

Silicon Carbide (SiC) Module – EliteSiC, 4 mohm SiC M3 MOSFET, 1200 V, 2-PACK Half Bridge Topology, F2 Package with HPS DBC

NXH004P120M3F2PTHG

The NXH004P120M3F2PTHG is a power module containing 4 mΩ / 1200 V SiC MOSFET half-bridge and a thermistor with HPS DBC in an F2 package.

Features

- 4 mΩ / 1200 V M3S SiC MOSFET Half-Bridge
- HPS 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

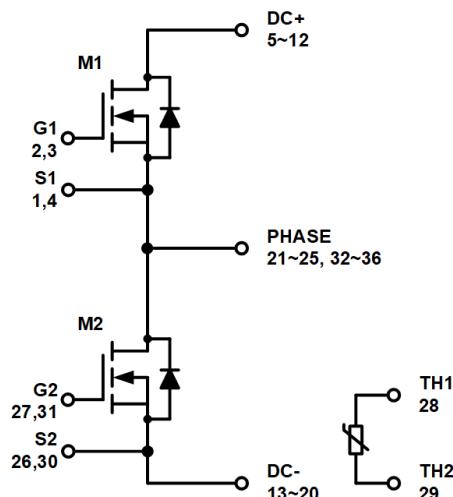
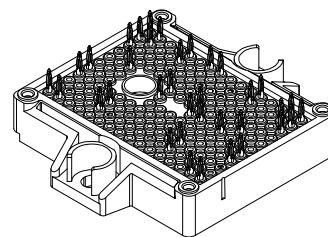


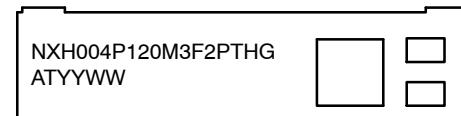
Figure 1. NXH004P120M3F2 Schematic Diagram

PACKAGE PICTURE



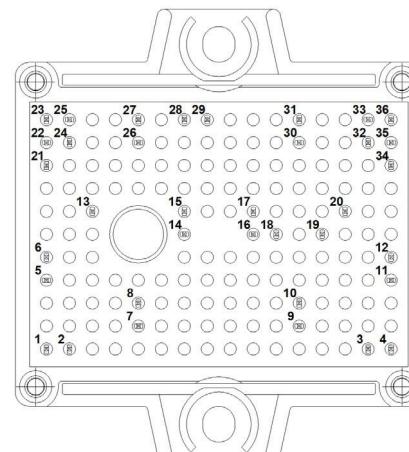
PIM36 56.7x42.5 (PRESS FIT)
CASE 180BY

MARKING DIAGRAM



NXH004P120M3F2PTHG = 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.

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

NXH004P120M3F2PTHG

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
SiC MOSFET			
Drain-Source Voltage	V_{DSS}	1200	V
Gate-Source Voltage	V_{GS}	+22/-10	V
Continuous Drain Current @ $T_c = 80^\circ\text{C}$ ($T_J = 175^\circ\text{C}$)	I_D	284	A
Pulsed Drain Current ($T_J = 175^\circ\text{C}$)	$I_{D\text{pulse}}$	568	A
Maximum Power Dissipation @ $T_c = 80^\circ\text{C}$ ($T_J = 175^\circ\text{C}$)	P_{tot}	785	W
Minimum Operating Junction Temperature	$T_{J\text{MIN}}$	-40	$^\circ\text{C}$
Maximum Operating Junction Temperature	$T_{J\text{MAX}}$	175	$^\circ\text{C}$

THERMAL PROPERTIES

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

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

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

NXH004P120M3F2PTHG

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

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
SiC MOSFET CHARACTERISTICS						
Total Gate Charge	$V_{DS} = 800\text{ V}$, $V_{GS} = -5/20\text{ V}$, $I_D = 200\text{ A}$	$Q_G(\text{TOTAL})$	—	876	—	nC
Gate-Source Charge		Q_{GS}	—	174	—	nC
Gate-Drain Charge		Q_{GD}	—	165	—	nC
Turn-on Delay Time	$T_J = 25^\circ\text{C}$ $V_{DS} = 600\text{ V}$, $I_D = 200\text{ A}$ $V_{GS} = -5\text{ V} / 18\text{ V}$, $R_G = 1\text{ }\Omega$	$t_{d(\text{on})}$	—	49	—	ns
Rise Time		t_r	—	15	—	
Turn-off Delay Time		$t_{d(\text{off})}$	—	127	—	
Fall Time		t_f	—	15	—	
Turn-on Switching Loss per Pulse		E_{ON}	—	1.44	—	mJ
Turn-off Switching Loss per Pulse		E_{OFF}	—	1.03	—	
Turn-on Delay Time	$T_J = 150^\circ\text{C}$ $V_{DS} = 600\text{ V}$, $I_D = 200\text{ A}$ $V_{GS} = -5\text{ V} / 18\text{ V}$, $R_G = 1\text{ }\Omega$	$t_{d(\text{on})}$	—	47	—	ns
Rise Time		t_r	—	15	—	
Turn-off Delay Time		$t_{d(\text{off})}$	—	140	—	
Fall Time		t_f	—	14	—	
Turn-on Switching Loss per Pulse		E_{ON}	—	1.77	—	mJ
Turn off Switching Loss per Pulse		E_{OFF}	—	1.18	—	
Diode Forward Voltage	$I_D = 200\text{ A}$, $T_J = 25^\circ\text{C}$ $I_D = 200\text{ A}$, $T_J = 125^\circ\text{C}$ $I_D = 200\text{ A}$, $T_J = 150^\circ\text{C}$	V_{SD}	—	5.1	7.5	V
Thermal Resistance – Chip-to-Case			—	4.7	—	
Thermal Resistance – Chip-to-Heatsink			—	4.6	—	
Thermal Resistance – Chip-to-Case	M1, M2	R_{thJC}	—	0.121	—	°C/W
Thermal Resistance – Chip-to-Heatsink	Thermal grease, Thickness = 2 Mil +2%, $A = 2.8\text{ W/mK}$	R_{thJH}	—	0.263	—	°C/W

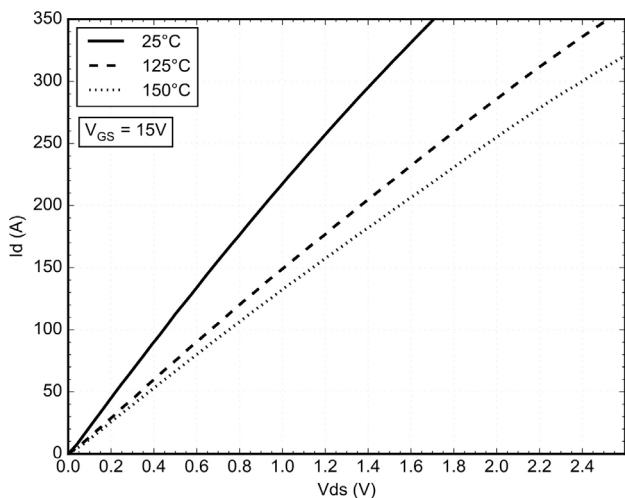
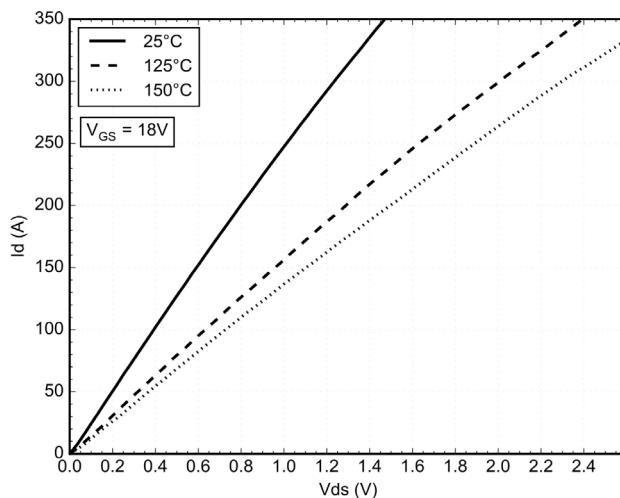
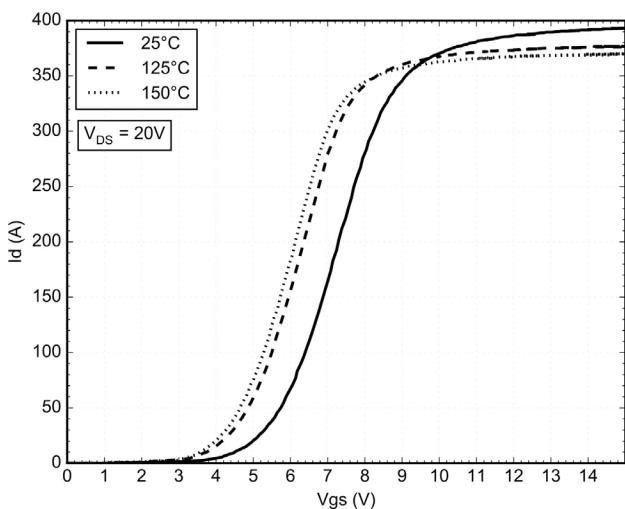
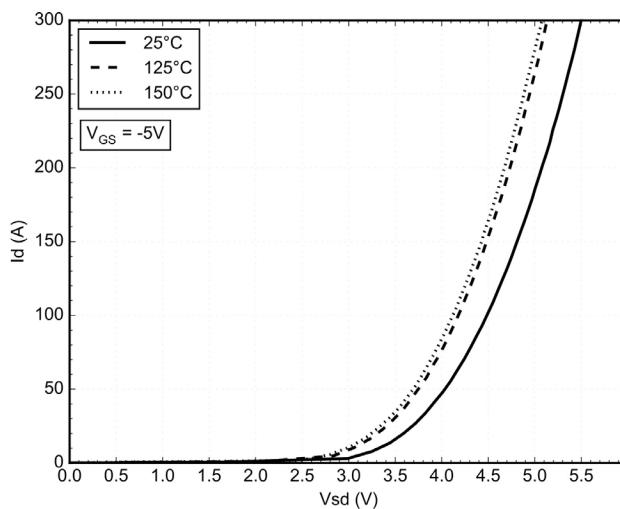
THERMISTOR CHARACTERISTICS

Nominal Resistance	$T_{NTC} = 25^\circ\text{C}$	R_{25}	—	5	—	kΩ
	$T_{NTC} = 100^\circ\text{C}$	R_{100}	—	493	—	Ω
	$T_{NTC} = 150^\circ\text{C}$	R_{150}	—	159.5	—	Ω
Deviation of R_{100}	$T_{NTC} = 100^\circ\text{C}$	$\Delta R/R$	—5	—	5	%
Power Dissipation – Recommended Limit	0.15 mA, Non-self-heating Effect	P_D	—	0.1	—	mW
Power Dissipation – Absolute Maximum	5 mA	P_D	—	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
NXH004P120M3F2PTHG	NXH004P120M3F2PTHG	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**

TYPICAL CHARACTERISTIC
(M1/M2 SiC MOSFET CHARACTERISTIC)

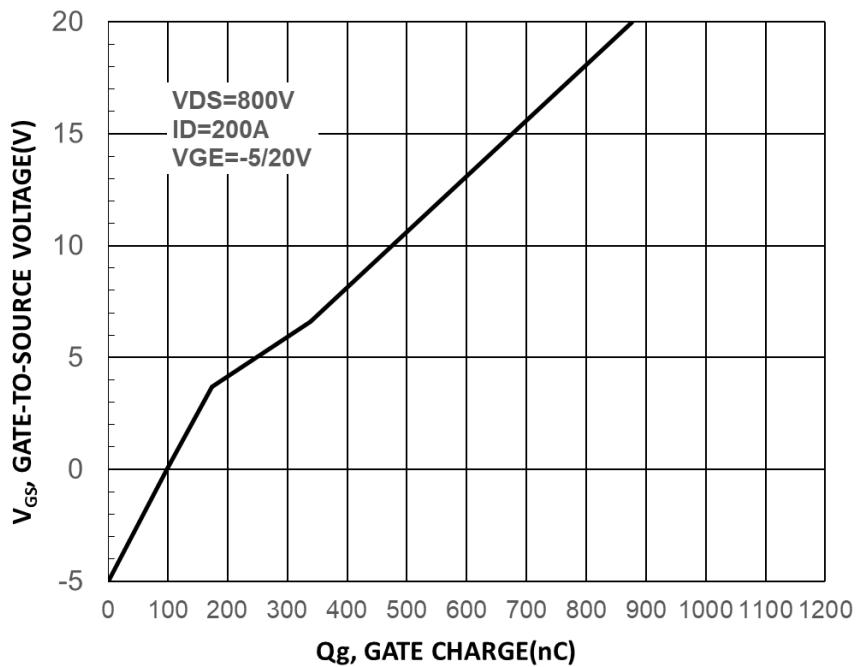


Figure 6. Gate-to-Source Voltage vs. Total Charge

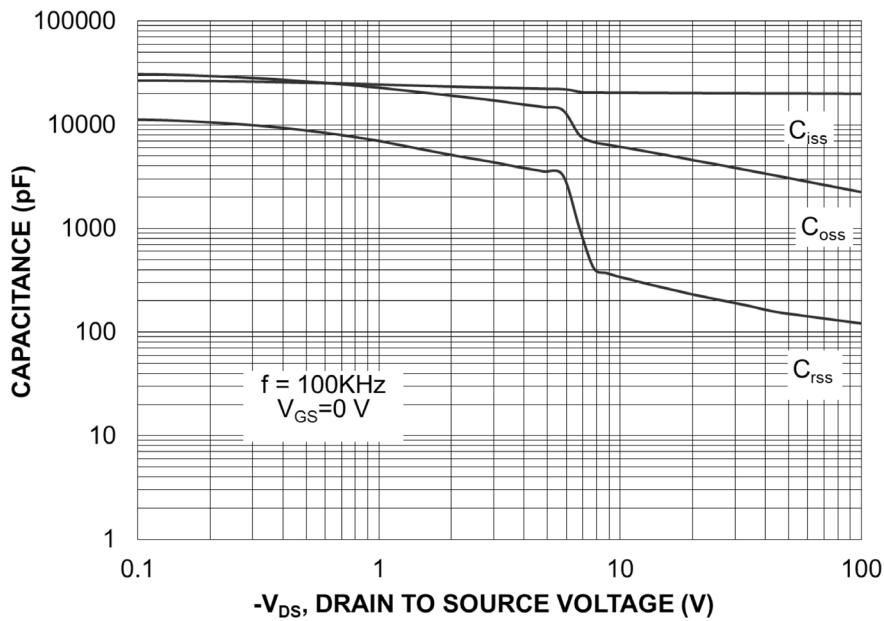


Figure 7. Capacitance vs. Drain-to-Source Voltage

TYPICAL CHARACTERISTIC
(M1/M1 SiC MOSFET SWITCHING CHARACTERISTIC)

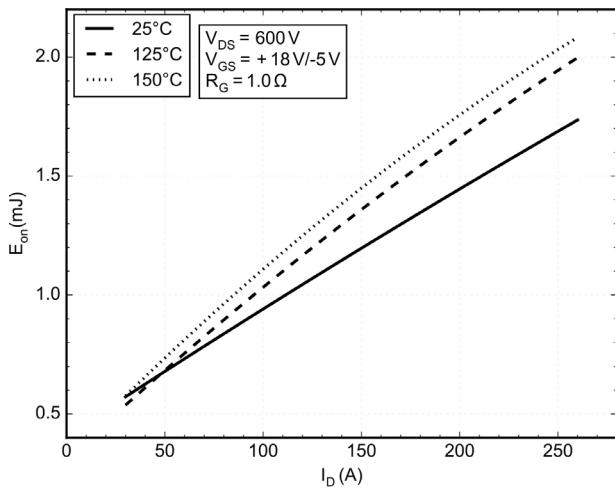


Figure 8. Typical Switching Loss E_{on} vs. I_D

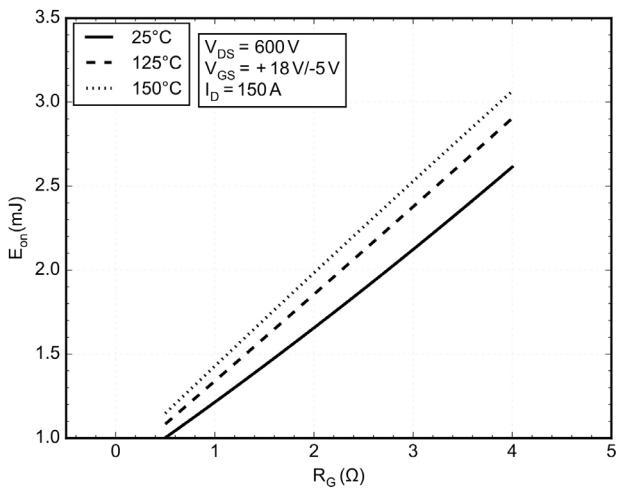


Figure 9. Typical Switching Loss E_{on} vs. R_G

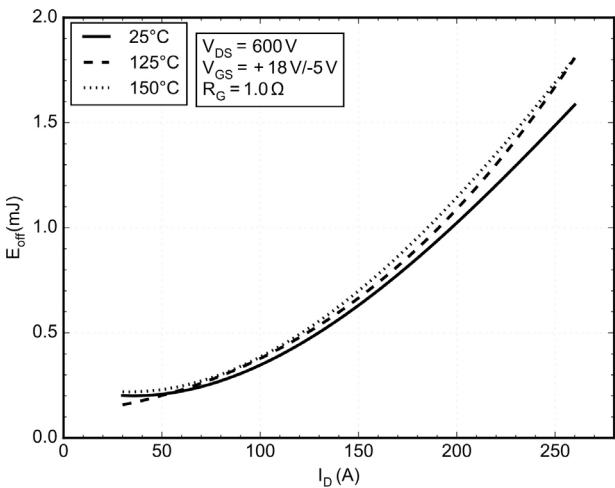


Figure 10. Typical Switching Loss E_{off} vs. I_D

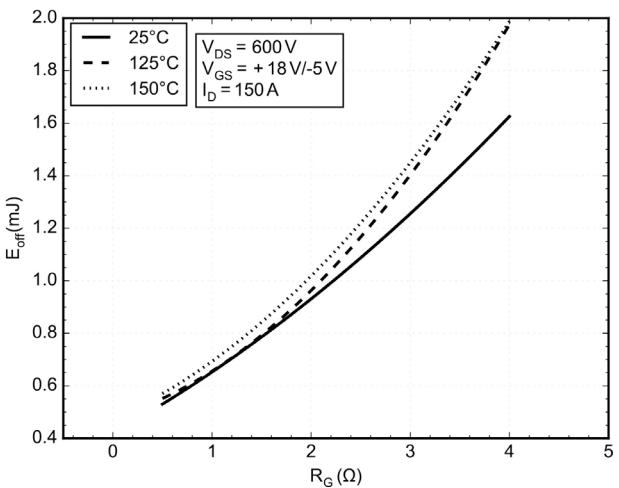


Figure 11. Typical Switching Loss E_{off} vs. R_G

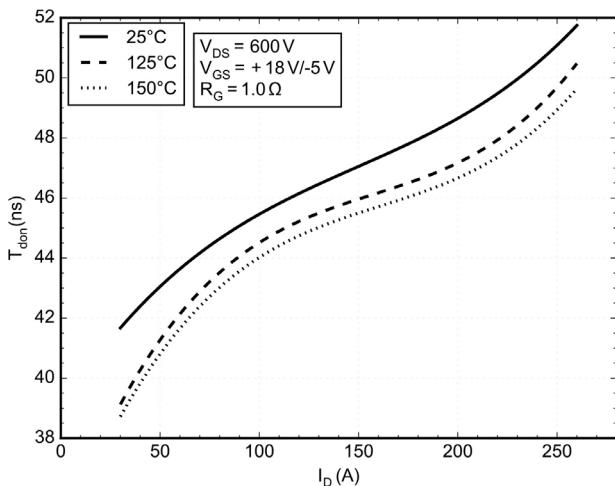


Figure 12. Typical Switching Loss T_{don} vs. I_D

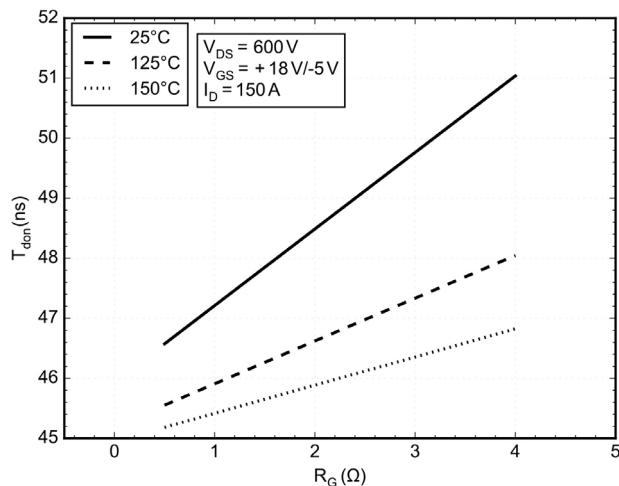


Figure 13. Typical Switching Loss T_{don} vs. R_G

TYPICAL CHARACTERISTIC
(M1/M1 SiC MOSFET SWITCHING CHARACTERISTIC)

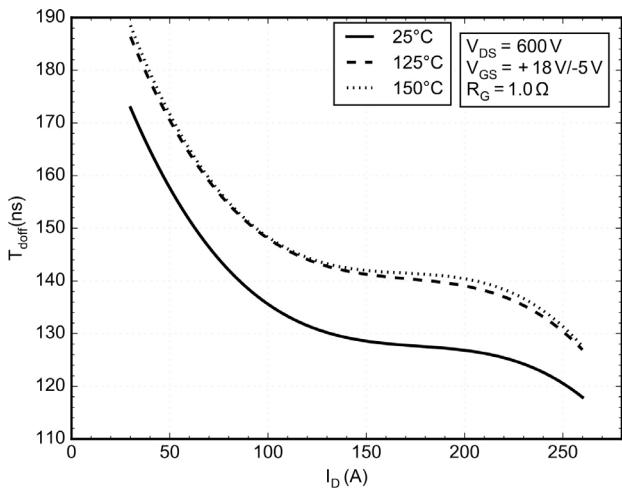


Figure 14. Typical Switching Loss T_{doff} vs. I_D

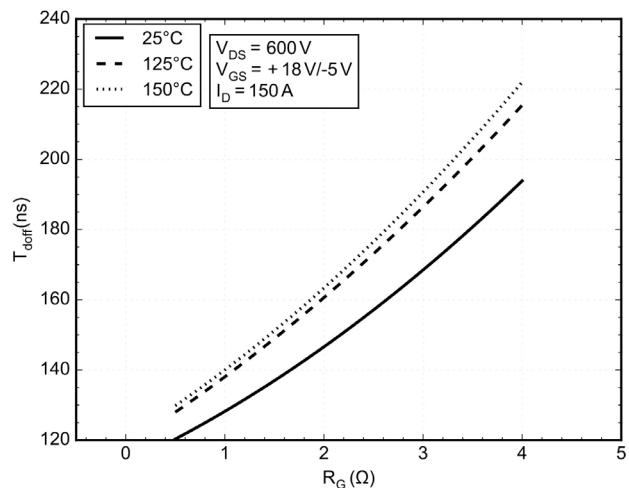


Figure 15. Typical Switching Loss T_{doff} vs. R_G

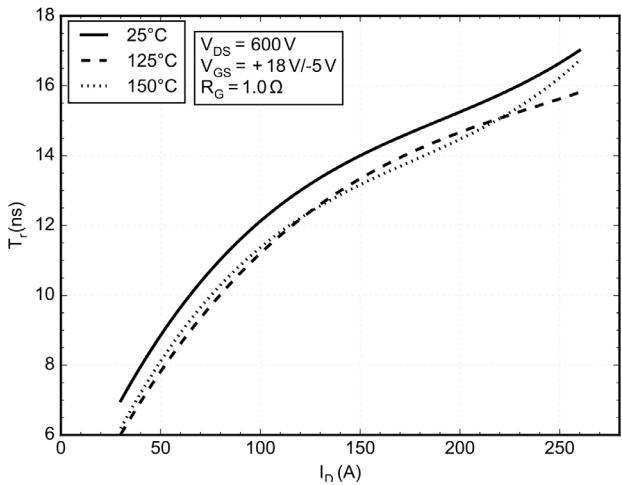


Figure 16. Typical Switching Loss T_r vs. I_D

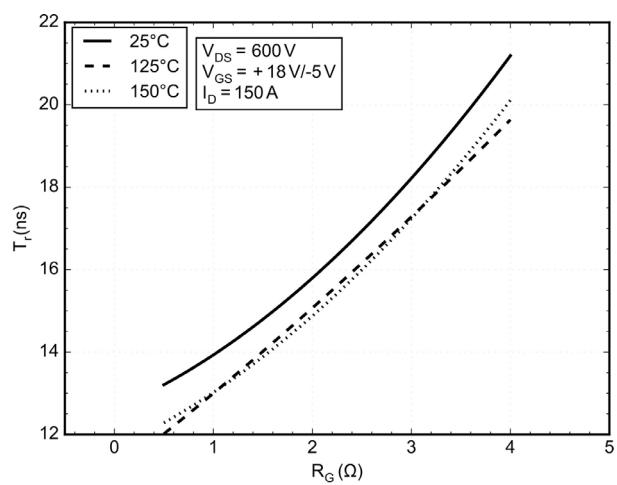


Figure 17. Typical Switching Loss T_r vs. R_G

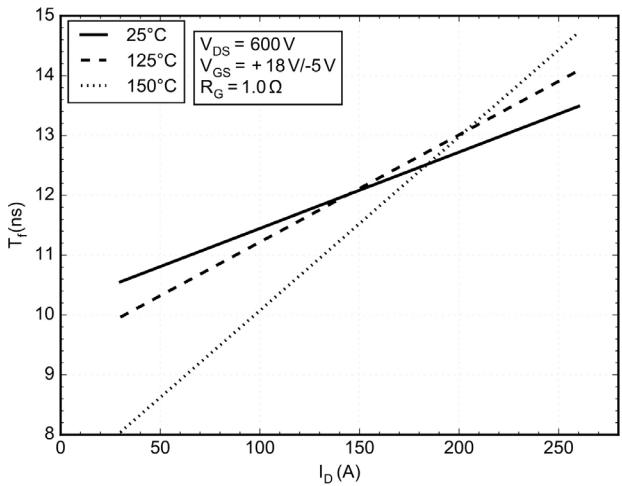


Figure 18. Typical Switching Loss T_f vs. I_D

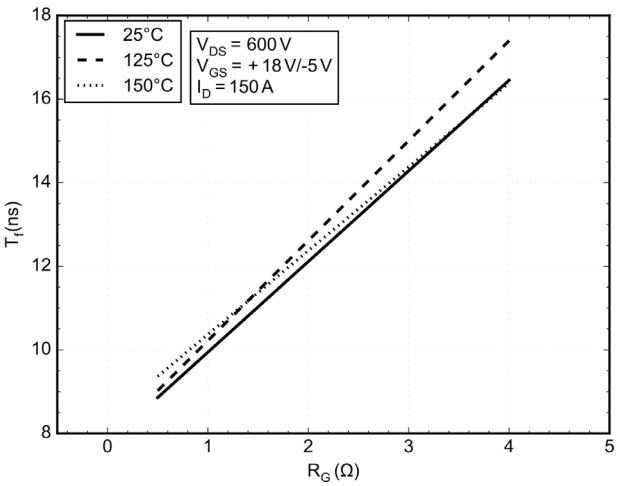
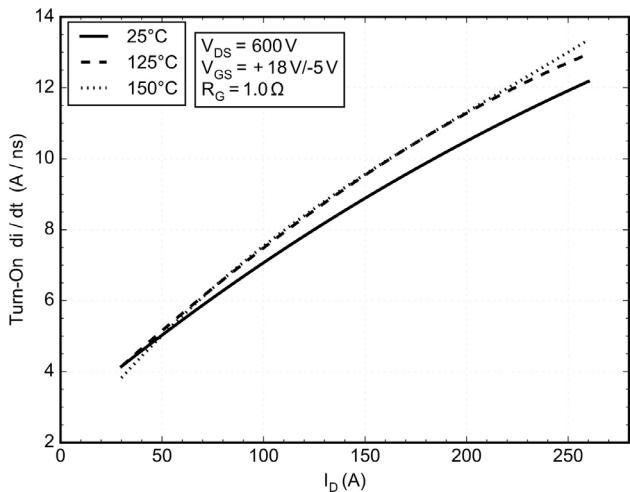
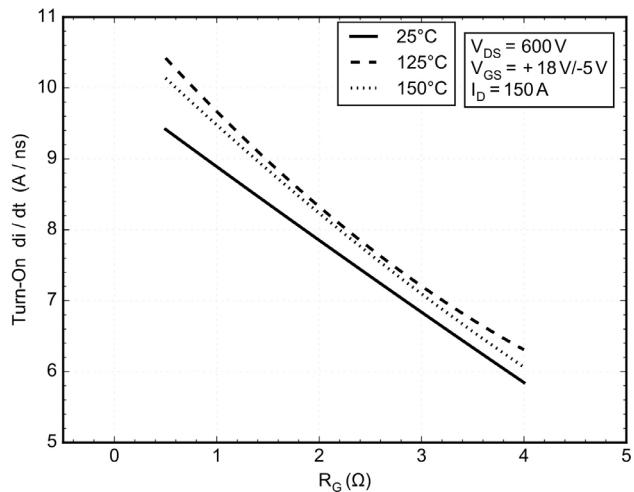
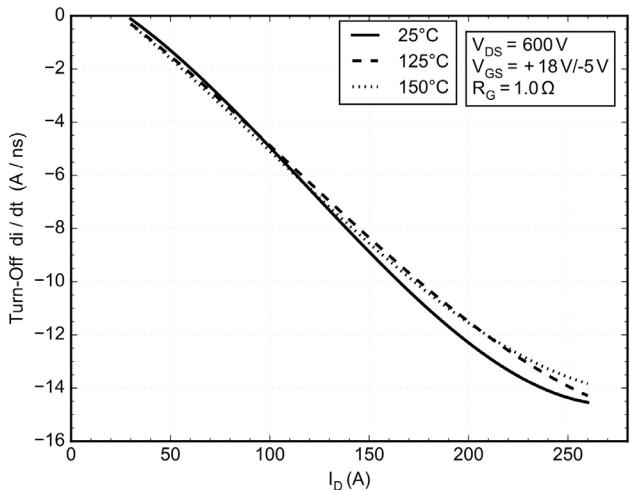
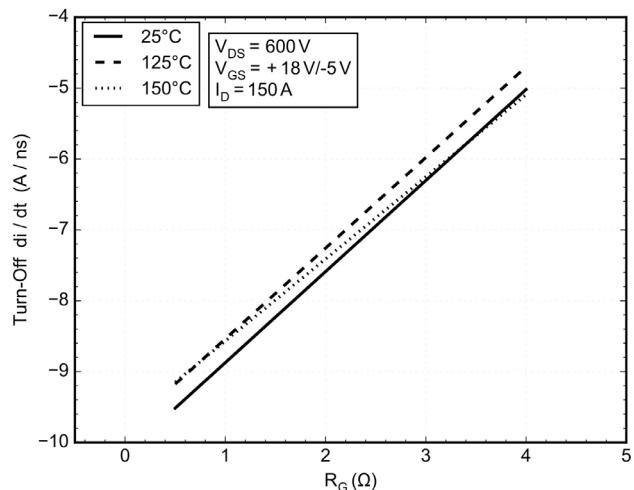
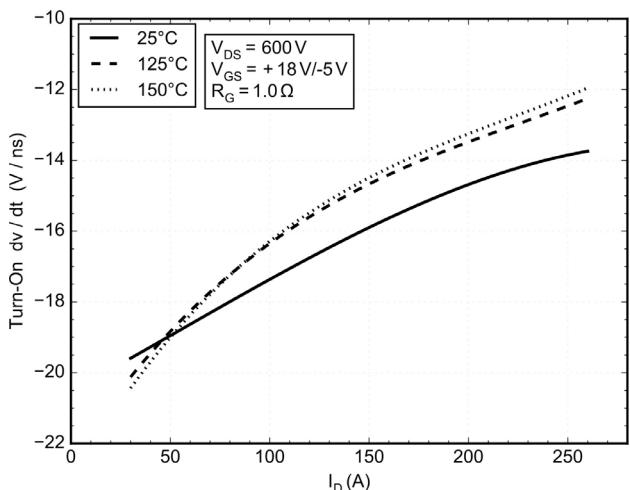
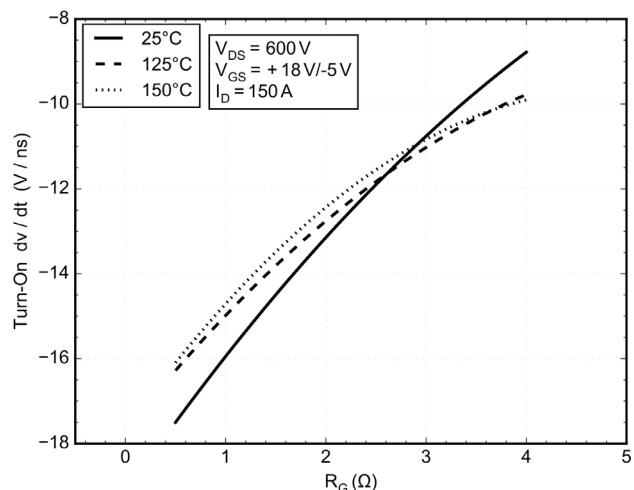
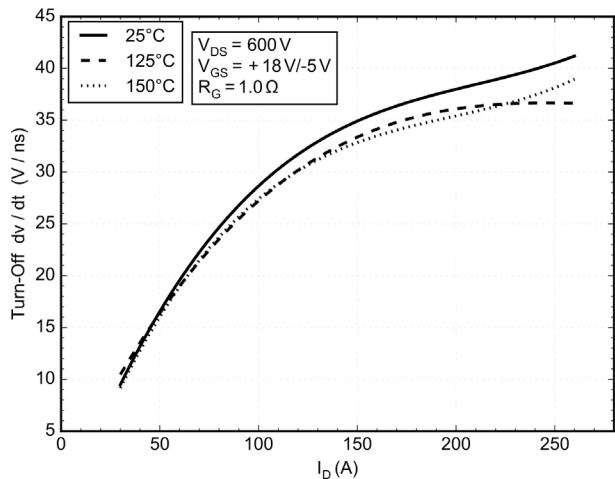
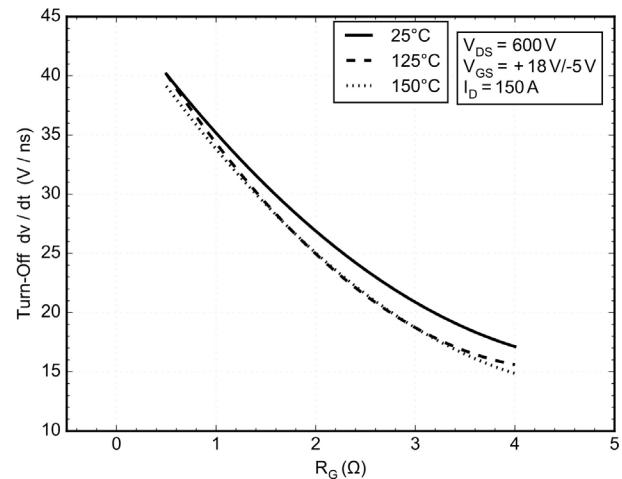


Figure 19. Typical Switching Loss T_f vs. R_G

TYPICAL CHARACTERISTIC
(M1/M1 SiC MOSFET SWITCHING CHARACTERISTIC)

Figure 20. di/dt ON vs. I_D Figure 21. di/dt ON vs. R_G Figure 22. di/dt OFF vs. I_D Figure 23. di/dt OFF vs. R_G Figure 24. dv/dt ON vs. I_D Figure 25. dv/dt ON vs. R_G

TYPICAL CHARACTERISTIC
(M1/M1 SiC MOSFET SWITCHING CHARACTERISTIC)**Figure 26. dv/dt OFF vs. ID****Figure 27. dv/dt OFF vs. RG**

TYPICAL CHARACTERISTIC
(M1/M1 SiC MOSFET CHARACTERISTIC)

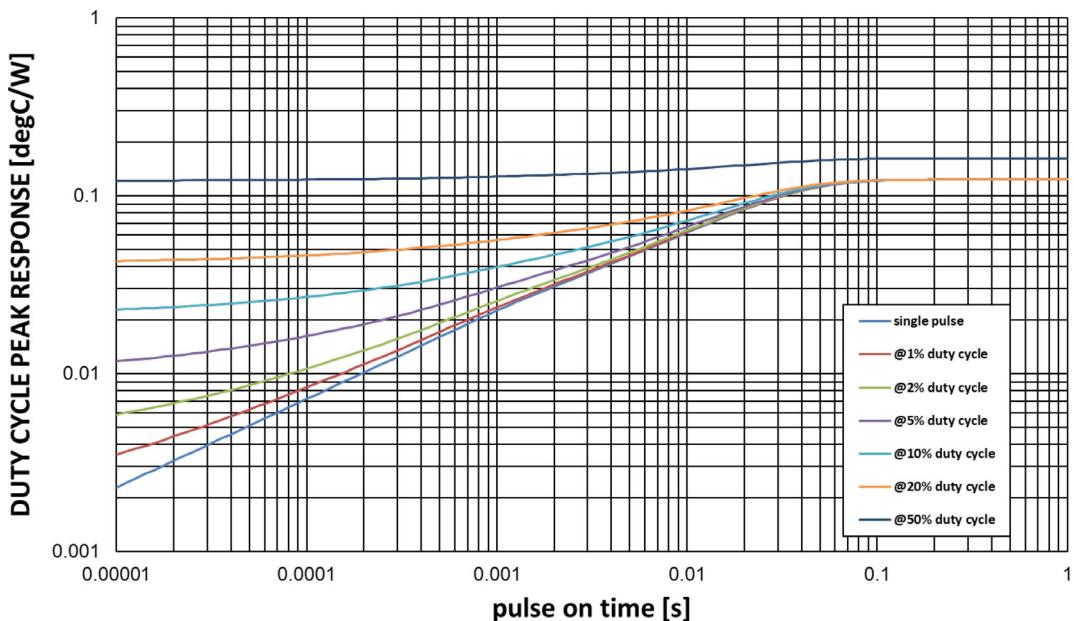


Figure 28. MOSFET Junction-to-Case Transient Thermal Impedance

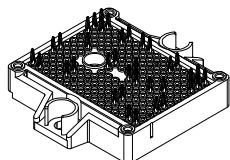
Table 1. FOSTER NETWORKS – M1, M2

Foster Element #	M1		M2	
	Rth (K/W)	Cth (Ws/K)	Rth (K/W)	Cth (Ws/K)
1	0.002696906	0.004098379	0.002720288	0.004514937
2	0.003154311	0.026752259	0.00279686	0.032605348
3	0.015256456	0.052736204	0.013216449	0.058320259
4	0.014153093	0.371590626	0.012551589	0.372984673
5	0.091397895	0.28781396	0.088665137	0.266129557

Table 2. CAUER NETWORKS – M1, M2

Cauer Element #	M1		M2	
	Rth (K/W)	Cth (Ws/K)	Rth (K/W)	Cth (Ws/K)
1	0.004167497	0.00326257	0.004133872	0.003626576
2	0.007647217	0.015697697	0.00758189	0.018148858
3	0.021401687	0.029324508	0.019509431	0.030697141
4	0.052959414	0.148179175	0.05061641	0.137728307
5	0.040482846	0.319017867	0.038108721	0.290558855

MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

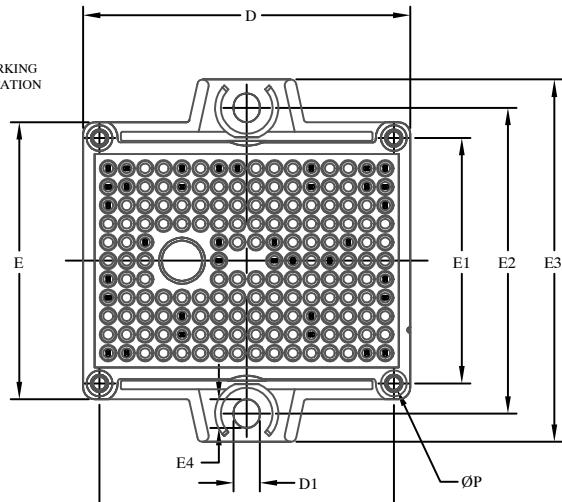
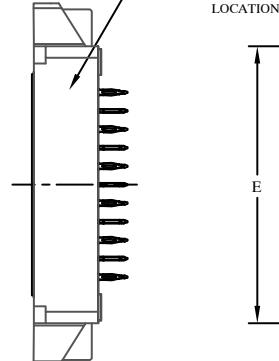


PIM36 56.7x42.5 (PRESS FIT)
CASE 180BY
ISSUE C

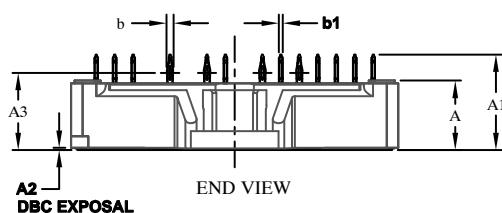
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NOTES:

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



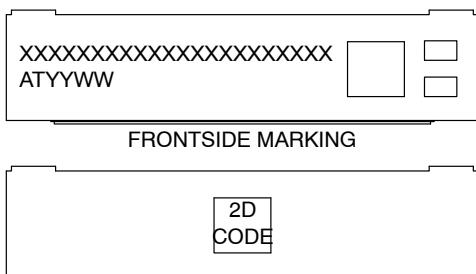
SIDE VIEW



A2
DBC EXPOSAL

END VIEW

GENERIC MARKING DIAGRAM*



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.

DOCUMENT NUMBER:	98AON19725H	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	PIM36 56.7x42.5 (PRESS FIT)	PAGE 1 OF 1

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