LM137HVQML 3-Terminal Adjustable Negative Regulators (High Voltage)

Check for Samples: LM137HVQML

FEATURES

- **Output Voltage Adjustable from −47V to −1.2V**
- **1.5A Output Current Specified, −55°C ≤ T_J ≤ +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 Short Circuit Protected**

DESCRIPTION

The LM137HV is an adjustable 3-terminal negative voltage regulator capable of supplying in excess of −1.5A over an output voltage range of −47V to −1.2V. This regulators is 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 LM137HV features internal current limiting, thermal shutdown and safe-area compensation, making them virtually blowout-proof against overloads.

The LM137HV serves a wide variety of applications including local on-card regulation, programmable-output voltage regulation or precision current regulation. The LM137HV is an ideal complement to the LM117HV adjustable positive regulator.

Connection Diagrams

See Physical Dimensions section for further information

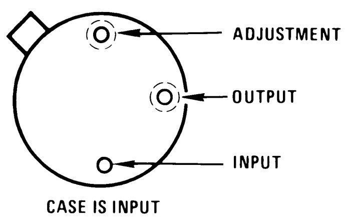


Figure 1. TO Package – Bottom View
See Package Number NDT0003A

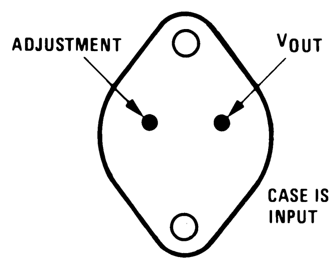
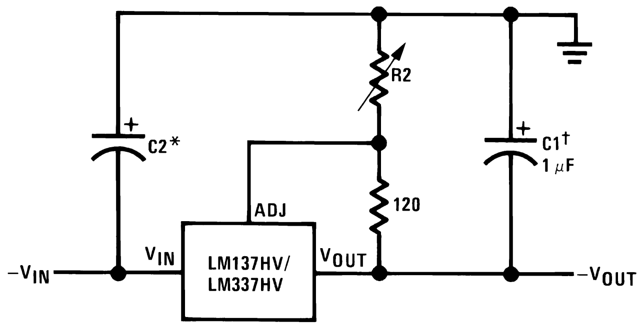


Figure 2. TO-3 Package (Bottom View)
See Package Number K

Typical Applications



$$-V_{OUT} = -1.25V\left(1 + \frac{R2}{120\Omega}\right) + \left[-I_{Adj}\,(R_2)\right]$$

†C1 = 1 µF solid tantalum or 10 µF aluminum electrolytic required for stability. 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.
*C2 = 1 µF solid tantalum is required only if regulator is more than 4″ from power-supply filter capacitor.

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				50V
Operating Ambient Temperature Range				$-55°C \le T_A \le +125°C$
Maximum Junction Temperature Range				+150°C
Storage Temperature				$-65°C \le T_A \le +150°C$
Lead Temperature (Soldering, 10 sec.)				300°C
Thermal Resistance	θ_{JA}	NDT0003A pkg. (Still Air @ 0.5W)		174°C/W
		NDT0003A pkg. (500LF / Min Air Flow @ 0.5W)		64°C/W
		K pkg. (Still Air @ 0.5W)		42°C/W
		K pkg. (500LF / Min Air Flow @ 0.5W)		14°C/W
	θ_{JC}	NDT0003A pkg. (@ 1.0W)		15°C/W
		K pkg.		4°C/W
		Package Weight (Typical)	NDT0003A pkg	955mg
			K pkg	12,750mg
ESD Rating[(3)]				4000V

(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 ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured 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 1. Quality Conformance Inspection

Mil-Std-883, Method 5004 and Method 5005		
Subgroup [(1)]	Description	Temp (°C)
1	Static tests at	+25°C
2	Static tests at	+125°C
3	Static tests at	-55°C
4	Dynamic tests at	+25°C
5	Dynamic tests at	+125°C
6	Dynamic tests at	-55°C
7	Functional tests at	+25°C
8A	Functional tests at	+125°C
8B	Functional tests at	-55°C
9	Switching tests at	+25°C
10	Switching tests at	+125°C
11	Switching tests at	-55°C

(1) Group "A" sample only, test at all temperature.

LM137HVH 883 Electrical Characteristics DC Parameters

The following conditions apply, unless otherwise specified. V_{IN} = −4.0V, I_O = 0.53A, V_O = V_{Ref}

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{Ref}	Reference Voltage	V_{IN} = -4.25V, I_O = 8 mA		-1.272	-1.23	V	1
				-1.28	-1.225	V	2, 3
		V_{IN} = -42V, I_O = 8mA		-1.272	-1.23	V	1
				-1.28	-1.225	V	2, 3
I_Q	Minimum Load Current	V_O = -1.7V, V_{IN} = -4.25V			3.0	mA	1, 2, 3
		V_O = -1.7V, V_{IN} = -11.75V			3.0	mA	1, 2, 3
		V_O = -1.7V, V_{IN} = -42V			5.0	mA	1, 2, 3
R_{Line}	Line Regulation	-42V ≤ V_{IN} ≤ -4.25V, I_O = 8mA			9.4	mV	1, 2, 3
I_{Adj}	Adjustment Pin Current	V_{IN} = -42V, I_O = 8mA			100	µA	1, 2, 3
		V_{IN} = -4.25V, I_O = 8mA			100	µA	1, 2, 3
		V_{IN} = -54V, I_O = 8mA			100	µA	1
ΔI_{Adj}	Adjustment Pin Current Change	-42V ≤ V_{IN} ≤ -4.25V, I_L = 8mA			6.0	µA	1, 2, 3
		V_{IN} = -6.25V, 8mA ≤ I_O ≤ 0.53A			5.0	µA	1, 2, 3
		-54V ≤ V_{IN} ≤ -4.25V, I_O = 8mA			6.0	µA	1
R_{Load}	Load Regulation	V_{IN} = -54V, 10mA ≤ I_O ≤ 60mA			25	mV	1
		V_{IN} = -6.25V, 8mA ≤ I_O ≤ 0.53A			25	mV	1
V_{Rth}	Thermal Regulation	I_O = 0.53A, V_{IN} = -14.5V			5	mV	1
I_{CL}	Current Limit	V_{IN} ≤ -14.25	See [(1)]	0.5	1.6	A	1
		V_{IN} = -51.25V	See [(1)]	0.1	0.5	A	1

(1) Specified parameter not tested.

LM137HVH 883 Electrical Characteristics AC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
R_R	Ripple Rejection	V_{IN} = -6.25V, V_O = V_{Ref}, f = 120Hz, e_I = 1V_{RMS}, I_L = 125mA	See (1) (2)		66	dB	4, 5, 6

(1) Tested at +25°C, specified, but not tested at +125°C and −55°C
(2) Bench test per (SG)RPI-3–362 Use TDN 70256657 (NSSG)

LM137HVK 883 Electrical Characteristics DC Parameters

The following conditions apply, unless otherwise specified. V_{IN} = −40V, I_L = 8.0mA, V_O = V_{Ref} = −1.25V (nominal)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{Ref}	Reference Voltage	V_{IN} = -4.25V		1.272	-1.23	V	1
				-1.28	-1.225	V	2, 3
		V_{IN} = -42V		-1.272	-1.23	V	1
		V_{IN} = -41.3V		-1.28	-1.225	V	2, 3
R_{Line}	Line Regulation	-42V ≤ V_{IN} ≤ -4.25V			9.4	mV	1
		-41.3V ≤ V_{IN} ≤ -4.25V			9.4	mV	2, 3
R_{Load}	Load Regulation	V_{IN} = -54V, 10mA ≤ I_O ≤ 110mA		-25	25	mV	1
		V_{IN} = -6.25V, 8mA ≤ I_O ≤ 1.5A		-25	25	mV	1, 2, 3
V_{Rth}	Thermal Regulation	I_O = 1.5A, V_{IN} = -14.5V, t = 10mS		-5.0	5.0	mV	1
I_{Adj}	Adjustment Pin Current	V_{IN} = -42V			100	µA	1
		V_{IN} = -41.3V			100	µA	2, 3
		V_{IN} = -4.25V			100	µA	1, 2, 3
		V_{IN} = -54V			100	µA	1
ΔI_{Adj}	Adjustment Pin Current Change	-42V ≤ V_{IN} ≤ -4.25V		-5.0	5.0	µA	1
		-41.3V ≤ V_{IN} ≤ -4.25V		-5.0	5.0	µA	2, 3
		-54V ≤ V_{IN} ≤ -4.25V		-6.0	6.0	µA	1
		V_{IN} = -6.25V, 8mA ≤ I_O ≤ 1.5A		-5.0	5.0	µA	1, 2, 3
I_Q	Minimum Load Current	V_O = 1.7V, V_{IN} = -4.25V			3.0	mA	1, 2, 3
		V_O = -1.7V, V_{IN} = -11.75V			3.0	mA	1, 2, 3
		V_O = -1.7V, V_{IN} = -42V			5.0	mA	1
		V_O = -1.7V, V_{IN} = -41.3V			5.0	mA	2, 3
I_{SC}	Short Circuit	V_{IN} = -5V		-2.85	-1.6	A	1
				-3.5	-1.6	A	2, 3
		V_{IN} = -51.25V	See (1)	-0.8	-0.2	A	1

(1) Specified parameter not tested.

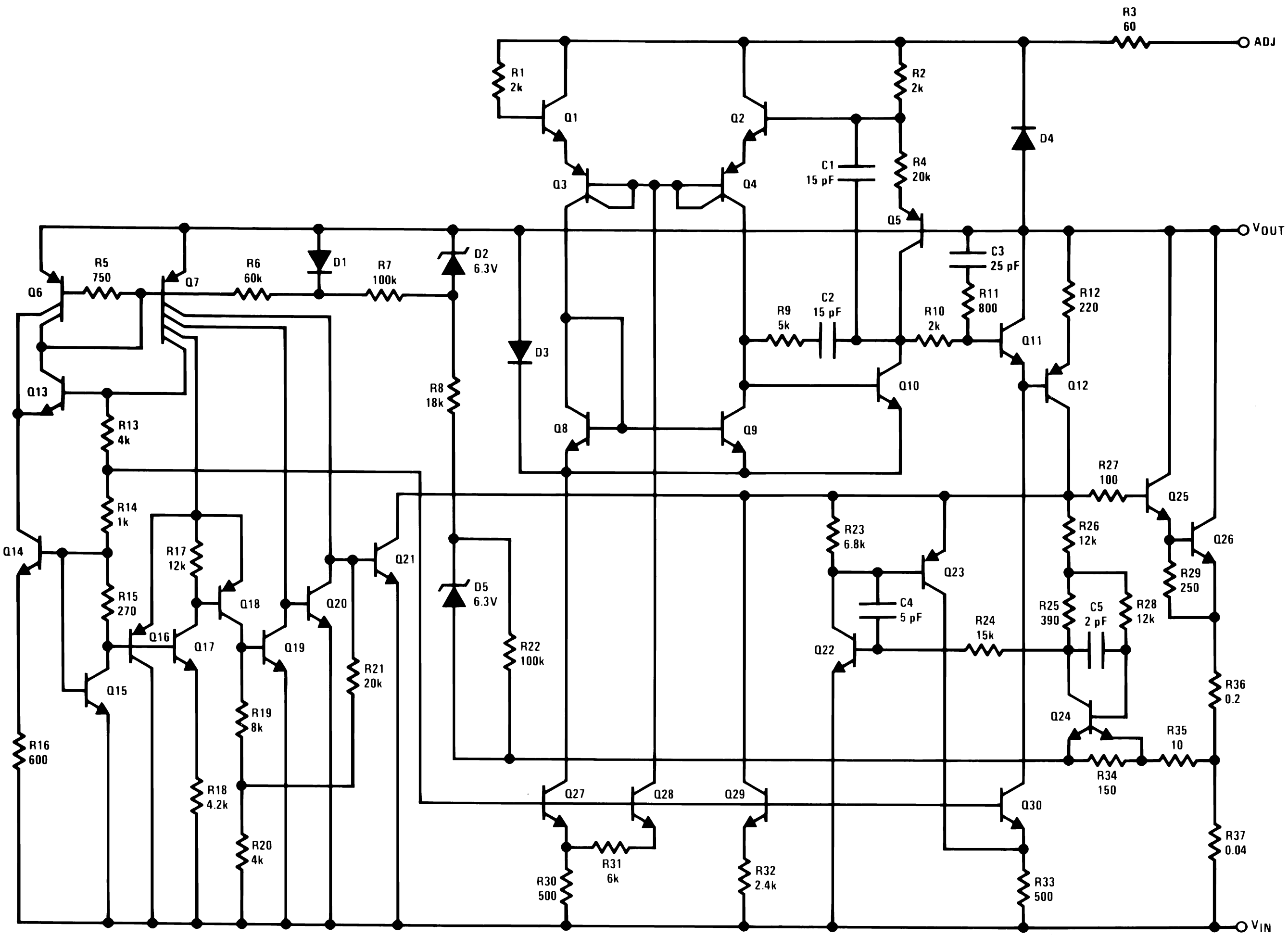
LM137HVK 883 Electrical Characteristics AC Parameters:

The following conditions apply, unless otherwise specified. V_{IN} = −40V, I_L = 8.0mA, V_O = V_{Ref} = −1.25V (nominal)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
R_R	Ripple Rejection	V_{IN} = -6.25V, V_O = V_{Ref}, f = 120Hz, e_{in} = 1V $_{RMS}$, I_L = 0.5A	See (1) (2)	66		dB	4, 5, 6

(1) Tested at +25°C, specified, but not tested at +125°C and −55°C
(2) Bench test per (SG)RPI-3–362 Use TDN 70256657 (NSSG)

Schematic Diagram



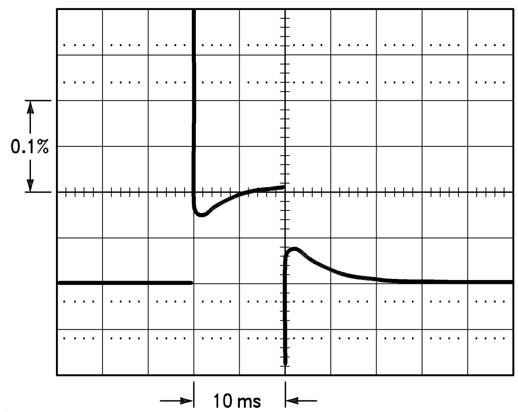
Thermal Regulation

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 LM137HV's specification is 0.02%/W, max.

In Figure 4, a typical LM137HV'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 x 10W = 0.2% max. When the 10W pulse is ended, the thermal regulation again shows a 3 mV step as the LM137HV 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).

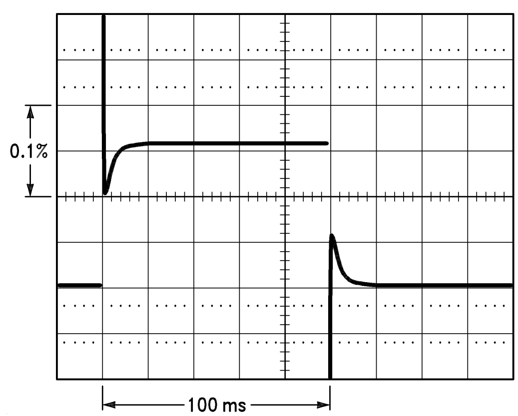
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large. Thermal regulation is the effect of these temperature gradients on output 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 LM137HV's specification is 0.02%/W, max.

In Figure 4, a typical LM137HV'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 x 10W = 0.2% max. When the 10W pulse is ended, the thermal regulation again shows a 3 mV step as the LM137HV 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).



LM137HV, V_{OUT} = −10V
V_{IN}−V_{OUT} = −40V
I_L = 0A→0.25A→0A
Vertical sensitivity, 5 mV/div

Figure 4.



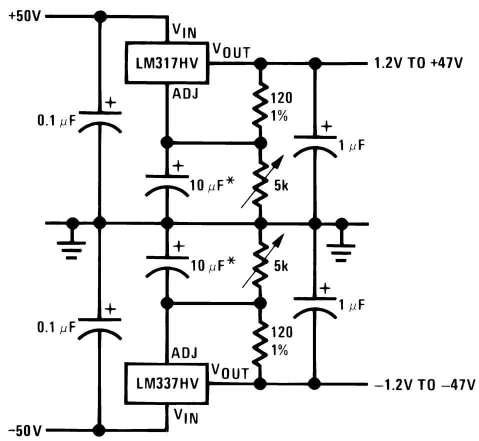
LM137HV, V_{OUT} = −10V
V_{IN}−V_{OUT} = −40V
I_L = 0A→0.25A→0A
Horizontal sensitivity, 20 ms/div

Figure 5.

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 LM137HV's specification is 0.02%/W, max.

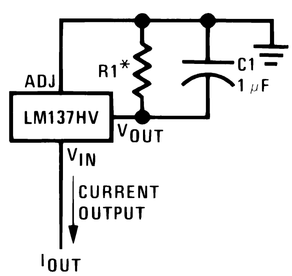
In Figure 4, a typical LM137HV's output drifts only 3 mV (or 0.03% of V_{OUT} = −10V) when a 10W pulse is applied for 10 ms. This performance is thus well inside the specification limit of 0.02%/W x 10W = 0.2% max. When the 10W pulse is ended, the thermal regulation again shows a 3 mV step as the LM137HV 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).

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 High Voltage Regulator



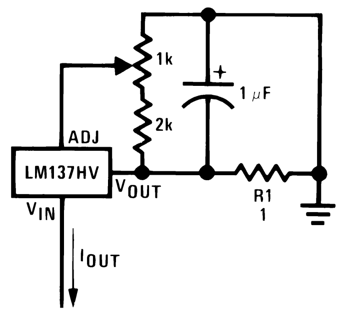
$$I_{OUT} = \frac{V_{REF}}{R1}$$

$^{*}\ 0.8\Omega \le R1 \le 120\Omega$

Figure 7. Current Regulator

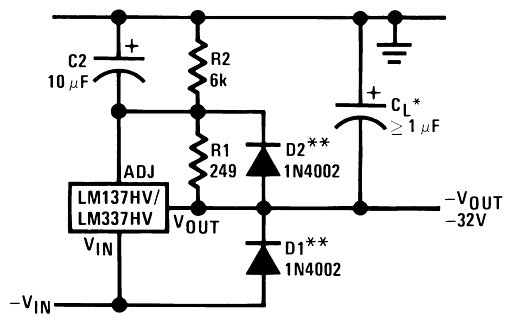
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large. Thermal regulation is the effect of these temperature gradients on output 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 LM137HV's specification is 0.02%/W, max.

In Figure 4, a typical LM137HV'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 x 10W = 0.2% max. When the 10W pulse is ended, the thermal regulation again shows a 3 mV step as the LM137HV 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).



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

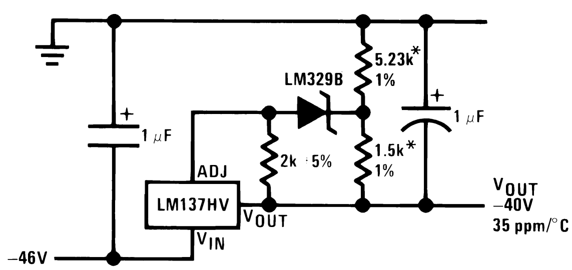
Figure 8. Adjustable Current Regulator



*When C_L is larger than 20 µF, D1 protects the LM137HV in case the input supply is shorted

**When C2 is larger than 10 µF and $-V_{OUT}$ is larger than −25V, D2 protects the LM137HV is case the output is shorted

Figure 9. Negative Regulator with Protection Diodes



*Use resistors with good tracking TC < 25 ppm/°C

Figure 10. High Stability −40V Regulator

Typical Performance Characteristics

(H and K-STEEL Package)

Load Regulation

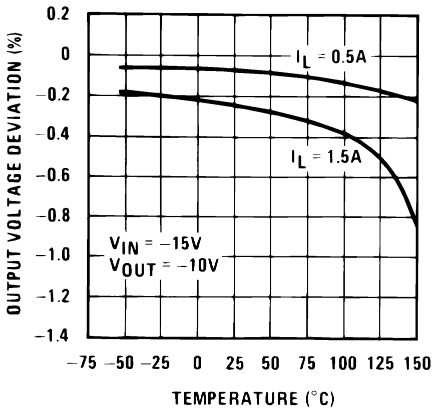


Figure 11.

Current Limit

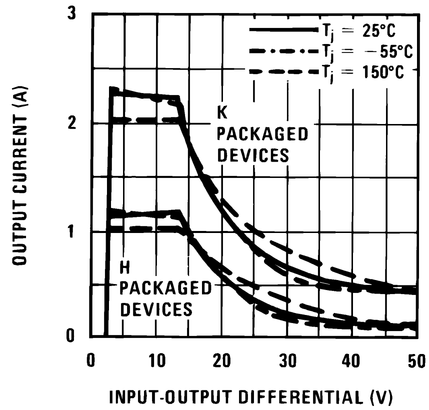


Figure 12.

Adjustment Current

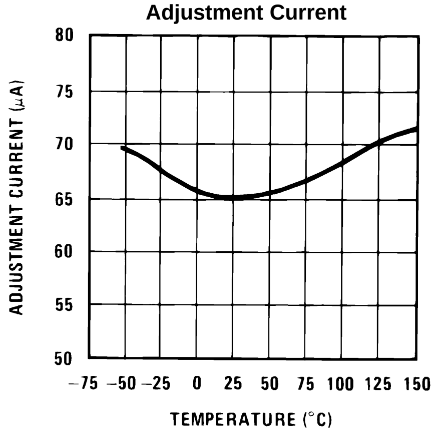


Figure 13.

Dropout Voltage

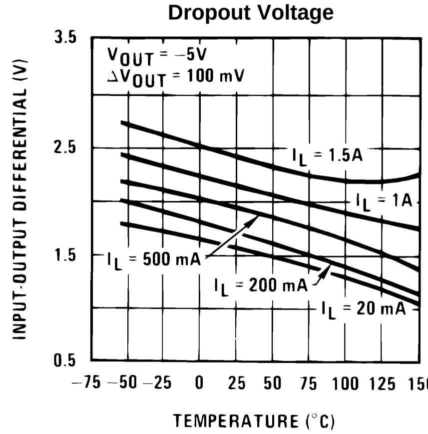


Figure 14.

Temperature Stability

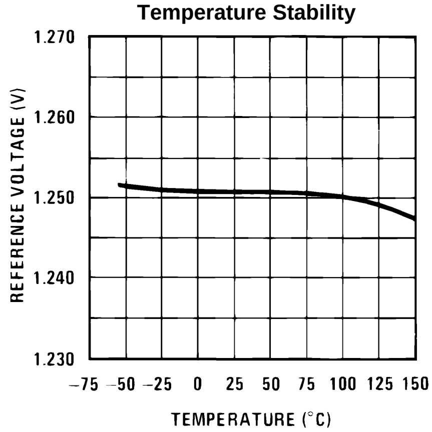


Figure 15.

Minimum Operating Current

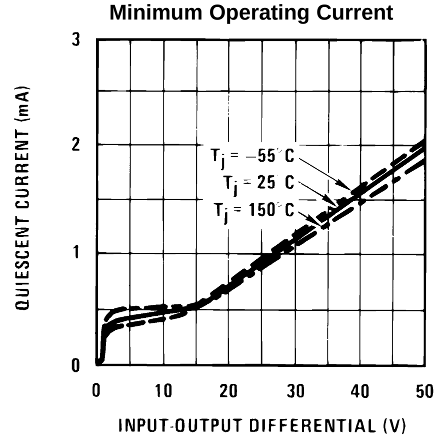


Figure 16.

Typical Performance Characteristics (continued)

(H and K-STEEL Package)

Ripple Rejection

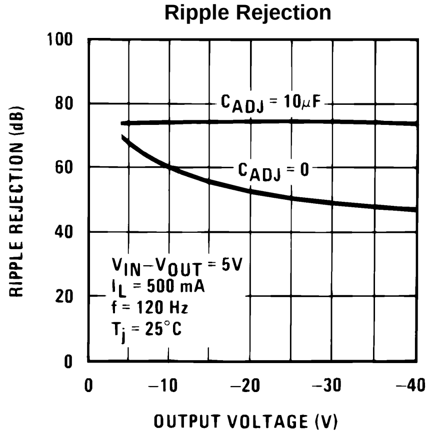


Figure 17.

Ripple Rejection

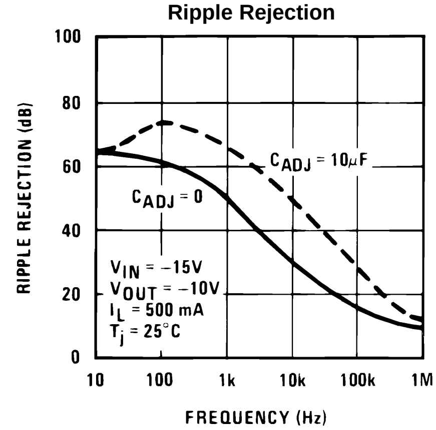


Figure 18.

Ripple Rejection

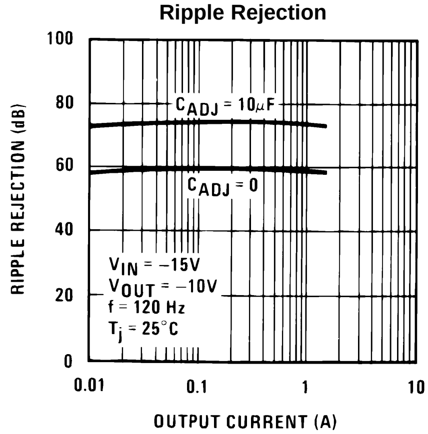


Figure 19.

Output Impedance

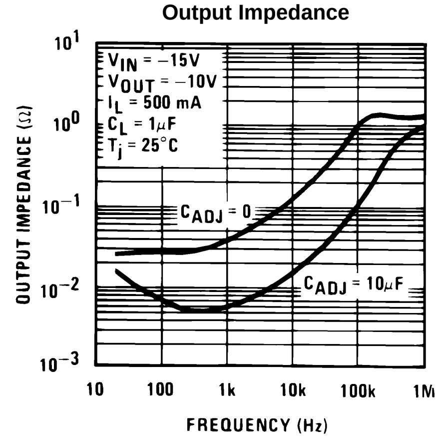


Figure 20.

Line Transient Response

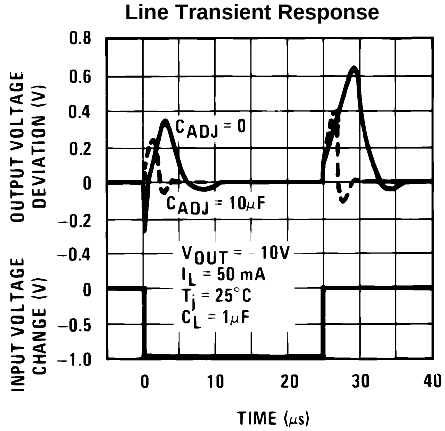


Figure 21.

Load Transient Response

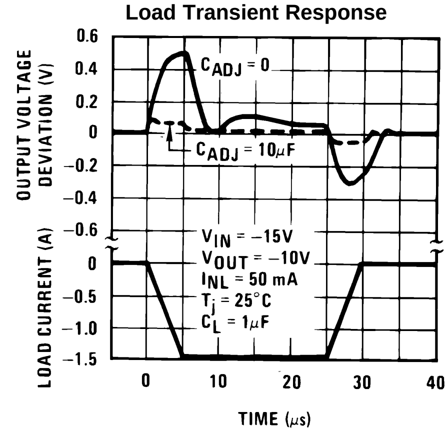


Figure 22.

REVISION HISTORY

Date Released	Revision	Section	Changes
12/16/2010	A	New Release, Corporate format	2 MDS data sheets converted into one Corp. Data sheet format. MNLM137HV-K rev 0A0, MNLM137HV-H rev 2A0 MDS datasheets will be archived.
04/17/2013	A		Changed layout of National Data Sheet to TI format.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM137HVH/883	ACTIVE	TO	NDT	3	20	TBD	Call TI	Call TI	-55 to 150	LM137HVH/883 Q ACO LM137HVH/883 Q >T	Samples
LM137HVK MD8	ACTIVE	DIESALE	Y	0	100	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125		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)] There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

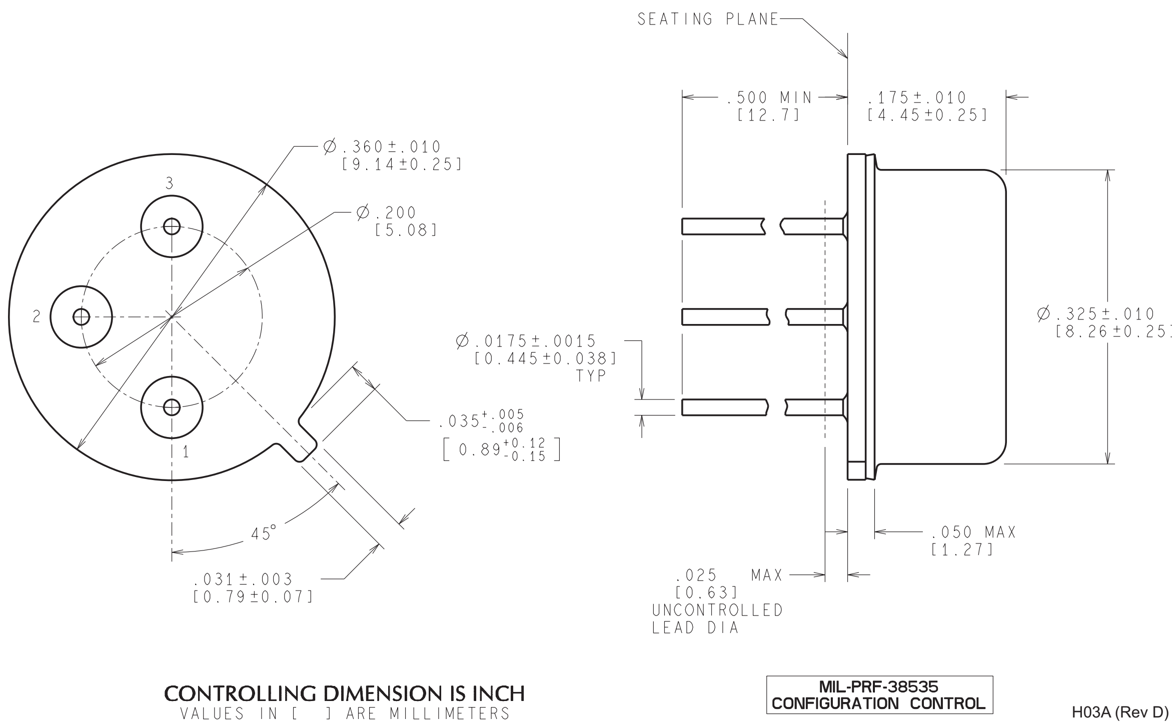
[(5)] Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

[(6)] Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

NDT0003A


SEATING PLANE
.500 MIN
[12.7]
.175±.010
[4.45±0.25]
Ø.360±.010
[9.14±0.25]
Ø.200
[5.08]
3
2
1
Ø.0175±.0015
[0.445±0.038]
TYP
.035+.005 -.006
[0.89+0.12 -0.15]
Ø.325±.010
[8.26±0.25]
45°
.031±.003
[0.79±0.07]
.050 MAX
[1.27]
.025 MAX
[0.63]
UNCONTROLLED
LEAD DIA
CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS
MIL-PRF-38535
CONFIGURATION CONTROL
H03A (Rev D)

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265