LM50およびLM50-Q1 SOT-23、単一電源、摂氏直読温度センサ

1 特長

- LM50-Q1はAEC-Q100グレード1認定済みで、車載用グレードのフローで製造
- 摂氏温度に直接較正(摂氏直読)
- リニア、+10mV/℃のスケール係数
- 25℃において±2℃の精度を保証
- -40℃～125℃の範囲全体にわたって規定
- リモート・アプリケーションに最適
- ウェハ・レベルのトリミングにより低コストを実現
- 4.5V～10Vで動作
- 消費電流130μA未満
- 低い自己発熱: 無気流で0.2℃未満
- 全温度範囲にわたって0.8℃未満の非直線性
- UL認定のコンポーネント

2 アプリケーション

- 車載
- コンピュータ
- ディスク・ドライブ
- バッテリ管理
- FAXマシン
- プリンタ
- ポータブル医療機器
- HVAC
- 電源モジュール

3 概要

LM50およびLM50-Q1デバイスは高精度の集積回路温度センサで、単一正電源を使用して-40℃～125℃の温度範囲を検出できます。デバイスの出力電圧は温度に正比例(10mV/℃)し、DCオフセットは500mVです。このオフセットにより、負電源を必要とせず、負の温度を読み取れます。

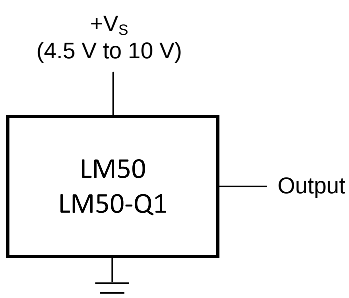
LM50またはLM50-Q1の理想的な出力電圧は、-40℃～125℃の温度範囲について100mV～1.75Vの範囲です。LM50およびLM50-Q1は外部の較正やトリミングを必要とせず、室温で±3℃の精度、-40℃～125℃の温度範囲全体にわたって±4℃の精度が得られます。LM50およびLM50-Q1のウェハ・レベルのトリミングと較正により、低コストと高精度が保証されます。LM50およびLM50-Q1のリニア出力、500mVのオフセット、工場での較正により、単一電源の環境で負の温度の読み取りが必要な場合に回路の要件が単純化されます。LM50およびLM50-Q1の静止電流は130μA未満なので、自己発熱は非常に低く、無気流時に0.2℃に制限されます。

製品情報(1)

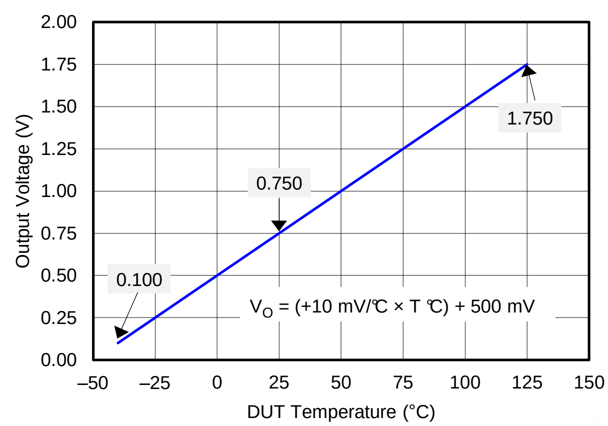
型番	パッケージ	本体サイズ(公称)
LM50、LM50-Q1	SOT-23 (3)	2.92mm×1.30mm

(1) 提供されているすべてのパッケージについては、巻末の注文情報を参照してください。

概略回路図



全範囲の摂氏温度センサ(-40℃～125℃)



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。

Revision E (September 2013) から **Revision F** に変更 **Page**

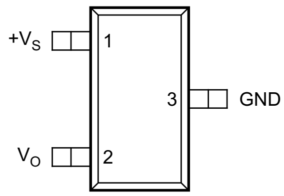
- 「*製品情報*」表、「*ピン構成および機能*」セクション、「*ESD定格*」表、「*詳細説明*」セクション、「*アプリケーションと実装*」セクション、「*電源に関する推奨事項*」セクション、「*レイアウト*」セクション、「*デバイスおよびドキュメントのサポート*」セクション、「*メカニカル、パッケージ、および注文情報*」セクション 追加 ... 1
- Added *Thermal Information* table ... 4
- Changed Junction-to-ambient, $R_{\theta JA}$, value in *Thermal Information* table From: 450°C/W To: 291.9°C/W ... 4
- Deleted the *Temperature To Digital Converter (Parallel TRI-STATE Outputs for Standard Data Bus to µP Interface) (125°C Full Scale)* figure ... 11

Revision C (February 2013) から **Revision E** に変更 **Page**

- データシート全体にLM50-Q1オプションを追加 ... 1

5 Pin Configuration and Functions

DBZ Package
3-Pin SOT-23
Top View



Pin Functions

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	+VS	Power	Positive power supply pin.
2	VOUT	Output	Temperature sensor analog output.
3	GND	Ground	Device ground pin, connected to power supply negative terminal.

6 Specifications

6.1 Absolute Maximum Ratings

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

	MIN	MAX	UNIT
Supply voltage	–0.2	12	V
Output voltage	–1	$+V_S + 0.6$	V
Output current		10	mA
Maximum junction temperature, T_J		150	°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 ESD Ratings

			VALUE	UNIT
LM50				
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM)(1)	±2000	V
		Charged-device model (CDM)	±750	
		Machine model(1)	±250	
LM50-Q1				
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002(2)	±2000	V
		Charged-device model (CDM), per AEC Q100-011	±750	

(1) The human body model is a 100-pF capacitor discharged through a 1.5-kΩ resistor into each pin. Machine model is a 200-pF capacitor discharged directly into each pin.
(2) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

6.3 Recommended Operating Conditions(1)

			MIN	MAX	UNIT
$+V_S$	Supply voltage		4.5	10	V
T_{MIN}, T_{MAX}	Specified temperature	LM50C, LM50-Q1	–40	125	°C
		LM50B	–25	100	
	Operating temperature		–40	150	°C

(1) Soldering process must comply with the Reflow Temperature Profile specifications. Reflow temperature profiles are different for lead-free and non-lead-free packages. Refer to www.ti.com/packaging.

6.4 Thermal Information

THERMAL METRIC(1)		LM50, LM50-Q1 DBZ (SOT-23) 3 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	291.9	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	114.3	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	62.3	°C/W
ψ_{JT}	Junction-to-top characterization parameter	7.4	°C/W
ψ_{JB}	Junction-to-board characterization parameter	61	°C/W

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

6.5 Electrical Characteristics: LM50B

$+V_S$ = 5 V (DC) and I_{LOAD} = 0.5 µA, in the circuit of Figure 12, $T_A = T_J$ = 25°C (unless otherwise noted)(1)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Accuracy(2)	T_A = 25°C	–2		2	°C
	$T_A = T_{MAX}$	–3		3	°C
	$T_A = T_{MIN}$	–3.5		3	°C
Nonlinearity(3)	$T_A = T_J = T_{MIN}$ to T_{MAX}	–0.8		0.8	°C
Sensor gain (average slope)	$T_A = T_J = T_{MIN}$ to T_{MAX}	9.7		10.3	mV/°C
Output resistance	$T_A = T_J = T_{MIN}$ to T_{MAX}		2000	4000	Ω
Line regulation(4)	$+V_S$ = 4.5 V to 10 V, $T_A = T_J = T_{MIN}$ to T_{MAX}	–1.2		1.2	mV/V
Quiescent current(5)	$+V_S$ = 4.5 V to 10 V, $T_A = T_J = T_{MIN}$ to T_{MAX}			180	µA
Change of quiescent current	$+V_S$ = 4.5 V to 10 V, $T_A = T_J = T_{MIN}$ to T_{MAX}			2	µA
Temperature coefficient of quiescent current	$T_A = T_J = T_{MIN}$ to T_{MAX}		1		µA/°C
Long term stability(6)	T_J = 125°C, for 1000 hours		±0.08		°C

(1) Limits are specified to TI's AOQL (Average Outgoing Quality Level).
(2) Accuracy is defined as the error between the output voltage and 10 mv/°C multiplied by the device's case temperature plus 500 mV, at specified conditions of voltage, current, and temperature (expressed in °C).
(3) Nonlinearity is defined as the deviation of the output-voltage-versus-temperature curve from the best-fit straight line, over the device's rated temperature range.
(4) Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output due to heating effects can be computed by multiplying the internal dissipation by the thermal resistance.
(5) Quiescent current is defined in the circuit of Figure 12.
(6) For best long-term stability, any precision circuit will give best results if the unit is aged at a warm temperature, and/or temperature cycled for at least 46 hours before long-term life test begins. This is especially true when a small (Surface-Mount) part is wave-soldered; allow time for stress relaxation to occur. The majority of the drift occurs in the first 1000 hours at elevated temperatures. The drift after 1000 hours does not continue at the first 1000 hour rate.

6.6 Electrical Characteristics: LM50C and LM50-Q1

$+V_S$ = 5 V (DC) and I_{LOAD} = 0.5 µA, in the circuit of Figure 12. $T_A = T_J$ = 25°C, unless otherwise noted.(1)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Accuracy(2)	T_A = 25°C	–3		3	°C
	$T_A = T_{MAX}$	–4		4	°C
	$T_A = T_{MIN}$	–4		4	°C
Nonlinearity(3)	$T_A = T_J = T_{MIN}$ to T_{MAX}	–0.8		0.8	°C
Sensor gain(average slope)	$T_A = T_J = T_{MIN}$ to T_{MAX}	9.7		10.3	mV/°C
Output resistance	$T_A = T_J = T_{MIN}$ to T_{MAX}		2000	4000	Ω
Line regulation(4)	$+V_S$ = 4.5 V to 10 V, $T_A = T_J = T_{MIN}$ to T_{MAX}	–1.2		1.2	mV/V
Quiescent current(5)	$+V_S$ = 4.5 V to 10 V, $T_A = T_J = T_{MIN}$ to T_{MAX}			180	µA
Change of quiescent current	$+V_S$ = 4.5 V to 10 V, $T_A = T_J = T_{MIN}$ to T_{MAX}			2	µA
Temperature coefficient of quiescent current	$T_A = T_J = T_{MIN}$ to T_{MAX}		2		µA/°C
Long term stability(6)	T_J = 125°C, for 1000 hours		±0.08		°C

(1) Limits are specified to TI's AOQL (Average Outgoing Quality Level).
(2) Accuracy is defined as the error between the output voltage and 10 mv/°C multiplied by the device's case temperature plus 500 mV, at specified conditions of voltage, current, and temperature (expressed in °C).
(3) Nonlinearity is defined as the deviation of the output-voltage-versus-temperature curve from the best-fit straight line, over the device's rated temperature range.
(4) Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output due to heating effects can be computed by multiplying the internal dissipation by the thermal resistance.
(5) Quiescent current is defined in the circuit of Figure 12.
(6) For best long-term stability, any precision circuit will give best results if the unit is aged at a warm temperature, and/or temperature cycled for at least 46 hours before long-term life test begins. This is especially true when a small (Surface-Mount) part is wave-soldered; allow time for stress relaxation to occur. The majority of the drift occurs in the first 1000 hours at elevated temperatures. The drift after 1000 hours does not continue at the first 1000 hour rate.

6.7 Typical Characteristics

To generate these curves the device was mounted to a printed circuit board as shown in Figure 20.

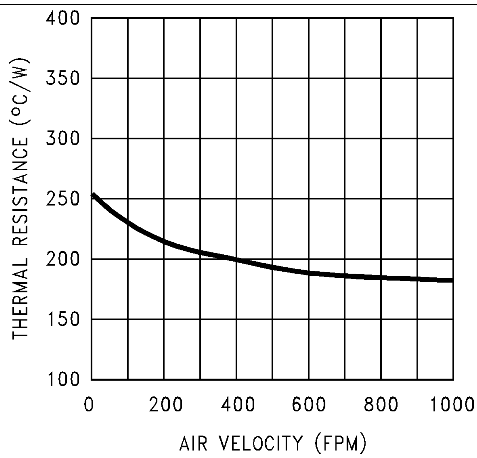


Figure 1. Junction-to-Ambient Thermal Resistance

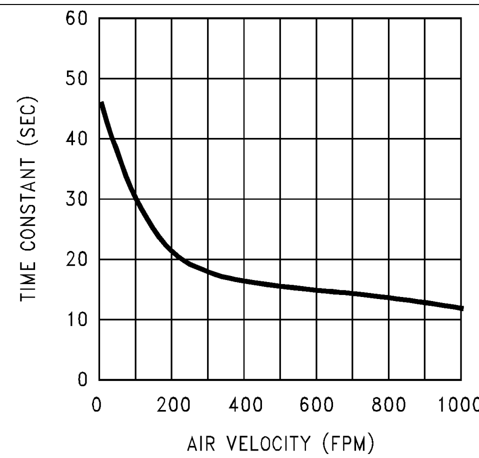
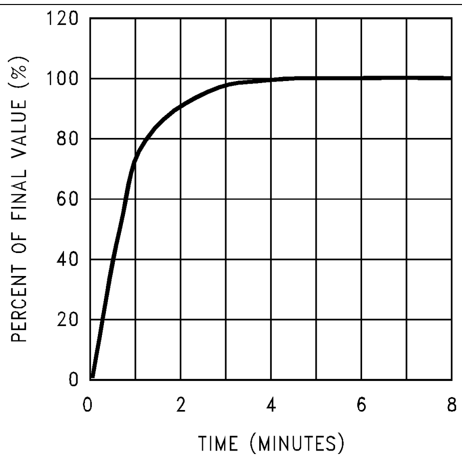


Figure 2. Thermal Time Constant



see Figure 20

Figure 3. Thermal Response in Still Air With Heat Sink

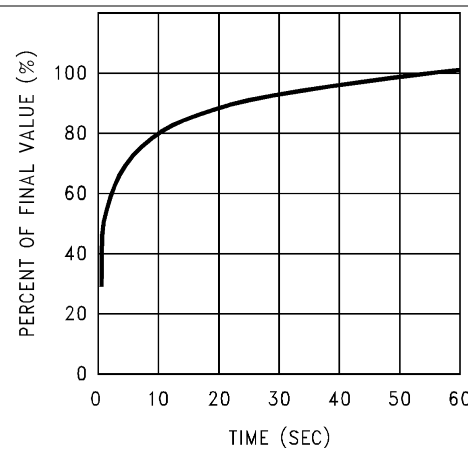


Figure 4. Thermal Response in Stirred Oil Bath With Heat Sink

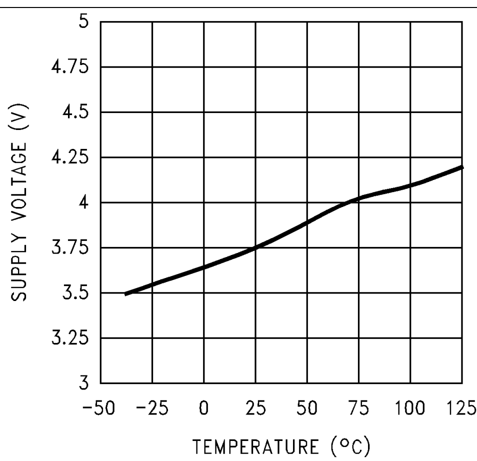


Figure 5. Start-Up Voltage vs Temperature

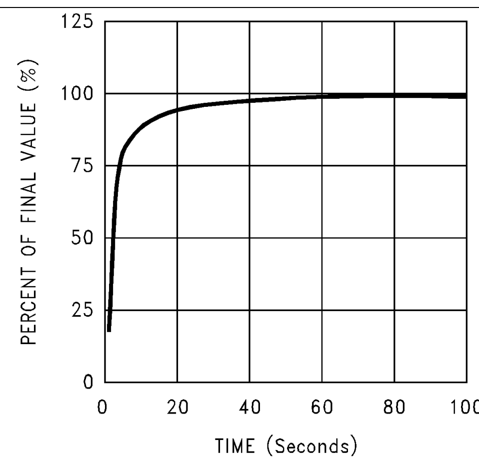
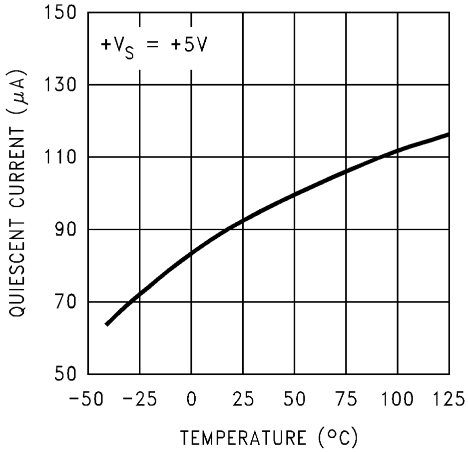


Figure 6. Thermal Response in Still Air Without a Heat Sink

Typical Characteristics (continued)

To generate these curves the device was mounted to a printed circuit board as shown in Figure 20.



see Figure 12

Figure 7. Quiescent Current vs Temperature

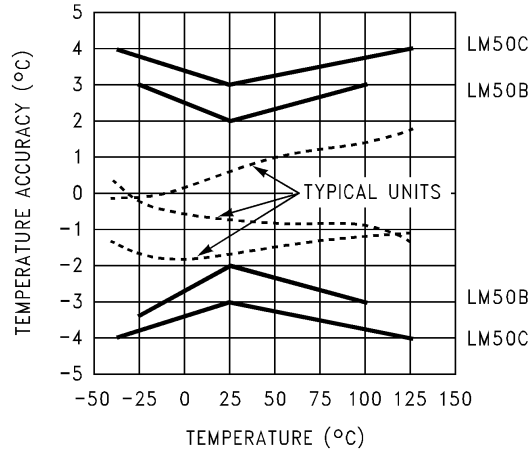


Figure 8. Accuracy vs Temperature

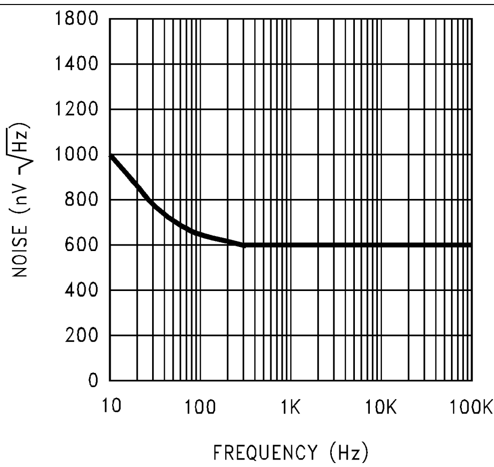


Figure 9. Noise Voltage

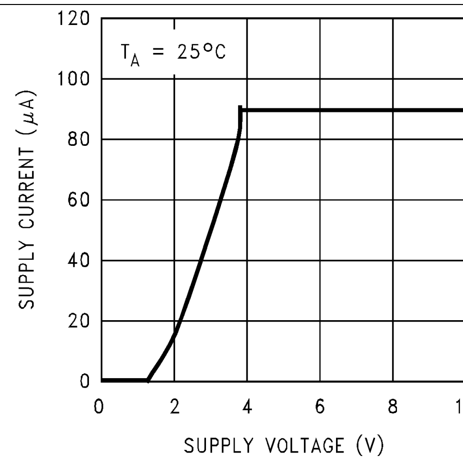


Figure 10. Supply Voltage vs Supply Current

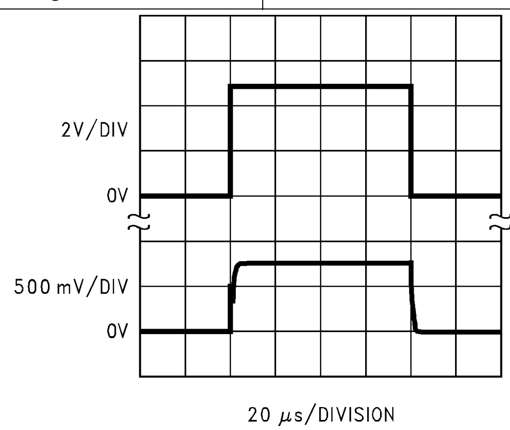


Figure 11. Start-Up Response

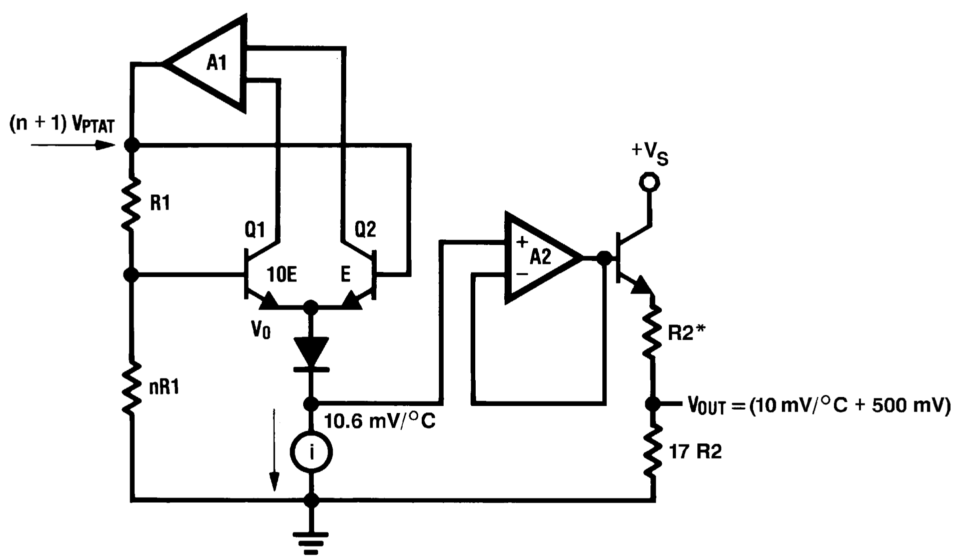
7 Detailed Description

7.1 Overview

The LM50 and LM50-Q1 devices are precision integrated-circuit temperature sensors that can sense a –40°C to 125°C temperature range using a single positive supply. The output voltage of the LM50 and LM50-Q1 has a positive temperature slope of 10 mV/°C. A 500-mV offset is included enabling negative temperature sensing when biased by a single supply.

The temperature-sensing element is comprised of a delta-V_{BE} architecture. The temperature-sensing element is then buffered by an amplifier and provided to the VOUT pin. The amplifier has a simple class A output stage with typical 2-kΩ output impedance as shown in the *Functional Block Diagram*.

7.2 Functional Block Diagram



*R2 ≈ 2k with a typical 1300-ppm/°C drift.

7.3 Feature Description

7.3.1 LM50 and LM50-Q1 Transfer Function

The LM50 and LM50-Q1 follow a simple linear transfer function to achieve the accuracy as listed in the *Electrical Characteristics: LM50B* table and the *Electrical Characteristics: LM50C and LM50-Q1* table.

Use Equation 1 to calculate the value of V_O.

$$V_O = 10\ \text{mV/°C} \times T\ \text{°C} + 500\ \text{mV} \quad (1)$$

where

- T is the temperature in °C
- V_O is the LMT90 output voltage

7.4 Device Functional Modes

The only functional mode of the device has an analog output directly proportional to temperature.

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 LM50 and LM50-Q1 have a wide supply range and a 10 mV/°C output slope with a 500-mV DC offset. Therefore, it can be easily applied in many temperature-sensing applications where a single supply is required for positive and negative temperatures.

8.2 Typical Application

8.2.1 Full-Range Centigrade Temperature Sensor

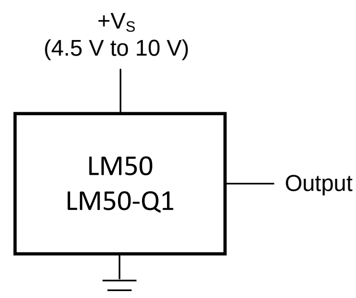


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Figure 12. Full-Range Centigrade Temperature Sensor Diagram(–40°C to 125°C)

8.2.1.1 Design Requirements

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

Table 1. Design Parameters

PARAMETER	VALUE
Power supply voltage	±3°C (maximum)
Output impedance	±4°C (maximum)
Accuracy at 25°C	10 mV/°C
Accuracy over –40°C to 125°C	4.5 V to 10 V
Temperature slope	4 kΩ (maximum)

8.2.1.2 Detailed Design Procedure

The LM50 and LM50-Q1 are simple temperature sensors that provides an analog output. Therefore design requirements related to layout are more important than other requirements. See *Layout* for more information.

8.2.1.2.1 Capacitive Loads

The LM50 and LM50-Q1 handle capacitive loading very well. Without any special precautions, the LM50 and LM50-Q1 can drive any capacitive load. The device has a nominal 2-kΩ output impedance (shown in *Functional Block Diagram*). The temperature coefficient of the output resistors is around 1300 ppm/°C. Taking into account this temperature coefficient and the initial tolerance of the resistors the output impedance of the device will not exceed 4 kΩ. In an extremely noisy environment it may be necessary to add some filtering to minimize noise pickup. TI recommends adding a 0.1-µF capacitor between +VS and GND to bypass the power supply voltage, as shown in Figure 14. It may also be necessary to add a capacitor from VOUT to ground. A 1-µF output capacitor with the 4-kΩ output impedance will form a 40-Hz low-pass filter. Since the thermal time constant of the LM50 and LM50-Q1 is much slower than the 25-ms time constant formed by the RC, the overall response time of the device will not be significantly affected. For much larger capacitors this additional time lag will increase the overall response time of the LM50 and LM50-Q1.

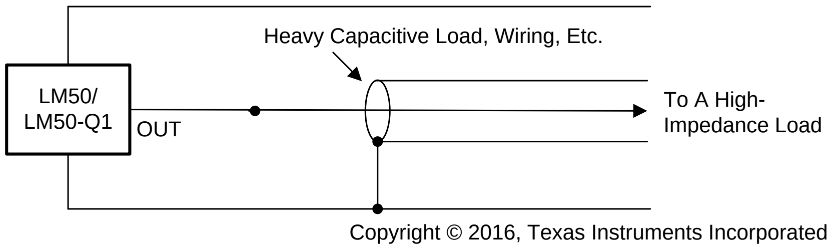


Figure 13. LM50 and LM50-Q1 No Decoupling Required for Capacitive Load

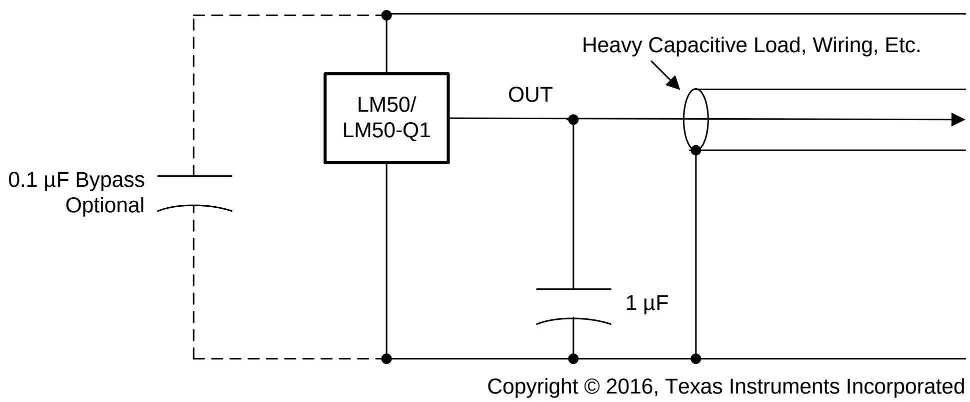


Figure 14. LM50C and LM50-Q1 with Filter for Noisy Environment

8.2.1.3 Application Curve

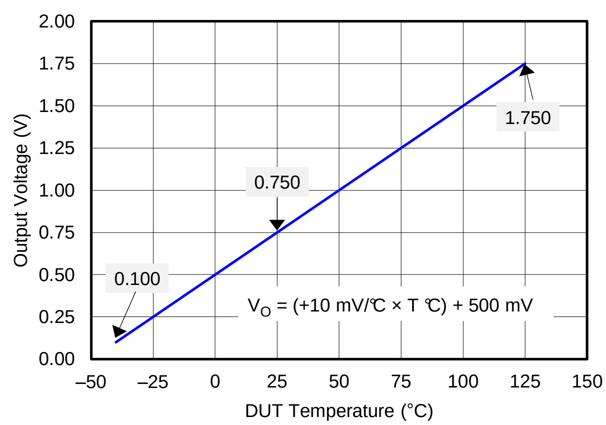


Figure 15. Output Transfer Function

8.3 System Examples

Figure 16 to Figure 18 show application circuit examples using the LM50 or LM50-Q1 devices. Customers must fully validate and test any circuit before implementing a design based on an example in this section. Unless otherwise noted, the design procedures in *Full-Range Centigrade Temperature Sensor* are applicable.

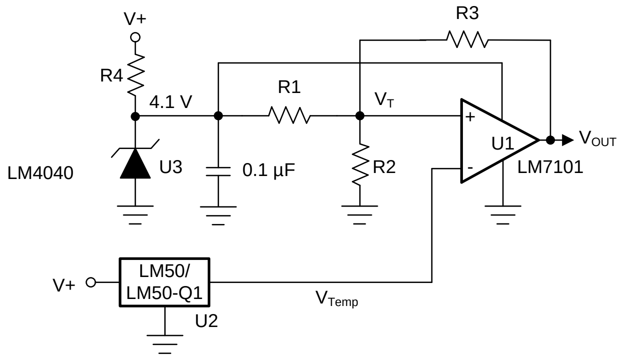
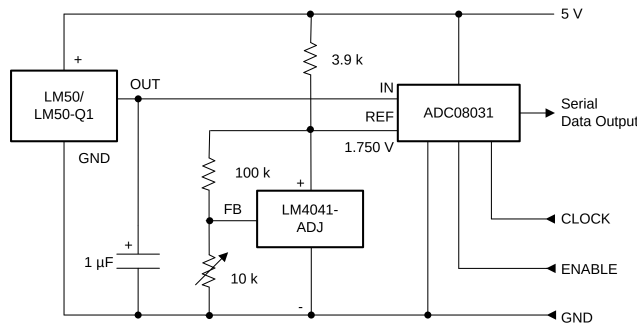
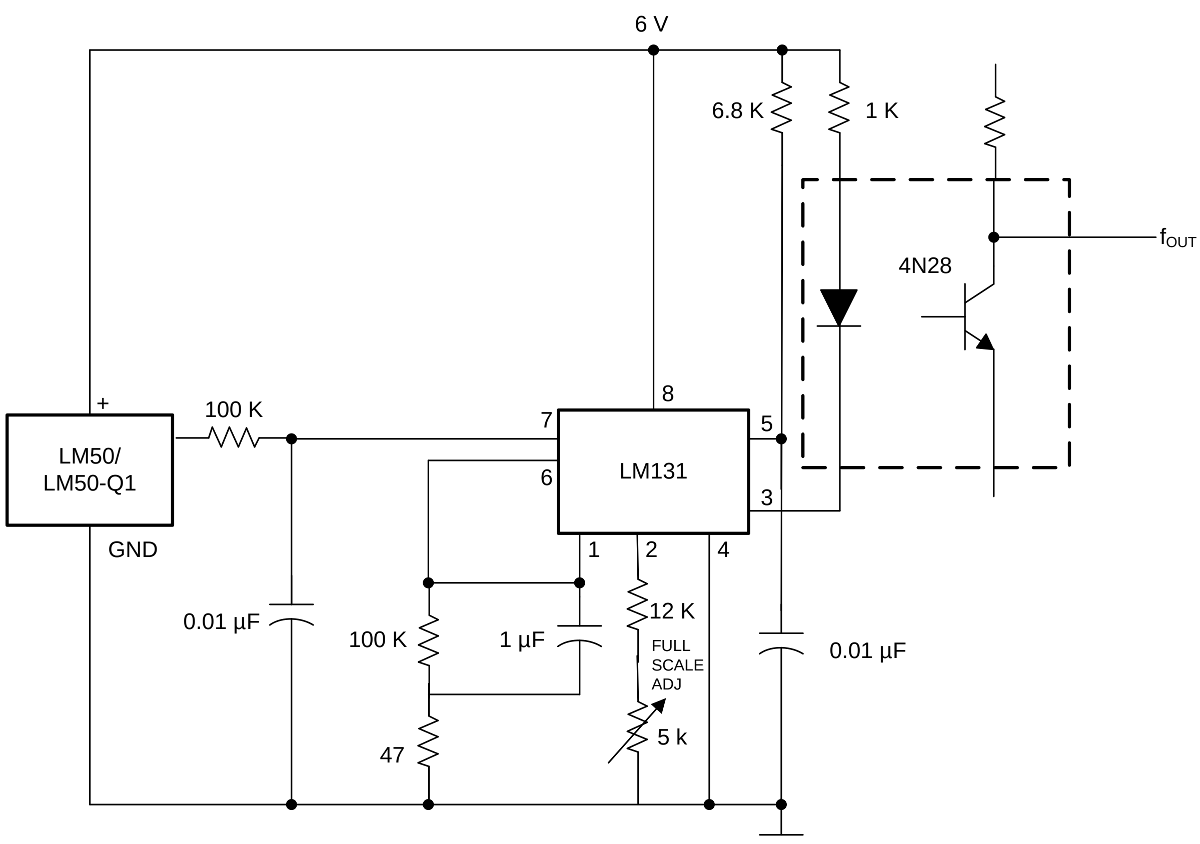


Figure 16. Centigrade Thermostat or Fan Controller



125°C full scale

Figure 17. Temperature To Digital Converter (Serial Output)



–40°C to 125°C; 100 Hz to 1750 Hz

Figure 18. LM50 or LM50-Q1 With Voltage-To-Frequency Converter and Isolated Output

9 Power Supply Recommendations

In an extremely noisy environment, it may be necessary to add some filtering to minimize noise pickup. TI recommends that a 0.1-µF capacitor be added from +VS to GND to bypass the power supply voltage, as shown in Figure 14.

10 Layout

10.1 Layout Guidelines

The LM50 and LM50-Q1 can be applied easily in the same way as other integrated-circuit temperature sensors. The device can be glued or cemented to a surface and its temperature will be within about 0.2°C of the surface temperature.

This presumes that the ambient air temperature is almost the same as the surface temperature; if the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM50 or LM50-Q1 die would be at an intermediate temperature between the surface temperature and the air temperature.

To ensure good thermal conductivity the backside of the LM50 and LM50-Q1 die is directly attached to the GND pin. The lands and traces to the device will, of course, be part of the printed-circuit board, which is the object whose temperature is being measured. These printed-circuit board lands and traces will not cause the LM50 or LM50-Q1's temperature to deviate from the desired temperature.

Alternatively, the LM50 and LM50-Q1 can be mounted inside a sealed-end metal tube, and can then be dipped into a bath or screwed into a threaded hole in a tank. As with any IC, the LM50 and LM50-Q1 and accompanying wiring and circuits must be kept insulated and dry, to avoid leakage and corrosion. This is especially true if the circuit may operate at cold temperatures where condensation can occur. Printed-circuit coatings and varnishes such as Humiseal and epoxy paints or dips are often used to ensure that moisture cannot corrode the device or its connections.

10.2 Layout Example

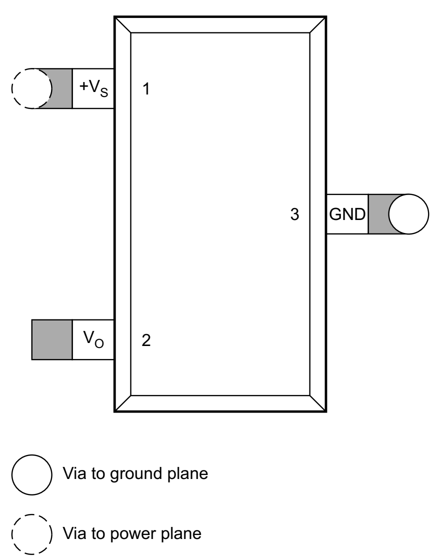
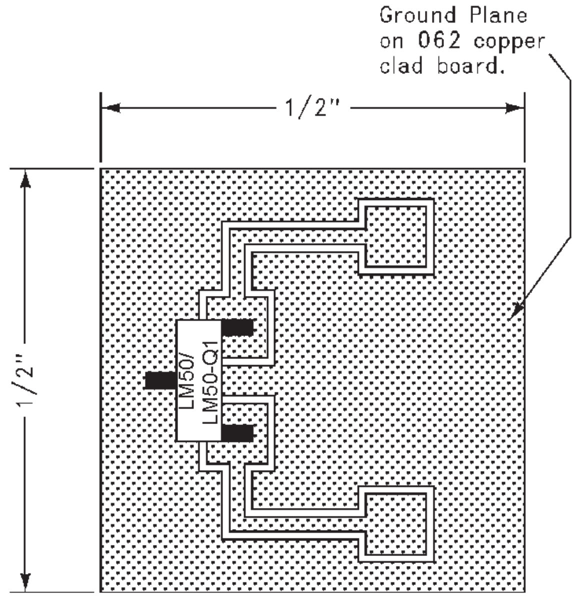


Figure 19. PCB Layout

Layout Example (continued)



1/2 in., square printed-circuit board with 2-oz foil or similar

Figure 20. Printed-Circuit Board Used for Heat Sink to Generate Thermal Response Curves

10.3 Thermal Considerations

Table 2 summarizes the thermal resistance of the LM50 and LM50-Q1 for different conditions.

Table 2. Temperature Rise of LM50 and LM50-Q1 Due to Self-Heating

			$R_{\theta JA}$ (°C/W)
SOT-23	No heat sink(1)	Still air	450
		Moving air	—
	Small heat fin(2)	Still air	260
		Moving air	180

(1) Part soldered to 30 gauge wire.
(2) Heat sink used is 1/2-in., square printed-circuit board with 2-oz foil; part attached as shown in Figure 20.

11 デバイスおよびドキュメントのサポート

11.1 関連リンク

次の表に、クイック・アクセス・リンクを示します。カテゴリには、技術資料、サポートおよびコミュニティ・リソース、ツールとソフトウェア、およびサンプル注文またはご購入へのクイック・アクセスが含まれます。

表 3. 関連リンク

製品	プロダクト・フォルダ	サンプルとご購入	技術資料	ツールとソフトウェア	サポートとコミュニティ
LM50	ここをクリック	ここをクリック	ここをクリック	ここをクリック	ここをクリック
LM50-Q1	ここをクリック	ここをクリック	ここをクリック	ここをクリック	ここをクリック

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

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

11.5 静電気放電に関する注意事項

すべての集積回路は、適切なESD保護方法を用いて、取扱いと保存を行うようにして下さい。

静電気放電はわずかな性能の低下から完全なデバイスの故障に至るまで、様々な損傷を与えます。高精度の集積回路は、損傷に対して敏感であり、極めてわずかなパラメータの変化により、デバイスに規定された仕様に適合しなくなる場合があります。

11.6 用語集

SLYZ022 — *TI用語集*.

この用語集には、用語や略語の一覧および定義が記載されています。

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
LM50BIM3	NRND	SOT-23	DBZ	3	1000	Non-RoHS & Green	Call TI	Level-1-260C-UNLIM	-40 to 150	T5B	
LM50BIM3X/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	T5B	Samples
LM50CIM3	ACTIVE	SOT-23	DBZ	3	1000	Non-RoHS & Green	Call TI	Level-1-260C-UNLIM	-40 to 125	T5C	Samples
LM50CIM3X	NRND	SOT-23	DBZ	3	3000	Non-RoHS & Green	Call TI	Level-1-260C-UNLIM	-40 to 150	T5C	
LM50CIM3X/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	T5C	Samples
LM50QIM3X/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	T5Q	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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OTHER QUALIFIED VERSIONS OF LM50, LM50-Q1 :

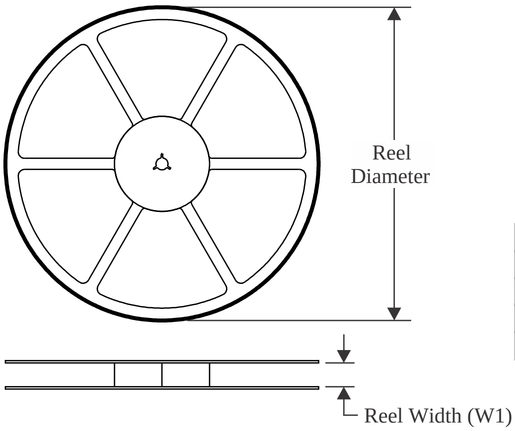
- Catalog : LM50
- Automotive : LM50-Q1

NOTE: Qualified Version Definitions:

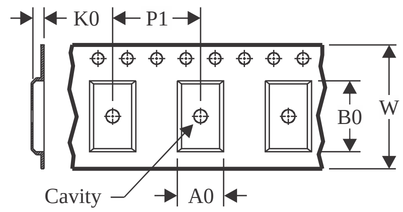
- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

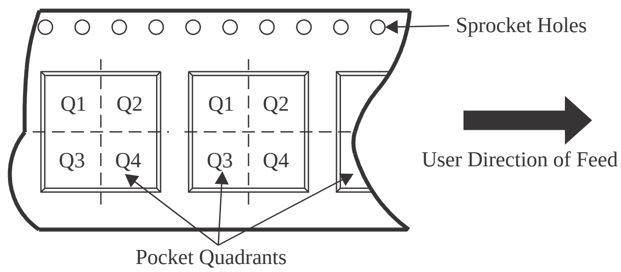


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

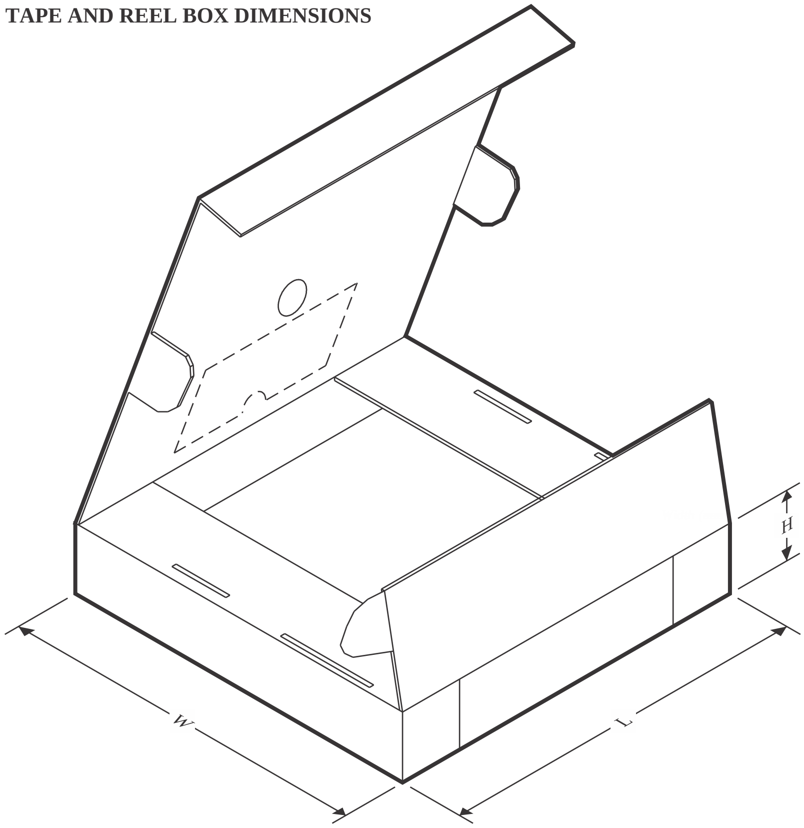
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM50BIM3	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM50BIM3X/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM50CIM3	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM50CIM3X	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM50CIM3X/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM50QIM3X/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



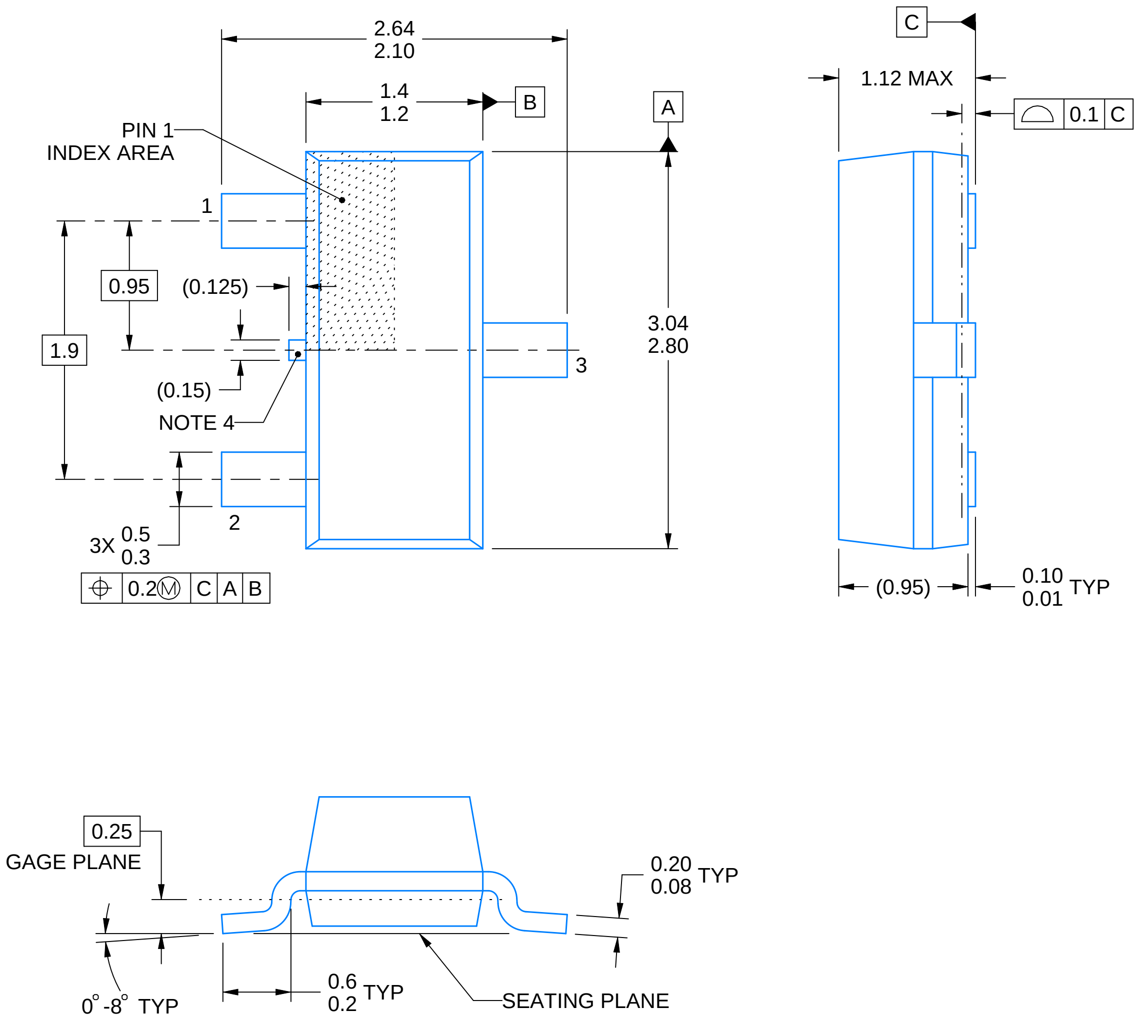
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM50BIM3	SOT-23	DBZ	3	1000	208.0	191.0	35.0
LM50BIM3X/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM50CIM3	SOT-23	DBZ	3	1000	208.0	191.0	35.0
LM50CIM3X	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM50CIM3X/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0
LM50QIM3X/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0

DBZ0003A

SOT-23 - 1.12 mm max height

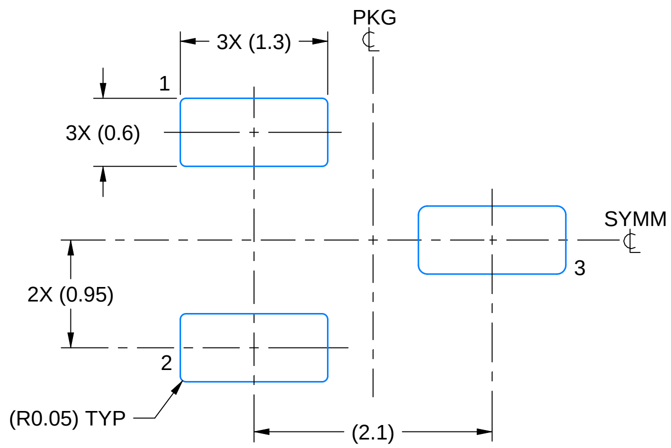
SMALL OUTLINE TRANSISTOR



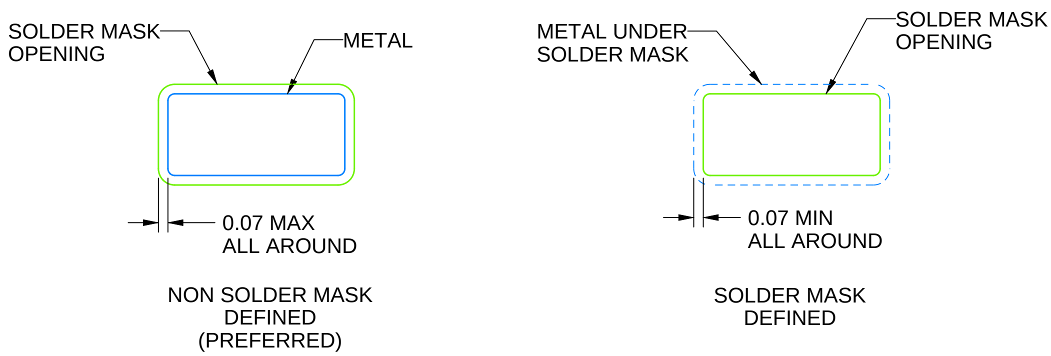
4214838/D 03/2023

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration TO-236, except minimum foot length.
4. Support pin may differ or may not be present.



LAND PATTERN EXAMPLE
SCALE:15X

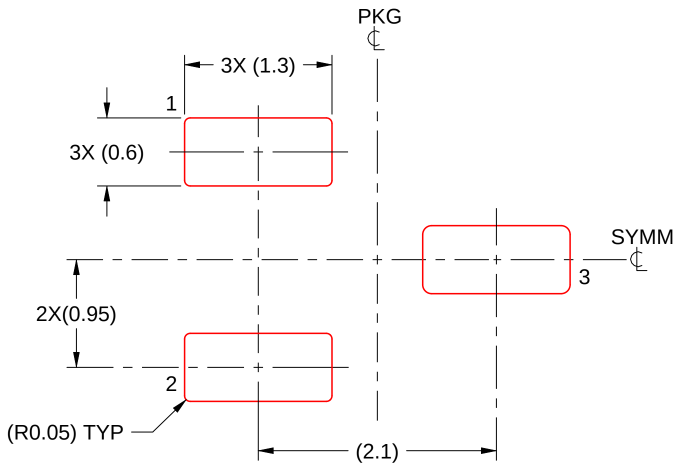


SOLDER MASK DETAILS

4214838/D 03/2023

NOTES: (continued)

4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:15X

4214838/D 03/2023

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
7. Board assembly site may have different recommendations for stencil design.

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