Precision Low Noise, Low Input Bias Current Operational Amplifiers

OP1177/OP2177/OP4177

FEATURES

- Low offset voltage: 60 µV maximum
- Very low offset voltage drift: 0.7 µV/°C maximum
- Low input bias current: 2 nA maximum
- Low noise: 8 nV/√Hz typical
- CMRR, PSRR, and A_{VO} > 120 dB minimum
- Low supply current: 400 µA per amplifier
- Dual supply operation: ±2.5 V to ±15 V
- Unity-gain stable
- No phase reversal
- Inputs internally protected beyond supply voltage

APPLICATIONS

- Wireless base station control circuits
- Optical network control circuits
- Instrumentation
- Sensors and controls
  - Thermocouples
  - Resistor thermal detectors (RTDs)
  - Strain bridges
  - Shunt current measurements
- Precision filters

PIN CONFIGURATIONS

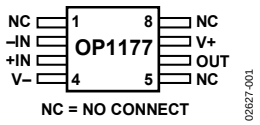


Figure 1. 8-Lead MSOP (RM Suffix)

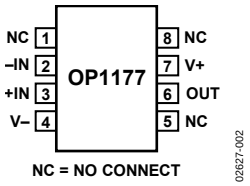


Figure 2. 8-Lead SOIC_N (R Suffix)

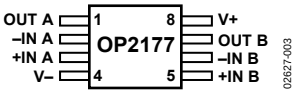


Figure 3. 8-Lead MSOP (RM Suffix)

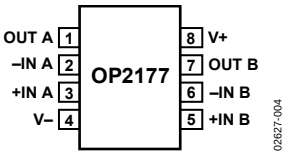


Figure 4. 8-Lead SOIC_N (R Suffix)

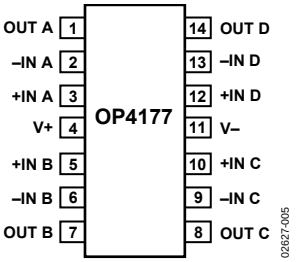


Figure 5. 14-Lead SOIC_N (R Suffix)

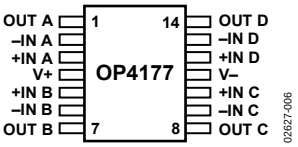


Figure 6. 14-Lead TSSOP (RU Suffix)

GENERAL DESCRIPTION

The OPx177 family consists of very high precision, single, dual, and quad amplifiers featuring extremely low offset voltage and drift, low input bias current, low noise, and low power consumption. Outputs are stable with capacitive loads of over 1000 pF with no external compensation. Supply current is less than 500 µA per amplifier at 30 V. Internal 500 Ω series resistors protect the inputs, allowing input signal levels several volts beyond either supply without phase reversal.

Unlike previous high voltage amplifiers with very low offset voltages, the OP1177 (single) and OP2177 (dual) amplifiers are available in tiny 8-lead surface-mount MSOP and 8-lead narrow SOIC packages. The OP4177 (quad) is available in TSSOP and 14-lead narrow SOIC packages. Moreover, specified performance in the MSOP and the TSSOP is identical to performance in the SOIC package. MSOP and TSSOP are available in tape and reel only.

The OPx177 family offers the widest specified temperature range of any high precision amplifier in surface-mount packaging. All versions are fully specified for operation from −40°C to +125°C for the most demanding operating environments.

Applications for these amplifiers include precision diode power measurement, voltage and current level setting, and level detection in optical and wireless transmission systems. Additional applications include line-powered and portable instrumentation and controls—thermocouple, RTD, strain-bridge, and other sensor signal conditioning—and precision filters.

SPECIFICATIONS

ELECTRICAL CHARACTERISTICS

V_S = ±5.0 V, V_{CM} = 0 V, T_A = 25°C, unless otherwise noted.

Table 1.

Parameter	Symbol	Conditions	Min	Typ[1]	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage						
OP1177	V_{OS}			15	60	µV
OP2177/OP4177	V_{OS}			15	75	µV
OP1177/OP2177	V_{OS}	−40°C < T_A < +125°C		25	100	µV
OP4177	V_{OS}	−40°C < T_A < +125°C		25	120	µV
Input Bias Current	I_B	−40°C < T_A < +125°C	−2	+0.5	+2	nA
Input Offset Current	I_{OS}	−40°C < T_A < +125°C	−1	+0.2	+1	nA
Input Voltage Range			−3.5		+3.5	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = −3.5 V to +3.5 V	120	126		dB
		−40°C < T_A < +125°C	118	125		dB
Large Signal Voltage Gain	A_{VO}	R_L = 2 kΩ, V_O = −3.5 V to +3.5 V	1000	2000		V/mV
Offset Voltage Drift						
OP1177/OP2177	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		0.2	0.7	µV/°C
OP4177	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		0.3	0.9	µV/°C
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	I_L = 1 mA, −40°C < T_A < +125°C	+4	+4.1		V
Output Voltage Low	V_{OL}	I_L = 1 mA, −40°C < T_A < +125°C		−4.1	−4	V
Output Current	I_{OUT}	$V_{DROPOUT}$ < 1.2 V		±10		mA
POWER SUPPLY						
Power Supply Rejection Ratio						
OP1177	PSRR	V_S = ±2.5 V to ±15 V	120	130		dB
		−40°C < T_A < +125°C	115	125		dB
OP2177/OP4177	PSRR	V_S = ±2.5 V to ±15 V	118	121		dB
		−40°C < T_A < +125°C	114	120		dB
Supply Current per Amplifier	I_{SY}	V_O = 0 V		400	500	µA
		−40°C < T_A < +125°C		500	600	µA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 2 kΩ		0.7		V/µs
Gain Bandwidth Product	GBP			1.3		MHz
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz		0.4		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		7.9	8.5	nV/√Hz
Current Noise Density	i_n	f = 1 kHz		0.2		pA/√Hz
MULTIPLE AMPLIFIERS CHANNEL SEPARATION	C_S	DC		0.01		µV/V
		f = 100 kHz		−120		dB

[1] Typical values cover all parts within one standard deviation of the average value. Average values given in many competitor data sheets as typical give unrealistically low estimates for parameters that can have both positive and negative values.

ELECTRICAL CHARACTERISTICS

V_S = ±15 V, V_{CM} = 0 V, T_A = 25°C, unless otherwise noted.

Table 2.

Parameter	Symbol	Conditions	Min	Typ[1]	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage						
OP1177	V_{OS}			15	60	µV
OP2177/OP4177	V_{OS}			15	75	µV
OP1177/OP2177	V_{OS}	−40°C < T_A < +125°C		25	100	µV
OP4177	V_{OS}	−40°C < T_A < +125°C		25	120	µV
Input Bias Current	I_B	−40°C < T_A < +125°C	−2	+0.5	+2	nA
Input Offset Current	I_{OS}	−40°C < T_A < +125°C	−1	+0.2	+1	nA
Input Voltage Range			−13.5		+13.5	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = −13.5 V to +13.5 V,				
		−40°C < T_A < +125°C	120	125		dB
Large Signal Voltage Gain	A_{VO}	R_L = 2 kΩ, V_O = −13.5 V to +13.5 V	1000	3000		V/mV
Offset Voltage Drift						
OP1177/OP2177	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		0.2	0.7	µV/°C
OP4177	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		0.3	0.9	µV/°C
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	I_L = 1 mA, −40°C < T_A < +125°C	+14	+14.1		V
Output Voltage Low	V_{OL}	I_L = 1 mA, −40°C < T_A < +125°C		−14.1	−14	V
Output Current	I_{OUT}	$V_{DROPOUT}$ < 1.2 V		±10		mA
Short-Circuit Current	I_{SC}			±25		mA
POWER SUPPLY						
Power Supply Rejection Ratio						
OP1177	PSRR	V_S = ±2.5 V to ±15 V	120	130		dB
		−40°C < T_A < +125°C	115	125		dB
OP2177/OP4177	PSRR	V_S = ±2.5 V to ±15 V	118	121		dB
		−40°C < T_A < +125°C	114	120		dB
Supply Current per Amplifier	I_{SY}	V_O = 0 V		400	500	µA
		−40°C < T_A < +125°C		500	600	µA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 2 kΩ		0.7		V/µs
Gain Bandwidth Product	GBP			1.3		MHz
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz		0.4		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		7.9	8.5	nV/√Hz
Current Noise Density	i_n	f = 1 kHz		0.2		pA/√Hz
MULTIPLE AMPLIFIERS CHANNEL SEPARATION	C_S	DC		0.01		µV/V
		f = 100 kHz		−120		dB

[1] Typical values cover all parts within one standard deviation of the average value. Average values given in many competitor data sheets as typical give unrealistically low estimates for parameters that can have both positive and negative values.

ABSOLUTE MAXIMUM RATINGS

Table 3.

Parameter	Rating
Supply Voltage	36 V
Input Voltage	V_{S-} to V_{S+}
Differential Input Voltage	±Supply Voltage
Storage Temperature Range	
R, RM, and RU Packages	−65°C to +150°C
Operating Temperature Range	
OP1177/OP2177/OP4177	−40°C to +125°C
Junction Temperature Range	
R, RM, and RU Packages	−65°C to +150°C
Lead Temperature, Soldering (10 sec)	300°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.

THERMAL RESISTANCE

θ_{JA} is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages.

Table 4. Thermal Resistance

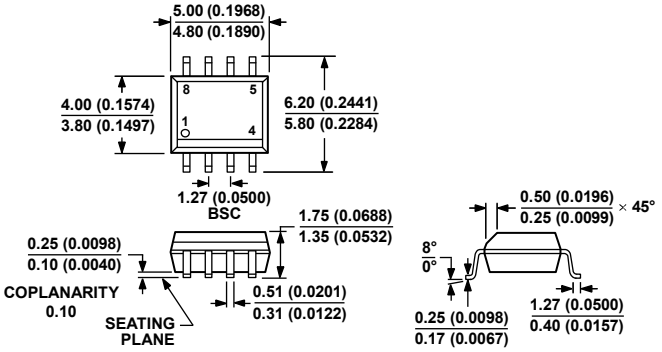
Package Type	θ_{JA}	θ_{JC}	Unit
8-Lead MSOP (RM-8)[1]	190	44	°C/W
8-Lead SOIC_N (R-8)	158	43	°C/W
14-Lead SOIC_N (R-14)	120	36	°C/W
14-Lead TSSOP (RU-14)	240	43	°C/W

[1] MSOP is available in tape and reel only.

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



COMPLIANT TO JEDEC STANDARDS MS-012-AA

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.

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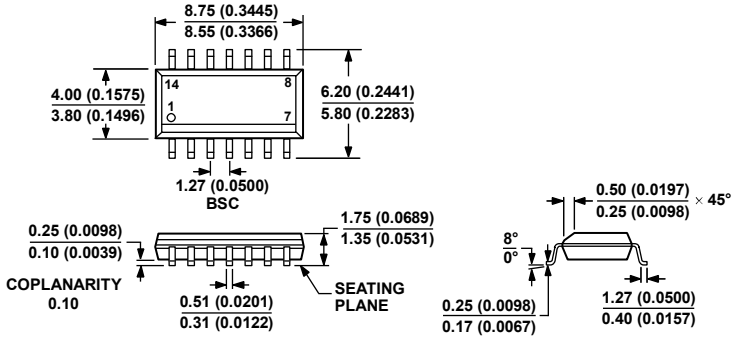
Figure 69. 8-Lead Standard Small Outline Package [SOIC_N]
Narrow Body
(R-8)
Dimensions shown in millimeters and (inches)



COMPLIANT TO JEDEC STANDARDS MS-012-AB

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.

060606-A

Figure 70. 14-Lead Standard Small Outline Package [SOIC_N]
Narrow Body
(R-14)
Dimensions shown in millimeters and (inches)

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option	Branding
OP1177AR	−40°C to +125°C	8-Lead SOIC_N	R-8	
OP1177AR-REEL	−40°C to +125°C	8-Lead SOIC_N	R-8	
OP1177AR-REEL7	−40°C to +125°C	8-Lead SOIC_N	R-8	
OP1177ARZ[1]	−40°C to +125°C	8-Lead SOIC_N	R-8	
OP1177ARZ-REEL[1]	−40°C to +125°C	8-Lead SOIC_N	R-8	
OP1177ARZ-REEL7[1]	−40°C to +125°C	8-Lead SOIC_N	R-8	
OP1177ARM-R2	−40°C to +125°C	8-Lead MSOP	RM-8	AZA
OP1177ARM-REEL	−40°C to +125°C	8-Lead MSOP	RM-8	AZA
OP1177ARMZ-R2[1]	−40°C to +125°C	8-Lead MSOP	RM-8	AZA#
OP1177ARMZ-REEL[1]	−40°C to +125°C	8-Lead MSOP	RM-8	AZA#
OP2177AR	−40°C to +125°C	8-Lead SOIC_N	R-8	
OP2177AR-REEL	−40°C to +125°C	8-Lead SOIC_N	R-8	
OP2177AR-REEL7	−40°C to +125°C	8-Lead SOIC_N	R-8	
OP2177ARZ[1]	−40°C to +125°C	8-Lead SOIC_N	R-8	
OP2177ARZ-REEL[1]	−40°C to +125°C	8-Lead SOIC_N	R-8	
OP2177ARZ-REEL7[1]	−40°C to +125°C	8-Lead SOIC_N	R-8	
OP2177ARM-R2	−40°C to +125°C	8-Lead MSOP	RM-8	B2A
OP2177ARM-REEL	−40°C to +125°C	8-Lead MSOP	RM-8	B2A
OP2177ARMZ-R2[1]	−40°C to +125°C	8-Lead MSOP	RM-8	B2A#
OP2177ARMZ-REEL[1]	−40°C to +125°C	8-Lead MSOP	RM-8	B2A#
OP4177AR	−40°C to +125°C	14-Lead SOIC_N	R-14	
OP4177AR-REEL	−40°C to +125°C	14-Lead SOIC_N	R-14	
OP4177AR-REEL7	−40°C to +125°C	14-Lead SOIC_N	R-14	
OP4177ARZ[1]	−40°C to +125°C	14-Lead SOIC_N	R-14	
OP4177ARZ-REEL[1]	−40°C to +125°C	14-Lead SOIC_N	R-14	
OP4177ARZ-REEL7[1]	−40°C to +125°C	14-Lead SOIC_N	R-14	
OP4177ARU	−40°C to +125°C	14-Lead TSSOP	RU-14	
OP4177ARU-REEL	−40°C to +125°C	14-Lead TSSOP	RU-14	
OP4177ARUZ[1]	−40°C to +125°C	14-Lead TSSOP	RU-14	
OP4177ARUZ-REEL[1]	−40°C to +125°C	14-Lead TSSOP	RU-14	

[1] Z = RoHS Compliant Part; # denotes Pb-free product may be top or bottom marked.