

MRLM101A-X-RH REV 0B0

Original Creation Date: 01/20/00

Last Update Date: 05/08/00

Last Major Revision Date: 01/20/00

**SINGLE OPERATIONAL AMPLIFIER - EXTERNALLY COMPENSATED:
 ALSO AVAILABLE GUARANTEED TO 100K RAD(Si) TESTED TO
 MIL-STD-883, METHOD 1019.5**

General Description

The LM101A is a general purpose operational amplifier which features improved performance over industry standards such as the LM709. Advanced processing techniques make possible an order of magnitude reduction in input currents, and a redesign of the biasing circuitry reduces the temperature drift of input current.

This amplifier offers many features which make its application nearly foolproof: overload protection on the input and output, no latch-up when the common mode range is exceeded, and freedom from oscillations and compensation with a single 30 pF capacitor. It has advantages over internally compensated amplifiers in that the frequency compensation can be tailored to the particular application. For example, in low frequency circuits it can be overcompensated for increased stability margin. Or the compensation can be optimized to give more than a factor of ten improvement in high frequency performance for most applications.

In addition, the device provides better accuracy and lower noise in high impedance circuitry. The low input currents also make it particularly well suited for long interval integrators or timers, sample and hold circuits and low frequency waveform generators. Further, replacing circuits where matched transistor pairs buffer the inputs of conventional IC op amps, it can give lower offset voltage and a drift at a lower cost.

Industry Part Number

LM101A

Prime Die

LM101A

NS Part Numbers

 LM101AHRQML
 LM101AHRQMLV
 LM101AJRQML
 LM101AJRQMLV
 LM101AWRQML
 LM101AWRQMLV

Controlling Document

SEE FEATURES SECTION

Processing

MIL-STD-883, Method 5004

Quality Conformance Inspection

MIL-STD-883, Method 5005

Subgrp Description		Temp (°C)
1	Static tests at	+25
2	Static tests at	+125
3	Static tests at	-55
4	Dynamic tests at	+25
5	Dynamic tests at	+125
6	Dynamic tests at	-55
7	Functional tests at	+25
8A	Functional tests at	+125
8B	Functional tests at	-55
9	Switching tests at	+25
10	Switching tests at	+125
11	Switching tests at	-55

Features

- Offset voltage 3 mV maximum over temperature
- Input current 100 nA maximum over temperature
- Offset current 20 nA maximum over temperature
- Guaranteed drift characteristics
- Offsets guaranteed over entire common mode and supply voltage ranges
- Slew rate of 10V/us as a summing amplifier

CONTROLLING DOCUMENTS:

LM101AHRQML	5962R9951501QGA
LM101AHRQMLV	5962R9951501VGA
LM101AJRQML	5962R9951501QPA
LM101AJRQMLV	5962R9951501VPA
LM101AWRQML	5962R9951501QHA
LM101AWRQMLV	5962R9951501VHA

(Absolute Maximum Ratings)

(Note 1)

Supply Voltage	±22V
Differential Input Voltage	±30V
Input Voltage (Note 3)	±15V
Output Short Circuit Duration (Note 2)	Continuous
Operating Ambient Temp. Range	-55 C ≤ Ta ≤ +125 C
Maximum Junction Temperature	150 C
Power Dissipation at TA = 25 C (Note 2)	
H-Pkg (Still Air)	750mW
H-Pkg (500LF/Min Air Flow)	1200mW
J8-Pkg (Still Air)	1000mW
J8-Pkg (500LF/Min Air Flow)	1500mW
W-Pkg (Still Air)	500mW
W-Pkg (500LF/Min Air Flow)	800mW
Thermal Resistance	
ThetaJA	
H-Pkg (Still Air)	165 C/W
H-Pkg (500LF/Min Air Flow)	89 C/W
J8-Pkg (Still Air)	128 C/W
J8-Pkg (500LF/Min Air Flow)	75 C/W
W-Pkg (Still Air)	233 C/W
W-Pkg (500LF/Min Air Flow)	155 C/W
ThetaJC	
H-Pkg	39 C/W
J8-Pkg	26 C/W
W-Pkg	26 C/W
Storage Temperature Range	-65 C to +150 C
Lead Temperature (Soldering, 10 seconds)	300 C
ESD Tolerance (Note 4)	2000V

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

Note 2: The maximum power dissipation must be derated at elevated temperatures and is dictated by Tjmax (maximum junction temperature), ThetaJA (package junction to ambient thermal resistance), and TA (ambient temperature). The maximum allowable power dissipation at any temperature is $P_{dmax} = (T_{jmax} - T_A) / \Theta_{JA}$ or the number given in the Absolute Maximum Ratings, whichever is lower.

Note 3: For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

Note 4: Human body model, 100 pF discharged through 1.5k Ohms.

Electrical Characteristics

DC PARAMETERS: See NOTE 3

(The following conditions apply to all the following parameters, unless otherwise specified.)

DC: $\pm V_{CC} = \pm 20V$, $V_{cm} = 0V$, $R_s = 50\ \Omega$

SYMBOL	PARAMETER	CONDITIONS	NOTES	PIN-NAME	MIN	MAX	UNIT	SUB-GROUPS
Vio	Input Offset Voltage	$+V_{CC} = 35V$, $-V_{CC} = -5V$, $V_{cm} = -15V$			-2	+2	mV	1
					-3	+3	mV	2, 3
		$+V_{CC} = 5V$, $-V_{CC} = -35V$, $V_{cm} = +15V$			-2	+2	mV	1
					-3	+3	mV	2, 3
		$V_{cm} = 0V$			-2	+2	mV	1
					-3	+3	mV	2, 3
		$+V_{CC} = 5V$, $-V_{CC} = -5V$, $V_{cm} = 0V$			-2	+2	mV	1
					-3	+3	mV	2, 3
		$+V_{CC} = 35V$, $-V_{CC} = -5V$, $V_{cm} = -15V$, $R_s = 100K\ \Omega$			-10	+10	nA	1, 2
					-20	+20	nA	3
		$+V_{CC} = 5V$, $-V_{CC} = -35V$, $V_{cm} = +15V$, $R_s = 100K\ \Omega$			-10	+10	nA	1, 2
					-20	+20	nA	3
Iio	Input Offset Current	$V_{cm} = 0V$, $R_s = 100K\ \Omega$			-10	+10	nA	1, 2
					-20	+20	nA	3
		$+V_{CC} = 5V$, $-V_{CC} = -5V$, $V_{cm} = 0V$, $R_s = 100K\ \Omega$			-10	+10	nA	1, 2
					-20	+20	nA	3
		$+V_{CC} = 35V$, $-V_{CC} = -5V$, $V_{cm} = -15V$, $R_s = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3
		$+V_{CC} = 5V$, $-V_{CC} = -35V$, $V_{cm} = +15V$, $R_s = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3
		$V_{cm} = 0V$, $R_s = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3
		$+V_{CC} = 5V$, $-V_{CC} = -5V$, $V_{cm} = 0V$, $R_s = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3
Iib+	Input Bias Current	$+V_{CC} = 35V$, $-V_{CC} = -5V$, $V_{cm} = -15V$, $R_s = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3
		$+V_{CC} = 5V$, $-V_{CC} = -35V$, $V_{cm} = +15V$, $R_s = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3
		$V_{cm} = 0V$, $R_s = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3
		$+V_{CC} = 5V$, $-V_{CC} = -5V$, $V_{cm} = 0V$, $R_s = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3
		$+V_{CC} = 35V$, $-V_{CC} = -5V$, $V_{cm} = -15V$, $R_s = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3
		$+V_{CC} = 5V$, $-V_{CC} = -35V$, $V_{cm} = +15V$, $R_s = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3

Electrical Characteristics

DC PARAMETERS: See NOTE 3(Continued)

(The following conditions apply to all the following parameters, unless otherwise specified.)

DC: $\pm V_{CC} = \pm 20V$, $V_{CM} = 0V$, $R_S = 50\ \Omega$

SYMBOL	PARAMETER	CONDITIONS	NOTES	PIN-NAME	MIN	MAX	UNIT	SUB-GROUPS
I _{ib} -	Input Bias Current	$+V_{CC} = 35V$, $-V_{CC} = -5V$, $V_{CM} = -15V$, $R_S = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3
		$+V_{CC} = 5V$, $-V_{CC} = -35V$, $V_{CM} = +15V$, $R_S = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3
		$V_{CM} = 0V$, $R_S = 100K\ \Omega$			-0.1	75	nA	1, 2
					-0.1	100	nA	3
+PSRR	Power Supply Rejection Ratio	$+V_{CC} = 10V$, $-V_{CC} = -20V$			-50	+50	uV/V	1
					-100	+100	uV/V	2, 3
-PSRR	Power Supply Rejection Ratio	$+V_{CC} = 20V$, $-V_{CC} = -10V$			-50	+50	uV/V	1
					-100	+100	uV/V	2, 3
CMRR	Common Mode Rejection Ratio	$V_{CC} = \pm 35V$ to $\pm 5V$, $V_{CM} = \pm 15V$			80		dB	1, 2, 3
V _{io} ADJ(+)	Adjustment for Input Offset Voltage				4		mV	1, 2, 3
V _{io} ADJ(-)	Adjustment for Input Offset Voltage					-4	mV	1, 2, 3
I _{os} +	Output Short Circuit Current	$+V_{CC} = 15V$, $-V_{CC} = -15V$, $t \leq 25mS$, $V_{CM} = -15V$			-60		mA	1, 2, 3
I _{os} -	Output Short Circuit Current	$+V_{CC} = 15V$, $-V_{CC} = -15V$, $t \leq 25mS$, $V_{CM} = +15V$				+60	mA	1, 2, 3
I _{cc}	Power Supply Current	$+V_{CC} = 15V$, $-V_{CC} = -15V$				3	mA	1
						2.32	mA	2
						3.5	mA	3
Delta V _{io} /Delta T	Temperature Coefficient of Input Offset Voltage	$+25\ ^\circ C \leq T_A \leq +125\ ^\circ C$	1		-15	+15	uV/ $^\circ C$	2
		$+25\ ^\circ C \leq T_A \leq -55\ ^\circ C$	1		-18	+18	uV/ $^\circ C$	3
Delta I _{io} /Delta T	Temperature Coefficient of Input Offset Current	$+25\ ^\circ C \leq T_A \leq +125\ ^\circ C$	1		-100	+100	pA/ $^\circ C$	2
		$+25\ ^\circ C \leq T_A \leq -55\ ^\circ C$	1		-200	+200	pA/ $^\circ C$	3

Electrical Characteristics

DC PARAMETERS: See NOTE 3(Continued)

(The following conditions apply to all the following parameters, unless otherwise specified.)

DC: $\pm V_{CC} = \pm 20V$, $V_{CM} = 0V$, $R_S = 50\ \Omega$

SYMBOL	PARAMETER	CONDITIONS	NOTES	PIN-NAME	MIN	MAX	UNIT	SUB-GROUPS
Avs-	Large Signal (Open Loop) Voltage Gain	$R_L = 2K\ \Omega$, $V_{out} = -15V$	2		50		V/mV	4
			2		25		V/mV	5, 6
		$R_L = 10K\ \Omega$, $V_{out} = -15V$	2		50		V/mV	4
			2		25		V/mV	5, 6
Avs+	Large Signal (Open Loop) Voltage Gain	$R_L = 2K\ \Omega$, $V_{out} = +15V$	2		50		V/mV	4
			2		25		V/mV	5, 6
		$R_L = 10K\ \Omega$, $V_{out} = +15V$	2		50		V/mV	4
			2		25		V/mV	5, 6
Avs	Large Signal (Open Loop) Voltage Gain	$V_{CC} = \pm 5V$, $R_L = 2K\ \Omega$, $V_{out} = \pm 2V$	2		10		V/mV	4, 5, 6
		$V_{CC} = \pm 5V$, $R_L = 10K\ \Omega$, $V_{out} = \pm 2V$	2		10		V/mV	4, 5, 6
Vop+	Output Voltage Swing	$R_L = 10K\ \Omega$, $V_{CM} = -20V$			+16		V	4, 5, 6
		$R_L = 2K\ \Omega$, $V_{CM} = -20V$			+15		V	4, 5, 6
Vop-	Output Voltage Swing	$R_L = 10K\ \Omega$, $V_{CM} = 20V$				-16	V	4, 5, 6
		$R_L = 2K\ \Omega$, $V_{CM} = 20V$				-15	V	4, 5, 6

AC PARAMETERS: See NOTE 3

(The following conditions apply to all the following parameters, unless otherwise specified.)

AC: $\pm V_{CC} = \pm 20V$, $V_{CM} = 0V$, $R_S = 50\ \Omega$

Sr+	Slew Rate	$A_V = 1$, $V_{in} = -5V$ to $+5V$			0.3		V/ μ S	7, 8A
					0.2		V/ μ S	8B
Sr-	Slew Rate	$A_V = 1$, $V_{in} = +5V$ to $-5V$			0.3		V/ μ S	7, 8A
					0.2		V/ μ S	8B
TR(tr)	Rise Time	$A_V = 1$, $V_{in} = 50mV$				800	nS	7, 8A, 8B
TR(os)	Overshoot	$A_V = 1$, $V_{in} = 50mV$				25	%	7, 8A, 8B
NI(BB)	Noise Broadband	$BW = 10Hz$ to $5KHz$, $R_S = 0\ \Omega$				15	μV_{rms}	7
NI(PC)	Noise Popcorn	$BW = 10Hz$ to $5KHz$, $R_S = 100K\ \Omega$				80	μV_{pk}	7

Electrical Characteristics

DC PARAMETERS: DRIFT VALUES

(The following conditions apply to all the following parameters, unless otherwise specified.)

DC: $\pm V_{CC} = \pm 20V$, $V_{CM} = 0V$, $R_S = 50\ \Omega$. "Delta calculations performed on JAN S and QMLV devices at group B, subgroup 5 only".

SYMBOL	PARAMETER	CONDITIONS	NOTES	PIN-NAME	MIN	MAX	UNIT	SUB-GROUPS
Vio	Input Offset Voltage	$V_{CM} = 0V$			-0.5	0.5	mV	1
Iib+	Input Bias Current	$V_{CM} = 0V$, $R_S = 100K\ \Omega$			-7.5	7.5	nA	1
Iib-	Input Bias Current	$V_{CM} = 0V$, $R_S = 100K\ \Omega$			-7.5	7.5	nA	1

Note 1: Calculated parameter.

Note 2: Datalog reading of $K = V/mV$.

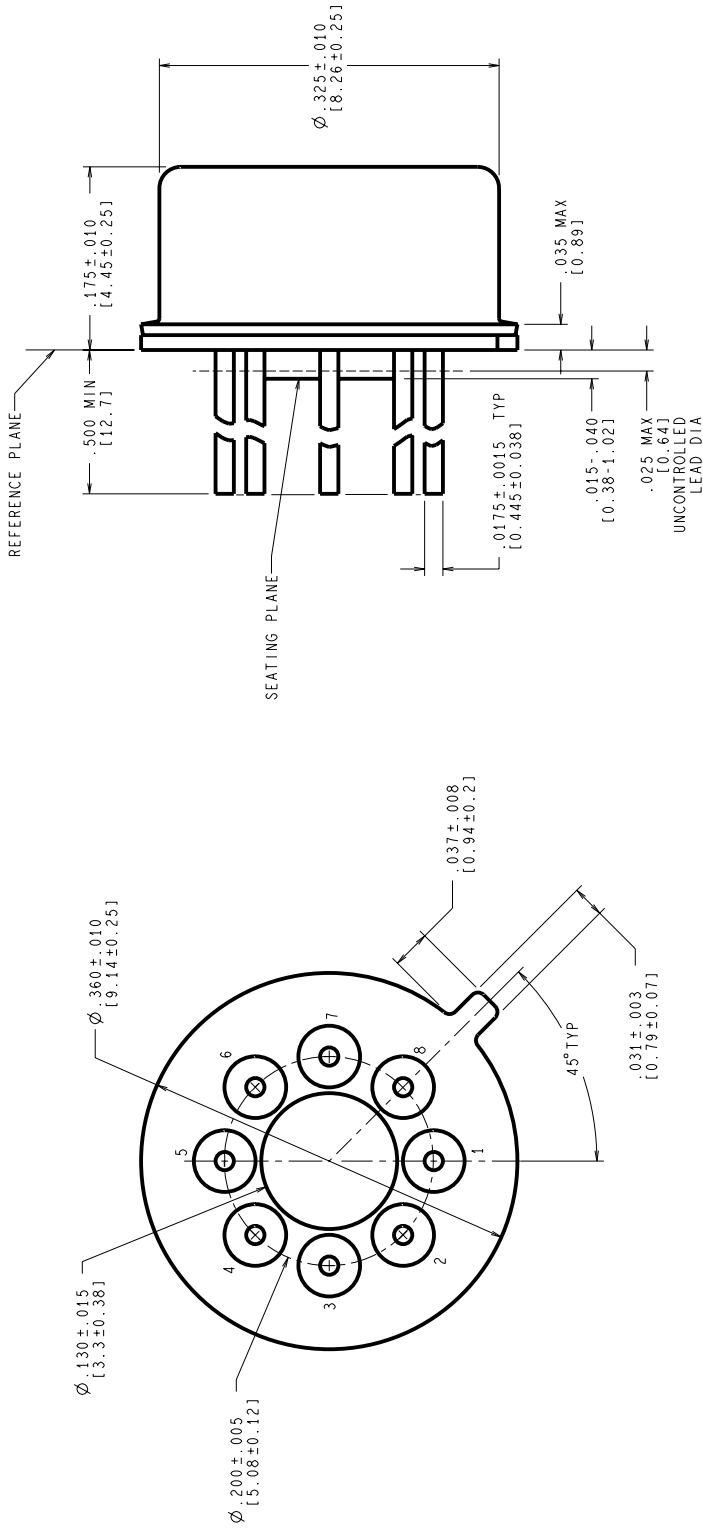
Note 3: Pre and post irradiation limits are identical to those listed under AC and DC electrical characteristics except as listed in the Post Radiation Limits Table. These parts may be dose rate sensitive in a space environment and demonstrate enhanced low dose rate effect. Radiation end point limits for the noted parameters are guaranteed only for the conditions as specified in MIL-STD-883, Method 1019.5

Graphics and Diagrams

GRAPHICS#	DESCRIPTION
08337HRB2	CERPACK (W), 10 LEAD (B/I CKT)
09384HRA4	METAL CAN, (H) TO-99, 8 LEAD, .200 DIA P.C. (B/I CKT)
09413HRB1	CERDIP (J), 8 LEAD (B/I CKT)
H08CRF	METAL CAN (H), TO-99, 8LD, .200 DIA P.C. (P/P DWG)
J08ARL	CERDIP (J), 8 LEAD (P/P DWG)
P000178A	METAL CAN (H), 8 LEAD (PINOUT)
P000180A	CERPACK (W), 10 LEAD (PINOUT)
P000226A	CERDIP (J), 8 LEAD (PINOUT)
W10ARG	CERPACK (W), 10 LEAD (P/P DWG)

See attached graphics following this page.

REVISIONS			
LTR	DESCRIPTION	E.C.N.	DATE
F	REVISE & REDRAW PER CURRENT STANDARD; UPDATE MIL/AERO STAMP & TITLE.	11002	06/22/95
			MS/



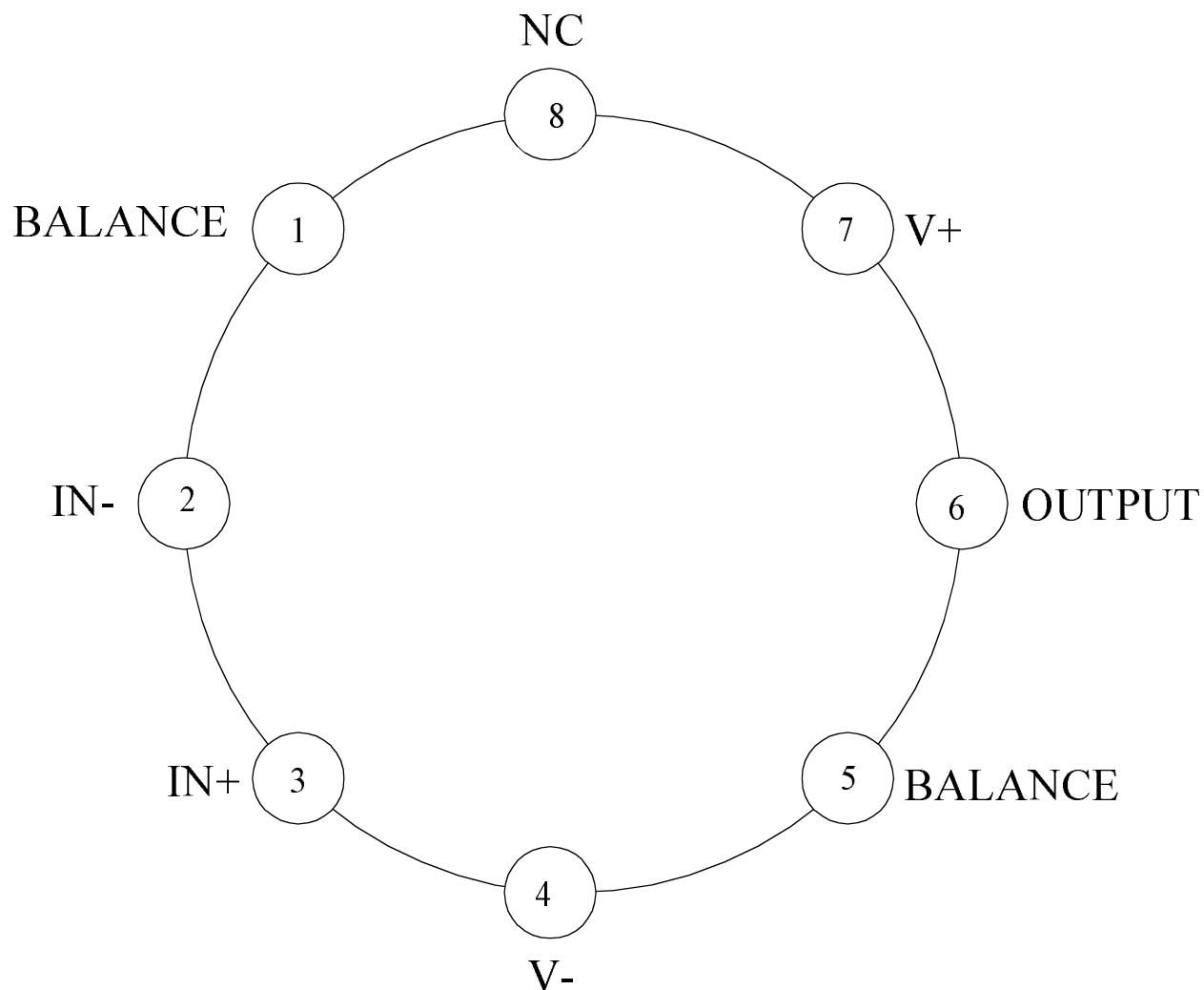
CONTROLLING DIMENSION IS INCH
VALUES IN [] ARE MILLIMETERS

MIL-I-38535
CONFIGURATION CONTROL

NOTES: UNLESS OTHERWISE SPECIFIED

- LEADS TO BE LOCATED WITHIN .007 IN/ 0.18 mm OF THEIR TRUE POSITIONS RELATIVE TO A MAXIMUM WIDTH TAB.
- STANDARD METAL CAN TYPE: SOLID BASE WITH CERAMIC STANDOFF.
- APPLIES TO MIL-AERO AND LINEAR PRODUCTS.
- REFERENCE JEDEC REGISTRATION TO-99, JEDEC PUBLICATION No.95.

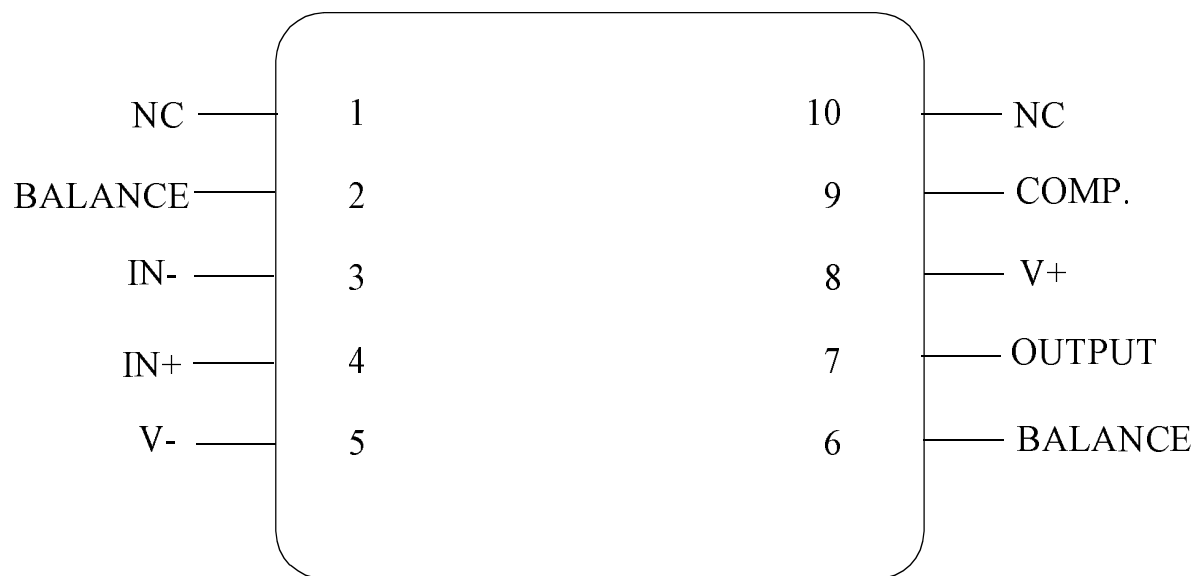
APPROVALS		DATE	National Semiconductor	
DESIGN	MARIA SUCHY	06/22/95	2000 Semiconductor dr., Santa Clara, CA 95052-8000	
DFTG	CHK			
ENGR	CHK			
			METAL CAN, TO-99, 8 LEAD, .200 DIA P.C.	
PROJECTION			SCALE	SIZE
			N/A	C
			DRAWING NUMBER	REV
			MKT-H08C	F
			DO NOT SCALE DRAWING	SHEET 1 of 1



LM101AH, LM101H
8 - PIN METAL CAN
CONNECTION DIAGRAM
TOP VIEW
P000178A



National Semiconductor™
MIL/AEROSPACE OPERATIONS
2900 SEMICONDUCTOR DRIVE
SANTA CLARA, CA 95050

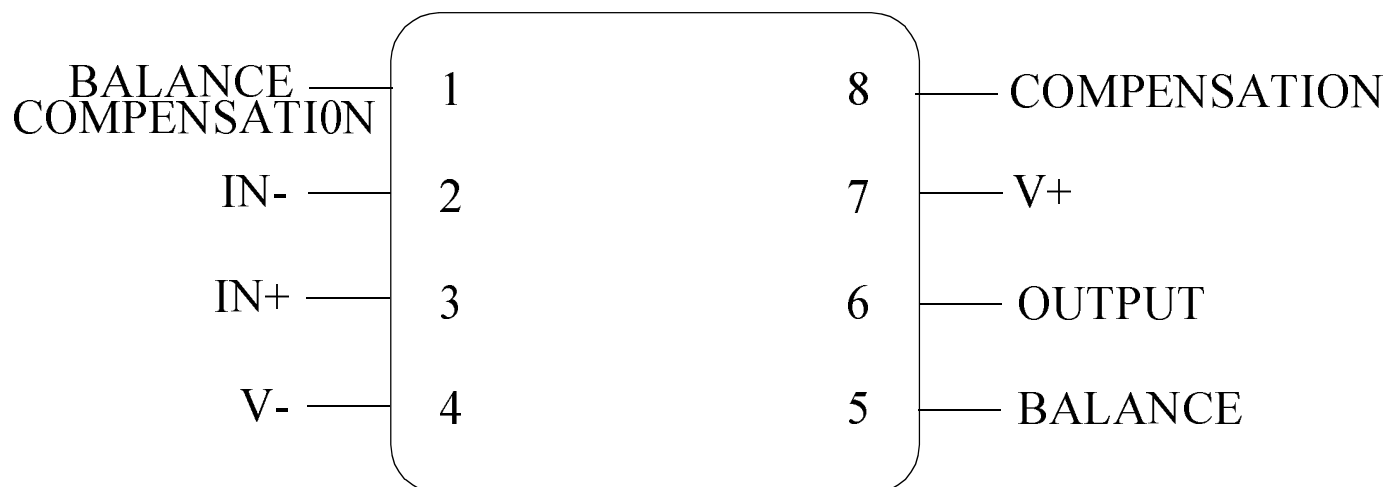


LM101AW
10 - LEAD CERPAC
CONNECTION DIAGRAM
TOP VIEW
P000180A



National Semiconductor™

MIL/AEROSPACE OPERATIONS
 2900 SEMICONDUCTOR DRIVE
 SANTA CLARA, CA 95050

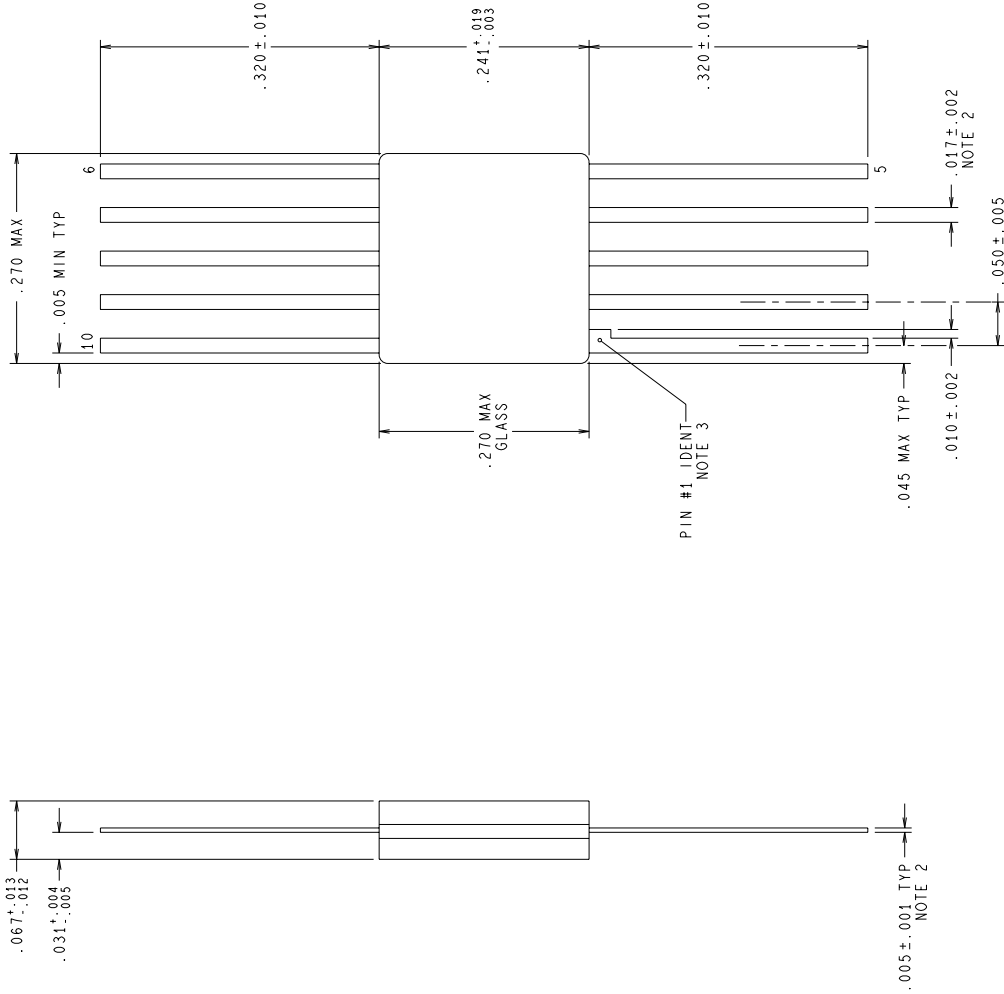


LM101AJ, LM101J
8 - LEAD DIP
CONNECTION DIAGRAM
TOP VIEW
P000226A



National Semiconductor™
MIL/AEROSPACE OPERATIONS
2900 SEMICONDUCTOR DRIVE
SANTA CLARA, CA 95050

REVISIONS			
LTR	DESCRIPTION	E.C.N.	DATE
F	REVISE AND REDRAW PER NEW STANDARD.	10510	07/28/94 DEG/AEP
G	.017±.002 WAS .017±.020.	10654	10/21/94 DEG/



NOTES: UNLESS OTHERWISE SPECIFIED.

1. LEAD FINISH: SOLDER DIPPED WITH Sn60 OR Sn63 SOLDER CONFORMING TO MIL-M-38510 TO A MINIMUM THICKNESS OF 200 MICROINCHES. SOLDER MAY BE APPLIED OVER LEAD BASIS METAL OR Sn PLATE.
2. MAXIMUM LIMIT MAY BE INCREASED BY .003 INCHES AFTER LEAD FINISH APPLIED.
3. LEAD 1 IDENTIFICATION SHALL BE:
 - a) A NOTCH OR OTHER MARK WITHIN THIS AREA
 - b) A TAB ON LEAD 1, EITHER SIDE
4. REFERENCE JEDEC REGISTRATION M0-003, VARIATION AG, DATED 06/01/76.

MIL/AERO
CONFIGURATION CONTROL

MIL-M-38510
CONFIGURATION CONTROL

APPROVALS		DATE	
DESIGN	<i>D. F. Grady</i>	07/28/94	
DFTG. CHK.			
EMER. CHK.			
PROJECTION			
SCALE	N/A	SIZE	C
DRAWING NUMBER	MKT-W10A		
REV	G		
DO NOT SCALE DRAWING		SHEET 1 of 1	

National Semiconductor
2000 Semiconductor dr., Santa Clara, CA 95052-8090

CERPACK, 10 LEAD

Revision History

Rev	ECN #	Rel Date	Originator	Changes
0A0	M0003656	05/08/00	Rose Malone	Initial MDS Release: MRLM101A-X-RH, Rev. 0A0
0B0	M0003678	05/08/00	Rose Malone	Update MDS: MRLM101A-X-RH, Rev. 0A0 to MRLM101A-X-RH, Rev. 0B0. Typo error in Features Section Controlling Documents: SMD Suffix VPA should be QPA for LM101AJRQML.