

Silicon Carbide (SiC) MOSFET – EliteSiC, 40 mohm, 1200 V, M3S, TO-247-3L

NTHL040N120M3S

Features

- Typ. $R_{DS(on)} = 40\text{ m}\Omega @ V_{GS} = 18\text{ V}$
- Ultra Low Gate Charge ($Q_{G(tot)} = 75\text{ nC}$)
- High Speed Switching with Low Capacitance ($C_{oss} = 80\text{ pF}$)
- 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)

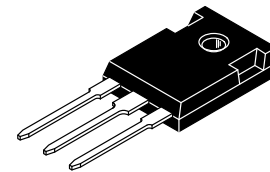
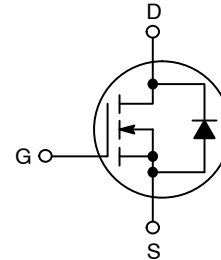
Parameter		Symbol	Value	Unit	
Drain-to-Source Voltage		V_{DSS}	1200	V	
Gate-to-Source Voltage		V_{GS}	-10/+22	V	
Recommended Operation Values of Gate-to-Source Voltage		$T_C < 175^\circ\text{C}$	V_{GSop}	-3/+18	V
Continuous Drain Current (Notes 1, 3)	Steady State	$T_C = 25^\circ\text{C}$	I_D	54	A
			P_D	231	W
Power Dissipation (Note 1)	Steady State	$T_C = 100^\circ\text{C}$	I_D	38	A
			P_D	115	W
Pulsed Drain Current (Note 2)	$T_C = 25^\circ\text{C}$		I_{DM}	134	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	45	A	
Single Pulse Drain-to-Source Avalanche Energy (Note 4)		E_{AS}	143	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. The maximum current rating is based on typical $R_{DS(on)}$ performance.
4. EAS of 143 mJ is based on starting $T_J = 25^\circ\text{C}$; $L = 1\text{ mH}$, $I_{AS} = 16.9\text{ A}$, $V_{DD} = 100\text{ V}$, $V_{GS} = 18\text{ V}$.

$V_{(BR)DSS}$	$R_{DS(ON)}\text{ MAX}$	$I_D\text{ MAX}$
1200 V	54 m Ω @ 18 V	54 A

N-CHANNEL MOSFET



TO-247-3LD
CASE 340CX

MARKING DIAGRAM



HL040N120M3S = Specific Device Code
 A = Assembly Location
 Y = Year
 WW = Work Week
 ZZ = Lot Traceability

ORDERING INFORMATION

Device	Package	Shipping
NTHL040N120M3S	TO-247-3L	30 Units / Tube

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Table 1. THERMAL CHARACTERISTICS

Parameter	Symbol	Max	Unit
Junction-to-Case – Steady State (Note 1)	$R_{\theta JC}$	0.65	°C/W
Junction-to-Ambient – Steady State (Note 1)	$R_{\theta JA}$	40	

Table 2. ELECTRICAL CHARACTERISTICS ($T_J = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
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°C (Note 6)	-	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	μA
Gate-to-Source Leakage Current	I_{GSS}	$V_{GS} = +22/-10\text{ V}, V_{DS} = 0\text{ V}$	-	-	±1	μA

ON-STATE CHARACTERISTICS (Note 2)

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 10\text{ mA}$	2.04	2.9	4.4	V
Recommended Gate Voltage	V_{GOP}		-3	-	+18	V
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 18\text{ V}, I_D = 20\text{ A}, T_J = 25^\circ\text{C}$	-	40	54	mΩ
		$V_{GS} = 18\text{ V}, I_D = 20\text{ A}, T_J = 175^\circ\text{C}$ (Note 6)	-	80	-	
Forward Transconductance	g_{FS}	$V_{DS} = 10\text{ V}, I_D = 20\text{ A}$ (Note 6)	-	16	-	S

CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	C_{ISS}	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$ (Note 6)	-	1700	-	pF
Output Capacitance	C_{OSS}		-	80	-	
Reverse Transfer Capacitance	C_{RSS}		-	7	-	
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = -3/18\text{ V}, V_{DS} = 800\text{ V}, I_D = 20\text{ A}$ (Note 6)	-	75	-	nC
Threshold Gate Charge	$Q_{G(TH)}$		-	4.4	-	
Gate-to-Source Charge	Q_{GS}		-	14	-	
Gate-to-Drain Charge	Q_{GD}		-	22	-	
Gate-Resistance	R_G	$f = 1\text{ MHz}$	-	3.8	-	Ω

SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = -3/18\text{ V}, V_{DS} = 800\text{ V}, I_D = 20\text{ A}, R_G = 4.7\text{ }\Omega$ Inductive load (Notes 5, 6)	-	13	-	ns
Rise Time	t_r		-	32	-	
Turn-Off Delay Time	$t_{d(OFF)}$		-	37	-	
Fall Time	t_f		-	11	-	
Turn-On Switching Loss	E_{ON}		-	412	-	μJ
Turn-Off Switching Loss	E_{OFF}		-	74	-	
Total Switching Loss	E_{tot}		-	486	-	

SOURCE-DRAIN DIODE CHARACTERISTICS

Continuous Source-Drain Diode Forward Current	I_{SD}	$V_{GS} = -3\text{ V}, T_C = 25^\circ\text{C}$ (Note 6)	-	-	45	A
Pulsed Source-Drain Diode Forward Current (Note 2)	I_{SDM}		-	-	134	
Forward Diode Voltage	V_{SD}	$V_{GS} = -3\text{ V}, I_{SD} = 20\text{ A}, T_J = 25^\circ\text{C}$	-	4.5	-	V

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Table 2. ELECTRICAL CHARACTERISTICS ($T_J = 25^\circ\text{C}$ unless otherwise specified) (continued)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
SOURCE-DRAIN DIODE CHARACTERISTICS						
Reverse Recovery Time	t_{RR}	$V_{GS} = -3/18\text{ V}$, $I_{SD} = 20\text{ A}$, $di_S/dt = 1000\text{ A}/\mu\text{s}$, $V_{DS} = 800\text{ V}$ (Note 6)	-	17	-	ns
Reverse Recovery Charge	Q_{RR}		-	81	-	nC
Reverse Recovery Energy	E_{REC}		-	6.7	-	μJ
Peak Reverse Recovery Current	I_{RRM}		-	9.3	-	A
Charge Time	T_A		-	9.5	-	ns
Discharge Time	T_B		-	7.7	-	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.

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

6. Defined by design, not subject to production test.

Typical Characteristics

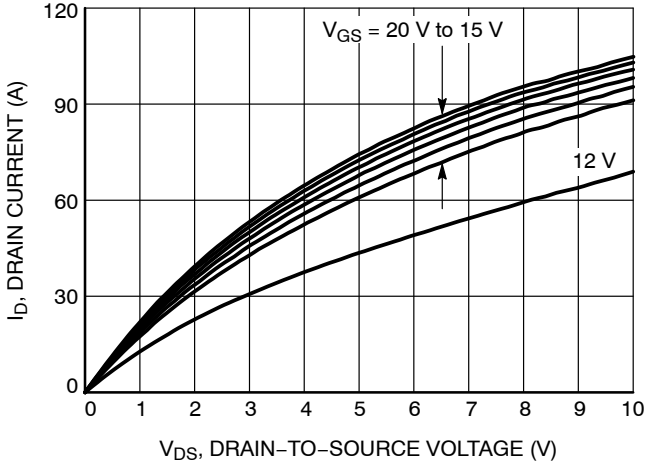


Figure 1. On-Region Characteristics

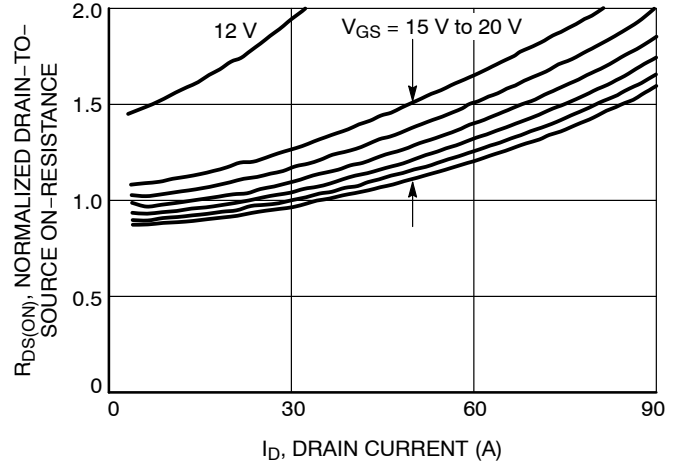


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

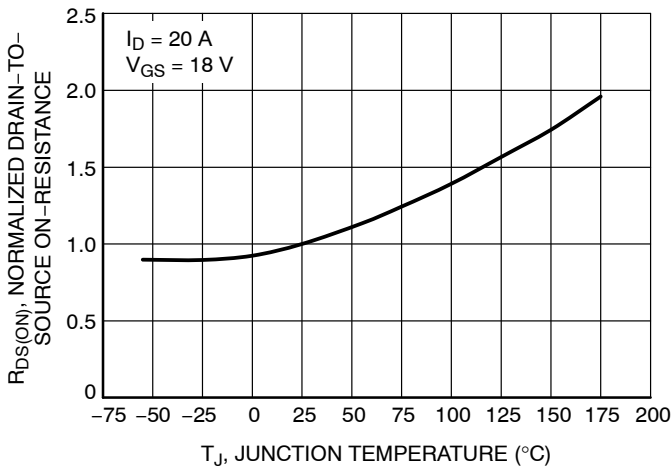


Figure 3. On-Resistance Variation with Temperature

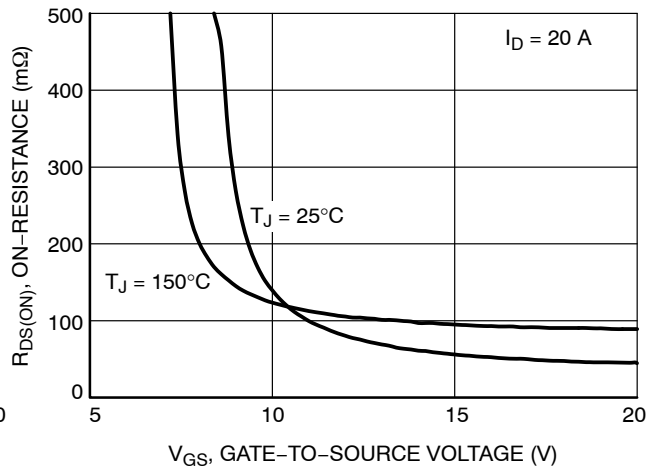


Figure 4. On-Resistance vs. Gate-to-Source Voltage

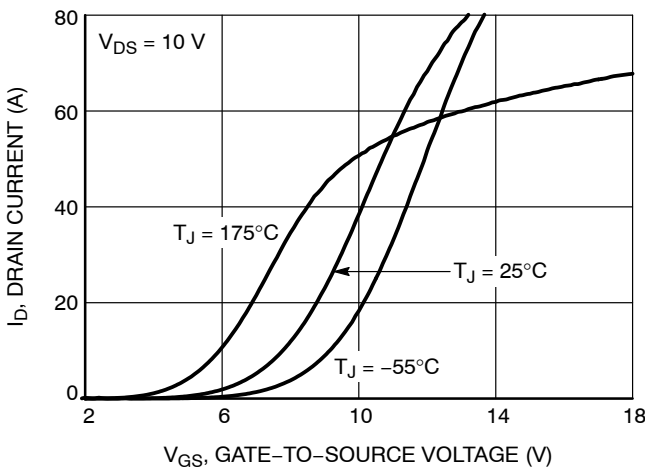


Figure 5. Transfer Characteristics

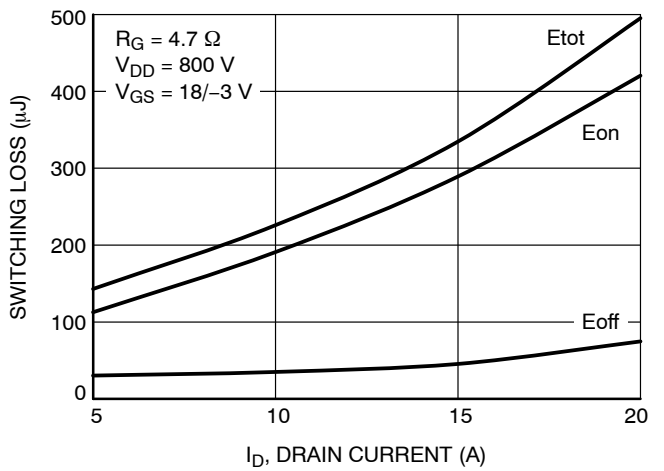


Figure 6. Switching Loss vs. Drain Current

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Typical Characteristics

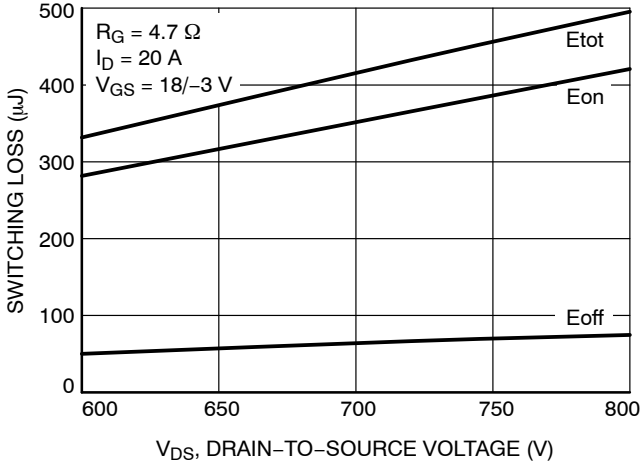


Figure 7. Switching Loss vs. Drain-to-Source Voltage

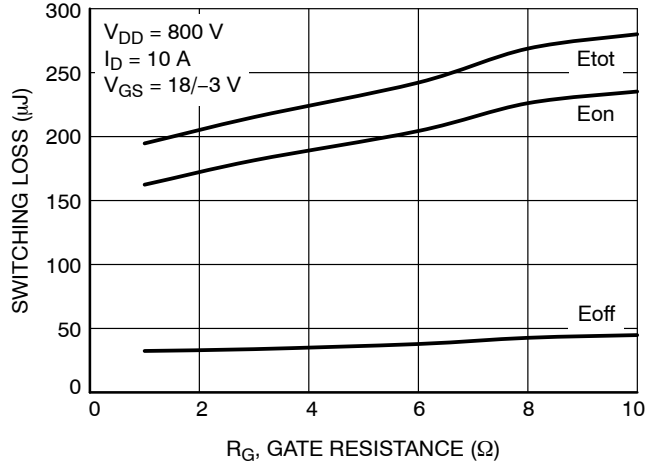


Figure 8. Switching Loss vs. Gate Resistance

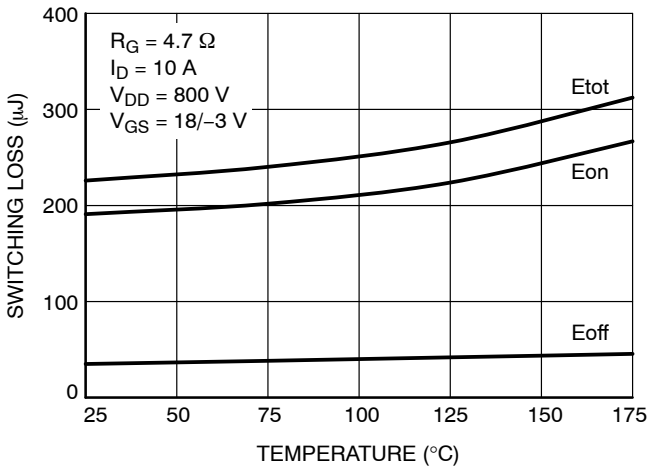


Figure 9. Switching Loss vs. Temperature

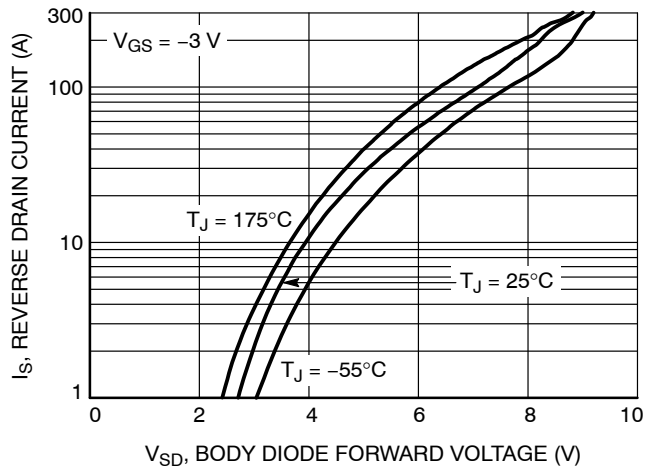


Figure 10. Reverse Drain Current vs. Body Diode Forward Voltage

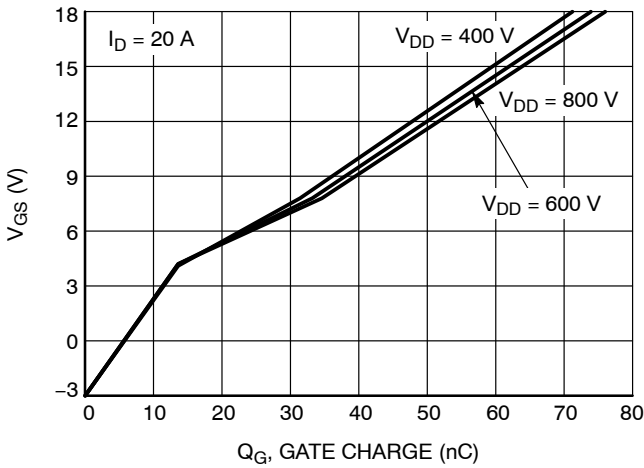


Figure 11. Gate-to-Source Voltage vs. Total Charge

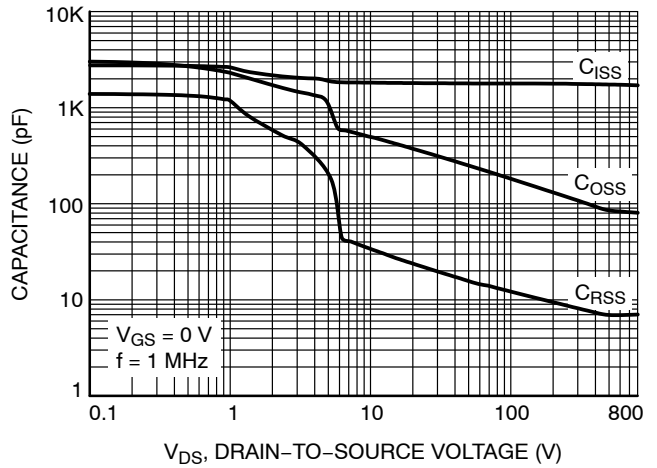


Figure 12. Capacitance vs. Drain-to-Source Voltage

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Typical Characteristics

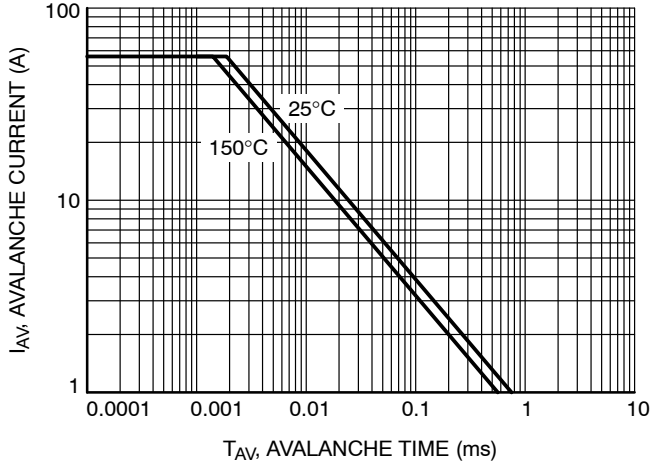


Figure 13. Unclamped Inductive Switching Capability

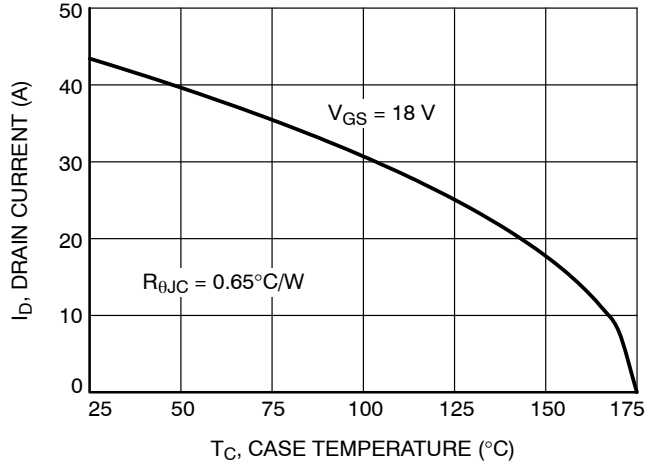


Figure 14. Maximum Continuous Drain Current vs. Case Temperature

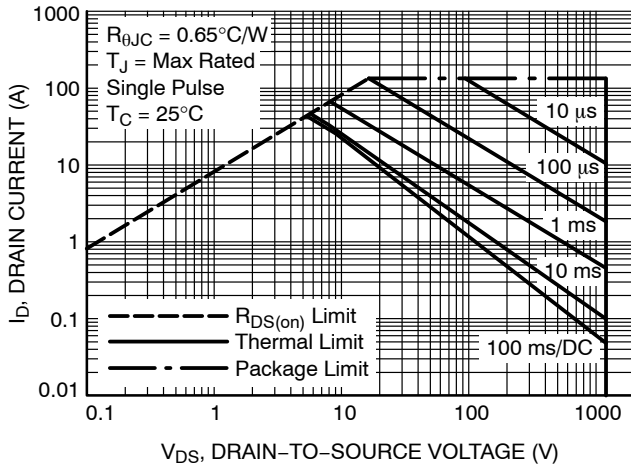


Figure 15. Safe Operating Area

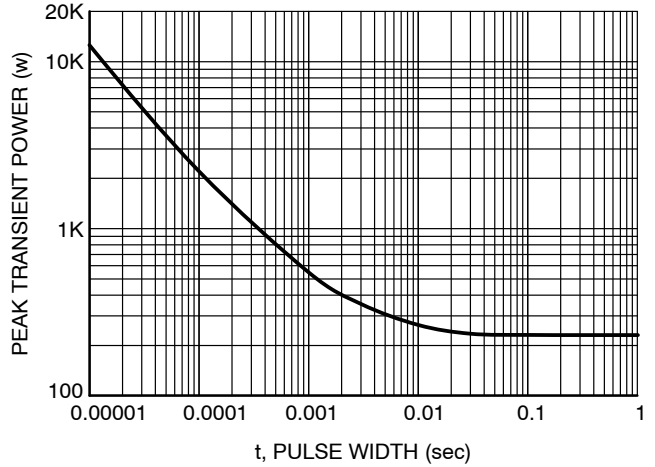


Figure 16. Single Pulse Maximum Power Dissipation

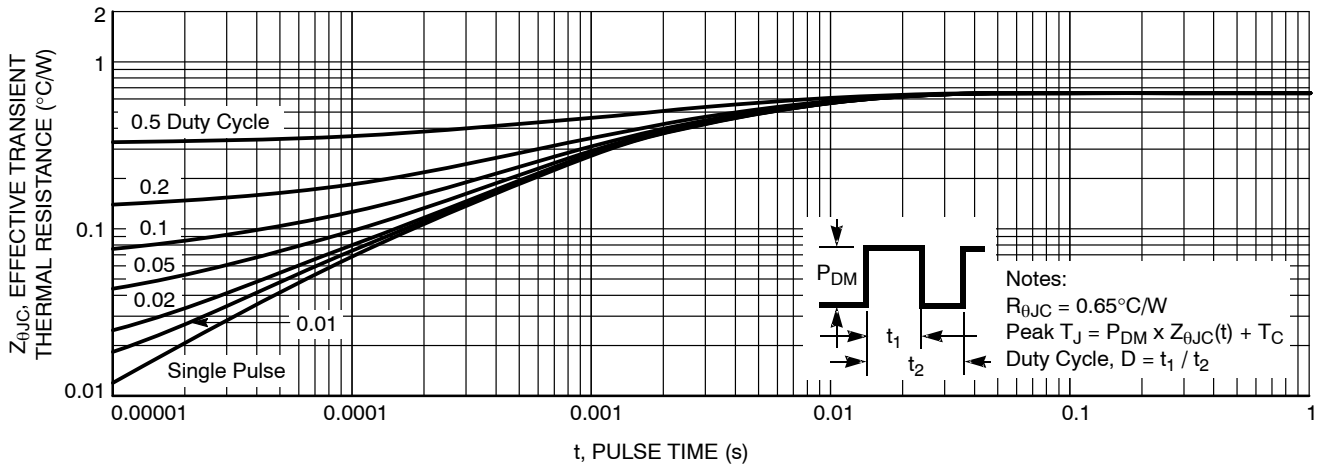
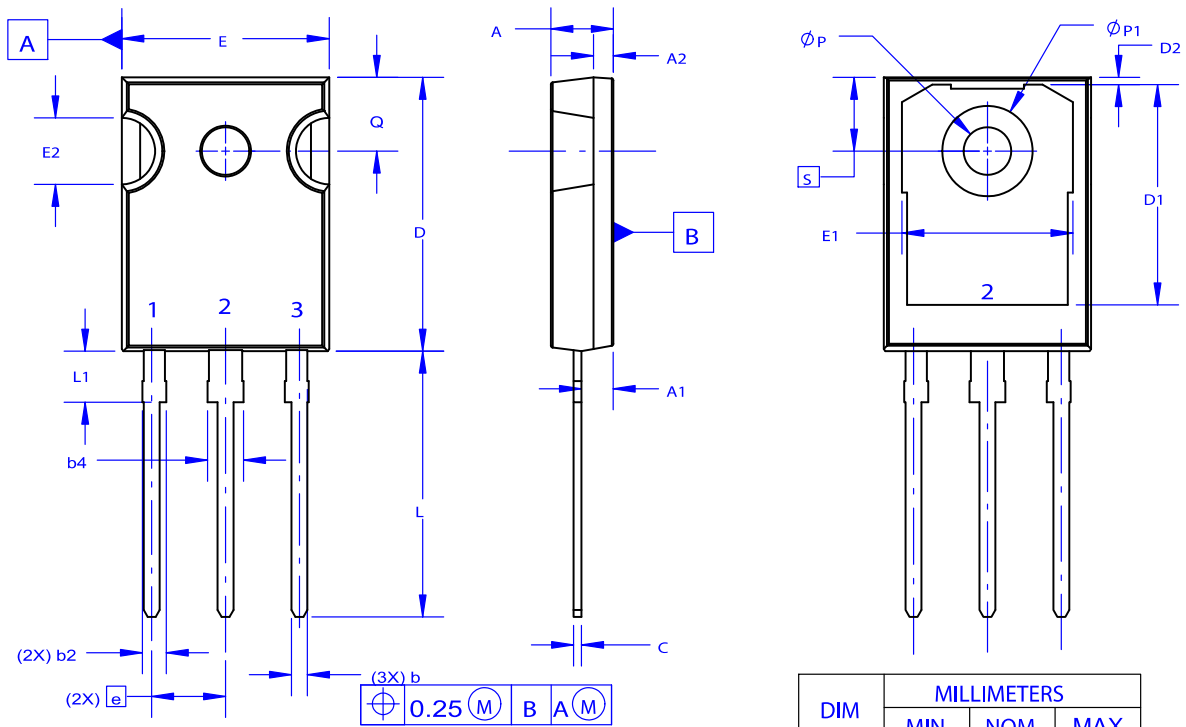


Figure 17. Junction-to-Case Transient Thermal Response

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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
ϕP	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	~	~
$\phi P1$	6.60	6.80	7.00

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