High Accuracy Instrumentation Amplifier

AMP02

FEATURES
Low Offset Voltage: 100 μV max
Low Drift: 2 μV/°C max
Wide Gain Range: 1 to 10,000
High Common-Mode Rejection: 115 dB min
High Bandwidth (G = 1000): 200 kHz typ
Gain Equation Accuracy: 0.5% max
Single Resistor Gain Set
Input Overvoltage Protection
Low Cost
Available in Die Form

APPLICATIONS
Differential Amplifier
Strain Gage Amplifier
Thermocouple Amplifier
RTD Amplifier
Programmable Gain Instrumentation Amplifier
Medical Instrumentation
Data Acquisition Systems

FUNCTIONAL BLOCK DIAGRAM

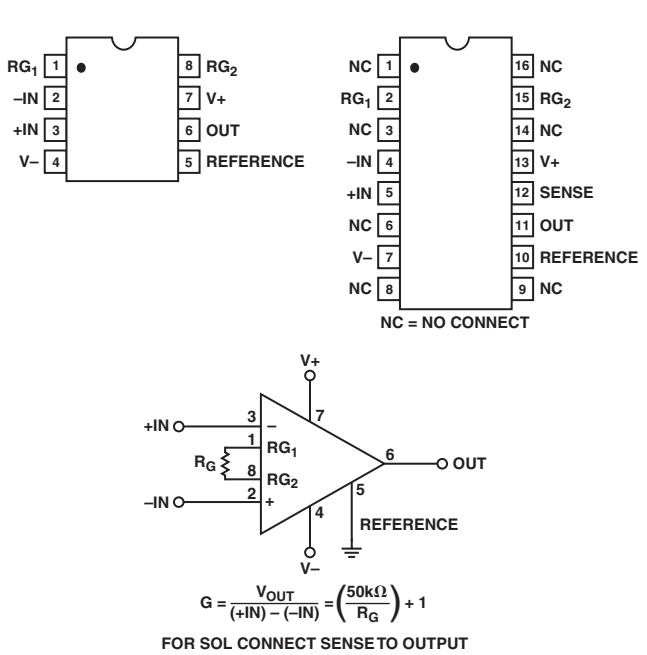


Figure 1. Basic Circuit Connections

GENERAL DESCRIPTION

The AMP02 is the first precision instrumentation amplifier available in an 8-lead package. Gain of the AMP02 is set by a single external resistor and can range from 1 to 10,000. No gain set resistor is required for unity gain. The AMP02 includes an input protection network that allows the inputs to be taken 60 V beyond either supply rail without damaging the device.

Laser trimming reduces the input offset voltage to under 100 μV. Output offset voltage is below 4 mV, and gain accuracy is better than 0.5% for a gain of 1000. ADI's proprietary thin-film resistor process keeps the gain temperature coefficient under 50 ppm/°C.

Due to the AMP02's design, its bandwidth remains very high over a wide range of gain. Slew rate is over 4 V/μs, making the AMP02 ideal for fast data acquisition systems.

A reference pin is provided to allow the output to be referenced to an external dc level. This pin may be used for offset correction or level shifting as required. In the 8-lead package, sense is internally connected to the output.

For an instrumentation amplifier with the highest precision, consult the AMP01 data sheet.

REV. E

AMP02–SPECIFICATIONS

ELECTRICAL CHARACTERISTICS (@ V_S = ±15 V, V_{CM} = 0 V, T_A = 25°C, unless otherwise noted.)

Parameter	Symbol	Conditions	AMP02E Min	AMP02E Typ	AMP02E Max	AMP02F Min	AMP02F Typ	AMP02F Max	Unit
OFFSET VOLTAGE									
Input Offset Voltage	V_{IOS}	T_A = 25°C		20	100		40	200	µV
		–40°C ≤ T_A ≤ +85°C		50	200		100	350	µV
Input Offset Voltage Drift	TCV_{IOS}	–40°C ≤ T_A ≤ +85°C		0.5	2		1	4	µV/°C
Output Offset Voltage	V_{OOS}	T_A = 25°C		1	4		2	8	mV
		–40°C ≤ T_A ≤ +85°C		4	10		9	20	mV
Output Offset Voltage Drift	TCV_{OOS}	–40°C ≤ T_A ≤ +85°C		50	100		100	200	µV/°C
Power Supply Rejection	PSR	V_S = ±4.8 V to ±18 V							
		G = 100, 1000	115	125		110	115		dB
		G = 10	100	110		95	100		dB
		G = 1	80	90		75	80		dB
		V_S = ±4.8 V to ±18 V							
		–40°C ≤ T_A ≤ +85°C							
		G = 1000, 100	110	120		105	110		dB
		G = 10	95	110		90	95		dB
		G = 1	75	90		70	75		dB
INPUT CURRENT									
Input Bias Current	I_B	T_A = 25°C		2	10		4	20	nA
Input Bias Current Drift	TCI_B	–40°C ≤ T_A ≤ +85°C		150			250		pA/°C
Input Offset Current	I_{OS}	T_A = 25°C		1.2	5		2	10	nA
Input Offset Current Drift	TCI_{OS}	–40°C ≤ T_A ≤ +85°C		9			15		pA/°C
INPUT									
Input Resistance	R_{IN}	Differential, G ≤ 1000		10			10		GΩ
		Common Mode, G = 1000		16.5			16.5		GΩ
Input Voltage Range	IVR	T_A = 25°C[1]	±11			±11			V
Common-Mode Rejection	CMR	V_{CM} = ±11 V							
		G = 1000, 100	115	120		110	115		dB
		G = 10	100	115		95	110		dB
		G = 1	80	95		75	90		dB
		V_{CM} = ±11 V							
		–40°C ≤ T_A ≤ +85°C							
		G = 100, 1000	110	120		105	115		dB
		G = 10	95	110		90	105		dB
		G = 1	75	90		70	85		dB
GAIN									
Gain Equation		G = 1000			0.50			0.70	%
Accuracy	$G = \frac{50\ k\Omega}{R_G} + 1$	G = 100			0.30			0.50	%
		G = 10			0.25			0.40	%
		G = 1			0.02			0.05	%
Gain Range	G		1		10k	1		10k	V/V
Nonlinearity		G = 1 to 1000		0.006			0.006		%
Temperature Coefficient	G_{TC}	1 ≤ G ≤ 1000[2, 3]		20	50		20	50	ppm/°C
OUTPUT RATING									
Output Voltage Swing	V_{OUT}	T_A = 25°C, R_L = 1 kΩ	±12	±13		±12	±13		V
		R_L = 1 kΩ, –40°C ≤ T_A ≤ +85°C	±11	±12		±11	±12		V
Positive Current Limit		Output-to-Ground Short		22			22		mA
Negative Current Limit		Output-to-Ground Short		32			32		mA
NOISE									
Voltage Density, RTI	e_n	f_O = 1 kHz							
		G = 1000		9			9		nV/√Hz
		G = 100		10			10		nV/√Hz
		G = 10		18			18		nV/√Hz
		G = 1		120			120		nV/√Hz
Noise Current Density, RTI	i_n	f_O = 1 kHz, G = 1000		0.4			0.4		pA/√Hz
Input Noise Voltage	e_n p-p	0.1 Hz to 10 Hz							
		G = 1000		0.4			0.4		µV p-p
		G = 100		0.5			0.5		µV p-p
		G = 10		1.2			1.2		µV p-p
DYNAMIC RESPONSE									
Small-Signal Bandwidth	BW	G = 1		1200			1200		kHz
(–3 dB)		G = 10		300			300		kHz
G = 100, 1000				200			200		kHz
Slew Rate	SR	G = 10, R_L = 1 kΩ	4	6		4	6		V/µs
Settling Time	t_S	To 0.01% ±10 V Step							
		G = 1 to 1000		10			10		µs
SENSE INPUT									
Input Resistance	R_{IN}			25			25		kΩ
Voltage Range				±11			±11		V
REFERENCE INPUT									
Input Resistance	R_{IN}			50			50		kΩ
Voltage Range				±11			±11		V
Gain to Output				1			1		V/V

Parameter	Symbol	Conditions	AMP02E Min	AMP02E Typ	AMP02E Max	AMP02F Min	AMP02F Typ	AMP02F Max	Unit
POWER SUPPLY									
Supply Voltage Range	V_S		±4.5		±18	±4.5		±18	V
Supply Current	I_{SY}	T_A = 25°C		5	6		5	6	mA
		–40°C ≤ T_A ≤ +85°C		5	6		5	6	mA

NOTES
[1]Input voltage range guaranteed by common-mode rejection test.
[2]Guaranteed by design.
[3]Gain tempco does not include the effects of external component drift.

Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS[1, 2]

Supply Voltage	±18 V
Common-Mode Input Voltage	[(V–) – 60 V] to [(V+) + 60 V]
Differential Input Voltage	[(V–) – 60 V] to [(V+) + 60 V]
Output Short-Circuit Duration	Continuous
Operating Temperature Range	–40°C to +85°C
Storage Temperature Range	–65°C to +150°C
Function Temperature Range	–65°C to +150°C
Lead Temperature (Soldering, 10 sec)	300°C

Package Type	θ_{JA}[3]	θ_{JC}	Unit
8-Lead Plastic DIP (P)	96	37	°C/W
16-Lead SOIC (S)	92	27	°C/W

NOTES
[1]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 sections of this specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
[2]Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted.
[3]θ_{JA} is specified for worst case mounting conditions, i.e., θ_{JA} is specified for device in socket for P-DIP package; θ_{JA} is specified for device soldered to printed circuit board for SOIC package.

ORDERING GUIDE

Model	V_{IOS} max @ T_A = 25°C	V_{OOS} max @ T_A = 25°C	Temperature Range	Package Description
AMP02EP	100 µV	4 mV	–40°C to +85°C	8-Lead Plastic DIP
AMP02FP	200 µV	8 mV	–40°C to +85°C	8-Lead Plastic DIP
AMP02AZ/883C	200 µV	10 mV	–55°C to +125°C	8-Lead CERDIP
AMP02FS	200 µV	8 mV	–40°C to +85°C	16-Lead SOIC
AMP02GBC				Die
AMP02FS-REEL	200 µV	8 mV	–40°C to +85°C	16-Lead SOIC

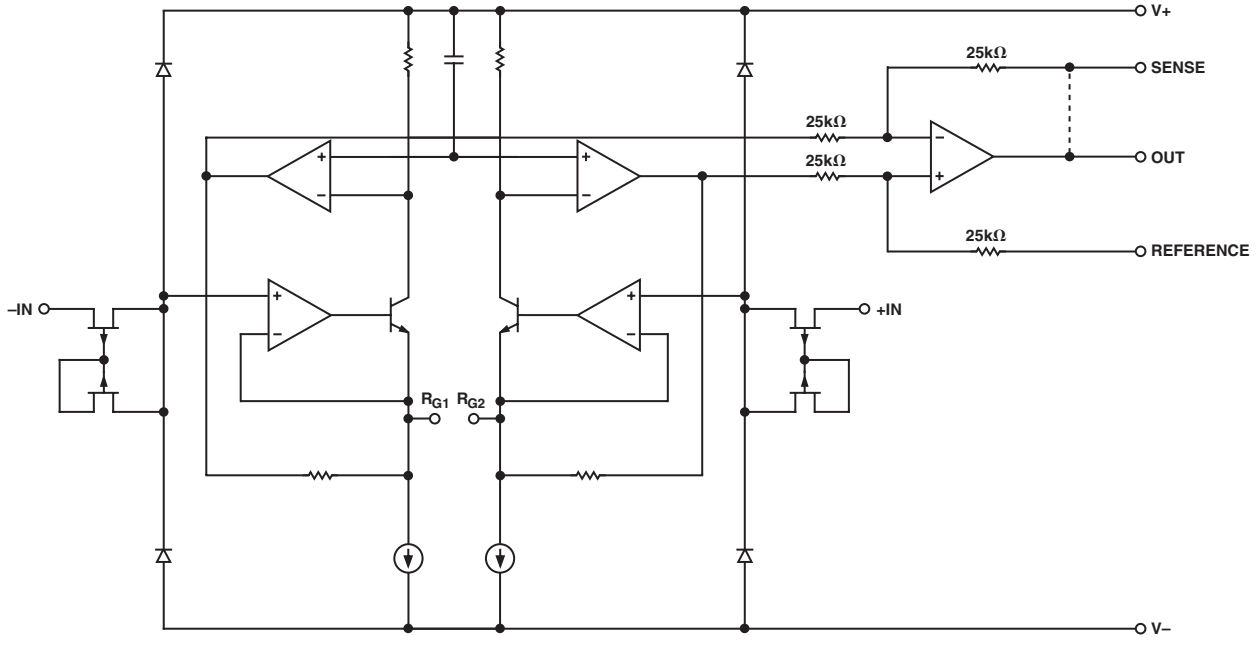
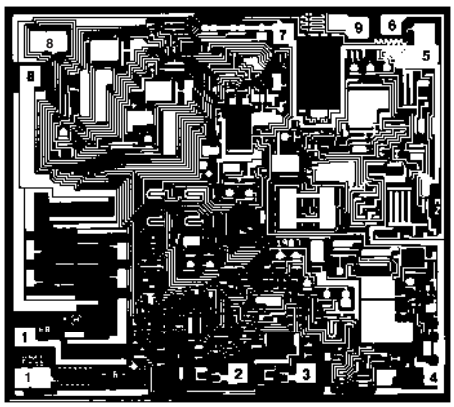


Figure 2. Simplified Schematic



1. RG_1
2. –IN
3. +IN
4. V–
5. REFERENCE
6. OUT
7. V+
8. RG_2
9. SENSE

CONNECT SUBSTRATE TO V–

DIE SIZE 0.103 inch × 0.116 inch, 11,948 sq. mils
(2.62 mm × 2.95 mm, 7.73 sq. mm)
NOTE: PINS 1 and 8 are KELVIN CONNECTED

Die Characteristics

WAFER TEST LIMITS* (@ V_S = ±15 V, V_{CM} = 0 V, T_A = 25°C, unless otherwise noted.)

Parameter	Symbol	Conditions	AMP02 GBC Limits	Unit
Input Offset Voltage	V_{IOS}		200	µV max
Output Offset Voltage	V_{OOS}		8	mV max
Power Supply Rejection	PSR	V_S = ±4.8 V to ±18 V G = 1000 G = 100 G = 10 G = 1	 110 110 95 75	dB
Input Bias Current	I_B		20	nA max
Input Offset Current	I_{OS}		10	nA max
Input Voltage Range	IVR	Guaranteed by CMR Tests	±11	V min
Common-Mode Rejection	CMR	V_{CM} = ±11 V G = 1000 G = 100 G = 10 G = 1	 110 110 95 75	dB
Gain Equation Accuracy		$G = \frac{50\,k\Omega}{R_G} + 1, G = 1000$	0.7	% max
Output Voltage Swing	V_{OUT}	R_L = 1 kΩ	±12	V min
Supply Current	I_{SY}		6	mA max

*Electrical tests are performed at wafer probe to the limits shown. Due to variations in assembly methods and normal yield loss, yield after packaging is not guaranteed for standard product dice. Consult factory to negotiate specifications based on dice lot qualifications through sample lot assembly and testing.

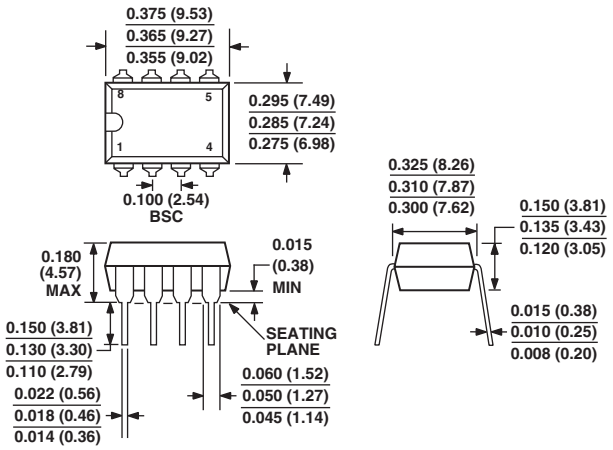
CAUTION

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 AMP02 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

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

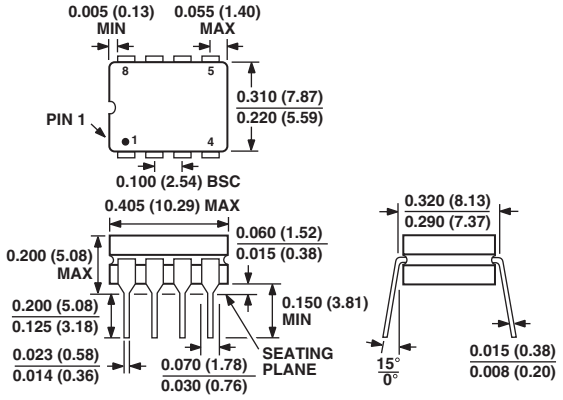
Dimensions shown in inches and (millimeters)



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 Ceramic DIP - Glass Hermetic Seal [CERDIP]
(Q-8)

Dimensions shown in inches and (millimeters)



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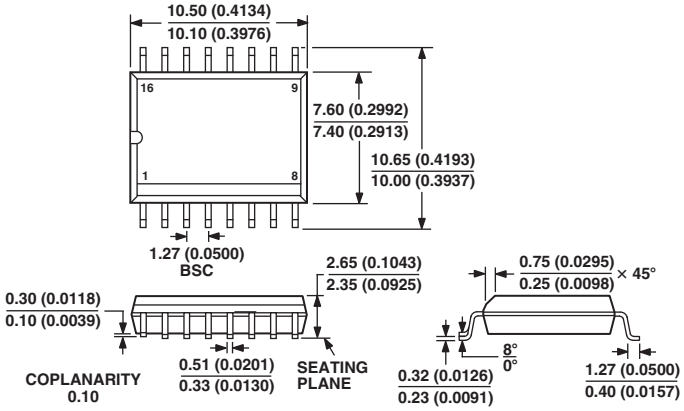
16-Lead Standard Small Outline Package [SOIC]
Wide Body
(R-16)

Dimensions shown in millimeters and (inches)



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REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN