ULTRA-SMALL LOW-INPUT-VOLTAGE LOW r_{ON} LOAD SWITCH

Check for Samples: TPS22903, TPS22904

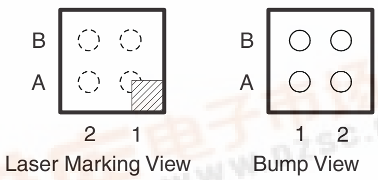
FEATURES

- Input Voltage: 1.1 V to 3.6 V
- Ultra-Low ON-State Resistance
  - r_{ON} = 66 mΩ at V_{IN} = 3.6 V
  - r_{ON} = 75 mΩ at V_{IN} = 2.5 V
  - r_{ON} = 90 mΩ at V_{IN} = 1.8 V
  - r_{ON} = 135 mΩ at V_{IN} = 1.2 V
- 500-mA Maximum Continuous Switch Current
- Quiescent Current < 1 µA
- Shutdown Current < 1 µA
- Low Control Input Threshold Enables Use of 1.2-V/1.8-V/2.5-V/3.3-V Logic
- Controlled Slew Rate (5 µs Max at 3.6 V)
- Quick Output Discharge (TPS22904 Only)
- ESD Performance Tested Per JESD 22
  - 2000-V Human-Body Model (A114-B, Class II)
  - 1000-V Charged-Device Model (C101)
- 4-Terminal Wafer Chip-Scale Package (WCSP)
  - 0.8 mm × 0.8 mm, 0.4-mm Pitch, 0.5-mm Height

APPLICATIONS

- PDAs
- Cell Phones
- GPS Devices
- MP3 Players
- Digital Cameras
- Peripheral Ports
- Portable Instrumentation

YFP PACKAGE



TERMINAL ASSIGNMENTS

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

DESCRIPTION

The TPS22903 and TPS22904 are ultra-small, low r_{ON} single channel load switches with controlled turn on. The device contains a P-channel MOSFET that can operate over an input voltage range of 1.1 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 TPS22904, a 85-Ω on-chip load resistor is added for output quick discharge when switch is turned off.

TPS22903 and TPS22904 are available in a space-saving 4-terminal WCSP 0.4-mm pitch (YFP). The devices are characterized for operation over the free-air temperature range of –40°C to 85°C.

FEATURE LIST

DEVICE	r_{ON} TYPICAL AT 3.6 V	SLEW RATE AT 3.6 V	QUICK OUTPUT DISCHARGE(1)	MAXIMUM OUTPUT CURRENT	ENABLE
TPS22903	66 mΩ	5 µs max	No	500 mA	Active high
TPS22904	66 mΩ	5 µs max	Yes	500 mA	Active high

(1) This feature discharges the output of the switch to ground through a 85-Ω resistor, preventing the output from floating.

ORDERING INFORMATION(1)

T_A	PACKAGE(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING(3)
–40°C to 85°C	WCSP – YFP (0.4-mm pitch)	Tape and reel	TPS22903YFPR	_ _ _4P_
			TPS22904YFPR	_ _ _4R_

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
(3) The actual top-side marking has three preceding characters to denote year, month, and sequence code, and one following character to designate the wafer fab/assembly site. Pin 1 identifier indicates solder-bump composition (1 = SnPb, • = Pb-free).

BLOCK DIAGRAM

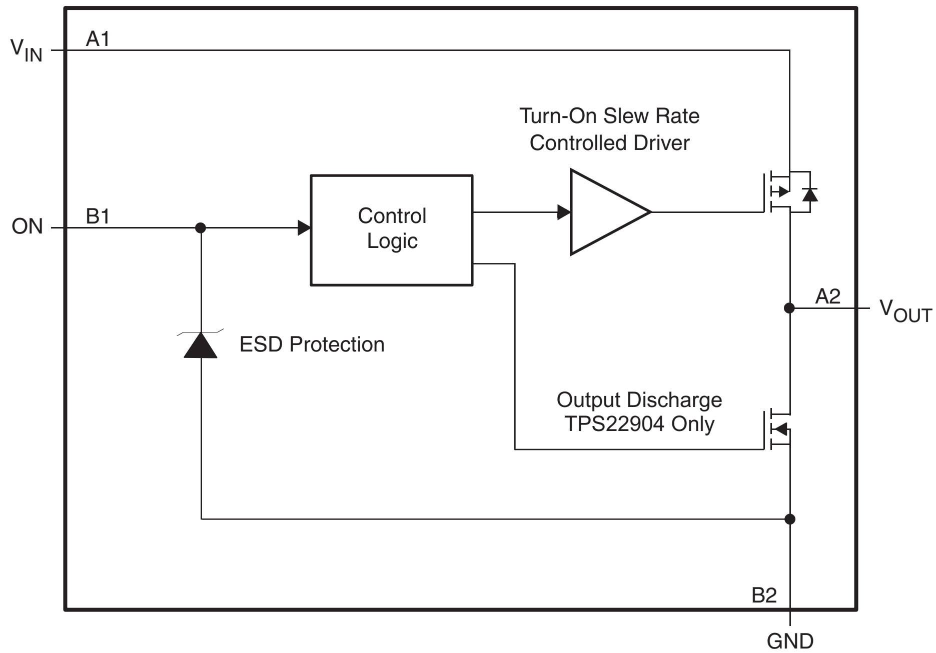


Figure 1. Functional Block Diagram

FUNCTION TABLE

ON (CONTROL INPUT)	V_{IN} TO V_{OUT}	V_{OUT} TO GND (TPS22904 ONLY)
L	OFF	ON
H	ON	OFF

TERMINAL FUNCTIONS

TERMINAL		I/O	DESCRIPTION
BALL NO.	NAME		
A1	V_{IN}	I	Input of the switch, bypass this input with a ceramic capacitor to ground
A2	V_{OUT}	O	Output of the switch
B1	ON	I	Switch control input, active high, do not leave floating
B2	GND	–	Ground

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_D	Power dissipation at T_A = 25°C			0.48	W
I_{MAX}	Maximum continuous switch current			0.5	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)		2000	V
		Charged Device Model (CDM)		1000	

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

THERMAL IMPEDANCE RATINGS

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

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

RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
V_{IN}	Input voltage range	1.1	3.6	V
V_{OUT}	Output voltage range		V_{IN}	V
V_{IH}	High-level input voltage, ON	0.85	3.6	V
V_{IL}	Low-level input voltage, ON		0.4	V
C_{IN}	Input capacitor(1)	1		µF

(1) See Application Information

ELECTRICAL CHARACTERISTICS

V_{IN} = 1.1 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, V_{IN} = V_{ON}		Full			1	µA
$I_{IN(OFF)}$	OFF-state supply current	V_{ON} = GND, OUT = Open		Full			1	µA
$I_{IN(LEAKAGE)}$	OFF-state switch current	V_{ON} = GND, V_{OUT} = 0		Full			1	µA
r_{ON}	ON-state resistance	I_{OUT} = –200 mA	V_{IN} = 3.6 V	25°C		66	90	mΩ
				Full			95	
			V_{IN} = 2.5 V	25°C		75	95	
				Full			110	
			V_{IN} = 1.8 V	25°C		90	115	
				Full			125	
			V_{IN} = 1.2 V	25°C		135	175	
				Full			185	
			V_{IN} = 1.1 V	25°C		157	275	
				Full			300	
r_{PD}	Output pulldown resistance	V_{IN} = 3.3 V, V_{ON} = 0 (TPS22904 only), I_{OUT} = 30 mA				85	135	Ω
I_{ON}	ON-state input leakage current	V_{ON} = 1.1 V to 3.6 V or GND		Full			1	µA

(1) Typical values are at V_{IN} = 3.3 V and T_A = 25°C.

SWITCHING CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	TPS22903			TPS22904			
			MIN	TYP[(1)]	MAX	MIN	TYP[(1)]	MAX	UNIT
t_{ON}	Turn-ON time	I_{OUT} = 100 mA, C_L = 0.1 µF		0.9	1.5		0.9	1.5	µs
t_{OFF}	Turn-OFF time	I_{OUT} = 100 mA, C_L = 0.1 µF		5.8	8		5.3	7	µs
t_r	V_{OUT} rise time	I_{OUT} = 100 mA, C_L = 0.1 µF		0.80	5		0.8	5	µs
t_f	V_{OUT} fall time	I_{OUT} = 100 mA, C_L = 0.1 µF		8.3	10		5.8	7	µs

(1) Typical values are at T_A = 25°C.

TYPICAL CHARACTERISTICS

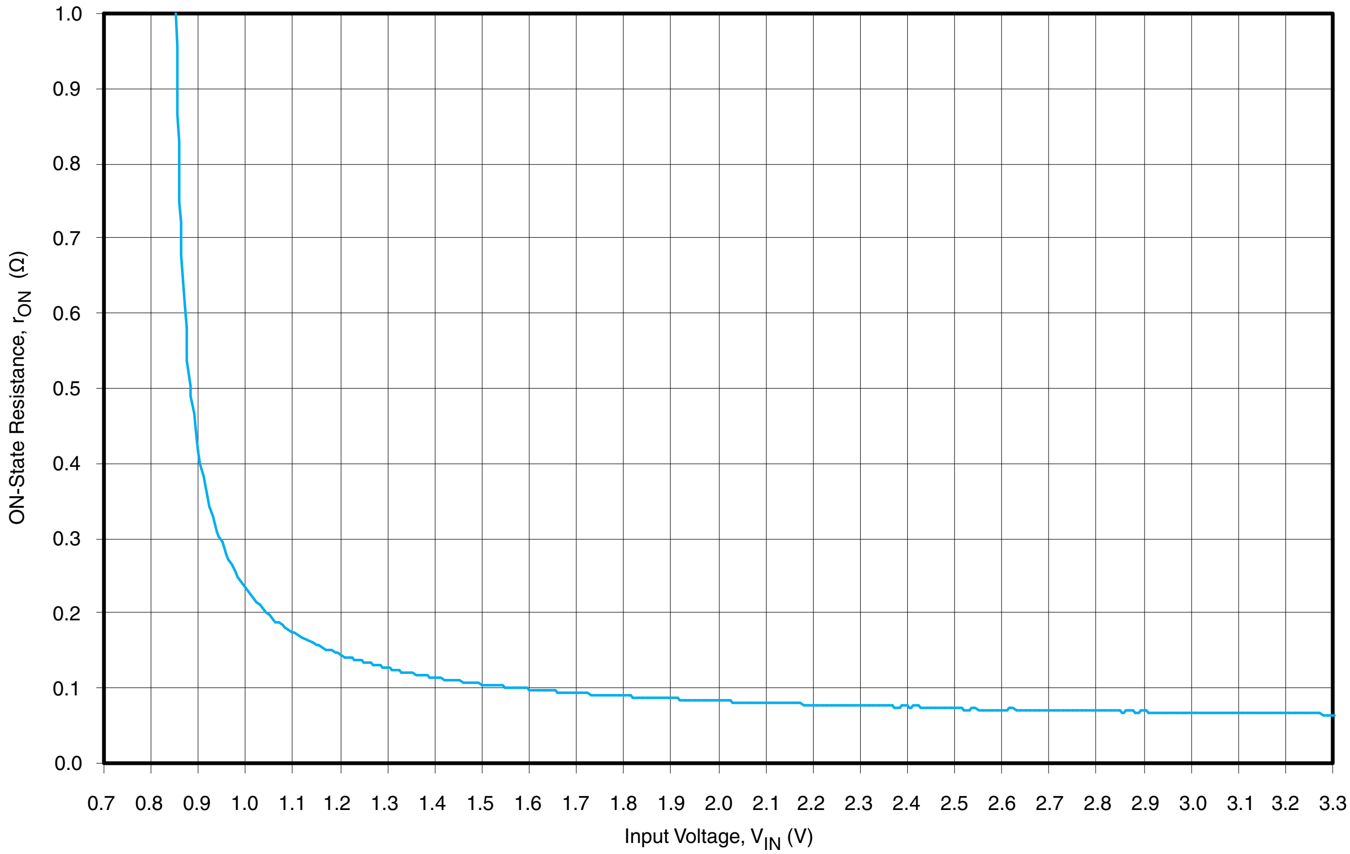


Figure 2. r_{ON} vs V_{IN}

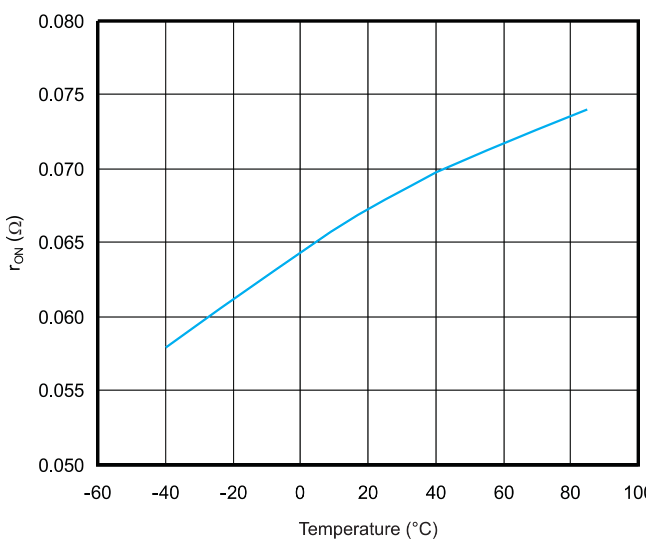


Figure 3. r_{ON} vs Temperature (V_{IN} = 3.3 V)

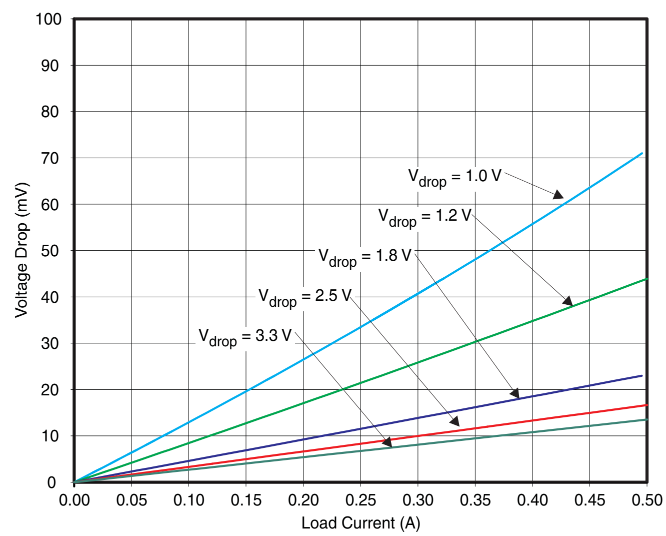


Figure 4. Voltage Drop vs Load Current

TYPICAL CHARACTERISTICS (continued)

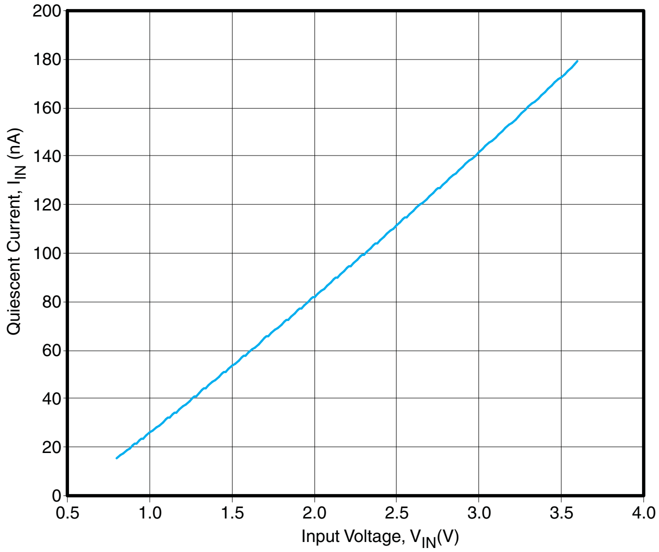


Figure 5. Quiescent Current vs V_{IN} (V_{ON} = V_{IN}, I_{OUT} = 0)

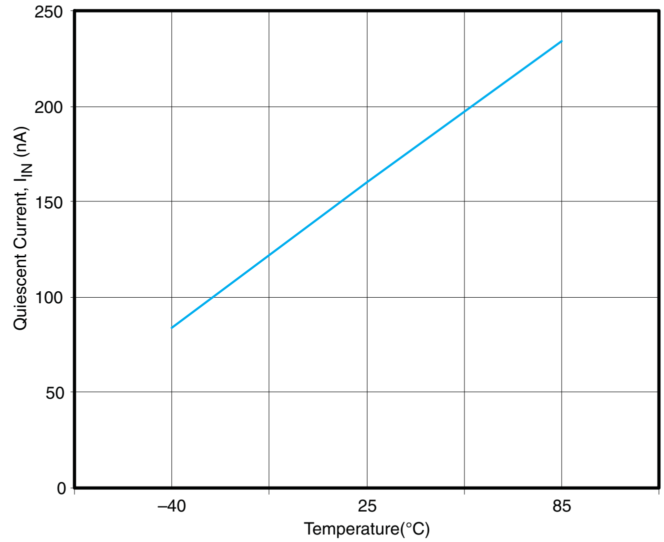


Figure 6. Quiescent Current vs Temperature (V_{IN} = 3.3 V, I_{OUT} = 0)

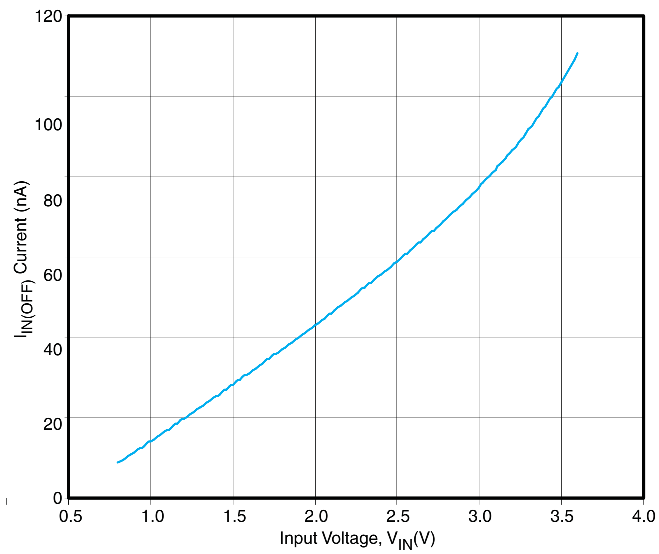


Figure 7. $I_{IN(OFF)}$ vs V_{IN} (V_{ON} = 0 V)

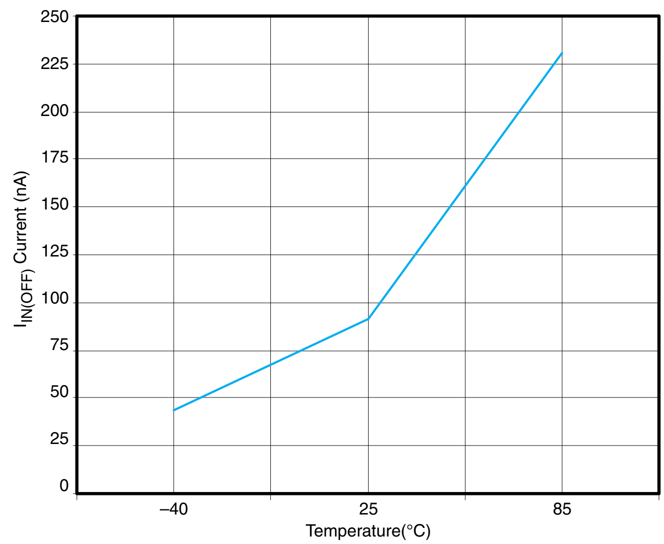


Figure 8. $I_{IN(OFF)}$ vs Temperature (V_{IN} = 3.3 V)

TYPICAL CHARACTERISTICS (continued)

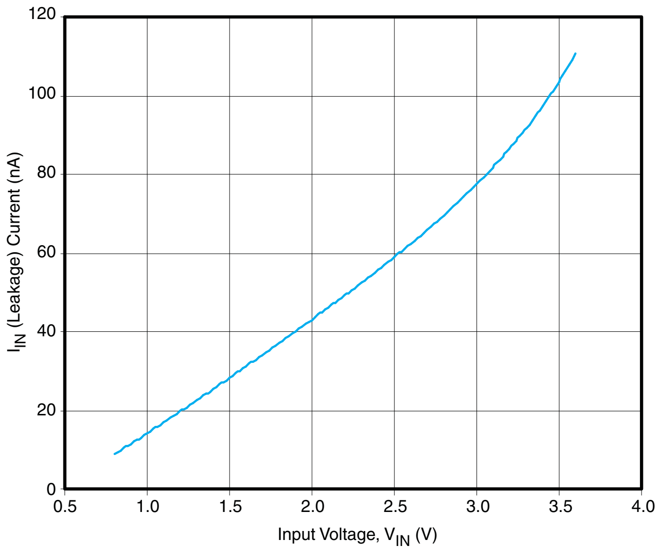


Figure 9. I_{IN}(Leakage) vs V_{IN} (I_{OUT} = 0)

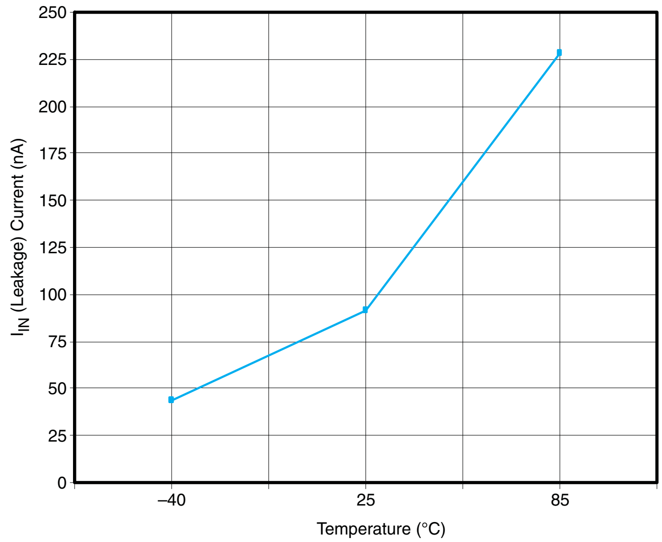


Figure 10. I_{IN} (Leakage) vs Temperature (V_{IN} = 3.3 V)

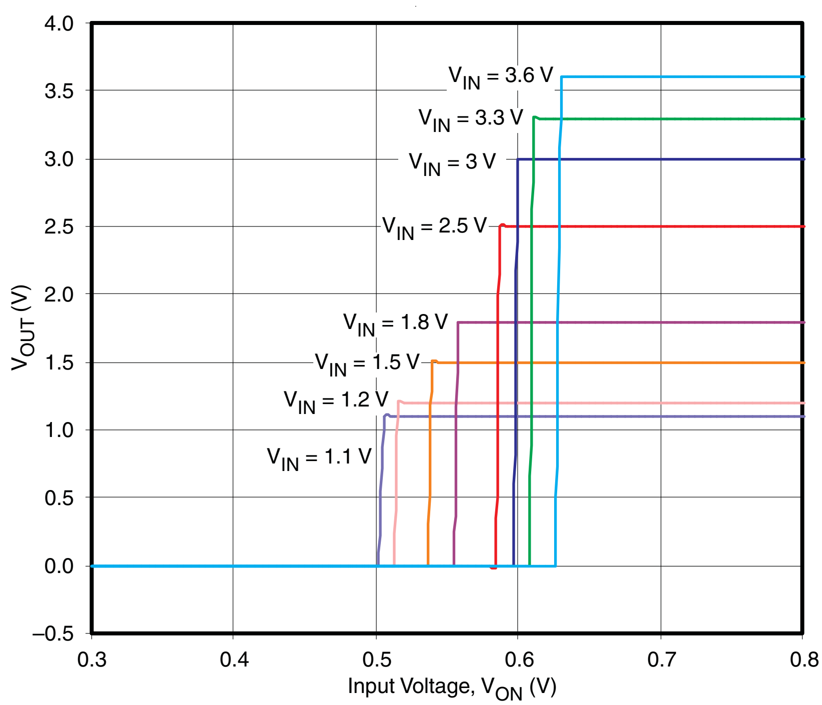


Figure 11. ON-Input Threshold

TYPICAL CHARACTERISTICS (continued)

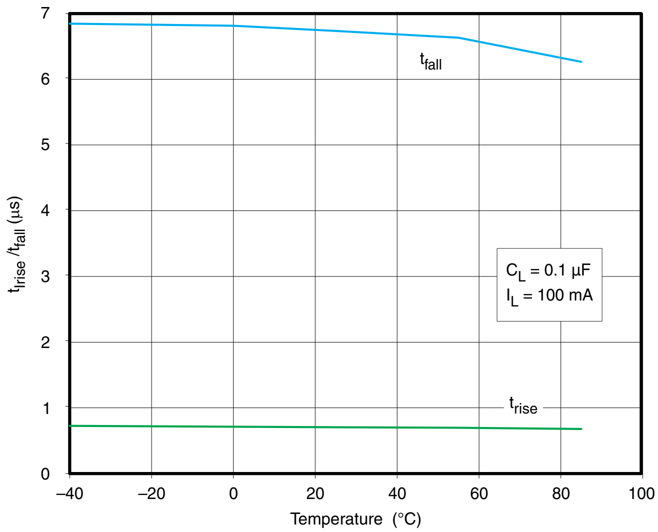


Figure 12. t_{rise} (TPS22903/4) / t_{fall} (TPS22903) vs Temperature (V_{IN} = 3.3 V)

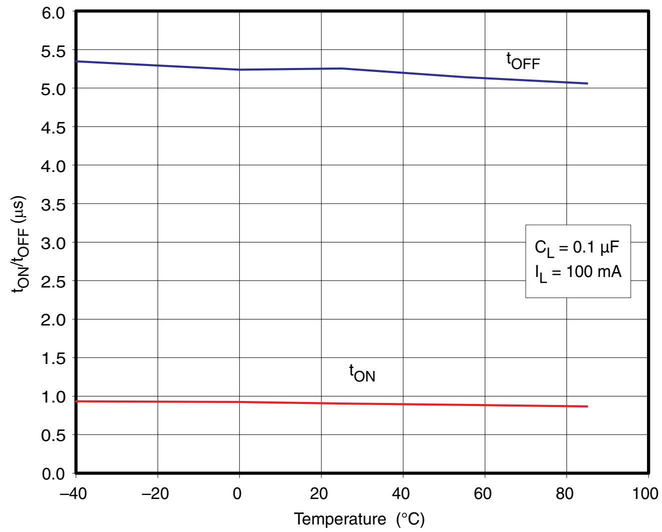


Figure 13. t_{ON} (TPS22903/4) / t_{OFF} (TPS22903) vs Temperature (V_{IN} = 3.3 V)

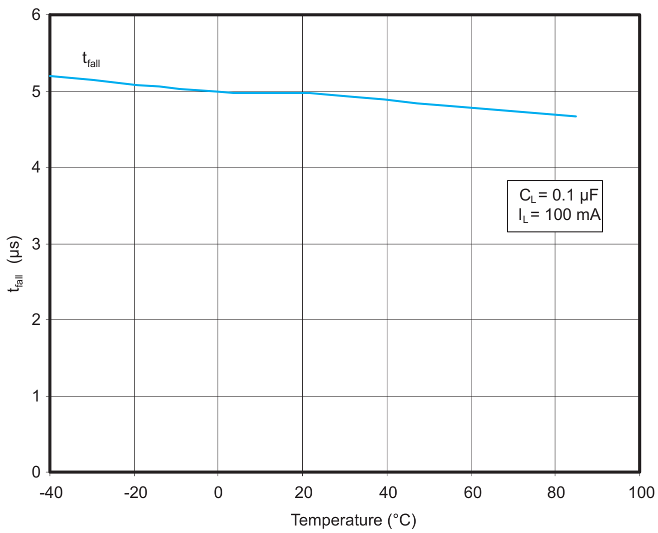


Figure 14. t_{fall} (TPS22904) vs Temperature (V_{IN} = 3.3 V)

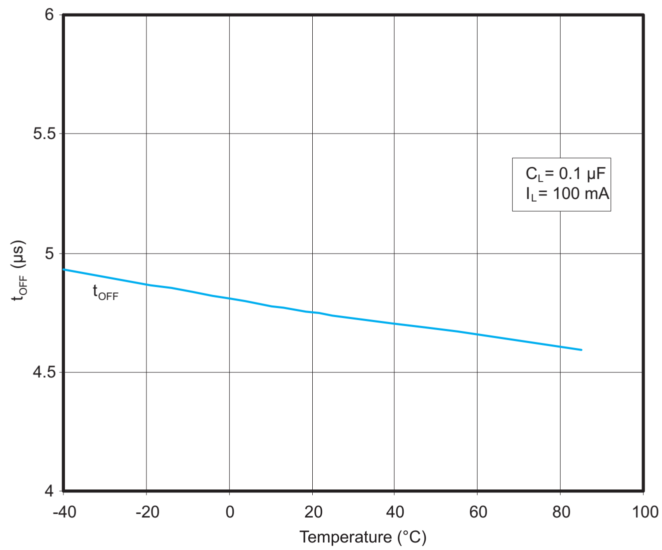


Figure 15. t_{OFF} (TPS22904) vs Temperature (V_{IN} = 3.3 V)

TYPICAL CHARACTERISTICS (continued)

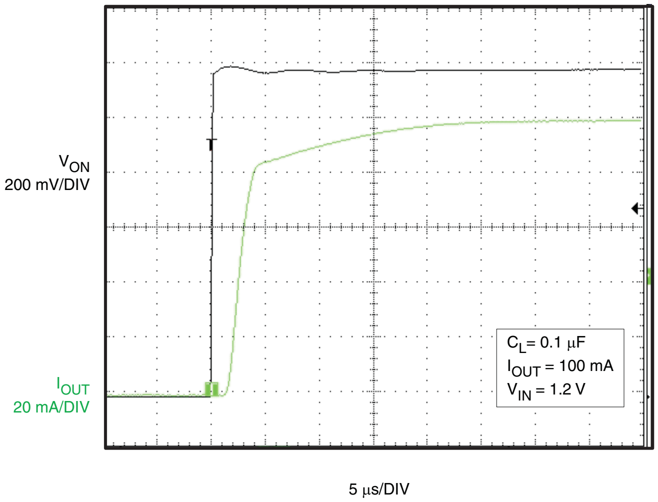


Figure 16. t_{ON} Response

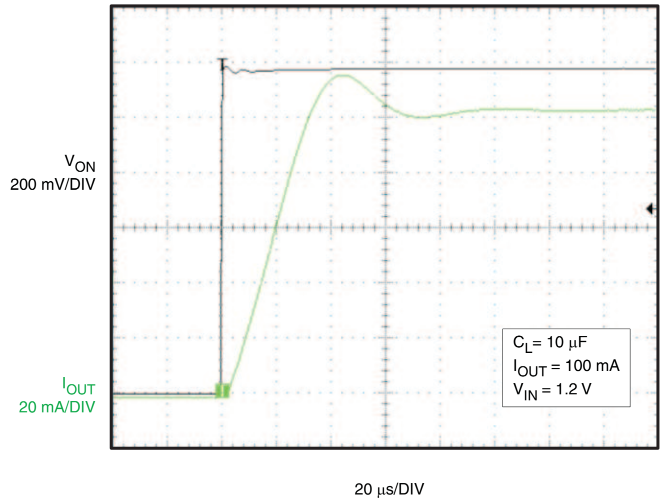


Figure 17. t_{ON} Response

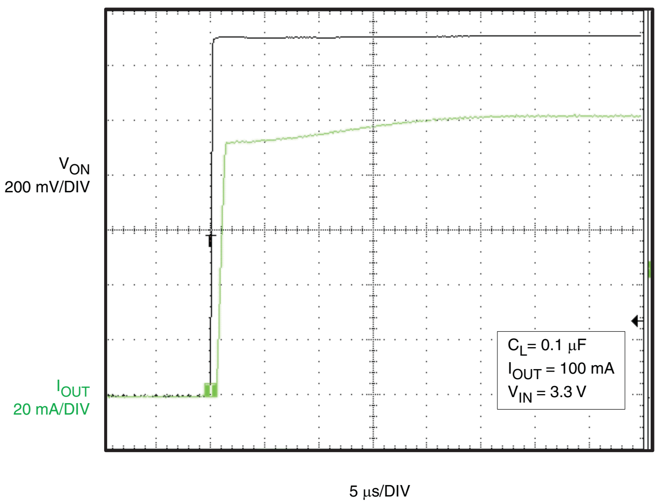


Figure 18. t_{ON} Response

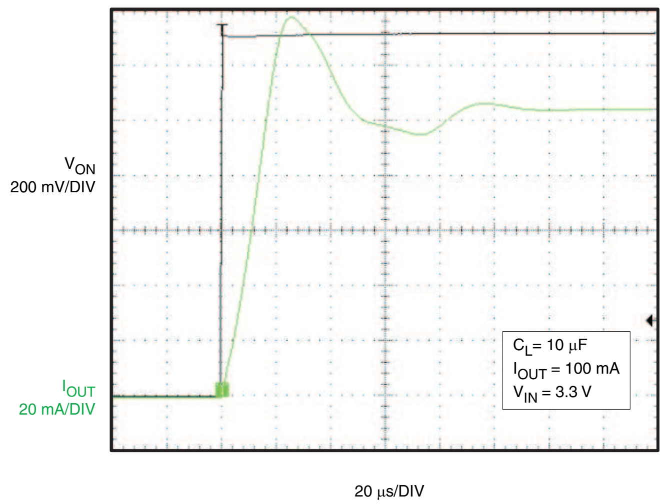


Figure 19. t_{ON} Response

TYPICAL CHARACTERISTICS (continued)

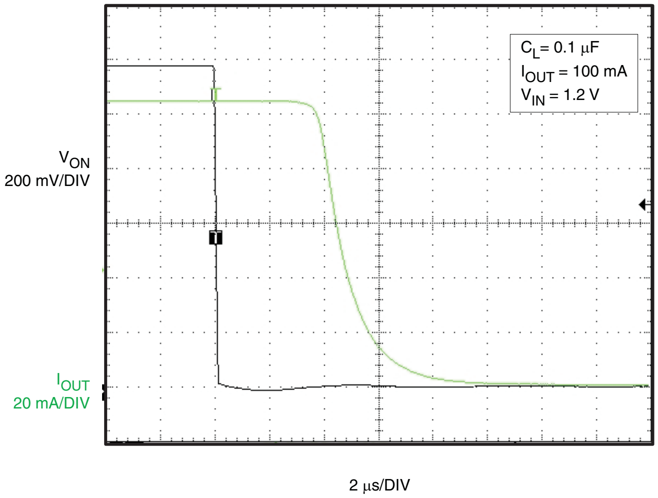


Figure 20. t_{OFF} Response (TPS22903)

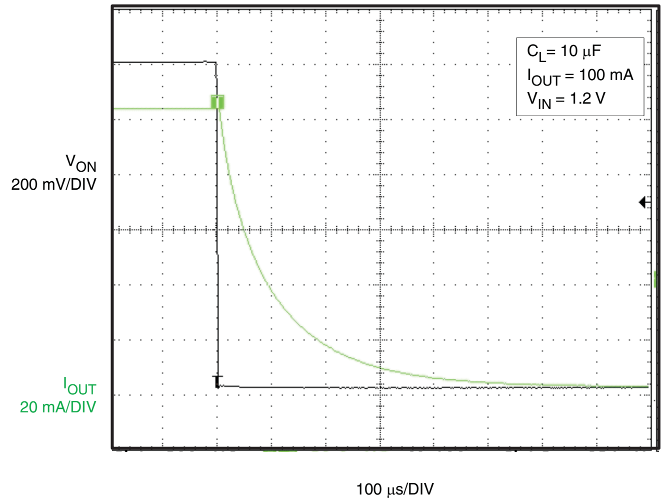


Figure 21. t_{OFF} Response (TPS22903)

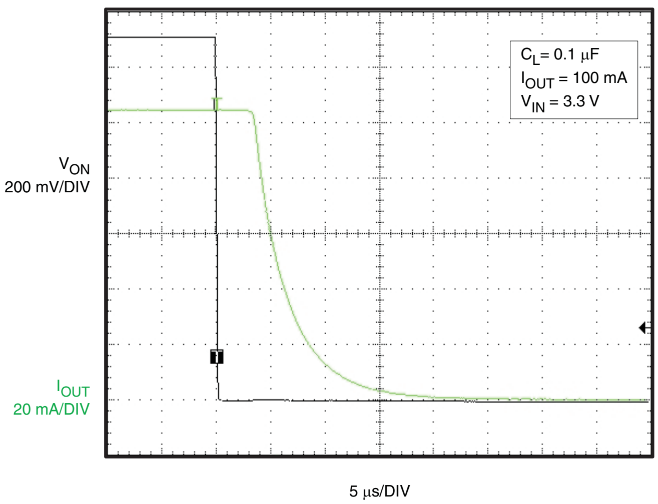


Figure 22. t_{OFF} Response (TPS22903)

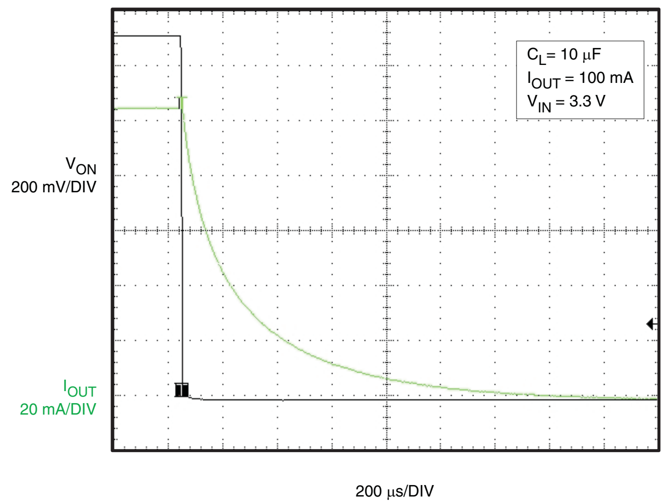


Figure 23. t_{OFF} Response (TPS22903)

TYPICAL CHARACTERISTICS (continued)

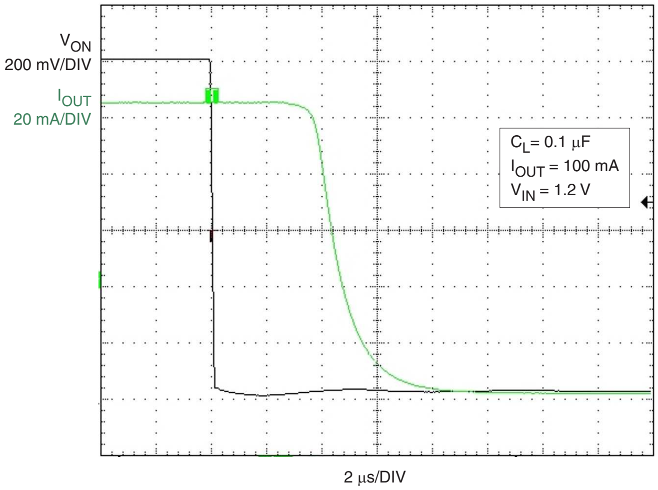


Figure 24. t_{OFF} Response (TPS22904)

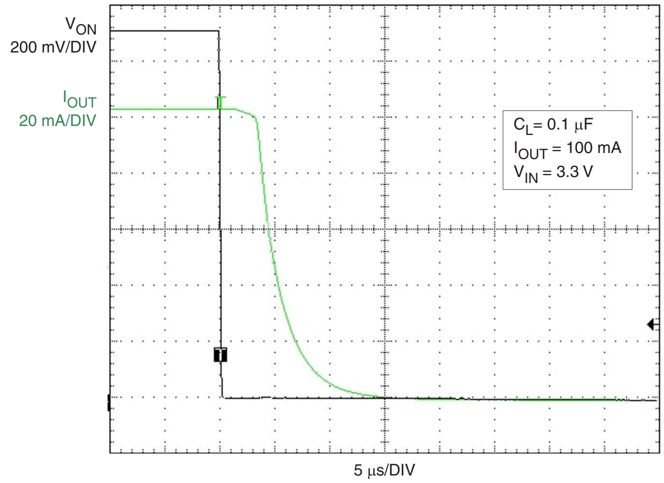


Figure 25. t_{OFF} Response (TPS22904)

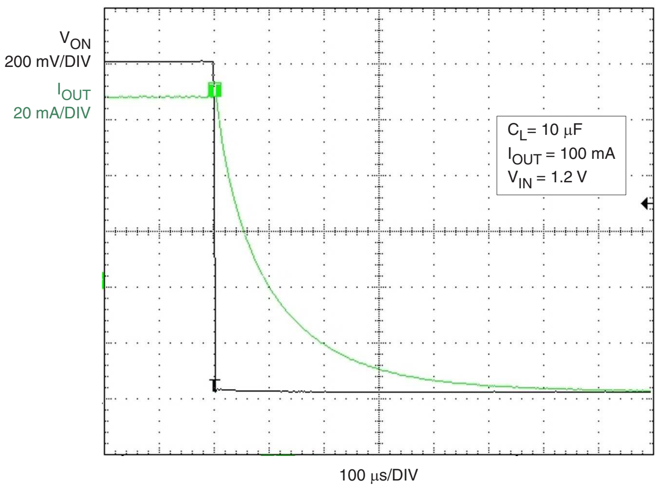


Figure 26. t_{OFF} Response (TPS22904)

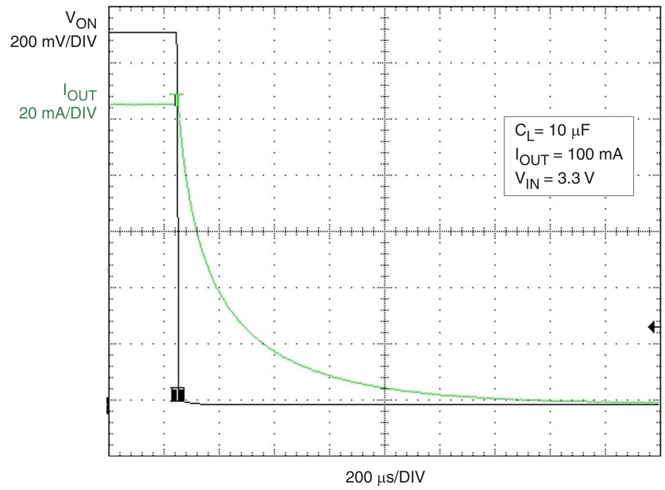
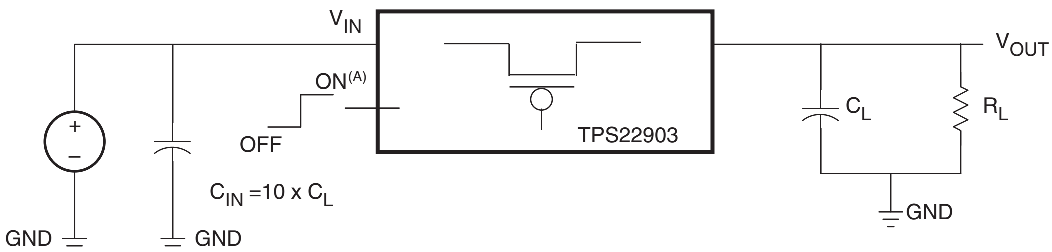
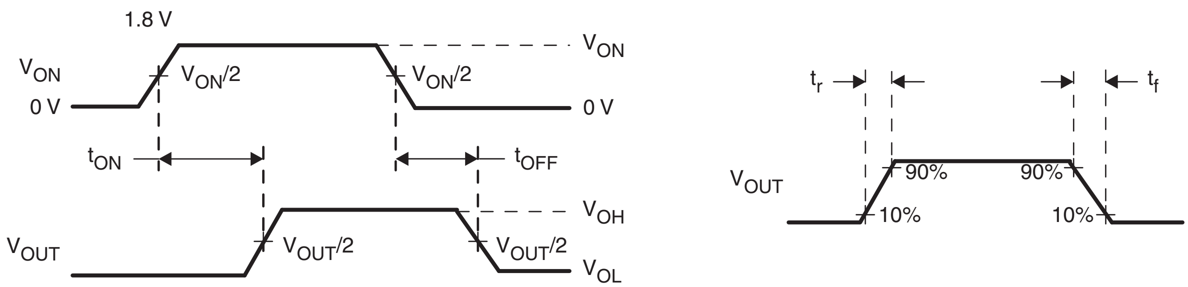


Figure 27. t_{OFF} Response (TPS22904)

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



t_{ON}/t_{OFF} WAVEFORMS

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

Figure 28. 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 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 thresholds. 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-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

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.

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
TPS22903YFPR	ACTIVE	DSBGA	YFP	4	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM
TPS22904YFPR	ACTIVE	DSBGA	YFP	4	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM
TPS22904YFPT	ACTIVE	DSBGA	YFP	4	250	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM

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

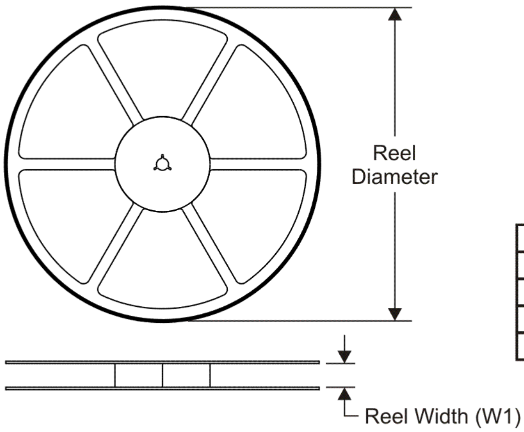
[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been 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)

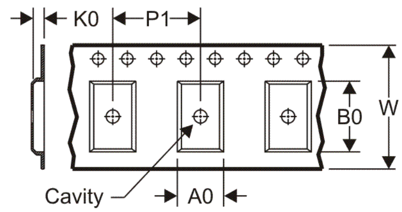
[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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

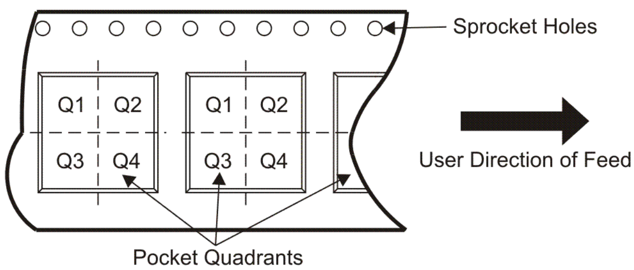
TAPE AND REEL INFORMATION





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

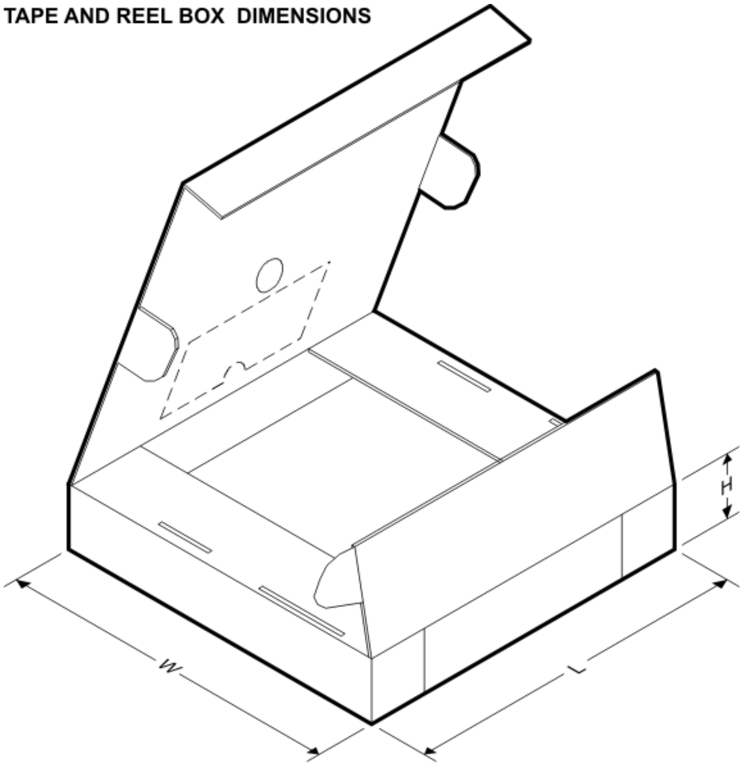
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS22903YFPR	DSBGA	YFP	4	3000	180.0	8.4	0.89	0.89	0.58	4.0	8.0	Q1
TPS22904YFPR	DSBGA	YFP	4	3000	180.0	8.4	0.89	0.89	0.58	4.0	8.0	Q1
TPS22904YFPT	DSBGA	YFP	4	250	180.0	8.4	0.89	0.89	0.58	4.0	8.0	Q1

TAPE AND REEL BOX DIMENSIONS

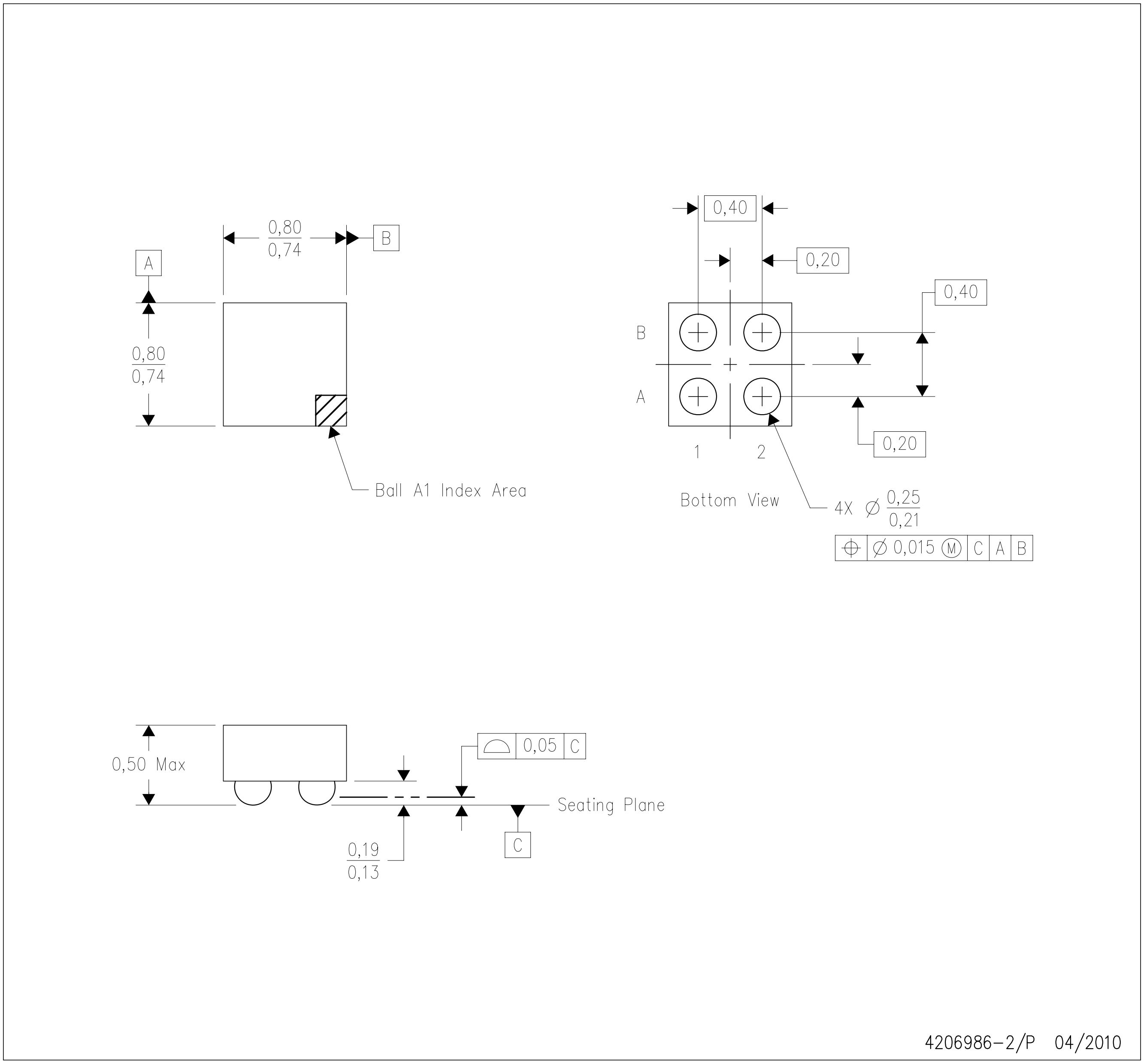


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS22903YFPR	DSBGA	YFP	4	3000	220.0	220.0	34.0
TPS22904YFPR	DSBGA	YFP	4	3000	220.0	220.0	34.0
TPS22904YFPT	DSBGA	YFP	4	250	220.0	220.0	34.0

查询"TPS22903"供应商

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.
- D. This is a Pb–free solder ball design.

NanoFree is a trademark of Texas Instruments.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DLP® Products	www.dlp.com	Communications and Telecom	www.ti.com/communications
DSP	dsp.ti.com	Computers and Peripherals	www.ti.com/computers
Clocks and Timers	www.ti.com/clocks	Consumer Electronics	www.ti.com/consumer-apps
Interface	interface.ti.com	Energy	www.ti.com/energy
Logic	logic.ti.com	Industrial	www.ti.com/industrial
Power Mgmt	power.ti.com	Medical	www.ti.com/medical
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Space, Avionics & Defense	www.ti.com/space-avionics-defense
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video and Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless-apps

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265