

# ADS7819

## 12-Bit 800kHz Sampling CMOS ANALOG-to-DIGITAL CONVERTER

### FEATURES

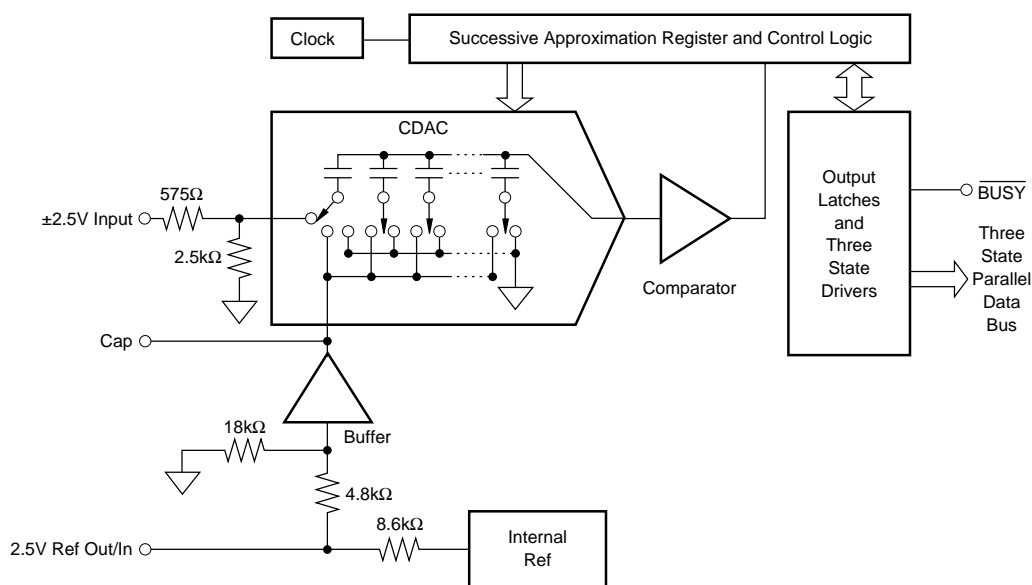
- 1.25 $\mu$ s THROUGHPUT TIME
- STANDARD  $\pm 2.5$ V INPUT RANGE
- 70dB min SINAD WITH 250kHz INPUT
- $\pm 3/4$  LSB max INL AND  $\pm 1$  LSB max DNL
- INTERNAL REFERENCE
- COMPLETE WITH S/H, REF, CLOCK, ETC.
- PARALLEL DATA w/ LATCHES
- 28-PIN 0.3" PDIP AND SOIC

### DESCRIPTION

The ADS7819 is a complete 12-bit sampling A/D using state-of-the-art CMOS structures. It contains a complete 12-bit capacitor-based SAR A/D with inherent S/H, reference, clock, interface for microprocessor use, and three-state output drivers.

The ADS7819 is specified at an 800kHz sampling rate, and guaranteed over the full temperature range. Laser-trimmed scaling resistors provide a  $\pm 2.5$ V input range and inherent overvoltage protection up to  $\pm 25$ V.

The 28-pin ADS7819 is available in a plastic 0.3" DIP and in an SOIC, both fully specified for operation over the industrial  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  range.



International Airport Industrial Park • Mailing Address: PO Box 11400 • Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd. • Tucson, AZ 85706  
Tel: (520) 746-1111 • Twx: 910-952-1111 • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

# SPECIFICATIONS

At  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $f_S = 800\text{kHz}$ ,  $+V_{DIG} = +V_{ANA} = +5\text{V}$ ,  $-V_{ANA} = -5\text{V}$ , using internal reference and the 50Ω input resistor shown in Figure 4b, unless otherwise specified.

PARAMETER	CONDITIONS	ADS7819P, U			ADS7819PB, UB			UNITS	
		MIN	TYP	MAX	MIN	TYP	MAX		
<b>RESOLUTION</b>				12			*	Bits	
<b>ANALOG INPUT</b>									
Voltage Range			±2.5			*		V	
Impedance			3.1			*		kΩ	
Capacitance			5			*		pF	
<b>THROUGHPUT SPEED</b>									
Conversion Time	Acquire & Convert		940			*		ns	
Complete Cycle				1250			*	ns	
Throughput Rate		800				*		kHz	
<b>DC ACCURACY</b>									
Integral Linearity Error	Ext. 2.5000V Ref Ext. 2.5000V Ref  +4.75V < $V_D$ < +5.25V -5.25V < $-V_{ANA}$ < -4.75V			±1			±0.75	LSB <sup>(1)</sup>	
Differential Linearity Error				±1			*	LSB	
No Missing Codes				Guaranteed		*			
Transition Noise <sup>(2)</sup>				0.1		*		LSB	
Full Scale Error <sup>(3, 4)</sup>					±0.5			±0.25	%
Full Scale Error Drift					±12		*		ppm/°C
Full Scale Error <sup>(3, 4)</sup>					±0.5		*		%
Full Scale Error Drift					±12		*		ppm/°C
Bipolar Zero Error <sup>(3)</sup>							*	±4	LSB
Bipolar Zero Error Drift					±2		*		ppm/°C
Power Supply Sensitivity ( $+V_{DIG} = +V_{ANA} = V_D$ )							*	LSB	
				±0.5			*	LSB	
<b>AC ACCURACY</b>									
Spurious-Free Dynamic Range	$f_{IN} = 250\text{kHz}$	74	84		77	85		dB <sup>(5)</sup>	
Total Harmonic Distortion	$f_{IN} = 250\text{kHz}$		-82	-74		-83	-77	dB	
Signal-to-(Noise+Distortion)	$f_{IN} = 250\text{kHz}$	68	71		70	*		dB	
Signal-to-Noise	$f_{IN} = 250\text{kHz}$	68	71		70	*		dB	
Usable Bandwidth <sup>(6)</sup>			1.5			*		MHz	
<b>SAMPLING DYNAMICS</b>									
Aperture Delay	FS Step		20			*		ns	
Aperture Jitter			10			*		ps	
Transient Response			180			*		ns	
Overvoltage Recovery <sup>(7)</sup>			250			*		ns	
<b>REFERENCE</b>									
Internal Reference Voltage	Ext. 2.5000V Ref	2.48	2.5	2.52	*	*	*	V	
Internal Reference DC Source Current (External load should be static)				100			*		μA
Internal Reference Drift				6					ppm/°C
External Reference Voltage Range For Specified Linearity			2.3	2.5	2.7	*	*	*	V
External Reference Current Drain					100			*	μA
<b>DIGITAL INPUTS</b>									
Logic Levels	$V_{IL} = 0\text{V}$ $V_{IH} = 5\text{V}$								
$V_{IL}$		-0.3		+0.8	*		*	V	
$V_{IH}$		+2.4		$V_D + 0.3$	*		*	V	
$I_{IL}$				±10			*	μA	
$I_{IH}$				±10			*	μA	
<b>DIGITAL OUTPUTS</b>									
Data Format	$I_{SINK} = 1.6\text{mA}$ $I_{SOURCE} = 500\mu\text{A}$ High-Z State, $V_{OUT} = 0\text{V}$ to $V_{DIG}$ High-Z State				Parallel 12-bits Binary Two's Complement				
Data Coding					+0.4	*		V	
$V_{OL}$							*	V	
$V_{OH}$							*	V	
Leakage Current					±5		*	μA	
Output Capacitance				15		*	pF		
<b>DIGITAL TIMING</b>									
Bus Access Time				62		*		ns	
Bus Relinquish Time				83		*		ns	

The information provided herein is believed to be reliable; however, BURR-BROWN assumes no responsibility for inaccuracies or omissions. BURR-BROWN assumes no responsibility for the use of this information, and all use of such information shall be entirely at the user's own risk. Prices and specifications are subject to change without notice. No patent rights or licenses to any of the circuits described herein are implied or granted to any third party. BURR-BROWN does not authorize or warrant any BURR-BROWN product for use in life support devices and/or systems.

# SPECIFICATIONS (CONT)

At  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ,  $f_s = 800\text{kHz}$ ,  $+V_{\text{DIG}} = +V_{\text{ANA}} = +5\text{V}$ ,  $-V_{\text{ANA}} = -5\text{V}$ , using internal reference and the  $50\Omega$  input resistor shown in Figure 4b, unless otherwise specified.

PARAMETER	CONDITIONS	ADS7819P, U			ADS7819PB, UB			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
<b>POWER SUPPLIES</b>								
Specified Performance								
$+V_{\text{DIG}} = +V_{\text{ANA}}$		+4.75	+5	+5.25	*	*	*	V
$-V_{\text{ANA}}$		-5.25	-5	-4.75	*	*	*	V
$+I_{\text{DIG}}$			+16			*		mA
$+I_{\text{ANA}}$			+16			*		mA
$-I_{\text{ANA}}$			-13			*		mA
Derated Performance								
$+V_{\text{DIG}} = +V_{\text{ANA}}$		+4.5	+5	+5.5	*	*	*	V
$-V_{\text{ANA}}$		-5.5	-5	-4.5	*	*	*	V
Power Dissipation	$f_s = 800\text{kHz}$		225	275			*	mW
<b>TEMPERATURE RANGE</b>								
Specified Performance								
		-40		+85	*		*	$^\circ\text{C}$
Derated Performance								
		-55		+125	*		*	$^\circ\text{C}$
Storage								
		-65		+150	*		*	$^\circ\text{C}$
Thermal Resistance ( $\theta_{\text{JA}}$ )								
Plastic DIP			75			*		$^\circ\text{C}/\text{W}$
SOIC			75			*		$^\circ\text{C}/\text{W}$

NOTES: (1) LSB means Least Significant Bit. For the 12-bit,  $\pm 2.5\text{V}$  input ADS7819, one LSB is 1.22mV. (2) Typical rms noise at worst case transitions and temperatures. (3) Measured with  $50\Omega$  in series with analog input. Adjustable to zero with external potentiometer. (4) Full scale error is the worst case of -Full Scale or +Full Scale untrimmed 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  $\pm 2.5\text{V}$  input. (6) Usable Bandwidth defined as Full-Scale input frequency at which Signal-to-(Noise+Distortion) degrades to 60dB, or 10 bits of accuracy. (7) Recovers to specified performance after 2 x FS input over voltage.

## ABSOLUTE MAXIMUM RATINGS

Analog Inputs: $V_{\text{IN}}$ .....	$\pm 25\text{V}$
REF .....	$+V_{\text{ANA}} + 0.3\text{V}$ to AGND2 $-0.3\text{V}$
CAP .....	Indefinite Short to AGND2
Momentary Short to $+V_{\text{ANA}}$	
Ground Voltage Differences: DGND, AGND1, AGND2 .....	$\pm 0.3\text{V}$
$+V_{\text{ANA}}$ .....	+7V
$+V_{\text{DIG}}$ to $+V_{\text{ANA}}$ .....	+0.3V
$+V_{\text{DIG}}$ .....	7V
$-V_{\text{ANA}}$ .....	-7V
Digital Inputs .....	$-0.3\text{V}$ to $+V_{\text{DIG}} + 0.3\text{V}$
Maximum Junction Temperature .....	$+165^\circ\text{C}$
Internal Power Dissipation .....	825mW
Lead Temperature (soldering, 10s) .....	$+300^\circ\text{C}$



## ELECTROSTATIC DISCHARGE SENSITIVITY

Electrostatic discharge can cause damage ranging from performance degradation to complete device failure. Burr-Brown Corporation recommends that all integrated circuits be handled and stored using appropriate ESD protection methods.

## ORDERING AND PACKAGE INFORMATION

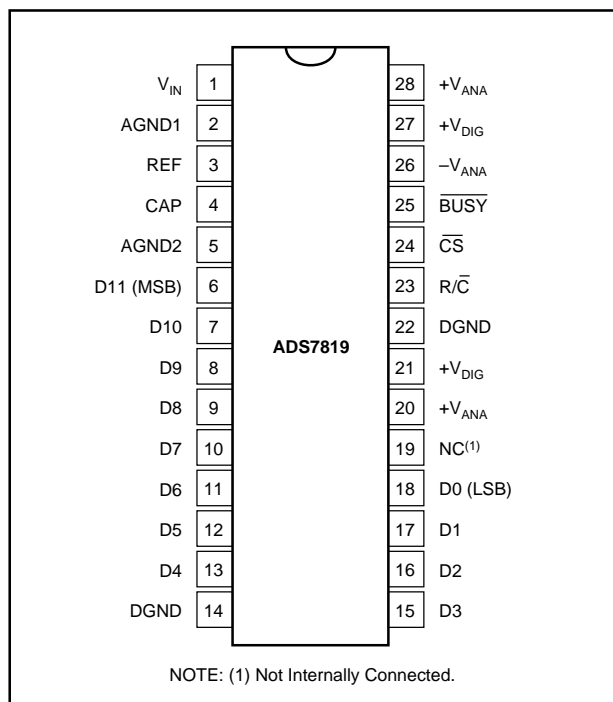
MODEL	MAXIMUM INTEGRAL LINEARITY ERROR (LSB)	MINIMUM SIGNAL-TO-(NOISE + DISTORTION) RATIO (dB)	SPECIFICATION TEMPERATURE RANGE	PACKAGE	PACKAGE DRAWING NUMBER <sup>(1)</sup>
ADS7819P	$\pm 1$	68	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	28-Pin Plastic DIP	246
ADS7819PB	$\pm 0.75$	70	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	28-Pin Plastic DIP	246
ADS7819U	$\pm 1$	68	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	28-Pin SOIC	217
ADS7819UB	$\pm 0.75$	70	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	28-Pin SOIC	217

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix D of Burr-Brown IC Data Book.

## PIN ASSIGNMENTS

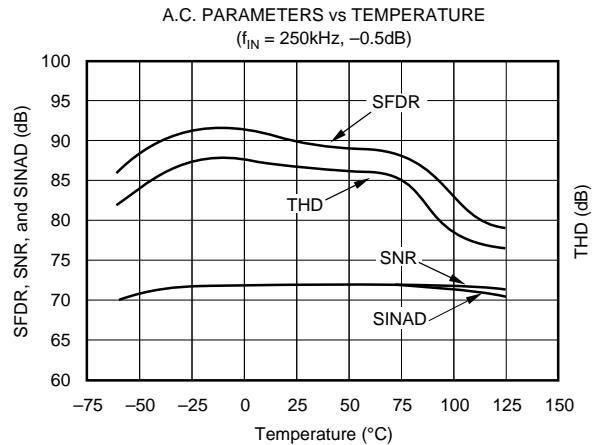
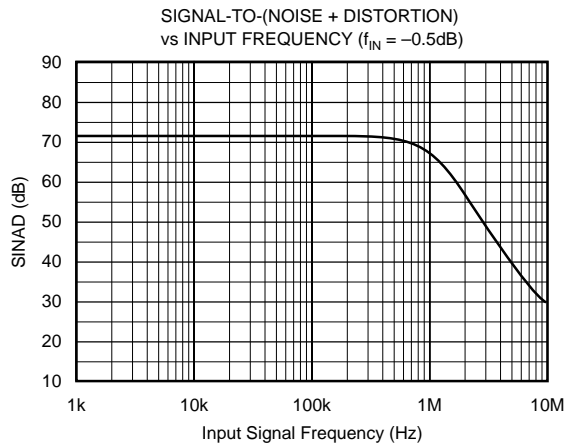
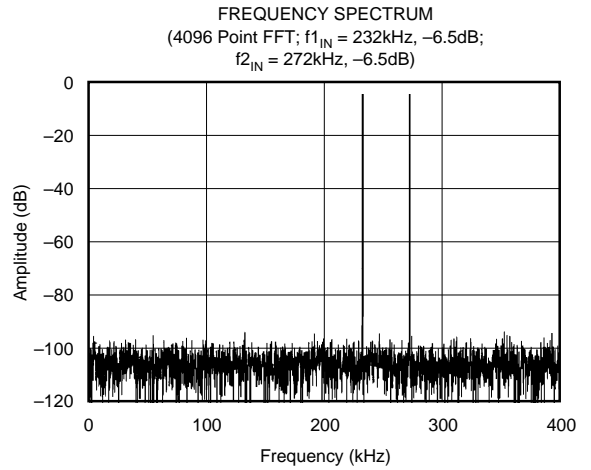
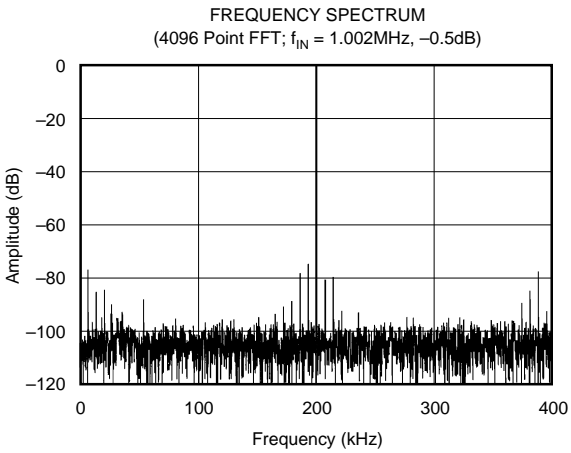
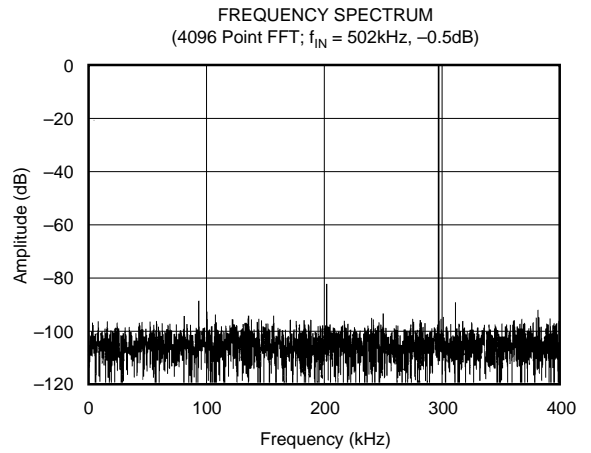
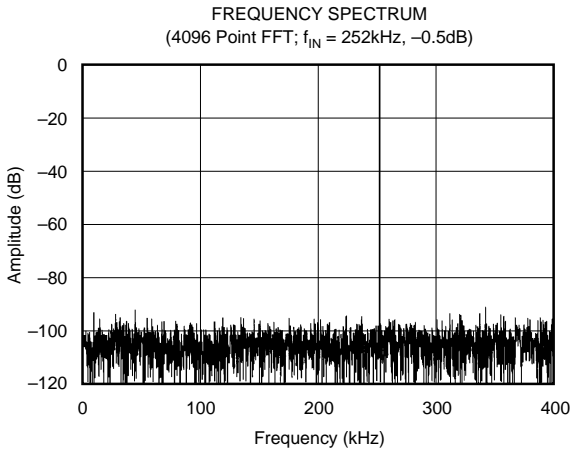
PIN #	NAME	DIGITAL I/O	DESCRIPTION
1	V <sub>IN</sub>		Analog Input. Connect via 50Ω to analog input. Full-scale input range is ±2.5V.
2	AGND1		Analog Ground. Used internally as ground reference point. Minimal current flow.
3	REF		Reference Input/Output. Outputs internal reference of +2.5V nominal. Can also be driven by external system reference. In both cases, decouple to ground with a 0.1μF ceramic capacitor.
4	CAP		Reference Buffer Output. 10μF tantalum capacitor to ground. Nominally +2V.
5	AGND2		Analog Ground.
6	D11 (MSB)	O	Data Bit 11. Most Significant Bit (MSB) of conversion results. Hi-Z state when $\overline{CS}$ is HIGH, or when $R/\overline{C}$ is LOW, or when a conversion is in progress.
7	D10	O	Data Bit 10. Hi-Z state when $\overline{CS}$ is HIGH, or when $R/\overline{C}$ is LOW, or when a conversion is in progress.
8	D9	O	Data Bit 9. Hi-Z state when $\overline{CS}$ is HIGH, or when $R/\overline{C}$ is LOW, or when a conversion is in progress.
9	D8	O	Data Bit 8. Hi-Z state when $\overline{CS}$ is HIGH, or when $R/\overline{C}$ is LOW, or when a conversion is in progress.
10	D7	O	Data Bit 7. Hi-Z state when $\overline{CS}$ is HIGH, or when $R/\overline{C}$ is LOW, or when a conversion is in progress.
11	D6	O	Data Bit 6. Hi-Z state when $\overline{CS}$ is HIGH, or when $R/\overline{C}$ is LOW, or when a conversion is in progress.
12	D5	O	Data Bit 5. Hi-Z state when $\overline{CS}$ is HIGH, or when $R/\overline{C}$ is LOW, or when a conversion is in progress.
13	D4	O	Data Bit 4. Hi-Z state when $\overline{CS}$ is HIGH, or when $R/\overline{C}$ is LOW, or when a conversion is in progress.
14	DGND		Digital Ground.
15	D3	O	Data Bit 3. Hi-Z state when $\overline{CS}$ is HIGH, or when $R/\overline{C}$ is LOW, or when a conversion is in progress.
16	D2	O	Data Bit 2. Hi-Z state when $\overline{CS}$ is HIGH, or when $R/\overline{C}$ is LOW, or when a conversion is in progress.
17	D1	O	Data Bit 1. Hi-Z state when $\overline{CS}$ is HIGH, or when $R/\overline{C}$ is LOW, or when a conversion is in progress.
18	D0 (LSB)	O	Data Bit 0. Least Significant Bit (LSB) of conversion results. Hi-Z state when $\overline{CS}$ is HIGH, or when $R/\overline{C}$ is LOW, or when a conversion is in progress.
19			Not internally connected.
20	+V <sub>ANA</sub>		Analog Positive Supply Input. Nominally +5V. Connect directly to pins 21, 27 and 28.
21	+V <sub>DIG</sub>		Digital Supply Input. Nominally +5V. Connect directly to pins 20, 27 and 28.
22	DGND		Digital ground.
23	R/ $\overline{C}$	I	Read/Convert Input. With $\overline{CS}$ LOW, a falling edge on $R/\overline{C}$ puts the internal sample/hold into the hold state and starts a conversion. With $\overline{CS}$ LOW and no conversion in progress, a rising edge on $R/\overline{C}$ enables the output data bits.
24	$\overline{CS}$	I	Chip Select. With $R/\overline{C}$ LOW, a falling edge on $\overline{CS}$ will initiate a conversion. With $R/\overline{C}$ HIGH and no conversion in progress, a falling edge on $\overline{CS}$ will enable the output data bits.
25	$\overline{BUSY}$	O	Busy Output. Falls when a conversion is started, and remains LOW until the conversion is completed and the data is latched into the output register. With $\overline{CS}$ LOW and $R/\overline{C}$ HIGH, output data will be valid when $\overline{BUSY}$ rises, so that the rising edge can be used to latch the data.
26	-V <sub>ANA</sub>		Analog Negative Supply Input. Nominally -5V. Decouple to ground with 0.1μF ceramic and 10μF tantalum capacitors.
27	+V <sub>DIG</sub>		Digital Supply Input. Nominally +5V. Connect directly to pins 20, 21 and 28.
28	+V <sub>ANA</sub>		Analog Positive Supply Input. Nominally +5V. Connect directly to pins 20, 21 and 27, and decouple to ground with 0.1μF ceramic and 10μF tantalum capacitors.

## PIN CONFIGURATION



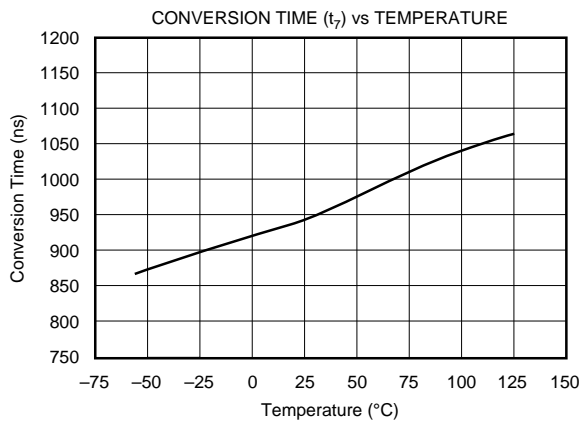
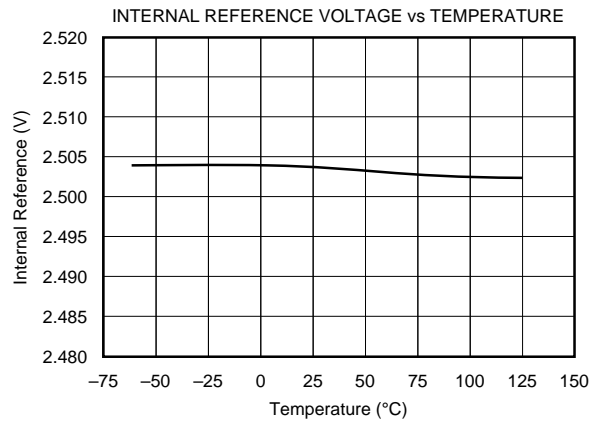
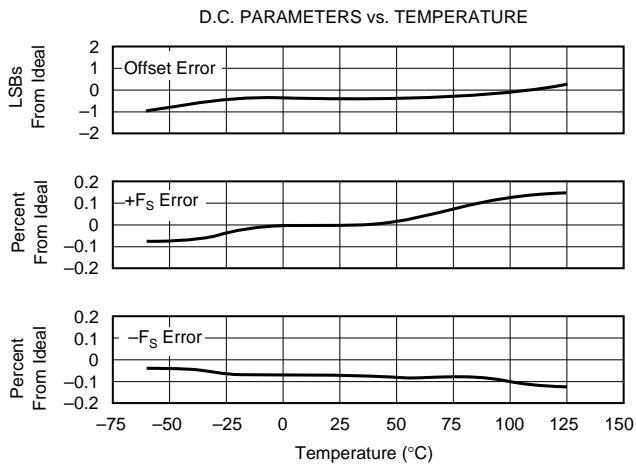
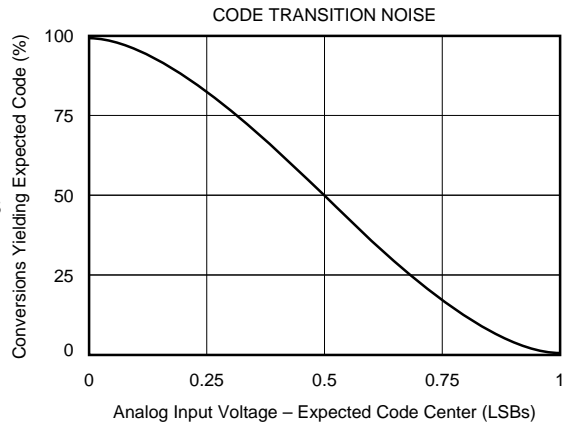
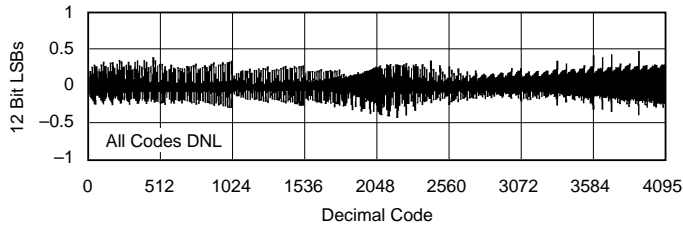
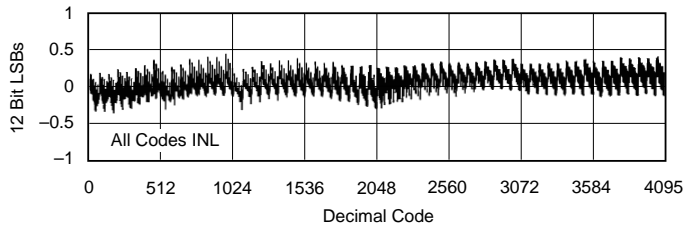
# TYPICAL PERFORMANCE CURVES

T = +25°C,  $f_s = 800\text{kHz}$ ,  $+V_{\text{DIG}} = +V_{\text{ANA}} = +5\text{V}$ ,  $-V_{\text{ANA}} = -5\text{V}$ , using internal reference and the input  $50\Omega$  resistors as shown in Figure 4b, unless otherwise specified.



# TYPICAL PERFORMANCE CURVES (CONT)

T = +25°C,  $f_s = 800\text{kHz}$ ,  $+V_{DIG} = +V_{ANA} = +5\text{V}$ ,  $-V_{ANA} = -5\text{V}$ , using internal reference and the 50Ω input resistors as shown in Figure 4b, unless otherwise specified.



## BASIC OPERATION

Figure 1 shows a basic circuit to operate the ADS7819. Taking  $\overline{R/C}$  (pin 23) LOW for 40ns will initiate a conversion.  $\overline{BUSY}$  (pin 25) will go LOW and stay LOW until the conversion is completed and the output registers are updated. Data will be output in Binary Two's Complement with the MSB on D11 (pin 6).  $\overline{BUSY}$  going HIGH can be used to latch the data. All convert commands will be ignored while  $\overline{BUSY}$  is LOW.

$\overline{CS}$	$\overline{R/C}$	$\overline{BUSY}$	OPERATION
1	X	X	None. Databus in Hi-Z state.
↓	0	1	Initiates conversion. Databus remains in Hi-Z state.
0	↓	1	Initiates conversion. Databus enters Hi-Z state.
0	1	↑	Conversion completed. Valid data from the most recent conversion on the databus.
↓	1	1	Enables databus with valid data from the most recent conversion.
↓	1	0	Conversion in progress. Databus in Hi-Z state, enabled when the conversion is completed.
0	↑	0	Conversion in progress. Databus in Hi-Z state, enabled when the conversion is completed.
0	0	↑	Conversion completed. Valid data from the most recent conversion in the output register but the output pins D11-D0 are tri-stated.
X	X	0	New convert commands ignored. Conversion in progress.

Table I. Control Line Functions for 'read' and 'convert'.

The ADS7819 will begin tracking the input signal at the end of the conversion. Allowing 1.25 $\mu$ s between convert commands assures accurate acquisition of a new signal.

## STARTING A CONVERSION

The combination of  $\overline{CS}$  (pin 24) and  $\overline{R/C}$  (pin 23) LOW for a minimum of 40ns puts the sample/hold of the ADS7819 in the hold state and starts a conversion.  $\overline{BUSY}$  (pin 25) will go LOW and stay LOW until the conversion is completed and the internal output register has been updated. All new convert commands during  $\overline{BUSY}$  LOW will be ignored.

The ADS7819 will begin tracking the input signal at the end of the conversion. Allowing 1.25 $\mu$ s between convert commands assures accurate acquisition of a new signal. Refer to Table I for a summary of  $\overline{CS}$ ,  $\overline{R/C}$ , and  $\overline{BUSY}$  states and Figures 2 and 3 for timing parameters.

DESCRIPTION	ANALOG VALUE	DIGITAL OUTPUT	
Full Scale Range	$\pm 2.5V$	<b>BINARY TWO'S COMPLEMENT</b>	
Least Significant Bit (LSB)	1.22mV	<b>BINARY CODE</b>	<b>HEX CODE</b>
+Full Scale (2.5V - 1LSB)	2.499V	0111 1111 1111	7FF
Midscale	0V	0000 0000 0000	000
One LSB below Midscale	-1.22mV	1111 1111 1111	FFF
-Full Scale	-2.5V	1000 0000 0000	800

TABLE II. Ideal Input Voltages and Output Codes.

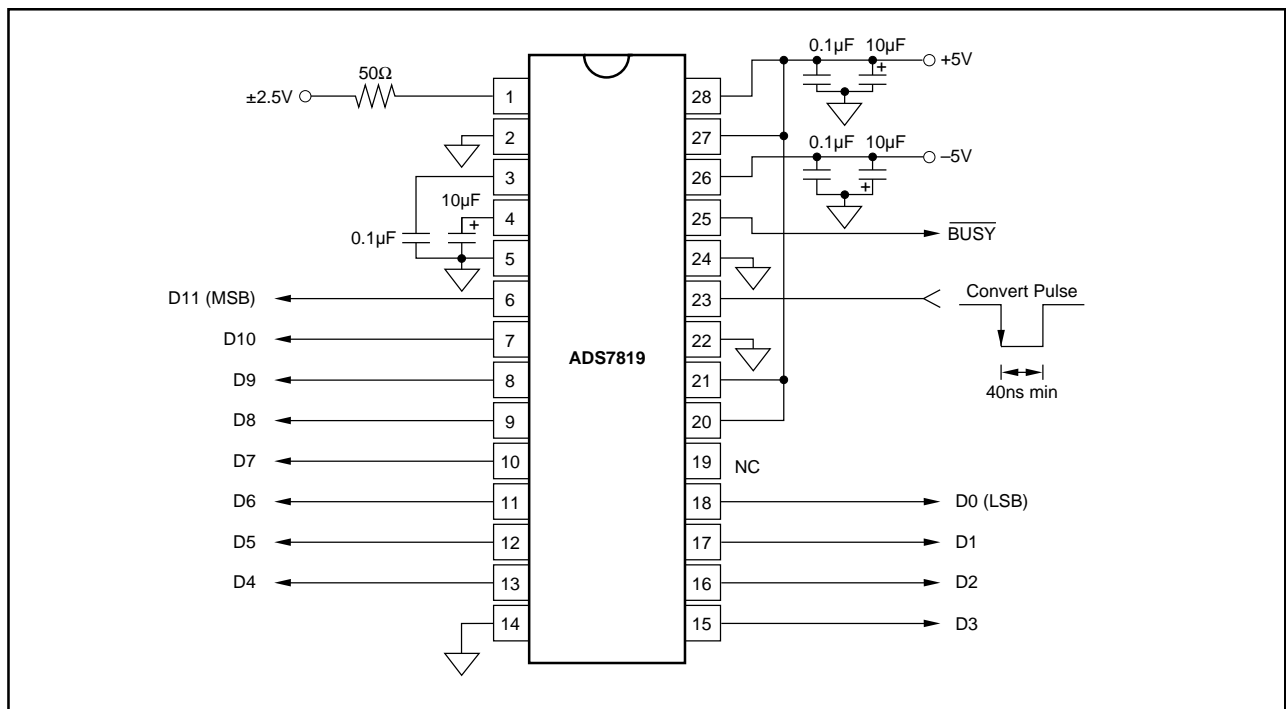


FIGURE 1. Basic Operation

$\overline{CS}$  and  $R/\overline{C}$  are internally OR'd and level triggered. There is not a requirement which input goes LOW first when initiating a conversion. If it is critical that  $\overline{CS}$  or  $R/\overline{C}$  initiate the conversion, be sure the less critical input is LOW at least 10ns 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. Note that the parallel output will be active whenever  $R/\overline{C}$  is HIGH and no conversion is in progress. See the **Reading Data** section and refer to Table I for control line functions for 'read' and 'convert' modes.

## READING DATA

The ADS7819 outputs full parallel data in Binary Two's Complement data format. The parallel output will be active when  $R/\overline{C}$  (pin 23) is HIGH,  $\overline{CS}$  (pin 24) is LOW, and no conversion is in progress. Any other combination will tri-state the parallel output. Valid conversion data can be read in a full parallel, 12-bit word on D11-D0 (pins 6-13 and 15-18). Refer to Table II for ideal output codes.

After the conversion is completed and the output registers have been updated,  $\overline{BUSY}$  (pin 25) will go HIGH. Valid data from the most recent conversion will be available on D11-D0 (pins 6-13 and 15-18).  $\overline{BUSY}$  going HIGH can be used to latch the data. Refer to Table III and Figures 2 and 3.

Note: For best performance, the external data bus connected to D11-D0 should not be active during a conversion. The switching noise of the external asynchronous data signals can cause digital feed through degrading the converter's performance.

The number of control lines can be reduced by tying  $\overline{CS}$  LOW while using  $R/\overline{C}$  to initiate conversions and activate the output mode of the converter. See Figure 2.

## INPUT RANGES

The ADS7819 has a  $\pm 2.5V$  input range. Figures 4a and 4b show the necessary circuit connections for the ADS7819 with and without external hardware trim. Offset and full scale error<sup>(1)</sup> specifications are tested and guaranteed with the 50 $\Omega$  resistor shown in Figure 4b. This external resistor makes it possible to trim the offset  $\pm 12mV$  using a trim pot or trim DAC. This resistor may be left out if the offset and gain errors will be corrected in software or if they are negligible in regards to the particular application. See the **Calibration** section of the data sheet for details.

The nominal input impedance of 3.125k $\Omega$  results from the combination of the internal resistor network shown on the front page of the product data sheet and the external 50 $\Omega$  resistor. The input resistor divider network provides inherent over-voltage protection guaranteed to at least  $\pm 25V$ . The 50 $\Omega$ , 1% resistor does not compromise the accuracy or drift of the converter. It has little influence relative to the internal resistors, and tighter tolerances are not required.

Note: The values shown for the internal resistors are for reference only. The exact values can vary by  $\pm 30\%$ . This is true of all resistors internal to the ADS7819. Each resistive divider is trimmed so that the proper division is achieved.

NOTE: (1) Full scale error includes offset and gain errors and is measured at both +FS and -FS.

SYMBOL	DESCRIPTION	MIN	TYP	MAX	UNITS
t <sub>1</sub>	Convert Pulse Width	40			ns
t <sub>2</sub>	Data Valid Delay After Start of Conversion		965	1100	ns
t <sub>3</sub>	$\overline{BUSY}$ Delay From Start of Conversion		70	125	ns
t <sub>4</sub>	$\overline{BUSY}$ LOW		960	1085	ns
t <sub>5</sub>	$\overline{BUSY}$ Delay After End of Conversion		90		ns
t <sub>6</sub>	Aperture Delay		20		ns
t <sub>7</sub>	Conversion Time		940	1030	ns
t <sub>8</sub>	Acquisition Time		180	220	ns
t <sub>7</sub> & t <sub>8</sub>	Throughput Time		1120	1250	ns
t <sub>9</sub>	Bus Relinquish Time	10	50	83	ns
t <sub>10</sub>	$\overline{BUSY}$ Delay After Data Valid	20	65	100	ns
t <sub>11</sub>	$R/\overline{C}$ to $\overline{CS}$ Setup Time	10			ns
t <sub>12</sub>	Time Between Conversions	1250			ns
t <sub>13</sub>	Bus Access Time	10	30	62	ns

TABLE III. Timing Specifications (T<sub>MIN</sub> to T<sub>MAX</sub>).



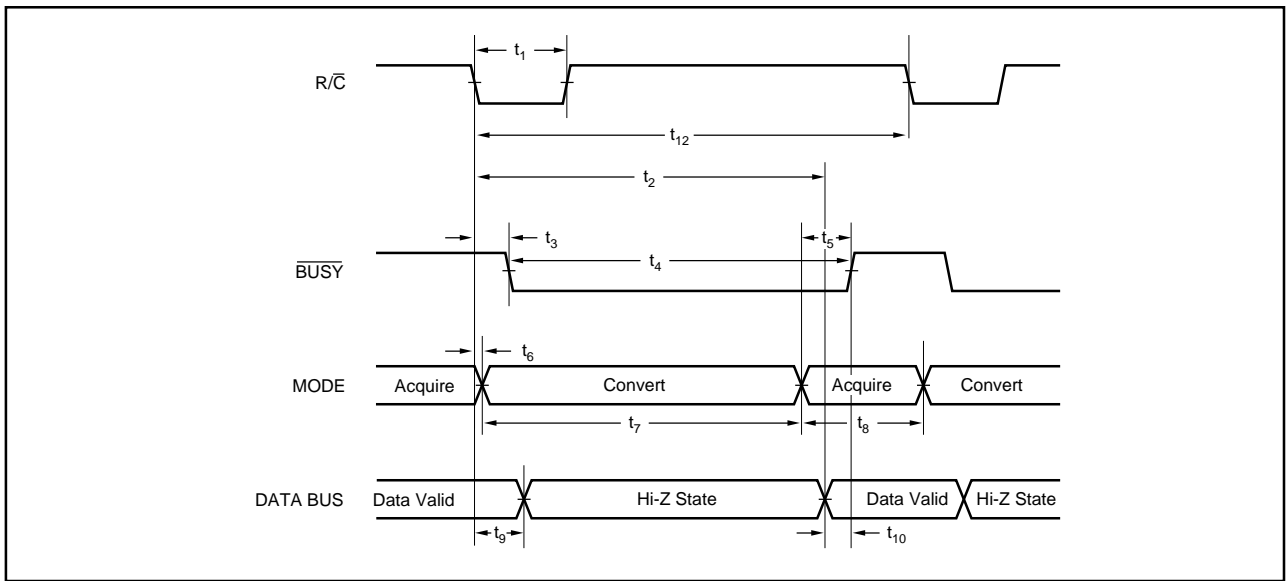


FIGURE 2. Conversion Timing with Outputs Enabled After Conversion ( $\overline{CS}$  Tied Low).

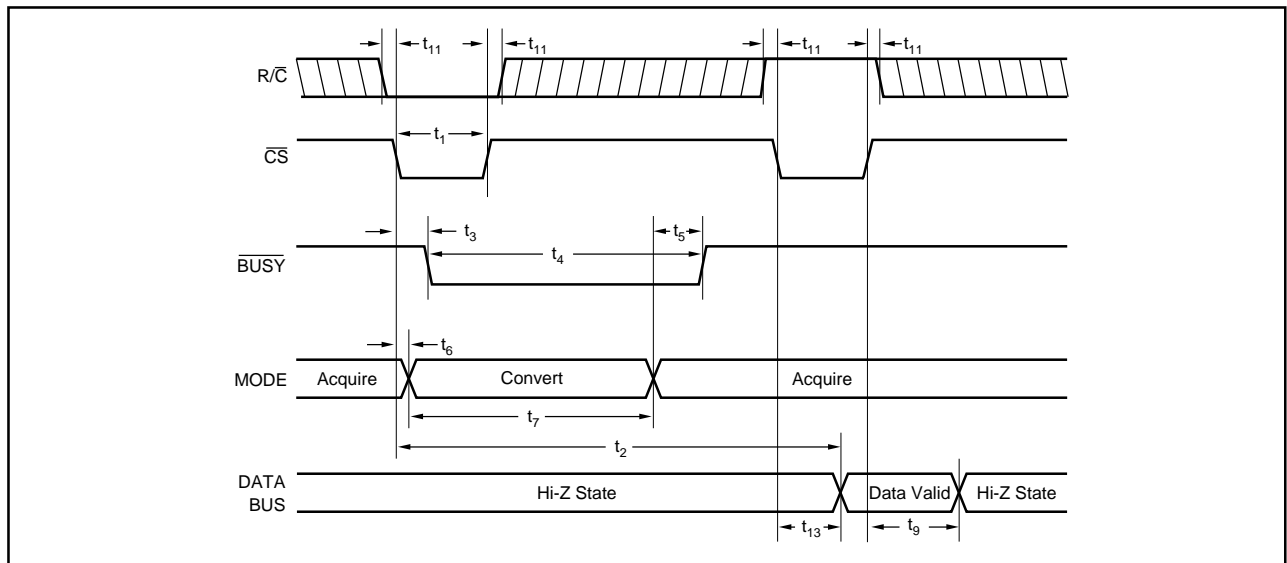


FIGURE 3. Using  $\overline{CS}$  to Control Conversion and Read Timing.

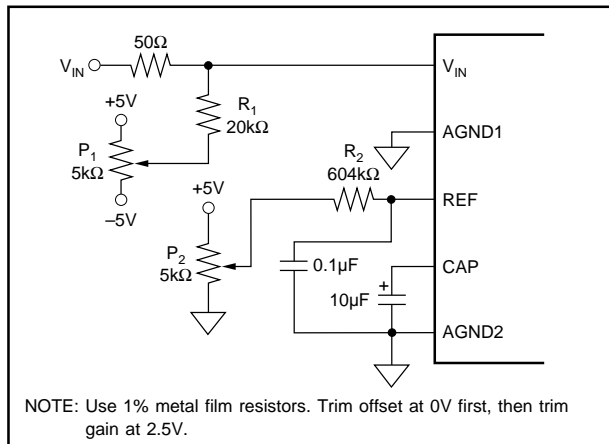


FIGURE 4a. Circuit Diagram With External Hardware Trim.

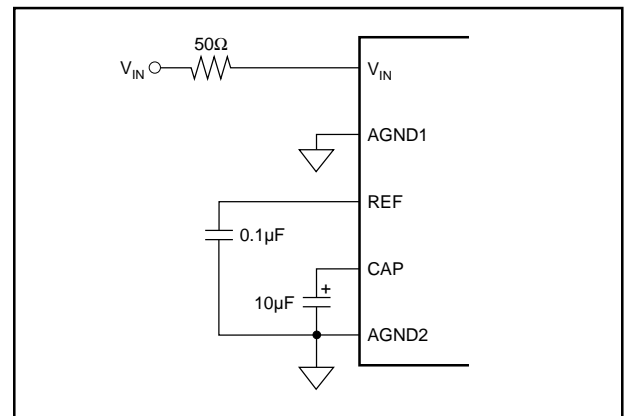


FIGURE 4b. Circuit Diagram Without External Hardware Trim.

# CALIBRATION

The ADS7819 can be trimmed in hardware or software. The offset should be trimmed before the gain since the offset directly affects the gain.

## Hardware Calibration

To calibrate the offset and gain of the ADS7819, install the proper resistors and potentiometers as shown in Figure 4a. The calibration range is  $\pm 12\text{mV}$  for bipolar zero and  $\pm 30\text{mV}$  for full scale.

Potentiometer  $P_1$  and resistor  $R_1$  form the offset adjust circuit and  $P_2$  and  $R_2$  the gain adjust circuit. The exact values are not critical.  $R_1$  and  $R_2$  should not be made any larger than the value shown. They can easily be made smaller to provide increased adjustment range. Reducing these below 15% of the indicated values could begin to adversely affect the operation of the converter.

$P_1$  and  $P_2$  can also be made larger to reduce power dissipation. However, larger resistances will push the useful adjustment range to the edges of the potentiometer.  $P_1$  should probably not exceed  $20\text{k}\Omega$  and  $P_2$   $100\text{k}\Omega$  in order to maintain reasonable sensitivity.

## Software Calibration

To calibrate the offset and gain of the ADS7819, no external resistors are required. See the **No Calibration** section for details on the effects of the external resistor.

## No Calibration

See Figure 4b for circuit connections. Note that the actual voltage dropped across the  $50\Omega$  resistor is nearly two orders of magnitude lower than the voltage dropped across the internal resistor divider network. This should be taken into consideration when choosing the accuracy and drift specifications of the external resistors. In most applications, 1% metal-film resistors will be sufficient.

The external  $50\Omega$  resistor shown in Figure 4b may not be necessary in some applications. This resistor provides trim capability for the offset and compensates for a slight gain adjustment internal to the ADS7819. Not using the  $50\Omega$  resistor will cause a small gain error but will have no effect on the inherent offset error. Figure 5 shows typical transfer function characteristics with and without the  $50\Omega$  resistor in the circuit.

# REFERENCE

The ADS7819 can operate with its internal 2.5V reference or an external reference. By applying an external reference to pin 3, the internal reference can be bypassed. The reference voltage at REF is buffered internally and output on CAP (pin 4).

The internal reference has a 6 ppm/ $^{\circ}\text{C}$  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 2.5V reference. A  $0.1\mu\text{F}$  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 band limit noise on the reference. Using a smaller value capacitor will introduce 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 2.3V to 2.7V and determines the actual LSB size. Increasing the reference voltage will increase the full scale range and the LSB size of the converter which can improve the SNR.

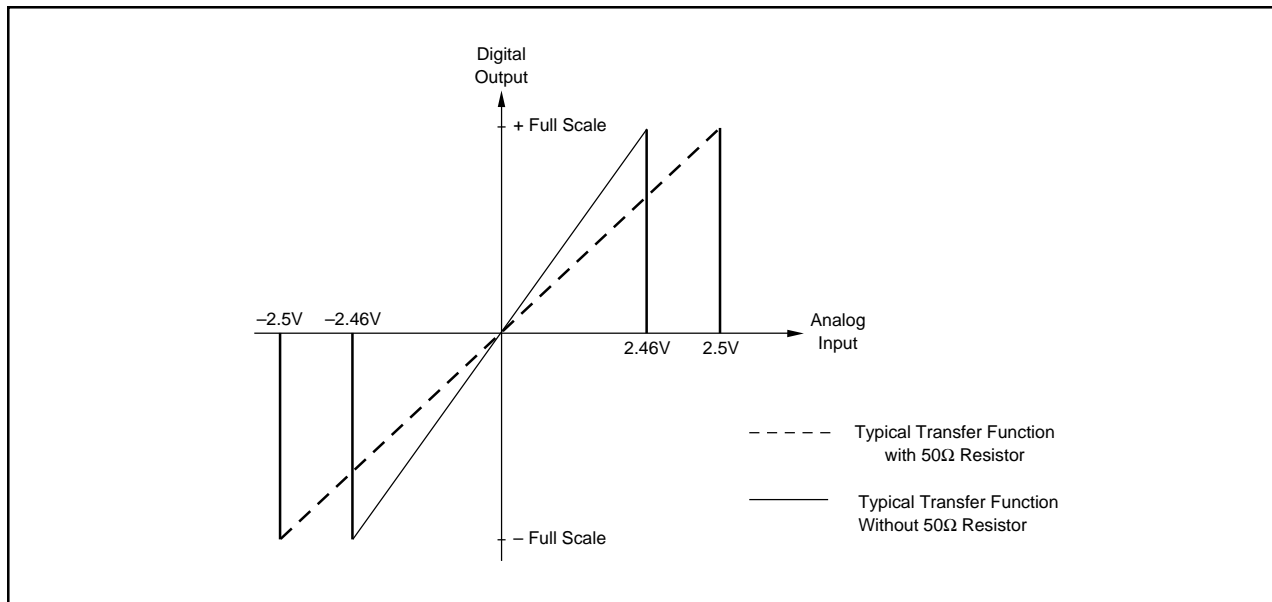


FIGURE 5. Circuit Diagram With and Without External Resistors.

## CAP

CAP (pin 4) is the output of the internal reference buffer. A 10 $\mu$ F tantalum capacitor should be placed as close to the CAP as possible to provide optimum switching currents for the CDAC throughout the conversion cycle and compensation for the output of the buffer. Using a capacitor any smaller than 1 $\mu$ F can cause the output buffer to oscillate and may not have sufficient charge for the CDAC. Capacitor values larger than 10 $\mu$ F will have little effect on improving performance. The voltage on the CAP pin is approximately 2V when using the internal reference, or 80% of an externally supplied reference.

## LAYOUT

### POWER

The ADS7819 uses the majority of its power for analog and static circuitry, and it should be considered as an analog component. For optimum performance, tie the analog and digital +5V power pins to the same +5V power supply and tie the analog and digital grounds together.

For best performance, the  $\pm$ 5V supplies can be produced from whatever analog supply is used for the rest of the analog signal conditioning. If  $\pm$ 12V or  $\pm$ 15V supplies are present, simple regulators can be used. The +5V power for the A/D should be separate from the +5V used for the system's digital logic. Connecting +V<sub>DIG</sub> (pin 27) directly to a digital supply can reduce converter performance due to switching noise from the digital logic.

Although it is not suggested, if the digital supply must be used to power the converter, be sure to properly filter the supply. Either using a filtered digital supply or a regulated analog supply, both V<sub>DIG</sub> and V<sub>ANA</sub> should be tied to the same +5V source.

### GROUNDING

Three ground pins are present on the ADS7819. DGND (pin 22) is the digital supply ground. AGND2 (pin 5) is the analog supply ground. AGND1 (pin 2) is the ground which all analog signals internal to the A/D 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 ADS should be tied to the analog ground plane, separated from the system's 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 ADS7819, compared to FET switches on

other CMOS A/D converters, releases 5%—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 op amp on the front end. Any op amp sufficient for the signal in an application will be sufficient to drive the ADS7819.

The resistive front end of the ADS7819 also provides a guaranteed  $\pm$ 25V over voltage protection. In most cases, this eliminates the need for external input protection circuitry.

### INTERMEDIATE LATCHES

The ADS7819 does have tri-state outputs for the parallel port, but intermediate latches should be used if the bus will be active during conversions. If the bus is not active during conversions, the tri-state outputs can be used to isolate the A/D from other peripherals on the same bus.

Intermediate latches are beneficial on any monolithic A/D converter. The ADS7819 has an internal LSB size of 610 $\mu$ V. Transients from fast switching signals on the parallel port, even when the A/D is tri-stated, can be coupled through the substrate to the analog circuitry causing degradation of converter performance.

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
ADS7819P	OBSOLETE	PDIP	NT	28		TBD	Call TI	Call TI
ADS7819PB	OBSOLETE	PDIP	NT	28		TBD	Call TI	Call TI
ADS7819U	OBSOLETE	SOIC	DW	28		TBD	Call TI	Call TI
ADS7819U/1K	OBSOLETE	SOIC	DW	28		TBD	Call TI	Call TI
ADS7819UB	OBSOLETE	SOIC	DW	28		TBD	Call TI	Call TI
ADS7819UB/1K	OBSOLETE	SOIC	DW	28		TBD	Call TI	Call TI

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

### Products

Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
Low Power Wireless	<a href="http://www.ti.com/lpw">www.ti.com/lpw</a>

### Applications

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

Mailing Address: Texas Instruments  
Post Office Box 655303 Dallas, Texas 75265