General Description

The LM137/LM337 are adjustable 3-terminal negative voltage regulators capable of supplying in excess of −1.5A over an output voltage range of −1.2V to −37V. 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/LM337 serve a wide variety of applications including local on-card regulation, programmable-output voltage regulation or precision current regulation. The LM137/LM337 are ideal complements to the LM117/LM317 adjustable positive regulators.

Features

- Output voltage adjustable from −1.2V to −37V
- 1.5A output current guaranteed, −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
- P † Product Enhancement tested
- Standard 3-lead transistor package
- Output is short circuit protected

<table>
<thead>
<tr>
<th>Device</th>
<th>Package</th>
<th>Rated Power Dissipation</th>
<th>Design Load Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM137/337</td>
<td>TO-3 (K)</td>
<td>20W</td>
<td>1.5A</td>
</tr>
<tr>
<td></td>
<td>TO-39 (H)</td>
<td>2W</td>
<td>0.5A</td>
</tr>
<tr>
<td>LM337</td>
<td>TO-220 (T)</td>
<td>15W</td>
<td>1.5A</td>
</tr>
</tbody>
</table>

Features

- Output voltage adjustable from −1.2V to −37V
- 1.5A output current guaranteed, −55°C to +150°C
- Line regulation typically 0.01%/V
- Load regulation typically 0.3%
- Excellent thermal regulation, 0.002%/W

Typical Applications

Adjustable Negative Voltage Regulator

Full output current not available at high input-output voltages

\[ V_{OUT} = -1.25V \left( 1 + \frac{R_2}{200Ω} \right) + \left( -\frac{R_{ADJ} \times R_2}{R_2} \right) \]

†C1 = 1 μF solid tantalum or 10 μF aluminum electrolytic required for stability

* 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 1 μF to 1000 μF of aluminum or tantalum electrolytic are commonly used to provide improved output impedance and rejection of transients
### Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications. (Note 4)

- Power Dissipation: Internally Limited
- Input-Output Voltage Differential: 40V

### Operating Junction Temperature Range
- LM137: −55°C to +150°C
- LM337: 0°C to +125°C

### Storage Temperature
- −65°C to +150°C

### Lead Temperature (Soldering, 10 sec.)
- 300°C

### Plastic Package (Soldering, 4 sec.)
- 260°C

### ESD Rating
- 2k Volts

### Electrical Characteristics (Note 1)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM137</th>
<th>LM337</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Line Regulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tj = 25°C, 3V ≤ [VIN − VOUT] ≤ 40V</td>
<td>0.01</td>
<td>0.02</td>
<td>0.01</td>
<td>0.04</td>
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<td></td>
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<td></td>
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<tr>
<td>Load Regulation</td>
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</tr>
<tr>
<td>Tj = 25°C, 10 mA ≤ IOUT ≤ IMAX</td>
<td>0.3</td>
<td>0.5</td>
<td>0.3</td>
<td>1.0</td>
</tr>
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<tr>
<td>Thermal Regulation</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Tj = 25°C, 10 ms Pulse</td>
<td>0.002</td>
<td>0.02</td>
<td>0.003</td>
<td>0.04</td>
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<td>Adjustment Pin Current</td>
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<td></td>
<td>65</td>
<td>100</td>
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<td>100</td>
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<tr>
<td>Adjustment Pin Current Charge</td>
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<td></td>
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<tr>
<td></td>
<td>10 mA ≤ IAK ≤ IMAX, 3.0V ≤ [VIN − VOUT] ≤ 40V, TA = 25°C</td>
<td>2</td>
<td>5</td>
<td>2</td>
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<tr>
<td>Reference Voltage</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tj = 25°C (Note 3)</td>
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<td></td>
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<tr>
<td>3V ≤ [VIN − VOUT] ≤ 40V, (Note 3)</td>
<td>−1.225</td>
<td>−1.250</td>
<td>−1.275</td>
<td>−1.213</td>
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<tr>
<td>10 mA ≤ IOUT ≤ IMAX, P ≤ PMAX</td>
<td>−1.200</td>
<td>−1.250</td>
<td>−1.300</td>
<td>−1.200</td>
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<tr>
<td>Line Regulation</td>
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</tr>
<tr>
<td>3V ≤ [VIN − VOUT] ≤ 40V, (Note 2)</td>
<td>0.02</td>
<td>0.05</td>
<td>0.02</td>
<td>0.07</td>
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<tr>
<td>Load Regulation</td>
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</tr>
<tr>
<td>10 mA ≤ IOUT ≤ IMAX, (Note 2)</td>
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<td>0.3</td>
<td>1.5</td>
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<tr>
<td>Temperature Stability</td>
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<tr>
<td>TMIN ≤ Tj ≤ TMAX</td>
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<tr>
<td>Minimum Load Current</td>
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<tr>
<td>VIN − VOUT ≤ 40V</td>
<td>2.5</td>
<td>5</td>
<td>2.5</td>
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<tr>
<td>VIN − VOUT ≤ 10V</td>
<td>1.2</td>
<td>3</td>
<td>1.5</td>
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<tr>
<td>Current Limit</td>
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<tr>
<td>VIN − VOUT ≤ 15V</td>
<td>1.5</td>
<td>2.2</td>
<td>3.5</td>
<td>1.5</td>
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<tr>
<td>K and T Package</td>
<td>0.5</td>
<td>0.8</td>
<td>1.8</td>
<td>0.5</td>
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<tr>
<td>H Package</td>
<td>0.24</td>
<td>0.4</td>
<td>0.15</td>
<td>0.4</td>
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<tr>
<td>VOUT − 40V, Tj = 25°C</td>
<td>0.15</td>
<td>0.17</td>
<td>0.10</td>
<td>0.17</td>
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<tr>
<td>RMS Output Noise, % of VOUT</td>
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<td>Tj = 25°C, 10 Hz ≤ f ≤ 10 kHz</td>
<td>0.003</td>
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<tr>
<td>Ripple Rejection Ratio</td>
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<tr>
<td>VOUT = −10V, f = 120 Hz</td>
<td>66</td>
<td>60</td>
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<td>CADJ = 10 µF</td>
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<td>Long-Term Stability</td>
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<tr>
<td>Tj = 125°C, 1000 Hours</td>
<td>0.3</td>
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<td>Thermal Resistance, Junction to Case</td>
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<tr>
<td>K Package</td>
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<tr>
<td>H Package</td>
<td>12</td>
<td>15</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>T Package</td>
<td>2.3</td>
<td>3</td>
<td>2.3</td>
<td>3</td>
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<tr>
<td>Thermal Resistance, Junction to Ambient (No Heat Sink)</td>
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<tr>
<td>K Package</td>
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<tr>
<td>H Package</td>
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<tr>
<td>T Package</td>
<td>50</td>
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<td>50</td>
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</tbody>
</table>

**Note 1:** Unless otherwise specified, these specifications apply −55°C ≤ Tj ≤ +150°C for the LM137, 0°C ≤ Tj ≤ +125°C for the LM337; VIN − VOUT = 5V; and IOUT = 0.1A for the TO-39 package and IOUT = 0.5A for the TO-3 and TO-220 packages. Although power dissipation is internally limited, these specifications are applicable for power dissipations of 2W for the TO-39 and 20W for the TO-3 and TO-220. IOUT ≤ 1.5A for the TO-3 and TO-220 packages, and 0.2A for the TO-39 package.

**Note 2:** Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation. Load regulation is measured on the output pin at a point 1/8 from the base of the TO-3 and TO-39 packages.

**Note 3:** Selected devices with tightened tolerance reference voltage available.

**Note 4:** Refer to RETS137H drawing for LM137H or RETS137K drawing for LM137K military specifications.
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.

In Figure 1, 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 at 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 2, 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).
Connection Diagrams

TO-3 Metal Can Package

Bottom View
Order Number LM137K/883
See NS Package Number K02C
Order Number LM337K STEEL
See NS Package Number K02A

TO-39 Metal Can Package

Bottom View
Order Number LM137H, LM137H/883 or LM337H
See NS Package Number H03A

TO-220 Plastic Package

Front View
Order Number LM337T
See NS Package Number T03B
Typical Applications (Continued)

Adjustable Lab Voltage Regulator

Full output current not available at high input-output voltages

The 10 μF capacitors are optional to improve ripple rejection

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5.2V Regulator with Electronic Shutdown*

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

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Current Regulator

I_{OUT} = \frac{1.25\text{V}}{R_1}

*0.8 \leq R_1 \leq 1200

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Adjustable Current Regulator

I_{OUT} = \frac{1.5\text{V}}{R_1} ± 15% adjustable

---

Negative Regulator with Protection Diodes

*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

---

High Stability – 10V Regulator

V_{OUT} ±15 ppm/°C

---
Typical Performance Characteristics (K Steel and T Packages)

- **Load Regulation**
  - V_{IN} = -15V
  - V_{OUT} = -13V
  - I_{L} = 1mA
  - I_{L} = 1.5mA

- **Current Limit**
  - I_{L} = 5mA
  - I_{L} = 1mA

- **Adjustment Current**
  - R_{2} = 1kΩ
  - R_{2} = 2kΩ

- **Dropout Voltage**
  - V_{DROP} = -3V
  - V_{DROP} = -13V

- **Temperature Stability**
  - T_{1} = 25°C
  - T_{1} = -55°C
  - T_{1} = 125°C

- **Minimum Operating Current**
  - I_{MIN} = 1mA

- **Ripple Rejection**
  - F = 1kHz

- **Output Impedance**
  - Frequency (Hz)
  - Time (s)

- **Line Transient Response**
  - V_{IN} = -15V
  - V_{OUT} = -13V

- **Load Transient Response**
  - V_{IN} = -15V
  - V_{OUT} = -13V

TL/H/9067-15
Physical Dimensions inches (millimeters)

Metal Can Package (H)
Order Number LM137H, LM137H/883 or LM337H
NS Package Number H03A

Metal Can Package (K)
Order Number LM337K STEEL
NS Package Number K02A
Physical Dimensions inches (millimeters) (Continued)

Mil-Aero Metal Can Package (K)
Order Number LM137K/883
NS Package Number K02C
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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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**Physical Dimensions** inches (millimeters) (Continued)

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**TO-220 Plastic Package (T)**

Order Number LM337T

NS Package Number T03B

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