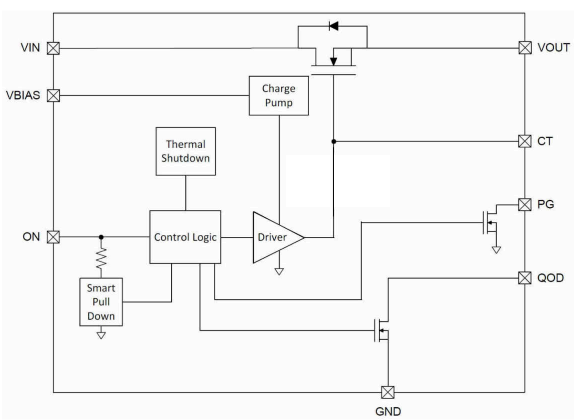
TPS22997 具有可调上升时间的 5.5V、10A、4mΩ 导通电阻负载开关

1 特性

- 输入电压范围 (V_{IN})：0.1V-5.5V
- 偏置电压范围：1.5V 至 5.5V
- 最大持续电流：10A
- 导通电阻 (R_{ON})：4mΩ（典型值）
- 可调转换率控制
- 可调节快速输出放电 (QOD)
- 开漏电源正常 (PG) 信号
- 热关断
- 低功耗：
  - 导通状态 (I_Q)：10µA（典型值）
  - 关闭状态 (I_{SD})：0.1µA（典型值）
- 热关断
- ON 引脚智能下拉电阻 ($R_{PD,ON}$)
  - ON ≥ V_{IH} (I_{ON})：25nA（典型值）
  - ON ≤ V_{IL} ($R_{PD,ON}$)：500kΩ（典型值）

2 应用

- 固态硬盘
- PC 和笔记本电脑
- 工业 PC
- 光学模块



TPS22997 方框图

3 说明

TPS22997 是一款单通道负载开关，具有可配置上升时间，从而可更大限度地降低浪涌电流。此器件包含一个可在 0.1 V 至 5.5V 输入电压范围内运行的 N 沟道 MOSFET，并且支持 10 A 的最大持续电流。

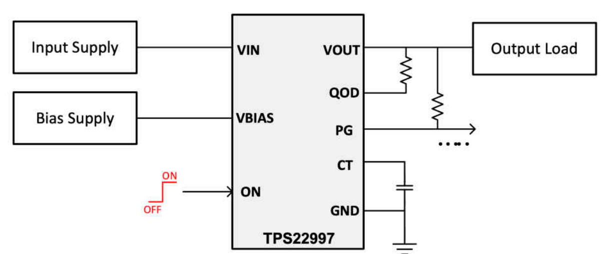
该开关由使能引脚 (ON) 控制，该引脚能够直接连接低电压 GPIO 信号 (V_{IH} = 0.8V)。TPS22997 器件具有可选的 QOD 引脚，用于在开关关闭时快速输出放电，并且输出的下降时间 (t_{FALL}) 可以通过外部电阻进行调整。器件上有一个电源正常 (PG) 信号，指示主 MOSFET 何时完全导通，可用于启用下游负载。集成式热关断功能可确保在高温环境中提供保护。

TPS22997 采用 10 引脚 WQFN 封装 (RYZ)（1.5mm × 2.0mm，间距为 0.5mm）并可在自然通风条件下的 –40°C 至 +125°C 温度范围运行。

器件信息

器件型号	封装(1)	封装尺寸（标称值）
TPS22997	WQFN (10)	1.5mm × 2.0mm

(1) 要了解所有可用封装，请参阅数据表末尾的可订购产品附录。



TPS22997 典型应用

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4 Revision History

注：以前版本的页码可能与当前版本的页码不同

DATE	REVISION	NOTES
December 2022	*	Initial Release

5 Pin Configuration and Functions

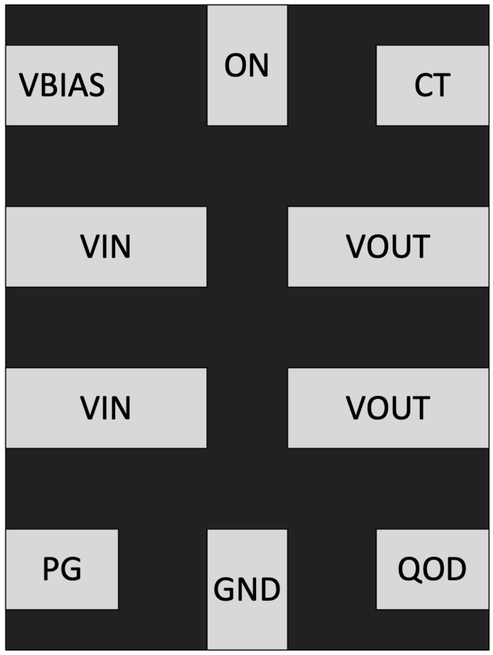


图 5-1. TPS22997 RYZ Package, 10-Pin WQFN (Top View)

表 5-1. Pin Functions

PIN		I/O[(1)]	DESCRIPTION
NAME	NO.		
VBIAS	1	I	Device bias supply
VIN	2, 3	I	Switch input
PG	4	O	Open drain power good signal, asserted high when the output is full load ready
GND	5	-	Device ground
QOD	6	-	Quick output discharge pin
VOUT	7, 8	O	Switch output
CT	9	I	Timing pin, can control the slew rate of the output through a capacitor to GND
ON	10	I	Enable pin

(1) I = Input, O = Output

6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V_{IN}	Input Voltage	–0.3	6	V
V_{BIAS}	Bias Voltage	–0.3	6	V
V_{ON}, V_{PG}, V_{QOD}	Control Pin Voltage	–0.3	6	V
V_{CT}	CT Pin Voltage		15	V
I_{MAX}	Maximum Current		10	A
T_J	Junction temperature		Internally Limited	°C
T_{stg}	Storage temperature	–65	150	°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]	±2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins[2]	±1000	

(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

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

		MIN	NOM	MAX	UNIT
V_{IN}	Input Voltage	0.1		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
V_{PG}, V_{QOD}	Control Pin Voltage	0		5.5	V
T_A	Ambient Temperature	-40		125	°C

6.4 Thermal Information

THERMAL METRIC		TPS22997	UNIT
		RYZ (WQFN)	
		10 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	83.7	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	73.9	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	18.2	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	2.0	°C/W
Y_{JB}	Junction-to-board characterization parameter	18.1	°C/W

6.5 Electrical Characteristics (VBIAS = 5 V)

over operating free-air temperature range (unless otherwise noted). Typical values are specified at 25°C and VIN = 3.3V, VBIAS = 5.5V.

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
Power Consumption							
$I_{SD,VBIAS}$	VBIAS Shutdown Current	ON = 0V	25°C		0.1		uA
			-40°C to 85°C			0.5	uA
			-40°C to 125°C			1	uA
$I_{Q,VBIAS}$	VBIAS Quiescent Current	ON > V_{IH}	25°C		10		uA
			-40°C to 85°C			15	uA
			-40°C to 125°C			15	uA
$I_{SD,VIN}$	VIN Shutdown Current	ON = 0V	25°C		0.1		uA
			-40°C to 85°C			1	uA
			-40°C to 125°C			7	uA
I_{ON}	ON pin leakage	ON = VBIAS	-40°C to 125°C		0.1		uA
Performance							
R_{ON}	On-Resistance	VIN = 5V	25°C		4		mΩ
			-40°C to 85°C			6	mΩ
			-40°C to 125°C			7	mΩ
R_{ON}	On-Resistance	VIN = 3.3V	25°C		4		mΩ
			-40°C to 85°C			6	mΩ
			-40°C to 125°C			7	mΩ
R_{ON}	On-Resistance	VIN = 1.8V	25°C		4		mΩ
			-40°C to 85°C			6	mΩ
			-40°C to 125°C			7	mΩ
R_{ON}	On-Resistance	VIN = 1.2V	25°C		4		mΩ
			-40°C to 85°C			6	mΩ
			-40°C to 125°C			7	mΩ
R_{ON}	On-Resistance	VIN = 0.8V	25°C		4		mΩ
			-40°C to 85°C			6	mΩ
			-40°C to 125°C			7	mΩ
$V_{OL,PG}$	Power Good VOL	I_{PG} = 1mA	-40°C to 125°C			0.2	V
$R_{PD,ON}$	Smart Pull Down Resistance		25°C		500		kΩ
			-40°C to 125°C			700	kΩ
R_{QOD}	QOD Resistance		25°C		50		Ω
			-40°C to 125°C			75	Ω
Protection							
TSD	Thermal Shutdown		-	150	170	190	°C
TSD_{HYS}	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_A	MIN	TYP	MAX	UNIT
Power Consumption							

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

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

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
$I_{SD,VBIAS}$	VBIAS Shutdown Current	ON = 0V	25°C		0.1		uA
			-40°C to 85°C			0.5	uA
			-40°C to 125°C			1	uA
$I_{Q,VBIAS}$	VBIAS Quiescent Current	ON > V_{IH}	25°C		10		uA
			-40°C to 85°C			15	uA
			-40°C to 125°C			15	uA
$I_{SD,VIN}$	VIN Shutdown Current	ON = 0V	25°C		0.1		uA
			-40°C to 85°C			1	uA
			-40°C to 125°C			7	uA
I_{ON}	ON pin leakage	ON = VBIAS	-40°C to 125°C		0.1		uA
Performance							
R_{ON}	On-Resistance	VIN = 3.3V	25°C		4		mΩ
			-40°C to 85°C			6	mΩ
			-40°C to 125°C			7	mΩ
R_{ON}	On-Resistance	VIN = 1.8V	25°C		4		mΩ
			-40°C to 85°C			6	mΩ
			-40°C to 125°C			7	mΩ
R_{ON}	On-Resistance	VIN = 1.2V	25°C		4		mΩ
			-40°C to 85°C			6	mΩ
			-40°C to 125°C			7	mΩ
R_{ON}	On-Resistance	VIN = 0.8V	25°C		4		mΩ
			-40°C to 85°C			6	mΩ
			-40°C to 125°C			7	mΩ
$V_{OL,PG}$	Power Good VOL	I_{PG} = 1mA	-40°C to 125°C			0.2	V
$R_{PD,ON}$	Smart Pull Down Resistance		25°C		500		kΩ
			-40°C to 125°C			700	kΩ
R_{QOD}	QOD Resistance		25°C		50		Ω
			-40°C to 125°C			100	Ω
Protection							
TSD	Thermal Shutdown		-	150	170	190	°C
TSD_{HYS}	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_A	MIN	TYP	MAX	UNIT
Power Consumption							
$I_{SD,VBIAS}$	VBIAS Shutdown Current	ON = 0V	25°C		0.1		uA
			-40°C to 85°C			0.5	uA
			-40°C to 125°C			1	uA
$I_{Q,VBIAS}$	VBIAS Quiescent Current	ON > V_{IH}	25°C		10		uA
			-40°C to 85°C			15	uA
			-40°C to 125°C			15	uA

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

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

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
$I_{SD,VIN}$	VIN Shutdown Current	ON = 0V	25°C		0.1		uA
			-40°C to 85°C			1	uA
			-40°C to 125°C			7	uA
I_{ON}	ON pin leakage	ON = VBIAS	-40°C to 125°C		0.1		uA
Performance							
R_{ON}	On-Resistance	VIN = 1.5V	25°C		4.5		mΩ
			-40°C to 85°C			6	mΩ
			-40°C to 125°C			7	mΩ
R_{ON}	On-Resistance	VIN = 1.2V	25°C		4.5		mΩ
			-40°C to 85°C			6	mΩ
			-40°C to 125°C			7	mΩ
R_{ON}	On-Resistance	VIN = 0.8V	25°C		4.5		mΩ
			-40°C to 85°C			6	mΩ
			-40°C to 125°C			7	mΩ
$V_{OL,PG}$	Power Good VOL	I_{PG} = 1mA	-40°C to 125°C			0.2	V
$R_{PD,ON}$	Smart Pull Down Resistance		25°C		500		kΩ
			-40°C to 125°C			700	kΩ
R_{QOD}	QOD Resistance		25°C		55		Ω
			-40°C to 125°C			100	Ω
Protection							
TSD	Thermal Shutdown		-	150	170	190	°C
TSD_{HYS}	Thermal Shutdown Hysteresis		-		20		°C

6.8 Switching Characteristics (VBIAS = 5 V)

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
VIN = 5V						
tON	Turn ON time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		1170		us
tRISE	Rise time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		819		us
tD	Delay time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		347		us
tFALL	Fall time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		2090		us
tOFF	Turn OFF time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		108		us
VIN = 3.3V						
tON	Turn ON time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		944		us
tRISE	Rise time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		567		us
tD	Delay time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		377		us
tFALL	Fall time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		2110		us
tOFF	Turn OFF time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		113		us
VIN = 1.8V						
tON	Turn ON time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		692		us
tRISE	Rise time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		327		us
tD	Delay time	R_L = 100 Ω, C_L = 10uF, CT = 1000pF		365		us

6.8 Switching Characteristics (VBIAS = 5 V) (continued)

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
tFALL	Fall time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		2150		us
tOFF	Turn OFF time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		117		us
VIN = 1.2V						
tON	Turn ON time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		591		us
tRISE	Rise time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		227		us
tD	Delay time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		364		us
tFALL	Fall time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		2180		us
tOFF	Turn OFF time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		120		us
VIN = 0.8V						
tON	Turn ON time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		523		us
tRISE	Rise time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		159		us
tD	Delay time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		365		us
tFALL	Fall time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		2260		us
tOFF	Turn OFF time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		129		us

6.9 Switching Characteristics (VBIAS = 3.3 V)

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
VIN = 3.3V						
tON	Turn ON time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		898		us
tRISE	Rise time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		563		us
tD	Delay time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		336		us
tFALL	Fall time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		2100		us
tOFF	Turn OFF time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		108		us
VIN = 1.8V						
tON	Turn ON time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		708		us
tRISE	Rise time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		331		us
tD	Delay time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		377		us
tFALL	Fall time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		2145		us
tOFF	Turn OFF time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		113		us
VIN = 1.2V						
tON	Turn ON time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		605		us
tRISE	Rise time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		231		us
tD	Delay time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		375		us
tFALL	Fall time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		2190		us
tOFF	Turn OFF time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		119		us
VIN = 0.8V						
tON	Turn ON time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		536		us
tRISE	Rise time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		162		us
tD	Delay time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		373		us
tFALL	Fall time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		2260		us

6.9 Switching Characteristics (VBIAS = 3.3 V) (continued)

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

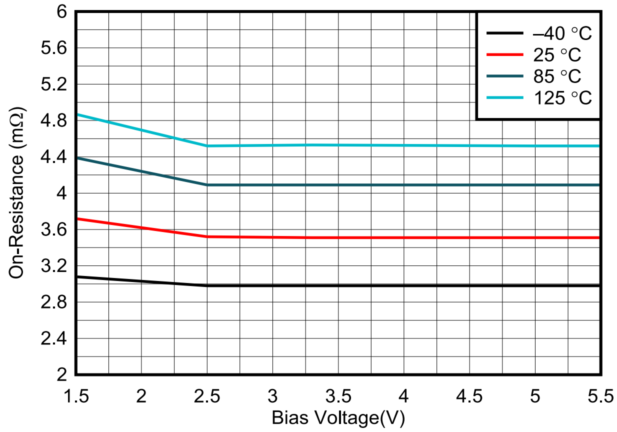
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
tOFF	Turn OFF time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		126		us

6.10 Switching Characteristics (VBIAS = 1.5 V)

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

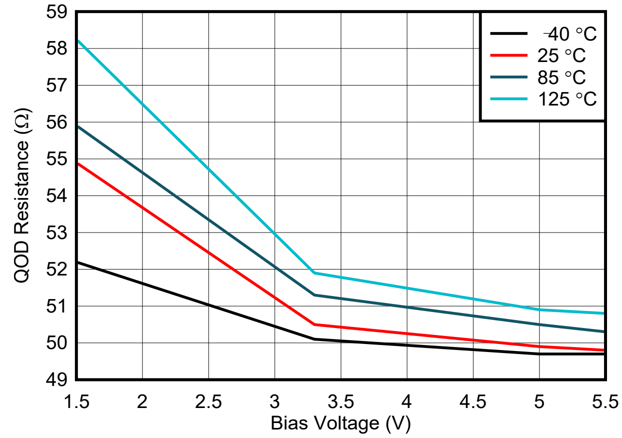
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
VIN = 1.5V						
tON	Turn ON time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		620		us
tRISE	Rise time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		281		us
tD	Delay time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		340		us
tFALL	Fall time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		2150		us
tOFF	Turn OFF time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		111		us
VIN = 1.2V						
tON	Turn ON time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		642		us
tRISE	Rise time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		237		us
tD	Delay time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		404		us
tFALL	Fall time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		2170		us
tOFF	Turn OFF time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		114		us
VIN = 0.8V						
tON	Turn ON time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		535		us
tRISE	Rise time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		166		us
tD	Delay time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		368		us
tFALL	Fall time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		2245		us
tOFF	Turn OFF time	R_L = 100 Ω , C_L = 10uF, CT = 1000pF		171		us

6.11 Typical Characteristics



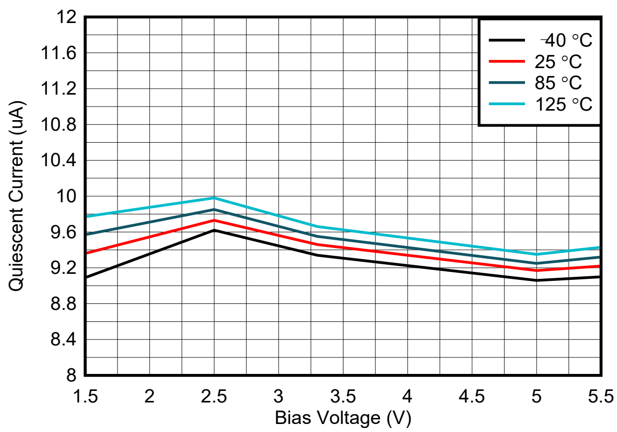
VIN = VBIAS

图 6-1. On-Resistance vs Bias Voltage



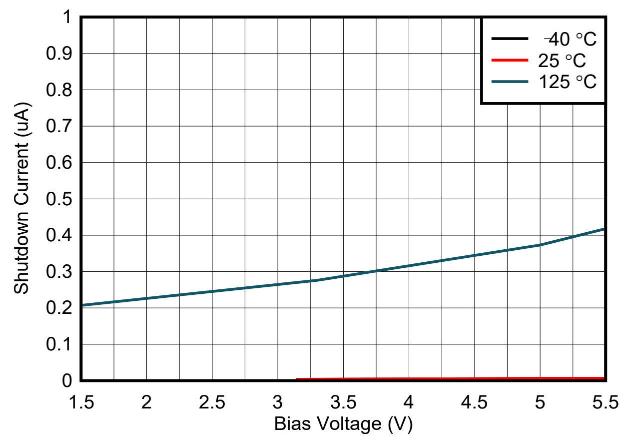
VIN = VBIAS

图 6-2. QOD-Resistance vs Bias Voltage



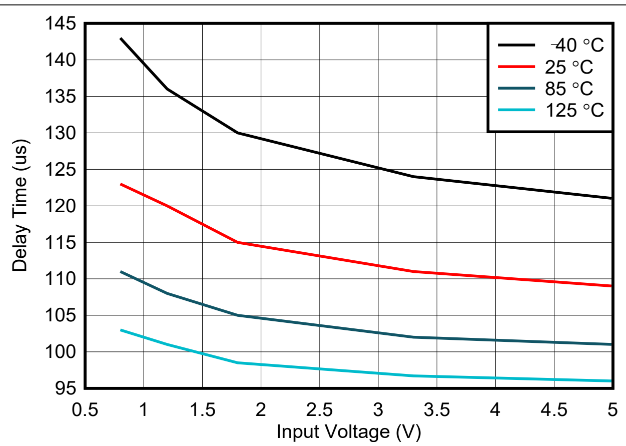
VIN = VBIAS VOUT = OPEN

图 6-3. Quiescent Current vs Bias Voltage



VIN = VBIAS VOUT = GND

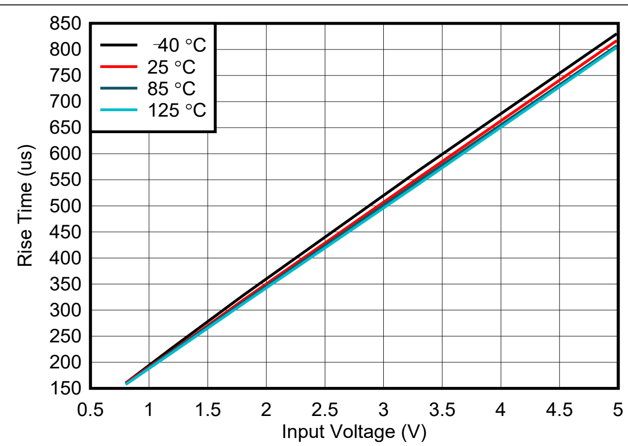
图 6-4. Shutdown Current vs Bias Voltage



VBIAS = 5 V C_L = 10 µF R_L = 100 Ω

CT = 1000 pF

图 6-5. Delay Time vs Input Voltage

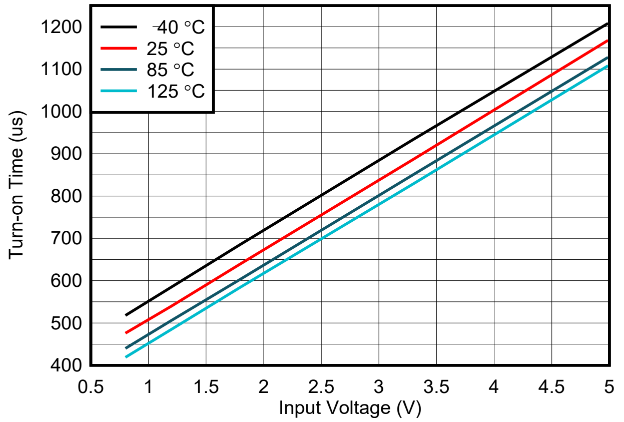


VBIAS = 5 V C_L = 10 µF R_L = 100 Ω

CT = 1000 pF

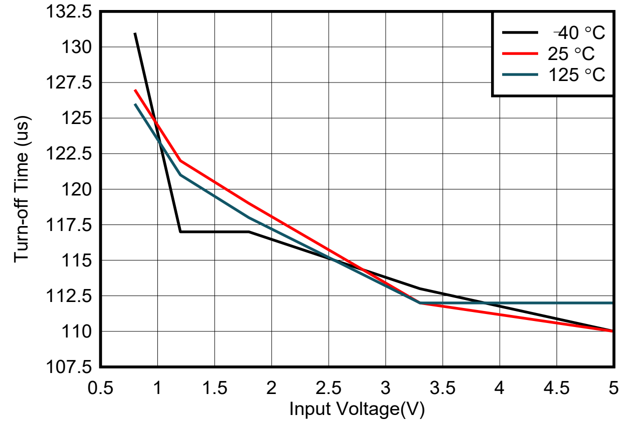
图 6-6. Rise Time vs Input Voltage

6.11 Typical Characteristics (continued)



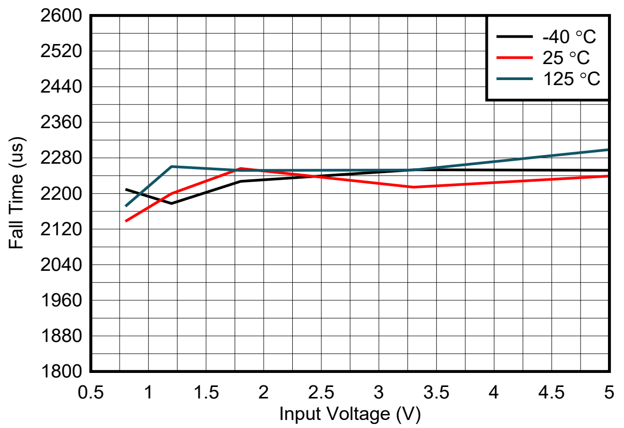
VBIAS = 5 V C_L = 10 µF R_L = 100 Ω
CT = 1000 pF

图 6-7. Turn-on Time vs Input Voltage



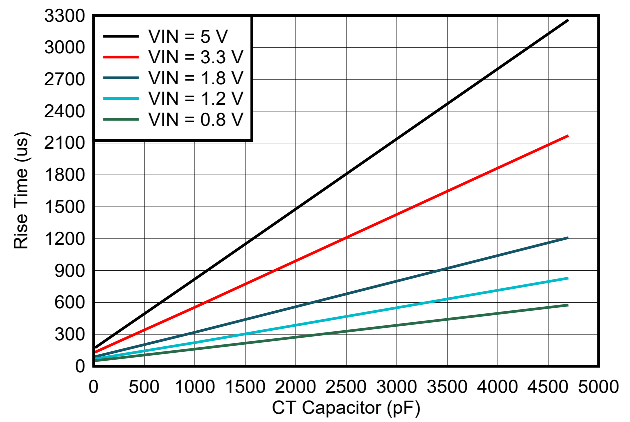
VBIAS = 5 V C_L = 10 µF R_L = 100 Ω
CT = 1000 pF

图 6-8. Turn-off Time vs Input Voltage



VBIAS = 5 V C_L = 10 µF R_L = 100 Ω
QOD = 2 kΩ CT = 1000 pF

图 6-9. Fall Time vs Input Voltage



VBIAS = 5 V C_L = 10 µF R_L = 100 Ω
CT = 1000 pF

图 6-10. Rise Time vs CT Capacitor

7 Parameter Measurement Information

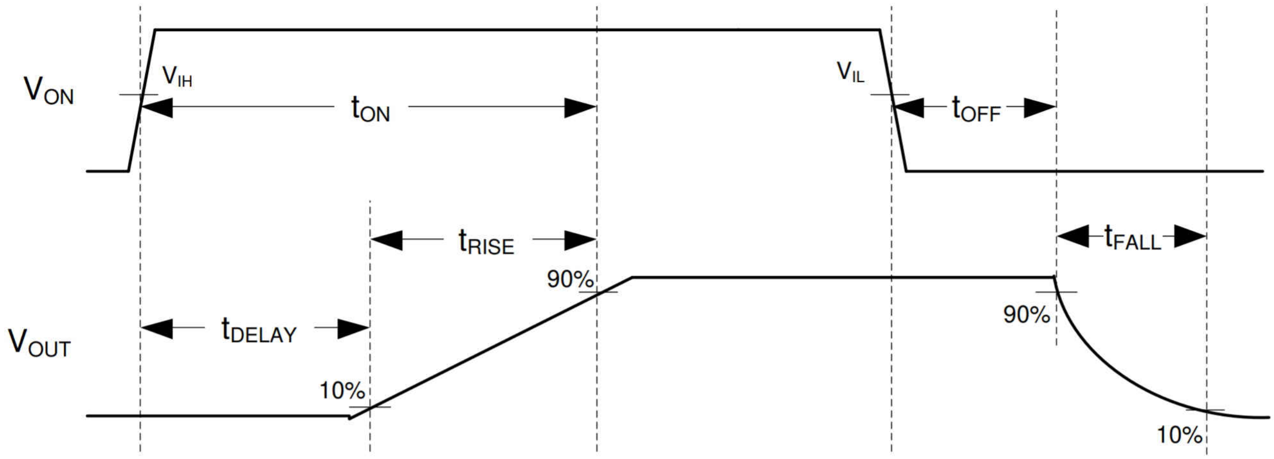


图 7-1. TPS22997 Timing Diagram

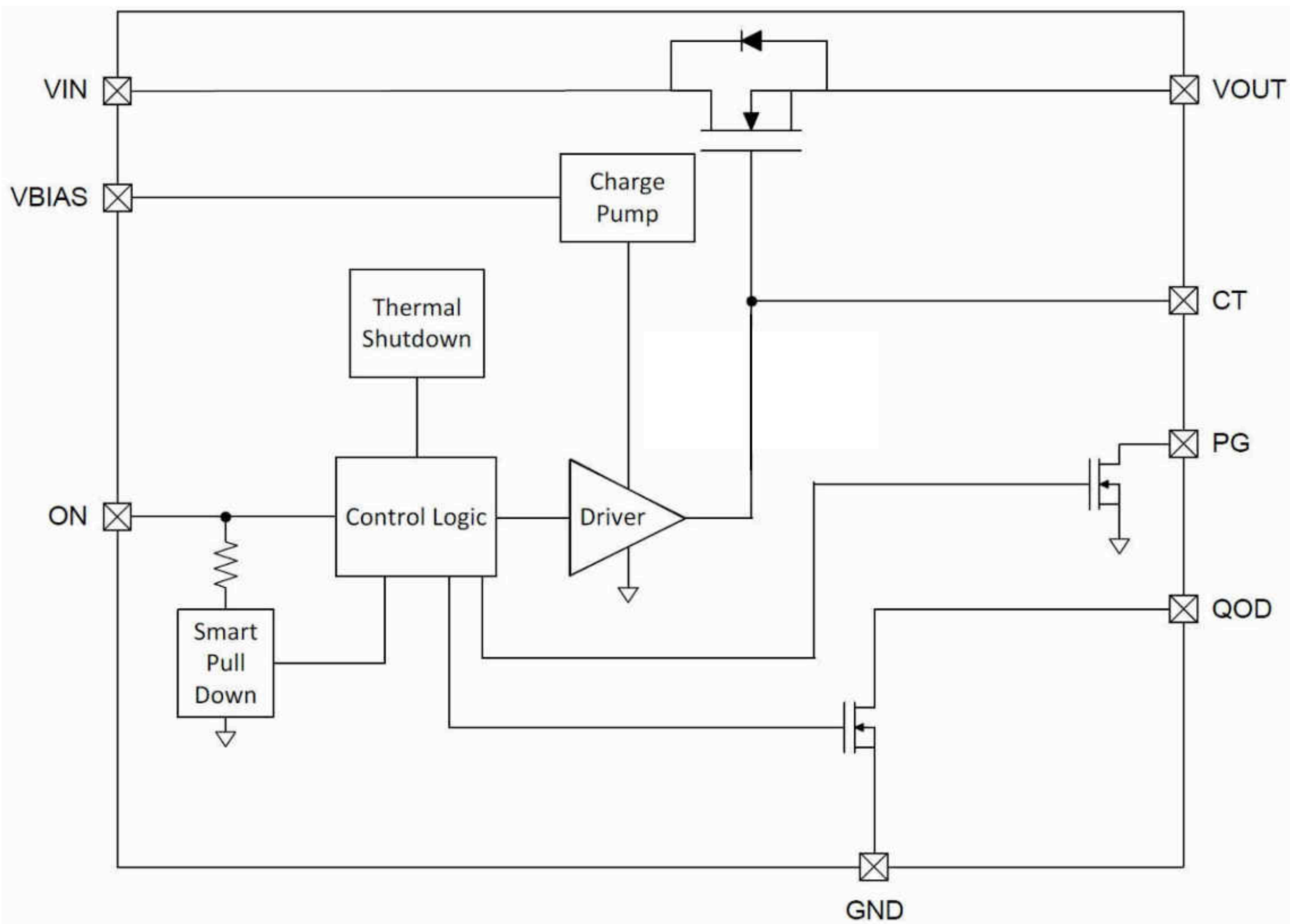
8 Detailed Description

8.1 Overview

The TPS22997 device is a single-channel load switch with a 4-mΩ power MOSFET designed to operate up to 10 A. The voltage range is 0.1 V to 5.5 V. A configurable rise time provides flexibility for power sequencing and minimizes inrush current for high capacitance loads.

The switch is controlled by an enable pin (ON), which is capable of interfacing directly with low voltage GPIO signals down to its V_{IH} level of 0.8 V. The TPS22997 device has an optional QOD pin for quick output discharge when switch is turned off, and the fall time (t_{FALL}) of the output can be adjusted through an external capacitor. There is a Power Good (PG) signal on the device that indicates when the main MOSFET is fully turned on and the on-resistance is at its final value.

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 the pin pull high, the device enables, and when it is low, the device disables.

8.3.2 Adjustable Slew Rate

A capacitor to GND on the CT pin sets the slew rate, and the higher the capacitance the lower the slew rate. The voltage on the CT pin can be as high as 15 V; therefore, the minimum voltage rating for the CT capacitor must be 30 V for optimal performance. Rise times for VBIAS = 5 V are shown below.

CT Capacitor	VIN = 5 V	VIN = 3.3 V	VIN = 1.8 V	VIN = 1.2 V	VIN = 0.8 V
0 pF	165 µs	126 µs	86 µs	66 µs	51 µs
220 pF	309 µs	221 µs	137 µs	99 µs	74 µs
1000 pF	819 µs	554 µs	319 µs	222 µs	160 µs
4700 pF	3260 µs	2170 µs	1210 µs	829 µs	575 µs

The following equation can be used to estimate the rise time for different VIN and CT capacitors at VBIAS = 5 V.

$$t_R = (0.1302\ V_{IN} + 0.0063) \times CT + 27.797\ V_{IN} + 30.54 \quad (1)$$

Where:

- t_R = Rise time in µs
- V_{IN} = Input voltage in V
- CT = CT capacitance in pF

8.3.3 Adjustable Quick Output Discharge

The TPS22997 device includes a QOD feature that can be configured in one of three ways:

1. QOD pin shorted to VOUT pin. Using this method, the discharge rate after the switch becomes disabled is controlled with the value of the internal resistance RQOD. The value of this resistance is listed in the Electrical Characteristics table.
2. QOD pin connected to VOUT pin using an external resistor R_{EXT}. After the switch becomes disabled, the discharge rate is controlled by the value of the total resistance of the QOD.
3. QOD pin is unused and left floating. Using this method, there is no quick output discharge functionality, and the output remains floating after the switch is disabled.

Fall time is dependent on the strength of the configured pulldown resistance on the output.

8.3.4 Thermal Shutdown

When the device temperature reaches 150°C (typical), the device shuts itself off to prevent thermal damage. After it cools off by about 20°C, the device 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.

8.3.5 Power Good (PG) Signal

The TPS22997 device has a Power Good (PG) output signal to indicate the gate of the pass FET is driven high and the switch is on with the on-resistance close to its final value (full load ready). The signal is an active high and open drain output which can be connected to a voltage source through an external pullup resistor, R_{PU}. This voltage source can be VOUT from the TPS22997 device or another external voltage. VBIAS is required for PG to have a valid output.

8.4 Device Functional Modes

The below table summarizes the device functional modes:

ON	Fault Condition	VOUT State
L	N/A	Hi-Z
H	None	V_{IN} (through R_{ON})

ON	Fault Condition	VOUT State
X	Thermal shutdown	Hi-Z

9 Application and Implementation

备注

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

This section highlights some of the design considerations when implementing this device in various applications.

9.2 Typical Application

This typical application demonstrates how to use the TPS22997 device to limit startup inrush current.

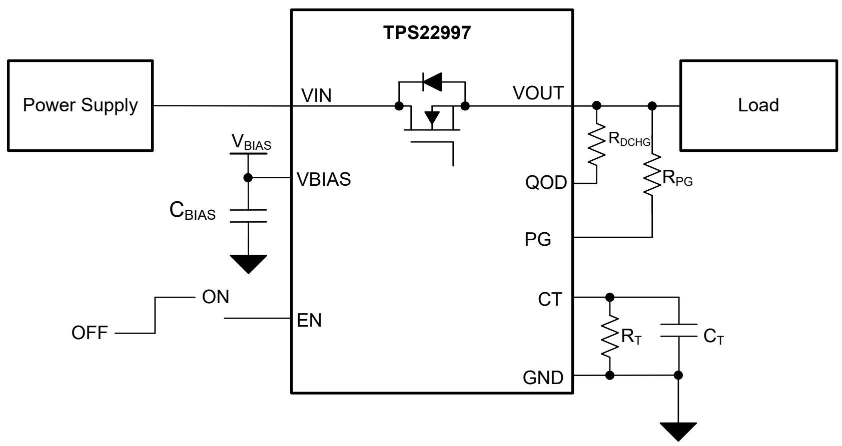


图 9-1. TPS22997 Basic Application

表 9-1. Component Descriptions

PARAMETER	Purpose
C_{BIAS}	Stabilize the bias supply and filter out low frequency noise.
C_T	Adjustable rise time capacitor.
R_T	Optional C_T capacitor discharge resistor for cases when device is disabled before output has fully ramped up. Use a resistor >10MΩ.
R_{DCHG}	Adjustable output discharge resistor.

9.2.1 Design Requirements

For this example, the values below are used as the design parameters.

表 9-2. Design Parameters

PARAMETER	VALUE
V_{BIAS}	5.0 V
V_{IN}	5.0 V
Load capacitance	220 μF
Maximum inrush current	1.5 A

9.2.2 Detailed Design Procedure

When the switch enables, the charge up the output capacitance from 0 V to the set value (1.8 V in this example). This charge arrives in the form of inrush current. Calculate inrush current using 方程式 2.

$$\text{Inrush Current} = C_L \times dVOUT/dt \quad (2)$$

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. Because rise time is 10% of VOUT to 90% of VOUT, this is 80% of the VIN value.
- dt is the rise time in VOUT during the ramp up of the output voltage when the device is enabled.

The TPS22997 offers an adjustable rise time for VOUT, allowing the user to control the inrush current during turn on. Calculate the appropriate rise time using the design requirements and the inrush current equation as shown below.

$$1.5\ \text{A} = 220\ \mu\text{F} \times (5.0\ \text{V} \times 80\%)\ /\ dt \quad (3)$$

$$dt = 586\ \text{us} \quad (4)$$

To ensure an inrush current of less than 1.5 A, a C_T setting that yields a rise time of more than 586 µs must be chosen. By using a 1000pF capacitance, a rise time of 819 µs is selected, limiting the inrush current to below 1.5 A.

9.2.3 Application Performance Plots

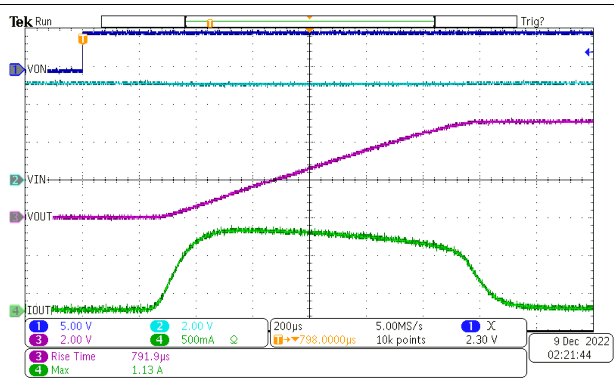


图 9-2. Inrush Current for CL = 220 µF with CT = 1000 pF

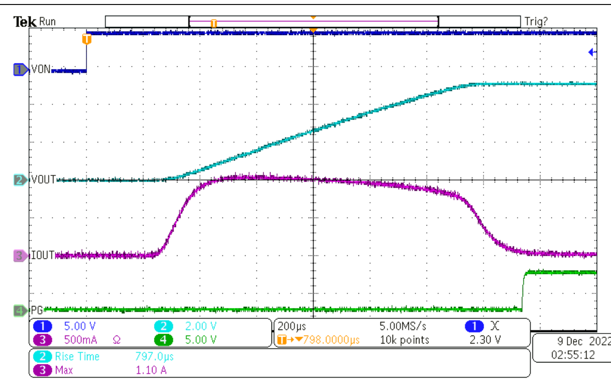


图 9-3. PG Pin Behavior with Inrush Current for CL = 220 µF with CT = 1000 pF

9.3 Power Supply Recommendations

The TPS22997 device is designed to operate with a VIN range of 0.1 V to 5.5 V. Regulate the VIN power supply well. The power supply must be able to withstand all transient load current steps. In most situations, using an input capacitance (C_{IN}) of 1 µF 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.

A capacitor (C_{BIAS}) is recommended to be placed as close to the device as possible to stabilize the supply and filter our low frequency noise.

9.4 Layout

9.4.1 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.

9.4.2 Layout Example

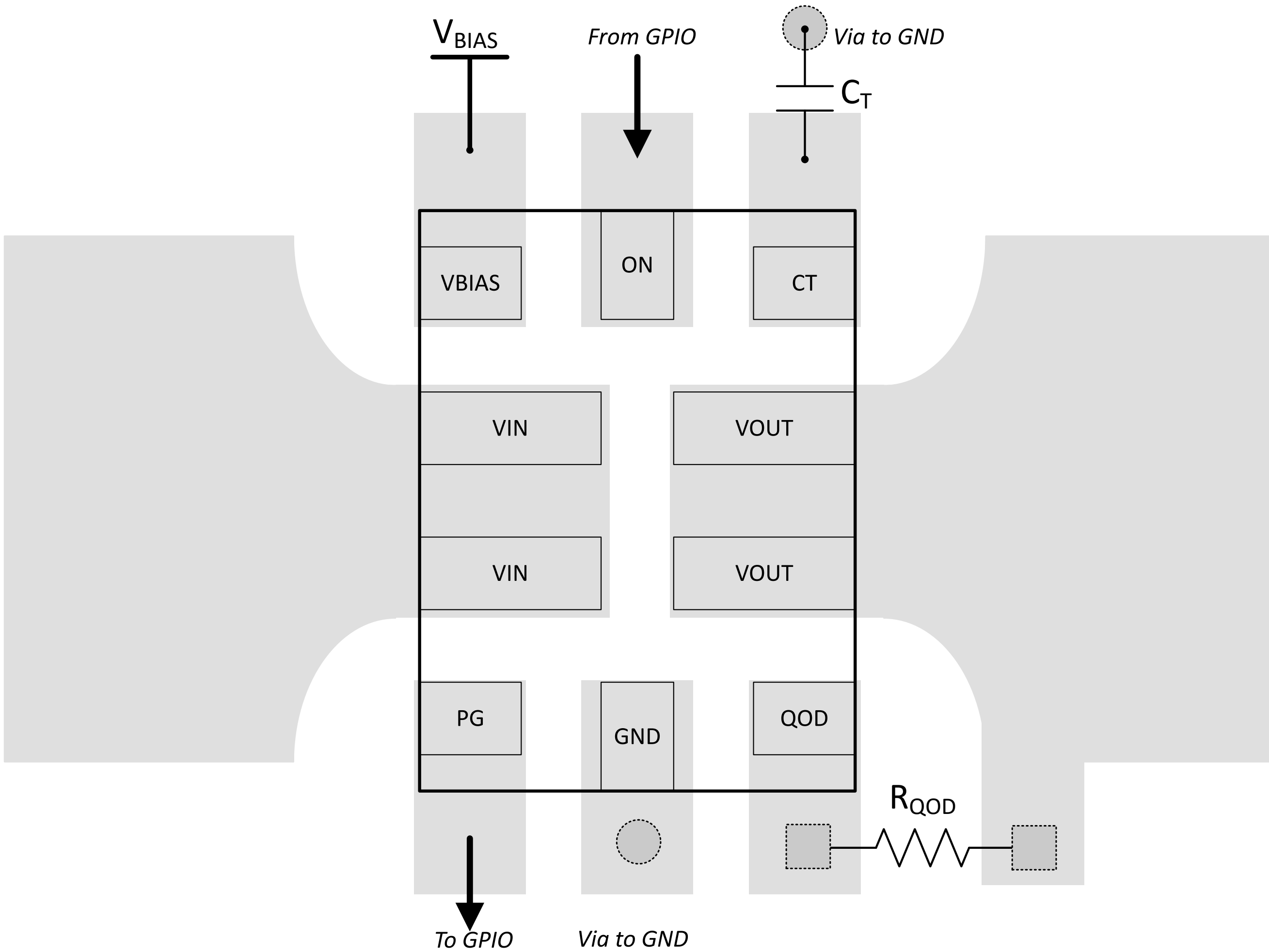


图 9-4. TPS22997 Layout Example

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.

10.1 接收文档更新通知

要接收文档更新通知，请导航至 ti.com 上的器件产品文件夹。点击*订阅更新* 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

10.2 支持资源

TI E2E™ 支持论坛是工程师的重要参考资料，可直接从专家获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题可获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的《使用条款》。

10.3 Trademarks

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ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

10.5 术语表

TI 术语表	本术语表列出并解释了术语、首字母缩略词和定义。

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
TPS22997RYZR	ACTIVE	WQFN-HR	RYZ	10	3000	RoHS & Green	Call TI | SN | NIPDAU	Level-2-260C-1 YEAR	-40 to 125	(102, 1O2)	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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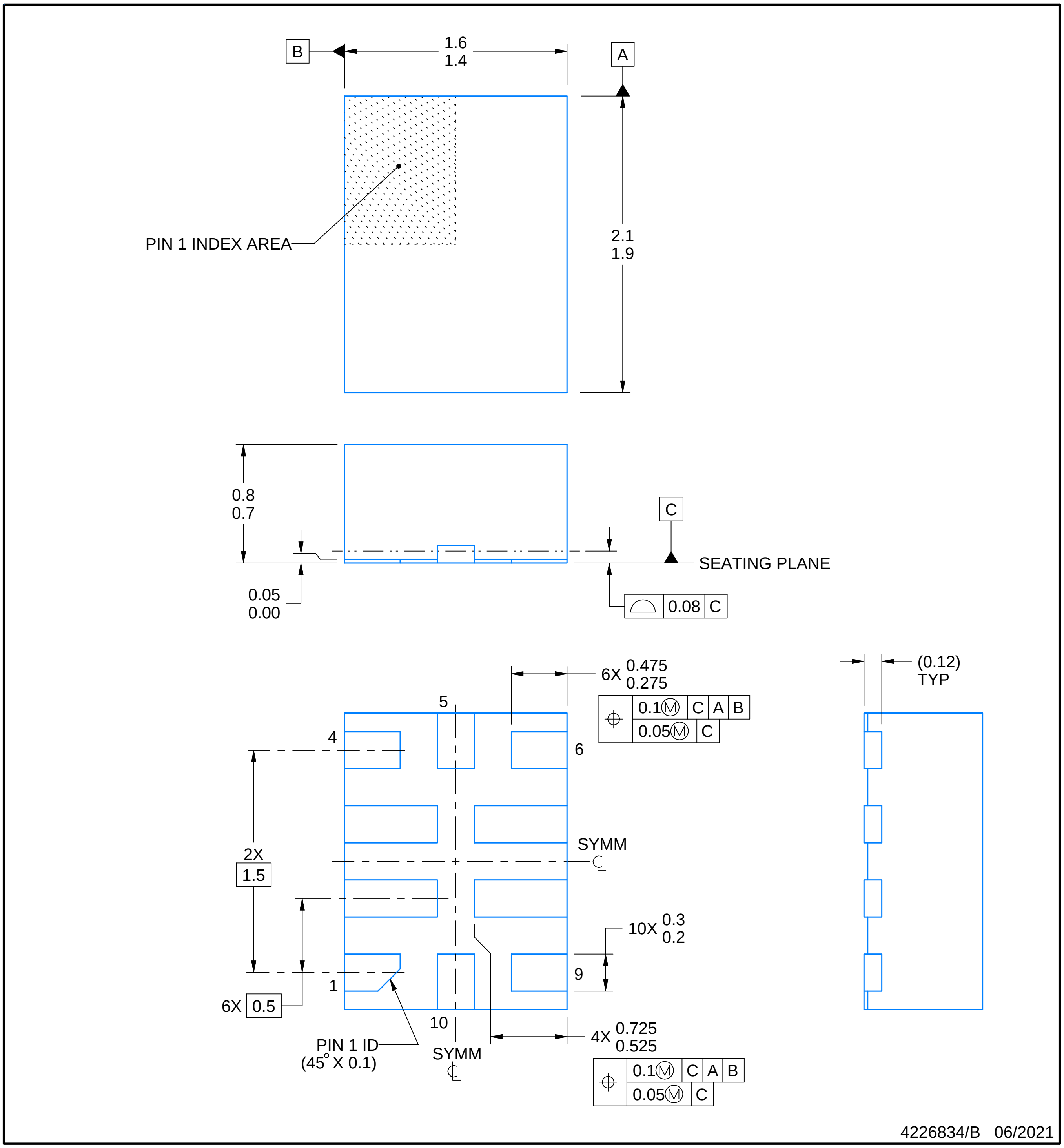
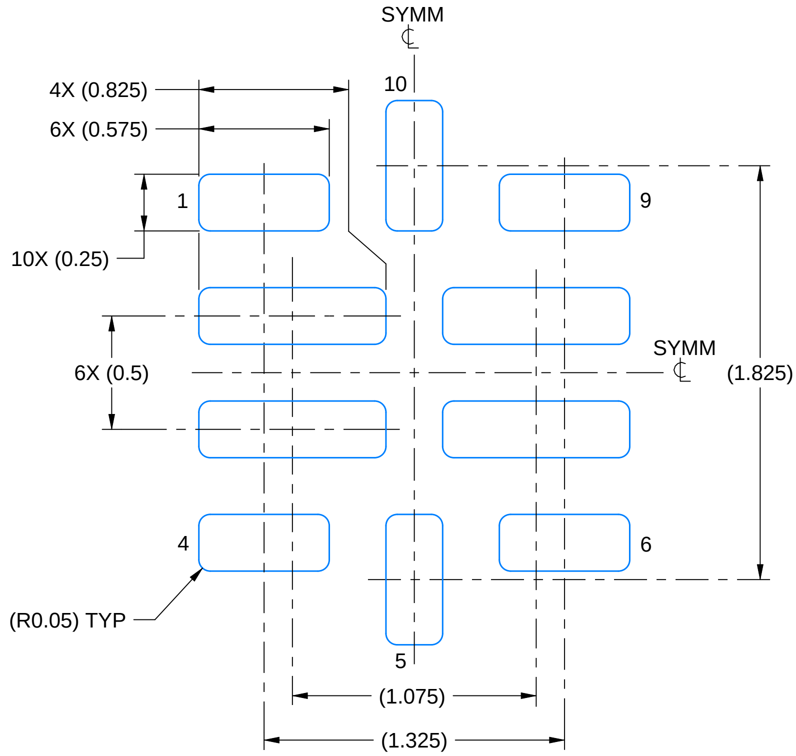
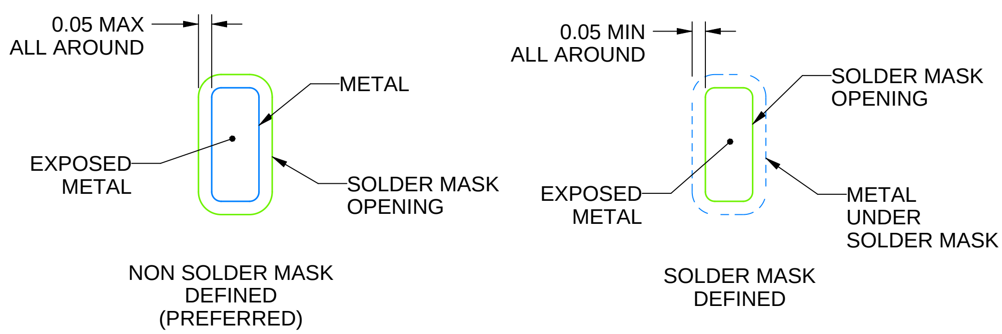


NOTES:

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.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:30X



SOLDER MASK DETAILS
NOT TO SCALE

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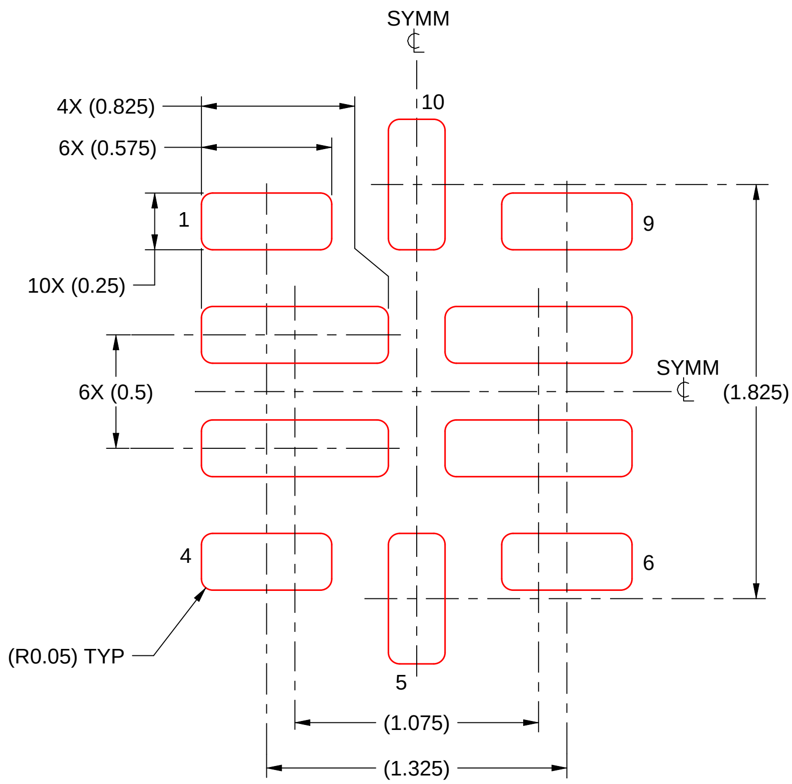
NOTES: (continued)

3. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICKNESS
SCALE: 30X

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NOTES: (continued)

5. 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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