ANALOG DEVICES

Low Cost, 300 MHz Voltage Feedback Amplifiers

AD8055/AD8056

FEATURES

Low Cost Single (AD8055) and Dual (AD8056)
Easy to Use Voltage Feedback Architecture
High Speed
300 MHz, –3 dB Bandwidth (G = +1)
- **1400 V/ms Slew Rate**
- **20 ns Settling to 0.1%**
- **Low Distortion: –72 dBc @ 10 MHz**
- **Low Noise: 6 nV/$\sqrt{Hz}$**
- **Low DC Errors: 5 mV Max V_{OS}, 1.2 μA Max I_B**

Small Packaging
- **AD8055 Available in SOT-23-5**
- **AD8056 Available in 8-Lead MSOP**

Excellent Video Specifications (R_L = 150 Ω, G = +2)
- **Gain Flatness 0.1 dB to 40 MHz**
- **0.01% Differential Gain Error**
- **0.02° Differential Phase Error**
- **Drives 4 Video Loads (37.5 V) with 0.02% Differential Gain and 0.1° Differential Phase**

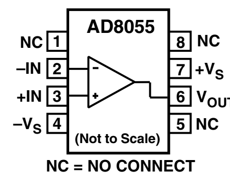
Low Power, ±5 V Supplies 5 mA Typ/Amplifier Power Supply Current
High Output Drive Current: Over 60 mA

APPLICATIONS

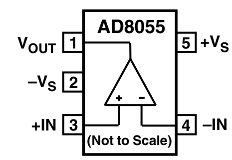
Imaging
Photodiode Preamp
Video Line Drivers
Differential Line Drivers
Professional Cameras
Video Switchers
Special Effects
A-to-D Drivers
Active Filters

FUNCTIONAL BLOCK DIAGRAMS

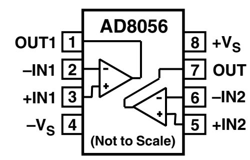
N-8 and R-8



RT-5



N-8, R-8, RM-8



PRODUCT DESCRIPTION

The AD8055 (single) and AD8056 (dual) voltage feedback amplifiers offer bandwidth and slew rate typically found in current feedback amplifiers. Additionally, these amplifiers are easy to use and available at a very low cost.

Despite their low cost, the AD8055 and AD8056 provide excellent overall performance. For video applications, their differential gain and phase error are 0.01% and 0.02° into a 150 Ω load and 0.02% and 0.1° while driving four video loads (37.50 Ω). Their 0.1 dB flatness out to 40 MHz, wide bandwidth out to 300 MHz, along with 1400 V/μs slew rate and 20 ns settling time, make them useful for a variety of high speed applications.

The AD8055 and AD8056 require only 5 mA typ/amplifier of supply current and operate on a dual ±5 V or a single +12 V power supply, while capable of delivering over 60 mA of load current. All this is offered in a small 8-lead PDIP package, 8-lead SOIC packages, a 5-lead SOT-23-5 package (AD8055), and an 8-lead MSOP package (AD8056). These features make the AD8055/AD8056 ideal for portable and battery-powered applications where size and power are critical. These amplifiers in the R-8, N-8, and RM packages are available in the extended temperature range of –40°C to +125°C.

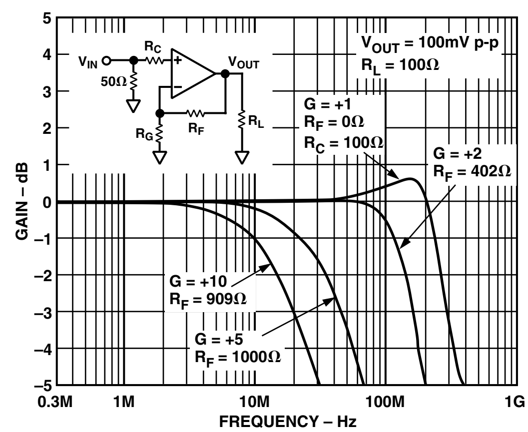


Figure 1. Frequency Response

REV. H

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AD8055/AD8056–SPECIFICATIONS (@ T_A = 25°C, V_S = ±5 V, R_F = 402 Ω, R_L = 100 Ω, Gain = +2, unless otherwise noted.)

Parameter	Conditions	AD8055A/AD8056A Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
–3 dB Bandwidth	G = +1, V_O = 0.1 V p-p	220	300		MHz
	G = +1, V_O = 2 V p-p	125	150		MHz
	G = +2, V_O = 0.1 V p-p	120	160		MHz
	G = +2, V_O = 2 V p-p	125	150		MHz
Bandwidth for 0.1 dB Flatness	V_O = 100 mV p-p	25	40		MHz
Slew Rate	G = +1, V_O = 4 V Step	1000	1400		V/μs
	G = +2, V_O = 4 V Step	750	840		V/μs
Settling Time to 0.1%	G = +2, V_O = 2 V Step		20		ns
Rise and Fall Time, 10% to 90%	G = +1, V_O = 0.5 V Step		2		ns
	G = +1, V_O = 4 V Step		2.7		ns
	G = +2, V_O = 0.5 V Step		2.8		ns
	G = +2, V_O = 4 V Step		4		ns
NOISE/HARMONIC PERFORMANCE					
Total Harmonic Distortion	f_C = 10 MHz, V_O = 2 V p-p, R_L = 1 kΩ		–72		dBc
	f_C = 20 MHz, V_O = 2 V p-p, R_L = 1 kΩ		–57		dBc
Crosstalk, Output-to-Output (AD8056)	f = 5 MHz, G = +2		–60		dB
Input Voltage Noise	f = 100 kHz		6		$nV/\sqrt{Hz}$
Input Current Noise	f = 100 kHz		1		$pA/\sqrt{Hz}$
Differential Gain Error	NTSC, G = +2, R_L = 150 Ω		0.01		%
	NTSC, G = +2, R_L = 37.5 Ω		0.02		%
Differential Phase Error	NTSC, G = +2, R_L = 150 Ω		0.02		Degree
	NTSC, G = +2, R_L = 37.5 Ω		0.1		Degree
DC PERFORMANCE					
Input Offset Voltage			3	5	mV
	T_{MIN} to T_{MAX}			10	mV
Offset Drift			6		μV/°C
Input Bias Current			0.4	1.2	μA
	T_{MIN} to T_{MAX}		1		μA
Open-Loop Gain	V_O = ±2.5 V	66	71		dB
	T_{MIN} to T_{MAX}	64			dB
INPUT CHARACTERISTICS					
Input Resistance			10		MΩ
Input Capacitance			2		pF
Input Common-Mode Voltage Range			3.2		±V
Common-Mode Rejection Ratio	V_{CM} = ±2.5 V		82		dB
OUTPUT CHARACTERISTICS					
Output Voltage Swing	R_L = 150 Ω	2.9	3.1		±V
Output Current*	V_O = ±2.0 V	55	60		mA
Short Circuit Current*			110		mA
POWER SUPPLY					
Operating Range		±4.0	±5.0	±6.0	V
Quiescent Current	AD8055		5.4	6.5	mA
	T_{MIN} to 125°C		7.6		mA
	T_{MIN} to 85°C			7.3	mA
	AD8056		10	12	mA
	T_{MIN} to 125°C		13.9		mA
	T_{MIN} to 85°C			13.3	mA
Power Supply Rejection Ratio	$+V_S$ = +5 V to +6 V, $–V_S$ = –5 V	66	72		dB
	$–V_S$ = –5 V to –6 V, $+V_S$ = +5 V	69	86		dB
OPERATING TEMPERATURE RANGE	AD8055ART	–40		+85	°C
	AD8055AR, AD8055AN, AD8056AR, AD8056AN, AD8056ARM	–40		+125	°C

*Output current is limited by the maximum power dissipation in the package. See the power derating curves.

Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS*

Supply Voltage . . . . 13.2 V
Input Voltage (Common-Mode) . . . . $\pm V_S$
Differential Input Voltage . . . . ±2.5 V
Output Short Circuit Duration
. . . . Observe Power Derating Curves
Storage Temperature Range N, R . . . .–65°C to +150°C
Operating Temperature Range (A Grade) . . .–40°C to +125°C
Lead Temperature Range (Soldering 10 sec) . . . . 300°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.

MAXIMUM POWER DISSIPATION

The maximum power that can be safely dissipated by the AD8055/AD8056 is limited by the associated rise in junction temperature. The maximum safe junction temperature for plastic encapsulated devices is determined by the glass transition temperature of the plastic, approximately 150°C. Exceeding this limit temporarily may cause a shift in parametric performance due to a change in the stresses exerted on the die by the package. Exceeding a junction temperature of 175°C for an extended period can result in device failure.

While the AD8055/AD8056 are internally short circuit protected, this may not be sufficient to guarantee that the maximum junction temperature (150°C) is not exceeded under all conditions. To ensure proper operation, it is necessary to observe the maximum power derating curves.

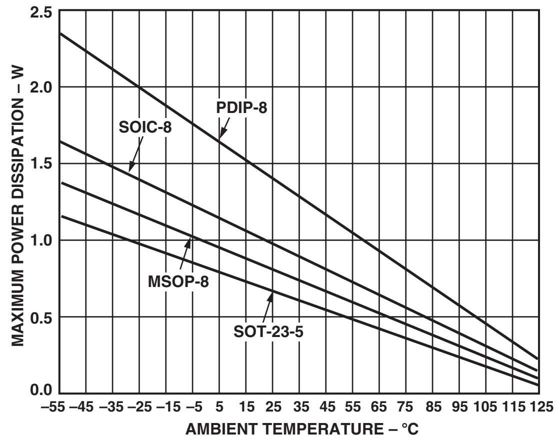


Figure 2. Plot of Maximum Power Dissipation vs. Temperature for AD8055/AD8056

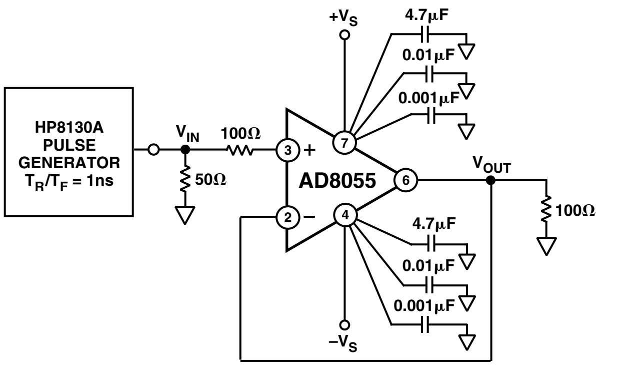
ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option	Branding Code
AD8055AN	–40°C to +125°C	PDIP	N-8	
AD8055AR	–40°C to +125°C	SOIC	R-8	
AD8055AR-REEL	–40°C to +125°C	13" Tape and Reel	R-8	
AD8055AR-REEL7	–40°C to +125°C	7" Tape and Reel	R-8	
AD8055ART-R2	–40°C to +85°C	Reel (SOT-23)	RT-5	H3A
AD8055ART-REEL	–40°C to +85°C	13" Tape and Reel	RT-5	H3A
AD8055ART-REEL7	–40°C to +85°C	7" Tape and Reel	RT-5	H3A
AD8055ARTZ-REEL7*	–40°C to +85°C	7" Tape and Reel	RT-5	H3A
AD8056AN	–40°C to +125°C	PDIP	N-8	
AD8056AR	–40°C to +125°C	SOIC	R-8	
AD8056AR-REEL	–40°C to +125°C	13" Tape and Reel	R-8	
AD8056AR-REEL7	–40°C to +125°C	7" Tape and Reel	R-8	
AD8056ARM	–40°C to +125°C	MSOP	RM-8	H5A
AD8056ARM-REEL	–40°C to +125°C	13" Tape and Reel	RM-8	H5A
AD8056ARM-REEL7	–40°C to +125°C	7" Tape and Reel	RM-8	H5A
AD8056ARMZ*	–40°C to +125°C	MSOP	RM-8	H5A
AD8056ARMZ-REEL*	–40°C to +125°C	13" Tape and Reel	RM-8	H5A
AD8056ARMZ-REEL7*	–40°C to +125°C	7" Tape and Reel	RM-8	H5A

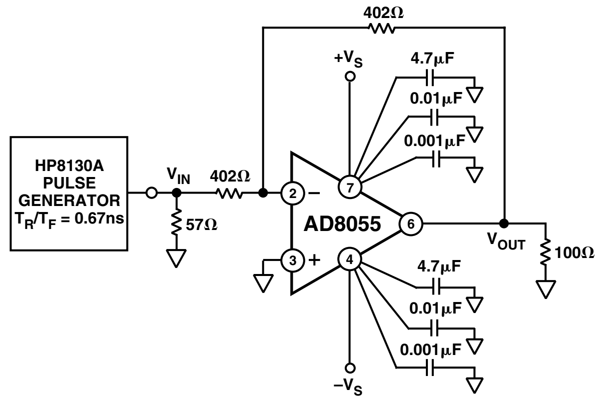
*This is a lead-free product.

CAUTION

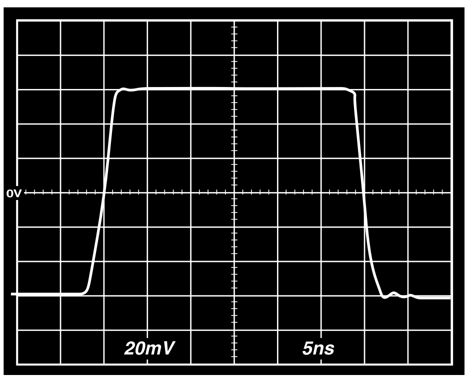
ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the AD8055/AD8056 feature proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



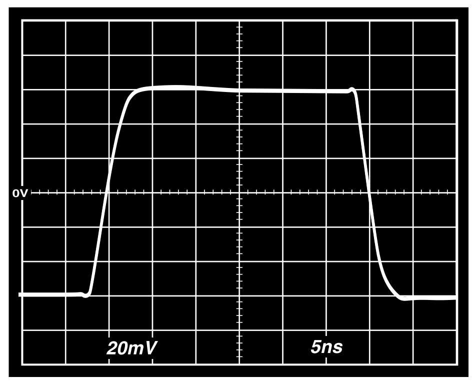
TPC 1. Test Circuit, G = +1, R_L = 100 Ω



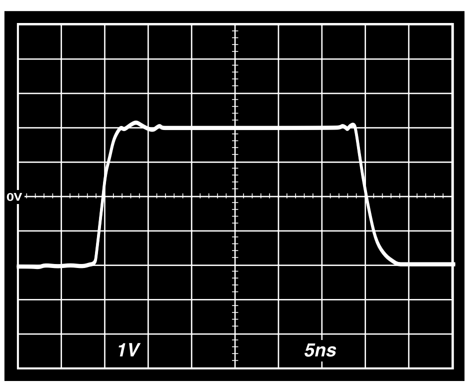
TPC 4. Test Circuit, G = –1, R_L = 100 Ω



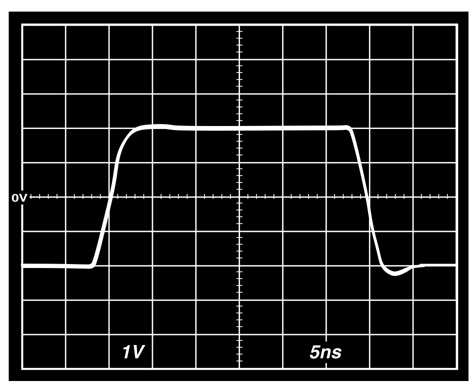
TPC 2. Small Step Response, G = +1



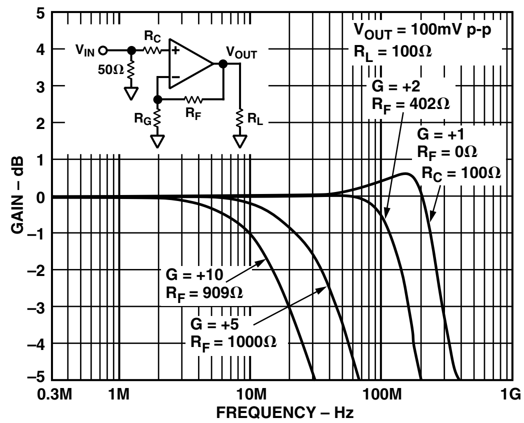
TPC 5. Small Step Response, G = –1



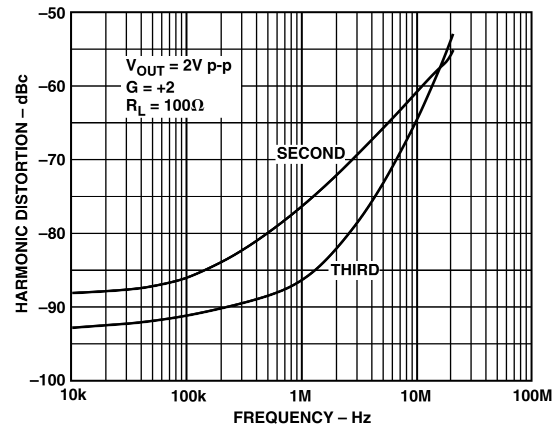
TPC 3. Large Step Response, G = +1



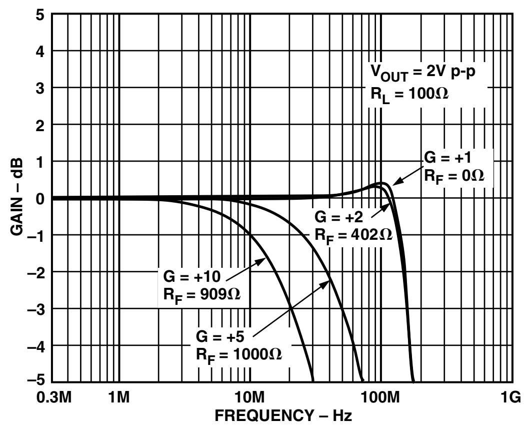
TPC 6. Large Step Response, G = –1



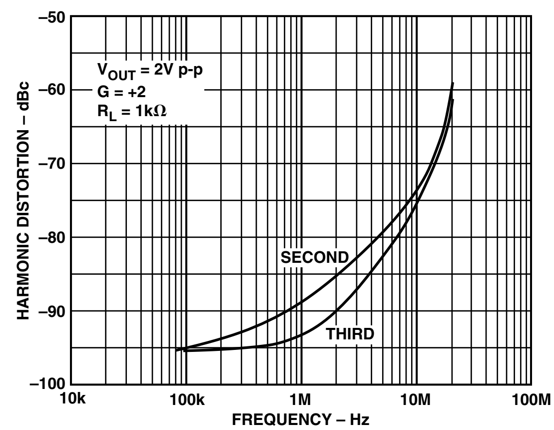
TPC 7. Small Signal Frequency Response, G = +1, G = +2, G = +5, G = +10



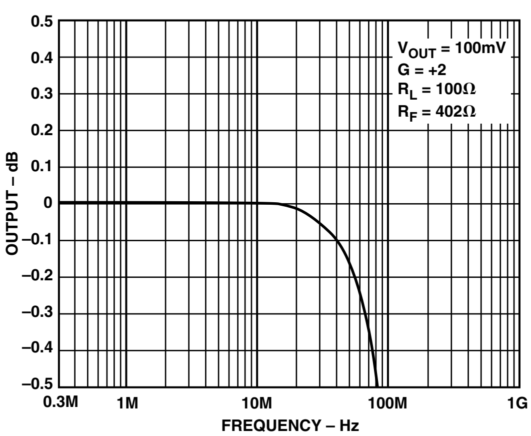
TPC 10. Harmonic Distortion vs. Frequency



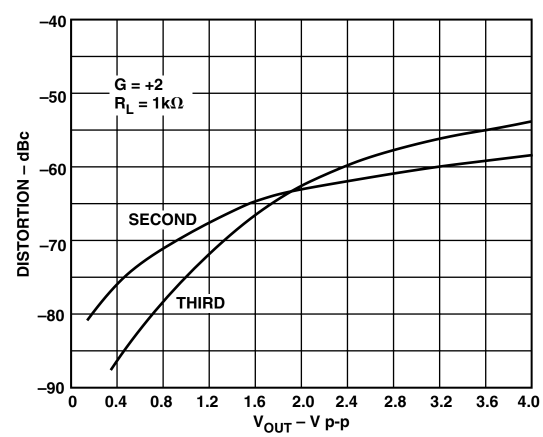
TPC 8. Large Signal Frequency Response, G = +1, G = +2, G = +5, G = +10



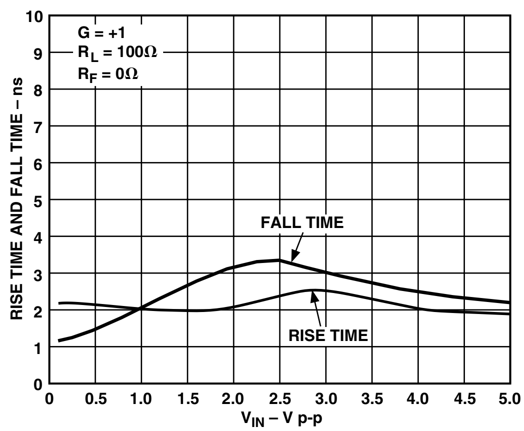
TPC 11. Harmonic Distortion vs. Frequency



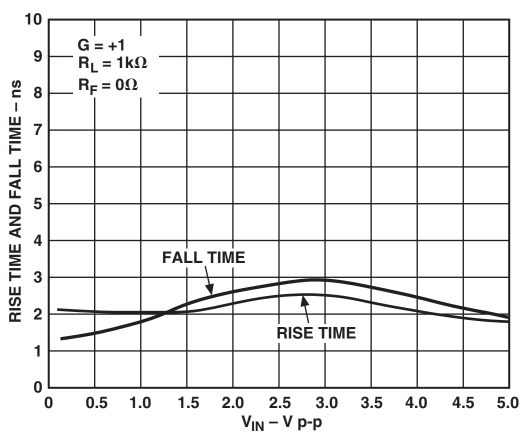
TPC 9. 0.1 dB Flatness



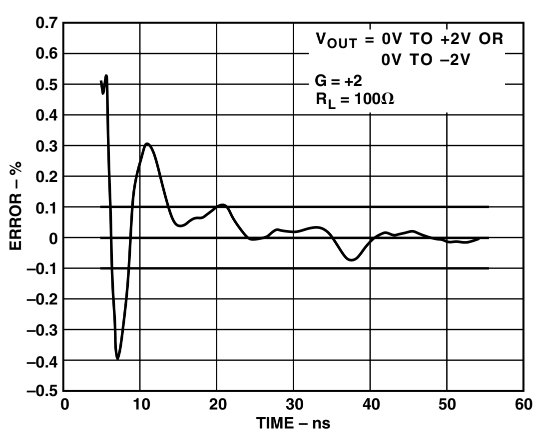
TPC 12. Distortion vs. V_{OUT} @ 20 MHz



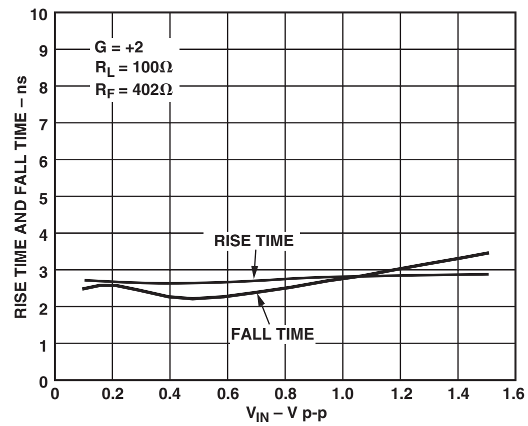
TPC 13. Rise Time and Fall Time vs. V_{IN}



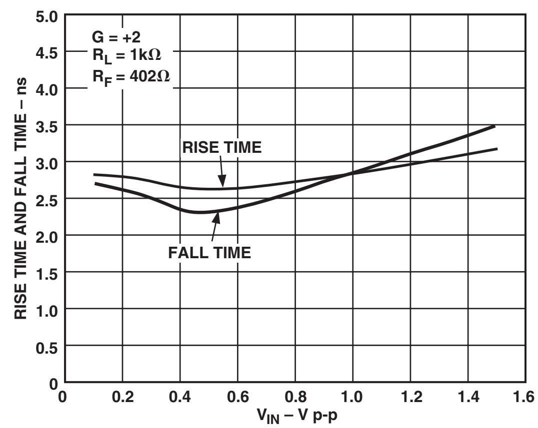
TPC 14. Rise Time and Fall Time vs. V_{IN}



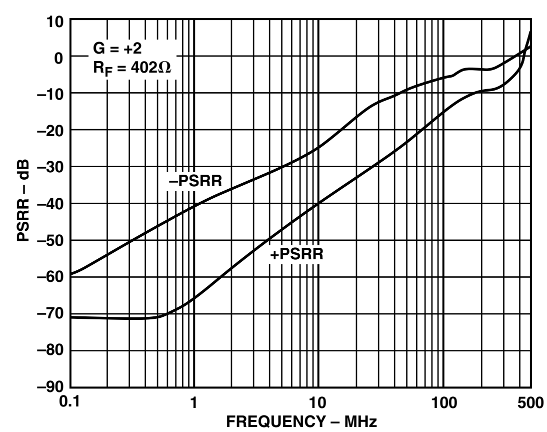
TPC 15. Settling Time



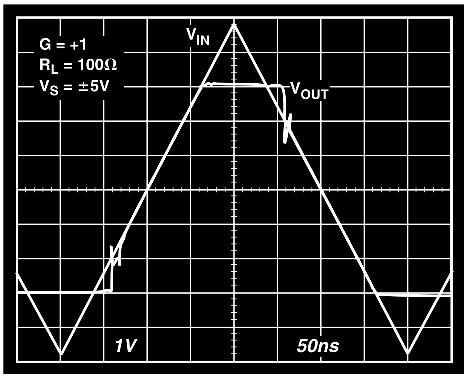
TPC 16. Rise Time and Fall Time vs. V_{IN}



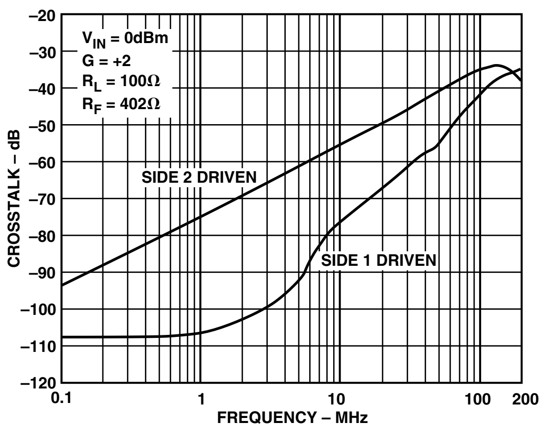
TPC 17. Rise Time and Fall Time vs. V_{IN}



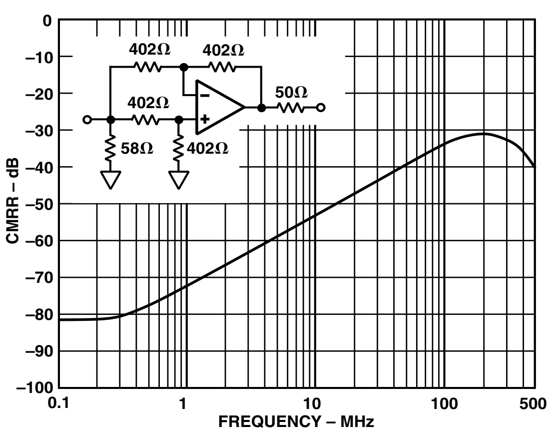
TPC 18. PSRR vs. Frequency



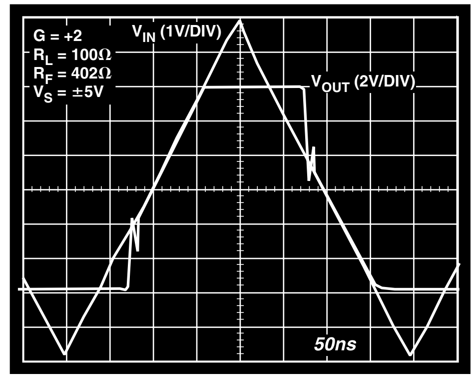
TPC 19. Overload Recovery



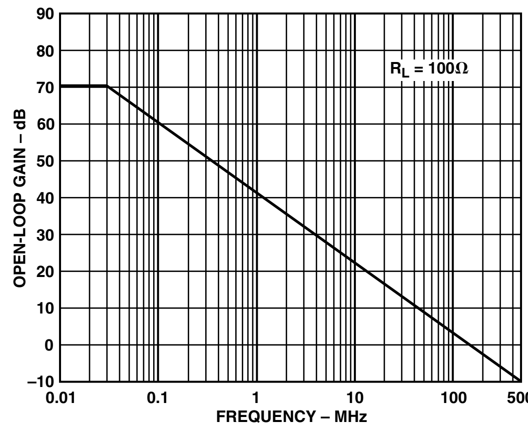
TPC 20. Crosstalk (Output-to-Output) vs. Frequency



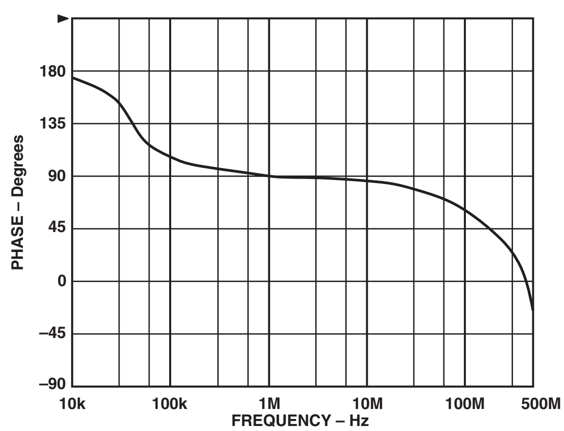
TPC 21. CMRR vs. Frequency



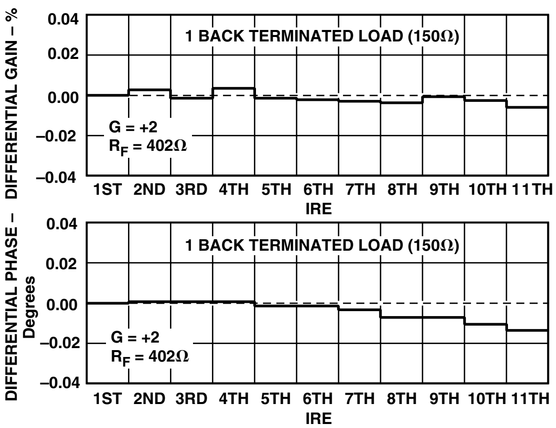
TPC 22. Overload Recovery



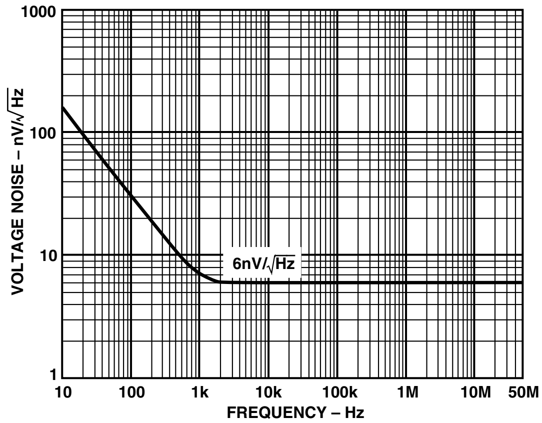
TPC 23. Open-Loop Gain vs. Frequency



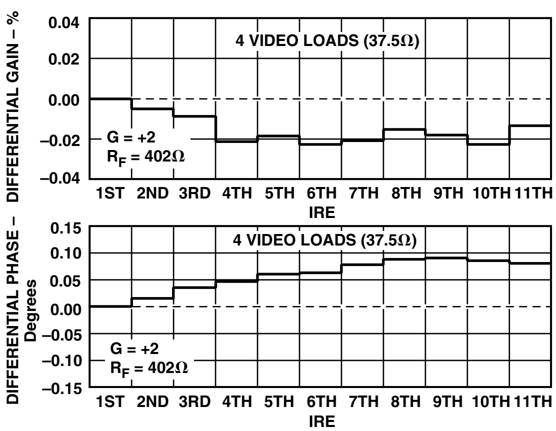
TPC 24. Phase vs. Frequency



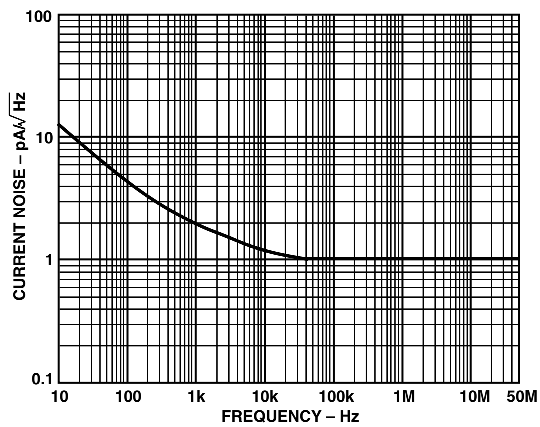
TPC 25. Differential Gain and Differential Phase



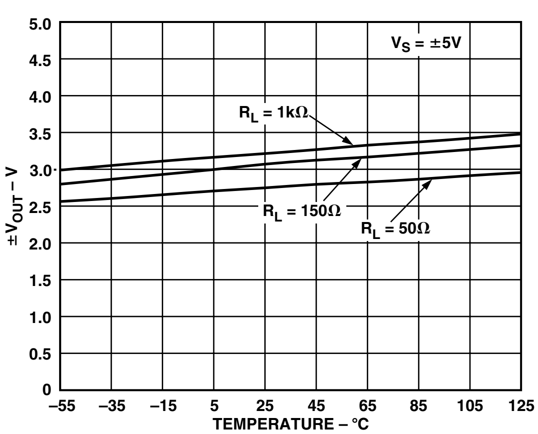
TPC 28. Voltage Noise vs. Frequency



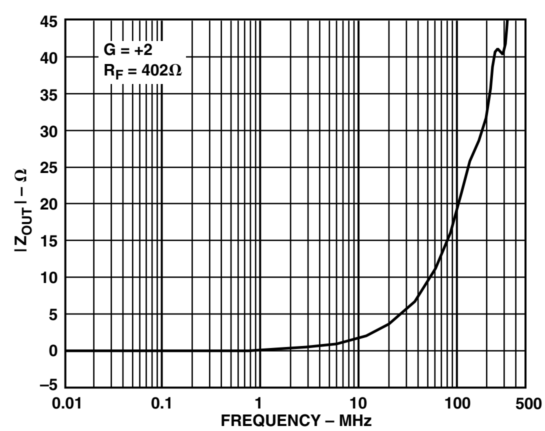
TPC 26. Differential Gain and Differential Phase



TPC 29. Current Noise vs. Frequency



TPC 27. Output Swing vs. Temperature



TPC 30. Output Impedance vs. Frequency

APPLICATIONS

Four-Line Video Driver

The AD8055 is a useful low cost circuit for driving up to four video lines. For such an application, the amplifier is configured for a noninverting gain-of-2 as shown in Figure 3. The input video source is terminated in 75 Ω and applied to the high impedance noninverting input.

Each output cable is connected to the op amp output via a 75 Ω series back termination resistor for proper cable termination. The terminating resistors at the other ends of the lines will divide the output signal by 2, which is compensated for by the gain-of-2 of the op amp stage.

For a single load, the differential gain error of this circuit was measured to be 0.01%, with a differential phase error of 0.02°. The two load measurements were 0.02% and 0.03°, respectively. For four loads, the differential gain error is 0.02%, while the differential phase increases to 0.1°.

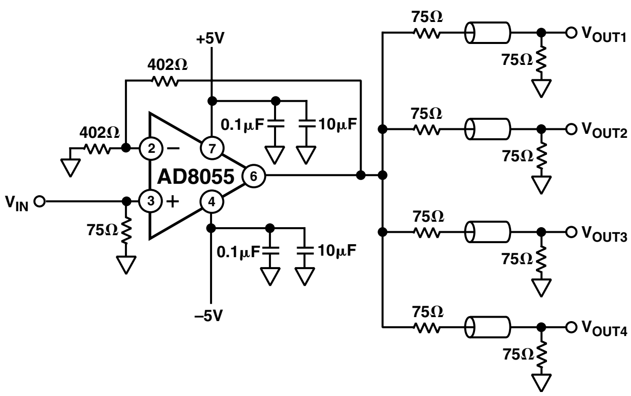


Figure 3. Four-Line Video Driver

Single-Ended-to-Differential Line Driver

Creating differential signals from single-ended signals is required for driving balanced, twisted pair cables, differential input A/D converters, and other applications that require differential signals. This is sometimes accomplished by using an inverting and a noninverting amplifier stage to create the complementary signals.

The circuit shown in Figure 4 shows how an AD8056 can be used to make a single-ended-to-differential converter that offers some advantages over the architecture mentioned above. Each op amp is configured for unity gain by the feedback resistors from the outputs to the inverting inputs. In addition, each output drives the opposite op amp with a gain of –1 by means of the crossed resistors. The result of this is that the outputs are complementary and there is high gain in the overall configuration.

Feedback techniques similar to a conventional op amp are used to control the gain of the circuit. From the noninverting input of AMP1 to the output of AMP2 is an inverting gain. Between these points a feedback resistor can be used to close the loop. As in the case of a conventional op amp inverting gain stage, an input resistor is added to vary the gain.

The gain of this circuit from the input to AMP1 output is R_F/R_I, while the gain to the output of AMP2 is $-R_F/R_I$. The circuit thus creates a balanced differential output signal from a single-ended input. The advantage of this circuit is that the gain can be changed by changing a single resistor, while still maintaining the balanced differential outputs.

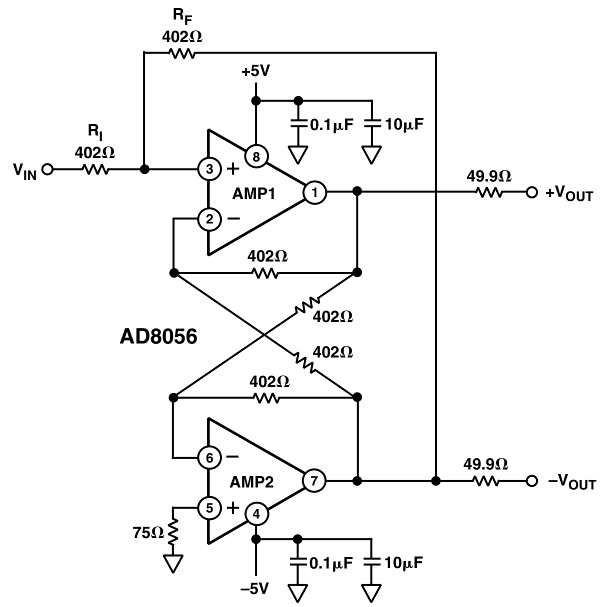


Figure 4. Single-Ended-to-Differential Line Driver

Low Noise, Low Power Preamp

The AD8055 makes a good, low cost, low noise, low power preamp. A gain-of-10 preamp can be made with a feedback resistor of 909 Ω and a gain resistor of 100 Ω as shown in Figure 5. The circuit has a –3 dB bandwidth of 20 MHz.

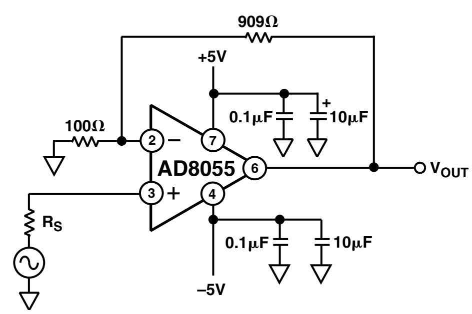


Figure 5. Low Noise, Low Power Preamp with G = +10 and BW = 20 MHz

With a low source resistance (< approximately 100 Ω), the major contributors to the input referred noise of this circuit are the input voltage noise of the amplifier and the noise of the 100 Ω resistor. These are 6 nV/$\sqrt{Hz}$ and 1.2 nV/$\sqrt{Hz}$, respectively. These values yield a total input referred noise of 6.1 nV/$\sqrt{Hz}$.

Power Dissipation Limits

With a 10 V supply (total $V_{CC} – V_{EE}$), the quiescent power dissipation of the AD8055 in the SOT-23-5 package is 65 mW, while the quiescent power dissipation of the AD8056 in the MSOP is 120 mW. This translates into a 15.6°C rise above the ambient for the SOT-23-5 package and a 24°C rise for the MSOP package.

The power dissipated under heavy load conditions is approximately equal to the supply voltage minus the output voltage, times the load current, plus the quiescent power computed above. This total power dissipation is then multiplied by the thermal resistance of the package to find the temperature rise, above ambient, of the part. The junction temperature should be kept below 150°C.

The AD8055 in the SOT-23-5 package can dissipate 270 mW while the AD8056 in the MSOP package can dissipate 325 mW (at 85°C ambient) without exceeding the maximum die temperature. In the case of the AD8056, this is greater than 1.5 V rms into 50 Ω, enough to accommodate a 4 V p-p sine wave signal on both outputs simultaneously. But since each output of the AD8055 or AD8056 is capable of supplying as much as 110 mA into a short circuit, a continuous short circuit condition will exceed the maximum safe junction temperature.

Resistor Selection

This table is provided as a guide to resistor selection for maintaining gain flatness versus frequency for various values of gain.

Gain	R_F (Ω)	R_G (Ω)	–3 dB Bandwidth (MHz)
+1	0		300
+2	402	402	160
+5	1k	249	45
+10	909	100	20

Driving Capacitive Loads

When driving a capacitive load, most op amps will exhibit peaking in the frequency response just before the frequency rolls off. Figure 6 shows the responses for an AD8056 running at a gain of +2, with a 100 Ω load that is shunted by various values of capacitance. It can be seen that under these conditions, the part is still stable with capacitive loads of up to 30 pF.

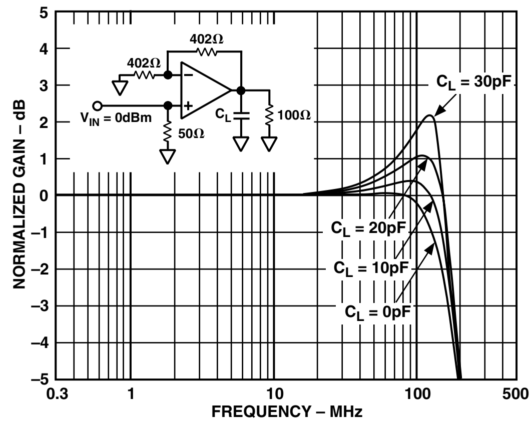


Figure 6. Capacitive Load Drive

In general, to minimize peaking or to ensure the stability for larger values of capacitive loads, a small series resistor, R_S, can be added between the op amp output and the capacitor, C_L. For the setup depicted in Figure 7, the relationship between R_S and C_L was empirically derived and is shown in Figure 8. R_S was chosen to produce less than 1 dB of peaking in the frequency response. Note also that after a sharp rise, R_S quickly settles to about 25 Ω.

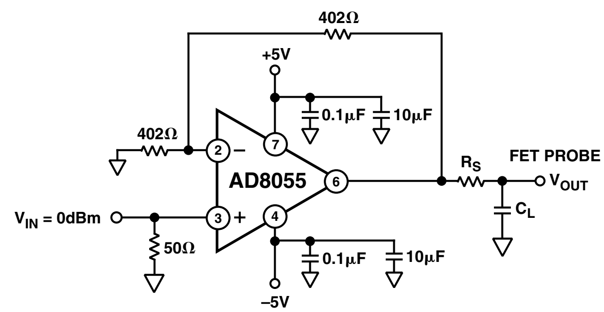


Figure 7. Setup for R_S vs. C_L

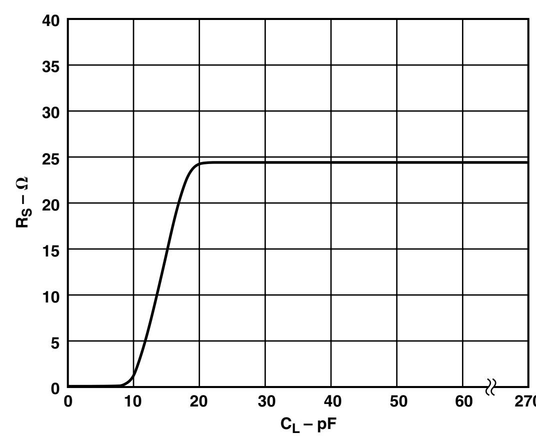
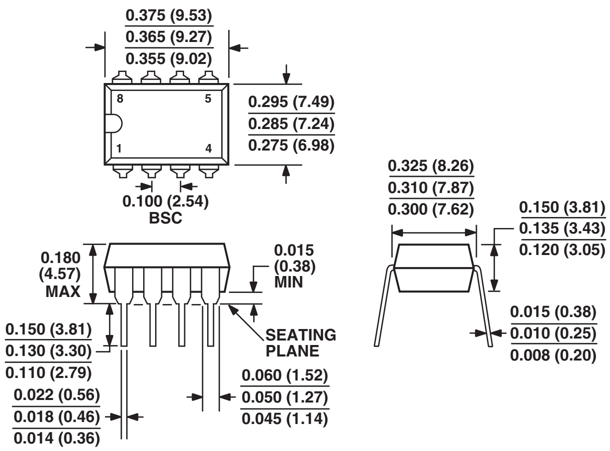


Figure 8. R_S vs. C_L

OUTLINE DIMENSIONS

8-Lead Plastic Dual In-Line Package [PDIP] (N-8)

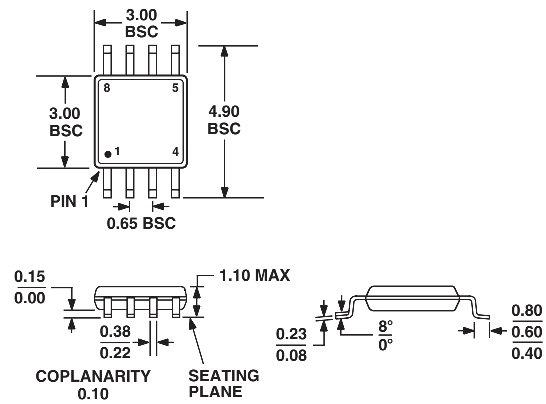
Dimensions shown in inches and (millimeters)



COMPLIANT TO JEDEC STANDARDS MO-095AA
CONTROLLING DIMENSIONS ARE IN INCHES; MILLIMETER DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF INCH EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN

8-Lead Mini Small Outline Package [MSOP] (RM-8)

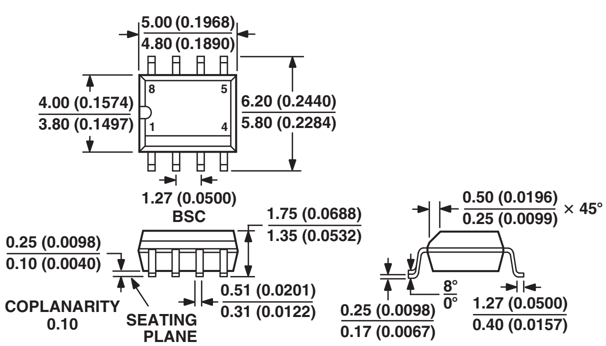
Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MO-187AA

8-Lead Standard Small Outline Package [SOIC] Narrow Body (R-8)

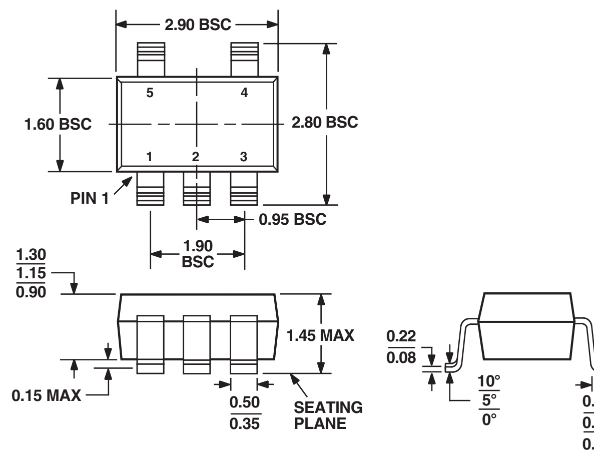
Dimensions shown in millimeters and (inches)



COMPLIANT TO JEDEC STANDARDS MS-012AA
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

5-Lead Small Outline Transistor Package [SOT-23] (RT-5)

Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MO-178AA

Revision History

Location	Page
6/03—Data Sheet changed from REV. G to REV. H.	
Changes to ABSOLUTE MAXIMUM RATINGS	3
Updated ORDERING GUIDE	3
Updated OUTLINE DIMENSIONS	11
2/03—Data Sheet changed from REV. F to REV. G.	
Changes to PRODUCT DESCRIPTION	1
Changes to SPECIFICATIONS	2
Change to ORDERING GUIDE	3
OUTLINE DIMENSIONS updated	11
10/02—Data Sheet changed from REV. E to REV. F.	
Text changes to reflect extended temperature range for R-8, N-8 packages	1
Changes to SPECIFICATIONS	2
Changes to ABSOLUTE MAXIMUM RATINGS	3
Figure 2 replaced	3
Changes to ORDERING GUIDE	3
OUTLINE DIMENSIONS updated	11
7/01—Data Sheet changed from REV. D to REV. E.	
TPC 24 replaced with new graph	7
3/01—Data Sheet changed from REV. C to REV. D.	
Edit to curve in TPC 23	7
2/01—Data Sheet changed from REV. B to REV. C.	
Edits to text at top of SPECIFICATIONS page (65 to ±5)	2

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