Not Recommended for New Designs

This product was manufactured for Maxim by an outside wafer foundry using a process that is no longer available. It is not recommended for new designs. The data sheet remains available for existing users.

A Maxim replacement or an industry second-source may be available. Please see the QuickView data sheet for this part or contact technical support for assistance.

For further information, contact Maxim's Applications Tech Support.

/VI/IXI/VI

Precision Low Voltage
Micropower Operational Amplifier

OP90

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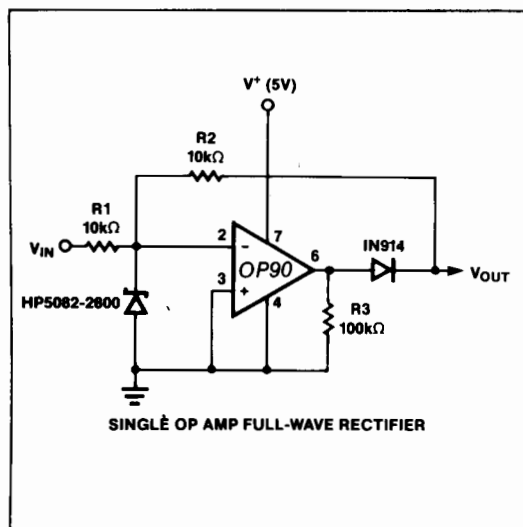
Unlike most other micropower operational amplifiers, the OP90 requires no external current setting resistor, and consumes less than 20µA of quiescent current, allowing operation from a lithium battery of greater than 10,000 hours. Even with this minimal current consumption, the amplifier can sink or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

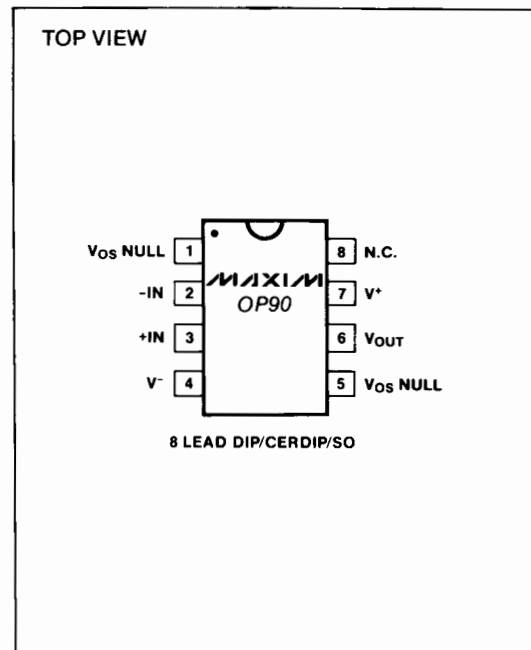Micropower Signal Processing

Battery Powered Analog Circuits

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

Typical Operating Circuit

SINGLE OP AMP FULL-WAVE RECTIFIER

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For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Precision Low Voltage
Micropower Operational Amplifier

OP90

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	5		0.4	7		0.4	8	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 75	1200 600 250		500 250 75	1000 500 200		400 200 75	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 ±10	±14.2 ±12		±14 ±10	±14.2 ±12		±14 ±10	±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		12			12			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)		650			650			650		pF

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ELECTRICAL CHARACTERISTICS (continued)

($V_S = \pm1.5V$ to $\pm15V$, $T_A = +25°C$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	OP90A/E			OP90F			OP90G			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Input Noise Voltage	$e_{np\text{-}p}$	$f_O = 0.1Hz$ to $10Hz$ $V_S = \pm15V$		3			3			3		$\mu V_{p\text{-}p}$
Input Resistance Differential Mode	R_{IN}	$V_S = \pm15V$		30			30			30		$M\Omega$
Input Resistance Common Mode	R_{INCM}	$V_S = \pm15V$		20			20			20		$G\Omega$

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

ELECTRICAL CHARACTERISTICS

($V_S = \pm1.5V$ to $\pm15V$, $-55°C \leq T_A \leq 125°C$, 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	$\mu V/°C$
Input Offset Current	I_{OS}	$V_{CM} = 0V$		1.5	10	nA
Input Bias Current	I_B	$V_{CM} = 0V$		4.0	30	nA
Large Signal Voltage Gain	A_{VO}	$V_S = \pm15V$, $V_O = \pm10V$ $R_L = 100k\Omega$ $R_L = 10k\Omega$ $R_L = 2k\Omega$	225 125 50	400 240 110		V/mV
		$V^+ = 5V$, $V^- = 0V$, $1V < V_O < 4V$ $R_L = 100k\Omega$ $R_L = 10k\Omega$	100 50	200 110		
Input Voltage Range	IVR	$V^+ = 5V$, $V^- = 0V$ $V_S = \pm15V$ (Note 4)	0/3.5 -15/13.5			V
Output Voltage Swing	V_O	$V_S = \pm15V$ $R_L = 10k\Omega$ $R_L = 2k\Omega$	±13.5 $\pm9,5$	±13.7 ±11.5		V
	V_{OH}	$V^+ = 5V$, $V^- = 0V$ $R_L = 2k\Omega$	3.9	4.1		V
	V_{OL}	$V^+ = 5V$, $V^- = 0V$ $R_L = 10k\Omega$		100	500	μV
Common Mode Rejection Ratio	CMRR	$V^+ = 5V$, $V^- = 0V$, $0V < V_{CM} < 3.5V$ $V_S = \pm15V$, $-15V < V_{CM} < 13.5V$	85 95	105 115		dB
Power Supply Rejection Ratio	PSRR			3.2	10	$\mu V/V$
Supply Current	I_{SY}	$V_S = \pm1.5V$ $V_S = \pm15V$		15 19	25 30	μA

Note 4: Guaranteed by CMRR test.

Precision Low Voltage
Micropower Operational Amplifier

OP90 (vertical, left margin)

ELECTRICAL CHARACTERISTICS

($V_S = \pm1.5V$ to $\pm15V$, $-25°C \leq T_A \leq 85°C$ for OP90E/F, $0°C \leq T_A \leq 70°C$ 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	$\mu V/°C$
Input Offset Current	I_{OS}	$V_{CM} = 0V$		0.8	10		1.0	10		1.3	10	nA
Input Bias Current	I_B	$V_{CM} = 0V$		4.0	25		4.0	30		4.0	30	nA
Large Signal Voltage Gain	A_{VO}	$V_S = \pm15V$, $V_O = \pm10V$ $R_L = 100k\Omega$ $R_L = 10k\Omega$ $R_L = 2k\Omega$	500 250 55	800 400 200		350 175 55	700 350 150		300 150 55	600 250 125		V/mV
		$V^+ = 5V$, $V^- = 0V$, $1V<V_O<4V$ $R_L = 100k\Omega$ $R_L = 10k\Omega$	150 75	280 140		100 50	220 110		80 40	160 90		
Input Voltage Range	IVR	$V^+ = 5V$, $V^- = 0V$ $V_S = \pm15V$ (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	$V_S = \pm15V$ $R_L = 10k\Omega$ $R_L = 2k\Omega$	±13.5 ±9.5	±14 ±11.8		±13.5 ±9.5	±14 ±11.8		±13.5 ±9.5	±14 ±11.8		V
	V_{OH}	$V^+ = 5V$, $V^- = 0V$ $R_L = 2k\Omega$	3.9	4.1		3.9	4.1		3.9	4.1		V
	V_{OL}	$V^+ = 5V$, $V^- = 0V$ $R_L = 10k\Omega$		100	500		100	500		100	500	μV
Common Mode Rejection Ratio	CMRR	$V^+ = 5V$, $V^- = 0V$, $0V<V_{CM}<3.5V$ $V_S = \pm15V$, $-15V<V_{CM}<13.5V$	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	$\mu V/V$
Supply Current	I_{SY}	$V_S = \pm1.5V$ $V_S = \pm15V$		13 17	25 30		13 17	25 30		12 16	25 30	μA

Note 5: Guaranteed by CMRR test.

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WAFER TEST LIMITS

($V_S = \pm1.5V$ to $\pm15V$, $T_A = 25°C$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	OP90GBC			UNITS
			MIN	TYP	MAX	
Input Offset Voltage	V_{OS}				250	μV
Input Offset Current	I_{OS}	$V_{CM} = 0V$			10	nA
Input Bias Current	I_B	$V_{CM} = 0V$			30	nA
Large Signal Voltage Gain	A_{VO}	$V_S = \pm15V$, $V_O = \pm10V$ $R_L = 100k\Omega$ $R_L = 10k\Omega$	500 250			V/mV
		$V^+ = 5V$, $V^- = 0V$, $1V < V_O < 4V$ $R_L = 100k\Omega$	125			
Input Voltage Range	IVR	$V^+ = 5V$, $V^- = 0V$ $V_S = \pm15V$ (Note 6)	0/4 $-15/13.5$			V
Output Voltage Swing	V_O	$V_S = \pm15V$ $R_L = 10k\Omega$ $R_L = 2k\Omega$	±14 ±10			V
	V_{OH}	$V^+ = 5V$, $V^- = 0V$ $R_L = 2k\Omega$	4.0			V
	V_{OL}	$V^+ = 5V$, $V^- = 0V$ $R_L = 10k\Omega$			500	μV
Common Mode Rejection Ratio	CMRR	$V^+ = 5V$, $V^- = 0V$, $0V < V_{CM} < 4V$ $V_S = \pm15V$, $-15V < V_{CM} < 13.5V$	80 90			dB
Power Supply Rejection Ratio	PSRR				10	$\mu V/V$
Supply Current	I_{SY}	$V_S = \pm15V$			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.

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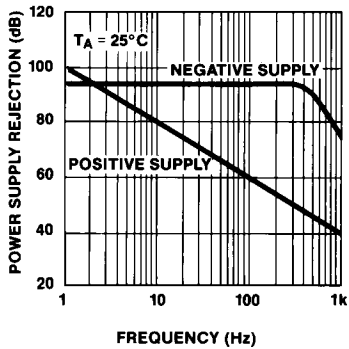
OP90

_____**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

6 _____ **/VI/IXI/VI**
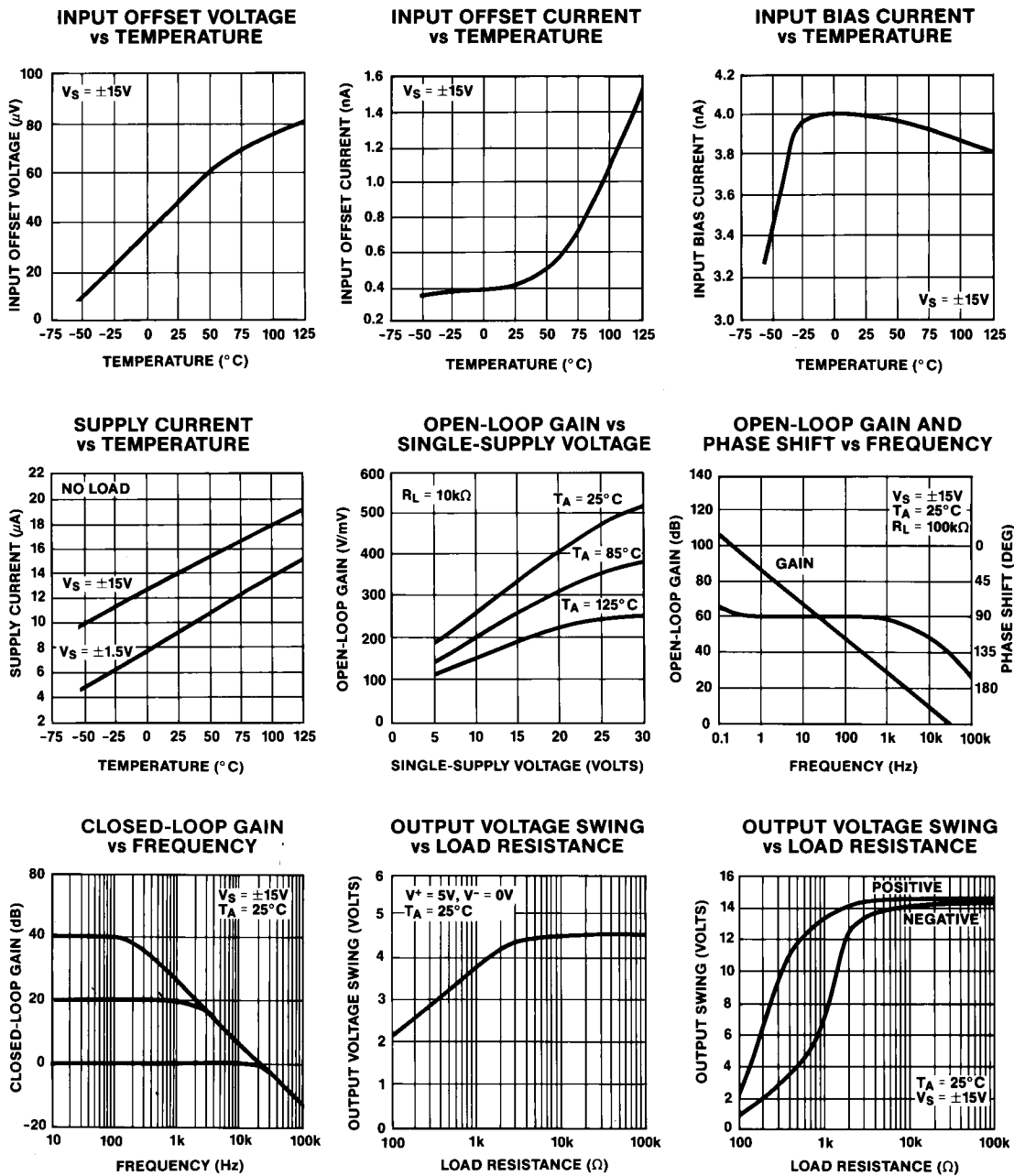
Typical Operating Characteristics (continued)

OP90

POWER SUPPLY REJECTION RATIO vs FREQUENCY

COMMON-MODE REJECTION RATIO vs FREQUENCY
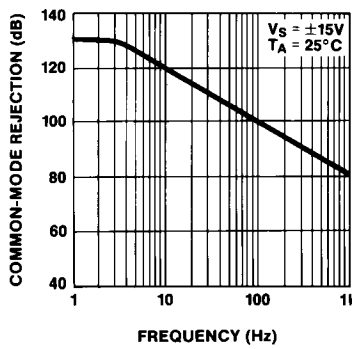
NOISE VOLTAGE DENSITY vs FREQUENCY
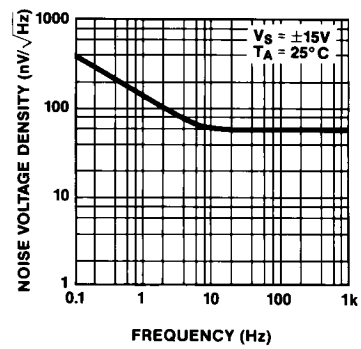
CURRENT NOISE DENSITY vs FREQUENCY
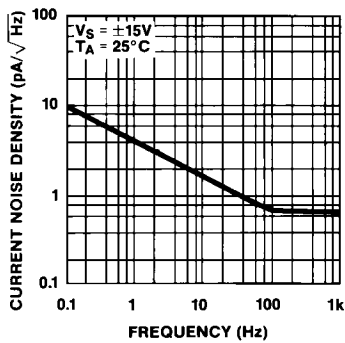
SMALL-SIGNAL TRANSIENT RESPONSE
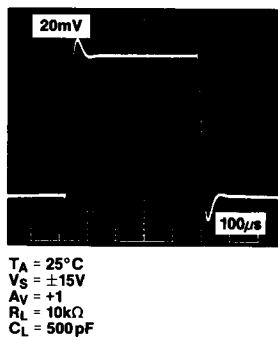
$T_A = 25°C$
$V_S = ±15V$
$A_V = +1$
$R_L = 10kΩ$
$C_L = 500pF$

LARGE-SIGNAL TRANSIENT RESPONSE

$T_A = 25°C$
$V_S = ±15V$
$A_V = +1$
$R_L = 10kΩ$
$C_L = 500pF$
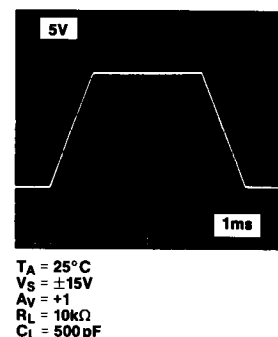
Precision Low Voltage
Micropower Operational Amplifier
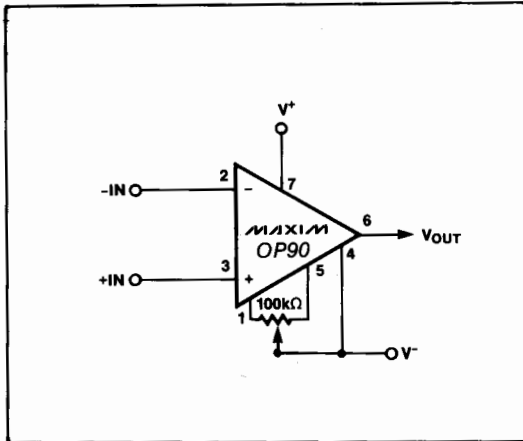
Figure 1. Offset Nulling Circuit
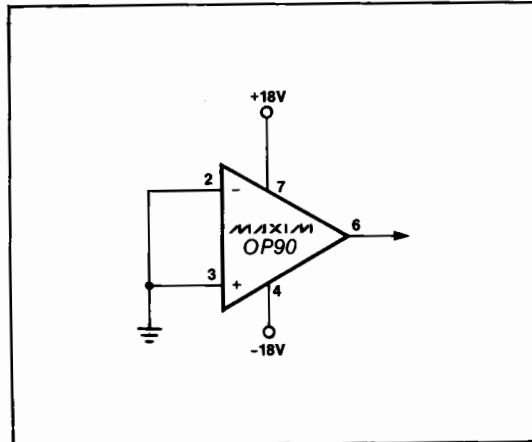
Figure 2. Burn-In Circuit

Chip Topography