

# TPS22995H-Q1 5.5V、3A、19mΩ オン抵抗の車載用ロード・スイッチ

## 1 特長

- 車載アプリケーション用に AEC-Q100 認定済み:
  - 温度グレード 1: -40°C ~ 125°C, T<sub>A</sub>
- 動作入力電圧範囲 (V<sub>IN</sub>): 0.8V ~ 5.5V
- バイアス電源電圧 (V<sub>BIAS</sub>): 1.5V ~ 5.5V
- 最大連続電流: 3A
- オン抵抗 (R<sub>ON</sub>): 19mΩ (標準値)
- 外付け抵抗によりスルーレート制御を調整可能
- クイック出力放電 (QOD): 100Ω (標準値)
- サーマル・シャットダウン
- 耐湿ピン:
  - GND への 100kΩ 短絡
  - 電源への 100kΩ 短絡
- ON ピンのスマート・プルダウン (R<sub>PD,ON</sub>):
  - ON ≥ V<sub>IH</sub> (I<sub>ON</sub>): 25nA (最大値)
  - ON ≤ V<sub>IL</sub> (R<sub>PD</sub>): 500kΩ (標準値)
- 低い消費電力:
  - オン状態 (I<sub>Q</sub>): 10μA (標準値)
  - オフ状態 (I<sub>SD</sub>): 0.1μA (標準値)

## 2 アプリケーション

- インフォテインメント
- クラスタ
- 先進運転支援システム (ADAS)

## 3 概要

TPS22995H-Q1 はシングルチャネルのロード・スイッチで、0.8V ~ 5.5V の入力電圧範囲で動作する 19mΩ の N チャンネル MOSFET を内蔵し、最大 3A の連続電流をサポートします。

このスイッチは、オンおよびオフ入力 (ON) により制御され、低電圧の GPIO 信号と直接接続可能です。TPS22995H-Q1 にはクイック出力放電機能があり、スイッチがオフになると出力電圧を既知の 0V 状態にします。また、本デバイスは立ち上がりを調整可能で、大きな容量性負荷のとき突入電流を制限できます。

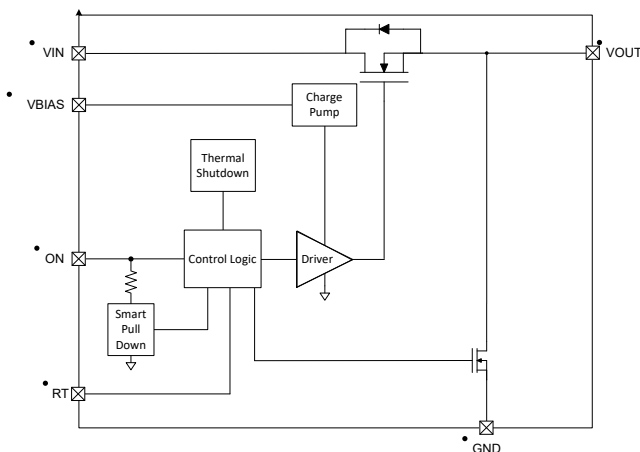
TPS22995H-Q1 のピンは高湿度条件に耐性があるため、デバイスはどのピンからでも GND や電源に対して 100kΩ の短絡で機能できます。タイミング・ピン (RT) が高湿度の影響を受ける場合、タイミングの変動は ±20% 以内にとどまると予測できます。

TPS22995H-Q1 は、2.8mm × 2.9mm、0.5mm ピッチの 6 ピン SOT パッケージで供給されます。このデバイスは、-40°C ~ +125°C の自由気流の周囲温度範囲で動作が規定されています。

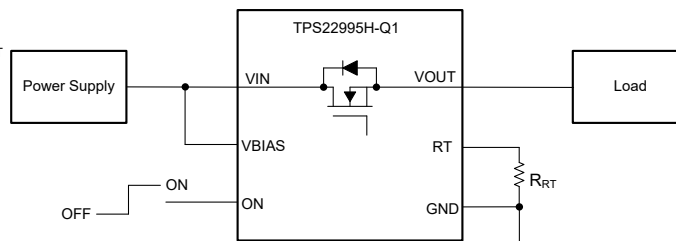
### パッケージ情報

部品番号	パッケージ (1)	本体サイズ (公称)
TPS22995H-Q1	SOT-23 (DDC, 6)	2.80mm × 2.90mm

(1) 利用可能な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。



ブロック図



代表的なアプリケーションの図



## Table of Contents

<b>1 特長</b> .....	1	8.1 Overview.....	11
<b>2 アプリケーション</b> .....	1	8.2 Functional Block Diagram.....	11
<b>3 概要</b> .....	1	8.3 Feature Description.....	11
<b>4 Revision History</b> .....	2	8.4 Device Functional Modes.....	12
<b>5 Pin Configuration and Functions</b> .....	3	<b>9 Application and Implementation</b> .....	13
<b>6 Specifications</b> .....	4	9.1 Application Information.....	13
6.1 Absolute Maximum Ratings.....	4	9.2 Typical Application.....	13
6.2 ESD Ratings.....	4	9.3 Power Supply Recommendations.....	14
6.3 Recommended Operating Conditions.....	4	9.4 Layout.....	14
6.4 Thermal Information.....	4	<b>10 Device and Documentation Support</b> .....	16
6.5 Electrical Characteristics (VBIAS = 5 V).....	5	10.1 ドキュメントの更新通知を受け取る方法.....	16
6.6 Electrical Characteristics (VBIAS = 3.3 V).....	5	10.2 サポート・リソース.....	16
6.7 Electrical Characteristics (VBIAS = 1.5 V).....	6	10.3 Trademarks.....	16
6.8 Switching Characteristics.....	7	10.4 静電気放電に関する注意事項.....	16
6.9 Typical Characteristics.....	9	10.5 用語集.....	16
<b>7 Parameter Measurement Information</b> .....	10	<b>11 Mechanical, Packaging, and Orderable Information</b> .....	16
<b>8 Detailed Description</b> .....	11		

## 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 * (June 2022) to Revision A (December 2022)	Page
• デバイス・ステータスを「事前情報」から「量産データ」に変更 .....	1

## 5 Pin Configuration and Functions

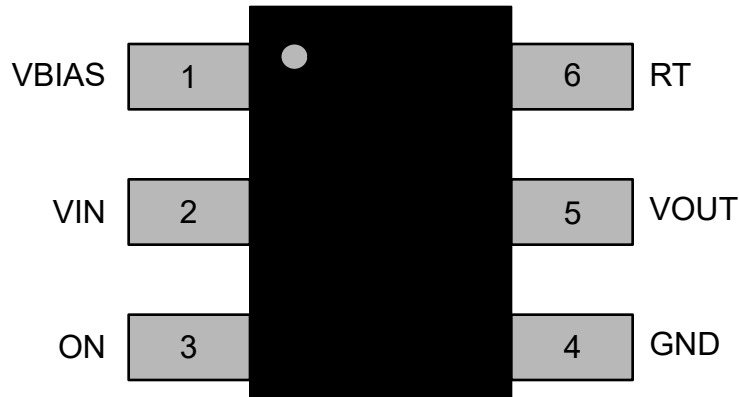


图 5-1. TPS22995H-Q1 DDC Package 6-Pin SOT-23 (Top View)

表 5-1. Pin Functions

PIN		TYPE <sup>(1)</sup>	DESCRIPTION
NAME	NO.		
VBIAS	1	P	Device bias supply
VIN	2	P	Switch input
ON	3	O	Enable pin to turn on/off the switch
GND	4	G	Device ground
VOUT	5	P	Switch output
RT	6	I	Slew rate control through a resistor to GND

(1) I = Input, O = Output, I/O = Input or Output, G = Ground, P = Power.

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

		MIN	MAX	UNIT
$V_{IN}$	Input Voltage	-0.3	6	V
$V_{BIAS}$	Bias Voltage	-0.3	6	V
$V_{ON}, V_{RT}$	Control Pin Voltage	-0.3	6	V
$I_{MAX}$	Maximum Current		3	A
$T_J$	Junction temperature		Internally Limited	°C
$T_{stg}$	Storage temperature	-65	150	°C

- (1) Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.

### 6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002 <sup>(1)</sup> HBM ESD classification level 1C	±2000	V
		Charged-device model (CDM), per AEC Q100-011 CDM ESD classification level C5	±1000	

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

### 6.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
$V_{IN}$	Input Voltage	0.8		5.5	V
$V_{BIAS}$	Bias Voltage	1.5		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	-40		125	°C

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		TPS22995H-Q1		UNIT
		DDC		
		6 PINS		
$R_{\theta JA}$	Junction-to-ambient thermal resistance	120.6		°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	65.5		°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	33.9		°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	17.2		°C/W
$Y_{JB}$	Junction-to-board characterization parameter	3.6		°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 (VBIAS = 5 V)

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

PARAMETER		TEST CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNIT
<b>Power Consumption</b>							
I <sub>SD,VBIAS</sub>	VBIAS Shutdown Current	ON = 0V	25°C		0.1		µA
			-40°C to 85°C			0.5	µA
			-40°C to 125°C			2	µA
I <sub>Q,VBIAS</sub>	VBIAS Quiescent Current	ON > V <sub>IH</sub>	25°C		10		µA
			-40°C to 85°C			20	µA
			-40°C to 125°C			20	µA
I <sub>SD,VIN</sub>	VIN Shutdown Current	ON = 0V	25°C		0.1		µA
			-40°C to 85°C			1	µA
			-40°C to 125°C			4	µA
I <sub>ON</sub>	ON pin leakage	ON = VBIAS	-40°C to 125°C		0.1		µA
<b>Performance</b>							
R <sub>ON</sub>	On-Resistance	VIN = 5 V, I <sub>OUT</sub> = -200 mA	25°C		19		mΩ
			-40°C to 85°C			26	mΩ
			-40°C to 125°C			29	mΩ
		VIN = 3.3 V, I <sub>OUT</sub> = -200 mA	25°C		19		mΩ
			-40°C to 85°C			25	mΩ
			-40°C to 125°C			28	mΩ
		VIN = 1.8 V, I <sub>OUT</sub> = -200 mA	25°C		19		mΩ
			-40°C to 85°C			25	mΩ
			-40°C to 125°C			28	mΩ
		VIN = 1.2 V, I <sub>OUT</sub> = -200 mA	25°C		19		mΩ
			-40°C to 85°C			25	mΩ
			-40°C to 125°C			28	mΩ
		VIN = 0.8 V, I <sub>OUT</sub> = -200 mA	25°C		19		mΩ
			-40°C to 85°C			25	mΩ
			-40°C to 125°C			28	mΩ
R <sub>PD,ON</sub>	Smart Pull Down Resistance	ON < V <sub>IL</sub>	25°C		500		kΩ
			-40°C to 125°C			1000	kΩ
R <sub>QOD</sub>	QOD Resistance	ON < V <sub>IL</sub>	25°C		100		Ω
R <sub>QOD</sub>			-40°C to 125°C			150	Ω
<b>Protection</b>							
TSD	Thermal Shutdown		-	150	170	190	°C
TSD <sub>HYS</sub>	Thermal Shutdown Hysteresis		-		20		°C

## 6.6 Electrical Characteristics (VBIAS = 3.3 V)

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

PARAMETER		TEST CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNIT
<b>Power Consumption</b>							
I <sub>SD,VBIAS</sub>	VBIAS Shutdown Current	ON = 0 V	25°C		0.1		µA
			-40°C to 85°C			0.5	µA
			-40°C to 125°C			2	µA

## 6.6 Electrical Characteristics (VBIAS = 3.3 V) (continued)

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

PARAMETER		TEST CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNIT
I <sub>Q,VBIAS</sub>	VBIAS Quiescent Current	ON > V <sub>IH</sub>	25°C		8.5		µA
			-40°C to 85°C			20	µA
			-40°C to 125°C			20	µA
I <sub>SD,VIN</sub>	VIN Shutdown Current	ON = 0V	25°C		0.1		µA
			-40°C to 85°C			1	µA
			-40°C to 125°C			4	µA
I <sub>ON</sub>	ON pin leakage	ON = VBIAS	-40°C to 125°C		0.1		µA
<b>Performance</b>							
R <sub>ON</sub>	On-Resistance	VIN = 3.3 V, I <sub>O<sub>UT</sub></sub> = -200 mA	25°C		19		mΩ
			-40°C to 85°C			26	mΩ
			-40°C to 125°C			29	mΩ
			25°C		19		mΩ
			-40°C to 85°C			25	mΩ
			-40°C to 125°C			28	mΩ
		VIN = 1.2 V, I <sub>O<sub>UT</sub></sub> = -200 mA	25°C		19		mΩ
			-40°C to 85°C			25	mΩ
			-40°C to 125°C			28	mΩ
			25°C		19		mΩ
			-40°C to 85°C			25	mΩ
			-40°C to 125°C			28	mΩ
VIN = 0.8 V, I <sub>O<sub>UT</sub></sub> = -200 mA	25°C		19		mΩ		
	-40°C to 85°C			25	mΩ		
	-40°C to 125°C			28	mΩ		
	25°C		500		kΩ		
	-40°C to 125°C			1000	kΩ		
	25°C		100		Ω		
-40°C to 125°C			150	Ω			
R <sub>PD,ON</sub>	Smart Pull Down Resistance	ON < V <sub>IL</sub>	25°C		500		kΩ
			-40°C to 125°C			1000	kΩ
R <sub>QOD</sub>	QOD Resistance	ON < V <sub>IL</sub>	25°C		100		Ω
			-40°C to 125°C			150	Ω
<b>Protection</b>							
TSD	Thermal Shutdown		-	150	170	190	°C
TSD <sub>HYS</sub>	Thermal Shutdown Hysteresis		-		20		°C

## 6.7 Electrical Characteristics (VBIAS = 1.5 V)

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

PARAMETER		TEST CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNIT
<b>Power Consumption</b>							
I <sub>SD,VBIAS</sub>	VBIAS Shutdown Current	ON = 0 V	25°C		0.1		µA
			-40°C to 85°C			0.5	µA
			-40°C to 125°C			2	µA
I <sub>Q,VBIAS</sub>	VBIAS Quiescent Current	ON > V <sub>IH</sub>	25°C		10		µA
			-40°C to 85°C			20	µA
			-40°C to 125°C			20	µA
I <sub>SD,VIN</sub>	VIN Shutdown Current	ON = 0 V	25°C		0.1		µA
			-40°C to 85°C			1	µA
			-40°C to 125°C			4	µA
I <sub>ON</sub>	ON pin leakage	ON = VBIAS	-40°C to 125°C		0.1		µA
<b>Performance</b>							

## 6.7 Electrical Characteristics (VBIAS = 1.5 V) (continued)

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

PARAMETER		TEST CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNIT
R <sub>ON</sub>	On-Resistance	VIN = 1.5 V, I <sub>OUT</sub> = -200 mA	25°C		22		mΩ
			-40°C to 85°C			30	mΩ
			-40°C to 125°C			34	mΩ
		VIN = 1.2 V, I <sub>OUT</sub> = -200 mA	25°C		22		mΩ
			-40°C to 85°C			30	mΩ
			-40°C to 125°C			34	mΩ
		VIN = 0.8 V, I <sub>OUT</sub> = -200 mA	25°C		21		mΩ
			-40°C to 85°C			28	mΩ
			-40°C to 125°C			31	mΩ
R <sub>PD,ON</sub>	Smart Pull Down Resistance	ON < V <sub>IL</sub>	25°C		500		kΩ
			-40°C to 125°C			800	kΩ
R <sub>QOD</sub>	QOD Resistance	ON < V <sub>IL</sub>	25°C		100		Ω
			-40°C to 125°C			150	Ω
<b>Protection</b>							
TSD	Thermal Shutdown		-	150	170	190	°C
TSD <sub>HYS</sub>	Thermal Shutdown Hysteresis		-		20		°C

## 6.8 Switching Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>VIN = 5.5 V</b>						
t <sub>ON</sub>	Turn ON time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		264		us
t <sub>RISE</sub>	Rise time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		129		us
t <sub>D</sub>	Delay time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		127		us
t <sub>FALL</sub>	Fall time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		1100		us
t <sub>OFF</sub>	Turn OFF time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		60.2		us
<b>VIN = 5 V</b>						
t <sub>ON</sub>	Turn ON time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		294		us
t <sub>RISE</sub>	Rise time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		166		us
t <sub>D</sub>	Delay time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		127		us
t <sub>FALL</sub>	Fall time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		1110		us
t <sub>OFF</sub>	Turn OFF time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		60.3		us
<b>VIN = 3.3 V</b>						
t <sub>ON</sub>	Turn ON time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		259		us
t <sub>RISE</sub>	Rise time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		129		us
t <sub>D</sub>	Delay time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		130		us
t <sub>FALL</sub>	Fall time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		1120		us
t <sub>OFF</sub>	Turn OFF time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		62		us
<b>VIN = 1.8 V</b>						
t <sub>ON</sub>	Turn ON time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		224		us
t <sub>RISE</sub>	Rise time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		89.1		us
t <sub>D</sub>	Delay time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		135		us
t <sub>FALL</sub>	Fall time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		1120		us
t <sub>OFF</sub>	Turn OFF time	R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 10 uF, RT = 1 kΩ		65.2		us

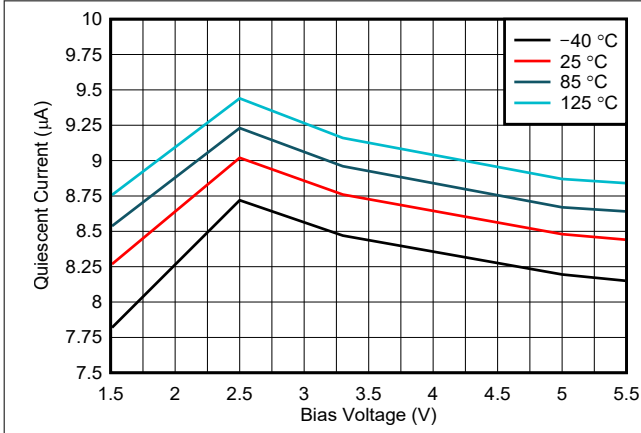
## 6.8 Switching Characteristics (continued)

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>VIN = 1.2 V</b>						
tON	Turn ON time	$R_L = 100\ \Omega$ , $C_L = 10\ \mu\text{F}$ , $RT = 1\ \text{k}\Omega$		208		us
tRISE	Rise time	$R_L = 100\ \Omega$ , $C_L = 10\ \mu\text{F}$ , $RT = 1\ \text{k}\Omega$		68.6		us
tD	Delay time	$R_L = 100\ \Omega$ , $C_L = 10\ \mu\text{F}$ , $RT = 1\ \text{k}\Omega$		140		us
tFALL	Fall time	$R_L = 100\ \Omega$ , $C_L = 10\ \mu\text{F}$ , $RT = 1\ \text{k}\Omega$		1160		us
tOFF	Turn OFF time	$R_L = 100\ \Omega$ , $C_L = 10\ \mu\text{F}$ , $RT = 1\ \text{k}\Omega$		66.7		us
<b>VIN = 0.8 V</b>						
tON	Turn ON time	$R_L = 100\ \Omega$ , $C_L = 10\ \mu\text{F}$ , $RT = 1\ \text{k}\Omega$		197		us
tRISE	Rise time	$R_L = 100\ \Omega$ , $C_L = 10\ \mu\text{F}$ , $RT = 1\ \text{k}\Omega$		53		us
tD	Delay time	$R_L = 100\ \Omega$ , $C_L = 10\ \mu\text{F}$ , $RT = 1\ \text{k}\Omega$		144		us
tFALL	Fall time	$R_L = 100\ \Omega$ , $C_L = 10\ \mu\text{F}$ , $RT = 1\ \text{k}\Omega$		1190		us
tOFF	Turn OFF time	$R_L = 100\ \Omega$ , $C_L = 10\ \mu\text{F}$ , $RT = 1\ \text{k}\Omega$		69.5		us

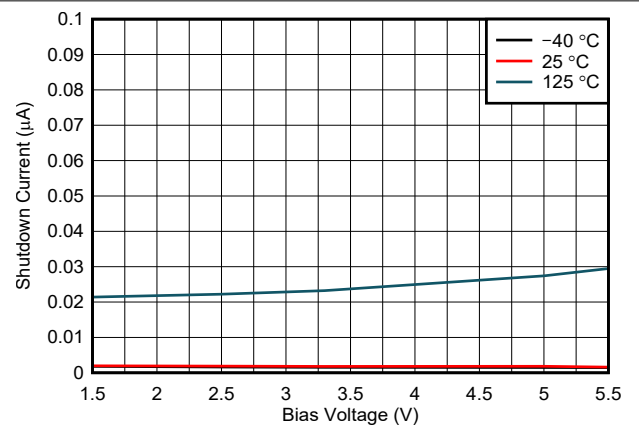


## 6.9 Typical Characteristics



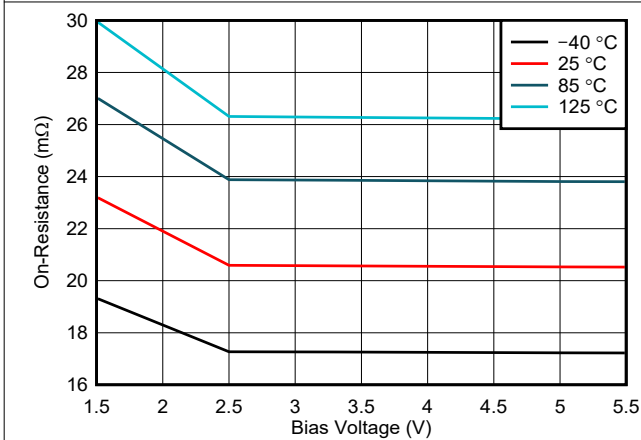
VIN = VBIAS

Figure 6-1. Quiescent Current vs Bias Voltage



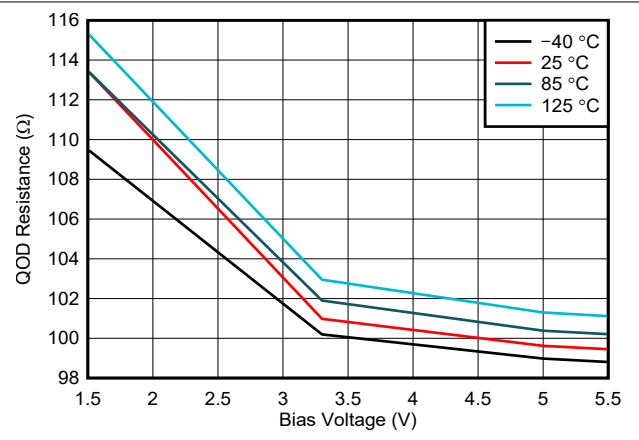
VIN = VBIAS

Figure 6-2. Shutdown Current vs Bias Voltage



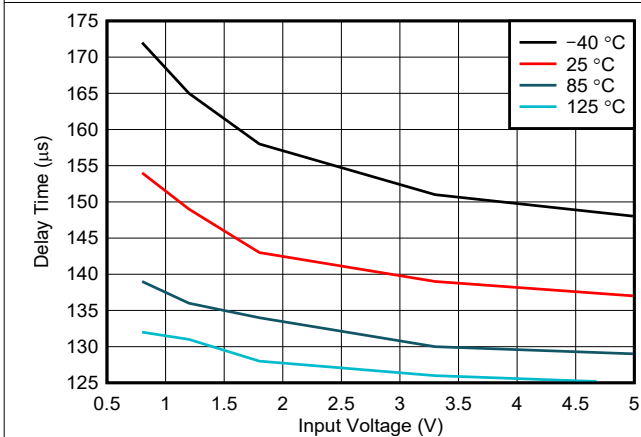
VIN = VBIAS

Figure 6-3. On-Resistance vs Bias Voltage



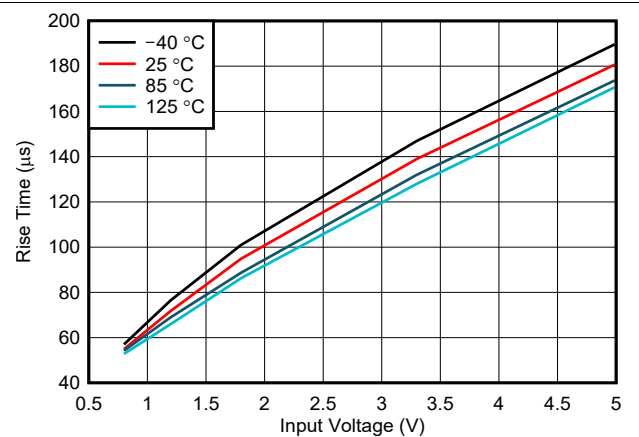
VIN = VBIAS

Figure 6-4. QOD Resistance vs Bias Voltage



VIN = VBIAS

Figure 6-5. Delay Time vs Bias Voltage



VIN = VBIAS

Figure 6-6. Rise Time vs Bias Voltage

## 7 Parameter Measurement Information

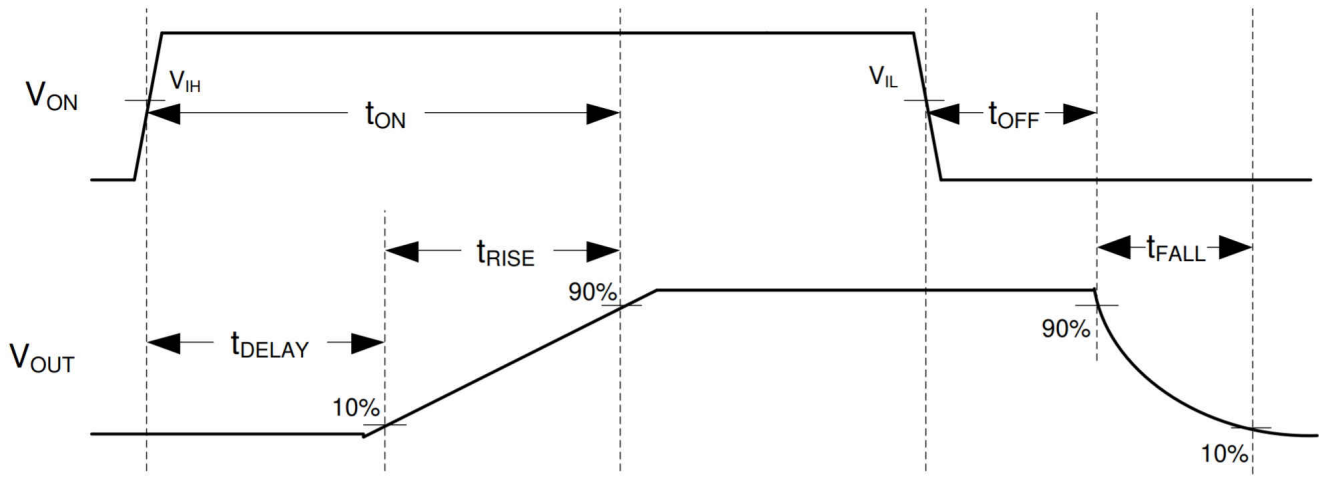


图 7-1. TPS22995H-Q1 Timing Parameters

## 8 Detailed Description

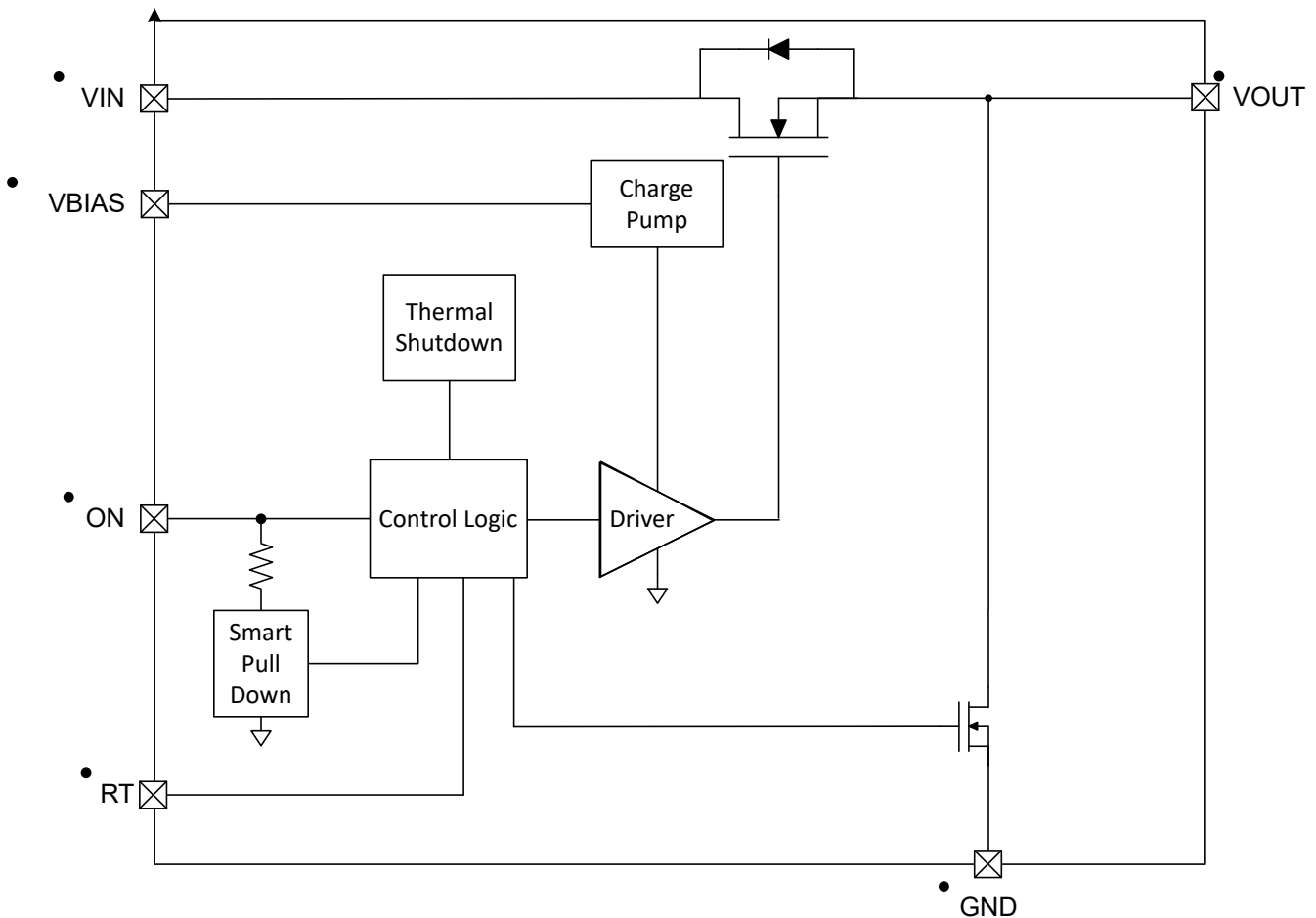
### 8.1 Overview

The TPS22995H-Q1 is a 5.5-V, 3-A load switch in a 6-pin SOT-23 package. To reduce voltage drop for low voltage and high-current rails, the device implements a low-resistance, 19-mΩ N-channel MOSFET, which reduces the drop-out voltage through the device.

The device has a configurable slew rate, which helps reduce or eliminate power supply droop because of large inrush currents. The slew rate can be configured by connecting a resistor to ground to the RT pin. The TPS22995H-Q1 also integrates a Quick Output Discharge circuit that is activated when the switch is turned off, pulling the output voltage down to a known 0-V state.

TPS22995H-Q1 increases circuit robustness by integrating tolerance to high humidity environments. When the timing pin (RT) is affected by high humidity, timing is expected to stay within  $\pm 20\%$ . Additionally, if the device experiences a 100-kΩ short from any pin to GND or power, the device continues to function.

### 8.2 Functional Block Diagram



### 8.3 Feature Description

#### 8.3.1 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 VIN, 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 the below table when the ON Pin Smart Pulldown is active.

表 8-1. On Pin Control

ON Pin Voltage	ON Pin Function
$\leq V_{IL}$	Pulldown active
$\geq V_{IH}$	No Pulldown

### 8.3.2 Quick Output Discharge (QOD)

TPS22995H-Q1 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 100  $\Omega$  and prevents the output from floating while the switch is disabled

### 8.3.3 Adjustable Slew Rate

A resistor to GND on the RT pin sets the slew rate, and the higher the resistor the lower the slew rate. Rise times are shown below.

表 8-2. Rise Time vs RT vs  $V_{IN}$ 

RT Resistor	$V_{IN} = 5\text{ V}$	$V_{IN} = 3.3\text{ V}$	$V_{IN} = 1.8\text{ V}$	$V_{IN} = 1.2\text{ V}$	$V_{IN} = 0.8\text{ V}$
GND	102 $\mu\text{s}$	79 $\mu\text{s}$	55 $\mu\text{s}$	42 $\mu\text{s}$	33 $\mu\text{s}$
1 k $\Omega$	166 $\mu\text{s}$	129 $\mu\text{s}$	89 $\mu\text{s}$	68 $\mu\text{s}$	53 $\mu\text{s}$
5 k $\Omega$	790 $\mu\text{s}$	607 $\mu\text{s}$	415 $\mu\text{s}$	318 $\mu\text{s}$	242 $\mu\text{s}$
10 k $\Omega$	1520 $\mu\text{s}$	1180 $\mu\text{s}$	800 $\mu\text{s}$	613 $\mu\text{s}$	465 $\mu\text{s}$
Open	4860 $\mu\text{s}$	3750 $\mu\text{s}$	2560 $\mu\text{s}$	1960 $\mu\text{s}$	1490 $\mu\text{s}$

The following equation can be used to estimate the rise time for different  $V_{IN}$  and RT resistors:

$$tR = (0.0246 V_{IN} + 0.0308) \times RT + 3.3219 V_{IN} + 6.7312$$

where

- $tR$  = Rise time in  $\mu\text{s}$ .
- $V_{IN}$  = Input voltage in V.
- RT = RT Resistor in  $\Omega$ .

### 8.3.4 Thermal Shutdown

When the device temperature reaches 170°C (typical), the device shuts itself off to prevent thermal damage. After the device cools off by about 20°C, 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.

## 8.4 Device Functional Modes

表 8-3. Device Functional Modes

ON	Fault Condition	VOUT State
L	N/A	Hi-Z
H	None	$V_{IN}$ through $R_{ON}$
X	Thermal shutdown	Hi-Z

## 9 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.

### 9.1 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  $V_{IN}$  and  $V_{BIAS}$  condition of the device. See the  $R_{ON}$  specification in the [Electrical Characteristics \( \$V\_{BIAS} = 5\text{ V}\$ \)](#) table of this data sheet. After the  $R_{ON}$  of the device is determined based upon the  $V_{IN}$  and  $V_{BIAS}$  conditions, use the below equation to calculate the input to output voltage drop.

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

where

- $\Delta V$  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.

### 9.2 Typical Application

This typical application demonstrates how the TPS22995H-Q1 device can be used to limit start-up inrush current.

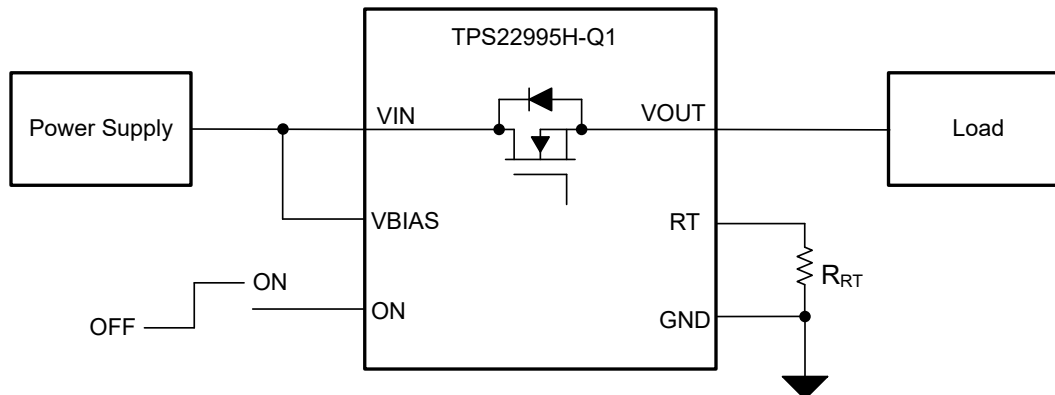


图 9-1. TPS22995H-Q1 Application Schematic

#### 9.2.1 Design Requirements

表 9-1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
$V_{BIAS}$	5.0 V
$V_{IN}$	5.0 V
$C_L$	47 $\mu\text{F}$
$R_L$	None
Maximum acceptable inrush current	200 mA

## 9.2.2 Detailed Design Procedure

When the switch is enabled, the output capacitors must be charged up from 0 V to  $V_{IN}$ . This charge arrives in the form of inrush current. Use the equation below to calculate inrush current.

$$I_{INRUSH} = C_L \times dVOUT/dt \quad (2)$$

where

- $C_L$  is the output capacitance.
- $dVOUT$  is the change in  $VOUT$  during the ramp up of the output voltage when device is enabled.
- $dt$  is the rise time in  $VOUT$  during the ramp up of the output voltage when the device is enabled.

The TPS22995H-Q1 offers an adjustable rise time for  $VOUT$ , allowing the user to control the inrush current during turn-on. The appropriate rise time can be calculated using the design requirements and the inrush current equation as shown below.

$$200 \text{ mA} = 47\mu\text{F} \times 5 \text{ V}/dt \quad (3)$$

where

$$dt = 1175 \text{ us} \quad (4)$$

The TPS22995H-Q1 has very fast rise times with  $RT$  pin grounded. The typical rise time is 147  $\mu\text{s}$  at  $V_{BIAS} = 5\text{V}$ ,  $V_{IN} = 5 \text{ V}$ ,  $R_L = 100 \Omega$ , and  $C_L = 0.1 \mu\text{F}$ . This rise time results in an inrush current of 1.59 A. According to the rise time [table](#), using  $R_T = 10 \text{ k}\Omega$  results in a rise time of 1520 us, which limits the inrush current to 154 mA. Alternatively, the [rise time equation](#) can be used to determine the resistor need.

## 9.3 Power Supply Recommendations

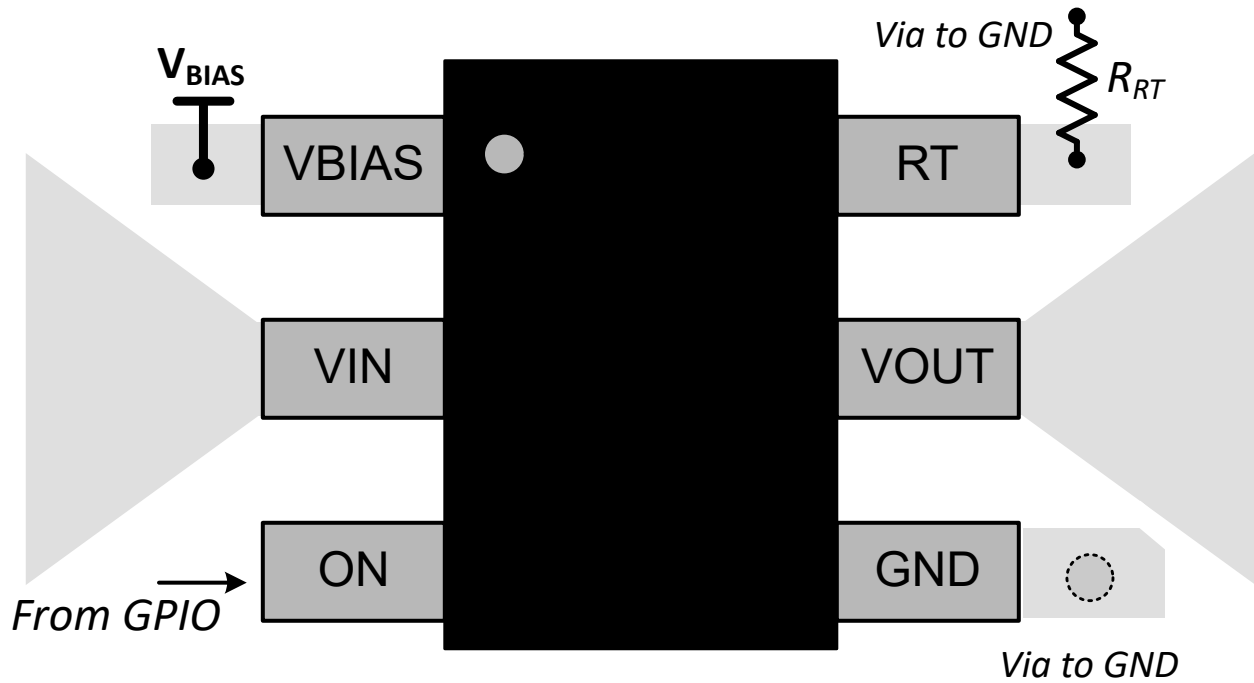
The TPS22995H-Q1 device is designed to operate with a  $V_{IN}$  range of 0.8 V to 5.5 V. The  $V_{IN}$  power supply must be well regulated and placed as close to the device terminal as possible. The power supply must be able to withstand all transient load current steps. In most situations, using an input capacitance ( $C_{IN}$ ) of 1  $\mu\text{F}$  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.

## 9.4 Layout

### 9.4.1 Layout Guidelines

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

### 9.4.2 Layout Example



9-2. Layout Example (SOT)

## 10 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.

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## 11 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 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
TPS22995HQDDCRQ1	ACTIVE	SOT-23-THIN	DDC	6	3000	RoHS & Green	Call TI	Level-1-260C-UNLIM	-40 to 125	995H	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.

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**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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