Low Cost, High Speed Differential Amplifier

AD8132

FEATURES

High speed
- **350 MHz, −3 dB bandwidth**
- **1200 V/µs slew rate**

Resistor set gain
Internal common-mode feedback
Improved gain and phase balance
- **−68 dB @ 10 MHz**

Separate input to set the common-mode output voltage
Low distortion: −99 dBc SFDR @ 5 MHz, 800 Ω load
Low power: 10.7 mA @ 5 V
Power supply range: +2.7 V to ±5.5 V

APPLICATIONS

Low power differential ADC drivers
Differential gain and differential filtering
Video line drivers
Differential in/out level shifting
Single-ended input to differential output drivers
Active transformers

GENERAL DESCRIPTION

The AD8132 is a low cost differential or single-ended input to differential output amplifier with resistor set gain. The AD8132 is a major advancement over op amps for driving differential input ADCs or for driving signals over long lines. The AD8132 has a unique internal feedback feature that provides output gain and phase matching balanced to −68 dB at 10 MHz, suppressing harmonics and reducing radiated EMI.

Manufactured using the next generation of Analog Devices, Inc., XFCB bipolar process, the AD8132 has a −3 dB bandwidth of 350 MHz and delivers a differential signal with −99 dBc SFDR at 5 MHz, despite its low cost. The AD8132 eliminates the need for a transformer with high performance ADCs, preserving the low frequency and dc information. The common-mode level of the differential output is adjustable by applying a voltage on the V_{OCM} pin, easily level shifting the input signals for driving single-supply ADCs. Fast overload recovery preserves sampling accuracy.

PIN CONFIGURATION

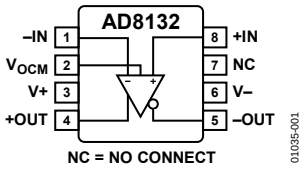


Figure 1.

The AD8132 is also used as a differential driver for the transmission of high speed signals over low cost twisted pair or coaxial cables. The feedback network can be adjusted to boost the high frequency components of the signal. The AD8132 is used for either analog or digital video signals or for other high speed data transmission. The AD8132 is capable of driving either a Category 3 or Category 5 twisted pair or coaxial cable with minimal line attenuation. The AD8132 has considerable cost and performance improvements over discrete line driver solutions.

Differential signal processing reduces the effects of ground noise that plagues ground-referenced systems. The AD8132 can be used for differential signal processing (gain and filtering) throughout a signal chain, easily simplifying the conversion between differential and single-ended components.

The AD8132 is available in both SOIC_N and MSOP packages for operation over the extended industrial temperature range of −40°C to +125°C.

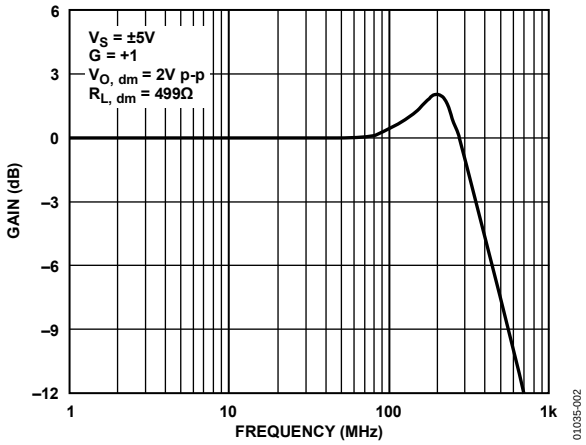


Figure 2. Large Signal Frequency Response

Rev. G

SPECIFICATIONS

±D_{IN} TO ±OUT SPECIFICATIONS

At T_A = 25°C, V_S = ±5 V, V_{OCM} = 0 V, G = 1, $R_{L, dm}$ = 499 Ω, R_F = R_G = 348 Ω, unless otherwise noted. For G = 2, $R_{L, dm}$ = 200 Ω, R_F = 1000 Ω, R_G = 499 Ω. Refer to Figure 56 and Figure 57 for test setup and label descriptions. All specifications refer to single-ended input and differential outputs, unless otherwise noted.

Table 1.

Parameter	Conditions	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
−3 dB Large Signal Bandwidth	V_{OUT} = 2 V p-p	300	350		MHz
	V_{OUT} = 2 V p-p, G = 2		190		MHz
−3 dB Small Signal Bandwidth	V_{OUT} = 0.2 V p-p		360		MHz
	V_{OUT} = 0.2 V p-p, G = 2		160		MHz
Bandwidth for 0.1 dB Flatness	V_{OUT} = 0.2 V p-p		90		MHz
	V_{OUT} = 0.2 V p-p, G = 2		50		MHz
Slew Rate	V_{OUT} = 2 V p-p	1000	1200		V/µs
Settling Time	0.1%, V_{OUT} = 2 V p-p		15		ns
Overdrive Recovery Time	V_{IN} = 5 V to 0 V step, G = 2		5		ns
NOISE/HARMONIC PERFORMANCE					
Second Harmonic	V_{OUT} = 2 V p-p, 1 MHz, $R_{L, dm}$ = 800 Ω		−96		dBc
	V_{OUT} = 2 V p-p, 5 MHz, $R_{L, dm}$ = 800 Ω		−83		dBc
	V_{OUT} = 2 V p-p, 20 MHz, $R_{L, dm}$ = 800 Ω		−73		dBc
Third Harmonic	V_{OUT} = 2 V p-p, 1 MHz, $R_{L, dm}$ = 800 Ω		−102		dBc
	V_{OUT} = 2 V p-p, 5 MHz, $R_{L, dm}$ = 800 Ω		−98		dBc
	V_{OUT} = 2 V p-p, 20 MHz, $R_{L, dm}$ = 800 Ω		−67		dBc
IMD	20 MHz, $R_{L, dm}$ = 800 Ω		−76		dBc
IP3	20 MHz, $R_{L, dm}$ = 800 Ω		40		dBm
Input Voltage Noise (RTI)	f = 0.1 MHz to 100 MHz		8		nV/√Hz
Input Current Noise	f = 0.1 MHz to 100 MHz		1.8		pA/√Hz
Differential Gain Error	NTSC, G = 2, $R_{L, dm}$ = 150 Ω		0.01		%
Differential Phase Error	NTSC, G = 2, $R_{L, dm}$ = 150 Ω		0.10		Degrees
INPUT CHARACTERISTICS					
Offset Voltage (RTI)	$V_{OS, dm}$ = $V_{OUT, dm}$/2; V_{DIN+} = $V_{DIN−}$ = V_{OCM} = 0 V		±1.0	±3.5	mV
	T_{MIN} to T_{MAX} variation		10		µV/°C
Input Bias Current			3	7	µA
Input Resistance	Differential		12		MΩ
	Common mode		3.5		MΩ
Input Capacitance			1		pF
Input Common-Mode Voltage			−4.7 to +3.0		V
CMRR	$\Delta V_{OUT, dm}/\Delta V_{IN, cm}$; $\Delta V_{IN, cm}$ = ±1 V; resistors matched to 0.01%		−70	−60	dB
OUTPUT CHARACTERISTICS					
Output Voltage Swing	Maximum ΔV_{OUT}; single-ended output		−3.6 to +3.6		V
Output Current			+70		mA
Output Balance Error	$\Delta V_{OUT, cm}/\Delta V_{OUT, dm}$; $\Delta V_{OUT, dm}$ = 1 V		−70		dB

V_{OCM} TO ±OUT SPECIFICATIONS

At T_A = 25°C, V_S = ±5 V, V_{OCM} = 0 V, G = 1, $R_{L, dm}$ = 499 Ω, R_F = R_G = 348 Ω, unless otherwise noted. For G = 2, $R_{L, dm}$ = 200 Ω, R_F = 1000 Ω, R_G = 499 Ω. Refer to Figure 56 and Figure 57 for test setup and label descriptions. All specifications refer to single-ended input and differential outputs, unless otherwise noted.

Table 2.

Parameter	Conditions	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
−3 dB Bandwidth	ΔV_{OCM} = 600 mV p-p		210		MHz
Slew Rate	ΔV_{OCM} = −1 V to +1 V		400		V/µs
Input Voltage Noise (RTI)	f = 0.1 MHz to 100 MHz		12		nV/√Hz
DC PERFORMANCE					
Input Voltage Range			±3.6		V
Input Resistance			50		kΩ
Input Offset Voltage	$V_{OS, cm} = V_{OUT, cm}$; $V_{DIN+} = V_{DIN-} = V_{OCM}$ = 0 V		±1.5	±7	mV
Input Bias Current			0.5		µA
V_{OCM} CMRR	$\Delta V_{OUT, dm}/\Delta V_{OCM}$; ΔV_{OCM} = ±1 V; resistors matched to 0.01%		−68		dB
Gain	$\Delta V_{OUT, cm}/\Delta V_{OCM}$; ΔV_{OCM} = ±1 V	0.985	1	1.015	V/V
POWER SUPPLY					
Operating Range		±1.35		±5.5	V
Quiescent Current	$V_{DIN+} = V_{DIN-} = V_{OCM}$ = 0 V	11	12	13	mA
	T_{MIN} to T_{MAX} variation		16		µA/°C
Power Supply Rejection Ratio	$\Delta V_{OUT, dm}/\Delta V_S$; ΔV_S = ±1 V		−70	−60	dB
OPERATING TEMPERATURE RANGE		−40		+125	°C

±D_{IN} TO ±OUT SPECIFICATIONS

At T_A = 25°C, V_S = 5 V, V_{OCM} = 2.5 V, G = 1, $R_{L, dm}$ = 499 Ω, R_F = R_G = 348 Ω, unless otherwise noted. For G = 2, $R_{L, dm}$ = 200 Ω, R_F = 1000 Ω, R_G = 499 Ω. Refer to Figure 56 and Figure 57 for test setup and label descriptions. All specifications refer to single-ended input and differential outputs, unless otherwise noted.

Table 3.

Parameter	Conditions	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
−3 dB Large Signal Bandwidth	V_{OUT} = 2 V p-p	250	300		MHz
	V_{OUT} = 2 V p-p, G = 2		180		MHz
−3 dB Small Signal Bandwidth	V_{OUT} = 0.2 V p-p		360		MHz
	V_{OUT} = 0.2 V p-p, G = 2		155		MHz
Bandwidth for 0.1 dB Flatness	V_{OUT} = 0.2 V p-p		65		MHz
	V_{OUT} = 0.2 V p-p, G = 2		50		MHz
Slew Rate	V_{OUT} = 2 V p-p	800	1000		V/µs
Settling Time	0.1%, V_{OUT} = 2 V p-p		20		ns
Overdrive Recovery Time	V_{IN} = 2.5 V to 0 V step, G = 2		5		ns
NOISE/HARMONIC PERFORMANCE					
Second Harmonic	V_{OUT} = 2 V p-p, 1 MHz, $R_{L, dm}$ = 800 Ω		−97		dBc
	V_{OUT} = 2 V p-p, 5 MHz, $R_{L, dm}$ = 800 Ω		−100		dBc
	V_{OUT} = 2 V p-p, 20 MHz, $R_{L, dm}$ = 800 Ω		−74		dBc
Third Harmonic	V_{OUT} = 2 V p-p, 1 MHz, $R_{L, dm}$ = 800 Ω		−100		dBc
	V_{OUT} = 2 V p-p, 5 MHz, $R_{L, dm}$ = 800 Ω		−99		dBc
	V_{OUT} = 2 V p-p, 20 MHz, $R_{L, dm}$ = 800 Ω		−67		dBc
IMD	20 MHz, $R_{L, dm}$ = 800 Ω		−76		dBc
IP3	20 MHz, $R_{L, dm}$ = 800 Ω		40		dBm
Input Voltage Noise (RTI)	f = 0.1 MHz to 100 MHz		8		nV/√Hz
Input Current Noise	f = 0.1 MHz to 100 MHz		1.8		pA/√Hz
Differential Gain Error	NTSC, G = 2, $R_{L, dm}$ = 150 Ω		0.025		%
Differential Phase Error	NTSC, G = 2, $R_{L, dm}$ = 150 Ω		0.15		Degrees
INPUT CHARACTERISTICS					
Offset Voltage (RTI)	$V_{OS, dm}$ = $V_{OUT, dm}$/2; V_{DIN+} = V_{DIN-} = V_{OCM} = 2.5 V		±1.0	±3.5	mV
	T_{MIN} to T_{MAX} variation		6		µV/°C
Input Bias Current			3	7	µA
Input Resistance	Differential		10		MΩ
	Common-mode		3		MΩ
Input Capacitance			1		pF
Input Common-Mode Voltage			0.3 to 3.0		V
CMRR	$\Delta V_{OUT, dm}/\Delta V_{IN, cm}$; $\Delta V_{IN, cm}$ = ±1 V; resistors matched to 0.01%		−70	−60	dB
OUTPUT CHARACTERISTICS					
Output Voltage Swing	Maximum ΔV_{OUT}; single-ended output		1.0 to 4.0		V
Output Current			50		mA
Output Balance Error	$\Delta V_{OUT, cm}/\Delta V_{OUT, dm}$; $\Delta V_{OUT, dm}$ = 1 V		−68		dB

V_{OCM} TO ±OUT SPECIFICATIONS

At T_A = 25°C, V_S = 5 V, V_{OCM} = 2.5 V, G = 1, $R_{L, dm}$ = 499 Ω, R_F = R_G = 348 Ω, unless otherwise noted. For G = 2, $R_{L, dm}$ = 200 Ω, R_F = 1000 Ω, R_G = 499 Ω. Refer to Figure 56 and Figure 57 for test setup and label descriptions. All specifications refer to single-ended input and differential outputs, unless otherwise noted.

Table 4.

Parameter	Conditions	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
−3 dB Bandwidth	ΔV_{OCM} = 600 mV p-p		210		MHz
Slew Rate	ΔV_{OCM} = 1.5 V to 3.5 V		340		V/µs
Input Voltage Noise (RTI)	f = 0.1 MHz to 100 MHz		12		nV/√Hz
DC PERFORMANCE					
Input Voltage Range			1.0 to 3.7		V
Input Resistance			30		kΩ
Input Offset Voltage	$V_{OS, cm} = V_{OUT, cm}$; $V_{DIN+} = V_{DIN-} = V_{OCM}$ = 2.5 V		±5	±11	mV
Input Bias Current			0.5		µA
V_{OCM} CMRR	$\Delta V_{OUT, dm}/\Delta V_{OCM}$; ΔV_{OCM} = 2.5 V ±1 V; resistors matched to 0.01%		−66		dB
Gain	$\Delta V_{OUT, cm}/\Delta V_{OCM}$; ΔV_{OCM} = 2.5 V ±1 V	0.985	1	1.015	V/V
POWER SUPPLY					
Operating Range		2.7		11	V
Quiescent Current	$V_{DIN+} = V_{DIN-} = V_{OCM}$ = 2.5 V	9.4	10.7	12	mA
	T_{MIN} to T_{MAX} variation		10		µA/°C
Power Supply Rejection Ratio	$\Delta V_{OUT, dm}/\Delta V_S$; ΔV_S = ±1 V		−70	−60	dB
OPERATING TEMPERATURE RANGE		−40		+125	°C

±D_{IN} TO ±OUT SPECIFICATIONS

At T_A = 25°C, V_S = 3 V, V_{OCM} = 1.5 V, G = 1, $R_{L, dm}$ = 499 Ω, R_F = R_G = 348 Ω, unless otherwise noted. For G = 2, $R_{L, dm}$ = 200 Ω, R_F = 1000 Ω, R_G = 499 Ω. Refer to Figure 56 and Figure 57 for test setup and label descriptions. All specifications refer to single-ended input and differential outputs, unless otherwise noted.

Table 5.

Parameter	Conditions	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
−3 dB Large Signal Bandwidth	V_{OUT} = 1 V p-p		350		MHz
	V_{OUT} = 1 V p-p, G = 2		165		MHz
−3 dB Small Signal Bandwidth	V_{OUT} = 0.2 V p-p		350		MHz
	V_{OUT} = 0.2 V p-p, G = 2		150		MHz
Bandwidth for 0.1 dB Flatness	V_{OUT} = 0.2 V p-p		45		MHz
	V_{OUT} = 0.2 V p-p, G = 2		50		MHz
NOISE/HARMONIC PERFORMANCE					
Second Harmonic	V_{OUT} = 1 V p-p, 1 MHz, $R_{L, dm}$ = 800 Ω		−100		dBc
	V_{OUT} = 1 V p-p, 5 MHz, $R_{L, dm}$ = 800 Ω		−94		dBc
	V_{OUT} = 1 V p-p, 20 MHz, $R_{L, dm}$ = 800 Ω		−77		dBc
Third Harmonic	V_{OUT} = 1 V p-p, 1 MHz, $R_{L, dm}$ = 800 Ω		−90		dBc
	V_{OUT} = 1 V p-p, 5 MHz, $R_{L, dm}$ = 800 Ω		−85		dBc
	V_{OUT} = 1 V p-p, 20 MHz, $R_{L, dm}$ = 800 Ω		−66		dBc
INPUT CHARACTERISTICS					
Offset Voltage (RTI)	$V_{OS, dm}$ = $V_{OUT, dm}$/2; V_{DIN+} = V_{DIN-} = V_{OCM} = 1.5 V		±10		mV
Input Bias Current			3		μA
Input Common-Mode Voltage			0.3 to 1.0		V
CMRR	$\Delta V_{OUT, dm}/\Delta V_{IN, cm}$; $\Delta V_{IN, cm}$ = ±0.5 V; resistors matched to 0.01%		−60		dB

V_{OCM} TO ±OUT SPECIFICATIONS

At T_A = 25°C, V_S = 3 V, V_{OCM} = 1.5 V, G = 1, $R_{L, dm}$ = 499 Ω, R_F = R_G = 348 Ω, unless otherwise noted. For G = 2, $R_{L, dm}$ = 200 Ω, R_F = 1000 Ω, R_G = 499 Ω. Refer to Figure 56 and Figure 57 for test setup and label descriptions. All specifications refer to single-ended input and differential outputs, unless otherwise noted.

Table 6.

Parameter	Conditions	Min	Typ	Max	Unit
DC PERFORMANCE					
Input Offset Voltage	$V_{OS, cm}$ = $V_{OUT, cm}$; V_{DIN+} = V_{DIN-} = V_{OCM} = 1.5 V		±7		mV
Gain	$\Delta V_{OUT, cm}/\Delta V_{OCM}$; ΔV_{OCM} = ±0.5 V		1		V/V
POWER SUPPLY					
Operating Range		2.7		11	V
Quiescent Current	V_{DIN+} = V_{DIN-} = V_{OCM} = 0 V		7.25		mA
Power Supply Rejection Ratio	$\Delta V_{OUT, dm}/\Delta V_S$; ΔV_S = ±0.5 V		−70		dB
OPERATING TEMPERATURE RANGE		−40		+125	°C

ABSOLUTE MAXIMUM RATINGS

Table 7.

Parameter	Rating
Supply Voltage	±5.5 V
V_{OCM}	$\pm V_S$
Internal Power Dissipation	250 mW
Operating Temperature Range	−40°C to +125°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering 10 sec)	300°C
Junction Temperature	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 RESISTANCE

θ_{JA} is specified for the worst-case conditions, that is, θ_{JA} is specified for the device soldered in a circuit board in still air.

Table 8.

Package Type	θ_{JA}	Unit
8-Lead SOIC/4-Layer	121	°C/W
8-Lead MSOP/4-Layer	142	°C/W

MAXIMUM POWER DISSIPATION

The maximum safe power dissipation in the AD8132 packages is limited by the associated rise in junction temperature (T_J) on the die. At approximately 150°C (the glass transition temperature), the plastic changes its properties. Even temporarily exceeding this temperature limit can change the stresses that the package exerts on the die, permanently shifting the parametric performance of the AD8132. Exceeding a junction temperature of 150°C for an extended period can result in changes in the silicon devices, potentially causing failure.

The power dissipated in the package (P_D) is the sum of the quiescent power dissipation and the power dissipated in the package due to the load drive for all outputs. The quiescent power is the voltage between the supply pins (V_S) times the quiescent current (I_S). The load current consists of the differential and common-mode currents flowing to the load, as well as currents flowing through the external feedback networks and the internal common-mode feedback loop. The internal resistor tap used in the common-mode feedback loop places a 1 kΩ differential load on the output. Consider rms voltages and currents when dealing with ac signals.

Airflow reduces θ_{JA}. In addition, more metal directly in contact with the package leads from metal traces through holes, ground, and power planes reduces the θ_{JA}.

Figure 3 shows the maximum safe power dissipation in the package vs. the ambient temperature for the 8-lead SOIC_N (θ_{JA} = 121°C/W) and MSOP (θ_{JA} = 142°C/W) packages on a JEDEC standard 4-layer board. θ_{JA} values are approximations.

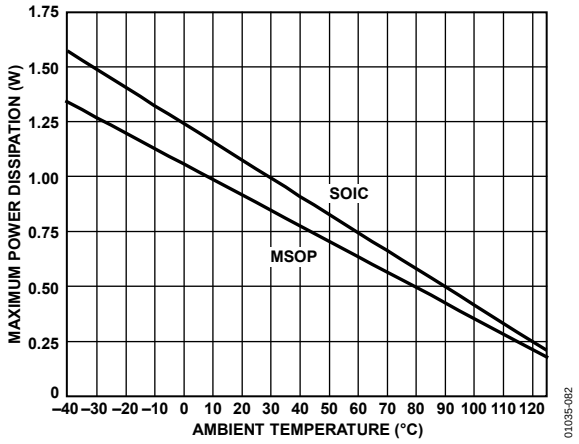
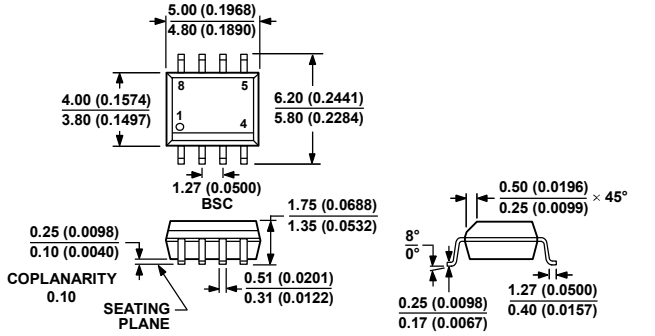


Figure 3. Maximum Power Dissipation vs. Temperature

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.

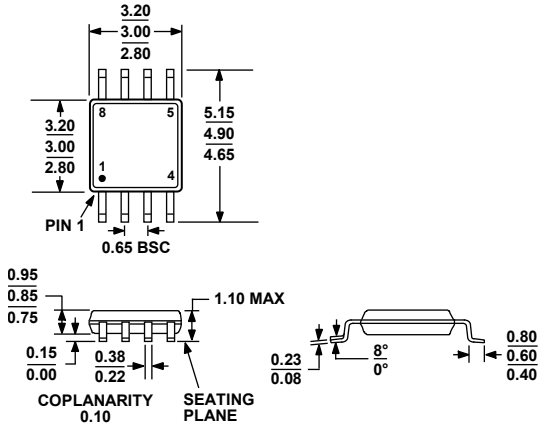
OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MS-012-AA
CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS
(IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR
REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

012407-A

Figure 84. 8-Lead Standard Small Outline Package [SOIC_N]
Narrow Body (R-8)
Dimensions shown in millimeters and (inches)



COMPLIANT TO JEDEC STANDARDS MO-187-AA

Figure 85. 8-Lead Mini Small Outline Package [MSOP]
(RM-8)
Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option	Branding	Ordering Quantity
AD8132AR	−40°C to +125°C	8-Lead SOIC_N	R-8		
AD8132AR-REEL	−40°C to +125°C	8-Lead SOIC_N, 13" Tape and Reel	R-8		2,500
AD8132AR-REEL7	−40°C to +125°C	8-Lead SOIC_N, 7" Tape and Reel	R-8		1,000
AD8132ARZ[1]	−40°C to +125°C	8-Lead SOIC_N	R-8		
AD8132ARZ-RL[1]	−40°C to +125°C	8-Lead SOIC_N, 13" Tape and Reel	R-8		2,500
AD8132ARZ-R7[1]	−40°C to +125°C	8-Lead SOIC_N, 7" Tape and Reel	R-8		1,000
AD8132ARM	−40°C to +125°C	8-Lead MSOP	RM-8	HMA	
AD8132ARM-REEL	−40°C to +125°C	8-Lead MSOP, 13" Tape and Reel	RM-8	HMA	3,000
AD8132ARM-REEL7	−40°C to +125°C	8-Lead MSOP, 7" Tape and Reel	RM-8	HMA	1,000
AD8132ARMZ[1]	−40°C to +125°C	8-Lead MSOP	RM-8	HMA#	
AD8132ARMZ-REEL[1]	−40°C to +125°C	8-Lead MSOP, 13" Tape and Reel	RM-8	HMA#	3,000
AD8132ARMZ-REEL7[1]	−40°C to +125°C	8-Lead MSOP, 7" Tape and Reel	RM-8	HMA#	1,000

[1] Z = RoHS Compliant Part, # denotes RoHS compliant product may be top or bottom marked.