

## Ultra-Low On-Resistance, 4-A Integrated Load Switch with Controlled Turn-on

Check for Samples: [TPS22920](#)

### FEATURES

- **Integrated Load Switch**
- **Input Voltage Range: 0.75-V to 3.6-V**
- **Integrated Pass-FET  $r_{\text{DS(on)}} = 2\text{m}\Omega$  (typ) at 3.6-V**
- **Ultra-Low ON-Resistance**
  - $r_{\text{ON}} = 5.3\text{-m}\Omega$  at 3.6-V
  - $r_{\text{ON}} = 5.4\text{-m}\Omega$  at 2.5-V
  - $r_{\text{ON}} = 5.5\text{-m}\Omega$  at 1.8-V
  - $r_{\text{ON}} = 5.8\text{-m}\Omega$  at 1.2-V
  - $r_{\text{ON}} = 6.1\text{-m}\Omega$  at 1.05-V
  - $r_{\text{ON}} = 7.3\text{-m}\Omega$  at 0.75-V
- **Ultra Small CSP-8 package 0.9mm×1.9mm, 0.5mm pitch**
- **4-A Maximum Continuous Switch Current**
- **Shutdown Current 5.5- $\mu\text{A}$  max**
- **Low Threshold Control Input**
- **Controlled slew- rate to avoid inrush current**
- **Quick Output Discharge Transistor**
- **ESD Performance Tested Per JESD 22**
  - 4000-V Human-Body Model (A114-B, Class II)
  - 1000-V Charged-Device Model (C101)

### APPLICATIONS

- **Notebook / Netbook Computer**
- **Tablet PC**
- **PDAs / Smartphones**
- **GPS Navigation Devices**
- **MP3 Players**

### DESCRIPTION

The TPS22920 is a small, ultra-low  $r_{\text{ON}}$  load switch with controlled turn on. The device contains a N-channel MOSFET that can operate over an input voltage range of 0.75 V to 3.6 V and switch currents up to 4-A. An integrated charge pump biases the NMOS switch in order to achieve a minimum switch ON resistance ( $r_{\text{ON}}$ ). The switch is controlled by an on/off input (ON), which is capable of interfacing directly with low-voltage control signals.

The TPS22920 has a 1250- $\Omega$  on-chip load resistor for quick output discharge when the switch is turned off.

The TPS22920 has an internally controlled rise time in order to reduce inrush current. The TPS22920 features a rise time of 880 $\mu\text{s}$  at 3.6-V.

The TPS22920 is available in an ultra-small, space-saving 8-pin CSP package and is characterized for operation over the free-air temperature range of  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

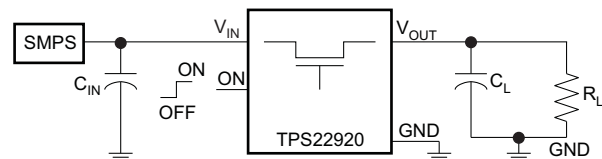


Figure 1. Typical Application

### FEATURE LIST

	$r_{\text{ON}}$ (typ) at 3.6 V	RISE TIME (typ) at 3.6V	QUICK OUTPUT DISCHARGE <sup>(1)</sup>	MAXIMUM OUTPUT CURRENT	ENABLE
TPS22920	5.3- m $\Omega$	880 $\mu\text{s}$	Yes	4-A	Active High

(1) This feature discharges the output of the switch to ground through a 1250- $\Omega$  resistor, preventing the output from floating. See Application section 'Output Pull-Down'

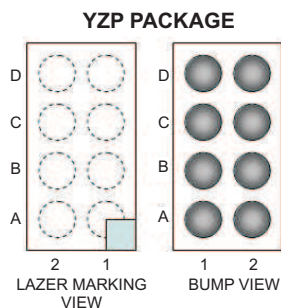


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



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.



**Figure 2. Bump Assignments**

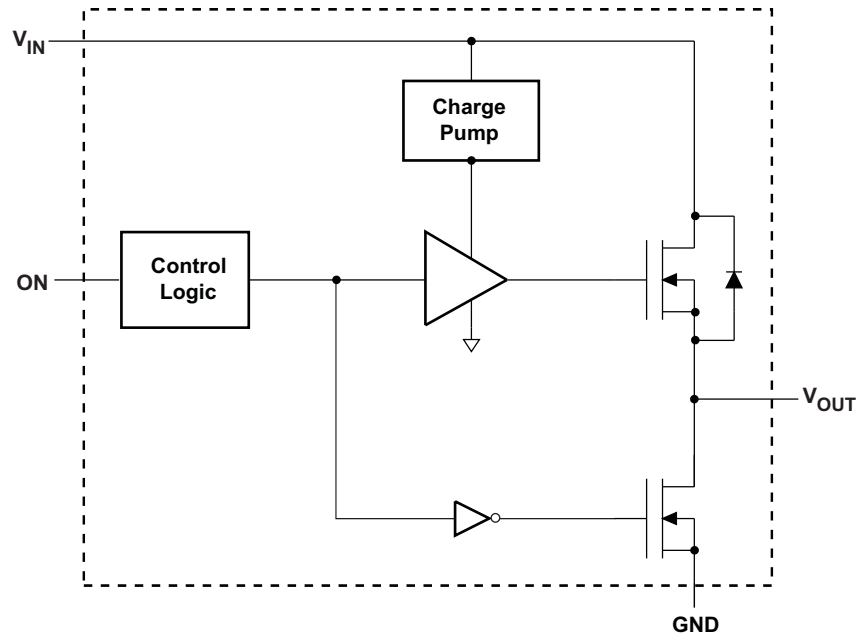
**Bump Assignments (YZP Package)**

<b>D</b>	GND	ON
<b>C</b>	V <sub>OUT</sub>	V <sub>IN</sub>
<b>B</b>	V <sub>OUT</sub>	V <sub>IN</sub>
<b>A</b>	V <sub>OUT</sub>	V <sub>IN</sub>
	<b>1</b>	<b>2</b>

**Pin Description**

TPS22920	PIN NAME	DESCRIPTION
YZP		
D1	GND	Ground
D2	ON	Switch control input, active high. Do not leave floating
A1, B1, C1	V <sub>OUT</sub>	Switch output
A2, B2, C2	V <sub>IN</sub>	Switch input, bypass this input with a ceramic capacitor to ground

## FUNCTIONAL BLOCK DIAGRAM



FUNCTION TABLE

ON	V <sub>IN</sub> to V <sub>OUT</sub>	V <sub>OUT</sub> to GND <sup>(1)</sup>
L	OFF	ON
H	ON	OFF

(1) See Application section 'Output Pull-Down'

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

		VALUE	UNIT
V <sub>IN</sub>	Input voltage range	-0.3 to 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 to 4	V
I <sub>MAX</sub>	Maximum Continuous Switch Current	4	A
I <sub>PLS</sub>	Maximum Pulsed Switch Current, pulse <300µS, 2% duty cycle	6	A
T <sub>A</sub>	Operating free-air temperature range	-40 to 85	°C
T <sub>J</sub>	Maximum junction temperature	125	°C
T <sub>STG</sub>	Storage temperature range	-65 to 150	°C
T <sub>LEAD</sub>	Maximum lead temperature (10-s soldering time)	300	°C
ESD	Electrostatic discharge protection	Human-Body Model (HBM)	4000
		Charged Device Model (CDM)	1000

(1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress 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 INFORMATION

THERMAL METRIC <sup>(1)</sup>		TPS22920	UNITS
		CS130P (8 PINS)	
$\theta_{JA}$	Junction-to-ambient thermal resistance	130	°C/W
$\theta_{JCTop}$	Junction-to-case (top) thermal resistance	54	
$\theta_{JB}$	Junction-to-board thermal resistance	51	
$\psi_{JT}$	Junction-to-top characterization parameter	1	
$\psi_{JB}$	Junction-to-board characterization parameter	50	
$\theta_{JCbot}$	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](#).

## RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
$V_{IN}$	Input voltage range	0.75	3.6	V
$V_{OUT}$	Output voltage range		$V_{IN}$	V
$V_{IH}$	High-level input voltage, ON	$V_{IN} = 2.5\text{-V to } 3.6\text{ V}$		V
		$V_{IN} = 0.75\text{-V to } 2.49\text{ V}$		V
$V_{IL}$	Low-level input voltage, ON	$V_{IN} = 2.5\text{-V to } 3.6\text{ V}$		V
		$V_{IN} = 0.75\text{-V to } 2.49\text{ V}$		V
$C_{IN}$	Input Capacitor	1 <sup>(1)</sup>		μF

(1) See *Input Capacitor* section in Application Information.

## ELECTRICAL CHARACTERISTICS

$V_{IN} = 0.75\text{ V to } 3.6\text{ V}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	$T_A$	MIN	TYP <sup>(1)</sup>	MAX	UNIT
$I_{IN}$	Quiescent Current $I_{OUT} = 0, V_{IN} = V_{ON}$	Full	68	160	μA	$V_{IN} = 3.6\text{ V}$
						$V_{IN} = 2.5\text{ V}$
						$V_{IN} = 1.8\text{ V}$
			103	200	μA	$V_{IN} = 1.2\text{ V}$
						$V_{IN} = 1.05\text{ V}$
						$V_{IN} = 0.75\text{ V}$
$I_{IN(Leak)}$	Off Supply Current (After Pull Down)	Full	5.5		μA	
$r_{ON}$	On-Resistance	25°C	5.3	8.8	mΩ	$V_{IN} = 3.6\text{ V}, I_{OUT} = -200\text{ mA}$
						Full
		25°C	5.4	8.9	mΩ	$V_{IN} = 2.5\text{ V}, I_{OUT} = -200\text{ mA}$
						Full
		25°C	5.5	9.1	mΩ	$V_{IN} = 1.8\text{ V}, I_{OUT} = -200\text{ mA}$
						Full
		25°C	5.8	9.4	mΩ	$V_{IN} = 1.2\text{ V}, I_{OUT} = -200\text{ mA}$
						Full
		25°C	6.1	9.7	mΩ	$V_{IN} = 1.05\text{ V}, I_{OUT} = -200\text{ mA}$
						Full
		25°C	7.3	11.0	mΩ	$V_{IN} = 0.75\text{ V}, I_{OUT} = -200\text{ mA}$
						Full
RPD	Output pull down resistance <sup>(2)</sup>	Full	1250	1500	Ω	
$I_{ON}$	ON input leakage current	Full	0.1		μA	

(1) Typical values are at  $V_{IN} = 3.3\text{ V}$  and  $T_A = 25^\circ\text{C}$ .

(2) See Output Pulldown in *Application Information*.

## SWITCHING CHARACTERISTICS

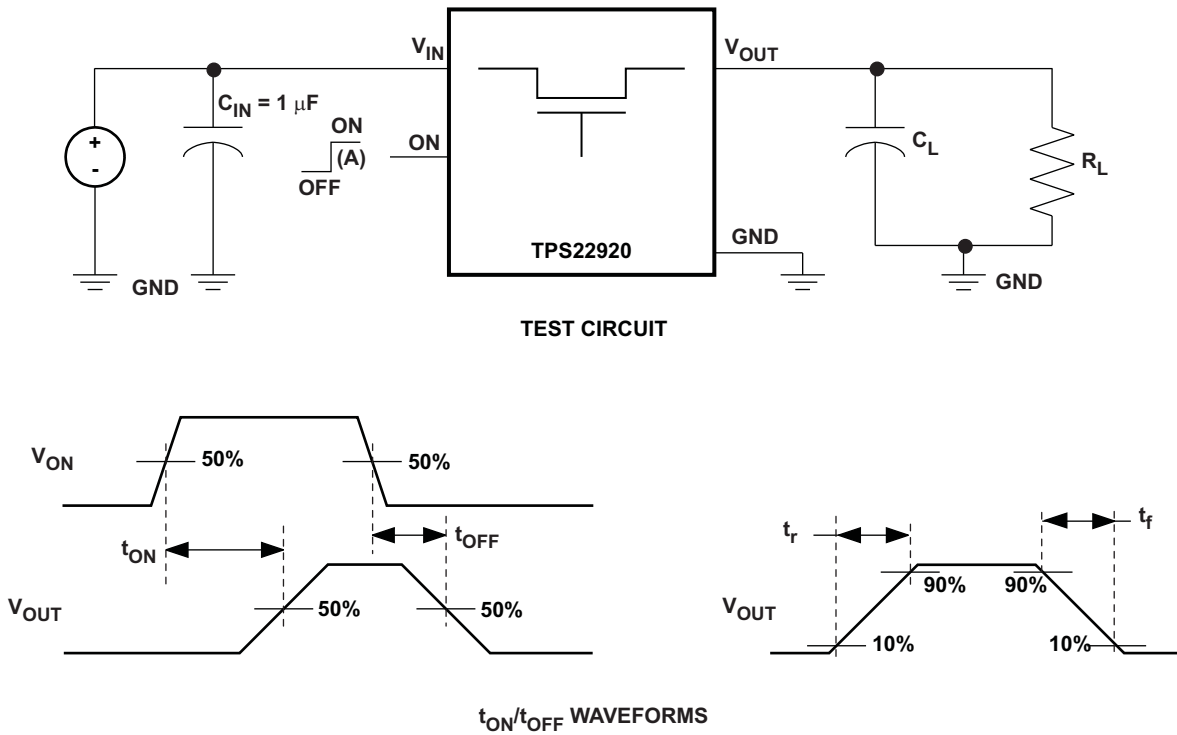
 $V_{IN} = 3.6\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
$t_{ON}$	Turn-ON time	$R_L = 10\ \Omega$ , $C_L = 0.1\ \mu\text{F}$ , $V_{IN} = 3.6\text{ V}$		970		$\mu\text{s}$
$t_{OFF}$	Turn-OFF time	$R_L = 10\ \Omega$ , $C_L = 0.1\ \mu\text{F}$ , $V_{IN} = 3.6\text{ V}$		3		
$t_r$	VOUT Rise time	$R_L = 10\ \Omega$ , $C_L = 0.1\ \mu\text{F}$ , $V_{IN} = 3.6\text{ V}$		880		
$t_f$	VOUT Fall time	$R_L = 10\ \Omega$ , $C_L = 0.1\ \mu\text{F}$ , $V_{IN} = 3.6\text{ V}$		2		

 $V_{IN} = 0.9\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
$t_{ON}$	Turn-ON time	$R_L = 10\ \Omega$ , $C_L = 0.1\ \mu\text{F}$ , $V_{IN} = 0.9\text{ V}$		840		$\mu\text{s}$
$t_{OFF}$	Turn-OFF time	$R_L = 10\ \Omega$ , $C_L = 0.1\ \mu\text{F}$ , $V_{IN} = 0.9\text{ V}$		16		
$t_r$	VOUT Rise time	$R_L = 10\ \Omega$ , $C_L = 0.1\ \mu\text{F}$ , $V_{IN} = 0.9\text{ V}$		470		
$t_f$	VOUT Fall time	$R_L = 10\ \Omega$ , $C_L = 0.1\ \mu\text{F}$ , $V_{IN} = 0.9\text{ V}$		5		

PARAMETRIC MEASUREMENT INFORMATION



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

**Figure 3. Test Circuit and  $t_{ON}/t_{OFF}$  Waveforms**

TYPICAL CHARACTERISTICS

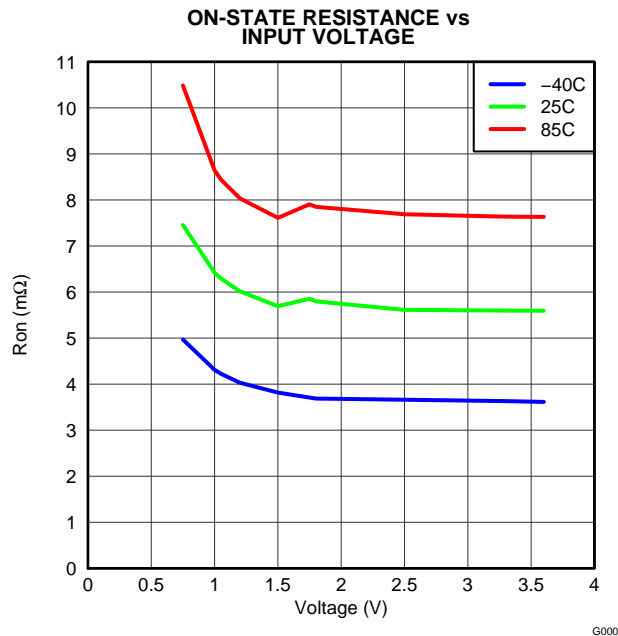


Figure 4.

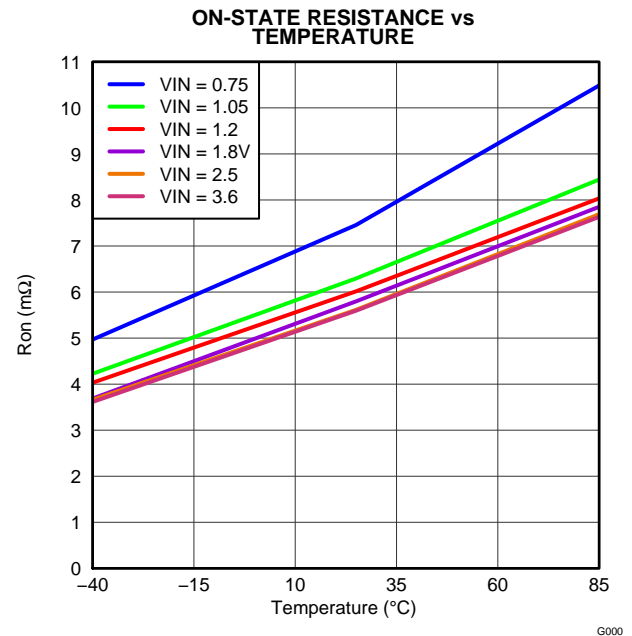


Figure 5.

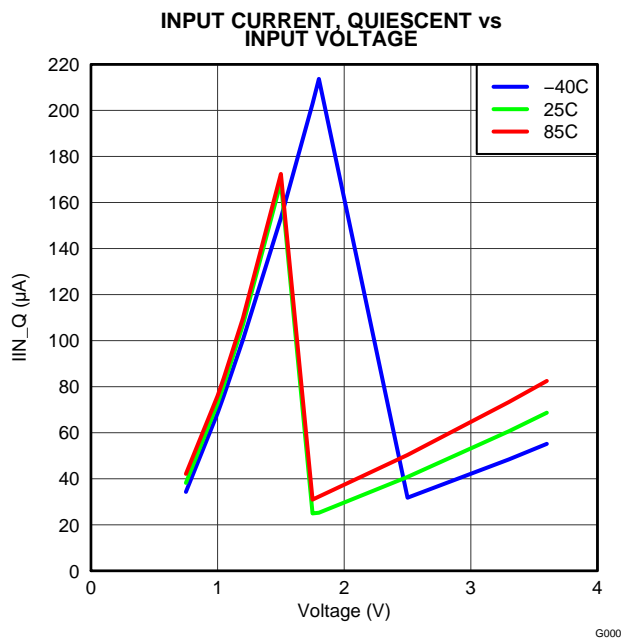


Figure 6.

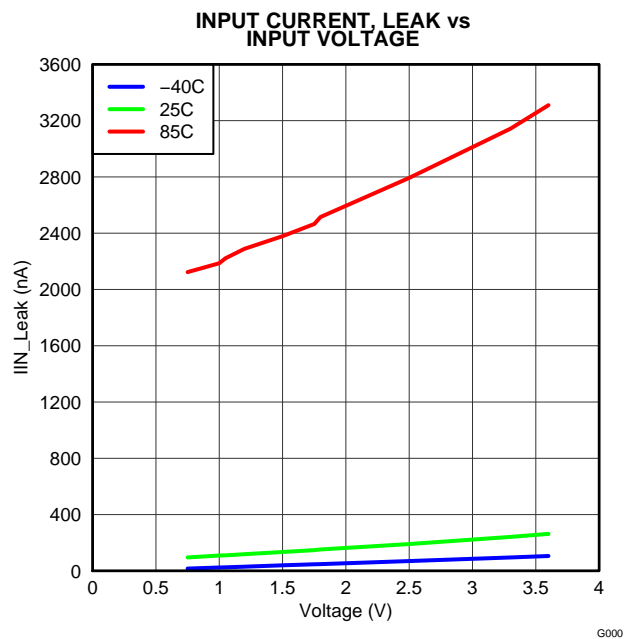


Figure 7.

**TYPICAL CHARACTERISTICS (continued)**

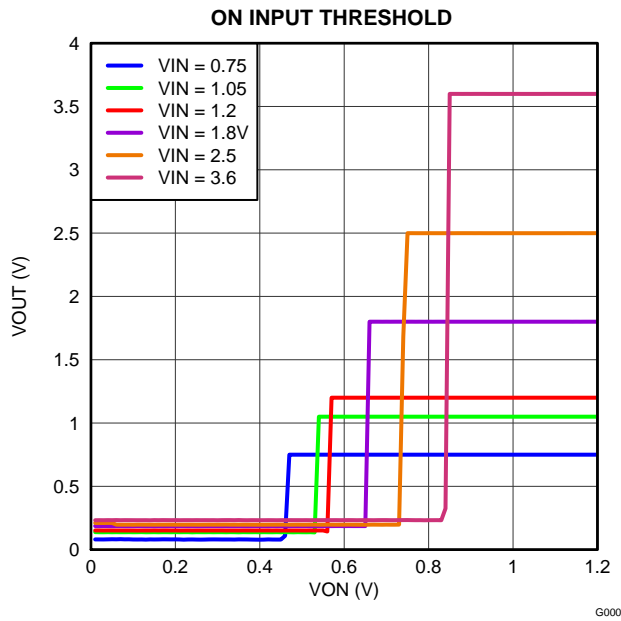


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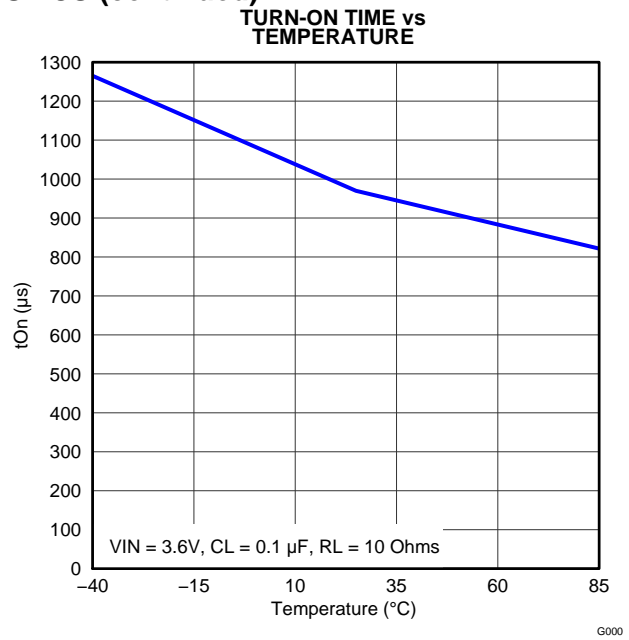


Figure 9.

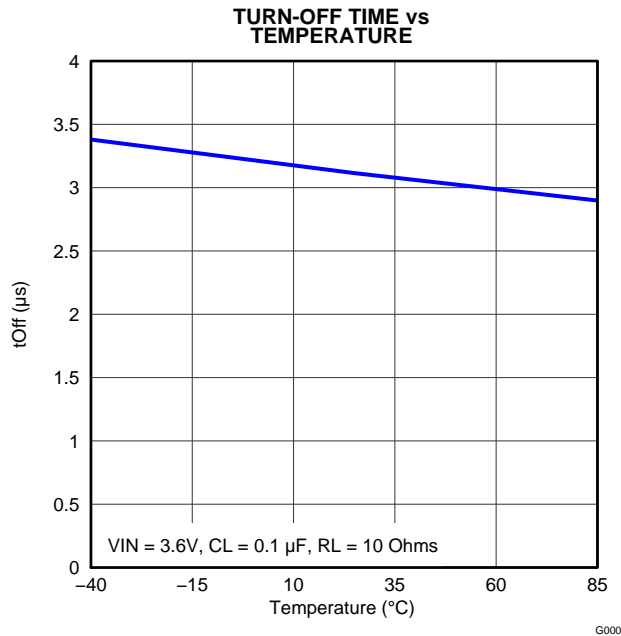


Figure 10.

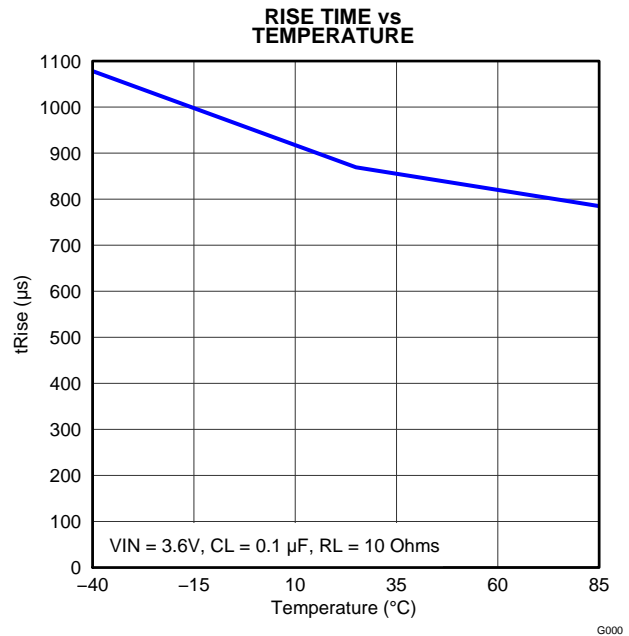


Figure 11.



TYPICAL CHARACTERISTICS (continued)

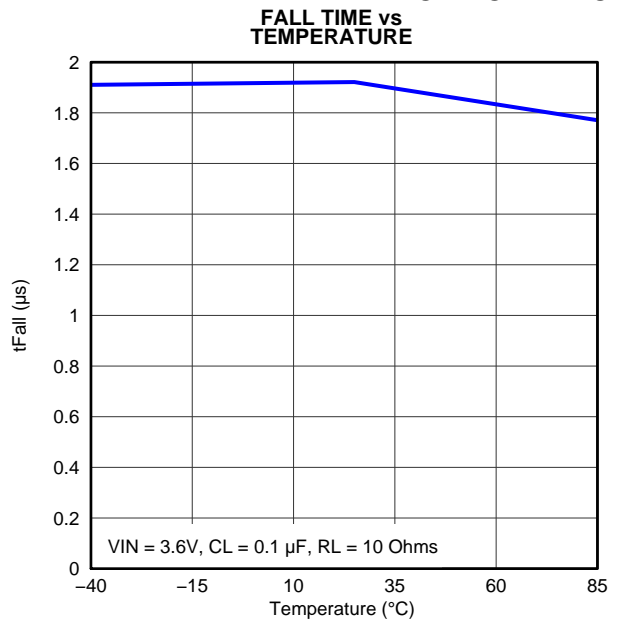


Figure 12.

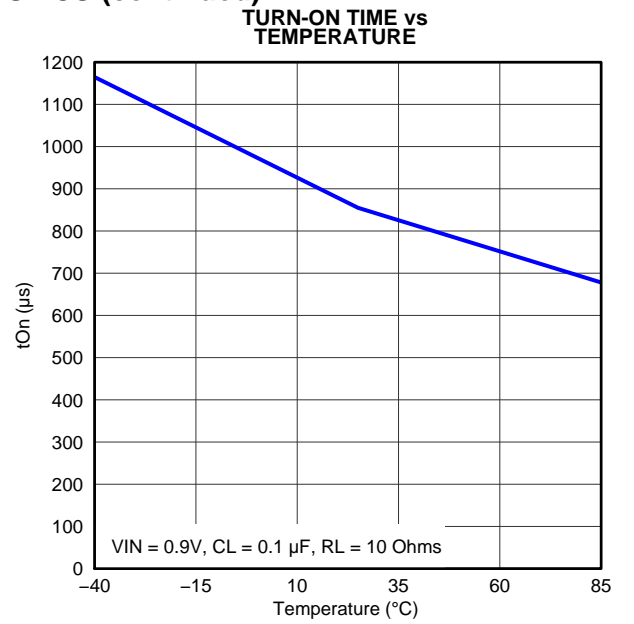


Figure 13.

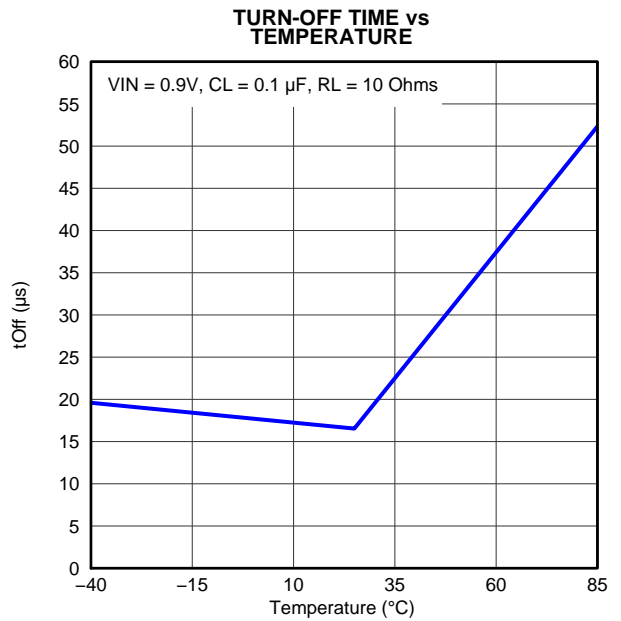


Figure 14.

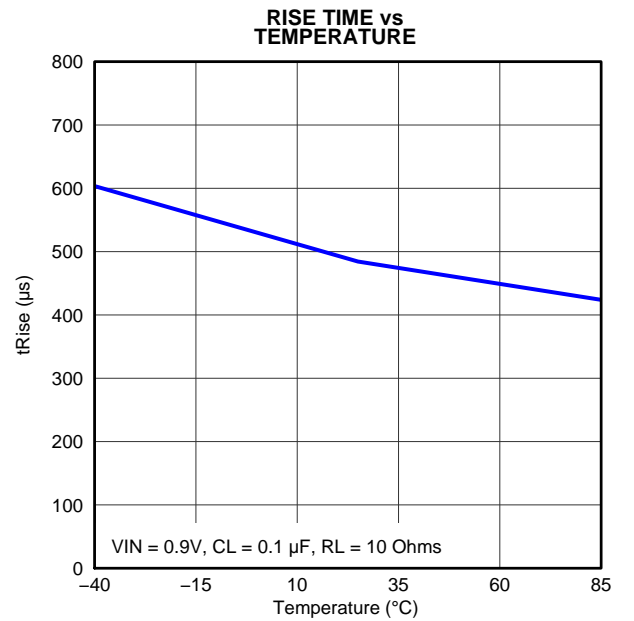


Figure 15.

**TYPICAL CHARACTERISTICS (continued)**

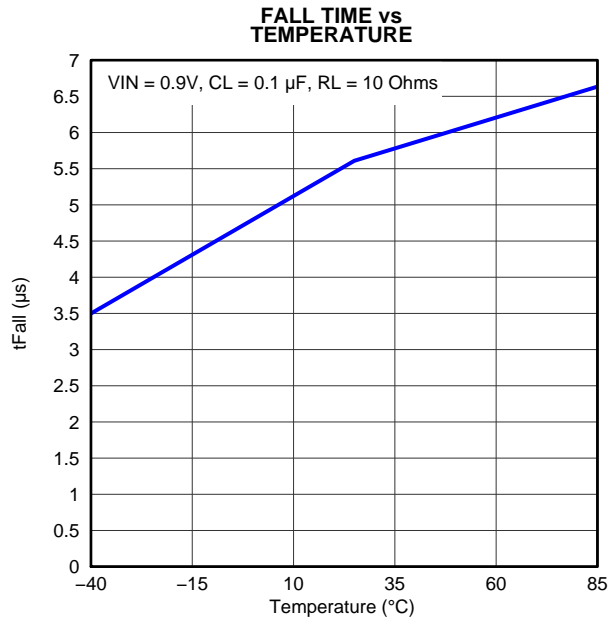


Figure 16.

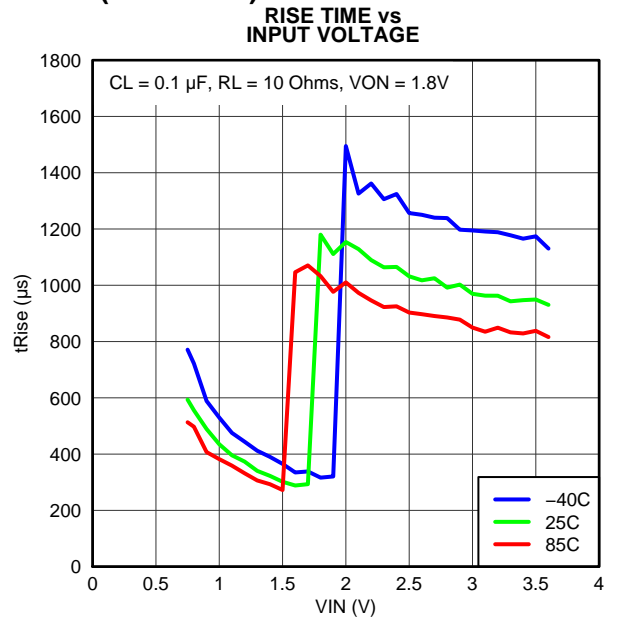


Figure 17.

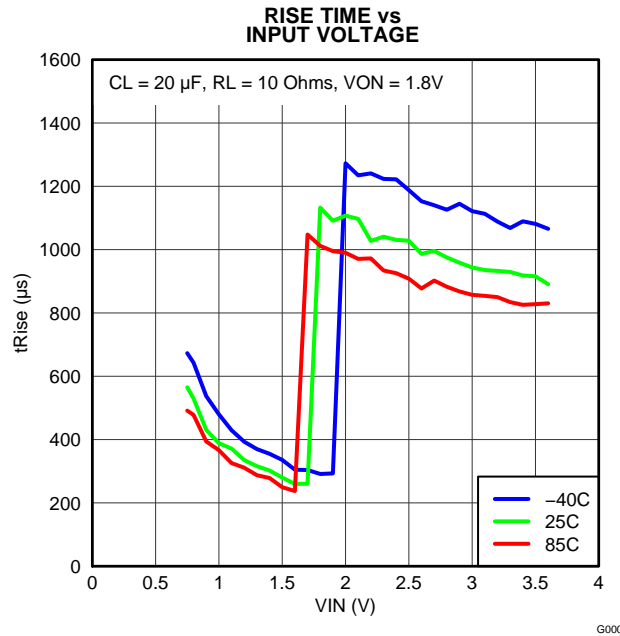


Figure 18.

TYPICAL CHARACTERISTICS (continued)

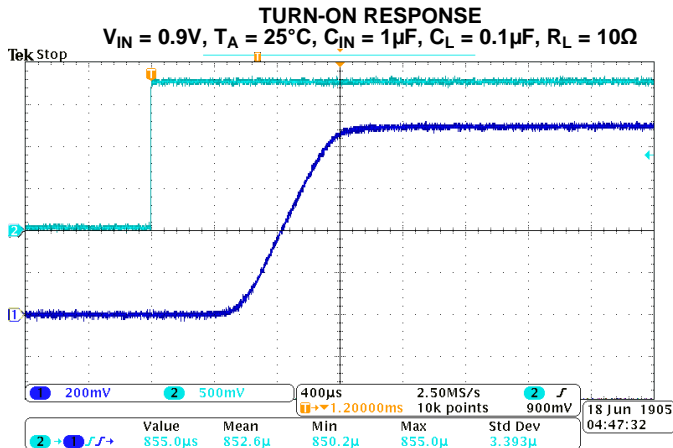


Figure 19.

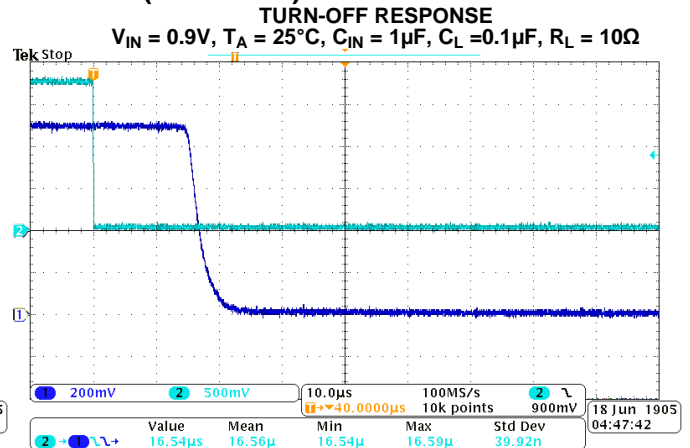


Figure 20.

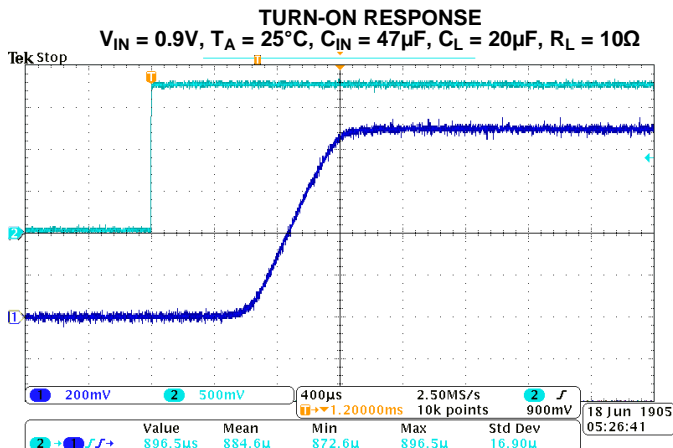


Figure 21.

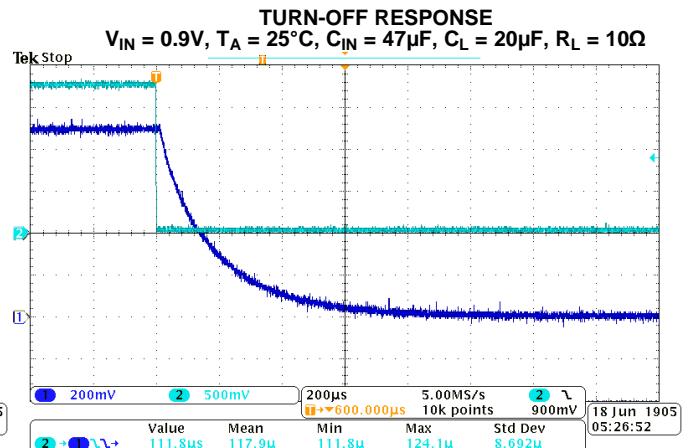


Figure 22.

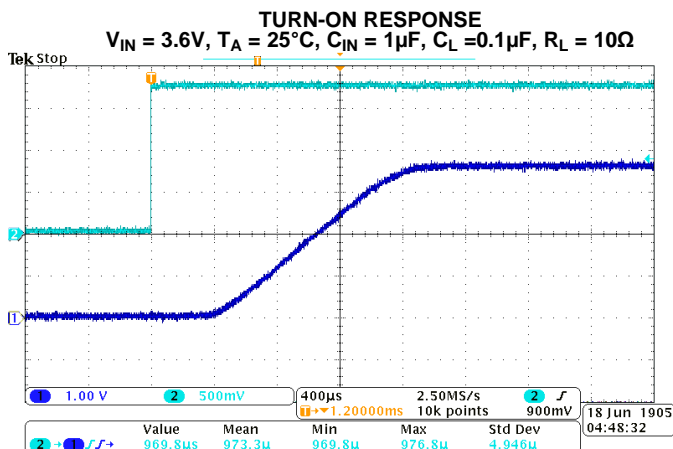


Figure 23.

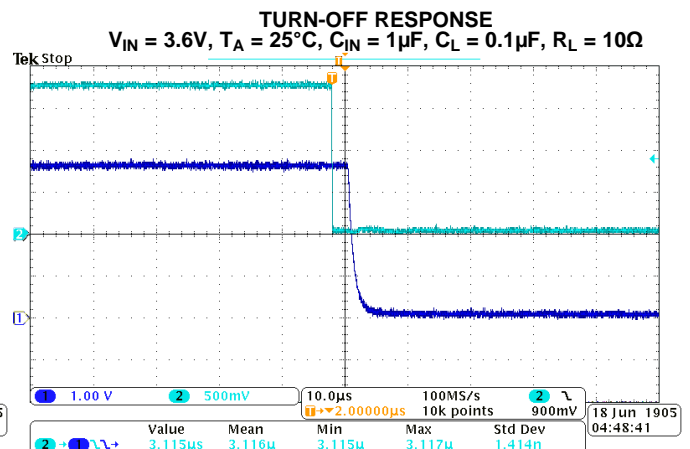


Figure 24.

TYPICAL CHARACTERISTICS (continued)

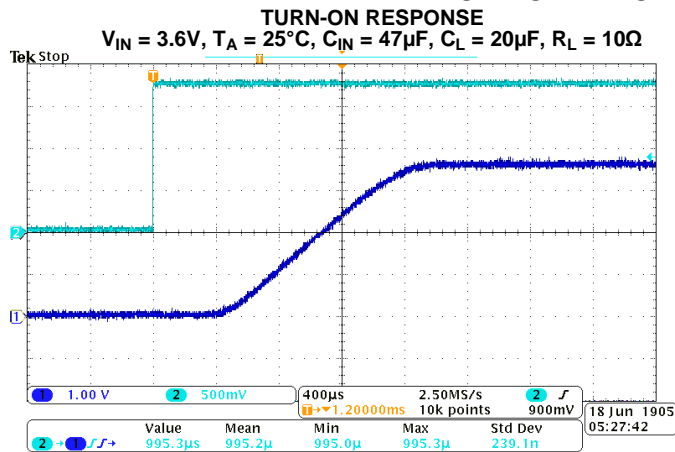


Figure 25.

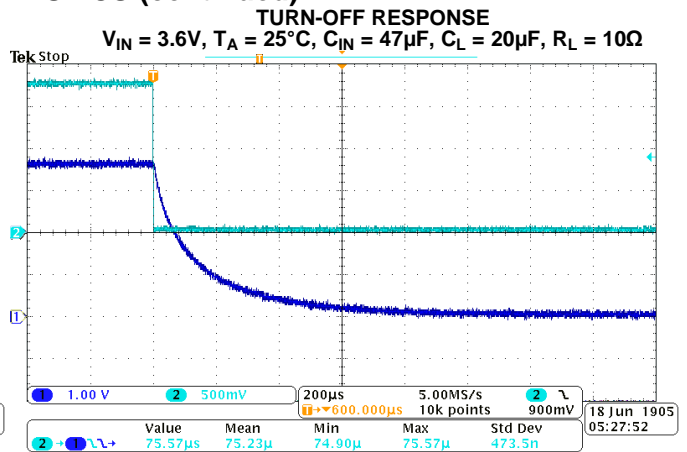


Figure 26.

## 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, 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 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.

### OUTPUT CAPACITOR

Due to the integral body diode in the NMOS switch, a  $C_{IN}$  greater than  $C_L$  is highly recommended. A  $C_L$  greater than  $C_{IN}$  can cause  $V_{OUT}$  to exceed  $V_{IN}$  when the system supply is removed. This could result in current flow through the body diode from  $V_{OUT}$  to  $V_{IN}$ . A  $C_{IN}$  to  $C_L$  ratio of 10 to 1 is recommended for minimizing  $V_{IN}$  dip caused by inrush currents during startup.

### OUTPUT PULL-DOWN

The output pulldown is active when the user is turning off the main pass FET. The pulldown discharges the output rail to approximately 10% of the rail, and then the output pulldown is automatically disconnected to optimize the shutdown current.

### 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.

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## REVISION HISTORY

Changes from Original (June 2011) to Revision A	Page
• Updated swapped image issue. ....	<a href="#">8</a>

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**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
TPS22920YZPR	ACTIVE	DSBGA	YZP	8	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	6Z	<a href="#">Samples</a>
TPS22920YZPRB	ACTIVE	DSBGA	YZP	8	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	6Z S	<a href="#">Samples</a>
TPS22920YZPT	ACTIVE	DSBGA	YZP	8	250	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	6Z	<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.

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

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

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

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

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

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

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

(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**

**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
TPS22920YZPR	DSBGA	YZP	8	3000	180.0	8.4	1.02	2.02	0.63	4.0	8.0	Q1
TPS22920YZPRB	DSBGA	YZP	8	3000	180.0	8.4	1.02	2.02	0.63	4.0	8.0	Q1
TPS22920YZPT	DSBGA	YZP	8	250	180.0	8.4	1.02	2.02	0.63	4.0	8.0	Q1

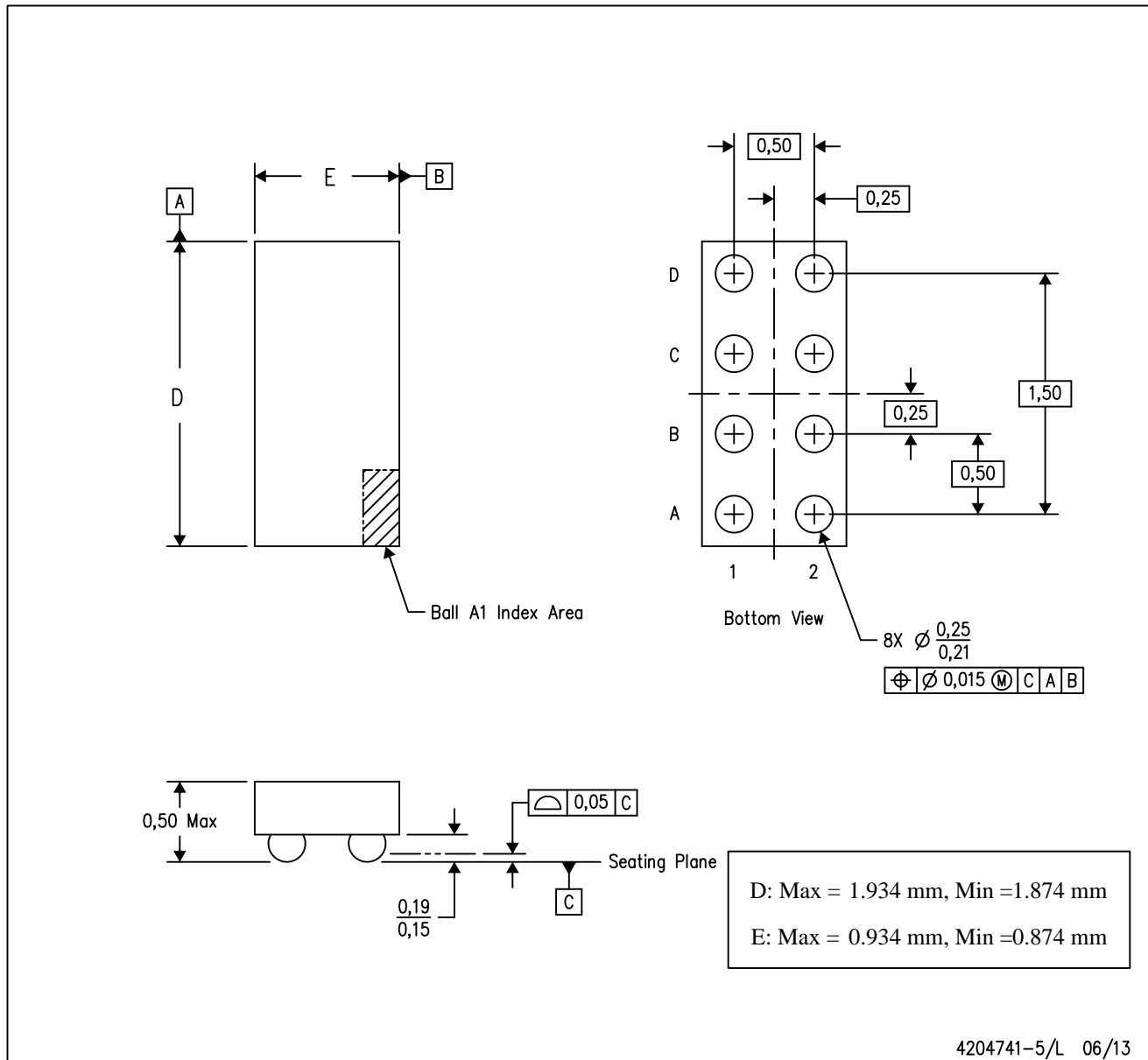
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS22920YZPR	DSBGA	YZP	8	3000	182.0	182.0	17.0
TPS22920YZPRB	DSBGA	YZP	8	3000	182.0	182.0	17.0
TPS22920YZPT	DSBGA	YZP	8	250	182.0	182.0	17.0

YZP (R-XBGA-N8)

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.

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