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

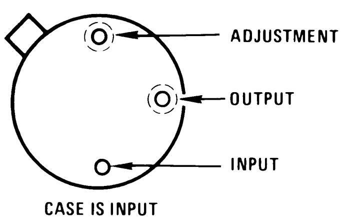


Figure 1. TO Package – Bottom View
See Package Number NDT0003A

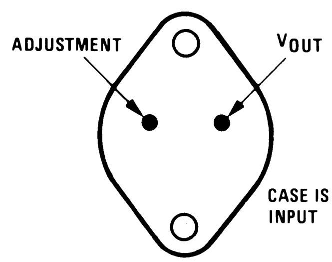
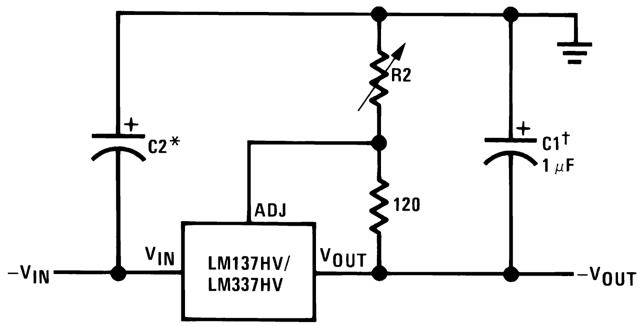


Figure 2. TO-3 Package (Bottom View)
See Package Number K

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 ≤ T_A ≤ +125°C
Maximum Junction Temperature Range				+150°C
Storage Temperature				−65°C ≤ T_A ≤ +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.

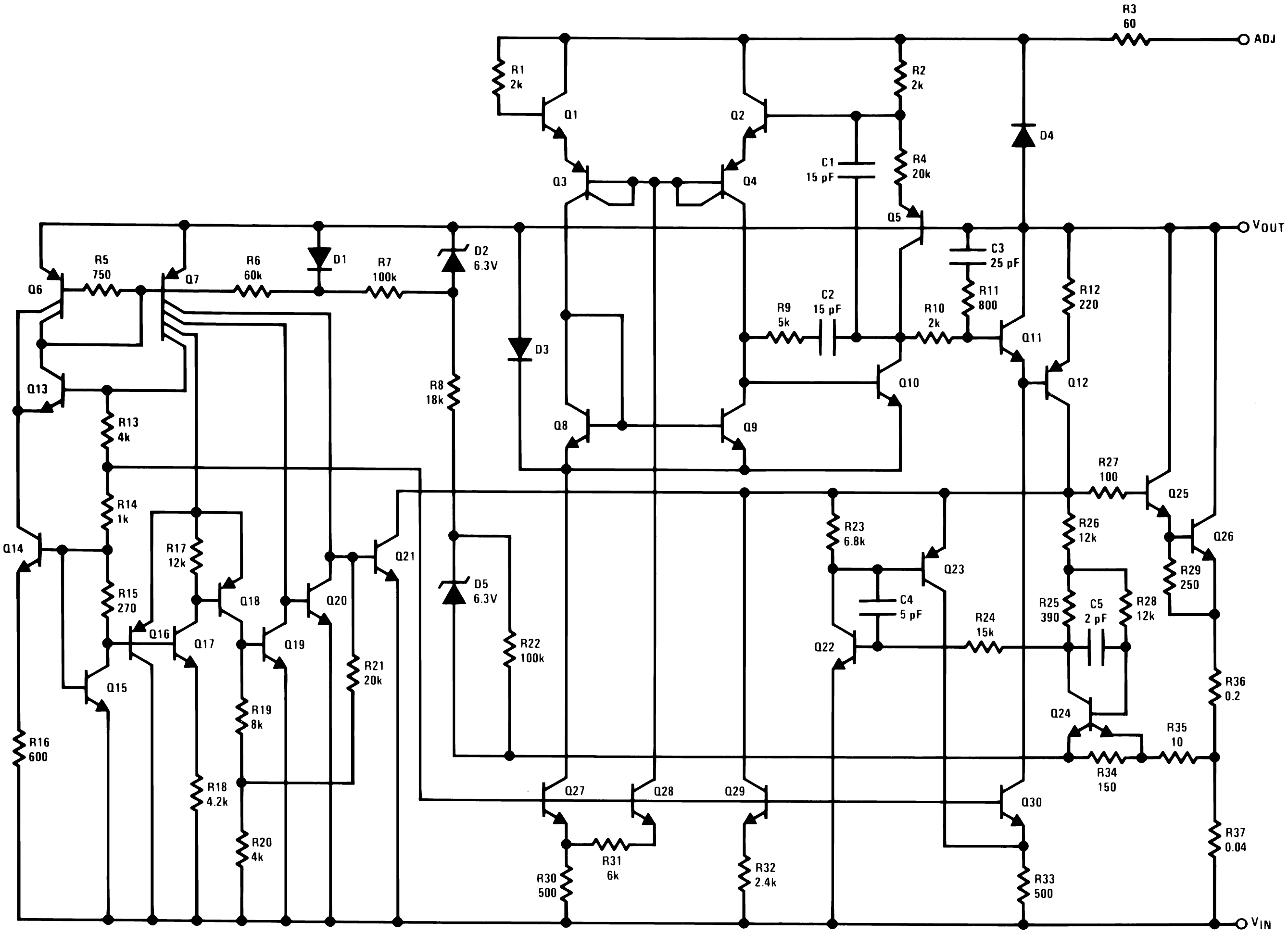
LM137HVK 883 Electrical Characteristics AC Parameters:

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).

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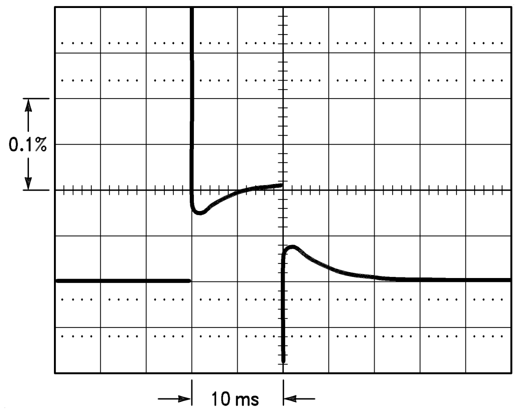
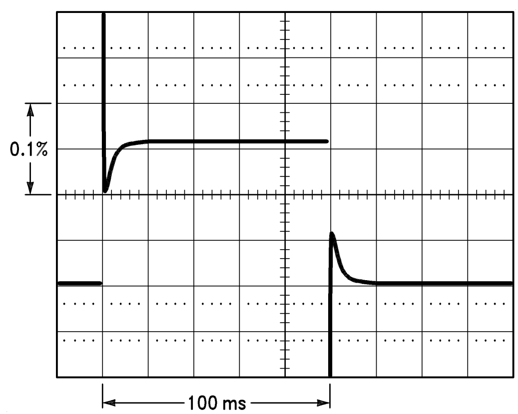


LM137HV, V_{OUT} = −10V
V_{IN}−V_{OUT} = −40V
I_L = 0A→0.25A→0A
Vertical sensitivity, 5 mV/div

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.

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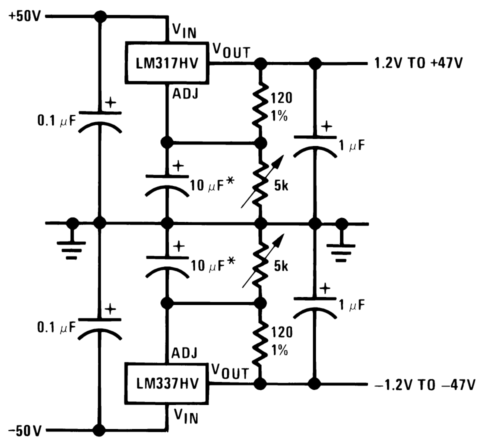
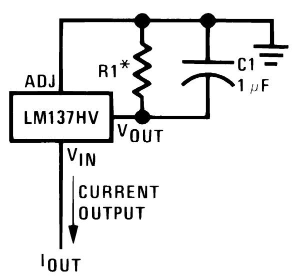
Typical Applications



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.

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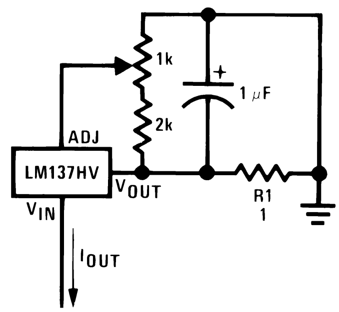
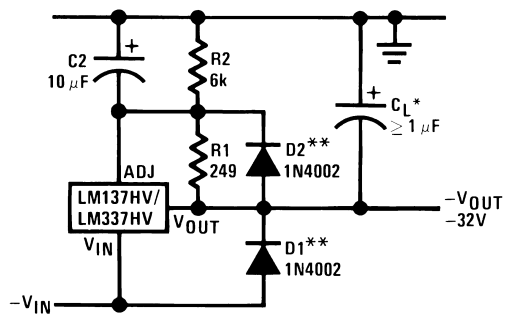


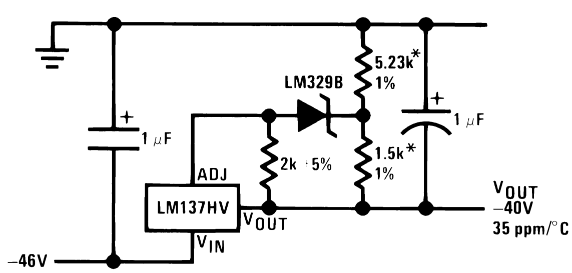
$$I_{OUT} = \left(\frac{1.5V}{R1}\right) \pm 15\% \text{ adjustable}$$

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

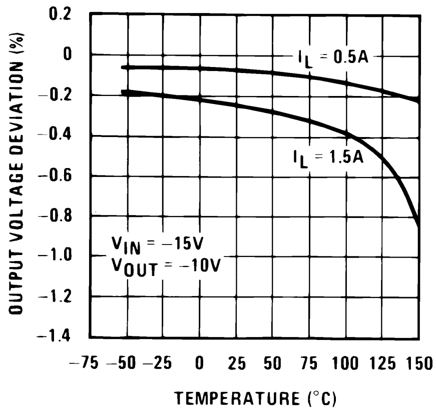


Figure 11.

Current Limit

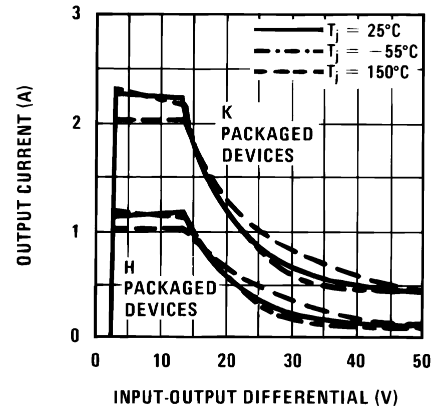


Figure 12.

Adjustment Current

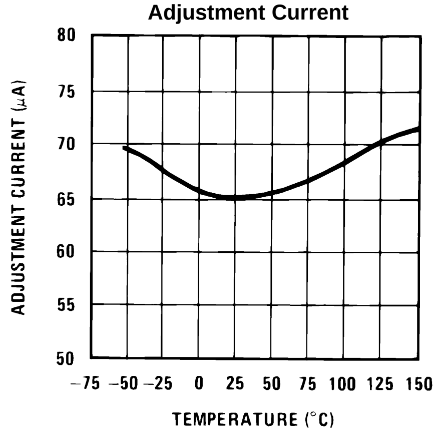


Figure 13.

Dropout Voltage

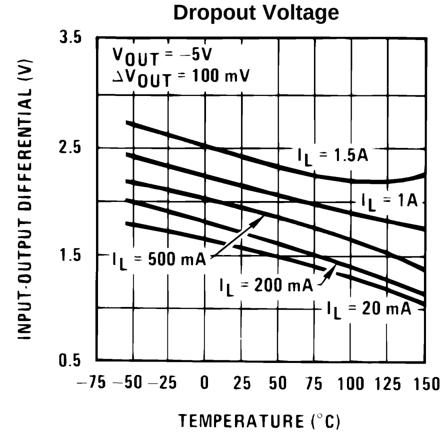


Figure 14.

Temperature Stability

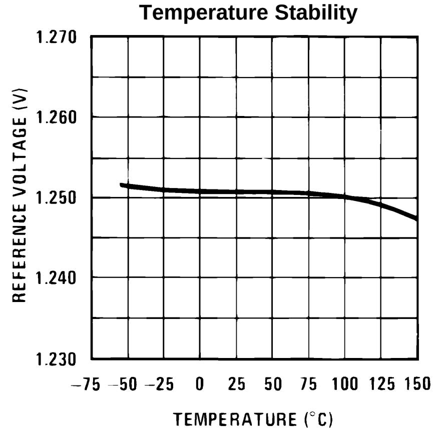


Figure 15.

Minimum Operating Current

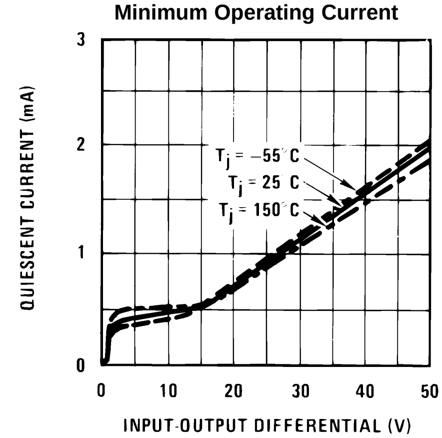


Figure 16.

Typical Performance Characteristics (continued)

(H and K-STEEL Package)

Ripple Rejection

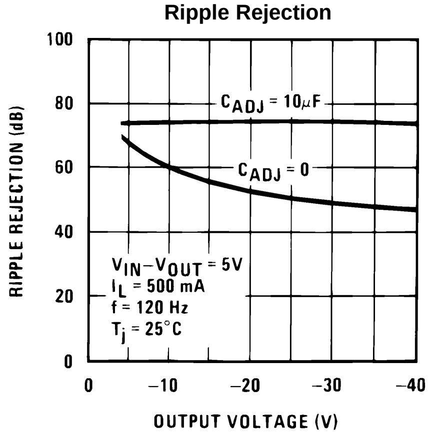


Figure 17.

Ripple Rejection

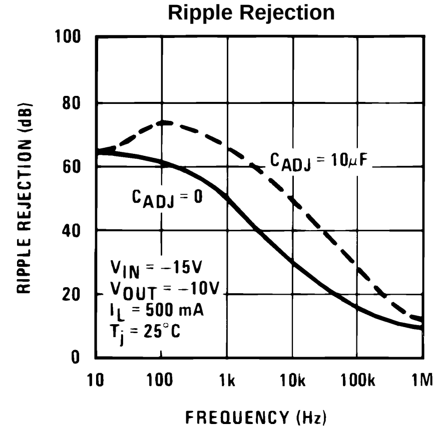


Figure 18.

Ripple Rejection

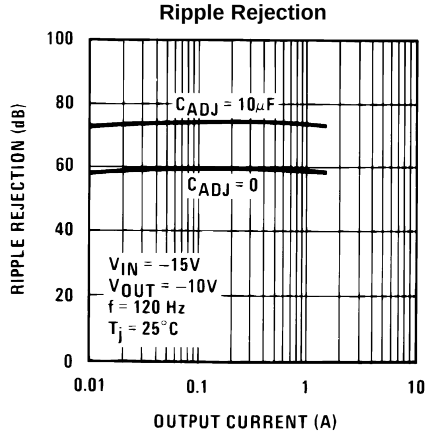


Figure 19.

Output Impedance

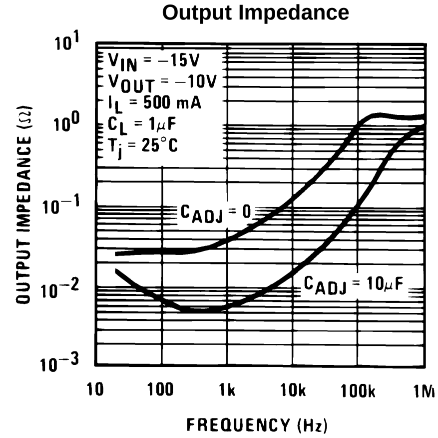


Figure 20.

Line Transient Response

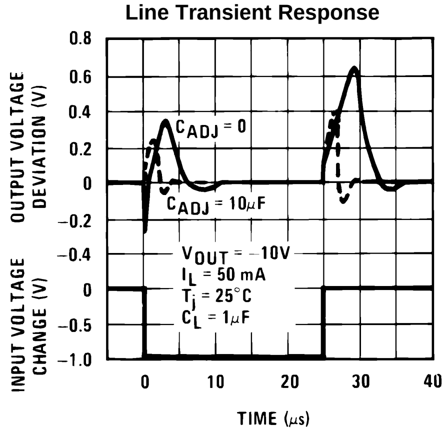


Figure 21.

Load Transient Response

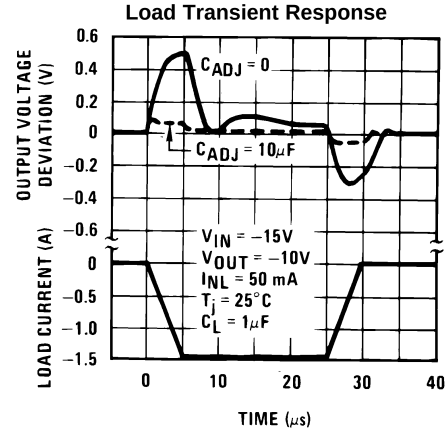


Figure 22.

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 part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM137HVH/883	Active	Production	TO (NDT) | 3	20 | JEDEC TRAY (5+1)	No	Call TI	Level-1-NA-UNLIM	-55 to 150	LM120H-15P+ LM137HVH/883 Q ACO LM137HVH/883 Q >T
LM137HVK MD8	Active	Production	DIESALE (Y) | 0	100 | JEDEC TRAY (5+1)	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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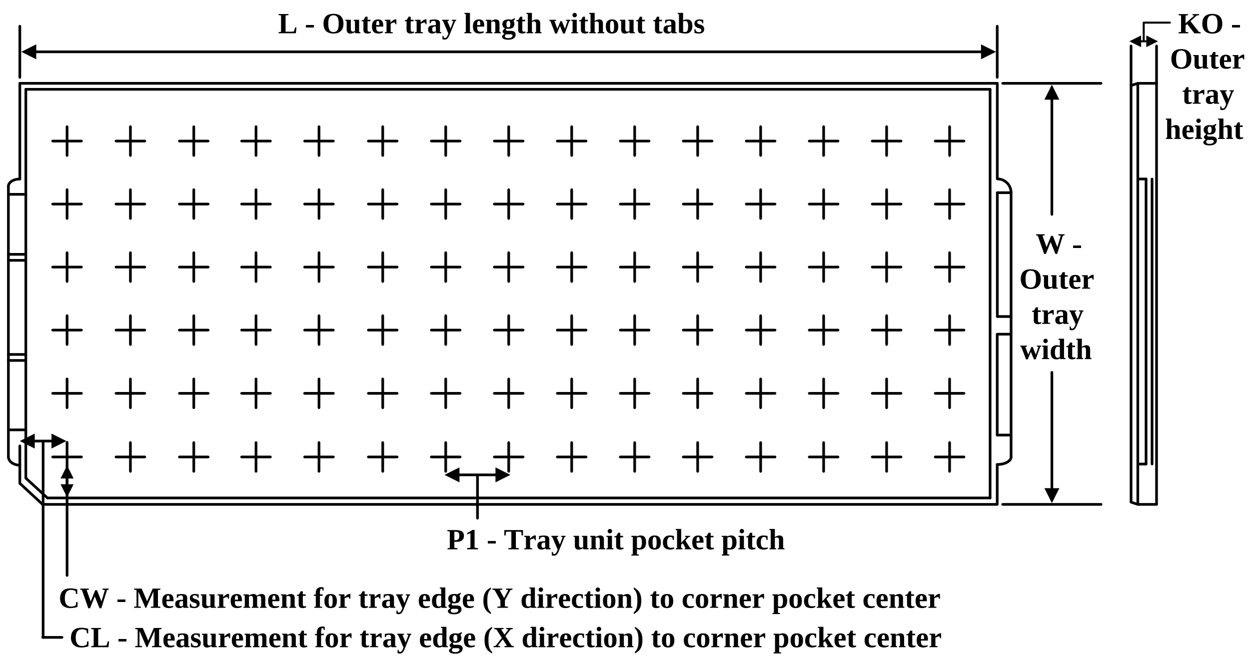
TRAY

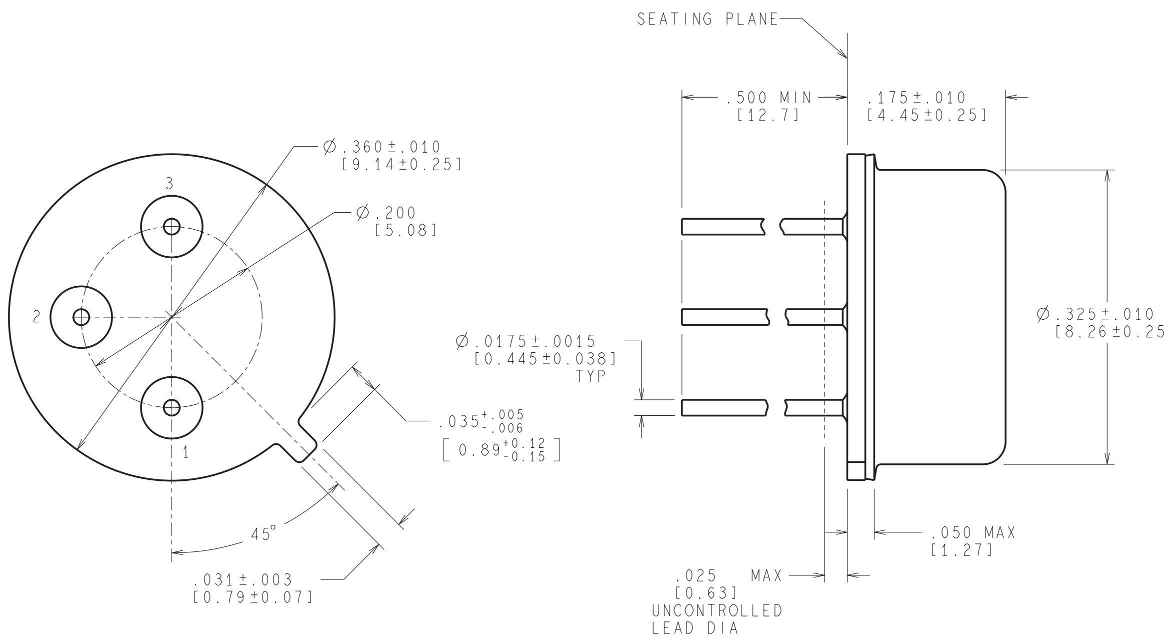


Chamfer on Tray corner indicates Pin 1 orientation of packed units.

*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
LM137HVH/883	NDT	TO-CAN	3	20	2 X 10	150	126.49	61.98	8890	11.18	12.95	18.54

NDT0003A



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