

# Silicon Carbide (SiC) MOSFET – 60 mohm, 900 V, M2, TO-247-4L

## NVH4L060N090SC1

### Features

- Typ.  $R_{DS(on)} = 60\text{ m}\Omega @ V_{GS} = 15\text{ V}$   
Typ.  $R_{DS(on)} = 43\text{ m}\Omega @ V_{GS} = 18\text{ V}$
- Ultra Low Gate Charge (typ.  $Q_{G(tot)} = 87\text{ nC}$ )
- Low Effective Output Capacitance (typ.  $C_{oss} = 113\text{ pF}$ )
- 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	$V_{DSS}$	900	V
Gate-to-Source Voltage	$V_{GS}$	+22/-8	V
Recommended Operation Values of Gate-to-Source Voltage	$T_C < 175^\circ\text{C}$ $V_{GSop}$	-5/+15	V
Continuous Drain Current $R_{\theta JC}$	Steady State $T_C = 25^\circ\text{C}$	$I_D$	46 A
Power Dissipation $R_{\theta JC}$		$P_D$	221 W
Continuous Drain Current $R_{\theta JC}$	Steady State $T_C = 100^\circ\text{C}$	$I_D$	32 A
Power Dissipation $R_{\theta JC}$		$P_D$	110 W
Pulsed Drain Current (Note 2)	$T_A = 25^\circ\text{C}$	$I_{DM}$	211 A
Single Pulse Surge Drain Current Capability (Note 3)	$T_A = 25^\circ\text{C}, t_p = 10\text{ }\mu\text{s}, R_G = 4.7\text{ }\Omega$	$I_{DSC}$	320 A
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55 to +175	$^\circ\text{C}$
Source Current (Body Diode)	$I_S$	22	A
Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 18\text{ A}, L = 1\text{ mH}$ ) (Note 4)	$E_{AS}$	162	mJ

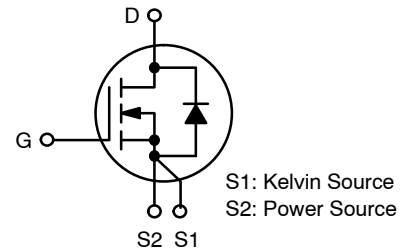
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### THERMAL RESISTANCE MAXIMUM RATINGS

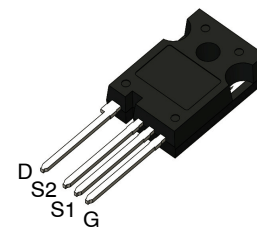
Parameter	Symbol	Value	Unit
Junction-to-Case (Note 1)	$R_{\theta JC}$	0.68	$^\circ\text{C}/\text{W}$
Junction-to-Ambient (Note 1)	$R_{\theta JA}$	40	$^\circ\text{C}/\text{W}$

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. Peak current might be limited by transconductance.
4.  $E_{AS}$  of 162 mJ is based on starting  $T_J = 25^\circ\text{C}$ ;  $L = 1\text{ mH}$ ,  $I_{AS} = 18\text{ A}$ ,  $V_{DD} = 100\text{ V}$ ,  $V_{GS} = 15\text{ V}$ .

$V_{(BR)DSS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
900 V	84 m $\Omega$ @ 15 V	46 A

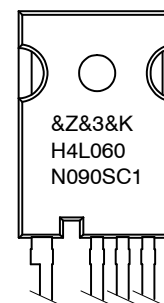


N-CHANNEL MOSFET



TO247-4L  
CASE 340CJ

### MARKING DIAGRAM



&Z = Assembly Plant Code  
&3 = Data Code (Year & Week)  
&K = Lot  
NVH4L060N090SC1 = Specific Device Code

### ORDERING INFORMATION

Device	Package	Shipping
NVH4L060N090SC1	TO247-4L	30 Units / Tube

# NVH4L060N090SC1

## ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	900			V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	$I_D = 1\text{ mA}$ , referenced to $25^\circ\text{C}$		574		mV/ $^\circ\text{C}$
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}, V_{DS} = 900\text{ V}, T_J = 25^\circ\text{C}$			100	$\mu\text{A}$
		$V_{GS} = 0\text{ V}, V_{DS} = 900\text{ V}, T_J = 175^\circ\text{C}$			250	
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{GS} = +22/-8\text{ V}, V_{DS} = 0\text{ V}$			$\pm 1$	$\mu\text{A}$

### ON CHARACTERISTICS

Gate Threshold Voltage	$V_{GS(th)}$	$V_{GS} = V_{DS}, I_D = 5\text{ mA}$	1.8	2.7	4.3	V
Recommended Gate Voltage	$V_{GOP}$		-5		+15	V
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 15\text{ V}, I_D = 20\text{ A}, T_J = 25^\circ\text{C}$		60	84	m $\Omega$
		$V_{GS} = 18\text{ V}, I_D = 20\text{ A}, T_J = 25^\circ\text{C}$		43		
		$V_{GS} = 15\text{ V}, I_D = 20\text{ A}, T_J = 175^\circ\text{C}$		76		
Forward Transconductance	$g_{FS}$	$V_{DS} = 20\text{ V}, I_D = 20\text{ A}$		17		S

### CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 450\text{ V}$		1770		pF
Output Capacitance	$C_{OSS}$			113		
Reverse Transfer Capacitance	$C_{RSS}$			11		
Total Gate Charge	$Q_{G(tot)}$	$V_{GS} = -5/15\text{ V}, V_{DS} = 720\text{ V}, I_D = 10\text{ A}$		87		nC
Threshold Gate Charge	$Q_{G(th)}$			17		
Gate-to-Source Charge	$Q_{GS}$			27		
Gate-to-Drain Charge	$Q_{GD}$			26		
Gate Resistance	$R_G$		$f = 1\text{ MHz}$		3.0	

### SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(on)}$	$V_{GS} = -5/15\text{ V}, V_{DS} = 720\text{ V}, I_D = 20\text{ A}, R_G = 2.5\text{ }\Omega$ , Inductive Load		17	31	ns
Rise Time	$t_r$			15	27	
Turn-Off Delay Time	$t_{d(off)}$			29	47	
Fall Time	$t_f$			11	20	
Turn-On Switching Loss	$E_{ON}$			183		$\mu\text{J}$
Turn-Off Switching Loss	$E_{OFF}$			52		
Total Switching Loss	$E_{TOT}$			235		

### DRAIN-SOURCE DIODE CHARACTERISTICS

Continuous Drain-to-Source Diode Forward Current	$I_{SD}$	$V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$			22	A
Pulsed Drain-to-Source Diode Forward Current (Note 2)	$I_{SDM}$	$V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$			184	A
Forward Diode Voltage	$V_{SD}$	$V_{GS} = -5\text{ V}, I_{SD} = 10\text{ A}, T_J = 25^\circ\text{C}$		3.9		V
Reverse Recovery Time	$t_{RR}$	$V_{GS} = -5/15\text{ V}, I_{SD} = 30\text{ A}, di_S/dt = 1000\text{ A}/\mu\text{s}, V_{DS} = 720\text{ V}$		18		ns
Reverse Recovery Charge	$Q_{RR}$			84		nC
Reverse Recovery Energy	$E_{REC}$			1.0		$\mu\text{J}$
Peak Reverse Recovery Current	$I_{RRM}$			9.0		A
Charge Time	$t_a$			10		ns
Discharge Time	$t_b$			8.0		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

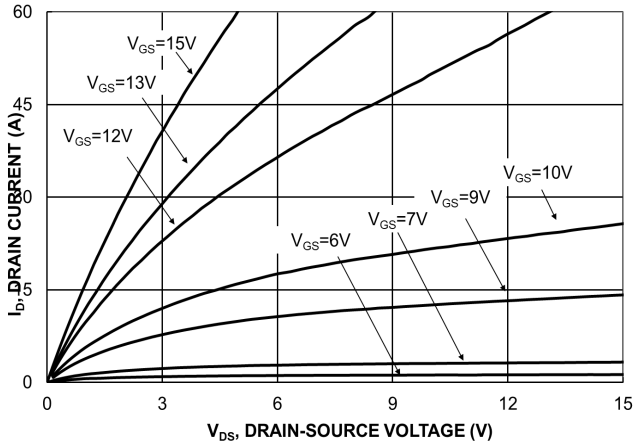


Figure 1. On-Region Characteristics

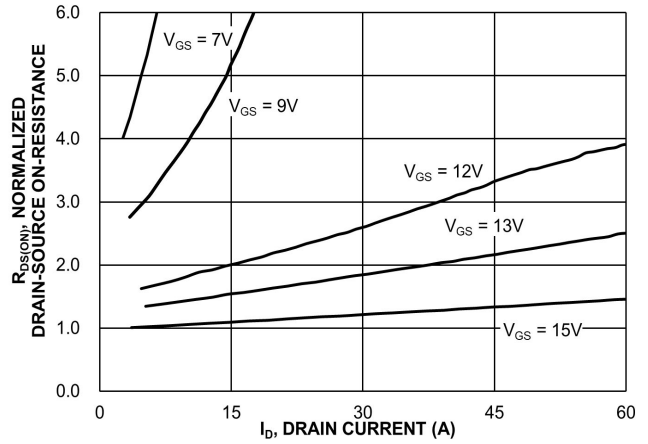


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

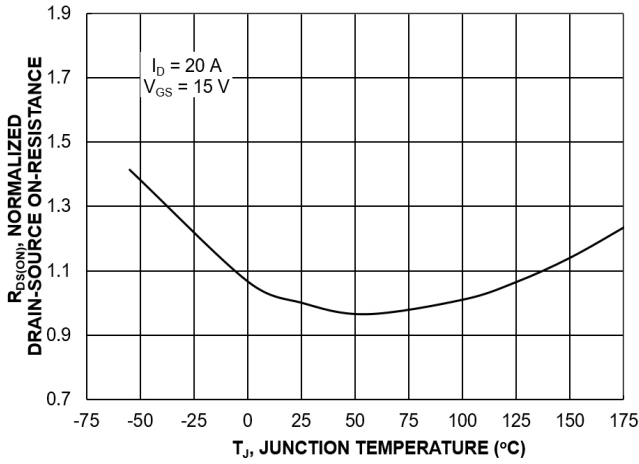


Figure 3. On-Resistance Variation with Temperature

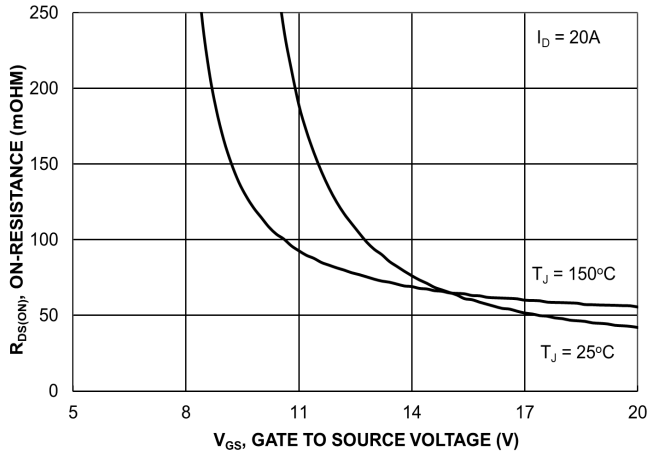


Figure 4. On-Resistance vs. Gate-to-Source Voltage

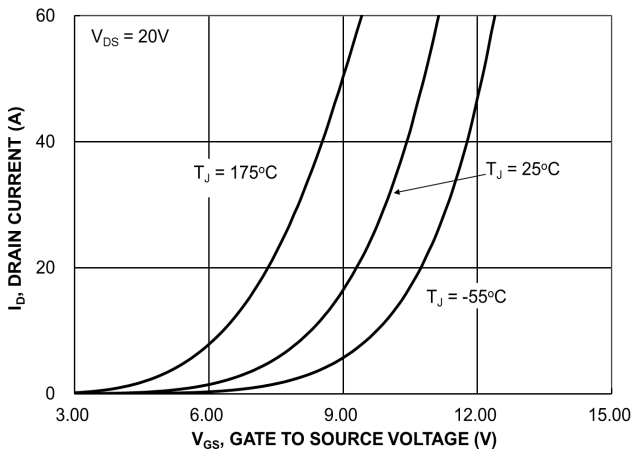


Figure 5. Transfer Characteristics

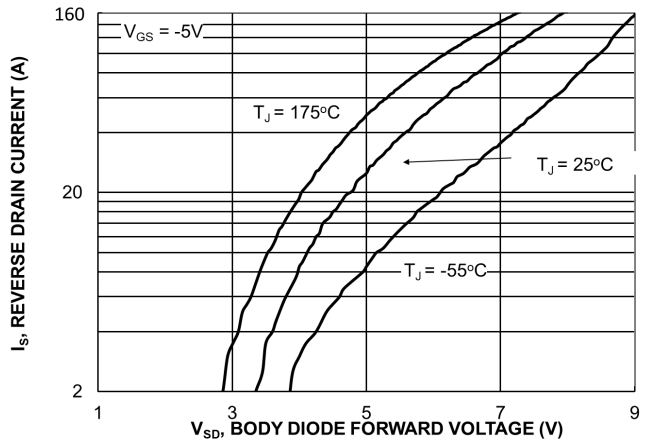


Figure 6. Diode Forward Voltage vs. Current

TYPICAL CHARACTERISTICS (continued)

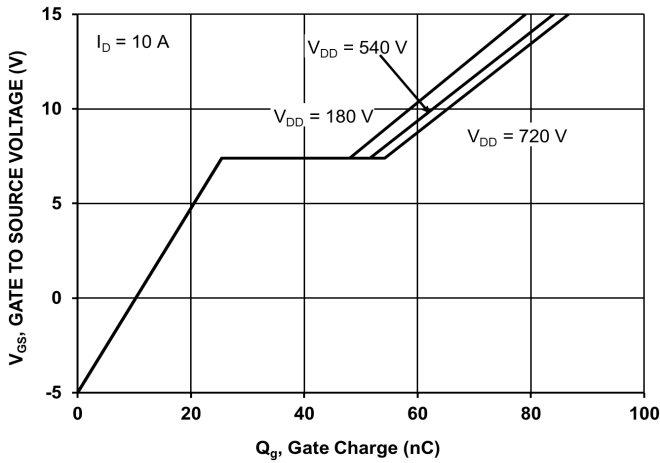


Figure 7. Gate-to-Source Voltage vs. Total Charge

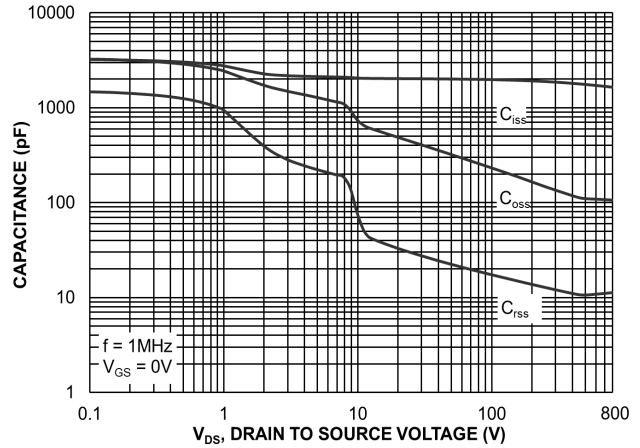


Figure 8. Capacitance vs. Drain-to-Source Voltage

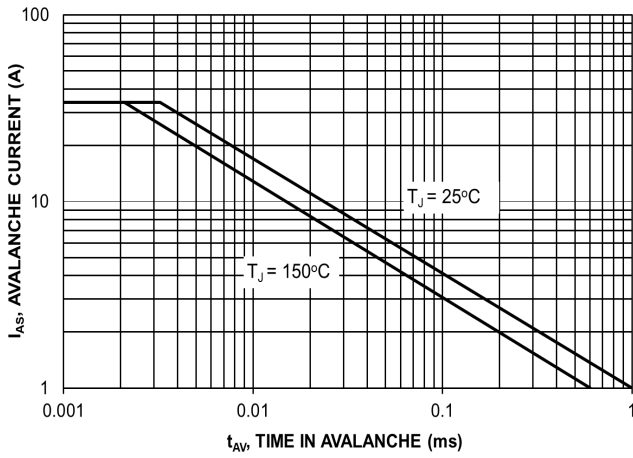


Figure 9. Unclamped Inductive Switching Capability

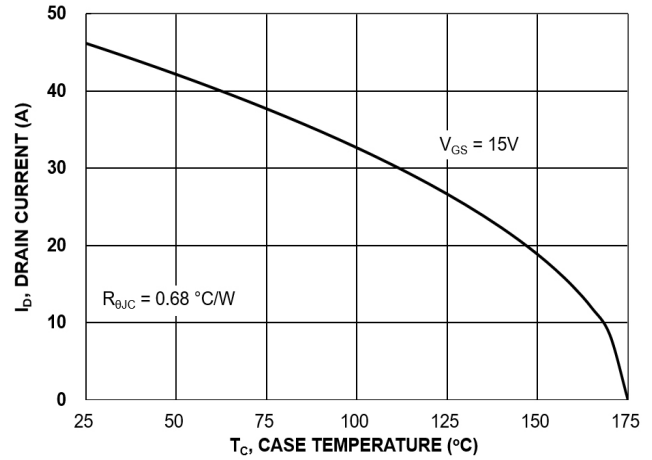


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

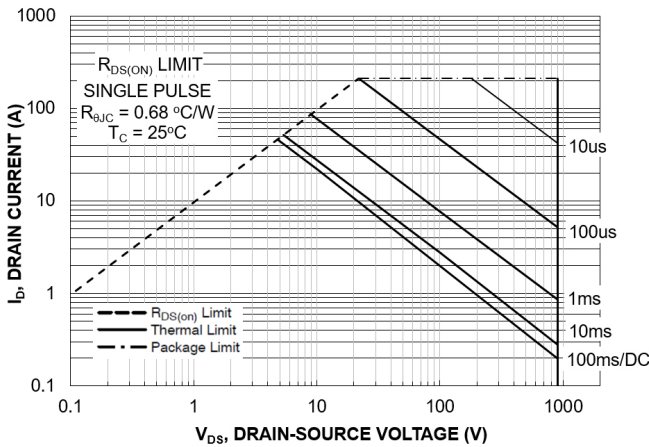


Figure 11. Safe Operating Area

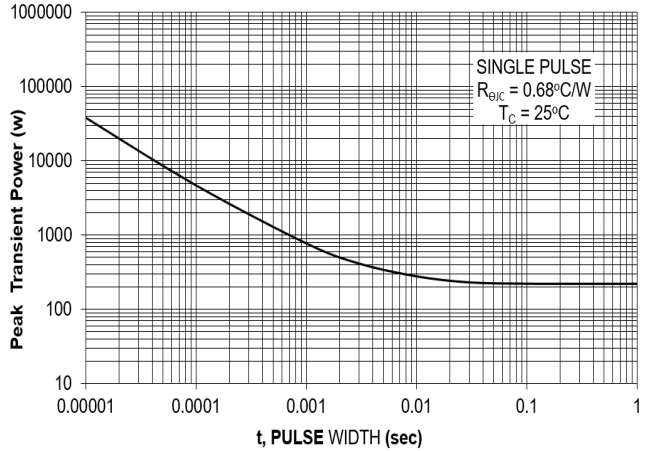


Figure 12. Single Pulse Maximum Power Dissipation

TYPICAL CHARACTERISTICS (continued)

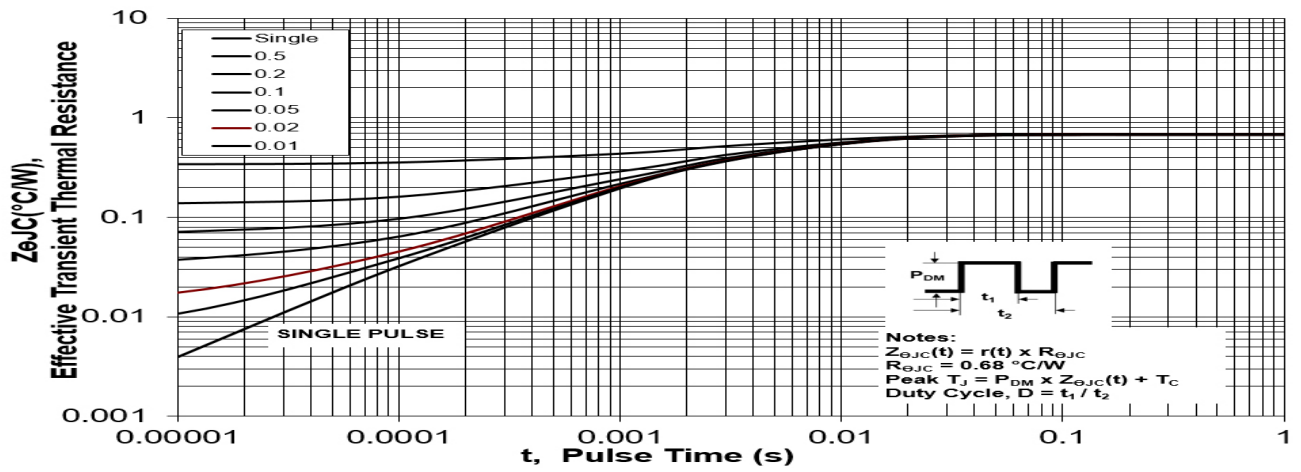
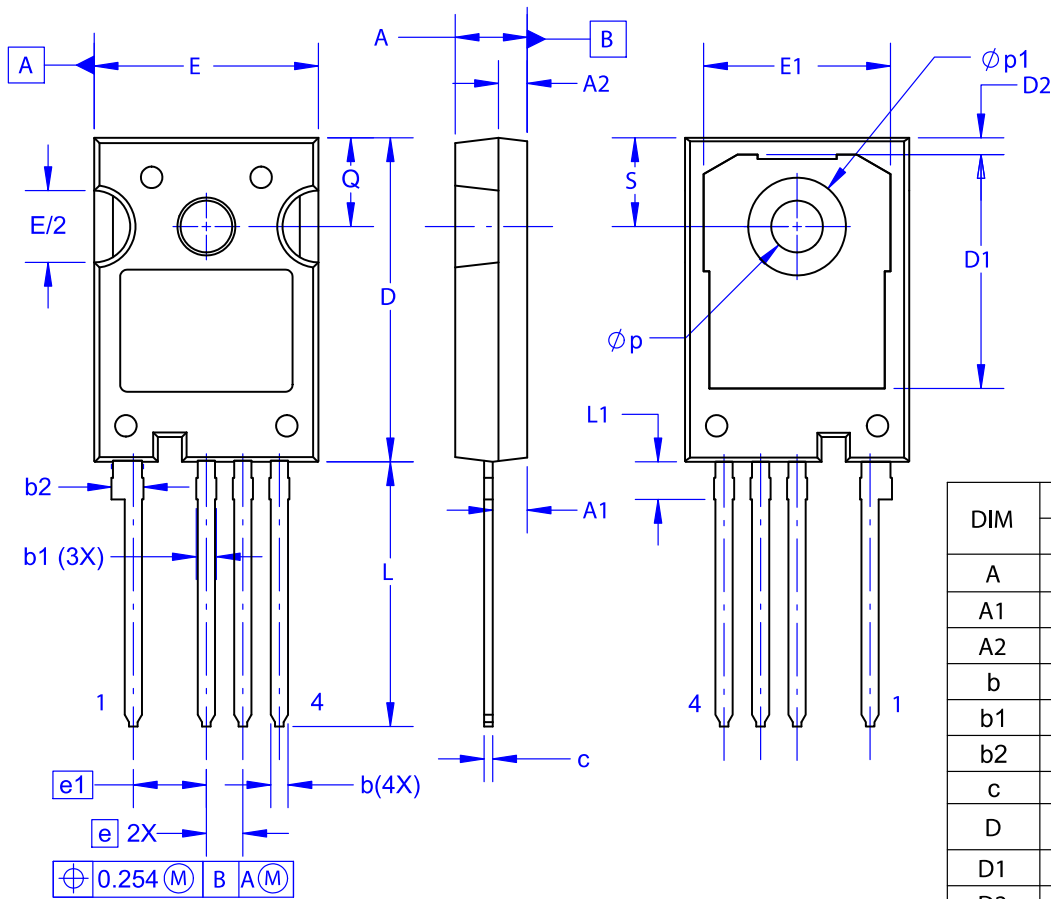


Figure 13. Junction-to-Ambient Thermal Response

**TO-247-4LD**  
**CASE 340CJ**  
**ISSUE A**

DATE 16 SEP 2019



DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.80	5.00	5.20
A1	2.10	2.40	2.70
A2	1.80	2.00	2.20
b	1.07	1.20	1.33
b1	1.20	1.40	1.60
b2	2.02	2.22	2.42
c	0.50	0.60	0.70
D	22.34	22.54	22.74
D1	16.00	16.25	16.50
D2	0.97	1.17	1.37
e	2.54 BSC		
e1	5.08 BSC		
E	15.40	15.60	15.80
E1	12.80	13.00	13.20
E/2	4.80	5.00	5.20
L	18.22	18.42	18.62
L1	2.42	2.62	2.82
p	3.40	3.60	3.80
p1	6.60	6.80	7.00
Q	5.97	6.17	6.37
S	5.97	6.17	6.37

NOTES:

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- B. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- C. ALL DIMENSIONS ARE IN MILLIMETERS.
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