

## LM137HVQML 3-Terminal Adjustable Negative Regulators (High Voltage)

Check for Samples: [LM137HVQML](#)

### FEATURES

- Output Voltage Adjustable from  $-47\text{V}$  to  $-1.2\text{V}$
- 1.5A Output Current Specified,  $-55^\circ\text{C} \leq T_J \leq +150^\circ\text{C}$
- 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/ $^\circ\text{C}$  Temperature Coefficient
- Temperature-Independent Current Limit
- Internal Thermal Overload Protection
- Standard 3-Lead Transistor Package
- Output Short Circuit Protected

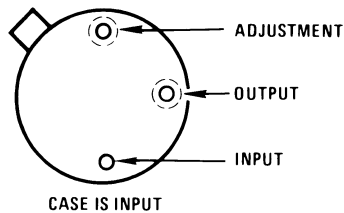
### DESCRIPTION

The LM137HV is an adjustable 3-terminal negative voltage regulator capable of supplying in excess of  $-1.5\text{A}$  over an output voltage range of  $-47\text{V}$  to  $-1.2\text{V}$ . This regulator is 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 LM137HV features internal current limiting, thermal shutdown and safe-area compensation, making them virtually blowout-proof against overloads.

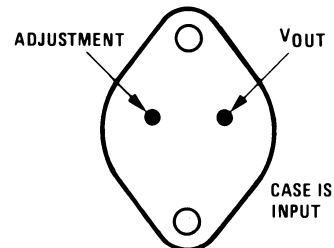
The LM137HV serves a wide variety of applications including local on-card regulation, programmable-output voltage regulation or precision current regulation. The LM137HV is an ideal complement to the LM117HV adjustable positive regulator.

### Connection Diagrams

See Physical Dimensions section for further information



**Figure 1. TO Package – Bottom View**  
See Package Number NDT0003A



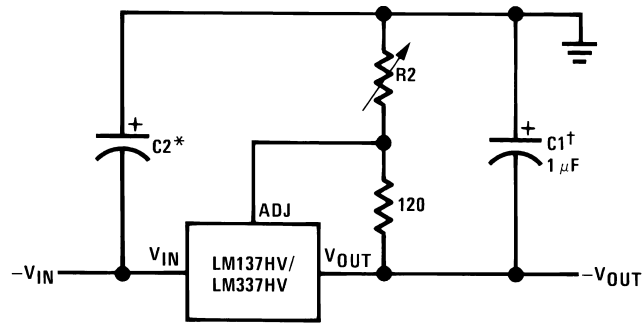
**Figure 2. TO-3 Package (Bottom View)**  
See Package Number K



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## Typical Applications



$$-V_{OUT} = -1.25V \left( 1 + \frac{R_2}{120\Omega} \right) + \left[ -I_{Adj}(R_2) \right]$$

†C1 = 1 μF solid tantalum or 10 μF aluminum electrolytic required for stability. Output capacitors in the range of 1 μF to 1000 μF of aluminum or tantalum electrolytic are commonly used to provide improved output impedance and rejection of transients.

\*C2 = 1 μF solid tantalum is required only if regulator is more than 4" from power-supply filter capacitor.

**Figure 3. Adjustable Negative Voltage Regulator**



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.

## Absolute Maximum Ratings<sup>(1)</sup>

|                                       |                 |   |          |         |
|---------------------------------------|-----------------|---|----------|---------|
| Power Dissipation <sup>(2)</sup>      |                 | Internally limited                          |          |         |
| Input–Output Voltage Differential     |                 | 50V   |          |         |
| Operating Ambient Temperature Range   |                 | -55°C ≤ T <sub>A</sub> ≤ +125°C             |          |         |
| Maximum Junction Temperature Range    |                 | +150°C                                      |          |         |
| Storage Temperature                   |                 | -65°C ≤ T <sub>A</sub> ≤ +150°C             |          |         |
| Lead Temperature (Soldering, 10 sec.) |                 | 300°C                                       |          |         |
| Thermal Resistance                    | θ <sub>JA</sub> | NDT0003A pkg. (Still Air @ 0.5W)            |          | 174°C/W |
|                                       |                 | NDT0003A pkg. (500LF / Min Air Flow @ 0.5W) |          | 64°C/W  |
|                                       |                 | K pkg. (Still Air @ 0.5W)                   |          | 42°C/W  |
|                                       |                 | K pkg. (500LF / Min Air Flow @ 0.5W)        |          | 14°C/W  |
|                                       | θ <sub>JC</sub> | NDT0003A pkg. (@ 1.0W)                      |          | 15°C/W  |
|                                       |                 | K pkg.                                      |          | 4°C/W   |
| Package Weight (Typical)              |                 | NDT0003A pkg                                | 955mg    |         |
|                                       |                 | K pkg                                       | 12,750mg |         |
| ESD Rating <sup>(3)</sup>             |                 | 4000V                                       |          |         |

- (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 ensure specific performance limits. 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<sub>Jmax</sub> (maximum junction temperature), θ<sub>JA</sub> (package junction to ambient thermal resistance, and T<sub>A</sub> (ambient temperature). The maximum allowable power dissipation at any temperature is P<sub>Dmax</sub> = (T<sub>Jmax</sub> - T<sub>A</sub>) / θ<sub>JA</sub> or the number given in the Absolute Maximum Ratings, whichever is lower.
- (3) Human body model, 100pF discharged through 1.5KΩ

**Table 1. Quality Conformance Inspection**

| Mil-Std-883, Method 5004 and Method 5005 |                     |           |
|--|---------------------|-----------|
| Subgroup <sup>(1)</sup>                  | Description         | Temp (°C) |
| 1  | Static tests at     | +25°C     |
| 2  | Static tests at     | +125°C    |
| 3  | Static tests at     | -55°C     |
| 4  | Dynamic tests at    | +25°C     |
| 5  | Dynamic tests at    | +125°C    |
| 6  | Dynamic tests at    | -55°C     |
| 7  | Functional tests at | +25°C     |
| 8A                                       | Functional tests at | +125°C    |
| 8B                                       | Functional tests at | -55°C     |
| 9  | Switching tests at  | +25°C     |
| 10                                       | Switching tests at  | +125°C    |
| 11                                       | Switching tests at  | -55°C     |

(1) Group "A" sample only, test at all temperature.

### LM137HVH 883 Electrical Characteristics DC Parameters

The following conditions apply, unless otherwise specified.  $V_{IN} = -4.0V$ ,  $I_O = 0.53A$ ,  $V_O = V_{Ref}$

| Symbol           | Parameter                     | Conditions                                    | Notes              | Min    | Max    | Unit    | Sub-groups |
|------------------|-------------------------------|---|--------------------|--------|--------|---------|------------|
| $V_{Ref}$        | Reference Voltage             | $V_{IN} = -4.25V$ , $I_O = 8mA$               |                    | -1.272 | -1.23  | V       | 1          |
|                  |                               |   |                    | -1.28  | -1.225 | V       | 2, 3       |
|                  |                               | $V_{IN} = -42V$ , $I_O = 8mA$                 |                    | -1.272 | -1.23  | V       | 1          |
|                  |                               |   |                    | -1.28  | -1.225 | V       | 2, 3       |
| $I_Q$            | Minimum Load Current          | $V_O = -1.7V$ , $V_{IN} = -4.25V$             |                    |        | 3.0    | mA      | 1, 2, 3    |
|                  |                               | $V_O = -1.7V$ , $V_{IN} = -11.75V$            |                    |        | 3.0    | mA      | 1, 2, 3    |
|                  |                               | $V_O = -1.7V$ , $V_{IN} = -42V$               |                    |        | 5.0    | mA      | 1, 2, 3    |
| $R_{Line}$       | Line Regulation               | $-42V \leq V_{IN} \leq -4.25V$ , $I_O = 8mA$  |                    |        | 9.4    | mV      | 1, 2, 3    |
| $I_{Adj}$        | Adjustment Pin Current        | $V_{IN} = -42V$ , $I_O = 8mA$                 |                    |        | 100    | $\mu A$ | 1, 2, 3    |
|                  |                               | $V_{IN} = -4.25V$ , $I_O = 8mA$               |                    |        | 100    | $\mu A$ | 1, 2, 3    |
|                  |                               | $V_{IN} = -54V$ , $I_O = 8mA$                 |                    |        | 100    | $\mu A$ | 1          |
| $\Delta I_{Adj}$ | Adjustment Pin Current Change | $-42V \leq V_{IN} \leq -4.25V$ , $I_L = 8mA$  |                    |        | 6.0    | $\mu A$ | 1, 2, 3    |
|                  |                               | $V_{IN} = -6.25V$ , $8mA \leq I_O \leq 0.53A$ |                    |        | 5.0    | $\mu A$ | 1, 2, 3    |
|                  |                               | $-54V \leq V_{IN} \leq -4.25V$ , $I_O = 8mA$  |                    |        | 6.0    | $\mu A$ | 1          |
| $R_{Load}$       | Load Regulation               | $V_{IN} = -54V$ , $10mA \leq I_O \leq 60mA$   |                    |        | 25     | mV      | 1          |
|                  |                               | $V_{IN} = -6.25V$ , $8mA \leq I_O \leq 0.53A$ |                    |        | 25     | mV      | 1          |
| $V_{Rth}$        | Thermal Regulation            | $I_O = 0.53A$ , $V_{IN} = -14.5V$             |                    |        | 5      | mV      | 1          |
| $I_{CL}$         | Current Limit                 | $V_{IN} \leq -14.25$                          | See <sup>(1)</sup> | 0.5    | 1.6    | A       | 1          |
|                  |                               | $V_{IN} = -51.25V$                            | See <sup>(1)</sup> | 0.1    | 0.5    | A       | 1          |

(1) Specified parameter not tested.

### LM137HVH 883 Electrical Characteristics AC Parameters

| Symbol         | Parameter        | Conditions   | Notes                 | Min | Max | Unit | Sub-groups |
|----------------|------------------|--|-----------------------|-----|-----|------|------------|
| R <sub>R</sub> | Ripple Rejection | V <sub>IN</sub> = -6.25V, V <sub>O</sub> = V <sub>Ref</sub> , f = 120Hz, e <sub>1</sub> = 1V <sub>RMS</sub> , I <sub>L</sub> = 125mA | See <sup>(1)(2)</sup> |     | 66  | dB   | 4, 5, 6    |

(1) Tested at +25°C, specified, but not tested at +125°C and -55°C

(2) Bench test per (SG)RPI-3-362 Use TDN 70256657 (NSSG)

### LM137HVK 883 Electrical Characteristics DC Parameters

The following conditions apply, unless otherwise specified. V<sub>IN</sub> = -40V, I<sub>L</sub> = 8.0mA, V<sub>O</sub> = V<sub>Ref</sub> = -1.25V (nominal)

| Symbol            | Parameter                     | Conditions  | Notes              | Min    | Max    | Unit | Sub-groups |
|-------------------|-------------------------------|---|--------------------|--------|--------|------|------------|
| V <sub>Ref</sub>  | Reference Voltage             | V <sub>IN</sub> = -4.25V                                  |                    | 1.272  | -1.23  | V    | 1          |
|                   |                               | V <sub>IN</sub> = -42V                                    |                    | -1.28  | -1.225 | V    | 2, 3       |
|                   |                               | V <sub>IN</sub> = -41.3V                                  |                    | -1.272 | -1.23  | V    | 1          |
|                   |                               | V <sub>IN</sub> = -41.3V                                  |                    | -1.28  | -1.225 | V    | 2, 3       |
| R <sub>Line</sub> | Line Regulation               | -42V ≤ V <sub>IN</sub> ≤ -4.25V                           |                    |        | 9.4    | mV   | 1          |
|                   |                               | -41.3V ≤ V <sub>IN</sub> ≤ -4.25V                         |                    |        | 9.4    | mV   | 2, 3       |
| R <sub>Load</sub> | Load Regulation               | V <sub>IN</sub> = -54V, 10mA ≤ I <sub>O</sub> ≤ 110mA     |                    | -25    | 25     | mV   | 1          |
|                   |                               | V <sub>IN</sub> = -6.25V, 8mA ≤ I <sub>O</sub> ≤ 1.5A     |                    | -25    | 25     | mV   | 1, 2, 3    |
| V <sub>Rth</sub>  | Thermal Regulation            | I <sub>O</sub> = 1.5A, V <sub>IN</sub> = -14.5V, t = 10mS |                    | -5.0   | 5.0    | mV   | 1          |
| I <sub>Adj</sub>  | Adjustment Pin Current        | V <sub>IN</sub> = -42V                                    |                    |        | 100    | μA   | 1          |
|                   |                               | V <sub>IN</sub> = -41.3V                                  |                    |        | 100    | μA   | 2, 3       |
|                   |                               | V <sub>IN</sub> = -4.25V                                  |                    |        | 100    | μA   | 1, 2, 3    |
|                   |                               | V <sub>IN</sub> = -54V                                    |                    |        | 100    | μA   | 1          |
| ΔI <sub>Adj</sub> | Adjustment Pin Current Change | -42V ≤ V <sub>IN</sub> ≤ -4.25V                           |                    | -5.0   | 5.0    | μA   | 1          |
|                   |                               | -41.3V ≤ V <sub>IN</sub> ≤ -4.25V                         |                    | -5.0   | 5.0    | μA   | 2, 3       |
|                   |                               | -54V ≤ V <sub>IN</sub> ≤ -4.25V                           |                    | -6.0   | 6.0    | μA   | 1          |
|                   |                               | V <sub>IN</sub> = -6.25V, 8mA ≤ I <sub>O</sub> ≤ 1.5A     |                    | -5.0   | 5.0    | μA   | 1, 2, 3    |
| I <sub>Q</sub>    | Minimum Load Current          | V <sub>O</sub> = 1.7V, V <sub>IN</sub> = -4.25V           |                    |        | 3.0    | mA   | 1, 2, 3    |
|                   |                               | V <sub>O</sub> = -1.7V, V <sub>IN</sub> = -11.75V         |                    |        | 3.0    | mA   | 1, 2, 3    |
|                   |                               | V <sub>O</sub> = -1.7V, V <sub>IN</sub> = -42V            |                    |        | 5.0    | mA   | 1          |
|                   |                               | V <sub>O</sub> = -1.7V, V <sub>IN</sub> = -41.3V          |                    |        | 5.0    | mA   | 2, 3       |
| I <sub>SC</sub>   | Short Circuit                 | V <sub>IN</sub> = -5V                                     |                    | -2.85  | -1.6   | A    | 1          |
|                   |                               | V <sub>IN</sub> = -5V                                     |                    | -3.5   | -1.6   | A    | 2, 3       |
|                   |                               | V <sub>IN</sub> = -51.25V                                 | See <sup>(1)</sup> | -0.8   | -0.2   | A    | 1          |

(1) Specified parameter not tested.

### LM137HVK 883 Electrical Characteristics AC Parameters:

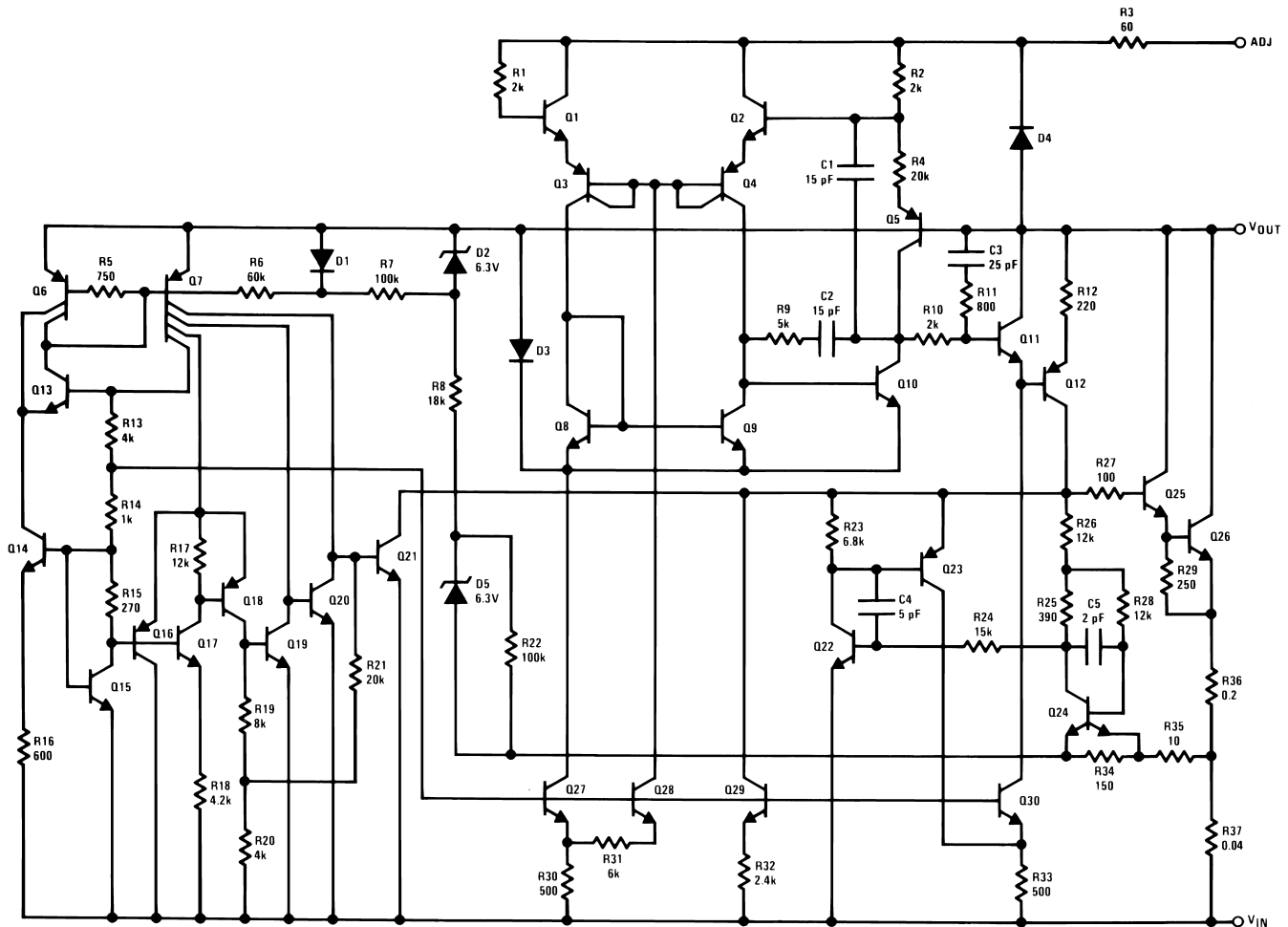
The following conditions apply, unless otherwise specified. V<sub>IN</sub> = -40V, I<sub>L</sub> = 8.0mA, V<sub>O</sub> = V<sub>Ref</sub> = -1.25V (nominal)

| Symbol         | Parameter        | Conditions   | Notes                 | Min | Max | Unit | Sub-groups |
|----------------|------------------|--|-----------------------|-----|-----|------|------------|
| R <sub>R</sub> | Ripple Rejection | V <sub>IN</sub> = -6.25V, V <sub>O</sub> = V <sub>Ref</sub> , f = 120Hz, e <sub>in</sub> = 1V <sub>RMS</sub> , I <sub>L</sub> = 0.5A | See <sup>(1)(2)</sup> | 66  |     | dB   | 4, 5, 6    |

(1) Tested at +25°C, specified, but not tested at +125°C and -55°C

(2) Bench test per (SG)RPI-3-362 Use TDN 70256657 (NSSG)

### Schematic Diagram



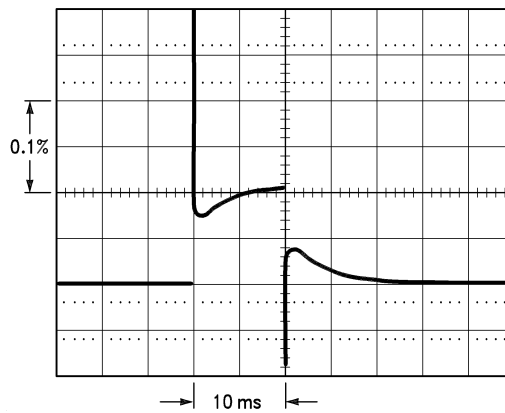
### Thermal Regulation

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 LM137HV's specification is 0.02%/W, max.

In Figure 4, a typical LM137HV'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  $0.02\%/W \times 10W = 0.2\%$  max. When the 10W pulse is ended, the thermal regulation again shows a 3 mV step as the LM137HV chip cools off. Note that the load regulation error of about 8 mV (0.08%) is additional to the thermal regulation error. In Figure 5, 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).

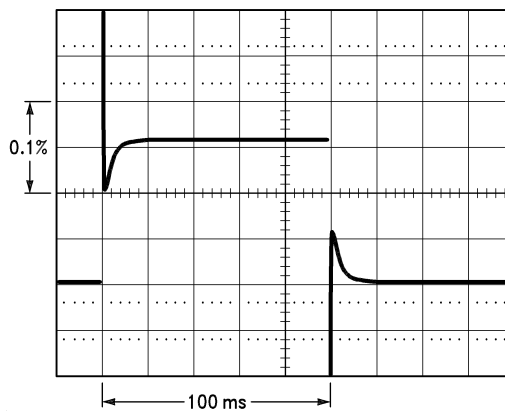
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large. Thermal regulation is the effect of these temperature gradients on output 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 LM137HV's specification is 0.02%/W, max.

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LM137HV,  $V_{OUT} = -10V$   
 $V_{IN} - V_{OUT} = -40V$   
 $I_L = 0A \rightarrow 0.25A \rightarrow 0A$   
 Vertical sensitivity, 5 mV/div

**Figure 4.**



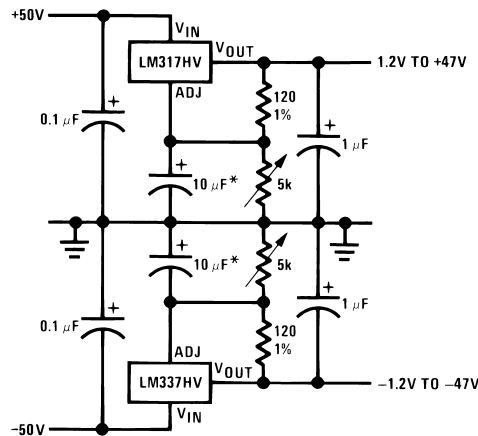
LM137HV,  $V_{OUT} = -10V$   
 $V_{IN} - V_{OUT} = -40V$   
 $I_L = 0A \rightarrow 0.25A \rightarrow 0A$   
 Horizontal sensitivity, 20 ms/div

**Figure 5.**

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 LM137HV's specification is 0.02%/W, max.

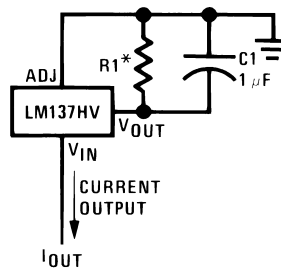
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### Typical Applications



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

Figure 6. Adjustable High Voltage Regulator



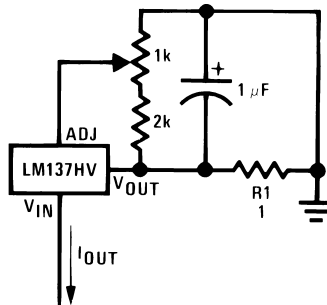
$$I_{OUT} = \frac{V_{REF}}{R1}$$

\*  $0.8\Omega \leq R1 \leq 120\Omega$

Figure 7. Current Regulator

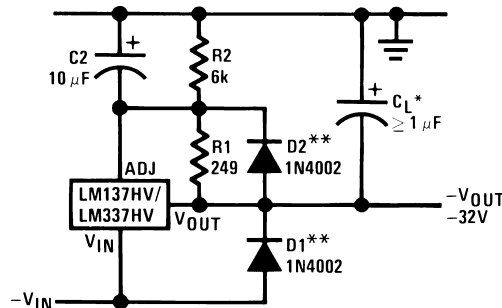
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large. Thermal regulation is the effect of these temperature gradients on output 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 LM137HV's specification is 0.02%/W, max.

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

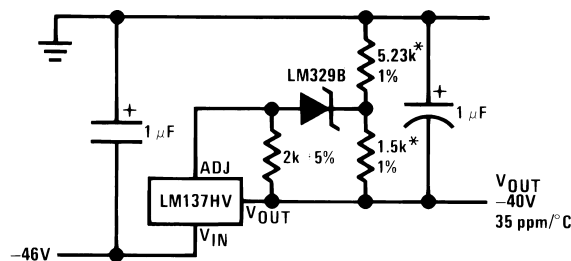
Figure 8. Adjustable Current Regulator



\*When  $C_L$  is larger than 20  $\mu F$ , D1 protects the LM137HV in case the input supply is shorted

\*\*When  $C_2$  is larger than 10  $\mu F$  and  $-V_{OUT}$  is larger than -25V, D2 protects the LM137HV in case the output is shorted

Figure 9. Negative Regulator with Protection Diodes



\*Use resistors with good tracking TC < 25 ppm/°C

Figure 10. High Stability -40V Regulator



### Typical Performance Characteristics

(H and K-STEEL Package)

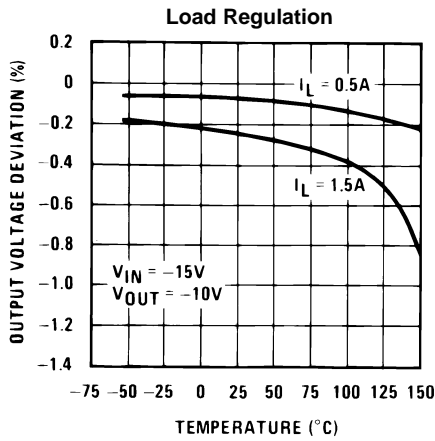


Figure 11.

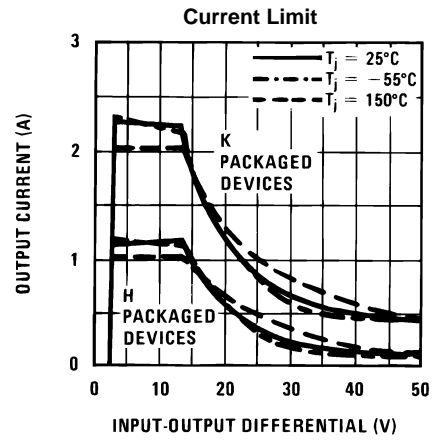


Figure 12.

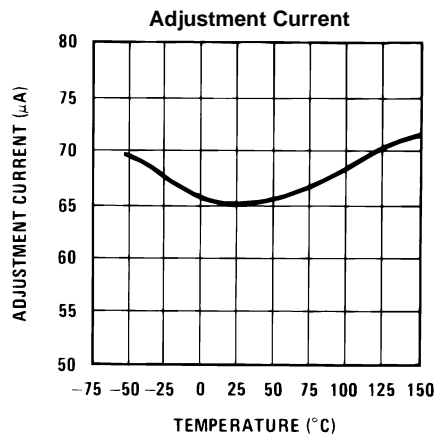


Figure 13.

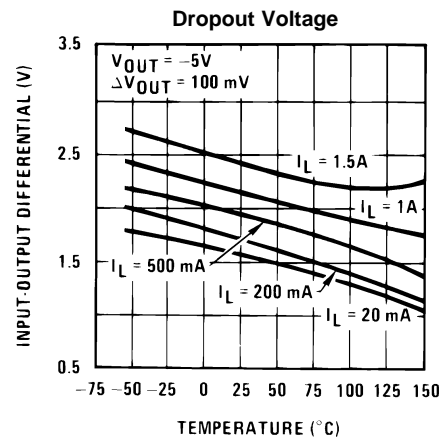


Figure 14.

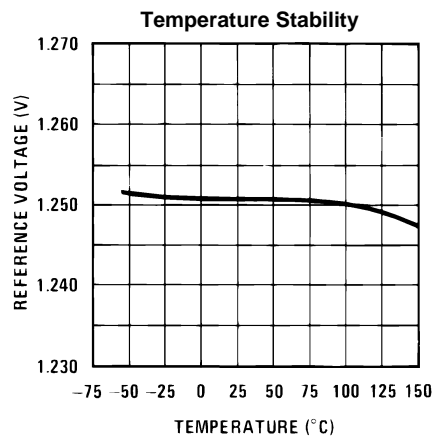


Figure 15.

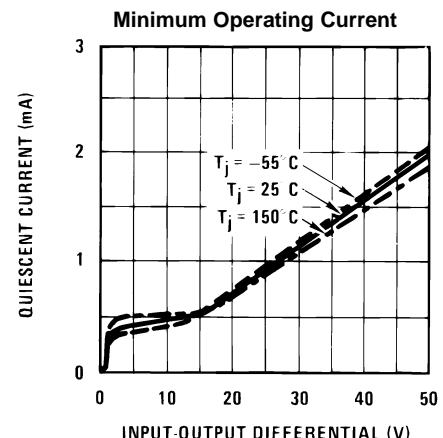


Figure 16.

Typical Performance Characteristics (continued)

(H and K-STEEL Package)

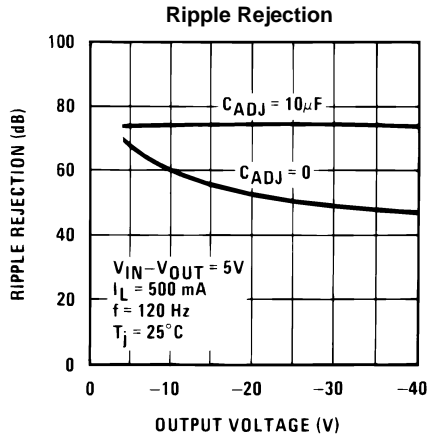


Figure 17.

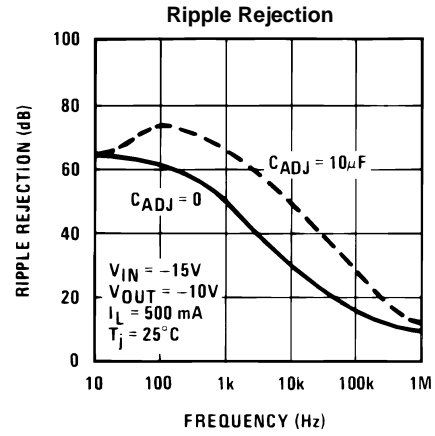


Figure 18.

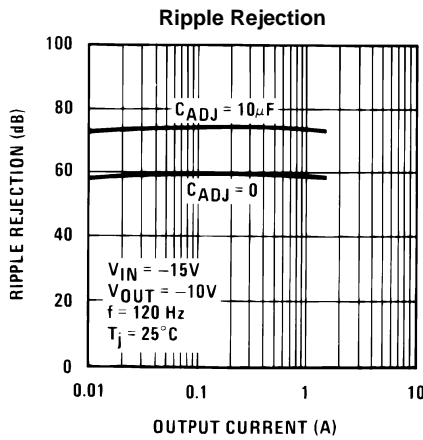


Figure 19.

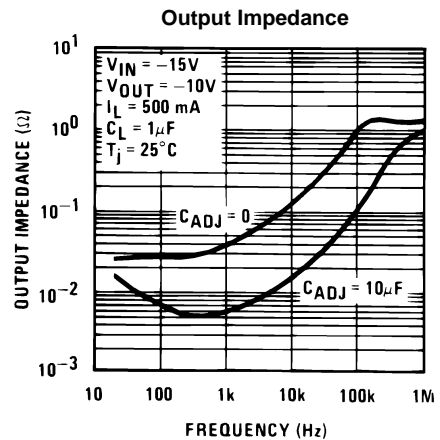


Figure 20.

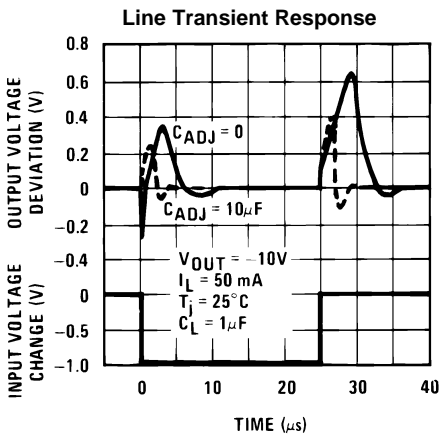


Figure 21.

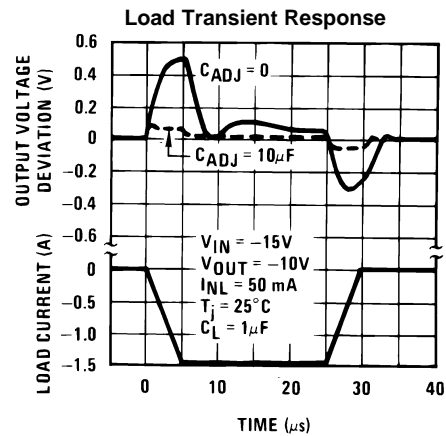


Figure 22.

**REVISION HISTORY**

| <b>Date Released</b> | <b>Revision</b> | <b>Section</b>                | <b>Changes</b>  |
|----------------------|-----------------|-------------------------------|---|
| 12/16/2010           | A               | New Release, Corporate format | 2 MDS data sheets converted into one Corp. Data sheet format. MNLM137HV-K rev 0A0, MNLM137HV-H rev 2A0 MDS datasheets will be archived. |
| 04/17/2013           | A               |                               | Changed layout of National Data Sheet to TI format.   |

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2) | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4)                | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|------------------|----------------------|--------------|---|---------|
| LM137HVH/883     | ACTIVE        | TO           | NDT                | 3    | 20             | TBD             | Call TI          | Call TI              | -55 to 150   | LM137HVH/883 Q ACO<br>LM137HVH/883 Q >T | 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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

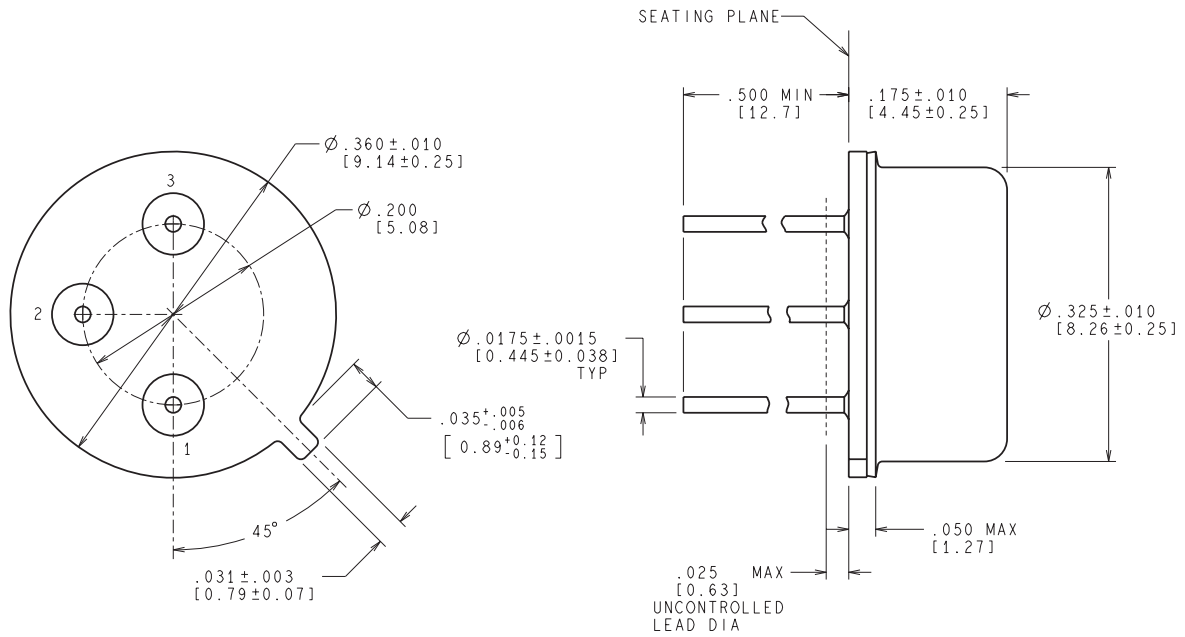
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side 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 Top-Side Marking for that device.

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H03A (Rev D)

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