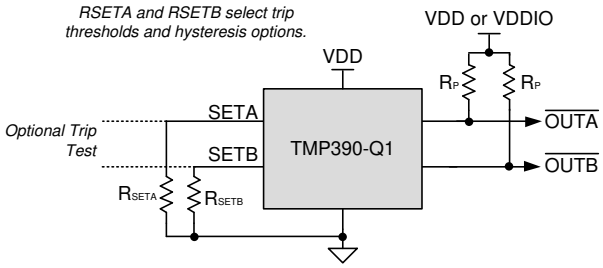
TMP390-Q1 超小型、2 チャネル (ホットおよびコールド・トリップ)、0.5µA、抵抗によりプログラム可能な温度スイッチ

1 特長

- 下記内容で AEC-Q100 認定済み
  - 温度グレード 1:–40℃～+125℃の動作温度範囲
  - 拡張動作温度範囲:–55℃～+130℃
- 機能安全対応
  - 機能安全システムの設計に役立つ資料を利用可能
- 温度トリップ・ポイントとヒステリシス選択を抵抗によりプログラム可能
  - 抵抗の公差がゼロ誤差に寄与
  - ヒステリシスの選択肢:5℃、10℃、20℃
- 過熱検出用と低温検出用の独立した出力
  - チャネル A (過熱):+30～+124℃、2℃刻み
  - チャネル B (低温):–50～+25℃、5℃刻み
- 較正なしでの精度
  - 0℃～+70℃で ±1.5℃以内
  - –55°C～+130°C で ±3.0°C 以内
- 超低消費電力:25℃で 0.5µA (標準値)
- 電源電圧:1.62～5.5V
- オープン・ドレイン出力
- トリップ・テスト機能によりインシステム・テストが可能
- SOT-563 (1.60mm × 1.20mm)、6 ピンのパッケージで供給

2 アプリケーション

- 車載用インフォテインメント・システム
  - USB チャージャ
  - インストルメント・クラスタ
  - メディア・インターフェイス
- カメラ
- レーダー / LIDAR



概略回路図

3 概要

TMP390-Q1 デバイスは、–55℃～130℃のシステム・サーマル・イベントを保護および検出できる、抵抗でプログラム可能な 2 チャネル超低消費電力温度スイッチ・ファミリの製品です。TMP390-Q1 は過熱 (ホット) と低温 (コールド) を個別に検出できます。トリップ温度 (T_{TRIP}) と熱ヒステリシス (T_{HYST}) は、SETA ピンと SETB ピンに 2 個の E96 系列抵抗 (公差 1%) を接続することで設定できます。チャネル A の抵抗の範囲は 1.05kΩ～909kΩ で、48 の固有の値の 1 つを表します。チャネル B の抵抗の範囲は 10.5kΩ～909kΩ です。

SETA 入力をグランドに接続する抵抗の値でチャネル A の T_{TRIP} スレッショルドを設定し、SETB 入力をグランドに接続する抵抗の値でチャネル B の T_{TRIP} スレッショルドを設定します。また、両方のチャネルの T_{HYST} に 5℃または 10℃を選択することで、デジタル出力の不要なスイッチングを防止できます。SETB 入力がグランドに接続されると、チャネル A は 20℃のヒステリシスで動作します。抵抗の精度は、T_{TRIP} の精度に影響しません。

顧客がボード・レベルの製造を行えるように、TMP390-Q1 は、SETA ピンまたは SETB ピンを使用してデジタル出力を駆動するトリップ・テスト機能をサポートしています。

製品情報

部品番号	パッケージ(1)	本体サイズ (公称)
TMP390-Q1	SOT-563 (6)	1.60mm × 1.20mm

(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。

デバイスの比較

部品番号	機能	出力タイプ
TMP390-Q1	ホット / コールド	オープン・ドレイン

英語版の TI 製品についての情報を翻訳したこの資料は、製品の概要を確認する目的で便宜的に提供しているものです。該当する正式な英語版の最新情報は、www.ti.com で閲覧でき、その内容が常に優先されます。TI では翻訳の正確性および妥当性につきましては一切保証いたしません。実際の設計などの前には、必ず最新版の英語版をご参照くださいますようお願いいたします。

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4 Revision History

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。

Changes from Revision A (April 2020) to Revision B (August 2019)	Page
• 文書全体にわたって表、図、相互参照の採番方法を更新	1
• 「*特長*」セクションに機能安全の箇条書き項目を追加	1

Changes from Revision * (September 2019) to Revision A (April 2020)	Page
• データシートのステータスを事前情報から量産データに変更	1
• 「拡張動作温度範囲：−55℃～+130℃」を追加	1
• 較正なしでの精度の範囲を +125°C から +130°C に変更	1
• Added *Channel A Trip Point Accuracy vs Operating Temperature* graph	6
• Added *Channel B Trip Point Accuracy vs Operating Temperature* graph	6

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5 Pin Configuration and Functions

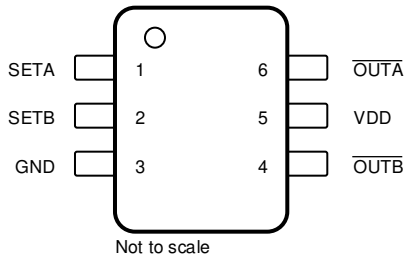


図 5-1. DRL Package 6-Pin SOT-563 Top View

表 5-1. Pin Functions

PIN		I/O	DESCRIPTION
NO.	NAME		
1	SETA	Input	Channel A temperature set point. Connect a standard E96, 1% resistance between SETA and GND.
2	SETB	Input	Channel B temperature and Hysteresis set point. Connect a standard E96, 1% resistance between SETB and GND.
3	GND	Ground	Device ground.
4	$\overline{\text{OUTB}}$	Logic Output	Channel B logic open-drain active low output. If unused, the output can be left floating or connected to GND.
5	VDD	Supply	Power supply voltage (1.62 V – 5.5 V).
6	$\overline{\text{OUTA}}$	Logic Output	Channel A logic open-drain active low output. If unused, the output can be left floating or connected to GND.

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6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Supply voltage	VDD	–0.3	6	V
Voltage at	$\overline{OUTA}$, $\overline{OUTB}$	-0.3	6	V
Voltage at	SETA, SETB	–0.3	VDD + 0.3	V
Junction temperature, T_J		–55	150	°C
Storage temperature, T_{stg}		–60	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) Powering the device when the operating junction temperature is outside the *Recommended Operating Conditions*, may affect the functional operation of the device. The device must be power cycled after the system has returned to conditions as indicated under *Recommended Operating Conditions*.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002(1) HBM ESD Classification Level 2	±2000	V
		Charged-device model (CDM), per AEC Q100-011 CDM ESD Classification Level C4A	±500	

(1) AEC Q100-002 indicates HBM stressing is done in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

6.3 Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
VDD	Supply voltage	1.62	3.3	5.5	V
V_{OUTA}	Channel A output pull-up voltage (open-drain)			VDD + 0.3	V
V_{OUTB}	Channel B output pull-up voltage (open-drain)			VDD + 0.3	V
I_{SETA}	SETA pin circuit leakage current	-20		20	nA
I_{SETB}	SETB pin circuit leakage current	-20		20	nA
R_{PA}	Pullup resistor connected from $\overline{OUTA}$ to VDDIO(1)	1	10		kΩ
R_{PB}	Pullup resistor connected from $\overline{OUTB}$ to VDDIO(1)				
T_A	Operating free-air temperature (specified performance)	–40		125	°C
	Operating free-air temperature (extended performance)	–55		130	°C

(1) Where VDDIO is an independent power supply other than VDD, and shall not exceed (VDD + 0.3) V.

6.4 Thermal Information

THERMAL METRIC(1)		TMP390-Q1 DRL (SOT) 6 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	210.3	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	105	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	87.5	°C/W
ψ_{JT}	Junction-to-top characterization parameter	6.1	°C/W
ψ_{JB}	Junction-to-board characterization parameter	87	°C/W
M_T	Thermal Mass	1.83	mJ/°C

(1) For more information about traditional and new thermal metrics, see the *Semiconductor IC Package Thermal Metrics* application report, (SPRA953).

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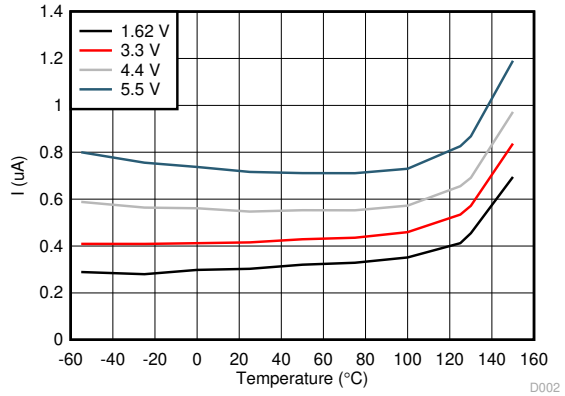
6.5 Electrical Characteristics

Minimum and maximum specifications are over -55°C to 130°C and VDD = 1.62V - 5.5V (unless otherwise noted); typical specifications are at T_A = 25°C and VDD = 3.3 V.

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
TEMPERATURE TO DIGITAL CONVERTER							
TEMPERATURE MEASUREMENT							
	Trip Point Accuracy (Channel A)	30°C to 70°C	VDD = 2.5V to 5.5V	–1.5	±0.5	1.5	°C
			VDD = 1.62V to 2.5V	–2.0	±0.5	2.0	
		30°C to 130°C	VDD = 2.5V to 5.5V	–2.5	±0.5	2.5	
			VDD = 1.62V to 2.5V	–3.0	±0.5	3.0	
	Trip Point Accuracy (Channel B)	0°C to 25°C	VDD = 2.5V to 5.5V	–1.75	±0.5	1.75	
			VDD = 1.62V to 2.5V	–2.0	±0.5	2.0	
		–55°C to 25°C	VDD = 2.5V to 5.5V	–2.5	±0.5	2.5	
			VDD = 1.62V to 2.5V	–3.0	±0.5	3.0	
T_{HYST}	Trip point hysteresis	表 7-2 selection column 2			5		°C
		表 7-2 selection column 3			10		°C
		Channel A only when SETB connected to GND			20		°C
TRIP POINT RESISTOR PROGRAMMING							
	SETA resistor range			1.05		909	kΩ
	SETB resistor range			10.5		909	kΩ
	SETA & SETB resistor tolerance	T_A=25°C		-1.0		1.0	%
	SETA & SETB resistor temperature coefficient			-100		100	ppm/°C
	SETA & SETB resistor lifetime drift			-0.2		0.2	%
DIGITAL INPUT/OUTPUT							
C_{IN}	Input capacitance for SETA & SETB (includes PCB)					50	pF
R_{PD}	Internal Pull down resistance	SETA & SETB			125		kΩ
V_{OL}	Output logic low level	I_{OL} = -3 mA		0		0.4	V
I_{LKG}	Leakage current on output high level			-0.1		0.1	µA
T_{Cov}	Conversion duration				0.65		ms
T_S	Sampling period				0.5		s
POWER SUPPLY							
I_Q	Average Quiescent current	VDD = 1.62V to 3.3V			0.5	1	µA
$I_{Standby}$	Standby current				0.25		
I_{Conv}	Conversion current				135		µA
I_{SU}	Startup (Reset) peak current	Reset Time interval only.			250		µA
V_{POR}	Power-on-reset threshold voltage	Supply going up			1.5		V
	Brownout detect	Supply going down			1.1		V
	Power Reset Time	Time required by device to reset after power up			10		ms

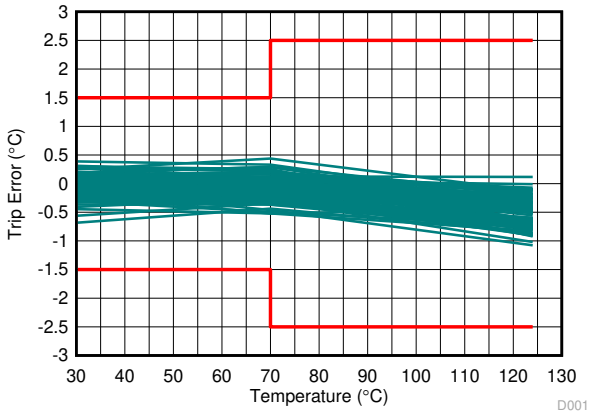
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6.6 Typical Characteristics



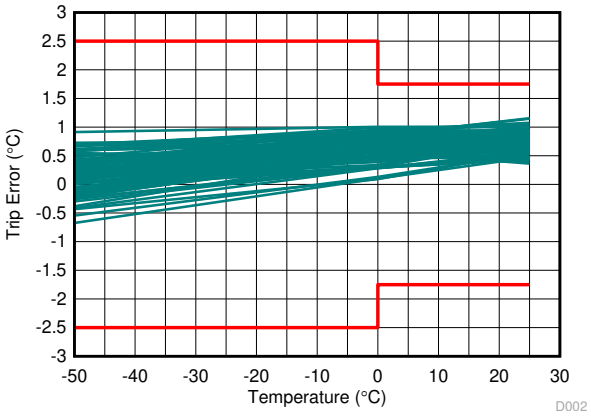
(V_S = 1.62 V, 3.3 V, 4.4 V, 5.5 V)

図 6-1. Average Supply Current vs Operating Temperature



(V_S = 3.3 V)

図 6-2. Channel A Trip Point Accuracy vs Operating Temperature



(V_S = 3.3 V)

図 6-3. Channel B Trip Point Accuracy vs Operating Temperature

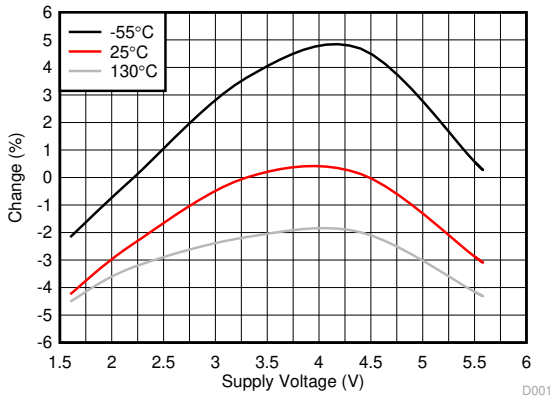


図 6-4. Sampling Period Variation vs Supply Voltage

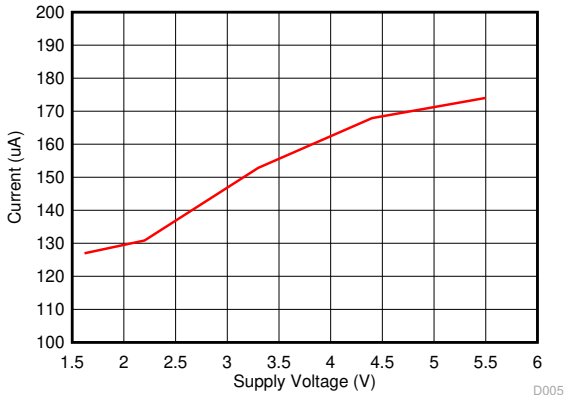
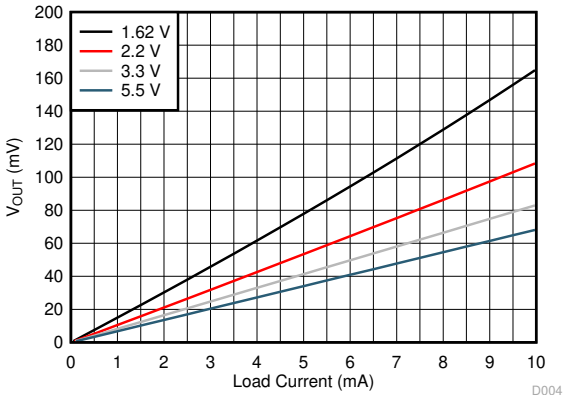


図 6-5. Conversion Current vs Supply Voltage



(T_{AMB} = 25°C)

図 6-6. Output Voltage vs Load Current

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7 Detailed Description

7.1 Overview

The TMP390-Q1 ultra-low power, dual channel, resistor programmable temperature switches enable detection and protection of system thermal events over a wide temperature range. The TMP390-Q1 offers independent overtemperature (hot) and undertemperature (cold) detection. The trip temperatures and hysteresis options are programmed by two E96-series (1%) standard decade value resistors on the SETA and SETB pins. The TMP390-Q1 can enable a customer board-level manufacturing test through the trip test function that can force the SETA or SETB pins to logic high to activates the digital outputs.

7.2 Functional Block Diagram

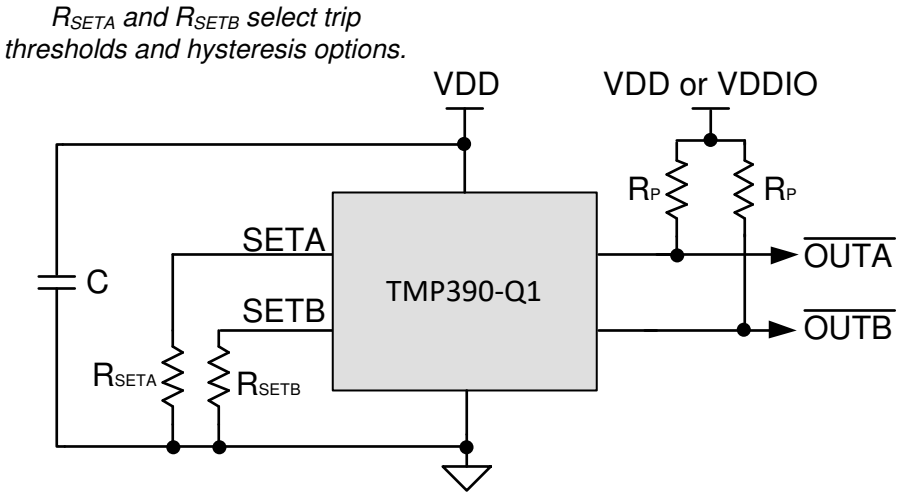


図 7-1. Simplified Schematic

7.3 Feature Description

The TMP390-Q1 requires two resistors to set the two trip points and hysteresis, according to 表 7-1 and 表 7-2, for the hot and cold channel device. The output of the TMP390-Q1 is open-drain and requires two pullup resistors. TI recommends to use a pullup voltage supply that does not exceed VDD + 0.3 V. The pullup resistors used in between the $\overline{OUTA}$ and $\overline{OUTB}$ pins and the pullup supply should be greater than 1 kΩ. The device powers on when the supply voltage goes beyond 1.5 V, and starts sampling the input resistors to set the two trip points and hysteresis value after power-on. These values will remain the same until the device goes through a power cycle. After the device sets the trip points and hysteresis level, the device will update the output every half a second. The conversion time is typically 0.65 ms when the temperature is checked against the trip points and the outputs are updated. The device remains in standby mode between conversions. If either channel is not used, the output can be grounded or left floating.

7.3.1 TMP390-Q1 Programming Tables

The temperature threshold and hysteresis options for the TMP390-Q1 device are programmed using two external 1% E96 standard resistors. The specific resistor value to ground on the SETA input sets the temperature threshold of channel A. The specific resistor value to ground on the SETB input sets the temperature threshold of channel B, as well as the hysteresis for both channel A and channel B.

表 7-1. TMP390-Q1 Channel A Threshold Setting

CHANNEL A (HOT) TRIP TEMPERATURE (°C)	CHANNEL A NOMINAL 1% RESISTORS (KΩ)	CHANNEL A (HOT) TRIP RESET TEMPERATURE (°C) FOR HYSTERESIS = 5°C	CHANNEL A (HOT) TRIP RESET TEMPERATURE (°C) FOR HYSTERESIS = 10°C
30	1.05	25	20
32	1.21	27	22
34	1.40	29	24

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表 7-1. TMP390-Q1 Channel A Threshold Setting (continued)

CHANNEL A (HOT) TRIP TEMPERATURE (°C)	CHANNEL A NOMINAL 1% RESISTORS (KΩ)	CHANNEL A (HOT) TRIP RESET TEMPERATURE (°C) FOR HYSTERESIS = 5°C	CHANNEL A (HOT) TRIP RESET TEMPERATURE (°C) FOR HYSTERESIS = 10°C
36	1.62	31	26
38	1.87	33	28
40	2.15	35	30
42	2.49	37	32
44	2.87	39	34
46	3.32	41	36
48	3.83	43	38
50	4.42	45	40
52	5.11	47	42
54	5.90	49	44
56	6.81	51	46
58	7.87	53	48
60	9.09	55	50
62	10.5	57	52
64	12.1	59	54
66	14.0	61	56
68	16.2	63	58
70	18.7	65	60
72	21.5	67	62
74	24.9	69	64
76	28.7	71	66
78	33.2	73	68
80	38.3	75	70
82	44.2	77	72
84	51.1	79	74
86	59.0	81	76
88	68.1	83	78
90	78.7	85	80
92	90.9	87	82
94	105	89	84
96	121	91	86
98	140	93	88
100	162	95	90
102	187	97	92
104	215	99	94
106	249	101	96
108	287	103	98
110	332	105	100
112	383	107	102
114	442	109	104
116	511	111	106
118	590	113	108
120	681	115	110
122	787	117	112

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表 7-1. TMP390-Q1 Channel A Threshold Setting (continued)

CHANNEL A (HOT) TRIP TEMPERATURE (°C)	CHANNEL A NOMINAL 1% RESISTORS (KΩ)	CHANNEL A (HOT) TRIP RESET TEMPERATURE (°C) FOR HYSTERESIS = 5°C	CHANNEL A (HOT) TRIP RESET TEMPERATURE (°C) FOR HYSTERESIS = 10°C
124	909	119	114

注

When the SETA pin is grounded or left floating during the device power up, the OUTA pin always stays low. The Channel B functionality is not affected by the SETA channel.

表 7-2. TMP390-Q1 Channel B Threshold and Hysteresis Setting

CHANNEL B (COLD) TRIP TEMPERATURE (°C)	CHANNEL B NOMINAL 1% RESISTORS (KΩ)		CHANNEL B (COLD) TRIP RESET TEMPERATURE (°C)	
	HYSTERESIS = 5°C	HYSTERESIS = 10°C	HYSTERESIS = 5°C	HYSTERESIS = 10°C
–50	90.9	105	–45	–40
–45	78.7	121	–40	–35
–40	68.1	140	–35	–30
–35	59.0	162	–30	–25
–30	51.1	187	–25	–20
–25	44.2	215	–20	–15
–20	38.3	249	–15	–10
–15	33.2	287	–10	–5
–10	28.7	332	–5	0
–5	24.9	383	0	5
0	21.5	442	5	10
5	18.7	511	10	15
10	16.2	590	15	20
15	14.0	681	20	25
20	12.1	787	25	30
25	10.5	909	30	35

7.3.2 Trip Test

The purpose of the trip test is in system manufacturing test without putting the TMP390-Q1 through costly temperature verification of the assembly of TMP390-Q1 and pullup resistors. When the SETA or SETB pin is set to a high logic level, the associated output goes low. When the input pin level goes low, the output goes to its previous condition before the trip test. The trip test does not affect the current condition of the device. The trip test signals should stay above 0.8 × VDD for logic high and below 0.2 × VDD for logic low.

The trip test operation is shown in 図 7-2. The trip test must be performed with a single toggle when the device is operating at a temperature that will not cause the corresponding output to trip. The trip test is intended for production testing after assembly, and must not be used as a functional feature.

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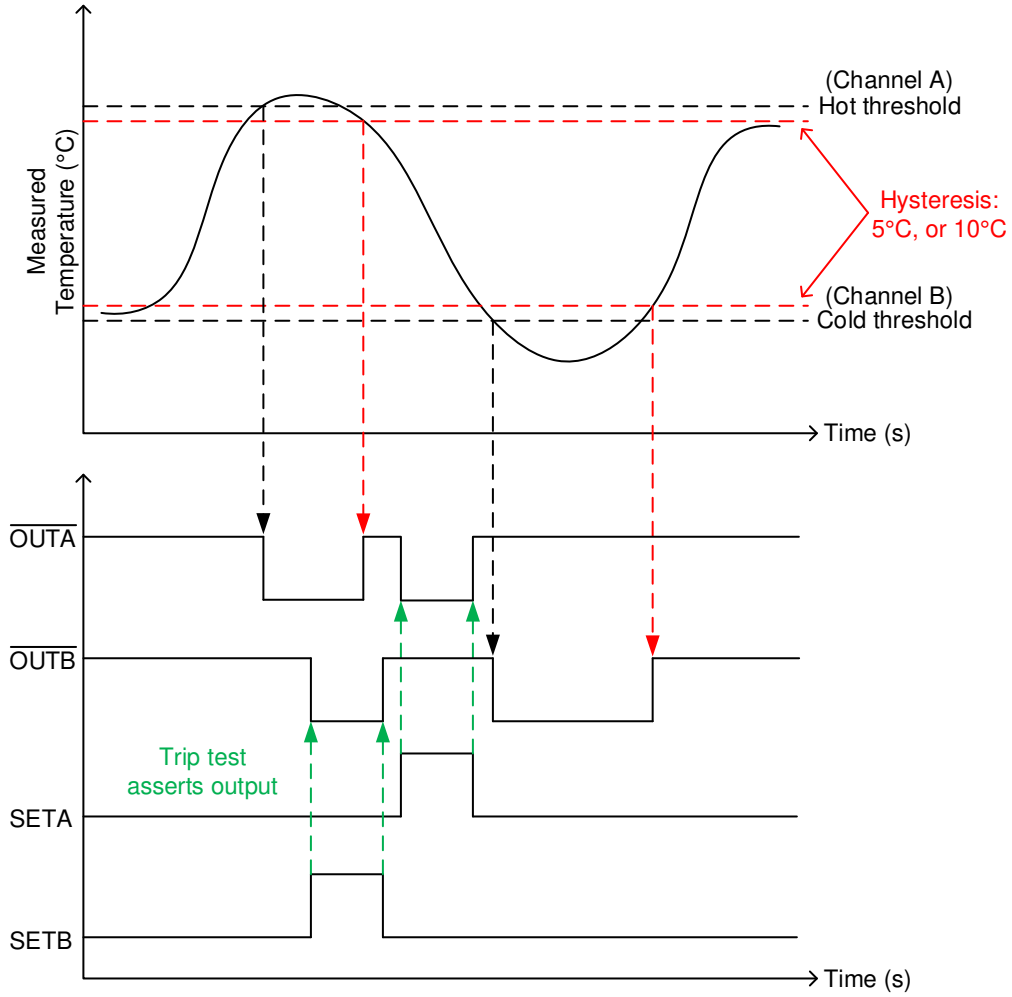


図 7-2. TMP390-Q1 Trip Test Operation

7.3.3 20°C Hysteresis

The 20°C hysteresis feature is only available on Channel A. To activate the feature, the SETB pin must be connected to ground and SETA pin connected to the resistor to set the appropriate trip point on Channel A.

7.4 Device Functional Modes

The device has one mode of operation, as described above, that applies when operated within the *Recommended Operating Conditions*.

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8 Application and Implementation

注

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8.1 Applications Information

The TMP390-Q1 device is part of a family of ultra-low power, dual channel, resistor programmable temperature switches that can enable detection and protection of system thermal events over a wide temperature range. The trip temperatures (T_{TRIP}) and hysteresis options are programmed by two E96-series (1%) standard decade value resistors on the SETA and SETB pins. The thermal hysteresis (T_{HYST}) function is to prevent undesired digital output switching due to small temperature changes.

8.2 Typical Applications

8.2.1 Simplified Application Schematic

図 8-1 shows the simplified schematic where R_{SETA} and R_{SETB} are used to set channel A trip point (SETA) and channel B trip point and hysteresis for both channels (SETB). SETA and SETB can be programmed at a variety of temperatures based on the device, as described in 表 7-1 for channel A trip point, and 表 7-2 for channel B trip point and hysteresis for both channels. $\overline{OUTA}$ and $\overline{OUTB}$ outputs correspond to the temperature threshold detection at SETA and SETB, respectively.

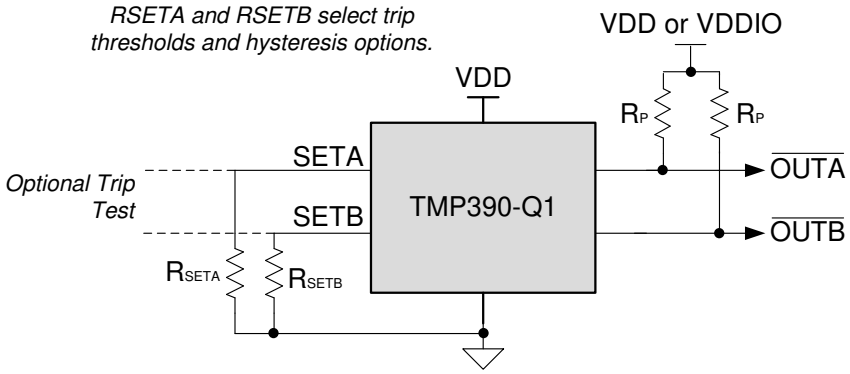


図 8-1. Simplified Schematic

8.2.1.1 Design Requirements

The TMP390-Q1 requires two resistors to set the high and low trip points and hysteresis, and two pullup resistors for the open-drain device. TI also highly recommends to place a 0.1-µF, power-supply bypassing capacitor close to the VDD supply pin. To minimize the internal power dissipation, use two pullup resistors greater than 1 kΩ from the $\overline{OUTA}$ and $\overline{OUTB}$ pins to the VDD pin. A separate supply, VDDIO, may be used for the pullup voltage to set the output voltage level to the level required by the MCU, as shown in 図 8-1. The open-drain output gives flexibility of pulling up to any voltage independent of VDD (VDDIO must be less than or equal to VDD + 0.3 V). This allows for use of longer cables or different power supply options. If a separate voltage level is not required, TI recommends to tie the pullup to the TMP390-Q1 VDD.

If the SETA or SETB connected resistor value is outside the legal range, the associated output goes to permanent output zero stage and the channel cannot be used. The other channel still will be in operating condition, and device can be used in one channel mode. If the SETB input is grounded or left floating, the Channel B cannot be used and the hysteresis for Channel A will be 20°C. The SETA and SETB connected resistors are measured during POR. If two consecutive measurements are not matching each other, then the device sets the associated channel output to zero and repeats the resistor measurements until the

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measurements match. When the measurements match, the channel output is released. Note that it is possible to connect some device outputs together by shorting the $\overline{OUTA}$ or $\overline{OUTB}$ line.

8.2.1.2 Detailed Design Procedure

The resistor to ground values on the SETA input sets the T_{TRIP} threshold of Channel A. The resistor to ground value on the SETB input sets the T_{TRIP} threshold of Channel B as well as the T_{HYST} 5°C and 10°C options. TI recommends that the resistors at SETA and SETB have a 1% tolerance at room temperature. Each resistor can range from 1.05 KΩ to 909 KΩ, representing one of 48 unique values. The exact temperature thresholds and trip points are shown in 表 7-1 and 表 7-2. The pullup resistors should be at least 1 kΩ to minimize internal power dissipation. To get the correct threshold for resistor values, take care to minimize the board level capacitance and leakage at the SETA and SETB pins.

The waveform for the TMP390-Q1 output under the hot/cold thresholds is shown in 図 8-2. The hysteresis can be set to 5°C, 10°C or 20°C. When the temperature exceeds the hot trip point threshold, $\overline{OUTA}$ goes low until the temperature drops below the hysteresis threshold. When the temperature drops below the cold trip threshold, $\overline{OUTB}$ goes low and returns high after the temperature rises above the hysteresis threshold. If the switch has already tripped and the temperature is in the hysteresis band, a POR event will cause the output to go high after the power is restored.

8.2.1.3 Application Curves

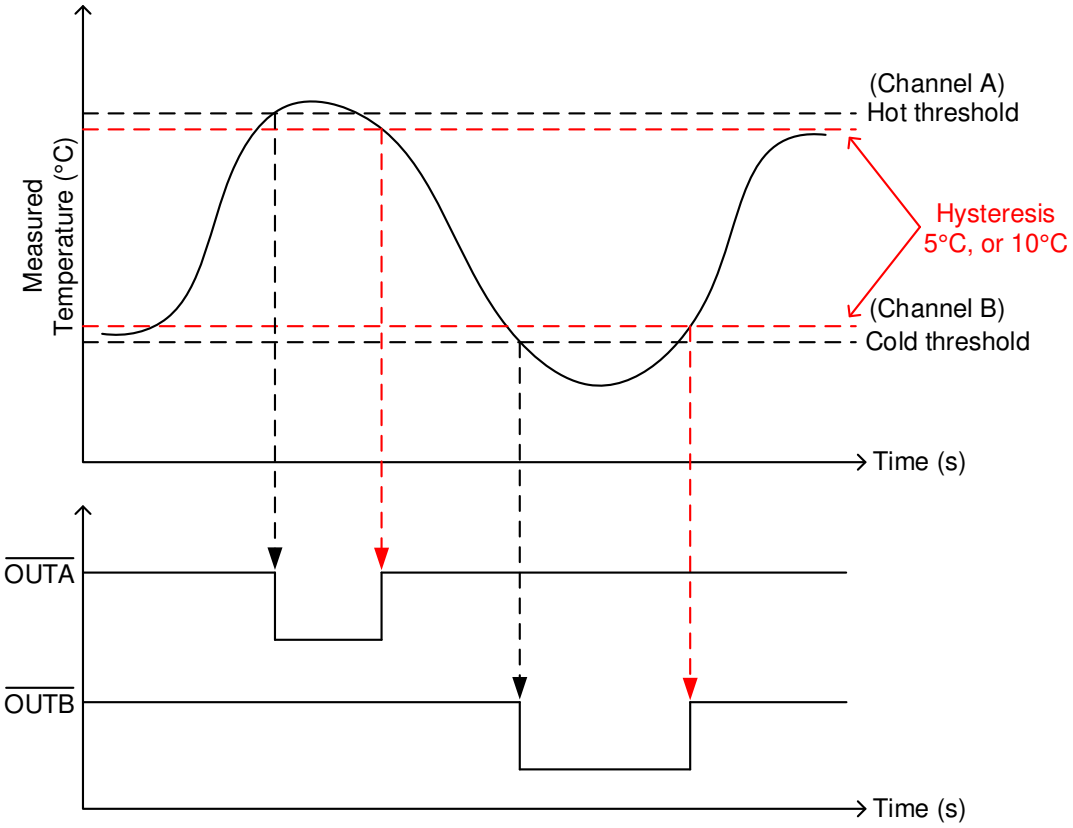


図 8-2. TMP390-Q1 Output With Hot/Cold Thresholds With Hysteresis

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8.2.2 TMP390-Q1 With 10°C Hysteresis

図 8-3 shows an example circuit for overtemperature and undertemperature protection using the TMP390-Q1. In this example, the trip points are set at –25°C and +90°C with 10°C hysteresis.

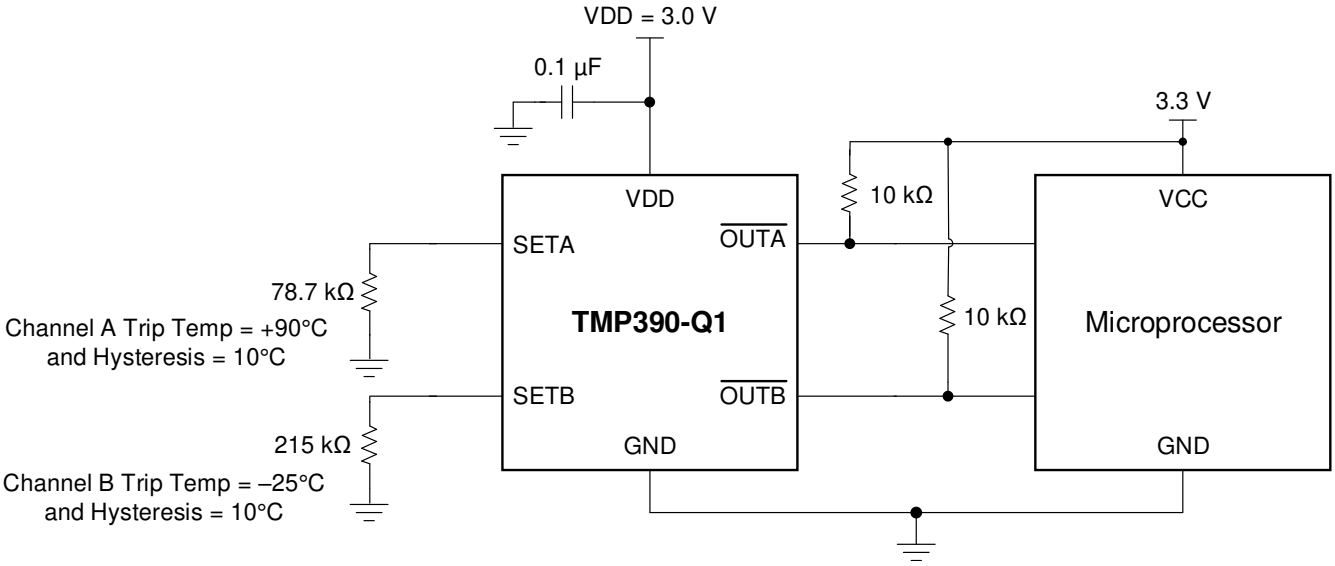


図 8-3. TMP390-Q1 Example Circuit at +90°C and –25°C Thresholds With 10°C Hysteresis

8.2.2.1 Design Requirements

In this example, VDD can be ≥ 3 V. The output pins may be tied to a switch to control a fan or other analog circuitry. This example uses 10-kΩ pullup resistors at the $\overline{\text{OUTA}}$ and $\overline{\text{OUTB}}$ outputs. Place a 0.1-µF bypass capacitor close to the TMP390-Q1 device to reduce noise coupled from the power supply. If needed, the output of multiple parts can be connected together.

8.2.2.2 Detailed Design Procedure

SETA sets the +90°C threshold using 78.7 kΩ. SETB sets the –25°C trip point and 10°C hysteresis using 215 kΩ. These values were determined using 表 7-1 and 表 7-2. These resistors should have maximum of 1% tolerance and 100 ppm/°C or less over the desired temperature range. A summary of the resistor settings used in this example is shown in 表 8-1. See 表 7-1 and 表 7-2 for additional trip points and hysteresis configurations.

The switching output of the TMP390-Q1 can be visualized with the output diagram shown in 図 8-4. It is key to notice that hysteresis is subtracted from the Channel A threshold and added to the Channel B threshold values. $\overline{\text{OUTA}}$ remains high until the sensor reaches +90°C where the output goes low, and returns high after the temperature drops back down to +80°C. $\overline{\text{OUTB}}$ trips when the temperature stays below –25°C and goes low until the temperature rises above –15°C.

表 8-1. Example Resistor Settings and Trip Points

CHANNEL	RESISTOR SETTING (kΩ)	HYSTERESIS (°C)	TRIP TEMPERATURE (°C)
SETA	78.7	10	+90
SETB	215		–25

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8.2.2.3 Application Curve

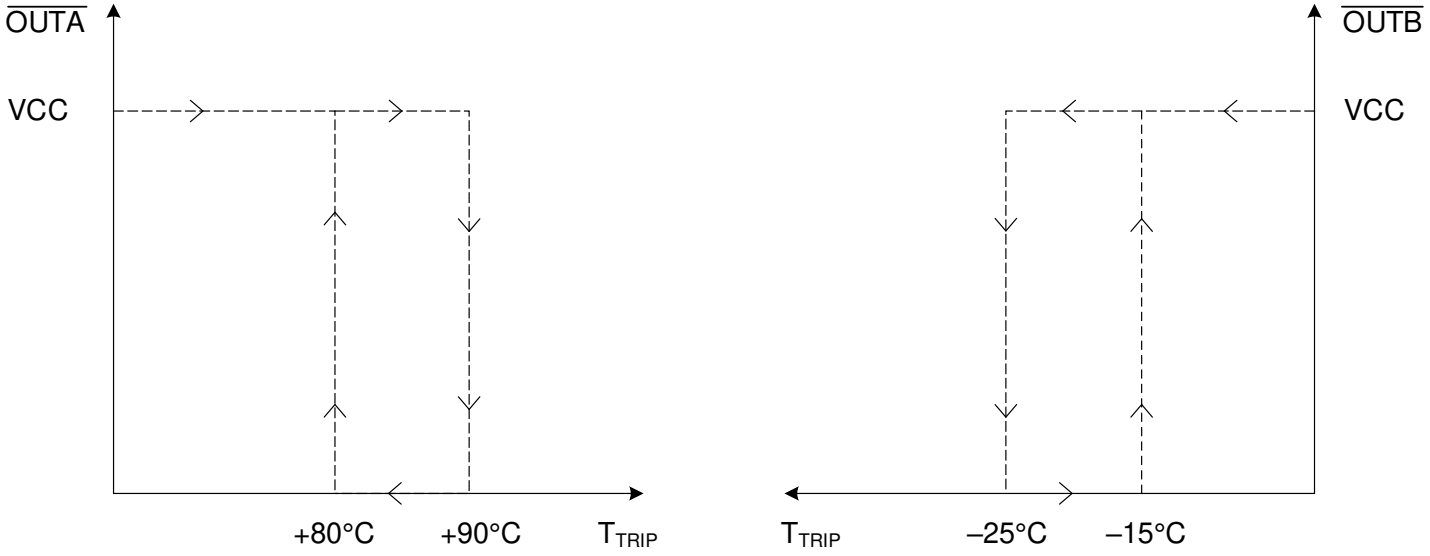


図 8-4. TMP390-Q1 Output Response With Hysteresis

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8.2.3 One Channel Operation for Hot Trip Point up to 124°C

図 8-5 shows the TMP390-Q1 configured for one channel operation, with a single resistor to set the hot trip point and hysteresis. 表 8-2 shows the possible resistor values and hysteresis values that may be used for one channel applications.

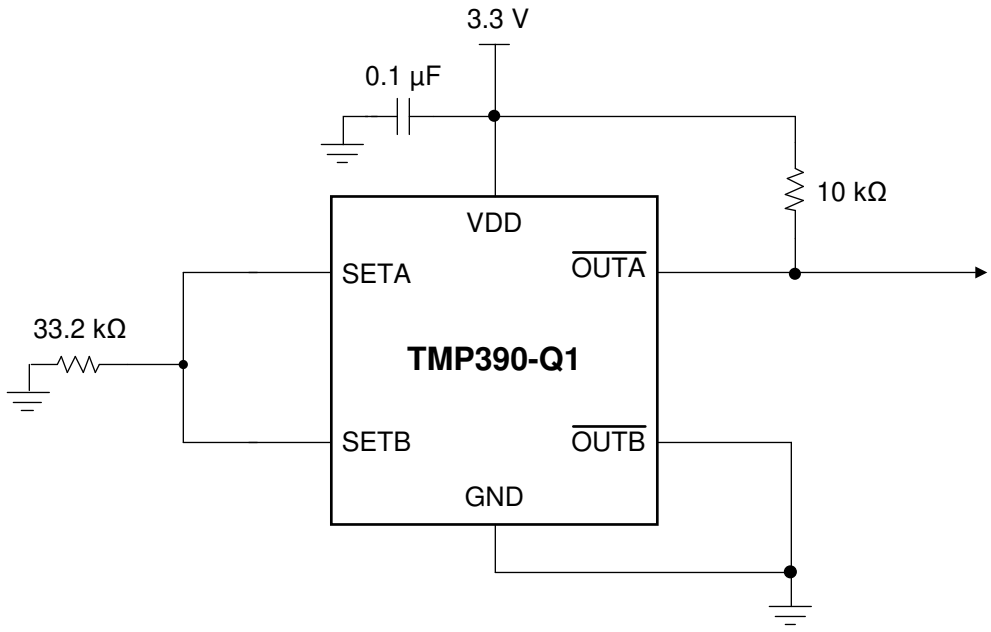


図 8-5. TMP390-Q1 One Channel (Hot) Operation Example Circuit With 78°C Trip Point and 5°C Hysteresis

表 8-2. Single Resistor One Channel Setting

NOMINAL 1% RESISTOR (KΩ)	CHANNEL A TRIP TEMPERATURE (°C)	HYSTERESIS (°C)
10.5	62	5
12.1	64	5
14.0	66	5
16.2	68	5
18.7	70	5
21.5	72	5
24.9	74	5
28.7	76	5
33.2	78	5
38.3	80	5
44.2	82	5
51.1	84	5
59.0	86	5
68.1	88	5
78.7	90	5
90.0	92	5
105	94	10
121	96	10
140	98	10
162	100	10
187	102	10

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表 8-2. Single Resistor One Channel Setting (continued)

NOMINAL 1% RESISTOR (KΩ)	CHANNEL A TRIP TEMPERATURE (°C)	HYSTERESIS (°C)
215	104	10
249	106	10
287	108	10
332	110	10
383	112	10
442	114	10
511	116	10
590	118	10
681	120	10
787	122	10
909	124	10

8.2.3.1 Application Curve

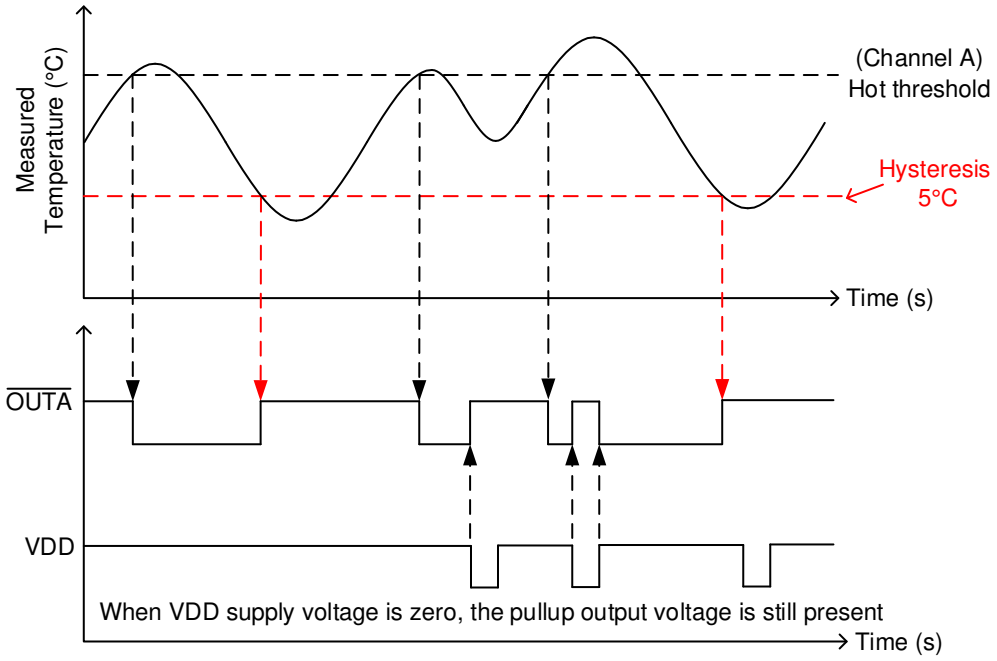


図 8-6. TMP390-Q1 One Channel (Hot) Operation Thresholds and Hysteresis

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8.2.4 One Channel Operation for Cold Trip Point

図 8-7 shows the TMP390-Q1 configured for one channel operation, with a single resistor to set the warm trip point and hysteresis. The resistor values for one channel warm trip point is same as described in 表 7-2.

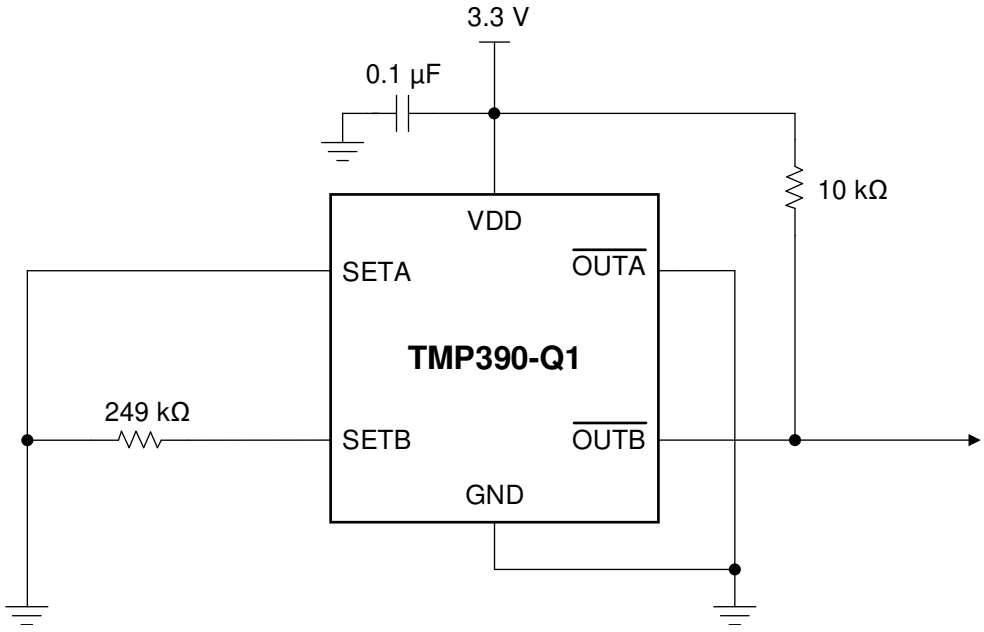


図 8-7. TMP390-Q1 One Channel (Cold) Operation Example Circuit With –20°C Trip Point and 10°C Hysteresis

8.2.4.1 Application Curve

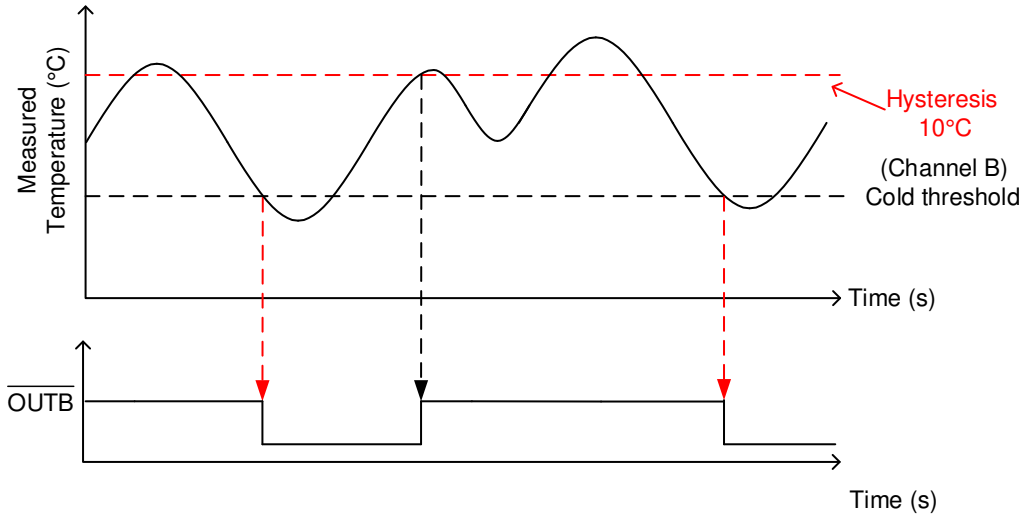


図 8-8. TMP390-Q1 One Channel (Cold) Operation Thresholds and Hysteresis

9 Power Supply Recommendations

The low supply current and wide supply range of the TMP390-Q1 allow the device to be powered from many sources. VDDIO must always be lower than or equal to VDD + 0.3 V.

Power supply bypassing is strongly recommended by adding a 0.1-µF capacitor from VDD to GND. In noisy environments, TI recommends to add a filter with 0.1-µF capacitor and 100-Ω resistor between external supply and VDD to limit the power supply noise.

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10 Layout

10.1 Layout Guidelines

The TMP390-Q1 is extremely simple to layout. Place the power supply bypass capacitor as close to the device as possible, and connect the capacitor as shown in 図 10-1. Place the R_{SETA} and R_{SETB} resistors as close to the device as possible. Carefully consider the resistor placement to avoid additional leakage or parasitic capacitance, as this may affect the actual resistor sense value for the trip thresholds and hysteresis. If there is a possibility of moisture condensation on the SETA and SETB circuits, which may lead to additional leakage current, consider adding a conformal coating to the circuits.

10.2 Layout Example

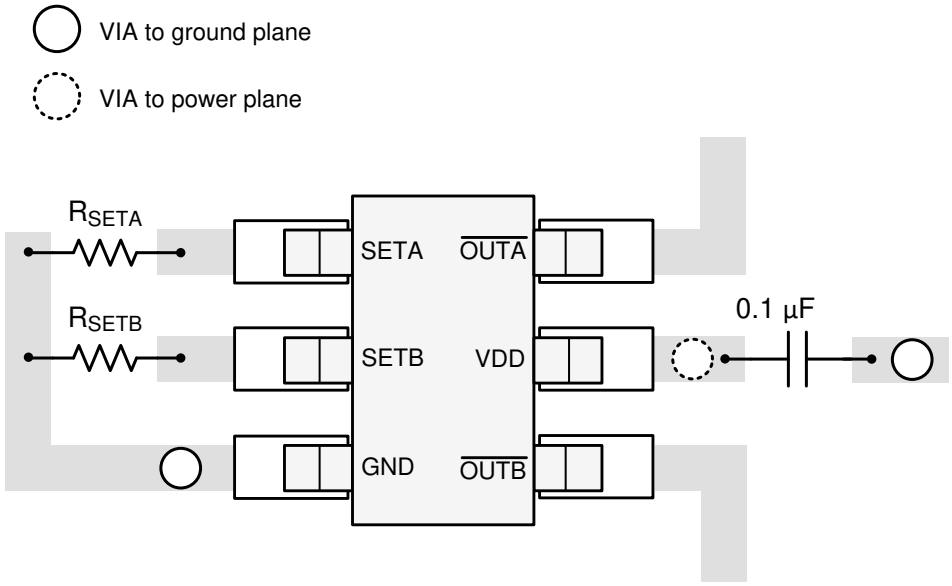


図 10-1. TMP390-Q1 Recommended Layout

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11 Device and Documentation Support

11.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

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ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

11.5 Glossary

TI Glossary — This glossary lists and explains terms, acronyms, and definitions.

12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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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)
TMP390AQDRLRQ1	Active	Production	SOT-5X3 (DRL) | 6	4000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 130	1G1
TMP390AQDRLRQ1.A	Active	Production	SOT-5X3 (DRL) | 6	4000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 130	1G1

(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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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 TMP390-Q1 :

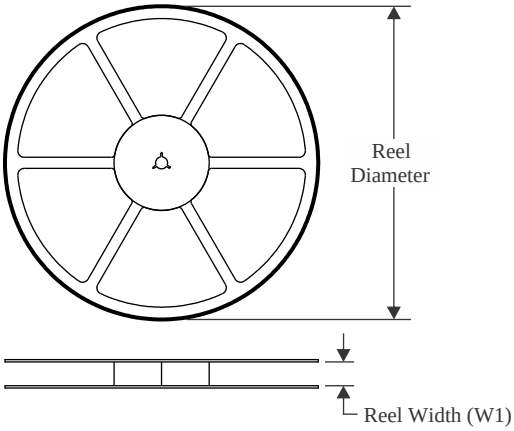
- Catalog : TMP390

NOTE: Qualified Version Definitions:

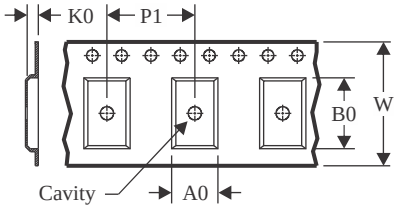
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS

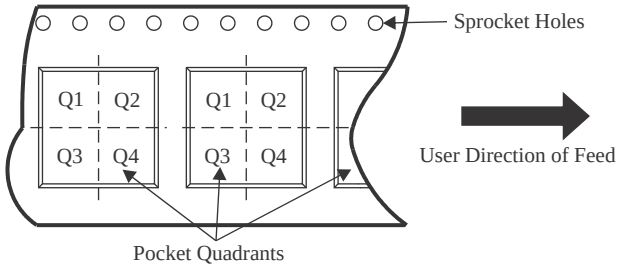


TAPE DIMENSIONS



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

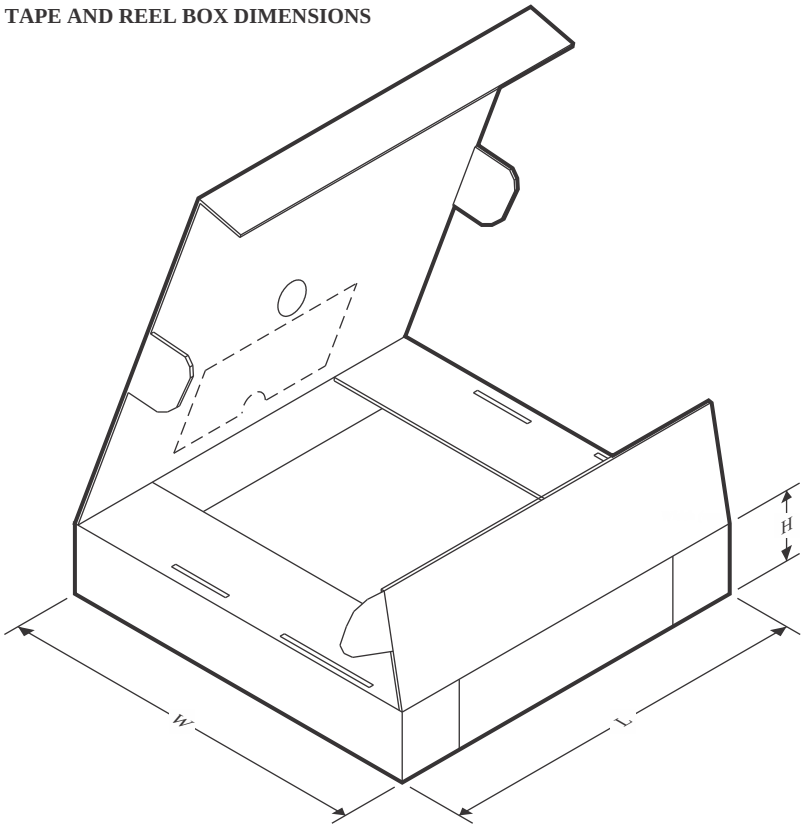
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TMP390AQDRLRQ1	SOT-5X3	DRL	6	4000	180.0	8.4	1.98	1.78	0.69	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)
TMP390AQDRLRQ1	SOT-5X3	DRL	6	4000	183.0	183.0	20.0

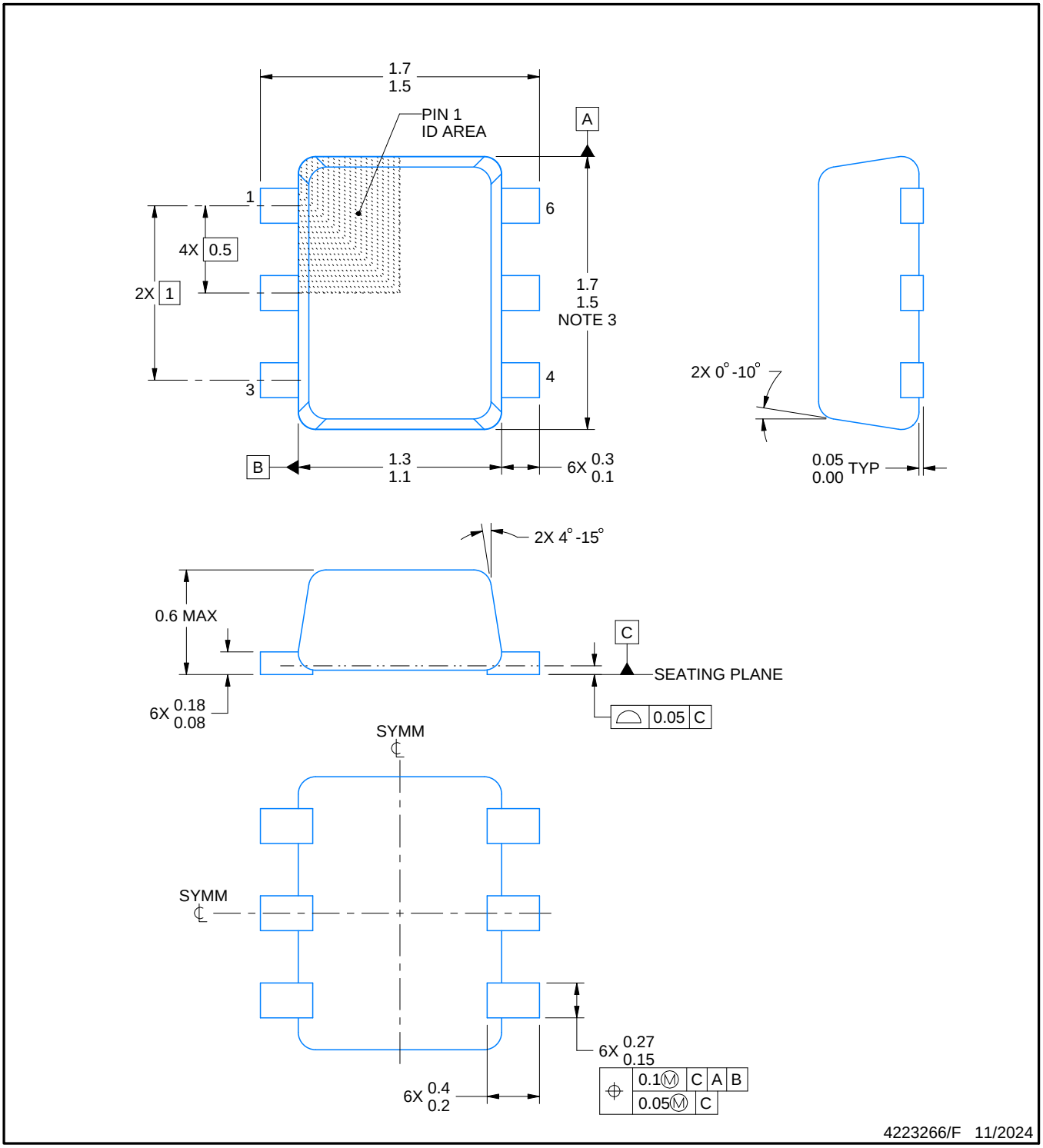


PACKAGE OUTLINE

DRL0006A

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



NOTES:

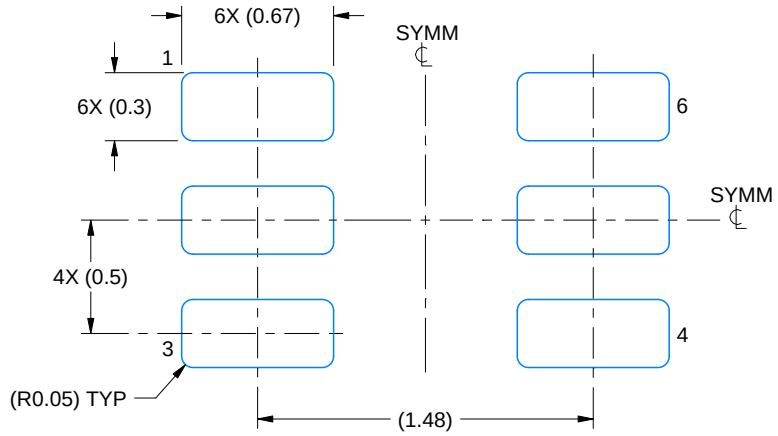
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-293 Variation UAAD

EXAMPLE BOARD LAYOUT

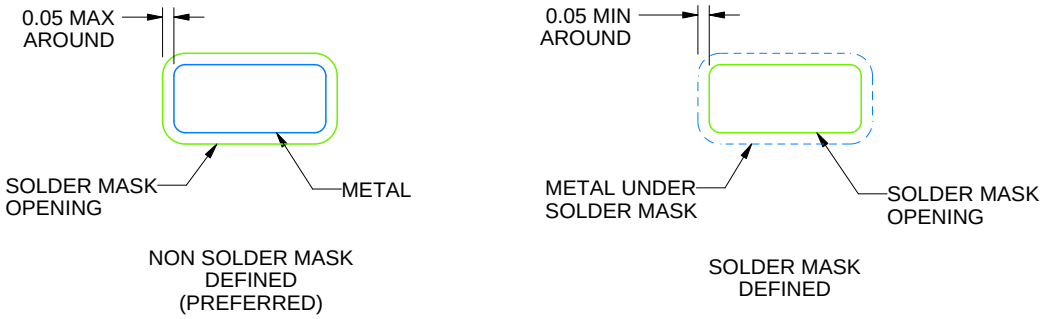
DRL0006A

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



LAND PATTERN EXAMPLE
SCALE:30X



SOLDERMASK DETAILS

4223266/F 11/2024

NOTES: (continued)

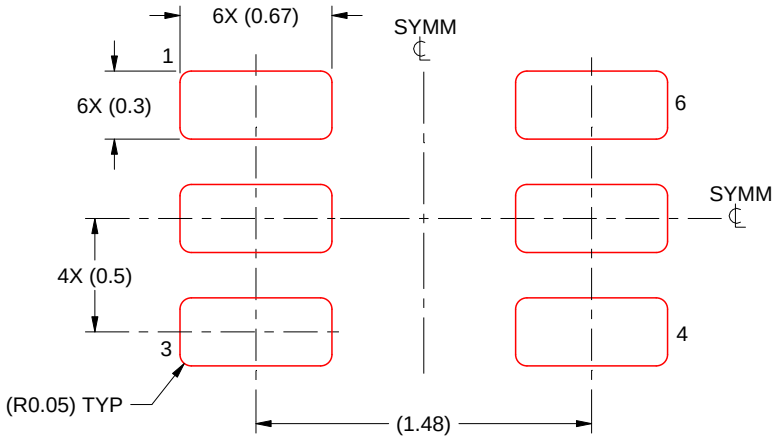
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
7. Land pattern design aligns to IPC-610, Bottom Termination Component (BTC) solder joint inspection criteria.

EXAMPLE STENCIL DESIGN

DRL0006A

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE:30X

4223266/F 11/2024

NOTES: (continued)

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

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