

# Silicon Carbide (SiC) MOSFET – 160 mohm, 1200 V, M1, TO-247-3L

## NVHL160N120SC1

### Features

- Typ.  $R_{DS(on)} = 160\text{ m}\Omega$
- Ultra Low Gate Charge (typ.  $Q_{G(tot)} = 34\text{ nC}$ )
- Low Effective Output Capacitance (typ.  $C_{oss} = 50\text{ pF}$ )
- 100% UIL Tested
- AEC-Q101 Qualified and PPAP Capable
- This Device is Halide Free and RoHS Compliant with exemption 7a, Pb-Free 2LI (on second level interconnection)

### Typical Applications

- Automotive On Board Charger
- Automotive DC-DC Converter for EV/HEV

### 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	$V_{GS}$	-15/+25	V
Recommended Operation Values of Gate-to-Source Voltage	$T_C < 175^\circ\text{C}$ $V_{GSop}$	-5/+20	V
Continuous Drain Current	Steady State $T_C = 25^\circ\text{C}$ $I_D$	17	A
Power Dissipation	$P_D$	119	W
Continuous Drain Current	Steady State $T_C = 100^\circ\text{C}$ $I_D$	12	A
Power Dissipation	$P_D$	59	W
Pulsed Drain Current (Note 2)	$T_A = 25^\circ\text{C}$ $I_{DM}$	69	A
Single Pulse Surge Drain Current Capability	$T_A = 25^\circ\text{C}$ , $t_p = 10\text{ }\mu\text{s}$ , $R_G = 4.7\text{ }\Omega$ $I_{DSC}$	140	A
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55 to +175	$^\circ\text{C}$
Source Current (Body Diode)	$I_S$	11	A
Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 23\text{ A}$ , $L = 1\text{ mH}$ ) (Note 3)	$E_{AS}$	128	mJ

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.

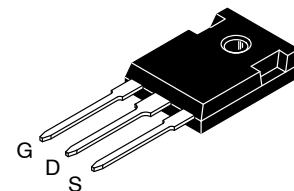
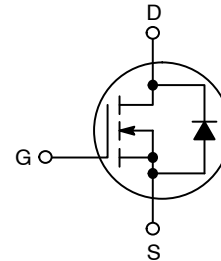
### THERMAL CHARACTERISTICS

Parameter	Symbol	Value	Unit
Junction-to-Case (Note 1)	$R_{\theta JC}$	1.3	$^\circ\text{C/W}$
Junction-to-Ambient (Note 1)	$R_{\theta JA}$	40	$^\circ\text{C/W}$

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 128 mJ is based on starting  $T_J = 25^\circ\text{C}$ ;  $L = 1\text{ mH}$ ,  $I_{AS} = 16\text{ A}$ ,  $V_{DD} = 120\text{ V}$ ,  $V_{GS} = 18\text{ V}$ .

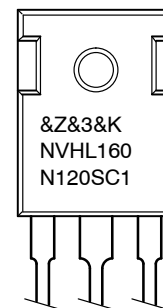
$V_{(BR)DSS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
1200 V	224 m $\Omega$ @ 20 V	17 A

### N-CHANNEL MOSFET



TO-247-3LD  
CASE 340CX

### MARKING DIAGRAM



&Z = Assembly Plant Code  
&3 = Date Code (Year & Week)  
&K = Lot  
NVHL160N120SC1 = Specific Device Code

### ORDERING INFORMATION

Device	Package	Shipping
NVHL160N120SC1	TO247-3L	30 Units / Tube

# NVHL160N120SC1

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
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### OFF 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 $25^\circ\text{C}$	-	600	-	$\text{mV}/^\circ\text{C}$
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}, T_J = 25^\circ\text{C}$	-	-	100	$\mu\text{A}$
		$V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}, T_J = 175^\circ\text{C}$	-	-	250	
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{GS} = +25/-15\text{ V}, V_{DS} = 0\text{ V}$	-	-	$\pm 1$	$\mu\text{A}$

### ON CHARACTERISTICS

Gate Threshold Voltage	$V_{GS(th)}$	$V_{GS} = V_{DS}, I_D = 2.5\text{ mA}$	1.8	3.1	4.3	V
Recommended Gate Voltage	$V_{GOP}$		-5	-	+20	V
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 20\text{ V}, I_D = 12\text{ A}, T_J = 25^\circ\text{C}$	-	162	224	$\text{m}\Omega$
		$V_{GS} = 20\text{ V}, I_D = 12\text{ A}, T_J = 175^\circ\text{C}$	-	271	377	
Forward Transconductance	$g_{FS}$	$V_{DS} = 10\text{ V}, I_D = 12\text{ A}$	-	3	-	S

### CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$	-	665	-	$\text{pF}$
Output Capacitance	$C_{OSS}$		-	50	-	
Reverse Transfer Capacitance	$C_{RSS}$		-	5	-	
Total Gate Charge	$Q_{G(tot)}$	$V_{GS} = -5/20\text{ V}, V_{DS} = 600\text{ V}, I_D = 16\text{ A}$	-	34	-	$\text{nC}$
Threshold Gate Charge	$Q_{G(th)}$		-	6	-	
Gate-to-Source Charge	$Q_{GS}$		-	12.5	-	
Gate-to-Drain Charge	$Q_{GD}$		-	9.6	-	
Gate Resistance	$R_G$		$f = 1\text{ MHz}$	-	1.4	

### SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(on)}$	$V_{GS} = -5/20\text{ V}, V_{DS} = 800\text{ V}, I_D = 16\text{ A}, R_G = 6\ \Omega,$ Inductive Load	-	11	-	ns
Rise Time	$t_r$		-	19	-	
Turn-Off Delay Time	$t_{d(off)}$		-	15	-	
Fall Time	$t_f$		-	8	-	
Turn-On Switching Loss	$E_{ON}$		-	200	-	$\mu\text{J}$
Turn-Off Switching Loss	$E_{OFF}$		-	34	-	
Total Switching Loss	$E_{TOT}$		-	234	-	

### DRAIN-SOURCE DIODE CHARACTERISTICS

Continuous Drain-to-Source Diode Forward Current	$I_{SD}$	$V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$	-	-	11	A
Pulsed Drain-to-Source Diode Forward Current (Note 2)	$I_{SDM}$	$V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$	-	-	69	A
Forward Diode Voltage	$V_{SD}$	$V_{GS} = -5\text{ V}, I_{SD} = 6\text{ A}, T_J = 25^\circ\text{C}$	-	4	10	V
Reverse Recovery Time	$t_{RR}$	$V_{GS} = -5/20\text{ V}, I_{SD} = 16\text{ A},$ $dI_S/dt = 1000\text{ A}/\mu\text{s}$	-	15	-	ns
Reverse Recovery Charge	$Q_{RR}$		-	45	-	nC
Reverse Recovery Energy	$E_{REC}$		-	3.9	-	$\mu\text{J}$
Peak Reverse Recovery Current	$I_{RRM}$		-	6.2	-	A
Charge Time	$T_a$		-	7.4	-	ns
Discharge Time	$T_b$		-	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.

# NVHL160N120SC1

## TYPICAL CHARACTERISTICS

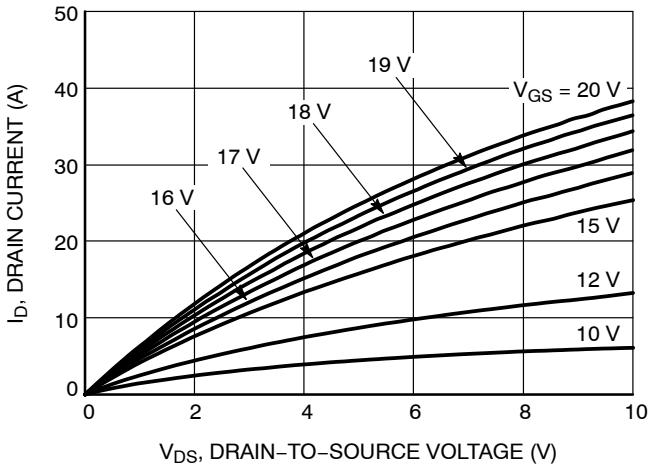


Figure 1. On-Region Characteristics

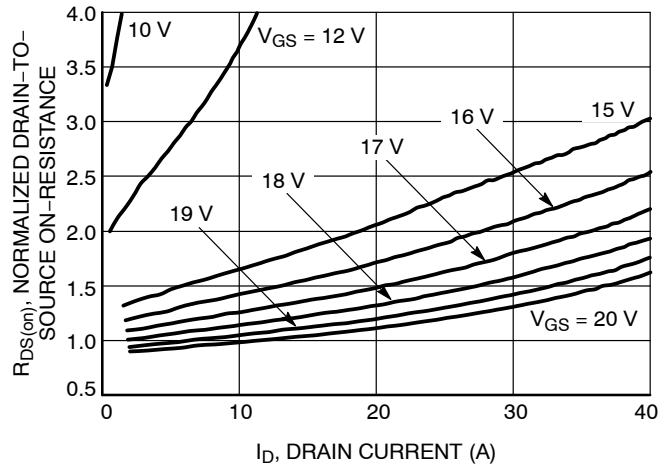


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

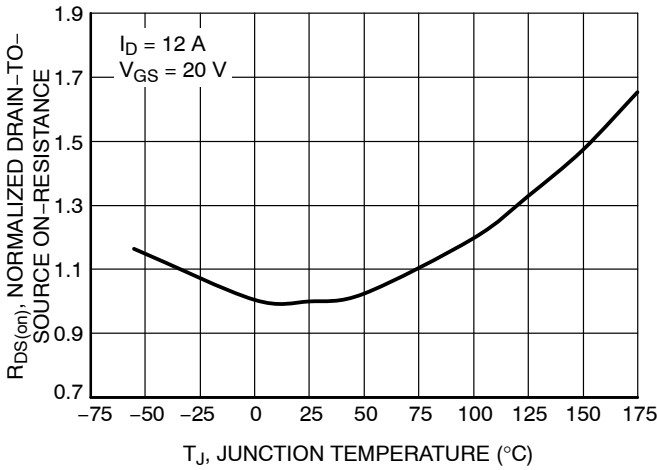


Figure 3. On-Resistance Variation with Temperature

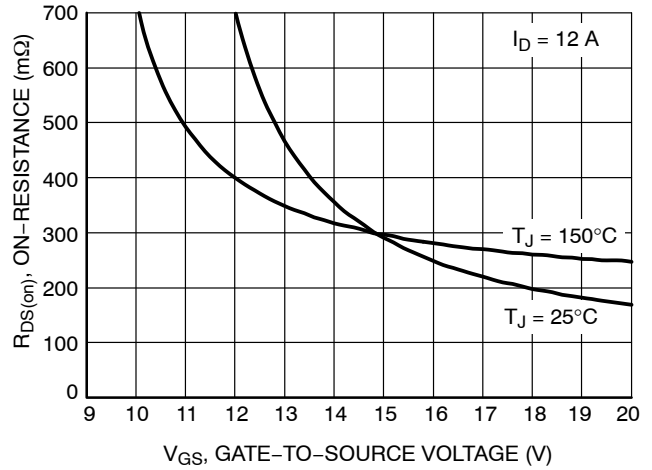


Figure 4. On-Resistance vs. Gate-to-Source Voltage

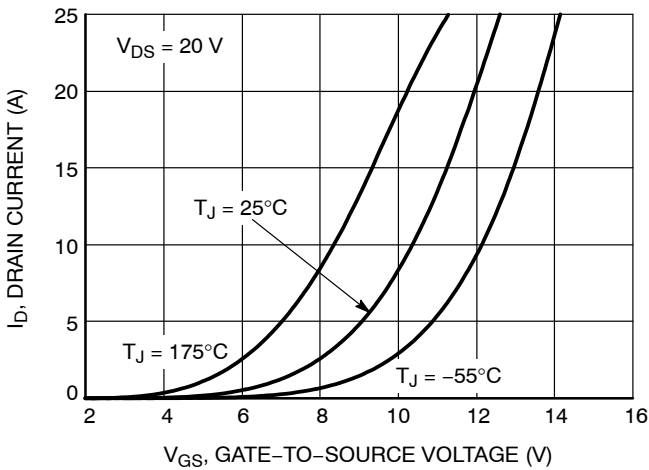


Figure 5. Transfer Characteristics

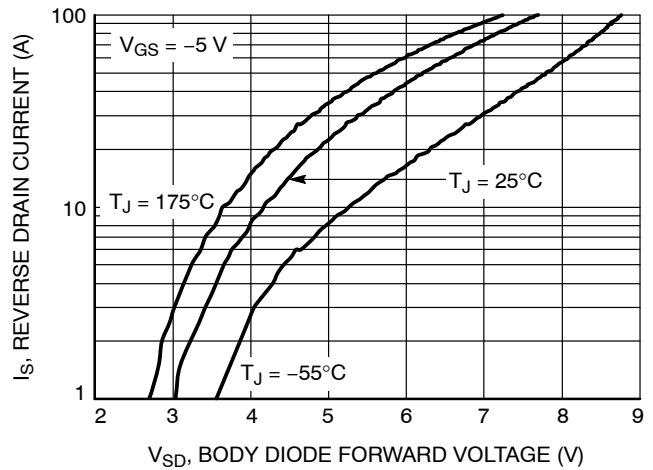
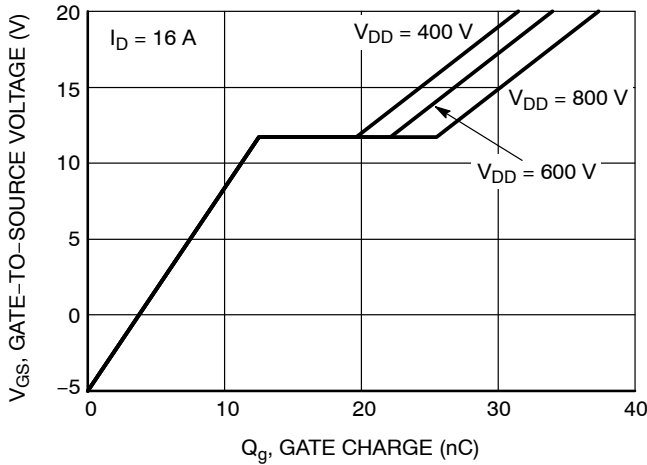


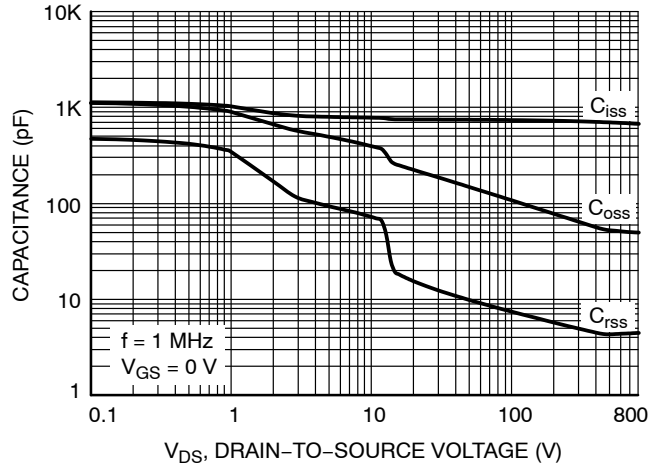
Figure 6. Diode Forward Voltage vs. Current

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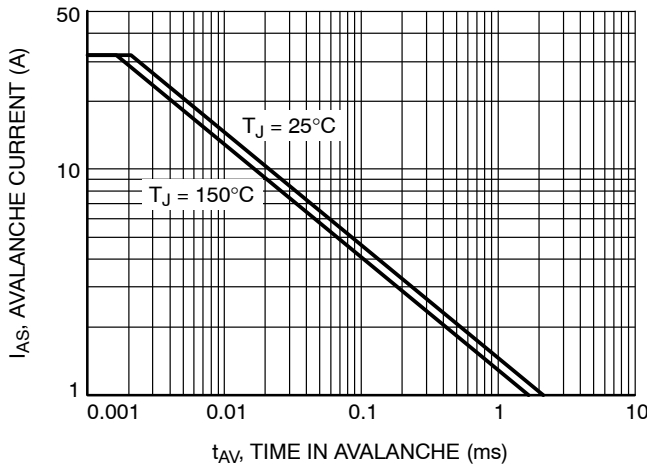
## TYPICAL CHARACTERISTICS (continued)



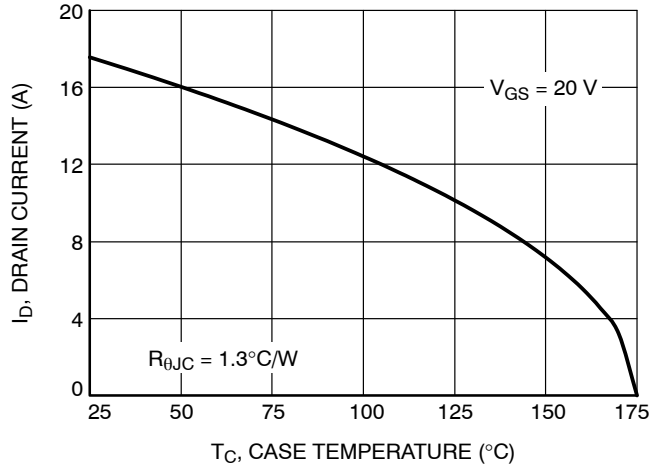
**Figure 7. Gate-to-Source Voltage vs. Total Charge**



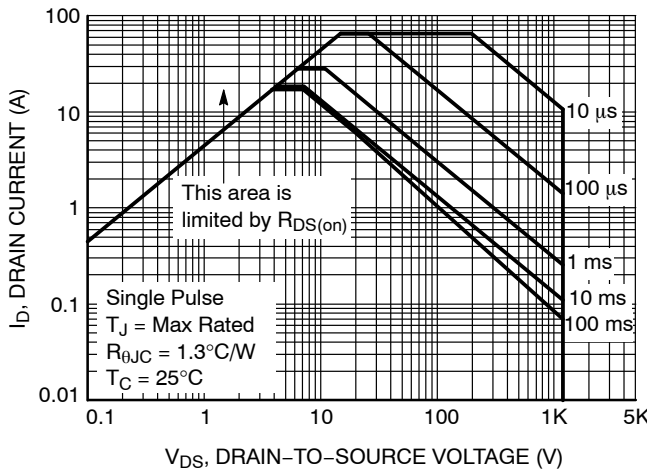
**Figure 8. Capacitance vs. Drain-to-Source Voltage**



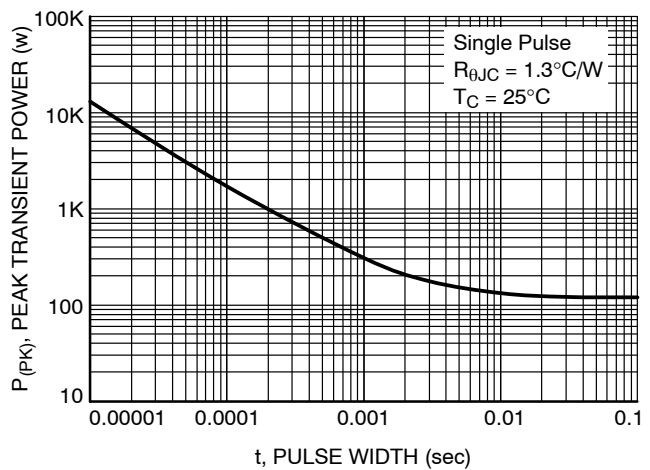
**Figure 9. Unclamped Inductive Switching Capability**



**Figure 10. Maximum Continuous Drain Current vs. Case Temperature**



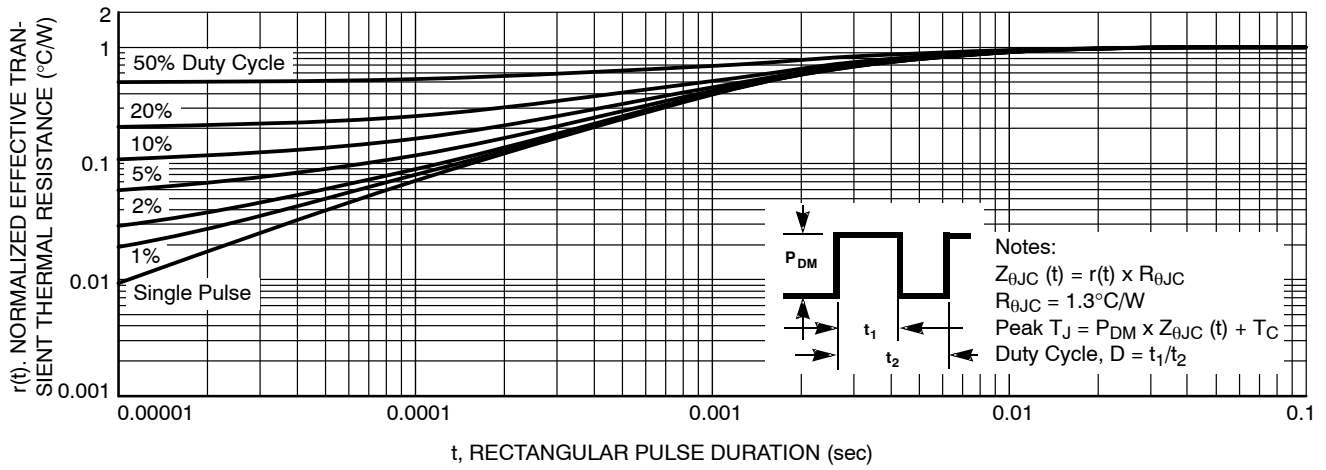
**Figure 11. Safe Operating Area**



**Figure 12. Single Pulse Maximum Power Dissipation**

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## TYPICAL CHARACTERISTICS (continued)



**Figure 13. Junction-to-Ambient Thermal Response**

# MECHANICAL CASE OUTLINE

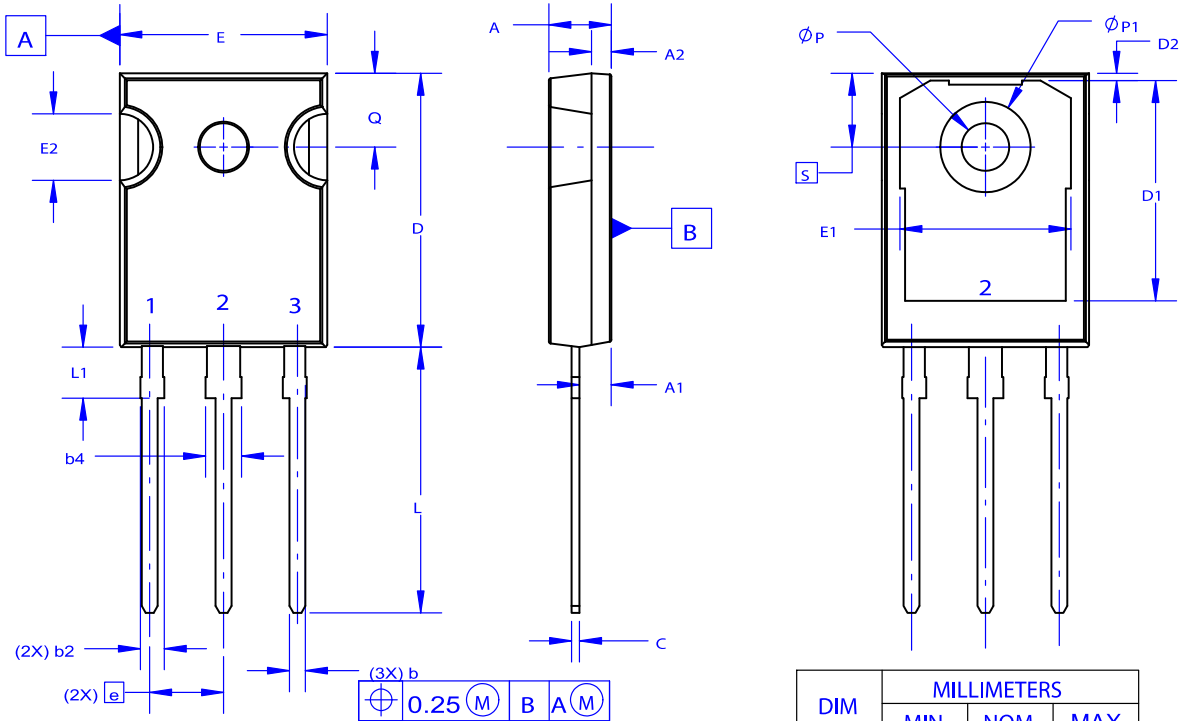
## PACKAGE DIMENSIONS

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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