



M.S.KENNEDY CORP.

# 1200V/100A SiC HALF BRIDGE

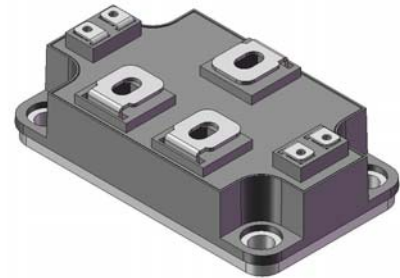
# 4804

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(315) 701-6751

**FEATURES:**

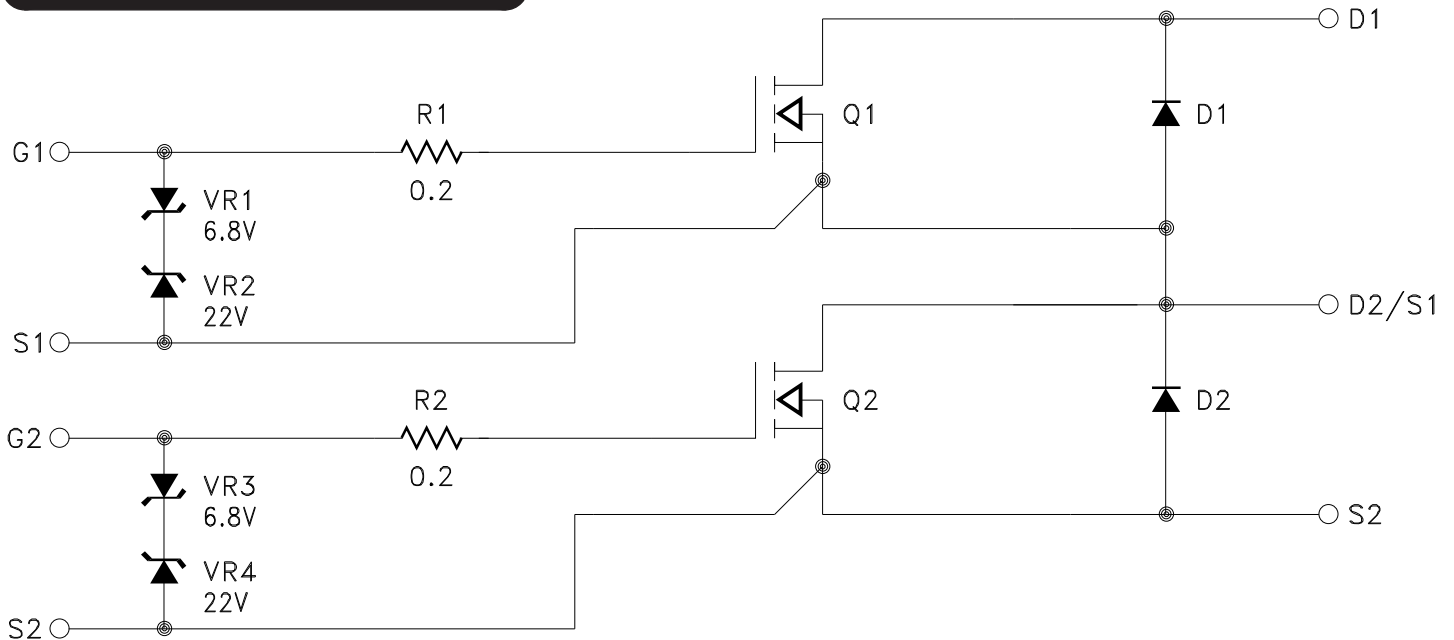
- Half Bridge Configuration
- Silicon Carbide Mosfet Provides Ultra Fast Switching
- Silicon Carbide Diode Provides Near Zero Recovery
- 1200V Rated Voltage
- 100A Continuous Output Current
- Internal Zener Clamps on Gates
- HI-REL Screening Available (Modified 38534)
- Light Weight Domed AISiC Baseplate
- Robust Mechanical Design for Hi-Rel Applications
- Ultra-Low Inductance Internal Layout
- Withstands 96 Hours HAST and Thermal Cycling (-55°C to +125°C)
- Contact MSK for MIL-PRF-38534 (Modified) Qualification Status



**DESCRIPTION:**

The MSK 4804 is one of a family of plastic encapsulated modules (PEM) developed specifically for use in military, aerospace and other severe environment applications. The SiC(Silicon Carbide) technology has superior switching performance compared to Si-Based modules. The half bridge configuration and 1200V/100A rating make it ideal for use in high current motor drive and inverter applications. The Aluminum Silicon Carbide (AlSiC) baseplate offers superior flatness and light weight; far better than copper or copper alloys found in most high power plastic modules. The high thermal conductivity materials used to construct the MSK 4804 allow high power outputs at elevated baseplate temperatures.

**EQUIVALENT SCHEMATIC**



**TYPICAL APPLICATIONS**

- Motor Drives
- Inverters

## ABSOLUTE MAXIMUM RATING ⑧

V <sub>DS</sub>	Collector to Emitter Voltage . . . . .	1200V
V <sub>GS</sub>	Gate to Emitter Voltage . . . . .	+25/-10V
I <sub>OUT</sub>	Current (Continuous) . . . . .	100A
I <sub>OUTP</sub>	Current Pulsed (1mS) . . . . .	200A
V <sub>CASE</sub>	Case Isolation Voltage . . . . .	2500 V

T <sub>ST</sub>	Storage Temperature Range . . .	-55°C to +125°C
T <sub>J</sub>	Junction Temperature . . . . .	175°C
T <sub>C</sub>	Case Operating Temperature Range	
	MSK 4804H . . . . .	-55°C to +125°C
	MSK 4804 . . . . .	-40°C to +85°C

## ELECTRICAL SPECIFICATIONS

Parameter ⑥	Test Conditions	Group A Subgroup	MSK 4804 H			MSK 4804			Units
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Drain-Source Voltage	I <sub>D</sub> = 100A, V <sub>GS</sub> = 20V	1	-	1.44	2.10	-	1.44	2.20	V
		2	-	1.78	2.40	-	-	-	V
		3	-	1.82	2.45	-	-	-	V
Drain-Source Leakage Current	V <sub>DS</sub> = 1000V, V <sub>GS</sub> = 0V	1	-	0.006	1	-	0.006	1.2	mA
		2	-	0.060	5	-	-	-	mA
Gate Threshold Voltage	I <sub>D</sub> = 1mA, V <sub>DS</sub> = V <sub>GS</sub>	1	1.0	1.66	3.5	0.8	1.6	3.5	V
		2	1.0	1.19	3.5	-	-	-	V
		3	1.0	2.47	3.5	-	-	-	V
Diode Forward Voltage	I <sub>D</sub> = 100A	1	-	1.88	2.20	-	1.88	2.30	V
		2	-	2.28	2.60	-	-	-	V
		3	-	1.67	2.20	-	-	-	V
Total Gate Charge ①	V = 600V, I <sub>D</sub> = 100A	4	-	500	570	-	500	590	nC
E(on) ①	V = 600V, I <sub>D</sub> = 100A, R <sub>G</sub> = 5Ω, V <sub>GS</sub> = -5/+20V	4	-	1.99	3.3	-	1.99	3.4	mJ
	V = 600V, I <sub>D</sub> = 50A, R <sub>G</sub> = 5Ω, V <sub>GS</sub> = -5/+20V	4	-	1.50	-	-	1.50	-	mJ
	V = 600V, I <sub>D</sub> = 100A, R <sub>G</sub> = 5Ω, V <sub>GS</sub> = -5/+20V	5	-	2.08	-	-	-	-	mJ
	V = 600V, I <sub>D</sub> = 50A, R <sub>G</sub> = 5Ω, V <sub>GS</sub> = -5/+20V	5	-	1.66	-	-	-	-	mJ
E(off) ①	V = 600V, I <sub>D</sub> = 100A, R <sub>G</sub> = 5Ω, V <sub>GS</sub> = -5/+20V	4	-	1.72	2.4	-	1.72	2.5	mJ
	V = 600V, I <sub>D</sub> = 50A, R <sub>G</sub> = 5Ω, V <sub>GS</sub> = -5/+20V	4	-	637	-	-	637	-	uJ
	V = 600V, I <sub>D</sub> = 100A, R <sub>G</sub> = 5Ω, V <sub>GS</sub> = -5/+20V	5	-	1.91	-	-	-	-	mJ
	V = 600V, I <sub>D</sub> = 50A, R <sub>G</sub> = 5Ω, V <sub>GS</sub> = -5/+20V	5	-	700	-	-	-	-	uJ
Diode Reverse Recovery Time ①	I <sub>S</sub> = 100, di/dt = 2200A/uS	4	-	47	-	-	47	-	nS
	I <sub>S</sub> = 50, di/dt = 2200A/uS	4	-	52	-	-	52	-	nS
	I <sub>S</sub> = 100, di/dt = 2200A/uS	5	-	56	-	-	-	-	nS
	I <sub>S</sub> = 50, di/dt = 2200A/uS	5	-	63	-	-	-	-	nS
Diode Reverse Energy ①	I <sub>S</sub> = 100, di/dt = 2200A/uS	4	-	460	790	-	460	800	uJ
	I <sub>S</sub> = 50, di/dt = 2200A/uS	4	-	470	-	-	470	-	uJ
	I <sub>S</sub> = 100, di/dt = 2200A/uS	5	-	776	-	-	-	-	uJ
	I <sub>S</sub> = 50, di/dt = 2200A/uS	5	-	824	-	-	-	-	uJ
Thermal Resistance ①	MOSFET @ T <sub>J</sub> = 125°C	-	-	0.160	0.190	-	0.160	0.190	°C/W
	DIODE @ T <sub>J</sub> = 125°C	-	-	0.350	0.370	-	0.350	0.370	°C/W

### NOTES:

- ① Guaranteed by design but not tested. Typical parameters are representative of actual device performance but are for reference only.
- ② Industrial grade devices shall be tested to subgroup 1 unless otherwise specified.
- ③ HI-REL grade devices ("H" suffix) shall be 100% tested to subgroups 1, 2 and sample tested to subgroup 3.
- ④ Subgroup 4 testing available upon request.
- ⑤ Subgroup 1, 4 T<sub>A</sub> = +25°C  
     2, 5 T<sub>A</sub> = +125°C  
     3, T<sub>A</sub> = -55°C
- ⑥ All specifications apply to both the upper and lower sections of the half bridge.
- ⑦ V<sub>GS</sub> = 20V unless otherwise specified.
- ⑧ Continuous operation at or above absolute maximum ratings may adversely effect the device performance and/or life cycle.

***THERMAL CALCULATIONS***

Power dissipation and maximum allowable temperature rise involve many variables working together. Drain current, PWM duty cycle and switching frequency all factor into power dissipation. DC losses or "ON-TIME" losses are simply  $V_{DS} \times \text{Drain Current} \times \text{PWM duty cycle}$ . For the MSK 4804,  $V_{DS} = 2.4V$  max., and at 100 amps and a PWM duty cycle of 30%, DC losses equal 240 watts. Switching losses vary proportionally with switching frequency. The MSK 4804 typical switching losses at  $V_{DS} = 600V$  and  $I_{DS} = 100A$  are about 3.99mJ, which is simply the sum of the turn-on switching loss and the turn-off switching loss. Multiplying the switching frequency times the switching losses will result in a power dissipation number for switching. The MSK 4804, at 5KHz, will exhibit switching power dissipation of 19.95 watts. The total losses are the sum of DC losses plus switching losses, or in this case, 91.95 watts total.

$91.95 \text{ watts} \times 0.190^{\circ}\text{C}/\text{W}$  thermal resistance equals 17.47 degrees of temperature rise between the case and the junction. Subtracting  $17.47^{\circ}\text{C}$  from the maximum junction temperature of  $150^{\circ}\text{C}$  equals  $132.53^{\circ}\text{C}$  maximum case temperature for this example.

$$V_{DS} \times I_D \times \text{PWM duty cycle} = 2.4V \times 100 \text{ amps} \times 30\% = 72 \text{ watts DC losses}$$

$$\text{Turn-on switching loss} + \text{Turn-off switching loss} = \text{Total switching losses} = 2.08\text{mJ} + 1.91\text{mJ} = 3.99\text{mJ}$$

$$\text{Total switching loss} \times \text{PWM frequency} = \text{Total switching power dissipation} = 3.99\text{mJ} \times 5\text{KHz} = 19.95 \text{ watts}$$

$$\text{Total power dissipation} = \text{DC losses} + \text{switching losses} = 72\text{W} + 19.95\text{W} = 91.95 \text{ watts}$$

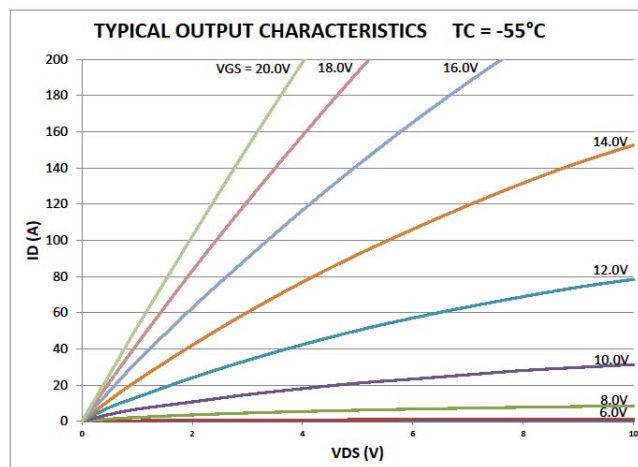
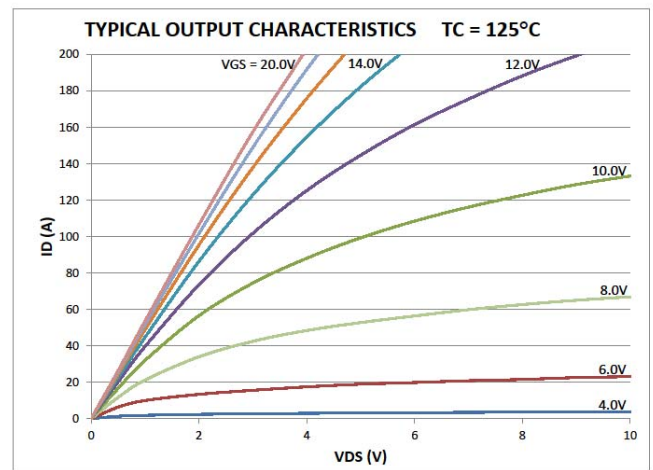
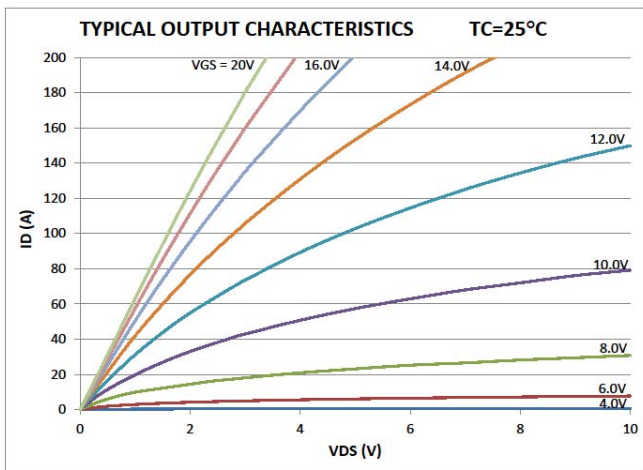
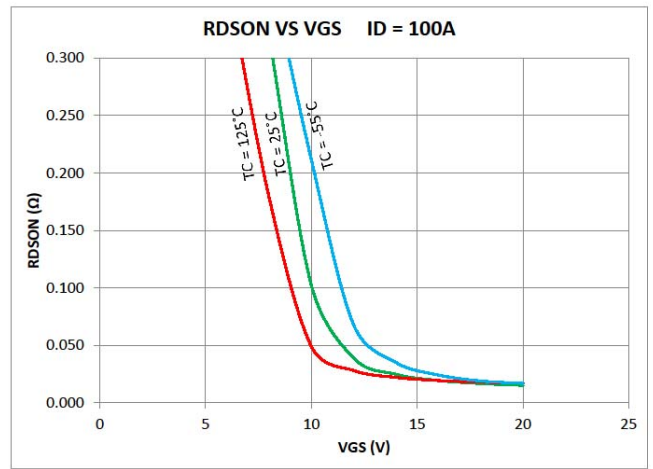
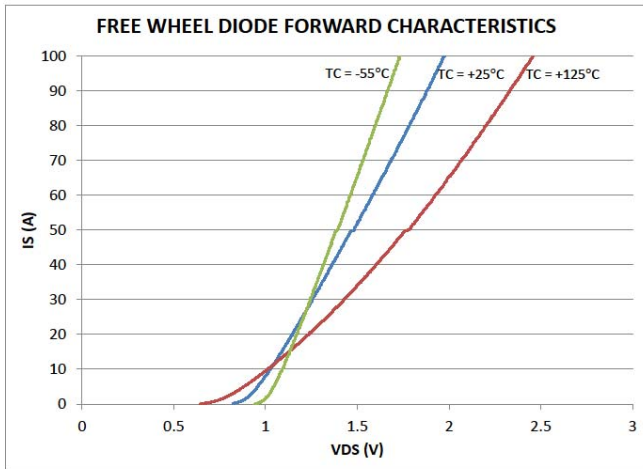
$$\text{Junction temperature rise above case} = \text{Total power dissipation} \times \text{thermal resistance}$$

$$91.95 \text{ watts} \times 0.190^{\circ}\text{C}/\text{W} = 17.47^{\circ}\text{C} \text{ temperature rise above case}$$

$$\text{Maximum junction temperature} - \text{junction temperature rise} = \text{maximum baseplate temperature}$$

$$150^{\circ}\text{C} - 17.47^{\circ}\text{C} = 132.53^{\circ}\text{C}$$

# TYPICAL PERFORMANCE CURVES

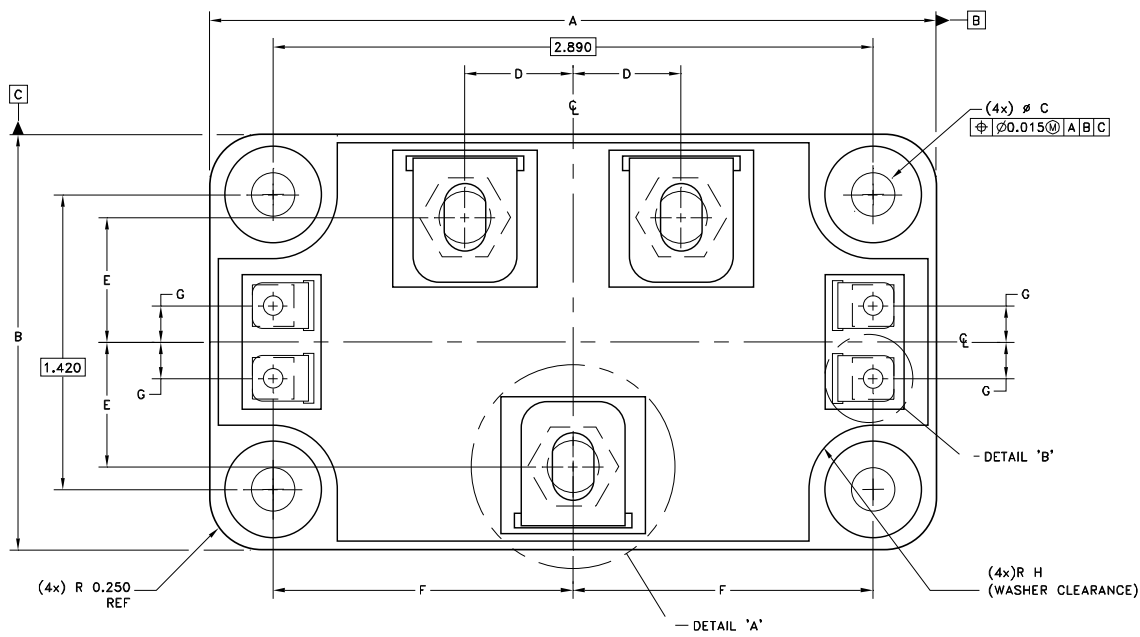


## SCREENING CHART

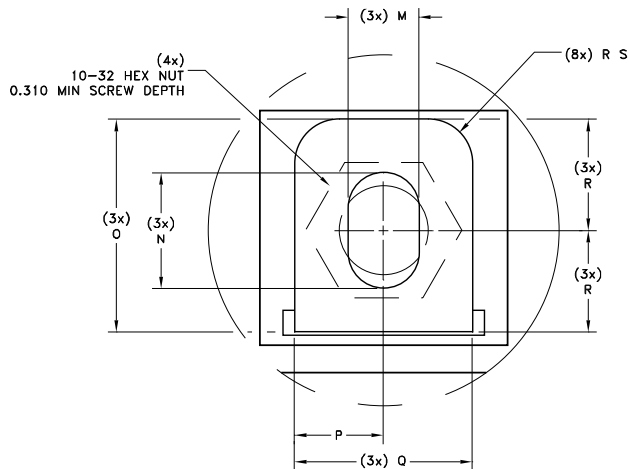
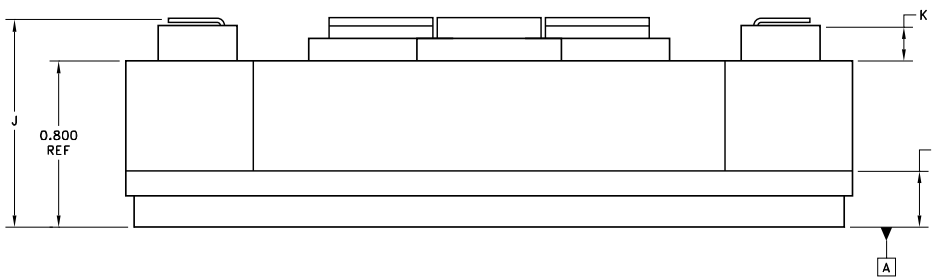
OPERATION	INDUSTRIAL	H SUFFIX
QUALIFICATION (MODIFIED)	NO	YES
ELEMENT EVALUATION	NO	YES
CLEAN ROOM PROCESSING	YES	YES
NON DESTRUCT BOND PULL SAMPLE	YES	YES
CERTIFIED OPERATORS	NO	YES
MIL LINE PROCESSING	YES	YES
MAX REWORK SPECIFIED	NO	YES
PRE-CAP VISUAL	YES - INDUSTRIAL	YES - CLASS H
TEMP CYCLE (-55°C TO +125°C)	NO	YES
BURN-IN	NO	YES - 160 HOURS
ELECTRICAL TESTING	YES - 25°C	YES - FULL TEMP
EXTERNAL VISUAL	YES - SAMPLE	YES
XRAY	NO	NO
PIN FINISH	NI	NI

NOTE: ADDITIONAL SCREENING IS AVAILABLE SUCH AS XRAY, CSAM, MECHANICAL SHOCK, ETC. CONTACT FACTORY FOR QUAL STATUS.

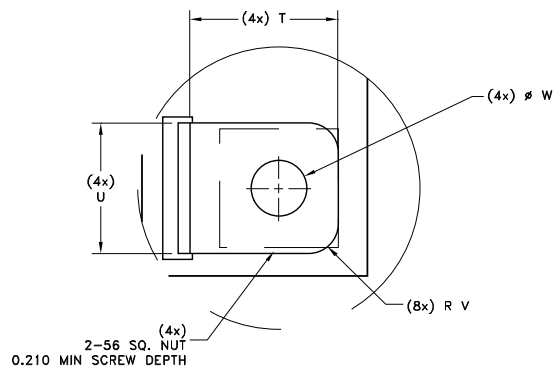
# MECHANICAL SPECIFICATIONS



REF	MIN	MAX
A	3.470	3.510
B	1.970	2.010
C	0.208	0.225
C $\phi$	$\phi$ 0.015	A B C
D*	0.496	0.546
E*	0.575	0.625
F*	1.420	1.470
G*	0.150	0.200
H*	0.240	
J	0.985	1.015
K	0.090	
L	0.255	0.285
M	0.195	0.230
N	0.310	0.340
O	0.500	0.700
P	0.200	0.300
Q	0.500	0.550
R		0.400
S*	0.100	
T		0.250
U		0.220
V	0.050	
W	0.090	0.110
WEIGHT		200g



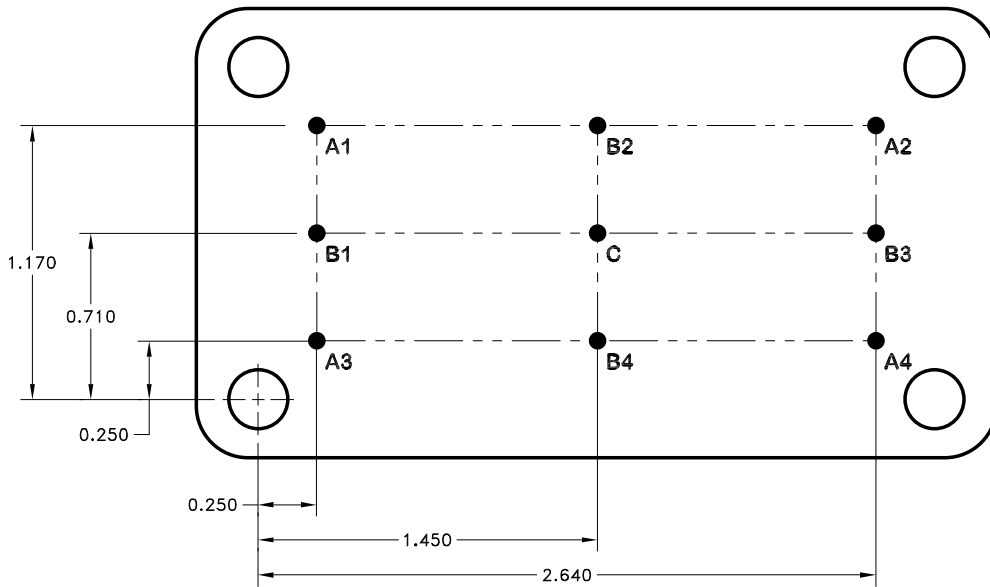
DETAIL 'A'  
SCALE 3:1



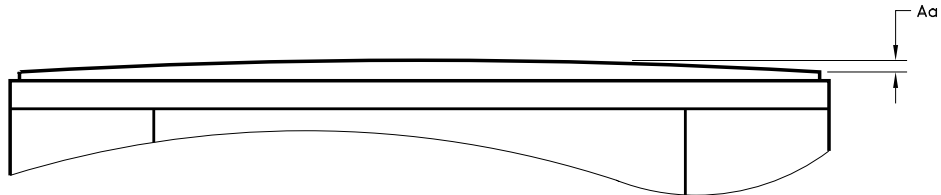
DETAIL 'B'  
SCALE 5:1

WEIGHT = 200 GRAMS MAX.

# MECHANICAL SPECIFICATIONS



**POWER MODULE (BOTTOM VIEW)**  
(NOT TO SCALE)



**POWER MODULE (SIDE VIEW)**  
**(EXAGGERATED DOME)**  
(NOT TO SCALE)

CONVEX BASEPLATE PROFILE (FROM POINT C)

REF	Z MIN	Z MAX
A1	0.000	0.007
A2	0.000	0.007
A3	0.000	0.007
A4	0.000	0.007
B1	0.000	0.007
B2	0.000	0.007
B3	0.000	0.007
B4	0.000	0.007

## ORDERING INFORMATION

**MSK4804 H**

**SCREENING**

BLANK = INDUSTRIAL

H = HI-REL (MODIFIED 38534)

**GENERAL PART NUMBER**

THE ABOVE EXAMPLE IS A MILITARY SCREENED MODULE.

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Please visit our website for the most recent revision of this datasheet.

Contact MSK for MIL-PRF-38534 (modified) qualification status.