



**Efficiency through technology**

**RELIABILITY REPORT  
2007**

**Power Semiconductor Devices**

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**IXYS Corporation**  
3540 Bassett Street  
Santa Clara CA 95054  
USA

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**IXYS Semiconductor GmbH**  
Edisonstrasse 15  
D-68623 Lampertheim  
Germany

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## QUALITY AND RELIABILITY

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IXYS is committed to setting a new standard for excellence in Power Semiconductors. Reflecting our dedication to industry leadership in the manufacture of medium to high power devices, reliability has assumed a primary position in raw material selection, design, and process technology.

Reliability utilizes information derived from applied research, engineering design, analysis of field applications and accelerated stress testing and integrates this knowledge to optimize device design and manufacturing processes.

All areas that impact reliability have received considerable attention in order to achieve our goal to be the # 1 Reliability Supplier of Power Semiconductor products. We believe IXYS products should be the most reliable components in your system.

We have committed significant resources to continuously improve and optimize our device design, wafer fab processes, assembly processes and test capabilities. As a result of this investment, IXYS has realized a dramatic improvement in reliability performance on all standardized tests throughout the product line.

Excellence in product reliability is "built-in", not tested-in. Moreover, it requires a total systems approach, involving all parties: from design to raw materials to manufacturing.

In addition to qualifying new products released to the market, life and environmental tests are periodically performed on standard products to maintain feedback on assembly and fabrication performance to assure product reliability. Further information on reliability of power devices is provided on [www.ixys.com](http://www.ixys.com).

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## RELIABILITY TESTS

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### High Temperature Reverse Bias (HTRB)

Failure Modes: Gradual degradation of break-down characteristics due to presence of foreign materials and polar/ionic contaminants disturbing the electric field termination structure.

Sensitive Parameters:  $BV_{DSS}$ ,  $BV_{CES}$ ,  $V_{DRRM}$ ,  $V_{RRM}$ ,  $I_{DSS}$ ,  $I_{CES}$ ,  $I_{DRM}$ ,  $I_{RRM}$ ,  $V_{TH}$ .

### High Temperature Gate Bias (HTGB)

Failure Modes: Rupture of the gate oxide due to localized thickness variations, structural anomalies, particulates in the oxide, channel inversion due to presence of mobile ions in the gate oxide.

Sensitive Parameters:  $I_{GSS}$ ,  $I_{GES}$ ,  $V_{TH}$ ,  $I_{DSS}$ ,  $I_{CES}$ .

### Temperature Cycle

Failure modes: Thermal fatigue of silicon-metal and metal-metal interfaces due to heating and cooling, causing thermal and electrical performance degradation.

Sensitive Parameters:  $R_{thJC}$ ,  $R_{DS(on)}$ ,  $V_{CE(sat)}$ ,  $V_T$ ,  $V_F$ .

### Humidity Test

Failure Modes: Degradation of electrical leakage characteristics due to moisture penetration into plastic packages.

Sensitive Parameters:  $BV_{DSS}$ ,  $BV_{CES}$ ,  $V_{DRRM}$ ,  $V_{RRM}$ ,  $I_{DSS}$ ,  $I_{CES}$ ,  $I_{DRM}$ ,  $I_{RRM}$ ,  $I_{GSS}$ ,  $I_{GES}$ ,  $V_{TH}$ .

### Power Cycle

Failure Modes: Thermal fatigue of silicon-metal and metal-metal interfaces due to heating and cooling can cause thermal and electrical performance degradation.

Sensitive Parameters:  $R_{thJC}$ ,  $R_{DS(on)}$ ,  $V_{CE(sat)}$ ,  $V_T$ ,  $V_F$ ,  $I_{DSS}$ ,  $I_{CES}$ ,  $I_{DRM}$ ,  $I_{RRM}$ ,  $BV_{DSS}$ ,  $BV_{CES}$ ,  $V_{DRRM}$ ,  $V_{RRM}$ .

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## TERMS IN TABLES

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### SUMMARY TABLES 1 AND 2:

#### **AF: acceleration factor**

$$AF = \exp \left\{ Ea \cdot \left[ \frac{T_2 - T_1}{T_2 \cdot T_1} \right] / k \right\} \quad (1)$$

Ea: activation energy; @ HTRB Ea = 1.0 eV  
@ HTGB Ea = 0.4 eV

k: Boltzmann's constant  $8.6 \cdot 10^{-5}$  eV/K

T<sub>1</sub>: abs. application junction temperature (273+T<sub>j</sub>) K

T<sub>2</sub>: abs. test junction temperature (273+T<sub>j</sub>) K

#### **UCL: upper confidence limit (60%)**

##### **Total Failures @ 60% UCL:**

$$N = r + dr \quad (2)$$

r: number of failed devices

dr: additional term, depending on both r and UCL

**MTTF: Mean Time To Failures** = 1/Failure Rate

**FIT:** 1 FIT = 1 failure / 10<sup>9</sup> hrs

### TABLES 3:

#### **ΔT: max T<sub>j</sub> - min T<sub>j</sub> during Test**

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## DEFINITION OF FAILURE

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Failure criteria are defined according to IEC 60747 standard series

## Summary of Tables 1A - 1H: HTRB

	<b>Table 1A</b> MOSFET/IGBT discrete device *)	<b>Table 1B</b> MOSFET/IGBT Module	<b>Table 1C</b> Thyr./Diode Module	<b>Table 1D</b> Controller/ Rec. Bridge*)	<b>Table 1E</b> FRED *)	<b>Table 1F</b> Schottky Diode*)	<b>Table 1G</b> Thyr./Diode discrete device*)	<b>Table 1H</b> ISOPLUS
Failure Rate [FIT] 125°C, 60% UCL	485	2003	10582	10653	1466	2848	3075	-
Failure Rate [FIT] 90°C, 60% UCL	29	120	634	638	88	171	184	-
Total Lots Tested	141	15	25	17	42	23	11	22
Total Devices Tested	4007	206	279	170	760	493	200	454
Total Actual Failures	1	0	1	0	0	1	0	1
60% UCL {eq. (2)}	2,00	0,92	2,00	0,92	0,92	2,00	0,92	-
Total Equivalent Device Hours @ 125°C {AF eq. (1)}	4126020	459266	188992	86360	627760	702170	299187	834903
MTTF 125°C 60% UCL	236	57	11	11	78	40	37	-
(Years) 90°C 60% UCL	3933	952	180	179	1301	669	620	-

## Summary of Table 2A - 2C: HTGB

	<b>Table 2A</b> MOSFET/IGBT discrete device *)	<b>Table 2B</b> MOSFET/IGBT Module	<b>Table 2C</b> ISOPLUS
Failure Rate [FIT] 125°C, 60% UCL	277	4747	-
Failure Rate [FIT] 90°C, 60% UCL	90	1531	-
Total Lots Tested	114	15	8
Total Devices Tested	3332	217	232
Total Actual Failures	0	0	0
60% UCL {eq. (2)}	0,92	0,92	-
Total Equivalent Device Hours @ 125°C {AF eq. (1)}	3315560	193820	519760
MTTF 125°C 60% UCL	411	24	-
(Years) 90°C 60% UCL	1275	75	-

\*) including ISOPLUS

### Summary of Tables 3A - 3H: Power Cycle

	<b>Table 3A</b> MOSFET/IGBT discrete device *)	<b>Table 3B</b> MOSFET/IGBT Module	<b>Table 3C</b> Thyr./Diode Module	<b>Table3D</b> Controller/ Rec. Bridge*)	<b>Table 3E</b> FRED *)	<b>Table 3F</b> Schottky Diode*)	<b>Table 3G</b> Thyr./Diode discrete device*)	<b>Table 3H</b> Isoplus
Total Lots Tested	15	4	5	3	10	8	6	1
Total Devices Tested	352	40	50	30	180	217	100	20
Total Failures	0	0	0	0	0	0	0	0
Total Device Cycles	3360000	350000	650000	120000	420000	1540044	260000	200000

### Summary of Tables 4A - 4J: Temperature Cycle

	<b>Table 4A</b> MOSFET/IGBT discrete device *)	<b>Table 4B</b> MOSFET/IGBT Module	<b>Table 4C</b> Thyr./Diode Module	<b>Table4D</b> Controller/ Rec. Bridge*)	<b>Table 4E</b> FRED *)	<b>Table 4F</b> Schottky Diode*)	<b>Table 4G</b> Thyr./Diode discrete device*)	<b>Table 4H</b> Isoplus	<b>Table 4J</b> Breakover Diode
Total Lots Tested	30	15	39	15	32	21	23	27	4
Total Devices Tested	786	150	451	150	580	554	398	642	80
Total Failures	0	0	2	0	0	0	0	0	0
Total Device Cycles	169300	9500	35600	11100	43400	151500	21100	134700	4000

### Summary of Tables 5A - 5J: Humidity Test

	<b>Table 5A</b> MOSFET/IGBT discrete device *)	<b>Table 5C</b> Thyr./Diode Module	<b>Table5D</b> Controller/ Rec. Bridge*)	<b>Table 5E</b> FRED *)	<b>Table 5F</b> Schottky Diode*)	<b>Table 5G</b> Thyr./Diode discrete device*)	<b>Table 5H</b> Isoplus	<b>Table 5J</b> Breakover Diode
Total Lots Tested	4	4	4	10	5	2	4	4
Total Devices Tested	80	40	40	178	214	40	80	80
Total Failures	0	0	0	0	1	0	0	0
Total Device Hours	24800	23360	6720	13008	20544	1920	3840	3840

\*) including ISOPLUS

HTRB (Tables 1A .. 1J)

TABLE 1A: MOSFET/IGBT single device									
#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours	Remark
								[hrs]	
1	IXBH16N170	TP0619	960	125	1000	30	0	30000	
2	IXBH40N160	1513	1280	125	168	20	0	3360	
3	IXBP5-N160G	1337	1280	125	168	20	0	3360	
4	IXDH20N120	1436	960	125	168	20	0	3360	
5	IXDN55N120D1	1393	960	125	168	10	0	1680	
6	IXEH28N60C2D2	1578	600	125	1000	20	0	20000	
7	IXEL40N400	1611	2200	125	262	10	0	2620	
8	IXEL40N400	1611	3000	125	168	10	0	1680	
9	IXER35N120D1	1400	960	125	168	20	0	3360	
10	IXFH12N80P	SK0524	640	125	1000	30	0	30000	
11	IXFH13N50	CK0539	400	125	1000	30	1	30000	168h OK
12	IXFH15N80	MP0510	640	125	1000	30	0	30000	
13	IXFH20N60	SK0446	480	125	1000	30	0	30000	
14	IXFH20N60	MK0537	480	125	1000	30	0	30000	
15	IXFH20N60	SK0544	480	125	1000	30	0	30000	
16	IXFH22N50P	N/A	400	125	1000	30	0	30000	
17	IXFH23N80Q	MP0510	640	125	1000	30	0	30000	
18	IXFH26N50Q	MK0532	400	125	1000	30	0	30000	
19	IXFH26N60Q	SK0451	480	125	1000	30	0	30000	
20	IXFH26N60Q	SK0604	480	125	1000	30	0	30000	
21	IXFH26N90	AP0538	720	125	1000	30	0	30000	
22	IXFH32N50	SK0531	400	125	1000	30	0	30000	
23	IXFH40N30Q	SP0543	240	125	1000	30	0	30000	
24	IXFH44N50P	SP0518	400	125	1000	30	0	30000	
25	IXFH50N20	SK0538	160	125	1000	30	0	30000	
26	IXFH69N30P	SK0527	240	125	1000	30	0	30000	
27	IXFH80N10Q	SK0510	80	125	1000	30	0	30000	
28	IXFK26N90	AP0517	720	125	1000	30	0	30000	
29	IXFK30N100Q2	SP0446	800	125	1000	30	0	30000	
30	IXFK34N80	AP0526	640	125	1000	30	0	30000	
31	IXFK64N50P	SP0518	400	125	1000	30	0	30000	
32	IXFP12N50PM	K550	400	125	1000	30	0	30000	
33	IXFR36N60P	SP0517	480	125	1000	30	0	30000	
34	IXFX48N50Q	SK0543	400	125	1000	30	0	30000	
35	IXFX48N50Q	ZP0545	400	125	1000	30	0	30000	
36	IXFX48N60P	SP0518	480	125	1000	30	0	30000	
37	IXFX52N60Q2	SP0541	480	125	1000	30	0	30000	
38	IXFX73N30Q	SK0613	240	125	1000	30	0	30000	
39	IXFX90N30	SK0613	240	125	1000	30	0	30000	
40	IXGH240N30PC	SP0537	240	125	1000	30	0	30000	
41	IXGH30N120B3	TP0606	960	125	1000	30	0	30000	
42	IXGH48N60B3	SK0607	480	125	1000	30	0	30000	
43	IXGH64N60B3	SK0608	480	125	1000	30	0	30000	
44	IXGH72N60B3	SK0608	480	125	1000	30	0	30000	
45	IXGH8N100	N/N	800	125	1000	30	0	30000	
46	IXGP86N30PB	SK0535	240	125	1000	30	0	30000	
47	IXGQ120N30TCD1	SK0631	240	125	1000	30	0	30000	
48	IXGQ150N30TCD1	SK0631	240	125	1000	30	0	30000	
49	IXGQ160N30PB	SK0601	240	125	1000	60	0	60000	
50	IXGQ160N30PB	SK0601	240	125	1000	30	0	30000	
51	IXGQ160N30PB	SK0601	240	125	1000	30	0	30000	
52	IXGQ160N30PB	SK0601	240	125	1000	30	0	30000	
53	IXGQ200N30PB	SK0631	240	125	1000	30	0	30000	
54	IXGQ240N30PB	SK0631	240	125	1000	30	0	30000	

**TABLE 1A (cont'd): MOSFET/IGBT single device**

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
55	IXGQ240N30PB	SK0631	240	125	1000	30	0	30000	
56	IXGQ240N30PB	SK0631	240	125	1000	30	0	30000	
57	IXGQ240N30PB	SK0631	240	125	1000	30	0	30000	
58	IXGQ85N33PCD1	SK0613	264	125	1000	27	0	27000	
59	IXGQ85N33PCD1	SK0638	264	125	1000	30	0	30000	
60	IXGQ86N30PB	K0543	240	125	1000	30	0	30000	
61	IXGQ86N30PBD1	SK0534	240	125	1000	30	0	30000	
62	IXGQ86N30PCD1	SK0534	240	125	1000	30	0	30000	
63	IXGQ90N27PB	SK0621	216	125	1000	30	0	30000	
64	IXGQ90N27PB	SK0640	216	125	1000	30	0	30000	
65	IXGQ90N30TCD1	SK0631	240	125	1000	30	0	30000	
66	IXKC13N80C	1769	640	125	1000	20	0	20000	
67	IXKC25N80C	1590	640	125	1000	20	0	20000	
68	IXKC40N60C	1281	480	125	1000	20	0	20000	
69	IXKH20N60C5	1631	480	125	1000	20	0	20000	
70	IXKP10N60C5M	1693	480	150	1000	20	0	20000	
71	IXKP13N60C5M	1716	480	150	1000	20	0	20000	
72	IXKP20N60C5	1653	480	125	1000	20	0	20000	
73	IXKP24N60C5	1671	480	150	800	20	0	16000	1000h, 200h at 125°C
74	IXKR25N80C	1521	640	125	168	20	0	3360	
75	IXTA36N30P	SK0509	240	125	1000	30	0	30000	
76	IXTA36N30P	K0526	240	125	1000	30	0	30000	
77	IXTA36N30P	K0537	240	125	1000	30	0	30000	
78	IXTA36N30P	SK0603	240	125	1000	30	0	30000	
79	IXTA36N30P	K0621	240	125	1000	30	0	30000	
80	IXTA36N30P	K640	240	125	1000	30	0	30000	
81	IXTA50N25T	K545	200	125	1000	30	0	30000	
82	IXTA50N28T	K634	224	125	1000	30	0	30000	
83	IXTA50N28T	K640	224	125	1000	30	0	30000	
84	IXTA60N20T	K545	160	125	1000	30	0	30000	
85	IXTA60N20T	SK0601	160	125	1000	30	0	30000	
86	IXTA75N10P	K0531	80	125	1000	30	0	30000	
87	IXTH04N100P	TPN/A	800	125	1000	30	0	30000	
88	IXTH04N100P	TPN/A	800	125	1000	30	0	30000	
89	IXTH1N80P	TP0604	640	125	1000	30	0	30000	
90	IXTH75N15	SK0450	120	125	1000	30	0	30000	
91	IXTH75N15	SK0515	120	125	1000	30	0	30000	
92	IXTK34N80	SP0546	640	125	1000	30	0	30000	
93	IXTK34N80	SP0603	640	125	1000	30	0	30000	
94	IXTK34N80	SP0603	640	125	1000	30	0	30000	
95	IXTK62N25	SS0444	200	125	1000	30	0	30000	
96	IXTK62N25	SS0516	200	125	1000	30	0	30000	
97	IXTK62N25	SS0517	200	125	1000	30	0	30000	
98	IXTK62N25	SS0517	200	125	1000	30	0	30000	
99	IXTK62N25	SS0524	200	125	1000	30	0	30000	
100	IXTN79N20	1140	160	125	168	10	0	1680	
101	IXTP14N60PM	K631	480	125	1000	30	0	30000	
102	IXTP14N60PM	K643	480	125	1000	30	0	30000	
103	IXTP18N60PM	K631	480	125	1000	30	0	30000	
104	IXTP8N50P	K646	400	125	1000	30	0	30000	
105	IXTQ22N50P	SS0633	400	125	1000	30	0	30000	
106	IXTQ22N60P	SK0539	480	125	1000	30	0	30000	
107	IXTQ22N60P	SK0604	480	125	1000	30	0	30000	
108	IXTQ22N60P	SK0609	480	125	1000	30	0	30000	
109	IXTQ22N60P	SK0608	480	125	1000	30	0	30000	
110	IXTQ22N60P	SK0608	480	125	1000	30	0	30000	
111	IXTQ22N60P	SK0609	480	125	1000	30	0	30000	
112	IXTQ22N60P	SK0609	480	125	1000	30	0	30000	
113	IXTQ26N50P	SK0604	400	125	1000	30	0	30000	
114	IXTQ30N60P	SK0517	480	125	1000	30	0	30000	

**TABLE 1A (cont'd): MOSFET/IGBT single device**

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
115	IXTQ44N30T	SK0629	240	125	1000	30	0	30000	
116	IXTQ64N25P	SK0535	200	125	1000	30	0	30000	
117	IXTQ69N30P	SK0535	240	125	1000	30	0	30000	
118	IXTQ74N20P	SK0515	160	125	1000	30	0	30000	
119	IXTQ76N25T	SK0613	200	125	1000	30	0	30000	
120	IXTQ80N28T	SK0519	224	125	1000	30	0	30000	
121	IXTQ80N28T	SK0518	224	125	1000	30	0	30000	
122	IXTQ82N25P	SK0450	200	125	1000	30	0	30000	
123	IXTQ82N25P	SS0506	200	125	1000	30	0	30000	
124	IXTQ82N25P	SK0514	200	125	1000	30	0	30000	
125	IXTQ82N25P	SK0519	200	125	1000	30	0	30000	
126	IXTQ82N25P	SK0519	200	125	1000	30	0	30000	
127	IXTQ82N25P	SK0538	240	125	1000	30	0	30000	
128	IXTQ82N25T	SK0603	200	125	1000	30	0	30000	
129	IXTQ88N28T	SK0545	224	125	1000	30	0	30000	
130	IXTQ88N30P	SK0515	240	125	1000	30	0	30000	
131	IXTQ88N30P	K0525Z	240	125	1000	30	0	30000	
132	IXTQ88N30P	SK0538	240	125	1000	30	0	30000	
133	IXTQ88N30P	SK0605	240	125	1000	30	0	30000	
134	IXTQ88N30T	SK0638	240	125	1000	30	0	30000	
135	IXTQ96N15P	SK0449	120	125	1000	30	0	30000	
136	IXTQ96N15P	SK0513	120	125	1000	30	0	30000	
137	IXTQ96N20P	SS0631	160	125	1000	30	0	30000	
138	IXTT88N30P	SP0626	240	125	1000	30	0	30000	
139	IXTV18N60PS	SP0636	480	125	1000	30	0	30000	
140	IXUC200N055	1594	44	125	1000	20	0	20000	
141	IXUN350N10	1354	80	125	1000	10	0	10000	

**TABLE 1B: MOSFET/IGBT Module**

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	GWM120-0075P3	1720	60	150	1000	77	0	77000	
2	GWM160-0055P3	1524	44	150	168	6	0	1008	
3	MKI75-06A7T	1368	480	125	168	8	0	1344	
4	MUBW15-12A6K	1431	960	125	1000	10	0	10000	
5	MUBW25-06A6K	1240	480	125	1000	10	0	10000	
6	MUBW30-12E6K	1127	960	125	168	10	0	1680	
7	MUBW30-12E6K	1127	1120	125	168	10	0	1680	
8	MUBW35-12E7	1242	1120	125	168	9	0	1512	
9	MUBW50-06A7T	1144	480	125	168	10	0	1680	
10	MUBW50-12T8	1777	960	125	1000	10	0	10000	
11	MWI50-12E7	1380	960	125	168	6	0	1008	
12	MWI60-06G6K	1347	480	125	500	10	0	5000	
13	VII130-06P1	1274	480	125	168	10	0	1680	
14	VMM90-09F	1201	720	125	168	10	0	1680	
15	VMO60-05F	1552	400	125	168	10	0	1680	

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	MCC 161-22io1	1416	1540	125	168	9	0	1512	
2	MCC122-16	1023	1120	130	1000	10	0	10000	
3	MCC132-16io1	1509	1120	125	1000	10	0	10000	
4	MCC162	1175	1120	125	168	10	0	1680	
5	MCC162	1624	800	126	168	20	0	3360	
6	MCC162-16io1	1593	1120	125	168	10	0	1680	
7	MCC21-16io8	1812	1120	125	168	10	0	1680	
8	MCC26-16io1	1539	1120	125	168	10	0	1680	
9	MCC310-16	1696	1120	125	168	10	0	1680	
10	MCC312-16io1	1170	1120	125	168	10	0	1680	
11	MCC44-18io8	1359	1260	125	168	10	0	1680	
12	MCC44-18io8	1359	1260	125	168	10	0	1680	
13	MCC44-16io1	1747	1120	125	168	10	0	1680	
14	MCC44-18io8	1232	1260	125	1000	10	1	10000	I_R @1000h
15	MCC44-18io8	1232	1260	125	1000	10	0	10000	
16	MCC56-16io8	1246	1120	125	168	10	0	1680	
17	MCC95-16io1	1421	1120	125	1000	10	0	10000	
18	MCC95-16io1	1701	1120	125	168	10	0	1680	
19	MCD56-16io1	1587	1120	125	168	10	0	1680	
20	MCO100-16io1	1156	1120	125	1000	20	0	20000	
21	MCO25-16io1	1155	1120	125	1000	20	0	20000	
22	MCO50-16io1	1154	1120	125	1000	10	0	10000	
23	MDD172-16n1	1554	1120	125	168	10	0	1680	
24	MDD26-16	1173	1120	150	1000	10	0	10000	
25	MDD26-16	1173	1120	125	168	10	0	1680	

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	MMO75-16io1	1379	1120	125	168	10	0	1680	
2	MMO75-16io1	1727	1120	125	168	10	0	1680	
3	MMO90-16	1710	1120	125	168	10	0	1680	
4	VBO19-16DT1	1584	1120	125	168	10	0	1680	
5	VHF36-16io5	1176	1120	125	168	10	0	1680	
6	VHF36-16io5	1542	1120	125	168	10	0	1680	
7	VHF36-16io5	1732	1120	125	168	10	0	1680	
8	VHFD37-16	1184	1120	125	168	10	0	1680	
9	VUB72-16	1657	1120	125	168	10	0	1680	
10	VUO121-16NO1	1352	1120	125	1000	10	0	10000	
11	VUO25-16NO8	1581	1120	125	168	10	0	1680	
12	VUO36-16NO8	1252	1120	150	1000	10	0	10000	
13	VUO36-16NO8	1252	1120	125	168	10	0	1680	
14	VUO52-18N01	1286	1120	125	168	10	0	1680	
15	VVO140-16	1684	1120	125	1000	10	0	10000	
16	VVO140-16io1	1420	1120	125	168	10	0	1680	
17	VY40-16io1	1745	1120	125	168	10	0	1680	



**TABLE 1E: FRED**

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	DHF30IM600PN	1508	480	125	1000	20	0	20000	
2	DHF30IM600QB	1625	480	125	1000	20	0	20000	
3	DHG10I1200PM	1682	960	125	1000	20	0	20000	
4	DHG10I600PM	1685	480	125	1000	20	0	20000	
5	DHG20C600QB	1711	480	125	1000	20	0	20000	
6	DHG30I1200HA	1652	960	125	1000	20	0	20000	
7	DHG30I1200HA	1734	960	125	1000	20	0	20000	
8	DHG60C600HB	1668	480	125	1000	20	0	20000	
9	DPG15I400PM	1770	320	125	1000	20	0	20000	
10	DPG20C200PN	1692	240	125	1000	20	0	20000	
11	DPG20C400PN	1768	320	125	1000	20	0	20000	
12	DPG30C300HB	1644	240	125	1000	20	0	20000	
13	DPG60C200QB	1608	160	125	1000	20	0	20000	
14	DPG60C300HB	1525	240	125	1000	20	0	20000	
15	DPG60C300QB	1481	240	125	1000	20	0	20000	
16	DPG60C400QB	1446	320	125	1000	20	0	20000	
17	DPG60IM300PC	1643	240	125	1000	20	0	20000	
18	DSEC240-04A	1148	320	125	168	20	0	3360	
19	DSEC240-06A	1215	480	125	1000	10	0	10000	
20	DSEC240-06A	1215	480	125	1000	10	0	10000	
21	DSEC59-02AQ	1159	160	125	1000	20	0	20000	
22	DSEC59-03AQ	1266	240	125	1000	20	0	20000	
23	DSEC60-03AR	1121	240	125	168	20	0	3360	
24	DSEE15-12CC	1220	480	125	1000	20	0	20000	
25	DSEI20-12A	1169	960	125	168	20	0	3360	
26	DSEI2x101-06A	1235	480	125	168	10	0	1680	
27	DSEI2x31-06C	1563	480	125	168	10	0	1680	
28	DSEI2x61-12B	1607	960	125	168	10	0	1680	
29	DSEP15-12CR	1168	960	125	168	20	0	3360	
30	DSEP15-12CR	1168	960	150	1000	20	0	20000	
31	DSEP29-06A	1736	480	125	168	20	0	3360	
32	DSEP29-06B	1263	480	125	168	20	0	3360	
33	DSEP30-12AR	1634	960	125	168	20	0	3360	
34	DSEP60-03A	1537	240	125	168	20	0	3360	
35	DSEP60-06A	1572	480	125	168	20	0	3360	
36	DSEP60-12A	1118	960	125	168	20	0	3360	
37	DSEP75-06AR	1619	480	125	1000	20	0	20000	
38	DSEP8-02A	1362	160	125	168	20	0	3360	
39	DSEP8-03AS	1738	240	125	1000	20	0	20000	
40	MEK300-06"DA"	1381	480	125	168	10	0	1680	
41	MEK95-06 DA	1312	480	125	168	10	0	1680	
42	MEO500-06DA	1279	480	125	1000	10	0	10000	

**TABLE 1F: Schottky Diode**

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	DSA120C150QB	1507	150	125	1000	20	0	20000	
2	DSA30C45HB	1714	45	125	1000	20	0	20000	
3	DSA60C100PB	1781	100	125	1000	16	0	16000	
4	DSA70C100HB	1782	100	125	1000	20	0	20000	
5	DSA90C200HB	1674	200	125	1000	20	0	20000	
6	DSB15IM45IB	1622	36	100	1000	20	0	20000	
7	DSB30C30PB	1718	24	100	1000	20	0	20000	
8	DSB30C45PB	1783	36	100	1000	20	0	20000	
9	DSB30C60PB	1672	60	125	1000	20	0	20000	
10	DSB40C15PB	1673	12	100	1000	20	0	20000	
11	DSS160-01A	1143	100	125	168	20	0	3360	
12	DSS20-01AC	1709	100	125	1000	20	0	20000	
13	DSS2x101-02A	1225	200	125	1000	10	0	10000	
14	DSS2x41-01A	1467	100	125	168	10	0	1680	
15	DSS31-0045A	1401	45	125	1000	20	0	20000	
16	DSS6-015AS	1723	120	150	1000	77	0	77000	

**TABLE 1F (cont'd): Schottky Diode**

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
17	DSS61-0045A	1238	45	125	1000	20	0	20000	
18	DSSK60-015A	1256	150	125	1000	20	0	20000	
19	DSSK60-015A	1600	150	125	168	20	0	3360	
20	DSSK60-015AR	1384	150	125	1000	20	0	20000	
21	DSSK60-02A	1187	200	125	1000	20	1	20000	
22	DSSK70-008A	1377	80	125	168	20	0	3360	
23	DSSK80-0045B	1261	36	100	168	20	0	3360	

**TABLE 1G: Thyristor/Diode single device**

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	CS19-12ho1S	1366	840	125	1000	20	0	20000	
2	CS20-14io1	1364	980	125	1000	20	0	20000	
3	CS45-16io1	1808	1120	125	168	20	0	3360	
4	CS8-12io2	1605	1280	125	168	10	0	1680	
5	DSA17-16A	1195	1120	150	1000	20	0	20000	
6	DSA17-16A	1195	1120	150	1000	20	0	20000	
7	DSA9-18F	1307	1260	125	168	10	0	1680	
8	DSD160-16A	1569	1280	125	168	20	0	3360	
9	DSP25-16	1564	1120	150	168	20	0	3360	
10	DSP45-16A	1167	1120	125	168	20	0	3360	
11	DSP8-08A	1146	560	150	168	20	0	3360	

**TABLE 1H: ISOPLUS**

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	CS45-16io1	1808	1120	125	168	20	0	3360	
2	DSEC60-03AR	1121	240	125	168	20	0	3360	
3	DSEE15-12CC	1220	480	125	1000	20	0	20000	
4	DSEP15-12CR	1168	960	125	168	20	0	3360	
5	DSEP15-12CR	1168	960	150	1000	20	0	20000	
6	DSEP30-12AR	1634	960	125	168	20	0	3360	
7	DSEP75-06AR	1619	480	125	1000	20	0	20000	
8	DSI45-16AR	1264	1120	150	168	11	0	1848	
9	DSS20-01AC	1709	100	125	1000	20	0	20000	
10	DSSK60-015AR	1384	150	125	1000	20	0	20000	
11	FUO22-16N	1291	1120	125	1000	20	0	20000	
12	GWM120-0075P3	1720	60	150	1000	77	0	77000	
13	GWM160-0055P3	1524	44	150	168	6	0	1008	
14	IXEL40N400	1611	3000	125	168	10	0	1680	
15	IXEL40N400	1611	2200	125	262	10	0	2620	
16	IXER35N120D1	1400	960	125	168	20	0	3360	
17	IXKC13N80C	1769	640	125	1000	20	0	20000	
18	IXKC25N80C	1590	640	125	1000	20	0	20000	
19	IXKC40N60C	1281	480	125	1000	20	0	20000	
20	IXKR25N80C	1521	640	125	168	20	0	3360	
21	IXUC200N055	1594	44	125	1000	20	0	20000	
22	LKK47-06C5	1675	480	150	1000	20	1	20000	

**TABLE 1J: Breakover Diode**

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	IXBOD1-08	1248	640	125	168	20	0	3360	
2	IXBOD1-09	1800	800	125	168	20	0	3360	
3	IXBOD1-10	1576	800	125	168	20	0	3360	

HTGB (Tables 2A .. 2C)

TABLE 2A: MOSFET/IGBT single device									
#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	IXDN75N120	1606	16	150	168	10	0	1680	
2	IXEH25N120D1	1757	16	150	168	20	0	3360	
3	IXEH40N120D1	1482	16	150	168	20	0	3360	
4	IXFH10N80P	SP0514	16	125	1000	30	0	30000	
5	IXFH12N80P	SK0524	16	125	1000	30	0	30000	
6	IXFH13N50	CK0539	16	125	1000	30	0	30000	
7	IXFH14N80P	SP0525	16	125	1000	30	0	30000	
8	IXFH15N80	MP0510	16	125	1000	30	0	30000	
9	IXFH20N60	SK0446	16	125	1000	30	0	30000	
10	IXFH20N60	MK0537	16	125	1000	30	0	30000	
11	IXFH20N80P	SK0524	16	125	1000	30	0	30000	
12	IXFH22N50P	N/A	16	125	1000	30	0	30000	
13	IXFH23N80Q	MP0510	16	125	1000	30	0	30000	
14	IXFH26N50Q	MK0532	16	125	1000	30	0	30000	
15	IXFH26N60Q	SK0451	16	125	1000	30	0	30000	
16	IXFH26N60Q	SK0604	16	125	1000	30	0	30000	
17	IXFH40N30Q	SP0543	16	125	1000	30	0	30000	
18	IXFH44N50P	SP0518	16	125	1000	30	0	30000	
19	IXFH50N20	SK0538	16	125	1000	30	0	30000	
20	IXFH69N30P	SK0527	16	125	1000	30	0	30000	
21	IXFH80N10Q	SK0510	16	125	1000	30	0	30000	
22	IXFK34N80	AP0526	16	125	1000	30	0	30000	
23	IXFK64N50P	SP0518	16	125	1000	30	0	30000	
24	IXFL100N50P	SP0549	16	125	1000	30	0	30000	
25	IXFL82N60P	SP0550	16	125	1000	30	0	30000	
26	IXFP12N50PM	K550	16	125	1000	30	0	30000	
27	IXFR36N60P	SP0517	16	125	1000	30	0	30000	
28	IXFX32N80P	SP0531	16	125	1000	30	0	30000	
29	IXFX48N50Q	SK0543	16	125	1000	30	0	30000	
30	IXFX48N50Q	ZP0545	16	125	1000	30	0	30000	
31	IXFX48N60P	SP0518	16	125	1000	30	0	30000	
32	IXFX52N60Q2	TM3849	16	125	1000	30	0	30000	
33	IXFX73N30Q	SK0613	16	125	1000	30	0	30000	
34	IXFX90N30	SK0613	16	125	1000	30	0	30000	
35	IXGD86N30PCD1	SK0529	16	125	1000	30	0	30000	
36	IXGH240N30PC	SP0537	16	125	1000	30	0	30000	
37	IXGH28N60B3	SK0608	16	125	1000	30	0	30000	
38	IXGH30N120B3	TP0606	16	125	1000	30	0	30000	
39	IXGH48N60B3	SK0607	16	125	1000	30	0	30000	
40	IXGH64N60B3	SK0608	16	125	1000	30	0	30000	
41	IXGH72N60B3	SK0608	16	125	1000	30	0	30000	
42	IXGQ120N30TCD1	SK0631	16	125	1000	30	0	30000	
43	IXGQ150N30TCD1	SK0631	16	125	1000	30	0	30000	
44	IXGQ160N30P	SK0503	16	125	1000	30	0	30000	
45	IXGQ160N30PB	SK0601	16	125	1000	30	0	30000	
46	IXGQ160N30PB	SK0601	16	125	1000	30	0	30000	
47	IXGQ160N30PB	SK0601	16	125	1000	30	0	30000	
48	IXGQ160N30PB	SK0601	16	125	1000	30	0	30000	
49	IXGQ180N30TCD1	SK0632	16	125	1000	30	0	30000	
50	IXGQ200N30PB	SK0631	16	125	1000	30	0	30000	
51	IXGQ240N30PB	SK0631	16	125	1000	30	0	30000	
52	IXGQ85N33PCD1	SK0613	16	125	1000	27	0	27000	
53	IXGQ85N33PCD1	SK0638	16	125	1000	30	0	30000	
54	IXGQ90N27PB	SK0611	16	125	1000	30	0	30000	
55	IXGQ90N27PB	SK0640	16	125	1000	30	0	30000	
56	IXGQ90N30TCD1	SK0631	16	125	1000	30	0	30000	
57	IXGR40N60C2D1	SP0635	16	125	1000	30	0	30000	
58	IXKP13N60C5M	1716	16	150	1000	20	0	20000	

**TABLE 2A (cont'd): MOSFET/IGBT single device**

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
59	IXKR40N60C	1287	16	150	168	25	0	4200	
60	IXLF19N250	1142	16	150	168	10	0	1680	
61	IXLF19N250A	1292	16	150	1000	20	0	20000	
62	IXTA36N30P	SK0509	16	125	1000	30	0	30000	
63	IXTA36N30P	K0526	16	125	1000	30	0	30000	
64	IXTA36N30P	K0537	16	125	1000	30	0	30000	
65	IXTA36N30P	SK0603	16	125	1000	30	0	30000	
66	IXTA36N30P	K0621	16	125	1000	30	0	30000	
67	IXTA36N30P	K640	16	125	1000	30	0	30000	
68	IXTA50N25T	K545	16	125	1000	30	0	30000	
69	IXTA50N25T	SK0604	16	125	1000	30	0	30000	
70	IXTA50N28T	K545	16	125	1000	30	0	30000	
71	IXTA50N28T	K0606	16	125	1000	30	0	30000	
72	IXTA50N28T	K634	16	125	1000	30	0	30000	
73	IXTA50N28T	K640	16	125	1000	30	0	30000	
74	IXTA60N20T	K545	16	125	1000	30	0	30000	
75	IXTA60N20T	SK0601	16	125	1000	30	0	30000	
76	IXTA75N10P	K0531	16	125	1000	30	0	30000	
77	IXTH1N250	TP0638	16	125	1000	30	0	30000	
78	IXTH75N15	SK0450	16	125	1000	30	0	30000	
79	IXTH75N15	SK0515	16	125	1000	30	0	30000	
80	IXTK34N80	SP0546	16	125	1000	30	0	30000	
81	IXTK62N25	SS0444	16	125	1000	30	0	30000	
82	IXTK62N25	SS0516	16	125	1000	30	0	30000	
83	IXTK62N25	SS0524	16	125	1000	30	0	30000	
84	IOTP14N60PM	K631	16	125	1000	30	0	30000	
85	IOTP14N60PM	K643	16	125	1000	30	0	30000	
86	IOTP18N60PM	K631	16	125	1000	30	0	30000	
87	IOTP8N50P	K646	16	125	1000	30	0	30000	
88	IXTQ22N50P	SS0633	16	125	1000	30	0	30000	
89	IXTQ22N60P	SK0539	16	125	1000	30	0	30000	
90	IXTQ22N60P	SK0604	16	125	1000	30	0	30000	
91	IXTQ26N50P	SK0604	16	125	1000	30	0	30000	
92	IXTQ30N60P	SK0517	16	125	1000	30	0	30000	
93	IXTQ64N25P	SK0535	16	125	1000	30	0	30000	
94	IXTQ69N30P	SK0450	16	125	1000	30	0	30000	
95	IXTQ69N30P	SK0535	16	125	1000	30	0	30000	
96	IXTQ74N20P	SK0515	16	125	1000	30	0	30000	
97	IXTQ76N25T	SK0613	16	125	1000	30	0	30000	
98	IXTQ80N28T	SK0519	16	125	1000	30	0	30000	
99	IXTQ80N28T	SK0519	16	125	1000	30	0	30000	
100	IXTQ82N25P	SK0450	16	125	1000	30	0	30000	
101	IXTQ82N25P	SK0514	16	125	1000	30	0	30000	
102	IXTQ82N25P	SK0538	16	125	1000	30	0	30000	
103	IXTQ82N25T	SK0514	16	125	1000	30	0	30000	
104	IXTQ82N25T	SK0603	16	125	1000	30	0	30000	
105	IXTQ88N30P	SK0515	16	125	1000	30	0	30000	
106	IXTQ88N30P	K0525Z	16	125	1000	30	0	30000	
107	IXTQ88N30P	SK0538	16	125	1000	30	0	30000	
108	IXTQ88N30P	SK0605	16	125	1000	30	0	30000	
109	IXTQ88N30T	SK0638	16	125	1000	30	0	30000	
110	IXTQ96N15P	SK0449	16	125	1000	30	0	30000	
111	IXTQ96N15P	SK0513	16	125	1000	30	0	30000	
112	IXTQ96N20P	SS0631	16	125	1000	30	0	30000	
113	IXTT88N30P	SP0626	16	125	1000	30	0	30000	
114	IXTV18N60PS	SP0636	16	125	1000	30	0	30000	

**TABLE 2B: MOSFET/IGBT Module**

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	GWM120-0075P3	1720	16	150	1000	77	0	77000	
2	GWM160-0055P3	1371	16	150	168	10	0	1680	
3	MDI300-12A4	1555	16	125	126	10	0	1260	
4	MII400-12E4	1741	16	125	168	10	0	1680	
5	MII75-12A3	1541	16	125	168	10	0	1680	
6	MUBW15-12A6K	1553	16	125	168	10	0	1680	
7	MUBW30-12E6K	1127	16	150	168	10	0	1680	
8	MUBW35-12E7	1285	16	125	168	10	0	1680	
9	MUBW50-12E8	1469	16	125	168	10	0	1680	
10	MWI30-06A7T	1635	16	125	168	10	0	1680	
11	VII130-06P1	1274	20	150	168	10	0	1680	
12	VMO1200-01F	1442	16	125	1000	10	0	10000	
13	VMO440-02F	1308	20	125	168	10	0	1680	
14	VMO440-02F	1308	16	150	168	10	0	1680	
15	VWM350-0075	1288	16	150	168	10	0	1680	

**TABLE 2C: ISOPLUS**

#	Part Number	Date Code or Test #	Voltage [V]	Temp. [°C]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	GWM120-0075P3SL	1720	16	150	1000	77	0	77000	
2	GWM160-0055P3	1371	16	150	168	10	0	1680	
3	IXFL100N50P	SP0549	16	125	1000	30	0	30000	
4	IXFL82N60P	SP0550	16	125	1000	30	0	30000	
5	IXGR40N60C2D1	SP0635	16	125	1000	30	0	30000	
6	IXKR40N60C	1287	16	150	168	25	0	4200	
7	IXLF19N250	1142	16	150	168	10	0	1680	
8	IXLF19N250A	1292	16	150	1000	20	0	20000	

**POWER CYCLE (Tables 3A ..3H)**

**TABLE 3A: MOSFET/IGBT single device**

#	Part Number	Date Code or Test #	T <sub>j</sub> (max) [°C]	ΔT [K]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	IXEH25N120D1	1277	125	80	2000	20	0	40000	
2	IXFH80N10Q	SK0510	-	100	10000	24	0	240000	
3	IXFX48N60P	SP0518	-	125	10000	24	0	240000	
4	IXFX73N30Q	SK0613	-	125	10000	24	0	240000	
5	IXFX90N30	SK0613	-	125	10000	24	0	240000	
6	IXGQ160N30P	SK0503	-	125	10000	24	0	240000	
7	IXGQ85N33PCD1	SK0614	-	125	10000	24	0	240000	
8	IXGQ90N27PB	SK0611	-	125	10000	24	0	240000	
9	IXKP13N60C5M	1716	125	80	10000	20	0	200000	
10	IXTP14N60PM	K643	-	50	10000	24	0	240000	
11	IXTQ26N50P	SK0604	-	125	10000	24	0	240000	
12	IXTQ30N60P	SK0517	-	125	10000	24	0	240000	
13	IXTQ76N25T	SK0613	-	125	10000	24	0	240000	
14	IXTQ82N25P	SS0506	-	100	10000	24	0	240000	
15	IXTQ96N20P	SS0631	-	100	10000	24	0	240000	

**TABLE 3B: MOSFET/IGBT Module**

#	Part Number	Date Code or Test #	T <sub>j</sub> (max) [°C]	ΔT [K]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	MKI75-06A7T	1464	125	80	10000	10	0	100000	
2	MKI75-06A7T	1676	125	80	10000	10	0	100000	
3	MKI75-06A7T	1772	125	80	5000	10	0	50000	
4	MKI75-06A7T	1776	125	80	10000	10	0	100000	

**TABLE 3C: Thyristor/Diode Module**

#	Part Number	Date Code or Test #	T <sub>j</sub> (max) [°C]	ΔT [K]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	MCC162-14io1	1375	125	80	10000	10	0	100000	
2	MCC56-14io1	1472	125	80	20000	10	0	200000	
3	MCC95-12	1351	125	80	10000	10	0	100000	
4	MCD40-16io6	1474	125	80	5000	10	0	50000	
5	MDD172-16N1	1133	125	80	20000	10	0	200000	

**TABLE 3D: Controller, Rectifier Bridge**

#	Part Number	Date Code or Test #	T <sub>j</sub> (max) [°C]	ΔT [K]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	VUO28-08NO7	1249	125	80	2000	10	0	20000	
2	VUO80-16	1456	125	80	5000	10	0	50000	
3	VUO82-16NO7	1328	125	80	5000	10	0	50000	

TABLE 3E: FRED									
#	Part Number	Date Code or Test #	T <sub>j</sub> (max) [°C]	ΔT [K]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	DH60-18A	1699	125	80	2000	20	0	40000	
2	DSEC30-02A	1206	125	80	2000	20	0	40000	
3	DSEC30-02A	1755	125	80	2000	20	0	40000	
4	DSEI2x101-06A	1139	125	80	5000	10	0	50000	
5	DSEI60-02A	1440	145	105	2000	20	0	40000	
6	DSEI60-12A	1599	150	105	2000	20	0	40000	
7	DSEP15-06A	1378	107	105	2000	20	0	40000	
8	DSEP29-06A	1736	150	105	2000	20	0	40000	
9	DSEP2x61-06A	1633	125	80	5000	10	0	50000	
10	DSEP60-06A	1262	135	90	2000	20	0	40000	

TABLE 3F: Schottky Diode									
#	Part Number	Date Code or Test #	T <sub>j</sub> (max) [°C]	ΔT [K]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	DSA15IM45IB	1621	125	80	4000	20	0	80000	
2	DSS6-015AS	1723	145	100	8572	77	0	660044	
3	DSS61-0045A	1238	125	80	4000	20	0	80000	
4	DSSK40-0015B	1336	125	80	2000	20	0	40000	
5	DSSK60-015A	1256	125	80	20000	20	0	400000	
6	DSSK60-015AR	1384	125	80	10000	20	0	200000	
7	DSSK80-0045B	1223	125	80	2000	20	0	40000	
8	DSSK80-006B	1575	125	80	2000	20	0	40000	

TABLE 3G: Thyristor/Diode single device									
#	Part Number	Date Code or Test #	T <sub>j</sub> (max) [°C]	ΔT [K]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	CS35-14io4	1473	125	80	2000	10	0	20000	
2	CS45-12io1	1601	125	80	5000	20	0	100000	
3	CS45-16io1	1165	125	80	2000	20	0	40000	
4	CS8-12io2	1605	125	80	2000	10	0	20000	
5	DSA1-18D	1435	150	105	2000	20	0	40000	
6	DSI45-08A	1760	150	105	2000	20	0	40000	

TABLE 3H: ISOPLUS									
#	Part Number	Date Code or Test #	T <sub>j</sub> (max) [°C]	ΔT [K]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	DSSK60-015AR	1384	125	80	10000	20	0	200000	

**TEMPERATURE CYCLE (Tables 4A ..4J)**

**TABLE 4A: MOSFET/IGBT single device**

#	Part Number	Date Code or Test #	Low Temp. [°C]	High Temp. [°C]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	FII50-12EL	1294	-55	150	100	20	0	2000	
2	FII50-12EL	1534	-55	150	100	20	0	2000	
3	FMM151-0075P	1145	-55	150	100	20	0	2000	
4	IRFP450	CK 0420	-55	125	100	30	0	3000	
5	IXBH9N160G	1574	-55	150	50	20	0	1000	
6	IXBP5-N160G	1337	-55	150	50	20	0	1000	
7	IXDD404SIA	1695	-55	150	500	30	0	15000	
8	IXDN404SI	SC 351	-55	150	1000	80	0	80000	
9	IXDN75N120	1606	-40	150	20	10	0	200	
10	IXDR30N120D1	1411	-55	150	50	20	0	1000	
11	IXER35N120D1	1207	-55	150	50	20	0	1000	
12	IXFF24N100	1390	-55	150	100	20	0	2000	
13	IXFH21N50Q	MP 0423	-55	125	100	30	0	3000	
14	IXFH24N50	MP 0419	-55	125	100	30	0	3000	
15	IXKC13N80C	1769	-55	150	100	20	0	2000	
16	IXKC25N80C	1590	-55	150	100	20	0	2000	
17	IXKC40N60C	1281	-55	150	100	20	0	2000	
18	IXKP10N60C5M	1693	-40	150	100	20	0	2000	
19	IXKP13N60C5M	1716	-55	150	100	20	0	2000	
20	IXKR25N80C	1189	-40	150	50	20	0	1000	
21	IXLF19N250A	1292	-55	150	100	20	0	2000	
22	IXTM1N100	TP 0423	-55	125	100	32	0	3200	
23	IXTM1N100	TP 0423	-55	125	100	32	0	3200	
24	IXTM1N100	TP 0424	-55	125	100	32	0	3200	
25	IXTN79N20	1140	-40	150	50	10	0	500	
26	IXTQ64N25P	SK 0414	-55	150	250	30	0	7500	
27	IXTQ69N30P	SK 0342	-65	155	100	30	0	3000	
28	IXTQ69N30P	SK 0411	-55	150	250	30	0	7500	
29	IXTQ96N15P	SK 0412	-55	150	250	30	0	7500	
30	IXUC200N055	1802	-55	150	90	50	0	4500	

**TABLE 4B: MOSFET/IGBT Module**

#	Part Number	Date Code or Test #	Low Temp. [°C]	High Temp. [°C]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	MDI300-12A4	1555	-40	150	50	10	0	500	
2	MII400-12E4	1741	-40	150	50	10	0	500	
3	MII75-12A3	1541	-40	150	50	10	0	500	
4	MKI50-06A7	1172	-40	150	50	10	0	500	
5	MKI75-06A7T	1562	-40	150	50	10	0	500	
6	MKI75-06A7T	1724	-40	150	50	10	0	500	
7	MKI75-06A7T	1724	-40	150	50	10	0	500	
8	MUBW15-12A7	1466	-40	150	50	10	0	500	
9	MUBW30-12A6K	1373	-40	150	50	10	0	500	
10	MUBW35-06A6	1244	-40	125	100	10	0	1000	
11	MUBW35-12E7	1285	-40	150	50	10	0	500	
12	MUBW75-12T8	1731	-40	150	100	10	0	1000	
13	MWI50-06A7T	1144	-40	150	100	10	0	1000	
14	VMM90-09F	1201	-40	150	50	10	0	500	
15	VMO1200-01F	1442	-40	150	100	10	0	1000	



**TABLE 4C: Thyristor/Diode Module**

#	Part Number	Date Code or Test #	Low Temp. [°C]	High Temp. [°C]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	MCC162	1175	-40	150	50	10	0	500	
2	MCC162-14	1816	-40	150	50	10	0	500	
3	MCC162-14io1	1544	-40	150	50	10	0	500	
4	MCC162-14io1	1629	-40	150	50	10	0	500	
5	MCC200-14	1717	-40	150	50	10	0	500	
6	MCC21	1821	-40	150	100	20	0	2000	
7	MCC255-14io1	1120	-40	150	50	10	0	500	
8	MCC26-12io1	1255	-40	150	50	10	0	500	
9	MCC26-14io1	1641	-40	150	50	10	0	500	
10	MCC26-16	1389	-40	150	100	10	0	1000	
11	MCC26-16io1	1324	-40	150	100	10	0	1000	
12	MCC26-16io1	1333	-40	150	100	10	0	1000	
13	MCC310-12io1	1545	-40	150	50	10	0	500	
14	MCC310-14io1	1627	-40	150	50	10	0	500	
15	MCC312, MCC255	1202	-40	150	100	6	0	600	
16	MCC312-16	1302	-40	150	200	10	0	2000	
17	MCC312-16	1302	-40	150	200	5	0	1000	
18	MCC44-12io1	1540	-40	150	50	10	0	500	
19	MCC44-16io1	1181	-40	150	50	10	0	500	
20	MCC56-12io1	1449	-40	150	50	10	0	500	
21	MCC95	1361	-40	150	100	10	0	1000	
22	MCC95	1361	-40	150	200	10	0	2000	
23	MCC95-12	1389	-40	150	100	40	0	4000	
24	MCC95-14io1	1788	-40	150	150	10	0	1500	
25	MCC95-16	1278	-40	150	100	10	0	1000	
26	MCD200-12io1	1586	-40	150	50	10	0	500	
27	MCD310-12	1257	-40	150	50	10	0	500	
28	MCD56-16io1	1646	-40	150	50	10	0	500	
29	MCD95-16io1	1342	-40	150	50	10	0	500	
30	MCO25-16io1	1155	-40	150	50	20	0	1000	
31	MCO450-14io1	1418	-40	150	50	10	0	500	
32	MCO50-16io1	1154	-40	150	50	10	0	500	
33	MCO600-16io1	1680	-40	150	50	10	0	500	
34	MDD172-16	1372	-40	150	50	10	0	500	
35	MDD172-16N1	1133	-40	150	100	10	0	1000	
36	MDD26-18N1	1749	-40	150	100	20	1	2000	
37	MDD26-18N1	1749	-40	150	100	20	1	2000	
38	MDD95-16	1585	-40	150	50	10	0	500	
39	MDI300-12A4	1555	-40	150	50	10	0	500	

**TABLE 4D: Controller, Rectifier Bridge**

#	Part Number	Date Code or Test #	Low Temp. [°C]	High Temp. [°C]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	MMO230-16	1543	-40	150	150	10	0	1500	
2	MMO74-12io6	1615	-55	150	300	10	0	3000	
3	VBO19-16DT1	1272	-40	150	50	10	0	500	
4	VBO19-16DT1	1648	-40	150	50	10	0	500	
5	VBO25-12NO2	1726	-40	150	50	10	0	500	
6	VUB120-16NO2	1300	-40	150	50	10	0	500	
7	VUB120-16NO2	1636	-40	150	50	10	0	500	
8	VUO28-08NO7	1249	-40	150	10	10	0	100	
9	VUO36-16	1428	-40	150	40	10	0	400	
10	VUO36-16nO8	1580	-40	150	10	10	0	100	
11	VUO80-16	1778	-40	150	100	10	0	1000	
12	VVY40-16io1	1679	-40	150	50	10	0	500	
13	VVZ40-14	1691	-40	150	100	10	0	1000	
14	VW2x60-14	1443	-40	150	50	10	0	500	
15	VWO85-12	1570	-40	125	50	10	0	500	

**TABLE 4E: FRED**

#	Part Number	Date Code or Test #	Low Temp. [°C]	High Temp. [°C]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	DH60-18A	1568	-40	150	50	20	0	1000	
2	DHG10I600PM	1685	-55	150	100	20	0	2000	
3	DHH55-36N1F	1604	-55	150	100	40	0	4000	
4	DPG15I400PM	1770	-55	150	100	20	0	2000	
5	DSEC29-06AC	1204	-55	150	100	20	0	2000	
6	DSEC30-02A	1339	-55	150	50	20	0	1000	
7	DSEC30-06A	1269	-55	150	100	20	0	2000	
8	DSEC59-02AQ	1159	-55	150	100	20	0	2000	
9	DSEC60-03AR	1121	-55	150	50	20	0	1000	
10	DSEE29-06CC	1771	-55	150	100	20	0	2000	
11	DSEI 2x121-02A	1397	-40	150	20	10	0	200	
12	DSEI120-12A	1174	-40	150	200	10	0	2000	
13	DSEI120-12A	1538	-40	150	50	20	0	1000	
14	DSEI120-12A	1756	-40	150	50	20	0	1000	
15	DSEI120-12A	1174	-40	150	200	10	0	2000	
16	DSEI20-12A	1169	-40	150	100	20	0	2000	
17	DSEI2x31-06C	1563	-40	150	20	10	0	200	
18	DSEI30-10A	1126	-40	150	50	20	0	1000	
19	DSEI36-06AS	1190	-40	150	100	20	0	2000	
20	DSEI60-06A	1804	-40	150	50	20	0	1000	
21	DSEP15-12CR	1514	-55	150	50	20	0	1000	
22	DSEP25-16AR	1712	-40	150	50	20	0	1000	
23	DSEP29-06B	1263	-50	150	50	20	0	1000	
24	DSEP2x25-12C	1468	-40	150	50	10	0	500	
25	DSEP30-06BR	1700	-55	150	50	20	0	1000	
26	DSEP40-03AS	1268	-55	150	100	20	0	2000	
27	DSEP8-03AS	1738	-40	150	100	20	0	2000	
28	DSEP8-12A	1438	-55	150	50	20	0	1000	
29	DSEP9-06CR	1437	-55	150	50	20	0	1000	
30	MEK150-04E	1365	-40	150	50	10	0	500	
31	MEK300-06	1737	-40	150	50	10	0	500	
32	MEO500-06DA	1279	-40	150	50	10	0	500	

**TABLE 4F: Schottky Diode**

#	Part Number	Date Code or Test #	Low Temp. [°C]	High Temp. [°C]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	DSA90C200HB	1674	-55	150	100	20	0	2000	
2	DSB15IM45IB	1622	-55	150	100	20	0	2000	
3	DSS20-01AC	1709	-55	150	100	20	0	2000	
4	DSS2x160-01A	1117	-40	150	100	20	0	2000	
5	DSS31-0045A SN	1492	-55	150	500	77	0	38500	
6	DSS40-0008D	1131	-55	150	100	20	0	2000	
7	DSS6-015AS	1723	-55	150	1000	77	0	77000	
8	DSS61-0045A	1238	-55	150	100	20	0	2000	
9	DSSK30-01A	1807	-55	150	50	20	0	1000	
10	DSSK40-0015B	1557	-55	150	50	20	0	1000	
11	DSSK40-008B	1260	-55	150	50	20	0	1000	
12	DSSK50-01A	1166	-55	150	50	20	0	1000	
13	DSSK60-0045B	1457	-55	150	50	20	0	1000	
14	DSSK60-015A	1256	-55	150	100	20	0	2000	
15	DSSK60-015AR	1304	-55	150	100	20	0	2000	
16	DSSK60-015AR	1573	-55	150	50	20	0	1000	
17	DSSK60-015AR	1591	-55	150	200	40	0	8000	
18	DSSK60-02A	1187	-55	150	100	20	0	2000	
19	DSSK80-0008D	1394	-55	150	50	20	0	1000	
20	DSSK80-0025B	1119	-55	150	100	20	0	2000	
21	DSSK80-006B	1575	-55	150	50	20	0	1000	

**TABLE 4G: Thyristor/Diode single device**

#	Part Number	Date Code or Test #	Low Temp. [°C]	High Temp. [°C]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	CS19-12H01	1404	-40	150	50	20	0	1000	
2	CS20-14io1	1364	-40	150	100	20	0	2000	
3	CS30-16io1DCSN	1820	-40	150	100	20	0	2000	
4	CS35-14io4	1473	-40	150	20	10	0	200	
5	CS45-12io1	1199	-40	150	50	20	0	1000	
6	CS45-16io1	1598	-40	150	50	20	0	1000	
7	CS45-16io1R	1284	-40	150	50	20	0	1000	
8	CS8-12io2	1388	-40	150	50	20	0	1000	
9	CS8-12io2	1605	-40	150	20	10	0	200	
10	DS75-04D	1243	-40	150	50	10	0	500	
11	DSA17-16A	1703	-40	150	20	20	0	400	
12	DSA17-16A	1195	-40	150	100	18	0	1800	
13	DSA17-16A	1195	-40	150	100	20	0	2000	
14	DSA2-18A	1398	-40	150	20	20	0	400	
15	DSA35-16A	1566	-40	150	20	10	0	200	
16	DSA75-18B	1388	-40	150	50	20	0	1000	
17	DSA9-18F	1307	-40	150	20	10	0	200	
18	DSI45-12A	1805	-40	150	50	20	0	1000	
19	DSI75-16	1160	-40	150	20	10	0	200	
20	DSP25-16	1564	-40	150	50	20	0	1000	
21	DSP25-16A	1639	-40	150	50	20	0	1000	
22	DSP25-16A	1273	-40	150	50	20	0	1000	
23	DSP8-08A	1146	-40	150	50	20	0	1000	

**TABLE 4H: ISOPLUS**

#	Part Number	Date Code or Test #	Low Temp. [°C]	High Temp. [°C]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	CS45-16io1R	1284	-40	150	50	20	0	1000	
2	DHH55-36N1F	1604	-55	150	100	40	0	4000	
3	DSEC29-06AC	1204	-55	150	100	20	0	2000	
4	DSEC60-03AR	1121	-55	150	50	20	0	1000	
5	DSEE29-06CC	1771	-55	150	100	20	0	2000	
6	DSEP15-12CR	1514	-55	150	50	20	0	1000	
7	DSEP25-16AR	1712	-40	150	50	20	0	1000	
8	DSEP30-06BR	1700	-55	150	50	20	0	1000	
9	DSEP9-06CR	1437	-55	150	50	20	0	1000	
10	DSS20-01AC	1709	-55	150	100	20	0	2000	
11	DSSK60-015AR	1304	-55	150	100	20	0	2000	
12	DSSK60-015AR	1573	-55	150	50	20	0	1000	
13	DWP25-16/18AL	1842	-55	150	100	22	0	2200	
14	FII50-12EL	1294	-55	150	100	20	0	2000	
15	FII50-12EL	1534	-55	150	100	20	0	2000	
16	FMM151-0075P	1145	-55	150	100	20	0	2000	
17	GWM120-0075P3	1720	-55	150	1000	80	0	80000	
18	GWM70-01P2	1448	-55	150	1000	10	0	10000	
19	IXDR30N120D1	1411	-55	150	50	20	0	1000	
20	IXER35N120D1	1207	-55	150	50	20	0	1000	
21	IXFF24N100	1390	-55	150	100	20	0	2000	
22	IXKC13N80C	1769	-55	150	100	20	0	2000	
23	IXKC25N80C	1590	-55	150	100	20	0	2000	
24	IXKC40N60C	1281	-55	150	100	20	0	2000	
25	IXKR25N80C	1189	-40	150	50	20	0	1000	
26	IXLF19N250A	1292	-55	150	100	20	0	2000	
27	IXUC200N055	1802	-55	150	90	50	0	4500	

**TABLE 4J: Breakover Diode**

#	Part Number	Date Code or Test #	Low Temp. [°C]	High Temp. [°C]	Number of Cycles	Sample Size	Failures	Device Cycles	Remark
1	IXBOD1-08	1248	-40	150	50	20	0	1000	
2	IXBOD1-09	1340	-40	150	50	20	0	1000	
3	IXBOD1-09	1800	-40	150	50	20	0	1000	
4	IXBOD1-10	1576	-40	150	50	20	0	1000	

## HUMIDITY TEST (Tables 5A ..5H)

**TABLE 5A: MOSFET/IGBT single device**

#	Part Number	Date Code or Test #	Temp. [°C]	Rel. H. [%]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	IXBH40N140	1188	121	100	48	20	0	960	
2	IXDD404SIA	1695	121	100	96	30	0	2880	
3	IXKP13N60C5M	1716	85	85	1000	20	0	20000	
4	IXKP13N60C5M	1687	121	100	96	10	0	960	

**TABLE 5B: MOSFET/IGBT Module**

#	Part Number	Date Code or Test #	Temp. [°C]	Rel. H. [%]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	MUBV25-06A6K	1240	85	85	1000	10	0	10000	
2	MWI30-12E6K	1200	85	85	168	10	0	1680	
3	VMO1200-01F	1442	85	85	1000	10	0	10000	
4	VMO440-02F	1308	85	85	168	10	0	1680	

**TABLE 5C: Thyristor/Diode Module**

#	Part Number	Date Code or Test #	Temp. [°C]	Rel. H. [%]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	MCC310-16io1	1171	85	85	168	10	0	1680	
2	MCC44-12io1	1748	85	85	168	10	0	1680	
3	MCD56-16io1B	1193	85	85	168	10	0	1680	
4	MCD56-16io8	1341	85	85	168	10	0	1680	
5								0	

**TABLE 5D: Controller, Rectifier Bridge**

#	Part Number	Date Code or Test #	Temp. [°C]	Rel. H. [%]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	VHF36-16	1654	85	85	168	10	0	1680	
2	VHF36-16io5	1176	85	85	168	10	0	1680	
3	VUO82-16NO7	1251	85	85	168	10	0	1680	
4	VUO82-16NO7	1251	85	85	168	10	0	1680	

**TABLE 5E: FRED**

#	Part Number	Date Code or Test #	Temp. [°C]	Rel. H. [%]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	DH60-18A	1297	121	100	48	20	0	960	
2	DPG60C400QB	1446	121	100	96	8	0	768	
3	DSEC59-02AQ	1159	121	100	96	20	0	1920	
4	DSEC60-03AR	1121	121	100	48	20	0	960	
5	DSEI2x61-12B	1607	121	100	96	20	0	1920	
6	DSEI36-06AS	1190	121	100	96	20	0	1920	
7	DSEI8-06AS	1535	121	100	48	20	0	960	
8	DSEP15-12CR	1168	121	100	48	20	0	960	
9	DSEP30-06BR	1536	121	100	48	20	0	960	
10	MEO450-12DA	1742	85	85	168	10	0	1680	

**TABLE 5F: Schottky Diode**

#	Part Number	Date Code or Test #	Temp. [°C]	Rel. H. [%]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	DSB15IM45IB	1622	121	100	96	20	0	1920	
2	DSS31-0045A SN	1492	121	100	96	77	0	7392	
3	DSS6-015AS	1723	121	100	96	77	0	7392	
4	DSS61-0045A	1238	121	100	96	20	0	1920	
5	DSSK60-015A	1256	121	100	96	20	1	1920	L_R @ 96h

**TABLE 5G: Thyristor/Diode single device**

#	Part Number	Date Code or Test #	Temp. [°C]	Rel. H. [%]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	CS45-12io1	1754	121	100	48	20	0	960	
2	DSDI60-14A	1806	121	100	48	20	0	960	

**TABLE 5H: ISOPLUS**

#	Part Number	Date Code or Test #	Temp. [°C]	Rel. H. [%]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	DSEC60-03AR	1121	121	100	48	20	0	960	
2	DSEP15-12CR	1168	121	100	48	20	0	960	
3	DSEP30-06BR	1536	121	100	48	20	0	960	
4	IXBH40N140	1188	121	100	48	20	0	960	
5								0	

**TABLE 5J: Breakover diode**

#	Part Number	Date Code or Test #	Temp. [°C]	Rel. H. [%]	Time [hrs]	Sample Size	Failures	Device Hours [hrs]	Remark
1	IXBOD1-08	1248	121	100	48	20	0	960	
2	IXBOD1-09	1340	121	100	48	20	0	960	
3	IXBOD1-09	1800	121	100	48	20	0	960	
4	IXBOD1-10	1576	121	100	48	20	0	960	