

## 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- $\mu$ s  $t_r$**
  - **TPS22902B: 220- $\mu$ s  $t_r$**
- **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**

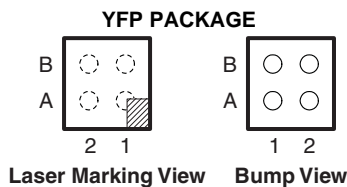
### APPLICATIONS

- **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- $\Omega$  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  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .


**Table 1. TERMINAL ASSIGNMENTS**

<b>B</b>	ON	GND
<b>A</b>	$V_{IN}$	$V_{OUT}$
	<b>2</b>	<b>1</b>

	$r_{ON}$ at 1.8 V (TYP)	SLEW RATE (TYP at 1.8 V)	QUICK OUTPUT DISCHARGE <sup>(1)</sup>	MAX OUTPUT CURRENT	ENABLE
TPS22901	109 m $\Omega$	40 $\mu$ s		500 mA	Active high
TPS22902	109 m $\Omega$	40 $\mu$ s	Yes	500 mA	Active high
TPS22902B	109 m $\Omega$	220 $\mu$ s	Yes	500 mA	Active high

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



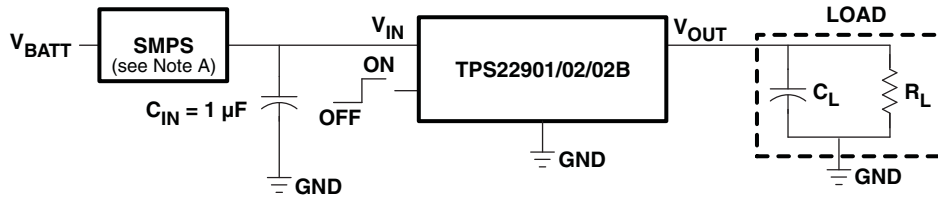
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**ORDERING INFORMATION**

T <sub>A</sub>	PACKAGE <sup>(1)</sup> (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](http://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](http://www.ti.com).

**TYPICAL APPLICATION**



A. Switched mode power supply

**APPLICATION BLOCK DIAGRAM**

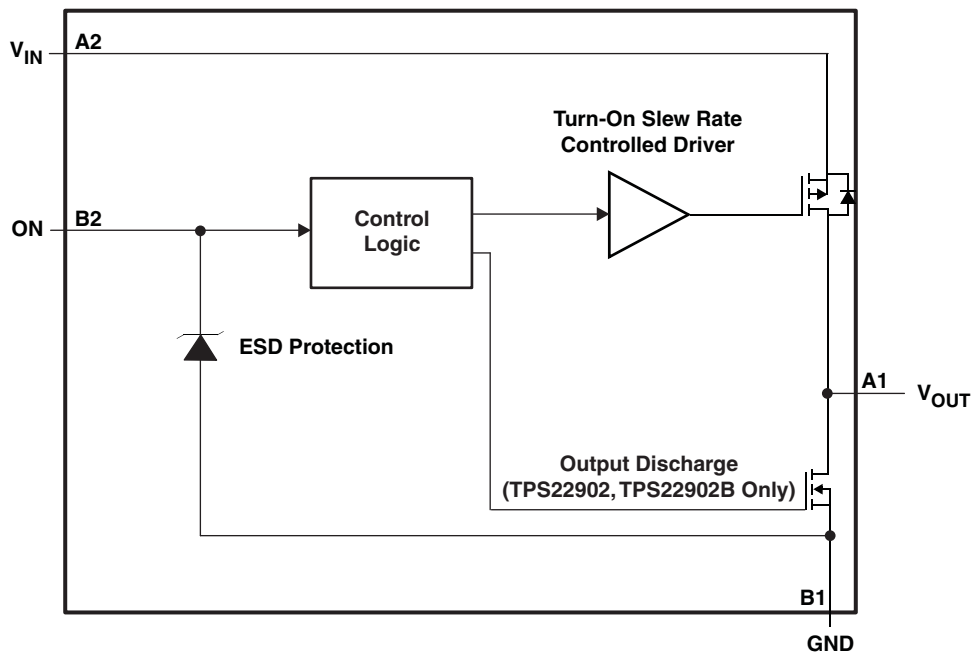


Figure 1. Functional Block Diagram

**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 <sub>OUT</sub>	Switch output
A2	V <sub>IN</sub>	Switch input, bypass this input with a ceramic capacitor to ground
B1	GND	Ground
B2	ON	Switch control input, active high

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

		MIN	MAX	UNIT
V <sub>IN</sub>	Input voltage range	-0.3	4	V
V <sub>OUT</sub>	Output voltage range		V <sub>IN</sub> + 0.3	V
V <sub>ON</sub>	Input voltage range	-0.3	4	V
P	Power dissipation at T <sub>A</sub> = 25°C		0.48	W
I <sub>MAX</sub>	Maximum continuous switch current		500	mA
T <sub>A</sub>	Operating free-air temperature range	-40	85	°C
T <sub>stg</sub>	Storage temperature range	-65	150	°C
T <sub>lead</sub>	Maximum lead temperature (10-s soldering time)		300	°C
ESD	Electrostatic discharge protection	Human-Body Model (HBM)		V
		Charged Device Model (CDM)		
			2000	
			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 <sub>JA</sub>	Package thermal impedance <sup>(1)</sup>	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 <sub>IN</sub>	Input voltage range	1	3.6	V
V <sub>OUT</sub>	Output voltage range		V <sub>IN</sub>	
V <sub>IH</sub>	High-level input voltage, ON	0.85	3.6	V
V <sub>IL</sub>	Low-level input voltage, ON		0.4	V
C <sub>IN</sub>	Input capacitor	1 <sup>(1)</sup>		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 <sup>(1)</sup>	MAX	UNIT			
$I_{IN}$	Quiescent current	$I_{OUT} = 0$ , $V_{IN} = V_{ON}$	$V_{IN} = 1.1\text{ V}$	Full	37	120	nA			
			$V_{IN} = 1.8\text{ V}$	Full	82	235				
			$V_{IN} = 3.6\text{ V}$	Full	204	880				
$I_{IN(OFF)}$	OFF-state supply current	$V_{ON} = \text{GND}$ , $\text{OUT} = \text{Open}$	$V_{IN} = 1.1\text{ V}$	Full	22	210	nA			
			$V_{IN} = 1.8\text{ V}$	Full	44	260				
			$V_{IN} = 3.6\text{ V}$	Full	137	700				
$I_{IN(LEAKAGE)}$	OFF-state switch current	$V_{ON} = \text{GND}$ , $V_{OUT} = 0$	$V_{IN} = 1.1\text{ V}$	Full	22	140	nA			
			$V_{IN} = 1.8\text{ V}$	Full	45	230				
			$V_{IN} = 3.6\text{ V}$	Full	137	610				
$r_{ON}$	ON-state resistance	$I_{OUT} = -200\text{ mA}$	$V_{IN} = 3.6\text{ V}$	25°C	78	95	mΩ			
				Full		95				
			$V_{IN} = 2.5\text{ V}$	25°C	93	110				
				Full		110				
			$V_{IN} = 1.8\text{ V}$	25°C	109	130				
				Full		130				
			$V_{IN} = 1.2\text{ V}$	25°C	146	200				
				Full		200				
			$V_{IN} = 1.1\text{ V}$	25°C	174	330				
				Full		330				
			$r_{PD}$	Output pulldown resistance	$V_{IN} = 3.3\text{ V}$ , $V_{ON} = 0$ , $I_{OUT} = 30\text{ mA}$ (TPS22902/TPS22902B only)	25°C		88	120	Ω
			$I_{ON}$	ON input leakage current	$V_{ON} = 1.1\text{ V to }3.6\text{ V or GND}$	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 <sup>(1)</sup>			TPS22902B <sup>(1)</sup>			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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	966			175			189			
		$C_L = 3.3\ \mu\text{F}$	3532			632			565			

 (1)  $RL\_CHIP = 120\ \Omega$ 
**SWITCHING CHARACTERISTICS**
 $V_{IN} = 1.2\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS		TPS22901			TPS22902 <sup>(1)</sup>			TPS22902B <sup>(1)</sup>			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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	995			163			175			
		$C_L = 3.3\ \mu\text{F}$	3650			587			523			

 (1)  $RL\_CHIP = 120\ \Omega$

### SWITCHING CHARACTERISTICS

V<sub>IN</sub> = 1.8 V, T<sub>A</sub> = 25°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS		TPS22901			TPS22902 <sup>(1)</sup>			TPS22902B <sup>(1)</sup>			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t <sub>ON</sub> Turn-ON time	R <sub>L</sub> = 500 Ω	C <sub>L</sub> = 0.1 μF	61			61			302			μs
		C <sub>L</sub> = 1 μF	72			72			335			
		C <sub>L</sub> = 3.3 μF	83			83			367			
t <sub>OFF</sub> Turn-OFF time	R <sub>L</sub> = 500 Ω	C <sub>L</sub> = 0.1 μF	38			8			8			μs
		C <sub>L</sub> = 1 μF	317			49			49			
		C <sub>L</sub> = 3.3 μF	1135			169			167			
t <sub>r</sub> V <sub>OUT</sub> rise time	R <sub>L</sub> = 500 Ω	C <sub>L</sub> = 0.1 μF	40			40			220			μs
		C <sub>L</sub> = 1 μF	45			45			220			
		C <sub>L</sub> = 3.3 μF	53			53			235			
t <sub>f</sub> V <sub>OUT</sub> fall time	R <sub>L</sub> = 500 Ω	C <sub>L</sub> = 0.1 μF	111			15			15			μs
		C <sub>L</sub> = 1 μF	1020			140			159			
		C <sub>L</sub> = 3.3 μF	3700			517			481			

(1) R<sub>L</sub>\_CHIP = 120 Ω

### SWITCHING CHARACTERISTICS

V<sub>IN</sub> = 2.5 V, T<sub>A</sub> = 25°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS		TPS22901			TPS22902 <sup>(1)</sup>			TPS22902B <sup>(1)</sup>			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t <sub>ON</sub> Turn-ON time	R <sub>L</sub> = 500 Ω	C <sub>L</sub> = 0.1 μF	45			45			223			μs
		C <sub>L</sub> = 1 μF	53			53			246			
		C <sub>L</sub> = 3.3 μF	61			61			268			
t <sub>OFF</sub> Turn-OFF time	R <sub>L</sub> = 500 Ω	C <sub>L</sub> = 0.1 μF	38			7			7			μs
		C <sub>L</sub> = 1 μF	314			46			47			
		C <sub>L</sub> = 3.3 μF	1140			161			158			
t <sub>r</sub> V <sub>OUT</sub> rise time	R <sub>L</sub> = 500 Ω	C <sub>L</sub> = 0.1 μF	32			32			175			μs
		C <sub>L</sub> = 1 μF	35			35			175			
		C <sub>L</sub> = 3.3 μF	41			41			187			
t <sub>f</sub> V <sub>OUT</sub> fall time	R <sub>L</sub> = 500 Ω	C <sub>L</sub> = 0.1 μF	113			14			18			μs
		C <sub>L</sub> = 1 μF	1040			139			185			
		C <sub>L</sub> = 3.3 μF	3795			516			471			

(1) R<sub>L</sub>\_CHIP = 120 Ω

**SWITCHING CHARACTERISTICS**
 $V_{IN} = 3\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS		TPS22901			TPS22902 <sup>(1)</sup>			TPS22902B <sup>(1)</sup>			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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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 <sup>(1)</sup>			TPS22902B <sup>(1)</sup>			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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	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			$\mu\text{s}$
		$C_L = 1\ \mu\text{F}$	1060			139			161			
		$C_L = 3.3\ \mu\text{F}$	3840			512			475			

 (1)  $R_{L\_CHIP} = 120\ \Omega$

TYPICAL CHARACTERISTICS

TPS22901, TPS22902, TPS22902B

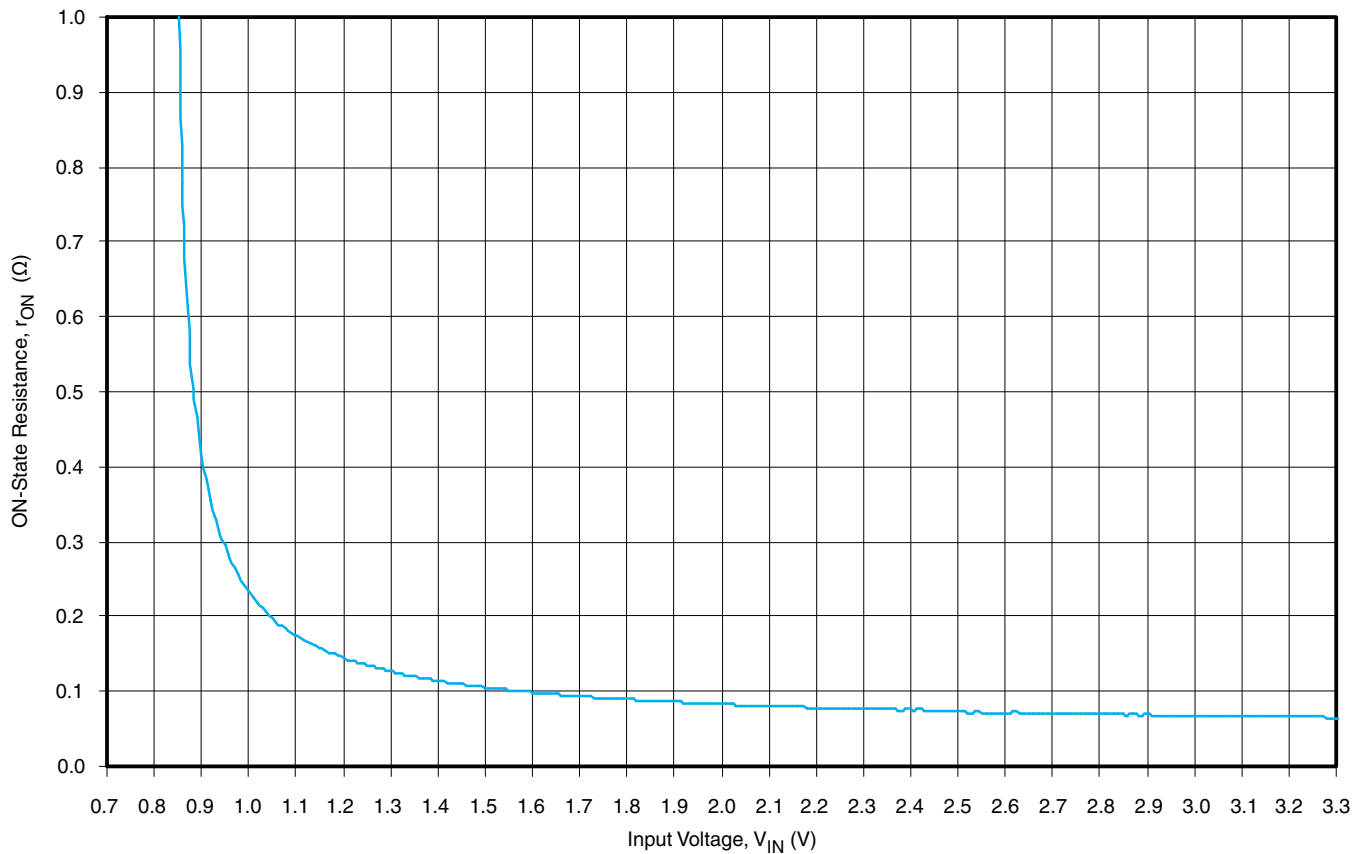


Figure 2.  $r_{ON}$  vs  $V_{IN}$

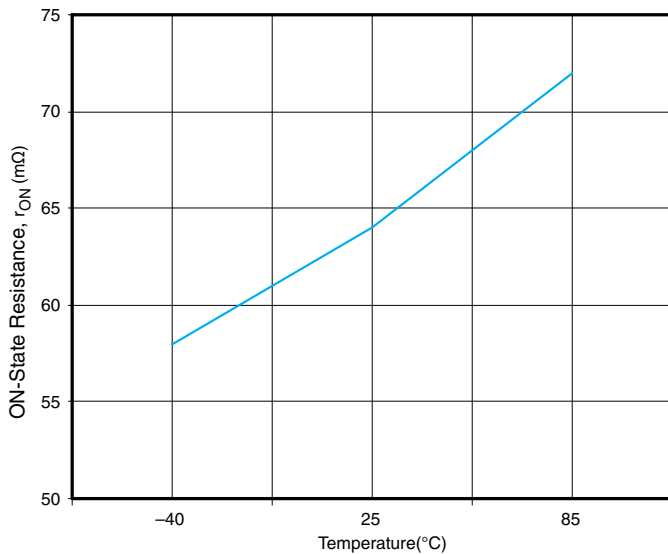


Figure 3.  $r_{ON}$  vs Temperature ( $V_{IN} = 3.3$  V)

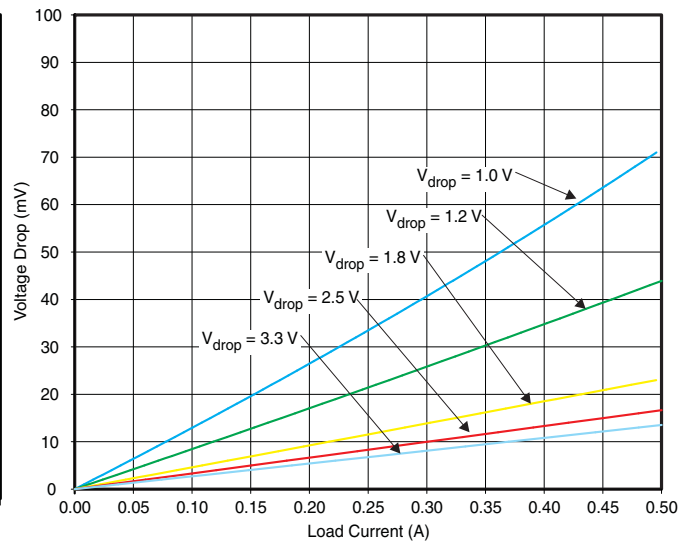


Figure 4. Voltage Drop vs. Load Current



TYPICAL CHARACTERISTICS (continued)

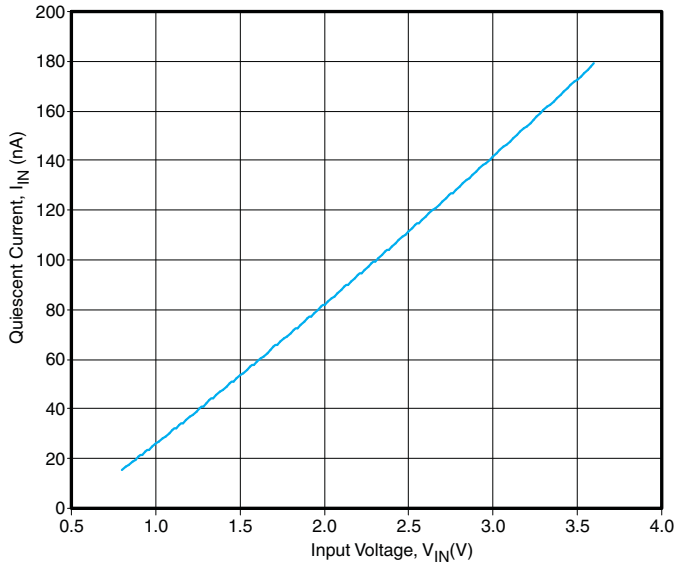


Figure 5. Quiescent Current vs V<sub>IN</sub> (V<sub>ON</sub> = V<sub>IN</sub>, I<sub>OUT</sub> = 0)

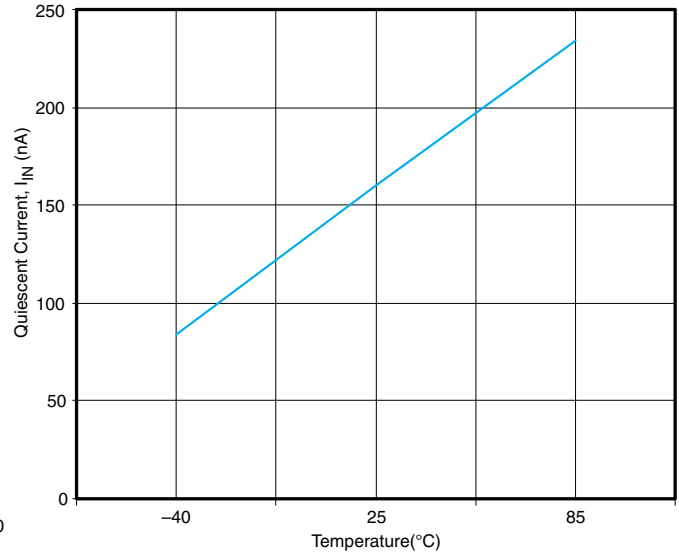


Figure 6. Quiescent Current vs Temperature (V<sub>IN</sub> = 3.3 V, I<sub>OUT</sub> = 0)

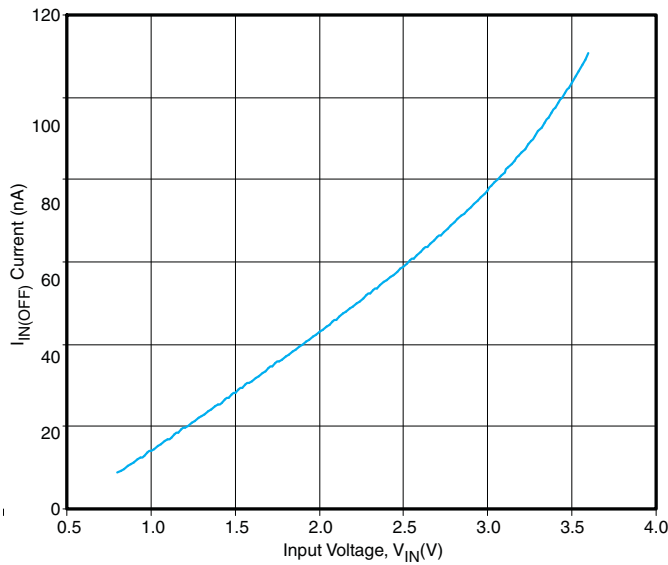


Figure 7. I<sub>IN(OFF)</sub> vs V<sub>IN</sub> (V<sub>ON</sub> = 0 V)

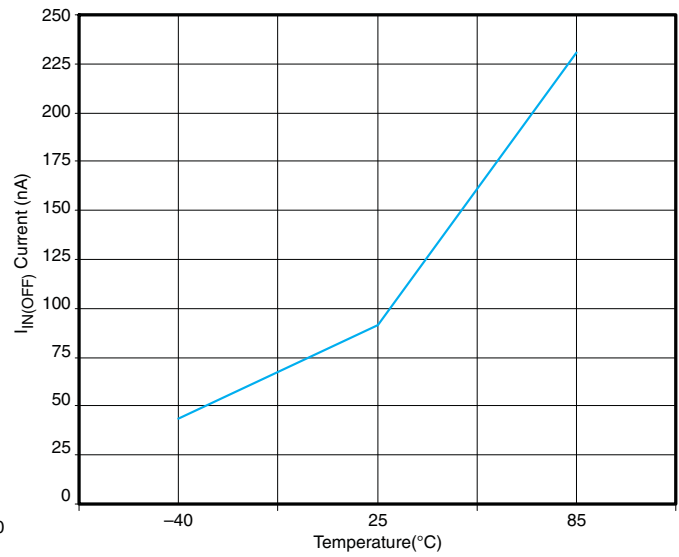


Figure 8. I<sub>IN(OFF)</sub> vs Temperature (V<sub>IN</sub> = 3.3 V)

TYPICAL CHARACTERISTICS (continued)

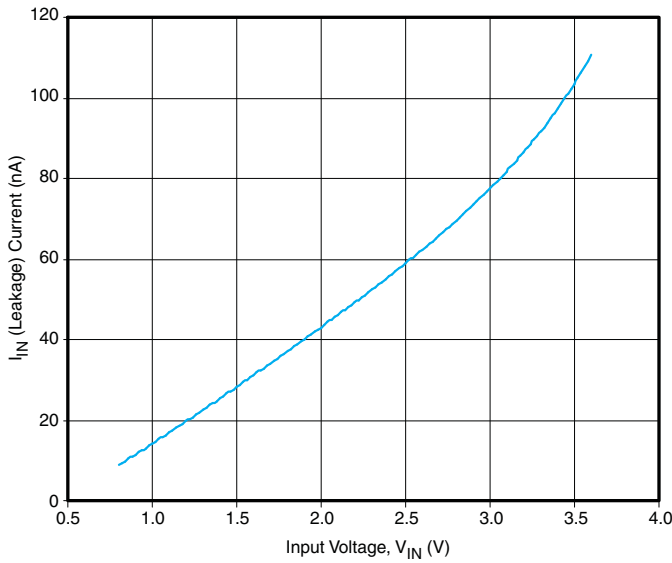


Figure 9.  $I_{IN}$ (Leakage) vs  $V_{IN}$  ( $I_{OUT} = 0$ )

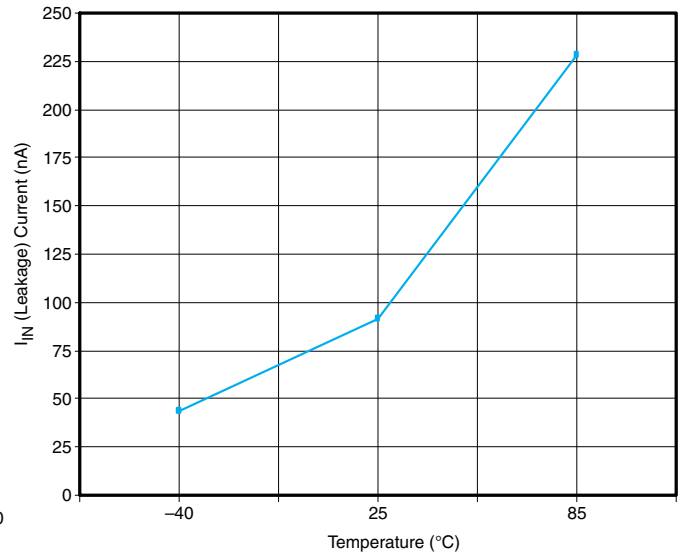


Figure 10.  $I_{IN}$  (Leakage) vs Temperature ( $V_{IN} = 3.3$  V)

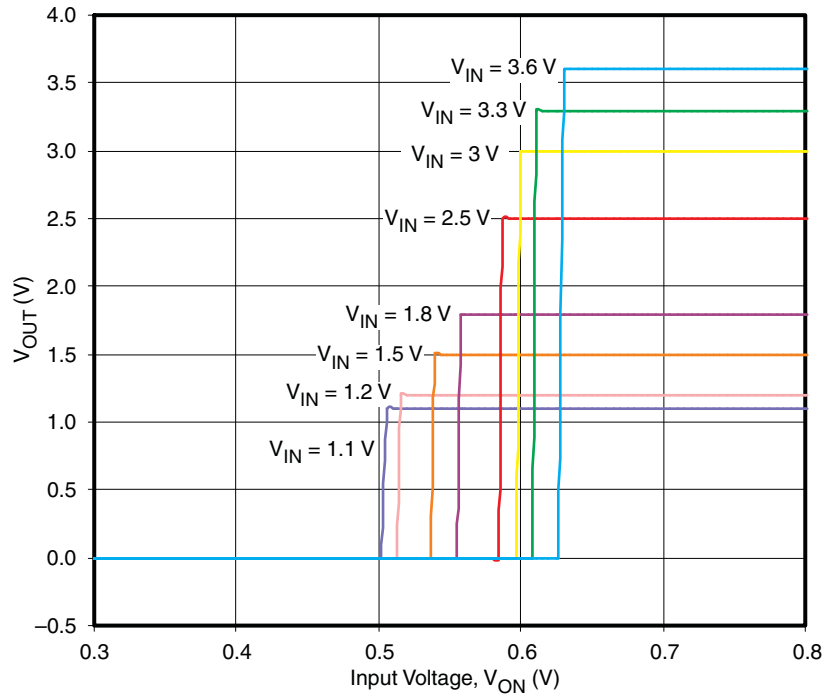


Figure 11. ON-Input Threshold

TPS22901

TYPICAL CHARACTERISTICS (continued)

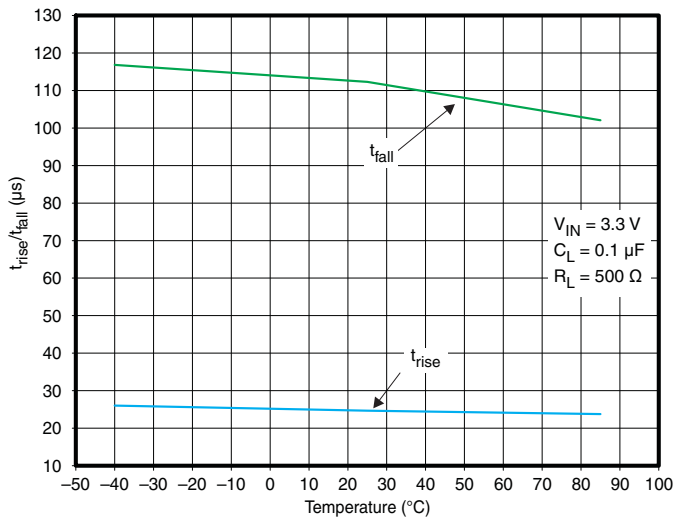


Figure 12.  $t_{rise}/t_{fall}$  vs Temperature

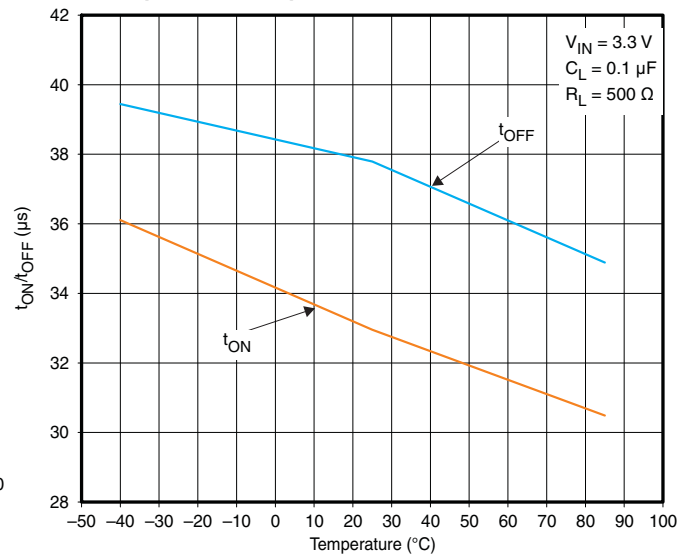


Figure 13.  $t_{ON}/t_{OFF}$  vs Temperature

TPS22902

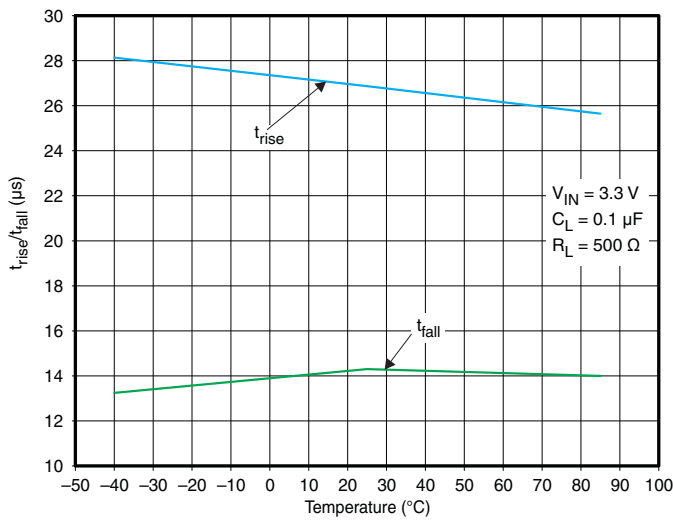


Figure 14.  $t_{rise}/t_{fall}$  vs Temperature

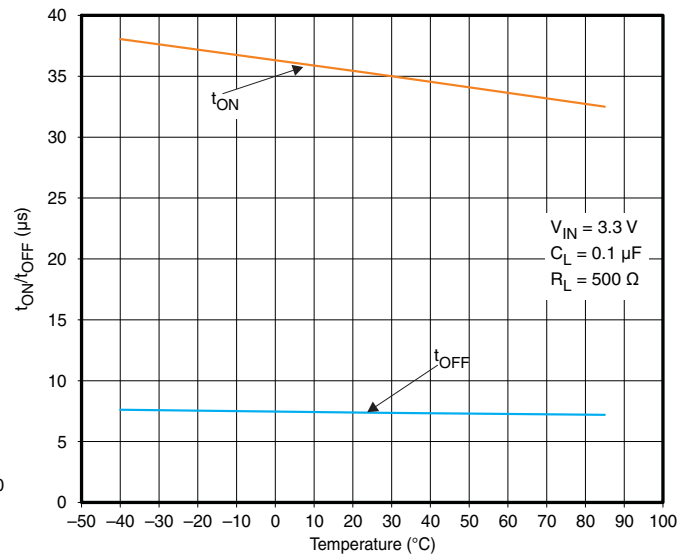


Figure 15.  $t_{ON}/t_{OFF}$  vs Temperature

TPS22902B

TYPICAL CHARACTERISTICS (continued)

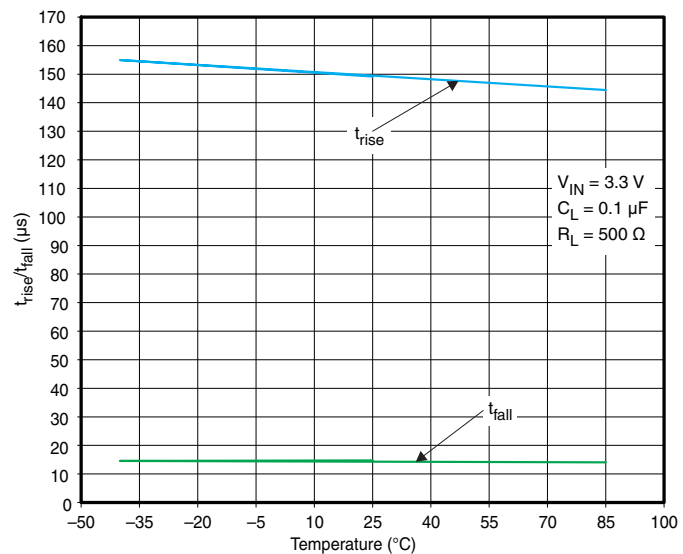


Figure 16.  $t_{rise}/t_{fall}$  vs Temperature

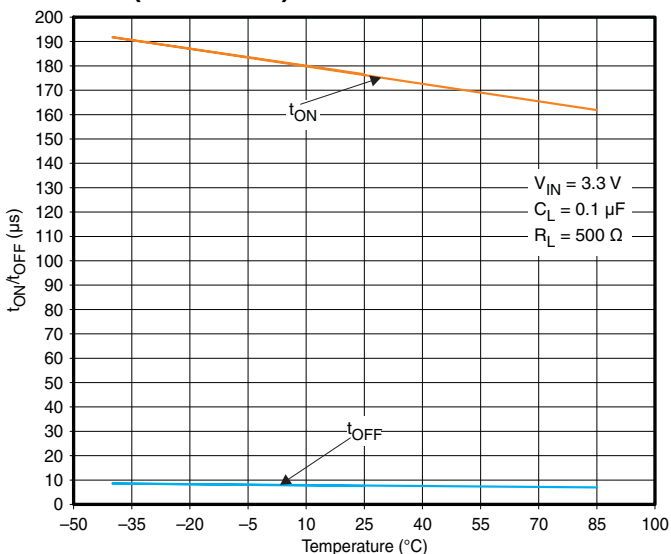


Figure 17.  $t_{ON}/t_{OFF}$  vs Temperature

TYPICAL CHARACTERISTICS (continued)

TPS22901 and TPS22902

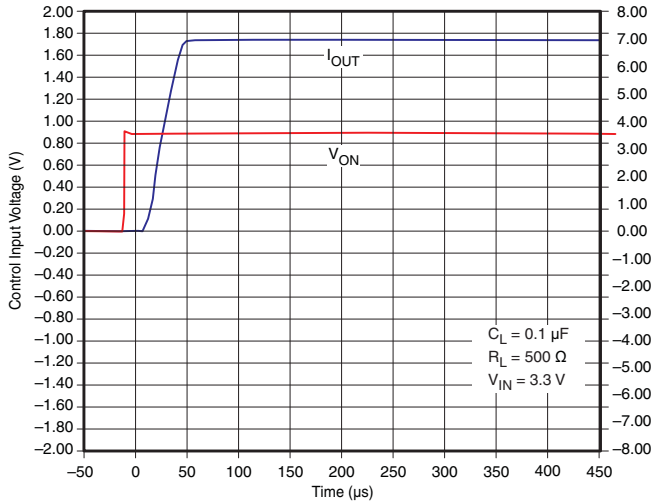


Figure 18.  $t_{ON}$  Response

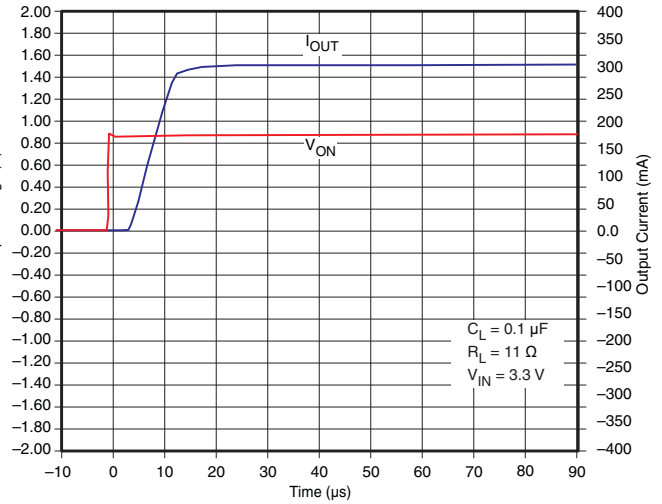


Figure 19.  $t_{ON}$  Response

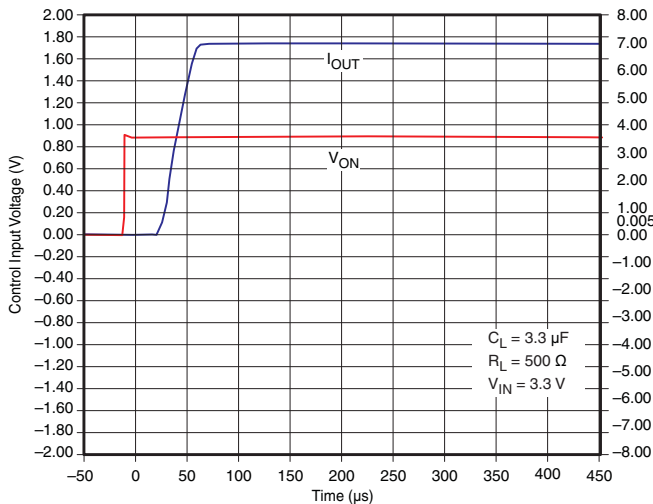


Figure 20.  $t_{ON}$  Response

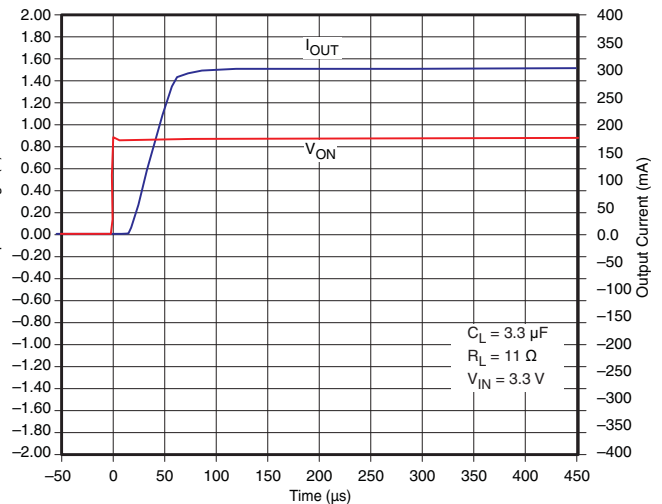


Figure 21.  $t_{ON}$  Response

TYPICAL CHARACTERISTICS (continued)

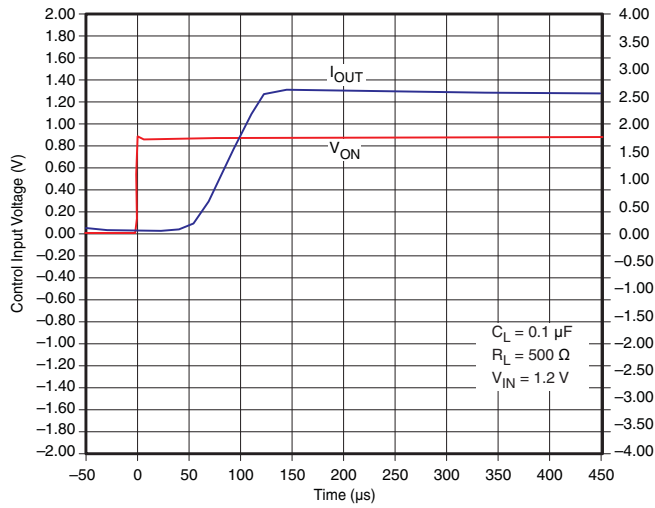


Figure 22.  $t_{ON}$  Response

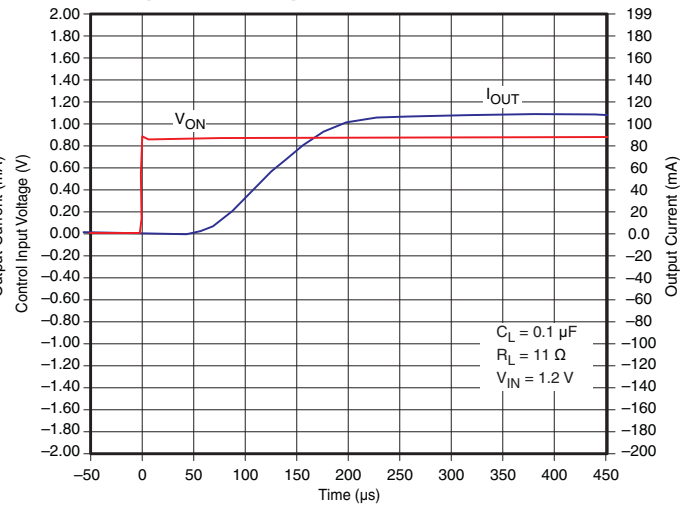


Figure 23.  $t_{ON}$  Response

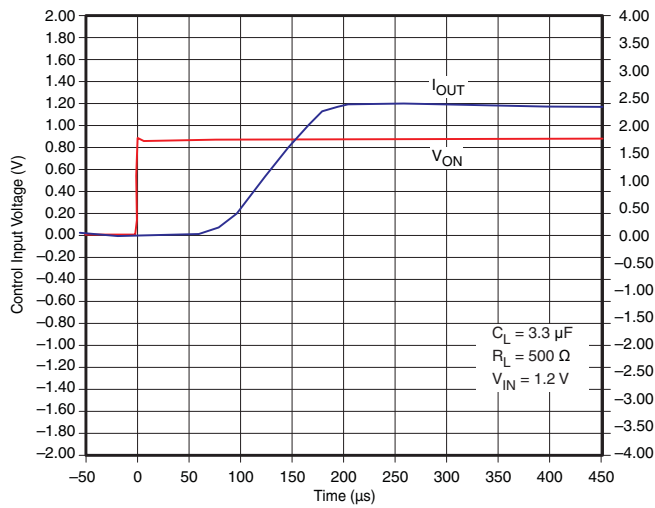


Figure 24.  $t_{ON}$  Response

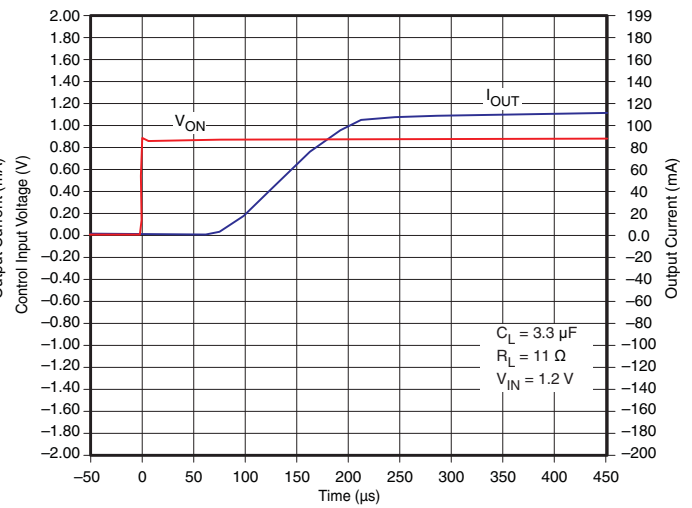


Figure 25.  $t_{ON}$  Response

TPS22901

TYPICAL CHARACTERISTICS (continued)

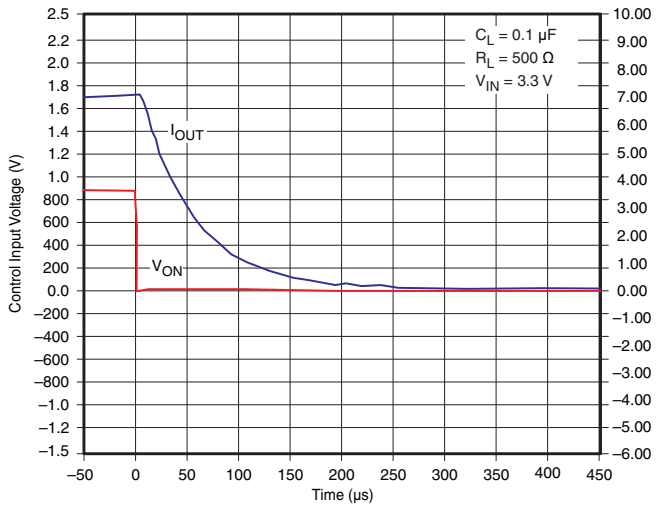


Figure 26.  $t_{OFF}$  Response

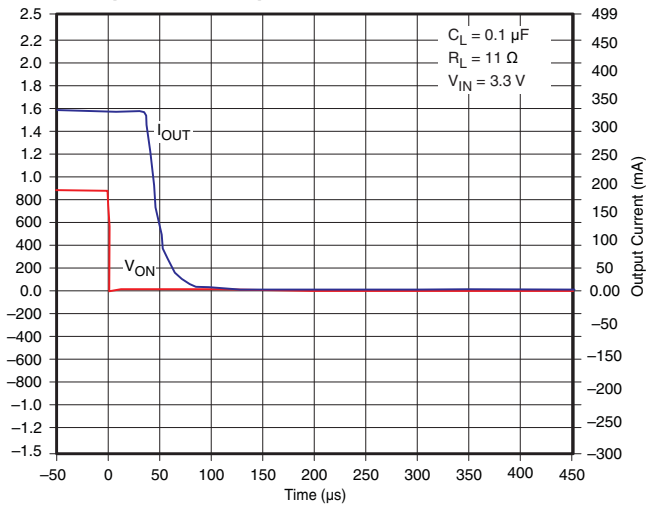


Figure 27.  $t_{OFF}$  Response

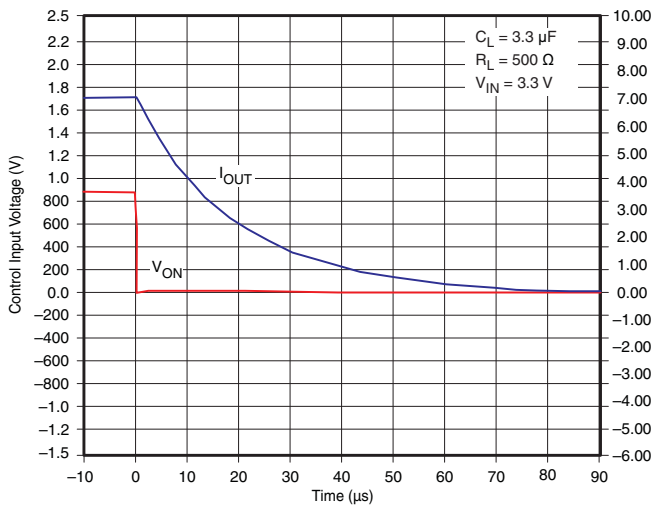


Figure 28.  $t_{OFF}$  Response

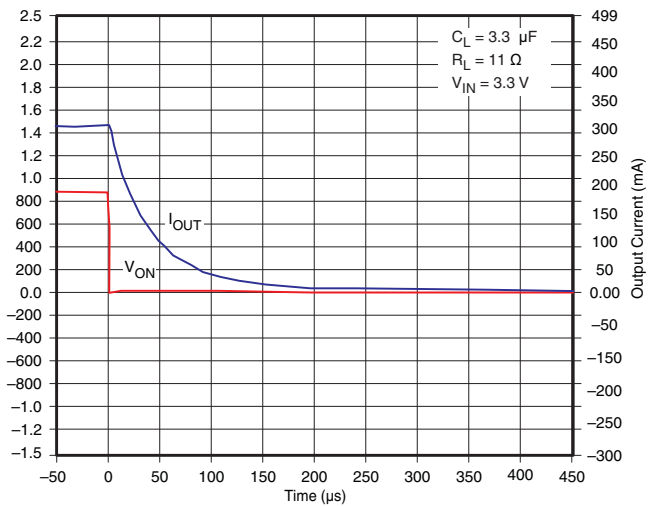


Figure 29.  $t_{OFF}$  Response

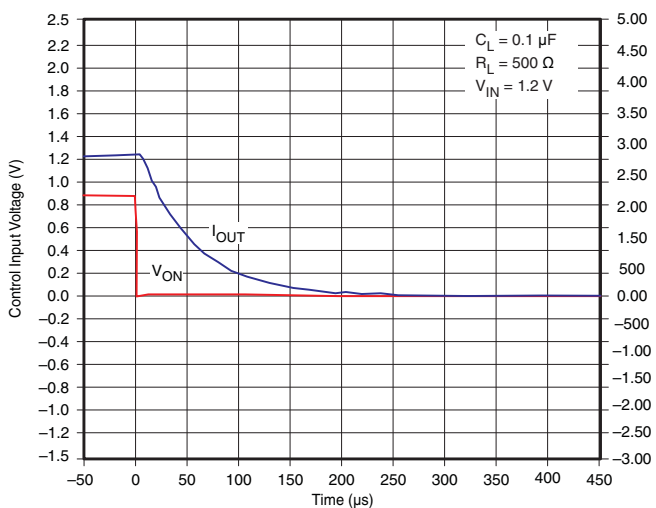


Figure 30.  $t_{OFF}$  Response

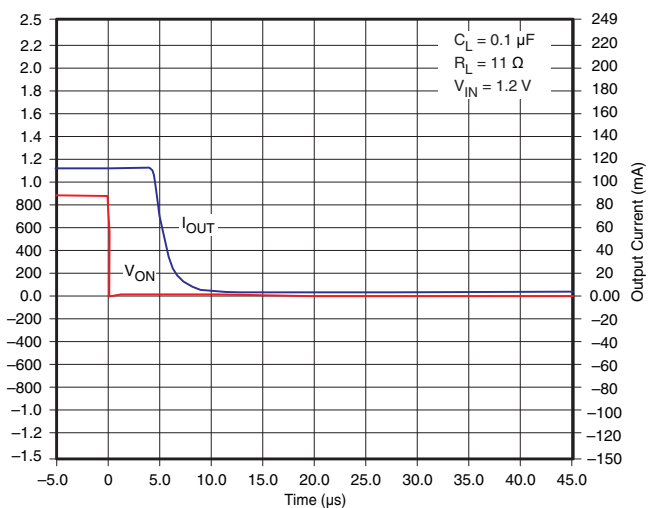
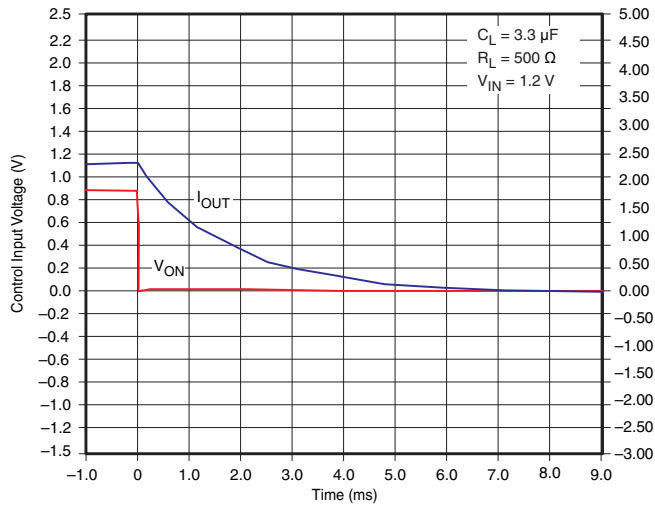
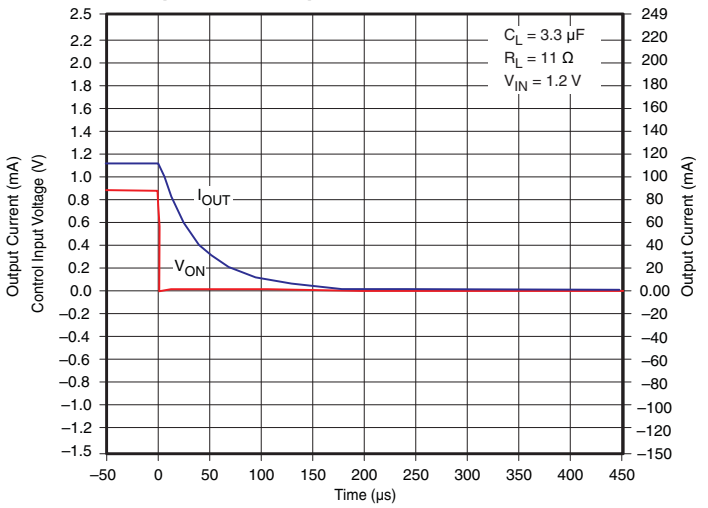


Figure 31.  $t_{OFF}$  Response

**TYPICAL CHARACTERISTICS (continued)**

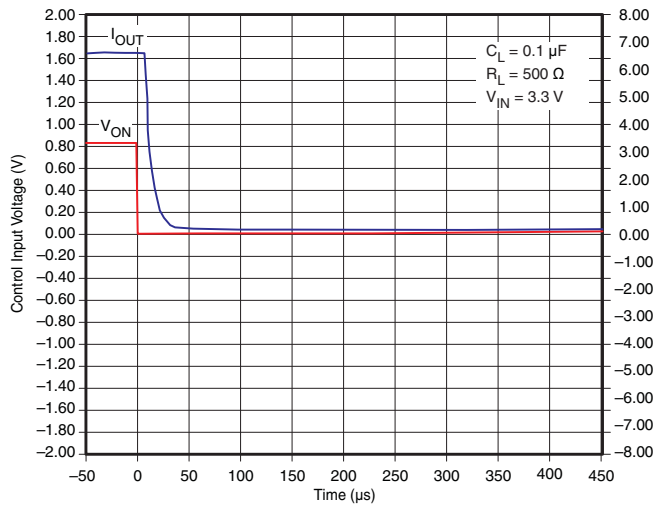


**Figure 32.  $t_{OFF}$  Response**

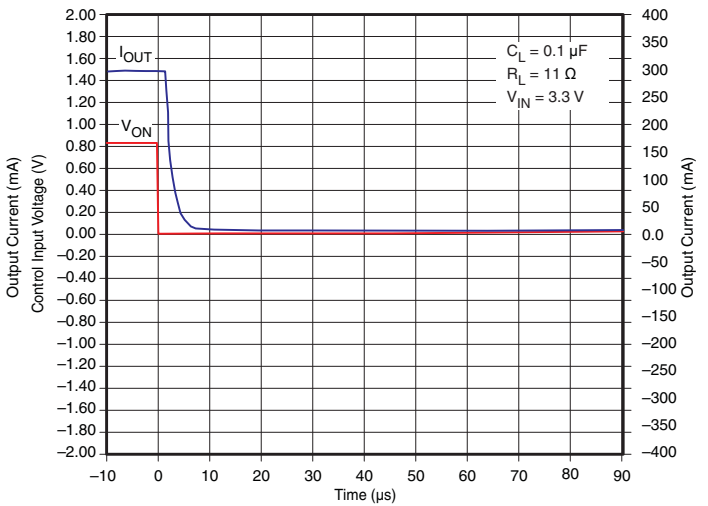


**Figure 33.  $t_{OFF}$  Response**

**TPS22902**



**Figure 34.  $t_{OFF}$  Response**



**Figure 35.  $t_{OFF}$  Response**



TYPICAL CHARACTERISTICS (continued)

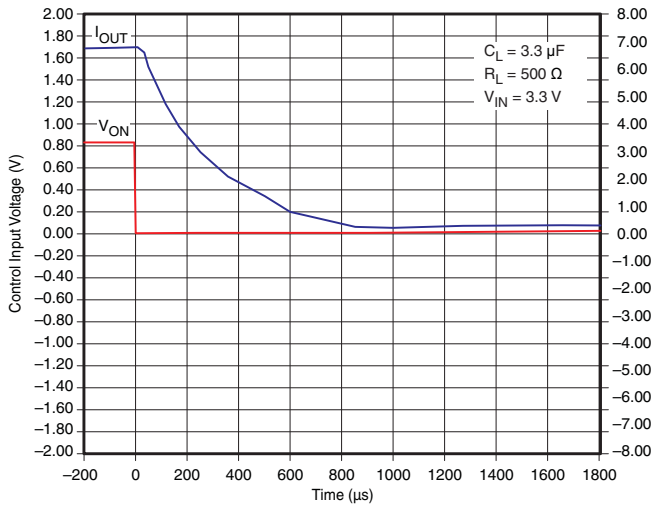


Figure 36.  $t_{OFF}$  Response

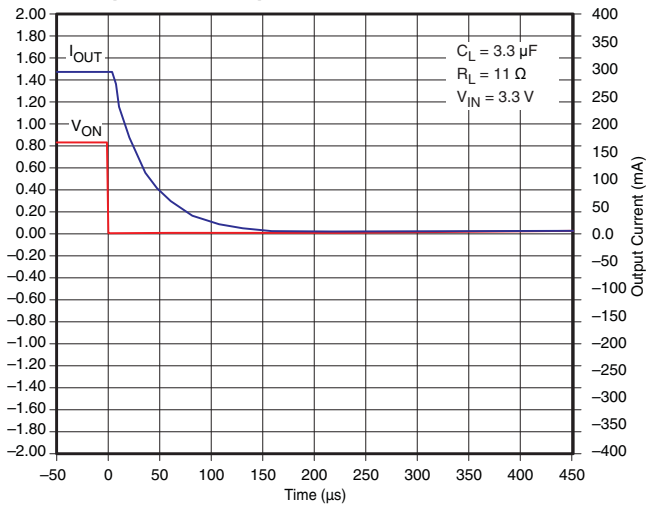


Figure 37.  $t_{OFF}$  Response

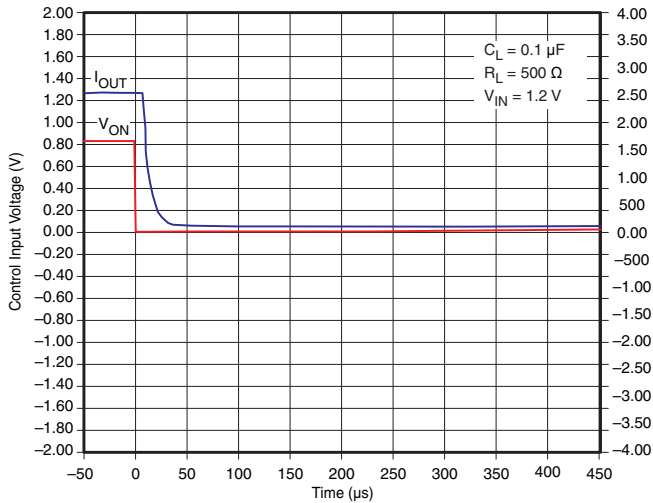


Figure 38.  $t_{OFF}$  Response

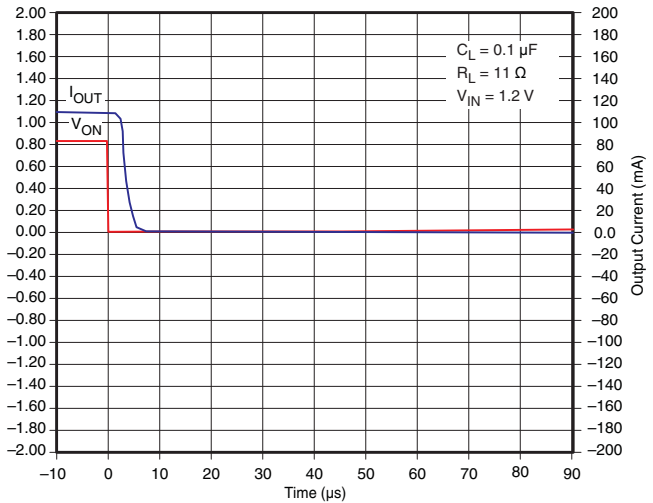


Figure 39.  $t_{OFF}$  Response

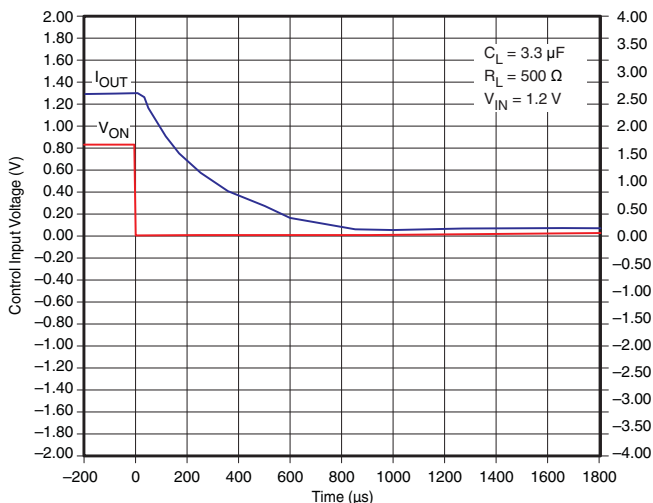


Figure 40.  $t_{OFF}$  Response

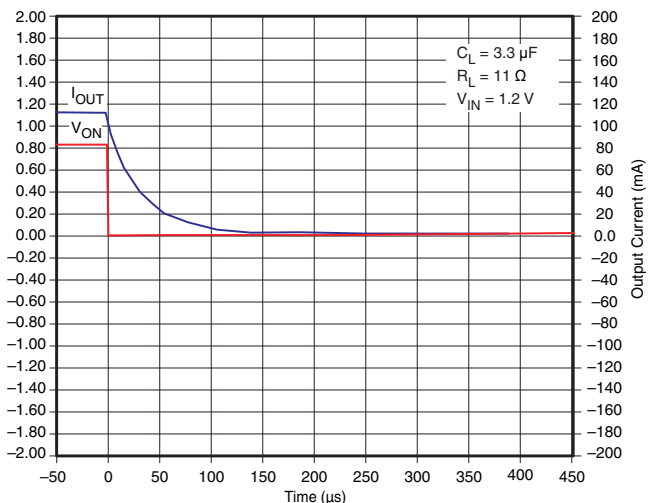


Figure 41.  $t_{OFF}$  Response

TYPICAL CHARACTERISTICS (continued)

TPS22902B

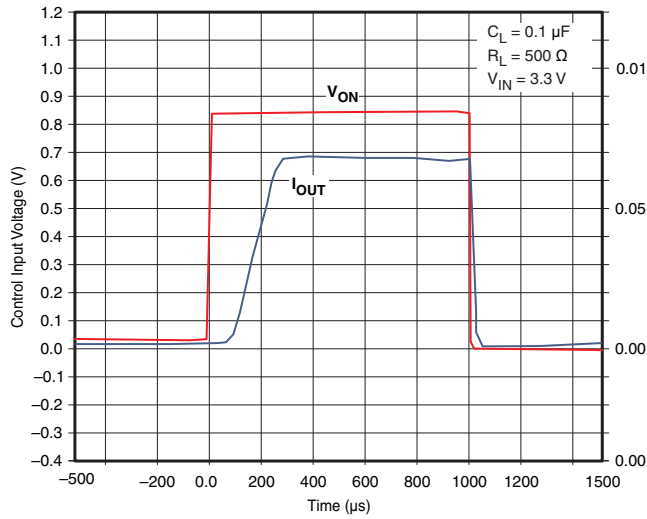


Figure 42.  $t_{ON}$  Response

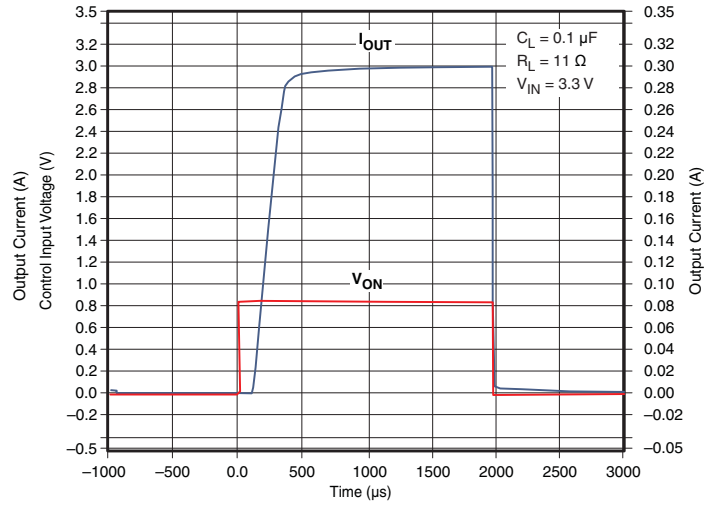


Figure 43.  $t_{ON}$  Response

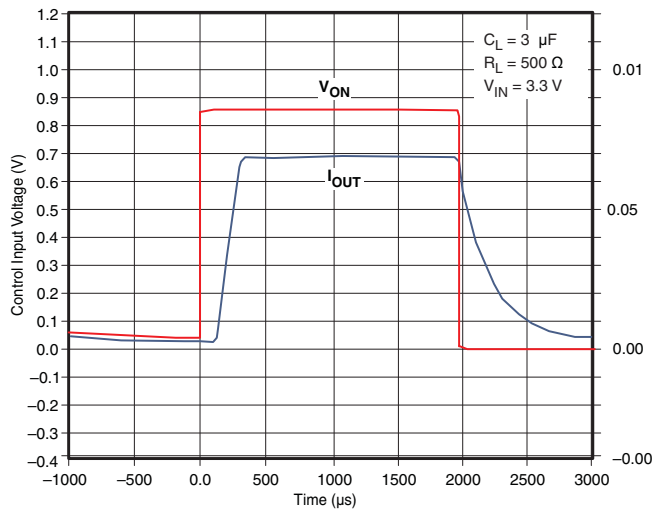


Figure 44.  $t_{ON}$  Response

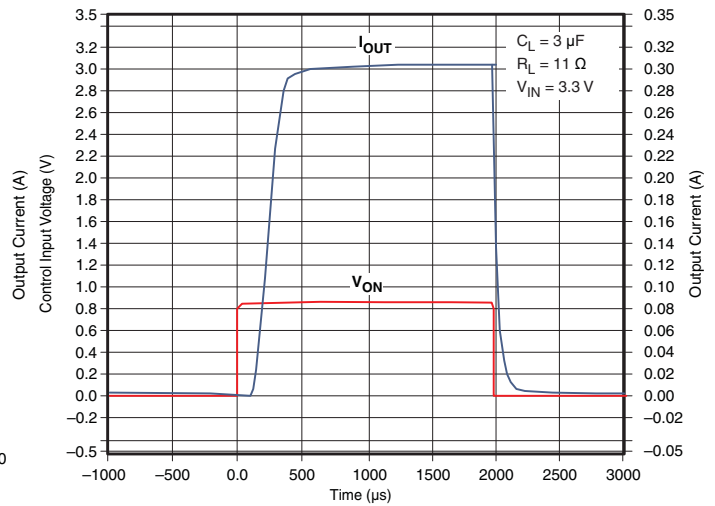


Figure 45.  $t_{ON}$  Response

TYPICAL CHARACTERISTICS (continued)

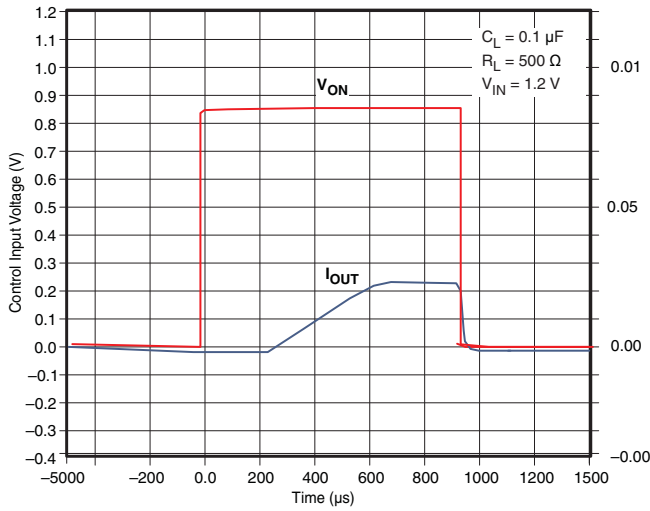


Figure 46.  $t_{ON}$  Response

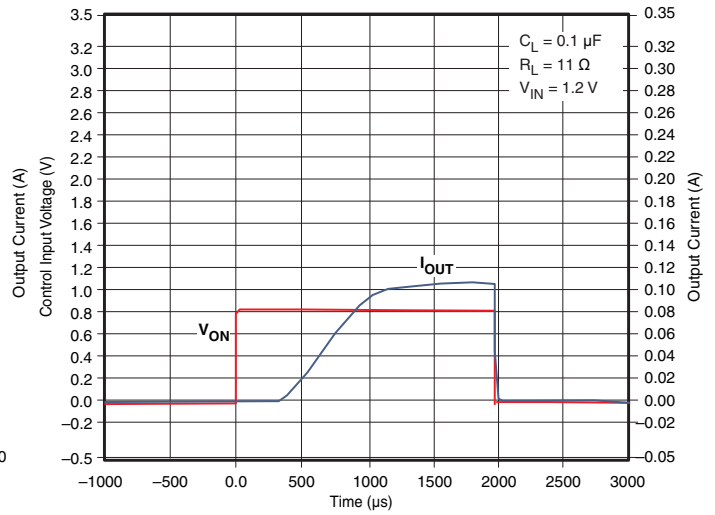


Figure 47.  $t_{ON}$  Response

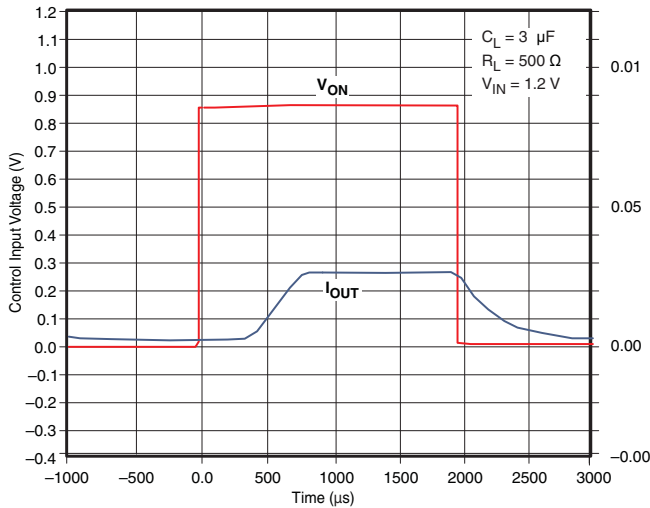


Figure 48.  $t_{ON}$  Response

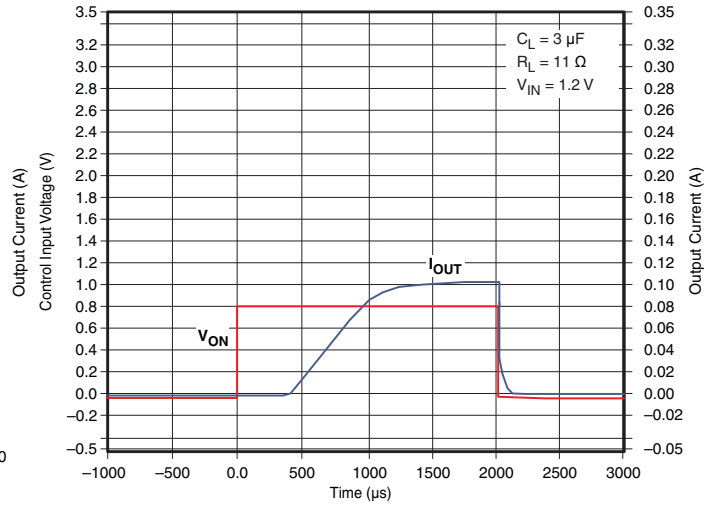


Figure 49.  $t_{ON}$  Response

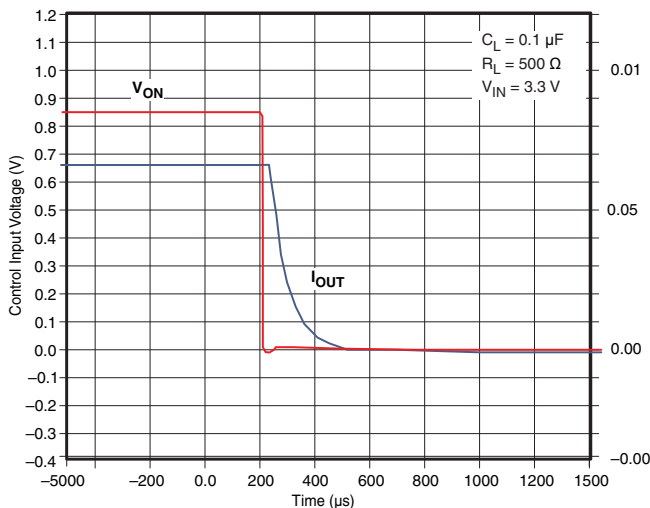


Figure 50.  $t_{OFF}$  Response

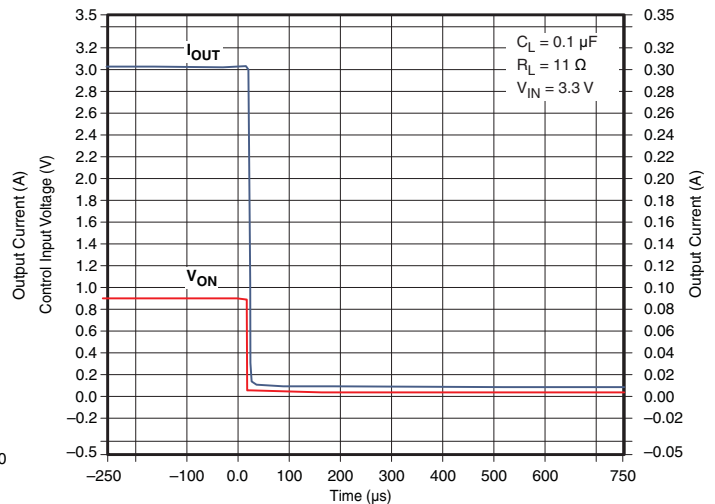


Figure 51.  $t_{OFF}$  Response

TYPICAL CHARACTERISTICS (continued)

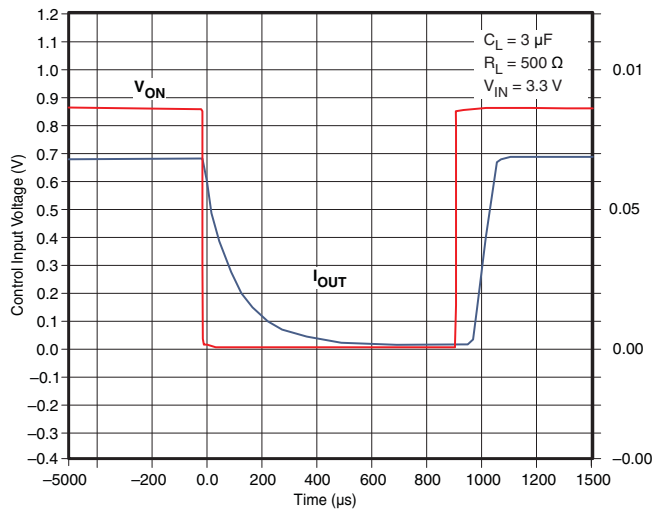


Figure 52.  $t_{OFF}$  Response

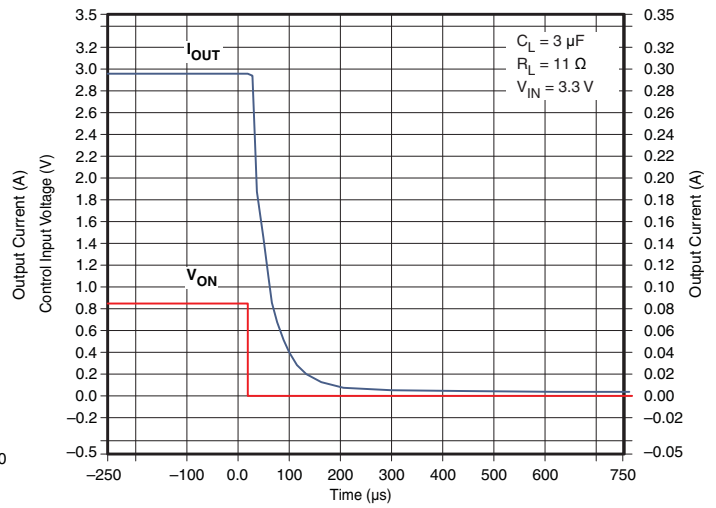


Figure 53.  $t_{OFF}$  Response

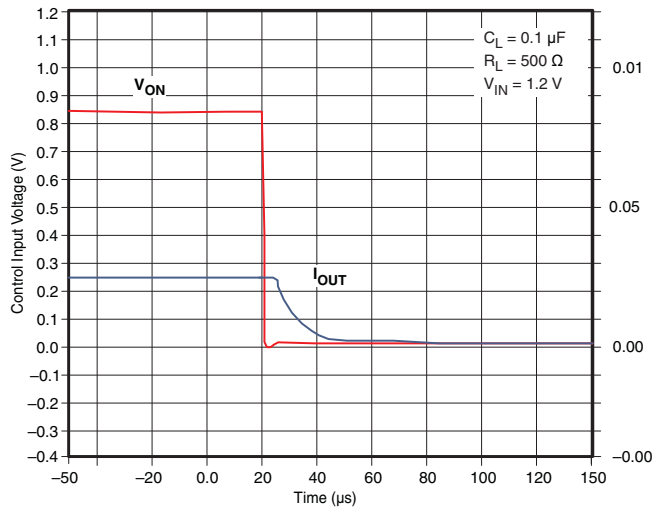


Figure 54.  $t_{OFF}$  Response

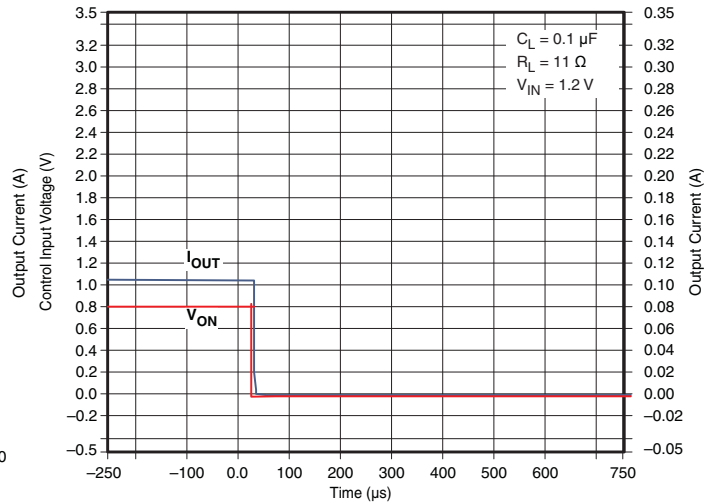


Figure 55.  $t_{OFF}$  Response

TYPICAL CHARACTERISTICS (continued)

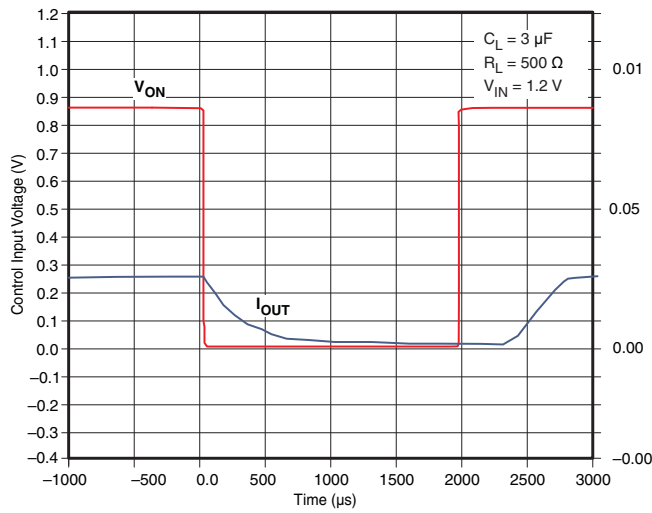


Figure 56. t<sub>OFF</sub> Response

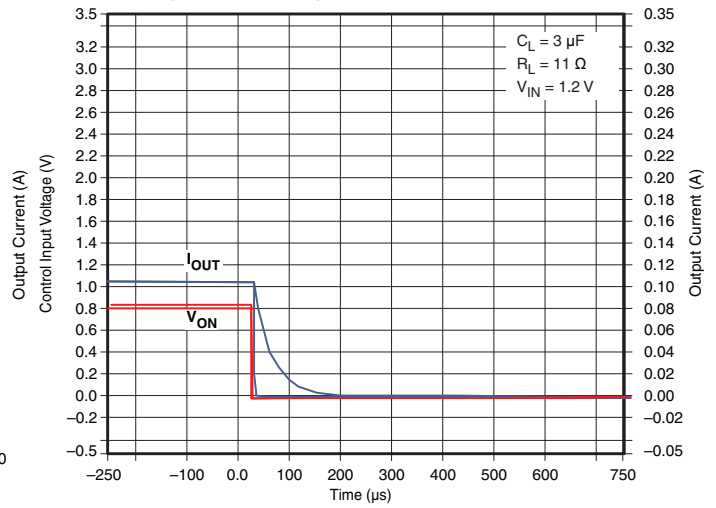


Figure 57. t<sub>OFF</sub> Response

PARAMETER MEASUREMENT INFORMATION

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

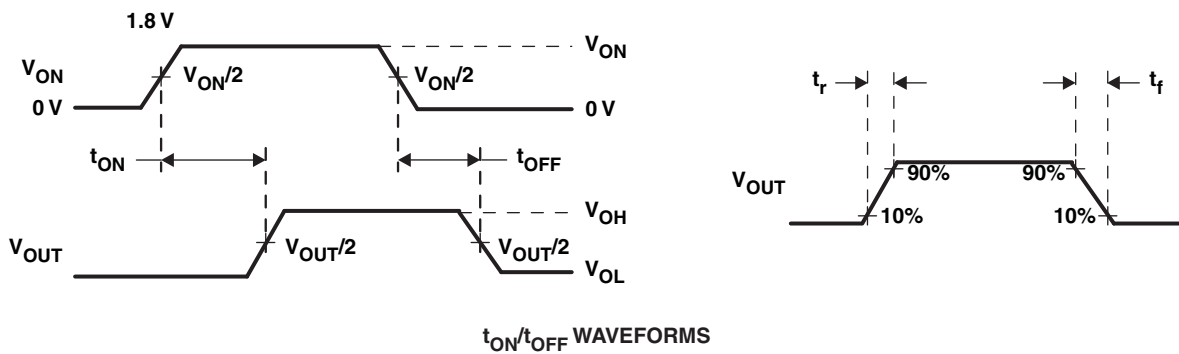
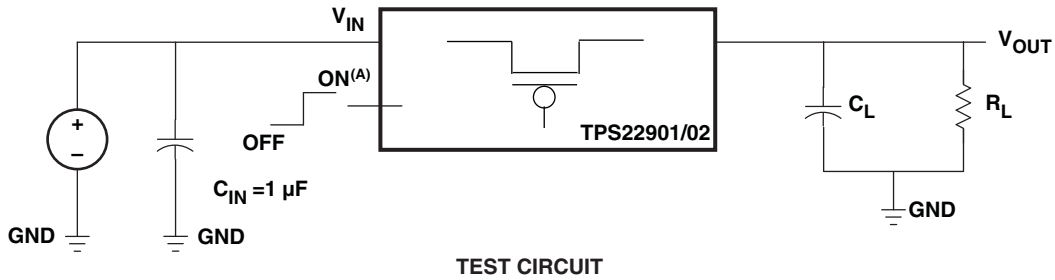


Figure 58. Test Circuit and  $t_{ON}/t_{OFF}$  Waveforms

## 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- $\mu$ 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)	Op Temp (°C)	Top-Side Markings (4)	Samples
TPS22901YFPR	ACTIVE	DSBGA	YFP	4	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	3P (3 ~ 5)	<a href="#">Samples</a>
TPS22902BYFPR	ACTIVE	DSBGA	YFP	4	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	3S 3	<a href="#">Samples</a>
TPS22902YFPR	ACTIVE	DSBGA	YFP	4	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	3R (3 ~ 5)	<a href="#">Samples</a>

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

**ACTIVE:** Product device recommended for new designs.

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

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

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

**OBSOLETE:** TI has discontinued the production of the device.

(2) 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.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

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**TAPE AND REEL INFORMATION**

**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	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

**TAPE AND REEL BOX DIMENSIONS**

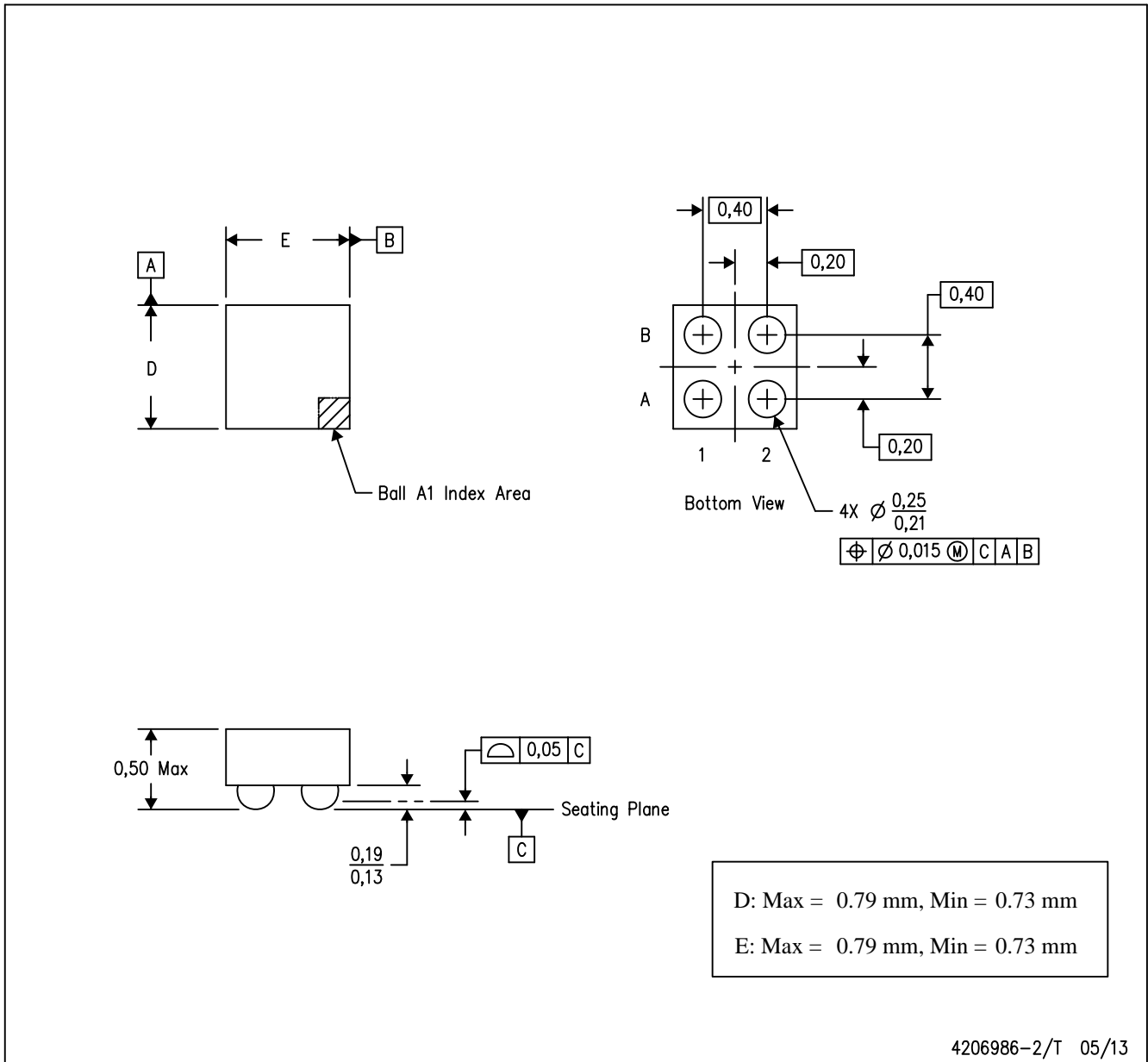

\*All dimensions are nominal

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

# MECHANICAL DATA

YFP (S-XBGA-N4)

DIE-SIZE BALL GRID ARRAY



- 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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### Applications

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