

**MJLP2951-X REV 1B1**

 Original Creation Date: 08/01/95  
 Last Update Date: 05/19/98  
 Last Major Revision Date: 01/21/97

**ADJUSTABLE MICROPPOWER VOLTAGE REGULATORS**
**General Description**

The LP2951 is a micropower voltage regulator with very low quiescent current (75 uA typ.) and very low dropout voltage (typ. 40 mV at light loads and 380 mV at 100mA). They are ideally suited for use in battery-powered systems. Furthermore, the quiescent current of the LP2951 increases only slightly in dropout, prolonging battery life.

The 8-Lead LP2951 is available in plastic, ceramic dual-in-line, or metal can packages and offers additional system functions.

One such feature is an error flag output which warns of a low output voltage, often due to falling batteries on the input. It may be used for a power-on reset. A second feature is the logic-compatible shutdown input which enables the regulator to be switched on and off. Also, the part may be pin-strapped for a 5V output or programmed from 1.24V to 29V with an external pair of resistors.

Careful design of the LP2951 has minimized all contributions to the error budget. This includes a tight initial tolerance (.5% typ.), extremely good load and line regulation (.05% typ.) and a very low output voltage temperature coefficient, making the part useful as a low-power voltage reference.

**Industry Part Number**

LP2951

**Prime Die**

LP2951

**NS Part Numbers**

 JL2951BGA\*  
 JL2951BPA\*\*  
 JL2951S2A\*\*\*  
 JL2951SGA\*\*\*\*  
 JL2951SPA\*\*\*\*\*

**Controlling Document**

See Features Page REV C

**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**

- SMD : 5962-3870501BGA\*, BPA\*\*, S2A\*\*\*, SGA\*\*\*\*, SPA\*\*\*\*\*.

**(Absolute Maximum Ratings)**

(Note 1)

Power Dissipation (Note 2)		
METAL CAN		675mW at +25 C
CERDIP		1.0W at +25 C
LCC		1.25W at +25 C
CERAMIC SOIC		1.0W at +25 C
Lead Temperature (Soldering, 10 seconds)		260 C
Storage Temperature Range		-65 C to +150 C
Operating Junction Temp Range LP2951		-55 C to +160 C
Input Supply Voltage		-0.3 to +30V
Feedback Input Voltage (Note 3, 4)		-1.5 to +30V
Shutdown Input Voltage (Note 3)		-0.3 to +30V
Error Comparator Out. Voltage (Note 3)		-0.3 to +30V
Thermal Resistance		
ThetaJA		
METAL CAN	(Still Air @ 0.5W)	163 C/W
	(500LF/Min Air flow @ 0.5W)	95 C/W
CERDIP	(Still Air @ 0.5W)	131 C/W
	(500LF/Min Air flow @ 0.5W)	75 C/W
LCC	(Still Air @ 0.5W)	95 C/W
	(500LF/Min Air flow @ 0.5W)	66 C/W
CERAMIC SOIC	(Still Air @ 0.5W)	215 C/W
	(500LF/Min Air flow @ 0.5W)	130 C/W
ThetaJC		
METAL CAN		51 C/W
CERDIP		21 C/W
LCC		24 C/W
CERAMIC SOIC		24 C/W
Package Weight (Typical)		TBD
ESD Rating		500V

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is 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 Pdmax = (Tjmax - TA)/ThetaJA or the number given in the Absolute Maximum Ratings, whichever is lower.

Note 3: May exceed input supply voltage.

Note 4: When used in dual-supply systems where the output terminal sees loads returned to a negative supply, the output voltage should be diode-clamped to ground.

## Electrical Characteristics

### DC PARAMETERS

(The following conditions apply to all the following parameters, unless otherwise specified.)  
 DC:  $V_{out} = 5V$  (Nominal),  $C_{load} = 3.3\mu F$ ,  $V_{sd} = 0.6V$ ,  $V_{in} = 6V$ ,  $I_l = -100\mu A$

SYMBOL	PARAMETER	CONDITIONS	NOTES	PIN-NAME	MIN	MAX	UNIT	SUB-GROUPS
Vo	Output Voltage	$V_{in} = 6V$ , $I_l = -100\mu A$			4.975	5.025	V	1
					4.94	5.06	V	2, 3
Voline	Line Regulation	$6V \leq V_{in} \leq 30V$ , $I_l = -1mA$			-5	5	mV	1
		$6V \leq V_{in} \leq 30V$ , $I_l = -1mA$			-25	25	mV	2, 3
Voload	Load Regulation	$-100\mu A \leq I_l \leq -100mA$ , $V_{in} = 6V$			-5	5	mV	1
		$-100\mu A \leq I_l \leq -100mA$ , $V_{in} = 6V$			-25	25	mV	2, 3
Vd	Dropout Voltage	$I_l = -100mA$				450	mV	1
					600	mV	2, 3	
		$I_l = -100\mu A$				80	mV	1
					150	mV	2, 3	
Ig	Ground Current	$I_l = -100mA$ , $V_{in} = 6V$				12	mA	1
					14	mA	2, 3	
		$I_l = -100\mu A$ , $V_{in} = 6V$				120	$\mu A$	1
					140	$\mu A$	2, 3	
		$I_l = -100\mu A$ , $V_{out} = 15V$ , $V_{in} = 30V$				120	$\mu A$	1
					140	$\mu A$	2, 3	
		$I_l = -100\mu A$ , $V_{in} = 30V$ , $V_{out} = 15V$				15	mA	1
					20	mA	2, 3	
Igdif	Ground Current Change	$6V \leq V_{in} \leq 30V$ , $I_l = -100\mu A$			-30	30	$\mu A$	1
		$6V \leq V_{in} \leq 30V$ , $I_l = -100\mu A$			-50	50	$\mu A$	2, 3
Igd0	Dropout Ground Current	$V_{in} = 4.5V$ , $I_l = -100\mu A$				170	$\mu A$	1
					200	$\mu A$	2, 3	
Vlt	Error Comparator Lower Threshold Voltage	$V_{in} = 6V$ , $I_l = -100\mu A$	1		0	0.8	mV	1, 2, 3
Vut	Error Comparator Upper Threshold Voltage	$V_{in} = 6V$ , $I_l = -100\mu A$	1		2	30	mV	1, 2, 3
Vrth	Thermal Regulation	$V_{in} = 30V$ , $I_l = -50mA$ , $2mS \leq T \leq 10mS$			-12.5	12.5	mV	1
Isc	Current Limit	$V_{out} = 0V$ , $V_{in} = 6V$				200	mA	1
					220	mA	2, 3	

## Electrical Characteristics

### DC PARAMETERS (Continued)

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

DC:  $V_{out} = 5V$  (Nominal),  $C_{load} = 3.3\mu F$ ,  $V_{sd} = 0.6V$ ,  $V_{in} = 6V$ ,  $I_l = -100\mu A$

SYMBOL	PARAMETER	CONDITIONS	NOTES	PIN-NAME	MIN	MAX	UNIT	SUB-GROUPS	
I <sub>gsc</sub>	Ground Current At Current Limit	$V_{out} = 0V$ , $V_{in} = 6V$				20	mA	1	
						25	mA	2, 3	
V <sub>ref</sub>	Reference Voltage				1.22	1.25	V	1	
					1.20	1.26	V	2, 3	
V <sub>rline</sub>	Reference Voltage Line Regulation	$2.3V \leq V_{in} \leq 30V$			-1.9	1.9	mV	1	
		$2.3V \leq V_{in} \leq 30V$			-10	10	mV	2, 3	
V <sub>rload</sub>	Reference Voltage Output Regulation	$1.2V \leq V_{out} \leq 29V$ , $V_{in} = 30V$			-1.2	1.2	mV	1	
		$1.2V \leq V_{out} \leq 29V$ , $V_{in} = 30V$			-5	5	mV	2, 3	
I <sub>fb</sub>	Feedback Pin Bias Current					40	nA	1	
						60	nA	2, 3	
I <sub>oh</sub>	Error Comparator Output Leakage Current	$V_o = 30V$				1	$\mu A$	1	
						2	$\mu A$	2, 3	
V <sub>ol</sub>	Error Comparator Output Low Voltage	$V_{in} = 4.5V$ , $V_{sd} = 2V$				250	mV	1	
						400	mV	2, 3	
I <sub>sd</sub>	Shutdown Pin Input Current	$V_{sd} = 2.4V$				50	$\mu A$	1	
						100	$\mu A$	2, 3	
		$V_{sd} = 30V$				600	$\mu A$	1	
					750	$\mu A$	2, 3		
V <sub>sd1</sub>	Shutdown Input Logic Voltage	(LOW)	1			0.6	V	1, 2, 3	
V <sub>sdh</sub>	Shutdown Input Logic Voltage	(HIGH)	1		2		V	1, 2, 3	
I <sub>lkg</sub>	Regular Output Bias Current In Shutdown	$V_{sd} = 2V$ , $V_{in} = 30V$ , $I_l = 0mA$				-10	10	$\mu A$	1
						-20	20	$\mu A$	2, 3

### AC PARAMETERS

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

AC:  $V_{in} = 6V$ ,  $C_{load} = 3.3\mu F$ ,  $V_{sd} = 0.6V$

R <sub>r</sub>	Ripple Rejection	$f = 120Hz$ , $V_{in} = 0.1V_{rms}$			50		dB	4
V <sub>noise</sub>	Output Noise	$C_l = 1\mu F$				600	$\mu V_{rms}$	7
		$C_l = 3.3\mu F$				250	$\mu V_{rms}$	7

## Electrical Characteristics

### DC PARAMETERS: DRIFT VALUES

(The following conditions apply to all the following parameters, unless otherwise specified.)  
 DC:  $V_{out} = 5V$  (Nominal),  $C_{load} = 3.3\mu F$ ,  $V_{sd} = 0.6V$ ,  $V_{in} = 6V$ ,  $I_l = -100\mu A$ . "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
I <sub>g</sub>	Ground Current	$I_l = -100\mu A$ , $V_{in} = 6V$			-6.5	6.5	$\mu A$	1
V <sub>ref</sub>	Reference Voltage				-0.0055	0.0055	V	1

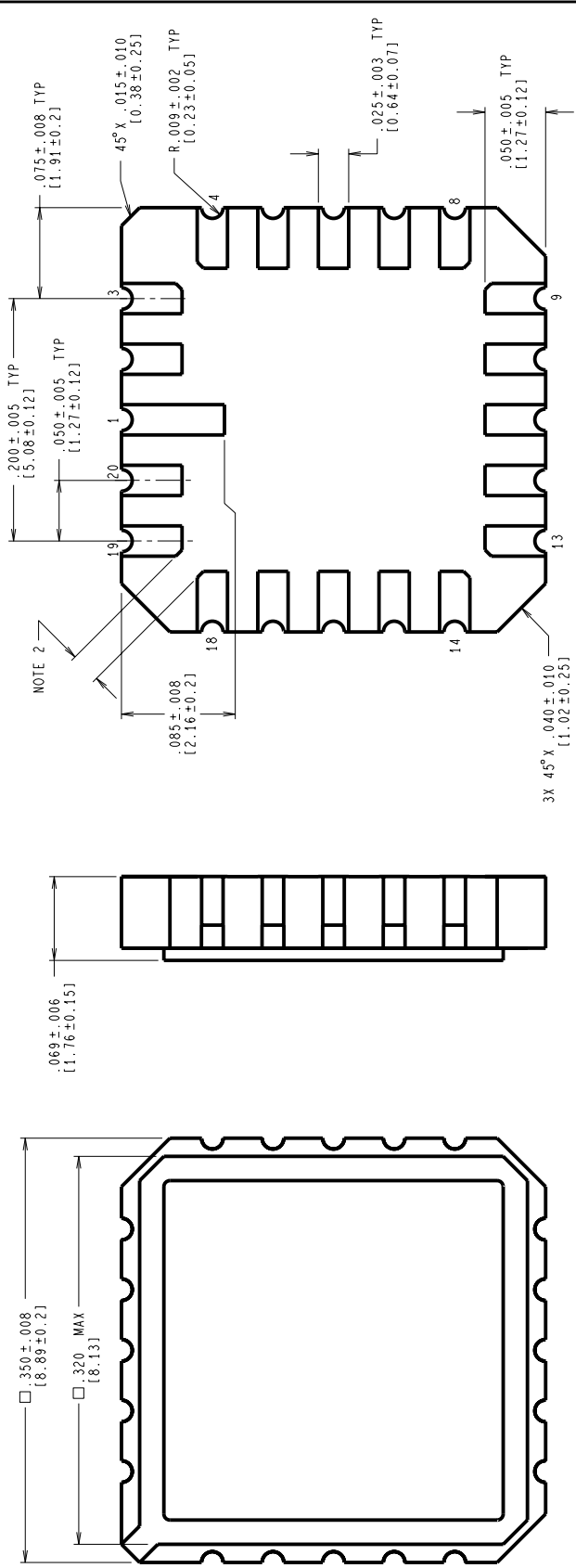
Note 1: Parameter tested go-no-go only.

## Graphics and Diagrams

GRAPHICS#	DESCRIPTION
05810HRA2	METAL CAN (H), TO-99, 8LD, .200 DIA P.C. (B/I CKT)
06059HRA2	CERDIP (J), 8 LEAD (B/I CKT)
06146HRA2	LCC (E), TYPE C, 20 TERMINAL(B/I CKT)
06341HRA1	CERPACK (W), 10 LEAD (B/I CKT)
E20ARE	LCC (E), TYPE C, 20 TERMINAL(P/P DWG)
H08CRF	METAL CAN (H), TO-99, 8LD, .200 DIA P.C. (P/P DWG)
J08ARL	CERDIP (J), 8 LEAD (P/P DWG)
P000205A	METAL CAN (H), 8 LEAD (PINOUT)
P000206A	CERDIP (J), 8 LEAD (PINOUT)
P000251B	LCC (E), 20 LEAD (PINOUT)
P000374A	CERAMIC SOIC (WG), 10 LEAD (PINOUT)
WG10ARC	CERAMIC SOIC (WG), 10 LEAD (P/P DWG)

See attached graphics following this page.

REVISIONS			
LTR	DESCRIPTION	E.C.N.	DATE
E	REVISE AND REDRAW.	10005	02/10/94 DEG/



CONTROLLING DIMENSION IS INCH  
VALUES IN [ ] ARE MILLIMETERS

NOTES: UNLESS OTHERWISE SPECIFIED.

1. LEAD FINISH TO BE ONE OF THE FOLLOWING:

- a. 50 MICRONS/12.7 MICROMETERS MINIMUM GOLD PLATING OVER 50-350 MICRONS/1.27-8.89 MICROMETERS NICKEL.
  - b. SOLDER DIP.  
SOLDER THICKNESS PER LATEST REVISION OF MIL-STD-1835.
2. CORNER PADS MAY HAVE A  $45^\circ \times .020$  IN/0.51mm MAXIMUM CHAMFER TO ACCOMPLISH THE .015 IN/0.38mm DIMENSION.
4. REFERENCE JEDEC REGISTRATION MS-004, VARIATION CB, DATED 7/90.

MIL/AERO  
CONFIGURATION CONTROL

APPROVALS		DATE
DRN: <i>Deane Gedy</i>		02/10/94
DFTG: CHK.		
ENGR: CHK.		
APPROVAL		

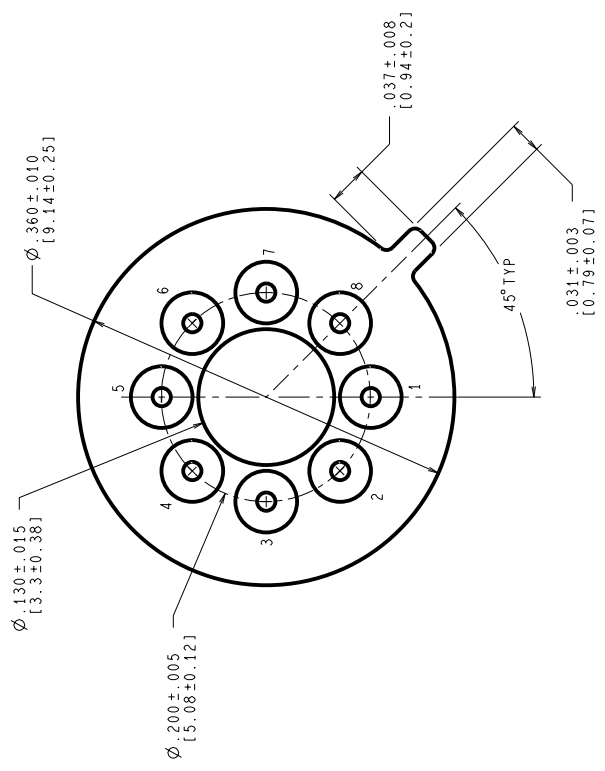
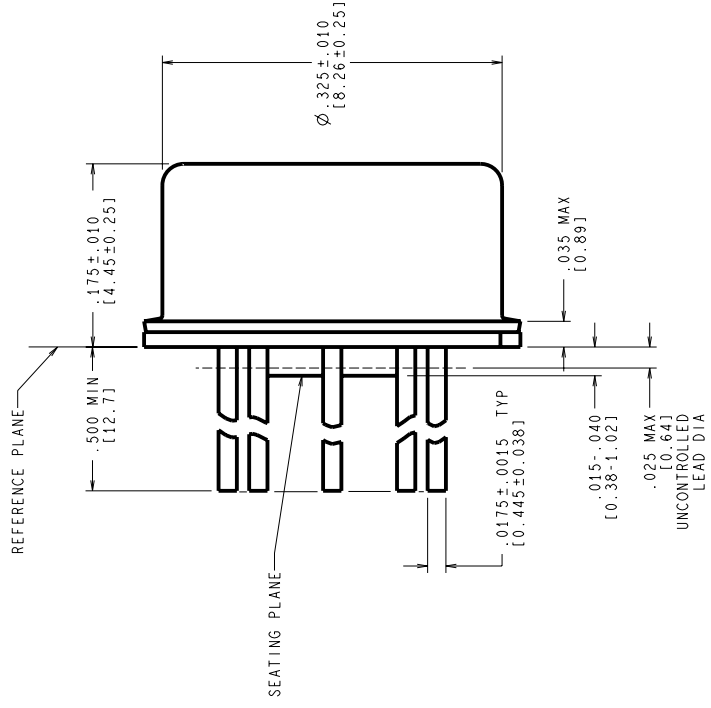
NATIONAL SEMICONDUCTOR CORPORATION 2900 Semiconductor Drive, Santa Clara, CA 95052-8000	
<b>LEADLESS CHIP CARRIER, TYPE C, 20 TERMINAL</b>	
SCALE	N/A
SIZE	C
DRAWING NUMBER	MKT-E20A
REV	E

DO NOT SCALE DRAWING SHEET 1 of 1



REVISIONS

LTR	DESCRIPTION	E.C. N.	DATE	BY/APP'D
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
DRN: MARTA SUCHY	06/22/95
DWG. CHK.	
ENGR. CHK.	

SCALE	N/A
SIZE	C
DRAWING NUMBER	MKT-H08C
REV	F

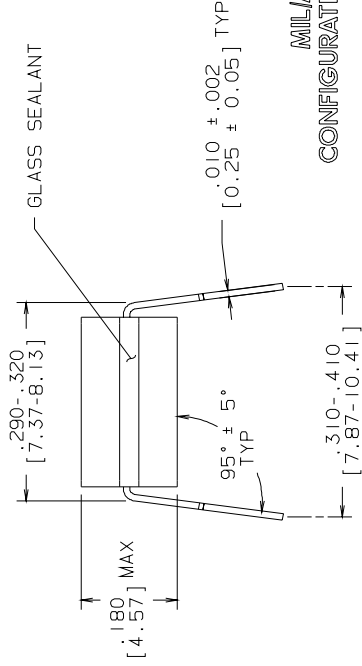
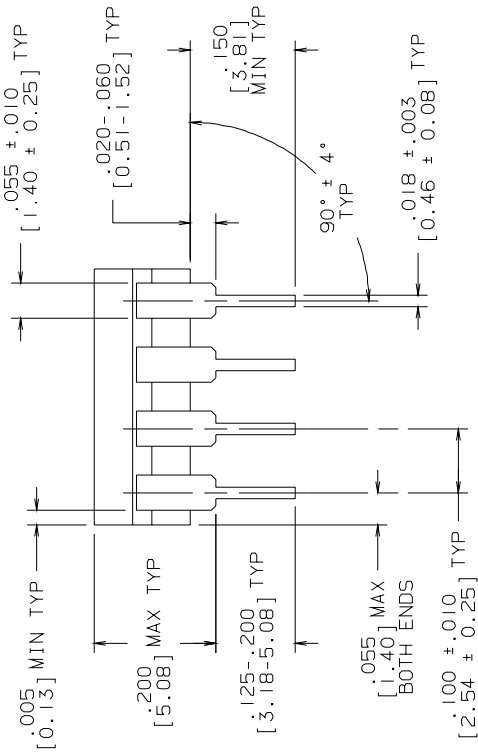
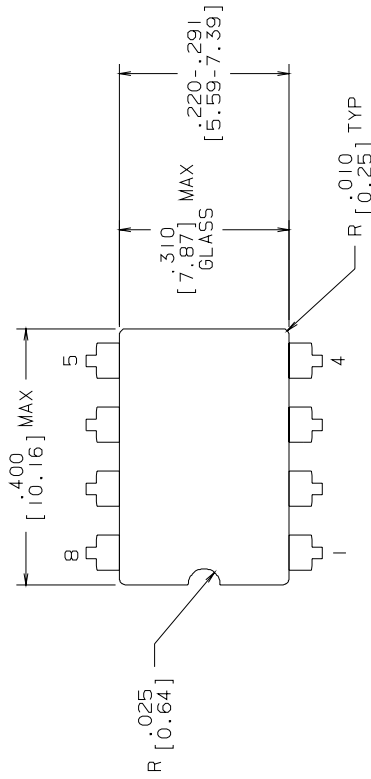
  

National Semiconductor	
2800, Semiconductor dr., Santa Clara, CA 95052-8090	
METAL CAN, 8 LEAD, .200 DIA P.C.	

DO NOT SCALE DRAWING	
SHEET 1 of 1	

R E V I S I O N S			
LTR	DESCRIPTION	E. C. N.	DATE
L	REVISE PER CURRENT STD; REDRAW	10002	09/21/93
			BY/APP'D TL/



MILAERO  
CONFIGURATION CONTROL  
MIL-M-38510  
CONFIGURATION CONTROL

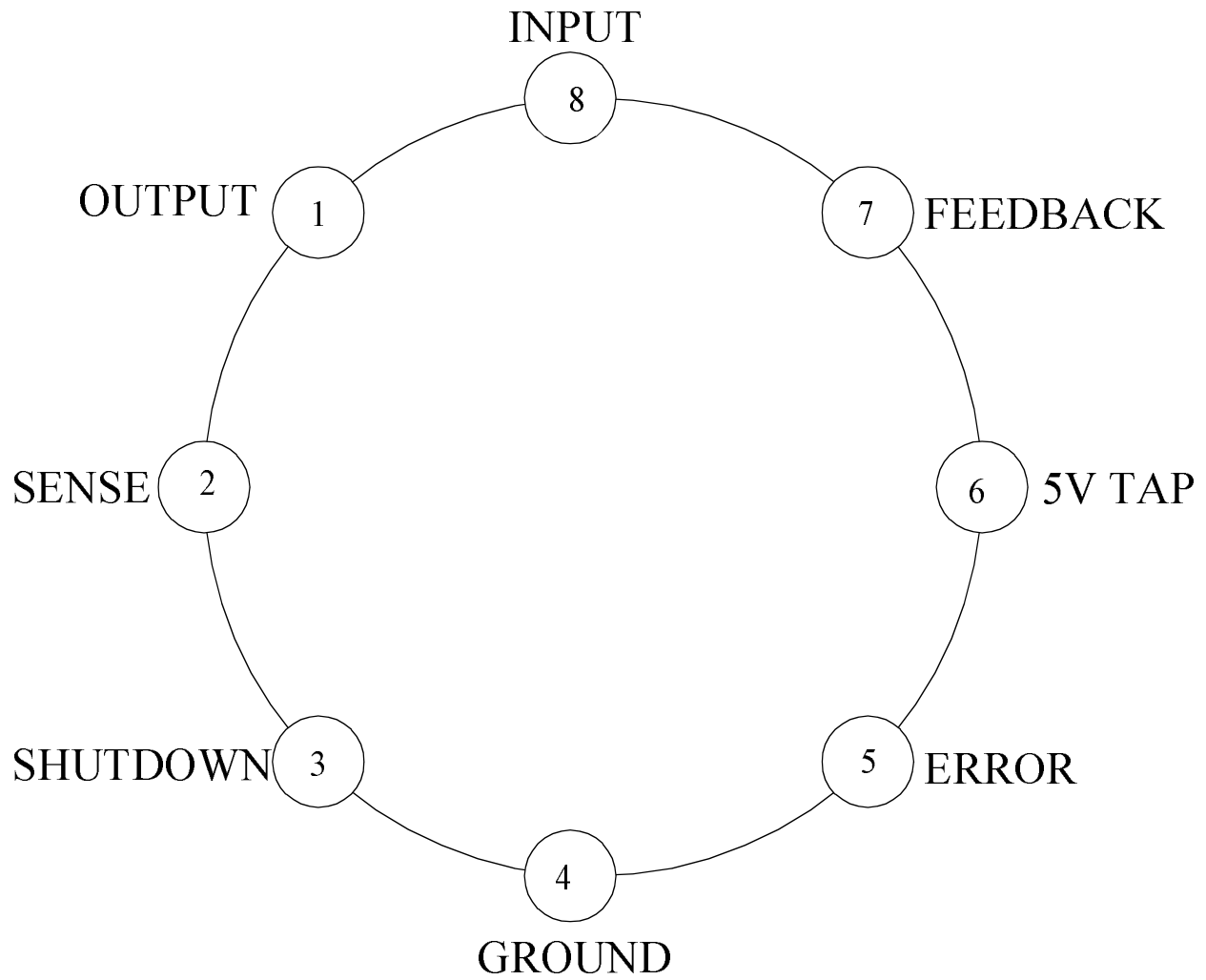
CONTROLLING DIMENSION: INCH	
APPROVALS	DATE
DRAWN <b>T. LEQUANG</b>	09/21/93
DFTG. CHK.	
ENGR. CHK.	
APPROVAL	
SCALE	DRAWING NUMBER
N/A	B MKT-J08A
DO NOT SCALE DRAWING	SHEET 1 OF 1

NOTES: UNLESS OTHERWISE SPECIFIED

- LEAD FINISH TO BE 200 MICROMETERS / 5.08 MICROMETERS MINIMUM SOLDER MEASURED AT THE CREST OF THE MAJOR FLATS.
- JEDEC REGISTRATION MO-036, VARIATION AA, DATED 04/1981.

NATIONAL SEMICONDUCTOR CORPORATION  
2900 Semiconductor Drive, Santa Clara, CA 95052-8090

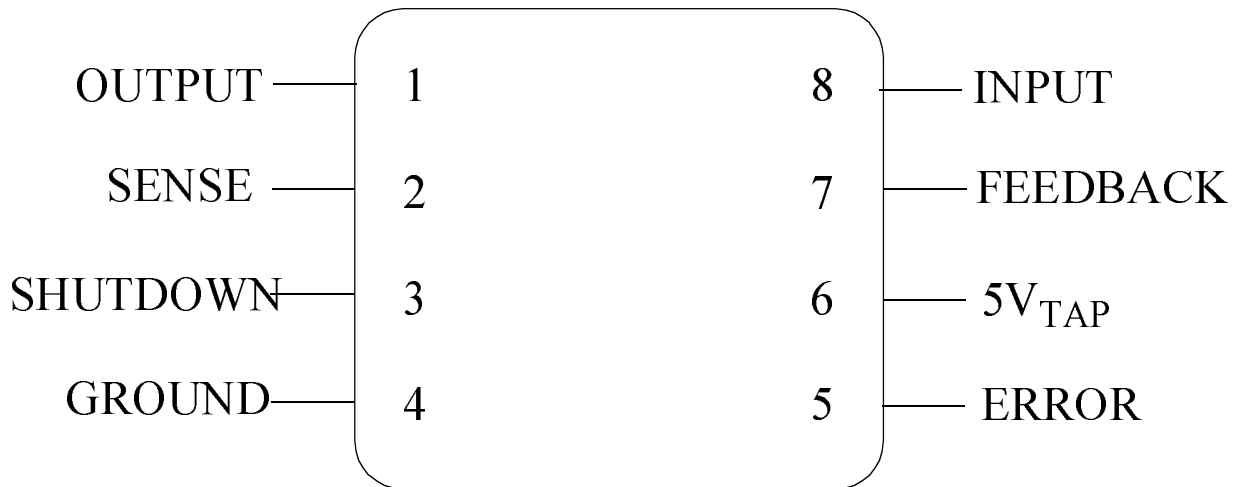
CERDIP (J),  
8 LEAD



**LP2951H**  
**8 - PIN METAL CAN**  
**CONNECTION DIAGRAM**  
**TOP VIEW**  
**P000205A**



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

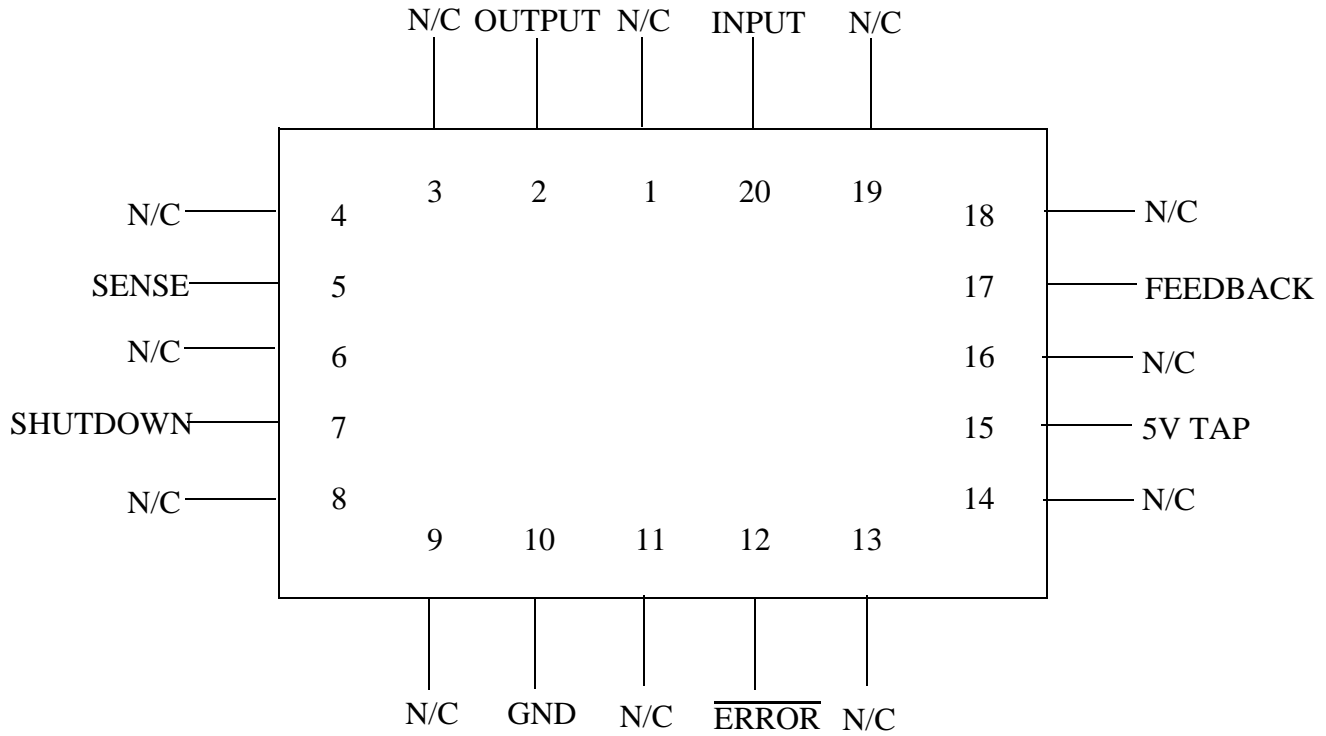


LP2951J  
8 - LEAD DIP  
CONNECTION DIAGRAM  
TOP VIEW  
P000206A

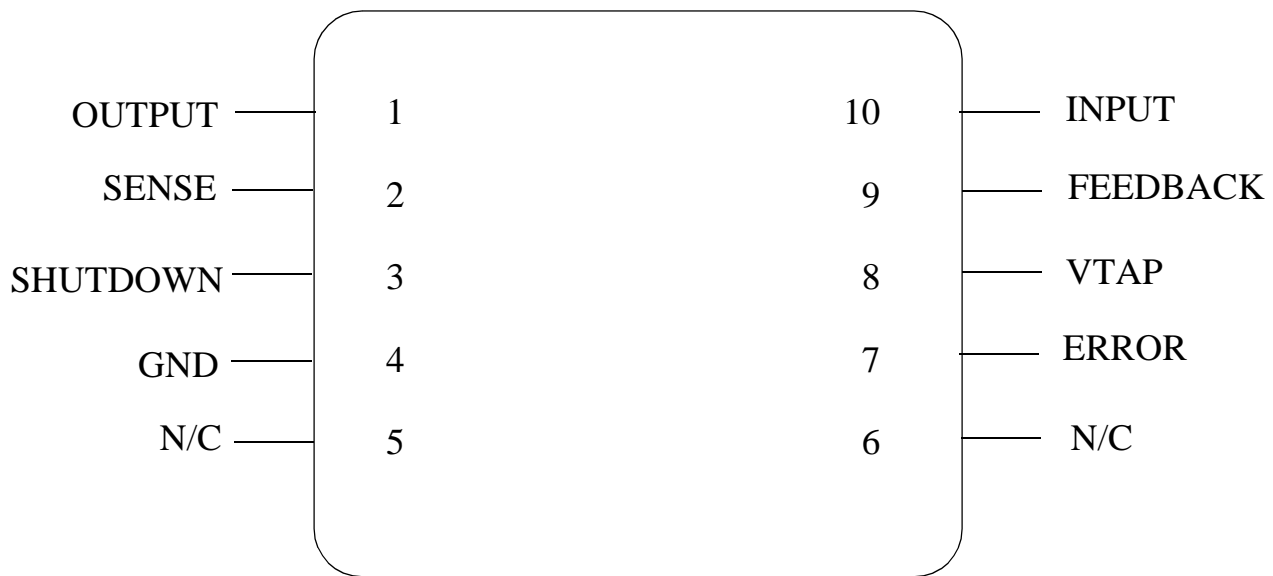


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MIL/AEROSPACE OPERATIONS  
2900 SEMICONDUCTOR DRIVE  
SANTA CLARA, CA 95050



**LP2951E**  
**20 - LEAD LCC**  
**CONNECTION DIAGRAM**  
**TOP VIEW**  
**P000251B**



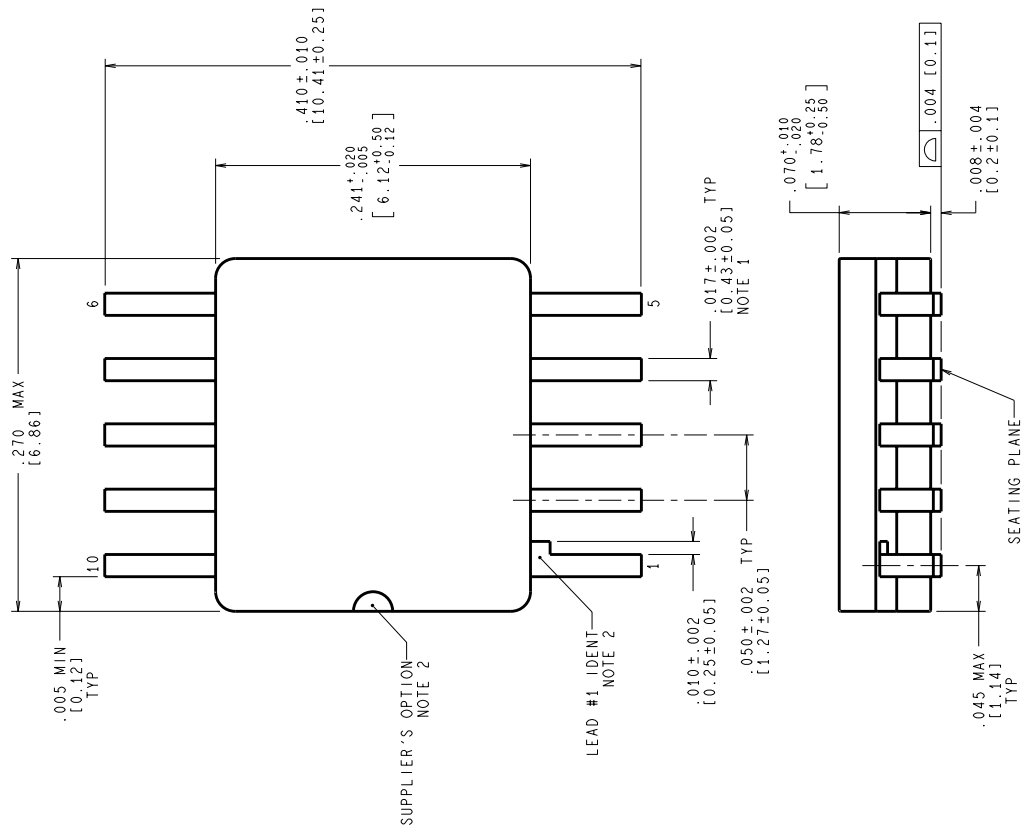
**LP2951WG**  
**10 - LEAD CERAMIC SOIC**  
**CONNECTION DIAGRAM**  
**TOP VIEW**  
**P000374A**



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

REVISIONS

LTR	DESCRIPTION	E.C.N.	DATE	BY/APP'D
A	RELEASE TO DOCUMENT CONTROL	11374	02/29/1996	MS/KH
B	LD PITCH TOL WAS ±.005; CHANGE LD RADIUS TO REF DIM; REMOVE THE OTHER R.006±.002 DIM. .040±.003 WAS .037±.003	11441	04/19/1996	MS/KH
C	R .015(0.38) WAS R .006(0.15)	11838	10/08/1997	TL/



CONTROLLING DIMENSION IS INCH  
VALUES IN | ARE MILLIMETERS

MIL-PRF-38535  
CONFIGURATION CONTROL

APPROVALS	DATE	SCALE	SIZE	DRAWING NUMBER	REV
DRN: MARYA SUCHY	02/29/96	N/A	C	(SC)MKT-WG10A	C
DATE: 02/29/96					
PROJ. CHK.					
ENGR. CHK.					
PROJECTION					
DO NOT SCALE DRAWING					
SHEET 1 of 1					

**National Semiconductor**  
2800 Semiconductor Dr., Santa Clara, CA 95052-8090

**CERPACK,  
10 LEAD,  
GULL WING**

NOTES: UNLESS OTHERWISE SPECIFIED

- LEAD FINISH: SOLDER DIPPED WITH Sn60 OR Sn63 SOLDER CONFORMING TO MIL-PRF-38535 TO A MINIMUM THICKNESS OF 200 MICRONS/ 5.08 MICROMETERS. SOLDER MAY BE APPLIED OVER LEAD BASIS METAL OR Sn PLATE. MAXIMUM LIMIT MAY BE INCREASED BY .003 IN/ 0.08mm AFTER LEAD FINISH APPLIED.
- LEAD 1 IDENTIFICATION SHALL BE:
  - A NOTCH OR OTHER MARK WITHIN THIS AREA
  - A TAB ON LEAD 1, EITHER SIDE
- NO JEDEC REGISTRATION AS OF FEBRUARY 1996.

**Revision History**

Rev	ECN #	Rel Date	Originator	Changes
1B1	M0002867	05/19/98	Barbara Lopez	Update MDS: MJLP2951-X Rev. 1A0 to MJLP2951-X Rev. 1B1. Updated SMD number to add suffixes. Updated NSID to add astericks associated with SMD suffix. Updated power dissipation, lead temperature, junction temperature, thermal resistance and ESD rating. Changed note 1 to Absolute note, updated note 2 to power dissipation note. Added graphics for all packages. Added Package Weights.