

## N-Channel CICLON NexFET™ Power MOSFETs

### FEATURES

- Ultra Low Qg and Qgd
- Low Thermal Resistance
- Avalanche Rated
- Pb Free Terminal Plating
- RoHS Compliant
- Halogen Free
- SON 5mm x 6mm Plastic Package

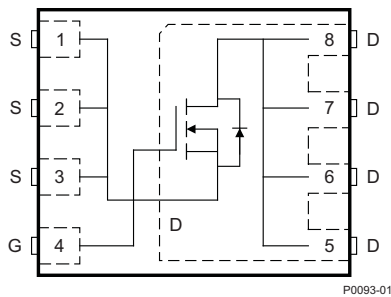
### APPLICATIONS

- Point-of-Load Synchronous Buck Converter for Applications in Networking, Telecom and Computing Systems
- Optimized for Control FET Applications

### DESCRIPTION

The NexFET™ power MOSFET has been designed to minimize losses in power conversion applications.

Top View



### PRODUCT SUMMARY

$V_{DS}$	Drain to Source Voltage	25	V
$Q_g$	Gate Charge Total (4.5V)	2.9	nC
$Q_{gd}$	Gate Charge Gate to Drain	0.7	nC
$R_{DS(on)}$	Drain to Source On Resistance	$V_{GS} = 4.5V$	13 mΩ
		$V_{GS} = 10V$	9 mΩ
$V_{GS(th)}$	Threshold Voltage	2	V

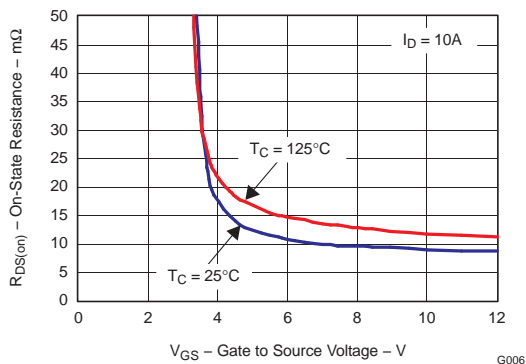
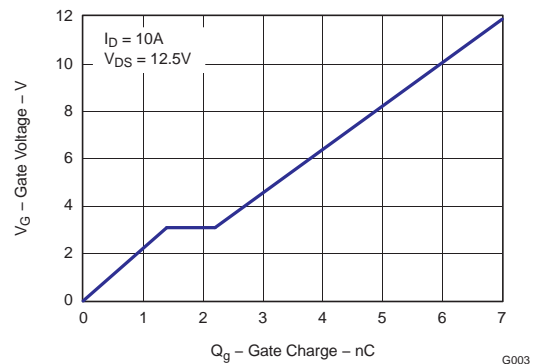
### ORDERING INFORMATION

Device	Package	Media	Qty	Ship
CSD16412Q5A	SON 5 x 6 Plastic Package	13-inch reel	2500	Tape and Reel

### ABSOLUTE MAXIMUM RATINGS

$T_A = 25^\circ\text{C}$ unless otherwise stated		VALUE	UNIT
$V_{DS}$	Drain to Source Voltage	25	V
$V_{GS}$	Gate to Source Voltage	+16 / -12	V
$I_D$	Continuous Drain Current, $T_C = 25^\circ\text{C}$	52	A
	Continuous Drain Current <sup>(1)</sup>	14	A
$I_{DM}$	Pulsed Drain Current, $T_A = 25^\circ\text{C}$ <sup>(2)</sup>	91	A
$P_D$	Power Dissipation <sup>(1)</sup>	3.0	W
$T_J, T_{STG}$	Operating Junction and Storage Temperature Range	-55 to 150	$^\circ\text{C}$
$E_{AS}$	Avalanche Energy, single pulse $I_D = 17A, L = 0.1\text{mH}, R_G = 25\Omega$	14	mJ

- (1)  $R_{\theta JA} = 42^\circ\text{C/W}$  on  $1\text{in}^2$  Cu (2 oz) on 0.060" thick FR4 PCB.  
 (2) Pulse width  $\leq 300\mu\text{s}$ , duty cycle  $\leq 2\%$

 **$R_{DS(ON)}$  vs  $V_{GS}$** 

**Gate Charge**


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NexFET is a trademark of Texas Instruments.

## ELECTRICAL CHARACTERISTICS

(T<sub>A</sub> = 25°C unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>Static Characteristics</b>						
BV <sub>DSS</sub>	Drain to Source Voltage	V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA	25			V
I <sub>DSS</sub>	Drain to Source Leakage Current	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 20V			1	μA
I <sub>GSS</sub>	Gate to Source Leakage Current	V <sub>DS</sub> = 0V, V <sub>GS</sub> = +16/-12V			100	nA
V <sub>GS(th)</sub>	Gate to Source Threshold Voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA	1.7	2.0	2.3	V
R <sub>DS(on)</sub>	Drain to Source On Resistance	V <sub>GS</sub> = 4.5V, I <sub>D</sub> = 10A		13	16	mΩ
		V <sub>GS</sub> = 10V, I <sub>D</sub> = 10A		9	11	mΩ
g <sub>fs</sub>	Transconductance	V <sub>DS</sub> = 15V, I <sub>D</sub> = 10A		33		S
<b>Dynamic Characteristics</b>						
C <sub>ISS</sub>	Input Capacitance	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 12.5V, f = 1MHz		410	530	pF
C <sub>OSS</sub>	Output Capacitance			350	450	pF
C <sub>RSS</sub>	Reverse Transfer Capacitance			32	42	pF
R <sub>g</sub>	Series Gate Resistance			0.7	1.4	Ω
Q <sub>g</sub>	Gate Charge Total (4.5V)	V <sub>DS</sub> = 12.5V, I <sub>D</sub> = 10A		2.9	3.8	nC
Q <sub>gd</sub>	Gate Charge Gate to Drain			0.7		nC
Q <sub>gs</sub>	Gate Charge Gate to Source			1.4		nC
Q <sub>g(th)</sub>	Gate Charge at V <sub>th</sub>			0.9		nC
Q <sub>OSS</sub>	Output Charge	V <sub>DS</sub> = 13V, V <sub>GS</sub> = 0V		7		nC
t <sub>d(on)</sub>	Turn On Delay Time	V <sub>DS</sub> = 12.5V, V <sub>GS</sub> = 4.5V, I <sub>D</sub> = 10A R <sub>G</sub> = 2Ω		5.5		ns
t <sub>r</sub>	Rise Time			7.1		ns
t <sub>d(off)</sub>	Turn Off Delay Time			5.7		ns
t <sub>f</sub>	Fall Time			3.3		ns
<b>Diode Characteristics</b>						
V <sub>SD</sub>	Diode Forward Voltage	I <sub>S</sub> = 10A, V <sub>GS</sub> = 0V		0.85	1.0	V
Q <sub>rr</sub>	Reverse Recovery Charge	V <sub>dd</sub> = 13V, I <sub>F</sub> = 10A, di/dt = 300A/μs		12		nC
t <sub>rr</sub>	Reverse Recovery Time	V <sub>dd</sub> = 13V, I <sub>F</sub> = 10A, di/dt = 300A/μs		16		ns

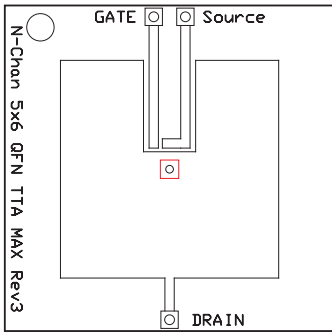
## THERMAL CHARACTERISTICS

(T<sub>A</sub> = 25°C unless otherwise stated)

PARAMETER		MIN	TYP	MAX	UNIT
R <sub>θJC</sub>	Thermal Resistance Junction to Case <sup>(1)</sup>			3.7	°C/W
R <sub>θJA</sub>	Thermal Resistance Junction to Ambient <sup>(1)(2)</sup>			53	°C/W

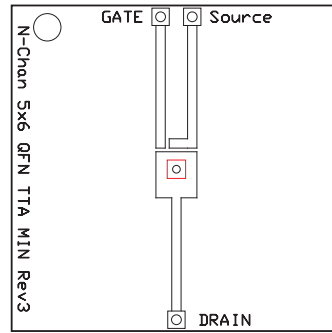
(1) R<sub>θJC</sub> is determined with the device mounted on a 1 inch square 2 oz. Cu pad on a 1.5 × 1.5 in 0.060 inch thick FR4 board. R<sub>θJC</sub> is specified by design while R<sub>θJA</sub> is determined by the user's board design.

(2) Device mounted on FR4 Material with 1 inch<sup>2</sup> of 2 oz. Cu.



Max  $R_{\theta JA} = 53^{\circ}\text{C/W}$   
when mounted on  
 $1\text{inch}^2$  of 2 oz. Cu.

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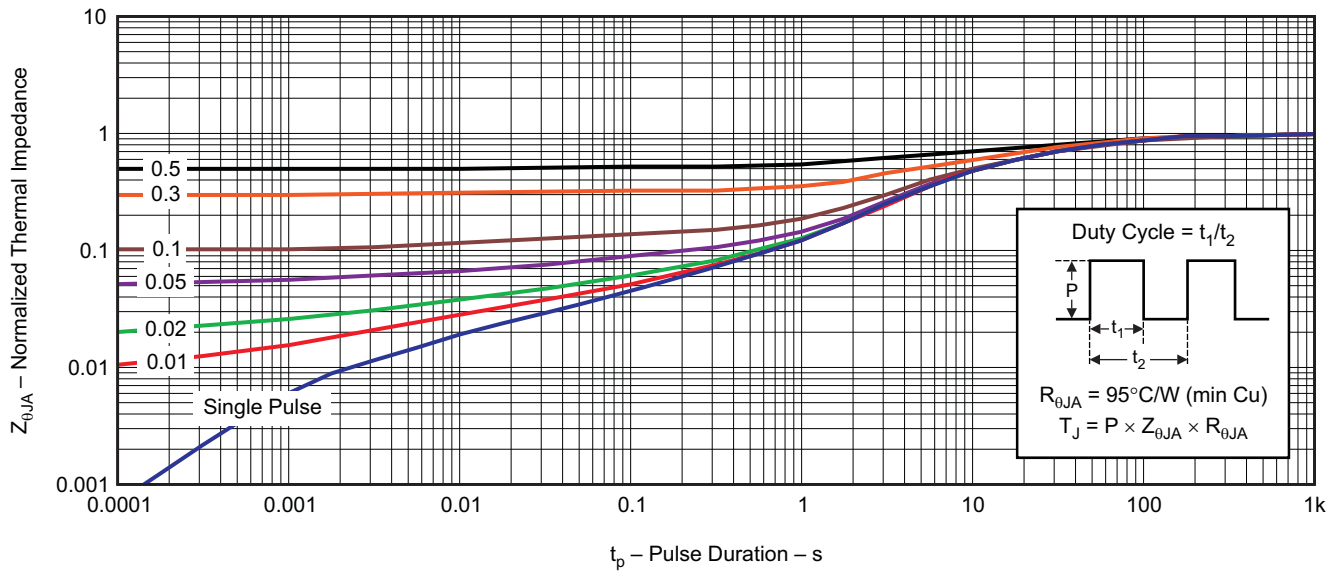


Max  $R_{\theta JA} = 119^{\circ}\text{C/W}$   
when mounted on  
minimum pad area of 2  
oz. Cu.

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### TYPICAL MOSFET CHARACTERISTICS

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

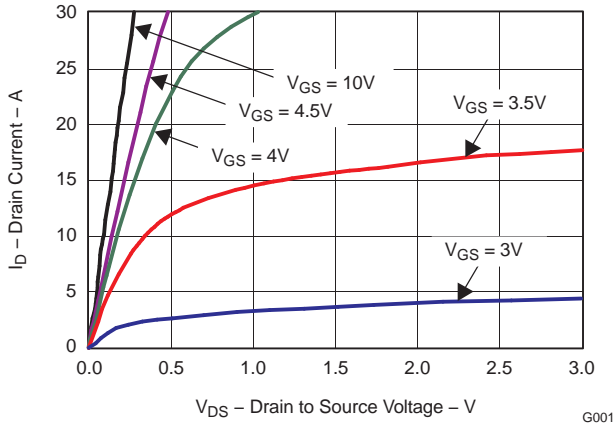


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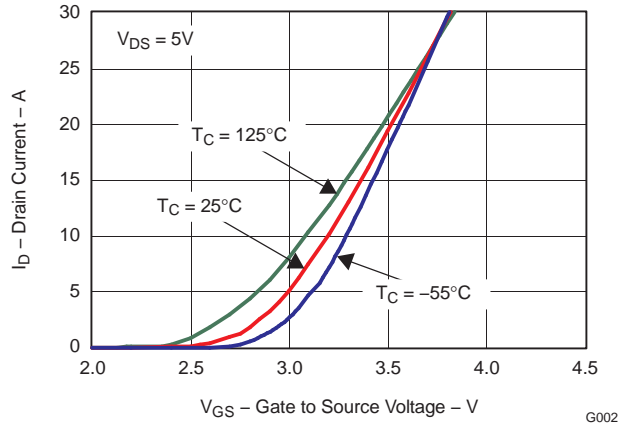
Figure 1. Transient Thermal Impedance

**TYPICAL MOSFET CHARACTERISTICS (continued)**

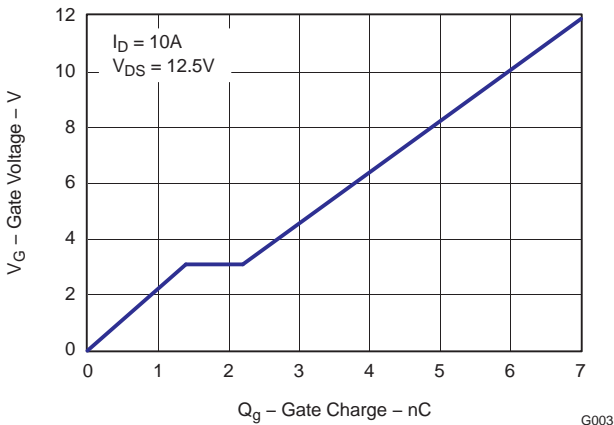
( $T_A = 25^\circ\text{C}$  unless otherwise stated)



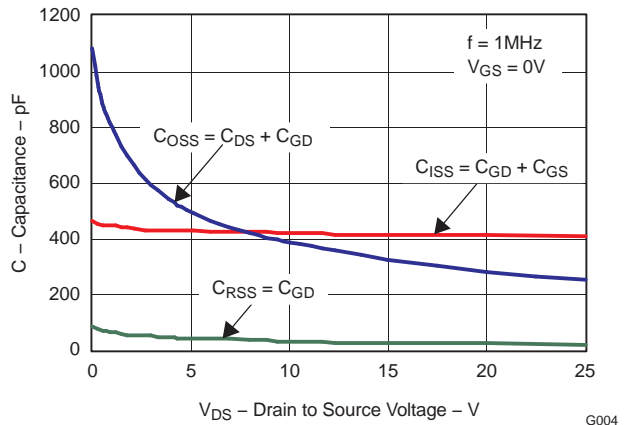
**Figure 2. Saturation Characteristics**



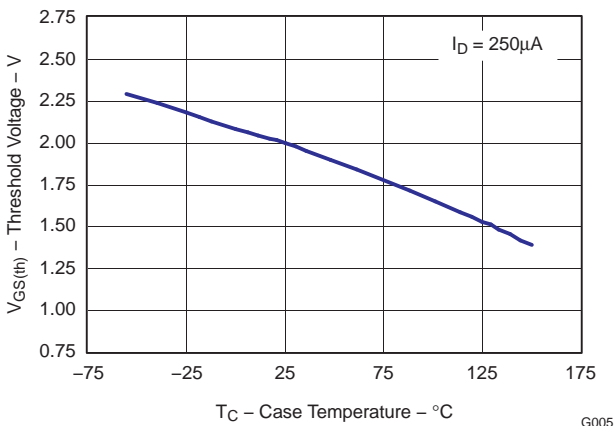
**Figure 3. Transfer Characteristics**



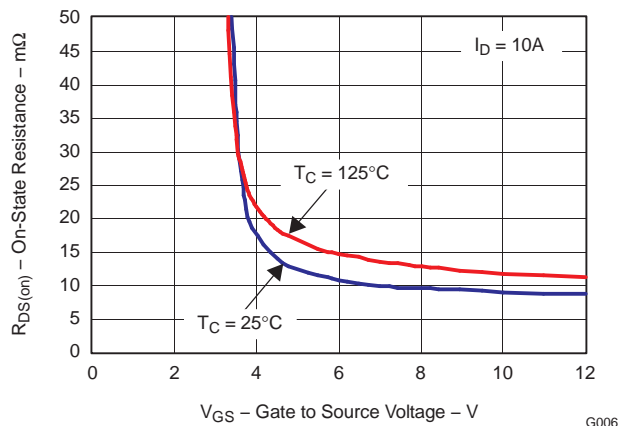
**Figure 4. Gate Charge**



**Figure 5. Capacitance**



**Figure 6. Threshold Voltage vs. Temperature**



**Figure 7. On Resistance vs. Gate Voltage**

TYPICAL MOSFET CHARACTERISTICS (continued)

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

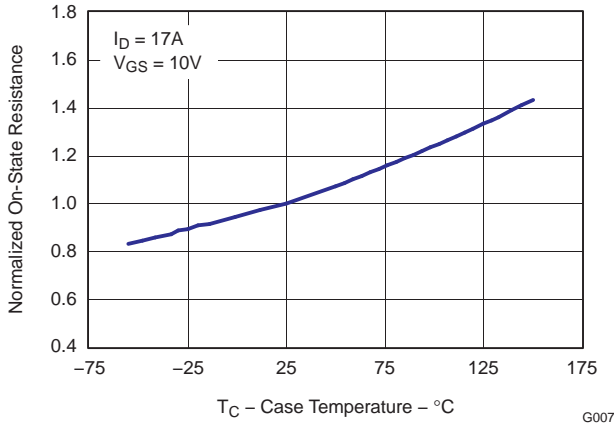


Figure 8. On Resistance vs. Temperature

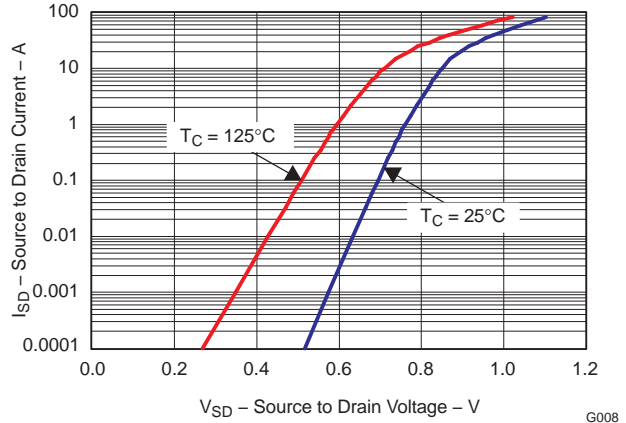


Figure 9. Typical Diode Forward Voltage

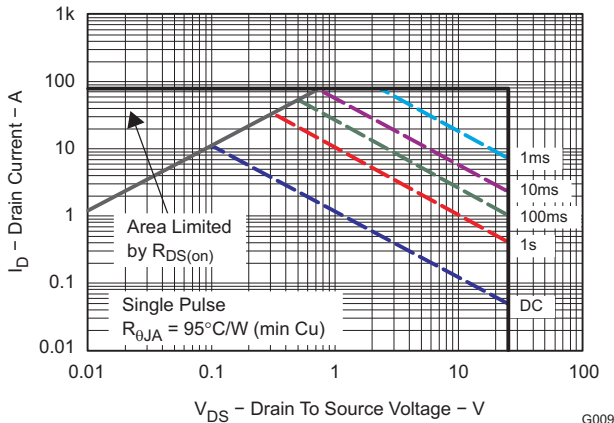


Figure 10. Maximum Safe Operating Area

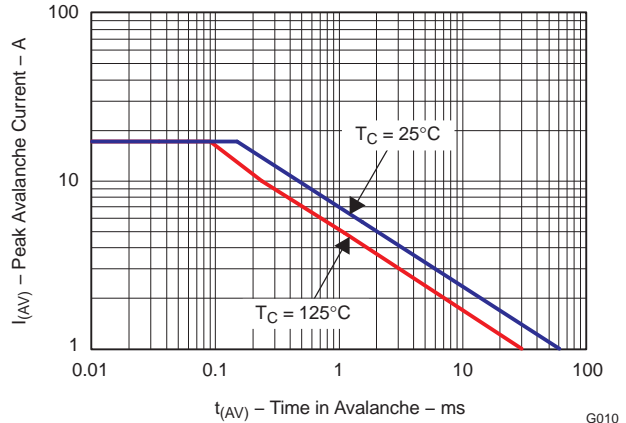


Figure 11. Single Pulse Unclamped Inductive Switching

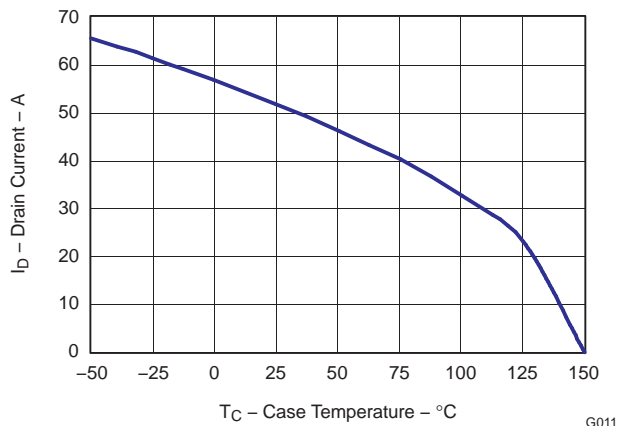
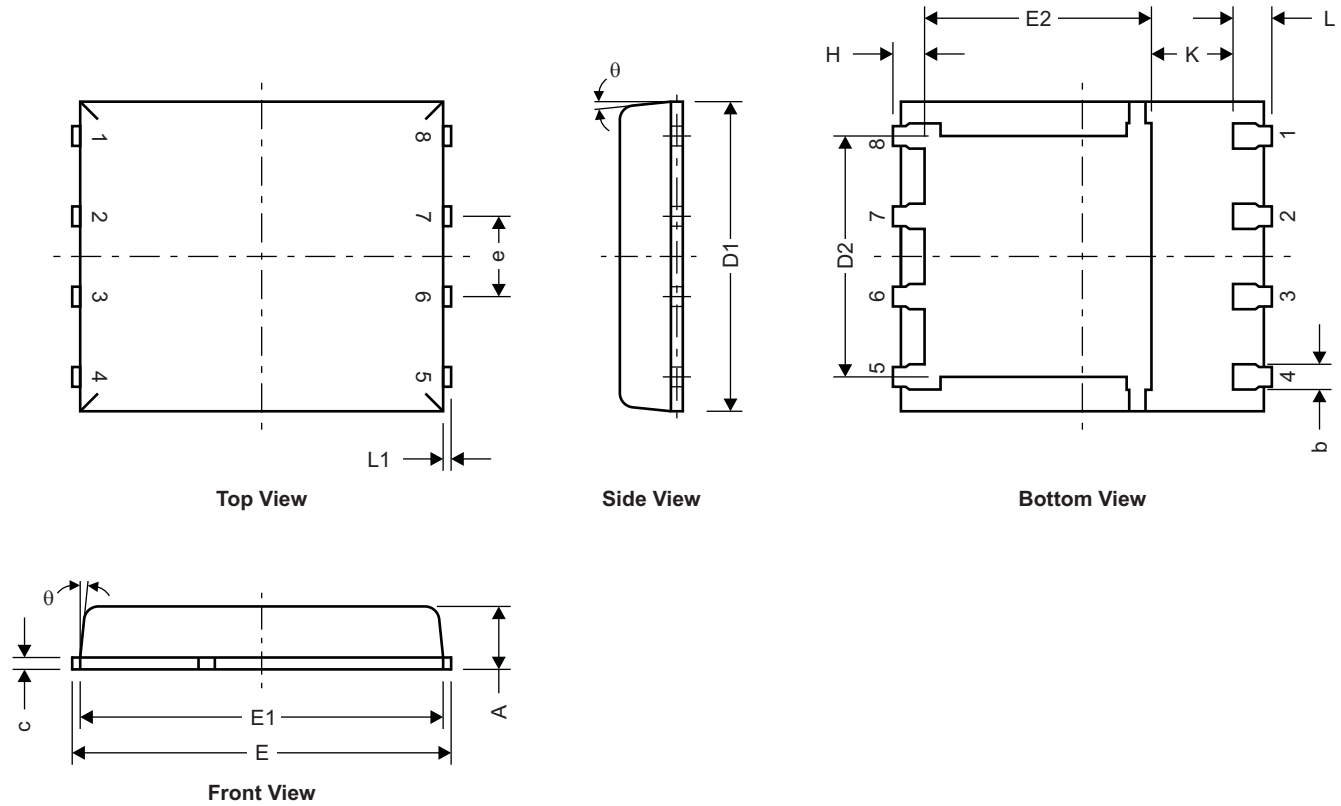


Figure 12. Maximum Drain Current vs. Temperature

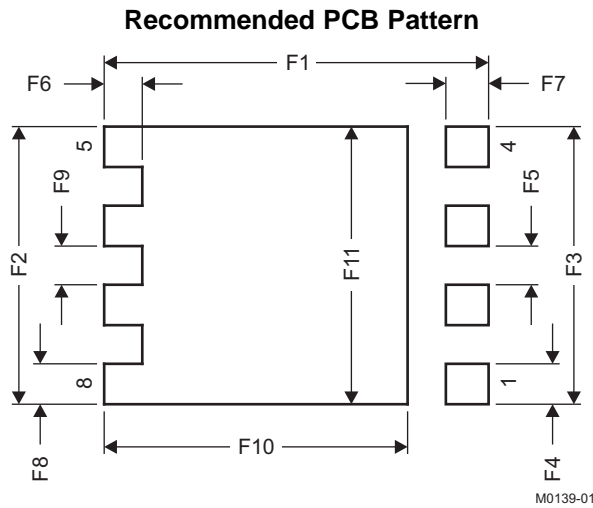
MECHANICAL DATA

Q5A Package Dimensions



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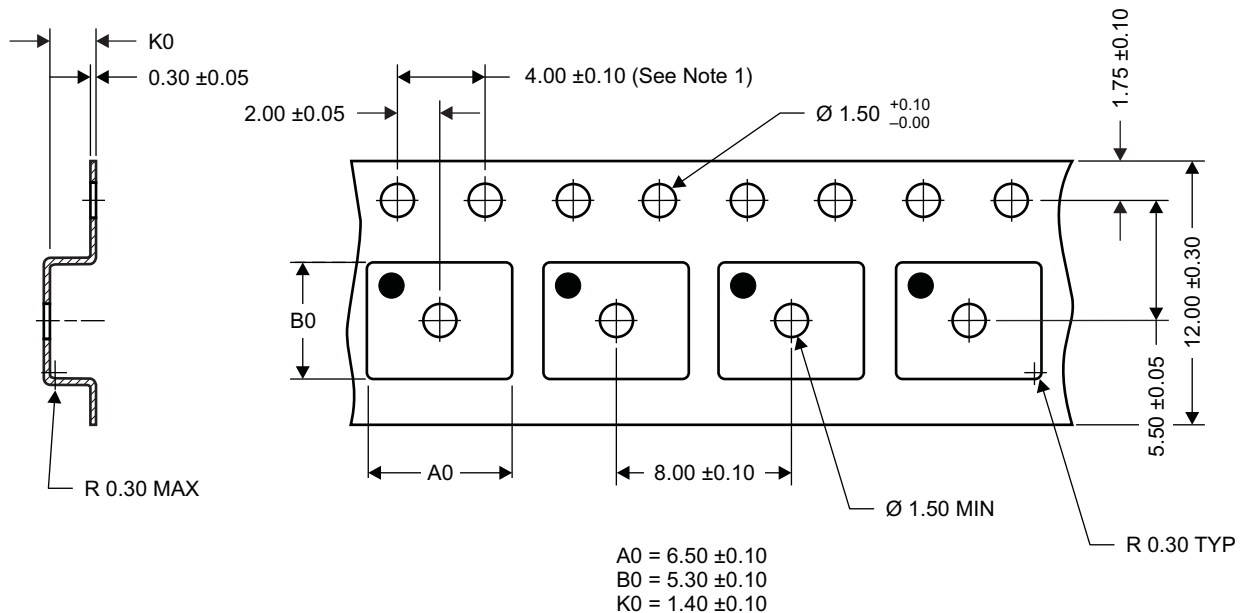
DIM	MILLIMETERS		
	MIN	NOM	MAX
A	0.90	1.00	1.10
b	0.33	0.41	0.51
c	0.20	0.25	0.30
D1	4.80	4.90	5.00
D2	3.61	3.81	3.96
E	5.90	6.00	6.10
E1	5.70	5.75	5.80
E2	3.38	3.58	3.78
e	1.27 BSC		
H	0.41	0.51	0.61
K	1.10		
L	0.51	0.61	0.71
L1	0.06	0.13	0.20
$\theta$	0°		12°



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
F1	6.205	6.305	0.244	0.248
F2	4.46	4.56	0.176	0.18
F3	4.46	4.56	0.176	0.18
F4	0.65	0.7	0.026	0.028
F5	0.62	0.67	0.024	0.026
F6	0.63	0.68	0.025	0.027
F7	0.7	0.8	0.028	0.031
F8	0.65	0.7	0.026	0.028
F9	0.62	0.67	0.024	0.026
F10	4.9	5	0.193	0.197
F11	4.46	4.56	0.176	0.18

For recommended circuit layout for PCB designs, see application note [SLPA005 – Reducing Ringing Through PCB Layout Techniques](#).

### Q5A Tape and Reel Information



### Notes:

- 10 sprocket hole pitch cumulative tolerance ±0.2
- Camber not to exceed 1mm IN 100mm, noncumulative over 250mm
- Material: black static dissipative polystyrene
- All dimensions are in mm (unless otherwise specified)
- A0 and B0 measured on a plane 0.3mm above the bottom of the pocket
- MSL1 260°C (IR and Convection) PbF Reflow Compatible

### Package Marking Information

**Location**

**1st Line**

CSD = Fixed Characters

NNNNN = Product Code

**2nd Line (Date Code)**

YY = Last 2 digits of the Year

WW = 2-digit Work Week

C = Country of Origin

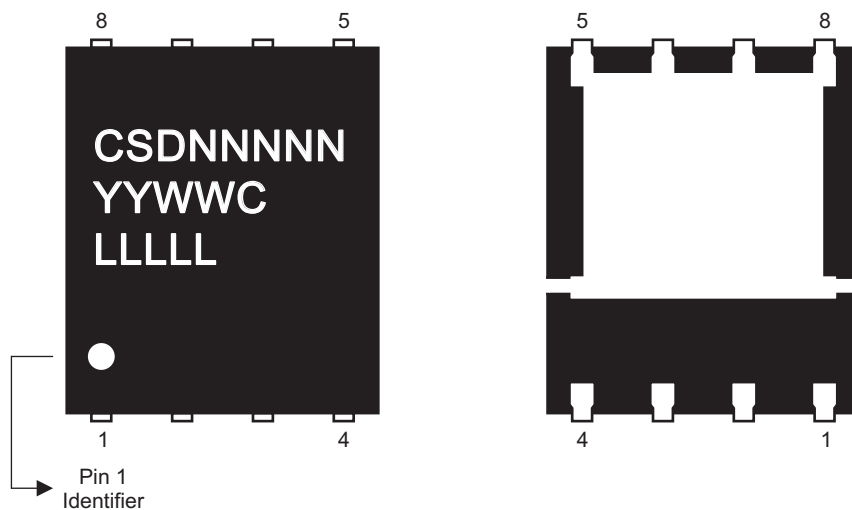
> Philippines = P

> Taiwan = T

> China = C

**3rd Line**

LLLLL = Last 5 digits of the Wafer Lot #



M0136-01



**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
CSD16412Q5A	ACTIVE	SON	DQJ	8	2500	Pb-Free (RoHS Exempt)	CU SN	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

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

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

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

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

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

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

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

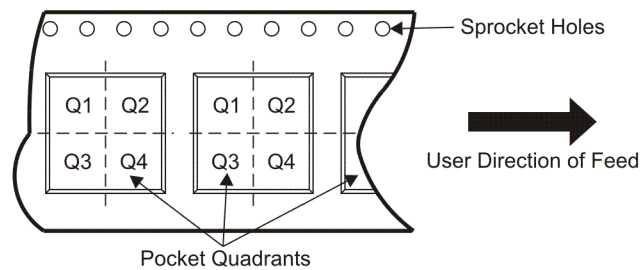
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## TAPE AND REEL INFORMATION



### 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
CSD16412Q5A	SON	DQJ	8	2500	330.2	12.4	6.5	5.3	1.4	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)
CSD16412Q5A	SON	DQJ	8	2500	347.0	342.0	55.0

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Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>	Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>	Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>	Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Energy	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
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RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>	Space, Avionics & Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>	Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
		Wireless	<a href="http://www.ti.com/wireless-apps">www.ti.com/wireless-apps</a>

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