

MNLM2940-12-X REV 1A1

 Original Creation Date: 07/22/96
 Last Update Date: 10/08/99
 Last Major Revision Date: 07/22/96

1A LOW DROPOUT REGULATOR
General Description

The LM2940 positive voltage regulator features the ability to source 1A of output current with a dropout voltage of typically 0.5V and a maximum of 1V over the entire temperature range. Furthermore, a quiescent current reduction circuit has been included which reduces the ground current when the differential between the input voltage and the output voltage exceeds approximately 3V. The quiescent current with 1A of output current and an input-output differential of 5V is therefore only 30 mA. Higher quiescent currents only exist when the regulator is in the dropout mode ($V_{in} - V_{out} \leq 3V$).

Designed also for vehicular applications, the LM2940 and all regulated circuitry are protected from reverse battery installations or 2-battery jumps. During line transients, such as load dump when the input voltage can momentarily exceed the specified maximum operating voltage, the regulator will automatically shut down to protect both the internal circuits and the load. The LM2940 cannot be harmed by temporary mirror-image insertion. Familiar regulator features such as short circuit and thermal overload protection are also provided.

Industry Part Number

LM2940

NS Part Numbers

 LM2940J-12/883
 LM2940K-12/883
 LM2940WG-12/883

Prime Die

LM2940

Controlling Document

SEE FEATURE 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

- Dropout voltage typically 0.5V @ $I_o = 1A$
- Output current in excess of 1A
- Output voltage trimmed before assembly
- Reverse battery protection
- Internal short circuit current limit
- Mirror image insertion protection
- CONTROLLING DOCUMENT
- LM2940J-12/883 5962-9088401QEA
- LM2940K-12/883 5962-9088401MYA
- LM2940WG-12/883 5962-9088401QXA

(Absolute Maximum Ratings)

(Note 1)

| | |
|---|--------------------|
| Input Voltage (Survival Voltage $\leq 100\text{ms}$) | 60V |
| Internal Power Dissipation (Note 2, 3) | Internally Limited |
| Maximum Junction Temperature | 150 C |
| Storage Temperature Range | -65 C to +150 C |
| Lead Temperature (Soldering, 10 seconds) | 300 C |
| Thermal Resistance | |
| ThetaJA | |
| T03 Pkg (Still Air) | 40 C/W |
| T03 Pkg (500LF/Min Air flow) | TBD |
| CERDIP (Still Air) | 73 C/W |
| CERDIP (500LF/Min Air flow) | 37 C/W |
| CERAMIC SOIC (Still Air) | 122 C/W |
| CERAMIC SOIC (500LF/Min Air Flow) | 77 C/W |
| ThetaJC | |
| T03 | 5 C/W |
| CERDIP | 3 C/W |
| (Note 3) | |
| CERAMIC SOIC | 5 C/W |
| (Note 3) | |
| Package Weight (Typical) | |
| T03 Pkg | TBD |
| CERDIP | 1970mg |
| CERAMIC SOIC | 360mg |
| ESD Susceptibility (Note 4) | 4000V |

Note 1: Absolute Maximum Ratings are limits beyond which damage to the device may occur. Operating Ratings are 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 T_{jmax} (maximum junction temperature), θ_{JA} (package junction to ambient thermal resistance), and T_A (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: The package material for these devices allows much improved heat transfer over our standard ceramic packages. In order to take full advantage of this improved heat transfer, heat sinking must be provided between the package base (directly beneath the die), and either metal traces on, or thermal vias through, the printed circuit board. Without this additional heat sinking, device power dissipation must be calculated using junction-to-ambient, rather than junction-to-case, thermal resistance. It must not be assumed that the device leads will provide substantial heat transfer out of the package, since the thermal resistance of the leadframe material is very poor, relative to the material of the package base. The stated junction-to-case thermal resistance is for the package material only, and does not account for the additional thermal resistance between the package base and the printed circuit board. The user must determine the value of the additional thermal resistance and must combine this with the stated value for the package, to calculate the total allowed power dissipation for the device.

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

Recommended Operating Conditions

(Note 1)

Input Voltage

26V

Operating Temperature Range

$-55\text{ C} \leq T_A \leq +125\text{ C}$

Note 1: Absolute Maximum Ratings are limits beyond which damage to the device may occur. Operating Ratings are 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.

Electrical Characteristics

DC PARAMETERS:

(The following conditions apply to all the following parameters, unless otherwise specified.)
DC: $V_{in} = 17V$, $I_o = 1A$, $C_{out} = 22\mu F$

| SYMBOL | PARAMETER | CONDITIONS | NOTES | PIN-NAME | MIN | MAX | UNIT | SUB-GROUPS | | |
|------------------------------|-----------------|--|-----------------------------------|--|-------|-------|------|------------|----|---------|
| Vout | Output Voltage | $V_{in} = 17V$, $I_o = 5mA$ | | | 11.64 | 12.36 | V | 1 | | |
| | | | | | 11.40 | 12.60 | V | 2, 3 | | |
| | | $V_{in} = 13.6V$, $I_o = 5mA$ | | | 11.64 | 12.36 | V | 1 | | |
| | | | | | 11.40 | 12.60 | V | 2, 3 | | |
| | | $V_{in} = 14V$, $I_o = 5mA$ | | | 11.64 | 12.36 | V | 1 | | |
| | | | | | 11.40 | 12.60 | V | 2, 3 | | |
| | | $V_{in} = 26V$, $I_o = 5mA$ | | | 11.64 | 12.36 | V | 1 | | |
| | | | | | 11.40 | 12.60 | V | 2, 3 | | |
| | | $V_{in} = 17V$, $I_o = 1A$ | | | 11.64 | 12.36 | V | 1 | | |
| | | | | | 11.40 | 12.60 | V | 2, 3 | | |
| | | $V_{in} = 13.6V$, $I_o = 1A$ | | | 11.64 | 12.36 | V | 1 | | |
| | | | | | 11.40 | 12.60 | V | 2, 3 | | |
| | | $V_{in} = 13.6V$, $I_o = 50mA$ | | | 11.64 | 12.36 | V | 1 | | |
| | | | | | 11.40 | 12.60 | V | 2, 3 | | |
| | | $V_{in} = 17V$, $I_o = 50mA$ | | | 11.64 | 12.36 | V | 1 | | |
| | | | | | 11.40 | 12.60 | V | 2, 3 | | |
| | | | Reverse Polarity Input Voltage DC | $R_o = 100 \text{ Ohms}$ | 1 | | -15 | | V | 1, 2, 3 |
| | | Iq | Quiescent Current | $V_{in} = 17V$, $I_o = 5mA$ | | | 0 | 15 | mA | 1 |
| | | | | | 0 | 20 | mA | 2, 3 | | |
| $V_{in} = 14V$, $I_o = 5mA$ | | | | | 0 | 15 | mA | 1 | | |
| | | | | | 0 | 20 | mA | 2, 3 | | |
| $V_{in} = 26V$, $I_o = 5mA$ | | | | | 0 | 15 | mA | 1 | | |
| | | | | | 0 | 20 | mA | 2, 3 | | |
| $V_{in} = 17V$, $I_o = 1A$ | | | | | 0 | 50 | mA | 1 | | |
| | | | | | 0 | 60 | mA | 2, 3 | | |
| Vrline | Line Regulation | | | $14V \leq V_{in} \leq 26V$, $I_o = 5mA$ | | | -75 | 75 | mV | 1 |
| | | | | | | | -120 | 120 | mV | 2, 3 |
| Vrload | Load Regulation | $V_{in} = 17V$, $50mA \leq I_o \leq 1A$ | | | -120 | 120 | mV | 1 | | |
| | | | | | -190 | 190 | mV | 2, 3 | | |

Electrical Characteristics

DC PARAMETERS: (Continued)

(The following conditions apply to all the following parameters, unless otherwise specified.)
DC: $V_{in} = 17V$, $I_o = 1A$, $C_{out} = 22\mu F$

| SYMBOL | PARAMETER | CONDITIONS | NOTES | PIN-NAME | MIN | MAX | UNIT | SUB-GROUPS |
|--------|-----------------------|----------------|-------|----------|-----|-----|------|------------|
| Vdo | Dropout Voltage | $I_o = 1A$ | | | 0 | 0.7 | V | 1 |
| | | | | | 0 | 1 | V | 2, 3 |
| | | $I_o = 100mA$ | | | 0 | 200 | mV | 1 |
| | | | | | 0 | 300 | mV | 2, 3 |
| Isc | Short Circuit Current | $V_{in} = 17V$ | | | 1.6 | | A | 1 |
| | | | | | 1.3 | | A | 2, 3 |

AC PARAMETERS:

(The following conditions apply to all the following parameters, unless otherwise specified.)
AC: $V_{in} = 17V$, $I_o = 1A$, $C_{out} = 22\mu F$

| | | | | | | | | |
|----|--|--|---|--|-----|------|---------------|-----------|
| | Max Line Transient | $V_o \leq 13V$, $R_o = 100 \text{ Ohms}$, $T = 20ms$ | 1 | | 40 | | V | 7, 8A, 8B |
| | Reverse Polarity Input Voltage Transient | $T = 20ms$, $R_o = 100 \text{ Ohms}$ | 1 | | -45 | | V | 7, 8A, 8B |
| No | Output Noise Voltage | $V_{in} = 17V$, $I_o = 5mA$, $10Hz = 100KHz$ | 1 | | 0 | 1000 | μV_{rms} | 4, 5, 6 |
| Zo | Output Impedance | $V_{in} = 17V$, $I_o = 100mA$ DC and $20mA$ AC, $f_o = 120Hz$ | 1 | | | 1 | Ohm | 4, 5, 6 |
| RR | Ripple Rejection | $V_{in} = 17V$, $1V_{rms}$, $f = 1KHz$, $I_o = 5mA$ | 1 | | 52 | | dB | 4 |
| | | | 1 | | 46 | | dB | 5, 6 |

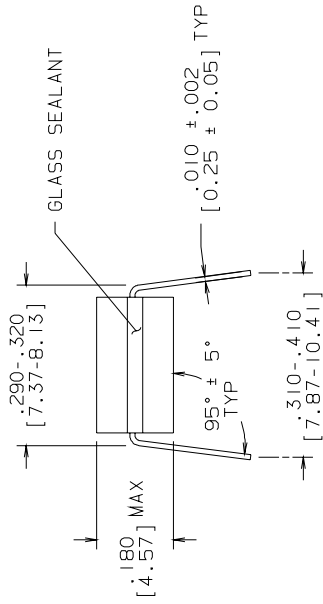
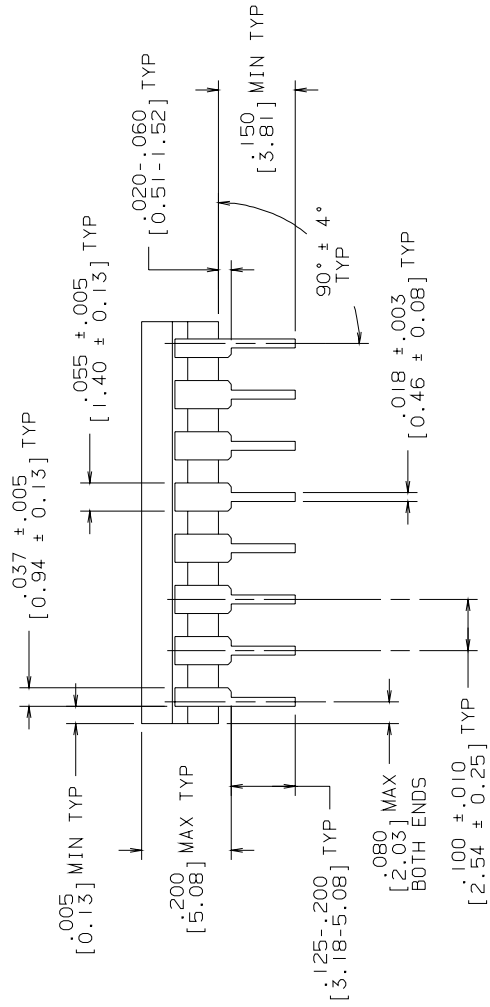
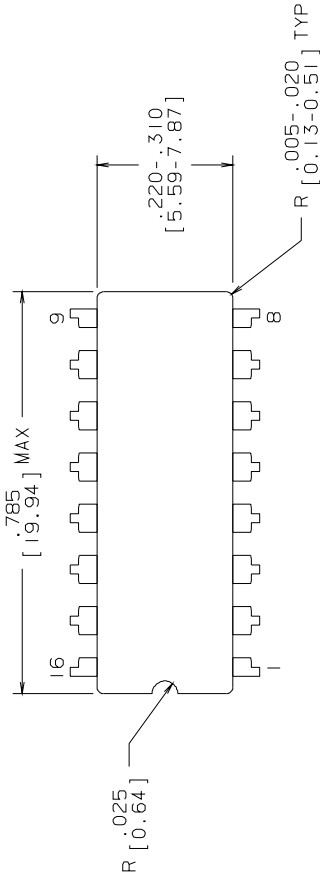
Note 1: Functional test only.

Graphics and Diagrams

| GRAPHICS# | DESCRIPTION |
|-----------|--|
| 05826HRA2 | METAL CAN (KA), TO-3, 2LD, LOW PROFILE (B/I CKT) |
| 06332HRA2 | CERDIP (J), 16 LEAD (B/I CKT) |
| 06351HRA1 | CERPACK (W), 16 LEAD (B/I CKT) |
| J16ARL | CERDIP (J), 16 LEAD (P/P DWG) |
| K02CRE | METAL CAN (KA), TO-3, 2LD, LOW PROFILE (P/P DWG) |
| P000137A | METAL CAN (KA), TO-3, 2LD, LOW PROFILE (PINOUT) |
| P000159A | CERDIP (J), 16 LEAD (PINOUT) |
| P000386A | CERAMIC SOIC (WG), 16 LEAD (PINOUT) |
| WG16ARC | CERAMIC SOIC (WG), 16 LEAD (P/P DWG) |

See attached graphics following this page.

| R E V I S I O N S | | | |
|-------------------|--------------------------------|----------|----------|
| LTR | DESCRIPTION | E. C. N. | DATE |
| L | REVISE PER CURRENT STD; REDRAW | 09996 | 09/15/93 |
| | | | TL/ |



MILIAERO
CONFIGURATION CONTROL

MIL-M-38510
CONFIGURATION CONTROL

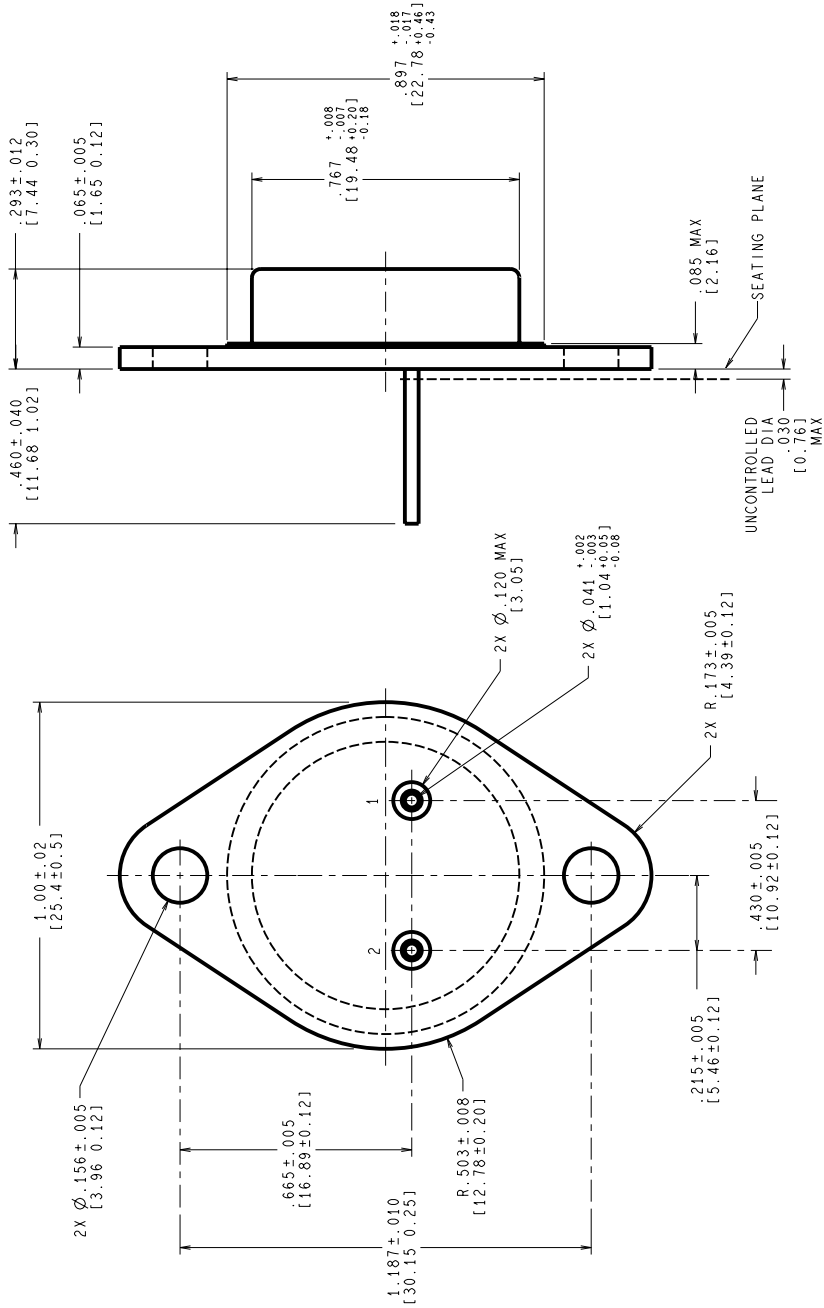
| CONTROLLING DIMENSION: INCH | |
|-----------------------------|--------------|
| APPROVALS | DATE |
| DRAWN T. LEQUANG | 09/15/93 |
| DFTG. CHK. | |
| ENGR. CHK. | |
| APPROVAL | |
| PROJECTION | INCH [MM] |
| SCALE N/A | SIZE B |
| DRAWING NUMBER MKT-J16A | REV L |
| DO NOT SCALE DRAWING | SHEET 1 OF 1 |

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

CERDIP (J),
16 LEAD

- 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 AD, DATED 04/1981.

| REVISIONS | | | |
|-----------|---|--------|--------------|
| LTR | DESCRIPTION | E.C.N. | DATE |
| E | REDRAW ON PROFILE: UPDATE MIL/AERO STAMP: NOTE 2: MIL-PRF-38535 WAS MIL-I-38535. | 11155 | 09/15/95 MS/ |



CONTROLLING DIMENSION IS INCH
VALUES IN [] ARE MILLIMETERS

**MIL-PRF-38535
CONFIGURATION CONTROL**

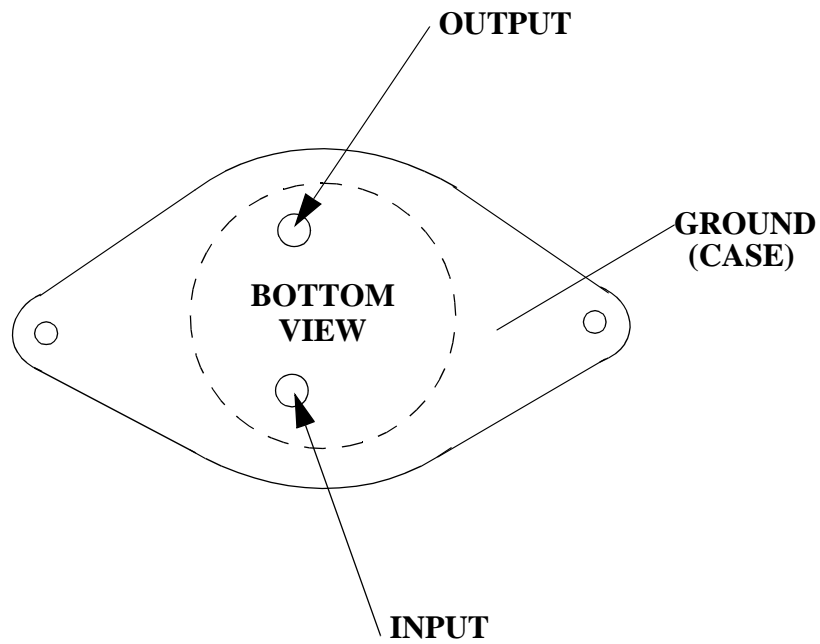
NOTES: UNLESS OTHERWISE SPECIFIED:

1. STANDARD HEADER TYPE SOLID BASE.
2. STANDARD LEAD FINISH:
PER MIL-PRF-38535 TYPE X OR EQUIVALENT.
3. LEAD NOT BENT GREATER THAN 15°.
4. DIMENSIONS BASED ON JEDEC STANDARD TO-3,
PUBLICATION 95, PAGE 98.

| APPROVALS | | DATE |
|-----------|-------------|----------|
| DRNWR | MARTA SUCHY | 09/15/95 |
| DFTG | CHK. | |
| ENGR | CHK. | |

| | | | | | |
|----------------------|--|-------|------|----------------|--------------|
| PROJECTION | | SCALE | SIZE | DRAWING NUMBER | REV. |
| | | N/A | C | MKT-K02C | E |
| DO NOT SCALE DRAWING | | | | | SHEET 1 of 1 |

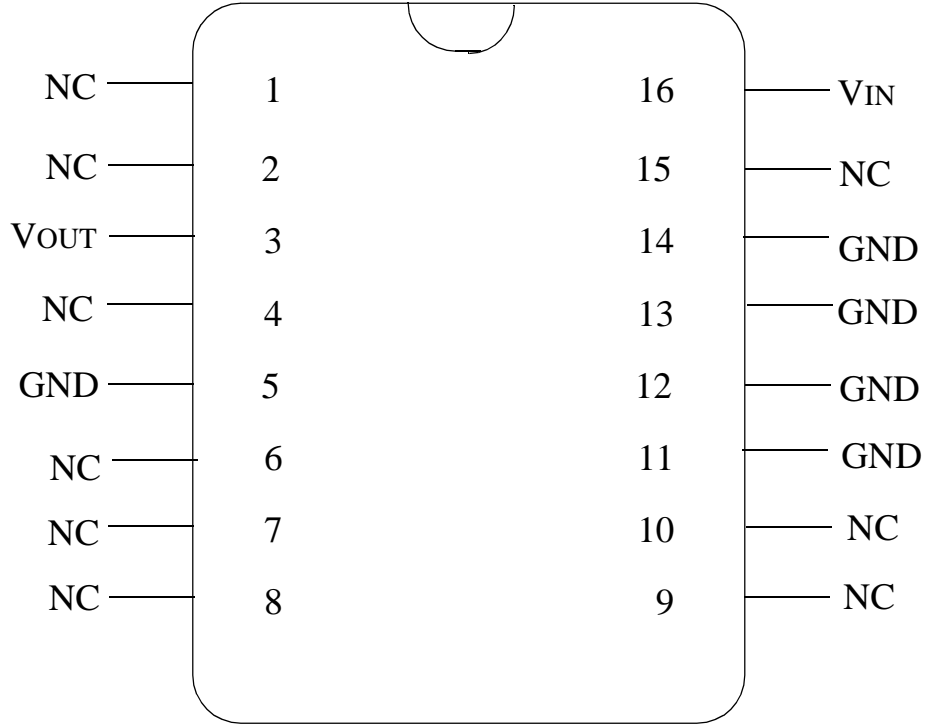
| | |
|--|--|
| | |
| National Semiconductor | |
| 2800 Semiconductor Dr., Santa Clara, CA 95052-8090 | |
| METAL CAN, TO-3, 2 LEAD, LOW PROFILE | |



LM2940K-XX/883
2 - LEAD TO3
CONNECTION DIAGRAM
BOTTOM VIEW
P000137A



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

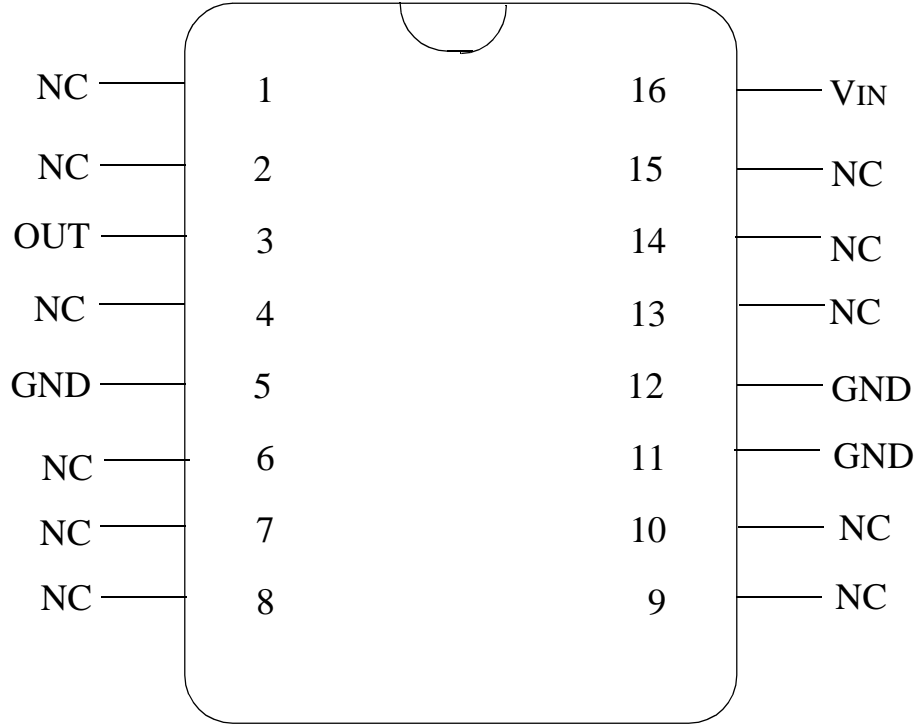


LM2940J-XX
16 - LEAD DIP
CONNECTION DIAGRAM
TOP VIEW
P000159A



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



LM2940WG
16 - LEAD CERAMIC SOIC
CONNECTION DIAGRAM
TOP VIEW
P000386A

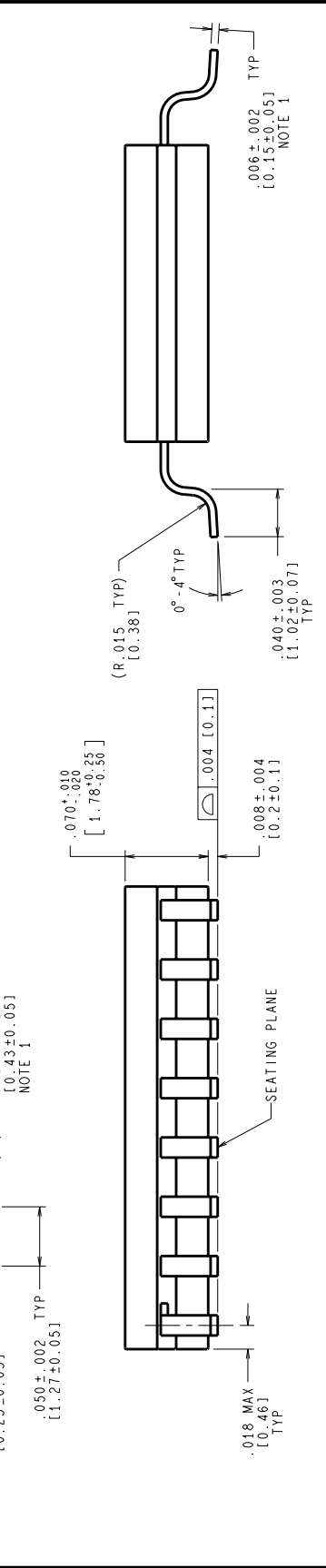
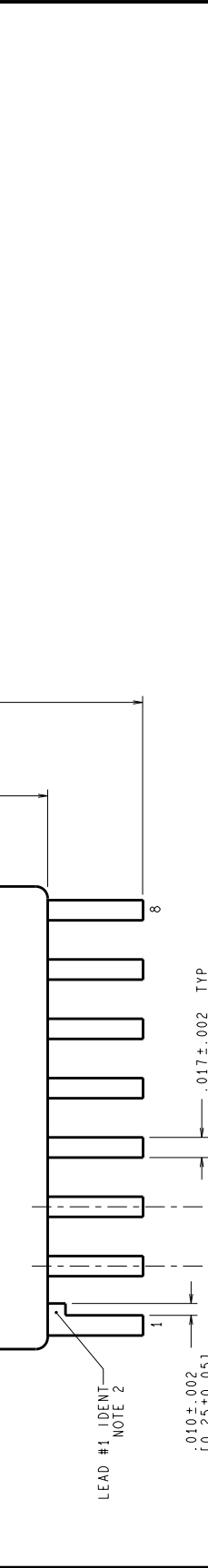
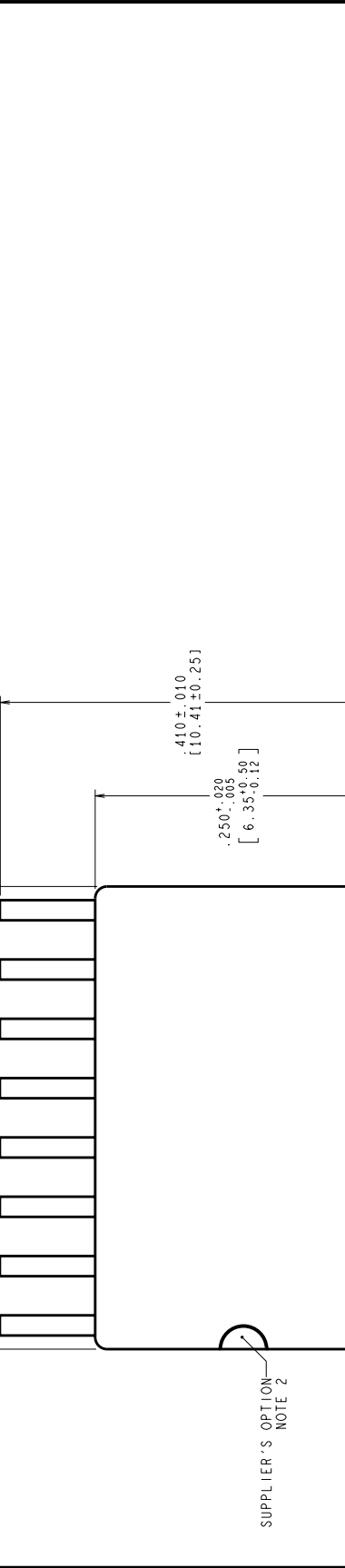


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MIL/AEROSPACE OPERATIONS
 2900 SEMICONDUCTOR DRIVE
 SANTA CLARA, CA 95050

| REVISIONS | | | |
|-----------|--|--------|------------|
| LTR | DESCRIPTION | E.C.N. | DATE |
| A | RELEASE TO DOCUMENT CONTROL | 11376 | 02/29/1996 |
| B | LD PITCH TOL WAS ±.005; CHANGE LD RADIUS TO REF DIM; REMOVE THE OTHER R.006±.002; DIM. .040±.003 WAS .037±.003 | 11443 | 04/19/1996 |
| C | R.015(0.38) WAS R.006(0.15) | 11840 | 10/08/1997 |

| APPROVALS | DATE | BY/APP'D |
|---|----------|----------|
| DRN: <i>MARYA SUCHY</i> | 02/29/96 | MS/KH |
| ENGR. CHK. | | MS/KH |
| PROJECTION | | |
|  | | |
| SCALE | SIZE | REV |
| N/A | C | C |
| DO NOT SCALE DRAWING | | |



**MIL-PRF-38535
CONFIGURATION CONTROL**

CONTROLLING DIMENSION IS INCH
VALUES IN | ARE MILLIMETERS

- 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.

National Semiconductor
2800 Semiconductor Dr., Santa Clara, CA 95052-8000

**CERPACK,
16 LEAD,
GULL WING**

SCALE: N/A C (SC) MKT-WG16A C
DRAWING NUMBER: C (SC) MKT-WG16A C
SHEET 1 of 1

Revision History

| Rev | ECN # | Rel Date | Originator | Changes |
|-----|----------|----------|---------------|---|
| 0A0 | M0000588 | 10/08/99 | Barbara Lopez | Initial Release of: MNL2940-12-X Rev 0A0. Added note for power dissipation and reference to thermal resistance for Aluminum Nitride package. |
| 1A1 | M0003226 | 10/08/99 | Rose Malone | Update MDS: MNL2940-12-X, Rev. 0A0 to MNL2940-12-X, Rev. 1A1. Moved reference to Controlling Document to Feature Section. Added Graphic's, reference to WG Pkg to Main Table and Absolute Section and also Package Weight heading. Changed Vdo, Io = 100mA, Max. condition for subgroup 1 from 150mV to 200mV and subgroup 2 from 200mV to 300mV. |