# LM137QML 3-Terminal Adjustable Negative Regulators

## 1 Features

- SMD 5962-99517
- Available TID Qualified to 30 krad(Si)
- Output Voltage Adjustable from −37 V to −1.2 V
- 1.5A Output Current Specified, −55°C to +150°C
- Line Regulation Typically 0.01%/V
- Load Regulation Typically 0.3%
- Excellent Thermal Regulation, 0.002%/W
- 77 dB Ripple Rejection
- Excellent Rejection of Thermal Transients
- 50 ppm/°C Temperature Coefficient
- Temperature-independent Current Limit
- Internal Thermal Overload Protection
- Standard 3-lead Transistor Package
- Output is Short Circuit Protected

## 2 Applications

- Multipurpose Power Supply
- On-card Voltage Regulation
- Programmable Voltage Supply
- Precision Current Supply
- Harsh Environments

## 3 Description

The LM137 are adjustable 3-terminal negative voltage regulators capable of supplying in excess of 1.5 A over an output voltage range of −37 V to −1.2 V. These regulators are exceptionally easy to apply, requiring only 2 external resistors to set the output voltage and 1 output capacitor for frequency compensation. The circuit design has been optimized for excellent regulation and low thermal transients. Further, the LM137 series features internal current limiting, thermal shutdown and safe-area compensation, making them virtually blowout-proof against overloads.

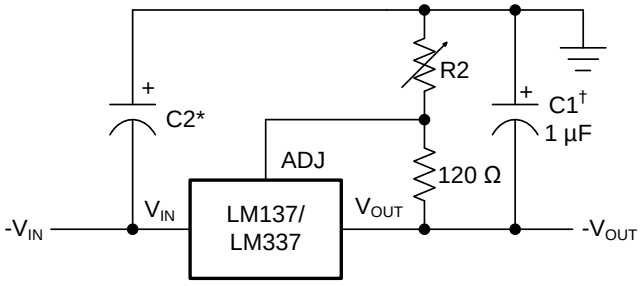
The LM137 serve a wide variety of applications including local on-card regulation, programmable-output voltage regulation or precision current regulation. The LM137 are ideal complements to the LM117 adjustable positive regulators.

**Device Information(1)**

| PART NUMBER | SMD NUMBER | PACKAGE |
|---|---|---|
| LM137K/883 | | TO-3 (K) |
| LM137H/883 | | TO-39 (NDT) |
| LM137H1PQMLV | 5962P9951708VXA<br>30 krad | TO-39 (NDT) |
| LM137H-MD8 | | Die |
| LM137KG-MD8 | | Die |
| LM137KG-MW8 | | Wafer |

(1) For all available packages, see the orderable addendum at the end of the data sheet.

**Simplified Schematic**




An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

**Changes from Revision E (December 2016) to Revision F** — **Page**

- Changed the T0-39 Metal Can Package From: Top View To: Bottom View ... 3

**Changes from Revision D (February 2015) to Revision E** — **Page**

- Updated the package orderable addendum ... 1

**Changes from Revision C (April 2013) to Revision D** — **Page**

- Added, updated, or renamed the following sections: Device Information table, *Specifications*, *Feature Description*, *Layout*, *Application and Implementation*, *Power supply Recommendations*, *Device and Documentation Support*, *Mechanical, Packaging, and Ordering Information* ... 1
- Changed Vout Recovery condition from -4.25 V to -40 V ... 9

**Changes from Revision B (March 2013) to Revision C** — **Page**

- Changed layout of National Data Sheet to TI format. ... 1

**Changes from Revision A (December 2010) to Revision B** — **Page**

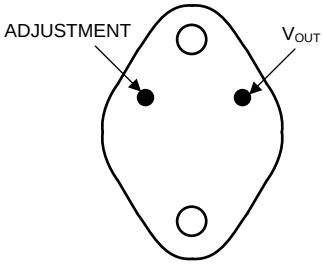
- Added new LM137H1PQMLV to *Ordering Information* ... 1
- Added to the HEADER of DC Parameters — Post Radiation Limits 5962P9951701VXA. Added the HEADER and TABLE of DC Parameters — Post Radiation Limits 5962P9951708VXA for *Electrical Characteristics* tables ... 6


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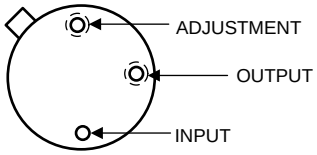
# 5 Pin Configuration and Functions

**TO-3 Metal Can Package**
**Package K**
**(Bottom View)**




NOTE: Case is Input

**T0-39 Metal Can Package**
**Package NDT**
**(Bottom View)**




NOTE: Case Is Input

**Pin Functions**

| PIN | | | I/O | DESCRIPTION |
|---|---|---|---|---|
| NAME | NUMBER | | | |
| | K | NDT | | |
| ADJUSTMENT | 1 | 1 | O | Adjustment |
| INPUT | Case | 3/Case | I | Input |
| OUTPUT /$V_{OUT}$ | 2 | 2 | O | Output |

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# 6 Specifications

## 6.1 Absolute Maximum Ratings(1)

| | | | UNIT |
|---|---|---|---|
| Power Dissipation(2) | | Internally Limited | |
| Input-Output Voltage Differential | | 40 | V |
| Operating Ambient Temperature | | $-55 \le T_A \le +125$ | °C |
| Operating Junction Temperature | | $-55 \le T_J \le +150$ | °C |
| Storage Temperature | | $-65 \le T_A \le +150$ | °C |
| Maximum Junction Temperature | | 150 | °C |
| Lead Temperature (Soldering, 10 sec.) | | 300 | °C |
| Maximum Power Dissipation (@25°C) | T0–3 | 28 | W |
| | T0–39 | 2.5 | W |
| Package Weight (typical) | T0–3 | 12,750 | mg |
| | T0–39 Metal Can | 955 | mg |

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

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

## 6.2 ESD Ratings

| | | | VALUE | UNIT |
|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1) | ±4000 | V |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible with the necessary precautions. Pins listed as ±4000 V may actually have higher performance. Human body model, 100 pF discharged through 1.5 KΩ.

## 6.3 Recommended Operating Conditions

| | MIN | MAX | UNIT |
|---|---|---|---|
| $T_A$ | | $-55 \le T_A \le +125$ | °C |
| Input Voltage | −41.25 | −4.25 | V |

## 6.4 Thermal Information

| THERMAL METRIC(1) | | TO-3 METAL CAN | TO-39 METAL CAN | UNIT |
|---|---|---|---|---|
| | | 2 PINS | 3 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 40 (Still Air) | 174 (Still Air @ 0.5W) | °C/W |
| | | 14 (500 LFM) | 64 (500 LFM @ 0.5W) | |
| $R_{\theta JC}$ | Junction-to-case thermal resistance | 4 | 15 (@ 1.0W) | |

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.


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## 6.5 Quality Conformance Inspection

**Table 1. Mil-Std-883, Method 5005 — Group A (1)**

| SUBGROUP | 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 |

(1) Group “A” sample only, test at all temps.

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## 6.6 LM137H 883 Electrical Characteristics DC Parameters

The following conditions apply, unless otherwise specified. $V_{IN}$ = −4.25V, $I_L$ = 8mA, $V_{OUT}$ = $V_{Ref}$ (1) (2)

| PARAMETER | | TEST CONDITIONS | SUB-GROUPS | MIN | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{Ref}$ | Reference Voltage | | 1 | -1.275 | -1.225 | V |
| | | | 2, 3 | -1.3 | -1.2 | V |
| | | $V_{IN}$ = -42 V | 1 | -1.275 | -1.225 | V |
| | | $V_{IN}$ = -41.3 V | 2, 3 | -1.3 | -1.2 | V |
| $I_Q$ | Minimum Load Current | $V_{OUT}$ = -1.7 V | 1, 2, 3 | | 3.0 | mA |
| | | $V_{OUT}$ = -1.7 V, $V_{IN}$ = -11.75 V | 1, 2, 3 | | 3.0 | mA |
| | | $V_{OUT}$ = -1.7 V, $V_{IN}$ = -42 V | 1 | | 5.0 | mA |
| | | $V_{OUT}$ = -1.7 V, $V_{IN}$ = -41.3 V | 2, 3 | | 5.0 | mA |
| $R_{Line}$ | Line Regulation | -42 V ≤ $V_{IN}$ ≤ -4.25 V | 1 | -9.0 | 9.0 | mV |
| | | -41.3 V ≤ $V_{IN}$ ≤ -4.25 V | 2, 3 | -23 | 23 | mV |
| $R_{Load}$ | Load Regulation | 5 mA ≤ $I_L$ ≤ 500 mA, $V_{IN}$ = -6.25 V | 1, 2, 3 | -25 | 25 | mV |
| | | 5mA ≤ $I_L$ ≤ 500 mA, $V_{IN}$ = -14.5 V | 1 | -25 | 25 | mV |
| | | 5mA ≤ $I_L$ ≤ 150 mA, $V_{IN}$ = -40 V | 1, 2, 3 | -25 | 25 | mV |
| $I_{Adj}$ | Adjustment Pin Current | $I_L$ = 5 mA | 1, 2, 3 | | 100 | µA |
| | | $V_{IN}$ = -42 V | 1 | | 100 | µA |
| | | $V_{IN}$ = -41.3 V | 2, 3 | | 100 | µA |
| $\Delta I_{Adj} / V_{Line}$ | Adjust Pin Current Change vs. Line Voltage | -42 V ≤ $V_{IN}$ ≤ -4.25 V, $I_L$ = 5 mA | 1 | -5.0 | 5.0 | µA |
| | | -41.3 V ≤ $V_{IN}$ ≤ -4.25 V, $I_L$ = 5 mA | 2, 3 | -5.0 | 5.0 | µA |
| $\Delta I_{Adj} / I_{Load}$ | Adjust Pin Current Change vs. Load Current | 5 mA ≤ $I_L$ ≤ 500 mA, $V_{IN}$ = -6.5 V | 1, 2, 3 | -5.0 | 5.0 | µA |
| $V_{Rth}$ | Thermal Regulation | $V_{IN}$ = -14.5 V, $I_L$ = 500 mA, t = 10 mS | 1 | -5.0 | 5.0 | mV |
| | | $V_{IN}$ = -14.5 V, $I_L$ = 5 mA, t = 10 mS | 1 | -5.0 | 5.0 | mV |
| $I_{CL}$ | Current Limit | $V_{IN}$ = -5 V | 1, 2, 3 | -1.8 | -0.5 | A |
| | | $V_{IN}$ = -40 V | 1, 2, 3 | -0.65 | -0.15 | A |
| $V_O$ | Output Voltage | | 1 | -1.28 | -1.22 | V |
| | | | 2, 3 | -1.3 | -1.2 | V |

(1) $V_{IN}$ = −41.3V at +125°C and −55°C
(2) −41.3V ≤ $V_{IN}$ ≤ −4.25V at +125°C and −55°C

## 6.7 LM137H 883 Electrical Characteristics AC Parameters

| PARAMETER | | TEST CONDITIONS | SUB-GROUPS | MIN | MAX | UNIT |
|---|---|---|---|---|---|---|
| $R_R$ | Ripple Rejection Ratio (1) | $V_{IN}$ = -6.25 V, $V_{OUT}$ = $V_{Ref}$, $I_L$ = 125 mA, $e_i$ = 1$V_{RMS}$, F = 120 Hz | 4,5,6 | 66 | | dB |

(1) Test at +25°C, ensured but not tested at +125°C and −55°C


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## 6.8 LM137K 883 Electrical Characteristics DC Parameters

The following conditions apply, unless otherwise specified. $V_{IN}$ = −4.25V, $I_L$ = 8mA, $V_{OUT}$ = $V_{Ref}$ (1) (2)

| PARAMETER | | TEST CONDITIONS | SUB-GROUPS | MIN | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{Ref}$ | Reference Voltage | | 1 | -1.275 | -1.225 | V |
| | | | 2, 3 | -1.3 | -1.2 | V |
| | | $V_{IN}$ = -42 V | 1 | -1.275 | -1.225 | V |
| | | $V_{IN}$ = -41.3 V | 2, 3 | -1.3 | -1.2 | V |
| $I_Q$ | Minimum Load Current | $V_{OUT}$ = -1.7 V | 1, 2, 3 | | 3.0 | mA |
| | | $V_{OUT}$ = -1.7 V, $V_{IN}$ = -11.75 V | 1, 2, 3 | | 3.0 | mA |
| | | $V_{OUT}$ = -1.7 V, $V_{IN}$ = -42 V | 1 | | 5.0 | mA |
| | | $V_{OUT}$ = -1.7 V, $V_{IN}$ = -41.3 V | 2, 3 | | 5.0 | mA |
| $R_{Line}$ | Line Regulation | -42 V ≤ $V_{IN}$ ≤ -4.25 V | 1 | -9.0 | 9.0 | mV |
| | | -41.3V ≤ $V_{IN}$ ≤ -4.25V | 2, 3 | -23 | 23 | mV |
| $R_{Load}$ | Load Regulation | $V_{IN}$ = -6.25 V, 8 mA ≤ $I_L$ ≤ 1.5 A | 1, 2, 3 | -25 | 25 | mV |
| | | $V_{IN}$ = -14.5 V, 8 mA ≤ $I_L$ ≤ 1.5 A | 1 | -25 | 25 | mV |
| | | $V_{IN}$ = -40 V, 8 mA ≤ $I_L$ ≤ 300 mA | 1 | -25 | 25 | mV |
| | | $V_{IN}$ = -40 V, 8 mA ≤ $I_L$ ≤ 250 mA | 2, 3 | -25 | 25 | mV |
| $I_{Adj}$ | Adjustment Pin Current | | 1, 2, 3 | | 100 | µA |
| | | $V_{IN}$ = -42 V | 1 | | 100 | µA |
| | | $V_{IN}$ = -41.3 V | 2, 3 | | 100 | µA |
| Δ $I_{Adj}$ / $V_{Line}$ | Adjust Pin Current Change vs. Line Voltage | -42 V ≤ $V_{IN}$ ≤ -4.25 V | 1 | -5.0 | 5.0 | µA |
| | | -41.3 V ≤ $V_{IN}$ ≤ -4.25 V | 2, 3 | -5.0 | 5.0 | µA |
| Δ $I_{Adj}$ / $I_{Load}$ | Adjust Pin Current Change vs. Load Current | 8 mA ≤ $I_L$ ≤ 1.5 A, $V_{IN}$ = -6.25 V | 1, 2, 3 | -5.0 | 5.0 | µA |
| $V_{Rth}$ | Thermal Regulation | $V_{IN}$ = -14.5 V, $I_L$ = 1.5 mA, t = 10 mS | 1 | -5.0 | 5.0 | mV |
| | | $V_{IN}$ = -14.5 V, $I_L$ = 8 mA, t = 10 mS | 1 | -5.0 | 5.0 | mV |
| $I_{CL}$ | Current Limit | $V_{IN}$ = -5 V | 1, 2, 3 | -3.5 | -1.5 | A |
| | | $V_{IN}$ = -40 V | 1, 2, 3 | -1.2 | -0.24 | A |

(1) $V_{IN}$ = −41.3V at +125°C and −55°C
(2) −41.3V ≤ $V_{IN}$ ≤ −4.25V at +125°C and −55°C

## 6.9 LM137K 883 Electrical Characteristics AC Parameters

| PARAMETER | | TEST CONDITIONS | SUB-GROUPS | MIN | MAX | UNIT |
|---|---|---|---|---|---|---|
| $R_R$ | Ripple Rejection Ratio (1) | $V_{IN}$ = -6.25 V, $V_{OUT}$ = $V_{Ref}$, f = 120 Hz, $I_L$ = 0.5 A, $e_I$ = 1$V_{RMS}$ | 4,5,6 | 66 | | dB |

(1) Test at +25°C, ensured but not tested at +125°C and −55°C



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## 6.10 LM137H RH Electrical Characteristics DC Parameters 5962P9951708VXA

The following conditions apply, unless otherwise specified. (1)

| PARAMETER | | TEST CONDITIONS | SUB-GROUPS | MIN | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{OUT}$ | Output Voltage | $V_{IN}$ = -4.25 V, $I_L$ = 5 mA | 1 | -1.275 | -1.225 | V |
| | | | 2, 3 | -1.3 | -1.2 | V |
| | | $V_{IN}$ = -4.25 V, $I_L$ = 500 mA | 1 | -1.275 | -1.225 | V |
| | | | 2, 3 | -1.3 | -1.2 | V |
| | | $V_{IN}$ = -41.25 V, $I_L$ = 5 mA | 1 | -1.275 | -1.225 | V |
| | | | 2, 3 | -1.3 | -1.2 | V |
| | | $V_{IN}$ = -41.25 V, $I_L$ = 50 mA | 1 | -1.275 | -1.225 | V |
| | | | 2, 3 | -1.3 | -1.2 | V |
| $V_{R\ Line}$ | Line Regulation | $V_{IN}$ = -41.25 V to -4.25 V, $I_L$ = 5 mA | 1 | -9.0 | 9.0 | mV |
| | | | 2, 3 | -23 | 23 | mV |
| $V_{R\ Load}$ | Load Regulation | $V_{IN}$ = -6.25 V, $I_L$ = 5 mA to 500 mA | 1 | -12 | 12 | mV |
| | | | 2, 3 | -24 | 24 | mV |
| | | $V_{IN}$ = -41.25 V, $I_L$ = 5 mA to 50 mA | 1 | -6.0 | 6.0 | mV |
| | | | 2, 3 | -12 | 12 | mV |
| | | $V_{IN}$ = -6.25 V, $I_L$ = 5 mA to 200 mA | 1 | -6.0 | 6.0 | mV |
| | | | 2, 3 | -12 | 12 | mV |
| $V_{Rth}$ | Thermal Regulation | $V_{IN}$ = -14.6 V, $I_L$ = 500 mA | 1 | -5.0 | 5.0 | mV |
| $I_{Adj}$ | Adjust Pin Current | $V_{IN}$ = -4.25 V, $I_L$ = 5 mA | 1, 2, 3 | 25 | 100 | µA |
| | | $V_{IN}$ = -41.25 V, $I_L$ = 5 mA | 1, 2, 3 | 25 | 100 | µA |
| $\Delta I_{Adj} / V_{Line}$ | Adjust Pin Current Change vs. Line Voltage | $V_{IN}$ = -41.25 V to -4.25 V, $I_L$ = 5 mA | 1, 2, 3 | -5.0 | 5.0 | µA |
| $\Delta I_{Adj} / I_{Load}$ | Adjust Pin Current Change vs. Load Current | $V_{IN}$ = -6.25 V, $I_L$ = 5 mA to 500 mA | 1, 2, 3 | -5.0 | 5.0 | µA |
| $I_{OS}$ | Output Short Circuit Current | $V_{IN}$ = -4.25 V | 1, 2, 3 | 0.5 | 1.8 | A |
| | | $V_{IN}$ = -40 V | 1, 2, 3 | 0.05 | 0.5 | A |
| $V_{OUT}$ Recovery | Output Voltage Recovery After Output Short Circuit Current | $V_{IN}$ = -4.25 V | 1 | -1.275 | -1.225 | V |
| | | | 2, 3 | -1.3 | -1.2 | V |
| | | $V_{IN}$ = -40 V | 1 | -1.275 | -1.225 | V |
| | | | 2, 3 | -1.3 | -1.2 | V |
| $I_Q$ | Minimum Load Current | $V_{IN}$ = -4.25 V | 1, 2, 3 | 0.2 | 3.0 | mA |
| | | $V_{IN}$ = -14.25 V | 1, 2, 3 | 0.2 | 3.0 | mA |
| | | $V_{IN}$ = -41.25 V | 1, 2, 3 | 1.0 | 5.0 | mA |
| $V_{Start}$ | Voltage Start-up | $V_{IN}$ = -4.25 V, $I_L$ = 500 mA | 1 | -1.275 | -1.225 | V |
| | | | 2, 3 | -1.3 | -1.2 | V |
| $V_{OUT}$ | Output Voltage (2) | $V_{IN}$ = -6.25 V, $I_L$ = 5 mA | 2 | -1.3 | -1.2 | V |

(1) 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 specified only for the conditions as specified in Mil-Std-883, Method 1019.5, Condition A.

(2) Tested at +125°C; correlated to +150°C


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## 6.11 LM137H RH Electrical Characteristics AC Parameters 5962P9951708VXA

The following conditions apply, unless otherwise specified.(1)

| PARAMETER | | TEST CONDITIONS | SUB-GROUPS | MIN | MAX | UNIT |
|---|---|---|---|---|---|---|
| $\Delta V_{IN}$ / $\Delta V_{OUT}$ | Ripple Rejection | $V_{IN}$ = -6.25 V, $I_L$ = 125 mA, $e_I$ = 1$V_{RMS}$ at 2400 Hz | 9 | 48 | | dB |
| $V_{NO}$ | Output Noise Voltage | $V_{IN}$ = -6.25 V, $I_L$ = 50 mA | 9 | | 120 | $\mu V_{RMS}$ |
| $\Delta V_{OUT}$ / $\Delta V_{IN}$ | Line Transient Response | $V_{IN}$ = -6.25 V, $V_{Pulse}$ = -1V, $I_L$ = 50 mA | 9 | | 80 | mV/V |
| $\Delta V_O$ / $\Delta I_L$ | Load Transient Response(2) | $V_{IN}$ = -6.25 V, $I_L$ = 50 mA, $\Delta I_L$ = 200 mA | 9 | | 60 | mV |

(1) 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 specified only for the conditions as specified in Mil-Std-883, Method 1019.5, Condition A.
(2) Limit of 0.3mV/mA is equivalent to 60mV

## 6.12 LM137H RH Electrical Characteristics DC Parameters Drift Values 5962P9951708VXA

The following conditions apply, unless otherwise specified. (1)
Delta calculations performed on QMLV devices at group B, subgroup 5 only.

| PARAMETER | | TEST CONDITIONS | SUB-GROUPS | MIN | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{OUT}$ | Output Voltage | $V_{IN}$ = -4.25 V, $I_L$ = 5 mA | 1 | -0.01 | 0.01 | V |
| | | $V_{IN}$ = -4.25 V, $I_L$ = 500 mA | 1 | -0.01 | 0.01 | V |
| | | $V_{IN}$ = -41.25 V, $I_L$ = 5 mA | 1 | -0.01 | 0.01 | V |
| | | $V_{IN}$ = -41.25 V, $I_L$ = 50 mA | 1 | -0.01 | 0.01 | V |
| $V_{R\ Line}$ | Line Regulation | $V_{IN}$ = -41.25 V to -4.25 V, $I_L$ = 5 mA | 1 | -4.0 | 4.0 | mV |
| $I_{Adj}$ | Adjust Pin Current | $V_{IN}$ = -4.25 V, $I_L$ = 5 mA | 1 | -10 | 10 | µA |
| | | $V_{IN}$ = -41.25 V, $I_L$ = 5 mA | 1 | -10 | 10 | µA |

(1) 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 specified only for the conditions as specified in Mil-Std-883, Method 1019.5, Condition A.

## 6.13 LM137H RH Electrical Characteristics DC Parameters Post Radiation Limits +25°C 5962P9951708VXA

The following conditions apply, unless otherwise specified.(1)

| PARAMETER | | TEST CONDITIONS | SUB-GROUPS | MIN | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{OUT}$ | Output Voltage | $V_{IN}$ = -41.25 V, $I_L$ = 5 mA | 1 | -1.30 | -1.225 | V |
| | | $V_{IN}$ = -41.25 V, $I_L$ = 50 mA | 1 | -1.30 | -1.225 | V |
| $V_{R\ Line}$ | Line Regulation | $V_{IN}$ = -41.25 V to -4.25 V, $I_L$ = 5 mA | 1 | -9.0 | +50 | mV |
| $I_{Adj}$ | Adjust Pin Current | $V_{IN}$ = -41.25 V, $I_L$ = 5 mA | 1 | 25 | 140 | µA |
| $\Delta I_{Adj}$ / $V_{Line}$ | Adjust Pin Current Change vs. Line Voltage | $V_{IN}$ = -41.25 V to -4.25 V, $I_L$ = 5 mA | 1 | -70 | +20 | µA |
| $V_{OUT}$ Recovery | Output Voltage Recovery After Output Short Circuit Current | $V_{IN}$ = -40 V | 1 | -1.30 | -1.225 | V |

(1) 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 specified only for the conditions as specified in Mil-Std-883, Method 1019.5, Condition A.

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## 6.14 Typical Performance Characteristics

(NDT & K Packages)

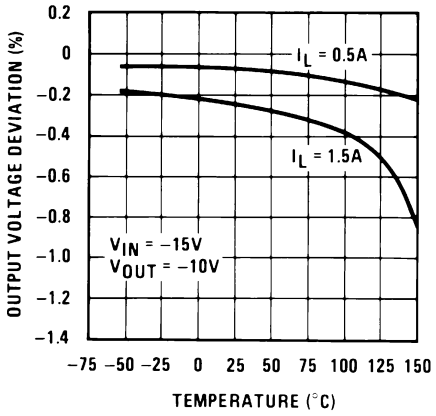



**Figure 1. Load Regulation**

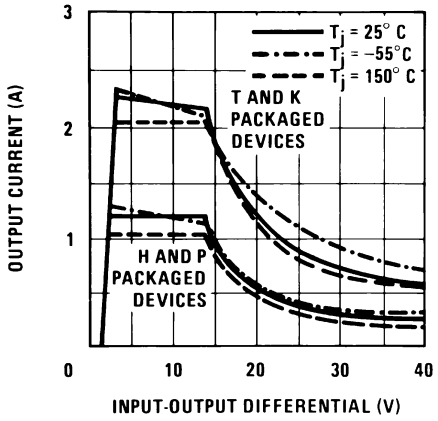



**Figure 2. Current Limit**

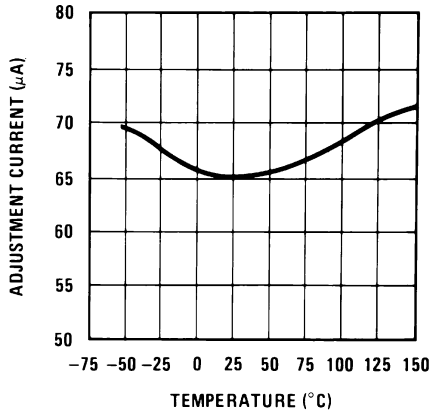



**Figure 3. Adjustment Current**

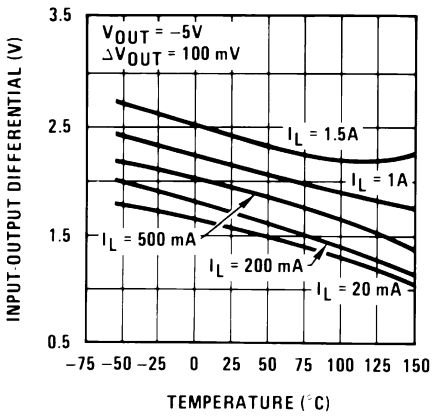



**Figure 4. Dropout Voltage**

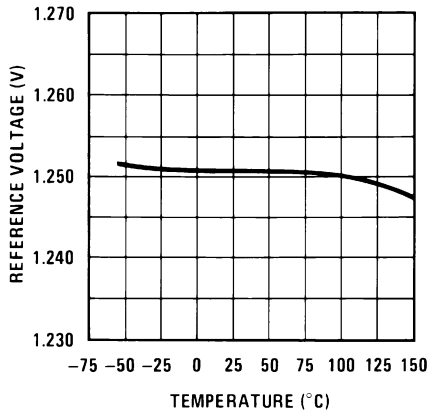



**Figure 5. Temperature Stability**

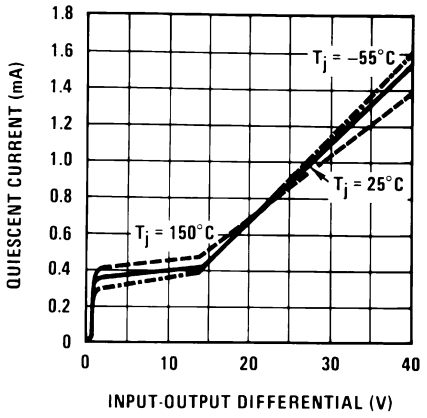



**Figure 6. Minimum Operating Current**


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## Typical Performance Characteristics (continued)

(NDT & K Packages)

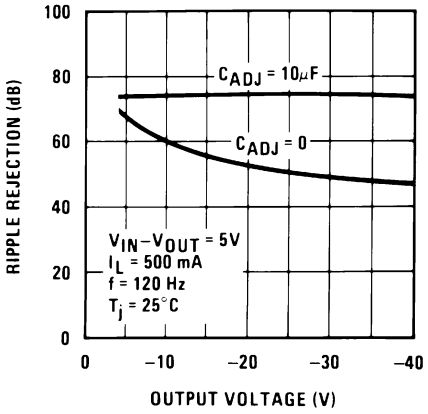



**Figure 7. Ripple Rejection**

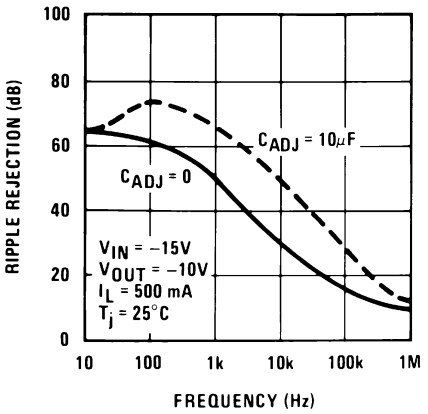



**Figure 8. Ripple Rejection**

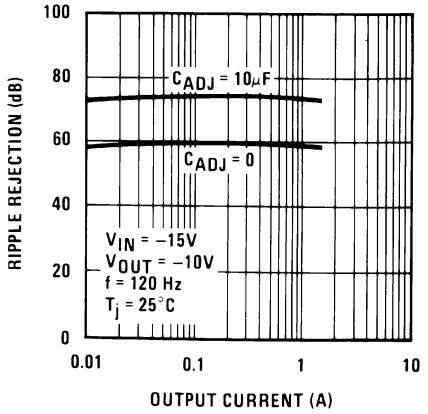



**Figure 9. Ripple Rejection**

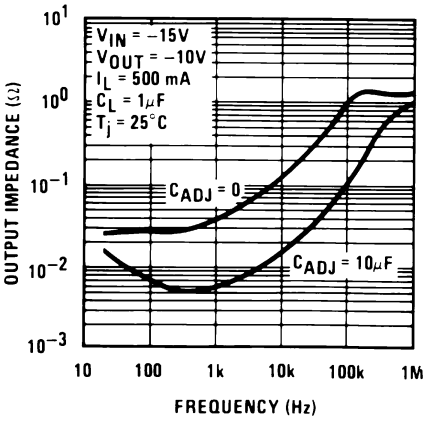



**Figure 10. Output Impedance**

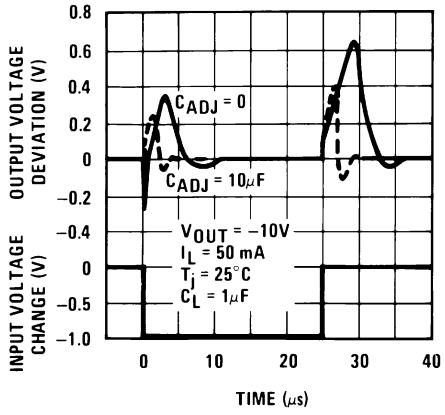



**Figure 11. Line Transient Response**

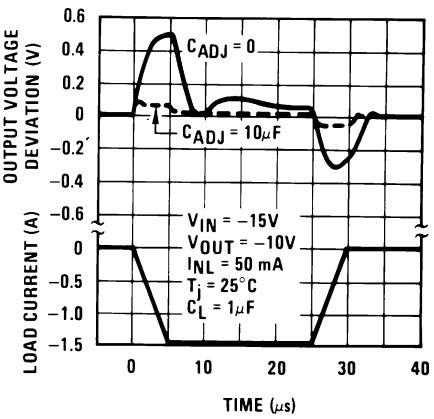



**Figure 12. Load Transient Response**

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# 7 Detailed Description

## 7.1 Functional Block Diagram

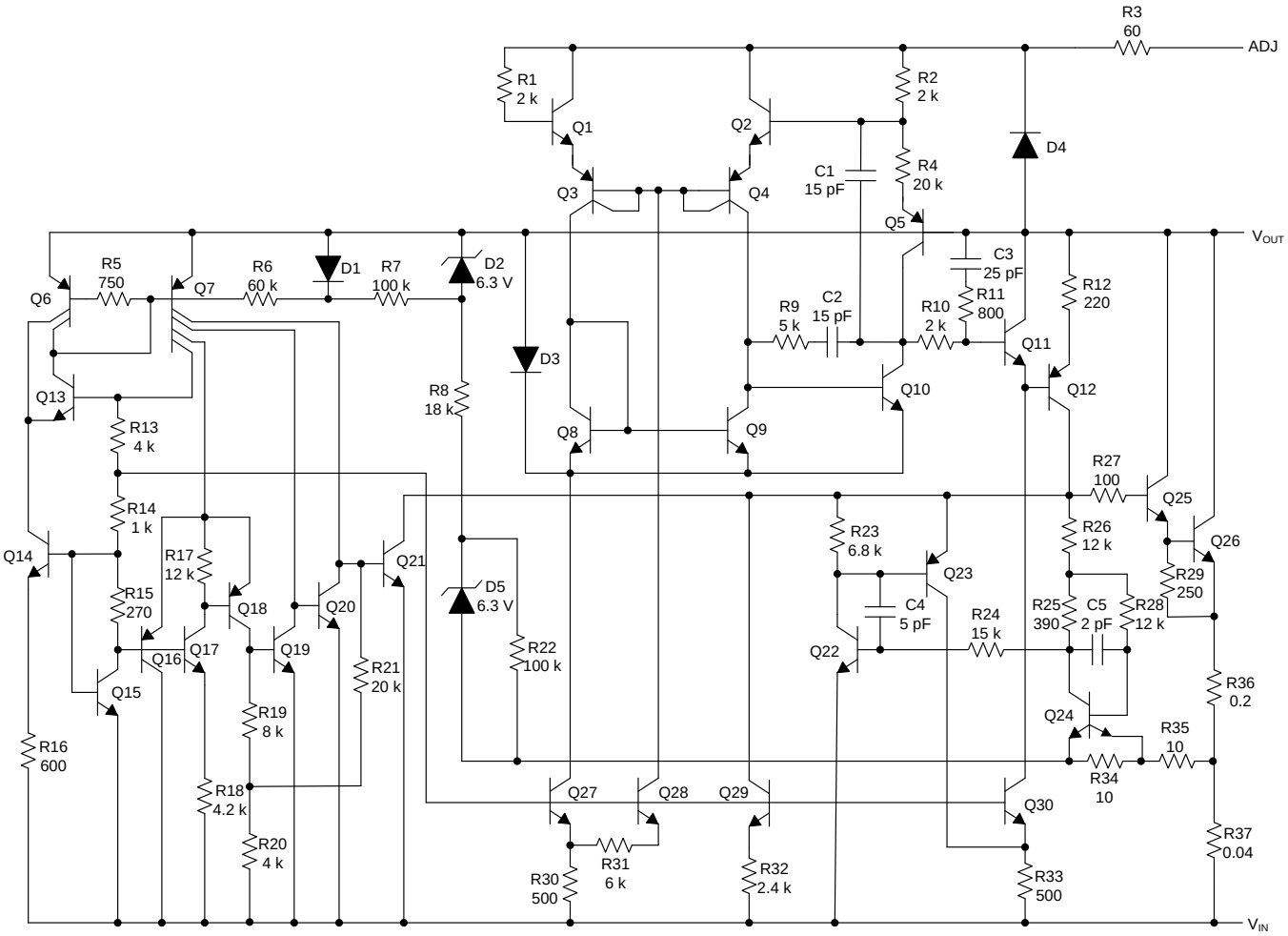



**Figure 13. Schematic Diagram**


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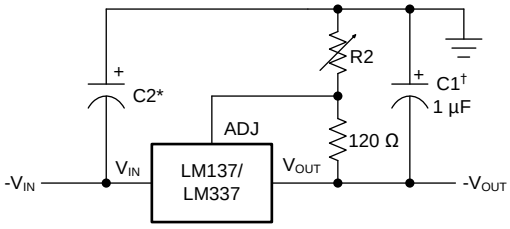
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# 8 Application and Implementation

**NOTE**

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

## 8.1 Application Information and Schematic Diagram



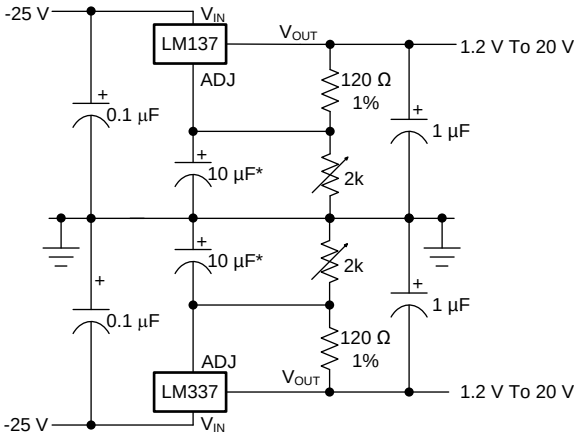

Full output current not available at high input-output voltages

$$-V_{OUT}\ 1.25\left(V1+\frac{R2}{120}\right)+(-I_{ADJ}\ x\ R2)$$

†C1 = 1 µF solid tantalum or 10 µF aluminum electrolytic required for stabilit
*C2 = 1 µF solid tantalum is required only if regulator is more than 4″ from power-supply filter capacitor
Output capacitors in the range of 1µF to 1000 µF of aluminum or tantalum electrolytic are commonly used to provide improved output impedance and rejection of transients

**Figure 14. Adjustable Negative Voltage Regulator**

## 8.2 Typical Applications




Full output current not available
at high input-output voltages
*The 10 µF capacitors are optional to improve ripple rejection

**Figure 15. Adjustable Lab Voltage Regulator**



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## Typical Applications (continued)

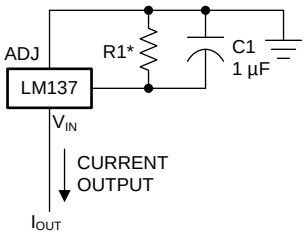
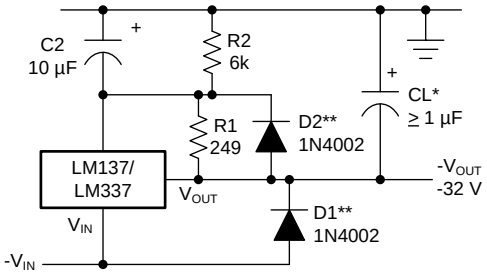


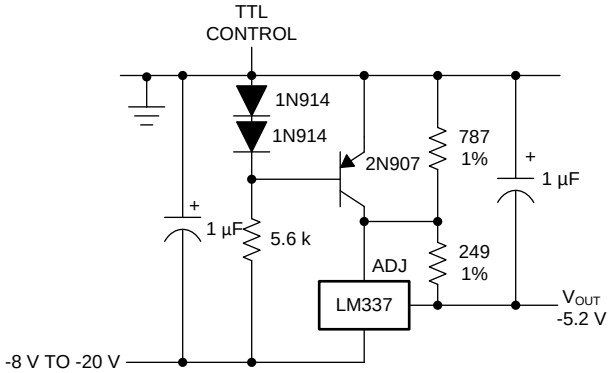

**Figure 16. Current Regulator**

$$I_{OUT} = \frac{1.250\ V}{R1}$$
$$*0.8\ \Omega \le R1 \le 120\ \Omega \quad (1)$$




*When $C_L$ is larger than 20 µF, D1 protects the LM137 in case the input supply is shorted
**When C2 is larger than 10 µF and $-V_{OUT}$ is larger than −25V, D2 protects the LM137 in case the output is shorted

**Figure 17. Negative Regulator with Protection Diodes**




*Minimum output ≈ −1.3V when control input is low

**Figure 18. −5.2V Regulator with Electronic Shutdown***

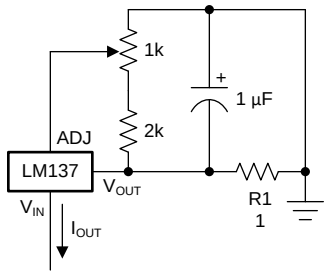



**Figure 19. Adjustable Current Regulator**


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## Typical Applications (continued)

$$I_{OUT} = \left(\frac{1.5\ V}{R1}\right) \pm 15\%\ \text{adjustable} \quad (2)$$

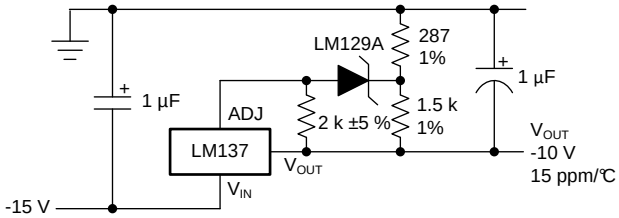



**Figure 20. High Stability −10V Regulator**

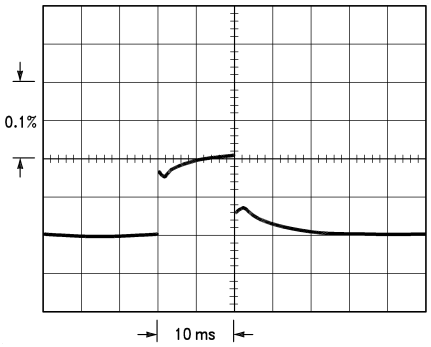


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# 9 Power Supply Recommendations

## 9.1 Thermal Regulation

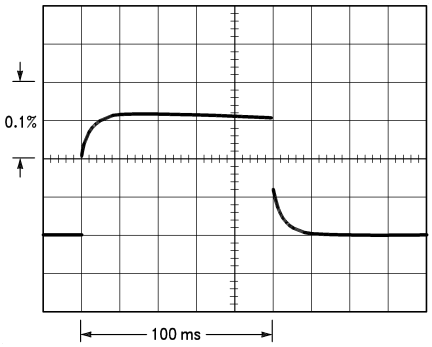
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large. Thermal regulation is the effect of these temperature gradients on output voltage (in percentage output change) per Watt of power change in a specified time. Thermal regulation error is independent of electrical regulation or temperature coefficient, and occurs within 5 ms to 50 ms after a change in power dissipation. Thermal regulation depends on IC layout as well as electrical design. The thermal regulation of a voltage regulator is defined as the percentage change of $V_{OUT}$, per Watt, within the first 10 ms after a step of power is applied. The LM137's specification is 0.02%/W, max.




LM137, $V_{OUT}$ = −10V  $V_{IN} - V_{OUT}$ = −40V
Horizontal sensitivity,5 ms/div  $I_L$ = 0A → 0.25A → 0A

**Figure 21.**

In Figure 21, a typical LM137's output drifts only 3 mV (or 0.03% of $V_{OUT}$ = −10V) when a 10W pulse is applied for 10 ms. This performance is thus well inside the specification limit of 0.02%/W × 10W = 0.2% max. When the 10W pulse is ended, the thermal regulation again shows a 3 mV step as the LM137 chip cools off. Note that the load regulation error of about 8 mV (0.08%) is additional to the thermal regulation error. In Figure 22, when the 10W pulse is applied for 100 ms, the output drifts only slightly beyond the drift in the first 10 ms, and the thermal error stays well within 0.1% (10 mV).




LM137, $V_{OUT}$ = −10V  $V_{IN} - V_{OUT}$ = −40V
Horizontal sensitivity, 20 ms/div  $I_L$ = 0A → 0.25A → 0A

**Figure 22.**


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# 10 Device and Documentation Support

## 10.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

## 10.2 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

**TI E2E™ Online Community** ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

## 10.3 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

## 10.4 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## 10.5 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

# 11 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5962P9951708VXA | ACTIVE | TO | NDT | 3 | 20 | Non-RoHS & Non-Green | Call TI | Call TI | -55 to 125 | LM137H1PQMLV 5962P9951708VXA Q ACO 5962P9951708VXA Q >T | Samples |
| LM137H MD8 | ACTIVE | DIESALE | Y | 0 | 120 | RoHS & Green | Call TI | Level-1-NA-UNLIM | -55 to 125 | | Samples |
| LM137H/883 | ACTIVE | TO | NDT | 3 | 20 | RoHS & Green | Call TI | Level-1-NA-UNLIM | -55 to 125 | LM137H/883 Q ACO LM137H/883 Q >T | Samples |
| LM137H1PQMLV | ACTIVE | TO | NDT | 3 | 20 | Non-RoHS & Green | Call TI | Level-1-NA-UNLIM | -55 to 125 | LM137H1PQMLV 5962P9951708VXA Q ACO 5962P9951708VXA Q >T | Samples |
| LM137K/883 | ACTIVE | TO | K | 2 | 50 | Non-RoHS & Non-Green | Call TI | Call TI | -55 to 125 | (LM120H-15P+, LM137K) /883 Q ACO /883 Q >T | Samples |
| LM137KG MD8 | ACTIVE | DIESALE | Y | 0 | 120 | RoHS & Green | Call TI | Level-1-NA-UNLIM | -55 to 125 | | Samples |
| LM137KG-MW8 | ACTIVE | WAFERSALE | YS | 0 | 1 | RoHS & Green | Call TI | Level-1-NA-UNLIM | -55 to 125 | | Samples |

(1) The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.



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(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF LM137QML, LM137QML-SP :**

- Military : LM137QML
- Space : LM137QML-SP

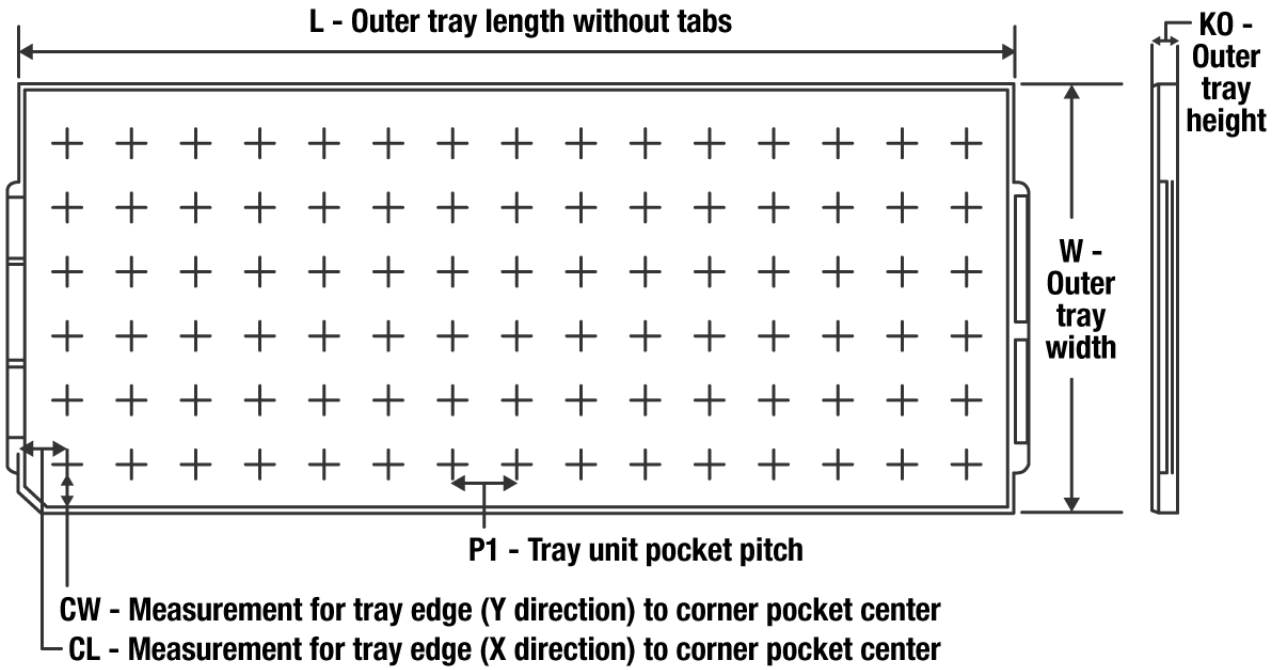
NOTE: Qualified Version Definitions:

- Military - QML certified for Military and Defense Applications
- Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application



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## TRAY




Chamfer on Tray corner indicates Pin 1 orientation of packed units.

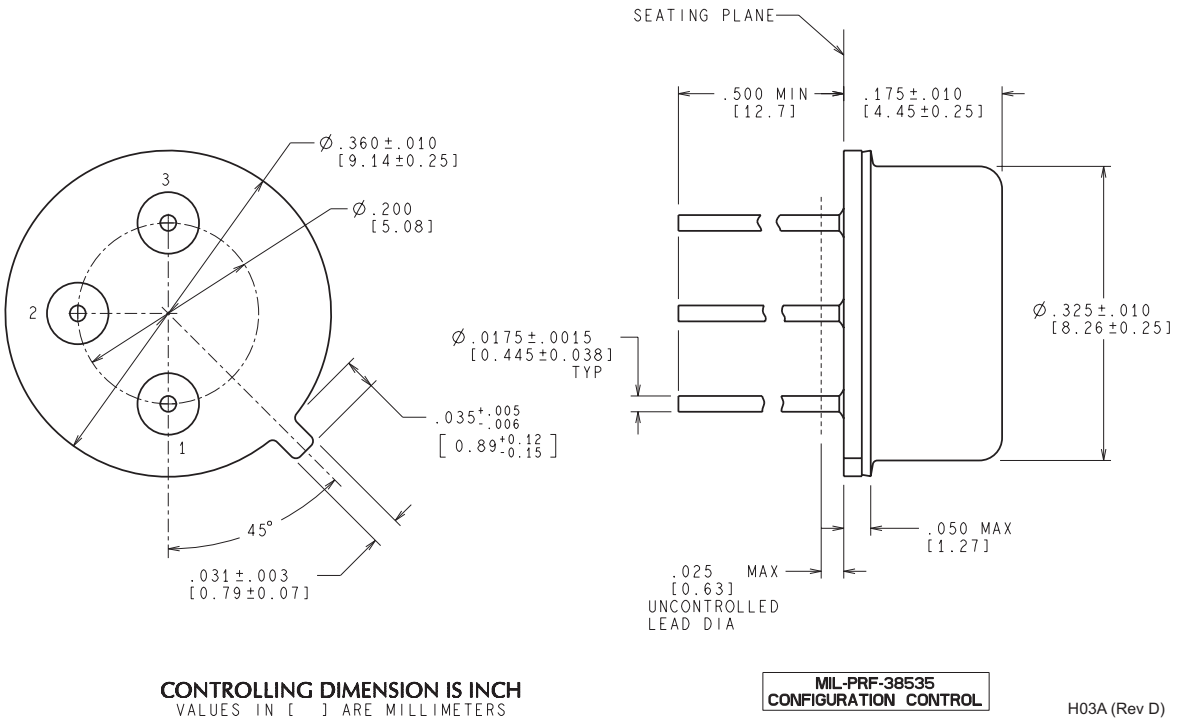
*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | Unit array matrix | Max temperature (°C) | L (mm) | W (mm) | K0 (µm) | P1 (mm) | CL (mm) | CW (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5962P9951708VXA | NDT | TO-CAN | 3 | 20 | 2 X 10 | 150 | 126.49 | 61.98 | 8890 | 11.18 | 12.95 | 18.54 |
| LM137H/883 | NDT | TO-CAN | 3 | 20 | 2 X 10 | 150 | 126.49 | 61.98 | 8890 | 11.18 | 12.95 | 18.54 |
| LM137H1PQMLV | NDT | TO-CAN | 3 | 20 | 2 X 10 | 150 | 126.49 | 61.98 | 8890 | 11.18 | 12.95 | 18.54 |
| LM137K/883 | K | TO-CAN | 2 | 50 | 9 X 6 | NA | 292.1 | 215.9 | 25654 | 3.87 | 22.3 | 25.4 |



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# NDT0003A




CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

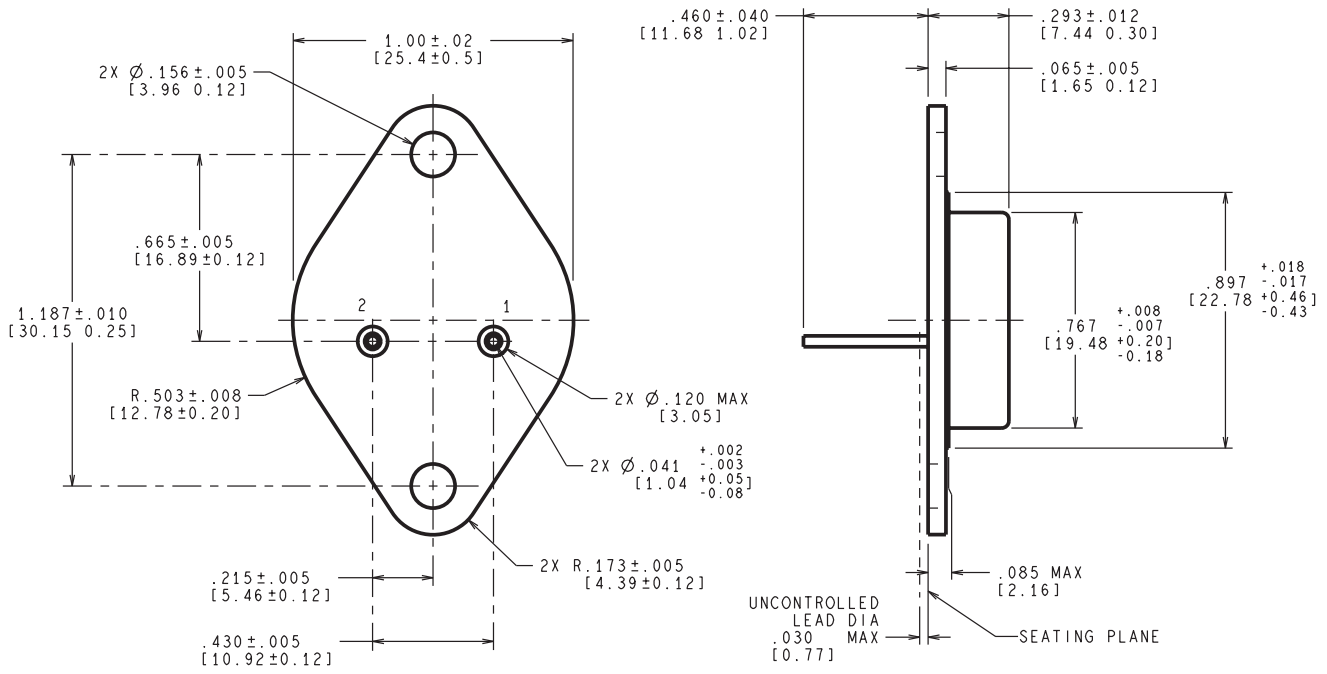
MIL-PRF-38535
CONFIGURATION CONTROL

H03A (Rev D)



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# K0002C




NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.

2. This drawing is subject to change without notice.

3. Leads not to be bent greater than 15º



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