同步降压 NexFET™ 电源块

特性

- 半桥式电源块
- 高达 27 V V_{IN}
- 在 **15 A** 电流下可实现 **91%** 的系统效率
- 高达 **20 A** 的工作电流
- 高频率工作（高达 **1.5MHz**）
- 高密度 — SON 3.3-mm × 3.3-mm 封装
- 针对 **5V** 栅极驱动进行了优化
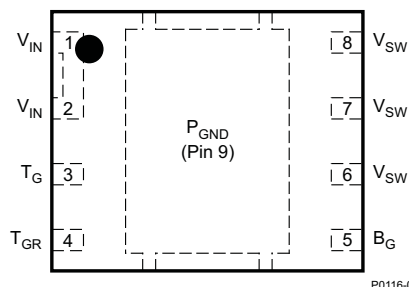- 低开关损耗
- 超低电感封装
- 符合 **RoHS** 标准
- 无卤素
- 无铅终端电镀

应用

- 同步降压型转换器
  - 高频应用
  - 高电流、低占空比应用
- 多相位同步降压转换器
- **POL DC-DC** 转换器
- **IMVP**、**VRM** 与 **VRD** 应用

说明

CSD87330Q3D NexFET™ 电源块是面向同步降压应用的优化设计，能够以 3.3 毫米 × 3.3 毫米的小巧外形提供高电流、高效率以及高频率性能。当与来自外部控制器/驱动的任一 5 V 栅极驱动器成对使用时，此产品提供一个灵活的解决方案以提供高密度电源，因此此产品为 5 V 栅极驱动应用提供最优解决方案。 该产品针对 5V 栅极驱动应用进行了优化，可提供高度灵活的解决方案，在与外部控制器/驱动器的任何 5V 栅极驱动配合使用时，均可提供高密度电源。

顶视图

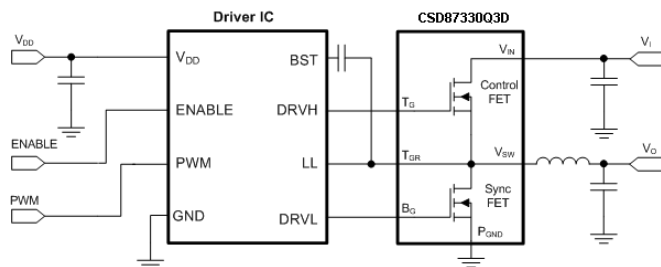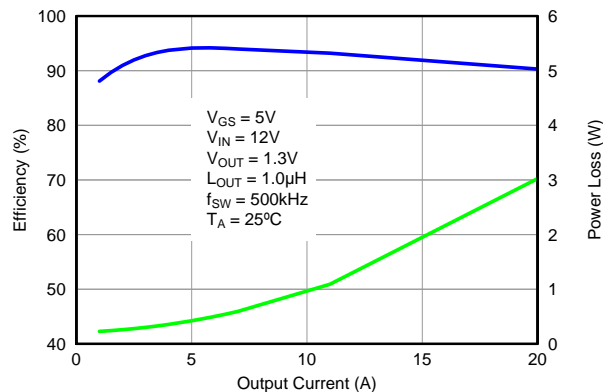P0116-01

订购信息

器件	封装	介质	数量	运输
CSD87330Q3D	SON 3.3-mm × 3.3-mm 塑料封装	13 英寸卷带	2500	卷带封装

典型电路

典型电源块效率与功率损耗

$V_{GS} = 5V$
$V_{IN} = 12V$
$V_{OUT} = 1.3V$
$L_{OUT} = 1.0\mu H$
$f_{SW} = 500kHz$
$T_A = 25ºC$

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.
NexFET is a trademark of Texas Instruments.

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.

最大绝对额定值

T_A = 25°C (unless otherwise noted)[1]

参数	CONDITIONS	数值		单位
		最小值	最大值	
Voltage Range	V_{IN} to P_{GND}		30	V
	V_{SW} to P_{GND}		30	V
	V_{SW} to P_{GND} (10ns)		32	V
	T_G to T_{GR}	-8	10	V
	B_G to P_{GND}	-8	10	V
Pulsed Current Rating, I_{DM}			60	A
Power Dissipation, P_D			6	W
Avalanche Energy E_{AS}	Sync FET, I_D = 55A, L = 0.1mH		151	mJ
	Control FET, I_D = 36A, L = 0.1mH		65	
Operating Junction and Storage Temperature Range, T_J, T_{STG}		−55	150	°C

(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 is not implied. 长时间处于最大绝对额定情况下会影响设备的可靠性。

建议的应用条件

T_A = 25° (unless otherwise noted)

参数	CONDITIONS	最小值	最大值	单位
Gate Drive Voltage, V_{GS}		4.5	8	V
Input Supply Voltage, V_{IN}			27	V
Switching Frequency, f_{SW}	C_{BST} = 0.1µF (min)		1500	kHz
Operating Current			20	A
Operating Temperature, T_J			125	°C

POWER BLOCK PERFORMANCE[1]

T_A = 25° (unless otherwise noted)

参数	CONDITIONS	最小值	典型值	最大值	单位
Power Loss, P_{LOSS}[1]	V_{IN} = 12V, V_{GS} = 5V, V_{OUT} = 1.3V, I_{OUT} = 15A, f_{SW} = 500kHz, L_{OUT} = 1µH, T_J = 25ºC		2		W
V_{IN} Quiescent Current, I_{QVIN}	T_G to T_{GR} = 0V B_G to P_{GND} = 0V		10		µA

(1) Measurement made with six 10-µF (TDK C3216X5R1C106KT or equivalent) ceramic capacitors placed across V_{IN} to P_{GND} pins and using a high current 5V driver IC.

热性能信息

T_A = 25°C (unless otherwise stated)

	热度量	最小值	典型值	最大值	单位
$R_{\theta JA}$	Junction to ambient thermal resistance (Min Cu)[1]			135	°C/W
	Junction to ambient thermal resistance (Max Cu)[1][2]			73	
$R_{\theta JC}$	Junction to case thermal resistance (Top of package)[1]			29	
	Junction to case thermal resistance (P_{GND} Pin)[1]			2.5	

(1) $R_{\theta JC}$ is determined with the device mounted on a 1-inch² (6.45-cm²), 2 oz. (0.071-mm thick) Cu pad on a 1.5-inch × 1.5-inch (3.81-cm × 3.81-cm), 0.06-inch (1.52-mm) thick FR4 board. $R_{\theta JC}$ is specified by design while $R_{\theta JA}$ is determined by the user's board design.
(2) Device mounted on FR4 material with 1-inch² (6.45-cm²) Cu.

电气特性

T_A = 25°C (unless otherwise stated)

参数		测试条件	Q1 Control FET			Q2 Sync FET			单位
			最小值	典型值	最大值	最小值	典型值	最大值	
Static Characteristics									
BV_{DSS}	漏极至源极电压	V_{GS} = 0V, I_{DS} = 250µA	30			30			V
I_{DSS}	Drain to Source Leakage Current	V_{GS} = 0V, V_{DS} = 20V			1			1	µA
I_{GSS}	Gate to Source Leakage Current	V_{DS} = 0V, V_{GS} = +10 / −8			100			100	na（不适用）
$V_{GS(th)}$	Gate to Source Threshold Voltage	V_{DS} = V_{GS}, I_{DS} = 250µA	0.75	0.95	1.15	1	1.4	2.1	V
$Z_{DS(on)}$	Effective AC On-Impedance	V_{IN} = 12V, V_{GS} = 5V, V_{OUT} = 1.3V, I_{OUT} = 15A, f_{SW} = 500kHz, L_{OUT} = 0.3µH, T_J = 25ºC		9.45	11.1		3.6	4.3	mΩ
g_{fs}	Transconductance	V_{DS} = 15V, I_{DS} = 15A		51			76		S
Dynamic Characteristics									
C_{ISS}	Input Capacitance	V_{GS} = 0V, V_{DS} = 15V, f = 1MHz		750	900		1360	1632	pF
C_{OSS}	Output Capacitance			310	370		580	700	pF
C_{RSS}	Reverse Transfer Capacitance			13	16		35	44	pF
R_G	Series Gate Resistance			1.3	2.6		0.8	1.6	Ω
Q_g	总栅极电荷 (4.5V)	V_{DS} = 15V, I_{DS} = 15A		4.8	5.8		9.6	11.5	nC
Q_{gd}	Gate Charge - Gate to Drain			0.9			1.8		nC
Q_{gs}	Gate Charge - Gate to Source			1.5			2		nC
$Q_{g(th)}$	Gate Charge at Vth			0.9			1.1		nC
Q_{OSS}	Output Charge	V_{DS} = 14V, V_{GS} = 0V		6			11		nC
$t_{d(on)}$	Turn On Delay Time	V_{DS} = 15V, V_{GS} = 4.5V, I_{DS} = 15A, R_G = 2Ω		4.5			4.5		ns
t_r	Rise Time			6.8			7.5		ns
$t_{d(off)}$	Turn Off Delay Time			9.4			9.1		ns
t_f	Fall Time			1.7			1.6		ns
Diode Characteristics									
V_{SD}	Diode Forward Voltage	I_{DS} = 15A, V_{GS} = 0V		0.85	1		0.85	1	V
Q_{rr}	Reverse Recovery Charge	V_{DS} = 14V, I_F = 15A, di/dt = 300A/µs		10			15		nC
t_{rr}	Reverse Recovery Time			14			18		ns
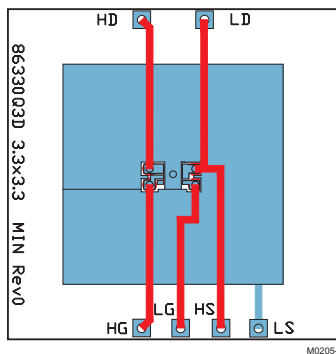
Max $R_{\theta JA}$ = 73°C/W when mounted on 1 inch^2 (6.45 cm^2) of 2-oz. (0.071-mm thick) Cu.
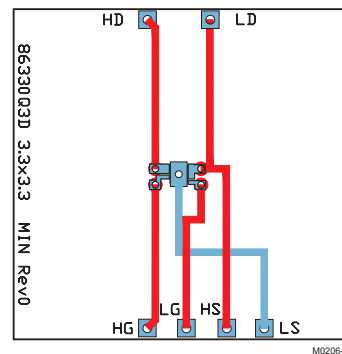
Max $R_{\theta JA}$ = 135°C/W when mounted on minimum pad area of 2-oz. (0.071-mm thick) Cu.

TYPICAL POWER BLOCK DEVICE CHARACTERISTICS

Test Conditions: V_{IN} = 12V, V_{DD} = 5V, f_{SW} = 500kHz, V_{OUT} = 1.2V, L_{OUT} = 1µH, I_{OUT} = 20A, T_J = 125°C, unless stated otherwise.
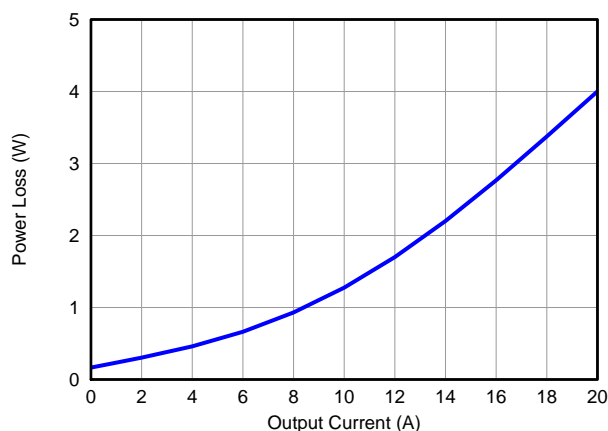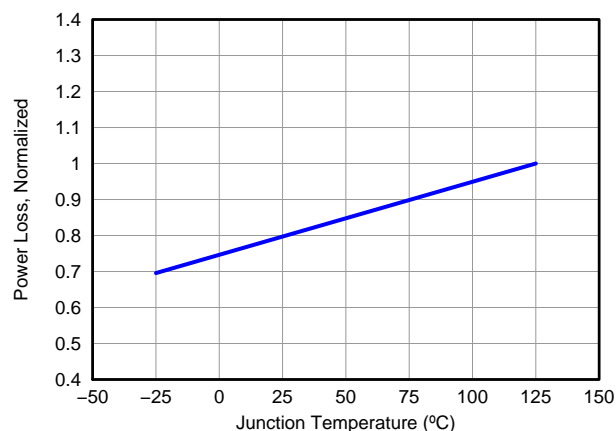
Figure 1. Power Loss vs Output Current
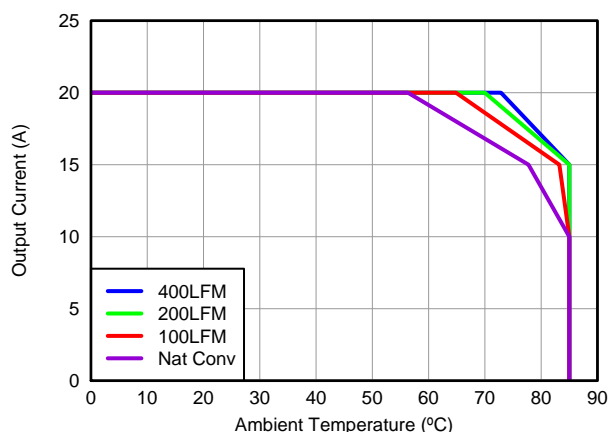
Figure 2. Power Loss vs Temperature
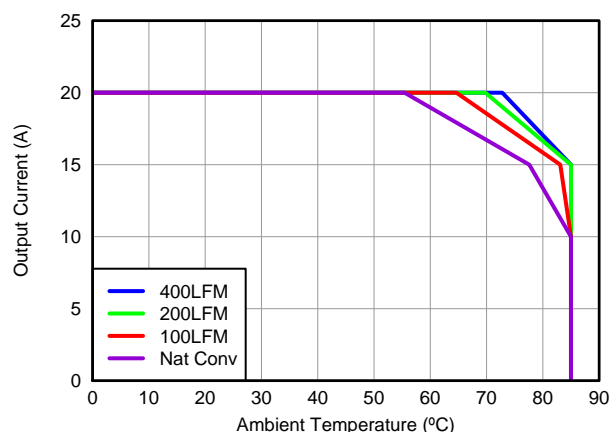
Figure 3. Safe Operating Area – PCB Vertical Mount[1]
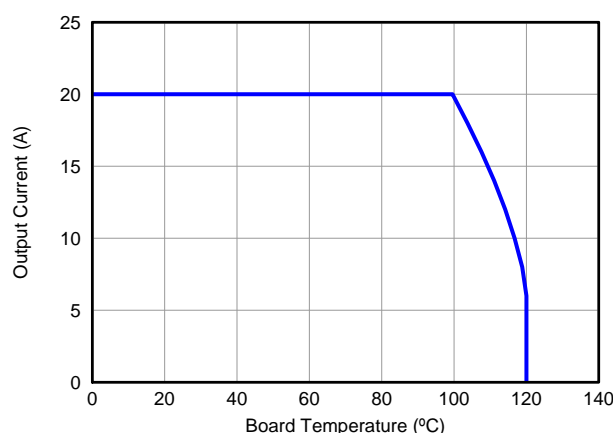
Figure 4. Safe Operating Area – PCB Horizontal Mount[1]

Figure 5. Typical Safe Operating Area[1]

(1) The Typical Power Block System Characteristic curves are based on measurements made on a PCB design with dimensions of 4.0" (W) × 3.5" (L) × 0.062" (H) and 6 copper layers of 1 oz. copper thickness. See Application Section for detailed explanation.

TYPICAL POWER BLOCK DEVICE CHARACTERISTICS (continued)

Test Conditions: V_{IN} = 12V, V_{DD} = 5V, f_{SW} = 500kHz, V_{OUT} = 1.2V, L_{OUT} = 1µH, I_{OUT} = 20A, T_J = 125°C, unless stated otherwise.
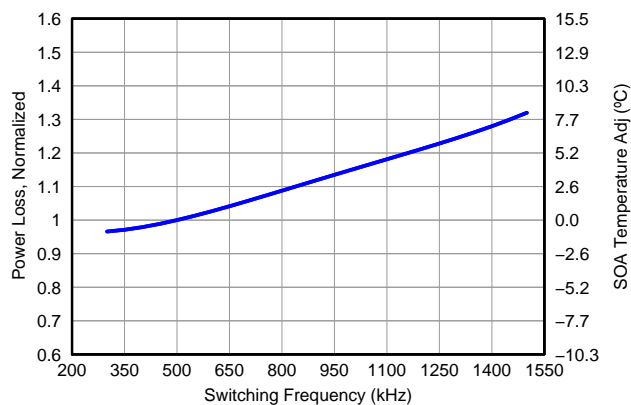

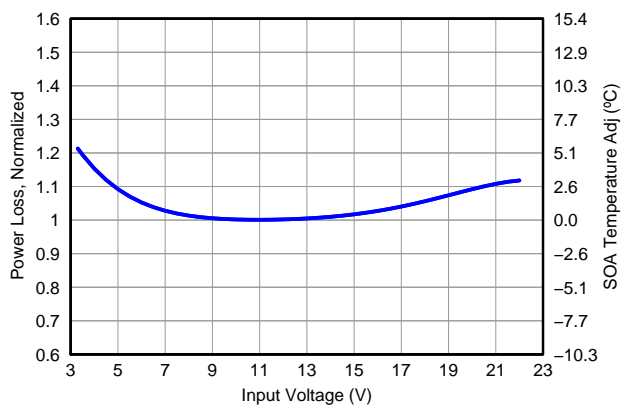Figure 6. Normalized Power Loss vs Switching Frequency

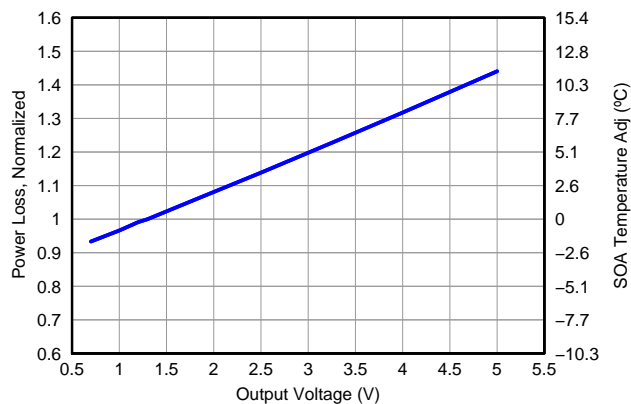Figure 7. Normalized Power Loss vs Input Voltage
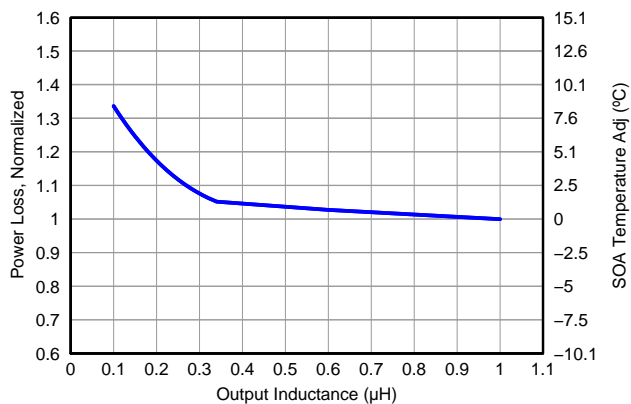

Figure 8. Normalized Power Loss vs. 输出电压

Figure 9. Normalized Power Loss vs. Output Inductance

TYPICAL POWER BLOCK MOSFET CHARACTERISTICS
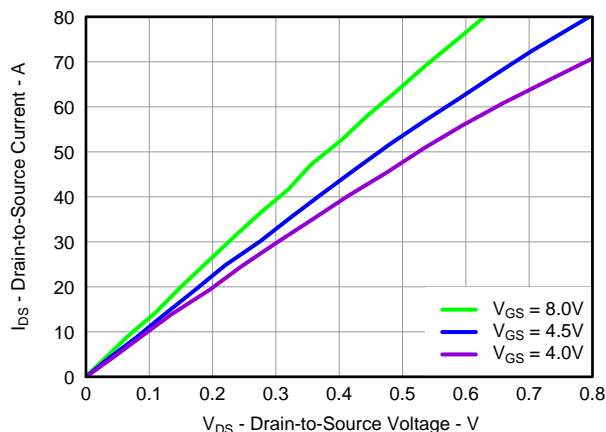
T_A = 25°C, unless stated otherwise.
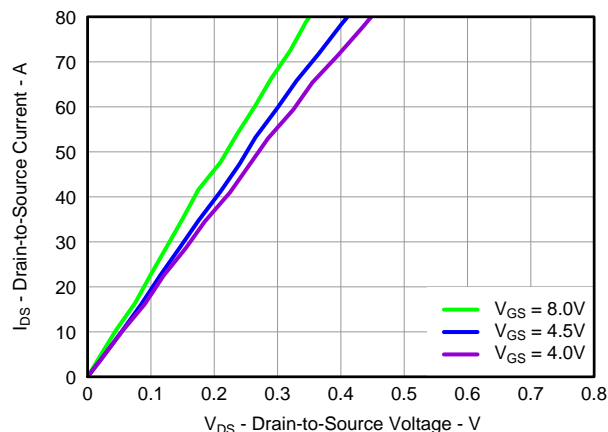

Figure 10. Control MOSFET Saturation

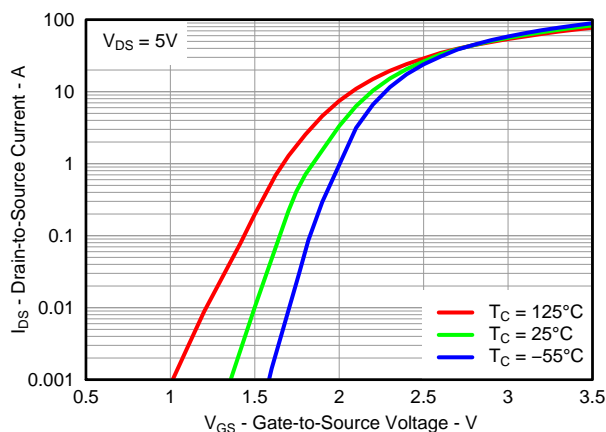**Figure 11. Sync MOSFET Saturation**

Figure 12. Control MOSFET Transfer
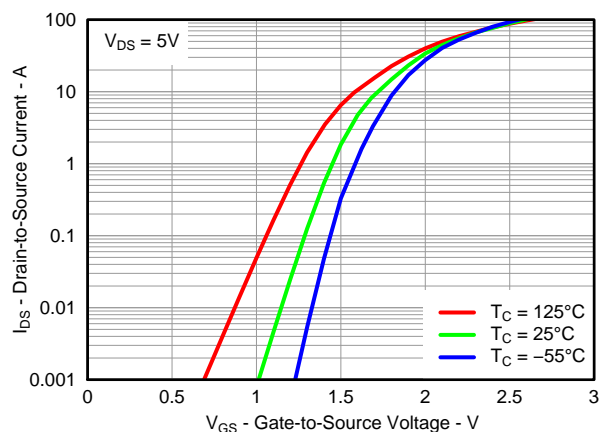
Figure 13. Sync MOSFET Transfer
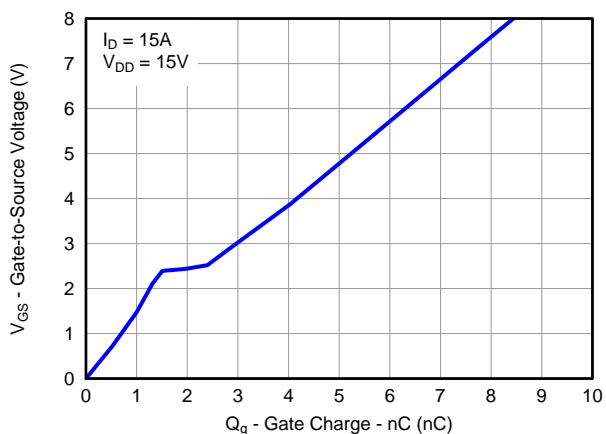
Figure 14. Control MOSFET Gate Charge

Figure 15. Sync MOSFET Gate Charge

TYPICAL POWER BLOCK MOSFET CHARACTERISTICS (continued)

T_A = 25°C, unless stated otherwise.
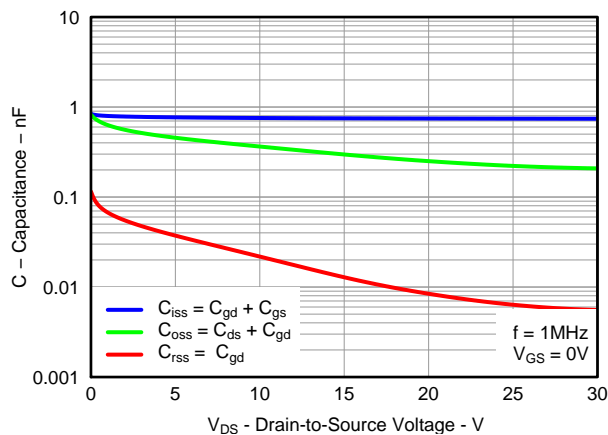
Figure 16. Control MOSFET Capacitance

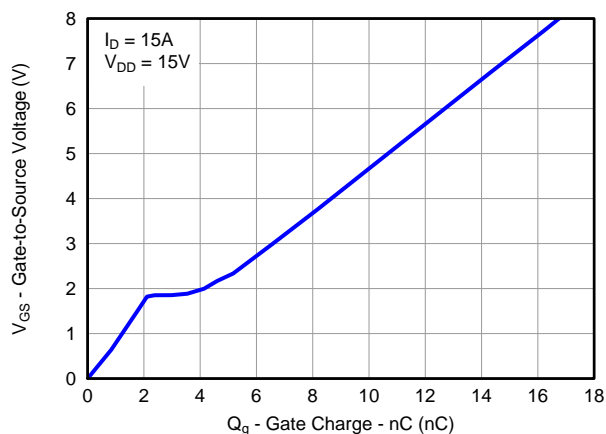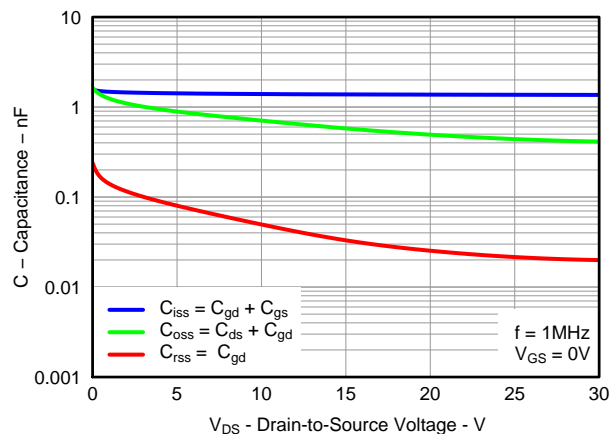Figure 17. Sync MOSFET Capacitance
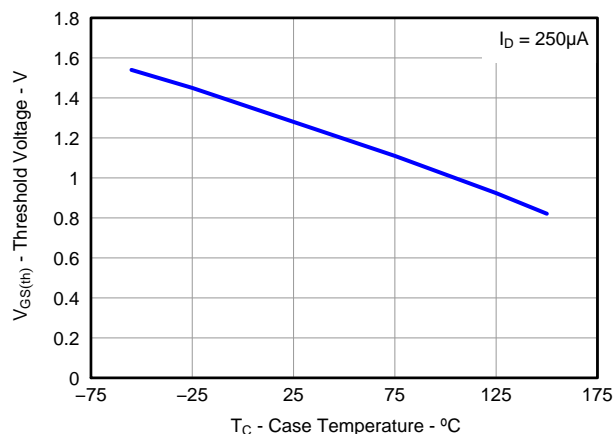
Figure 18. Control MOSFET $V_{GS(th)}$
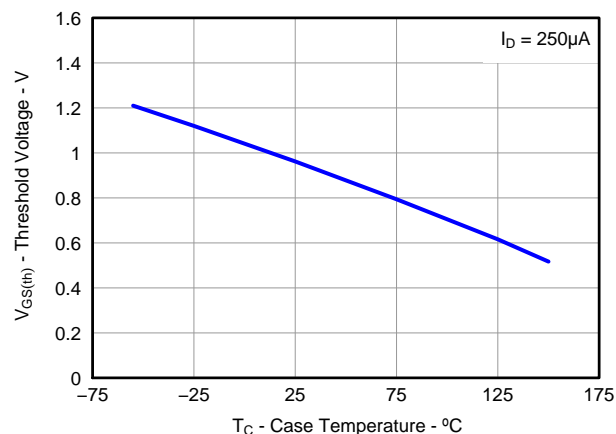
Figure 19. Sync MOSFET $V_{GS(th)}$
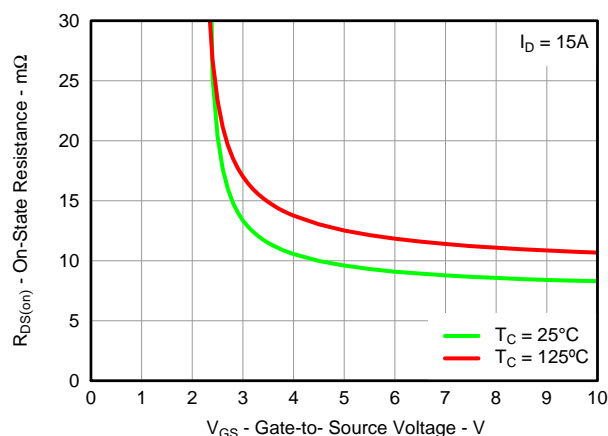
Figure 20. Control MOSFET $R_{DS(on)}$ vs V_{GS}
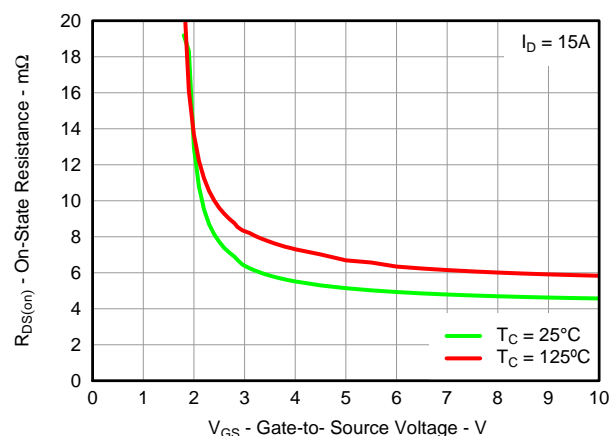
Figure 21. Sync MOSFET $R_{DS(on)}$ vs V_{GS}

TEXAS INSTRUMENTS

TYPICAL POWER BLOCK MOSFET CHARACTERISTICS (continued)

T_A = 25°C, unless stated otherwise.
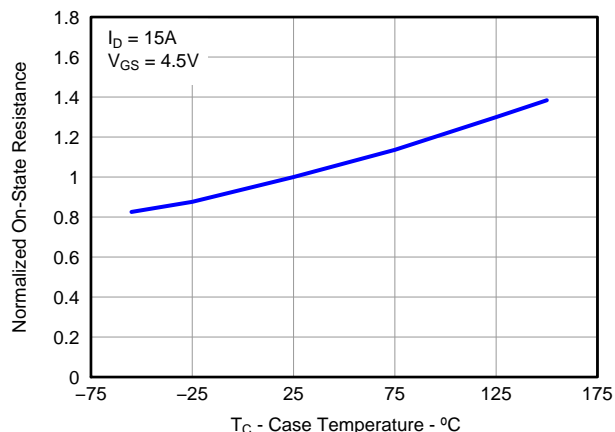
Figure 22. Control MOSFET Normalized $R_{DS(on)}$
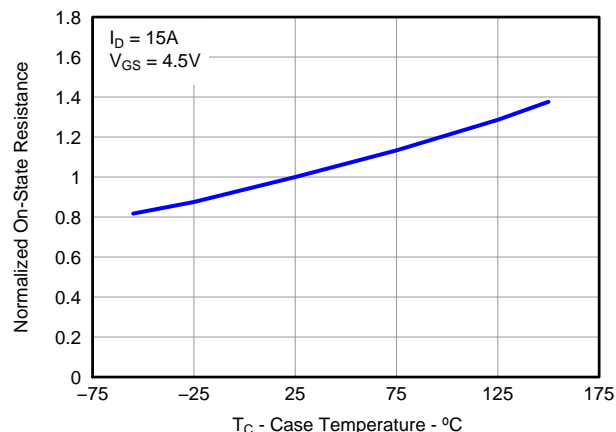
Figure 23. Sync MOSFET Normalized $R_{DS(on)}$
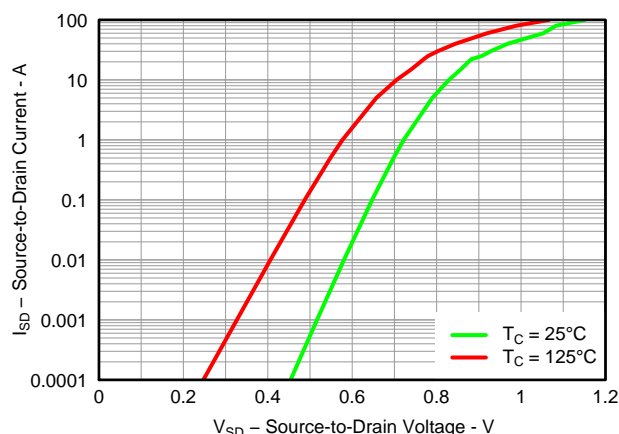
Figure 24. Control MOSFET Body Diode
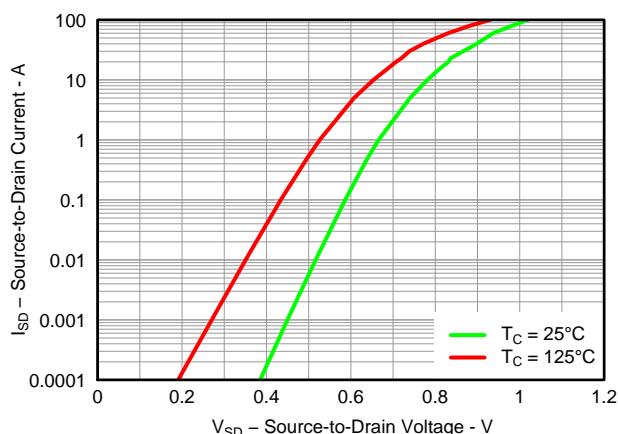
Figure 25. Sync MOSFET Body Diode
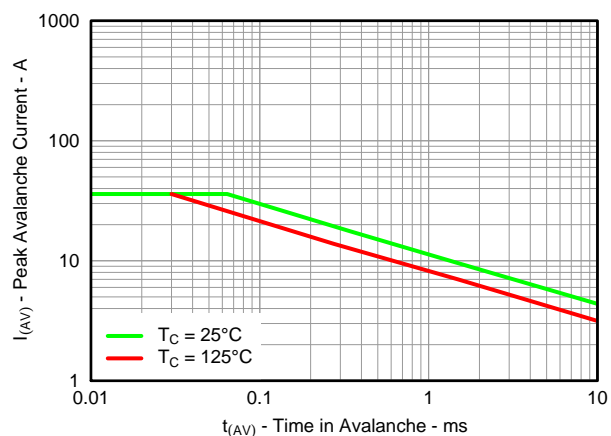
Figure 26. Control MOSFET Unclamped Inductive Switching
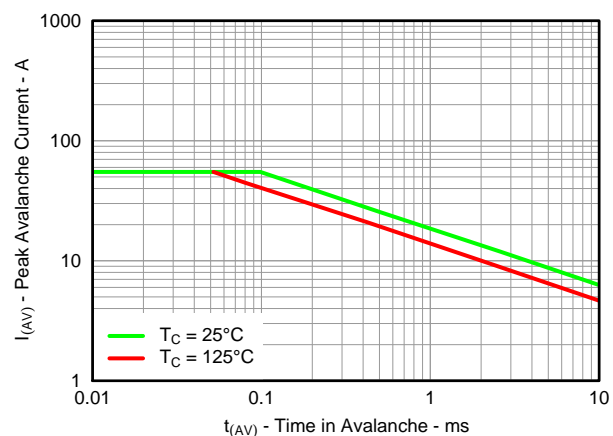
Figure 27. Sync MOSFET Unclamped Inductive Switching

应用信息

Equivalent System Performance

Many of today's high performance computing systems require low power consumption in an effort to reduce system operating temperatures and improve overall system efficiency. This has created a major emphasis on improving the conversion efficiency of today's Synchronous Buck Topology. In particular, there has been an emphasis in improving the performance of the critical Power Semiconductor in the Power Stage of this Application (see Figure 28). As such, optimization of the power semiconductors in these applications, needs to go beyond simply reducing $R_{DS(ON)}$.
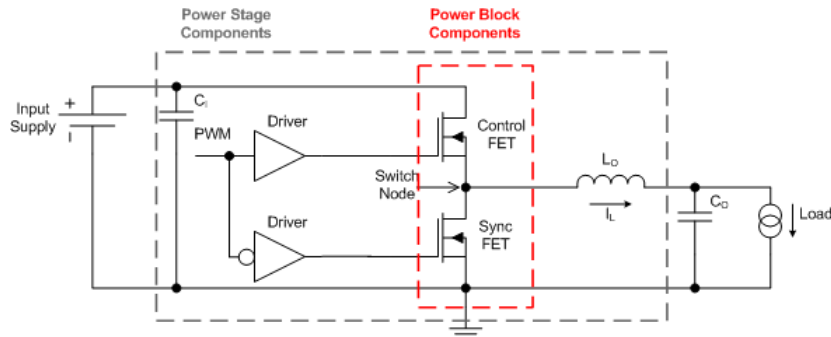
Figure 28.

The CSD87330Q5D is part of TI's Power Block product family which is a highly optimized product for use in a synchronous buck topology requiring high current, high efficiency, and high frequency. It incorporates TI's latest generation silicon which has been optimized for switching performance, as well as minimizing losses associated with Q_{GD}, Q_{GS}, and Q_{RR}. Furthermore, TI's patented packaging technology has minimized losses by nearly eliminating parasitic elements between the Control FET and Sync FET connections (see Figure 29). A key challenge solved by TI's patented packaging technology is the system level impact of Common Source Inductance (CSI). CSI greatly impedes the switching characteristics of any MOSFET which in turn increases switching losses and reduces system efficiency. As a result, the effects of CSI need to be considered during the MOSFET selection process. In addition, standard MOSFET switching loss equations used to predict system efficiency need to be modified in order to account for the effects of CSI. Further details behind the effects of CSI and modification of switching loss equations are outlined in TI's Application Note SLPA009.
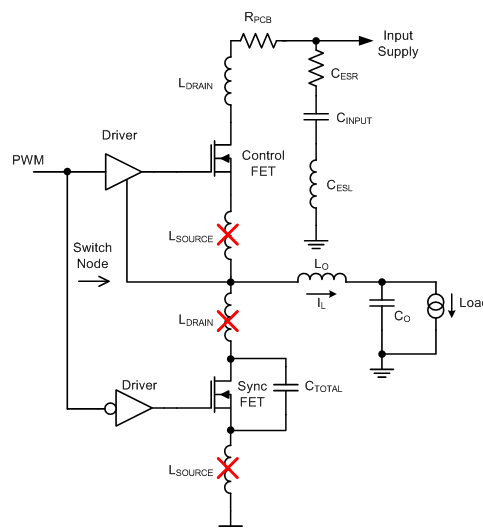
Figure 29.

The combination of TI's latest generation silicon and optimized packaging technology has created a benchmarking solution that outperforms industry standard MOSFET chipsets of similar $R_{DS(ON)}$ and MOSFET chipsets with lower $R_{DS(ON)}$. Figure 30 and Figure 31 compare the efficiency and power loss performance of the CSD87330Q5D versus industry standard MOSFET chipsets commonly used in this type of application. This comparison purely focuses on the efficiency and generated loss of the power semiconductors only. The performance of CSD87330Q5D clearly highlights the importance of considering the Effective AC On-Impedance ($Z_{DS(ON)}$) during the MOSFET selection process of any new design. Simply normalizing to traditional MOSFET $R_{DS(ON)}$ specifications is not an indicator of the actual in-circuit performance when using TI's Power Block technology.
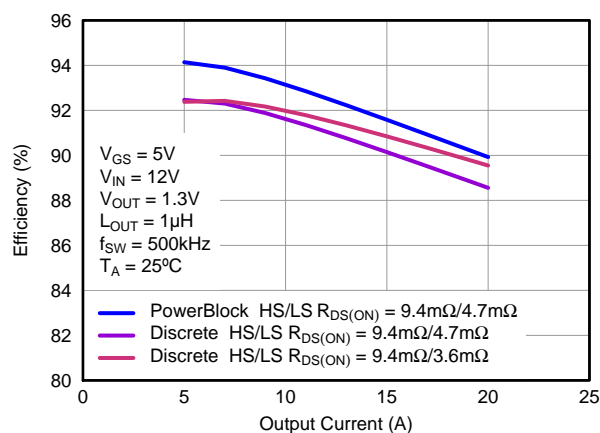
Figure 30.
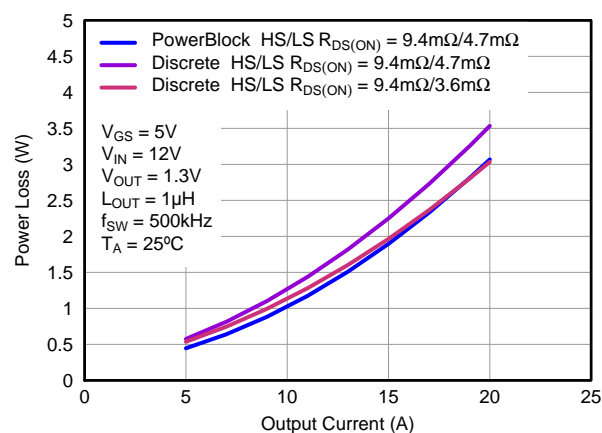
Figure 31.

The chart below compares the traditional DC measured $R_{DS(ON)}$ of CSD87330Q5D versus its $Z_{DS(ON)}$. This comparison takes into account the improved efficiency associated with TI's patented packaging technology. As such, when comparing TI's Power Block products to individually packaged discrete MOSFETs or dual MOSFETs in a standard package, the in-circuit switching performance of the solution must be considered. In this example, individually packaged discrete MOSFETs or dual MOSFETs in a standard package would need to have DC measured $R_{DS(ON)}$ values that are equivalent to CSD87330Q5D's $Z_{DS(ON)}$ value in order to have the same efficiency performance at full load. Mid to light-load efficiency will still be lower with individually packaged discrete MOSFETs or dual MOSFETs in a standard package.

Comparison of $R_{DS(ON)}$ vs. $Z_{DS(ON)}$

参数	HS		LS	
	Typ	**最大值**	**Typ**	**最大值**
Effective AC On-Impedance $Z_{DS(ON)}$ (V_{GS} = 5V)	9.5	11.1	3.6	4.3
DC Measured $R_{DS(ON)}$ (V_{GS} = 4.5V)	9.5	11.1	4.9	5.8

The CSD87330Q3D NexFET™ power block is an optimized design for synchronous buck applications using 5V gate drive. The Control FET and Sync FET silicon are parametrically tuned to yield the lowest power loss and highest system efficiency. As a result, a new rating method is needed which is tailored towards a more systems centric environment. System level performance curves such as Power Loss, Safe Operating Area, and normalized graphs allow engineers to predict the product performance in the actual application.

Power Loss Curves

MOSFET centric parameters such as $R_{DS(ON)}$ and Q_{gd} are needed to estimate the loss generated by the devices. In an effort to simplify the design process for engineers, Texas Instruments has provided measured power loss performance curves. Figure 1 plots the power loss of the CSD87330Q3D as a function of load current. This curve is measured by configuring and running the CSD87330Q3D as it would be in the final application (see Figure 32).The measured power loss is the CSD87330Q3D loss and consists of both input conversion loss and gate drive loss. Equation 1 is used to generate the power loss curve.

$$(V_{IN} \times I_{IN}) + (V_{DD} \times I_{DD}) - (V_{SW\_AVG} \times I_{OUT}) = \text{Power Loss} \tag{1}$$

The power loss curve in Figure 1 is measured at the maximum recommended junction temperatures of 125°C under isothermal test conditions.

Safe Operating Curves (SOA)

The SOA curves in the CSD87330Q3D data sheet provides guidance on the temperature boundaries within an operating system by incorporating the thermal resistance and system power loss. Figure 3 to Figure 5 outline the temperature and airflow conditions required for a given load current. The area under the curve dictates the safe operating area. All the curves are based on measurements made on a PCB design with dimensions of 4" (W) × 3.5" (L) × 0.062" (T) and 6 copper layers of 1 oz. copper thickness.

Normalized Curves

The normalized curves in the CSD87330Q3D data sheet provides guidance on the Power Loss and SOA adjustments based on their application specific needs. These curves show how the power loss and SOA boundaries will adjust for a given set of systems conditions. The primary Y-axis is the normalized change in power loss and the secondary Y-axis is the change is system temperature required in order to comply with the SOA curve. The change in power loss is a multiplier for the Power Loss curve and the change in temperature is subtracted from the SOA curve.
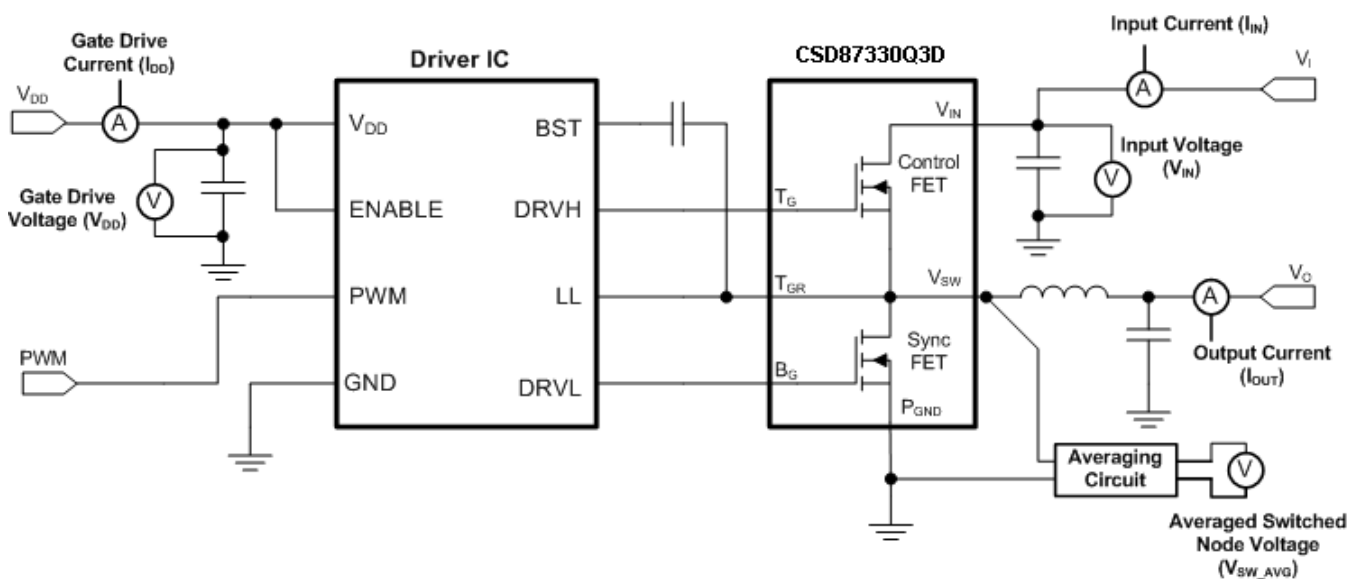

Figure 32. 典型应用

Calculating Power Loss and SOA

The user can estimate product loss and SOA boundaries by arithmetic means (see Design Example). Though the Power Loss and SOA curves in this data sheet are taken for a specific set of test conditions, the following procedure will outline the steps the user should take to predict product performance for any set of system conditions.

设计示例

Operating Conditions:
- Output Current = 15A
- Input Voltage = 12V
- Output Voltage = 1.2V
- Switching Frequency = 1000kHz
- Inductor = 0.4µH

Calculating Power Loss

- Power Loss at 15A = 2.2W (Figure 1)
- Normalized Power Loss for input voltage ≈ 1.0 (Figure 7)
- Normalized Power Loss for output voltage ≈ 0.98 (Figure 8)
- Normalized Power Loss for switching frequency ≈ 1.17 (Figure 6)
- Normalized Power Loss for output inductor ≈ 1.06 (Figure 9)
- **Final calculated Power Loss = 2.2W × 1.0 × 0.98 × 1.17 × 1.06 ≈ 2.67W**

Calculating SOA Adjustments

- SOA adjustment for input voltage ≈ 0ºC (Figure 7)
- SOA adjustment for output voltage ≈ –0.29ºC (Figure 8)
- SOA adjustment for switching frequency ≈ 4.1ºC (Figure 6)
- SOA adjustment for output inductor ≈ 1.5ºC (Figure 9)
- **Final calculated SOA adjustment = 0 + (–0.29) + 4.1 + 1.5 ≈ 5.3ºC**

In the design example above, the estimated power loss of the CSD87330Q3D would increase to 2.67W. In addition, the maximum allowable board and/or ambient temperature would have to decrease by 5.3ºC. Figure 33 graphically shows how the SOA curve would be adjusted accordingly.

1. Start by drawing a horizontal line from the application current to the SOA curve.
2. Draw a vertical line from the SOA curve intercept down to the board/ambient temperature.
3. Adjust the SOA board/ambient temperature by subtracting the temperature adjustment value.

In the design example, the SOA temperature adjustment yields a reduction in allowable board/ambient temperature of 5.3ºC. In the event the adjustment value is a negative number, subtracting the negative number would yield an increase in allowable board/ambient temperature.
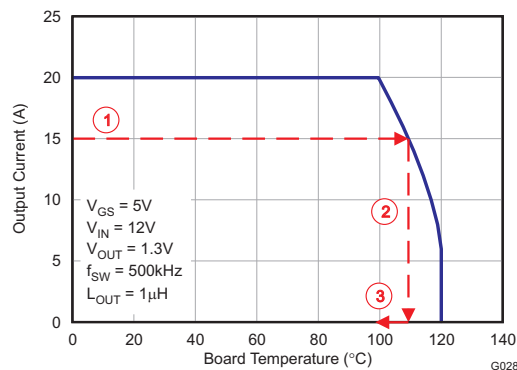

Figure 33. Power Block SOA

RECOMMENDED PCB DESIGN OVERVIEW

There are two key system-level parameters that can be addressed with a proper PCB design: Electrical and Thermal performance. Properly optimizing the PCB layout will yield maximum performance in both areas. A brief description on how to address each parameter is provided.

Electrical Performance

The Power Block has the ability to switch voltages at rates greater than 10kV/μs. Special care must be then taken with the PCB layout design and placement of the input capacitors, Driver IC, and output inductor.

- The placement of the input capacitors relative to the Power Block's VIN and PGND pins should have the highest priority during the component placement routine. It is critical to minimize these node lengths. As such, ceramic input capacitors need to be placed as close as possible to the VIN and PGND pins (see Figure 34). The example in Figure 34 uses 6 × 10-μF ceramic capacitors (TDK Part # C3216X5R1C106KT or equivalent). Notice there are ceramic capacitors on both sides of the board with an appropriate amount of vias interconnecting both layers. In terms of priority of placement next to the Power Block, C5, C7, C19, and C8 should follow in order.
- The Driver IC should be placed relatively close to the Power Block Gate pins. T_G and B_G should connect to the outputs of the Driver IC. The T_{GR} pin serves as the return path of the high-side gate drive circuitry and should be connected to the Phase pin of the IC (sometimes called LX, LL, SW, PH, etc.). The bootstrap capacitor for the Driver IC will also connect to this pin.
- The switching node of the output inductor should be placed relatively close to the Power Block VSW pins. Minimizing the node length between these two components will reduce the PCB conduction losses and actually reduce the switching noise level. [1]

Thermal Performance

The Power Block has the ability to utilize the GND planes as the primary thermal path. As such, the use of thermal vias is an effective way to pull away heat from the device and into the system board. Concerns of solder voids and manufacturability problems can be addressed by the use of three basic tactics to minimize the amount of solder attach that will wick down the via barrel:

- Intentionally space out the vias from each other to avoid a cluster of holes in a given area.
- Use the smallest drill size allowed in your design. The example in Figure 34 uses vias with a 10 mil drill hole and a 16 mil capture pad.
- Tent the opposite side of the via with solder-mask.

In the end, the number and drill size of the thermal vias should align with the end user's PCB design rules and manufacturing capabilities.
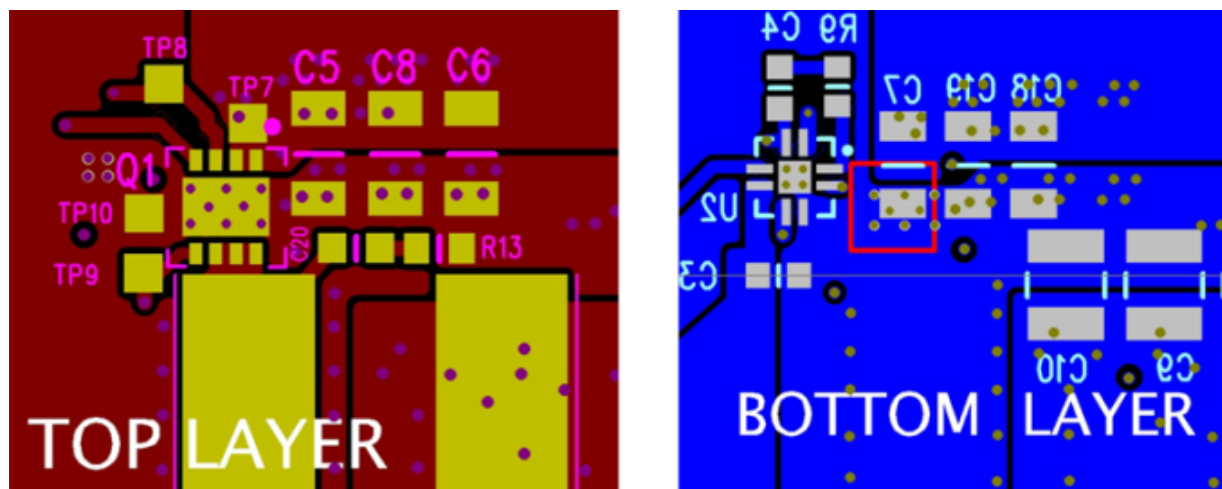
Figure 34. Recommended PCB Layout (Top Down)

[1] Keong W. Kam, David Pommerenke, "EMI Analysis Methods for Synchronous Buck Converter EMI Root Cause Analysis", University of Missouri – Rolla

MECHANICAL DATA

Q3D Package Dimensions

Top View

Side View

Bottom View

Pinout	
Position	Designation
Pin 1	V_{IN}
Pin 2	V_{IN}
Pin 3	T_G
Pin 4	T_{GR}
Pin 5	B_G
Pin 6	V_{SW}
Pin 7	V_{SW}
Pin 8	V_{SW}
Pin 9	P_{GND}

Exposed tie clips may vary
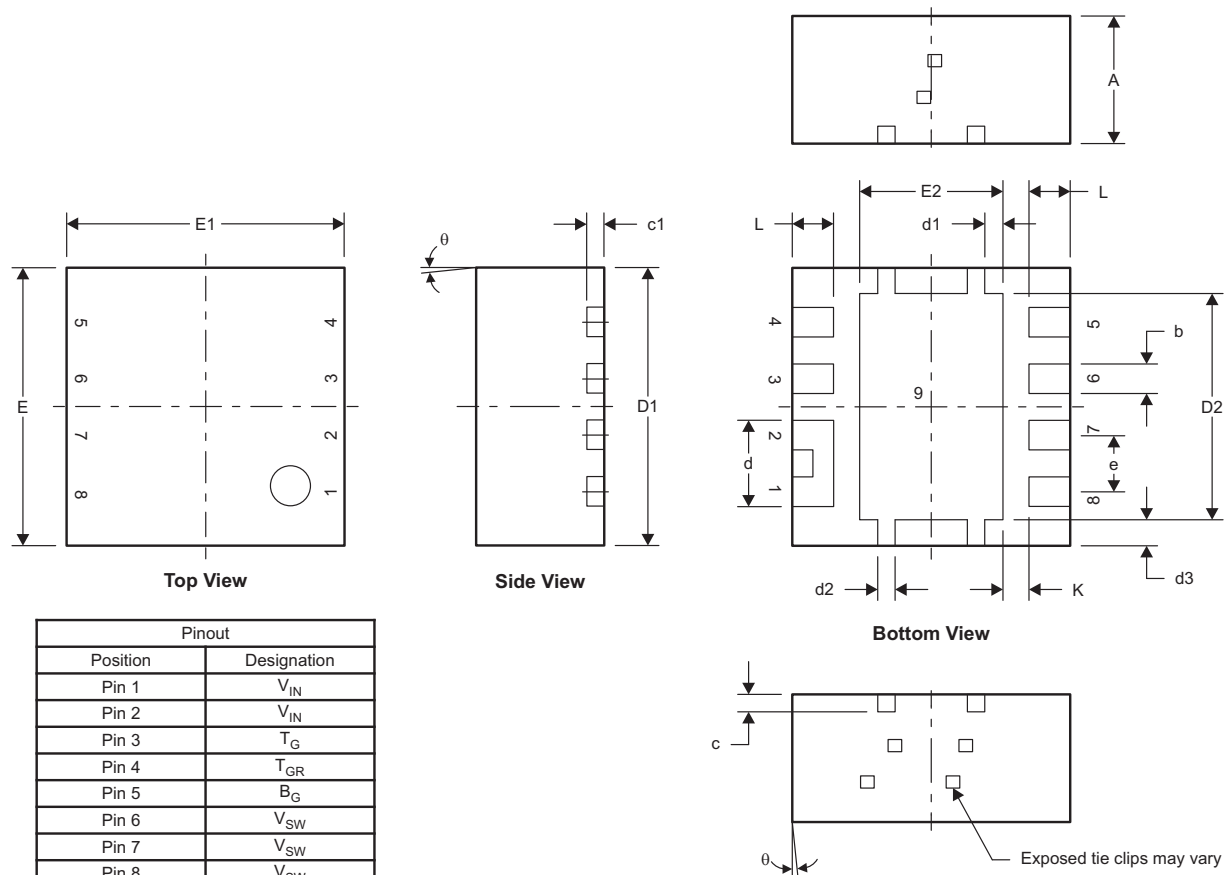
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DIM	MILLIMETERS		INCHES	
	最小值	最大值	最小值	最大值
a	1.40	1.55	0.055	0.061
b	0.280	0.400	0.011	0.016
c	0.150	0.250	0.006	0.010
c1	0.150	0.250	0.006	0.010
d	0.940	1.040	0.037	0.041
d1	0.160	0.260	0.006	0.010
d2	0.150	0.250	0.006	0.010
d3	0.250	0.350	0.010	0.014
D1	3.200	3.400	0.126	0.134
D2	2.650	2.750	0.104	0.108
E	3.200	3.400	0.126	0.134
E1	3.200	3.400	0.126	0.134
E2	1.750	1.850	0.069	0.073
e	0.650 TYP		0.026 TYP	
L	0.400	0.500	0.016	0.020
θ	0.00	–	–	–
K	0.300 TYP		0.012 TYP	

Land Pattern Recommendation

NOTE: Dimensions are in mm (inches).

Stencil Recommendation

NOTE: Dimensions are in mm (inches).

For recommended circuit layout for PCB designs, see application note SLPA005 − *Reducing Ringing Through PCB Layout Techniques.*
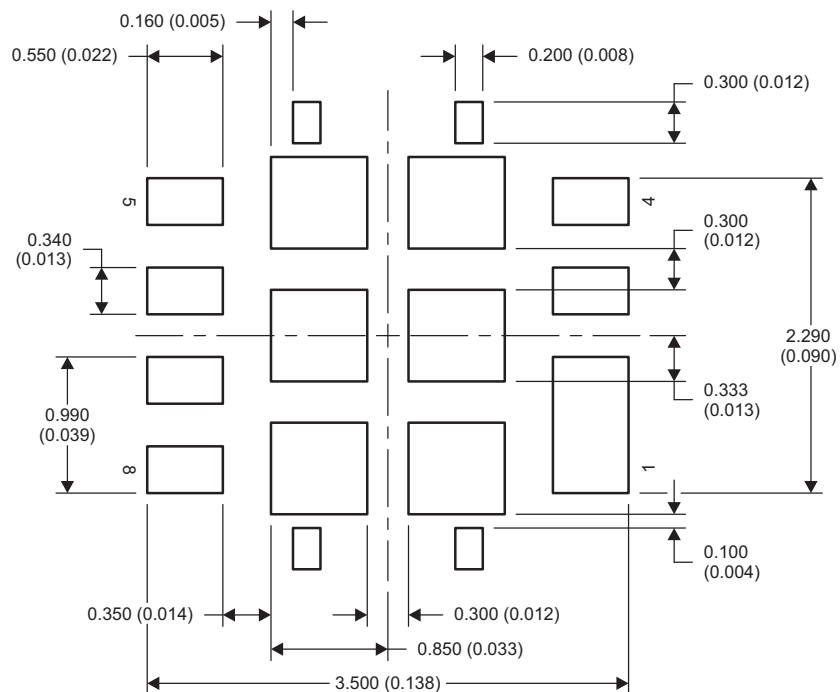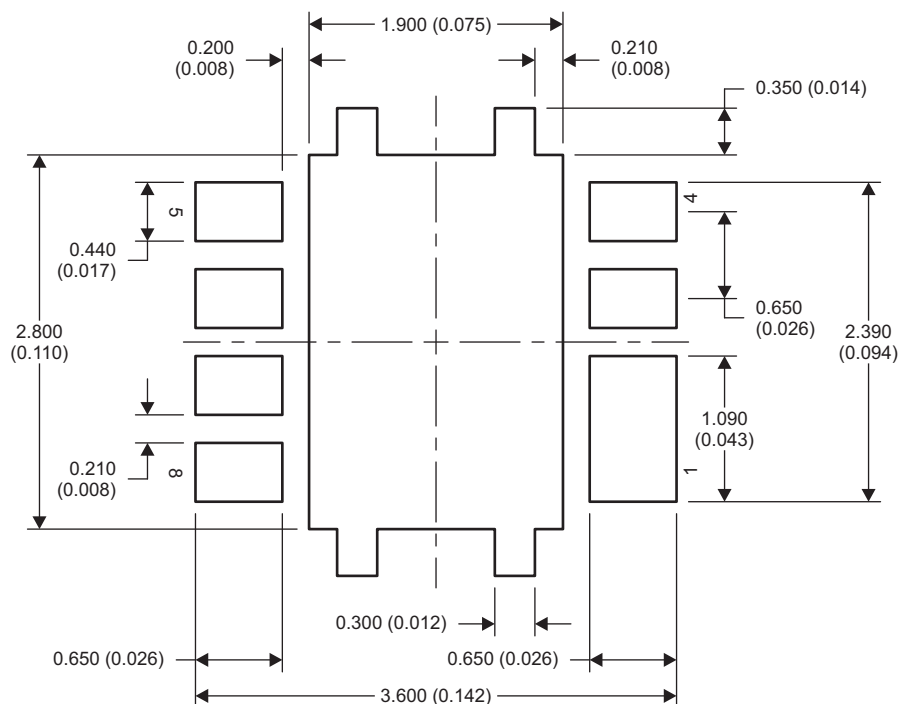
Q3D Tape and Reel Information
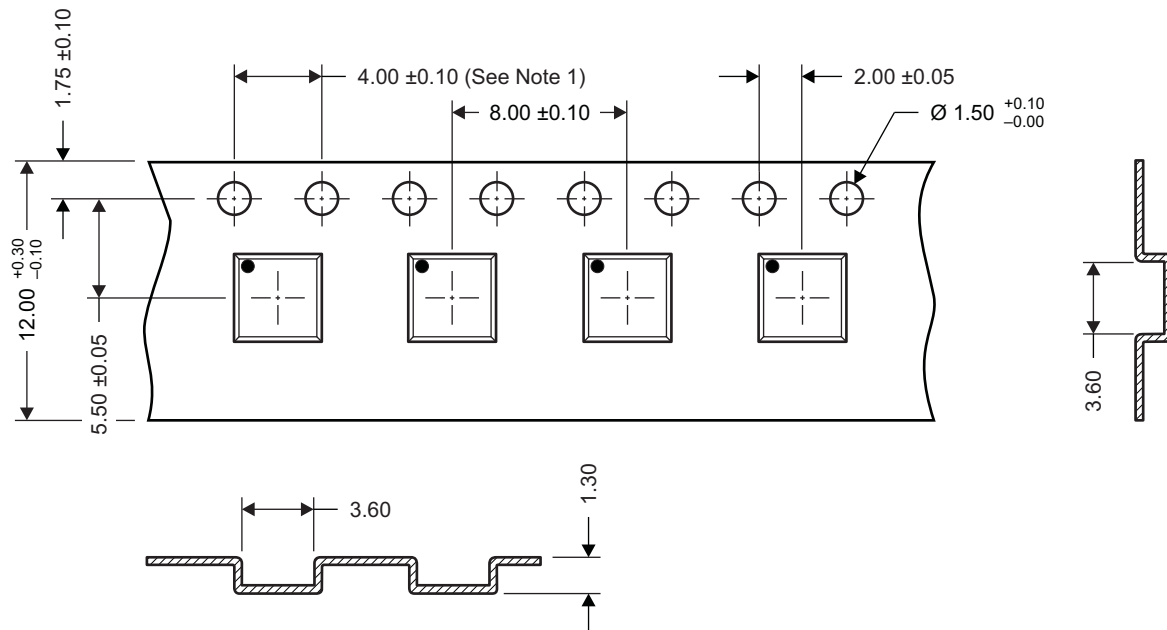
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NOTES: 1. 10-sprocket hole-pitch cumulative tolerance ±0.2

2. Camber not to exceed 1mm in 100mm, noncumulative over 250mm

3. Material: black static-dissipative polystyrene

4. All dimensions are in mm, unless otherwise specified.

5. Thickness: 0.30 ±0.05mm

6. MSL1 260°C (IR and convection) PbF reflow compatible

PACKAGE OPTION ADDENDUM

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
CSD87330Q3D	Active	Production	VSON-CLIP (DPB) | 8	2500 | LARGE T&R	ROHS Exempt	NIPDAU | SN	Level-1-260C-UNLIM	-55 to 150	87330D
CSD87330Q3D.B	Active	Production	VSON-CLIP (DPB) | 8	2500 | LARGE T&R	ROHS Exempt	NIPDAU	Level-1-260C-UNLIM	-55 to 150	87330D
CSD87330Q3DG4	Active	Production	VSON-CLIP (DPB) | 8	2500 | LARGE T&R	ROHS Exempt	NIPDAU	Level-1-260C-UNLIM	-55 to 150	87330D
CSD87330Q3DG4.B	Active	Production	VSON-CLIP (DPB) | 8	2500 | LARGE T&R	ROHS Exempt	NIPDAU	Level-1-260C-UNLIM	-55 to 150	87330D

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

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

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

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

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

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

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

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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
CSD87330Q3D	VSON-CLIP	DPB	8	2500	330.0	12.4	3.55	3.55	1.7	8.0	12.0	Q1
CSD87330Q3DG4	VSON-CLIP	DPB	8	2500	330.0	12.4	3.55	3.55	1.7	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)
CSD87330Q3D	VSON-CLIP	DPB	8	2500	346.0	346.0	33.0
CSD87330Q3DG4	VSON-CLIP	DPB	8	2500	346.0	346.0	33.0