19-2772; Rev 2; 10/95

MAXIM

High-Precision, Low-Voltage, Micropower Operational Amplifier

General Description

Maxim's MAX480 is a precision micropower operational amplifier with flexible power-supply capability and superior DC performance characteristics over the industry-standard OP90. The MAX480's guaranteed 140µV maximum offset voltage (25µV typ) is the lowest of any other micropower op amp. This represents an improvement over the highest grade OP90A. Similarly, input bias current, input offset current, and drift specifications are improved over the OP90 family.

Both input and output voltage ranges include the negative supply rail, allowing maximum signal range capability in single-supply applications. The MAX480 operates with either single supplies ranging from +1.6V to +36V or dual supplies from ±0.8V to ±18V. The MAX480 consumes less than 20µA, allowing operation in excess of 10,000 hours from a 250mA-hr lithium coin cell. Even with a minimal quiescent current, the amplifier sinks or sources 5mA from its output.

MAX480 is available in 8-pin DIP and Narrow Small Outline (SO) packages in commercial, extended, and military temperature ranges.

Applications

Precision Micropower Amplifiers

Micropower Signal Processing

Battery-Powered Analog Circuits

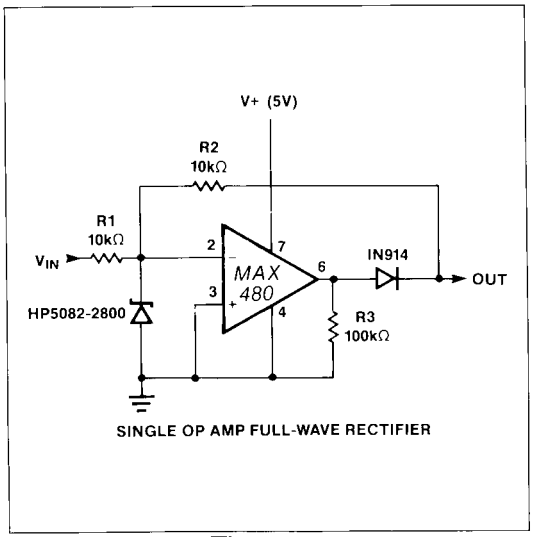
Features

- ♦ **Single- or Dual-Supply Operation: +1.6V to +36V, ±0.8V to ±18V**
- ♦ **True Single-Supply Operation: Input and Output Voltage Ranges Include Ground**
- ♦ **2.0µV/°C Max Offset Voltage Drift**
- ♦ **20µA Max Supply Current**
- ♦ **5mA Min Output Drive**
- ♦ **140µV Max Input Offset Voltage**
- ♦ **3nA Max Input Bias Current**
- ♦ **700V/mV Min Open-Loop Gain**
- ♦ **Standard 741 Pin Out With Nulling to V-**
- ♦ **Improved OP90 Replacement**

Ordering Information

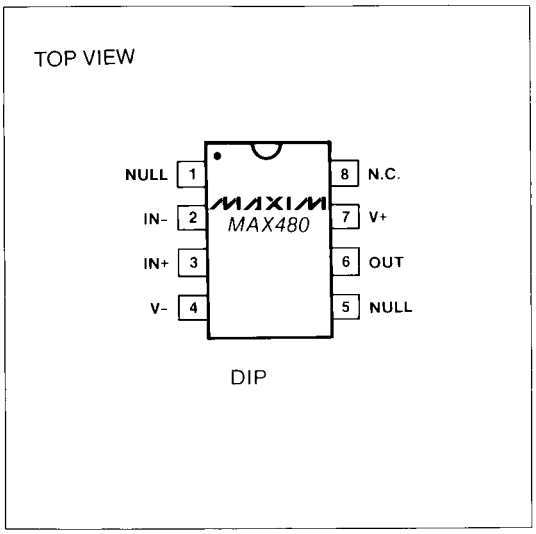
PART	TEMP. RANGE	PIN-PACKAGE
MAX480CPA	0°C to +70°C	8 Plastic DIP
MAX480CSA	0°C to +70°C	8 Narrow SO
MAX480EPA	-40°C to +85°C	8 Plastic DIP
MAX480ESA	-40°C to +85°C	8 Narrow SO
MAX480MJA	-55°C to +125°C	8 CERDIP

Typical Operating Circuit



SINGLE OP AMP FULL-WAVE RECTIFIER

Pin Configuration



High-Precision, Low-Voltage, Micropower Operational Amplifier

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (V+ to V-) ..... ±18V
Differential Input Voltage ..... [(V-)-20V] to [(V+)+20V]
Common-Mode Input Voltage ..... [(V-)-20V] to [(V+)+20V]
Output Short-Circuit Duration ..... Indefinite
Continuous Power Dissipation
CERDIP (J)—derate at 8.0mW/°C above +70°C 640mW
Plastic DIP (P)—derate at 9.09mW/°C above +70°C 727mW
Small Outline (S)—derate at 5.88mW/°C above +70°C ... 471mW

Operating Temperature Ranges:
MAX480 (CPA, CSA) ..... 0°C to +70°C
MAX480 (EPA, ESA) ..... -40°C to +85°C
MAX480MJA ..... -55°C to +125°C
Junction Temperature (T_J) ..... -65°C to +150°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (Soldering, 10sec) ..... +300°C

Note 1: Absolute maximum ratings apply to packaged parts, unless otherwise noted.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_S = ±1.5V to ±15V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	V_{OS}			25	140	µV
Input Offset Current	I_{OS}	V_{CM} = 0V		0.2	1	nA
Input Bias Current	I_B	V_{CM} = 0V		1	3	nA
Large Signal Voltage Gain	A_{VO}	V_S = ±15V, V_O = ±10V R_L = 100kΩ R_L = 10kΩ R_L = 2kΩ	 700 300 100	 1200 600 250		V/mV
		V+ = 5V, V- = 0V, 1V<V_O<4V R_L = 100kΩ R_L = 10kΩ	 200 100	 400 180		
Input Voltage	IVR	V+ = 5V, V- = 0V V_S = ±15V (Note 2)	0/4 -15/13.5			V
Output Voltage Swing	V_O	V_S = ±15V R_L = 10kΩ R_L = 2kΩ	 ±14 ±11	 ±14.2 ±12		V
	V_{OH}	V+ = 5V, V- = 0V, R_L = 2kΩ	4.0	4.2		
	V_{OL}	V+ = 5V, V- = 0V, R_L = 10kΩ		100	500	µV
Common-Mode Rejection Ratio	CMRR	V+ = 5V, V- = 0V, 0V<V_{CM}<4V V_S = ±15V, -15V<V_{CM}<13.5V	90 100	110 130		dB
Power-Supply Rejection Ratio	PSRR			1.0	5.6	µV/V
Slew Rate	SR	V_S = ±15V	5	12		V/ms
Supply Current	I_{SY}	V_S = ±1.5V V_S = ±15V		9 14	15 20	µA
Capacitive Load Stability		A_V = +1, No Oscillations (Note 3)	250	650		pF
Input Noise Voltage	e_{np-p}	f_O = 0.1Hz to 10Hz, V_S = ±15V		3		$µV_{p-p}$
Input Resistance Differential Mode	R_{IN}	V_S = ±15V		30		MΩ
Input Resistance Common Mode	R_{INCM}	V_S = ±15V		20		GΩ

ELECTRICAL CHARACTERISTICS

(V_S = ±1.5V to ±15V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

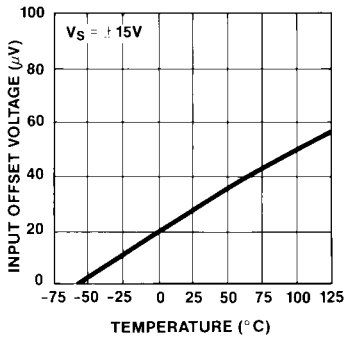
PARAMETER	SYMBOL	CONDITIONS	MAX480C			MAX480E			MAX480M			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}			40	220		50	250		70	300	µV
Input Offset Voltage Drift	TCV_{OS}	(Note 3)		0.3	2.0		0.3	2.0		0.3	2.0	µV/°C
Input Offset Current	I_{OS}	V_{CM} = 0V		0.2	2.0		0.3	2.0		0.5	2.0	nA
Input Bias Current	I_B	V_{CM} = 0V		1	3		2	5		3	7	nA
Large Signal Voltage Gain	A_{VO}	V_S = ±15V, V = ±10V R_L = 100kΩ R_L = 10kΩ R_L = 2kΩ	500 200 75	950 400 125		500 200 75	800 400 150		180 100 50	400 240 110		V/mV
		V+ = 5V, V− = 0V, 1V<V_O<4V R_L = 100kΩ R_L = 10kΩ	 150 75	 360 150		 150 75	 280 140		 75 50	 200 110		
Input Voltage Range	IVR	V+ = 5V, V− = 0V V_S = ±15V (Note 2)	0/3.5 -15/13.5			0/3.5 -15/13.5			0/3.5 -15/13.5			V
Output Voltage Swing	V_O	V_S = ±15V R_L = 10kΩ R_L = 2kΩ	±13.5 ±10.5	±14 ±11.8		±13.5 ±10.5	+14 ±11.8		±13.5 ±10.5	±13.7 +11.5		V
	V_{OH}	V+ = 5V, V− = 0V R_L = 2kΩ	3.9	4.1		3.9	4.1		3.9	4.1		
	V_{OL}	V+ = 5V, V− = 0V R_L = 10kΩ		100	500		100	500		100	500	µV
Common-Mode Rejection Ratio	CMRR	V+ = 5V, V− = 0V, 0V<V_{CM}<3.5V V_S = ±15V, -15V<V_{CM}<13.5V	90 100	110 120		90 100	110 120		85 95	105 115		dB
Power-Supply Rejection Ratio	PSRR			1.0	5.6		1.0	5.6		3.2	10	µV/V
Supply Current	Isy	V_S = ±1.5V V_S = ±15V		12 16	25 30		13 17	25 30		15 19	25 30	µA

Note 2: Guaranteed by CMRR test.
Note 3: Guaranteed by design.

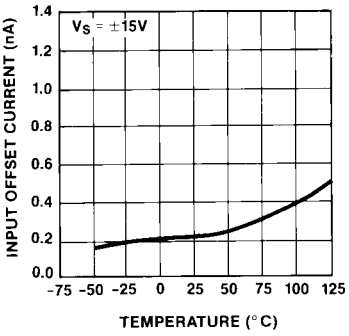
High-Precision, Low-Voltage, Micropower Operational Amplifier

Typical Operating Characteristics

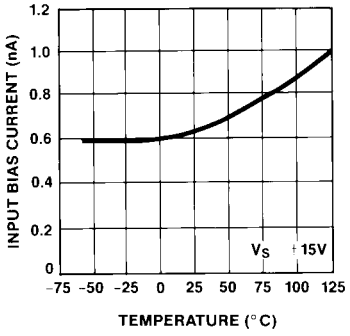
INPUT OFFSET VOLTAGE vs TEMPERATURE



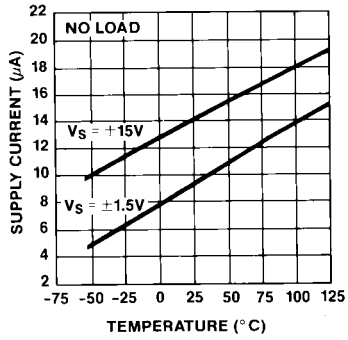
INPUT OFFSET CURRENT vs TEMPERATURE



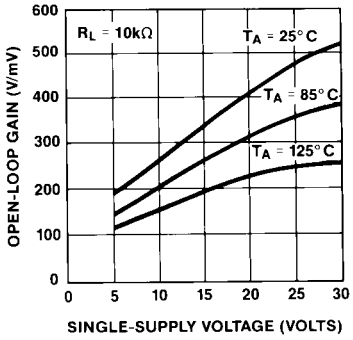
INPUT BIAS CURRENT vs TEMPERATURE



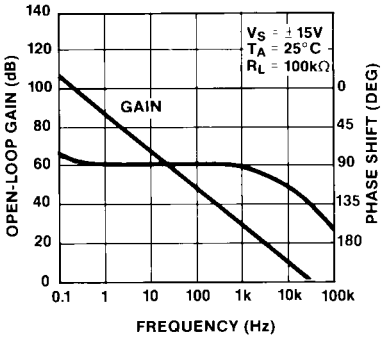
SUPPLY CURRENT vs TEMPERATURE



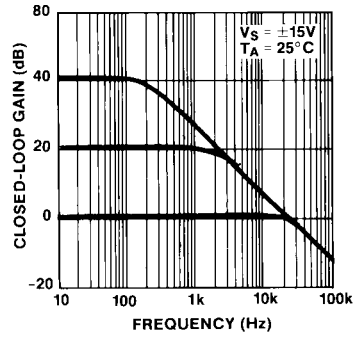
OPEN-LOOP GAIN vs SINGLE-SUPPLY VOLTAGE



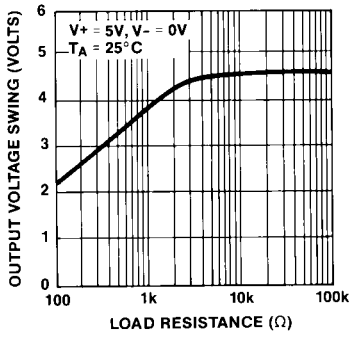
OPEN-LOOP GAIN AND PHASE SHIFT vs FREQUENCY



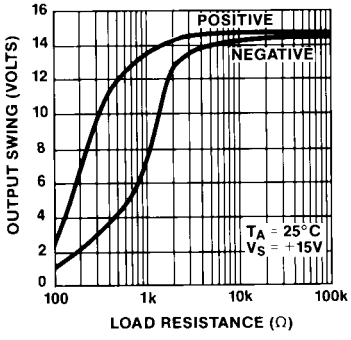
CLOSED-LOOP GAIN vs FREQUENCY



OUTPUT VOLTAGE SWING vs LOAD RESISTANCE

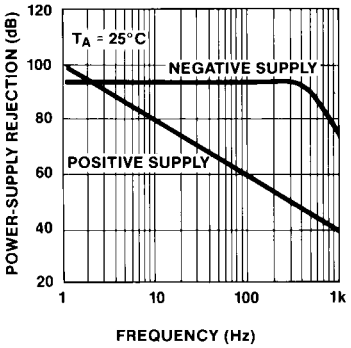


OUTPUT VOLTAGE SWING vs LOAD RESISTANCE

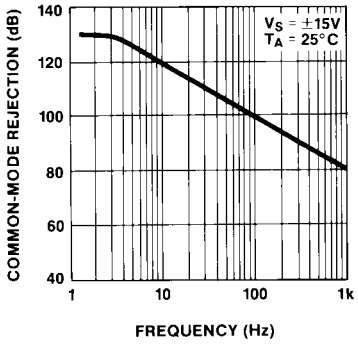


Typical Operating Characteristics (continued)

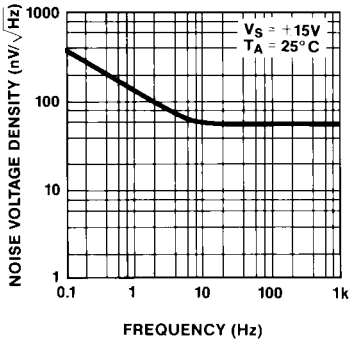
POWER-SUPPLY REJECTION RATIO vs FREQUENCY



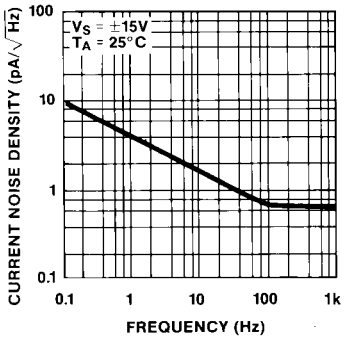
COMMON-MODE REJECTION RATIO vs FREQUENCY



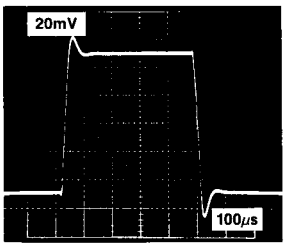
NOISE VOLTAGE DENSITY vs FREQUENCY



CURRENT NOISE DENSITY vs FREQUENCY

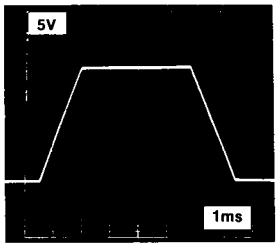


SMALL SIGNAL TRANSIENT RESPONSE



T_A = 25°C
V_S = ±15V
A_V = +1
R_L = 10kΩ
C_L = 500pF

LARGE SIGNAL TRANSIENT RESPONSE



T_A = 25°C
V_S = +15V
A_V = +1
R_L = 10kΩ
C_L = 500pF

High-Precision, Low-Voltage, Micropower Operational Amplifier

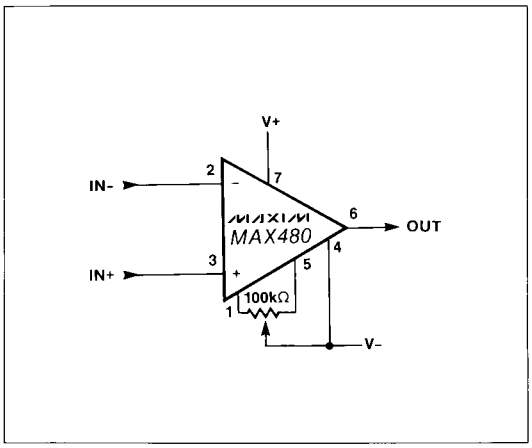


Figure 1. Offset Nulling Circuit

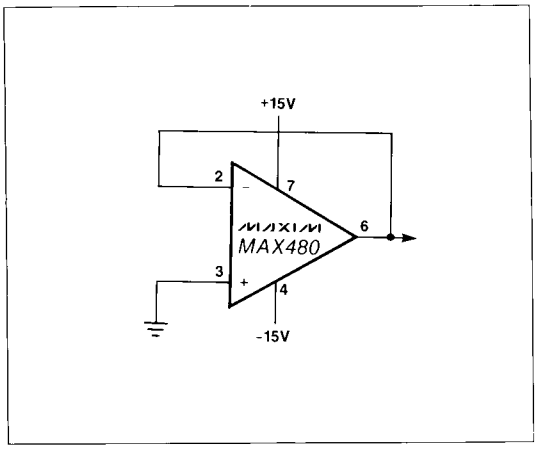
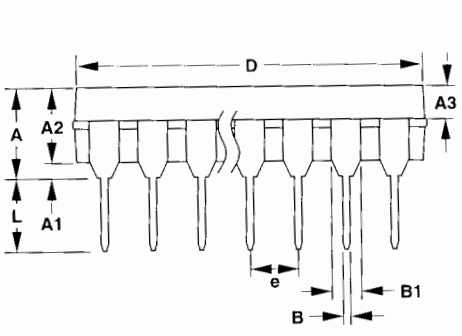


Figure 2. Burn-In Circuit

High-Precision, Low-Voltage, Micropower Operational Amplifier

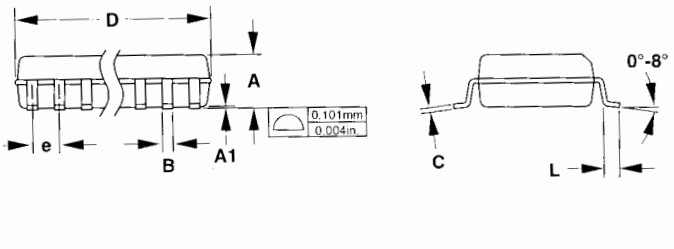
Package Information



Plastic DIP
PLASTIC
DUAL-IN-LINE
PACKAGE
(0.300 in.)

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	–	0.200	–	5.08
A1	0.015	–	0.38	–
A2	0.125	0.175	3.18	4.45
A3	0.055	0.080	1.40	2.03
B	0.016	0.022	0.41	0.56
B1	0.045	0.065	1.14	1.65
C	0.008	0.012	0.20	0.30
D1	0.005	0.080	0.13	2.03
E	0.300	0.325	7.62	8.26
E1	0.240	0.310	6.10	7.87
e	0.100	–	2.54	–
eA	0.300	–	7.62	–
eB	–	0.400	–	10.16
L	0.115	0.150	2.92	3.81

DIM	PINS	INCHES		MILLIMETERS	
		MIN	MAX	MIN	MAX
D	8	0.348	0.390	8.84	9.91
D	14	0.735	0.765	18.67	19.43
D	16	0.745	0.765	18.92	19.43
D	18	0.885	0.915	22.48	23.24
D	20	1.015	1.045	25.78	26.54
D	24	1.14	1.265	28.96	32.13



SO
SMALL OUTLINE
PACKAGE
(0.150 in.)

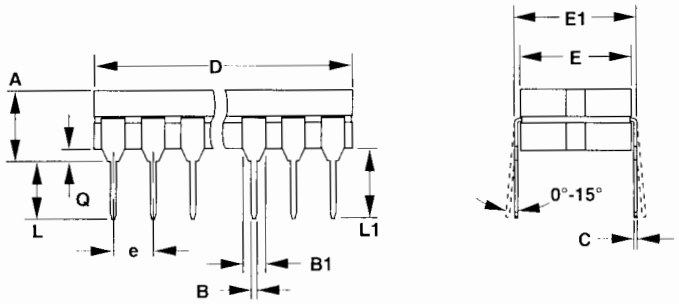
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
E	0.150	0.157	3.80	4.00
e	0.050		1.27	
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27

DIM	PINS	INCHES		MILLIMETERS	
		MIN	MAX	MIN	MAX
D	8	0.189	0.197	4.80	5.00
D	14	0.337	0.344	8.55	8.75
D	16	0.386	0.394	9.80	10.00

21-0041A

High-Precision, Low-Voltage, Micropower Operational Amplifier

Package Information (continued)



CERDIP
CERAMIC DUAL-IN-LINE
PACKAGE
(0.300 in.)

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	–	0.200	–	5.08
B	0.014	0.023	0.36	0.58
B1	0.038	0.065	0.97	1.65
C	0.008	0.015	0.20	0.38
E	0.220	0.310	5.59	7.87
E1	0.290	0.320	7.37	8.13
e	0.100		2.54	
L	0.125	0.200	3.18	5.08
L1	0.150	–	3.81	–
Q	0.015	0.070	0.38	1.78
S	–	0.098	–	2.49
S1	0.005	–	0.13	–

DIM	PINS	INCHES		MILLIMETERS	
		MIN	MAX	MIN	MAX
D	8	–	0.405	–	10.29
D	14	–	0.785	–	19.94
D	16	–	0.840	–	21.34
D	18	–	0.960	–	24.38
D	20	–	1.060	–	26.92
D	24	–	1.280	–	32.51