Octal, 14-Bit, 65 MSPS, Serial LVDS, 1.8 V Analog-to-Digital Converter

Data Sheet

AD9257-EP

FEATURES

- Low power: 55 mW per channel at 65 MSPS with scalable power options
- SNR = 75.5 dB (to Nyquist)
- SFDR = 91 dBc (to Nyquist)
- DNL = ±0.6 LSB (typical), INL = ±1.1 LSB (typical)
- Serial LVDS (ANSI-644, default)
  - Low power, reduced signal option (similar to IEEE 1596.3)
- Data and frame clock outputs
- 650 MHz full power analog bandwidth
- 2 V p-p input voltage range
- 1.8 V supply operation
- Serial port control
  - Full chip and individual channel power-down modes
  - Flexible bit orientation
  - Built-in and custom digital test pattern generation
  - Programmable clock and data alignment
  - Programmable output resolution
  - Standby mode

ENHANCED PRODUCT FEATURES

- Supports defense and aerospace applications (AQEC standard)
- Military temperature range (−55°C to +125°C)
- Controlled manufacturing baseline
- Qualification data available on request

APPLICATIONS

- Medical imaging and nondestructive ultrasound
- Portable ultrasound and digital beam forming systems
- Quadrature radio receivers
- Diversity radio receivers
- Optical networking
- Test equipment

GENERAL DESCRIPTION

The AD9257-EP is an octal, 14-bit, 65 MSPS analog-to-digital converter (ADC) with an on-chip sample-and-hold circuit designed for low cost, low power, small size, and ease of use. The product operates at a conversion rate of up to 65 MSPS and is optimized for outstanding dynamic performance and low power in applications where a small package size is critical.

The ADC requires a single 1.8 V power supply and LVPECL-/CMOS-/LVDS-compatible sample rate clock for full performance operation. No external reference or driver components are required for many applications.

The ADC automatically multiplies the sample rate clock for the appropriate LVDS serial data rate. A data clock output (DCO) for capturing data on the output and a frame clock output (FCO) for signaling a new output byte are provided. Individual channel

FUNCTIONAL BLOCK DIAGRAM

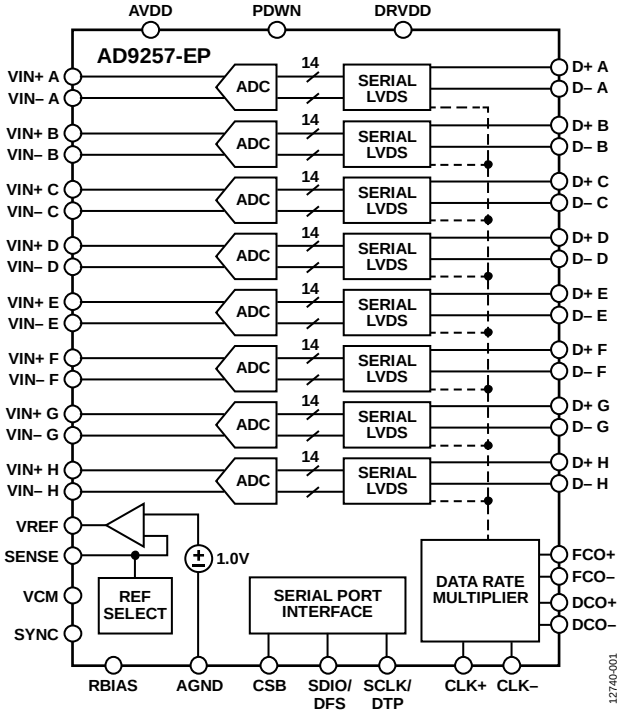

Figure 1.

power-down is supported and typically consumes 1 mW when all channels are disabled. 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).

The AD9257-EP is available in an RoHS-compliant, 64-lead LFCSP. It is specified over the −55°C to +125°C temperature. This product is protected by a U.S. patent. Additional application and technical information can be found in the AD9257 data sheet.

PRODUCT HIGHLIGHTS

1. Small Footprint. Eight ADCs are contained in a small, space-saving package.
2. Low Power of 55 mW/Channel at 65 MSPS with Scalable Power Options.
3. Ease of Use. A DCO is provided that operates at frequencies of up to 455 MHz and supports double data rate (DDR) operation.
4. User Flexibility. The SPI control offers a wide range of flexible features to meet specific system requirements.
5. Pin Compatible with the AD9637 (12-Bit Octal ADC).

Rev. A Document Feedback

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2/15—Revision 0: Initial Version

SPECIFICATIONS

DC SPECIFICATIONS

AVDD = 1.8 V, DRVDD = 1.8 V, 2 V p-p differential input, 1.0 V internal reference, AIN = −1.0 dBFS, unless otherwise noted.

Table 1.

Parameter[1]	Temp	Min	Typ	Max	Unit
RESOLUTION		14			Bits
ACCURACY					
No Missing Codes	Full		Guaranteed		
Offset Error	Full	−0.7	−0.3	+0.1	% FSR
Offset Matching	Full	0	0.23	0.6	% FSR
Gain Error	Full	−7.0	−2.9	+1.0	% FSR
Gain Matching	Full	−1.0	+1.6	+5.0	% FSR
Differential Nonlinearity (DNL)	Full	−0.95	±0.6	+1.6	LSB
Integral Nonlinearity (INL)	Full	−4.5	±1.1	+4.5	LSB
TEMPERATURE DRIFT					
Offset Error	Full		±2		ppm/°C
INTERNAL VOLTAGE REFERENCE					
Output Voltage (1 V Mode)	Full	0.98	0.99	1.01	V
Load Regulation at 1.0 mA (V_{REF} = 1 V)	Full		2		mV
Input Resistance	Full		7.5		kΩ
INPUT REFERRED NOISE					
V_{REF} = 1.0 V	25°C		0.94		LSB rms
ANALOG INPUTS					
Differential Input Voltage (V_{REF} = 1 V)	Full		2		V p-p
Common-Mode Voltage	Full		0.9		V
Common-Mode Range	Full	0.5		1.3	V
Differential Input Resistance			5.2		kΩ
Differential Input Capacitance	Full		3.5		pF
POWER SUPPLY					
AVDD	Full	1.7	1.8	1.9	V
DRVDD	Full	1.7	1.8	1.9	V
I_{AVDD}	Full		198	211	mA
I_{DRVDD} (ANSI-644 Mode)	Full		60	93	mA
I_{DRVDD} (Reduced Range Mode)	25°C		45		mA
TOTAL POWER CONSUMPTION					
Total Power Dissipation (Eight Channels, ANSI-644 Mode)	Full		464	547	mW
Total Power Dissipation (Eight Channels, Reduced Range Mode)	25°C		437		mW
Power-Down Dissipation	25°C		1		mW
Standby Dissipation[2]	25°C		92		mW

[1] See the AN-835 Application Note, *Understanding High Speed ADC Testing and Evaluation*, for definitions and for details on how these tests were completed.
[2] Can be controlled via the SPI.

AC SPECIFICATIONS

AVDD = 1.8 V, DRVDD = 1.8 V, 2 V p-p differential input, 1.0 V internal reference, AIN = −1.0 dBFS, unless otherwise noted. CLK divider = 8 used for typical characteristics at input frequency ≥ 19.7 MHz.

Table 2.

Parameter[1]	Temp	Min	Typ	Max	Unit
SIGNAL-TO-NOISE RATIO (SNR)					
f_{IN} = 9.7 MHz	25°C		75.7		dBFS
f_{IN} = 19.7 MHz	Full	72.8	75.6		dBFS
f_{IN} = 30.5 MHz	25°C		75.5		dBFS
f_{IN} = 63.5 MHz	25°C		74.9		dBFS
f_{IN} = 123.4 MHz	25°C		73.2		dBFS
SIGNAL-TO-NOISE AND DISTORTION RATIO (SINAD)					
f_{IN} = 9.7 MHz	25°C		75.6		dBFS
f_{IN} = 19.7 MHz	Full	70.9	75.6		dBFS
f_{IN} = 30.5 MHz	25°C		75.4		dBFS
f_{IN} = 63.5 MHz	25°C		74.8		dBFS
f_{IN} = 123.4 MHz	25°C		72.8		dBFS
EFFECTIVE NUMBER OF BITS (ENOB)					
f_{IN} = 9.7 MHz	25°C		12.3		Bits
f_{IN} = 19.7 MHz	Full	11.5	12.3		Bits
f_{IN} = 30.5 MHz	25°C		12.2		Bits
f_{IN} = 63.5 MHz	25°C		12.1		Bits
f_{IN} = 123.4 MHz	25°C		11.8		Bits
SPURIOUS-FREE DYNAMIC RANGE (SFDR)					
f_{IN} = 9.7 MHz	25°C		96		dBc
f_{IN} = 19.7 MHz	Full	78	96		dBc
f_{IN} = 30.5 MHz	25°C		91		dBc
f_{IN} = 63.5 MHz	25°C		95		dBc
f_{IN} = 123.4 MHz	25°C		83		dBc
WORST HARMONIC (SECOND OR THIRD)					
f_{IN} = 9.7 MHz	25°C		−99		dBc
f_{IN} = 19.7 MHz	Full		−98	−78	dBc
f_{IN} = 30.5 MHz	25°C		−91		dBc
f_{IN} = 63.5 MHz	25°C		−98		dBc
f_{IN} = 123.4 MHz	25°C		−83		dBc
WORST OTHER (EXCLUDING SECOND OR THIRD)					
f_{IN} = 9.7 MHz	25°C		−96		dBc
f_{IN} = 19.7 MHz	Full		−96	−86	dBc
f_{IN} = 30.5 MHz	25°C		−98		dBc
f_{IN} = 63.5 MHz	25°C		−95		dBc
f_{IN} = 123.4 MHz	25°C		−94		dBc
TWO-TONE INTERMODULATION DISTORTION (IMD)—AIN1 AND AIN2 = −7.0 dBFS					
f_{IN1} = 30 MHz, f_{IN2} = 32 MHz	25°C		92		dBc
CROSSTALK[2]	25°C		−98		dB
Crosstalk (Overrange Condition)[3]	25°C		−94		dB
POWER SUPPLY REJECTION RATIO (PSRR)[4]	25°C				
AVDD			52		dB
DRVDD			71		dB
ANALOG INPUT BANDWIDTH, FULL POWER	25°C		650		MHz

[1] See the AN-835 Application Note, *Understanding High Speed ADC Testing and Evaluation*, for definitions and for details on how these tests were completed.
[2] Crosstalk is measured at 10 MHz with −1.0 dBFS analog input on one channel and no input on the adjacent channel.
[3] Overrange condition is 3 dB above the full-scale input range.
[4] PSRR is measured by injecting a sinusoidal signal at 10 MHz to the power supply pin and measuring the output spur on the FFT. PSRR is calculated as the ratio of the amplitudes of the spur voltage over the pin voltage, expressed in decibels.

DIGITAL SPECIFICATIONS

AVDD = 1.8 V, DRVDD = 1.8 V, 2 V p-p differential input, 1.0 V internal reference, AIN = −1.0 dBFS, unless otherwise noted.

Table 3.

Parameter[1, 2]	Temp	Min	Typ	Max	Unit
CLOCK INPUTS (CLK+, CLK−)					
Logic Compliance			CMOS/LVDS/LVPECL		
Differential Input Voltage[3]	Full	0.2		3.6	V p-p
Input Voltage Range	Full	AGND − 0.2		AVDD + 0.2	V
Input Common-Mode Voltage	Full		0.9		V
Input Resistance (Differential)	25°C		15		kΩ
Input Capacitance	25°C		4		pF
LOGIC INPUTS (PDWN, SYNC, SCLK)					
Logic 1 Voltage	Full	1.2		AVDD + 0.2	V
Logic 0 Voltage	Full	0		0.8	V
Input Resistance	25°C		30		kΩ
Input Capacitance	25°C		2		pF
LOGIC INPUT (CSB)					
Logic 1 Voltage	Full	1.2		AVDD + 0.2	V
Logic 0 Voltage	Full	0		0.8	V
Input Resistance	25°C		26		kΩ
Input Capacitance	25°C		2		pF
LOGIC INPUT (SDIO)					
Logic 1 Voltage	Full	1.2		AVDD + 0.2	V
Logic 0 Voltage	Full	0		0.8	V
Input Resistance	25°C		26		kΩ
Input Capacitance	25°C		5		pF
LOGIC OUTPUT (SDIO)[4]					
Logic 1 Voltage (I_{OH} = 800 µA)	Full		1.79		V
Logic 0 Voltage (I_{OL} = 50 µA)	Full			0.05	V
DIGITAL OUTPUTS (D± x), ANSI-644					
Logic Compliance			LVDS		
Differential Output Voltage (V_{OD})	Full	±247	±350	±454	mV
Output Offset Voltage (V_{OS})	Full	1.13	1.21	1.38	V
Output Coding (Default)			Twos complement		
DIGITAL OUTPUTS (D± x), LOW POWER, REDUCED SIGNAL OPTION					
Logic Compliance			LVDS		
Differential Output Voltage (V_{OD})	Full	±150	±200	±250	mV
Output Offset Voltage (V_{OS})	Full	1.13	1.21	1.38	V
Output Coding (Default)			Twos complement		

[1] See the AN-835 Application Note, *Understanding High Speed ADC Testing and Evaluation*, for definitions and for details on how these tests were completed.
[2] When referencing a single function of a multifunction pin in the parameters, only the portion of the pin name that is relevant to the specification is listed. For full pin names of multifunction pins, refer to the Pin Configuration and Function Descriptions section.
[3] This is specified for LVDS and LVPECL only.
[4] This is specified for 13 SDIO/DFS pins sharing the same connection.

SWITCHING SPECIFICATIONS

AVDD = 1.8 V, DRVDD = 1.8 V, 2 V p-p differential input, 1.0 V internal reference, AIN = −1.0 dBFS, unless otherwise noted.

Table 4.

Parameter[1, 2]	Temp	Min	Typ	Max	Unit
CLOCK[3]					
Input Clock Rate	Full	10		520	MHz
Conversion Rate	Full	10		65	MSPS
Clock Pulse Width High (t_{EH})	Full		7.69		ns
Clock Pulse Width Low (t_{EL})	Full		7.69		ns
OUTPUT PARAMETERS[3]					
Propagation Delay (t_{PD})	Full	1.5	2.3	3.1	ns
Rise Time (t_R) (20% to 80%)	Full		300		ps
Fall Time (t_F) (20% to 80%)	Full		300		ps
FCO Propagation Delay (t_{FCO})	Full	1.5	2.3	3.1	ns
DCO Propagation Delay (t_{CPD})[4]	Full		t_{FCO} + (t_{SAMPLE}/28)		ns
DCO to Data Delay (t_{DATA})[4]	Full	(t_{SAMPLE}/28) − 300	(t_{SAMPLE}/28)	(t_{SAMPLE}/28) + 300	ps
DCO to FCO Delay (t_{FRAME})[4]	Full	(t_{SAMPLE}/28) − 300	(t_{SAMPLE}/28)	(t_{SAMPLE}/28) + 300	ps
Data to Data Skew ($t_{DATA-MAX}$ − $t_{DATA-MIN}$)	Full		±50	±200	ps
Wake-Up Time (Standby)	25°C		35		µs
Wake-Up Time (Power-Down)[5]	25°C		375		µs
Pipeline Latency	Full		16		Clock cycles
APERTURE					
Aperture Delay (t_A)	25°C		1		ns
Aperture Uncertainty (Jitter)	25°C		0.1		ps rms
Out-of-Range Recovery Time	25°C		1		Clock cycles

[1] See the AN-835 Application Note, *Understanding High Speed ADC Testing and Evaluation*, for definitions and for details on how these tests were completed.
[2] Measured on standard FR-4 material.
[3] Can be adjusted via the SPI.
[4] t_{SAMPLE}/28 is based on the number of bits divided by 2 because the delays are based on half duty cycles. $t_{SAMPLE} = 1/f_S$.
[5] Wake-up time is defined as the time required to return to normal operation from power-down mode.

TIMING SPECIFICATIONS

Table 5.

Parameter	Description	Limit	Unit
SYNC TIMING REQUIREMENTS			
t_{SSYNC}	SYNC to rising edge of CLK+ setup time	0.24	ns typ
t_{HSYNC}	SYNC to rising edge of CLK+ hold time	0.40	ns typ
SPI TIMING REQUIREMENTS[1]	See Figure 4		
t_{DS}	Setup time between the data and the rising edge of SCLK	2	ns min
t_{DH}	Hold time between the data and the rising edge of SCLK	2	ns min
t_{CLK}	Period of the SCLK	40	ns min
t_S	Setup time between CSB and SCLK	2	ns min
t_H	Hold time between CSB and SCLK	2	ns min
t_{HIGH}	SCLK pulse width high	10	ns min
t_{LOW}	SCLK pulse width low	10	ns min
t_{EN_SDIO}	Time required for the SDIO pin to switch from an input to an output relative to the SCLK falling edge (not shown in Figure 4)	10	ns min
t_{DIS_SDIO}	Time required for the SDIO pin to switch from an output to an input relative to the SCLK rising edge (not shown in Figure 4)	10	ns min

[1] When referring to a single function of a multifunction pin, only the portion of the pin name that is relevant to the specification is listed. For full pin names of multifunction pins, refer to the Pin Configuration and Function Descriptions section.

Timing Diagrams

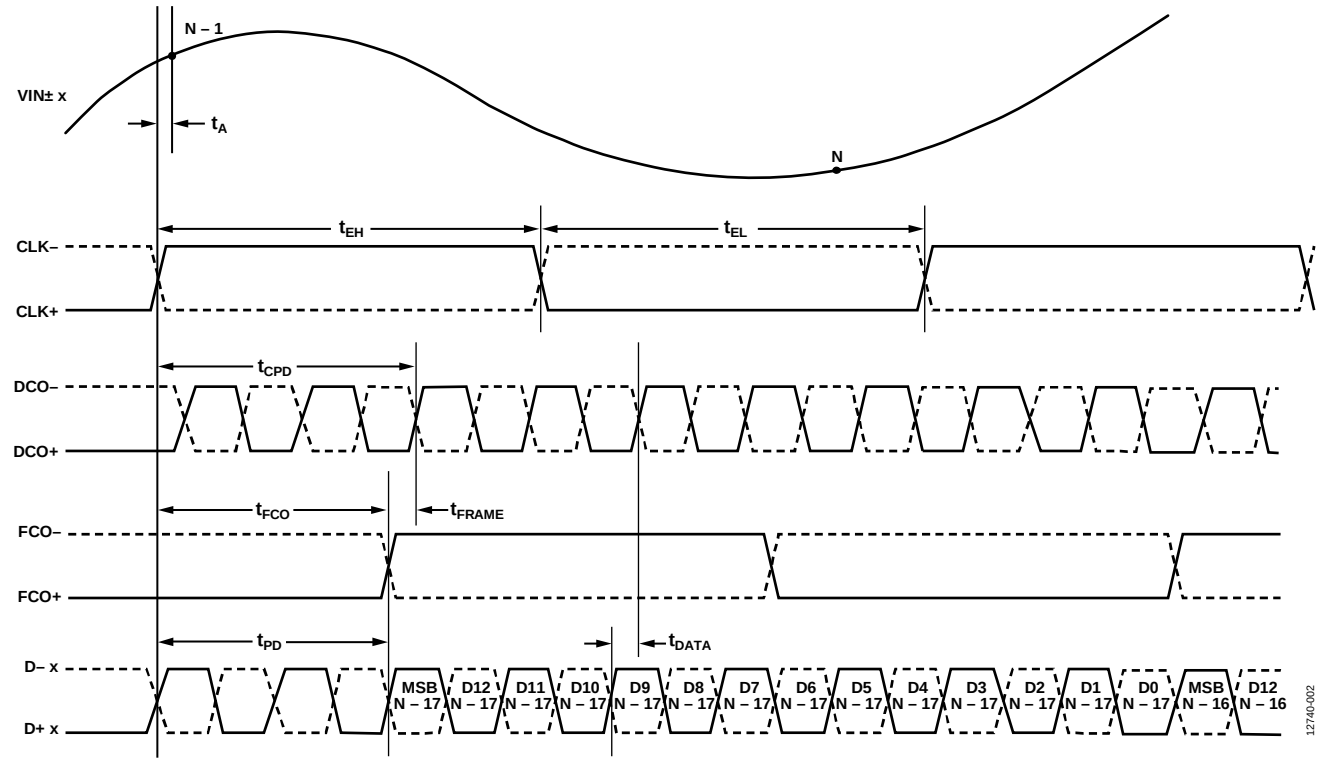


Figure 2. Word Wise DDR,1× Frame, 14-Bit Output Mode (Default)

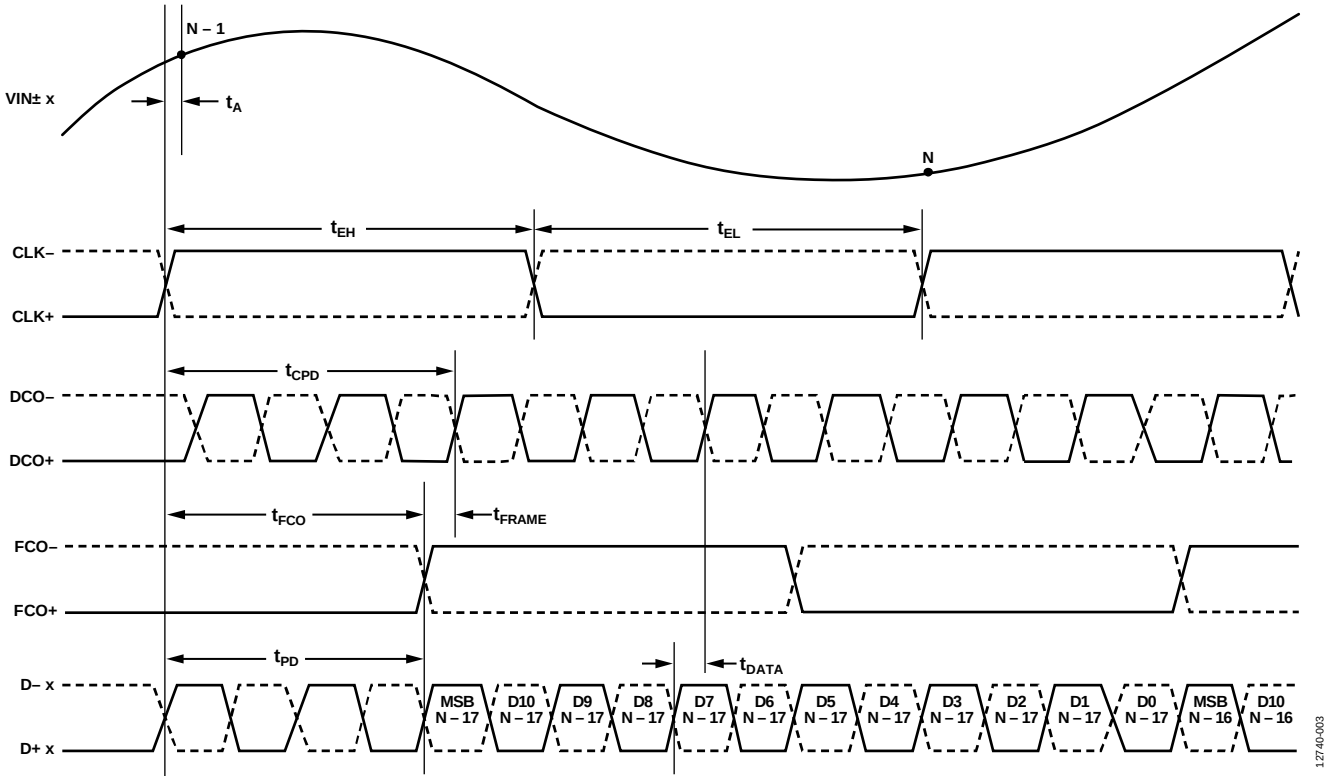


Figure 3. Word Wise DDR, 1× Frame, 12-Bit Output Mode

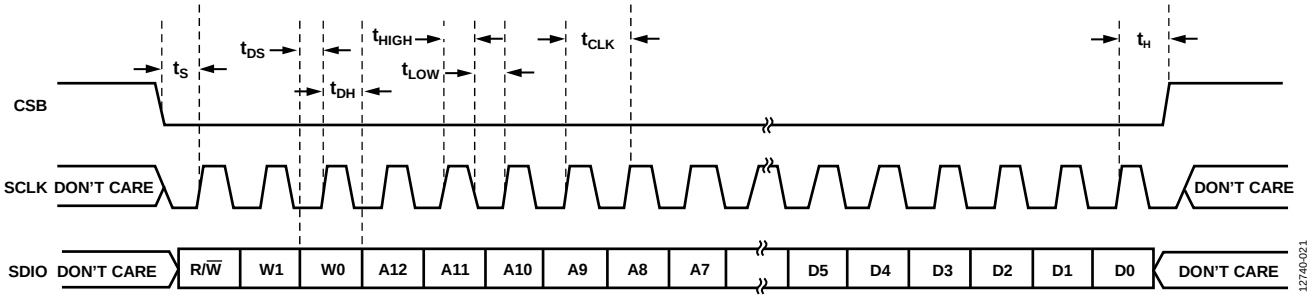


Figure 4. Serial Port Interface Timing Diagram

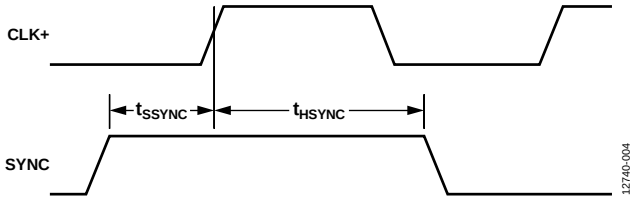


Figure 5. SYNC Input Timing Requirements

ABSOLUTE MAXIMUM RATINGS

Table 6.

Parameter	Rating
Electrical	
AVDD to AGND	−0.3 V to +2.0 V
DRVDD to AGND	−0.3 V to +2.0 V
Digital Outputs (D± x, DCO+, DCO−, FCO+, FCO−) to AGND	−0.3 V to +2.0 V
CLK+, CLK− to AGND	−0.3 V to +2.0 V
VIN+ x, VIN− x to AGND	−0.3 V to +2.0 V
SCLK/DTP, SDIO/DFS, CSB to AGND	−0.3 V to +2.0 V
SYNC, PDWN to AGND	−0.3 V to +2.0 V
RBIAS, VCM to AGND	−0.3 V to +2.0 V
VREF, SENSE to AGND	−0.3 V to +2.0 V
Environmental	
Operating Temperature Range (Ambient)	−55°C to +125°C
Maximum Junction Temperature	150°C
Lead Temperature (Soldering, 10 sec)	300°C
Storage Temperature Range (Ambient)	−65°C to +150°C

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

THERMAL CHARACTERISTICS

The exposed pad must be soldered to the ground plane for the LFCSP package. Soldering the exposed pad to the PCB 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)	θ_{JA}[1, 2]	θ_{JC}[1, 3]	θ_{JB}[1, 4]	Ψ_{JT}[1, 2]	Unit
64-Lead LFCSP 9 mm × 9 mm (CP-64-4)	0	22.3	1.4	N/A	0.1	°C/W
	1.0	19.5	N/A	11.8	0.2	°C/W
	2.5	17.5	N/A	N/A	0.2	°C/W

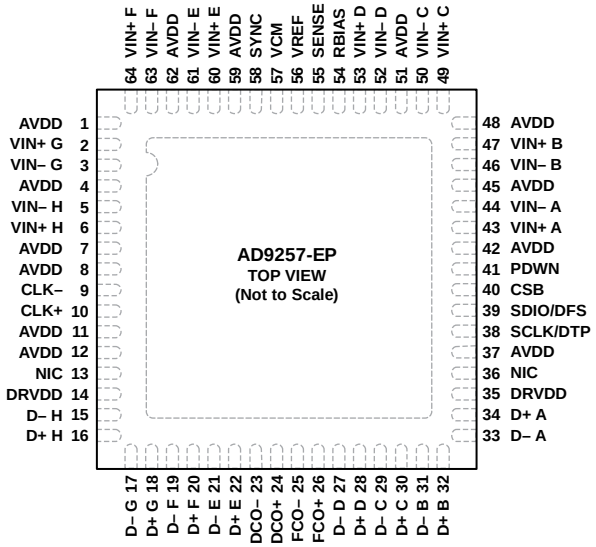
[1] Per JEDEC 51-7, plus JEDEC 25-5 2S2P test board.
[2] Per JEDEC JESD51-2 (still air) or JEDEC JESD51-6 (moving air).
[3] Per MIL-Std 883, Method 1012.1.
[4] Per JEDEC JESD51-8 (still air).

Typical θ_{JA} is specified for a 4-layer PCB with a solid ground plane. As shown Table 7, airflow improves heat dissipation, which reduces θ_{JA}. In addition, metal in direct contact with the package leads from metal traces, through holes, ground, and power planes reduces θ_{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. NIC = NOT INTERNALLY CONNECTED. THESE PINS CAN BE CONNECTED TO GROUND.
2. THE EXPOSED THERMAL PAD ON THE BOTTOM OF THE PACKAGE PROVIDES THE ANALOG GROUND FOR THE DEVICE. THIS EXPOSED PAD MUST BE CONNECTED TO GROUND FOR PROPER OPERATION.

12740-005

Figure 6. Pin Configuration, Top View

Table 8. Pin Function Descriptions

Pin No.	Mnemonic	Description
0	AGND, EP	Analog Ground, Exposed Pad. The exposed thermal pad on the bottom of the package provides the analog ground for the device. This exposed pad must be connected to ground for proper operation.
1, 4, 7, 8, 11, 12, 37, 42, 45, 48, 51, 59, 62	AVDD	1.8 V Analog Supply.
13, 36	NIC	Not Internally Connected. These pins can be connected to ground.
14, 35	DRVDD	1.8 V Digital Output Driver Supply.
2, 3	VIN+ G, VIN– G	ADC G Analog Input True, ADC G Analog Input Complement.
5, 6	VIN– H, VIN+ H	ADC H Analog Input Complement, ADC H Analog Input True.
9, 10	CLK–, CLK+	Input Clock Complement, Input Clock True.
15, 16	D– H, D+ H	ADC H Digital Output Complement, ADC H Digital Output True.
17, 18	D– G, D+ G	ADC G Digital Output Complement, ADC G Digital Output True.
19, 20	D– F, D+ F	ADC F Digital Output Complement, ADC F Digital Output True.
21, 22	D– E, D+ E	ADC E Digital Output Complement, ADC E Digital Output True.
23, 24	DCO–, DCO+	Data Clock Digital Output Complement, Data Clock Digital Output True.
25, 26	FCO–, FCO+	Frame Clock Digital Output Complement, Frame Clock Digital Output True.
27, 28	D– D, D+ D	ADC D Digital Output Complement, ADC D Digital Output True.
29, 30	D– C, D+ C	ADC C Digital Output Complement, ADC C Digital Output True.
31, 32	D– B, D + B	ADC B Digital Output Complement, ADC B Digital Output True.
33, 34	D– A, D+ A	ADC A Digital Output Complement, ADC A Digital Output True.
38	SCLK/DTP	Serial Clock (SCLK)/Digital Test Pattern (DTP).
39	SDIO/DFS	Serial Data Input/Output (SDIO)/Data Format Select (DFS).
40	CSB	Chip Select Bar.
41	PDWN	Power-Down.
43, 44	VIN+ A, VIN– A	ADC A Analog Input True, ADC A Analog Input Complement.
46, 47	VIN– B, VIN+ B	ADC B Analog Input Complement, ADC B Analog Input True.
49, 50	VIN+ C, VIN– C	ADC C Analog Input True, ADC C Analog Input Complement.

Pin No.	Mnemonic	Description
52, 53	VIN− D, VIN+ D	ADC D Analog Input Complement, ADC D Analog Input True.
54	RBIAS	Analog Current Bias Setting. Connect to 10 kΩ (1% tolerance) resistor to ground.
55	SENSE	Reference Mode Selection.
56	VREF	Voltage Reference Input/Output.
57	VCM	Analog Output Voltage at Midsupply. This pin sets the common mode of the analog inputs.
58	SYNC	Digital Input. SYNC input to clock divider. 30 kΩ internal pull-down resistor.
60, 61	VIN+ E, VIN− E	ADC E Analog Input True, ADC E Analog Input Complement.
63, 64	VIN− F, VIN+ F	ADC F Analog Input Complement, ADC F Analog Input True.

TYPICAL PERFORMANCE CHARACTERISTICS

See the AD9257 data sheet for a full set of Typical Performance Characteristics plots.

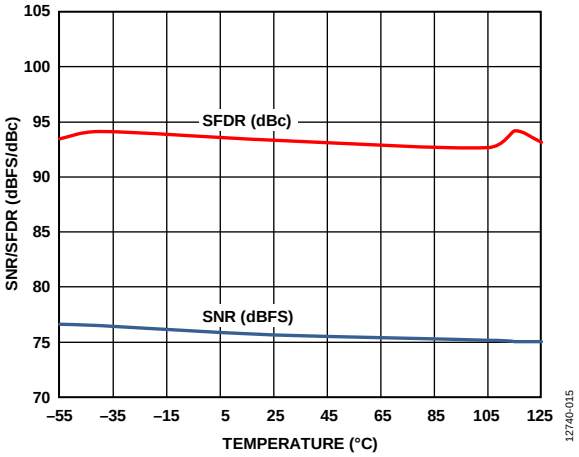


Figure 7. SNR/SFDR vs. Temperature, f_{IN} = 9.7 MHz, f_{SAMPLE} = 65 MSPS

OUTLINE DIMENSIONS

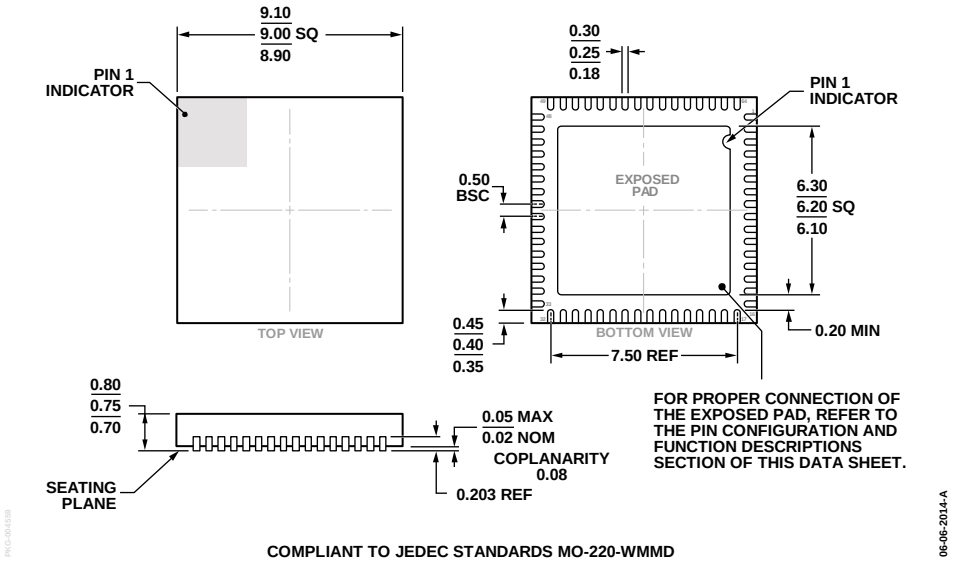


Figure 8. 64-Lead Lead Frame Chip Scale Package [LFCSP_WQ]
9 mm × 9 mm Body, Very Very Thin Quad
(CP-64-17)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1]	Temperature Range	Package Description	Package Option
AD9257TCPZ-65-EP	−55°C to +125°C	64-Lead Lead Frame Chip Scale Package [LFCSP_WQ]	CP-64-17

[1] Z = RoHS Compliant Part.