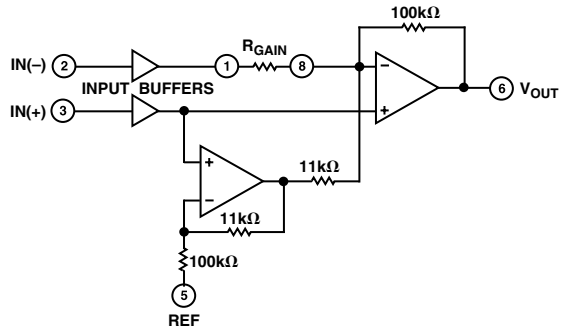
Precision Single Supply Instrumentation Amplifier

AMP04*

FEATURES
Single Supply Operation
Low Supply Current: 700 μA Max
Wide Gain Range: 1 to 1000
Low Offset Voltage: 150 μV Max
Zero-In/Zero-Out
Single-Resistor Gain Set
8-Lead Mini-DIP and SO Packages

APPLICATIONS
Strain Gages
Thermocouples
RTDs
Battery-Powered Equipment
Medical Instrumentation
Data Acquisition Systems
PC-Based Instruments
Portable Instrumentation

FUNCTIONAL BLOCK DIAGRAM



GENERAL DESCRIPTION

The AMP04 is a single-supply instrumentation amplifier designed to work over a +5 volt to ±15 volt supply range. It offers an excellent combination of accuracy, low power consumption, wide input voltage range, and excellent gain performance.

Gain is set by a single external resistor and can be from 1 to 1000. Input common-mode voltage range allows the AMP04 to handle signals with full accuracy from ground to within 1 volt of the positive supply. And the output can swing to within 1 volt of the positive supply. Gain bandwidth is over 700 kHz. In addition to being easy to use, the AMP04 draws only 700 μA of supply current.

For high resolution data acquisition systems, laser trimming of low drift thin-film resistors limits the input offset voltage to under 150 μV, and allows the AMP04 to offer gain nonlinearity of 0.005% and a gain tempco of 30 ppm/°C.

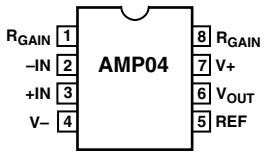
A proprietary input structure limits input offset currents to less than 5 nA with drift of only 8 pA/°C, allowing direct connection of the AMP04 to high impedance transducers and other signal sources.

The AMP04 is specified over the extended industrial (–40°C to +85°C) temperature range. AMP04s are available in plastic and ceramic DIP plus SO-8 surface mount packages.

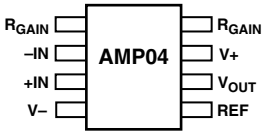
Contact your local sales office for MIL-STD-883 data sheet and availability.

PIN CONNECTIONS

8-Lead Epoxy DIP (P Suffix)



8-Lead Narrow-Body SO (S Suffix)



*Protected by U.S. Patent No. 5,075,633.

REV. B

AMP04–SPECIFICATIONS

ELECTRICAL CHARACTERISTICS (V_S = 5 V, V_{CM} = 2.5 V, T_A = 25°C unless otherwise noted)

Parameter	Symbol	Conditions	AMP04E Min	AMP04E Typ	AMP04E Max	AMP04F Min	AMP04F Typ	AMP04F Max	Unit
OFFSET VOLTAGE									
Input Offset Voltage	V_{IOS}			30	150			300	µV
		–40°C ≤ T_A ≤ +85°C			300			600	µV
Input Offset Voltage Drift	TCV_{IOS}				3			6	µV/°C
Output Offset Voltage	V_{OOS}			0.5	1.5			3	mV
		–40°C ≤ T_A ≤ +85°C			3			6	mV
Output Offset Voltage Drift	TCV_{OOS}				30			50	µV/°C
INPUT CURRENT									
Input Bias Current	I_B			22	30			40	nA
		–40°C ≤ T_A ≤ +85°C			50			60	nA
Input Bias Current Drift	TCI_B			65			65		pA/°C
Input Offset Current	I_{OS}			1	5			10	nA
		–40°C ≤ T_A ≤ +85°C			10			15	nA
Input Offset Current Drift	TCI_{OS}			8			8		pA/°C
INPUT									
Common-Mode Input Resistance				4			4		GΩ
Differential Input Resistance				4			4		GΩ
Input Voltage Range	V_{IN}		0		3.0	0		3.0	V
Common-Mode Rejection	CMR	0 V ≤ V_{CM} ≤ 3.0 V							
		G = 1	60	80		55			dB
		G = 10	80	100		75			dB
		G = 100	90	105		80			dB
		G = 1000	90	105		80			dB
Common-Mode Rejection	CMR	0 V ≤ V_{CM} ≤ 2.5 V							
		–40°C ≤ T_A ≤ +85°C							
		G = 1	55			50			dB
		G = 10	75			70			dB
		G = 100	85			75			dB
		G = 1000	85			75			dB
Power Supply Rejection	PSRR	4.0 V ≤ V_S ≤ 12 V							
		–40°C ≤ T_A ≤ +85°C							
		G = 1	95			85			dB
		G = 10	105			95			dB
		G = 100	105			95			dB
		G = 1000	105			95			dB
GAIN (G = 100 K/R_{GAIN})									
Gain Equation Accuracy		G = 1 to 100		0.2	0.5			0.75	%
		G = 1 to 100							
		–40°C ≤ T_A ≤ +85°C			0.8			1.0	%
		G = 1000		0.4			0.75		%
Gain Range	G		1		1000	1		1000	V/V
Nonlinearity		G = 1, R_L = 5 kΩ		0.005					%
		G = 10, R_L = 5 kΩ		0.015					%
		G = 100, R_L = 5 kΩ		0.025					%
Gain Temperature Coefficient	ΔG/ΔT			30			50		ppm/°C
OUTPUT									
Output Voltage Swing High	V_{OH}	R_L = 2 kΩ	4.0	4.2		4.0			V
		R_L = 2 kΩ							
		–40°C ≤ T_A ≤ +85°C	3.8			3.8			V
Output Voltage Swing Low	V_{OL}	R_L = 2 kΩ							
		–40°C ≤ T_A ≤ +85°C			2.0			2.5	mV
Output Current Limit		Sink		30			30		mA
		Source		15			15		mA

Parameter	Symbol	Conditions	AMP04E Min	AMP04E Typ	AMP04E Max	AMP04F Min	AMP04F Typ	AMP04F Max	Unit
NOISE									
Noise Voltage Density, RTI	e_N	f = 1 kHz, G = 1		270			270		nV/√Hz
		f = 1 kHz, G = 10		45			45		nV/√Hz
		f = 100 Hz, G = 100		30			30		nV/√Hz
		f = 100 Hz, G = 1000		25			25		nV/√Hz
Noise Current Density, RTI	i_N	f = 100 Hz, G = 100		4			4		pA/√Hz
Input Noise Voltage	e_N p-p	0.1 Hz to 10 Hz, G = 1		7			7		µV p-p
		0.1 Hz to 10 Hz, G = 10		1.5			1.5		µV p-p
		0.1 Hz to 10 Hz, G = 100		0.7			0.7		µV p-p
DYNAMIC RESPONSE									
Small Signal Bandwidth	BW	G = 1, –3 dB		300			300		kHz
POWER SUPPLY									
Supply Current	I_{SY}			550	700			700	µA
		–40°C ≤ T_A ≤ +85°C			850			850	µA

Specifications subject to change without notice.

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

Parameter	Symbol	Conditions	AMP04E Min	AMP04E Typ	AMP04E Max	AMP04F Min	AMP04F Typ	AMP04F Max	Unit
OFFSET VOLTAGE									
Input Offset Voltage	V_{IOS}			80	400			600	µV
		–40°C ≤ T_A ≤ +85°C			600			900	µV
Input Offset Voltage Drift	TCV_{IOS}				3			6	µV/°C
Output Offset Voltage	V_{OOS}			1	3			6	mV
		–40°C ≤ T_A ≤ +85°C			6			9	mV
Output Offset Voltage Drift	TCV_{OOS}				30			50	µV/°C
INPUT CURRENT									
Input Bias Current	I_B			17	30			40	nA
		–40°C ≤ T_A ≤ +85°C			50			60	nA
Input Bias Current Drift	TCI_B			65			65		pA/°C
Input Offset Current	I_{OS}			2	5			10	nA
		–40°C ≤ T_A ≤ +85°C			15			20	nA
Input Offset Current Drift	TCI_{OS}			28			28		pA/°C
INPUT									
Common-Mode Input Resistance				4			4		GΩ
Differential Input Resistance				4			4		GΩ
Input Voltage Range	V_{IN}		–12		+12	–12		+12	V
Common-Mode Rejection	CMR	–12 V ≤ V_{CM} ≤ +12 V							
		G = 1	60	80		55			dB
		G = 10	80	100		75			dB
		G = 100	90	105		80			dB
		G = 1000	90	105		80			dB
Common-Mode Rejection	CMR	–11 V ≤ V_{CM} ≤ +11 V							
		–40°C ≤ T_A ≤ +85°C							
		G = 1	55			50			dB
		G = 10	75			70			dB
		G = 100	85			75			dB
		G = 1000	85			75			dB
Power Supply Rejection	PSRR	±2.5 V ≤ V_S ≤ ±18 V							
		–40°C ≤ T_A ≤ +85°C							
		G = 1	75			70			dB
		G = 10	90			80			dB
		G = 100	95			85			dB
		G = 1000	95			85			dB

Parameter	Symbol	Conditions	AMP04E Min	AMP04E Typ	AMP04E Max	AMP04F Min	AMP04F Typ	AMP04F Max	Unit
GAIN (G = 100 K/R_{GAIN})									
Gain Equation Accuracy		G = 1 to 100		0.2	0.5			0.75	%
		G = 1000		0.4			0.75		%
		G = 1 to 100							
		–40°C ≤ T_A ≤ +85°C			0.8			1.0	%
Gain Range	G		1		1000	1		1000	V/V
Nonlinearity		G = 1, R_L = 5 kΩ		0.005			0.005		%
		G = 10, R_L = 5 kΩ		0.015			0.015		%
		G = 100, R_L = 5 kΩ		0.025			0.025		%
Gain Temperature Coefficient	ΔG/ΔT			30			50		ppm/°C
OUTPUT									
Output Voltage Swing High	V_{OH}	R_L = 2 kΩ	13	13.4		13			V
		R_L = 2 kΩ							
		–40°C ≤ T_A ≤ +85°C	12.5			12.5			V
Output Voltage Swing Low	V_{OL}	R_L = 2 kΩ							
		–40°C ≤ T_A ≤ +85°C			–14.5			–14.5	V
Output Current Limit		Sink		30			30		mA
		Source		15			15		mA
NOISE									
Noise Voltage Density, RTI	e_N	f = 1 kHz, G = 1		270			270		nV/√Hz
		f = 1 kHz, G = 10		45			45		nV/√Hz
		f = 100 Hz, G = 100		30			30		nV/√Hz
		f = 100 Hz, G = 1000		25			25		nV/√Hz
Noise Current Density, RTI	i_N	f = 100 Hz, G = 100		4			4		pA/√Hz
Input Noise Voltage	e_N p-p	0.1 Hz to 10 Hz, G = 1		5			5		µV p-p
		0.1 Hz to 10 Hz, G = 10		1			1		µV p-p
		0.1 Hz to 10 Hz, G = 100		0.5			0.5		µV p-p
DYNAMIC RESPONSE									
Small Signal Bandwidth	BW	G = 1, –3 dB		700			700		kHz
POWER SUPPLY									
Supply Current	I_{SY}			750	900			900	µA
		–40°C ≤ T_A ≤ +85°C			1100			1100	µA

Specifications subject to change without notice.

WAFER TEST LIMITS (V_S = 5 V, V_{CM} = 2.5 V, T_A = 25°C unless otherwise noted)

Parameter	Symbol	Conditions	Limit	Unit
OFFSET VOLTAGE				
Input Offset Voltage	V_{IOS}		300	µV max
Output Offset Voltage	V_{OOS}		3	mV max
INPUT CURRENT				
Input Bias Current	I_B		40	nA max
Input Offset Current	I_{OS}		10	nA max
INPUT				
Common-Mode Rejection	CMR	0 V ≤ V_{CM} ≤ 3.0 V		
		G = 1	55	dB min
		G = 10	75	dB min
		G = 100	80	dB min
		G = 1000	80	dB min
Common-Mode Rejection	CMR	V_S = ±15 V, –12 V ≤ V_{CM} ≤ +12 V		
		G = 1	55	dB min
		G = 10	75	dB min
		G = 100	80	dB min

Parameter	Symbol	Conditions	Limit	Unit
Power Supply Rejection	PSRR	G = 1000 4.0 V ≤ V_S ≤ 12 V	80	dB min
		G = 1	85	dB min
		G = 10	95	dB min
		G = 100	95	dB min
		G = 1000	95	dB min
GAIN (G = 100 K/R_{GAIN}) Gain Equation Accuracy		G = 1 to 100	0.75	% max
OUTPUT Output Voltage Swing High	V_{OH}	R_L = 2 kΩ	4.0	V min
Output Voltage Swing Low	V_{OL}	R_L = 2 kΩ	2.5	mV max
POWER SUPPLY Supply Current	I_{SY}	V_S = ±15	900 700	μA max μA max

NOTE
Electrical tests and 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.

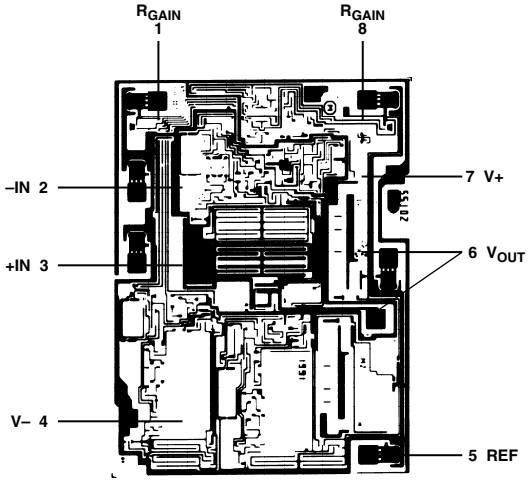
ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage . . . . . ±18 V
Common-Mode Input Voltage[2] . . . . . ±18 V
Differential Input Voltage . . . . . 36 V
Output Short-Circuit Duration to GND . . . . . Indefinite
Storage Temperature Range
  Z Package . . . . . –65°C to +175°C
  P, S Package . . . . . –65°C to +150°C
Operating Temperature Range
  AMP04A . . . . . –55°C to +125°C
  AMP04E, F . . . . . –40°C to +85°C
Junction Temperature Range
  Z Package . . . . . –65°C to +175°C
  P, S Package . . . . . –65°C to +150°C
Lead Temperature Range (Soldering, 60 sec) . . . . . 300°C

Package Type	θ_{JA}[3]	θ_{JC}	Unit
8-Lead Cerdip (Z)	148	16	°C/W
8-Lead Plastic DIP (P)	103	43	°C/W
8-Lead SOIC (S)	158	43	°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 the worst case conditions, i.e., θ_{JA} is specified for device in socket for cerdip, P-DIP, and LCC packages; θ_{JA} is specified for device soldered in circuit board for SOIC package.

DICE CHARACTERISTICS



AMP04 Die Size 0.075 × 0.99 inch, 7,425 sq. mils. Substrate (Die Backside) Is Connected to V+. Transistor Count, 81.

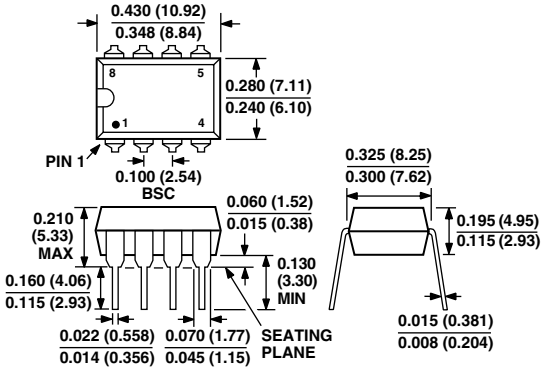
ORDERING GUIDE

Model	Temperature Range	V_{OS} @ 5 V T_A = 25°C	Package Description	Package Option
AMP04EP	XIND	150 μV	Plastic DIP	N-8
AMP04ES	XIND	150 μV	SOIC	SO-8
AMP04ES-REEL7	XIND	150 μV	SOIC	SO-8
AMP04FP	XIND	300 μV	Plastic DIP	N-8
AMP04FS	XIND	300 μV	SOIC	SO-8
AMP04FS-REEL	XIND	150 μV	SOIC	SO-8
AMP04FS-REEL7	XIND	150 μV	SOIC	SO-8
AMP04GBC	25°C	300 μV		

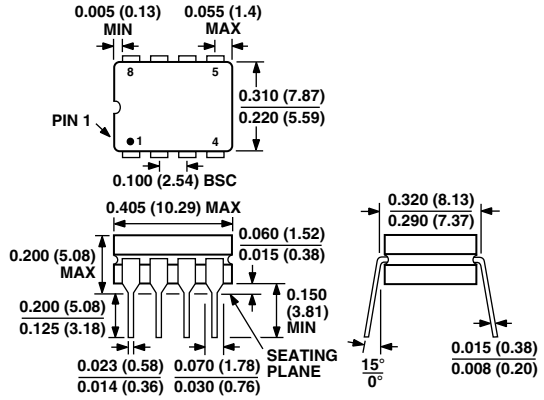
OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

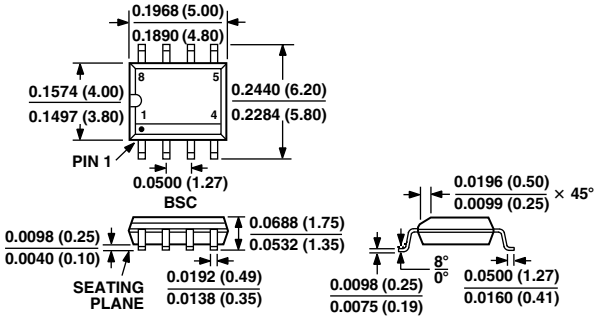
8-Lead Plastic DIP (N-8)



8-Lead Cerdip (Q-8)



8-Lead Narrow-Body SO (SO-8)



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