National Semiconductor is now part of

Texas Instruments.

Search http://www.ti.com/ for the latest technical

information and details on our current products and services.

National Semiconductor

December 8, 2010

LM137QML

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 serve 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

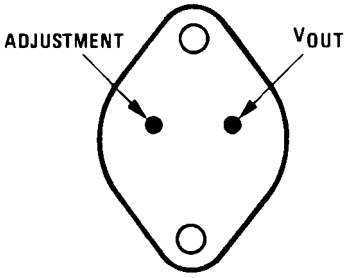
Ordering Information

NS Part Number	SMD Part Number	NS Package Number	Package Description
LM137K/883		K02C	2LD Low Profile T0–3 Metal Can
LM137H/883		H03A	3LD T0–39 Metal Can
LM137HPQMLV	5962P9951701VXA 30k rd(Si)	H03A	3LD T0–39 Metal Can
LM137H MD8		(*Note 1*)	Bare Die
LM137KG MD8		(*Note 1*)	Bare Die

Note 1: FOR ADDITIONAL DIE INFORMATION, PLEASE VISIT THE HI REL WEB SITE AT: www.national.com/analog/space/level_die

Connection Diagrams

TO-3
Metal Can Package

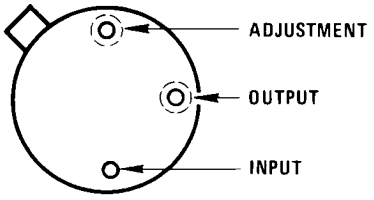


20122405

Case is Input

Bottom View
See NS Package Number K02C

TO-39
Metal Can Package



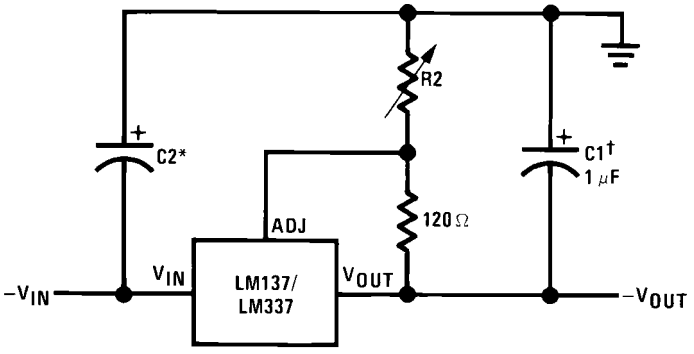
20122406

Case Is Input

Bottom View
See NS Package Number H03A

Typical Applications

Adjustable Negative Voltage Regulator



20122401

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 2*)

Power Dissipation (*Note 3*)	Internally Limited
Input-Output Voltage Differential	40V
Operating Ambient Temperature Range	$-55°C \leq T_A \leq +125°C$
Operating Junction Temperature Range	$-55°C \leq T_J \leq +150°C$
Storage Temperature	$-65°C \leq T_A \leq +150°C$
Maximum Junction Temperature	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	2.5 Watts
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 6*)	4000V

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 883 Electrical Characteristics

DC Parameters

The following conditions apply, unless otherwise specified. V_{IN} = –4.25V, I_L = 8mA, V_{OUT} = V_{Ref}

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{Ref}	Reference Voltage			-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
		V_{IN} = -42V		-1.275	-1.225	V	1
		V_{IN} = -41.3V		-1.3	-1.2	V	2, 3
I_Q	Minimum Load Current	V_{OUT} = -1.7V			3.0	mA	1, 2, 3
		V_{OUT} = -1.7V, V_{IN} = -11.75V			3.0	mA	1, 2, 3
		V_{OUT} = -1.7V, V_{IN} = -42V			5.0	mA	1
		V_{OUT} = -1.7V, V_{IN} = -41.3V			5.0	mA	2, 3
R_{Line}	Line Regulation	-42V ≤ V_{IN} ≤ -4.25V		-9.0	9.0	mV	1
		-41.3V ≤ V_{IN} ≤ -4.25V		-23	23	mV	2, 3
R_{Load}	Load Regulation	5mA ≤ I_L ≤ 500mA, V_{IN} = -6.25V		-25	25	mV	1, 2, 3
		5mA ≤ I_L ≤ 500mA, V_{IN} = -14.5V		-25	25	mV	1
		5mA ≤ I_L ≤ 150mA, V_{IN} = -40V		-25	25	mV	1, 2, 3
I_{Adj}	Adjustment Pin Current	I_L = 5 mA			100	µA	1, 2, 3
		V_{IN} = -42V			100	µA	1
		V_{IN} = -41.3V			100	µA	2, 3
$\Delta I_{Adj} / V_{Line}$	Adjust Pin Current Change vs. Line Voltage	-42V ≤ V_{IN} ≤ -4.25V, I_L = 5 mA		-5.0	5.0	µA	1
		-41.3V ≤ V_{IN} ≤ -4.25V, I_L = 5 mA		-5.0	5.0	µA	2, 3
$\Delta I_{Adj} / I_{Load}$	Adjust Pin Current Change vs. Load Current	5 mA ≤ I_L ≤ 500 mA, V_{IN} = -6.5V		-5.0	5.0	µA	1, 2, 3
θ_R	Thermal Regulation	V_{IN} = -14.5V, I_L = 500mA, t = 10mS		-5.0	5.0	mV	1
		V_{IN} = -14.5V, I_L = 5mA, t = 10mS		-5.0	5.0	mV	1
θ_{JC}	Thermal Resistance		(*Note 7*)		15	°C/W	1
I_{CL}	Current Limit	V_{IN} = -5V		-1.8	-0.5	A	1, 2, 3
		V_{IN} = -40V		-0.65	-0.15	A	1, 2, 3
V_O	Output Voltage			-1.28	-1.22	V	1
				-1.3	-1.2	V	2, 3

AC Parameters

R_R	Ripple Rejection Ratio	V_{IN} = -6.25V, V_{OUT} = V_{Ref}, I_L = 125mA, e_i = 1V_{RMS}, F = 120Hz	(*Note 5*, *Note 8*)	66		dB	4, 5, 6

LM137K 883 Electrical Characteristics

DC Parameters

The following conditions apply, unless otherwise specified. V_{IN} = –4.25V, I_L = 8mA, V_{OUT} = V_{Ref}

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{Ref}	Reference Voltage			-1.275	-1.225	V	1
				-1.3	-1.2	V	2, 3
		V_{IN} = -42V		-1.275	-1.225	V	1
		V_{IN} = -41.3V		-1.3	-1.2	V	2, 3
I_Q	Minimum Load Current	V_{OUT} = -1.7V			3.0	mA	1, 2, 3
		V_{OUT} = -1.7V, V_{IN} = -11.75V			3.0	mA	1, 2, 3
		V_{OUT} = -1.7V, V_{IN} = -42V			5.0	mA	1
		V_{OUT} = -1.7V, V_{IN} = -41.3V			5.0	mA	2, 3
R_{Line}	Line Regulation	-42V ≤ V_{IN} ≤ -4.25V		-9.0	9.0	mV	1
		-41.3V ≤ V_{IN} ≤ -4.25V		-23	23	mV	2, 3
R_{Load}	Load Regulation	V_{IN} = -6.25V, 8mA ≤ I_L ≤ 1.5A		-25	25	mV	1, 2, 3
		V_{IN} = -14.5V, 8mA ≤ I_L ≤ 1.5A		-25	25	mV	1
		V_{IN} = -40V, 8mA ≤ I_L ≤ 300 mA		-25	25	mV	1
		V_{IN} = -40V, 8mA ≤ I_L ≤ 250 mA		-25	25	mV	2, 3
I_{Adj}	Adjustment Pin Current				100	µA	1, 2, 3
		V_{IN} = -42V			100	µA	1
		V_{IN} = -41.3V			100	µA	2, 3
$\Delta I_{Adj} / V_{Line}$	Adjust Pin Current Change vs. Line Voltage	-42V ≤ V_{IN} ≤ -4.25V		-5.0	5.0	µA	1
		-41.3V ≤ V_{IN} ≤ -4.25V		-5.0	5.0	µA	2, 3
$\Delta I_{Adj} / I_{Load}$	Adjust Pin Current Change vs. Load Current	8 mA ≤ I_L ≤ 1.5A, V_{IN} = -6.25V		-5.0	5.0	µA	1, 2, 3
V_{Rth}	Thermal Regulation	V_{IN} = -14.5V, I_L = 1.5mA, t = 10mS		-5.0	5.0	mV	1
		V_{IN} = -14.5V, I_L = 8mA, t = 10mS		-5.0	5.0	mV	1
θ_{JC}	Thermal Resistance		(*Note 7*)		4.0	°C/W	1
I_{CL}	Current Limit	V_{IN} = -5V		-3.5	-1.5	A	1, 2, 3
		V_{IN} = -40V		-1.2	-0.24	A	1, 2, 3

AC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
R_R	Ripple Rejection Ratio	V_{IN} = -6.25V, V_{OUT} = V_{Ref}, f = 120Hz, I_L = 0.5A, e_I = $1V_{RMS}$	(*Note 5*, *Note 8*)	66		dB	4, 5, 6

LM137H RH Electrical Characteristics

DC Parameters

The following conditions apply, unless otherwise specified. (*Note 14*)

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
$\Delta I_{Adj} / V_{Line}$	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
$\Delta I_{Adj} / I_{Load}$	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	(*Note 9*)	-1.3	-1.2	V	2

AC Parameters

The following conditions apply, unless otherwise specified.

(*Note 14*)

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	9
V_{NO}	Output Noise Voltage	V_{IN} = -6.25V, I_L = 50mA			120	μV_{RMS}	9
ΔV_{OUT} / ΔV_{IN}	Line Transient Response	V_{IN} = -6.25V, V_{Pulse} = -1V, I_L = 50mA			80	mV/V	9
ΔV_O / ΔI_L	Load Transient Response	V_{IN} = -6.25V, I_L = 50mA, ΔI_L = 200mA	(*Note 10*)		60	mV	9

DC Parameters Drift Values

The following conditions apply, unless otherwise specified.

(*Note 14*)

Delta calculations performed on QMLV 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

DC Parameters Post Radiation Limits +25°C

The following conditions apply, unless otherwise specified.

(*Note 14*)

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
ΔI_{Adj} / V_{Line}	Adjust Pin Current Change vs. Line Voltage	V_{IN} = -41.25V to -4.25V, I_L = 5mA		-20	20	µA	1

Note 2: 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 3: 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 4: Group “A” sample only, test at all temps.

Note 5: Bench test, refer to (SG)RPI-3-362.

Note 6: Human body model, 100pF discharged through 1.5KΩ

Note 7: Guaranteed parameter, not tested.

Note 8: Test at +25°C, guaranteed but not tested at +125°C and −55°C

Note 9: Tested at +125°C ; correlated to +150°C

Note 10: Limit of 0..3mV/mA is equivalent to 60mV

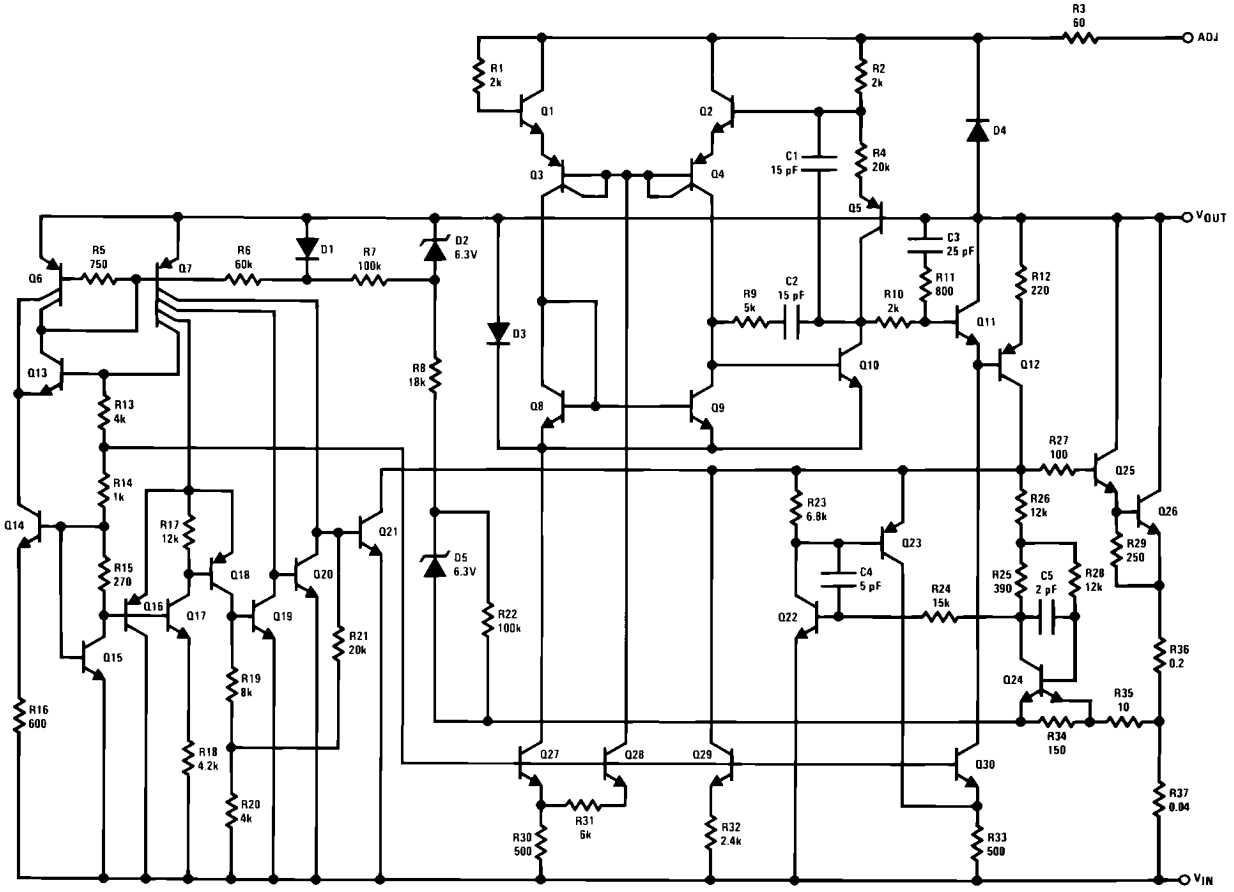
Note 11: V_{IN} = −41.3V at +125°C and −55°C

Note 12: $-41.3V \leq V_{IN} \leq -4.25V$ at +125°C and −55°C

Note 13: Pre Burn-In stress test per RPI-5-025.

Note 14: Pre and post irradiation limits are identical to those listed under AC and DC electrical characteristics except as listed in the Post Radiation Limits Table. These parts may be dose rate sensitive in a space environment and demonstrate enhanced low dose rate effect. Radiation end point limits for the noted parameters are guaranteed only for the conditions as specified in Mil-Std-883, Method 1019.5, Condition A.

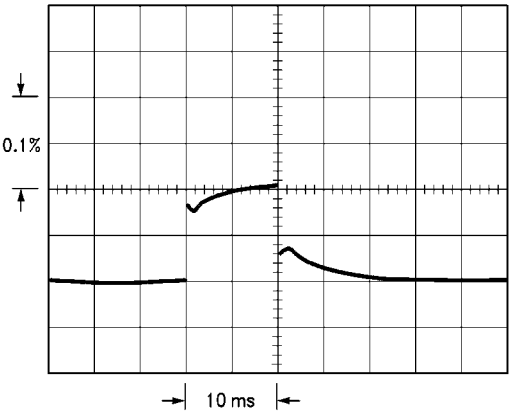
Schematic Diagram



20122402

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.

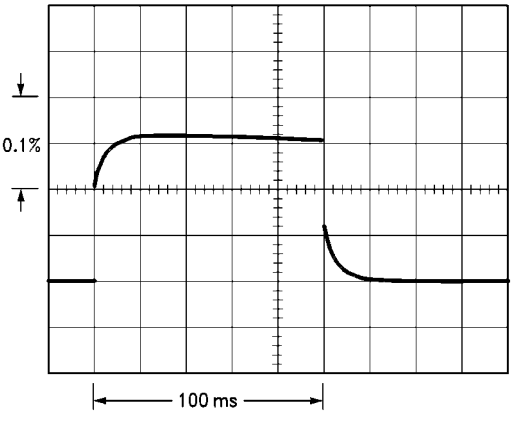


20122403

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).



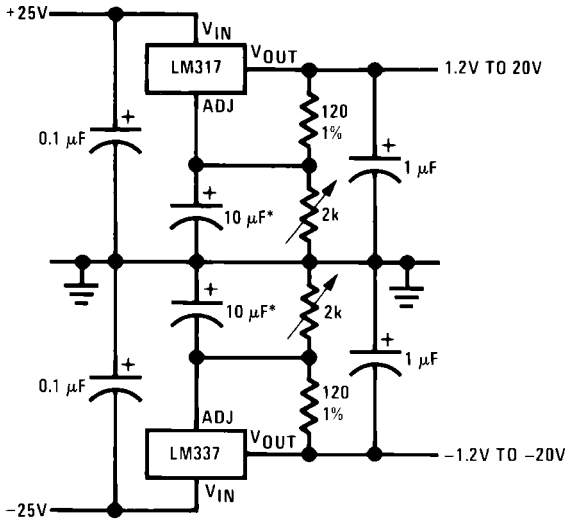
20122404

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

FIGURE 2.

Typical Applications

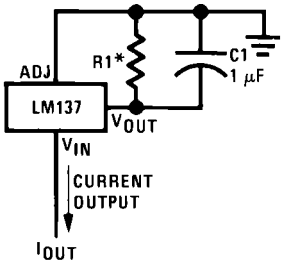
Adjustable Lab Voltage Regulator



20122409

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

Current Regulator

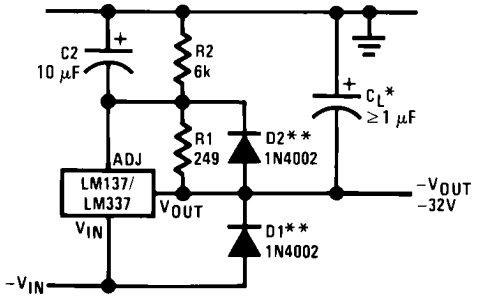


20122411

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

*0.8Ω ≤ R1 ≤ 120Ω

Negative Regulator with Protection Diodes

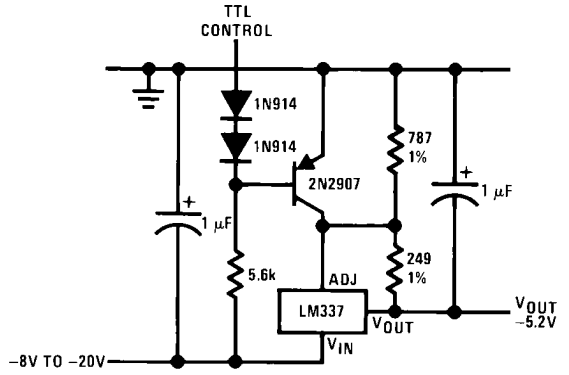


20122413

*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

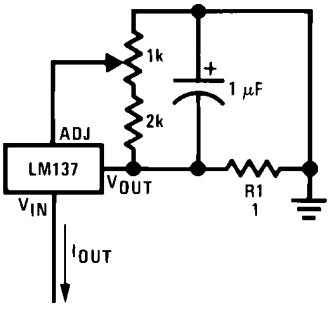
−5.2V Regulator with Electronic Shutdown*



20122410

*Minimum output −1.3V when control input is low

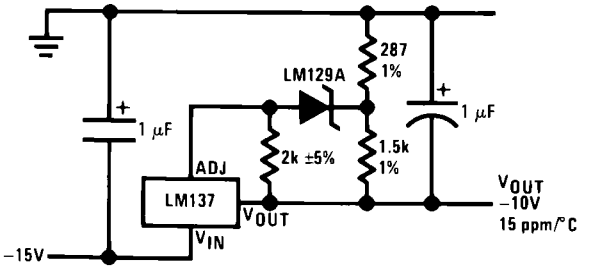
Adjustable Current Regulator



20122412

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

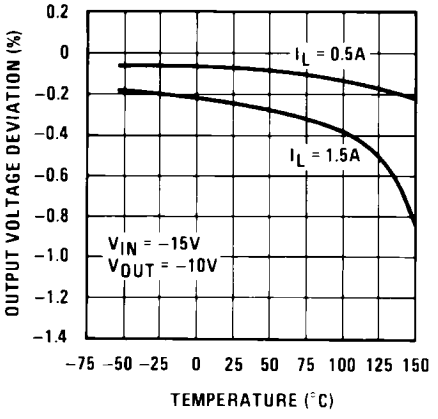
High Stability −10V Regulator



20122414

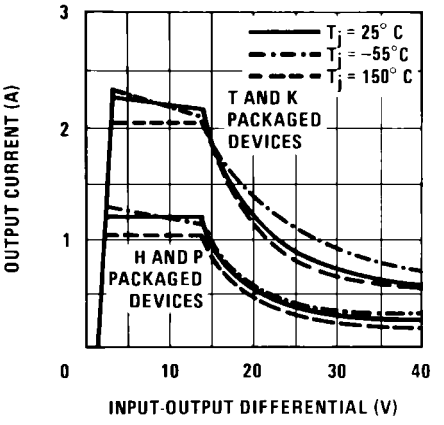
Typical Performance Characteristics (H & K Packages)

Load Regulation



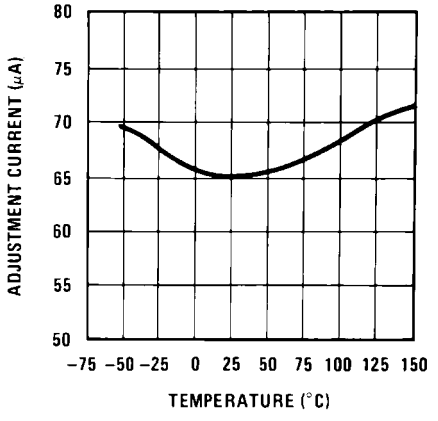
20122416

Current Limit



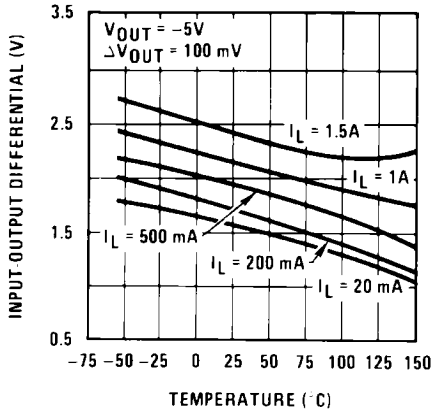
20122417

Adjustment Current



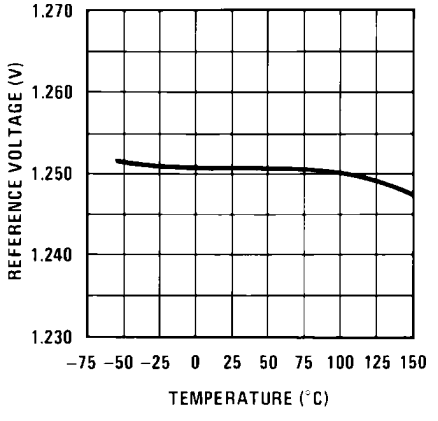
20122418

Dropout Voltage



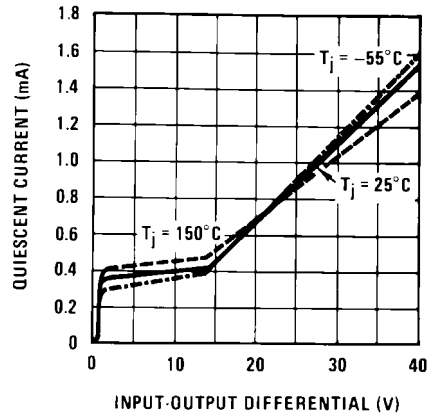
20122419

Temperature Stability



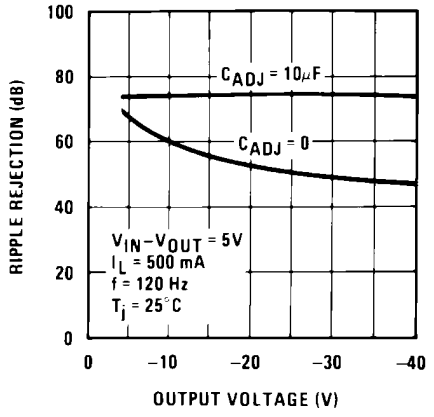
20122420

Minimum Operating Current



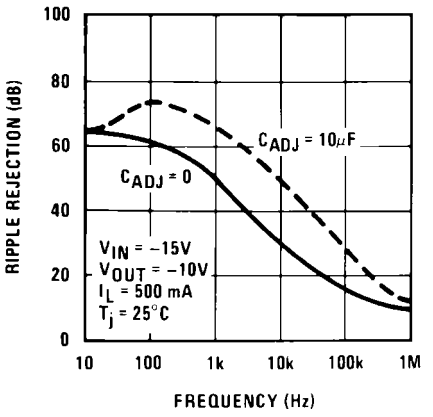
20122421

Ripple Rejection



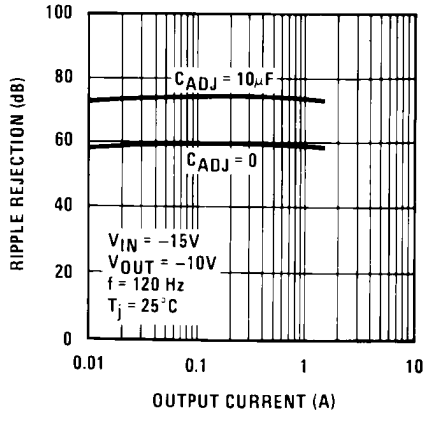
20122422

Ripple Rejection



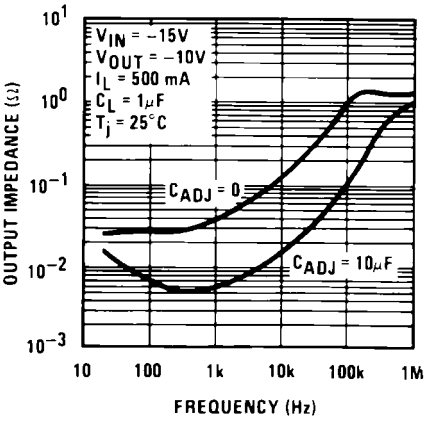
20122423

Ripple Rejection



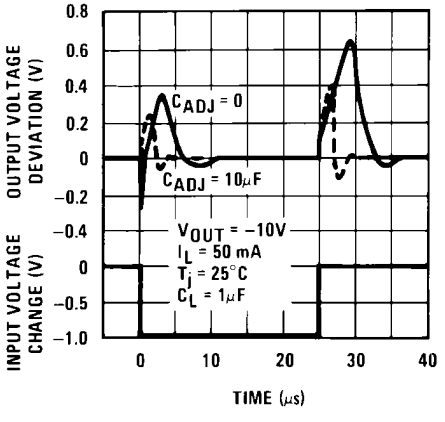
20122424

Output Impedance



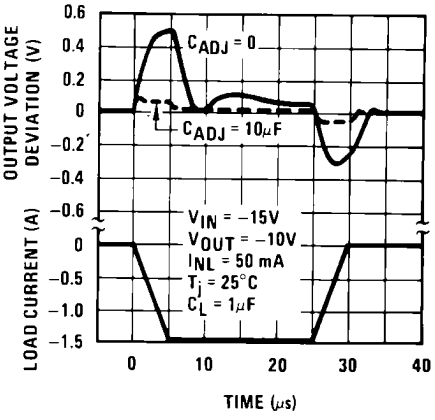
20122425

Line Transient Response



20122426

Load Transient Response

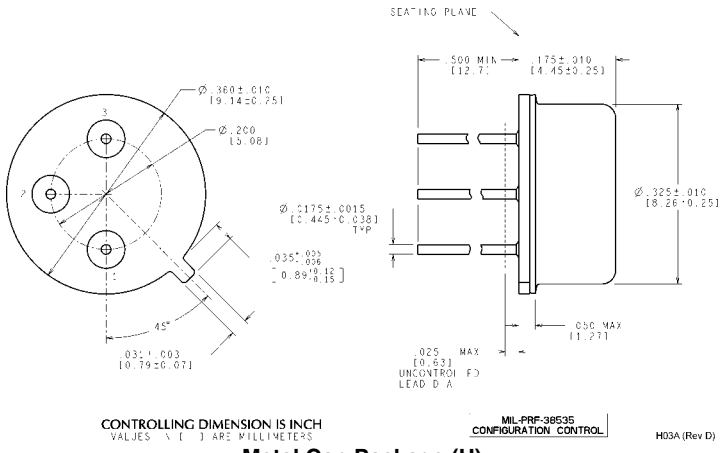


20122427

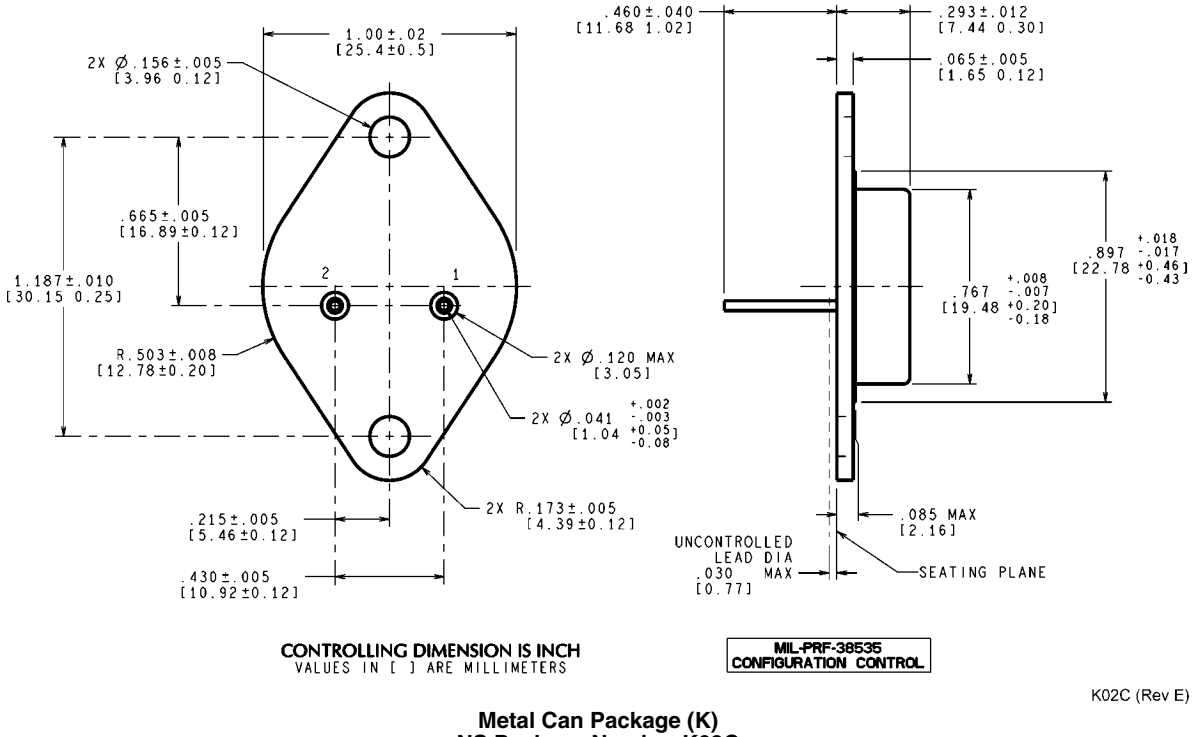
Revision History

Date Released	Revision	Section	Changes
12/08/2010	A	New Release, Corporate format	3 MDS data sheets converted into one Corp. data sheet format. MNLM137-X, Rev. 0B1, MNLM137-K Rev. 0A0, and MRLM137–X-RH Rev. 2A0. 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

For more National Semiconductor product information and proven design tools, visit the following Web sites at: www.national.com

Products		Design Support	
Amplifiers	www.national.com/amplifiers	WEBENCH® Tools	www.national.com/webench
Audio	www.national.com/audio	App Notes	www.national.com/appnotes
Clock and Timing	www.national.com/timing	Reference Designs	www.national.com/refdesigns
Data Converters	www.national.com/adc	Samples	www.national.com/samples
Interface	www.national.com/interface	Eval Boards	www.national.com/evalboards
LVDS	www.national.com/lvds	Packaging	www.national.com/packaging
Power Management	www.national.com/power	Green Compliance	www.national.com/quality/green
Switching Regulators	www.national.com/switchers	Distributors	www.national.com/contacts
LDOs	www.national.com/ldo	Quality and Reliability	www.national.com/quality
LED Lighting	www.national.com/led	Feedback/Support	www.national.com/feedback
Voltage References	www.national.com/vref	Design Made Easy	www.national.com/easy
PowerWise® Solutions	www.national.com/powerwise	Applications & Markets	www.national.com/solutions
Serial Digital Interface (SDI)	www.national.com/sdi	Mil/Aero	www.national.com/milaero
Temperature Sensors	www.national.com/tempsensors	SolarMagic™	www.national.com/solarmagic
PLL/VCO	www.national.com/wireless	PowerWise® Design University	www.national.com/training

National Semiconductor Americas Technical Support Center
Email: support@nsc.com
Tel: 1-800-272-9959

National Semiconductor Europe Technical Support Center
Email: europe.support@nsc.com

National Semiconductor Asia Pacific Technical Support Center
Email: ap.support@nsc.com

National Semiconductor Japan Technical Support Center
Email: jpn.feedback@nsc.com