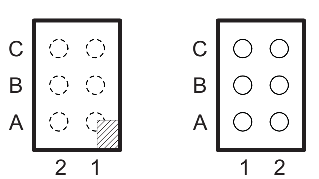
LOW INPUT VOLTAGE, ULTRA-LOW r_{ON} LOAD SWITCHES

Check for Samples: TPS22921, TPS22922, TPS22922B

FEATURES

- **Input Voltage: 0.9 V to 3.6 V**
- **Ultra-Low ON Resistance (Typical Values)**
  - **r_{ON} = 14 mΩ at V_{IN} = 3.6 V**
  - **r_{ON} = 20 mΩ at V_{IN} = 2.5 V**
  - **r_{ON} = 33 mΩ at V_{IN} = 1.8 V**
  - **r_{ON} = 67 mΩ at V_{IN} = 1.2 V**
  - **r_{ON} = 116 mΩ at V_{IN} = 1.0 V**
- **2-A Maximum Continuous Switch Current**
- **Ultra-Low Quiescent Current:**
  - **Typical 78 nA at 1.8 V**
- **Ultra-Low Shutdown Current:**
  - **Typical 35 nA at 1.8 V**
- **Low Threshold Control Input Enable the use of 1.2 V, 1.8 V, 2.5 V, or 3.3 V Logic**
- **Controlled Slew Rate to Avoid Inrush Currents**
- **Typical Rise Times at V_{IN} = 1.8 V**
  - **TPS22921 and TPS22922: 30 μs**
  - **TPS22922B: 200 μs**
- **ESD Performance Tested Per JESD 22**
  - **3000-V Human-Body Model (A114-B, Class II)**
  - **1000-V Charged-Device Model (C101)**
- **Six Terminal Wafer-Chip-Scale Package (nominal dimensions shown - see addendum for details)**
  - **0.9 mm × 1.4 mm, 0.5-mm Pitch, 0.5-mm Height (YZP)**
  - **0.9 mm × 1.4 mm, 0.5-mm Pitch, 0.625-mm Height (YZT)**
  - **0.8 mm × 1.2 mm, 0.4-mm Pitch, 0.5-mm Height (YFP)**

YFP, YZP, AND YZT PACKAGES



Laser Marking View **Bump View**

APPLICATIONS

- **PDAs**
- **Cell Phones**
- **GPS Devices**
- **MP3 Players**
- **Peripheral Ports**
- **Portable Media Players**
- **RF Modules**

DESCRIPTION

TPS22921, TPS22922, and TPS22922B are ultra-low r_{ON} load switches with controlled turn on. TPS22921/2/2B contain an ultra-low r_{ON} P-channel MOSFET that can operate over an input voltage range of 0.9 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 TPS22922 and in TPS22922B, a 120-Ω on-chip load resistor is added for output quick discharge when switch is turned off. The rise time (slew rate) of the device is internally controlled in order to avoid inrush current: TPS22921 and TPS22922 feature a 30 μs rise time whereas TPS22922B is 200 μs.

TPS22921, TPS22922, and TPS22922B feature ultra-low quiescent and shutdown current and are available in space-saving 6-terminals wafer-chip-scale packages (WCSP: YZP and YZT with 0.5-mm pitch and YFP with 0.4-mm pitch) which make them ideal for portable electronics. The devices are characterized for operation over the free-air temperature range of –40°C to 85°C.

TERMINAL ASSIGNMENTS

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

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

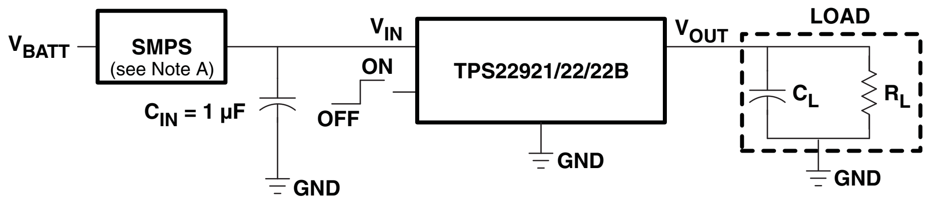
	r_{ON} AT 1.8 V (TYP)	SLEW RATE (TYP at 1.8 V)	QUICK OUTPUT DISCHARGE(1)	MAX OUTPUT CURRENT	ENABLE
TPS22921	33 mΩ	30 µs	No	2 A	active high
TPS22922	33 mΩ	30 µs	Yes	2 A	active high
TPS22922B	33 mΩ	200 µs	Yes	2 A	active high

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

ORDERING INFORMATION

For package and ordering information, see the Package Option Addendum at the end of this document.

TYPICAL APPLICATION



A. Switched mode power supply

APPLICATION BLOCK DIAGRAM

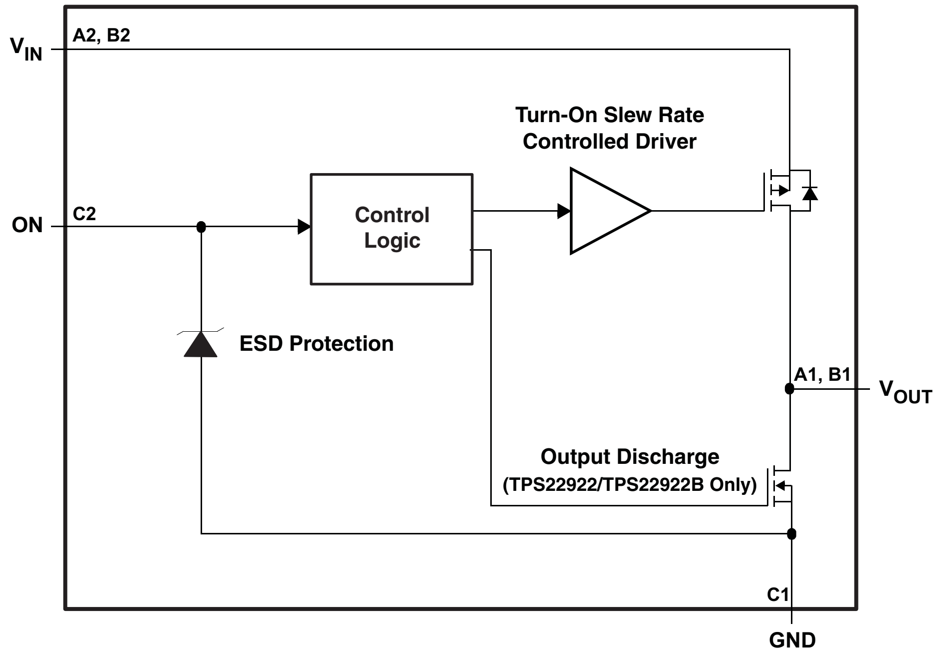


Figure 1. Functional Block Diagram

FUNCTION TABLE

ON	V_{IN} TO V_{OUT}	V_{OUT} TO GND(1)
L	OFF	ON
H	ON	OFF

(1) TPS22922/TPS22922B only

TERMINAL FUNCTIONS

TERMINAL		DESCRIPTION
NO.	NAME	
A1, B1	V_{OUT}	Switch output
A2, B2	V_{IN}	Switch input
C1	GND	Ground
C2	ON	Switch control input, active high. Do not leave floating

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			0.645	W
I_{MAX}	Maximum continuous switch current			2	A
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)		3000	V
		Charged Device Model (CDM)		1000	
		Machine Model (MM)		300	

(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	155	°C/W
		YZP/YZT package	123	

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

RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
V_{IN}	Input voltage range	0.9	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) Refer to Application Information.

ELECTRICAL CHARACTERISTICS

V_{IN} = 0.9 V to 3.6 V, T_A = –40°C to 85°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP[(1)]	MAX	UNIT
I_{IN}	Quiescent current	I_{OUT} = 0 mA	V_{IN} = 1 V	Full		30	120	nA
			V_{IN} = 1.8 V	Full		78	235	
			V_{IN} = 3.6 V	Full		200	880	
$I_{IN(OFF)}$	OFF-state supply current	V_{ON} = GND, OUT = Open	V_{IN} = 1 V	Full		10	210	nA
			V_{IN} = 1.8 V	Full		35	260	
			V_{IN} = 3.6 V	Full		120	700	
$I_{IN(LEAKAGE)}$	OFF-state switch current	V_{ON} = GND, V_{OUT} = 0 V	V_{IN} = 1 V	Full		12	140	nA
			V_{IN} = 1.8 V	Full		50	230	
			V_{IN} = 3.6 V	Full		130	610	
r_{ON}	ON-state resistance	I_{OUT} = –200 mA	V_{IN} = 3.6 V	25°C		14	45	mΩ
				Full			50	
			V_{IN} = 2.5 V	25°C		20	55	
				Full			60	
			V_{IN} = 1.8 V	25°C		33	65	
				Full			75	
			V_{IN} = 1.2 V	25°C		67	100	
				Full			120	
			V_{IN} = 1.1 V	25°C		82	150	
				Full			160	
			V_{IN} = 1 V	25°C		116	160	
				Full			170	
r_{PD}	Output pulldown resistance	V_{IN} = 3.3 V, V_{ON} = 0 V, I_{OUT} = 30 mA (TPS22922 and TPS22922B only)		25°C		65	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°C.

SWITCHING CHARACTERISTICS

V_{IN} = 0.9 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TPS22921			TPS22922			TPS22922B			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω,	C_L = 0.1 μF		121			121			638		μs
			C_L = 1 μF		160			160			712		
			C_L = 3 μF		188			188			799		
t_{OFF}	Turn-OFF time	R_L = 500 Ω,	C_L = 0.1 μF		46			40			40		μs
			C_L = 1 μF		308			279			279		
			C_L = 3 μF		975			807			807		
t_r	V_{OUT} rise time	R_L = 500 Ω,	C_L = 0.1 μF		60			60			462		μs
			C_L = 1 μF		85			85			465		
			C_L = 3 μF		107			107			507		
t_f	V_{OUT} fall time	R_L = 500 Ω,	C_L = 0.1 μF		119			51			51		μs
			C_L = 1 μF		969			434			434		
			C_L = 3 μF		3174			1264			1264		

SWITCHING CHARACTERISTICS

V_{IN} = 1.0 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TPS22921			TPS22922			TPS22922B			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω,	C_L = 0.1 µF		105			105			549		µs
			C_L = 1 µF		136			136			613		
			C_L = 3 µF		157			157			683		
t_{OFF}	Turn-OFF time	R_L = 500 Ω,	C_L = 0.1 µF		46			28			28		µs
			C_L = 1 µF		309			186			186		
			C_L = 3 µF		983			511			511		
t_r	V_{OUT} rise time	R_L = 500 Ω,	C_L = 0.1 µF		51			51			386		µs
			C_L = 1 µF		78			78			388		
			C_L = 3 µF		88			88			419		
t_f	V_{OUT} fall time	R_L = 500 Ω,	C_L = 0.1 µF		121			34			34		µs
			C_L = 1 µF		986			306			306		
			C_L = 3 µF		3300			908			908		

SWITCHING CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS		TPS22921			TPS22922			TPS22922B			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω,	C_L = 0.1 µF		91			93			484		µs
			C_L = 1 µF		118			118			540		
			C_L = 3 µF		137			137			599		
t_{OFF}	Turn-OFF time	R_L = 500 Ω,	C_L = 0.1 µF		44			21			21		µs
			C_L = 1 µF		311			144			144		
			C_L = 3 µF		99			383			383		
t_r	V_{OUT} rise time	R_L = 500 Ω,	C_L = 0.1 µF		46			46			335		µs
			C_L = 1 µF		60			60			336		
			C_L = 3 µF		76			76			363		
t_f	V_{OUT} fall time	R_L = 500 Ω,	C_L = 0.1 µF		122			29			29		µs
			C_L = 1 µF		1000			224			224		
			C_L = 3 µF		3300			732			732		

SWITCHING CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS		TPS22921			TPS22922			TPS22922B			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω,	C_L = 0.1 µF		83			83			435		µs
			C_L = 1 µF		103			103			485		
			C_L = 3 µF		122			122			536		
t_{OFF}	Turn-OFF time	R_L = 500 Ω,	C_L = 0.1 µF		44			17			17		µs
			C_L = 1 µF		312			117			117		
			C_L = 3 µF		1000			319			319		
t_r	V_{OUT} rise time	R_L = 500 Ω,	C_L = 0.1 µF		41			41			301		µs
			C_L = 1 µF		54			54			302		
			C_L = 3 µF		67			67			325		
t_f	V_{OUT} fall time	R_L = 500 Ω,	C_L = 0.1 µF		123			25			25		µs
			C_L = 1 µF		1000			214			214		
			C_L = 3 µF		3400			632			632		

SWITCHING CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS		TPS22921			TPS22922			TPS22922B			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω,	C_L = 0.1 µF		54			54			282		µs
			C_L = 1 µF		67			67			314		
			C_L = 3 µF		78			78			344		
t_{OFF}	Turn-OFF time	R_L = 500 Ω,	C_L = 0.1 µF		41			10			10		µs
			C_L = 1 µF		312			67			67		
			C_L = 3 µF		1000			181			181		
t_r	V_{OUT} rise time	R_L = 500 Ω,	C_L = 0.1 µF		30			30			200		µs
			C_L = 1 µF		37			37			202		
			C_L = 3 µF		47			47			219		
t_f	V_{OUT} fall time	R_L = 500 Ω,	C_L = 0.1 µF		121			17			17		µs
			C_L = 1 µF		1000			158			158		
			C_L = 3 µF		3450			461			461		

SWITCHING CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS		TPS22921			TPS22922			TPS22922B			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω,	C_L = 0.1 μF		40			40			211		μs
			C_L = 1 μF		50			50			233		
			C_L = 3 μF		59			59			256		
t_{OFF}	Turn-OFF time	R_L = 500 Ω,	C_L = 0.1 μF		41			10			10		μs
			C_L = 1 μF		316			56			56		
			C_L = 3 μF		1000			153			153		
t_r	V_{OUT} rise time	R_L = 500 Ω,	C_L = 0.1 μF		23			23			164		μs
			C_L = 1 μF		29			29			165		
			C_L = 3 μF		38			38			177		
t_f	V_{OUT} fall time	R_L = 500 Ω,	C_L = 0.1 μF		122			16			16		μs
			C_L = 1 μF		1086			147			147		
			C_L = 3 μF		3600			430			430		

SWITCHING CHARACTERISTICS

V_{IN} = 3 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TPS22921			TPS22922			TPS22922B			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω,	C_L = 0.1 μF		30			30			182		μs
			C_L = 1 μF		38			38			201		
			C_L = 3 μF		45			45			221		
t_{OFF}	Turn-OFF time	R_L = 500 Ω,	C_L = 0.1 μF		40			10			10		μs
			C_L = 1 μF		353			51			51		
			C_L = 3 μF		1036			139			139		
t_r	V_{OUT} rise time	R_L = 500 Ω,	C_L = 0.1 μF		20			20			149		μs
			C_L = 1 μF		25			25			150		
			C_L = 3 μF		33			33			161		
t_f	V_{OUT} fall time	R_L = 500 Ω,	C_L = 0.1 μF		104			15			15		μs
			C_L = 1 μF		1030			143			143		
			C_L = 3 μF		3230			419			419		

SWITCHING CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS		TPS22921			TPS22922			TPS22922B			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_{ON}	Turn-ON time	R_L = 500 Ω,	C_L = 0.1 μF		30			30			159		μs
			C_L = 1 μF		38			38			175		
			C_L = 3 μF		45			45			193		
t_{OFF}	Turn-OFF time	R_L = 500 Ω,	C_L = 0.1 μF		42			10			10		μs
			C_L = 1 μF		310			51			51		
			C_L = 3 μF		988			139			139		
t_r	V_{OUT} rise time	R_L = 500 Ω,	C_L = 0.1 μF		20			20			137		μs
			C_L = 1 μF		25			25			138		
			C_L = 3 μF		33			33			148		
t_f	V_{OUT} fall time	R_L = 500 Ω,	C_L = 0.1 μF		120			15			15		μs
			C_L = 1 μF		1100			143			143		
			C_L = 3 μF		3600			419			419		

TYPICAL CHARACTERISTICS

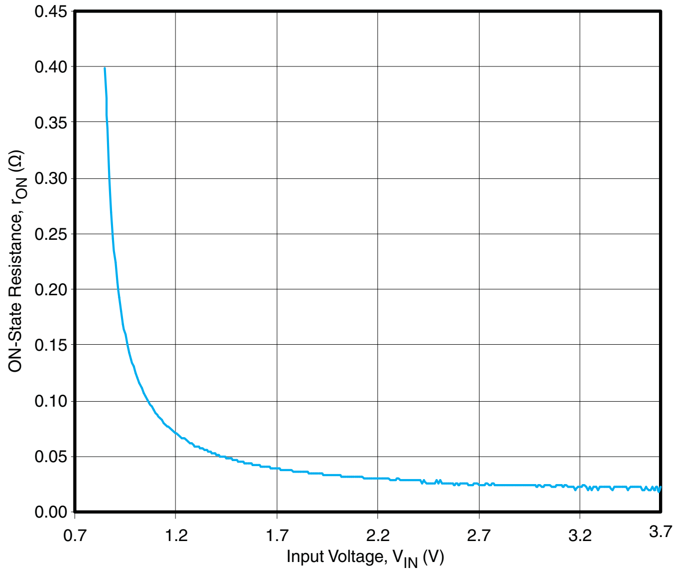


Figure 2. r_{ON} vs. V_{IN}

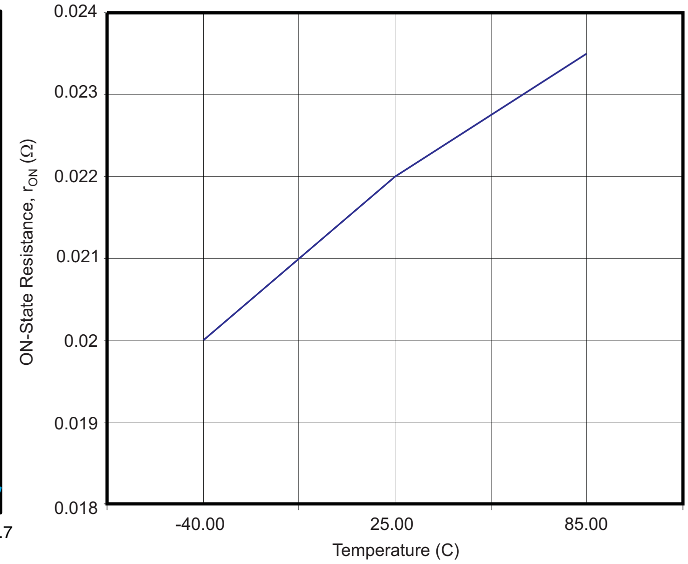


Figure 3. r_{ON} vs. Temperature (V_{IN} = 3.3 V)

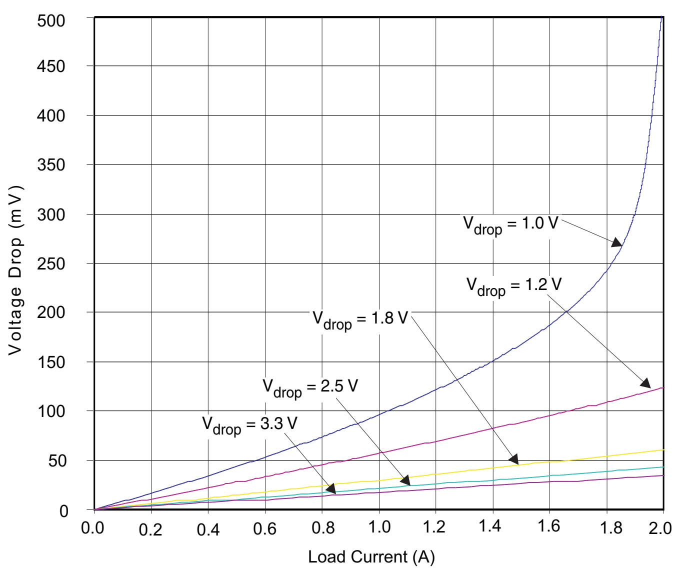


Figure 4. Voltage Drop vs Load Current

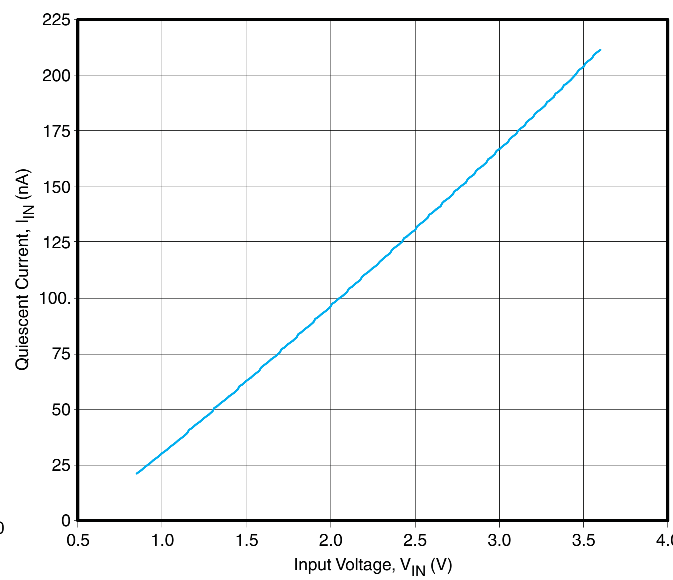


Figure 5. Quiescent Current vs. V_{IN} (V_{ON} = V_{IN})

TYPICAL CHARACTERISTICS (continued)

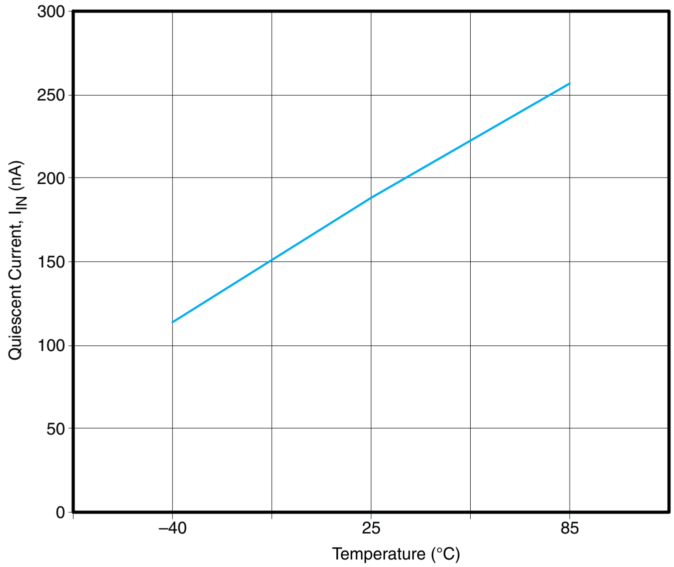


Figure 6. Quiescent Current vs. Temperature (V_{IN} = 3.3 V, I_{OUT} = 0 mA)

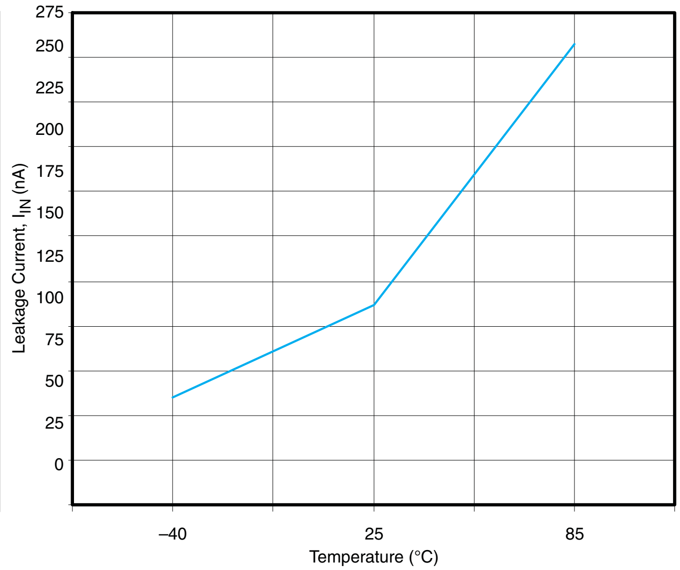


Figure 7. I_{IN} Leakage Current vs. Temperature (V_{IN} = 3.3 V)

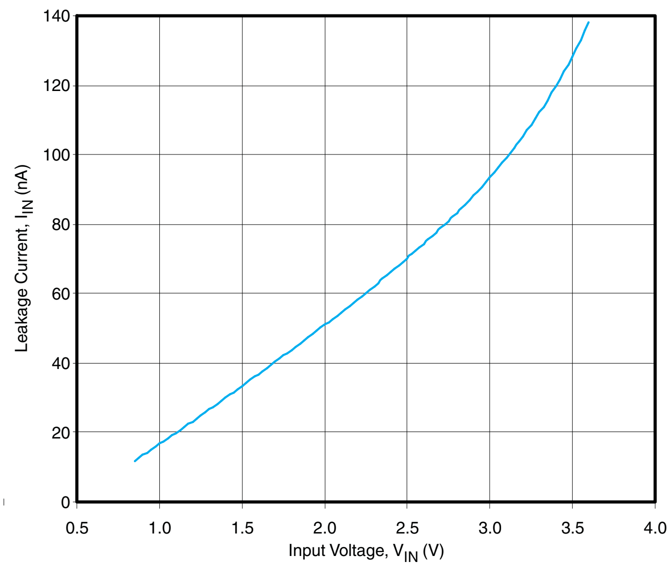


Figure 8. Leakage Current vs V_{IN}

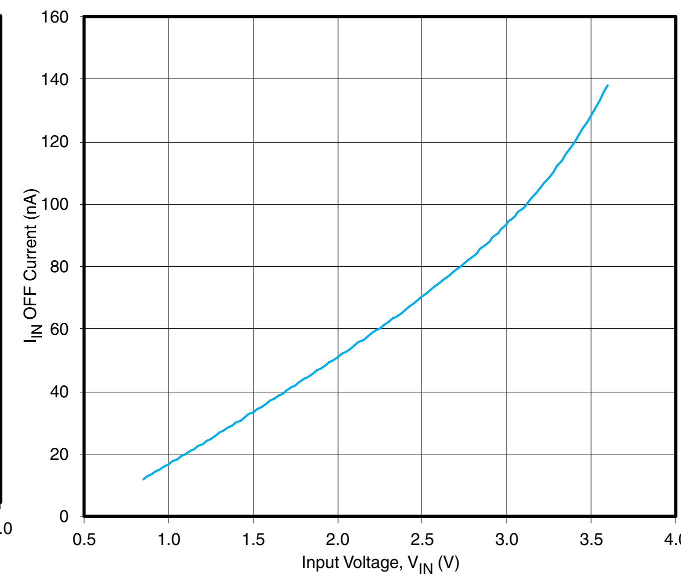


Figure 9. I_{IN} (OFF) vs V_{IN} (V_{ON} = 0 V)

TYPICAL CHARACTERISTICS (continued)

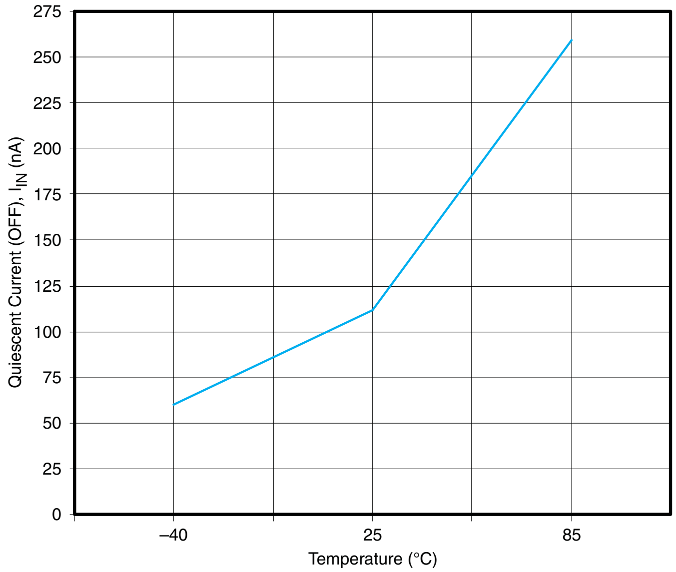


Figure 10. I_{IN} (OFF) vs Temperature (V_{IN} = 3.3 V)

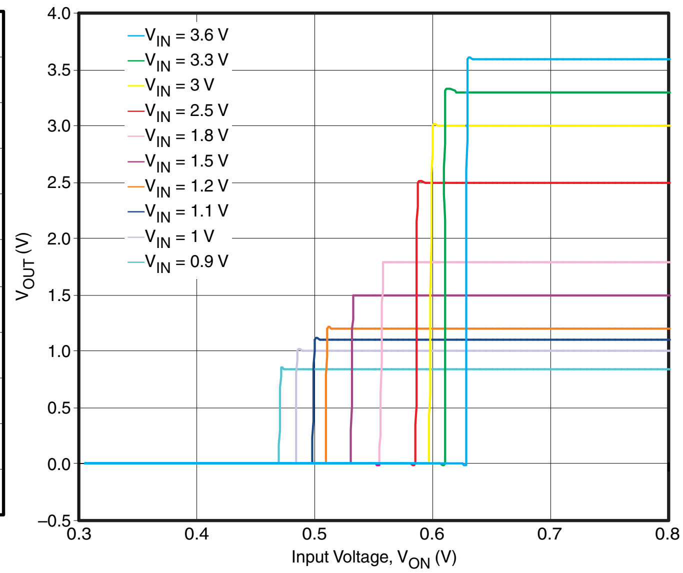


Figure 11. ON-Input Threshold

TPS22921

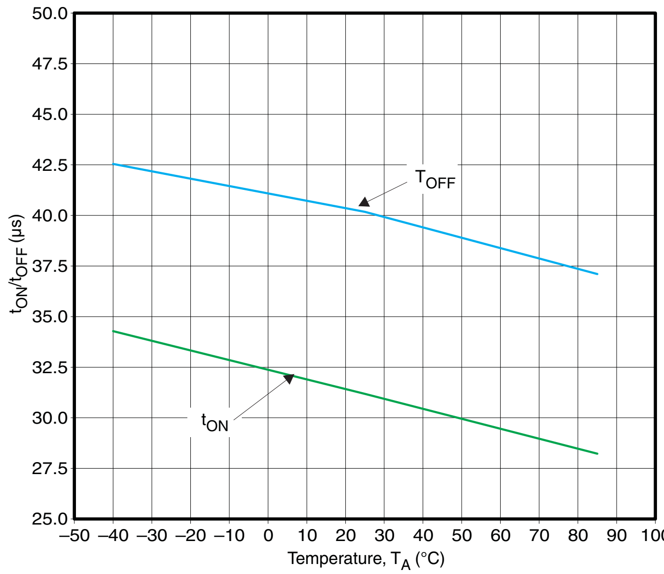


Figure 12. t_{ON}/t_{OFF} vs Temperature (V_{IN} = 3.3 V)

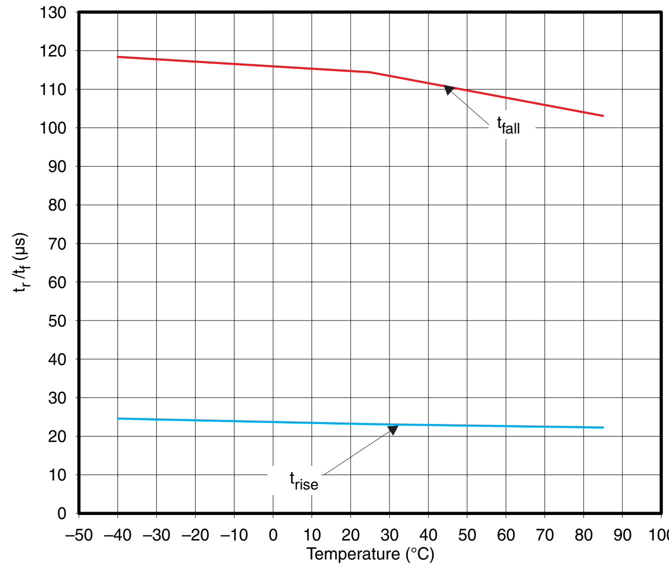


Figure 13. t_{rise}/t_{fall} vs Temperature (V_{IN} = 3.3 V)

TPS22922

TYPICAL CHARACTERISTICS (continued)

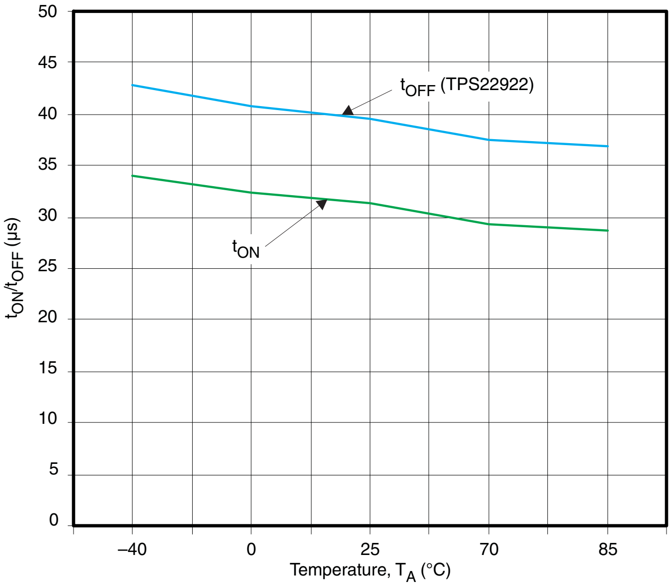


Figure 14. t_{ON}/t_{OFF} vs Temperature (V_{IN} = 3.3 V)

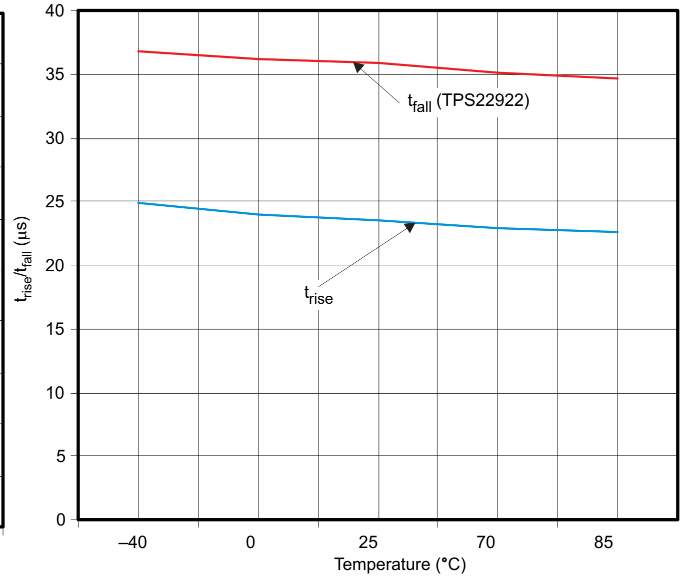


Figure 15. t_{rise}/t_{fall} vs Temperature (V_{IN} = 3.3 V)

TPS22922B

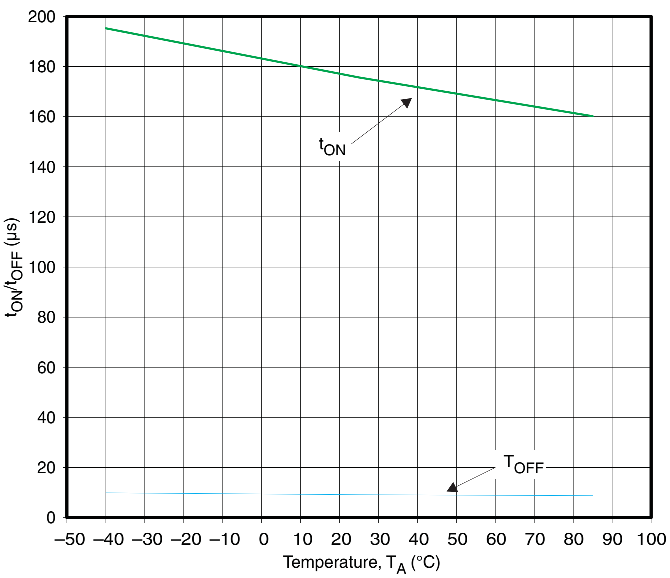


Figure 16. t_{ON}/t_{OFF} vs Temperature (V_{IN} = 3.3 V)

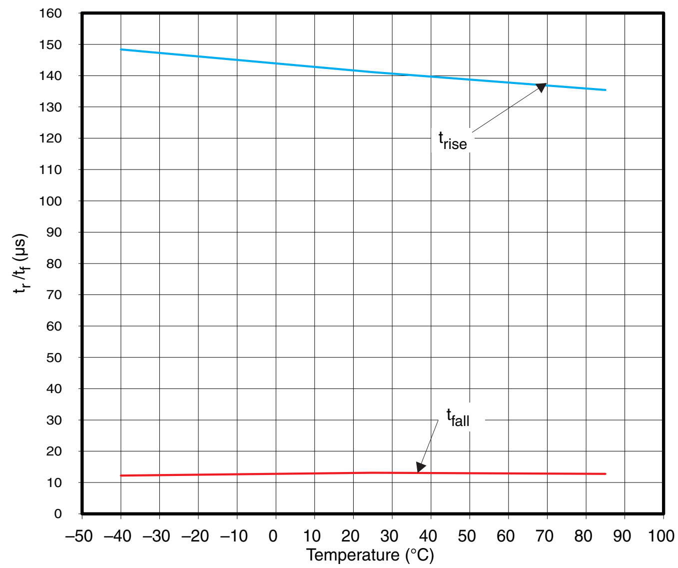


Figure 17. t_{rise}/t_{fall} vs Temperature (V_{IN} = 3.3 V)

TPS22921 and TPS22922

TYPICAL CHARACTERISTICS (continued)

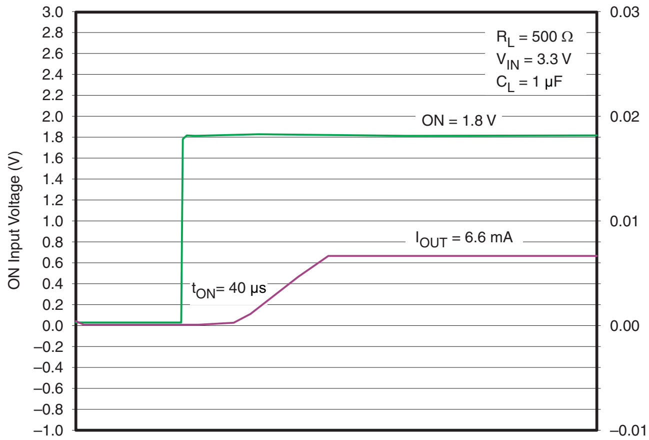


Figure 18. t_{ON} Response

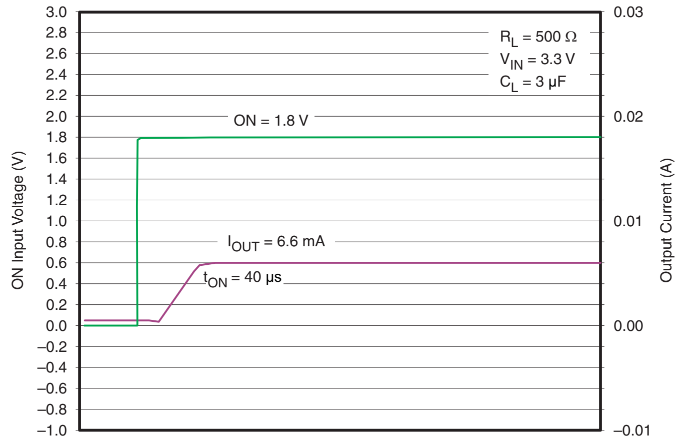


Figure 19. t_{ON} Response

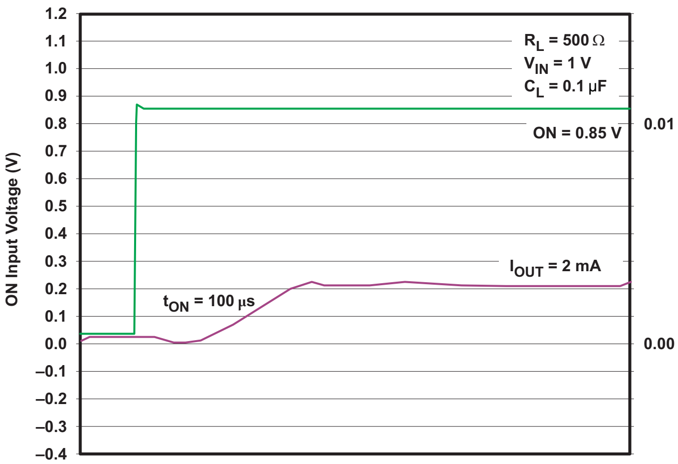


Figure 20. t_{ON} Response

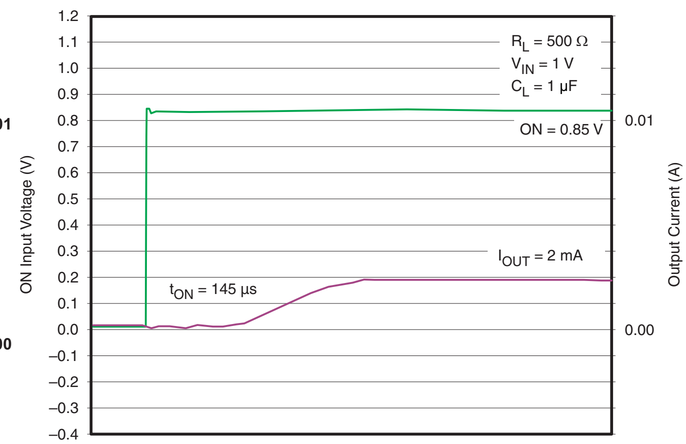


Figure 21. t_{ON} Response

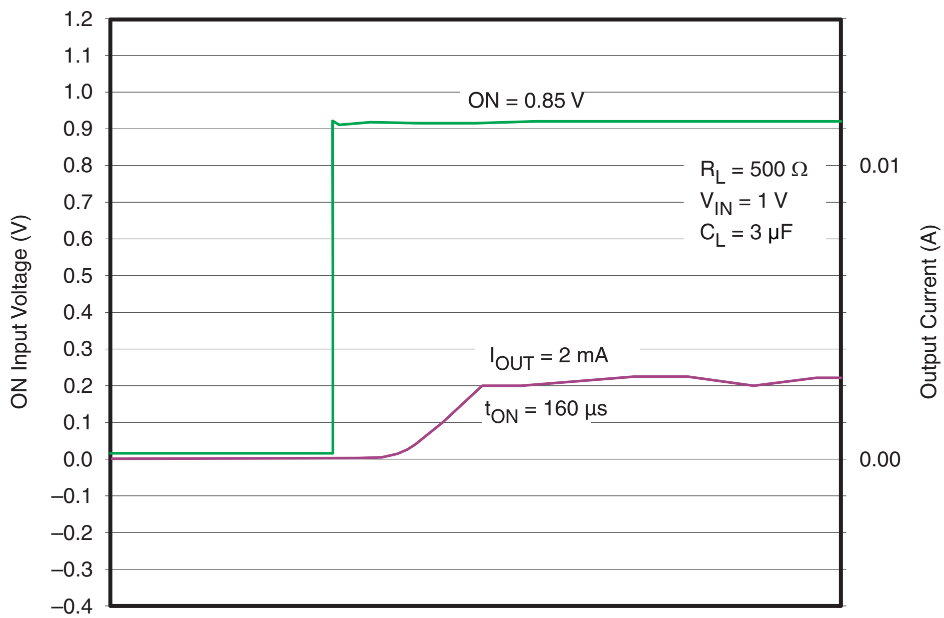


Figure 22. t_{ON} Response

TYPICAL CHARACTERISTICS (continued)

TPS22921

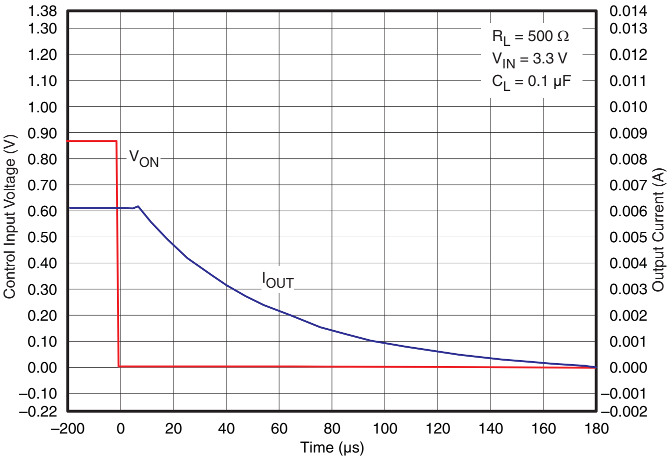


Figure 23. t_{OFF} Response

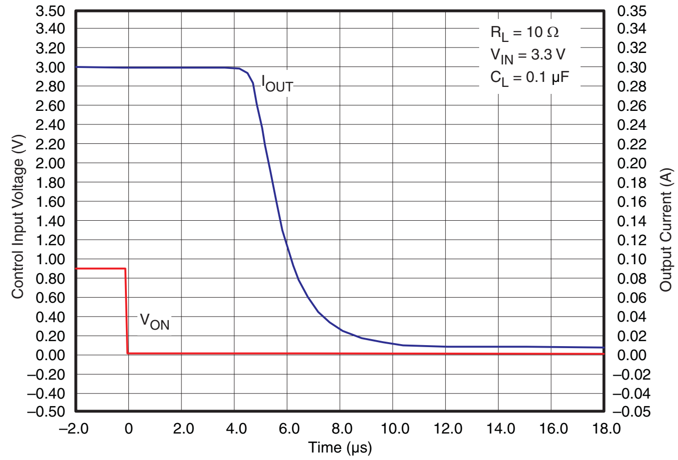


Figure 24. t_{OFF} Response

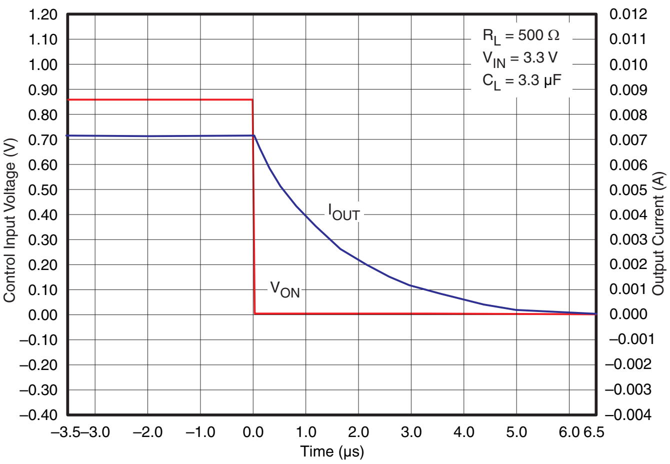


Figure 25. t_{OFF} Response

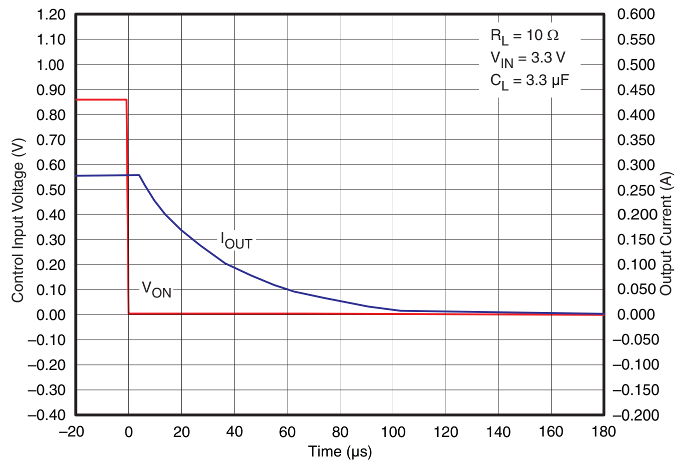


Figure 26. t_{OFF} Response

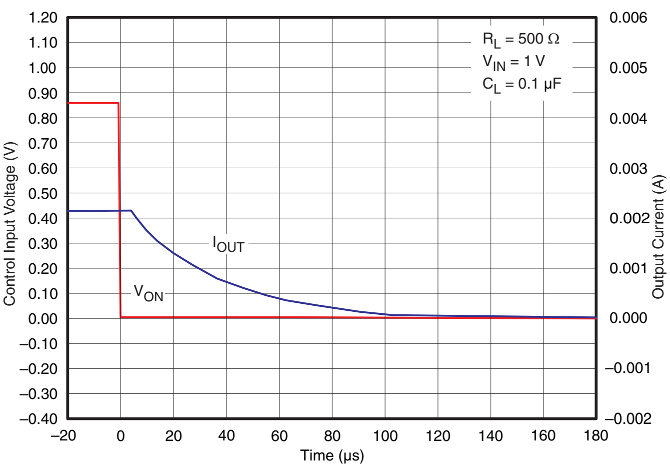


Figure 27. t_{OFF} Response

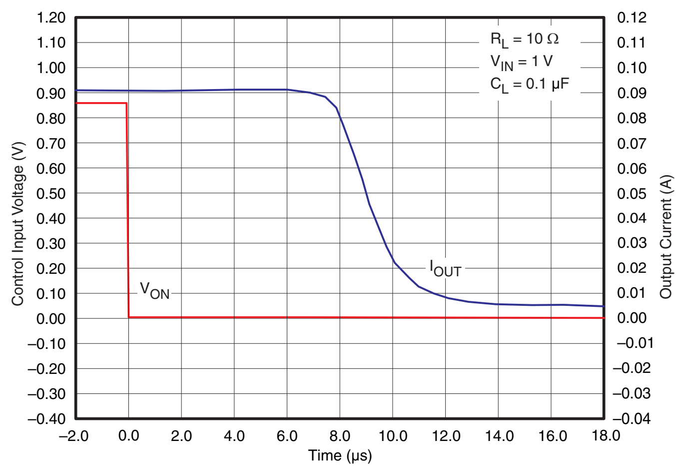


Figure 28. t_{OFF} Response

TYPICAL CHARACTERISTICS (continued)

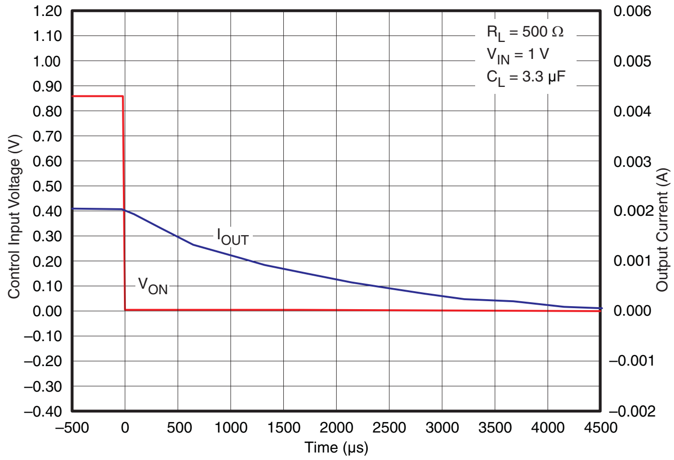


Figure 29. t_{OFF} Response

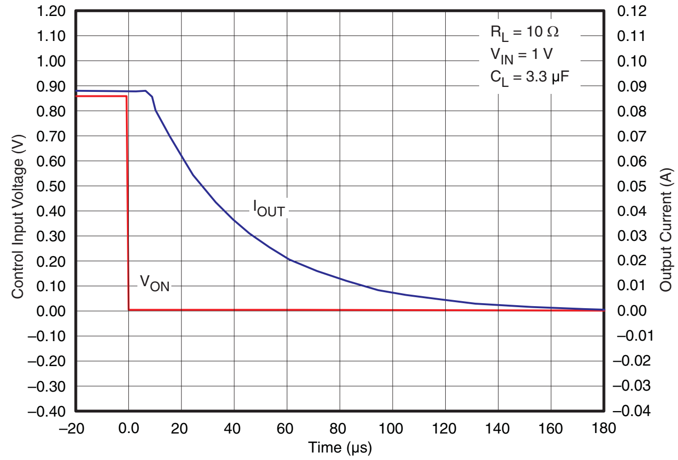


Figure 30. t_{OFF} Response

TPS22922

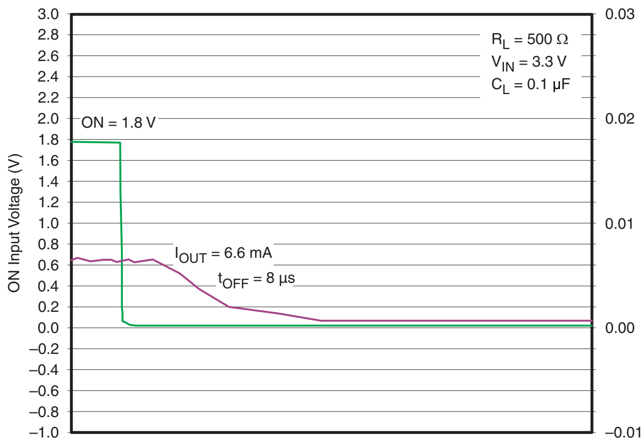


Figure 31. t_{OFF} Response

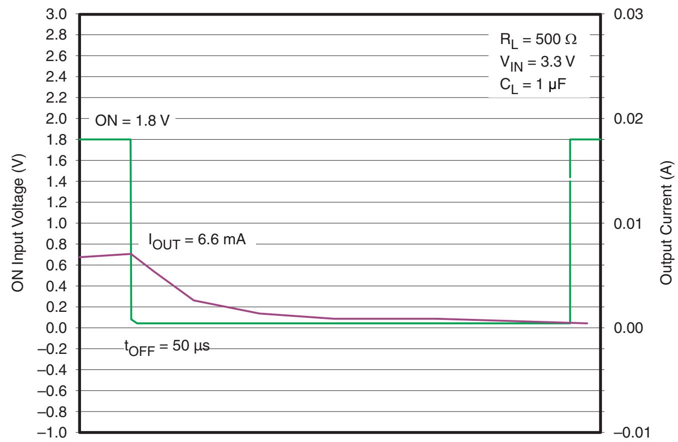


Figure 32. t_{OFF} Response

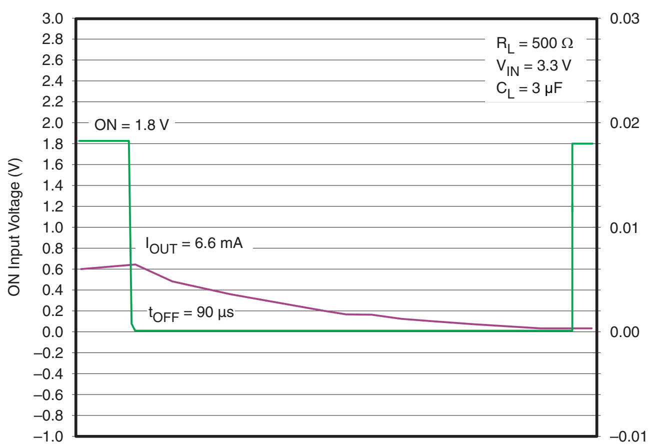


Figure 33. t_{OFF} Response

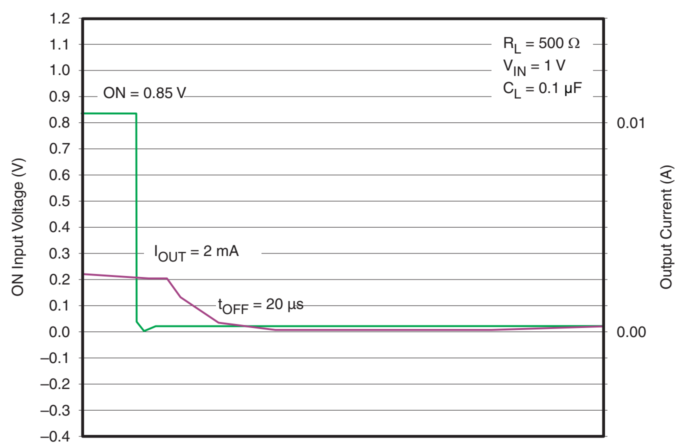


Figure 34. t_{OFF} Response

TYPICAL CHARACTERISTICS (continued)

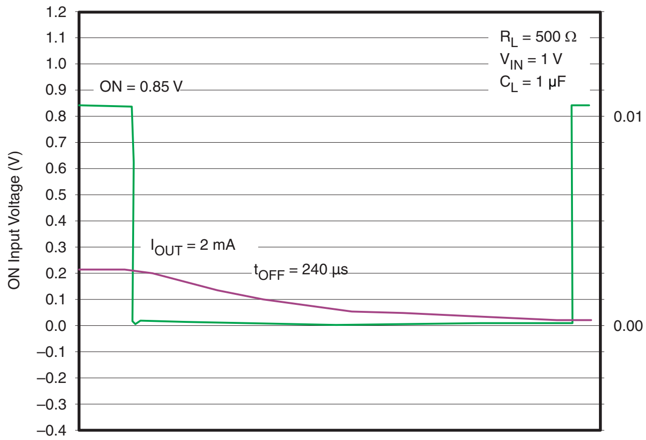


Figure 35. t_{OFF} Response

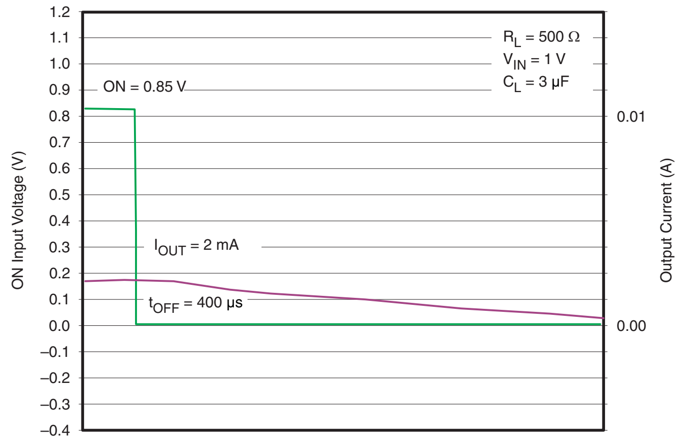


Figure 36. t_{OFF} Response

TPS22922B

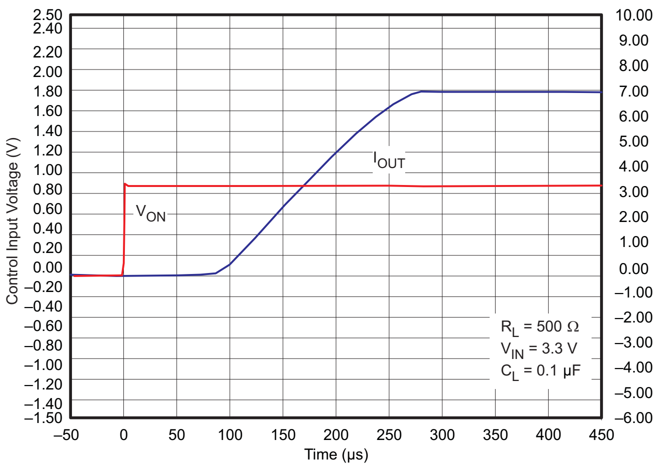


Figure 37. t_{ON} Response

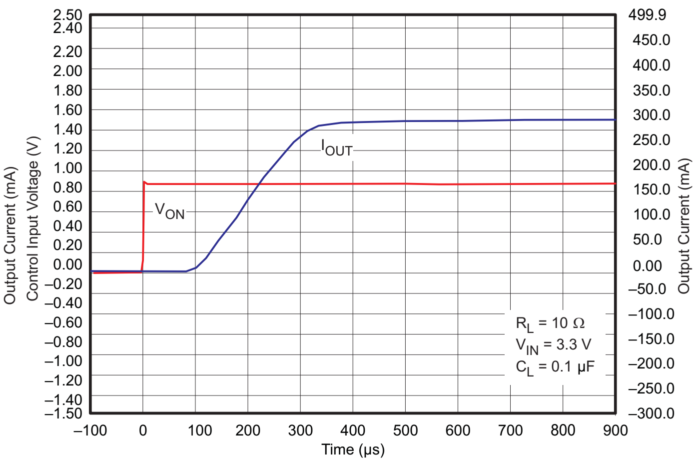


Figure 38. t_{ON} Response

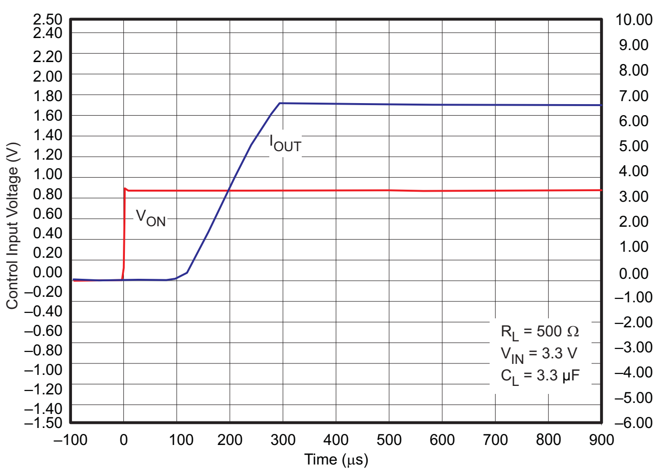


Figure 39. t_{ON} Response

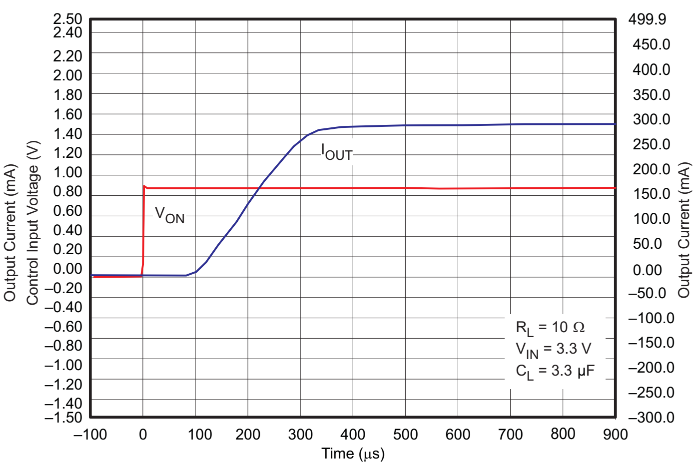


Figure 40. t_{ON} Response

TYPICAL CHARACTERISTICS (continued)

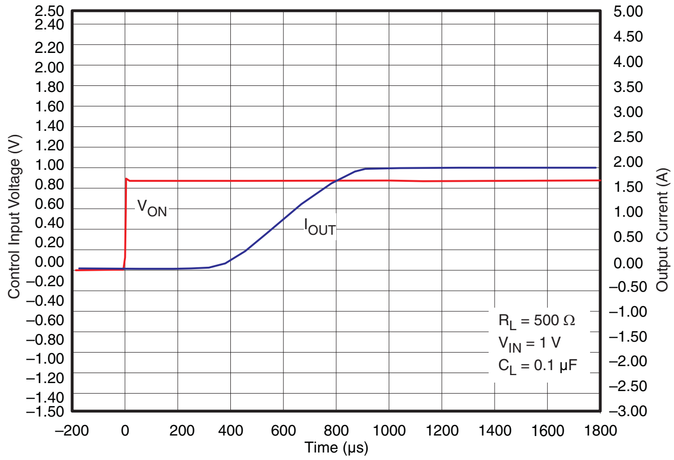


Figure 41. t_{ON} Response

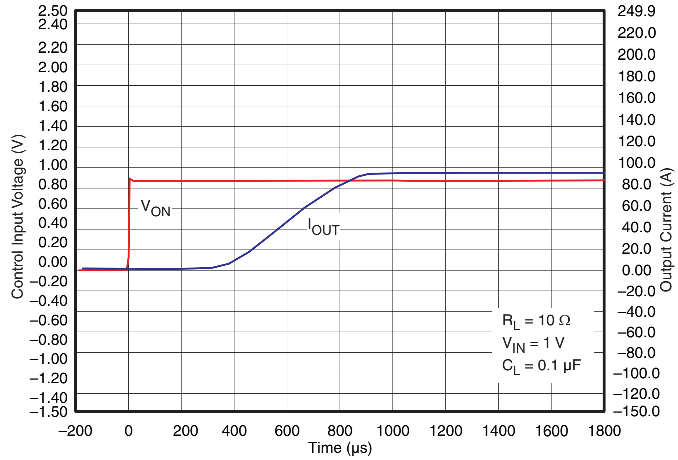


Figure 42. t_{ON} Response

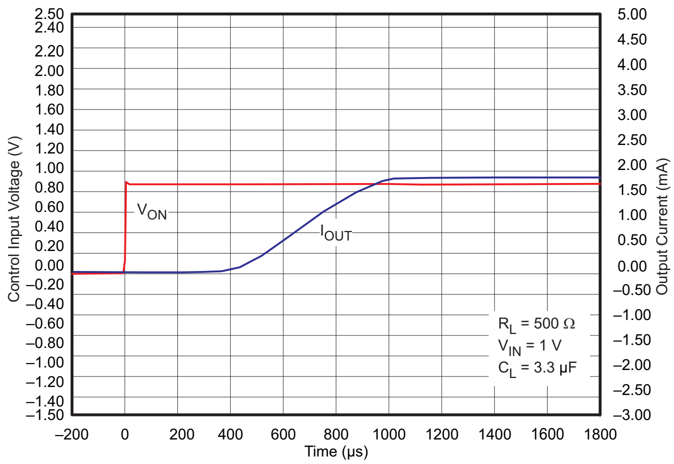


Figure 43. t_{ON} Response

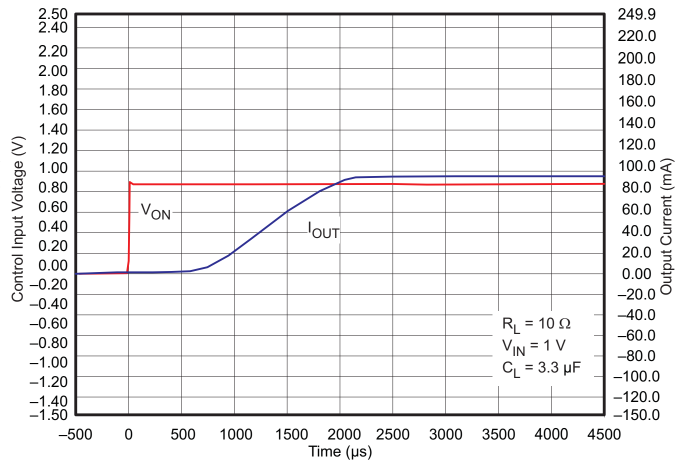


Figure 44. t_{ON} Response

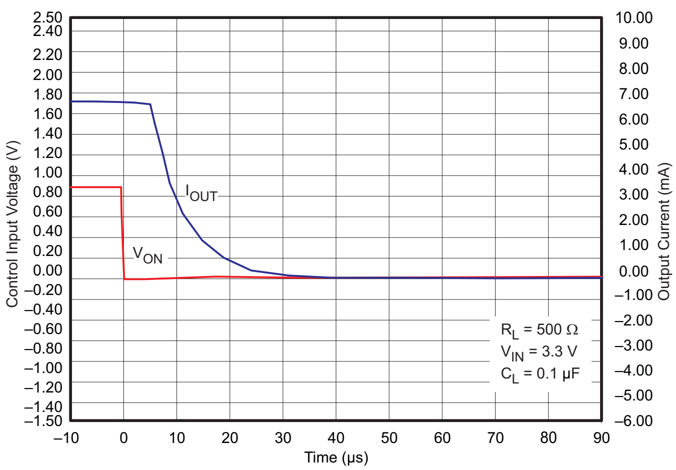


Figure 45. t_{OFF} Response

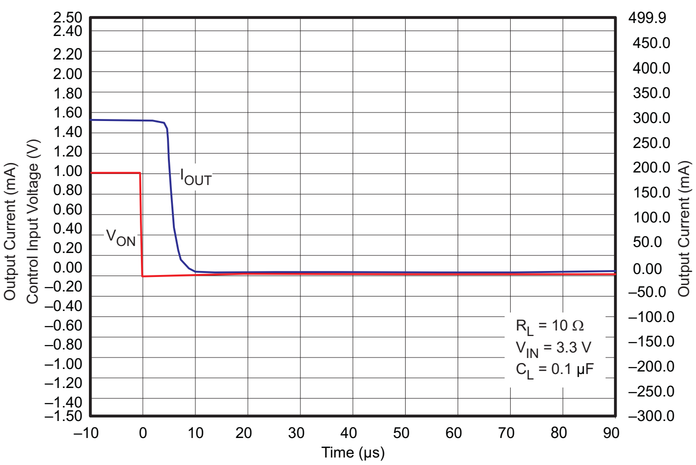


Figure 46. t_{OFF} Response

TYPICAL CHARACTERISTICS (continued)

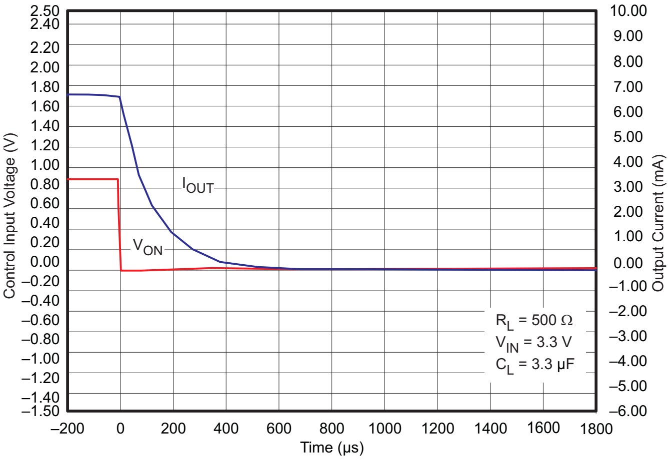


Figure 47. t_{OFF} Response

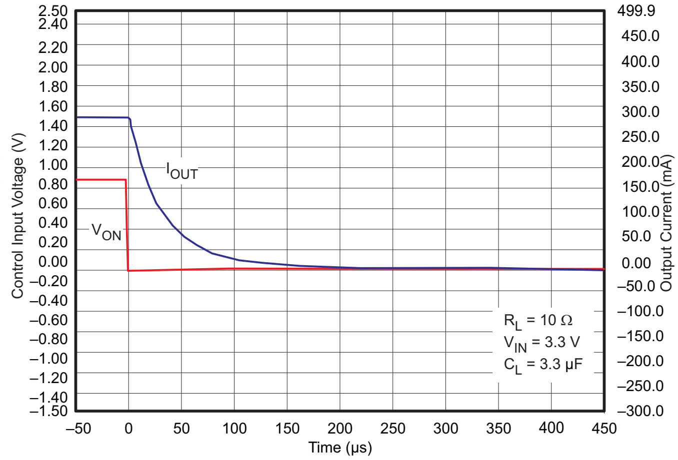


Figure 48. t_{OFF} Response

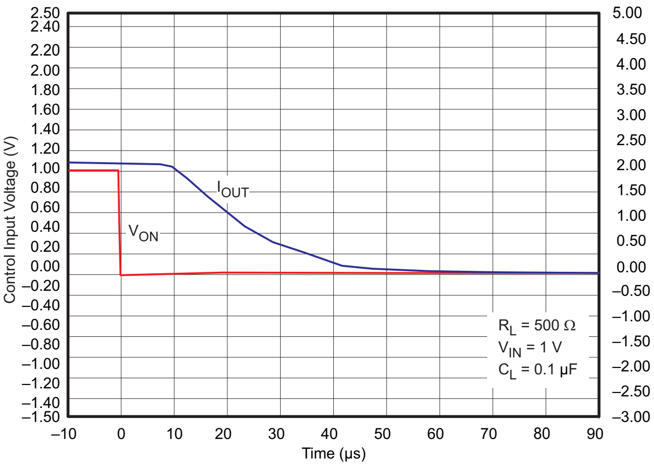


Figure 49. t_{OFF} Response

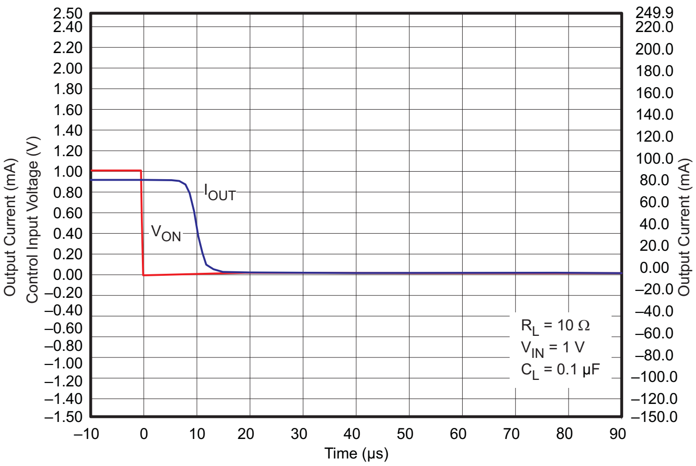


Figure 50. t_{OFF} Response

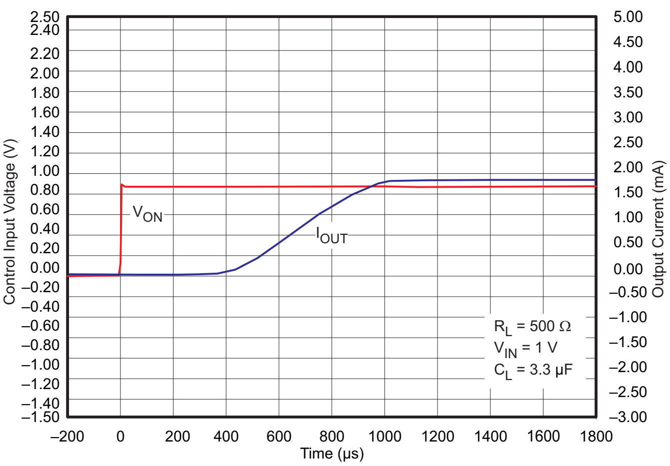


Figure 51. t_{ON} Response

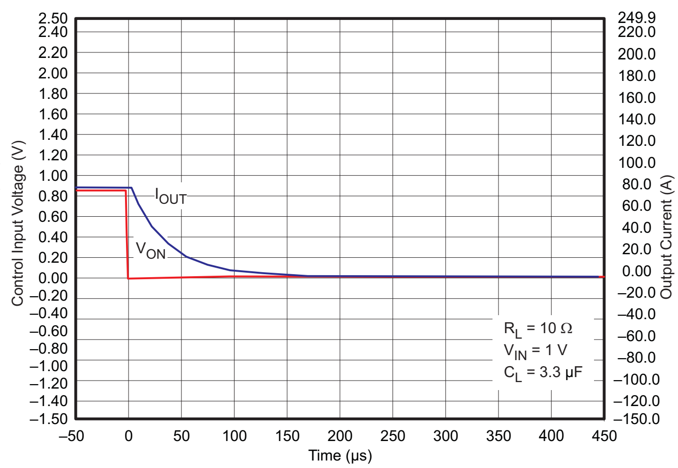
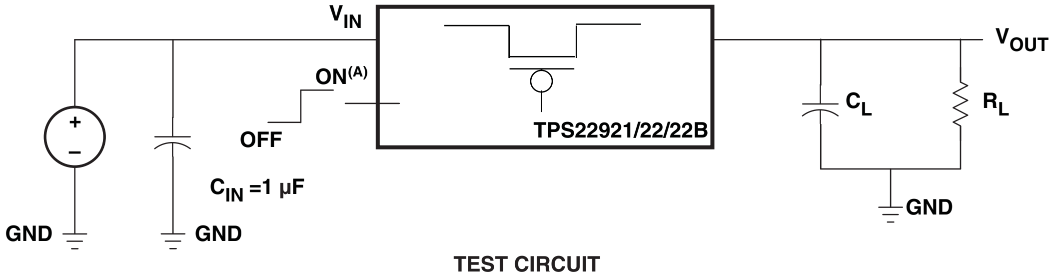


Figure 52. t_{OFF} Response

PARAMETER MEASURMENT INFORMATION

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



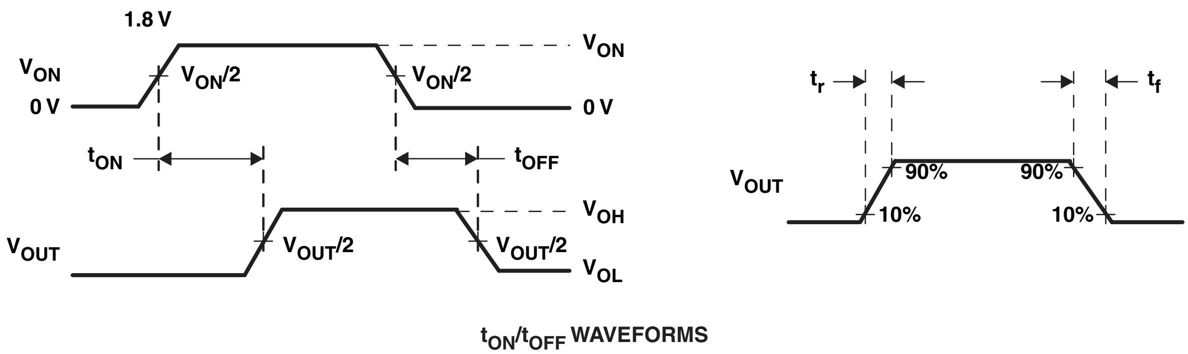


Figure 53. Test Circuit and t_{ON}/t_{OFF} Waveforms

APPLICATION INFORMATION

ON/OFF Control

The ON pin controls the state of the switch. Activating ON continuously holds the switch in the on state. 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 inrush currents when the switch turns on into a discharged load capacitor or short-circuit, a capacitor must 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 higher current application. When switching a heavy load, it is recommended to have an input capacitor about 10 or more times higher than the output capacitor in order to avoid any supply 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 will help minimize the parasitic electrical effects along with minimizing the case to ambient thermal impedance.

REVISION HISTORY

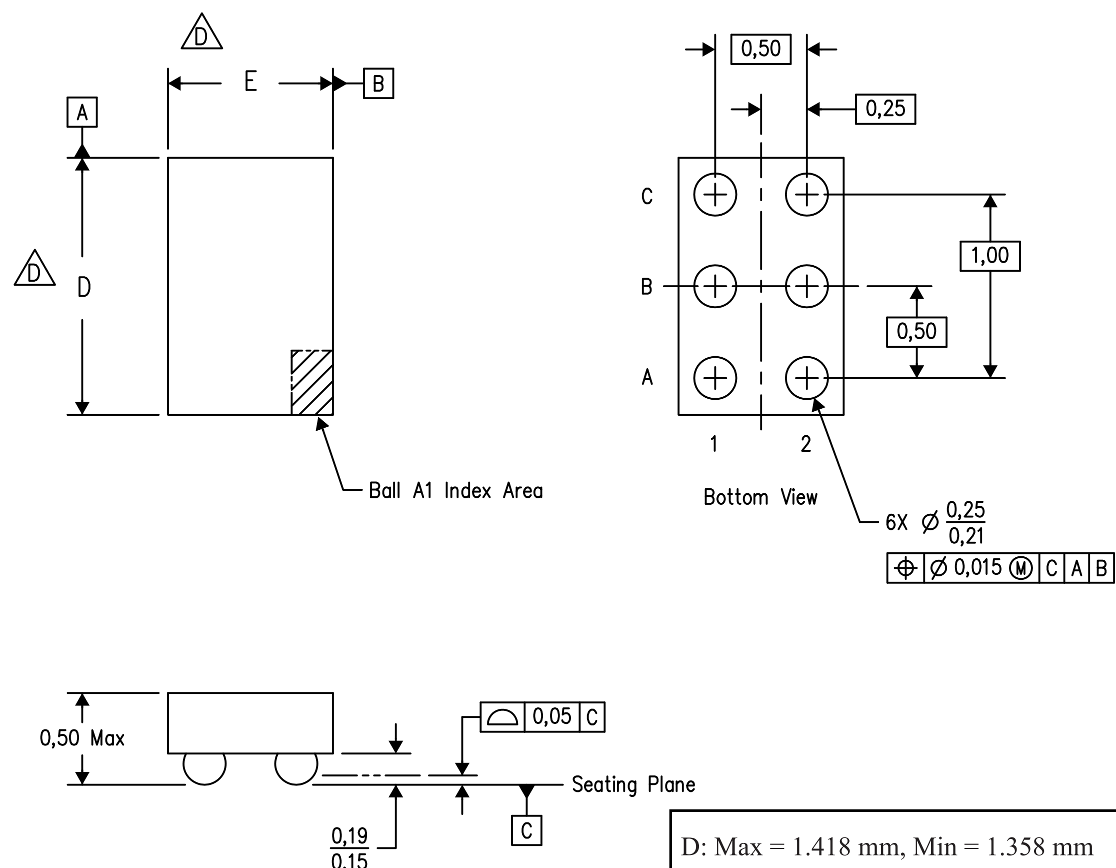
Changes from Original (November 2008) to Revision A **Page**

- Added Note A to the TYPICAL APPLICATION circuit 2
- Changed text in the ON/OFF Control section, deleted sentence: "When the MOSFET is off, the body diode is disabled so no current can flow through it." 21

Changes from Revision A (December 2008) to Revision B **Page**

- Changed Feature From: Ultra-Low Quiescent Current: 78 nA at 1.8 V To: Ultra-Low Quiescent Current: Typical 78 nA at 1.8 V 1
- Changed Feature From: Typical 78 nA at 1.8 V To: Ultra-Low Shutdown Current: Typical 35 nA at 1.8 V 1
- Added Feature: Typical Rise Times at V_{IN} = 1.8 V 1
- Changed Feature From: Six Terminal Wafer-Chip-Scale Package To: Six Terminal Wafer-Chip-Scale Package (nominal dimensions shown - see addendum for details 1
- Changed Feature From: 0.5-mm Height To: 0.5-mm Height (YFP) 1
- Changed TPS22921 QUICK OUTPUT DISCHARGE From: - To: No 2
- Changed the format of the ELECTRICAL CHARACTERISTICS Test Conditions From: V_{IN} = 1-V to V_{IN} = 1 V 5
- Deleted Note 1 - RL_CHIP = 120 Ω from all SWITCHING CHARACTERISTICS tables 5
- Changed Figure 51 title From: t_{OFF} Response To: t_{ON} Response 19
- Changed text in the ON/OFF Control section From: "Activating ON continuously holds the switch in the on state so long as there is no fault." To: "Activating ON continuously holds the switch in the on state." 21

YZP (R–XBGA–N6) DIE–SIZE BALL GRID ARRAY



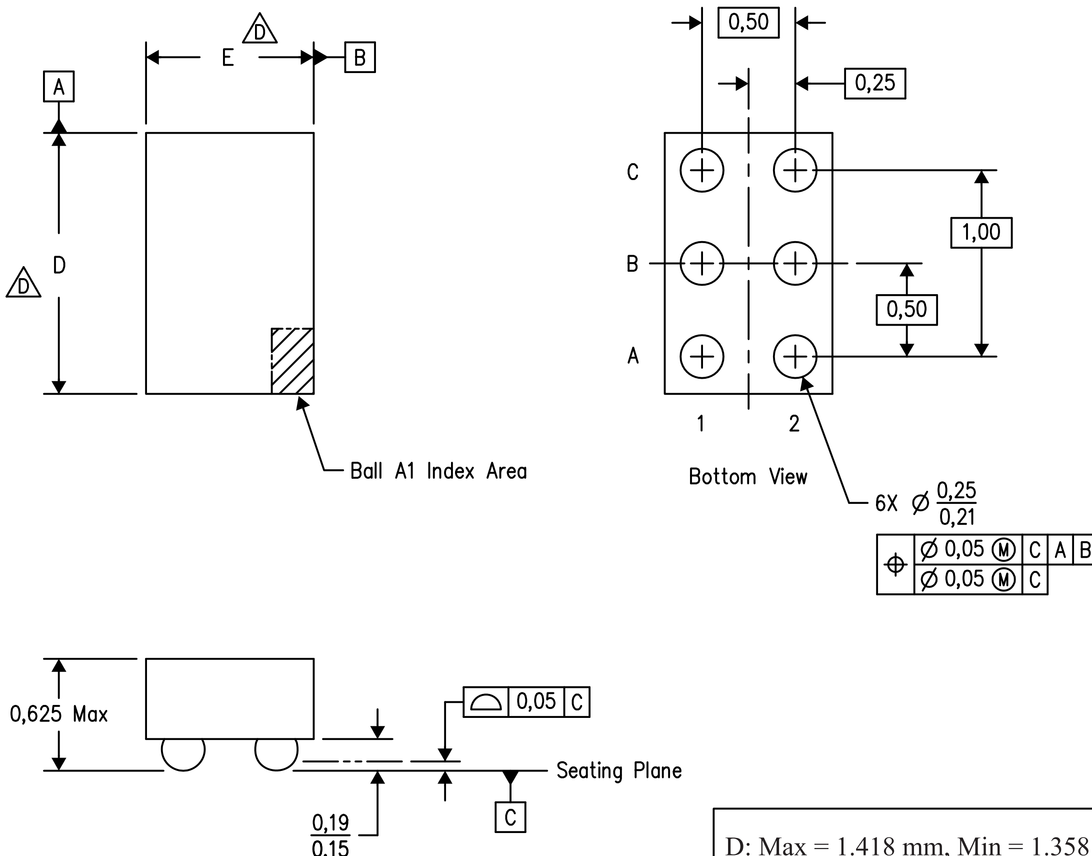
D: Max = 1.418 mm, Min = 1.358 mm

E: Max = 0.918 mm, Min = 0.858 mm

4204741–4/J 06/12

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.
- 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. This package is a Pb–free solder ball design. Refer to the 6 YEP package (drawing 4204725) for tin–lead (SnPb).

YZT (R–XBGA–N6) DIE–SIZE BALL GRID ARRAY



D: Max = 1.418 mm, Min = 1.358 mm

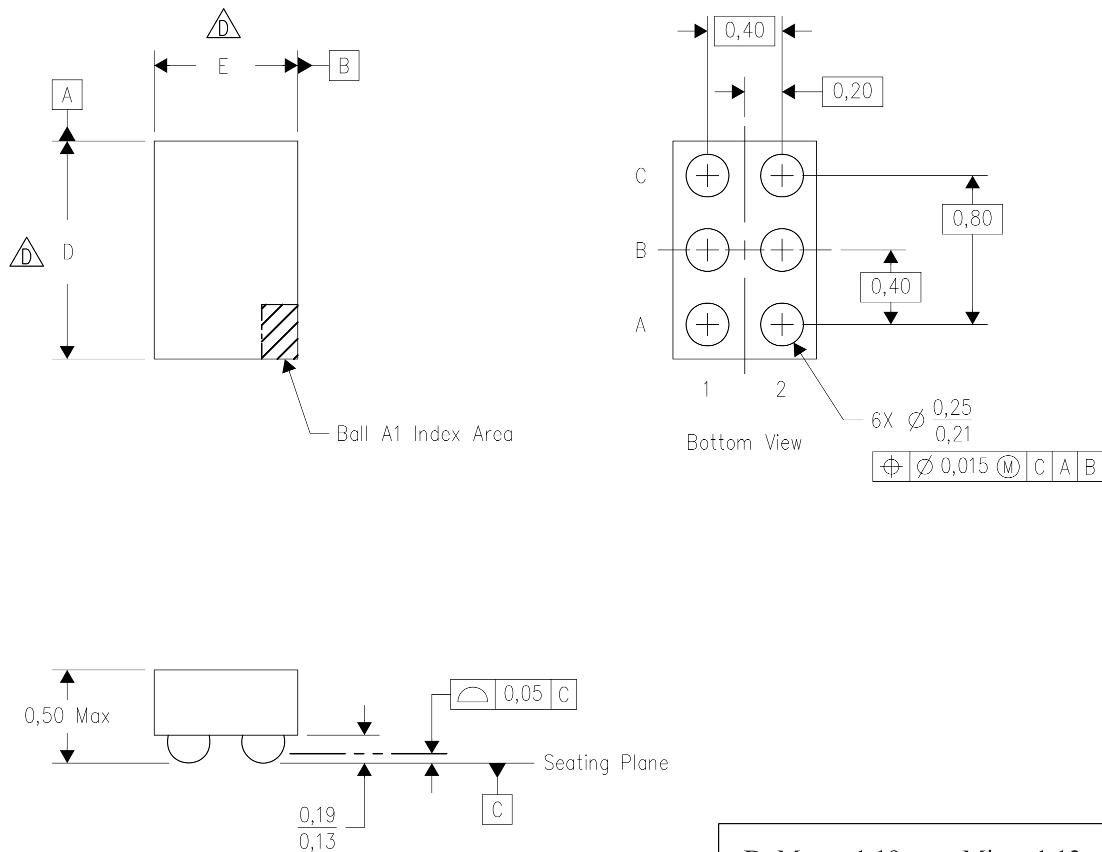
E: Max = 0.918 mm, Min = 0.858 mm

4205418–4/G 04/13

NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. NanoFree™ package configuration.
- 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 3 matrix pattern is shown for illustration only.
- F. This package contains Pb–free balls. Refer to the 4 YET package (drawing 4205421) for tin–lead (SnPb).

NanoFree is a trademark of Texas Instruments.

YFP (R–XBGA–N6) DIE–SIZE BALL GRID ARRAY



D: Max = 1.19 mm, Min = 1.13 mm

E: Max = 0.79 mm, Min = 0.73 mm

4206986–3/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.
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 3 matrix pattern is shown for illustration only.
F. This package contains Pb–free balls.

NanoFree is a trademark of Texas Instruments

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
TPS22921YFPR	ACTIVE	DSBGA	YFP	6	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	(3Y ~ 3Y3)	Samples
TPS22921YZPR	ACTIVE	DSBGA	YZP	6	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	3Y3	Samples
TPS22921YZTR	ACTIVE	DSBGA	YZT	6	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	(3Y3 ~ 3Y5)	Samples
TPS22922BYFPR	ACTIVE	DSBGA	YFP	6	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM		3Z3	Samples
TPS22922BYZPR	ACTIVE	DSBGA	YZP	6	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	3Z3	Samples
TPS22922YFPR	ACTIVE	DSBGA	YFP	6	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM		(2Z ~ 2Z3)	Samples
TPS22922YZPR	ACTIVE	DSBGA	YZP	6	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	2Z3	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) 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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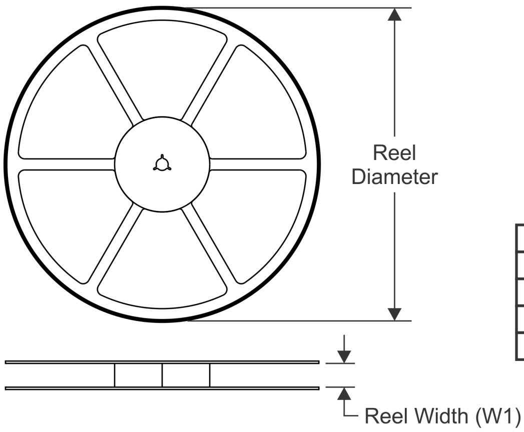
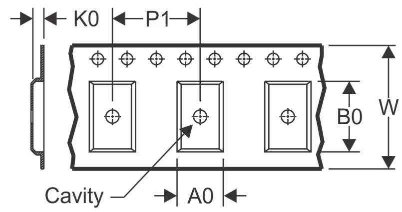
TAPE AND REEL INFORMATION

REEL DIMENSIONS

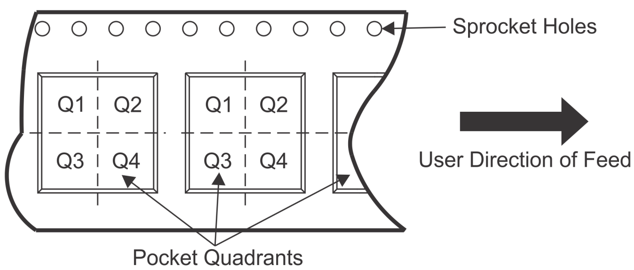


TAPE DIMENSIONS



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

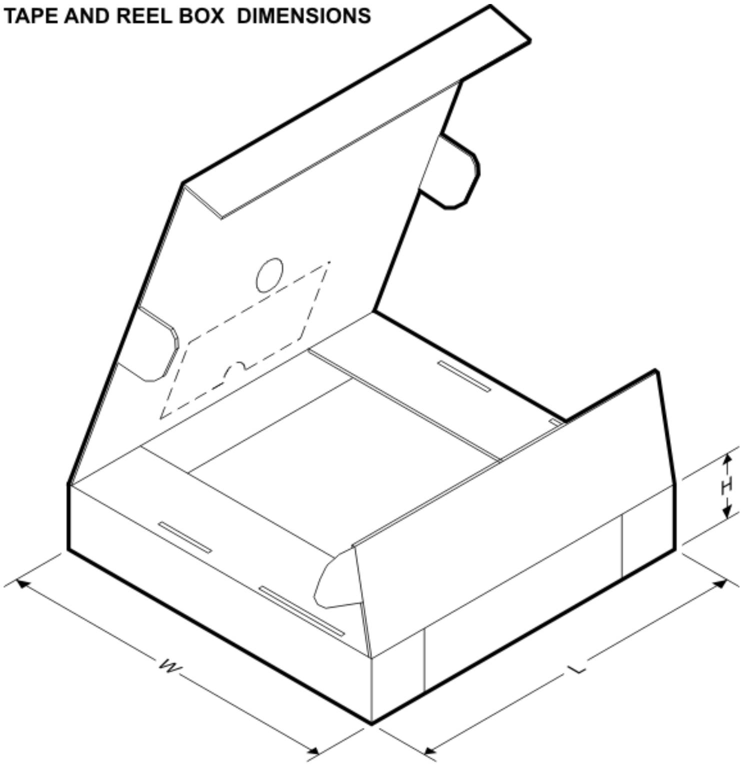
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS22921YFPR	DSBGA	YFP	6	3000	180.0	8.4	0.89	1.29	0.62	4.0	8.0	Q1
TPS22921YZPR	DSBGA	YZP	6	3000	180.0	8.4	1.02	1.52	0.63	4.0	8.0	Q1
TPS22921YZTR	DSBGA	YZT	6	3000	178.0	9.2	1.02	1.52	0.75	4.0	8.0	Q1
TPS22922BYFPR	DSBGA	YFP	6	3000	180.0	8.4	0.89	1.29	0.62	4.0	8.0	Q1
TPS22922BYZPR	DSBGA	YZP	6	3000	180.0	8.4	1.02	1.52	0.63	4.0	8.0	Q1
TPS22922YFPR	DSBGA	YFP	6	3000	180.0	8.4	0.89	1.29	0.62	4.0	8.0	Q1
TPS22922YZPR	DSBGA	YZP	6	3000	180.0	8.4	1.02	1.52	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)
TPS22921YFPR	DSBGA	YFP	6	3000	182.0	182.0	17.0
TPS22921YZPR	DSBGA	YZP	6	3000	220.0	220.0	34.0
TPS22921YZTR	DSBGA	YZT	6	3000	220.0	220.0	35.0
TPS22922BYFPR	DSBGA	YFP	6	3000	220.0	220.0	34.0
TPS22922BYZPR	DSBGA	YZP	6	3000	220.0	220.0	34.0
TPS22922YFPR	DSBGA	YFP	6	3000	182.0	182.0	17.0
TPS22922YZPR	DSBGA	YZP	6	3000	220.0	220.0	34.0

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