

CSD95378BQ5M 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测
- 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 × 6mm SON 封装
- 超低电感封装
- 系统已优化的 PCB 封装
- 符合 RoHS 环保标准 – 无铅引脚镀层
- 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

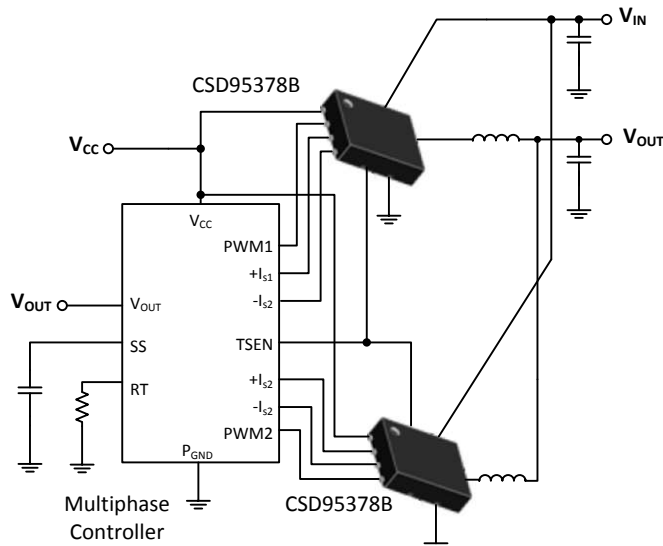
CSD95378BQ5M NexFET™ 智能功率级的设计针对高功率、高密度同步降压转换器中的使用进行了高度优化。这款产品集成了驱动器 IC 和功率 MOSFET 来完善功率级开关功能。该组合可在 5mm x 6mm 小型封装中提供高电流、高效率的高速切换功能。它还集成了准确电流感测和温度感测功能，以简化系统设计并提高准确度。此外，PCB 封装已经过优化，可帮助减少设计时间并简化总体系统设计的完成。

器件信息⁽¹⁾

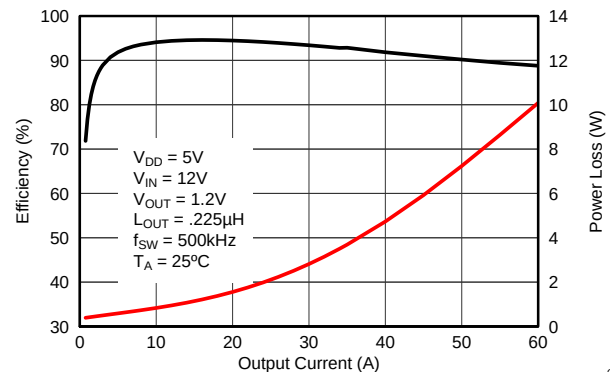
器件	包装介质	数量	封装	运输
CSD95378BQ5M	13 英寸卷带	2500	SON 5.00mm × 6.00mm 封装	卷带封装
CSD95378BQ5MT	7 英寸卷带	250		

(1) 如需了解所有可用封装，请参阅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



目录

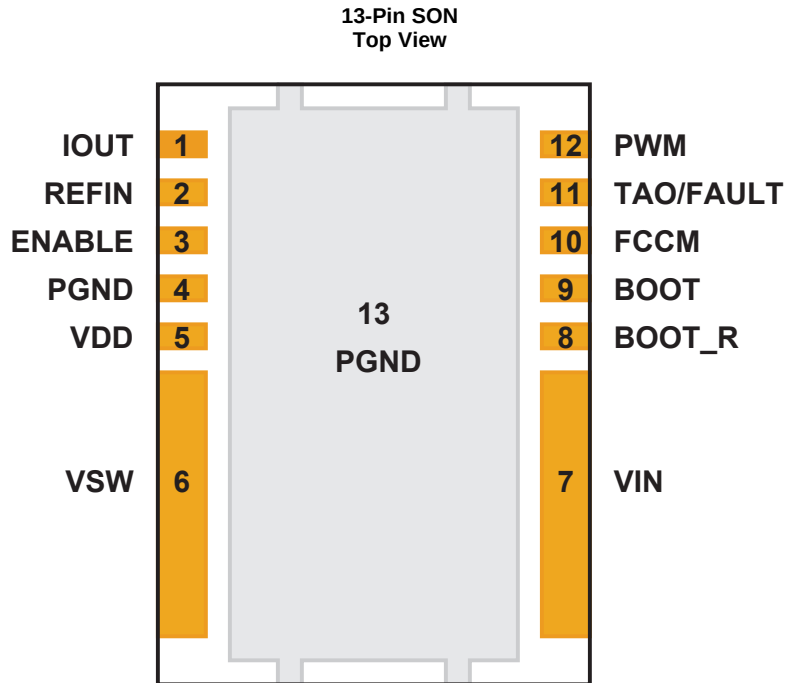
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4 修订历史记录

Changes from Revision A (July 2014) to Revision B	Page
• Updated the CSD95378B parts in the Application Schematic	5
• 已添加 器件和文档支持 中的 接收文档更新通知 和 社区资源 部分	6

Changes from Original (April 2014) to Revision A	Page
• Updated the controller IC in the Application Schematic to the TPS40428	5

5 Pin Configuration and Functions



Pin Functions

PIN		DESCRIPTION
NAME	NO.	
BOOT	9	Bootstrap capacitor connection. Connect a minimum of 0.1-μF, 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-kΩ 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-μA 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)⁽¹⁾

	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, IOUT, REFIN to P_{GND}	–0.3	$V_{DD} + 0.3\text{ V}$	V
BOOT to BOOT_R ⁽²⁾	–0.3	$V_{DD} + 0.3\text{ V}$	V
Power dissipation, P_D		12	W
Operating junction temperature, T_J	–55	150	$^\circ\text{C}$
Storage temperature, T_{stg}	–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

	MIN	MAX	UNIT
$V_{(ESD)}$ Electrostatic discharge	Human-body model (HBM)	–2000	2000
	Charged-device model (CDM)	–500	500

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 ⁽¹⁾		16	V
V_{OUT} Output voltage		5.5	V
I_{OUT} Continuous output current	$V_{IN} = 12\text{ V}$, $V_{DD} = 5\text{ V}$, $V_{OUT} = 1.2\text{ V}$, $f_{SW} = 500\text{ kHz}$, $L_{OUT} = 0.225\text{ }\mu\text{H}$ ⁽²⁾		60
I_{OUT-PK} Peak output current ⁽³⁾			90
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- μF (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

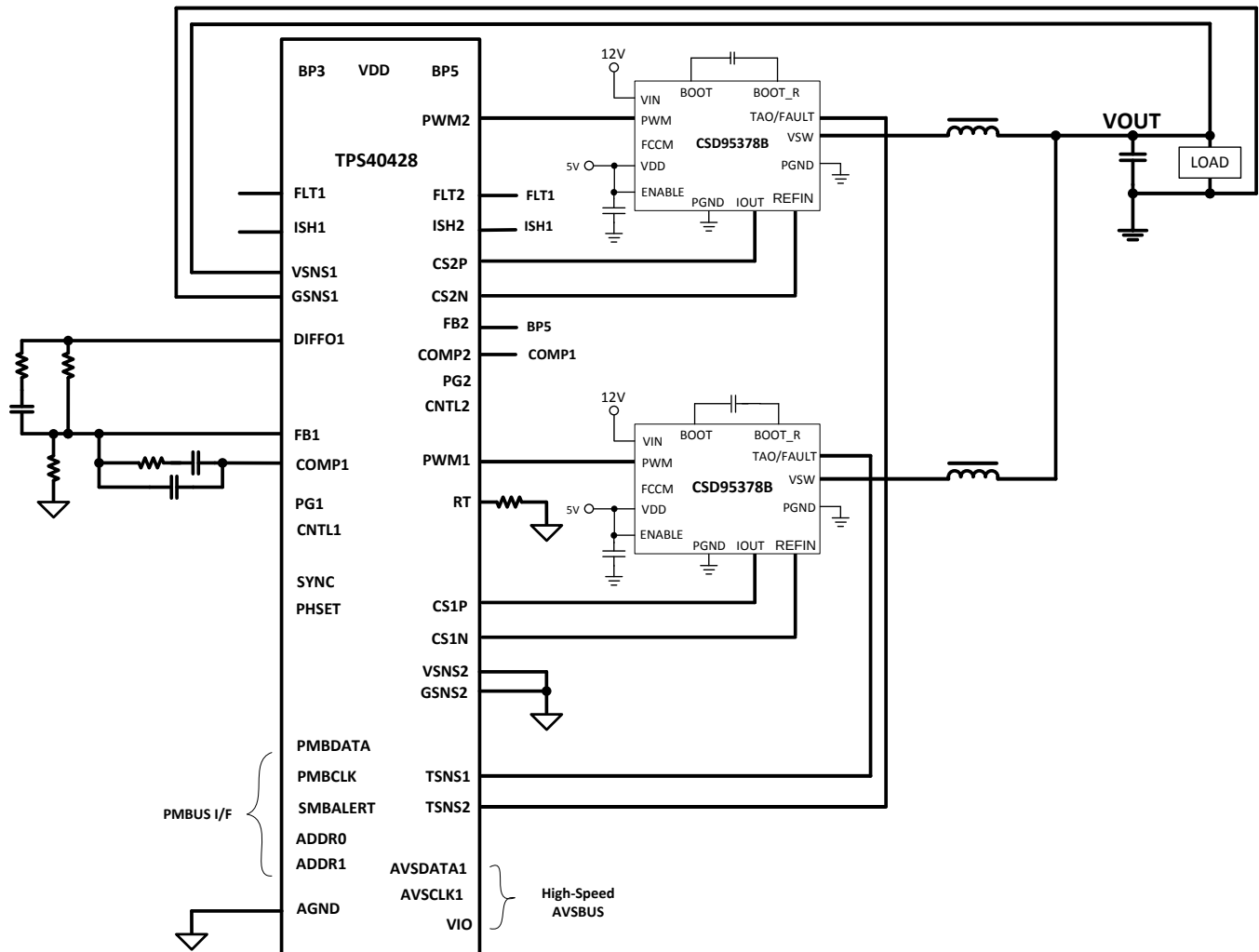
 $T_A = 25^\circ\text{C}$ (unless otherwise noted)

THERMAL METRIC	MIN	TYP	MAX	UNIT
$R_{\theta JC}$ Junction-to-case (top-of-package) thermal resistance ⁽¹⁾			15	$^\circ\text{C/W}$
$R_{\theta JB}$ Junction-to-board thermal resistance ⁽²⁾			1.5	

- (1) $R_{\theta JC}$ is determined with the device mounted on a 1-in² (6.45 -cm²), 2-oz (0.071-mm) thick Cu pad on a 1.5-in $\times$ 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

7.1 Typical Application



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8 器件和文档支持

8.1 接收文档更新通知

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8.4 静电放电警告



这些装置包含有限的内置 ESD 保护。存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

8.5 Glossary

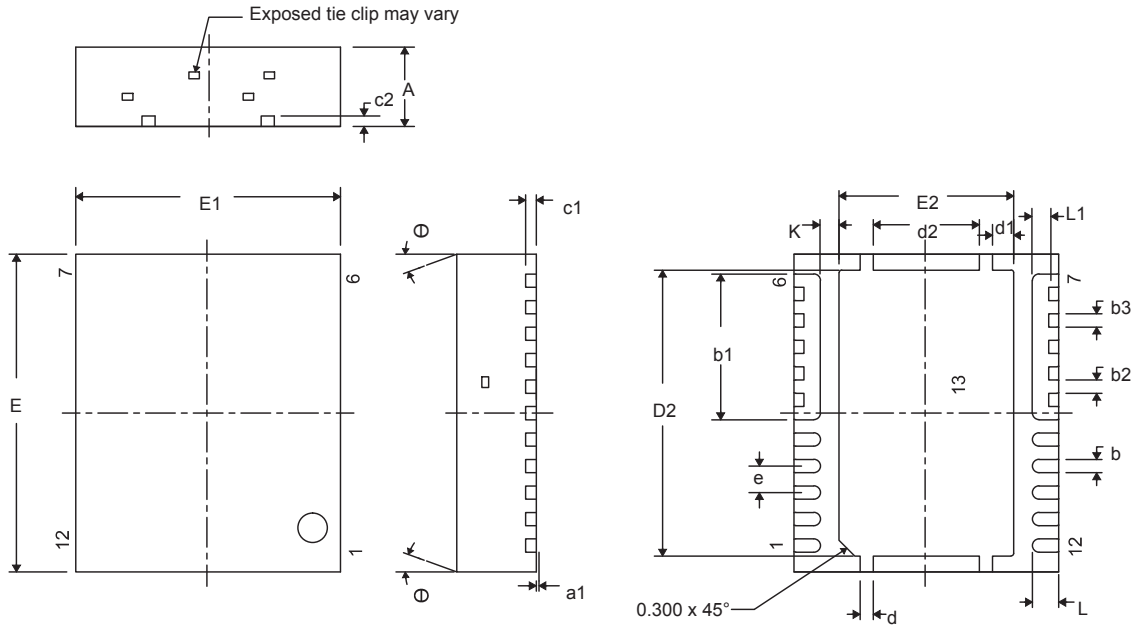
[SLYZ022](#) — *TI Glossary*.

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、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。这些数据发生变化时，我们可能不会另行通知或修订此文档。如欲获取此产品说明书的浏览器版本，请参见左侧的导航栏。

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	1.400	1.450	1.500	0.057	0.059	0.061
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	0.00	—	—	0.00	—	—

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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)
CSD95378BQ5M	Active	Production	LSON-CLIP (DQP) 12	2500 LARGE T&R	ROHS Exempt	NIPDAU SN	Level-2-260C-1 YEAR	-55 to 150	95378BM
CSD95378BQ5M.A	Active	Production	LSON-CLIP (DQP) 12	2500 LARGE T&R	ROHS Exempt	NIPDAU	Level-2-260C-1 YEAR	-55 to 150	95378BM
CSD95378BQ5M.B	Active	Production	LSON-CLIP (DQP) 12	2500 LARGE T&R	-	Call TI	Call TI	-55 to 150	
CSD95378BQ5MG4	Active	Production	LSON-CLIP (DQP) 12	2500 LARGE T&R	ROHS Exempt	NIPDAU	Level-2-260C-1 YEAR	-55 to 150	95378BM
CSD95378BQ5MG4.A	Active	Production	LSON-CLIP (DQP) 12	2500 LARGE T&R	ROHS Exempt	NIPDAU	Level-2-260C-1 YEAR	-55 to 150	95378BM
CSD95378BQ5MG4.B	Active	Production	LSON-CLIP (DQP) 12	2500 LARGE T&R	-	Call TI	Call TI	-55 to 150	
CSD95378BQ5MT	Active	Production	LSON-CLIP (DQP) 12	250 SMALL T&R	ROHS Exempt	NIPDAU	Level-2-260C-1 YEAR	-55 to 150	95378BM
CSD95378BQ5MT.A	Active	Production	LSON-CLIP (DQP) 12	250 SMALL T&R	ROHS Exempt	NIPDAU	Level-2-260C-1 YEAR	-55 to 150	95378BM
CSD95378BQ5MT.B	Active	Production	LSON-CLIP (DQP) 12	250 SMALL T&R	-	Call TI	Call TI	-55 to 150	

⁽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.

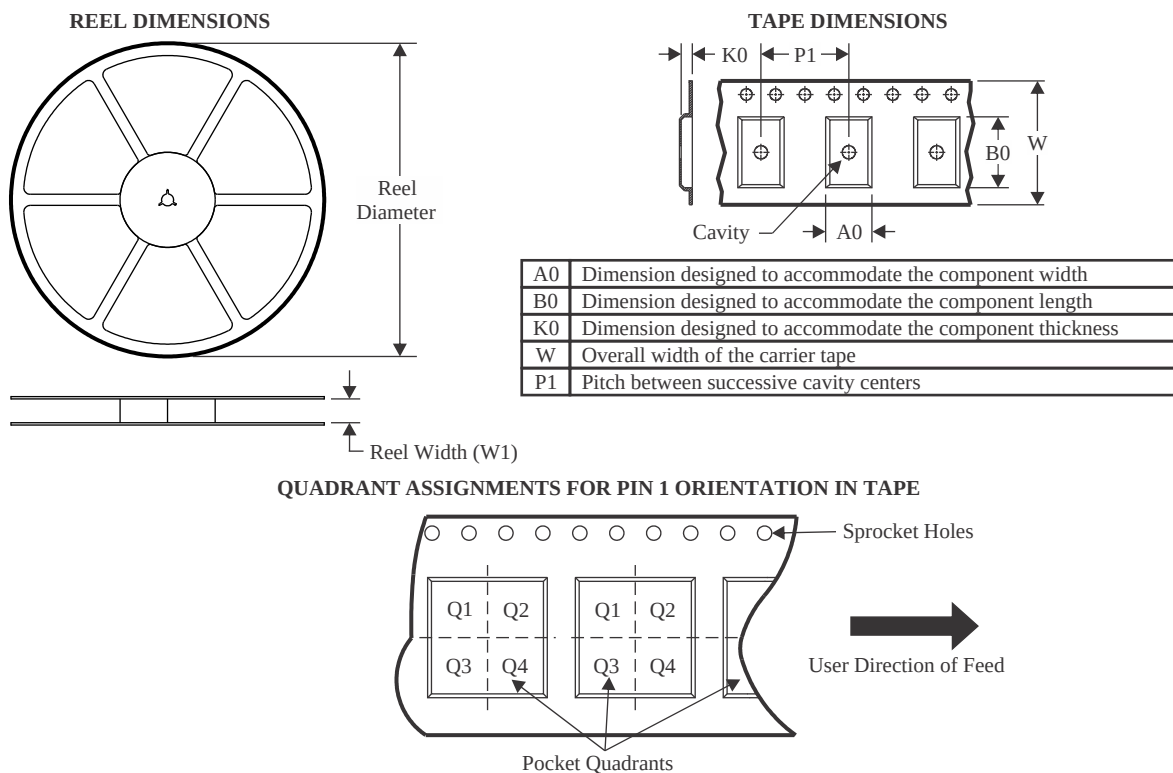
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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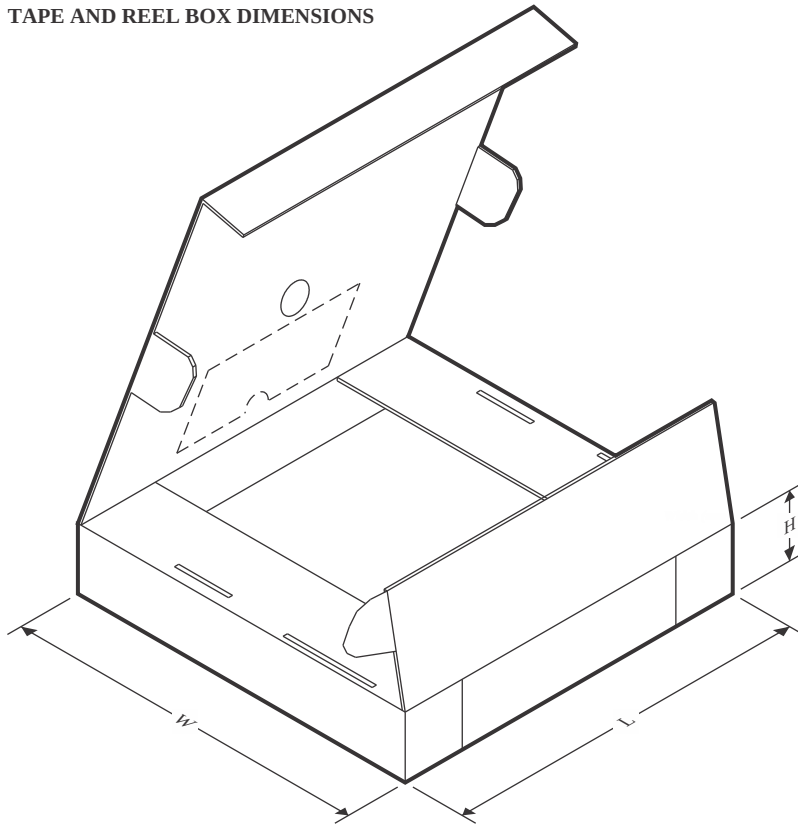
TAPE AND REEL INFORMATION



*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
CSD95378BQ5M	LSON-CLIP	DQP	12	2500	330.0	12.4	5.3	6.3	1.8	8.0	12.0	Q1
CSD95378BQ5MG4	LSON-CLIP	DQP	12	2500	330.0	12.4	5.3	6.3	1.8	8.0	12.0	Q1
CSD95378BQ5MT	LSON-CLIP	DQP	12	250	180.0	12.4	5.3	6.3	1.8	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)
CSD95378BQ5M	LSON-CLIP	DQP	12	2500	346.0	346.0	33.0
CSD95378BQ5MG4	LSON-CLIP	DQP	12	2500	346.0	346.0	33.0
CSD95378BQ5MT	LSON-CLIP	DQP	12	250	210.0	185.0	35.0

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