具有 Eco-mode™ 的 4.5V 至 18V 输入，6A 同步降压转换器

查询样片: **TPS56628**

特性

- **D-CAP2™** 模式支持快速瞬态响应
- 低输出纹波，支持陶瓷输出电容器
- 宽 V_{IN} 输入电压范围：**4.5V** 至 **18V**
- 输出电压范围：**0.76V** 至 **5.5V**
- 高效率集成型场效应晶体管 **(FET)** 针对较低占空比应用进行了优化
  - 36mΩ（高侧）与 **28mΩ**（低侧）
- 高效率，关断时流耗少于 **10µA**
- 高初始带隙基准精度
- 预偏置软启动
- **650kHz** 开关频率 **(f_{SW})**
- 逐周期过流限制
- 在轻负载情况下实现高效率的自动跳跃 **Eco-mode™** 模式
- 电源正常输出
- 固定软启动时间：**1.0ms**

应用范围

- 低电压系统的广泛应用
  – 数字电视电源
  – 高清 **Blu-ray Disc™** 播放器
  – 网络家庭终端设备
  – 数字机顶盒 **(STB)**

说明

TPS56628 是一款自适应接通时间 D-CAP2™ 模式同步降压转换器。 TPS56628 可帮助系统设计人员通过一个成本有效、低组件数量、低待机电流解决方案来完成多种终端设备的电源总线调节器集。 TPS56628 的主控制环路使用 D-CAP2™ 模式控制，此控制方式在无需外部补偿组件的情况下提供快速瞬态响应。 自适应接通时间控制支持较高负载状态下的脉宽调制 (PWM) 模式与轻负载下的 Eco-mode™ 工作模式之间的无缝转换。 Eco-mode™ 使 TPS56628 能够在较轻负载条件下保持高效率。 TPS56628 的专有电路还使该器件可采用诸如高分子有机半导体固体电容器 (POSCAP) 或高分子聚合物电容器 (SP-CAP) 等低等效串联电阻 (ESR) 输出电容器，以及超低 ESR 陶瓷电容器。 该器件的工作输入电压介于 4.5V 至 18V VIN 之间。 输出电压可在 0.76V 至 5.5V 的范围内设定。TPS56628 采用 8 引脚 DDA 封装，并且设计运行温度范围在 -40°C 至 85°C 之间。
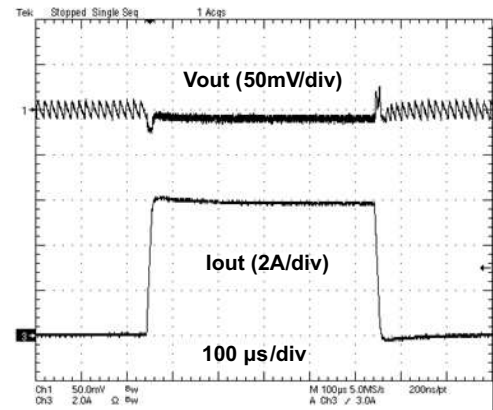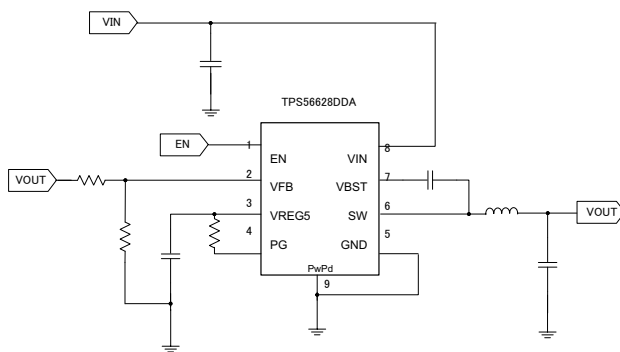
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D-CAP2, Eco-mode are trademarks of Texas Instruments.
Blu-ray Disc is a trademark of Blu-ray Disc Association.

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)(2)(3)]

T_A	PACKAGE	ORDERABLE PART NUMBER	PIN	TRANSPORT MEDIA
−40°C to 85°C	DDA	TPS56628DDA	8	Tube
		TPS56628DDAR		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	VIN, EN	−0.3	20	V
	VBST	−0.3	26	
	VBST (10 ns transient)	−0.3	28	
	VBST (vs SW)	−0.3	6.5	
	VFB, PG	−0.3	6.5	
	SW	−2	20	
	SW (10 ns transient)	−3	22	
Output voltage range	VREG5	−0.3	6.5	V
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		TPS56628	UNITS
		DDA (8 PINS)	
θ_{JA}	Junction-to-ambient thermal resistance	43.5	°C/W
θ_{JCtop}	Junction-to-case (top) thermal resistance	49.4	
θ_{JB}	Junction-to-board thermal resistance	25.6	
ψ_{JT}	Junction-to-top characterization parameter	7.4	
ψ_{JB}	Junction-to-board characterization parameter	25.5	
θ_{JCbot}	Junction-to-case (bottom) thermal resistance	5.2	

RECOMMENDED OPERATING CONDITIONS

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

			MIN	MAX	UNIT
V_{IN}	Supply input voltage range		4.5	18	V
V_I	Input voltage range	VBST	−0.1	24	V
		VBST (10 ns transient)	−0.1	27	
		VBST(vs SW)	−0.1	6.0	
		PG	−0.1	5.7	
		EN	−0.1	18	
		VFB	−0.1	5.5	
		SW	−1.8	18	
		SW (10 ns transient)	−3	22	
V_O	Output voltage range	VREG5	−0.1	5.7	V
I_O	Output Current range	I_{VREG5}	0	5	mA
T_A	Operating free-air temperature		−40	85	°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 = 5 V, V_{FB} = 0.8 V		950	1400	µA
I_{VINSDN}	Shutdown supply current	V_{IN} current, T_A = 25°C, EN = 0 V		3	10	µA
LOGIC THRESHOLD						
V_{EN}	EN high-level input voltage	EN	1.6			V
	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						
V_{FBTH}	V_{FB} threshold voltage	T_A = 25°C, V_O = 1.05 V, I_O = 10 mA, Eco-mode™ operation		772		mV
		T_A = 25°C, V_O = 1.05 V, continuous mode operation	757	765	773	mV
		T_A = -40 to 85°C, V_O = 1.05 V, continuous mode operation[1]	751		779	mV
I_{VFB}	V_{FB} input current	V_{FB} = 0.8 V, T_A = 25°C		0	±0.15	µA
V_{REG5} OUTPUT						
V_{VREG5}	V_{REG5} output voltage	T_A = 25°C, 6 V < V_{IN} < 18 V, 0 < I_{VREG5} < 5 mA	5.2	5.5	5.7	V
I_{VREG5}	Output current	V_{IN} = 6 V, V_{REG5} = 4.0 V, T_A = 25°C	20			mA
V_{FB} VOLTAGE AND DISCHARGE RESISTANCE						
R_{DISCHG}	V_{OUT} discharge resistance	EN = 0 V, SW = 0.5 V, T_A = 25°C		500	800	Ω
MOSFET						
$R_{DS(on)}$	High side switch resistance	25°C, V_{BST} - SW = 5.5 V		36		mΩ
	Low side switch resistance	25°C		28		mΩ
CURRENT LIMIT						
I_{OCL}	Current limit	L out = 1.5 µH[1]	6.6	7.3	8.9	A

(1) Not production tested.

ELECTRICAL CHARACTERISTICS (continued)

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
THERMAL SHUTDOWN						
T_{SDN}	Thermal shutdown threshold	Shutdown temperature [2]		165		°C
		Hysteresis [2]		35		
ON-TIME TIMER CONTROL						
t_{ON}	On time	V_{IN} = 12 V, V_O = 1.05 V		150		ns
$t_{OFF(MIN)}$	Minimum off time	T_A = 25°C, V_{FB} = 0.7 V		260	310	ns
SOFT START						
T_{SS}	Soft-start time	Internal soft-start time	0.7	1.0	1.3	ms
POWER GOOD						
V_{THPG}	PG threshold	VFB rising (Good)	85%	90%	95%	
		VFB falling (Fault)		85%		
IPG	PG sink current	PG = 5 V	2	4		mA
HICCUP AND OVER-VOLTAGE PROTECTION						
V_{OVP}	Output OVP threshold	OVP Detect (L > H)		125%		
V_{HICCUP}	Output Hiccup threshold	Hiccup detect (H > L)		65%		
$T_{HICCUPDELAY}$	Output Hiccup delay	To hiccup state		250		µs
$T_{HICCUPENDELAY}$	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	0.13	0.32	0.48	

(2)   Not production tested.

DEVICE INFORMATION

DDA PACKAGE
(TOP VIEW)

```
        1  EN                      VIN  8
                 ┌ ─ ─ ─ ─ ─ ┐
                 │  EXPOSED  │
                 │ THERMAL PAD│
        2  VFB   │           │    VBST  7
                 │  TPS56628 │
                 │           │
                 │    DDA    │
        3  VREG5 │   HSOP8   │     SW   6
                 │           │
                 │           │
                 └ ─ ─ ─ ─ ─ ┘
        4  PG                      GND  5
```
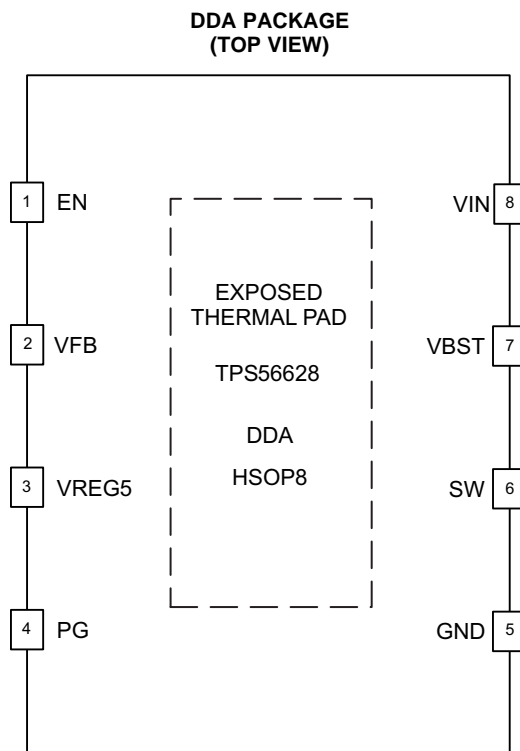
PIN FUNCTIONS

PIN		DESCRIPTION
NAME	NO.	
EN	1	Enable input control. EN is active high and must be pulled up to enable the device.
VFB	2	Converter feedback input. Connect to output voltage with feedback resistor divider.
VREG5	3	5.5 V power supply output. A capacitor (typical 1 µF) should be connected to GND. VREG5 is not active when EN is low.
PG	4	Open drain power good output
GND	5	Ground pin. Power ground return for switching circuit. Connect sensitive VFB returns to GND at a single point.
SW	6	Switch node connection between high-side NFET and low-side NFET.
VBST	7	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	8	Input voltage supply pin.
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
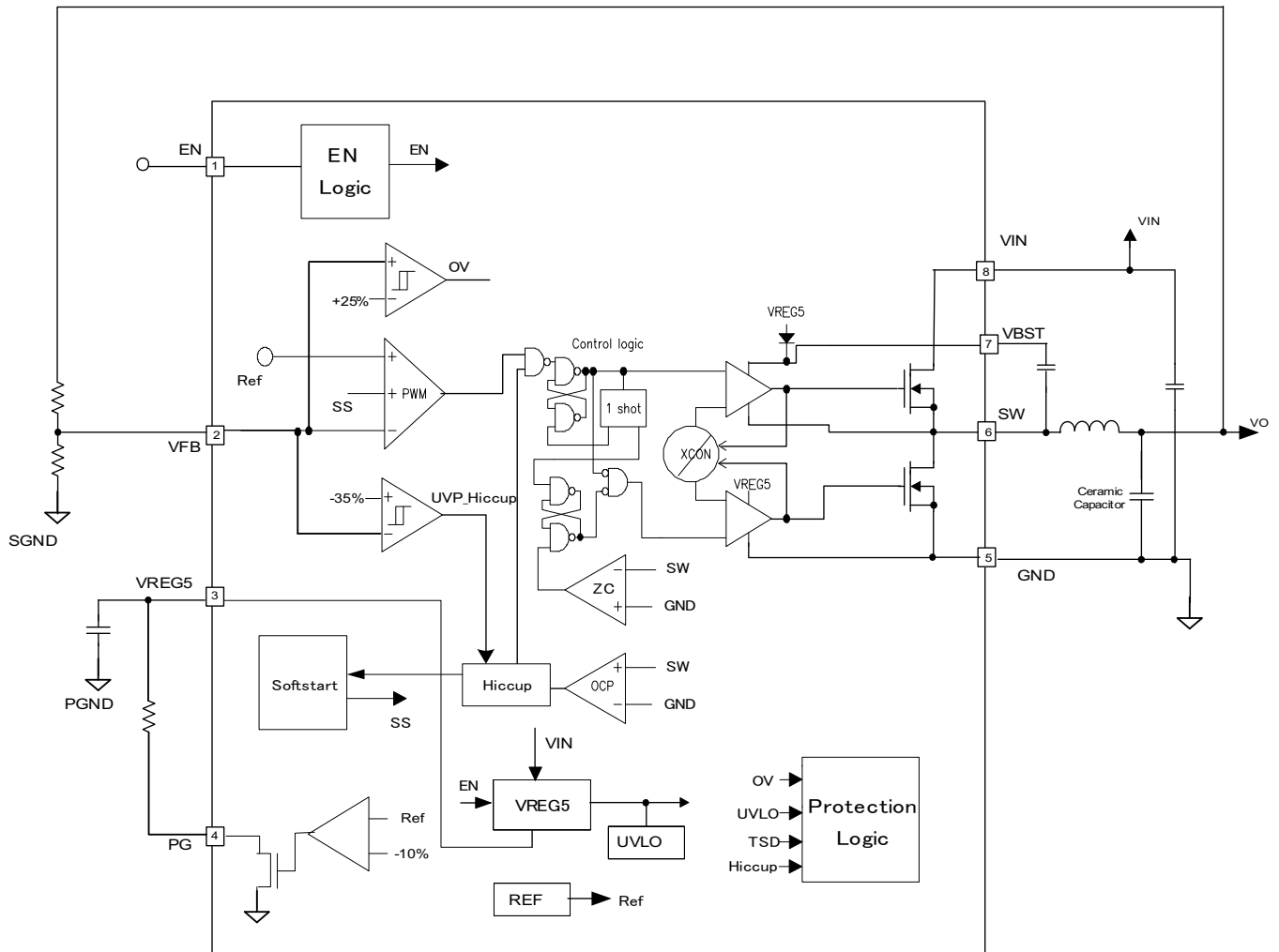
OVERVIEW

The TPS56628 is a 6-A synchronous step-down (buck) converter with two integrated N-channel MOSFETs with Auto-Skip mode to improve light load efficiency. 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. The PG output can be used for sequence operation.

DETAILED DESCRIPTION

PWM Operation

The main control loop of the TPS56628 is an adaptive on-time pulse width modulation (PWM) controller that supports a proprietary D-CAP2™ mode control. D-CAP2™ mode control combines adaptive 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

TPS56628 uses an adaptive on-time control scheme and does not have a dedicated on board oscillator. The TPS56628 runs with a pseudo-constant frequency of 650 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.

Auto-Skip Eco-mode™ Control

The TPS56628 is designed with Auto-Skip Eco-mode™ to increase light load efficiency. As the output current decreases from heavy load condition, the inductor current is also reduced and eventually comes to a point where its rippled valley touches zero level, which is the boundary between continuous conduction and discontinuous conduction modes. The rectifying MOSFET is turned off when its zero inductor current is detected. As the load current further decreases the converters runs in discontinuous conduction mode. The on-time is kept almost the same as it was in the continuous conduction mode so that it takes longer time to discharge the output capacitor with smaller load current to the level of the reference voltage. The transition point to the light load operation $I_{OUT(LL)}$ current can be calculated in Equation 1

$$I_{OUT(LL)} = \frac{1}{2 \cdot L \cdot fsw} \cdot \frac{(V_{IN} - V_{OUT}) \cdot V_{OUT}}{V_{IN}}$$

(1)

Soft Start and Pre-Biased Soft Start

The TPS56628 has an internal 1.0 ms soft-start. When the EN pin becomes high, internal soft-start function begins ramping up the reference voltage to the PWM comparator.

The TPS56628 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 V_{FB}), 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 (V_O) 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.

Power Good

The power-good function is activated after soft start has finished. The power good function becomes active after 1.7 times soft-start time. When the output voltage becomes within -10% of the target value, internal comparators detect power good state and the power good signal becomes high. The power good output, PG is an open drain output. If the feedback voltage goes under 15% of the target value, the power good signal becomes low. Rpg resistor value, which is connected between PG and VREG5, is required from 25kΩ to 150kΩ.

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 V_{IN}, V_{OUT}, 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 I_{OUT}. The TPS56628 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 is 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 250 µs detecting the UVP voltage, device will shut down and re-start after approximately 12ms hiccup time

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

Overvoltage Protection

TPS56628 detects overvoltage 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 VREG5 pin. When the VREG5 voltage is lower than UVLO threshold voltage, the TPS56628 is shut off. This protection is non-latching.

Thermal Shutdown

TPS56628 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

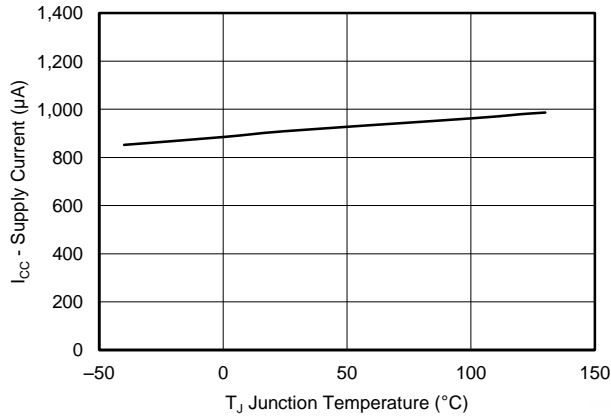VIN = 12 V, V_O = 1.05V, T_A = 25°C (unless otherwise noted).

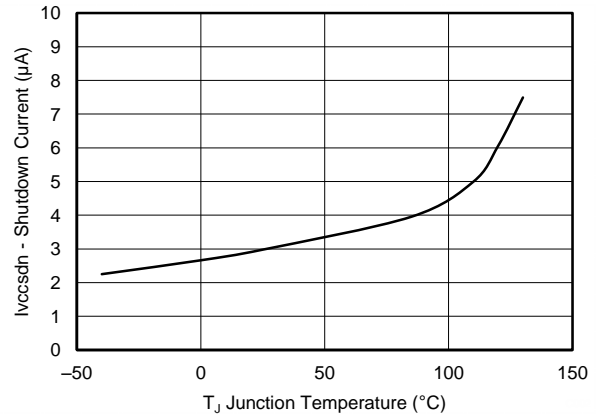Figure 1. SUPPLY CURRENT vs JUNCTION TEMPERATURE

Figure 2. VIN SHUTDOWN CURRENT vs
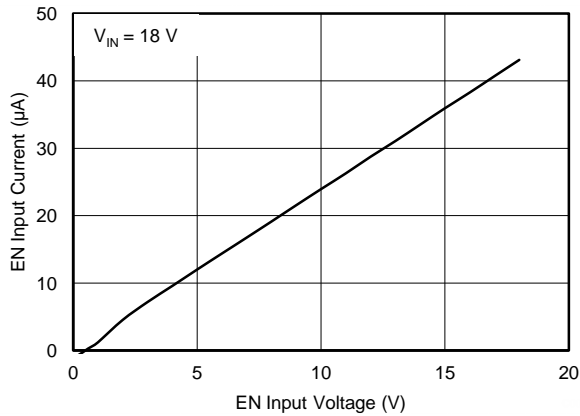JUNCTION TEMPERATURE

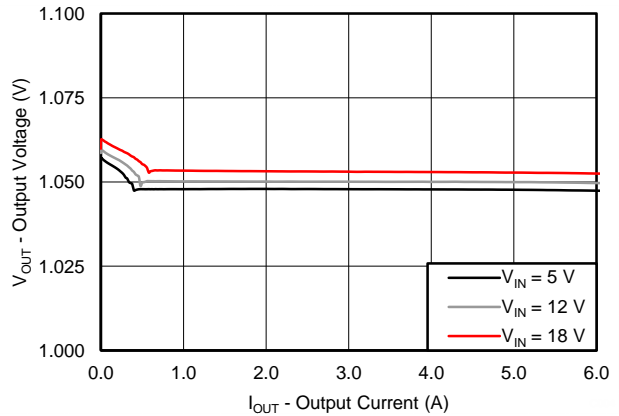Figure 3. EN CURRENT vs EN VOLTAGE
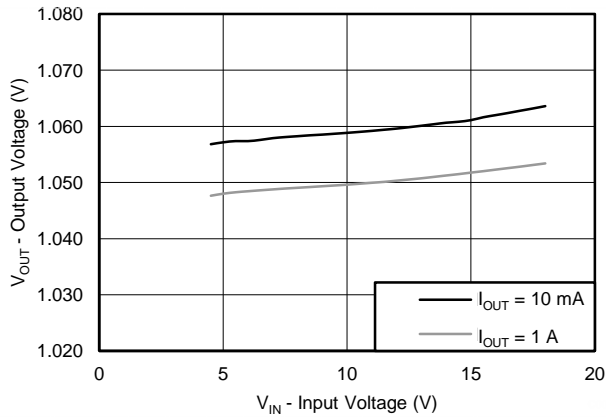

Figure 4. 1.05-V OUTPUT VOLTAGE vs OUTPUT CURRENT

Figure 5. 1.05-V OUTPUT VOLTAGE vs INPUT VOLTAGE

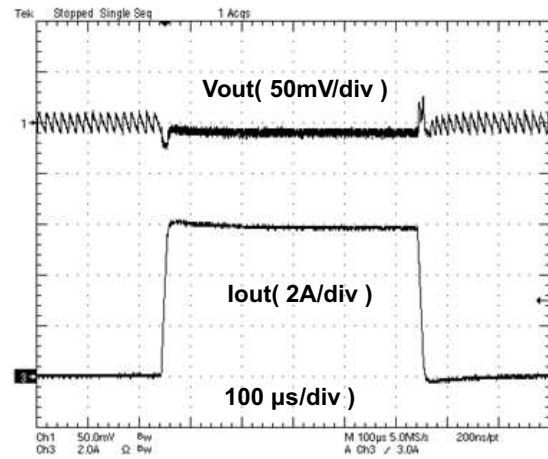Figure 6. 1.05-V, LOAD TRANSIENT RESPONSE

TYPICAL CHARACTERISTICS (continued)

VIN = 12 V, V_O = 1.05V, T_A = 25°C (unless otherwise noted).
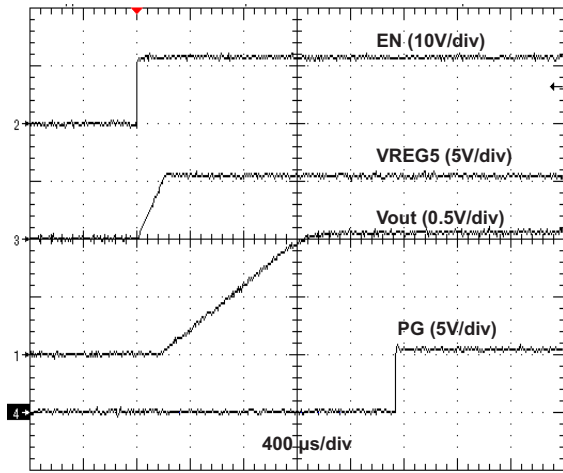
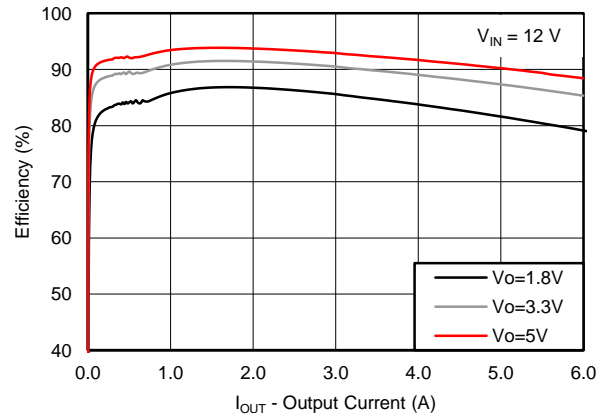**Figure 7. START-UP WAVE FORM**

Figure 8. EFFICIENCY vs OUTPUT CURRENT
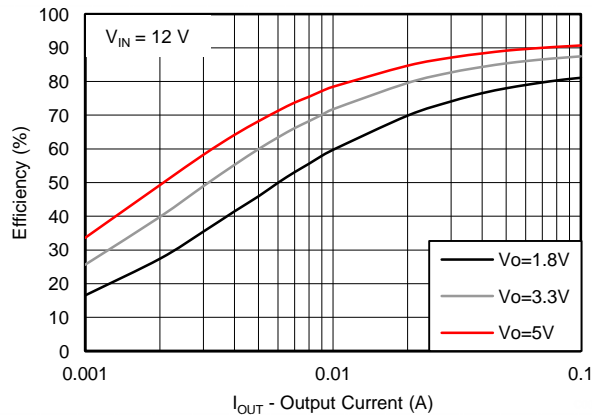

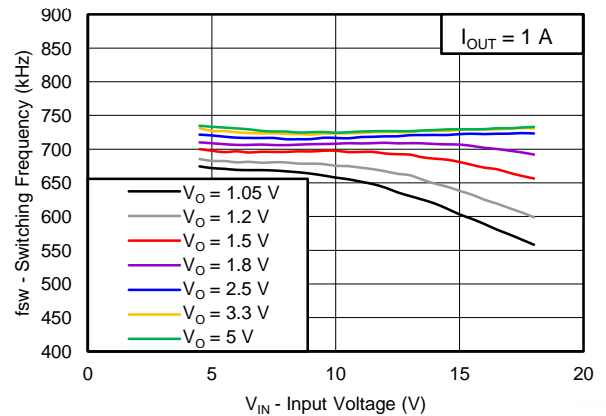**Figure 9. LIGHT LOAD EFFICIENCY vs OUTPUT CURRENT**

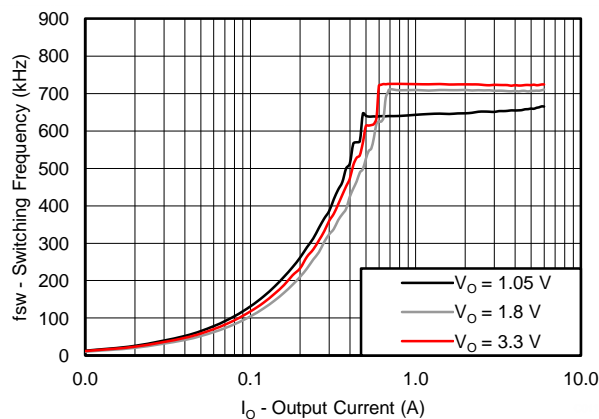**Figure 10. SWITCHING FREQUENCY vs INPUT VOLTAGE**

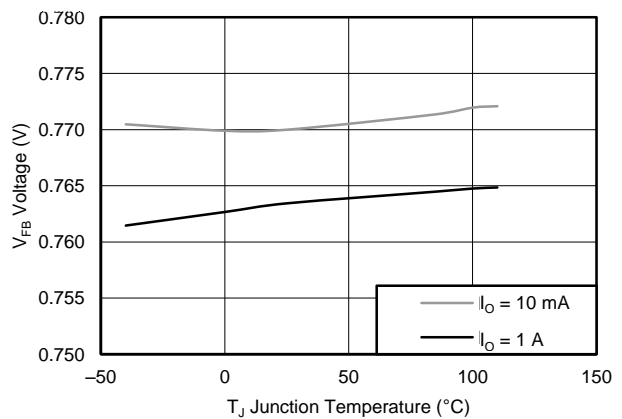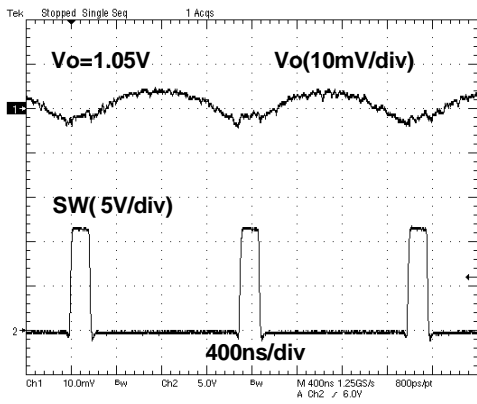**Figure 11. SWITCHING FREQUENCY vs OUTPUT CURRENT**

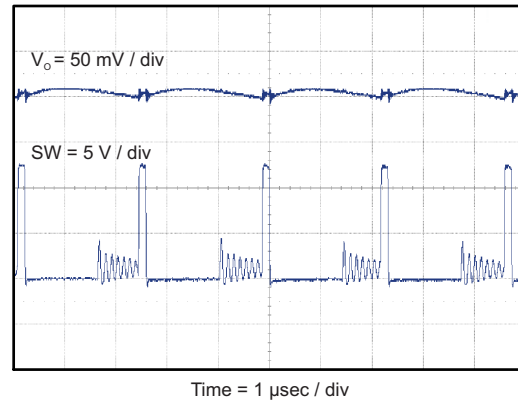**Figure 12. VFB VOLTAGE vs JUNCTION TEMPERATURE**

TYPICAL CHARACTERISTICS (continued)

VIN = 12 V, V_O = 1.05V, T_A = 25°C (unless otherwise noted).

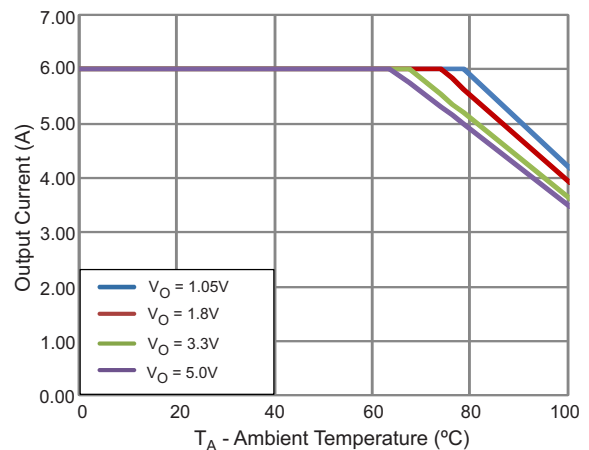**Figure 13. VOLTAGE RIPPLE AT OUTPUT (I_O = 6 A)**

Time = 1 μsec / div

Figure 14. DCM VOLTAGE RIPPLE AT OUTPUT (I_O = 30 mA)
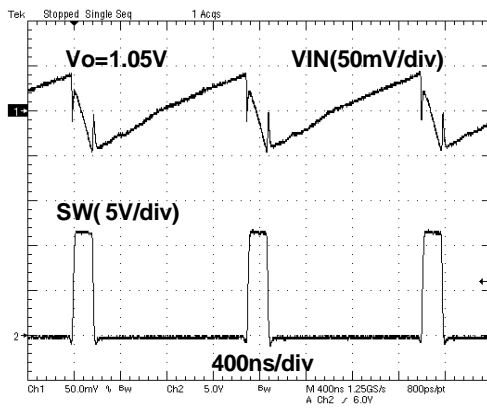
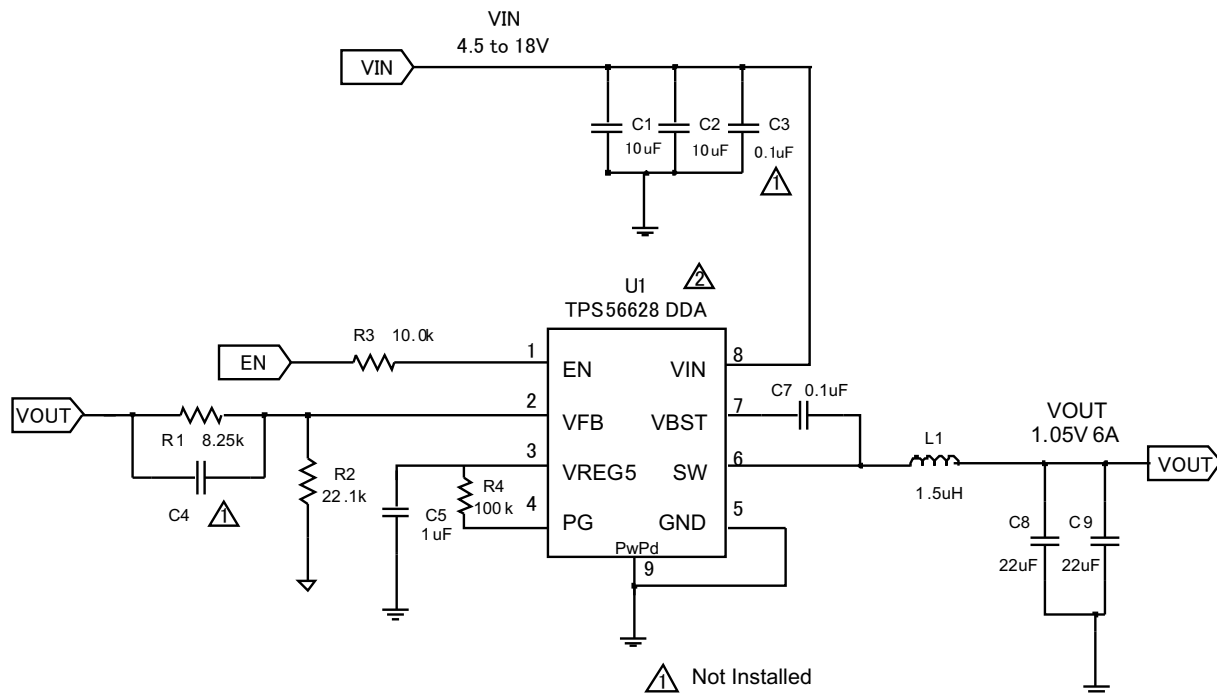**Figure 15. VOLTAGE RIPPLE AT INPUT (I_O = 6 A)**

Figure 16. OUTPUT CURRENT vs AMBIENT TEMPERATURE

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 17. 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.

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

(2)

Output Filter Selection

The output filter used with the TPS56628 is an LC circuit. This LC filter has double pole at:

$$F_P = \frac{1}{2\pi\sqrt{L_{OUT} \times C_{OUT}}}$$

(3)

At low frequencies, the overall loop gain is set by the output set-point resistor divider network and the internal gain of the TPS56628. 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 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 be 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 (µF)	
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	MAX
1	6.81	22.1	5	150	220	1.0	1.5	4.7	22	68
1.05	8.25	22.1	5	150	220	1.0	1.5	4.7	22	68
1.2	12.7	22.1	5		100	1.0	1.5	4.7	22	68
1.5	21.5	22.1	5		68	1.0	1.5	4.7	22	68
1.8	30.1	22.1	5		22	1.2	1.5	4.7	22	68
2.5	49.9	22.1	5		22	1.5	2.2	4.7	22	68
3.3	73.2	22.1	2		22	1.8	2.2	4.7	22	68
5	124	22.1	2		22	2.2	3.3	4.7	22	68

(1) Optional

For higher output voltages, additional phase boost can be achieved by adding a feed forward capacitor (C4) in parallel with R1

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 650 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.

$$I_{IPP} = \frac{V_{OUT}}{V_{IN(max)}} \times \frac{V_{IN(max)} - V_{OUT}}{L_O \times f_{SW}}$$

(4)

$$I_{Ipeak} = I_O + \frac{I_{Ipp}}{2}$$

(5)

$$I_{Lo(RMS)} = \sqrt{I_O{}^2 + \frac{1}{12}I_{IPP}{}^2}$$

(6)

For this design example, the calculated peak current is 6.51 A and the calculated RMS current is 6.01 A. The inductor used is a TDK SPM6530-1R5M100 with a peak current rating of 11.5 A and an RMS current rating of 11 A.

The capacitor value and ESR determines the amount of output voltage ripple. The TPS56628 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.

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

(7)

For this design two TDK C3216X5R0J226M 22µF output capacitors are used. The typical ESR is 2 mΩ each. The calculated RMS current is 0.286 A and each output capacitor is rated for 4A.

Input Capacitor Selection

The TPS56628 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 (C3) from pin 8 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 1-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 attached to an external heatsink. The thermal pad must be soldered to the printed circuit board (PCB). After soldering, the PCB can be used as a heartsick. 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 heartsick 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.
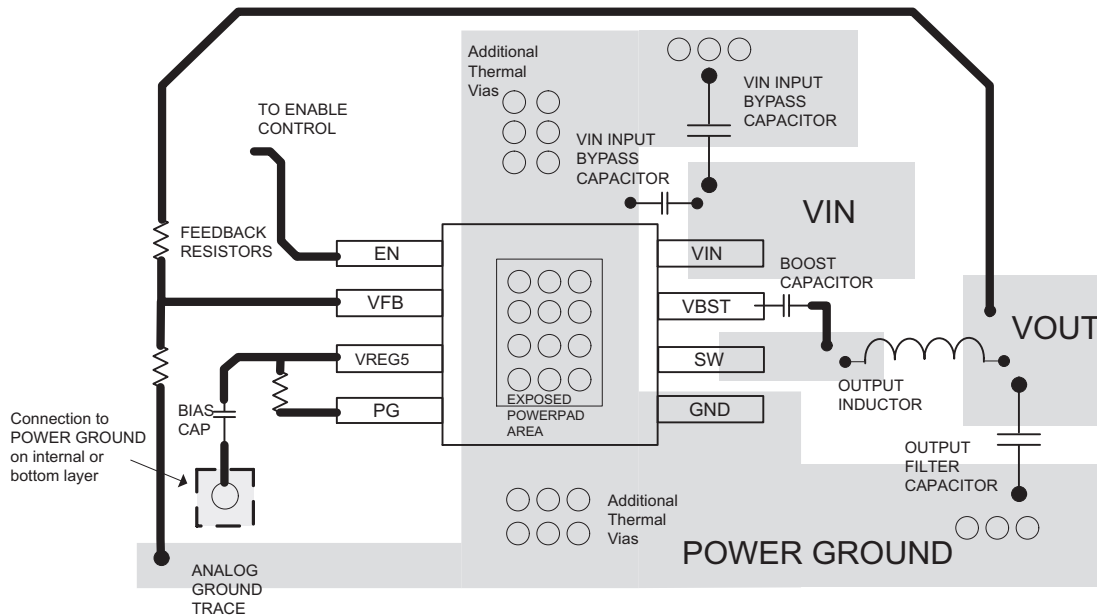
The exposed thermal pad dimensions for this package are shown in the following illustration.
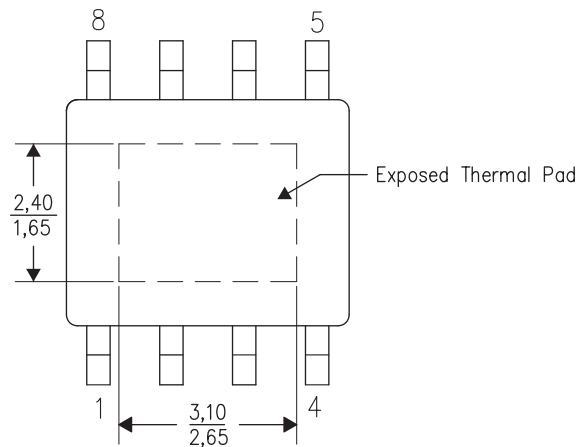
Figure 18. Thermal Pad Dimensions

LAYOUT CONSIDERATIONS

1. The TPS56628 can supply large load currents up to 6 A, so heat dissipation may be a concern. The top side area of PCB adjacent to the TPS56628 should be filled with ground as much as possible to dissipate heat.

2. The bottom side area directly below the IC should a dedicated ground area. It should be directly connected to the thermal pad of the device using vias as shown. The ground area should be as large as practical. Additional internal layers can be dedicated as ground planes and connected to the vias as well.

3. Keep the input switching current loop as small as possible.

4. 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.

5. Keep analog and non-switching components away from switching components.

6. Make a single point connection from the signal ground to power ground.

7. Do not allow switching current to flow under the device.

8. Keep the pattern lines for VIN, SW, and PGND (POWERGROUND) broad.

9. Exposed pad of device must be connected to PGND with solder.

10. VREG5 capacitor should be placed near the device, and connected PGND.

11. Output capacitor should be connected to a broad pattern of the PGND.

12. Voltage feedback loop should be as short as possible, and preferably with ground shield.

13. Lower resistor of the voltage divider which is connected to the VFB pin should be tied to ANALOG GROUND.

14. Providing sufficient via is preferable for VIN, SW and PGND connection.

15. VFB node should be as short as possible.

16. VIN Capacitor should be placed as near as possible to the device.

Figure 19. PCB Layout

修订历史记录

谨记：当前版本的页码也许与之前的版本不同。

修订历史记录

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
TPS56628DDA	ACTIVE	SO PowerPAD	DDA	8	75	RoHS & Green	NIPDAU | NIPDAUAG	Level-2-260C-1 YEAR	-40 to 85	56628	Samples
TPS56628DDAR	ACTIVE	SO PowerPAD	DDA	8	2500	RoHS & Green	NIPDAU | NIPDAUAG	Level-2-260C-1 YEAR	-40 to 85	56628	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) 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.

(6) 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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PACKAGE MATERIALS INFORMATION

TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSIONS

A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS56628DDAR	SO Power PAD	DDA	8	2500	330.0	12.8	6.4	5.2	2.1	8.0	12.0	Q1

![Texas Instruments logo] **PACKAGE MATERIALS INFORMATION**

TAPE AND REEL BOX DIMENSIONS

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS56628DDAR	SO PowerPAD	DDA	8	2500	366.0	364.0	50.0

DDA 8   **PowerPAD™ SOIC - 1.7 mm max height**

Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4202561/G

DDA (R−PDSO−G8)   PowerPAD ™ PLASTIC SMALL−OUTLINE

1,27

8   5

0,51
0,31   ⊕ 0,25Ⓜ

THERMAL PAD

SIZE AND SHAPE SHOWN
ON SEPARATE SHEET

4,00
3,80

6,20
5,80

1   4

5,00
4,80

1,70 MAX

0,15
0,00

0,20 NOM

Gage Plane

0°−8°

0,25

1,27
0,40

Seating Plane

⌒ 0,10

4202561/F 12/11

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.

TEXAS
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www.ti.com

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.

Top View

Exposed Thermal Pad Dimensions

4206322−6/L 05/12

NOTE: A. All linear dimensions are in millimeters

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TEXAS INSTRUMENTS
www.ti.com

DDA (R−PDSO−G8)   PowerPAD™ PLASTIC SMALL OUTLINE

Example Board Layout
Via pattern and copper pad size
may vary depending on layout constraints

0,127mm Thick Stencil Design Example
Reference table below for other
solder stencil thicknesses
(Note E)

4x1,30   1,27

solder mask
over copper

6xØ0,33

3x1,30

2,40 2,95   5,75

3,10

4,90

Example Solder Mask
Defined Pad
(See Note C, D)

Non Solder Mask Defined Pad

0,45   1,27

2,15

3,10

Y   2,40   5,75

X

Example Solder Mask Opening
(Note F)

0,5

2,2

Pad Geometry
(Note C)

0,07
All Around

Center Power Pad Solder Stencil Opening		
Stencil Thickness	X	Y
0.1mm	3.3	2.6
0.127mm	3.1	2.4
0.152mm	2.9	2.2
0.178mm	2.8	2.1

4208951−6/D 04/12

NOTES: A.   All linear dimensions are in millimeters.
B.   This drawing is subject to change without notice.
C.   Publication IPC−7351 is recommended for alternate designs.
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, 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.
E.   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.
F.   Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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