TEXAS INSTRUMENTS

LM337-N-MIL
JAJSDG3 – JUNE 2017

LM337-N 負電圧可変型3端子レギュレータ

1 特長

- 1.5Aの出力電流
- ライン・レギュレーション0.01%/V (標準値)
- 負荷レギュレーション0.3% (標準値)
- 77dBのリップル除去
- 50ppm/℃の温度ドリフト係数
- 過熱保護機能
- 内部的な短絡電流制限保護

2 アプリケーション

- 産業用電源
- ファクトリ・オートメーション・システム
- ビル・オートメーション・システム
- PLCシステム
- 計測機器
- IGBTドライブの負のゲート電源
- ネットワーキング
- セットトップ·ボックス

3 概要

LM337-N-MILは3端子の負電圧レギュレータであり、-1.25V～-37Vの出力電圧範囲で、-1.5A以上の電流を供給できます。2つの外付け抵抗だけで出力電圧を、1つの出力コンデンサだけで周波数補償を設定できます。優れたレギュレーションを維持し、熱的な過渡変動を低減するよう、回路設計が最適化されています。さらに、LM337-N-MILは内部的な電流制限、サーマル・シャットダウン、安全領域補償を搭載しており、過負荷によるブローアウトは事実上発生しません。

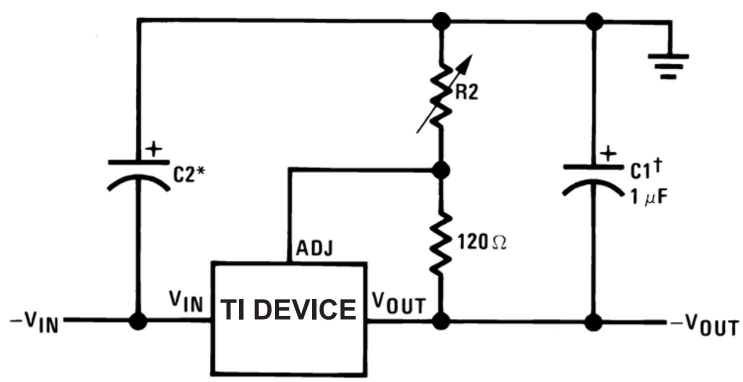
LM337-N-MILは、可変正電圧レギュレータのLM117およびLM317を補完するために最適な製品です。

製品情報(1)

型番	パッケージ	本体サイズ(公称)
LM337-N-MIL	SOT-223 (4)	3.50mm×6.50mm
	TO (3)	8.255mm×8.255mm
	TO-220 (3)	10.16mm×14.986mm

(1) 利用可能なすべてのパッケージについては、このデータシートの末尾にある注文情報を参照してください。LF01は、TO-220パッケージのリード形成(ベント)バージョンです。

可変負電圧レギュレータ



入力/出力電圧が高い場合は最大の出力電流を利用できません

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

†C1 = 安定のため1µFの固形タンタルまたは10µFのアルミ電解コンデンサが必要です

*C2 = レギュレータがフィルタ·コンデンサから4"以上離れている場合のみ、1µFの固形タンタル·コンデンサが必要です

出力インピーダンスと過渡抑制を改善するため、出力コンデンサとして1µF～1000µFの範囲のアルミまたはタンタル電解コンデンサが一般に使用されます

English Data Sheet: SNVSAX3

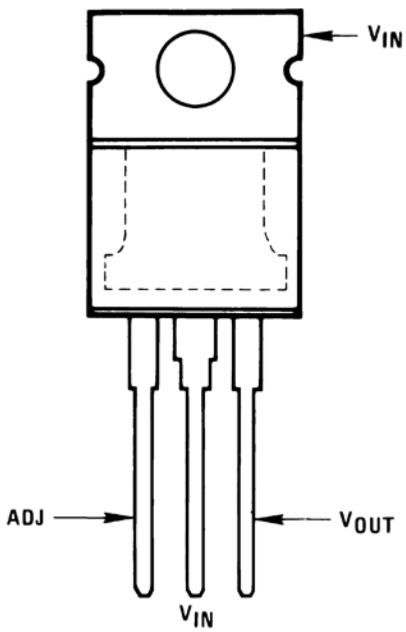
目次

4 改訂履歴

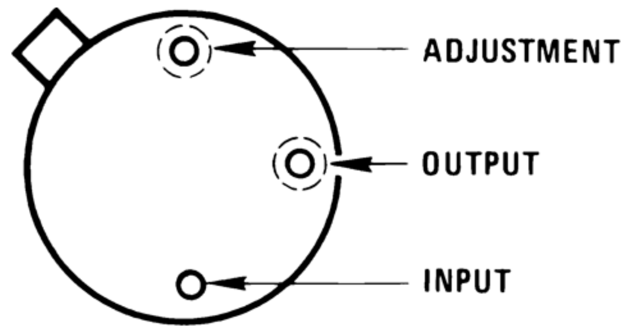
日付	改訂内容	注
2017年6月	*	初版

5 Pin Configuration and Functions

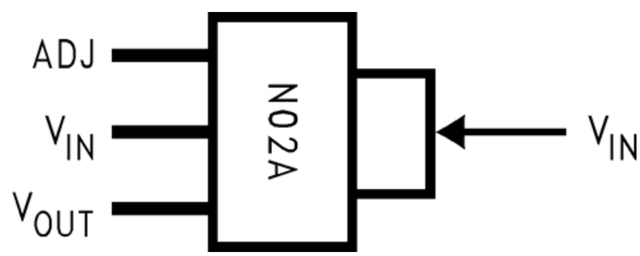
TO-220 Plastic Package
Package Number NDE0003B
Front View



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
	3 V ≤ $\|V_{IN} - V_{OUT}\|$ ≤ 40 V, (2) 10 mA ≤ I_{OUT} ≤ I_{MAX}, P ≤ P_{MAX}; −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
	$\|V_{IN} - V_{OUT}\|$ ≤ 15 V; 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
	$\|V_{IN} - V_{OUT}\|$ = 40 V, T_J = 25°C; 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)

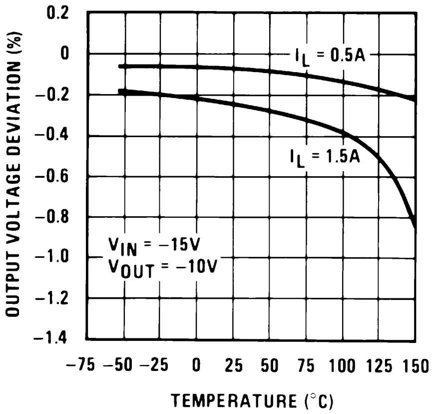


Figure 1. Load Regulation

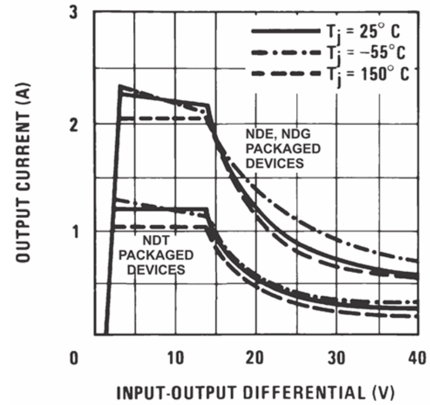


Figure 2. Current Limit

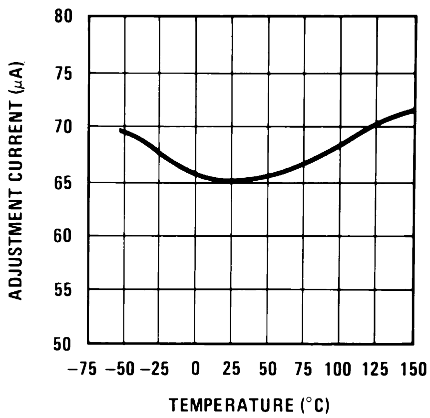


Figure 3. Adjustment Current

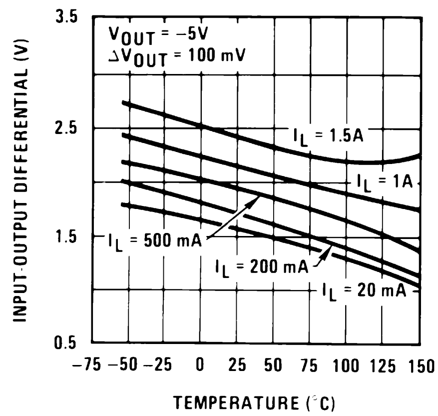


Figure 4. Dropout Voltage

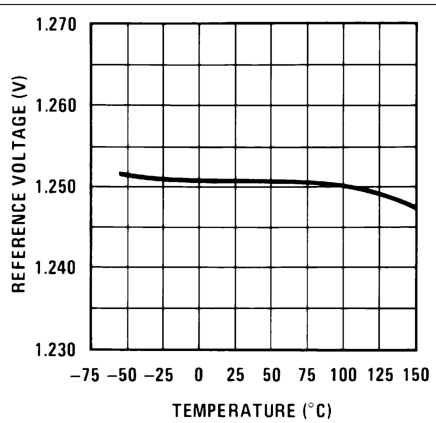


Figure 5. Temperature Stability

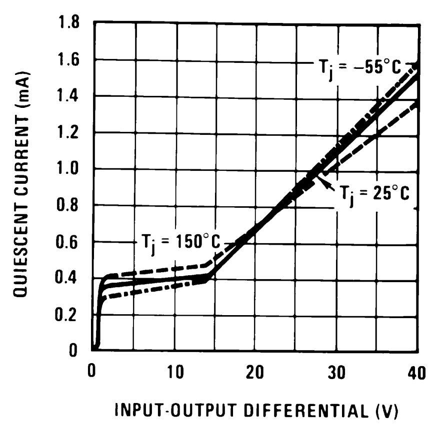


Figure 6. Minimum Operating Current

Typical Characteristics (continued)

(NDE Package)

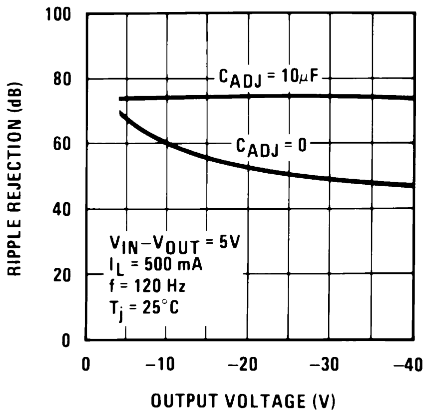


Figure 7. Ripple Rejection

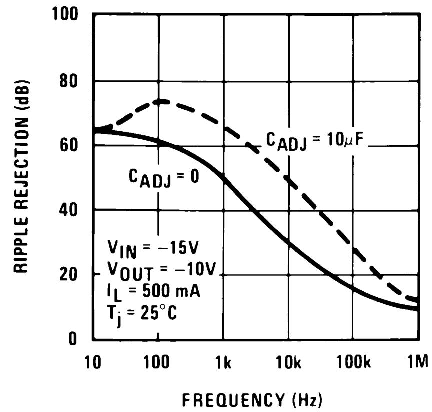


Figure 8. Ripple Rejection

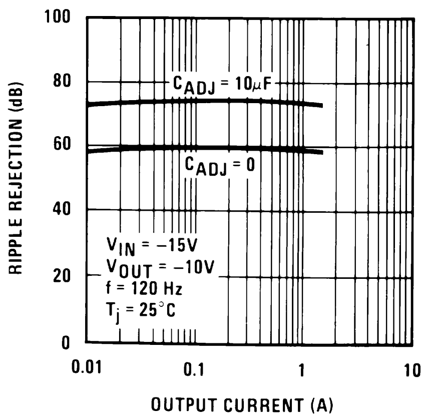


Figure 9. Ripple Rejection

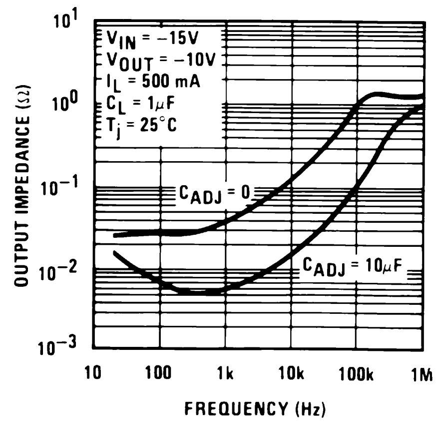


Figure 10. Output Impedance

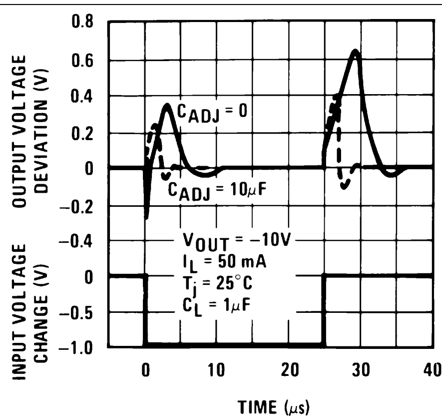


Figure 11. Line Transient Response

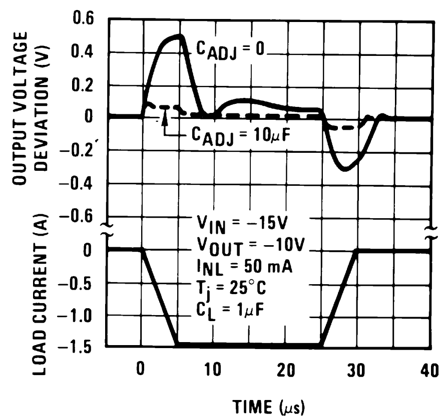


Figure 12. Load Transient Response

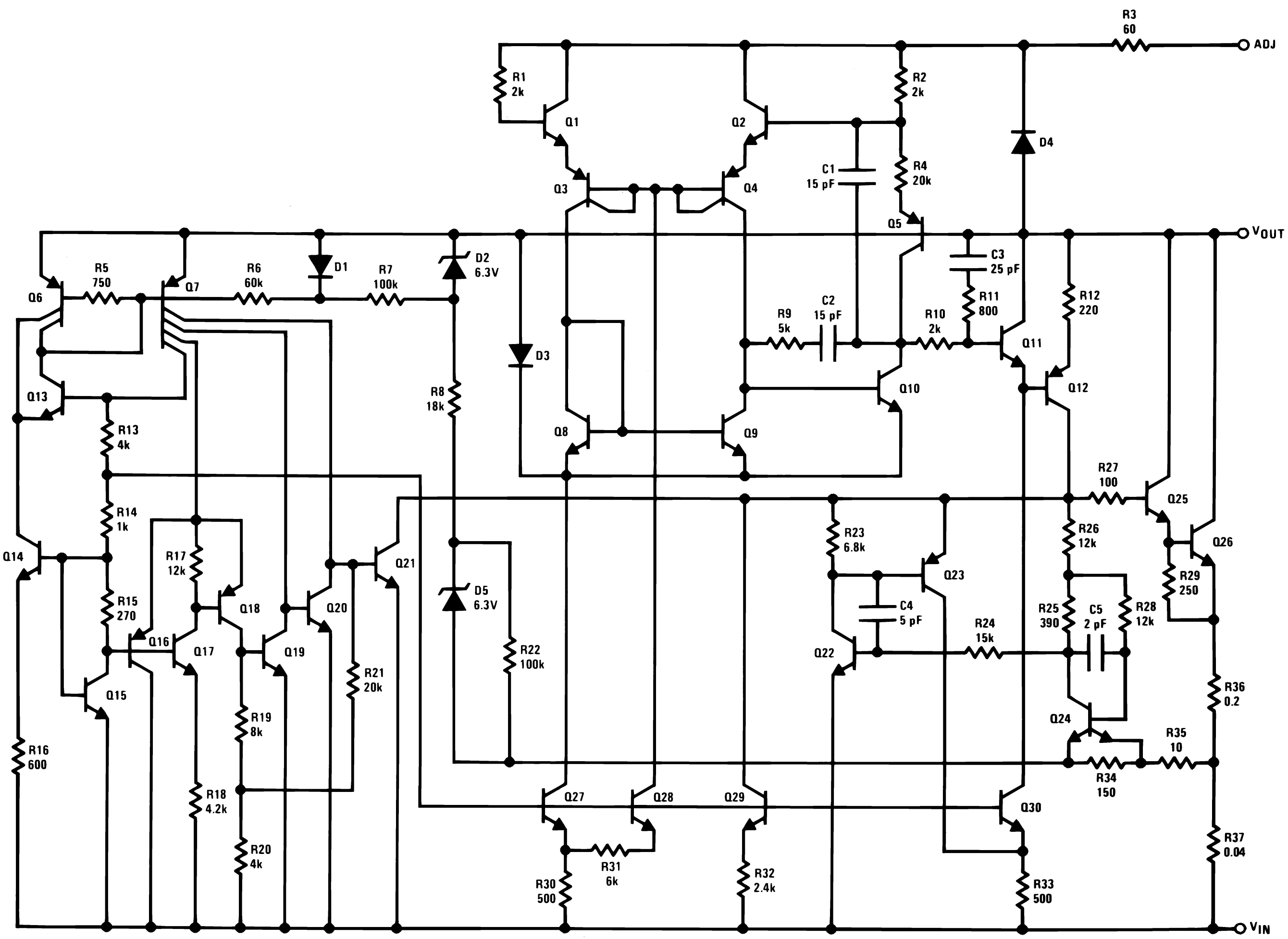
7 Detailed Description

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.

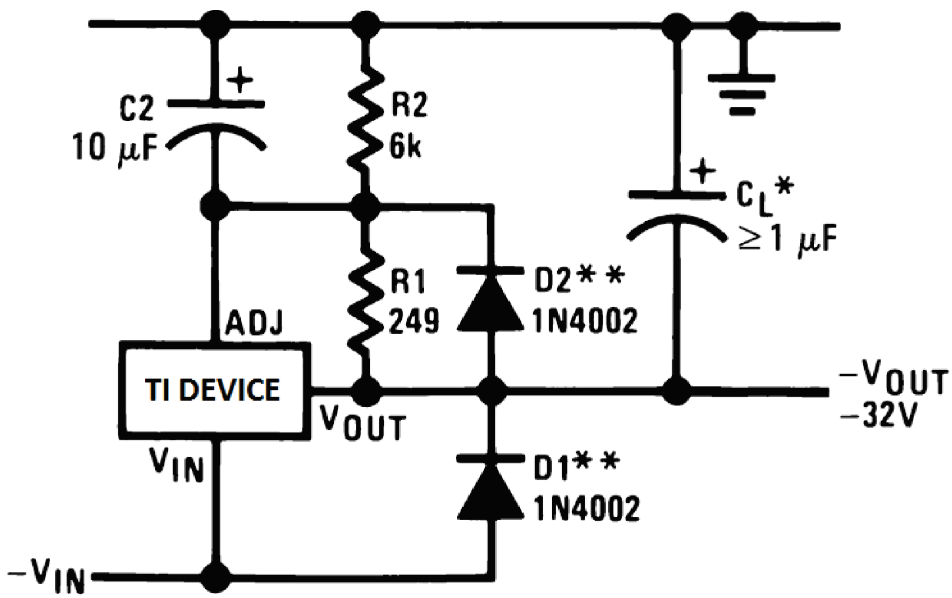
7.4 Device Functional Modes

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.

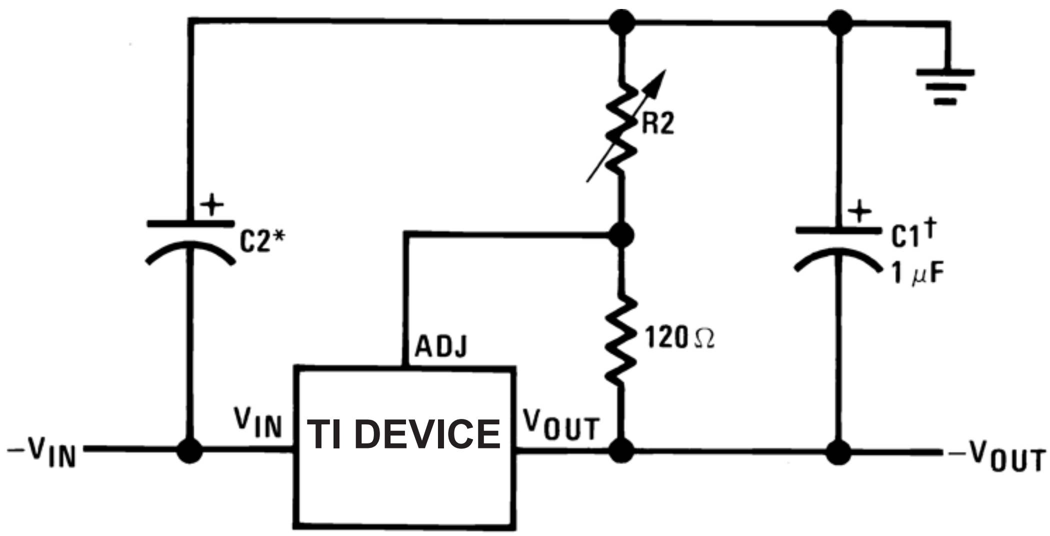
8.1 Application Information

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

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

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.

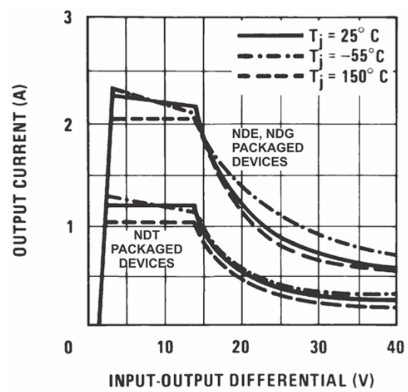
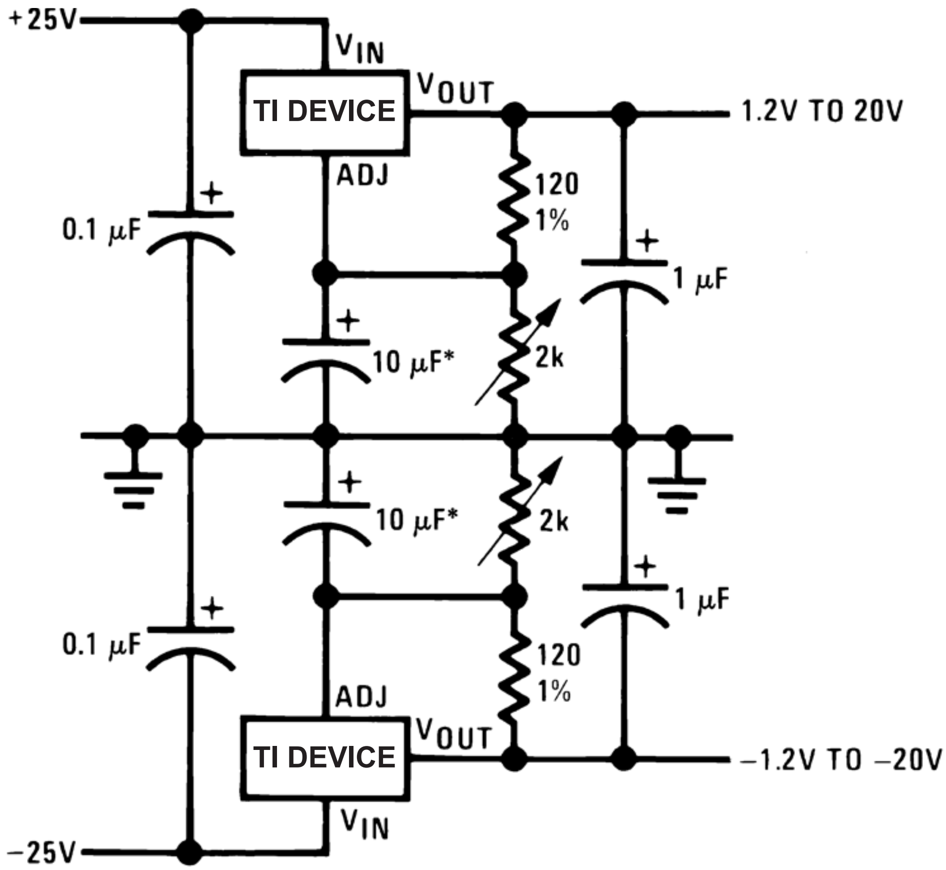


Figure 15. Current Limit

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)

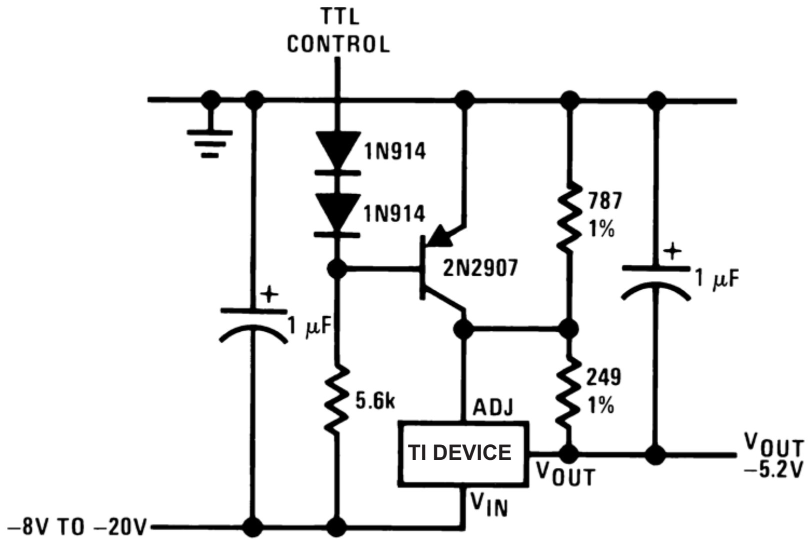


Full output current not available at high input-output voltages
*The 10 µF capacitors are optional to improve ripple rejection

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.

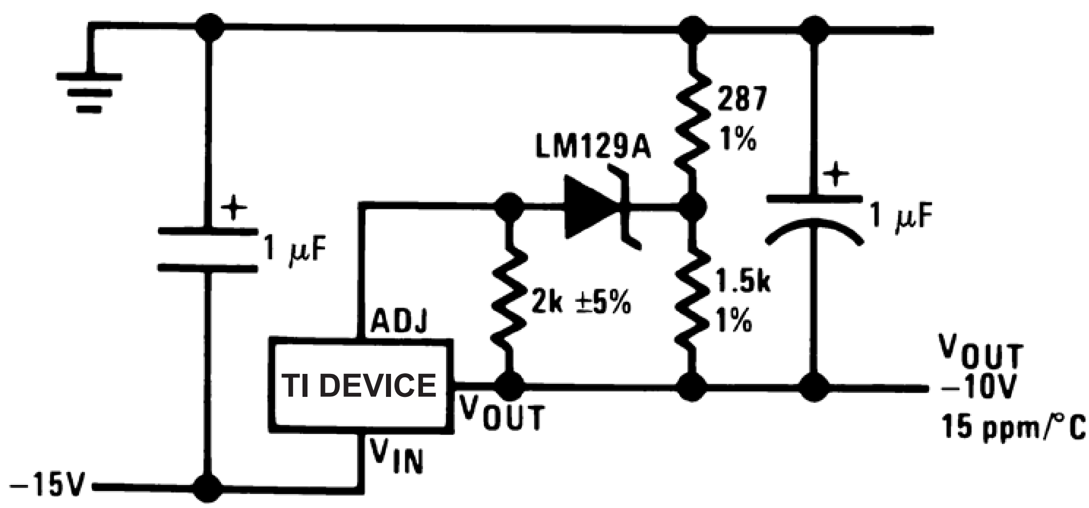
Typical Applications (continued)



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

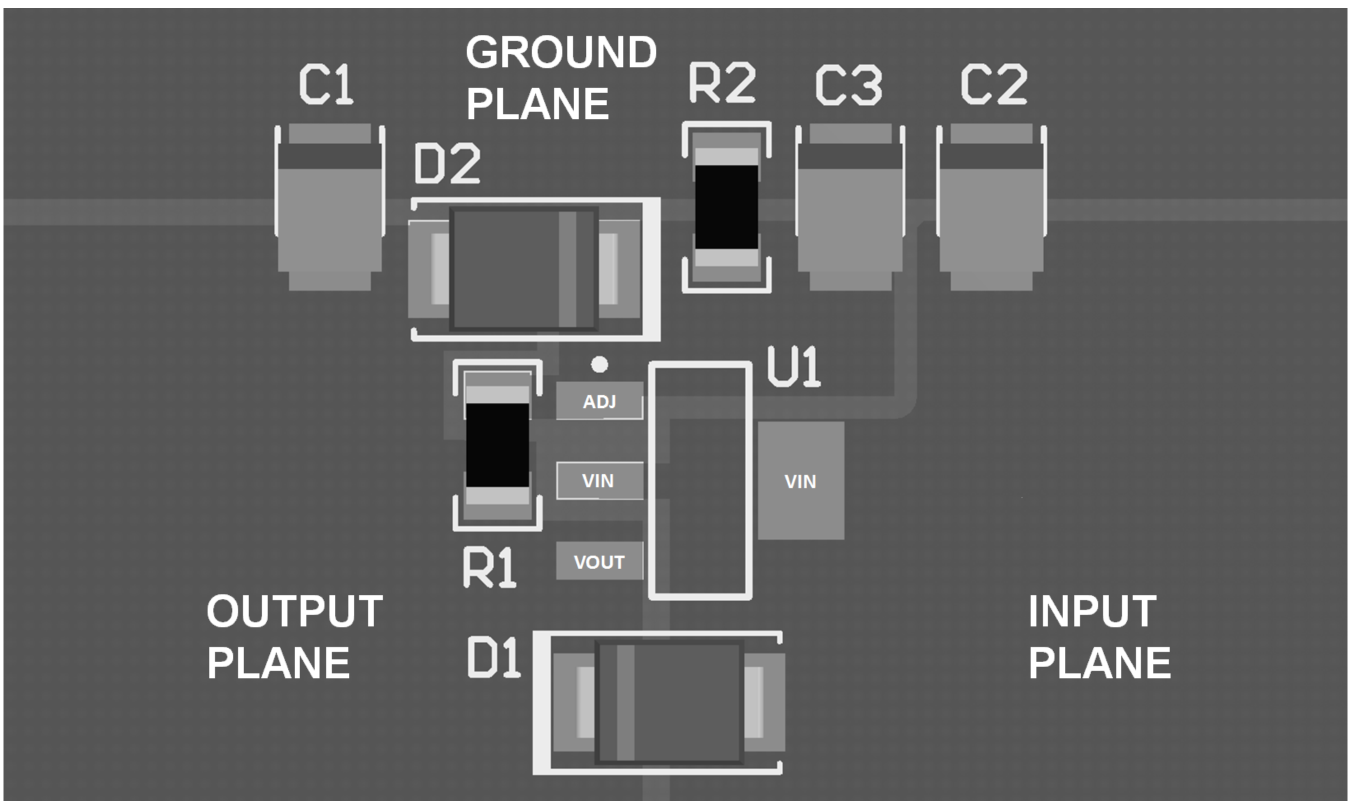


Figure 16. Layout Example (SOT-223)

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.

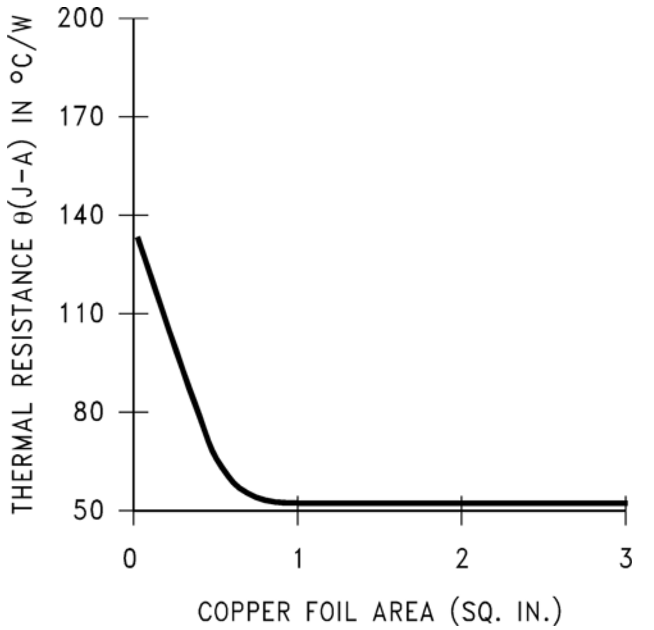


Figure 17. $\theta_{(J-A)}$ vs Copper (2 ounce) Area for the SOT-223 Package

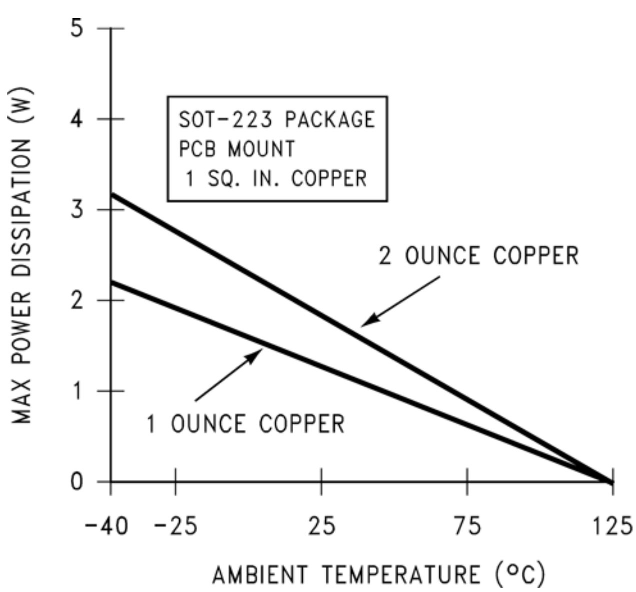


Figure 18. Maximum Power Dissipation vs T_{AMB} for the SOT-223 Package

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

11 デバイスおよびドキュメントのサポート

11.1 ドキュメントのサポート

11.1.1 関連資料

関連資料については、以下を参照してください。

AN-1028、SNVA036

11.2 コミュニティ・リソース

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11.4 静電気放電に関する注意事項

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11.5 Glossary

SLYZ022 — *TI Glossary*.

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

12 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。

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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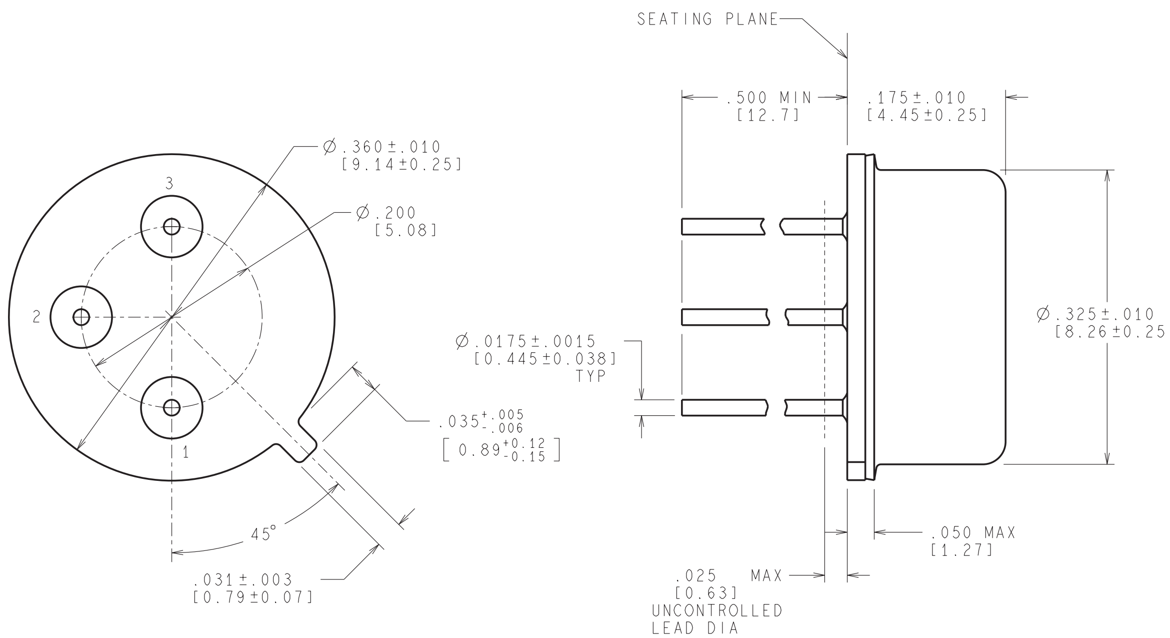
NDT0003A



CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

MIL-PRF-38535
CONFIGURATION CONTROL

H03A (Rev D)

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