TPS2296xC 具有反向电流保护和受控接通功能的 5.5V、3A、13mΩ 导通电阻负载开关

1 特性

- 集成 N 通道负载开关
- 输入电压范围：1V 至 5.5V
- 内部导通 FET R_{DSON} = 8mΩ（典型值）
- 超低导通电阻
  - R_{ON} = 13mΩ（典型值），此时 V_{IN} = 5V
  - R_{ON} = 14m?（典型值），此时 V_{IN} = 3.3V
  - R_{ON} = 18m?（典型值），此时 V_{IN} = 1.8V
- 3A 最大持续开关电流
- 反向电流保护（禁用时）
- 低关断电流 (760nA)
- 1.3V GPIO 低阈值控制输入
- 受控转换率可避免浪涌电流
- 快速输出放电（只适用于 TPS22964）
- 六引脚晶圆级芯片规模封装（标称尺寸 - 请参见附录了解详细信息）
  - 0.9mm x 1.4mm，0.5mm 焊球间距，0.5mm 高度 (YZP)
- 经测试，静电放电 (ESD) 性能符合 JESD 22 规范
  - 2kV 人体模型（A114-B，II 类）
  - 500V 充电器件模型 (C101)

2 应用

- 智能手机
- 笔记本计算机和 超极本™
- 平板电脑
- 固态硬盘 (SSD)
- 数字电视 (DTV)/IP 机顶盒
- POS 终端及媒体网关

3 说明

TPS22963/64 是一款具有受控接通功能的小型超低 R_{ON} 负载开关。 此器件包含一个低 R_{DSON} N 通道金属氧化物半导体场效应晶体管 (MOSFET)，可在 1V 至 5.5 输入电压范围内运行并支持高达 3A 的开关电流。 采用集成电荷泵偏置 NMOS 开关，从而获得一个低开关导通电阻。 此开关可由一个打开/关闭输入 (ON) 控制，此输入可与低压 GPIO 控制信号直接对接。 TPS22963/64 器件的上升时间受到内部控制以避免浪涌电流。

TPS22963/64 提供反向电流保护。 当电源开关禁用时，该器件将防止电流流向开关输入端。 反向电流保护功能只有在该器件禁用时才有效，以便允许某些应用中特意的反向电流（开关使能时）。

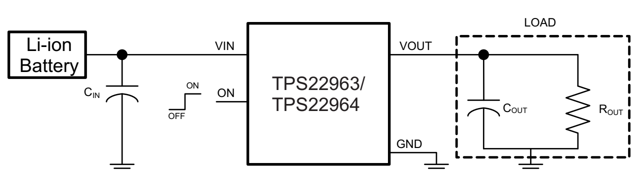
TPS22963/64 采用超小型、节省空间的 6 引脚晶圆级芯片 (WCSP) 封装，额定工作环境温度范围为 –40°C 至 85°C。

器件信息(1)

器件型号	封装	封装尺寸（标称值）
TPS2296xC	DSBGA (6)	1.40mm x 0.90mm

(1) 要了解所有可用封装，请见数据表末尾的可订购产品附录。

4 简化电路原理图



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5 修订历史记录

Changes from Original (June 2013) to Revision A	**Page**
• 已添加 *引脚配置和功能部分，ESD 额定值表，特性描述部分，器件功能模式，应用和实施部分，电源相关建议部分，布局部分，器件和文档支持部分以及机械、封装和可订购信息部分*	1

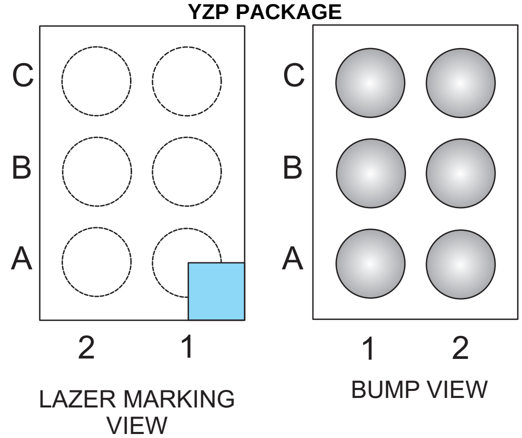
6 Device Comparison Table

	R_{ON} (Typ) at 3.3 V	Rise Time (Typ) at 3.3 V(1)	Quick Output Discharge (QOD)(2)	Maximum Output Current	Enable
TPS22963C	14 mΩ	715 µs	No	3 A	Active High
TPS22964C	14 mΩ	715 µs	Yes	3 A	Active High

(1) Additional rise time options are possible. Contact factory for more information.
(2) This feature discharges the output of the switch to ground through a 273 Ω resistor, preventing the output from floating (only in TPS22964C).

7 Pin Configuration and Functions

6-PINS
YZP PACKAGE



Pin Assignments (YZP Package)

C	GND	ON
B	VOUT	VIN
A	VOUT	VIN
	1	**2**

Pin Functions

PIN		I/O	DESCRIPTION
TPS22963/64	NAME		
C1	GND	-	Ground
C2	ON	I	Switch control input, active high. Do not leave floating
A1, B1	VOUT	O	Switch output
A2, B2	VIN	I	Switch input. Use a bypass capacitor to ground (ceramic)

8 Specifications

8.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V_{IN}	Input voltage range	–0.3	6	V
V_{OUT}	Output voltage range	–0.3	6	V
V_{ON}	ON pin voltage range	–0.3	6	V
I_{MAX}	Maximum continuous switch current		3	A
I_{PLS}	Maximum pulsed switch current, 100 µs pulse, 2% duty cycle, T_A = –40°C to 85°C		4	A
T_A	Operating free air temperature range	–40	85	°C
T_J	Maximum junction temperature		125	°C
T_{stg}	Storage temperature range	–65	150	°C

8.2 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. Manufacturing with less than 500-V HBM is possible with the necessary precautions.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 250-V CDM is possible with the necessary precautions.

8.3 Recommended Operating Conditions

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

			MIN	TYP	MAX	UNIT
V_{IN}	Input voltage range		1		5.5	V
V_{OUT}	Output voltage range		0		5.5	V
$V_{IH, ON}$	High-level ON voltage	V_{IN} = 2.5 V to 5.5 V	1.3		5.5	V
		V_{IN} = 1 V to 2.49 V	1.1		5.5	
$V_{IL, ON}$	Low-level ON voltage	V_{IN} = 2.5 V to 5.5 V	0		0.6	V
		V_{IN} = 1 V to 2.49 V	0		0.4	
C_{IN}	Input capacitor			1 (1)		µF

(1) Refer to the application section

8.4 Thermal Information

THERMAL METRIC (1)		TPS2296xC YZP 6 PINS	UNIT
$R_{θJA}$	Junction-to-ambient thermal resistance	132.0	°C/W
$R_{θJCtop}$	Junction-to-case (top) thermal resistance	1.4	
$R_{θJB}$	Junction-to-board thermal resistance	22.8	
$ψ_{JT}$	Junction-to-top characterization parameter	5.7	
$ψ_{JB}$	Junction-to-board characterization parameter	22.6	

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

8.5 Electrical Characteristics

V_{IN} = 1 V to 5.5 V, T_A = –40°C to 85°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
$I_{Q, VIN}$	Quiescent current	I_{OUT} = 0, V_{ON} = V_{IN} = 5 V	Full		66.5	96	µA
		I_{OUT} = 0, V_{ON} = V_{IN} = 4.5 V	Full		57	82	
		I_{OUT} = 0, V_{ON} = V_{IN} = 3.3 V	Full		38	60	
		I_{OUT} = 0, V_{ON} = V_{IN} = 2.5 V	Full		33.3	55	
		I_{OUT} = 0, V_{ON} = V_{IN} = 1.8 V	Full		28.3	45	
		I_{OUT} = 0, V_{ON} = V_{IN} = 1.2 V	Full		22.8	36	
		I_{OUT} = 0, V_{ON} = V_{IN} = 1.1 V	Full		21.6	34	
		I_{OUT} = 0, V_{ON} = V_{IN} = 1 V	Full		20.3	33	
$I_{SD, VIN}$	Shut down current	V_{ON} = 0, V_{IN} = 5 V, V_{OUT} = 0 V	Full		0.76	2	µA
		V_{ON} = 0, V_{IN} = 1 V, V_{OUT} = 0 V	Full		0.07	0.8	
R_{ON}	On-resistance	V_{IN} = 5 V, I_{OUT} = –200 mA	25˚C		13.3	21	mΩ
			Full			26	
		V_{IN} = 4.5 V, I_{OUT} = –200 mA	25˚C		13.3	21	mΩ
			Full			26	
		V_{IN} = 3.3 V, I_{OUT} = –200 mA	25˚C		13.8	22	mΩ
			Full			27	
		V_{IN} = 2.5 V, I_{OUT} = –200 mA	25˚C		15.4	24	mΩ
			Full			29	
		V_{IN} = 1.8 V, I_{OUT} = –200 mA	25˚C		18.2	28	mΩ
			Full			33	
		V_{IN} = 1.2 V, I_{OUT} = –200 mA	25˚C		25.6	37	mΩ
			Full			44	
		V_{IN} = 1.1 V, I_{OUT} = –200 mA	25˚C		28.7	41	mΩ
			Full			50	
		V_{IN} = 1 V, I_{OUT} = –200 mA	25°C		33.8	48	mΩ
			Full			60	
$V_{HYS, ON}$	ON pin hysteresis	V_{IN} = 5 V	Full		115		mV
		V_{IN} = 4.5 V	Full		105		
		V_{IN} = 3.3 V	Full		80		
		V_{IN} = 2.5 V	Full		65		
		V_{IN} = 1.8 V	Full		50		
		V_{IN} = 1.2 V	Full		35		
		V_{IN} = 1.1 V	Full		30		
		V_{IN} = 1 V	Full		30		
I_{ON}	ON pin leakage current	V_{ON} = 1.1 V to 5.5 V	Full			150	nA
$I_{RC, VIN}$	Reverse current when disabled	V_{IN} = V_{ON} = 0 V, V_{OUT} = 5 V	25°C		–0.02		µA
			85°C		–2.1		
R_{PD} (1)	Output pulldown resistance	V_{ON} = 0 V, I_{OUT} = 2 mA	Full		273	325	Ω

(1) Available in TPS22964 only.

8.6 Switching Characteristics

PARAMETER		TEST CONDITION	TPS22963/64 TYP	UNIT
V_{IN} = 5.0 V, T_A = 25°C (unless otherwise noted)				
t_{ON}	Turn-ON time	R_{OUT} = 10Ω, C_{IN} = 1µF, C_{OUT} = 0.1µF	928	µs
t_{OFF}	Turn-OFF time	R_{OUT} = 10Ω, C_{IN} = 1µF, C_{OUT} = 0.1µF	2.5	
t_R	VOUT rise time	R_{OUT} = 10Ω, C_{IN} = 1µF, C_{OUT} = 0.1µF	890	
t_F	VOUT fall time	R_{OUT} = 10Ω, C_{IN} = 1µF, C_{OUT} = 0.1µF	2.1	
t_D	Delay time	R_{OUT} = 10Ω, C_{IN} = 1µF, C_{OUT} = 0.1µF	561	
V_{IN} = 4.5 V, T_A = 25°C (unless otherwise noted)				
t_{ON}	Turn-ON time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	905	µs
t_{OFF}	Turn-OFF time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	2.6	
t_R	VOUT rise time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	859	
t_F	VOUT fall time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	2.1	
t_D	Delay time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	560	
V_{IN} = 3.3 V, T_A = 25°C (unless otherwise noted)				
t_{ON}	Turn-ON time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	836	µs
t_{OFF}	Turn-OFF time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	2.8	
t_R	VOUT rise time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	715	
t_F	VOUT fall time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	2	
t_D	Delay time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	553	
V_{IN} = 1.8 V, T_A = 25°C (unless otherwise noted)				
t_{ON}	Turn-ON time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	822	µs
t_{OFF}	Turn-OFF time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	2.8	
t_R	VOUT rise time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	651	
t_F	VOUT fall time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	2	
t_D	Delay time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	558	
V_{IN} = 1.2 V, T_A = 25°C (unless otherwise noted)				
t_{ON}	Turn-ON time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	852	µs
t_{OFF}	Turn-OFF time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	3.2	
t_R	VOUT rise time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	535	
t_F	VOUT fall time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	1.8	
t_D	Delay time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	594	
V_{IN} = 1.1 V, T_A = 25°C (unless otherwise noted)				
t_{ON}	Turn-ON time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	861	µs
t_{OFF}	Turn-OFF time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	3.5	
t_R	VOUT rise time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	518	
t_F	VOUT fall time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	1.9	
t_D	Delay time	R_{OUT} = 10 Ω, C_{IN} = 1 µF, C_{OUT} = 0.1 µF	604	

8.7 Typical Electrical Characteristics

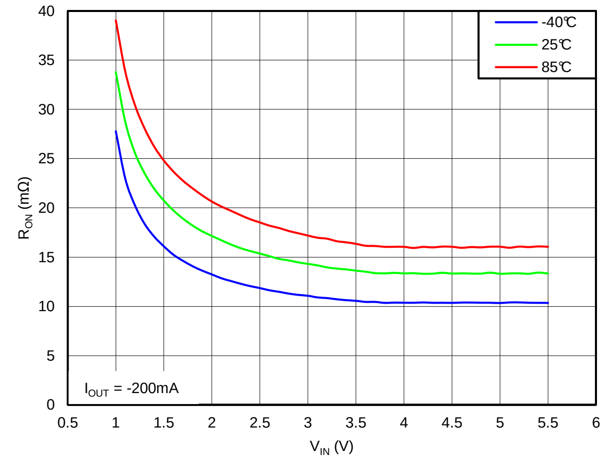


图 1. On Resistance vs V_{IN}

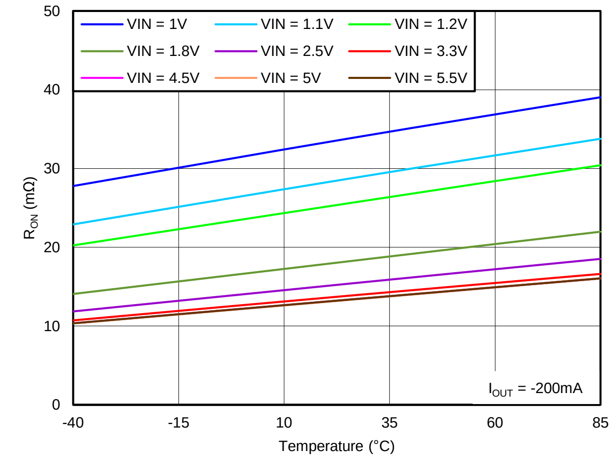


图 2. On Resistance vs Temperature

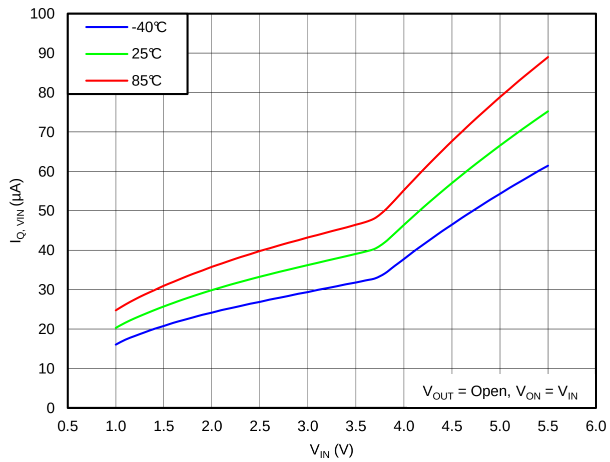


图 3. Quiescent Current vs V_{IN}

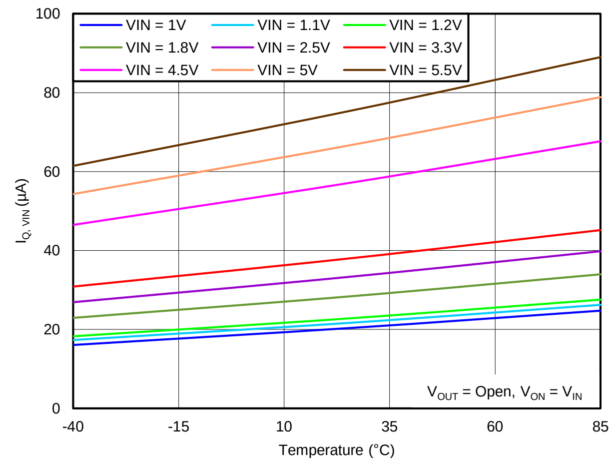


图 4. Quiescent Current vs Temperature

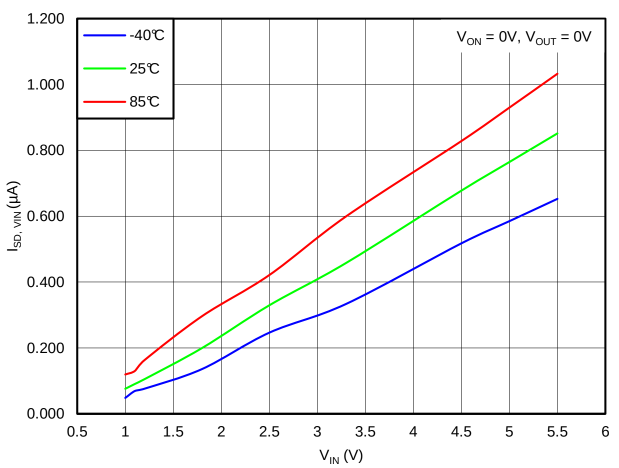


图 5. Shut Down Current vs V_{IN}

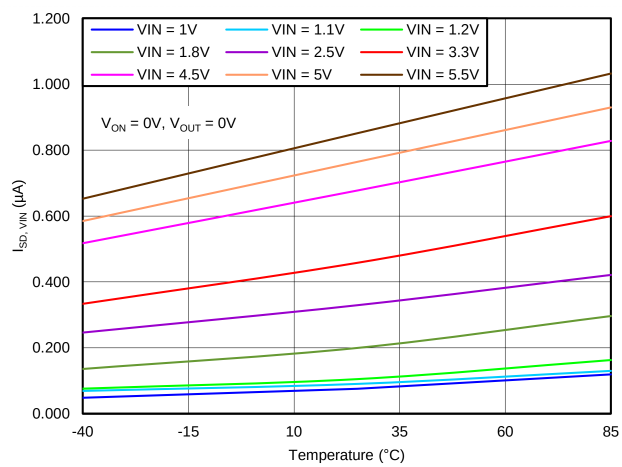


图 6. Shut Down Current vs Temperature

Typical Electrical Characteristics (接下页)

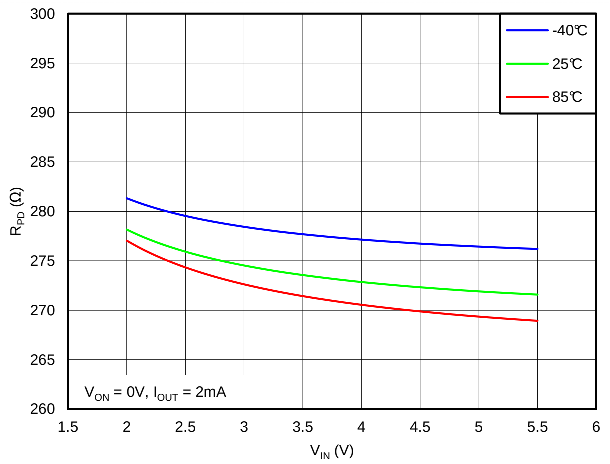


图 7. Output Pulldown Resistance vs V_{IN}

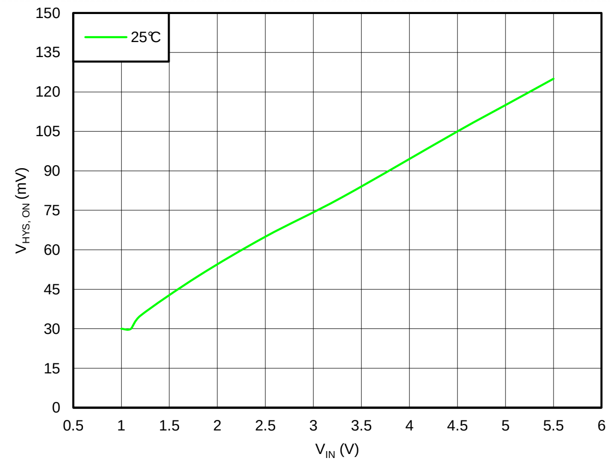


图 8. On Pin Hysteresis vs V_{IN}

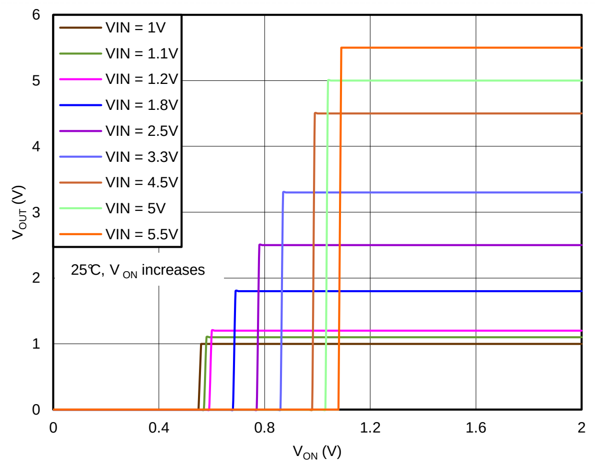


图 9. Output Voltage vs V_{ON} Rising

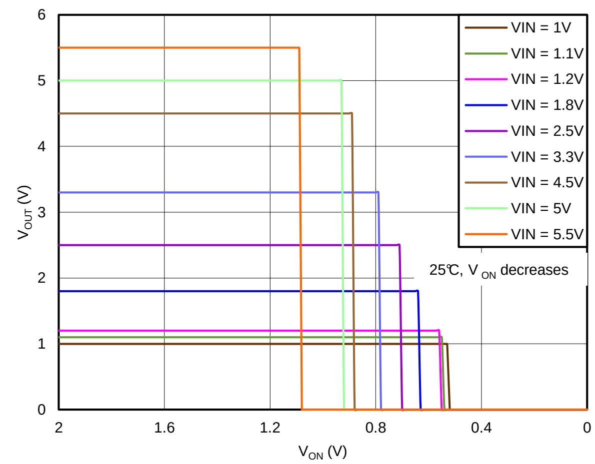


图 10. Output Voltage vs V_{ON} Falling

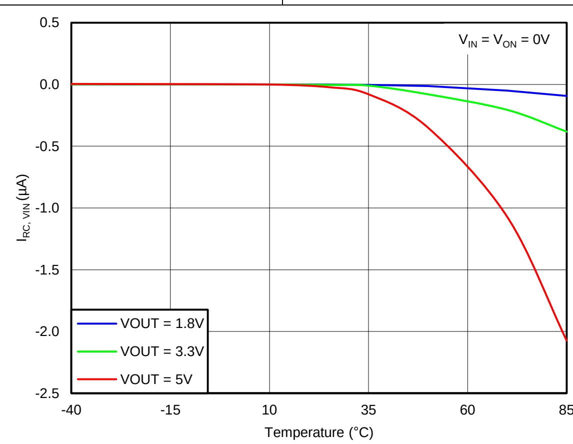


图 11. Reverse Current When Disabled vs Temperature

8.8 Typical Switching Characteristics

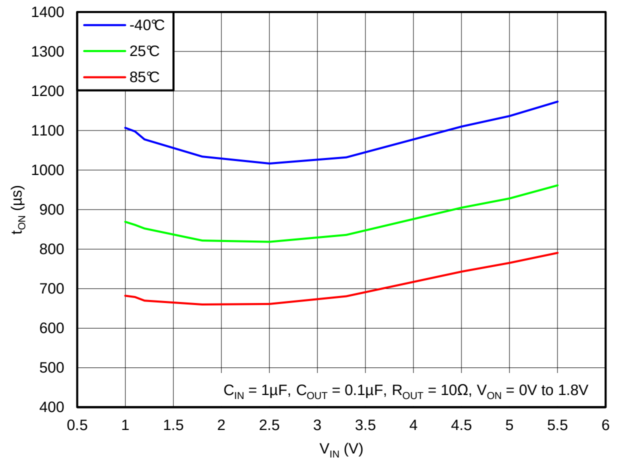


图 12. Turn-On Time vs V_{IN}

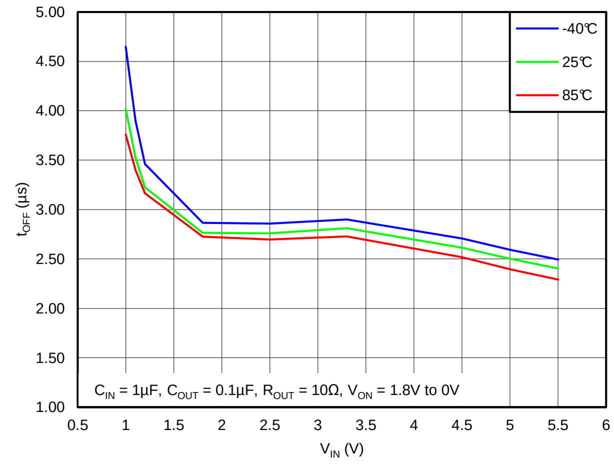


图 13. Turn-Off Time vs V_{IN}

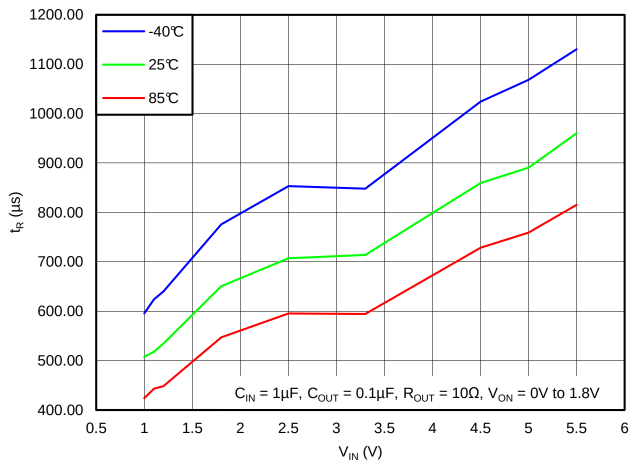


图 14. V_{OUT} Rise Time vs V_{IN}

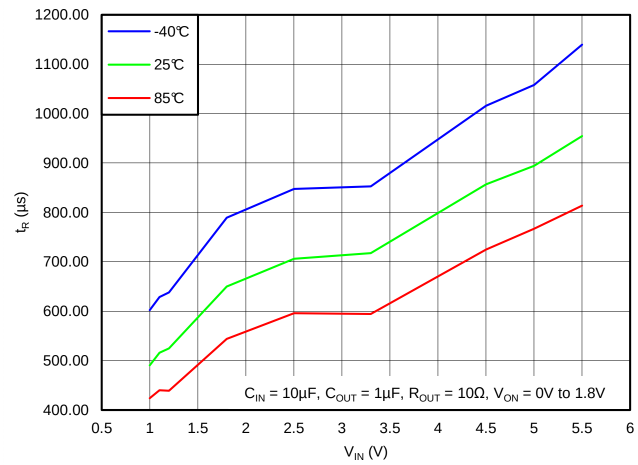


图 15. V_{OUT} Rise Time vs V_{IN}

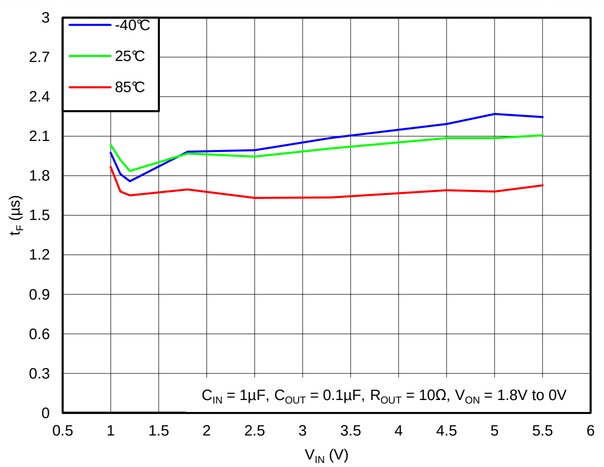


图 16. V_{OUT} Fall Time vs V_{IN}

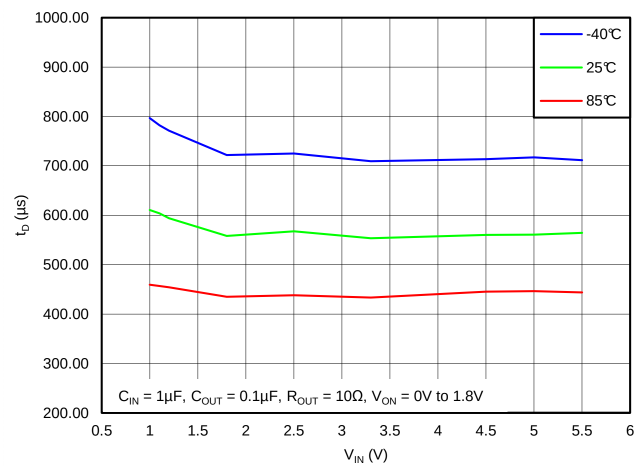


图 17. Delay Time vs V_{IN}

8.9 Typical AC Scope Captures at T_A = 25ºC

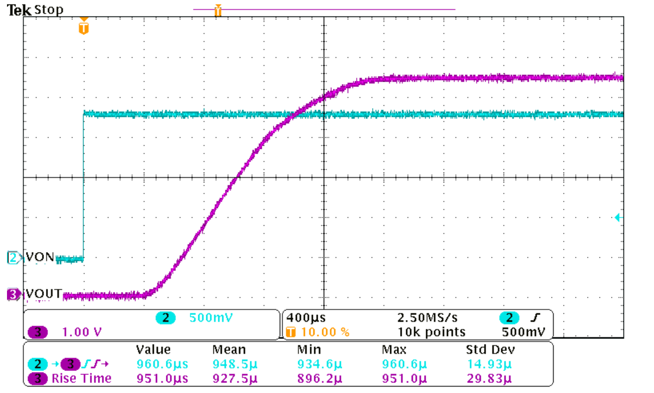


图 18. Turn-On Response Time (V_{IN} = 5.5 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

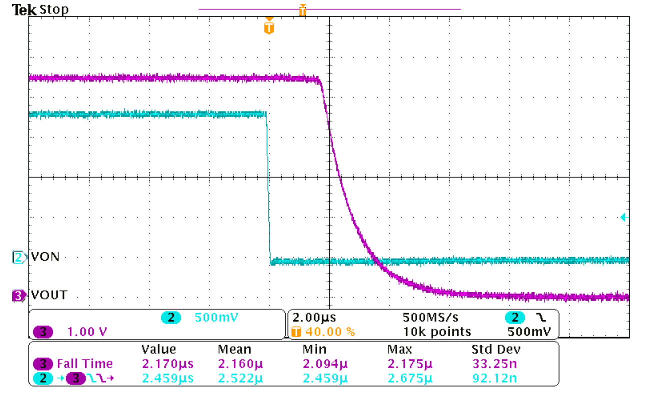


图 19. Turn-Off Response Time (V_{IN} = 5.5 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

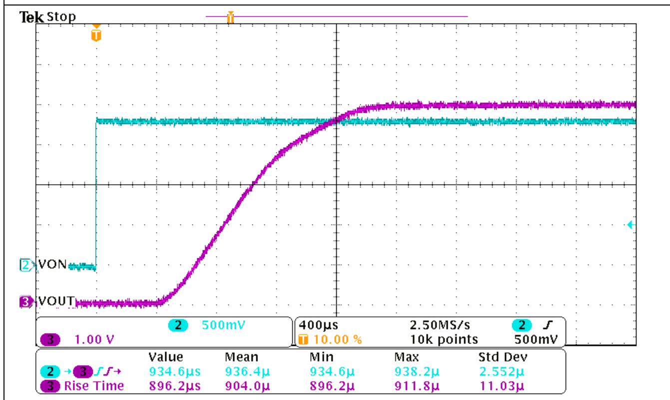


图 20. Turn-On Response Time (V_{IN} = 5 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

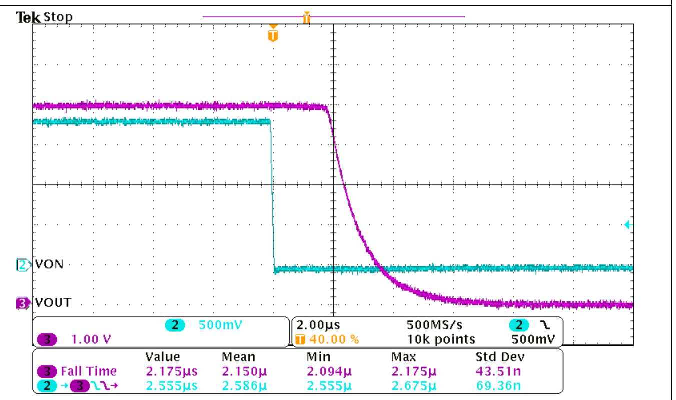


图 21. Turn-Off Response Time (V_{IN} = 5 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

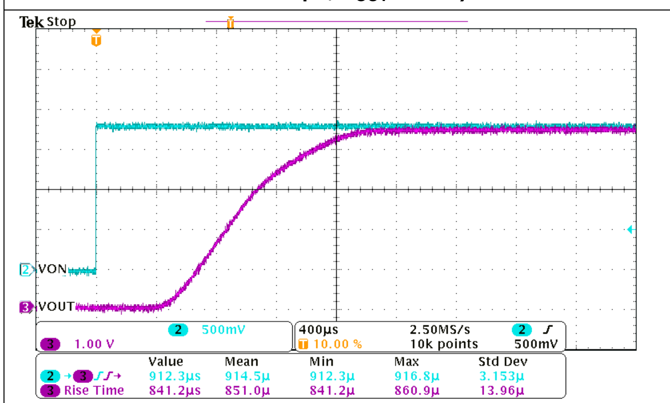


图 22. Turn-On Response Time (V_{IN} = 4.5 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

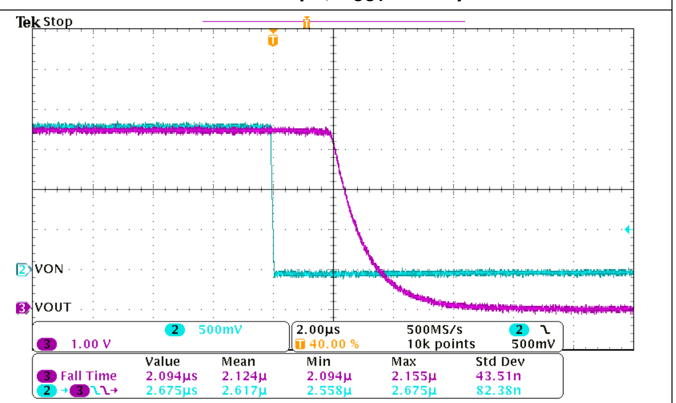


图 23. Turn-Off Response Time (V_{IN} = 4.5 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

Typical AC Scope Captures at T_A = 25ºC (接下页)

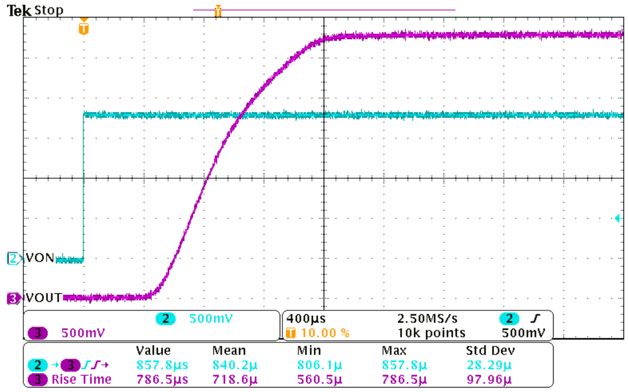


图 24. Turn-On Response Time (V_{IN} = 3.3 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

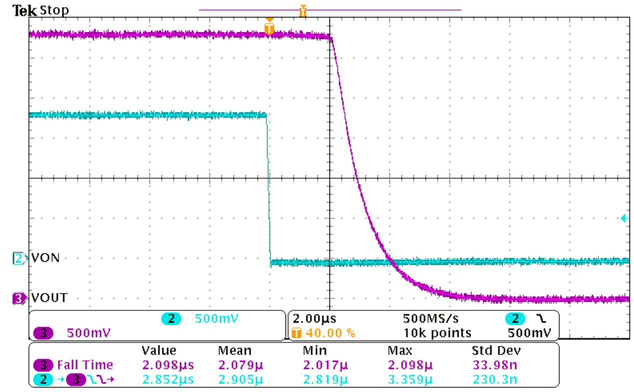


图 25. Turn-Off Response Time (V_{IN} = 3.3 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

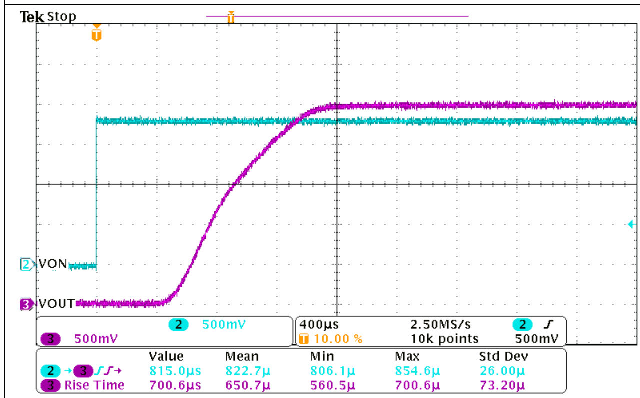


图 26. Turn-On Response Time (V_{IN} = 2.5 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

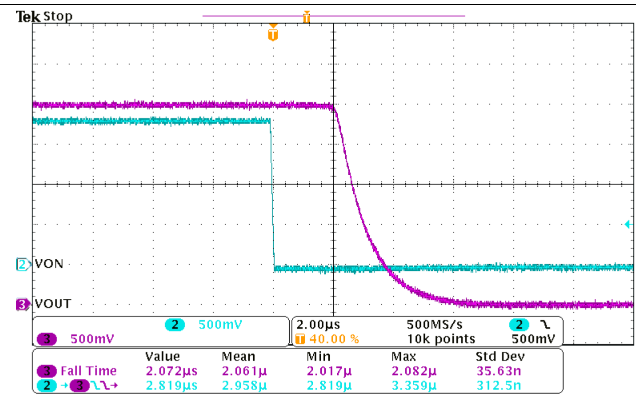


图 27. Turn-Off Response Time (V_{IN} = 2.5 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

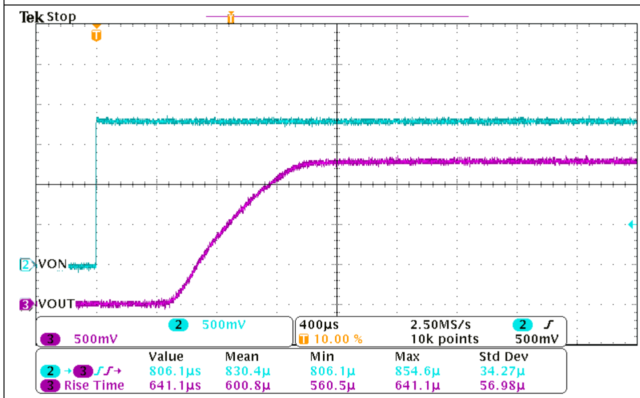


图 28. Turn-On Response Time (V_{IN} = 1.8 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

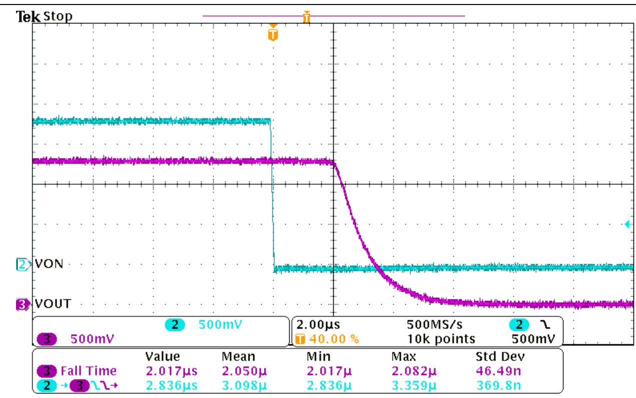


图 29. Turn-Off Response Time (V_{IN} = 1.8 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

Typical AC Scope Captures at T_A = 25ºC (接下页)

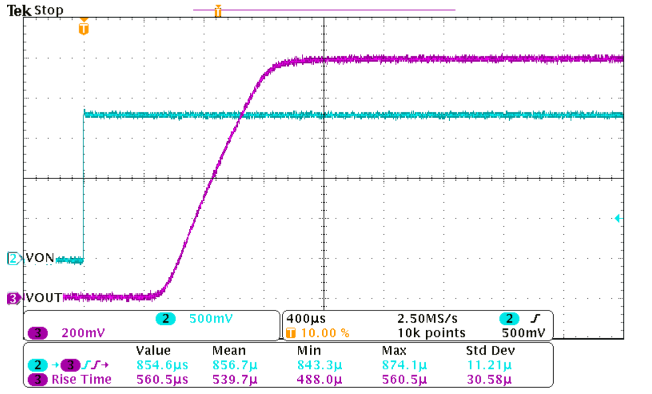


图 30. Turn-On Response Time (V_{IN} = 1.2 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

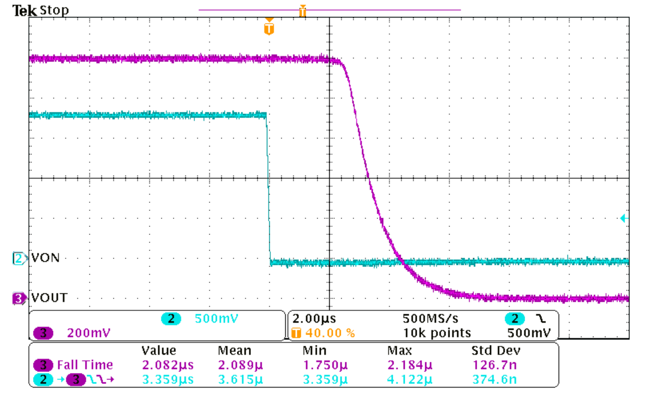


图 31. Turn-Off Response Time (V_{IN} = 1.2 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

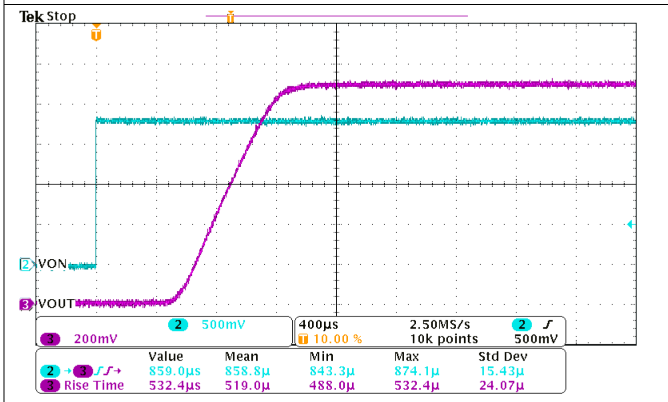


图 32. Turn-On Response Time (V_{IN} = 1.1 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

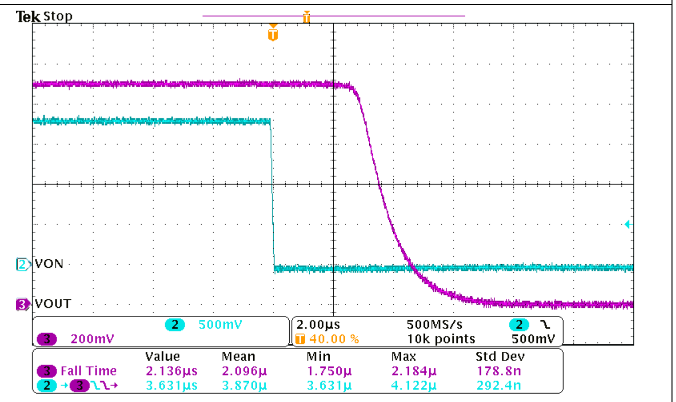


图 33. Turn-Off Response Time (V_{IN} = 1.1 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

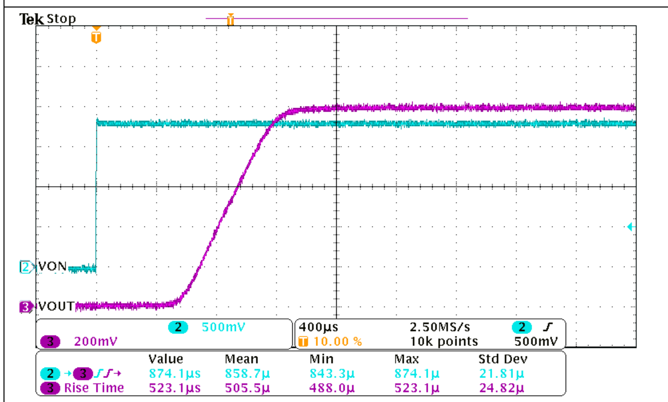


图 34. Turn-On Response Time (V_{IN} = 1 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

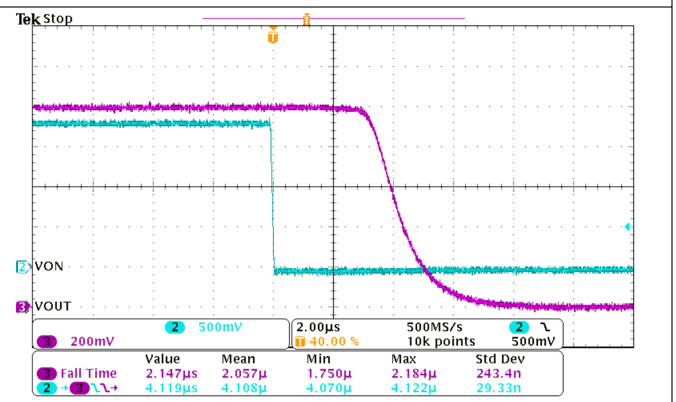


图 35. Turn-Off Response Time (V_{IN} = 1 V, C_{IN} = 1 µF, C_{OUT} = 0.1 µF, R_{OUT} = 10 Ω)

9 Parametric Measurement Information

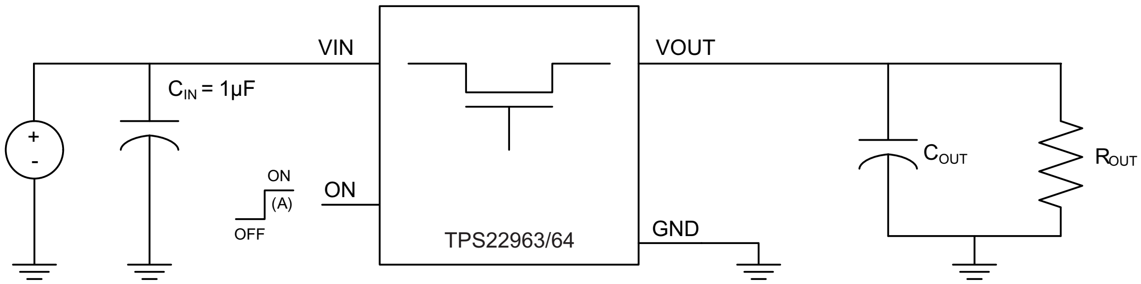
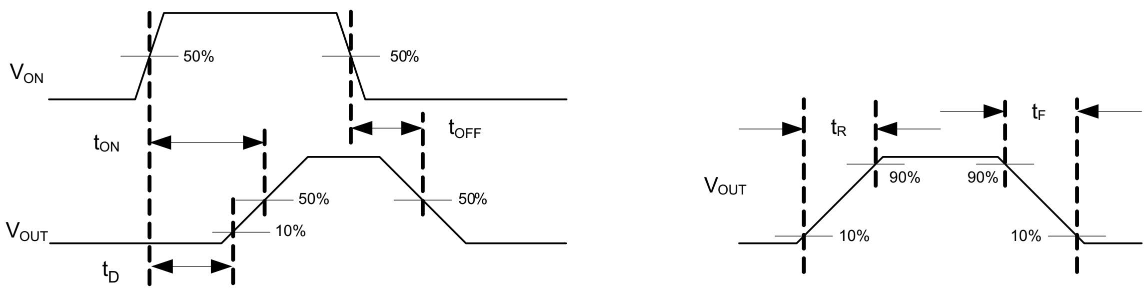


图 36. Test Circuit



A. Rise and fall times of the control signal are 100 ns.

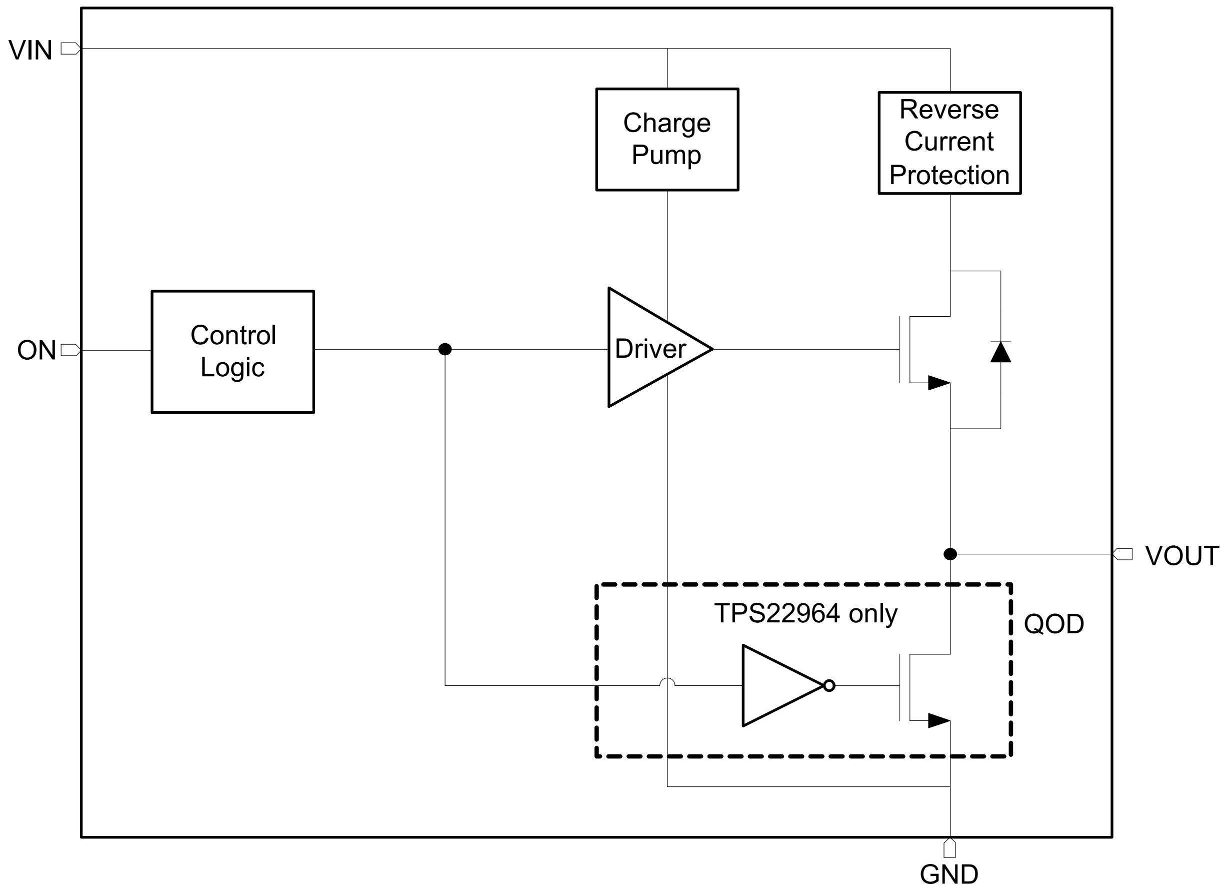
图 37. Timing Waveforms

10 Detailed Description

10.1 Overview

The TPS22963/64 is a single channel, 3-A load switch in a small, space saving CSP-6 package. These devices implement an N-channel MOSFET to provide an ultra-low On-resistance for a low voltage drop across the device. A controlled rise time is used in applications to limit the inrush current.

10.2 Functional Block Diagram



10.3 Feature Description

10.3.1 On/Off Control

The ON pin controls the state of the switch. It is an active "High" pin and has a low threshold making it capable of interfacing with low voltage GPIO control signals. It can be used with any microcontroller with 1.2 V, 1.8 V, 2.5 V, 3.3 V or 5.5 V GPIOs. Applying V_{IH} on the ON pin will put the switch in the ON-state and V_{IL} will put the switch in the OFF-state.

10.3.2 Quick Output Discharge

The TPS22964 includes the Quick Output Discharge (QOD) feature. When the switch is disabled, a discharge resistance with a typical value of 273Ω is connected between the output and ground. This resistance pulls down the output and prevents it from floating when the device is disabled.

10.4 Device Functional Modes

表 1. Function Table

ON	VIN to VOUT	OUTPUT DISCHARGE(1) (2)
L	OFF	ACTIVE
H	ON	DISABLED

(1) This feature discharges the output of the switch to ground through a 273 Ω resistor, preventing the output from floating.
(2) This feature is in the TPS22964 device only (not in the TPS22963).

11 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. Customers should validate and test their design implementation to confirm system functionality.

11.1 Application Information

11.1.1 Input Capacitor

It is recommended to place a capacitor (C_{IN}) between VIN and GND pins of TPS22963/64. This capacitor helps to limit the voltage drop on the input voltage supply when the switch turns ON into a discharged load capacitor. A 1-µF ceramic capacitor that is placed close to the IC pins is usually sufficient. Higher values of C_{IN} can be used to further reduce the voltage drop in high current applications.

11.1.2 Output Capacitor

It is recommended to place a capacitor (C_{OUT}) between VOUT and GND pins of TPS22963/64. This capacitor acts as a low pass filter along with the switch ON-resistance to remove any voltage glitches coming from the input voltage source. It is generally recommended to have C_{IN} greater than C_{OUT} so that once the switch is turned ON, C_{OUT} can charge up to V_{IN} without V_{IN} dropping significantly. A 0.1-µF ceramic capacitor that is placed close to the IC pins is usually sufficient.

Application Information (接下页)

11.1.3 Standby Power Reduction

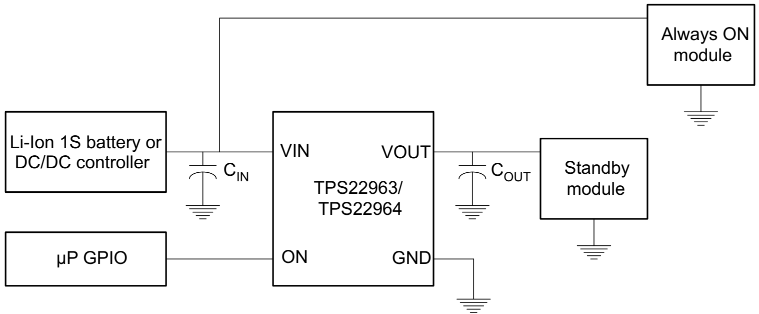


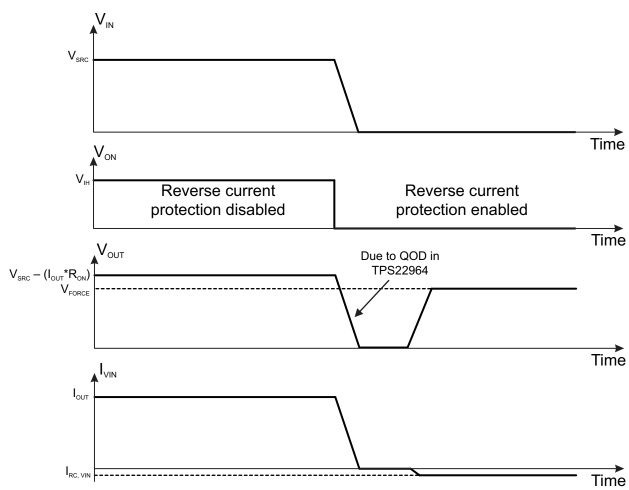
图 38. Standby Power Reduction

Any end equipment that is being powered from the battery has a need to reduce current consumption in order to keep the battery charged for a longer time. TPS22963/64 helps to accomplish this by turning off the supply to the modules that are in standby state and hence significantly reduces the leakage current overhead of the standby modules.

11.1.4 Reverse Current Protection

The reverse current protection feature prevents the current to flow from VOUT to VIN when TPS22963/64 is disabled. This feature is particularly useful when the output of TPS22963/64 needs to be driven by another voltage source after TPS22963/64 is disabled (for example in a power multiplexer application). In order for this feature to work, TPS22963/64 has to be disabled and either of the following conditions shall be met: V_{IN} > 1 V or V_{OUT} > 1 V.

图 39 demonstrates the ideal behavior of reverse current protection circuit in TPS22963/64. After the device is disabled via the ON pin and VOUT is forced to an external voltage V_{FORCE}, a very small amount of current given by $I_{RC,VIN}$ will flow from VOUT to VIN. This will prevent any extra current loading on the voltage source supplying the V_{FORCE} voltage.



I_{VIN} = Current through VIN pin.

V_{SRC} = Input voltage applied to the device.

V_{FORCE} = External voltage source forced at VOUT pin of the device.

I_{OUT} = Output load current.

图 39. Reverse Current Protection

Application Information (接下页)

11.1.5 Power Supply Sequencing Without a GPIO Input

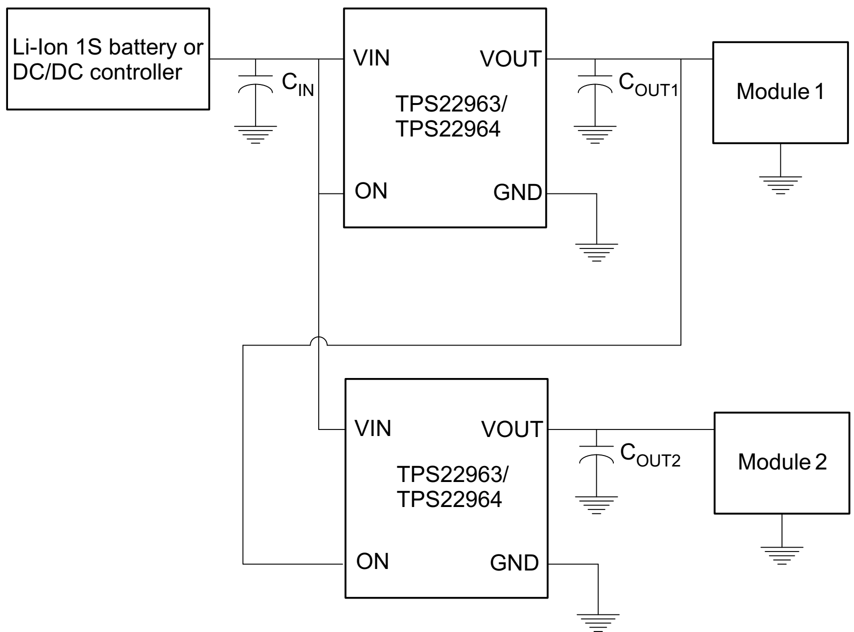


图 40. Power Supply Sequencing Without a GPIO Input

In many end equipments, there is a need to power up various modules in a pre-determined manner. TPS22963/64 can solve the problem of power sequencing without adding any complexity to the overall system. 图 40 shows the configuration required for powering up two modules in a fixed sequence. The output of the first load switch is tied to the enable of the second load switch, so when Module 1 is powered the second load switch is enabled and Module 2 is powered.

11.2 Typical Application

TPS22963/64 is an ultra-low ON-resistance, 3-A integrated load switch that is capable of interfacing directly with 1S battery in portable consumer devices such as smartphones, tablets etc. Its wide input voltage range (1 V to 5.5 V) makes it suitable to be used for lower voltage rails as well inside different end equipments to accomplish power sequencing, inrush current control and reducing leakage current in sub-systems that are in standby mode. 图 41 shows the typical application circuit of TPS22963/64.

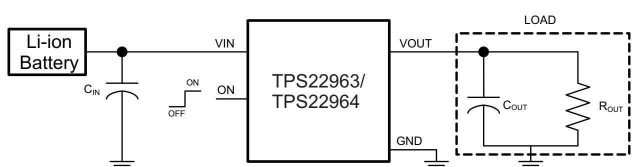


图 41. Typical Application Circuit

11.2.1 Design Requirements

DESIGN PARAMETER	EXAMPLE VALUE
V_{IN}	3.3 V
C_L	4.7 µF
Maximum Acceptable Inrush Current	30 mA

11.2.2 Detailed Design Procedure

11.2.2.1 Managing Inrush Current

When the switch is enabled, the output capacitors must be charged up from 0 V to the set value (3.3 V in this example). This charge arrives in the form of inrush current. Inrush current can be calculated using the following equation:

$$I_{INRUSH} = C_L \times \frac{dV_{OUT}}{dt}$$

where

- C = output capacitance
- dV = output voltage
- dt = rise time (1)

The TPS22963/64 offers a controlled rise time for minimizing inrush current. This device can be selected based upon the minimum acceptable rise time which can be calculated using the design requirements and the inrush current equation. An output capacitance of 4.7 µF will be used since the amound of inrush current increases with output capacitance:

30 mA = 4.7 µF x 3.3 V / dt (2)

dt = 517 µs (3)

To ensure an inrush current of less than 30 mA, a device with a rise time greater than 517 µs must be used. The TPS22963/64 has a typical rise time of 715 µs at 3.3 V which meets the above design requirements.

11.2.3 Application Curves

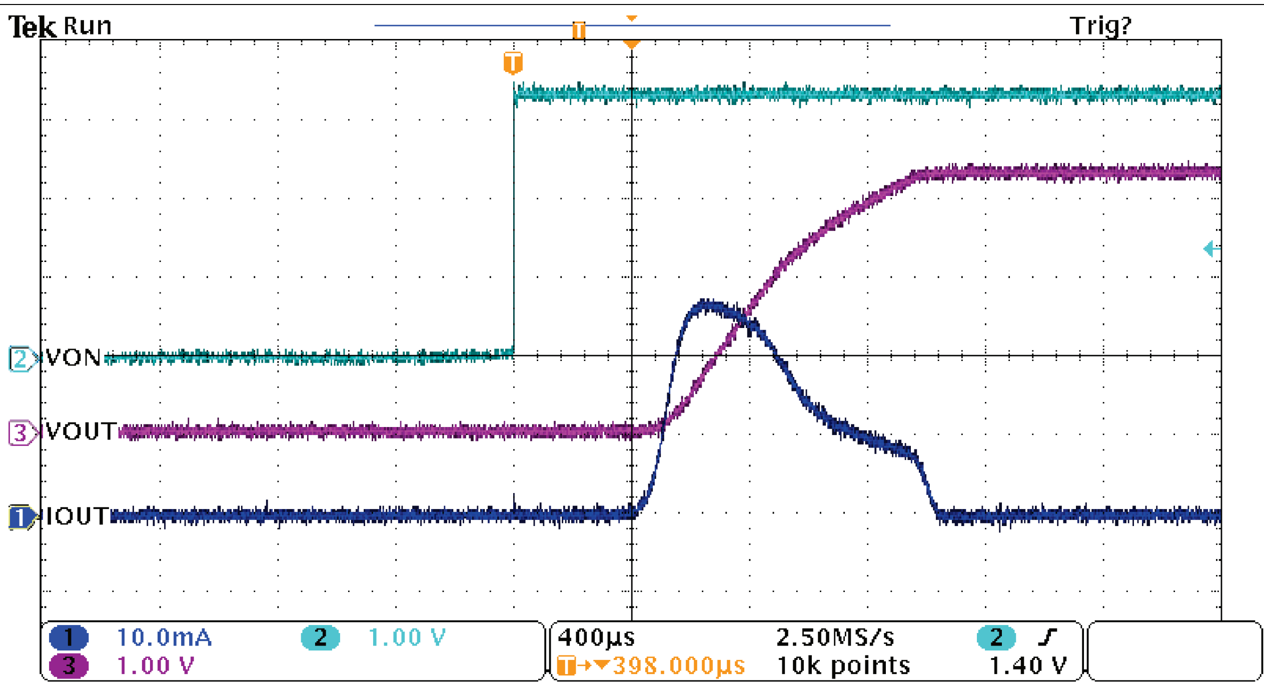


图 42. TPS22963/64 Inrush Current with 4.7 µF Output Capacitor

12 Power Supply Recommendations

The device is designed to operate with a VIN range of 1 V to 5.5 V. This supply must be well regulated and placed as close to the device terminal as possible with the recommended 1 µF bypass capacitor. If the supply is located more than a few inches from the device terminals, additional bulk capacitance may be required in addition to the ceramic bypass capacitors. If additional bulk capacitance is required, an electrolytic, tantalum, or ceramic capacitor of 10 µF may be sufficient

13 Layout

13.1 Layout Guidelines

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

For higher reliability, the maximum IC junction temperature, $T_{J(max)}$, should be restricted to 125˚C under normal operating conditions. Junction temperature is directly proportional to power dissipation in the device and the two are related by 公式 4.

$$T_J = T_A + \Theta_{JA} \times P_D \quad (4)$$

where
- T_J = Junction temperature of the device
- T_A = Ambient temperature
- P_D = Power dissipation inside the device
- Θ_{JA} = Junction to ambient thermal resistance. See Thermal Information section of the datasheet. This parameter is highly dependent on board layout.

13.2 Layout Example

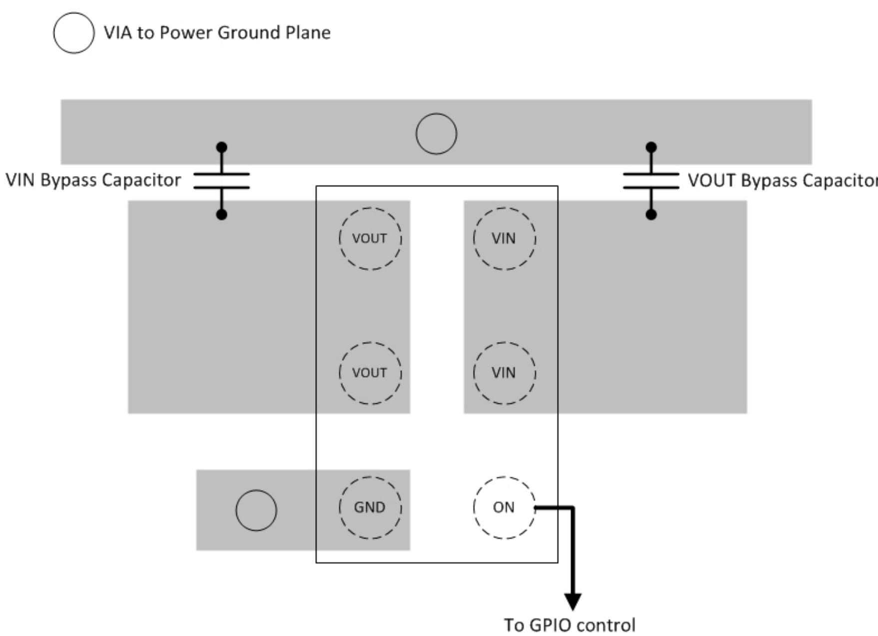


图 43. Layout Example

14 器件和文档支持

14.1 相关链接

以下表格列出了快速访问链接。 范围包括技术文档、支持与社区资源、工具和软件，并且可以快速访问样片或购买链接。

表 **2.** 相关链接

器件	产品文件夹	样片与购买	技术文档	工具与软件	支持与社区
TPS22963C	请单击此处	请单击此处	请单击此处	请单击此处	请单击此处
TPS22964C	请单击此处	请单击此处	请单击此处	请单击此处	请单击此处

14.2 商标

超极本 is a trademark of Intel Corporation in the U.S. and/or other countries.
All other trademarks are the property of their respective owners.

14.3 静电放电警告

这些装置包含有限的内置 ESD 保护。 存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

14.4 术语表

SLYZ022 — *TI 术语表*。

这份术语表列出并解释术语、首字母缩略词和定义。

15 机械封装和可订购信息

以下页中包括机械封装和可订购信息。 这些信息是针对指定器件可提供的最新数据。 这些数据会在无通知且不对本文档进行修订的情况下发生改变。 欲获得该数据表的浏览器版本，请查阅左侧的导航栏。

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
TPS22963CYZPR	ACTIVE	DSBGA	YZP	6	3000	RoHS & Green	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BD	Samples
TPS22963CYZPT	ACTIVE	DSBGA	YZP	6	250	RoHS & Green	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BD	Samples
TPS22964C2YZPR	ACTIVE	DSBGA	YZP	6	6000	RoHS & Green	SNAGCU	Level-1-260C-UNLIM	-40 to 85	DK	Samples
TPS22964CYZPR	ACTIVE	DSBGA	YZP	6	3000	RoHS & Green	SNAGCU	Level-1-260C-UNLIM	-40 to 85	DK	Samples
TPS22964CYZPT	ACTIVE	DSBGA	YZP	6	250	RoHS & Green	SNAGCU	Level-1-260C-UNLIM	-40 to 85	DK	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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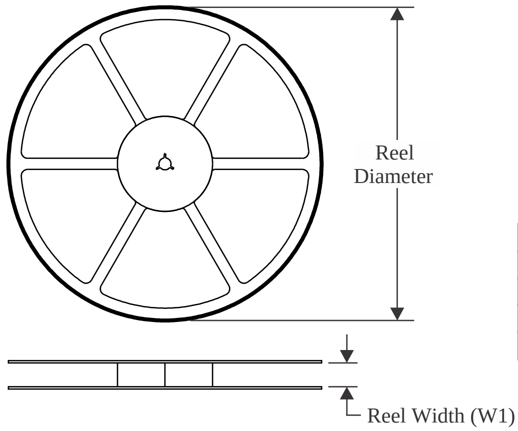
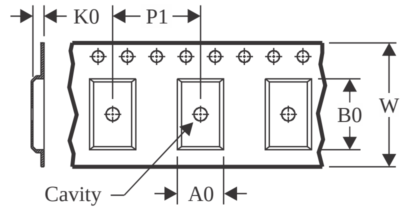
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

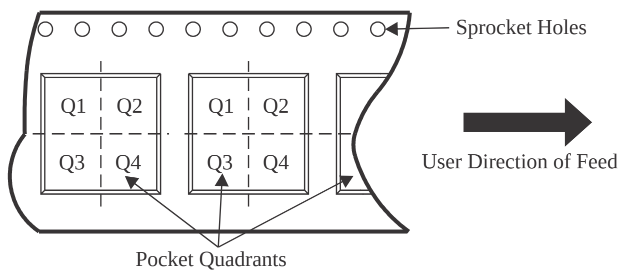


TAPE DIMENSIONS



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

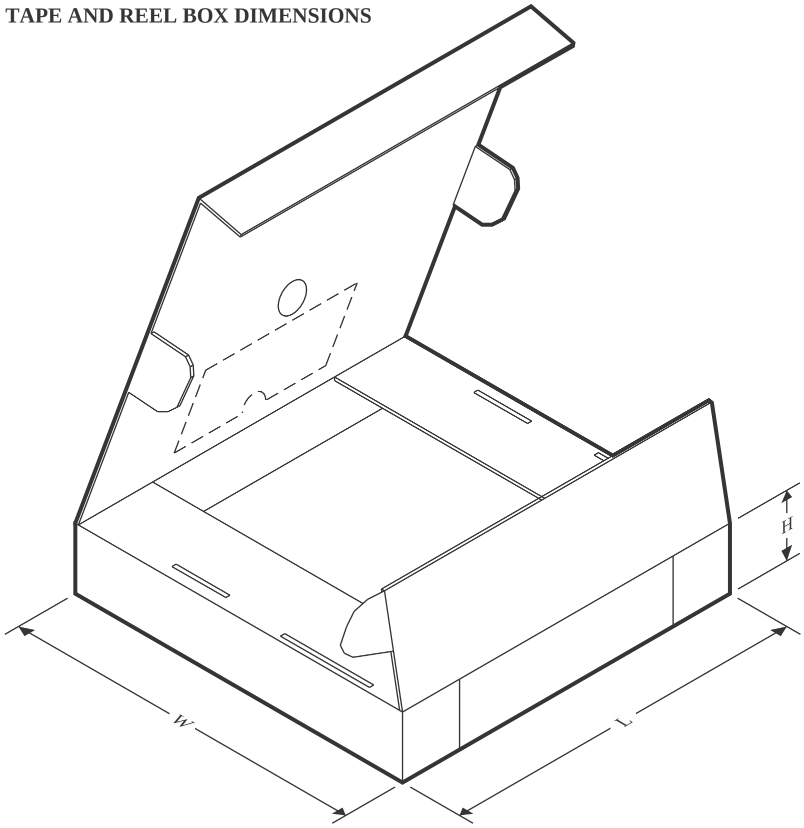
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS22963CYZPR	DSBGA	YZP	6	3000	180.0	8.4	1.04	1.54	0.56	4.0	8.0	Q1
TPS22963CYZPT	DSBGA	YZP	6	250	180.0	8.4	1.04	1.54	0.56	4.0	8.0	Q1
TPS22964C2YZPR	DSBGA	YZP	6	6000	180.0	8.4	1.04	1.57	0.6	2.0	8.0	Q1
TPS22964CYZPR	DSBGA	YZP	6	3000	180.0	8.4	1.04	1.54	0.56	4.0	8.0	Q1
TPS22964CYZPR	DSBGA	YZP	6	3000	180.0	8.4	1.04	1.57	0.6	4.0	8.0	Q1
TPS22964CYZPT	DSBGA	YZP	6	250	180.0	8.4	1.04	1.57	0.6	4.0	8.0	Q1
TPS22964CYZPT	DSBGA	YZP	6	250	180.0	8.4	1.04	1.54	0.56	4.0	8.0	Q1

TAPE AND REEL BOX DIMENSIONS



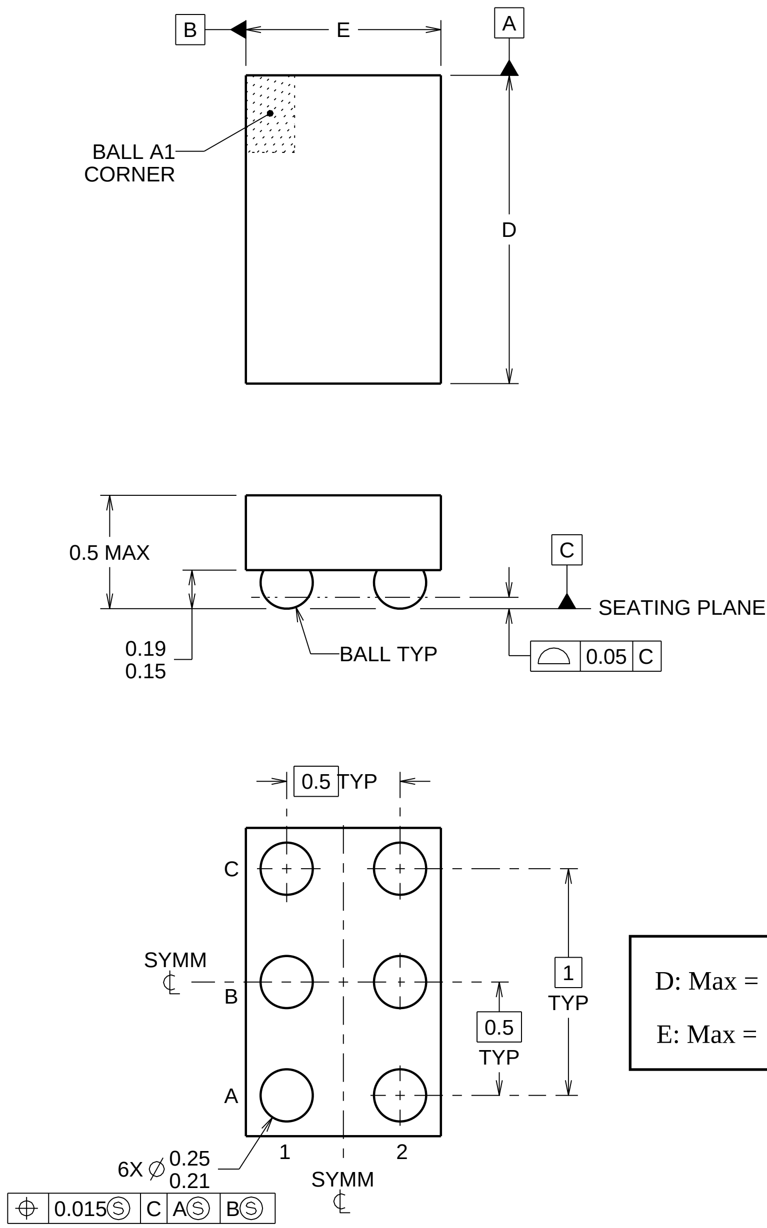
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS22963CYZPR	DSBGA	YZP	6	3000	182.0	182.0	20.0
TPS22963CYZPT	DSBGA	YZP	6	250	182.0	182.0	20.0
TPS22964C2YZPR	DSBGA	YZP	6	6000	182.0	182.0	20.0
TPS22964CYZPR	DSBGA	YZP	6	3000	182.0	182.0	20.0
TPS22964CYZPR	DSBGA	YZP	6	3000	182.0	182.0	20.0
TPS22964CYZPT	DSBGA	YZP	6	250	182.0	182.0	20.0
TPS22964CYZPT	DSBGA	YZP	6	250	182.0	182.0	20.0

YZP0006

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



D: Max = 1.472 mm, Min =1.412 mm

E: Max = 0.972 mm, Min =0.912 mm

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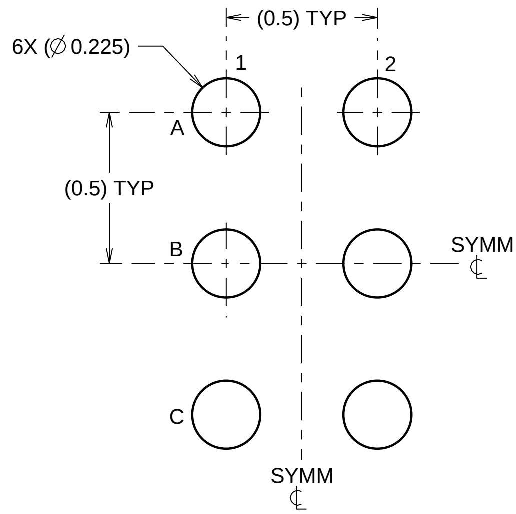
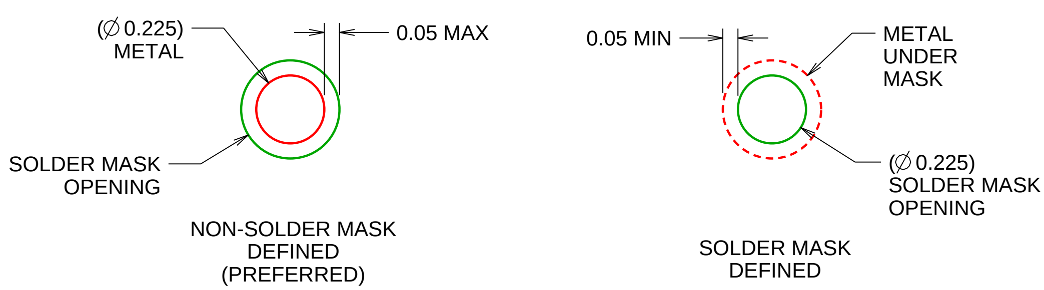
NOTES:

NanoFree Is a trademark of Texas Instruments.

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. NanoFree™ package configuration.



LAND PATTERN EXAMPLE
SCALE:40X



SOLDER MASK DETAILS
NOT TO SCALE

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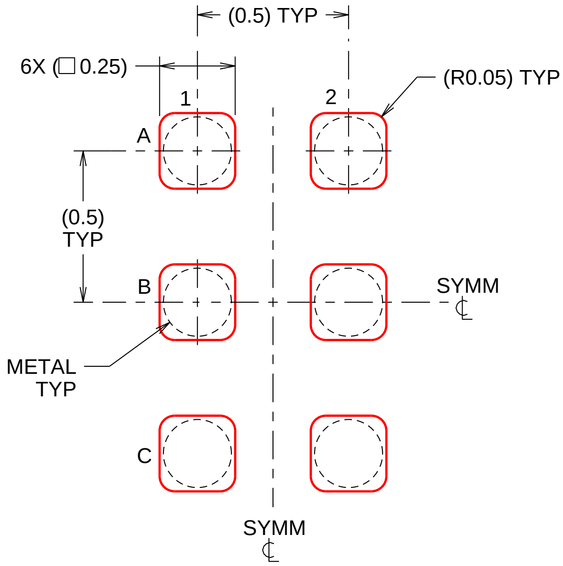
NOTES: (continued)

4. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints.
For more information, see Texas Instruments literature number SBVA017 (www.ti.com/lit/sbva017).



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

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NOTES: (continued)

5. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

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