

# Silicon Carbide (SiC) MOSFET – 22 mohm, 1200 V, M3, D<sup>2</sup>PAK-7L

## NTBG022N120M3S

### Features

- Typ.  $R_{DS(on)} = 22\text{ m}\Omega$
- Low switching losses (Typ. EON 485  $\mu\text{J}$  at 40 A, 800 V)
- 100% Avalanche Tested
- These Devices are RoHS Compliant

### Typical Applications

- Solar Inverters
- Electric Vehicle Charging Stations
- Uninterruptible Power Supplies (UPS)
- Energy Storage Systems
- Switch Mode Power Supplies (SMPS)

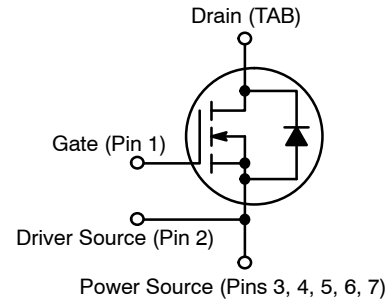
### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Parameter		Symbol	Value	Unit
Drain-to-Source Voltage		$V_{DSS}$	1200	V
Gate-to-Source Voltage		$V_{GS}$	-10/+22	V
Recommended Operation Values of Gate-to-Source Voltage		$T_C < 175^\circ\text{C}$	$V_{GSop}$	-3/+18 V
Continuous Drain Current (Note 2)	Steady State	$T_C = 25^\circ\text{C}$	$I_D$	58 A
			$P_D$	234 W
Power Dissipation $R_{\theta JC}$ (Note 2)	Steady State	$T_C = 100^\circ\text{C}$	$I_D$	41 A
			$P_D$	117 W
Continuous Drain Current $R_{\theta JC}$ (Note 2)		$T_C = 25^\circ\text{C}$	$I_{DM}$	159 A
Power Dissipation $R_{\theta JC}$ (Notes 1, 2)			$T_J, T_{stg}$	-55 to +175
Pulsed Drain Current (Note 3)		$I_S$	53	A
Operating Junction and Storage Temperature Range		$E_{AS}$	267	mJ
Source Current (Body Diode) $T_C = 25^\circ\text{C}, V_{GS} = -3\text{ V}$		$T_L$	245	$^\circ\text{C}$
Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 23.1\text{ A}, L = 1\text{ mH}$ ) (Notes 4, 5)				
Maximum Lead Temperature for Soldering (1/8" from case for 10 seconds)				

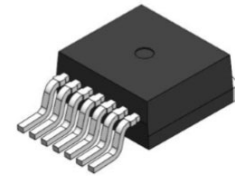
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Surface mounted on a FR-4 board using 1 in<sup>2</sup> pad of 2 oz copper.
2. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.
3. Repetitive rating, limited by max junction temperature.
4. Peak current might be limited by transconductance
5.  $E_{AS}$  of 264 mJ is based on starting  $T_J = 25^\circ\text{C}$ ;  $L = 1\text{ mH}$ ,  $I_{AS} = 23.1\text{ A}$ ,  $V_{DD} = 100\text{ V}$ ,  $V_{GS} = 18\text{ V}$ .

$V_{(BR)DSS}$	$R_{DS(ON)}\text{ MAX}$	$I_D\text{ MAX}$
1200 V	30 m $\Omega$ @ 18 V	58 A

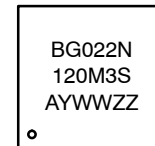


N-CHANNEL MOSFET



D2PAK-7L  
CASE 418BJ

### MARKING DIAGRAM



BG022N120M3S = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
ZZ = Lot Traceability

### ORDERING INFORMATION

Device	Package	Shipping
NTBG022N120M3S	D2PAK-7L	800 / Tape & Reel

# NTBG022N120M3S

## THERMAL CHARACTERISTICS

Parameter	Symbol	Typ	Max	Unit
Junction-to-Case – Steady State	$R_{\theta JC}$	0.64	–	°C/W
Junction-to-Ambient – Steady State	$R_{\theta JA}$	–	40	

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
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### OFF-STATE CHARACTERISTICS

Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	1200	–	–	V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	$I_D = 1\text{ mA}$ , referenced to $25^\circ\text{C}$	–	0.3	–	V/°C
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}$ $T_J = 25^\circ\text{C}$	–	–	100	$\mu\text{A}$
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{GS} = +22/-10\text{ V}, V_{DS} = 0\text{ V}$	–	–	$\pm 1$	$\mu\text{A}$

### ON-STATE CHARACTERISTICS (Note 6)

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 20\text{ mA}$	2.04	2.72	4.4	V
Recommended Gate Voltage	$V_{GOP}$		–3	–	+18	V
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 18\text{ V}, I_D = 40\text{ A}, T_J = 25^\circ\text{C}$	–	22	30	$\text{m}\Omega$
		$V_{GS} = 18\text{ V}, I_D = 40\text{ A}, T_J = 175^\circ\text{C}$	–	47	–	
Forward Transconductance	$g_{FS}$	$V_{DS} = 10\text{ V}, I_D = 40\text{ A}$	–	34	–	S

### CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$	–	3200	–	$\text{pF}$
Output Capacitance	$C_{OSS}$		–	148	–	
Reverse Transfer Capacitance	$C_{RSS}$		–	14	–	
Threshold Gate Charge	$Q_{G(TH)}$	$V_{GS} = -3/18\text{ V}, V_{DS} = 800\text{ V}, I_D = 40\text{ A}$	–	20	–	$\text{nC}$
Total Gate Charge	$Q_{G(TOT)}$		–	148	–	
Gate-to-Source Charge	$Q_{GS}$		–	35	–	
Gate-to-Drain Charge	$Q_{GD}$		–	38	–	
Gate-Resistance	$R_G$		$f = 1\text{ MHz}$	–	1.5	

### SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = -3/18\text{ V}, V_{DS} = 800\text{ V}, I_D = 40\text{ A}, R_G = 4.5\ \Omega$ inductive load (Note 6)	–	18	–	$\text{ns}$
Rise Time	$t_r$		–	24	–	
Turn-Off Delay Time	$t_{d(OFF)}$		–	47	–	
Fall Time	$t_f$		–	14	–	
Turn-On Switching Loss	$E_{ON}$		–	485	–	$\mu\text{J}$
Turn-Off Switching Loss	$E_{OFF}$		–	220	–	
Total Switching Loss	$E_{tot}$		–	705	–	

### SOURCE-DRAIN DIODE CHARACTERISTICS

Continuous Source-Drain Diode Forward Current	$I_{SD}$	$V_{GS} = -3\text{ V}, T_C = 25^\circ\text{C}$	–	–	53	A
Pulsed Source-Drain Diode Forward Current (Note 6)	$I_{SDM}$		–	–	159	
Forward Diode Voltage	$V_{SD}$	$V_{GS} = -3\text{ V}, I_{SD} = 40\text{ A}, T_J = 25^\circ\text{C}$	–	4.5	–	V

# NTBG022N120M3S

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise specified) (continued)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
<b>SOURCE-DRAIN DIODE CHARACTERISTICS</b>						
Reverse Recovery Time	$t_{RR}$	$V_{GS} = -3/18\text{ V}$ , $I_{SD} = 40\text{ A}$ , $di_S/dt = 1000\text{ A}/\mu\text{s}$ , $V_{DS} = 800\text{ V}$	-	23	-	ns
Reverse Recovery Charge	$Q_{RR}$		-	146	-	nC
Reverse Recovery Energy	$E_{REC}$		-	5	-	$\mu\text{J}$
Peak Reverse Recovery Current	$I_{RRM}$		-	13	-	A
Charge time	$t_A$		-	13	-	ns
Discharge time	$t_B$		-	10	-	ns

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

6.  $E_{ON}/E_{OFF}$  result is with body diode

TYPICAL CHARACTERISTICS

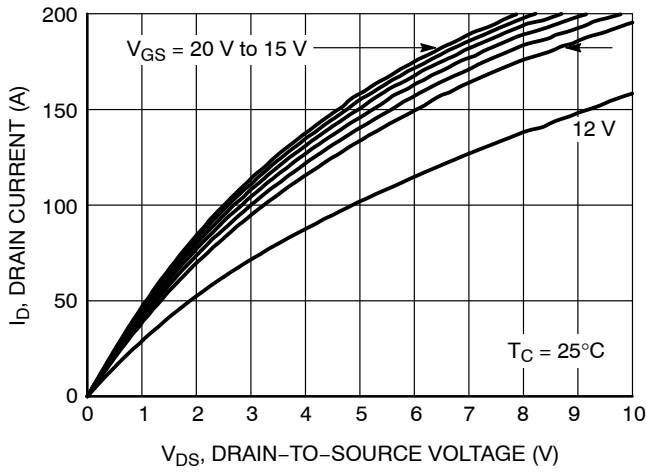


Figure 1. On-Region Characteristics

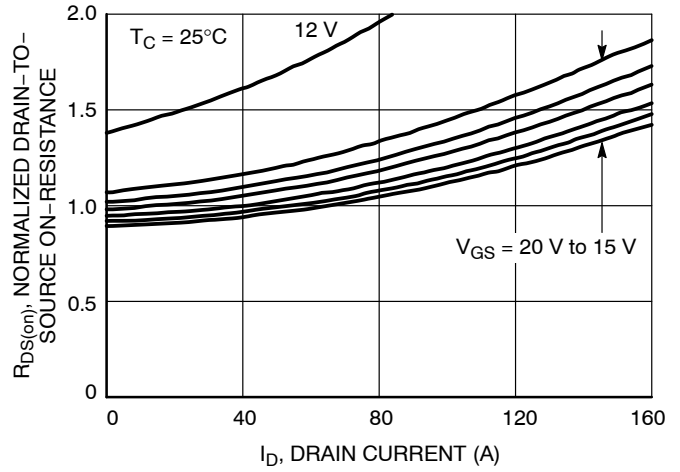


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

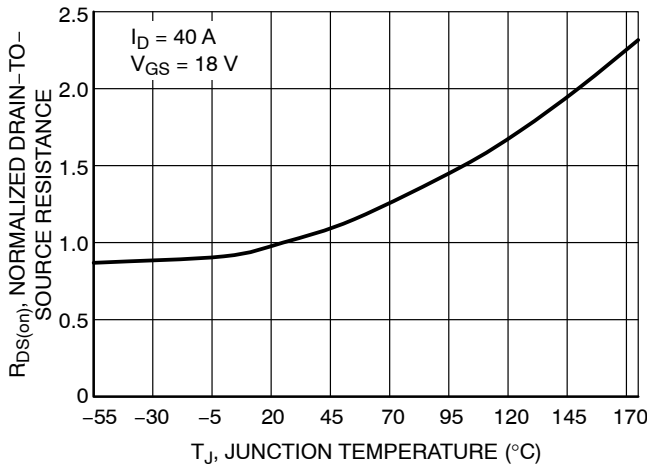


Figure 3. On-Resistance Variation with Temperature

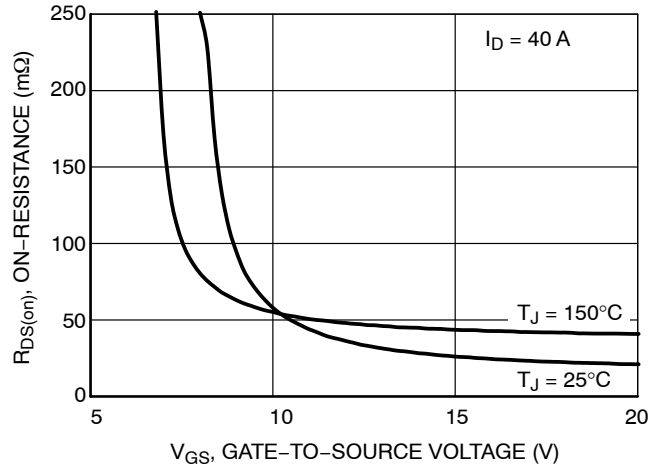


Figure 4. On-Resistance vs. Gate-to-Source Voltage

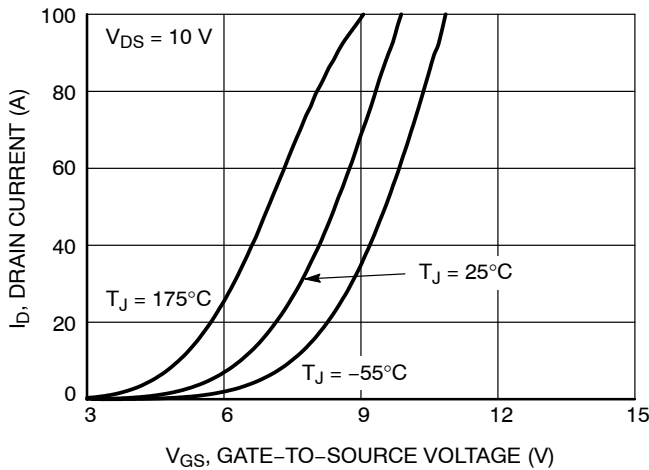


Figure 5. Transfer Characteristics

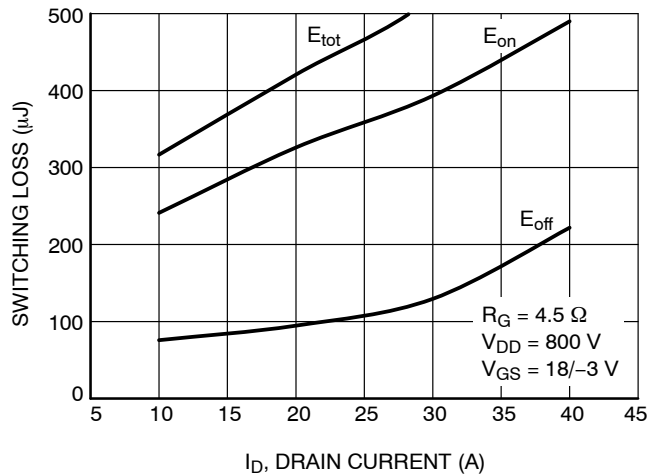


Figure 6. Switching Loss vs. Drain Current

# NTBG022N120M3S

## TYPICAL CHARACTERISTICS

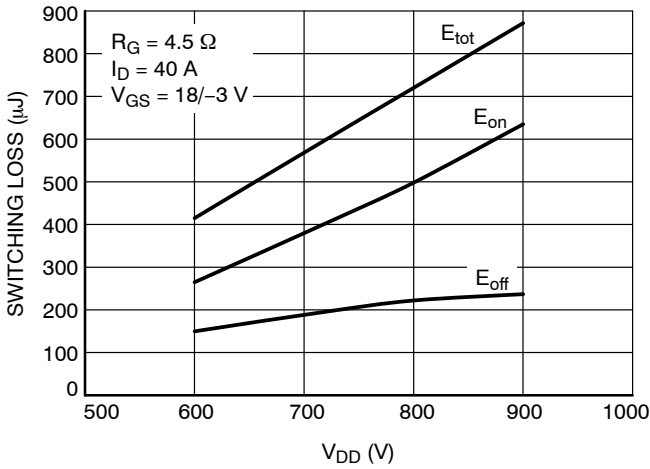


Figure 7. Switching Loss vs. Drain Voltage

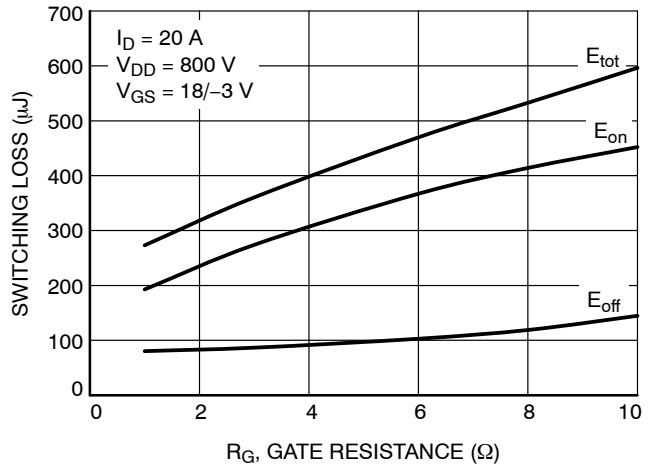


Figure 8. Switching Loss vs. Gate Resistance

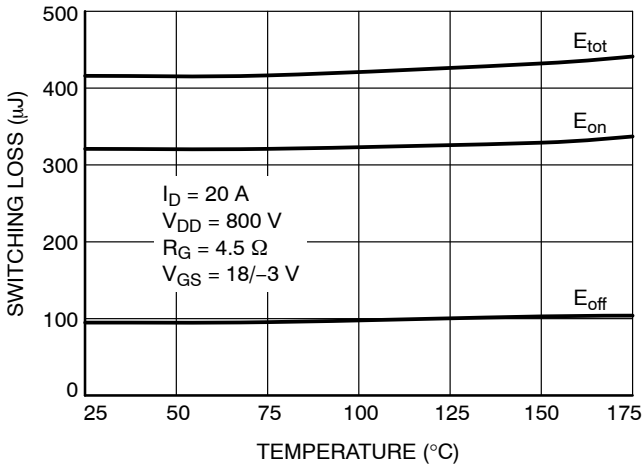


Figure 9. Switching Loss vs. Temperature

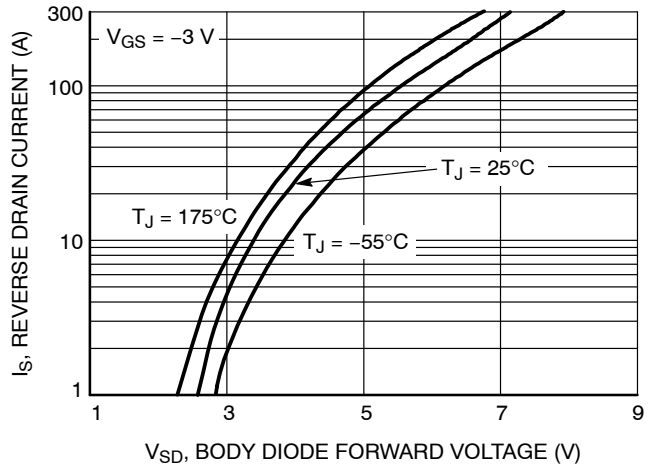
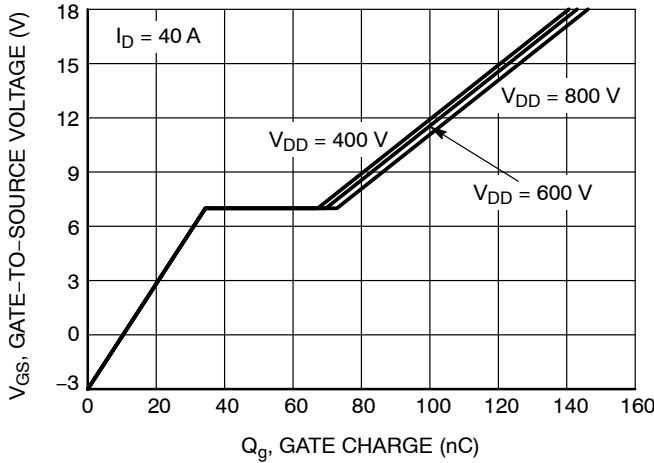


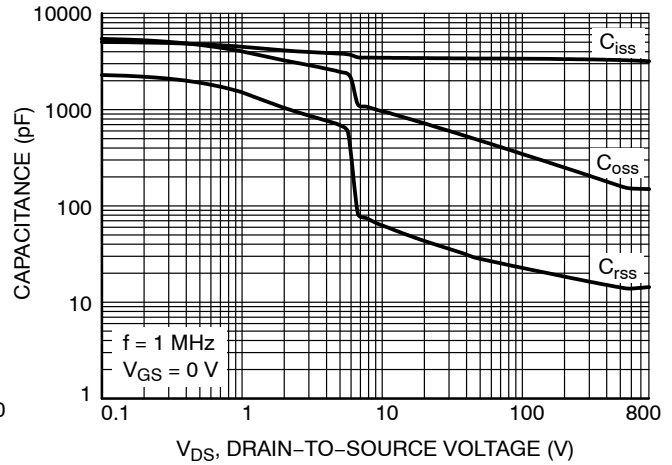
Figure 10. Diode Forward Voltage vs. Current

# NTBG022N120M3S

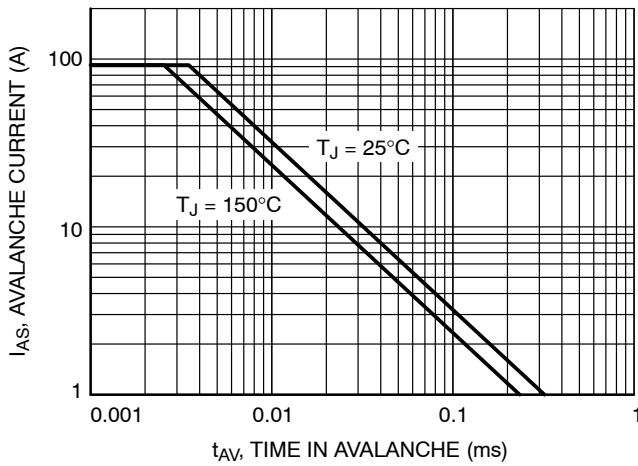
## TYPICAL CHARACTERISTICS



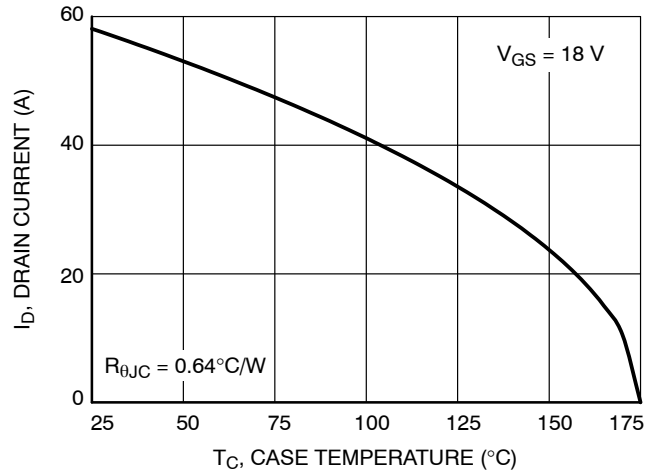
**Figure 11. Gate-to-Source Voltage vs. Total Charge**



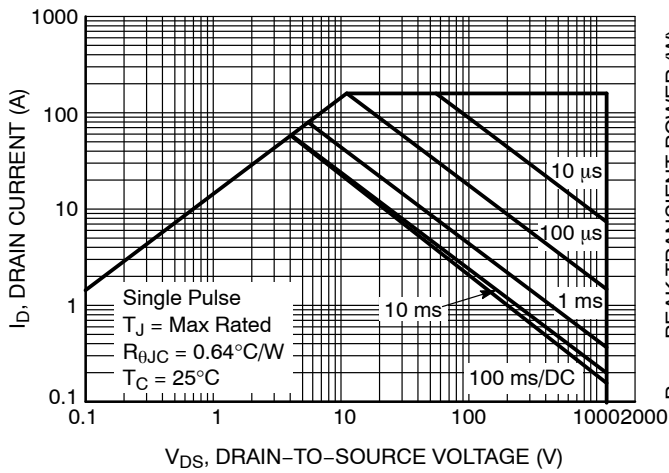
**Figure 12. Capacitance vs. Drain-to-Source Voltage**



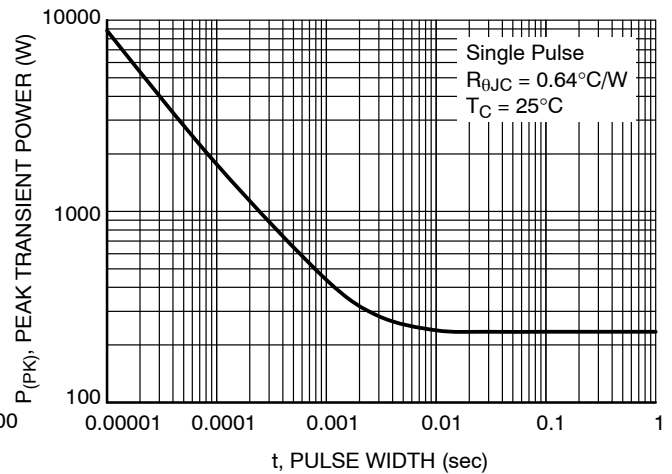
**Figure 13. Unclamped Inductive Switching Capability**



**Figure 14. Maximum Continuous Drain Current vs. Case Temperature**



**Figure 15. Safe Operating Area**



**Figure 16. Single Pulse Maximum Power Dissipation**

# NTBG022N120M3S

## TYPICAL CHARACTERISTICS

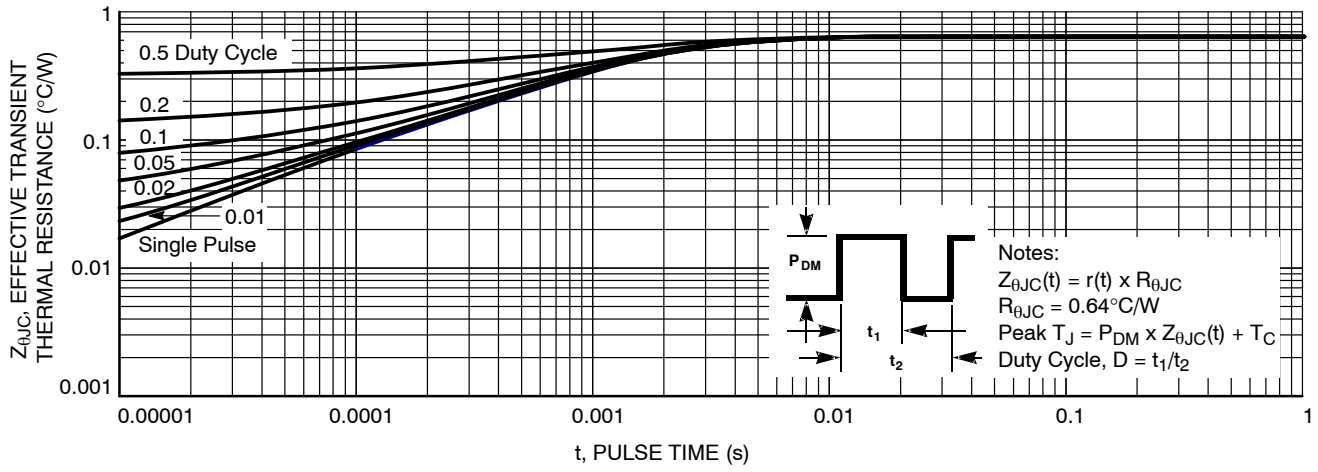


Figure 17. Junction-to-Case Transient Thermal Response

# MECHANICAL CASE OUTLINE

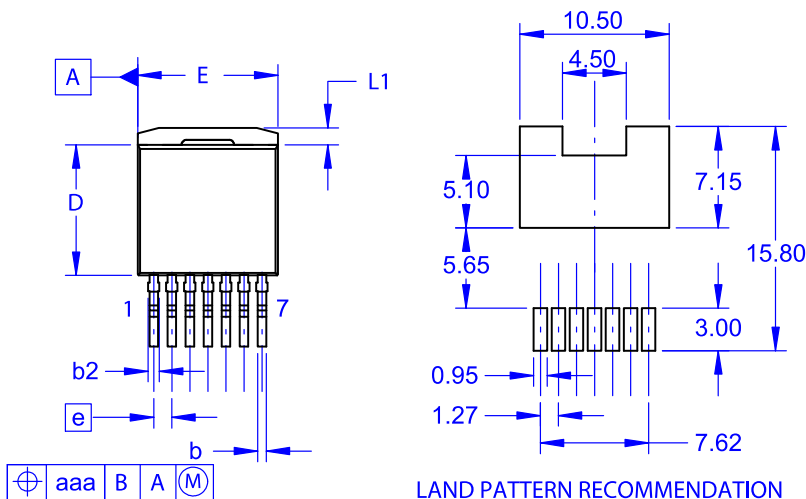
## PACKAGE DIMENSIONS

ON Semiconductor®



### D<sup>2</sup>PAK7 (TO-263-7L HV) CASE 418BJ ISSUE B

DATE 16 AUG 2019



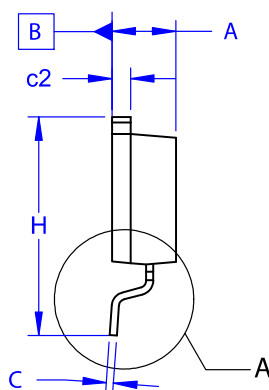
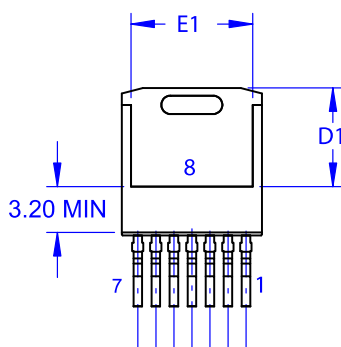
NOTES:

A. PACKAGE CONFORMS TO JEDEC TO-263 VARIATION CB EXCEPT WHERE NOTED.  
B. ALL DIMENSIONS ARE IN MILLIMETERS.

$\triangle$  OUT OF JEDEC STANDARD VALUE.  
D. DIMENSION AND TOLERANCE AS PER ASME Y14.5-2009.

E. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.30	4.50	4.70
A1	0.00	0.10	0.20
b2	0.60	0.70	0.80
b	0.51	0.60	0.70
c	0.40	0.50	0.60
c2	1.20	1.30	1.40
D	9.00	9.20	9.40
D1	6.15	6.80	7.15
E	9.70	9.90	10.20
E1	7.15	7.65	8.15
e	~	1.27	~
H	15.10	15.40	15.70
L	2.44	2.64	2.84
L1	1.00	1.20	1.40
L3	~	0.25	~
aaa	~	~	0.25

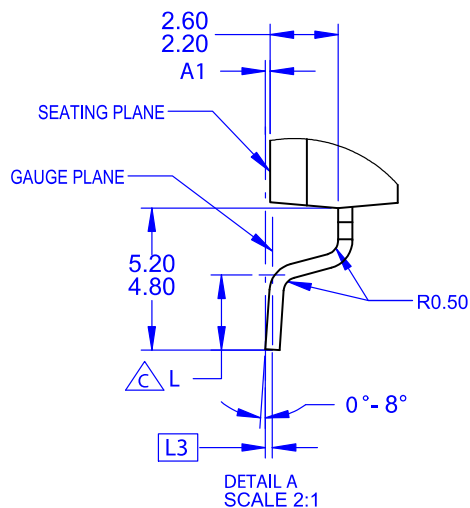


#### GENERIC MARKING DIAGRAM\*



XXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.



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