

TPS22991 5V、3A、25mΩ ロード スイッチ デバイス、小型プラスチック パッケージ

1 特長

- シングル チャネル 負荷スイッチを内蔵
- 入力電圧範囲: 1V~5.5V
- 最大連続スイッチ電流: 3A
- 25mΩ (標準値) のオン抵抗
- 低い静止電流:
 - I_Q (3.3V 時) $V_{IN} = 6\mu A$ (標準値)
- 低シャットダウン電流:
 - I_{SD} (3.3V 時) $V_{IN} = 14nA$ (標準値)
- スルーレート制御:
 - バージョン B, BN: 立ち上がり時間 (t_R) (3.3V 時) $V_{IN} = 141\mu s$
 - バージョン C, CN: 立ち上がり時間 (t_R) (3.3V 時) $V_{IN} = 662\mu s$
- クイック出力放電 (QOD): 150Ω
- サーマル シャットダウン保護機能
- 0.85 × 0.75mm、0.4mm ピッチ UQFN パッケージ

2 アプリケーション

- PC とノート PC
- ウェアラブル
- ソリッド ステート ドライブ (SSD)
- 産業用 PC

3 概要

TPS22991 は、スルーレート制御機能を備えた小型低 R_{ON} のシングル チャネル ロード スイッチです。このデバイスは、1.0V~5.5V の入力電圧範囲で動作できる N チャネル MOSFET を内蔵し、3A の最大連続電流をサポートできます。このスイッチは、オン オフ入力により制御され、低電圧の制御信号と直接接続可能です。

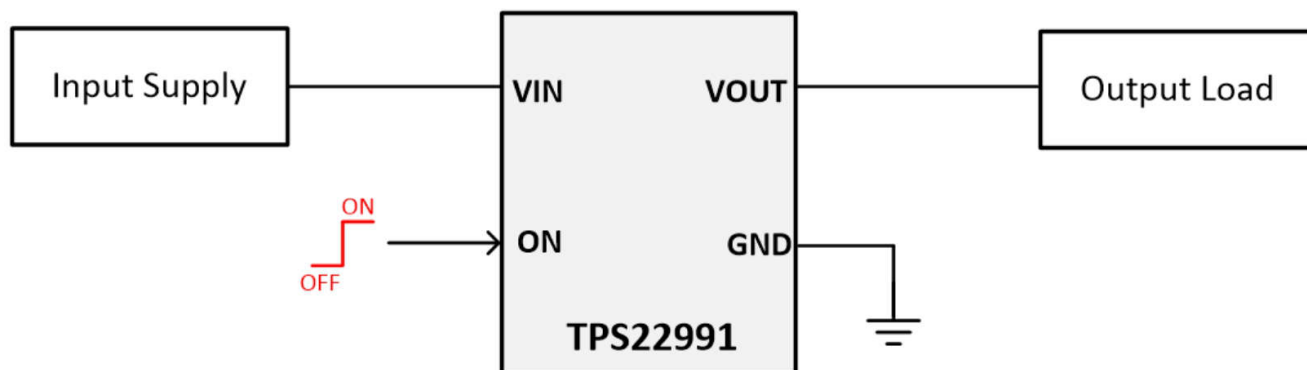
このデバイスは、小型で R_{ON} が小さいため、スペースの制約が厳しいバッテリー駆動アプリケーションで使うのに理想的です。このスイッチは入力電圧範囲が広いので、各種電圧レールのための多用途なソリューションとして使えます。デバイスの立ち上がり時間を制御できるため、大きな負荷容量により発生する突入電流が大幅に減少し、電源ドループが低減、または生じなくなります。TPS22991 は、スイッチがオフになった際に迅速に出力を放電 (QOD) するための 150Ω のプルダウン抵抗を内蔵することで、ソリューション全体のサイズをさらに縮小しています。

TPS22991 は、小型で省スペースの 0.85mm × 0.75mm、0.4mm ピッチ、4 ピン UQFN パッケージ で供給されます。周囲温度 $-55^{\circ}C \sim +125^{\circ}C$ で動作が規定されています。

パッケージ情報

部品番号	パッケージ (1)	パッケージ サイズ (2)
TPS22991	RAA (UQFN, 4)	0.85mm × 0.75mm

- (1) 利用可能なすべてのパッケージについては、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。
- (2) パッケージ サイズ (長さ × 幅) は公称値であり、該当する場合はピンも含まれます。



TPS22991 の代表的なアプリケーション



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4 Device Comparison Table

表 4-1. Functionality Comparison

PART NUMBER	QUICK OUTPUT DISCHARGE (QOD)	TURN ON TIME
TPS22991B	Yes	Fast
TPS22991BN	No	Fast
TPS22991C	Yes	Slow
TPS22991CN	No	Slow

5 Pin Configuration and Functions



図 5-1. TPS22991 RAA Package, 4-Pin UQFN (Top View)

表 5-1. Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
VIN	1	I	Switch input.
ON	2	I	Active high switch control input.
VOUT	3	O	Switch output.
GND	4	—	Device ground.

6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V _{IN}	Maximum input voltage range	−0.3	6	V
V _{OUT}	Maximum output voltage range	−0.3	6	V
V _{ON}	Maximum ON pin voltage range	−0.3	6	V
I _{MAX}	Maximum continuous current		3	A
I _{PLS}	Maximum pulsed current (2ms, 2% duty cycle)		4	A
T _J	Junction temperature	−55	150	°C
T _{STG}	Storage temperature	−65	150	°C
T _{LEAD}	Maximum lead temperature (10s soldering time)		300	°C

- (1) Stresses beyond those listed under *Absolute Maximum Rating* 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 Condition*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 ESD Ratings

			VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/ JEDEC JS-001, all pins ⁽¹⁾	±1750	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins ⁽²⁾	±1000	

- (1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
 (2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less is possible with the necessary precautions. Pins listed may actually have higher performance.

6.3 Recommended Operating Conditions

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

		MIN	TYP	MAX	UNIT
V _{IN}	Input voltage range	1.0		5.5	V
V _{OUT}	Output voltage range	0		5.5	V
V _{IH}	ON pin high voltage Range	0.8		5.5	V
V _{IL}	ON pin low voltage range	0		0.35	V
T _A	Ambient temperature	−55		125	°C

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TPS22991	UNIT
		4 PINS	
		RAA	
R _{θJA}	Junction-to-ambient thermal resistance	225.3	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	214.5	°C/W
R _{θJB}	Junction-to-board thermal resistance	83.6	°C/W
Ψ _{JT}	Junction-to-top characterization parameter	13.1	°C/W

THERMAL METRIC ⁽¹⁾		TPS22991	UNIT
		4 PINS	
		RAA	
Ψ_{JB}	Junction-to-board characterization parameter	83	°C/W

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

6.5 Electrical Characteristics

Typical values at $V_{IN} = 3.3V$ unless otherwise specified

PARAMETER		TEST CONDITIONS		T _A	MIN	TYP	MAX	UNIT
INPUT SUPPLY (VIN)								
I _{Q, VIN}	VIN quiescent current	V _{ON} ≥ V _{IH} , VOUT = Open		25°C			6	μA
				–40°C to 85°C			12	μA
				–55°C to 125°C			14	μA
I _{SD, VIN}	VIN shutdown current	V _{ON} ≤ V _{IL} , VOUT = Open		25°C			14	nA
				–40°C to 85°C			20	μA
				–55°C to 125°C			67	μA
I _{SD, VIN}	VIN shutdown current	V _{ON} ≤ V _{IL} , VOUT = GND	V _{ON} ≤ V _{IL} , VOUT = GND	25°C			15	nA
				–40°C to 85°C			20	μA
				–55°C to 125°C			67	μA
ON-RESISTANCE (RON)								
RON	ON-state resistance	I _{OUT} = –200mA	VIN = 5V	25°C			25	mΩ
				–40°C to 85°C			35	mΩ
				–40°C to 105°C			38	mΩ
				–55°C to 125°C			40	mΩ
			VIN = 3.3V	25°C			25	mΩ
				–40°C to 85°C			35	mΩ
				–40°C to 105°C			38	mΩ
				–55°C to 125°C			40	mΩ
			VIN = 1.8V	25°C			25	mΩ
				–40°C to 85°C			35	mΩ
				–40°C to 105°C			38	mΩ
				–55°C to 125°C			40	mΩ
			VIN = 1V	25°C			35	mΩ
				–40°C to 85°C			48	mΩ
				–40°C to 105°C			52	mΩ
				–55°C to 125°C			60	mΩ
THERMAL SHUTDOWN (TSD)								
T _{SD,R}	Thermal shutdown			Rising			170	°C
T _{SD,F}	Thermal shutdown			Falling			150	°C
ENABLE PIN (ON)								
I _{ON}	ON pin leakage	V _{ON} ≥ V _{IH}		–55°C to 125°C		100		nA
R _{PD, ON}	Smart pull down resistance	V _{ON} ≤ V _{IL}		–55°C to 125°C		500		kΩ
V _{IH,ON}	ON pin threshold (VIH rising)			–55°C to 125°C		0.8		V
V _{Hys,ON}	ON pin threshold (hysteresis)			–55°C to 125°C		0.07		V
V _{IL,ON}	ON pin threshold (VIL falling)			–55°C to 125°C		0.35		V

6.5 Electrical Characteristics (続き)

Typical values at VIN = 3.3V unless otherwise specified

PARAMETER		TEST CONDITIONS		T _A	MIN	TYP	MAX	UNIT
QUICK OUTPUT DISCHARGE (QOD)								
R _{QOD}	QOD pin internal discharge resistance (Version B, C)	V _{ON} ≤ V _{IL}	V _{IN} = 1V	–55°C to 125°C		190		Ω
			V _{IN} = 3.3V	–55°C to 125°C		150		Ω
			V _{IN} = 5V	–55°C to 125°C		140		Ω

6.6 Switching Characteristics (Version C, CN)

Unless otherwise noted, the typical characteristics in the following table apply to an input voltage of 3.3V, an ambient temperature of 25°C, and a load of CL = 0.1μF, RL = 10Ω. Timing parameter measurement details are shown in the timing diagram in the data sheet. Parameter not tested in production

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t _{ON}	Turn ON time	VIN = 5.0V			1119		μs
		VIN = 3.3V			996		μs
		VIN = 1.8V			853		μs
		VIN = 1.0V			774		μs
t _R	Output rise time	VIN = 5.0V			794		μs
		VIN = 3.3V			662		μs
		VIN = 1.8V			514		μs
		VIN = 1.0V			397		μs
t _D	Delay time	VIN = 5.0V			332		μs
		VIN = 3.3V			341		μs
		VIN = 1.8V			346		μs
		VIN = 1.0V			383		μs
t _{OFF}	Turn OFF time	VIN = 5.0V			6		μs
		VIN = 3.3V			4		μs
		VIN = 1.8V			2		μs
		VIN = 1.0V			4		μs
t _F	Output Fall time	VIN = 5.0V			5		μs
		VIN = 3.3V			5		μs
		VIN = 1.8V			5		μs
		VIN = 1.0V			5		μs

6.7 Switching Characteristics (Version B, BN)

Unless otherwise noted, the typical characteristics in the following table apply to an input voltage of 3.3V, an ambient temperature of 25°C, and a load of CL = 0.1μF, RL = 10Ω. Timing parameter measurement details are shown in the timing diagram in the data sheet. Parameter not tested in production

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t _{ON}	Turn ON time	VIN = 5.0V			302		μs
		VIN = 3.3V			259		μs
		VIN = 1.8V			216		μs
		VIN = 1.0V			198		μs
t _R	Output rise time	VIN = 5.0V			173		μs
		VIN = 3.3V			141		μs
		VIN = 1.8V			107		μs
		VIN = 1.0V			81		μs

6.7 Switching Characteristics (Version B, BN) (続き)

Unless otherwise noted, the typical characteristics in the following table apply to an input voltage of 3.3V, an ambient temperature of 25°C, and a load of $C_L = 0.1\mu\text{F}$, $R_L = 10\Omega$. Timing parameter measurement details are shown in the timing diagram in the data sheet. Parameter not tested in production

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_D	Delay time	VIN = 5.0V		127		μs
		VIN = 3.3V		117		μs
		VIN = 1.8V		109		μs
		VIN = 1.0V		116		μs
t_{OFF}	Turn OFF time	VIN = 5.0V		6		μs
		VIN = 3.3V		4		μs
		VIN = 1.8V		2		μs
		VIN = 1.0V		4		μs
t_F	Output fall time	VIN = 5.0V		5		μs
		VIN = 3.3V		5		μs
		VIN = 1.8V		5		μs
		VIN = 1.0V		5		μs

7 Typical Characteristics

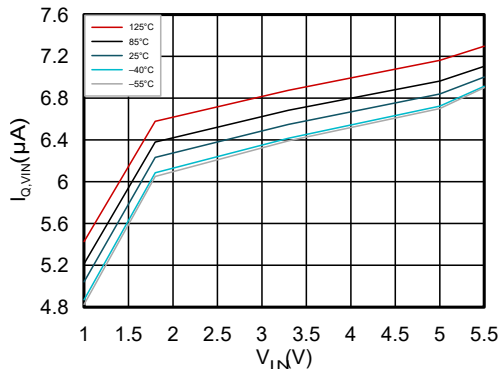
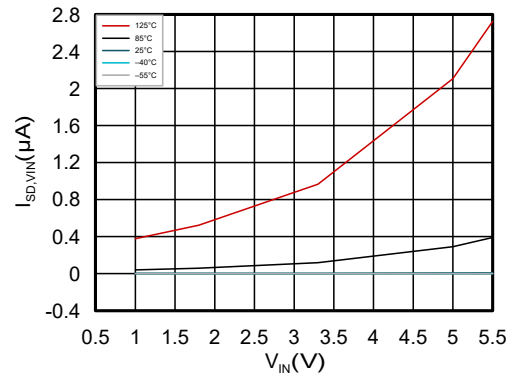
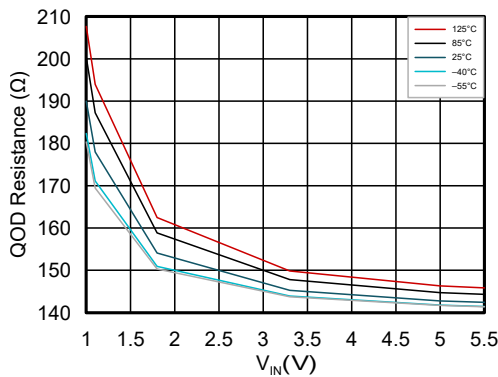


Figure 7-1. V_{IN} Quiescent Current vs Input Voltage



TPS22991B, TPS22991C

Figure 7-2. V_{IN} Shutdown Current vs Input Voltage



TPS22991B, TPS22991C

Figure 7-3. QOD Resistance vs Input Voltage

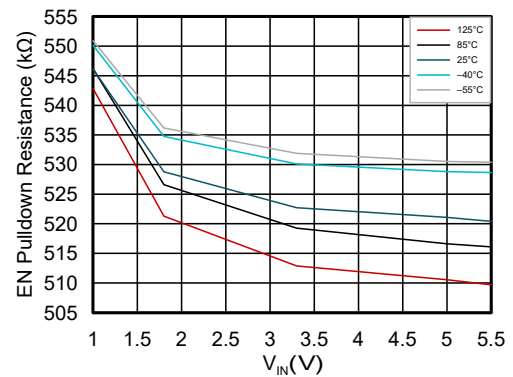


Figure 7-4. ON Pin Resistance $R_{PD,ON}$ vs Input Voltage

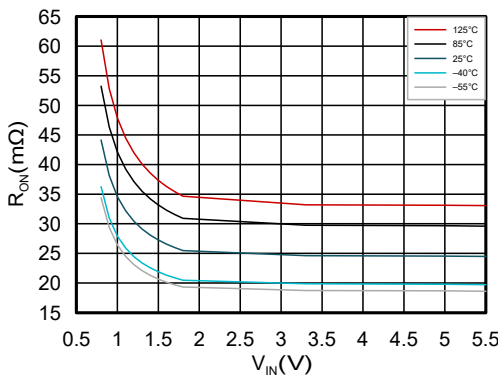
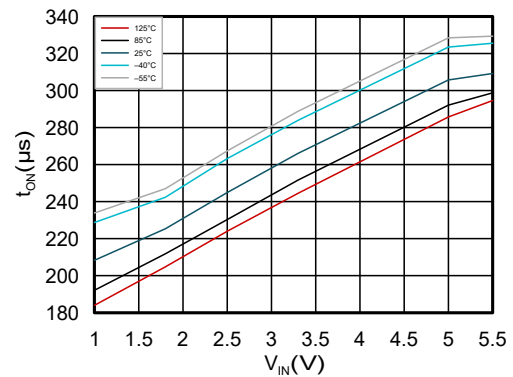


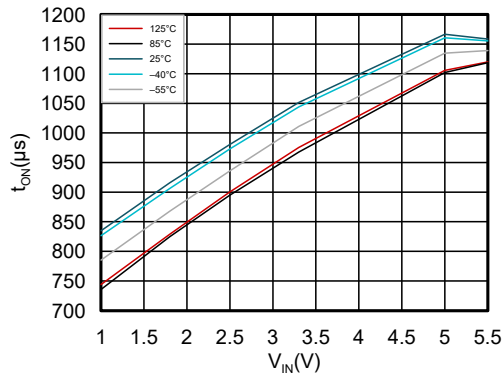
Figure 7-5. R_{ON} vs Input Voltage



$C_L = 0.1\mu F$ $R_L = 10\Omega$ TPS22991B, TPS22991BN

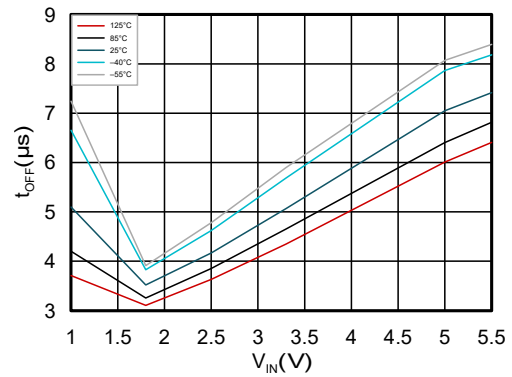
Figure 7-6. Turn ON Time vs Input Voltage

7 Typical Characteristics (continued)



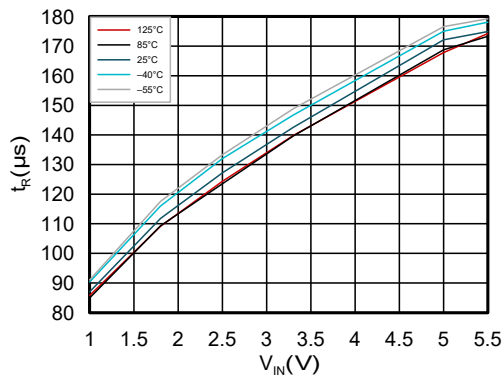
$C_L = 0.1\mu\text{F}$ $R_L = 10\Omega$ TPS22991C, TPS22991CN

図 7-7. Turn ON Time vs Input Voltage



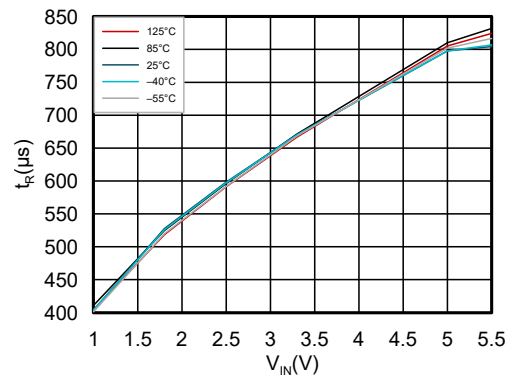
$C_L = 0.1\mu\text{F}$ $R_L = 10\Omega$

図 7-8. Turn OFF Time vs Input Voltage



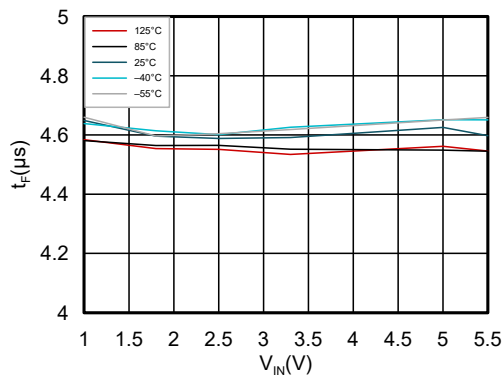
$C_L = 0.1\mu\text{F}$ $R_L = 10\Omega$ TPS22991B, TPS22991BN

図 7-9. Rise Time vs Input Voltage



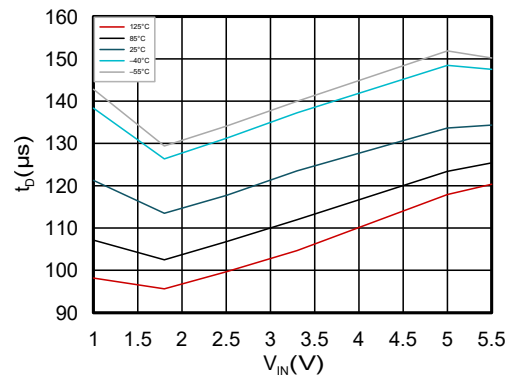
$C_L = 0.1\mu\text{F}$ $R_L = 10\Omega$ TPS22991C, TPS22991CN

図 7-10. Rise Time vs Input Voltage



$C_L = 0.1\mu\text{F}$ $R_L = 10\Omega$

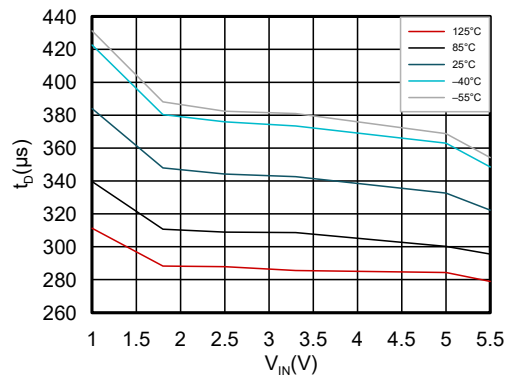
図 7-11. Fall Time vs Input Voltage



$C_L = 0.1\mu\text{F}$ $R_L = 10\Omega$ TPS22991B, TPS22991BN

図 7-12. Delay Time vs Input Voltage

7 Typical Characteristics (continued)



$C_L = 0.1\mu F$

$R_L = 10\Omega$

TPS22991C, TPS22991CN

7-13. Delay Time vs Input Voltage

8 Parameter Measurement Information

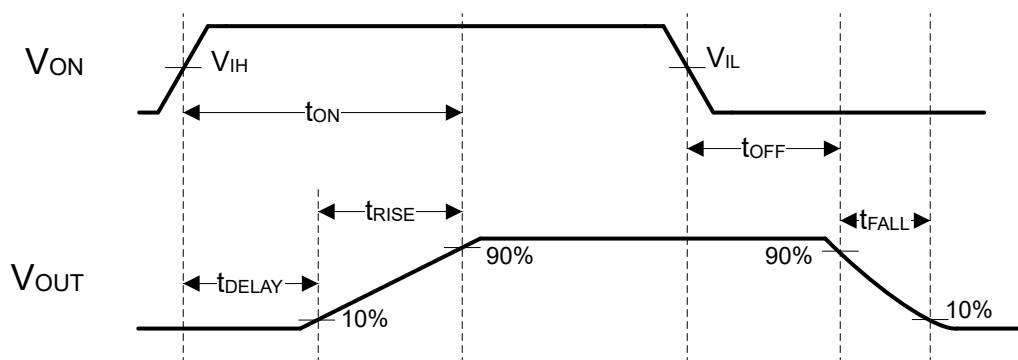


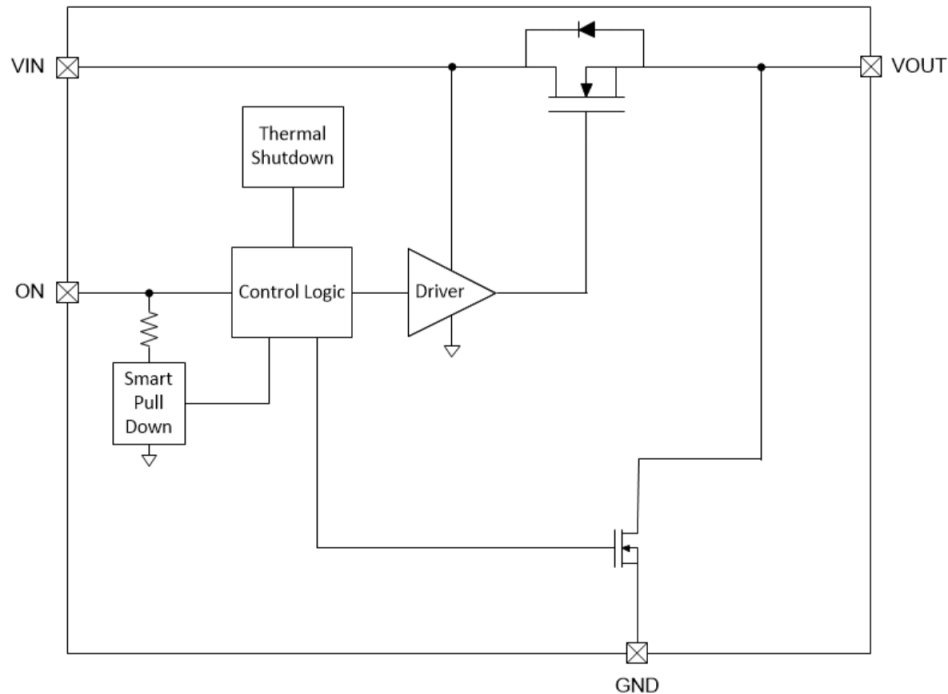
図 8-1. Timing Parameter Measurement Information

9 Detailed Description

9.1 Overview

The TPS22991 is a small, low R_{ON} , single channel load switch with controlled slew rate. The device contains an N-channel MOSFET that can operate over an input voltage range of 1V to 5.5V and can support a maximum continuous current of 3A. The switch is controlled by an on and off input, which is capable of interfacing directly with low-voltage control signals.

9.2 Functional Block Diagram



9.3 Feature Description

9.3.1 On and Off Control

The ON pin controls the state of the switch. The ON pin is compatible with standard GPIO logic threshold so it can be used in a wide variety of applications. When power is first applied to V_{IN} , a smart pulldown is used to keep the ON pin from floating until the system sequencing is complete. After the ON pin is deliberately driven high ($\geq V_{IH}$), the smart pulldown is disconnected to prevent unnecessary power loss. See [表 9-1](#) when the ON pin smart pulldown is active.

表 9-1. On Pin Control

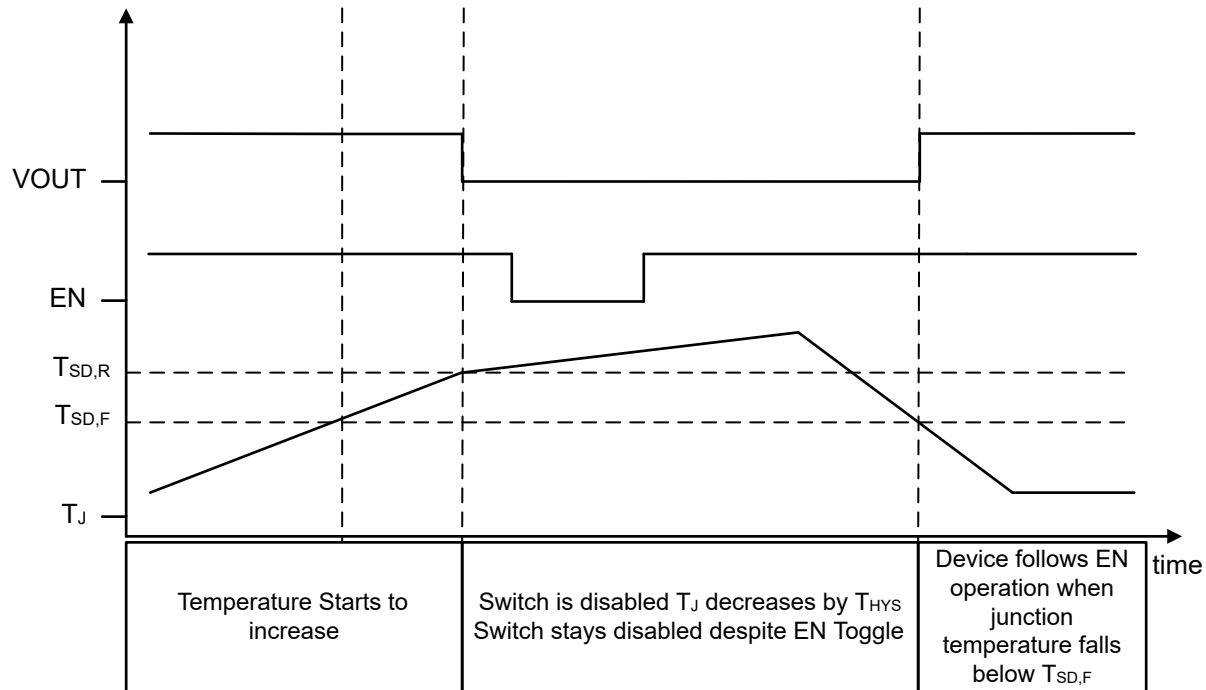
ON PIN VOLTAGE	ON PIN SMART PULLDOWN STATUS
$\leq V_{IL}$	Smart pulldown resistance active
$\geq V_{IH}$	Smart pulldown disconnected

9.3.2 Quick Output Discharge

TPS22991B and TPS22991C integrates quick output discharge. When the switch is disabled, a discharge resistor is connected between VOUT and GND. This resistor has a typical value of 150 Ω when $V_{IN} = 3.3V$, and prevents the output from floating while the switch is disabled.

9.3.3 Thermal Shutdown

When the device temperature reaches $T_{SD,R}$, the device shuts itself off to prevent thermal damage. After the device cools off to $T_{SD,F}$, it turns back on. If the device is kept in a thermally stressful environment, then the device oscillates between these two states until it can keep its temperature below the thermal shutdown point.



9.3.4 Input Capacitor (C_{IN})

To limit the voltage drop on the input supply caused by transient in-rush currents when the switch turns on into a discharged load capacitor or short-circuit, a capacitor needs to be placed between V_{IN} and GND. A $1\mu F$ ceramic capacitor, C_{IN} , placed close to the pins, is usually sufficient. Higher values of C_{IN} can be used to further reduce the voltage drop during high-current application. When switching heavy loads, it is recommended to have an input capacitor about 10 times higher than the output capacitor to avoid excessive voltage drop.

9.3.5 Output Capacitor (C_L)

Due to the integrated body diode in the MOSFET, a C_{IN} greater than C_L is highly recommended. A C_L greater than C_{IN} can cause V_{OUT} to exceed V_{IN} when the system supply is removed. This could result in current flow through the body diode from V_{OUT} to V_{IN} . A C_{IN} to C_L ratio of 10 to 1 is recommended for minimizing V_{IN} dip caused by inrush currents during startup.

9.4 Device Functional Modes

The table below describes the connection of the V_{OUT} pin depending on the state of the ON pin.

ON	FAULT CONDITION	VOUT STATE
L	N/A	- Hi-Z for BN, CN - GND through QOD resistor for B, C
H	None	V_{IN} through R_{ON}
X	Thermal shutdown	- Hi-Z for BN, CN - GND through QOD resistor for B, C

10 Application and Implementation

注

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, as well as validating and testing their design implementation to confirm system functionality.

10.1 Application Information

The input to output voltage drop in the device is determined by the R_{ON} of the device and the load current. The R_{ON} of the device depends upon the V_{IN} condition of the device. After the R_{ON} of the device is determined based upon the V_{IN} condition, use the below equation to calculate the input to output voltage drop.

$$\Delta V = I_{LOAD} \times R_{ON} \quad (1)$$

where

- ΔV is the voltage drop from V_{IN} to V_{OUT} .
- I_{LOAD} is the load current.
- R_{ON} is the on-resistance of the device for a specific V_{IN} and V_{BIAS} .

10.2 Typical Application

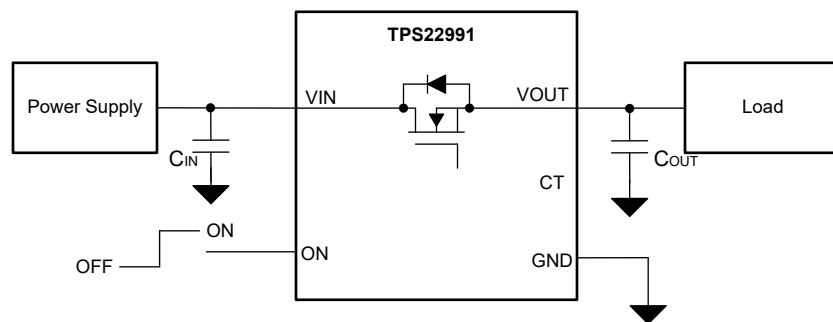


図 10-1. Typical Application Diagram

表 10-1. Recommended External Components

COMPONENT	TYPICAL VALUE	PURPOSE
C_{IN}	1 μ F	Filtering voltage transients
C_{OUT}	100nF	Filtering voltage transients

10.2.1 Design Requirements

For this design example, use the input parameters shown in 表 10-2.

表 10-2. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
V_{IN}	5V
Load current	2A
Load capacitance	10 μ F

10.2.2 Detailed Design Procedure

The input to output voltage drop in the device is determined by the R_{ON} of the device and the load current. The R_{ON} of the device depends upon the V_{IN} condition of the device. After the R_{ON} of the device is determined based upon the V_{IN} condition, use the below equation to calculate the input to output voltage drop.

$$\Delta V = I_{LOAD} \times R_{ON} \quad (2)$$

where

- ΔV is the voltage drop from V_{IN} to V_{OUT} .
- I_{LOAD} is the load current.
- R_{ON} is the on-resistance of the device for a specific V_{IN} and V_{BIAS} .

An appropriate I_{LOAD} must be chosen such that the I_{MAX} specification of the device is not violated.

To determine how much inrush current is caused by the load capacitance, use 式 3.

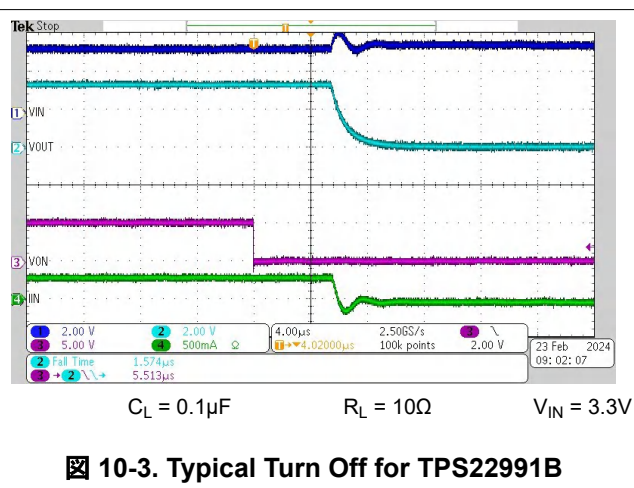
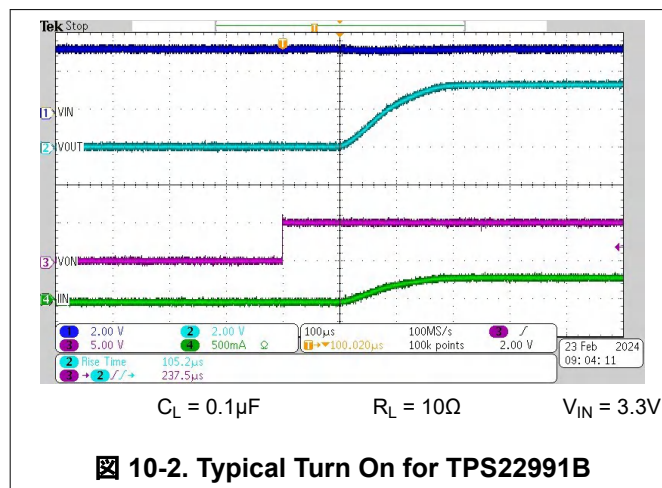
$$I_{INRUSH} = C_L \times dV_{OUT} / dt \quad (3)$$

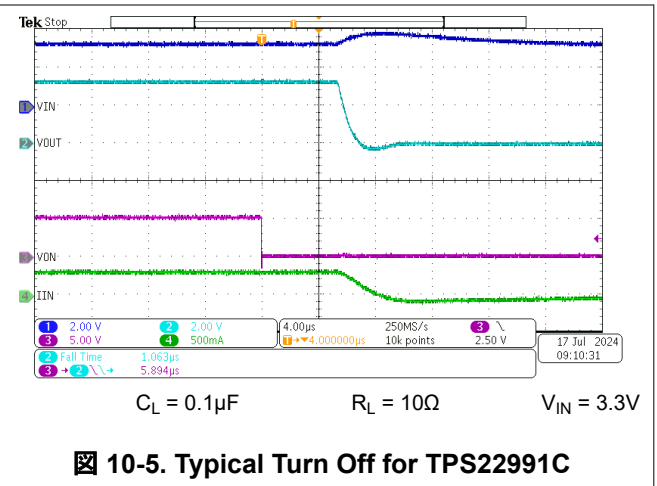
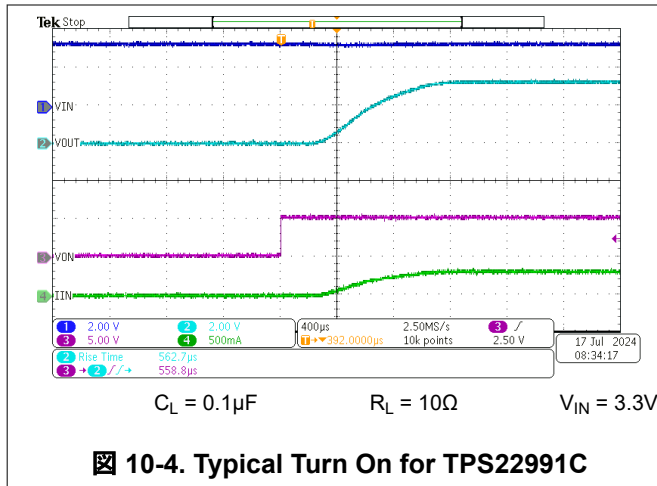
where

- I_{INRUSH} is amount of inrush current caused by C_L
- C_L is the load capacitance on V_{OUT}
- dt is the rise time for V_{OUT} when the device is enabled
- dV_{OUT} is change in the V_{OUT} voltage after the device is enabled.

The slew rate of the device dV_{OUT}/dt at a given V_{IN} voltage can be found in the electrical characteristic table for a given version. I_{INRUSH} has to be within the I_{MAX} and I_{PLS} limits.

10.2.3 Application Curves





10.3 Power Supply Recommendations

The TPS22991 device is designed to operate with a V_{IN} range of 1V to 5.5V. Regulate the V_{IN} power supply well and place as close to the device terminal as possible. The power supply must be able to withstand all transient load current steps. In most situations, using an input capacitance (C_{IN}) of 1µF is sufficient to prevent the supply voltage from dipping when the switch is turned on. In cases where the power supply is slow to respond to a large transient current or large load current step, additional bulk capacitance can be required on the input.

10.4 Layout

10.4.1 Layout Guidelines

For best performance, all traces must be as short as possible. To be most effective, place the input and output capacitors close to the device to minimize the effects that parasitic trace inductances can have on normal operation. Using wide traces for VIN, VOUT, and GND helps minimize the parasitic electrical effects.

10.4.2 Layout Example

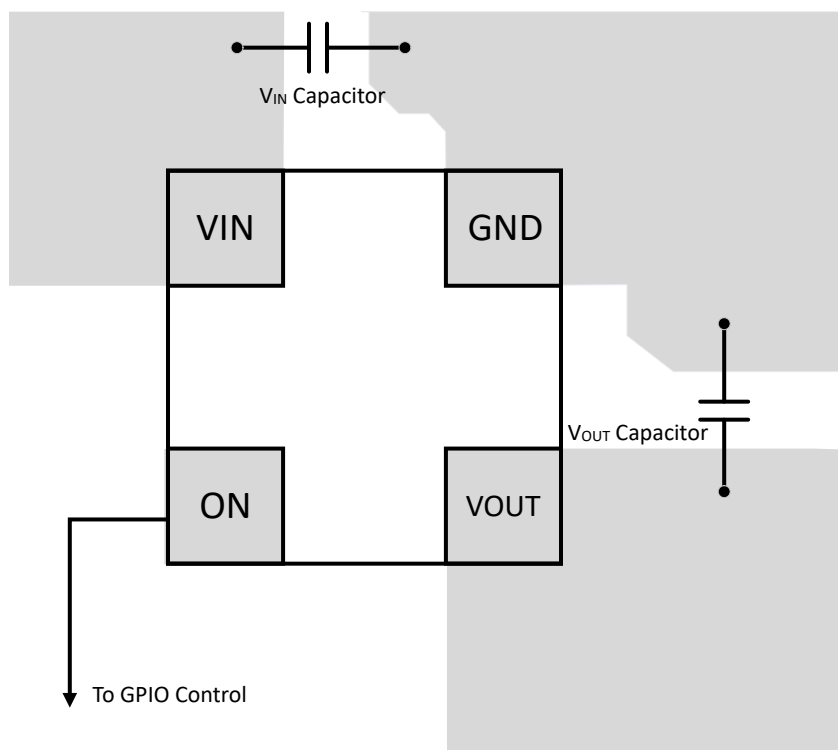


図 10-6. TPS22991 Layout

11 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

11.1 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、www.tij.co.jp のデバイス製品フォルダを開いてください。[通知] 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ることができます。変更の詳細については、改訂されたドキュメントに含まれている改訂履歴をご覧ください。

11.2 サポート・リソース

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11.5 用語集

[テキサス・インスツルメンツ用語集](#) この用語集には、用語や略語の一覧および定義が記載されています。

12 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 (August 2024) to Revision B (February 2024)	Page
• Deleted the notes for device preview.....	3

Changes from Revision * (May 2024) to Revision A (August 2024)	Page
• ドキュメントのステータスを「事前情報」から「量産データ」に変更	1

13 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.

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)
PTPS22991BRAAR	Active	Preproduction	UQFN-HR (RAA) 4	3000 LARGE T&R	-	Call TI	Call TI	-55 to 125	
PTPS22991BRAAR.A	Active	Preproduction	UQFN-HR (RAA) 4	3000 LARGE T&R	-	Call TI	Call TI	-55 to 125	
TPS22991BNRAAR	Active	Production	UQFN-HR (RAA) 4	3000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-55 to 125	J
TPS22991BRAAR	Active	Production	UQFN-HR (RAA) 4	3000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-55 to 125	H
TPS22991BRAAR.A	Active	Production	UQFN-HR (RAA) 4	3000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-55 to 125	H
TPS22991CNRAAR	Active	Production	UQFN-HR (RAA) 4	3000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-55 to 125	K
TPS22991CRAAR	Active	Production	UQFN-HR (RAA) 4	3000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-55 to 125	I

⁽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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TAPE AND REEL INFORMATION



*All dimensions are nominal

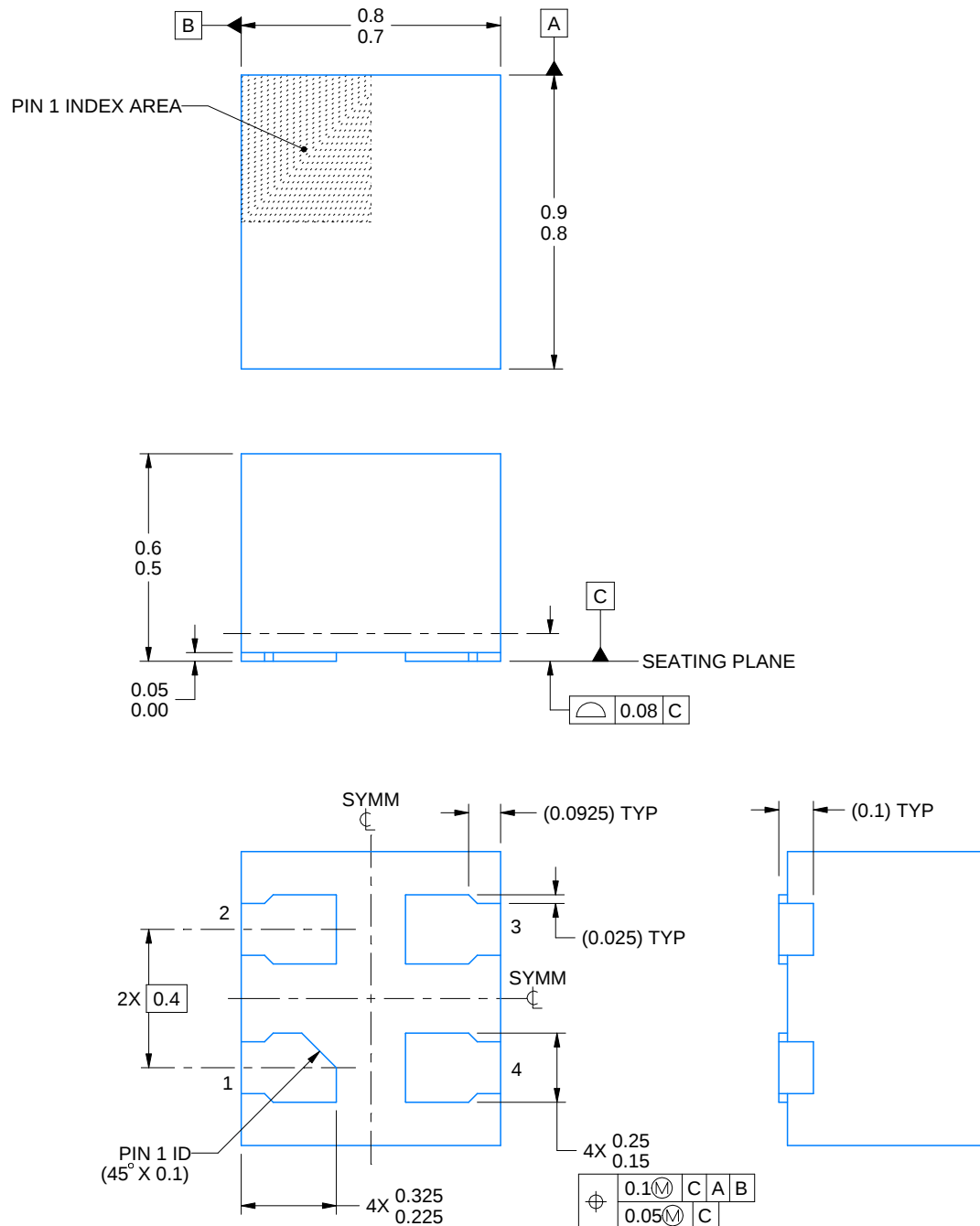
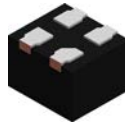
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS22991BNRAAR	UQFN-HR	RAA	4	3000	180.0	8.4	0.9	1.0	0.66	2.0	8.0	Q1
TPS22991BRAAR	UQFN-HR	RAA	4	3000	180.0	8.4	0.9	1.0	0.66	2.0	8.0	Q1
TPS22991CNRAAR	UQFN-HR	RAA	4	3000	180.0	8.4	0.9	1.0	0.66	2.0	8.0	Q1
TPS22991CRAAR	UQFN-HR	RAA	4	3000	180.0	8.4	0.9	1.0	0.66	2.0	8.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS22991BNRAAR	UQFN-HR	RAA	4	3000	210.0	185.0	35.0
TPS22991BRAAR	UQFN-HR	RAA	4	3000	210.0	185.0	35.0
TPS22991CNRAAR	UQFN-HR	RAA	4	3000	210.0	185.0	35.0
TPS22991CRAAR	UQFN-HR	RAA	4	3000	210.0	185.0	35.0



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NOTES:

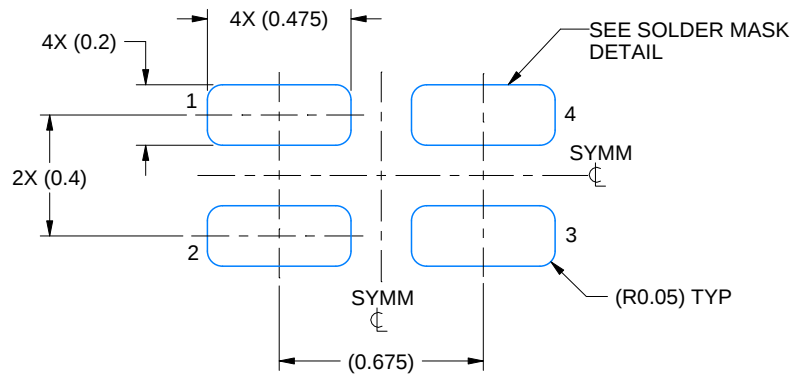
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

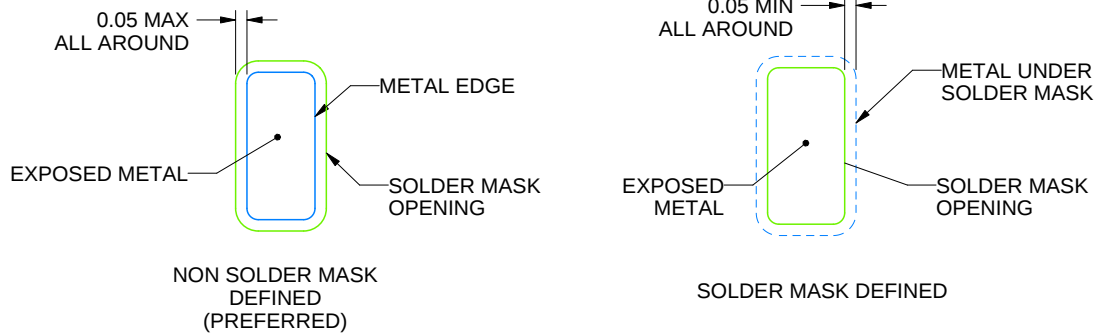
RAA0004A

UQFN-HR - 0.6 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 40X



SOLDER MASK DETAILS

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NOTES: (continued)

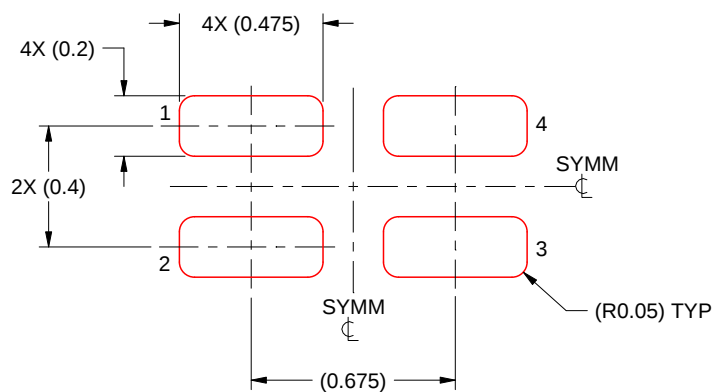
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

EXAMPLE STENCIL DESIGN

RAA0004A

UQFN-HR - 0.6 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.1 MM THICK STENCIL
SCALE: 40X

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NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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