LM78M05-MIL 系列 3 端子 500mA 正电压稳压器

1 特性

- 输出电流超过 0.5A
- 无外部组件
- 内部热过载保护
- 内部短路电流限制
- 输出晶体管安全区域补偿
- 采用 3 引脚 TO-220、TO-252 和 TO 封装
- 输出电压：5V

2 应用

- 电子销售终端
- 医疗、健康和健身 应用
- 打印机
- 电器和白色家电
- 电视和机顶盒

3 说明

LM78M05-MIL 三引脚正电压稳压器采用内置电流限制、热关断和安全运行区域保护，这使得它们基本不会因输出过载而损坏。

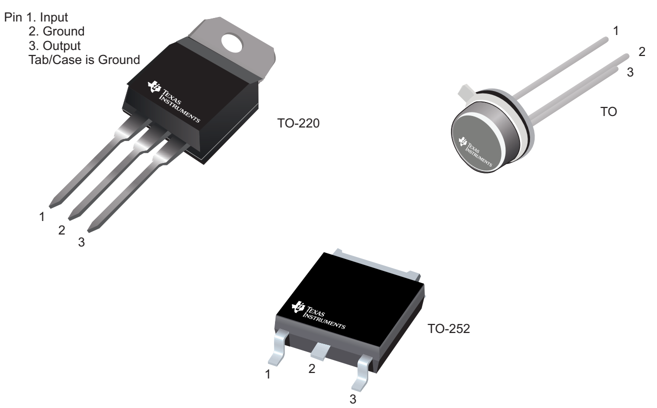
凭借充分的散热，它们可以提供超过 0.5A 的输出电流。典型 应用 包括本地（卡上）稳压器，这些稳压器可以消除与单点稳压相关的噪声和性能下降情况。

器件信息(1)

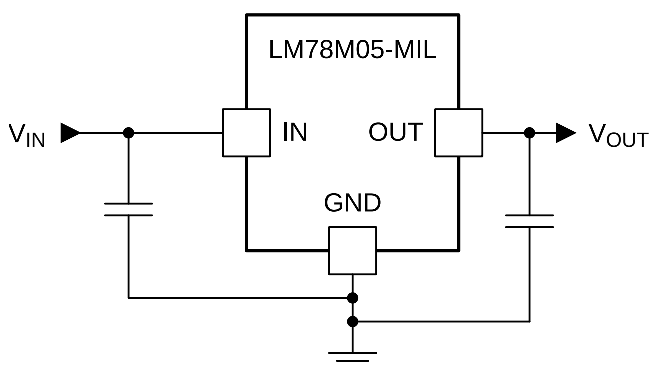
器件型号	封装	封装尺寸（标称值）
LM78M05	TO-220 (3)	10.16mm × 14.986mm
	TO-252 (3)	6.10mm × 6.58mm
	TO (3)	9.14mm × 9.14mm

(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



简化应用



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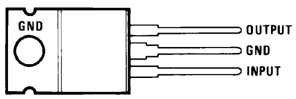
4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

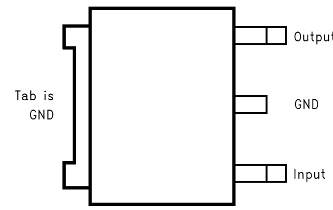
日期	修订版本	说明
2017 年 6 月	*	初始发行版。

5 Pin Configuration and Functions

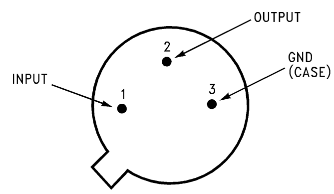
NDE Package
3-Pin TO-220
Top View



NDP Package
3-Pin TO-252
Top View



NDT Package
3-Pin TO
Top View



Pin Functions

PIN				I/O	DESCRIPTION
NAME	NO.				
	TO-220	TO-252	TO		
GND	2/TAB	2/TAB	3	—	Tab is GND
INPUT	1	1	1	I	Input
OUTPUT	2	2	2	O	Output

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)(2)

		MIN	MAX	UNIT
Input voltage	5 V ≤ V_O ≤ 15 V		35	V
Power dissipation		Internally limited		
Lead temperature (Soldering, 10 s)	TO package (NDT)		300	°C
	TO-220 package (NDE)		260	
Operating junction temperature		–40	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.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.

6.2 Recommended Operating Conditions

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

	MIN	MAX	UNIT
Input voltage	V_{OUT} + 1.8	35	V
Output current		0.5	A

6.3 Thermal Information

THERMAL METRIC[(1)]		LM78M05 NDP (TO-252) 3 PINS	LM78M05 NDT (TO) 3 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	38	162.4	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	48.4	23.9	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	17.7	—	°C/W
ψ_{JT}	Junction-to-top characterization parameter	6.7	—	°C/W
ψ_{JB}	Junction-to-board characterization parameter	17.9	—	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	4.4	—	°C/W

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

6.4 Electrical Characteristics

V_{IN} = 10 V, C_{IN} = 0.33 µF, C_O = 0.1 µF, T_J = 25°C (unless otherwise noted). Limits are specified by production testing or correlation techniques using standard Statistical Quality Control (SQC) methods.

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_O	Output voltage	I_L = 500 mA		4.8	5	5.2	V
		5 mA ≤ I_L ≤ 500 mA, P_D ≤ 7.5 W, 7.5 V ≤ V_{IN} ≤ 20 V, –40°C ≤ T_J ≤ 125°C		4.75	5	5.25	
V_{RLINE}	Line regulation	7.2 V ≤ V_{IN} ≤ 25 V	I_L = 100 mA			50	mV
			I_L = 500 mA			100	
V_{RLOAD}	Load regulation	I_L = 5 mA to 500 mA				100	mV
I_Q	Quiescent current	I_L = 500 mA			4	10	mA
ΔI_Q	Quiescent current change	5 mA ≤ I_L ≤ 500 mA,				0.5	mA
		7.5 V ≤ V_{IN} ≤ 25 V, I_L = 500 mA				1	
V_n	Output noise voltage	10 Hz ≤ f ≤ 100 kHz			40		µV
ΔV_{IN}	Ripple rejection	f = 120 Hz, I_L = 500 mA			78		dB
V_{IN}	Input voltage required to maintain line regulation	I_L = 500 mA		7.2			V
ΔV_O	Long-term stability	I_L = 500 mA, –40°C ≤ T_J ≤ 125°C				20	mV/khrs

6.5 Typical Characteristics

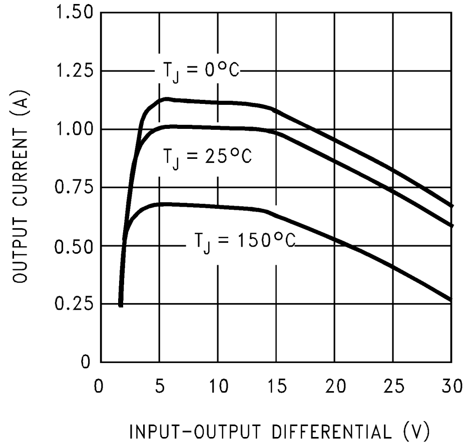


Figure 1. Peak Output Current

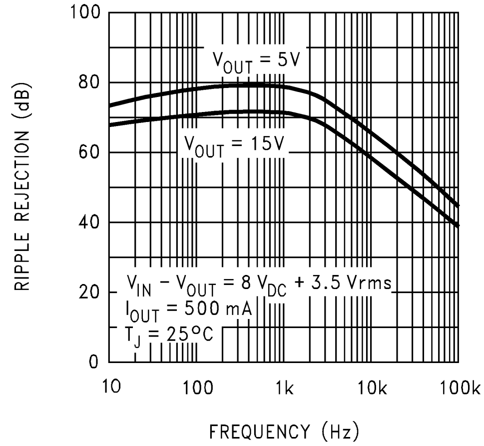


Figure 2. Ripple Rejection

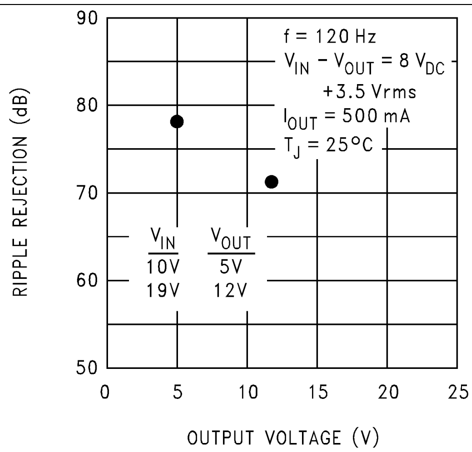


Figure 3. Ripple Rejection

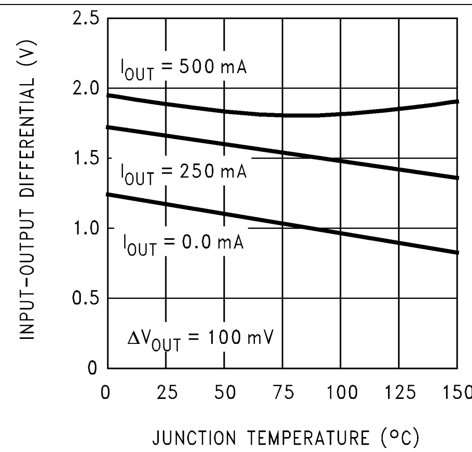
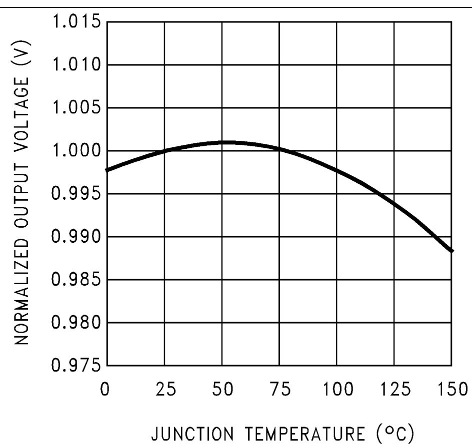


Figure 4. Dropout Voltage



Normalized to 1 V T$_J$ = 25°C

Figure 5. Output Voltage

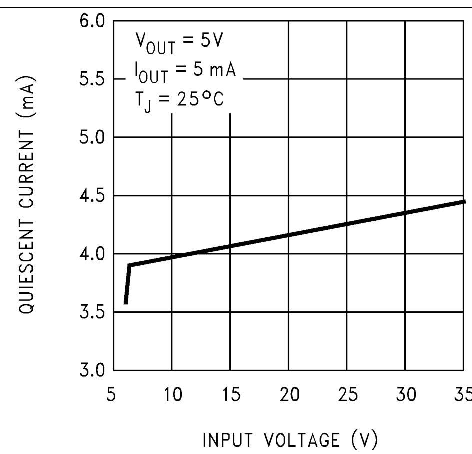


Figure 6. Quiescent Current

Typical Characteristics (continued)

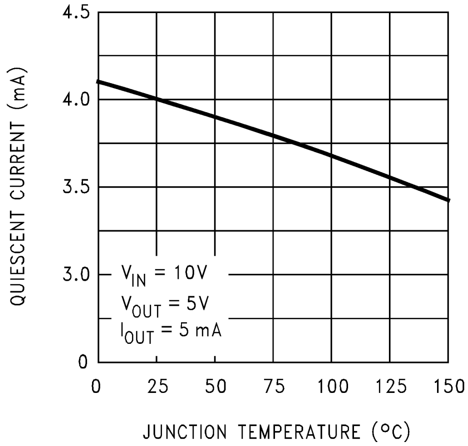


Figure 7. Quiescent Current

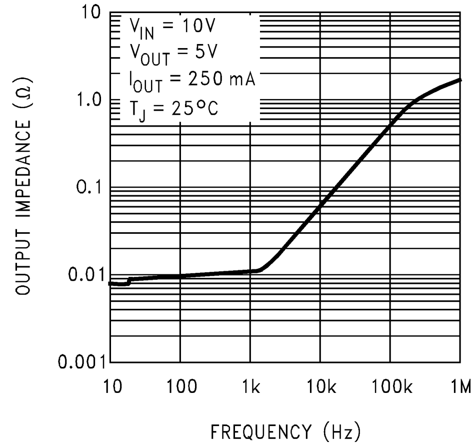


Figure 8. Output Impedance

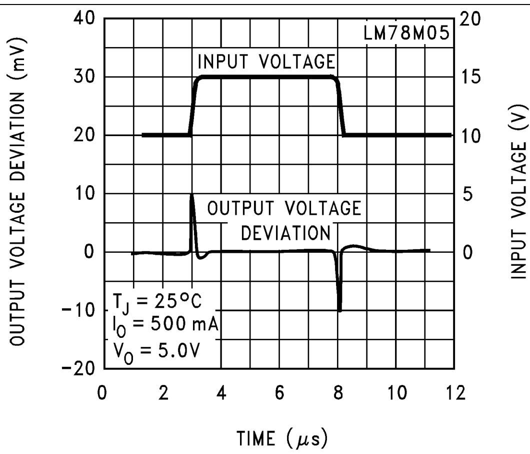


Figure 9. Line Transient Response

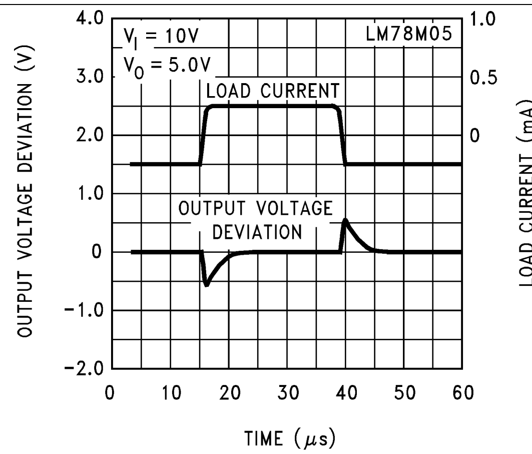


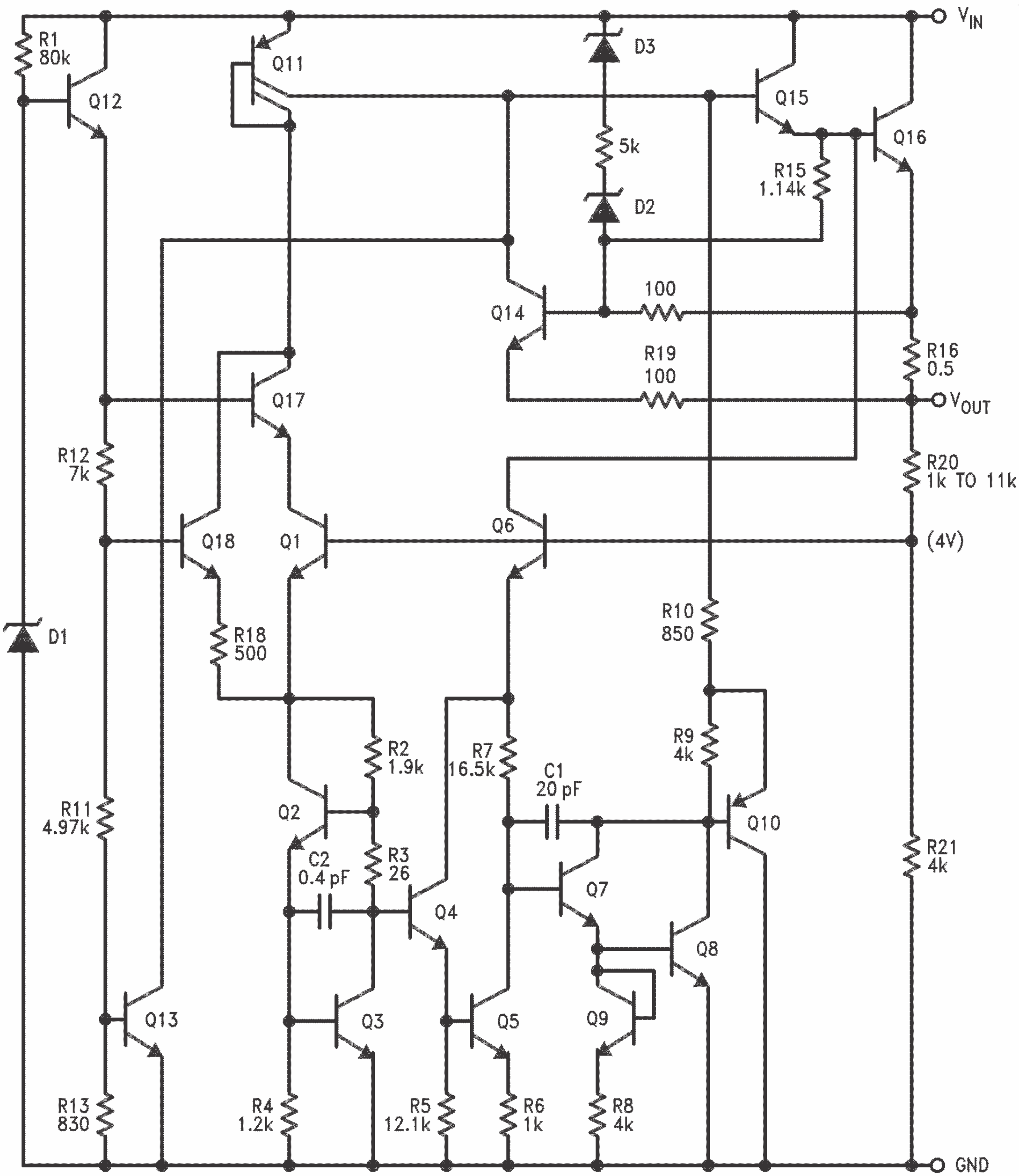
Figure 10. Load Transient Response

7 Detailed Description

7.1 Overview

The LM78M05-MIL device is a fixed positive voltage regulators. It can accept up to 35 V at the input and regulate it down to outputs of 5 V, 12 V, or 15 V. The device is capable of supplying up to 500 mA of output current, although it is important to ensure an adequate amount of heat sinking to avoid exceeding thermal limits. However, in the case of accidental overload the device has built in current limiting, thermal shutdown and safe-operating area protection to prevent damage from occurring.

7.2 Functional Block Diagram



7.3 Feature Description

The LM78M05-MIL fixed voltage regulator has built-in thermal overload protection which prevents the device from being damaged due to excessive junction temperature.

The regulator also contains internal short-circuit protection which limits the maximum output current, and safe-area protection for the pass transistor which reduces the short-circuit current as the voltage across the pass transistor is increased.

Although the internal power dissipation is automatically limited, the maximum junction temperature of the device must be maintained below 125°C to meet data sheet specifications. An adequate heat sink must be provided to assure this limit is not exceeded under worst-case operating conditions (maximum input voltage and load current) if reliable performance is to be obtained.

7.4 Device Functional Modes

7.4.1 Normal Operation

The device OUTPUT pin sources current necessary to make the voltage at the OUTPUT pin equal to the fixed voltage level of the device.

7.4.2 Operation With Low Input Voltage

The device requires up to 2-V headroom (V_{IN} – V_{OUT}) to operate in regulation. With less headroom, the device may drop out of regulation in which the OUTPUT voltage would equal INPUT voltage minus dropout voltage.

7.4.3 Operation in Self Protection

When an overload occurs, the device shuts down Darlington NPN output stage or reduce 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

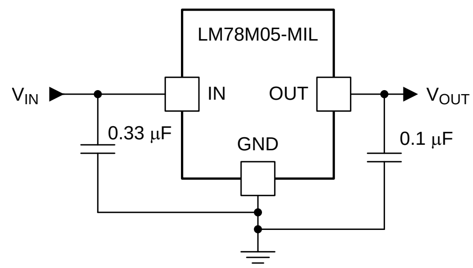
NOTE

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

The LM78M05-MIL device is a fixed voltage regulator that needs no external feedback resistors in order to set the output voltage. Input. Output capacitors are not required for the device to be stable. However, input capacitance helps filter noise from the supply and output capacitance improves the transient response.

8.2 Typical Application



C_{IN} required if regulator input is more than 4 inches from input filter capacitor (or if no input filter capacitor is used).
C_{OUT} is optional for improved transient response.

Figure 11. Typical Application

8.2.1 Design Requirements

For this design example, use the parameters listed in Table 1 as the input parameters.

Table 1. Design Parameters

PARAMETER	VALUE
C_{IN}	0.33 µF
C_{OUT}	0.1 µF

8.2.2 Detailed Design Procedure

8.2.2.1 Input Voltage

Regardless of the output voltage option being used (5 V, 12 V, 15 V), the input voltage must be at least 2 V greater to ensure proper regulation (7 V, 14 V, 17 V).

8.2.2.2 Output Current

Depending on the input-output voltage differential, the output current must be limited to ensure maximum power dissipation is not exceeded. The graph in Figure 1 shows the appropriate current limit for a variety of conditions.

8.2.2.3 Input Capacitor

If no power supply filter capacitor is used or if the device is placed more than four inches away from the capacitor of the power supply, an additional capacitor placed at the input pin of the device helps bypass noise.

8.2.2.4 Output Capacitor

This device is designed to be stable with no output capacitance and can be omitted from the design if needed. However if large changes in load are expected, an output capacitor is recommended to improve the transient response.

8.2.3 Application Curves

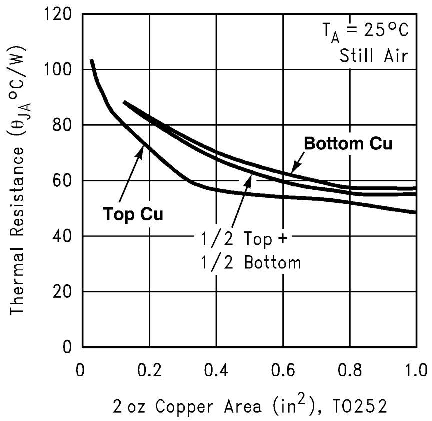


Figure 12. $R_{\theta JA}$ vs 2-oz Copper Area for PFM

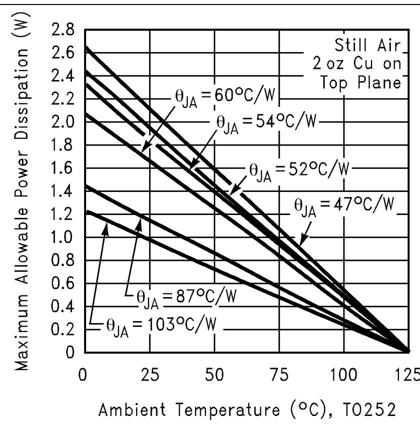


Figure 13. Maximum Allowable Power Dissipation vs Ambient Temperature for PFM

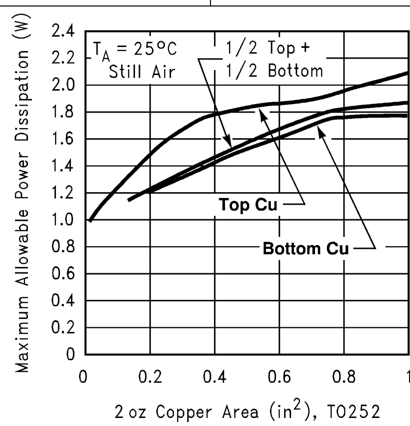


Figure 14. Maximum Allowable Power Dissipation vs 2-oz Copper Area for PFM

9 Power Supply Recommendations

The LM78M05-MIL device is designed to operate from an input voltage supply range between V_{OUT} + 2 V to 35 V. If the device is more than four inches from the power supply filter capacitors, an input bypass capacitor 0.1-µF or greater of any type is recommended.

10 Layout

10.1 Layout Guidelines

Follow these layout guidelines to ensure proper regulation of the output voltage with minimum noise. TI recommends that the input terminal be bypassed to ground with a bypass capacitor. The optimum placement is closest to the input terminal of the device and the system GND. Take care to minimize the loop area formed by the bypass-capacitor connection, the input terminal, and the system GND. Traces carrying the load current must be wide to reduce the amount of parasitic trace inductance. In cases when VIN shorts to ground, an external diode must be placed from VOUT to VIN to divert the surge current from the output capacitor and protect the device. This diode must be placed close to the corresponding device pins to increase their effectiveness.

10.2 Layout Example

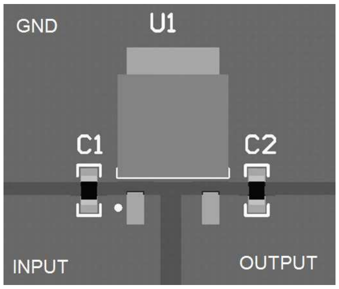


Figure 15. Layout Recommendation

10.3 Thermal Considerations

When an integrated circuit operates with appreciable current, its junction temperature is elevated. It is important to quantify its thermal limits to achieve acceptable performance and reliability. This limit is determined by summing the individual parts consisting of a series of temperature rises from the semiconductor junction to the operating environment. A one-dimension steady-state model of conduction heat transfer is demonstrated in Figure 16. The heat generated at the device junction flows through the die to the die attach pad, through the lead frame to the surrounding case material, to the printed-circuit board, and eventually to the ambient environment.

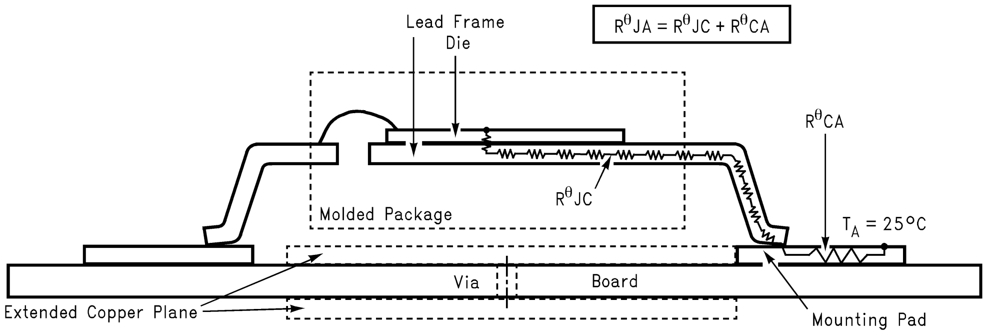
There are several variables that may affect the thermal resistance and in turn the need for a heat sink, which includes the following.

Component variables ($R_{\theta JC}$)

- Leadframe size and material
- Number of conduction pins
- Die size
- Die attach material
- Molding compound size and material

Application variables ($R_{\theta CA}$)

- Mounting pad size, material, and location
- Placement of mounting pad
- PCB size and material
- Traces length and width
- Adjacent heat sources
- Volume of air
- Ambient temperature
- Shape of mounting pad



The case temperature is measured at the point where the leads contact the mounting pad surface

Figure 16. Cross-Sectional View of Integrated Circuit Mounted on a Printed-Circuit Board

Thermal Considerations (continued)

The LM78M05-MIL regulator has internal thermal shutdown to protect the device from overheating. Under all possible operating conditions, the junction temperature of the device must be within the range of 0°C to 125°C. A heat sink may be required depending on the maximum power dissipation and maximum ambient temperature of the application. To determine if a heat sink is needed, the power dissipated by the regulator (P_D) is calculated using Equation 1.

$$I_{IN} = I_L + I_G \quad (1)$$

$$P_D = (V_{IN} – V_{OUT}) \times I_L + (V_{IN} \times I_G) \quad (2)$$

Figure 17 shows the voltages and currents which are present in the circuit.

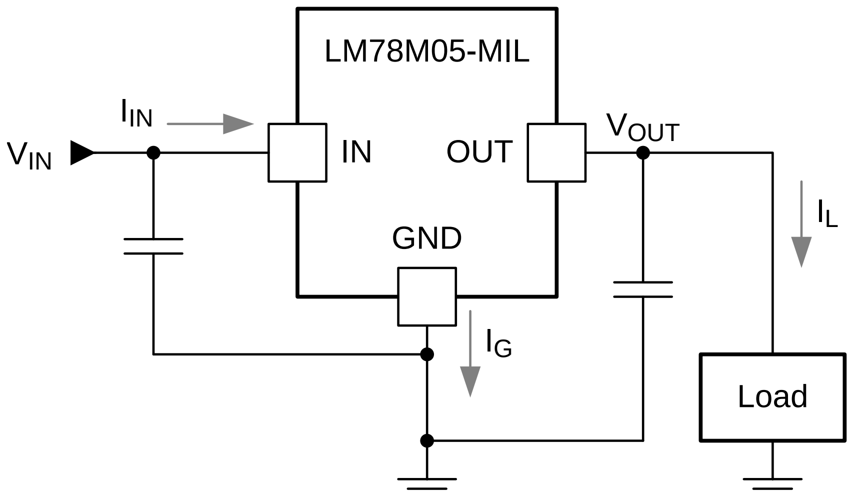


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Figure 17. Power Dissipation Diagram

Use to calculate the maximum allowable temperature rise, $T_{R(max)}$.

$$T_{R(max)} = T_{J(max)} – T_{A(max)}$$

where

- $T_{J(max)}$ is the maximum allowable junction temperature (125°C)
- $T_{A(max)}$ is the maximum ambient temperature encountered in the application

Using the calculated values for $T_{R(max)}$ and P_D, the maximum allowable value for the junction-to-ambient thermal resistance ($R_{\theta JA}$) can be calculated with Equation 3.

$$R_{\theta JA} = T_{R(max)} / P_D \quad (3)$$

As a design aid, Table 2 shows the value of the $R_{\theta JA}$ of TO-252 for different heat sink area. The copper patterns that we used to measure these $R_{\theta JA}$ are shown at the end of *AN–1028 Maximum Power Enhancement Techniques for Power Packages* (SNVA036). Figure 12 reflects the same test results as what are in the Table 2.

Figure 13 shows the maximum allowable power dissipation versus ambient temperature for the PFM device. Figure 14 shows the maximum allowable power dissipation versus copper area (in^2) for the TO-252 device. For power enhancement techniques to be used with TO-252 package, see *AN–1028 Maximum Power Enhancement Techniques for Power Packages* (SNVA036).

Table 2. $R_{\theta JA}$ Different Heat Sink Area

LAYOUT	COPPER AREA (in^2)		THERMAL RESISTANCE: $R_{\theta JA}$ (°C/W)
	TOP SIDE(1)	BOTTOM SIDE	TO-252
1	0.0123	0	103

(1) Tab of device is attached to topside copper.

Thermal Considerations (continued)

Table 2. $R_{\theta JA}$ Different Heat Sink Area (continued)

LAYOUT	COPPER AREA (in^2)		THERMAL RESISTANCE: $R_{\theta JA}$ (°C/W)
	TOP SIDE[1]	BOTTOM SIDE	TO-252
2	0.066	0	87
3	0.3	0	60
4	0.53	0	54
5	0.76	0	52
6	1	0	47
7	0	0.2	84
8	0	0.4	70
9	0	0.6	63
10	0	0.8	57
11	0	1	57
12	0.066	0.066	89
13	0.175	0.175	72
14	0.284	0.284	61
15	0.392	0.392	55
16	0.5	0.5	53

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：

《用于电源封装的 AN–1028 最大电源增强技巧》(SNVA036)

11.2 接收文档更新通知

要接收文档更新通知，请导航至 TI.com 上的器件产品文件夹。单击右上角的*通知我* 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

11.3 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》。

TI E2E™ 在线社区 ***TI 的工程师对工程师 (E2E) 社区。***此社区的创建目的在于促进工程师之间的协作。在 e2e.ti.com 中，您可以咨询问题、分享知识、拓展思路并与同行工程师一道帮助解决问题。

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。

11.4 商标

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

11.5 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。

11.6 Glossary

SLYZ022 — *TI Glossary*.

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

12 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。这些数据如有变更，恕不另行通知和修订此文档。如欲获取此数据表的浏览器版本，请参阅左侧的导航。

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)
LM78M05CH	Active	Production	TO (NDT) | 3	500 | BULK	Yes	AU	Level-1-NA-UNLIM	-40 to 125	(LM78M05CH, LM78M 05CH)
LM78M05CH/NOPB	Active	Production	TO (NDT) | 3	500 | BULK	Yes	AU	Level-1-NA-UNLIM	-40 to 125	(LM78M05CH, LM78M 05CH)

(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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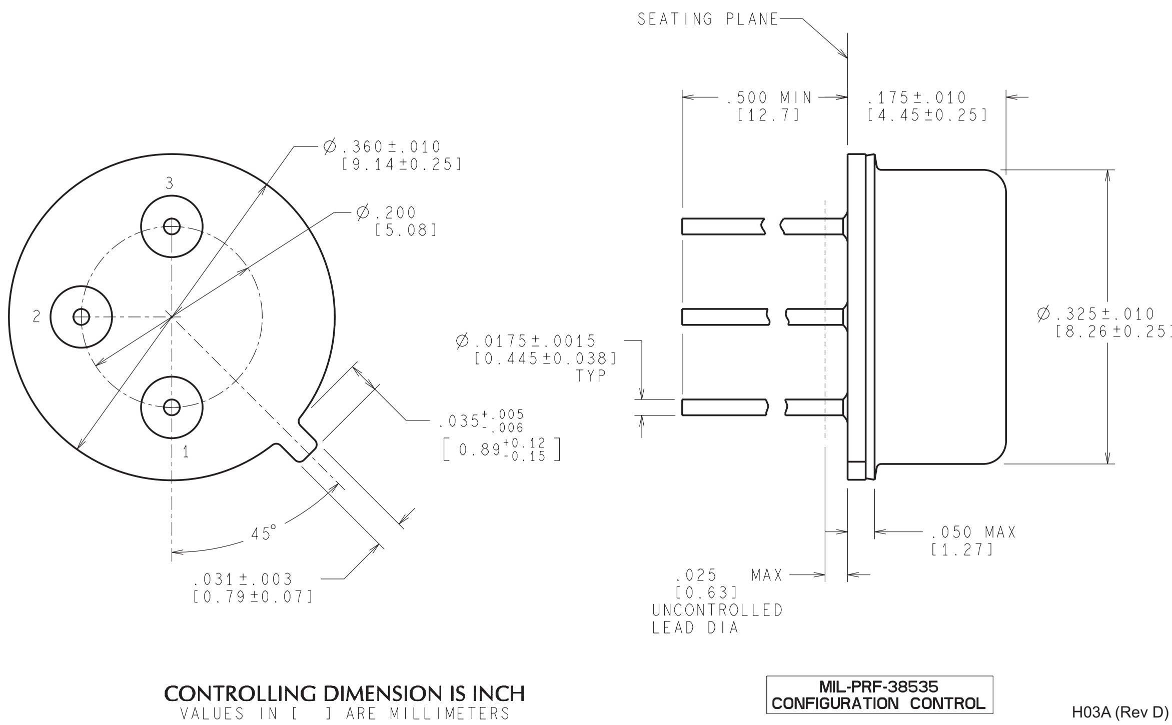
NDT0003A



H03A (Rev D)

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