LM337-N 3 端子可调节负稳压器

1 特性

- 1.5A 输出电流
- 线路调节 0.01%/V（典型值）
- 负载调节 0.3%（典型值）
- 77dB 纹波抑制
- 50ppm/°C 温度系数
- 热过载保护
- 内部短路电流限制保护

2 应用

- 工业用电源
- 工厂自动化系统
- 楼宇自动化系统
- PLC 系统
- 仪表
- IGBT 驱动器负栅极电源
- 网络
- 机顶盒

3 说明

LM337-N-MIL 是一款可调节 3 端子负电压稳压器，能够在 −1.25V 至 −37V 的输出电压范围内提供 −1.5A 或更大的电流。它仅需要使用两个外部电阻器来设置输出电压以及使用一个输出电容器进行频率补偿。电路设计已经过优化，可实现出色的稳压和低热瞬态。此外，LM337-N-MIL 还 具有 内部电流限制、热关断和安全区域补偿功能，使其几乎能够在过载时防止烧毁。

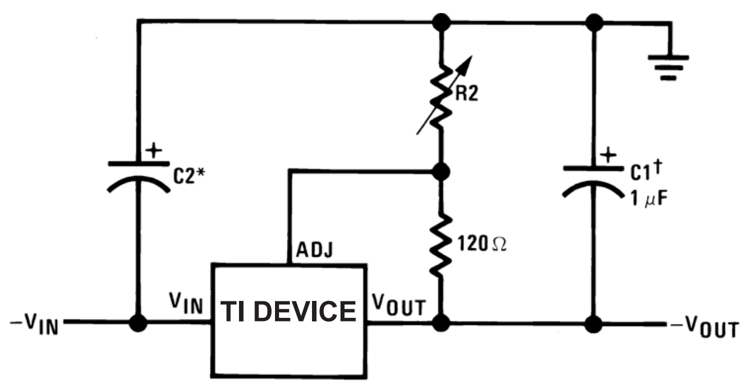
LM337-N-MIL 是对 LM117 和 LM317 可调节负稳压器的理想补充。

器件信息(1)

器件型号	封装	封装尺寸（标称值）
LM337-N-MIL	SOT-223 (4)	3.50mm × 6.50mm
	TO (3)	8.255mm × 8.255mm
	TO-220 (3)	10.16mm × 14.986mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。LF01 是 TO-220 封装的成型（弯曲）版本。

可调节负电压稳压器



满载输出电流在高输入到输出电压下不可用

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

†C1 为 1μF 的固体钽或 10μF 的铝电解电容器（用于实现稳定性时需要）
*C2 为 1μF 的固体钽（仅当稳压器与电源滤波电容器的距离大于 4 英寸时才需要）
通常使用 1μF 至 1000μF 范围内的铝或钽电解输出电容器来提供更佳的输出阻抗和瞬态抑制

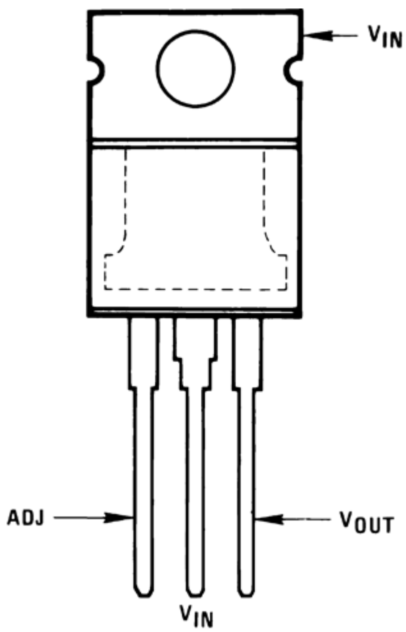
目录

4 修订历史记录

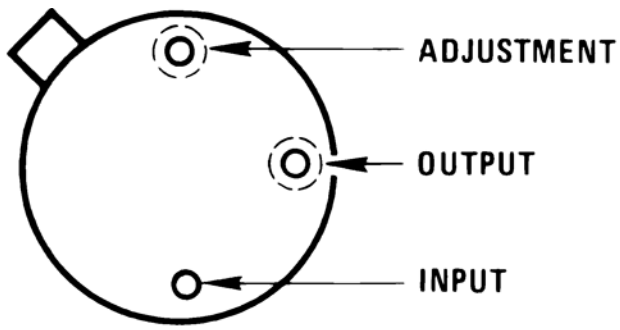
日期	修订版本	注意
2017 年 6 月	*	初始发行版。

5 Pin Configuration and Functions

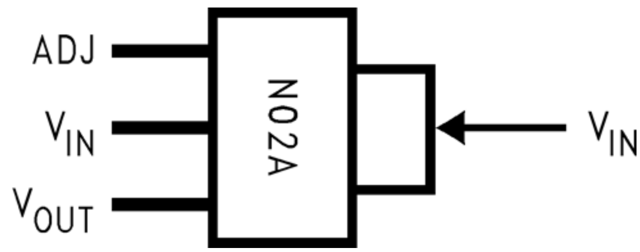
TO-220 Plastic Package
Package Number NDE0003B
Front View



TO Metal Can Package
3-Pin Package Number NDT0003A
Bottom View



SOT-223
3-Lead Package Marked N02A
Front View



Pin Functions

PIN				I/O	DESCRIPTION
NAME	TO-220	TO	SOT-223		
ADJ	1	1	1	—	Adjust pin
V_{IN}	2, TAB	3, CASE	2, 4	I	Input voltage pin for the regulator
V_{OUT}	3	2	3	O	Output voltage pin for the regulator

6 Specifications

6.1 Absolute Maximum Ratings

		MIN	MAX	UNIT
Power dissipation		Internally Limited		
Input-output voltage differential		–0.3	40	V
Operating junction temperature		0	125	°C
Storage temperature, T_{stg}		–65	150	°C

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 [1]	±2000	V

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Pins listed as ±2000 V may actually have higher performance.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
Operating junction temperature		0	125	°C

6.4 Thermal Information

THERMAL METRIC [1]		LM337-N-MIL			UNIT
		NDT (TO)	DCY (SOT-223)	NDE OR NDG (TO-220)	
		3 PINS	3 PINS	3 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	140 [2]	58.3	22.9	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	12	36.6	15.7	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	—	7.2	4.1	°C/W
ψ_{JT}	Junction-to-top characterization parameter	—	1.3	2.4	°C/W
ψ_{JB}	Junction-to-board characterization parameter	—	7	4.1	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	—	—	1	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.
(2) No heat sink.

6.5 Electrical Characteristics

Unless otherwise specified, these specifications apply: 0°C ≤ T_j ≤ 125°C for the LM337-N-MIL; $V_{IN} - V_{OUT}$ = 5 V; and I_{OUT} = 0.1 A for the TO package and I_{OUT} = 0.5 A for the SOT-223 and TO-220 packages. Although power dissipation is internally limited, these specifications are applicable for power dissipations of 2 W for the TO and SOT-223, and 20 W for the TO-220. I_{MAX} is 1.5 A for the SOT-223 and TO-220 packages, and 0.2 A for the TO package.

PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Line regulation	T_J = 25°C, 3 V ≤ $\|V_{IN} - V_{OUT}\|$ ≤ 40 V(1) I_L = 10 mA			0.01	0.04	%/V
Load regulation	T_J = 25°C, 10 mA ≤ I_{OUT} ≤ I_{MAX}			0.3%	1%	
Thermal regulation	T_J = 25°C, 10-ms Pulse			0.003	0.04	%/W
Adjustment pin current				65	100	μA
Adjustment pin current charge	10 mA ≤ I_L ≤ I_{MAX} 3 V ≤ $\|V_{IN} - V_{OUT}\|$ ≤ 40 V, T_A = 25°C			2	5	μA
Reference voltage	3 V ≤ $\|V_{IN} - V_{OUT}\|$ ≤ 40 V, (2) 10 mA ≤ I_{OUT} ≤ I_{MAX}, P ≤ P_{MAX}	T_J = 25°C (2)	−1.213	−1.25	−1.287	V
		−55°C ≤ T_J ≤ 150°C	−1.2	−1.25	−1.3	V
Line regulation	3 V ≤ $\|V_{IN} - V_{OUT}\|$ ≤ 40 V, (1)			0.02	0.07	%/V
Load regulation	10 mA ≤ I_{OUT} ≤ I_{MAX}, (1)			0.3%	1.5%	
Temperature stability	T_{MIN} ≤ T_j ≤ T_{MAX}			0.6%		
Minimum load current	$\|V_{IN} - V_{OUT}\|$ ≤ 40 V			2.5	10	mA
	$\|V_{IN} - V_{OUT}\|$ ≤ 10 V			1.5	6	mA
Current limit	$\|V_{IN} - V_{OUT}\|$ ≤ 15 V	K, DCY and NDE package	1.5	2.2	3.7	A
		NDT package	0.5	0.8	1.9	A
	$\|V_{IN} - V_{OUT}\|$ = 40 V, T_J = 25°C	K, DCY and NDE package	0.15	0.4		A
		NDT package	0.1	0.17		A
RMS output noise, % of V_{OUT}	T_j = 25°C, 10 Hz ≤ f ≤ 10 kHz			0.003%		
Ripple rejection ratio	V_{OUT} = −10 V, f = 120 Hz			60		dB
	C_{ADJ} = 10 μF		66	77		dB
Long-term stability	T_J = 125°C, 1000 Hours			0.3%	1%	

(1) Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation. Load regulation is measured on the output pin at a point ⅛ in. below the base of the TO packages.
(2) Selected devices with tightened tolerance reference voltage available.

6.6 Typical Characteristics

(NDE Package)

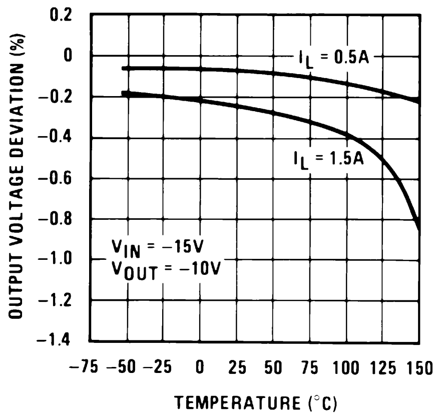


Figure 1. Load Regulation

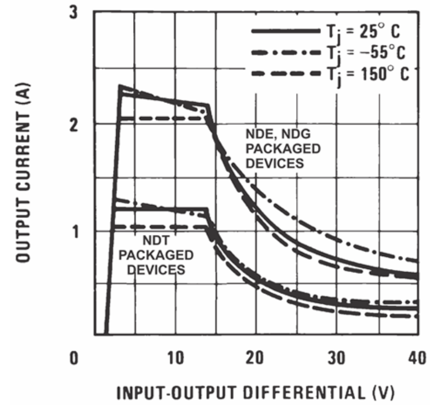


Figure 2. Current Limit

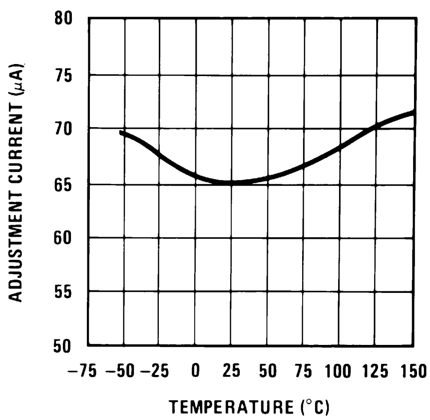


Figure 3. Adjustment Current

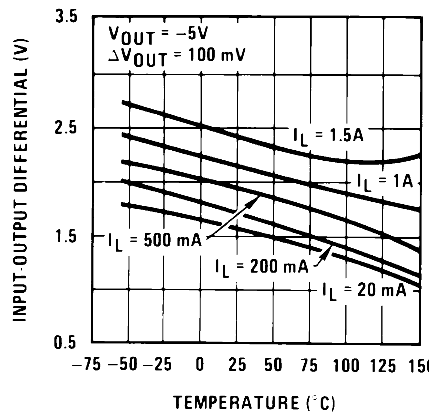


Figure 4. Dropout Voltage

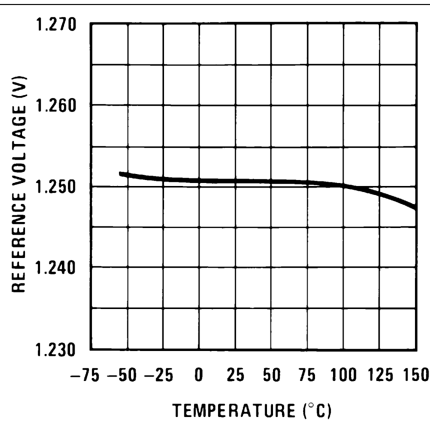


Figure 5. Temperature Stability

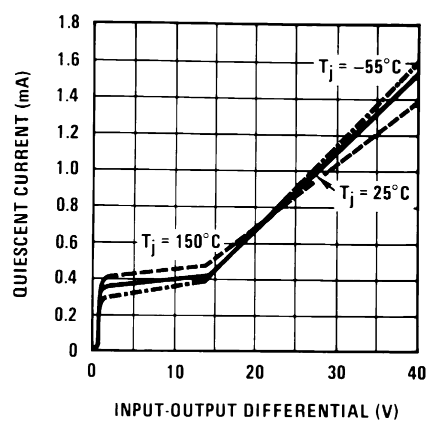


Figure 6. Minimum Operating Current

Typical Characteristics (continued)

(NDE Package)

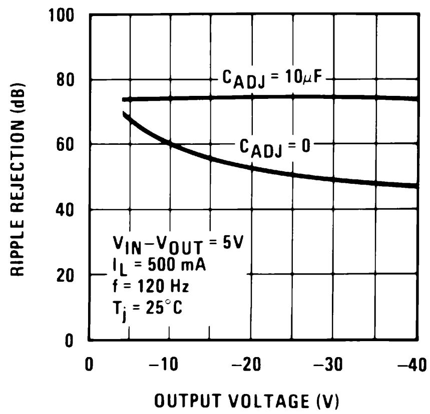


Figure 7. Ripple Rejection

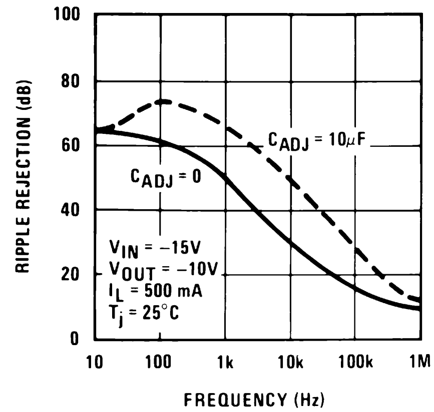


Figure 8. Ripple Rejection

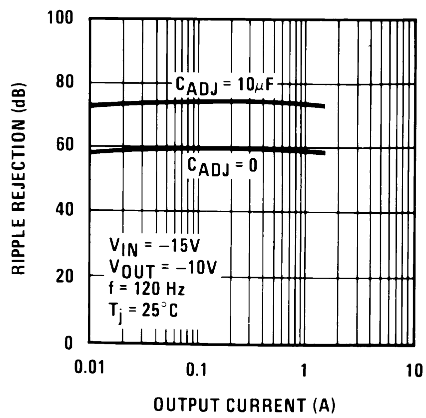


Figure 9. Ripple Rejection

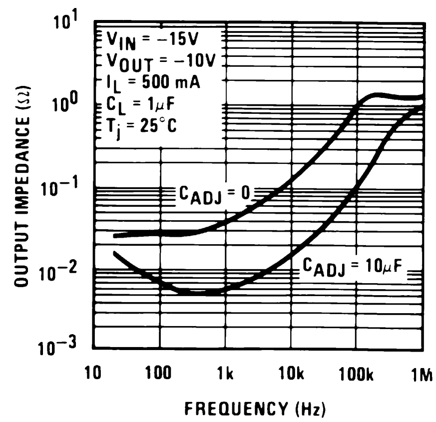


Figure 10. Output Impedance

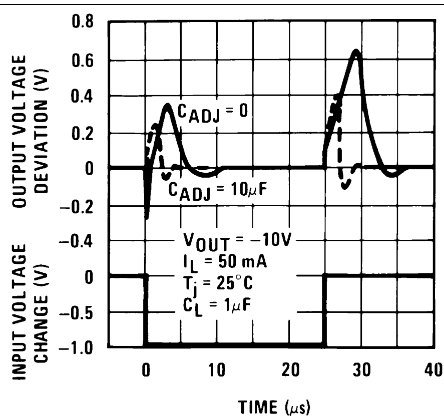


Figure 11. Line Transient Response

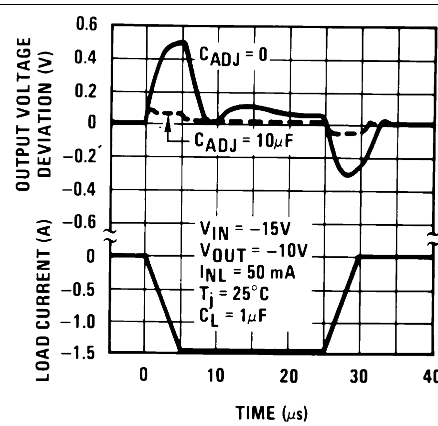


Figure 12. Load Transient Response

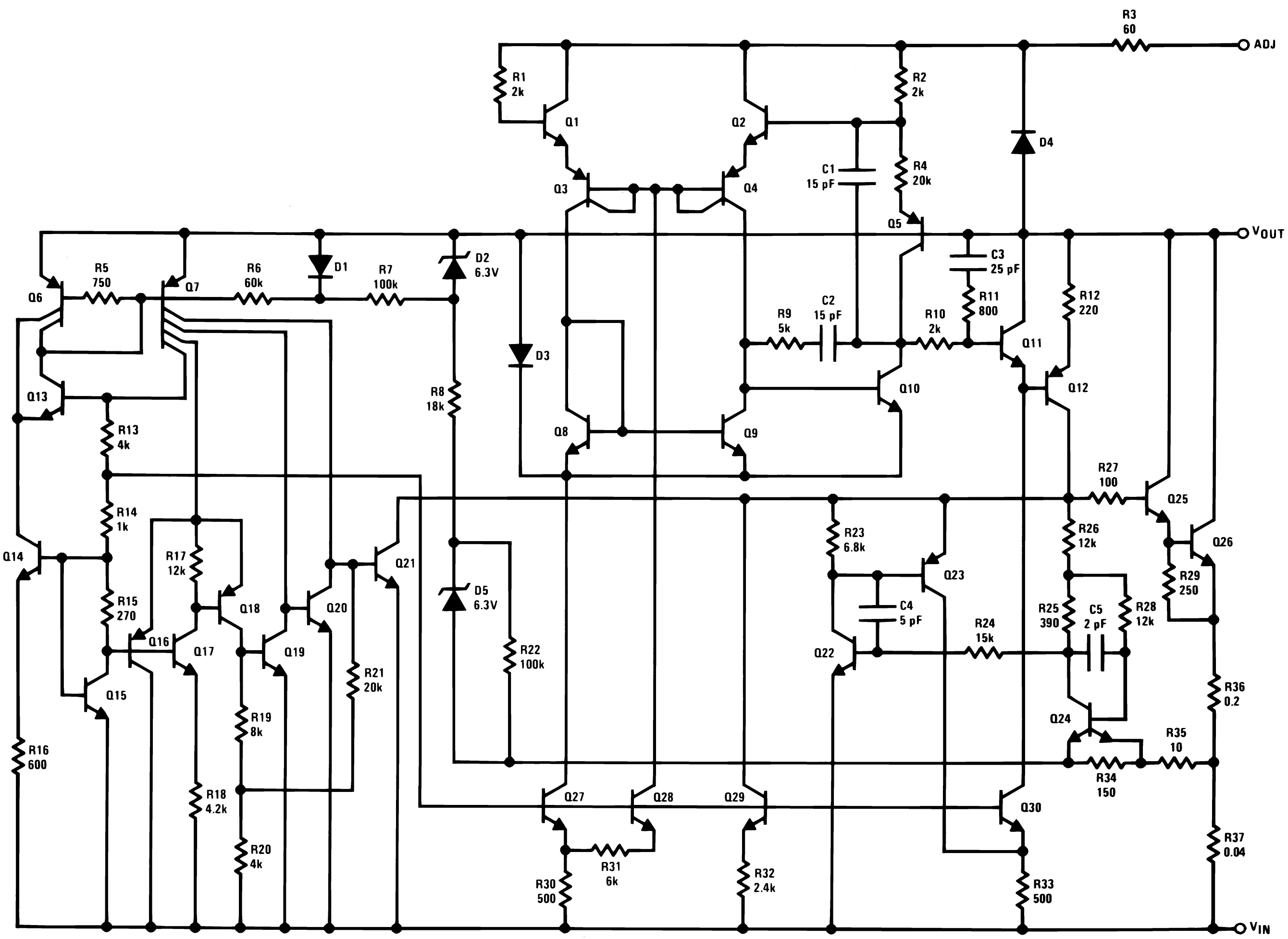
7 Detailed Description

7.1 Overview

In operation, the LM337-N-MIL develops a nominal −1.25-V reference voltage between the output and adjustment terminal. The reference voltage is impressed across program resistor R1 (120 Ω for example) and, because the voltage is constant, a constant current then flows through the output set resistor R2, giving an output voltage calculated by Equation 1.

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

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 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 because 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.

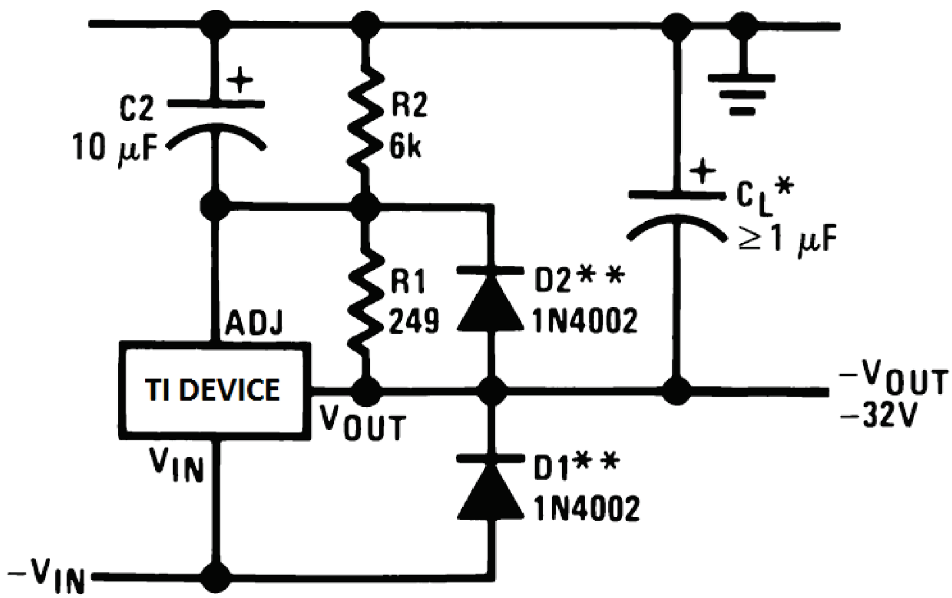
7.4 Device Functional Modes

7.4.1 Protection Diodes

When external capacitors are used with any IC regulator, it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator. Most 10-μF capacitors have low enough internal series resistance to deliver 20-A spikes when shorted. Although the surge is short, there is enough energy to damage parts of the IC.

When an output capacitor is connected to a negative output regulator and the input is shorted, the output capacitor pulls current out of the output of the regulator. The current depends on the value of the capacitor, the output voltage of the regulator, and the rate at which V_{IN} is shorted to ground.

The bypass capacitor on the adjustment terminal can discharge through a low current junction. Discharge occurs when either the input, or the output, is shorted. Figure 13 shows the placement of the protection diodes.



*When C_L is larger than 20 μF, D1 protects the LM1337-N-MIL in case the input supply is shorted
**When C2 is larger than 10 μF and $-V_{OUT}$ is larger than −25V, D2 protects the LM1337-N-MIL in case the output is shorted

Figure 13. Regulator With Protection Diodes

8 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

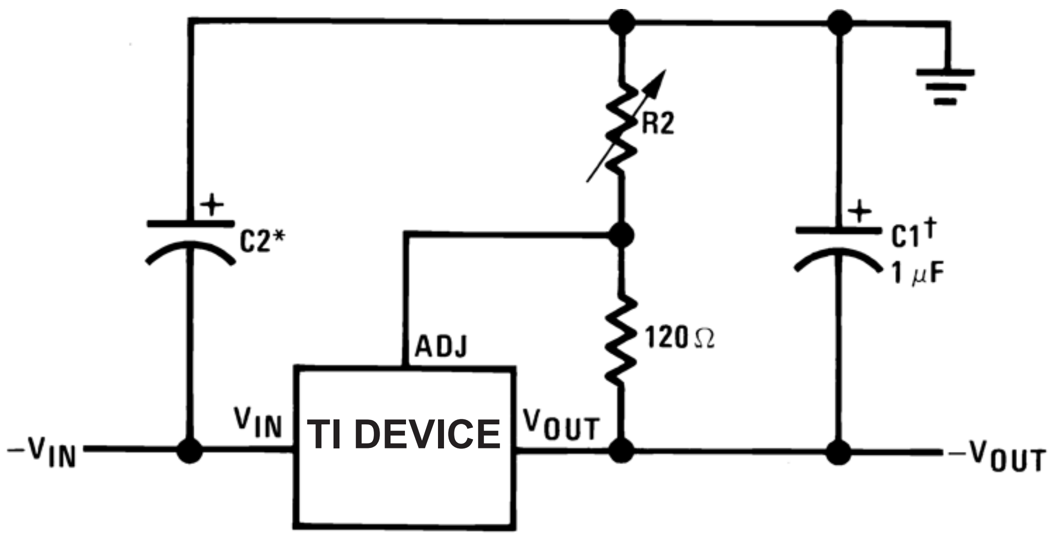
8.1 Application Information

The LM337-N-MIL is a versatile, high performance, negative output linear regulator with high accuracy and a wide temperature range. An output capacitor can be added to further improve transient response, and the ADJ pin can be bypassed to achieve very high ripple-rejection ratios. The functionality of the device can be utilized in many different applications that require negative voltage supplies, such as bipolar amplifiers, operational amplifiers, and constant current regulators.

8.2 Typical Applications

8.2.1 Adjustable Negative Voltage Regulator

The LM337-N-MIL can be used as a simple, negative output regulator to enable a variety of output voltages needed for demanding applications. By using an adjustable R2 resistor, a variety of negative output voltages can be made possible as shown in Figure 14.



Full output current not available at high input-output voltages
†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 inches 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 14. Adjustable Negative Voltage Regulator

$$-V_{OUT} = -1.25V\left(1+\frac{R2}{120}\right)+\left(-I_{ADJ}\times R2\right) \quad (2)$$

8.2.1.1 Design Requirements

The device component count is very minimal, employing two resistors as part of a voltage divider circuit and an output capacitor for load regulation. An input capacitor is needed if the device is more than 4 inches from the filter capacitors.

Typical Applications (continued)

8.2.1.2 Detailed Design Procedure

The output voltage is set based on the selection of the two resistors, R1 and R2, as shown in Figure 14.

8.2.1.3 Application Curve

As shown in Figure 15, the maximum output current capability is limited by the input-output voltage differential, package type, and junction temperature.

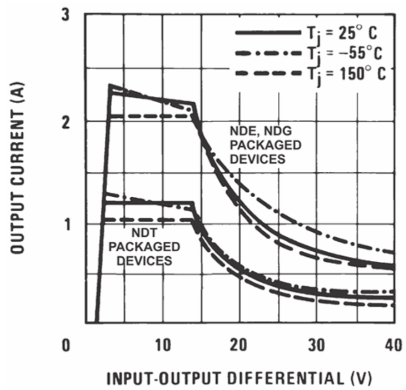
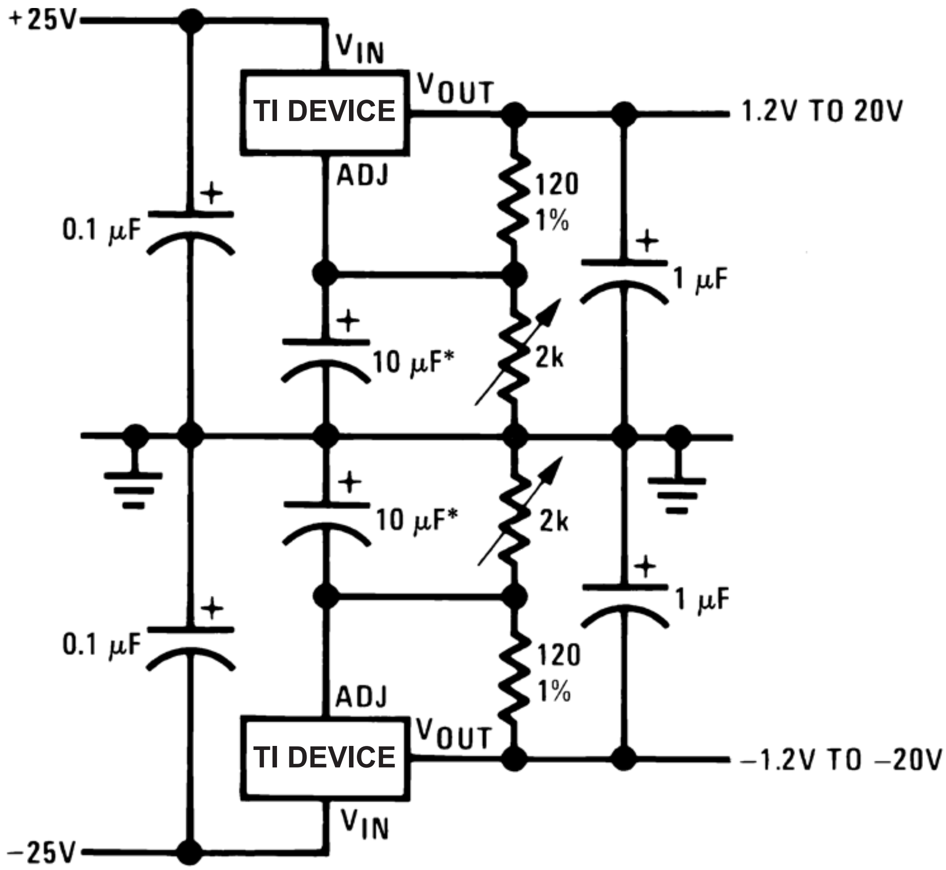


Figure 15. Current Limit

8.2.2 Adjustable Lab Voltage Regulator

The LM337-N-MIL can be combined with a positive regulator such as the LM317-N to provide both a positive and negative voltage rail. This can be useful in applications that use bi-directional amplifiers and dual-supply operational amplifiers.

Typical Applications (continued)

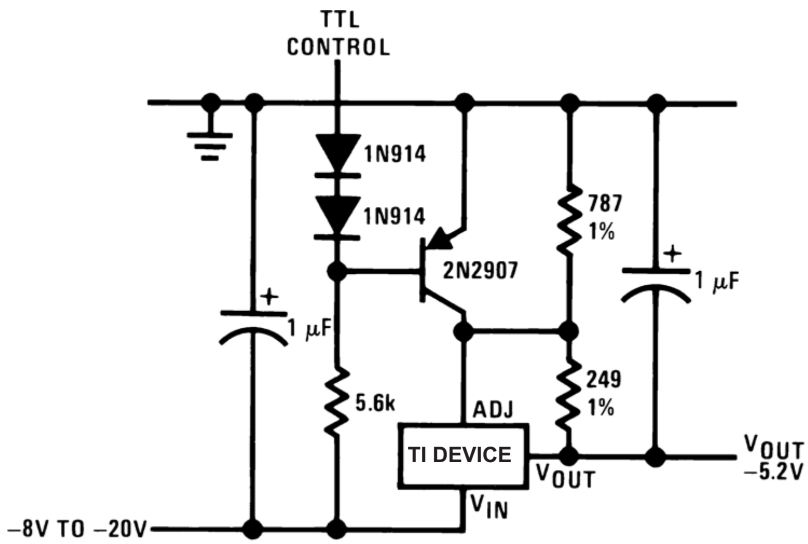


Full output current not available at high input-output voltages
*The 10 µF capacitors are optional to improve ripple rejection

8.2.3 −5.2-V Regulator with Electronic Shutdown

The LM337-N-MIL can be used with a PNP transistor to provide shutdown control from a TTL control signal. The PNP can short or open the ADJ pin to GND. When ADJ is shorted to GND by the PNP, the output is −1.3 V. When ADJ is disconnected from GND by the PNP, then the LM337-N-MIL outputs the programmed output of −5.2 V.

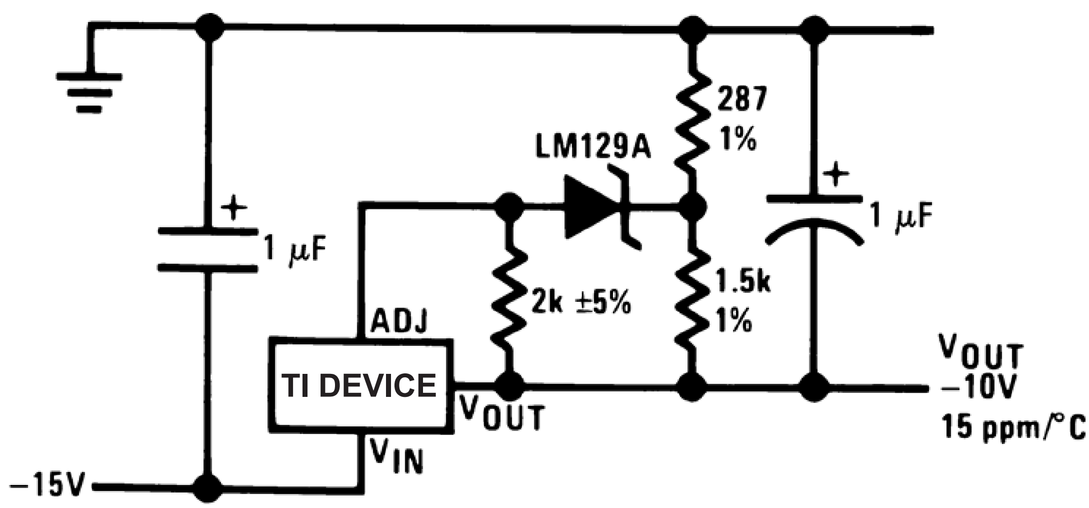
Typical Applications (continued)



Minimum output ≃ −1.3 V when control input is low

8.2.4 High Stability −10-V Regulator

Using a high stability shunt voltage reference in the feedback path, such as the LM329, provides damping necessary for a stable, low noise output.



9 Power Supply Recommendations

The input supply to the LM337-N must be kept at a voltage level such that the maximum input to output differential voltage rating is not exceeded. The minimum dropout voltage must also be met with extra headroom when possible to keep the LM337-N-MIL in regulation. TI recommends an input capacitor, especially when the input pin is placed more than 4 inches away from the power-supply filter capacitor.

10 Layout

10.1 Layout Guidelines

Some layout guidelines must be followed to ensure proper regulation of the output voltage with minimum noise. Traces carrying the load current must be wide to reduce the amount of parasitic trace inductance and the feedback loop from V_{OUT} to ADJ must be kept as short as possible. To improve PSRR, a bypass capacitor can be placed at the ADJ pin and must be placed as close as possible to the IC. In cases when V_{IN} shorts to ground, an external diode must be placed from V_{IN} to V_{OUT} to divert the surge current into the output capacitor and protect the IC. Similarly, in cases when a large bypass capacitor is placed at the ADJ pin and V_{OUT} shorts to ground, an external diode must be placed from V_{OUT} to ADJ to provide a path for the bypass capacitor to discharge. These diodes must be placed close to the corresponding IC pins to increase their effectiveness.

10.2 Layout Example

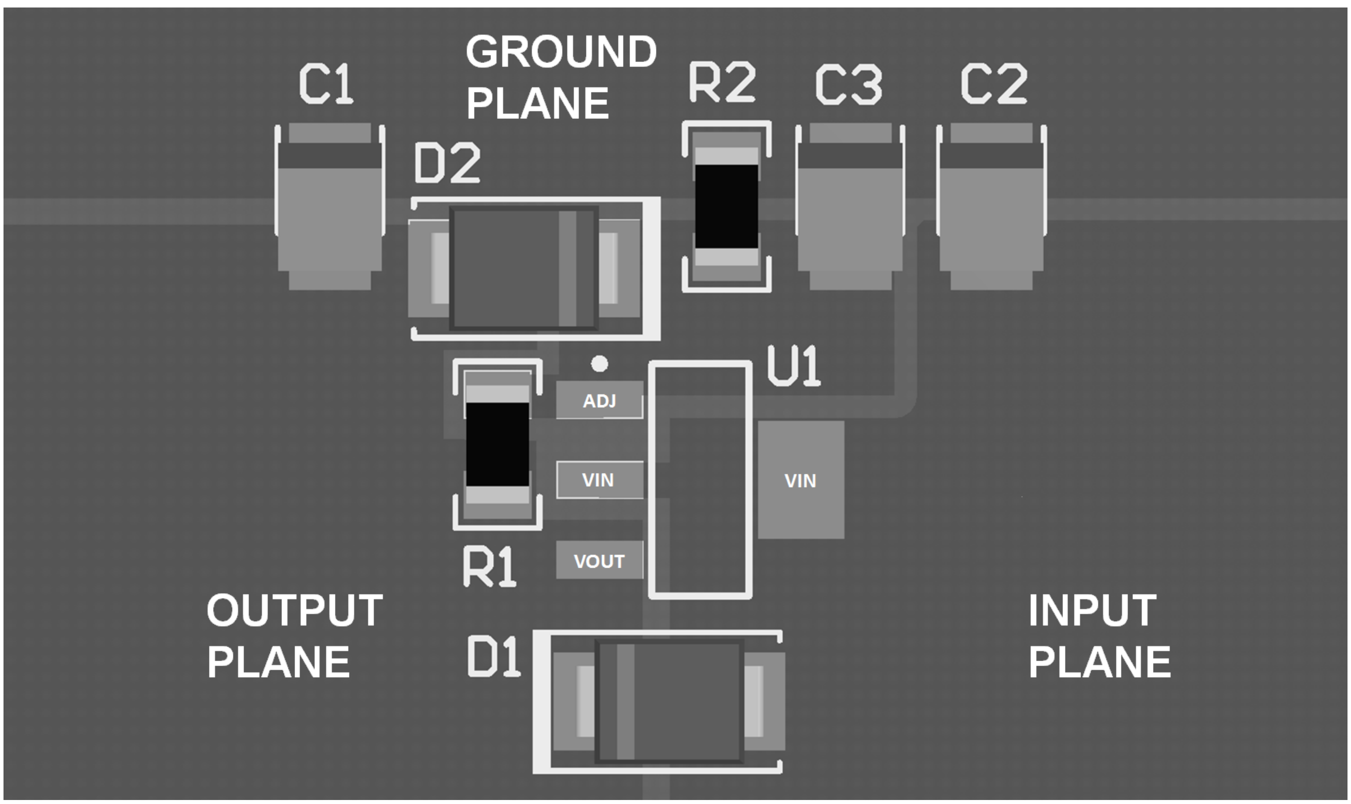


Figure 16. Layout Example (SOT-223)

10.3 Thermal Considerations

10.3.1 Heatsinking SOT-223 Package Parts

The SOT-223 DCY packages use a copper plane on the PCB and the PCB itself as a heatsink. To optimize the heat sinking ability of the plane and PCB, solder the tab of the package to the plane.

Figure 17 and Figure 18 show the information for the SOT-223 package. Figure 18 assumes a $\theta_{(J-A)}$ of 75°C/W for 1 ounce copper and 51°C/W for 2 ounce copper and a maximum junction temperature of 125°C.

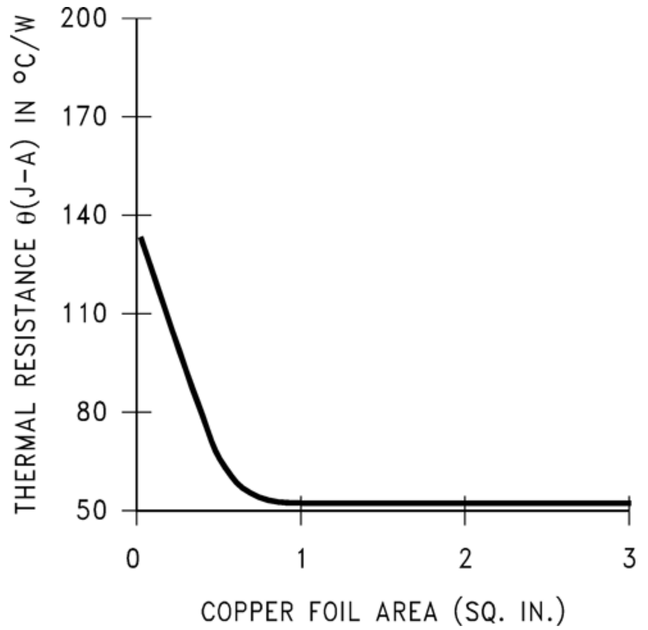


Figure 17. $\theta_{(J-A)}$ vs Copper (2 ounce) Area for the SOT-223 Package

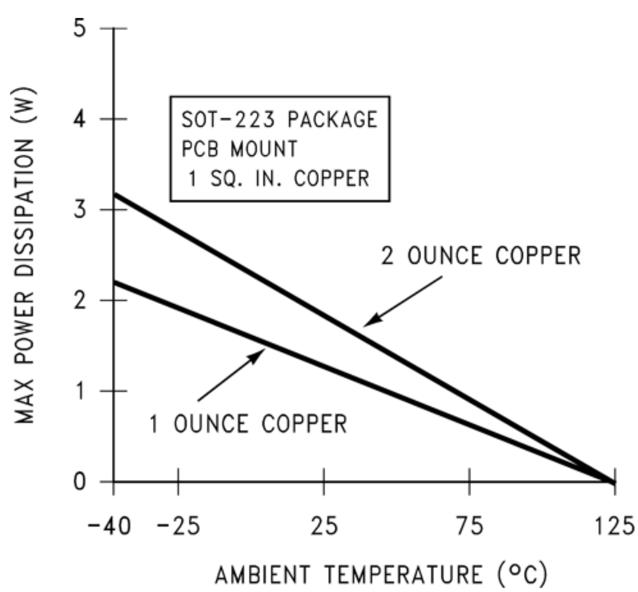


Figure 18. Maximum Power Dissipation vs T_{AMB} for the SOT-223 Package

See AN-1028, SNVA036, for power enhancement techniques to be used with the SOT-223 package.

11 器件和文档支持

11.1 文档支持

11.1.1 相关文档

请参阅如下相关文档：

AN-1028、SNVA036

11.2 社区资源

下列链接提供到 TI 社区资源的连接。链接的内容由各个分销商“按照原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的 《使用条款》。

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设计支持 ***TI 参考设计支持*** 可帮助您快速查找有帮助的 E2E 论坛、设计支持工具以及技术支持的联系信息。

11.3 商标

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

11.4 静电放电警告

这些装置包含有限的内置 ESD 保护。 存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

11.5 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

12 机械、封装和可订购信息

以下页面包括机械、封装和可订购信息。这些信息是指定器件的最新可用数据。这些数据发生变化时，我们可能不会另行通知或修订此文档。如欲获取此产品说明书的浏览器版本，请参阅左侧的导航栏。

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM337H	ACTIVE	TO	NDT	3	500	RoHS & Green	AU	Level-1-NA-UNLIM	0 to 0	(LM337H, LM337H)	Samples
LM337H/NOPB	ACTIVE	TO	NDT	3	500	RoHS & Green	AU	Level-1-NA-UNLIM	0 to 0	(LM337H, LM337H)	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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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 finish/Ball material - Orderable Devices 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.

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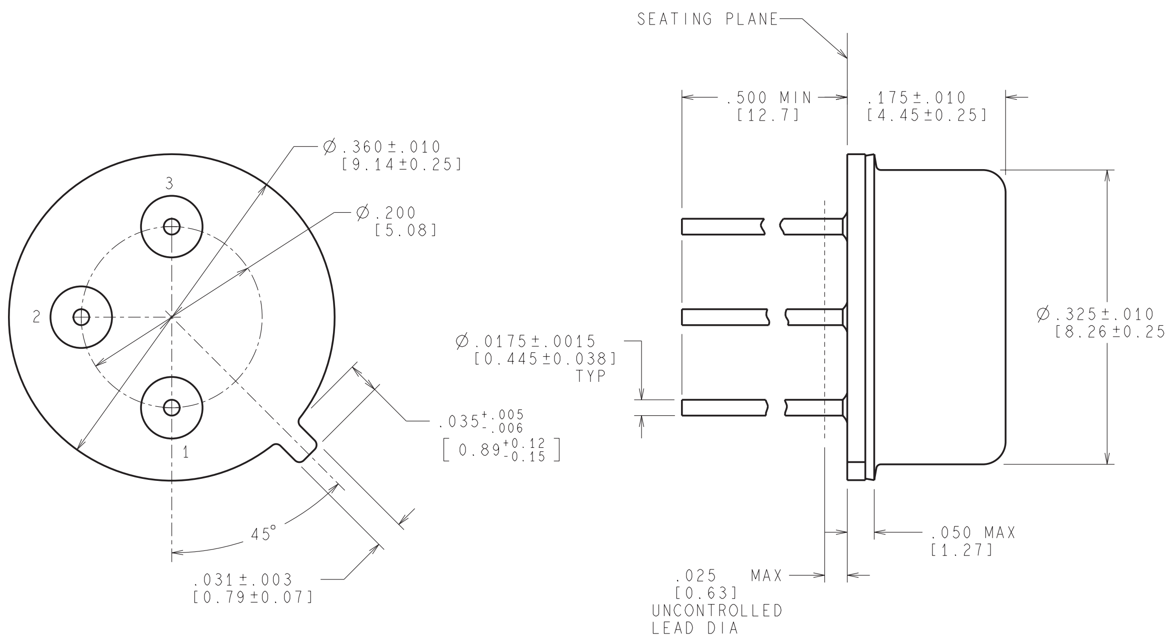
NDT0003A



CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

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CONFIGURATION CONTROL

H03A (Rev D)

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