LM137JAN

LM137JAN 3-Terminal Adjustable Negative Regulators

Literature Number: SNVS332A

National Semiconductor

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LM137JAN

3-Terminal Adjustable Negative Regulators

General Description

The LM137 are adjustable 3-terminal negative voltage regulators capable of supplying in excess of –1.5A over an output voltage range of –37V to –1.2V. 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 serves 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.

Features

- Output voltage adjustable from –37V to –1.2V
- 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
- Standard 3-lead transistor package
- Output is short circuit protected

LM137 Series Packages and Power Capability

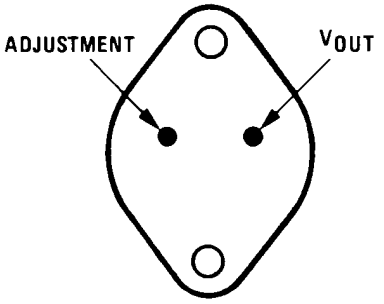
Device	Package	Rated Power Dissipation	Design Load Current
LM137	TO-3 (K)	20W	1.5A
	TO-39 (H)	2W	0.5A

Ordering Information

NS Part Number	JAN Part Number	NS Package Number	Package Description
JL137BXA	JM38510/11803BXA	H03A	3LD T0–39 Metal Can
JL137SXA	JM38510/11803SXA	H03A	3LD T0–39 Metal Can
JL137SYA	JM38510/11804SYA	K02C	2LD Low Profile T0–3 Metal Can

Connection Diagrams

TO-3
Metal Can Package



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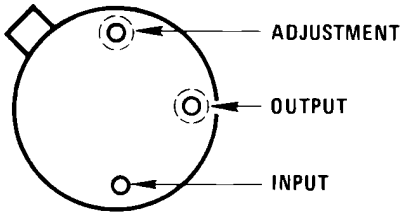
Case is Input

Bottom View
See NS Package Number K02C

TO-39
Metal Can Package



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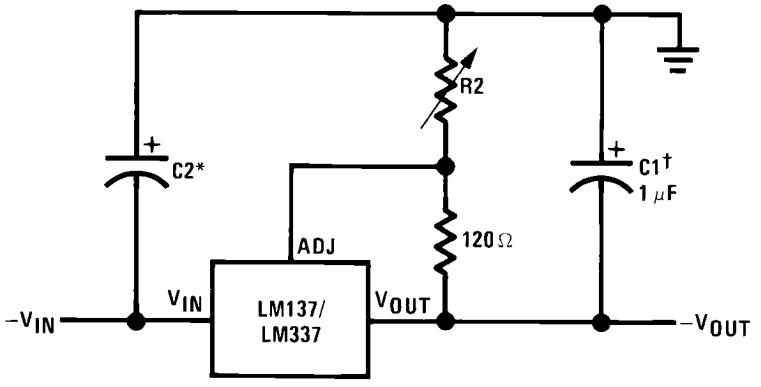
Case Is Input

Bottom View
See NS Package Number H03A

Typical Applications

Adjustable Negative Voltage Regulator



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Full output current not available at high input-output voltages

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

†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 (*Note 1*)

Power Dissipation (*Note 2*)	Internally Limited
Input-Output Voltage Differential	40V
Operating Ambient Temperature Range	$-55°C \leq T_A \leq +125°C$
Operating Junction Temperature Range	$-55°C \leq T_J \leq +150°C$
Maximum Junction Temperature	+150°C
Storage Temperature	$-65°C \leq T_A \leq +150°C$
Lead Temperature (Soldering, 10 sec.)	300°C
Minimum Input Voltage	–41.25V
Maximum Power Dissipation (@25°C)	
T0–3	28 Watts
T0–39	2.5Watts
Thermal Resistance	
θ_{JA}	
T0–3 Metal Can (Still Air)	40°C/W
T0–3 Metal Can (500LF/Min Air Flow)	14°C/W
T0–39 Metal Can (Still Air @ 0.5W)	174°C/W
T0–39 Metal Can (500LF/Min Air Flow @ 0.5W)	64°C/W
θ_{JC}	
T0–3	4°C/W
T0–39 Metal Can (@ 1.0W)	15°C/W
Package Weight (typical)	
T0–3	12,750mg
T0–39 Metal Can	955mg
ESD Rating (*Note 3*)	4K Volts

Recommended Operating Conditions

T_A	$-55°C \leq T_A \leq +125°C$
Input Voltage Range	–41.25V to –4.25V

Quality Conformance Inspection

Mil-Std-883, Method 5005 — Group A

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

LM137H Electrical Characteristics

DC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{OUT}	Output Voltage	V_{IN} = -4.25V, I_L = 5mA		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
		V_{IN} = -4.25V, I_L = 500mA		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
		V_{IN} = -41.25V, I_L = 5mA		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
		V_{IN} = -41.25V, I_L = 50mA		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
$V_{R\ Line}$	Line Regulation	V_{IN} = -41.25V to -4.25V, I_L = 5mA		-9.0	9.0	mV	1
				-23	23	mV	2, 3
$V_{R\ Load}$	Load Regulation	V_{IN} = -6.25V, I_L = 5mA to 500mA		-12	12	mV	1
				-24	24	mV	2, 3
		V_{IN} = -41.25V, I_L = 5mA to 50mA		-6.0	6.0	mV	1
				-12	12	mV	2, 3
		V_{IN} = -6.25V, I_L = 5mA to 200mA		-6.0	6.0	mV	1
				-12	12	mV	2, 3
V_{Rth}	Thermal Regulation	V_{IN} = -14.6V, I_L = 500mA		-5.0	5.0	mV	1
I_{Adj}	Adjust Pin Current	V_{IN} = -4.25V, I_L = 5mA		25	100	µA	1, 2, 3
		V_{IN} = -41.25V, I_L = 5mA		25	100	µA	1, 2, 3
ΔI_{Adj} / V_{Line}	Adjust Pin Current Change vs. Line Voltage	V_{IN} = -41.25V to -4.25V, I_L = 5mA		-5.0	5.0	µA	1, 2, 3
ΔI_{Adj} / I_{Load}	Adjust Pin Current Change vs. Load Current	V_{IN} = -6.25V, I_L = 5mA to 500mA		-5.0	5.0	µA	1, 2, 3
I_{OS}	Output Short Circuit Current	V_{IN} = -4.25V		0.5	1.8	A	1, 2, 3
		V_{IN} = -40V		0.05	0.5	A	1, 2, 3
V_{OUT} Recovery	Output Voltage Recovery After Output Short Circuit Current	V_{IN} = -4.25V		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
		V_{IN} = -40V		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
I_Q	Minimum Load Current	V_{IN} = -4.25V		0.2	3.0	mA	1, 2, 3
		V_{IN} = -14.25V		0.2	3.0	mA	1, 2, 3
		V_{IN} = -41.25V		1.0	5.0	mA	1, 2, 3
V_{Start}	Voltage Start-up	V_{IN} = -4.25V, I_L = 500mA		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
V_{OUT}	Output Voltage	V_{IN} = -6.25V, I_L = 5mA (No Subgroup)	(*Note 4*)	-1.3	-1.2	V	

AC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
ΔV_{IN} / ΔV_{OUT}	Ripple Rejection	V_{IN} = -6.25V, I_L = 125mA, e_i = $1V_{RMS}$ at 2400Hz		48		dB	4
V_{NO}	Output Noise Voltage	V_{IN} = -6.25V, I_L = 50mA			120	μV_{RMS}	
ΔV_{OUT} / ΔV_{IN}	Line Transient Response	V_{IN} = -6.25V, V_{Pulse} = -1V, I_L = 50mA			80	mV/V	7
ΔV_{OUT} / ΔI_L	Load Transient Response	V_{IN} = -6.25V, I_L = 50mA, ΔI_L = 200mA	(*Note 5*)		60	mV	7

DC Parameters: Drift Values

Delta calculations performed on JAN S devices at group B, subgroup 5 only.

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{OUT}	Output Voltage	V_{IN} = -4.25V, I_L = 5mA		-0.01	0.01	V	1
		V_{IN} = -4.25V, I_L = 500mA		-0.01	0.01	V	1
		V_{IN} = -41.25V, I_L = 5mA		-0.01	0.01	V	1
		V_{IN} = -41.25V, I_L = 50mA		-0.01	0.01	V	1
$V_{R\ Line}$	Line Regulation	V_{IN} = 41.25V to -4.25V, I_L = 5mA		-4.0	4.0	mV	1
I_{Adj}	Adjust Pin Current	V_{IN} = -4.25V, I_L = 5mA		-10	10	µA	1
		V_{IN} = -41.25V, I_L = 5mA		-10	10	µA	1

LM137K Electrical Characteristics

DC Parameters:

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{OUT}	Output Voltage	V_{IN} = -4.25V, I_L = 5mA		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
		V_{IN} = -4.25V, I_L = 1.5A		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
		V_{IN} = -41.25V, I_L = 5mA		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
		V_{IN} = -41.25V, I_L = 200mA		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
$V_{R\ Line}$	Line Regulation	-41.25V ≤ V_{IN} ≤ -4.25V, I_L = 5mA		-9.0	9.0	mV	1
				-23	23	mV	2, 3
$V_{R\ Load}$	Load Regulation	V_{IN} = -6.25V, I_L = 5mA to 1.5A		-6.0	6.0	mV	1
				-12	12	mV	2, 3
		V_{IN} = -41.25V, I_L = 5mA to 200mA		-6.0	6.0	mV	1
				-12	12	mV	2, 3
V_{Rth}	Thermal Regulation	V_{IN} = -14.6V, I_L = 1.5A		-5.0	5.0	mV	1
I_{Adj}	Adjust Pin Current	V_{IN} = -4.25V, I_L = 5mA		25	100	µA	1, 2, 3
		V_{IN} = -41.25V, I_L = 5mA		25	100	µA	1, 2, 3
ΔI_{Adj} / V_{Line}	Adjust Pin Current Change vs. Line Voltage	-41.25V ≤ V_{IN} ≤ -4.25, I_L = 5mA		-5.0	5.0	µA	1, 2, 3
ΔI_{Adj} / I_{Load}	Adjust Pin Current Change vs. Load Current	V_{IN} = -6.25V, I_L = 5mA to 1.5A		-5.0	5.0	µA	1, 2, 3
I_{OS}	Output Short Circuit Current	V_{IN} = -4.25V		1.5	3.5	A	1, 2, 3
		V_{IN} = -40V		0.2	1.0	A	1, 2, 3
V_{OUT} Recovery	Output Voltage Recovery	V_{IN} = -4.25V		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
		V_{IN} = -40V		-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
I_Q	Minimum Load Current	V_{IN} = -4.25V		0.2	3.0	mA	1, 2, 3
		V_{IN} = -14.25V		0.2	3.0	mA	1, 2, 3
		V_{IN} = -41.25V		1.0	5.0	mA	1, 2, 3
V_{Start}	Voltage Start-up	V_{IN} = 4.25V, I_L = 1.5A		-1.275	-1.225	V	1
		V_{IN} = 4.25V, I_L = 1.5A		-1.3	-1.2	V	2, 3
V_{OUT}	Output Voltage	V_{IN} = -6.25V, I_L = 5mA No Subgroup	(*Note 4*)	-1.3	-1.2	V	

AC Parameters:

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
ΔV_{IN} / ΔV_{OUT}	Ripple Rejection	V_{IN} = -6.25V, I_L = 500mA, e_I = 1V_{RMS} at 2400Hz		50		dB	4
V_{NO}	Output Noise Voltage	V_{IN} = -6.25V, I_L = 100mA			120	μV_{RMS}	
ΔV_{OUT} / ΔV_{IN}	Line Transient Response	V_{IN} = -6.25V, I_L = 100mA, V_{Pulse} = -1V			80	mV/V	7
ΔV_{OUT} / ΔI_L	Load Transient Response	V_{IN} = -6.25V, I_L = 100mA, ΔI_L = 400mA	(*Note 6*)		60	mV	7

DC Parameters: Drift Values

Delta calculations performed on JAN S devices at group B, subgroup 5 only.

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{OUT}	Output Voltage	V_{IN} = -4.25V, I_L = 5mA		-0.01	0.01	V	1
$V_{R\ line}$	Line Regulation	V_{IN} = -41.25V to -4.25, I_L = 5mA		-4.0	4.0	mV	1
I_{Adj}	Adjust Pin Current	V_{IN} = -41.25V, I_L = 5mA		-10	10	µA	1

Note 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 guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

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

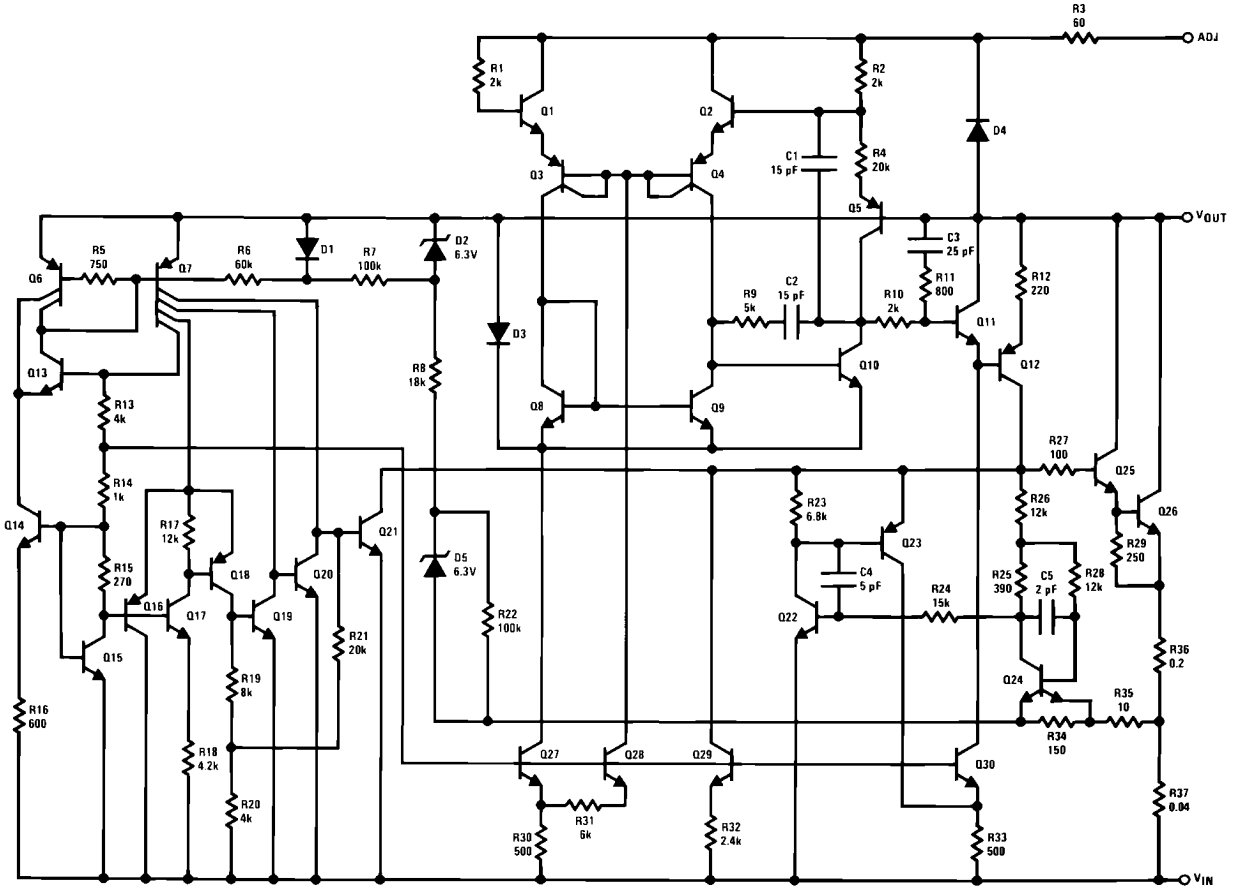
Note 3: Human body model, 100pF discharged through 1.5KΩ

Note 4: Tested at +125°C ; correlated to +150°C

Note 5: Slash sheet limit of 0.3mV/mA is equivalent to 60mV

Note 6: Slash sheet limit of 0.15mV/mA is equivalent to 60mV

Schematic Diagram



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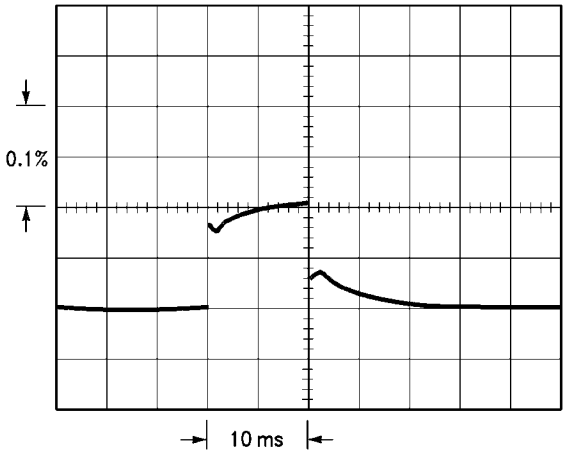
Thermal Regulation

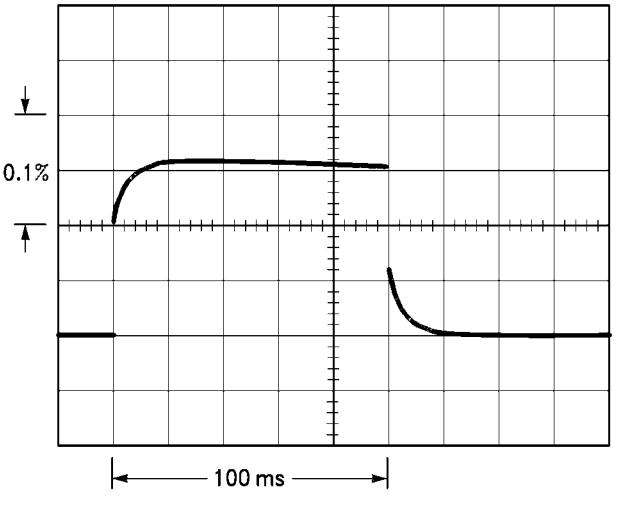
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large. Thermal regulation is the effect of these temperature gradients on output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



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

FIGURE 1.

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 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 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).

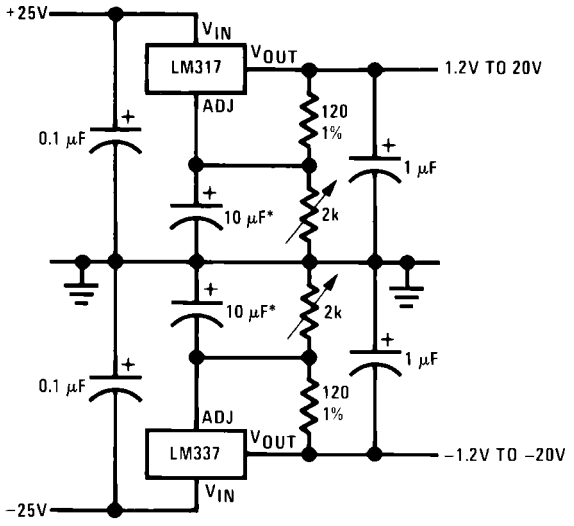


LM137, V_{OUT} = −10V
$V_{IN} - V_{OUT}$ = −40V
I_L = 0A → 0.25A → 0A
Horizontal sensitivity, 20 ms/div

FIGURE 2.

Typical Applications

Adjustable Lab Voltage Regulator



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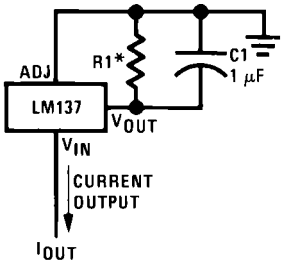
Full output current not available
at high input-output voltages
*The 10 µF capacitors are optional to improve ripple rejection

Current Regulator



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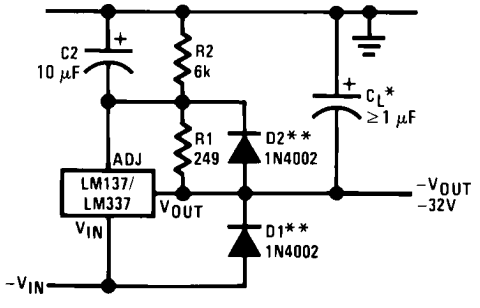
$$I_{OUT} = \frac{1.250V}{R1}$$

*0.8Ω ≤ R1 ≤ 120Ω

Negative Regulator with Protection Diodes



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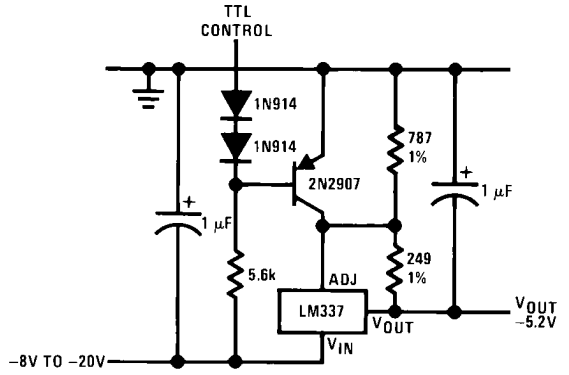
*When C_L is larger than 20 µF, D1 protects the LM137 in case the input supply is shorted

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

−5.2V Regulator with Electronic Shutdown*



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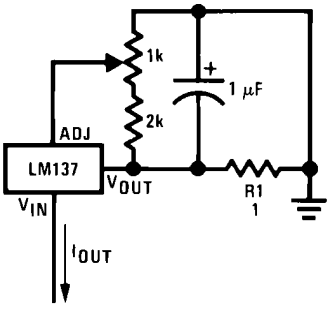
*Minimum output " −1.3V when control input is low

Adjustable Current Regulator



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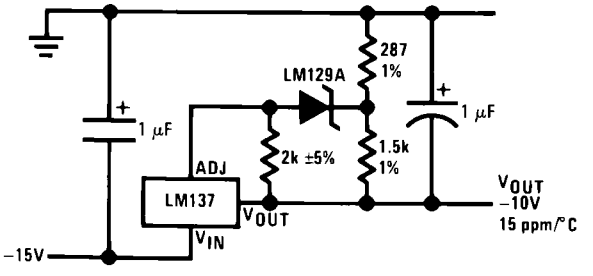
$$I_{OUT} = \left(\frac{1.5V}{R1}\right) \pm 15\% \text{ adjustable}$$

High Stability −10V Regulator



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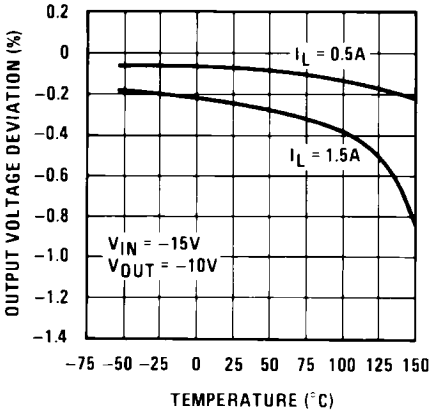
Typical Performance Characteristics (H & K Packages)

Load Regulation



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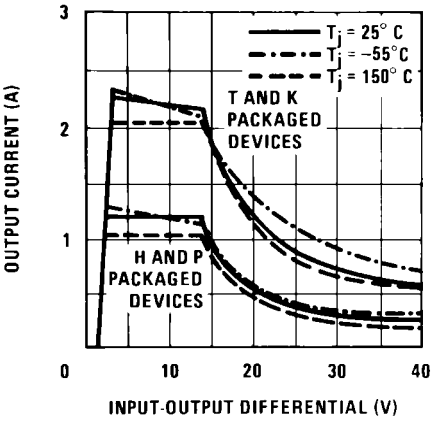
Current Limit



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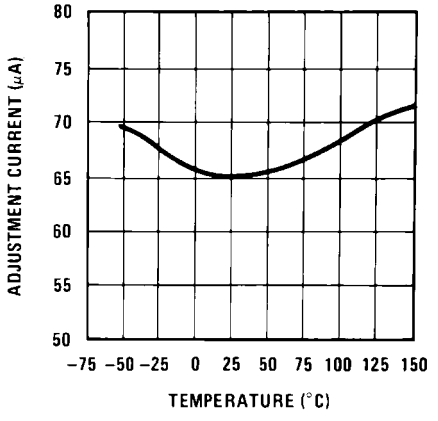
Adjustment Current



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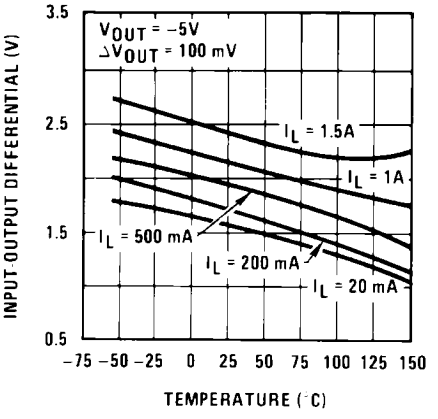
Dropout Voltage



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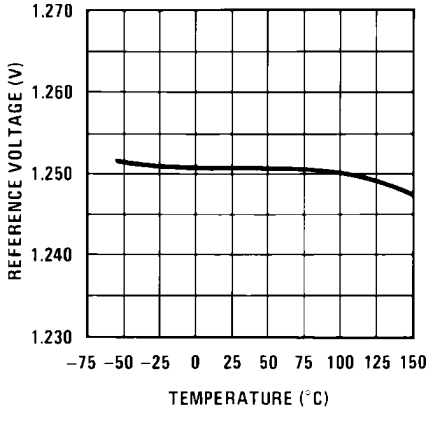
Temperature Stability



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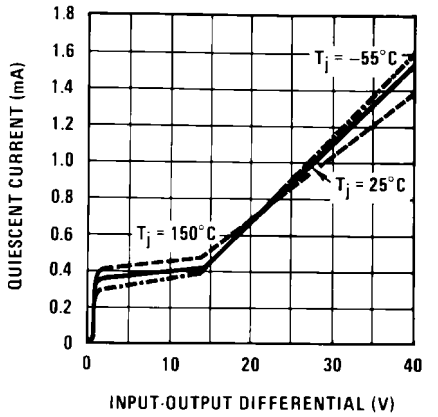
Minimum Operating Current



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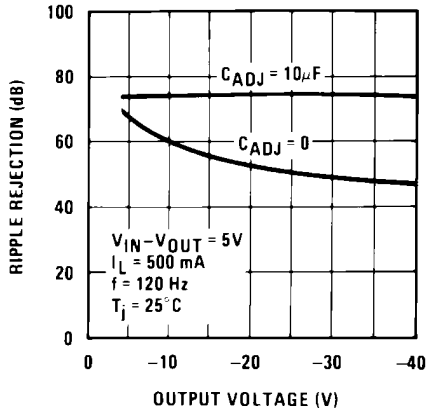
Ripple Rejection



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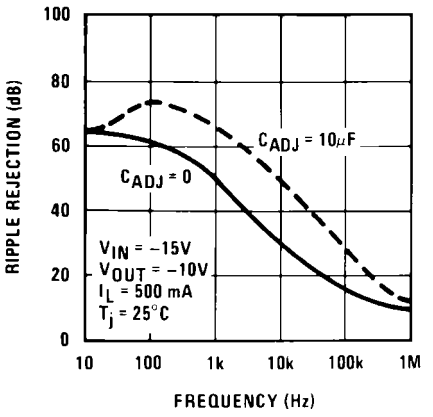
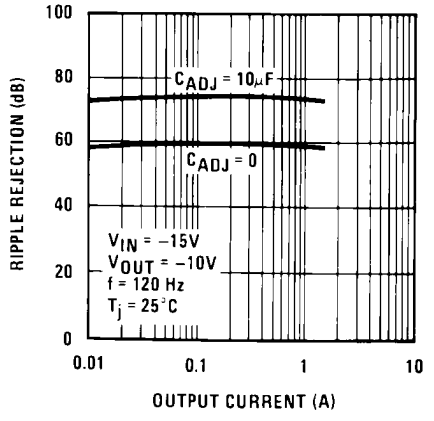
Ripple Rejection



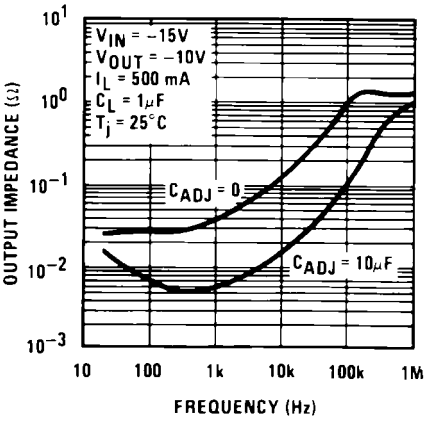
20129723

Ripple Rejection



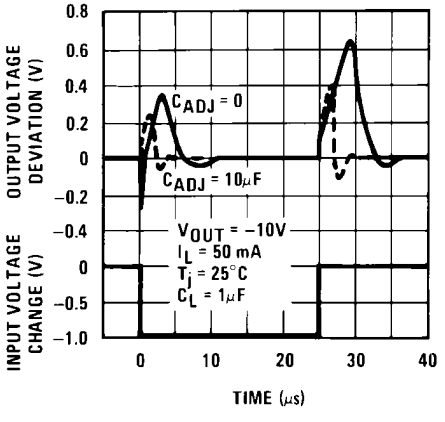
20129724

Output Impedance



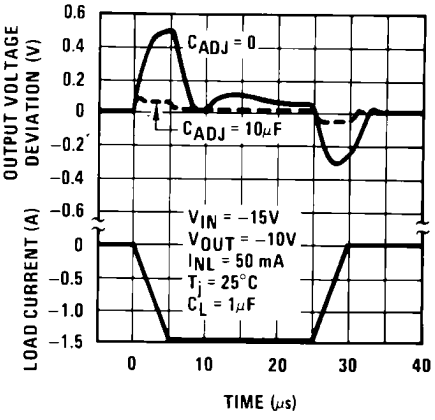
20129725

Line Transient Response



20129726

Load Transient Response

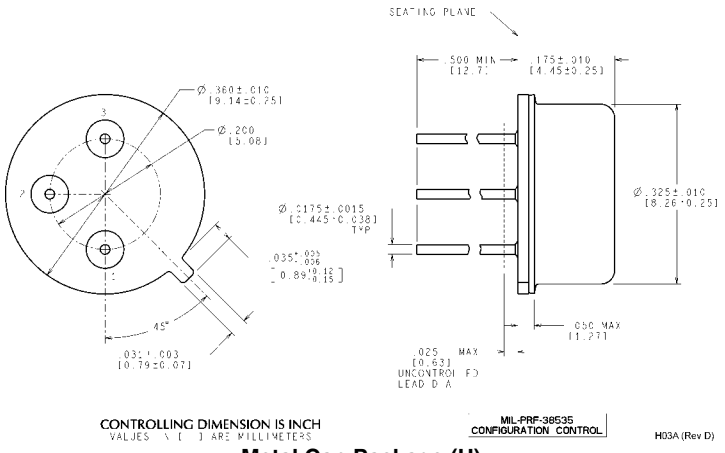


20129727

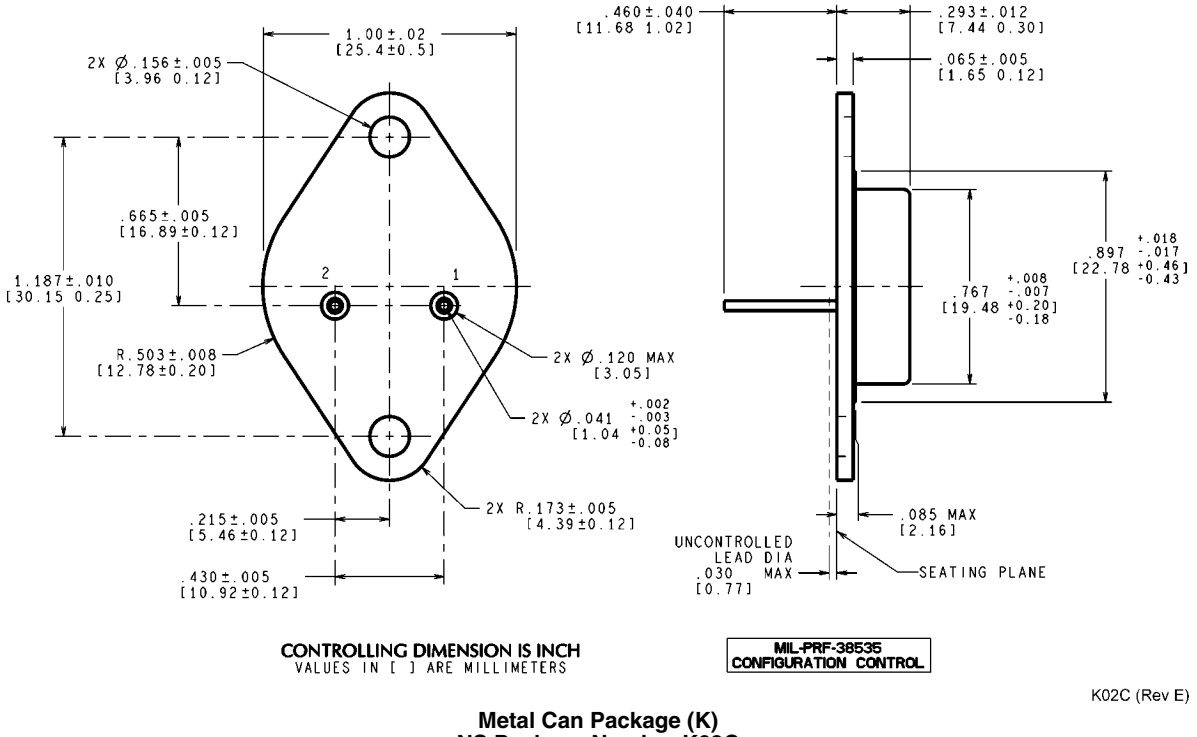
Revision History

Date Released	Revision	Section	Changes
12/08/2010	A	New Release, Corporate format	2 MDS data sheets converted into one Corp. data sheet format. MJLM137-H Rev. 0A0, MJLM137-K Rev. 0A0. MDS data sheets will be archived.

Physical Dimensions inches (millimeters) unless otherwise noted



Metal Can Package (H)
NS Package Number H03A



Metal Can Package (K)
NS Package Number K02C

Notes

Notes

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