

# Silicon Carbide (SiC) MOSFET – 20 mohm, 900 V, M1, TO-247-3L

## NTHL020N090SC1

### Features

- Typ.  $R_{DS(on)} = 20\text{ m}\Omega @ V_{GS} = 15\text{ V}$
- Typ.  $R_{DS(on)} = 16\text{ m}\Omega @ V_{GS} = 18\text{ V}$
- Ultra Low Gate Charge ( $Q_{G(tot)} = 196\text{ nC}$ )
- Low Effective Output Capacitance ( $C_{oss} = 296\text{ pF}$ )
- 100% UIL Tested
- This Device is Halide Free and RoHS Compliant with exemption 7a, Pb-Free 2LI (on second level interconnection)

### Typical Applications

- UPS
- DC-DC Converter
- Boost Inverter

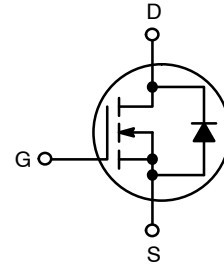
### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Parameter		Symbol	Value	Unit	
Drain-to-Source Voltage		$V_{DSS}$	900	V	
Gate-to-Source Voltage		$V_{GS}$	+22/-8	V	
Recommended Operation Values of Gate - Source Voltage		$T_C < 175^\circ\text{C}$ $V_{GSop}$	+15/-5	V	
Continuous Drain Current $R_{\theta JC}$	Steady State	$T_C = 25^\circ\text{C}$	$I_{DC}$	118	A
			$P_{DC}$	503	W
Continuous Drain Current $R_{\theta JC}$	Steady State	$T_C = 100^\circ\text{C}$	$I_{DC}$	83	A
			$P_{DC}$	251	W
Pulsed Drain Current (Note 2)		$T_A = 25^\circ\text{C}$	$I_{DM}$	472	A
Operating Junction and Storage Temperature Range		$T_J, T_{stg}$	-55 to +175	$^\circ\text{C}$	
Source Current (Body Diode)		$I_S$	153	A	
Single Pulse Drain-to-Source Avalanche Energy ( $I_L = 23\text{ A}_{pk}, L = 1\text{ mH}$ ) (Note 3)		$E_{AS}$	264	mJ	

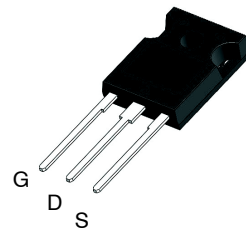
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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 162 mJ is based on starting  $T_J = 25^\circ\text{C}$ ;  $L = 1\text{ mH}$ ,  $I_{AS} = 23\text{ A}$ ,  $V_{DD} = 100\text{ V}$ ,  $V_{GS} = 15\text{ V}$ .

$V_{(BR)DSS}$	$R_{DS(ON)}\text{ MAX}$	$I_D\text{ MAX}$
900 V	28 m $\Omega$ @ 15 V	118 A



N-CHANNEL MOSFET



TO-247 LONG LEADS  
CASE 340CX

### MARKING DIAGRAM



- \$Y = onsemi Logo
- &Z = Assembly Plant Code
- &3 = Date Code (Year & Week)
- &K = Lot
- NTHL020N090SC1 = Specific Device Code

### ORDERING INFORMATION

Device	Package	Shipping
NTHL020N090SC1	TO-247 Long Lead	30 Units / Tube

# NTHL020N090SC1

**Table 1. THERMAL CHARACTERISTICS**

Parameter	Symbol	Max	Unit
Thermal Resistance Junction-to-Case (Note 1)	$R_{\theta JC}$	0.30	°C/W
Thermal Resistance Junction-to-Ambient (Note 1)	$R_{\theta JA}$	40	°C/W

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

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit	
<b>OFF CHARACTERISTICS</b>							
Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	900			V	
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	$I_D = 1\text{ mA}$ , refer to $25^\circ\text{C}$		500		mV/°C	
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}, V_{DS} = 900\text{ V}$	$T_J = 25^\circ\text{C}$		100	$\mu\text{A}$	
			$T_J = 175^\circ\text{C}$		250	$\mu\text{A}$	
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{GS} = +22/-8\text{ V}, V_{DS} = 0\text{ V}$			$\pm 1$	$\mu\text{A}$	
<b>ON CHARACTERISTICS</b>							
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 20\text{ mA}$	1.8	2.7	4.3	V	
Recommended Gate Voltage	$V_{GOP}$		-5		+15	V	
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 15\text{ V}, I_D = 60\text{ A}, T_J = 25^\circ\text{C}$		20	28	m $\Omega$	
		$V_{GS} = 18\text{ V}, I_D = 60\text{ A}, T_J = 25^\circ\text{C}$		16			
		$V_{GS} = 15\text{ V}, I_D = 60\text{ A}, T_J = 175^\circ\text{C}$		27			
Forward Transconductance	$g_{FS}$	$V_{DS} = 20\text{ V}, I_D = 60\text{ A}$		49		S	
<b>CHARGES, CAPACITANCES &amp; GATE RESISTANCE</b>							
Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 450\text{ V}$		4415		pF	
Output Capacitance	$C_{OSS}$			296			
Reverse Transfer Capacitance	$C_{RSS}$			24			
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = -5/15\text{ V}, V_{DS} = 720\text{ V}, I_D = 60\text{ A}$		196		nC	
Threshold Gate Charge	$Q_{G(TH)}$			42			
Gate-to-Source Charge	$Q_{GS}$			78			
Gate-to-Drain Charge	$Q_{GD}$			55			
Gate-Resistance	$R_G$		$f = 1\text{ MHz}$		1.6		$\Omega$
<b>SWITCHING CHARACTERISTICS</b>							
Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = -5/15\text{ V}, V_{DS} = 720\text{ V}, I_D = 60\text{ A}, R_G = 2.5\ \Omega,$ Inductive Load		40		ns	
Rise Time	$t_r$			63			
Turn-Off Delay Time	$t_{d(OFF)}$			55			
Fall Time	$t_f$			13			
Turn-On Switching Loss	$E_{ON}$				2025		$\mu\text{J}$
Turn-Off Switching Loss	$E_{OFF}$				201		
Total Switching Loss	$E_{TOT}$				2226		
<b>DRAIN-SOURCE DIODE CHARACTERISTICS</b>							
Continuous Drain-Source Diode Forward Current	$I_{SD}$	$V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$			153	A	
Pulsed Drain-Source Diode Forward Current (Note 2)	$I_{SDM}$	$V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$			472	A	
Forward Diode Voltage	$V_{SD}$	$V_{GS} = -5\text{ V}, I_{SD} = 30\text{ A}, T_J = 25^\circ\text{C}$		3.8		V	

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

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
<b>DRAIN-SOURCE DIODE CHARACTERISTICS</b>						
Reverse Recovery Time	$t_{RR}$	$V_{GS} = -5/15\text{ V}, I_{SD} = 60\text{ A},$ $di_S/dt = 1000\text{ A}/\mu\text{s}, V_{DS} = 720\text{ V}$		28		ns
Reverse Recovery Charge	$Q_{RR}$			199		nC
Reverse Recovery Energy	$E_{REC}$			4		$\mu\text{J}$
Peak Reverse Recovery Current	$I_{RRM}$			14		A
Charge Time	$T_a$			16		ns
Discharge Time	$T_b$			12		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.

TYPICAL CHARACTERISTICS

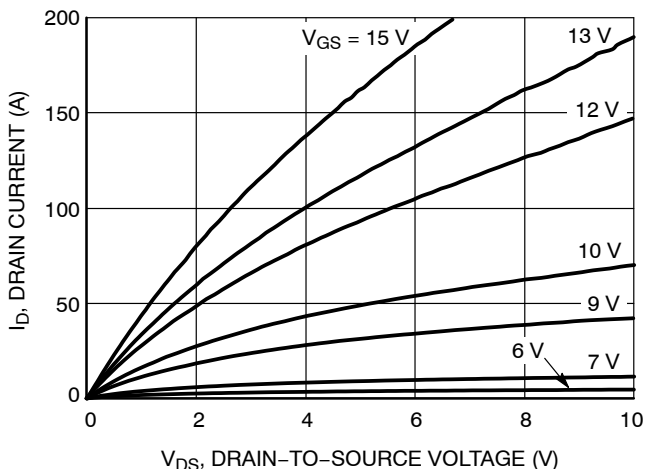


Figure 1. On-Region Characteristics

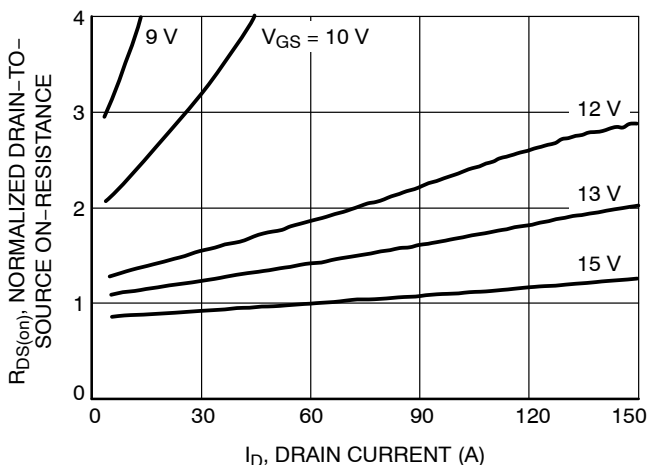


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

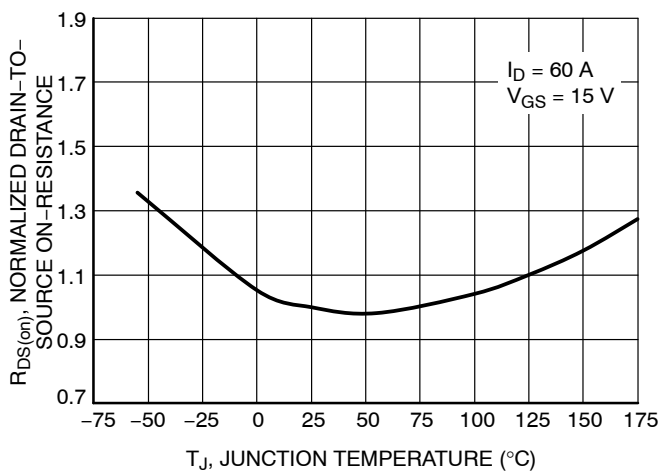


Figure 3. On-Resistance Variation with Temperature

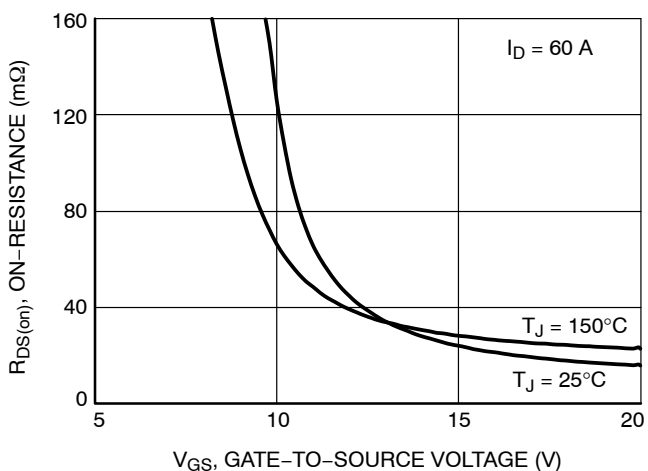


Figure 4. On-Resistance vs. Gate-to-Source Voltage

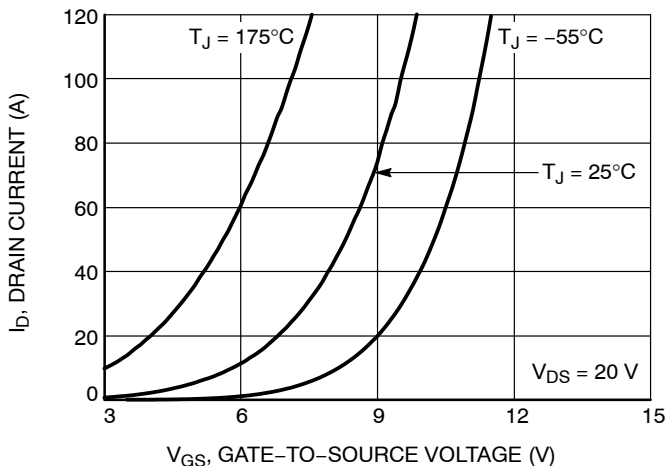


Figure 5. Transfer Characteristics

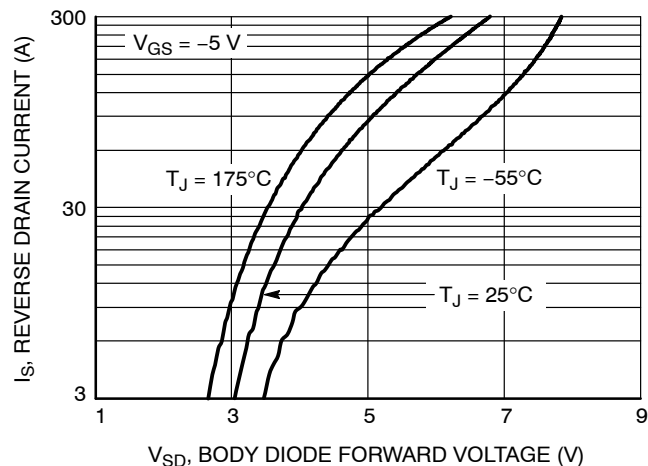


Figure 6. Diode Forward Voltage vs. Current

TYPICAL CHARACTERISTICS (continued)

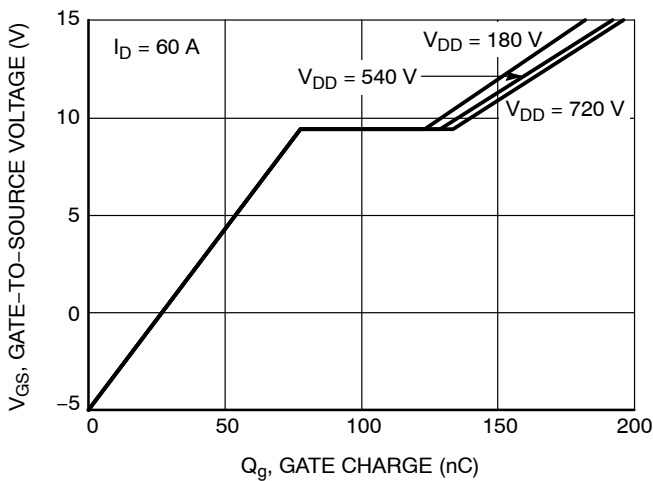


Figure 7. Gate-to-Source Voltage vs. Total Charge

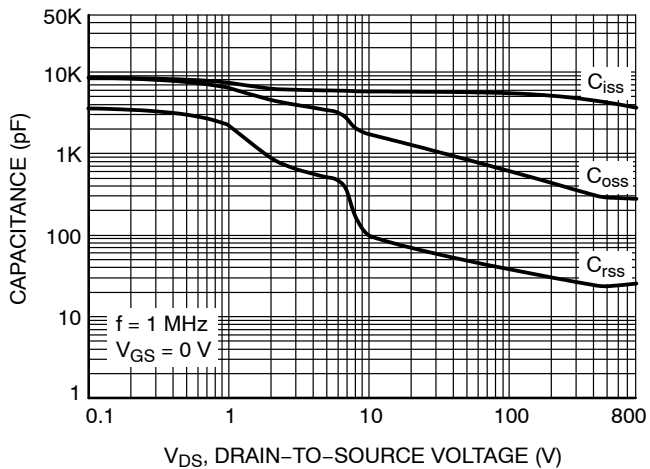


Figure 8. Capacitance vs. Drain-to-Source Voltage

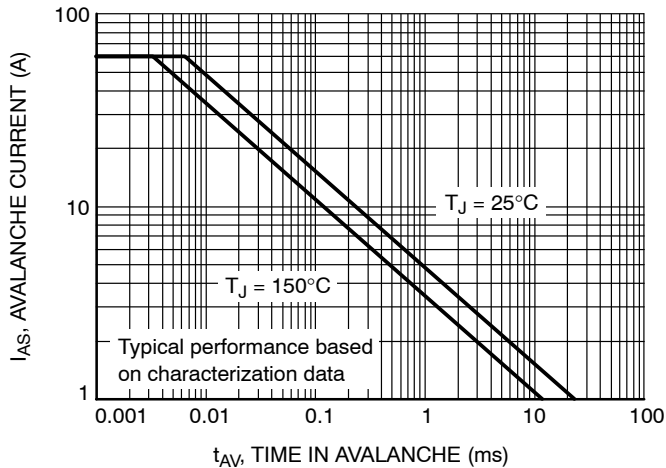


Figure 9. Unclamped Inductive Switching Capability

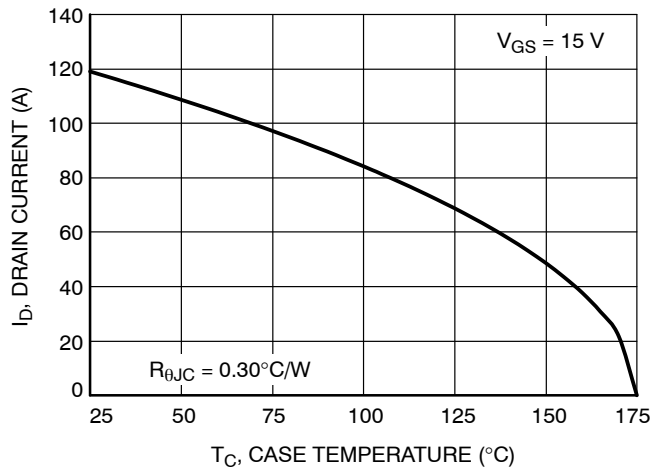


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

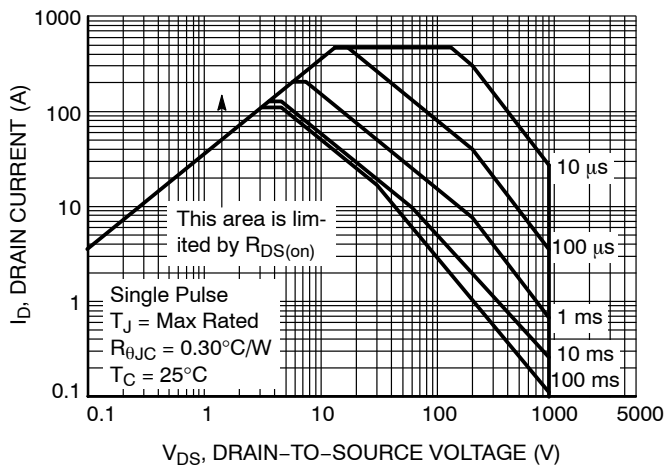


Figure 11. Safe Operating Area

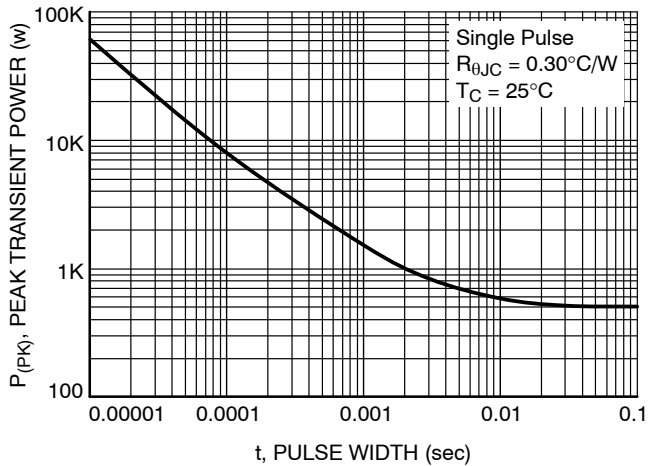


Figure 12. Single Pulse Maximum Power Dissipation

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## TYPICAL CHARACTERISTICS (continued)

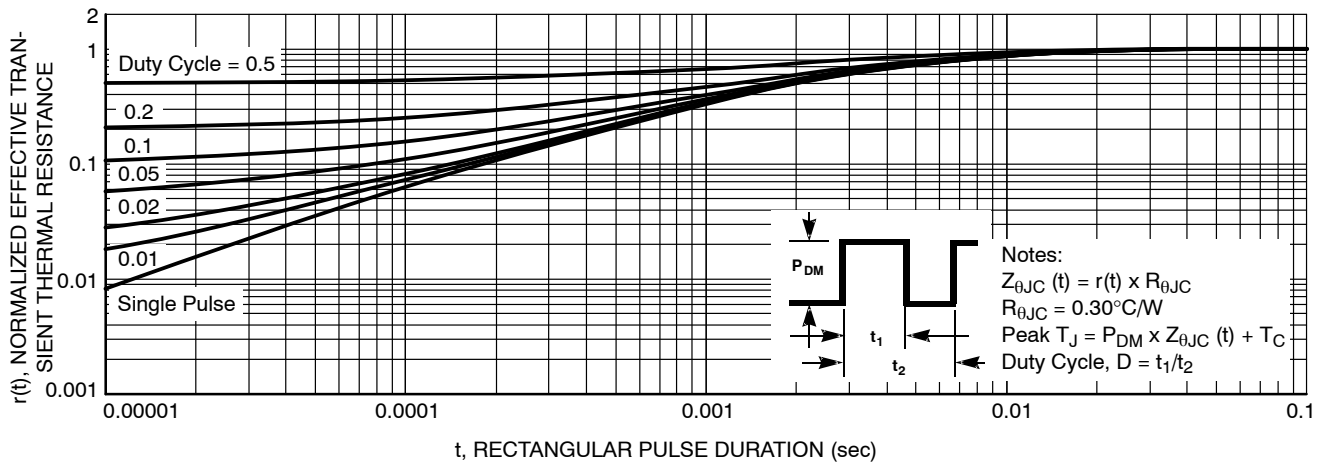


Figure 13. Junction-to-Ambient Transient Thermal Response Curve

# MECHANICAL CASE OUTLINE

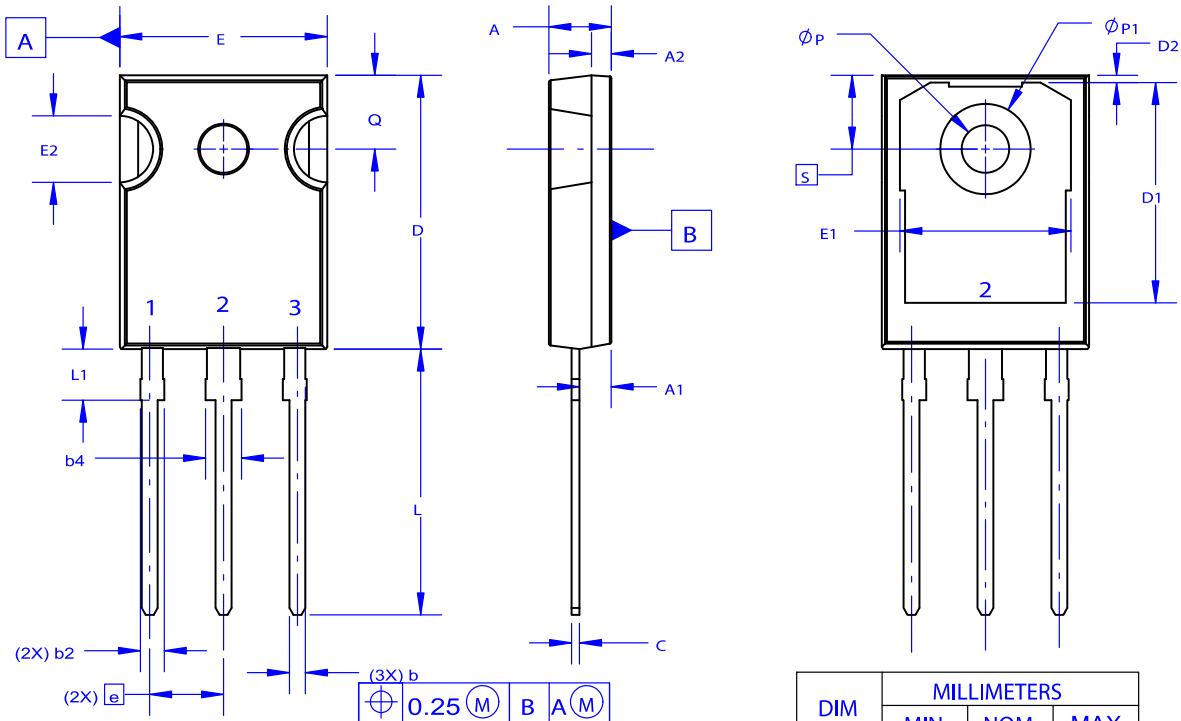
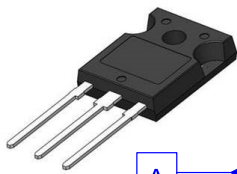
## PACKAGE DIMENSIONS

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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