

4.5V to 23V Input, 2-A Synchronous Step-Down SWIFT™ Converter

Check for Samples: [TPS54239](#)

FEATURES

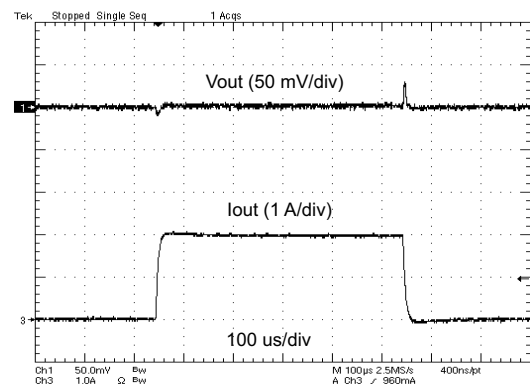
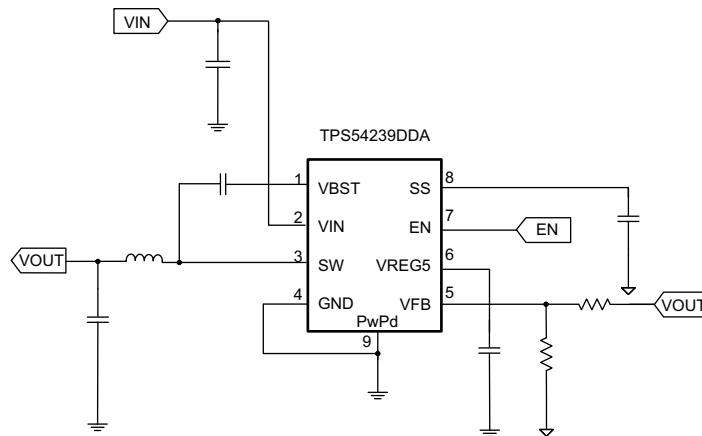
- **D-CAP2™ Mode Enables Fast Transient Response**
- **Low Output Ripple and Allows Ceramic Output Capacitor**
- **Wide V_{IN} Input Voltage Range: 4.5 V to 23 V**
- **Output Voltage Range: 0.76 V to 7.0 V**
- **Highly Efficient Integrated FETs Optimized for Lower Duty Cycle Applications**
 - 140 m Ω (High Side) and 70 m Ω (Low Side)
- **High Efficiency, less than 10 μ A at shutdown**
- **High Initial Bandgap Reference Accuracy**
- **Adjustable Soft Start**
- **Pre-Biased Soft Start**
- **600-kHz Switching Frequency (f_{SW})**
- **Cycle By Cycle Over Current Limit**

DESCRIPTION

The TPS54239 is an adaptive on-time D-CAP2™ mode synchronous buck converter. The TPS54239 enables system designers to complete the suite of various end-equipment power bus regulators with a cost effective, low component count, low standby current solution. The main control loop for the TPS54239 uses the D-CAP2™ mode control that provides a fast transient response with no external compensation components. The TPS54239 also has a proprietary circuit that enables the device to adopt to both low equivalent series resistance (ESR) output capacitors, such as POSCAP or SP-CAP, and ultra-low ESR ceramic capacitors. The device operates from 4.5-V to 23-V V_{IN} input. The output voltage can be programmed between 0.76 V and 7 V. The device also features an adjustable soft start time. The TPS54239 is available in the 8-pin DDA package, and designed to operate from -40°C to 85°C .

APPLICATIONS

- **Wide Range of Applications for Low Voltage System**
 - Digital TV Power Supply
 - High Definition Blu-ray Disc™ Players
 - Networking Home Terminal
 - Digital Set Top Box (STB)



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

D-CAP2 is a trademark of Texas Instruments.

Blu-ray Disc is a trademark of Blu-ray Disc Association.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

Copyright © 2013, Texas Instruments Incorporated



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

ORDERING INFORMATION⁽¹⁾

T _A	PACKAGE ⁽²⁾ ⁽³⁾	ORDERABLE PART NUMBER	PIN	TRANSPORT MEDIA
–40°C to 85°C	DDA	TPS54239DDA	8	Tube
		TPS54239DDAR		Tape and Reel

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
 (2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
 (3) All package options have Cu NIPDAU lead/ball finish.

ABSOLUTE MAXIMUM RATINGS

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

		VALUE		UNIT
		MIN	MAX	
Input voltage range	V _{IN} , EN	–0.3	25	V
	V _{BST}	–0.3	31	
	V _{BST} (10 ns transient)	–0.3	33	
	V _{BST} (vs SW)	–0.3	6.5	
	V _{FB} , SS	–0.3	6.5	
	SW	–2	25	
	SW (10 ns transient)	–3	27	
Output voltage range	V _{REG5}	–0.3	6.5	V
	GND	–0.3	0.3	
Voltage from GND to thermal pad, V _{diff}		–0.2	0.2	V
Electrostatic discharge	Human Body Model (HBM)		2	kV
	Charged Device Model (CDM)		500	V
Operating junction temperature, T _J		–40	150	°C
Storage temperature, T _{stg}		–55	150	

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

THERMAL INFORMATION

THERMAL METRIC ⁽¹⁾		TPS54239	UNITS
		DDA (8 PINS)	
θ _{JA}	Junction-to-ambient thermal resistance	46.2	°C/W
θ _{JCtop}	Junction-to-case (top) thermal resistance	53.9	
θ _{JB}	Junction-to-board thermal resistance	29.7	
ψ _{JT}	Junction-to-top characterization parameter	10.0	
ψ _{JB}	Junction-to-board characterization parameter	29.6	
θ _{JCbot}	Junction-to-case (bottom) thermal resistance	6.6	

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](http://www.ti.com/lit/an/spra953).

RECOMMENDED OPERATING CONDITIONS

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

			MIN	MAX	UNIT
V_{IN}	Supply input voltage range		4.5	23	V
V_I	Input voltage range	VBST	−0.1	29	V
		VBST (10 ns transient)	−0.1	32	
		VBST(vs SW)	−0.1	5.7	
		SS	−0.1	5.7	
		EN	−0.1	23	
		VFB	−0.1	5.5	
		SW	−1.8	23	
		SW (10 ns transient)	−3	26	
		GND	−0.1	0.1	
V_O	Output voltage range	VREG5	−0.1	5.7	V
I_O	Output Current range	I_{VREG5}	0	10	mA
T_A	Operating free-air temperature		−40	85	°C
T_J	Operating junction temperature		−40	150	°C

ELECTRICAL CHARACTERISTICS

over operating free-air temperature range, $V_{IN} = 12$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SUPPLY CURRENT						
I _{VIN}	Operating - non-switching supply current	V _{IN} current, T _A = 25°C, EN = 5V, V _{FB} = 0.8V	850	1200		μA
I _{VINSDN}	Shutdown supply current	V _{IN} current, T _A = 25°C, EN = 0 V	3.0	10		μA
LOGIC THRESHOLD						
V _{ENH}	EN high-level input voltage	EN	1.6			V
V _{ENL}	EN low-level input voltage	EN			0.6	V
R _{EN}	EN pin resistance to GND	V _{EN} = 12 V	200	400	800	kΩ
V _{FB} VOLTAGE AND DISCHARGE RESISTANCE						
V _{F_BTH}	V _{FB} threshold voltage	T _A = 25°C, V _O = 1.05 V, continuous mode operation	749	765	781	mV
I _{V_{FB}}	V _{FB} input current	V _{FB} = 0.8 V, T _A = 25°C		0	±0.1	μA
V _{REG5} OUTPUT						
V _{V_{REG5}}	V _{REG5} output voltage	T _A = 25°C, 6.0 V < V _{IN} < 23 V, 0 < I _{V_{REG5}} < 5 mA	5.2	5.5	5.7	V
I _{V_{REG5}}	Output current	V _{IN} = 6 V, V _{REG5} = 4.0 V, T _A = 25°C	20			mA
MOSFET						
R _{DS(on)h}	High side switch resistance	25°C, V _{BST} - SW = 5.5 V ⁽¹⁾		140		mΩ
R _{DS(on)l}	Low side switch resistance	25°C ⁽¹⁾		70		mΩ
CURRENT LIMIT						
I _{ocl}	Current limit	L out = 2.2 μH ⁽¹⁾	2.5	3.1	4.6	A
THERMAL SHUTDOWN						
T _{SDN}	Thermal shutdown threshold	Shutdown temperature ⁽¹⁾		165		°C
		Hysteresis ⁽¹⁾		40		
ON-TIME TIMER CONTROL						
t _{ON}	On time	V _{IN} = 12 V, V _O = 1.05 V		160		ns
t _{OFF(MIN)}	Minimum off time	T _A = 25°C, V _{FB} = 0.7 V ⁽¹⁾		260	310	ns

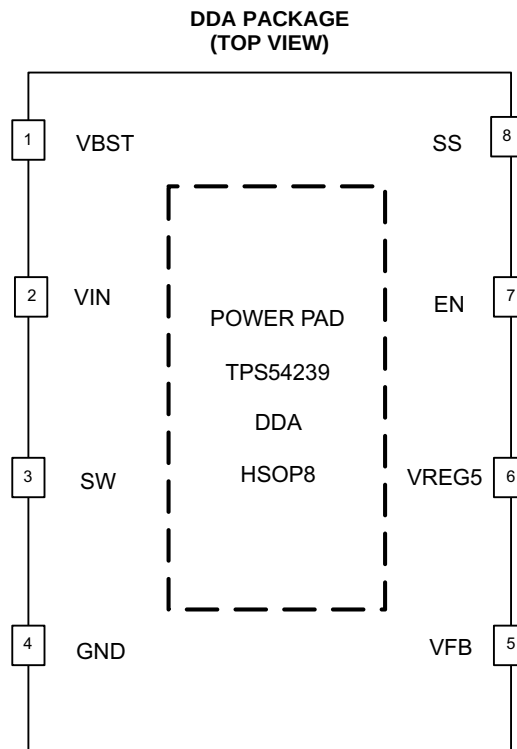
(1) Not production tested.

ELECTRICAL CHARACTERISTICS (continued)

over operating free-air temperature range, $V_{IN} = 12\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SOFT START						
I _{SSC}	SS charge current	V _{SS} = 1.0 V	4.2	6.0	7.8	μA
I _{SSD}	SS discharge current	V _{SS} = 0.5 V	0.8	1.5		mA
HICCUP AND OVERVOLTAGE PROTECTION						
V _{OVP}	Output OVP threshold	OVP Detect (L>H)	125%			
V _{UVP}	Output Hiccup threshold	Hiccup detect (H>L)	65%			
T _{UVPDEL}	Output Hiccup delay	to Hiccup state	6			μs
T _{UVPEN}	Output Hiccup Enable delay	Relative to soft-start time	x1.7			
UVLO						
UVLO	UVLO threshold	Wake up V _{REG5} voltage	3.45	3.75	4.05	V
		Hysteresis V _{REG5} voltage	0.17	0.33	0.47	

DEVICE INFORMATION



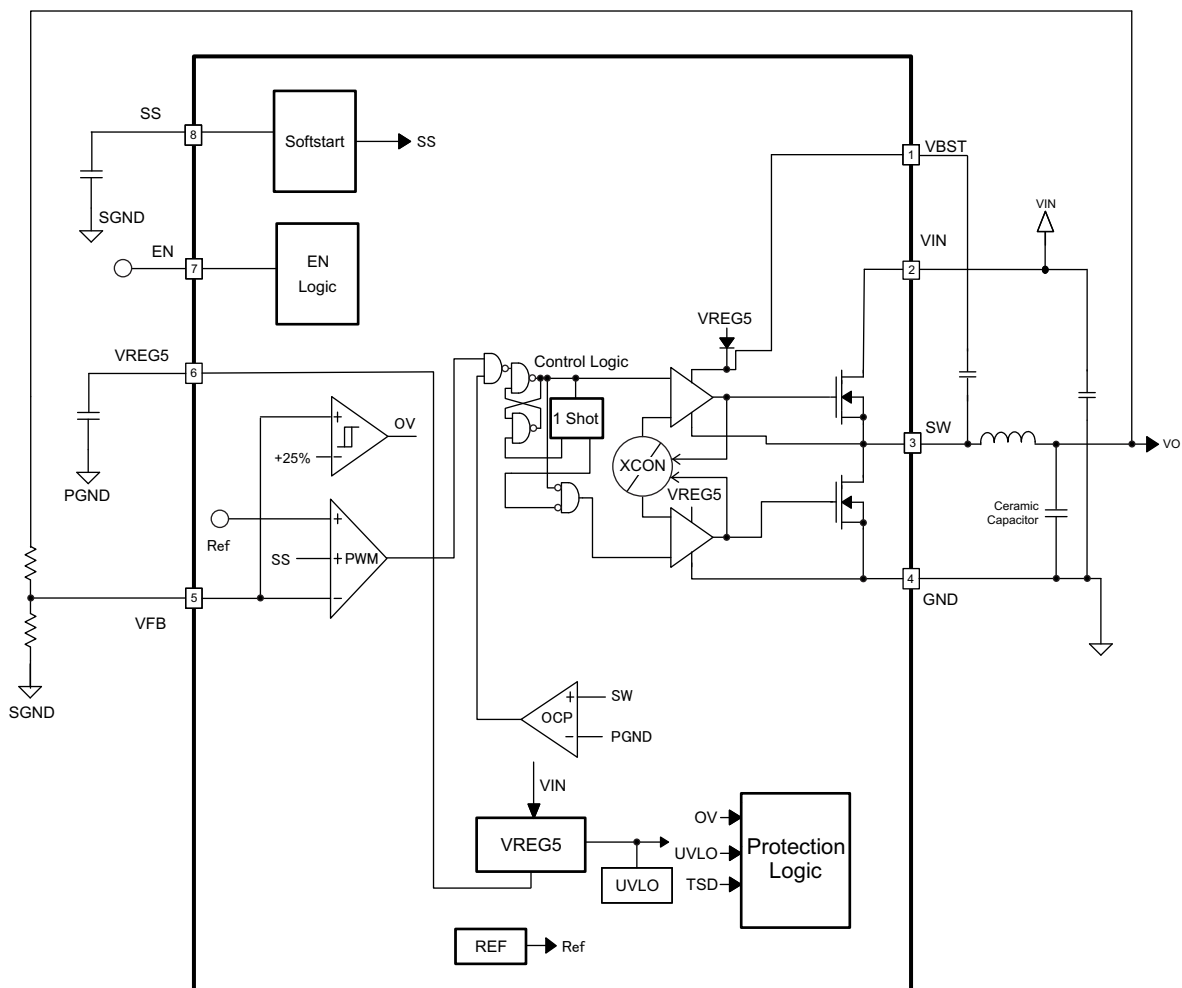
PIN FUNCTIONS

PIN		DESCRIPTION
NAME	NO.	
VBST	1	Supply input for the high-side FET gate drive circuit. Connect 0.1 μF capacitor between VBST and SW pins. An internal diode is connected between VREG5 and VBST.
VIN	2	Input voltage supply pin.
SW	3	Switch node connection between high-side NFET and low-side NFET.
GND	4	Ground pin. Power ground return for switching circuit. Connect sensitive SS and VFB returns to GND at a single point.
VFB	5	Converter feedback input. Connect to output voltage with feedback resistor divider.

PIN FUNCTIONS (continued)

PIN		DESCRIPTION
NAME	NO.	
VREG5	6	5.5 V power supply output. A capacitor (typical 0.47 μ F) should be connected to GND. VREG5 is not active when EN is low.
EN	7	Enable input control. EN is active high and must be pulled up to enable the device.
SS	8	Soft-start control. An external capacitor should be connected to GND.
Exposed Thermal Pad	Back side	Thermal pad of the package. Must be soldered to achieve appropriate dissipation. Must be connected to GND.

FUNCTIONAL BLOCK DIAGRAM



OVERVIEW

The TPS54239 is a 2-A synchronous step-down (buck) converter with two integrated N-channel MOSFETs. It operates using D-CAP2™ mode control. The fast transient response of D-CAP2™ control reduces the output capacitance required to meet a specific level of performance. Proprietary internal circuitry allows the use of low ESR output capacitors including ceramic and special polymer types.

DETAILED DESCRIPTION

PWM Operation

The main control loop of the TPS54239 is an adaptive on-time pulse width modulation (PWM) controller that supports a proprietary D-CAP2™ mode control. D-CAP2™ mode control combines constant on-time control with an internal compensation circuit for pseudo-fixed frequency and low external component count configuration with both low ESR and ceramic output capacitors. It is stable even with virtually no ripple at the output.

At the beginning of each cycle, the high-side MOSFET is turned on. This MOSFET is turned off after internal one shot timer expires. This one shot is set by the converter input voltage, VIN, and the output voltage, VO, to maintain a pseudo-fixed frequency over the input voltage range, hence it is called adaptive on-time control. The one-shot timer is reset and the high-side MOSFET is turned on again when the feedback voltage falls below the reference voltage. An internal ramp is added to reference voltage to simulate output ripple, eliminating the need for ESR induced output ripple from D-CAP2™ mode control.

PWM Frequency and Adaptive On-Time Control

TPS54239 uses an adaptive on-time control scheme and does not have a dedicated on board oscillator. The TPS54239 runs with a pseudo-constant frequency of 600 kHz by using the input voltage and output voltage to set the on-time one-shot timer. The on-time is inversely proportional to the input voltage and proportional to the output voltage; therefore, when the duty ratio is VOUT/VIN, the frequency is constant.

Soft Start and Pre-Biased Soft Start

The soft start function is adjustable. When the EN pin becomes high, 6 µA current begins charging the capacitor which is connected from the SS pin to GND. Smooth control of the output voltage is maintained during start up. The equation for the slow start time is shown in [Equation 1](#). VFB voltage is 0.765 V and SS pin source current is 6 µA.

$$t_{SS}(\text{ms}) = \frac{C_{SS}(\text{nF}) \times V_{REF} \times 1.1}{I_{SS}(\mu\text{A})} = \frac{C_{SS}(\text{nF}) \times 0.765 \times 1.1}{6} \quad (1)$$

The TPS54239 contains a unique circuit to prevent current from being pulled from the output during startup if the output is pre-biased. When the soft-start commands a voltage higher than the pre-bias level (internal soft start becomes greater than feedback voltage VFB), the controller slowly activates synchronous rectification by starting the first low side FET gate driver pulses with a narrow on-time. It then increments that on-time on a cycle-by-cycle basis until it coincides with the time dictated by (1-D), where D is the duty cycle of the converter. This scheme prevents the initial sinking of the pre-bias output, and ensure that the out voltage (VO) starts and ramps up smoothly into regulation and the control loop is given time to transition from pre-biased start-up to normal mode operation.

Current Protection

The output overcurrent protection (OCP) is implemented using a cycle-by-cycle valley detect control circuit. The switch current is monitored by measuring the low-side FET switch voltage between the SW pin and GND. This voltage is proportional to the switch current. To improve accuracy, the voltage sensing is temperature compensated.

During the on time of the high-side FET switch, the switch current increases at a linear rate determined by VIN, VOUT, the on-time and the output inductor value. During the on time of the low-side FET switch, this current decreases linearly. The average value of the switch current is the load current Iout. The TPS54239 constantly monitors the low-side FET switch voltage, which is proportional to the switch current, during the low-side on-time. If the measured voltage is above the voltage proportional to the current limit, an internal counter is incremented per each SW cycle and the converter maintains the low-side switch on until the measured voltage is below the voltage corresponding to the current limit at which time the switching cycle is terminated and a new switching

cycle begins. In subsequent switching cycles, the on-time is set to a fixed value and the current is monitored in the same manner. If the over current condition exists for 7 consecutive switching cycles, the internal OCL threshold is set to a lower level, reducing the available output current. When a switching cycle occurs where the switch current is not above the lower OCL threshold, the counter is reset and the OCL limit is returned to the higher value.

There are some important considerations for this type of over-current protection. The load current one half of the peak-to-peak inductor current higher than the over-current threshold. Also when the current is being limited, the output voltage tends to fall as the demanded load current may be higher than the current available from the converter. This may cause the output voltage to fall. When the VFB voltage becomes lower than 65% of the target voltage, the UVP comparator detects it. After 6 μ s detecting the UVP voltage, device will shut down and re-start after 7 times SS period for Hiccup.

When the over current condition is removed, the output voltage returns to the regulated value. This protection is non-latching.

Over Voltage Protection

TPS54239 detects over voltage conditions by monitoring the feedback voltage (VFB). This function is enabled after approximately 1.7 x times the soft start time.

When the feedback voltage becomes higher than 125% of the target voltage, the OVP comparator output goes high and both the high-side MOSFET driver and the low-side MOSFET driver turn off. This function is non-latch operation.

UVLO Protection

Undervoltage lock out protection (UVLO) monitors the voltage of the V_{REG5} pin. When the V_{REG5} voltage is lower than UVLO threshold voltage, the TPS54239 is shut off. This protection is non-latching.

Thermal Shutdown

TPS54239 monitors the temperature of itself. If the temperature exceeds the threshold value (typically 165°C), the device is shut off. This is non-latch protection.

TYPICAL CHARACTERISTICS

$V_{IN} = 12\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted).

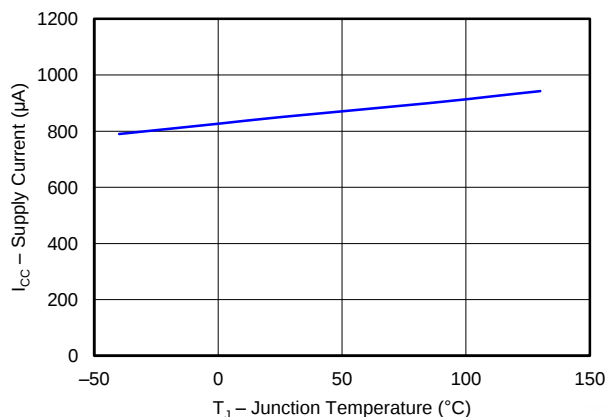


Figure 1. VIN CURRENT vs JUNCTION TEMPERATURE

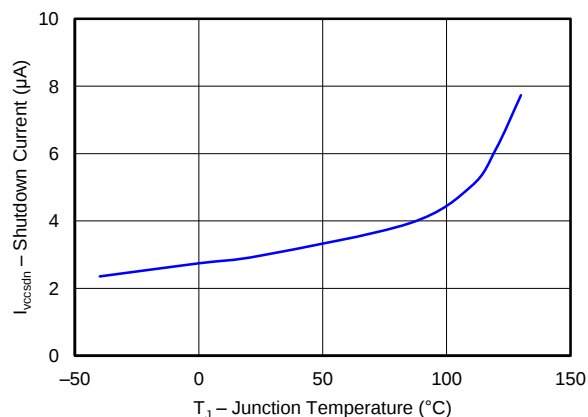


Figure 2. VIN SHUTDOWN CURRENT vs JUNCTION TEMPERATURE

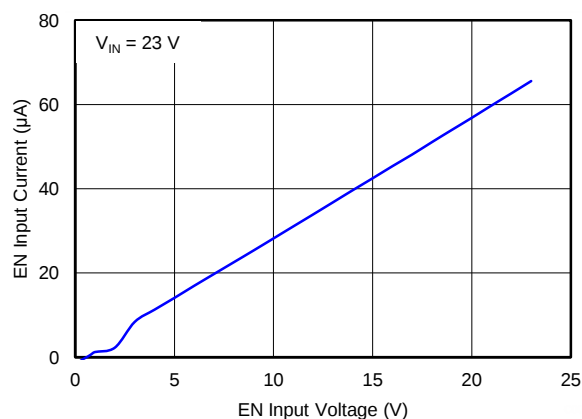


Figure 3. EN CURRENT vs EN VOLTAGE

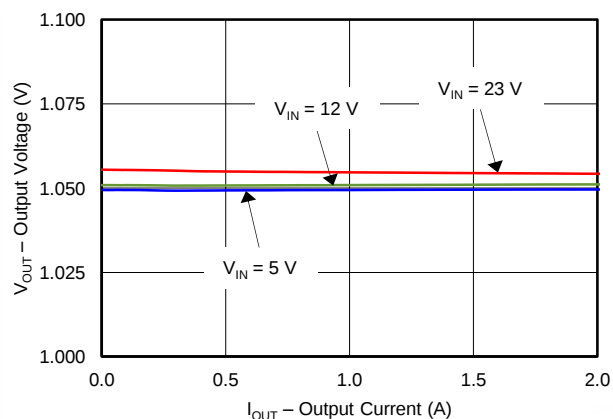


Figure 4. 1.05-V OUTPUT VOLTAGE vs OUTPUT CURRENT

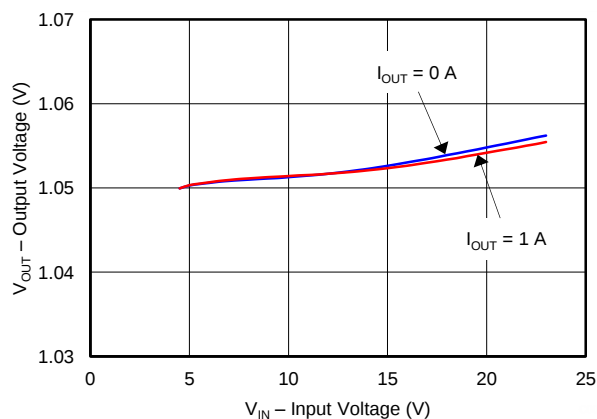


Figure 5. 1.05-V OUTPUT VOLTAGE vs INPUT VOLTAGE

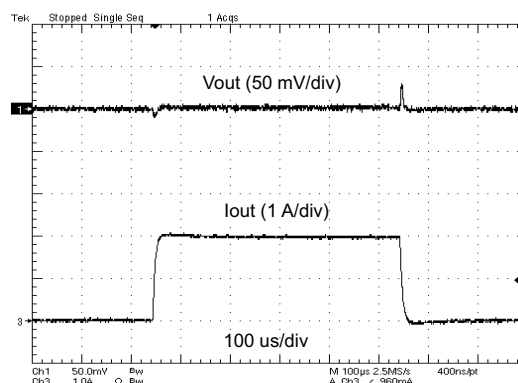


Figure 6. 1.05-V, LOAD TRANSIENT RESPONSE

TYPICAL CHARACTERISTICS

$V_{IN} = 12\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted).

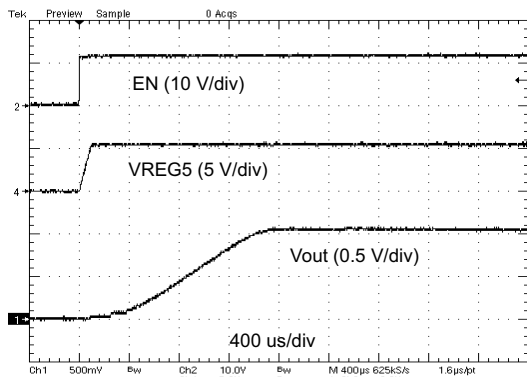


Figure 7. START-UP WAVE FORM

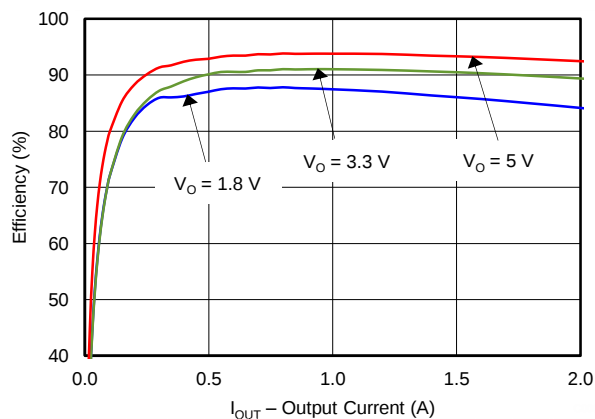


Figure 8. EFFICIENCY vs OUTPUT CURRENT

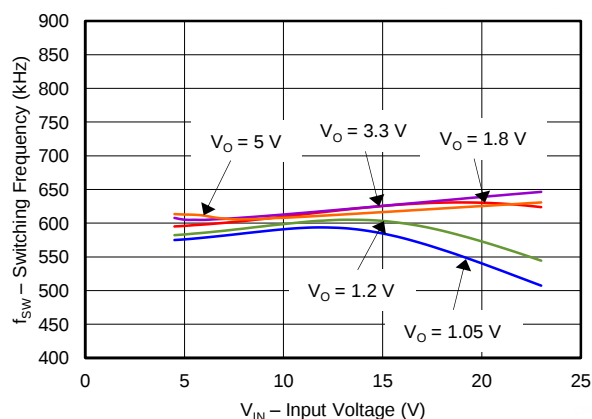


Figure 9. SWITCHING FREQUENCY vs INPUT VOLTAGE ($I_O = 1\text{ A}$)

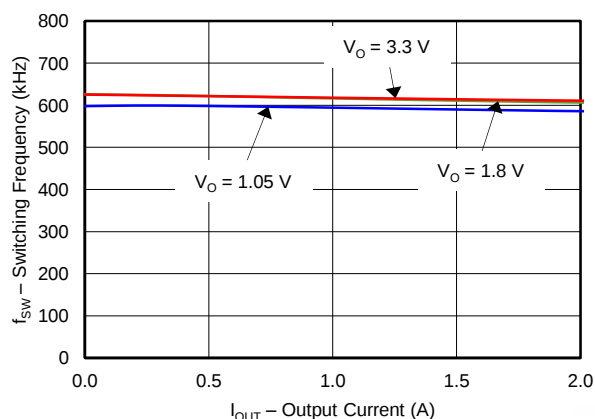


Figure 10. SWITCHING FREQUENCY vs OUTPUT CURRENT

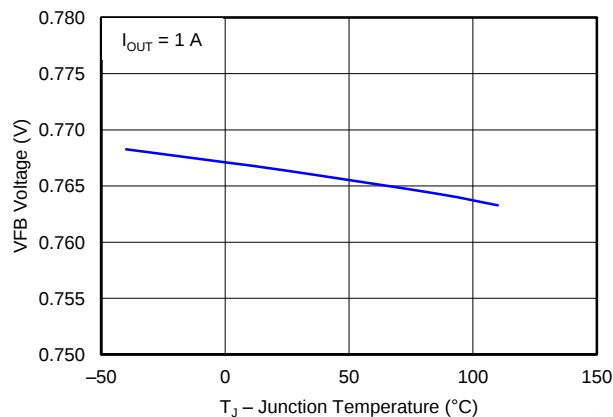


Figure 11. VFB VOLTAGE vs JUNCTION TEMPERATURE ($I_O = 1\text{ A}$)

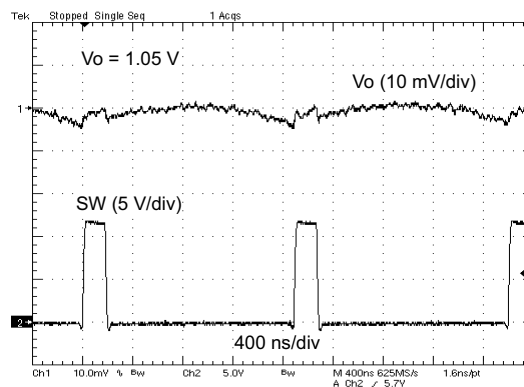


Figure 12. VOLTAGE RIPPLE AT OUTPUT ($I_O = 2\text{ A}$)

TYPICAL CHARACTERISTICS (continued)

VIN = 12 V, T_A = 25°C (unless otherwise noted).

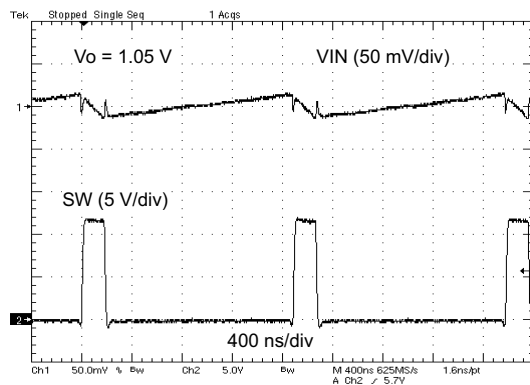


Figure 13. VOLTAGE RIPPLE AT INPUT (I_O = 2 A)

DESIGN GUIDE

Step-By-Step Design Procedure

To begin the design process, the user must know a few application parameters:

- Input voltage range
- Output voltage
- Output current
- Output voltage ripple
- Input voltage ripple

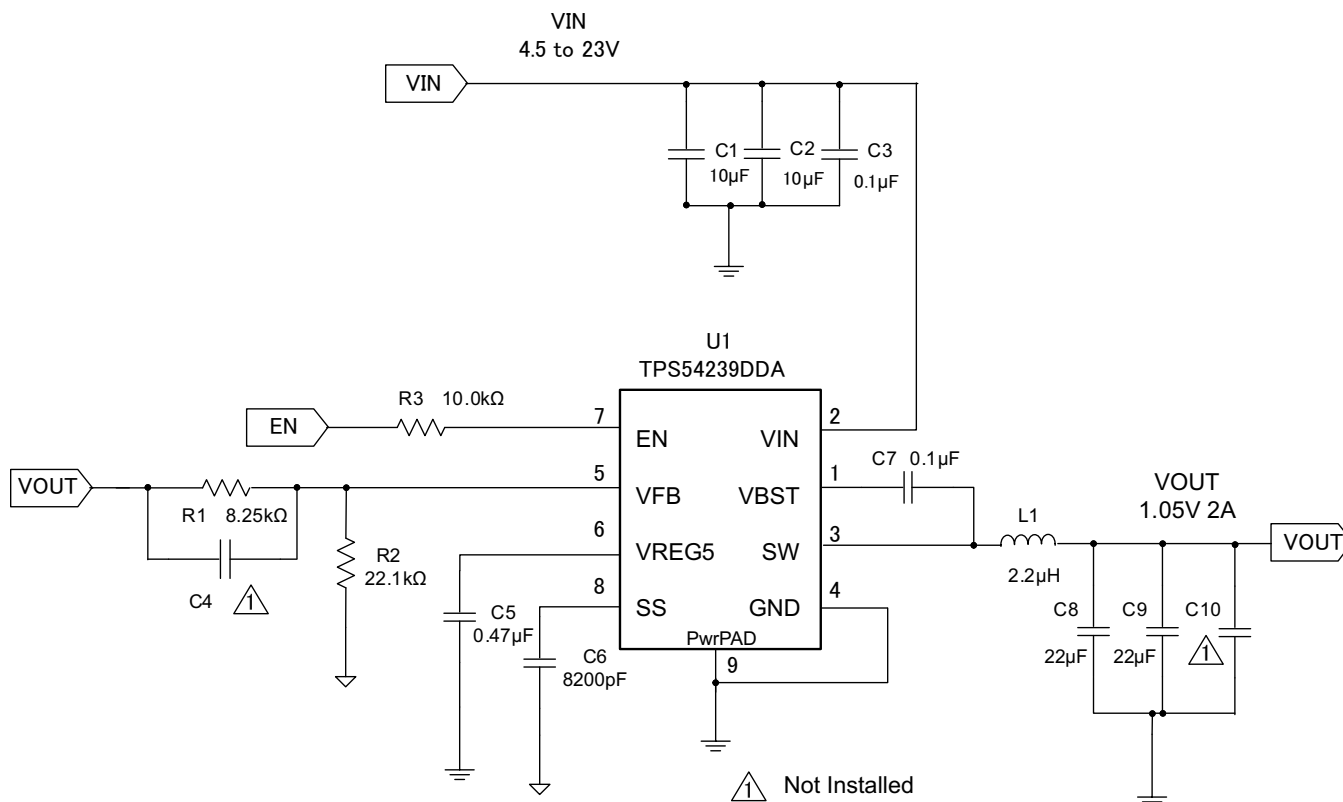


Figure 14. Shows the schematic diagram for this design example.

Output Voltage Resistors Selection

The output voltage is set with a resistor divider from the output node to the VFB pin. It is recommended to use 1% tolerance or better divider resistors. Start by using Equation 2 to calculate V_{OUT} .

To improve efficiency at light loads consider using larger value resistors, high resistance is more susceptible to noise, and the voltage errors from the VFB input current are more noticeable.

$$V_{OUT} = 0.765 \times \left(1 + \frac{R1}{R2} \right) \quad (2)$$

Output Filter Selection

The output filter used with the TPS54239 is an LC circuit. This LC filter has double pole at:

$$F_P = \frac{1}{2\pi\sqrt{L_{OUT} \times C_{OUT}}} \quad (3)$$

At low frequencies, the overall loop gain is set by the output set-point resistor divider network and the internal gain of the TPS54239. The low frequency phase is 180 degrees. At the output filter pole frequency, the gain rolls off at a –40 dB per decade rate and the phase drops rapidly. D-CAP2™ introduces a high frequency zero that reduces the gain roll off to –20 dB per decade and increases the phase to 90 degrees one decade above the zero frequency. The inductor and capacitor selected for the output filter must be selected so that the double pole of Equation 3 is located below the high frequency zero but close enough that the phase boost provided by the high frequency zero provides adequate phase margin for a stable circuit. To meet this requirement use the values recommended in Table 1.

Table 1. Recommended Component Values

Output Voltage (V)	R1 (kΩ)	R2 (kΩ)	C4 (pF) ⁽¹⁾			L1 (μH)			C8 + C9 + C10 (μF)	
			Min	Typ	Max	Min	Typ	Max	Min	Max
1	6.81	22.1	5	150	220	1.5	2.2	4.7	22	68
1.05	8.25	22.1	5	150	220	1.5	2.2	4.7	22	68
1.2	12.7	22.1	5		100	1.5	2.2	4.7	22	68
1.5	21.5	22.1	5		68	1.5	2.2	4.7	22	68
1.8	30.1	22.1	5		22	2.2	3.3	4.7	22	68
2.5	49.9	22.1	5		22	2.2	3.3	4.7	22	68
3.3	73.2	22.1	5		22	2.2	3.3	4.7	22	68
5	124	22.1	5		22	3.3		4.7	22	68
6.5	165	22.1	5		22	3.3		4.7	22	68

(1) Optional

Since the DC gain is dependent on the output voltage, the required inductor value increases as the output voltage increases. Additional phase boost can be achieved by adding a feed forward capacitor (C4) in parallel with R1. The amount of available phase boost is dependent on the output voltage. Higher output voltages will allow greater phase boost.

The inductor peak-to-peak ripple current, peak current and RMS current are calculated using Equation 4, Equation 5 and Equation 6. The inductor saturation current rating must be greater than the calculated peak current and the RMS or heating current rating must be greater than the calculated RMS current. Use 600 kHz for f_{SW} .

Use 600 kHz for f_{SW} . Make sure the chosen inductor is rated for the peak current of Equation 5 and the RMS current of Equation 6.

$$I_{P-P} = \frac{V_{OUT}}{V_{IN(MAX)}} \times \frac{V_{IN(MAX)} - V_{OUT}}{L_O \times f_{SW}} \quad (4)$$

$$I_{PEAK} = I_O + \frac{I_{P-P}}{2} \quad (5)$$

$$I_{LO(RMS)} = \sqrt{I_O^2 + \frac{1}{12} I_{P-P}^2} \quad (6)$$

For this design example, the calculated peak current is 2.38 A and the calculated RMS current is 2.01 A. The inductor used is a TDK CLF7045T-2R2N with a peak current rating of 5.5 A and an RMS current rating of 4.3 A. For high current designs, TDK SPM6530T-4R7M 4.7μH is also recommended. The SPM6530 series has a higher current rating than the CLF7045 series.

The capacitor value and ESR determines the amount of output voltage ripple. The TPS54239 is intended for use with ceramic or other low ESR capacitors. Recommended values range from 22μF to 68μF. Use Equation 7 to determine the required RMS current rating for the output capacitor.

$$I_{Co(RMS)} = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{\sqrt{12} \times V_{IN} \times L_O \times f_{SW}} \quad (7)$$

For this design two TDK C3216X5R0J226M 22μF output capacitors are used. The typical ESR is 2 mΩ each. The calculated RMS current is 0.22 A and each output capacitor is rated for 4A.

Input Capacitor Selection

The TPS54239 requires an input decoupling capacitor and a bulk capacitor is needed depending on the application. A ceramic capacitor over 10 μF is recommended for the decoupling capacitor. An additional 0.1 μF capacitor from pin 2 to ground is optional to provide additional high frequency filtering. The capacitor voltage rating needs to be greater than the maximum input voltage.

Bootstrap Capacitor Selection

A 0.1 μF . ceramic capacitor must be connected between the VBST to SW pin for proper operation. It is recommended to use a ceramic capacitor.

VREG5 Capacitor Selection

A 0.47 μF . ceramic capacitor must be connected between the VREG5 to GND pin for proper operation. It is recommended to use a ceramic capacitor.

THERMAL INFORMATION

This 8-pin DDA package incorporates an exposed thermal pad that is designed to be directly to an external heatsink. The thermal pad must be soldered directly to the printed board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For additional information on the exposed thermal pad and how to use the advantage of its heat dissipating abilities, see the Technical Brief, PowerPAD™ Thermally Enhanced Package, Texas Instruments Literature No. [SLMA002](#) and Application Brief, PowerPAD™ Made Easy, Texas Instruments Literature No. [SLMA004](#).

The exposed thermal pad dimensions for this package are shown in the following illustration.

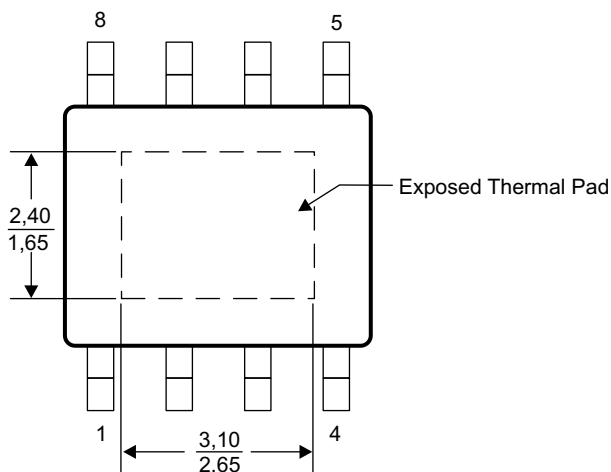


Figure 15. Thermal Pad Dimensions

LAYOUT CONSIDERATIONS

1. Keep the input switching current loop as small as possible.
2. Keep the SW node as physically small and short as possible to minimize parasitic capacitance and inductance and to minimize radiated emissions. Kelvin connections should be brought from the output to the feedback pin of the device.
3. Keep analog and non-switching components away from switching components.
4. Make a single point connection from the analog ground to power ground.
5. Do not allow switching current to flow under the device.
6. Keep the pattern lines for VIN and PGND broad.
7. Exposed pad of device must be connected to PGND with solder.
8. VREG5 capacitor should be placed near the device, and connected to PGND.
9. Output capacitor should be connected to a broad pattern of the PGND.
10. Voltage feedback loop should be as short as possible, and preferably with ground shield.
11. Lower resistor of the voltage divider which is connected to the VFB pin should be tied to analog ground trace.
12. Providing sufficient via is preferable for VIN, SW and PGND connection.
13. VIN input bypass capacitor and VIN high frequency bypass capacitor must be placed as near as possible to the device.
14. Performance based on four layer printed circuit board.

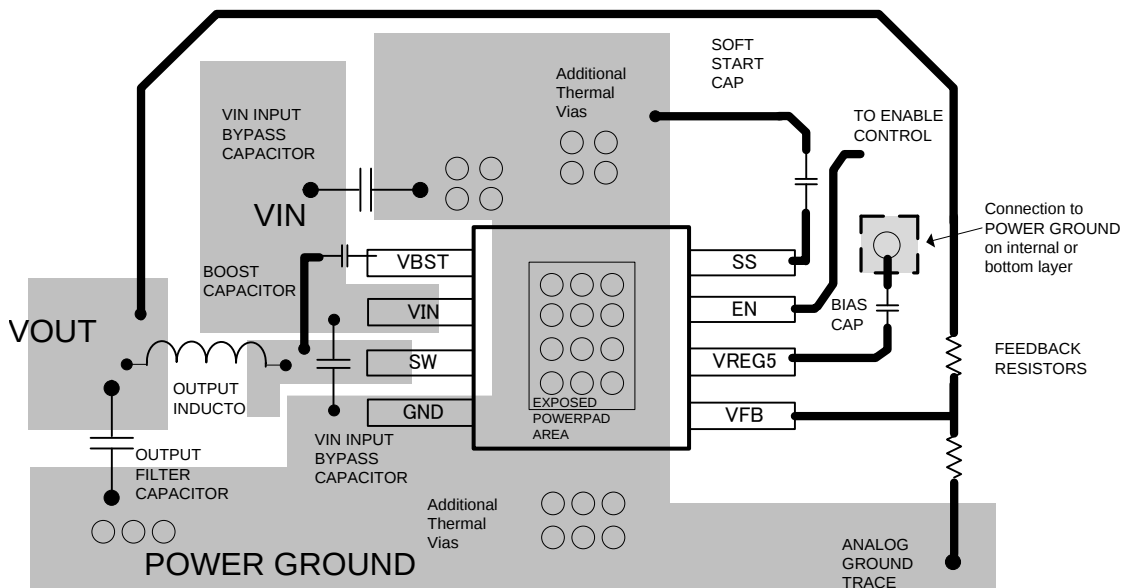


Figure 16. PCB Layout

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
TPS54239DDA	ACTIVE	SO PowerPAD	DDA	8	75	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-2-260C-1 YEAR	-40 to 85		Samples
TPS54239DDAR	ACTIVE	SO PowerPAD	DDA	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-2-260C-1 YEAR	-40 to 85		Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

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

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

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

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

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

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

(4) Only one of markings shown within the brackets will appear on the physical device.

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

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

TAPE AND REEL INFORMATION


*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
TPS54239DDAR	SO Power PAD	DDA	8	2500	330.0	12.8	6.4	5.2	2.1	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS

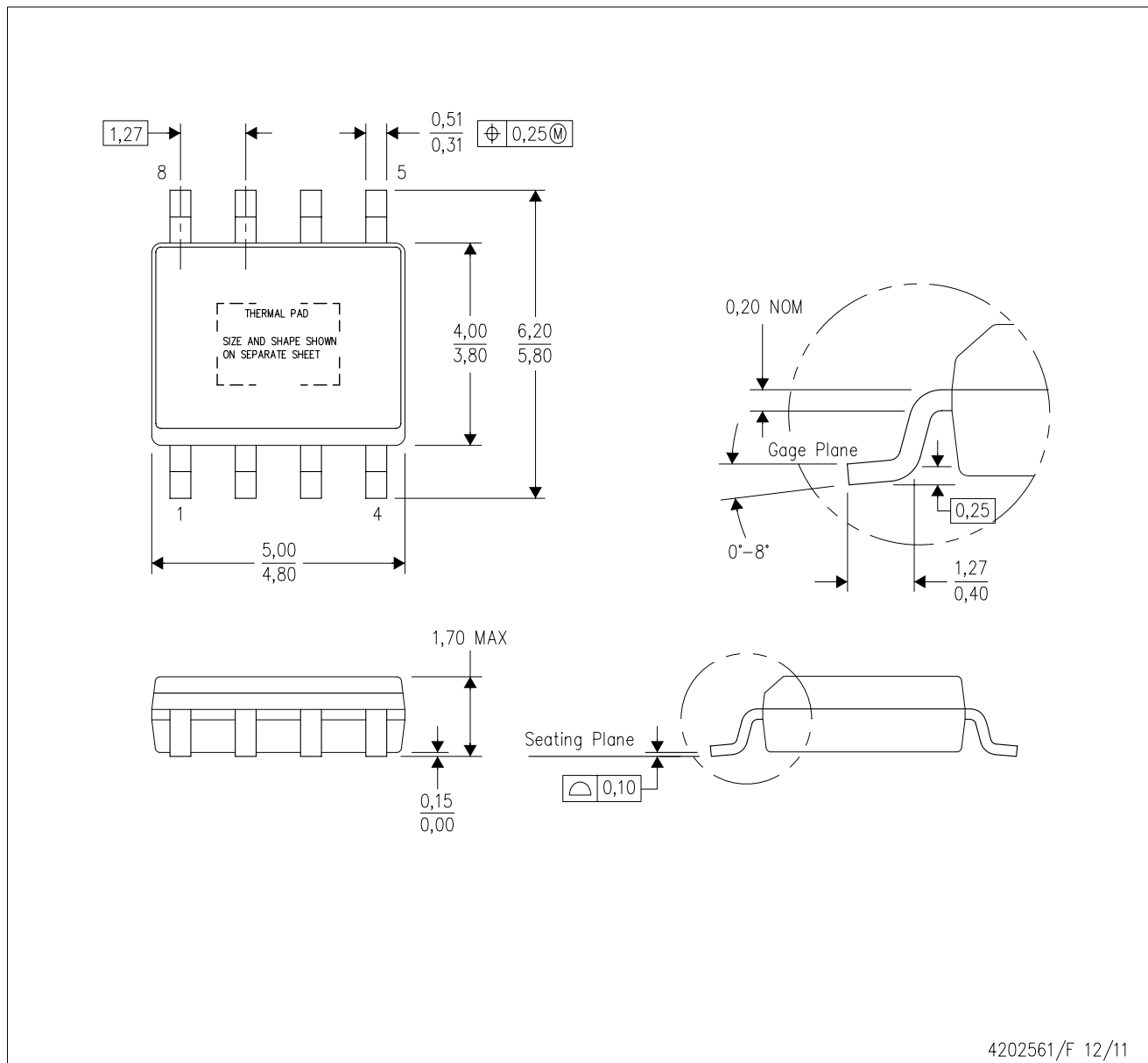


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS54239DDAR	SO PowerPAD	DDA	8	2500	366.0	364.0	50.0

DDA (R-PDSO-G8)

PowerPAD™ PLASTIC SMALL-OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5-1994.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 - D. This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 for information regarding recommended board layout. This document is available at www.ti.com <<http://www.ti.com>>.
 - E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
 - F. This package complies to JEDEC MS-012 variation BA

PowerPAD is a trademark of Texas Instruments.

DDA (R-PDSO-G8)

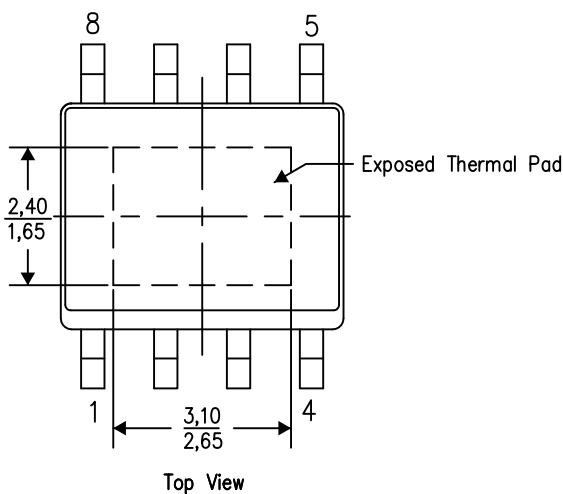
PowerPAD™ PLASTIC SMALL OUTLINE

THERMAL INFORMATION

This PowerPAD™ package incorporates an exposed thermal pad that is designed to be attached to a printed circuit board (PCB). The thermal pad must be soldered directly to the PCB. After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For additional information on the PowerPAD package and how to take advantage of its heat dissipating abilities, refer to Technical Brief, PowerPAD Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 and Application Brief, PowerPAD Made Easy, Texas Instruments Literature No. SLMA004. Both documents are available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



Exposed Thermal Pad Dimensions

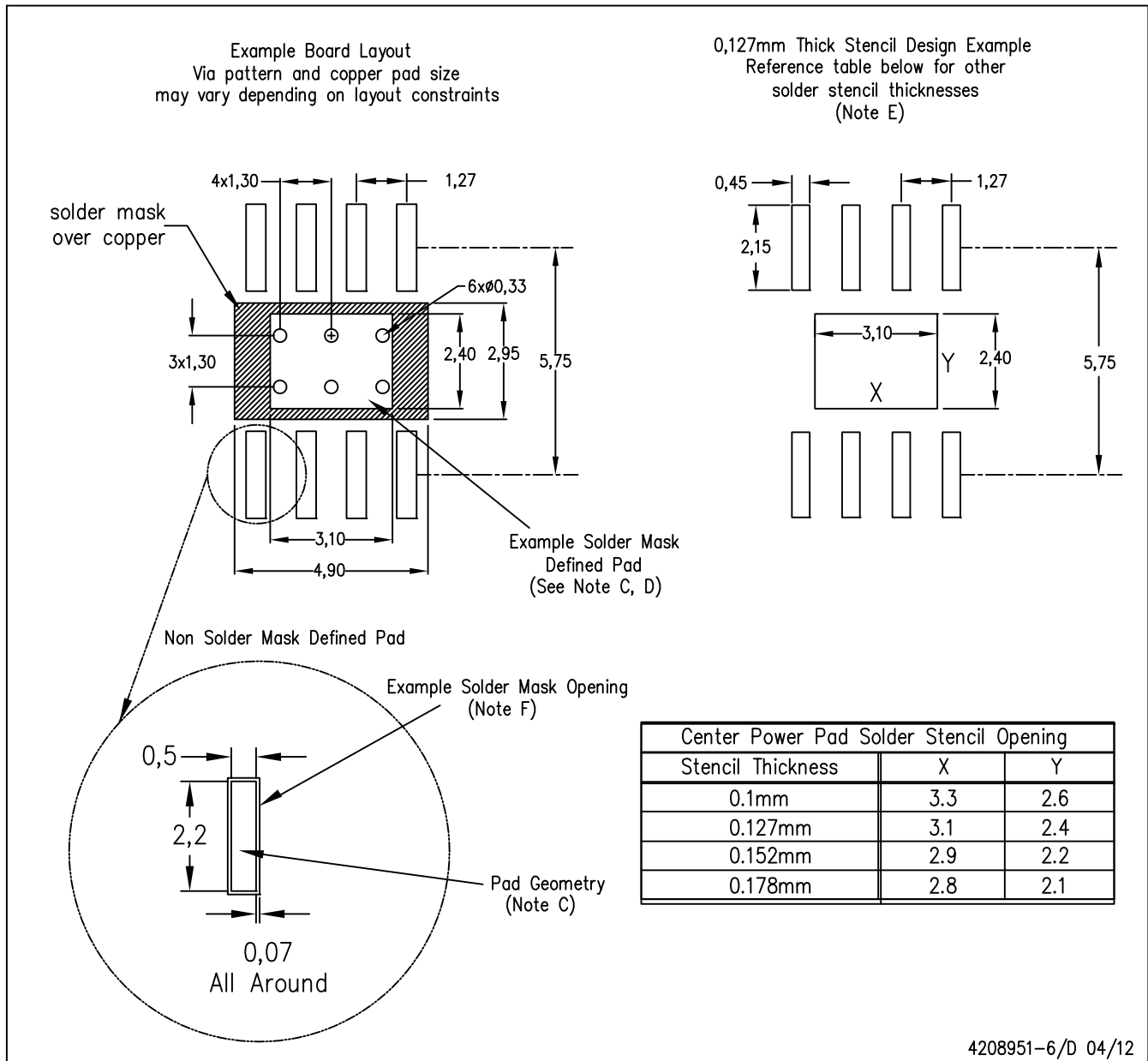
4206322-6/L 05/12

NOTE: A. All linear dimensions are in millimeters

PowerPAD is a trademark of Texas Instruments

DDA (R-PDSO-G8)

PowerPAD™ PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPAD Thermally Enhanced Package, Texas Instruments Literature No. SLMA002, SLMA004, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <<http://www.ti.com>>. Publication IPC-7351 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.
 - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

PowerPAD is a trademark of Texas Instruments.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

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

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

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

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com