

# MOSFET - SiC Power, Single N-Channel

## 1200 V, 40 mΩ, 60 A

### NVHL040N120SC1

#### Features

- Typ.  $R_{DS(on)} = 40 \text{ m}\Omega$
- Ultra Low Gate Charge (typ.  $Q_{G(tot)} = 106 \text{ nC}$ )
- Low Effective Output Capacitance (typ.  $C_{oss} = 140 \text{ pF}$ )
- 100% UIL Tested
- Qualified According to AEC-Q101
- These Devices are RoHS Compliant

#### 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 $R_{\theta JC}$	Steady State $T_C = 25^\circ\text{C}$	$I_D$	60	A
		Power Dissipation $R_{\theta JC}$	$P_D$	348
Continuous Drain Current $R_{\theta JC}$	Steady State $T_C = 100^\circ\text{C}$	$I_D$	42	A
		Power Dissipation $R_{\theta JC}$	$P_D$	174
Pulsed Drain Current (Note 2)	$T_A = 25^\circ\text{C}$	$I_{DM}$	240	A
Single Pulse Surge Drain Current Capability	$T_A = 25^\circ\text{C}$ , $t_p = 10 \mu\text{s}$ , $R_G = 4.7 \Omega$	$I_{DSC}$	416	A
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55 to +175	$^\circ\text{C}$	
Source Current (Body Diode)	$I_S$	34	A	
Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 23 \text{ A}$ , $L = 1 \text{ mH}$ ) (Note 3)	$E_{AS}$	613	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)	$R_{\theta JC}$	0.43	$^\circ\text{C}/\text{W}$
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.  $E_{AS}$  of 613 mJ is based on starting  $T_J = 25^\circ\text{C}$ ;  $L = 1 \text{ mH}$ ,  $I_{AS} = 35 \text{ A}$ ,  $V_{DD} = 120 \text{ V}$ ,  $V_{GS} = 20 \text{ V}$ .

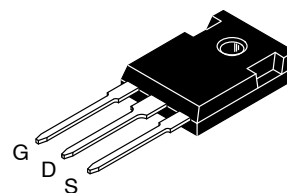
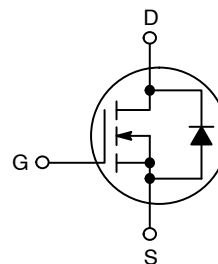


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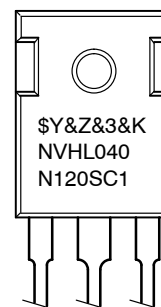
$V_{(BR)DSS}$	$R_{DS(on)} \text{ MAX}$	$I_D \text{ MAX}$
1200 V	56 mΩ @ 20 V	60 A

#### N-CHANNEL MOSFET



TO-247-3LD  
CASE 340CX

#### MARKING DIAGRAM



\$Y = ON Semiconductor Logo  
 &Z = Assembly Plant Code  
 &3 = Data Code (Year & Week)  
 &K = Lot  
 NVHL040N120SC1 = Specific Device Code

#### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

# NVHL040N120SC1

## ELECTRICAL CHARACTERISTICS

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

Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	1200	-	-	V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	$I_D = 1\text{ mA}$ , referenced to $25^\circ\text{C}$	-	450	-	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	$V_{GS(th)}$	$V_{GS} = V_{DS}, I_D = 10\text{ mA}$	1.8	2.97	4.3	V
Recommended Gate Voltage	$V_{GOP}$		-5	-	+20	V
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 20\text{ V}, I_D = 35\text{ A}, T_J = 25^\circ\text{C}$	-	39	56	m $\Omega$
		$V_{GS} = 20\text{ V}, I_D = 35\text{ A}, T_J = 175^\circ\text{C}$	-	67	100	
Forward Transconductance	$g_{FS}$	$V_{DS} = 20\text{ V}, I_D = 35\text{ A}$	-	20	-	S

### CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$	-	1781	-	$\mu\text{F}$
Output Capacitance	$C_{OSS}$		-	140	-	
Reverse Transfer Capacitance	$C_{RSS}$		-	12	-	
Total Gate Charge	$Q_{G(tot)}$	$V_{GS} = -5/20\text{ V}, V_{DS} = 600\text{ V}, I_D = 47\text{ A}$	-	106	-	nC
Threshold Gate Charge	$Q_{G(th)}$		-	16	-	
Gate-to-Source Charge	$Q_{GS}$		-	34	-	
Gate-to-Drain Charge	$Q_{GD}$		-	26	-	
Gate Resistance	$R_G$		$f = 1\text{ MHz}$	-	2.2	

### SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(on)}$	$V_{GS} = -5/20\text{ V}, V_{DS} = 800\text{ V},$ $I_D = 47\text{ A}, R_G = 4.7\text{ }\Omega,$ Inductive Load	-	18	-	ns
Rise Time	$t_r$		-	41	-	
Turn-Off Delay Time	$t_{d(off)}$		-	33	-	
Fall Time	$t_f$		-	10.4	-	
Turn-On Switching Loss	$E_{ON}$		-	1003	-	$\mu\text{J}$
Turn-Off Switching Loss	$E_{OFF}$		-	247	-	
Total Switching Loss	$E_{TOT}$		-	1248	-	

### DRAIN-SOURCE DIODE CHARACTERISTICS

Continuous Drain-to-Source Diode Forward Current	$I_{SD}$	$V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$	-	-	34	A
Pulsed Drain-to-Source Diode Forward Current (Note 2)	$I_{SDM}$	$V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$	-	-	240	A
Forward Diode Voltage	$V_{SD}$	$V_{GS} = -5\text{ V}, I_{SD} = 17.5\text{ A}, T_J = 25^\circ\text{C}$	-	3.8	-	V
Reverse Recovery Time	$t_{RR}$	$V_{GS} = -5/20\text{ V}, I_{SD} = 47\text{ A},$ $di_s/dt = 1000\text{ A}/\mu\text{s}$	-	24	-	ns
Reverse Recovery Charge	$Q_{RR}$		-	125	-	nC
Reverse Recovery Energy	$E_{REC}$		-	8.5	-	$\mu\text{J}$
Peak Reverse Recovery Current	$I_{RRM}$		-	10.4	-	A
Charge Time	$t_a$		-	12.4	-	ns
Discharge Time	$t_b$		-	11.6	-	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

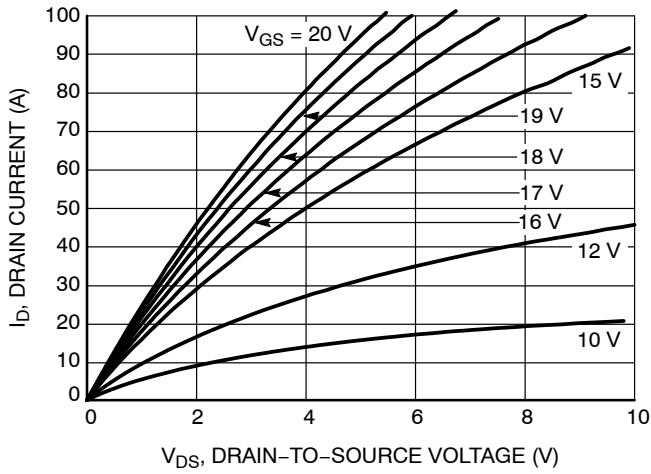


Figure 1. On-Region Characteristics

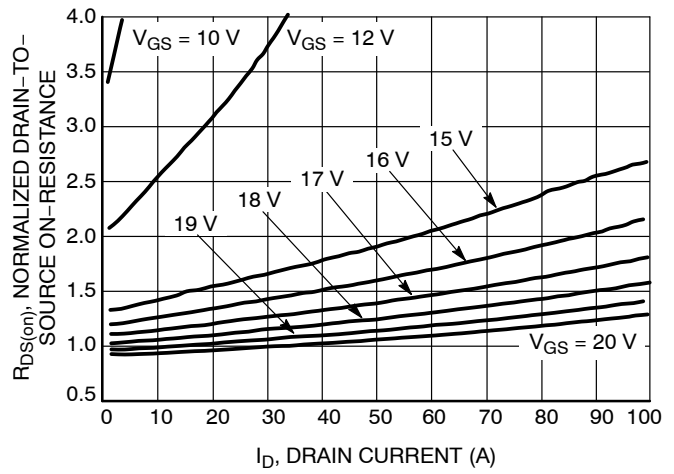


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

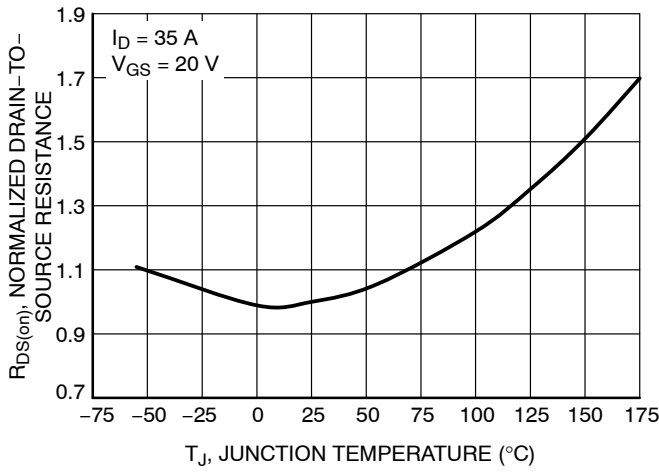


Figure 3. On-Resistance Variation with Temperature

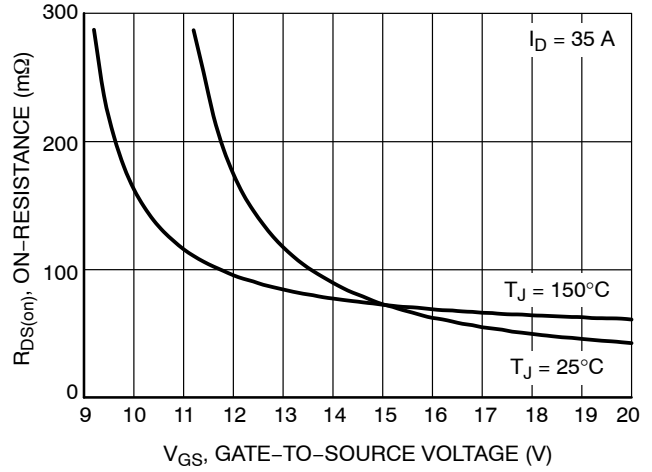


Figure 4. On-Resistance vs. Gate-to-Source Voltage

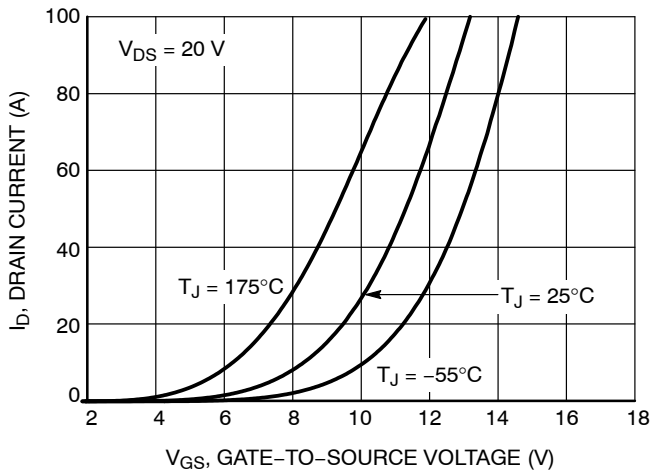


Figure 5. Transfer Characteristics

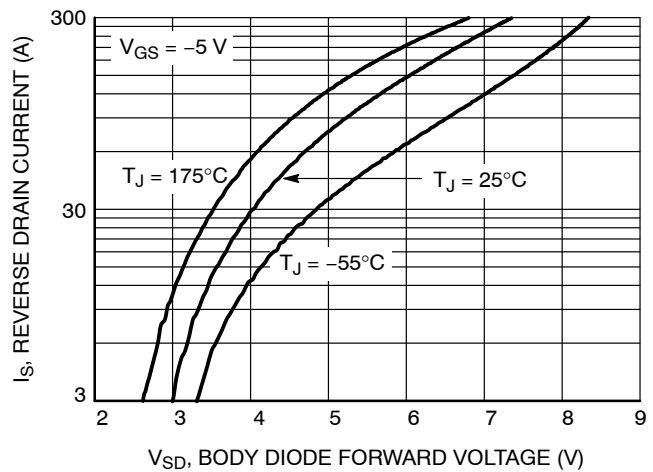
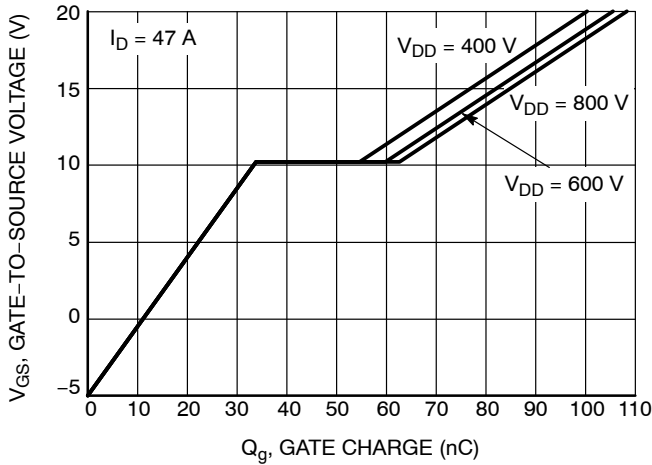


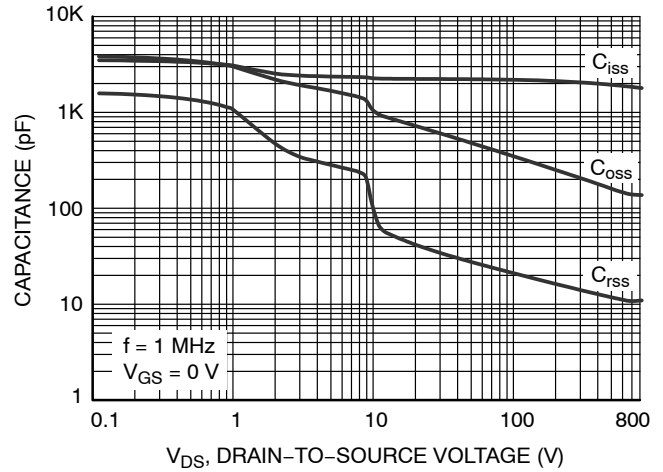
Figure 6. Diode Forward Voltage vs. Current

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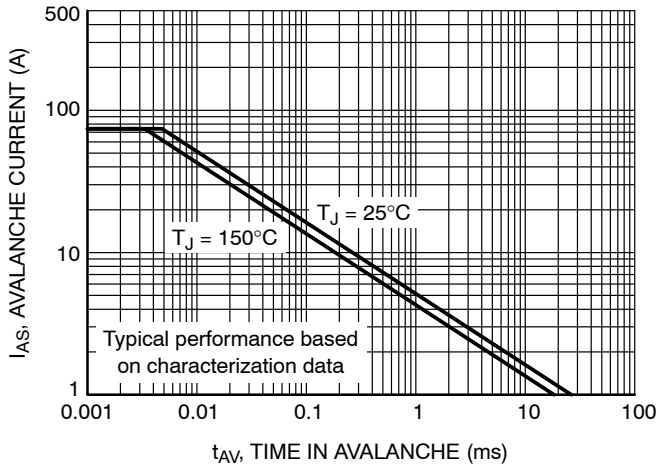
## TYPICAL CHARACTERISTICS



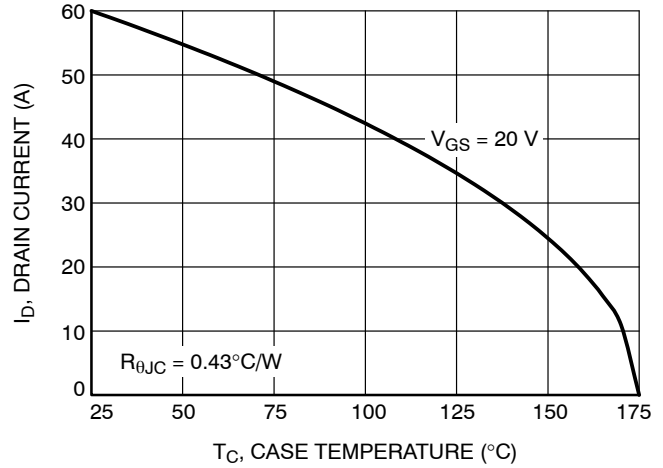
**Figure 7. Gate-to-Source Voltage vs. Total Charge**



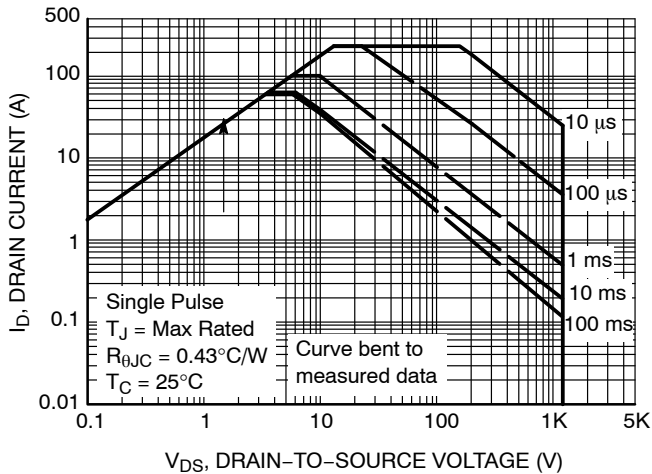
**Figure 8. Capacitance vs. Drain-to-Source Voltage**



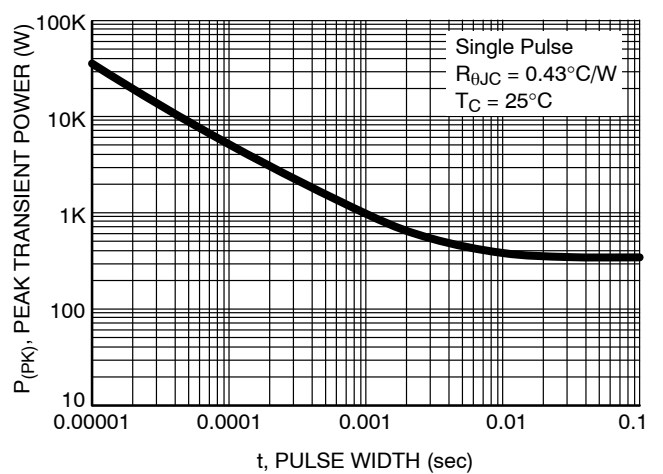
**Figure 9. Unclamped Inductive Switching Capability**



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



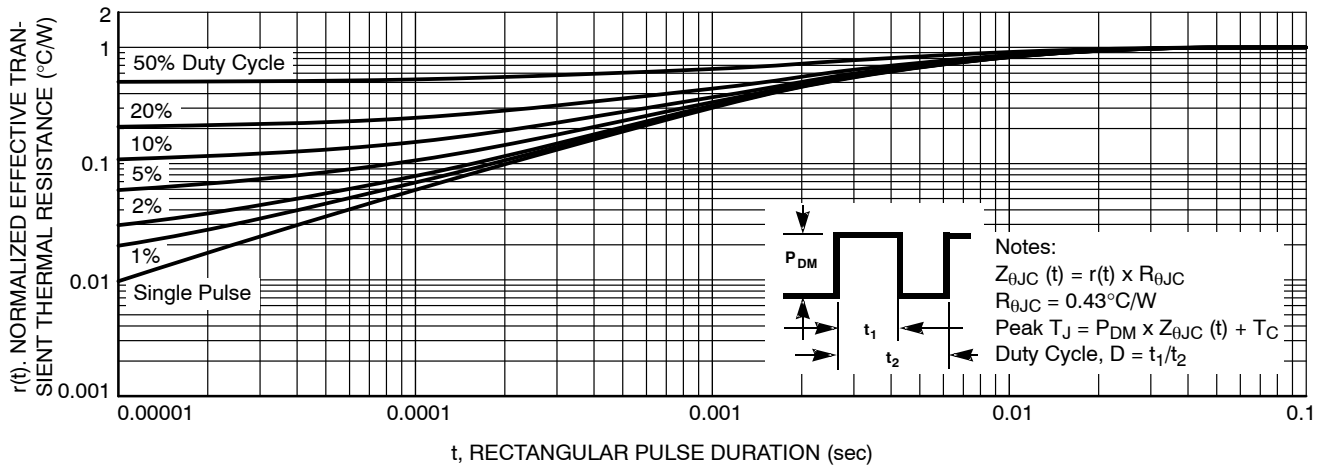
**Figure 11. Safe Operating Area**



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

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## TYPICAL CHARACTERISTICS



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

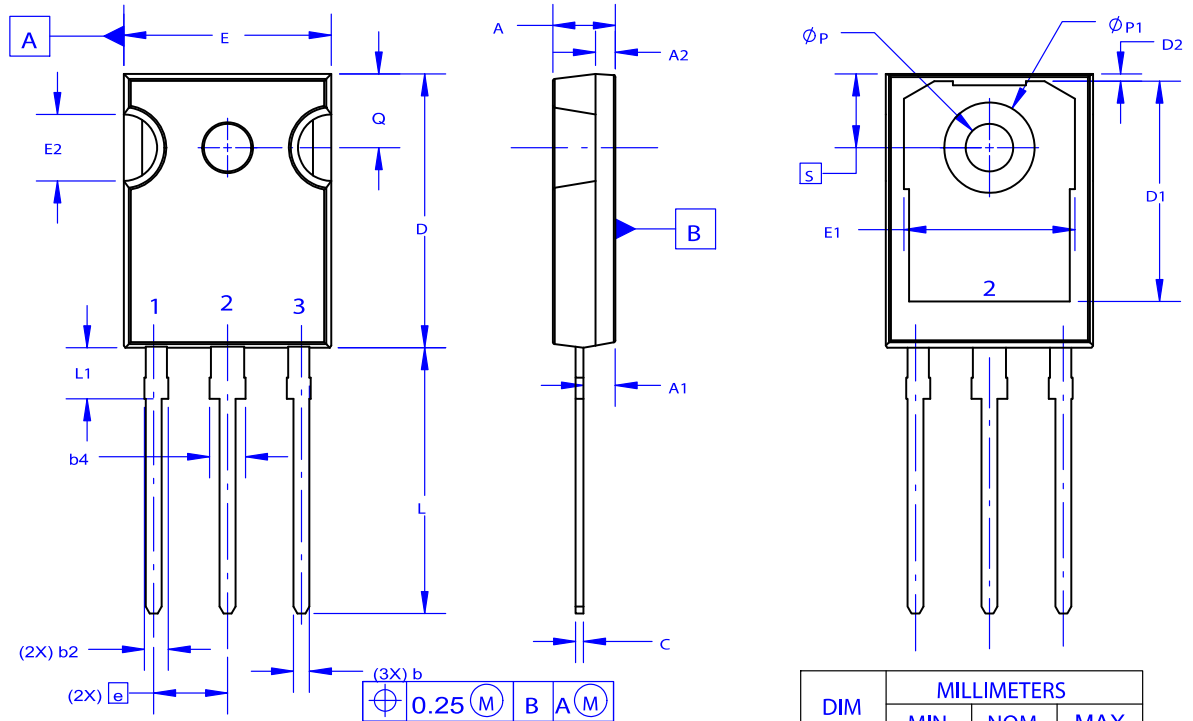
### PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Top Marking	Package	Packing Method	Reel Size	Tape Width	Quantity
NVHL040N120SC1	NVHL040N120SC1	TO-247 Long Lead	Tube	N/A	N/A	30 Units

# NVHL040N120SC1

## PACKAGE DIMENSIONS


TO-247-3LD  
CASE 340CX  
ISSUE O



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

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