



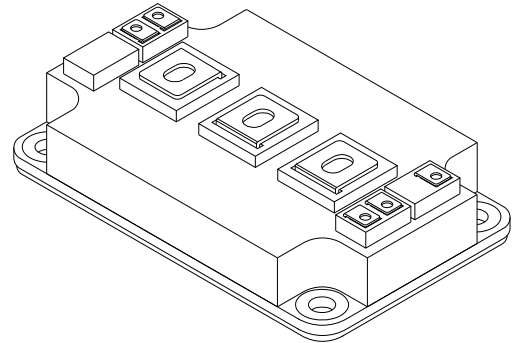
M.S.KENNEDY CORP.

# 600V/600A HALF BRIDGE PEM

# 4803

**FEATURES:**

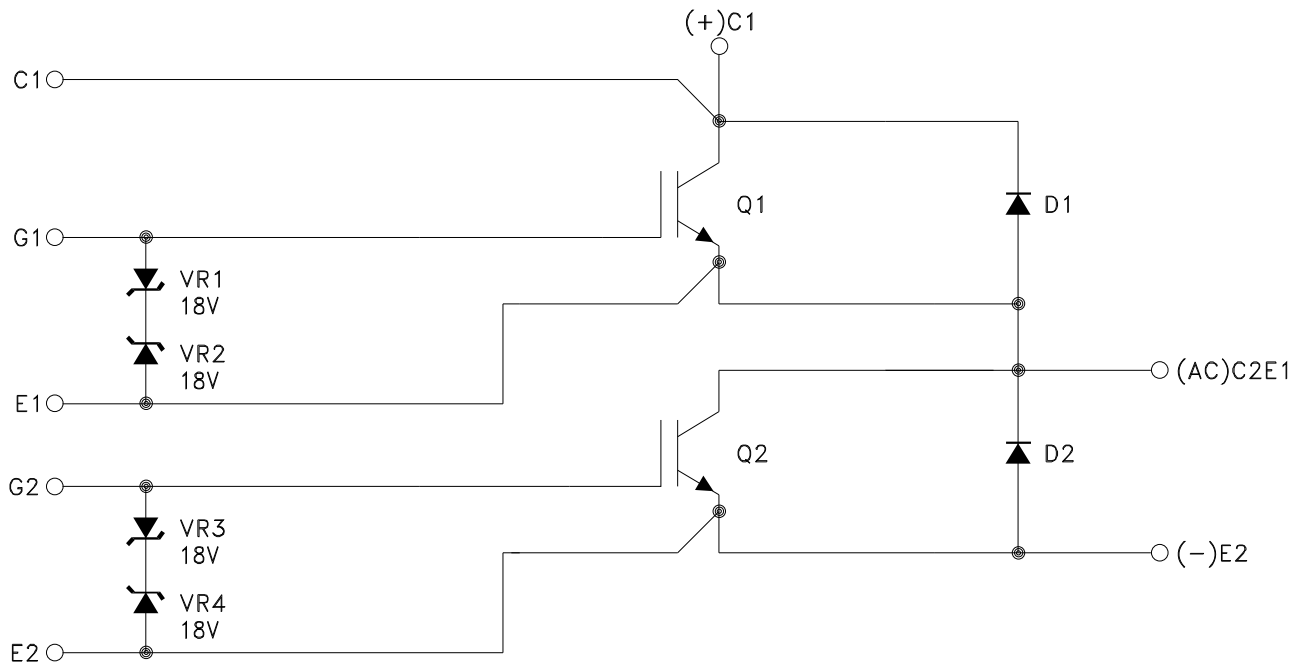
- Half Bridge Configuration
- 600V Rated Voltage
- 600A Continuous Output Current
- Internal Zener Clamps on Gates
- Encapsulation Provides Near Hermetic Performance
- HI-REL Screening Available (Modified 38534)
- Light Weight Domed ALSIC Baseplate
- Robust Mechanical Design for Hi-Rel Applications
- Ultra-Low Inductance Internal Layout
- Withstands 96 Hours HAST and Thermal Cycling (-55°C to +125°C)
- High Side Collector Sense Pin for De-Sat Detection



**DESCRIPTION:**

The MSK4803 is one of a family of plastic encapsulated modules (PEM) developed specifically for use in military, aerospace and other severe environment applications. The half bridge configuration and 600 volt/600 amp 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 the copper or copper alloys found in most high power plastic modules. The high thermal conductivity materials used to construct the MSK4803 allow high power outputs at elevated baseplate temperatures.

**EQUIVALENT SCHEMATIC**



**TYPICAL APPLICATIONS**

- Motor Drives
- Inverters

## ABSOLUTE MAXIMUM RATING <sup>⑧</sup>

V <sub>CE</sub>	Collector to Emitter Voltage . . . . .	600V
V <sub>GE</sub>	Gate to Emitter Voltage . . . . .	± 20V
I <sub>OUT</sub>	Current (Continuous) . . . . .	600A
I <sub>OUTP</sub>	Current Pulsed (1mS) . . . . .	1200A
V <sub>CASE</sub>	Case Isolation Voltage . . . . .	2500 V

T <sub>ST</sub>	Storage Temperature Range <sup>⑨</sup> . . . . .	-55°C to +125°C
T <sub>J</sub>	Junction Temperature . . . . .	150°C
T <sub>C</sub>	Case Operating Temperature Range	
	MSK4803H . . . . .	-55°C to +125°C
	MSK4803 . . . . .	-40°C to +85°C

## ELECTRICAL SPECIFICATIONS

Parameter <sup>⑥</sup>	Test Conditions	Group A Subgroup	MSK4803H			MSK4803			Units
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Emitter Saturation Voltage	I <sub>C</sub> = 600A, V <sub>GE</sub> = 15V	1	-	2.1	2.5	-	2.1	2.6	V
		2	-	2.5	2.9	-	-	-	V
		3	-	1.9	2.3	-	-	-	V
Collector-Emitter Leakage Current	V <sub>CE</sub> = 600V, V <sub>GE</sub> = 0V	1	-	0.2	10	-	0.2	10	uA
		2	-	0.5	100	-	-	-	uA
Gate Threshold Voltage	I <sub>C</sub> = 60mA, V <sub>CE</sub> = V <sub>GE</sub>	1	5.0	5.7	6.5	4.7	5.7	6.8	V
		2	3.0	4.6	5.6	-	-	-	V
		3	4.0	6.5	8.5	-	-	-	V
Gate Leakage Current	V <sub>CE</sub> = 0V, V <sub>GE</sub> = ± 15V	1	-	0.1	10	-	0.1	10	uA
		2	-	0.6	10	-	-	-	uA
		3	-	0.1	10	-	-	-	uA
Diode Forward Voltage	I <sub>C</sub> = 600A	1	-	1.9	2.6	-	1.9	2.7	V
		2	-	1.9	2.6	-	-	-	V
		3	-	1.8	2.5	-	-	-	V
Total Gate Charge <sup>①</sup>	V = 300V, I <sub>C</sub> = 600A	4	-	3.9	5.2	-	3.9	5.5	uC
E(on) <sup>①</sup>	V = 300V, I <sub>C</sub> = 600A, R <sub>G</sub> = 5Ω, V <sub>GE</sub> = -7/+15V	4	-	25	-	-	25	-	mJ
	V = 300V, I <sub>C</sub> = 300A, R <sub>G</sub> = 5Ω, V <sub>GE</sub> = -7/+15V	4	-	12	17	-	12	20	mJ
E(off) <sup>①</sup>	V = 300V, I <sub>C</sub> = 600A, R <sub>G</sub> = 10Ω, V <sub>GE</sub> = -7/+15V	4	-	73	-	-	73	-	mJ
	V = 300V, I <sub>C</sub> = 300A, R <sub>G</sub> = 10Ω, V <sub>GE</sub> = -7/+15V	4	-	35	44	-	35	46	mJ
Diode Reverse Recovery Time <sup>①</sup>	I <sub>E</sub> = 600, di/dt = 2100A/uS	4	-	130	-	-	130	-	nS
	I <sub>E</sub> = 300, di/dt = 2100A/uS	4	-	100	-	-	100	-	nS
Diode Reverse Energy <sup>①</sup>	I <sub>E</sub> = 600, di/dt = 2100A/uS	4	-	6.5	-	-	6.5	-	mJ
	I <sub>E</sub> = 300, di/dt = 2100A/uS	4	-	3.0	5.0	-	3.0	5.3	mJ
Thermal Resistance <sup>①</sup>	IGBT @ T <sub>J</sub> = 125°C	-	-	0.07	0.09	-	0.07	0.9	°C/W
	DIODE @ T <sub>J</sub> = 125°C	-	-	0.09	0.10	-	0.09	0.10	°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 Subgroups 4 testing available upon request.
- ⑤ Subgroup 1, 4 T<sub>A</sub> = +25°C  
                   2     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>GE</sub> = 15V unless otherwise specified.
- ⑧ Continuous operation at or above absolute maximum ratings may adversely effect the device performance and/or life cycle
- ⑨ Internal solder reflow temperature is 180°C, do not exceed.

***THERMAL CALCULATIONS***

Power dissipation and maximum allowable temperature rise involve many variables working together. Collector current, PWM duty cycle and switching frequency all factor into power dissipation. DC losses or "ON-TIME" losses are simply  $V_{CE(SAT)} \times \text{Collector Current} \times \text{PWM duty cycle}$ . For the MSK4803,  $V_{CE(SAT)} = 2.5V$  max., and at 600 amps and a PWM duty cycle of 30%, DC losses equal 450 watts. Switching losses vary proportionally with switching frequency. The MSK4803 typical switching losses at  $V_{CE} = 300V$  and  $I_{CE} = 600A$  are about 98mJ, 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 MSK4803, at 5KHz, will exhibit switching power dissipation of 490 watts. The total losses are the sum of DC losses plus switching losses, or in this case, 940 watts total.  $940 \text{ watts} \times 0.09^\circ\text{C/W}$  thermal resistance equals 85 degrees of temperature rise between the case and the junction. Subtracting  $85^\circ\text{C}$  from the maximum junction temperature of  $150^\circ\text{C}$  equals  $65^\circ\text{C}$  maximum case temperature for this example.

$$V_{CE(SAT)} \times I_C \times \text{PWM duty cycle} = 2.5V \times 600 \text{ amps} \times 30\% = 450 \text{ watts DC losses}$$

$$\text{Turn-on switching loss} + \text{Turn-off switching loss} = \text{Total switching losses} = 2.5 + 73 = 98\text{mJ}$$

$$\text{Total switching loss} \times \text{PWM frequency} = \text{Total switching power dissipation} = 98\text{mJ} \times 5\text{KHz} = 490 \text{ watts}$$

$$\text{Total power dissipation} = \text{DC losses} + \text{switching losses} = 450 + 490 = 940 \text{ watts}$$

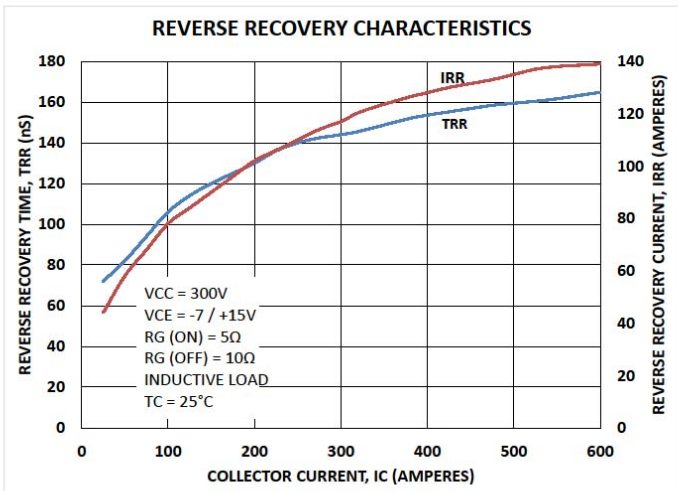
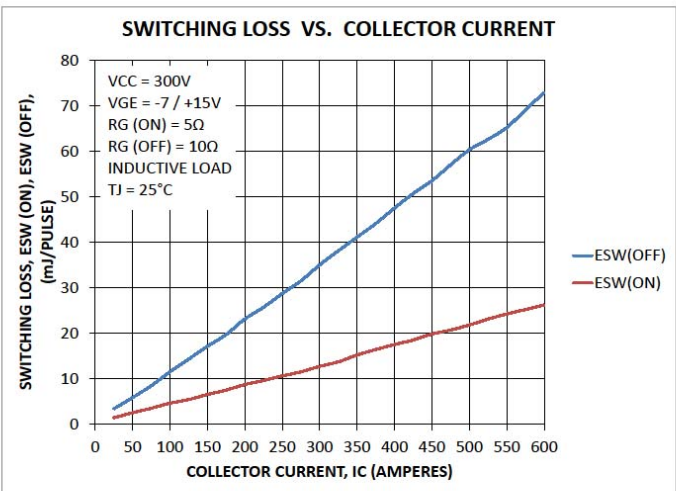
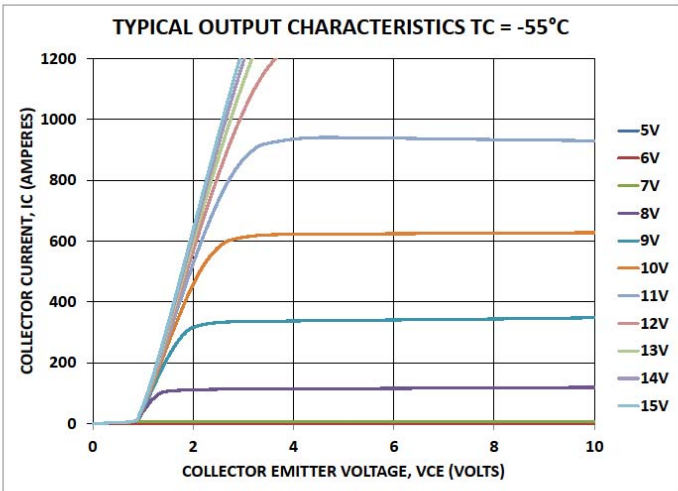
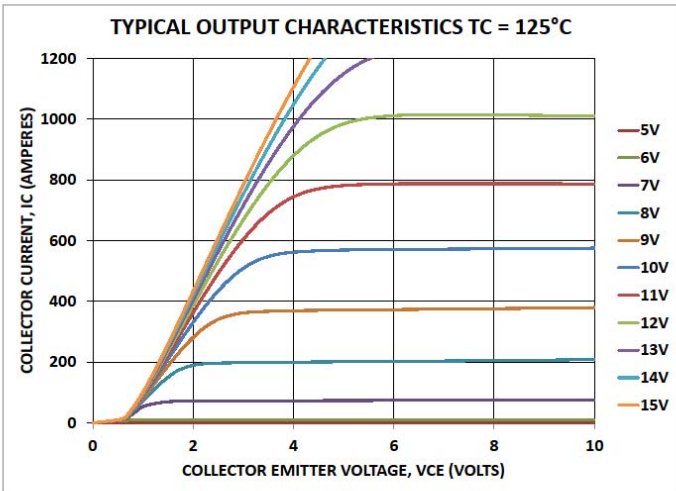
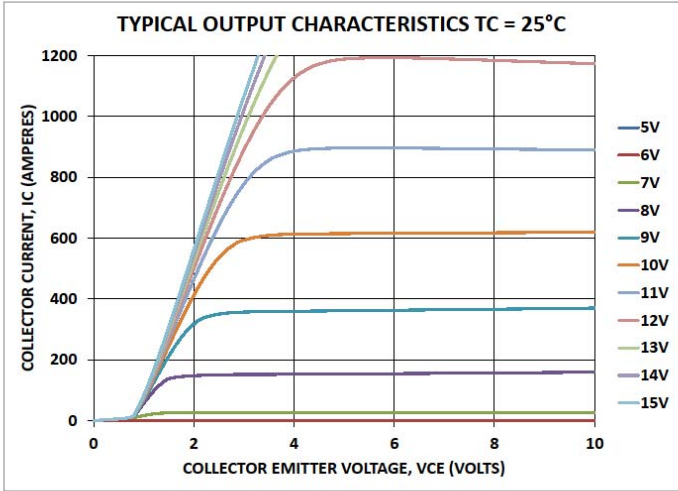
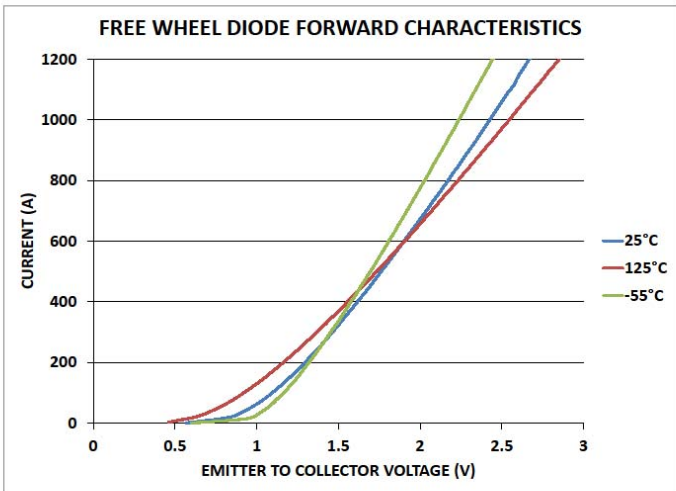
$$\text{Junction temperature rise above case} = \text{Total power dissipation} \times \text{thermal resistance}$$

$$940 \text{ watts} \times 0.09^\circ\text{C/W} = 84.6^\circ\text{C temperature rise above case}$$

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

$$150^\circ\text{C} - 85^\circ\text{C} = 65^\circ\text{C}$$

# TYPICAL PERFORMANCE CURVES



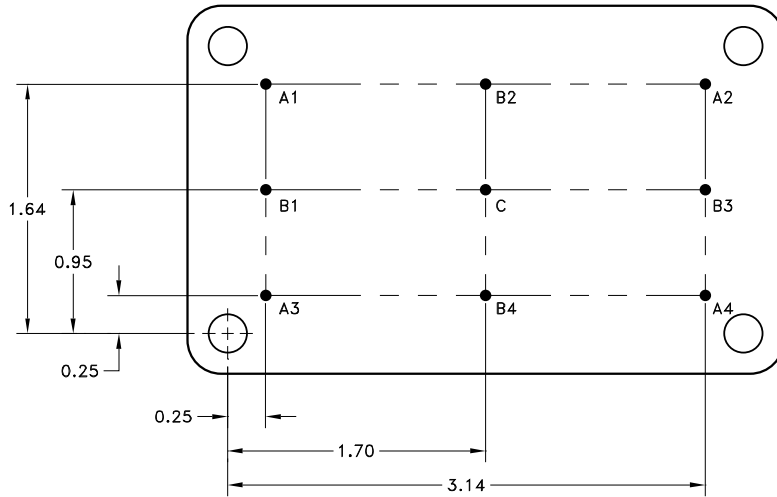
## SCREENING CHART

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
ENCAPSULANT	GEL COAT	GEL COAT
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

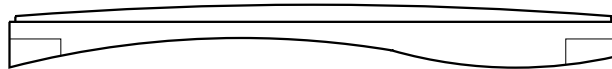
NOTE: ADDITIONAL SCREENING IS AVAILABLE SUCH AS XRAY, CSAM, MECHANICAL SHOCK, ETC. CONTACT FACTORY FOR QUAL STATUS.



**MECHANICAL SPECIFICATIONS CONT'D**



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



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

**CONVEX BASE PLATE PROFILE (FROM POINT C)**

REF	Z MIN	Z MAX
A1	0.000	0.008
A2	0.000	0.008
A3	0.000	0.008
A4	0.000	0.008
B1	0.000	0.008
B2	0.000	0.008
B3	0.000	0.008
B4	0.000	0.008

ALL DIMENSIONS ARE SPECIFIED IN INCHES

**ORDERING INFORMATION**

**MSK4803 H**

**SCREENING**

BLANK = INDUSTRIAL; H = HI-REL (MODIFIED 38534)

**GENERAL PART NUMBER**

THE ABOVE EXAMPLE IS A HI-REL SCREENED MODULE.

## REVISION HISTORY

REV	STATUS	DATE	DESCRIPTION
B	Released	04/14	Add form number. Update electrical specifications and performance curves for new generation IGBT and diode.

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