ULTRA-SMALL, LOW-INPUT VOLTAGE, LOW R_{ON} LOAD SWITCH

Check for Samples: TPS22908

FEATURES

- Low Input Voltage: 1.0 V to 3.6 V
- Ultra-Low ON-State Resistance (R_{ON})
- Typical R_{ON} values
  - R_{ON} = 28 mΩ at VIN = 3.6 V
  - R_{ON} = 33 mΩ at VIN = 2.5 V
  - R_{ON} = 42 mΩ at VIN = 1.8 V
  - R_{ON} = 70 mΩ at VIN = 1.2 V
- 1-A Maximum Continuous Switch Current
- Maximum Quiescent Current = 1 µA
- Maximum Shutdown Current = 1 µA
- Low Control Input Thresholds Enable Use of Low-Voltage Logic
- Controlled Slew Rate to Avoid Inrush Currents
- Ultra-Small Four Terminal Wafer-Chip-Scale Package (WCSP)
  - Nominal Dimensions - See Addendum for Details
  - 0.9 mm × 0.9 mm
  - 0.5-mm Pitch, 0.6-mm Height
- Quick Output Discharge (QOD)

APPLICATIONS

- Battery Powered Equipment
- Portable Industrial Equipment
- Portable Medical Equipment
- Portable Media Players
- Point of Sale Terminal
- GPS Devices
- Digital Cameras
- Portable Instrumentation
- Smartphones / Tablets

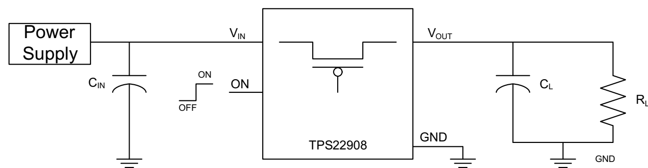


Figure 1. Typical Application

DESCRIPTION

The TPS22908 is an ultra small, low R_{ON} load switch with controlled turn-on. The device contains 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.

The TPS22908 is available in a space-saving 4-terminal WCSP with 0.5-mm pitch (YZT). The device is characterized for operation over the free-air temperature range of –40°C to 85°C.

ORDERING INFORMATION

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

FEATURE LIST

DEVICE	R_{ON} (typical) VIN = 3.6 V	RISE TIME (typical) VIN = 3.6 V	QUICK OUTPUT DISCHARGE(1)	MAXIMUM CURRENT	ENABLE
TPS22908	28 mΩ	105 µs	Yes	1 A	Active high

(1) This feature discharges the output of the switch to ground through an 80-Ω resistor, preventing the output from floating.

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

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

ABSOLUTE MAXIMUM RATINGS

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

			VALUE	UNIT(2)
V_{IN}	Supply voltage range		–0.3 to 4	V
V_{OUT}	Output voltage range		–0.3 to (V_{IN} + 0.3)	V
V_{ON}	Input voltage range		–0.3 to 4	V
I_{MAX}	Maximum Continuous Switch Current for V_{IN} >= 1.2V		1	A
	Maximum Continuous Switch Current at V_{IN} = 1.0V		0.6	
T_A	Operating free-air temperature range(3)		–40 to 85	°C
T_J	Maximum junction temperature		125	°C
T_{STG}	Storage temperature range		–65 to 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.
(2) All voltage values are with respect to network ground terminal.
(3) In applications where high power dissipation and/or poor package thermal resistance is present, the maximum ambient temperature may have to be derated. Maximum ambient temperature [TA(max)] is dependent on the maximum operating junction temperature [$T_{J(max)}$], the maximum power dissipation of the device in the application [$P_{D(max)}$], and the junction-to-ambient thermal resistance of the part/package in the application (θ_{JA}), as given by the following equation: $T_{A(max)} = T_{J(max)} – (\theta_{JA} \times P_{D(max)})$

THERMAL INFORMATION

THERMAL METRIC(1)(2)		TPS22908 YZT (4 PINS)	UNITS
Θ_{JA}	Junction-to-ambient thermal resistance	188	°C/W
$\Theta_{JC(top)}$	Junction-to-case(top) thermal resistance	2	
Θ_{JB}	Junction-to-board thermal resistance	33	
Ψ_{JT}	Junction-to-top characterization parameter	9.1	
Ψ_{JB}	Junction-to-board characterization parameter	33	
$\Theta_{JC(bottom)}$	Junction-to-case(bottom) thermal resistance	N/A	

(1) For more information about traditional and new thermal metrics, see the IC Package Thermal Metrics application report, SPRA953
(2) For thermal estimates of this device based on PCB copper area, see the TI PCB Thermal Calculator.

RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
V_{IN}	Input voltage range	1.0	3.6	V
V_{ON}	ON voltage range	0	3.6	V
V_{OUT}	Output voltage range	0	V_{IN}	V
V_{IH}	High-level input voltage, ON	0.85	3.6	V
V_{IL}	Low-level input voltage, ON	0	0.4	V
C_{IN}	Input capacitor	1(1)		µF

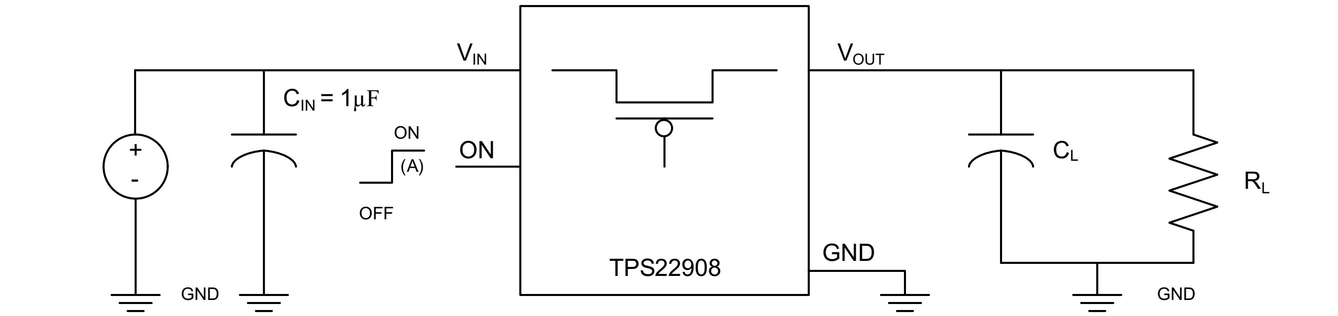
(1) Refer to application section.

ELECTRICAL CHARACTERISTICS

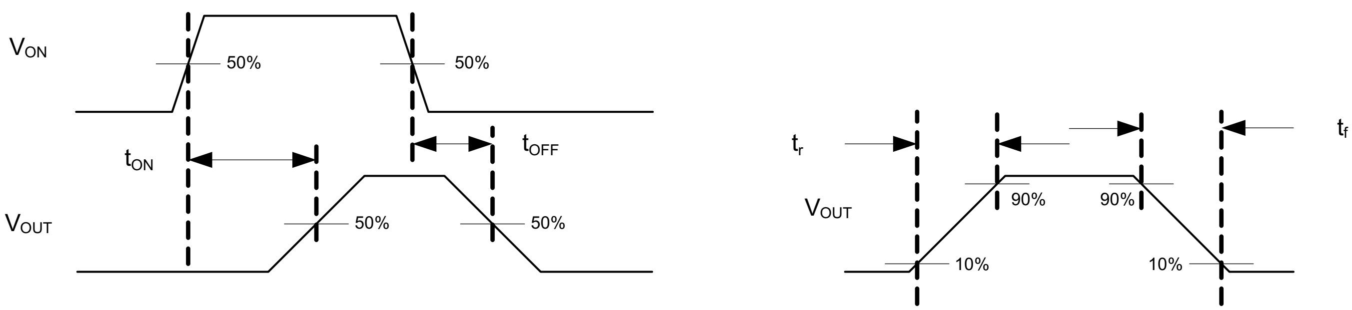
Unless otherwise noted the specification applies over the operating ambient temp –40°C ≤ T_A ≤ 85°C. Typical values are for V_{IN} = 3.6 V, and T_A = 25°C unless otherwise noted.

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
POWER SUPPLIES AND CURRENTS								
I_{IN}	Quiescent current	I_{OUT} = 0 mA, V_{IN} = V_{ON}		Full		0.19	1	µA
$I_{IN(OFF)}$	OFF-state supply current	V_{ON} = 0 V, V_{OUT} = Open		Full		0.12	1	µA
$I_{IN(LEAK)}$	OFF-state supply current	V_{ON} = 0 V, V_{OUT} = 0 V		Full		0.12	1	µA
I_{ON}	ON pin input leakage current	V_{ON} = 1.1 V to 3.6 V		Full		0.01	0.1	µA
RESISTANCE AND SWITCH CHARACTERISTICS								
R_{ON}	ON-state resistance	I_{OUT} = –200 mA	V_{IN} = 3.6 V	25°C		28.2	32.1	mΩ
				Full			34.9	
			V_{IN} = 2.5 V	25°C		33.1	37.5	mΩ
				Full			40.6	
			V_{IN} = 1.8 V	25°C		41.5	50.3	mΩ
				Full			54.0	
			V_{IN} = 1.2 V	25°C		69.7	87.3	mΩ
				Full			91.2	
			V_{IN} = 1.0 V	25°C		112	155	mΩ
				Full			156	
R_{PD}	Output pulldown resistance	V_{IN} = 3.3 V, V_{ON} = 0 V, I_{OUT} = 30 mA		25°C		80	100	Ω

SWITCHING CHARACTERISTIC MEASUREMENT INFORMATION



TEST CIRCUIT



t_{ON}/t_{OFF} WAVEFORMS

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

Figure 2. Test Circuit and t_{ON}/t_{OFF} Waveforms

SWITCHING CHARACTERISTICS

PARAMETER		TEST CONDITION	TPS22908 MIN	TPS22908 TYP	TPS22908 MAX	UNIT
V_{IN} = 3.6 V, T_A = 25°C (unless otherwise noted)						
t_{ON}	Turn-ON time	R_L = 10 Ω, C_L = 0.1 µF		110		µs
t_{OFF}	Turn-OFF time	R_L = 10 Ω, C_L = 0.1 µF		5		
t_R	V_{OUT} Rise time	R_L = 10 Ω, C_L = 0.1 µF		105		
t_F	V_{OUT} Fall time	R_L = 10 Ω, C_L = 0.1 µF		2		
V_{IN} = 1.0 V, T_A = 25°C (unless otherwise noted)						
t_{ON}	Turn-ON time	R_L = 10 Ω, C_L = 0.1 µF		493		µs
t_{OFF}	Turn-OFF time	R_L = 10 Ω, C_L = 0.1 µF		7		
t_R	V_{OUT} Rise time	R_L = 10 Ω, C_L = 0.1 µF		442		
t_F	V_{OUT} Fall time	R_L = 10 Ω, C_L = 0.1 µF		2		

FUNCTIONAL BLOCK DIAGRAM and PIN DESCRIPTIONS

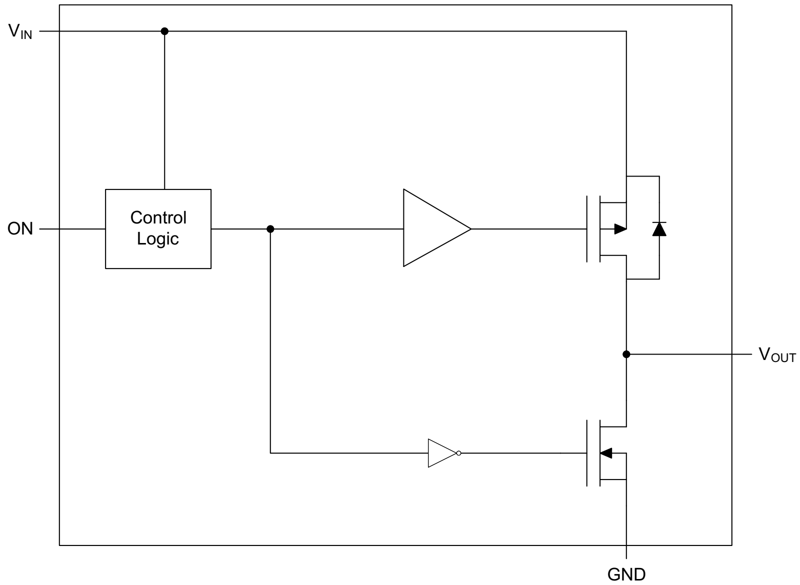


Figure 3. Functional Block Diagram

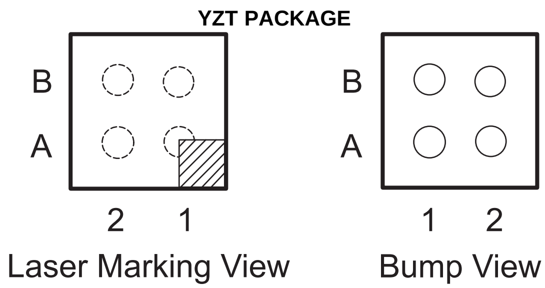


Table 1. FUNCTIONAL TABLE

ON	V_{IN} to V_{OUT}	V_{OUT} to GND
L	Off	On
H	On	Off

PIN DESCRIPTIONS

TPS22908 YZT	PIN NAME	DESCRIPTION
B2	ON	Switch control input, active high. Do not leave floating.
B1	GND	Ground
A2	V_{IN}	Switch input, bypass capacitor recommended for minimizing V_{IN} dip. See Application Information.
A1	V_{OUT}	Switch output

TYPICAL DC CHARACTERISTICS

V_{IN} vs. QUIESCENT CURRENT (I_{IN})

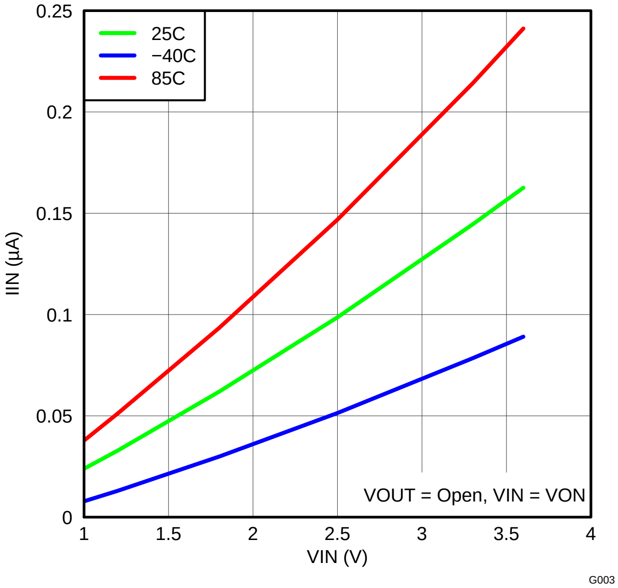


Figure 4.

V_{IN} vs. $I_{IN(LEAK)}$

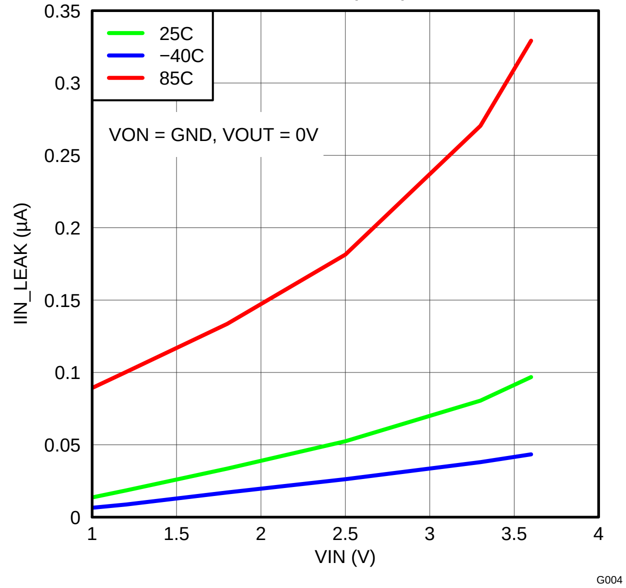


Figure 5.

V_{IN} vs. $I_{IN(OFF)}$

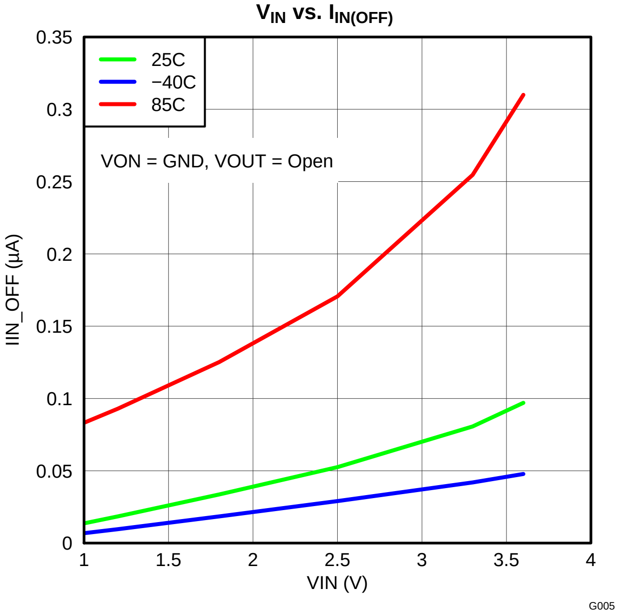


Figure 6.

TEMPERATURE vs. R_{ON}

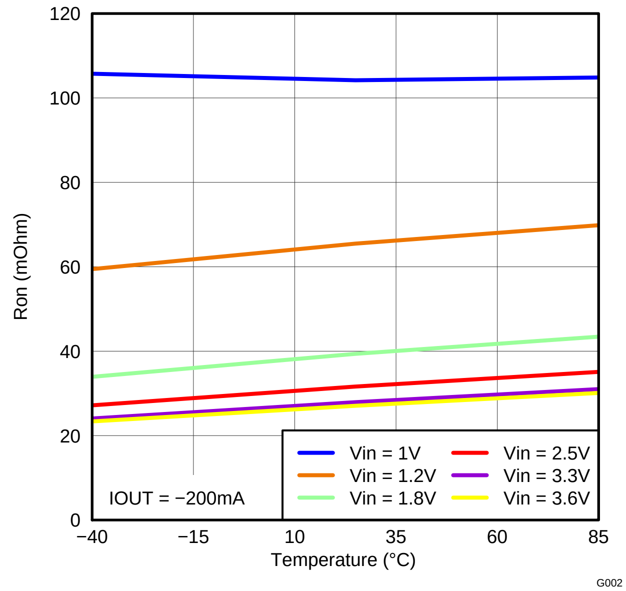


Figure 7.

TYPICAL DC CHARACTERISTICS (continued)

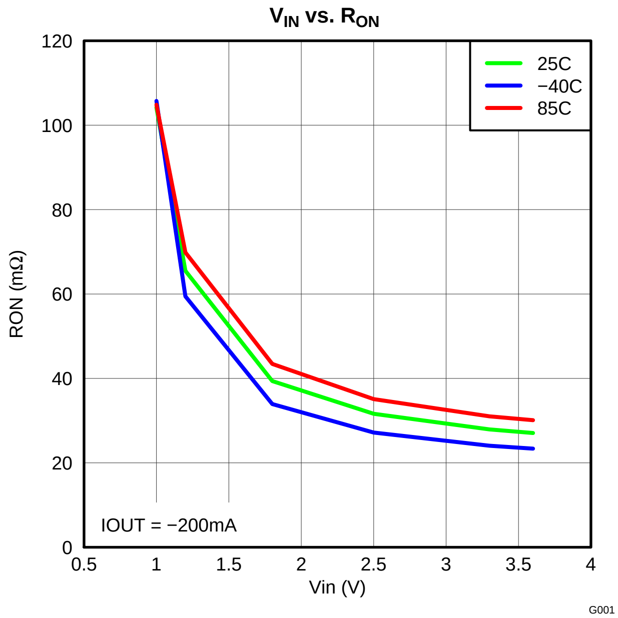


Figure 8.

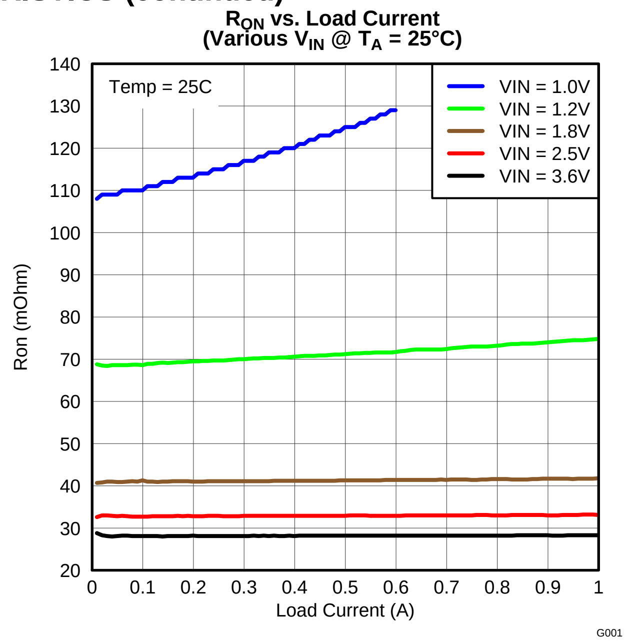


Figure 9.

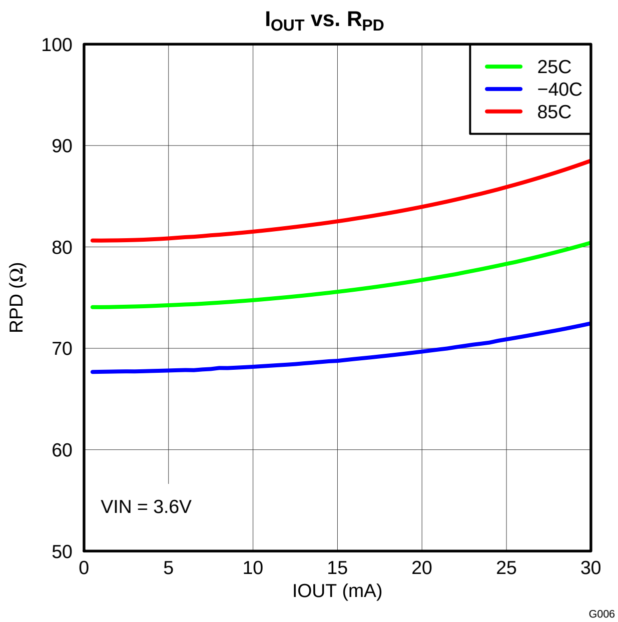


Figure 10.

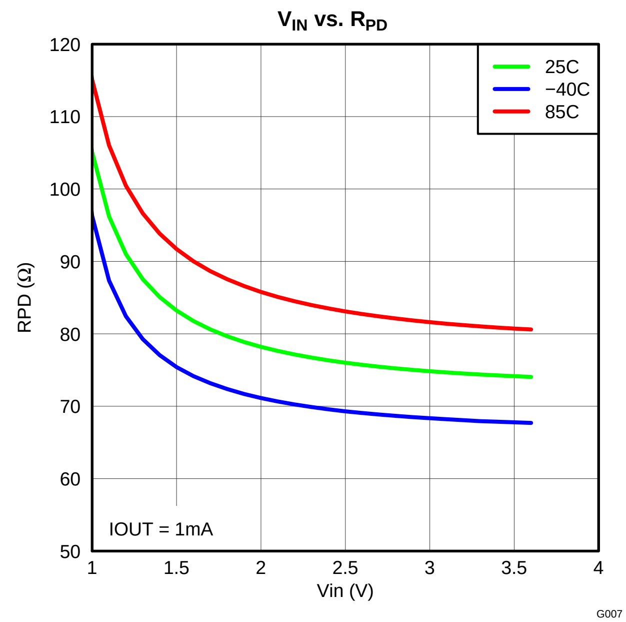


Figure 11.

TYPICAL DC CHARACTERISTICS (continued)

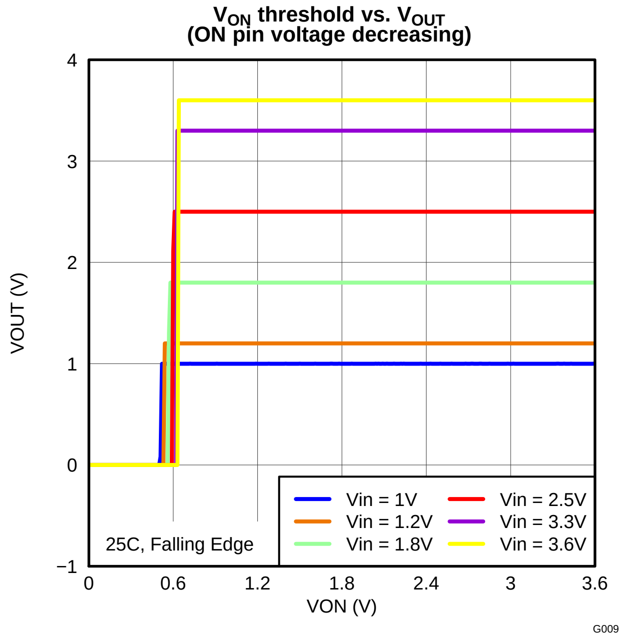


Figure 12.

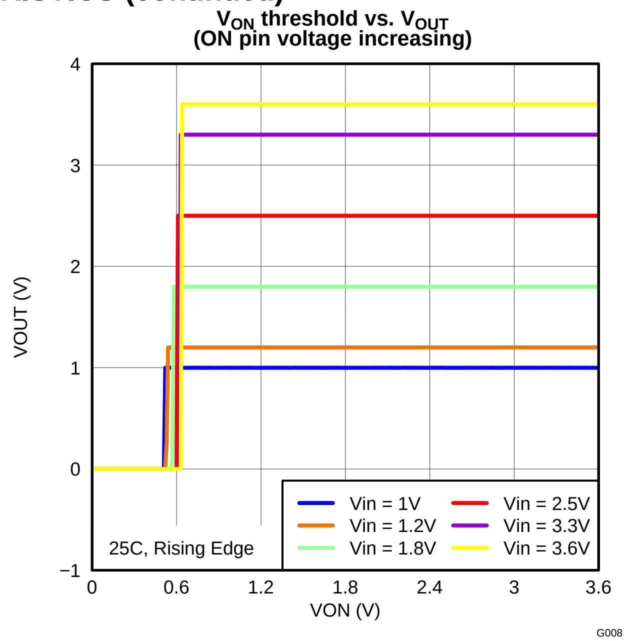


Figure 13.

TYPICAL SWITCHING CHARACTERISTICS

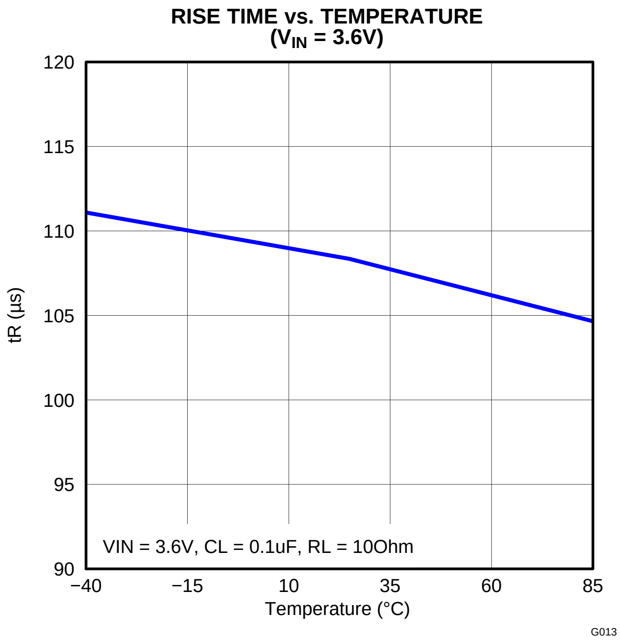


Figure 14.

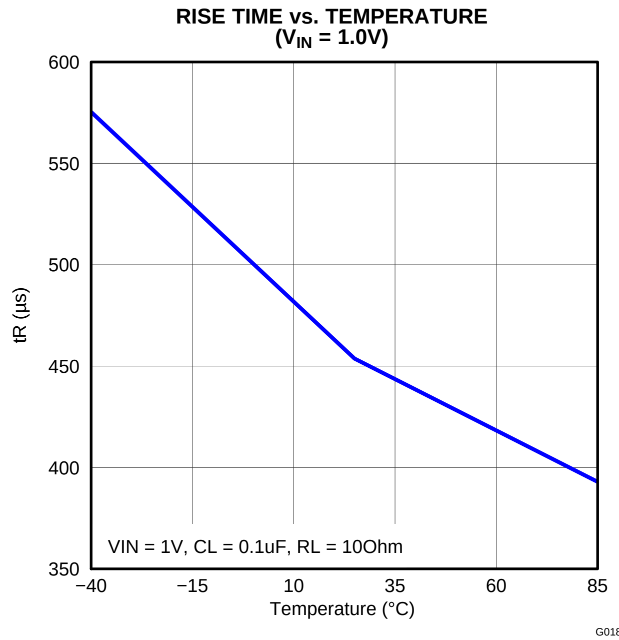


Figure 15.

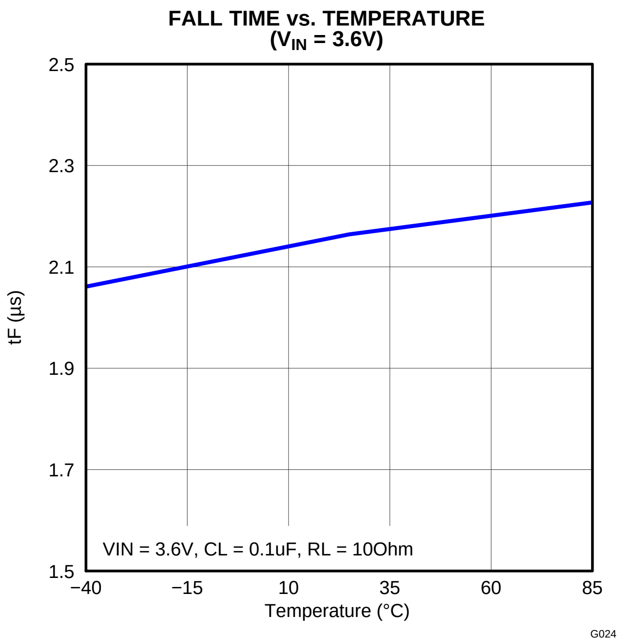


Figure 16.

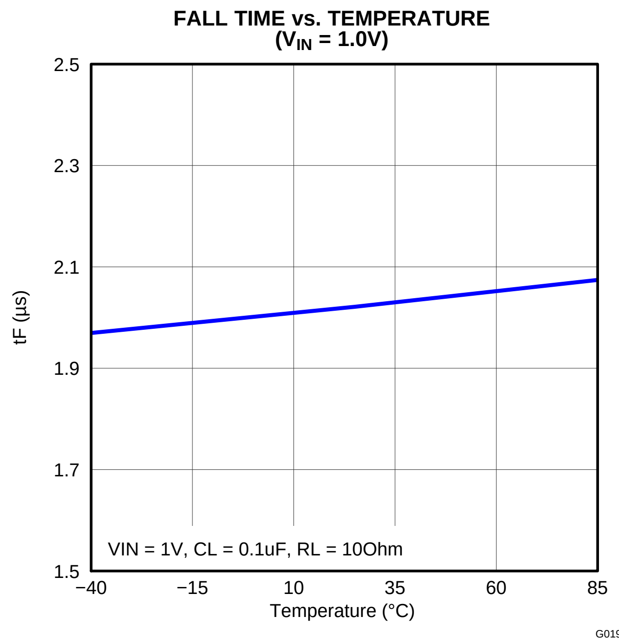


Figure 17.

TYPICAL SWITCHING CHARACTERISTICS (continued)

TURN-ON TIME vs. TEMPERATURE (V_{IN} = 3.6V)

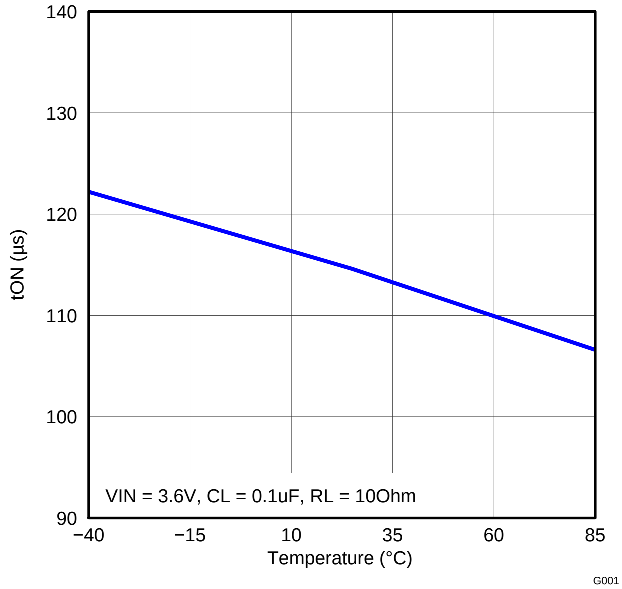


Figure 18.

TURN-ON TIME vs. TEMPERATURE (V_{IN} = 1.0V)

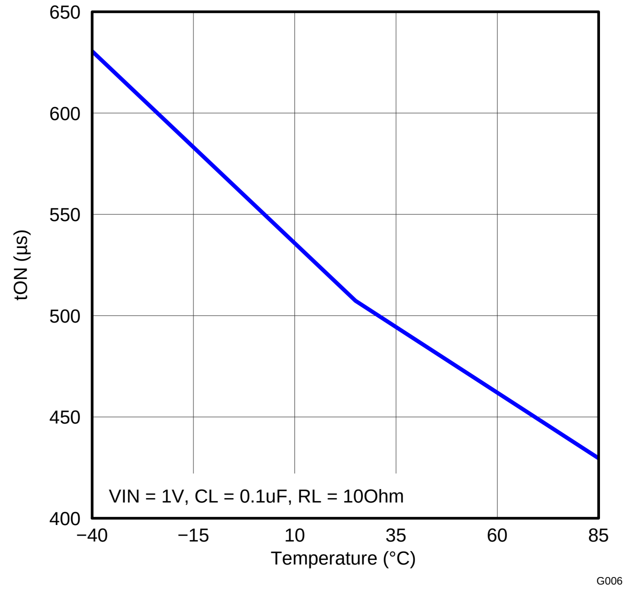


Figure 19.

TURN-OFF TIME vs. TEMPERATURE (V_{IN} = 3.6V)

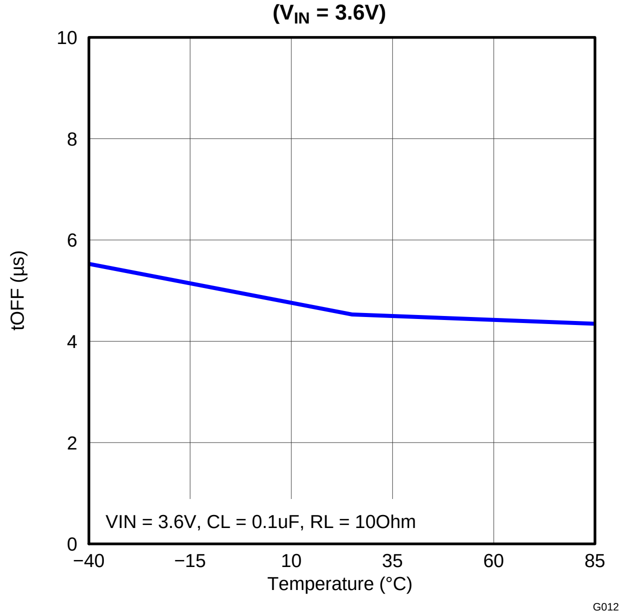


Figure 20.

TURN-OFF TIME vs. TEMPERATURE (V_{IN} = 1.0V)

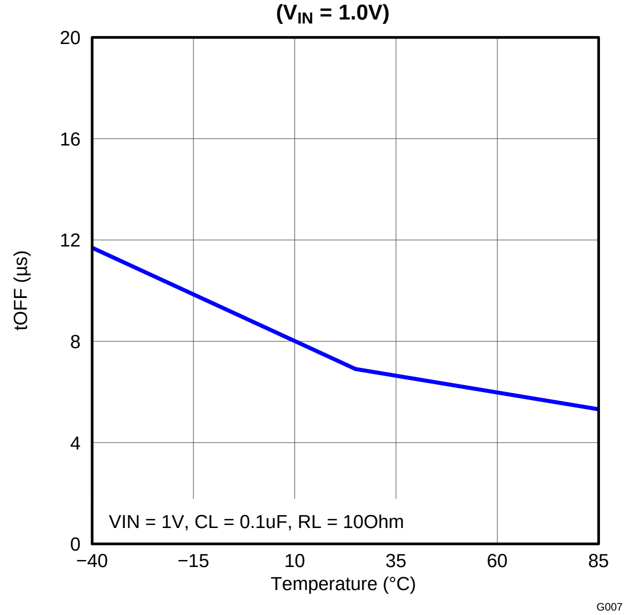


Figure 21.

TYPICAL SWITCHING CHARACTERISTICS (continued)

RISE TIME vs. V_{IN} (C_L = 0.1µF)

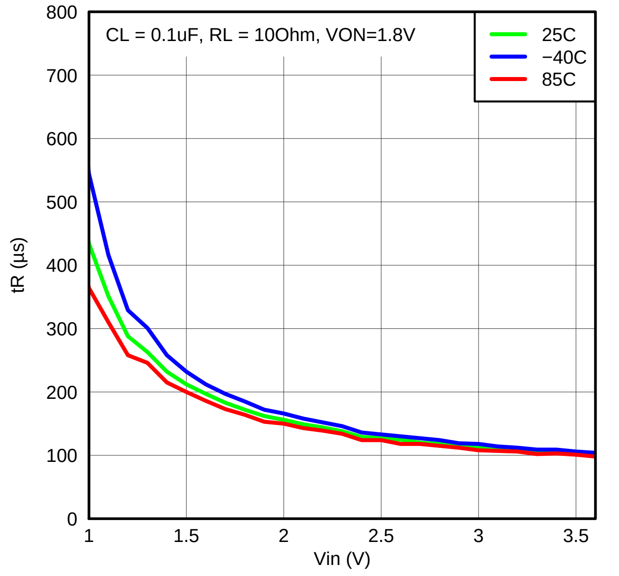


Figure 22.

RISE TIME vs. V_{IN} (C_L = 1µF)

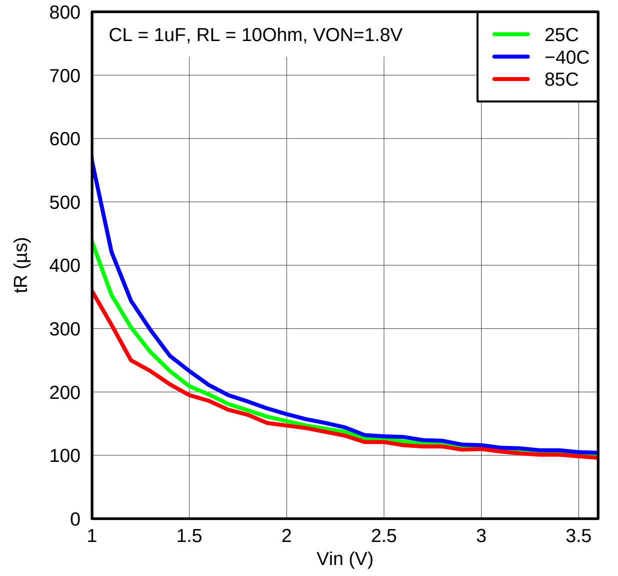


Figure 23.

TYPICAL SWITCHING SCOPE CAPTURES AT T_A = 25°C

TURN-ON RESPONSE TIME
(V_{IN} = 3.6V, C_{IN} = 10µF, C_L = 1µF, R_L = 10Ω)

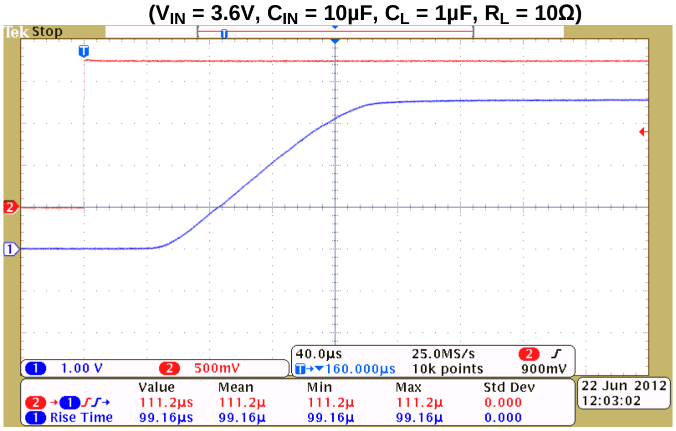


Figure 24.

TURN-ON RESPONSE TIME
(V_{IN} = 1.0V, C_{IN} = 10µF, C_L = 1µF, R_L = 10Ω)

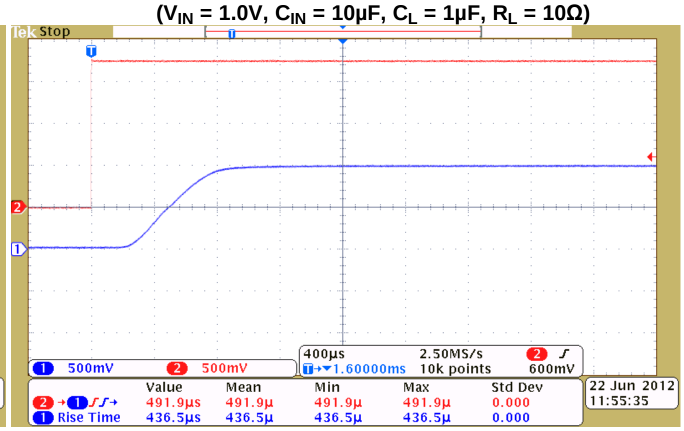


Figure 25.

TURN-ON RESPONSE TIME
(V_{IN} = 3.6V, C_{IN} = 1µF, C_L = 0.1µF, R_L = 10Ω)

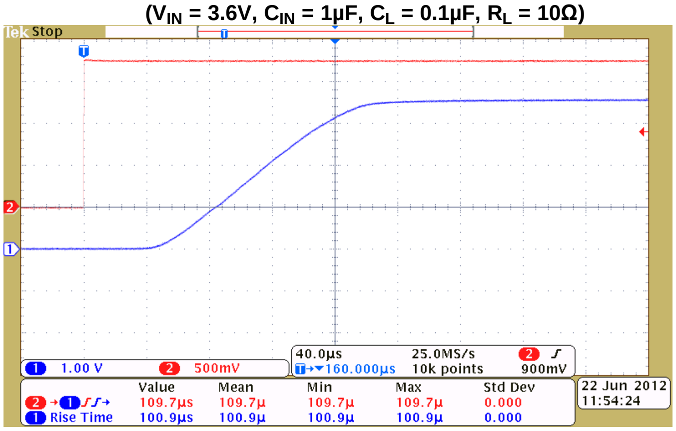


Figure 26.

TURN-ON RESPONSE TIME
(V_{IN} = 1.0V, C_{IN} = 1µF, C_L = 0.1µF, R_L = 10Ω)

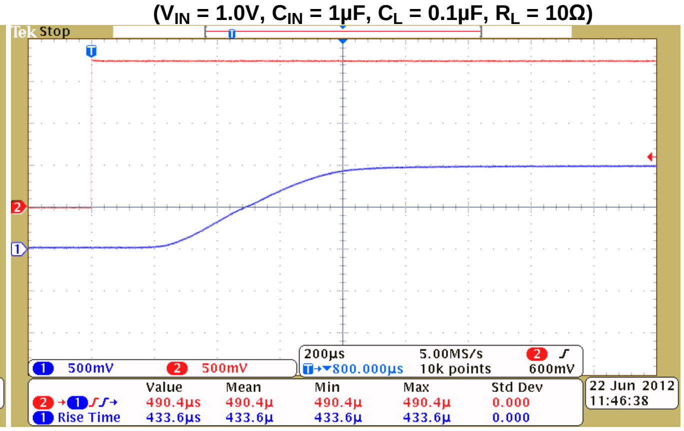


Figure 27.

TURN-OFF RESPONSE TIME
(V_{IN} = 3.6V, C_{IN} = 10µF, C_L = 1µF, R_L = 10Ω)

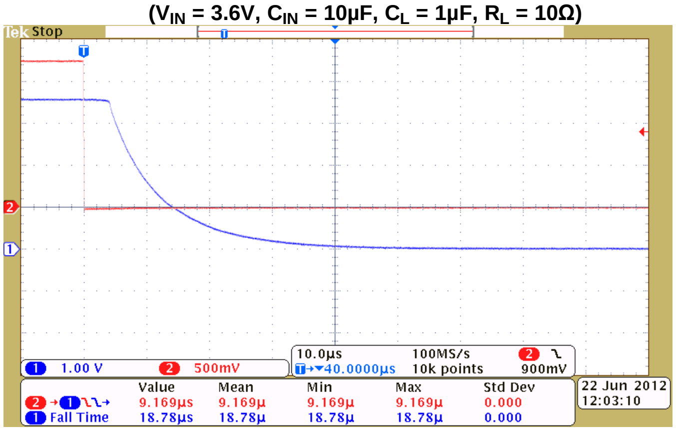


Figure 28.

TURN-OFF RESPONSE TIME
(V_{IN} = 1.0V, C_{IN} = 10µF, C_L = 1µF, R_L = 10Ω)

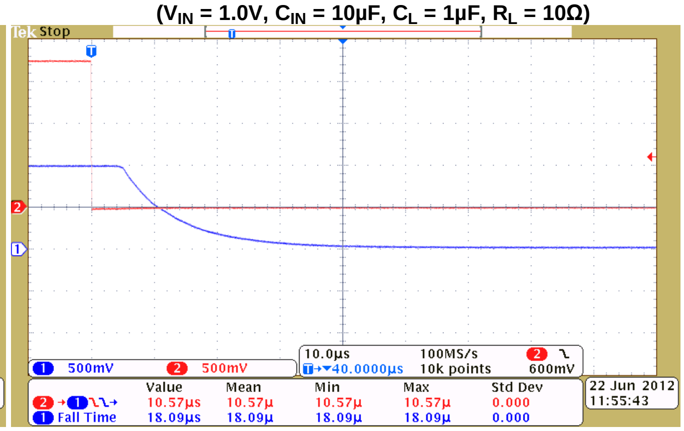


Figure 29.

TYPICAL SWITCHING SCOPE CAPTURES AT T_A = 25°C (continued)

TURN-OFF RESPONSE TIME
(V_{IN} = 3.6V, C_{IN} = 1µF, C_L = 0.1µF, R_L = 10Ω)

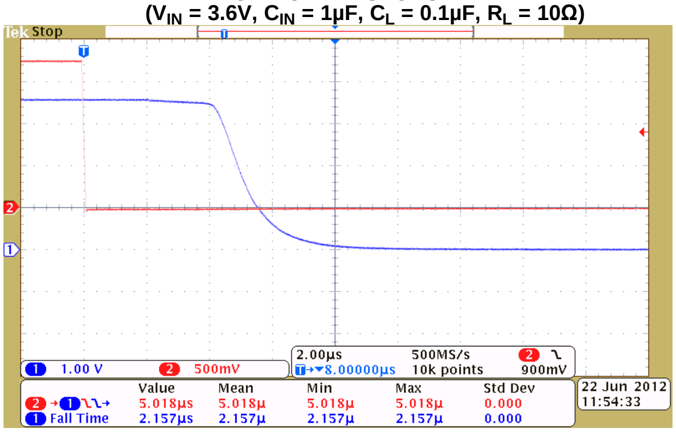


Figure 30.

TURN-OFF RESPONSE TIME
(V_{IN} = 1.0V, C_{IN} = 1µF, C_L = 0.1µF, R_L = 10Ω)

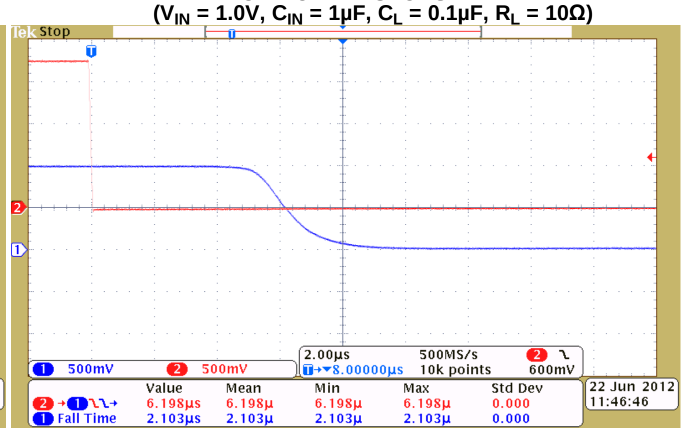


Figure 31.

APPLICATION INFORMATION

ON/OFF CONTROL

The ON pin controls the state of the switch. Asserting ON high enables the switch. 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 or higher GPIOs.

INPUT CAPACITOR (OPTIONAL)

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

OUTPUT CAPACITOR (OPTIONAL)

Due to the integrated body diode of the PMOS switch, a C_{IN} greater than C_L is highly recommended. A C_L greater than C_{IN} can cause V_{OUT} to exceed V_{IN} when the system supply is removed. This could result in current flow through the body diode from V_{OUT} to V_{IN}. A C_{IN} to C_L ratio of at least 10 to 1 is recommended for minimizing V_{IN} dip caused by inrush currents during startup; however, a 10 to 1 ratio for capacitance is not required for proper functionality of the device. A ratio smaller than 10 to 1 (such as 1 to 1) could cause slightly more V_{IN} dip at turn on due to inrush currents.

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 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.

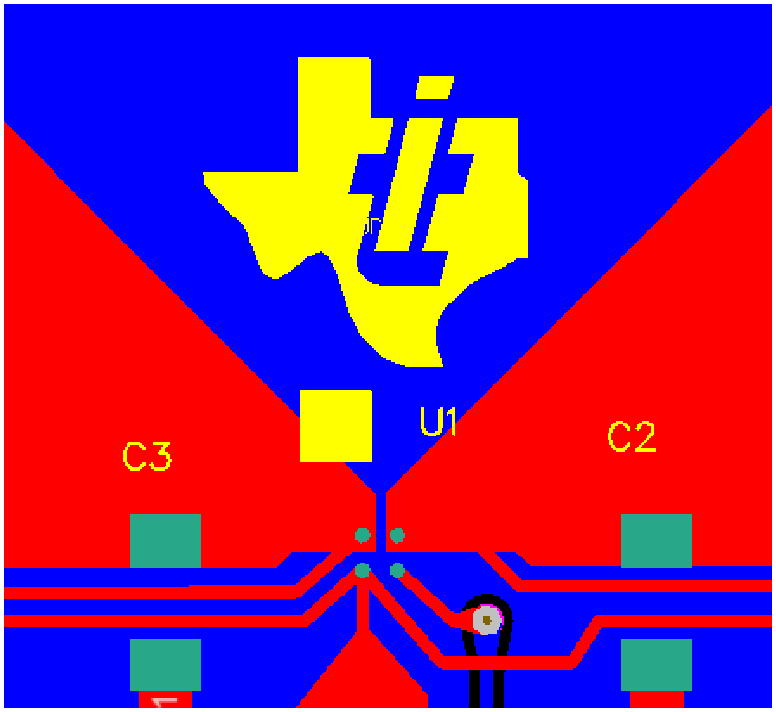


Figure 32. Layout

REVISION HISTORY

Changes from Revision A (August 2012) to Revision B	Page
• Updated FEATURES.	1
• Added Layout graphic.	14

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)	Device Marking (4/5)	Samples
TPS22908YZTR	ACTIVE	DSBGA	YZT	4	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	AT	Samples
TPS22908YZTT	ACTIVE	DSBGA	YZT	4	250	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	(AT ~ ATF)	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) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device 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 Device Marking for that device.

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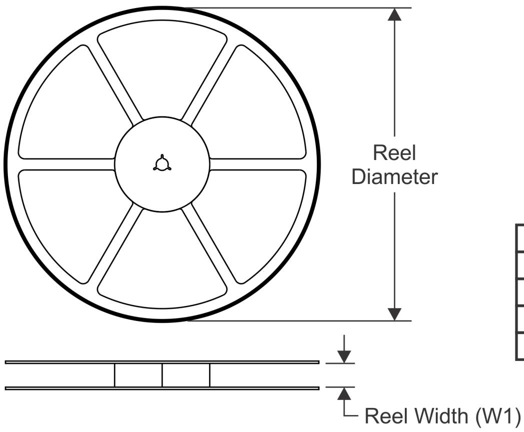
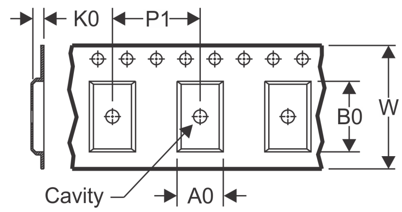
TAPE AND REEL INFORMATION

REEL DIMENSIONS

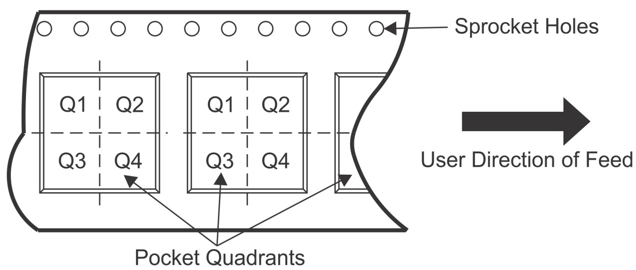


TAPE DIMENSIONS



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

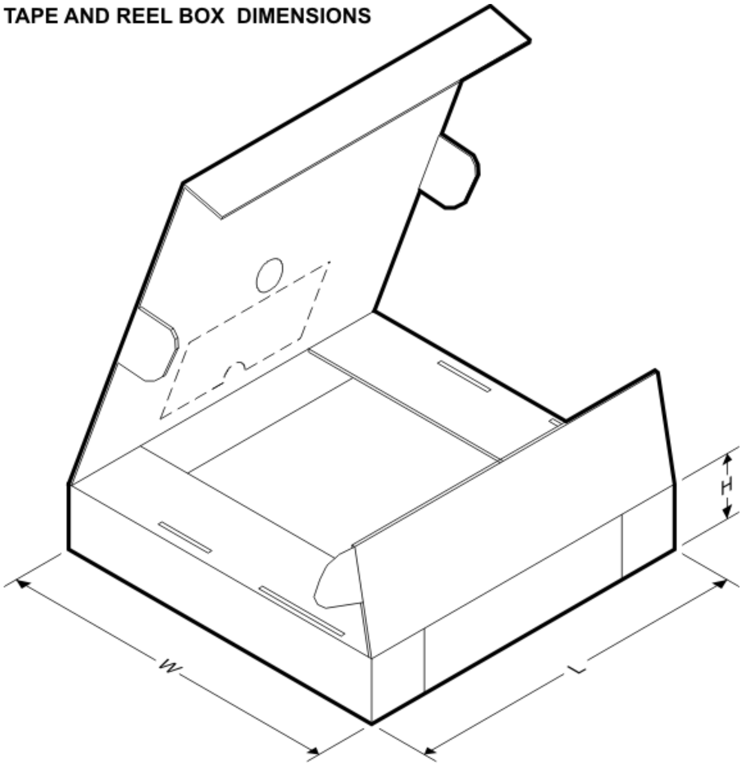
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS22908YZTT	DSBGA	YZT	4	250	180.0	8.4	0.99	0.99	0.69	4.0	8.0	Q1

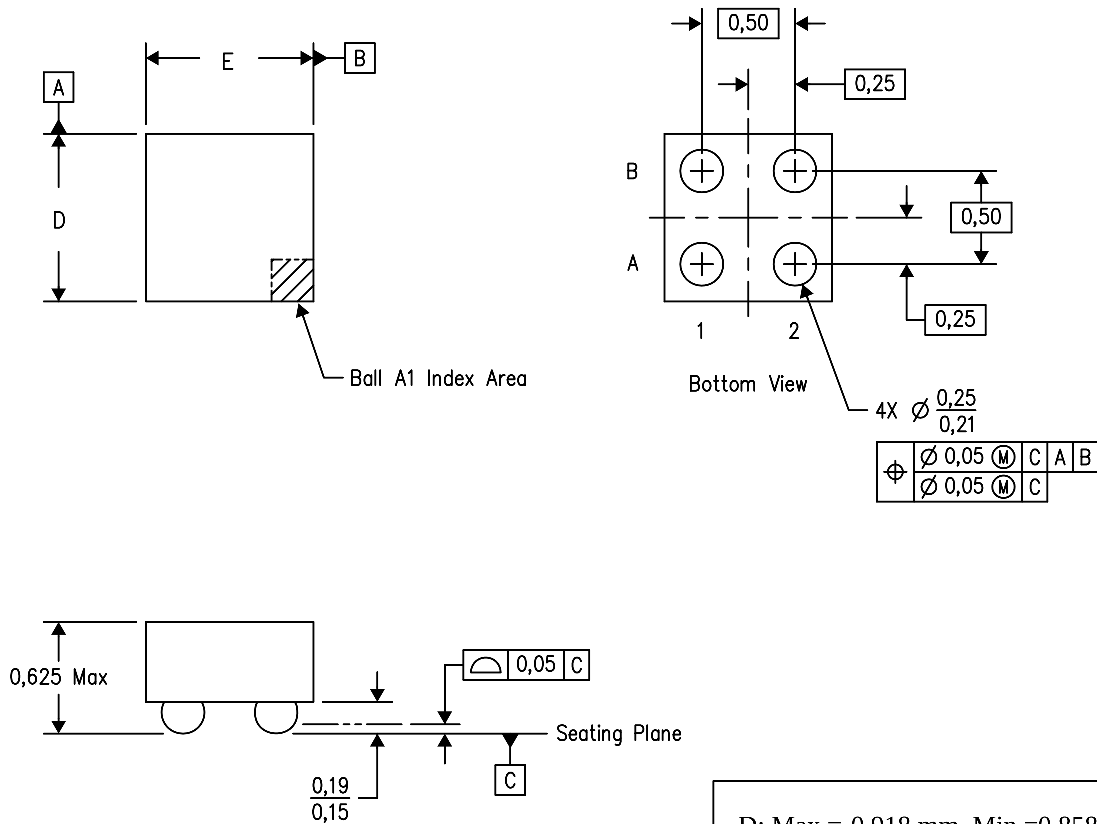
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS22908YZTT	DSBGA	YZT	4	250	182.0	182.0	17.0

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



D: Max = 0.918 mm, Min =0.858 mm

E: Max = 0.918 mm, Min =0.858 mm

4205418–2/H 05/13

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

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