

LM137/LM337

3-Terminal Adjustable Negative Regulators

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

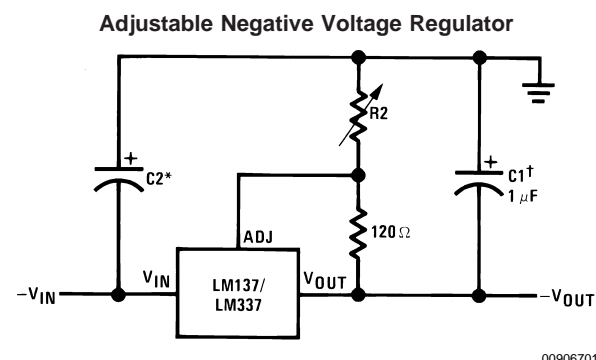
- Output voltage adjustable from -1.2V to -37V
- 1.5A output current guaranteed, -55°C to $+150^{\circ}\text{C}$
- Line regulation typically $0.01\%/V$
- Load regulation typically 0.3%

- Excellent thermal regulation, $0.002\%/W$
- 77 dB ripple rejection
- Excellent rejection of thermal transients
- $50\text{ ppm}/^{\circ}\text{C}$ temperature coefficient
- Temperature-independent current limit
- Internal thermal overload protection
- P⁺ Product Enhancement tested
- Standard 3-lead transistor package
- Output is short circuit protected

LM137 Series Packages and Power Capability

Device	Package	Rated Power Dissipation	Design Load Current
LM137/337	TO-3 (K)	20W	1.5A
	TO-39 (H)	2W	0.5A
LM337	TO-220 (T)	15W	1.5A
LM337	SOT-223 (MP)	2W	1A

Typical Applications



Full output current not available at high input-output voltages

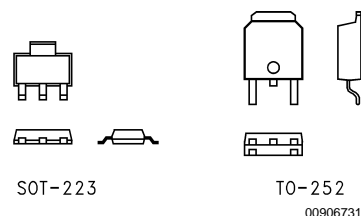
$$-V_{OUT} = -1.25V \left(1 + \frac{R2}{120} \right) + (-I_{ADJ} \times R2)$$

†C1 = $1\text{ }\mu\text{F}$ solid tantalum or $10\text{ }\mu\text{F}$ aluminum electrolytic required for stability

*C2 = $1\text{ }\mu\text{F}$ solid tantalum is required only if regulator is more than 4" from power-supply filter capacitor

Output capacitors in the range of $1\text{ }\mu\text{F}$ to $1000\text{ }\mu\text{F}$ of aluminum or tantalum electrolytic are commonly used to provide improved output impedance and rejection of transients

Comparison between SOT-223 and D-Pak (TO-252) Packages



Absolute Maximum Ratings (Notes 1,

4)

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

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

LM337I

-40°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)

Parameter	Conditions	LM137			LM337			Units
		Min	Typ	Max	Min	Typ	Max	
Line Regulation	$T_j = 25^\circ\text{C}$, $3\text{V} \leq V_{\text{IN}} - V_{\text{OUT}} \leq 40\text{V}$ (Note 2) $I_L = 10\text{ mA}$		0.01	0.02		0.01	0.04	%/V
Load Regulation	$T_j = 25^\circ\text{C}$, $10\text{ mA} \leq I_{\text{OUT}} \leq I_{\text{MAX}}$		0.3	0.5		0.3	1.0	%
Thermal Regulation	$T_j = 25^\circ\text{C}$, 10 ms Pulse		0.002	0.02		0.003	0.04	%/W
Adjustment Pin Current			65	100		65	100	μA
Adjustment Pin Current Charge	$10\text{ mA} \leq I_L \leq I_{\text{MAX}}$ $3.0\text{V} \leq V_{\text{IN}} - V_{\text{OUT}} \leq 40\text{V}$, $T_A = 25^\circ\text{C}$		2	5		2	5	μA
Reference Voltage	$T_j = 25^\circ\text{C}$ (Note 3) $3\text{V} \leq V_{\text{IN}} - V_{\text{OUT}} \leq 40\text{V}$, (Note 3) $10\text{ mA} \leq I_{\text{OUT}} \leq I_{\text{MAX}}$, $P \leq P_{\text{MAX}}$	-1.225	-1.250	-1.275	-1.213	-1.250	-1.287	V
		-1.200	-1.250	-1.300	-1.200	-1.250	-1.300	V
Line Regulation	$3\text{V} \leq V_{\text{IN}} - V_{\text{OUT}} \leq 40\text{V}$, (Note 2)		0.02	0.05		0.02	0.07	%/V
Load Regulation	$10\text{ mA} \leq I_{\text{OUT}} \leq I_{\text{MAX}}$, (Note 2)		0.3	1		0.3	1.5	%
Temperature Stability	$T_{\text{MIN}} \leq T_j \leq T_{\text{MAX}}$		0.6			0.6		%
Minimum Load Current	$ V_{\text{IN}} - V_{\text{OUT}} \leq 40\text{V}$ $ V_{\text{IN}} - V_{\text{OUT}} \leq 10\text{V}$		2.5	5		2.5	10	mA
			1.2	3		1.5	6	mA
Current Limit	$ V_{\text{IN}} - V_{\text{OUT}} \leq 15\text{V}$ K, MP and T Package	1.5	2.2	3.5	1.5	2.2	3.7	A
		0.5	0.8	1.8	0.5	0.8	1.9	A
	$ V_{\text{IN}} - V_{\text{OUT}} = 40\text{V}$, $T_j = 25^\circ\text{C}$ K, MP and T Package	0.24	0.4		0.15	0.4		A
		0.15	0.17		0.10	0.17		A
RMS Output Noise, % of V_{OUT}	$T_j = 25^\circ\text{C}$, $10\text{ Hz} \leq f \leq 10\text{ kHz}$		0.003			0.003		%
Ripple Rejection Ratio	$V_{\text{OUT}} = -10\text{V}$, $f = 120\text{ Hz}$ $C_{\text{ADJ}} = 10\text{ }\mu\text{F}$		60			60		dB
		66	77		66	77		dB
Long-Term Stability	$T_j = 125^\circ\text{C}$, 1000 Hours		0.3	1		0.3	1	%
Thermal Resistance, Junction to Case	H Package		12	15		12	15	$^\circ\text{C/W}$
	K Package		2.3	3		2.3	3	$^\circ\text{C/W}$
	T Package					4		$^\circ\text{C/W}$
Thermal Resistance, Junction to Ambient (No Heat Sink)	H Package		140			140		$^\circ\text{C/W}$
	K Package		35			35		$^\circ\text{C/W}$
	T Package					50		$^\circ\text{C/W}$
	MP Package					170		$^\circ\text{C/W}$

Note 1: Unless otherwise specified, these specifications apply $-55^\circ\text{C} \leq T_j \leq +150^\circ\text{C}$ for the LM137, $0^\circ\text{C} \leq T_j \leq +125^\circ\text{C}$ for the LM337; $V_{\text{IN}} - V_{\text{OUT}} = 5\text{V}$; and $I_{\text{OUT}} = 0.1\text{A}$ for the TO-39 package and $I_{\text{OUT}} = 0.5\text{A}$ for the TO-3, SOT-223 and TO-220 packages. Although power dissipation is internally limited, these specifications are applicable for power dissipations of 2W for the TO-39 and SOT-223 (see Application Hints), and 20W for the TO-3, and TO-220. I_{MAX} is 1.5A for the TO-3, SOT-223 and TO-220 packages, and 0.2A for the TO-39 package.

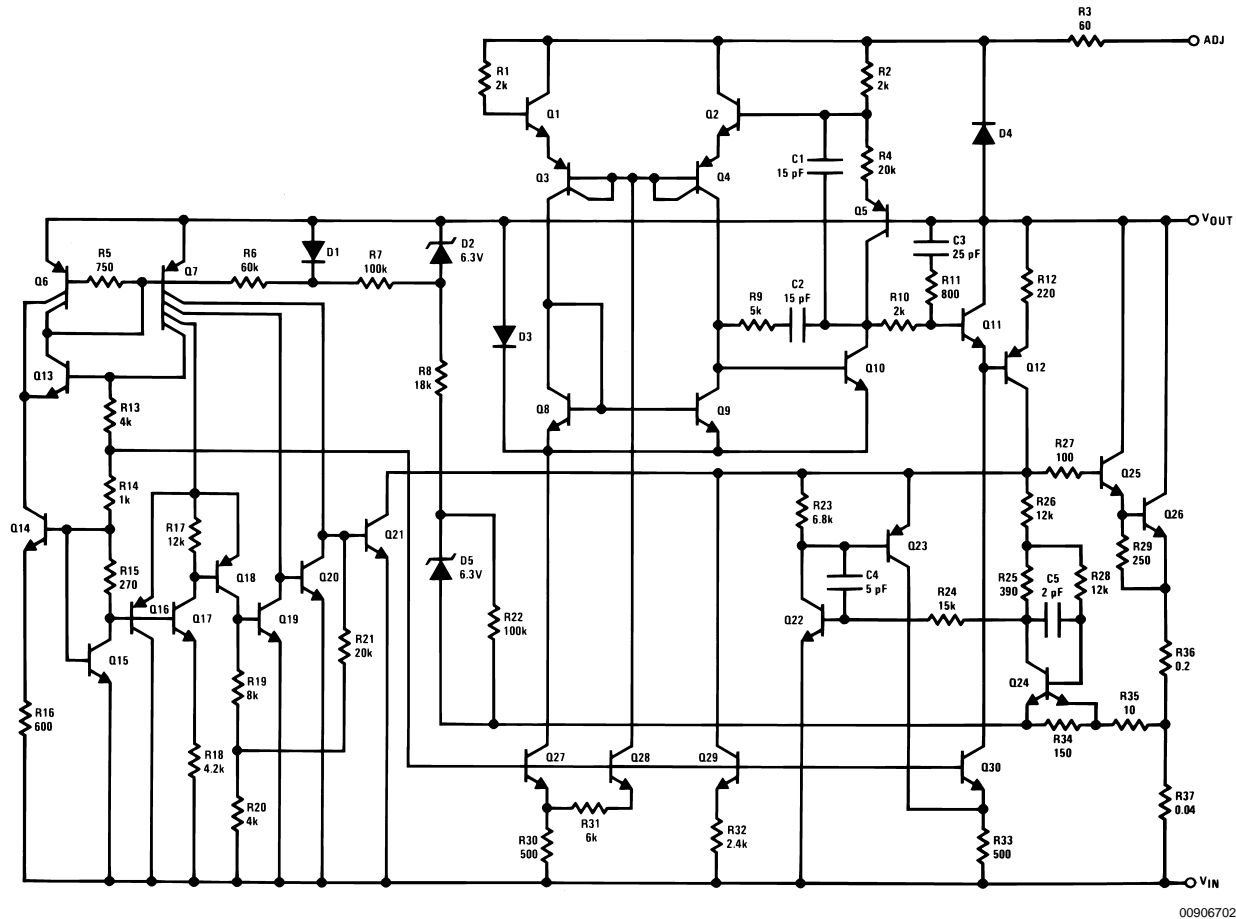
Note 2: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation. Load regulation is measured on the output pin at a point $\frac{1}{8}$ " below the base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

Electrical Characteristics (Note 1) (Continued)

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.

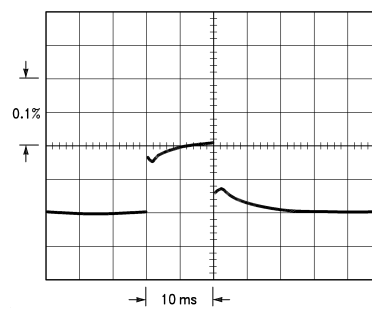
Schematic Diagram



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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.



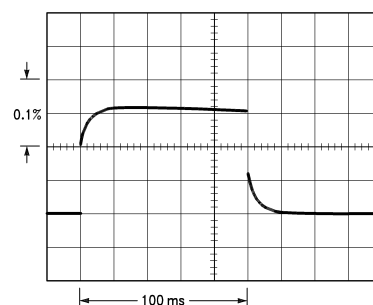
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LM137, $V_{OUT} = -10V$
 $V_{IN} - V_{OUT} = -40V$
 $I_{IL} = 0A \rightarrow 0.25A \rightarrow 0A$
 Vertical sensitivity, 5 mV/div

FIGURE 1.

Thermal Regulation (Continued)

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 $0.02\%/W \times 10W = 0.2\%$ 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).



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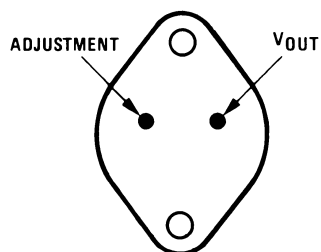
LM137, $V_{OUT} = -10V$ $V_{IN} - V_{OUT} = -40V$ $I_L = 0A \rightarrow 0.25A \rightarrow 0A$

Horizontal sensitivity, 20 ms/div

FIGURE 2.

Connection Diagrams

**TO-3
Metal Can Package**



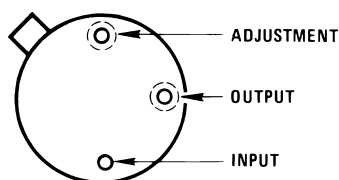
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Bottom View

Order Number LM137K/883
LM137KPQML and LM137KPQMLV(Note 5)
See NS Package Number K02C
Order Number LM337K STEEL
See NS Package Number K02A

Case is Input

**TO-39
Metal Can Package**



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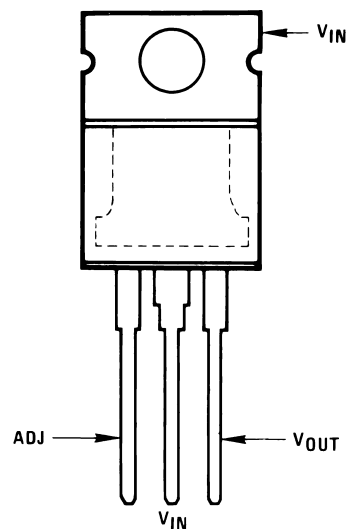
Bottom View

Order Number LM137H, LM137H/883 or LM337H
LM137HPQML and LM137HPQMLV(Note 5)
See NS Package Number H03A

Case Is Input

Note 5: See STD Mil DWG 5962P99517 for Radiation Tolerant Devices

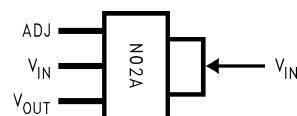
**TO-220
Plastic Package**



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Front View
Order Number LM337T
See NS Package Number T03B

3-Lead SOT-223



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Front View
Order Number LM337IMP
Package Marked N02A See NS Package Number MA04A

Application Hints

When a value for $\theta_{(H-A)}$ is found using the equation shown, a heatsink must be selected that has a value that is less than or equal to this number.

HEATSINKING SOT-223 PACKAGE PARTS

The SOT-223 ("MP") packages use a copper plane on the PCB and the PCB itself as a heatsink. To optimize the heat sinking ability of the plane and PCB, solder the tab of the package to the plane.

Figures 3, 4 show the information for the SOT-223 package. Figure 4 assumes a $\theta_{(J-A)}$ of 75°C/W for 1 ounce copper and 51°C/W for 2 ounce copper and a maximum junction temperature of 125°C.

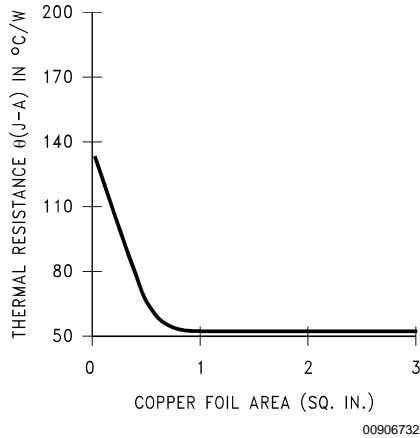


FIGURE 3. $\theta_{(J-A)}$ vs Copper (2 ounce) Area for the SOT-223 Package

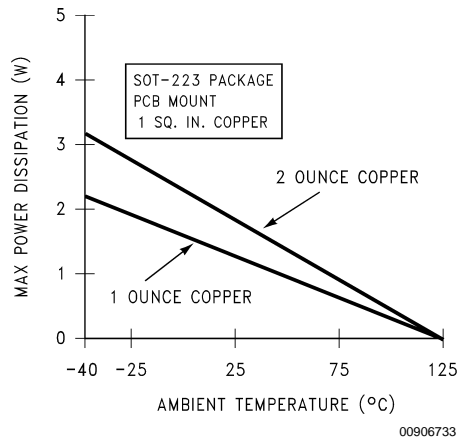
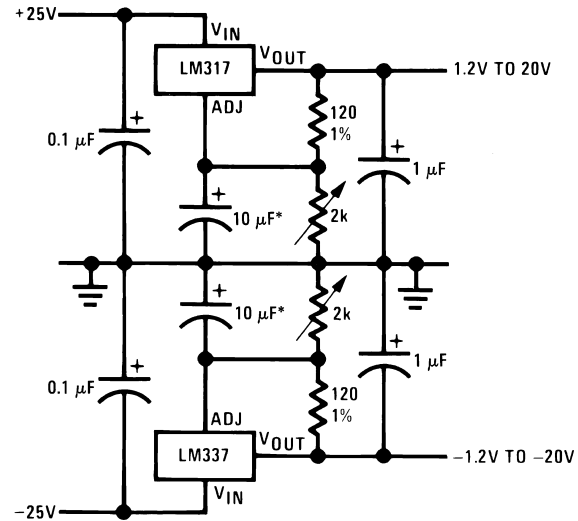


FIGURE 4. Maximum Power Dissipation vs. T_{AMB} for the SOT-223 Package

Please see AN1028 for power enhancement techniques to be used with the SOT-223 package.

Typical Applications

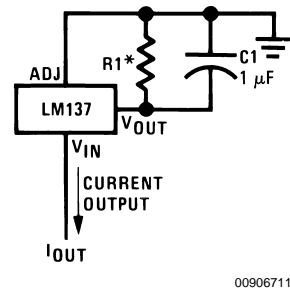
Adjustable Lab Voltage Regulator



Full output current not available at high input-output voltages

*The 10 μ F capacitors are optional to improve ripple rejection

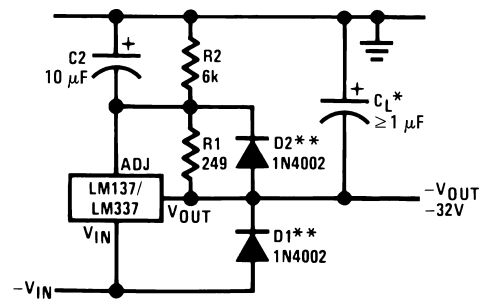
Current Regulator



$$I_{OUT} = \frac{1.250V}{R1}$$

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

Negative Regulator with Protection Diodes

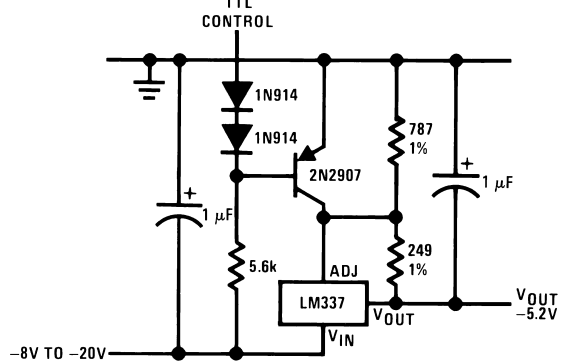


*When C_L is larger than 20 μ F, D1 protects the LM137 in case the input supply is shorted

**When C_2 is larger than 10 μ F and $-V_{OUT}$ is larger than -25V, D2 protects the LM137 in case the output is shorted

Typical Applications (Continued)

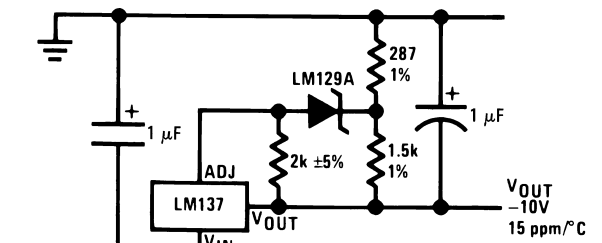
-5.2V Regulator with Electronic Shutdown*



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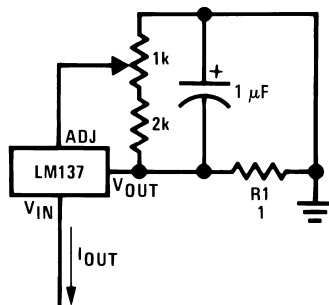
*Minimum output $\approx -1.3V$ when control input is low

High Stability -10V Regulator



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Adjustable Current Regulator

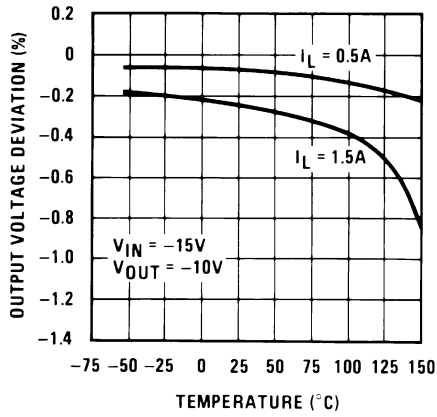


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$$I_{OUT} = \left(\frac{1.5V}{R1} \right) \pm 15\% \text{ adjustable}$$

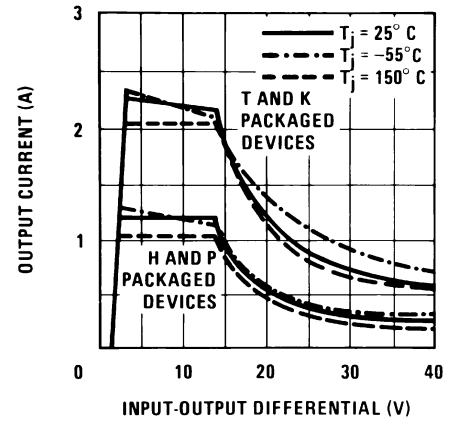
Typical Performance Characteristics (K Steel and T Packages)

Load Regulation



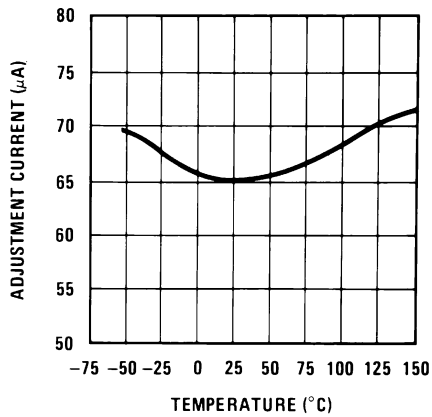
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Current Limit



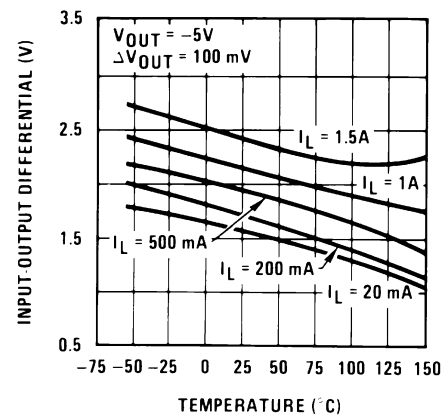
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Adjustment Current



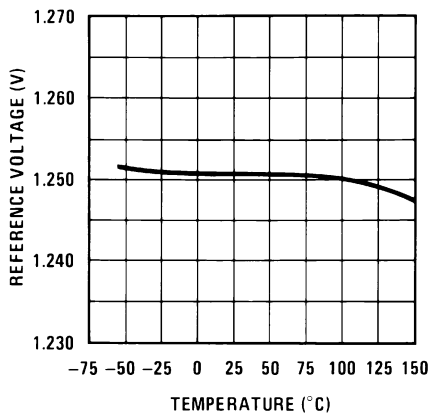
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Dropout Voltage



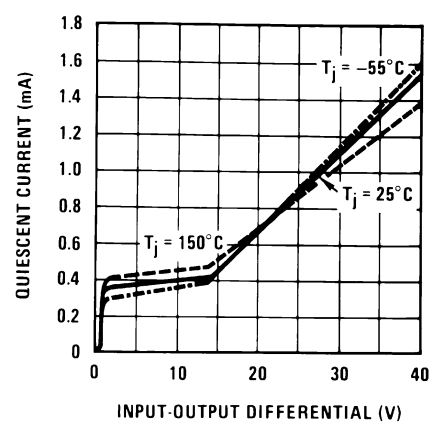
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Temperature Stability



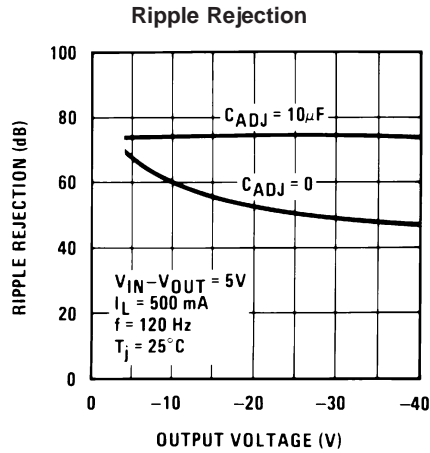
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Minimum Operating Current

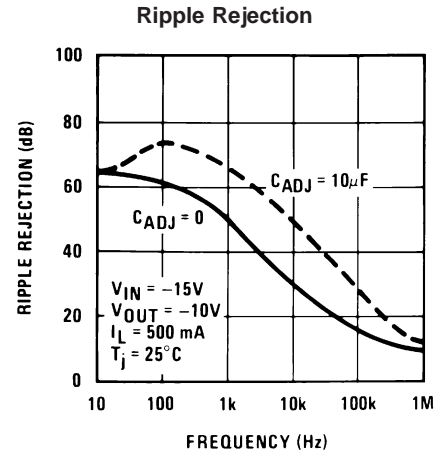


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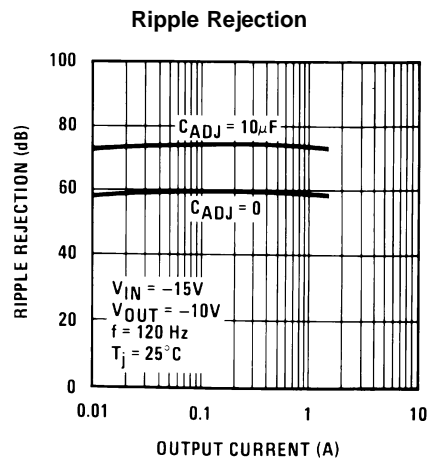
Typical Performance Characteristics (K Steel and T Packages) (Continued)



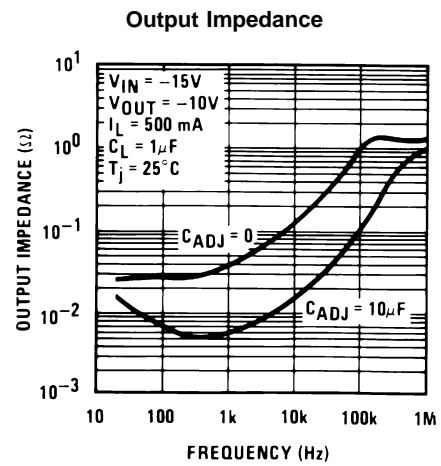
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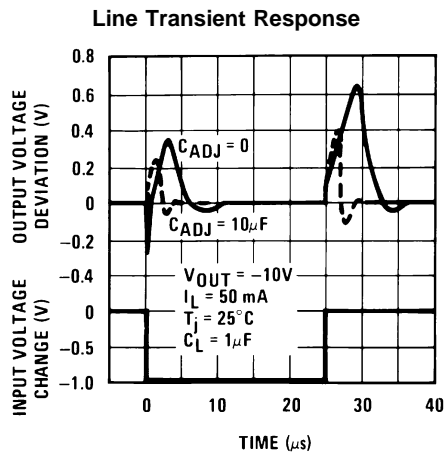
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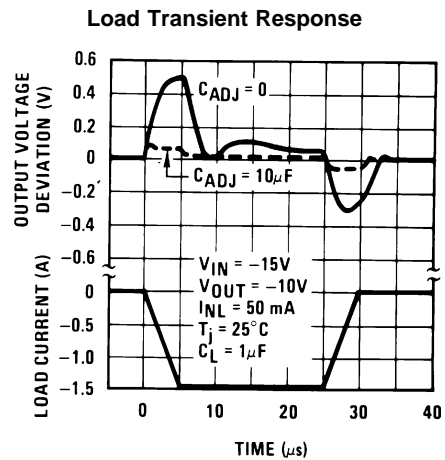
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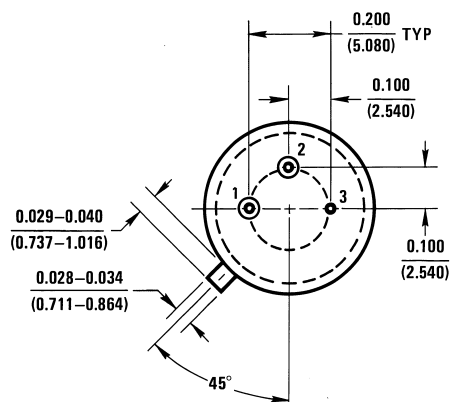
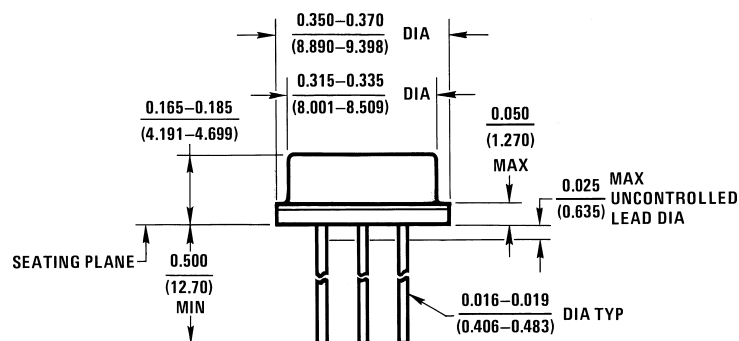
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inches (millimeters)

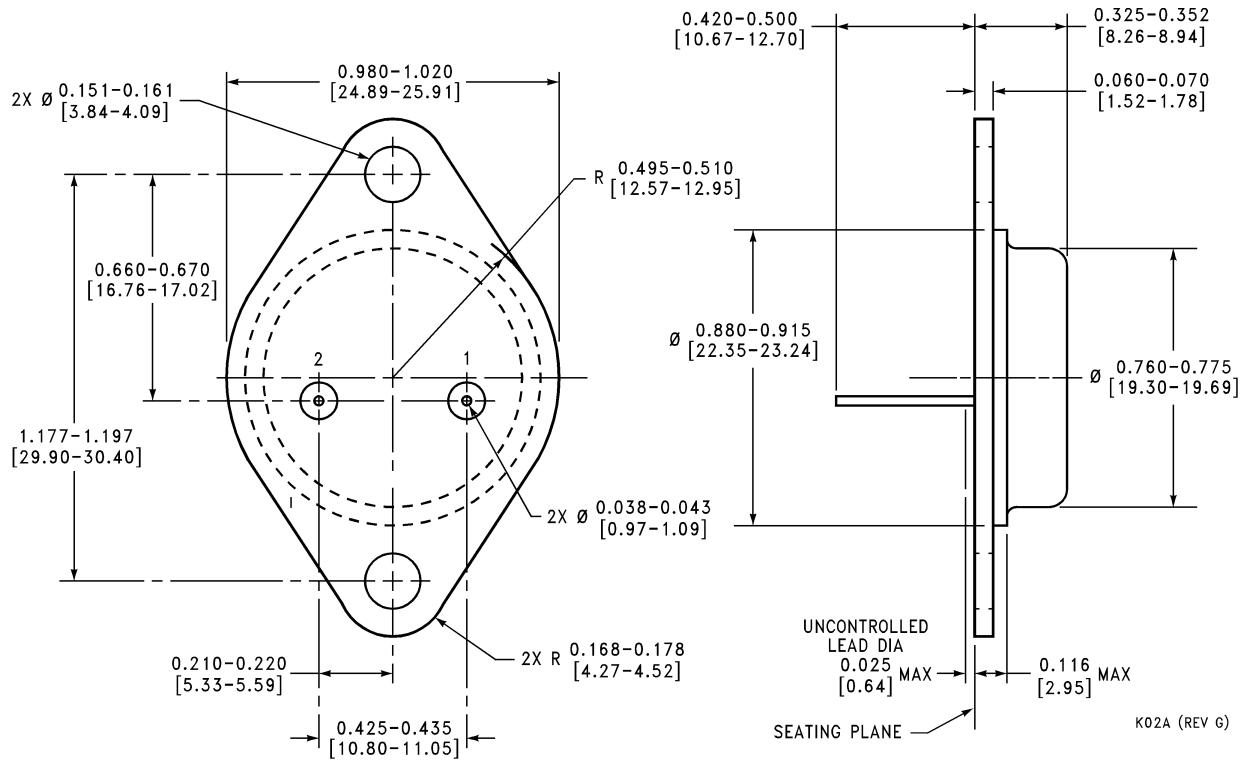
unless otherwise noted



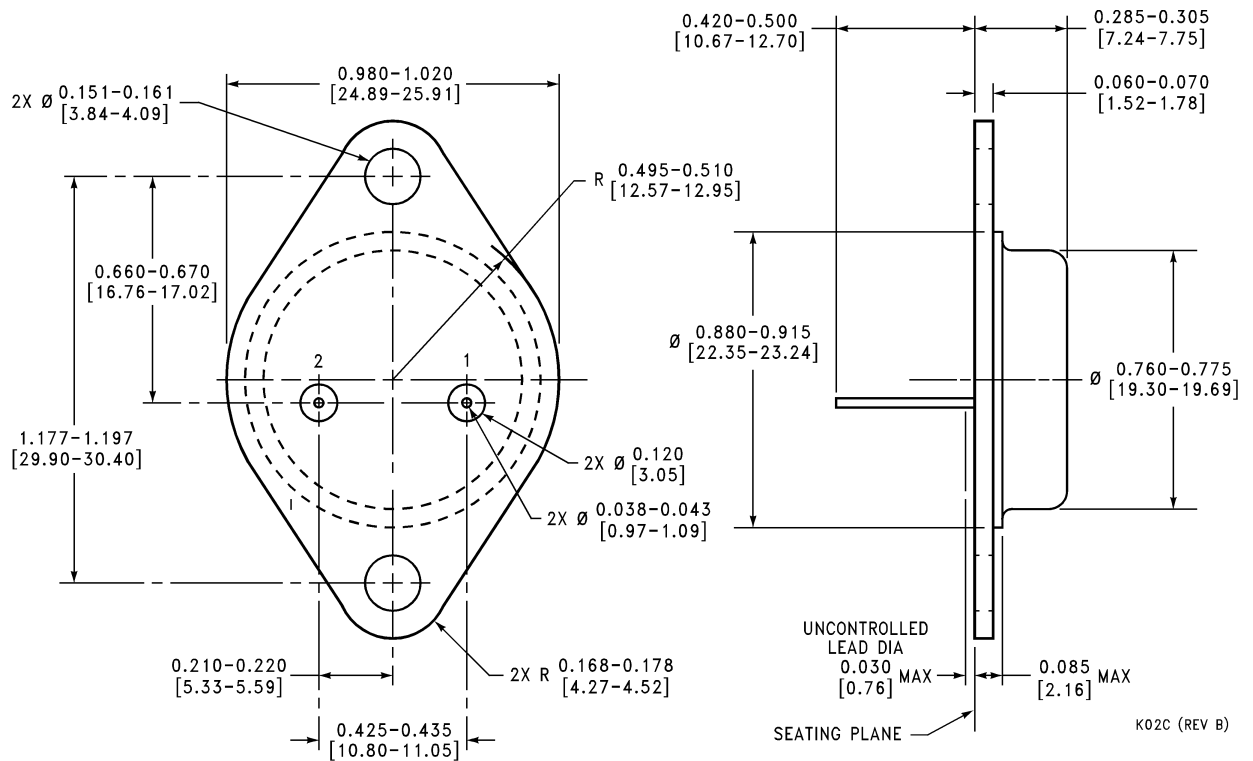
H03A (REV B)

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

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)

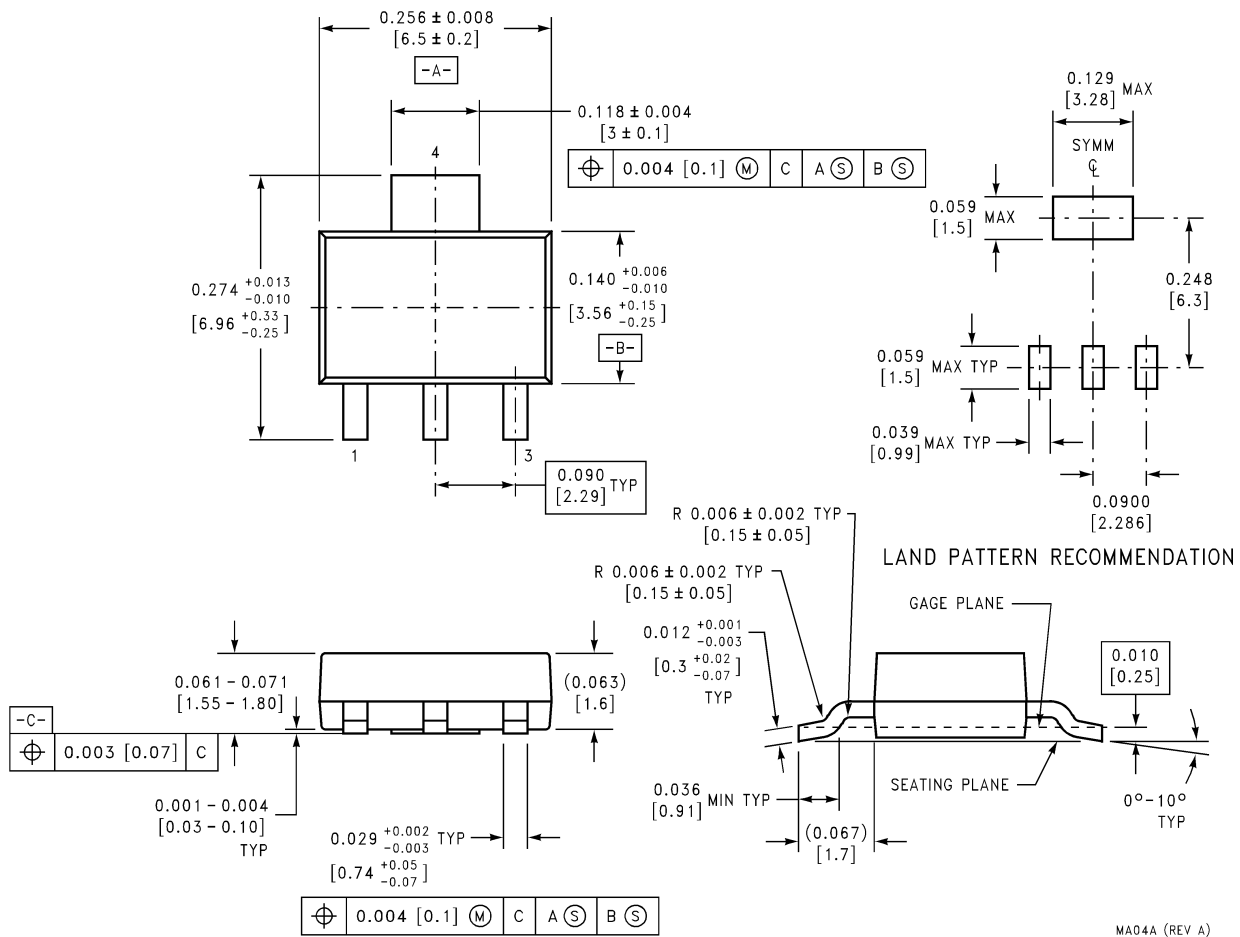


Metal Can Package (K)
Order Number LM337K STEEL
NS Package Number K02A



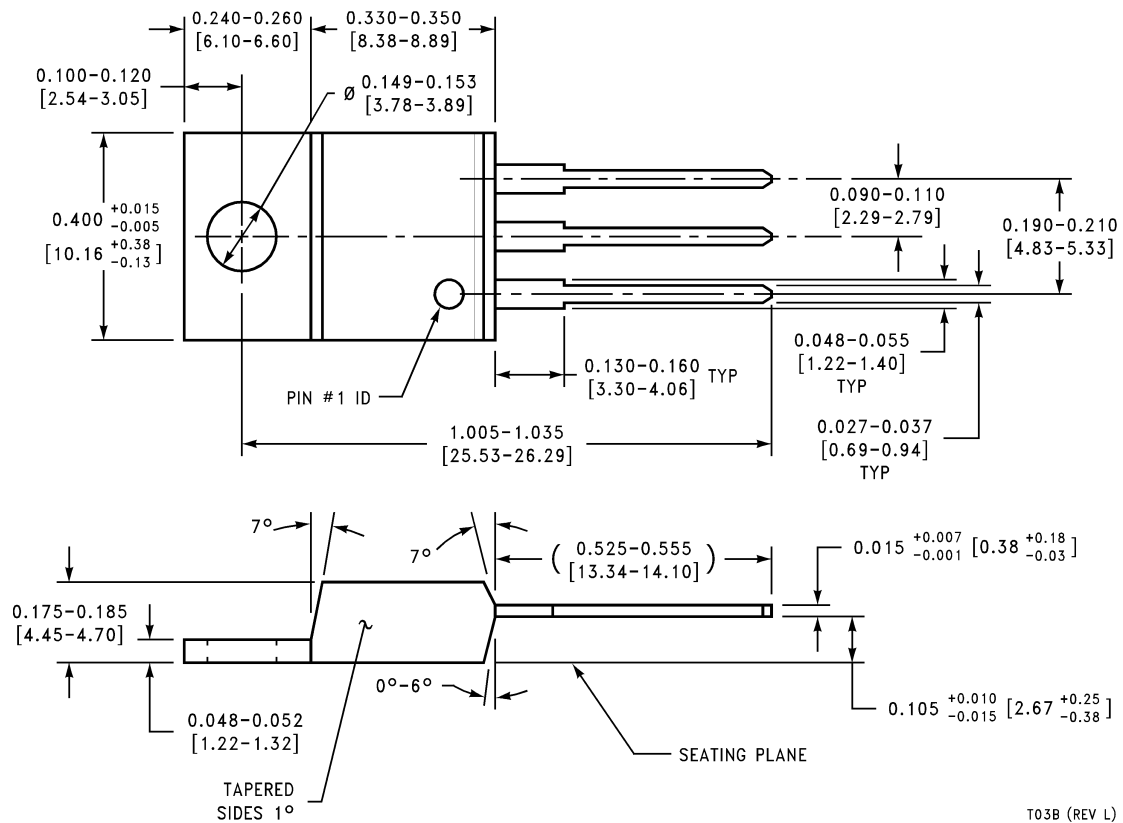
Mil-Aero Metal Can Package (K)
Order Number LM137K/883
NS Package Number K02C

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



3-Lead SOT-223 Package
Order Number LM337IMP
NS Package Number M04A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



TO-220 Plastic Package (T)
Order Number LM337T
NS Package Number T03B

T03B (REV L)

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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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Products > Analog - Regulators > Linear Regulators - Standard/NPN > Negative Voltage - Adjustable > LM337

LM337 Product Folder

3-Terminal Adjustable Negative Regulator

General Description	Features	Datasheet	Package & Models	Samples & Pricing	Application Notes
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Parametric Table

Multiple Output Capability	No
On/Off Pin	No
Error Flag	-
Input Voltage, min (Volt)	-40

Parametric Table

Input Voltage, max (Volt)	-4.20
Output Current, max	1500 mA
Watchdog	-
Output Voltage, min (Volt)	-37
Output Voltage, max (Volt)	-1.20

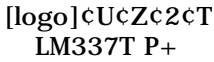
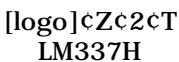
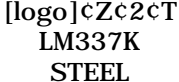
Datasheet

Title	Size in Kbytes	Date	<div></div> View Online	<div></div> Download	<div></div> Receive via Email
LM137 LM337 3-Terminal Adjustable Negative Regulators	421 Kbytes	10-Dec-01	View Online	Download	Receive via Email
LM137 LM337 3-Terminal Adjustable Negative Regulators (JAPANESE) <div></div>	185 Kbytes		View Online	Download	Receive via

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Package Availability, Models, Samples & Pricing

Part Number	Package			Status	Models		Samples & Electronic Orders	Budgetary Pricing		Std Pack Size	Package Marking
	Type	Pins	MSL		SPICE	IBIS		Qty	\$US each		
LM337IMP	SOT-223	4	MSL	Full production	N/A	N/A	<div>Samples</div> <div>Buy Now</div>	1K+	\$0.4400	reel of 1000	c2cT N02A
LM337IMPX	SOT-223	4	MSL	Full production	N/A	N/A	<div>Buy Now</div>	1K+	\$0.4400	reel of 2000	c2cT N02A

LM337T	TO 220	3	MSL	Full production	N/A	N/A	<div>Buy Now</div>	1K+	\$0.3550	rail of 45	
LM337H	TO-39	3	MSL	Full production	N/A	N/A	<div>Buy Now</div>	1K+	\$1.6800	bag of 500	
LM337K STEEL	TO-3	3	MSL	Full production	N/A	N/A	<div>Buy Now</div>	250+	\$2.4000	tray of 50	
LM337K MDC	Die			Full production	N/A	N/A	<div>Samples</div>			tray of N/A	-
LM337K MWC	Wafer			Full production	N/A	N/A				wafer jar of N/A	-

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

LM137 Series Packages and Power Capability

		Rated	Design
Device	Package	Power	Load
		Dissipation	Current
LM137/337	TO-3 (K)	20W	1.5A

	TO-39 (H)	2W	0.5A
LM337	TO-220 (T)	15W	1.5A
LM337	SOT-223 (MP)	2W	1A

Application Notes

Title	Size in Kbytes	Date	<div></div> View Online	<div></div> Download	<div></div> Receive via Email
LB-46: A New Production Technique for Trimming Voltage Regulators	91 Kbytes	28-Jun-96	View Online	Download	Receive via Email

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LM137 Product Folder

3-Terminal Adjustable Negative Regulator

General Description	Features	Datasheet	Package & Models	Samples & Pricing	Application Notes
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Parametric Table

Multiple Output Capability	No
On/Off Pin	No
Error Flag	-
Input Voltage, min (Volt)	-40

Parametric Table

Input Voltage, max (Volt)	-4.20
Output Current, max	1500 mA
Watchdog	-
Output Voltage, min (Volt)	-37
Output Voltage, max (Volt)	-1.20

Datasheet

Title	Size in Kbytes	Date	<div></div> View Online	<div></div> Download	<div></div> Receive via Email
LM137 LM337 3-Terminal Adjustable Negative Regulators	421 Kbytes	10-Dec-01	View Online	Download	Receive via Email
LM137 Mil-Aero (DESC) Datasheet MDLM137-H	12 Kbytes		View Online	Download	Receive via Email
LM137 Mil-Aero (DESC) Datasheet MDLM137-K	12 Kbytes		View Online	Download	Receive via Email
LM137 Mil-Aero (JAN) Datasheet MJLM137-H	104 Kbytes		View Online	Download	Receive via Email
LM137 Mil-Aero (JAN) Datasheet MJLM137-K	111 Kbytes		View Online	Download	Receive via Email
LM137 Mil-Aero Datasheet MNLM137-K	110 Kbytes		View Online	Download	Receive via Email
LM137 Mil-Aero Datasheet MNLM137-WG	126 Kbytes		View Online	Download	Receive via Email
LM137 Mil-Aero Datasheet MNLM137-X	197 Kbytes		View Online	Download	Receive via Email
LM137 Mil-Aero Datasheet MNLM137A-H	15 Kbytes		View Online	Download	Receive via Email
LM137 Mil-Aero Datasheet MRLM137-K-RH	113 Kbytes		View Online	Download	Receive via Email

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Package Availability, Models, Samples & Pricing

Part Number	Package	Status	Models	Samples & Electronic	Budgetary Pricing	Std Pack	Package
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	Type	Pins	MSL		SPICE	IBIS	Orders	Qty	\$US each	Size	Marking
LM137H	TO-39	3	MSL	Full production	N/A	N/A	Buy Now	250+	\$8.4000	bag of 500	[logo]cZc2cT LM137HP+
LM137H-MPR	TO-39	3	MSL	Full production	N/A	N/A				tray of N/A	[logo]cZcSc4cASE LM137H-MPR
LM137AH/883	TO-39	3	MSL	Full production	N/A	N/A	Buy Now	50+	\$14.0000	tray of 20	[logo] cZcSc4cASE LM137AH/883QcM
7703403XA	TO-39	3	MSL	Full production	N/A	N/A	Buy Now	50+	\$7.8000	tray of 20	[logo] cZcSc4cASE QcM 27014 7703403XA
LM137H/883	TO-39	3	MSL	Full production	N/A	N/A	Buy Now	50+	\$11.6000	tray of 20	[logo] cZcSc4cASE LM137H/883QcM
7703403YA	TO-3	2	MSL	Full production	N/A	N/A	Buy Now	50+	\$9.0000	tray of 50	[logo]cZcSc4cA 7703403YA 27014 QcMSE
LM137K/883	TO-3	2	MSL	Full production	N/A	N/A	Buy Now	50+	\$9.0000	tray of 50	[logo]cZcSc4cA LM137K/883 QcM SE
LM137WG/883	Ceramic SOIC	16	MSL	Full production	N/A	N/A				tray of N/A	[logo]cZcSc4cASE LM137WG/883Q
LM137WG-MPR	Ceramic SOIC	16	MSL	Preliminary	N/A	N/A				tray of N/A	[logo]cZcSc4cASE LM137WG-MPR PROTO
JM38510/11803BX	TO-39	3	MSL	Full production	N/A	N/A		50+	\$29.9000	tray of 20	[logo] cZcSc4cA 27014 QcM JM38510/11803BXA SE
JM38510/11804BY	TO-3	2	MSL	Full production	N/A	N/A		50+	\$20.0000	tray of 50	[logo]cZcSc4cA JM38510/ 11804BYA 27014 QS SE
JM38510/11803SX	TO-39	3	MSL	Full production	N/A	N/A		50+	\$194.0000	tray of 20	[logo] cZcSc4cASE 27014 Q JM38510/11803SXA
LM137KPQMLV	TO-3	2	MSL	Full production	N/A	N/A				tray of N/A	[logo]cZcSc4cA LM137KPQMLV 5962P99517 02VYA SE
JM38510/11804SY	TO-3	2	MSL	Full production	N/A	N/A		50+	\$200.0000	tray of 50	[logo]cZcSc4cA JM38510/ 11804SYA 27014 QSE
5962-9951701VZA	Ceramic SOIC	16	MSL	Full production	N/A	N/A		50+	\$199.0000	tray of 42	[logo]cZcSc4cASE LM137WG-QMLV 5962 9951701VZA
LM137K MDA	Die			Full production	N/A	N/A	Samples			tray of N/A	-
LM137KG MDA	Die			Full production	N/A	N/A	Samples			tray of N/A	-
LM137H MD8	Die			Full production	N/A	N/A	Samples			tray of N/A	-

LM137K MDS	Die	Full production	N/A	N/A				tray of N/A	-
LM137H MDS	Die	Full production	N/A	N/A		50+	\$42.0000	tray of 100	-
LM137KG MWA	Wafer	Full production	N/A	N/A				wafer jar of N/A	-
LM137H MW8	Wafer	Full production	N/A	N/A				wafer jar of N/A	-

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AN-182: Improving Power Supply Reliability with IC Power Regulators	76 Kbytes	4-Nov-95	View Online	Download	Receive via Email

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