MSK

M.S.KENNEDY CORP.

# 1200V/100A SiC HALF BRIDGE

# 4804

4707 Dey Road Liverpool, N.Y. 13088

(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 AlSiC 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
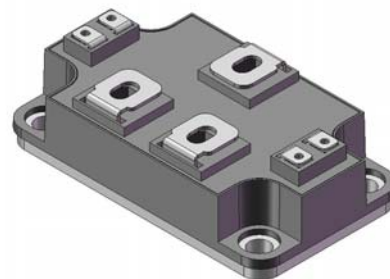
DESCRIPTION:

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
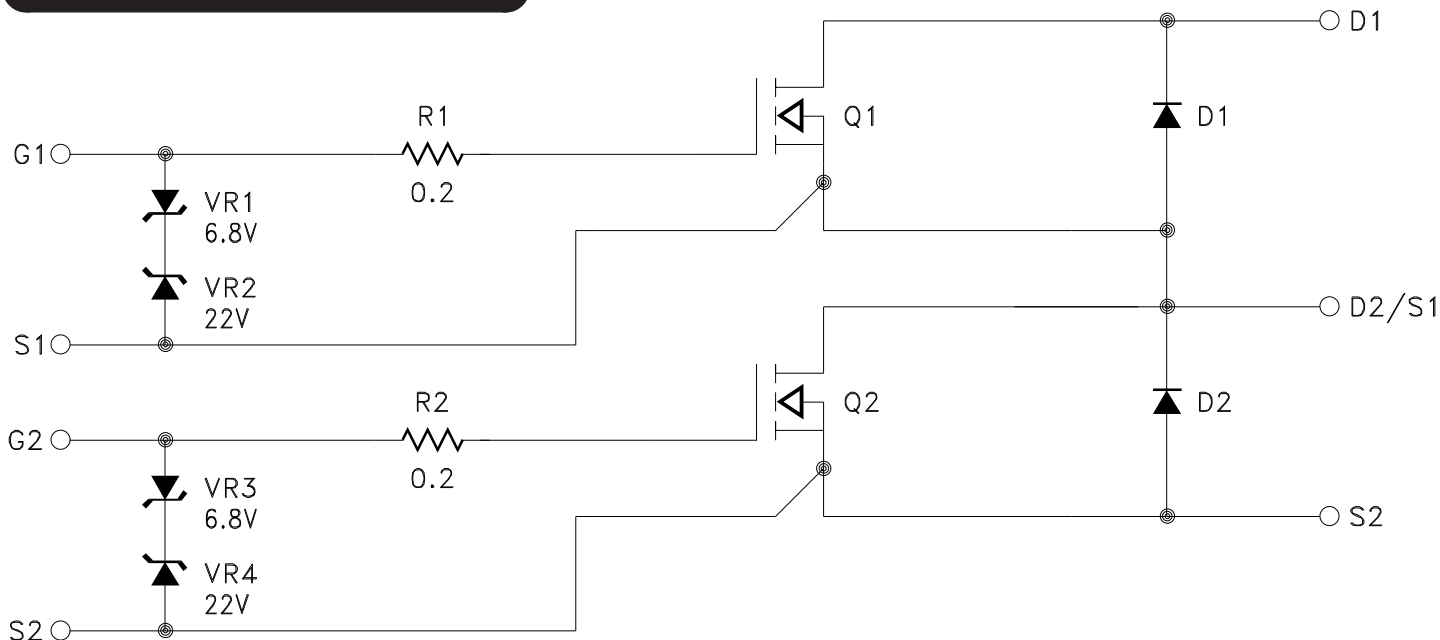
TYPICAL APPLICATIONS

- Motor Drives
- Inverters

ABSOLUTE MAXIMUM RATING [8]

V_{DS} Collector to Emitter Voltage 1200V
V_{GS} Gate to Emitter Voltage . . . .+25/-10V
I_{OUT} Current (Continuous) 100A
I_{OUTP} Current Pulsed (1mS) 200A
V_{CASE} Case Isolation Voltage . . . . 2500 V

T_{ST} Storage Temperature Range   . -55°C to +125°C
T_J Junction Temperature . . . . .175°C
T_C 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 Min.	Typ.	Max.	MSK 4804 Min.	Typ.	Max.	Units
Drain-Source Voltage	$I_D = 100A, V_{GS} = 20V$	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	$V_{DS} = 1000V, V_{GS} = 0V$	1	-	0.006	1	-	0.006	1.2	mA
		2	-	0.060	5	-	-	-	mA
Gate Threshold Voltage	$I_D = 1mA, V_{DS} = V_{GS}$	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	$I_D = 100A$	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]	$V = 600V, I_D = 100A$	4	-	500	570	-	500	590	nC
E(on) [1]	$V = 600V, I_D = 100A, R_G = 5\Omega, V_{GS} = -5/+20V$	4	-	1.99	3.3	-	1.99	3.4	mJ
	$V = 600V, I_D = 50A, R_G = 5\Omega, V_{GS} = -5/+20V$	4	-	1.50	-	-	1.50	-	mJ
	$V = 600V, I_D = 100A, R_G = 5\Omega, V_{GS} = -5/+20V$	5	-	2.08	-	-	-	-	mJ
	$V = 600V, I_D = 50A, R_G = 5\Omega, V_{GS} = -5/+20V$	5	-	1.66	-	-	-	-	mJ
E(off) [1]	$V = 600V, I_D = 100A, R_G = 5\Omega, V_{GS} = -5/+20V$	4	-	1.72	2.4	-	1.72	2.5	mJ
	$V = 600V, I_D = 50A, R_G = 5\Omega, V_{GS} = -5/+20V$	4	-	637	-	-	637	-	uJ
	$V = 600V, I_D = 100A, R_G = 5\Omega, V_{GS} = -5/+20V$	5	-	1.91	-	-	-	-	mJ
	$V = 600V, I_D = 50A, R_G = 5\Omega, V_{GS} = -5/+20V$	5	-	700	-	-	-	-	uJ
Diode Reverse Recovery Time [1]	$I_S = 100, di/dt = 2200A/uS$	4	-	47	-	-	47	-	nS
	$I_S = 50, di/dt = 2200A/uS$	4	-	52	-	-	52	-	nS
	$I_S = 100, di/dt = 2200A/uS$	5	-	56	-	-	-	-	nS
	$I_S = 50, di/dt = 2200A/uS$	5	-	63	-	-	-	-	nS
Diode Reverse Energy [1]	$I_S = 100, di/dt = 2200A/uS$	4	-	460	790	-	460	800	uJ
	$I_S = 50, di/dt = 2200A/uS$	4	-	470	-	-	470	-	uJ
	$I_S = 100, di/dt = 2200A/uS$	5	-	776	-	-	-	-	uJ
	$I_S = 50, di/dt = 2200A/uS$	5	-	824	-	-	-	-	uJ
Thermal Resistance [1]	MOSFET @ $T_J = 125°C$	-	-	0.160	0.190	-	0.160	0.190	°C/W
	DIODE @ $T_J = 125°C$	-	-	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 $T_A = +25°C$
          2, 5 $T_A = +125°C$
          3, $T_A = -55°C$
[6] All specifications apply to both the upper and lower sections of the half bridge.
[7] $V_{GS} = 20V$ unless otherwise specified.
[8] Continuous operation at or above absolute maximum ratings may adversly effect the device performance and/or life cycle.

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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} x Drain Current x 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 watts x 0.190°C/W thermal resistance equals 17.47 degrees of temperature rise between the case and the junction. Subtracting 17.47°C from the maximum junction temperature of 150°C equals 132.53°C maximum case temperature for this example.

V_{DS} x I_D x PWM duty cycle = 2.4V x 100 amps x 30% = 72 watts DC losses

Turn-on switching loss + Turn-off switching loss = Total switching losses = 2.08mJ + 1.91mJ = 3.99mJ

Total switching loss x PWM frequency = Total switching power dissipation = 3.99mJ x 5KHz = 19.95 watts

Total power dissipation = DC losses + switching losses = 72W + 19.95W = 91.95 watts

Junction temperature rise above case = Total power dissipation x thermal resistance
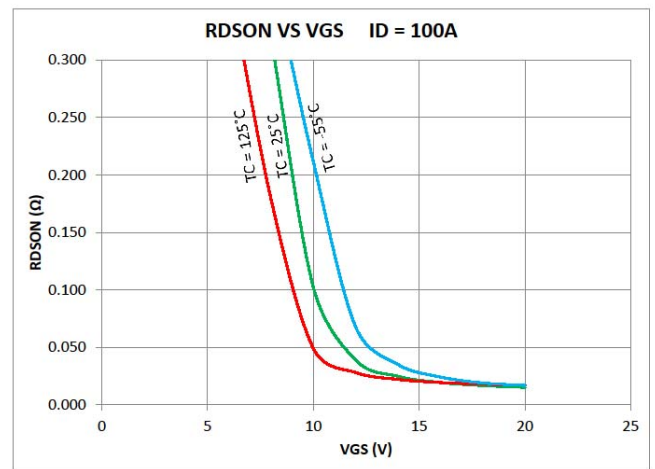
91.95 watts x 0.190°C/W = 17.47°C temperature rise above case

Maximum junction temperature - junction temperature rise = maximum baseplate temperature

150°C - 17.47°C = 132.53°C

TYPICAL PERFORMANCE CURVES

FREE WHEEL DIODE FORWARD CHARACTERISTICS

TC = -55°C   TC = +25°C   TC = +125°C

IS (A) vs VDS (V)

RDSON VS VGS   ID = 100A

TC = 125°C   TC = 25°C   TC = -55°C

RDSON (Ω) vs VGS (V)

TYPICAL OUTPUT CHARACTERISTICS   TC=25°C

VGS = 20V   16.0V   14.0V
12.0V
10.0V
8.0V
6.0V
4.0V

ID (A) vs VDS (V)

TYPICAL OUTPUT CHARACTERISTICS   TC = 125°C

VGS = 20.0V   14.0V   12.0V
10.0V
8.0V
6.0V
4.0V

ID (A) vs VDS (V)

TYPICAL OUTPUT CHARACTERISTICS   TC = -55°C

VGS = 20.0V   18.0V   16.0V
14.0V
12.0V
10.0V
8.0V
6.0V

ID (A) vs VDS (V)
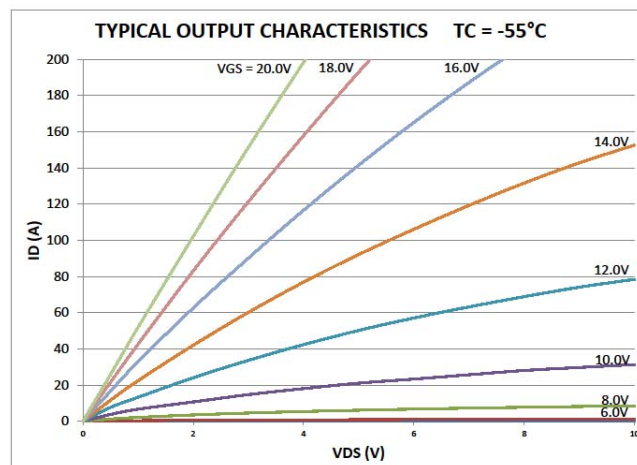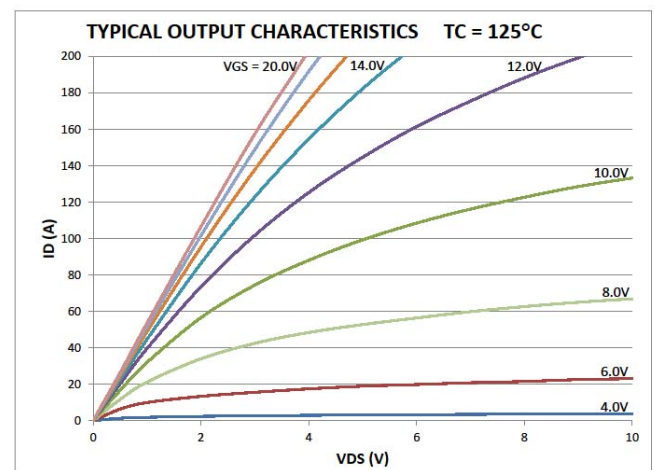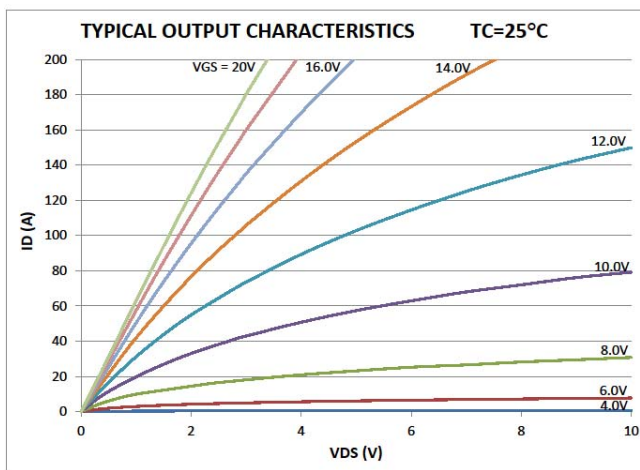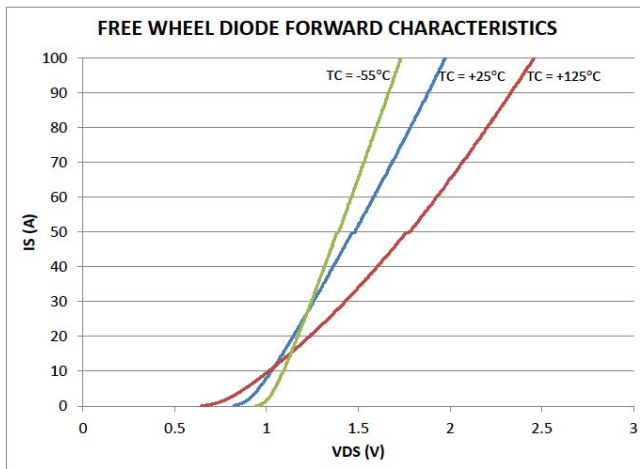
OPERATION	INDUSTRIAL	H SUFFIX
QUALIFICATION (MODIFIED)	NO	YES
ELEMENT EVALUATION	NO	YES
CLEAN ROOM PROCESSING	YES	YES
NON DESTRUCT BOND PULL SAMPLE	YES	YES
CERTIFIED OPERATORS	NO	YES
MIL LINE PROCESSING	YES	YES
MAX REWORK SPECIFIED	NO	YES
PRE-CAP VISUAL	YES - INDUSTRIAL	YES - CLASS H
TEMP CYCLE (-55°C 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.
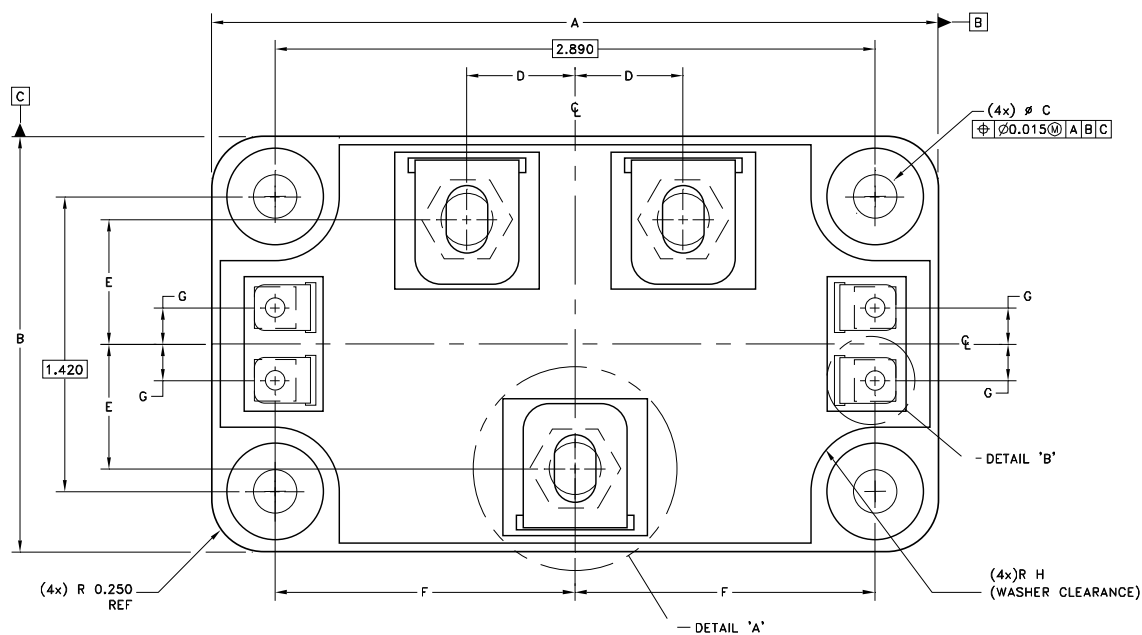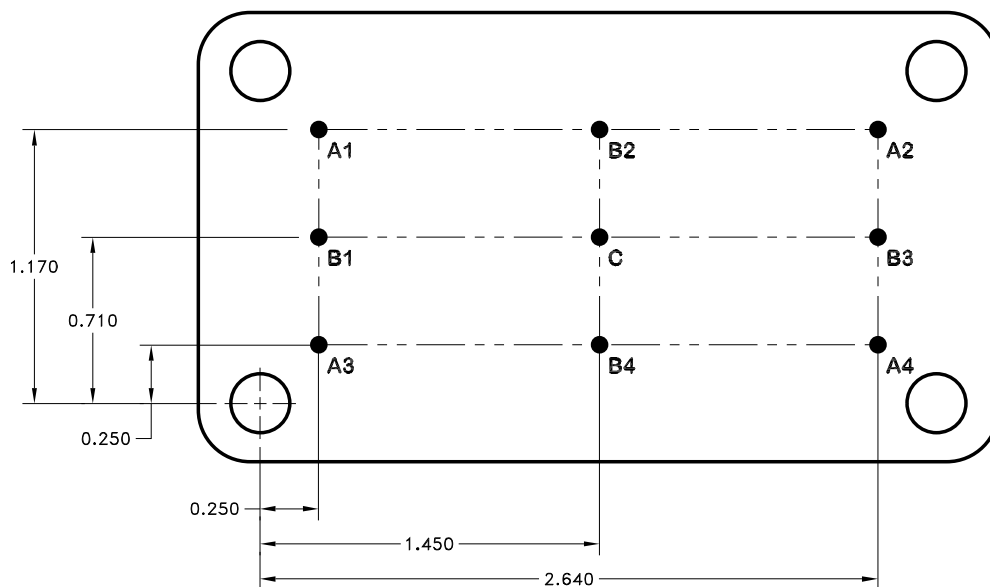
REF	MIN	MAX
A	3.470	3.510
B	1.970	2.010
C	0.208	0.225
C⊕	⊕ Ø0.015Ⓜ A B C	
D*	0.496	0.546
E*	0.575	0.625
F*	1.420	1.470
G*	0.150	0.200
H*	0.240	
J	0.985	1.015
K	0.090	
L	0.255	0.285
M	0.195	0.230
N	0.310	0.340
O	0.500	0.700
P	0.200	0.300
Q	0.500	0.550
R		0.400
S*	0.100	
T		0.250
U		0.220
V	0.050	
W	0.090	0.110
WEIGHT		200g

DETAIL 'A'
SCALE 3:1

DETAIL 'B'
SCALE 5:1
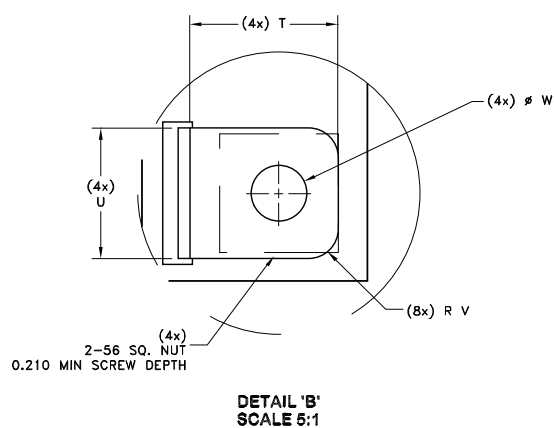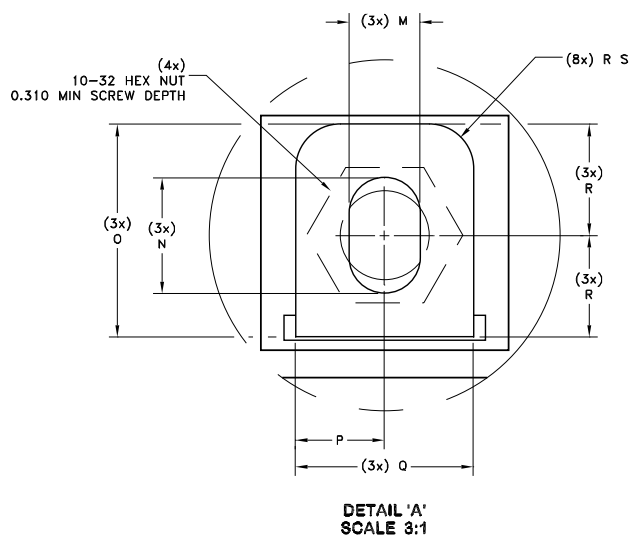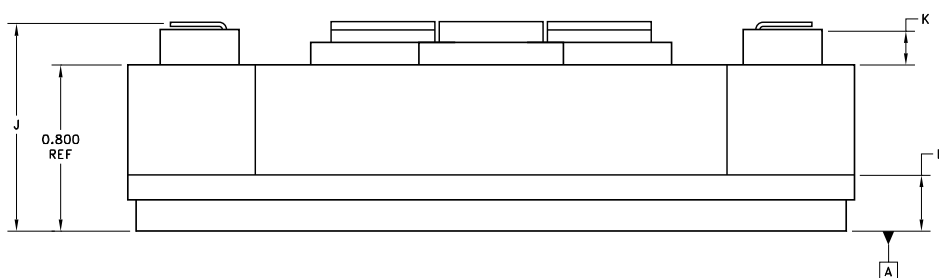
WEIGHT = 200 GRAMS MAX.

1.170

0.710

0.250

0.250

1.450

2.640

A1   B2   A2

B1   C   B3

A3   B4   A4

POWER MODULE (BOTTOM VIEW)
(NOT TO SCALE)

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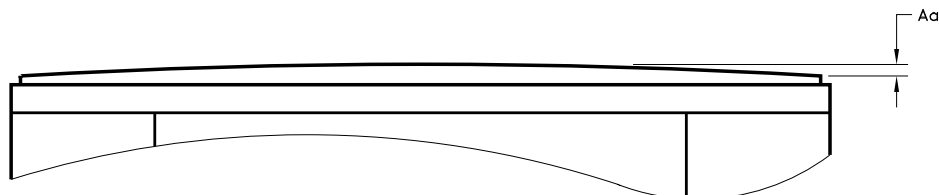
POWER MODULE (SIDE VIEW)
(EXAGGERATED DOME)
(NOT TO SCALE)

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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