Precision Low Voltage Micropower Operational Amplifier

General Description

The OP90 is a precision bipolar micropower operational amplifier with flexible power supply capability. Both the input voltage range and output voltage swing of the OP90 include the negative rail, allowing "ground-sensing" operation when the part is driven from a single positive voltage supply. The OP90 will accept a single power supply voltage of any value in the range +1.6V to +36V. Alternatively, the amplifier can be operated from dual power supplies in the range of ±0.8V to ±18V.

Unlike most other micropower operational amplifiers, the OP90 requires no external current setting resistor, and consumes less than 20μA of quiescent current, allowing operation from a lithium battery of greater than 10,000 hours. Even with this minimal current consumption, the amplifier can sink or source 5mA of current into the load.

Every OP90 (A/E grade) is internally trimmed to guarantee an input offset voltage of less than 150μV. This eliminates the need for external nulling in most applications, although null pins are provided if required. The guaranteed minimum open loop gain of 700,000 together with power supply rejection ratio of 5.6μV/V and common-mode rejection ratio of 100dB allow the OP90 to be used in applications requiring low power operation together with precision performance.

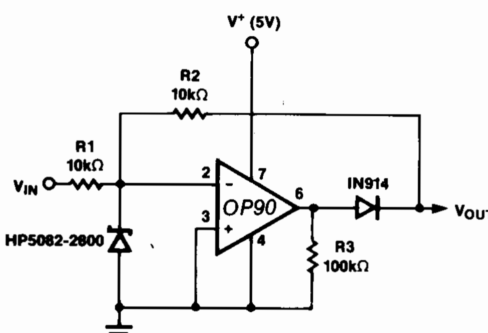
Applications

Precision Micropower Amplifiers

Micropower Signal Processing

Battery Powered Analog Circuits

Typical Operating Circuit



SINGLE OP AMP FULL-WAVE RECTIFIER

Features

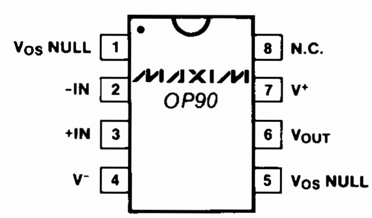
- **Single/Dual Supply Operation: +1.6V to +36V, ±0.8V to ±18V**
- **True Single-Supply Operation: Input and Output Voltage Ranges Include Ground**
- **Low Supply Current: 20μA Max**
- **High Output Drive: 5mA Min**
- **Low Input Offset Voltage: 150μV Max**
- **High Open Loop Gain: 700V/mV Min**
- **High PSRR: 5.6μV/V Max**
- **Standard 741 Pin Out With Nulling to V⁻**

Ordering Information

PART	TEMP. RANGE	PACKAGE
OP90AZ	-55°C to +125°C	8 Lead CERDIP
OP90EZ	-25°C to +85°C	8 Lead CERDIP
OP90FZ	-25°C to +85°C	8 Lead CERDIP
OP90GP	0°C to +70°C	8 Lead Plastic DIP
OP90GS	0°C to +70°C	8 Lead SO
OP90GC/D	0°C to +70°C	Dice

Pin Configuration

TOP VIEW



8 LEAD DIP/CERDIP/SO

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ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (V^+ to V^-) .... ±18V
Internal Power Dissipation 500mW
  Hermetic DIP (Z) — derate at 7.1mW/°C above +80°C
  Plastic DIP (P) — derate at 5.6mW/°C above +36°C
  Small Outline (S) — derate at 5mW/°C above +55°C
Differential Input Voltage .... [(V^-)-20V] to [(V^+)+20V]
Common Mode Input Voltage .... [(V^-)-20V] to [(V^+)+20V]
Output Short Circuit Duration .... Indefinite

Storage Temperature Range .... -65°C to +150°C
Operating Temperature Range
  OP90A .... -55°C to +125°C
  OP90E, OP90F .... -25°C to +85°C
  OP90G .... 0°C to +70°C
Junction Temperature (T_J) .... -65°C to +160°C
Lead Temperature (Soldering, 10 sec) .... +300°C

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

Stresses above 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 above 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	OP90A/E			OP90F			OP90G			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}			50	150		75	250		125	450	µV
Input Offset Current	I_{OS}	V_{CM} = 0V		0.4	3		0.4	5		0.4	5	nA
Input Bias Current	I_B	V_{CM} = 0V		4.0	15		4.0	20		4.0	25	nA
Large Signal Voltage Gain	A_{VO}	V_S = ±15V, V_O = ±10V R_L = 100kΩ R_L = 10kΩ R_L = 2kΩ	 700 350 125	 1200 600 250		 500 250 100	 1000 500 200		 400 200 100	 800 400 200		V/mV
		V^+ = 5V, V^- = 0V, 1V<V_O<4V R_L = 100kΩ R_L = 10kΩ	 200 100	 400 180		 125 75	 300 140		 100 70	 250 140		
Input Voltage Range	IVR	V^+ = 5V, V^- = 0V V_S = ±15V (Note 2)	0/4 -15/13.5			0/4 -15/13.5			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		 ±14 ±11	 ±14.2 ±12		 ±14 ±11	 ±14.2 ±12		V
	V_{OH}	V^+ = 5V, V^- = 0V R_L = 2kΩ	4.0	4.2		4.0	4.2		4.0	4.2		V
	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}<4V V_S = ±15V, -15V<V_{CM}<13.5V	90 100	110 130		80 90	100 120		80 90	100 120		dB
Power Supply Rejection Ratio	PSRR			1.0	5.6		1.0	5.6		3.2	10	µV/V
Slew Rate	SR	V_S = ±15V	5	12		5	12		5	12		V/ms
Supply Current	I_{SY}	V_S = ±1.5V V_S = ±15V		9 14	15 20		9 14	15 20		9 14	15 20	µA
Capacitive Load Stability		A_V = +1 No Oscillations (Note 3)	250	650		250	650		250	650		pF

ELECTRICAL CHARACTERISTICS (continued)

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

PARAMETER	SYMBOL	CONDITIONS	OP90A/E			OP90F			OP90G			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Input Noise Voltage	e_{np-p}	f_O = 0.1Hz to 10Hz V_S = ±15V		3			3			3		μV_{p-p}
Input Resistance Differential Mode	R_{IN}	V_S = ±15V		30			30			30		MΩ
Input Resistance Common Mode	R_{INCM}	V_S = ±15V		20			20			20		GΩ

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

ELECTRICAL CHARACTERISTICS

(V_S = ±1.5V to ±15V, -55°C ≤ T_A ≤ 125°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	OP90A			UNITS
			MIN	TYP	MAX	
Input Offset Voltage	V_{OS}			80	400	µV
Average Input Offset Voltage Drift	TCV_{OS}			0.3	2.5	µV/°C
Input Offset Current	I_{OS}	V_{CM} = 0V		1.5	5	nA
Input Bias Current	I_B	V_{CM} = 0V		4.0	20	nA
Large Signal Voltage Gain	A_{VO}	V_S = ±15V, V_O = ±10V R_L = 100kΩ R_L = 10kΩ R_L = 2kΩ	 225 125 50	 400 240 110		V/mV
		V^+ = 5V, V^- = 0V, 1V<V_O<4V R_L = 100kΩ R_L = 10kΩ	 100 50	 200 110		
Input Voltage Range	IVR	V^+ = 5V, V^- = 0V V_S = ±15V (Note 4)	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	 ±13.7 ±11.5		V
	V_{OH}	V^+ = 5V, V^- = 0V R_L = 2kΩ	3.9	4.1		V
	V_{OL}	V^+ = 5V, V^- = 0V R_L = 10kΩ		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	85 95	105 115		dB
Power Supply Rejection Ratio	PSRR			3.2	10	µV/V
Supply Current	I_{SY}	V_S = ±1.5V V_S = ±15V		15 19	25 30	µA

Note 4: Guaranteed by CMRR test.

Precision Low Voltage Micropower Operational Amplifier

ELECTRICAL CHARACTERISTICS

(V_S = ±1.5V to ±15V, -25°C ≤ T_A ≤ 85°C for OP90E/F, 0°C ≤ T_A ≤ 70°C for OP90G, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	OP90E			OP90F			OP90G			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}			70	270		110	550		180	675	µV
Average Input Offset Voltage Drift	TCV_{OS}			0.3	2		0.6	5		1.2	5	µV/°C
Input Offset Current	I_{OS}	V_{CM} = 0V		0.8	3		1.0	5		1.3	7	nA
Input Bias Current	I_B	V_{CM} = 0V		4.0	15		4.0	20		4.0	25	nA
Large Signal Voltage Gain	A_{VO}	V_S = ±15V, V_O = ±10V R_L = 100kΩ R_L = 10kΩ R_L = 2kΩ	 500 250 100	 800 400 200		 350 175 75	 700 350 150		 300 150 75	 600 250 125		V/mV
		V^+ = 5V, V^- = 0V, 1V<V_O<4V R_L = 100kΩ R_L = 10kΩ	 150 75	 280 140		 100 50	 220 110		 80 40	 160 90		
Input Voltage Range	IVR	V^+ = 5V, V^- = 0V V_S = ±15V (Note 5)	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	 ±14 ±11.8		V
	V_{OH}	V^+ = 5V, V^- = 0V R_L = 2kΩ	3.9	4.1		3.9	4.1		3.9	4.1		V
	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		80 90	100 110		80 90	100 110		dB
Power Supply Rejection Ratio	PSRR			1.0	5.6		3.2	10		5.6	17.8	µV/V
Supply Current	I_{SY}	V_S = ±1.5V V_S = ±15V		13 17	25 30		13 17	25 30		12 16	25 30	µA

Note 5: Guaranteed by CMRR test.

WAFER TEST LIMITS

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

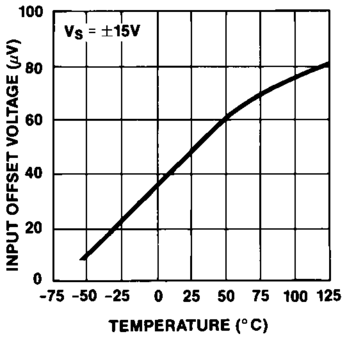
PARAMETER	SYMBOL	CONDITIONS	OP90GBC MIN	OP90GBC TYP	OP90GBC MAX	UNITS
Input Offset Voltage	V_{OS}				250	µV
Input Offset Current	I_{OS}	V_{CM} = 0V			5	nA
Input Bias Current	I_B	V_{CM} = 0V			20	nA
Large Signal Voltage Gain	A_{VO}	V_S = ±15V, V_O = ±10V R_L = 100kΩ R_L = 10kΩ	 500 250			V/mV
		V^+ = 5V, V^- = 0V, 1V<V_O<4V R_L = 100kΩ	 125			V/mV
Input Voltage Range	IVR	V^+ = 5V, V^- = 0V V_S = ±15V (Note 6)	0/4 -15/13.5			V
Output Voltage Swing	V_O	V_S = ±15V R_L = 10kΩ R_L = 2kΩ	 ±14 ±11			V
	V_{OH}	V^+ = 5V, V^- = 0V R_L = 2kΩ	 4.0			V
	V_{OL}	V^+ = 5V, V^- = 0V R_L = 10kΩ			 500	µV
Common Mode Rejection Ratio	CMRR	V^+ = 5V, V^- = 0V, 0V<V_{CM}<4V V_S = ±15V, -15V<V_{CM}<13.5V	80 90			dB
Power Supply Rejection Ratio	PSRR				10	µV/V
Supply Current	I_{SY}	V_S = ±15V			20	µA

Note 6: Guaranteed by CMRR test.

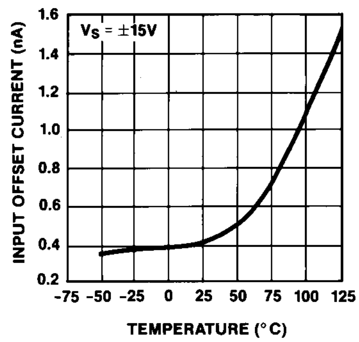
Electrical tests are performed at wafer probe to the limits shown. Due to variations in assembly methods and normal yield loss, yield after packaging is guaranteed for standard product dice. Consult factory to negotiate specifications based on dice lot qualification through sample lot assembly and testing.

Typical Operating Characteristics

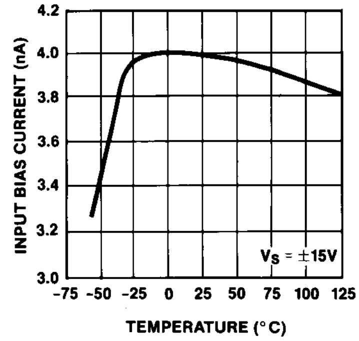
INPUT OFFSET VOLTAGE vs TEMPERATURE



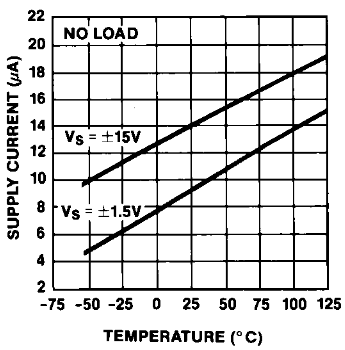
INPUT OFFSET CURRENT vs TEMPERATURE



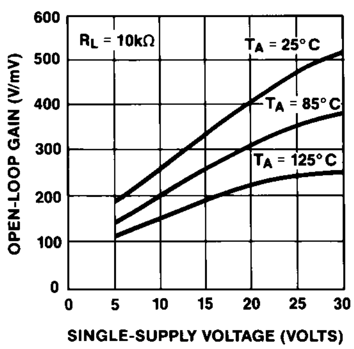
INPUT BIAS CURRENT vs TEMPERATURE



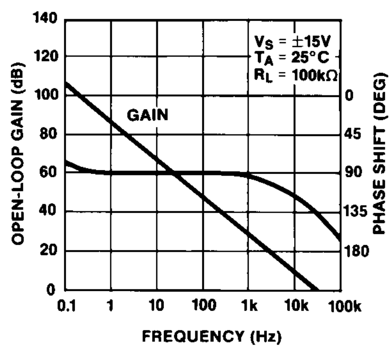
SUPPLY CURRENT vs TEMPERATURE



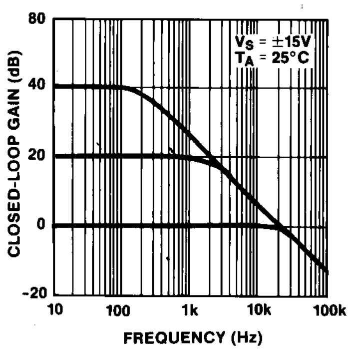
OPEN-LOOP GAIN vs SINGLE-SUPPLY VOLTAGE



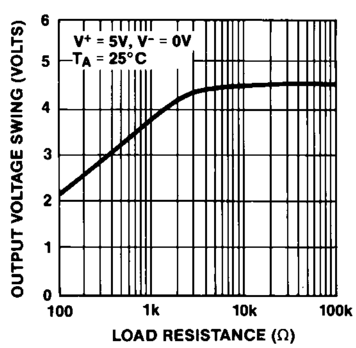
OPEN-LOOP GAIN AND PHASE SHIFT vs FREQUENCY



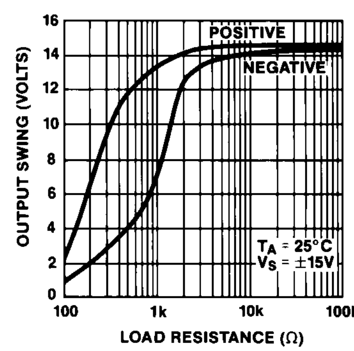
CLOSED-LOOP GAIN vs FREQUENCY



OUTPUT VOLTAGE SWING vs LOAD RESISTANCE

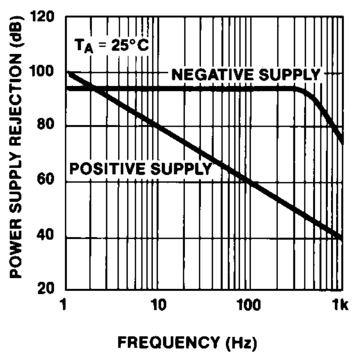


OUTPUT VOLTAGE SWING vs LOAD RESISTANCE

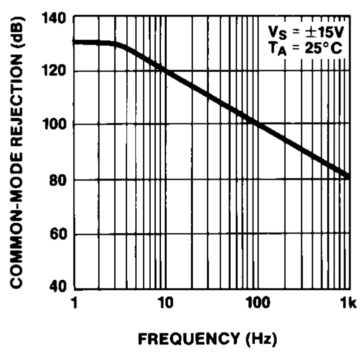


Typical Operating Characteristics (continued)

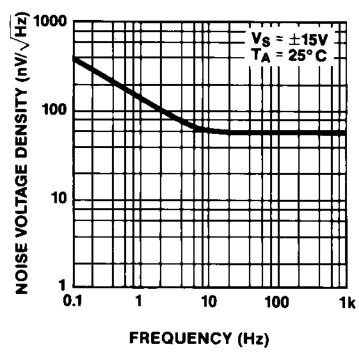
POWER SUPPLY REJECTION RATIO vs FREQUENCY



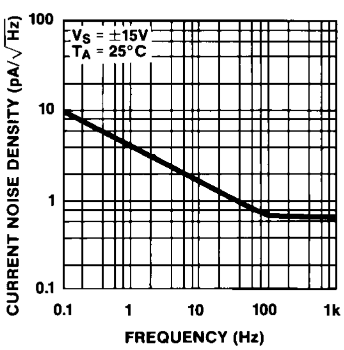
COMMON-MODE REJECTION RATIO vs FREQUENCY



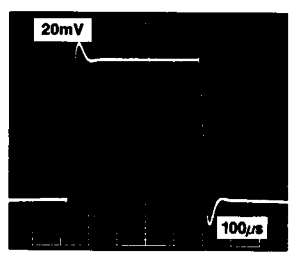
NOISE VOLTAGE DENSITY vs FREQUENCY



CURRENT NOISE DENSITY vs FREQUENCY

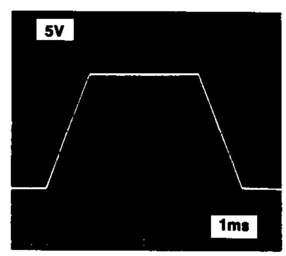


SMALL-SIGNAL TRANSIENT RESPONSE



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

Precision Low Voltage Micropower Operational Amplifier

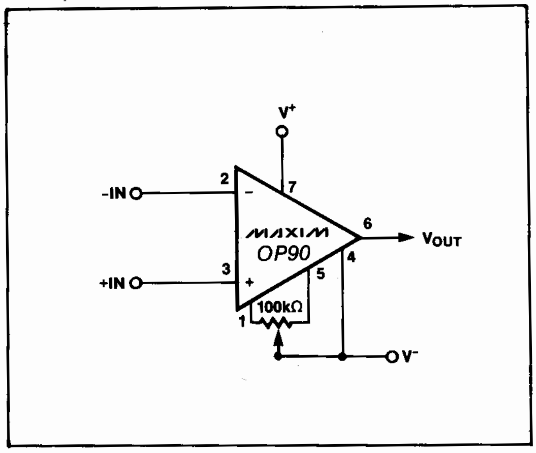


Figure 1. Offset Nulling Circuit

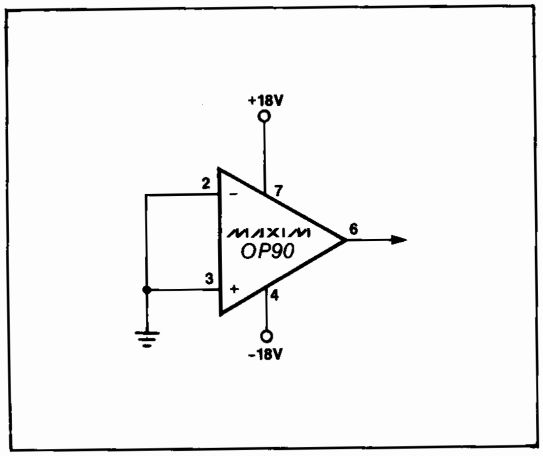
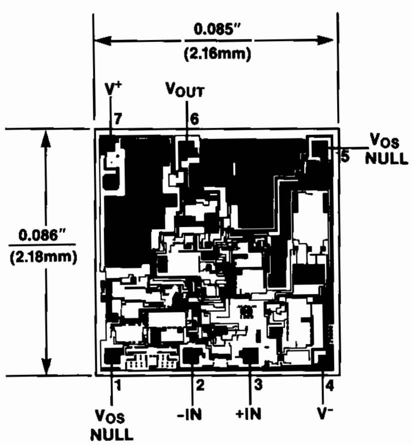


Figure 2. Burn-In Circuit

Chip Topography



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