TPS2291xx 具有受控接通功能的超小型、低导通电阻负载开关

1 特性

- 集成单负载开关
- 四引脚晶圆级芯片规模封装（标称尺寸）
  – 0.9mm × 0.9mm，0.5mm 间距，0.5mm 高度 (YZV)
- 输入电压范围：1.4V 至 5.5V
- 低导通电阻
  – 在 VIN = 5V 时，$r_{导通}$ = 60mΩ
  – 在 VIN = 3.3V 时，$r_{导通}$ = 61mΩ
  – 在 VIN = 1.8V 时，$r_{导通}$ = 74mΩ
  – 在 VIN = 1.5V 时，$r_{导通}$ = 84mΩ
- 2A 最大持续开关电流
- 低阈值控制输入
- 受控转换率
- 欠压闭锁
- 全时反向电流保护
- 快速输出放电晶体管（TPS22913B/C 器件）

2 应用范围

- 笔记本计算机和 超极本™
- 平板电脑和机顶盒
- 便携式工业/医疗设备
- 便携式媒体播放器
- 销售点终端
- 全球卫星定位系统 (GPS) 导航器件
- 数码摄像机
- 便携式仪表
- 智能电话 / 无线手持终端

3 说明

TPS22910A、TPS22912C 和 TPS22913B/C 均为具有受控接通功能的小型、低 r_{ON} 负载开关。此器件包括一个 P 通道金属氧化物半导体场效应晶体管 (MOSFET)，可在 1.4V 至 5.5V 的输入电压范围内运行。此开关由一个开/关输入 (ON) 控制，该输入能够与低压通用输入输出 (GPIO) 控制信号直接对接。

TPS22910A、TPS22912C 和 TPS22913B/C 器件在接通和关断状态下均能提供反向电流保护。当输出电压（$V_{输出}$）被 V_{RCP} 驱动至高于输入电压（$V_{输入}$）时，内部反向电压比较器将禁用此电源开关以快速（典型值为 10µs）停止流向此开关输入端的电流。反向电流保护一直有效，即便当电源开关被禁用时也是如此。此外，如果此输入电压过低，欠压闭锁 (UVLO) 保护会将此开关关闭。

TPS22913B/C 包含一个 150Ω 片上负载电阻器，用于在此开关被关闭时进行快速输出放电。

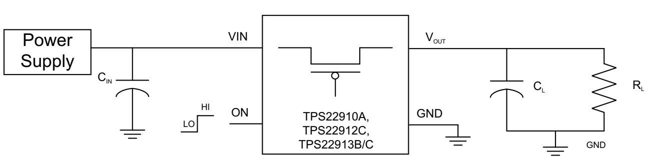
此系列器件提供了多种转换率选项以避免浪涌电流问题（详细信息请参见*Device Comparison Table*），并且采用超小型、节省空间的 4 引脚晶圆级芯片规模封装 (WCSP) 封装，自然通风环境下的额定运行温度范围为 –40°C 至 85°C。

器件信息[(1)]

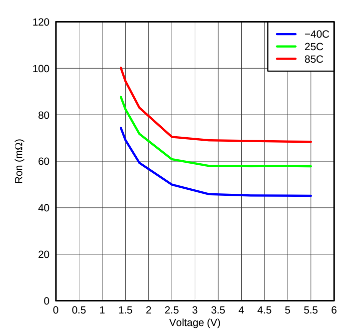
器件型号	封装	封装尺寸（标称值）
TPS22910A	DSBGA (4)	0.90mm x 0.90mm
TPS22912C		
TPS22913B		
TPS22913C		

(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



导通状态电阻与输入电压间的关系



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5 修订历史记录

Changes from Revision E (June 2014) to Revision F	Page
• Updated 'ON' pin description in the Pin Functions table.	3

Changes from Revision D (May 2014) to Revision E	Page
• Updated Switching Characteristics table	6
• Updated Typical DC Characteristics section.	7
• Updated Timing Waveforms graphic.	17
• Updated Application Curves section.	22

Changes from Revision C (May 2013) to Revision D	Page
• 已整合 TPS22910A、TPS22912C 和 TPS22913B/C 数据表。	1

6 Device Comparison Table

DEVICE	r_{ON} (typ) at 3.3 V	RISE TIME at 3.3V (typ)	QUICK OUTPUT DISCHARGE	MAXIMUM OUTPUT CURRENT	ENABLE
TPS22910A	61 mΩ	1 µs	No	2 A	Active Low
TPS22912C	61 mΩ	1000 µs	No	2 A	Active High
TPS22913B	61 mΩ	66 µs	Yes	2 A	Active High
TPS22913C	61 mΩ	660 µs	Yes	2 A	Active High

7 Pin Configuration and Functions

YZV PACKAGE

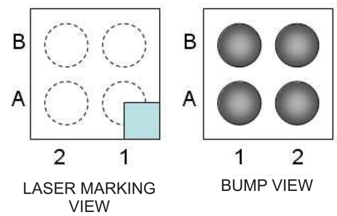


Table 1. Pin Assignments

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

Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
VOUT	A1	O	Switch output
VIN	A2	I	Switch input, use a bypass capacitor (ceramic) to ground.
GND	B1	–	Ground
ON	B2	I	Switch control input. Do not leave floating

8 Specifications

8.1 Absolute Maximum Ratings

		MIN	MAX	UNIT
V_{IN}	Input voltage range	–0.3	6	V
V_{OUT}	Output voltage range	–0.3	6	V
V_{ON}	Input voltage range	–0.3	6	V
I_{MAX}	Maximum continuous switch current		2	A
I_{PLS}	Maximum pulsed switch current, pulse < 300 µs, 2% duty cycle		2.5	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]	±1000	

(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. Pins listed as ±2000 V may actually have higher performance.
(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. Pins listed as ±1000 V may actually have higher performance.

8.3 Recommended Operating Conditions

			MIN	MAX	UNIT
V_{IN}	Input voltage range		1.4	5.5	V
V_{ON}	ON voltage range		0	5.5	V
V_{OUT}	Output voltage range			V_{IN}	
V_{IH}	High-level input voltage, ON	VIN = 1.4 V to 5.5 V	1.1	5.5	V
V_{IL}	Low-level input voltage, ON	VIN = 3.61 V to 5.5 V		0.6	V
		VIN = 1.4 V to 3.6 V		0.4	V
C_{IN}	Input capacitor		1 [1]		µF

(1) Refer to the application section.

8.4 Thermal Information

THERMAL METRIC [1]		TPS22910	TPS22912	TPS22913	UNIT
		CSP	CSP	CSP	
		4 PINS	4 PINS	4 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	189.1	189.1	189.1	°C/W
$R_{\theta JCtop}$	Junction-to-case (top) thermal resistance	1.9	1.9	1.9	
$R_{\theta JB}$	Junction-to-board thermal resistance	36.8	36.8	36.8	
ψ_{JT}	Junction-to-top characterization parameter	11.3	11.3	11.3	
ψ_{JB}	Junction-to-board characterization parameter	36.8	36.8	36.8	

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

8.5 Electrical Characteristics

The electrical characteristics in this section apply to all devices unless otherwise noted. For TPS22910A V_{ON} = 0 V where enabled and V_{ON} = V_{IN} where disabled. For TPS22912C and TPS22913B/C V_{ON} = V_{IN} where enabled and V_{ON} = 0 V where disabled. V_{IN} = 1.4 V to 5.5 V, T_A = –40ºC to 85ºC (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
I_{IN}	Quiescent current	I_{OUT} = 0 mA, V_{IN} = 5.25 V, V_{ON} = Enabled	Full		2	10	µA
		I_{OUT} = 0 mA, V_{IN} = 4.2 V, V_{ON} = Enabled			2	7.0	
		I_{OUT} = 0 mA, V_{IN} = 3.6 V, V_{ON} = Enabled			2	7.0	
		I_{OUT} = 0 mA, V_{IN} = 2.5 V, V_{ON} = Enabled			0.9	5	
		I_{OUT} = 0 mA, V_{IN} = 1.5 V, V_{ON} = Enabled			0.7	5	
$I_{IN(off)}$	Off supply current	R_L = 1 MΩ, V_{IN} = 5.25 V, V_{ON} = Disabled	Full		1.2	10	µA
		R_L = 1 MΩ, V_{IN} = 4.2 V, V_{ON} = Disabled			0.2	7.0	
		R_L = 1 MΩ, V_{IN}= 3.6 V, V_{ON} = Disabled			0.1	7.0	
		R_L = 1 MΩ, V_{IN} = 2.5 V, V_{ON} = Disabled			0.1	5	
		R_L = 1 MΩ, V_{IN} = 1.5 V, V_{ON} = Disabled			0.1	5	
$I_{IN(Leakage)}$	Leakage current	V_{OUT} = 0 V, V_{IN}= 5.25 V, V_{ON} = Disabled	Full		1.2	10	µA
		V_{OUT} = 0 V, V_{IN} = 4.2 V, V_{ON} = Disabled			0.2	7.0	
		V_{OUT} = 0 V, V_{IN} = 3.6 V, V_{ON} = Disabled			0.1	7.0	
		V_{OUT} = 0 V, V_{IN} = 2.5 V, V_{ON} = Disabled			0.1	5	
		V_{OUT} = 0 V, V_{IN} = 1.5 V, V_{ON} = Disabled			0.1	5	
r_{ON}	On-resistance	V_{IN} = 5.25 V, I_{OUT} = –200 mA	25°C		60	80	mΩ
			Full			110	
		V_{IN} = 5.0 V, I_{OUT} = –200 mA	25°C		60	80	
			Full			110	
		V_{IN} = 4.2 V, I_{OUT} = –200 mA	25°C		60	80	
			Full			110	
		V_{IN} = 3.3 V, I_{OUT} = –200 mA	25°C		60.7	80	
			Full			110	
		V_{IN} = 2.5 V, I_{OUT} = –200 mA	25°C		63.4	90	
			Full			120	
		V_{IN} = 1.8 V, I_{OUT} = –200 mA	25°C		74.2	100	
			Full			130	
		V_{IN} = 1.5 V, I_{OUT} = –200 mA	25°C		83.9	120	
			Full			150	
RPD (1)	Output pull down resistance	V_{IN} = 3.3 V, I_{OUT} = 30 mA, V_{ON} = 0	25°C		153	200	Ω
UVLO	Under voltage lockout	V_{IN} increasing, V_{ON} = 0 V, I_{OUT} = –100 mA	Full			1.2	V
		V_{IN} decreasing, V_{ON} = 0 V, R_L = 10 Ω		0.50			
I_{ON}	ON input leakage current	V_{ON} = 1.4 V to 5.25 V or GND	Full			1	µA
V_{RCP}	Reverse current voltage threshold	TPS22910A, TPS22913B/C			44		mV
		TPS22912C			54		
t_{DELAY}	Reverse current response delay	V_{IN} = 5 V			10		µs
I_{RCP}(leak)	Reverse current protection leakage after reverse current event.	V_{OUT} – V_{IN} > V_{RCP}	25°C		0.3		µA

(1) Only applies to the TPS22913B/C devices

8.6 Switching Characteristics, Typical

PARAMETER		TEST CONDITION	TPS22910A	TPS22912C	TPS22913B	TPS22913C	UNIT
VIN = 5 V, T_A = 25ºC (unless otherwise noted)							
t_{ON}	Turn-ON time	R_L = 10 Ω, C_L = 0.1 µF	2	840	76	770	µs
t_{OFF}	Turn-OFF time	R_L = 10 Ω, C_L = 0.1 µF	5.5	6.6	6.6	6.6	
t_R	VOUT rise time	R_L = 10 Ω, C_L = 0.1 µF	1	912	82	838	
t_F	VOUT fall time	R_L = 10 Ω, C_L = 0.1 µF	3	3	3	3	
VIN = 3.3 V, T_A = 25ºC (unless otherwise noted)							
t_{ON}	Turn-ON time	R_L = 10 Ω, C_L = 0.1 µF	2.5	1147	102	1048	µs
t_{OFF}	Turn-OFF time	R_L = 10 Ω, C_L = 0.1 µF	7	8.6	8.5	8.6	
t_R	VOUT rise time	R_L = 10 Ω, C_L = 0.1 µF	1	1030	97	980	
t_F	VOUT fall time	R_L = 10 Ω, C_L = 0.1 µF	3.5	3	3	3	
VIN = 1.5 V, T_A = 25ºC (unless otherwise noted)							
t_{ON}	Turn-ON time	R_L = 10 Ω, C_L = 0.1 µF	4.5	2513	234	2344	µs
t_{OFF}	Turn-OFF time	R_L = 10 Ω, C_L = 0.1 µF	16.5	17.4	17	18	
t_R	VOUT rise time	R_L = 10 Ω, C_L = 0.1 µF	2	1970	244	1823	
t_F	VOUT fall time	R_L = 10 Ω, C_L = 0.1 µF	7	6.5	6.5	6.5	

8.7 Typical DC Characteristics

The typical characteristics curves in this section apply to all devices unless otherwise noted.

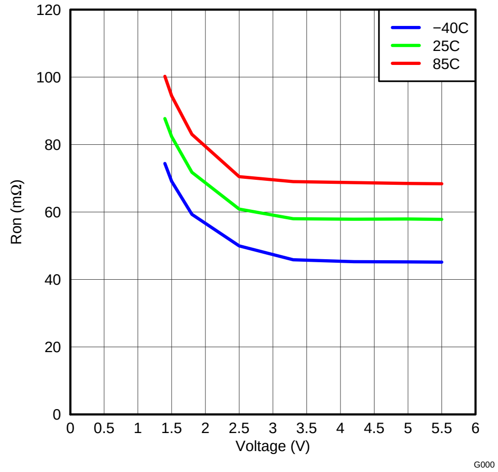


Figure 1. On-State Resistance vs Input Voltage

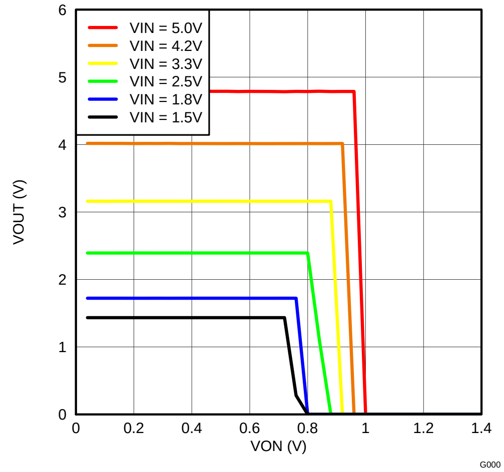


Figure 2. TPS22910A On Input Threshold (Active Low)

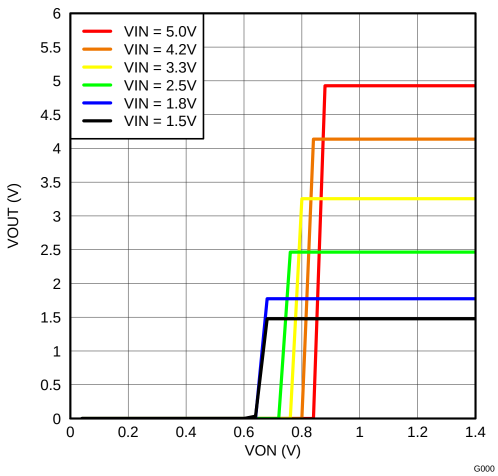


Figure 3. TPS22912C and TPS22913B/C On Input Threshold (Active High)

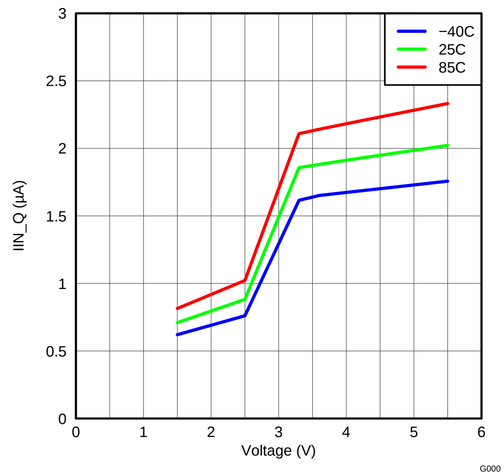


Figure 4. Input Current, Quiescent vs Input Voltage

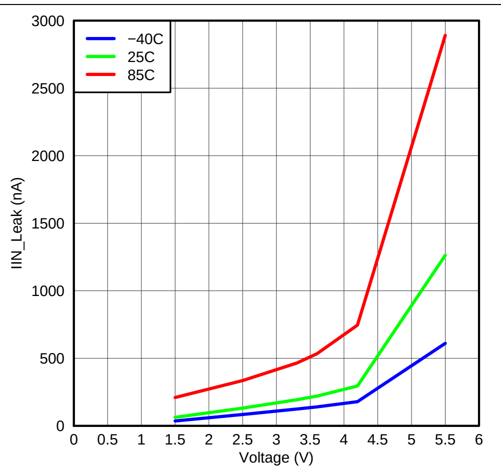


Figure 5. Input Current, Leak vs Input Voltage

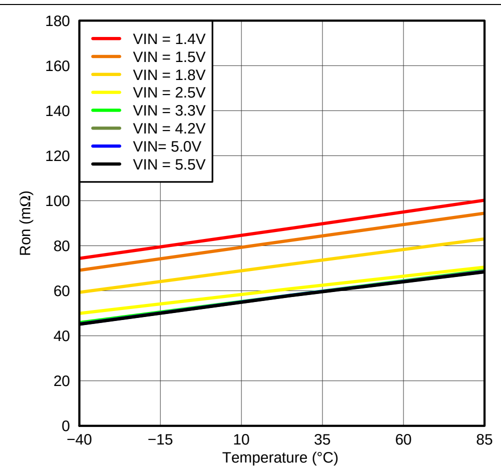


Figure 6. On-state Resistance vs Temperature

Typical DC Characteristics (continued)

The typical characteristics curves in this section apply to all devices unless otherwise noted.

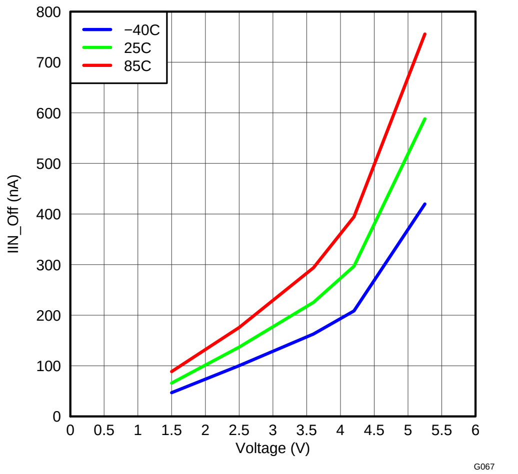


Figure 7. Input Current, Off vs Input Voltage

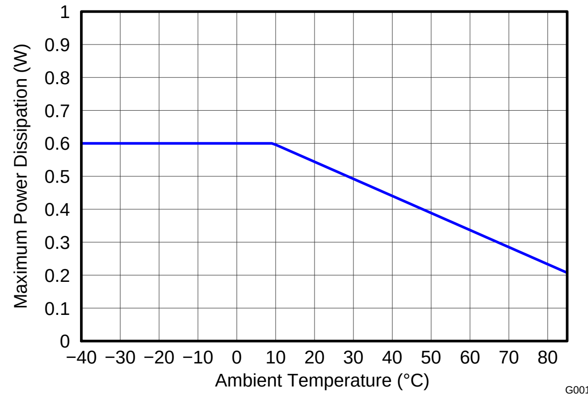


Figure 8. Allowable Power Dissipation

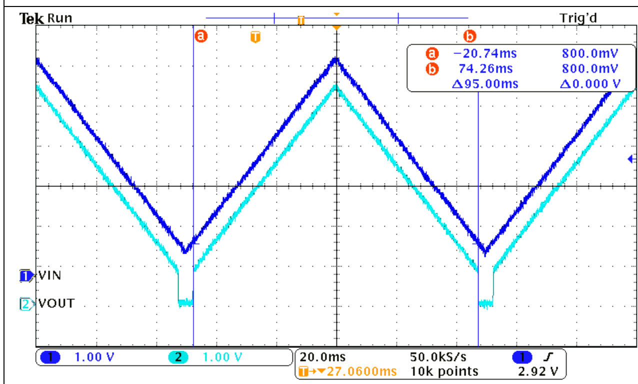


Figure 9. Under Voltage Lockout Response
(IOUT = –100mA)

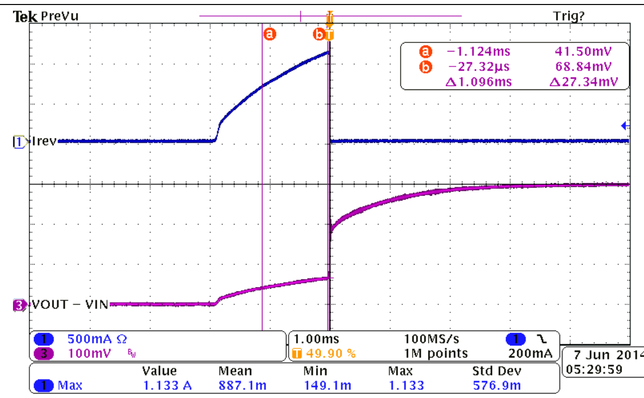


Figure 10. Full-Time Reverse Current Protection
(VIN = 3.0 V, VOUT Ramp up From 3.0 V to 3.3 V)

8.8 Typical AC Characteristics, TPS22910A

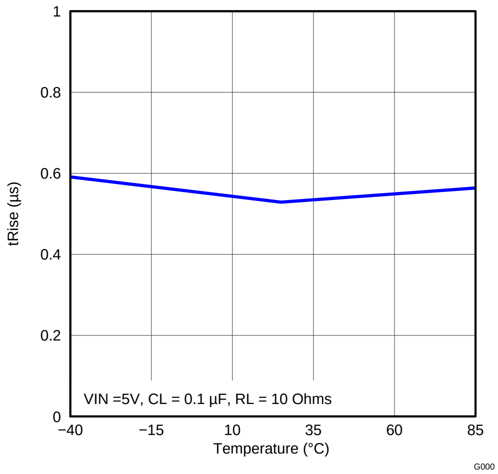


Figure 11. Rise Time vs Temperature

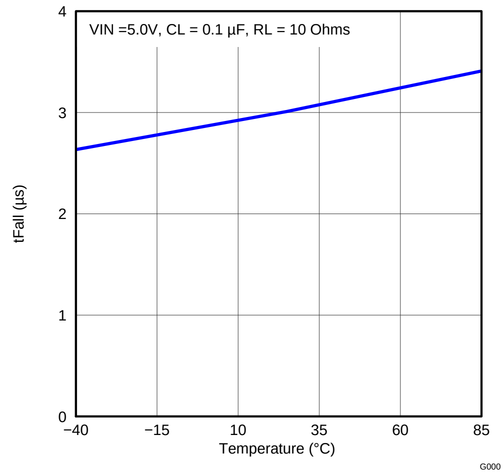


Figure 12. Fall Time vs Temperature

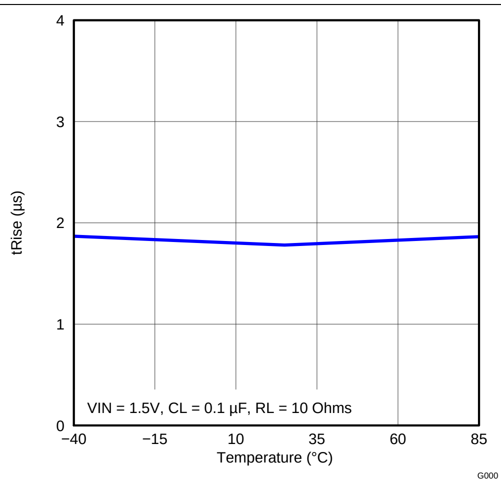


Figure 13. Rise Time vs Temperature

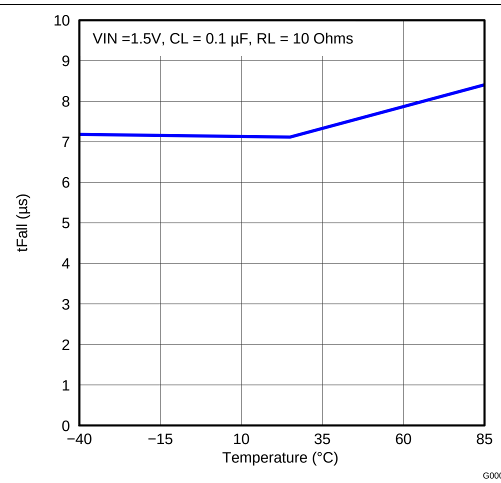


Figure 14. Fall Time vs Temperature

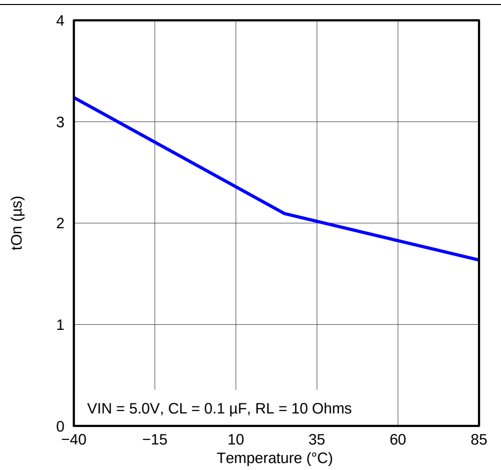


Figure 15. Turn-on Time vs Temperature

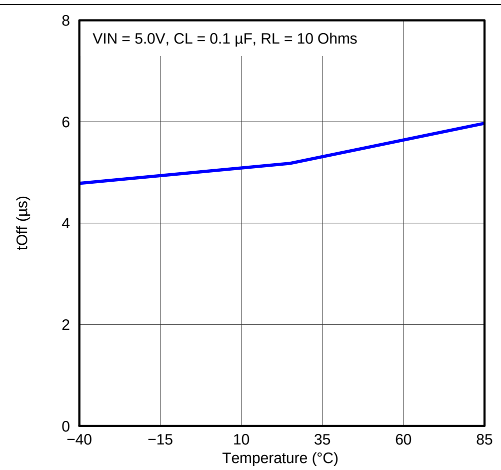


Figure 16. Turn-off Time vs Temperature

Typical AC Characteristics, TPS22910A (continued)

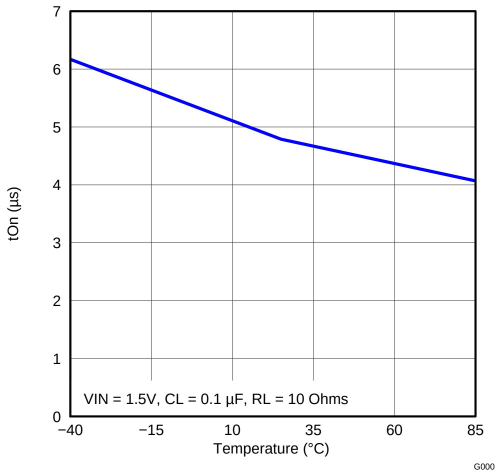


Figure 17. Turn-on Time vs Temperature

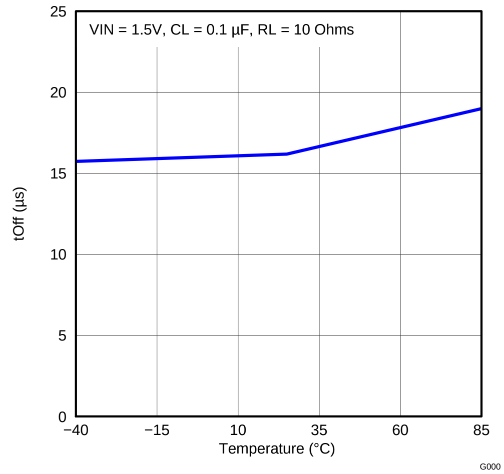


Figure 18. Turn-off Time vs Temperature

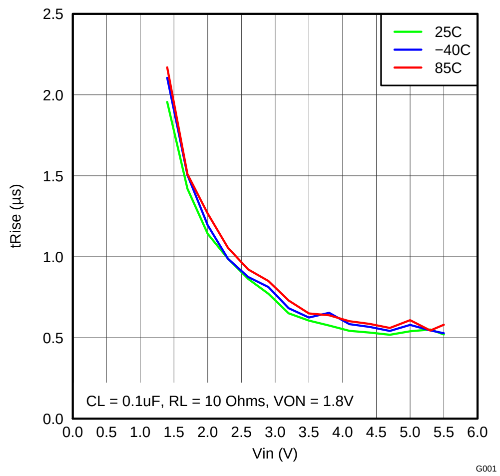


Figure 19. Rise Time vs Input Voltage

8.9 Typical AC Characteristics, TPS22912C

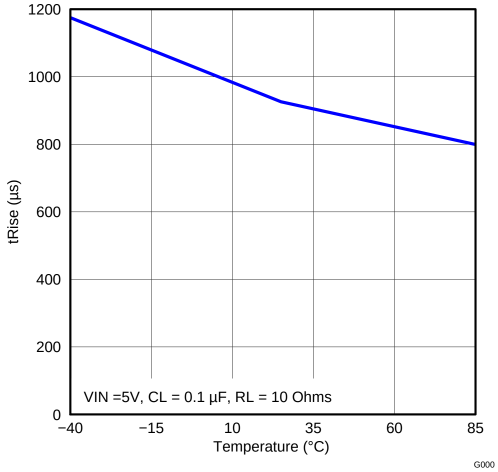


Figure 20. Rise Time vs Temperature

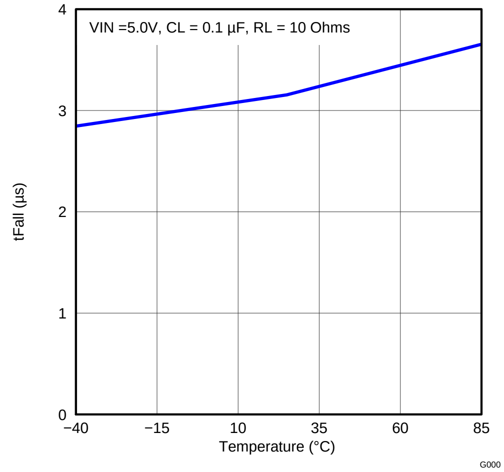


Figure 21. Fall Time vs Temperature

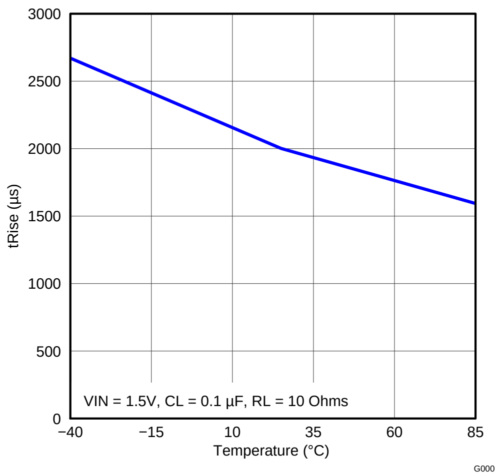


Figure 22. Rise Time vs Temperature

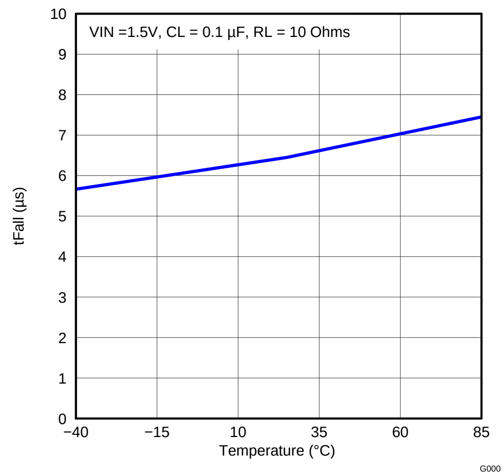


Figure 23. Fall Time vs Temperature

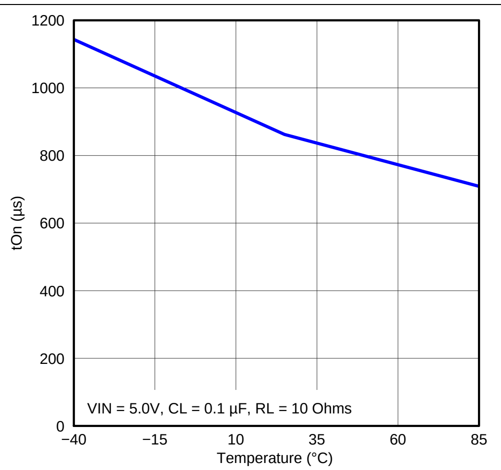


Figure 24. Turn-on Time vs Temperature

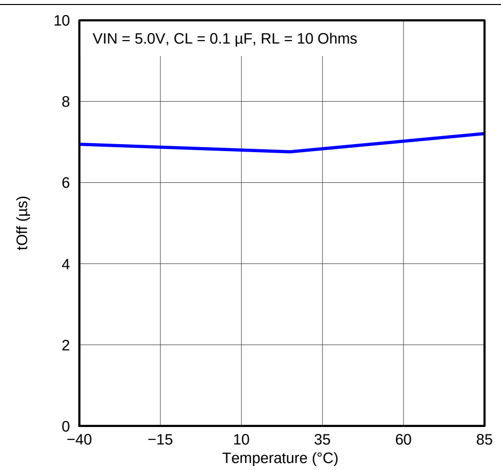


Figure 25. Turn-off Time vs Temperature

Typical AC Characteristics, TPS22912C (continued)

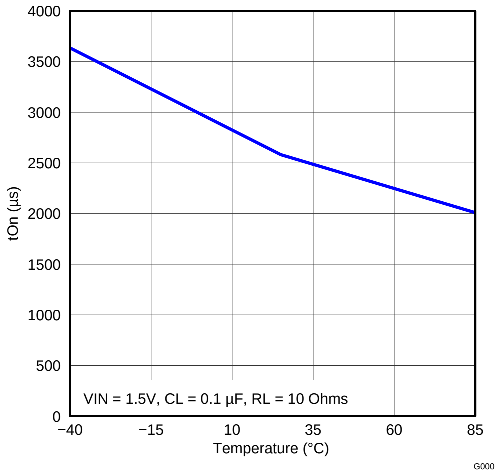


Figure 26. Turn-on Time vs Temperature

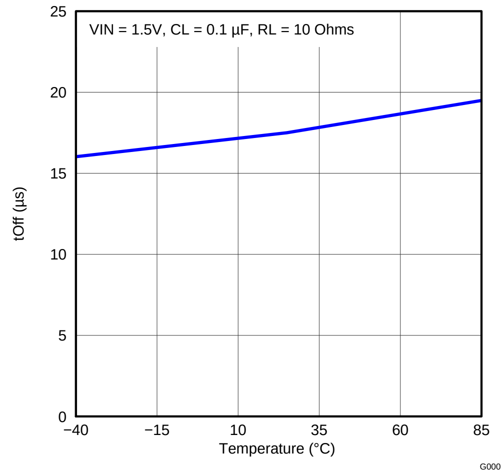


Figure 27. Turn-off Time vs Temperature

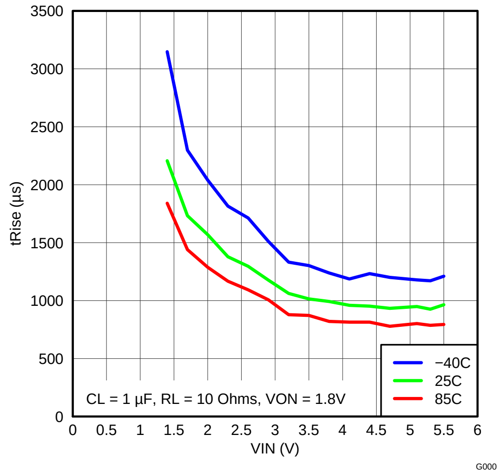


Figure 28. Rise Time vs Input Voltage

8.10 Typical AC Characteristics, TPS22913B

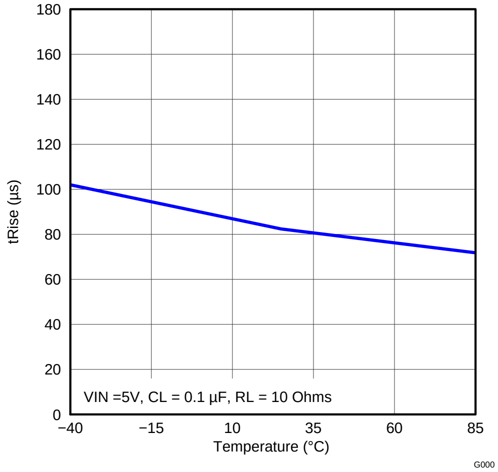


Figure 29. Rise Time vs Temperature

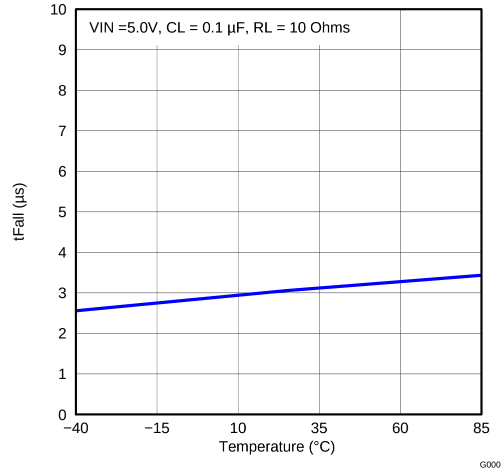


Figure 30. Fall Time vs Temperature

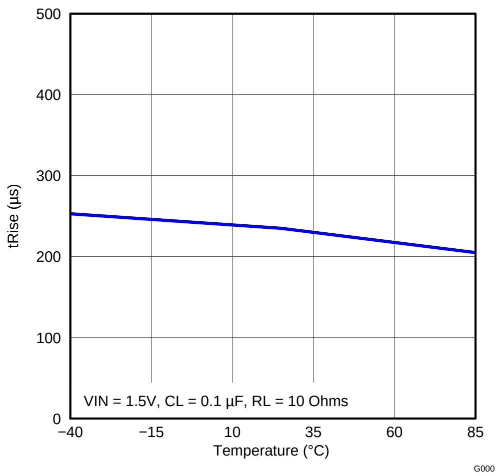


Figure 31. Rise Time vs Temperature

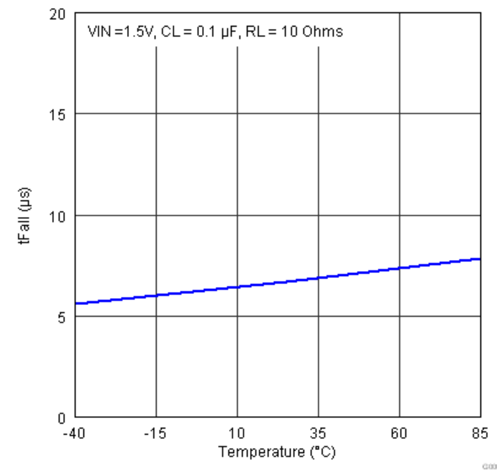


Figure 32. Fall Time vs Temperature

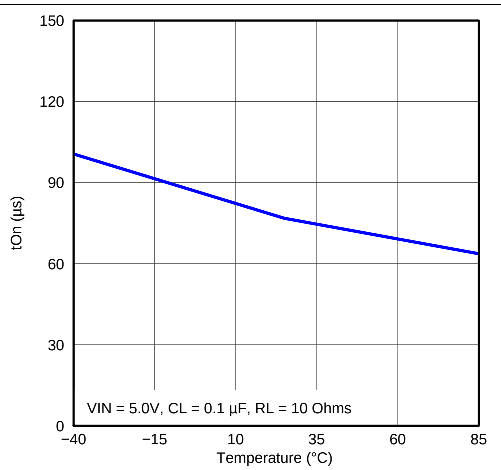


Figure 33. Turn-on Time vs Temperature

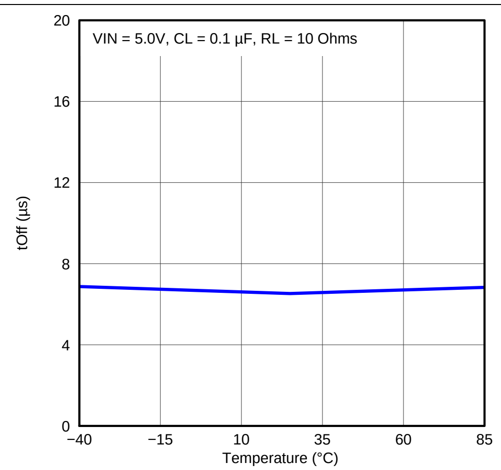


Figure 34. Turn-off Time vs Temperature

Typical AC Characteristics, TPS22913B (continued)

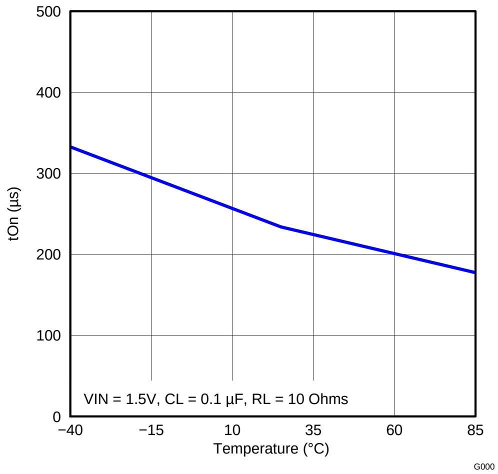


Figure 35. Turn-on Time vs Temperature

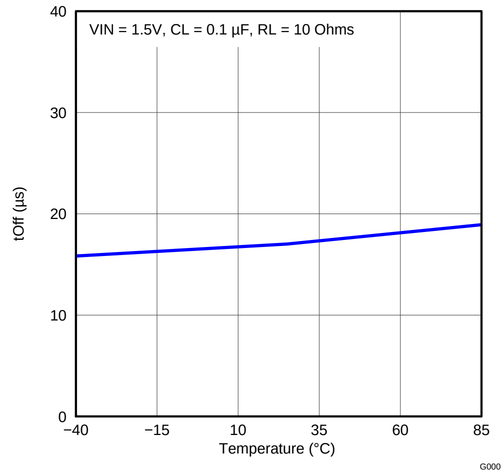


Figure 36. Turn-off Time vs Temperature

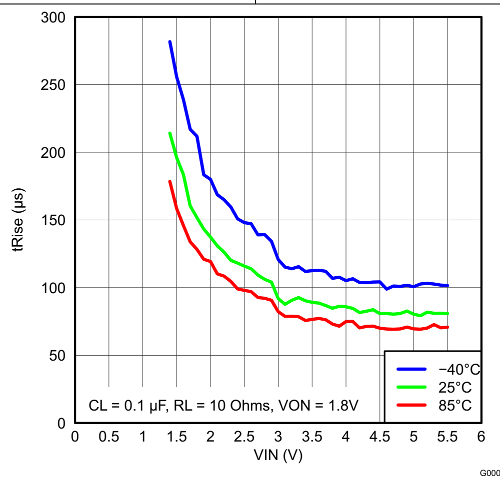


Figure 37. Rise Time vs Input Voltage

8.11 Typical AC Characteristics, TPS22913C

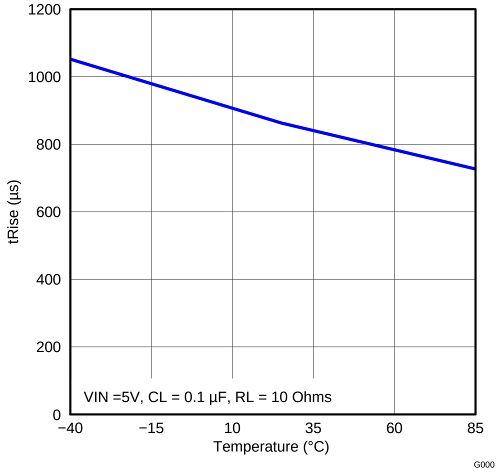


Figure 38. Rise Time vs Temperature

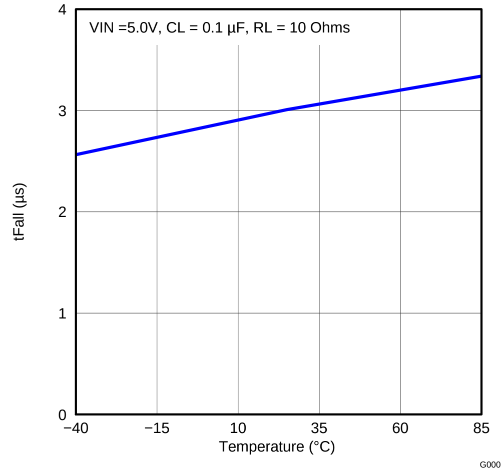


Figure 39. Fall Time vs Temperature

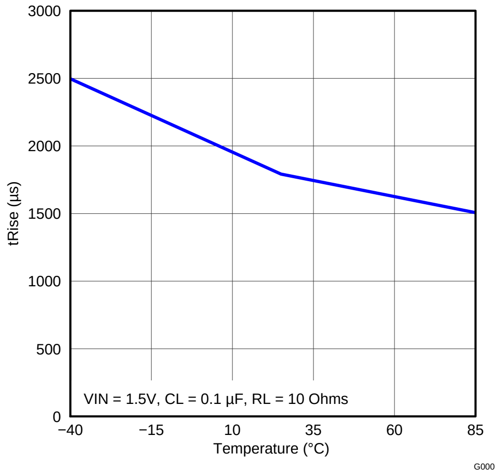


Figure 40. Rise Time vs Temperature

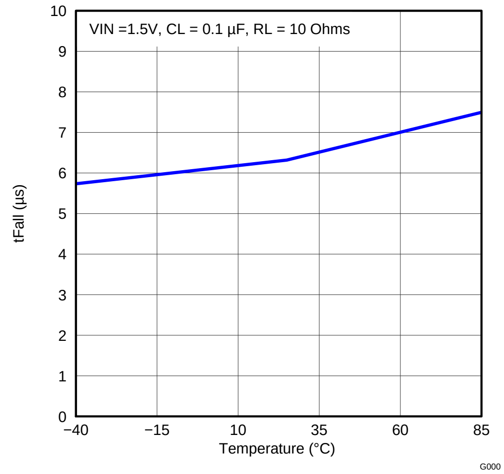


Figure 41. Fall Time vs Temperature

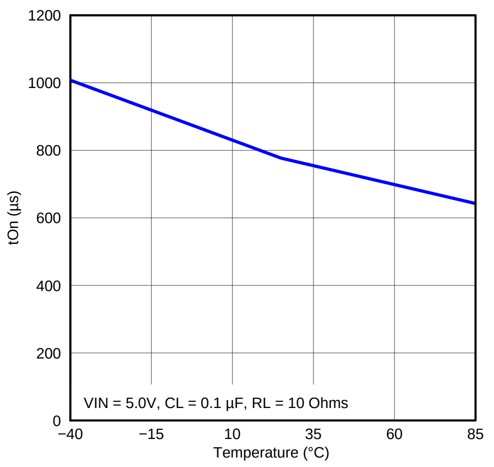


Figure 42. Turn-on Time vs Temperature

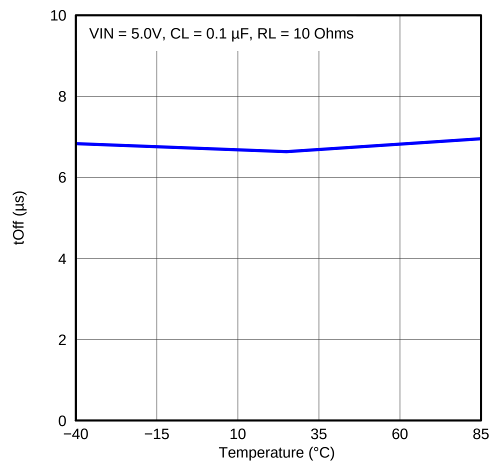


Figure 43. Turn-Off Time vs Temperature

Typical AC Characteristics, TPS22913C (continued)

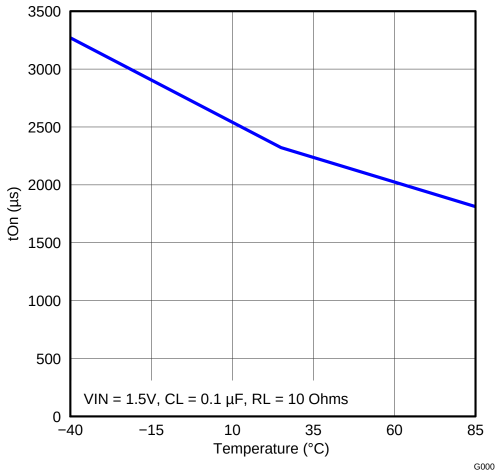


Figure 44. Turn-On Time vs Temperature

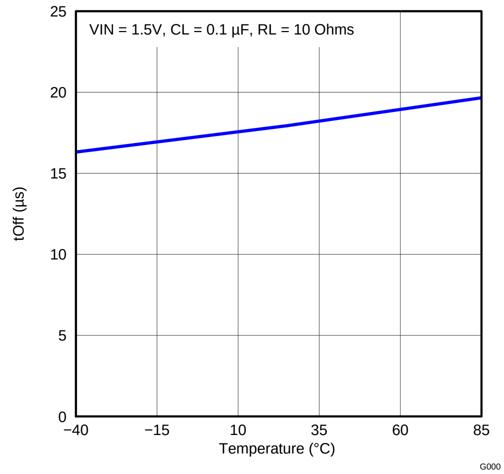


Figure 45. Turn-Off Time vs Temperature

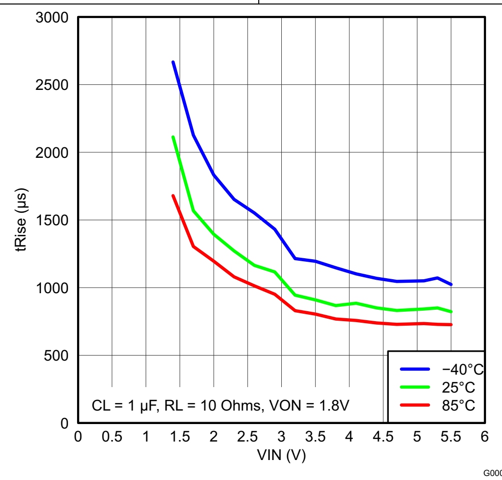


Figure 46. Rise Time vs Input Voltage

9 Parameter Measurement Information

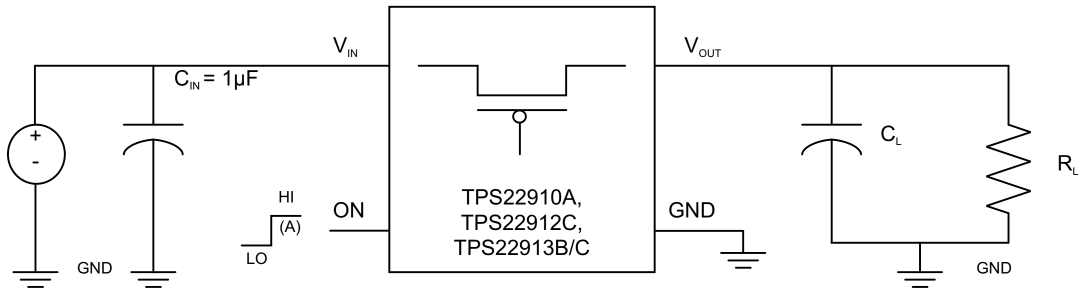
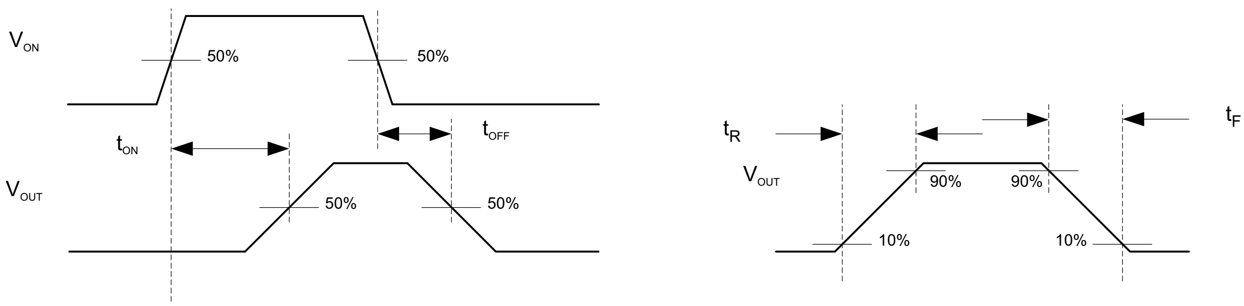


Figure 47. Timing Test Circuit



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

Figure 48. Timing Waveforms

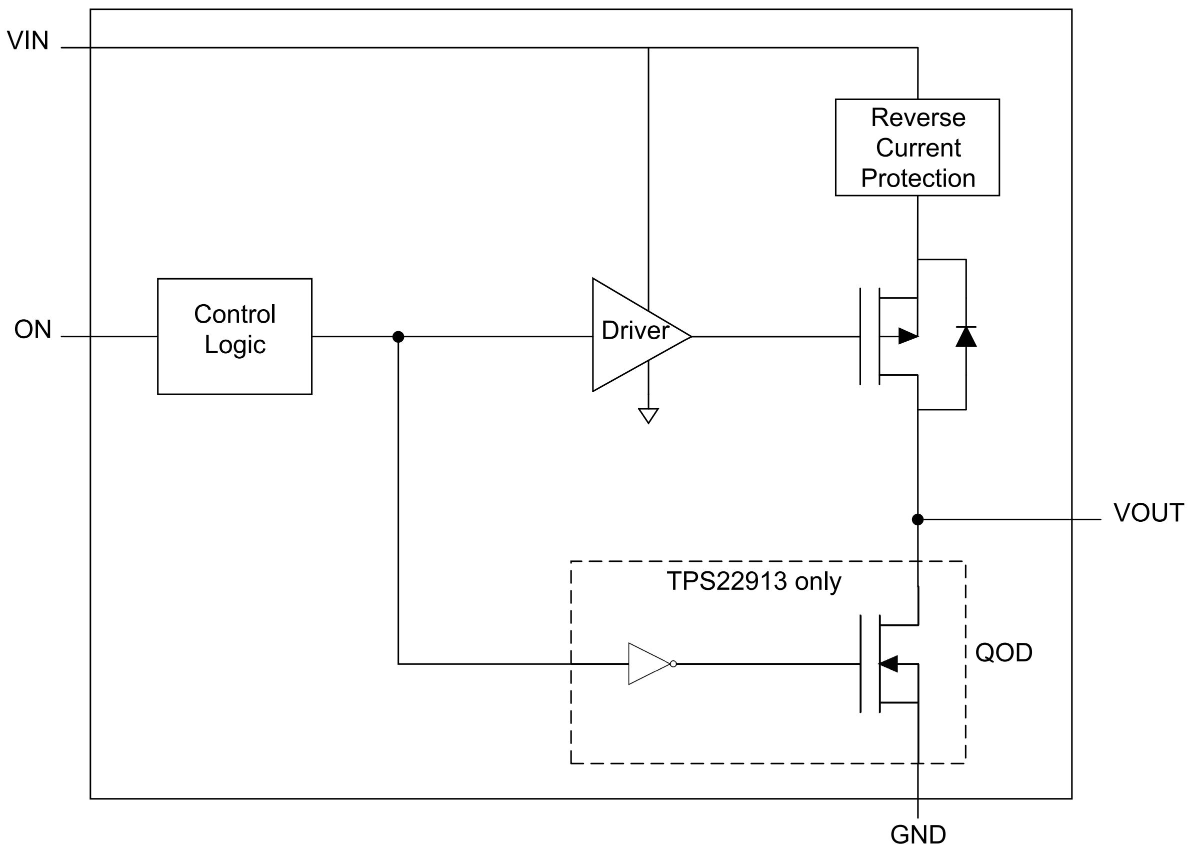
10 Detailed Description

10.1 Overview

This family of devices are single channel, 2-A load switches in ultra-small, space saving 4-pin WCSP package. These devices implement a low resistance P-channel MOSFET with a controlled rise time for applications that need to limit the inrush current.

These devices are designed to have very low leakage current during off state. This prevents downstream circuits from pulling high standby current from the supply. Integrated control logic, driver, power supply, and output discharge FET eliminates the need for additional external components, which reduces solution size and BOM count.

10.2 Functional Block Diagram



10.3 Feature Description

10.3.1 On/Off Control

The ON pin controls the state of the switch. The ON pin is compatible with standard GPIO logic threshold. It can be used with any microcontroller with 1.2-V, 1.8-V, 2.5-V, 3.3-V, or 5.5-V GPIO.

10.3.2 Under-Voltage Lockout

Under-voltage lockout protection turns off the switch if the input voltage drops below the under-voltage lockout threshold (UVLO). With the ON pin active, the input voltage rising above the under-voltage lockout threshold will cause a controlled turn-on of the switch to limit current over-shoot.

Feature Description (continued)

10.3.3 Full-Time Reverse Current Protection

In a scenario where V_{OUT} is greater than V_{IN}, there is potential for reverse current to flow through the pass FET or the body diode. The devices monitor V_{IN} and V_{OUT} voltage levels. When the reverse current voltage threshold (V_{RCP}) is exceeded, the switch is disabled (within 10μs typ). Additionally, the body diode is disengaged so as to prevent any reverse current flow to VIN. The peak instantaneous reverse current is the current it takes to activate the reverse current protection. After the reverse current protection has activated due to the peak instantaneous reverse current, the DC (off-state) leakage current from V_{OUT} and V_{IN} is referred to as I_{RCP}(leak) (see Figure 49). The pass FET, and the output voltage (V_{OUT}), will resume normal operation when the reverse voltage scenario is no longer present.

The following formula can be used to calculate the amount of peak instantaneous reverse current for a particular application:

$$I_{RC} = \frac{V_{RCP}}{r_{ON(VIN)}}$$

Where,

I_{RC} is the amount of reverse current,
$r_{ON(VIN)}$ is the on-resistance at the VIN of the reverse current condition.
V_{RCP} is the reverse voltage threshold.

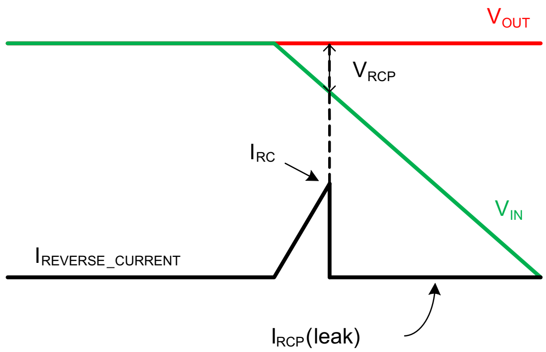


Figure 49. Reverse Current

10.4 Device Functional Modes

Table 2 describes what the VOUT pin will be connected to for a particular device as determined by the ON pin

Table 2. VOUT Function Table

ON	TPS22910A	TPS22912C	TPS22913B/C
L	VIN	Open	GND
H	Open	VIN	VIN

11 Application and Implementation

11.1 Application Information

This section will highlight some of the design considerations when implementing this device in various applications. A PSPICE model for this device is also available in the product page of this device on www.ti.com for further aid.

11.1.1 VIN to VOUT Voltage Drop

The VIN to VOUT voltage drop in the device is determined by the R_{ON} of the device and the load current. The R_{ON} of the device depends upon the VIN condition of the device. Refer to the R_{ON} specification of the device in the Electrical Characteristics table of this datasheet. Once the R_{ON} of the device is determined based upon the VIN conditions, use Equation 1 to calculate the VIN to VOUT voltage drop:

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

Where,

ΔV = Voltage drop from VIN to VOUT

I_{LOAD} = Load current

R_{ON} = On-resistance of the device for a specific V_{IN}

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

11.1.2 On/Off Control

The ON pin controls the state of the switch. The ON pin has a low threshold, making it capable of interfacing with low-voltage signals. The ON pin is compatible with standard GPIO logic thresholds. It can be used with any microcontroller with 1.2 V or higher GPIO voltage. This pin cannot be left floating and must be driven either high or low for proper functionality.

11.1.3 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 or short-circuit, 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 used to further reduce the voltage drop during high current applications. When switching heavy loads, it is recommended to have an input capacitor about 10 times higher than the output capacitor to avoid excessive voltage drop.

11.1.4 Output Capacitor (Optional)

Due to the integrated 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}. A C_{IN} to C_L ratio of 10 to 1 is recommended for minimizing VIN dip caused by inrush currents during startup, however a 10 to 1 ratio for capacitance is not required for proper functionality of the device. A ratio smaller than 10 to 1 (such as 1 to 1) could cause slightly more V_{IN} dip upon turn-on due to inrush currents. This can be mitigated by using a device with a longer rise time.

11.2 Typical Application

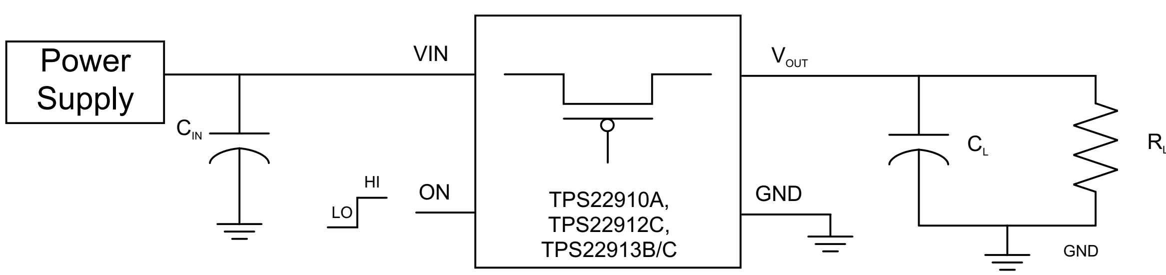


Figure 50. Typical Application

Typical Application (continued)

11.2.1 Design Requirements

Design Parameter	Example Value
VIN	1.5 V to 5 V
CL	0.1 µF to 1 µF
Maximum Acceptable Inrush Current	1 A

11.2.2 Detailed Design Procedure

11.2.2.1 Inrush Current

When the switch is enabled, the output capacitors must be charged up from 0-V to VIN voltage. This charge arrives in the form of inrush current. Inrush current can be calculated using the following equation:

$$\text{Inrush Current} = C \times \frac{dv}{dt} \quad (2)$$

Where,

C = Output capacitance

$\frac{dv}{dt}$ = Output slew rate

The TPS22910A, TPS22912C, and TPS22913B/C offer several different rise time options to control the inrush current during turn-on. The appropriate device can be selected based upon the maximum acceptable slew rate which can be calculated using the design requirements and the inrush current equation. An output capacitance of 1.0 µF will be used since the inrush follows the following equations:

$$1.0\ A = 1.0\ \mu F \times \frac{dv}{dt} \quad (3)$$

$$\frac{dv}{dt} = 1\ V/\mu s \quad (4)$$

To ensure an inrush current of less than 1 A, a device with a slew rate less than 1 V/µs must be used

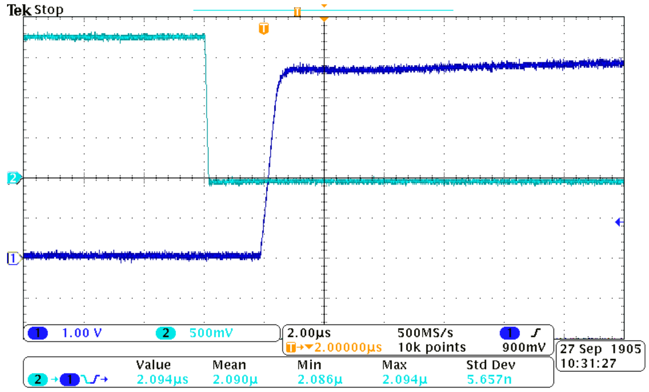
The TPS22910A has a typical rise time of 1 µs at 3.3 V . This results in a slew rate of 3.3 V/µs which is above the 1 V/µs requirement meaning the TPS22910 could not be used to meet the design requirements.

The TPS22913B has a typical rise time of 66 µs at 3.3 V. This results in a slew rate of 50 mV/µs which is below the 1 V/µs requirement; therefor, the TPS22913B could be used to meet the design requirements. The TPS22912C or TPS22913C have lower slew rates than the TPS22913B, so they could also be used, but the output would rise more slowly.

11.2.3 Application Curves

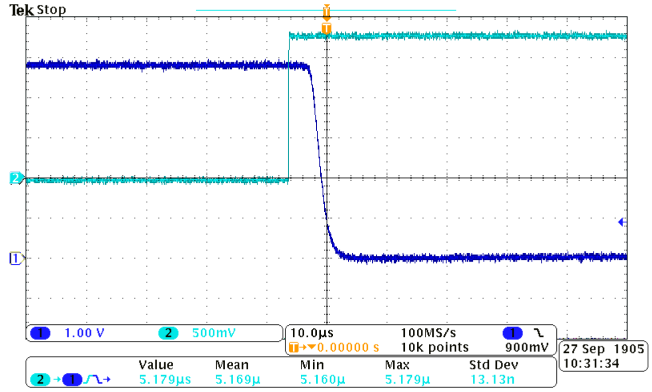
11.2.3.1 Typical Application Characteristics for TPS22910A

The dark blue curve (Channel 1) represents the VOUT pin of the device. The light blue curve (Channel 2) represents the ON pin of the device.



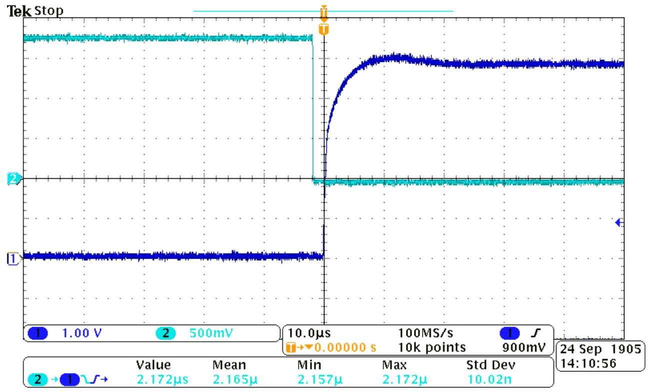
V_{IN} = 5 V T_A = 25°C C_{IN} = 10 µF
C_L = 0.1 µF R_L = 10Ω

Figure 51. Turn-on Response



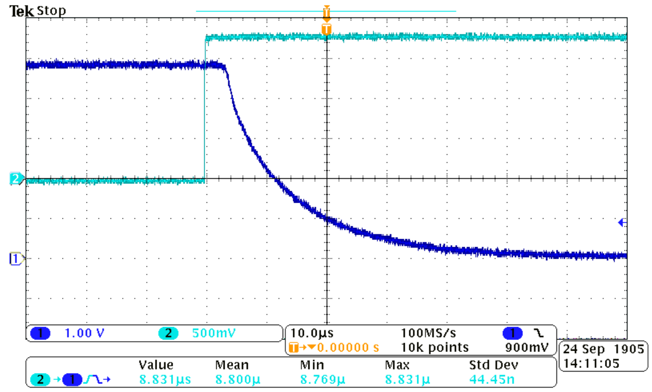
V_{IN} = 5 V T_A = 25°C C_{IN} = 10 µF
C_L = 0.1 µF R_L = 10Ω

Figure 52. Turn-off Response



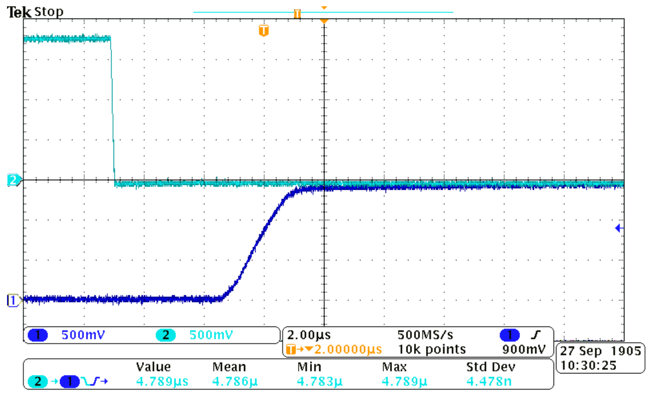
V_{IN} = 5 V T_A = 25°C C_{IN} =10 µF
C_L = 1 µF R_L = 10 Ω

Figure 53. Turn-on Response Time



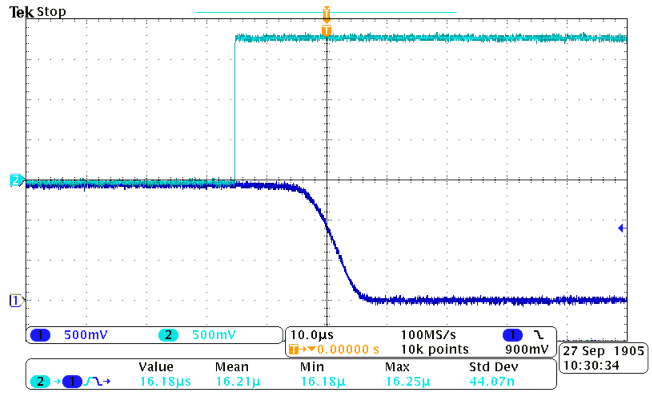
V_{IN} = 5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10Ω

Figure 54. Turn-off Response Time



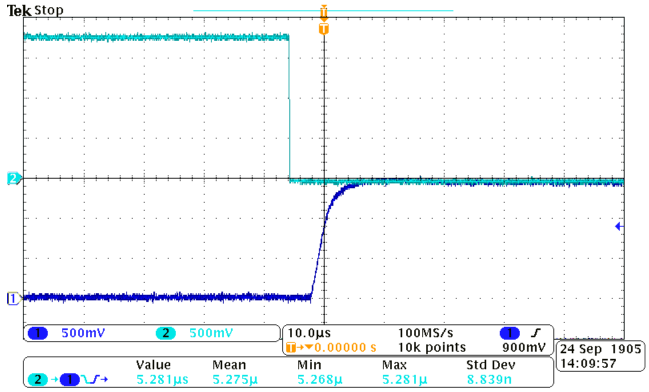
V_{IN} = 1.5 V T_A = 25°C C_{IN} = 10 µF
C_L = 0.1 µF R_L = 10Ω

Figure 55. Turn-on Response Time



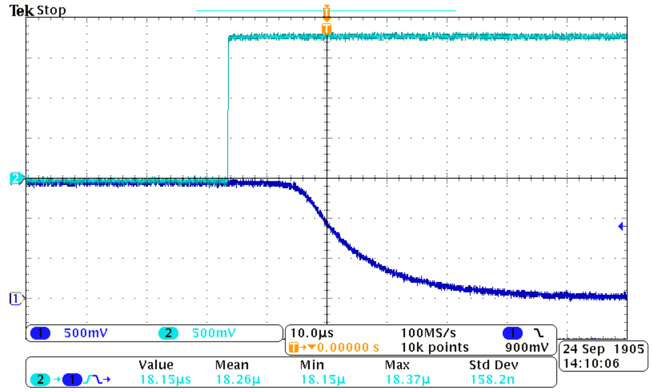
V_{IN} = 1.5 V T_A = 25°C C_{IN} = 10 µF
C_L = 0.1 µF R_L = 10Ω

Figure 56. Turn-off Response Time



V_{IN} = 1.5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10Ω

Figure 57. Turn-on Response Time

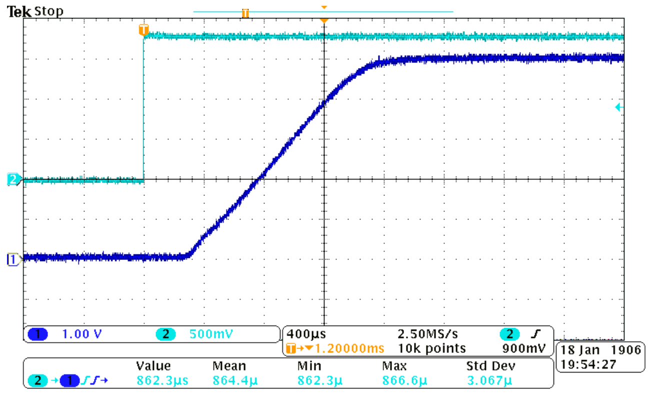


V_{IN} = 1.5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10Ω

Figure 58. Turn-off Response Time

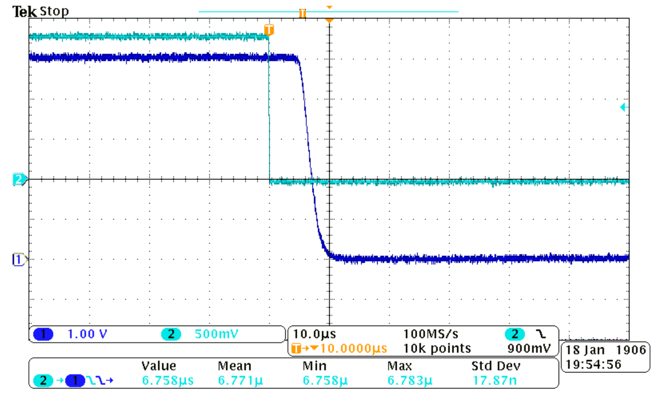
11.2.3.2 Typical Application Characteristics for TPS22912C

The dark blue curve (Channel 1) represents the VOUT pin of the device. The light blue curve (Channel 2) represents the ON pin of the device.



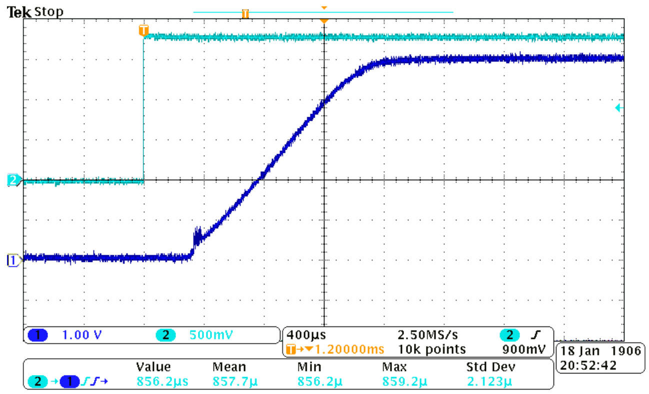
V_{IN} = 5 V T_A = 25°C C_{IN} = 1 µF
C_L = 0.1 µF R_L = 10Ω

Figure 59. Turn-on Response



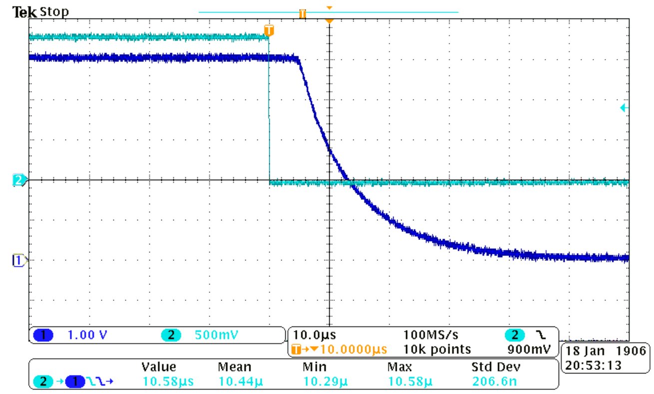
V_{IN} = 5 V T_A = 25°C C_{IN} = 1 µF
C_L = 0.1 µF R_L = 10 Ω

Figure 60. Turn-off Response



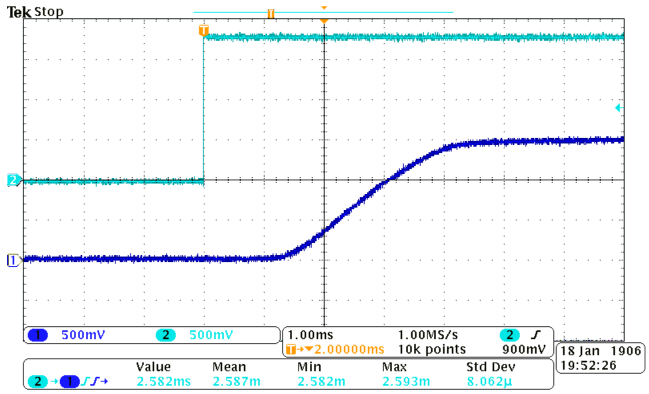
V_{IN} = 5 V T_A = 25°C C_{IN} =10 µF
C_L = 1 µF R_L = 10 Ω

Figure 61. Turn-on Response Time



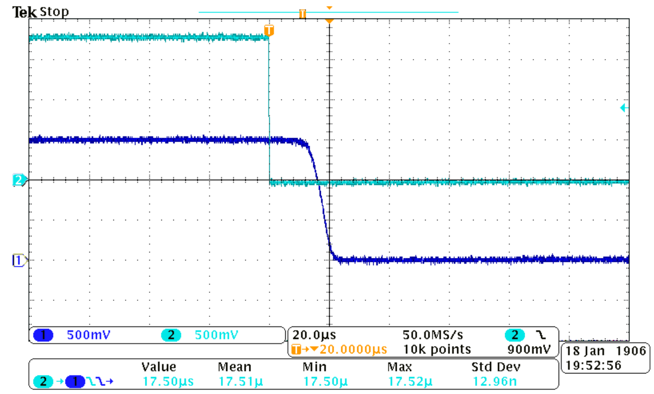
V_{IN} = 5 T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10 Ω

Figure 62. Turn-off Response Time



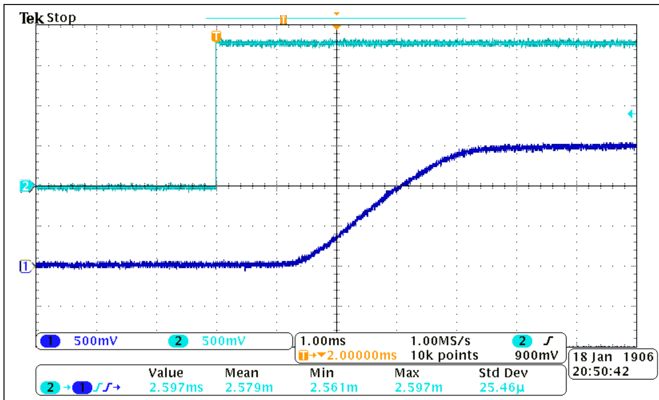
V_{IN} = 1.5 V T_A = 25°C C_{IN} = 1 µF
C_L = 0.1 µF R_L = 10 Ω

Figure 63. Turn-on Response Time



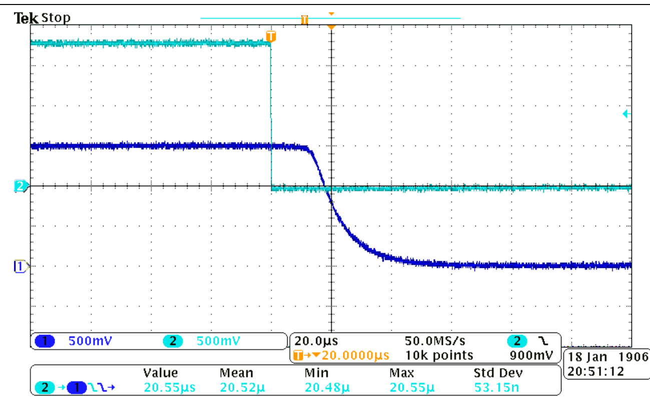
V_{IN} = 1.5 V T_A = 25°C C_{IN} = 1 µF
C_L = 0.1 µF R_L = 10 Ω

Figure 64. Turn-off Response Time



V_{IN} = 1.5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10 Ω

Figure 65. Turn-on Response Time

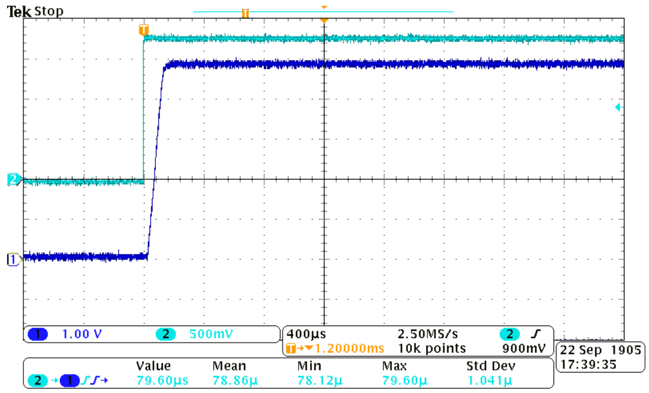


V_{IN} = 1.5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10 Ω

Figure 66. Turn-off Response Time

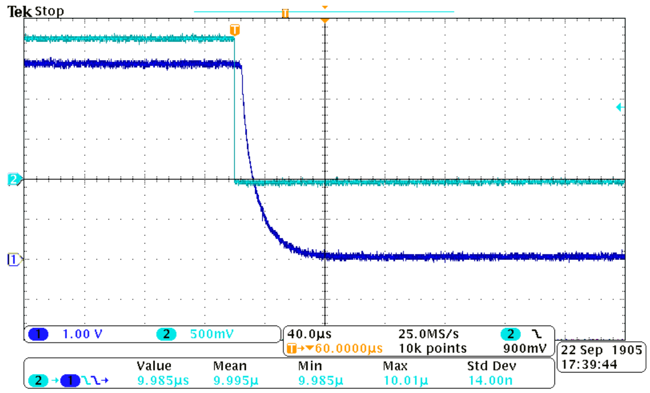
11.2.3.3 Typical Application Characteristics For TPS22913B

The dark blue curve (Channel 1) represents the VOUT pin of the device. The light blue curve (Channel 2) represents the ON pin of the device.



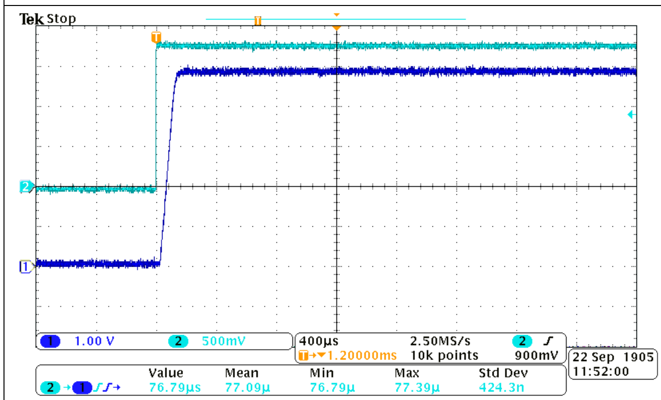
V_{IN} = 5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10 Ω

Figure 67. Turn-on Response



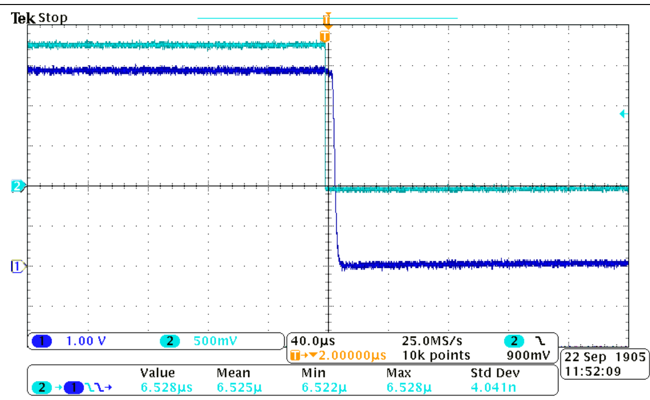
V_{IN} = 5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10 Ω

Figure 68. Turn-off Response



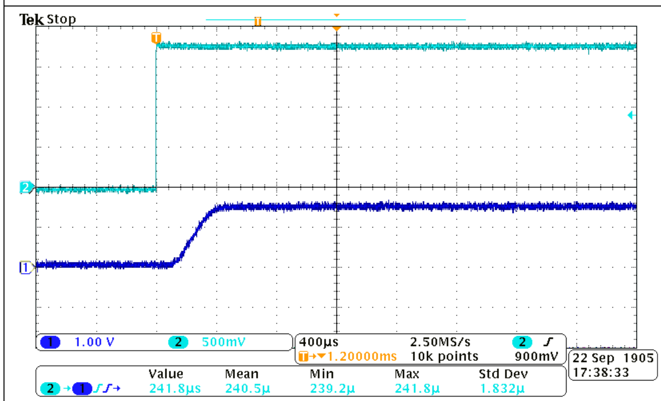
V_{IN} = 5 V T_A = 25°C C_{IN} = 1 µF
C_L = 0.1 µF R_L = 10 Ω

Figure 69. Turn-on Response Time



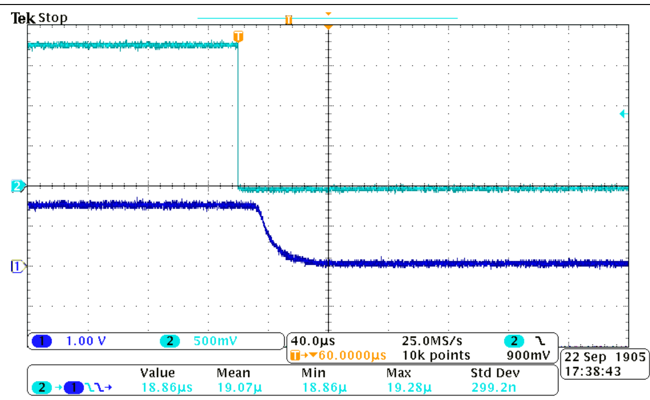
V_{IN} = 5 V T_A = 25°C C_{IN} = 1 µF
C_L = 0.1 µF R_L = 10 Ω

Figure 70. Turn-off Response Time



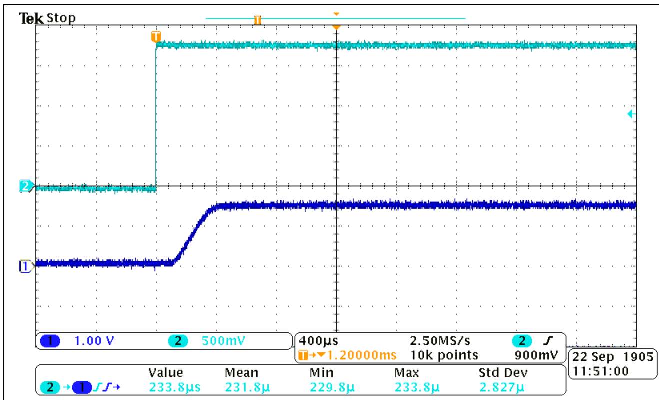
V_{IN} = 1.5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10 Ω

Figure 71. Turn-on Response Time



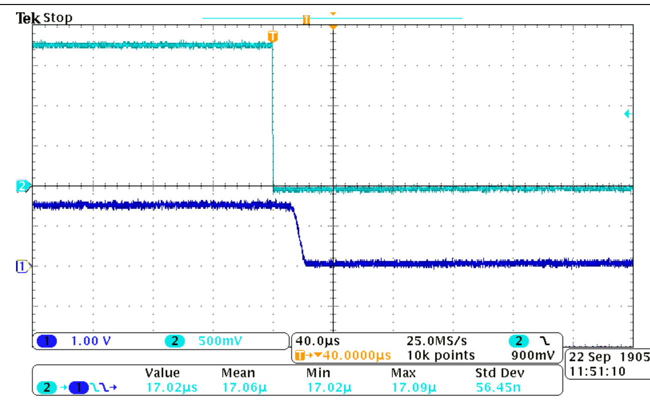
V_{IN} = 1.5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10 Ω

Figure 72. Turn-off Response Time



V_{IN} = 1.5 V T_A = 25°C C_{IN} = 1 µF
C_L = 0.1 µF R_L = 10 Ω

Figure 73. Turn-on Response Time

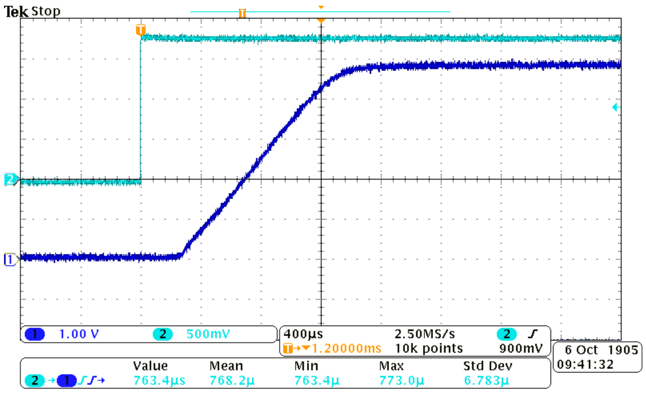


V_{IN} = 1.5 V T_A = 25°C C_{IN} = 1 µF
C_L = 0.1 µF R_L = 10 Ω

Figure 74. Turn-off Response Time

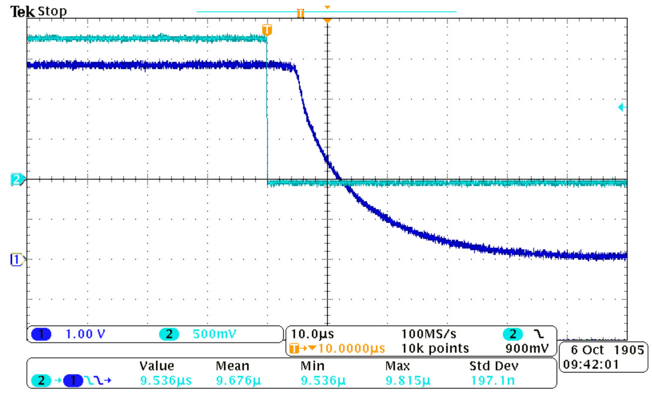
11.2.3.4 Typical Application Characteristics for TPS22913C

The dark blue curve (Channel 1) represents the VOUT pin of the device. The light blue curve (Channel 2) represents the ON pin of the device.



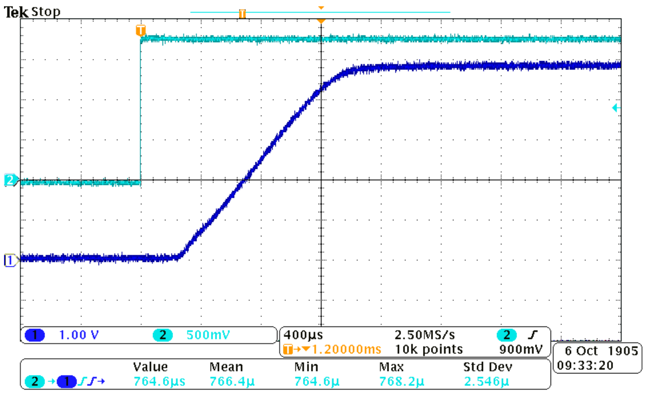
V_{IN} = 5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10 Ω

Figure 75. Turn-On Response Time



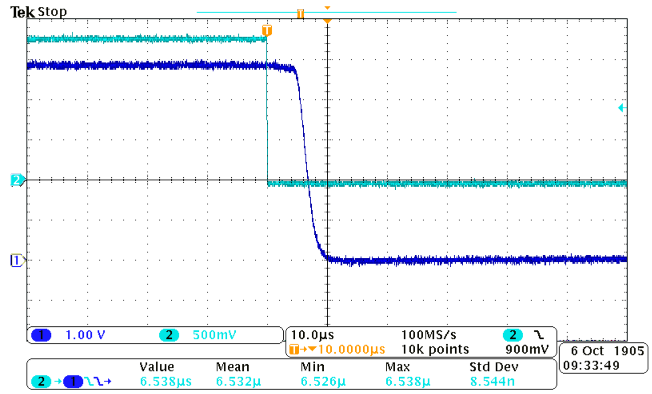
V_{IN} = 5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10 Ω

Figure 76. Turn-Off Response Time



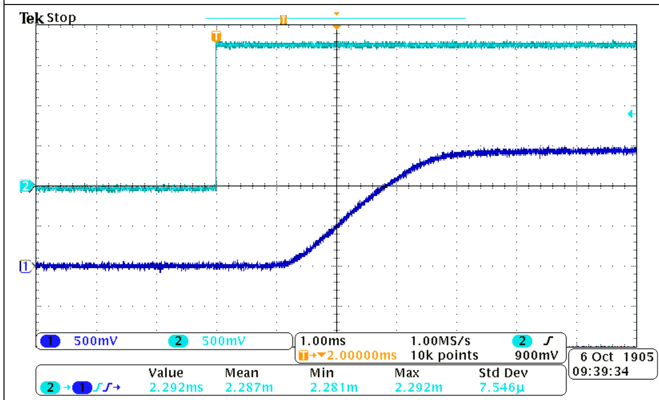
V_{IN} = 5 V T_A = 25°C C_{IN} = 1 µF
C_L = 0.1 µF R_L = 10 Ω

Figure 77. Turn-On Response Time



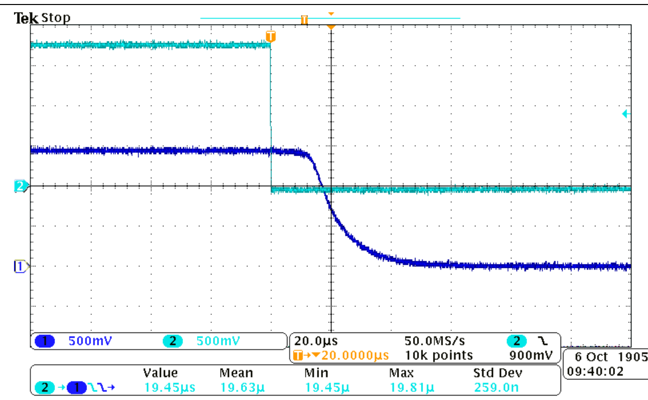
V_{IN} = 5 V T_A = 25°C C_{IN} = 1 µF
C_L = 0.1 µF R_L = 10 Ω

Figure 78. Turn-Off Response Time



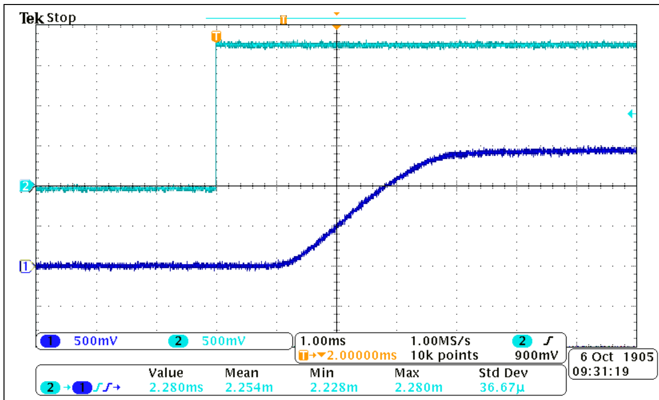
V_{IN} = 1.5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10 Ω

Figure 79. Turn-Off Response Time



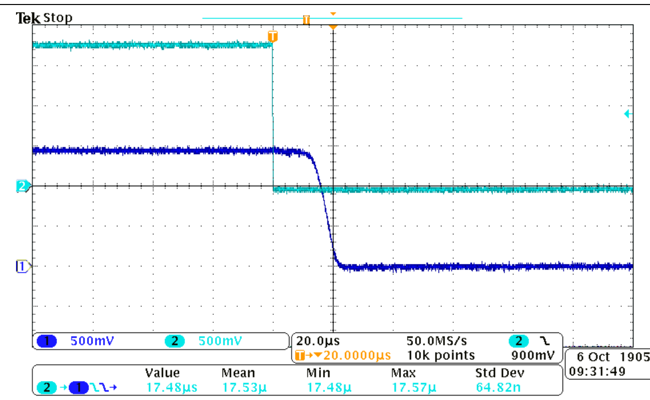
V_{IN} = 1.5 V T_A = 25°C C_{IN} = 10 µF
C_L = 1 µF R_L = 10 Ω

Figure 80. Turn-Off Response Time



V_{IN} = 1.5 V T_A = 25°C C_{IN} = 1 µF
C_L = 0.1 µF R_L = 10 Ω

Figure 81. Turn-Off Response Time



V_{IN} = 1.5 V T_A = 25°C C_{IN} = 1 µF
C_L = 0.1 µF R_L = 10 Ω

Figure 82. Turn-Off Response Time

12 Power Supply Recommendations

The device is designed to operate with a VIN range of 1.4 V to 5.5 V.

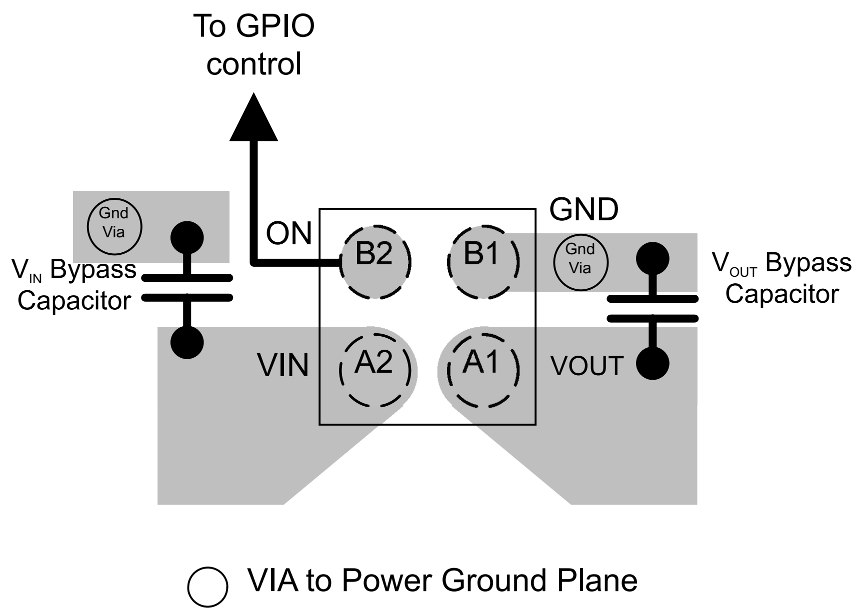
13 Layout

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 helps minimize the parasitic electrical effects along with minimizing the case to ambient thermal impedance.

13.2 Layout Example

The figure below shows an example for these devices. Notice the connection to system ground between the V_{OUT} Bypass Capacitor ground and the GND pin of the load switch, this creates a ground barrier which helps to reduce the ground noise seen by the device.



13.3 Thermal Considerations

The maximum IC junction temperature should be restricted to 125°C under normal operating conditions. To calculate the maximum allowable dissipation, $P_{D(max)}$ for a given output current and ambient temperature, use the following equation as a guideline:

$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_A}{R_{\theta JA}} \quad (5)$$

where

- $P_{D(max)}$ = maximum allowable power dissipation
- $T_{J(max)}$ = maximum allowable junction temperature
- T_A = ambient temperature of the device
- θ_{JA} = junction to air thermal impedance. See the *Thermal Information* section. This parameter is highly dependent upon board layout.

14 器件和文档支持

14.1 相关链接

下面的表格列出了快速访问链接。范围包括技术文档、支持和社区资源、工具和软件，以及样片或购买的快速访问。

表 **3.** 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
TPS22910A	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
TPS22912C	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
TPS22913B	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
TPS22913C	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.
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 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)
TPS22910AYZVR	Active	Production	DSBGA (YZV) | 4	3000 | LARGE T&R	Yes	SAC396	Level-1-260C-UNLIM	-40 to 85	75
TPS22910AYZVR.A	Active	Production	DSBGA (YZV) | 4	3000 | LARGE T&R	Yes	SAC396	Level-1-260C-UNLIM	-40 to 85	75
TPS22910AYZVR.B	Active	Production	DSBGA (YZV) | 4	3000 | LARGE T&R	Yes	SAC396	Level-1-260C-UNLIM	-40 to 85	75
TPS22910AYZVT	Active	Production	DSBGA (YZV) | 4	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	75
TPS22910AYZVT.A	Active	Production	DSBGA (YZV) | 4	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	75
TPS22910AYZVT.B	Active	Production	DSBGA (YZV) | 4	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	75
TPS22912CYZVR	Active	Production	DSBGA (YZV) | 4	3000 | LARGE T&R	Yes	SAC396	Level-1-260C-UNLIM	-40 to 85	78
TPS22912CYZVR.A	Active	Production	DSBGA (YZV) | 4	3000 | LARGE T&R	Yes	SAC396	Level-1-260C-UNLIM	-40 to 85	78
TPS22912CYZVR.B	Active	Production	DSBGA (YZV) | 4	3000 | LARGE T&R	Yes	SAC396	Level-1-260C-UNLIM	-40 to 85	78
TPS22912CYZVT	Active	Production	DSBGA (YZV) | 4	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	78
TPS22912CYZVT.A	Active	Production	DSBGA (YZV) | 4	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	78
TPS22912CYZVT.B	Active	Production	DSBGA (YZV) | 4	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	78
TPS22913BYZVR	Active	Production	DSBGA (YZV) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	64
TPS22913BYZVR.A	Active	Production	DSBGA (YZV) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	64
TPS22913BYZVR.B	Active	Production	DSBGA (YZV) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	64
TPS22913BYZVT	Active	Production	DSBGA (YZV) | 4	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	64
TPS22913BYZVT.A	Active	Production	DSBGA (YZV) | 4	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	64
TPS22913BYZVT.B	Active	Production	DSBGA (YZV) | 4	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	64
TPS22913CYZVR	Active	Production	DSBGA (YZV) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	76
TPS22913CYZVR.A	Active	Production	DSBGA (YZV) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	76
TPS22913CYZVR.B	Active	Production	DSBGA (YZV) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	76
TPS22913CYZVT	Active	Production	DSBGA (YZV) | 4	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	76
TPS22913CYZVT.A	Active	Production	DSBGA (YZV) | 4	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	76
TPS22913CYZVT.B	Active	Production	DSBGA (YZV) | 4	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	76

(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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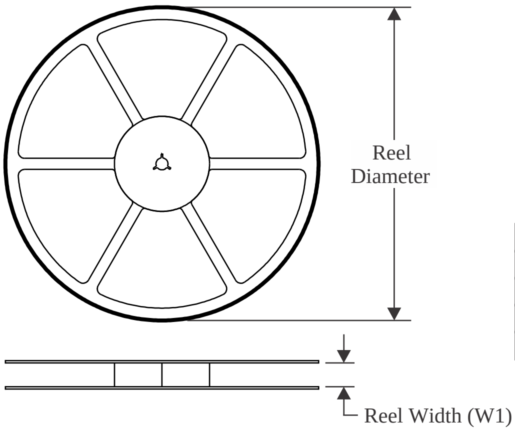
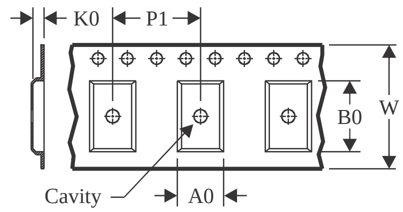
TAPE AND REEL INFORMATION

REEL DIMENSIONS

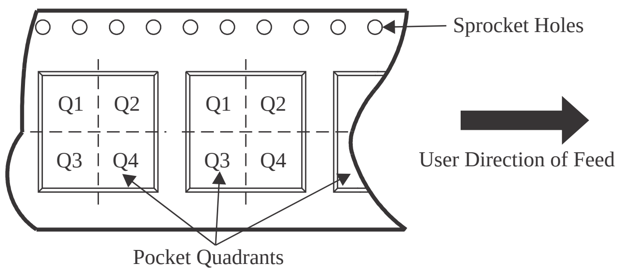


TAPE DIMENSIONS



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

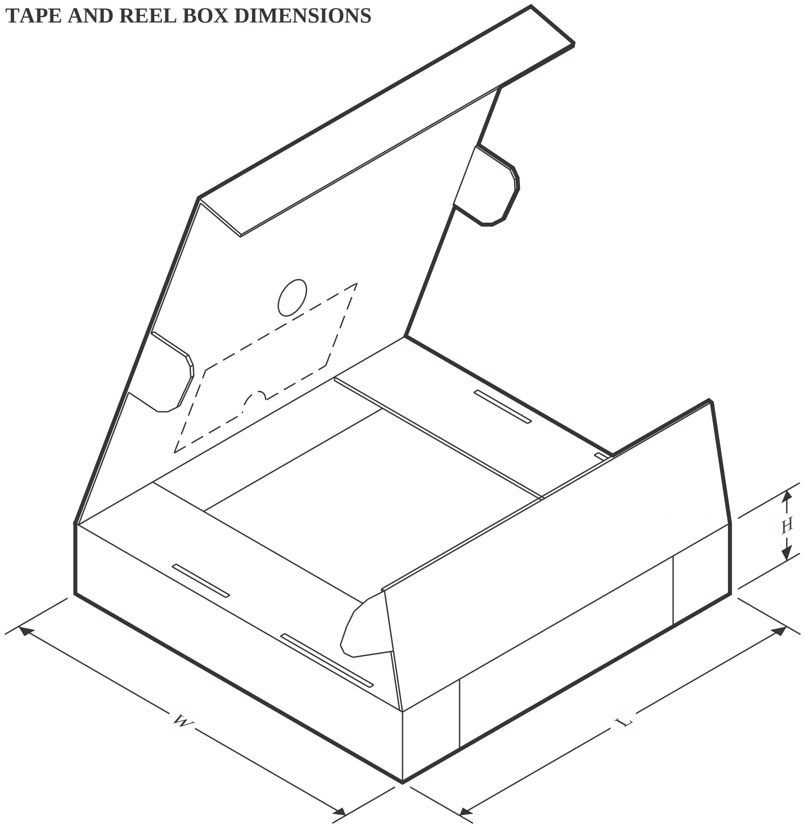
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS22910AYZVR	DSBGA	YZV	4	3000	178.0	9.2	1.0	1.0	0.63	4.0	8.0	Q1
TPS22910AYZVT	DSBGA	YZV	4	250	178.0	9.2	1.0	1.0	0.63	4.0	8.0	Q1
TPS22912CYZVR	DSBGA	YZV	4	3000	178.0	9.2	1.0	1.0	0.63	4.0	8.0	Q1
TPS22912CYZVT	DSBGA	YZV	4	250	178.0	9.2	1.0	1.0	0.63	4.0	8.0	Q1
TPS22913BYZVR	DSBGA	YZV	4	3000	180.0	8.4	1.0	1.0	0.63	4.0	8.0	Q1
TPS22913BYZVT	DSBGA	YZV	4	250	180.0	8.4	1.0	1.0	0.63	4.0	8.0	Q1
TPS22913CYZVR	DSBGA	YZV	4	3000	180.0	8.4	1.0	1.0	0.63	4.0	8.0	Q1
TPS22913CYZVT	DSBGA	YZV	4	250	180.0	8.4	1.0	1.0	0.63	4.0	8.0	Q1

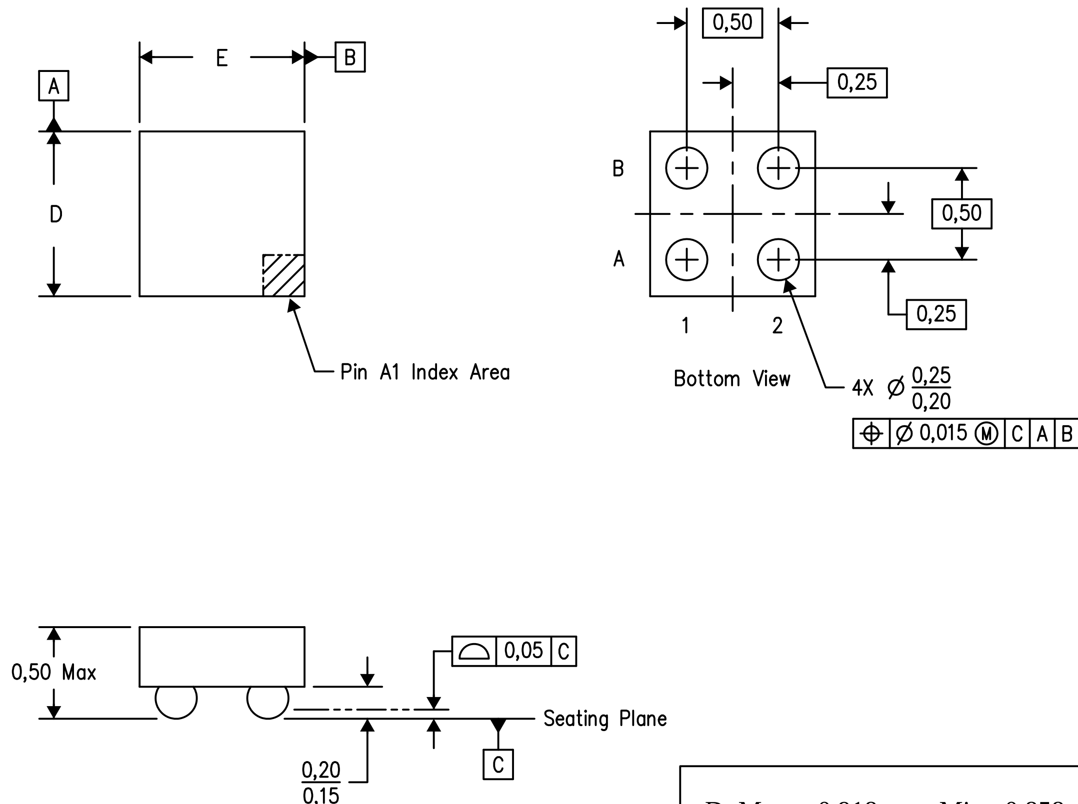
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS22910AYZVR	DSBGA	YZV	4	3000	220.0	220.0	35.0
TPS22910AYZVT	DSBGA	YZV	4	250	220.0	220.0	35.0
TPS22912CYZVR	DSBGA	YZV	4	3000	220.0	220.0	35.0
TPS22912CYZVT	DSBGA	YZV	4	250	220.0	220.0	35.0
TPS22913BYZVR	DSBGA	YZV	4	3000	182.0	182.0	20.0
TPS22913BYZVT	DSBGA	YZV	4	250	182.0	182.0	20.0
TPS22913CYZVR	DSBGA	YZV	4	3000	182.0	182.0	20.0
TPS22913CYZVT	DSBGA	YZV	4	250	182.0	182.0	20.0

YZV (S–XBGA–N4) DIE–SIZE BALL GRID ARRAY



D: Max = 0.918 mm, Min =0.858 mm

E: Max = 0.918 mm, Min =0.858 mm

4206083/C 07/13

NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
- B. This drawing is subject to change without notice.
- C. NanoFree™ package configuration.

NanoFree is a trademark of Texas Instruments.

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