

TPS22990 5.5V、10A、3.9mΩ オン抵抗負荷スイッチ

1 特長

- シングル・チャネル負荷スイッチを内蔵
- VBIAS電圧範囲: 2.5V~5.5V
- VIN電圧範囲: 0.6V~V_{BIAS}
- オン抵抗
 - V_{IN} = 5VでR_{ON} = 3.9mΩ (標準値)
(V_{BIAS} = 5V)
 - V_{IN} = 3.3VでR_{ON} = 3.9mΩ (標準値)
(V_{BIAS} = 3.3V)
- 最大連続スイッチ電流 10A
- 静止電流
 - V_{BIAS} = 5VでI_Q, V_{BIAS} = 63μA
- シャットダウン電流
 - V_{BIAS} = 5VでI_{SD}, V_{BIAS} = 5.5μA
 - V_{BIAS} = 5V, V_{IN} = 5VでI_{SD}, V_{IN} = 4nA
- CTによりスルー・レート制御し調整可能
- パワーグッド(PG)インジケータ
- クイック出力放電(QOD) (TPS22990のみ)
- サーマル・パッド付き3mm×2mmのSON 10ピン・パッケージ
- ESD性能はJESD 22に準拠しテスト済み
 - HBM 2kV, CDM 1kV

2 アプリケーション

- ノートPC、Chromebook、タブレット
- デスクトップPCおよび産業用PC
- ソリッド・ステート・ドライブ(SSD)
- サーバー
- テレコム・システム

3 概要

TPS22990製品ファミリは、TPS22990とTPS22990Nの2つのデバイスで構成されます。各デバイスは3.9mΩのシングル・チャネル負荷スイッチで、電源オンの制御と調整が可能です。PGインジケータが内蔵されています。

このデバイスにはNチャネルMOSFETが含まれており、0.6V~5.5Vの入力電圧範囲で動作し、最大連続電流10Aに対応できます。入力電圧範囲が広く、大電流の能力を持つため、複数の設計や最終機器に広く使用可能です。3.9mΩのオン抵抗により、負荷スイッチでの電圧降下と、負荷スイッチからの電力損失が最小化されます。

デバイスの立ち上がり時間を制御することで、大きな負荷容量により発生する突入電流が大幅に低減され、電源ドレープが低減、または排除されます。CTによりスルー・レートを調整できるため、設計が柔軟になり、突入電流と電源オン・タイミングの要件について最適な組み合わせを実現できます。内蔵のPGインジケータは、負荷スイッチの状態をシステムに通知するため、シームレスな電源シーケンスが簡単に行えます。

TPS22990にはオプションとして218Ωのオンチップ抵抗が搭載され、スイッチがディセーブルになったときに出力を迅速に放電し、フローティング状態の電源によって下流の負荷に未知の状態が発生することを回避します。

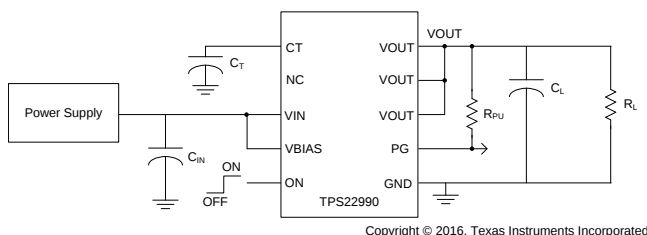
TPS22990は小型で省スペースの3mm×2mm 10-SONパッケージで利用でき、大きな消費電力に対応できるようサーマル・パッドが付属しています。このデバイスは、自由通気で-40℃~+105℃の温度範囲で動作するよう規定されています。

製品情報⁽¹⁾

型番	パッケージ	本体サイズ(公称)
TPS22990	WSO (10)	3.00mm×2.00mm
TPS22990N		

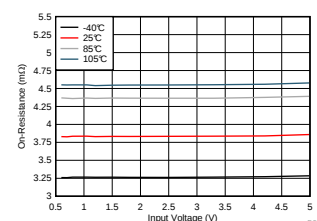
(1) 利用可能なすべてのパッケージについては、このデータシートの末尾にある注文情報を参照してください。

代表的なアプリケーション



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オン抵抗と入力電圧との関係



V_{BIAS} = 5V, I_{OUT} = -200mA



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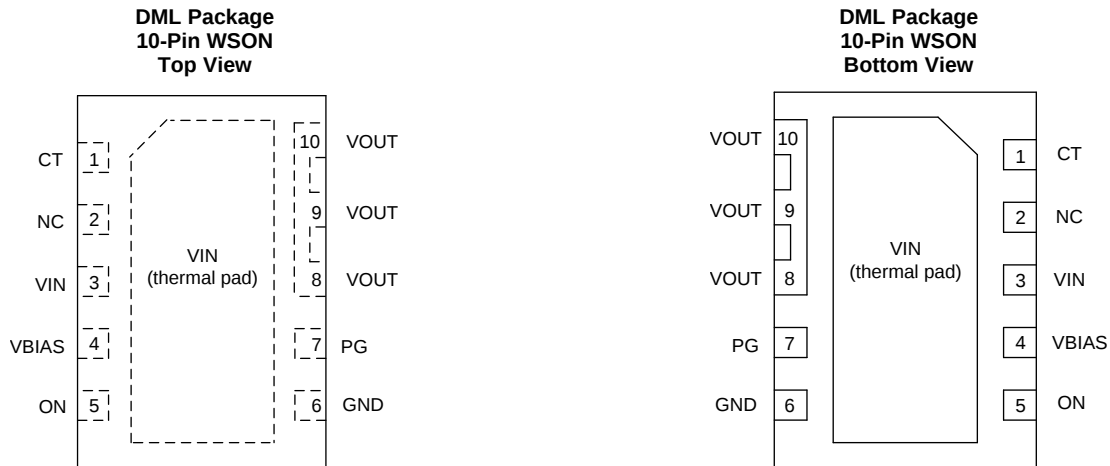
4 改訂履歴

Revision B (September 2016) から Revision C に変更		Page
•	Updated V_{IH} in Recommended Operating Conditions	4
Revision A (July 2016) から Revision B に変更		Page
•	Removed the status column from <i>Device Comparison Table</i>	3
•	Added the comment “(TPS22990 Only)” to the “ R_{PD} ” cell in both <i>Electrical Characteristics</i> tables	7
2016年5月発行のものから更新		Page
•	デバイスのステータスを製品プレビューから量産データへ変更	1

5 Device Comparison Table

DEVICE	R_{ON} at $V_{BIAS} = 5\text{ V}$	QOD	I_{MAX}	ENABLE
TPS22990	3.9 mΩ	Yes	10 A	Active high
TPS22990N	3.9 mΩ	No	10 A	Active high

6 Pin Configuration and Functions



Pin Functions

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	CT	O	VOUT slew rate control
2	NC	—	Not internally connected
3	VIN	I	Switch input. Bypass this input with a ceramic capacitor to GND
4	VBIAS	P	Bias voltage. Power supply to the device
5	ON	I	Active high switch control input. Do not leave floating
6	GND	GND	Device ground
7	PG	O	Power good. Active high, open drain output. Tie to GND if not used
8	VOUT	O	Switch output
9			
10			
—	VIN (Thermal Pad)	I	Switch input. VIN and thermal pad (exposed center pad) to alleviate thermal stress. See the Layout section for layout guidelines

7 Specifications

7.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V _{IN}	Input voltage	−0.3	6	V
V _{BIAS}	Bias voltage	−0.3	6	V
V _{OUT}	Output voltage	−0.3	6	V
V _{ON}	ON voltage	−0.3	6	V
V _{PG}	PG voltage	−0.3	6	V
V _{CT}	CT voltage	−0.3	15	V
I _{MAX}	Maximum continuous switch current at T _J = 125°C		10	A
I _{PLS}	Maximum pulsed switch current, pulse < 300 μs, 2% duty cycle		12	A
T _J	Maximum junction temperature		125	°C
T _{LEAD}	Maximum lead temperature (10-s soldering time)		300	°C
T _{stg}	Storage temperature	−65	150	°C

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

7.2 ESD Ratings

		VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2000
		Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±1000

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
 (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V _{IN}	Input voltage		0.6	V _{BIAS}	V
V _{BIAS}	Bias voltage		2.5	5.5	V
V _{OUT}	Output voltage			V _{IN}	V
V _{ON}	ON voltage		0	5.5	V
V _{PG}	PG voltage		0	5.5	V
V _{IH, ON}	High-level input voltage, ON	V _{BIAS} = 2.5 V to 5 V, T _A < 85°C	1.05	5.5	V
		V _{BIAS} = 2.5 V to 5.5 V, T _A < 105°C	1.2	5.5	
V _{IL, ON}	Low-level input voltage, ON		0	0.5	V
C _{IN}	Input capacitor		1 ⁽¹⁾		μF
T _A	Operating free-air temperature		−40	105	°C

- (1) See the [Application Information](#) section.

7.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TPS22990	UNIT
		DML (WSON)	
		10 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	51.4	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	65	°C/W
R _{θJB}	Junction-to-board thermal resistance	17	°C/W
ψ _{JT}	Junction-to-top characterization parameter	2.1	°C/W
ψ _{JB}	Junction-to-board characterization parameter	17	°C/W
R _{θJC(bot)}	Junction-to-case (bottom) thermal resistance	3.7	°C/W

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

7.5 Electrical Characteristics—V_{BIAS} = 5 V

Unless otherwise noted, the specification in the following table applies over the operating ambient temp $-40^{\circ}\text{C} \leq T_A \leq +105^{\circ}\text{C}$ (full) and V_{BIAS} = 5 V. Typical values are for T_A = 25°C (unless otherwise noted).

PARAMETER		TEST CONDITIONS	T _A	MIN	TYP	MAX	UNIT
POWER SUPPLIES AND CURRENTS							
I _Q , V _{BIAS}	V _{BIAS} quiescent current	I _{OUT} = 0 A, V _{IN} = V _{ON} = 5 V	–40°C to +85°C		63	76	μA
			–40°C to +105°C			77	
I _{SD} , V _{BIAS}	V _{BIAS} shutdown current	V _{ON} = 0 V, V _{OUT} = 0 V	–40°C to +85°C		5.5	7	μA
			–40°C to +105°C			7	
I _{SD} , V _{IN}	V _{IN} shutdown current	V _{ON} = 0 V, V _{OUT} = 0 V	V _{IN} = 5 V	–40°C to +85°C	0.004	4	μA
				–40°C to +105°C		10	
			V _{IN} = 3.3 V	–40°C to +85°C	0.003	3	
				–40°C to +105°C		7	
			V _{IN} = 2.5 V	–40°C to +85°C	0.002	2	
				–40°C to +105°C		5	
			V _{IN} = 1.8 V	–40°C to +85°C	0.002	2	
				–40°C to +105°C		4	
			V _{IN} = 1.05 V	–40°C to +85°C	0.001	1	
				–40°C to +105°C		3	
			V _{IN} = 0.6 V	–40°C to +85°C	0.001	1	
				–40°C to +105°C		2	
I _{ON}	ON pin input leakage current	V _{ON} = 5.5 V	–40°C to +105°C			0.1	μA
V _{HYS,ON}	ON pin hysteresis	V _{IN} = 5 V	25°C		123		mV
I _{PG, LKG}	Leakage current into PG pin	V _{PG} = 5 V	–40°C to +105°C			0.5	μA
V _{PG,OL}	PG output low voltage	V _{ON} = 0 V, I _{PG} = 1 mA	–40°C to +105°C			0.2	V
RESISTANCE CHARACTERISTICS							

Electrical Characteristics— $V_{BIAS} = 5\text{ V}$ (continued)

Unless otherwise noted, the specification in the following table applies over the operating ambient temp $-40^{\circ}\text{C} \leq T_A \leq +105^{\circ}\text{C}$ (full) and $V_{BIAS} = 5\text{ V}$. Typical values are for $T_A = 25^{\circ}\text{C}$ (unless otherwise noted).

PARAMETER		TEST CONDITIONS		T _A	MIN	TYP	MAX	UNIT
R _{ON}	On-state resistance	I _{OUT} = −200 mA, V _{ON} = 5 V	V _{IN} = 5 V	25°C		3.9	4.8	mΩ
				−40°C to +85°C			5.7	
				−40°C to +105°C			6	
			V _{IN} = 3.3 V	25°C		3.9	4.8	
				−40°C to +85°C			5.7	
				−40°C to +105°C			6	
			V _{IN} = 2.5 V	25°C		3.9	4.8	
				−40°C to +85°C			5.7	
				−40°C to +105°C			6	
			V _{IN} = 1.8 V	25°C		3.9	4.8	
				−40°C to +85°C			5.7	
				−40°C to +105°C			6	
		V _{IN} = 1.05 V	25°C		3.9	4.8		
			−40°C to +85°C			5.7		
			−40°C to +105°C			6		
		V _{IN} = 0.6 V	25°C		3.9	4.8		
			−40°C to +85°C			5.7		
			−40°C to +105°C			6		
R _{PD}	Output pull-down resistance (TPS22990 Only)	V _{IN} = V _{OUT} = 5 V, V _{ON} = 0 V		−40°C to +105°C		218	253	Ω

7.6 Electrical Characteristics— $V_{BIAS} = 3.3\text{ V}$

Unless otherwise noted, the specification in the following table applies over the operating ambient temp $-40^{\circ}\text{C} \leq T_A \leq +105^{\circ}\text{C}$ (full) and $V_{BIAS} = 3.3\text{ V}$. Typical values are for $T_A = 25^{\circ}\text{C}$ (unless otherwise noted).

PARAMETER		TEST CONDITIONS		T _A	MIN	TYP	MAX	UNIT
POWER SUPPLIES AND CURRENTS								
I _Q , V _{BIAS}	V _{BIAS} quiescent current	I _{OUT} = 0 A, V _{IN} = V _{ON} = 3.3 V		−40°C to +85°C		48	58	μA
				−40°C to +105°C			59	
I _{SD} , V _{BIAS}	V _{BIAS} shutdown current	V _{ON} = 0 V, V _{OUT} = 0 V		−40°C to +85°C		4.5	6	μA
				−40°C to +105°C			7	
I _{SD} , V _{IN}	V _{IN} shutdown current	V _{ON} = 0 V, V _{OUT} = 0 V	V _{IN} = 3.3 V	−40°C to +85°C		0.003	3	μA
				−40°C to +105°C			7	
			V _{IN} = 2.5 V	−40°C to +85°C		0.002	2	
				−40°C to +105°C			5	
			V _{IN} = 1.8 V	−40°C to +85°C		0.002	2	
				−40°C to +105°C			4	
			V _{IN} = 1.05 V	−40°C to +85°C		0.001	1	
				−40°C to +105°C			3	
			V _{IN} = 0.6 V	−40°C to +85°C		0.001	1	
				−40°C to +105°C			2	
I _{ON}	ON pin input leakage current	V _{ON} = 5.5 V		−40°C to +105°C			0.1	μA
V _{HYS,ON}	ON pin hysteresis	V _{IN} = 3.3 V		25°C		100		mV
I _{PG} , LKG	Leakage current into PG pin	V _{PG} = 5 V		−40°C to +105°C			0.5	μA
V _{PG,OL}	PG output low voltage	V _{ON} = 0 V, I _{PG} = 1 mA		−40°C to +105°C			0.2	V
RESISTANCE CHARACTERISTICS								

Electrical Characteristics— $V_{BIAS} = 3.3\text{ V}$ (continued)

Unless otherwise noted, the specification in the following table applies over the operating ambient temp $-40^{\circ}\text{C} \leq T_A \leq +105^{\circ}\text{C}$ (full) and $V_{BIAS} = 3.3\text{ V}$. Typical values are for $T_A = 25^{\circ}\text{C}$ (unless otherwise noted).

PARAMETER	TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
R_{ON} On-state resistance	$I_{OUT} = -200\text{ mA}$, $V_{ON} = 5\text{ V}$	$V_{IN} = 3.3\text{ V}$	25°C	3.9	4.8	mΩ
			-40°C to +85°C	5.7		
			-40°C to +105°C	6		
		$V_{IN} = 2.5\text{ V}$	25°C	3.9	4.8	
			-40°C to +85°C	5.7		
			-40°C to +105°C	6		
		$V_{IN} = 1.8\text{ V}$	25°C	3.9	4.8	
			-40°C to +85°C	5.7		
			-40°C to +105°C	6		
		$V_{IN} = 1.05\text{ V}$	25°C	3.9	4.8	
			-40°C to +85°C	5.7		
			-40°C to +105°C	6		
		$V_{IN} = 0.6\text{ V}$	25°C	3.9	4.8	
			-40°C to +85°C	5.7		
			-40°C to +105°C	6		
R_{PD} Output pull-down resistance (TPS22990 Only)	$V_{IN} = V_{OUT} = 3.3\text{ V}$, $V_{ON} = 0\text{ V}$	-40°C to +105°C		219	256	Ω

7.7 Switching Characteristics

over operating free-air temperature range (unless otherwise noted)

PARAMETER ⁽¹⁾		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IN} = 5 V, V_{ON} = V_{BIAS} = 5 V, T_A = 25°C (unless otherwise noted)						
t _{ON}	Turnon time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		34		μs
t _{OFF}	Turnoff time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		5.4		
t _R	VO _{UT} rise time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		31		
t _F	VO _{UT} fall time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		2.3		
t _D	ON delay time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		21		
t _{PG,ON}	PG turnon time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		152		
t _{PG,OFF}	PG turnoff time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		1.3		
V_{IN} = 1.05 V, V_{ON} = V_{BIAS} = 5 V, T_A = 25°C (unless otherwise noted)						
t _{ON}	Turnon time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		30		μs
t _{OFF}	Turnoff time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		8		
t _R	VO _{UT} rise time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		13		
t _F	VO _{UT} fall time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		2.2		
t _D	ON delay time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		24		
t _{PG,ON}	PG turnon time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		134		
t _{PG,OFF}	PG turnoff time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		1.3		
V_{IN} = 0.6 V, V_{ON} = V_{BIAS} = 5 V, T_A = 25°C (unless otherwise noted)						
t _{ON}	Turnon time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		29		μs
t _{OFF}	Turnoff time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		8.8		
t _R	VO _{UT} rise time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		10		
t _F	VO _{UT} fall time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		2.2		
t _D	ON delay time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		24		
t _{PG,ON}	PG turnon time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		131		
t _{PG,OFF}	PG turnoff time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		1.3		

(1) Turnoff time and fall time are dependent on the time constant at the load. For TPS22990N, there is no QOD. The time constant is $R_L \times C_L$. For TPS22990, internal pull down R_{PD} is enabled when the switch is disabled. The time constant is $(R_{PD}/R_L) \times C_L$.

Switching Characteristics (continued)

over operating free-air temperature range (unless otherwise noted)

PARAMETER ⁽¹⁾		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V _{IN} = 3.3 V, V _{ON} = 5 V, V _{BIAS} = 3.3 V, T _A = 25°C (unless otherwise noted)						
t _{ON}	Turnon time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		33		μs
t _{OFF}	Turnoff time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		6.2		
t _R	V _{OUT} rise time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		24		
t _F	V _{OUT} fall time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		2.4		
t _D	ON delay time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		22		
t _{PG,ON}	PG turnon time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		132		
t _{PG,OFF}	PG turnoff time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		1.5		
V _{IN} = 1.05 V, V _{ON} = 5 V, V _{BIAS} = 3.3 V, T _A = 25°C (unless otherwise noted)						
t _{ON}	Turnon time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		30		μs
t _{OFF}	Turnoff time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		8.7		
t _R	V _{OUT} rise time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		12		
t _F	V _{OUT} fall time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		2.3		
t _D	ON delay time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		24		
t _{PG,ON}	PG turnon time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		122		
t _{PG,OFF}	PG turnoff time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		1.5		
V _{IN} = 0.6 V, V _{ON} = 5 V, V _{BIAS} = 3.3 V, T _A = 25°C (unless otherwise noted)						
t _{ON}	Turnon time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		30		μs
t _{OFF}	Turnoff time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		9.4		
t _R	V _{OUT} rise time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		9		
t _F	V _{OUT} fall time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		2.3		
t _D	ON delay time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		25		
t _{PG,ON}	PG turnon time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		119		
t _{PG,OFF}	PG turnoff time	R _L = 10 Ω, C _L = 0.1 μF, C _T = 0 pF, R _{PU} = 10 kΩ, C _{IN} = 1 μF		1.5		

7.8 Typical Characteristics

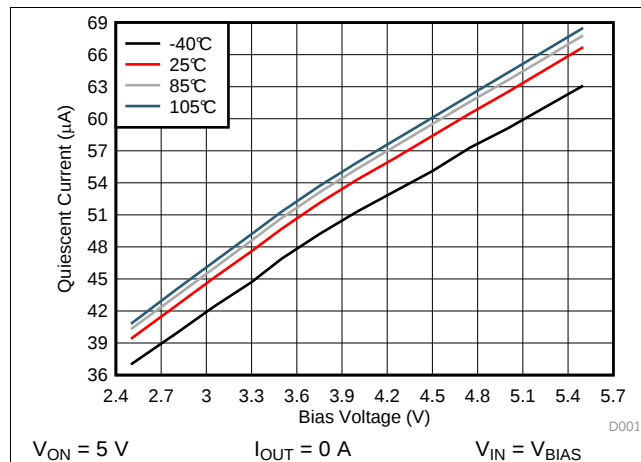


Figure 1. Quiescent Current vs Bias Voltage

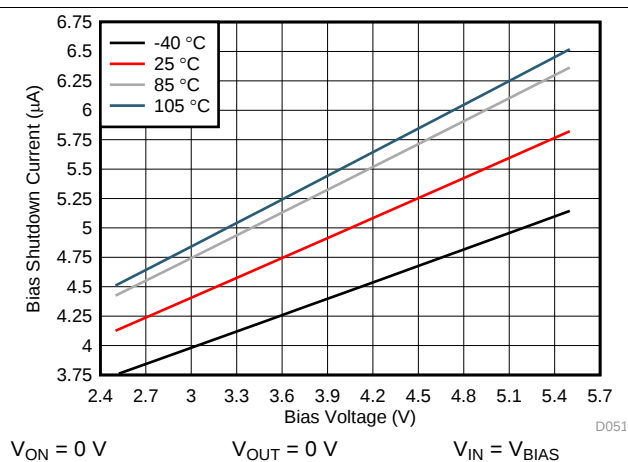


Figure 2. Bias Shutdown Current vs Bias Voltage

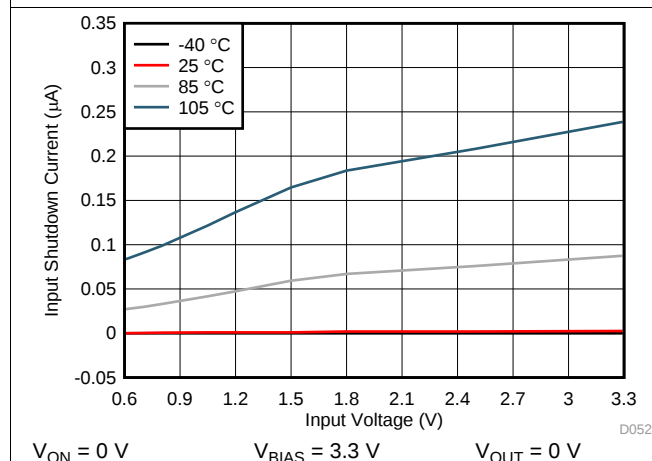


Figure 3. Input Shutdown Current vs Input Voltage

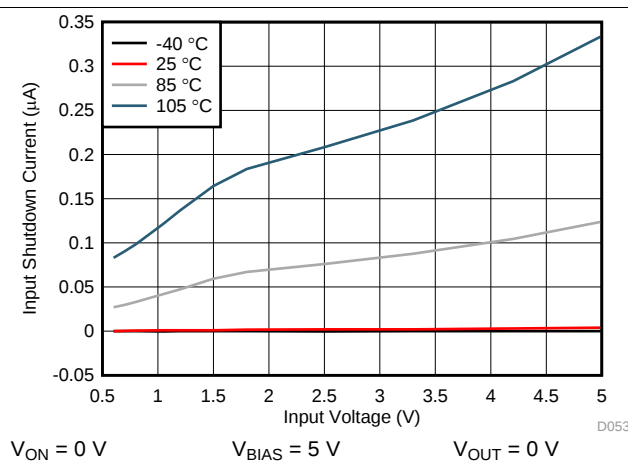


Figure 4. Input Shutdown Current vs Input Voltage

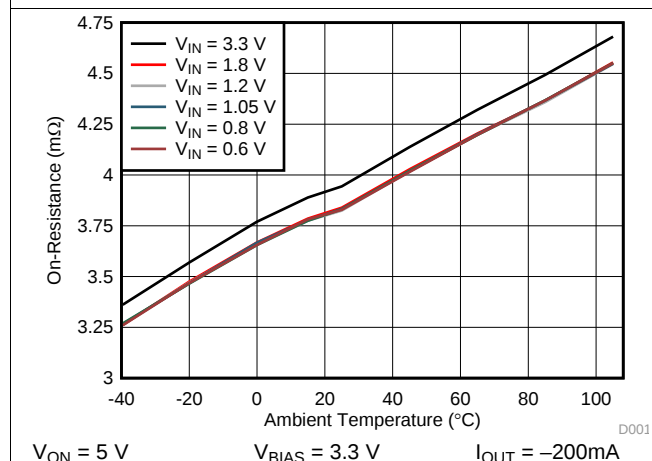


Figure 5. On-Resistance vs Ambient Temperature

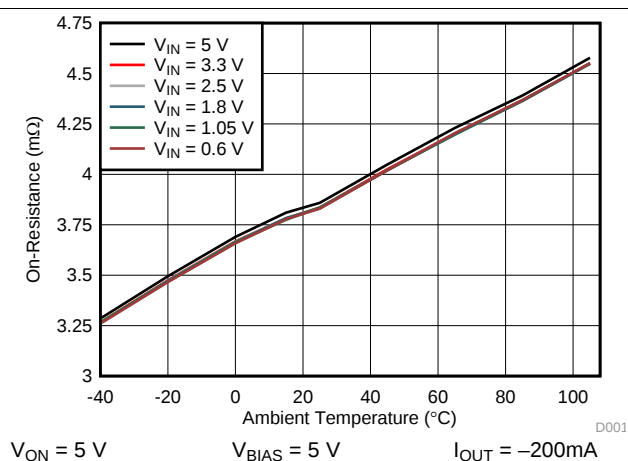


Figure 6. On-Resistance vs Ambient Temperature

Typical Characteristics (continued)

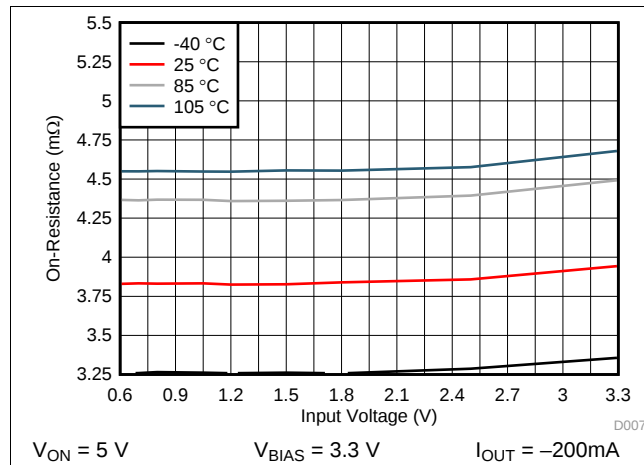


Figure 7. On-Resistance vs Input Voltage

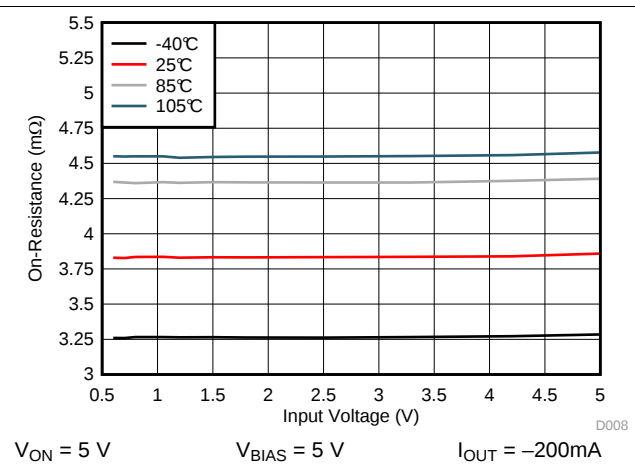


Figure 8. On-Resistance vs Input Voltage

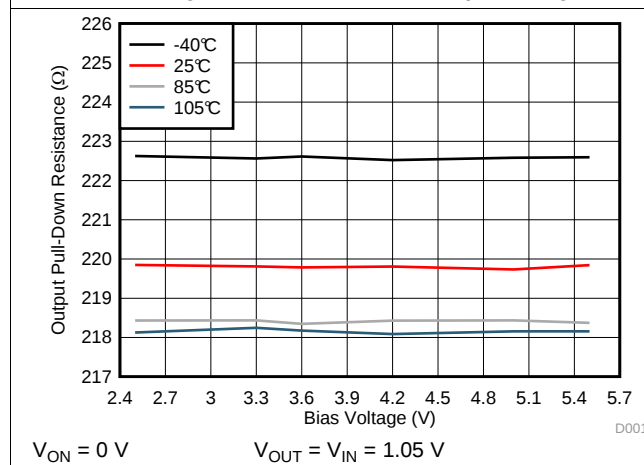


Figure 9. Output Pull-Down Resistance vs Bias Voltage

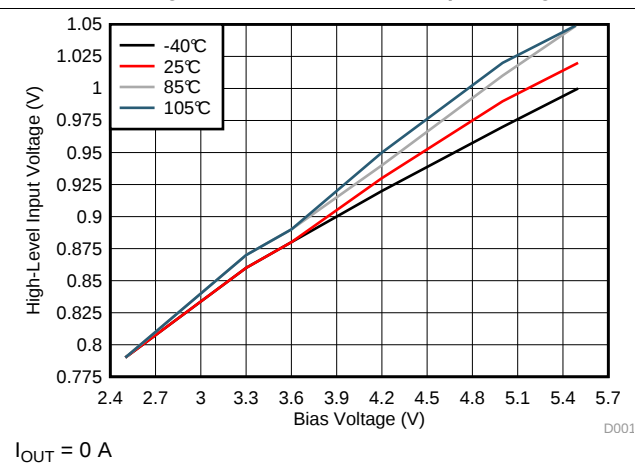


Figure 10. High-Level Input Voltage vs Bias Voltage

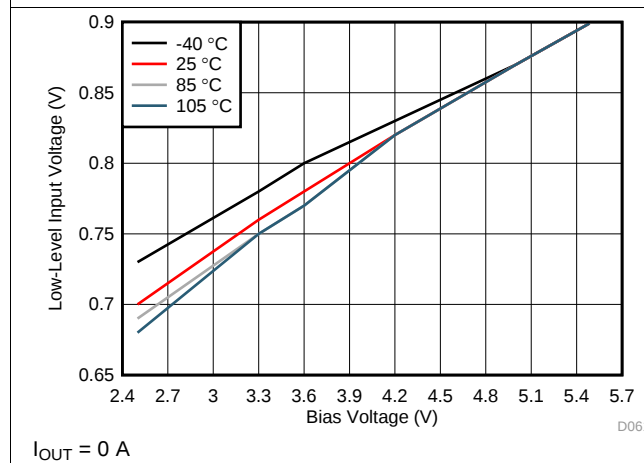


Figure 11. Low-Level Input Voltage vs Bias Voltage

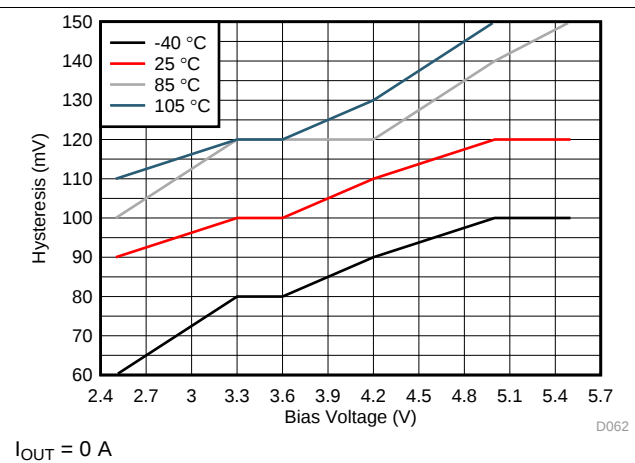


Figure 12. Hysteresis vs Bias Voltage

Typical Characteristics (continued)

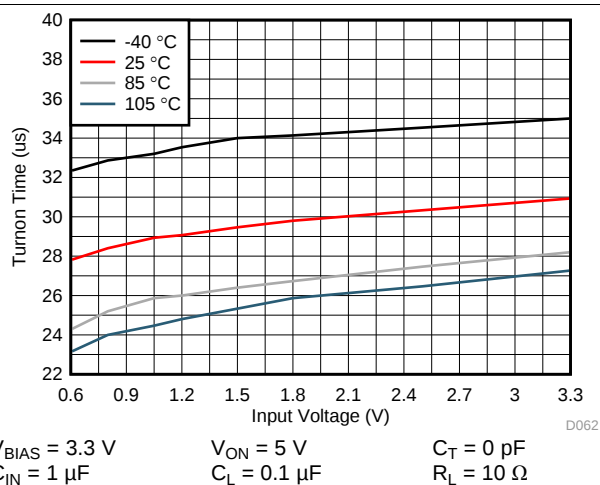


Figure 13. Turnon Time vs Input Voltage

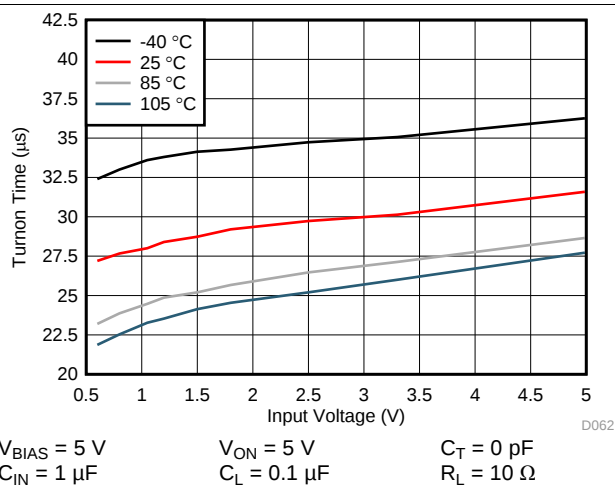


Figure 14. Turnon Time vs Input Voltage

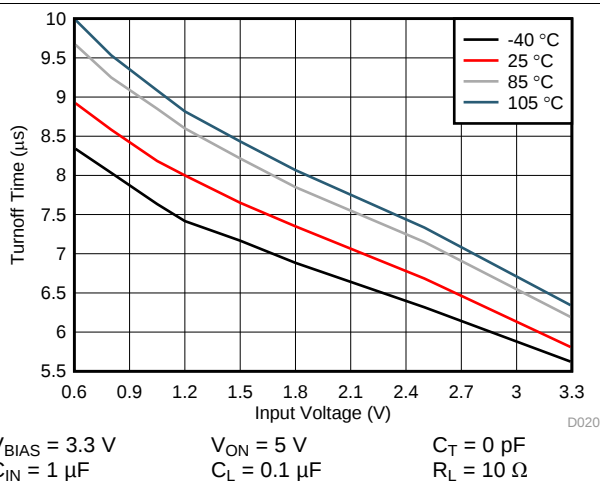


Figure 15. Turnoff Time vs Input Voltage

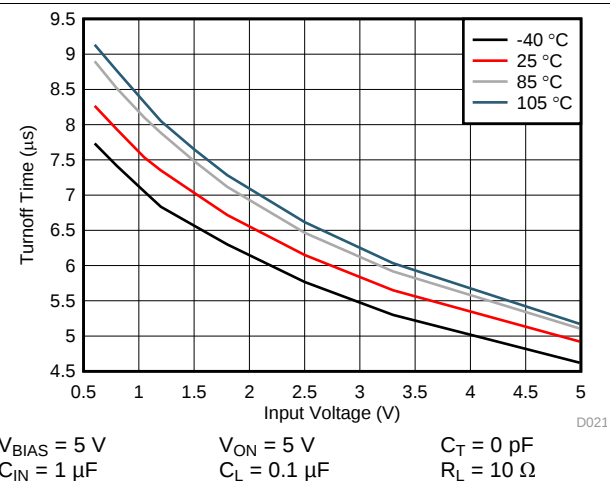


Figure 16. Turnoff Time vs Input Voltage

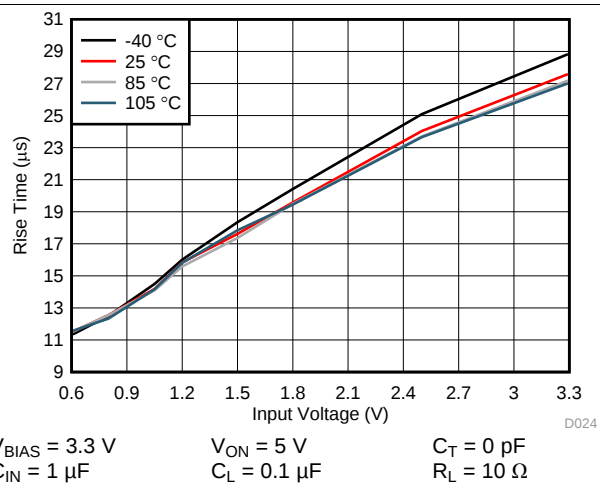


Figure 17. Rise Time vs Input Voltage

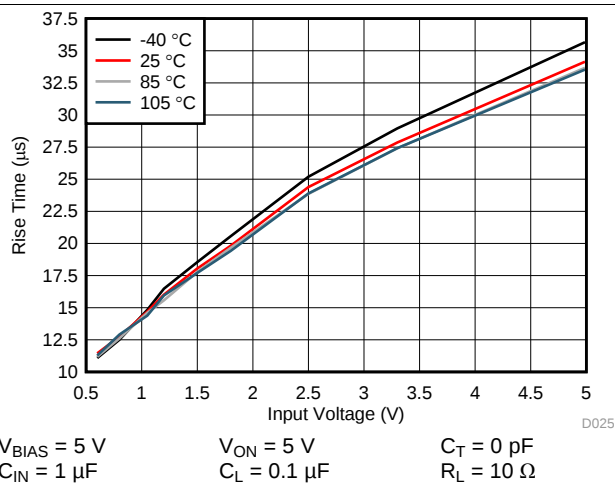


Figure 18. Rise Time vs Input Voltage

Typical Characteristics (continued)

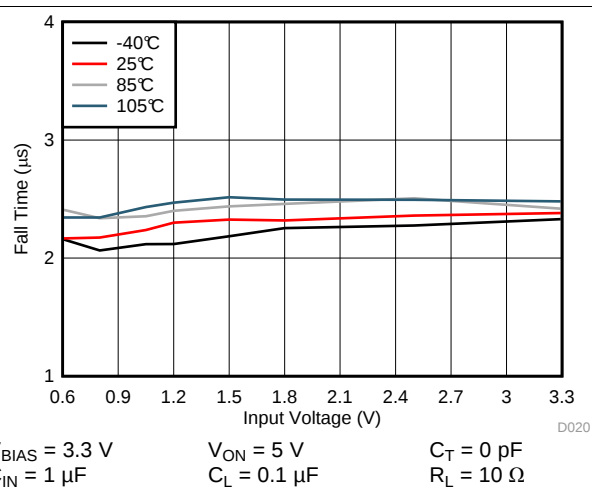


Figure 19. Fall Time vs Input Voltage

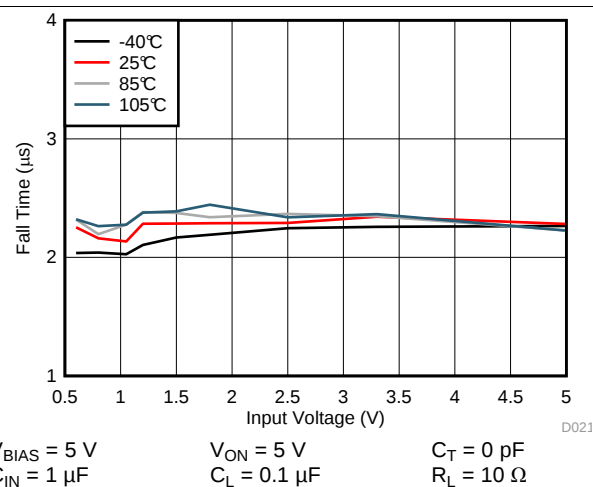


Figure 20. Fall Time vs Input Voltage

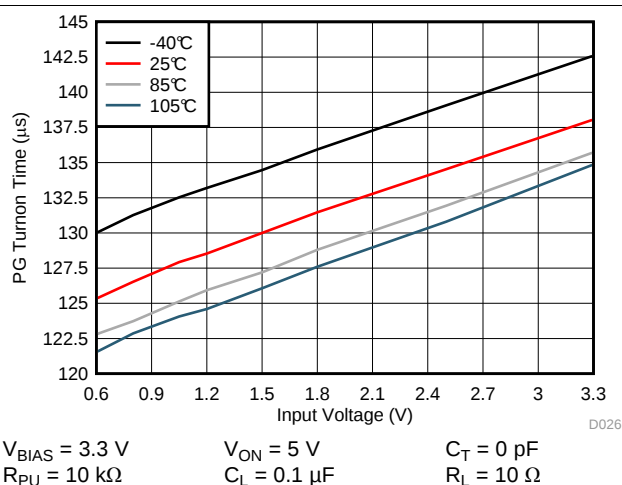


Figure 21. PG Turnon Time vs Input Voltage

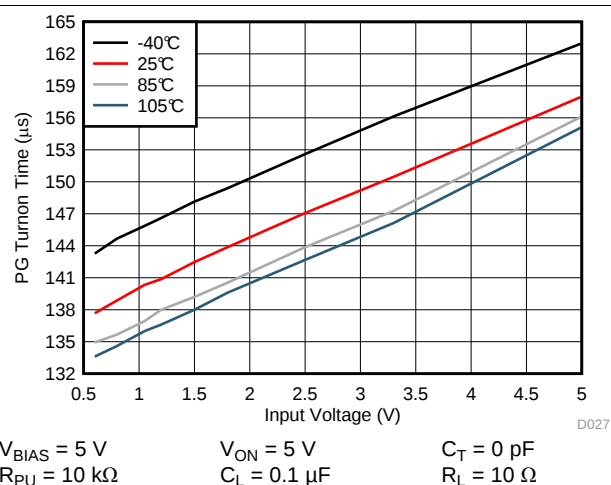


Figure 22. PG Turnon Time vs Input Voltage

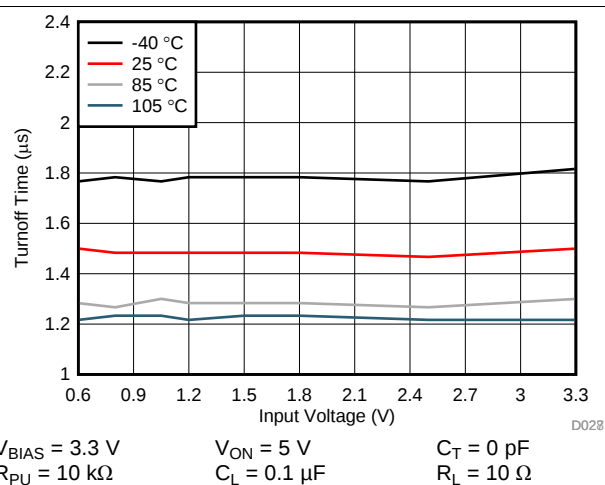


Figure 23. PG Turnoff Time vs Input Voltage

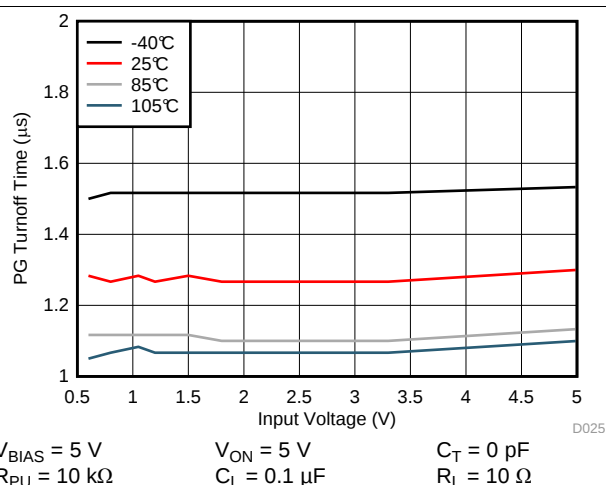


Figure 24. PG Turnoff Time vs Input Voltage

Typical Characteristics (continued)

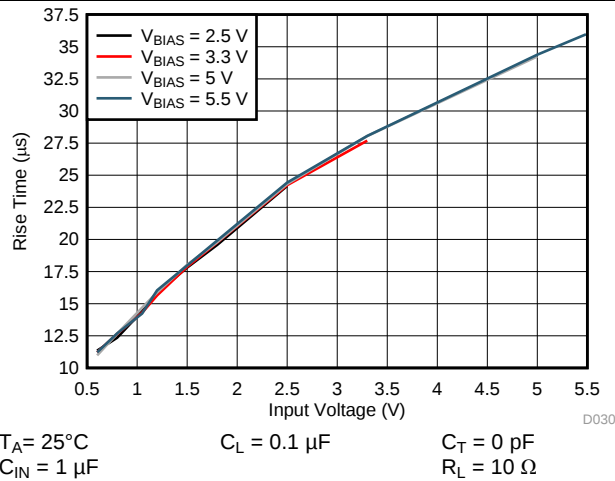


Figure 25. Rise Time vs Input Voltage

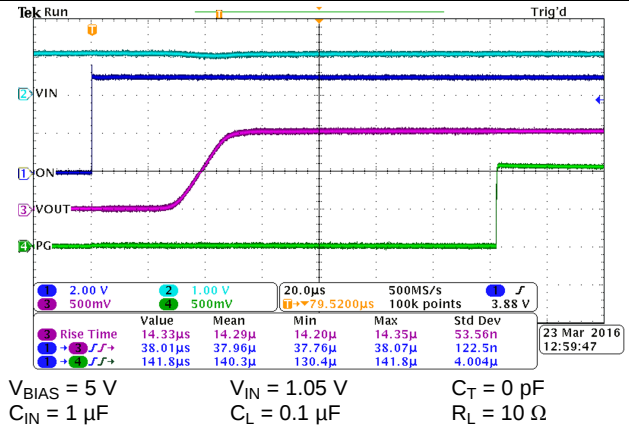


Figure 26. Turnon Response

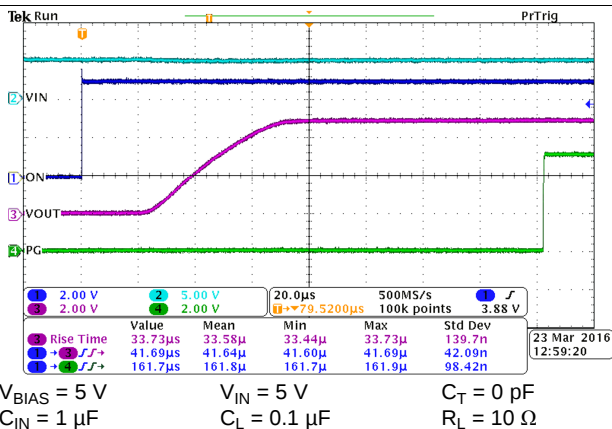


Figure 27. Turnon Response

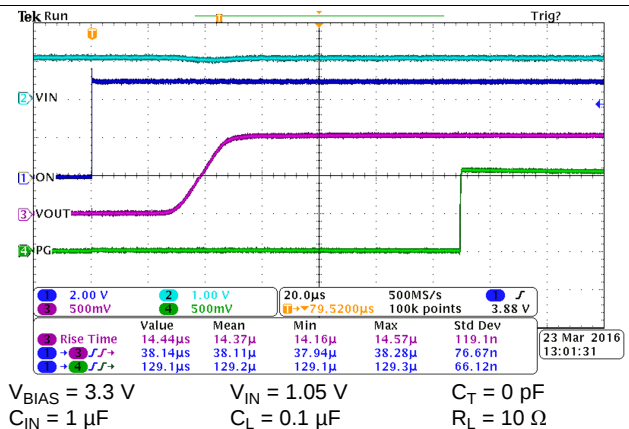


Figure 28. Turnon Response

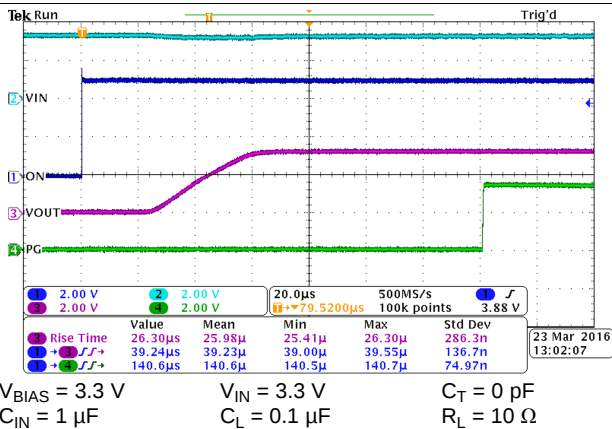


Figure 29. Turnon Response

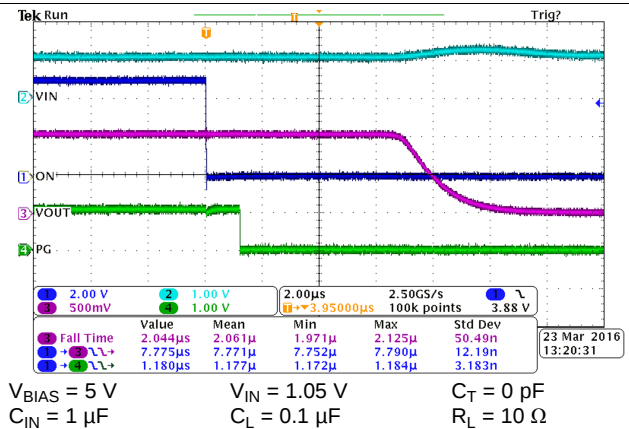


Figure 30. Turnon Response

Typical Characteristics (continued)

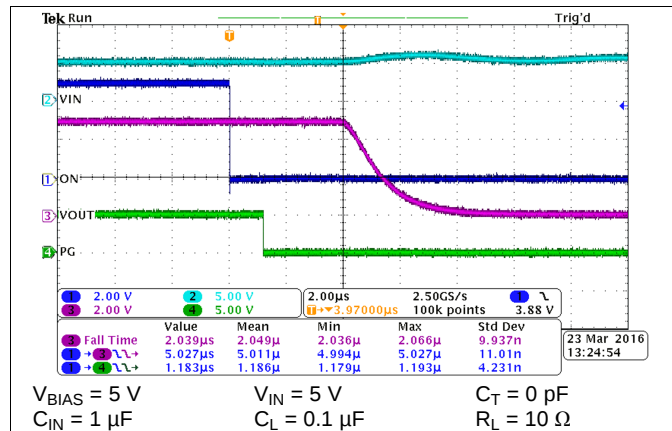


Figure 31. Turnoff Response

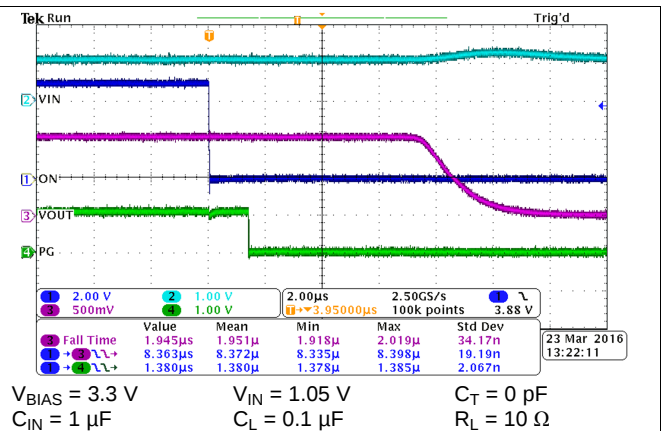


Figure 32. Turnoff Response

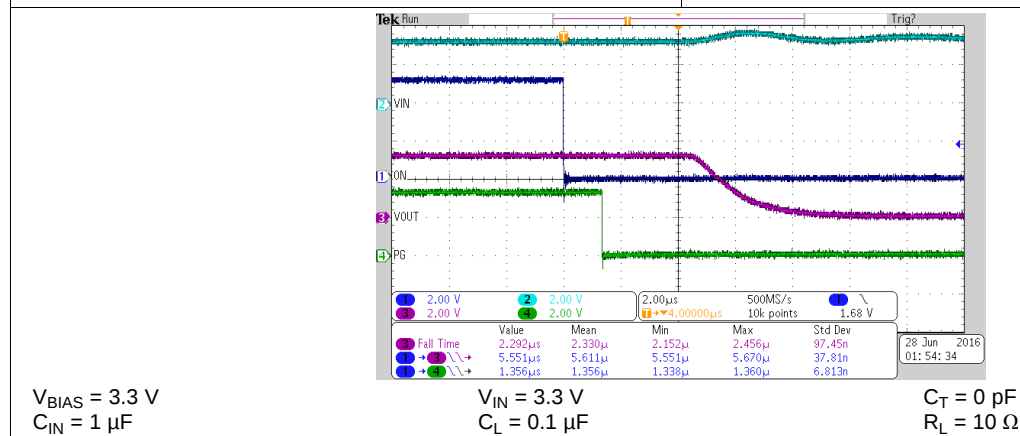


Figure 33. Turnoff Response

8 Parameter Measurement Information

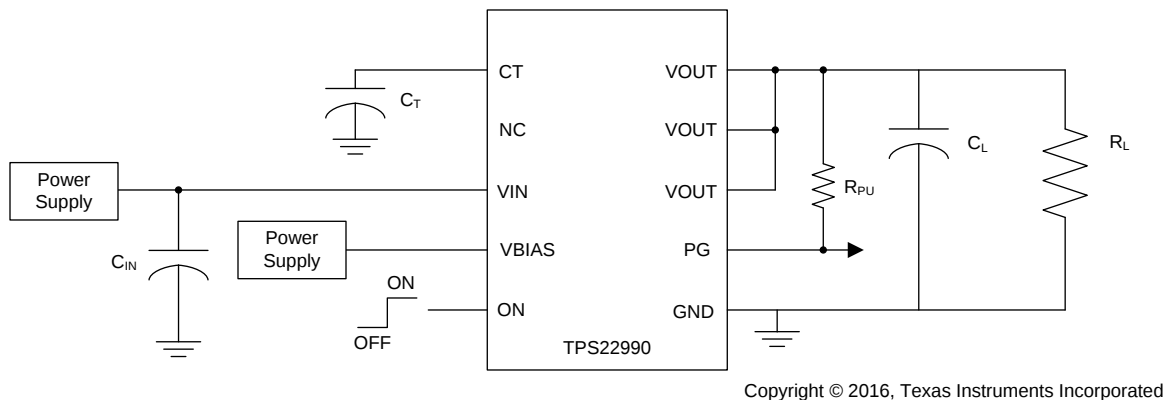
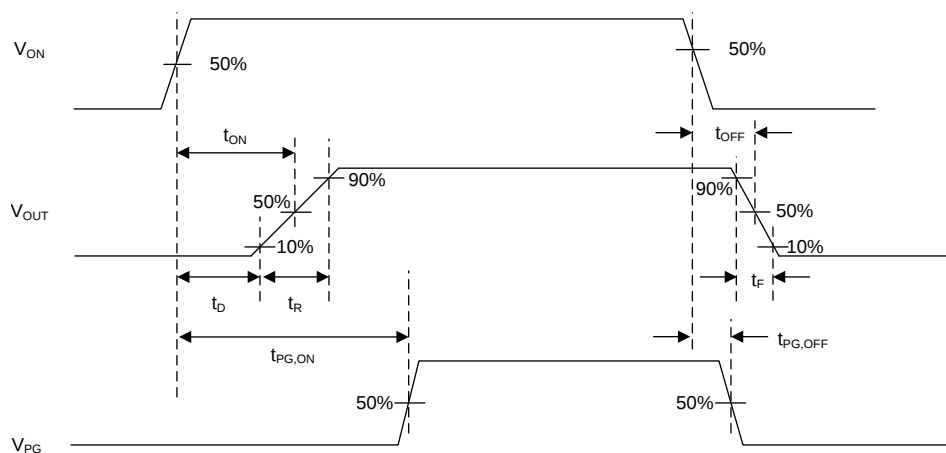


Figure 34. Timing Test Circuit



Rise and fall times of the control signals is 100 ns.

Figure 35. Timing Waveforms

9 Detailed Description

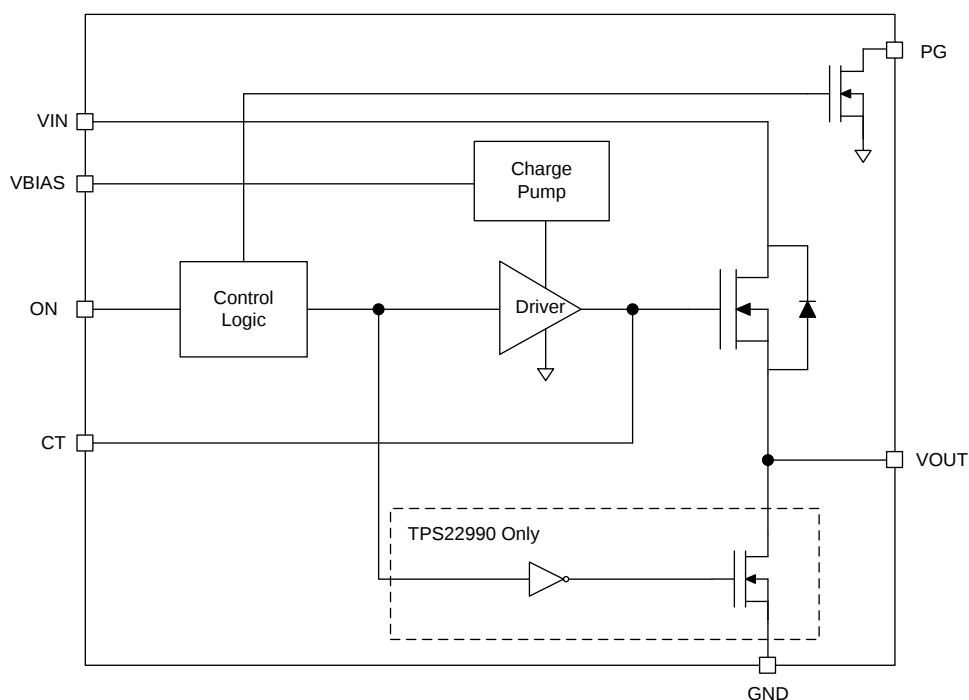
9.1 Overview

The TPS22990 device is a single channel load switch with a controlled adjustable turnon and integrated PG indicator. The device contains an N-channel MOSFET that can operate over an input voltage range of 0.6 V to 5.5 V and can support a maximum continuous current of 10 A. The wide input voltage range and high current capability enable the devices to be used across multiple designs and end equipment. 3.9-mΩ On-resistance minimizes the voltage drop across the load switch and power loss from the load switch.

The controlled rise time for the device greatly reduces inrush current caused by large bulk load capacitances, thereby reducing or eliminating power supply droop. The adjustable slew rate through CT provides the design flexibility to trade off the inrush current and power up timing requirements. Integrated PG indicator notifies the system about the status of the load switch to facilitate seamless power sequencing.

During shutdown, the device has very low leakage current, thereby reducing unnecessary leakages for downstream modules during standby. The TPS22990 has an optional 218-Ω On-chip resistor for quick discharge of the output when switch is disabled.

9.2 Functional Block Diagram



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9.3 Feature Description

9.3.1 On and Off Control

The ON pin controls the state of the load switch. Asserting the pin high enables the switch. The minimum voltage that guarantees logic high is 1.2 V. This pin cannot be left floating and must be tied either high or low for proper functionality.

Feature Description (continued)

9.3.2 Adjustable Rise Time

The TPS22990 has controlled rise time for inrush current control. A capacitor to GND on the CT pin adjusts the rise time. Without any capacitor on the CT, the rise time is at its minimum for fastest timing. The voltage on the CT pin can be as high as 15 V; therefore the minimum voltage rating for the CT capacitor must be 25 V for optimal performance. An approximate equation for the relationship between C_T , V_{IN} and rise time when V_{BIAS} is set to 5 V is shown in Equation 1. As shown in Figure 35, rise time is defined as from 10% to 90% measurement on V_{OUT} .

$$t_R = (0.011 \times V_{IN} + 0.002) \times C_T + 4.7 \times V_{IN} + 7.8$$

where

- t_R is the rise time (in μs)
 - V_{IN} is the input voltage (in V)
 - C_T is the capacitance value on the CT pin (in pF)
- (1)

Table 1 contains rise time values measured on a typical device. Rise times shown below are only valid for the power-up sequence where V_{IN} and V_{BIAS} are already in steady state condition before the ON pin is asserted high.

Table 1. Rise Time vs CT Capacitor

C_T (pF)	Rise Time (μs) at 25°C $C_L = 0.1 \mu F$, $C_{IN} = 1 \mu F$, $R_L = 10 \Omega$, $V_{BIAS} = 5 V$				
	$V_{IN} = 5 V$	$V_{IN} = 3.3 V$	$V_{IN} = 1.8 V$	$V_{IN} = 1.05 V$	$V_{IN} = 0.6 V$
0	30.5	24.8	17.5	12.6	9.5
220	44.6	34	22.7	15.8	11.4
470	56.6	42.2	27.1	18.8	13.2
1000	85	61.1	38.9	25.2	17.9
2200	154.6	107	64.7	40.9	27.7
4700	284.6	193.5	114.4	72.8	48.1
10000	598.5	404.8	233.2	146.9	98.6

9.3.3 Power Good (PG)

The TPS22990 has a power good (PG) output signal to indicate the gate of the pass FET is driven high and the switch is on with the On-resistance close to its final value (full load ready). The signal is an active high and open drain output which can be connected to a voltage source through an external pull up resistor, R_{PU} . This voltage source can be V_{OUT} from the TPS22990 or another external voltage. V_{BIAS} is required for PG to have a valid output. Equation 2 below shows the approximate equation for the relationship between C_T , V_{IN} and PG turnon time ($t_{PG,ON}$) when V_{BIAS} is set to 5 V.

$$t_{PG,ON} = (0.013 \times V_{IN} + 0.04) \times C_T + 4.7 \times V_{IN} + 129$$

where

- $t_{PG,ON}$ is the PG turnon time (in μs)
 - V_{IN} is the input voltage (in V)
 - C_T is the capacitance value on the CT pin (in pF)
- (2)

Table 2 contains PG turnon time values measured on a typical device.

Table 2. PG Turnon Time vs CT Capacitor

C_T (pF)	Typical PG turnon time (us) at 25°C $C_L = 0.1 \mu\text{F}$, $C_{IN} = 1 \mu\text{F}$, $R_L = 10 \Omega$, $V_{BIAS} = 5 \text{ V}$, $R_{PU} = 10 \text{ k}\Omega$				
	$V_{IN} = 5 \text{ V}$	$V_{IN} = 3.3 \text{ V}$	$V_{IN} = 1.8 \text{ V}$	$V_{IN} = 1.05 \text{ V}$	$V_{IN} = 0.6 \text{ V}$
0	151.9	144.4	137.5	133.9	131.3
220	177.7	164.6	153.3	147.1	143.5
470	200.9	183.2	167.4	159.2	154.4
1000	257.2	227.8	202.5	189.5	181.3
2200	390.6	332.3	282.4	257.1	241.6
4700	636.4	525.6	429.8	382.7	353.3
10000	1239	999.8	792.4	689.4	627.4

9.3.4 Quick Output Discharge (QOD) (TPS22990 Only)

The TPS22990 family includes an optional QOD feature. When the switch is disabled, a discharge resistor is connected between VOUT and GND. This resistor has a typical value of 218 Ω and prevents the output from floating while the switch is disabled.

9.4 Device Functional Modes

Table 3 shows the function table for TPS22990.

Table 3. Function Table

ON	VIN to VOUT	OUTPUT DISCHARGE ⁽¹⁾
L	OFF	ENABLED
H	ON	DISABLED

(1) This feature is in the TPS22990 only (not in TPS22990N).

10 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

10.1 Application Information

10.1.1 Input to Output Voltage Drop

The input to output voltage drop in the device is determined by the R_{ON} of the device and the load current. The R_{ON} of the device depends upon the V_{IN} and V_{BIAS} condition of the device. See the R_{ON} specification in the [Electrical Characteristics— \$V_{BIAS} = 5\text{ V}\$](#) table of this datasheet. Once the R_{ON} of the device is determined based upon the V_{IN} and V_{BIAS} conditions, use [Equation 3](#) to calculate the input to output voltage drop.

$$\Delta V = I_{LOAD} \times R_{ON}$$

where

- ΔV is the voltage drop from V_{IN} to V_{OUT}
- I_{LOAD} is the load current
- R_{ON} is the on-resistance of the device for a specific V_{IN} and V_{BIAS}
- An appropriate I_{LOAD} must be chosen such that the I_{MAX} specification of the device is not violated (3)

10.1.2 Input Capacitor

It is recommended to use a capacitor between V_{IN} and GND close to the device pins. This helps limit the voltage drop on the input supply caused by transient inrush currents when the switch is turned on into a discharged capacitor at the load. A 1- μF ceramic capacitor, C_{IN} , is usually sufficient. Higher values of C_{IN} can be used to further reduce the voltage drop. A C_{IN} to C_L ratio of 10 to 1 is recommended for minimizing V_{IN} dip caused by inrush currents during startup, where C_L is the load capacitance.

10.1.3 Thermal Consideration

The maximum junction temperature should be limited to below 125°C. Use [Equation 4](#) to calculate the maximum allowable dissipation, $P_{D(max)}$ for a given output load current and ambient temperature. $R_{\theta JA}$ is highly dependent upon board layout.

$$P_{D(max)} = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

where

- $P_{D(max)}$ is the maximum allowable power dissipation
- $T_{J(max)}$ is the maximum allowable junction temperature
- T_A is the ambient temperature
- $R_{\theta JA}$ is the junction-to-air thermal impedance (4)

10.1.4 PG Pull Up Resistor

The PG output is an open drain signal which connects to a voltage source through a pull up resistor R_{PU} . The PG signal can be used to drive the enable pins of downstream devices, EN. PG is active high, and its voltage is given by [Equation 5](#).

Application Information (continued)

$$V_{PG} = V_{OUT} - (I_{PG,LK} + I_{EN,LK}) \times R_{PU}$$

where

- V_{OUT} is the voltage where PG is tied to
- $I_{PG,LK}$ is the leakage current into PG pin
- $I_{EN,LK}$ is the leakage current into the EN pin driven by PG
- R_{PU} is the pull up resistance

(5)

V_{PG} needs to be higher than $V_{IH, MIN}$ of the EN pin to be treated as logic high. The maximum R_{PU} is determined by [Equation 6](#).

$$R_{PU,MAX} = \frac{V_{OUT} - V_{IH,MIN}}{I_{PG,LK} + I_{EN,LK}}$$

(6)

When PG is disabled, with 1 mA current into PG pin ($I_{PG} = 1 \text{ mA}$), $V_{PG,OL}$ is less than 0.2 V and treated as logic low as long as $V_{IL,MAX}$ of the EN pin is greater than 0.2 V. The minimum R_{PU} is determined by [Equation 7](#).

$$R_{PU,MIN} = \frac{V_{OUT}}{I_{PG} + I_{EN,LK}}$$

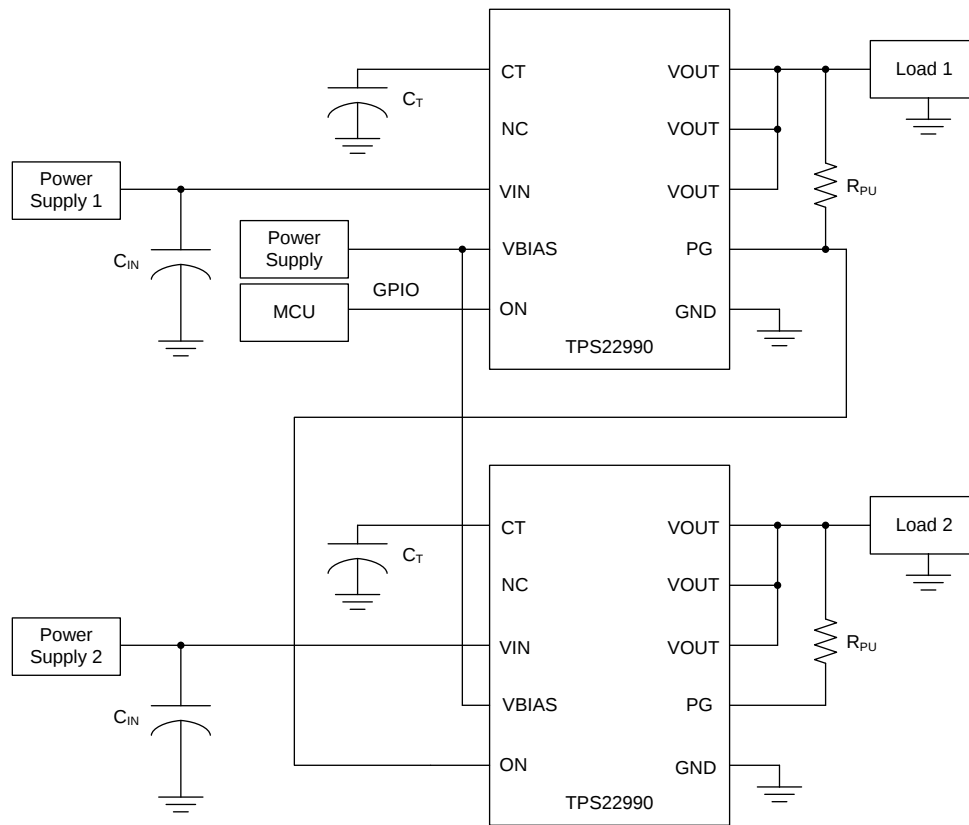
(7)

R_{PU} can be chosen within the range defined by $R_{PU,MIN}$ and $R_{PU,MAX}$. $R_{PU} = 10 \text{ k}\Omega$ is used for characterization.

10.1.5 Power Sequencing

The TPS22990 has an integrated power good indicator which can be used for power sequencing. As shown in [Figure 36](#), the switch to the second load is controlled by the PG signal from the first switch. This ensures that the power to load 2 is only enabled after the power to load 1 is enabled and the first switch is full load ready.

Application Information (continued)



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Figure 36. Power Sequencing

10.1.6 Standby Power Reduction

Any end equipment that is being powered from a battery has a need to reduce current consumption in order to maintain the battery charge for a longer time. The TPS22990 devices help to accomplish this reduction by turning off the supply to the downstream modules that are in standby state and significantly reduce the leakage current overhead of the standby modules as shown in [Figure 37](#).

Application Information (continued)

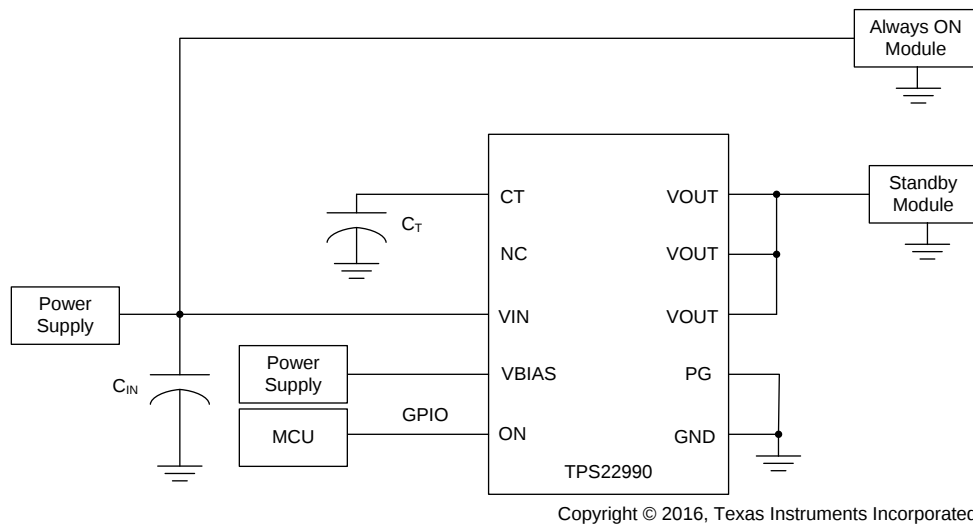


Figure 37. Standby Power Reduction

10.2 Typical Application

Figure 38 demonstrates how to use TPS22990 to limit inrush current to output capacitance.

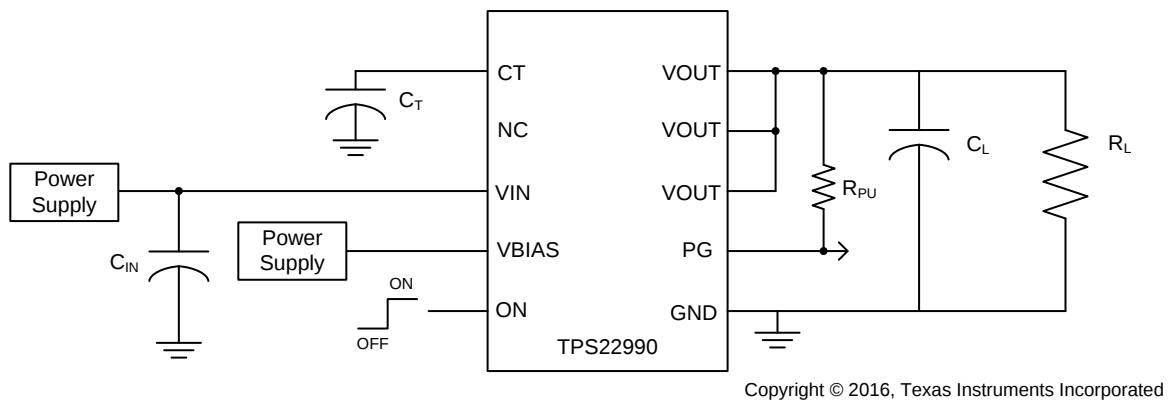


Figure 38. Powering a Downstream Module

Typical Application (continued)

10.2.1 Design Requirements

For this design example, use the input parameters shown in [Table 4](#).

Table 4. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
V_{BIAS}	3.3 V
V_{IN}	1.05 V
C_L	10 μ F
R_L	None
Maximum acceptable inrush current	100 mA

10.2.2 Detailed Design Procedure

10.2.2.1 Managing Inrush Current

When the switch is enabled, the output capacitors must be charged up from 0 V to V_{IN} . This charge arrives in the form of inrush current. Inrush current can be calculated using [Equation 8](#).

$$I_{INRUSH} = C_L \times \frac{dV}{dt} \approx C_L \times \frac{0.8 \times V_{IN}}{t_R}$$

where

- I_{INRUSH} is the Inrush current
- C_L is the Load capacitance
- dV/dt is the Output slew rate
- V_{IN} is the Input voltage
- t_R is the rise time

(8)

Minimum acceptable rise time can be calculated using the design requirements and the inrush current equation. See [Equation 9](#).

$$t_R = \frac{0.8 \times V_{IN} \times C_L}{I_{INRUSH}} = 84 \mu s$$

(9)

The TPS22990 has very fast timing without a CT capacitor (C_T). The typical rise time is 12 μ s at $V_{BIAS} = 3.3$ V, $V_{IN} = 1.05$ V, $R_L = 10 \Omega$, and $C_L = 0.1 \mu$ F. As shown in [Figure 39](#), the rise time is much smaller than 84 μ s and the inrush current is 460 mA without C_T . The C_T for the required rise time must be calculated using [Equation 1](#). For 84 μ s, the calculated $C_T = 5259$ pF. [Figure 40](#) shows the inrush current is less than 100 mA with $C_T = 6800$ pF.

10.2.3 Application Curves

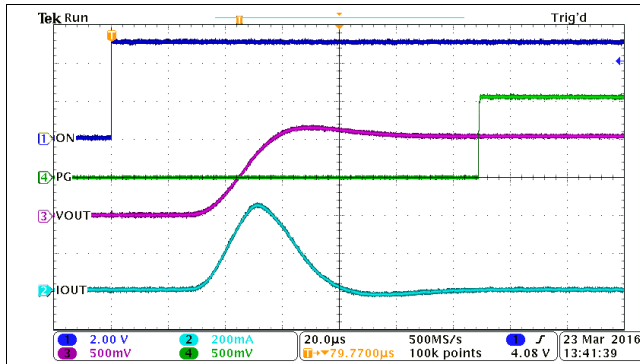


Figure 39. . Inrush Current with $C_T = 0$ pF

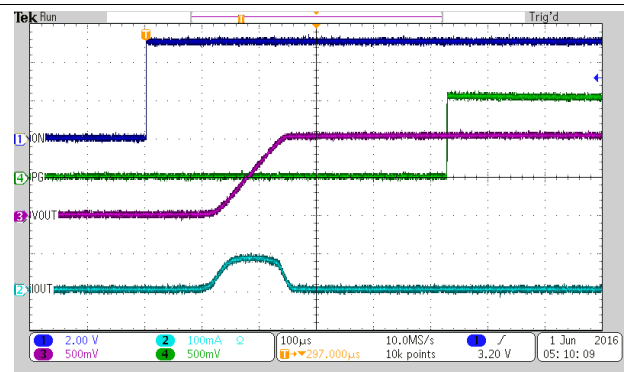


Figure 40. Inrush Current with $C_T = 6800$ pF

11 Power Supply Recommendations

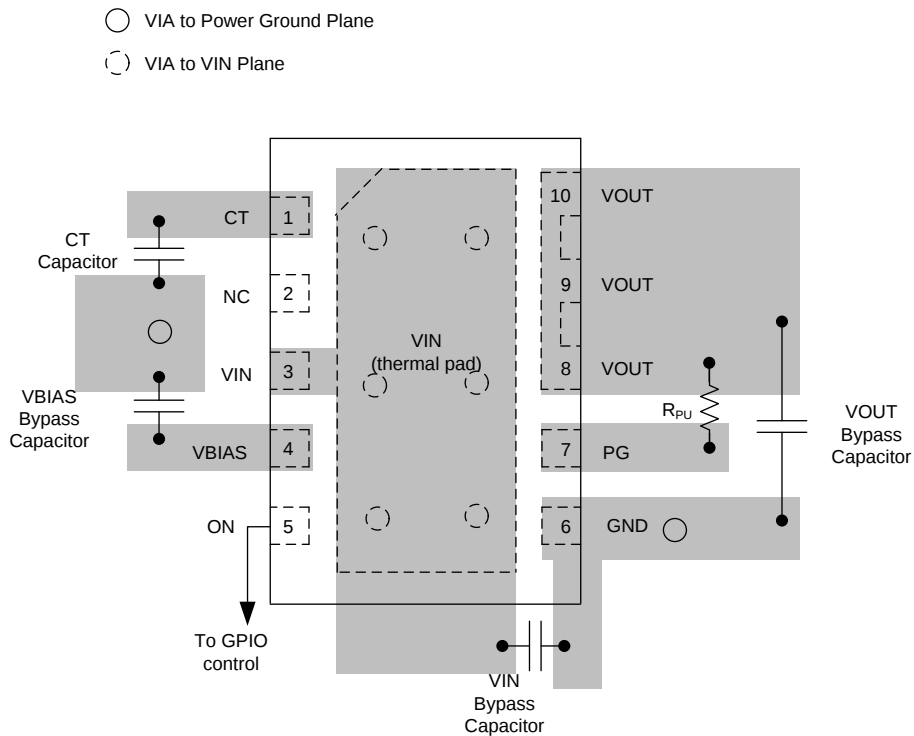
The device is designed to operate with a V_{BIAS} range of 2.5 V to 5.5 V, and a V_{IN} range of 0.6 V to V_{BIAS} . The supply must be well regulated and placed as close to the device terminal as possible with the recommended 1- μ F bypass capacitor. If the supply is located more than a few inches from the device terminals, additional bulk capacitance may be required in addition to the ceramic bypass capacitors. In the case where the power supply is slow to respond to a large load current step, additional bulk may also be required. If additional bulk capacitance is required, an electrolytic, tantalum, or ceramic capacitor of 10 μ F may be sufficient.

12 Layout

12.1 Layout Guidelines

For best performance, all traces must be as short as possible. To be most effective, the input and output capacitors must 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. The CT trace must be as short as possible to reduce parasitic capacitance.

12.2 Layout Example



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Figure 41. Layout Example

13 デバイスおよびドキュメントのサポート

13.1 ドキュメントのサポート

13.1.1 関連資料

関連資料については、以下を参照してください。

- 『TPS22990 負荷スイッチ評価モジュール』、[SLVUAS2](#)
- 『負荷スイッチのオン抵抗の基礎』、[SLVA771](#)

13.2 ドキュメントの更新通知を受け取る方法

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13.3 コミュニティ・リソース

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13.6 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

14 メカニカル、パッケージ、および注文情報

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PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TPS22990DMLR	Active	Production	WSON (DML) 10	3000 LARGE T&R	Yes	NIPDAU NIPDAUAG	Level-2-260C-1 YEAR	-40 to 105	RB990
TPS22990DMLR.A	Active	Production	WSON (DML) 10	3000 LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 105	RB990
TPS22990DMLR.B	Active	Production	WSON (DML) 10	3000 LARGE T&R	-	Call TI	Call TI	-40 to 105	
TPS22990DMLT	Active	Production	WSON (DML) 10	250 SMALL T&R	Yes	NIPDAU NIPDAUAG	Level-2-260C-1 YEAR	-40 to 105	RB990
TPS22990DMLT.A	Active	Production	WSON (DML) 10	250 SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 105	RB990
TPS22990DMLT.B	Active	Production	WSON (DML) 10	250 SMALL T&R	-	Call TI	Call TI	-40 to 105	
TPS22990NDMLR	Active	Production	WSON (DML) 10	3000 LARGE T&R	Yes	Call TI Nipdauag	Level-2-260C-1 YEAR	-40 to 105	RB990N
TPS22990NDMLR.A	Active	Production	WSON (DML) 10	3000 LARGE T&R	Yes	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 105	RB990N
TPS22990NDMLR.B	Active	Production	WSON (DML) 10	3000 LARGE T&R	-	Call TI	Call TI	-40 to 105	
TPS22990NDMLT	Active	Production	WSON (DML) 10	250 SMALL T&R	Yes	Call TI Nipdauag	Level-2-260C-1 YEAR	-40 to 105	RB990N
TPS22990NDMLT.A	Active	Production	WSON (DML) 10	250 SMALL T&R	Yes	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 105	RB990N
TPS22990NDMLT.B	Active	Production	WSON (DML) 10	250 SMALL T&R	-	Call TI	Call TI	-40 to 105	

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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TAPE AND REEL INFORMATION



*All dimensions are nominal

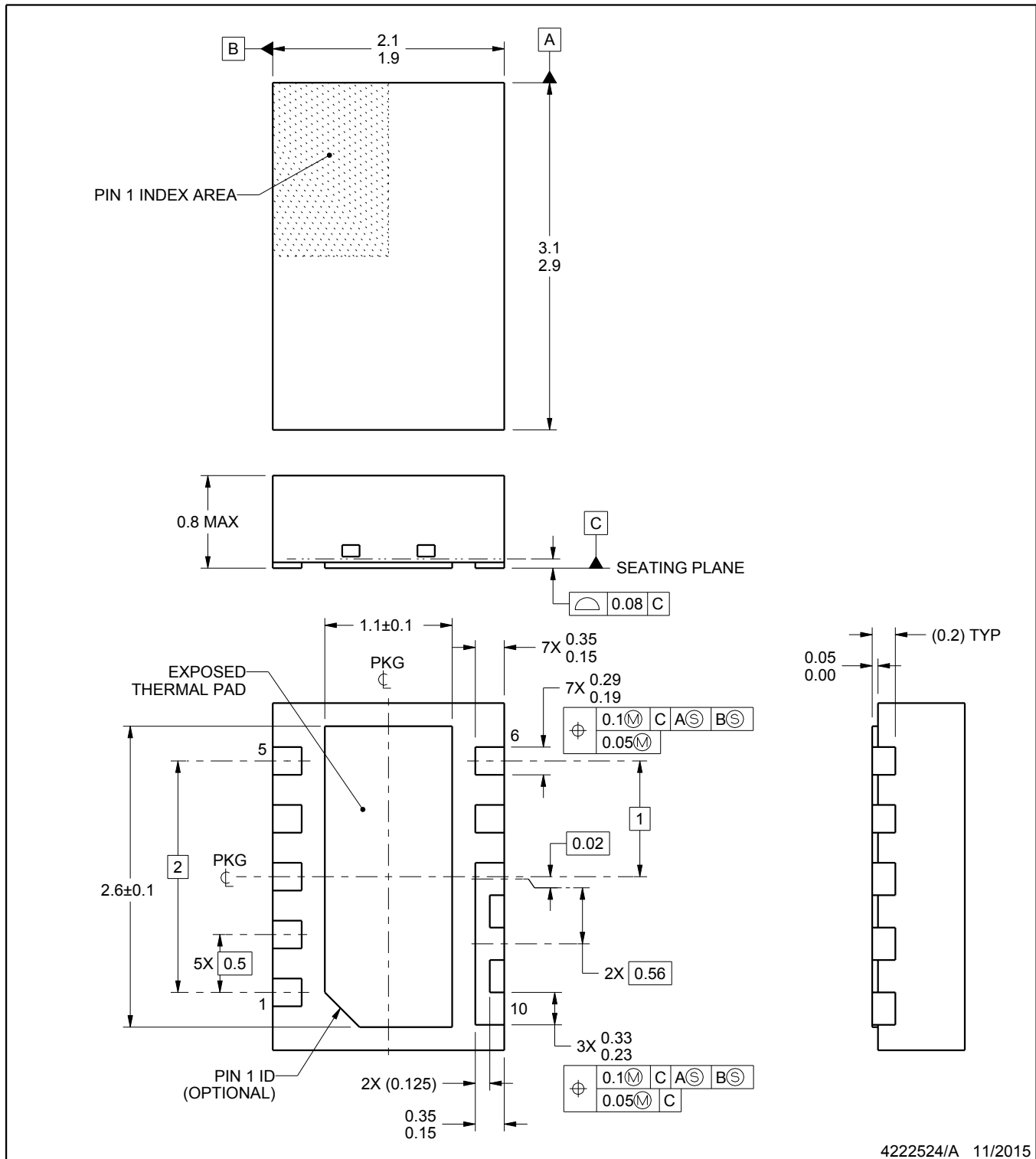
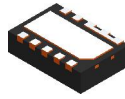
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS22990DMLR	WSO	DML	10	3000	180.0	8.4	2.3	3.2	1.0	4.0	8.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS22990DMLR	WSO	DML	10	3000	213.0	191.0	35.0



NOTES:

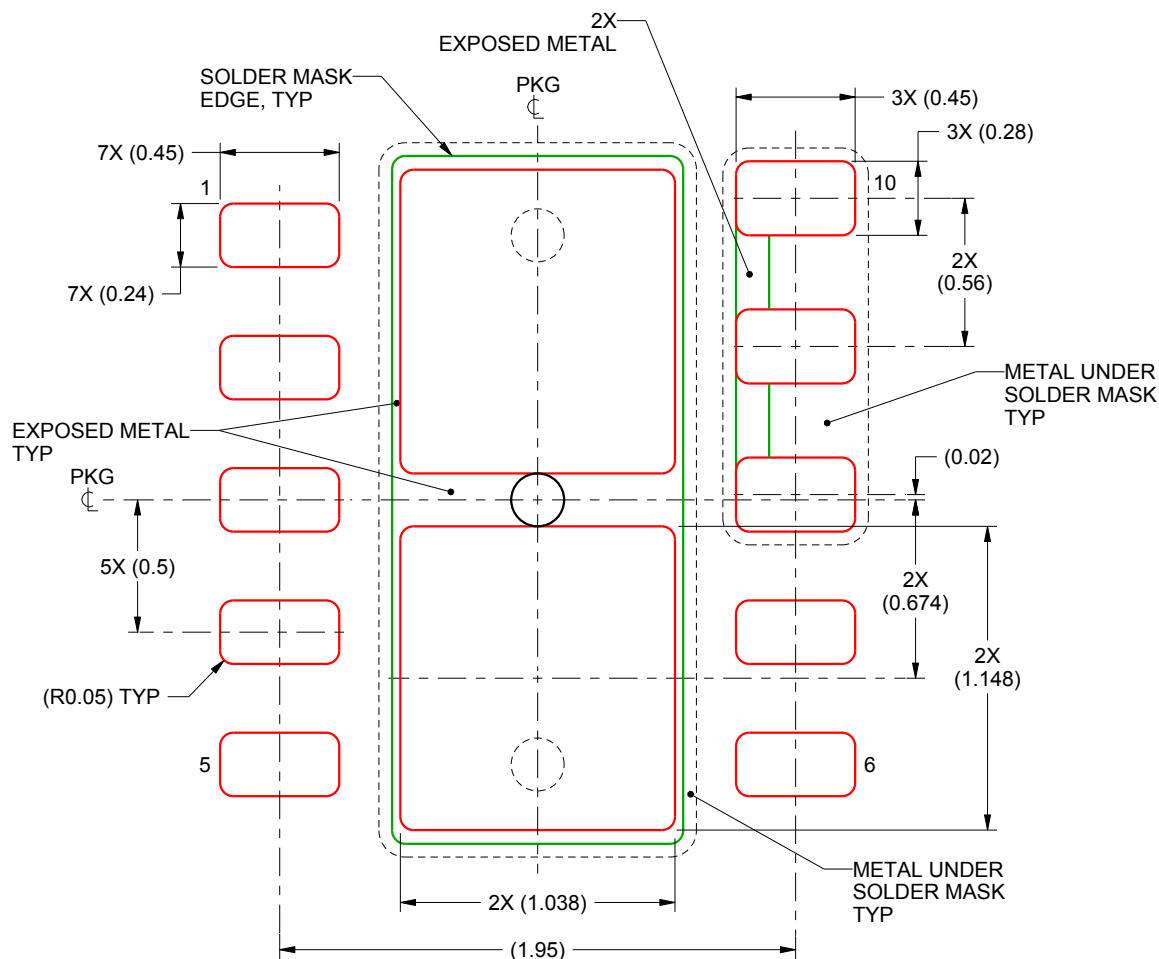
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE STENCIL DESIGN

DML0010A

WSN - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD
83% PRINTED SOLDER COVERAGE BY AREA
SCALE:35X

4222524/A 11/2015

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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