LM60-Q1 2.7V、SOT-23温度センサ

1 特長

- **車載アプリケーション用にAEC-Q100認定済み**
  - デバイス温度グレード 1: 動作時周囲温度 –40℃～+125°C
  - デバイスHBM ESD分類レベル2
- **較正済み線形スケール係数**: 6.25mV/℃
- -40℃から＋125℃までの範囲全体が定格内
- **リモート・アプリケーションに最適**
- SOT-23**パッケージで供給**
- **主な仕様**
  - 25℃での精度: ±2℃および±3℃(最大値)
  - −40℃～＋125℃での精度: ±4℃(最大値)
  - −25℃～＋125℃での精度: ±3℃(最大値)
  - 温度勾配: 6.25mV/℃
  - 電源電圧範囲: 2.7V～10V
  - 25℃での電流ドレイン: 110µA (最大値)
  - 非直線性: ±0.8℃(最大値)
  - 出力インピーダンス: 800Ω(最大値)

2 アプリケーション

- **車載用**
- **携帯電話およびコンピュータ**
- **電源モジュール**
- **バッテリ管理**
- FAX**およびプリンタ**
- HVAC**およびディスク・ドライブ**
- **家電製品**

3 概要

LM60-Q1デバイスは高精度の統合回路温度センサで、単一の2.7V電源により動作し、-40℃～125℃の温度範囲を検出できます。デバイスの出力電圧は摂氏温度に正比例(6.25mV/℃)し、DCオフセットは424mVです。

このオフセットにより、負電源を必要とせずに負温度を読み取れます。デバイスの公称出力電圧は、-40℃～＋125℃の温度範囲について 174mV～1205mVです。このデバイスは、室温で±2℃、-25℃～＋125℃の温度範囲全体にわたって±3℃の精度を維持するよう較正済みです。

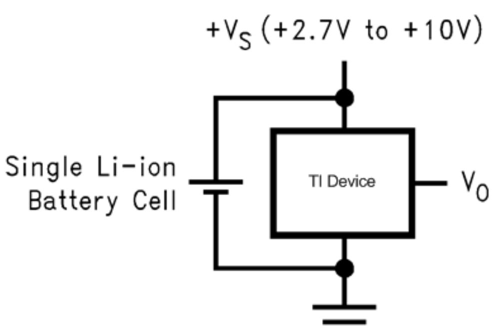
デバイスの線形出力、424mVのオフセット、工場での較正により、単一電源の環境で負温度の読み取りが要求される場合に必要な外部回路が簡素化されます。静止電流が110µA未満なので、自己発熱が非常に少なく、SOT-23パッケージの静止空気中で0.1℃に抑えられています。このデバイスは本質的に低消費電力であり、様々なロジック・ゲートの出力から直接電源を供給できるので、専用の制御端子を備えていなくても容易にシャットダウンができます。

製品情報(1)

型番	パッケージ	本体サイズ(公称)
LM60-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、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。

概略回路図



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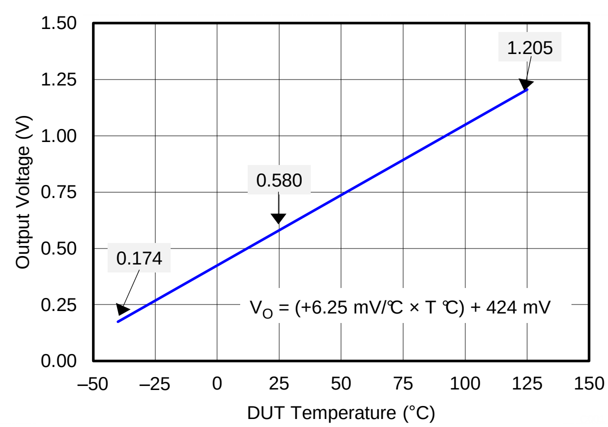
全範囲の摂氏温度センサ (−40℃～＋125℃)



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。

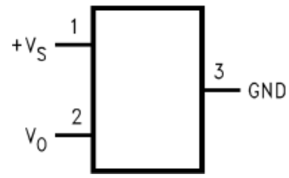
日付	改訂内容	注
2017年8月	*	初版。車載用デバイスをSNIS119から、スタンドアロンのデータシートへ移動

5 Device Comparison Table

ORDER NUMBER	ACCURACY OVER SPECIFIED TEMPERATURE RANGE	SPECIFIED TEMPERATURE RANGE
LM60BIM3	±3	–25°C ≤ T_A ≤ +125°C
LM60BIM3X		
LM60CIM3	±4	–40°C ≤ T_A ≤ +125°C
LM60CIM3X		
LM60QIM3	±4	–40°C ≤ T_A ≤ +125°C
LM60QIM3X		
LM60BIZ	±3	–25°C ≤ T_A ≤ +125°C
LM60CIZ	±4	–40°C ≤ T_A ≤ +125°C

6 Pin Configuration and Functions

DBZ Package
3-Pin SOT-23
Top View



Pin Functions

PIN		TYPE	DESCRIPTION
NAME	SOT-23		
GND	3	GND	Device ground, connected to power supply negative terminal
V_{OUT}	2	O	Temperature sensor analog output
$+V_S$	1	POWER	Positive power supply pin

7 Specifications

7.1 Absolute Maximum Ratings

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

	MIN	MAX	UNIT
Supply voltage	−0.2	12	V
Output voltage	−0.6	V_S + 0.6	V
Output current		10	mA
Input current at any pin(2)		5	mA
Maximum junction temperature (T_{JMAX})		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) When the input voltage (V_I) at any pin exceeds power supplies (V_I < GND or V_I > $+V_S$), the current at that pin should be limited to 5 mA.

7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge(1)	Human-body model (HBM), per AEC Q100-002(2)	±2500	V
		Machine model (MM)	±250	

(1) The human body model is a 100-pF capacitor discharged through a 1.5-kΩ resistor into each pin. The 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.

7.3 Recommended Operating Conditions

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

	MIN	MAX	UNIT
LM60-Q1 ($T_{MIN} \le T_A \le T_{MAX}$)	–40	125	°C
Supply voltage ($+V_S$)	2.7	10	V

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

7.4 Thermal Information

THERMAL METRIC(1)		LM60-Q1 DBZ (SOT-23) 3 PINS	UNIT
$R_{\theta JA}$ (2)	Junction-to-ambient thermal resistance	266	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	135	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	59	°C/W
ψ_{JT}	Junction-to-top characterization parameter	18	°C/W
ψ_{JB}	Junction-to-board characterization parameter	58	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor or IC Package Thermal Metrics* application report.
(2) The junction to ambient thermal resistance ($R_{\theta JA}$) is specified without a heat sink in still air.

7.5 Electrical Characteristics

Unless otherwise noted, these specifications apply for $+V_S = 3\ V_{DC}$ and $I_{LOAD} = 1\ \mu A$. All limits $T_A = T_J = 25°C$ unless otherwise noted.

PARAMETER	TEST CONDITIONS		MIN(1)	TYP(2)	MAX(1)	UNIT
Accuracy(3)	LM60-Q1		–3		3	°C
		$T_A = T_J = T_{MIN}$ to T_{MAX}	–4		4	°C
Output voltage at 0°C				424		mV
Nonlinearity(4)	LM60-Q1	$T_A = T_J = T_{MIN}$ to T_{MAX}	–0.8		±0.8	°C
Sensor gain (average slope)	LM60-Q1	$T_A = T_J = T_{MIN}$ to T_{MAX}	6		6.5	mV/°C
Output impedance	$T_A = T_J = T_{MIN}$ to T_{MAX}				800	Ω
Line regulation(5)	$3\ V \le +V_S \le 10\ V$	$T_A = T_J = T_{MIN}$ to T_{MAX}	–0.3		0.3	mV/V
	$2.7\ V \le +V_S \le 3.3\ V$	$T_A = T_J = T_{MIN}$ to T_{MAX}	–2.3		2.3	mV
Quiescent current	$2.7\ V \le +V_S \le 10\ V$			82	110	μA
		$T_A = T_J = T_{MIN}$ to T_{MAX}			125	μA
Change of quiescent current	$2.7\ V \le +V_S \le 10\ V$			±5		μA
Temperature coefficient of quiescent current				0.2		μA/°C

(1) Limits are specified to TI's AOQL (Average Outgoing Quality Level).
(2) Typicals are at $T_J = T_A = 25°C$ and represent most likely parametric norm.
(3) Accuracy is defined as the error between the output voltage and 6.25 mV/°C times the case temperature of the device plus 424 mV, at specified conditions of voltage, current, and temperature (expressed in °C).
(4) Nonlinearity is defined as the deviation of the output-voltage-versus-temperature curve from the best-fit straight line, over the rated temperature range of the device.
(5) 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.

Electrical Characteristics (continued)

Unless otherwise noted, these specifications apply for $+V_S$ = 3 V_{DC} and I_{LOAD} = 1 µA. All limits T_A = T_J = 25°C unless otherwise noted.

PARAMETER	TEST CONDITIONS	MIN(1)	TYP(2)	MAX(1)	UNIT
Long-term stability(6)	T_J = T_{MAX} = 125°C for 1000 hours		±0.2		°C

(6) For best long-term stability, any precision circuit will give best results if the unit is aged at a warm temperature, temperature cycled for at least 46 hours before long-term life test begins for both temperatures. 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 will occur in the first 1000 hours at elevated temperatures. The drift after 1000 hours will not continue at the first 1000 hour rate.

7.6 Typical Characteristics

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

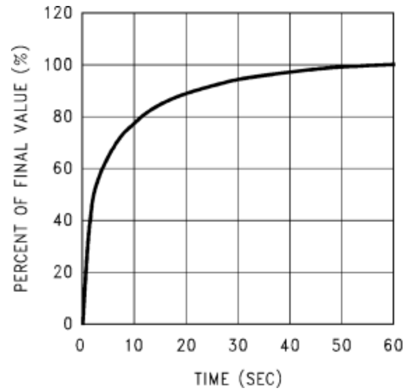


Figure 1. Thermal Resistance Junction to Air

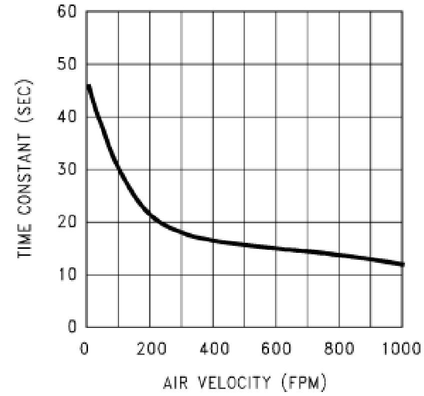


Figure 2. Thermal Time Constant

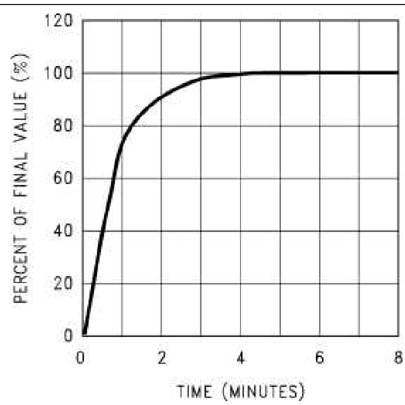


Figure 3. Thermal Response in Still Air With Heat Sink

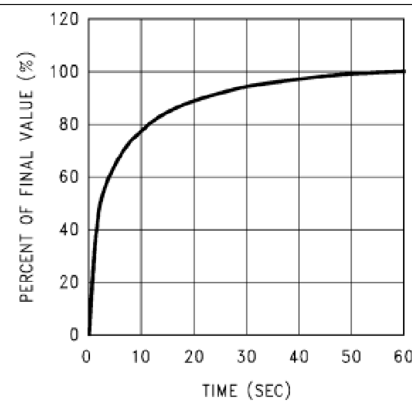


Figure 4. Thermal Response in Stirred Oil Bath With Heat Sink

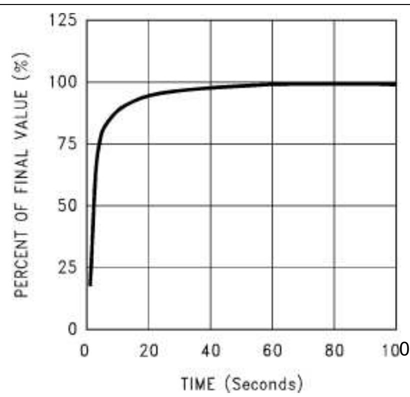


Figure 5. Thermal Response in Still Air Without a Heat Sink

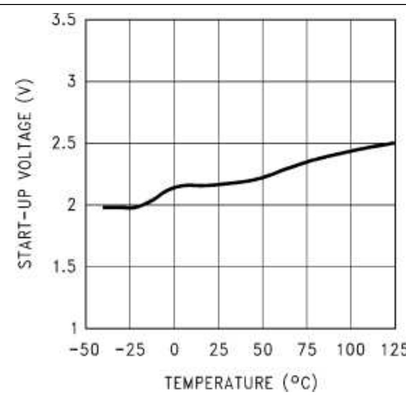


Figure 6. Start-Up Voltage vs Temperature

Typical Characteristics (continued)

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

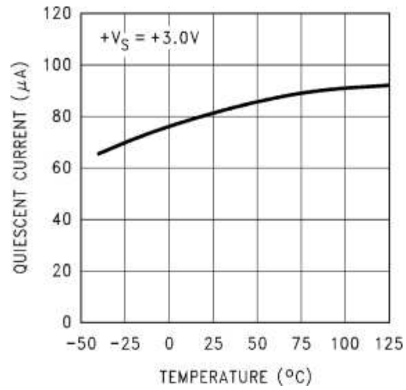


Figure 7. Quiescent Current vs Temperature

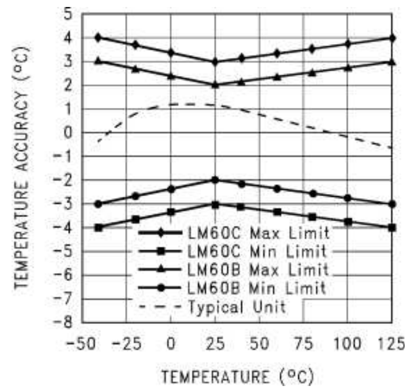


Figure 8. Accuracy vs Temperature

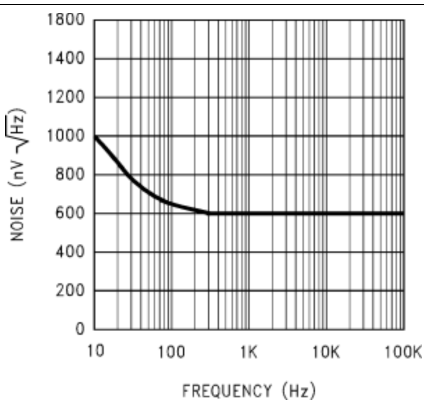


Figure 9. Noise Voltage

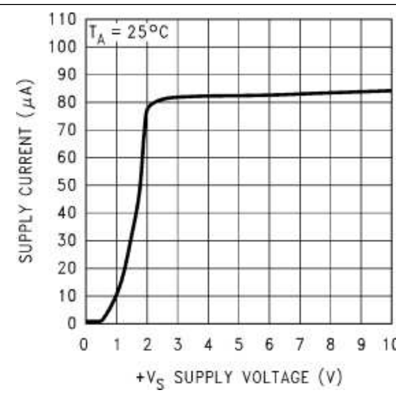
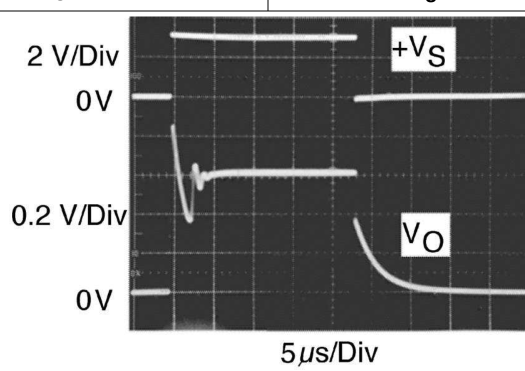


Figure 10. Supply Voltage vs Supply Current



SVA-1268122

Figure 11. Start-Up Response

8 Detailed Description

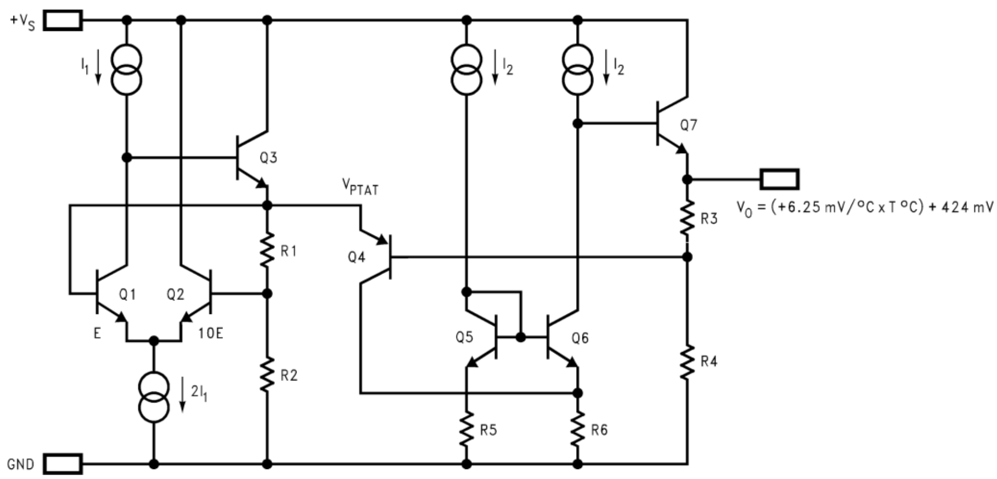
8.1 Overview

TheLM60-Q1 devices are precision analog bipolar temperature sensors that can sense a −40°C to +125°C temperature range while operating from a single 2.7-V supply. The output voltage of the LM60-Q1 is linearly proportional to Celsius (Centigrade) temperature (6.25 mV/°C) and has a DC offset of 424 mV. The offset allows reading negative temperatures with a single positive supply. The nominal output voltage of the device ranges from 174 mV to 1205 mV for a −40°C to +125°C temperature range. The device is calibrated to provide accuracies of ±2.0°C at room temperature and ±3°C over the full −25°C to +125°C temperature range.

With a quiescent current of the device is less than 110 µA, self-heating is limited to a very low 0.1°C in still air in the SOT-23 package. Shutdown capability for the device is intrinsic because its inherent low power consumption allows it to be powered directly from the output of many logic gates.

The output of the LM60-Q1 is a Class A base emitter follower, thus the LM60-Q1 can source quite a bit of current while sinking less than 1 µA. In any event load current should be minimized in order to limit it's contribution to the total temperature error. The temperature-sensing element is based on a delta V_{BE} topology of two transistors (Q1 and Q2 in *Functional Block Diagram*) that are sized with a 10:1 area ratio.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 LM60 Transfer Function

The LM60 follows a simple linear transfer function to achieve the accuracy as listed in *Electrical Characteristics* as given:

$$V_O = (6.25\ \text{mV/°C} \times T\ \text{°C}) + 424\ \text{mV} \quad (1)$$

where

- T is the temperature
- V_O is the LM60-Q1 output voltage

8.4 Device Functional Modes

The only functional mode for this device is an analog output directly proportional to temperature.

9 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.

9.1 Application Information

The device has a low supply current and a wide supply range, therefore it can easily be driven by a battery.

9.1.1 Capacitive Loads

The device handles capacitive loading well. Without any special precautions, the device can drive any capacitive load as shown in Figure 12. Over the specified temperature range the device has a maximum output impedance of 800 Ω. In an extremely noisy environment, adding some filtering to minimize noise pick-up may be required. TI recommends that 0.1 μF be added from $+V_S$ to GND to bypass the power supply voltage, as shown in Figure 13. In a noisy environment, adding a capacitor from the output to ground may be required. A 1-μF output capacitor with the 800-Ω output impedance forms a 199-Hz, low-pass filter. Because the thermal time constant of the device is much slower than the 6.3-ms time constant formed by the RC, the overall response time of the device is not be significantly affected. For much larger capacitors, this additional time lag increases the overall response time of the device.

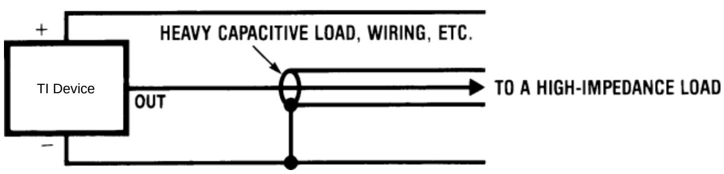


Figure 12. No Decoupling Required for Capacitive Load

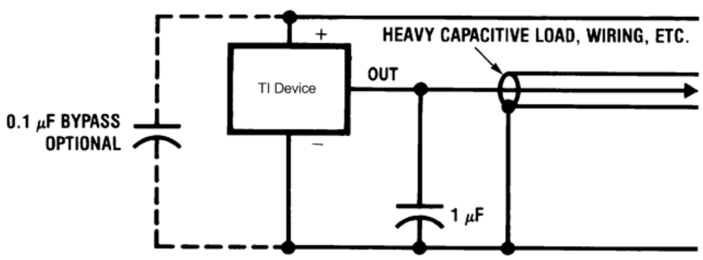
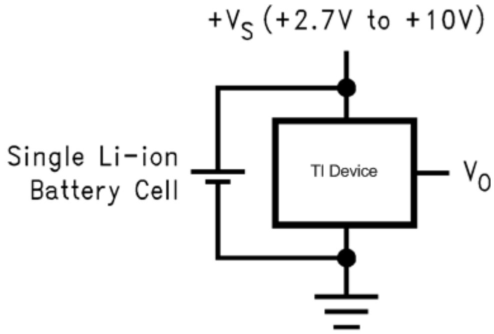


Figure 13. Filter Added for Noisy Environment

9.2 Typical Applications

9.2.1 Full-Range Centigrade Temperature Sensor

Because the LM60-Q1 is a simple temperature sensor that provides an analog output, design requirements related to the layout are also important. Refer to *Layout* for details.



V_O = (6.25 mV/°C × T°C) + 424 mV

Figure 14. Full-Range Centigrade Temperature Sensor (−40°C to +125°C) Operating From a Single Li-Ion Battery Cell

9.2.1.1 Design Requirements

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

Table 1. Temperature and Typical V_O Values of Figure 14

TEMPERATURE (T)	TYPICAL V_O
125°C	1205 mV
100°C	1049 mV
25°C	580 mV
0°C	424 mV
–25°C	268 mV
–40°C	174 mV

9.2.1.2 *Detailed Design Procedure*

Selection of the LM60-Q1 is based on the output voltage transfer function being able to meet the needs of the rest of the system.

9.2.1.3 *Application Curve*

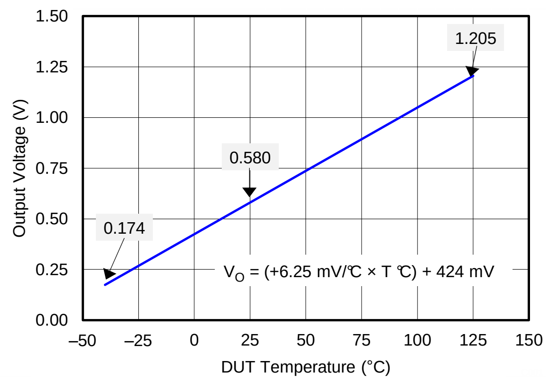


Figure 15. LM60-Q1 Output Transfer Function

9.2.2 Centigrade Thermostat Application

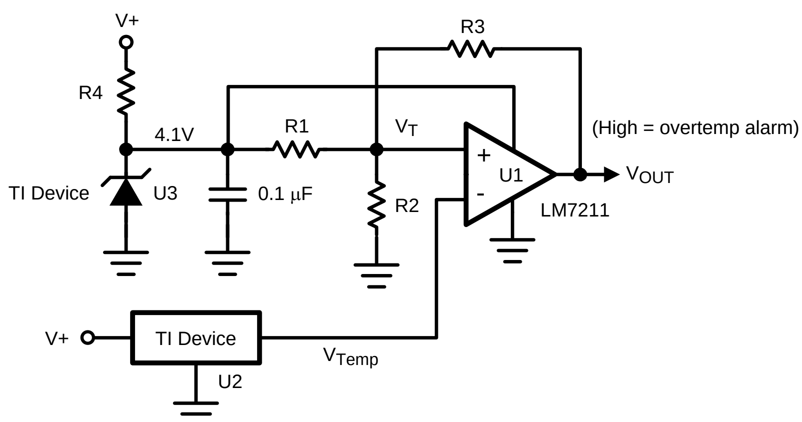


Figure 16. Centigrade Thermostat

9.2.2.1 *Design Requirements*

A simple thermostat can be created by using a reference (LM4040) and a comparator (LM7211) as shown in Figure 16.

9.2.2.2 *Detailed Design Procedure*

Use Equation 2 and Equation 3 to calculate the threshold values for T1 and T2.

$$V_{T1} = \frac{(4.1)R2}{R2 + R1||R3} \tag{2}$$

$$V_{T2} = \frac{(4.1)R2||R3}{R1 + R2||R3} \tag{3}$$

9.2.2.3 Application Curve

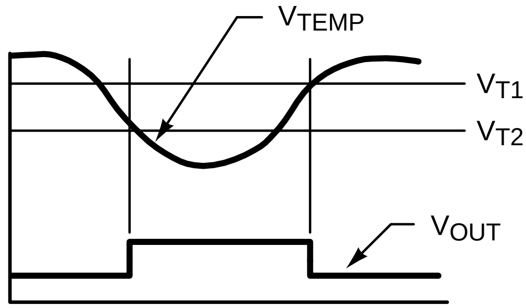


Figure 17. Thermostat Output Waveform

9.3 System Examples

9.3.1 Conserving Power Dissipation With Shutdown

The LM60-Q1 draws very little power, therefore it can simply be shutdown by driving the LM60-Q1 supply pin with the output of a logic gate as shown in Figure 18.

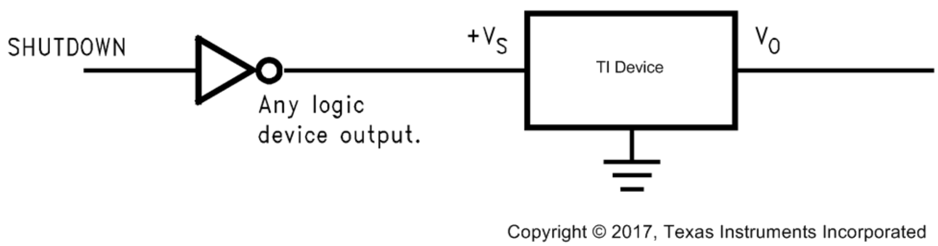


Figure 18. Conserving Power Dissipation With Shutdown

10 Power Supply Recommendations

In an extremely noisy environment, add some filtering to minimize noise pick-up. Adding 0.1 μF from $+V_S$ to GND is recommended to bypass the power supply voltage, as shown in Figure 13. In a noisy environment, add a capacitor from the output to ground.

11 Layout

11.1 Layout Guidelines

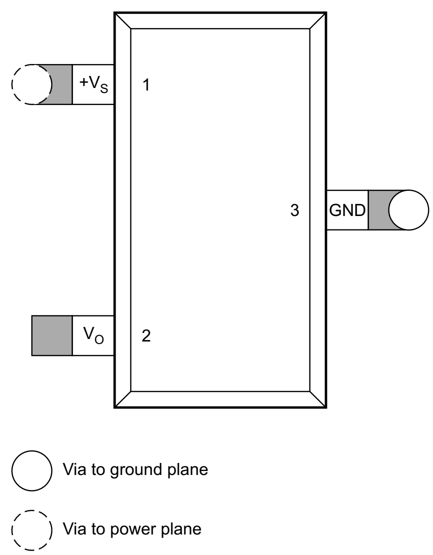
The LM60-Q1 can be applied easily in the same way as other integrated-circuit temperature sensors. It can be glued or cemented to a surface. The temperature that the LM60-Q1 is sensing will be within about +0.1°C of the surface temperature that the leads of th LM60-Q1 are attached to.

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 device die would be at an intermediate temperature between the surface temperature and the air temperature.

To ensure good thermal conductivity the backside of the device 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 do not cause the temperature of the device to deviate from the desired temperature.

Alternatively, the device 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 device and accompanying wiring and circuits must be kept insulated and dry to avoid leakage and corrosion. Specifically when the device operates at cold temperatures where condensation can occur. Printed-circuit coatings and varnishes such as a conformal coating and epoxy paints or dips are often used to ensure that moisture cannot corrode the device or connections.

11.2 Layout Example



1/2-inch square printed circuit board with 2-oz. copper foil or similar.

Figure 19. PCB Layout

11.3 Thermal Considerations

The thermal resistance junction to ambient ($R_{\theta JA}$) is the parameter used to calculate the rise of a device junction temperature due to the device power dissipation. Use Equation 4 to calculate the rise in the die temperature of the device.

$$T_J = T_A + R_{\theta JA} [(+V_S I_Q) + (+V_S - V_O) I_L] \quad (4)$$

where

- I_Q is the quiescent current
- I_L is the load current on the output

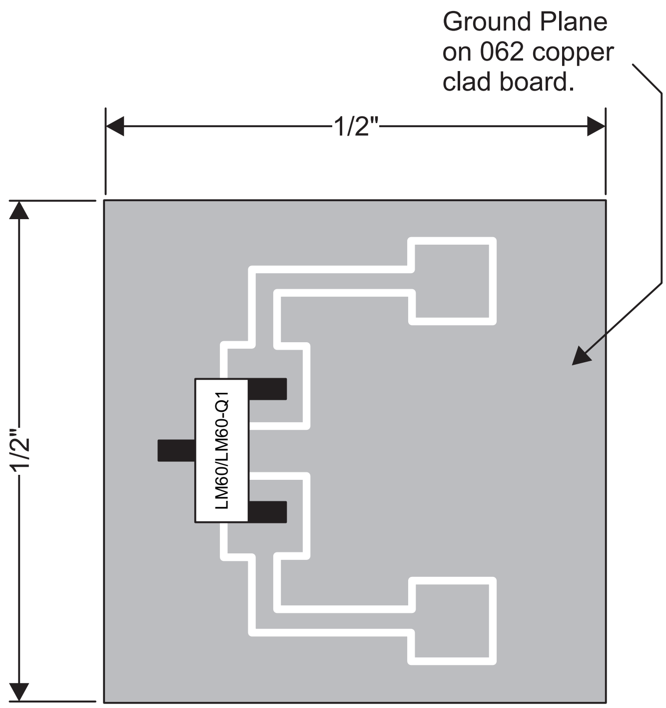
Thermal Considerations (continued)

Table 2 summarizes the rise in die temperature of the LM60-Q1 without any loading, and the thermal resistance for different conditions. The values in Table 2 were actually measured where as the values shown in where calculated using modeling methods as described in the *Semiconductor and IC Package Thermal Metrics* (SPRA953) application report.

Table 2. Temperature Rise of LM60-Q1 Due to Self-Heating and Thermal Resistance ($R_{\theta JA}$)

	SOT-23(1) NO HEAT SINK		SOT-23(2) SMALL HEAT FIN		TO-92(1) NO HEAT FIN		TO-92(3) SMALL HEAT FIN	
	$R_{\theta JA}$ (°C/W)	$T_J - T_A$ (°C)	$R_{\theta JA}$ (°C/W)	$T_J - T_A$ (°C)	$R_{\theta JA}$ (°C/W)	$T_J - T_A$ (°C)	$R_{\theta JA}$ (°C/W)	$T_J - T_A$ (°C)
Still air	450	0.17	260	0.1	180	0.07	140	0.05
Moving air	—	—	180	0.07	90	0.034	70	0.026

(1) Part soldered to 30 gauge wire.
(2) Heat sink used is 1/2-in square printed-circuit board with 2-oz. foil with part attached as shown in Figure 20.
(3) Part glued or leads soldered to 1-in square of 1/16-in printed-circuit board with 2-oz. foil or similar.



1/2-in Square Printed-Circuit Board with 2-oz. Copper Foil or Similar.

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

12 デバイスおよびドキュメントのサポート

12.1 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。

12.2 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。

12.3 商標

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12.4 静電気放電に関する注意事項

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12.5 Glossary

SLYZ022 — *TI Glossary*.

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

13 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
LM60QIM3X/NOPB	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	L60Q	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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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF LM60-Q1 :

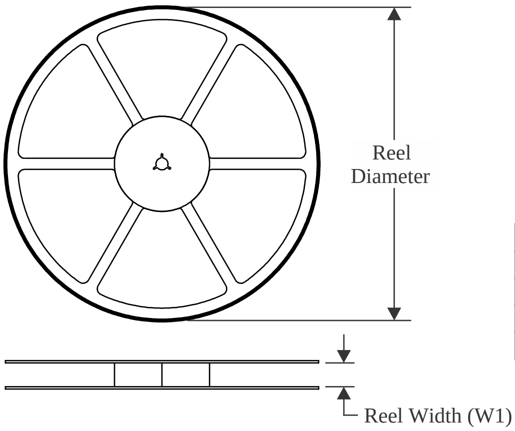
- Catalog : LM60

NOTE: Qualified Version Definitions:

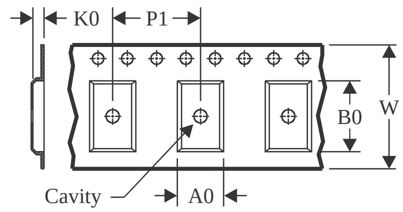
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS

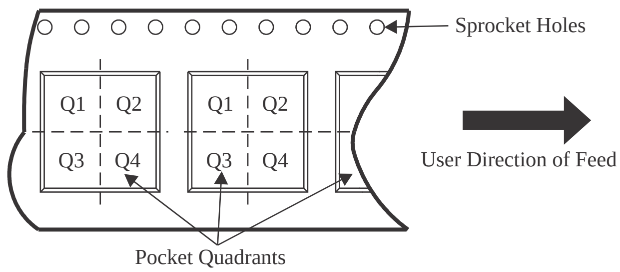


TAPE DIMENSIONS



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

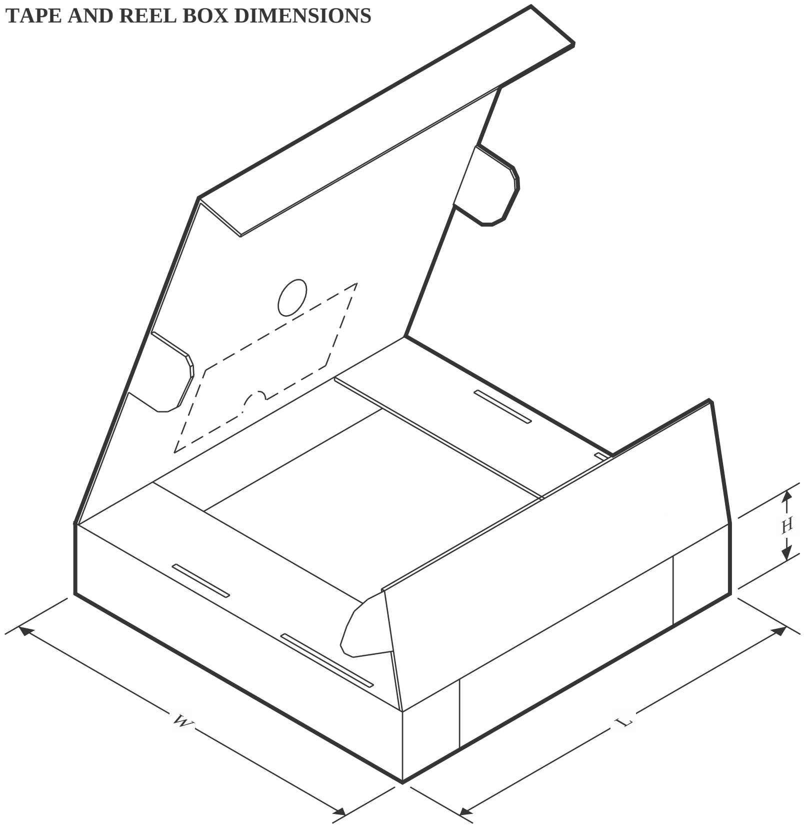
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

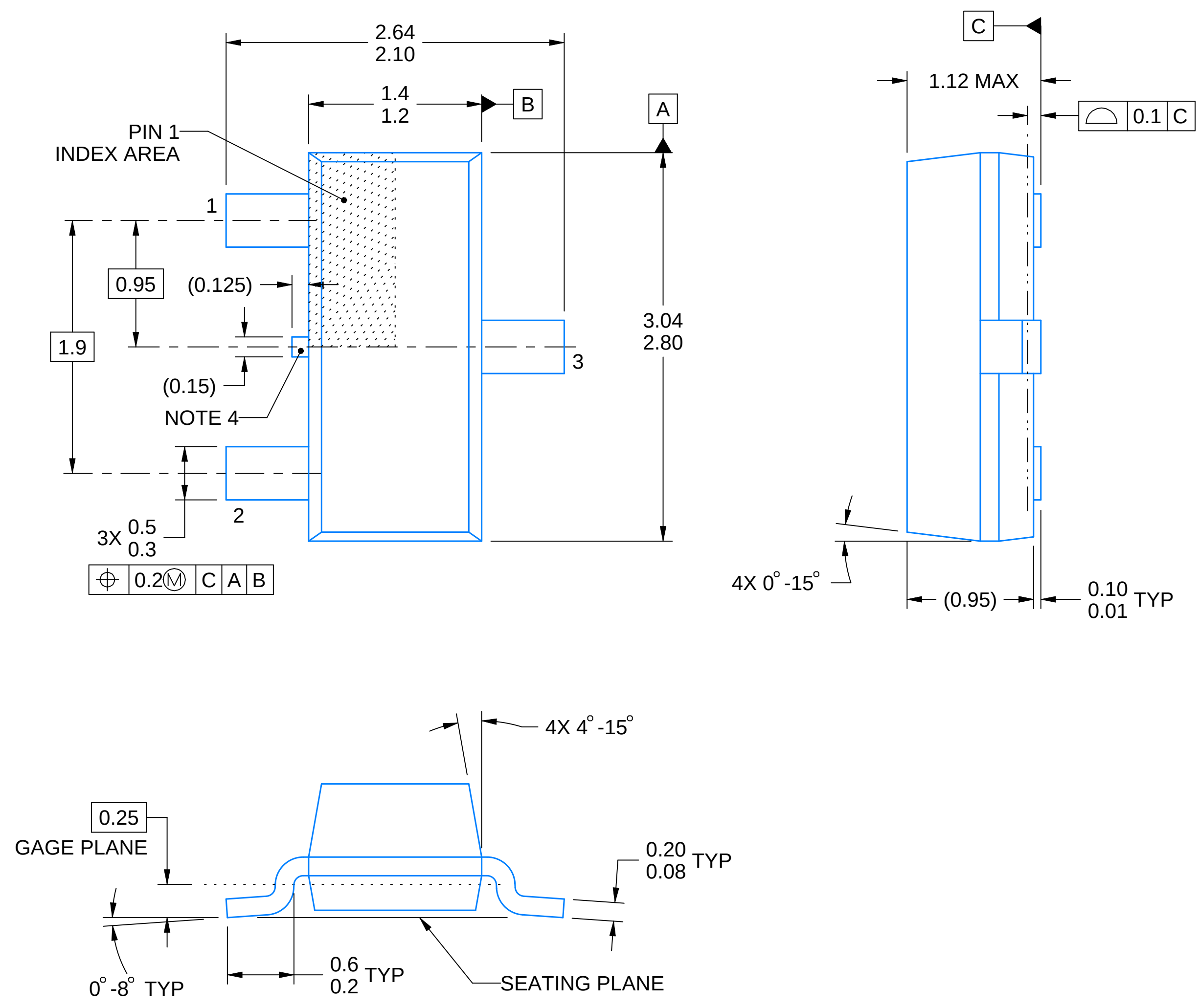
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM60QIM3X/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

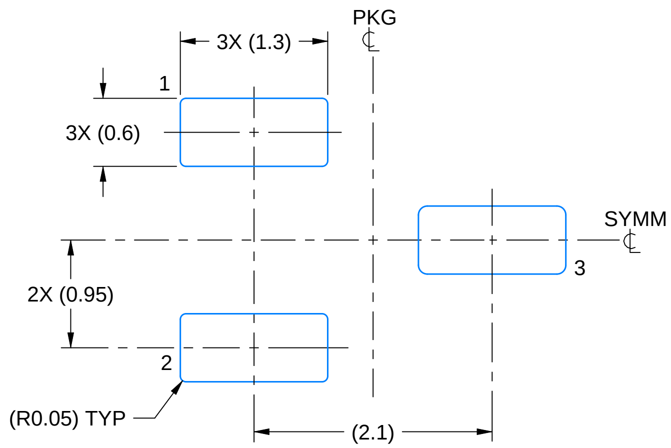
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM60QIM3X/NOPB	SOT-23	DBZ	3	3000	208.0	191.0	35.0



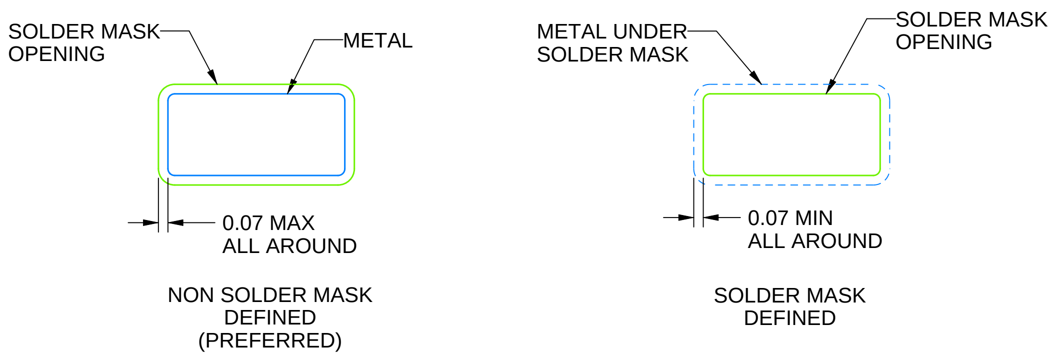
4214838/F 08/2024

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.
5. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25mm per side



LAND PATTERN EXAMPLE
SCALE:15X

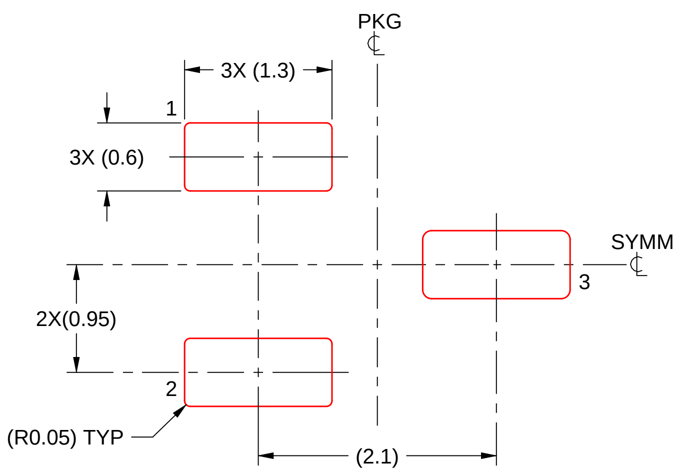


SOLDER MASK DETAILS

4214838/F 08/2024

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. 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/F 08/2024

NOTES: (continued)

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

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