Low Cost, High Speed Differential Amplifier

AD8132

FEATURES

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

Resistor settable gain
Internal common-mode feedback to improve 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 settable 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 ADI's next generation 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.

FUNCTIONAL BLOCK DIAGRAM

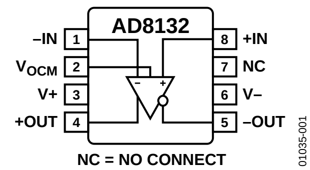

Figure 1.

The AD8132 can also be 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 can be used for either analog or digital video signals or for other high speed data transmission. The AD8132 is capable of driving either cat3 or cat5 twisted pair or coaxial 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 and MSOP packages for operation over −40°C to +125°C temperatures.

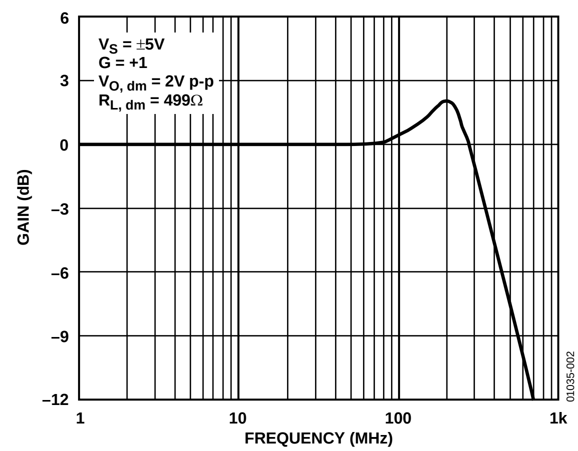

Figure 2. Large Signal Frequency Response

Rev. D

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SPECIFICATIONS

±D_{IN} TO ±OUT SPECIFICATIONS

At 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		$nV/\sqrt{Hz}$
Input Current Noise	f = 0.1 MHz to 100 MHz		1.8		$pA/\sqrt{Hz}$
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 to +3		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 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 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		$nV/\sqrt{Hz}$
Input Current Noise	f = 0.1 MHz to 100 MHz		1.8		$pA/\sqrt{Hz}$
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		Degree
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			1 to 3		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 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 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
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 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. [1]

Parameter	Ratings
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

[1] Thermal resistance measured on SEMI-standard, 4-layer board.
8-Lead SOIC: θ_{JA} = 121°C/W
8-Lead MSOP: θ_{JA} = 142°C/W

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 listed in the operational section of this specification is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability.

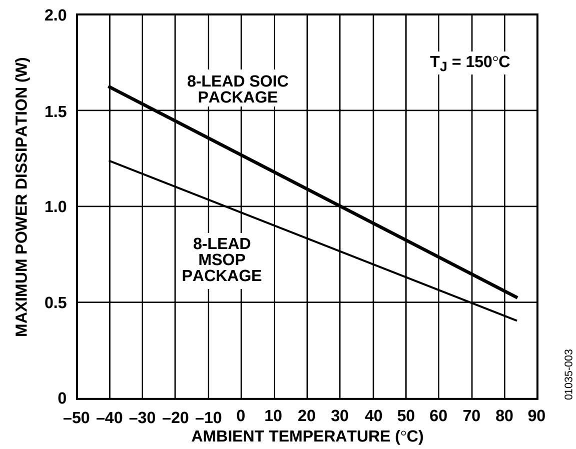

Figure 3. Plot of Maximum Power Dissipation vs. Temperature

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

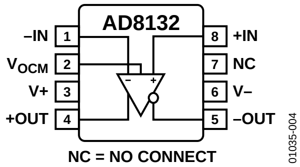

Figure 4. Pin Configuration

Table 8. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	−IN	Negative Input.
2	V_{OCM}	Voltage applied to this pin sets the common-mode output voltage with a ratio of 1:1. For example, 1 V dc on V_{OCM} sets the dc bias level on +OUT and −OUT to 1 V.
3	V+	Positive Supply Voltage.
4	+OUT	Positive Output. Note that the voltage at $-D_{IN}$ is inverted at +OUT (see Figure 64).
5	−OUT	Negative Output. Note that the voltage at $+D_{IN}$ is inverted at −OUT (see Figure 64).
6	V−	Negative Supply Voltage.
7	NC	No Connect.
8	+IN	Positive Input.

OUTLINE DIMENSIONS

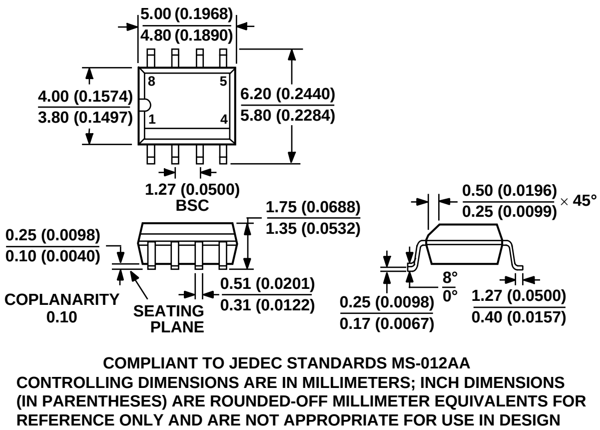

Figure 82. 8-Lead Standard Small Outline Package [SOIC]
Narrow Body (R-8)
Dimensions shown in millimeters and (inches)

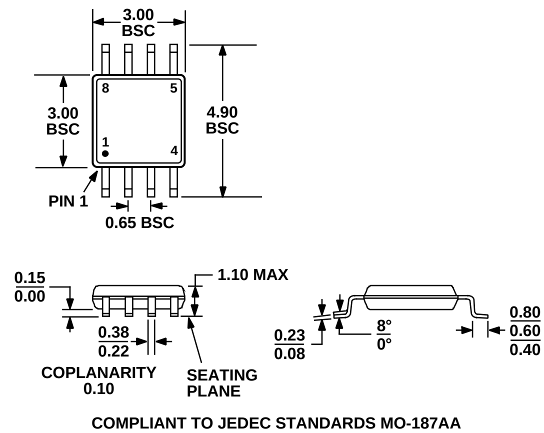

Figure 83. 8-Lead Mini Small Outline Package [MSOP]
(RM-8)
Dimensions shown in millimeters

ORDERING GUIDE

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

[1] Z = Pb-free part