MIL-PRF-38534 CERTIFIED

600V/200A THREE PHASE BRIDGE PEM WITH BRAKE

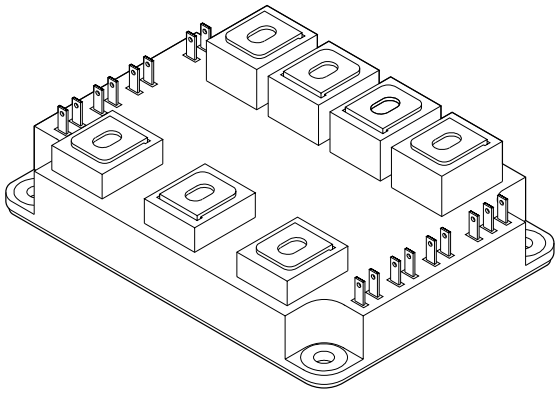
4851

M.S.KENNEDY CORP.

4707 Dey Road Liverpool, N.Y. 13088 (315) 701-6751

FEATURES:

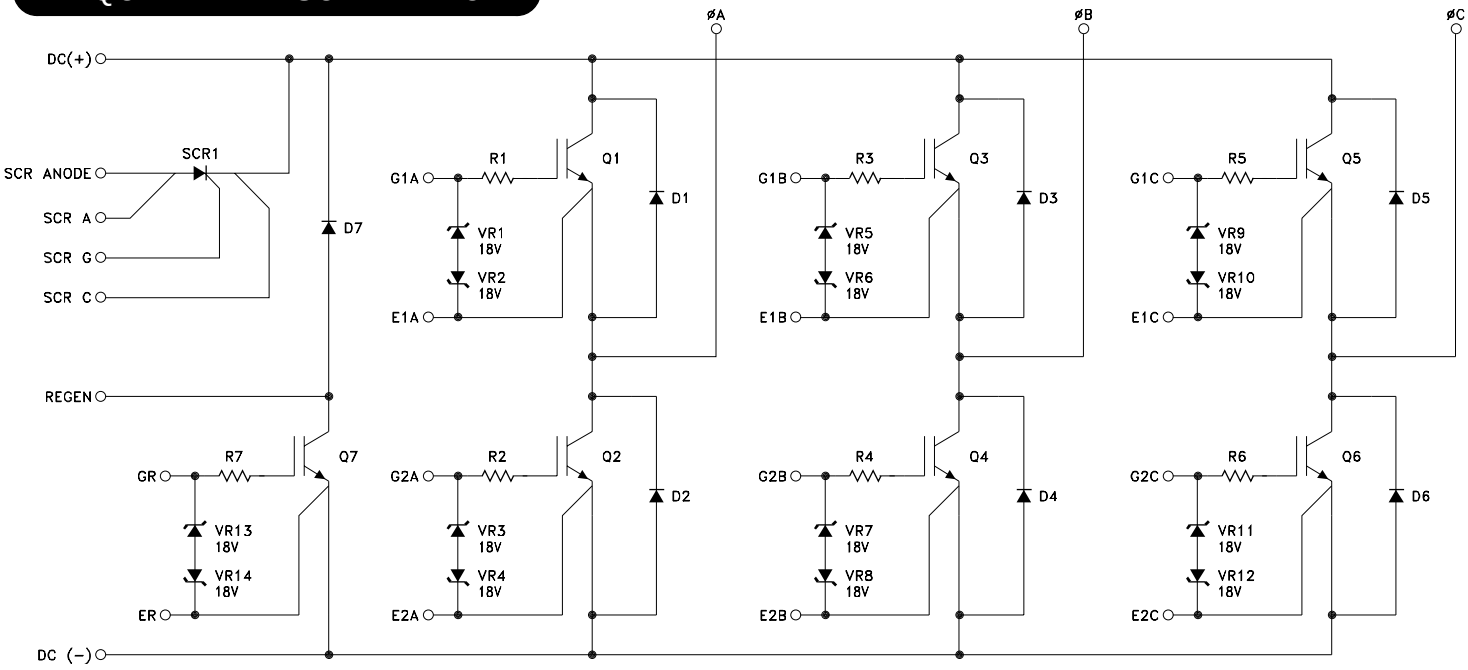
- Full Three Phase Bridge Configuration with SCR/IGBT Brake
- 600V Rated Voltage
- 200A Continuous Output Current
- Internal Zener Clamps on Gates
- Proprietary Encapsulation Provides Near Hermetic Performance
- MIL-PRF-38534 Screening Available (Modified)
- Light Weight Domed ALSIC Baseplate
- Robust Mechanical Design for Hi-Rel Applications
- Ultra-Low Inductance Internal Layout
- Withstands 96 Hours HAST and Thermal Cycling (-55°C to +125°C)



DESCRIPTION:

The MSK 4851 is one of a family of plastic encapsulated modules (PEM) developed specifically for use in military, aerospace and other severe environment applications. The Three Phase Bridge configuration along with the SCR/IGBT brake circuit and 600 volt/200 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 MSK 4851 allow high power outputs at elevated baseplate temperatures. Our proprietary coating, SEES™ - Severe Environment Encapsulation System - protects the internal circuitry of MSK PEM's from moisture and contamination, allowing them to pass the rugged environmental screening requirements of military and aerospace applications. MSK PEM's are also available with industry standard silicone gel coatings for a lower cost option.

EQUIVALENT SCHEMATIC



TYPICAL APPLICATIONS

- Motor Drives
- Inverters

ABSOLUTE MAXIMUM RATING ⑧

V_{CE}	Collector to Emitter Voltage 600V	T_{ST}	Storage Temperature Range . . . -55°C to +125°C
V_{GE}	Gate to Emitter Voltage . . . . . ±20V	T_J	Junction Temperature . . . . . 150°C
I_{OUT}	Current (Continuous) 200A	T_C	Case Operating Temperature Range
I_{OUTP}	Current Pulsed (1mS) 400A		MSK 4851H/E . . . . . -55°C to +125°C
V_{CASE}	Case Isolation Voltage 2500V		MSK 4851 . . . . . -40°C to +85°C

ELECTRICAL SPECIFICATIONS

Parameter ⑥	Test Conditions	Group A Subgroup	MSK 4851 H/E Min.	MSK 4851 H/E Typ.	MSK 4851 H/E Max.	MSK 4851 Min.	MSK 4851 Typ.	MSK 4851 Max.	Units
Collector-Emitter Saturation Voltage	IC = 200A, VGE = 15V	1	-	1.9	2.6	-	1.9	2.7	V
		2	-	1.9	2.6	-	1.9	2.7	V
		3	-	2.0	2.8	-	2.0	2.9	V
Collector-Emitter Leakage Current	VCE = 600V, VGE = 0V	1	-	0.01	1.0	-	0.01	1.5	mA
		2	-	0.01	9.0	-	0.01	10.0	mA
		① 3	-	0.01	1.5	-	0.01	2.0	mA
Gate Threshold Voltage	IC = 30mA, VCE = VGE	1	4.0	5.8	7.5	4.0	5.8	7.5	V
		2	4.0	5.8	7.5	4.0	5.8	7.5	V
		3	4.0	6.2	8.5	4.0	6.2	8.5	V
Gate Leakage Current	VCE = 0V, VGE = ±15V	1	-10	0.10	10	-12	0.10	12	uA
		2	-10	0.15	10	-12	0.15	12	uA
		3	-10	0.10	10	-12	0.10	12	uA
Diode Forward Voltage	IC = 200A	1	-	1.5	2.6	-	1.5	2.7	V
		2	-	1.5	2.7	-	1.5	2.8	V
		3	-	1.6	2.8	-	1.6	2.9	V
SCR Reverse Leakage	VRRM = 600V	1	-	0.01	15	-	0.01	18	mA
		2	-	0.01	15	-	0.01	18	mA
		3	-	0.01	15	-	0.01	18	mA
SCR On Voltage	IF = 100A	1	-	1.0	1.35	-	1.0	1.4	V
		2	-	1.0	1.35	-	1.0	1.4	V
		3	-	1.0	1.5	-	1.0	1.6	V
SCR Holding Current		1	-	100	300	-	100	325	mA
		2	-	90	300	-	90	325	mA
		3	-	110	300	-	110	325	mA
Regen Diode Forward Voltage	IF = 50A	1	-	1.3	2.4	-	1.3	2.5	V
Total Gate Charge ①	V = 300V, IC = 200A	4	-	1000	1700	-	1000	1700	nC
Turn-On Delay ①	V = 300V, IC = 200A, RG = 20Ω	4	-	450	900	-	450	900	nS
Rise Time ①	V = 300V, IC = 200A, RG = 20Ω	4	-	200	700	-	200	700	nS
E(on)	V = 300V, IC = 200A, RG = 20Ω, VGE = -7/+12V	4	-	17.5	-	-	17.5	-	mJ
	V = 300V, IC = 200A, RG = 20Ω, VGE = -7/+15V	4	-	10.8	-	-	10.8	-	mJ
	V = 300V, IC = 200A, RG = 20Ω, VGE = -7/+12V	5	-	18.9	-	-	18.9	-	mJ
	V = 300V, IC = 200A, RG = 20Ω, VGE = -7/+15V	5	-	12.6	-	-	12.6	-	mJ
E(off)	V = 300V, IC = 200A, RG = 10Ω, VGE = -7/+12V	4	-	7.7	-	-	7.7	-	mJ
	V = 300V, IC = 200A, RG = 10Ω, VGE = -7/+12V	5	-	11.3	-	-	11.3	-	mJ
Turn-Off Delay ①	V = 300V, IC = 200A, RG = 10Ω	4	-	0.78	2.1	-	0.78	2.1	uS
Fall Time ①	V = 300V, IC = 200A, RG = 10Ω	4	-	52	300	-	52	300	nS
Diode Reverse Recovery Time ①	IE = 200A, di/dt = 400A/uS	4	-	65	170	-	65	170	nS
Diode Reverse Recovery Charge ①	IE = 200A, di/dt = 400A/uS	4	-	3.0	6.0	-	3.0	6.0	uC
Thermal Resistance ①	IGBT @ TJ = 125°C	4	-	0.18	0.20	-	0.18	0.25	°C/W
	BRIDGE DIODE @ TJ = 125°C	4	-	0.3	0.36	-	0.3	0.40	°C/W
	REGEN SCR	4	-	0.25	0.27	-	0.25	0.28	°C/W
	REGEN DIODE	4	-	0.7	0.8	-	0.7	0.9	°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 and "E" suffix devices shall be tested to subgroup 1 unless otherwise specified.
③ Military grade devices ("H" suffix) shall be 100% tested to subgroups 1, 2 and samples tested to subgroup 3.
④ Subgroups 4 testing available upon request.
⑤ Subgroup 1, 4 T_A = +25°C
2, 5 T_A = +125°C
3, 6 T_A = -55°C
⑥ All specifications apply to both the upper and lower sections of the half bridge.
⑦ V_{GE} = 15V unless otherwise specified.
⑧ Continuous operation at or above absolute maximum ratings may adversly effect the device performance and/or life cycle.

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) x Collector Current x PWM duty cycle. For the MSK 4851, V_{CE}(SAT) = 2.6V max., and at 200 amps and a PWM duty cycle of 30%, DC losses equal 156 watts. Switching losses, in milli-joules, vary proportionally with switching frequency. The MSK 4851 typical switching losses at V_{CE} = 300V and I_{CE} = 200A are about 25.2mJ, 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 4851, at 15KHz, will exhibit switching power dissipation of 378 watts. The total losses are the sum of DC losses plus switching losses, or in this case, 534 watts total.

534 watts x 0.20°C/W thermal resistance equals 107 degrees of temperature rise between the case and the junction. Subtracting 107°C from the maximum junction temperature of 150°C equals 43°C maximum case temperature for this example.

V_{CE}(SAT) x IC x PWM duty cycle = 2.6V x 200 amps x 30% = 156 watts DC losses

Turn-on switching loss + Turn-off switching loss = Total switching losses = 7.7 + 17.5 = 25.2mJ

Total switching loss x PWM frequency = Total switching power dissipation = 25.2mJ x 15KHz = 378watts

Total power dissipation = DC losses + switching losses = 156 + 378 = 534 watts

Junction temperature rise above case = Total power dissipation x thermal resistance

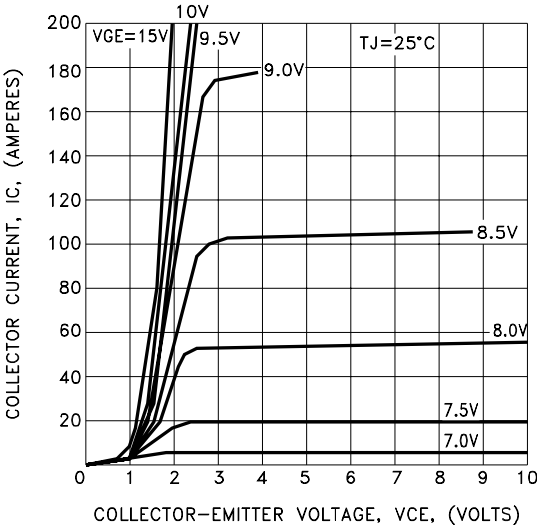
534 watts x 0.2°C/W = 107°C temperature rise above case

Maximum junction temperature - junction temperature rise = maximum baseplate temperature

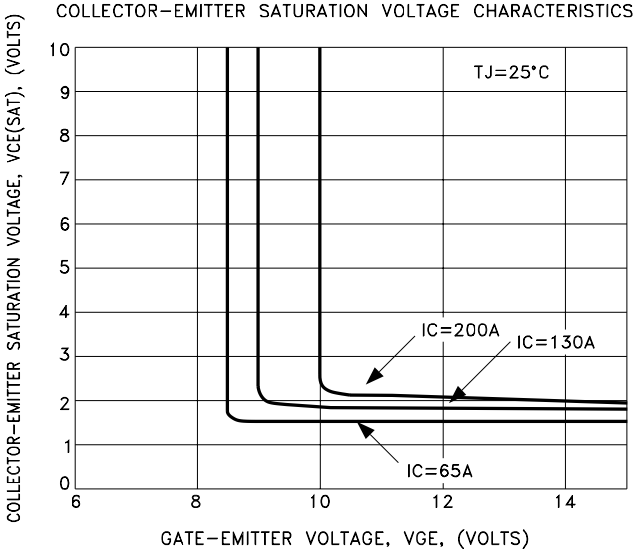
150°C - 107°C = 43°C

TYPICAL PERFORMANCE CURVES

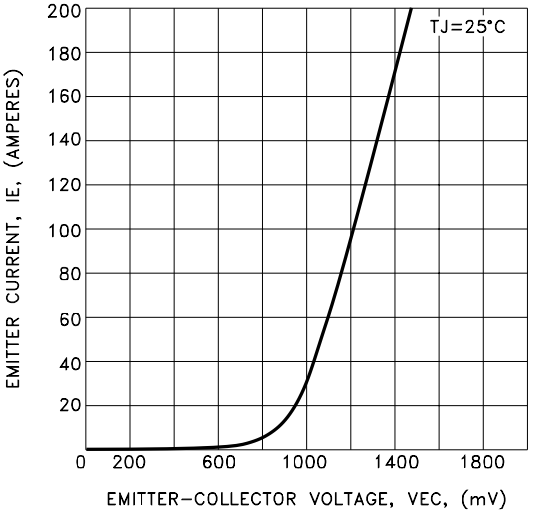
TYPICAL OUTPUT CHARACTERISTICS



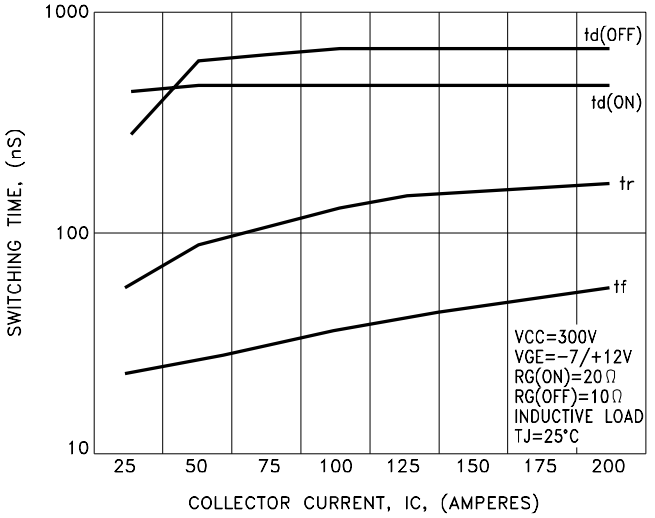
COLLECTOR–EMITTER SATURATION VOLTAGE CHARACTERISTICS



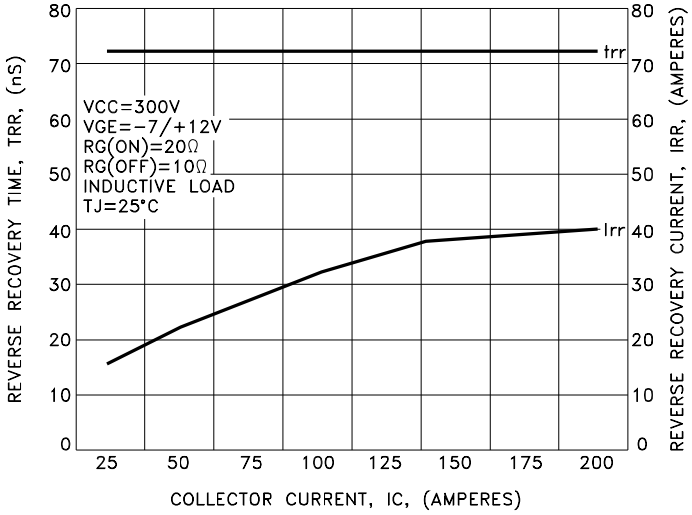
FREE–WHEEL DIODE FORWARD CHARACTERISTICS



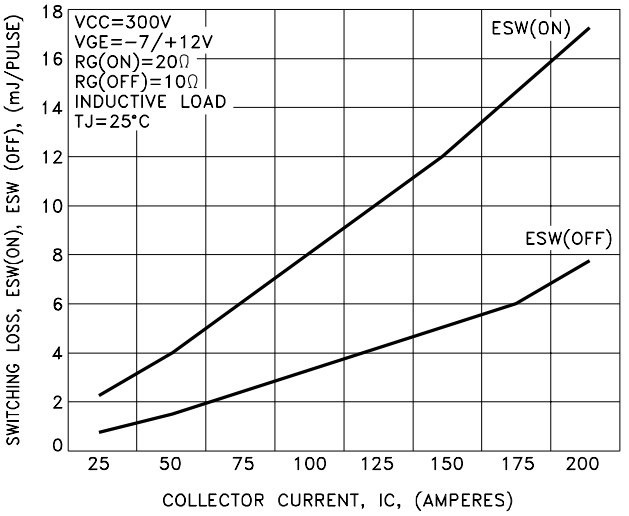
SWITCHING CHARACTERISTICS



REVERSE RECOVERY CHARACTERISTICS



SWITCHING LOSS vs. COLLECTOR CURRENT

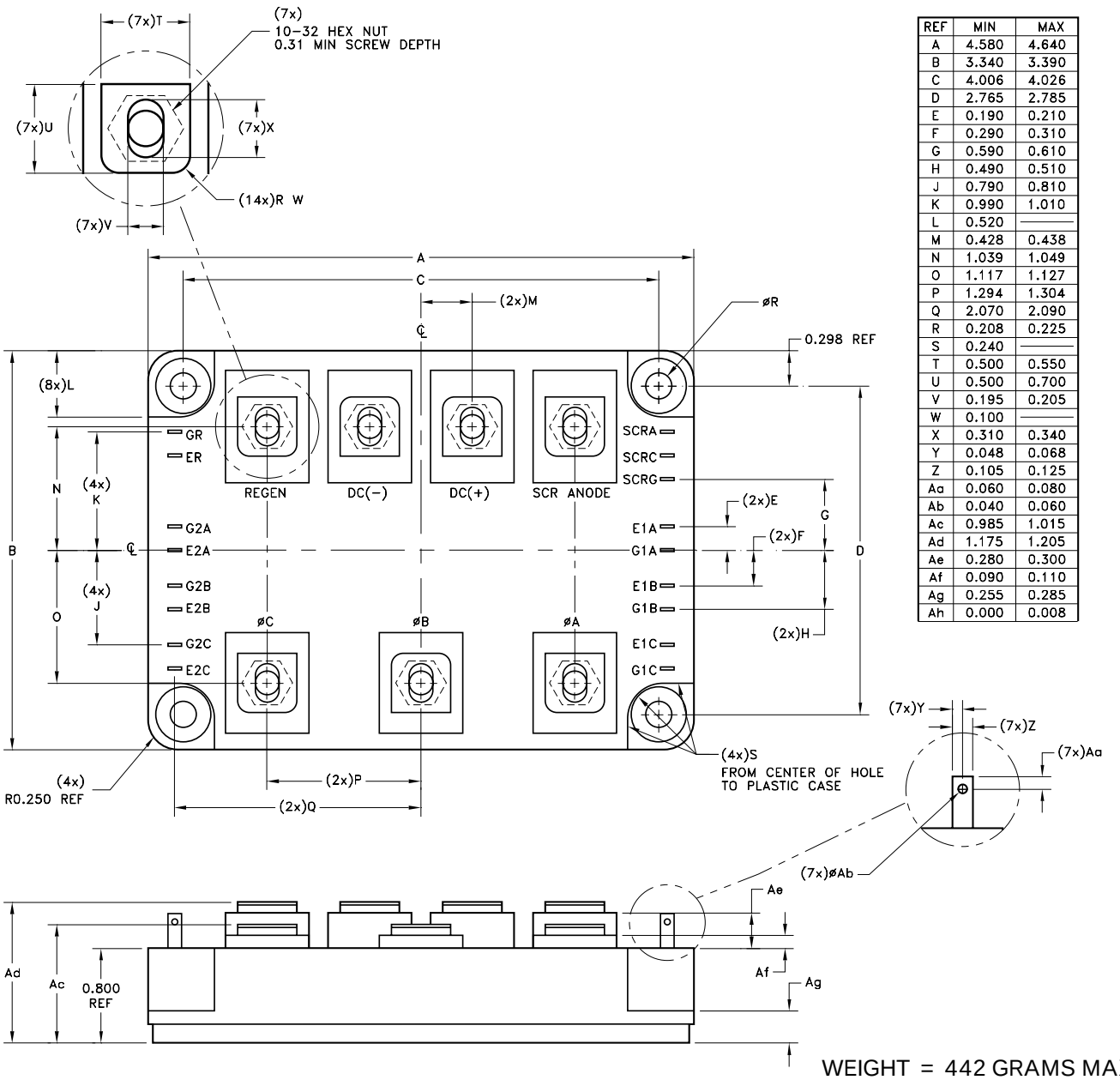


SCREENING CHART

OPERATION IN ACCORDANCE WITH MIL-PRF-38534	INDUSTRIAL	CLASS E	CLASS H
QUALIFICATION (MODIFIED)	NO	NO	YES
ELEMENT EVALUATION	NO	YES	YES
CLEAN ROOM PROCESSING	YES	YES	YES
NON DESTRUCT BOND PULL SAMPLE	YES	YES	YES
CERTIFIED OPERATORS	NO	YES	YES
MIL LINE PROCESSING	YES	YES	YES
MAX REWORK SPECIFIED	NO	YES	YES
ENCAPSULANT	GEL COAT	SEES™	SEES™
PRE-CAP VISUAL	YES - INDUSTRIAL	YES - CLASS H	YES - CLASS H
TEMP CYCLE (-55°C TO +125°C)	NO	YES	YES
BURN-IN	NO	YES - 96 HOURS	YES - 160 HOURS
ELECTRICAL TESTING	YES - 25°C	YES - 25°C	YES - FULL TEMP
EXTERNAL VISUAL	YES - SAMPLE	YES - SAMPLE	YES
XRAY	NO	NO	NO
PIN FINISH	NI	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	4.580	4.640
B	3.340	3.390
C	4.006	4.026
D	2.765	2.785
E	0.190	0.210
F	0.290	0.310
G	0.590	0.610
H	0.490	0.510
J	0.790	0.810
K	0.990	1.010
L	0.520	———
M	0.428	0.438
N	1.039	1.049
O	1.117	1.127
P	1.294	1.304
Q	2.070	2.090
R	0.208	0.225
S	0.240	———
T	0.500	0.550
U	0.500	0.700
V	0.195	0.205
W	0.100	———
X	0.310	0.340
Y	0.048	0.068
Z	0.105	0.125
Aa	0.060	0.080
Ab	0.040	0.060
Ac	0.985	1.015
Ad	1.175	1.205
Ae	0.280	0.300
Af	0.090	0.110
Ag	0.255	0.285
Ah	0.000	0.008

WEIGHT = 442 GRAMS MAX.

ORDERING INFORMATION

MSK4851 H

- H — SCREENING
  - BLANK = INDUSTRIAL; E = EXTENDED RELIABILITY;
  - H = MIL-PRF-38534 CLASS H (MODIFIED)
- MSK4851 — GENERAL PART NUMBER

THE ABOVE EXAMPLE IS A MILITARY SCREENED MODULE.

M.S. Kennedy Corp.
4707 Dey Road Liverpool, New York 13088
Phone (315) 701-6751
FAX (315) 701-6752
www.mskennedy.com