

# Silicon Carbide (SiC) **MOSFET** - 40 mohm, 1200 V, M1, TO-247-4L

## **NVH4L040N120SC1**

#### **Features**

- Typ.  $R_{DS(on)} = 40 \text{ m}\Omega$
- Ultra Low Gate Charge  $(Q_{G(tot)} = 106 \text{ nC})$
- High Speed Switching with Low Capacitance (Coss = 137 pF)
- 100% Avalanche 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<sub>J</sub> = 25°C unless otherwise noted)

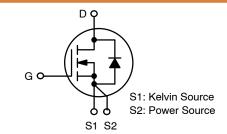
Parameter			Symbol	Value	Unit
Drain-to-Source Voltage			V <sub>DSS</sub>	1200	V
Gate-to-Source Voltage			$V_{GS}$	-15/+25	V
Recommended Operation Values of Gate-to-Source Voltage		T <sub>C</sub> < 175°C	$V_{GSop}$	-5/+20	>
Continuous Drain Current (Note 2)	Steady State	T <sub>C</sub> = 25°C	I <sub>D</sub>	58	Α
Power Dissipation (Note 2)			P <sub>D</sub>	319	W
Continuous Drain Current (Notes 1, 2)	Steady State	T <sub>C</sub> = 100°C	I <sub>D</sub>	41	Α
Power Dissipation (Notes 1, 2)			P <sub>D</sub>	160	W
Pulsed Drain Current (Note 3)	T <sub>A</sub> = 25°C		I <sub>DM</sub>	232	Α
Single Pulse Surge Drain Current Capability	$T_C = 25^{\circ}C, t_p = 10 \mu s,$ $R_G = 4.7 \Omega$		I <sub>DSC</sub>	416	Α
Operating Junction and Storage Temperature Range			T <sub>J</sub> , T <sub>stg</sub>	-55 to +175	°C
Source Current (Body Diode)			Is	32	Α
Single Pulse Drain-to-Source Avalanche Energy (I <sub>L(pk)</sub> = 34 A, L = 1 mH) (Note 4)			E <sub>AS</sub>	578	mJ
Maximum Lead Temperature for Soldering (1/8" from case for 5 s)			TL	300	°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. JA is constant value to follow guide table of LV/HV discrete final datasheet
- generation.

  2. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.
- 3. Repetitive rating, limited by max junction temperature.
- 4. EAS of 578 mJ is based on starting  $T_J = 25^{\circ}C$ ; L = 1 mH,  $I_{AS} = 34$  A,  $V_{DD} = 120 \text{ V}, V_{GS} = 20 \text{ V}.$

V <sub>(BR)DSS</sub>	R <sub>DS(ON)</sub> MAX	I <sub>D</sub> MAX
1200 V	56 mΩ @ 20 V	58 A

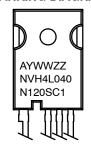


## **N-CHANNEL MOSFET**



TO247-4L CASE 340CJ

#### **MARKING DIAGRAM**



= Assembly Location Α

= Year WW = Work Week = Lot Traceability

NVH4L040N120SC1 = Specific Device Code

#### ORDERING INFORMATION

Device	Package	Shipping
NVH4L040N120SC1	TO247-4L	30 Units / Tube

**Table 1. THERMAL RESISTANCE MAXIMUM RATINGS** 

Parameter	Symbol	Max	Unit
Junction-to-Case - Steady State (Note 2)	$R_{ heta JC}$	0.47	°C/W
Junction-to-Ambient - Steady State (Notes 1, 2)	$R_{\theta JA}$	40	

## Table 2. ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise specified)

V <sub>(BR)DSS</sub> V <sub>(BR)DSS</sub> /T <sub>J</sub>	$V_{GS} = 0 \text{ V}, I_D = 1 \text{ mA}$ $I_D = 1 \text{ mA}, \text{ reference}$		1200		·	
V <sub>(BR)DSS</sub> /T <sub>J</sub>			1200			
	I <sub>D</sub> = 1 mA, referenced		1200	-	-	V
I <sub>DSS</sub>		I <sub>D</sub> = 1 mA, referenced to 25°C		0.45	-	V/°C
	$V_{GS} = 0 \text{ V},$ $T_J = 25^{\circ}\text{C}$		-	-	100	μΑ
1	V <sub>DS</sub> = 1200 V	T <sub>J</sub> = 175°C	-	-	1	mA
I <sub>GSS</sub>	$V_{GS} = +25/-15 \text{ V}, V_{D}$	<sub>S</sub> = 0 V	-	-	±1	μΑ
	•					
V <sub>GS(TH)</sub>	$V_{GS} = V_{DS}, I_{D} = 10 \text{ m}$	A	1.8	3.0	4.3	V
$V_{GOP}$			-5	-	+20	V
R <sub>DS(on)</sub>	V <sub>GS</sub> = 20 V, I <sub>D</sub> = 35 A	, T <sub>J</sub> = 25°C	-	40	56	mΩ
	V <sub>GS</sub> = 20 V, I <sub>D</sub> = 35 A	V <sub>GS</sub> = 20 V, I <sub>D</sub> = 35 A, T <sub>J</sub> = 175°C		70	100	
9 <sub>FS</sub>	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 35 A		-	20	-	S
SISTANCE						
C <sub>ISS</sub>	V <sub>GS</sub> = 0 V, f = 1 MHz, V <sub>DS</sub> = 800 V		-	1762	-	pF
C <sub>OSS</sub>			_	137	_	
C <sub>RSS</sub>			_	11	-	
	$V_{GS} = -5/20 \text{ V}, V_{DS} = 600 \text{ V},$ $I_D = 47 \text{ A}$		_	106	_	nC
` '			_	16	_	
Q <sub>GS</sub>			_	34	_	
$Q_{GD}$			_	26	_	
R <sub>G</sub>	f = 1 MHz		_	2.4	_	Ω
10 V						
t <sub>d(ON)</sub>	$V_{GS} = -5/20 \text{ V}, V_{DS} = 800 \text{ V},$ $I_{D} = 47 \text{ A}, R_{G} = 4.7 \Omega$		_	17	30	ns
t <sub>r</sub>			_	20	36	
			_	32	51	
t <sub>f</sub>				10	20	
E <sub>ON</sub>				411	_	μJ
			_	205	_	
+				616	_	
	ı					
I <sub>SD</sub>	$V_{GS} = -5 \text{ V}, T_{J} = 25^{\circ}\text{C}$		-	-	32	Α
I <sub>SDM</sub>			-	-	232	
V <sub>SD</sub>	$V_{GS} = -5 \text{ V}, I_{SD} = 17.$ $T_{J} = 25^{\circ}\text{C}$	5 A,	-	3.7	-	V
	V <sub>GS(TH)</sub> V <sub>GOP</sub> R <sub>DS(on)</sub> 9FS  SISTANCE  C <sub>ISS</sub> C <sub>OSS</sub> C <sub>RSS</sub> Q <sub>G(TOT)</sub> Q <sub>GS</sub> Q <sub>GD</sub> R <sub>G</sub> 10 V  t <sub>d(OFF)</sub> t <sub>f</sub> E <sub>ON</sub> E <sub>OFF</sub> E <sub>tot</sub> TICS  I <sub>SD</sub>	$\begin{array}{ c c c } \hline V_{GS(TH)} & V_{GS} = V_{DS}, \ I_D = 10 \ m \\ \hline V_{GOP} \\ \hline R_{DS(on)} & V_{GS} = 20 \ V, \ I_D = 35 \ A \\ \hline V_{GS} = 20 \ V, \ I_D = 35 \ A \\ \hline V_{GS} = 20 \ V, \ I_D = 35 \ A \\ \hline V_{DS} = 20 \ V, \ I_D = 35 \ A \\ \hline SISTANCE \\ \hline C_{ISS} & V_{DS} = 20 \ V, \ I_D = 35 \ A \\ \hline SISTANCE \\ \hline C_{OSS} & V_{GS} = 0 \ V, \ f = 1 \ MHz, \\ \hline C_{OSS} & V_{GS} = -5/20 \ V, \ V_{DS} = 10 \ A \\ \hline V_{GS} = -5/20 \ V, \ V_{DS} = 10 \ A \ A \\ \hline V_{GS} = -5/20 \ V, \ V_{DS} = 10 \ A \ A \ A \ A \ A \ A \ A \ A \ A \ $	$\begin{array}{c c} V_{GS(TH)} & V_{GS} = V_{DS}, I_D = 10 \text{ mA} \\ \hline V_{GOP} \\ \hline R_{DS(on)} & V_{GS} = 20 \text{ V}, I_D = 35 \text{ A}, T_J = 25^{\circ}\text{C} \\ \hline V_{GS} = 20 \text{ V}, I_D = 35 \text{ A}, T_J = 175^{\circ}\text{C} \\ \hline V_{GS} = 20 \text{ V}, I_D = 35 \text{ A} \\ \hline SISTANCE \\ \hline C_{ISS} & V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}, V_{DS} = 800 \text{ V} \\ \hline C_{OSS} & C_{RSS} \\ \hline C_{RSS} & V_{GS} = -5/20 \text{ V}, V_{DS} = 600 \text{ V}, I_D = 47 \text{ A} \\ \hline Q_{G} & V_{GS} = -5/20 \text{ V}, V_{DS} = 800 \text{ V}, I_D = 47 \text{ A} \\ \hline 10 \text{ V} & V_{GS} = -5/20 \text{ V}, V_{DS} = 800 \text{ V}, I_D = 47 \text{ A}, R_G = 4.7 \Omega \\ \hline Inductive load \\ \hline TICS & I_{SD} & V_{GS} = -5 \text{ V}, T_J = 25^{\circ}\text{C} \\ \hline I_{SDM} & V_{GS} = -5 \text{ V}, I_{SD} = 17.5 \text{ A}, \\ \hline \end{array}$	$\begin{array}{ c c c c } \hline V_{GS(TH)} & V_{GS} = V_{DS}, I_D = 10 \text{ mA} & 1.8 \\ \hline V_{GOP} & -5 \\ \hline R_{DS(on)} & V_{GS} = 20 \text{ V}, I_D = 35 \text{ A}, T_J = 25^{\circ}\text{C} & - \\ \hline V_{GS} = 20 \text{ V}, I_D = 35 \text{ A}, T_J = 175^{\circ}\text{C} & - \\ \hline 9_{FS} & V_{DS} = 20 \text{ V}, I_D = 35 \text{ A} & - \\ \hline SISTANCE & - \\ \hline C_{ISS} & V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}, V_{DS} = 800 \text{ V} & - \\ \hline C_{OSS} & - \\ \hline C_{RSS} & - \\ \hline Q_{G(TOT)} & V_{GS} = -5/20 \text{ V}, V_{DS} = 600 \text{ V}, & - \\ \hline 1_D = 47 \text{ A} & - \\ \hline Q_{GS} & - \\ \hline Q_{GD} & - \\ \hline R_G & f = 1 \text{ MHz} & - \\ \hline 10 \text{ V} & \\ \hline t_f & I_D = 47 \text{ A}, R_G = 4.7 \Omega \\ \hline I_D = 47 \text{ A}, R_G = 4.7 \Omega \\ \hline E_{ON} & - \\ \hline E_{DF} & - \\ \hline E_{tot} & - \\ \hline TICS & \\ \hline V_{SD} & V_{GS} = -5 \text{ V}, T_J = 25^{\circ}\text{C} & - \\ \hline - \\ \hline V_{SD} & V_{GS} = -5 \text{ V}, I_{SD} = 17.5 \text{ A}, & - \\ \hline \end{array}$	$\begin{array}{ c c c c } \hline V_{GS(TH)} & V_{GS} = V_{DS}, I_D = 10 \text{ mA} & 1.8 & 3.0 \\ \hline V_{GOP} & -5 & - \\ \hline R_{DS(on)} & V_{GS} = 20 \text{ V, } I_D = 35 \text{ A, } T_J = 25^{\circ}\text{C} & - & 40 \\ \hline V_{GS} = 20 \text{ V, } I_D = 35 \text{ A, } T_J = 175^{\circ}\text{C} & - & 70 \\ \hline g_{FS} & V_{DS} = 20 \text{ V, } I_D = 35 \text{ A} & - & 20 \\ \hline \textbf{SISTANCE} & & - & 20 \\ \hline \hline \textbf{SISTANCE} & & & - & 1762 \\ \hline \hline \textbf{C}_{ISS} & V_{GS} = 0 \text{ V, } f = 1 \text{ MHz, } V_{DS} = 800 \text{ V} & - & 1762 \\ \hline \textbf{C}_{OSS} & & & - & 137 \\ \hline \textbf{C}_{RSS} & & & - & 106 \\ \hline \textbf{Q}_{G(TOT)} & V_{GS} = -5/20 \text{ V, } V_{DS} = 600 \text{ V, } \\ \hline \textbf{I}_D = 47 \text{ A} & & - & 16 \\ \hline \textbf{Q}_{GS} & & - & 26 \\ \hline \textbf{R}_{G} & f = 1 \text{ MHz} & - & 2.4 \\ \hline \hline \textbf{10 V} & & & & - & 20 \\ \hline \hline \textbf{t}_{d(ON)} & V_{GS} = -5/20 \text{ V, } V_{DS} = 800 \text{ V, } \\ \hline \textbf{I}_D = 47 \text{ A, } R_G = 4.7  \Omega \\ \hline \textbf{I}_D = 47 \text{ A, } R_G = 4.7  \Omega \\ \hline \textbf{I}_D = 47 \text{ A, } R_G = 4.7  \Omega \\ \hline \textbf{I}_D = 47 \text{ A, } R_G = 5.7  0$	$\begin{array}{ c c c c c }\hline V_{GS(TH)} & V_{GS} = V_{DS}, \ I_D = 10 \ mA & 1.8 & 3.0 & 4.3 \\ \hline V_{GOP} & -5 & - & +20 \\ \hline R_{DS(on)} & V_{GS} = 20 \ V, \ I_D = 35 \ A, \ T_J = 25^{\circ}C & - & 40 & 56 \\ \hline V_{GS} = 20 \ V, \ I_D = 35 \ A, \ T_J = 175^{\circ}C & - & 70 & 100 \\ \hline g_{FS} & V_{DS} = 20 \ V, \ I_D = 35 \ A & - & 20 & - \\ \hline SISTANCE & & & & & & & & & & & \\ \hline C_{ISS} & V_{GS} = 0 \ V, \ f = 1 \ MHz, \ V_{DS} = 800 \ V & - & 1762 \ - & & & & & & & & \\ \hline C_{OSS} & & & & & & & & & & & & \\ \hline C_{RSS} & & & & & & & & & & & & & \\ \hline C_{RSS} & & & & & & & & & & & & & \\ \hline C_{RSS} & & & & & & & & & & & & & & \\ \hline C_{RSS} & & & & & & & & & & & & & & & \\ \hline C_{RSS} & & & & & & & & & & & & & & & \\ \hline C_{RSS} & & & & & & & & & & & & & & & \\ \hline C_{RSS} & & & & & & & & & & & & & & & & \\ \hline C_{RSS} & & & & & & & & & & & & & & & & & \\ \hline C_{RSS} & & & & & & & & & & & & & & & & & \\ \hline C_{RSS} & & & & & & & & & & & & & & & & & \\ \hline C_{RSS} & & & & & & & & & & & & & & & & & & $

Table 2. ELECTRICAL CHARACTERISTICS ( $T_J = 25^{\circ}C$  unless otherwise specified) (continued)

Parameter	Symbol	Test Condition	Min	Тур	Max	Unit		
DRAIN-SOURCE DIODE CHARACTERISTICS								
Reverse Recovery Time	t <sub>RR</sub>	$V_{GS} = -5/20 \text{ V, } I_{SD} = 47 \text{ A,}$ $dI_S/dt = 1000 \text{ A/}\mu\text{s}$	-	24	-	ns		
Reverse Recovery Charge	Q <sub>RR</sub>		-	124.8	-	nC		
Reverse Recovery Energy	E <sub>REC</sub>		-	8.4	-	μJ		
Peak Reverse Recovery Current	I <sub>RRM</sub>		-	10.4	-	Α		
Charge Time	Ta	]	-	12.4	-	ns		
Discharge Time	Tb	7	_	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**

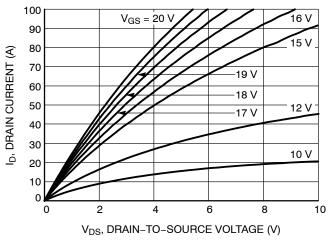


Figure 1. On-Region Characteristics

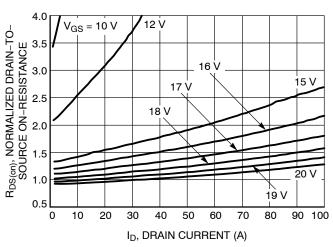


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

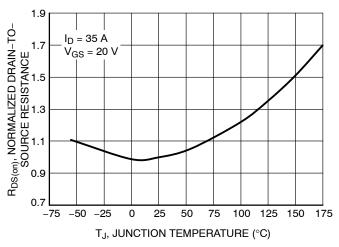


Figure 3. On–Resistance Variation with Temperature

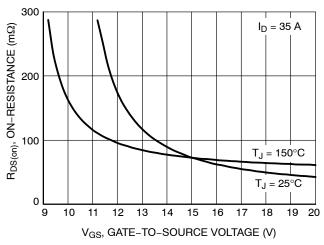


Figure 4. On-Resistance vs. Gate-to-Source Voltage

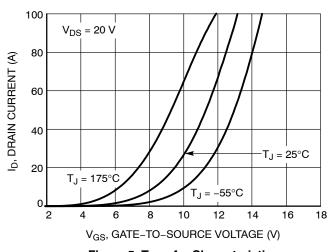


Figure 5. Transfer Characteristics

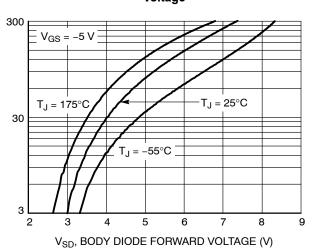


Figure 6. Diode Forward Voltage vs. Current

REVERSE DRAIN CURRENT (A)

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#### TYPICAL CHARACTERISTICS (continued)

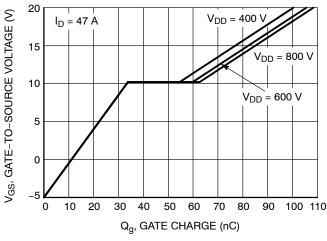


Figure 7. Gate-to-Source Voltage vs. Total Charge

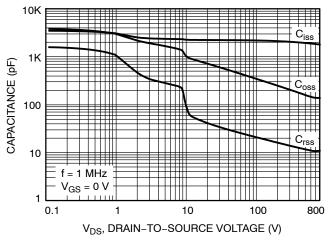


Figure 8. Capacitance vs. Drain-to-Source Voltage

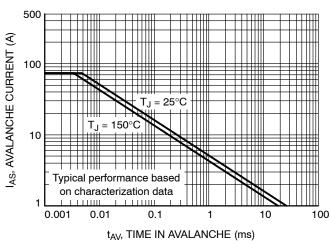


Figure 9. Unclamped Inductive Switching Capability

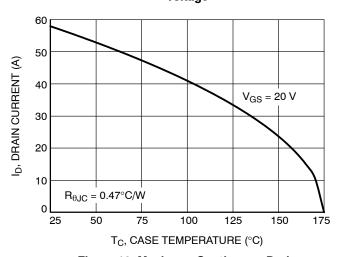


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

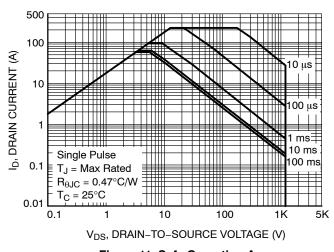


Figure 11. Safe Operating Area

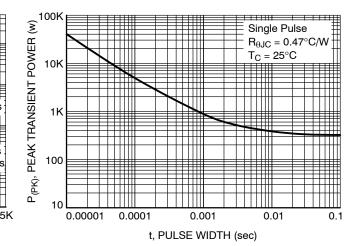


Figure 12. Single Pulse Maximum Power Dissipation

## TYPICAL CHARACTERISTICS (continued)

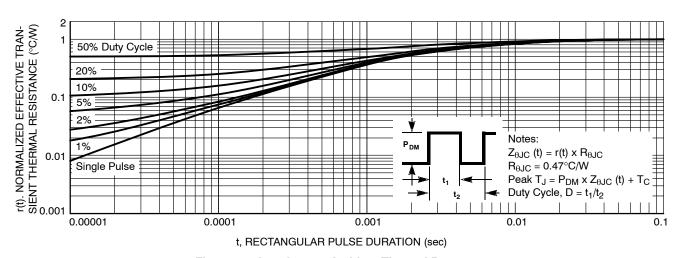
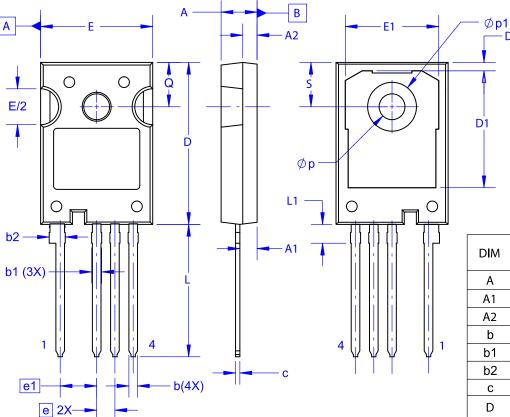


Figure 13. Junction-to-Ambient Thermal Response

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

**DATE 16 SEP 2019** 

D2



#### NOTES:

0.254 M

- A. NO INDUSTRY STANDARD APPLIES TO THIS PACKAGE.
  B. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD
  FLASH, AND TIE BAR EXTRUSIONS.
  C. ALL DIMENSIONS ARE IN MILLIMETERS.
  D. DRAWING CONFORMS TO ASME Y14.5-2009.

DIM	MIN	NOM	MAX		
Α	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		
С	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		
е	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		
р	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		

**MILLIMETERS** 

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