Quad Low Offset, Low Power Operational Amplifier

OP400

FEATURES

Low input offset voltage: 150 µV maximum
Low offset voltage drift over –55°C to +125°C: 1.2 pV/°C maximum
Low supply current (per amplifier): 725 µA maximum
High open-loop gain: 5000 V/mV minimum
Input bias current: 3 nA maximum
Low noise voltage density: 11 nV/√Hz at 1 kHz
Stable with large capacitive loads: 10 nF typical
Pin-compatible to LM148, HA4741, RM4156, and LT1014, with improved performance
Available in die form

FUNCTIONAL BLOCK DIAGRAMS

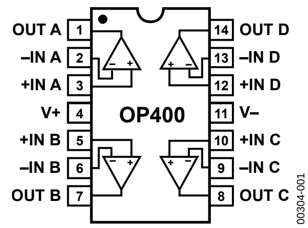


Figure 1. 14-Pin Ceramic DIP (Y-Suffix) and 14-Pin Plastic DIP (P-Suffix)

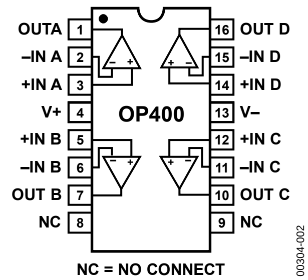


Figure 2. 16-Pin SOIC (S-Suffix)

GENERAL DESCRIPTION

The OP400 is the first monolithic quad operational amplifier that features OP77-type performance. Precision performance is not sacrificed with the OP400 to obtain the space and cost savings offered by quad amplifiers.

The OP400 features an extremely low input offset voltage of less than 150 µV with a drift of less than 1.2 µV/°C, guaranteed over the full military temperature range. Open-loop gain of the OP400 is more than 5 million into a 10 kΩ load, input bias current is less than 3 nA, CMR is more than 120 dB, and PSRR is less than 1.8 µV/V. On-chip Zener zap trimming is used to achieve the low input offset voltage of the OP400 and eliminates the need for offset nulling. The OP400 conforms to the industry-standard quad pinout, which does not have null terminals.

The OP400 features low power consumption, drawing less than 725 µA per amplifier. The total current drawn by this quad amplifier is less than that of a single OP07, yet the OP400 offers significant improvements over this industry-standard op amp. Voltage noise density of the OP400 is a low 11 nV/√Hz at 10 Hz, half that of most competitive devices.

The OP400 is pin-compatible with the LM148, HA4741, RM4156, and LT1014 operational amplifiers and can be used to upgrade systems having these devices. The OP400 is an ideal choice for applications requiring multiple precision operational amplifiers and where low power consumption is critical.

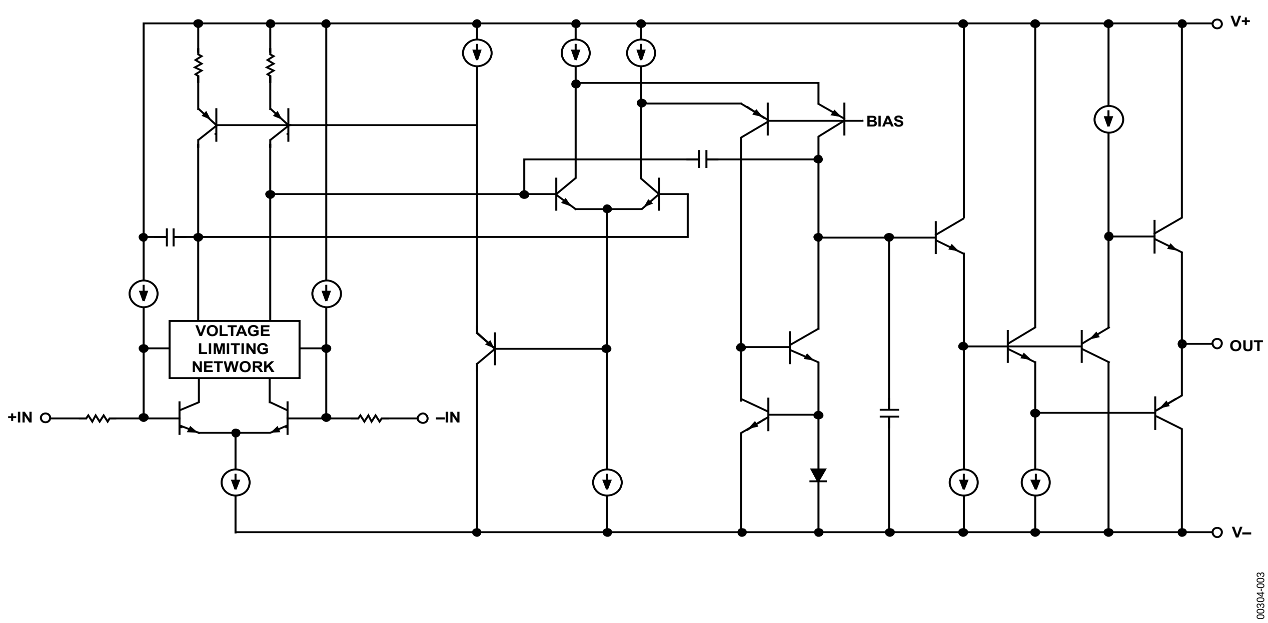


Figure 3. Simplified Schematic (One of Four Amplifiers Is Shown)

SPECIFICATIONS

ELECTRICAL CHARACTERISTICS

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

Table 1.

Parameter	Symbol	Conditions	OP400A/E Min	OP400A/E Typ	OP400A/E Max	OP400F Min	OP400F Typ	OP400F Max	OP400G/H Min	OP400G/H Typ	OP400G/H Max	Unit
INPUT CHARACTERISTICS												
Input Offset Voltage	V_{OS}			40	150		60	230		80	300	µV
Long-Term Input Voltage Stability				0.1			0.1			0.1		µV/mo
Input Offset Current	I_{OS}	V_{CM} = 0 V		0.1	1.0		0.1	2.0		0.1	3.5	nA
Input Bias Current	I_B	V_{CM} = 0 V		0.75	3.0		0.75	6.0		0.75	7.0	nA
Input Noise Voltage	$e_{n\ p\text{-}p}$	0.1 Hz to 10 Hz		0.5			0.5			0.5		µV p-p
Input Resistance Differential Mode	R_{IN}			10			10			10		MΩ
Input Resistance Common Mode	R_{INCM}			200			200			200		GΩ
Large Signal Voltage Gain	A_{VO}	V_O = ±10 V										
		R_L = 10 kΩ	5000	12,000		3000	7000		3000	7000		V/mV
		R_L = 2 kΩ	2000	3500		1500	3000		1500	3000		V/mV
Input Voltage Range[1]	IVR		±12	±13		±12	±13		±12	±13		V
Common-Mode Rejection	CMR	V_{CM} = 12 V	120	140		115	140		110	135		dB
Input Capacitance	C_{IN}			3.2			3.2			3.2		pF
OUTPUT CHARACTERISTICS												
Output Voltage Swing	V_O	R_L = 10 kΩ	±12	±12.6		±12	±12.6		±12	±12.6		V
POWER SUPPLY												
Power Supply Rejection Ratio	PSRR	V_S = 3 V to 18 V		0.1	1.8		0.1	3.2		0.2	5.6	µV/V
Supply Current per Amplifier	I_{SY}	No load		600	725		600	725		600	725	µA
DYNAMIC PERFORMANCE												
Slew Rate	SR		0.1	0.15		0.1	0.15		0.1	0.15		V/µs
Gain Bandwidth Product	GBWP	A_V = 1		500			500			500		kHz
Channel Separation	CS	V_O = 20 V p-p, f_O = 10 Hz[2]	123	135		123	135		123	135		dB
Capacitive Load Stability		A_V = 1, no oscillations		10			10			10		nF
NOISE PERFORMANCE												
Input Noise Voltage Density[3]	e_n	f_O = 10 Hz[3]		22	36		22	36		22		nV/√Hz
		f_O = 1000 Hz[3]		11	18		11	18		11		nV/√Hz
Input Noise Current	$i_{n\ p\text{-}p}$	0.1 Hz to 10 Hz		15			15			15		pA p-p
Input Noise Current Density	i_n	f_O = 10 Hz		0.6			0.6			0.6		pA/√Hz

[1] Guaranteed by CMR test.
[2] Guaranteed but not 100% tested.
[3] Sample tested.

@ V_S = ±15 V, −55°C ≤ T_A ≤ +125°C for OP400A, unless otherwise noted.

Table 2.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Input Offset Voltage	V_{OS}			70	270	µV
Average Input Offset Voltage Drift	TCV_{OS}			0.3	1.2	µV/°C
Input Offset Current	I_{OS}	V_{CM} = 0 V		0.1	2.5	nA
Input Bias Current	I_B	V_{CM} = 0 V		1.3	5.0	nA
Large Signal Voltage Gain	A_{VO}	V_O = ±10 V, R_L = 10 kΩ	3000	9000		V/mV
		R_L = 2 kΩ	1000	2300		
Input Voltage Range[1]	IVR		±12	±12.5		V
Common-Mode Rejection	CMR	V_{CM} = ±12 V		115	130	dB
OUTPUT CHARACTERISTICS						
Output Voltage Swing	V_O	R_L = 10 kΩ	±12	±12.4		
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_O = 3 V to 18 V		0.2	3.2	µV/V
Supply Current per Amplifier	I_{SY}	No load		600	775	µA
DYNAMIC PERFORMANCE						
Capacitive Load Stability		A_V = 1, no oscillations		8		nF

[1] Guaranteed by CMR test.

@ V_S = ±15 V, −25°C ≤ T_A ≤ +85°C for OP400E/F, 0°C ≤ T_A ≤ 70°C for OP400G, −40°C ≤ T_A ≤ +85°C for OP400H, unless otherwise noted.

Table 3.

			OP400E			OP400F			OP400G/H			
Parameter	Symbol	Conditions	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Unit
INPUT CHARACTERISTICS												
Input Offset Voltage	V_{OS}			60	220		80	350		110	400	µV
Average Input Offset Voltage Drift	TCV_{OS}			0.3	1.2		0.3	2.0		0.6	2.5	µV/°C
Input Offset Current	I_{OS}	V_{CM} = 0 V										
		E, F, G grades		0.1	2.5		0.1	3.5		0.2	6.0	nA
		H grade								0.2	12.0	nA
Input Bias Current	I_B	V_{CM} = 0 V										
		E, F, G grades		0.9	5.0		0.9	10.0		1.0	12.0	nA
		H grade								1.0	20.0	nA
Large-Signal Voltage Gain	A_{VO}	V_{CM} = 0 V										
		R_L = 10 kΩ	3000	10,000		2000	5000		2000	5000		V/mV
		R_L = 2 kΩ	1500	2700		1000	2000		1000	2000		V/mV
Input Voltage Range[1]	IVR		±12	±12.5		±12	±12.5		±12	±12.5		V
Common-Mode Rejection	CMR	V_{CM} = ±12 V	115	135		110	135		105	130		dB
OUTPUT CHARACTERISTICS												
Output Voltage Swing	V_O	R_L = 10 kΩ	±12	±12.4		±12	±12.4		±12	±12.6		V
		R_L = 2 kΩ	±11	±12		±11	±12		±11	±12.2		V
POWER SUPPLY												
Power Supply Rejection Ratio	PSRR	V_S = ±3 V to ±18 V		0.15	3.2		0.15	5.6		0.3	10.0	µV/V
Supply Current per Amplifier	I_{SY}	No load		600	775		600	775		600	775	µA
DYNAMIC PERFORMANCE												
Capacitive Load Stability		No oscillations		10			10			10		nF

[1] Guaranteed by CMR test.

ABSOLUTE MAXIMUM RATINGS

Table 4.

Parameter	Rating
Supply Voltage	±20 V
Differential Input Voltage	±30 V
Input Voltage	Supply voltage
Output Short-Circuit Duration	Continuous
Storage Temperature Range	
P, Y Packages	−65°C to +150°C
Lead Temperature (Soldering 60 sec)	300°C
Junction Temperature (T_J) Range	−65°C to +150°C
Operating Temperature Range	
OP400A	−55°C to +125°C
OP400E, OP400F	−25°C to +85°C
OP400G	0°C to 70°C
OP400H	−40°C to +85°C

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.

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

THERMAL RESISTANCE

θ_{JA} is specified for worst-case mounting conditions, that is, θ_{JA} is specified for device in socket for CERDIP and PDIP packages; θ_{JA} is specified for device soldered to printed circuit board for SOIC package.

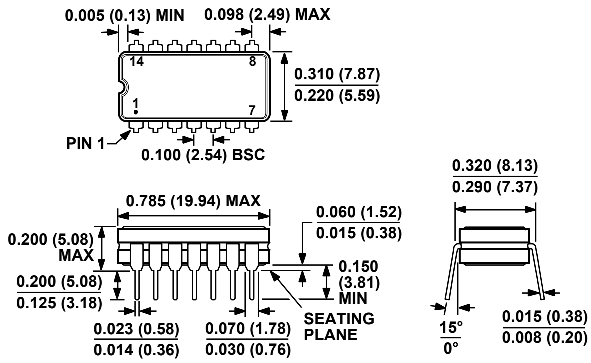
Table 5. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
14-Pin Ceramic DIP (Y)	94	10	°C/W
14-Pin Plastic DIP (P)	76	33	°C/W
16-Pin SOIC (S)	88	23	°C/W

ESD CAUTION

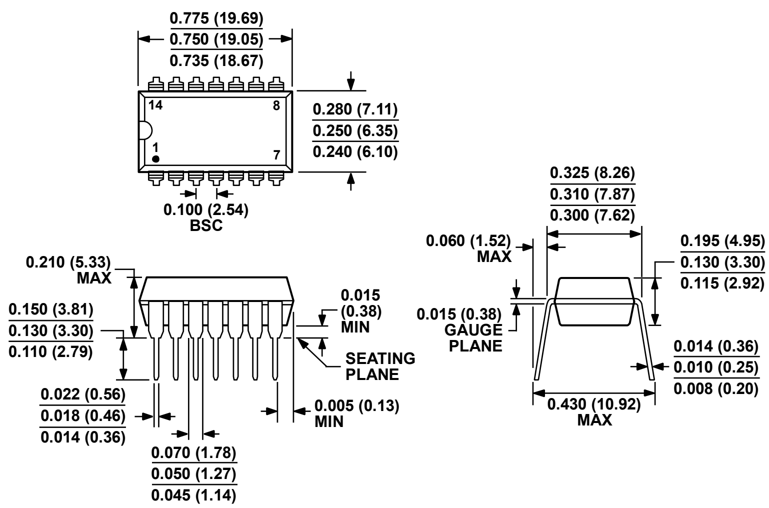
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken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

OUTLINE DIMENSIONS



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.

Figure 35. 14-Lead Ceramic Dual In-Line Package [CERDIP]
(Q-14)
[Y-Suffix]
Dimensions shown in inches and (millimeters)



COMPLIANT TO JEDEC STANDARDS MS-001
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.
CORNER LEADS MAY BE CONFIGURED AS WHOLE OR HALF LEADS.

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Figure 36. 14-Lead Plastic Dual In-Line Package [PDIP]
(N-14)
[P-Suffix]
Dimensions shown in inches and (millimeters)

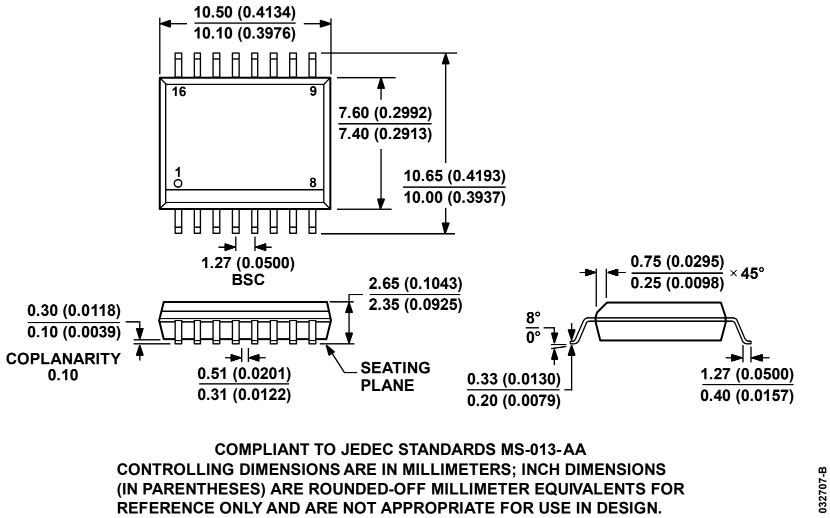

Figure 37. 16-Lead Standard Small Outline Package [SOIC_W]
Wide Body (RW-16)
[S-Suffix]
Dimensions shown in millimeters and (inches)

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
OP400AY	−55°C to +125°C	14-Lead CERDIP	Y-Suffix (Q-14)
OP400EY	−25°C to +85°C	14-Lead CERDIP	Y-Suffix (Q-14)
OP400FY	−25°C to +85°C	14-Lead CERDIP	Y-Suffix (Q-14)
OP400GP	0°C to +70°C	14-Lead PDIP	P-Suffix (N-14)
OP400GPZ[1]	0°C to +70°C	14-Lead PDIP	P-Suffix (N-14)
OP400HP	−40°C to +85°C	14-Lead PDIP	P-Suffix (N-14)
OP400HPZ[1]	−40°C to +85°C	14-Lead PDIP	P-Suffix (N-14)
OP400GS	0°C to +70°C	16-Lead SOIC_W	S-Suffix (RW-16)
OP400GS-REEL	0°C to +70°C	16-Lead SOIC_W	S-Suffix (RW-16)
OP400GSZ[1]	0°C to +70°C	16-Lead SOIC_W	S-Suffix (RW-16)
OP400GSZ-REEL[1]	0°C to +70°C	16-Lead SOIC_W	S-Suffix (RW-16)
OP400HS	−40°C to +85°C	16-Lead SOIC_W	S-Suffix (RW-16)
OP400HS-REEL	−40°C to +85°C	16-Lead SOIC_W	S-Suffix (RW-16)
OP400HSZ[1]	−40°C to +85°C	16-Lead SOIC_W	S-Suffix (RW-16)
OP400HSZ-REEL[1]	−40°C to +85°C	16-Lead SOIC_W	S-Suffix (RW-16)
OP400GBC		Die	

[1] Z = RoHS Compliant Part.

SMD PARTS AND EQUIVALENTS

SMD Part Number[1]	Analog Devices Equivalent
5962-8777101M3A	OP400ATCMDA
5962-8777101MCA	OP400AYMDA

[1] For military processed devices, please refer to the standard microcircuit drawing (SMD) available at the Defense Supply Center Columbus website.