Low Cost Micropower, Low Noise CMOS Rail-to-Rail, Input/Output Operational Amplifiers

Data Sheet

AD8613/AD8617/AD8619

FEATURES

Offset voltage: 2.2 mV maximum
Low input bias current: 1 pA maximum
Single-supply operation: 1.8 V to 5.5 V
Low noise: 22 nV/√Hz
Micropower: 50 µA/amplifier maximum over temperature
No phase reversal
Unity gain stable
Qualified for automotive applications

APPLICATIONS

Battery-powered instrumentation
Multipole filters
Current shunt sense
Sensors
ADC predrivers
DAC drivers/level shifters
Low power ASIC input or output amplifiers

GENERAL DESCRIPTION

The AD8613/AD8617/AD8619 are single, dual, and quad micropower, rail-to-rail input and output amplifiers that feature low supply current, as well as low input voltage and current noise.

The parts are fully specified to operate from 1.8 V to 5 V single supply, or ±0.9 V and ±2.5 V dual supply. The combination of low noise, very low input bias currents, and low power consumption make the AD8613/AD8617/AD8619 especially useful in portable and loop-powered instrumentation.

The ability to swing rail-to-rail at both the input and output enables designers to buffer CMOS ADCs, DACs, ASICs, and other wide output swing devices in low power, single-supply systems.

The AD8613 is available in a 5-lead SC70 package and a 5-lead TSOT-23 package. The AD8617 is available in 8-lead MSOP, 8-lead SOIC, and 8-lead LFCSP packages. The AD8619 is available in 14-lead TSSOP and 14-lead SOIC packages. The AD8617W is qualified for automotive applications and is available in 8-lead MSOP and 8-lead SOIC packages. The AD8619W is qualified for automotive applications and is available in 14-lead SOIC and 14-lead TSSOP packages.

PIN CONFIGURATIONS

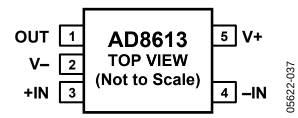

Figure 1. 5-Lead SC70 and 5-Lead TSOT-23

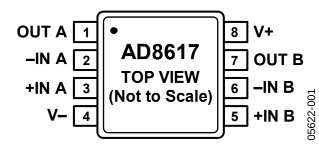

Figure 2. 8-Lead MSOP and 8-Lead SOIC_N

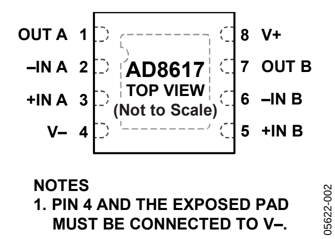

Figure 3. 8-Lead LFCSP

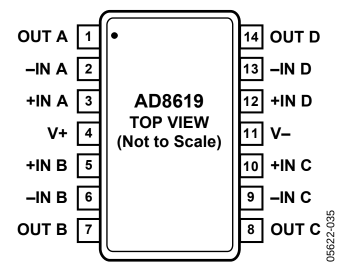

Figure 4. 14-Lead TSSOP and 14-Lead SOIC

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10/2005—Rev. 0 to Rev. A
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9/2005—Revision 0: Initial Version

SPECIFICATIONS

Electrical characteristics at V_{SY} = 5 V, V_{CM} = V_{SY}/2, T_A = 25°C, unless otherwise noted.

Table 1.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	−0.3 V < V_{CM} < +5.3 V		0.4	2.2	mV
		−40°C < T_A < +125°C, −0.3 V < V_{CM} < +5.2 V			2.2	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		1	4.5	µV/°C
AD8613				2.5	7.0	µV/°C
Input Bias Current	I_B			0.2	1	pA
		−40°C < T_A < +85°C			110	pA
		−40°C < T_A < +125°C			780	pA
Input Offset Current	I_{OS}			0.1	0.5	pA
		−40°C < T_A < +85°C			50	pA
		−40°C < T_A < +125°C			250	pA
Input Voltage Range	IVR		0		5	V
Common-Mode Rejection Ratio	CMRR	0 V < V_{CM} < 5 V		95		dB
		−40°C < T_A < +125°C	68			dB
Large Signal Voltage Gain	A_{VO}	R_L = 10 kΩ, 0.5 V < V_O < 4.5 V	235	500		V/mV
Input Capacitance	C_{DIFF}			1.9		pF
	C_{CM}			2.5		pF
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	I_L = 1 mA	4.95	4.98		V
		−40°C to +125°C	4.9			V
		I_L = 10 mA		4.7		V
		−40°C to +125°C	4.50			V
Output Voltage Low	V_{OL}	I_L = 1 mA		20	30	mV
		−40°C to +125°C			50	mV
		I_L = 10 mA		190	275	mV
		−40°C to +125°C			335	mV
Short-Circuit Current	I_{SC}			±80		mA
Closed-Loop Output Impedance	Z_{OUT}	f = 10 kHz, A_V = 1		15		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	1.8 V < V_{SY} < 5 V	67	94		dB
		−40°C < T_A < +125°C	64			dB
Supply Current/Amplifier	I_{SY}	V_O = V_{SY}/2		38		µA
		−40°C < T_A < +125°C			50	µA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 10 kΩ		0.1		V/µs
Settling Time to 0.1%	t_S	G = ±1, V_{IN} = 2 V step, C_L = 20 pF, R_L = 1 kΩ		23		µs
Gain Bandwidth Product	GBP	R_L = 100 kΩ		400		kHz
		R_L = 10 kΩ		350		kHz
Phase Margin	$Ø_M$	R_L = 10 kΩ, R_L = 100 kΩ, C_L = 20 pF		70		Degrees
NOISE PERFORMANCE						
Peak-to-Peak Noise	e_n p-p	0.1 Hz to 10 Hz		2.3	3.5	µV
Voltage Noise Density	e_n	f = 1 kHz		25		nV/√Hz
		f = 10 kHz		22		nV/√Hz
Current Noise Density	i_n	f = 1 kHz		0.05		pA/√Hz

Electrical characteristics at V_{SY} = 1.8 V, V_{CM} = $V_{SY}/2$, T_A = 25°C, unless otherwise noted.

Table 2.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	−0.3 V < V_{CM} < +1.9 V		0.4	2.2	mV
		−0.3 V < V_{CM} < +1.8 V; −40°C < T_A < +125°C			2.2	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		1	8.5	µV/°C
AD8613				3.7	9.0	µV/°C
Input Bias Current	I_B			0.2	1	pA
		−40°C < T_A < +85°C			110	pA
		−40°C < T_A < +125°C			780	pA
Input Offset Current	I_{OS}			0.1	0.5	pA
		−40°C < T_A < +85°C			50	pA
		−40°C < T_A < +125°C			250	pA
Input Voltage Range	IVR		0		1.8	V
Common-Mode Rejection Ratio	CMRR	0 V < V_{CM} < 1.8 V	58	86		dB
		−40°C < T_A < +125°C	55			dB
Large Signal Voltage Gain	A_{VO}	R_L = 10 kΩ, 0.5 V < V_O < 1.3 V	85	1000		V/mV
Input Capacitance	C_{DIFF}			2.1		pF
	C_{CM}			3.8		pF
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	I_L = 1 mA	1.65	1.73		V
		−40°C to +125°C	1.6			V
Output Voltage Low	V_{OL}	I_L = 1 mA		44	60	mV
		−40°C to +125°C			80	mV
Short-Circuit Current	I_{SC}			±7		mA
Closed-Loop Output Impedance	Z_{OUT}	f = 10 kHz, A_V = 1		15		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	1.8 V < V_S < 5 V	67	94		dB
Supply Current/Amplifier	I_{SY}	V_O = $V_{SY}/2$		38		µA
		−40°C < T_A < +125°C			50	µA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 10 kΩ		0.1		V/µs
Settling Time to 0.1%	t_S	G = ±1, V_{IN} = 1 V step, C_L = 20 pF, R_L = 1 kΩ		6.5		µs
Gain Bandwidth Product	GBP	R_L = 100 kΩ		400		kHz
		R_L = 10 kΩ		350		kHz
Phase Margin	$Ø_M$	R_L = 10 kΩ, R_L = 100 kΩ, C_L = 20 pF		70		Degrees
NOISE PERFORMANCE						
Peak-to-Peak Noise	e_n p-p	0.1 Hz to 10 Hz		2.3	3.5	µV
Voltage Noise Density	e_n	f = 1 kHz		25		nV/√Hz
		f = 10 kHz		22		nV/√Hz
Current Noise Density	i_n	f = 1 kHz		0.05		pA/√Hz

ABSOLUTE MAXIMUM RATINGS

T_A = 25°C, unless otherwise noted.

Table 3.

Parameter	Rating
Supply Voltage	6 V
Input Voltage	V_{SS} − 0.3 V to V_{DD} + 0.3 V
Input Current	±10 mA
Differential Input Voltage	±6 V
Output Short-Circuit Duration to GND	Indefinite
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	−40°C to +125°C
Junction Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 60 sec)	300°C
ESD AD8613	
HBM	±4000 V
FICDM	±1000 V
ESD AD8617	
HBM	±3000 V
FICDM	±1000 V
MM	±100 V
ESD AD8619	
HBM	±4000 V
FICDM	±1250 V
MM	±200 V

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.

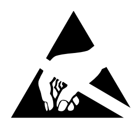
THERMAL RESISTANCE

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

Table 4. Thermal Characteristics

Package Type	θ_{JA}	θ_{JC}	Unit
5-Lead TSOT-23 (UJ-5)	207	61	°C/W
5-Lead SC70 (KS-5)	376	126	°C/W
8-Lead MSOP (RM-8)	210	45	°C/W
8-Lead SOIC_N (R-8)	158	43	°C/W
8-Lead LFCSP (CP-8-21)	81	20	°C/W
14-Lead SOIC_N (R-14)	120	36	°C/W
14-Lead TSSOP (RU-14)	180	35	°C/W

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.

TYPICAL PERFORMANCE CHARACTERISTICS

V_{SY} = 5 V or ±2.5 V, unless otherwise noted.

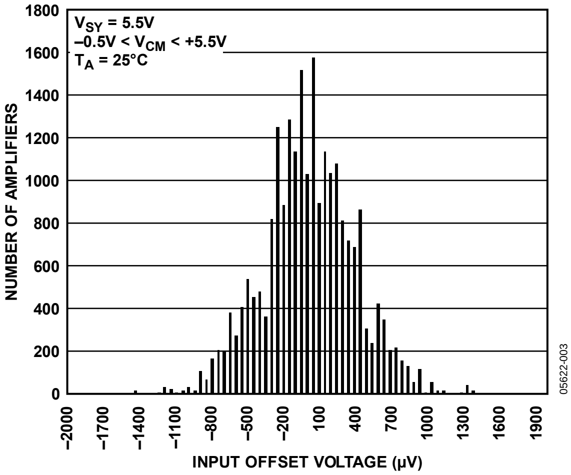


Figure 5. Input Offset Voltage Distribution

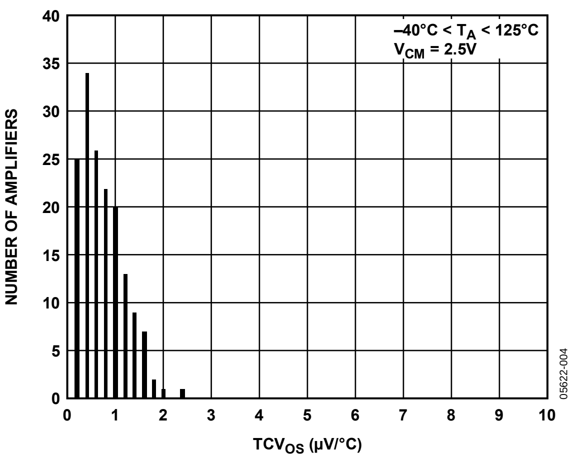
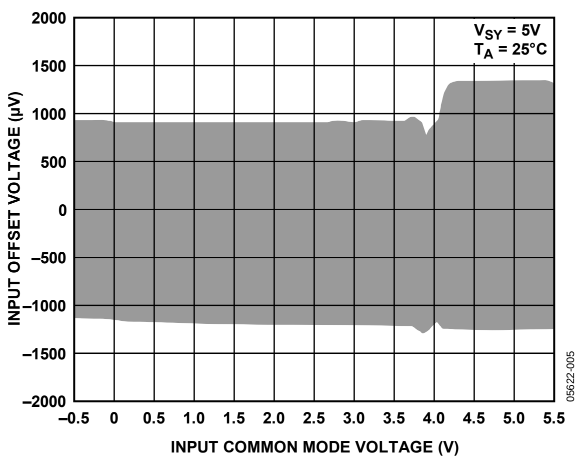


Figure 6. Input Offset Voltage Drift Distribution



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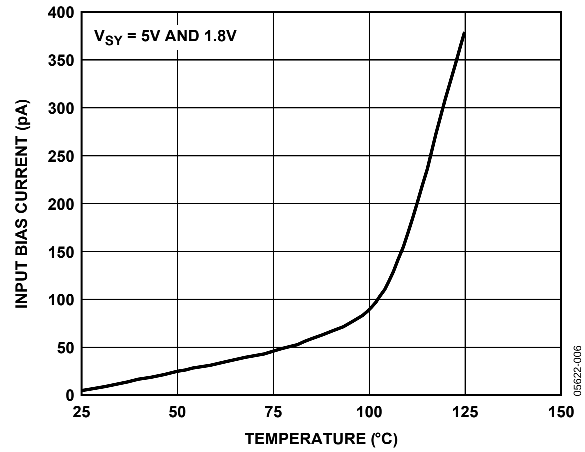

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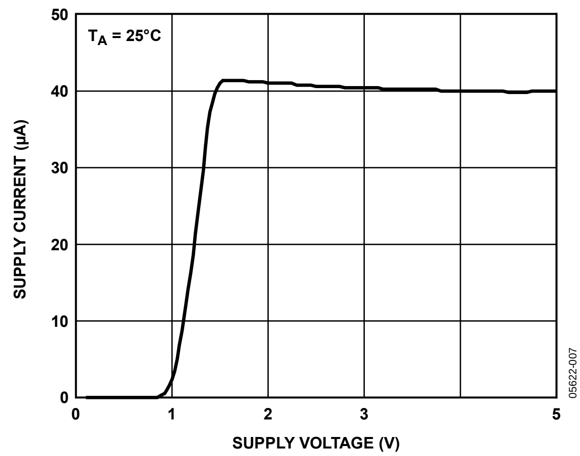

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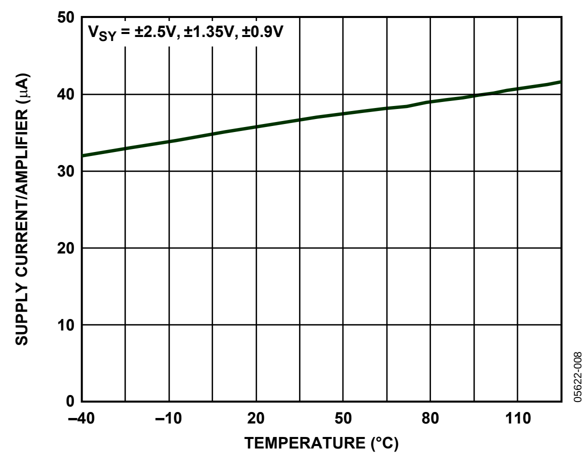

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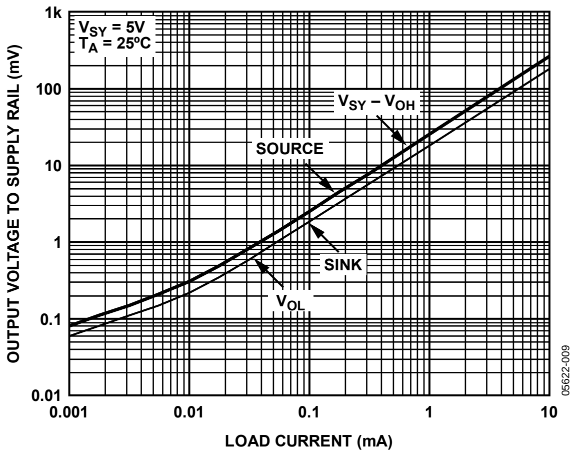

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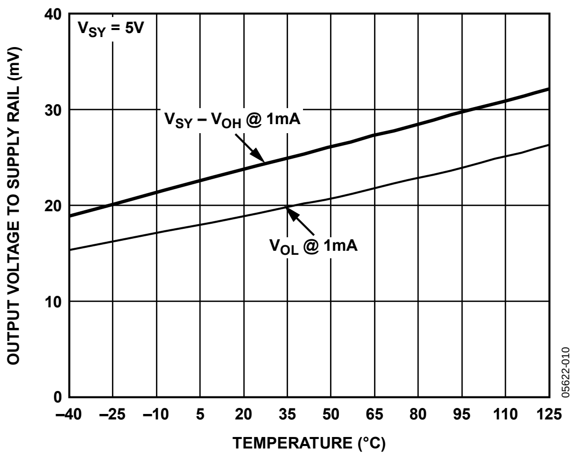

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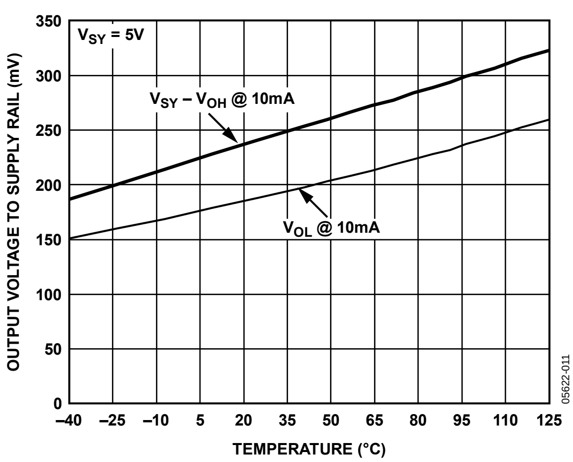

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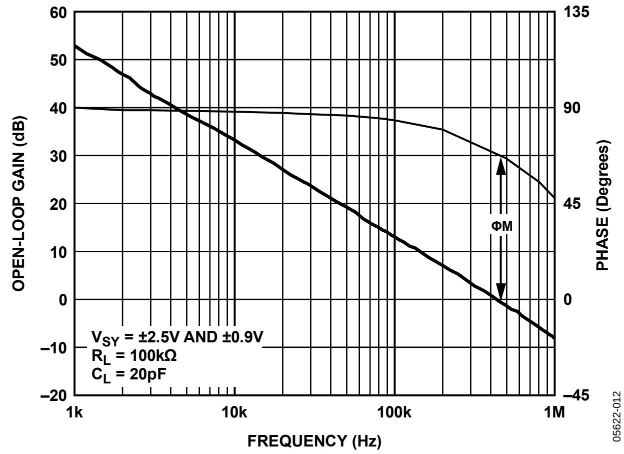

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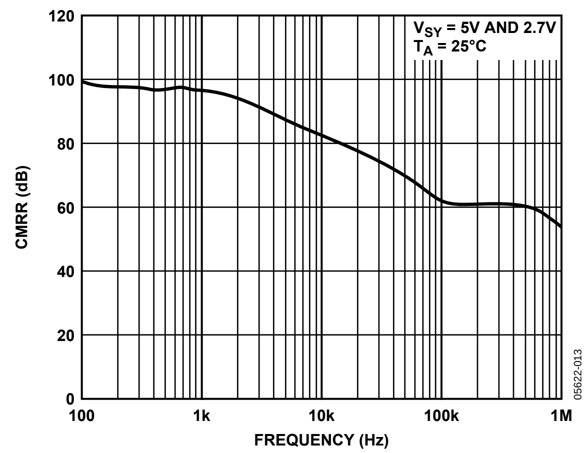

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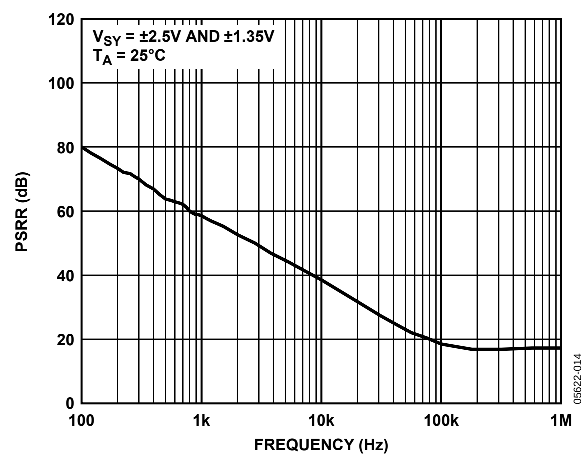

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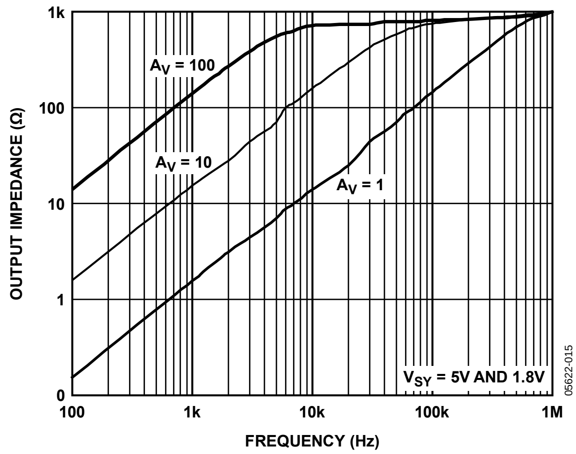

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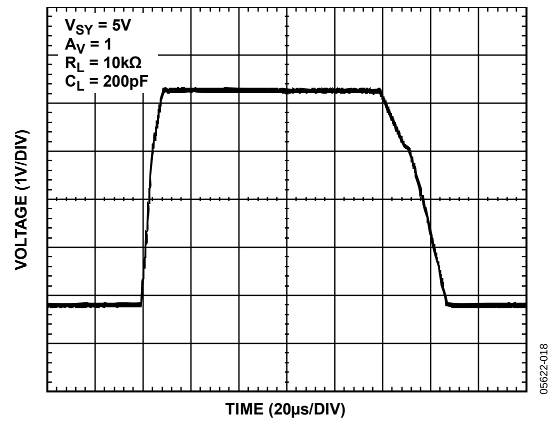

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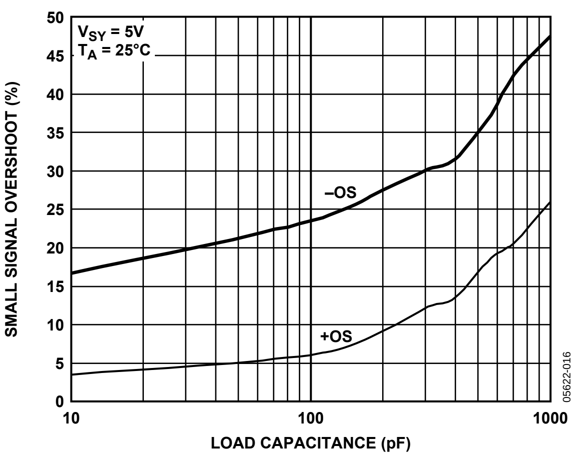

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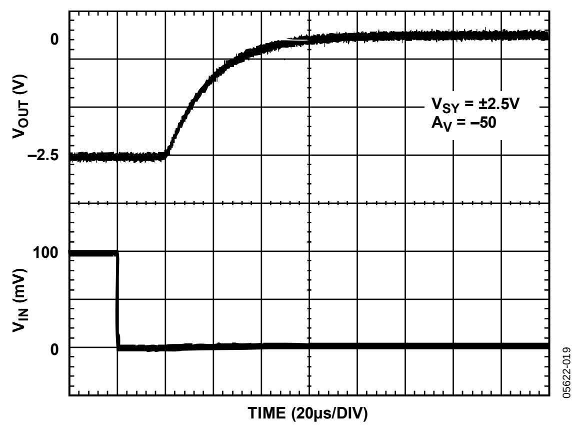


Figure 21. Positive Overload Recovery

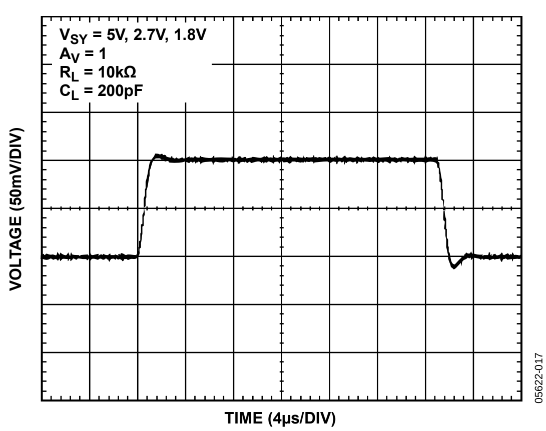
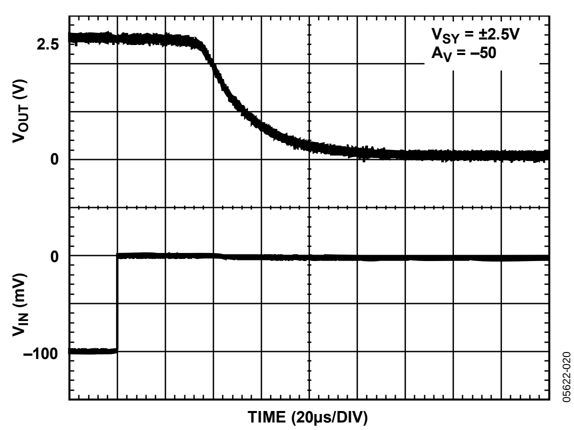


Figure 19. Small Signal Transient Response



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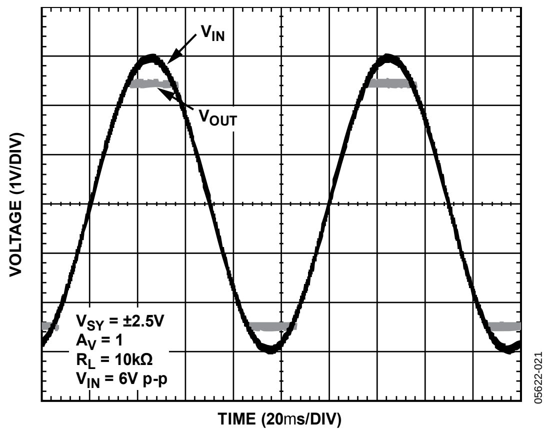

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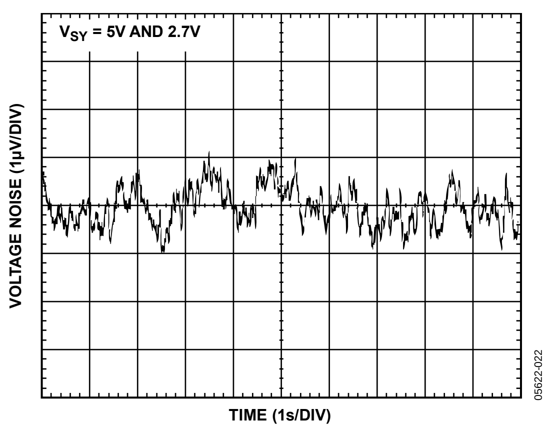

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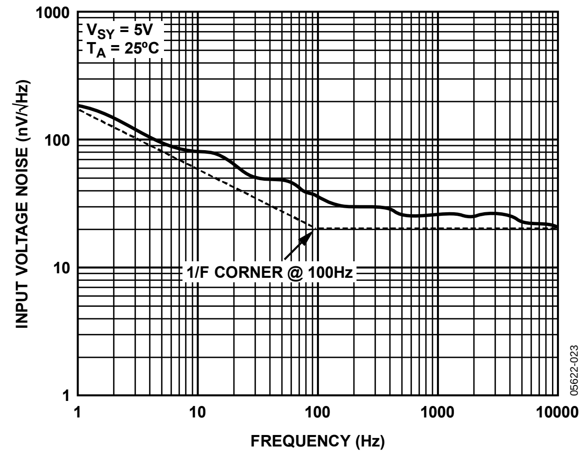

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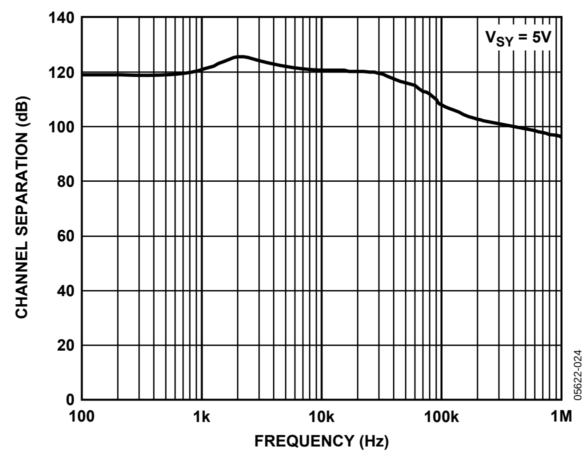


Figure 26. Channel Separation

V_{SY} = 1.8 V or ±0.9 V, unless otherwise noted.

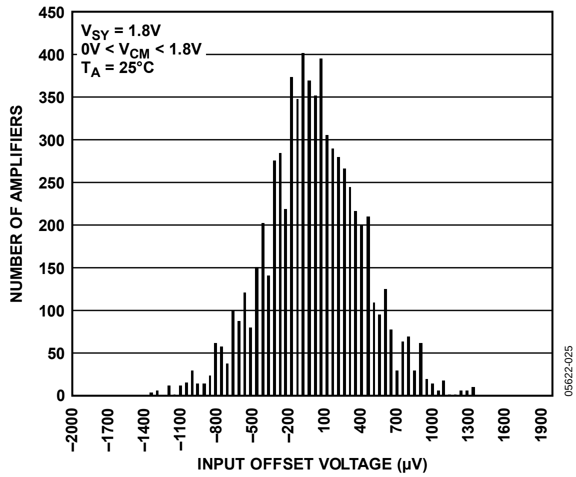
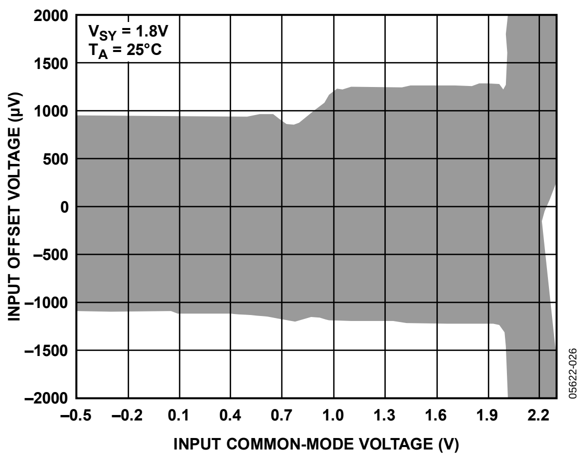


Figure 27. Input Offset Voltage Distribution



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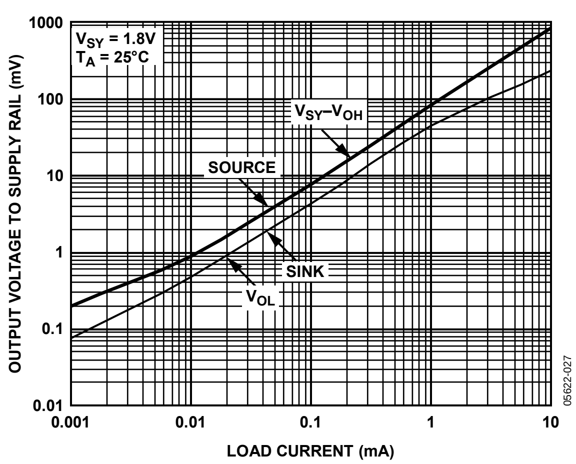

Figure 29. Output Voltage to Supply Rail vs. Load Current

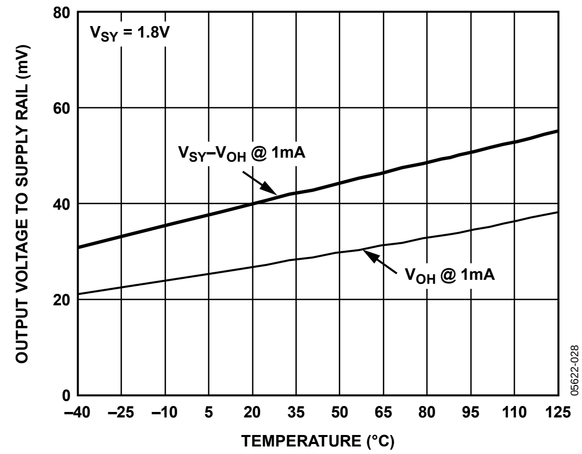

Figure 30. Output Voltage to Supply Rail vs. Temperature (I_L = 1 mA)

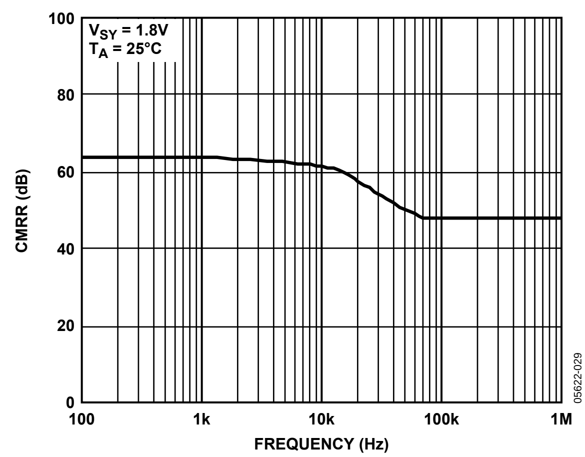

Figure 31. CMRR vs. Frequency

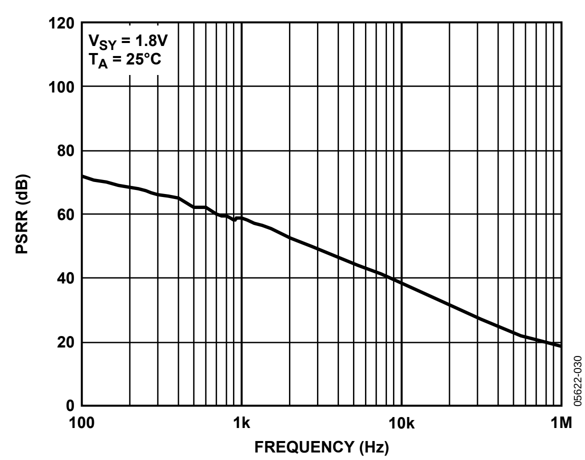

Figure 32. PSRR vs. Frequency

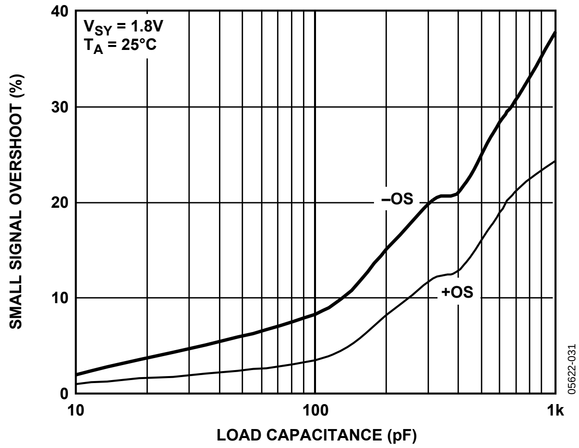

Figure 33. Small Signal Overshoot vs. Load Capacitance

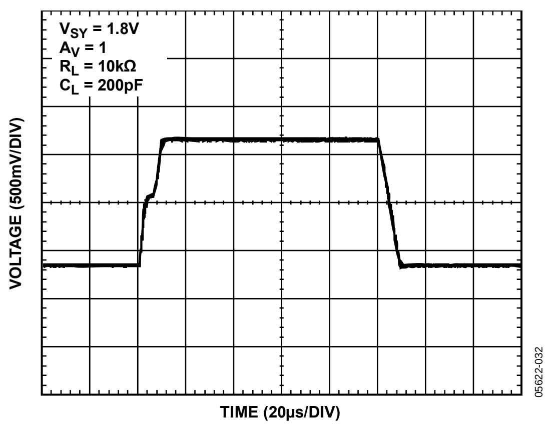

Figure 34. Large Signal Transient Response

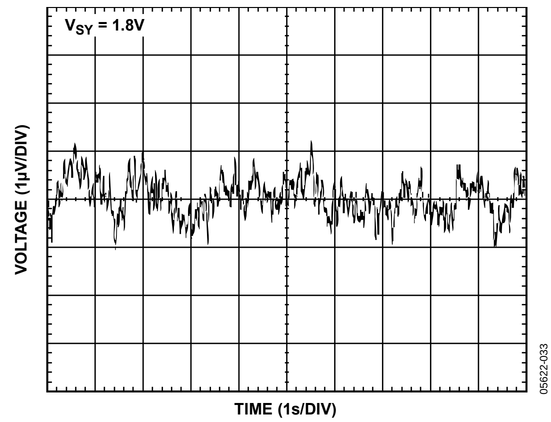

Figure 35. 0.1 Hz to 10 Hz Input Voltage Noise

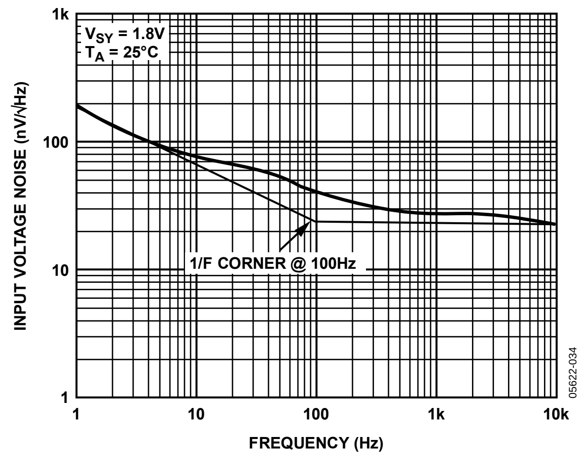

Figure 36. Voltage Noise Density

OUTLINE DIMENSIONS

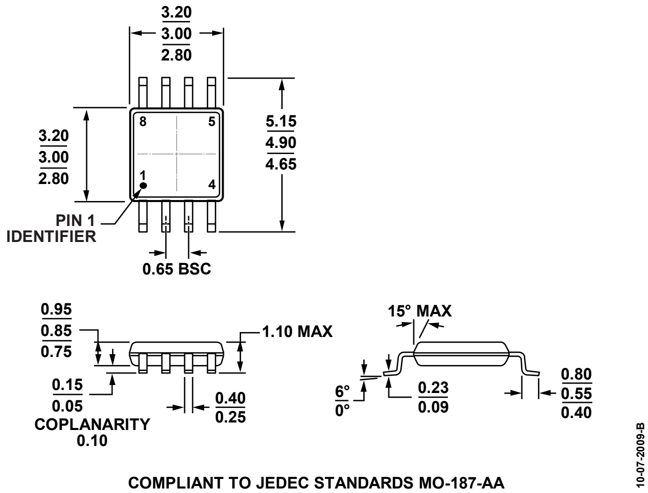

Figure 37. 8-Lead Mini Small Outline Package [MSOP]
(RM-8)
Dimensions shown in millimeters

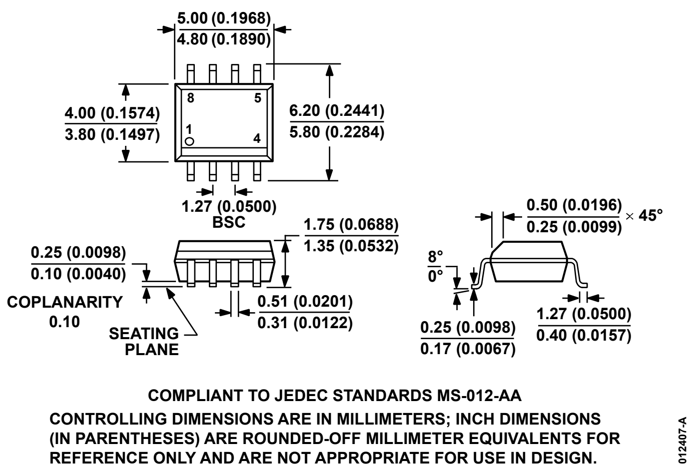

Figure 38. 8-Lead Standard Small Outline Package [SOIC_N]
Narrow Body (R-8)
Dimensions shown in millimeters and (inches)

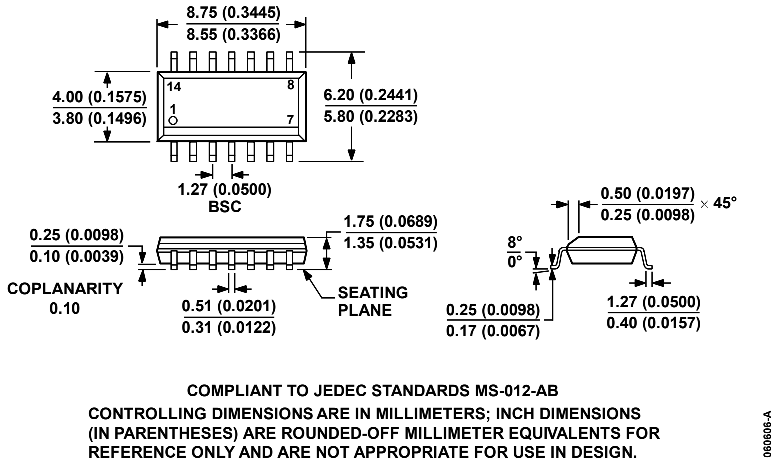

Figure 39. 14-Lead Standard Small Outline Package [SOIC_N]
Narrow Body (R-14)
Dimensions shown in millimeters and (inches)

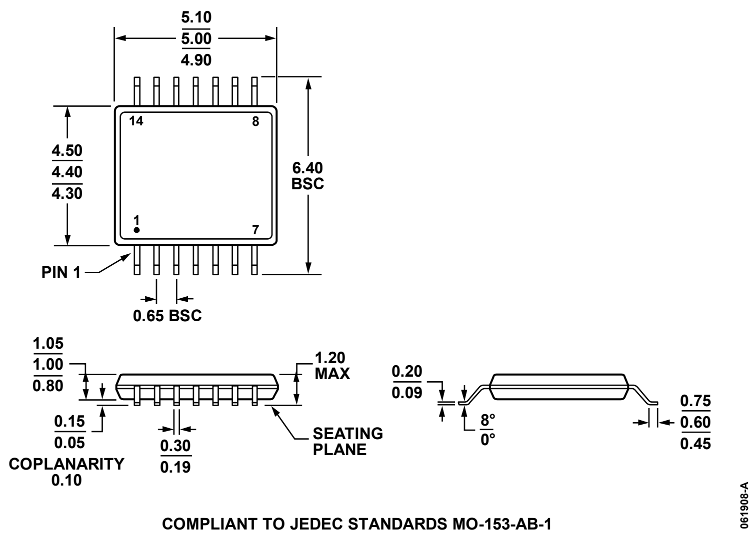

Figure 40. 14-Lead Thin Shrink Small Outline Package [TSSOP]
(RU-14)
Dimensions shown in millimeters

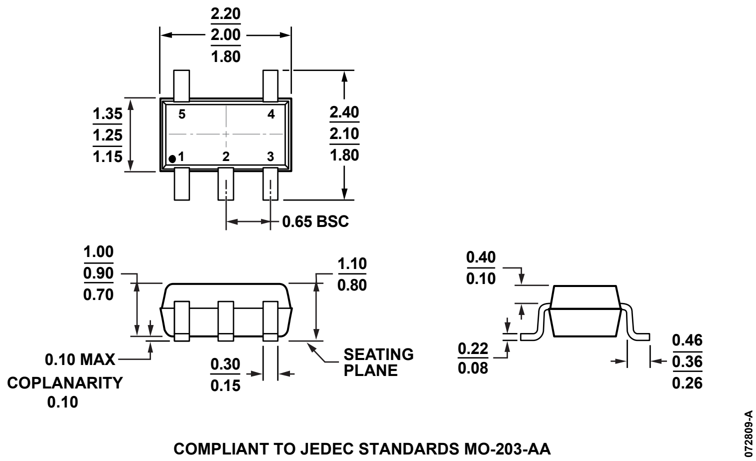

Figure 41. 5-Lead Thin Shrink Small Outline Transistor Package [SC70]
(KS-5)
Dimensions shown in millimeters

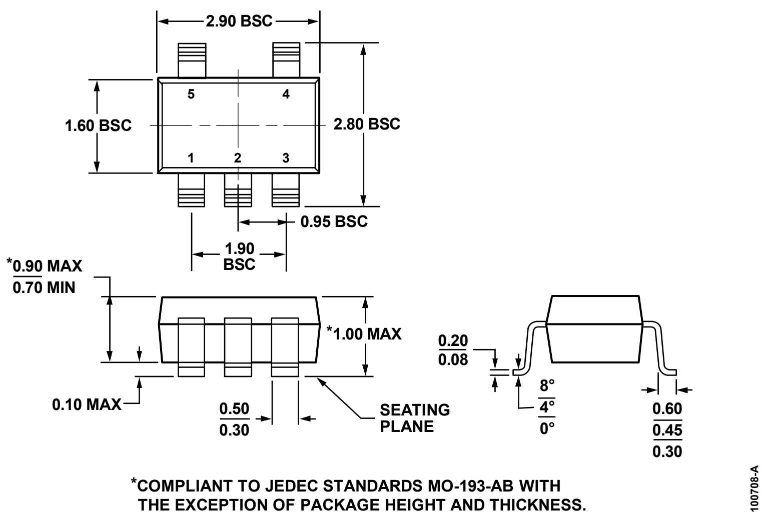

Figure 42. 5-Lead Thin Small Outline Transistor Package [TSOT-23]
(UJ-5)
Dimensions shown in millimeters

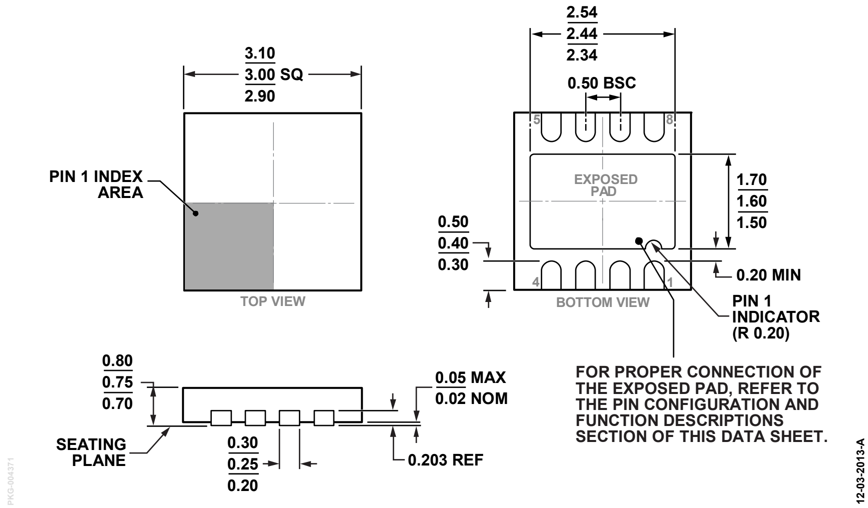

Figure 43. 8-Lead Lead Frame Chip Scale Package [LFCSP]
3 mm × 3 mm Body and 0.75 mm Package Height
(CP-8-21)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1, 2]	Temperature Range	Package Description	Package Option	Branding
AD8613AKSZ-R2	−40°C to +125°C	5-Lead SC70	KS-5	A0Y
AD8613AKSZ-REEL	−40°C to +125°C	5-Lead SC70	KS-5	A0Y
AD8613AKSZ-REEL7	−40°C to +125°C	5-Lead SC70	KS-5	A0Y
AD8613AUJZ-R2	−40°C to +125°C	5-Lead TSOT-23	UJ-5	A0Y
AD8613AUJZ-REEL	−40°C to +125°C	5-Lead TSOT-23	UJ-5	A0Y
AD8613AUJZ-REEL7	−40°C to +125°C	5-Lead TSOT-23	UJ-5	A0Y
AD8617ACPZ-R2	−40°C to +125°C	8-Lead LFCSP	CP-8-21	A0T
AD8617ACPZ-R7	−40°C to +125°C	8-Lead LFCSP	CP-8-21	A0T
AD8617ARMZ	−40°C to +125°C	8-Lead MSOP	RM-8	A0T
AD8617ARMZ-REEL	−40°C to +125°C	8-Lead MSOP	RM-8	A0T
AD8617ARZ	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8617ARZ-REEL	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8617ARZ-REEL7	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8617WARMZ-REEL	−40°C to +125°C	8-Lead MSOP	RM-8	A23
AD8617WARZ-RL	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8617WARZ-R7	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8619ARUZ	−40°C to +125°C	14-Lead TSSOP	RU-14	
AD8619ARUZ-REEL	−40°C to +125°C	14-Lead TSSOP	RU-14	
AD8619ARZ	−40°C to +125°C	14-Lead SOIC_N	R-14	
AD8619ARZ-REEL7	−40°C to +125°C	14-Lead SOIC_N	R-14	
AD8619WARZ-RL	−40°C to +125°C	14-Lead SOIC_N	R-14	
AD8619WARZ-R7	−40°C to +125°C	14-Lead SOIC_N	R-14	
AD8619WARUZ-R7	−40°C to +125°C	14-Lead TSSOP	RU-14	
AD8619WARUZ-RL	−40°C to +125°C	14-Lead TSSOP	RU-14	

[1] Z = RoHS Compliant Part.
[2] W = Qualified for Automotive Applications.

AUTOMOTIVE PRODUCTS

The AD8617W and AD8619W models are available with controlled manufacturing to support the quality and reliability requirements of automotive applications. Note that these automotive models may have specifications that differ from the commercial models; therefore, designers should review the Specifications section of this data sheet carefully. Only the automotive grade products shown are available for use in automotive applications. Contact your local Analog Devices account representative for specific product ordering information and to obtain the specific Automotive Reliability reports for these models.

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