Low Noise, Precision Operational Amplifier

OP27

FEATURES

Low noise: 80 nV p-p (0.1 Hz to 10 Hz), 3 nV/√Hz
Low drift: 0.2 μV/°C
High speed: 2.8 V/μs slew rate, 8 MHz gain bandwidth
Low V_{OS}: 10 μV
Excellent CMRR: 126 dB at VCM of ±11 V
High open-loop gain: 1.8 million
Fits OP07, 5534A sockets
Available in die form

GENERAL DESCRIPTION

The OP27 precision operational amplifier combines the low offset and drift of the OP07 with both high speed and low noise. Offsets down to 25 μV and maximum drift of 0.6 μV/°C make the OP27 ideal for precision instrumentation applications. Exceptionally low noise, e_n = 3.5 nV/√Hz, at 10 Hz, a low 1/f noise corner frequency of 2.7 Hz, and high gain (1.8 million), allow accurate high-gain amplification of low-level signals. A gain-bandwidth product of 8 MHz and a 2.8 V/μs slew rate provide excellent dynamic accuracy in high speed, data-acquisition systems.

A low input bias current of ±10 nA is achieved by use of a bias current cancellation circuit. Over the military temperature range, this circuit typically holds I_B and I_{OS} to ±20 nA and 15 nA, respectively.

The output stage has good load driving capability. A guaranteed swing of ±10 V into 600 Ω and low output distortion make the OP27 an excellent choice for professional audio applications.

(Continued on Page 3)

PIN CONFIGURATIONS

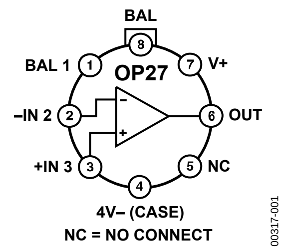

Figure 1. 8-Lead TO-99 (J-Suffix)

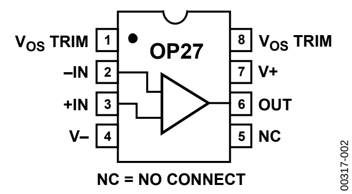

Figure 2. 8-Lead CERDIP – Glass Hermetic Seal (Z-Suffix), 8-Lead PDIP (P-Suffix), 8-Lead SO (S-Suffix)

FUNCTIONAL BLOCK DIAGRAM

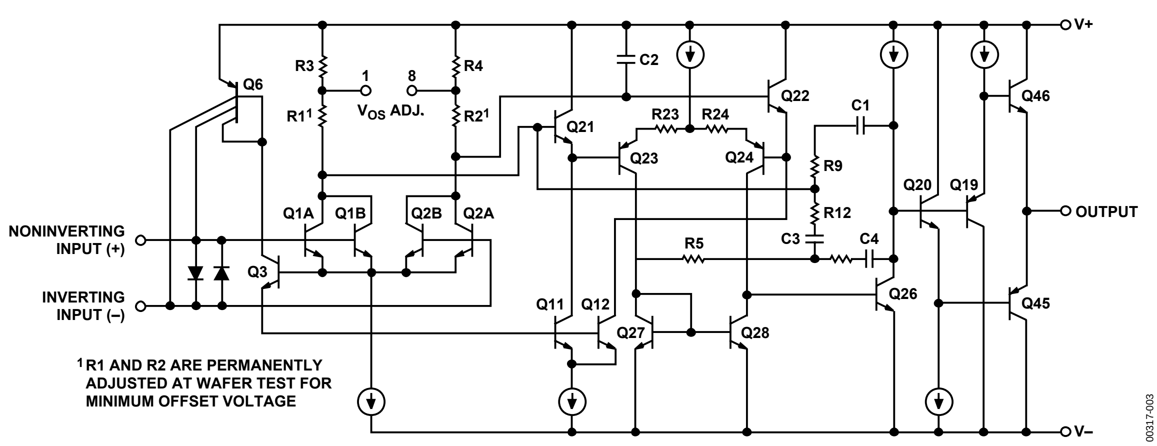

Figure 3.

GENERAL DESCRIPTION

(Continued from Page 1)

PSRR and CMRR exceed 120 dB. These characteristics, coupled with long-term drift of 0.2 μV/month, allow the circuit designer to achieve performance levels previously attained only by discrete designs.

Low cost, high volume production of OP27 is achieved by using an on-chip Zener zap-trimming network. This reliable and stable offset trimming scheme has proven its effectiveness over many years of production history.

The OP27 provides excellent performance in low noise, high accuracy amplification of low level signals. Applications include stable integrators, precision summing amplifiers, precision voltage threshold detectors, comparators, and professional audio circuits such as tape heads and microphone preamplifiers.

The OP27 is a direct replacement for OP06, OP07, and OP45 amplifiers; AD741 types can be directly replaced by removing the nulling potentiometer of the AD741.

SPECIFICATIONS

ELECTRICAL CHARACTERISTICS

$V_S = \pm 15$ V, $T_A = 25°C$, unless otherwise noted.

Table 1.

			OP27A/E			OP27/G			
Parameter	**Symbol**	**Conditions**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**
INPUT OFFSET VOLTAGE[1]	V_{OS}			10	25		30	100	µV
LONG-TERM V_{OS} STABILITY[2, 3]	V_{OS}/Time			0.2	1.0		0.4	2.0	µV/M_O
INPUT OFFSET CURRENT	I_{OS}			7	35		12	75	nA
INPUT BIAS CURRENT	I_B			±10	±40		±15	±80	nA
INPUT NOISE VOLTAGE[3, 4]	$e_{n\ p\text{-}p}$	0.1 Hz to 10 Hz		0.08	0.18		0.09	0.25	µV p-p
INPUT NOISE	e_n	f_O = 10 Hz		3.5	5.5		3.8	8.0	nV/√Hz
Voltage Density[3]		f_O = 30 Hz		3.1	4.5		3.3	5.6	nV/√Hz
		f_O = 1000 Hz		3.0	3.8		3.2	4.5	nV/√Hz
INPUT NOISE	i_n	f_O = 10 Hz		1.7	4.0		1.7		pA/√Hz
Current Density[3]		f_O = 30 Hz		1.0	2.3		1.0		pA/√Hz
		f_O = 1000 Hz		0.4	0.6		0.4	0.6	pA/√Hz
INPUT RESISTANCE									
Differential Mode[5]	R_{IN}		1.3	6		0.7	4		MΩ
Common Mode	R_{INCM}			3			2		GΩ
INPUT VOLTAGE RANGE	IVR		±11.0	±12.3		±11.0	±12.3		V
COMMON-MODE REJECTION RATIO	CMRR	$V_{CM} = \pm 11$ V	114	126		100	120		dB
POWER SUPPLY REJECTION RATIO	PSRR	$V_S = \pm 4$ V to ±18 V		1	10		2	20	µV/V
LARGE SIGNAL VOLTAGE GAIN	A_{VO}	$R_L \geq 2$ k Ω, $V_O = \pm 10$ V	1000	1800		700	1500		V/mV
		$R_L \geq 600$ Ω, $V_O = \pm 10$ V	800	1500		600	1500		V/mV
OUTPUT VOLTAGE SWING	V_O	$R_L \geq 2$ k Ω	±12.0	±13.8		±11.5	±13.5		V
		$R_L \geq 600$ Ω	±10.0	±11.5		±10.0	±11.5		V
SLEW RATE[6]	SR	$R_L \geq 2$ kΩ	1.7	2.8		1.7	2.8		V/µs
GAIN BANDWIDTH PRODUCT[6]	GBW		5.0	8.0		5.0	8.0		MHz
OPEN-LOOP OUTPUT RESISTANCE	R_O	$V_O = 0$, $I_O = 0$		70			70		Ω
POWER CONSUMPTION	P_d	V_O		90	140		100	170	mW
OFFSET ADJUSTMENT RANGE		$R_P = 10$ kΩ		±4.0			±4.0		mV

[1] Input offset voltage measurements are performed approximately 0.5 seconds after application of power. A/E grades guaranteed fully warmed up.
[2] Long-term input offset voltage stability refers to the average trend line of V_{OS} vs. time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in V_{OS} during the first 30 days are typically 2.5 µV. Refer to the Typical Performance Characteristics section.
[3] Sample tested.
[4] See voltage noise test circuit (Figure 31).
[5] Guaranteed by input bias current.
[6] Guaranteed by design.

V_S = ±15 V, −55°C ≤ T_A ≤ 125°C, unless otherwise noted.

Table 2.

Parameter	Symbol	Conditions	OP27A Min	OP27A Typ	OP27A Max	Unit
INPUT OFFSET VOLTAGE[1]	V_{OS}			30	60	µV
AVERAGE INPUT OFFSET DRIFT	TCV_{OS}[2]					
	TCV_{OSn}[3]			0.2	0.6	µV/°C
INPUT OFFSET CURRENT	I_{OS}			15	50	nA
INPUT BIAS CURRENT	IB			±20	±60	nA
INPUT VOLTAGE RANGE	IVR		±10.3	±11.5		V
COMMON-MODE REJECTION RATIO	CMRR	V_{CM} = ±10 V	108	122		dB
POWER SUPPLY REJECTION RATIO	PSRR	V_S = ±4.5 V to ±18 V		2	16	µV/V
LARGE SIGNAL VOLTAGE GAIN	A_{VO}	R_L ≥ 2 kΩ, V_O = ±10 V	600	1200		V/mV
OUTPUT VOLTAGE SWING	V_O	R_L ≥ 2 kΩ	±11.5	±13.5		V

[1] Input offset voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power. A/E grades guaranteed fully warmed up.
[2] The TCV_{OS} performance is within the specifications unnulled or when nulled with R_P = 8 kΩ to 20 kΩ. TCV_{OS} is 100% tested for A/E grades, sample tested for G grades.
[3] Guaranteed by design.

V_S = ±15 V, −25°C ≤ T_A ≤ 85°C for OP27J, OP27Z, 0°C ≤ T_A ≤ 70°C for OP27EP, and −40°C ≤ T_A ≤ 85°C for OP27GP, OP27GS, unless otherwise noted.

Table 3.

Parameter	Symbol	Conditions	OP27E Min	OP27E Typ	OP27E Max	OP27G Min	OP27G Typ	OP27G Max	Unit
INPUT ONSET VOLTAGE	V_{OS}			20	50		55	220	µV
AVERAGE INPUT OFFSET DRIFT	TCV_{OS}[1]			0.2	0.6		0 4	1.8	µV/°C
	TCV_{OSn}[2]			0.2	0.6		0 4	1.8	µV/°C
INPUT OFFSET CURRENT	I_{OS}			10	50		20	135	nA
INPUT BIAS CURRENT	I_B			±14	±60		±25	±150	nA
INPUT VOLTAGE RANGE	IVR		±10.5	±11.8		±10.5	±11.8		V
COMMON-MODE REJECTION RATIO	CMRR	V_{CM} = ±10 V	110	124		96	118		dB
POWER SUPPLY REJECTION RATIO	PSRR	V_S = ±4.5 V to ±18 V		2	15		2	32	µV/V
LARGE SIGNAL VOLTAGE GAIN	A_{VO}	R_L ≥ 2 kΩ, V_O = ±10 V	750	1500		450	1000		V/mV
OUTPUT VOLTAGE SWING	V_O	R_L ≥ 2 kΩ	±11.7	±13.6		±11.0	±13.3		V

[1] The TCV_{OS} performance is within the specifications unnulled or when nulled with R_P = 8 kΩ to 20 kΩ. TCV_{OS} is 100% tested for A/E grades, sample tested for C/G grades.
[2] Guaranteed by design.

TYPICAL ELECTRICAL CHARACTERISTICS

V_S = ±15 V, T_A = 25°C unless otherwise noted.

Table 4.

Parameter	Symbol	Conditions	OP27N Typical	Unit
AVERAGE INPUT OFFSET VOLTAGE DRIFT[1]	TCV_{OS} or TCV_{OSn}	Nulled or unnulled R_P = 8 kΩ to 20 kΩ	0.2	µV/°C
AVERAGE INPUT OFFSET CURRENT DRIFT	TCI_{OS}		80	pA/°C
AVERAGE INPUT BIAS CURRENT DRIFT	TCI_B		100	pA/°C
INPUT NOISE VOLTAGE DENSITY	e_n	f_O = 10 Hz	3.5	nV/√Hz
	e_n	f_O = 30 Hz	3.1	nV/√Hz
	e_n	f_O = 1000 Hz	3.0	nV/√Hz
INPUT NOISE CURRENT DENSITY	i_n	f_O = 10 Hz	1.7	pA/√Hz
	i_n	f_O = 30 Hz	1.0	pA/√Hz
	i_n	f_O = 1000 Hz	0.4	pA/√Hz
INPUT NOISE VOLTAGE SLEW RATE	e_{np-p}	0.1 Hz to 10 Hz	0.08	µV p-p
	SR	R_L ≥ 2 kΩ	2.8	V/µs
GAIN BANDWIDTH PRODUCT	GBW		8	MHz

[1] Input offset voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power.

ABSOLUTE MAXIMUM RATINGS

Table 5.

Parameter	Rating
Supply Voltage	±22 V
Input Voltage[1]	±22 V
Output Short-Circuit Duration	Indefinite
Differential Input Voltage[2]	±0.7 V
Differential Input Current[2]	±25 mA
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	
OP27A (J, Z)	−55°C to +125°C
OP27E, (Z)	−25°C to +85°C
OP27E, (P)	0°C to 70°C
OP27G (P, S, J, Z)	−40°C to +85°C
Lead Temperature Range (Soldering, 60 sec)	300°C
Junction Temperature	−65°C to +150°C

[1] For supply voltages less than ±22 V, the absolute maximum input voltage is equal to the supply voltage.
[2] The inputs of the OP27 are protected by back-to-back diodes. Current limiting resistors are not used in order to achieve low noise. If differential input voltage exceeds ±0.7 V, the input current should be limited to 25 mA.

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 device in socket for TO, CERDIP, and PDIP packages; θ_{JA} is specified for device soldered to printed circuit board for SO package.

Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted.

Table 6.

Package Type	θ_{JA}	θ_{JC}	Unit
TO-99 (J)	150	18	°C/W
8-Lead Hermetic DIP (Z)	148	16	°C/W
8-Lead Plastic DIP (P)	103	43	°C/W
8-Lead SO (S)	158	43	°C/W

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.

OUTLINE DIMENSIONS

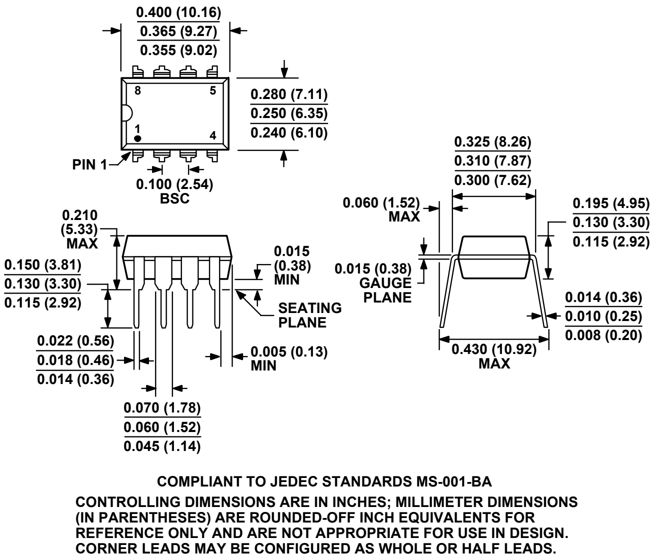

Figure 46. 8-Lead Plastic Dual-in-Line Package [PDIP]
(N-8)
P-Suffix
Dimensions shown in inches and (millimeters)

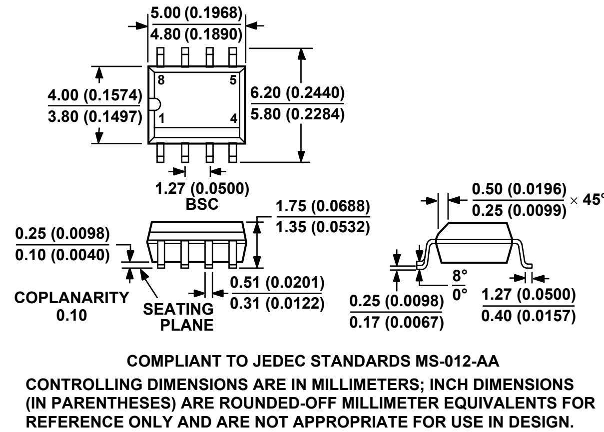

Figure 48. 8-Lead Standard Small Outline Package [SOIC]
Narrow Body
(R-8)
S-Suffix
Dimensions shown in millimeters and (inches)

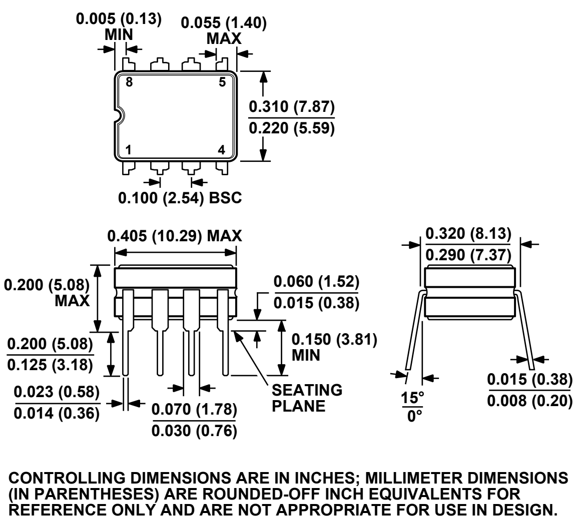

Figure 47. 8-Lead Ceramic DIP – Glass Hermetic Seal [CERDIP]
(Q-8)
Z-Suffix
Dimensions shown in inches and (millimeters)

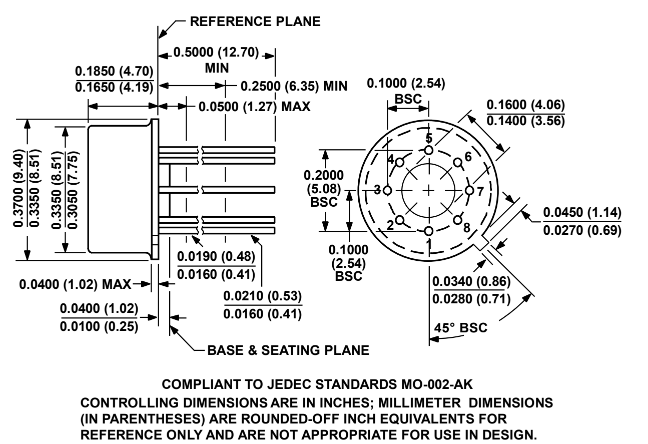

Figure 49. 8-Lead Metal Can [TO-99]
(H-08)
J-Suffix
Dimensions shown in inches and (millimeters)

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
OP27AJ/883C	–55° to +125°C	8-Lead Metal Can (TO-99)	J-Suffix (H-08)
OP27GJ	–40° to +85°C	8-Lead Metal Can (TO-99)	J-Suffix (H-08)
OP27AZ	–55° to +125°C	8-Lead CERDIP	Z-Suffix (Q-8)
OP27AZ/883C	–55° to +125°C	8-Lead CERDIP	Z-Suffix (Q-8)
OP27EZ	–25° to +85°C	8-Lead CERDIP	Z-Suffix (Q-8)
OP27GZ	–40° to +85°C	8-Lead CERDIP	Z-Suffix (Q-8)
OP27EP	0° to +70°C	8-Lead PDIP	P-Suffix (N-8)
OP27EPZ[1]	0° to +70°C	8-Lead PDIP	P-Suffix (N-8)
OP27GP	–40° to +85°C	8-Lead PDIP	P-Suffix (N-8)
OP27GPZ[1]	–40° to +85°C	8-Lead PDIP	P-Suffix (N-8)
OP27GS	–40° to +85°C	8-Lead SOIC	S-Suffix (R-8)
OP27GS-REEL	–40° to +85°C	8-Lead SOIC	S-Suffix (R-8)
OP27GS-REEL7	–40° to +85°C	8-Lead SOIC	S-Suffix (R-8)
OP27GSZ[1]	–40° to +85°C	8-Lead SOIC	S-Suffix (R-8)
OP27GSZ-REEL[1]	–40° to +85°C	8-Lead SOIC	S-Suffix (R-8)
OP27GSZ-REEL7[1]	–40° to +85°C	8-Lead SOIC	S-Suffix (R-8)
OP27NBC		Die	

[1] Z = Pb-free part.