

Silicon Carbide (SiC) MOSFET – EliteSiC, 22 mohm, 1200 V, M3S, TO-247-3L NTHL022N120M3S

Features

- Typ. $R_{DS(on)} = 22\text{ m}\Omega @ V_{GS} = 18\text{ V}$
- Ultra Low Gate Charge ($Q_{G(tot)} = 137\text{ nC}$)
- Low Effective Output Capacitance ($C_{oss} = 146\text{ pF}$)
- 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)

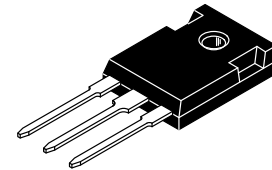
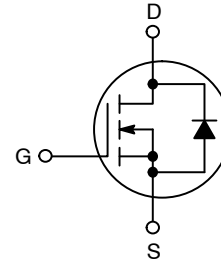
Parameter	Symbol	Value	Unit
Drain-to-Source Voltage	V_{DSS}	1200	V
Gate-to-Source Voltage	V_{GS}	-10/+22	V
Recommended Operation Values of Gate-to-Source Voltage	$T_C < 175^\circ\text{C}$ V_{GSop}	-3/+18	V
Continuous Drain Current (Notes 1, 3)	Steady State $T_C = 25^\circ\text{C}$	I_D	89 A
		P_D	348 W
Power Dissipation (Note 1)	Steady State $T_C = 100^\circ\text{C}$	I_D	62 A
		P_D	174 W
Continuous Drain Current (Notes 1, 3)	Steady State $T_C = 25^\circ\text{C}$	I_{DM}	275 A
Pulsed Drain Current (Note 2)	$T_C = 25^\circ\text{C}$	I_{DM}	275 A
Operating Junction and Storage Temperature Range	T_J, T_{stg}	-55 to +175	$^\circ\text{C}$
Source Current (Body Diode) $T_C = 25^\circ\text{C}$ $V_{GS} = -3\text{ V}$ (Note 1)	I_S	72	A
Single Pulse Drain-to-Source Avalanche Energy ($I_{L(pk)} = 23.1\text{ A}$, $L = 1\text{ mH}$) (Note 4)	E_{AS}	267	mJ
Maximum Lead Temperature for Soldering (1/25" from case for 10 s)	T_L	270	$^\circ\text{C}$

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. 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 Ω @ 18 V	89 A

N-CHANNEL MOSFET



TO-247-3L
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	TO-247-3L	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°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

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	m Ω
		$V_{GS} = 18\text{ V}, I_D = 40\text{ A}, T_J = 175^\circ\text{C}$ (Note 6)	-	44	-	
Forward Transconductance	g_{FS}	$V_{DS} = 10\text{ V}, I_D = 40\text{ A}$ (Note 6)	-	34	-	S

CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	C_{ISS}	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$	-	3175	-	pF
Output Capacitance	C_{OSS}		-	146	-	
Reverse Transfer Capacitance	C_{RSS}		-	14	-	
Total Gate Charge	$Q_G(TOT)$	$V_{GS} = -3/18\text{ V}, V_{DS} = 800\text{ V}, I_D = 40\text{ A}$	-	137	-	nC
Threshold Gate Charge	$Q_G(TH)$		-	9.2	-	
Gate-to-Source Charge	Q_{GS}		-	15	-	
Gate-to-Drain Charge	Q_{GD}		-	34	-	
Gate-Resistance	R_G	$f = 1\text{ MHz}$	-	1.5	-	Ω

SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = -3/18\text{ V}, V_{DS} = 800\text{ V}, I_D = 40\text{ A}, R_G = 4.5\text{ }\Omega$ Inductive Load (Notes 5, 6)	-	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	-	μJ
Turn-Off Switching Loss	E_{OFF}		-	307	-	
Total Switching Loss	E_{tot}		-	1519	-	

SOURCE-DRAIN DIODE CHARACTERISTICS

Continuous Source-Drain Diode Forward Current (Note 1)	I_{SD}	$V_{GS} = -3\text{ V}, T_C = 25^\circ\text{C}$ (Note 6)	-	-	72	A
Pulsed Source-Drain Diode Forward Current (Note 2)	I_{SDM}		-	-	275	
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
SOURCE-DRAIN DIODE CHARACTERISTICS						
Reverse Recovery Time	t_{RR}	$V_{GS} = -3/18\text{ V}, I_{SD} = 40\text{ A},$ $di_S/dt = 1000\text{ A}/\mu\text{s}, V_{DS} = 800\text{ V}$ (Note 6)	-	24	-	ns
Reverse Recovery Charge	Q_{RR}		-	150	-	nC
Reverse Recovery Energy	E_{REC}		-	14	-	μJ
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.

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

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

TYPICAL CHARACTERISTICS

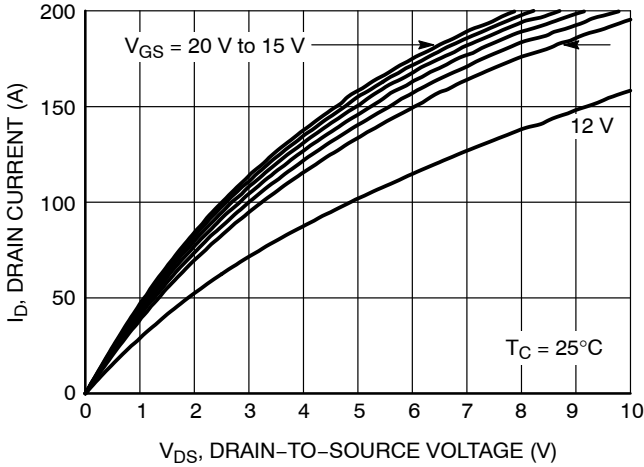


Figure 1. On-Region Characteristics

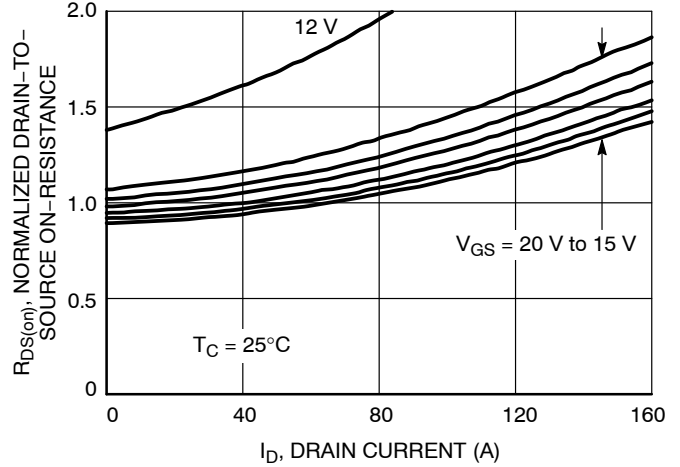


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

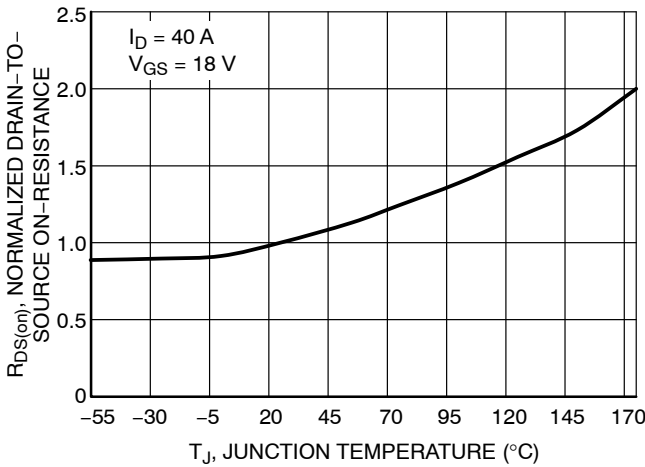


Figure 3. On-Resistance Variation with Temperature

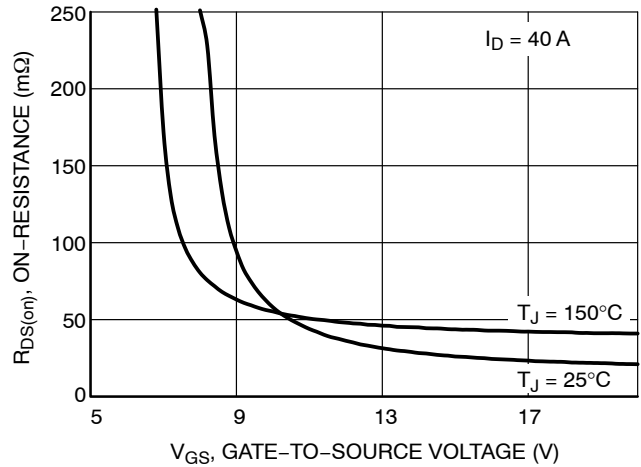


Figure 4. On-Resistance vs. Gate-to-Source Voltage

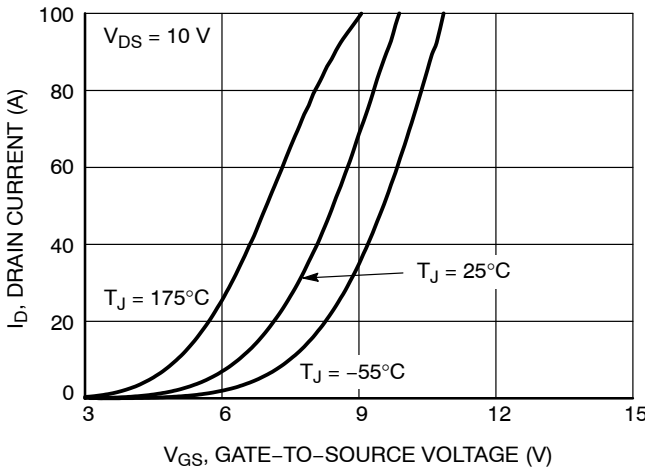


Figure 5. Transfer Characteristics

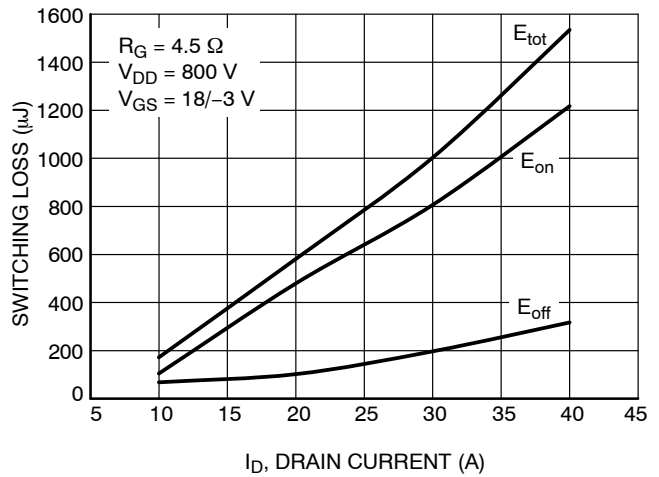


Figure 6. Switching Loss vs. Drain Current

TYPICAL CHARACTERISTICS

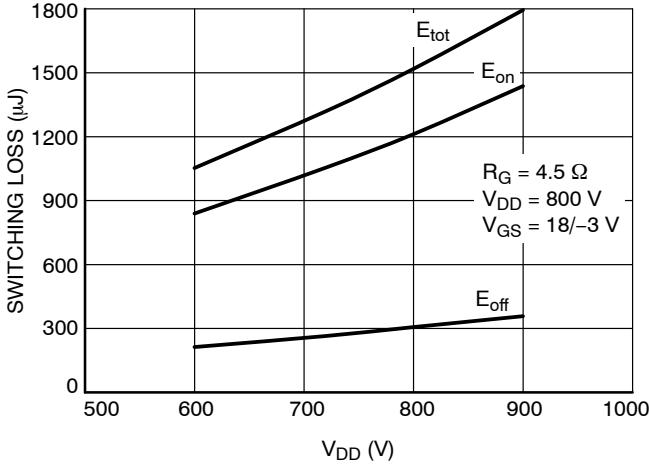


Figure 7. Switching Loss vs. Drain Voltage

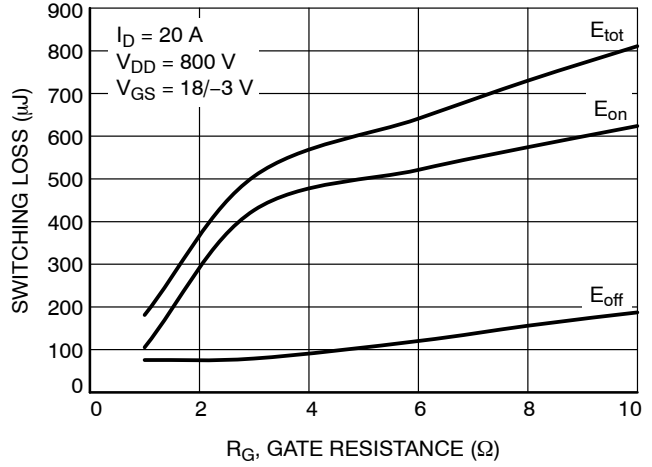


Figure 8. Switching Loss vs. Gate Resistance

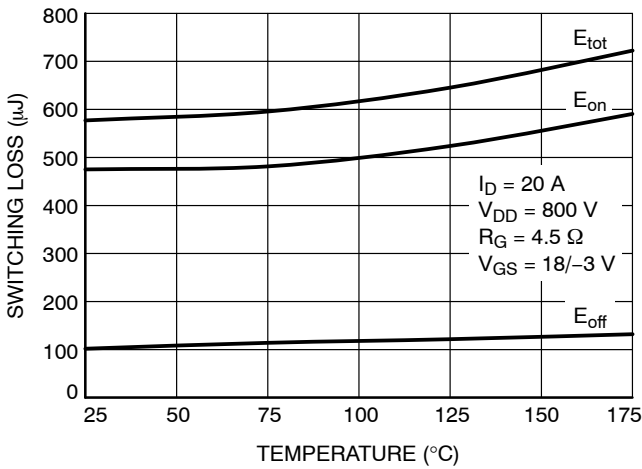


Figure 9. Switching Loss vs. Temperature

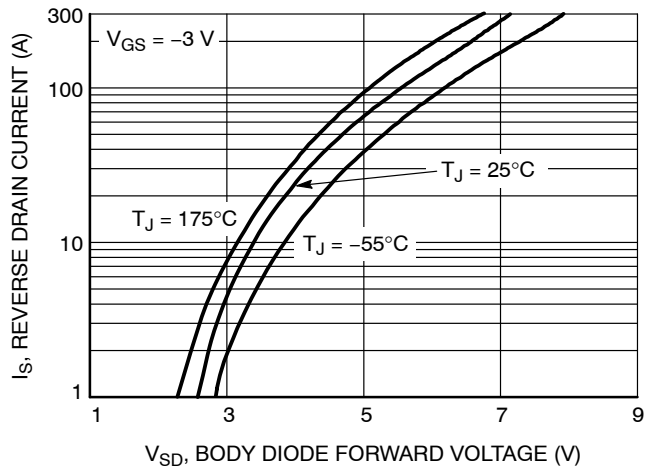


Figure 10. Diode Forward Voltage vs. Current

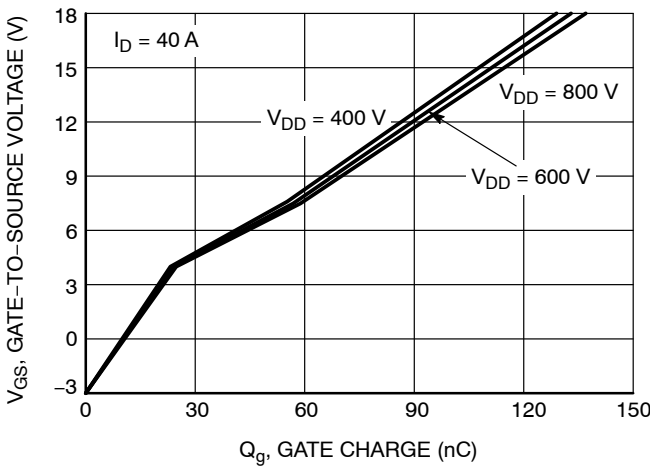


Figure 11. Gate-to-Source Voltage vs. Total Charge

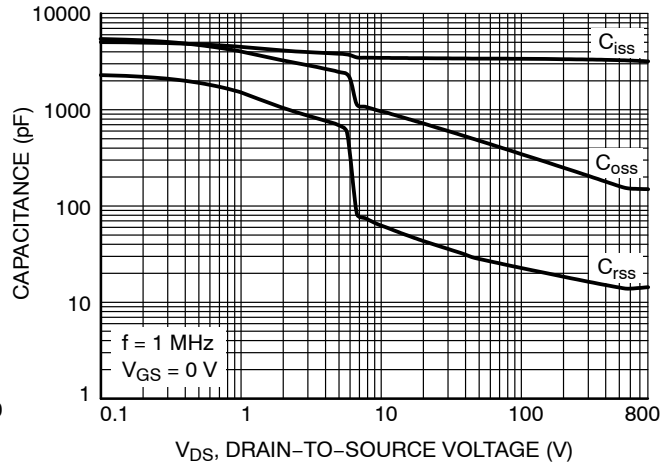


Figure 12. Capacitance vs. Drain-to-Source Voltage

TYPICAL CHARACTERISTICS

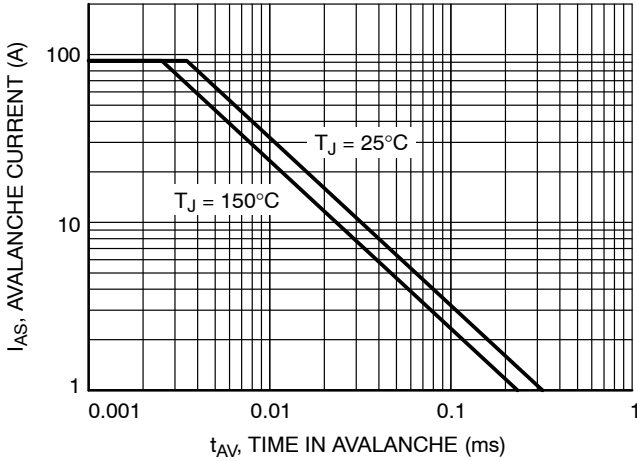


Figure 13. Unclamped Inductive Switching Capability

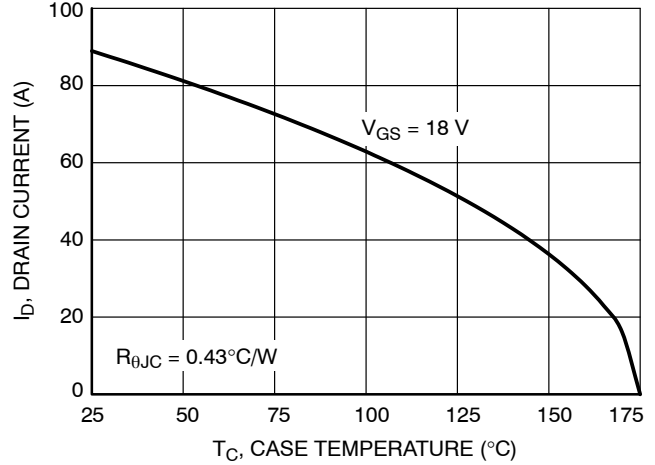


Figure 14. Maximum Continuous Drain Current vs. Case Temperature

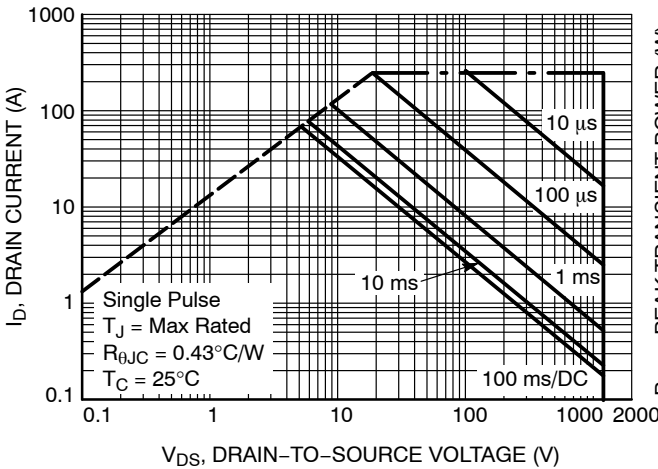


Figure 15. Safe Operating Area

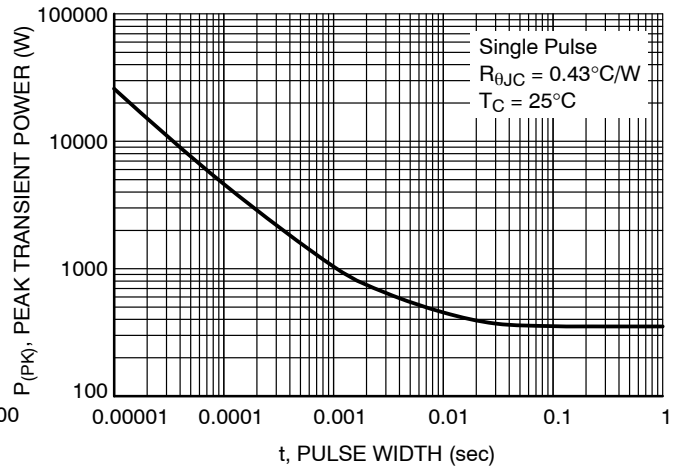


Figure 16. Single Pulse Maximum Power Dissipation

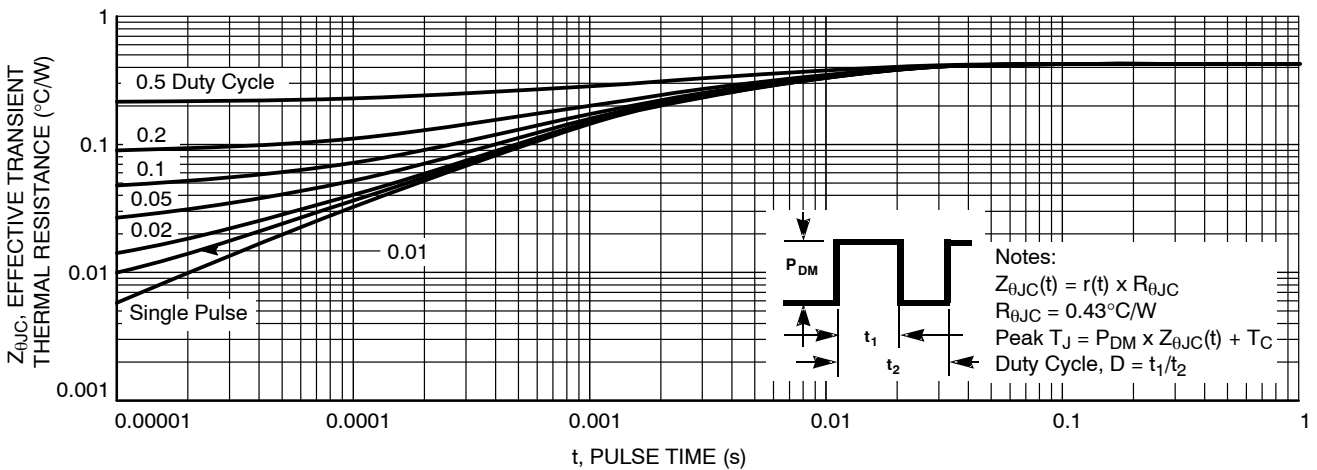


Figure 17. Junction-to-Case Transient Thermal Response

MECHANICAL CASE OUTLINE

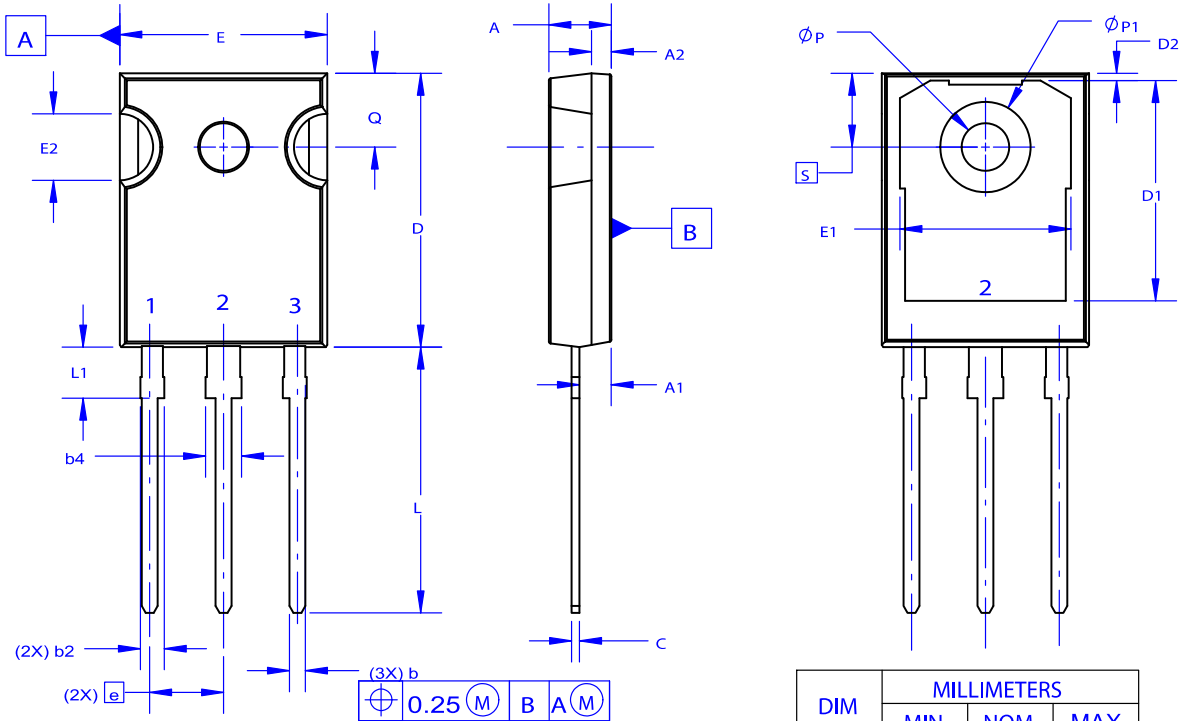
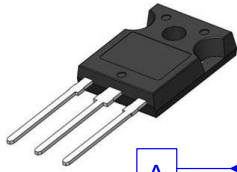
PACKAGE DIMENSIONS

ON Semiconductor®



TO-247-3LD
CASE 340CX
ISSUE A

DATE 06 JUL 2020



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

GENERIC MARKING DIAGRAM*



- XXXXX = 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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[G3R40MT12J](#)