

# N1M120040PD3

## Silicon Carbide Power MOSFET

N-Channel Enhancement Mode

$V_{DS}$	1200V
$I_D @ 25^\circ\text{C}$	60A
$R_{DS(ON)}$	40m $\Omega$

### Features

- Low On-Resistance
- Low Capacitances
- Low Switching Losses
- Easy to Parallel and Simple to Drive

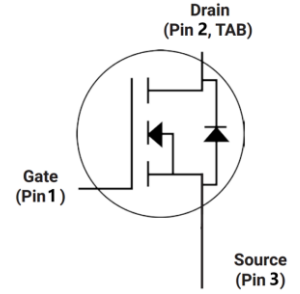
### Benefits

- Improved System Efficiency
- Reduced Cooling Requirements
- Increased Power Density
- Increased System Switching Frequency

### Applications

- Solar inverter
- EV charging station
- UPS
- Industrial power supply

### Package



Part Number	Package
N1M120040PD3	TO-247-3

### Maximum Ratings ( $T_C = 25^\circ\text{C}$ unless otherwise specified)

Symbol	Parameter	Value	Unit	Test Conditions	Note
$V_{DSmax}$	Drain - Source Voltage	1200	V	$V_{GS} = 0\text{ V}, I_D = 100\ \mu\text{A}$	
$V_{GSmax}$	Gate - Source Voltage	-10/+22	V	Absolute maximum values, DC	
$V_{GSop}$	Gate - Source Voltage	-5/+18	V	Recommended operational values	
$I_D$	Continuous Drain Current	60	A	$T_C = 25^\circ\text{C}$	Fig.13
		43	A	$T_C = 100^\circ\text{C}$	
$I_{D(pulse)}$	Pulsed Drain Current	160	A	Pulse width $t_p$ limited by $T_{jmax}$	Fig.20
$P_D$	Power Dissipation	319	W	$T_C=25^\circ\text{C}$	Fig.14
$T_J, T_{stg}$	Operating Junction and Storage Temperature	-55 to + 175	$^\circ\text{C}$		
$T_L$	Maximum Lead Temperature for Soldering, 1/8" from Case for 10 Seconds	260	$^\circ\text{C}$		

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

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	1200			V	$V_{GS}=0V, I_D=1mA$	
$V_{GS(th)}$	Gate Threshold Voltage	2.0	3.0	4.5	V	$V_{DS}=V_{GS}, I_D=10mA$	Fig.9
$I_{DSS}$	Zero Gate Voltage Drain Current		1	100	uA	$V_{DS}=1200V, V_{GS}=0V$	
			10			$V_{DS}=1200V, V_{GS}=0V, T_J=175^\circ\text{C}$	
$I_{GSS}$	Gate-Source Leakage Current			+100	nA	$V_{GS}=+22V, V_{DS}=0V$	
				-100		$V_{GS}=-10V, V_{DS}=0V$	
$R_{DS(on)}$	Drain-Source On-State Resistance		40	56	m $\Omega$	$V_{GS}=18V, I_D=30A$	Fig.4
			54			$V_{GS}=18V, I_D=30A, T_J=175^\circ\text{C}$	
$g_{fs}$	Transconductance		16.1		S	$V_{DS}=20V, I_{DS}=30A$	Fig.5
$C_{iss}$	Input Capacitance		1960		pF	$V_{GS}=0V, V_{DS}=800V, f=1MHz$	Fig.12
$C_{oss}$	Output Capacitance		125				
$C_{riss}$	Reverse Transfer Capacitance		5				
$E_{oss}$	Stored Energy in Output Capacitance		51				
$C_{o(er)}$	Energy Related Output Capacitance		159		pF	$V_{GS}=0V, V_{DS}=0V \text{ to } 800V$	
$C_{o(tr)}$	Time Related Output Capacitance		261				
$E_{on}$	Turn-On Switching Energy		644		$\mu J$	$V_{DS}=800V, V_{GS}= -5/18V, I_D=30A, R_{G(ext)}=2\Omega$	Fig.15, 16
$E_{off}$	Turn Off Switching Energy		137				
$t_{d(on)}$	Turn-On Delay Time		21		ns	$V_{DS}=800V, V_{GS}= -5/18V, I_D=30A, R_{G(ext)}=2\Omega$	
$t_r$	Rise Time		38				
$t_{d(off)}$	Turn-Off Delay Time		38				
$t_f$	Fall Time		10				
$R_{G(int)}$	Internal Gate Resistance		3.5		$\Omega$	$f = 1 \text{ MHz}, V_{AC} = 30 \text{ mV}$	
$Q_{gs}$	Gate to Source Charge		28		nC	$V_{DS}=800V, V_{GS}=-5/18V, I_D=30A$	Fig.10
$Q_{gd}$	Gate to Drain Charge		36				
$Q_g$	Total Gate Charge		108				

**Reverse Diode Characteristics**

Symbol	Parameter	Typ.	Max.	Unit	Test conditions	Note
$V_{SD}$	Diode Forward Voltage	4.1		V	$V_{GS}=-5V, I_{SD}=30A$	Fig.7
$I_S$	Continuous Diode Forward Current		60	A		
$I_{SM}$	Pulsed Diode Forward Current		160	A		
$t_{rr}$	Reverse Recovery Time	45		ns	$I_{SD}=30A, V_R=800V, dif/dt=1000A/us$	
$Q_{rr}$	Reverse Recovery Charge	206		nC		

**Thermal Characteristics**

Symbol	Parameter	Typ.	Unit	Test conditions	Note
$R_{\theta JC}$	Thermal Resistance from Junction to Case	0.47	$^\circ\text{C/W}$		Fig.19
$R_{\theta JA}$	Thermal Resistance from Junction to Ambient	40			

## Typical Performance

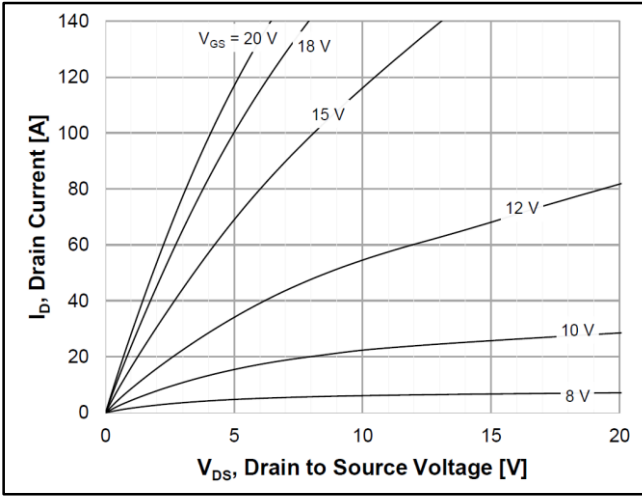


Figure 1. Output Characteristics  $T_J = -40\text{ }^\circ\text{C}$

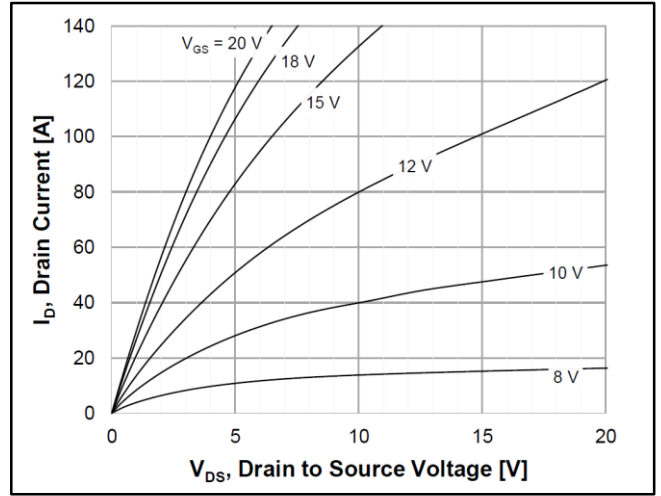


Figure 2. Output Characteristics  $T_J = 25\text{ }^\circ\text{C}$

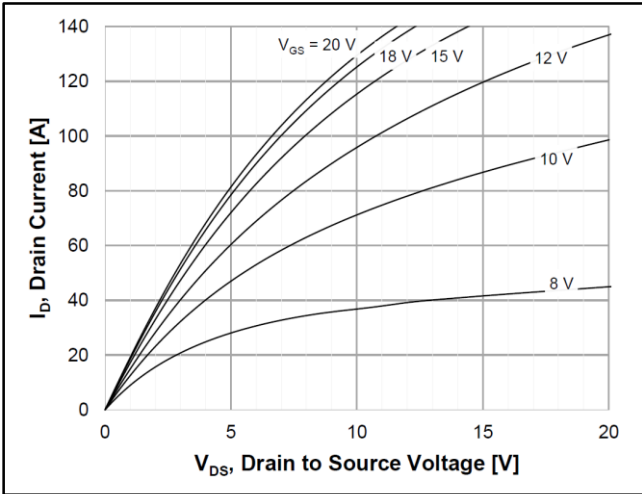


Figure 3. Output Characteristics  $T_J = 175\text{ }^\circ\text{C}$

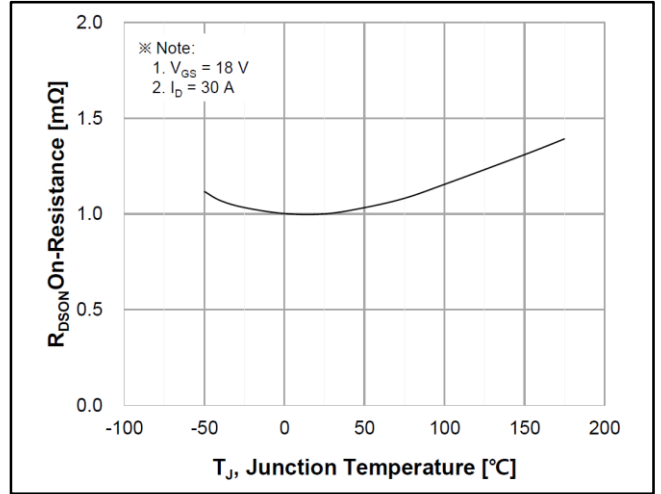


Figure 4. Normalized On-Resistance vs. Temperature

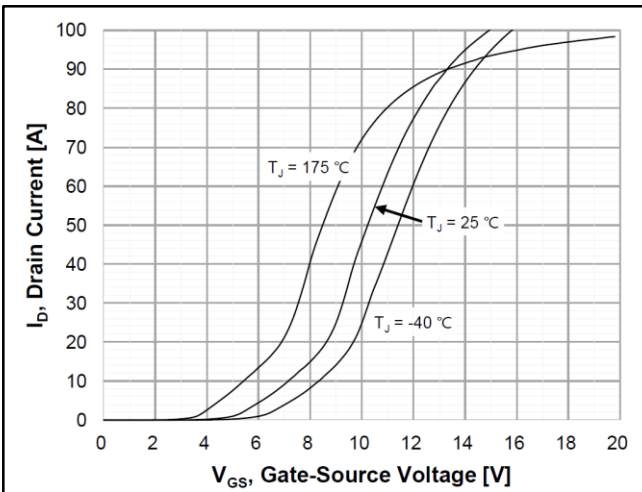


Figure 5. Transfer Characteristics for Various Junction Temperatures

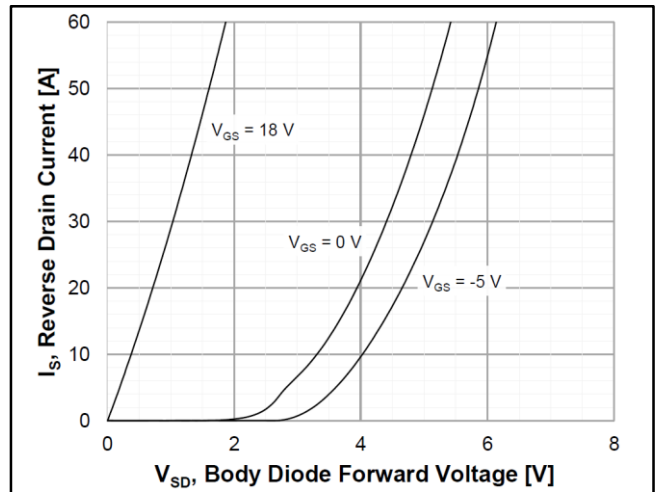


Figure 6. Body Diode Characteristics at  $-40\text{ }^\circ\text{C}$

## Typical Performance

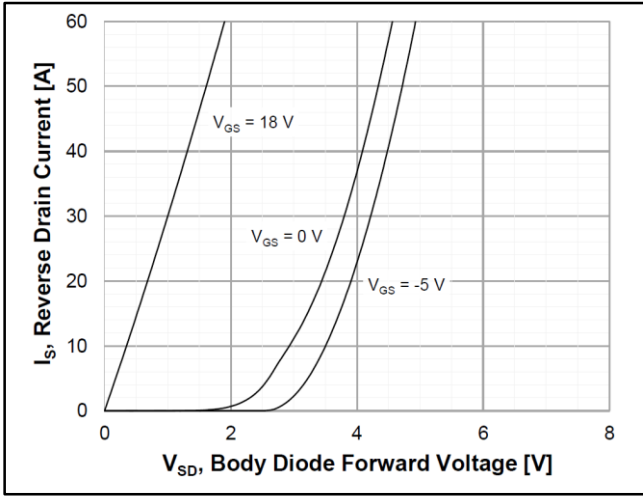


Figure 7. Body Diode Characteristics at 25 °C

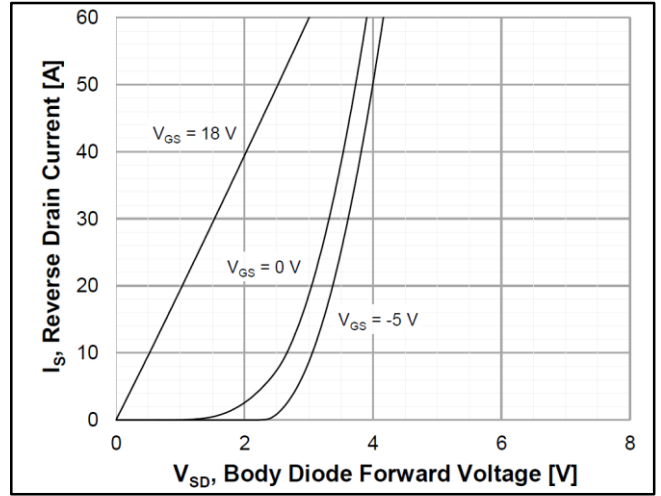


Figure 8. Body Diode Characteristics at 175 °C

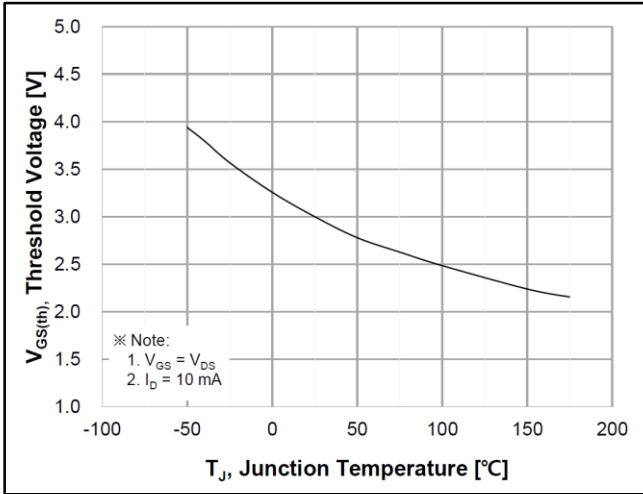


Figure 9. Threshold Voltage vs. Temperature

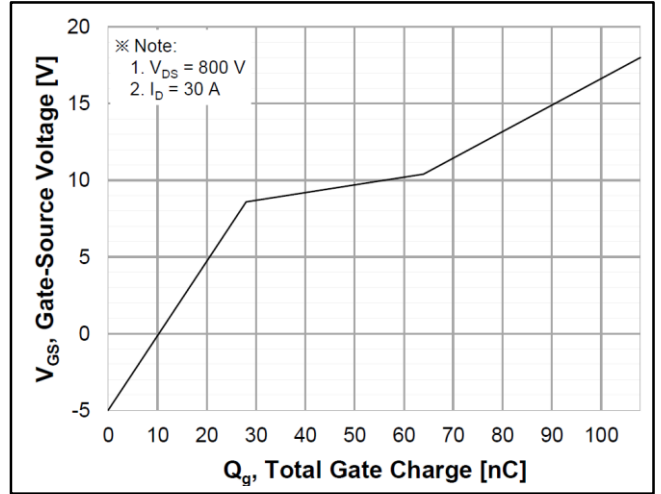


Figure 10. Gate Charge Characteristics

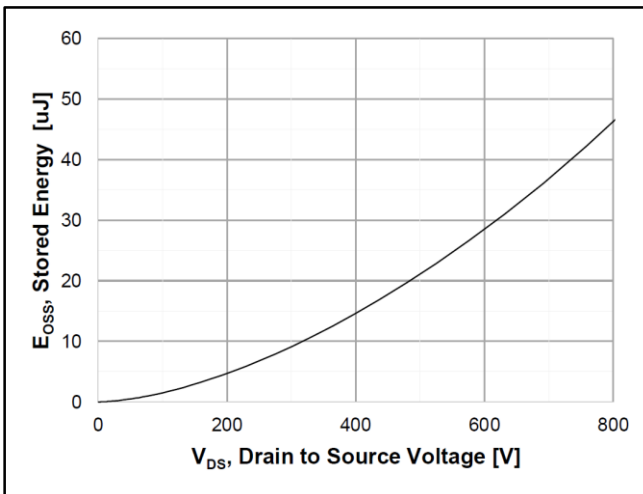


Figure 11. Output Capacitor Stored Energy

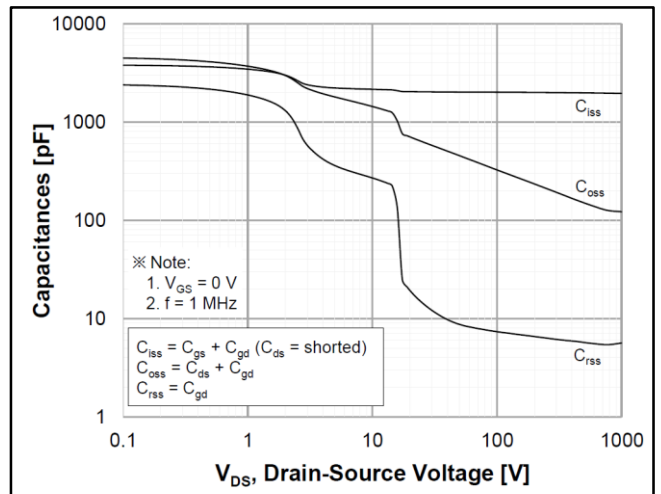
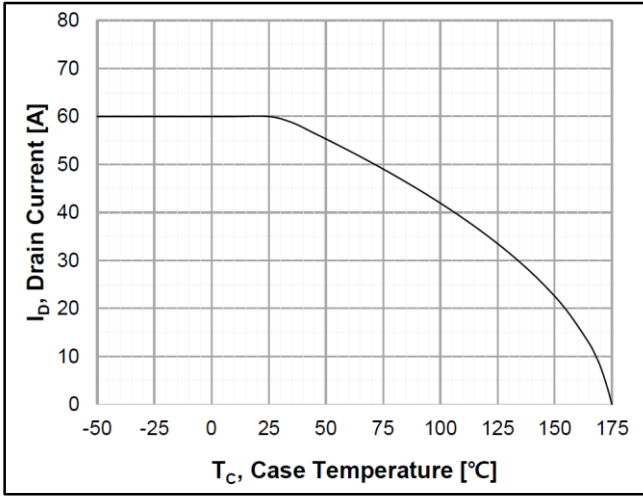
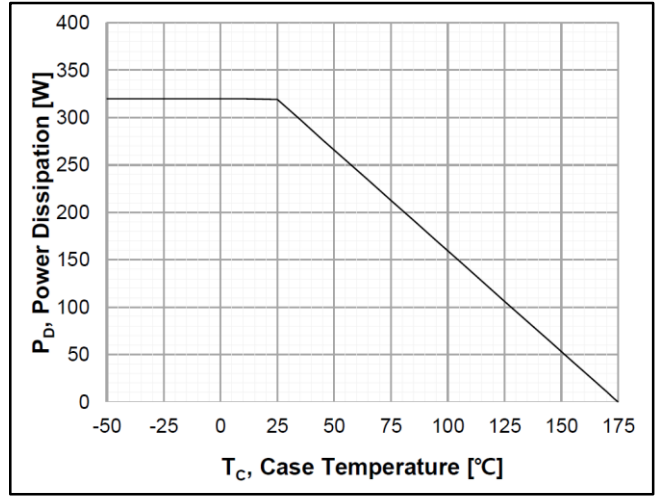


Figure 12. Capacitances vs. Drain-Source Voltage (0 - 1000V)

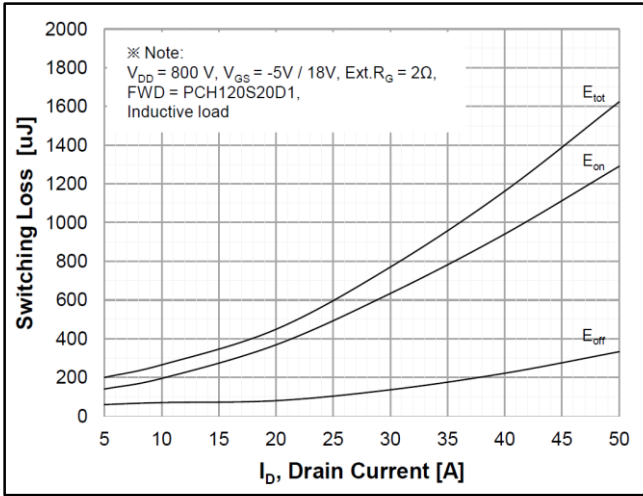
## Typical Performance



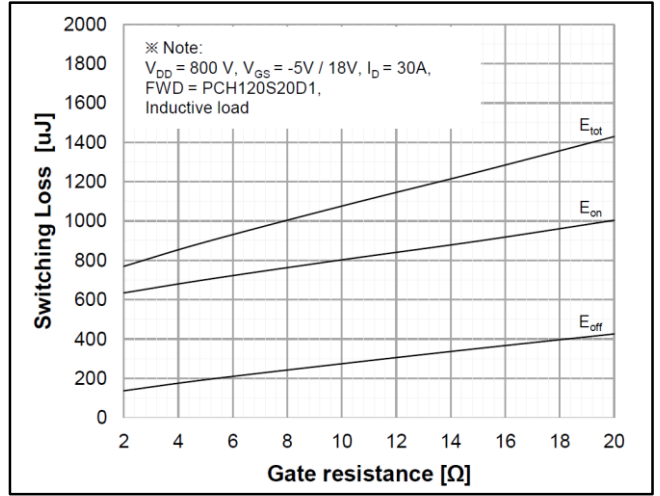
**Figure 13. Continuous Drain Current Derating vs. Case Temperature**



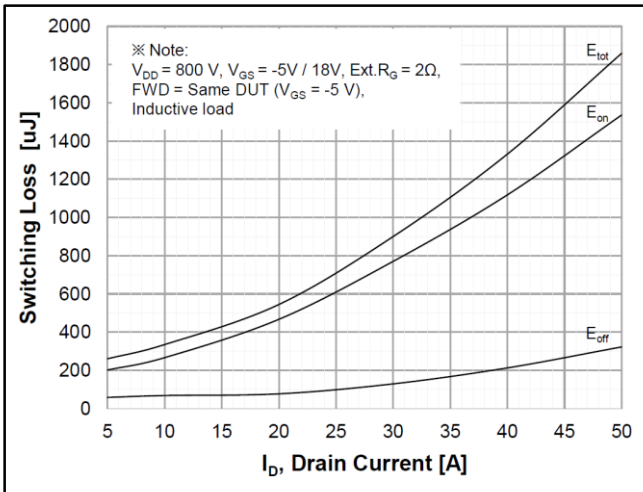
**Figure 14. Maximum Power Dissipation Derating vs. Case Temperature**



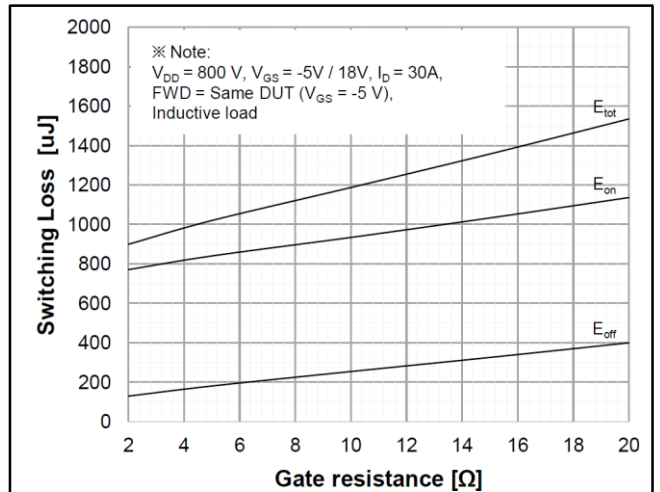
**Figure 15. Switching Losses vs. Drain Current**



**Figure 16. Switching Losses vs. Gate Resistance**

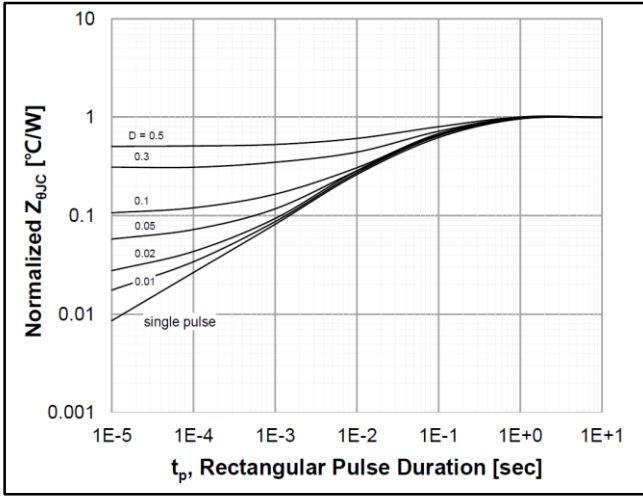


**Figure 17. Switching Losses vs. Drain Current**

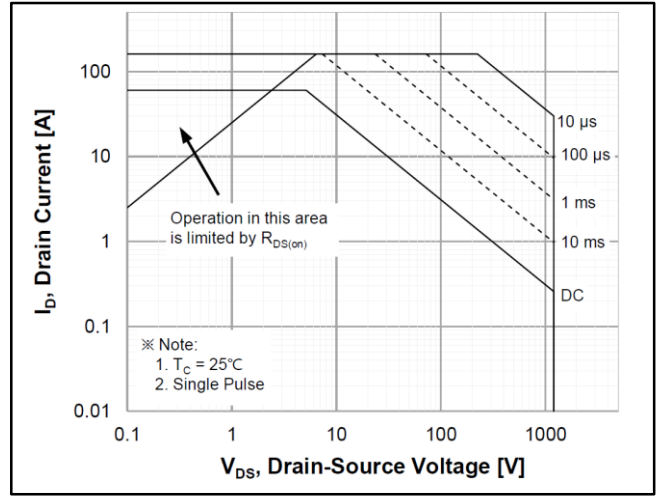


**Figure 18. Switching Losses vs. Gate Resistance**

## Typical Performance

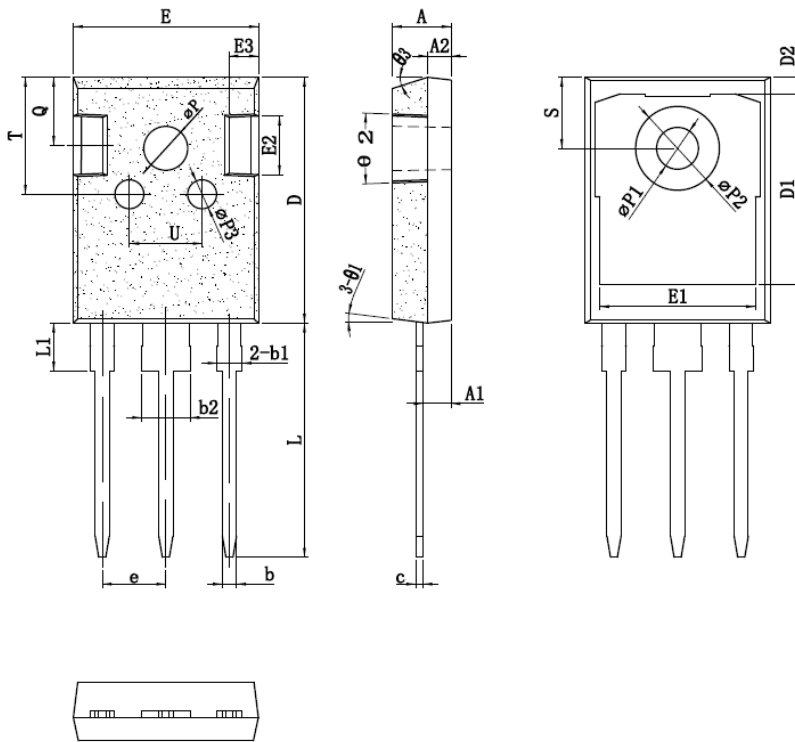


**Figure 19. Transient Thermal Impedance (Junction - Case)**



**Figure 20. Safe Operating Area**

## Package TO-247-3



SYMBOL	mm		
	MIN	NOM	MAX
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.15	1.20	1.25
b1	1.95	2.10	2.25
b2	2.95	3.10	3.25
c	0.55	0.60	0.65
D	20.90	21.00	21.10
D1	16.35	16.55	16.75
D2	1.05	1.20	1.35
E	15.70	15.80	15.90
E1	13.10	13.25	13.40
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	5.40	5.44	5.48
L	19.80	19.98	20.15
L1	—	—	4.30
$\phi P$	3.60	3.70	3.80
$\phi P1$	3.45	3.55	3.65
$\phi P2$	7.03	7.18	7.33
$\phi P3$	2.40	2.50	2.60
Q	5.60	5.80	6.00
S	6.05	6.15	6.25
T	9.80	10.00	10.20
U	6.00	6.20	6.40
$\theta 1$	5°	7°	9°
$\theta 2$	1°	3°	5°
$\theta 3$	13°	15°	17°