19-0096 Rev 1; 8/94

MAXIM

Low-Noise, Precision Op Amp

MXL1007

General Description

The Maxim MXL1007 operational amplifier features low-noise, ±15V performance: 2.5nV/√Hz wideband noise, 1/f corner frequency of 2Hz, and 60nVp-p 0.1Hz to 10Hz noise. Precision and speed performance includes 10µV typical offset voltage, 0.2µV/°C drift, 130dB CMRR and PSRR, and an 8MHz unity-gain stable bandwidth. In addition, the MXL1007's voltage gain is 20 million with a 2kΩ load and 12 million with a 600Ω load.

Maxim's MXL1007 is a pin-compatible alternative to other industry-standard low-noise op amps such as the OP27 and LT1007.

For applications requiring higher performance, see the MAX427/MAX437 and MAX410/MAX412/MAX414 data sheets.

Applications

Low-Noise Signal Processing

Threshold Detection

Strain-Gauge Amplifiers

Microphone Preamplifiers

Features

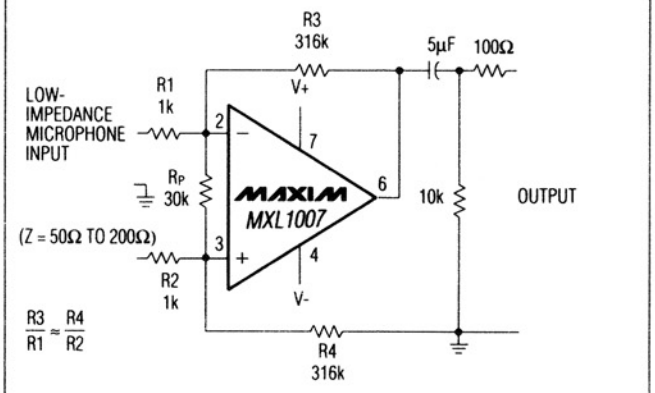
- **Low-Noise Performance:**
  4.5nV/√Hz Max (10Hz)
  3.8nV/√Hz Max (1kHz)
- **High-Voltage Gain:**
  7 Million Min (2kΩ Load)
  3 Million Min (600Ω Load)
- **25µV Max Offset Voltage**
- **0.6µV/°C Max Drift**
- **117dB Min CMRR**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MXL1007ACN8	0°C to +70°C	8 Plastic DIP
MXL1007CN8	0°C to +70°C	8 Plastic DIP
MXL1007CS8	0°C to +70°C	8 SO
MXL1007CS	0°C to +70°C	16 Wide SO
MXL1007AMJ8	-55°C to +125°C	8 CERDIP
MXL1007MJ8	-55°C to +125°C	8 CERDIP
MXL1007AMH	-55°C to +125°C	8 TO-99
MXL1007MH	-55°C to +125°C	8 TO-99

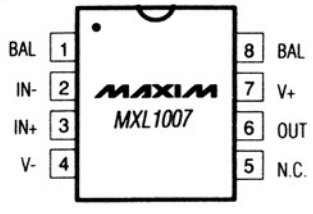
Typical Application Circuit

LOW-NOISE MICROPHONE PREAMPLIFIER



Pin Configurations

TOP VIEW



DIP/SO

Pin Configurations continued on last page.

Low-Noise, Precision Op Amp

ABSOLUTE MAXIMUM RATINGS

Supply Voltage ..... ±22V
Input Voltage (Note 1) ..... ±22V
Output Short-Circuit Duration ..... Continuous
Differential Input Voltage (Note 2) ..... ±0.7V
Differential Input Current (Note 2) ..... ±25mA
Continuous Power Dissipation (T_A = +70°C)
8-Pin Plastic DIP (derate 9.09mW/°C above +70°C) ... 727mW
8-Pin SO (derate 5.88mW/°C above +70°C) 471mW
16-Pin Wide SO (derate 9.52mW/°C above +70°C) 726mW
8-Pin CERDIP (derate 8.00mW/°C above +70°C) 640mW
8-Pin TO-99 (derate 6.67mW/°C above +70°C) 533mW
Operating Temperature Ranges:
MXL1007AC_/C_ ..... 0°C to +70°C
MXL1007AM_/M_ ..... -55°C to +125°C
Junction Temperature Range ..... -65°C to +150°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (soldering, 10sec) ..... +300°C

Note 1: For supply voltages less than ±22V, the absolute maximum input voltage is equal to the supply voltage.
Note 2: MXL1007 inputs are protected by back-to-back diodes. Current-limiting resistors are not used in order to achieve low noise. If differential input voltage exceeds ±0.7V, the input current should be limited to 25mA.

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

PARAMETER	SYMBOL	CONDITIONS	MXL1007AM/AC			MXL1007M/C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage (Note 3)	V_{OS}			10	25		20	60	µV
Long-Term V_{OS} Stability (Notes 4, 5)	V_{OS}/TIME			0.2	1.0		0.2	1.0	µV/Mo
Input Bias Current	I_B			±10	±35		±15	±55	nA
Input Offset Current	I_{OS}			7	30		12	50	nA
Input Voltage Range	I_{VR}		±11.0	±12.5		±11.0	±12.5		V
Input Resistance – Common Mode	R_{INCM}			7			5		GΩ
Input Noise Voltage (Notes 5, 6)	e_{np-p}	0.1Hz to 10Hz		0.06	0.13		0.06	0.13	μV_{p-p}
Input Noise-Voltage Density (Note 5)	e_n	f_O = 10Hz		2.8	4.5		2.8	4.5	$nV/\sqrt{Hz}$
		f_O = 1kHz		2.5	3.8		2.5	3.8	
Input Noise-Current Density (Notes 5, 7)	i_n	f_O = 10Hz		1.5	4.0		1.5	4.0	$pA/\sqrt{Hz}$
		f_O = 1kHz		0.4	0.6		0.4	0.6	
Large-Signal Voltage Gain	A_{VO}	$R_L \geq 2k\Omega$, V_O = ±12V	7.0	20.0		5.0	20.0		V/µV
		$R_L \geq 1k\Omega$, V_O = ±10V	5.0	16.0		3.5	16.0		
		$R_L \geq 600\Omega$, V_O = ±10V	3.0	12.0		2.0	12.0		
Output Voltage Swing	V_O	$R_L \geq 2k\Omega$	±13.0	±13.8		±12.5	±13.5		V
		$R_L \geq 600\Omega$	±11.0	±12.5		±10.5	±12.5		
Open-Loop Output Resistance	R_O	V_O = 0, I_O = 0		70			70		Ω
Common-Mode Rejection Ratio	CMRR	V_{CM} = ±11V	117	130		110	126		dB
Power-Supply Rejection Ratio	PSRR	V_S = ±4V to ±18V	110	130		106	126		dB
Gain-Bandwidth Product (Note 5)	GBP	f_O = 100kHz	5.0	8.0		5.0	8.0		MHz
Slew Rate (Note 5)	SR	$R_L \geq 2k\Omega$	1.7	2.5		1.7	2.5		V/µs
Power Dissipation	PD	V_O = 0		80	120		80	140	mW

ELECTRICAL CHARACTERISTICS

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

PARAMETER	SYMBOL	CONDITIONS	MXL1007AM			MXL1007M			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage (Note 3)	V_{OS}			25	60		50	160	µV
Average Offset-Voltage Drift (Note 8)	TCV_{OS}			0.2	0.6		0.3	1.0	µV/°C
Input Offset Current	I_{OS}			15	50		20	85	nA
Input Bias Current	I_B			±20	±60		±35	±95	nA
Input Voltage Range	I_{VR}		±10.3	±11.5		±10.3	±11.5		V
Common-Mode Rejection Ratio	CMRR	V_{CM} = ±10.3V	112	126		104	120		dB
Power-Supply Rejection Ratio	PSRR	V_S = ±4.5V to ±18V	104	126		100	120		dB
Large-Signal Voltage Gain	A_{VOL}	$R_L \geq 2k\Omega$, V_O = ±10V	3.0	14.0		2.0	14.0		V/µV
		$R_L \geq 1k\Omega$, V_O = ±10V	2.0	10.0		1.5	10.0		
Maximum Output-Voltage Swing	V_{OUT}	$R_L \geq 2k\Omega$	±12.5	±13.5		±12.0	±13.5		V
Power Dissipation	PD	V_O = 0		100	150		100	170	mW

ELECTRICAL CHARACTERISTICS

(V_S = ±15V, T_A = 0°C to +70°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MXL1007AC			MXL1007C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage (Note 3)	V_{OS}			20	50		35	110	µV
Average Offset-Voltage Drift (Note 8)	TCV_{OS}			0.2	0.6		0.3	1.0	µV/°C
Input Offset Current	I_{OS}			10	40		15	70	nA
Input Bias Current	I_B			±14	±45		±20	±75	nA
Input Voltage Range	I_{VR}		±10.5	±11.8		±10.5	±11.8		V
Common-Mode Rejection Ratio	CMRR	V_{CM} = ±10.5V	114	126		106	120		dB
Power-Supply Rejection Ratio	PSRR	V_S = ±4.5V to ±18V	106	126		102	120		dB
Large-Signal Voltage Gain	A_{VOL}	$R_L \geq 2k\Omega$, V_O = ±10V	4.0	18.0		2.5	18.0		V/µV
		$R_L \geq 1k\Omega$, V_O = ±10V	2.5	14.0		2.0	14.0		
Maximum Output-Voltage Swing	V_{OUT}	$R_L \geq 2k\Omega$	±12.5	±13.6		±12.0	±13.6		V
Power Dissipation	PD	V_O = 0		90	144		90	160	mW

Note 3: Input Offset Voltage measurements are performed by automatic test equipment approximately 0.5 sec after application of power.

Note 4: Long-Term Input Offset Voltage Stability refers to the average trend line of Offset Voltage vs. Time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in V_{OS} during the first 30 days are typically 2.5µV.

Note 5: This parameter is guaranteed by design and is not tested.

Note 6: See the test circuit for 0.1Hz to 10Hz tester in the *Typical Operating Characteristics* section.

Note 7: See the test circuit for current noise meaurement in the *Applications Information* section.

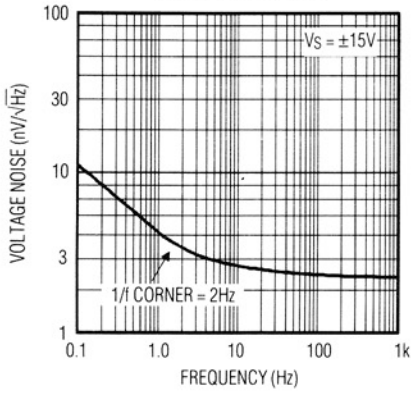
Note 8: The Average Input Offset Drift performance is within the specificaions unnulled or when nulled with a pot having a range of 8kΩ to 20kΩ. AM and AC grades are sample tested to 0.1% AQL. C grade is guaranteed by design.

Low-Noise, Precision Op Amp

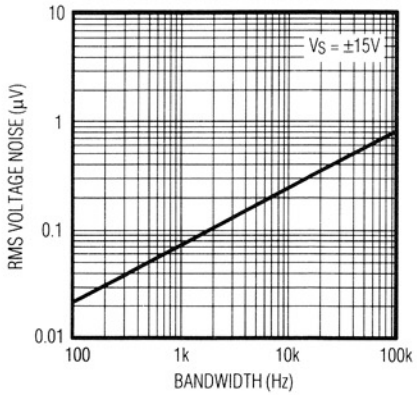
Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted)

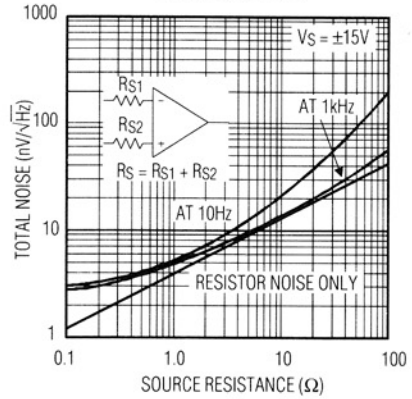
VOLTAGE-NOISE DENSITY vs. FREQUENCY



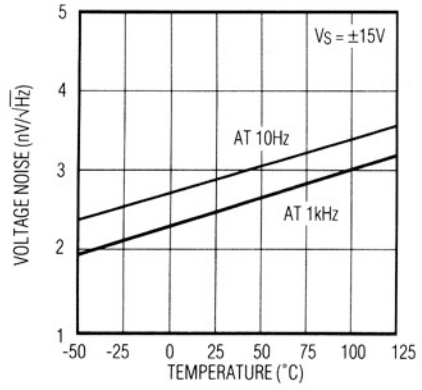
INPUT WIDEBAND VOLTAGE NOISE vs. BANDWIDTH (0.1Hz TO FREQUENCY INDICATED)



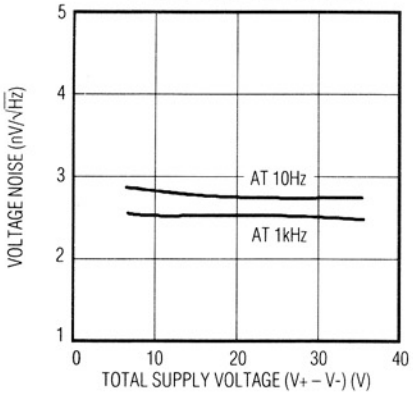
TOTAL NOISE vs. SOURCE RESISTANCE



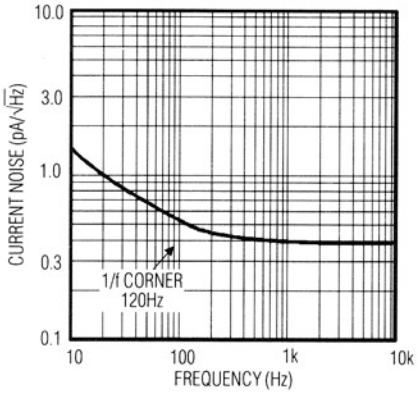
VOLTAGE-NOISE DENSITY vs. TEMPERATURE



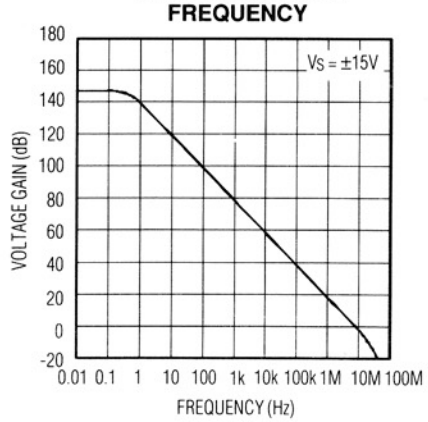
VOLTAGE-NOISE DENSITY vs. SUPPLY VOLTAGE



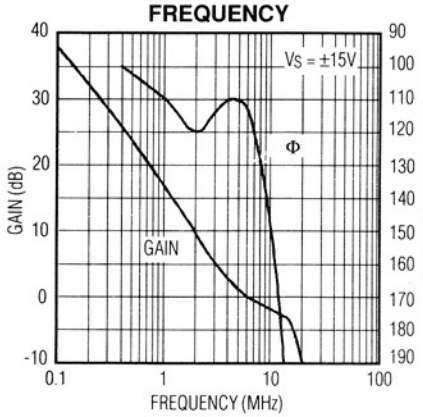
CURRENT-NOISE DENSITY vs. FREQUENCY



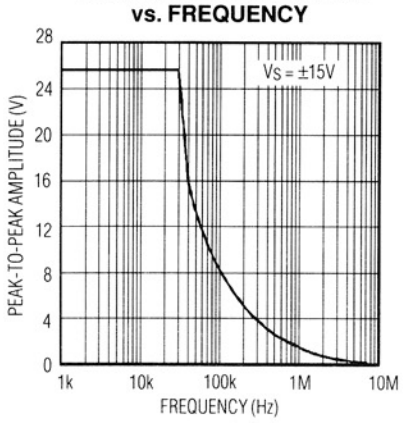
VOLTAGE GAIN vs. FREQUENCY



GAIN, PHASE SHIFT vs. FREQUENCY

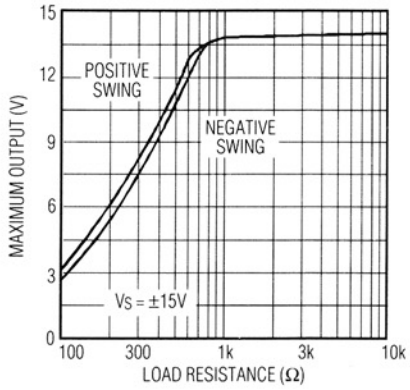


MAXIMUM OUTPUT SWING vs. FREQUENCY

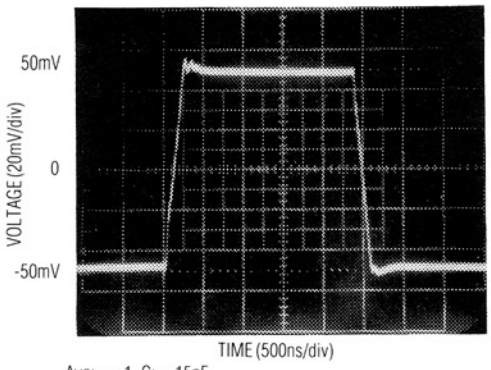


Typical Operating Characteristics (continued)

MAXIMUM OUTPUT VOLTAGE vs. LOAD RESISTANCE

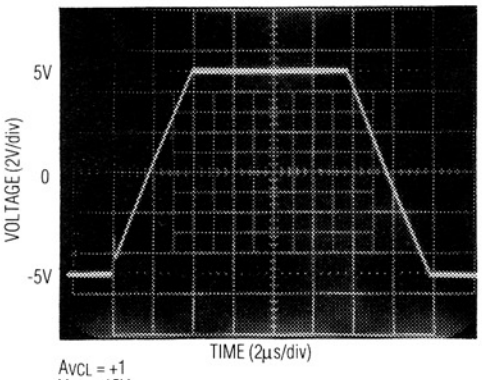


SMALL-SIGNAL TRANSIENT RESPONSE



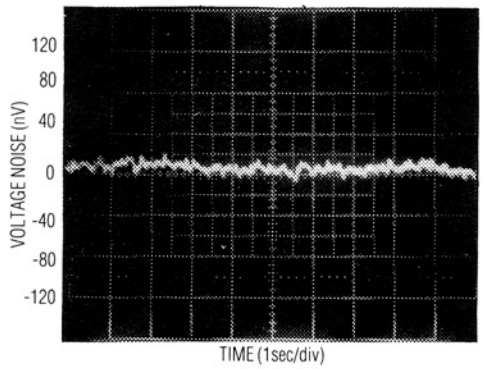
AVCL = +1, CL = 15pF
VS = ±15V

LARGE-SIGNAL TRANSIENT RESPONSE



AVCL = +1
VS = ±15V

LOW-FREQUENCY NOISE



0.1Hz TO 10Hz PEAK-TO-PEAK NOISE

NOTE: (OSERVATION TIME LIMITED TO 10 SECONDS.)

Low-Noise, Precision Op Amp

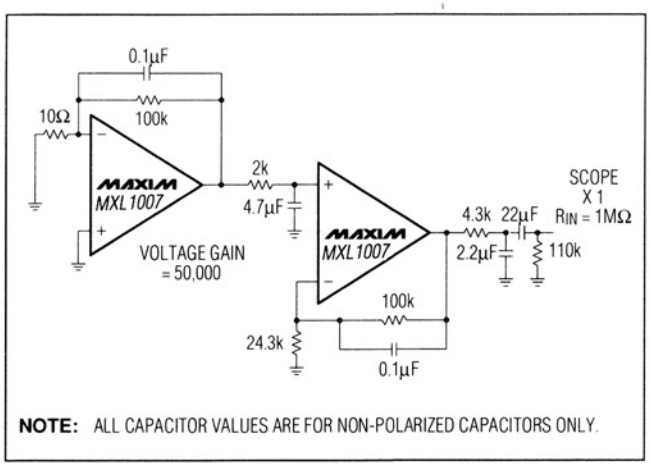


Figure 1. Voltage-Noise Test Circuit (0.1Hz to 10Hz)

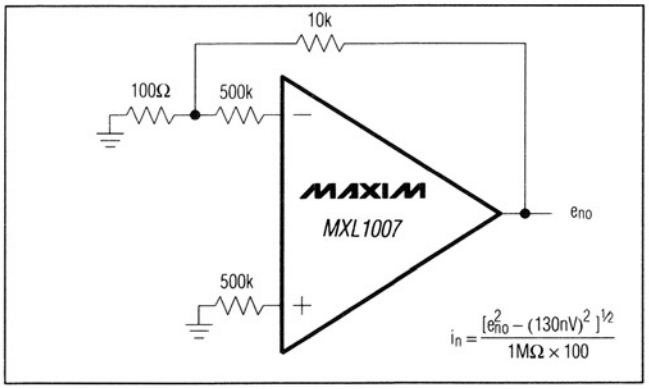


Figure 2. Current-Noise Test Circuit

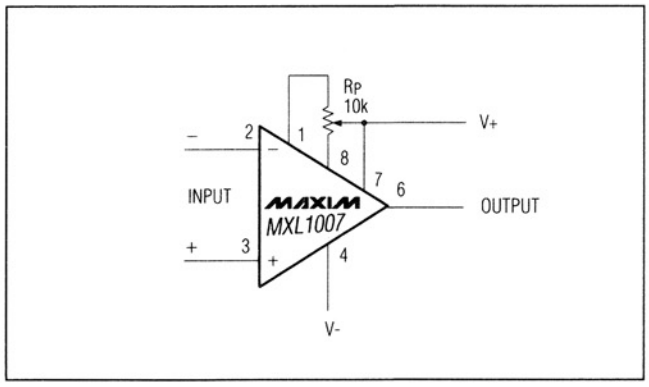
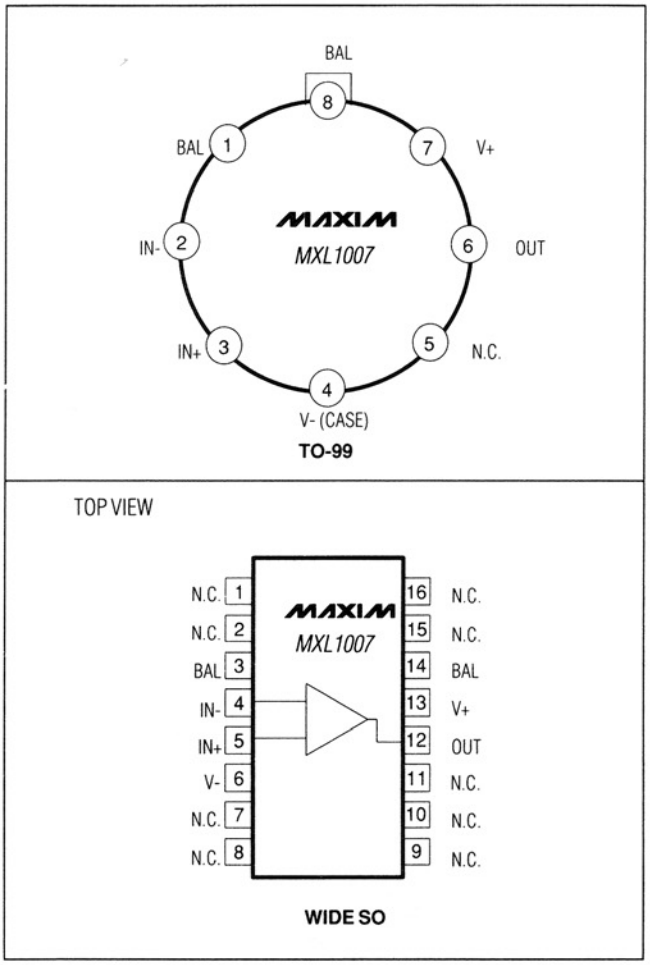


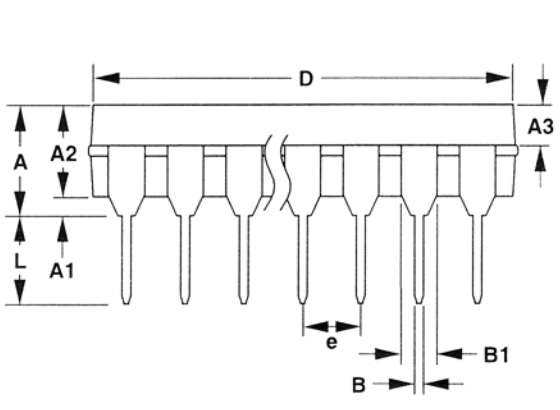
Figure 3. Offset Nulling Circuit

Pin Configurations (continued)



Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)

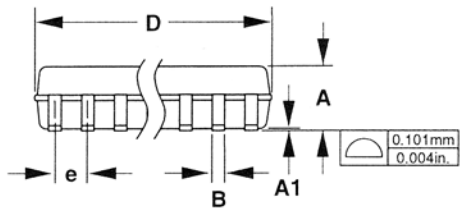


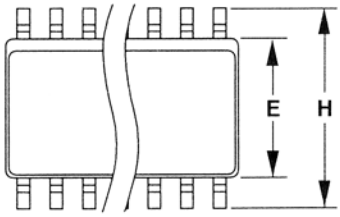
Plastic DIP
PLASTIC
DUAL-IN-LINE
PACKAGE
(0.300 in.)

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

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

21-0043A





Narrow SO
SMALL-OUTLINE
PACKAGE
(0.150 in.)

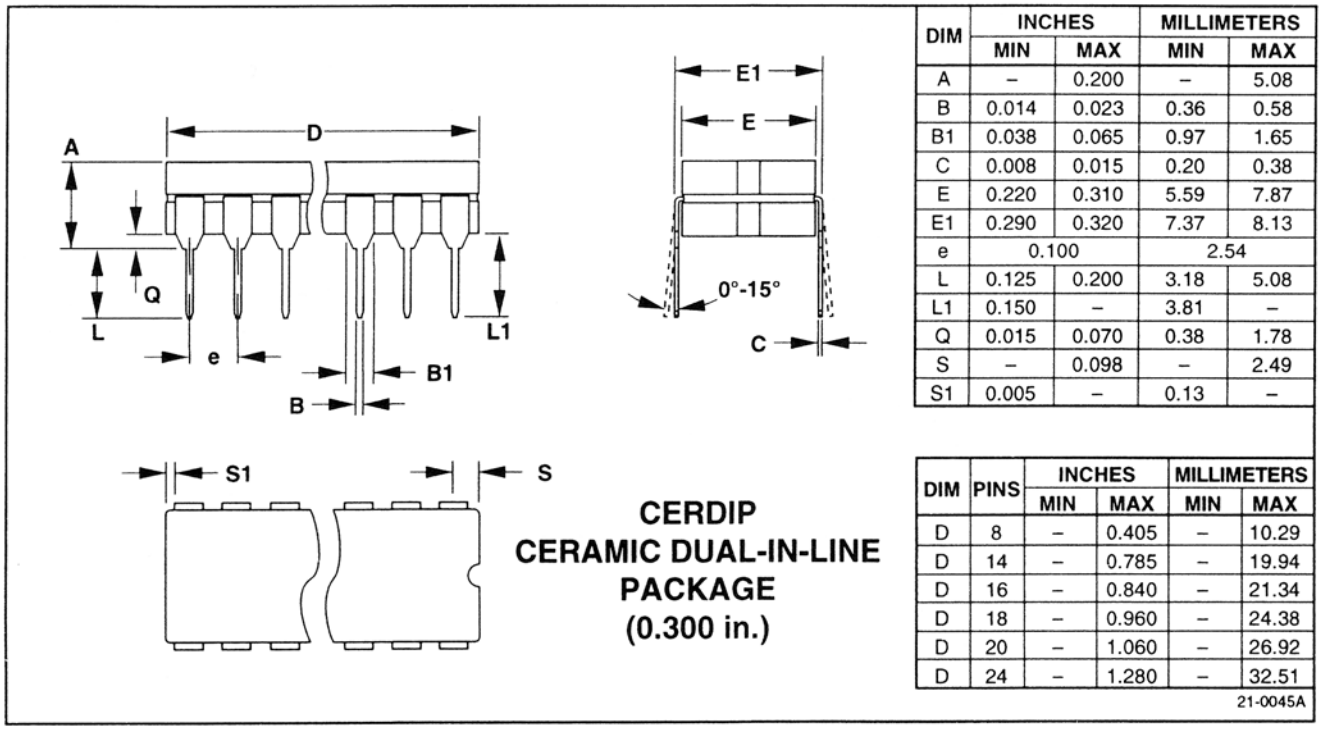
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
E	0.150	0.157	3.80	4.00
e	0.050		1.27	
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27

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

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)



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	–

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

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

21-0045A