

# Silicon Carbide (SiC) Module - EliteSiC, 4 m $\Omega$ SiC M3 MOSFET, 1200 V, 2-PACK Half Bridge Topology, F2 Package with Si<sub>3</sub>N<sub>4</sub> DBC NXH004P120M3F2PTNG

The NXH004P120M3F2PTNG is a power module containing 4 m $\Omega$  / 1200 V SiC MOSFET half-bridge and a thermistor with Si<sub>3</sub>N<sub>4</sub> DBC in an F2 package.

## Features

- 4 m $\Omega$  / 1200 V M3S SiC MOSFET Half-Bridge
- Si<sub>3</sub>N<sub>4</sub> DBC
- Thermistor
- Pre-Applied Thermal Interface Material (TIM)
- Press-Fit Pins
- These Devices are Pb-Free, Halide Free and are RoHS Compliant

## Typical Applications

- Solar Inverter
- Uninterruptible Power Supplies
- Electric Vehicle Charging Stations
- Industrial Power

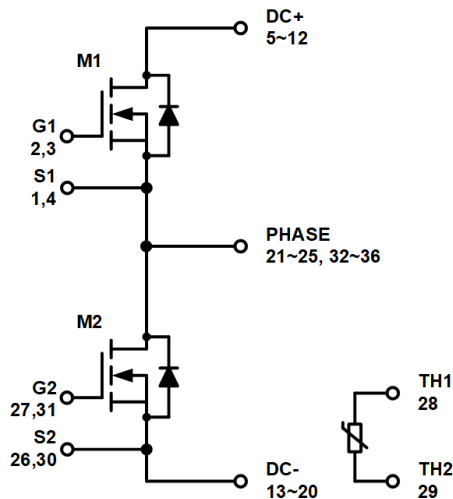
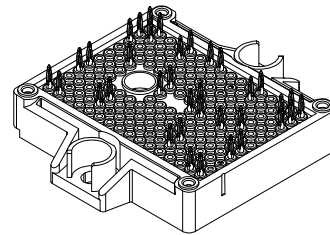


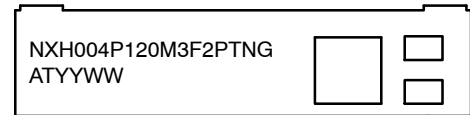
Figure 1. NXH004P120M3F2 Schematic Diagram

## PACKAGE PICTURE



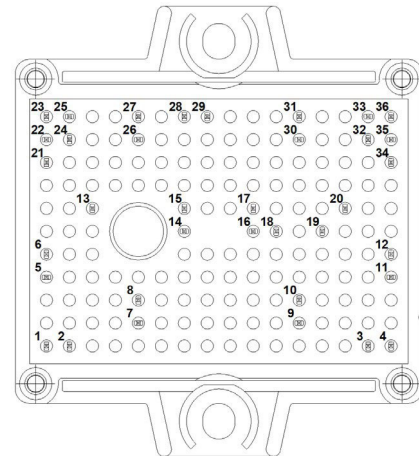
PIM36 56.7x42.5 (PRESS FIT)  
CASE 180BY

## MARKING DIAGRAM



NXH004P120M3F2PTNG = Specific Device Code  
AT = Assembly & Test Site Code  
YWW = Year and Work Week Code

## PIN CONNECTIONS



See Pin Function Description for pin names

## ORDERING INFORMATION

See detailed ordering and shipping information on page 4 of this data sheet.

# NXH004P120M3F2PTNG

## PIN FUNCTION DESCRIPTION

Pin	Name	Description
1	S1	Q1 Kelvin Emitter (High side switch)
2	G1	Q1 Gate (High side switch)
3	G1	Q1 Gate (High side switch)
4	S1	Q1 Kelvin Emitter (High side switch)
5	DC+	DC Positive Bus connection
6	DC+	DC Positive Bus connection
7	DC+	DC Positive Bus connection
8	DC+	DC Positive Bus connection
9	DC+	DC Positive Bus connection
10	DC+	DC Positive Bus connection
11	DC+	DC Positive Bus connection
12	DC+	DC Positive Bus connection
13	DC*	DC Negative Bus connection
14	DC-	DC Negative Bus connection
15	DC-	DC Negative Bus connection
16	DC-	DC Negative Bus connection
17	DC-	DC Negative Bus connection
18	DC-	DC Negative Bus connection
19	DC-	DC Negative Bus connection
20	DC-	DC Negative Bus connection
21	PHASE	Center point of half bridge
22	PHASE	Center point of half bridge
23	PHASE	Center point of half bridge
24	PHASE	Center point of half bridge
25	PHASE	Center point of half bridge
26	S2	Q2 Kelvin Emitter (Low side switch)
27	G2	Q2 Gate (Low side switch)
28	TH1	Thermistor Connection 1
29	TH2	Thermistor Connection 2
30	S2	Q2 Kelvin Emitter (Low side switch)
31	G2	Q2 Gate (Low side switch)
32	PHASE	Center point of half bridge
33	PHASE	Center point of half bridge
34	PHASE	Center point of half bridge
35	PHASE	Center point of half bridge
36	PHASE	Center point of half bridge

# NXH004P120M3F2PTNG

## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
<b>SIC MOSFET</b>			
Drain-Source Voltage	$V_{DS}$	1200	V
Gate-Source Voltage	$V_{GS}$	+22/-10	V
Continuous Drain Current @ $T_c = 80\text{ }^{\circ}\text{C}$ ( $T_J = 175\text{ }^{\circ}\text{C}$ )	$I_D$	338	A
Pulsed Drain Current ( $T_J = 175\text{ }^{\circ}\text{C}$ )	$I_{Dpulse}$	676	A
Maximum Power Dissipation @ $T_c = 80\text{ }^{\circ}\text{C}$ ( $T_J = 175\text{ }^{\circ}\text{C}$ )	$P_{tot}$	1098	W
Minimum Operating Junction Temperature	$T_{JMIN}$	-40	$^{\circ}\text{C}$
Maximum Operating Junction Temperature	$T_{JMAX}$	175	$^{\circ}\text{C}$

## THERMAL PROPERTIES

Storage Temperature Range	$T_{stg}$	-40 to 150	$^{\circ}\text{C}$
TIM Layer Thickness	$T_{TIM}$	160 $\pm$ 20	$\mu\text{m}$

## INSULATION PROPERTIES

Isolation Test Voltage, $t = 1\text{ s}$ , 60 Hz	$V_{is}$	4800	$V_{RMS}$
Creepage Distance		12.7	mm
CTI		600	
Substrate Ceramic Material		Si3N4	
Substrate Ceramic Material Thickness		0.38	mm
Substrate Warpage (Note 2)	W	Max 0.18	mm

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. Refer to ELECTRICAL CHARACTERISTICS, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for Safe Operating parameters.
2. Height difference between horizontal plane and substrate copper bottom.

## RECOMMENDED OPERATING RANGES

Rating	Symbol	Min	Max	Unit
Module Operating Junction Temperature	$T_J$	-40	150	$^{\circ}\text{C}$

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>SIC MOSFET CHARACTERISTICS</b>						
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}$ , $V_{DS} = 1200\text{ V}$	-	-	300	$\mu\text{A}$
Drain-Source On Resistance	$R_{DS(ON)}$	$V_{GS} = 18\text{ V}$ , $I_D = 200\text{ A}$ , $T_J = 25\text{ }^{\circ}\text{C}$	-	4.00	5.5	$\text{m}\Omega$
		$V_{GS} = 18\text{ V}$ , $I_D = 200\text{ A}$ , $T_J = 125\text{ }^{\circ}\text{C}$	-	6.45	-	
		$V_{GS} = 18\text{ V}$ , $I_D = 200\text{ A}$ , $T_J = 150\text{ }^{\circ}\text{C}$	-	7.50	-	
Gate-Source Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$ , $I_D = 120\text{ mA}$	1.8	2.8	4.4	V
Gate Leakage Current	$I_{GSS}$	$V_{GS} = -10\text{ V} / 20\text{ V}$ , $V_{DS} = 0\text{ V}$	-600	-	600	nA
Gate-Resistance	$R_G$	$f = 1\text{ MHz}$	-	0.25	-	$\Omega$
Input Capacitance	$C_{ISS}$	$V_{DS} = 800\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$	-	16410	-	pF
Reverse Transfer Capacitance	$C_{RSS}$		-	72	-	
Output Capacitance	$C_{OSS}$		-	960	-	

# NXH004P120M3F2PTNG

## ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25 °C unless otherwise noted) (continued)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>SIC MOSFET CHARACTERISTICS</b>						
Total Gate Charge	Q <sub>G(TOTAL)</sub>	V <sub>DS</sub> = 800 V, V <sub>GS</sub> = -5/20 V, I <sub>D</sub> = 200 A	-	876	-	nC
Gate-Source Charge	Q <sub>GS</sub>		-	174	-	nC
Gate-Drain Charge	Q <sub>GD</sub>		-	165	-	nC
Turn-on Delay Time	t <sub>d(on)</sub>	T <sub>J</sub> = 25 °C V <sub>DS</sub> = 600 V, I <sub>D</sub> = 200 A V <sub>GS</sub> = -5 V / 18 V, R <sub>G</sub> = 1 Ω	-	49	-	ns
Rise Time	t <sub>r</sub>		-	15	-	
Turn-off Delay Time	t <sub>d(off)</sub>		-	127	-	
Fall Time	t <sub>f</sub>		-	15	-	
Turn-on Switching Loss per Pulse	E <sub>ON</sub>		-	1.44	-	mJ
Turn-off Switching Loss per Pulse	E <sub>OFF</sub>		-	1.03	-	
Turn-on Delay Time	t <sub>d(on)</sub>	T <sub>J</sub> = 150 °C V <sub>DS</sub> = 600 V, I <sub>D</sub> = 200 A V <sub>GS</sub> = -5 V / 18 V, R <sub>G</sub> = 1 Ω	-	47	-	ns
Rise Time	t <sub>r</sub>		-	15	-	
Turn-off Delay Time	t <sub>d(off)</sub>		-	140	-	
Fall Time	t <sub>f</sub>		-	14	-	
Turn-on Switching Loss per Pulse	E <sub>ON</sub>		-	1.77	-	mJ
Turn-off Switching Loss per Pulse	E <sub>OFF</sub>		-	1.18	-	
Diode Forward Voltage	V <sub>SD</sub>	I <sub>D</sub> = 200 A, T <sub>J</sub> = 25 °C	-	5.1	7.5	V
		I <sub>D</sub> = 200 A, T <sub>J</sub> = 125 °C	-	4.7	-	
		I <sub>D</sub> = 200 A, T <sub>J</sub> = 150 °C	-	4.6	-	
Thermal Resistance – Chip-to-Case	R <sub>thJC</sub>	M1, M2	-	0.0865	-	°C/W
Thermal Resistance – Chip-to-Heatsink	R <sub>thJH</sub>	Thermal grease, Thickness = 2 Mil +2%, A = 2.8 W/mK	-	0.2163	-	°C/W

## THERMISTOR CHARACTERISTICS

Nominal Resistance	R <sub>25</sub>	T <sub>NTC</sub> = 25 °C	-	5	-	kΩ
	R <sub>100</sub>	T <sub>NTC</sub> = 100 °C	-	493	-	Ω
	R <sub>150</sub>	T <sub>NTC</sub> = 150 °C	-	159.5	-	Ω
Deviation of R <sub>100</sub>	ΔR/R	T <sub>NTC</sub> = 100 °C	-5	-	5	%
Power Dissipation – Recommended Limit	P <sub>D</sub>	0.15 mA, non-self-heating effect	-	0.1	-	mW
Power Dissipation – Absolute Maximum		5 mA	-	34.2	-	mW
Power Dissipation Constant			-	1.4	-	mW/K
B-value		B (25/50), tolerance ±2%	-	3375	-	K
B-value		B (25/100), tolerance ±2%	-	3436	-	K

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.

## ORDERING INFORMATION

Orderable Part Number	Marking	Package	Shipping
NXH004P120M3F2PTNG	NXH004P120M3F2PTNG	F2HALFBR: Case 180BY Press-fit Pins with pre-applied thermal interface material (TIM) (Pb-Free / Halide Free)	20 Units / Blister Tray

## TYPICAL CHARACTERISTIC (M1/M2 SiC MOSFET CHARACTERISTIC)

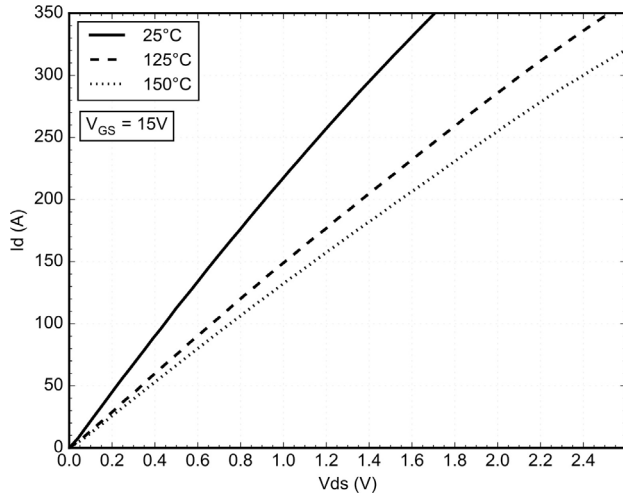


Figure 2. MOSFET Typical Output Characteristic

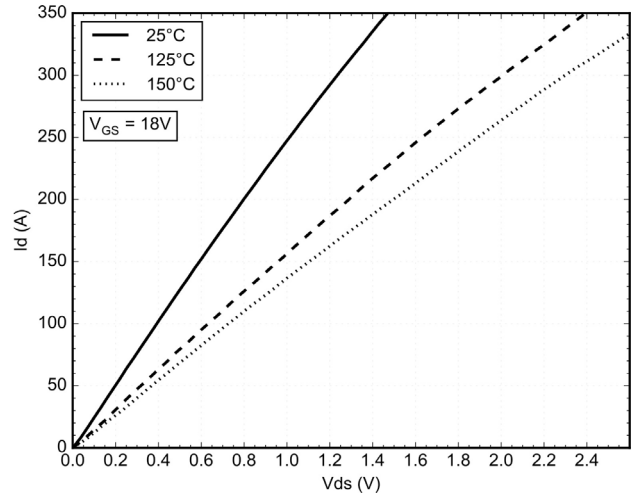


Figure 3. MOSFET Typical Output Characteristic

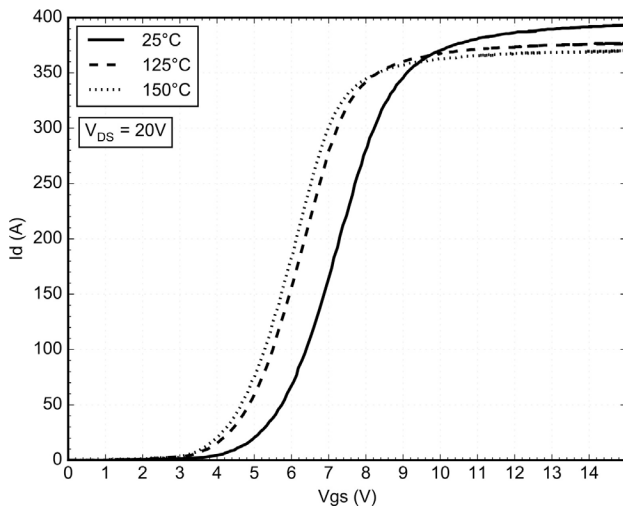


Figure 4. MOSFET Typical Transfer Characteristic

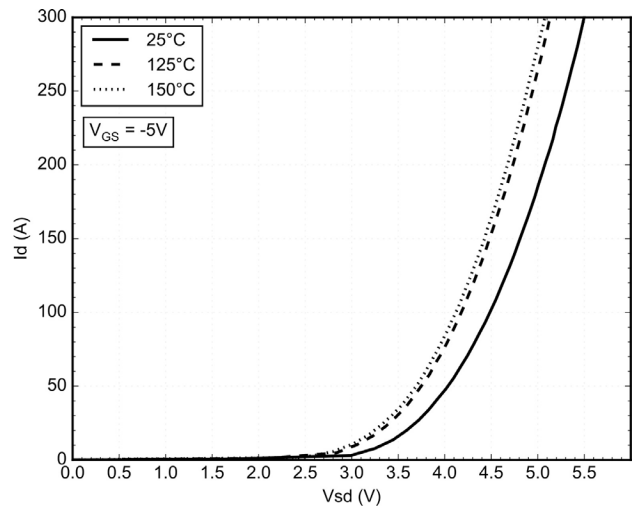


Figure 5. Body Diode Forward Characteristic

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## TYPICAL CHARACTERISTIC (M1/M2 SiC MOSFET CHARACTERISTIC)

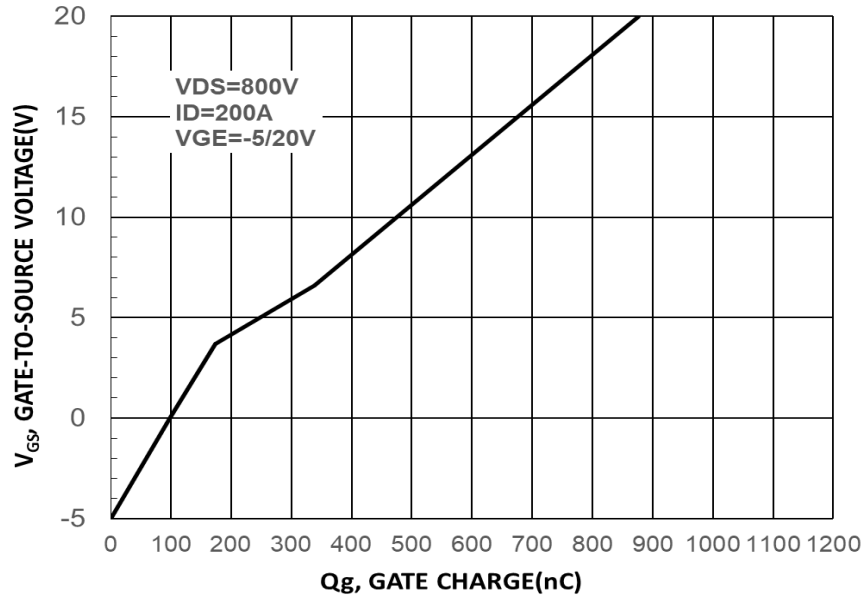


Figure 6. Gate-to-Source Voltage vs. Total Charge

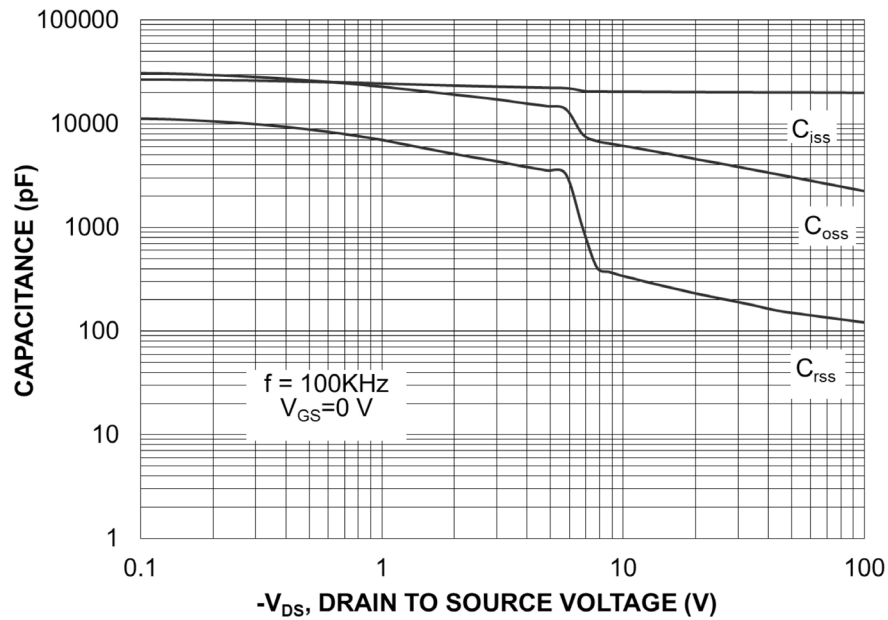


Figure 7. Capacitance vs. Drain-to-Source Voltage

## TYPICAL CHARACTERISTIC (M1/M1 SiC MOSFET SWITCHING CHARACTERISTIC)

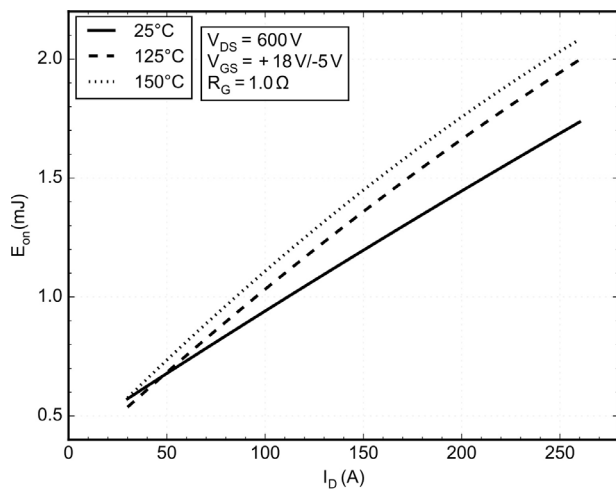


Figure 8. Typical Switching Loss  $E_{on}$  vs.  $I_D$

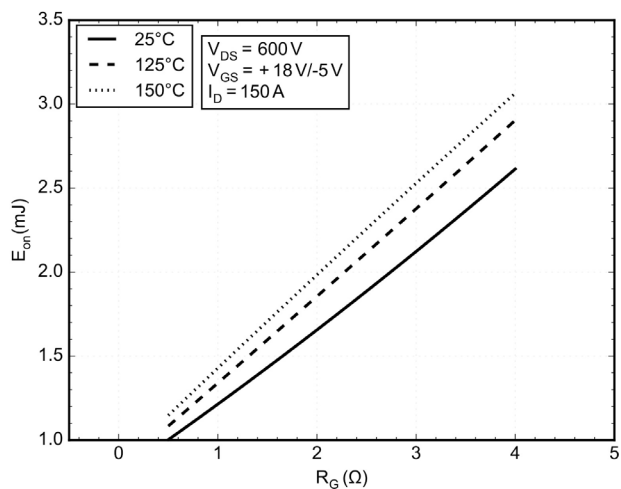


Figure 9. Typical Switching Loss  $E_{on}$  vs.  $R_G$

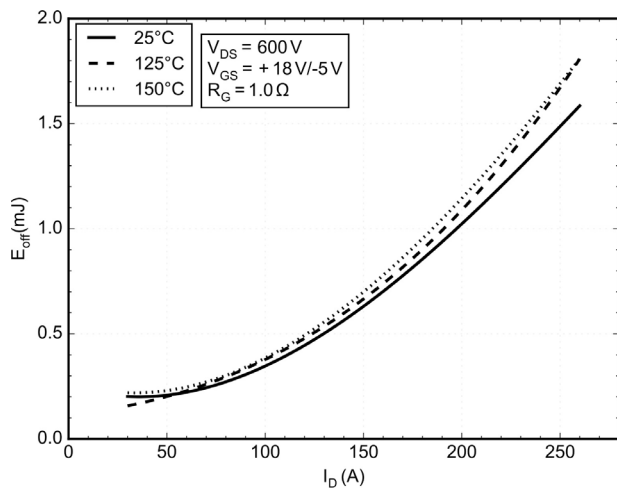


Figure 10. Typical Switching Loss  $E_{off}$  vs.  $I_D$

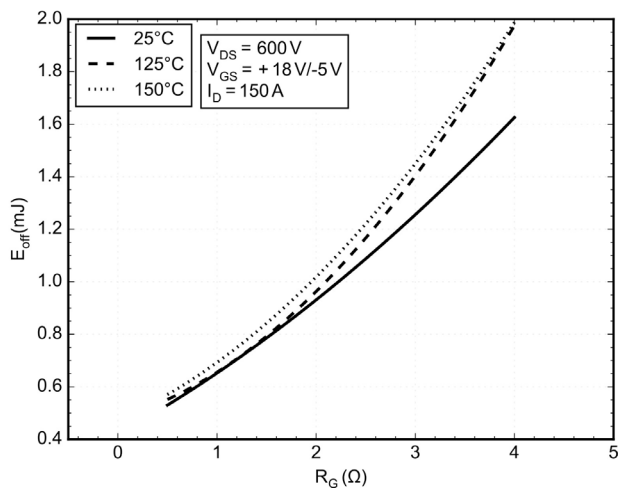


Figure 11. Typical Switching Loss  $E_{off}$  vs.  $R_G$

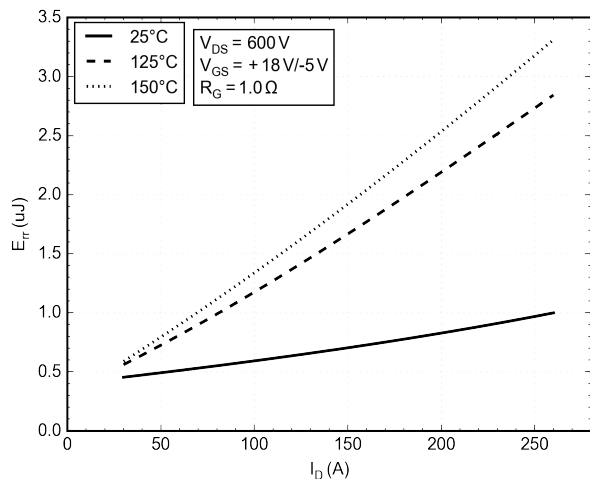


Figure 12.  $E_{rr}$  vs.  $I_D$

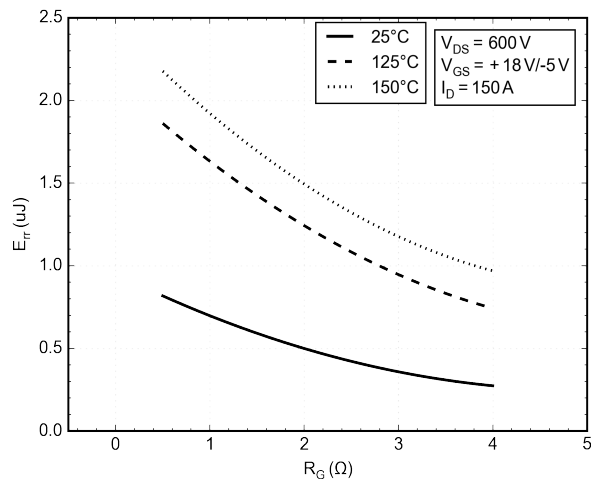


Figure 13.  $E_{rr}$  vs.  $R_G$

**TYPICAL CHARACTERISTIC**  
(M1/M1 SiC MOSFET SWITCHING CHARACTERISTIC)

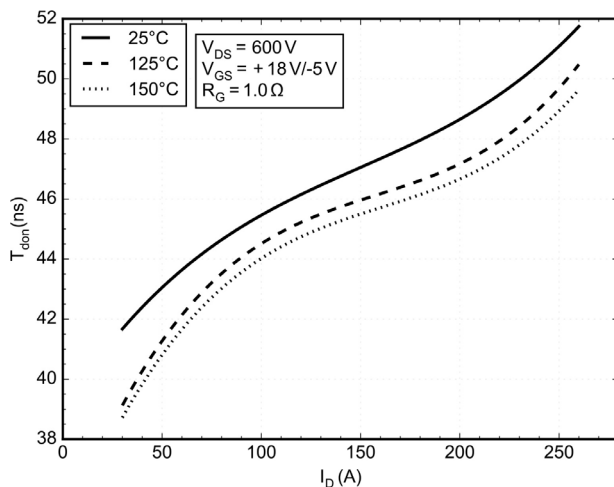


Figure 14. Typical Switching Loss  $T_{don}$  vs.  $I_D$

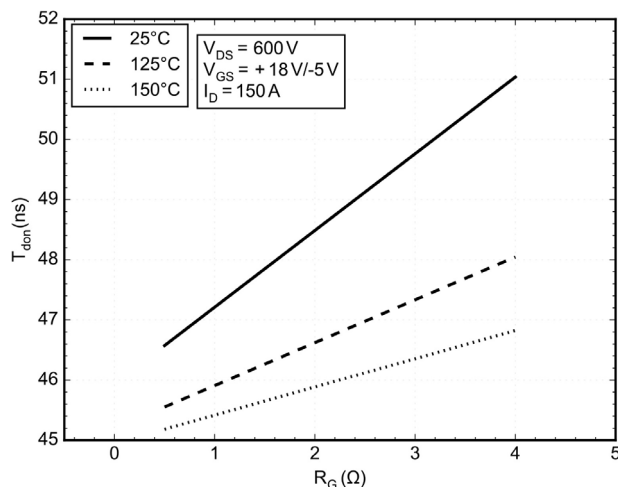


Figure 15. Typical Switching Loss  $T_{don}$  vs.  $R_G$

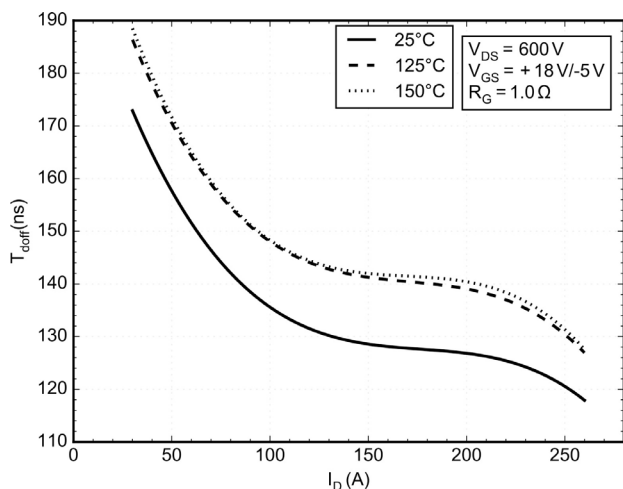


Figure 16. Typical Switching Loss  $T_{doff}$  vs.  $I_D$

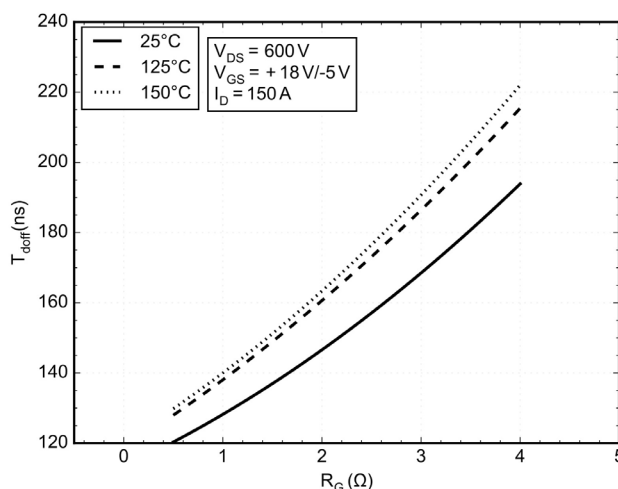


Figure 17. Typical Switching Loss  $T_{doff}$  vs.  $R_G$

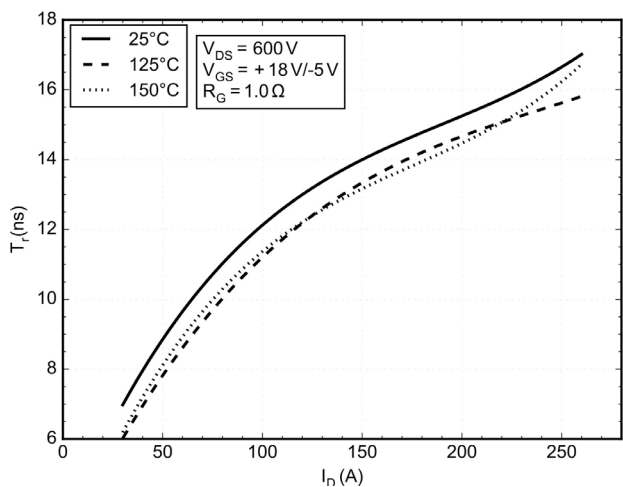


Figure 18. Typical Switching Loss  $T_r$  vs.  $I_D$

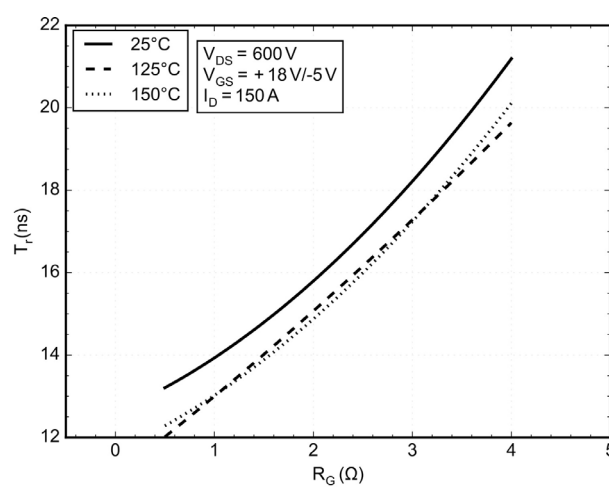


Figure 19. Typical Switching Loss  $T_r$  vs.  $R_G$



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## TYPICAL CHARACTERISTIC (M1/M1 SiC MOSFET SWITCHING CHARACTERISTIC)

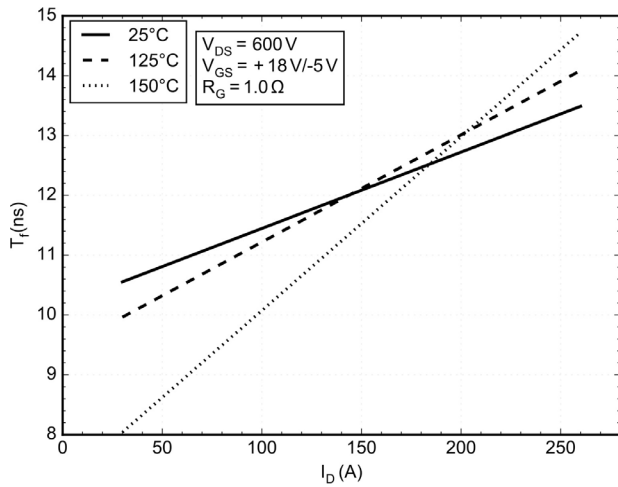


Figure 20. Typical Switching Loss  $T_f$  vs.  $I_D$

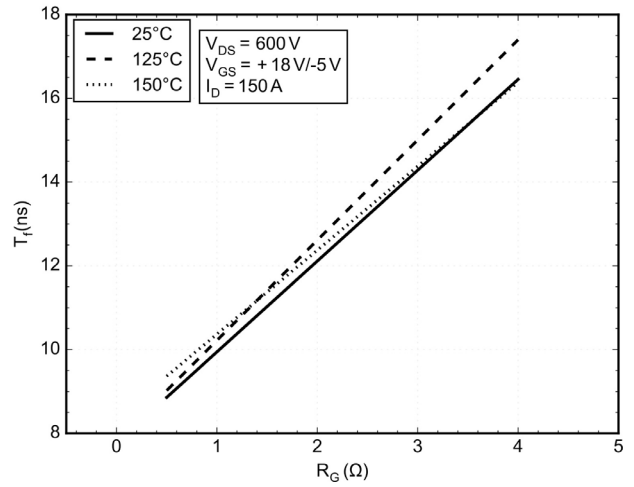


Figure 21. Typical Switching Loss  $T_f$  vs.  $R_G$

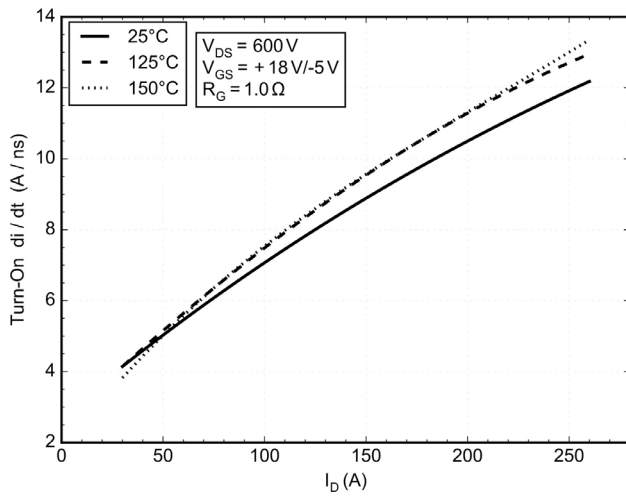


Figure 22.  $di/dt$  ON vs.  $I_D$

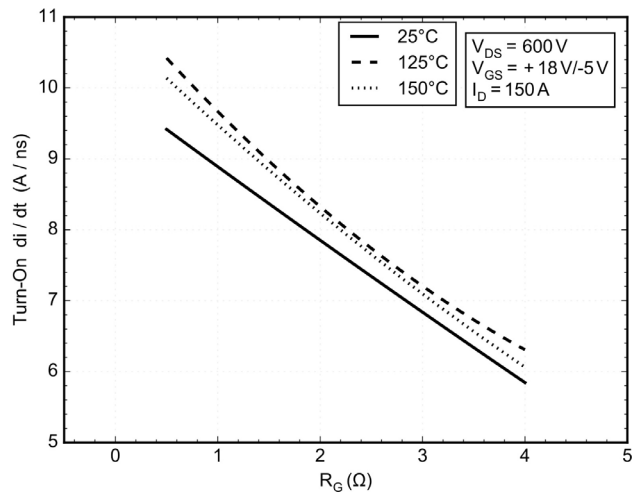


Figure 23.  $di/dt$  ON vs.  $R_G$

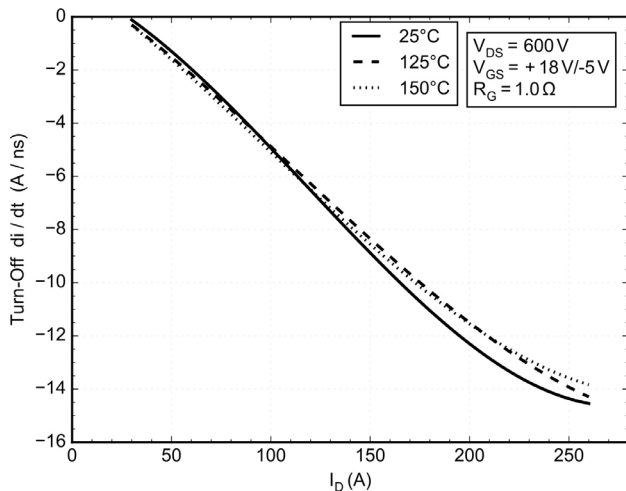


Figure 24.  $di/dt$  OFF vs.  $I_D$

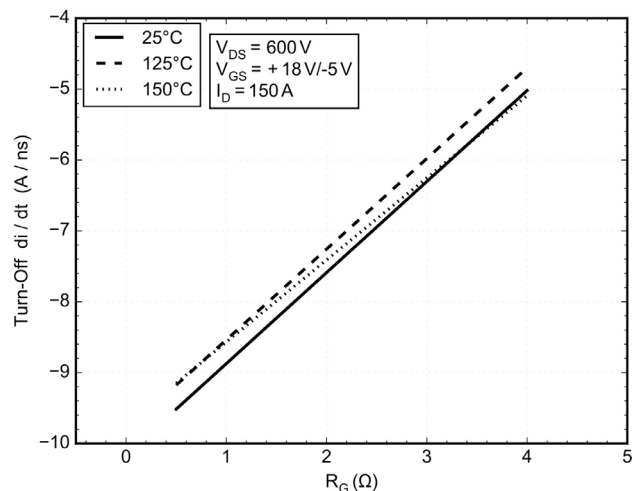


Figure 25.  $di/dt$  OFF vs.  $R_G$

# NXH004P120M3F2PTNG

## TYPICAL CHARACTERISTIC (M1/M1 SiC MOSFET SWITCHING CHARACTERISTIC)

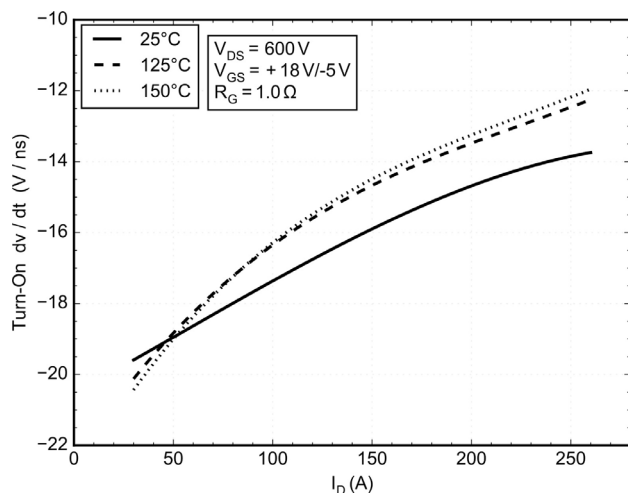


Figure 26. dv/dt ON vs.  $I_D$

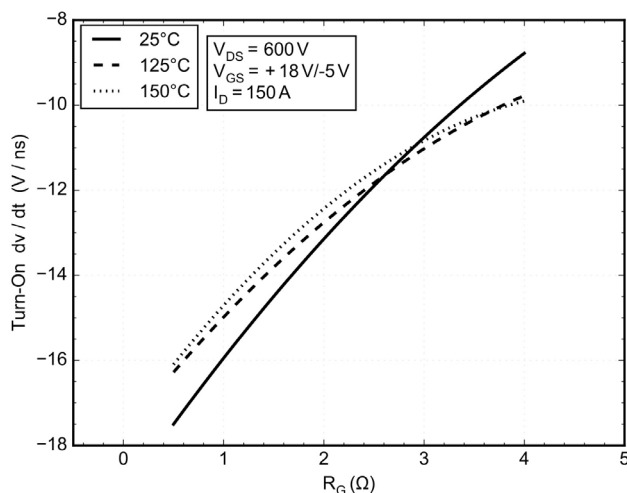


Figure 27. dv/dt ON vs.  $R_G$

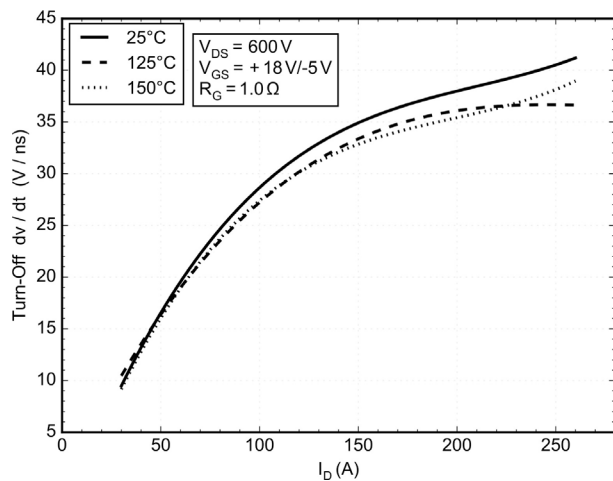


Figure 28. dv/dt OFF vs.  $I_D$

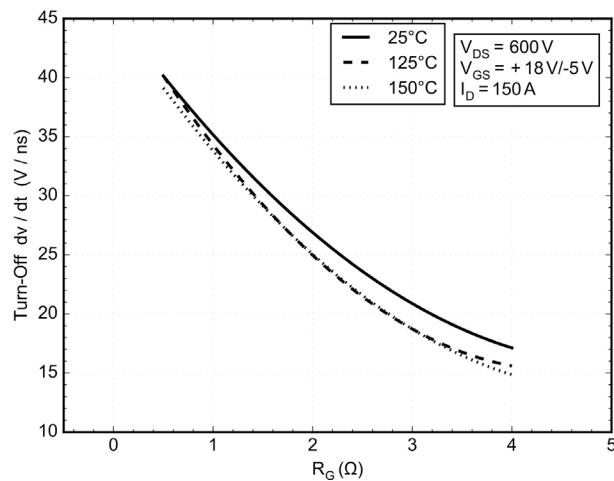


Figure 29. dv/dt OFF vs.  $R_G$

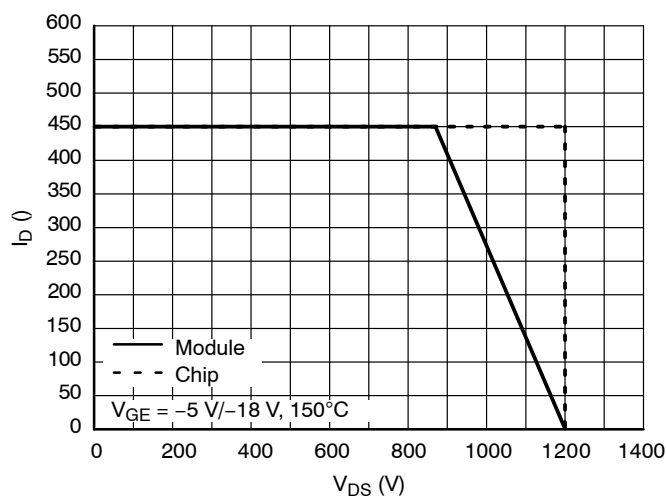


Figure 30.  $I_D$  vs.  $V_{DS}$

# NXH004P120M3F2PTNG

## TYPICAL CHARACTERISTIC (M1/M1 SiC MOSFET CHARACTERISTIC)

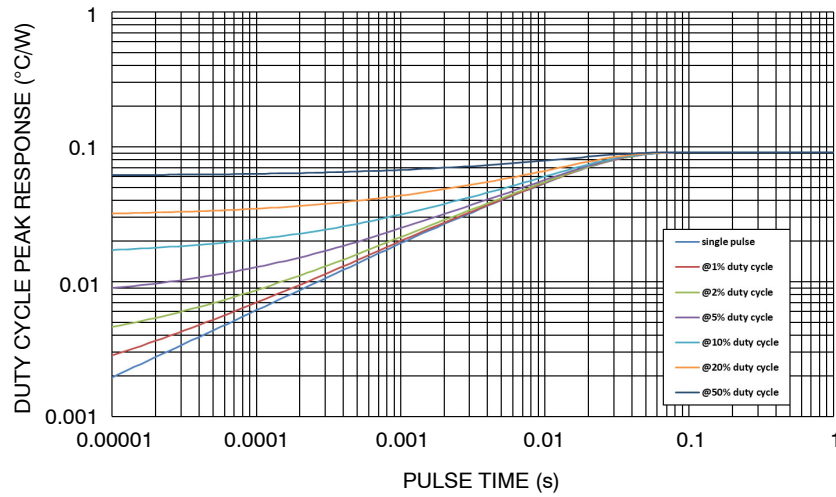


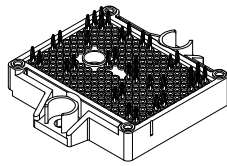
Figure 31. MOSFET Junction-to-Case Transient Thermal Impedance

Table 1. FOSTER NETWORKS – M1, M2

Foster Element #	M1		M2	
	Rth (K/W)	Cth (Ws/K)	Rth (K/W)	Cth (Ws/K)
1	0.002647961	0.004161301	0.002725216	0.004856711
2	0.002444931	0.034646168	0.002426413	0.040108541
3	0.013557501	0.053331797	0.010799871	0.065908508
4	0.005504314	0.401847444	0.007638193	0.280679257
5	0.063262666	0.234364095	0.062698843	0.241165352

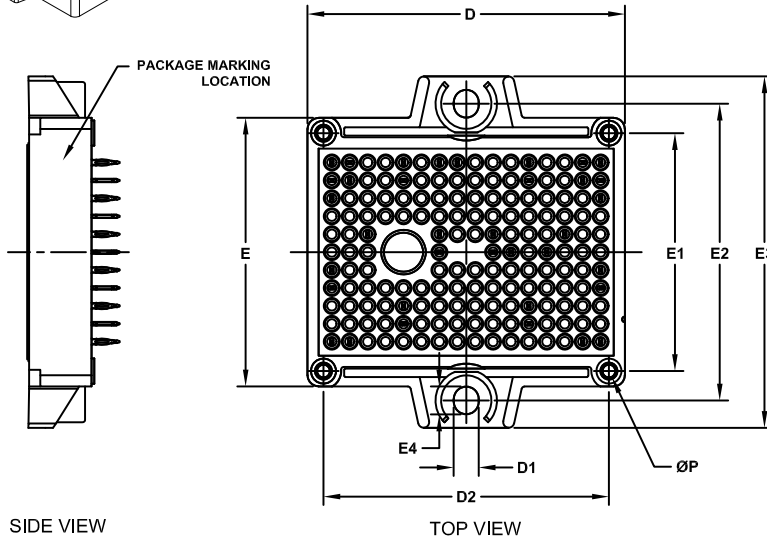
Table 2. CAUER NETWORKS – M1, M2

Foster Element #	M1		M2	
	Rth (K/W)	Cth (Ws/K)	Rth (K/W)	Cth (Ws/K)
1	0.003915600	0.003393528	0.004064858	0.003941433
2	0.007570901	0.018020942	0.007699491	0.020548568
3	0.018609828	0.027406805	0.017488460	0.031091119
4	0.030985450	0.159081224	0.026891921	0.141648163
5	0.026335596	0.184389438	0.030143806	0.187809865



PIM36 56.70x42.50x12.00  
CASE 180BY  
ISSUE E

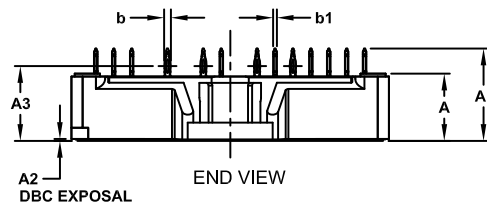
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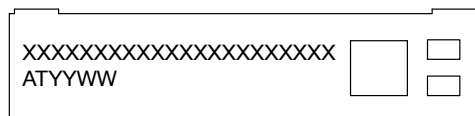
NOTES:

1. CONTROLLING DIMENSION: MILLIMETERS
2. PIN POSITION TOLERANCE IS  $\pm 0.4\text{mm}$
3. PRESS FIT PIN

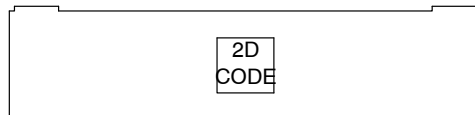
DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	11.65	12.00	12.35
A1	16.10	16.50	16.90
A2	0.00	0.35	0.60
A3	12.95	13.35	13.75
b	1.15	1.20	1.25
b1	0.59	0.64	0.69
D	56.40	56.70	57.00
D1	4.40	4.50	4.60
D2	50.85	51.00	51.15
E	47.70	48.00	48.30
E1	42.35	42.50	42.65
E2	52.90	53.00	53.10
E3	62.30	62.80	63.30
E4	4.90	5.00	5.10
P	2.20	2.30	2.40



GENERIC  
MARKING DIAGRAM\*

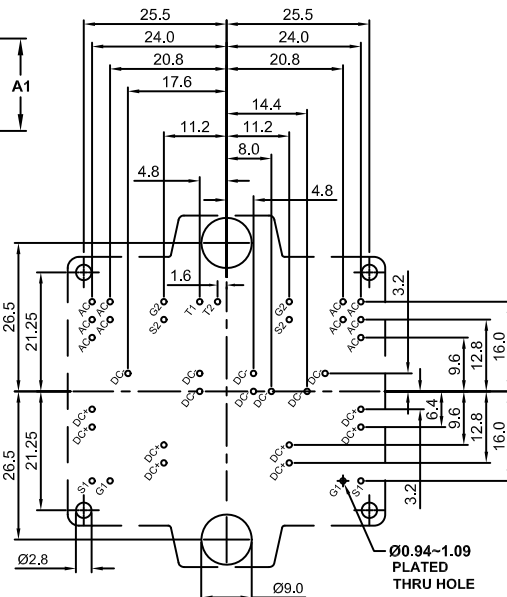


FRONTSIDE MARKING



BACKSIDE MARKING

XXXXX = Specific Device Code  
AT = Assembly & Test Site Code  
YYWW = Year and Work Week Code



RECOMMENDED  
MOUNTING PATTERN

\*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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