

## IV2Q12040T4Z – 1200V 40mΩ Gen2 Automotive SiC MOSFET

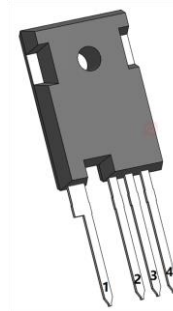
### Features

- 2<sup>nd</sup> Generation SiC MOSFET Technology with +15~+18V gate drive
- High blocking voltage with low on-resistance
- High speed switching with low capacitance
- 175°C operating junction temperature capability
- Ultra fast and robust intrinsic body diode
- Kelvin gate input easing driver circuit design
- AEC-Q101 qualified

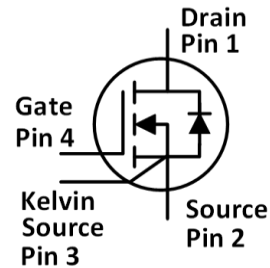
### Applications

- EV chargers and OBCs
- Solar boosters
- Automotive compressor inverters
- AC/DC power supplies

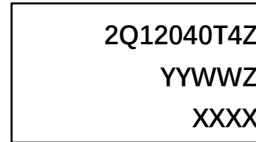
### Outline:



TO247-4



### Marking Diagram:



2Q12040T4Z= Specific Device Code  
 YY = Year  
 WW = Work Week  
 Z = Assembly Location  
 XXXX = Lot Traceability

### Absolute Maximum Ratings (T<sub>c</sub>=25°C unless otherwise specified)

Symbol	Parameter	Value	Unit	Test Conditions	Note
V <sub>DS</sub>	Drain-Source voltage	1200	V	V <sub>GS</sub> =0V, I <sub>D</sub> =100μA	
V <sub>GSmax</sub> (Transient)	Maximum transient voltage	-10 to 23	V	Duty cycle<1%, and pulse width<200ns	
V <sub>GSon</sub>	Recommended turn-on voltage	15 to 18	V		
V <sub>GSoff</sub>	Recommended turn-off voltage	-5 to -2	V	Typical -3.5V	
I <sub>D</sub>	Drain current (continuous)	65	A	V <sub>GS</sub> =18V, T <sub>C</sub> =25°C	Fig. 23
		48	A	V <sub>GS</sub> =18V, T <sub>C</sub> =100°C	
I <sub>DM</sub>	Drain current (pulsed)	162	A	Pulse width limited by SOA and dynamic R <sub>θ(j-c)</sub>	Fig. 25, 26
I <sub>SM</sub>	Body diode current (pulsed)	162	A	Pulse width limited by SOA and dynamic R <sub>θ(j-c)</sub>	Fig. 25, 26
P <sub>TOT</sub>	Total power dissipation	375	W	T <sub>C</sub> =25°C	Fig. 24
T <sub>stg</sub>	Storage temperature range	-55 to 175	°C		
T <sub>J</sub>	Operating junction temperature	-55 to 175	°C		
T <sub>L</sub>	Solder Temperature	260	°C	wave soldering only allowed at leads, 1.6mm from case for 10 s	

### Thermal Data

Symbol	Parameter	Value	Unit	Note
R <sub>θ(j-c)</sub>	Thermal Resistance from Junction to Case	0.4	°C/W	Fig. 25

**Electrical Characteristics** ( $T_c=25^\circ\text{C}$  unless otherwise specified)

Symbol	Parameter	Value			Unit	Test Conditions	Note
		Min.	Typ.	Max.			
$I_{DSS}$	Zero gate voltage drain current		5	100	$\mu\text{A}$	$V_{DS}=1200\text{V}, V_{GS}=0\text{V}$	
$I_{GSS}$	Gate leakage current			$\pm 100$	$\text{nA}$	$V_{DS}=0\text{V}, V_{GS}=-5\sim 20\text{V}$	
$V_{TH}$	Gate threshold voltage	1.8	2.8	4.5	$\text{V}$	$V_{GS}=V_{DS}, I_D=9\text{mA}$	Fig. 8, 9
			2.1			$V_{GS}=V_{DS}, I_D=9\text{mA}$ @ $T_J=175^\circ\text{C}$	
$R_{ON}$	Static drain-source on-resistance		40	52	$\text{m}\Omega$	$V_{GS}=18\text{V}, I_D=20\text{A}$ @ $T_J=25^\circ\text{C}$	Fig. 4, 5, 6, 7
			75		$\text{m}\Omega$	$V_{GS}=18\text{V}, I_D=20\text{A}$ @ $T_J=175^\circ\text{C}$	
			50	65	$\text{m}\Omega$	$V_{GS}=15\text{V}, I_D=20\text{A}$ @ $T_J=25^\circ\text{C}$	
			80		$\text{m}\Omega$	$V_{GS}=15\text{V}, I_D=20\text{A}$ @ $T_J=175^\circ\text{C}$	
$C_{iss}$	Input capacitance		2160		$\text{pF}$	$V_{DS}=800\text{V}, V_{GS}=0\text{V},$ $f=1\text{MHz}, V_{AC}=25\text{mV}$	Fig. 16
$C_{oss}$	Output capacitance		100		$\text{pF}$		
$C_{rss}$	Reverse transfer capacitance		5.8		$\text{pF}$		
$E_{oss}$	$C_{oss}$ stored energy		40		$\mu\text{J}$		Fig. 17
$Q_g$	Total gate charge		110		$\text{nC}$	$V_{DS}=800\text{V}, I_D=30\text{A},$ $V_{GS}=-3$ to $18\text{V}$	Fig. 18
$Q_{gs}$	Gate-source charge		25		$\text{nC}$		
$Q_{gd}$	Gate-drain charge		59		$\text{nC}$		
$R_g$	Gate input resistance		2.1		$\Omega$	$f=1\text{MHz}$	
$E_{ON}$	Turn-on switching energy		446.3		$\mu\text{J}$	$V_{DS}=800\text{V}, I_D=30\text{A},$ $V_{GS}=-3.5$ to $18\text{V},$ $R_{G(\text{ext})}=3.3\Omega,$ $L=200\mu\text{H}$ $T_J=25^\circ\text{C}$	Fig. 19, 20
$E_{OFF}$	Turn-off switching energy		70.0		$\mu\text{J}$		
$t_{d(\text{on})}$	Turn-on delay time		9.6		ns		
$t_r$	Rise time		22.1				
$t_{d(\text{off})}$	Turn-off delay time		19.3				
$t_f$	Fall time		10.5				
$E_{ON}$	Turn-on switching energy		644.4		$\mu\text{J}$	$V_{DS}=800\text{V}, I_D=30\text{A},$ $V_{GS}=-3.5$ to $18\text{V},$ $R_{G(\text{ext})}=3.3\Omega, L=200\mu\text{H}$ $T_J=175^\circ\text{C}$	Fig. 22
$E_{OFF}$	Turn-off switching energy		73.8		$\mu\text{J}$		

**Reverse Diode Characteristics** ( $T_c=25^\circ\text{C}$  unless otherwise specified)

Symbol	Parameter	Value			Unit	Test Conditions	Note
		Min.	Typ.	Max.			
$V_{SD}$	Diode forward voltage		4.2		V	$I_{SD}=20\text{A}, V_{GS}=0\text{V}$	Fig. 10, 11, 12
			4.0		V	$I_{SD}=20\text{A}, V_{GS}=0\text{V},$ $T_J=175^\circ\text{C}$	
$I_S$	Diode forward current (continuous)			63	A	$V_{GS}=-2\text{V}, T_c=25^\circ\text{C}$	
				36	A	$V_{GS}=-2\text{V}, T_c=100^\circ\text{C}$	
$t_{rr}$	Reverse recovery time		42.0		ns	$V_{GS}=-3.5\text{V}/+18\text{V},$ $I_{SD}=30\text{A}, V_R=800\text{V},$ $R_{G(\text{ext})}=10\Omega, L=200\mu\text{H}$ $di/dt=3000\text{A}/\mu\text{s}$	
$Q_{rr}$	Reverse recovery charge		198.1		nC		
$I_{RRM}$	Peak reverse recovery current		17.4		A		

## Typical Performance (curves)

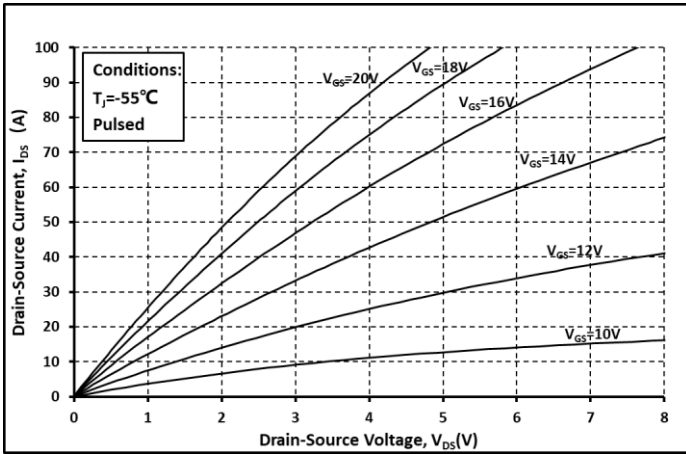


Fig. 1 Output Curve @  $T_j = -55^\circ\text{C}$

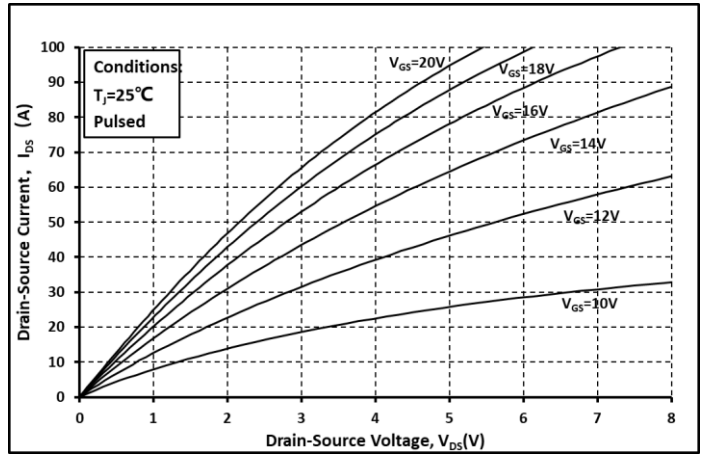


Fig. 2 Output Curve @  $T_j = 25^\circ\text{C}$

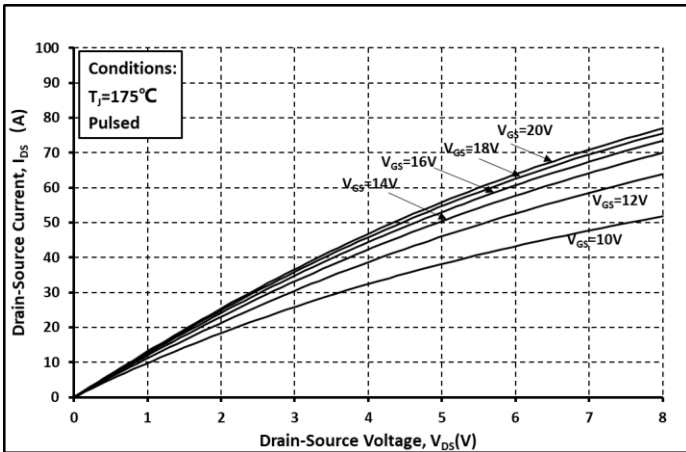


Fig. 3 Output Curve @  $T_j = 175^\circ\text{C}$

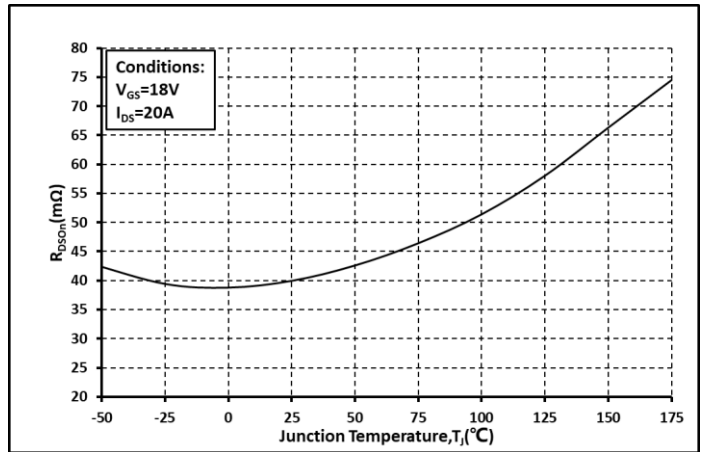


Fig. 4  $R_{on}$  vs. Temperature

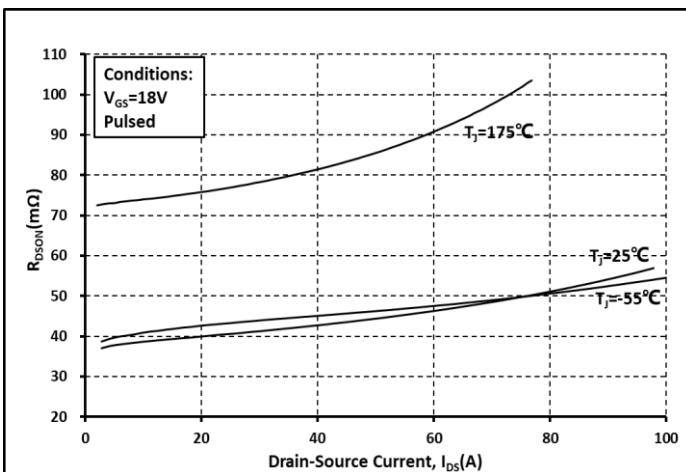


Fig. 5  $R_{on}$  vs.  $I_{DS}$  @ Various Temperature

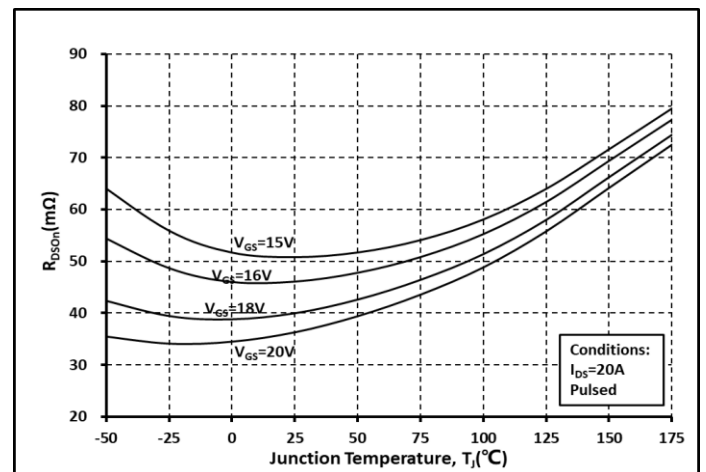


Fig. 6  $R_{on}$  vs. Temperature @ Various  $V_{GS}$

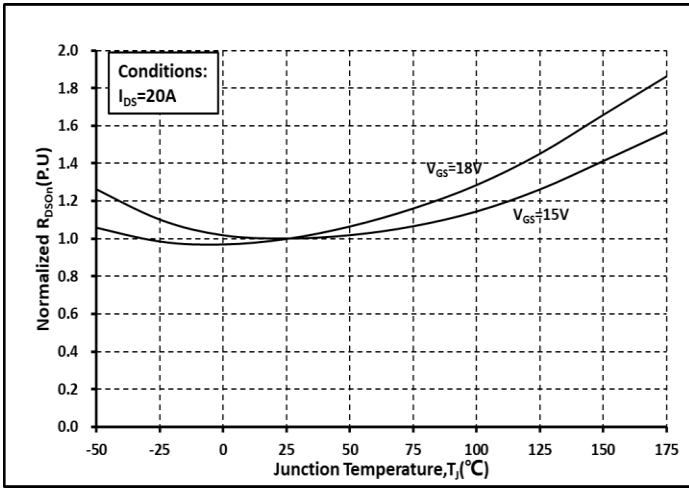


Fig. 7 Normalized Ron vs. Temperature

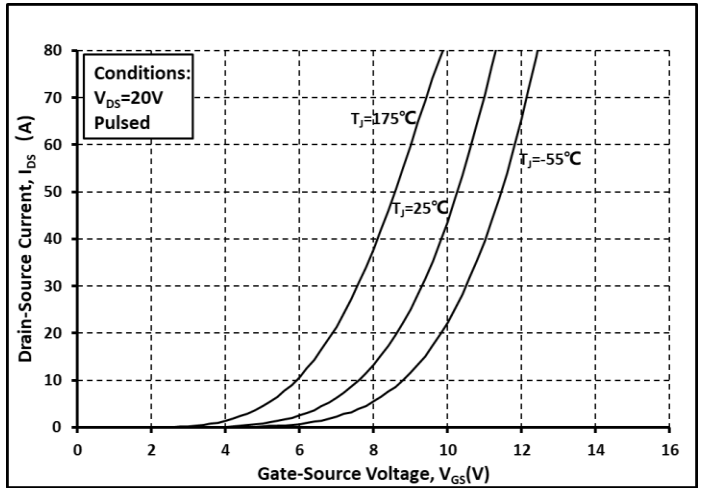


Fig. 8 Transfer Curves @ Various Temperature

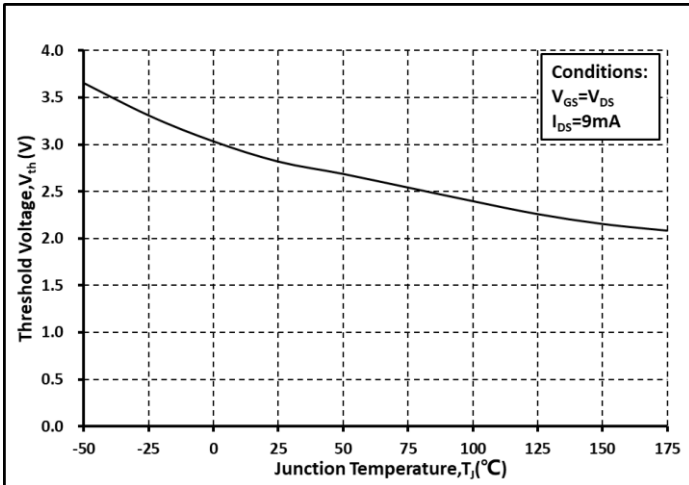


Fig. 9 Threshold Voltage vs. Temperature

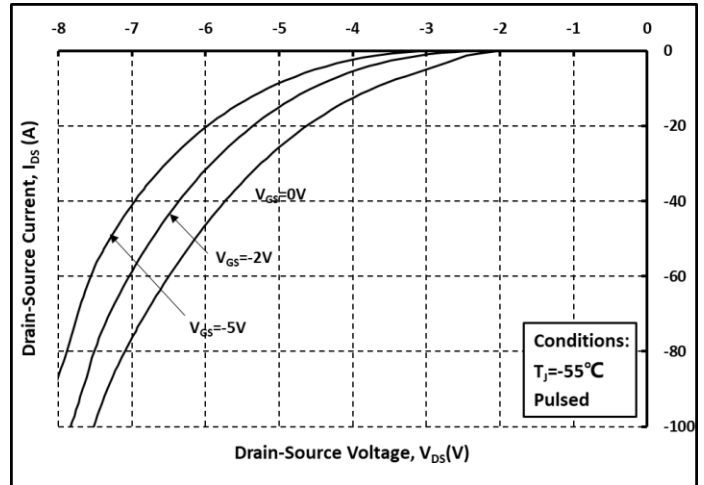


Fig. 10 Body Diode curves @  $T_j = -55^\circ\text{C}$

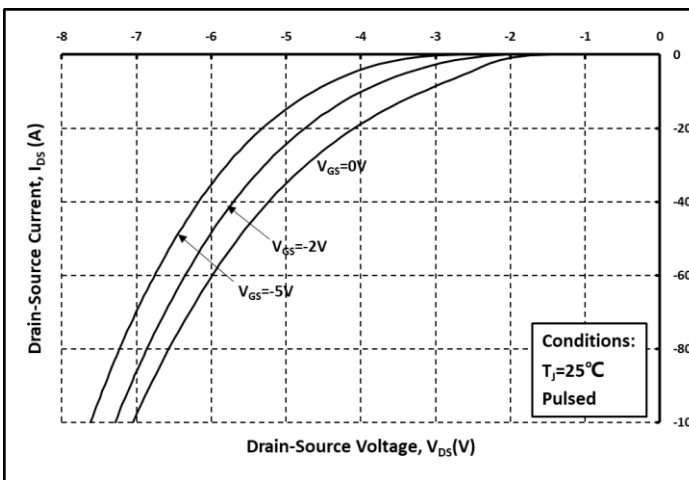


Fig. 11 Body Diode curves @  $T_j = 25^\circ\text{C}$

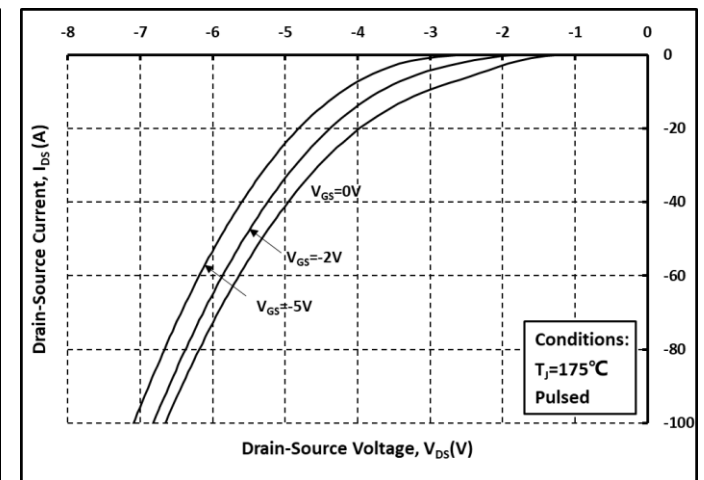


Fig. 12 Body Diode curves @  $T_j = 175^\circ\text{C}$

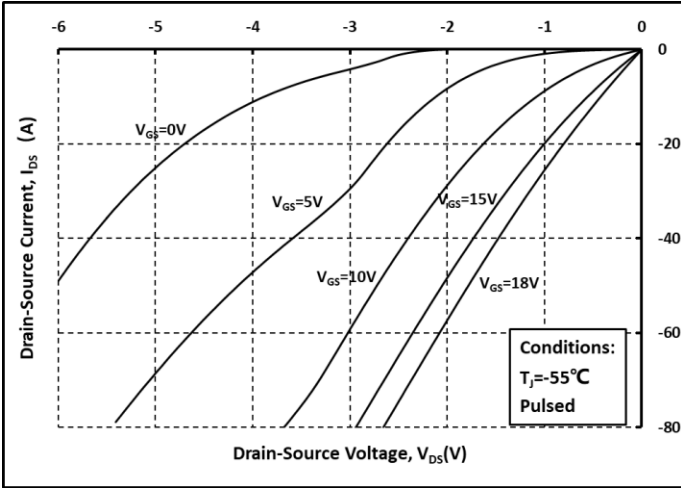


Fig. 13 3<sup>rd</sup> Quadrant curves @  $T_j = -55^\circ\text{C}$

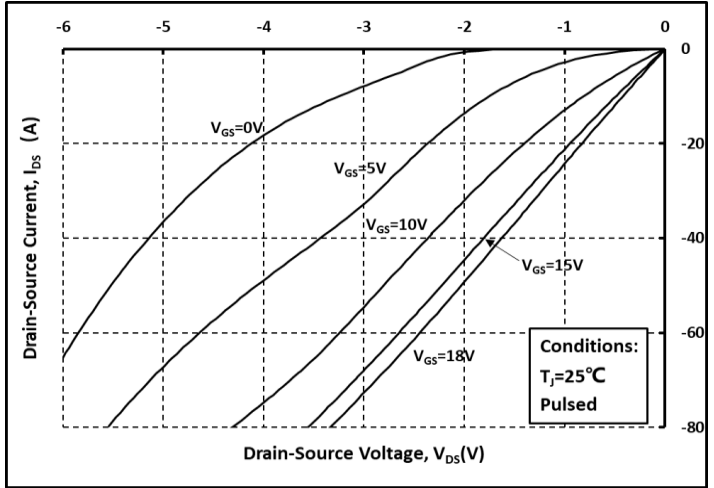


Fig. 14 3<sup>rd</sup> Quadrant curves @  $T_j = 25^\circ\text{C}$

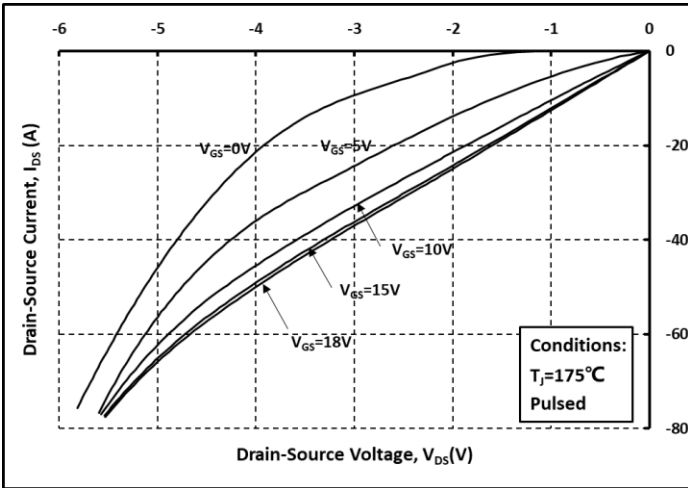


Fig. 15 3<sup>rd</sup> Quadrant curves @  $T_j = 175^\circ\text{C}$

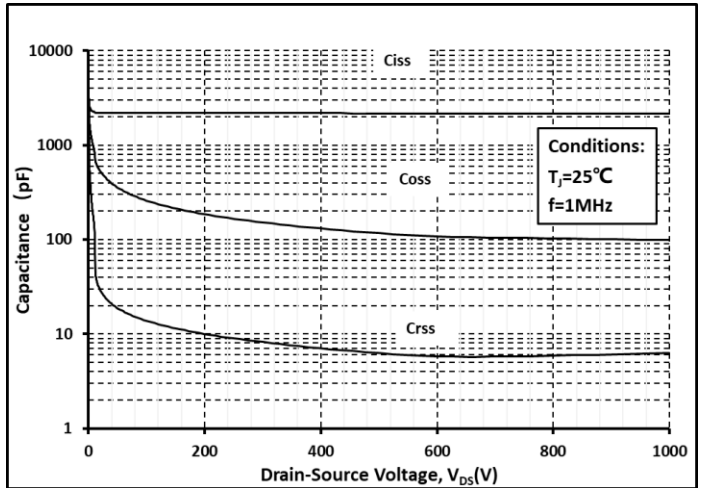


Fig. 16 Capacitance vs.  $V_{DS}$

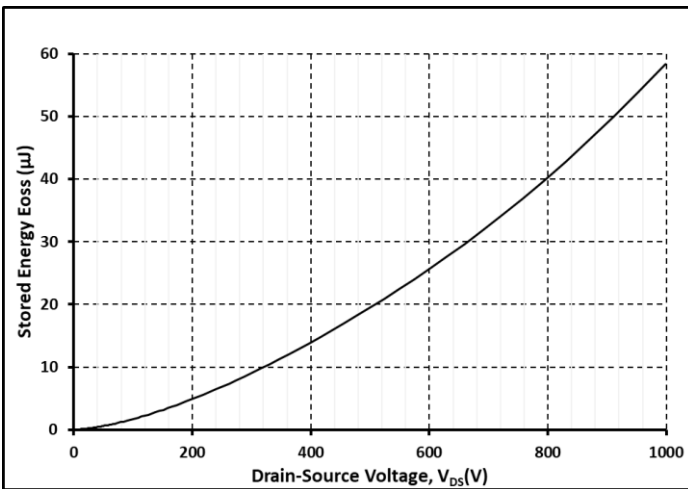


Fig. 17 Output Capacitor Stored Energy

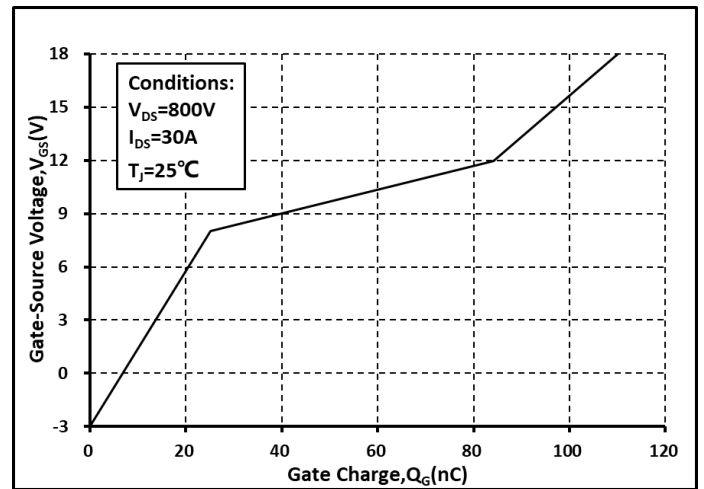


Fig. 18 Gate Charge Characteristics

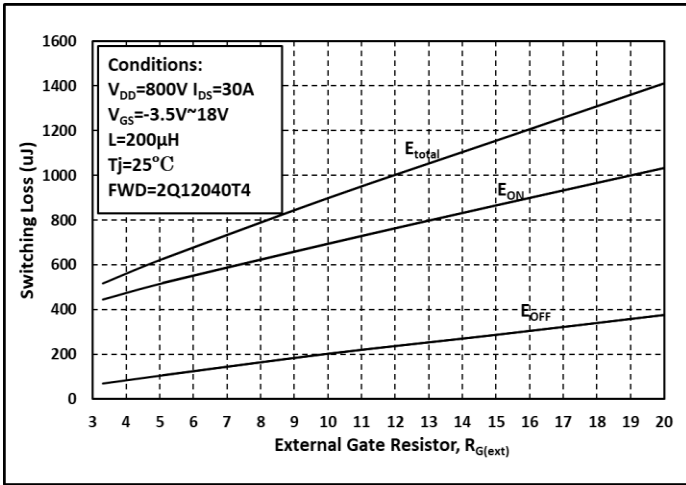


Fig. 19 Switching Energy vs.  $R_{G(ext)}$

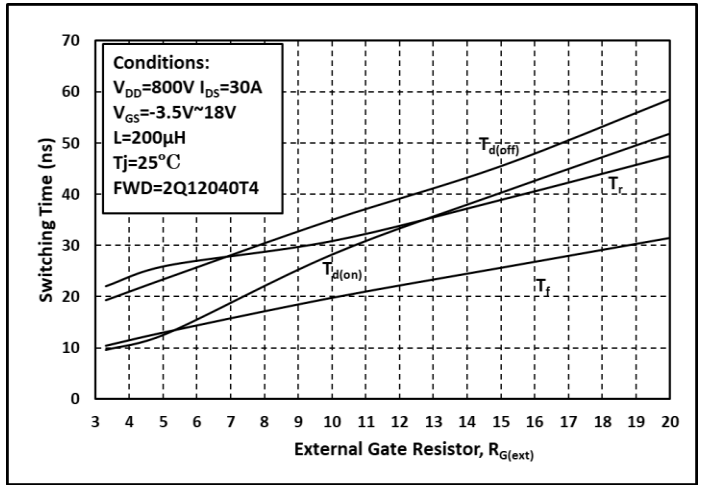


Fig. 20 Switching Times vs.  $R_{G(ext)}$

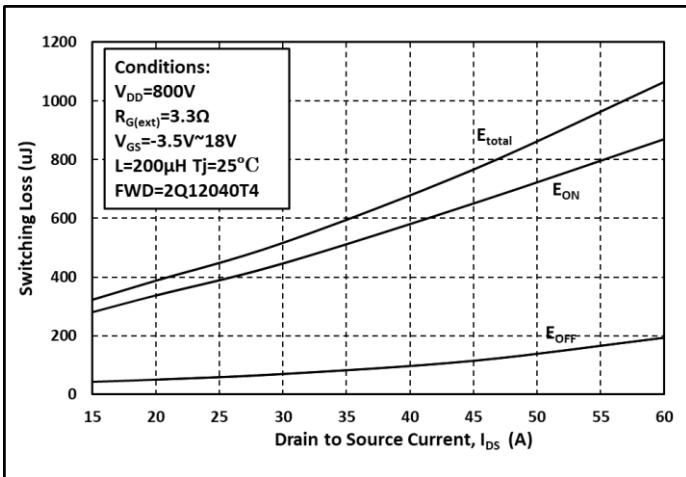


Fig. 21 Switching Energy vs.  $I_{DS}$

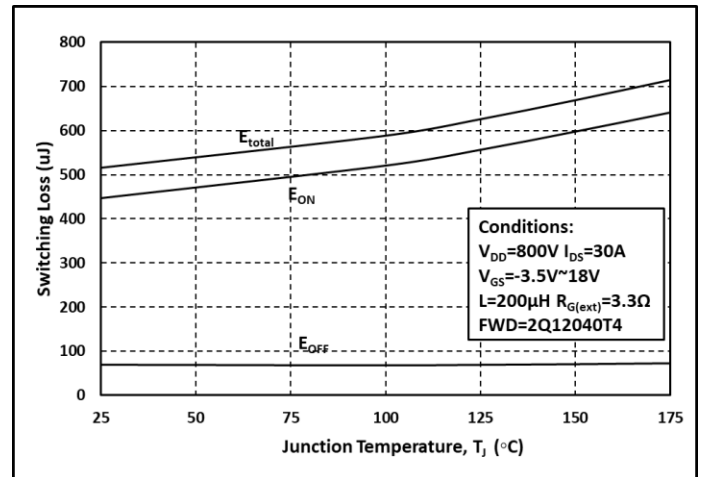


Fig. 22 Switching Energy vs. Temperature

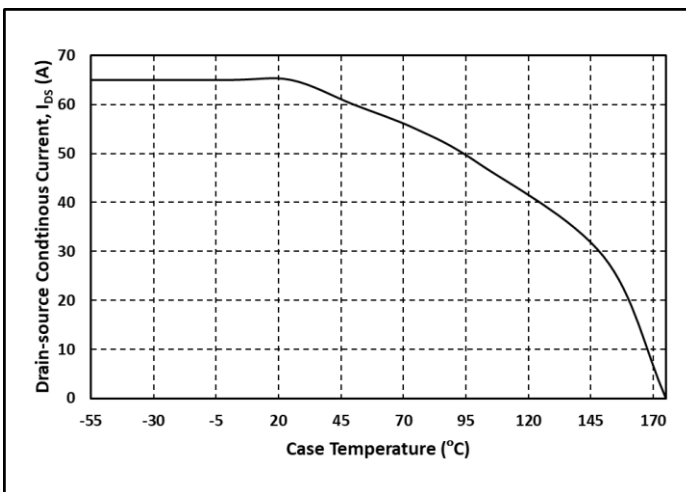


Fig. 23 Continuous Drain Current vs. Case Temperature

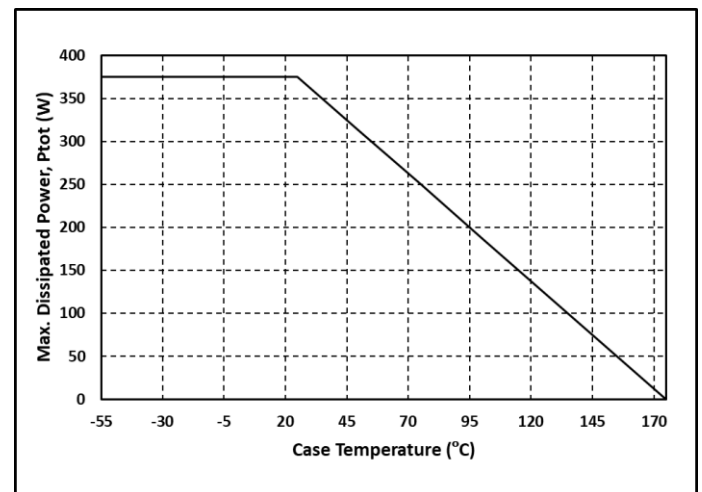


Fig. 24 Max. Power Dissipation Derating vs. Case Temperature

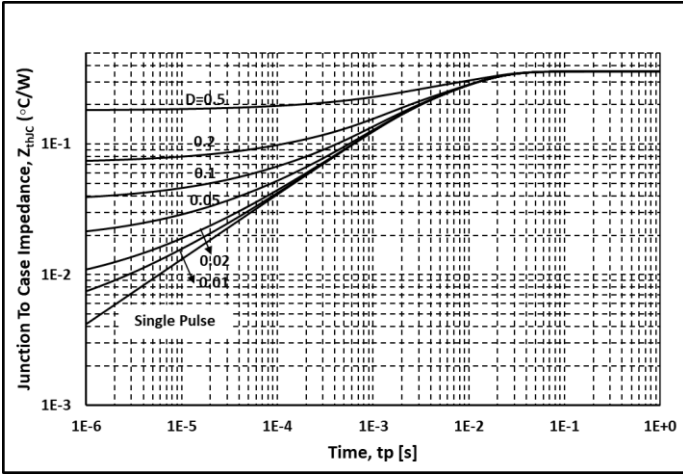


Fig. 25 Thermal impedance

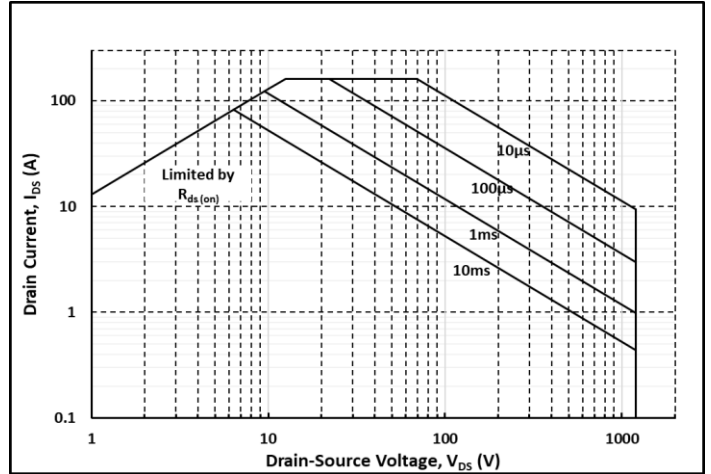
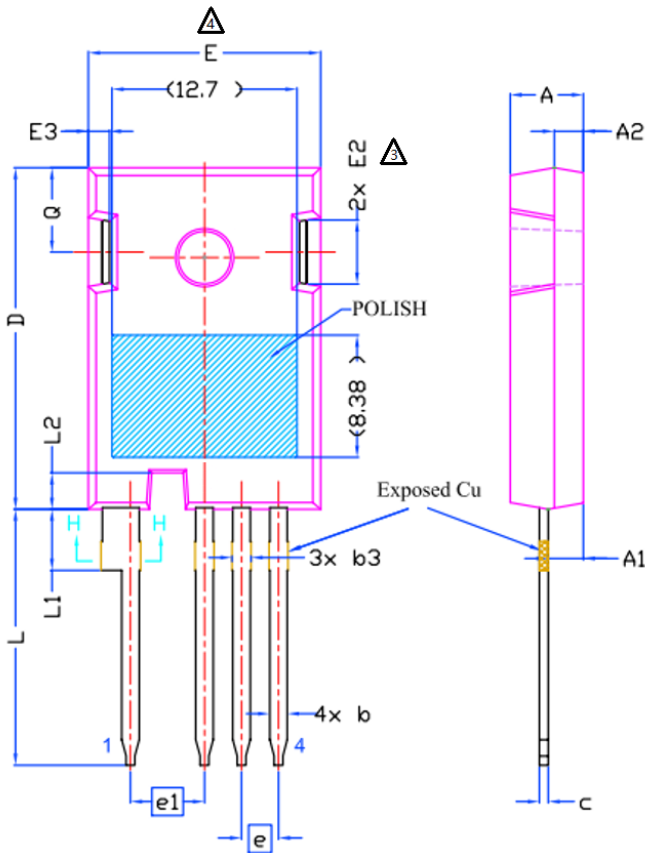


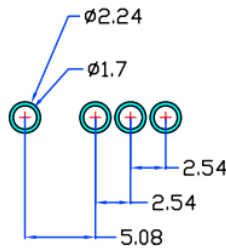
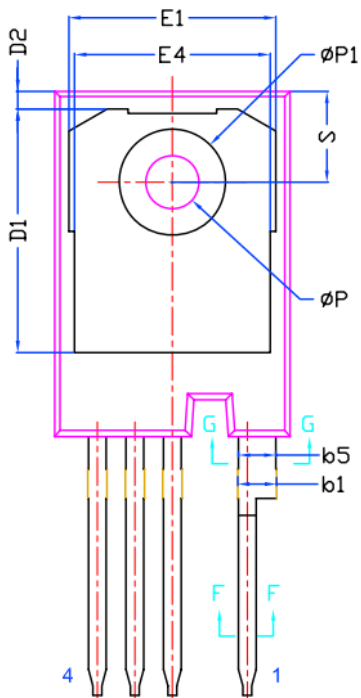
Fig. 26 Safe Operating Area



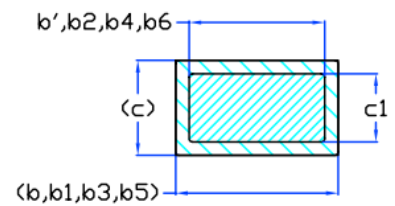
# Package Dimensions



Dimensions In Millimeters		
SYMBOL	MIN.	MAX.
A	4.83	5.21
A1	2.29	2.54
A2	1.91	2.16
b	1.07	1.33
b'	1.07	1.28
b1	2.39	2.94
b2	2.39	2.84
b3	1.07	1.60
b4	1.07	1.50
b5	2.39	2.69
b6	2.39	2.64
c	0.55	0.68
c1	0.55	0.65
D	23.30	23.60
D1	16.25	17.65
D2	0.95	1.25
E	15.75	16.13
E1	13.10	14.15
E2	3.68	5.10
E3	1.00	1.90
E4	12.38	13.43
e	2.54 BSC	
e1	5.08 BSC	
L	17.31	17.82
L1	3.97	4.37
L2	2.35	2.65
N	4	
φP	3.51	3.65
φP1	7.18 REF.	
Q	5.49	6
S	6.04	6.3



Recommended Solder Pad Layout



Section F--F, G--G, H--H

**Note:**

1. Package Reference: JEDEC TO247, Variation AD
2. All Dimensions are in mm
3. Slot Required, Notch May Be Rounded
4. Dimension D&E Do Not Include Mold Flash
5. Subject to Change Without Notice

## Notes

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