

## CSD95378BQ5MC 同步降压 NexFET™ 智能功率级

### 1 特性

- 60A 持续运行电流能力
- 电流 30A 时，系统效率为 93.4%
- 电流 30A 时，低功耗损耗为 2.8W
- 高频工作（高达 1.25MHz）
- 支持强制连续传导模式 (FCCM) 的二极管仿真模式
- 温度补偿双向电流感应
- 模拟温度输出（0°C 时 400mV）
- 故障监控
  - 高端短路、过流和过热保护
- 3.3V 和 5V 脉宽调制 (PWM) 信号兼容
- 三态 PWM 输入
- 集成型自举二极管
- 用于击穿保护的经优化死区时间
- 高密度 5mm x 6mm SON 封装
- 超低电感封装
- 系统优化的 PCB 封装
- DualCool™ 封装
- 符合 RoHS 标准 - 无铅端子镀层
- 无卤素

### 2 应用

- 多相位同步降压转换器
  - 高频应用
  - 高电流、低占空比应用
- 负载点 (POL) 直流 - 直流转换器
- 内存和图形卡
- 台式机和服务器 VR11.x / VR12.x V 内核和存储器同步转换器

### 3 说明

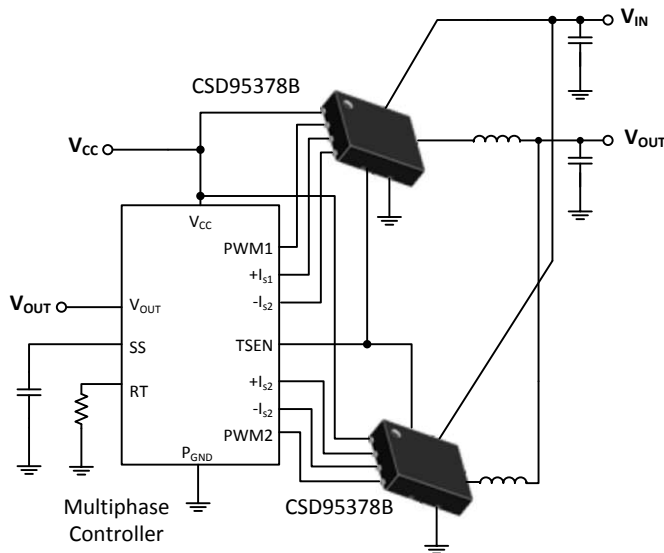
CSD95378BQ5MC NexFET™ 智能功率级的设计经过高度优化，适用于高功率、高密度同步降压转换器。此产品集成了驱动器 IC 和功率 MOSFET 以实现功率级开关功能。该组合可在 5mm x 6mm 小型封装中提供高效率和高速度的高电流切换功能。它还集成了准确电流感测和温度感测功能，以简化系统设计并提高准确度。此外，已经对印刷电路板 (PCB) 封装进行了优化，以帮助减少设计时间并简化总体系统设计。

器件信息(1)

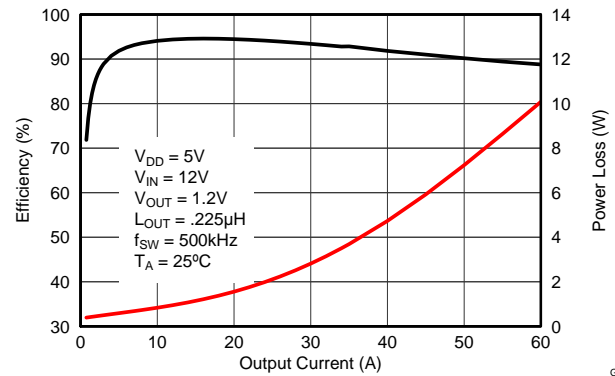
器件	包装介质	数量	封装	运输
CSD95378BQ5MC	13 英寸卷带	2500	SON	卷带封装
CSD95378BQ5MCT	7 英寸卷带	250	5.00mm x 6.00mm DualCool 封装	

(1) 要了解所有可用封装，请见数据表末尾的可订购产品附录。

应用图表



典型功率级效率与功率损耗



G001



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## 4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

<b>Changes from Revision B (June 2015) to Revision C</b>	<b>Page</b>
• Changed the CSD95378B parts in the <i>Application Schematic</i> section .....	<b>6</b>
• 已添加“接收文档更新通知”部分添加到了“器件和文档支持”部分 .....	<b>7</b>

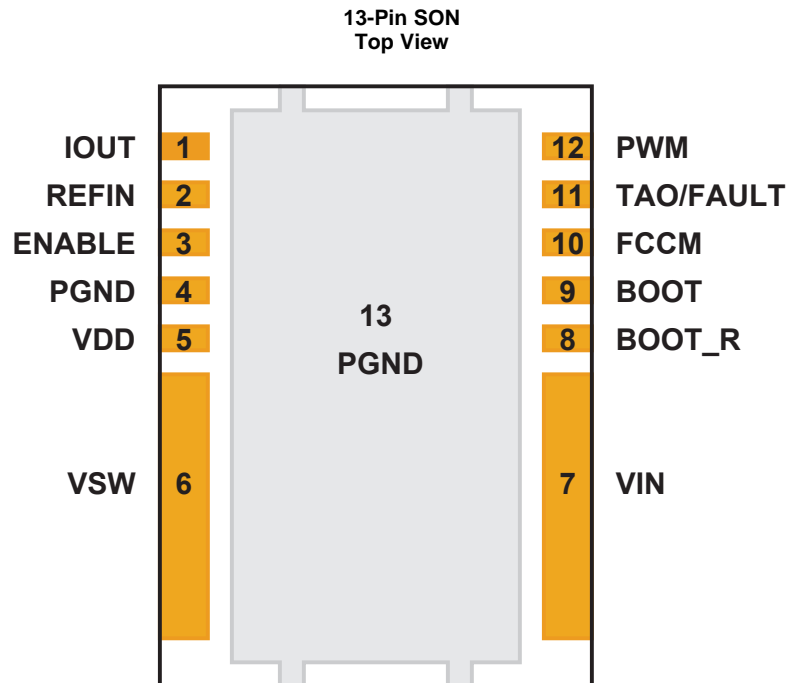
  

<b>Changes from Revision A (June 2014) to Revision B</b>	<b>Page</b>
• 将机械制图表中的 MAX A 尺寸更正成了 1.050mm (0.041 英寸) 。 .....	<b>8</b>

<b>Changes from Original (April 2014) to Revision A</b>	<b>Page</b>
• Updated the controller IC in the <i>Application Schematic</i> to the TPS40428. ....	<b>6</b>

## 5 Pin Configuration and Functions



### Pin Functions

PIN		DESCRIPTION
NAME	NUMBER	
BOOT	9	Bootstrap capacitor connection. Connect a minimum of 0.1- $\mu$ F, 16-V, X7R ceramic capacitor from BOOT to BOOT_R pins. The bootstrap capacitor provides the charge to turn on the control FET. The bootstrap diode is integrated.
BOOT_R	8	Return path for HS gate driver, connected to $V_{SW}$ internally.
ENABLE	3	Enables device operation. If ENABLE = logic high, turns on device. If ENABLE = logic low, the device is turned off and both MOSFET gates are actively pulled low. An internal 100-k $\Omega$ pulldown resistor will pull the ENABLE pin low if left floating.
FCCM	10	This pin enables the diode emulation function. When this pin is held low, diode emulation mode is enabled for sync FET. When FCCM is high, the device is operated in Forced Continuous Conduction Mode. An internal 5- $\mu$ A current source will pull the FCCM pin to 3.3 V if left floating.
IOUT	1	Output of current sensing amplifier. $V(IOUT) - V(REFIN)$ is proportional to the phase current.
$P_{GND}$	4	Power ground, connected directly to pin 13.
$P_{GND}$	13	Power ground.
PWM	12	Pulse width modulated tri-state input from external controller. Logic low sets control FET gate low and sync FET gate high. Logic high sets control FET gate high and sync FET gate low. Open or Hi-Z sets both MOSFET gates low if greater than the tri-state shutdown hold-off time ( $t_{3HT}$ ).
REFIN	2	External reference voltage input for current sensing amplifier.
TAO/ FAULT	11	Temperature Analog Output. Reports a voltage proportional to the die temperature. An ORing diode is integrated in the IC. When used in multiphase application, a single wire can be used to connect the TAO pins of all the ICs. Only the highest temperature will be reported. TAO will be pulled up to 3.3 V if thermal shutdown occurs. TAO should be bypassed to $P_{GND}$ with a 1-nF, 16-V, X7R ceramic capacitor.
$V_{DD}$	5	Supply voltage to gate driver and internal circuitry.
$V_{IN}$	7	Input voltage pin. Connect input capacitors close to this pin.
$V_{SW}$	6	Phase node connecting the HS MOSFET source and LS MOSFET drain-pin connection to the output inductor.

## 6 Specifications

### 6.1 Absolute Maximum Ratings

 $T_A = 25^\circ\text{C}$  (unless otherwise noted)<sup>(1)</sup>

	MIN	MAX	UNIT
$V_{IN}$ to $P_{GND}$	-0.3	25	V
$V_{IN}$ to $V_{SW}$	-0.3	25	V
$V_{IN}$ to $V_{SW}$ (10 ns)	-7	27	V
$V_{SW}$ to $P_{GND}$	-0.3	20	V
$V_{SW}$ to $P_{GND}$ (10 ns)	-7	23	V
$V_{DD}$ to $P_{GND}$	-0.3	7	V
ENABLE, PWM, FCCM, TAO, IOOUT, REFIN to $P_{GND}$	-0.3	$V_{DD} + 0.3\text{ V}$	V
BOOT to BOOT_R <sup>(2)</sup>	-0.3	$V_{DD} + 0.3\text{ V}$	V
$P_D$ Power dissipation		12	W
$T_J$ Operating junction	-55	150	$^\circ\text{C}$
$T_{stg}$ Storage temperature	-55	150	$^\circ\text{C}$

- (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 in the *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) Should not exceed 7 V.

### 6.2 ESD Ratings

	VALUE	UNIT
$V_{(ESD)}$ Electrostatic discharge	Human-body model (HBM)	$\pm 2000$
	Charged-device model (CDM)	$\pm 500$
		V

### 6.3 Recommended Operating Conditions

 $T_A = 25^\circ\text{C}$  (unless otherwise noted)

	MIN	MAX	UNIT
$V_{DD}$ Gate drive voltage	4.5	5.5	V
$V_{IN}$ Input supply voltage <sup>(1)</sup>		16	V
$V_{OUT}$ Output voltage		5.5	V
$I_{OUT}$ Continuous output current	$V_{IN} = 12\text{ V}$ , $V_{DD} = 5\text{ V}$ , $V_{OUT} = 1.2\text{ V}$ , $f_{SW} = 500\text{ kHz}$ , $L_{OUT} = 0.225\text{ }\mu\text{H}$ <sup>(2)</sup>	60	A
$I_{OUT-PK}$ Peak output current <sup>(3)</sup>		90	A
$f_{SW}$ Switching frequency	$C_{BST} = 0.1\text{ }\mu\text{F}$ (min)	1250	kHz
On-time duty cycle	$f_{SW} = 1\text{ MHz}$	85%	
Minimum PWM on time	40		ns
Operating temperature	-40	125	$^\circ\text{C}$

- (1) Operating at high  $V_{IN}$  can create excessive AC voltage overshoots on the switch node ( $V_{SW}$ ) during MOSFET switching transients. For reliable operation, the switch node ( $V_{SW}$ ) to ground voltage must remain at or below the *Absolute Maximum Ratings*.
- (2) Measurement made with six 10- $\mu\text{F}$  (TDK C3216X5R1C106KT or equivalent) ceramic capacitors placed across  $V_{IN}$  to  $P_{GND}$  pins.
- (3) System conditions as defined in Note 1. Peak output current is applied for  $t_p = 50\text{ }\mu\text{s}$ .

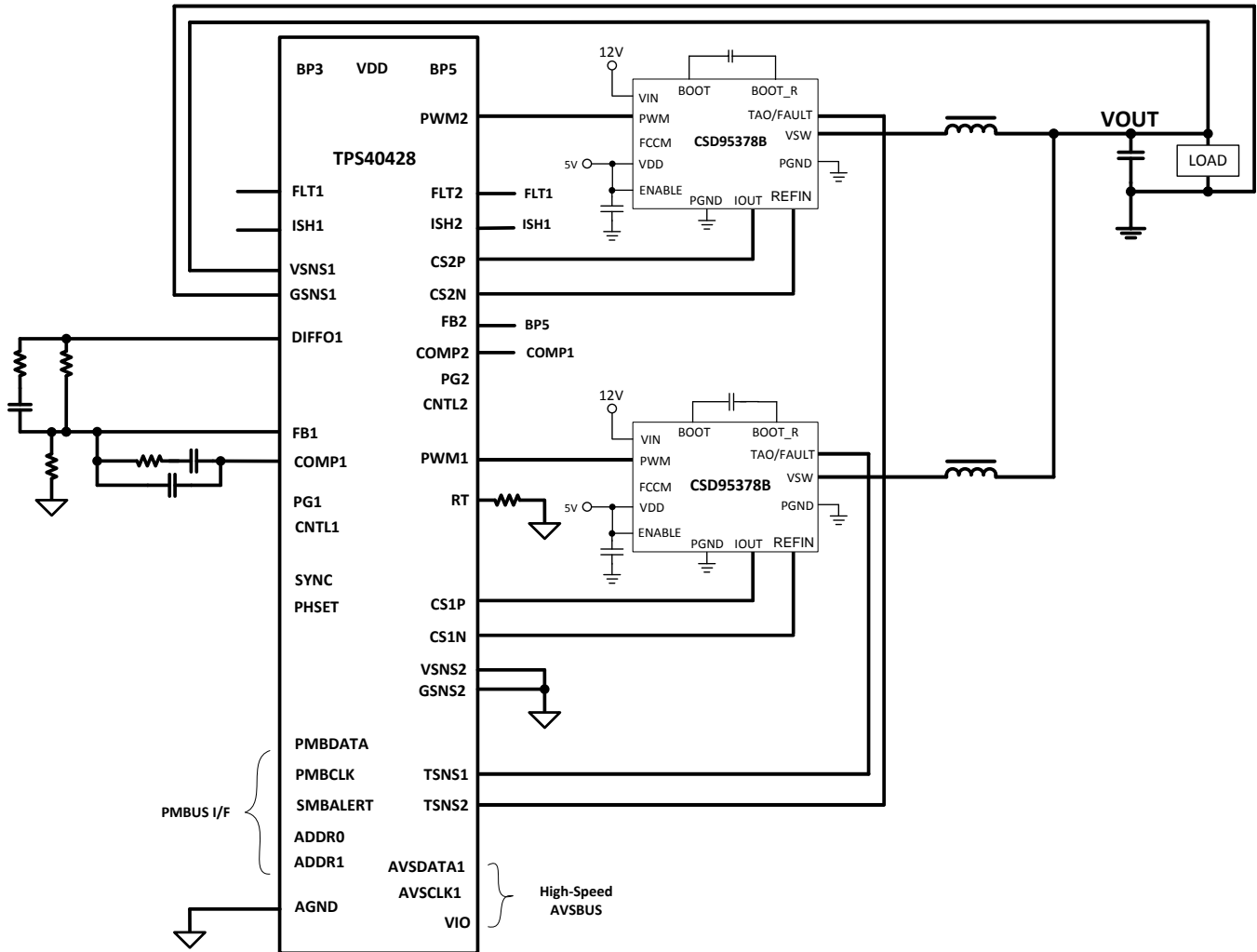
## 6.4 Thermal Information

$T_A = 25^\circ\text{C}$  (unless otherwise noted)

THERMAL METRIC		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction-to-case (top of package) thermal resistance <sup>(1)</sup>			5	$^\circ\text{C/W}$
$R_{\theta JB}$	Junction-to-board thermal resistance <sup>(2)</sup>			1.5	$^\circ\text{C/W}$

- (1)  $R_{\theta JC}$  is determined with the device mounted on a 1-in<sup>2</sup> (6.45-cm<sup>2</sup>), 2-oz (0.071-mm) thick Cu pad on a 1.5-in × 1.5-in, 0.06-in (1.52-mm) thick FR4 board.
- (2)  $R_{\theta JB}$  value based on hottest board temperature within 1 mm of the package.

## 7 Application Schematic



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## 8 器件和文档支持

### 8.1 接收文档更新通知

如需接收文档更新通知，请访问 [www.ti.com.cn](http://www.ti.com.cn) 网站上的器件产品文件夹。点击右上角的提醒我 (Alert me) 注册后，即可每周定期收到已更改的产品信息。有关更改的详细信息，请查阅已修订文档中包含的修订历史记录。

### 8.2 社区资源

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### 8.3 商标

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### 8.4 静电放电警告



ESD 可能会损坏该集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理措施和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

### 8.5 Glossary

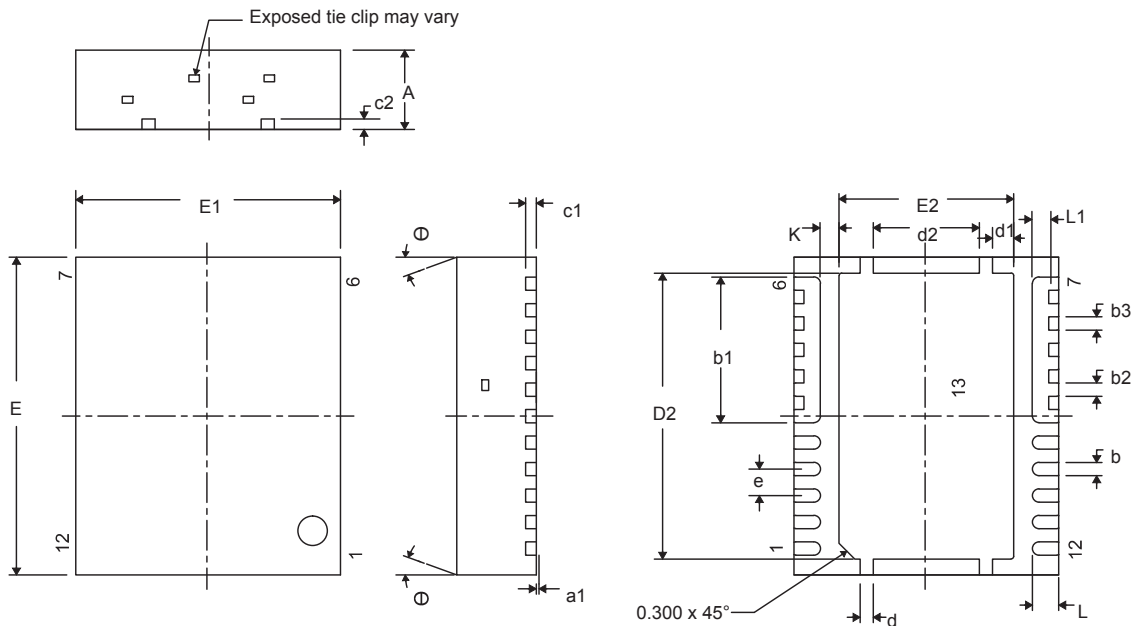
**SLYZ022** — *TI Glossary*.

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

## 9 机械、封装和可订购信息

以下页中包括机械、封装和可订购信息。这些信息是针对指定器件可提供的最新数据。这些数据会在无通知且不对本文档进行修订的情况下发生改变。欲获得该数据表的浏览器版本，请查阅左侧的导航栏。

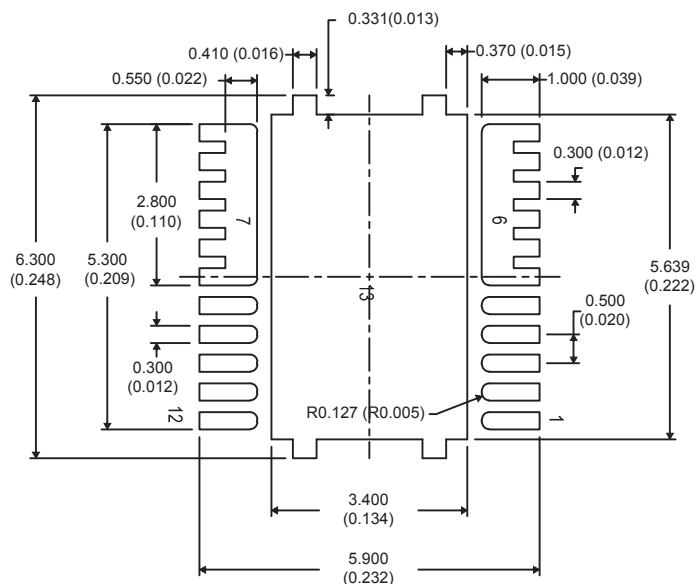
### 9.1 机械制图



DIM	毫米			英寸		
	最小值	标称值	最大值	最小值	标称值	最大值
A	0.950	1.000	1.050	0.037	0.039	0.041
a1	0.000	0.000	0.050	0.000	0.000	0.002
b	0.200	0.250	0.320	0.008	0.010	0.013
b1	2.750 典型值			0.108 典型值		
b2	0.200	0.250	0.320	0.008	0.010	0.013
b3	0.250 典型值			0.010 典型值		
c1	0.150	0.200	0.250	0.006	0.008	0.010
c2	0.200	0.250	0.300	0.008	0.010	0.012
D2	5.300	5.400	5.500	0.209	0.213	0.217
d	0.200	0.250	0.300	0.008	0.010	0.012
d1	0.350	0.400	0.450	0.014	0.016	0.018
d2	1.900	2.000	2.100	0.075	0.079	0.083
E	5.900	6.000	6.100	0.232	0.236	0.240
E1	4.900	5.000	5.100	0.193	0.197	0.201
E2	3.200	3.300	3.400	0.126	0.130	0.134
e	0.500 典型值			0.020 典型值		
K	0.350 典型值			0.014 典型值		
L	0.400	0.500	0.600	0.016	0.020	0.024
L1	0.210	0.310	0.410	0.008	0.012	0.016
θ	0.000	—	—	0.000	—	—

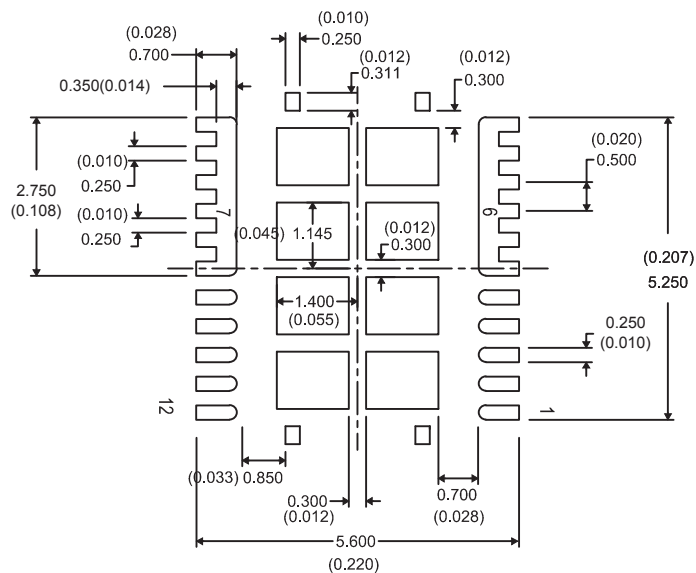


## 9.2 建议印刷电路板 (PCB) 焊盘图案



1. 尺寸单位为 mm (英寸)。

## 9.3 建议模板开口



1. 尺寸单位为 mm (英寸)。

2. 模板厚度为 100 $\mu$ m。

**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
CSD95378BQ5MC	ACTIVE	VSON-CLIP	DMC	12	2500	RoHS-Exempt & Green	SN	Level-2-260C-1 YEAR	-55 to 150	95378BMC	<a href="#">Samples</a>
CSD95378BQ5MCT	ACTIVE	VSON-CLIP	DMC	12	250	RoHS-Exempt & Green	SN	Level-2-260C-1 YEAR	-55 to 150	95378BMC	<a href="#">Samples</a>

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

**ACTIVE:** Product device recommended for new designs.

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

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

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

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

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

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

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

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(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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**TAPE AND REEL INFORMATION**

**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
CSD95378BQ5MC	VSON-CLIP	DMC	12	2500	330.0	15.4	5.3	6.3	1.2	8.0	12.0	Q1
CSD95378BQ5MC	VSON-CLIP	DMC	12	2500	330.0	12.4	5.3	6.3	1.2	8.0	12.0	Q1
CSD95378BQ5MCT	VSON-CLIP	DMC	12	250	180.0	12.4	5.3	6.3	1.2	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)
CSD95378BQ5MC	VSON-CLIP	DMC	12	2500	336.6	336.6	41.3
CSD95378BQ5MC	VSON-CLIP	DMC	12	2500	367.0	367.0	38.0
CSD95378BQ5MCT	VSON-CLIP	DMC	12	250	213.0	191.0	35.0

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