

# TPS74301 1.5A Ultra-LDO With Programmable Sequencing

## 1 Features

- Track Pin Allows for Flexible Power-Up Sequencing
- 1% Accuracy Over Line, Load, and Temperature
- Supports Input Voltages as Low as 0.9V with External Bias Supply
- Adjustable Output (0.8V to 3.6V)
- Ultra-Low Dropout:
  - 55mV at 1.5A (typ)
- Stable with any output capacitor  $\geq 2.2\mu\text{F}$  (new chip)
- Stable with any or no Output Capacitor (legacy chip)
- Excellent Transient Response
- Available in 5mm × 5mm × 1mm QFN and DDPAK-7 Packages
- Open-Drain Power-Good
- Active High Enable

## 2 Applications

- [Network attached storage - enterprise](#)
- [Rack servers](#)
- [Network interface cards \(NIC\)](#)
- [Merchant network and server PSU](#)

## 3 Description

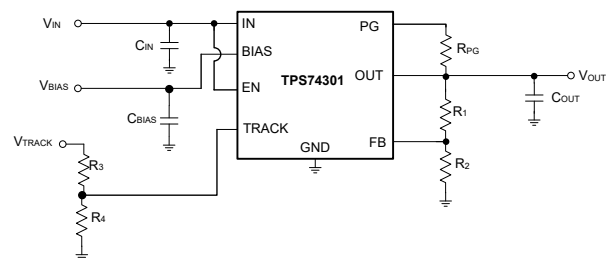
The TPS743 low-dropout (LDO) linear regulator provides an easy-to-use robust power management design for a wide variety of applications. The TRACK pin allows the output to track an external supply. This feature is useful in minimizing the stress on ESD structures that are present between the CORE and I/O power pins of many processors. The enable input and power-good output allow easy sequencing with external regulators. This complete flexibility allows the user to configure a solution that meets the sequencing requirements of FPGAs, DSPs, and other applications with special start-up requirements.

A precision reference and error amplifier deliver 1% accuracy over load, line, temperature, and process. The device is stable with any type of capacitor greater than or equal to  $2.2\mu\text{F}$ . Each LDO is stable with low-cost ceramic output capacitors and the family is fully specified from  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

### Package Information

PART NUMBER	PACKAGE <sup>(1)</sup>	PACKAGE SIZE <sup>(2)</sup>
TPS74301	RGW	5mm × 5mm
	KTW	10.1mm × 15.24mm

- (1) For all available packages, see [Section 10](#).  
 (2) The package size (length × width) is a nominal value and includes pins, where applicable.



**Typical Application Circuit**



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## 4 Pin Configurations and Functions

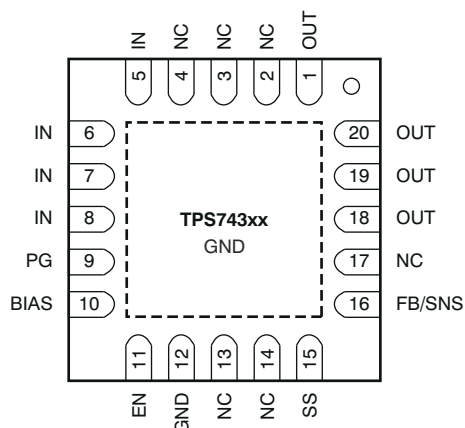


Figure 4-1. RGW PACKAGE 5 × 5 QFN-20 (TOP VIEW)

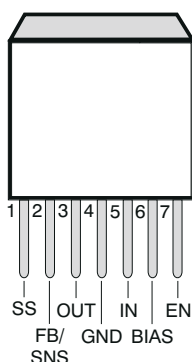


Figure 4-2. KTW PACKAGE DDPACK-7 SURFACE-MOUNT (Legacy only)

## Pin Descriptions

Table 4-1. Pin Functions

PIN			TYPE <sup>(1)</sup>	DESCRIPTION
NAME	KTW (DDPAK)	RGW (QFN)		
Bias	6	10	I	Bias input voltage for error amplifier, reference, and internal control circuits.
EN	7	11	I	Enable pin. Driving this pin high enables the regulator. Driving this pin low puts the regulator into shutdown mode. This pin must not be left floating.
FB	2	16	I	This pin is the feedback connection to the center tap of an external resistor divider network that sets the output voltage. This pin must not be left floating.
GND	4	12	G	Ground.
IN	5	5–8	I	Unregulated input to the device.
NC	N/A	2–4, 13, 14, 17	—	No connection. This pin can be left floating or connected to GND to allow better thermal contact to the top-side plane.
OUT	3	1, 18–20	O	Regulated output voltage. No capacitor is required on this pin for stability.
PAD/TAB	—	—	—	Must be soldered to the ground plane for increased thermal performance.
PG	—	9	O	Power-Good (PG) is an open-drain, active-high output that indicates the status of $V_{OUT}$ . When $V_{OUT}$ exceeds the PG trip threshold, the PG pin goes into a high-impedance state. When $V_{OUT}$ is below this threshold the pin is driven to a low-impedance state. A pullup resistor from 10kΩ to 1MΩ must be connected from this pin to a supply up to 5.5V. The supply can be higher than the input voltage. Alternatively, the PG pin can be left floating if output monitoring is not necessary.

**Table 4-1. Pin Functions (continued)**

PIN			TYPE <sup>(1)</sup>	DESCRIPTION
NAME	KTW (DDPAK)	RGW (QFN)		
TRACK	1	15	I	Tracking pin. Connect this pin to the center tap of a resistor divider off of an external supply to program the device to track an external supply.

(1) I = Input, O = Output, I/O = Input or Output, G = Ground, P = Power, N/A = Not applicable.

## 5 Specifications

### 5.1 Absolute Maximum Ratings

over operating temperature range (unless otherwise noted)<sup>(1)</sup>

		MIN	MAX	UNIT
$V_{IN}, V_{BIAS}$	Input voltage	−0.3	6	V
$V_{EN}$	Enable voltage	−0.3	6	V
$V_{PG}$	Power good voltage	−0.3	6	V
$I_{PG}$	PG sink current	0	1.5	mA
$V_{SS}$	Soft-start voltage	−0.3	6	V
$V_{FB}$	Feedback voltage	−0.3	6	V
$V_{OUT}$	Output voltage	−0.3	$V_{IN} + 0.3$	V
$I_{OUT}$	Maximum output current	Internally limited		
	Output short-circuit duration	Indefinite		
$P_{DISS}$	Continuous total power dissipation	See Thermal Information		
$T_J$	Junction Temperature (Legacy Chip)	−40	125	°C
	Junction Temperature (New Chip)	−40	150	°C
$T_{stg}$	Storage Temperature	−55	150	

- (1) Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.

### 5.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins <sup>(1)</sup>	±2000
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins <sup>(2)</sup>	±500

- (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.

### 5.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
$V_{IN}$	Input supply voltage	$V_{OUT} + V_{DO}$ ( $V_{IN}$ )	$V_{OUT} + 0.3$	5.5	V
$V_{EN}$	Enable supply voltage		$V_{IN}$	5.5	V
$V_{BIAS}$ <sup>(1)</sup>	BIAS supply voltage	$V_{OUT} + V_{DO}$ ( $V_{BIAS}$ ) <sup>(2)</sup>	$V_{OUT} + 1.6$ <sup>(2)</sup>	5.5	V
$V_{OUT}$	Output voltage	0.8		3.6	V
$I_{OUT}$	Output current	0		1.5	A
$C_{OUT}$	Output capacitor (legacy chip)	0			μF
	Output capacitor (new chip)	2.2			μF
$C_{IN}$	Input capacitor <sup>(3)</sup>	1			μF
$C_{BIAS}$	Bias capacitor	0.1	1		μF
$T_J$	Operating junction temperature	−40		125	°C

- (1) BIAS supply is required when  $V_{IN}$  is below  $V_{OUT} + V_{DO}$  ( $V_{BIAS}$ ).  
(2)  $V_{BIAS}$  has a minimum voltage of 2.7 V or  $V_{OUT} + V_{DO}$  ( $V_{BIAS}$ ), whichever is higher (new chip).  
(3) If  $V_{IN}$  and  $V_{BIAS}$  are connected to the same supply, the recommended minimum capacitor for the supply is 4.7 μF.

## 5.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		TPS742				UNIT
		RGW (VQFN) (legacy chip)	RGW (VQFN) (new chip)	RGR (VQFN)	KTW (DDPAK/ TO-263)	
		20 PINS	20 PINS	20 PINS	7 PINS	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	35.4	34.7	44.2	47.2	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	32.4	31	50.3	63.7	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	14.7	13.5	19.6	19.5	°C/W
ψ <sub>JT</sub>	Junction-to-top characterization parameter	0.4	1.4	0.7	4.2	°C/W
ψ <sub>JB</sub>	Junction-to-board characterization parameter	14.8	13.5	17.8	19.4	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case (bottom) thermal resistance	3.9	3.6	4.3	3.3	°C/W

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

## 5.5 Electrical Characteristics

at V<sub>EN</sub> = 1.1 V, V<sub>IN</sub> = V<sub>OUT</sub> + 0.3 V, C<sub>BIAS</sub> = 0.1 μF, C<sub>IN</sub> = C<sub>OUT</sub> = 10 μF, I<sub>OUT</sub> = 50 mA, V<sub>BIAS</sub> = 5.0 V, and T<sub>J</sub> = –40°C to 125°C, (unless otherwise noted); typical values are at T<sub>J</sub> = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V <sub>IN</sub>	Input voltage range		V <sub>OUT</sub> + V <sub>DO</sub>		5.5	V
V <sub>BIAS</sub>	BIAS pin voltage range		2.375		5.25	V
V <sub>REF</sub>	Internal reference	T <sub>J</sub> = 25°C	0.796	0.8	0.804	V
V <sub>OUT</sub>	Output voltage	V <sub>IN</sub> = 5V, I <sub>OUT</sub> = 1.5A, V <sub>BIAS</sub> = 5V	V <sub>REF</sub>		3.6	V
V <sub>OUT</sub>	Accuracy <sup>(1)</sup>	2.375V ≤ V <sub>BIAS</sub> ≤ 5.25V, V <sub>OUT</sub> + 1.62V ≤ V <sub>BIAS</sub> 50mA ≤ I <sub>OUT</sub> ≤ 1.5A	-1	±0.2	1	%
ΔV <sub>OUT(ΔVIN)</sub>	Line regulation	V <sub>OUT(NOM)</sub> + 0.3V ≤ V <sub>IN</sub> ≤ 5.5V, VQFN		0.0005	0.05	%V
		V <sub>OUT(NOM)</sub> + 0.3V ≤ V <sub>IN</sub> ≤ 5.5V, DDPAK/TO-263		0.0005	0.06	
ΔV <sub>OUT(ΔIOUT)</sub>	Load regulation	0 mA ≤ I <sub>OUT</sub> ≤ 50mA (Legacy Chip)		0.013		%mA
		50 mA ≤ I <sub>OUT</sub> ≤ 1.5 A (Legacy Chip)		0.04		
		50 mA ≤ I <sub>OUT</sub> ≤ 1.5 A (New Chip)		0.09		%A
V <sub>DO</sub>	V <sub>IN</sub> dropout voltage <sup>(2)</sup>	I <sub>OUT</sub> = 1.5 A, V <sub>BIAS</sub> – V <sub>OUT(NOM)</sub> ≥ 1.62 V, VQFN		55	100	mV
		I <sub>OUT</sub> = 1.5 A, V <sub>BIAS</sub> – V <sub>OUT(NOM)</sub> ≥ 1.62 V, DDPAK/TO-263 (Legacy chip only)		60	120	
	V <sub>BIAS</sub> dropout voltage <sup>(2)</sup>	I <sub>OUT</sub> = 1.5A, V <sub>IN</sub> = V <sub>BIAS</sub> (Legacy Chip)			1.4	V
		I <sub>OUT</sub> = 1.5A, V <sub>IN</sub> = V <sub>BIAS</sub> (New Chip)			1.43	
I <sub>CL</sub>	Current limit	V <sub>OUT</sub> = 80% × V <sub>OUT(nom)</sub> , (Legacy Chip)	1.8		4	A
		V <sub>OUT</sub> = 80% × V <sub>OUT(nom)</sub> , (New Chip)	2		5.5	
I <sub>BIAS</sub>	BIAS pin current	I <sub>OUT</sub> = 0mA to 1.5A (Legacy Chip)		2	4	mA
		I <sub>OUT</sub> = 0mA to 1.5A (New Chip)		1	2	

## 5.5 Electrical Characteristics (continued)

at  $V_{EN} = 1.1\text{ V}$ ,  $V_{IN} = V_{OUT} + 0.3\text{ V}$ ,  $C_{BIAS} = 0.1\text{ }\mu\text{F}$ ,  $C_{IN} = C_{OUT} = 10\text{ }\mu\text{F}$ ,  $I_{OUT} = 50\text{ mA}$ ,  $V_{BIAS} = 5.0\text{ V}$ , and  $T_J = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , (unless otherwise noted); typical values are at  $T_J = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$I_{SHDN}$	Shutdown supply current ( $I_{GND}$ )	$V_{EN} \leq 0.4\text{ V}$ (Legacy Chip)		1	100	$\mu\text{A}$
		$V_{EN} \leq 0.4\text{ V}$ , (New Chip)		0.85	2.75	
$I_{FB}$	Feedback pin current <sup>(3)</sup>	$I_{OUT} = 50\text{ mA}$ to $1.5\text{ A}$ (Legacy Chip)	–250	68	250	nA
		$I_{OUT} = 50\text{ mA}$ to $1.5\text{ A}$ (New Chip)	–30	0.15	30	nA
PSRR	Power-supply rejection ( $V_{IN}$ to $V_{OUT}$ )	1 kHz, $I_{OUT} = 1.5\text{ A}$ , $V_{IN} = 1.8\text{ V}$ , $V_{OUT} = 1.5\text{ V}$ (Legacy Chip)		73		dB
		1 kHz, $I_{OUT} = 1.5\text{ A}$ , $V_{IN} = 1.8\text{ V}$ , $V_{OUT} = 1.5\text{ V}$ (New Chip)		60		
		300 kHz, $I_{OUT} = 1.5\text{ A}$ , $V_{IN} = 1.8\text{ V}$ , $V_{OUT} = 1.5\text{ V}$ (Legacy Chip)		42		
		300 kHz, $I_{OUT} = 1.5\text{ A}$ , $V_{IN} = 1.8\text{ V}$ , $V_{OUT} = 1.5\text{ V}$ (New Chip)		30		
	Power-supply rejection ( $V_{BIAS}$ to $V_{OUT}$ )	1 kHz, $I_{OUT} = 1.5\text{ A}$ , $V_{IN} = 1.8\text{ V}$ , $V_{OUT} = 1.5\text{ V}$ (Legacy Chip)		62		
		1 kHz, $I_{OUT} = 1.5\text{ A}$ , $V_{IN} = 1.8\text{ V}$ , $V_{OUT} = 1.5\text{ V}$ (New Chip)		59		
$V_n$	Output noise voltage	300 kHz, $I_{OUT} = 1.5\text{ A}$ , $V_{IN} = 1.8\text{ V}$ , $V_{OUT} = 1.5\text{ V}$		50		$\mu\text{Vrms} \times V_{out}$
$V_n$	Output noise voltage	BW = 100Hz to 100kHz, $I_{OUT} = 1.5\text{ A}$ , $C_{SS} = 1\text{ nF}$ (Legacy Chip)		16		$\mu\text{Vrms} \times V_{out}$
		BW = 100 Hz to 100 kHz, $I_{OUT} = 3\text{ A}$ , $C_{SS} = 1\text{ nF}$ (New Chip)		20		
$V_{TRAN}$	% $V_{OUT}$ droop during load transient	$I_{OUT} = 50\text{ mA}$ to $1.5\text{ A}$ at $1\text{ A}/\mu\text{s}$ , $C_{OUT} = \text{none}$ (Legacy Chip)		3.5		% $V_{OUT}$
$V_{TRAN}$	% $V_{OUT}$ droop during load transient	$I_{OUT} = 50\text{ mA}$ to $1.5\text{ A}$ at $1\text{ A}/\mu\text{s}$ , $C_{OUT} = 2.2\text{ }\mu\text{F}$ (New Chip)		1.7		% $V_{OUT}$
$t_{STR}$	Minimum start-up time	$R_{LOAD}$ for $I_{OUT} = 1.5\text{ A}$ , $C_{SS} = \text{open}$ (Legacy Chip)		100		$\mu\text{s}$
		$R_{LOAD}$ for $I_{OUT} = 1.0\text{ A}$ , $C_{SS} = \text{open}$ (New Chip)		250		
$V_{EN(hi)}$	Enable input high level		1.1		5.5	V
$V_{EN(lo)}$	Enable input low level		0		0.4	V
$V_{EN(hys)}$	Enable pin hysteresis	(Legacy Chip)		50		mV
		(New Chip)		55		
$V_{EN(dg)}$	Enable pin deglitch time			20		$\mu\text{s}$
$I_{EN}$	Enable pin current	$V_{EN} = 5\text{ V}$ (Legacy Chip)		0.1	1	$\mu\text{A}$
		$V_{EN} = 5\text{ V}$ (New Chip)		0.1	0.25	
$V_{IT}$	PG trip threshold	$V_{OUT}$ decreasing (Legacy Chip)	86.5	90	93.5	% $V_{OUT}$
		$V_{OUT}$ decreasing (New Chip)	85	90	94	
$V_{HYS}$	PG trip hysteresis	(Legacy Chip)		3		% $V_{OUT}$
		(New Chip)		2.5		

## 5.5 Electrical Characteristics (continued)

at  $V_{EN} = 1.1\text{ V}$ ,  $V_{IN} = V_{OUT} + 0.3\text{ V}$ ,  $C_{BIAS} = 0.1\text{ }\mu\text{F}$ ,  $C_{IN} = C_{OUT} = 10\text{ }\mu\text{F}$ ,  $I_{OUT} = 50\text{ mA}$ ,  $V_{BIAS} = 5.0\text{ V}$ , and  $T_J = -40^\circ\text{C}$  to  $125^\circ\text{C}$ , (unless otherwise noted); typical values are at  $T_J = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{PG(I_O)}$	PG output low voltage	$I_{PG} = 1\text{ mA}$ (sinking), $V_{OUT} < V_{IT}$ (Legacy Chip)		0.3	V
		$I_{PG} = 1\text{ mA}$ (sinking), $V_{OUT} < V_{IT}$ (New Chip)		0.12	
$I_{PG(I_{kg})}$	PG leakage current	$V_{PG} = 5.25\text{ V}$ , $V_{OUT} > V_{IT}$ (Legacy Chip)		0.03	$\mu\text{A}$
		$V_{PG} = 5.25\text{ V}$ , $V_{OUT} > V_{IT}$ (New Chip)		0.001	
$T_J$	Operating junction temperature	-40		125	$^\circ\text{C}$
$T_{SD}$	Thermal shutdown temperature	Shutdown, temperature increasing (Legacy Chip)		155	$^\circ\text{C}$
		Shutdown, temperature increasing (New Chip)		165	
		Reset, temperature decreasing		140	

- (1) For adjustable devices tested at 0.8V, resistor tolerance is not taken into account.
- (2) Dropout is defined as the voltage from the input to  $V_{OUT}$  when  $V_{OUT}$  is 2% below nominal.
- (3)  $I_{FB}$  current flow is out of the device.



## 5.6 Typical Characteristics

at  $T_J = 25^\circ\text{C}$ ,  $V_{OUT} = 1.5\text{V}$ ,  $V_{IN} = V_{OUT(NOM)} + 0.3\text{V}$ ,  $V_{BIAS} = 3.3\text{V}$  (legacy chip),  $V_{BIAS} = 5.0\text{V}$  (new chip),  $I_{OUT} = 50\text{mA}$ ,  $V_{EN} = V_{IN}$ ,  $C_{IN} = 1\mu\text{F}$ ,  $C_{BIAS} = 4.7\mu\text{F}$ ,  $C_{SS} = 0.01\mu\text{F}$  (legacy chip), and  $C_{OUT} = 10\mu\text{F}$  (unless otherwise noted)

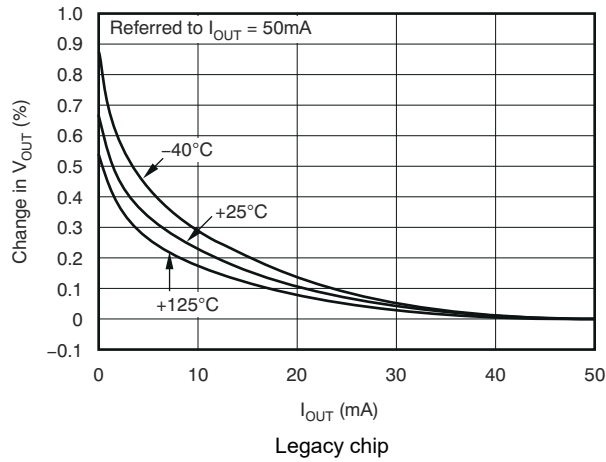


Figure 5-1. Load Regulation (legacy chip)

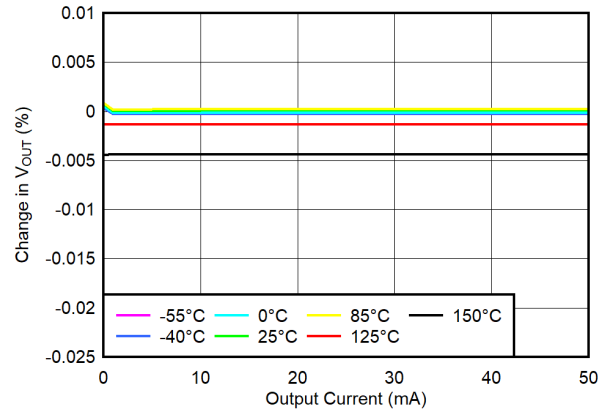


Figure 5-2. Load Regulation (new chip)

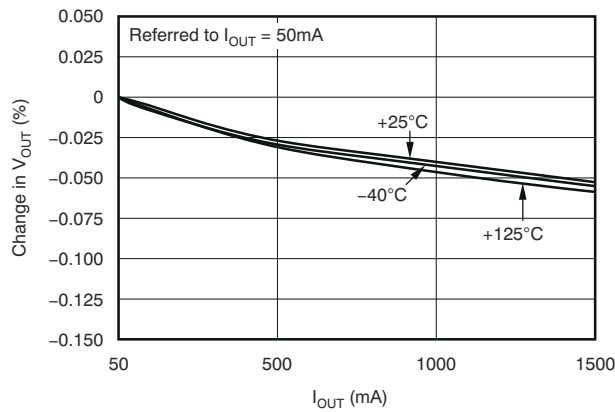


Figure 5-3. Load Regulation (legacy chip)

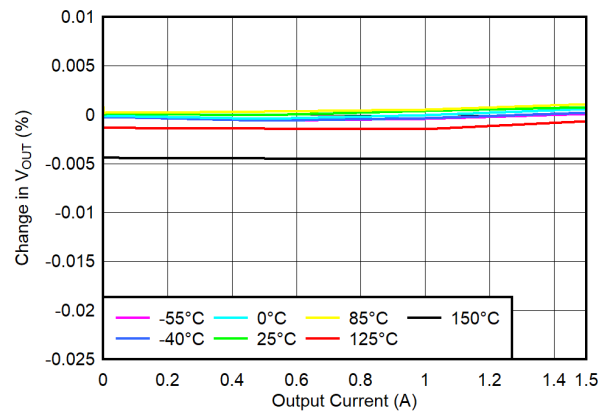


Figure 5-4. Load Regulation (new chip)

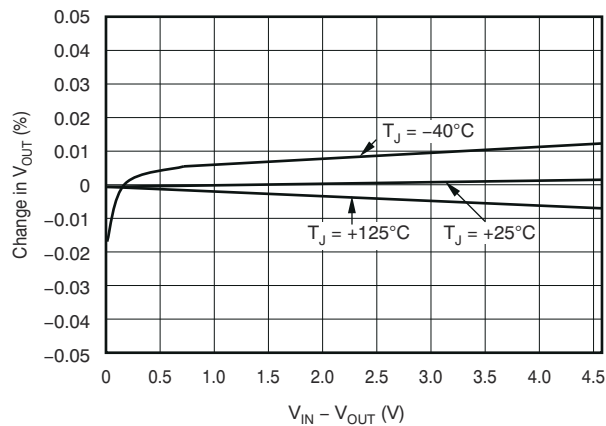


Figure 5-5. Line Regulation (legacy chip)

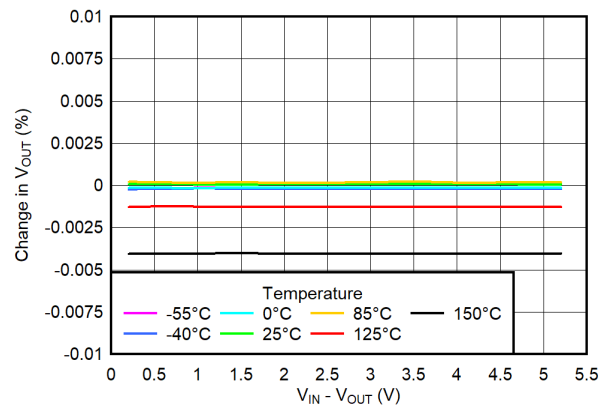


Figure 5-6. Line Regulation (new chip)

## 5.6 Typical Characteristics (continued)

at  $T_J = 25^\circ\text{C}$ ,  $V_{OUT} = 1.5\text{V}$ ,  $V_{IN} = V_{OUT(NOM)} + 0.3\text{V}$ ,  $V_{BIAS} = 3.3\text{V}$  (legacy chip),  $V_{BIAS} = 5.0\text{V}$  (new chip),  $I_{OUT} = 50\text{mA}$ ,  $V_{EN} = V_{IN}$ ,  $C_{IN} = 1\mu\text{F}$ ,  $C_{BIAS} = 4.7\mu\text{F}$ ,  $C_{SS} = 0.01\mu\text{F}$  (legacy chip), and  $C_{OUT} = 10\mu\text{F}$  (unless otherwise noted)

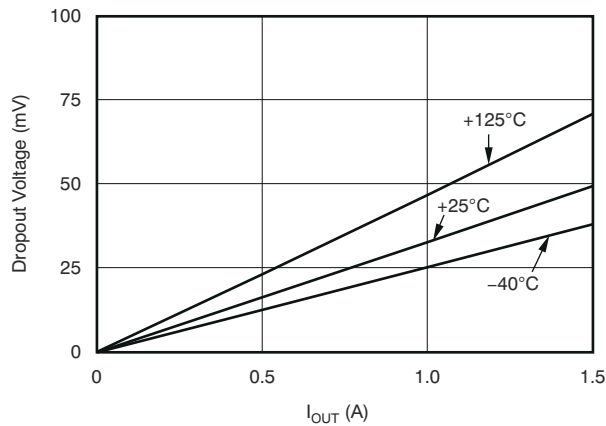


Figure 5-7.  $V_{IN}$  Dropout Voltage vs  $I_{OUT}$  and Temperature ( $T_J$ ) (legacy chip)

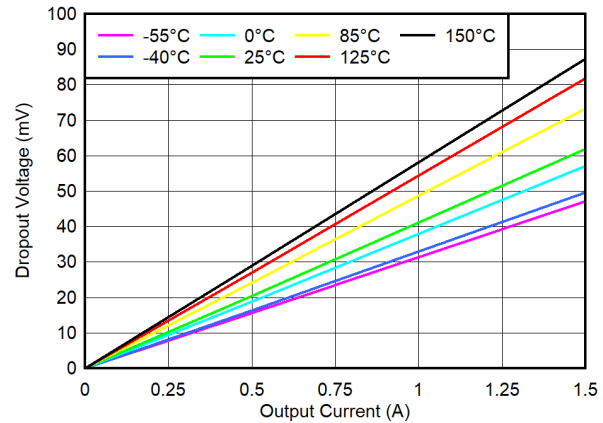


Figure 5-8.  $V_{IN}$  Dropout Voltage vs  $I_{OUT}$  and Temperature ( $T_J$ ) (new chip)

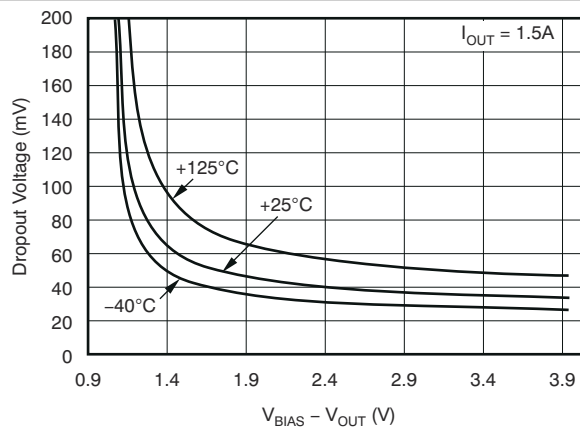


Figure 5-9.  $V_{IN}$  Dropout Voltage vs  $V_{BIAS} - V_{OUT}$  and Temperature ( $T_J$ )

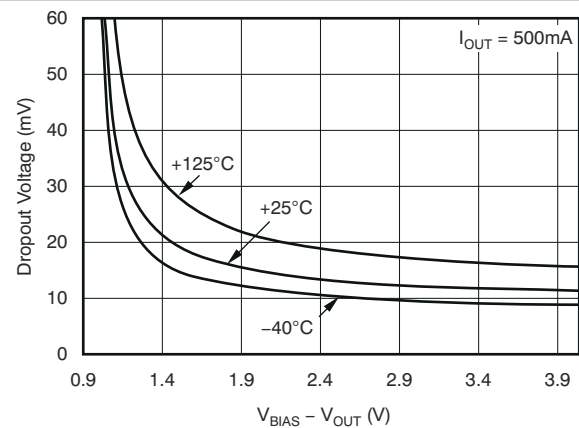


Figure 5-10.  $V_{IN}$  Dropout Voltage vs  $V_{BIAS} - V_{OUT}$  and Temperature ( $T_J$ )

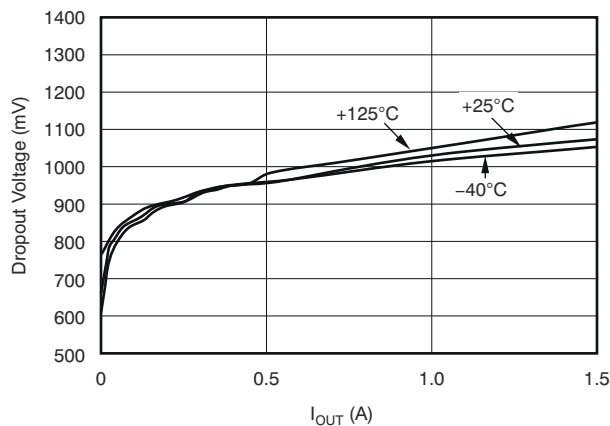


Figure 5-11.  $V_{BIAS}$  Dropout Voltage vs  $I_{OUT}$  and Temperature (legacy chip)

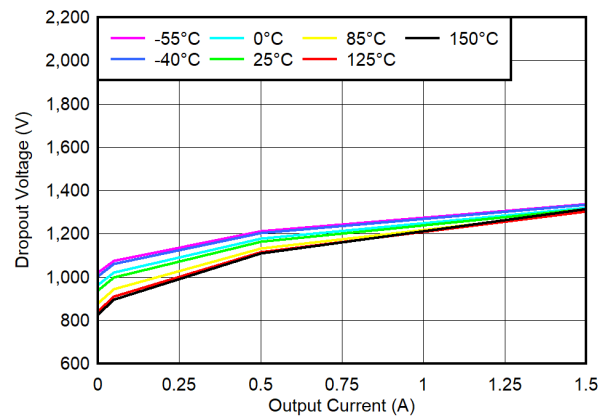


Figure 5-12.  $V_{BIAS}$  Dropout Voltage vs  $I_{OUT}$  and Temperature (new chip)

## 5.6 Typical Characteristics (continued)

at  $T_J = 25^\circ\text{C}$ ,  $V_{OUT} = 1.5\text{V}$ ,  $V_{IN} = V_{OUT(NOM)} + 0.3\text{V}$ ,  $V_{BIAS} = 3.3\text{V}$  (legacy chip),  $V_{BIAS} = 5.0\text{V}$  (new chip),  $I_{OUT} = 50\text{mA}$ ,  $V_{EN} = V_{IN}$ ,  $C_{IN} = 1\mu\text{F}$ ,  $C_{BIAS} = 4.7\mu\text{F}$ ,  $C_{SS} = 0.01\mu\text{F}$  (legacy chip), and  $C_{OUT} = 10\mu\text{F}$  (unless otherwise noted)

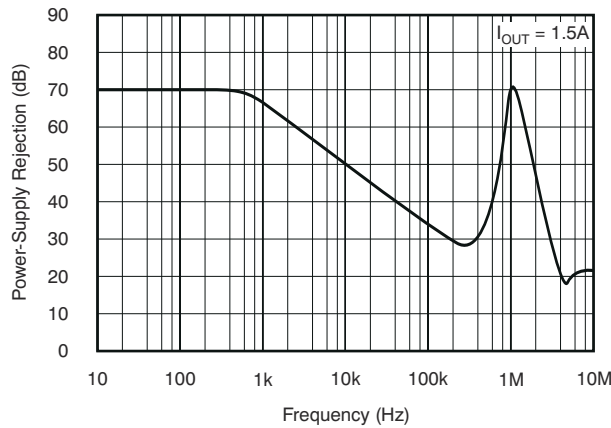


Figure 5-13.  $V_{BIAS}$  PSRR vs Frequency (legacy chip)

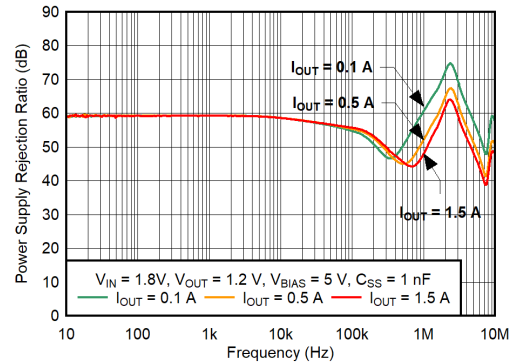


Figure 5-14.  $V_{BIAS}$  PSRR vs Frequency (new chip)

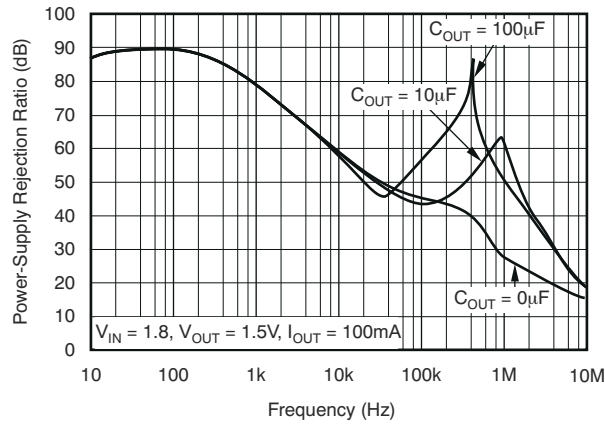


Figure 5-15.  $V_{IN}$  PSRR vs Frequency (legacy chip)

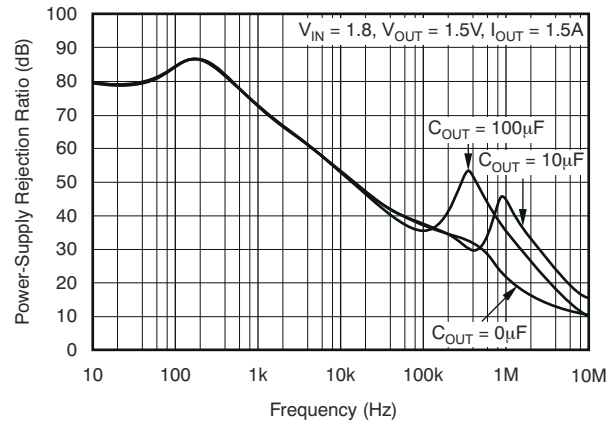


Figure 5-16.  $V_{IN}$  PSRR vs Frequency (legacy chip)

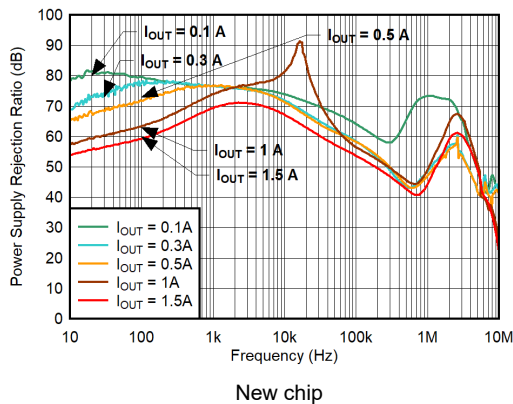


Figure 5-17.  $V_{IN}$  PSRR vs Frequency (new chip)

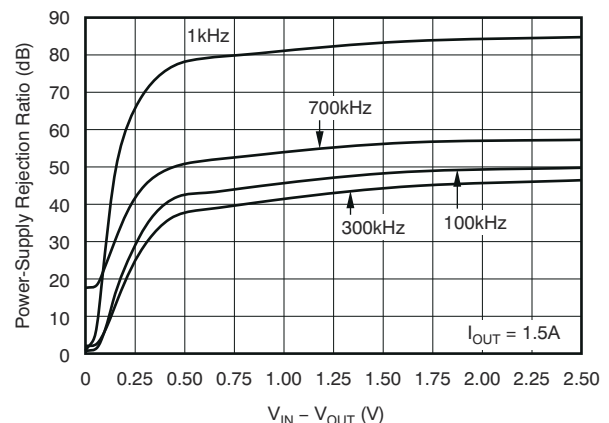


Figure 5-18.  $V_{IN}$  PSRR vs  $V_{IN} - V_{OUT}$  (legacy chip)

## 5.6 Typical Characteristics (continued)

at  $T_J = 25^\circ\text{C}$ ,  $V_{OUT} = 1.5\text{V}$ ,  $V_{IN} = V_{OUT(NOM)} + 0.3\text{V}$ ,  $V_{BIAS} = 3.3\text{V}$  (legacy chip),  $V_{BIAS} = 5.0\text{V}$  (new chip),  $I_{OUT} = 50\text{mA}$ ,  $V_{EN} = V_{IN}$ ,  $C_{IN} = 1\mu\text{F}$ ,  $C_{BIAS} = 4.7\mu\text{F}$ ,  $C_{SS} = 0.01\mu\text{F}$  (legacy chip), and  $C_{OUT} = 10\mu\text{F}$  (unless otherwise noted)

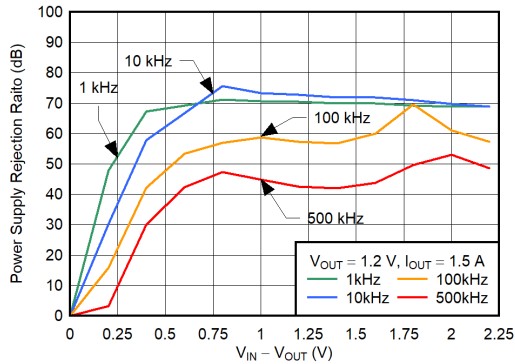


Figure 5-19.  $V_{IN}$  PSRR vs  $(V_{IN} - V_{OUT})$  (new chip)

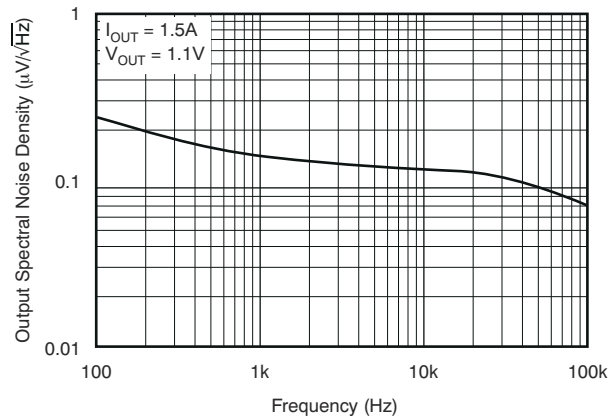


Figure 5-20. Noise Spectral Density (legacy chip)

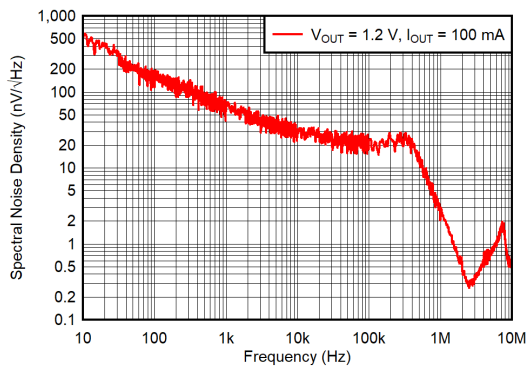


Figure 5-21. Noise Spectral Density (new chip)

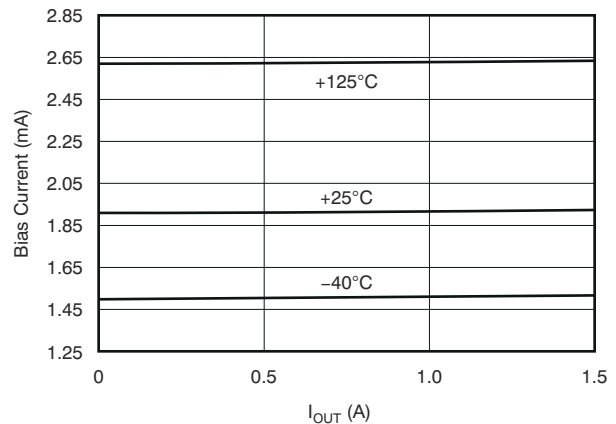


Figure 5-22.  $I_{BIAS}$  vs  $I_{OUT}$  and Temperature (legacy chip)

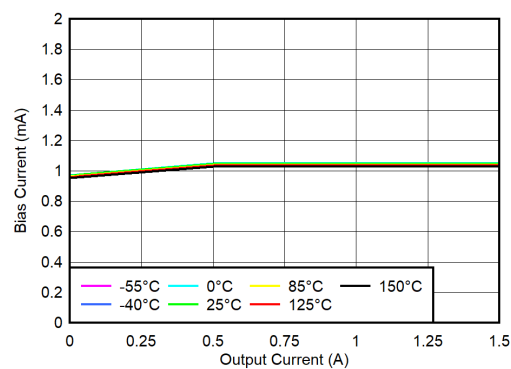


Figure 5-23. BIAS Pin Current vs Output Current and Temperature ( $T_J$ ) (new chip)

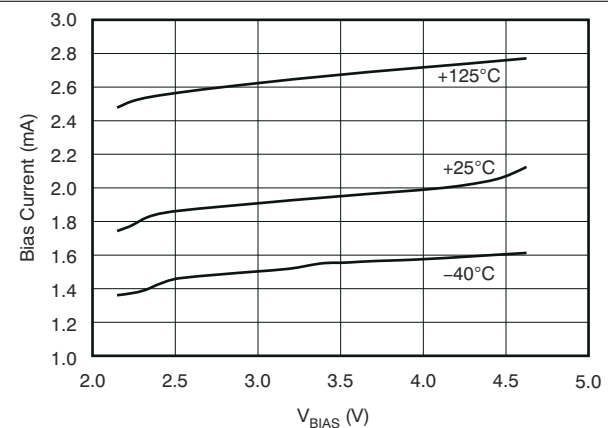
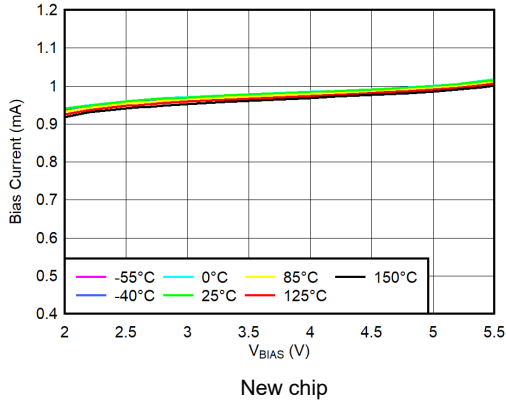


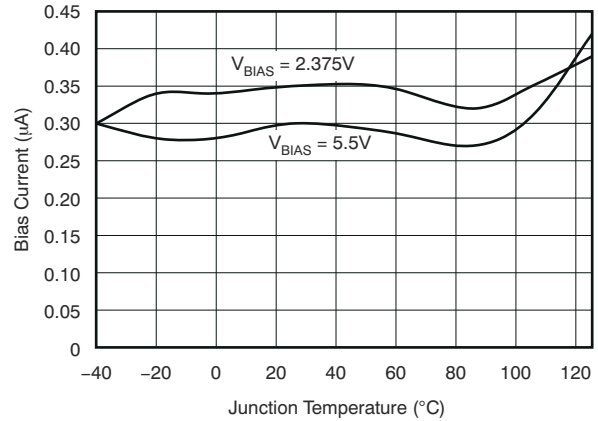
Figure 5-24.  $I_{BIAS}$  vs  $V_{BIAS}$  and  $V_{OUT}$  (legacy chip)

## 5.6 Typical Characteristics (continued)

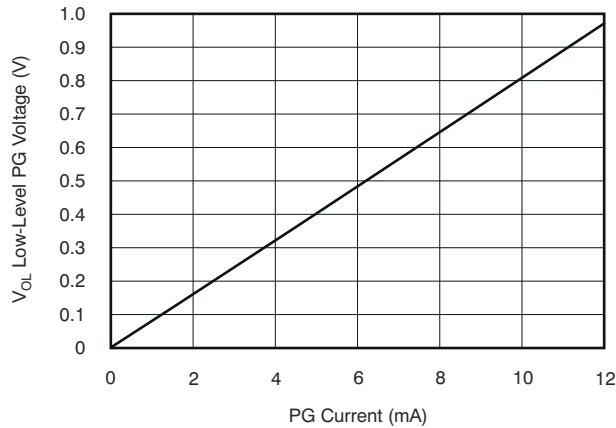
at  $T_J = 25^\circ\text{C}$ ,  $V_{OUT} = 1.5\text{V}$ ,  $V_{IN} = V_{OUT(NOM)} + 0.3\text{V}$ ,  $V_{BIAS} = 3.3\text{V}$  (legacy chip),  $V_{BIAS} = 5.0\text{V}$  (new chip),  $I_{OUT} = 50\text{mA}$ ,  $V_{EN} = V_{IN}$ ,  $C_{IN} = 1\mu\text{F}$ ,  $C_{BIAS} = 4.7\mu\text{F}$ ,  $C_{SS} = 0.01\mu\text{F}$  (legacy chip), and  $C_{OUT} = 10\mu\text{F}$  (unless otherwise noted)



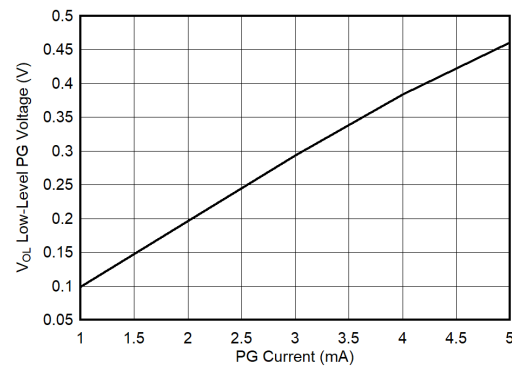
**Figure 5-25. BIAS Pin Current vs  $V_{BIAS}$  and Temperature ( $T_J$ ) (new chip)**



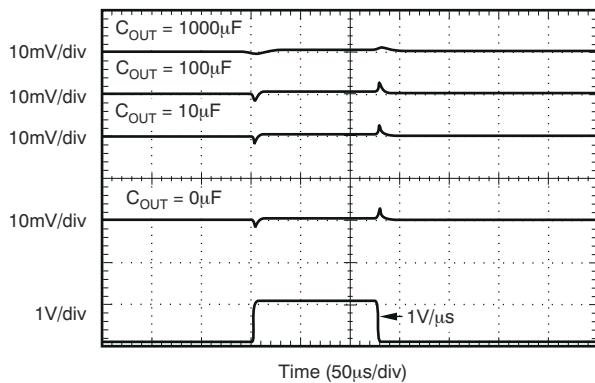
**Figure 5-26.  $I_{BIAS}$  Shutdown vs Temperature (legacy chip)**



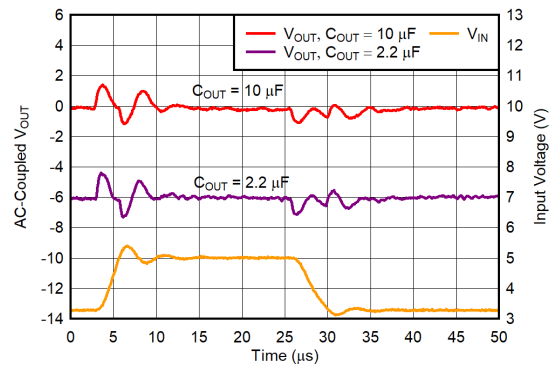
**Figure 5-27. Low-Level PG Voltage vs PG Current (legacy chip)**



**Figure 5-28. Low-Level PG Voltage vs Current (new chip)**



**Figure 5-29.  $V_{BIAS}$  Line Transient (1.5A) (legacy chip)**



**Figure 5-30.  $V_{BIAS}$  Line Transient (new chip)**

## 5.6 Typical Characteristics (continued)

at  $T_J = 25^\circ\text{C}$ ,  $V_{OUT} = 1.5\text{V}$ ,  $V_{IN} = V_{OUT(NOM)} + 0.3\text{V}$ ,  $V_{BIAS} = 3.3\text{V}$  (legacy chip),  $V_{BIAS} = 5.0\text{V}$  (new chip),  $I_{OUT} = 50\text{mA}$ ,  $V_{EN} = V_{IN}$ ,  $C_{IN} = 1\mu\text{F}$ ,  $C_{BIAS} = 4.7\mu\text{F}$ ,  $C_{SS} = 0.01\mu\text{F}$  (legacy chip), and  $C_{OUT} = 10\mu\text{F}$  (unless otherwise noted)

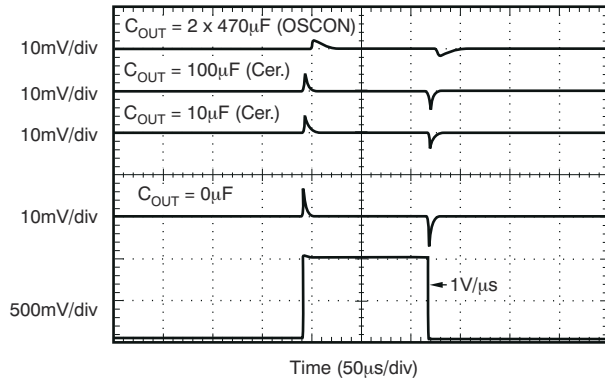
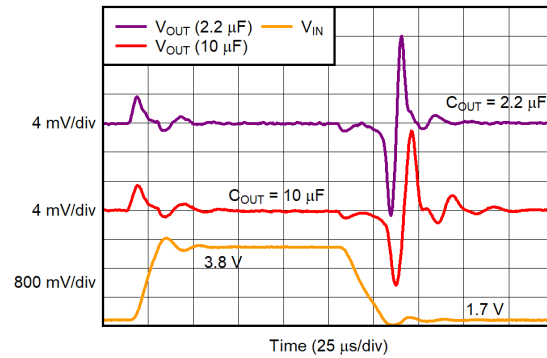


Figure 5-31.  $V_{IN}$  Line Transient (legacy chip)



New chip

Figure 5-32.  $V_{IN}$  Line Transient (new chip)

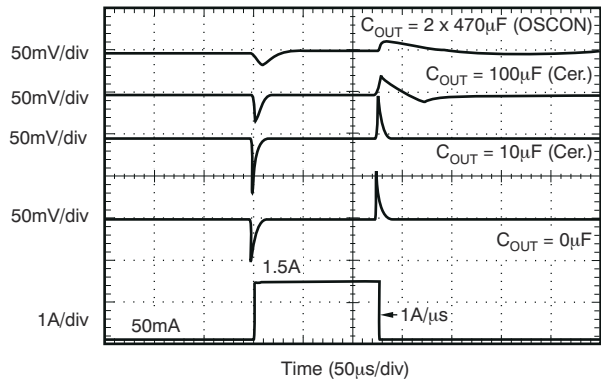


Figure 5-33. Output Load Transient Response (legacy chip)

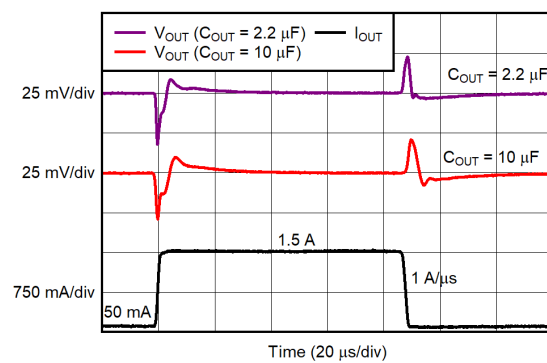


Figure 5-34. Output Load Transient Response (new chip)

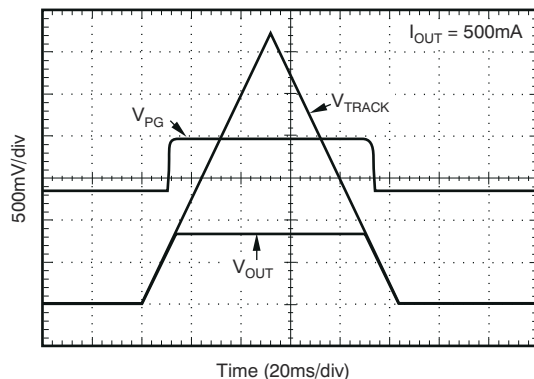


Figure 5-35. Tracking Response (legacy chip)

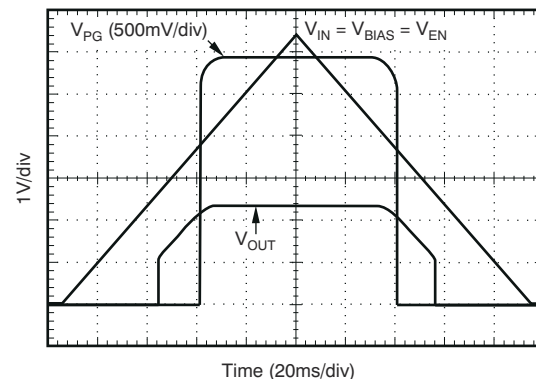
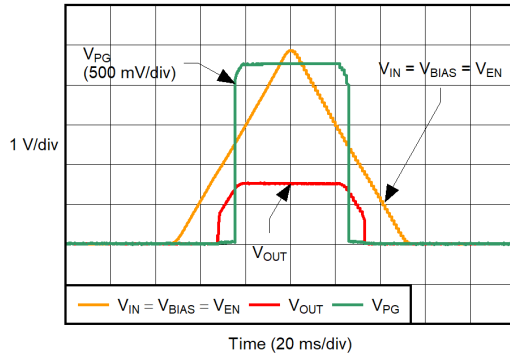


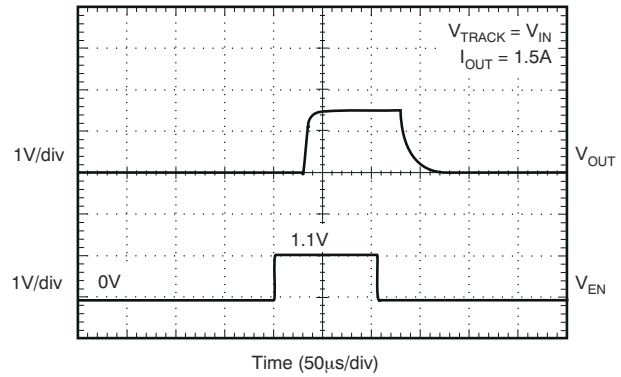
Figure 5-36. Power-Up/Power-Down (legacy chip)

## 5.6 Typical Characteristics (continued)

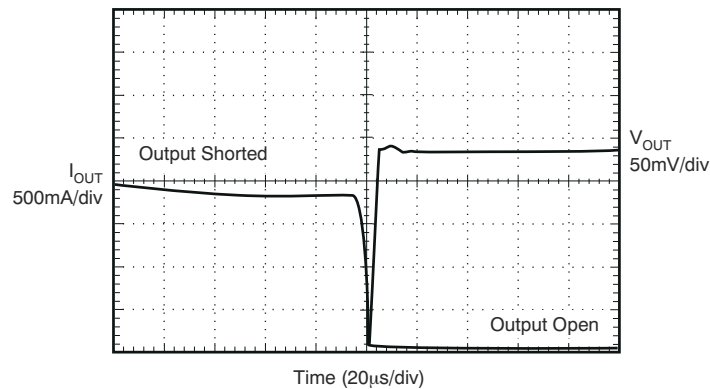
at  $T_J = 25^\circ\text{C}$ ,  $V_{OUT} = 1.5\text{V}$ ,  $V_{IN} = V_{OUT(NOM)} + 0.3\text{V}$ ,  $V_{BIAS} = 3.3\text{V}$  (legacy chip),  $V_{BIAS} = 5.0\text{V}$  (new chip),  $I_{OUT} = 50\text{mA}$ ,  $V_{EN} = V_{IN}$ ,  $C_{IN} = 1\mu\text{F}$ ,  $C_{BIAS} = 4.7\mu\text{F}$ ,  $C_{SS} = 0.01\mu\text{F}$  (legacy chip), and  $C_{OUT} = 10\mu\text{F}$  (unless otherwise noted)



**Figure 5-37. Power-Up, Power-Down (new chip)**



**Figure 5-38. Turn-On Response (legacy chip)**



**Figure 5-39. Output Short Circuit Recovery**

## 6 Detailed Description

### 6.1 Overview

The TPS743 belongs to a family of ultra-low dropout regulators that feature soft-start and tracking capabilities. These regulators use a low current bias input to power all internal control circuitry, allowing the NMOS pass transistor to regulate very low input and output voltages.

The use of an NMOS-pass FET offers several critical advantages for many applications. Unlike a PMOS topology device, the output capacitor has little effect on loop stability. This architecture allows the TPS743 devices to be stable with any output capacitor  $\geq 2.2\mu\text{F}$ . Transient response is also superior to PMOS topologies, particularly for low  $V_{\text{IN}}$  applications.

The TPS743 devices features a TRACK pin that allows the output to track an external supply. This feature is useful in minimizing the stress on ESD structures that are present between the CORE and I/O power pins of many processors. A power-good (PG) output is also available to allow supply monitoring and sequencing of follow-on supplies. To control the output turn-on, an enable (EN) pin with hysteresis and deglitch is provided to allow slow-ramping signals to be utilized for sequencing the device. The low  $V_{\text{IN}}$  and  $V_{\text{OUT}}$  capability allows for inexpensive, easy-to-design, and efficient linear regulation between the multiple supply voltages often present in processor intensive systems.

### 6.2 Functional Block Diagram

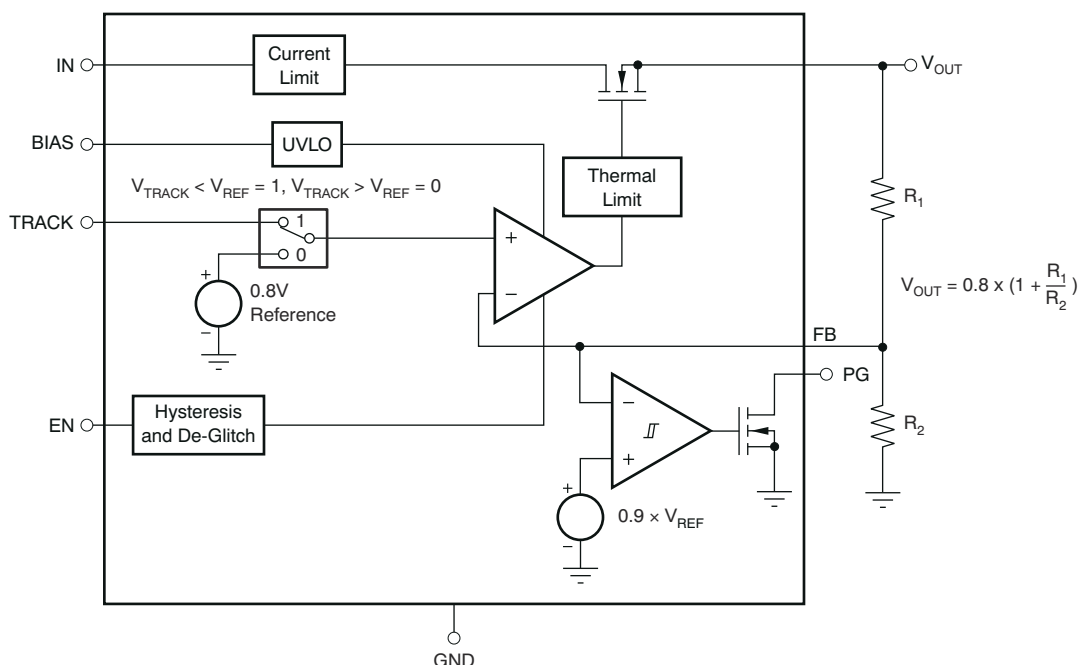


Figure 6-1. Legacy chip Functional Block Diagram





### Figure 6-2. New chip Functional Block Diagram

## 6.3 Feature Description

### 6.3.1 Enable/Shutdown

The enable (EN) pin is active high and is compatible with standard digital signaling levels.  $V_{EN}$  below 0.4V turns the regulator off, while  $V_{EN}$  above 1.1V turns the regulator on. Unlike many regulators, the enable circuitry has hysteresis and deglitching for use with relatively slow-ramping analog signals. This configuration allows the TPS743 to be enabled by connecting the output of another supply to the EN pin. The enable circuitry typically has 50mV of hysteresis and a deglitch circuit to help avoid on-off cycling because of small glitches in the  $V_{EN}$  signal.

The enable threshold is typically 0.8V and varies with temperature and process variations. Temperature variation is approximately  $-1\text{mV}/^{\circ}\text{C}$ ; therefore, process variation accounts for most of the variation in the enable threshold. If precise turn-on timing is required, a fast rise-time signal must be used to enable the TPS743.

If not used, EN can be connected to either IN or BIAS. If EN is connected to IN, EN must be connected as close as possible to the largest capacitance on the input to prevent voltage droops on that line from triggering the enable circuit.

### 6.3.2 Power-Good (QFN Package Only)

The power-good (PG) pin is an open-drain output and can be connected to any 5.5V or lower rail through an external pullup resistor. This pin requires at least 1.1V on  $V_{BIAS}$  to have a valid output. The PG output is high-impedance when  $V_{OUT}$  is greater than  $V_{IT} + V_{HYS}$ . If  $V_{OUT}$  drops below  $V_{IT}$  or if  $V_{BIAS}$  drops below 1.9V, the open-drain output turns on and pulls the PG output low. The PG pin also asserts when the device is disabled. The recommended operating condition of PG pin sink current is up to 1mA, so the pullup resistor for PG must be in the range of 10k $\Omega$  to 1M $\Omega$ . PG is only provided on the QFN package. If output voltage monitoring is not needed, the PG pin can be left floating.

### 6.3.3 Internal Current Limit

The TPS743 features a factory-trimmed, accurate current limit that is flat over temperature and supply voltage. The current limit allows the device to supply surges of up to 1.8A and maintain regulation. The current limit responds in about 10 $\mu\text{s}$  to reduce the current during a short-circuit fault. Recovery from a short-circuit condition is well-controlled and results in very little output overshoot when the load is removed. See Output Short-Circuit Recovery in the *Typical Characteristics* section for output short-circuit recovery performance.

The internal current limit protection circuitry of the TPS743 is designed to protect against overload conditions. This circuitry is not intended to allow operation above the rated current of the device. Continuously running the TPS743 above the rated current degrades device reliability.

## 6.4 Device Functional Modes

### 6.4.1 Normal Operation

The device regulates to the nominal output voltage under the following conditions:

- The input voltage and bias voltage are both at least at the respective minimum specifications.
- The enable voltage has previously exceeded the enable rising threshold voltage and has not decreased below the enable falling threshold.
- The output current is less than the current limit.
- The device junction temperature is less than the maximum specified junction temperature.
- The device is not operating in dropout.

### 6.4.2 Dropout Operation

If the input voltage is lower than the nominal output voltage plus the specified dropout voltage, but all other conditions are met for normal operation, the device operates in dropout mode. In this condition, the output voltage is the same as the input voltage minus the dropout voltage. The transient performance of the device is significantly degraded because the pass device is in a triode state and no longer controls the current through the LDO. Line or load transients in dropout can result in large output voltage deviations.

### 6.4.3 Disabled

The device is disabled under the following conditions:

- The input or bias voltages are below the respective minimum specifications.
- The enable voltage is less than the enable falling threshold voltage or has not yet exceeded the enable rising threshold.
- The device junction temperature is greater than the thermal shutdown temperature.

Table 6-1 shows the conditions that lead to the different modes of operation.

**Table 6-1. Device Functional Mode Comparison**

OPERATING MODE	PARAMETER				
	$V_{IN}$	$V_{EN}$	$V_{BIAS}$	$I_{OUT}$	$T_J$
Normal mode	$V_{IN} > V_{OUT(nom)} + V_{DO}(V_{IN})$	$V_{EN} > V_{EN(high)}$	$V_{BIAS} \geq V_{OUT} + 1.4\text{ V}$	$I_{OUT} < I_{CL}$	$T_J < 125^\circ\text{C}$
Dropout mode	$V_{IN} < V_{OUT(nom)} + V_{DO}(V_{IN})$	$V_{EN} > V_{EN(high)}$	$V_{BIAS} < V_{OUT} + 1.4\text{ V}$	—	$T_J < 125^\circ\text{C}$
Disabled mode (any true condition disables the device)	$V_{IN} < V_{IN(min)}$	$V_{EN} < V_{EN(low)}$	$V_{BIAS} < V_{BIAS(min)}$	—	$T_J > 155^\circ\text{C}$

## 7 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, as well as validating and testing their design implementation to confirm system functionality.

### 7.1 Application Information

#### 7.1.1 Input, Output, and Bias Capacitor Requirements

The legacy chip device does not require any output capacitor for stability, however, the new chip requires an output capacitor of 2.2 $\mu$ F or greater. If an output capacitor is needed, the device is designed to be stable for all available types and values of output capacitance. The device is also stable with multiple capacitors in parallel, of any type or value.

The capacitance required on the IN and BIAS pins is strongly dependent on the input supply source impedance. To counteract any inductance in the input, the minimum recommended capacitor for  $V_{IN}$  and  $V_{BIAS}$  is 1 $\mu$ F. If  $V_{IN}$  and  $V_{BIAS}$  are connected to the same supply, the recommended minimum capacitor for  $V_{BIAS}$  is 4.7 $\mu$ F. Good quality, low ESR capacitors must be used on the input; ceramic X5R and X7R capacitors are preferred. These capacitors must be placed as close the pins as possible for optimum performance.

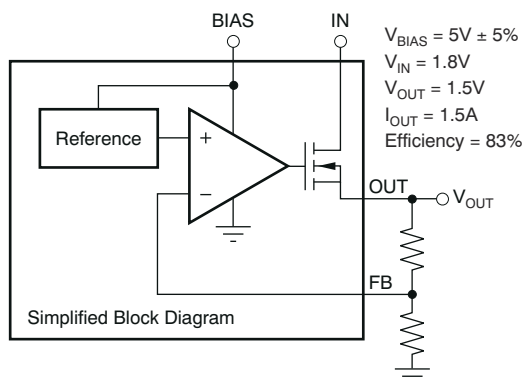
#### 7.1.2 Transient Response

The TPS743 is designed to have transient response within 5% for most applications without any output capacitor. In some cases, the transient response can be limited by the transient response of the input supply. This limitation is especially true in applications where the difference between the input and output is less than 300mV. In this case, adding additional input capacitance improves the transient response much more than just adding additional output capacitance. With a solid input supply, adding additional output capacitance reduces undershoot and overshoot during a transient at the expense of a slightly longer  $V_{OUT}$  recovery time. Refer to Output Load Transient Response in the *Typical Characteristics* section. Because the legacy chip is stable without an output capacitor and the new chip is stable with output capacitors  $\geq 2.2\mu$ F, many applications can allow for little or no capacitance at the LDO output. For these applications, local bypass capacitance for the device under power can be sufficient to meet the transient requirements of the application. This design reduces the total solution cost by avoiding the need to use expensive high-value capacitors at the LDO output.

#### 7.1.3 Dropout Voltage

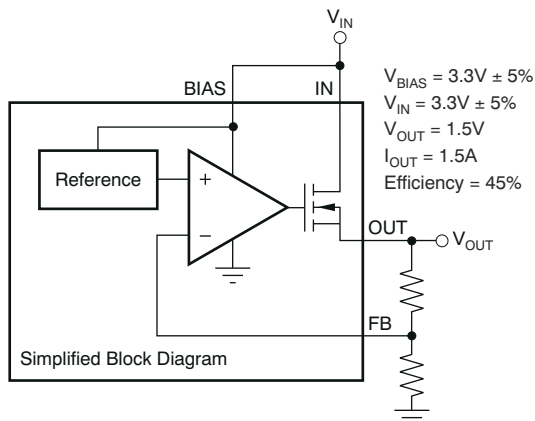
The TPS743 offers industry-leading dropout performance, making the device well-suited for high-current low  $V_{IN}$ /low  $V_{OUT}$  applications. The extremely low dropout of the TPS743 allows the device to be used instead of a DC/DC converter and still achieve good efficiencies. This efficiency allows users to rethink the power architecture for user applications to find the smallest, simplest, and lowest cost solution.

There are two different specifications for dropout voltage with the TPS743. The first specification (as shown in [Figure 7-1](#)) is referred to as  $V_{IN}$  Dropout and is for users wishing to apply an external bias voltage to achieve low dropout. This specification assumes that  $V_{BIAS}$  is at least 1.62V above  $V_{OUT}$ , which is the case for  $V_{BIAS}$  when powered by a 3.3V rail with 5% tolerance and with  $V_{OUT} = 1.5$ V. If  $V_{BIAS}$  is higher than  $3.3\text{V} \times 0.95$  or  $V_{OUT}$  is less than 1.5V,  $V_{IN}$  dropout is less than specified.



**Figure 7-1. Typical Application of the TPS743 Using an Auxiliary Bias Rail**

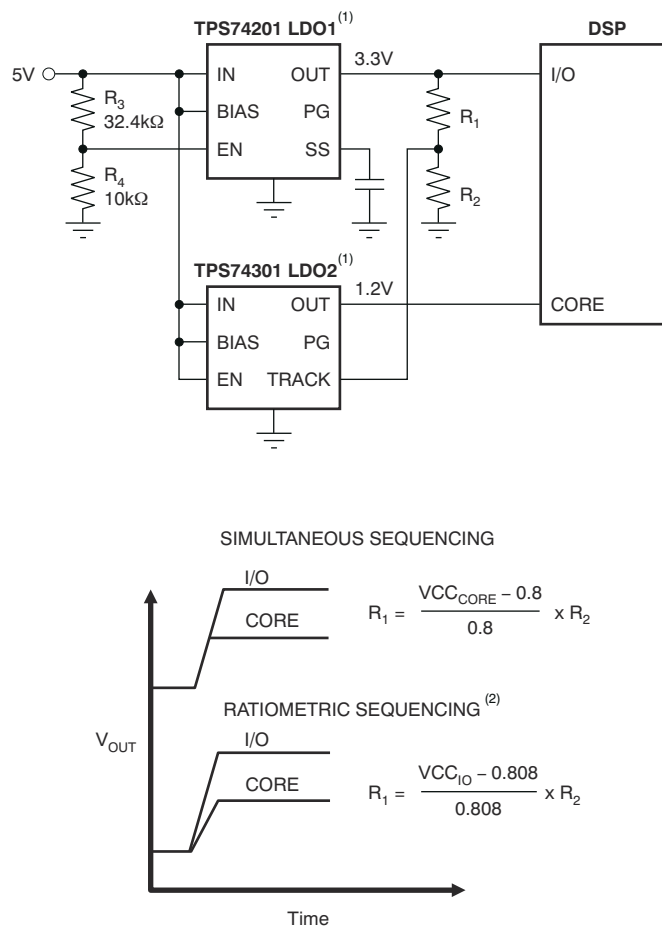
The second specification (shown in [Figure 7-2](#)), referred to as  $V_{BIAS}$  Dropout, is for users who wish to tie IN and BIAS together. This option allows the device to be used in applications where an auxiliary bias voltage is unavailable or low dropout is not required. Dropout is limited by BIAS in these applications because  $V_{BIAS}$  provides the gate drive to the pass FET, and therefore must be 1.4V above  $V_{OUT}$ . Because of this usage, IN and BIAS tied together easily consume huge power. Pay attention not to exceed the power rating of the IC package.



**Figure 7-2. Typical Application of the TPS743xx Without an Auxiliary Bias**

### 7.1.4 Programmable Sequencing With Track

The TPS743 features a track pin that allows the output to track an external supply at start-up. While the TRACK input is below 0.8V, the error amplifier regulates the FB pin to the TRACK input. Properly choosing the resistor divider network ( $R_1$  and  $R_2$ ) as shown in Figure 7-3 enables the regulator output to track the external supply to obtain a simultaneous or ratiometric start-up. Once the TRACK input reaches 0.8V, the error amplifier regulates the FB pin to the 0.8V internal reference. Further increases to the TRACK input have no effect.



- NOTES: (1) Capacitors on IN, BIAS, and OUT along with the resistors necessary to set the output voltage have been omitted for simplification.  
 (2) Lowest value for  $V_{CORE}$  and highest value for  $R_2$  should be used in this calculation.  $R_1$  must be the closest standard value below the calculated value for proper ratiometric sequencing.

**Figure 7-3. Various Sequencing Methods Using the TRACK Pin**

The maximum recommended value for  $R_2$  is 100kΩ. Once  $R_2$  is selected,  $R_1$  is calculated using one of the equations given in Figure 7-3.

### 7.1.5 Sequencing Requirements

The device can have  $V_{IN}$ ,  $V_{BIAS}$ ,  $V_{EN}$ , and  $V_{TRACK}$  sequenced in any order without causing damage to the device. However, for the track function to work as intended, certain sequencing rules must be applied.  $V_{BIAS}$  must be present and the device enabled before the track signal starts to ramp.  $V_{IN}$  must ramp up faster than the external supply being tracked so that the tracking signal does not drive the device into  $V_{IN}$  dropout as  $V_{OUT}$  ramps up. The preferred method to sequence the tracking device is to have  $V_{IN}$ ,  $V_{BIAS}$ , and  $V_{EN}$  above the minimum

required voltages before enabling the master supply to initiate the startup sequence. This method is illustrated in [Figure 7-3](#). Resistors  $R_3$  and  $R_4$  disable the master supply until the input voltage is above 3.52V (typical).

If the TRACK pin is not needed the pin must be connected to  $V_{IN}$  for the legacy chip, for the new chip this pin can be left floating. Configured in this way, the device starts up typically within 40 $\mu$ s (legacy chip) or 100 $\mu$ s (new chip), which can result in large inrush current that can cause the input supply to droop. If soft-start is needed, consider the [TPS742](#) or [TPS744](#) devices.

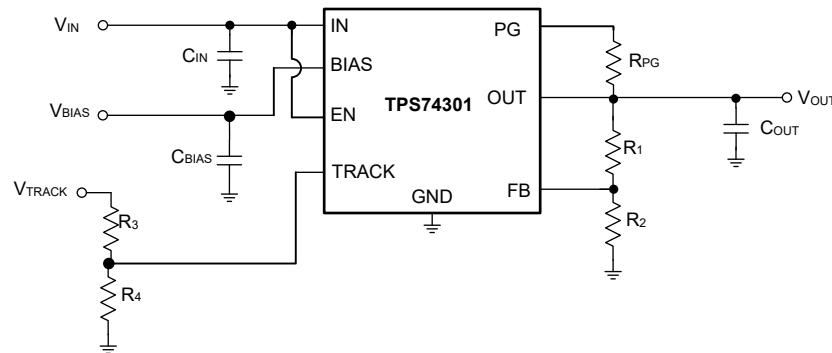
#### Note

**NOTE:** When  $V_{BIAS}$  and  $V_{EN}$  are present and  $V_{IN}$  is not supplied, this device outputs approximately 50 $\mu$ A of current from OUT. Although this condition does not cause any damage to the device, the output current can charge up the OUT node if total resistance between OUT and GND (including external feedback resistors) is greater than 10k $\Omega$ .

## 7.2 Typical Application

### 7.2.1 Adjustable Voltage Part and Setting

[Figure 7-4](#) is a typical application circuit for the TPS74301 adjustable device.



**Figure 7-4. Typical Application Circuit for the TPS74301**

$R_1$  and  $R_2$  can be calculated for any output voltage using the formula shown in [Table 7-1](#). Refer to [Table 7-1](#) for sample resistor values of common output voltages. To achieve the maximum accuracy specifications,  $R_2$  must be  $\leq 4.99$ k $\Omega$ .

**Table 7-1. Standard 1% Resistor Values for Programming the Output Voltage <sup>(1)</sup>**

$R_1$ (k $\Omega$ )	$R_2$ (k $\Omega$ )	$V_{OUT}$ (V)
Short	Open	0.8
0.619	4.99	0.9
1.13	4.53	1.0
1.37	4.42	1.05
1.87	4.99	1.1
2.49	4.99	1.2
4.12	4.75	1.5
3.57	2.87	1.8
3.57	1.69	2.5
3.57	1.15	3.3

(1)  $V_{OUT} = 0.8 \times (1 + R_1/R_2)$

### 7.2.2 Design Requirements

The design goals are  $V_{IN} = 1.8\text{ V}$ ,  $V_{OUT} = 1.5\text{ V}$ , and  $I_{OUT} = 1\text{ A}$  (maximum). The design optimizes transient response and meets a 1-ms start-up time with a start-up dominated by the soft-start feature. The input supply comes from a supply on the same circuit board. The available system rails for  $V_{BIAS}$  are 2.7 V, 3.3 V, and 5 V.

The design space consists of  $C_{IN}$ ,  $C_{OUT}$ ,  $C_{BIAS}$ ,  $C_{SS}$ ,  $V_{BIAS}$ ,  $R_1$ ,  $R_2$ , and  $R_3$ , and the circuit is from [Section 7.2.1](#).

This example uses a  $V_{IN}$  of 1.8 V, with a  $V_{BIAS}$  of 2.5 V.

**Table 7-2. Design Parameters**

PARAMETER	VALUE
$V_{IN}$	1.8V
$V_{OUT}$	1.5V
$I_{OUT}$	1A
$V_{BIAS}$	2.5V

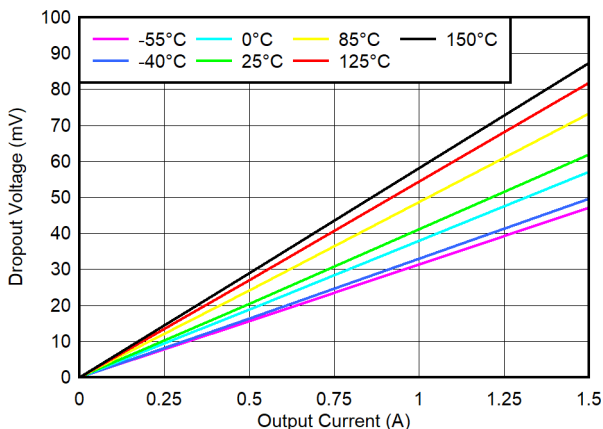
### 7.2.3 Detailed Design Procedure

This is assuming the table for the standard capacitor values is put back in as [Table 6-1](#).

Using [Section](#) ,  $R_1$  is selected to be 4.12 k $\Omega$  for  $V_{OUT} = 1.5\text{ V}$  and  $R_2$  is 4.75 k $\Omega$ . Using [Section 6.4](#),  $C_{SS}$  is 1000 pF for a 1-ms typical start-up time. For optimal performance, 5-V rail for a Bias supply is used. And  $R_3$  of 100 k $\Omega$  is selected as the PG bus is used by other devices with additional 100-k $\Omega$  pullup resistors.

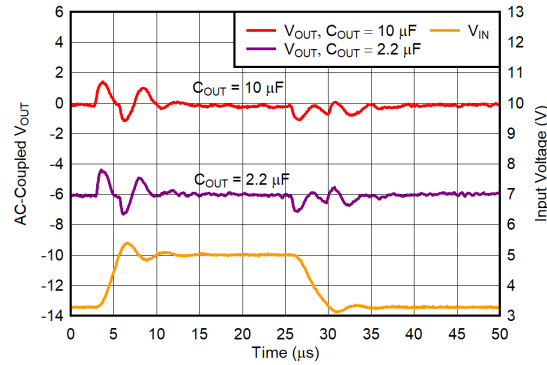
A  $C_{IN}$  of 10  $\mu\text{F}$  is used for better transient performance on the input supply, a  $C_{BIAS}$  of 1  $\mu\text{F}$  is used to verify that the Bias supply is solid, and a  $C_{OUT}$  of 1  $\mu\text{F}$  is used to provide some local capacitance on the output.

### 7.2.4 Application Performance Plots

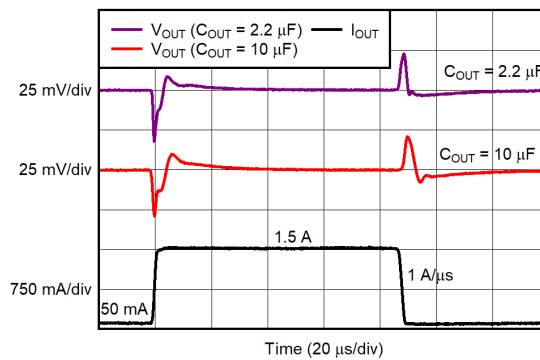


**Figure 7-5.  $V_{IN}$  Dropout Voltage vs  $I_{OUT}$  and Temperature ( $T_J$ )**

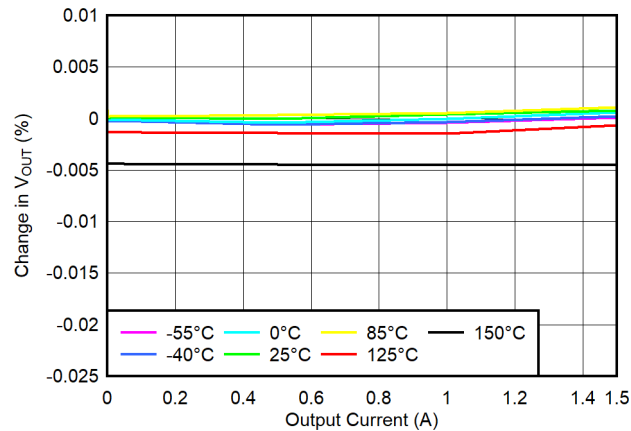




**Figure 7-6.  $V_{BIAS}$  Line Transient**



**Figure 7-7. Output Load Transient Response (new chip)**



**Figure 7-8. Load Regulation**

### 7.3 Power Supply Recommendations

The TPS743 devices are designed to operate from an input voltage from 1.1 V to 5.5 V, provided the bias rail is at least 1.4-V higher than the input supply. The bias rail and the input supply must both provide adequate headroom and current for the device to operate normally.

Connect a low-output impedance power supply directly to the IN pin of the TPS743 devices. This supply must have at least 1  $\mu$ F of capacitance near the IN pin for stability. A supply with similar requirements must also be connected directly to the bias rail with a separate 1  $\mu$ F or larger capacitor.

If the IN pin is tied to the bias pin, a minimum 4.7  $\mu\text{F}$  of capacitance is needed for stability.

To increase the overall PSRR of the solution at higher frequencies, use a pi-filter or ferrite bead before the input capacitor.

## 7.4 Layout

### 7.4.1 Layout Guidelines

#### 7.4.1.1 Layout Recommendations and Power Dissipation

An optimal layout can greatly improve transient performance, PSRR, and noise. To minimize the voltage droop on the input of the device during load transients, the capacitance on IN and BIAS must be connected as close as possible to the device. This capacitance also minimizes the effects of parasitic inductance and resistance of the input source and can therefore improve stability. To achieve optimal transient performance and accuracy, the top side of  $R_1$  in [Figure 7-4](#) must be connected as close as possible to the load. If BIAS is connected to IN, connecting the BIAS as close as possible to the sense point of the input supply is recommended. This connection minimizes the voltage droop on BIAS during transient conditions and can improve the turn-on response.

Knowing the device power dissipation and proper sizing of the thermal plane that is connected to the tab or pad is critical to avoiding thermal shutdown and providing reliable operation. Power dissipation of the device depends on input voltage and load conditions, and can be calculated using [Equation 1](#):

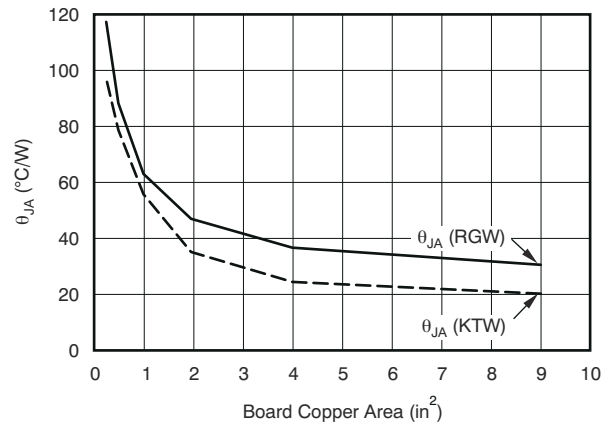
$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} \quad (1)$$

Power dissipation can be minimized and greater efficiency can be achieved by using the lowest possible input voltage necessary to achieve the required output voltage regulation.

On the QFN (RGW) package, the primary conduction path for heat is through the exposed pad to the printed circuit board (PCB). The pad can be connected to ground or be left floating; however, the pad must be attached to an appropriate amount of copper PCB area to verify the device does not overheat. On the DDPAK (KTW) package, the primary conduction path for heat is through the tab to the PCB. That tab must be connected to ground. The maximum junction-to-ambient thermal resistance depends on the maximum ambient temperature, maximum device junction temperature, and power dissipation of the device and can be calculated using [Equation 2](#):

$$R_{\theta JA} = \frac{(+125^{\circ}\text{C} - T_A)}{P_D} \quad (2)$$

Knowing the maximum  $R_{\theta JA}$ , the minimum amount of PCB copper area needed for appropriate heatsinking can be estimated using [Figure 7-9](#).



$\theta_{JA}$  value at board size of 9in<sup>2</sup> (that is, 3in × 3in) is a JEDEC standard.

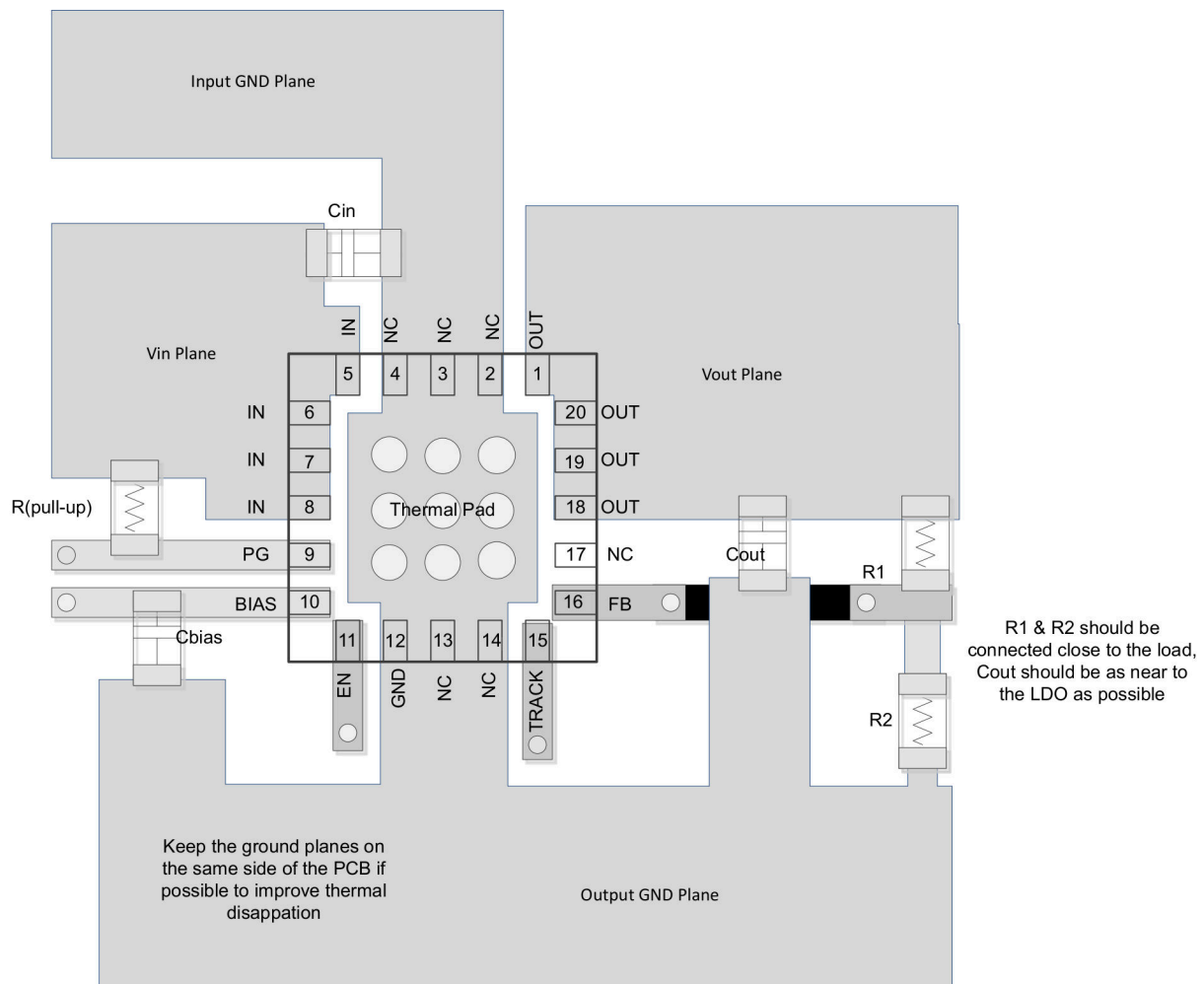
**Figure 7-9.  $\theta_{JA}$  vs Board Size**

[Figure 7-9](#) shows the variation of  $\theta_{JA}$  as a function of ground plane copper area in the board. This figure is intended only as a guideline to demonstrate the effects of heat spreading in the ground plane and must not be used to estimate actual thermal performance in real application environments.

**Note**

**NOTE:** When the device is mounted on an application PCB, using  $\Psi_{JT}$  and  $\Psi_{JB}$ , as explained in the [Section 7.4.1.1](#) section is strongly recommended.

### 7.4.2 Layout Example



**Figure 7-10. Layout Example**

### 7.4.3 Thermal Protection

Thermal protection disables the output when the junction temperature rises to approximately 165°C, allowing the device to cool. When the junction temperature cools to approximately 140°C, the output circuitry is enabled. Depending on power dissipation, thermal resistance, and ambient temperature the thermal protection circuit can cycle on and off. This cycling limits the dissipation of the regulator, protecting the regulator from damage as a result of overheating.

Activation of the thermal protection circuit indicates excessive power dissipation or inadequate heatsinking. For reliable operation, junction temperature must be limited to 125°C maximum. To estimate the margin of safety in a complete design (including heatsink), increase the ambient temperature until thermal protection is triggered; use worst-case loads and signal conditions. For good reliability, thermal protection must trigger at least 40°C above the maximum expected ambient condition of the application. This condition produces a worst-case junction temperature of 125°C at the highest expected ambient temperature and worst-case load.

The internal protection circuitry of the TPS743 is designed to protect against overload conditions. The circuitry is not intended to replace proper heatsinking. Continuously running the TPS743 into thermal shutdown degrades device reliability.

#### 7.4.4 Estimating Junction Temperature

Using the thermal metrics  $\Psi_{JT}$  and  $\Psi_{JB}$ , shown in the [Section 5.4](#) table, the junction temperature can be estimated with corresponding formulas (given in [Equation 3](#)). For backwards compatibility, an older  $\theta_{JC, Top}$  parameter is listed as well.

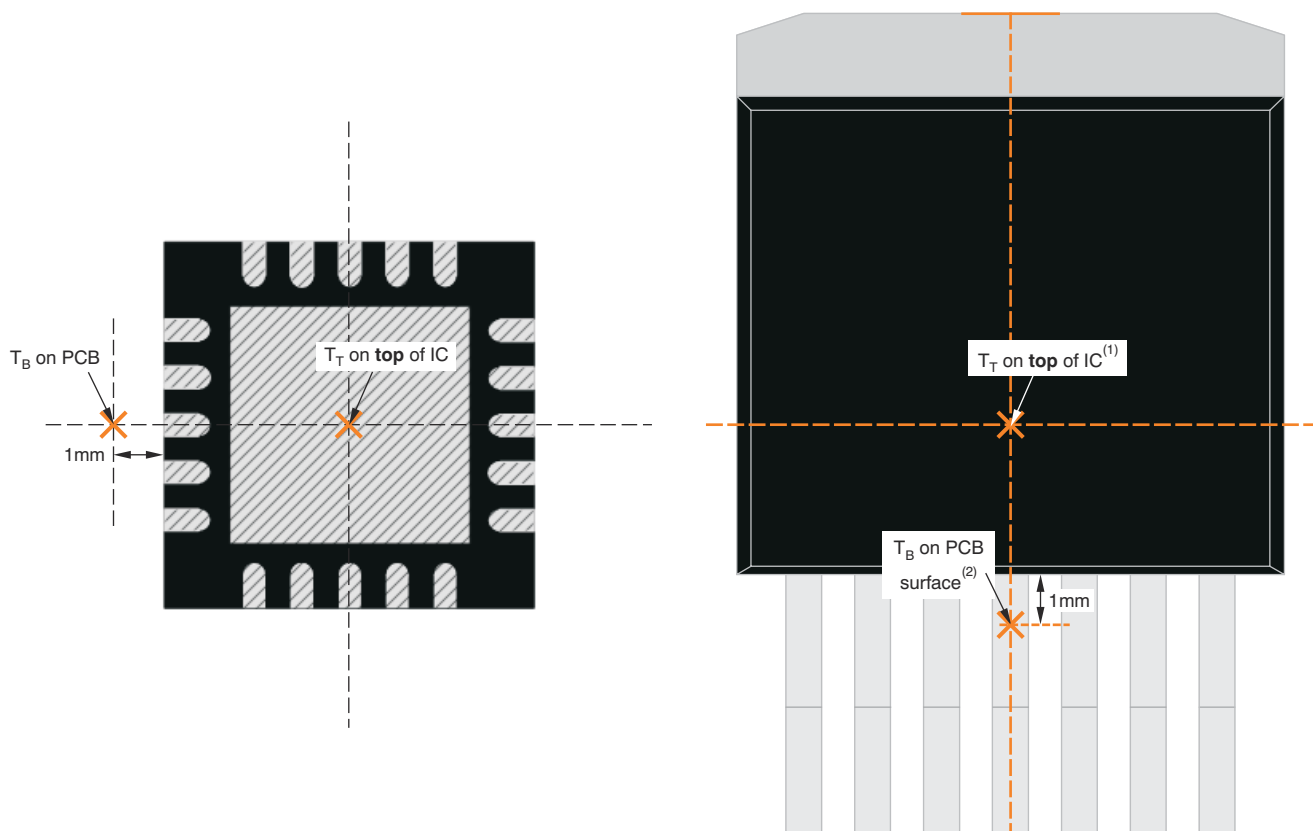
$$\begin{aligned}\Psi_{JT}: T_J &= T_T + \Psi_{JT} \cdot P_D \\ \Psi_{JB}: T_J &= T_B + \Psi_{JB} \cdot P_D\end{aligned}\tag{3}$$

Where  $P_D$  is the power dissipation shown by [Equation 1](#),  $T_T$  is the temperature at the center-top of the IC package, and  $T_B$  is the PCB temperature measured 1mm away from the IC package *on the PCB surface* (as [Figure 7-11](#) shows).

#### Note

**NOTE:** Both  $T_T$  and  $T_B$  can be measured on actual application boards using a thermo-gun (an infrared thermometer).

For more information about measuring  $T_T$  and  $T_B$ , see the [Using New Thermal Metrics](#) application note, available for download at [www.ti.com](http://www.ti.com).



(a) Example RGW (QFN) Package Measurement

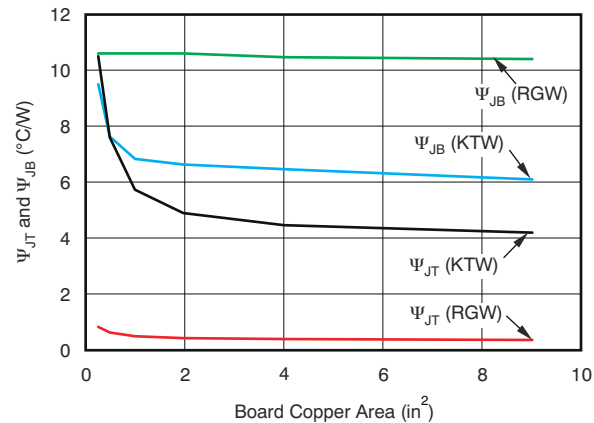
(b) Example KTW (DDPAK) Package Measurement

- $T_T$  is measured at the center of both the X- and Y-dimensional axes.
- $T_B$  is measured **below** the package lead **on the PCB surface**.

**Figure 7-11. Measuring Points for  $T_T$  and  $T_B$**

Compared with  $\theta_{JA}$ , the thermal metrics  $\Psi_{JT}$  and  $\Psi_{JB}$  are less independent of board size, but these metrics do have a small dependency. Figure 7-12 shows characteristic performance of  $\Psi_{JT}$  and  $\Psi_{JB}$  versus board size.

Looking at Figure 7-12, the RGW package thermal performance has negligible dependency on board size. The KTW package, however, does have a measurable dependency on board size. This dependency exists because the package shape is not point-symmetric to an IC center. In the KTW package, for example (see Figure 7-11), silicon is not beneath the measuring point of  $T_T$  which is the center of the X and Y dimension, so that  $\Psi_{JT}$  has a dependency. Also, because of that non-point-symmetry, device heat distribution on the PCB is not point-symmetric, either, so that  $\Psi_{JB}$  has a dependency.



**Figure 7-12.  $\Psi_{JT}$  and  $\Psi_{JB}$  vs Board Size**

For a more detailed discussion of why TI does not recommend using  $\theta_{JC,Top}$  to determine thermal characteristics, refer to the [Using New Thermal Metrics](#) application note, available for download at [www.ti.com](http://www.ti.com). Also, refer to the [IC Package Thermal Metrics](#) application note (also available on the TI web site) for further information.

## 8 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

### 8.1 Documentation Support

#### 8.1.1 Related Documentation

For related documentation see the following:

- Texas Instruments, [6A Current-Sharing Dual LDO design guide](#)
- Texas Instruments, [Using New Thermal Metrics application note](#)

#### 8.1.2 Device Nomenclature

**Table 8-1. Device Nomenclature**

PRODUCT <sup>(1)</sup>	V <sub>OUT</sub>
TPS74301yyyzM3	<p><b>yyy</b> is the package designator.</p> <p><b>z</b> is the package quantity.</p> <p><b>M3</b> is a suffix designator for devices that only use the latest manufacturing flow (CSO: RFB). Devices without this suffix can ship with the legacy chip (CSO: DLN) or the new chip (CSO: RFB). The reel packaging label provides CSO information to distinguish which chip is being used. Device performance for new and legacy chips is denoted throughout the document.</p>

(1) For the most current package and ordering information see the Package Option Addendum at the end of this document, or visit the device product folder on [www.ti.com](http://www.ti.com).

### 8.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](http://ti.com). Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

### 8.3 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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### 8.4 Trademarks

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### 8.5 Electrostatic Discharge Caution



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.

### 8.6 Glossary

[TI Glossary](#)

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

## 9 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

**Changes from Revision K (December 2009) to Revision L (December 2024)**

**Page**

- Updated the number formatting for tables, figures, and cross-references throughout the document..... 1
- Changed entire document to align with current family format..... 1
- Added M3 devices to document..... 1



Changes from Revision J (December, 2009) to Revision K (August, 2010)	Page
• Revised <a href="#">Layout Recommendations and Power Dissipation</a> section.....	26
• Revised <a href="#">Estimating Junction Temperature</a> section.....	29

## 10 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

## PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS74301KTWR	ACTIVE	DDPAK/ TO-263	KTW	7	500	RoHS & Green	Call TI   SN	Level-3-245C-168 HR	-40 to 85	TPS74301	<a href="#">Samples</a>
TPS74301RGWR	ACTIVE	VQFN	RGW	20	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	TPS 74301	<a href="#">Samples</a>
TPS74301RGWRG4	ACTIVE	VQFN	RGW	20	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	TPS 74301	<a href="#">Samples</a>
TPS74301RGWRM3	ACTIVE	VQFN	RGW	20	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	TPS 74301	<a href="#">Samples</a>
TPS74301RGWT	ACTIVE	VQFN	RGW	20	250	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	TPS 74301	<a href="#">Samples</a>
TPS74301RGWTG4	ACTIVE	VQFN	RGW	20	250	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	TPS 74301	<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.

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

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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.

<sup>(6)</sup> Lead finish/Ball material - Orderable Devices 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.

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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
TPS74301RGWR	VQFN	RGW	20	3000	330.0	12.4	5.3	5.3	1.5	8.0	12.0	Q2
TPS74301RGWRM3	VQFN	RGW	20	3000	330.0	12.4	5.3	5.3	1.1	8.0	12.0	Q2
TPS74301RGWT	VQFN	RGW	20	250	180.0	12.4	5.3	5.3	1.5	8.0	12.0	Q2

## TAPE AND REEL BOX DIMENSIONS

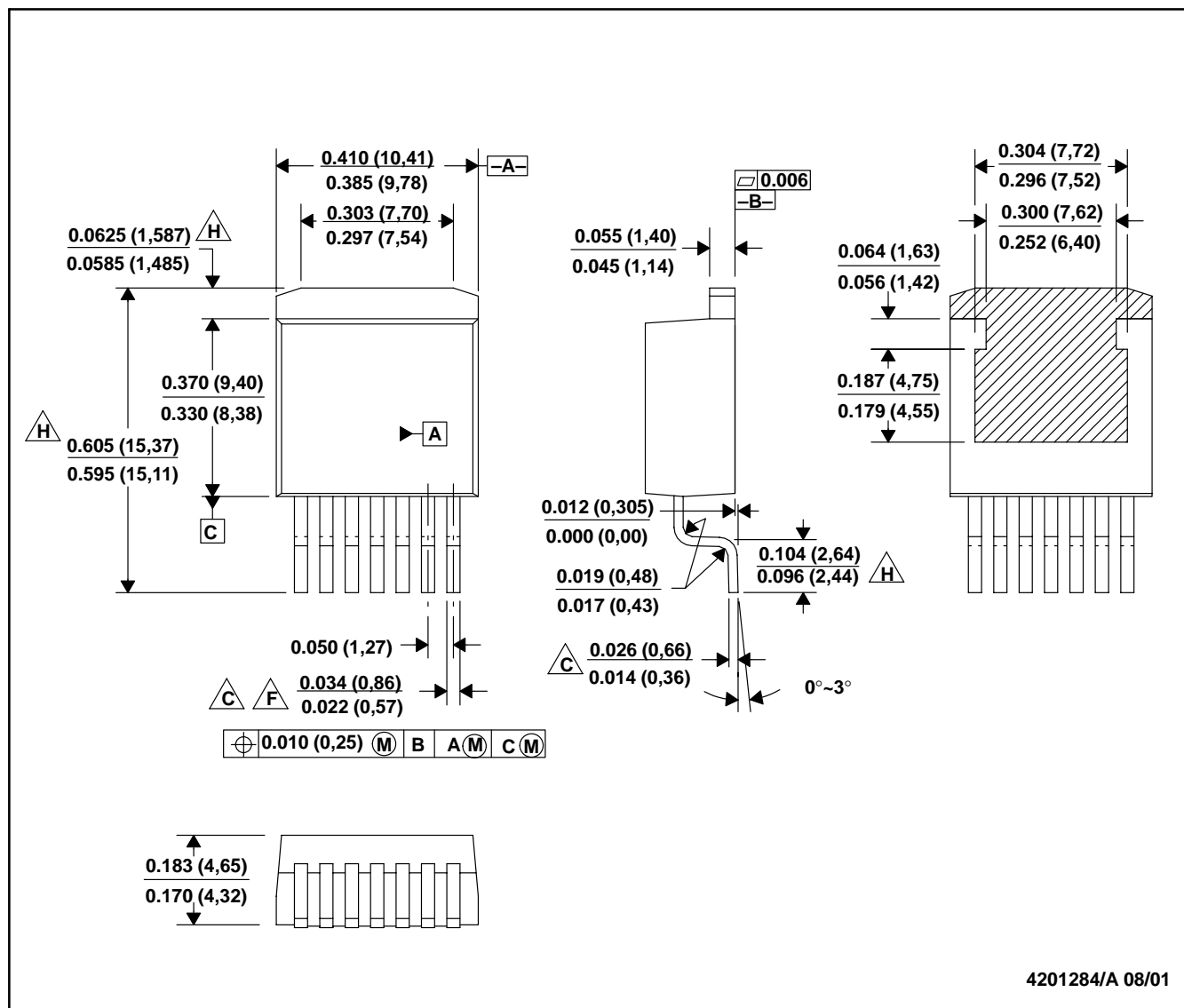


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS74301RGWR	VQFN	RGW	20	3000	356.0	356.0	35.0
TPS74301RGWRM3	VQFN	RGW	20	3000	367.0	367.0	35.0
TPS74301RGWT	VQFN	RGW	20	250	210.0	185.0	35.0

## KTW (R-PSFM-G7)

## PLASTIC FLANGE-MOUNT



- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - Lead width and height dimensions apply to the plated lead.
  - Leads are not allowed above the Datum B.
  - Stand-off height is measured from lead tip with reference to Datum B.
  - Lead width dimension does not include dambar protrusion. Allowable dambar protrusion shall not cause the lead width to exceed the maximum dimension by more than 0.003".
  - Cross-hatch indicates exposed metal surface.
  - Falls within JEDEC MO-169 with the exception of the dimensions indicated.

## GENERIC PACKAGE VIEW

**RGW 20**

**VQFN - 1 mm max height**

5 x 5, 0.65 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



4227157/A



**VQFN - 1 mm max height**

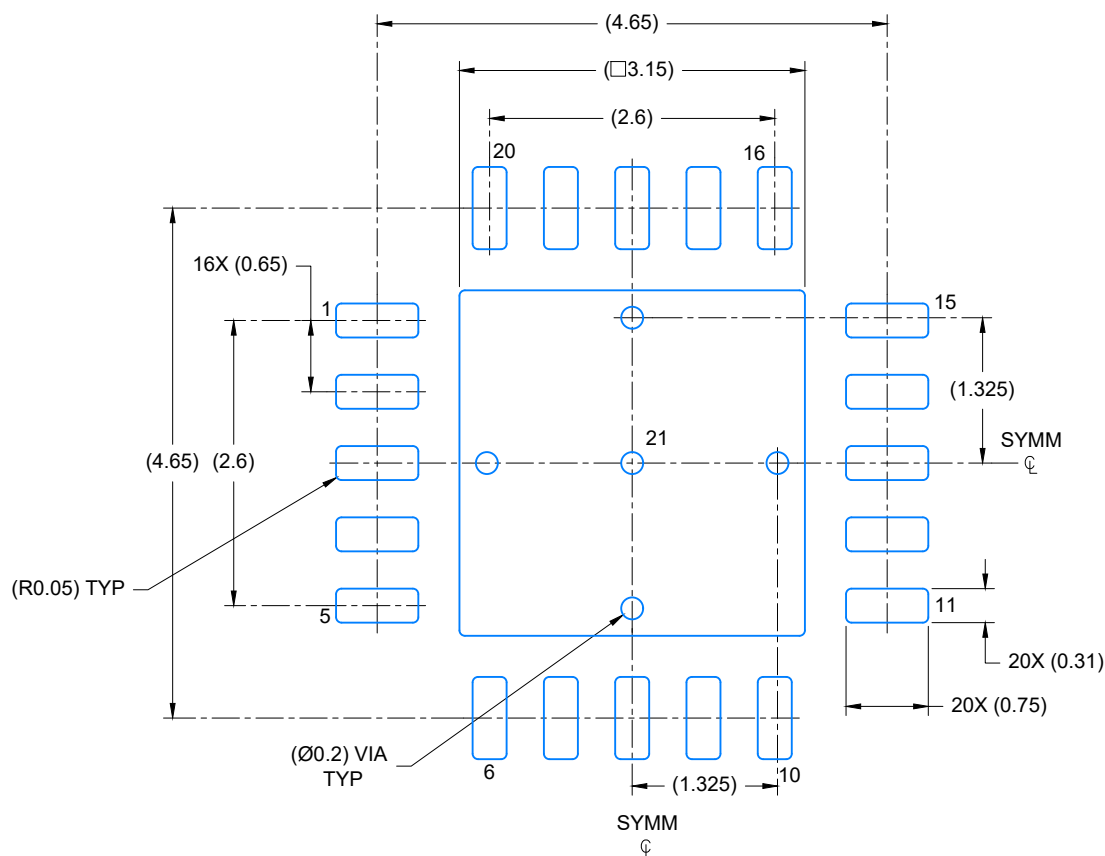
The drawing illustrates the mechanical specifications of a 20-pin connector. It includes three main views: a top view, a side view, and a detail view of the pin assembly.

**Top View:** Shows a square footprint with overall dimensions of 5.1 by 5.1. A shaded region in the top-left corner is designated as the "PIN 1 INDEX AREA". The width of this area is dimensioned as 4.9. The pin pitch is 2.6, with 16 pins on each of the four sides. A central square area is dimensioned as 3.15 ± 0.1. Symmetry is indicated by "SYMM" and center lines.

**Side View:** Shows the profile of the connector. The total height is 1 MAX. The seating plane is indicated by a triangle and the label "SEATING PLANE". The distance from the base to the seating plane is 0.05. The pin height is 0.08. A detail callout "C" points to the seating plane area.

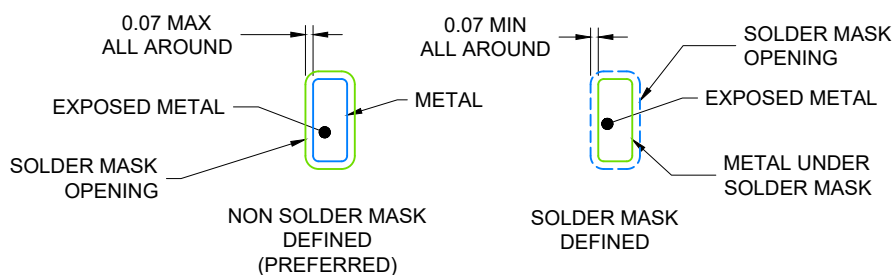
**Detail View:** Provides a close-up of the pin assembly. The pin pitch is 2.6. The pin height is 0.65. The pin width is 0.1. The pin spacing is 0.05. The pin is seated in a housing with a depth of 0.36. The housing thickness is 0.65. The pin is dimensioned as 20X 0.1 (M) C A B. The housing is dimensioned as 20X 0.05 (M) C. The pin is seated in a housing with a depth of 0.36. The housing thickness is 0.65. The pin is dimensioned as 20X 0.1 (M) C A B. The housing is dimensioned as 20X 0.05 (M) C.

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 optimal thermal and mechanical performance.



## LAND PATTERN EXAMPLE

SCALE: 15X



## SOLDER MASK DETAILS

4219039/A 06/2018

NOTES: (continued)

- This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
- Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

PLASTIC QUAD FLATPACK-NO LEAD

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