ANALOG DEVICES

Precision, Unity-Gain Differential Amplifier
AMP03

FEATURES
High CMRR: 100 dB Typ
Low Nonlinearity: 0.001% Max
Low Distortion: 0.001% Typ
Wide Bandwidth: 3 MHz Typ
Fast Slew Rate: 9.5 V/μs Typ
Fast Settling (0.01%): 1 μs Typ
Low Cost

APPLICATIONS
Summing Amplifiers
Instrumentation Amplifiers
Balanced Line Receivers
Current-Voltage Conversion
Absolute Value Amplifier
4 to 20 mA Current Transmitter
Precision Voltage Reference Applications
Lower Cost and Higher Speed Version of INA105

GENERAL DESCRIPTION

The AMP03 is a monolithic unity-gain, high speed differential amplifier. Incorporating a matched thin film resistor network, the AMP03 features stable operation over temperature without requiring expensive external matched components. The AMP03 is a basic analog building block for differential amplifier and instrumentation applications.
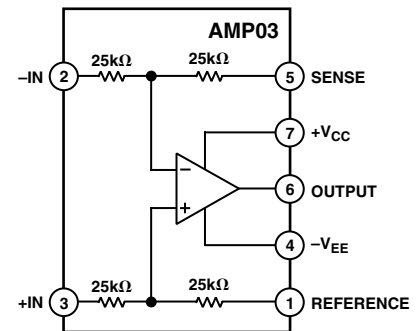
The differential amplifier topology of the AMP03 both amplifies the difference between two signals and provides extremely high rejection of the common-mode input voltage. By providing common-mode rejection (CMR) of 100 dB typical, the AMP03 solves common problems encountered in instrumentation design. As an example, the AMP03 is ideal for performing either addition or subtraction of two signals without using expensive externally matched precision resistors. The large common-mode rejection is made possible by matching the internal resistors to better than 0.002% and maintaining a thermally symmetric layout. Additionally, due to high CMR over frequency, the AMP03 is an ideal general amplifier for buffering signals in a noisy environment into data acquisition systems.

The AMP03 is a higher speed alternative to the INA105. Featuring slew rates of 9.5 V/μs and a bandwidth of 3 MHz, the AMP03 offers superior performance to the INA105 for high speed current sources, absolute value amplifiers, and summing amplifiers.
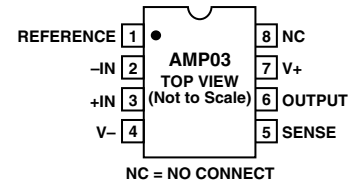
FUNCTIONAL BLOCK DIAGRAM

PIN CONNECTIONS

8-Lead PDIP
(P Suffix)

NC = NO CONNECT

8-Lead SOIC
(S Suffix)

NC = NO CONNECT

Header
(J Suffix)

NC = NO CONNECT

REV. F

AMP03* PRODUCT PAGE QUICK LINKS

Last Content Update: 02/23/2017

COMPARABLE PARTS 🗗

View a parametric search of comparable parts.

DOCUMENTATION 🗗

Application Notes

- AN-244: A User's Guide to I.C. Instrumentation Amplifiers
- AN-245: Instrumentation Amplifiers Solve Unusual Design Problems
- AN-348: Avoiding Passive-Component Pitfalls
- AN-589: Ways to Optimize the Performance of a Difference Amplifier
- AN-671: Reducing RFI Rectification Errors in In-Amp Circuits

Data Sheet

- AMP03: Military Data Sheet
- AMP03: Precision, Unity-Gain Differential Amplifier Data Sheet

Technical Books

- A Designer's Guide to Instrumentation Amplifiers, 3rd Edition, 2006

REFERENCE MATERIALS 🗗

Technical Articles

- Auto-Zero Amplifiers
- High-performance Adder Uses Instrumentation Amplifiers
- Input Filter Prevents Instrumentation-amp RF-Rectification Errors
- The AD8221 - Setting a New Industry Standard for Instrumentation Amplifiers

DESIGN RESOURCES 🗗

- AMP03 Material Declaration
- PCN-PDN Information
- Quality And Reliability
- Symbols and Footprints

DISCUSSIONS 🗗

View all AMP03 EngineerZone Discussions.

SAMPLE AND BUY 🗗

Visit the product page to see pricing options.

TECHNICAL SUPPORT 🗗

Submit a technical question or find your regional support number.

DOCUMENT FEEDBACK 🗗

Submit feedback for this data sheet.

AMP03–SPECIFICATIONS

ELECTRICAL CHARACTERISTICS (@ V_S = ±15 V, T_A = +25°C, unless otherwise noted.)

Parameter	Symbol	Conditions	AMP03F Min	AMP03F Typ	AMP03F Max	AMP03B Min	AMP03B Typ	AMP03B Max	AMP03G Min	AMP03G Typ	AMP03G Max	Unit
Offset Voltage	V_{OS}	V_{CM} = 0 V	–400	+10	+400	–700	+20	+700	–750	+25	+750	µV
Gain Error		No Load, V_{IN} = ±10 V, R_S = 0 Ω		0.00004	0.008		0.00004	0.008		0.001	0.008	%
Input Voltage Range	IVR	(Note 1)	±20			±20			±20			V
Common-Mode Rejection	CMR	V_{CM} = ±10 V	85	100		80	95		80	95		dB
Power Supply Rejection Ratio	PSRR	V_S = ±6 V to ±18 V		0.6	10		0.6	10		0.7	10	µV/V
Output Swing	V_O	R_L = 2 kΩ	±12	±13.7		±12	±13.7		±12	±13.7		V
Short-Circuit Current Limit	I_{SC}	Output Shorted to Ground	+45/–15			+45/–15			+45/–15			mA
Small-Signal Bandwidth (–3 dB)	BW	R_L = 2 kΩ		3			3			3		MHz
Slew Rate	SR	R_L = 2 kΩ	6	9.5		6	9.5		6	9.5		V/µs
Capacitive Load Drive Capability	C_L	No Oscillation		300			300			300		pF
Supply Current	I_{SY}	No Load		2.5	3.5		2.5	3.5		2.5	3.5	mA

NOTES
[1]Input voltage range guaranteed by CMR test.

Specifications subject to change without notice.

ELECTRICAL CHARACTERISTICS (@ V_S = ±15 V, –55°C ≤ T_A ≤ +125°C for B Grade)

Parameter	Symbol	Conditions	AMP03B Min	AMP03B Typ	AMP03B Max	Unit
Offset Voltage	V_{OS}	V_{CM} = 0 V	–1500	+150	+1500	µV
Gain Error		No Load, V_{IN} = ±10 V, R_S = 0 Ω		0.0014	0.02	%
Input Voltage Range	IVR		±20			V
Common-Mode Rejection	CMR	V_{CM} = ±10 V	75	95		dB
Power Supply Rejection Ratio	PSRR	V_S = ±6 V to ±18 V		0.7	20	µV/V
Output Swing	V_O	R_L = 2 kΩ	±12	±13.7		V
Slew Rate	SR	R_L = 2 kΩ		9.5		V/µs
Supply Current	I_{SY}	No Load		3.0	4.0	mA

Specifications subject to change without notice.

ELECTRICAL CHARACTERISTICS (@ V_S = ±15 V, –40°C ≤ T_A ≤ +85°C for F and G Grades)

Parameter	Symbol	Conditions	AMP03F Min	AMP03F Typ	AMP03F Max	AMP03G Min	AMP03G Typ	AMP03G Max	Unit
Offset Voltage	V_{OS}	V_{CM} = 0 V	–1000	+100	+1000	–2000	+200	+2000	µV
Gain Error		No Load, V_{IN} = ±10 V, R_S = 0 Ω		0.0008	0.015		0.002	0.02	%
Input Voltage Range	IVR		±20			±20			V
Common-Mode Rejection	CMR	V_{CM} = ±10 V	80	95		75	90		dB
Power Supply Rejection Ratio	PSRR	V_S = ±6 V to ±18 V		0.7	15		1.0	15	µV/V
Output Swing	V_O	R_L = 2 kΩ	±12	±13.7		±12	±13.7		V
Slew Rate	SR	R_L = 2 kΩ		9.5			9.5		V/µs
Supply Current	I_{SY}	No Load		2.6	4.0		2.6	4.0	mA

Specifications subject to change without notice.

REV. F

WAFER TEST LIMITS (@ $V_S = \pm 15$ V, $T_A = 25°C$, unless otherwise noted.)*

Parameter	Symbol	Conditions	AMP03GBC Limit	Unit
Offset Voltage	V_{OS}	$V_S = \pm 18$ V	0.5	mV max
Gain Error		No Load, $V_{IN} = \pm 10$ V, $R_S = 0$ Ω	0.008	% max
Input Voltage Range	IVR		± 10	V min
Common-Mode Rejection	CMR	$V_{CM} = \pm 10$ V	80	dB min
Power Supply Rejection Ratio	PSRR	$V_S = \pm 6$ V to ± 18 V	8	µV/V max
Output Swing	V_O	$R_L = 2$ kΩ	± 12	V max
Short-Circuit Current Limit	I_{SC}	Output Shorted to Ground	+45/–15	mA min
Supply Current	I_{SY}	No Load	3.5	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.

ABSOLUTE MAXIMUM RATINGS[1]
Supply Voltage . . . . ± 18 V
Input Voltage[2] . . . . Supply Voltage
Output Short-Circuit Duration . . . . Continuous
Storage Temperature Range
  P, J Package . . . . –65°C to +150°C
Lead Temperature (Soldering, 60 sec) . . . . 300°C
Junction Temperature . . . . 150°C
Operating Temperature Range
  AMP03B . . . . –55°C to +125°C
  AMP03F, AMP03G . . . . –40°C to +85°C

Package Type	θ_{JA}[3]	θ_{JC}	Unit
Header (J)	150	18	°C/W
8-Lead PDIP (P)	103	43	°C/W
8-Lead SOIC (S)	155	40	°C/W

NOTES
[1]Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted.
[2]For supply voltages less than ± 18 V, the absolute maximum input voltage is equal to the supply voltage.
[3]θ_{JA} is specified for worst-case mounting conditions, i.e., θ_{JA} is specified for device in socket for header and PDIP packages and for device soldered to printed circuit board for SOIC package.

ORDERING GUIDE

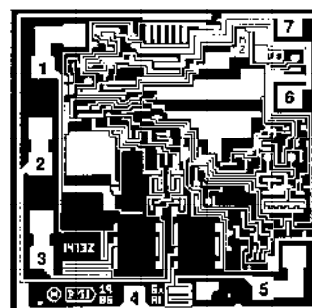| Model[1]	Temperature Range	Package Description	Package Option[2]
AMP03GP	–40°C to +85°C	8-Lead PDIP	P-8
AMP03BJ	–40°C to +85°C	Header	H-08B
AMP03FJ	–40°C to +85°C	Header	H-08B
AMP03BJ/883C	–55°C to +125°C	Header	H-08B
AMP03GS	–40°C to +85°C	8-Lead SOIC	S-8
AMP03GS-REEL	–40°C to +85°C	8-Lead SOIC	S-8
5962-9563901MGA	–55°C to +125°C	Header	H-08B
AMP03GBC		Die	

NOTES
[1]Burn-in is available on commercial and industrial temperature range parts in PDIP and header packages.
[2]Consult factory for /883 data sheet.

DICE CHARACTERISTICS

1. REFERENCE
2. –IN
3. +IN
4. –V_{EE}
5. SENSE
6. OUTPUT
7. +V_{CC}
8. NC

DIE SIZE 0.076 inch × 0.076 inch, 5,776 sq. mm
(1.93 mm × 1.93 mm, 3.73 sq. mm)

BURN-IN CIRCUIT

SLEW RATE TEST CIRCUIT

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 AMP03 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.
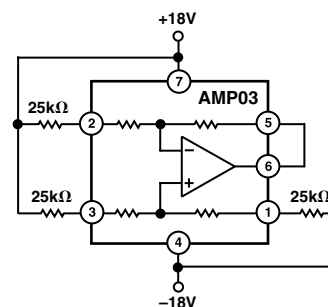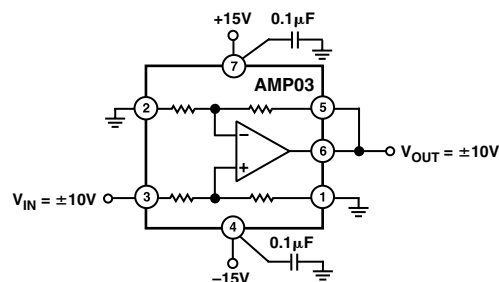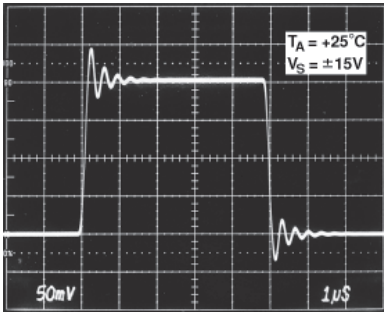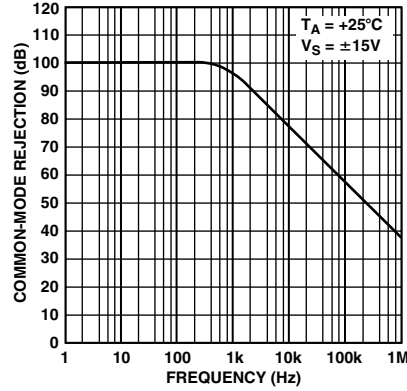

WARNING!
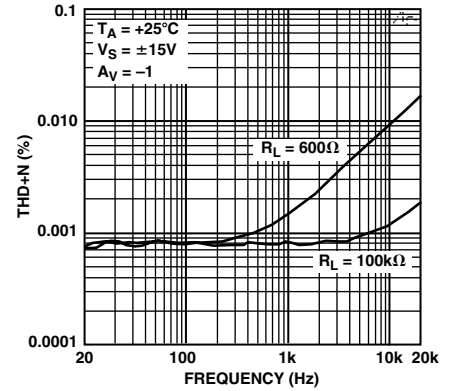ESD SENSITIVE DEVICE

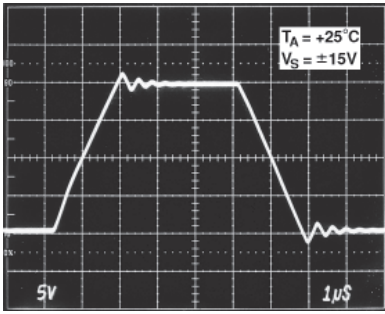# AMP03–Typical Performance Characteristics
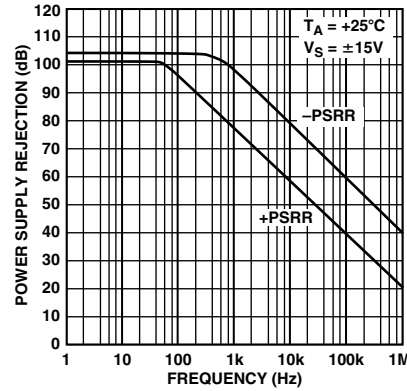

TPC 1. Small Signal Transient Response

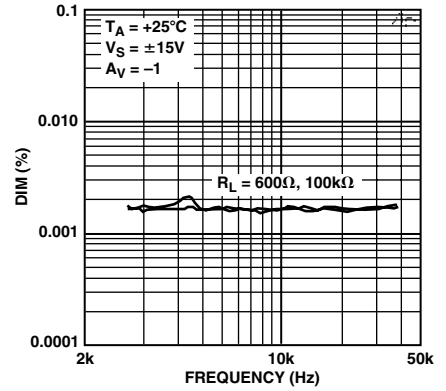TPC 2. Common-Mode Rejection vs. Frequency

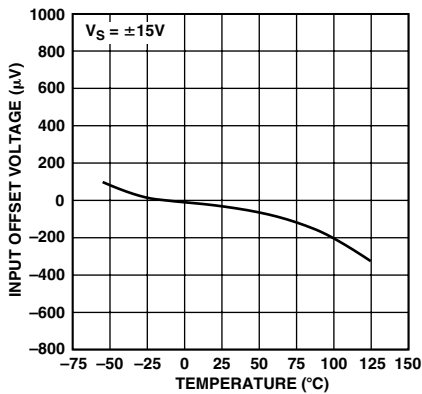TPC 3. Total Harmonic Distortion vs. Frequency

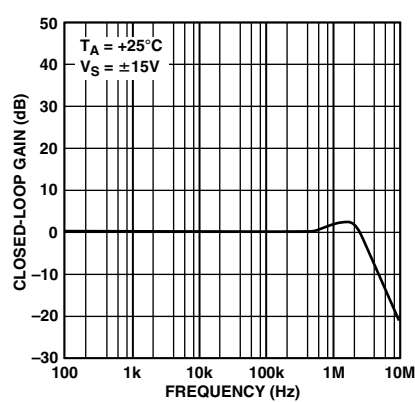TPC 4. Large Signal Transient Response

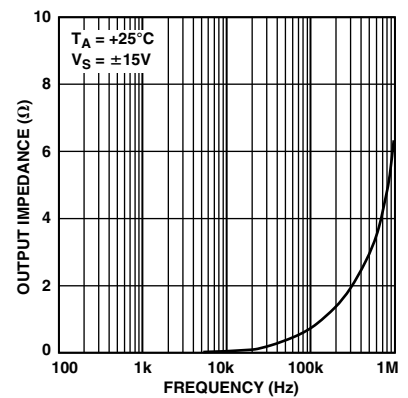TPC 5. Power Supply Rejection vs. Frequency

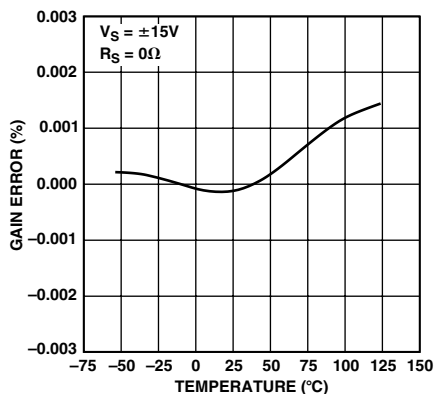TPC 6. Dynamic Intermodulation Distortion vs. Frequency
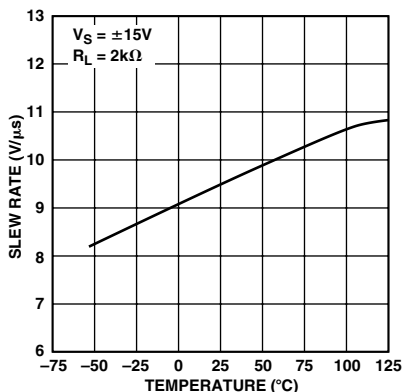

TPC 7. Input Offset Voltage vs. Temperature
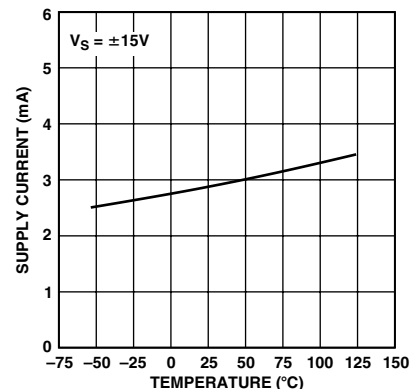

TPC 8. Closed-Loop Gain vs. Frequency
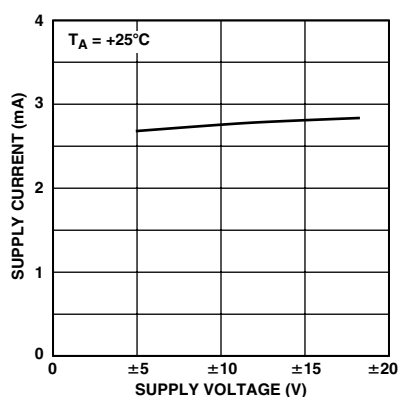

TPC 9. Closed-Loop Output Impedance vs. Frequency

TPC 10. Gain Error vs. Temperature

TPC 11. Slew Rate vs. Temperature

TPC 12. Supply Current vs. Temperature

TPC 13. Supply Current vs. Supply Voltage

TPC 14. Maximum Output Voltage vs. Output Current (Source)

TPC 15. Maximum Output Voltage vs. Output Current (Sink)
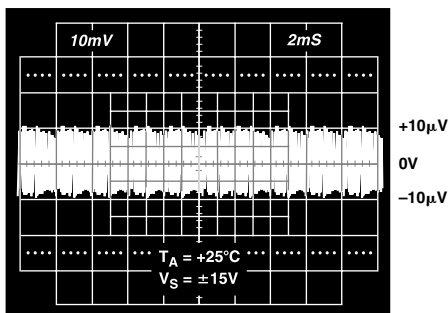

TPC 16. Voltage Noise Density vs. Frequency

0.1 TO 10Hz PEAK-TO-PEAK NOISE

TPC 17. Low Frequency Voltage Noise

NOTE: EXTERNAL AMPLIFIER GAIN = 1000; THEREFORE, VERTICAL SCALE = 10µV/DIV.

TPC 18. Voltage Noise from 0 kHz to 1 kHz

NOTE: EXTERNAL AMPLIFIER GAIN = 1000; THEREFORE, VERTICAL SCALE = 10µV/DIV.

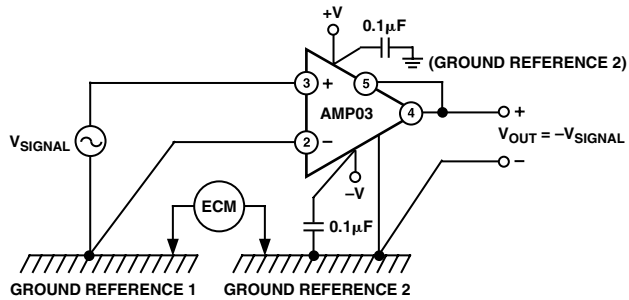TPC 19. Voltage Noise from 0 kHz to 10 kHz

AMP03

Figure 1. AMP03 Serves to Reject Common-Mode Voltages in Instrumentation Systems. Common-Mode Voltages Occur Due to Ground Current Returns. V_{SIGNAL} and E_{CM} Must Be within the Common-Mode Range of AMP03.

APPLICATIONS INFORMATION

The AMP03 represents a versatile analog building block. In order to capitalize on the fast settling time, high slew rate, and high CMR, proper decoupling and grounding techniques must be employed. Figure 1 illustrates the use of 0.1 µF decoupling capacitors and proper ground connections.

MAINTAINING COMMON-MODE REJECTION

In order to achieve the full common-mode rejection capability of the AMP03, the source impedance must be carefully controlled. Slight imbalances of the source resistance will result in a degradation of dc CMR—even a 5 Ω imbalance will degrade CMR by 20 dB. Also, the matching of the reactive source impedance must be matched in order to preserve the CMRR over frequency.
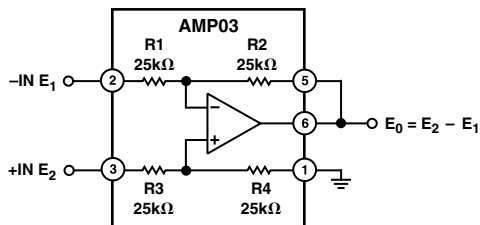
APPLICATION CIRCUITS

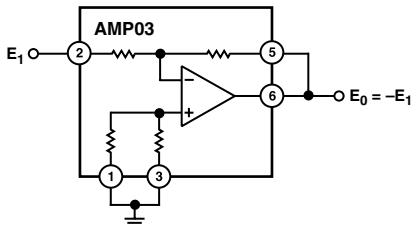Figure 2. Precision Difference Amplifier. Rejects Common-Mode Signal = $(E_1 + E_2)/2$ by 100 dB

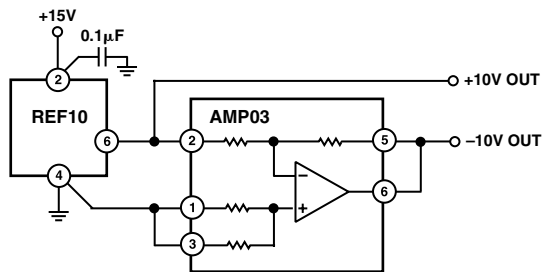Figure 3. Precision Unity-Gain Inverting Amplifier
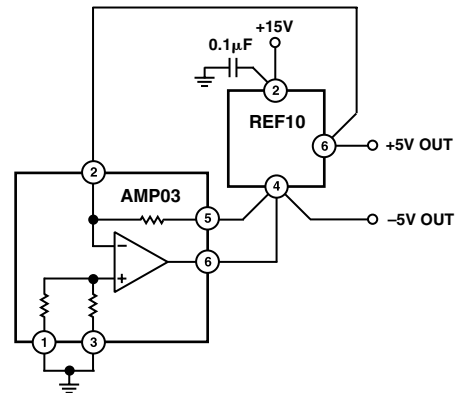

Figure 4. ±10 V Precision Voltage Reference
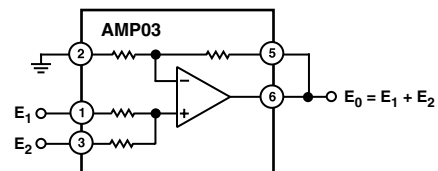

Figure 5. ±5 V Precision Voltage Reference
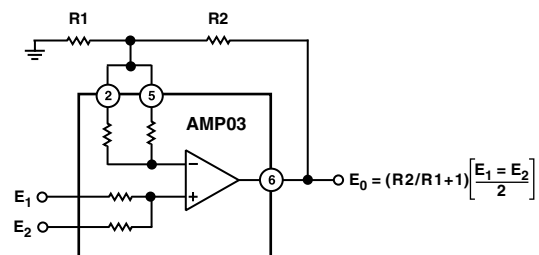

Figure 6. Precision Summing Amplifier

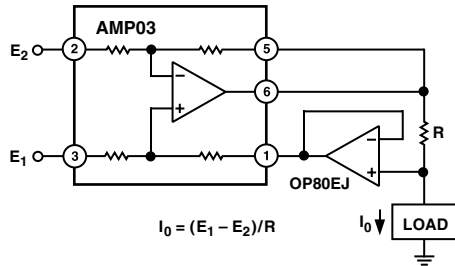Figure 7. Precision Summing Amplifier with Gain

REV. F

Figure 8. Differential Input Voltage-to-Current Converter for Low I_{OUT}. OP80EJ maintains 250 fA max input current, allowing I_O to be less than 1 pA.
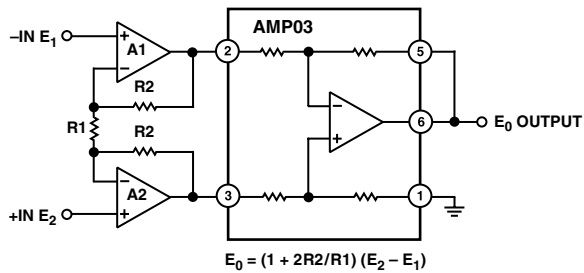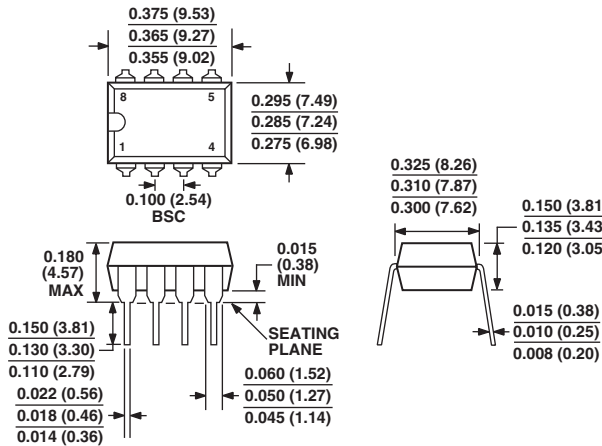

Figure 9. Suitable Instrumentation Amplifier Requirements Can Be Addressed by Using an Input Stage Consisting of A1, A2, R1, and R2. The following matrix suggests a suitable amplifier.

System Design Requirement	Suggested Op Amp For A1 and A2
Source Impedance Low, Need Low Voltage Noise Performance	OP27, OP37 OP227 (Dual Matched) OP270 (Dual) OP271 OP470 OP471
Source Impedance High ($R_S \geq 15$ kΩ). Need Low Current Noise	OP80 OP41 OP43 OP249 OP97
Require Ultrahigh Input Impedance	OP80 OP97 OP41 OP43
Need Wider Bandwidth and High Speed	OP42 OP43 OP249

AMP03

OUTLINE DIMENSIONS

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

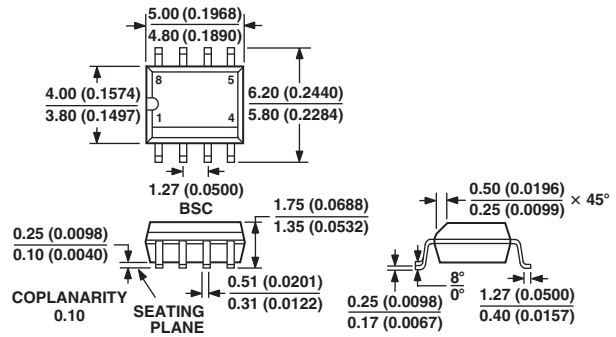Dimensions shown in inches and (millimeters)

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 Small Outline Package [SOIC]
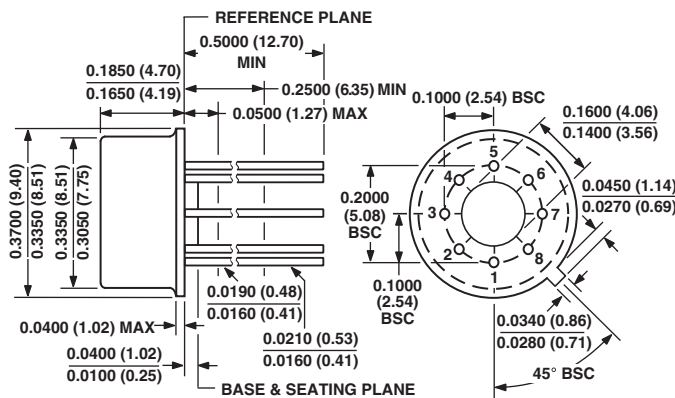### [S Suffix]
(R-8)

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

8-Lead Metal Can [TO-99]
[J Suffix]
(H-08B)

Dimensions shown in inches and (millimeters)

COMPLIANT TO JEDEC STANDARDS MO-002AK

CONTROLLING DIMENSIONS ARE IN INCHES; MILLIMETERS DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF INCH EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN

Revision History

REV. F