LM137JAN 3-Terminal Adjustable Negative Regulators

Check for Samples: LM137JAN

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

Table 1. LM137 Series Packages and Power Capability

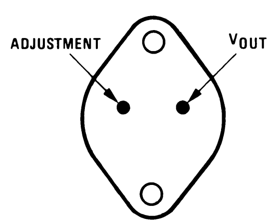
Device	Package	Rated Power Dissipation	Design Load Current
LM137	TO-3 (K)	20W	1.5A
	TO-39 (H)	2W	0.5A

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.

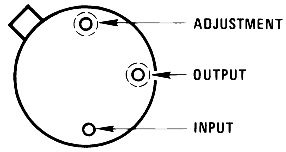
The LM137 serves a wide variety of applications including local on-card regulation, programmable-output voltage regulation or precision current regulation. The LM137 are ideal complements to the LM117 adjustable positive regulators.

Connection Diagram



Case is Input

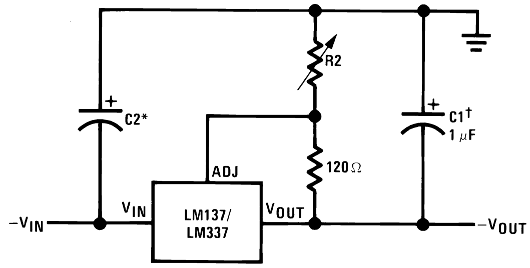
Figure 1. TO-3 Metal Can Package Bottom View



Case Is Input

Figure 2. TO-39 Metal Can Package Bottom View

Typical Applications



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

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 [1]

Power Dissipation [2]	Internally Limited
Input-Output Voltage Differential	40V
Operating Ambient Temperature Range	−55°C ≤ T_A ≤ +125°C
Operating Junction Temperature Range	−55°C ≤ T_J ≤ +150°C
Maximum Junction Temperature	+150°C
Storage Temperature	−65°C ≤ T_A ≤ +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 [3]	4K Volts

(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.
(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.
(3) Human body model, 100pF discharged through 1.5KΩ

Table 2. Recommended Operating ConditionsMil-Std-883, Method 5005 — Group A

T_A	−55°C ≤ T_A ≤ +125°C
Input Voltage Range	−41.25V to −4.25V

Table 3. Quality Conformance InspectionMil-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

Table 3. Quality Conformance InspectionMil-Std-883, Method 5005 — Group A (continued)

Subgroup	Description	Temp (°C)
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)	(1)	-1.3	-1.2	V	

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

LM137H Electrical Characteristics 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	(1)		60	mV	7

(1) Slash sheet limit of 0.3mV/mA is equivalent to 60mV

LM137H Electrical Characteristics 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	(1)	-1.3	-1.2	V	

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

LM137K Electrical Characteristics AC Parameters:

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
$\Delta V_{IN} / \Delta V_{OUT}$	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}	
$\Delta V_{OUT} / \Delta V_{IN}$	Line Transient Response	V_{IN} = -6.25V, I_L = 100mA, V_{Pulse} = -1V			80	mV/V	7
$\Delta V_{OUT} / \Delta I_L$	Load Transient Response	V_{IN} = -6.25V, I_L = 100mA, ΔI_L = 400mA	(1)		60	mV	7

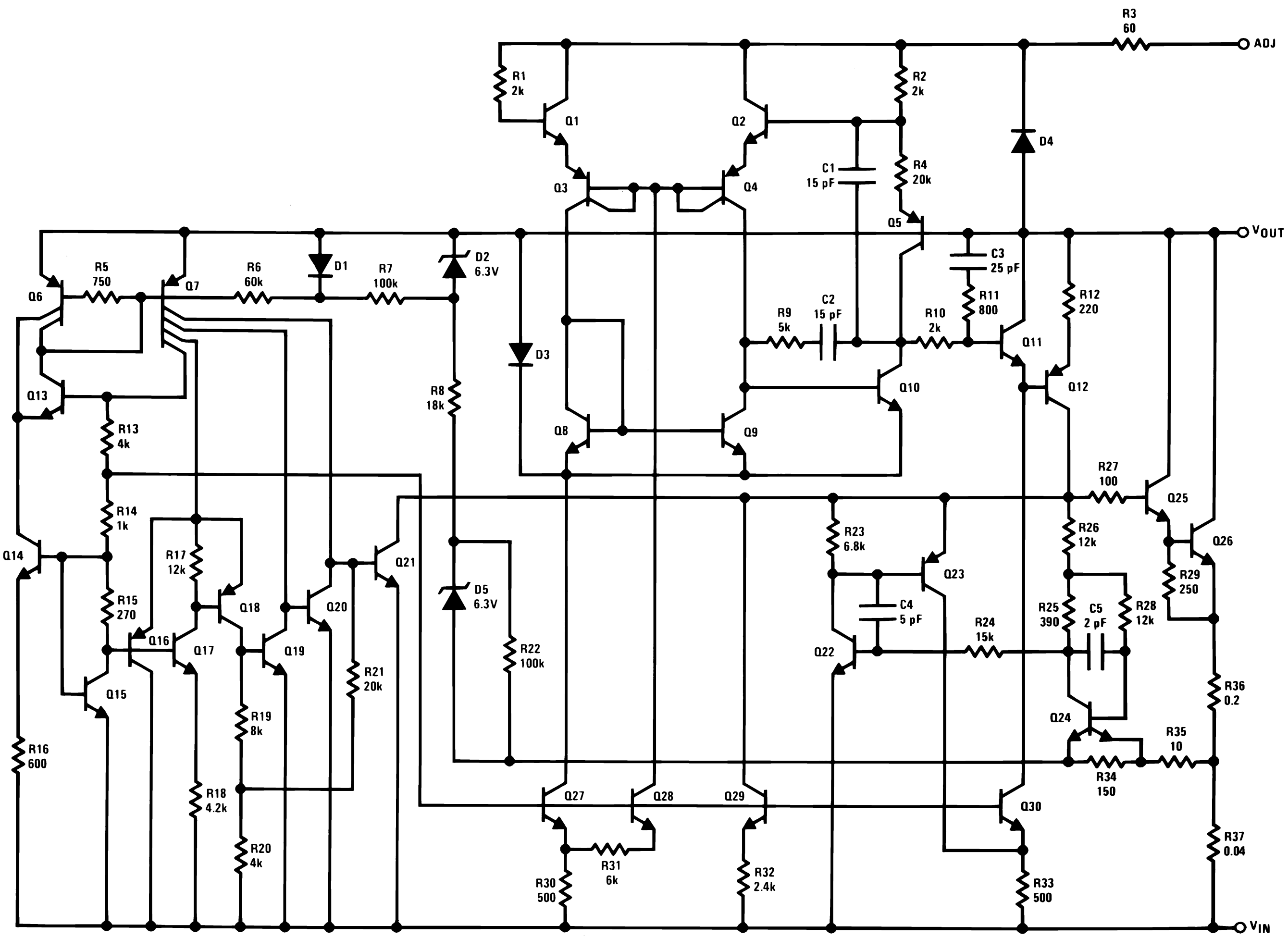
(1) Slash sheet limit of 0.15mV/mA is equivalent to 60mV

LM137K Electrical Characteristics DC Parameters: Drift Values

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

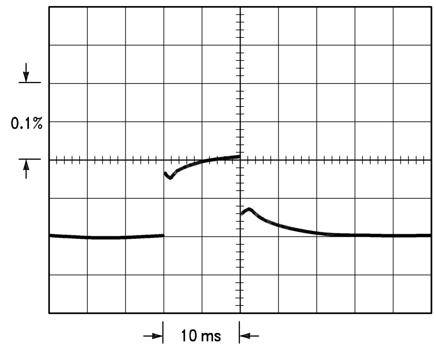
Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{OUT}	Output Voltage	V_{IN} = -4.25V, I_L = 5mA		-0.01	0.01	V	1
$V_{R\ line}$	Line Regulation	V_{IN} = -41.25V to -4.25, I_L = 5mA		-4.0	4.0	mV	1
I_{Adj}	Adjust Pin Current	V_{IN} = -41.25V, I_L = 5mA		-10	10	µA	1

Schematic Diagram



Thermal Regulation

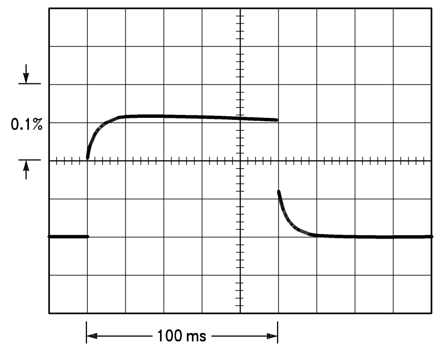
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large. Thermal regulation is the effect of these temperature gradients on output 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 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 4.

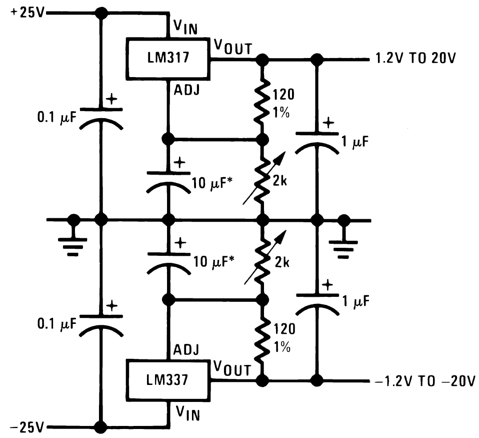
In Figure 4, a typical LM137's output drifts only 3 mV (or 0.03% of V_{OUT} = −10V) when a 10W pulse is applied for 10 ms. This performance is thus well inside the specification limit of 0.02%/W × 10W = 0.2% max. When the 10W pulse is ended, the thermal regulation again shows a 3 mV step as the LM137 chip cools off. Note that the load regulation error of about 8 mV (0.08%) is additional to the thermal regulation error. In Figure 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).



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

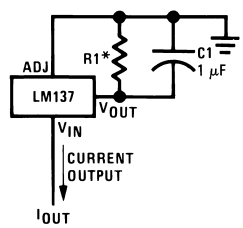
Figure 5.

Typical Applications



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

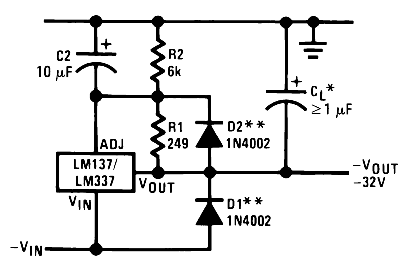
Figure 6. Adjustable Lab Voltage Regulator



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

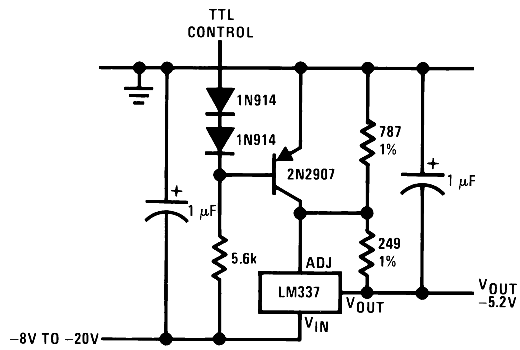
*0.8Ω ≤ R1 ≤ 120Ω

Figure 7. Current Regulator



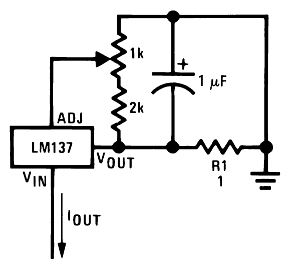
*When C_L is larger than 20 μF, D1 protects the LM137 in case the input supply is shorted
**When C2 is larger than 10 μF and $-V_{OUT}$ is larger than −25V, D2 protects the LM137 in case the output is shorted

Figure 8. Negative Regulator with Protection Diodes



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

Figure 9. −5.2V Regulator with Electronic Shutdown*



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

Figure 10. Adjustable Current Regulator

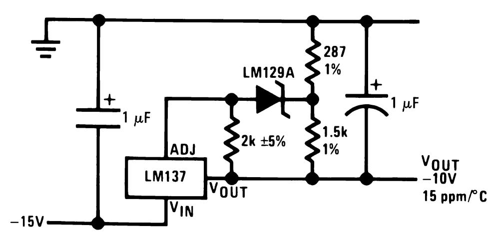
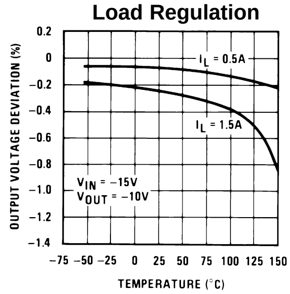


Figure 11. High Stability −10V Regulator

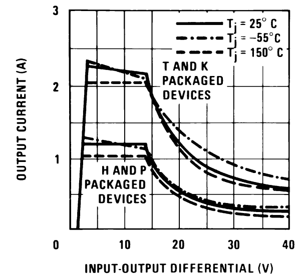
Typical Performance Characteristics

(H & K Packages)

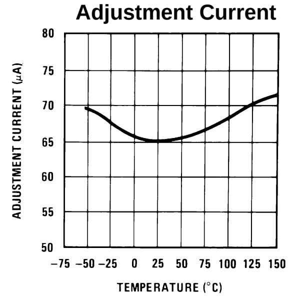
Load Regulation



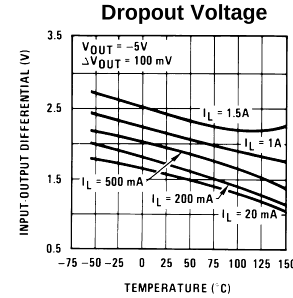
Current Limit



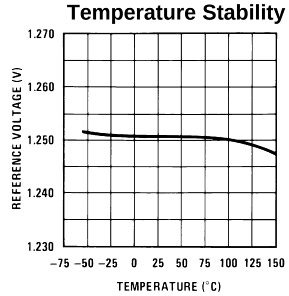
Adjustment Current



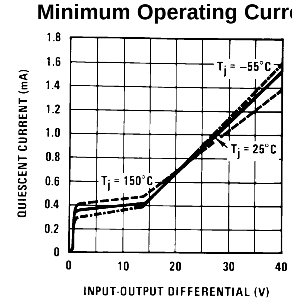
Dropout Voltage



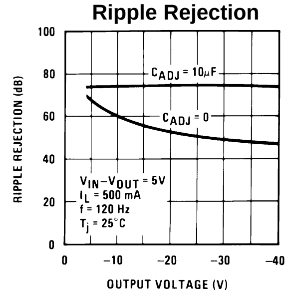
Temperature Stability



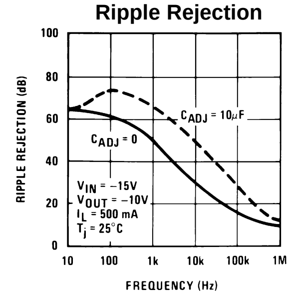
Minimum Operating Current



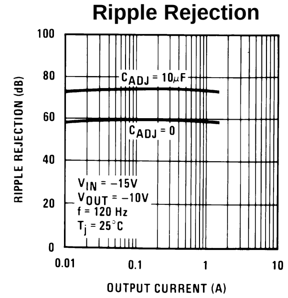
Ripple Rejection



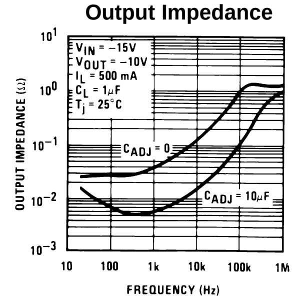
Ripple Rejection



Ripple Rejection



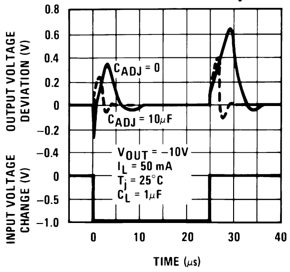
Output Impedance



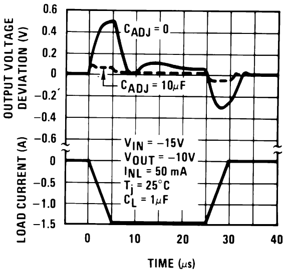
Typical Performance Characteristics (continued)

(H & K Packages)

Line Transient Response



Load Transient Response



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.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
JL137BXA	ACTIVE	TO	NDT	3	20	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 150	JL137BXA JM38510/11803BXA Q ACO JM38510/11803BXA Q >T	Samples
JL137SYA	ACTIVE	TO	K	2	50	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 150	JL137SYA Q JM38510/ 11804SYA ACO 11804SYA >T	Samples
JM38510/11803BXA	ACTIVE	TO	NDT	3	20	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 150	JL137BXA JM38510/11803BXA Q ACO JM38510/11803BXA Q >T	Samples
JM38510/11804SYA	ACTIVE	TO	K	2	50	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 150	JL137SYA Q JM38510/ 11804SYA ACO 11804SYA >T	Samples
M38510/11803BXA	ACTIVE	TO	NDT	3	20	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 150	JL137BXA JM38510/11803BXA Q ACO JM38510/11803BXA Q >T	Samples
M38510/11803BXX	ACTIVE	TO	NDT	3	20	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 150	JL137BXA JM38510/11803BXA Q ACO JM38510/11803BXA Q >T	Samples
M38510/11804SYA	ACTIVE	TO	K	2	50	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 150	JL137SYA Q JM38510/ 11804SYA ACO 11804SYA >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) Only one of markings shown within the brackets will appear on the physical device.

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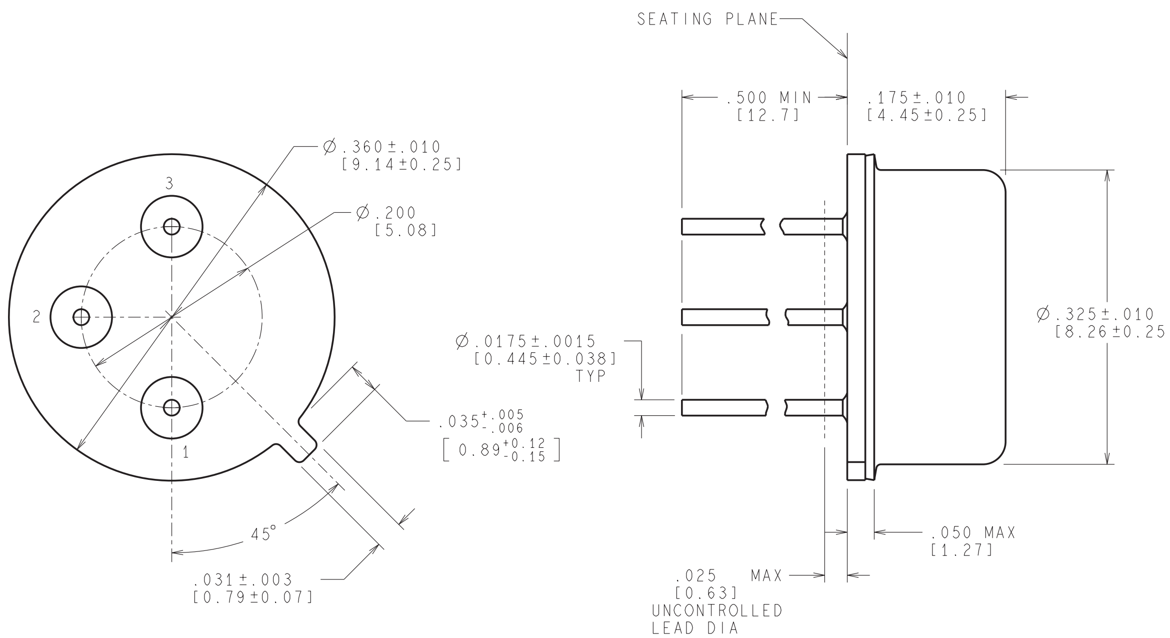
OTHER QUALIFIED VERSIONS OF LM137JAN, LM137JAN-SP :

- Military: LM137JAN
- Space: LM137JAN-SP

NOTE: Qualified Version Definitions:

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

NDT0003A



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CONFIGURATION CONTROL

H03A (Rev D)

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