参考資料

LM78M05-MILシリーズ 3端子、500mA、正電圧レギュレータ

1 特長

- 0.5Aを超える出力電流
- 外付け部品なし
- 内部的な熱過負荷保護
- 内部的な短絡電流制限
- 出力トランジスタの安全領域補償
- 3ピンTO-220、TO-252、およびTOパッケージで供給
- 出力電圧: 5V

2 アプリケーション

- レジ用電子機器
- 医療用および保健用アプリケーション
- プリンタ
- 白物家電、その他家電製品
- テレビおよびセットトップ・ボックス

3 概要

LM78M05-MIL 3ピン正電圧レギュレータには、電流制限、サーマル・シャットダウン、安全動作領域保護機能が組み込まれており、出力の過負荷に対して事実上完全な耐性があります。

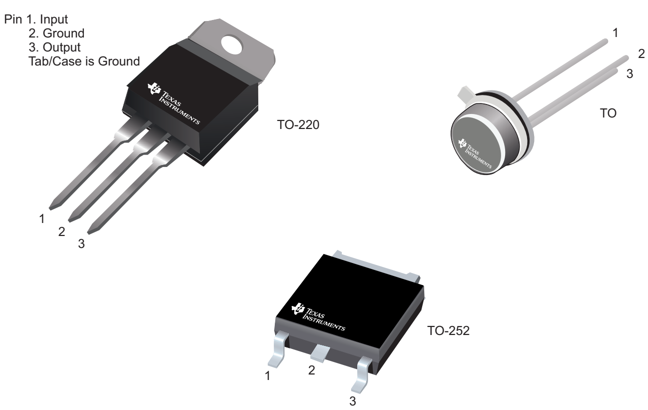
十分なヒートシンクがあれば、0.5Aを超える出力電流を供給できます。一般的な用途には、ローカル(オンカード)レギュレータがあり、単一点レギュレーションに付きもののノイズを排除し、パフォーマンス劣化を抑制できます。

製品情報(1)

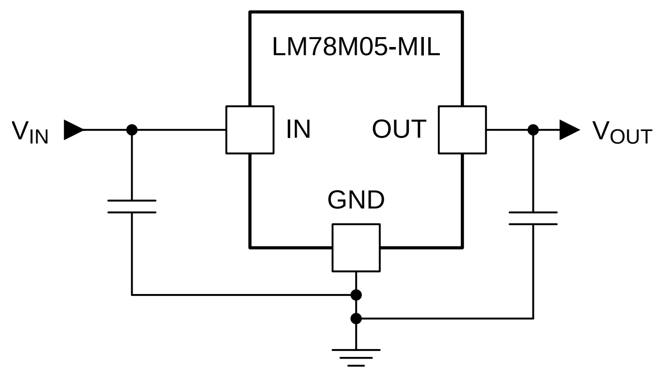
型番	パッケージ	本体サイズ(公称)
LM78M05	TO-220 (3)	10.16mm×14.986mm
	TO-252 (3)	6.10mm×6.58mm
	TO (3)	9.14mm×9.14mm

(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。

利用可能なパッケージ



アプリケーション概略図



目次

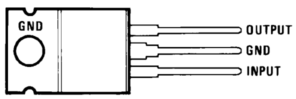
4 改訂履歴

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

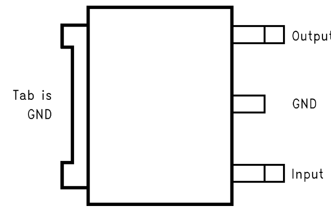
日付	改訂内容	注
2017年6月	*	初版

5 Pin Configuration and Functions

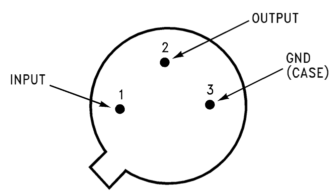
NDE Package
3-Pin TO-220
Top View



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

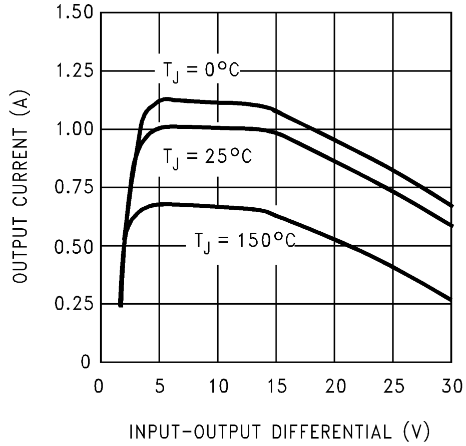


Figure 1. Peak Output Current

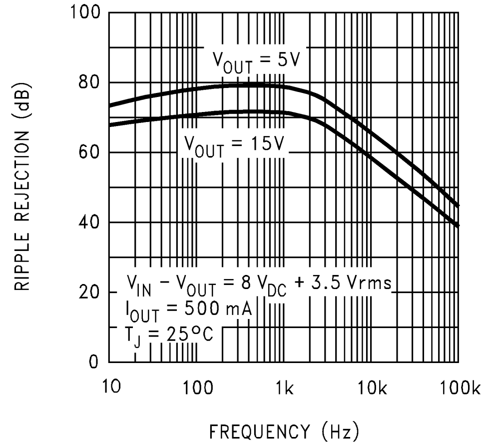


Figure 2. Ripple Rejection

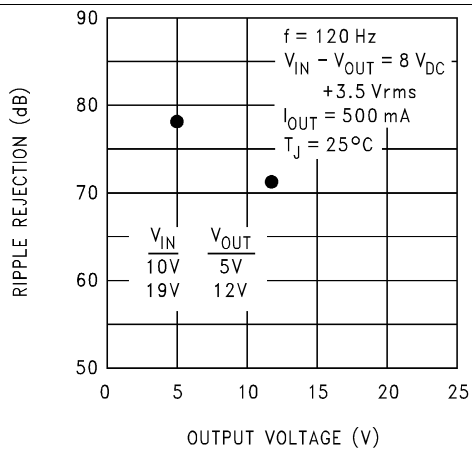


Figure 3. Ripple Rejection

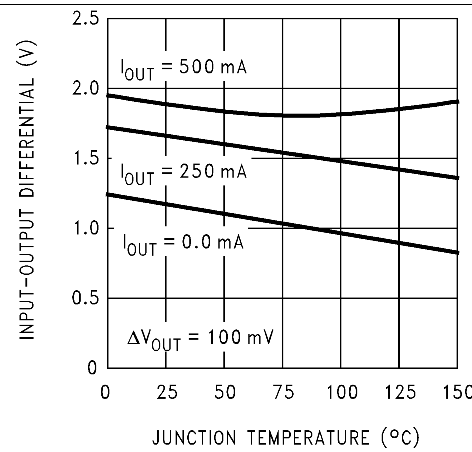
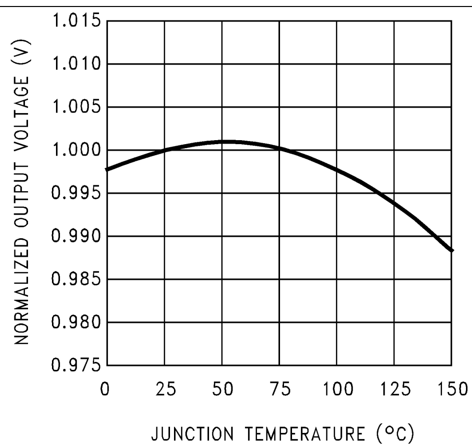


Figure 4. Dropout Voltage



Normalized to 1 V T_J = 25°C

Figure 5. Output Voltage

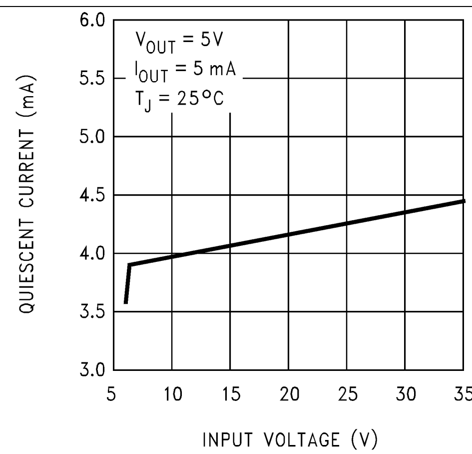


Figure 6. Quiescent Current

Typical Characteristics (continued)

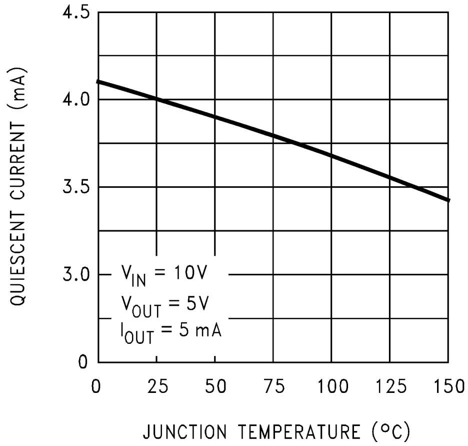


Figure 7. Quiescent Current

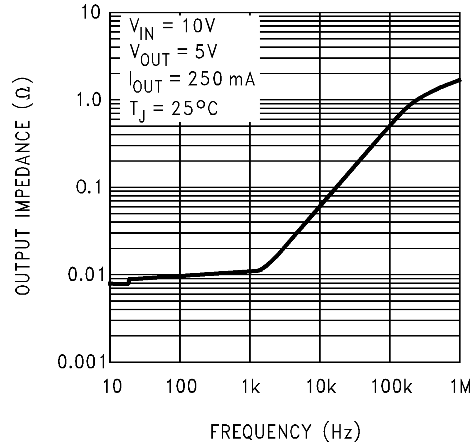


Figure 8. Output Impedance

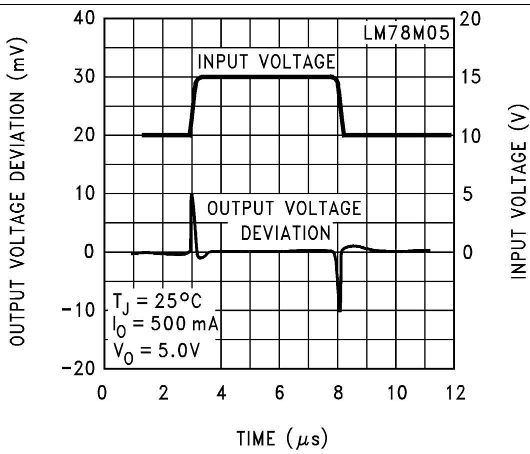


Figure 9. Line Transient Response

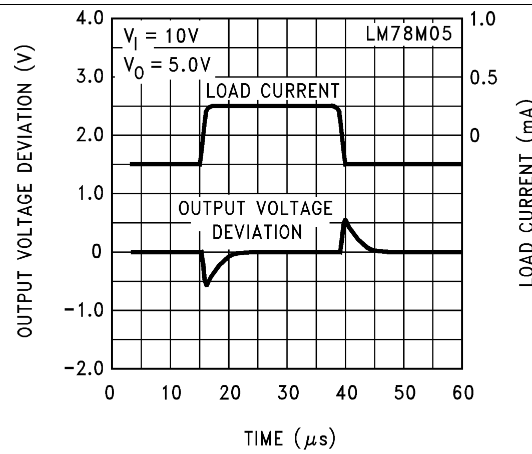


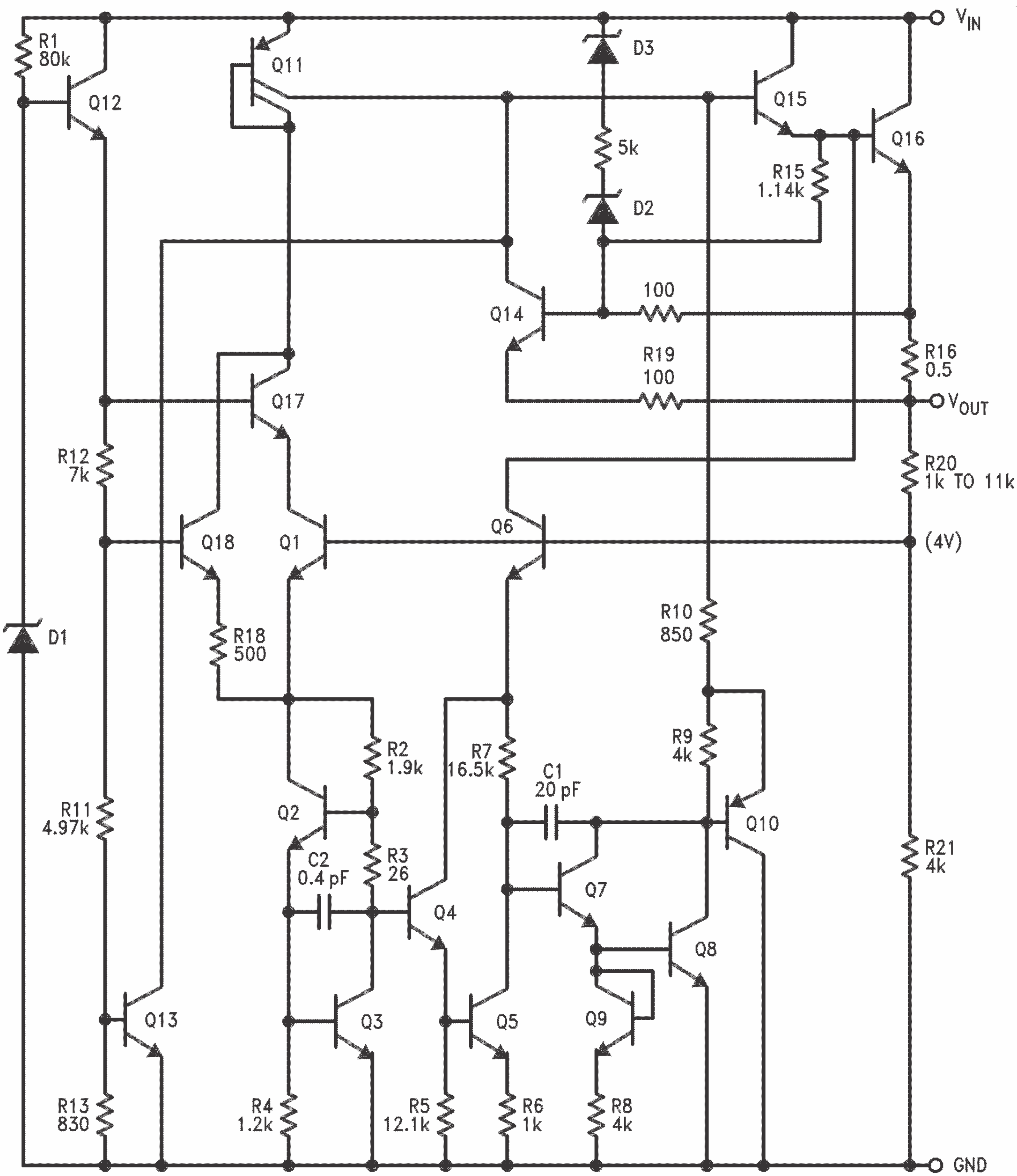
Figure 10. Load Transient Response

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



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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

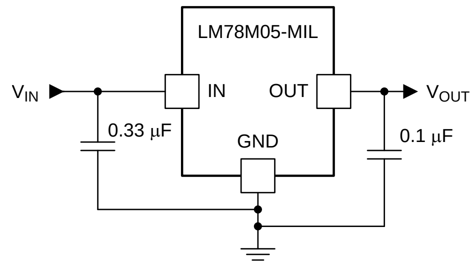
NOTE

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

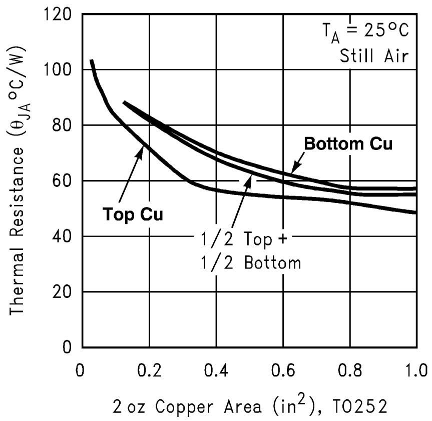


Figure 12. $R_{\theta JA}$ vs 2-oz Copper Area for PFM

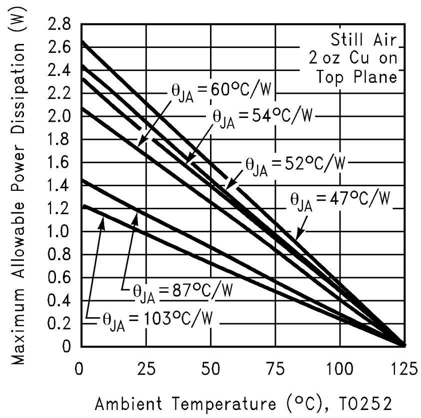


Figure 13. Maximum Allowable Power Dissipation vs Ambient Temperature for PFM

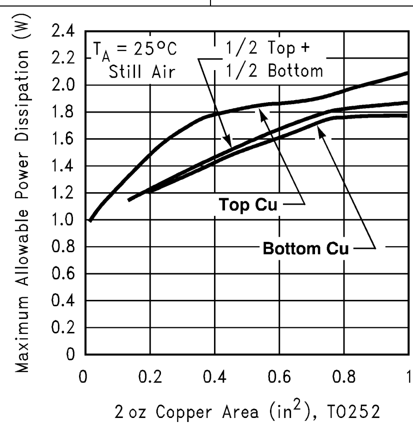


Figure 14. Maximum Allowable Power Dissipation vs 2-oz Copper Area for PFM

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

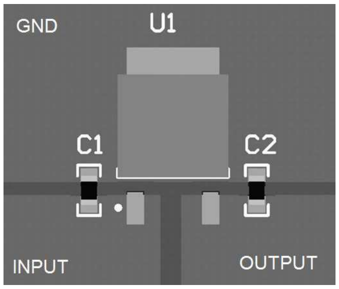


Figure 15. Layout Recommendation

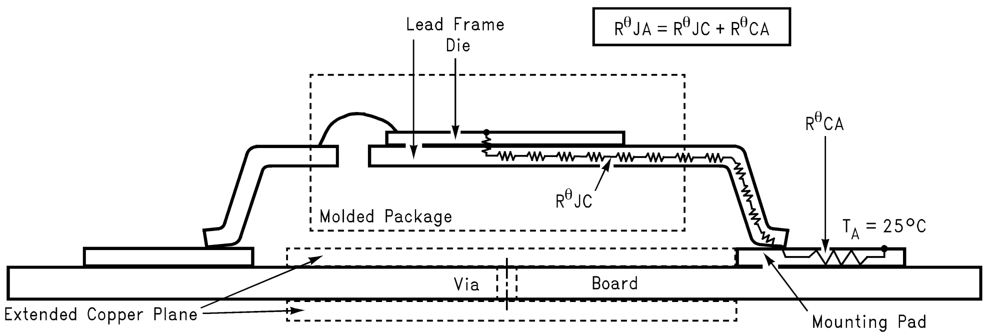
10.3 Thermal Considerations

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.

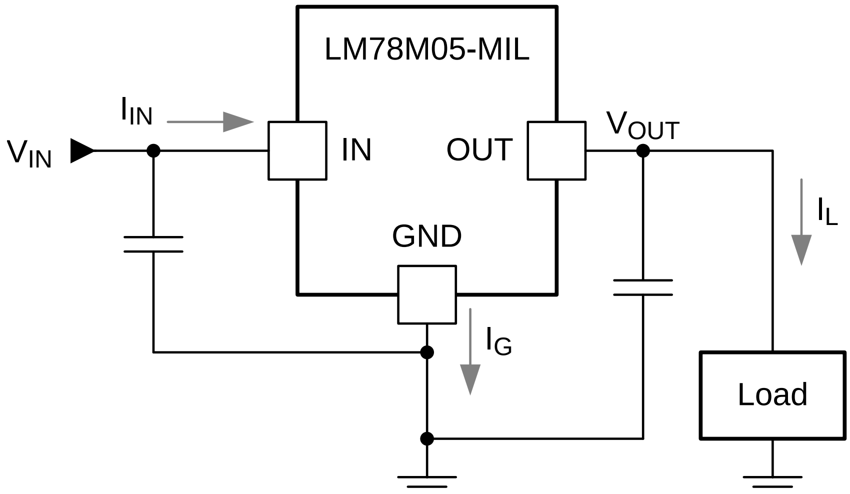


Figure 17. Power Dissipation Diagram

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 (in²)		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 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 電源パッケージの最大電力拡張技法』(SNVA036)

11.2 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、ti.comのデバイス製品フォルダを開いてください。右上の隅にある「*通知を受け取る*」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

11.3 コミュニティ・リソース

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

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設計サポート ***TIの設計サポート*** 役に立つE2Eフォーラムや、設計サポート・ツールをすばやく見つけることができます。技術サポート用の連絡先情報も参照できます。

11.4 商標

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11.5 静電気放電に関する注意事項

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11.6 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
LM78M05CH	ACTIVE	TO	NDT	3	500	RoHS & Green	AU	Level-1-NA-UNLIM	-40 to 125	(LM78M05CH, LM78M 05CH)	Samples
LM78M05CH/NOPB	ACTIVE	TO	NDT	3	500	RoHS & Green	AU	Level-1-NA-UNLIM	-40 to 125	(LM78M05CH, LM78M 05CH)	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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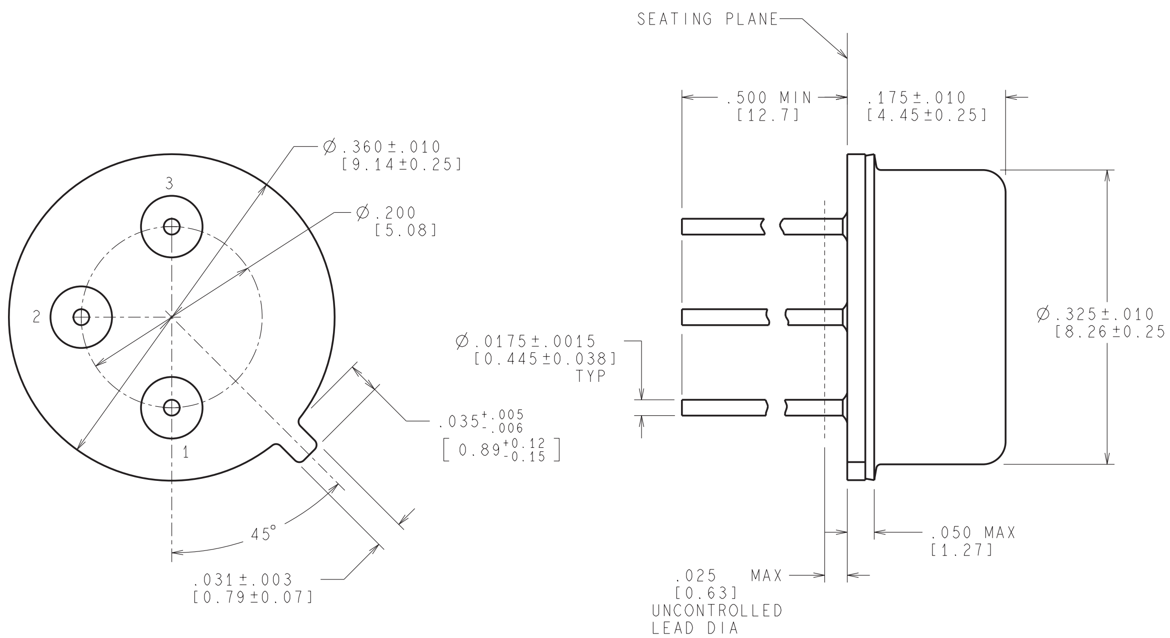

CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

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