TPS2290x 具有受控开通功能的 3.6V、500mA、78mΩ 导通电阻负载开关

1 特性

- 集成 P 沟道负载开关
- 低输入电压：1V 至 3.6V
- 导通电阻（典型值）
  - V_{IN} = 3.6V 时，r_{ON} = 78mΩ
  - V_{IN} = 2.5V 时，r_{ON} = 93mΩ
  - V_{IN} = 1.8V 时，r_{ON} = 109mΩ
  - V_{IN} = 1.2V 时，r_{ON} = 146mΩ
- 500mA 最大持续开关电流
- 静态电流：1.8V 时为 82nA
- 关断电流：1.8V 时为 44nA
- 低控制输入阈值支持使用 1.2V、1.8V、2.5V 和 3.3V 逻辑
- 受控转换率，可避免浪涌电流
  - V_{IN} = 1.8V 时 t_r = 40 μs (TPS22901/2)
  - V_{IN} = 1.8V 时 t_r = 220 μs (TPS22902B)
- 快速输出放电 (TPS22902/2B)
- ESD 性能测试符合 JESD 22 标准
  - 2000V 人体放电模型{42}（A114-B，II 类）
  - 1000V 充电器件模型 (C101)
- 四引脚晶圆芯片级 DSBGA 封装
  - 0.8mm × 0.8mm，间距 0.4mm，高 0.5mm (YFP)

2 应用

- 个人数字助理 (PDA)
- 手机
- 全球卫星定位 (GPS) 设备
- MP3 播放器
- 数码照相机
- 外设端口
- 便携式仪表
- 射频模块

3 说明

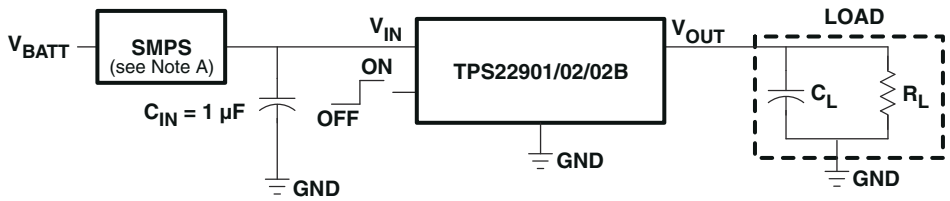
TPS22901、TPS22902 和 TPS22902B 是具有受控开通功能的小型低导通电阻 (r_{ON}) 负载开关。这些器件包含一个 P 沟道 MOSFET，该 MOSFET 可在 1.0V 至 3.6V 的输入电压范围内运行。此开关由一个导通/关断输入 (ON) 控制，可与低电压控制信号直接连接。在 TPS22902 和 TPS22902B 中添加了一个 88Ω 片上负载电阻器，用于在开关关闭时进行快速输出放电。

TPS22901、TPS22902 和 TPS22902B 采用节省空间的 0.4mm 间距 4 引脚 DSBGA (YFP) 封装。这些器件在自然通风环境下的额定运行温度范围为 –40°C 至 85°C。

器件信息

器件型号	封装(1)	封装尺寸（标称值）
TPS22901	DSBGA (4)	0.80mm × 0.80mm
TPS22902		
TPS22902B		

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。



A. 开关模式电源

典型应用原理图

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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

Changes from Revision D (January 2015) to Revision E (September 2020) **Page**

- 更新了整个文档的表、图和交叉参考的编号格式。 1

Changes from Revision C (December 2012) to Revision D (January 2015) **Page**

- 添加了 *ESD 等级* 表、*特性说明* 部分、*器件功能模式*、*应用和实现* 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
- Deleted the *ORDERING INFORMATION* table 3

Changes from Revision B (March 2009) to Revision C (December 2012) **Page**

- Changed the *ORDERING INFORMATION* table 3

5 Device Comparison Table

	R_{ON} at 1.8 V (TYP)	RISE TIME (TYP at 1.8 V)	QUICK OUTPUT DISCHARGE(1)	MAX OUTPUT CURRENT	ENABLE
TPS22901	109 mΩ	40 µs	No	500 mA	Active high
TPS22902			Yes		
TPS22902B		220 µs	Yes		

(1) This feature discharges the output of the switch to ground through an 88 Ω resistor, preventing the output from floating.

6 Pin Configuration and Functions

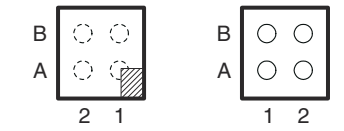


图 6-1. YFP Package 4-Pin DSBGA

Pin Assignments

B	ON	GND
A	V_{IN}	V_{OUT}
	2	**1**

Pin Functions

PIN		I/O	DESCRIPTION
NO.	NAME		
A1	V_{OUT}	O	Switch output
A2	V_{IN}	I	Switch input, bypass this input with a ceramic capacitor to ground
B1	GND	-	Ground
B2	ON	I	Switch control input, active high

7 Specifications

7.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V_{IN}	Input voltage	–0.3	4	V
V_{OUT}	Output voltage		V_{IN} + 0.3	V
V_{ON}	Input voltage	–0.3	4	V
P	Power dissipation at T_A = 25°C		0.48	W
I_{MAX}	Maximum continuous switch current		500	mA
T_A	Operating free-air temperature	–40	85	°C
T_{lead}	Maximum lead temperature (10-s soldering time)		300	°C
T_{stg}	Storage temperature	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under 节 7.3. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

7.2 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)	±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.

7.3 Recommended Operating Conditions

		MIN	MAX	UNIT
V_{IN}	Input voltage	1	3.6	V
V_{OUT}	Output voltage		V_{IN}	V
V_{IH}	High-level input voltage, ON	0.85	3.6	V
V_{IL}	Low-level input voltage, ON		0.4	V
C_{IN}	Input capacitor	See (1)		μF

(1) See 节 10.1.1.

7.4 Thermal Information

THERMAL METRIC(1)		TPS2290X YFP (DSBGA) 4 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	192.1	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	2.3	
$R_{\theta JB}$	Junction-to-board thermal resistance	35.8	
ψ_{JT}	Junction-to-top characterization parameter	11.8	
ψ_{JB}	Junction-to-board characterization parameter	35.6	

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

7.5 Electrical Characteristics

V_{IN} = 1.0 V to 3.6 V, T_A = –40°C to 85°C (unless otherwise noted). Typical values are for T_A = 25°C

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
I_Q	Quiescent current	I_{OUT} = 0, V_{IN} = V_{ON}	V_{IN} = 1.1 V	Full		37	120	nA
			V_{IN} = 1.8 V	Full		82	235	
			V_{IN} = 3.6 V	Full		204	880	
$I_{IN(OFF)}$	OFF-state supply current	V_{ON} = GND, V_{OUT} = Open	V_{IN} = 1.1 V	Full		22	210	nA
			V_{IN} = 1.8 V	Full		44	260	
			V_{IN} = 3.6 V	Full		137	700	
$I_{IN(LEAKAGE)}$	OFF-state switch current	V_{ON} = GND, V_{OUT} = 0 V	V_{IN} = 1.1 V	Full		22	140	nA
			V_{IN} = 1.8 V	Full		45	230	
			V_{IN} = 3.6 V	Full		137	610	
r_{ON}	ON-state resistance	I_{OUT} = - 200 mA	V_{IN} = 3.6 V	25°C		78	95	mΩ
				Full			95	
			V_{IN} = 2.5 V	25°C		93	110	
				Full			110	
			V_{IN} = 1.8 V	25°C		109	130	
				Full			130	
			V_{IN} = 1.2 V	25°C		146	200	
				Full			200	
			V_{IN} = 1.1 V	25°C		174	330	
				Full			330	
r_{PD}	Output pulldown resistance	V_{IN} = 3.3 V, V_{ON} = 0, I_{OUT} = 30 mA (TPS22902/TPS22902B only)		25°C		88	120	Ω
I_{ON}	ON input leakage current	V_{ON} = 1.1 V to 3.6 V or GND		Full			25	nA

7.6 Switching Characteristics (V_{IN} = 1.1 V)

V_{IN} = 1.1 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TPS22901			TPS22902[1]			TPS22902B[1]			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω	C_L = 0.1 µF		108			108			531		µs
			C_L = 1 µF		131			131			596		
			C_L = 3.3 µF		153			153			659		
t_{OFF}	Turn-OFF time	R_L = 500 Ω	C_L = 0.1 µF		39			11			11		µs
			C_L = 1 µF		317			69			67		
			C_L = 3.3 µF		1105			238			225		
t_r	V_{OUT} rise time	R_L = 500 Ω	C_L = 0.1 µF		70			70			365		µs
			C_L = 1 µF		78			78			367		
			C_L = 3.3 µF		92			92			395		
t_f	V_{OUT} fall time	R_L = 500 Ω	C_L = 0.1 µF		107			18			21		µs
			C_L = 1 µF		966			175			189		
			C_L = 3.3 µF		3532			632			565		

(1) Quick Output Discharge

7.7 Switching Characteristics (V_{IN} = 1.2 V)

V_{IN} = 1.2 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TPS22901			TPS22902[1]			TPS22902B[1]			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω	C_L = 0.1 µF		96			96			471		µs
			C_L = 1 µF		116			116			527		
			C_L = 3.3 µF		135			135			587		
t_{OFF}	Turn-OFF time	R_L = 500 Ω	C_L = 0.1 µF		39			10			10		µs
			C_L = 1 µF		317			62			61		
			C_L = 3.3 µF		1110			210			199		
t_r	V_{OUT} rise time	R_L = 500 Ω	C_L = 0.1 µF		62			62			324		µs
			C_L = 1 µF		69			69			325		
			C_L = 3.3 µF		81			81			350		
t_f	V_{OUT} fall time	R_L = 500 Ω	C_L = 0.1 µF		109			17			20		µs
			C_L = 1 µF		995			163			175		
			C_L = 3.3 µF		3650			587			523		

(1) Quick Output Discharge

7.8 Switching Characteristics (V_{IN} = 1.8 V)

V_{IN} = 1.8 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TPS22901			TPS22902(1)			TPS22902B(1)			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω	C_L = 0.1 µF		61			61			302		µs
			C_L = 1 µF		72			72			335		
			C_L = 3.3 µF		83			83			367		
t_{OFF}	Turn-OFF time	R_L = 500 Ω	C_L = 0.1 µF		38			8			8		µs
			C_L = 1 µF		317			49			49		
			C_L = 3.3 µF		1135			169			167		
t_r	V_{OUT} rise time	R_L = 500 Ω	C_L = 0.1 µF		40			40			220		µs
			C_L = 1 µF		45			45			220		
			C_L = 3.3 µF		53			53			235		
t_f	V_{OUT} fall time	R_L = 500 Ω	C_L = 0.1 µF		111			15			15		µs
			C_L = 1 µF		1020			140			159		
			C_L = 3.3 µF		3700			517			481		

(1) Quick Output Discharge

7.9 Switching Characteristics (V_{IN} = 2.5 V)

V_{IN} = 2.5 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TPS22901			TPS22902(1)			TPS22902B(1)			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω	C_L = 0.1 µF		45			45			223		µs
			C_L = 1 µF		53			53			246		
			C_L = 3.3 µF		61			61			268		
t_{OFF}	Turn-OFF time	R_L = 500 Ω	C_L = 0.1 µF		38			7			7		µs
			C_L = 1 µF		314			46			47		
			C_L = 3.3 µF		1140			161			158		
t_r	V_{OUT} rise time	R_L = 500 Ω	C_L = 0.1 µF		32			32			175		µs
			C_L = 1 µF		35			35			175		
			C_L = 3.3 µF		41			41			187		
t_f	V_{OUT} fall time	R_L = 500 Ω	C_L = 0.1 µF		113			14			18		µs
			C_L = 1 µF		1040			139			185		
			C_L = 3.3 µF		3795			516			471		

(1) Quick Output Discharge

7.10 Switching Characteristics (V_{IN} = 3.0 V)

V_{IN} = 3.0 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TPS22901			TPS22902[1]			TPS22902B[1]			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω	C_L = 0.1 µF		38			38			191		µs
			C_L = 1 µF		45			45			211		
			C_L = 3.3 µF		53			53			231		
t_{OFF}	Turn-OFF time	R_L = 500 Ω	C_L = 0.1 µF		38			7			7		µs
			C_L = 1 µF		320			46			46		
			C_L = 3.3 µF		1145			53			156		
t_r	V_{OUT} rise time	R_L = 500 Ω	C_L = 0.1 µF		28			28			159		µs
			C_L = 1 µF		31			31			160		
			C_L = 3.3 µF		37			37			170		
t_f	V_{OUT} fall time	R_L = 500 Ω	C_L = 0.1 µF		114			14			17		µs
			C_L = 1 µF		1045			139			160		
			C_L = 3.3 µF		3815			509			473		

(1) Quick Output Discharge

7.11 Switching Characteristics (V_{IN} = 3.6 V)

V_{IN} = 3.6 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TPS22901			TPS22902[1]			TPS22902B[1]			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω	C_L = 0.1 µF		33			33			166		µs
			C_L = 1 µF		39			39			183		
			C_L = 3.3 µF		46			46			201		
t_{OFF}	Turn-OFF time	R_L = 500 Ω	C_L = 0.1 µF		38			7			7		µs
			C_L = 1 µF		322			46			45		
			C_L = 3.3 µF		1145			156			155		
t_r	V_{OUT} rise time	R_L = 500 Ω	C_L = 0.1 µF		25			25			146		µs
			C_L = 1 µF		28			28			146		
			C_L = 3.3 µF		34			34			156		
t_f	V_{OUT} fall time	R_L = 500 Ω	C_L = 0.1 µF		116			14			17		µs
			C_L = 1 µF		1060			139			161		
			C_L = 3.3 µF		3840			512			475		

(1) Quick Output Discharge

7.12 Typical Characteristics

7.12.1 Typical DC Characteristics

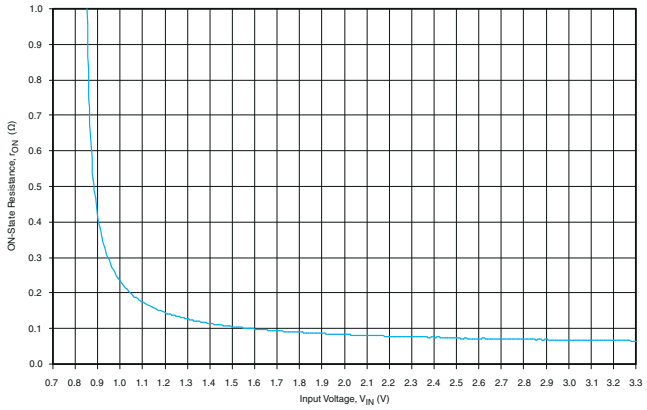


图 7-1. r_{ON} vs V_{IN}

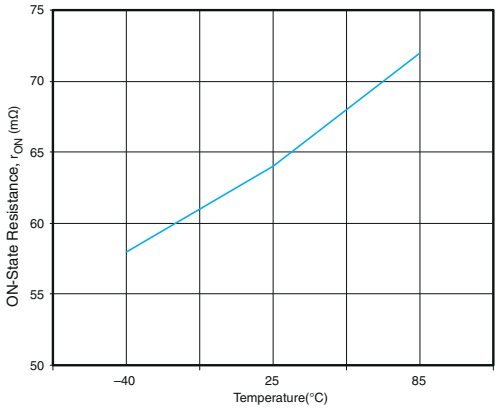


图 7-2. r_{ON} vs Temperature (V_{IN} = 3.3 V)

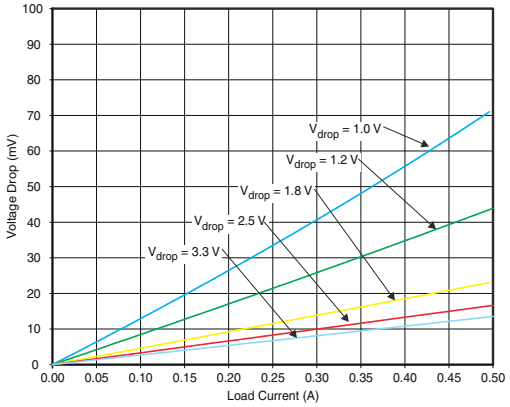


图 7-3. Voltage Drop vs. Load Current

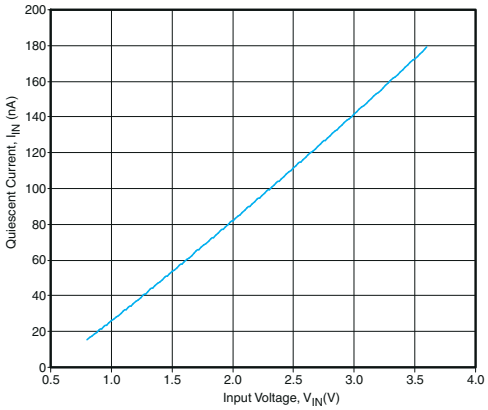


图 7-4. Quiescent Current vs V_{IN} (V_{ON} = V_{IN}, I_{OUT} = 0)

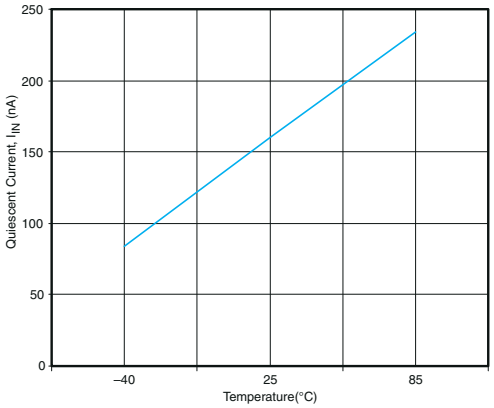


图 7-5. Quiescent Current vs Temperature (V_{IN} = 3.3 V, I_{OUT} = 0)

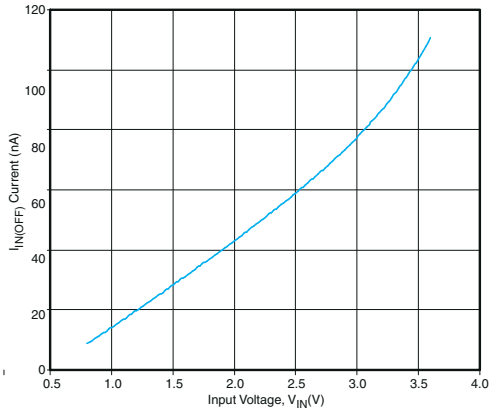


图 7-6. $I_{IN(OFF)}$ vs V_{IN} (V_{ON} = 0 V)

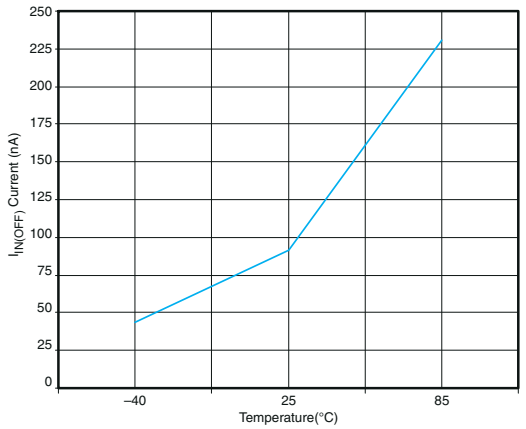


图 7-7. $I_{IN(OFF)}$ vs Temperature (V_{IN} = 3.3 V)

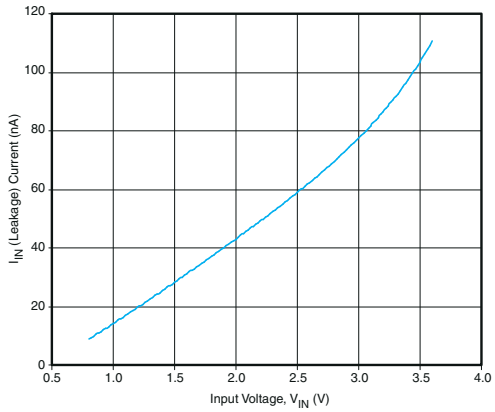


图 7-8. I_{IN}(Leakage) vs V_{IN} (I_{OUT} = 0)

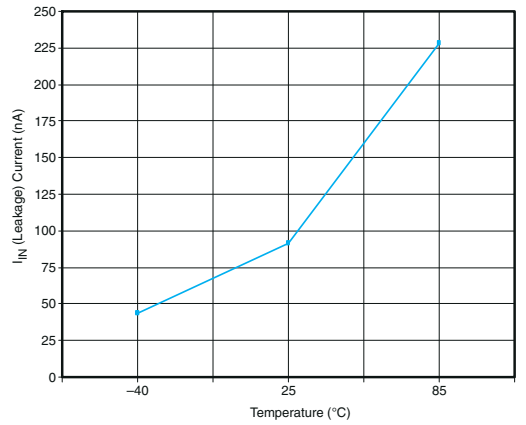


图 7-9. I_{IN} (Leakage) vs Temperature (V_{IN} = 3.3 V)

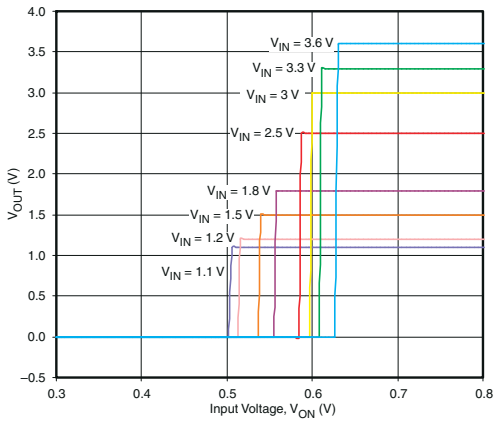


图 7-10. ON-Input Threshold

7.12.2 Typical AC Characteristics

7.12.2.1 TPS22901

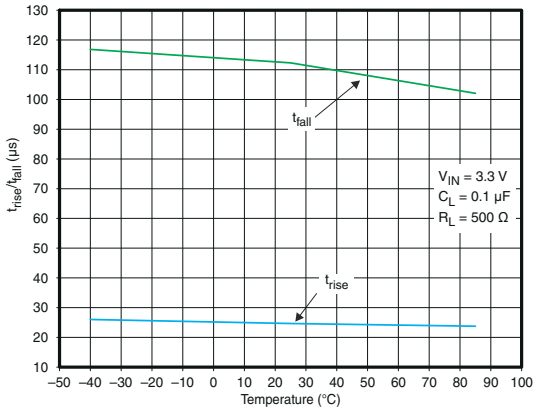


图 7-11. t_{rise}/t_{fall} vs Temperature

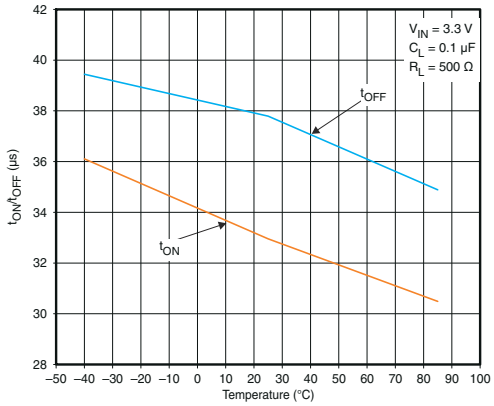


图 7-12. t_{ON}/t_{OFF} vs Temperature

7.12.2.2 TPS22902

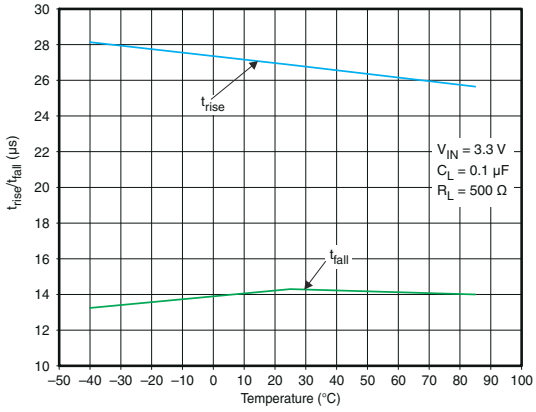


图 7-13. t_{rise}/t_{fall} vs Temperature

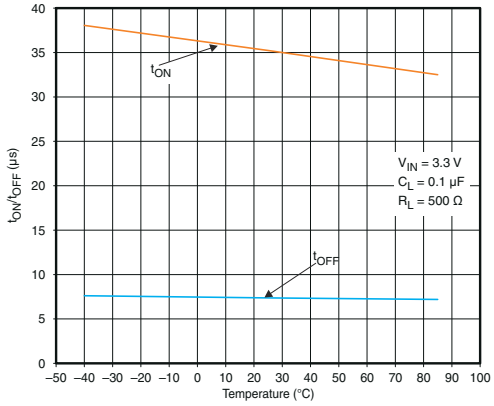


图 7-14. t_{ON}/t_{OFF} vs Temperature

7.12.2.3 TPS22902B

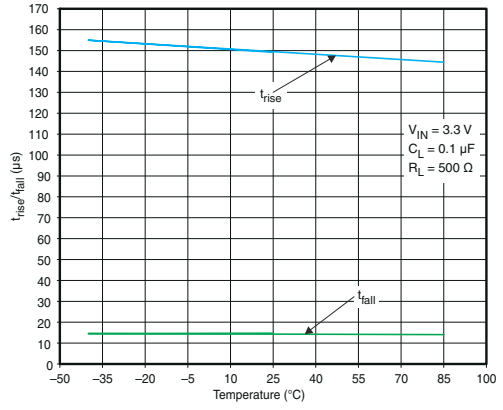


图 7-15. t_{rise}/t_{fall} vs Temperature

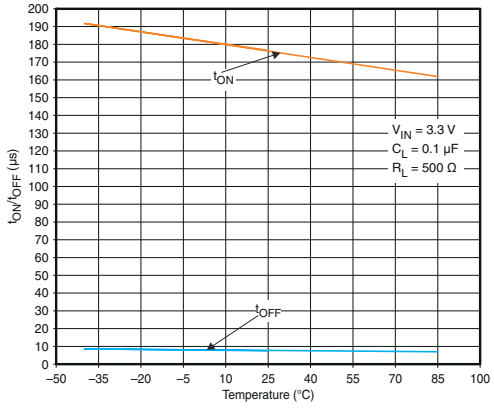


图 7-16. t_{ON}/t_{OFF} vs Temperature

7.12.2.4 TPS22901 and TPS22902

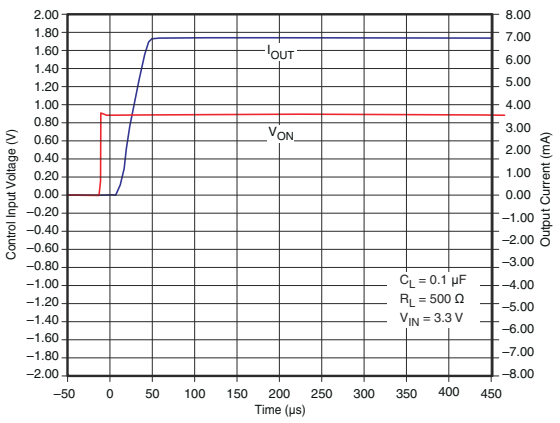


图 7-17. t_{ON} Response

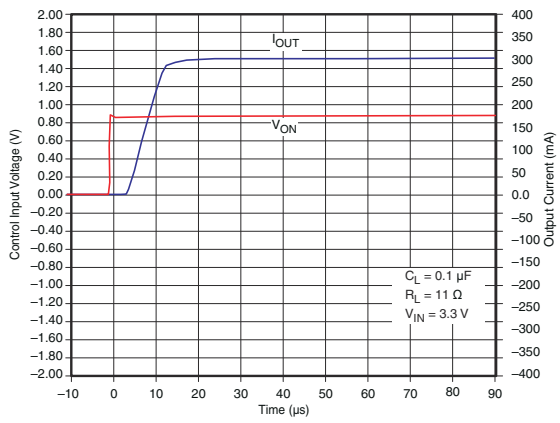


图 7-18. t_{ON} Response

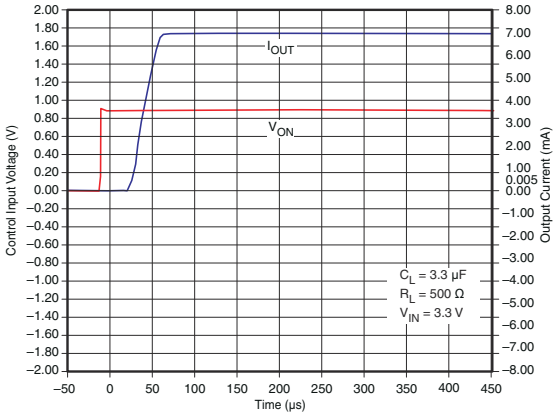


图 7-19. t_{ON} Response

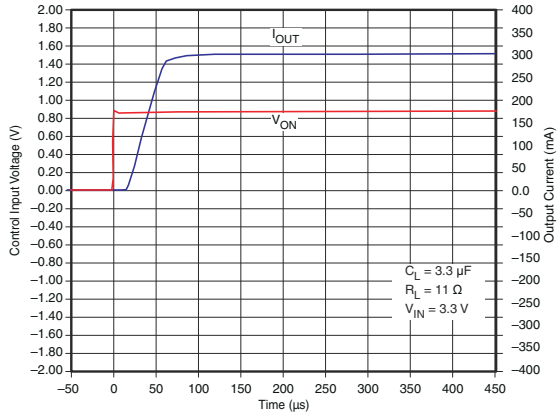


图 7-20. t_{ON} Response

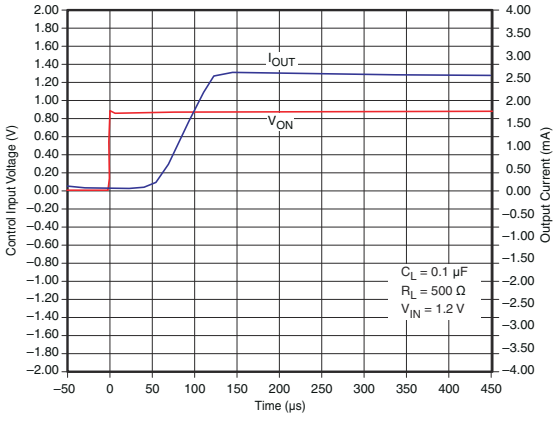


图 7-21. t_{ON} Response

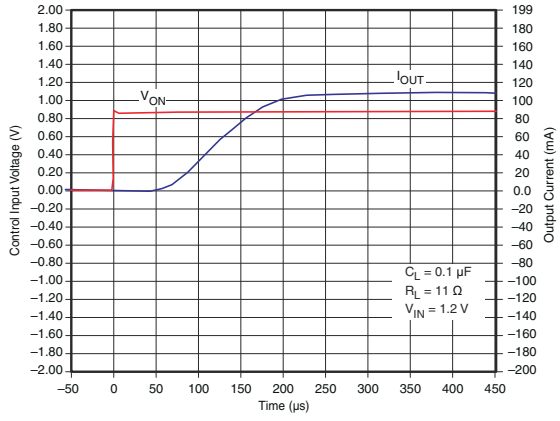


图 7-22. t_{ON} Response

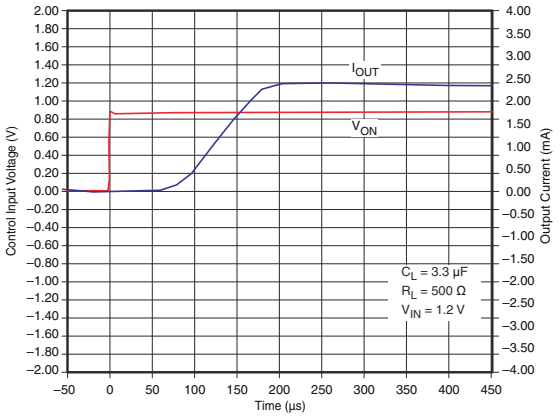


图 7-23. t_{ON} Response

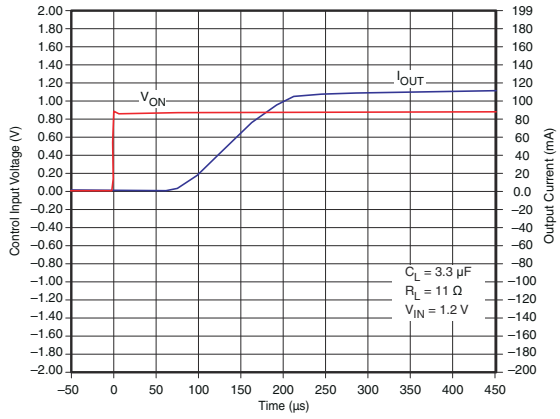


图 7-24. t_{ON} Response

7.12.2.5 TPS22901

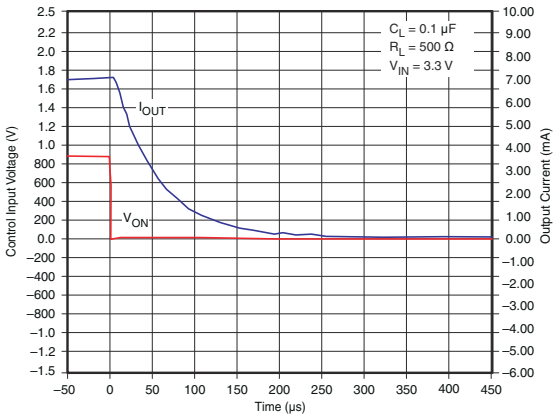


图 7-25. t_{OFF} Response

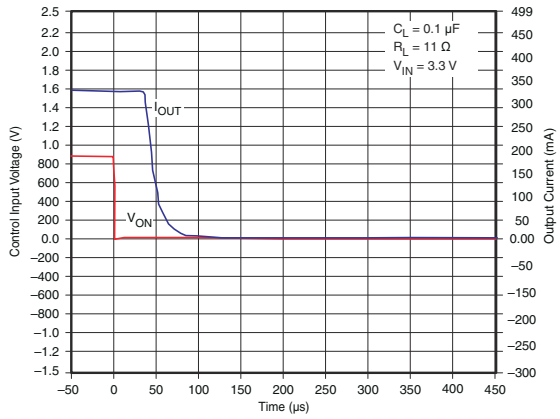


图 7-26. t_{OFF} Response

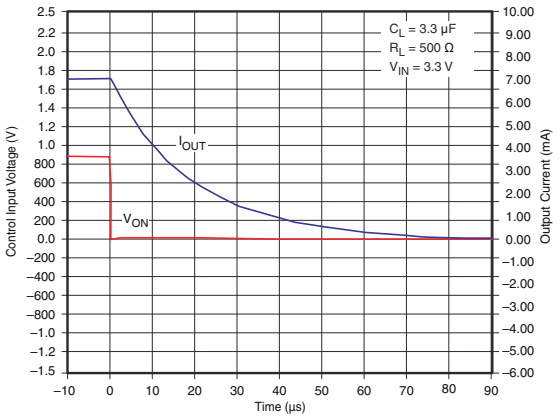


图 7-27. t_{OFF} Response

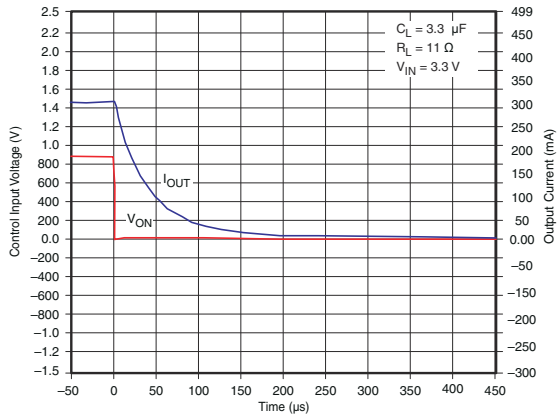


图 7-28. t_{OFF} Response

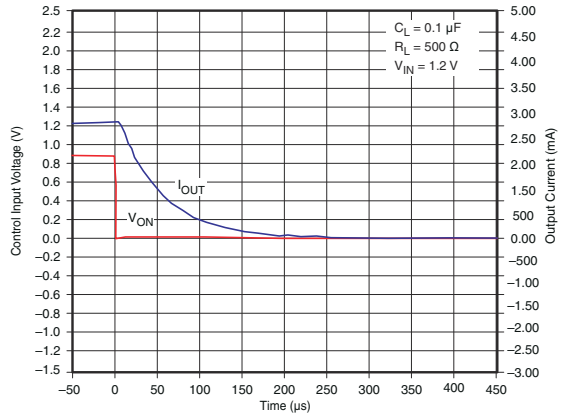


图 7-29. t_{OFF} Response

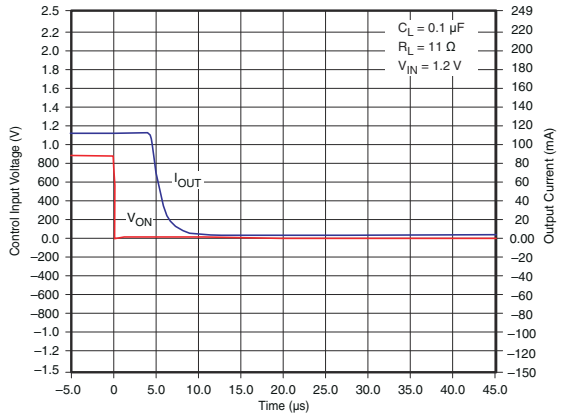


图 7-30. t_{OFF} Response

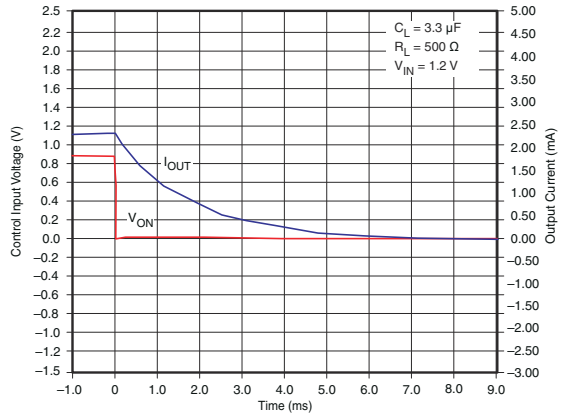


图 7-31. t_{OFF} Response

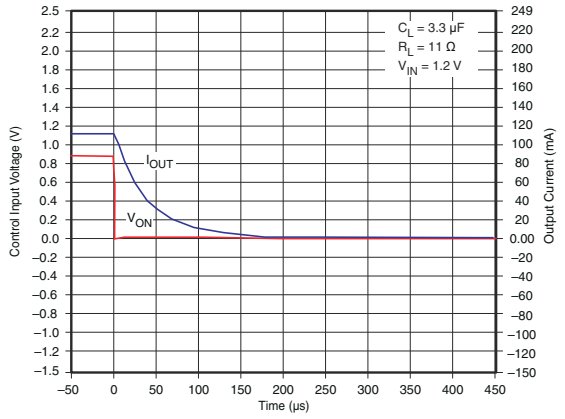


图 7-32. t_{OFF} Response

7.12.2.6 TPS22902

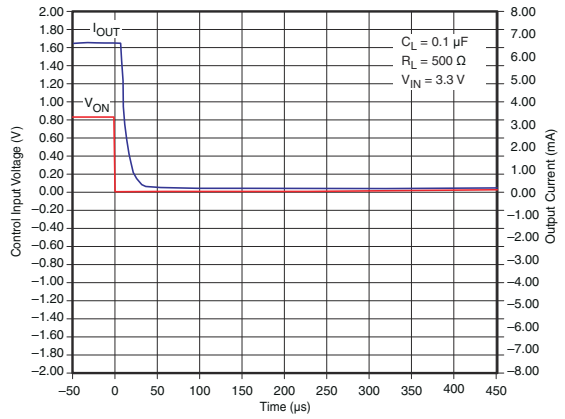


图 7-33. t_{OFF} Response

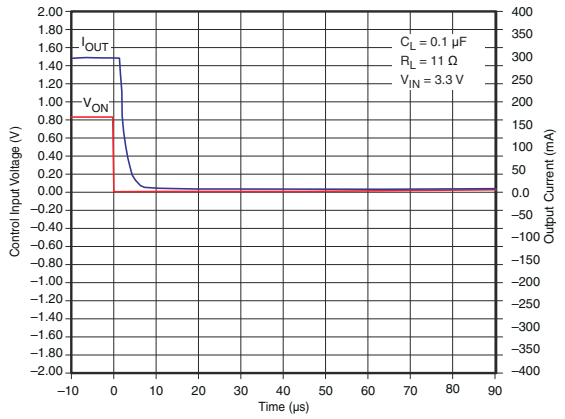


图 7-34. t_{OFF} Response

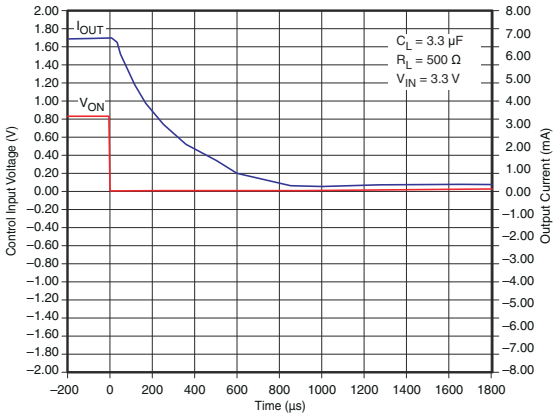


图 7-35. t_{OFF} Response

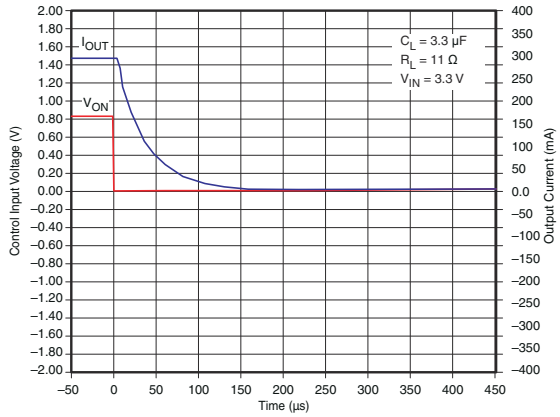


图 7-36. t_{OFF} Response

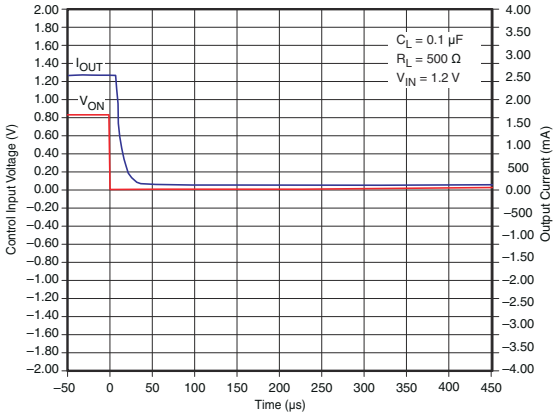


图 7-37. t_{OFF} Response

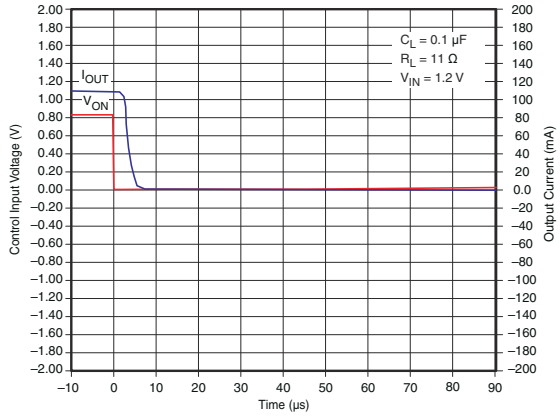


图 7-38. t_{OFF} Response

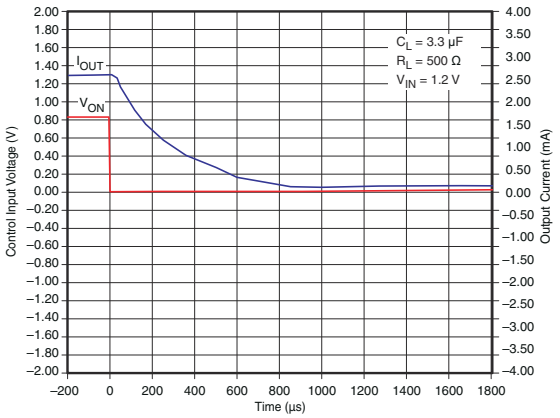


图 7-39. t_{OFF} Response

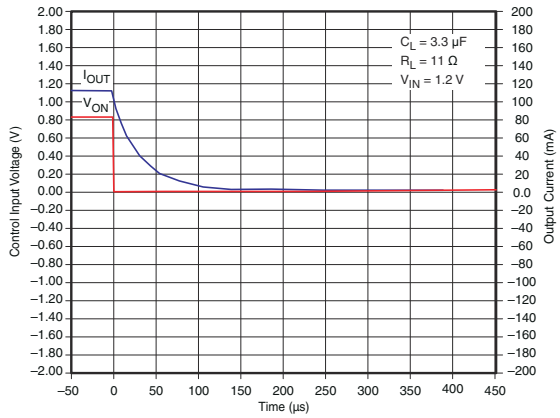


图 7-40. t_{OFF} Response

7.12.2.7 TPS22902B

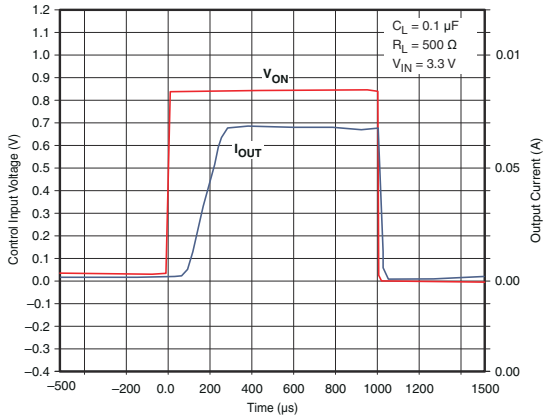


图 7-41. t_{ON} Response

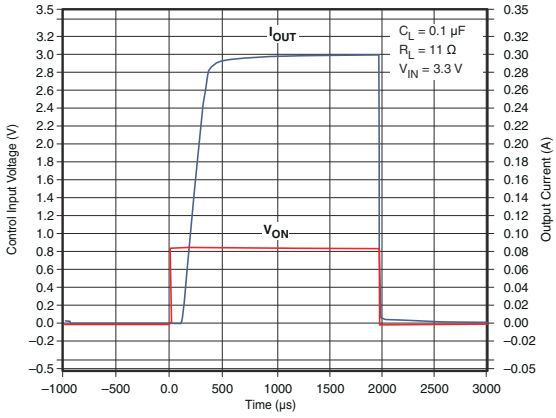


图 7-42. t_{ON} Response

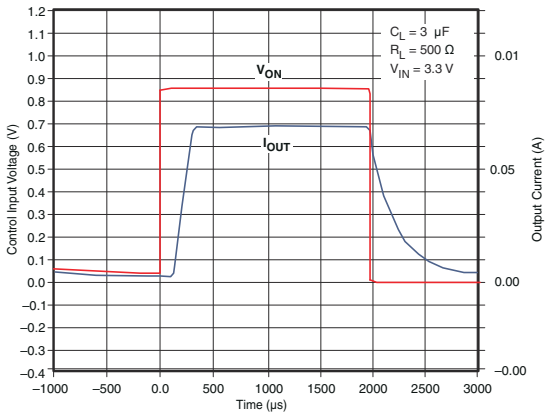


图 7-43. t_{ON} Response

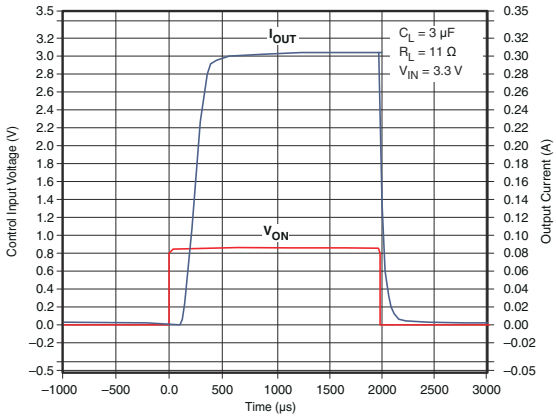


图 7-44. t_{ON} Response

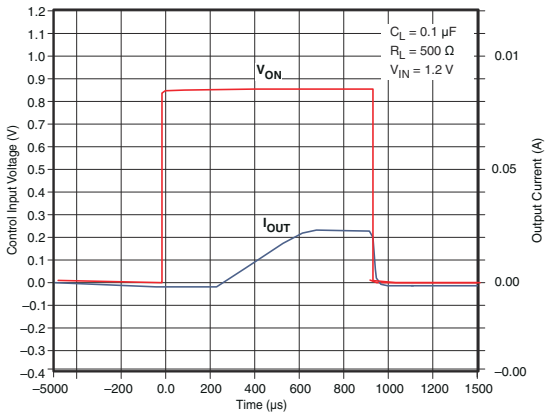


图 7-45. t_{ON} Response

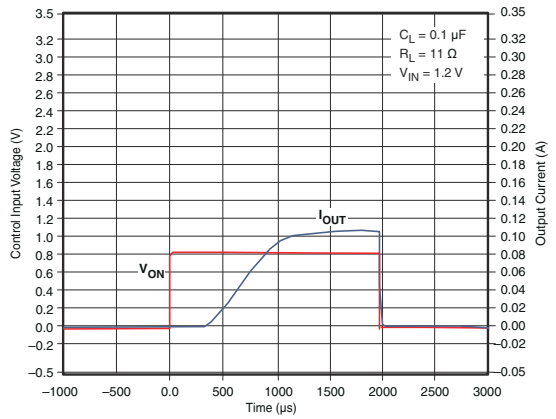


图 7-46. t_{ON} Response

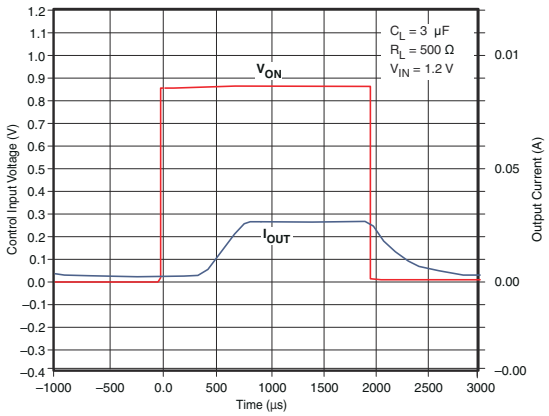


图 7-47. t_{ON} Response

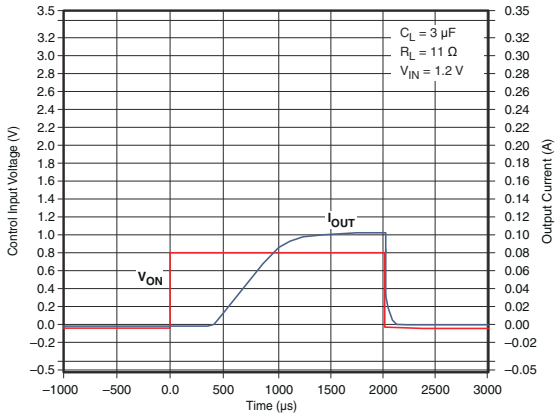


图 7-48. t_{ON} Response

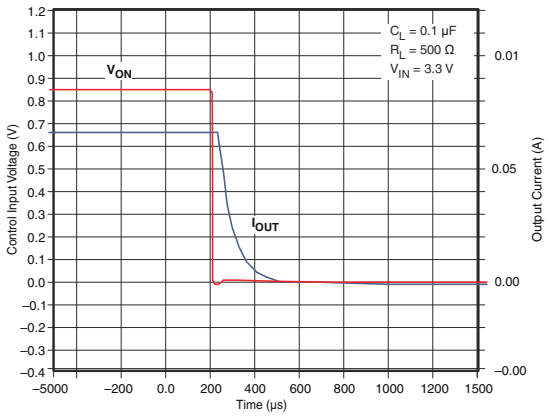


图 7-49. t_{OFF} Response

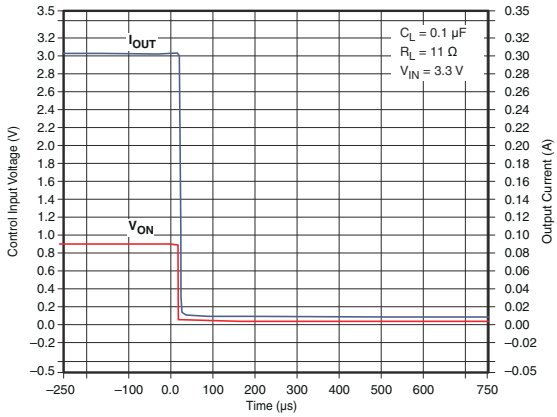


图 7-50. t_{OFF} Response

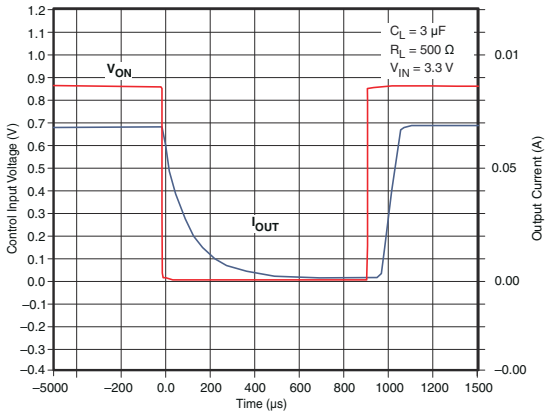


图 7-51. t_{OFF} Response

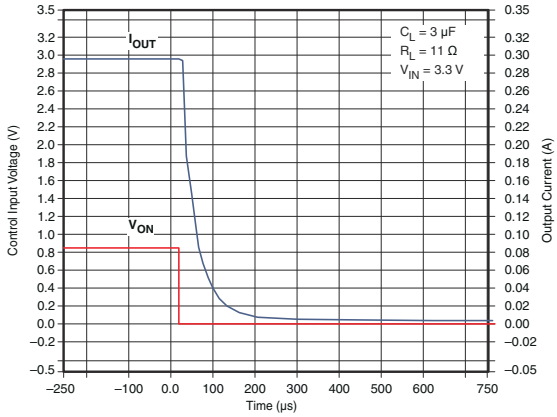


图 7-52. t_{OFF} Response

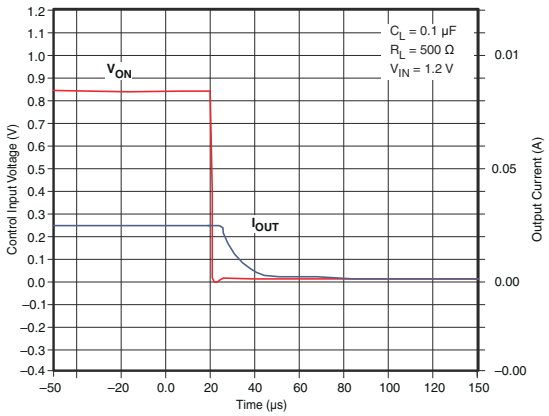


图 7-53. t_{OFF} Response

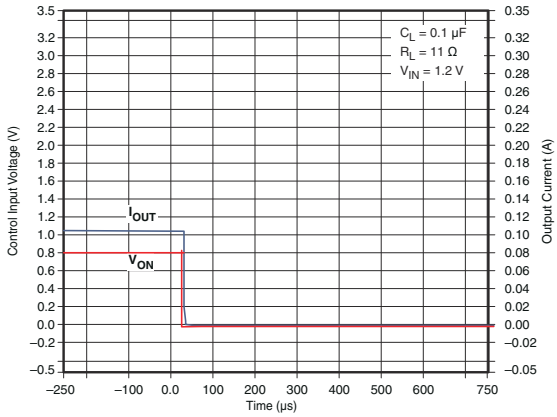


图 7-54. t_{OFF} Response

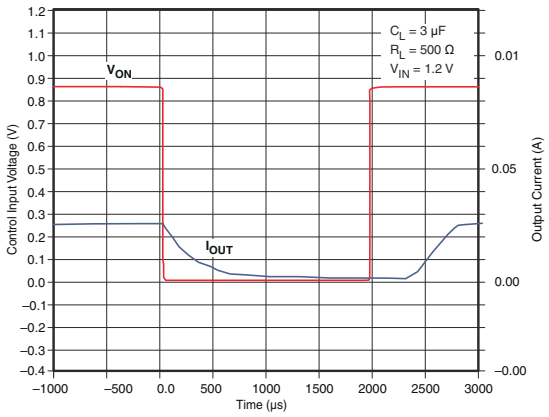


图 7-55. t_{OFF} Response

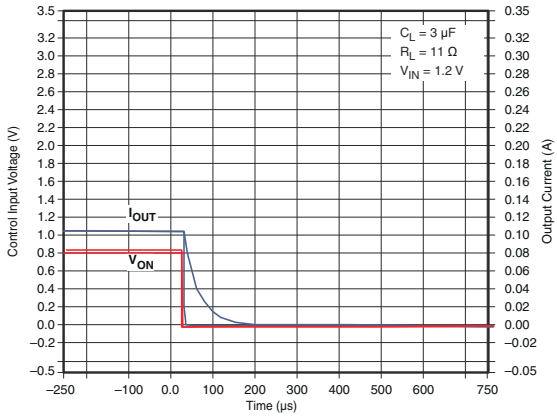
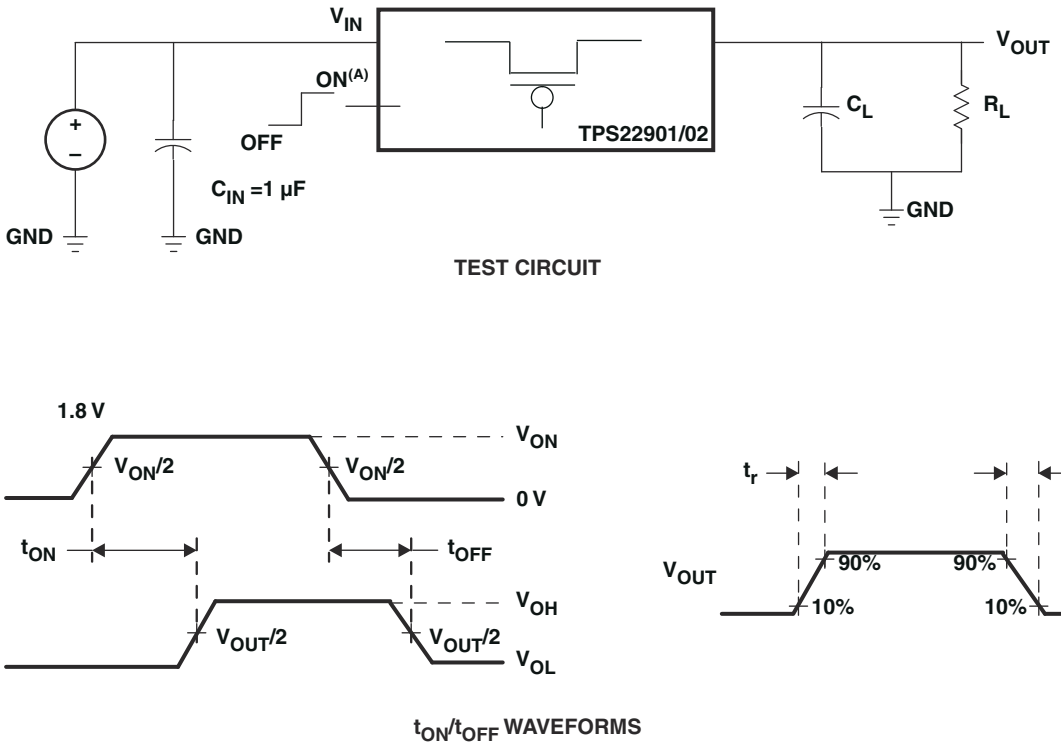


图 7-56. t_{OFF} Response

8 Parameter Measurement Information



A. t_{rise} and t_{fall} of the control signal is 100 ns.

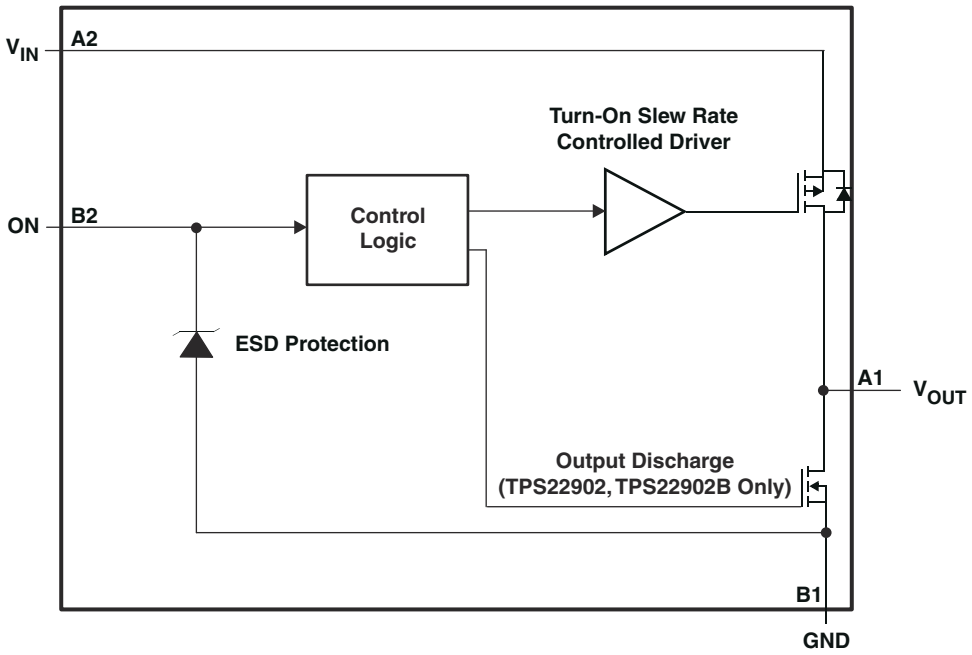
图 8-1. Test Circuit and t_{ON}/t_{OFF} Waveforms

9 Detailed Description

9.1 Overview

The TPS2290x and TPS22902B is a single channel, 500-mA load switch in a small, space-saving DSBGA-4 package. These devices implement a P-channel MOSFET to provide a low ON-resistance for a low voltage drop across the device. A controlled rise time is used in applications to limit the inrush current.

9.2 Functional Block Diagram



9.3 Feature Description

9.3.1 ON/OFF Control

The ON pin controls the state of the switch. Activating ON continuously holds the switch in the on state. ON is active-high and has a low threshold, making it capable of interfacing with low-voltage signals. The ON pin is compatible with standard GPIO logic threshold, and it can be used with any microcontroller with 1.2 V, 1.8 V, 2.5 V or 3.3 V GPIOs.

9.3.2 Quick Output Discharge

The TPS2290x and TPS22902B includes the Quick Output Discharge (QOD) feature. When the switch is disabled, a discharge resistance with a typical value of 88 Ω is connected between the output and ground. This resistance pulls down the output and prevents it from floating when the device is disabled.

9.4 Device Functional Modes

表 9-1 lists the VOUT pin connections for a particular device as determined by the ON pin.

Table 9-1. VOUT Function Table

ON (Control Input)	TPS22901	TPS22902/2B
L	Open	GND
H	VIN	VIN

10 Application and Implementation

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

10.1 Application Information

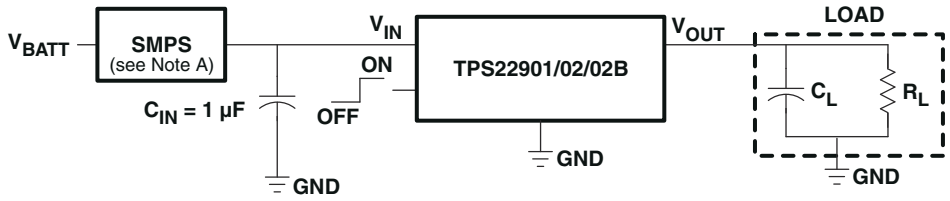
10.1.1 Input Capacitor (Optional)

To limit the voltage drop on the input supply caused by transient inrush currents when the switch turns on into a discharged load capacitor, a capacitor needs to be placed between V_{IN} and GND. A 1-μF ceramic capacitor, C_{IN}, placed close to the pins is usually sufficient. Higher values of C_{IN} can be use to further reduce the voltage drop during high current application. When switching heavy loads, TI recommends using an input capacitor about 10 times higher than the output capacitor in order to avoid excessive voltage drop.

10.1.2 Output Capacitor (Optional)

Because of the integral body diode in the PMOS switch, a C_{IN} greater than C_L is highly recommended. A C_L greater than C_{IN} can cause V_{OUT} to exceed V_{IN} when the system supply is removed. This could result in current flow through the body diode from V_{OUT} to V_{IN}.

10.2 Typical Application



A. Switched-mode power supply

图 10-1. Typical Application Schematic

10.2.1 Design Requirements

Table 10-1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
V_{IN}	1.8 V
C_L	4.7 µF
Load current	500 mA
Ambient Temperature	25 °C
Maximum inrush current	200 mA

10.2.2 Detailed Design Procedure

10.2.2.1 Managing Inrush Current

When the switch is enabled, the output capacitors must be charged up from 0 V to the set value (1.8 V in this example). This charge arrives in the form of inrush current. Inrush current can be calculated using the following equation:

$$I_{INRUSH} = C_L \times \frac{dV_{OUT}}{dt} \quad (1)$$

where:

- C_L = Output capacitance
- dV_{OUT} = Output voltage
- dt = Rise time

The TPS2290x and TPS22902B 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 amount of inrush current increases with output capacitance:

$$200\ mA = 4.7\ \mu F \times 1.8V / dt \quad (2)$$
$$dt = 42.3\ \mu s$$

To ensure an inrush current of less than 200 mA, a device with a rise time greater than 42.3 µs must be used. The TPS22902B has a typical rise time of 220 µs at 1.8 V which meets the above design requirements. The TPS22901/2 has a faster rise time of 40 µs at 1.8 V, and this would result in an inrush current larger than desired.

10.2.2.2 VIN to VOUT Voltage Drop

The voltage drop from VIN to VOUT is determined by the ON-resistance of the device and the load current. R_{ON} can be found in 节 *7.5* and is dependent on temperature. When the value of R_{ON} is found, the following equation can be used to calculate the voltage drop across the device:

$$\Delta V = I_{LOAD} \times R_{ON} \quad (3)$$

where:

- ΔV = Voltage drop across the device
- I_{LOAD} = Load current
- R_{ON} = ON-resistance of the device

At V_{IN} = 1.8 V, the TPS22901/2/2B has an R_{ON} value of 109 mΩ. Using this value and the defined load current, the above equation can be evaluated:

$$\Delta V = 500\ mA \times 109\ m\Omega \quad (4)$$
$$\Delta V = 54.5\ mV$$

Therefore, the voltage drop across the device will be 54.5 mV.

10.2.3 Application Curve

图 10-2 shows the expected voltage drop across the device for different load currents and input voltages.

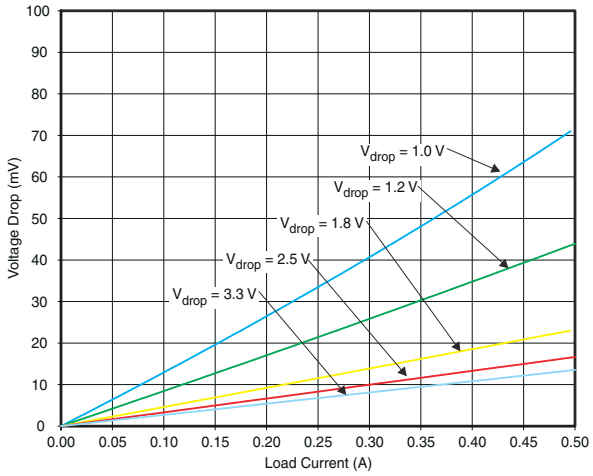


图 10-2. Voltage Drop vs Load Current

11 Power Supply Recommendations

The device is designed to operate with a VIN range of 1 V to 3.6 V. This supply must be well regulated and placed as close to the device terminals as possible. It must also be able to withstand all transient and load currents, using a recommended input capacitance of 1 µF if necessary. 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.

12 Layout

12.1 Layout Guidelines

For best performance, V_{IN}, V_{OUT}, and GND traces should be as short and wide as possible to help minimize the parasitic electrical effects. 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.

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

$$T_J = T_A + \theta_{JA} \times P_D \quad (5)$$

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.

12.2 Layout Example

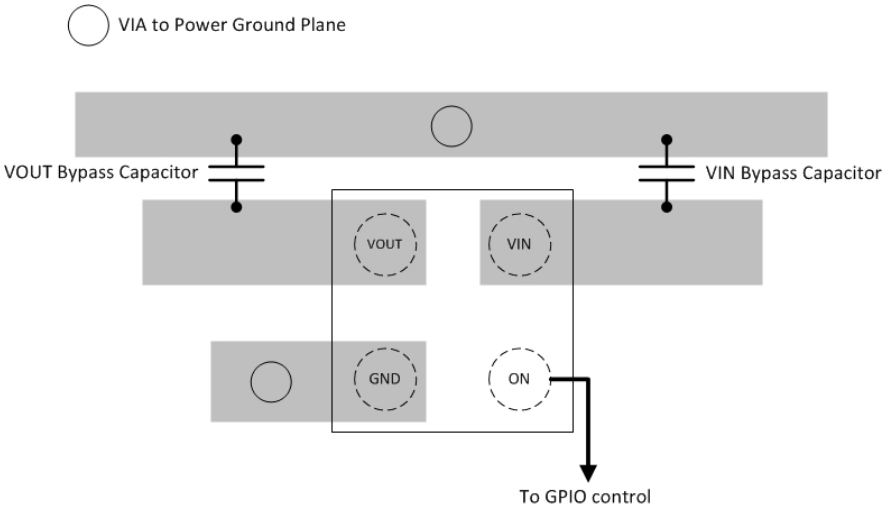


图 12-1. Layout Example Schematic

13 Device and Documentation Support

13.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 13-1. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
TPS22901	Click here	Click here	Click here	Click here	Click here
TPS22902	Click here	Click here	Click here	Click here	Click here
TPS22902B	Click here	Click here	Click here	Click here	Click here

13.2 Trademarks

所有商标均为其各自所有者的财产。

13.3 Electrostatic Discharge Caution

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

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

13.4 Glossary

TI Glossary This glossary lists and explains terms, acronyms, and definitions.

14 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TPS22901YFPR	Active	Production	DSBGA (YFP) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	3P (3, 5)
TPS22901YFPR.A	Active	Production	DSBGA (YFP) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	3P (3, 5)
TPS22902BYFPR	Active	Production	DSBGA (YFP) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	3S 3
TPS22902BYFPR.A	Active	Production	DSBGA (YFP) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	3S 3
TPS22902YFPR	Active	Production	DSBGA (YFP) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	3R
TPS22902YFPR.A	Active	Production	DSBGA (YFP) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	3R

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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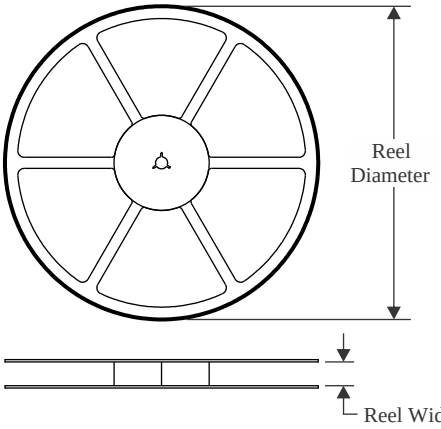
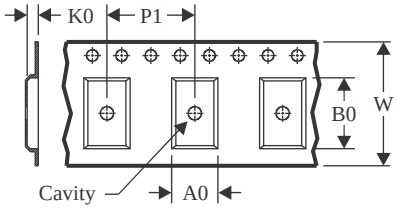
TAPE AND REEL INFORMATION

REEL DIMENSIONS

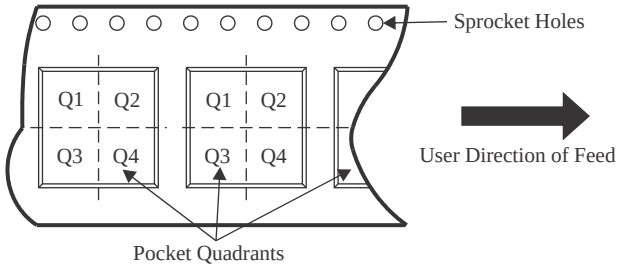


TAPE DIMENSIONS



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

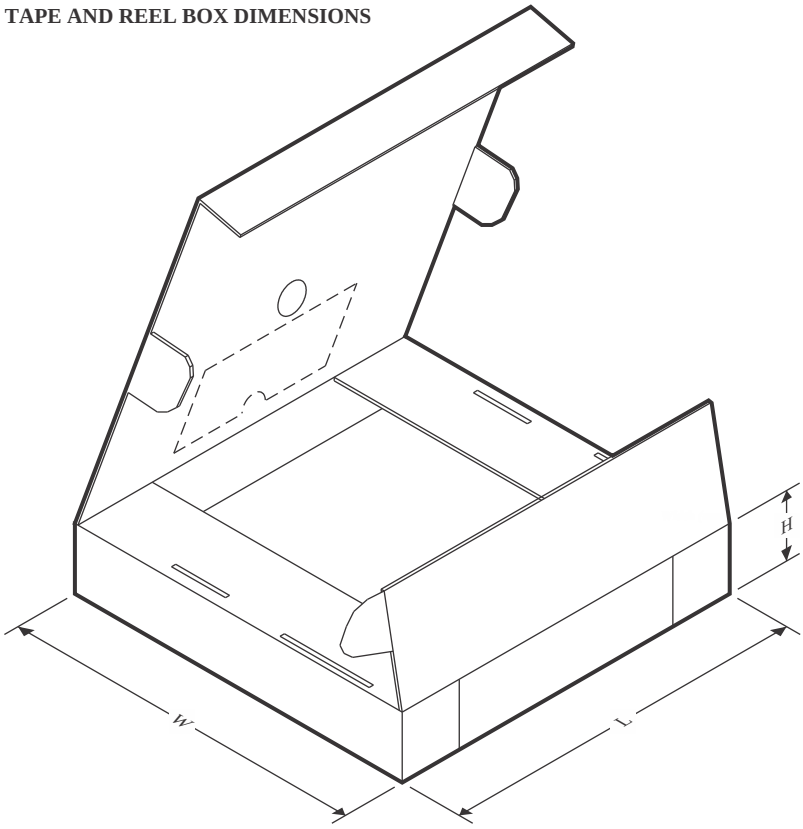
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS22901YFPR	DSBGA	YFP	4	3000	178.0	9.2	0.89	0.89	0.58	4.0	8.0	Q1
TPS22902BYFPR	DSBGA	YFP	4	3000	180.0	8.4	0.89	0.89	0.58	4.0	8.0	Q1
TPS22902YFPR	DSBGA	YFP	4	3000	180.0	8.4	0.89	0.89	0.58	4.0	8.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

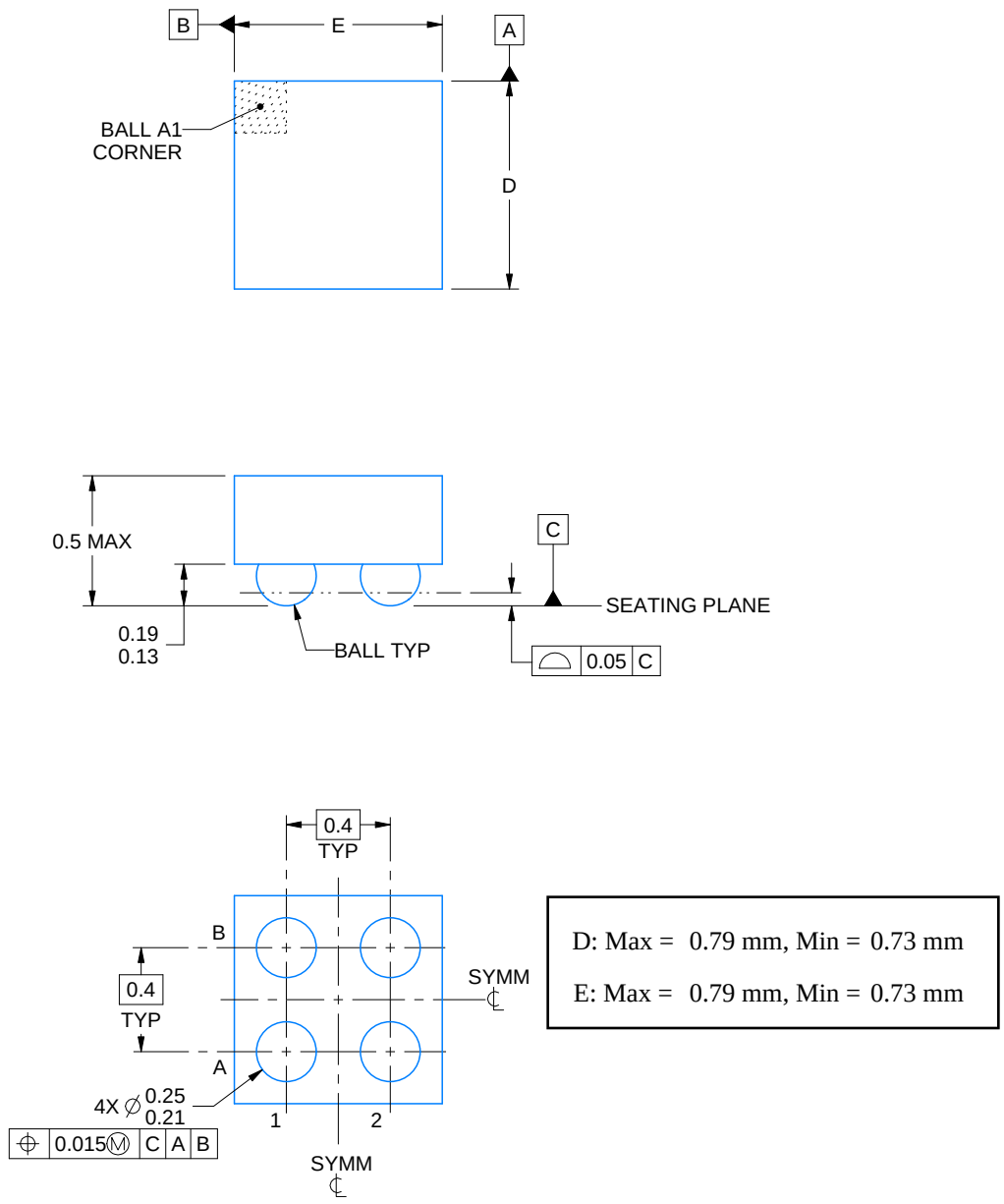
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS22901YFPR	DSBGA	YFP	4	3000	220.0	220.0	35.0
TPS22902BYFPR	DSBGA	YFP	4	3000	182.0	182.0	20.0
TPS22902YFPR	DSBGA	YFP	4	3000	182.0	182.0	20.0

PACKAGE OUTLINE

YFP0004

DSBGA - 0.5 mm max height

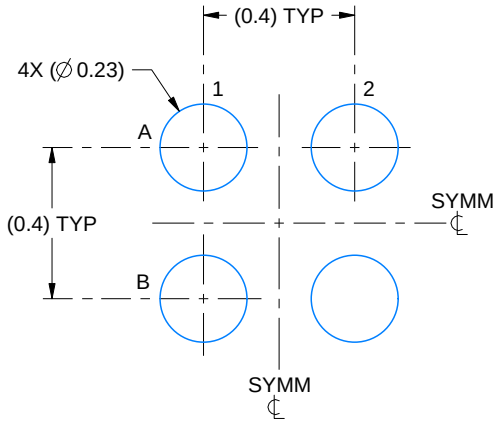
DIE SIZE BALL GRID ARRAY



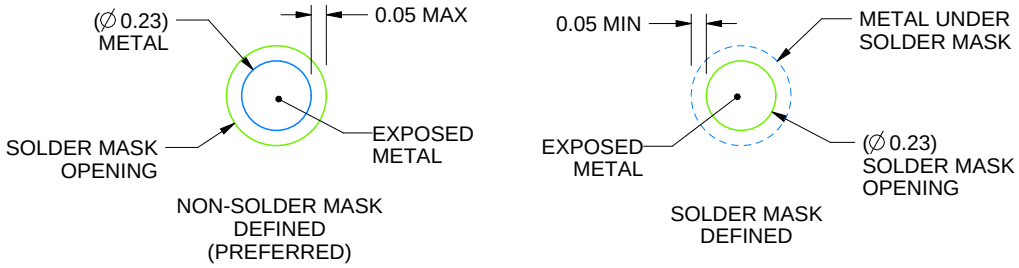
4223507/A 01/2017

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:50X



SOLDER MASK DETAILS
NOT TO SCALE

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NOTES: (continued)

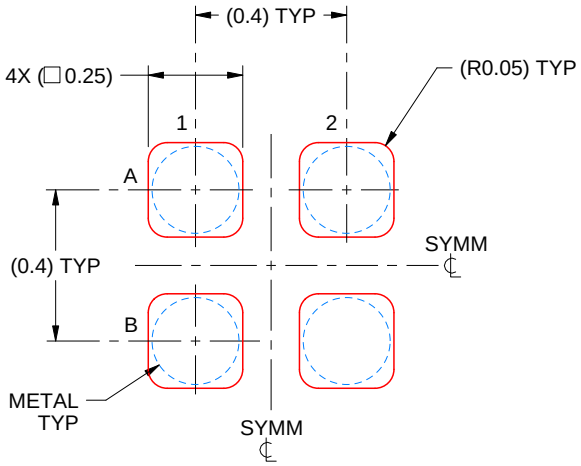
3. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints.
For more information, see Texas Instruments literature number SNVA009 (www.ti.com/lit/snva009).

EXAMPLE STENCIL DESIGN

YFP0004

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE:50X

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NOTES: (continued)

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

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