

ULTRA SMALL, LOW INPUT VOLTAGE, LOW r_{ON} , LOAD SWITCHES

Check for Samples: [TPS22901](#), [TPS22902](#), [TPS22902B](#)

FEATURES

- Low Input Voltage: 1.0 V to 3.6 V
- Ultra-Low ON Resistance
 - $r_{ON} = 78\text{ m}\Omega$ at $V_{IN} = 3.6\text{ V}$
 - $r_{ON} = 93\text{ m}\Omega$ at $V_{IN} = 2.5\text{ V}$
 - $r_{ON} = 109\text{ m}\Omega$ at $V_{IN} = 1.8\text{ V}$
 - $r_{ON} = 146\text{ m}\Omega$ at $V_{IN} = 1.2\text{ V}$
- 500-mA Maximum Continuous Switch Current
- Ultra Low Quiescent Current: 82 nA at 1.8 V
- Ultra Low Shutdown Current: 44 nA at 1.8 V
- Low Control Input Thresholds Enable Use of 1.2-V/1.8-V/2.5-V/3.3-V Logic
- Controlled Slew Rate to Avoid Inrush Currents
 - TPS22901 and TPS22902: 40- μs t_r
 - TPS22902B: 220- μs t_r
- ESD Performance Tested Per JESD 22
 - 2000-V Human-Body Model (A114-B, Class II)
 - 1000-V Charged-Device Model (C101)
- Four-Terminal Wafer-Chip-Scale Package (WCSP)
 - 0.8 mm $\times$ 0.8 mm, 0.4 mm Pitch, 0.5 mm Height

APPLICATIONS

- Personal Digital Assistants (PDAs)
- Cellular Phones
- GPS Devices
- MP3 Players
- Digital Cameras
- Peripheral Ports
- Portable Instrumentation
- RF Modules

DESCRIPTION

TPS22901, TPS22902, and TPS22902B are ultra-small, low ON resistance (r_{ON}) load switches with controlled turn on. The devices contain a P-channel MOSFET that operates over an input voltage range of 1.0 V to 3.6 V. The switch is controlled by an on/off input (ON), which is capable of interfacing directly with low-voltage control signals. In TPS22902 and in TPS22902B, a 120- Ω on-chip load resistor is added for output quick discharge when the switch is turned off.

TPS22901, TPS22902, and TPS22902B are available in a space-saving 4-terminal WCSP with 0.4-mm pitch (YFP). The devices are characterized for operation over the free-air temperature range of -40°C to 85°C .

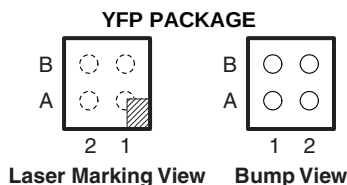


Table 1. TERMINAL ASSIGNMENTS

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

	r_{ON} at 1.8 V (TYP)	SLEW RATE (TYP at 1.8 V)	QUICK OUTPUT DISCHARGE ⁽¹⁾	MAX OUTPUT CURRENT	ENABLE
TPS22901	109 m Ω	40 μs		500 mA	Active high
TPS22902	109 m Ω	40 μs	Yes	500 mA	Active high
TPS22902B	109 m Ω	220 μs	Yes	500 mA	Active high

(1) This feature discharges the output of the switch to ground through a 120- Ω resistor, preventing the output from floating.



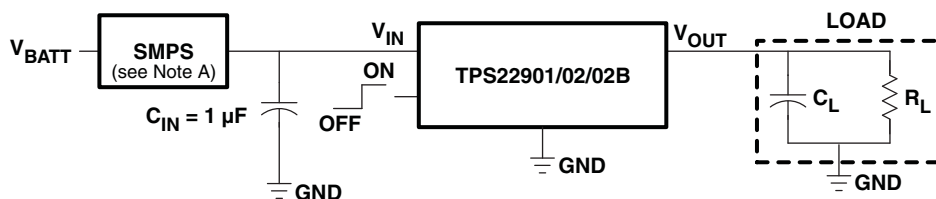
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

ORDERING INFORMATION

T_A	PACKAGE ⁽¹⁾ ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	WCSP – YFP (0.4 mm pitch)	Tape and reel	TPS22901YFPR	__ _3P
			TPS22902YFPR	__ _3R
			TPS22902BYFPR	__ _3S

(1) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

TYPICAL APPLICATION

A. Switched mode power supply

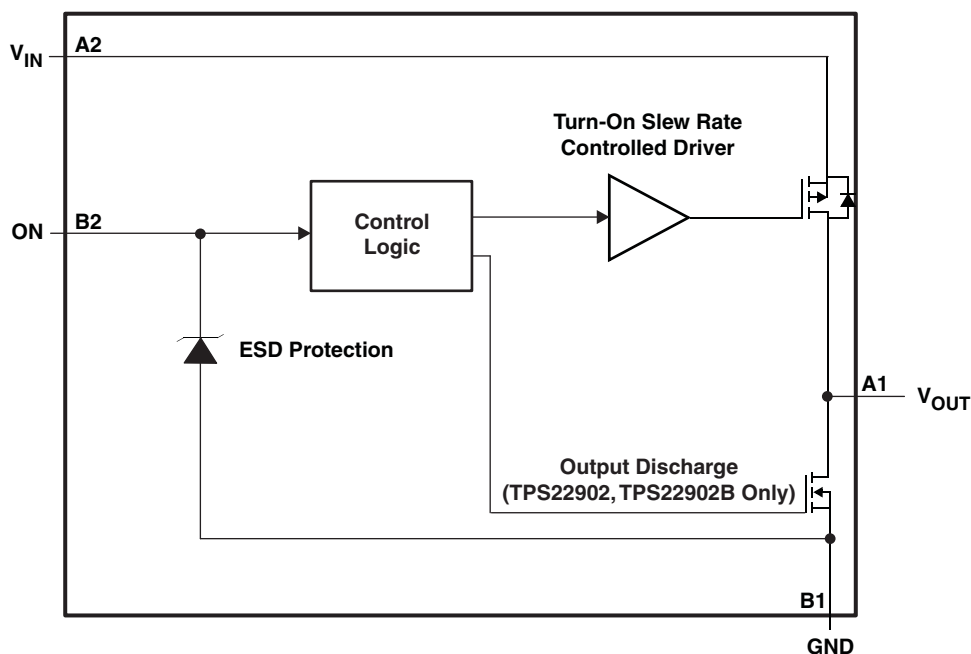
APPLICATION BLOCK DIAGRAM

Figure 1. Functional Block Diagram

FUNCTION TABLE

ON (Control Input)	V_{IN} to V_{OUT}	V_{OUT} to GND (TPS22902, TPS22902B only)
L	OFF	ON
H	ON	OFF

TERMINAL FUNCTIONS

TERMINAL		DESCRIPTION
BALL NO.	NAME	
A1	V _{OUT}	Switch output
A2	V _{IN}	Switch input, bypass this input with a ceramic capacitor to ground
B1	GND	Ground
B2	ON	Switch control input, active high

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

		MIN	MAX	UNIT
V _{IN}	Input voltage range	−0.3	4	V
V _{OUT}	Output voltage range		V _{IN} + 0.3	V
V _{ON}	Input voltage range	−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 range	−40	85	°C
T _{stg}	Storage temperature range	−65	150	°C
T _{lead}	Maximum lead temperature (10-s soldering time)		300	°C
ESD	Electrostatic discharge protection	Human-Body Model (HBM)	2000	V
		Charged Device Model (CDM)	1000	

- (1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

THERMAL IMPEDANCE RATINGS

			UNIT
θ _{JA}	Package thermal impedance ⁽¹⁾	YFP package	205 °C/W

- (1) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
V _{IN}	Input voltage range	1	3.6	V
V _{OUT}	Output voltage range		V _{IN}	
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	1 ⁽¹⁾		μF

- (1) See [Application Information](#).

ELECTRICAL CHARACTERISTICS
 $V_{IN} = 1.0\text{ V to }3.6\text{ V}$, $T_A = -40^\circ\text{C to }85^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T _A	MIN	TYP ⁽¹⁾	MAX	UNIT
I _{IN}	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, 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 _{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

(1) Typical values are at the specified V_{IN} and $T_A = 25^\circ\text{C}$.

SWITCHING CHARACTERISTICS

 $V_{IN} = 1.1\text{ V}$, $T_A = 25^\circ\text{C}$ (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	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		108			108			531		μs
		$C_L = 1\ \mu\text{F}$		131			131			596		
		$C_L = 3.3\ \mu\text{F}$		153			153			659		
t_{OFF} Turn-OFF time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		39			11			11		μs
		$C_L = 1\ \mu\text{F}$		317			69			67		
		$C_L = 3.3\ \mu\text{F}$		1105			238			225		
t_r V_{OUT} rise time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		70			70			365		μs
		$C_L = 1\ \mu\text{F}$		78			78			367		
		$C_L = 3.3\ \mu\text{F}$		92			92			395		
t_f V_{OUT} fall time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		107			18			21		μs
		$C_L = 1\ \mu\text{F}$		966			175			189		
		$C_L = 3.3\ \mu\text{F}$		3532			632			565		

(1) $R_{L_CHIP} = 120\ \Omega$

SWITCHING CHARACTERISTICS

 $V_{IN} = 1.2\text{ V}$, $T_A = 25^\circ\text{C}$ (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	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		96			96			471		μs
		$C_L = 1\ \mu\text{F}$		116			116			527		
		$C_L = 3.3\ \mu\text{F}$		135			135			587		
t_{OFF} Turn-OFF time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		39			10			10		μs
		$C_L = 1\ \mu\text{F}$		317			62			61		
		$C_L = 3.3\ \mu\text{F}$		1110			210			199		
t_r V_{OUT} rise time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		62			62			324		μs
		$C_L = 1\ \mu\text{F}$		69			69			325		
		$C_L = 3.3\ \mu\text{F}$		81			81			350		
t_f V_{OUT} fall time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		109			17			20		μs
		$C_L = 1\ \mu\text{F}$		995			163			175		
		$C_L = 3.3\ \mu\text{F}$		3650			587			523		

(1) $R_{L_CHIP} = 120\ \Omega$

SWITCHING CHARACTERISTICS $V_{IN} = 1.8\text{ V}$, $T_A = 25^\circ\text{C}$ (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	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		61			61			302		μs
		$C_L = 1\ \mu\text{F}$		72			72			335		
		$C_L = 3.3\ \mu\text{F}$		83			83			367		
t_{OFF} Turn-OFF time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		38			8			8		μs
		$C_L = 1\ \mu\text{F}$		317			49			49		
		$C_L = 3.3\ \mu\text{F}$		1135			169			167		
t_r V_{OUT} rise time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		40			40			220		μs
		$C_L = 1\ \mu\text{F}$		45			45			220		
		$C_L = 3.3\ \mu\text{F}$		53			53			235		
t_f V_{OUT} fall time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		111			15			15		μs
		$C_L = 1\ \mu\text{F}$		1020			140			159		
		$C_L = 3.3\ \mu\text{F}$		3700			517			481		

(1) $R_{L_CHIP} = 120\ \Omega$ **SWITCHING CHARACTERISTICS** $V_{IN} = 2.5\text{ V}$, $T_A = 25^\circ\text{C}$ (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	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		45			45			223		μs
		$C_L = 1\ \mu\text{F}$		53			53			246		
		$C_L = 3.3\ \mu\text{F}$		61			61			268		
t_{OFF} Turn-OFF time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		38			7			7		μs
		$C_L = 1\ \mu\text{F}$		314			46			47		
		$C_L = 3.3\ \mu\text{F}$		1140			161			158		
t_r V_{OUT} rise time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		32			32			175		μs
		$C_L = 1\ \mu\text{F}$		35			35			175		
		$C_L = 3.3\ \mu\text{F}$		41			41			187		
t_f V_{OUT} fall time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		113			14			18		μs
		$C_L = 1\ \mu\text{F}$		1040			139			185		
		$C_L = 3.3\ \mu\text{F}$		3795			516			471		

(1) $R_{L_CHIP} = 120\ \Omega$

SWITCHING CHARACTERISTICS

 $V_{IN} = 3\text{ V}$, $T_A = 25^\circ\text{C}$ (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	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		38			38			191		μs
		$C_L = 1\ \mu\text{F}$		45			45			211		
		$C_L = 3.3\ \mu\text{F}$		53			53			231		
t_{OFF} Turn-OFF time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		38			7			7		μs
		$C_L = 1\ \mu\text{F}$		320			46			46		
		$C_L = 3.3\ \mu\text{F}$		1145			53			156		
t_r V_{OUT} rise time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		28			28			159		μs
		$C_L = 1\ \mu\text{F}$		31			31			160		
		$C_L = 3.3\ \mu\text{F}$		37			37			170		
t_f V_{OUT} fall time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		114			14			17		μs
		$C_L = 1\ \mu\text{F}$		1045			139			160		
		$C_L = 3.3\ \mu\text{F}$		3815			509			473		

(1) $R_{L_CHIP} = 120\ \Omega$

SWITCHING CHARACTERISTICS

 $V_{IN} = 3.6\text{ V}$, $T_A = 25^\circ\text{C}$ (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	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		33			33			166		μs
		$C_L = 1\ \mu\text{F}$		39			39			183		
		$C_L = 3.3\ \mu\text{F}$		46			46			201		
t_{OFF} Turn-OFF time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		38			7			7		μs
		$C_L = 1\ \mu\text{F}$		322			46			45		
		$C_L = 3.3\ \mu\text{F}$		1145			156			155		
t_r V_{OUT} rise time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		25			25			146		μs
		$C_L = 1\ \mu\text{F}$		28			28			146		
		$C_L = 3.3\ \mu\text{F}$		34			34			156		
t_f V_{OUT} fall time	$R_L = 500\ \Omega$	$C_L = 0.1\ \mu\text{F}$		116			14			17		μs
		$C_L = 1\ \mu\text{F}$		1060			139			161		
		$C_L = 3.3\ \mu\text{F}$		3840			512			475		

(1) $R_{L_CHIP} = 120\ \Omega$

TYPICAL CHARACTERISTICS

TPS22901, TPS22902, TPS22902B

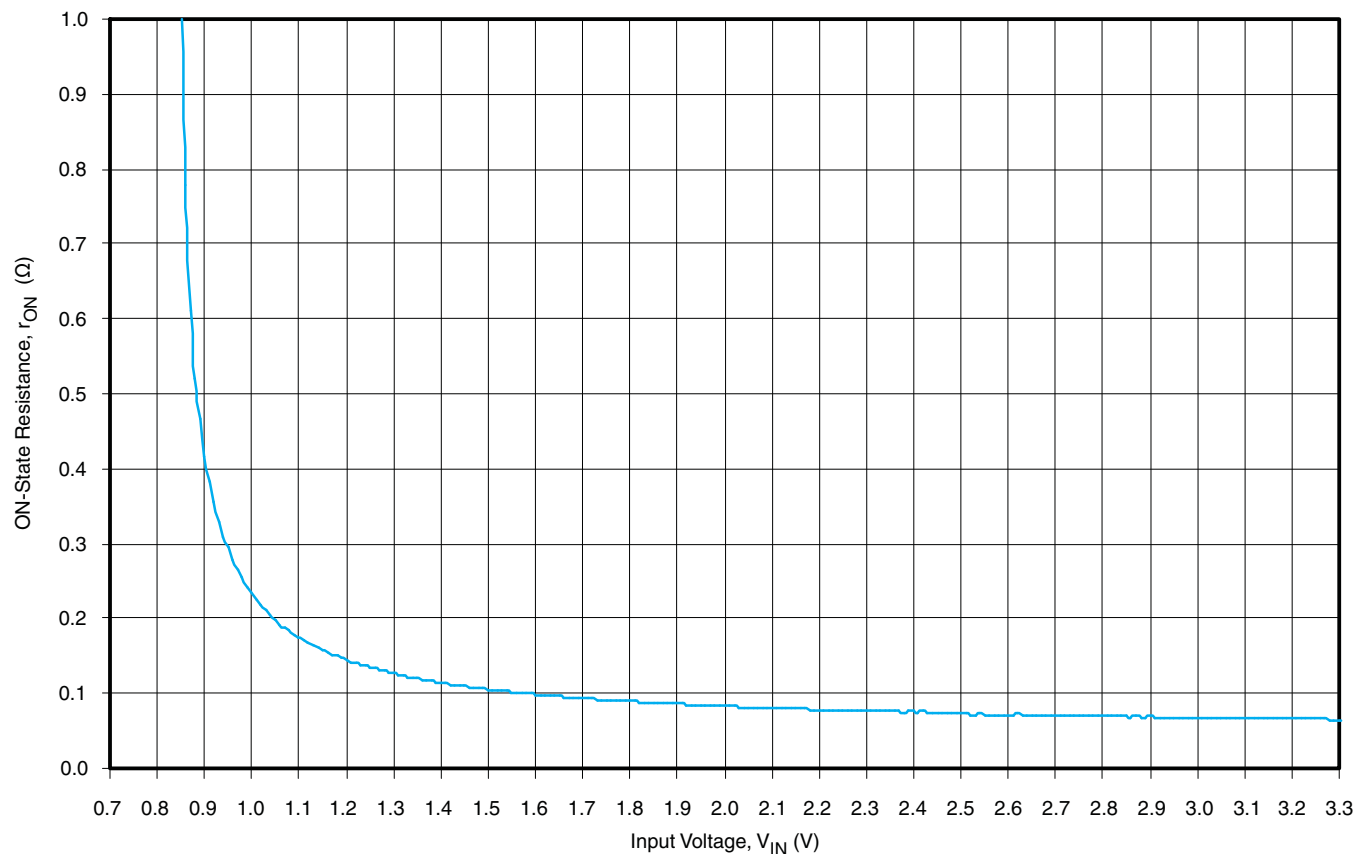
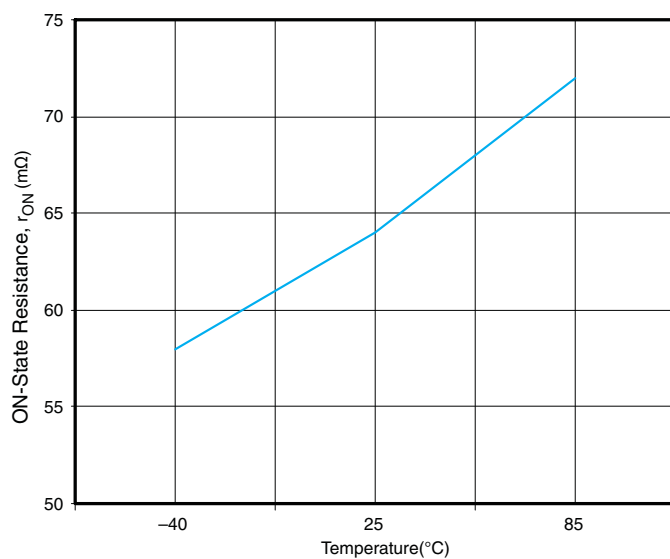
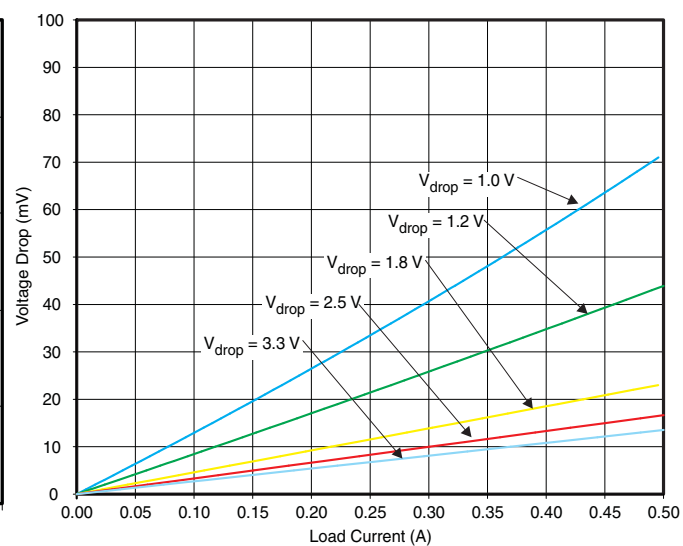
Figure 2. r_{ON} vs V_{IN} Figure 3. r_{ON} vs Temperature ($V_{IN} = 3.3$ V)

Figure 4. Voltage Drop vs. Load Current

TYPICAL CHARACTERISTICS (continued)

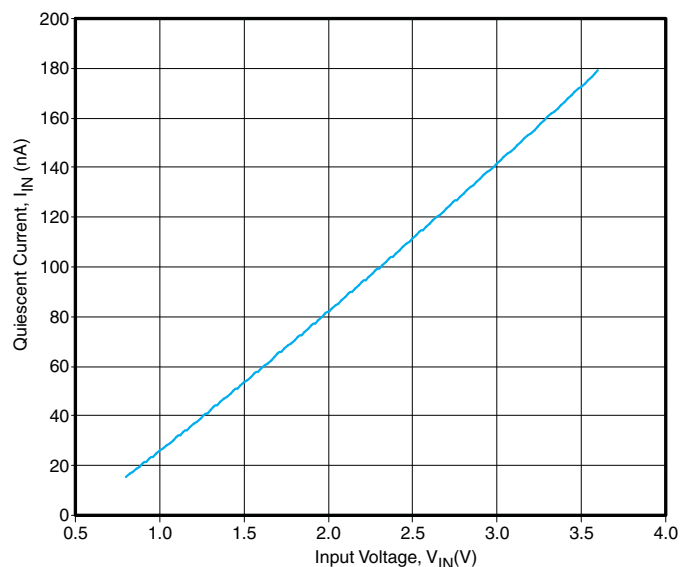


Figure 5. Quiescent Current vs V_{IN} ($V_{ON} = V_{IN}$, $I_{OUT} = 0$)

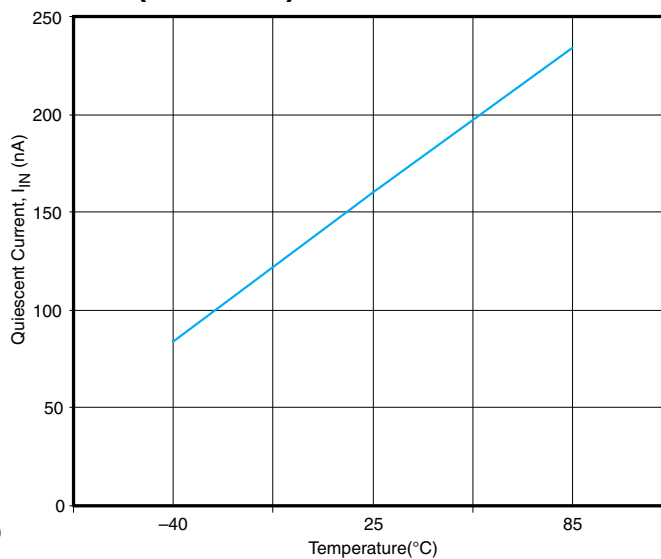


Figure 6. Quiescent Current vs Temperature ($V_{IN} = 3.3$ V, $I_{OUT} = 0$)

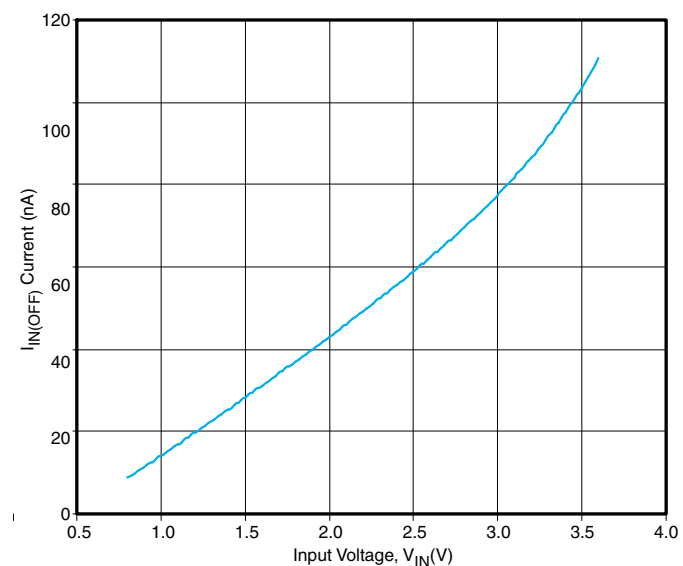


Figure 7. $I_{IN(OFF)}$ vs V_{IN} ($V_{ON} = 0$ V)

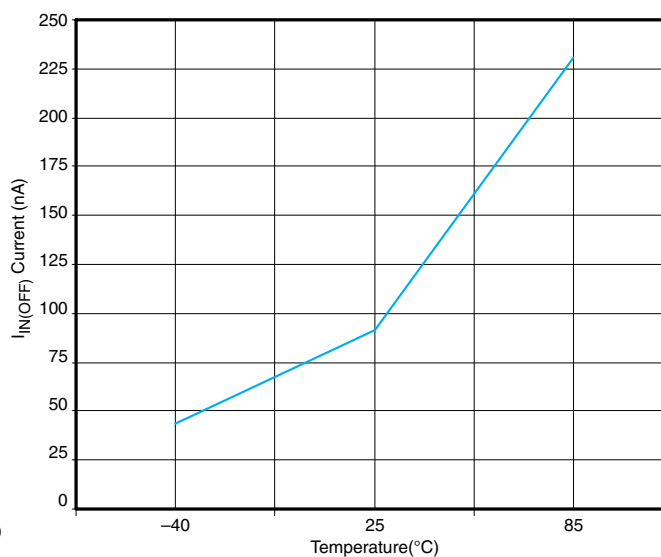


Figure 8. $I_{IN(OFF)}$ vs Temperature ($V_{IN} = 3.3$ V)

TYPICAL CHARACTERISTICS (continued)

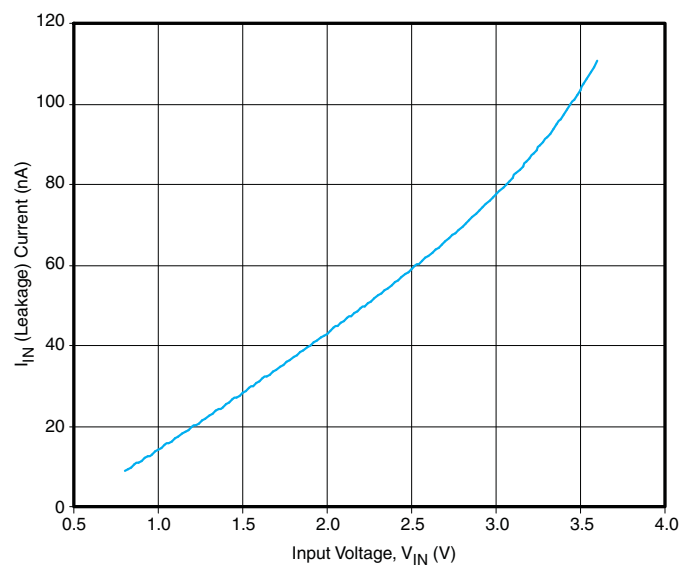


Figure 9. I_{IN} (Leakage) vs V_{IN} ($I_{OUT} = 0$)

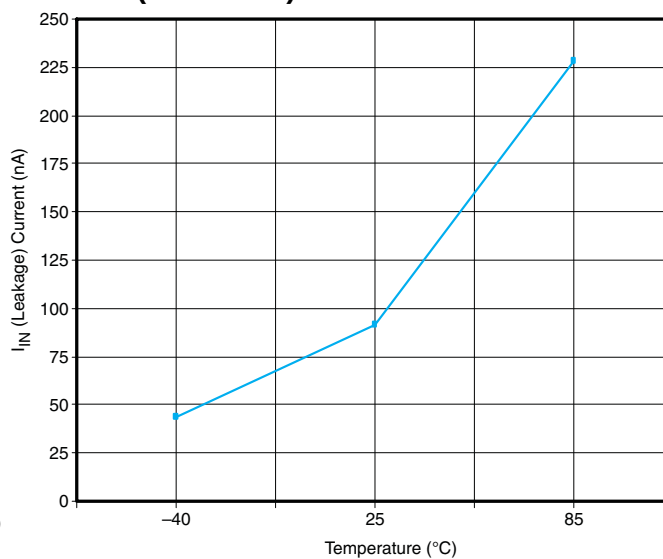


Figure 10. I_{IN} (Leakage) vs Temperature ($V_{IN} = 3.3$ V)

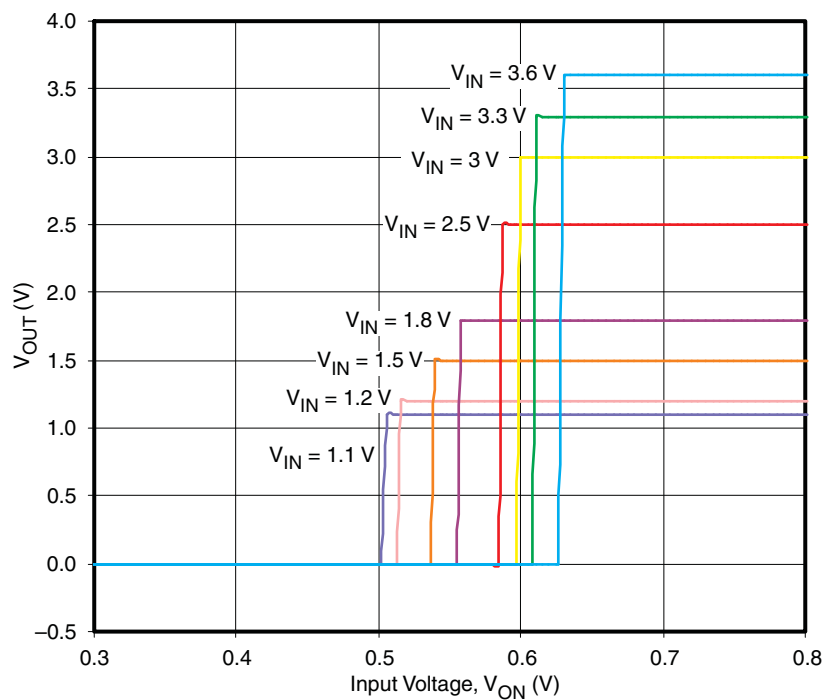


Figure 11. ON-Input Threshold

TPS22901

TYPICAL CHARACTERISTICS (continued)

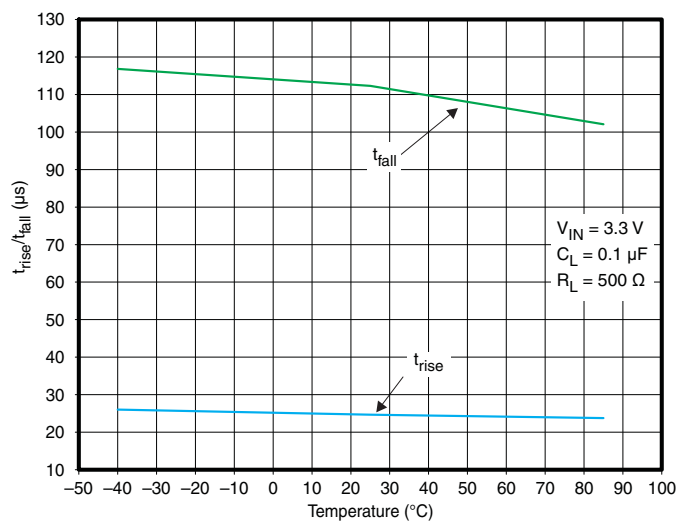


Figure 12. t_{rise}/t_{fall} vs Temperature

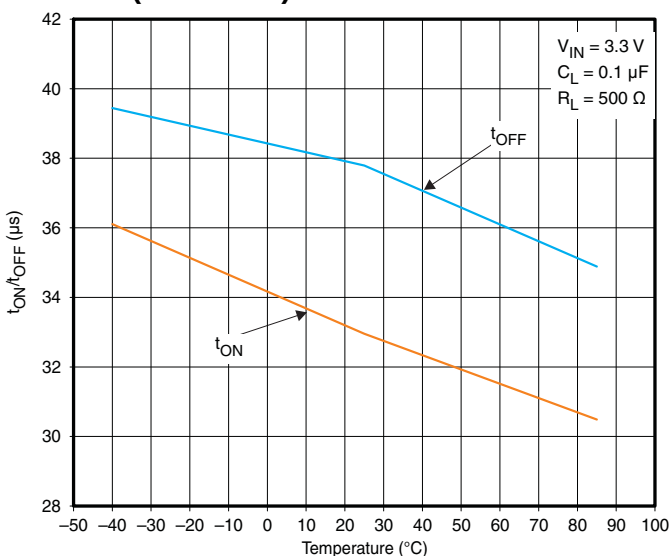


Figure 13. t_{ON}/t_{OFF} vs Temperature

TPS22902

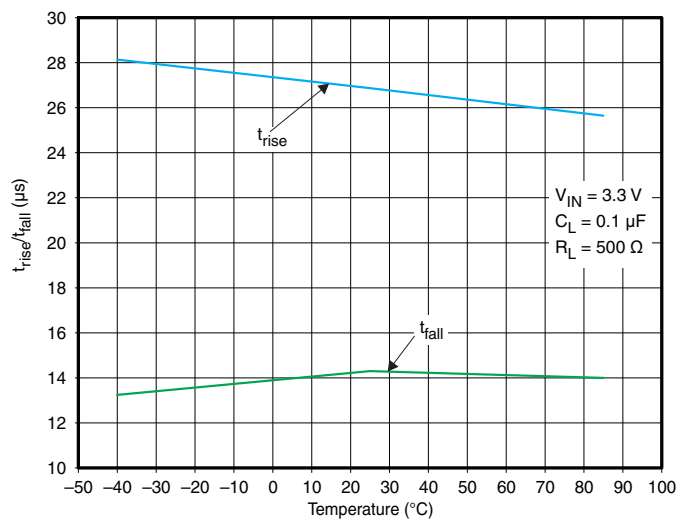


Figure 14. t_{rise}/t_{fall} vs Temperature

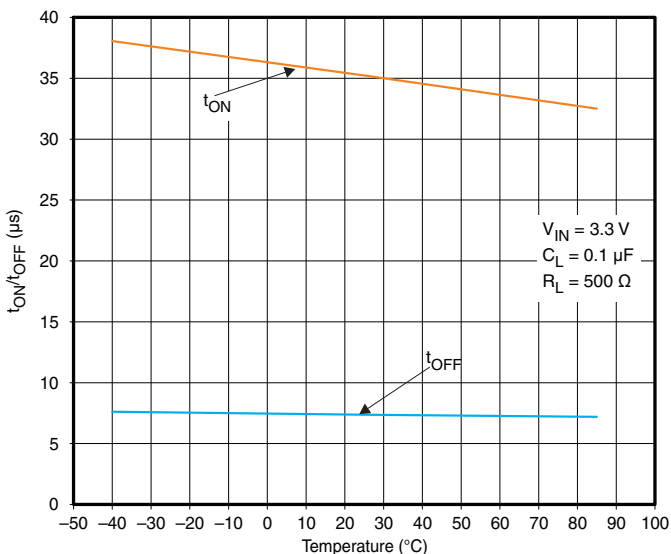
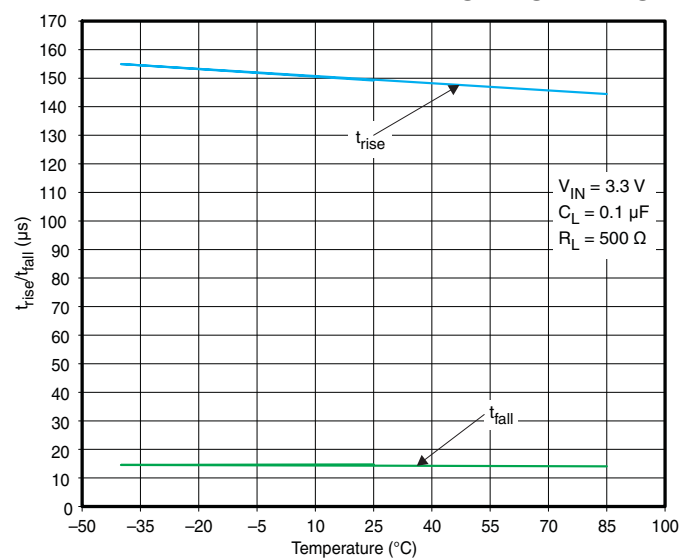
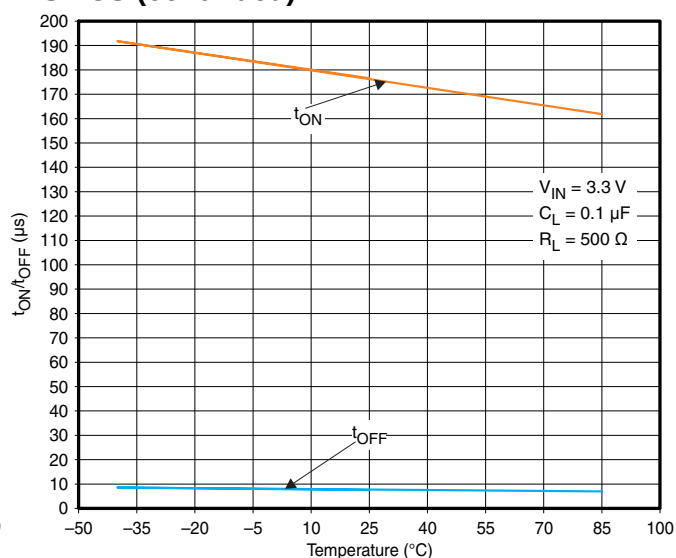


Figure 15. t_{ON}/t_{OFF} vs Temperature

TPS22902B

TYPICAL CHARACTERISTICS (continued)**Figure 16. t_{rise}/t_{fall} vs Temperature****Figure 17. t_{ON}/t_{OFF} vs Temperature**

TYPICAL CHARACTERISTICS (continued)

TPS22901 and TPS22902

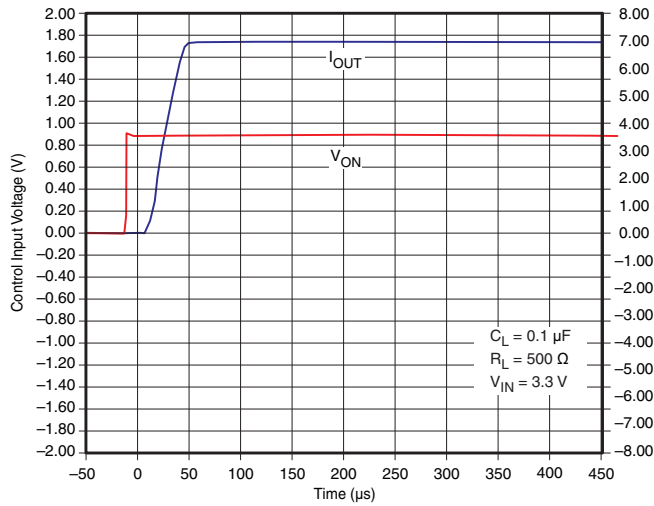


Figure 18. t_{ON} Response

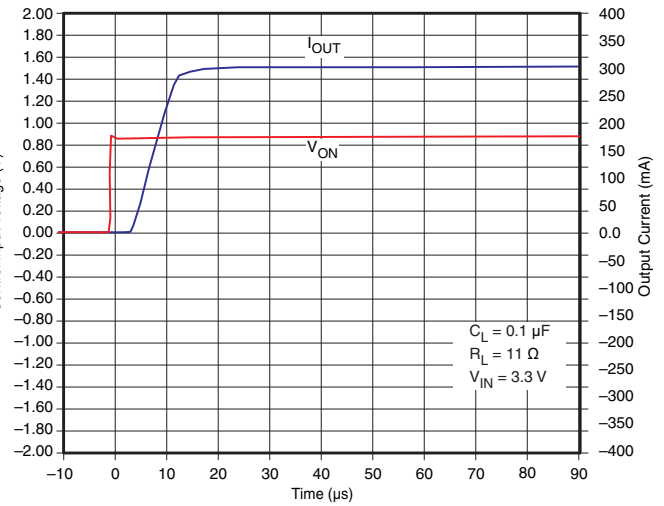


Figure 19. t_{ON} Response

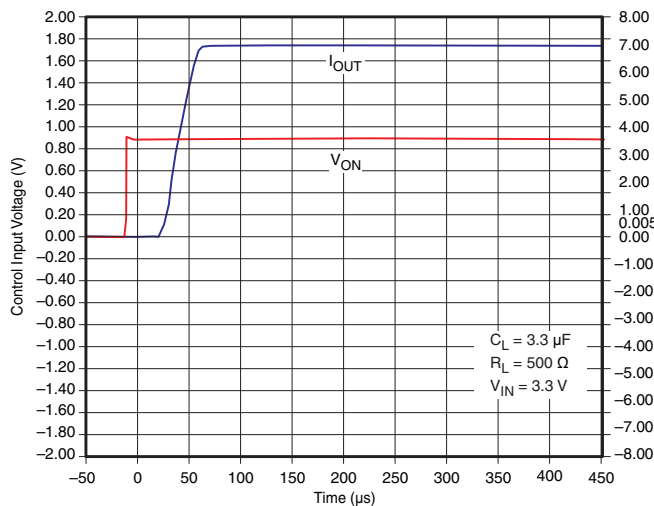


Figure 20. t_{ON} Response

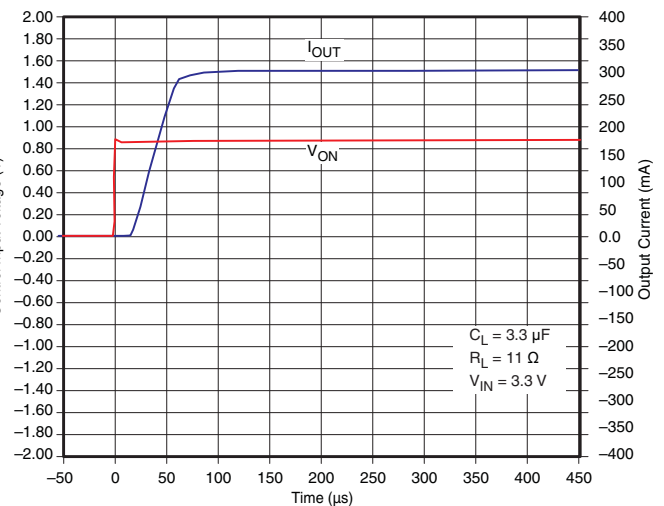


Figure 21. t_{ON} Response

TYPICAL CHARACTERISTICS (continued)

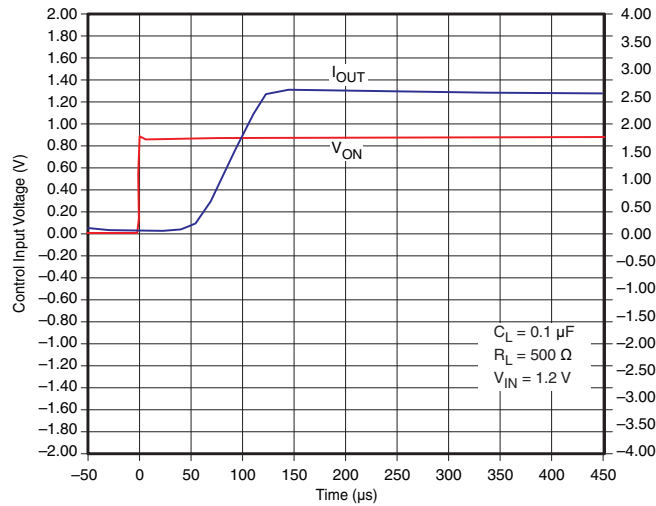


Figure 22. t_{ON} Response

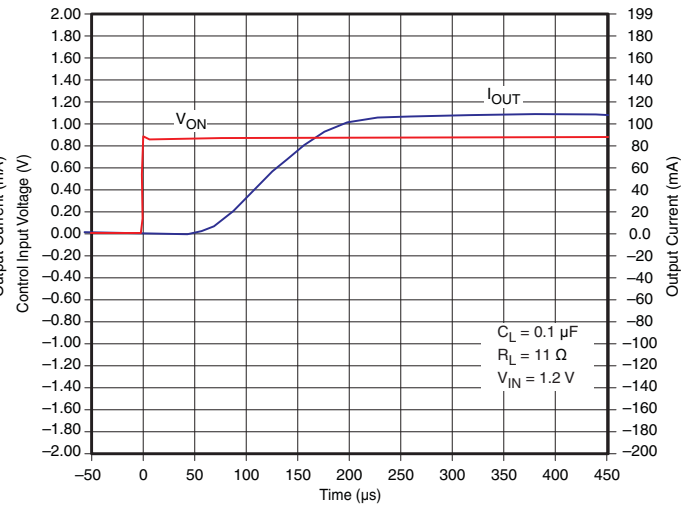


Figure 23. t_{ON} Response

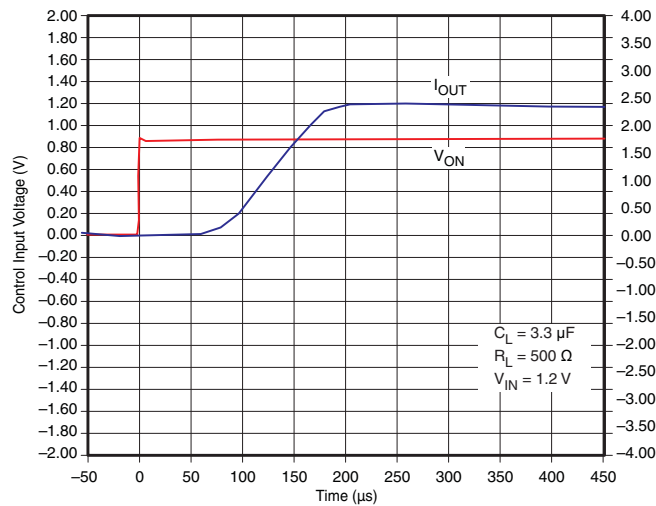


Figure 24. t_{ON} Response

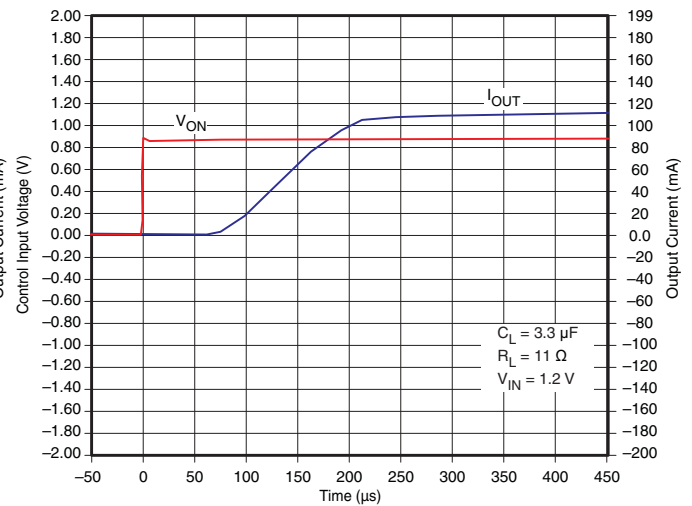


Figure 25. t_{ON} Response

TPS22901

TYPICAL CHARACTERISTICS (continued)

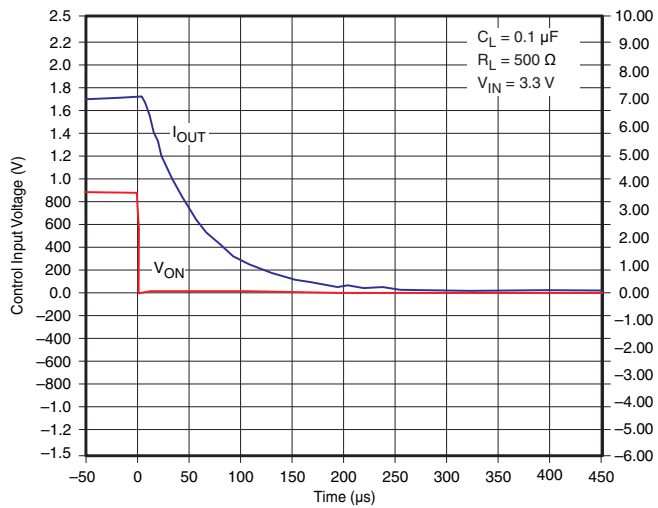


Figure 26. t_{OFF} Response

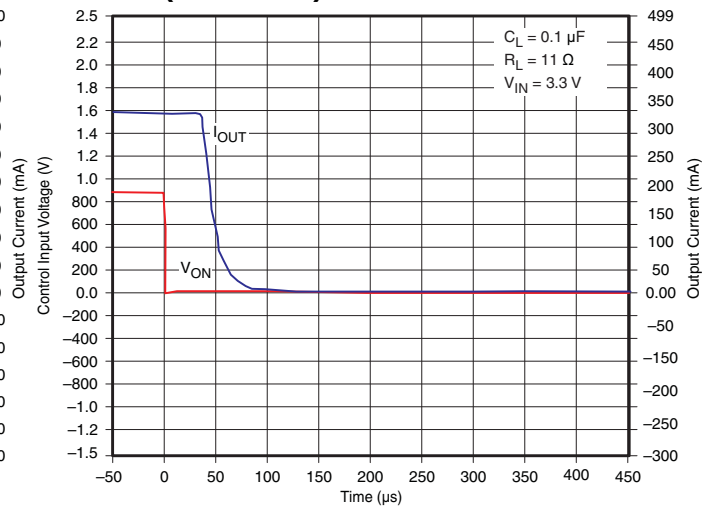


Figure 27. t_{OFF} Response

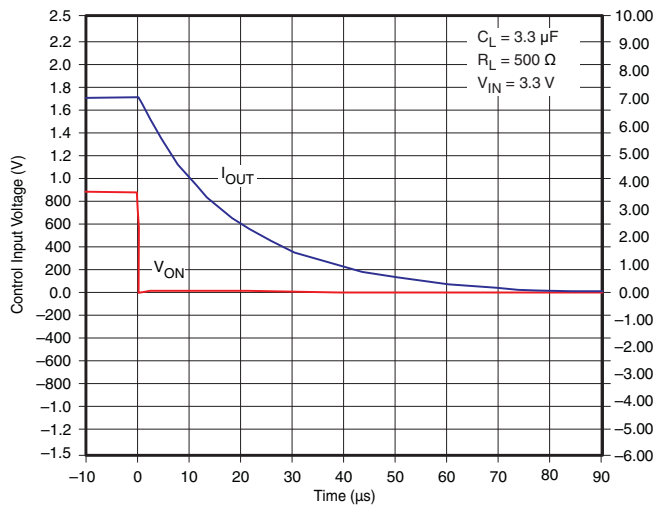


Figure 28. t_{OFF} Response

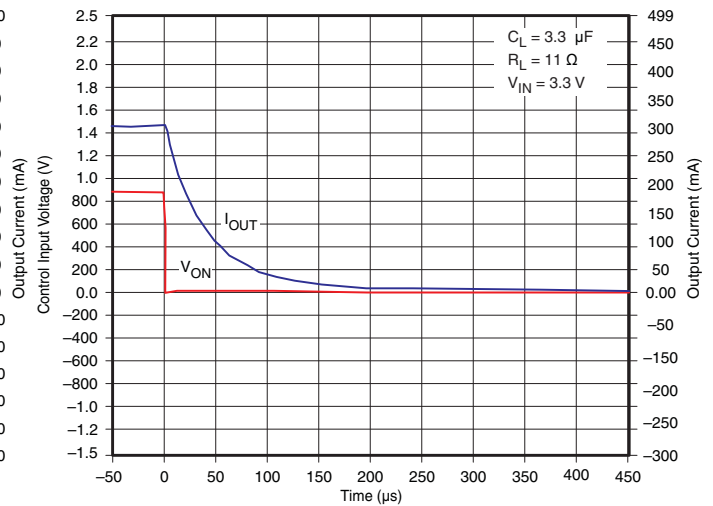


Figure 29. t_{OFF} Response

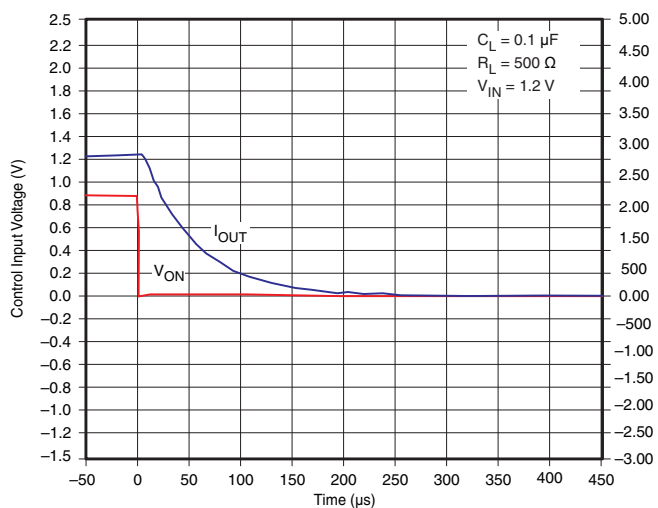


Figure 30. t_{OFF} Response

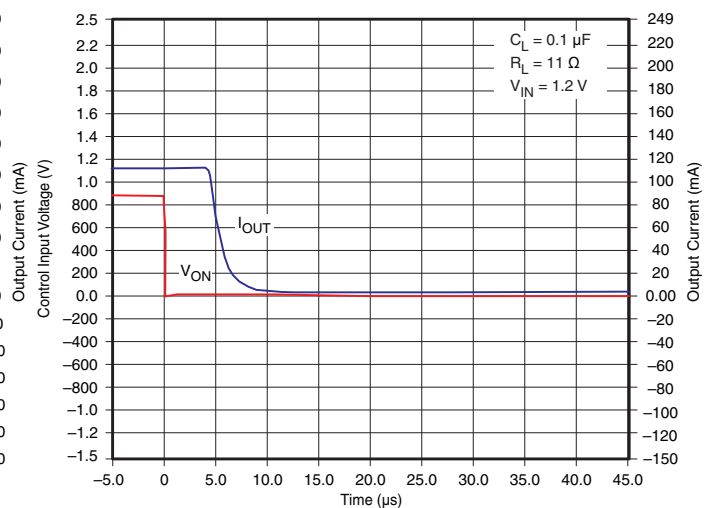
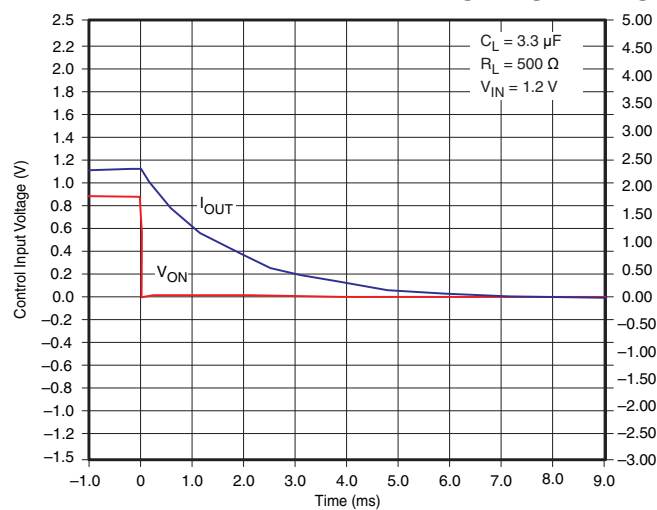
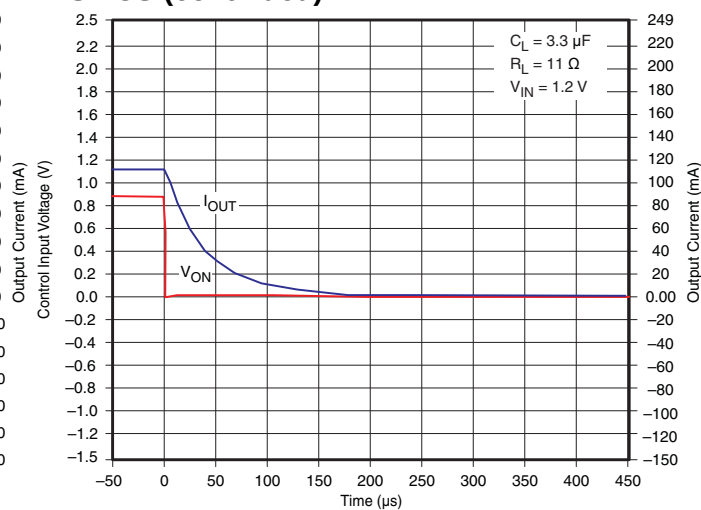
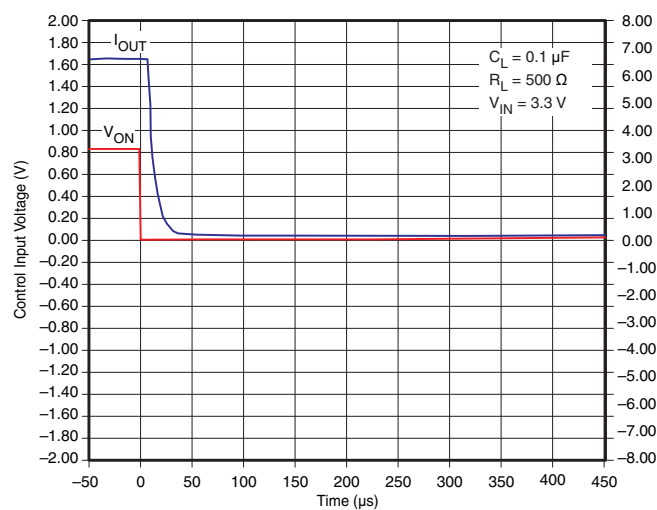
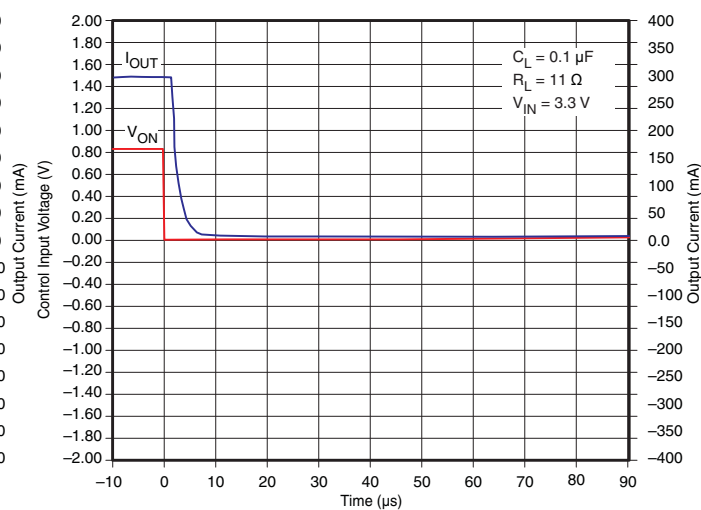


Figure 31. t_{OFF} Response

TYPICAL CHARACTERISTICS (continued)**Figure 32. t_{OFF} Response****Figure 33. t_{OFF} Response****TPS22902****Figure 34. t_{OFF} Response****Figure 35. t_{OFF} Response**

TYPICAL CHARACTERISTICS (continued)

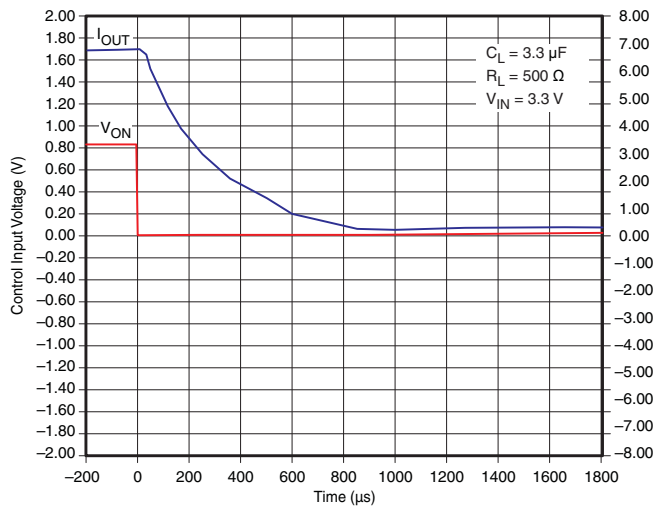


Figure 36. t_{OFF} Response

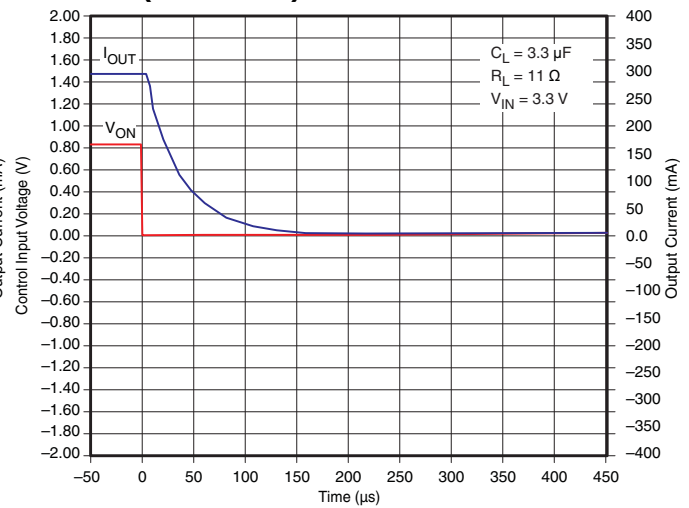


Figure 37. t_{OFF} Response

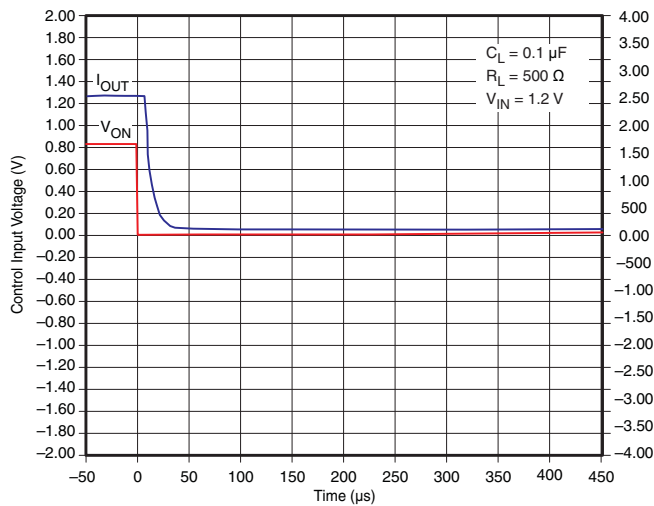


Figure 38. t_{OFF} Response

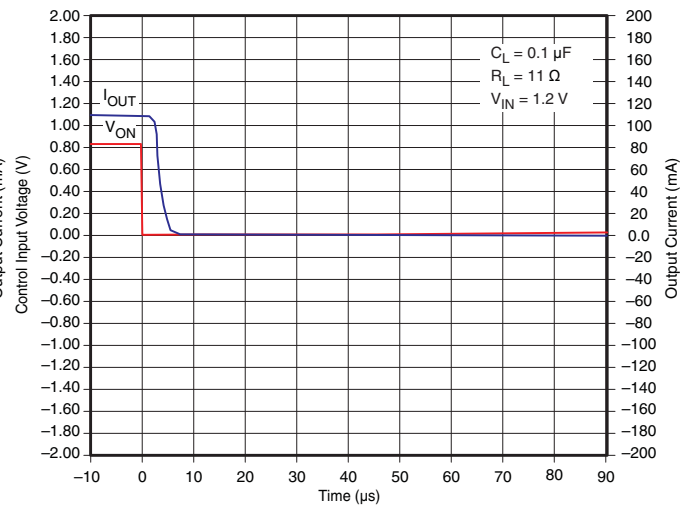


Figure 39. t_{OFF} Response

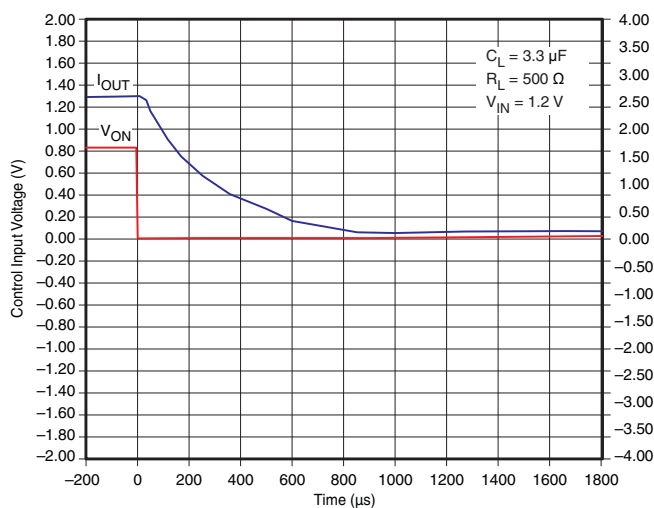


Figure 40. t_{OFF} Response

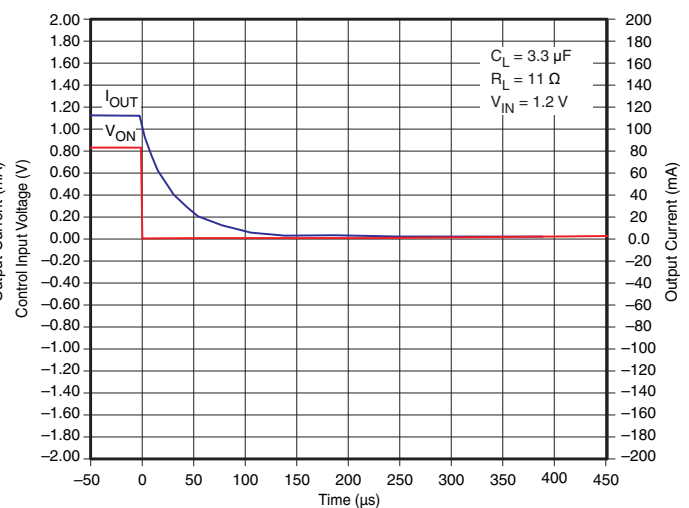


Figure 41. t_{OFF} Response

TYPICAL CHARACTERISTICS (continued)

TPS22902B

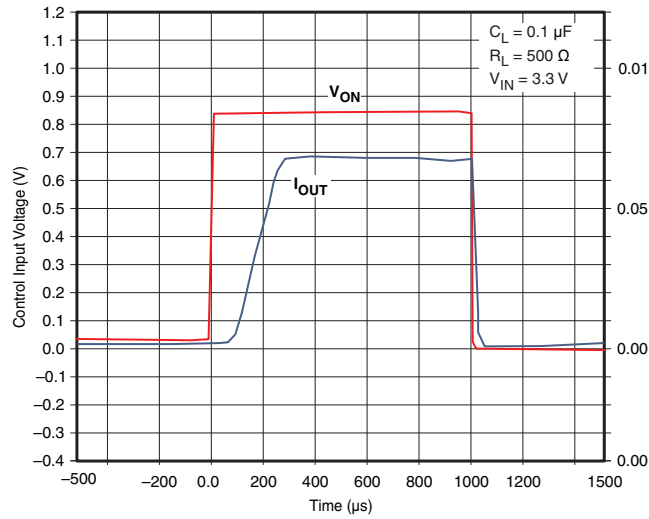


Figure 42. t_{ON} Response

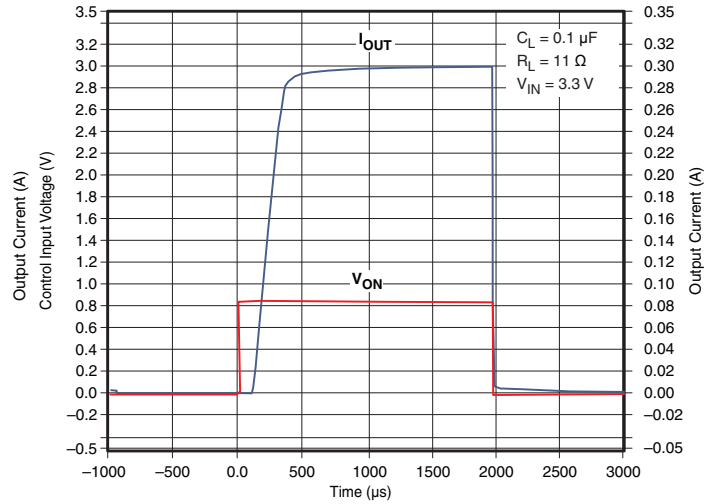


Figure 43. t_{ON} Response

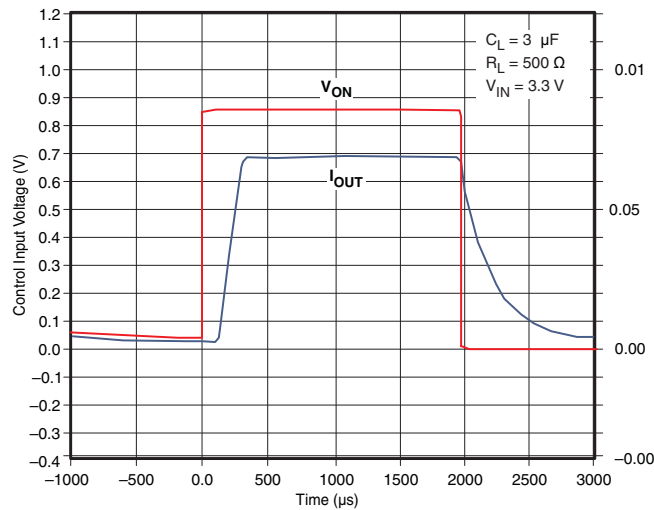


Figure 44. t_{ON} Response

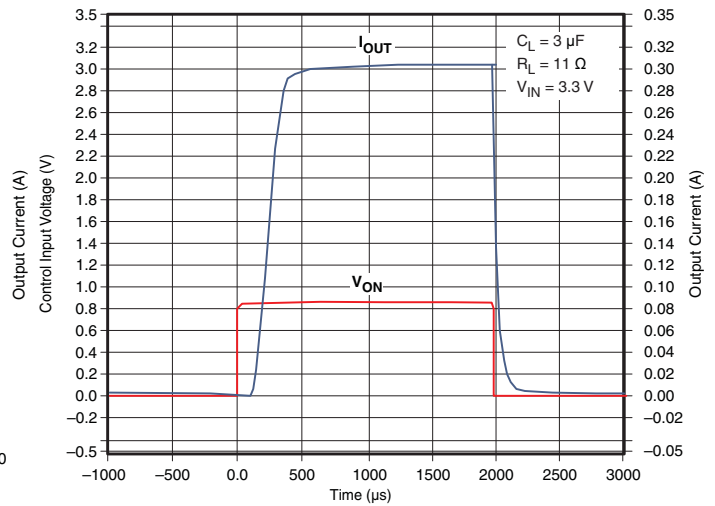


Figure 45. t_{ON} Response

TYPICAL CHARACTERISTICS (continued)

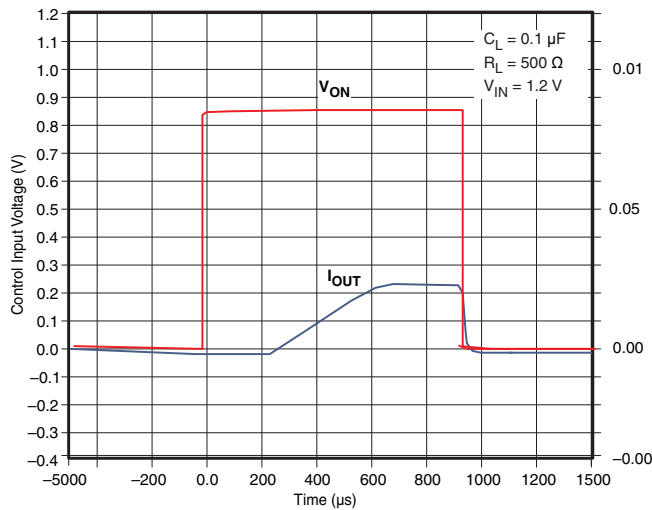


Figure 46. t_{ON} Response

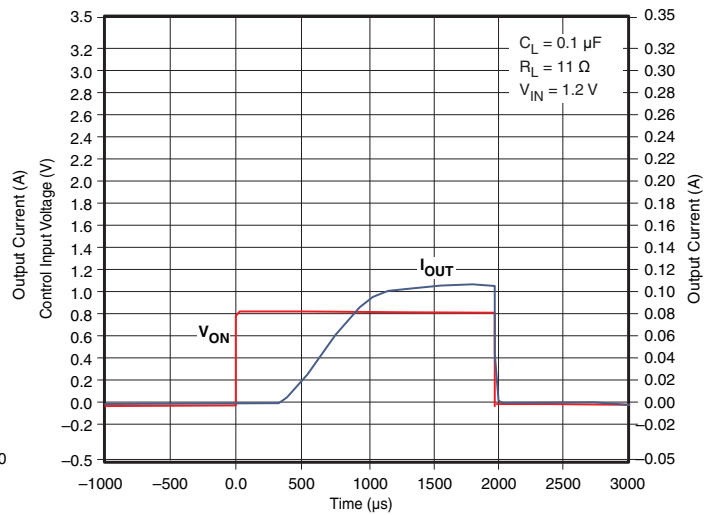


Figure 47. t_{ON} Response

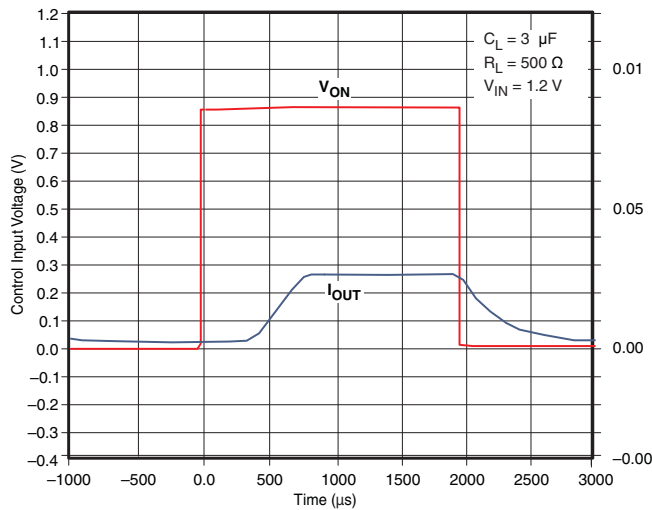


Figure 48. t_{ON} Response

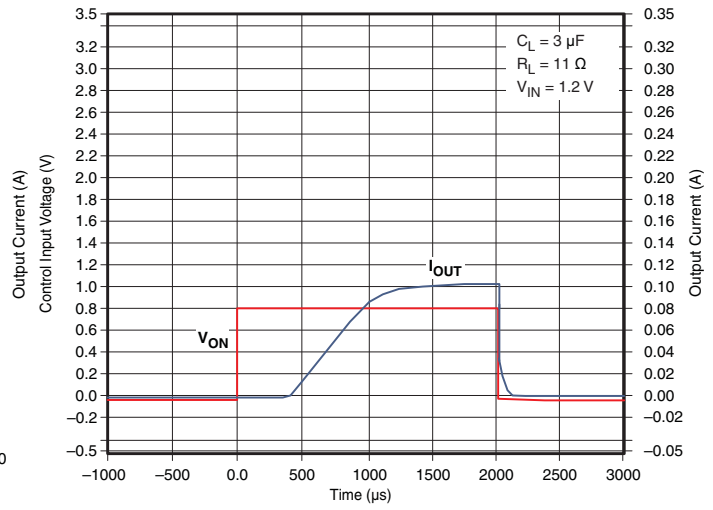


Figure 49. t_{ON} Response

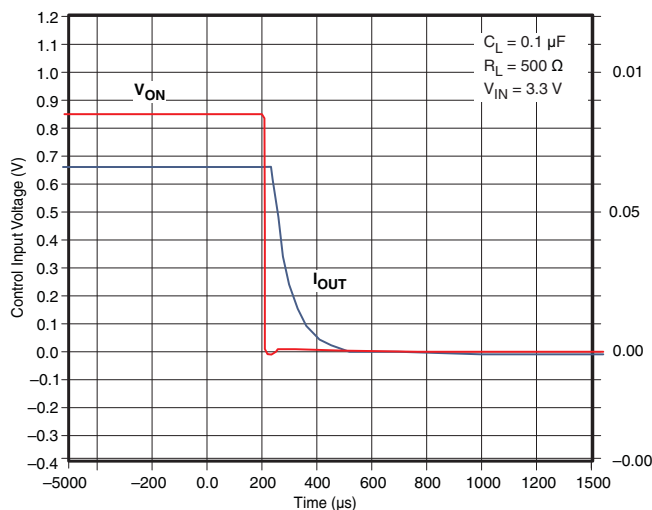


Figure 50. t_{OFF} Response

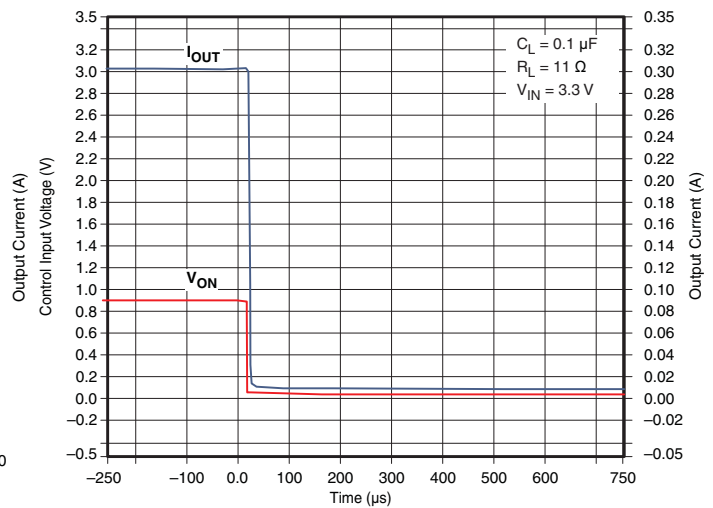
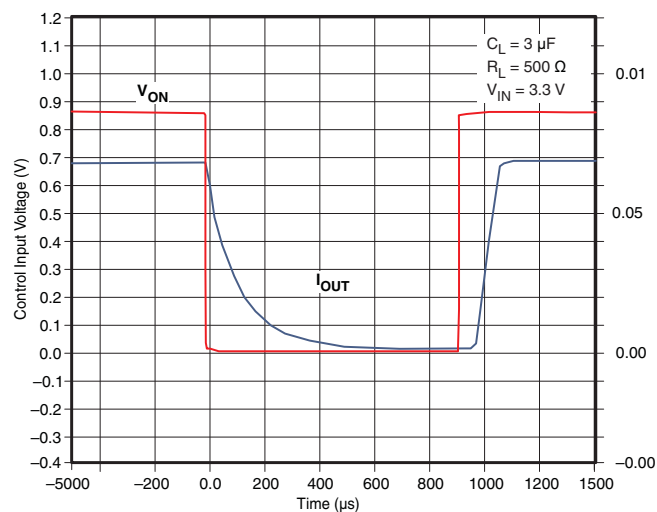
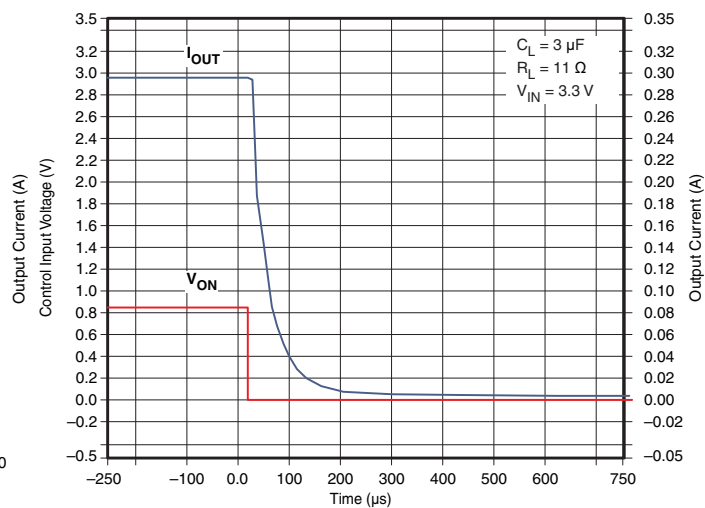
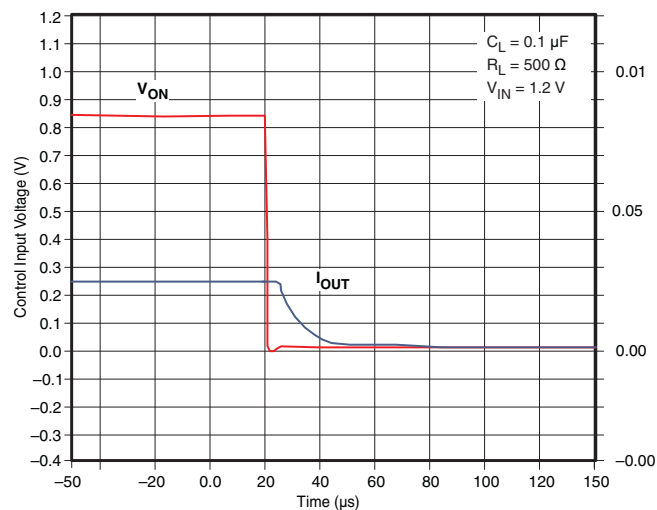
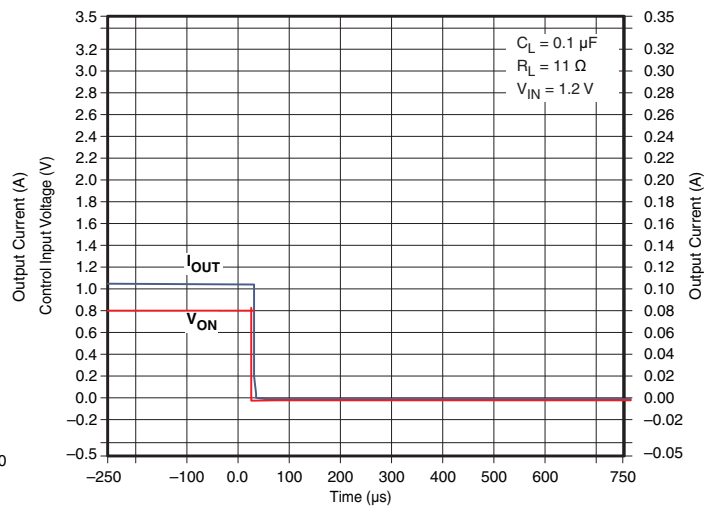


Figure 51. t_{OFF} Response

TYPICAL CHARACTERISTICS (continued)

Figure 52. t_{OFF} ResponseFigure 53. t_{OFF} ResponseFigure 54. t_{OFF} ResponseFigure 55. t_{OFF} Response

TYPICAL CHARACTERISTICS (continued)

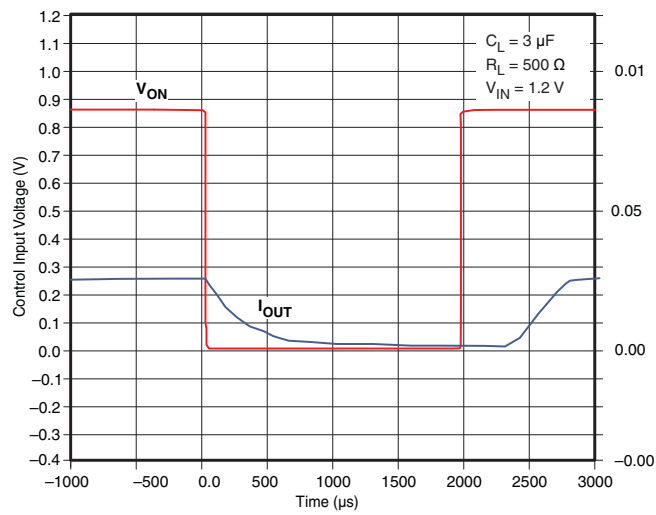


Figure 56. t_{OFF} Response

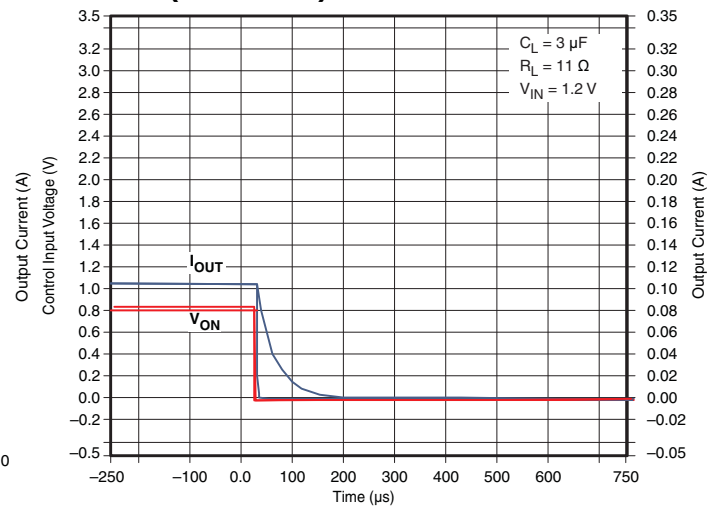


Figure 57. t_{OFF} Response

PARAMETER MEASUREMENT INFORMATION

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

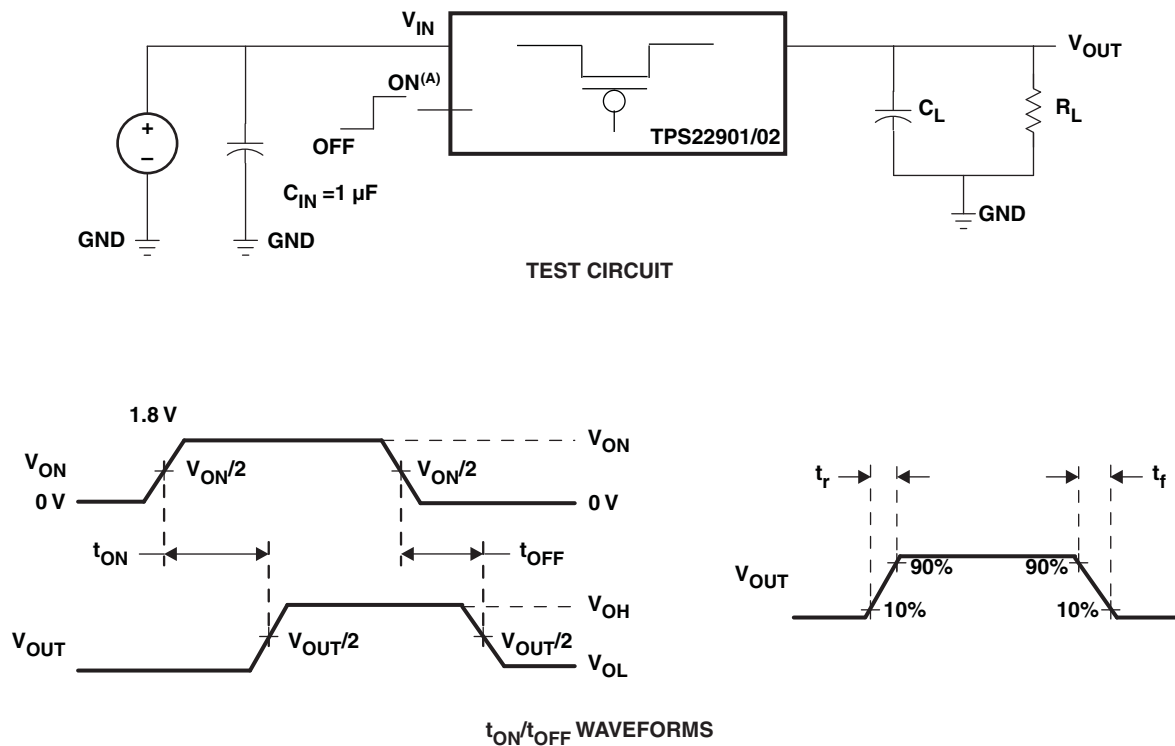


Figure 58. Test Circuit and $t_{\text{ON}}/t_{\text{OFF}}$ Waveforms

APPLICATION INFORMATION

ON/OFF Control

The ON pin controls the state of the switch. Activating ON continuously holds the switch in the on state so long as there is no fault. 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. It can be used with any microcontroller with 1.2-V, 1.8-V, 2.5-V or 3.3-V GPIOs.

Input Capacitor

To limit the voltage drop on the input supply caused by transient in-rush 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- μ F 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 application. When switching heavy loads, it is recommended to have an input capacitor about 10 times higher than the output capacitor, this in order to avoid excessive voltage drop.

Output Capacitor

Due to 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} .

Board Layout

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 and short-circuit operation. Using wide traces for V_{IN} , V_{OUT} , and GND helps minimize the parasitic electrical effects along with minimizing the case-to-ambient thermal impedance.

REVISION HISTORY

Changes from Revision B (March 2009) to Revision C	Page
Updated the ORDERING INFORMATION table.	2

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
TPS22901YFPR	ACTIVE	DSBGA	YFP	4	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	
TPS22902BYFPR	ACTIVE	DSBGA	YFP	4	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	
TPS22902YFPR	ACTIVE	DSBGA	YFP	4	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSELETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

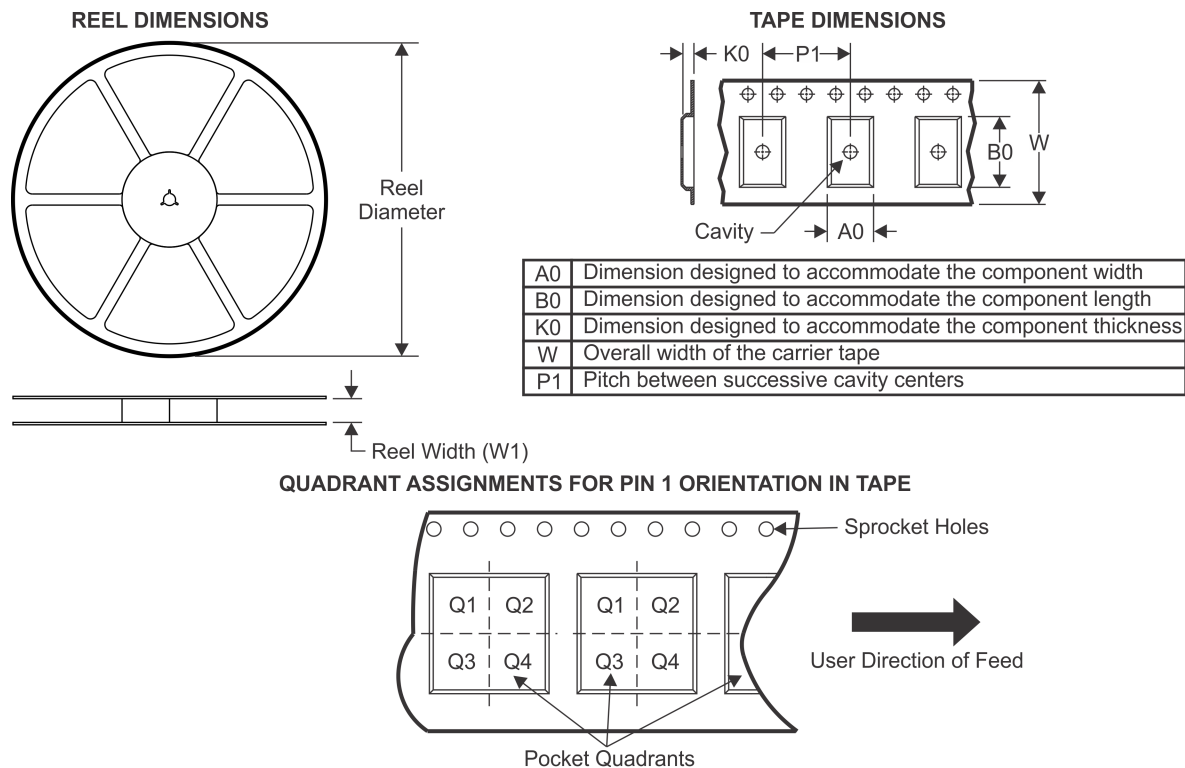
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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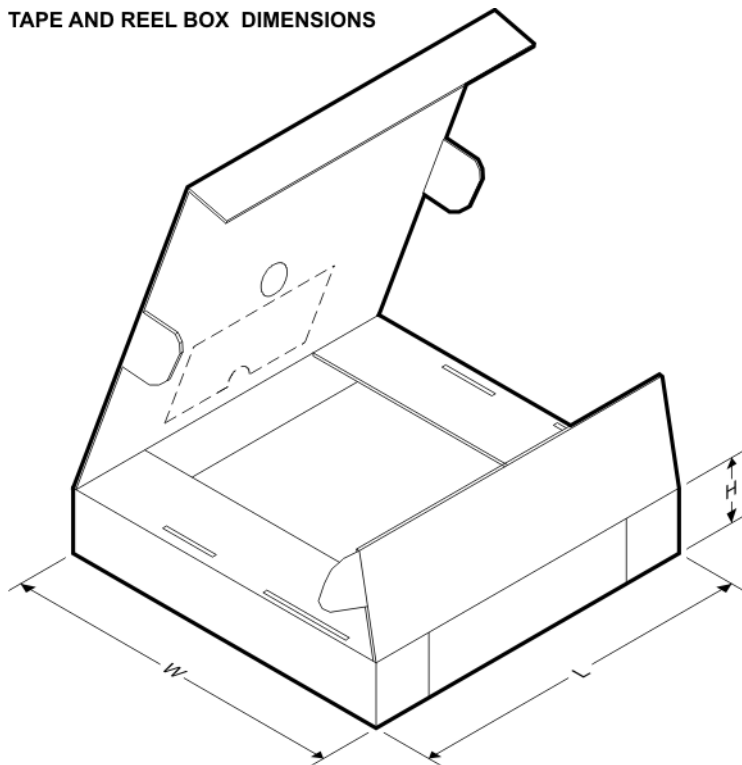
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION


*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	180.0	8.4	0.89	0.89	0.58	4.0	8.0	Q1
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	178.0	9.2	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

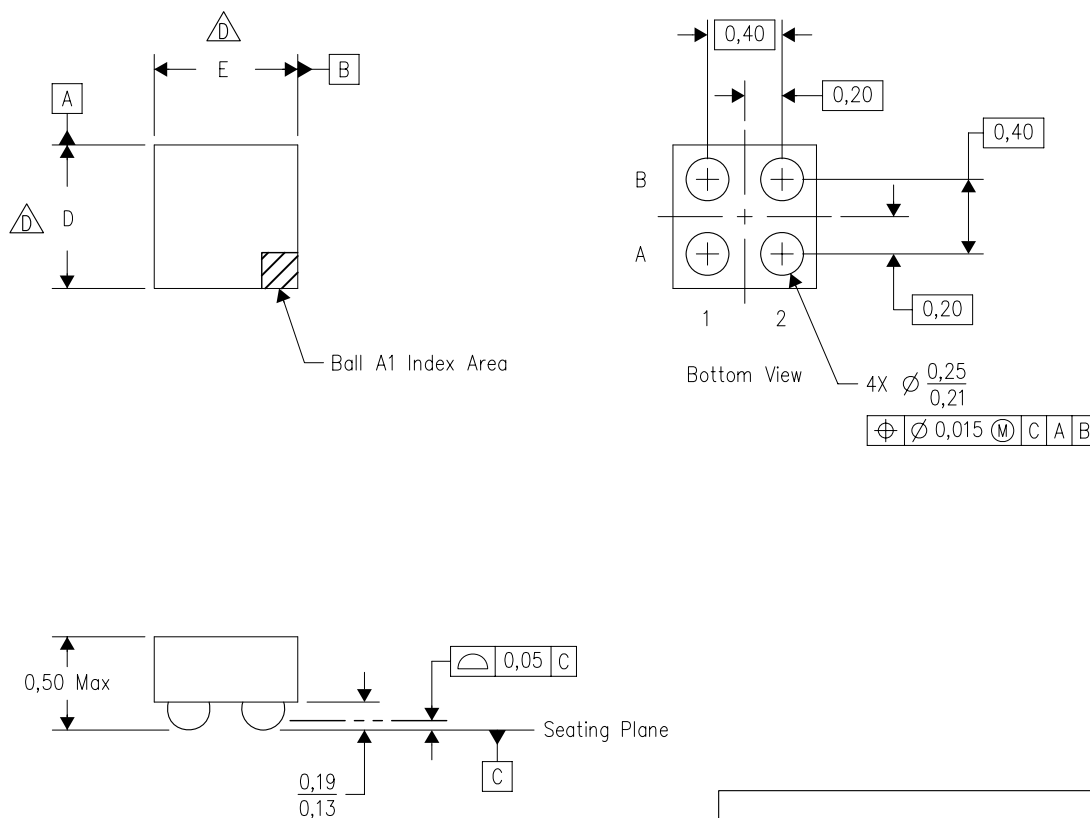


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS22901YFPR	DSBGA	YFP	4	3000	220.0	220.0	34.0
TPS22901YFPR	DSBGA	YFP	4	3000	220.0	220.0	35.0
TPS22902BYFPR	DSBGA	YFP	4	3000	210.0	185.0	35.0
TPS22902YFPR	DSBGA	YFP	4	3000	270.0	225.0	227.0
TPS22902YFPR	DSBGA	YFP	4	3000	210.0	185.0	35.0

YFP (S-XBGA-N4)

DIE-SIZE BALL GRID ARRAY



D: Max = 0.79 mm, Min = 0.73 mm

E: Max = 0.79 mm, Min = 0.73 mm

4206986-2/R 02/12

- 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.
 - $\triangle D$ The package size (Dimension D and E) of a particular device is specified in the device Product Data Sheet version of this drawing, in case it cannot be found in the product data sheet please contact a local TI representative.
 - E. Reference Product Data Sheet for array population.
2 x 2 matrix pattern is shown for illustration only.
 - F. This package contains Pb-free balls.

NanoFree is a trademark of Texas Instruments

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