TMP392 Ultra-Small, Dual-Channel (Hot and Warm Trip), 0.5-µA, Resistor-Programmable Temperature Switch

1 Features

- Resistor programmable temperature trip points and hysteresis options
  - Resistor tolerances contribute zero error
  - Hysteresis options: 5°C, 10°C and 20°C
- Dual outputs for overtemperature detection
  - Channel A (overtemperature-hot): +30 to +124°C, 2°C steps
  - Channel B (overtemperature-warm): +30 to +105°C, 5°C steps
- Accuracy level options (maximum at +30°C to +130°C):
  - A2 Level: ±3.0°C (±1.5°C from +30°C to +70°C)
  - A3 Level: ±3.5°C (±2.0°C from +30°C to +70°C)
- Ultra-low power consumption: 0.5 µA typical at 25°C
- Supply voltage: 1.62 to 5.5 V
- Open-drain outputs
- Trip test function enables in-system testing
- Available in a SOT-563 (1.60-mm × 1.20-mm), 6-pin package

2 Applications

- DC/AC inverter
- DC/DC converter
- Temperature transmitters
- Environmental control systems (ECS)
- Power tools
- Power banks
- Lighting Control
- Industrial Robots
- Machine Vision
- STB & DVR
- WLAN/Wi-Fi access points

3 Description

The TMP392 device is part of a family of ultra-low power, dual channel, resistor programmable temperature switches that enable protection and detection of system thermal events from 30°C to 130°C. The TMP392 offers dual overtemperature (hot and warm) detection. The trip temperatures (T_{TRIP}) and thermal hysteresis (T_{HYST}) options are programmed by two E96-series resistors (1% tolerance) on the SETA and SETB pins. Channel A resistors can range from 1.05 KΩ to 909 KΩ, representing one of 48 unique values. Channel B resistors can range from 10.5 KΩ to 909 KΩ

The value of the resistor to ground on SETA input sets the T_{TRIP} threshold of Channel A. The value of the resistor to ground on SETB input sets the T_{TRIP} threshold of Channel B, as well as the T_{HYST} options of 5°C, or 10°C for both channels, to prevent undesired digital output switching. When the SETB input is connected to ground, Channel A operates with 20°C hysteresis. Resistors accuracy has no impact to T_{TRIP} accuracy.

To enable customer board-level manufacturing, the TMP392 supports a trip test function where the digital outputs are activated by exercising the SETA or SETB pin.

Device Information(1)

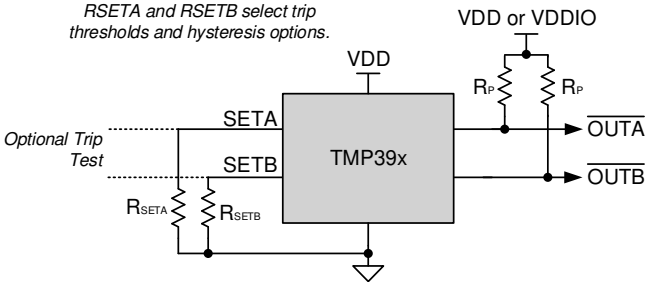
PART NUMBER	PACKAGE	BODY SIZE (NOM)
TMP392	SOT-563 (6)	1.60 mm × 1.20 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Device Comparison

PART NUMBER	FUNCTION	OUTPUT TYPE
TMP390	Hot / Cold	Open-Drain
TMP392	Hot / Warm	

Simplified Schematic



An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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4 Revision History

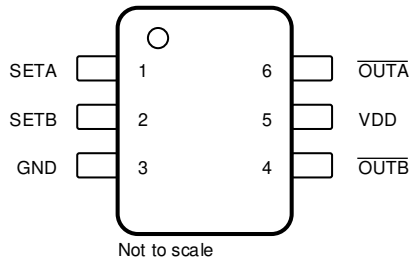
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

DATE	REVISION	NOTES
November 2019	*	Initial release.

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5 Pin Configuration and Functions

DRL Package
6-Pin SOT-563
Top View



Not to scale

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 ANSI/ESDA/JEDEC JS-001(1)	±2000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	±500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

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)	–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)		TMP392 DRL (SOT) 6 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	230	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	103.4	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	111.6	°C/W
ψ_{JT}	Junction-to-top characterization parameter	5.3	°C/W
ψ_{JB}	Junction-to-board characterization parameter	110.5	°C/W

(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

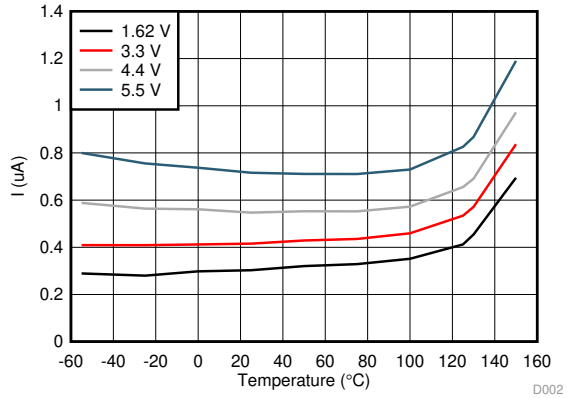
Minimum and maximum specifications are over -55°C to 130°C and VDD = 1.62V - 5.5V (unless otherwise noted); typical specifications are at T_A = 25°C and VDD = 3.3 V.

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
TEMPERATURE TO DIGITAL CONVERTER							
TEMPERATURE MEASUREMENT							
	Trip Point Accuracy	TMP392A2	30°C to 70°C, VDD = 2.5V to 5.5V(1)	-1.5	±0.5	1.5	°C
			30°C to 70°C, VDD = 1.62V to 2.5V(1)	-2.0	±0.5	2.0	
			30°C to 130°C, VDD = 2.5V to 5.5V(1)	-2.5	±0.5	2.5	
			30°C to 130°C, VDD = 1.62V to 2.5V(1)	-3.0	±0.5	3.0	
		TMP392A3	30°C to 70°C(1)	-2.0	±0.5	2.0	°C
			30°C to 130°C(1)	-3.5		3.5	°C
T_{HYST}	Trip point hysteresis	Table 2 selection column 2			5		°C
		Table 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(2)			-100		100	ppm/°C
	SETA & SETB resistor lifetime drift(2)			-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

(1) Trip point accuracy test conditions is from 30°C to 130°C, since for the TMP392 the trip points for both channels is from 30°C to 124°C
(2) Recommended Value

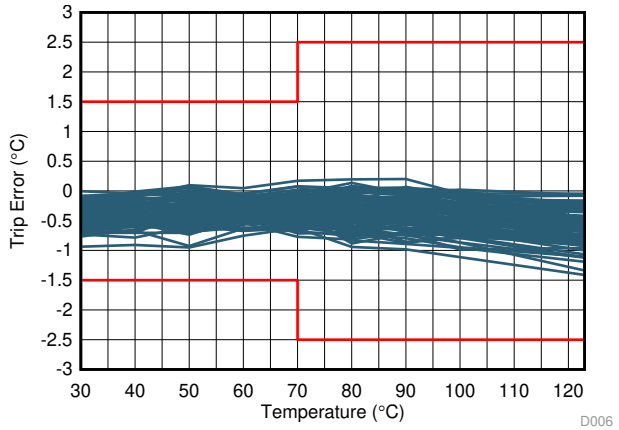
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6.6 Typical Characteristics



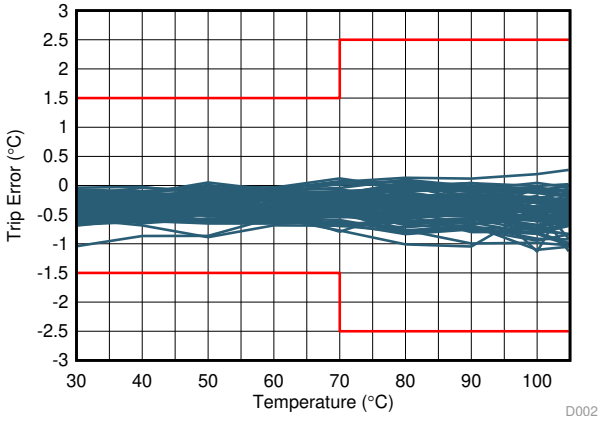
(V_S = 1.62 V, 3.3 V, 4.4 V, 5.5 V)

Figure 1. Average Supply Current vs Operating Temperature



(V_S = 3.3 V)

Figure 2. Hot Trip Point Accuracy vs Operating Temperature



(V_S = 3.3 V)

Figure 3. Warm Trip Point Accuracy vs Operating Temperature

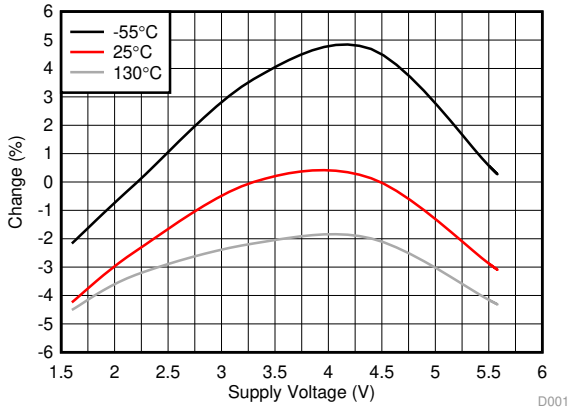


Figure 4. Sampling Period Variation vs Supply Voltage

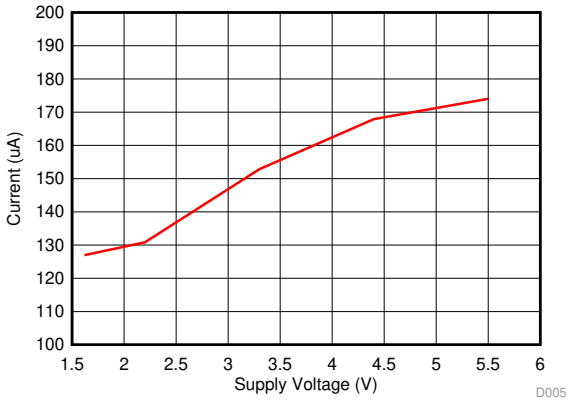
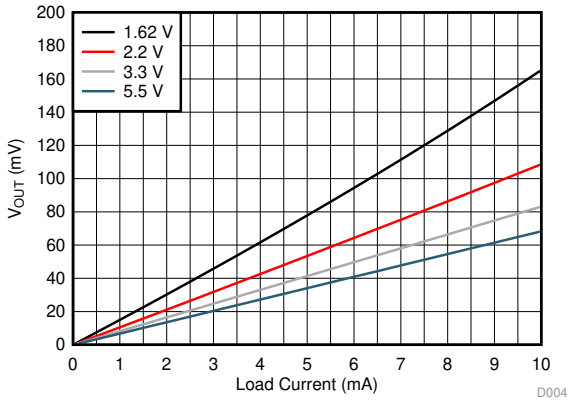


Figure 5. Conversion Current vs Supply Voltage



(T_{AMB} = 25°C)

Figure 6. Output Voltage vs Load Current

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7 Detailed Description

7.1 Overview

The TMP392 ultra-low power, dual channel, resistor programmable temperature switches enable detection and protection of system thermal events over a wide temperature range. The TMP392 offers dual overtemperature (hot and warm) detection. Channel A is referred to as the hot channel, and Channel B is referred to as the warm channel. The trip temperatures and hysteresis options are programmed by two E96-series (1%) standard decade value resistors on the SETA and SETB pins. The TMP392 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

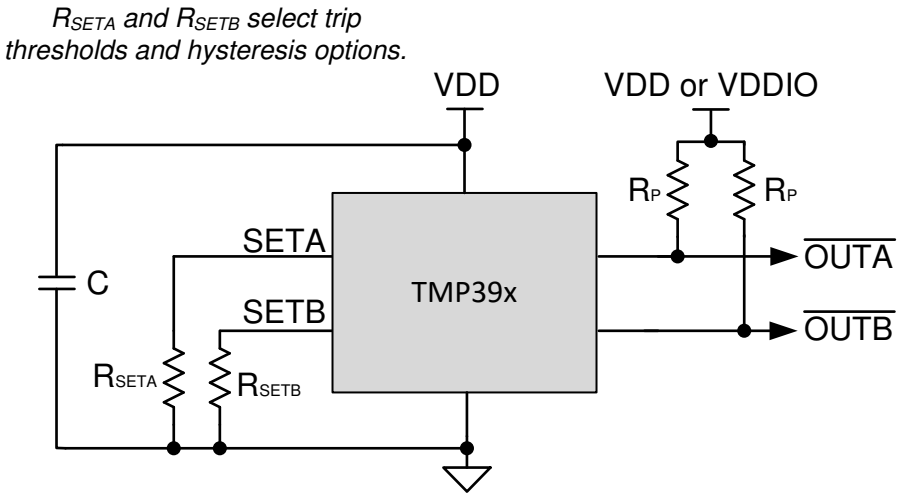


Figure 7. Simplified Schematic

7.3 Feature Description

The TMP392 requires two resistors to set the two trip points and hysteresis, according to Table 1 and Table 2 for the hot and warm channel device. The output of the TMP392 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 TMP392 Programming Tables

The temperature threshold and hysteresis options for the TMP392 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.

Table 1. TMP392 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

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Feature Description (continued)

Table 1. TMP392 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
34	1.40	29	24
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

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Feature Description (continued)

Table 1. TMP392 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
122	787	117	112
124	909	119	114

NOTE

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.

Table 2. TMP392 Channel B Threshold and Hysteresis Setting

CHANNEL B (WARM) TRIP TEMPERATURE (°C)	CHANNEL B NOMINAL 1% RESISTORS (KΩ)		CHANNEL B (WARM) TRIP RESET TEMPERATURE (°C)	
	HYSTERESIS = 5°C	HYSTERESIS = 10°C	HYSTERESIS = 5°C	HYSTERESIS = 10°C
30	90.9	105	25	20
35	78.7	121	30	25
40	68.1	140	35	30
45	59.0	162	40	35
50	51.1	187	45	40
55	44.2	215	50	45
60	38.3	249	55	50
65	33.2	287	60	55
70	28.7	332	65	60
75	24.9	383	70	65
80	21.5	442	75	70
85	18.7	511	80	75
90	16.2	590	85	80
95	14.0	681	90	85
100	12.1	787	95	90
105	10.5	909	100	95

NOTE

When the SETB pin is grounded or left floating during the POR, the OUTB pin always stays low and the Channel A hysteresis is set to 20°C.

7.3.2 Trip Test

The purpose of the trip test is in system manufacturing test without putting the TMP392 through costly temperature verification of the assembly of TMP392 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 Figure 8. 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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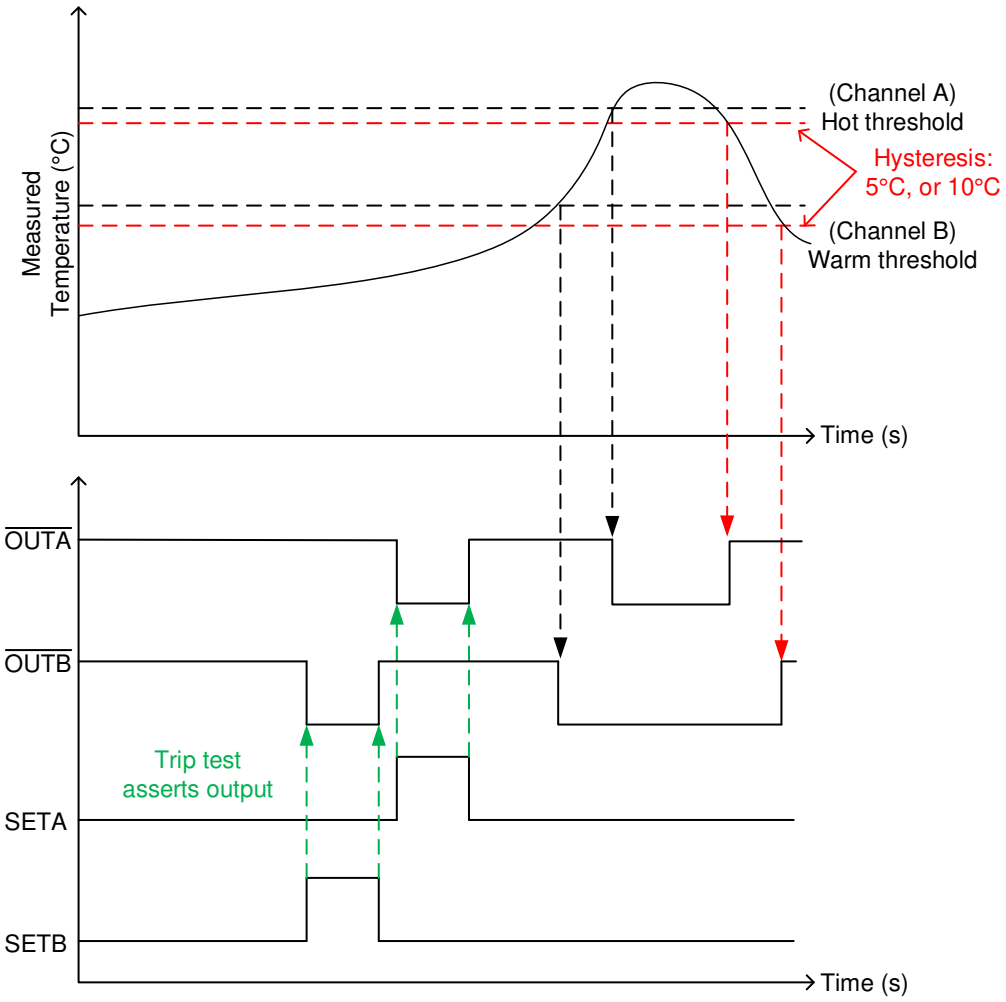


Figure 8. TMP392 Trip Test Operation

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

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 Applications Information

The TMP392 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

Figure 9 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 Table 1 for channel A trip point, and Table 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.

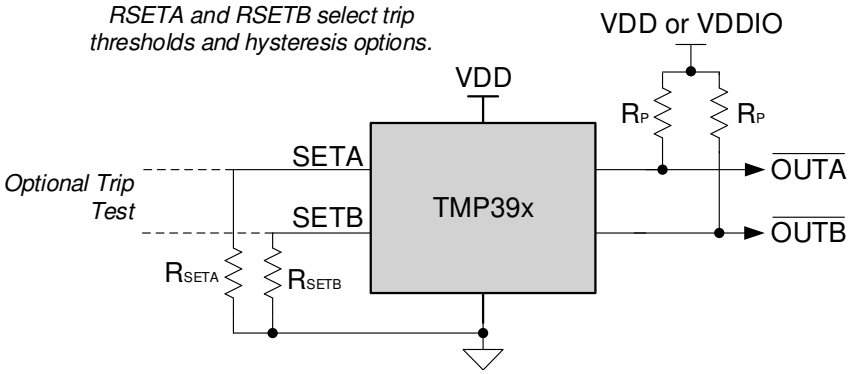


Figure 9. Simplified Schematic

8.2.1.1 Design Requirements

The TMP392 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 Figure 9. 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 TMP392 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 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.

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Typical Applications (continued)

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 Table 1 and Table 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 TMP392 output for hot/warm thresholds is shown in Figure 10. 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 exceeds the warm trip threshold, $\overline{OUTB}$ goes low and returns high after the temperature drops below 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

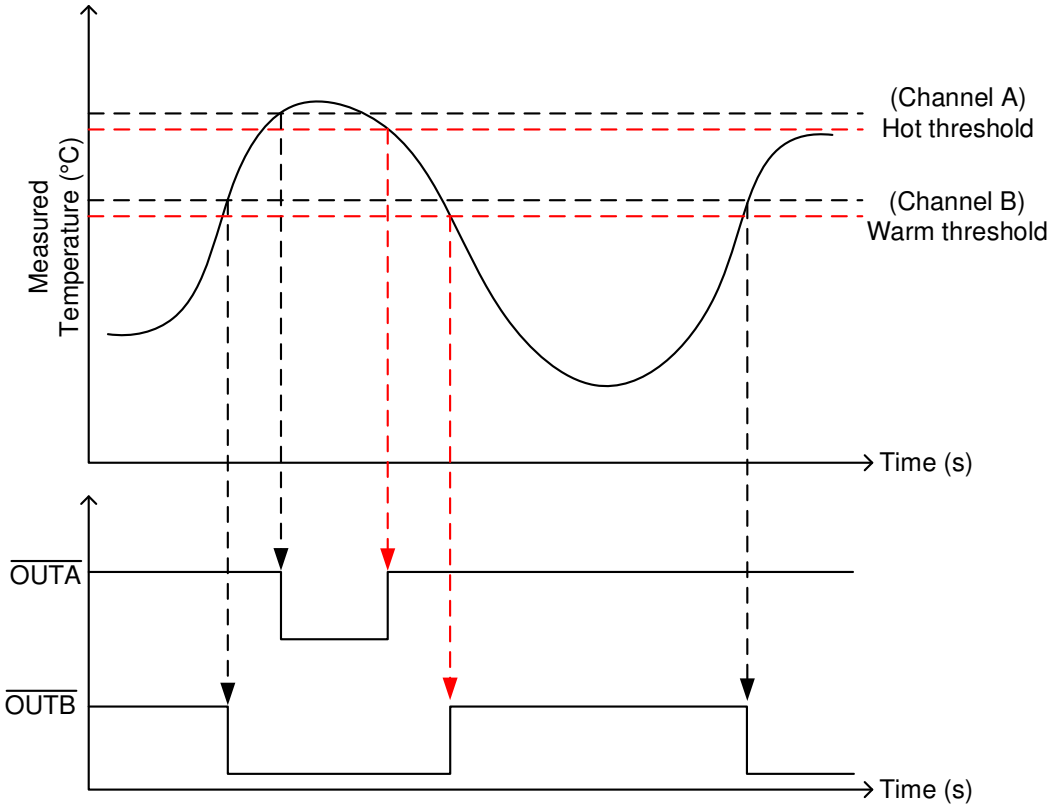


Figure 10. TMP392 Output With Hot/Warm Thresholds and Hysteresis

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Typical Applications (continued)

8.2.2 TMP392 With 10°C Hysteresis

Figure 11 shows an example circuit for dual overtemperature protection using the TMP392. In this example, the trip points are set at +60°C and +90°C with 10°C hysteresis. This circuit is useful in cases where a lower overtemperature detection may be used to warn the application of rising system temperature and take software corrective actions such as lowering the performance, while the higher overtemperature detection may be used to start a fan to cool the system to a lower temperature.

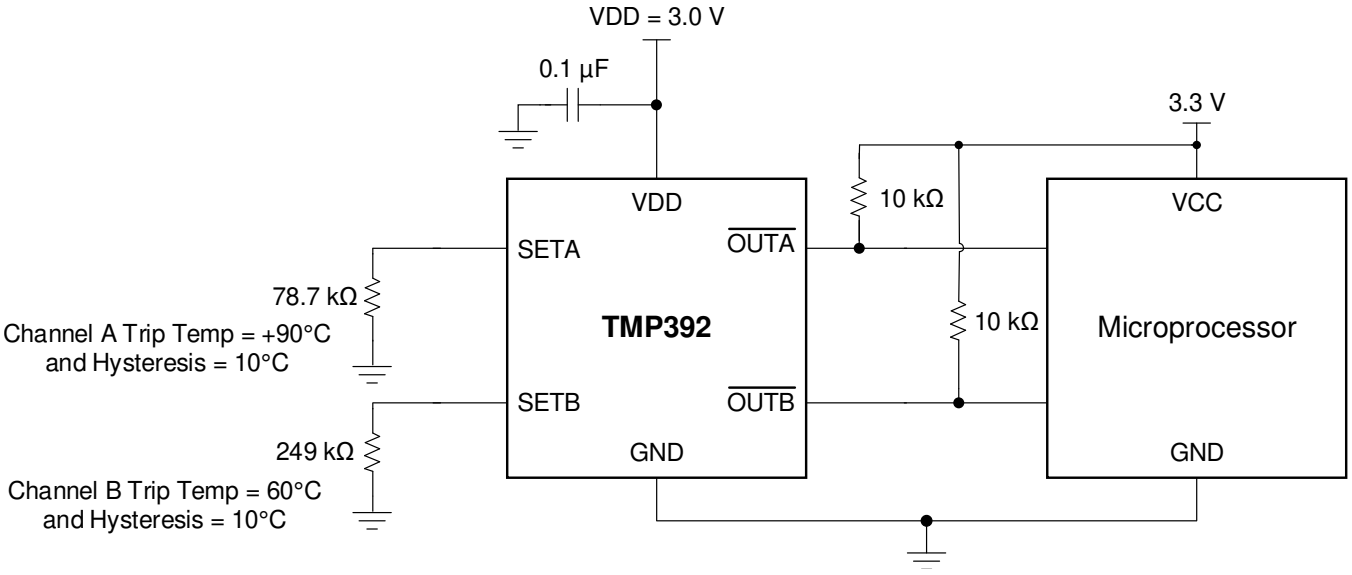


Figure 11. TMP392 Example Circuit at +90°C and +60°C Thresholds With 10°C Hysteresis

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. Figure 11 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 TMP392 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 +60°C trip point and 10°C hysteresis using 249 kΩ. These values were determined using Table 1 and Table 2. These resistors should have maximum of 1% tolerance at room temperature and 100 ppm/°C or less over the desired temperature range. A summary of the resistor settings used in this example is shown in Table 3. See Table 1 and Table 2 for additional trip points and hysteresis configurations.

The switching output of the TMP392 can be visualized with the output diagram shown in Figure 12. It is key to notice that hysteresis is subtracted from both Channel A and 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. $\overline{\text{OUTB}}$ remains high until the sensor reaches +60°C where the output goes low, and returns high after the temperature drops back down to +50°C.

Table 3. Example Resistor Settings and Trip Points

CHANNEL	RESISTOR SETTING (kΩ)	HYSTERESIS (°C)	TRIP TEMPERATURE (°C)
SETA	78.7	10	+90
SETB	249		+60

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8.2.2.3 Application Curve

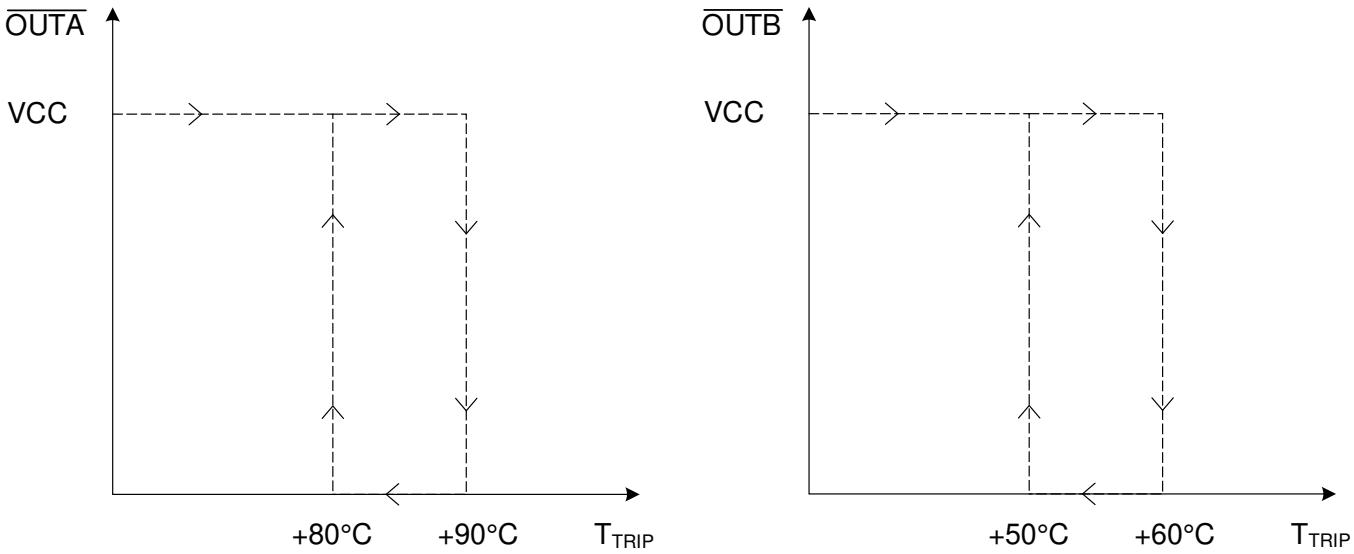


Figure 12. TMP392 Output Response With Hysteresis

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

Figure 13 shows the TMP392 configured for one channel operation, with a single resistor to set the hot trip point and hysteresis. Table 4 shows the possible resistor values and hysteresis values that may be used for one channel applications.

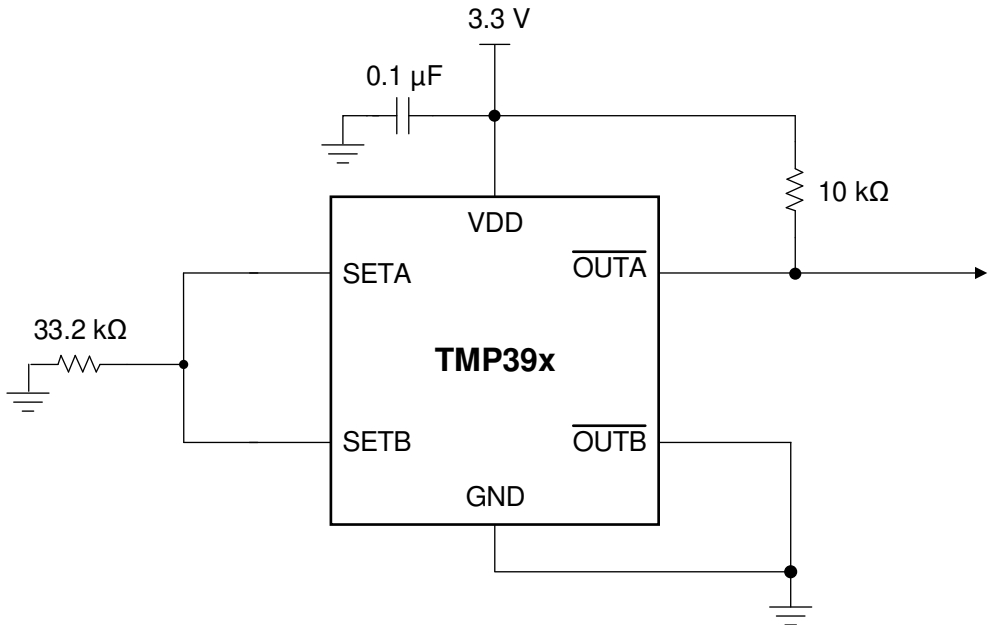


Figure 13. TMP392 One Channel (Hot) Operation Example Circuit With 78°C Trip Point and 5°C Hysteresis

Table 4. 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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Table 4. 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

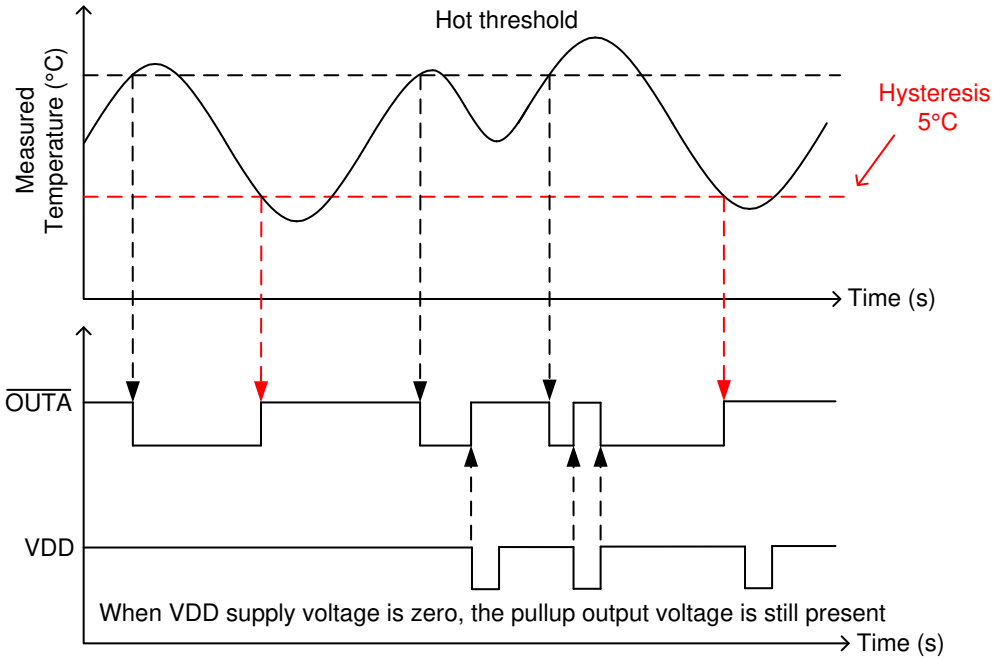


Figure 14. TMP392 One Channel (Hot) Operation Thresholds and Hysteresis

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8.2.4 One Channel Operation for Warm Trip Point from 30°C up to 105°C

Figure 15 shows the TMP392 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 Table 2.

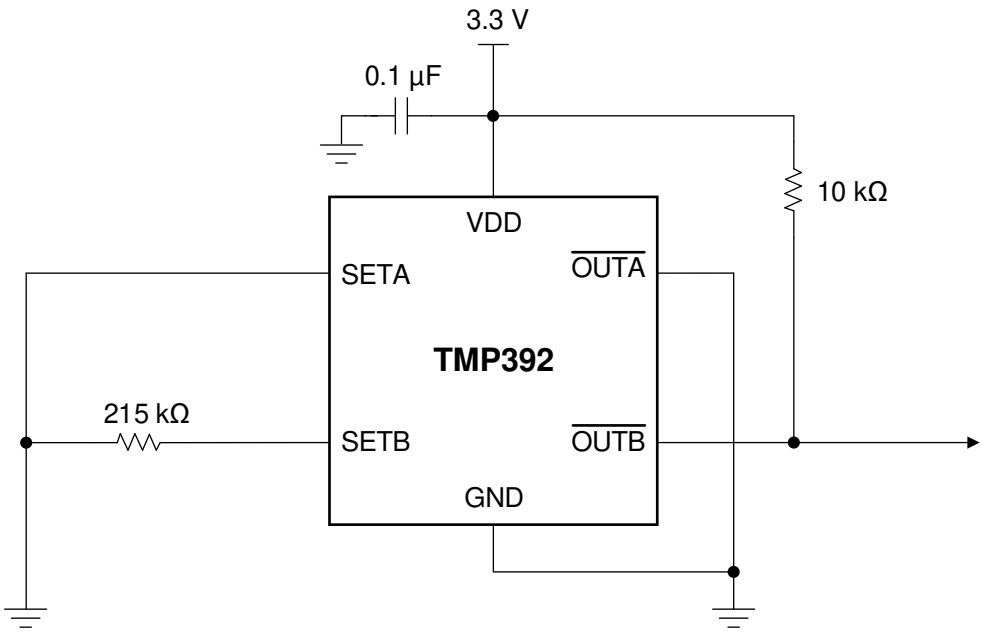


Figure 15. TMP392 One Channel (Warm) Operation Example Circuit With 55°C Trip Point and 10°C Hysteresis

9 Power Supply Recommendations

The low supply current and wide supply range of the TMP392 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.

10 Layout

10.1 Layout Guidelines

The TMP392 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 Figure 16. 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.

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10.2 Layout Example

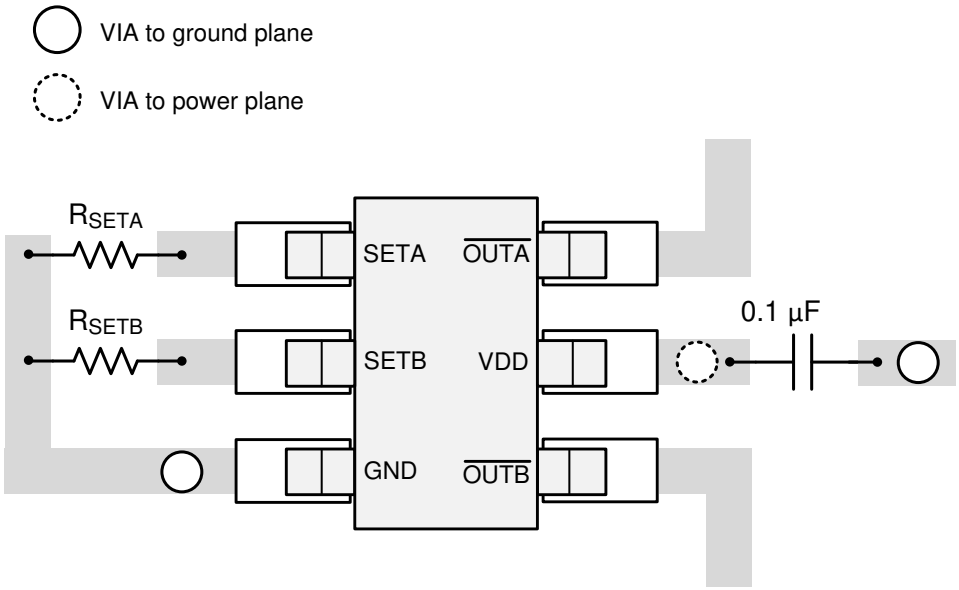


Figure 16. TMP392 Recommended Layout

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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. In the upper right corner, click on *Alert me* 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.

11.2 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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11.3 Trademarks

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All other trademarks are the property of their respective owners.

11.4 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

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

SLYZ022 — *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 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
TMP392A2DRLR	ACTIVE	SOT-5X3	DRL	6	4000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 130	1CH	Samples
TMP392A2DRLT	ACTIVE	SOT-5X3	DRL	6	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 130	1CH	Samples
TMP392A3DRLR	ACTIVE	SOT-5X3	DRL	6	4000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 130	1CI	Samples
TMP392A3DRLT	ACTIVE	SOT-5X3	DRL	6	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 130	1CI	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.

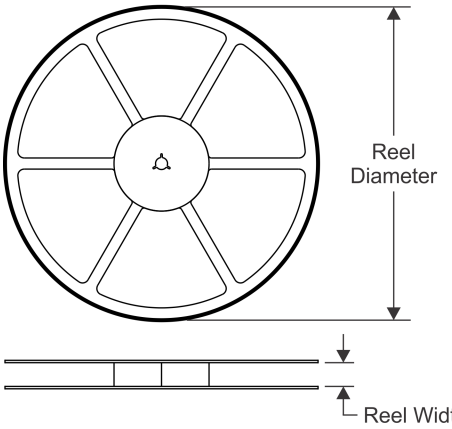
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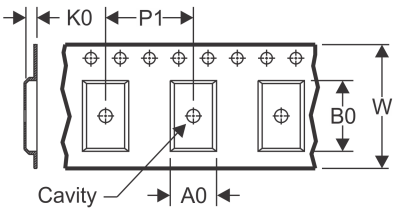
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TAPE AND REEL INFORMATION

REEL DIMENSIONS

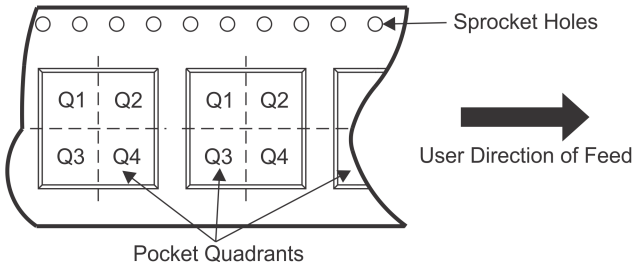


TAPE DIMENSIONS



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

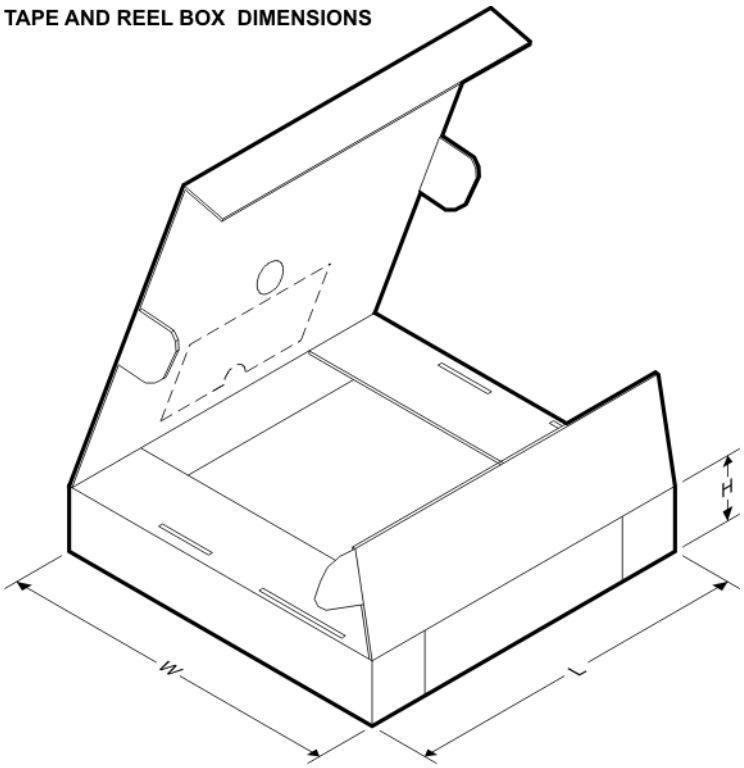
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TMP392A2DRLR	SOT-5X3	DRL	6	4000	180.0	8.4	1.98	1.78	0.69	4.0	8.0	Q3
TMP392A2DRLT	SOT-5X3	DRL	6	250	180.0	8.4	1.98	1.78	0.69	4.0	8.0	Q3
TMP392A3DRLR	SOT-5X3	DRL	6	4000	180.0	8.4	1.98	1.78	0.69	4.0	8.0	Q3
TMP392A3DRLT	SOT-5X3	DRL	6	250	180.0	8.4	1.98	1.78	0.69	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

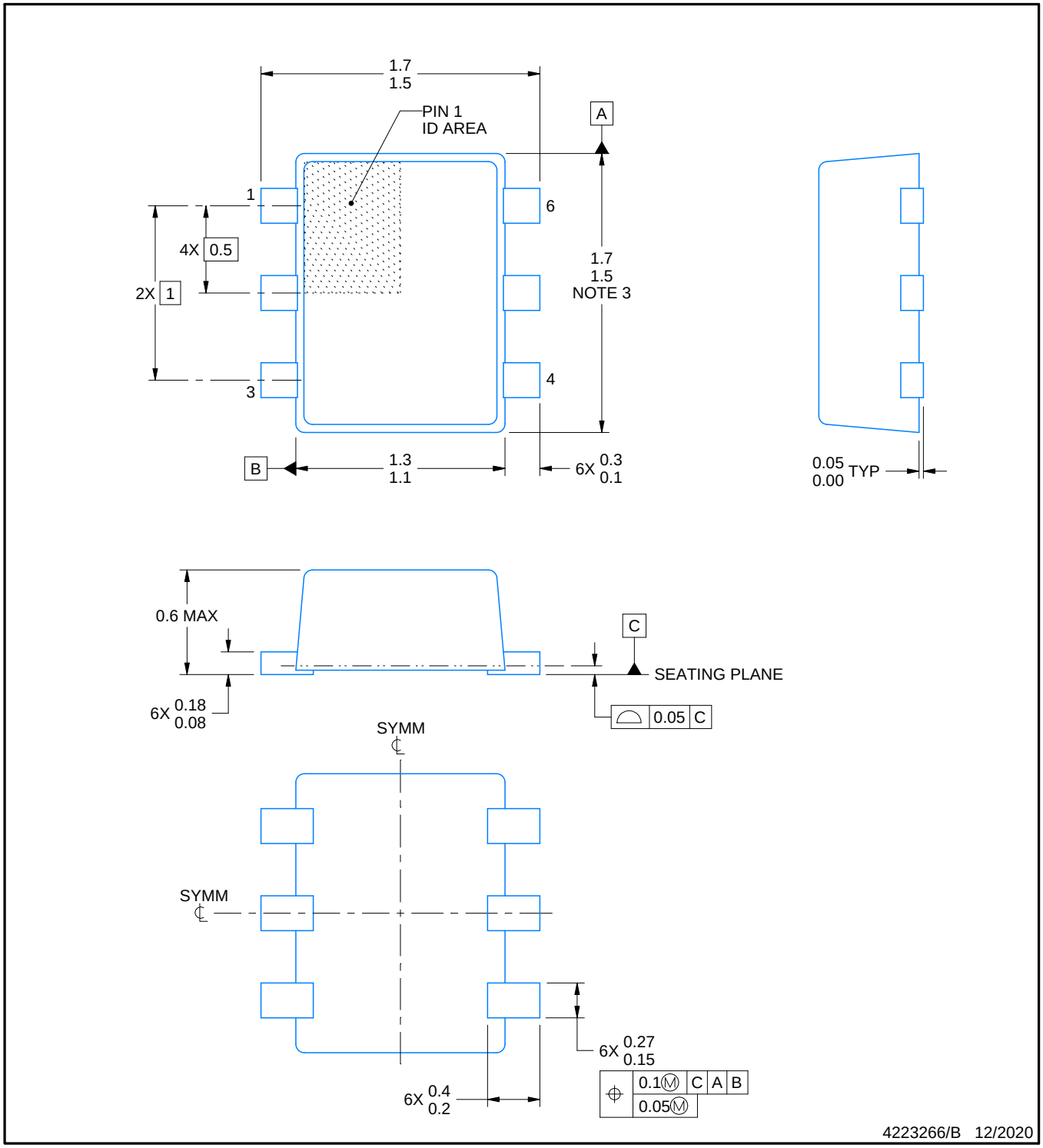
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TMP392A2DRLR	SOT-5X3	DRL	6	4000	183.0	183.0	20.0
TMP392A2DRLT	SOT-5X3	DRL	6	250	183.0	183.0	20.0
TMP392A3DRLR	SOT-5X3	DRL	6	4000	183.0	183.0	20.0
TMP392A3DRLT	SOT-5X3	DRL	6	250	183.0	183.0	20.0

PACKAGE OUTLINE

DRL0006A

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



NOTES:

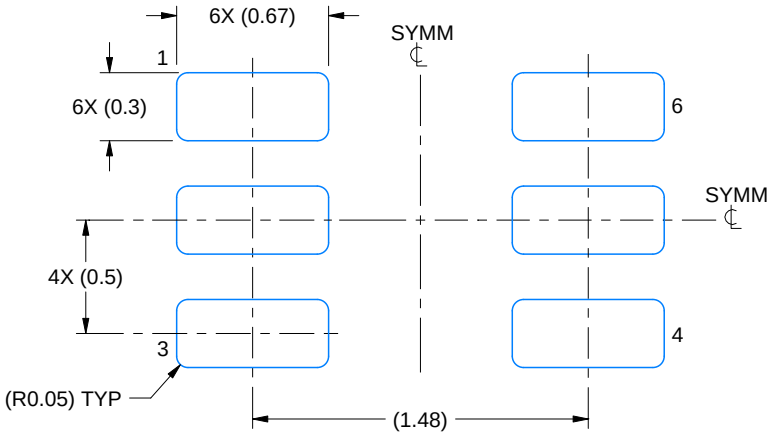
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or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

EXAMPLE BOARD LAYOUT

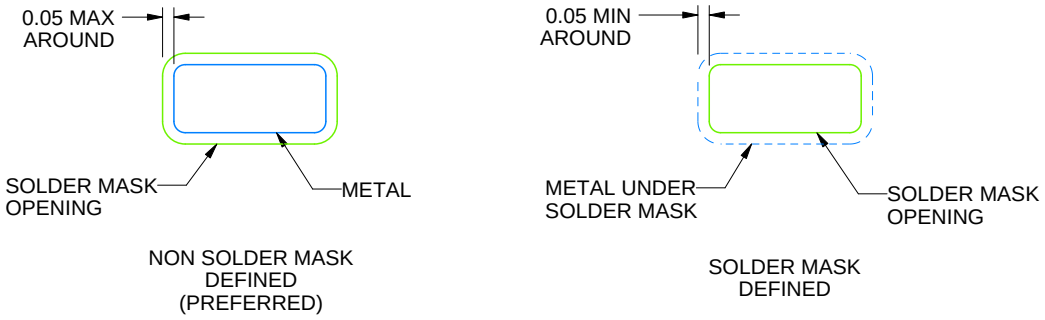
DRL0006A

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



LAND PATTERN EXAMPLE
SCALE:30X

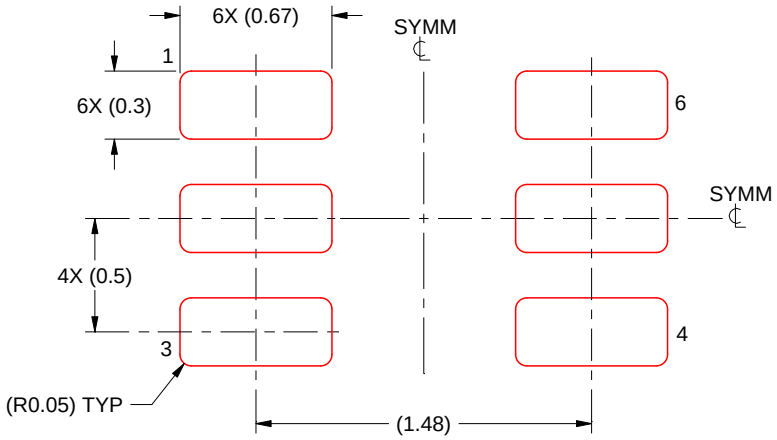


SOLDERMASK DETAILS

4223266/B 12/2020

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 0.1 mm THICK STENCIL
SCALE:30X

4223266/B 12/2020

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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