ground as near to the power supplies as possible. This helps to prevent dynamic digital ground currents from modulating the analog ground through a common impedance to power ground.

SIGNAL CONDITIONING

The FET switches used for the sample hold on many CMOS A/D converters release a significant amount of charge injection which can cause the driving op amp to oscillate. The FET switch on the ADS8515, compared to the FET switches on other CMOS A/D converters, releases 5% to 10% of the charge. There is also a resistive front end which attenuates any charge which is released. The end result is a minimal requirement for the antialias filter on the front end. Any op amp sufficient for the signal in an application is sufficient to drive the ADS8515.

The resistive front end of the ADS8515 also provides an assured ±25-V overvoltage protection. In most cases, this eliminates the need for external input protection circuitry.

INTERMEDIATE LATCHES

The ADS8515 does have 3-state outputs for the parallel port, but intermediate latches should be used if the bus is to be active during conversions. If the bus is not active during conversion, the 3-state outputs can be used to isolate the A/D converter from other peripherals on the same bus. The 3-state outputs can also be used when the A/D converter is the only peripheral on the data bus.

Intermediate latches are beneficial on any monolithic A/D converter. The ADS8515 has an internal LSB size of 38 μ V. Transients from fast switching signals on the parallel port, even when the A/D converter is 3-stated, can be coupled through the substrate to the analog circuitry causing degradation of converter performance.



REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision C (August 2010) to Revision D	Page
Deleted row from Absolute Maximum Ratings regarding V _{DIG} to V _{ANA}	2
• Deleted text regarding V _{ANA} from the pin 28 description in the <i>Pin Description</i> table	5
Changed text in first and second sentences of the <i>Power</i> section	15
Changes from Revision B (June 2010) to Revision C	Page
Updated document format to current standards	1
Added text to end of <i>Power</i> section	15

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PACKAGING INFORMATION

Orderable part number	Status	Material type	Package Pins	Package qty Carrier	RoHS	Lead finish/ Ball material	MSL rating/ Peak reflow	Op temp (°C)	Part marking (6)
	('')	(2)			(0)	(4)	(5)		(0)
ADS8515IBDB	Active	Production	SSOP (DB) 28	50 TUBE	Yes	Call TI	Level-2-260C-1 YEAR	-40 to 85	ADS8515I B
ADS8515IBDB.A	Active	Production	SSOP (DB) 28	50 TUBE	Yes	Call TI	Level-2-260C-1 YEAR	-40 to 85	ADS8515I B
ADS8515IBDBR	Active	Production	SSOP (DB) 28	2000 LARGE T&R	Yes	Call TI	Level-2-260C-1 YEAR	-40 to 85	ADS8515I B
ADS8515IBDBR.A	Active	Production	SSOP (DB) 28	2000 LARGE T&R	Yes	Call TI	Level-2-260C-1 YEAR	-40 to 85	ADS8515I B
ADS8515IDB	Active	Production	SSOP (DB) 28	50 TUBE	Yes	Call TI	Level-2-260C-1 YEAR	-40 to 85	ADS8515I
ADS8515IDB.A	Active	Production	SSOP (DB) 28	50 TUBE	Yes	Call TI	Level-2-260C-1 YEAR	-40 to 85	ADS8515I
ADS8515IDBR	Active	Production	SSOP (DB) 28	2000 LARGE T&R	Yes	Call TI	Level-2-260C-1 YEAR	-40 to 85	ADS8515I
ADS8515IDBR.A	Active	Production	SSOP (DB) 28	2000 LARGE T&R	Yes	Call TI	Level-2-260C-1 YEAR	-40 to 85	ADS8515I

⁽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.

⁽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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PACKAGE MATERIALS INFORMATION

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TAPE AND REEL INFORMATION





A0	Dimension designed to accommodate the component width
В0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
ADS8515IBDBR	SSOP	DB	28	2000	330.0	16.4	8.1	10.4	2.5	12.0	16.0	Q1
ADS8515IDBR	SSOP	DB	28	2000	330.0	16.4	8.1	10.4	2.5	12.0	16.0	Q1

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*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
ADS8515IBDBR	SSOP	DB	28	2000	350.0	350.0	43.0
ADS8515IDBR	SSOP	DB	28	2000	350.0	350.0	43.0

PACKAGE MATERIALS INFORMATION

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TUBE

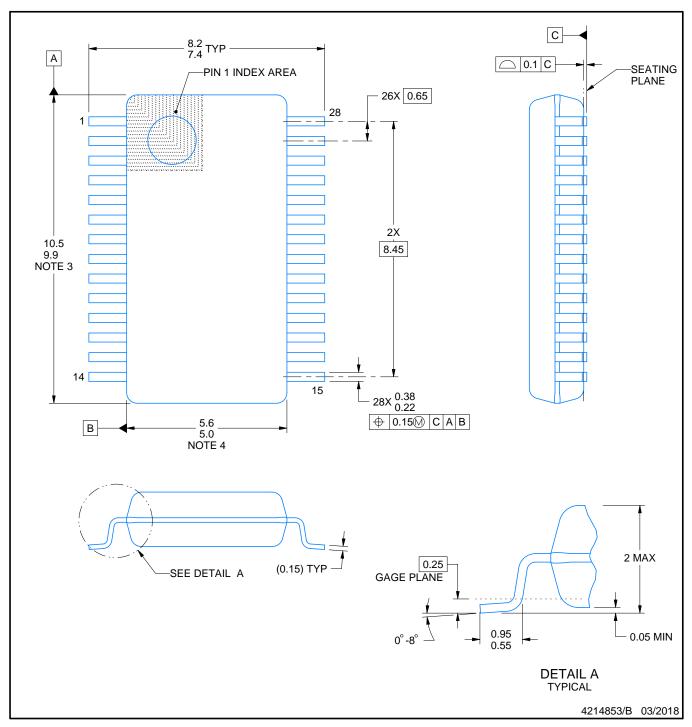


*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
ADS8515IBDB	DB	SSOP	28	50	530	10.5	4000	4.1
ADS8515IBDB.A	DB	SSOP	28	50	530	10.5	4000	4.1
ADS8515IDB	DB	SSOP	28	50	530	10.5	4000	4.1
ADS8515IDB.A	DB	SSOP	28	50	530	10.5	4000	4.1



SMALL OUTLINE PACKAGE



NOTES:

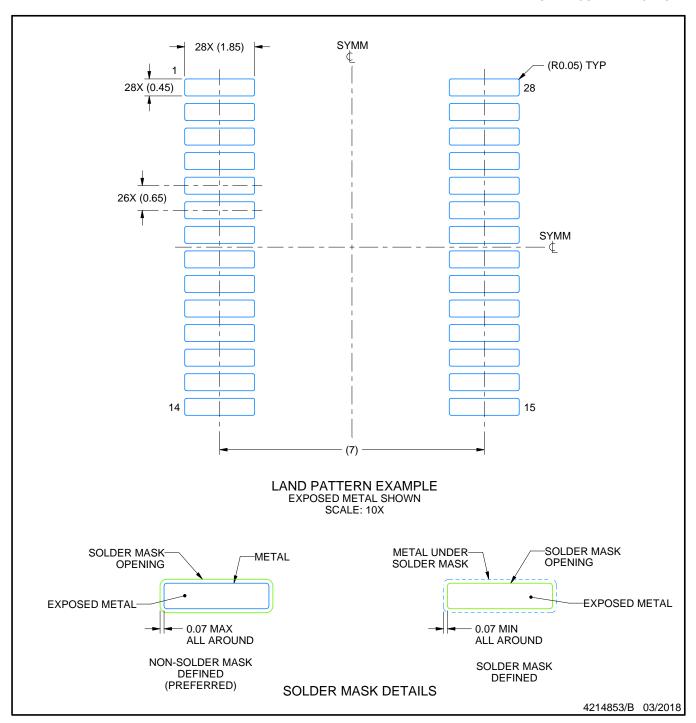
- 1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.

 2. This drawing is subject to change without notice.

 3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not
- exceed 0.15 mm per side.
- 4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
- 5. Reference JEDEC registration MO-150.



SMALL OUTLINE PACKAGE



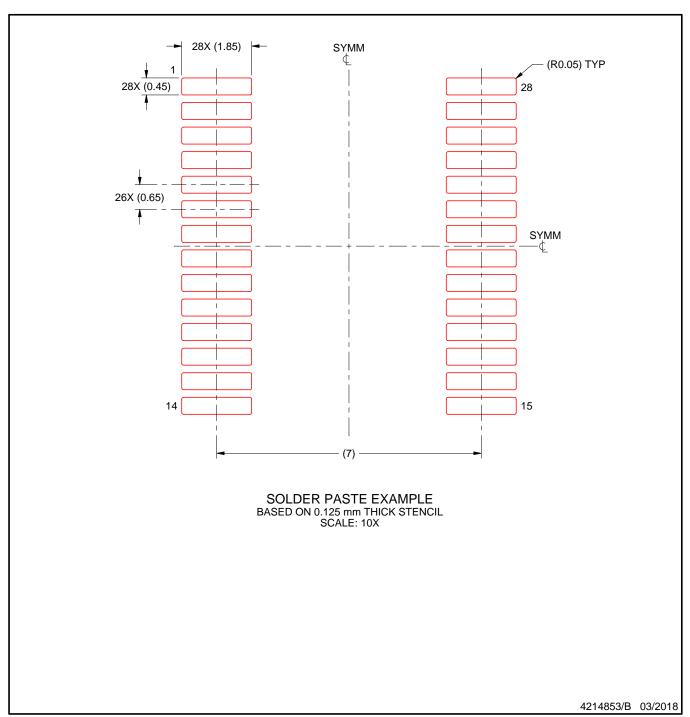
NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SMALL OUTLINE PACKAGE



NOTES: (continued)

- 8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
- 9. Board assembly site may have different recommendations for stencil design.



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