LM338-MIL 5A 可调节稳压器

1 特性

- 额定峰值输出电流为 7A
- 额定输出电流为 5A
- 低至 1.2V 的可调节输出
- 额定热调节
- 电流限制在各种温度下保持恒定
- 已通过 P^+ 产品增强性能测试
- 输出具有短路保护

2 应用

- 可调节电源
- 恒定电流稳压器
- 电池充电器

3 说明

LM338-MIL 系列可调节 3 端子正电压稳压器能够在 1.2V 至 32V 输出范围内提供超过 5A 的电流。它们极易使用，并且仅需要 2 个电阻器即可设置输出电压。电路设计精心细致，可实现出色的负载和线路调节，并且可与许多商用电源相媲美。LM338-MIL 系列采用标准的 3 引线晶体管封装。

LM338-MIL 系列具有随时间而变化的电流限制这一独特特性。电流限制电路支持稳压器在较短的时间内消耗高达 12A 的峰值电流。这使得 LM338-MIL 能够在高瞬态负载下使用，并且可加快满载条件下的启动速度。在持续负载条件下，电流限制会降至安全的值，以保护稳压器。此外，芯片中还包含热过载保护和安全区域保护功能（针对功率晶体管）。即使调节 (ADJ) 引脚意外断开，过载保护功能仍然起作用。

通常不需要使用电容器，除非器件的位置距离输入滤波电容器超过 6 英寸，此时需要使用输入旁路。可以添加输出电容器以改善瞬态响应，而旁路掉调节引脚可提高稳压器的纹波抑制能力。

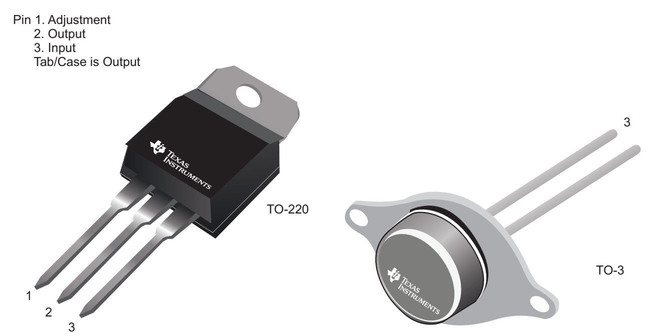
除了替代固定稳压器或分立式设计之外，LM338-MIL 也可应用于各种其他 应用。由于该稳压器是浮动的并且仅接收输入到输出差分电压，因此，只要不超过最大输入到输出差分电压，就可以对数百伏特的电源电压进行调节；请勿使输出对地短路。LM338-MIL 系列中具有 *K* 后缀的器件编号对应的器件采用钢 TO-CAN 封装，而具有 *T* 后缀的器件编号对应的器件采用 TO-220 塑料封装。LM338-MIL 的 T_J 额定范围为 –55°C 至 150°C，而 LM338-MIL 的 T_J 额定范围为 0°C 至 125°C。

器件信息(1)

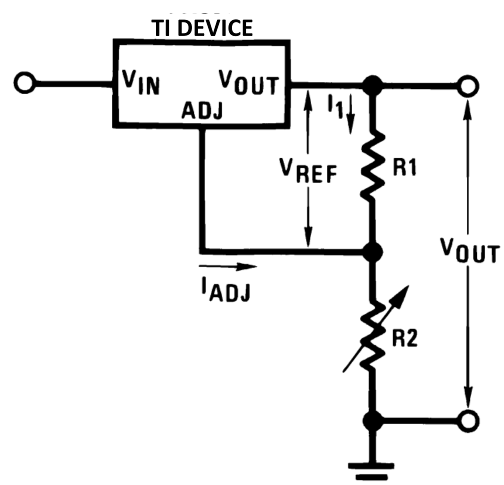
器件型号	封装	封装尺寸（标称值）
LM338-MIL	TO-220 (3)	10.16mm × 14.986mm
	TO-CAN (2)	25.40mm × 38.94mm

(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。

可用封装



典型应用电路



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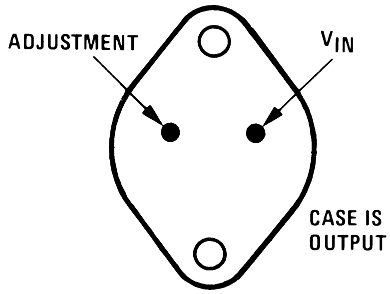
4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

日期	修订版本	注意
2017 年 6 月	*	初始发行版。

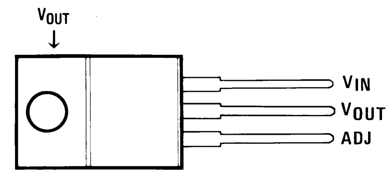
5 Pin Configuration and Functions

NDS Package
2-Pin TO-CAN
Bottom View



Package Number NDS0002A

NDE Package
3-Pin TO-220
Front View



Package Number NDE0003B

Pin Functions

PIN			I/O	DESCRIPTION
NAME	TO-220	TO-CAN		
ADJ	1	1	I	Output voltage adjustment pin. Connect to a resistor divider to set V_O
V_{IN}	3	2	I	Supply input pin
V_{OUT}	2	Case	O	Voltage output pin

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

		MIN	MAX	UNIT
Input and output voltage differential		–0.3	40	V
Power dissipation		Internally limited		
Lead temperature	TO-3 package (soldering, 10 s)		300	°C
	TO-220 package (soldering, 4 s)		260	
Operating temperature, T_J		0	125	°C
Storage temperature, T_{stg}		–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 Recommended Operating Conditions

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

	MIN	MAX	UNIT
Input-to-output voltage differential	3	40	V
Output current		5	A

6.3 Thermal Information

THERMAL METRIC(1)		LM338		UNIT
		NDE (TO-220)	NDS (TO-CAN)	
		3 PINS	2 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	22.9	35	°C/W

(1) For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report.

Thermal Information (continued)

THERMAL METRIC(1)		LM338		UNIT
		NDE (TO-220)	NDS (TO-CAN)	
		3 PINS	2 PINS	
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	15.7	1	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	4.1	—	°C/W
ψ_{JT}	Junction-to-top characterization parameter	2.1	—	°C/W
ψ_{JB}	Junction-to-board characterization parameter	4.1	—	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	0.7	—	°C/W

6.4 Electrical Characteristics

Values apply for T_J = 25°C; V_{IN} – V_{OUT} = 5 V; and I_{OUT} = 10 mA (unless otherwise noted).[1]

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{REF}	Reference voltage	3 V ≤ (V_{IN} – V_{OUT}) ≤ 35 V, 10 mA ≤ I_{OUT} ≤ 5 A, P ≤ 50 W, T_J = 0°C to 125°C		1.19	1.24	1.29	V
V_{RLINE}	Line regulation	3 V ≤ (V_{IN} – V_{OUT}) ≤ 35 V[2]	T_J = 25°C		0.005%	0.03%	V
			T_J = 0°C to 125°C		0.02%	0.06%	V
V_{RLOAD}	Load regulation	10 mA ≤ I_{OUT} ≤ 5 A[2]	T_J = 25°C		0.1	0.5	
			T_J = 0°C to 125°C		0.3	1	
	Thermal regulation	20-ms pulse			0.002%	0.02%	W
I_{ADJ}	Adjustment pin current	T_J = 0°C to 125°C			45	100	µA
ΔI_{ADJ}	Adjustment pin current change	10 mA ≤ I_{OUT} ≤ 5 A, 3 V ≤ (V_{IN} – V_{OUT}) ≤ 35 V, T_J = 0°C to 125°C			0.2	5	µA
$\Delta V_{R/T}$	Temperature stability	T_J = 0°C to 125°C			1		
$I_{LOAD(MIN)}$	Minimum load current	V_{IN} – V_{OUT} = 35 V, T_J = 0°C to 125°C			3.5	10	mA
I_{CL}	Current limit	V_{IN} – V_{OUT} ≤ 10 V					
		DC, T_J = 0°C to 125°C		5	8		A
		0.5-ms peak, T_J = 0°C to 125°C		7	12		A
		V_{IN} – V_{OUT} = 30 V				1	A
V_N	RMS output noise (percent of V_{OUT})	10 Hz ≤ f ≤ 10 kHz			0.003%		
$\Delta V_R/\Delta V_{IN}$	Ripple rejection ratio	V_{OUT} = 10 V, f = 120 Hz, C_{ADJ} = 0 µF, T_J = 0°C to 125°C			60		dB
		V_{OUT} = 10 V, f = 120 Hz, C_{ADJ} = 10 µF, T_J = 0°C to 125°C		60	75		dB
	Long-term stability	T_J = 125°C, 1000 Hrs			0.3%	1%	

(1) These specifications are applicable for power dissipations up to 50 W for the TO-3 (NDS) package and 25 W for the TO-220 (NDE) package. Power dissipation is specified at these values up to 15-V input-output differential. Above 15-V differential, power dissipation is limited by internal protection circuitry. All limits (that is, the numbers in the minimum and maximum columns) are specified to TI's AOQL (Average Outgoing Quality Level).

(2) Regulation is measured at a constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specifications for thermal regulation.

6.5 Typical Characteristics

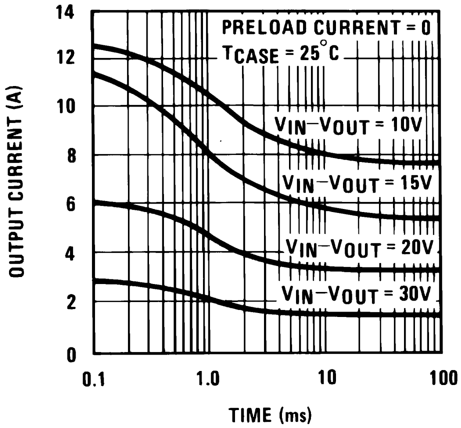


Figure 1. Current Limit

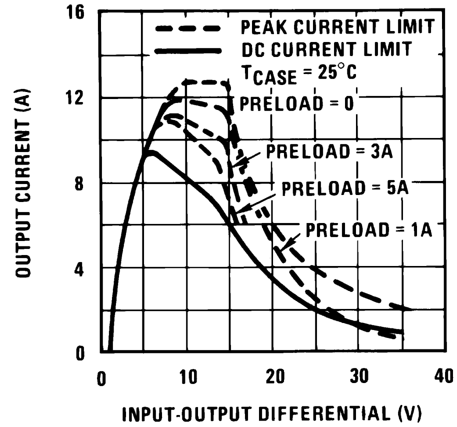


Figure 2. Current Limit

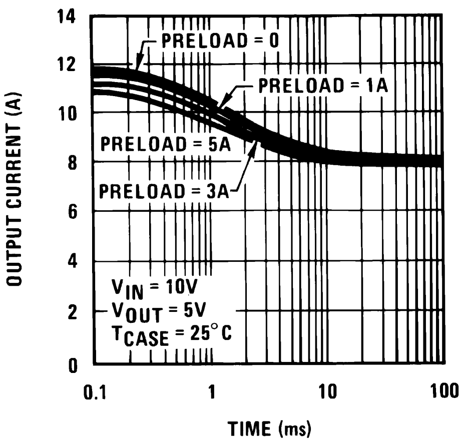


Figure 3. Current Limit

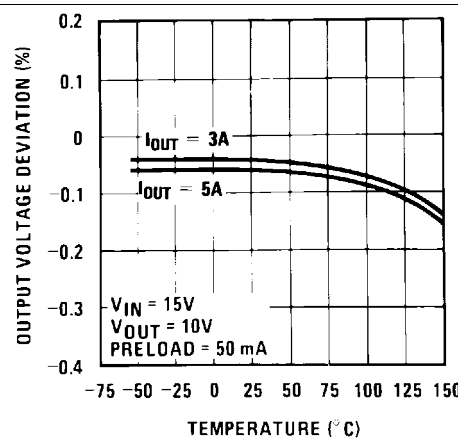


Figure 4. Load Regulation

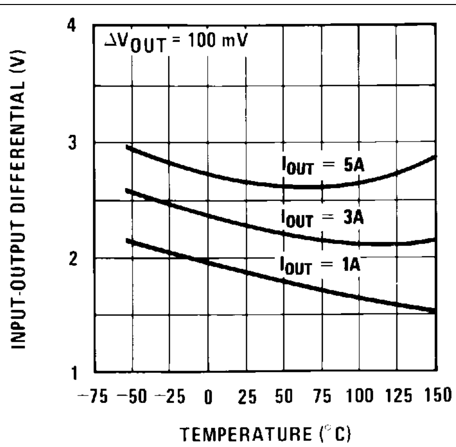


Figure 5. Dropout Voltage

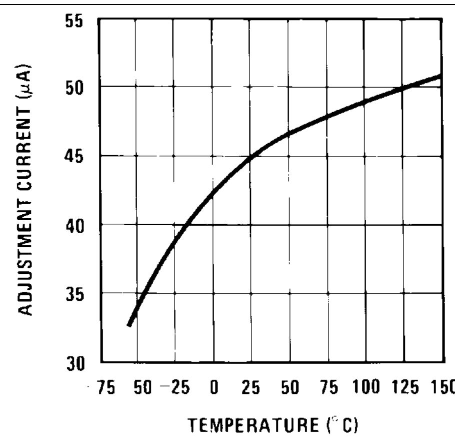


Figure 6. Adjustment Current

Typical Characteristics (continued)

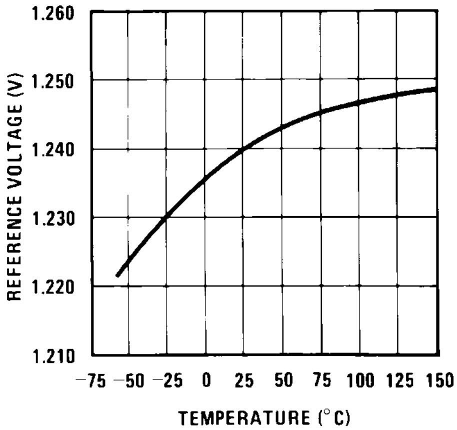


Figure 7. Temperature Stability

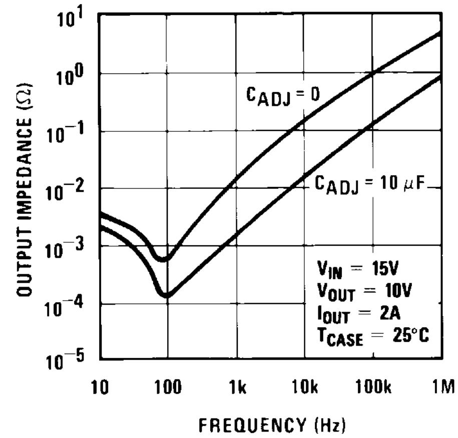


Figure 8. Output Impedance

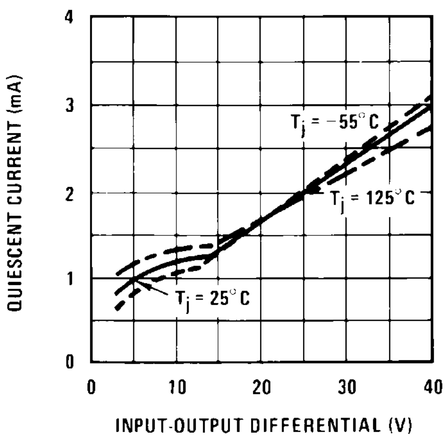


Figure 9. Minimum Operating Current

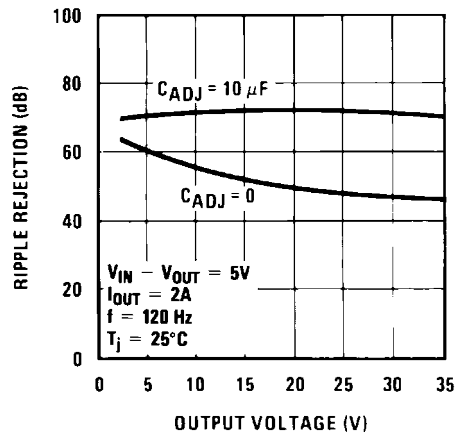


Figure 10. Ripple Rejection

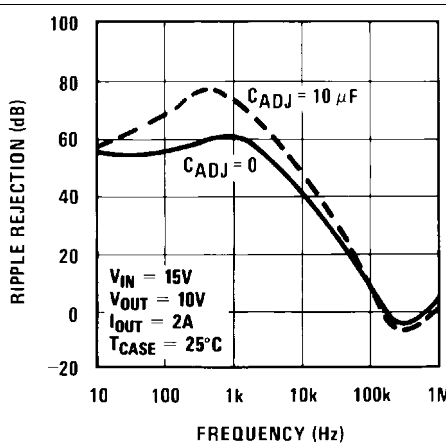


Figure 11. Ripple Rejection

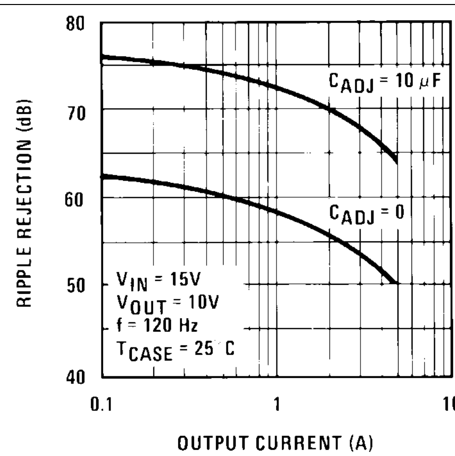


Figure 12. Ripple Rejection

Typical Characteristics (continued)

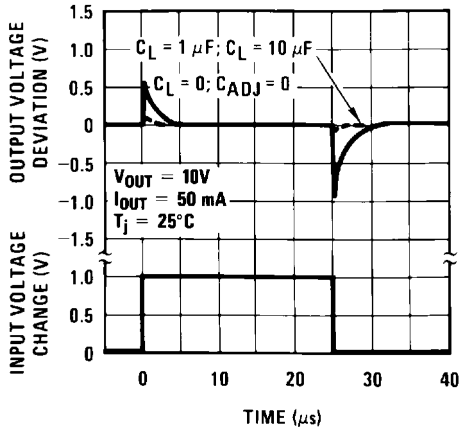


Figure 13. Line Transient Response

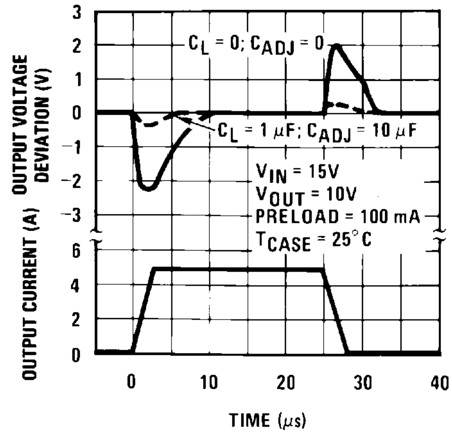


Figure 14. Load Transient Response

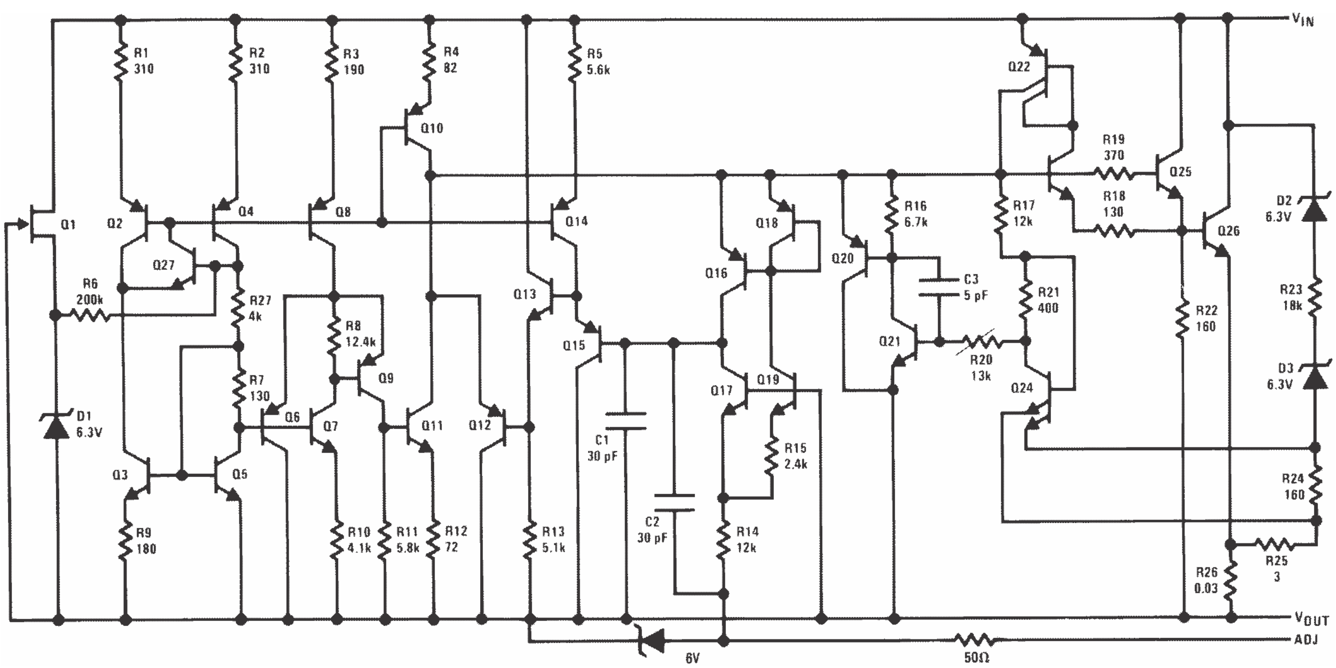
7 Detailed Description

7.1 Overview

The LM338 device is an adjustable, three-terminal, positive-voltage regulator capable of supplying more than 5 A over an output-voltage range of 1.2 V to 32 V. It requires only two external resistors to set the output voltage. The device feature a typical line regulation of 0.005% and typical load regulation of 0.1%. It includes time-dependent current limiting, thermal overload protection, and safe operating area protection. Overload protection remains functional even if the ADJUST terminal is disconnected.

The LM338 device is versatile in its applications, including uses in programmable output regulation and local on-card regulation. Or, by connecting a fixed resistor between the ADJUST and OUTPUT terminals, the LM338 device can function as a precision current regulators. An optional output capacitor can be added to improve transient response. The ADJUST terminal can be bypassed to achieve very high ripple-rejection ratios, which are difficult to achieve with standard three-terminal regulators.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 NPN Darlington Output Drive

NPN Darlington output topology provides naturally low output impedance and an output capacitor is optional. To support maximum current and lowest temperature, 3-V headroom is recommended (V_I – V_O).

7.3.2 Overload Block

Overcurrent and overtemperature shutdown protects the device against overload or damage from operating in excessive heat.

7.3.3 Programmable Feedback

Op amp with 1.25-V offset input at the ADJUST terminal provides easy output voltage or current (not both) programming. For current regulation applications, a single resistor whose resistance value is 1.25 V/IO and power rating is greater than 1.25 V^2/R must be used. For voltage regulation applications, two resistors set the output voltage.

7.4 Device Functional Modes

7.4.1 Normal Operation

The device OUTPUT pin sources current necessary to make OUTPUT pin 1.25 V greater than ADJUST terminal to provide output regulation.

7.4.2 Operation With Low Input Voltage

The device requires up to 3-V headroom (V_I – V_O) to operate in regulation. With less headroom, the device may drop out and OUTPUT voltage is INPUT voltage minus drop out voltage.

7.4.3 Operation at Light Loads

The device passes its bias current to the OUTPUT pin. The load or feedback must consume this minimum current for regulation or the output may be too high. A 250-Ω feedback resistor between OUTPUT and ADJUST consumes the worst case minimum load current of 5 mA.

7.4.4 Operation in Self Protection

When an overload occurs, the device shuts down Darlington NPN output stage or reduces the output current to prevent device damage. The device automatically resets from the overload. The output may be reduced or alternate between on and off until the overload is removed.

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

In operation, the LM338-MIL develops a nominal 1.25-V reference voltage (V_{REF}) between the output and adjustment terminal. The reference voltage is impressed across program resistor R_1 and, since the voltage is constant, a constant current I_1 then flows through the output set resistor R_2, giving an output voltage calculated with Equation 1.

$$V_{OUT} = V_{REF}\left(1+\frac{R2}{R2}\right)+I_{ADJ}R2 \quad (1)$$

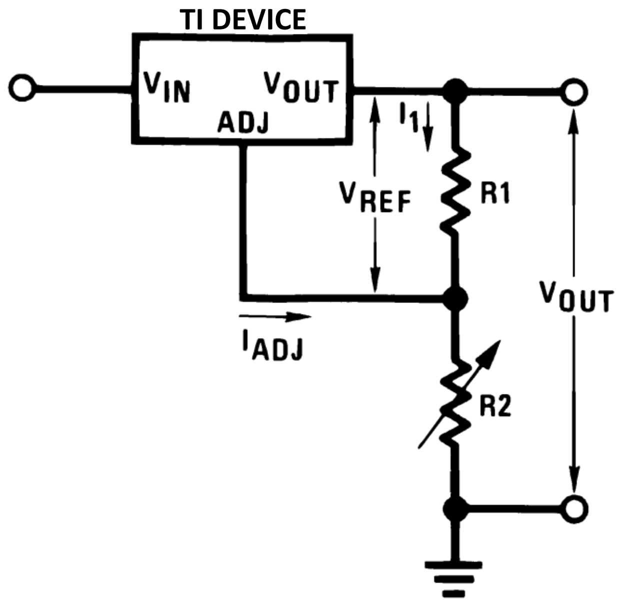


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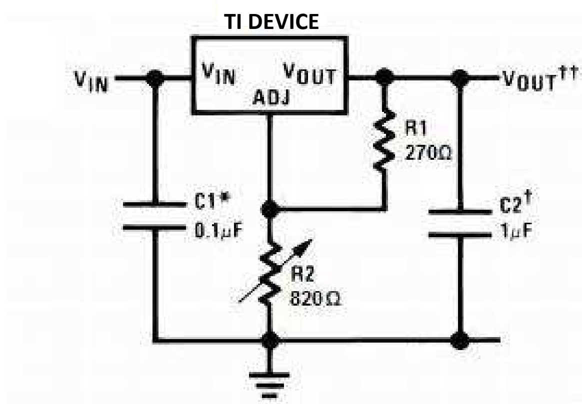
Figure 15. Typical Application Circuit

Because the 50-µA current from the adjustment terminal represents an error term, the LM338-MIL was designed to minimize I_{ADJ} and make it very constant with line and load changes. To do this, all quiescent operating current is returned to the output establishing a minimum load current requirement. If there is insufficient load on the output, the output rises.

8.2 Typical Applications

8.2.1 Constant 5-V Regulator



*Needed if device is more than 6 inches from filter capacitors.

†Optional—improves transient response

†† $V_{OUT} = 1.25\ V\left(1+\frac{R2}{R1}\right)+I_{ADJ}\left(R_2\right)$

Figure 16. Constant 5-V Regulator

8.2.1.1 Design Requirements

R1: Because the LM338-MIL produces a typical 1.24 V potential between the OUTPUT and ADJUST pins, placing a 270-Ω resistor between them causes 4.6 mA to flow through R1 and R2.

R2: To achieve a 5-V output, the sum of the voltages across R1 and R2 must equal 5 V. Therefore, Vr2 must equal 3.76 V when 4.6 mA is flowing through it. R2 = Vr2 / I = 3.76 V / 4.6 mA = ~820 Ω.

C_{IN}: 0.1 µF of input capacitance helps filter out unwanted noise, especially if the regulator is located far from the power supply filter capacitors.

C_{OUT}: The regulator is stable without any output capacitance, but adding a 1-µF capacitor improves the transient response.

C_{ADJ}: A 10-µF capacitor bypassing the ADJUST pin to ground improves the regulators ripple rejection.

D1: Protection diode D1 is recommended if C_{OUT} is used. The diode provides a low-impedance discharge path to prevent the capacitor from discharging into the output of the regulator (see *Protection Diodes*).

D2: Protection diode D2 is recommended if C_{ADJ} is used. The diode provides a low-impedance discharge path to prevent the capacitor from discharging into the output of the regulator (see *Protection Diodes*).

Table 1 lists the design parameters for this typical application.

Table 1. Design Parameters

PARAMETER	VALUE
Feedback resistor 1 (R1)	270 Ω
Feedback resistor 2 (R2)	820 Ω
Input capacitor (C_{IN})	0.1 µF
Output capacitor (C_{OUT})	1 µF
Adjust capacitor(C_{ADJ})	10 µF

8.2.1.2 Detailed Design Procedure

8.2.1.2.1 External Capacitors

An input bypass capacitor is recommended. A 0.1-µF disc or 1-µF solid tantalum on the input is suitable input bypassing for almost all applications. The device is more sensitive to the absence of input bypassing when adjustment or output capacitors are used but the above values eliminate the possibility of problems.

The adjustment terminal can be bypassed to ground on the LM338-MIL to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. With a 10-µF bypass capacitor, 75-dB ripple rejection is obtainable at any output level. Increases over 20 µF do not appreciably improve the ripple rejection at frequencies above 120 Hz. If the bypass capacitor is used, it is sometimes necessary to include protection diodes to prevent the capacitor from discharging through internal low current paths and damaging the device.

In general, the best type of capacitors to use are solid tantalum. Solid tantalum capacitors have low impedance even at high frequencies. Depending upon capacitor construction, it takes about 25 µF in aluminum electrolytic to equal 1-µF solid tantalum at high frequencies. Ceramic capacitors are also good at high frequencies; but some types have a large decrease in capacitance at frequencies around 0.5 MHz. For this reason, 0.01-µF disc may seem to work better than a 0.1-µF disc as a bypass.

Although the LM338-MIL is stable with no output capacitors, like any feedback circuit, certain values of external capacitance can cause excessive ringing. This occurs with values between 500 pF and 5000 pF. A 1-µF solid tantalum (or 25-µF aluminum electrolytic) on the output swamps this effect and insures stability.

8.2.1.2.2 Load Regulation

The LM338-MIL is capable of providing extremely good load regulation but a few precautions are needed to obtain maximum performance. The current set resistor connected between the adjustment terminal and the output terminal (usually 240 Ω) must be tied directly to the output of the regulator (case) rather than near the load. This eliminates line drops from appearing effectively in series with the reference and degrading regulation. For example, a 15-V regulator with 0.05-Ω resistance between the regulator and load has a load regulation due to line resistance of 0.05 Ω × I_L. If the set resistor is connected near the load, the effective line resistance is 0.05 Ω (1 + R2/R1) or in this case, 11.5 times worse.

Figure 17 shows the effect of resistance between the regulator and 240-Ω set resistor.

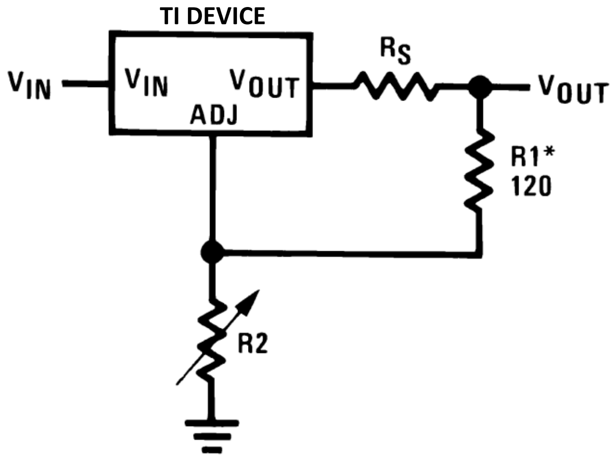


Figure 17. Regulator With Line Resistance in Output Lead

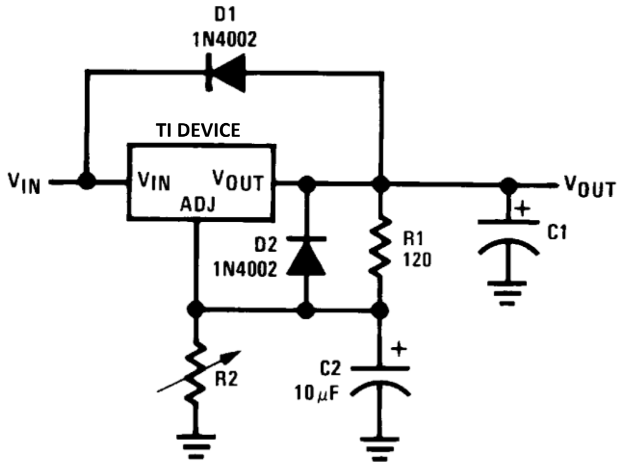
With the TO-3 package, it is easy to minimize the resistance from the case to the set resistor, by using 2 separate leads to the case. The ground of R2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation.

8.2.1.2.3 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 20-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 regulator and the input is shorted, the output capacitor discharges into the output of the regulator. The discharge current depends on the value of the capacitor, the output voltage of the regulator, and the rate of decrease of V_{IN}. In the LM338-MIL this discharge path is through a large junction that is able to sustain 25-A surge with no problem. This is not true of other types of positive regulators. For output capacitors of 100 µF or less at output of 15 V or less, there is no need to use diodes.

The bypass capacitor on the adjustment terminal can discharge through a low current junction. Discharge occurs when *either* the input or output is shorted. Internal to the LM338-MIL is a 50-Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25-V or less and 10-µF capacitance. Figure 18 shows an LM338-MIL with protection diodes included for use with outputs greater than 25 V and high values of output capacitance.



$$V_{OUT} = 1.25V\left(1 + \frac{R2}{R1}\right) + I_{ADJ}R2$$

D1 protects against C1
D2 protects against C2

Figure 18. Regulator With Protection Diodes

8.2.1.3 Application Curves

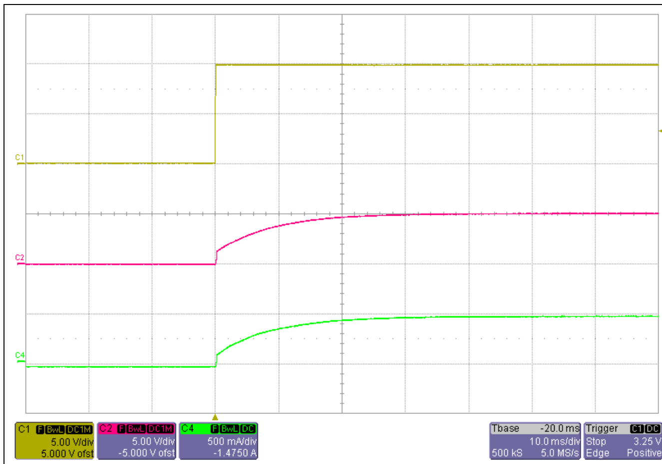


Figure 19. Regulator Start-Up

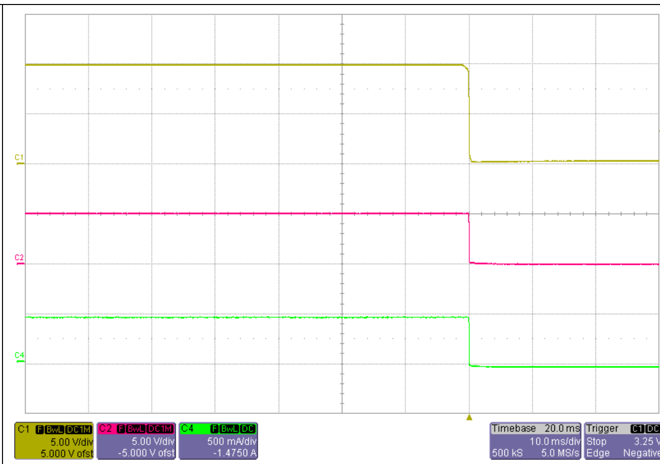


Figure 20. Regulator Shutdown

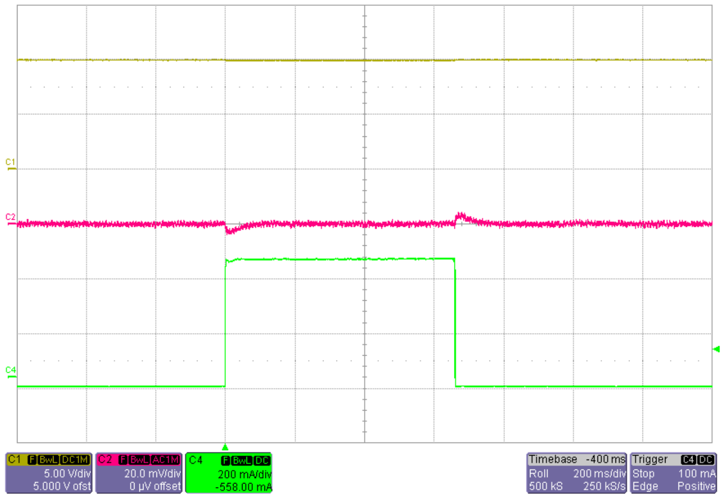


Figure 21. Regulator Response to Load Step

8.3 System Examples

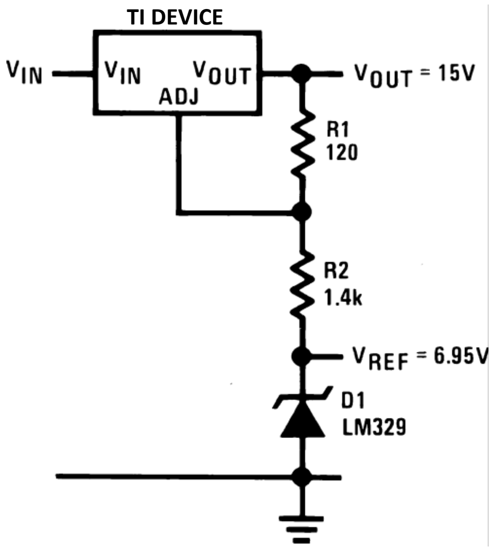


Figure 22. Regulator and Voltage Reference

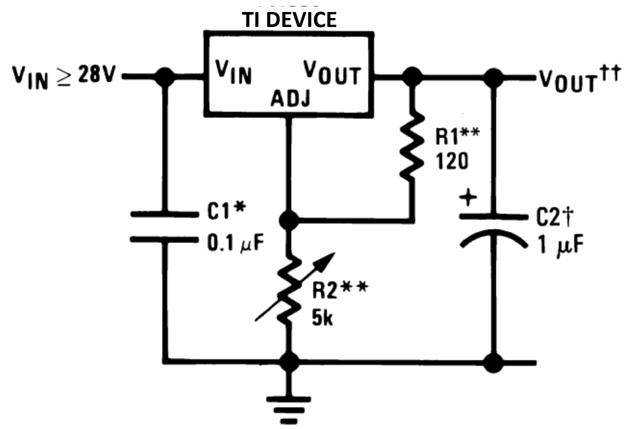
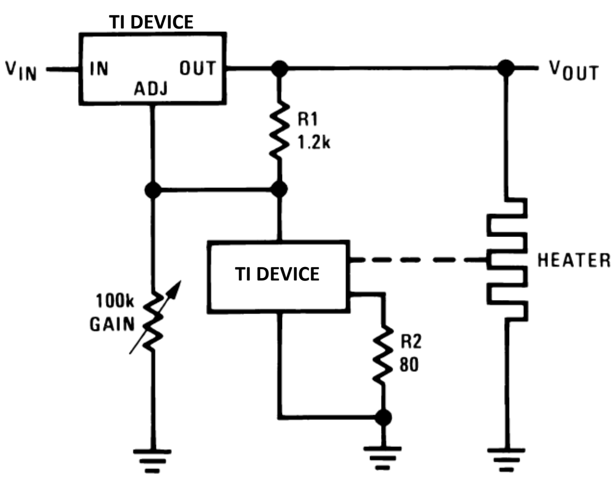


Figure 23. 1.2-V to 25-V Adjustable Regulator



Full output current not available at high input-output voltages

†Optional—improves transient response. 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.

*Needed if device is more than 6 inches from filter capacitors.

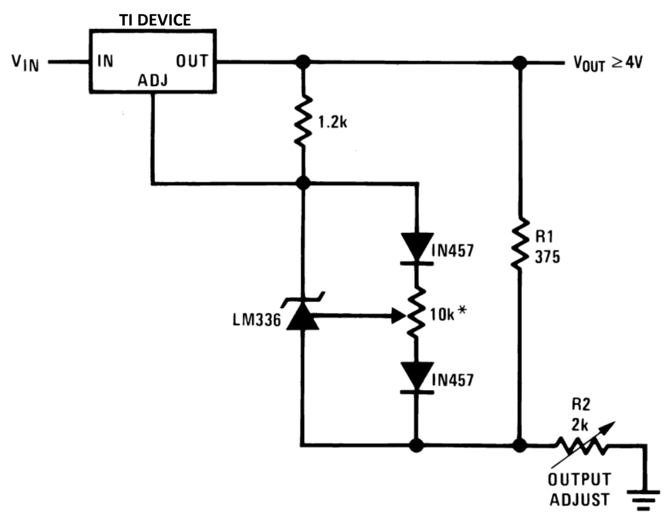
$$\dagger\dagger V_{OUT} = 1.25V\left(1 + \frac{R2}{R1}\right) + I_{ADJ}\,(R_2)$$

R1, R2 as an assembly can be ordered from Bourns:

MIL part no. 7105A-AT2-502

COMM part no. 7105A-AT7-502

Figure 24. Temperature Controller



* Adjust for 3.75 across R1

Figure 25. Precision Power Regulator With Low Temperature Coefficient

System Examples (continued)

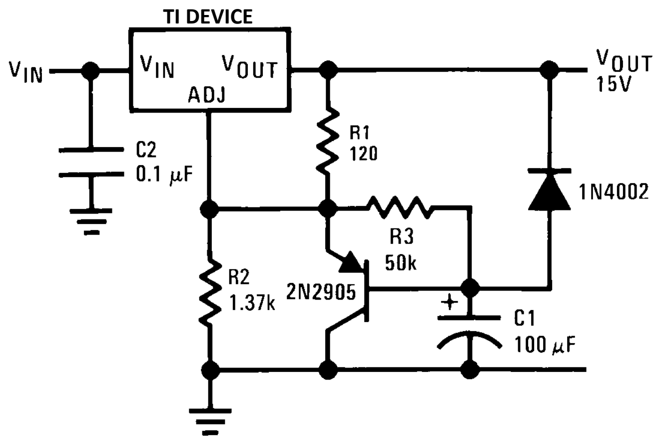
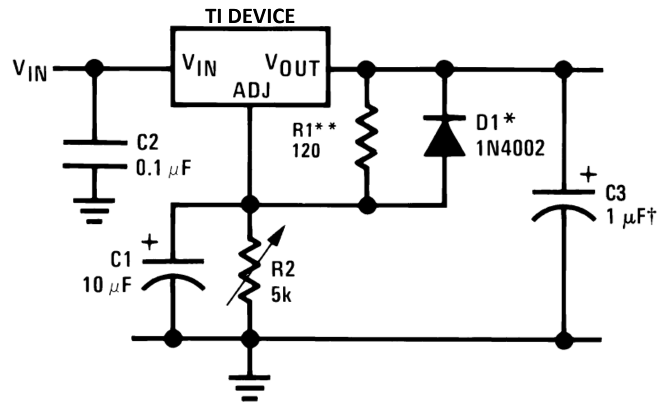


Figure 26. Slow Turnon 15-V Regulator



†Solid tantalum

*Discharges C1 if output is shorted to ground

Figure 27. Adjustable Regulator With Improved Ripple Rejection

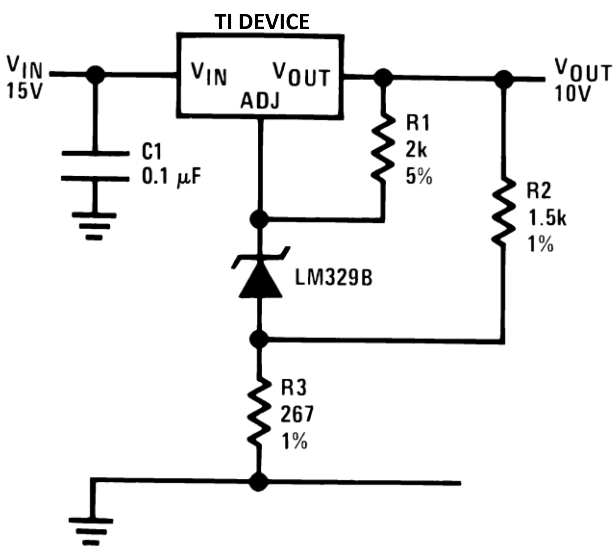
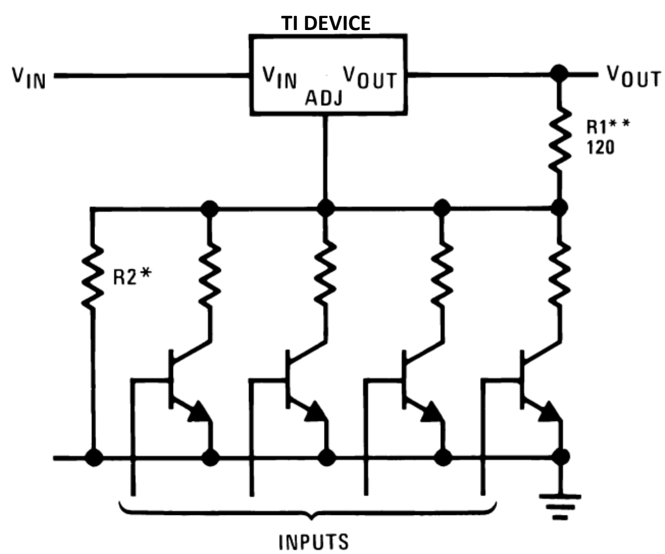


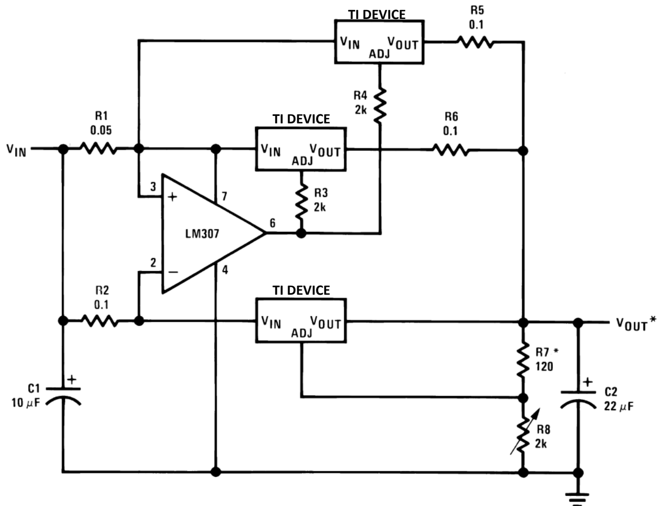
Figure 28. High Stability 10-V Regulator



*Sets maximum V_{OUT}

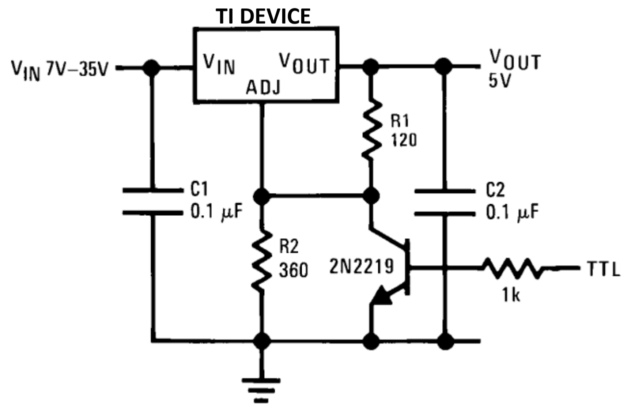
Figure 29. Digitally Selected Outputs

System Examples (continued)



* Minimum load—100 mA

Figure 30. 15-A Regulator



** Minimum output ≈ 1.2 V

Figure 31. 5-V Logic Regulator With Electronic Shutdown**

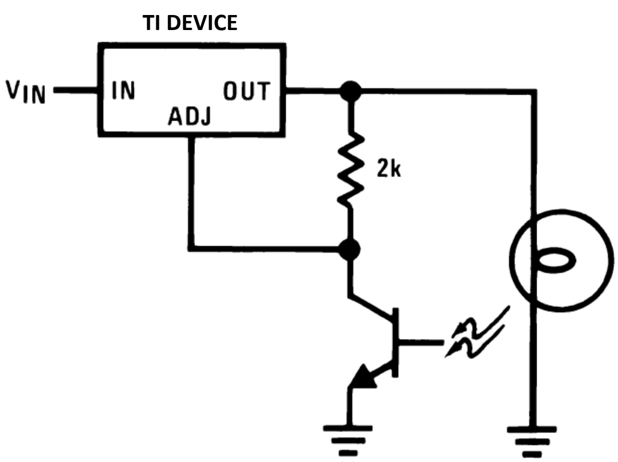
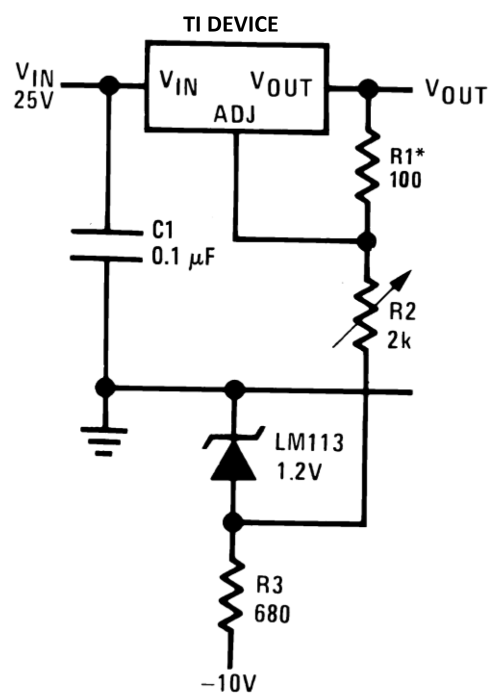


Figure 32. Light Controller



Full output current not available at high input-output voltages

Figure 33. 0 to 22-V Regulator

System Examples (continued)

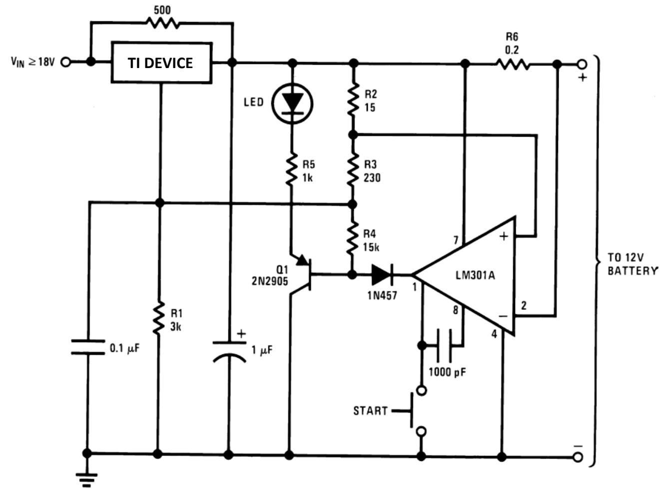


Figure 34. 12-V Battery Charger

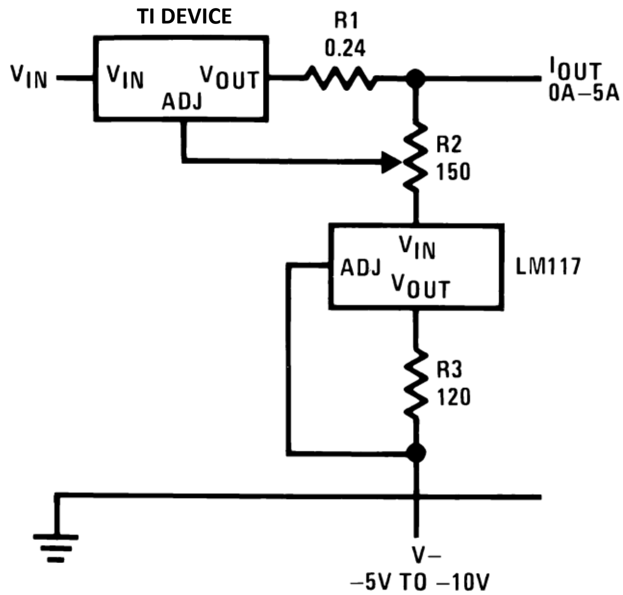


Figure 35. Adjustable Current Regulator

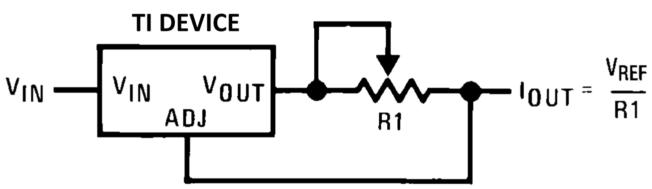


Figure 36. Precision Current Limiter

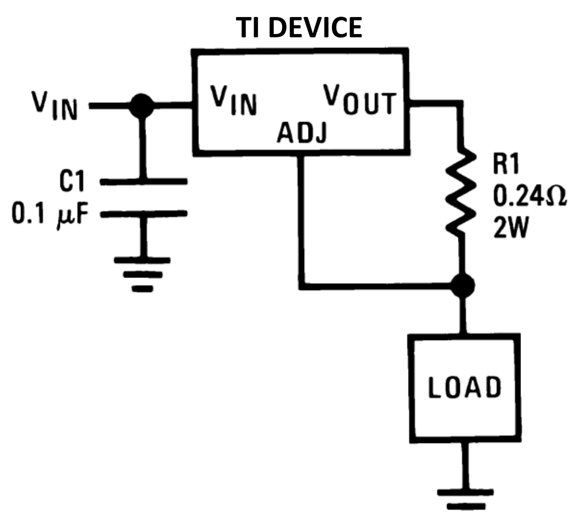


Figure 37. 5-A Current Regulator

System Examples (continued)

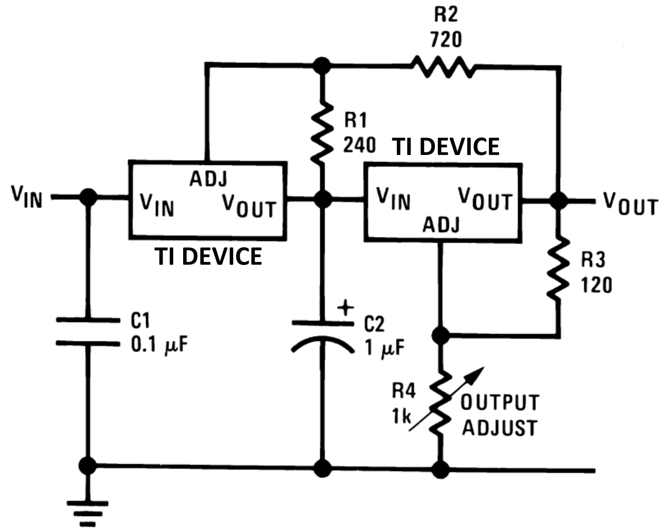
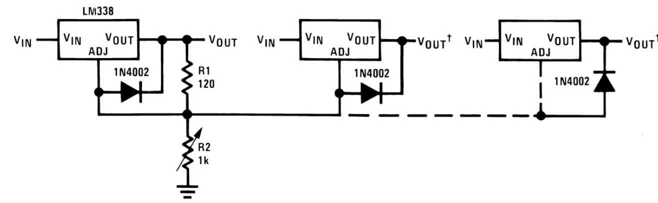
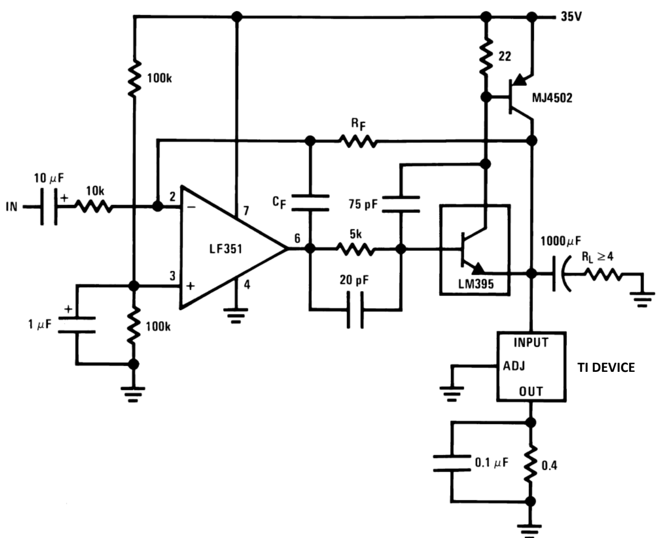


Figure 38. Tracking Preregulator



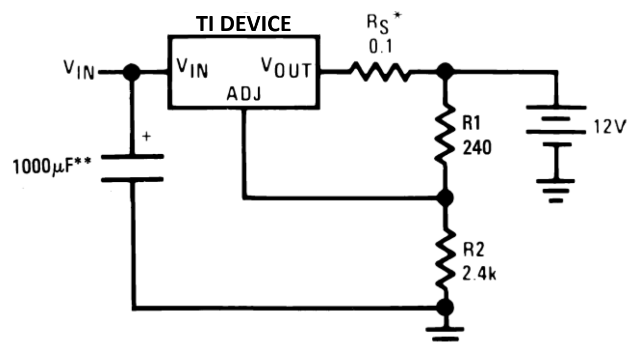
† Minimum load—10 mA
* All outputs within ±100 mV

Figure 39. Adjusting Multiple On-Card Regulators With Single Control*



A_V = 1, R_F = 10k, C_F = 100 pF
A_V = 10, R_F = 100k, C_F = 10 pF
Bandwidth ≥ 100 kHz
Distortion ≤ 0.1%

Figure 40. Power Amplifier



*R_S—sets output impedance of charger $Z_{OUT} = R_S \left(1 + \frac{R2}{R1}\right)$

Use of R_S allows low charging rates with fully charged battery.
**The 1000 µF is recommended to filter out input transients

*R_S—sets output impedance of charger $Z_{OUT} = R_S \left(1 + \frac{R2}{R1}\right)$

Use of R_S allows low charging rates with fully charged battery.
**The 1000 µF is recommended to filter out input transients

Figure 41. Simple 12-V Battery Charger

System Examples (continued)

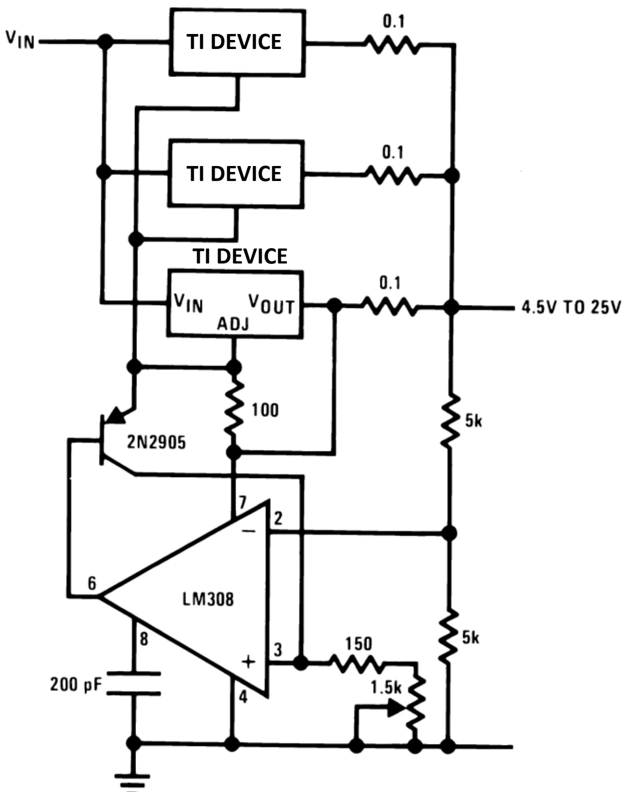
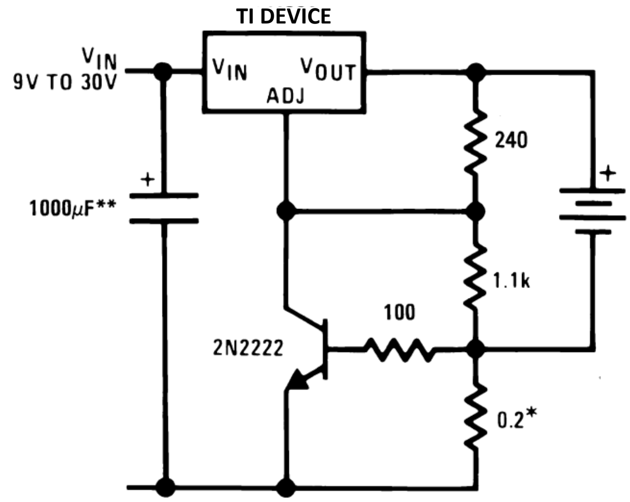


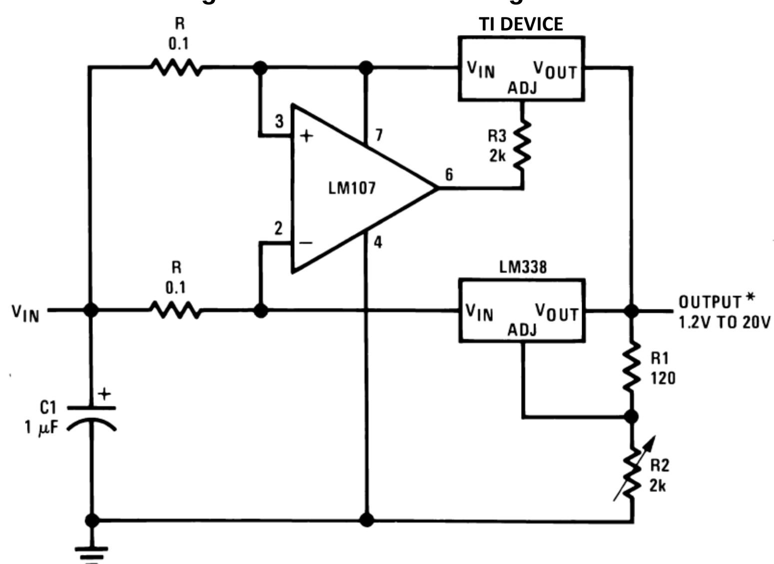
Figure 42. Adjustable 15-A Regulator



* Set max charge current to 3 A

** THE 1000 µF is recommended to filter out input transients.

Figure 43. Current Limited 6-V Charger



* Minimum load—100 mA

Figure 44. 10-A Regulator

9 Power Supply Recommendations

The input supply to LM338 must be kept at a voltage level such that its 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 LM338 in regulation. TI recommends a capacitor be placed at the input to bypass noise.

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_{OUT} to V_{IN} to divert the surge current from the output capacitor and protect the IC. Similarly, in cases when a large bypass capacitor is placed at the ADJ pin and VOUT shorts to ground, an external diode must be placed from ADJ to V_{OUT} 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

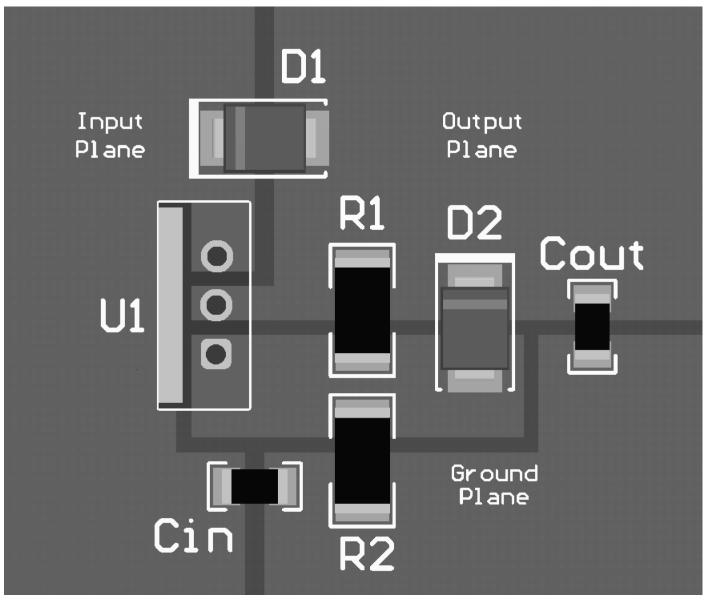


Figure 45. LMx38 Layout

11 器件和文档支持

11.1 接收文档更新通知

要接收文档更新通知，请导航至德州仪器 TI.com.cn 上的器件产品文件夹。请单击右上角的*通知我* 进行注册，即可收到任意产品信息更改每周摘要。有关更改的详细信息，请查看任意已修订文档中包含的修订历史记录。

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。

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All other trademarks are the property of their respective owners.

11.4 静电放电警告

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ESD 的损坏小至导致微小的性能降级，大至整个器件故障。 精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

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
LM338K STEEL	ACTIVE	TO-3	NDS	2	50	Non-RoHS & Non-Green	Call TI	Call TI	0 to 0	LM338K STEELP+	Samples
LM338K STEEL/NOPB	ACTIVE	TO-3	NDS	2	50	RoHS & Green	Call TI	Level-1-NA-UNLIM	0 to 0	LM338K STEELP+	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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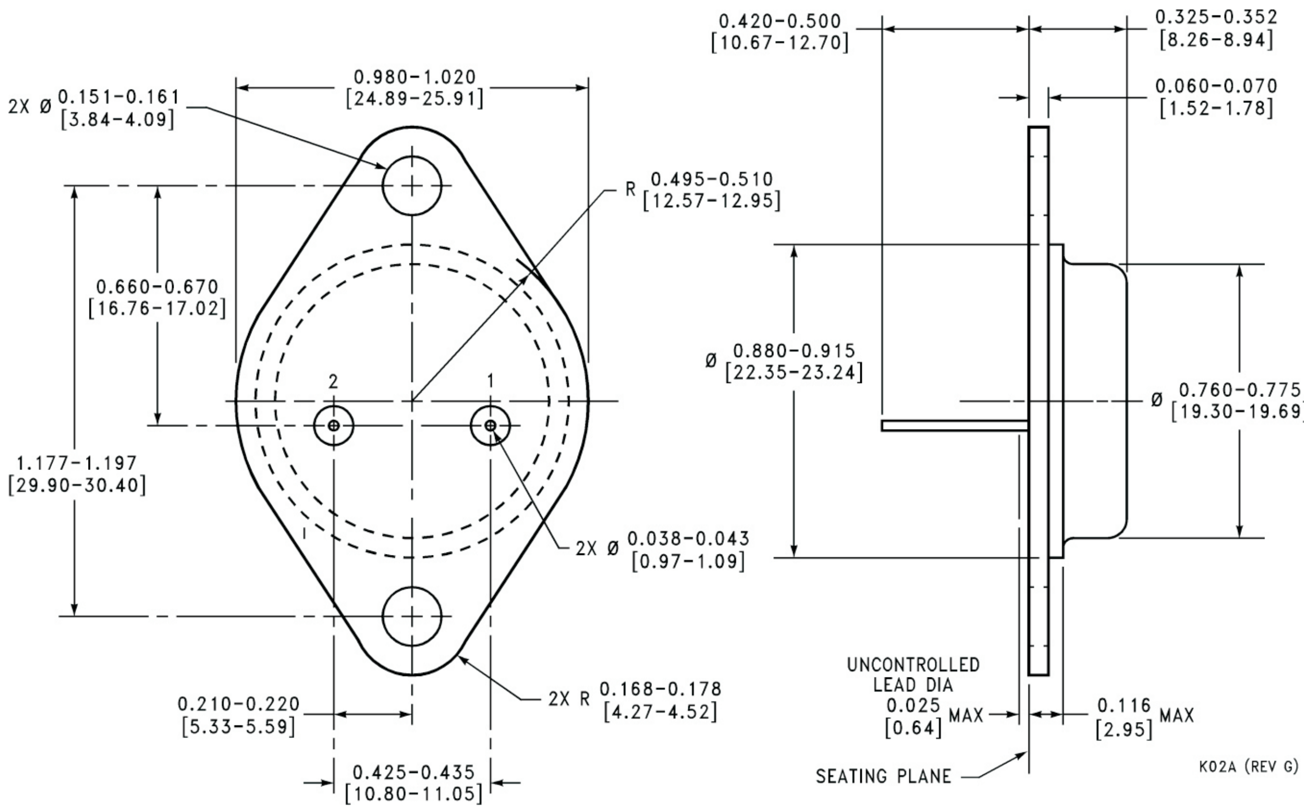
0.980–1.020
[24.89–25.91]
2X Ø 0.151–0.161
[3.84–4.09]
R 0.495–0.510
[12.57–12.95]
0.660–0.670
[16.76–17.02]
2
1
1.177–1.197
[29.90–30.40]
2X Ø 0.038–0.043
[0.97–1.09]
2X R 0.168–0.178
[4.27–4.52]
0.210–0.220
[5.33–5.59]
0.425–0.435
[10.80–11.05]
0.420–0.500
[10.67–12.70]
0.325–0.352
[8.26–8.94]
0.060–0.070
[1.52–1.78]
Ø 0.880–0.915
[22.35–23.24]
Ø 0.760–0.775
[19.30–19.69]
UNCONTROLLED
LEAD DIA
0.025
[0.64] MAX
0.116
[2.95] MAX
SEATING PLANE
K02A (REV G)

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