

### FEATURES

- 1.8 V analog supply operation
- 1.8 V to 3.3 V output supply
- SNR
  - 77.6 dBFS at 9.7 MHz input
  - 76.4 dBFS at 70 MHz input
- SFDR
  - 94 dBc at 9.7 MHz input
  - 93 dBc at 70 MHz input
- Low power
  - 111 mW at 65 MSPS
- Differential input with 700 MHz bandwidth
- On-chip voltage reference and sample-and-hold circuit
- 2 V p-p differential analog input
- DNL =  $-0.5/+1.0$  LSB
- Interleaved data output for reduced pin-count interface
- Serial port control options
  - Offset binary, Gray code, or twos complement data format
  - Optional clock duty cycle stabilizer
  - Integer 1-to-8 input clock divider
  - Built-in selectable digital test pattern generation
  - Energy-saving power-down modes
  - Data clock output (DCO) with programmable clock and data alignment

### ENHANCED PRODUCT FEATURES

- Supports defense and aerospace applications (AQEC standard)
- Military temperature range ( $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ )
- Controlled manufacturing baseline
- Enhanced product change notification
- Qualification data available on request

### APPLICATIONS

- Communications
- Diversity radio systems
- Multimode digital receivers
  - GSM, EDGE, W-CDMA, LTE, CDMA2000, WiMAX, TD-SCDMA
- Smart antenna systems
- Battery-powered instruments
- Handheld scope meters
- Portable medical imaging
- Ultrasound
- Radar/LIDAR
- PET/SPECT imaging

### FUNCTIONAL BLOCK DIAGRAM

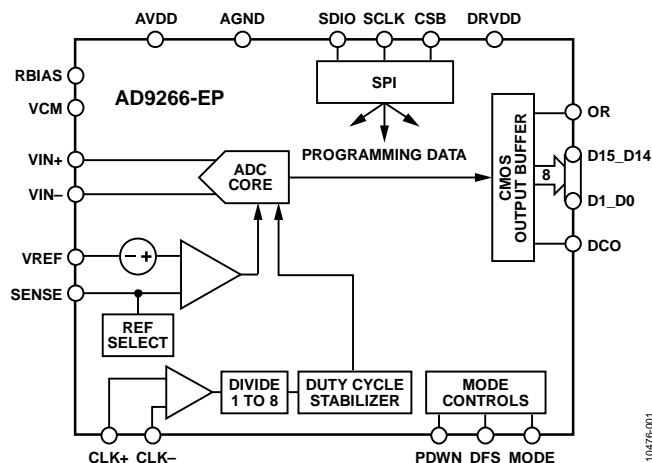


Figure 1.

### PRODUCT HIGHLIGHTS

- The [AD9266-EP](#) operates from a single 1.8 V analog power supply and features a separate digital output driver supply to accommodate 1.8 V to 3.3 V logic families.
- The patented sample-and-hold circuit maintains excellent performance at high input frequencies and is designed for low cost, low power, and ease of use.
- A standard serial port interface supports various product features and functions, such as data output formatting, internal clock divider, power-down, DCO and data output (D15\_D14 to D1\_D0) timing and offset adjustments, and voltage reference modes.
- The [AD9266-EP](#) is packaged in a 32-lead RoHS-compliant LFCSP that is pin compatible with the [AD9609](#) 10-bit ADC, the [AD9629](#) 12-bit ADC, and the [AD9649](#) 14-bit ADC, enabling a simple migration path between 10-bit and 16-bit converters sampling at 65 MSPS.

Rev. A

Information furnished by Analog Devices is believed to be accurate and reliable. However, no responsibility is assumed by Analog Devices for its use, nor for any infringements of patents or other rights of third parties that may result from its use. Specifications subject to change without notice. No license is granted by implication or otherwise under any patent or patent rights of Analog Devices. Trademarks and registered trademarks are the property of their respective owners.

TABLE OF CONTENTS

Features .....	1	Digital Specifications .....	6
Enhanced Product Features .....	1	Switching Specifications .....	7
Applications .....	1	Timing Specifications .....	8
Functional Block Diagram .....	1	Absolute Maximum Ratings .....	9
Product Highlights .....	1	Thermal Characteristics .....	9
Revision History .....	2	ESD Caution.....	9
General Description .....	3	Pin Configuration and Function Descriptions.....	10
Specifications.....	4	Outline Dimensions .....	11
DC Specifications .....	4	Ordering Guide .....	11
AC Specifications.....	5		

REVISION HISTORY

- 7/12—Rev. 0 to Rev. A  
Changes to Resolution Parameter, Table 1 and Note 3, Table 1 ..... 4
- 1/12—Revision 0: Initial Version

## GENERAL DESCRIPTION

The [AD9266-EP](#) is a monolithic, single-channel 1.8 V supply, 16-bit, 65 MSPS analog-to-digital converter (ADC). It features a high performance sample-and-hold circuit and on-chip voltage reference.

The product uses multistage differential pipeline architecture with output error correction logic to provide 16-bit accuracy at 65 MSPS data rates and to guarantee no missing codes over the full operating temperature range.

The ADC contains several features designed to maximize flexibility and minimize system cost, such as programmable clock and data alignment and programmable digital test pattern generation. The available digital test patterns include built-in deterministic and pseudorandom patterns, along with custom user-defined test patterns entered via the serial port interface (SPI).

A differential clock input with a selectable internal 1-to-8 divide ratio controls all internal conversion cycles. An optional duty cycle stabilizer (DCS) compensates for wide variations in the clock duty cycle while maintaining excellent overall ADC performance.

The interleaved digital output data is presented in offset binary, gray code, or twos complement format. A data output clock (DCO) is provided to ensure proper latch timing with receiving logic. CMOS levels from 1.8 V through 3.3 V are supported.

The [AD9266-EP](#) is available in a 32-lead RoHS-compliant LFCSP and is specified over the  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  temperature range.

Additional application and technical information can be found in the [AD9266](#) data sheet.

This product is protected by a U.S. patent.

## SPECIFICATIONS

### DC SPECIFICATIONS

AVDD = 1.8 V; DRVDD = 1.8 V, maximum sample rate, 2 V p-p differential input, 1.0 V internal reference; AIN = –1.0 dBFS, 50% duty cycle clock, DCS disabled, unless otherwise noted.

Table 1.

Parameter	Temp	Min	Typ	Max	Unit
RESOLUTION	Full	16			Bits
ACCURACY					
No Missing Codes	Full		Guaranteed		
Offset Error	Full		+0.05	±0.30	% FSR
Gain Error <sup>1</sup>	25°C		–1.3		% FSR
Differential Nonlinearity (DNL) <sup>2</sup>	Full			–0.9/+1.7	LSB
	25°C		–0.5/+1.0		LSB
Integral Nonlinearity (INL) <sup>2</sup>	Full			±6.5	LSB
	25°C		±2.6		LSB
TEMPERATURE DRIFT					
Offset Error	Full		±2		ppm/°C
INTERNAL VOLTAGE REFERENCE					
Output Voltage (1 V Mode)	Full	0.983	0.995	1.007	V
Load Regulation Error at 1.0 mA	25°C		2		mV
INPUT-REFERRED NOISE					
VREF = 1.0 V	25°C		2.8		LSB rms
ANALOG INPUT					
Input Span, VREF = 1.0 V	25°C		2		V p-p
Input Capacitance <sup>3</sup>	25°C		6.5		pF
Input Common-Mode Voltage	25°C		0.9		V
Input Common-Mode Range	Full	0.5		1.3	V
REFERENCE INPUT RESISTANCE	Full		7.5		kΩ
POWER SUPPLIES					
Supply Voltage					
AVDD	Full	1.7	1.8	1.9	V
DRVDD	Full	1.7		3.6	V
Supply Current					
IAVDD <sup>2</sup>	Full		56.3	62.2	mA
IDRVDD <sup>2</sup> (1.8 V)	25°C		5.2		mA
IDRVDD <sup>2</sup> (3.3 V)	25°C		9.3		mA
POWER CONSUMPTION					
DC Input	25°C		107		mW
Sine Wave Input <sup>2</sup> (DRVDD = 1.8 V)	Full		111	122	mW
Sine Wave Input <sup>2</sup> (DRVDD = 3.3 V)	25°C		132		mW
Standby Power <sup>4</sup>	25°C		44		mW
Power-Down Power	25°C		0.5		mW

<sup>1</sup> Measured with 1.0 V external reference.

<sup>2</sup> Measured with a 10 MHz input frequency at rated sample rate, full-scale sine wave, with approximately 5 pF loading on each output bit.

<sup>3</sup> Input capacitance refers to the effective capacitance between the differential inputs.

<sup>4</sup> Standby power is measured with a dc input and the CLK active.

**AC SPECIFICATIONS**

AVDD = 1.8 V; DRVDD = 1.8 V, maximum sample rate, 2 V p-p differential input, 1.0 V internal reference; AIN = -1.0 dBFS, 50% duty cycle clock, DCS disabled, unless otherwise noted.

**Table 2.**

Parameter <sup>1</sup>	Temp	Min	Typ	Max	Unit
SIGNAL-TO-NOISE RATIO (SNR)					
$f_{IN} = 9.7 \text{ MHz}$	25°C		77.6		dBFS
$f_{IN} = 30.5 \text{ MHz}$	25°C		77.4		dBFS
	Full	76.5			dBFS
$f_{IN} = 70 \text{ MHz}$	25°C		76.4		dBFS
SIGNAL-TO-NOISE-AND-DISTORTION (SINAD)					
$f_{IN} = 9.7 \text{ MHz}$	25°C		77.4		dBFS
$f_{IN} = 30.5 \text{ MHz}$	25°C		77.2		dBFS
	Full	76.0			dBFS
$f_{IN} = 70 \text{ MHz}$	25°C		76.3		dBFS
EFFECTIVE NUMBER OF BITS (ENOB)					
$f_{IN} = 9.7 \text{ MHz}$	25°C		12.6		Bits
$f_{IN} = 30.5 \text{ MHz}$	25°C		12.5		Bits
	Full	12.3			Bits
$f_{IN} = 70 \text{ MHz}$	25°C		12.4		Bits
WORST SECOND OR THIRD HARMONIC					
$f_{IN} = 9.7 \text{ MHz}$	25°C		-94		dBc
$f_{IN} = 30.5 \text{ MHz}$	25°C		-93		dBc
	Full			-80	dBc
$f_{IN} = 70 \text{ MHz}$	25°C		-93		dBc
SPURIOUS-FREE DYNAMIC RANGE (SFDR)					
$f_{IN} = 9.7 \text{ MHz}$	25°C		94		dBc
$f_{IN} = 30.5 \text{ MHz}$	25°C		93		dBc
	Full	80			dBc
$f_{IN} = 70 \text{ MHz}$	25°C		93		dBc
WORST OTHER (HARMONIC OR SPUR)					
$f_{IN} = 9.7 \text{ MHz}$	25°C		-92		dBc
$f_{IN} = 30.5 \text{ MHz}$	25°C		-101		dBc
	Full			-88	dBc
$f_{IN} = 70 \text{ MHz}$	25°C		-98		dBc
TWO-TONE SFDR					
$f_{IN} = 30.5 \text{ MHz} (-7 \text{ dBFS}), 32.5 \text{ MHz} (-7 \text{ dBFS})$	25°C		90		dBc
ANALOG INPUT BANDWIDTH	25°C		700		MHz

<sup>1</sup> See the AN-835 Application Note, *Understanding High Speed ADC Testing and Evaluation*, for a complete set of definitions.

**DIGITAL SPECIFICATIONS**

AVDD = 1.8 V; DRVDD = 1.8 V, maximum sample rate, 2 V p-p differential input, 1.0 V internal reference; AIN = -1.0 dBFS, 50% duty cycle clock, DCS disabled, unless otherwise noted.

**Table 3.**

Parameter	Temp	Min	Typ	Max	Unit
<b>DIFFERENTIAL CLOCK INPUTS (CLK+, CLK-)</b>					
Logic Compliance			CMOS/LVDS/LVPECL		
Internal Common-Mode Bias	Full		0.9		V
Differential Input Voltage	Full	0.2		3.6	V p-p
Input Voltage Range	Full	GND - 0.3		AVDD + 0.2	V
High Level Input Current	Full	-10		+10	μA
Low Level Input Current	Full	-10		+10	μA
Input Resistance	Full	8	10	12	kΩ
Input Capacitance	Full		4		pF
<b>LOGIC INPUTS (SCLK/DFS, MODE, SDIO/PDWN)<sup>1</sup></b>					
High Level Input Voltage	Full	1.2		DRVDD + 0.3	V
Low Level Input Voltage	Full	0		0.8	V
High Level Input Current	Full	-50		-75	μA
Low Level Input Current	Full	-10		+10	μA
Input Resistance	Full		30		kΩ
Input Capacitance	Full		2		pF
<b>LOGIC INPUTS (CSB)<sup>2</sup></b>					
High Level Input Voltage	Full	1.2		DRVDD + 0.3	V
Low Level Input Voltage	Full	0		0.8	V
High Level Input Current	Full	-10		+10	μA
Low Level Input Current	Full	40		135	μA
Input Resistance	Full		26		kΩ
Input Capacitance	Full		2		pF
<b>DIGITAL OUTPUTS</b>					
DRVDD = 3.3 V					
High Level Output Voltage, I <sub>OH</sub> = 50 μA	Full	3.29			V
High Level Output Voltage, I <sub>OH</sub> = 0.5 mA	Full	3.25			V
Low Level Output Voltage, I <sub>OL</sub> = 1.6 mA	Full			0.2	V
Low Level Output Voltage, I <sub>OL</sub> = 50 μA	Full			0.05	V
DRVDD = 1.8 V					
High Level Output Voltage, I <sub>OH</sub> = 50 μA	Full	1.79			V
High Level Output Voltage, I <sub>OH</sub> = 0.5 mA	Full	1.75			V
Low Level Output Voltage, I <sub>OL</sub> = 1.6 mA	Full			0.2	V
Low Level Output Voltage, I <sub>OL</sub> = 50 μA	Full			0.05	V

<sup>1</sup> Internal 30 kΩ pull-down.

<sup>2</sup> Internal 30 kΩ pull-up.

**SWITCHING SPECIFICATIONS**

AVDD = 1.8 V; DRVDD = 1.8 V, maximum sample rate, 2 V p-p differential input, 1.0 V internal reference; AIN = -1.0 dBFS, 50% duty cycle clock, DCS disabled, unless otherwise noted.

**Table 4.**

Parameter	Temp	Min	Typ	Max	Unit
<b>CLOCK INPUT PARAMETERS</b>					
Input Clock Rate	Full			520	MHz
Conversion Rate <sup>1</sup>	Full	3		65	MSPS
CLK Period—Divide-by-1 Mode ( $t_{CLK}$ )	Full	15.38			ns
CLK Pulse Width High ( $t_{CH}$ )			7.69		ns
Aperture Delay ( $t_A$ )	Full		1.0		ns
Aperture Uncertainty (Jitter, $t_j$ )	Full		0.1		ps rms
<b>DATA OUTPUT PARAMETERS</b>					
Data Propagation Delay ( $t_{PD}$ )	Full		3		ns
DCO Propagation Delay ( $t_{DCO}$ )	Full		3		ns
DCO to Data Skew ( $t_{SKEW}$ )	Full		0.1		ns
Pipeline Delay (Latency)	Full		9		Cycles
Wake-Up Time <sup>2</sup>	Full		350		$\mu$ s
Standby	Full		300		ns
OUT-OF-RANGE RECOVERY TIME	Full		2		Cycles

<sup>1</sup> Conversion rate is the clock rate after the CLK divider.

<sup>2</sup> Wake-up time is dependent on the value of the decoupling capacitors.

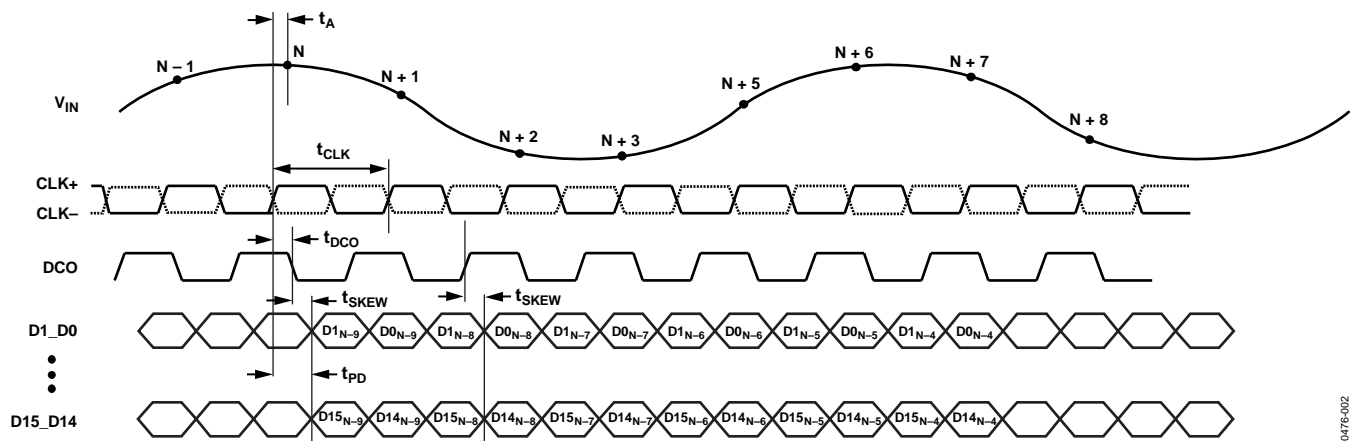


Figure 2. CMOS Output Data Timing

10476-002

## TIMING SPECIFICATIONS

Table 5.

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
SPI TIMING REQUIREMENTS					
$t_{DS}$	Setup time between the data and the rising edge of SCLK	2			ns
$t_{DH}$	Hold time between the data and the rising edge of SCLK	2			ns
$t_{CLK}$	Period of the SCLK	40			ns
$t_S$	Setup time between CSB and SCLK	2			ns
$t_H$	Hold time between CSB and SCLK	2			ns
$t_{HIGH}$	SCLK pulse width high	10			ns
$t_{LOW}$	SCLK pulse width low	10			ns
$t_{EN\_SDIO}$	Time required for the SDIO pin to switch from an input to an output relative to the SCLK falling edge	10			ns
$t_{DIS\_SDIO}$	Time required for the SDIO pin to switch from an output to an input relative to the SCLK rising edge	10			ns



## ABSOLUTE MAXIMUM RATINGS

Table 6.

Parameter	Rating
AVDD to AGND	–0.3 V to +2.0 V
DRVDD to AGND	–0.3 V to +3.9 V
VIN+, VIN– to AGND	–0.3 V to AVDD + 0.2 V
CLK+, CLK– to AGND	–0.3 V to AVDD + 0.2 V
VREF to AGND	–0.3 V to AVDD + 0.2 V
SENSE to AGND	–0.3 V to AVDD + 0.2 V
VCM to AGND	–0.3 V to AVDD + 0.2 V
RBIAS to AGND	–0.3 V to AVDD + 0.2 V
CSB to AGND	–0.3 V to DRVDD + 0.3 V
SCLK/DFS to AGND	–0.3 V to DRVDD + 0.3 V
SDIO/PDWN to AGND	–0.3 V to DRVDD + 0.3 V
MODE/OR to AGND	–0.3 V to DRVDD + 0.3 V
D1_D0 Through D15_D14 to AGND	–0.3 V to DRVDD + 0.3 V
DCO to AGND	–0.3 V to DRVDD + 0.3 V
Operating Temperature Range (Ambient)	–55°C to +125°C
Maximum Junction Temperature Under Bias	150°C
Storage Temperature Range (Ambient)	–65°C to +150°C

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## THERMAL CHARACTERISTICS

The exposed paddle is the only ground connection for the chip. The exposed paddle must be soldered to the AGND plane of the user's circuit board. Soldering the exposed paddle to the user's board also increases the reliability of the solder joints and maximizes the thermal capability of the package.

Table 7. Thermal Resistance

Package Type	Airflow Velocity (m/sec)	$\theta_{JA}^{1,2}$	$\theta_{JC}^{1,3}$	$\theta_{JB}^{1,4}$	$\Psi_{JT}^{1,2}$	Unit
32-Lead LFCSP 5 mm × 5 mm	0	37.1	3.1	20.7	0.3	°C/W
	1.0	32.4			0.5	°C/W
	2.5	29.1			0.8	°C/W

<sup>1</sup> Per JEDEC 51-7, plus JEDEC 51-5 252P test board.

<sup>2</sup> Per JEDEC JESD51-2 (still air) or JEDEC JESD51-6 (moving air).

<sup>3</sup> Per MIL-Std 883, Method 1012.1.

<sup>4</sup> Per JEDEC JESD51-8 (still air).

Typical  $\theta_{JA}$  is specified for a 4-layer PCB with a solid ground plane. As shown in Table 7, airflow improves heat dissipation, which reduces  $\theta_{JA}$ . In addition, metal in direct contact with the package leads from metal traces, through holes, ground, and power planes reduces the  $\theta_{JA}$ .

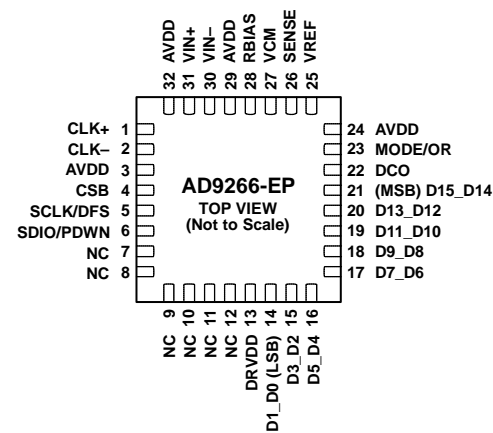
## ESD CAUTION



### ESD (electrostatic discharge) sensitive device.

Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

## PIN CONFIGURATION AND FUNCTION DESCRIPTIONS



## NOTES

1. NC = NO CONNECT. DO NOT CONNECT TO THIS PIN.
2. THE EXPOSED PADDLE (PIN 0) IS THE ONLY GND CONNECTION ON THE CHIP AND MUST BE CONNECTED TO THE PCB AGND.

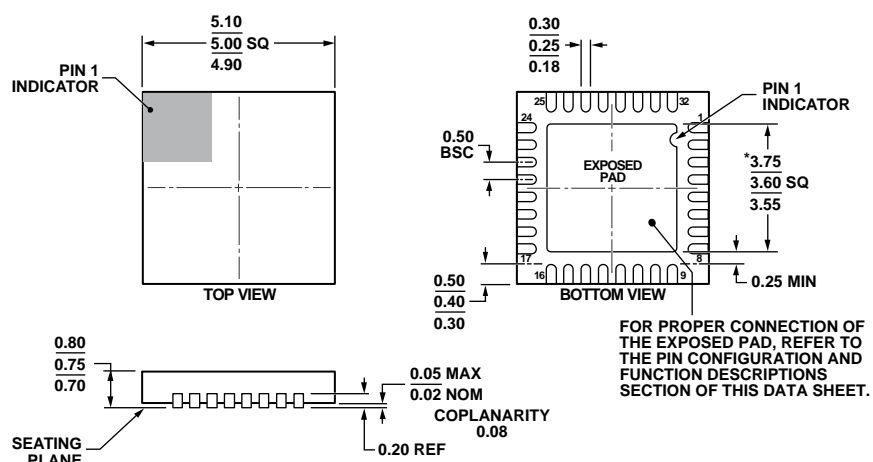
10476-003

Figure 3. Pin Configuration

Table 8. Pin Function Descriptions

Pin No.	Mnemonic	Description
0	Exposed Paddle	AGND. The exposed paddle is the only ground connection on the chip. It must be soldered to the analog ground of the PCB to ensure proper functionality and heat dissipation, noise, and mechanical strength benefits.
1, 2	CLK+, CLK–	Differential Encode Clock for PECL, LVDS, or 1.8 V CMOS Inputs.
3, 24, 29, 32	AVDD	1.8 V Supply Pin for ADC Core Domain.
4	CSB	SPI Chip Select. Active low enable, 30 k $\Omega$ internal pull-up.
5	SCLK/DFS	SPI Clock Input in SPI Mode (SCLK). 30 k $\Omega$ internal pull-down. Data Format Select in Non-SPI Mode (DFS). Static control of data output format. 30 k $\Omega$ internal pull-down. DFS high = twos complement output; DFS low = offset binary output.
6	SDIO/PDWN	SPI Data Input/Output (SDIO). Bidirectional SPI data I/O with 30 k $\Omega$ internal pull-down. Non-SPI Mode Power-Down (PDWN). Static control of chip power-down with 30 k $\Omega$ internal pull-down.
7 to 12	NC	No Connect. Do not connect to this pin.
14 to 21	D1_D0 (LSB) to (MSB) D15_D14	ADC Digital Outputs.
13	DRVDD	1.8 V to 3.3 V Supply Pin for Output Driver Domain.
22	DCO	Data Clock Digital Output.
23	MODE/OR	Chip Mode Select Input (MODE)/Out-of-Range Digital Output in SPI Mode (OR). Default = out-of-range (OR) digital output (SPI Register 0x2A, Bit 0 = 1). Option = chip mode select input (SPI Register 0x2A, Bit 0 = 0). Chip power-down (SPI Register 0x08, Bits[7:5] = 100b). Chip standby (SPI Register 0x08, Bits[7:5] = 101b). Normal operation, output disabled (SPI Register 0x08, Bits[7:5] = 110b). Normal operation, output enabled (SPI Register 0x08, Bits[7:5] = 111b). Out-of-range (OR) digital output only in non-SPI mode.
25	VREF	1.0 V Voltage Reference Input/Output.
26	SENSE	Reference Mode Selection.
27	VCM	Analog Output Voltage at Mid AVDD Supply. Sets common mode of the analog inputs.
28	RBIAIS	Set Analog Current Bias. Connect to 10 k $\Omega$ (1% tolerance) resistor to ground.
30, 31	VIN–, VIN+	ADC Analog Inputs.

## OUTLINE DIMENSIONS



\*COMPLIANT TO JEDEC STANDARDS MO-220-WHHD-5  
WITH EXCEPTION TO EXPOSED PAD DIMENSION.

Figure 4. 32-Lead Lead Frame Chip Scale Package [LFCSP\_WQ]  
5 mm × 5 mm Body, Very Very Thin Quad (CP-32-12)  
Dimensions shown in millimeters

09-16-2010-B

## ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option
AD9266TCPZ-65EP	–55°C to +125°C	32-Lead Lead Frame Chip Scale Package [LFCSP_WQ]	CP-32-12
AD9266TCPZRL7-65EP	–55°C to +125°C	32-Lead Lead Frame Chip Scale Package [LFCSP_WQ]	CP-32-12

<sup>1</sup> Z = RoHS Compliant Part.

**NOTES**