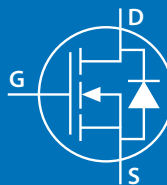


## EPC2308 – Enhancement Mode Power Transistor

 $V_{DS}$ , 150 V $R_{DS(on)}$ , 6 mΩ max

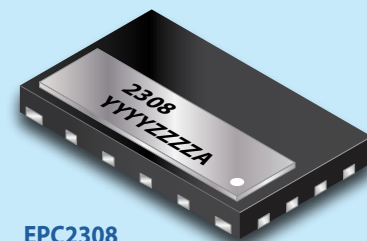
Revised December 19, 2024

Gallium Nitride's exceptionally high electron mobility and low temperature coefficient allows very low  $R_{DS(on)}$ , while its lateral device structure and majority carrier diode provide exceptionally low  $Q_G$  and zero  $Q_{RR}$ . The end result is a device that can handle tasks where very high switching frequency, and low on-time are beneficial as well as those where on-state losses dominate.

**Application Notes:**

- Easy-to-use and reliable gate, Gate Drive ON = 5 V typical, OFF = 0 V (negative voltage not needed)
- Top of FET is electrically connected to source

**Questions:**  
Ask a GaN Expert

**EPC2308**

Package size: 3 x 5 mm

**Maximum Ratings**

PARAMETER		VALUE	UNIT
$V_{DS}$	Drain-to-Source Voltage (Continuous)	150	V
	Drain-to-Source Voltage (Repetitive Transient) <sup>(1)</sup>	180	
$I_D$	Continuous ( $T_J \leq 125^\circ\text{C}$ )	63	A
	Pulsed (25 °C, $T_{PULSE} = 300 \mu\text{s}$ )	157	
$V_{GS}$	Gate-to-Source Voltage	6	V
	Gate-to-Source Voltage	-4	
	Gate-to-Source Voltage (Repetitive Transient) <sup>(1)</sup>	7	
$T_J$	Operating Temperature	-40 to 150	°C
$T_{STG}$	Storage Temperature	-55 to 175	

<sup>(1)</sup> Pulsed repetitively, duty cycle factor ( $DC_{Factor}$ )  $\leq 1\%$ ; Figure 13;

**Thermal Characteristics**

PARAMETER		TYP	UNIT
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case (Case TOP)	0.5	°C/W
$R_{\theta JB}$	Thermal Resistance, Junction-to-Board (Case BOTTOM)	2.8	
$R_{\theta JA\_JEDEC}$	Thermal Resistance, Junction-to-Ambient (using JEDEC 51-2 PCB)	54	
$R_{\theta JA\_EVB}$	Thermal Resistance, Junction-to-Ambient (EPC90148 EVB)	23	

**Static Characteristics ( $T_J = 25^\circ\text{C}$  unless otherwise stated)**

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
BV <sub>DSS</sub>	Drain-to-Source Voltage	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 200 μA	150			V
I <sub>DSS</sub>	Drain-Source Leakage	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 120 V		0.01	0.2	mA
I <sub>GSS</sub>	Gate-to-Source Forward Leakage	V <sub>GS</sub> = 5 V		0.015	2	
	Gate-to-Source Forward Leakage <sup>#</sup>	V <sub>GS</sub> = 5 V, T <sub>J</sub> = 125°C		0.2	4	
	Gate-to-Source Reverse Leakage	V <sub>GS</sub> = -4 V		0.1	1	
V <sub>GS(TH)</sub>	Gate Threshold Voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 5 mA	0.8	1.2	2.5	V
R <sub>DS(on)</sub>	Drain-Source On Resistance	V <sub>GS</sub> = 5 V, I <sub>D</sub> = 15 A		4.5	6	mΩ
V <sub>SD</sub>	Source-Drain Forward Voltage <sup>#</sup>	V <sub>GS</sub> = 0 V, I <sub>S</sub> = 0.5 A		1.5		V

<sup>#</sup> Defined by design. Not subject to production test.

**Applications**

- High density DC-DC from 80–100 V
- AC/DC
- Synchronous rectification from 28–54 V for chargers, adaptors, and power supplies
- Solar optimizers and microinverters
- Motor drive and DC-DC for battery-operated power tools and robots
- USB fast chargers

**Benefits**

- Higher Efficiency – Lower conduction and switching losses, zero reverse recovery losses
- Ultra small footprint – Higher power density
- Thermally enhanced QFN package with exposed top and ultra-low thermal resistances for cooler operations
- Wettable flanks and 0.6 mm between high voltage and low voltage pads to simplify assembly and inspection

Scan QR code or click link below for more information including reliability reports, device models, demo boards!



<https://l.ead.me/EPC2308>

Dynamic Characteristics<sup>#</sup> ( $T_J = 25^\circ\text{C}$  unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$C_{ISS}$	Input Capacitance	$V_{DS} = 75\text{ V}, V_{GS} = 0\text{ V}$		1667	2377	pF
$C_{RSS}$	Reverse Transfer Capacitance			3.1		
$C_{OSS}$	Output Capacitance			401	558	
$C_{OSS(ER)}$	Effective Output Capacitance, Energy Related (Note 1)	$V_{DS} = 0\text{ to }75\text{ V}, V_{GS} = 0\text{ V}$		510		
$C_{OSS(TR)}$	Effective Output Capacitance, Time Related (Note 2)			665		
$R_G$	Gate Resistance			0.4		$\Omega$
$Q_G$	Total Gate Charge	$V_{DS} = 75\text{ V}, V_{GS} = 5\text{ V}, I_D = 15\text{ A}$		11.7	16	nC
$Q_{GS}$	Gate-to-Source Charge	$V_{DS} = 75\text{ V}, I_D = 15\text{ A}$		4.2		
$Q_{GD}$	Gate-to-Drain Charge			1		
$Q_{G(TH)}$	Gate Charge at Threshold			3		
$Q_{OSS}$	Output Charge	$V_{DS} = 75\text{ V}, V_{GS} = 0\text{ V}$		50	61	
$Q_{RR}$	Source-Drain Recovery Charge			0		

<sup>#</sup> Defined by design. Not subject to production test.

All measurements were done with substrate connected to source.

Note 1:  $C_{OSS(ER)}$  is a fixed capacitance that gives the same stored energy as  $C_{OSS}$  while  $V_{DS}$  is rising from 0 to 50%  $BV_{DSS}$ .

Note 2:  $C_{OSS(TR)}$  is a fixed capacitance that gives the same charging time as  $C_{OSS}$  while  $V_{DS}$  is rising from 0 to 50%  $BV_{DSS}$ .

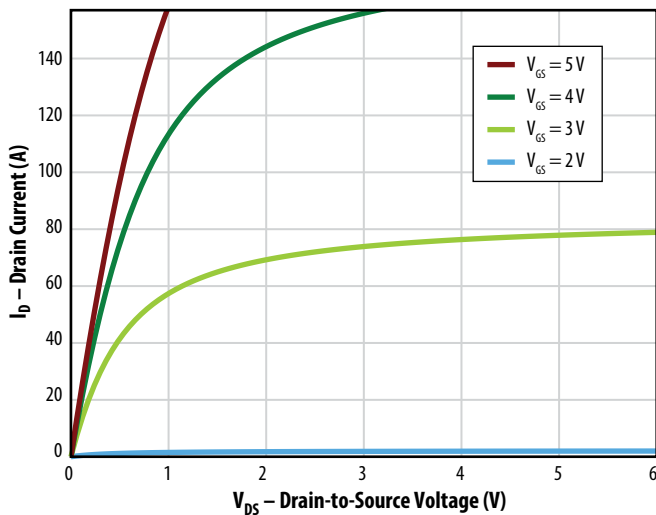
Figure 1: Typical Output Characteristics at  $25^\circ\text{C}$ 

Figure 2: Typical Transfer Characteristics

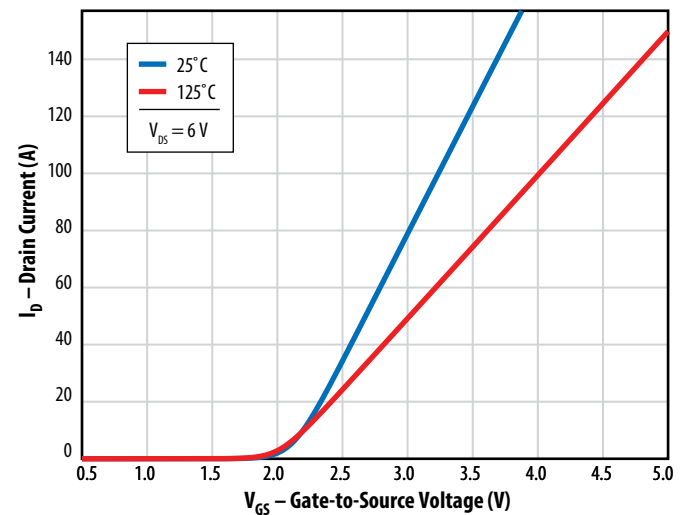
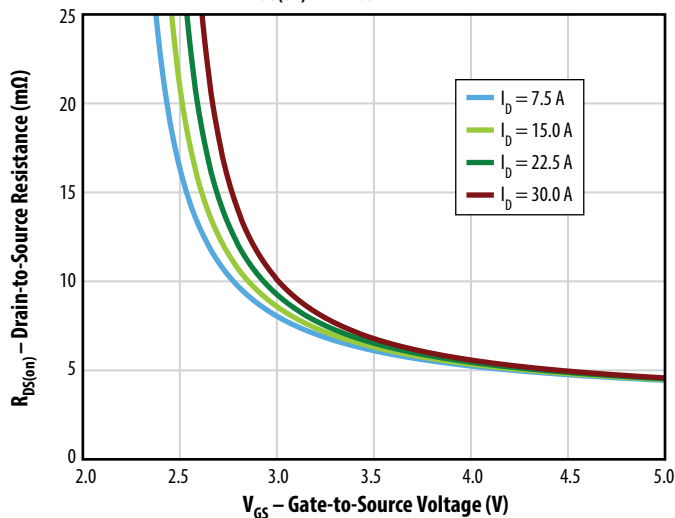
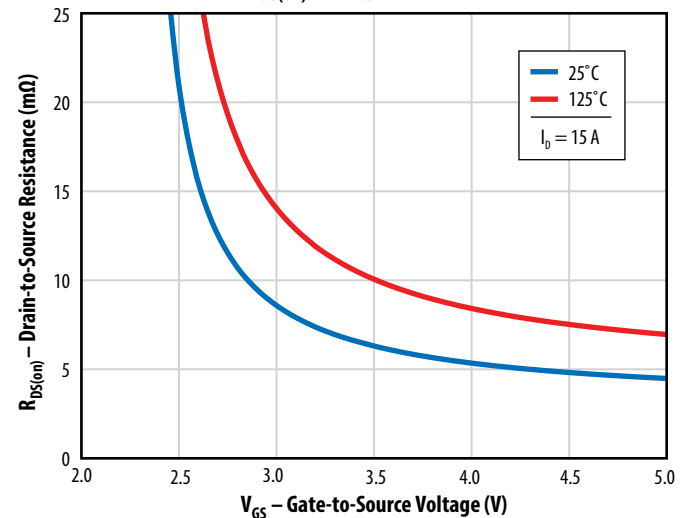
Figure 3: Typical  $R_{DS(on)}$  vs.  $V_{GS}$  for Various Drain CurrentsFigure 4: Typical  $R_{DS(on)}$  vs.  $V_{GS}$  for Various Temperatures

Figure 5a: Typical Capacitance (Linear Scale)

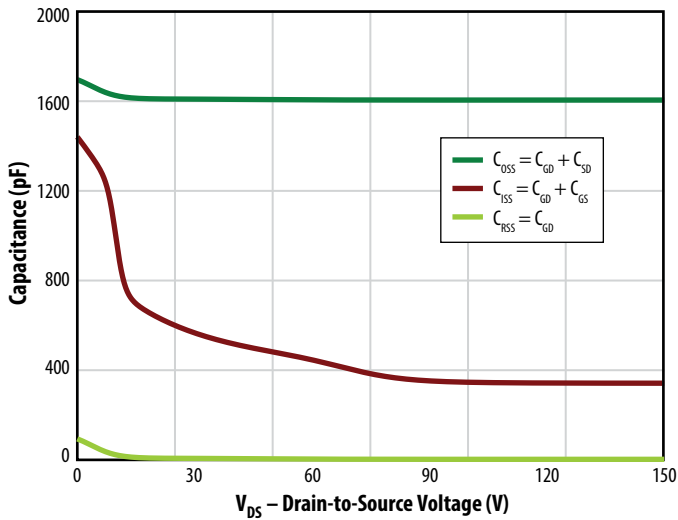


Figure 5b: Typical Capacitance (Log Scale)

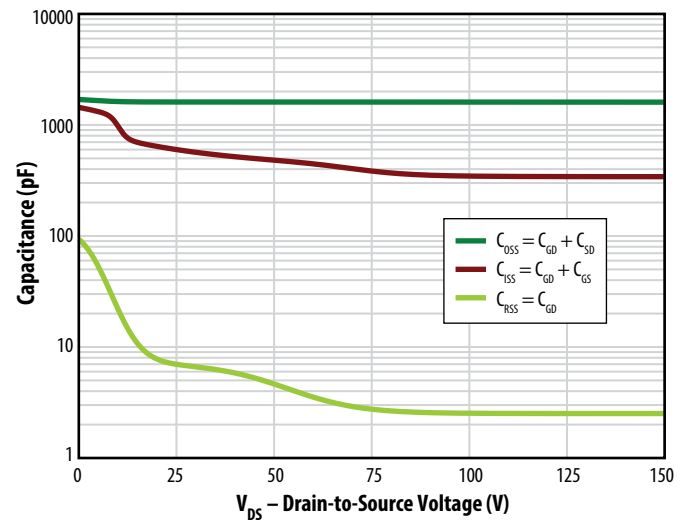
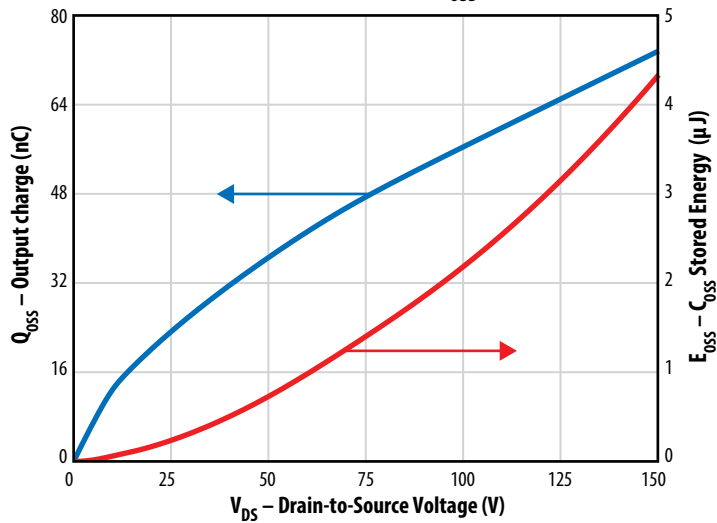
Figure 6: Typical Output Charge and  $C_{OSS}$  Stored Energy

Figure 7: Typical Gate Charge

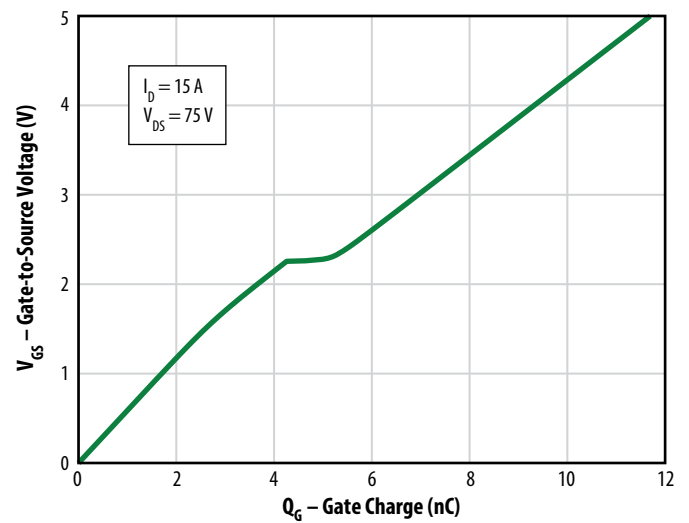


Figure 8: Typical Reverse Drain-Source Characteristics

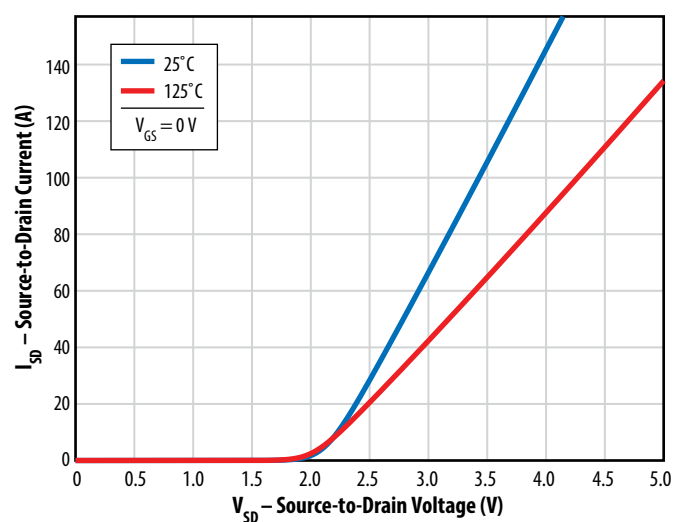
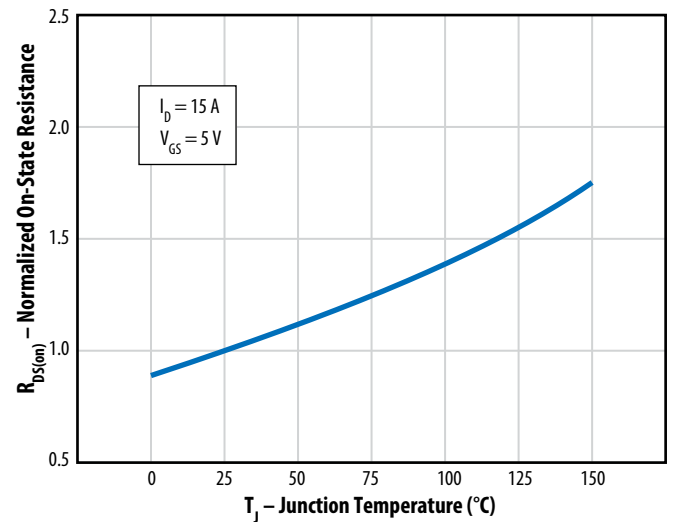


Figure 9: Typical Normalized On-State Resistance vs. Temp.



Note: Negative gate drive voltage increases the reverse drain-source voltage.  
EPC recommends 0 V for OFF.

Figure 10: Typical Normalized Threshold Voltage vs. Temp.

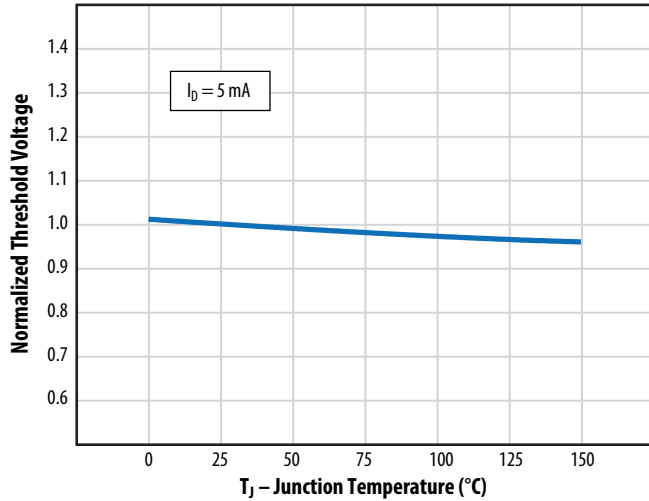


Figure 11: Safe Operating Area

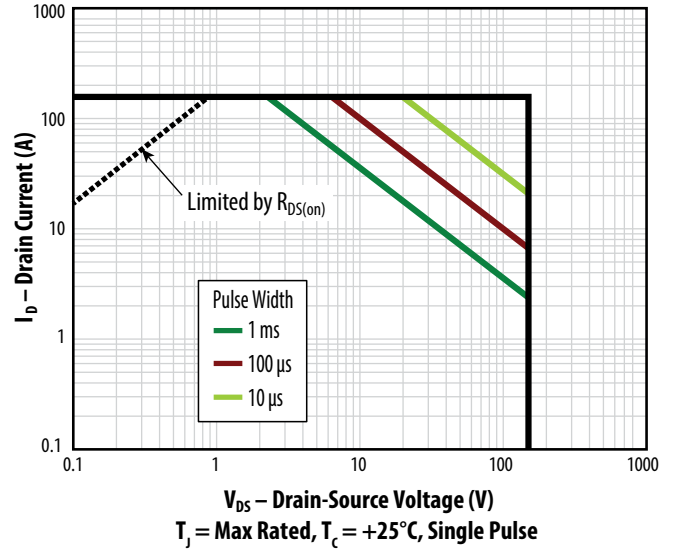


Figure 12: Typical Transient Thermal Response Curves

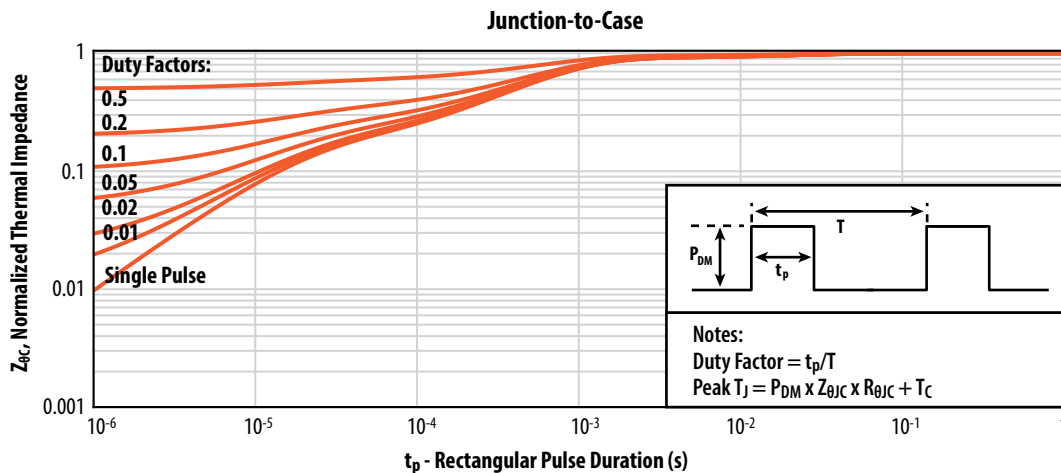
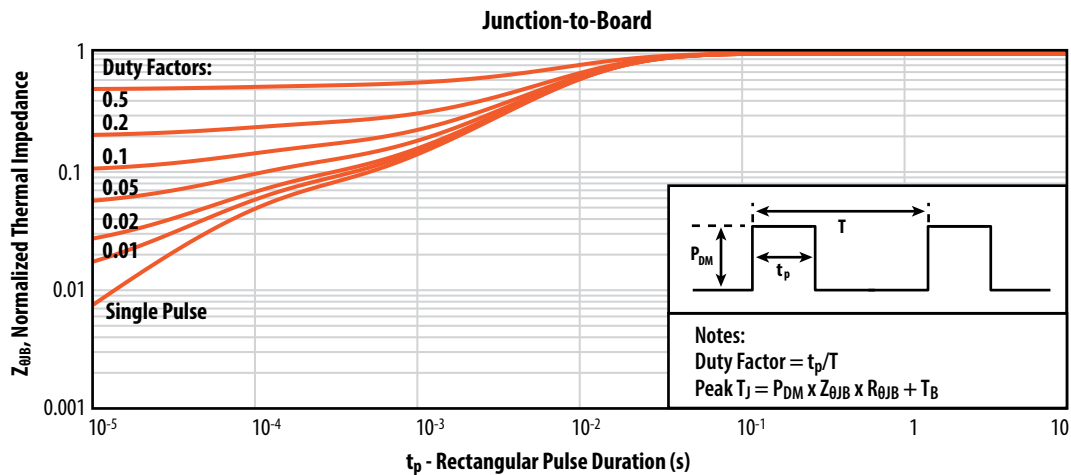
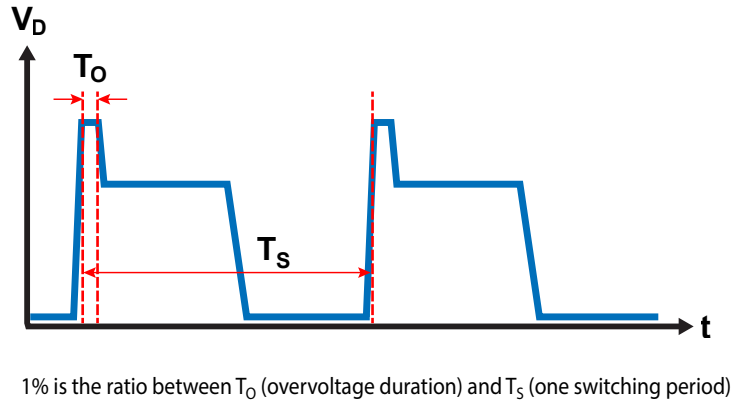


Figure 13: Duty Cycle Factor ( $DC_{Factor}$ ) Illustration for Repetitive Overvoltage Specification

## LAYOUT CONSIDERATIONS

GaN transistors generally behave like power MOSFETs, but at much higher switching speeds and power densities, therefore layout considerations are very important, and care must be taken to minimize layout parasitic inductances. The recommended design utilizes the first inner layer as a power loop return path. This return path is located directly beneath the top layer's power loop allowing for the smallest physical loop size. This method is also commonly referred to as flux cancellation. Variations of this concept can be implemented by placing the bus capacitors either next to the high side device, next to the low side device, or between the low and high side devices, but in all cases the loop is closed using the first inner layer right beneath the devices.

A similar concept is also used for the gate loop, with the first inner layer used as a reference for the gate loop under the gate resistors and the relative pins of the gate driver: ground for the bottom FET and switch node for the top FET.

Furthermore, to minimize the common source inductance between power and gate loops, the power and gate loops are laid out perpendicular to each other, and a via next to the source pad closest to the gate pad is used as Kelvin connection for the gate driver return path.

The [EPC90148 Half-Bridge Development Board Using EPC2308](#) implements our recommended vertical inner layout.

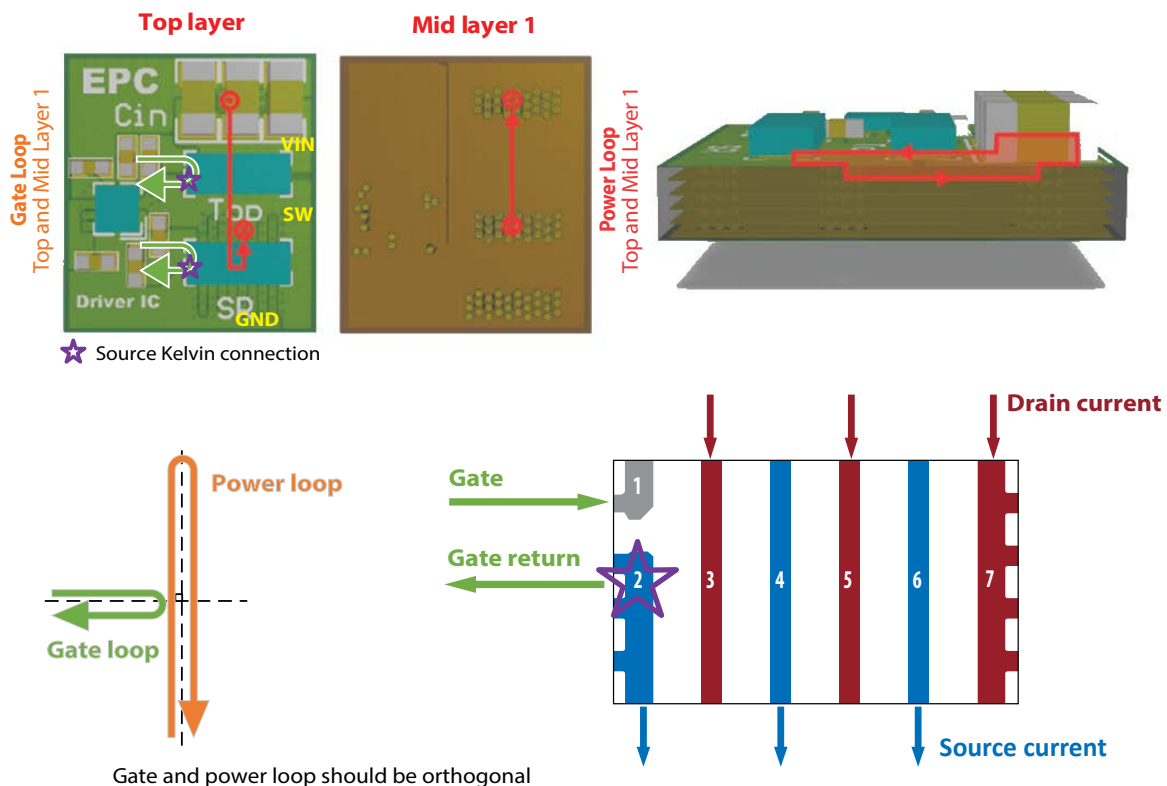


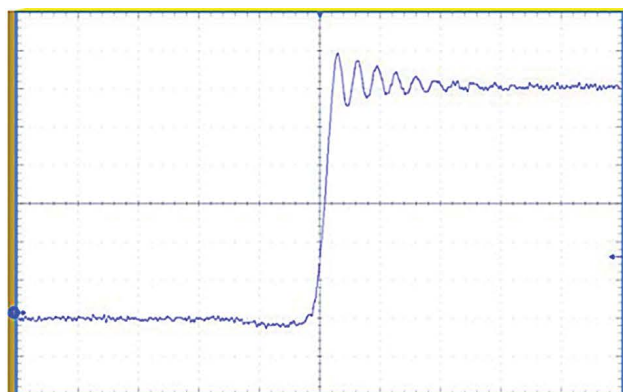
Figure 14: Inner Vertical Layout for Power and Gate Loops

Detailed recommendations on layout can be found on EPC's website: [Optimizing PCB Layout with eGaN FETs.pdf](#)

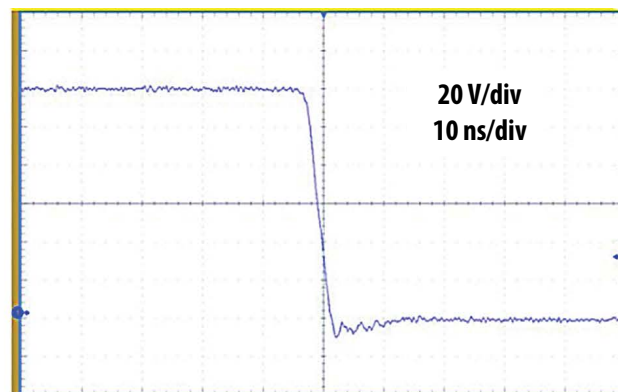
## TYPICAL SWITCHING BEHAVIOR

The following typical switching waveforms are captured in these conditions:

- **EPC90148: 150 V, 12 A Half-Bridge Development Board Featuring EPC2308**
- Gate driver: NCP51820 with 1A source and 2A sink capability
- External  $R_{G(ON)} = 1\ \Omega$ ,  $R_{G(OFF)} = 0\ \Omega$
- $V_{IN} = 120\text{ V}$ ,  $I_L = 30\text{ A}$



**Typical turn ON: 46 V/ns**



**Typical turn OFF: 28 V/ns**

*Figure 15: Typical half-bridge voltage switching waveforms*

See the [EPC90148 Half-Bridge Development Board Using EPC2308 Quick Start Guide](#) for more information.

## TYPICAL THERMAL CONCEPT

The EPC2308 can take advantage of dual sided cooling to maximize its heat dissipation capabilities in high power density designs.

**Note that the top of EPC FETs are connected to source potential, so for half-bridge topologies the Thermal Interface Material (TIM) needs to provide electrical isolation to the heatsink.**

Recommended best practice thermal solutions are covered in detail in

[How2AppNote012 - How to Get More Power Out of an eGaN Converter.pdf](#).

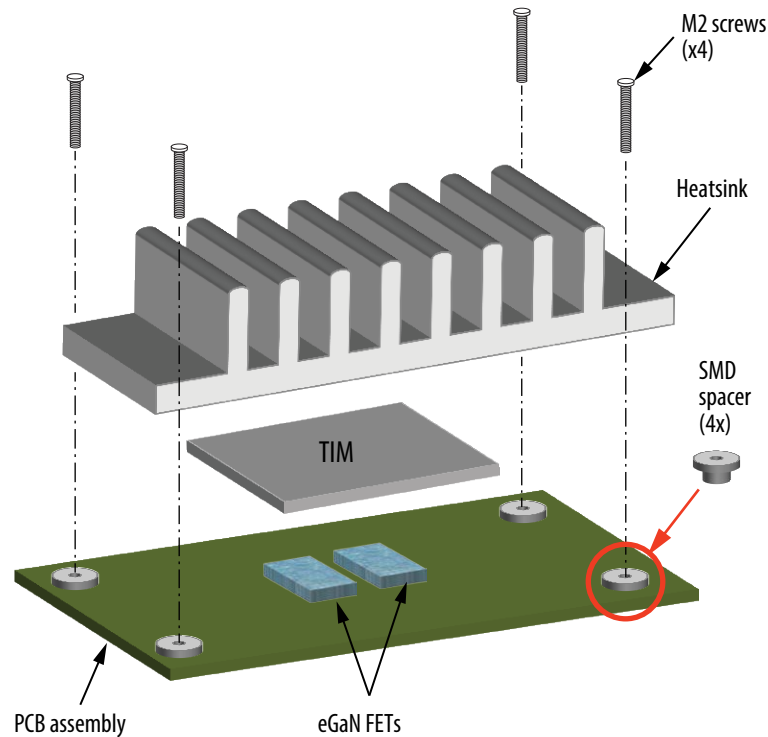


Figure 16: Exploded view of heatsink assembly using screws

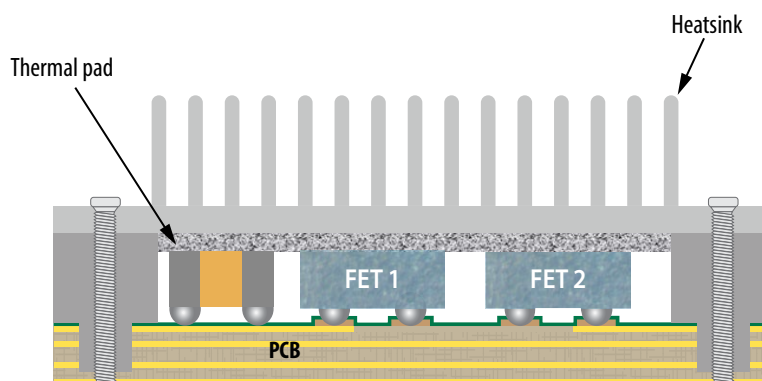
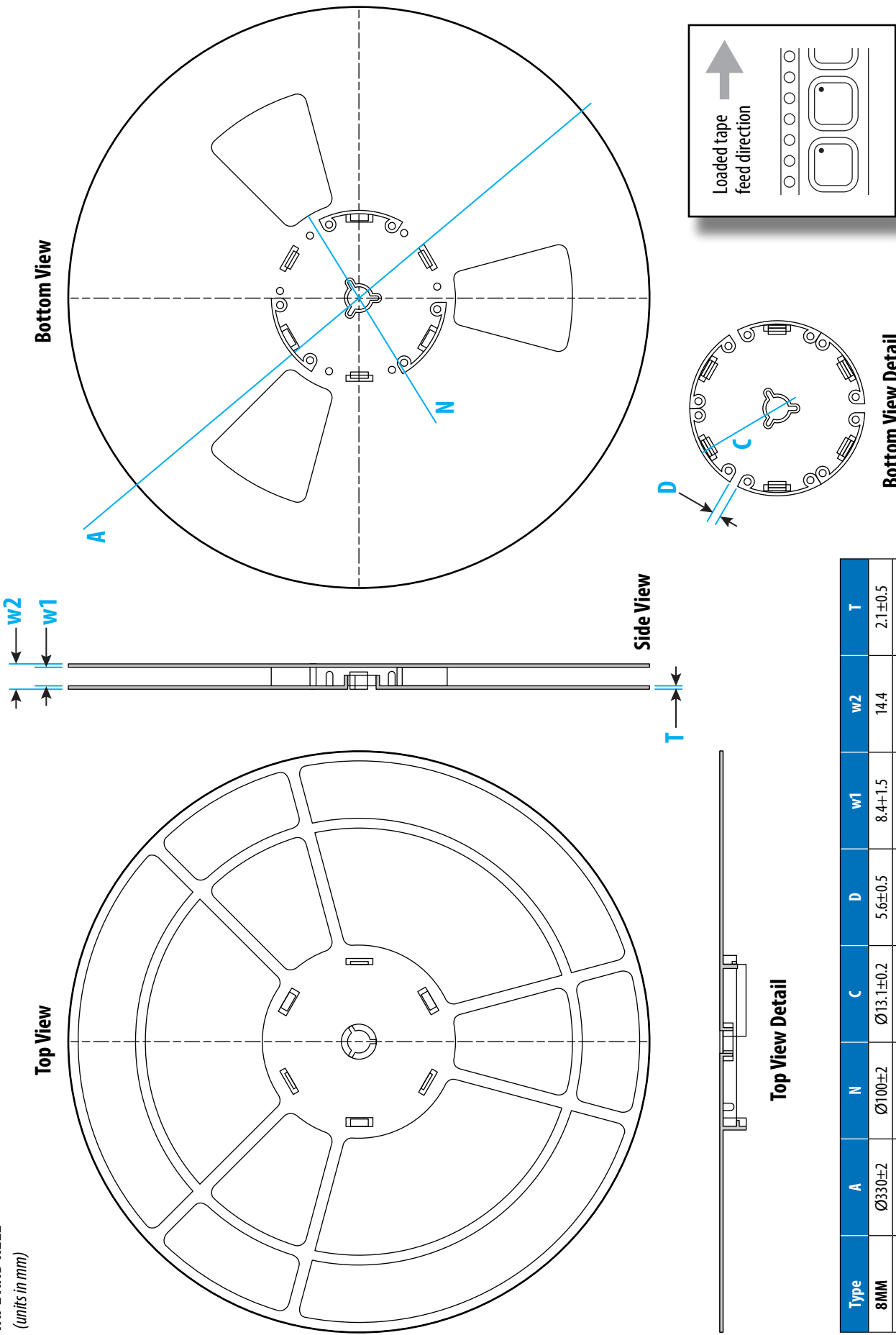


Figure 17: A cross-section image of dual sided thermal solution

**Note: Connecting the heatsink to ground is recommended and can significantly improve radiated EMI**

The thermal design can be optimized by using the [GaN FET Thermal Calculator](#) on EPC's website.

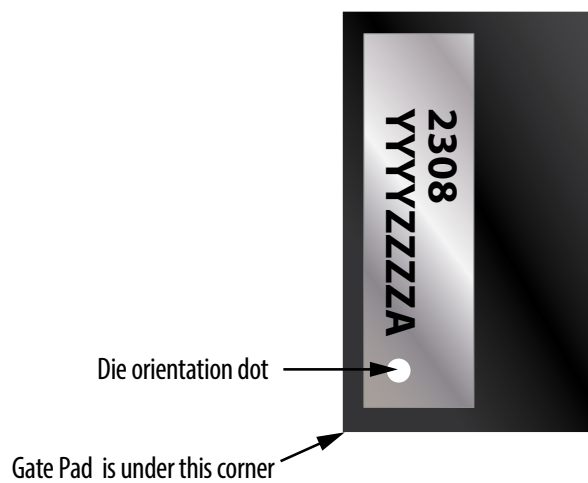
TAPE AND REEL  
(units in mm)



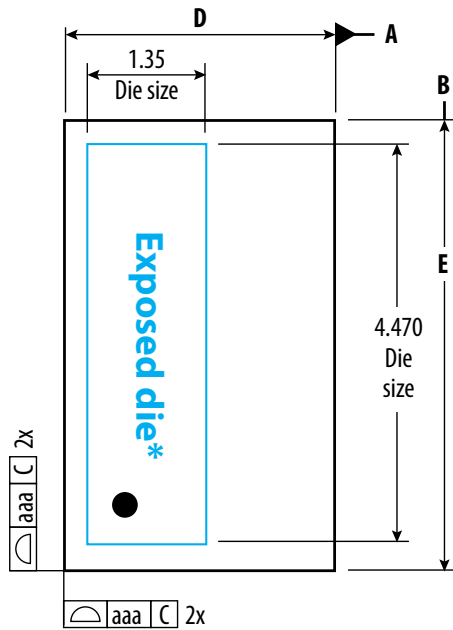
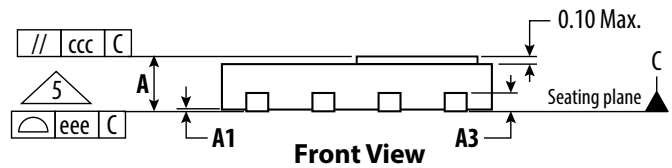
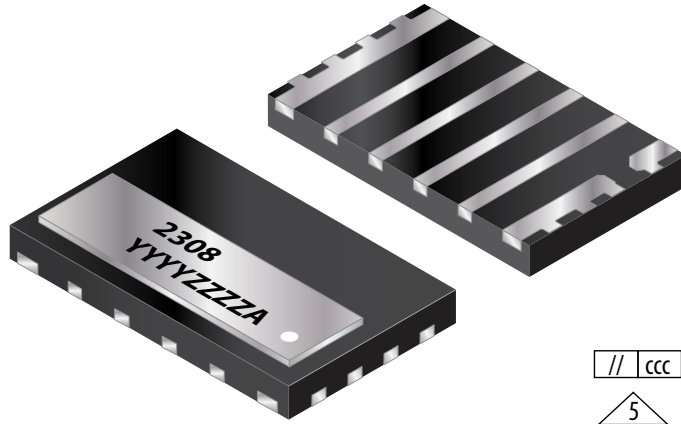
Type	A	N	C	D	w1	w2	T
8MM	Ø330±2	Ø100±2	Ø13.1±0.2	5.6±0.5	8.4±1.5	14.4	2.1±0.5
12MM	Ø330±2	Ø100±2	Ø13.1±0.2	5.6±0.5	12.4±1.5	18.4	2.1±0.5
16MM	Ø330±2	Ø100±2	Ø13.1±0.2	5.6±0.5	16.4±1.5	22.4	2.1±0.5
24MM	Ø330±2	Ø100±2	Ø13.1±0.2	5.6±0.5	24.4±1.5	30.4	2.1±0.5



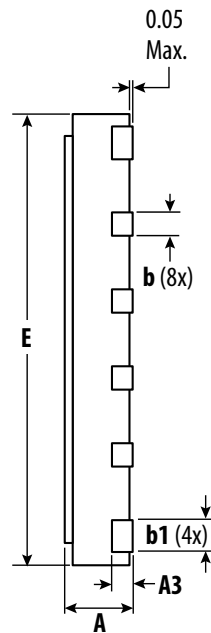
## Part Marking



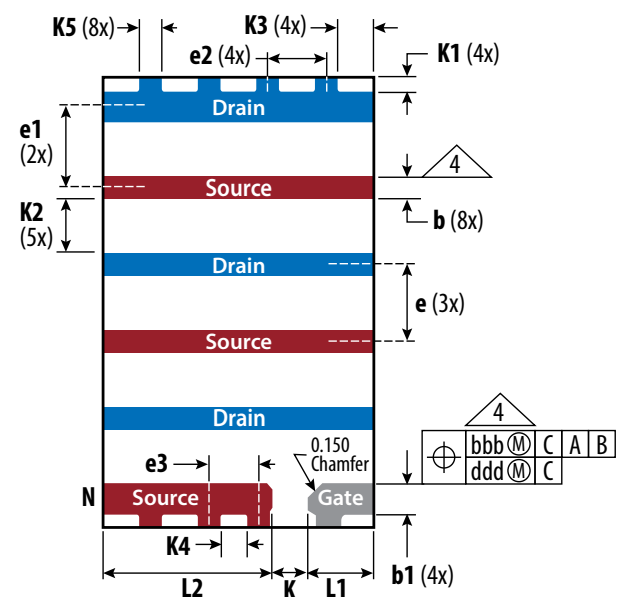
Part Number	Laser Markings	
	Part # Marking Line 1	Lot _Date Code Marking Line 2
EPC2308	2308	YYYYZZZZA



Top View



Side View



Bottom View

\*The exposed die is the silicon substrate that is internally connected to the source.  
It is not recommended to use it as an electrical connection

SYMBOL	Dimension (mm)			
	MIN	Nominal	MAX	Note
A			0.70	
A1	0.00	0.02	0.05	
A3			0.25	
b	0.20	0.25	0.30	4
b1	0.30	0.35	0.40	4
D	2.90	3.00	3.10	
E	4.90	5.00	5.10	
e		0.85 BSC		
e1		0.90 BSC		
e2		0.65 BSC		
e3		0.55 BSC		
L1	0.625	0.725	0.825	
L2	1.775	1.875	1.975	

SYMBOL	Dimension (mm)			
	MIN	Nominal	MAX	Note
K		0.40 Ref		
K1		0.15 Ref		
K2		0.60 Ref		
K3		0.40 Ref		
K4		0.30 Ref		
K5		0.25 Ref		
aaa		0.05		
bbb		0.10		
ccc		0.10		
ddd		0.05		
eee		0.08		
N		7		3

**Notes:**

1. Dimensioning and tolerancing conform to ASME Y14.5-2009
2. All dimensions are in millimeters
3. **N** is the total number of terminals
4. Dimension **b** applies to the metalized terminal and a radius on the other end of it, dimension **b** should not be measured in that radius area.
5. Coplanarity applies to the terminals and all the other bottom surface metallization.

1

2

3

4

5

6

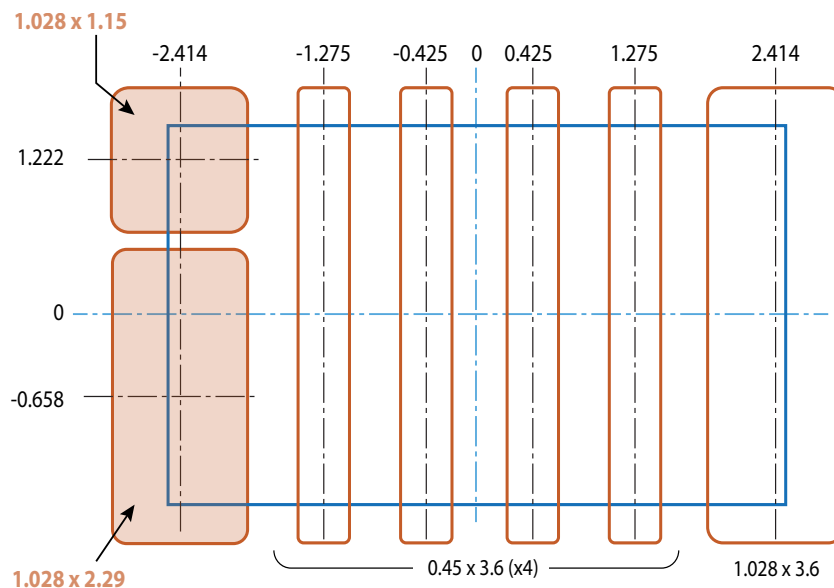
7

PIN	Description
1	Gate
2	Source
3	Drain
4	Source
5	Drain
6	Source
7	Drain

Radius = 0.05

Split stencil design can be provided upon request, but EPC has tested this stencil design and not found any scooping issues.

**RECOMMENDED  
COPPER DRAWING**  
(units in mm)



Legend:

Part outline  
Copper

Radius = 0.05

**3D COMPOSITE**

Legend:

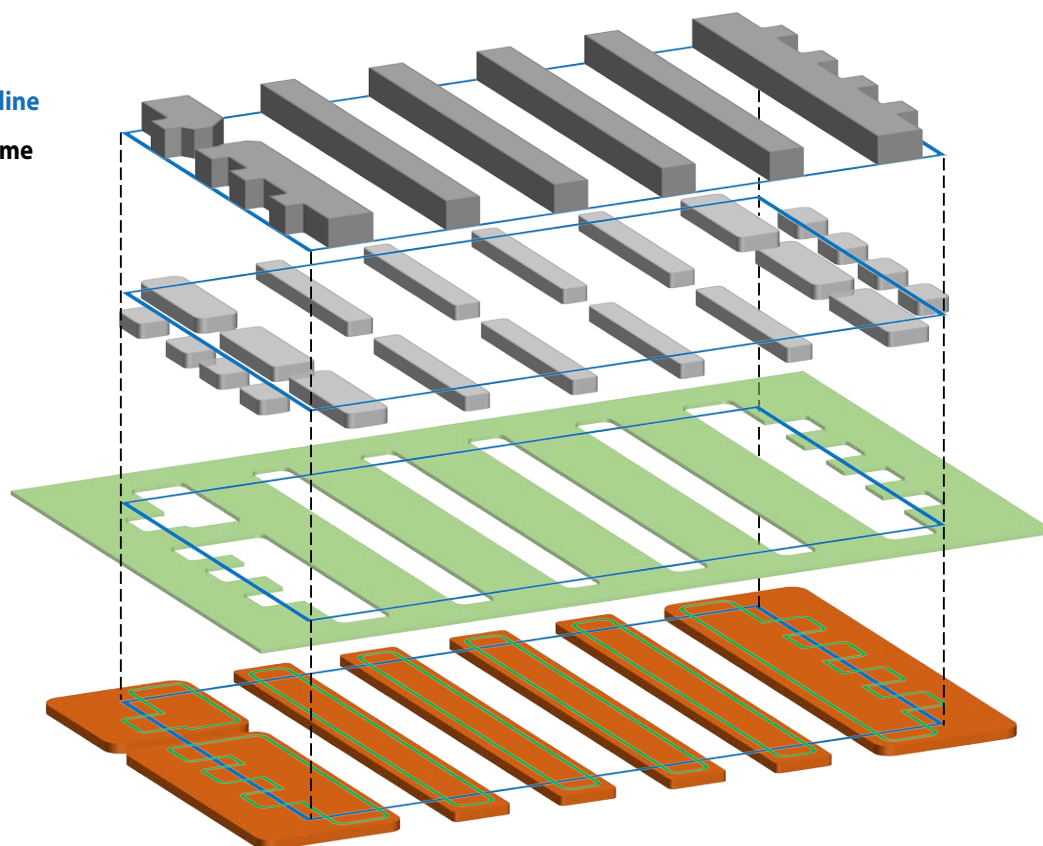
Part outline

Lead frame

Paste

Mask

Copper



## ADDITIONAL RESOURCES AVAILABLE

Solder mask defined pads are recommended for best reliability.

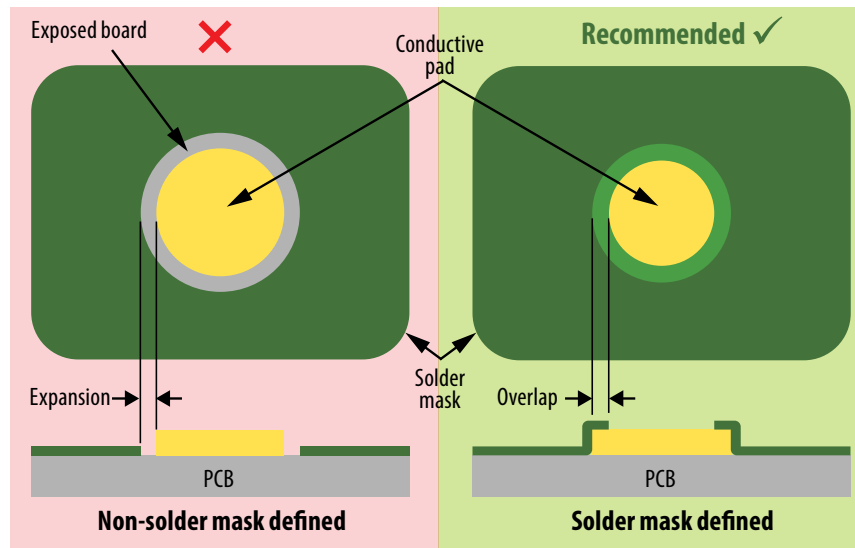


Figure 17: Solder mask defined versus non-solder mask defined pad

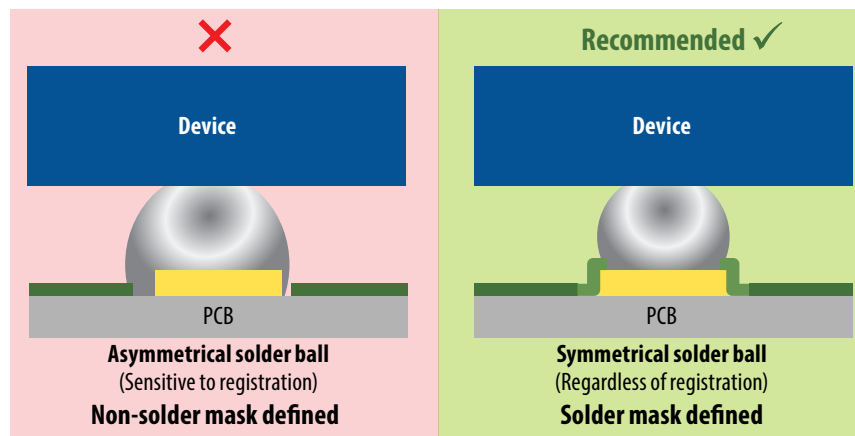


Figure 18: Effect of solder mask design on the solder ball symmetry

## Additional resources available

- Assembly resources – [https://epc-co.com/epc/Portals/0/epc/documents/product-training/Appnote\\_GaNassembly.pdf](https://epc-co.com/epc/Portals/0/epc/documents/product-training/Appnote_GaNassembly.pdf)
- Library of Altium footprints for production FETs and ICs – <https://epc-co.com/epc/documents/altium-files/EPC%20Altium%20Library.zip>  
(for preliminary device Altium footprints, contact EPC)

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EPC Patent Listing: <https://epc-co.com/epc/about-epc/patents>

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