Zero-Drift, Single-Supply, Rail-to-Rail Input/Output Operational Amplifier

AD8628/AD8629/AD8630

FEATURES

Lowest auto-zero amplifier noise
Low offset voltage: 1 µV
Input offset drift: 0.002 µV/°C
Rail-to-rail input and output swing
5 V single-supply operation
High gain, CMRR, and PSRR: 130 dB
Very low input bias current: 100 pA maximum
Low supply current: 1.0 mA
Overload recovery time: 50 µs
No external components required

APPLICATIONS

Automotive sensors
Pressure and position sensors
Strain gage amplifiers
Medical instrumentation
Thermocouple amplifiers
Precision current sensing
Photodiode amplifiers

GENERAL DESCRIPTION

This amplifier has ultralow offset, drift, and bias current. The AD8628/AD8629/AD8630 are wide bandwidth auto-zero amplifiers featuring rail-to-rail input and output swing and low noise. Operation is fully specified from 2.7 V to 5 V single supply (±1.35 V to ±2.5 V dual supply).

The AD8628/AD8629/AD8630 provide benefits previously found only in expensive auto-zeroing or chopper-stabilized amplifiers. Using Analog Devices, Inc., topology, these zero-drift amplifiers combine low cost with high accuracy and low noise. No external capacitor is required. In addition, the AD8628/AD8629/AD8630 greatly reduce the digital switching noise found in most chopper-stabilized amplifiers.

With an offset voltage of only 1 µV, drift of less than 0.005 µV/°C, and noise of only 0.5 µV p-p (0 Hz to 10 Hz), the AD8628/AD8629/AD8630 are suited for applications where error sources cannot be tolerated. Position and pressure sensors, medical equipment, and strain gage amplifiers benefit greatly from nearly zero drift over their operating temperature range. Many systems can take advantage of the rail-to-rail input and output swings provided by the AD8628/AD8629/AD8630 to reduce input biasing complexity and maximize SNR.

PIN CONFIGURATIONS

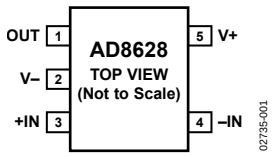


Figure 1. 5-Lead TSOT (UJ-5) and 5-Lead SOT-23 (RJ-5)

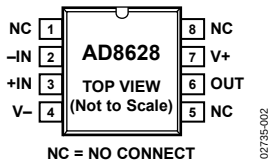


Figure 2. 8-Lead SOIC_N (R-8)

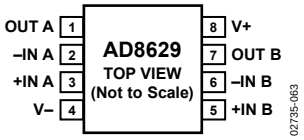


Figure 3. 8-Lead SOIC_N (R-8) and 8-Lead MSOP (RM-8)

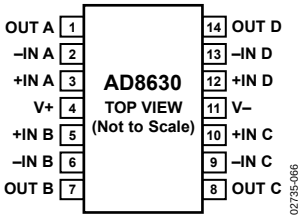


Figure 4. 14-Lead SOIC_N (R-14) and 14-Lead TSSOP (RU-14)

The AD8628/AD8629/AD8630 are specified for the extended industrial temperature range (−40°C to +125°C). The AD8628 is available in tiny 5-lead TSOT, 5-lead SOT-23, and 8-lead narrow SOIC plastic packages. The AD8629 is available in the standard 8-lead narrow SOIC and MSOP plastic packages. The AD8630 quad amplifier is available in 14-lead narrow SOIC and 14-lead TSSOP plastic packages.

SPECIFICATIONS

ELECTRICAL CHARACTERISTICS—V_S = 5.0 V

V_S = 5.0 V, V_{CM} = 2.5 V, T_A = 25°C, unless otherwise noted.

Table 1.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}			1	5	µV
		−40°C ≤ T_A ≤ +125°C			10	µV
Input Bias Current	I_B					
AD8628/AD8629				30	100	pA
AD8630				100	300	pA
		−40°C ≤ T_A ≤ +125°C			1.5	nA
Input Offset Current	I_{OS}			50	200	pA
		−40°C ≤ T_A ≤ +125°C			250	pA
Input Voltage Range			0		5	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = 0 V to 5 V	120	140		dB
		−40°C ≤ T_A ≤ +125°C	115	130		dB
Large Signal Voltage Gain	A_{VO}	R_L = 10 kΩ, V_O = 0.3 V to 4.7 V	125	145		dB
		−40°C ≤ T_A ≤ +125°C	120	135		dB
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C ≤ T_A ≤ +125°C		0.002	0.02	µV/°C
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	R_L = 100 kΩ to ground	4.99	4.996		V
		−40°C ≤ T_A ≤ +125°C	4.99	4.995		V
		R_L = 10 kΩ to ground	4.95	4.98		V
		−40°C ≤ T_A ≤ +125°C	4.95	4.97		V
Output Voltage Low	V_{OL}	R_L = 100 kΩ to V+		1	5	mV
		−40°C ≤ T_A ≤ +125°C		2	5	mV
		R_L = 10 kΩ to V+		10	20	mV
		−40°C ≤ T_A ≤ +125°C		15	20	mV
Short-Circuit Limit	I_{SC}		±25	±50		mA
		−40°C ≤ T_A ≤ +125°C		±40		mA
Output Current	I_O			±30		mA
		−40°C ≤ T_A ≤ +125°C		±15		mA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_S = 2.7 V to 5.5 V, −40°C ≤ T_A ≤ +125°C	115	130		dB
Supply Current per Amplifier	I_{SY}	V_O = V_S/2		0.85	1.1	mA
		−40°C ≤ T_A ≤ +125°C		1.0	1.2	mA
INPUT CAPACITANCE	C_{IN}					
Differential				1.5		pF
Common Mode				8.0		pF
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 10 kΩ		1.0		V/µs
Overload Recovery Time				0.05		ms
Gain Bandwidth Product	GBP			2.5		MHz
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz		0.5		µV p-p
		0.1 Hz to 1.0 Hz		0.16		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		22		nV/√Hz
Current Noise Density	i_n	f = 10 Hz		5		fA/√Hz

ELECTRICAL CHARACTERISTICS—V_S = 2.7 V

V_S = 2.7 V, V_{CM} = 1.35 V, V_O = 1.4 V, T_A = 25°C, unless otherwise noted.

Table 2.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}			1	5	µV
		−40°C ≤ T_A ≤ +125°C			10	µV
Input Bias Current	I_B					
AD8628/AD8629				30	100	pA
AD8630				100	300	pA
		−40°C ≤ T_A ≤ +125°C		1.0	1.5	nA
Input Offset Current	I_{OS}			50	200	pA
		−40°C ≤ T_A ≤ +125°C			250	pA
Input Voltage Range			0		2.7	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = 0 V to 2.7 V	115	130		dB
		−40°C ≤ T_A ≤ +125°C	110	120		dB
Large Signal Voltage Gain	A_{VO}	R_L = 10 kΩ, V_O = 0.3 V to 2.4 V	110	140		dB
		−40°C ≤ T_A ≤ +125°C	105	130		dB
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C ≤ T_A ≤ +125°C		0.002	0.02	µV/°C
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	R_L = 100 kΩ to ground	2.68	2.695		V
		−40°C ≤ T_A ≤ +125°C	2.68	2.695		V
		R_L = 10 kΩ to ground	2.67	2.68		V
		−40°C ≤ T_A ≤ +125°C	2.67	2.675		V
Output Voltage Low	V_{OL}	R_L = 100 kΩ to V+		1	5	mV
		−40°C ≤ T_A ≤ +125°C		2	5	mV
		R_L = 10 kΩ to V+		10	20	mV
		−40°C ≤ T_A ≤ +125°C		15	20	mV
Short-Circuit Limit	I_{SC}		±10	±15		mA
		−40°C ≤ T_A ≤ +125°C		±10		mA
Output Current	I_O			±10		mA
		−40°C ≤ T_A ≤ +125°C		±5		mA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_S = 2.7 V to 5.5 V, −40°C ≤ T_A ≤ +125°C	115	130		dB
Supply Current per Amplifier	I_{SY}	V_O = V_S/2		0.75	1.0	mA
		−40°C ≤ T_A ≤ +125°C		0.9	1.2	mA
INPUT CAPACITANCE	C_{IN}					
Differential				1.5		pF
Common Mode				8.0		pF
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 10 kΩ		1		V/µs
Overload Recovery Time				0.05		ms
Gain Bandwidth Product	GBP			2		MHz
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz		0.5		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		22		nV/√Hz
Current Noise Density	i_n	f = 10 Hz		5		fA/√Hz

ABSOLUTE MAXIMUM RATINGS

Table 3.

Parameter	Rating
Supply Voltage	6 V
Input Voltage	GND − 0.3 V to V_S + 0.3 V
Differential Input Voltage[1]	±5.0 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

[1] Differential input voltage is limited to ±5 V or the supply voltage, whichever is less.

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 CHARACTERISTICS

θ_{JA} is specified for worst-case conditions, that is, θ_{JA} is specified for the device soldered in a circuit board for surface-mount packages. This was measured using a standard two-layer board.

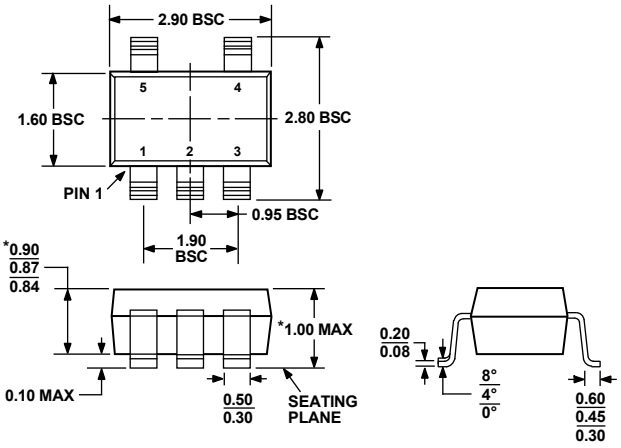
Table 4.

Package Type	θ_{JA}	θ_{JC}	Unit
5-Lead TSOT (UJ-5)	207	61	°C/W
5-Lead SOT-23 (RJ-5)	230	146	°C/W
8-Lead SOIC_N (R-8)	158	43	°C/W
8-Lead MSOP (RM-8)	190	44	°C/W
14-Lead SOIC_N (R-14)	105	43	°C/W
14-Lead TSSOP (RU-14)	148	23	°C/W

ESD CAUTION

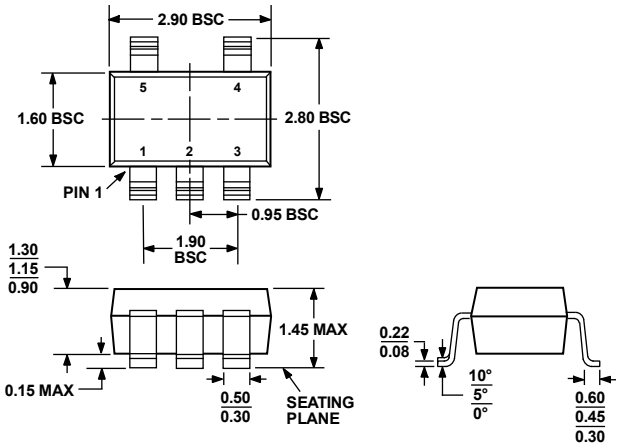
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

OUTLINE DIMENSIONS



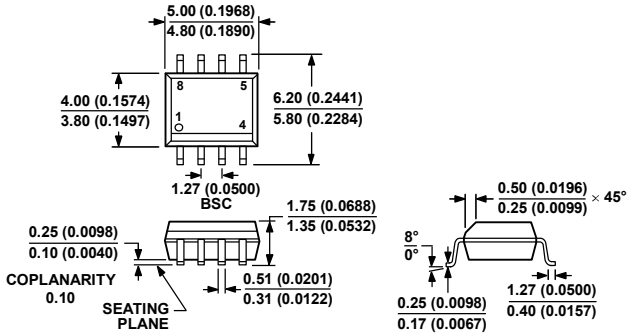
*COMPLIANT TO JEDEC STANDARDS MO-193-AB WITH THE EXCEPTION OF PACKAGE HEIGHT AND THICKNESS.

Figure 65. 5-Lead Thin Small Outline Transistor Package [TSOT] (UJ-5)
Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MO-178-AA

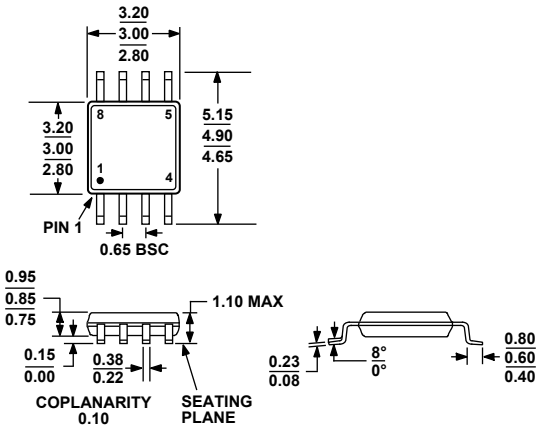
Figure 66. 5-Lead Small Outline Transistor Package [SOT-23] (RJ-5)
Dimensions shown in millimeters



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 67. 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 68. 8-Lead Mini Small Outline Package [MSOP] (RM-8)
Dimensions shown in millimeters

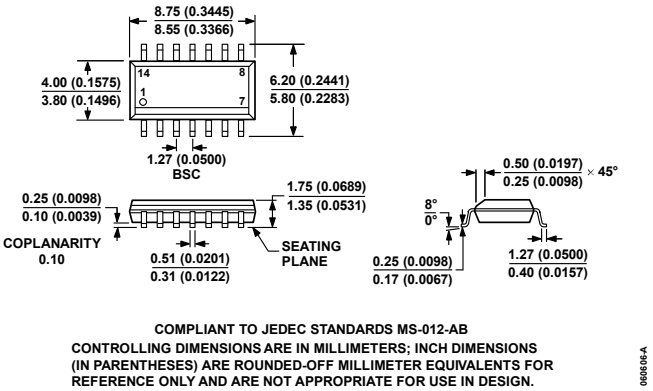


Figure 69. 14-Lead Standard Small Outline Package [SOIC_N]
Narrow Body (R-14)
Dimensions shown in millimeters and (inches)

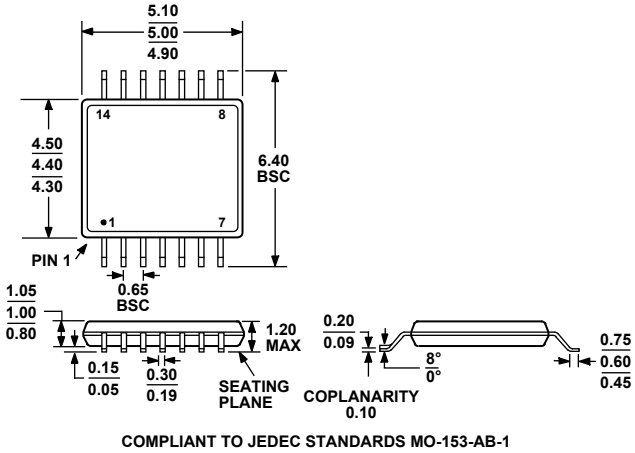


Figure 70. 14-Lead Thin Shrink Small Outline Package [TSSOP]
(RU-14)
Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option	Branding
AD8628AUJ-R2	−40°C to +125°C	5-Lead TSOT	UJ-5	AYB
AD8628AUJ-REEL	−40°C to +125°C	5-Lead TSOT	UJ-5	AYB
AD8628AUJ-REEL7	−40°C to +125°C	5-Lead TSOT	UJ-5	AYB
AD8628AUJZ-R2[1]	−40°C to +125°C	5-Lead TSOT	UJ-5	A0L
AD8628AUJZ-REEL[1]	−40°C to +125°C	5-Lead TSOT	UJ-5	A0L
AD8628AUJZ-REEL7[1]	−40°C to +125°C	5-Lead TSOT	UJ-5	A0L
AD8628AR	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8628AR-REEL	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8628AR-REEL7	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8628ARZ[1]	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8628ARZ-REEL[1]	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8628ARZ-REEL7[1]	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8628ART-R2	−40°C to +125°C	5-Lead SOT-23	RJ-5	AYA
AD8628ART-REEL7	−40°C to +125°C	5-Lead SOT-23	RJ-5	AYA
AD8628ARTZ-R2[1]	−40°C to +125°C	5-Lead SOT-23	RJ-5	A0L
AD8628ARTZ-REEL7[1]	−40°C to +125°C	5-Lead SOT-23	RJ-5	A0L
AD8629ARZ[1]	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8629ARZ-REEL[1]	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8629ARZ-REEL7[1]	−40°C to +125°C	8-Lead SOIC_N	R-8	
AD8629ARMZ-R2[1]	−40°C to +125°C	8-Lead MSOP	RM-8	A06
AD8629ARMZ-REEL[1]	−40°C to +125°C	8-Lead MSOP	RM-8	A06
AD8630ARUZ[1]	−40°C to +125°C	14-Lead TSSOP	RU-14	
AD8630ARUZ-REEL[1]	−40°C to +125°C	14-Lead TSSOP	RU-14	
AD8630ARZ[1]	−40°C to +125°C	14-Lead SOIC_N	R-14	
AD8630ARZ-REEL[1]	−40°C to +125°C	14-Lead SOIC_N	R-14	
AD8630ARZ-REEL7[1]	−40°C to +125°C	14-Lead SOIC_N	R-14	

[1] Z = RoHS Compliant Part.