

# Silicon Carbide (SiC) MOSFET – 22 mohm, 1200 V, M3, TO-247-3L NTHL022N120M3S

**Features**

- Typ.  $R_{DS(on)} = 22\text{ m}\Omega @ V_{GS} = 18\text{ V}$
- Ultra Low Gate Charge ( $Q_{G(tot)} = 139\text{ nC}$ )
- Low Effective Output Capacitance ( $C_{oss} = 141\text{ pF}$ )
- 100% Avalanche Tested
- This Device is Halide Free and RoHS Compliant with Exemption 7a, Pb-Free 2LI (on second level interconnection)

**Typical Applications**

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

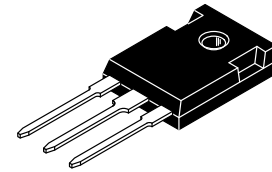
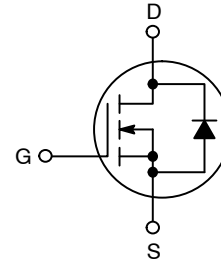
**MAXIMUM RATINGS** ( $T_J = 25^\circ\text{C}$  unless otherwise noted)

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 1)	Steady State	$T_C = 25^\circ\text{C}$	$I_D$	68	A
			$P_D$	352	W
Continuous Drain Current (Note 1)	Steady State	$T_C = 100^\circ\text{C}$	$I_D$	48	A
			$P_D$	176	W
Pulsed Drain Current (Note 2)	$T_C = 25^\circ\text{C}$		$I_{DM}$	252	A
Operating Junction and Storage Temperature Range		$T_J, T_{stg}$	-55 to +175	$^\circ\text{C}$	
Source Current (Body Diode) $T_C = 25^\circ\text{C}$ $V_{GS} = -3\text{ V}$		$I_S$	72	A	
Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 23.1\text{ A}$ , $L = 1\text{ mH}$ ) (Note 3)		$E_{AS}$	267	mJ	
Maximum Lead Temperature for Soldering (1/8" from case for 5 s)		$T_L$	260	$^\circ\text{C}$	

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. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.
2. Repetitive rating, limited by max junction temperature.
3.  $E_{AS}$  of 267 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	68 A

**N-CHANNEL MOSFET**

**TO-247-3LD  
CASE 340CX**
**MARKING DIAGRAM**


HL022N120M3S = Specific Device Code  
 A = Assembly Location  
 Y = Year  
 WW = Work Week  
 ZZ = Lot Traceability

**ORDERING INFORMATION**

Device	Package	Shipping
NTHL022N120M3S	TO247-3L	30 Units / Tube

# NTHL022N120M3S

## THERMAL CHARACTERISTICS

Parameter	Symbol	Max	Unit
Junction-to-Case – Steady State (Note 1)	$R_{\theta JC}$	0.43	°C/W
Junction-to-Ambient – Steady State (Note 1)	$R_{\theta JA}$	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 2)

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	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$	-	3130	-	$\text{pF}$
Output Capacitance	$C_{OSS}$		-	141	-	
Reverse Transfer Capacitance	$C_{RSS}$		-	12	-	
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = -3/18\text{ V}, V_{DS} = 800\text{ V}, I_D = 40\text{ A}$	-	139	-	$\text{nC}$
Threshold Gate Charge	$Q_{G(TH)}$		-	20	-	
Gate-to-Source Charge	$Q_{GS}$		-	24	-	
Gate-to-Drain Charge	$Q_{GD}$		-	39	-	
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 4)	-	19	-	ns
Rise Time	$t_r$		-	50	-	
Turn-Off Delay Time	$t_{d(OFF)}$		-	44	-	
Fall Time	$t_f$		-	14	-	
Turn-On Switching Loss	$E_{ON}$		-	1212	-	$\mu\text{J}$
Turn-Off Switching Loss	$E_{OFF}$		-	307	-	
Total Switching Loss	$E_{tot}$		-	1519	-	

### SOURCE-DRAIN DIODE CHARACTERISTICS

Continuous Source-Drain Diode Forward Current	$I_{SD}$	$V_{GS} = -3\text{ V}, T_C = 25^\circ\text{C}$	-	-	72	A
Pulsed Source-Drain Diode Forward Current (Note 2)	$I_{SDM}$		-	-	252	
Forward Diode Voltage	$V_{SD}$	$V_{GS} = -3\text{ V}, I_{SD} = 40\text{ A}, T_J = 25^\circ\text{C}$	-	4.5	-	V

# NTHL022N120M3S

## 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	$t_{RR}$	$V_{GS} = -3/18\text{ V}, I_{SD} = 40\text{ A},$ $di_S/dt = 1000\text{ A}/\mu\text{s}, V_{DS} = 800\text{ V}$	-	24	-	ns
Reverse Recovery Charge	$Q_{RR}$		-	150	-	nC
Reverse Recovery Energy	$E_{REC}$		-	14	-	$\mu\text{J}$
Peak Reverse Recovery Current	$I_{RRM}$		-	12	-	A
Charge time	$t_A$		-	14	-	ns
Discharge time	$t_B$		-	11	-	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.

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

TYPICAL CHARACTERISTICS

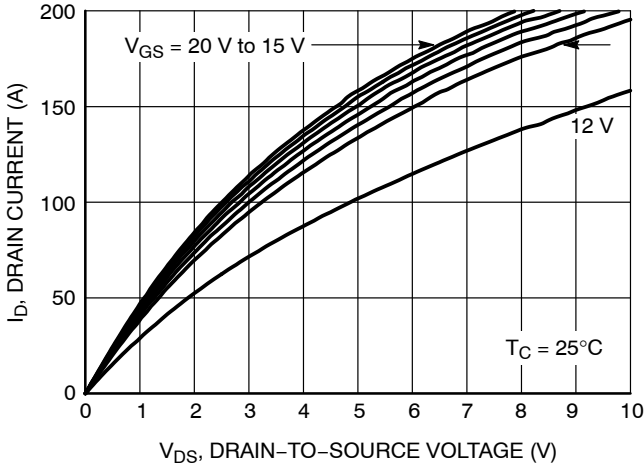


Figure 1. On-Region Characteristics

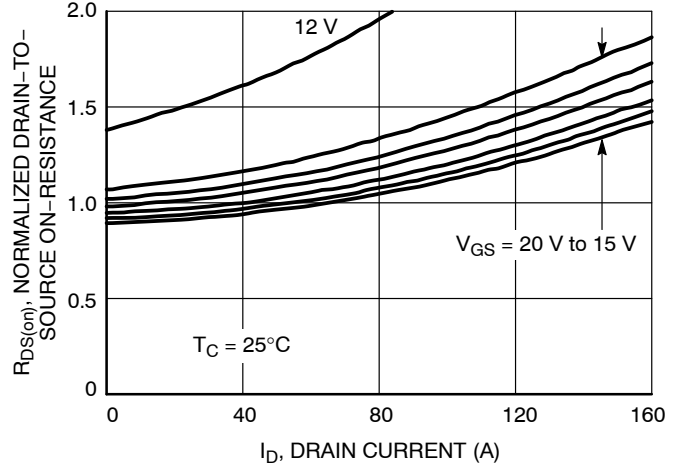


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

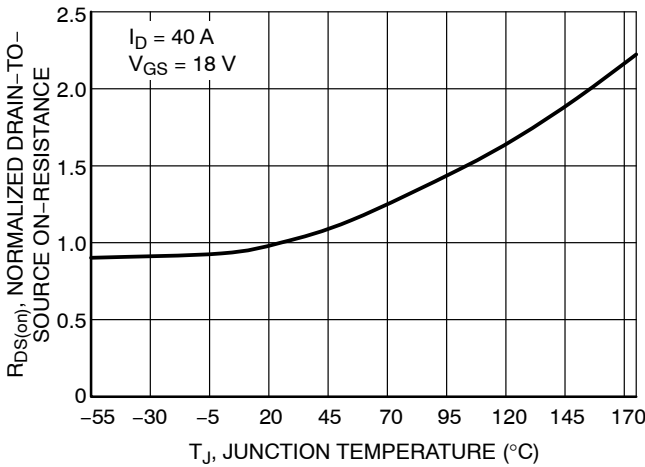


Figure 3. On-Resistance Variation with Temperature

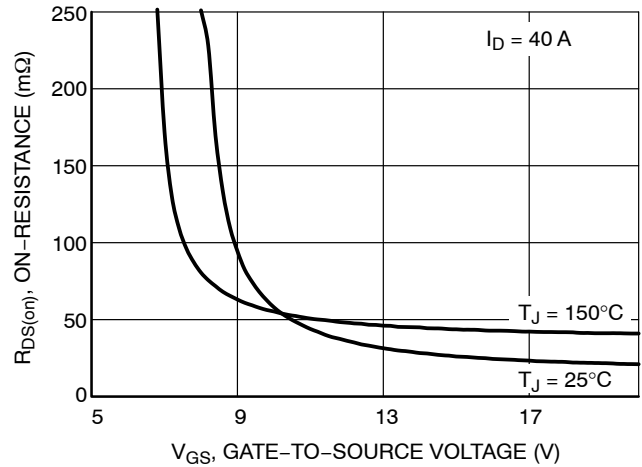


Figure 4. On-Resistance vs. Gate-to-Source Voltage

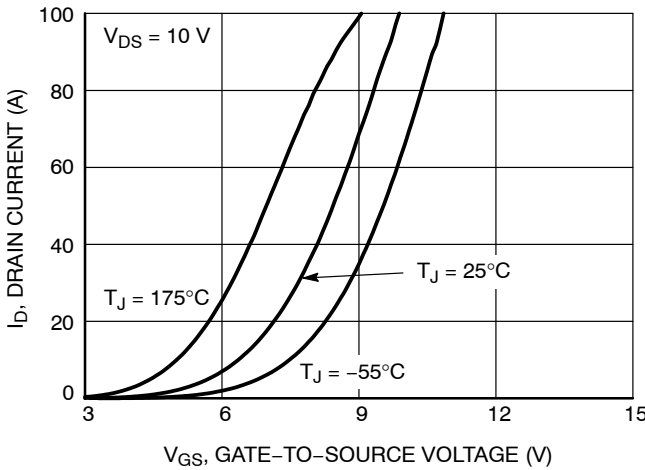


Figure 5. Transfer Characteristics

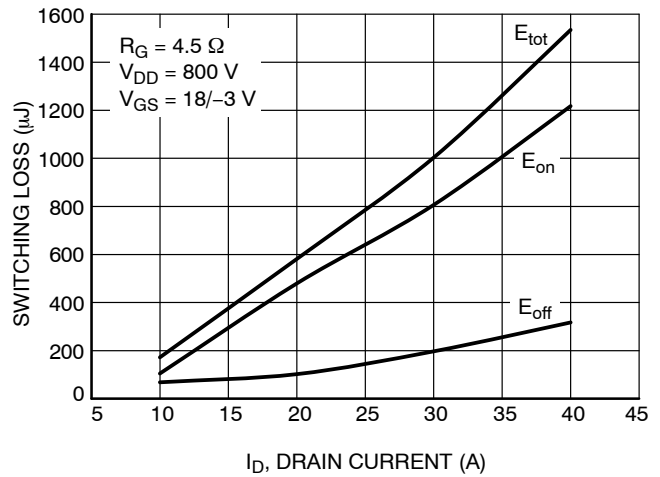


Figure 6. Switching Loss vs. Drain Current

TYPICAL CHARACTERISTICS

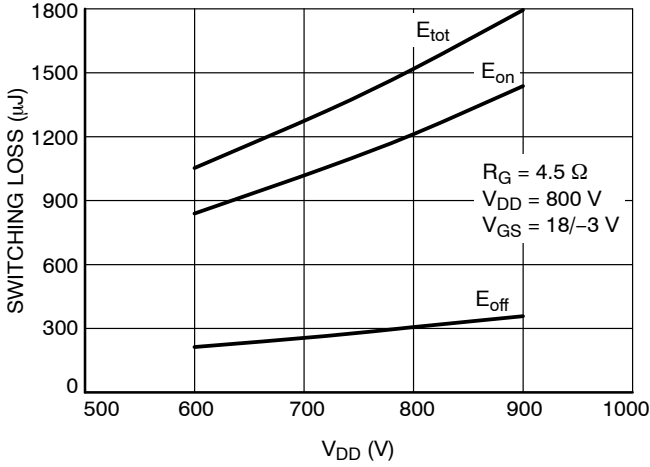


Figure 7. Switching Loss vs. Drain Voltage

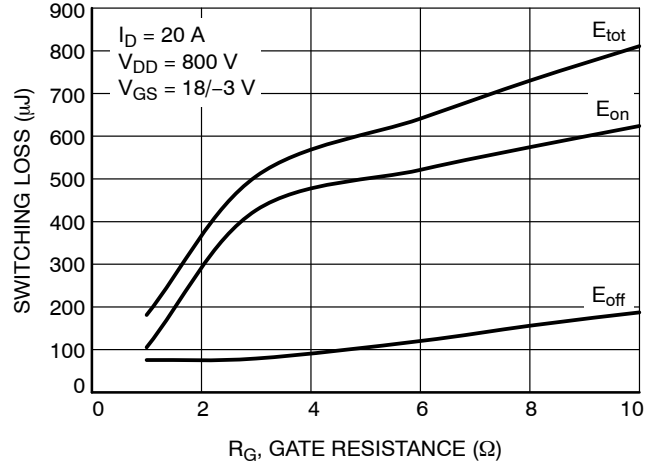


Figure 8. Switching Loss vs. Gate Resistance

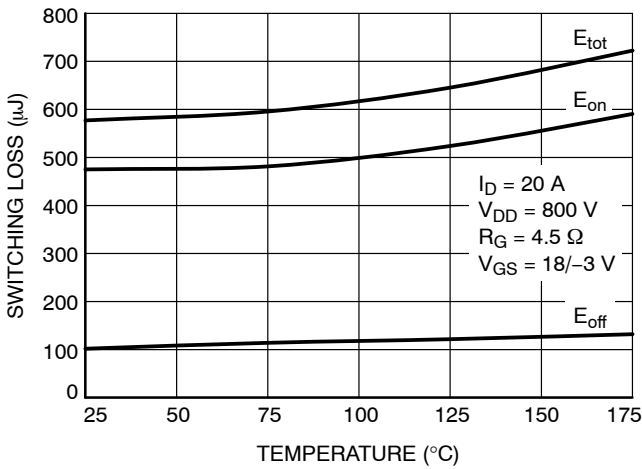


Figure 9. Switching Loss vs. Temperature

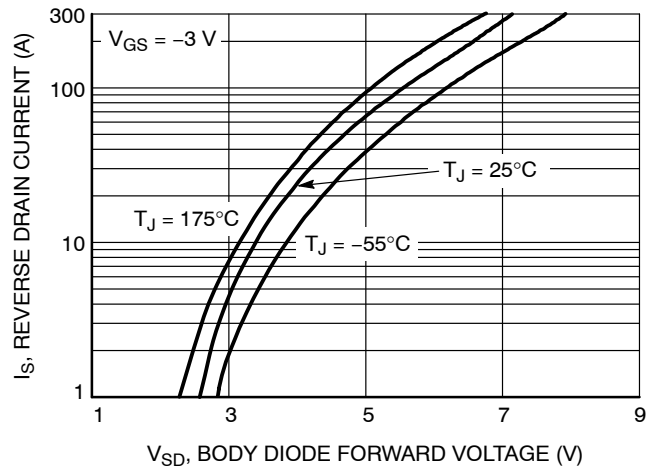


Figure 10. Diode Forward Voltage vs. Current

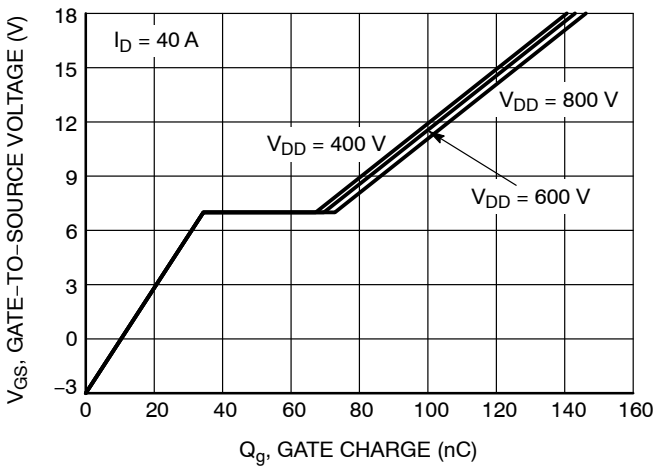


Figure 11. Gate-to-Source Voltage vs. Total Charge

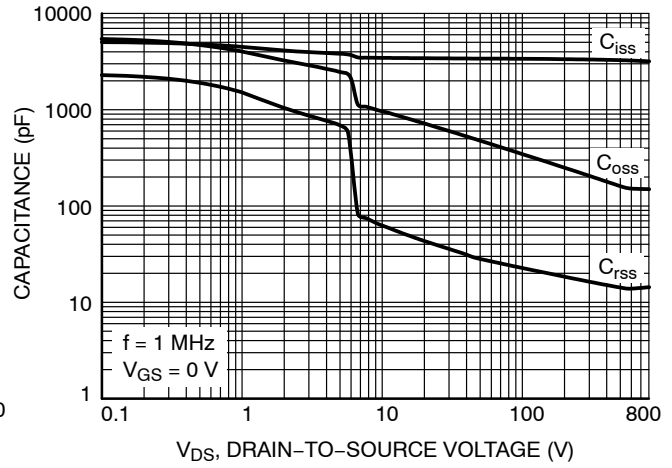


Figure 12. Capacitance vs. Drain-to-Source Voltage

TYPICAL CHARACTERISTICS

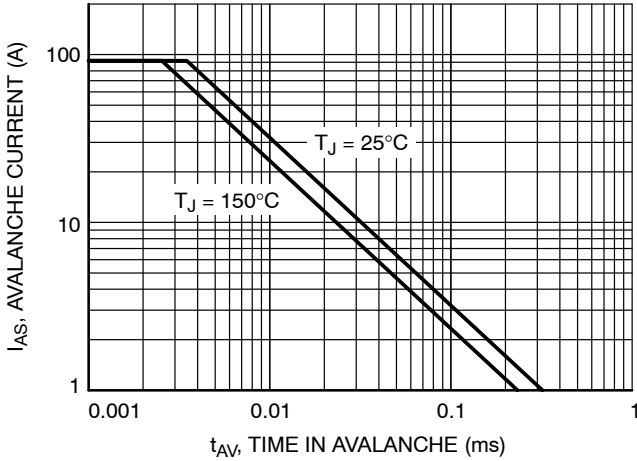


Figure 13. Unclamped Inductive Switching Capability

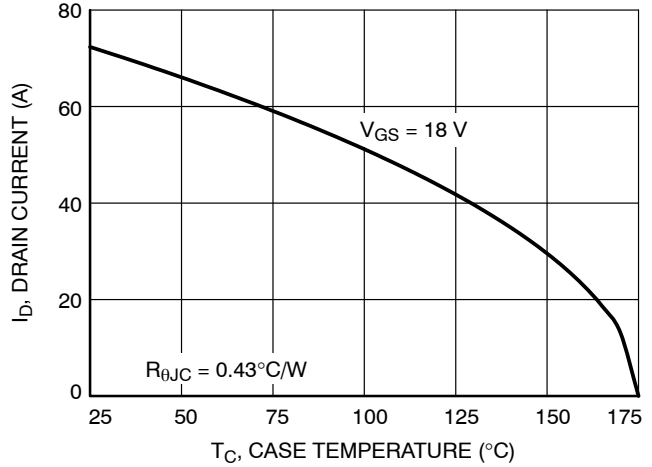


Figure 14. Maximum Continuous Drain Current vs. Case Temperature

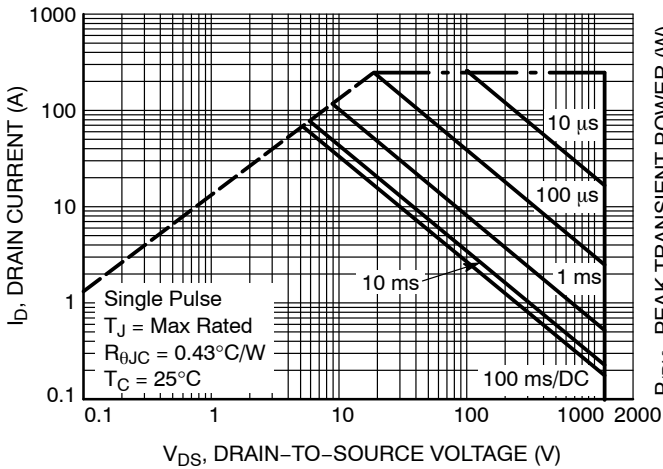


Figure 15. Safe Operating Area

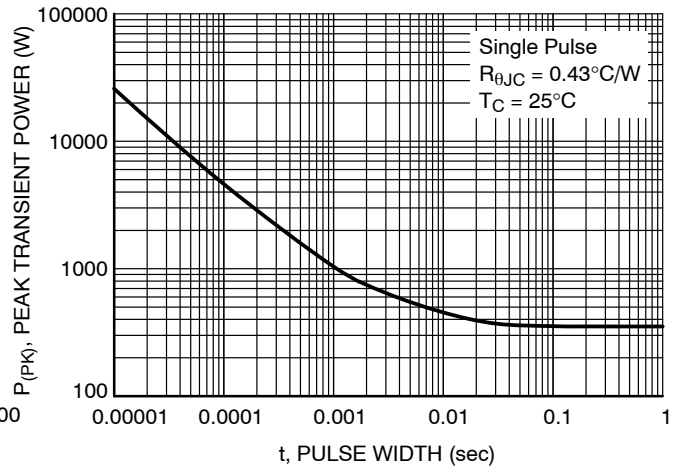


Figure 16. Single Pulse Maximum Power Dissipation

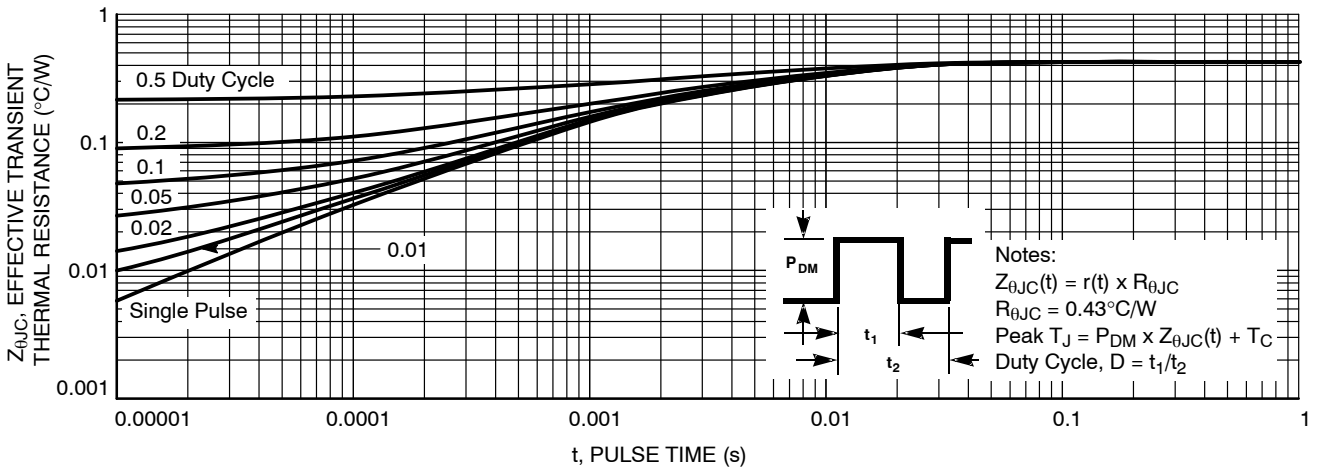
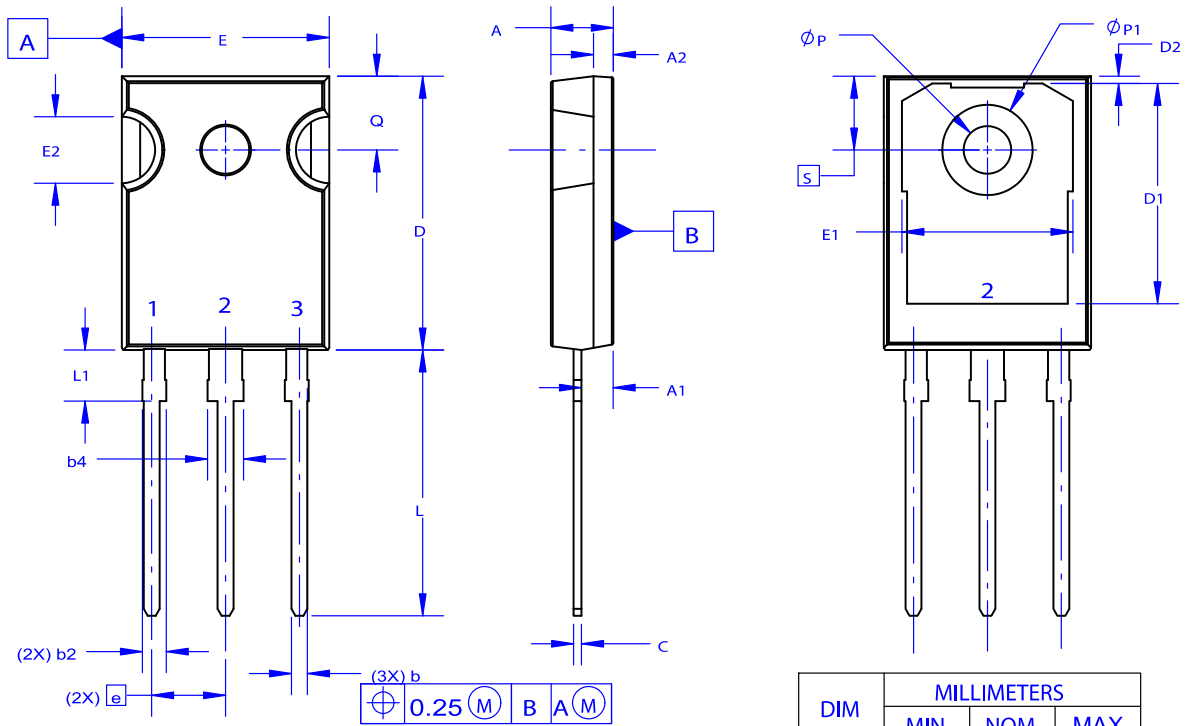


Figure 17. Junction-to-Case Transient Thermal Response

# NTHL022N120M3S

## PACKAGE DIMENSIONS

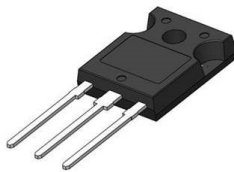
TO-247-3LD  
CASE 340CX  
ISSUE A



NOTES: UNLESS OTHERWISE SPECIFIED.

- A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DRAWING CONFORMS TO ASME Y14.5 - 2009.
- D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.
- E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.58	4.70	4.82
A1	2.20	2.40	2.60
A2	1.40	1.50	1.60
D	20.32	20.57	20.82
E	15.37	15.62	15.87
E2	4.96	5.08	5.20
e	~	5.56	~
L	19.75	20.00	20.25
L1	3.69	3.81	3.93
ØP	3.51	3.58	3.65
Q	5.34	5.46	5.58
S	5.34	5.46	5.58
b	1.17	1.26	1.35
b2	1.53	1.65	1.77
b4	2.42	2.54	2.66
c	0.51	0.61	0.71
D1	13.08	~	~
D2	0.51	0.93	1.35
E1	12.81	~	~
ØP1	6.60	6.80	7.00



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

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