

# Switch and I/O Reliability Report

March, 2003

Datasheet.Directory

**International**  
 **Rectifier**

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## 1.0 INTRODUCTION

The March, 2003 Reliability Report has been expanded to include test results for switch devices as well as input/output devices. The report contains the accumulated data obtained on power MOSFET transistors, IGBT's, Schottky diodes, Fast Recovery Epitaxial Diodes (FREDS), Input Rectifiers and SCRs built at International Rectifier Corporation's facilities as well as International Rectifier subcontractors.

Section 2 contains a description of the ENVIRONMENTAL STRESS TESTS which are performed and the observed failure modes.

Section 3, THE MATRIX QUALIFICATION PHILOSOPHY, is a presentation of the philosophy of reliability testing that allows one to extrapolate the reliability of devices based upon the results of similar devices. By following this rationale, International Rectifier is able to assess the reliability of thousands of separate devices based on a smaller sample size.

Section 4 of the present report contains an update on the latest results of our LONG TERM RELIABILITY TESTING PROGRAM. The data is separated initially by function (transistors vs. diodes) and further subdivided down to the individual part number. The data presented in the tables are limited to devices with date codes on, or after, 0101. This provides a minimum 24 month rolling average from quarter to quarter.

Section 5 presents acceleration factors which have been obtained for high temperature reverse bias (HTRB), gate stress acceleration due to applied gate bias voltage and thermal acceleration, power cycling capability, voltage acceleration under high humidity environmental stress, applied bias acceleration under HTRB conditions and applied bias acceleration for N-channel and P-channel gate stress.

Additional switch or I/O reliability information can be obtained by contacting the following individuals:

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**SECTION 2.0**  
**ENVIRONMENTAL STRESS AND FAILURE MODES**

## 2.1 ENVIRONMENTAL STRESS TEST

### HIGH TEMPERATURE REVERSE BIAS (HTRB)

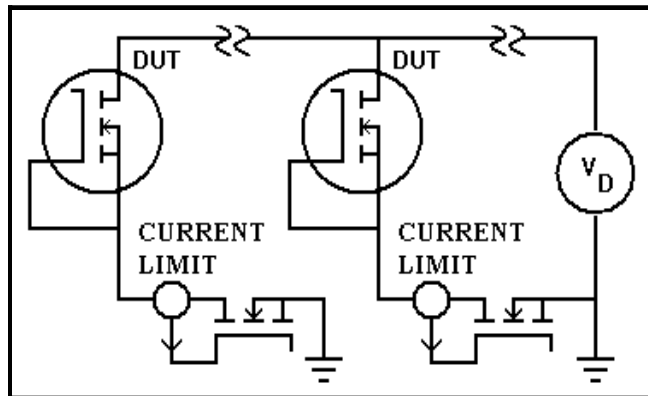
#### CONDITIONS:

Temperature:  $T = 150^{\circ}\text{C}$  or  $175^{\circ}\text{C}$

Duration: 1000 hours (typical)

Bias:  $V_S = V_G = 0\text{V}$   
 $V_D =$  Maximum rated  $BV_{DSS}$  for voltage ratings up to 500V;  
80% of maximum rated  $BV_{DSS}$  for voltage ratings from 600V to 1000V

#### CIRCUIT DIAGRAM



#### PURPOSE:

The purpose of high temperature reverse bias burn-in is to stress the devices with applied bias in the blocking mode (cut-off mode) while at elevated junction temperatures. This will accelerate any blocking voltage degradation process.

#### FAILURE MODES:

The primary failure mode for HTRB stress is a gradual degradation of the breakdown characteristics or  $BV_{DSS}$ . This degradation has been attributed to the presence of foreign materials and polar/ionic contaminants. These materials, migrating under application of electric field at high temperature, can perturb the electric field termination structure.

A secondary failure mode, threshold voltage degradation has been present in HTRB stress with less frequency than the primary failure mode. The mechanism responsible for this degradation is under investigation.

Extreme care must be exercised in the course of a long term test to avoid potential hazards such as electrostatic discharge or electrical overstress to the gate during test. Failures arising from this abuse can be virtually indistinguishable from true HTRB failures which result from the actual stress test.

#### SENSITIVE

**PARAMETERS:**  $BV_{DSS}$ ,  $I_{DSS}$ ,  $I_{GSS}$ ,  $V_{GS(th)}$

## 2.2 ENVIRONMENTAL STRESS TEST

### GATE STRESS

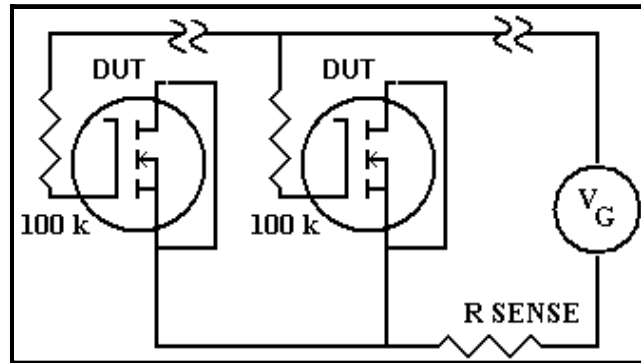
#### CONDITIONS:

Temperature:  $T = 150^{\circ}\text{C}$  or  $175^{\circ}\text{C}$

Duration: 1000 hours  
(typical)

Bias:  $V_S = V_D = 0\text{V}$   
 $V_G = +20\text{V}$  (N-channel)  
 $V_G = -20\text{V}$  (P-channel)

#### CIRCUIT DIAGRAM



#### PURPOSE:

The purpose of long term high temperature gate stress is to stress the devices with applied bias to the gate while at elevated junction temperatures. This will accelerate what is known as time-dependent dielectric breakdown (TDDB) of the gate structure.

#### FAILURE MODES:

The primary failure mode for long term gate stress is a rupture of the gate oxide, causing either a resistive short between gate-to-source or gate-to-drain or what appears to be a low breakdown diode between the gate and source.

The oxide breakdown or TDDB has been attributed to the degradation in time of existing defects in the thermally grown oxide. These defects can take the form of localized thickness variations, structural anomalies or the presence of particulate within the oxide.

Extreme care must be exercised in the course of a long term test to avoid potential hazards such as electrostatic discharge or electrical overstress to the gate during test. Failures arising from this abuse are virtually indistinguishable from true TDDB's which result from the actual stress test.

Another failure mode occasionally observed is degradation of the threshold parameter,  $V_{GS(th)}$ , due to the presence of highly mobile ions such as Sodium ions within the gate oxide. Under the influence of bias at high temperatures, these ions will move through the oxide toward the negative surface and once sufficient number have accumulated, the FET channel in the vicinity can begin to invert, lowering the effective threshold voltage. This failure mode is very rare with HEXFETs due to inherent features in the design and due to cleanliness of wafer fabrication.

#### SENSITIVE

#### PARAMETERS:

$I_{GSS}$ ,  $V_{GS(th)}$

## 2.3 ENVIRONMENTAL STRESS TEST

### POWER CYCLING

#### CONDITIONS:

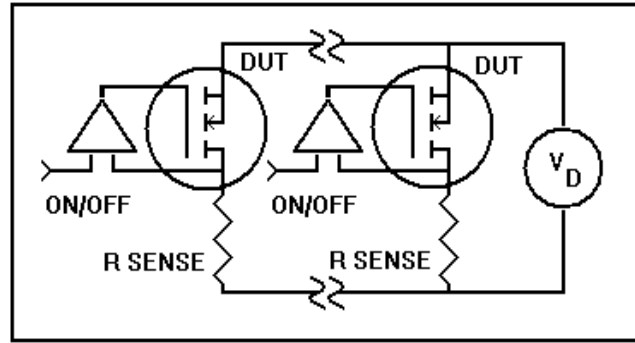
#### DIAGRAM

Temperature  $T_{\min} = 30^{\circ}\text{C}$   
 $T_{\max} = 30^{\circ}\text{C} + \Delta T$   
 $\Delta T = 70^{\circ}\text{C}$  or  $100^{\circ}\text{C}$

Duration: 5,000 to 10,000  
cycles

Bias:  $V_S = 0$   
 $V_G = 11\text{V}(\text{on})/0\text{V}(\text{off})$   
 $V_D = 30\text{V}$  to  $60\text{V}$

#### CIRCUIT



#### PURPOSE:

The purpose of power cycling is to simulate the thermal and current pulsing stresses which devices will encounter in actual circuit applications when either the equipment is turned on and off or the power is applied to the device in short bursts interspersed with quiescent, low power periods. The simulation is achieved by the on/off application of power to each device while they are in the active linear region.

#### FAILURE MODES:

The primary failure mode for power cycling is a thermal fatigue of the silicon/metal interfaces and metal/metal interfaces. The fatigue, due to the thermo-mechanical stresses from the heating and cooling, will cause electrical or thermal performance to degrade.

If the degradation occurs at the header/die interface, then the thermal impedance,  $\theta_{jC}$ , will begin to increase well before any electrical effect is seen. If the degradation occurs at the wire bond/die interface or the wire bond/post interface, then the on resistance,  $R_{DS(\text{on})}$ , will slowly increase or become unstable with time. The thermal impedance, when measured during this time may appear to decrease or change erratically.

The mechanical stresses from the application of power can also propagate fractures in the silicon when the die is thermally mismatched to the solder/heat sink system. These fractures will manifest themselves in the form of shorted gates or degraded breakdown characteristics ( $BV_{DSS}$ ).

## 2.4 ENVIRONMENTAL STRESS TEST

### TEMPERATURE CYCLING

#### CONDITIONS:

Temperature:  $T_{\min} = -55^{\circ}\text{C}$   
 $T_{\max} = +150^{\circ}\text{C}$   
 $\Delta T = 205^{\circ}\text{C}$

Duration: 1000 cycles (typical)

Bias: No bias applied during test

#### PURPOSE:

The purpose of temperature cycling is to simulate thermal stresses which devices will encounter in the actual circuit applications (as with power cycling) in combination with potentially extreme operating ambient temperatures. Some equipment is destined to be used in extreme environments, and subject to daily temperature cycles.

#### FAILURE MODES:

The primary failure mode for temperature cycling is a thermal fatigue of the silicon/metal interfaces and metal/metal interfaces. The fatigue, as in the case of power cycling in section 2.3, results from thermomechanical stresses due to heating and cooling and will cause electrical or thermal performance to degrade.

If the degradation occurs at the header/die interface, then the thermal impedance,  $\theta_{JC}$ , will begin to increase well before any electrical effect is seen.

If the degradation occurs at the wire bond/die interface or the wire bond/bond post interface, then the on resistance,  $R_{DS(on)}$ , will slowly increase or become unstable with time. The thermal impedance, when measured during this time may appear to decrease or change erratically.

The mechanical stresses from the temperature can also propagate fractures in the silicon when the die is thermally mismatched to the solder/heat sink system. These fractures will manifest themselves in the form of shorted gates or degraded breakdown characteristics ( $BV_{DSS}$ ).

#### SENSITIVE PARAMETERS:

$I_{GSS}$ ,  $BV_{DSS}$ ,  $\theta_{JC}$ ,  $R_{DS(on)}$ .



## 2.5 ENVIRONMENTAL STRESS TEST

TEMPERATURE & HUMIDITY (85°C/85%RH)

### CONDITIONS:

#### DIAGRAM

Temperature:  $T = +85^{\circ}\text{C}$

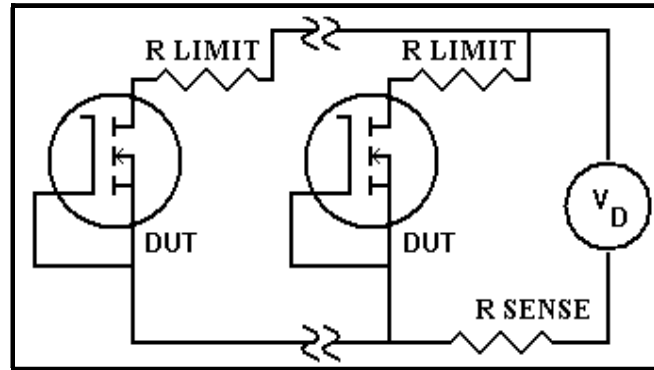
Duration: 1000 hours (typical)

Relative Humidity: 85%

Bias:  $V_G = V_S = 0\text{ V}$

$V_D = 100\%$  of maximum rated  
 $BV_{DSS}$  up to 100 V: 100V for all  
devices with rated  $BV_{DSS}$  greater  
than 100V.

### CIRCUIT



### PURPOSE:

The purpose of temperature-humidity-bias testing is to subject non-hermetic encapsulated devices to temperature and humidity extremes with bias on the drain. This test is a method of examining the ability of a non-hermetic package to withstand the deleterious effects of a humid environment. The devices are placed in a temperature and humidity chamber at ambient pressure and are biased in a cut-off mode.

### FAILURE MODES:

There are two primary failure modes which have been observed. The first failure mode comes about as a result of the ingress of water molecules into the active area on the surface of the die. Once sufficient water has accumulated in the region of the electric field termination structure on the HEXFET, the perturbation of that field begins to degrade the breakdown characteristics of the device.

The second failure mode that has been observed is due to cathodic corrosion of the Aluminum source bonding pad. As with the first failure mode, water will ingress to the top of the die. There, in the presence of applied bias, an electric current through the few monolayers of water will begin to cause the bond pad to dissolve. Eventually, the corrosion will proceed to the point where the current capability of the device is impaired and parameters such as  $R_{DS(on)}$  and  $V_{SD}$  begin to increase and become unstable.

The dominance of either of these failure modes is basically determined by the amount of bias present during the test.

### 3.0 THE MATRIX QUALIFICATION PHILOSOPHY

The matrix qualification philosophy uses the homogeneous nature of the switch or I/O designs. All part types in a given family or technology typically consist of identical structures replicated hundreds or thousands of times across the surface of a die and surrounded by an electric field termination structure. To illustrate the philosophy of matrix qualification, an analysis of the HEXFET power MOSFET is presented.

Certain HEXFET power transistors are made with small die that have a few hundred cells. Other devices have large die with thousands of cells. For this product family, the HEXFET design is fundamentally the same from one part type to another.

There are small variations in the thickness of various layers, which must be considered. The chips' lengths and widths also vary. In principal, however, all devices should age the same way on those environmental stress tests used for qualification.

The matrix qualification philosophy allows us to exploit the homogeneity of the family. For a given environmental test, there will be one specific part type from the family which has been found or is expected to be found to have the highest failure rate. This is considered the worst case part. For example, the larger the die the more susceptible it is to thermomechanical stress, the larger the gate surface area (and hence the higher the probability of TDDB failure), and the larger the surface area of the field termination structure (a greater target of opportunity for micro contaminant effects). On tests which apply higher rated static dc reverse bias voltages (drain-to-source) have higher probabilities of failure. The higher probability failure is due to the higher field strength (in general).

Within a given family, for a given test, there is one part type which would be expected to see the least amount of stress. This part would be considered a best case part. An example would be the smallest die in the family with the lowest  $V_{DS}$  rating.

Once we have identified the worst case and best case part number, for a given test, we use the test data on these two part numbers to "bracket" the rest of the part types within the family. If the best and worst case parts pass the qualification, then all the other part types within the family are considered qualified by similarity. If we have chosen our family members well, then this approach is rational from a reliability physics perspective. The key is in selecting the families and family members correctly.

## **CRITICAL HEXFET ATTRIBUTES FOR CONSIDERATION IN MATRIX QUALIFICATION**

A fundamental requirement to the application of the matrix qualification philosophy is identifying all of the critical HEXFET attributes. Once the critical attributes have been identified, it follows that the best case and worst case part types and the appropriate reliability tests are established for every category. It is necessary at that point to show all of the part types that are qualified based on the best and worst case part types. When this is complete, the next and final step is to perform the actual testing, collect the relevant data and present the results.

Our consideration of the reliability of HEXFETs in this report will focus only on the part types manufactured at HEXFET America and its subcontractors. The most significant distinction that arises is the part family: TO-220, D-Pak, HEXDIP and HEXSENSE. For the most part, the reliability of the families is mutually exclusive based on the differences in packaging.

For each part family, there are two aspects of reliability that must be assessed—package level reliability and die level reliability. These two categories establish the foundation of the matrix testing. Further evaluation of the categories leads to the specific concerns involved and the appropriate reliability tests to assess performance. With the advent of new generations of HEXFET dice, some design changes give rise to the necessity of presenting data for each generation independently. Where this becomes a necessity, the part types are identified as additional worst case devices.

### **DIE LEVEL**

Concern #1: Field Distortion

The presence of polar molecules, such as water and ionic contaminants from the atmosphere, on top of the passivation surface and along the edge of the die, will distort the electric field when a high voltage is applied to the MOSFET, giving increased local leakage current and possible eventual thermal runaway. Failures occur in the random and wearout region, and can be accelerated by high temperature reverse bias (HTRB). The critical factor involved with the HTRB test is the field strength that is applied to the device termination structure by the selected bias. Ideally, we want to apply the maximum possible bias to each device to create the highest possible stress and thus maximize the field strength.

The best case is the device with the lowest voltage rating type in the family because the bias applied in HTRB test creates the lowest field strength.

To test the dielectric strength of the gate oxide, the rated gate voltage is applied to the gate for several hundreds of hours while at elevated junction temperatures. This will accelerate what is known as time-dependent dielectric breakdown (TDDB) of the gate structure. There are four variables involved in the stress test for a given generation of HEXFET die. They are the bias applied, the junction temperature applied, the duration of the stress and the thickness of the gate oxide.

The worst case device for this test is highly flexible. Since the basic structure of the gates remains the same for all part types in a family, we would take the worst case device as that device that is subjected to the greatest field strength at the highest temperature. Further, it would seem that there is a difference between logic level devices (with a gate thickness on the order of 500Å) and a standard HEXFET (gate oxide thickness around 1000Å), however, the logic level FET is stressed at 10V and the standard FET at 20V (duration and junction temperature being the same). Since the determining factor of the stress test is the field strength it follows that:

$$\text{logic level} = 10\text{V}/500\text{Å} = 20\text{V}/1000\text{Å} = \text{standard product},$$

they are the same. In other words, under the given conditions, there is no difference between the logic-level FET and the standard FET for the HTGB test. Nonetheless, logic FET gate stress data is presented for the satisfaction of customer requirements.

## **PACKAGE LEVEL**

### **Concern #3: Die Attach Fatigue**

Die attach fatigue is normally caused by the differential thermal expansion between the die and the header and by the different thermal expansion coefficients of silicon and the header material. This shows up as cracking or separation of the die or voiding of the die attach, resulting in degraded on-resistance and/or thermal fatigue. Additionally, HEXSENSE devices can experience degradation/failure of the current sensing (ratio) capability. These failures largely occur in the wearout region. The susceptibility of a given die attach to thermal fatigue is normally ascertained with a thermomechanical stress test (power cycling or unbiased temperature cycling).

The best case device is that which has the least amount of internal physical stress imposed by die on the package, therefore it would be the smallest die size in the family.

short circuits or instability of the device parameters. Wire bond defects can be tested by a thermomechanical stress test (power cycling or unbiased temperature cycling).

The best case device is that which has the smallest bond wires over a non-active area bond pad. This is usually the smallest, hex size in the family that is greater than 60V rated (all 60V devices, n- and p-channel, and lower, are active area bonded).

The worst case is the device with the largest bond wires or multiple bond wires (i.e. two source wires) placed over an active area. This is usually a 60V device with the largest die size for the family.

#### Concern #5: Metal Corrosion

Under the environmental stress conditions of humidity/temperature/bias, it is expected that a die packaged in a non-hermetic package will be susceptible to one of two predominating failure modes: 1) excess leakage currents under reverse bias will increase to the point of causing a parametric failure of  $I_{DSS}$  or, 2) cathodic corrosion of the internal metallization will result in a parametric shift in the on-resistance,  $R_{DS(on)}$  eventually resulting in an open circuit condition. The cause of both of these phenomena is the ingress of water into the plastic package from the ambient atmosphere to the chip surface, forming external surface leakage paths. This can lead to excessive drain current and eventually parametric failure. Internal package stresses can promote moisture ingress by corrupting the integrity of the mold compound and allowing moisture paths occur.

The application of reverse bias under blocking conditions ( $V_G = V_S$ ) can result in cathodic corrosion of the source bond pad. As the corrosion proceeds, the aluminum source pad slowly dissolves causing intermittent continuity between the source wire and the top metallization of the chip. Eventually, the continuity goes altogether and the device presents an open circuit.

The best case device is that which has the smallest die with the lowest voltage rating.

The worst case device is that which has the largest die (primary factor) with the highest voltage rating (secondary factor; both n- and p- channel).

# 4.0 Long Term Reliability Test Results

## 4.1 Transistors

### 4.1.1 High Temperature Reverse Bias

#### Power MOSFETs

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL
D2Pak (TO-263) & TO-262: P-channel	IRF9224NS	143	175	44	80	1000	0		5.5E+07	17
	IRF9224NL	143	150	44	77	1000	0		1.1E+07	84
	Total						0		6.6E+07	14
D2Pak (TO-263) & TO-262: N-channel, Low Voltage	IRF3704S	208	175	20	40	1000	0		2.1E+07	44
	IRL3803L	133	150	24	77	1000	0		8.2E+06	112
	IRL3803L	133	150	24	77	1000	0		8.2E+06	112
	IRF1404L	133	150	32	77	1000	0		8.2E+06	112
	IRF3205L	110	175	44	80	1000	0		4.1E+07	22
	IRF3205L	110	175	44	80	1000	0		4.1E+07	22
	IRF1312S	202	175	64	80	1000	0		4.1E+07	22
	Total					511	0		1.7E+08	5
D2Pak (TO-263) & TO-262: N-channel, Mid Voltage	IRF8010SJS	226	175	80	79	1000	0		4.1E+07	22
D2Pak (TO-263) & TO-262: N-channel, High Voltage	IRFBC40L	133	150	480	74	1000	0		7.9E+06	116
Direct FET	IRF6601	NA	150	16	55	1020	0		6.0E+06	153
	IRF6601	NA	150	16	55	1013	0		5.9E+06	154
	IRF6601	NA	150	16	55	1013	0		5.9E+06	154
	IRF6601	NA	150	16	55	510	0		3.0E+06	306
	IRF6601	NA	150	16	55	1000	0		5.9E+06	156
	IRF6601	NA	150	16	55	1000	0		5.9E+06	156
	IRF6601	NA	150	16	55	1000	0		5.9E+06	156
	IRF6601	NA	150	16	30	1564	0		5.0E+06	183
	IRF6601	NA	150	16	40	588	0		2.5E+06	365
	IRF6602	NA	150	16	55	1013	0		5.9E+06	154
	IRF6602	NA	150	16	55	1013	0		5.9E+06	154
	IRF6602	NA	150	16	55	1013	0		5.9E+06	154
	IRF6602	NA	150	16	55	1000	0		5.9E+06	156
	IRF6602	NA	150	16	40	1564	0		6.7E+06	137
	IRF6604	NA	150	24	55	506	0		3.0E+06	309
	IRF6607	NA	150	24	55	506	0		3.0E+06	309
	IRF6607	NA	150	24	55	506	0		3.0E+06	309
Total					935	0		8.8E+07	10	
D-Pak & I-Pak (TO-252): P-channel	IRFR5505	232	175	44	80	1000	0		4.1E+07	22
	IRFR9024N	232	175	48	80	1000	0		4.2E+07	22
	IRFR9120N	151	175	80	80	1000	0		4.1E+07	22
	IRFU9210	211	175	160	80	1000	0		4.1E+07	22
	IRFU9220	227	175	160	80	1000	0		4.1E+07	22
	IRFU9220	232	175	160	80	1000	0		4.1E+07	22
Total					480	0		2.5E+08	4	
D-Pak & I-Pak (TO-252): N-channel, Low Voltage	IRF3711	139	175	16	79	1000	0		4.1E+07	22
	IRFR3711	232	175	16	80	1000	0		4.1E+07	22
	IRLR7811W	145	175	24	80	1000	0		4.1E+07	22
	IRLR7811W	216	150	24	80	1000	0		8.5E+06	107
	IRLR7833	233	175	24	80	1000	0		4.1E+07	22
	IRLR7833AA	234	175	24	80	1000	0		4.1E+07	22
	IRLR8503	123	150	30	40	1000	0		4.3E+06	211
	IRLR8503	232	175	24	80	1000	0		4.1E+07	22
	IRLU7821	224	175	24	80	1000	0		4.1E+07	22
	IRLU7833	237	175	24	80	1000	0		4.1E+07	22
	IRFR3504	216	175	32	80	1168	0		4.8E+07	19
	IRFR2405	218	175	0	5	384	0		8.6E+05	1066
	IRFR2405	218	175	0	5	384	0		8.6E+05	1066
	IRFR3505	216	175	44	80	1168	0		4.8E+07	19
	IRLR3105	212	175	44	80	1000	0		4.1E+07	22
	IRFR2407	147	175	60	80	1000	0		4.1E+07	22
	IRFR2407	147	175	60	80	1000	0		4.1E+07	22
IRFU3418	217	175	64	80	1000	0		4.1E+07	22	
Total					1249	0		6.1E+08	2	
D-Pak & I-Pak (TO-252): N-channel, Mid-Voltage	IRFR120	232	175	80	80	1000	0		4.1E+07	22
	IRFR3410	221	175	80	80	1000	0		4.1E+07	22
	IRFR3411	140	175	80	80	1000	0		4.1E+07	22
	IRFR530N	104	175	80	80	1000	0		4.1E+07	22
	IRFR530V	104	175	80	80	1000	0		4.1E+07	22
	IRLU110	150	150	80	48	1000	0		5.1E+06	179
	IRFU24N15D	202	175	120	80	1000	0		4.1E+07	22
	IRFU24N15D	202	175	150	80	1000	0		4.5E+07	20
	IRFU15N20D	119	175	200	80	1000	0		4.7E+07	20
	IRFU12N25D	119	175	200	80	1000	0		4.1E+07	22
	IRFU12N25D	119	175	250	80	1000	0		4.8E+07	19
	IRFU420A	141	150	400	80	1000	0		8.5E+06	107
	IRFU430A	144	150	400	80	1000	0		8.5E+06	107
Total					1008	0		4.5E+08	2	
D-Pak & I-Pak (TO-252): N-channel, High-Voltage	IRFRC20	147	150	480	80	1000	0		8.5E+06	107
Flip Chip Devices, P-channel	IRF6100	0046	150	16	85	500	0		4.5E+06	202
	IRF6100	0046	150	16	84	1000	0		9.0E+06	102
	IRF6100	0046	150	16	84	1000	0		9.0E+06	102
Total					253	0		2.2E+07	41	
Flip Chip Devices, N-channel	IRF6156	NA	150	16	60	500	0		3.2E+06	287
	IRF6156	NA	150	16	60	500	0		3.2E+06	287
	IRF6156	NA	150	16	60	500	0		3.2E+06	287
Total					180	0		9.6E+06	96	

**Power MOSFETs (continued)**

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL	
<b>TO-220 Fullpack, P-channel</b>	IRF9630G	205	150	160	80	1000	0		8.5E+06	107	
<b>TO-220 Fullpack, N-channel, Low Voltage</b>	IRF13205	205	175	44	80	1000	0		4.1E+07	22	
	IRFIZ44N	203	150	44	43	1000	0		4.6E+06	200	
	IRFIZ34E	151	175	48	80	1000	0		4.1E+07	22	
	Total				203		0		8.7E+07	11	
<b>TO-220 Fullpack, N-channel, Mid Voltage</b>	IRL1520N	215	175	80	40	1000	0		2.1E+07	44	
	IRL13615	144	175	1000	80	1000	0		7.0E+08	1	
	Total				120		0		7.2E+08	1	
<b>TO-220 Fullpack, N-channel, High Voltage</b>	IRFIBF20G	205	150	720	80	1000	0		8.5E+06	107	
	IRFIBF20G	205	150	720	80	1000	0		8.5E+06	107	
	Total				160		0		1.7E+07	54	
<b>Micro-3, P-channel</b>	IRLML6302	114	150	20	40	1000	0		4.3E+06	212	
	IRLML6302	114	150	20	40	1000	0		4.3E+06	212	
	Total				80		0		8.6E+06	0	
<b>Micro-3, N-channel</b>	IRLML2402	110	150	20	40	1000	0		4.3E+06	212	
	IRLML2502	227	150	20	40	1000	0		4.3E+06	212	
	IRLML2502	231	150	20	40	1000	0		4.3E+06	212	
	Total				120		0		1.3E+07	71	
<b>SO-8, P-channel, Low Voltage</b>	IRF7233	206	150	9.6	20	1000	0		2.1E+06	430	
	IRF7233	206	150	9.6	20	1000	0		2.1E+06	430	
	IRF7404	113	150	20	40	1000	0		4.3E+06	212	
	IRF7404	119	150	20	40	1000	0		4.3E+06	212	
	IRF7314	145	150	20	20	1000	0		2.2E+06	424	
	IRF7205	144	150	30	40	1000	0		4.3E+06	211	
	Total				180		0		1.9E+07	47	
<b>SO-8, P-channel, Mid Voltage</b>	IRF6216	144	150	120	80	1000	0		8.5E+06	107	
	IRF6217	144	150	120	80	1000	0		8.5E+06	107	
	Total				160		0		1.7E+07	54	
<b>SO-8, N-channel, Low Voltage</b>	IRF7476	112	150	9.6	80	1000	0		8.5E+06	107	
	IRF7101	150	150	16	10	1000	0		1.1E+06	860	
	IRF7101	205	150	16	10	1000	0		1.1E+06	860	
	IRF7311	150	150	16	10	1000	0		1.1E+06	860	
	IRF7311	205	150	16	10	1000	0		1.1E+06	860	
	IRF7403	103	150	30	40	1000	0		4.3E+06	211	
	IRF7413	108	150	30	40	1000	0		4.3E+06	211	
	IRF7413A	150	150	24	20	1000	0		2.1E+06	430	
	IRF7413A	206	150	24	20	1000	0		2.1E+06	430	
	IRF7455	108	150	24	80	1000	0		8.5E+06	107	
	IRF7811A	109	150	22.4	80	1000	0		8.5E+06	108	
	IRF7811W	205	150	24	80	1000	0		8.5E+06	107	
	IRF7822	227	150	24	80	1000	0		8.5E+06	107	
	IRF7822	228	150	24	80	1000	0		8.5E+06	107	
	IRF7822	232	150	24	80	1000	0		8.5E+06	107	
	IRL7821	231	150	24	80	1000	0		8.5E+06	107	
	IRF7484	143	150	32	80	1000	0		8.5E+06	107	
	IRF7484	146	150	32	80	1000	0		8.5E+06	107	
	IRF7341Q	145	175	44	80	1000	0		4.1E+07	22	
	IRF7491	220	150	64	80	1000	0		8.5E+06	107	
IRF7380	211	150	64	40	1000	0		4.3E+06	215		
Total					1160		0		1.6E+08	6	
<b>SO-8, N-channel, Mid Voltage</b>	IRF7474	102	150	80	80	1000	0		8.5E+06	107	
	IRF7490	222	175	80	80	1000	0		4.1E+07	22	
	IRF7492	239	150	160	80	1000	0		8.5E+06	107	
	IRF7492	239	150	160	80	1000	0		8.5E+06	107	
	IRF7492	239	150	160	80	1000	0		8.5E+06	107	
	IRF7492	219	150	160	80	1000	0		8.5E+06	107	
	IRF7492	220	150	160	80	1000	0		8.5E+06	107	
	IRF3000	201	150	300	80	1000	0		1.0E+07	89	
	Total					640		0		1.0E+08	9
	<b>SOT-223, N-channel, Low Voltage</b>	IRLL3303	103	150	30	40	1000	0		4.3E+06	211
IRLL014N		114	150	44	40	1000	0		4.3E+06	215	
IRFL014		124	150	48	40	1000	0		4.3E+06	215	
IRLL014		152	175	48	80	1000	0		4.1E+07	22	
Total						200		0		5.4E+07	17
<b>SOT-223, N-channel, Mid Voltage</b>	IRFL4310	144	150	80	40	1000	1	Parametric shift due to ionic contamination	4.3E+06	474	
	IRFL4310	216	150	100	40	1000	1	Parametric shift due to ionic contamination	4.5E+06	445	
	IRFL4310	103	150	100	40	1000	0		4.5E+06	201	
	FB180SA10	129	150	100	8	500	0		4.5E+05	2015	
	IRFL4315	124	150	120	80	1000	0		8.5E+06	107	
	IRFL4315	217	150	120	80	1000	0		8.5E+06	107	
	IRFL214	201	150	250	40	1000	0		5.0E+06	183	
	FA57SA50LC	108	150	500	8	500	0		5.9E+05	1558	
Total					336		2		3.6E+07	85	

**Power MOSFETs (continued)**

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL	
<b>Super TO-220, N-channel</b>	IRLBA3803P	139	175	30	38	1000	0		2.0E+07	46	
	IRFBA90N20D	112	175	160	80	1000	0		4.1E+07	22	
	IRFBA90N20D	119	175	160	80	1000	0		4.1E+07	22	
	<b>Total</b>					198	0		1.0E+08	9	
<b>Super TO-247, N-channel</b>	IRFP32N60K	149	150	480	80	1000	0		8.5E+06	107	
	IRFP39N60K	136	150	480	80	1000	0		8.5E+06	107	
	<b>Total</b>				160	0	0		1.7E+07	54	
<b>TO-220, P-channel</b>	IRF9620	145	150	160	80	1000	0		8.5E+06	107	
<b>TO-220, N-channel, Low Voltage</b>	IRF3711	139	175	16	80	1000	0		4.1E+07	22	
	IRL3803	211	175	24	80	1000	0		4.1E+07	22	
	IRF1404	119	175	32	80	1000	0		4.1E+07	22	
	IRF1404	119	175	32	80	1000	0		4.1E+07	22	
	IRF1404	119	175	32	80	1000	0		4.1E+07	22	
	IRF1404	119	175	32	80	1000	0		4.1E+07	22	
	IRF1404	228	175	32	40	1000	0		2.1E+07	44	
	IRF2804	214	175	32	80	1000	0		4.1E+07	22	
	IRF2804	211	175	32	80	1000	0		4.1E+07	22	
	IRL1404	132	175	32	80	1000	0		4.1E+07	22	
	IRL1404	132	175	32	80	1000	0		4.1E+07	22	
	IRL1404	132	175	32	80	1000	0		4.1E+07	22	
	IRL1404	133	175	32	80	1000	0		4.1E+07	22	
	IRL1404	133	175	32	80	1000	0		4.1E+07	22	
	IRL1404	134	175	32	80	1000	0		4.1E+07	22	
	IRL1404	135	175	32	80	1000	0		4.1E+07	22	
	IRL1404	135	175	32	80	1000	0		4.1E+07	22	
	IRL1404	137	175	32	80	1072	0		4.4E+07	21	
	IRL1404	140	175	32	80	1000	0		4.1E+07	22	
	IRL1404	205	175	32	75	1000	0		3.9E+07	24	
	IRF1405	107	175	44	80	1000	0		4.1E+07	22	
	IRF3205	130	175	44	80	1000	0		4.1E+07	22	
	IRF3205	131	175	44	80	1000	0		4.1E+07	22	
	IRF3205	112	175	44	50	96	0		2.5E+06	370	
	IRF3205	112	175	44	50	96	0		2.5E+06	370	
	IRF3205	141	175	44	80	1000	0		4.1E+07	22	
	IRF3205	141	175	44	80	1000	0		4.1E+07	22	
	IRF3205	207	175	44	20	1000	0		1.0E+07	89	
	IRF3205	140	175	44	80	832	0		3.4E+07	27	
	IRF3205	140	175	44	80	832	0		3.4E+07	27	
	IRFZ44N	215	175	44	40	1000	0		2.1E+07	44	
	IRFZ44V	207	175	60	50	1000	0		2.7E+07	34	
	IRFZ44V	150	175	48	80	808	0		3.4E+07	27	
	IRFZ46N	210	175	44	44	1000	0		2.3E+07	40	
	IRFZ48V	150	175	48	40	808	0		1.7E+07	55	
	IRF1407	215	175	60	80	1000	0		4.1E+07	22	
	IRF2807	119	175	60	50	1000	0		2.6E+07	36	
	IRF2807	119	175	60	80	1000	0		4.1E+07	22	
	IRF2807	112	175	60	50	96	0		2.5E+06	370	
	IRF3808	142	175	60	80	1000	0		4.1E+07	22	
	IRF3808	144	175	60	80	1000	0		4.1E+07	22	
	IRF3808	144	175	60	80	1000	0		4.1E+07	22	
	IRF3808	121	175	60	80	596	0		2.5E+07	37	
	IRF3808	121	175	60	85	408	0		1.8E+07	51	
	IRF3808	124	175	60	80	1000	0		4.1E+07	22	
	IRF3808	124	175	60	80	1000	0		4.1E+07	22	
	<b>Total</b>					3394	0		1.6E+09	1	
	<b>TO-220, N-channel, Mid Voltage</b>	IRLC120V	138	175	80	80	1000	2	Parametric shift due to assembly anomaly	4.1E+07	75
		IRF3710	119	175	80	80	952	0		3.9E+07	23
		IRF3710	134	175	80	80	1000	0		4.1E+07	22
		IRF3710	134	175	80	79	1000	0		4.1E+07	22
IRF3710		150	175	80	80	1000	0		4.1E+07	22	
IRL110V		114	175	80	80	1000	0		4.1E+07	22	
IRL540V		131	175	80	80	1000	0		4.1E+07	22	
IRFB52N15D		140	175	120	80	1000	0		4.1E+07	22	
IRF630N		112	175	160	50	96	0		2.5E+06	370	
IRF640N		118	175	160	80	1000	0		4.1E+07	22	
IRFB38N20D		140	175	160	80	1000	0		4.1E+07	22	
IRF644N		102	175	250	85	1000	0		5.1E+07	18	
IRF644N		102	175	250	80	1000	0		4.8E+07	19	
IRF820		140	150	400	47	1000	0		5.0E+06	183	
IRFB5N50K		111	150	400	80	1000	0		8.5E+06	107	
<b>Total</b>						1141	2		5.3E+08	6	
<b>TO-220, N-channel, High Voltage</b>	IRFB16N60K	232	150	480	80	1000	0		8.5E+06	107	
	IRFB9N60A	209	150	480	80	1000	0		8.5E+06	107	
	<b>Total</b>				160	0	0		1.7E+07	54	
<b>TO-247, N-channel, Low Voltage</b>	IRFP4004	238	175	32	80	1000	0		4.1E+07	22	
	IRFP4004	240	175	32	80	1000	0		4.1E+07	22	
	IRFP054	151	175	48	80	1000	0		4.1E+07	22	
	IRFP064	221	175	60	80	1000	0		4.3E+07	21	
	IRFP2707	213	175	60	80	1000	0		4.1E+07	22	
	IRFP2907	206	175	60	80	1000	0		4.1E+07	22	
	IRFP2907	206	175	60	80	1000	0		4.1E+07	22	
	IRFP2907	206	175	60	80	1000	0		4.1E+07	22	
<b>Total</b>					640	0		3.3E+08	3		



**Power MOSFETs (continued)**

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL
<b>TO-247, N-channel, Mid Voltage</b>	IRFP4510	240	175	80	80	1000	0		4.1E+07	22
	IRFP4510	240	175	80	80	1000	0		4.1E+07	22
	IRFP4710	146	175	80	80	1000	0		4.1E+07	22
	IRFP250N	101	175	160	85	1000	0		4.4E+07	21
	IRFP260	126	150	160	80	1000	0		8.5E+06	107
	IRFP260	126	150	160	80	1000	0		8.5E+06	107
	IRFP260	126	150	160	80	1000	0		8.5E+06	107
	IRFP260N	112	175	160	50	96	0		2.5E+06	370
	IRFP90N20D	111	175	160	80	716	0		3.0E+07	31
	IRFP90N20D	120	175	160	80	1000	0		4.1E+07	22
	IRFP9240	204	150	160	85	1000	0		9.1E+06	101
	IRFP9240	126	150	-100	77	1000	0		3.6E+06	258
	IRFP264N	112	175	200	80	1000	0		4.1E+07	22
	IRFP450N	109	150	400	80	1000	0		8.5E+06	107
	IRFP460	134	150	400	80	1000	0		8.5E+06	107
	IRFP460	134	150	400	80	1000	0		8.5E+06	107
	IRFP460	135	150	400	80	1000	0		8.5E+06	107
	IRFP460A	206	150	400	80	1000	0		8.5E+06	107
	IRFP460A	101	150	400	80	1000	0		8.5E+06	107
	IRFP460N	106	150	400	80	1000	0		8.5E+06	107
Total					1577		0		3.8E+08	2
<b>TO-247, N-channel, High Voltage</b>	IRFP21N60K	151	150	480	80	1000	0		8.5E+06	107
	IRFP27N60K	144	150	480	80	1000	0		8.5E+06	107
	IRFPG50	204	150	720	80	1000	0		6.6E+06	139
Total					240		0		2.4E+07	39
<b>TSOP-6, P-channel</b>	IRLMS6802	114	150	16	40	1000	2	Parametric shift due to excessive drain-source leakage	4.3E+06	728
	IRLMS6702	112	150	20	40	1000	0		4.3E+06	212
	IRLMS6802	114	150	16	40	1000	0		4.3E+06	215
	IRLMS6802	114	150	16	40	1000	0		4.3E+06	215
Total					160		2		1.7E+07	181

**IGBT's**

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL
<b>D2Pak (TO-263) &amp; TO-262</b>	IRGS4B60KD1	217	150	480	80	1000	0		8.5E+06	107
	IRGS4B60KD1	217	150	480	80	1000	0		8.5E+06	107
Total					160		0		1.7E+07	0
<b>D-Pak</b>	IRG4RC20F	147	150	480	80	1000	0		8.5E+06	107
	IRG4RC10UD	147	150	480	80	1000	0		8.5E+06	107
Total					160		0		1.7E+07	0
<b>TO-220 Fullpack</b>	IRGIB10B60K	227	175	480	77	1000	0		4.0E+07	23
	IRGIB10B60K	227	175	480	77	1000	0		4.0E+07	23
	IRGIB10B60K	227	175	480	77	1000	0		4.0E+07	23
	IRGIB15B60K	205	150	480	80	1000	0		8.5E+06	107
	IRGIB10B60KD	227	175	480	77	1000	0		4.0E+07	23
Total					388		0		1.7E+08	0
<b>SOT-227</b>	GA100NA60U	110	150	600	8	500	0		6.3E+05	1461
	GA200SA60U	112	150	600	8	500	0		6.3E+05	1461
Total					16		0		1.3E+06	0
<b>TO-220</b>	IRG4BC10SD	218	150	480	40	1000	0		4.3E+06	215
	IRGB15B60KD	203	150	480	80	1000	0		8.5E+06	107
	IRGB15B60KD	126	150	480	80	1000	0		8.5E+06	107
	IRGB15B60KD	126	150	480	80	1000	0		8.5E+06	107
	IRGB15B60KD	203	150	480	80	1000	0		8.5E+06	107
Total					360		0		3.8E+07	0
<b>TO-247</b>	IRG4PH50U	126	150	800	77	1000	0		4.9E+06	187
	IRG4PC50S-P	NA	150	480	77	1016	0		8.3E+06	110
	IRGP50B60PD1	234	150	480	80	1000	0		8.5E+06	107
	IRGP50B60PD1	234	150	480	80	1000	0		8.5E+06	107
	IRGP50B60PD1	234	150	480	80	1000	0		8.5E+06	107
Total					394		0		3.88E+07	0

## 4.1.2 High Temperature Gate Bias

### Power MOSFETs

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL	
<b>D2Pak (TO-263) &amp; TO-262: Standard Gate</b>	IRFZ444NS	143	175	20	80	1000	0		4.32E+07	21.2	
	IRFZ44NL	150	175	16	46	1000	0		5.29E+06	173.1	
	IRF1312S	202	175	20	80	1000	0		5.69E+08	1.6	
	IRFBC40L	133	150	16	77	1000	0		2.69E+06	340.7	
	<b>Total</b>					<b>283</b>	<b>0</b>		<b>6.20E+08</b>	<b>1.5</b>	
<b>D2Pak (TO-263) &amp; TO-262: Low QG</b>	IRFSL38N20D	141	175	30	80	168	0		2.76E+06	331.8	
	IRFSL38N20D	141	175	30	80	168	0		2.76E+06	331.8	
	<b>Total</b>					<b>160</b>	<b>0</b>		<b>5.52E+06</b>	<b>165.9</b>	
<b>Direct FET Logic Level</b>	IRF6607	NA	150	9.6	55	506	1	Parametric shift due to silicon anomaly	1.74E+06	1164.9	
	IRF6604	NA	150	9.6	55	506	0		1.74E+06	527.8	
	IRF6607	NA	150	9.6	55	506	0		1.74E+06	527.8	
	IRF6607	NA	150	9.6	55	506	0		1.74E+06	527.8	
	<b>Total</b>					<b>220</b>	<b>1</b>		<b>6.94E+06</b>	<b>291.2</b>	
<b>Direct FET Standard Gate</b>	IRF6601	NA	150	16	55	1000	1	Parametric shift due to silicon anomaly	3.43E+06	589.4	
	IRF6601	NA	150	20	55	1014	0		1.63E+07	56.1	
	IRF6601	NA	150	20	55	1013	0		1.63E+07	56.1	
	IRF6601	NA	150	16	55	507	0		1.74E+06	526.8	
	IRF6601	NA	150	16	55	1000	0		3.43E+06	267.1	
	IRF6601	NA	150	16	55	1000	0		3.43E+06	267.1	
	IRF6601	NA	150	16	30	1564	0		2.93E+06	313.1	
	IRF6601	NA	150	16	40	583	0		1.45E+06	629.9	
	IRF6602	NA	150	20	55	1013	0		1.63E+07	56.1	
	IRF6602	NA	150	20	55	1013	0		1.63E+07	56.1	
	IRF6602	NA	150	16	55	1000	0		3.43E+06	267.1	
	IRF6602	NA	150	16	40	1564	0		3.90E+06	234.8	
<b>Total</b>					<b>605</b>	<b>1</b>		<b>8.90E+07</b>	<b>22.7</b>		
<b>D-Pak &amp; I-Pak (TO-252): Logic Level</b>	IRLR7811W	145	175	9.6	80	1000	0		9.20E+06	99.5	
	IRLR7811W	216	150	9.6	80	1000	0		4.99E+06	183.6	
	IRLR8503	123	150	20	40	1000	0		2.03E+09	0.5	
	IRLR8503	232	175	16	80	1000	0		5.69E+08	1.6	
	<b>Total</b>					<b>280</b>	<b>0</b>		<b>2.61E+09</b>	<b>0.4</b>	
<b>D-Pak &amp; I-Pak (TO-252): Standard Gate</b>	IRF3711	139	175	16	79	1000	0		4.27E+07	21.5	
	IRLR7833	233	175	16	80	1000	0		4.32E+07	21.2	
	IRLU7821	224	175	20	80	1000	0		5.69E+08	1.6	
	IRFR120	232	175	20	80	1000	0		1.64E+07	55.7	
	IRFR3412	146	175	16	80	1000	0		4.32E+07	21.2	
	IRFUC20	214	150	20	40	1000	0		4.46E+06	205.6	
	IRFU24N15D	202	175	30	80	1000	0		1.64E+07	55.7	
	IRFU15N20D	119	175	30	80	1000	0		1.64E+07	55.7	
	IRFU12N25D	119	175	30	80	1000	0		1.64E+07	55.7	
	IRFU420A	141	150	30	80	1000	0		8.91E+06	102.8	
	IRFU430A	144	150	30	80	1000	0		8.91E+06	102.8	
	<b>Total</b>					<b>839</b>	<b>0</b>		<b>7.86E+08</b>	<b>1.2</b>	
	<b>D-Pak &amp; I-Pak (TO-252): P-channel, Standard Gate</b>	IRFR5505	232	175	20	80	1000	0		4.32E+07	21.2
		IRFR9024N	232	175	20	80	1000	0		4.32E+07	21.2
IRFU9210		211	175	20	80	1000	0		1.64E+07	55.7	
IRFU9220		227	175	20	80	1000	0		1.64E+07	55.7	
IRFU9220		232	175	20	80	1000	0		1.64E+07	55.7	
<b>Total</b>					<b>400</b>	<b>0</b>		<b>1.36E+08</b>	<b>6.7</b>		
<b>Flip Chip Devices: Logic Level</b>	IRF6156	NA	150	9.6	60	500	0		1.02E+07	89.9	
	IRF6156	NA	150	9.6	60	500	0		1.02E+07	89.9	
	IRF6156	NA	150	9.6	60	500	0		1.02E+07	89.9	
	<b>Total</b>					<b>180</b>	<b>0</b>		<b>3.06E+07</b>	<b>30.0</b>	
<b>Flip Chip Devices: P-channel, Logic Level</b>	IRF6100	0046	150	9.6	90	500	0		1.53E+07	59.9	
	IRF6100	0046	150	9.6	85	1000	0		2.89E+07	31.7	
	IRF6100	0046	150	9.6	85	1000	0		2.89E+07	31.7	
	<b>Total</b>					<b>260</b>	<b>0</b>		<b>7.31E+07</b>	<b>12.5</b>	
<b>TO-220 Fullpack: Standard Gate</b>	IRLI520N	203	150	16	39	1000	0		4.15E+07	22.1	
	IRLI520N	215	175	16	40	1000	0		7.84E+07	11.7	
	IRLI3615	144	175	16	80	1000	0		1.57E+08	5.8	
	<b>Total</b>					<b>159</b>	<b>0</b>		<b>2.77E+08</b>	<b>3.3</b>	
<b>TO-220 Fullpack: Low QG</b>	IRFIB5N50L	219	150	30	80	1000	0		8.91E+06	102.8	

**Power MOSFETs (continued)**

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL
<b>Micro-3: Logic Level</b>	IRLML2402	110	150	12	40	1000	0		1.54E+08	5.9
	IRLML2502	227	150	12	40	1000	0		1.54E+08	5.9
	IRLML2502	231	150	12	40	1000	0		1.54E+08	5.9
	IRLML6302	114	150	12	40	644	0		9.94E+07	9.2
	Total					160	0		5.62E+08	1.6
<b>SO-8: Logic Level</b>	IRF7811A	109	150	9.6	80	1000	0		4.99E+06	183.6
	IRF7811W	205	150	9.6	75	1000	0		2.20E+07	41.7
	IRF7822	227	150	9.6	80	1000	0		2.34E+07	39.1
	IRF7822	228	150	9.6	80	1000	0		2.34E+07	39.1
	IRF7822	232	150	9.6	80	1000	0		2.34E+07	39.1
Total					395	0		9.73E+07	9.4	
<b>SO-8: Standard Gate</b>	IRF7403	103	150	20	40	1000	0		1.54E+08	5.9
	IRF7413	147	150	16	40	1000	0		1.40E+07	65.3
	IRL7821	231	150	16	80	1000	0		2.34E+07	39.1
	IRF7484	143	150	8	80	1000	0		5.72E+04	16009.9
	IRF7484	146	150	8	80	1000	0		5.72E+04	16009.9
	IRF7491	220	150	20	80	1000	0		8.91E+06	102.8
	IRF7380	211	150	20	40	1000	0		3.08E+07	29.7
	IRF7492	219	150	20	80	1000	0		8.91E+06	102.8
	IRF7492	220	150	20	80	1000	0		8.91E+06	102.8
	IRF7492	227	150	16	80	1000	0		2.79E+06	327.9
	IRF7492	230	150	16	80	1000	0		2.79E+06	327.9
	IRF7492	233	150	16	80	1000	0		2.79E+06	327.9
	IRF3000	201	150	30	80	1000	0		8.91E+06	102.8
	IRF7341Q	145	175	20	80	1000	0		5.75E+03	159337.7
	Total					1000	0		2.67E+08	3.4
<b>SO-8: P-channel, Logic Level</b>	IRF7404	113	150	12	40	1000	0		1.54E+08	5.9
	IRF7314	145	150	12	20	1000	0		7.01E+06	130.7
	Total				60	0		1.61E+08	5.7	
<b>SO-8: P-channel, Standard Gate</b>	IRF7205	144	150	20	40	1000	0		1.54E+08	5.9
	IRF6216	144	150	20	80	1000	0		2.34E+07	39.1
	IRF6217	144	150	20	80	1000	0		2.34E+07	39.1
	Total				200	0		2.01E+08	4.6	
<b>SOT-223: Logic Level</b>	IRLL014	152	175	20	80	1000	0		1.43E+10	0.1
<b>SOT-223: Standard Gate</b>	IRLL3303	103	150	16	40	1000	0		4.25E+07	21.6
	IRLL014N	114	150	16	40	1000	0		4.25E+07	21.6
	IRFL014	152	175	20	80	1000	0		1.64E+07	55.7
	IRFL014	124	150	20	40	1000	0		4.46E+06	205.6
	IRFL4310	103	150	20	40	1000	0		1.54E+08	5.9
	IRFL4310	216	150	20	40	1000	0		1.54E+08	5.9
	IRFL214	201	150	20	40	1000	0		8.10E+07	11.3
Total				320	0		4.96E+08	1.8		
<b>SOT-223: Low QG</b>	IRFL4315	124	150	24	80	1000	0		2.79E+06	327.9
	IRFL4315	217	150	24	80	1000	0		2.79E+06	327.9
	Total				160	0		5.59E+06	164.0	
<b>SOT-227: Standard Gate</b>	FB180SA10	129	150	20	8	500	0		4.46E+05	2056.1
	FA57SA50LC	108	150	20	8	500	0		1.70E+05	5405.7
	Total				16	0		6.15E+05	1489.5	
<b>Super-220: Low QG</b>	IRFBA90N20D	112	175	30	80	1000	0		1.64E+07	55.7
	IRFBA90N20D	119	175	30	80	1000	0		1.64E+07	55.7
	Total				160	0		3.29E+07	27.9	
<b>Super TO-247: Low QG</b>	IRFPS35N50L	116	150	30	80	1000	0		8.91E+06	102.8
<b>TO-220: Logic Level</b>	IRLZ44	101	150	10	80	1000	0		8.91E+06	102.8
	IRLZ44	101	150	10	80	1000	0		8.91E+06	102.8
	Total				160	0		1.78E+07	51.4	

**Power MOSFETs (continued)**

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL
<b>TO-220: Standard Gate</b>	IRL2910	150	150	16	47	1000	0		5.00E+07	18.3
	IRF2804L	214	175	20	80	1000	0		1.14E+08	8.1
	IRF3205	130	175	20	80	1000	0		1.14E+08	8.1
	IRF3205	131	175	20	78	1000	0		1.11E+08	8.3
	IRF3205	141	175	20	80	1000	0		1.14E+08	8.1
	IRF3205	141	175	20	80	1000	0		1.14E+08	8.1
	IRFZ44N	216	175	20	40	1000	0		2.16E+07	42.4
	IRFZ46N	209	175	20	49	1000	0		2.65E+07	34.6
	IRF3808	144	175	20	80	1000	0		1.14E+08	8.1
	IRF3808	121	175	20	80	592	0		2.56E+07	35.8
	IRF3808	121	175	20	80	408	0		1.76E+07	52.0
	IRF3808	124	175	20	80	1000	0		4.32E+07	21.2
	IRL110V	131	175	16	80	1000	1	Parametric shift due to assembly anomaly	4.32E+07	46.8
	IRL110V	114	175	16	80	1000	0		4.32E+07	21.2
	IRLC120V	138	175	16	80	1000	0		4.32E+07	21.2
	IRF640N	118	175	20	80	1000	0		1.64E+07	55.7
	IRF644N	102	175	20	80	1000	0		1.64E+07	55.7
	IRF740	109	175	20	80	1000	0		1.64E+07	55.7
	IRF740	109	175	20	80	1000	0		1.64E+07	55.7
	<b>Total</b>					1414		1		1.06E+09
<b>TO-220: Low QG</b>	IRFB38N20D	140	175	30	80	1000	0		1.64E+07	55.7
	IRFB5N50K	111	150	30	80	1000	0		8.91E+06	102.8
	IRFB16N60K	232	150	30	80	1000	0		8.91E+06	102.8
	<b>Total</b>				240		0		3.43E+07	26.7
<b>TO-220: P-channel, Standard Gate</b>	IRF9Z34	101	150	20	80	1000	0		8.91E+06	102.8
	IRF9Z34	101	150	20	80	1000	0		8.91E+06	102.8
	IRF9620	145	150	20	80	1000	0		8.91E+06	102.8
	<b>Total</b>				240		0		2.67E+07	34.3
<b>TO-247: Standard Gate</b>	IRFP4004	238	175	20	80	1000	0		4.32E+07	21.2
	IRFP4004	238	175	20	80	1000	0		4.32E+07	21.2
	IRFP4004	240	175	20	80	1000	0		4.32E+07	21.2
	IRFP4004	240	175	20	80	1000	0		4.32E+07	21.2
	IRFP054	151	175	20	80	1000	0		1.64E+07	55.7
	IRFP2707	213	175	20	80	1000	0		1.14E+08	8.1
	IRFP4510	240	175	20	80	1000	0		4.32E+07	21.2
	IRFP4510	240	175	20	80	1000	0		4.32E+07	21.2
	IRFP4510	244	175	20	80	1000	0		4.32E+07	21.2
	IRFP260	126	150	20	80	1000	0		8.91E+06	102.8
	IRFP260	126	150	20	80	1000	0		8.91E+06	102.8
	IRFP260	126	150	20	80	1000	0		8.91E+06	102.8
	IRFP264N	112	175	20	80	1000	0		1.64E+07	55.7
	IRFP460	112	150	20	80	1000	0		8.91E+06	102.8
	IRFP460	112	150	20	80	1000	0		8.91E+06	102.8
	IRFPG50	204	150	20	80	1000	0		8.91E+06	102.8
	IRFPG50	126	150	20	77	1000	0		8.58E+06	106.8
<b>Total</b>					1357		0		5.11E+08	1.8
<b>TO-247: Low QG</b>	IRFP90N20D	120	175	30	80	1000	0		1.64E+07	55.7
	IRFP90N20D	120	175	30	80	1000	0		1.64E+07	55.7
	IRFP17N50L	102	150	30	80	1000	0		8.91E+06	102.8
	IRFP23N50L	117	150	30	80	1000	0		8.91E+06	102.8
	IRFP450N	109	150	30	80	1000	0		8.91E+06	102.8
	IRFP460A	101	150	30	80	1000	0		8.91E+06	102.8
	IRFP460LC	112	150	30	80	1000	0		8.91E+06	102.8
IRFP460N	106	150	30	80	1000	0		8.91E+06	102.8	
<b>Total</b>					640		0		8.64E+07	10.6
<b>TSOP-6: Logic Level</b>	IRLMS6702	112	150	12	40	1000	0		1.54E+08	5.9
	IRLMS6802	114	150	12	40	1000	0		1.54E+08	5.9
	IRLMS6802	114	150	12	40	1000	0		1.54E+08	5.9
	IRLMS6802	117	150	12	40	1000	0		1.54E+08	5.9
	IRLMS6802	114	150	12	40	1000	0		1.54E+08	5.9
<b>Total</b>					200		0		7.71E+08	1.2

**IGBTs**

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL
<b>D2Pak (TO-263) &amp; TO-262</b>	IRGS4B60KD1	217	150	20	80	1000	0		8.91E+06	102.8
	IRGS4B60KD1	217	150	20	80	1000	0		8.91E+06	102.8
	IRGS4B60KD1	217	150	20	80	1000	0		8.91E+06	102.8
	Total				240		0		2.67E+07	34.3
<b>TO-220 Fullpack</b>	IRG4IBC30S	151	150	20	61	1000	0		6.80E+06	134.8
	IRGIB10B60KD	227	175	20	77	1000	0		1.58E+07	57.9
	IRGIB15B60KD	227	175	20	77	1000	0		1.58E+07	57.9
	IRGIB6B60KD	227	175	20	77	1000	0		1.58E+07	57.9
	Total				292		0		5.43E+07	16.9
<b>Solderable TO-247</b>	IRG4PC60FP	138	150	20	80	1000	0		8.91E+06	102.8
	IRG4PC60UP	139	150	20	80	1000	0		8.91E+06	102.8
	IRG4PC60UP	139	150	20	80	1000	0		8.91E+06	102.8
	Total				240		0		2.67E+07	34.3
<b>SOT-227</b>	GA100NA60U	110	150	20	8	500	0		1.70E+05	5405.7
	GA200SA60U	112	150	20	8	500	0		1.70E+05	5405.7
	Total				16		0		3.39E+05	2702.9
<b>Super TO-247</b>	IRGPS40B120U	106	150	20	80	1000	0		8.91E+06	102.8
	IRGPS60B120KD	105	150	20	80	1000	0		8.91E+06	102.8
	IRGPS60B120KD	105	150	20	78	1000	0		8.69E+06	105.4
	IRGPS60B120KD	105	150	20	80	1000	0		8.91E+06	102.8
	Total				318		0		3.54E+07	25.9
<b>TO-220</b>	IRG4BC20U	107	150	20	50	1000	1	Parametric shift due to mechanical damage	5.57E+06	363.0
	IRG4BC20U	107	150	20	50	1000	0		5.57E+06	164.5
	IRG4BC30U	124	150	20	50	1000	0		5.57E+06	164.5
	IRG4PC50U	122	150	20	50	1000	0		5.57E+06	164.5
	IRG4PC50U	122	150	20	50	1000	0		5.57E+06	164.5
	IRG4BC10UD	127	150	20	40	1000	0		4.46E+06	205.6
	IRG4BC10UD	218	150	20	40	1000	0		4.46E+06	205.6
	IRG4BC20UD	139	150	20	37	1000	0		4.12E+06	222.3
	IRG4BC30FD	141	150	20	80	1000	0		8.91E+06	102.8
	IRGB15B60KD	126	150	20	80	1000	0		8.91E+06	102.8
	IRGB15B60KD	126	150	20	80	1000	0		8.91E+06	102.8
	IRGB15B60KD	126	150	20	80	1000	0		8.91E+06	102.8
	IRGB5B120KD	140	150	20	80	1000	0		8.91E+06	102.8
	IRGB5B120KD	140	150	20	80	1000	0		8.91E+06	102.8
	Total				847		1		9.44E+07	21.4
	<b>TO-247</b>	IRG4PC60F	139	150	20	80	1000	1	Catastrophic gate electrical overstress	8.91E+06
IRG4PC50U		122	150	20	50	1000	0		5.57E+06	164.5
IRG4PC60F		139	150	20	80	500	0		4.46E+06	205.6
IRG4PC60U		139	150	20	80	1000	0		8.91E+06	102.8
IRG4PC60U		139	150	20	80	1000	0		8.91E+06	102.8
IRG4PC50S-P		NA	150	16	77	1002	0		2.69E+06	340.0
IRGP30B60KD		128	150	20	80	1000	0		8.91E+06	102.8
IRGP50B60KDE		128	150	20	80	1000	0		8.91E+06	102.8
IRGP50B60KDE		132	150	20	80	1000	0		8.91E+06	102.8
IRGP50B60PD1		234	150	20	80	1000	0		8.91E+06	102.8
IRGP50B60PD1		234	150	20	80	1000	0		8.91E+06	102.8
IRGP50B60PD1		234	150	20	80	1000	0		8.91E+06	102.8
IRGP20B120UDE		135	150	20	80	1000	0		8.91E+06	102.8
IRGP30B120KDE		135	150	20	80	1000	0		8.91E+06	102.8
Total					1087		1		1.11E+08	18.3

### 4.1.3 Temperature Cycling

#### Power MOSFETs

Category	Part Number	Date Code	Temperature Excursion	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 250	# of failures @ 500	# of failures @ 1000	
<b>D2Pak (TO-263) &amp; TO-262</b>	IRF1312S	202	-55°C/150°C	0	80	1000	0		0	0	0	
	IRF1404L	227	-55°C/150°C	0	40	1000	0		0	0	0	
	IRF1404L	227	-55°C/150°C	0	40	1000	0		0	0	0	
	IRF1404L	227	-55°C/150°C	0	40	1000	0		0	0	0	
	IRF1404L	227	-55°C/150°C	0	40	1000	0		0	0	0	
	IRF1404S	223	-55°C/150°C	0	20	1000	0		0	0	0	
	IRF1404S	223	-55°C/150°C	0	20	1000	0		0	0	0	
	IRF1404S	223	-55°C/150°C	0	20	1000	0		0	0	0	
	IRF1404S	223	-55°C/150°C	0	20	1000	0		0	0	0	
	IRF1404S	133	-55°C/150°C	0	77	1000	0		0	0	0	
	IRF2804L	214	-55°C/150°C	0	80	1000	0		0	0	0	
	IRF2804L	219	-55°C/150°C	0	80	1000	0		0	0	0	
	IRF640NS	216	-55°C/150°C	0	39	1000	0		0	0	0	
	IRF8010SJS	226	-55°C/150°C	0	80	1000	0		0	0	0	
	IRF9224NS	143	-55°C/150°C	0	77	1000	0		0	0	0	
	IRFZ44NL	150	-55°C/150°C	0	40	1000	0		0	0	0	
	IRFZ44NS	203	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFZ44VS	143	-55°C/150°C	0	80	1000	0		0	0	0	
	IRL3803S	133	-55°C/150°C	0	77	1000	0		0	0	0	
	IRL3803S	133	-55°C/150°C	0	77	1000	0		0	0	0	
	Total					1107		0		0	0	0
	<b>Direct FET</b>	IRF6601	NA	-40/125	0	30	1000	0		0	0	0
		IRF6601	NA	-40/125	0	55	556	0		0	0	0
IRF6601		NA	-40/125	0	55	556	0		0	0	0	
IRF6601		NA	-40/125	0	55	556	0		0	0	0	
IRF6601		NA	-40/125	0	55	629	0		0	0	0	
IRF6601		NA	-40/125	0	55	1000	0		0	0	0	
IRF6601		NA	-40/125	0	55	1000	0		0	0	0	
IRF6601		NA	-40/125	0	55	1000	0		0	0	0	
IRF6601		NA	-40/125	0	40	1087	0		0	0	0	
IRF6602		NA	-40/125	0	40	1000	0		0	0	0	
IRF6602		NA	-40/125	0	55	500	0		0	0	0	
IRF6602		NA	-40/125	0	55	500	0		0	0	0	
IRF6602		NA	-40/125	0	55	500	0		0	0	0	
IRF6602		NA	-40/125	0	55	1000	0		0	0	0	
IRF6604		NA	-40/125	0	55	502	0		0	0	0	
IRF6607		NA	-40/125	0	55	546	0		0	0	0	
IRF6607		NA	-40/125	0	55	518	0		0	0	0	
IRF6607	NA	-40/125	0	55	518	0		0	0	0		
Total					935		0		0	0	0	
<b>D-Pak &amp; I-Pak (TO-252)</b>	IRF3711	139	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFR120	232	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFR12N25D	119	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFR15N20D	118	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFR2405	218	-55°C/150°C	0	5	750	0		0	0	0	
	IRFR2405	218	-55°C/150°C	0	5	750	0		0	0	0	
	IRFR2407	147	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFR2407	147	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFR24N15D	202	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFR3410	221	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFR3412	146	-55°C/150°C	0	80	1000	1	Parametric shift due to ionic contamination	1	0	0	
	IRFR3412	146	-55°C/150°C	0	100	1000	0		0	0	0	
	IRFR3711	232	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFR5505	232	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFR9024N	232	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFR9120N	151	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFU3418	217	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFU420A	141	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFU430A	144	-55°C/150°C	0	80	1000	0		0	0	0	
	IRFUC20	211	-55°C/150°C	0	40	1000	0		0	0	0	
	IRLR024N	147	-55°C/150°C	0	80	1000	0		0	0	0	
	IRLR120N	143	-55°C/150°C	0	200	1000	0		0	0	0	
	IRLR3103	147	-55°C/150°C	0	80	1000	0		0	0	0	
IRLR3103	147	-55°C/150°C	0	80	1000	0		0	0	0		
IRLR7821	215	-55°C/150°C	0	40	1000	0		0	0	0		
IRLR8503	123	-55°C/150°C	0	40	1000	1	Parametric shift due to die attach degradation	0	0	1		
IRLU110	150	-55°C/150°C	0	67	1000	0		0	0	0		
IRLU7833	233	-55°C/150°C	0	80	3000	0		0	0	0		
IRLU7833	234	-55°C/150°C	0	80	3000	0		0	0	0		
IRLU7833	237	-55°C/150°C	0	80	3000	0		0	0	0		
Total					2257		2	1	0	1		
<b>Flip Chip Devices</b>	IRF6100	0046	-55°C/150°C	0	95	500	0		0	0	0	
	IRF6100	0046	-55°C/150°C	0	80	500	0		0	0	0	
	IRF6100	0046	-55°C/150°C	0	85	500	0		0	0	0	
	IRF6100	NA	-55°C/150°C	0	60	500	0		0	0	0	
	IRF6100	NA	-55°C/150°C	0	60	500	0		0	0	0	
	IRF6156	NA	-40°C/125°C	0	60	500	0		0	0	0	
	IRF6156	NA	-40°C/125°C	0	60	500	0		0	0	0	
	IRF6156	NA	-40°C/125°C	0	60	500	0		0	0	0	
Total					630		0	0	0	0		

**Power MOSFETs (continued)**

Category	Part Number	Date Code	Temperature Excursion	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 250	# of failures @ 500	# of failures @ 1000
<b>TO-220 Fullpack</b>	IRF13205	205	-55°C/150°C	0	80	1000	0		0	0	0
	IRF1510V	102	-55°C/150°C	0	80	1000	0		0	0	0
	IRF1520V	102	-55°C/150°C	0	80	1000	0		0	0	0
	IRF19630G	205	-55°C/150°C	0	80	1000	0		0	0	0
	IRF19630G	205	-55°C/150°C	0	80	1000	0		0	0	0
	IRF19630G	205	-55°C/150°C	0	80	1000	0		0	0	0
	IRF19630G	205	-55°C/150°C	0	80	1000	0		0	0	0
	IRF19630G	205	-55°C/150°C	0	80	1000	0		0	0	0
	IRF19630G	205	-55°C/150°C	0	80	1000	0		0	0	0
	IRF19630G	205	-55°C/150°C	0	80	1000	0		0	0	0
	IRF19630G	205	-55°C/150°C	0	80	1000	0		0	0	0
	IRF19630G	205	-55°C/150°C	0	80	1000	0		0	0	0
	IRF19630G	205	-55°C/150°C	0	80	1000	0		0	0	0
	IRF19630G	205	-55°C/150°C	0	80	1000	0		0	0	0
Total					880		0		0	0	0
<b>Micro-3</b>	IRLML2402	110	-55°C/150°C	0	40	1000	0		0	0	0
	IRLML2502	227	-55°C/150°C	0	40	1000	0		0	0	0
	IRLML2502	231	-55°C/150°C	0	40	1000	0		0	0	0
	IRLML2803	211	-55°C/150°C	0	40	1000	0		0	0	0
	IRLML6302	114	-55°C/150°C	0	40	1000	0		0	0	0
	IRLML6302	114	-55°C/150°C	0	40	1000	0		0	0	0
Total					240		0		0	0	0
<b>Micro-8</b>	IRF7601	120	-55°C/150°C	0	100	1000	1	Parametric shift due to die attach degradation	0	0	1
<b>SO-8</b>	IRF3000	201	-55°C/150°C	0	80	1000	0		0	0	0
	IRF6216	144	-55°C/150°C	0	80	1000	0		0	0	0
	IRF6217	144	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7233	206	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7233	206	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7404	113	-55°C/150°C	0	40	1000	0		0	0	0
	IRF7404	119	-55°C/150°C	0	40	1000	0		0	0	0
	IRF7413	150	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7413	206	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7455	108	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7484	143	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7484	146	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7490	222	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7491	220	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7492	239	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7492	239	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7492	219	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7492	220	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7807	120	-55°C/150°C	0	100	1000	0		0	0	0
IRF7811A	109	-55°C/150°C	0	80	1000	0		0	0	0	
IRF7811W	205	-55°C/150°C	0	80	1000	0		0	0	0	
IRL7821	231	-55°C/150°C	0	80	1000	0		0	0	0	
Total					1780		0		0	0	0
<b>SO-8 Dual</b>	IRF7101	150	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7101	205	-55°C/150°C	0	40	1000	0		0	0	0
	IRF7311	150	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7311	205	-55°C/150°C	0	80	1000	0		0	0	0
	IRF7314	145	-55°C/150°C	0	20	1000	0		0	0	0
	IRF7380	211	-55°C/150°C	0	40	1000	0		0	0	0
Total					340		0		0	0	0
<b>SOT-223</b>	IRFL014	124	-55°C/150°C	0	40	1000	0		0	0	0
	IRFL214	201	-55°C/150°C	0	40	1000	0		0	0	0
	IRFL4310	103	-55°C/150°C	0	40	1000	0		0	0	0
	IRFL4310	144	-55°C/150°C	0	40	1000	0		0	0	0
	IRFL4310	216	-55°C/150°C	0	40	1000	0		0	0	0
	IRFL4315	124	-55°C/150°C	0	80	1000	0		0	0	0
	IRFL4315	217	-55°C/150°C	0	80	1000	0		0	0	0
	IRFL4315	217	-55°C/150°C	0	80	1000	0		0	0	0
	IRLL014	152	-55°C/150°C	0	80	1000	0		0	0	0
	IRLL014N	114	-55°C/150°C	0	40	1000	0		0	0	0
IRLL3303	103	-55°C/150°C	0	40	1000	0		0	0	0	
Total					600		0		0	0	
<b>SOT227</b>	FA57SA50LC	108	-40°C/125°C	0	8	100	0		0	0	0
	FB180SA10	129	-40°C/125°C	0	8	100	0		0	0	0
	Total					16			0	0	0
<b>Super TO-220</b>	IRFBA90N20D	119	-55°C/150°C	0	80	1000	0		0	0	0
	IRLBA3803P	103	-55°C/150°C	0	50	1000	0		0	0	0
	IRLBA3803P	139	-55°C/150°C	0	40	1000	0		0	0	0
	IRLBA3803P	218	-55°C/150°C	0	40	1000	0		0	0	0
Total					210		0		0	0	
<b>Super TO-247</b>	IRFPS32N60K	149	-55°C/150°C	0	80	1000	0		0	0	0
	IRFPS36N50L	116	-55°C/150°C	0	80	1000	0		0	0	0
	IRFPS39N60K	136	-55°C/150°C	0	80	1000	0		0	0	0
	Total					240			0	0	0

**Power MOSFETs (continued)**

Category	Part Number	Date Code	Temperature Excursion	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 250	# of failures @ 500	# of failures @ 1000
<b>TO-220</b>	IRF1010N	119	-55°C/150°C	0	80	1000	0		0	0	0
	IRF1404	119	-55°C/150°C	0	47	1000	0		0	0	0
	IRF1404	117	-55°C/150°C	0	100	1000	0		0	0	0
	IRF1404	225	-55°C/150°C	0	80	1000	0		0	0	0
	IRF1404	225	-55°C/150°C	0	80	1000	0		0	0	0
	IRF1404L	223	-55°C/150°C	0	20	1000	0		0	0	0
	IRF1404L	223	-55°C/150°C	0	20	1000	0		0	0	0
	IRF1405	107	-55°C/150°C	0	80	1000	0		0	0	0
	IRF1407	215	-55°C/150°C	0	80	1000	0		0	0	0
	IRF2804	211	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3205	106	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3205	106	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3205	130	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3205	150	-55°C/150°C	0	49	1000	0		0	0	0
	IRF3205	131	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3205	141	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3205	141	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3205	140	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3710	119	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3710S	134	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3711	120	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3711	139	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3808	121	-55°C/150°C	0	85	1000	0		0	0	0
	IRF3808	124	-55°C/150°C	0	80	1000	0		0	0	0
	IRF3808	124	-55°C/150°C	0	80	1000	0		0	0	0
	IRF520V	102	-55°C/150°C	0	80	1000	0		0	0	0
	IRF540N	144	-55°C/150°C	0	80	1000	0		0	0	0
	IRF640N	118	-55°C/150°C	0	80	1000	0		0	0	0
	IRF9620	145	-55°C/150°C	0	80	1000	0		0	0	0
	IRFB16N60K	232	-55°C/150°C	0	80	1000	0		0	0	0
	IRFB52N15D	140	-55°C/150°C	0	80	1000	0		0	0	0
	IRFB95N50K	111	-55°C/150°C	0	80	1000	0		0	0	0
	IRFB96N60A	209	-55°C/150°C	0	80	1000	0		0	0	0
	IRFBG30	110	-55°C/150°C	0	85	1000	0		0	0	0
	IRFBG30	110	-55°C/150°C	0	85	1000	0		0	0	0
	IRFBG30	110	-55°C/150°C	0	85	1000	0		0	0	0
	IRFZ24N	106	-55°C/150°C	0	80	1000	0		0	0	0
	IRFZ24N	210	-55°C/150°C	0	43	1000	0		0	0	0
	IRFZ44N	212	-55°C/150°C	0	40	1000	0		0	0	0
	IRFZ44V	207	-55°C/150°C	0	60	1000	0		0	0	0
	IRFZ44V	150	-55°C/150°C	0	80	1000	0		0	0	0
	IRL1404	132	-55°C/150°C	0	80	1000	0		0	0	0
	IRL1404	132	-55°C/150°C	0	80	1000	0		0	0	0
	IRL1404	109	-55°C/150°C	0	80	1000	0		0	0	0
	IRL2203N	119	-55°C/150°C	0	80	1000	0		0	0	0
	IRL3714	111	-55°C/150°C	0	80	1000	0		0	0	0
IRL3715	126	-55°C/150°C	0	80	1000	0		0	0	0	
IRL3715	109	-55°C/150°C	0	80	1000	0		0	0	0	
IRL3803	211	-55°C/150°C	0	80	1000	0		0	0	0	
Total					3679		0		0	0	0
<b>TO-247</b>	IRFP054	151	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP064	221	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP064	104	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP064N	206	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP064N	101	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP13N60L	146	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP17N50L	102	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP21N60K	151	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP23N50L	117	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP250N	225	-55°C/150°C	0	40	1000	0		0	0	0
	IRFP260	126	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP260	126	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP260	126	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP264N	112	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP27N60K	144	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP2907	206	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP2907	206	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP2907	206	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP2907	225	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP2907	225	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP4004	238	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP4004	240	-55°C/150°C	0	100	1000	0		0	0	0
	IRFP4004	240	-55°C/150°C	0	100	1000	0		0	0	0
	IRFP450N	109	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP4510	240	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP4510	240	-55°C/150°C	0	80	1000	0		0	0	0
	IRFP460	225	-55°C/150°C	0	59	1000	0		0	0	0
IRFP460	134	-55°C/150°C	0	80	1000	0		0	0	0	
IRFP460	134	-55°C/150°C	0	80	1000	0		0	0	0	
IRFP460	135	-55°C/150°C	0	80	1000	0		0	0	0	
IRFP460A	206	-55°C/150°C	0	80	1000	0		0	0	0	
IRFP460LC	225	-55°C/150°C	0	38	1000	0		0	0	0	
IRFP460N	106	-55°C/150°C	0	80	1000	0		0	0	0	
IRFP460Z	214	-55°C/150°C	0	39	1000	0		0	0	0	
IRFP4710	146	-55°C/150°C	0	80	1000	0		0	0	0	
IRFP90N20D	120	-55°C/150°C	0	80	1000	1	Parametric shift due to ionic contamination	0	1	0	
IRFP90N20D	111	-55°C/150°C	0	80	1000	0		0	0	0	
Total					2856		1		0	1	0
<b>TSOP-6</b>	IRLMS6702	112	-55°C/150°C	0	40	1000	0		0	0	0
	IRLMS6802	114	-55°C/150°C	0	40	1000	0		0	0	0
	IRLMS6802	117	-55°C/150°C	0	40	1000	0		0	0	0
	IRLMS6802	114	-55°C/150°C	0	40	1000	0		0	0	0
	IRLMS6802	114	-55°C/150°C	0	40	1000	0		0	0	0
Total					200		0		0	0	0



**IGBTs**

Category	Part Number	Date Code	Temperature Excursion	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 250	# of failures @ 500	# of failures @ 1000
<b>D2Pak (TO-263) &amp; TO-262</b>	IRGS4B60KD1	217	-55°C/150°C	0	80	1000	0		0	0	0
	IRGS4B60KD1	217	-55°C/150°C	0	80	1000	0		0	0	0
	IRGS4B60KD1	217	-55°C/150°C	0	73	1000	0		0	0	0
	<b>Total</b>				<b>233</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>D-Pak &amp; I-Pak (TO-252)</b>	IRG4RC10UD	147	-55°C/150°C	0	77	1000	0		0	0	0
<b>TO-220 Fullpack</b>	IRG4IBC30S	148	-55°C/150°C	0	40	1000	0		0	0	0
	IRG4IBC30W	124	-55°C/150°C	0	40	1000	0		0	0	0
	IRGIB10B60K	227	-55°C/150°C	0	80	1000	0		0	0	0
	IRGIB10B60K	227	-55°C/150°C	0	80	1000	0		0	0	0
	IRGIB10B60K	227	-55°C/150°C	0	80	1000	0		0	0	0
<b>Total</b>				<b>320</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>Soldereable TO-247</b>	IRG4PC60FP	138	-55°C/150°C	0	78	1000	0		0	0	0
	IRG4PC60UP	139	-55°C/150°C	0	80	1000	0		0	0	0
	IRG4PC60UP	139	-55°C/150°C	0	80	1000	0		0	0	0
<b>Total</b>				<b>238</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>SOT-227</b>	GA100NA60U	110	-40°C/125°C	0	8	150	0		0	0	0
	GA200SA60U	112	-40°C/125°C	0	8	100	0		0	0	0
<b>Total</b>				<b>16</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>Super TO-247</b>	IRGPS40B120U	106	-55°C/150°C	0	80	1000	0		0	0	0
	IRGPS60B120KD	105	-55°C/150°C	0	80	1000	0		0	0	0
	IRGPS60B120KD	105	-55°C/150°C	0	80	1000	0		0	0	0
	IRGPS60B120KD	105	-55°C/150°C	0	80	1000	0		0	0	0
<b>Total</b>				<b>320</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>Super TO-247 Co-Pak</b>	IRG4PSC71UD	240	-55°C/150°C	0	80	1000	0		0	0	0
	IRG4PSC71UD	240	-55°C/150°C	0	80	1000	0		0	0	0
	IRG4PSC71UD	240	-55°C/150°C	0	80	1000	0		0	0	0
<b>Total</b>				<b>240</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>TO-220</b>	IRG4BC20F	225	-55°C/150°C	0	80	1000	0		0	0	0
	IRG4BC20F	225	-55°C/150°C	0	80	1000	0		0	0	0
	IRG4BC20U	107	-55°C/150°C	0	50	1000	0		0	0	0
	IRG4BC30U	124	-55°C/150°C	0	50	1000	0		0	0	0
	IRG4PC50U	122	-55°C/150°C	0	50	1000	0		0	0	0
<b>Total</b>				<b>360</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>TO-220 Co-Pak</b>	IRG4BC10SD	127	-55°C/150°C	0	40	1000	0		0	0	0
	IRG4BC10UD	216	-55°C/150°C	0	40	1000	0		0	0	0
	IRG4BC20UD	150	-55°C/150°C	0	50	1000	0		0	0	0
	IRG4BC30FD	141	-55°C/150°C	0	80	1000	0		0	0	0
	IRG4BC30KD	127	-55°C/150°C	0	40	1000	0		0	0	0
	IRGB5B120KD	140	-55°C/150°C	0	80	1000	0		0	0	0
	IRGB5B120KD	140	-55°C/150°C	0	80	1000	0		0	0	0
	IRGB5B120KD	140	-55°C/150°C	0	80	1000	0		0	0	0
<b>Total</b>				<b>490</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>TO-247</b>	IRG4PC50S-P	NA	-55/150	0	77	1014	0		0	0	0
	IRG4PC50U	224	-55°C/150°C	0	20	1000	0		0	0	0
	IRG4PC60F	139	-55°C/150°C	0	80	1000	0		0	0	0
	IRG4PC60U	139	-55°C/150°C	0	80	1000	0		0	0	0
	IRG4PC60U	139	-55°C/150°C	0	80	1000	0		0	0	0
	IRG4PC60U	139	-55°C/150°C	0	80	2000	0		0	0	0
	IRG4PC60U	139	-55°C/150°C	0	80	2000	0		0	0	0
	IRG4PH50U	221	-55°C/150°C	0	20	1000	0		0	0	0
	IRGP20B120U	135	-55°C/150°C	0	80	1000	0		0	0	0
	IRGP20B120U	135	-55°C/150°C	0	80	96	0		0	0	0
IRGP30B120K	135	-55°C/150°C	0	80	1000	0		0	0	0	
<b>Total</b>				<b>757</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>TO-247 Co-Pak</b>	IRG4PC30FD	106	-55°C/150°C	0	80	1000	0		0	0	0
	IRGP30B60KD	128	-55°C/150°C	0	80	1000	0		0	0	0
	IRGP50B60KDE	128	-55°C/150°C	0	80	1000	0		0	0	0
	IRGP50B60KDE	132	-55°C/150°C	0	80	1000	0		0	0	0
	IRGP50B60PD1	234	-55°C/150°C	0	80	1000	0		0	0	0
	IRGP50B60PD1	234	-55°C/150°C	0	80	1000	0		0	0	0
	IRGP50B60PD1	234	-55°C/150°C	0	80	1000	0		0	0	0
<b>Total</b>				<b>560</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>	

## 4.1.4 Power Cycling

### Power MOSFETs

Category	Part Number	Date Code	Junction Temperature Excursion	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ midpoint	# of failures @ end of test
D2Pak (TO-263) & TO-262	IRF1312S	202	100°C	0	80	8572	0		0	0
	IRF1404S	133	100°C	0	80	8572	0		0	0
	IRF1404S	133	100°C	0	80	8572	0		0	0
	IRF1404S	227	150°C	0	80	1000	0		0	0
	IRFB40S	133	100°C	0	79	8572	0		0	0
	IRFZ44VS	143	100°C	0	80	8572	0		0	0
	IRL3803S	133	100°C	0	80	8572	0		0	0
	IRL3803S	133	100°C	0	80	8572	0		0	0
	Total					639		0	0	0
D-Pak & I-Pak (TO-252)	IRF3711	139	100°C	0	80	15000	0		0	0
	IRFR2407	147	100°C	0	79	15000	0		0	0
	IRFU24N15D	150	100°C	0	75	20648	0		0	0
	IRLR3103	147	100°C	0	80	15000	0		0	0
	IRLR3103	147	100°C	0	80	15000	0		0	0
	IRLR7811W	216	100°C	0	80	15000	0		0	0
	IRLR7821	224	100°C	0	80	15000	0		0	0
	IRLR7833AA	234	100°C	0	79	15000	0		0	0
	IRLU7833	237	100°C	0	80	15000	0		0	0
Total					713		0	0	0	
TO-220 Fullpack	IRF1520V	102	100°C	0	80	8572	0		0	0
	IRF1520V	219	100°C	0	80	8572	0		0	0
	Total					160		0	0	0
SO-8	IRF6216	144	100°C	0	80	15000	0		0	0
	IRF6217	144	100°C	0	80	15000	0		0	0
	IRF7484	143	100°C	0	77	16000	0		0	0
	IRF7492	219	100°C	NA	80	0	0		0	0
	Total					317		0	0	0
SOT-223	IRFL4315	217	100°C	0	80	15000	0		0	0
	IRLL014	152	100°C	0	80	15000	0		0	0
	Total					160		0	0	0
SOT-227	FA57SA50LC	108	100°C	NA	18	2500	0		0	0
	FB180SA10	129	100°C	NA	18	2500	0		0	0
	Total					36		0	0	0
Super TO-220	IRFBA23N50L	118	100°C	0	80	8572	0		0	0
	IRFBA90N20D	112	100°C	0	80	5000	0		0	0
	IRFBA90N20D	119	100°C	0	80	5000	0		0	0
	Total					240		0	0	0
Super TO-247	IRF35N50L	116	100°C	0	80	5000	0		0	0
	IRF35N50L	116	100°C	0	77	2500	0		0	0
	Total					157		0	0	0
TO-220	IRF1405	107	100°C	0	80	8572	0		0	0
	IRF1407	215	100°C	0	80	8572	0		0	0
	IRF2804	211	100°C	0	80	8572	0		0	0
	IRF2804L	204	100°C	0	80	8572	0		0	0
	IRF3205	130	100°C	0	45	8572	0		0	0
	IRF3205	131	100°C	0	45	8572	0		0	0
	IRF3205	141	100°C	0	80	8572	0		0	0
	IRF3711	139	100°C	0	80	8572	1	Parametric shift due to random mechanical damage	1	0
	IRF3808	121	100°C	0	80	8572	0		0	0
	IRF520V	102	100°C	0	80	8572	0		0	0
	IRFB16N60K	232	100°C	0	80	8572	0		0	0
	IRFB38N20D	140	100°C	0	80	8572	0		0	0
	IRFB52N15D	140	100°C	0	80	8572	0		0	0
	IRFB5N50K	111	100°C	0	80	4886	0		0	0
	IRL1404	109	100°C	0	80	8572	0		0	0
Total					1130		1	1	0	
TO-247	IRFP054	151	100°C	0	67	5000	0		0	0
	IRFP064	104	100°C	0	80	5000	0		0	0
	IRFP064N	206	100°C	0	80	5000	0		0	0
	IRFP064N	101	100°C	0	80	5000	0		0	0
	IRFP23N50L	117	100°C	0	80	5000	0		0	0
	IRFP260	126	100°C	0	80	5000	0		0	0
	IRFP260	126	100°C	0	80	5000	0		0	0
	IRFP264N	112	100°C	0	80	5000	0		0	0
	IRFP2907	206	100°C	0	80	5000	0		0	0
	IRFP2907	206	100°C	0	80	5000	0		0	0
	IRFP2907	206	100°C	0	80	5000	0		0	0
	IRFP4510	238	100°C	0	80	5000	0		0	0
	IRFP4510	240	100°C	0	80	5000	0		0	0
	IRFP4510	240	100°C	0	80	5000	0		0	0
	IRFP460A	206	100°C	0	80	5000	0		0	0
	IRFP460N	106	100°C	0	80	4370	0		0	0
	IRFP90N20D	111	100°C	0	80	3045	0		0	0
IRFP90N20D	120	100°C	0	80	5000	0		0	0	
Total					1427		0	0	0	

**IGBTs**

Category	Part Number	Date Code	Junction Temperature Excursion	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ midpoint	# of failures @ end of test
<b>TO-247</b>	IRG4PC50S-P	NA	100°C	0	77	5000	0		0	0
	IRG4PC50S-P	NA	125 & 85/85	0	308	0	0		0	0
	IRG4PC60F	139	100°C	0	80	5000	0		0	0
	IRG4PC60U	139	100°C	0	80	5000	0		0	0
	IRG4PC60U	139	100°C	0	80	5000	0		0	0
	IRGP20B120U	135	100°C	0	80	5000	0		0	0
	IRGP30B120K	135	100°C	0	80	5000	0		0	0
	<b>Total</b>				<b>785</b>		<b>0</b>		<b>0</b>	<b>0</b>
<b>TO-247 Co-Pak</b>	IRGP30B60KD	128	100°C	0	80	5000	0		0	0
	IRGP50B60KDE	128	100°C	0	80	5000	0		0	0
	IRGP50B60KDE	132	100°C	0	80	5854	0		0	0
	IRGP50B60PD1	234	100°C	0	30	5000	0		0	0
	IRGP50B60PD1	234	100°C	0	30	5000	0		0	0
	IRGP50B60PD1	234	100°C	0	30	5000	0		0	0
	<b>Total</b>				<b>330</b>		<b>0</b>		<b>0</b>	<b>0</b>
<b>D2Pak (TO-263) &amp; TO-262 Co-Pak</b>	IRGS4B60KD1	217	100°C	0	80	8572	0		0	0
	IRGS4B60KD1	217	100°C	0	80	8572	0		0	0
	<b>Total</b>				<b>160</b>		<b>0</b>		<b>0</b>	<b>0</b>
<b>TO-220 Fullpack</b>	IRGIB10B60K	227	100°C	0	80	8572	0		0	0
<b>Solderable TO-247</b>	IRG4PC60FP	138	100°C	0	80	5000	1	Parametric shift due to ionic contamination	0	1
	IRG4PC60UP	139	100°C	0	80	5000	0		0	0
	<b>Total</b>				<b>160</b>		<b>1</b>		<b>0</b>	<b>0</b>
<b>SOT-227</b>	GA100NA60U	110	100°C	NA	18	2500	0		0	0
	GA200SA60U	112	100°C	NA	18	2500	0		0	0
	<b>Total</b>				<b>36</b>		<b>0</b>		<b>0</b>	<b>0</b>
<b>Super TO-247</b>	IRGPS40B120U	106	100°C	0	80	5000	0		0	0
	IRGPS60B120KD	105	100°C	0	30	5000	0		0	0
	IRGPS60B120KD	105	100°C	0	30	5000	0		0	0
	IRGPS60B120KD	105	100°C	0	30	5000	0		0	0
	<b>Total</b>				<b>170</b>		<b>0</b>		<b>0</b>	<b>0</b>
<b>Super TO-247 Co-Pak</b>	IRG4PSC71UD	240	100°C	0	30	5000	0		0	0
	IRG4PSC71UD	240	100°C	0	30	5000	0		0	0
	IRG4PSC71UD	240	100°C	0	30	5000	0		0	0
	<b>Total</b>				<b>90</b>		<b>0</b>		<b>0</b>	<b>0</b>
<b>TO-220 Co-Pak</b>	IRG4BC30FD	141	100°C	0	80	2971	0		0	0
	IRGB5B120KD	140	100°C	0	80	8572	0		0	0
	IRGB5B120KD	140	100°C	0	80	8572	0		0	0
	<b>Total</b>				<b>240</b>		<b>0</b>		<b>0</b>	<b>0</b>

### 4.1.5 High Humidity, High Temperature Reverse Bias (H3TRB)

#### Power MOSFETs

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 168 hours	# of failures @ 500 hours	# of failures @ 1000 hours	
<b>D2Pak (TO-263) &amp; TO-262: N-channel</b>	IRF1312S	202	85°C/85%RH	64	80	1000	0		0	0	0	
	IRF1404L	133	85°C/85%RH	32	77	1000	0		0	0	0	
	IRF3205L	110	85°C/85%RH	44	80	1000	0		0	0	0	
	IRF3205L	110	85°C/85%RH	44	80	1000	0		0	0	0	
	IRF3704S	203	85°C/85%RH	20	40	1000	0		0	0	0	
	IRF530NL	110	85°C/85%RH	80	80	1000	0		0	0	0	
	IRF8010SJS	226	85°C/85%RH	80	80	1000	0		0	0	0	
	IRFBC40L	133	85°C/85%RH	100	76	1000	0		0	0	0	
	IRFSL3808	121	85°C/85%RH	60	80	1000	0		0	0	0	
	IRFSL3808	125	85°C/85%RH	60	80	1000	0		0	0	0	
	IRFZ44VS	143	85°C/85%RH	48	80	1000	0		0	0	0	
	IRL3803L	133	85°C/85%RH	24	77	1000	0		0	0	0	
	IRL3803L	133	85°C/85%RH	24	77	1000	0		0	0	0	
	Total					987		0		0	0	0
	<b>D2Pak (TO-263) &amp; TO-262: P-channel</b>	IRF9224NL	143	85°C/85%RH	44	77	1000	0		0	0	0
<b>Direct FET</b>	IRF6601	NA	85°C/85%RH	16	55	593	1	Parametric shift due to silicon anomaly	1	0	0	
	IRF6601	NA	85°C/85%RH	16	55	1001	0		0	0	0	
	IRF6601	NA	85°C/85%RH	16	55	1001	0		0	0	0	
	IRF6601	NA	85°C/85%RH	16	55	1001	0		0	0	0	
	IRF6601	NA	85°C/85%RH	16	55	529	0		0	0	0	
	IRF6601	NA	85°C/85%RH	16	55	593	0		0	0	0	
	IRF6601	NA	85°C/85%RH	16	55	593	0		0	0	0	
	IRF6602	NA	85°C/85%RH	16	55	1007	0		0	0	0	
	IRF6602	NA	85°C/85%RH	16	55	1007	0		0	0	0	
	IRF6602	NA	85°C/85%RH	16	55	1007	0		0	0	0	
	IRF6602	NA	85°C/85%RH	16	55	593	0		0	0	0	
	IRF6604	NA	85°C/85%RH	24	55	505	2	Parametric shift due to assembly anomaly	2	0	0	
	IRF6607	NA	85°C/85%RH	24	55	505	0		0	0	0	
IRF6607	NA	85°C/85%RH	24	55	505	0		0	0	0		
IRF6607	NA	85°C/85%RH	24	55	505	0		0	0	0		
Total					825		3		3	0	0	
<b>D-Pak &amp; I-Pak (TO-252)</b>	IRF3711	139	85°C/85%RH	16	80	1024	0		0	0	0	
	IRFR110	216	85°C/85%RH	100	40	1000	0		0	0	0	
	IRFR120	232	85°C/85%RH	80	75	1000	0		0	0	0	
	IRFR220N	203	85°C/85%RH	100	74	1000	0		0	0	0	
	IRFR2407	147	85°C/85%RH	60	80	1000	0		0	0	0	
	IRFR2407	147	85°C/85%RH	60	80	1000	0		0	0	0	
	IRFR3410	221	85°C/85%RH	80	80	1000	0		0	0	0	
	IRFR3411	140	85°C/85%RH	80	80	1000	0		0	0	0	
	IRFR3412	146	85°C/85%RH	80	80	1000	0		0	0	0	
	IRFR3504	216	85°C/85%RH	32	80	1000	0		0	0	0	
	IRFR3505	216	85°C/85%RH	44	80	1000	0		0	0	0	
	IRFR3711	232	85°C/85%RH	16	80	1000	0		0	0	0	
	IRFR530V	104	85°C/85%RH	80	80	1000	0		0	0	0	
	IRFR620	147	85°C/85%RH	100	79	1000	0		0	0	0	
	IRFU12N25D	119	85°C/85%RH	100	80	976	0		0	0	0	
	IRFU16N20D	119	85°C/85%RH	100	80	1000	0		0	0	0	
	IRFU24N15D	202	85°C/85%RH	100	80	1000	0		0	0	0	
	IRFU3418	217	85°C/85%RH	64	80	1000	0		0	0	0	
	IRFU420A	141	85°C/85%RH	100	80	1000	0		0	0	0	
	IRFU430A	144	85°C/85%RH	100	80	1000	0		0	0	0	
	IRLR024N	147	85°C/85%RH	44	80	1000	0		0	0	0	
	IRLR3103	147	85°C/85%RH	24	80	1000	0		0	0	0	
	IRLR3103	147	85°C/85%RH	24	80	1000	0		0	0	0	
	IRLR3105	212	85°C/85%RH	44	80	1000	0		0	0	0	
	IRLR7811W	145	85°C/85%RH	24	80	1000	1	parametric shift due to excessive gate leakage	1	0	0	
	IRLR7811W	216	85°C/85%RH	24	80	1000	0		0	0	0	
	IRLR7821	218	85°C/85%RH	24	40	500	0		0	0	0	
IRLR7833	233	85°C/85%RH	24	80	1000	0		0	0	0		
IRLR7833AA	234	85°C/85%RH	24	80	1000	0		0	0	0		
IRLR8503	123	85°C/85%RH	30	40	1000	0		0	0	0		
IRLU7821	218	85°C/85%RH	24	40	644	0		0	0	0		
IRLU7833	237	85°C/85%RH	24	80	2000	0		0	0	0		
Total					2388		1		1	0	0	
<b>D-Pak &amp; I-Pak (TO-252)</b>	IRFR5505	232	85°C/85%RH	44	80	1000	0		0	0	0	
	IRFR9024N	140	85°C/85%RH	55	67	1000	0		0	0	0	
	IRFR9120N	151	85°C/85%RH	80	80	1000	0		0	0	0	
Total					227		0		0	0	0	
<b>Flip Chip Devices: N-channel</b>	IRF6156	NA	85°C/85%RH	16	80	812	0		0	0	0	
	IRF6156	NA	85°C/85%RH	16	60	500	0		0	0	0	
	IRF6156	NA	85°C/85%RH	16	60	500	0		0	0	0	
	IRF6156	NA	85°C/85%RH	16	80	500	0		0	0	0	
	IRF6156	NA	85°C/85%RH	16	80	500	0		0	0	0	
Total					360		0		0	0	0	

**Power MOSFETs (continued)**

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 168 hours	# of failures @ 500 hours	# of failures @ 1000 hours
<b>Flip Chip Devices: P-channel</b>	IRF6100	0046	85°C/85%RH	16	84	1000	0		0	0	0
	IRF6100	0046	85°C/85%RH	16	85	1000	0		0	0	0
	IRF6100	0046	85°C/85%RH	16	85	500	0		0	0	0
	<b>Total</b>						254	0	0	0	0
<b>TO-220 Fullpack</b>	IRF1510V	102	85°C/85%RH	80	80	1000	0		0	0	0
	IRF1520V	102	85°C/85%RH	80	80	1000	0		0	0	0
	IRF15N50L	219	85°C/85%RH	100	80	1000	0		0	0	0
	IRF1Z24V	103	85°C/85%RH	60	80	1000	0		0	0	0
	IRL13615	144	85°C/85%RH	100	80	1000	0		0	0	0
	IRL13803	225	85°C/85%RH	24	80	1000	0		0	0	0
	IRL13803	225	85°C/85%RH	24	80	1000	0		0	0	0
	IRL1520N	212	85°C/85%RH	100	40	1000	0		0	0	0
<b>Total</b>						600	0	0	0	0	
<b>Micro-3: N-channel</b>	IRLML2402	110	85°C/85%RH	20	40	1000	0		0	0	0
	IRLML2502	227	85°C/85%RH	20	39	1000	0		0	0	0
	IRLML2502	231	85°C/85%RH	20	40	1000	0		0	0	0
<b>Total</b>						119	0	0	0	0	
<b>Micro-3: P-channel</b>	IRLML6302	114	85°C/85%RH	20	40	1000	0		0	0	0
	IRLML6302	114	85°C/85%RH	20	40	1000	0		0	0	0
<b>Total</b>						318	0	0	0	0	
<b>SO-8: N-channel</b>	IRF3000	201	85°C/85%RH	100	80	1000	0		0	0	0
	IRF7413	108	85°C/85%RH	30	40	1000	0		0	0	0
	IRF7413A	206	85°C/85%RH	24	80	1000	0		0	0	0
	IRF7455	108	85°C/85%RH	24	80	1000	0		0	0	0
	IRF7476	112	85°C/85%RH	9.6	80	1000	0		0	0	0
	IRF7484	143	85°C/85%RH	32	77	1000	0		0	0	0
	IRF7490	222	85°C/85%RH	80	80	1000	0		0	0	0
	IRF7491	220	85°C/85%RH	64	80	1000	0		0	0	0
	IRF7492	239	85°C/85%RH	100	80	1024	0		0	0	0
	IRF7492	239	85°C/85%RH	100	80	1000	0		0	0	0
	IRF7492	220	85°C/85%RH	100	80	1000	0		0	0	0
	IRF7492	239	85°C/85%RH	100	80	1000	0		0	0	0
	IRF7492	220	85°C/85%RH	100	80	1000	0		0	0	0
	IRF7811A	109	85°C/85%RH	24	80	1000	0		0	0	0
	IRF7811W	205	85°C/85%RH	24	80	1000	0		0	0	0
IRL7821	231	85°C/85%RH	24	80	1000	0		0	0	0	
<b>Total</b>						1157	0	0	0	0	
<b>SO-8: P-channel</b>	IRF6216	144	85°C/85%RH	100	80	1000	0		0	0	0
	IRF6217	144	85°C/85%RH	100	80	1000	0		0	0	0
	IRF7205	144	85°C/85%RH	30	40	1000	0		0	0	0
	IRF7233	206	85°C/85%RH	9.6	79	976	0		0	0	0
	IRF7233	206	85°C/85%RH	9.6	80	1000	0		0	0	0
	IRF7404	113	85°C/85%RH	20	40	1000	0		0	0	0
	IRF7404	119	85°C/85%RH	20	40	1000	0		0	0	0
<b>Total</b>						2753	0	0	0	0	
<b>SO-8 Dual: N-channel</b>	IRF7101	150	85°C/85%RH	16	80	1000	0		0	0	0
	IRF7101	205	85°C/85%RH	16	40	976	0		0	0	0
	IRF7311	150	85°C/85%RH	16	80	1000	0		0	0	0
	IRF7311	205	85°C/85%RH	16	80	1000	0		0	0	0
	IRF7380	211	85°C/85%RH	64	40	1000	0		0	0	0
<b>Total</b>						320	0	0	0	0	
<b>SO-8 Dual: P-channel</b>	IRF7314	145	85°C/85%RH	20	40	1000	0		0	0	0
<b>SOT-223</b>	IRFL014	124	85°C/85%RH	60	40	1000	0		0	0	0
	IRFL4310	144	85°C/85%RH	100	40	1000	0		0	0	0
	IRFL4315	124	85°C/85%RH	100	80	1000	0		0	0	0
	IRFL4315	217	85°C/85%RH	100	80	1000	0		0	0	0
	IRFL4315	217	85°C/85%RH	100	80	1000	0		0	0	0
	IRLL014	152	85°C/85%RH	48	80	1000	0		0	0	0
	IRLL014N	114	85°C/85%RH	44	40	1000	0		0	0	0
IRLL3303	103	85°C/85%RH	30	40	1000	0		0	0	0	
<b>Total</b>						480	0	0	0	0	
<b>SOT-227</b>	FA57SA50LC	108	85°C/85%RH	100	8	500	0		0	0	0
	FB180SA10	129	85°C/85%RH	100	8	500	0		0	0	0
<b>Total</b>						16	0	0	0	0	
<b>Super TO-220</b>	IRFBA23N50L	118	85°C/85%RH	100	80	1000	0		0	0	0
	IRFBA90N20D	119	85°C/85%RH	100	80	1000	0		0	0	0
	IRLBA3803P	139	85°C/85%RH	30	40	1000	0		0	0	0
<b>Total</b>						200	0	0	0	0	
<b>Super TO-247</b>	IRFPS35N50L	116	85°C/85%RH	100	77	500	0		0	0	0
	IRFPS39N60K	136	85°C/85%RH	100	80	1000	0		0	0	0
	IRFPS40N50L	123	85°C/85%RH	100	80	1000	0		0	0	0
<b>Total</b>						237	0	0	0	0	

**Power MOSFETs (continued)**

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 168 hours	# of failures @ 500 hours	# of failures @ 1000 hours
<b>TO-220</b>	IRF1404	225	85°C/85%RH	32	80	1000	0		0	0	0
	IRF1404	225	85°C/85%RH	32	80	1000	0		0	0	0
	IRF1407	215	85°C/85%RH	60	80	1000	0		0	0	0
	IRF2804	211	85°C/85%RH	32	80	1000	0		0	0	0
	IRF2804L	210	85°C/85%RH	32	80	1000	0		0	0	0
	IRF3205	106	85°C/85%RH	55	80	1000	0		0	0	0
	IRF3205	106	85°C/85%RH	55	80	1000	0		0	0	0
	IRF3205	130	85°C/85%RH	44	80	1000	0		0	0	0
	IRF3205	122	85°C/85%RH	44	30	500	0		0	0	0
	IRF3205	141	85°C/85%RH	44	80	1000	0		0	0	0
	IRF3205	141	85°C/85%RH	44	80	1000	0		0	0	0
	IRF3710	119	85°C/85%RH	80	80	952	0		0	0	0
	IRF3710	150	85°C/85%RH	80	80	1000	0		0	0	0
	IRF3710	150	85°C/85%RH	80	80	1000	0		0	0	0
	IRF3710S	134	85°C/85%RH	80	80	1000	0		0	0	0
	IRF3711	120	85°C/85%RH	20	80	928	0		0	0	0
	IRF3711	139	85°C/85%RH	16	80	1000	0		0	0	0
	IRF3808	142	85°C/85%RH	60	80	1000	0		0	0	0
	IRF3808	144	85°C/85%RH	60	80	1000	0		0	0	0
	IRF3808	144	85°C/85%RH	60	80	1000	0		0	0	0
	IRF3808	121	85°C/85%RH	60	80	1052	0		0	0	0
	IRF3808	124	85°C/85%RH	60	80	1000	0		0	0	0
	IRF3808	124	85°C/85%RH	60	80	1000	0		0	0	0
	IRF520V	102	85°C/85%RH	80	80	1000	0		0	0	0
	IRF634	216	85°C/85%RH	100	40	1000	0		0	0	0
	IRF640N	118	85°C/85%RH	100	80	1000	0		0	0	0
	IRF644N	102	85°C/85%RH	100	85	1000	0		0	0	0
	IRF644N	102	85°C/85%RH	100	85	1000	0		0	0	0
	IRF740	150	85°C/85%RH	100	49	1000	0		0	0	0
	IRF740	213	85°C/85%RH	100	40	1000	0		0	0	0
	IRFB11NS0A	201	85°C/85%RH	100	44	1000	0		0	0	0
	IRFB16N60K	232	85°C/85%RH	100	80	1000	0		0	0	0
	IRFB38N20D	140	85°C/85%RH	100	80	1000	0		0	0	0
	IRFB4710	122	85°C/85%RH	80	80	1000	0		0	0	0
	IRFB4710	122	85°C/85%RH	80	80	500	0		0	0	0
	IRFB52N15D	140	85°C/85%RH	100	80	1000	0		0	0	0
	IRFB5NS0K	111	85°C/85%RH	100	80	1000	0		0	0	0
	IRFB9N60A	209	85°C/85%RH	100	80	1000	0		0	0	0
	IRFZ24N	106	85°C/85%RH	55	79	1000	0		0	0	0
	IRFZ44N	215	85°C/85%RH	55	40	1000	0		0	0	0
	IRL1404	109	85°C/85%RH	32	80	1000	0		0	0	0
	IRL3803	211	85°C/85%RH	24	80	1000	0		0	0	0
	IRL640	214	85°C/85%RH	100	40	1000	0		0	0	0
	<b>Total</b>				<b>3172</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>TO-247</b>	IRFP054	151	85°C/85%RH	48	80	1000	0		0	0	0
	IRFP064N	206	85°C/85%RH	48	80	1000	0		0	0	0
	IRFP13N60L	146	85°C/85%RH	100	80	1000	0		0	0	0
	IRFP17N50L	120	85°C/85%RH	100	80	976	0		0	0	0
	IRFP21N60K	151	85°C/85%RH	100	80	1000	1	Parametric shift due to ionic contamination	0	0	1
	IRFP260	126	85°C/85%RH	100	80	1000	0		0	0	0
	IRFP260	126	85°C/85%RH	100	80	1000	0		0	0	0
	IRFP264N	112	85°C/85%RH	100	80	1000	0		0	0	0
	IRFP27N60K	144	85°C/85%RH	100	80	1000	0		0	0	0
	IRFP2907	206	85°C/85%RH	64	80	1000	0		0	0	0
	IRFP2907	206	85°C/85%RH	64	80	1000	0		0	0	0
	IRFP2907	225	85°C/85%RH	60	80	1000	0		0	0	0
	IRFP2907	225	85°C/85%RH	60	80	1000	0		0	0	0
	IRFP4004	238	85°C/85%RH	32	80	1000	0		0	0	0
	IRFP4004	240	85°C/85%RH	32	80	1000	0		0	0	0
	IRFP450N	109	85°C/85%RH	100	80	1000	0		0	0	0
	IRFP4510	240	85°C/85%RH	80	80	1000	0		0	0	0
	IRFP4510	240	85°C/85%RH	80	80	1000	0		0	0	0
	IRFP460	134	85°C/85%RH	100	80	1000	0		0	0	0
	IRFP460	134	85°C/85%RH	100	80	1000	0		0	0	0
	IRFP460	135	85°C/85%RH	100	80	1000	0		0	0	0
	IRFP460A	206	85°C/85%RH	100	80	1000	0		0	0	0
IRFP460A	101	85°C/85%RH	100	80	1000	0		0	0	0	
IRFP460N	106	85°C/85%RH	100	80	1000	0		0	0	0	
IRFP90N20D	111	85°C/85%RH	100	80	716	0		0	0	0	
IRFP90N20D	120	85°C/85%RH	100	80	1000	0		0	0	0	
IRFP9240	204	85°C/85%RH	100	80	1000	0		0	0	0	
IRFP9240	126	85°C/85%RH	-100	77	1000	0		0	0	0	
IRFP950	204	85°C/85%RH	100	80	1000	0		0	0	0	
	<b>Total</b>				<b>2397</b>		<b>1</b>		<b>0</b>	<b>0</b>	<b>1</b>
<b>TSOP-6: P-channel</b>	IRLMS6702	112	85°C/85%RH	20	40	1000	0		0	0	0
	IRLMS6802	114	85°C/85%RH	20	40	1000	0		0	0	0
	IRLMS6802	114	85°C/85%RH	20	40	1000	0		0	0	0
	IRLMS6802	117	85°C/85%RH	20	40	1000	0		0	0	0
	IRLMS6802	114	85°C/85%RH	20	40	1000	0		0	0	0
	<b>Total</b>				<b>239</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>

**IGBT's**

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 168 hours	# of failures @ 500 hours	# of failures @ 1000 hours
<b>TO-247</b>	IRG4PC50S-P	NA	85°C/85%RH	100	77	1000	0		0	0	0
	IRG4PC60F	139	85°C/85%RH	100	80	1000	0		0	0	0
	IRG4PC60U	139	85°C/85%RH	100	80	1000	0		0	0	0
	IRG4PC60U	139	85°C/85%RH	100	80	1000	0		0	0	0
	IRG4PH50U	126	85°C/85%RH	100	80	1000	0		0	0	0
	<b>Total</b>				<b>397</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>TO-247 Co-Pak</b>	IRG4PC30FD	106	85°C/85%RH	100	80	1000	0		0	0	0
	IRGP20B120UDE	135	85°C/85%RH	100	80	1000	0		0	0	0
	IRGP30B120KDE	135	85°C/85%RH	100	80	1000	5	Parametric shift due to ionic contamination	0	1	4
	IRGP30B60KD	128	85°C/85%RH	100	80	1000	0		0	0	0
	IRGP50B60PD1	234	85°C/85%RH	100	80	1000	0		0	0	0
	IRGP50B60PD1	234	85°C/85%RH	100	80	1000	0		0	0	0
	<b>Total</b>				<b>560</b>		<b>5</b>		<b>0</b>	<b>1</b>	<b>4</b>
<b>D2Pak (TO-263) &amp; TO-262</b>	IRGS4B60KD1	217	85°C/85%RH	100	80	1000	0		0	0	0
	IRGS4B60KD1	217	85°C/85%RH	100	80	1000	0		0	0	0
	IRGS4B60KD1	217	85°C/85%RH	100	80	1000	0		0	0	0
	<b>Total</b>				<b>240</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>D-Pak &amp; I-Pak (TO-252)</b>	IRG4RC10UD	147	85°C/85%RH	100	80	1000	0		0	0	0
	IRG4RC20F	147	85°C/85%RH	100	80	1000	0		0	0	0
	<b>Total</b>				<b>160</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>TO-220 Fullpack</b>	IRGB10B60K	227	85°C/85%RH	100	80	1000	1	Parametric shift due to ionic contamination	1	0	0
	IRGB10B60K	227	85°C/85%RH	100	80	1000	0		0	0	0
	IRGB10B60K	227	85°C/85%RH	100	80	1000	0		0	0	0
	<b>Total</b>				<b>240</b>		<b>1</b>		<b>1</b>	<b>0</b>	<b>0</b>
<b>TO-220 Fullpack Co-Pak</b>	IRGB15B60KD	128	85°C/85%RH	100	80	1000	0		0	0	0
	IRG4IBC20UD	210	85°C/85%RH	100	40	1000	1	parametric shift due to excessive drain to source leakage	0	1	0
	<b>Total</b>				<b>120</b>		<b>1</b>		<b>0</b>	<b>1</b>	<b>0</b>
<b>Solderable TO-247</b>	IRG4PC60FP	138	85°C/85%RH	100	80	1000	0		0	0	0
	IRG4PC60UP	139	85°C/85%RH	100	80	1000	0		0	0	0
	IRG4PC60UP	139	85°C/85%RH	100	80	1000	0		0	0	0
	<b>Total</b>				<b>240</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>SOT-227</b>	GA100NA60U	110	85°C/85%RH	100	8	500	0		0	0	0
	GA200SA60U	112	85°C/85%RH	100	8	500	0		0	0	0
	<b>Total</b>				<b>16</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>TO-220</b>	IRG4BC20F	225	85°C/85%RH	100	80	1000	0		0	0	0
	IRG4BC20F	225	85°C/85%RH	100	80	1000	0		0	0	0
	IRG4BC20U	107	85°C/85%RH	100	50	1000	0		0	0	0
	IRG4BC20U	107	85°C/85%RH	100	50	1000	0		0	0	0
	IRG4BC30U	124	85°C/85%RH	100	50	1000	0		0	0	0
	<b>Total</b>				<b>310</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>TO-220 Co-Pak</b>	IRG4BC30FD	141	85°C/85%RH	100	80	1000	0		0	0	0
	IRG4BC30UD	151	85°C/85%RH	100	48	1000	0		0	0	0
	IRGB15B60KD	126	85°C/85%RH	100	80	1000	0		0	0	0
	IRGB15B60KD	203	85°C/85%RH	100	80	1000	0		0	0	0
	IRGB5B120KD	140	85°C/85%RH	100	80	1000	0		0	0	0
	IRGB5B120KD	140	85°C/85%RH	100	79	1000	0		0	0	0
	<b>Total</b>				<b>447</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>

## 4.1.6 Autoclave

### Power MOSFETs

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	
<b>D2Pak (TO-263) &amp; TO-262</b>	IRF5210S	143	121°C/15PSIG	0	77	96	0		
	IRF5210S	203	121°C/15PSIG	0	80	96	0		
	IRF740LCS	143	121°C/15PSIG	0	77	96	0		
	IRF740LCS	203	121°C/15PSIG	0	80	96	0		
	IRFR8010SJS	226	121°C/15PSIG	0	80	96	0		
	IRF9540NS	143	121°C/15PSIG	0	77	96	0		
	IRF9540NS	203	121°C/15PSIG	0	80	96	0		
	IRFZ44NS	216	121°C/15PSIG	0	40	96	0		
	IRFZ44VS	143	121°C/15PSIG	0	80	96	0		
	IRF2804L	214	121°C/15PSIG	0	80	96	0		
	IRF2804L	219	121°C/15PSIG	0	80	96	0		
	IRFSL3808	121	121°C/15PSIG	0	80	96	0		
	IRFSL3808	125	121°C/15PSIG	0	80	96	0		
	IRFZ44NL	150	121°C/15PSIG	0	43	96	0		
					1034		0		
	<b>D-Pak &amp; I-Pak (TO-252)</b>	IRF3711	139	121°C/15PSIG	0	80	96	0	
		IRFR120	232	121°C/15PSIG	0	80	96	0	
IRFR2405		218	121°C/15PSIG	0	5	336	0		
IRFR2405		218	121°C/15PSIG	0	5	336	0		
IRFR2407		147	121°C/15PSIG	0	80	96	0		
IRFR2407		147	121°C/15PSIG	0	80	96	0		
IRFR3411		150	121°C/15PSIG	0	80	96	0		
IRFR3412		146	121°C/15PSIG	0	80	96	0		
IRFR3504		216	121°C/15PSIG	0	94	96	0		
IRFR3505		216	121°C/15PSIG	0	80	96	0		
IRFR3711		232	121°C/15PSIG	0	80	96	0		
IRFR5505		232	121°C/15PSIG	0	80	96	0		
IRFR9024N		232	121°C/15PSIG	0	79	96	0		
IRLR024N		147	121°C/15PSIG	0	80	96	0		
IRLR3103		147	121°C/15PSIG	0	80	96	0		
IRLR3103		147	121°C/15PSIG	0	80	96	0		
IRLR3105		212	121°C/15PSIG	0	80	96	0		
IRLR7811W		216	121°C/15PSIG	0	80	96	0		
IRLR7833		233	121°C/15PSIG	0	80	96	0		
IRLR7833AA		234	121°C/15PSIG	0	80	96	0		
IRLR8503		232	121°C/15PSIG	0	80	96	0		
IRFU15N20D		119	121°C/15PSIG	0	80	96	0		
IRFU24N15D		202	121°C/15PSIG	0	80	96	0		
IRFU3418		217	121°C/15PSIG	0	80	96	0		
IRFU420A		141	121°C/15PSIG	0	80	96	0		
IRFU430A		144	121°C/15PSIG	0	80	96	0		
IRFUC20	215	121°C/15PSIG	0	40	96	0			
IRLU7821	219	121°C/15PSIG	0	80	96	0			
IRLU7833	237	121°C/15PSIG	0	80	96	0			
				2143		0			
<b>TO-220 Fullpack</b>	IRF13205	205	121°C/15PSIG	0	80	96	0		
	IRF1510V	102	121°C/15PSIG	0	80	96	0		
	IRF1520V	102	121°C/15PSIG	0	80	96	0		
	IRFI9630G	205	121°C/15PSIG	0	80	96	0		
	IRFIB5N50L	219	121°C/15PSIG	0	80	96	0		
	IRFIBF20G	205	121°C/15PSIG	0	80	96	0		
	IRFIBF20G	205	121°C/15PSIG	0	80	96	0		
	IRFIZ24V	103	121°C/15PSIG	0	80	96	0		
	IRLI3803	225	121°C/15PSIG	0	80	96	0		
	IRLI3803	225	121°C/15PSIG	0	80	96	0		
	IRLI520N	141	121°C/15PSIG	0	40	96	0		
	IRLI520N	210	121°C/15PSIG	0	46	96	0		
	IRLI520N	216	121°C/15PSIG	0	40	96	0		
				926		0			



**Power MOSFETs (continued)**

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode
<b>Micro-3</b>	IRLML2402	110	121°C/15PSIG	0	40	96	0	
	IRLML2502	227	121°C/15PSIG	0	40	96	0	
	IRLML2502	231	121°C/15PSIG	0	40	96	0	
	IRLML6302	114	121°C/15PSIG	0	35	96	0	
	IRLML6302	114	121°C/15PSIG	0	40	96	0	
					195		0	
<b>SO-8</b>	IRF3000	201	121°C/15PSIG	0	80	96	0	
	IRF6216	144	121°C/15PSIG	0	80	96	0	
	IRF6217	144	121°C/15PSIG	0	80	96	0	
	IRF7403	103	121°C/15PSIG	0	40	96	0	
	IRF7455	108	121°C/15PSIG	0	80	96	0	
	IRF7484	146	121°C/15PSIG	0	80	96	0	
	IRF7491	220	121°C/15PSIG	0	80	96	0	
	IRF7492	239	121°C/15PSIG	0	80	96	0	
	IRF7811A	109	121°C/15PSIG	0	80	96	0	
	IRL7821	231	121°C/15PSIG	0	80	96	0	
					760		0	
<b>SO-8 Dual</b>	IRF7314	145	121°C/15PSIG	0	20	96	0	
	IRF7380	211	121°C/15PSIG	0	40	96	0	
					60		0	
<b>SOT-223</b>	IRFL014	238	121°C/15PSIG	0	80	96	0	
	IRFL014	124	121°C/15PSIG	0	40	96	0	
	IRFL214	201	121°C/15PSIG	0	40	96	0	
	IRFL4310	103	121°C/15PSIG	0	40	96	0	
	IRFL4310	144	121°C/15PSIG	0	40	96	0	
	IRFL4310	216	121°C/15PSIG	0	40	96	0	
	IRFL4315	124	121°C/15PSIG	0	80	96	0	
	IRFL4315	217	121°C/15PSIG	0	80	96	0	
	IRFL4315	217	121°C/15PSIG	0	80	96	0	
	IRLL2705	238	121°C/15PSIG	0	80	96	0	
					600		0	
<b>Super TO-220</b>	IRFBA23N50L	118	121°C/15PSIG	0	80	96	0	
	IRFBA90N20D	112	121°C/15PSIG	0	80	96	0	
	IRFBA90N20D	119	121°C/15PSIG	0	80	96	0	
	IRLBA3803P	139	121°C/15PSIG	0	40	96	0	
					280		0	
<b>Super TO-247</b>	IRFPS35N50L	116	121°C/15PSIG	0	80	96	0	

**Power MOSFETs (continued)**

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	
<b>TO-220</b>	IRF1404	225	121°C/15PSIG	0	80	96	0		
	IRF1404	225	121°C/15PSIG	0	80	96	0		
	IRF1405	107	121°C/15PSIG	0	80	96	0		
	IRF1407	215	121°C/15PSIG	0	80	96	0		
	IRF2804	211	121°C/15PSIG	0	80	96	0		
	IRF3205	106	121°C/15PSIG	0	80	96	0		
	IRF3205	106	121°C/15PSIG	0	80	96	0		
	IRF3205	130	121°C/15PSIG	0	80	96	0		
	IRF3205	131	121°C/15PSIG	0	80	96	0		
	IRF3205	141	121°C/15PSIG	0	80	96	0		
	IRF3205	141	121°C/15PSIG	0	80	96	0		
	IRF3711	139	121°C/15PSIG	0	80	96	0		
	IRF3808	117	121°C/15PSIG	0	80	96	0		
	IRF3808	121	121°C/15PSIG	0	80	96	0		
	IRF520V	102	121°C/15PSIG	0	80	96	0		
	IRF730	150	121°C/15PSIG	0	40	96	0		
	IRF840	118	121°C/15PSIG	0	7	96	0		
	IRF9620	145	121°C/15PSIG	0	80	96	0		
	IRFB16N60K	232	121°C/15PSIG	0	80	96	0		
	IRFB38N20D	140	121°C/15PSIG	0	80	96	0		
	IRFB4710	110	121°C/15PSIG	0	80	96	0		
	IRFB4710	110	121°C/15PSIG	0	80	96	0		
	IRFB52N15D	140	121°C/15PSIG	0	80	96	0		
	IRFB5N50K	111	121°C/15PSIG	0	80	96	0		
	IRFBE30	150	121°C/15PSIG	0	47	96	0		
	IRFZ24N	106	121°C/15PSIG	0	80	96	0		
	IRFZ44N	216	121°C/15PSIG	0	40	96	0		
	IRL1404	109	121°C/15PSIG	0	80	96	0		
	IRL1404	109	121°C/15PSIG	0	80	96	0		
	IRL3803	211	121°C/15PSIG	0	80	96	0		
	IRL520N	210	121°C/15PSIG	0	41	96	0		
					2255			0	
	<b>TO-247</b>	IRFP064	104	121°C/15PSIG	0	80	96	0	
IRFP064N		206	121°C/15PSIG	0	80	96	0		
IRFP17N50L		102	121°C/15PSIG	0	80	96	0		
IRFP23N50L		117	121°C/15PSIG	0	80	96	0		
IRFP250N		209	121°C/15PSIG	0	42	96	0		
IRFP260		126	121°C/15PSIG	0	80	96	0		
IRFP260		133	121°C/15PSIG	0	80	96	0		
IRFP264N		112	121°C/15PSIG	0	80	96	0		
IRFP2907		206	121°C/15PSIG	0	80	96	0		
IRFP2907		206	121°C/15PSIG	0	80	96	0		
IRFP2907		206	121°C/15PSIG	0	80	96	0		
IRFP2907		225	121°C/15PSIG	0	80	96	0		
IRFP4004		238	121°C/15PSIG	0	80	96	0		
IRFP4004		240	121°C/15PSIG	0	80	96	0		
IRFP450N		109	121°C/15PSIG	0	80	96	0		
IRFP4510		240	121°C/15PSIG	0	80	96	0		
IRFP4510		240	121°C/15PSIG	0	80	96	0		
IRFP460		134	121°C/15PSIG	0	80	96	0		
IRFP460		134	121°C/15PSIG	0	80	96	0		
IRFP460		135	121°C/15PSIG	0	80	96	0		
IRFP460N	106	121°C/15PSIG	0	80	96	0			
IRFP4710	146	121°C/15PSIG	0	80	96	0			
IRFP90N20D	111	121°C/15PSIG	0	80	96	0			
IRFP90N20D	120	121°C/15PSIG	0	80	96	0			
IRFPE50	214	121°C/15PSIG	0	40	96	0			
				1922			0		

**IGBTs**

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode
<b>D2Pak (TO-263) &amp; TO-262</b>	IRGS4B60KD1	217	121°C/15PSIG	0	80	96	0	
	IRGS4B60KD1	217	121°C/15PSIG	0	79	96	0	
	IRGS4B60KD1	217	121°C/15PSIG	0	80	96	0	
					239		0	
<b>D-Pak &amp; I-Pak (TO-252)</b>	IRG4RC10UD	147	121°C/15PSIG	0	80	96	0	
<b>TO-220 Fullpack</b>	IRGIB10B60K	227	121°C/15PSIG	0	80	96	0	
	IRGIB10B60K	227	121°C/15PSIG	0	80	96	0	
	IRGIB10B60K	227	121°C/15PSIG	0	80	96	0	
					240		0	
<b>Solderable TO-247</b>	IRG4PC60FP	138	121°C/15PSIG	0	80	96	0	
	IRG4PC60UP	139	121°C/15PSIG	0	80	96	0	
	IRG4PC60UP	139	121°C/15PSIG	0	80	96	0	
				240		0		
<b>Super TO-247</b>	IRGPS40B120U	106	121°C/15PSIG	0	80	96	0	
	IRGPS60B120KD	105	121°C/15PSIG	0	80	96	0	
	IRGPS60B120KD	105	121°C/15PSIG	0	80	96	0	
	IRGPS60B120KD	105	121°C/15PSIG	0	80	96	0	
	IRG4PSC71UD	240	121°C/15PSIG	0	80	96	0	
	IRG4PSC71UD	240	121°C/15PSIG	0	80	96	0	
	IRG4PSC71UD	240	121°C/15PSIG	0	80	96	0	
					560		0	
<b>TO-220</b>	IRG4BC20F	225	121°C/15PSIG	0	80	96	0	
	IRG4BC20F	225	121°C/15PSIG	0	80	96	0	
	IRG4BC20U	107	121°C/15PSIG	0	50	96	0	
	IRG4BC20U	107	121°C/15PSIG	0	50	96	0	
	IRG4BC30U	124	121°C/15PSIG	0	50	96	0	
	IRG4PC50U	122	121°C/15PSIG	0	50	96	0	
	IRG4PC50U	122	121°C/15PSIG	0	50	96	0	
				410		0		
<b>TO-220 Co-Pak</b>	IRG4BC10UD	216	121°C/15PSIG	0	40	96	0	
	IRG4BC20KD	139	121°C/15PSIG	0	40	96	0	
	IRG4BC30FD	141	121°C/15PSIG	0	80	96	0	
	IRG4BC30UD	145	121°C/15PSIG	0	53	96	0	
	IRGB20B60PD	247	121°C/15PSIG	0	100	96	0	
	IRGB5B120KD	140	121°C/15PSIG	0	80	96	0	
	IRGB5B120KD	140	121°C/15PSIG	0	80	96	0	
	IRGB5B120KD	140	121°C/15PSIG	0	80	96	0	
				553		0		
<b>TO-247</b>	IRG4PC50S-P	NA	121°C/15PSIG	0	77	96	1	Parametric shift due to die attach degradation
	IRG4PC60F	139	121°C/15PSIG	0	80	96	0	
	IRG4PC60U	139	121°C/15PSIG	0	80	96	0	
	IRG4PF50W	124	121°C/15PSIG	0	30	96	0	
	IRG4PH40U	149	121°C/15PSIG	0	40	96	0	
	IRG4PH50U	210	121°C/15PSIG	0	39	96	0	
	IRGP30B120K	135	121°C/15PSIG	0	80	96	0	
					506		1	
<b>TO-247 Co-Pak</b>	IRG4PC30FD	126	121°C/15PSIG	0	85	96	0	
	IRG4PC50UD	144	121°C/15PSIG	0	40	96	0	
	IRGP20B60PD	238	121°C/15PSIG	0	80	96	0	
	IRGP30B60KD	128	121°C/15PSIG	0	80	96	0	
	IRGP50B60KDE	128	121°C/15PSIG	0	80	96	0	
					365		0	

## 4.2 Diodes

### 4.2.1 High Temperature Reverse Bias

#### Schottky

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL
<b>D2Pak (TO-263) &amp; TO-262</b>	32CTQ045S	2002	125	36	114	1000	0		2.1E+06	445
	MBR20100CT	4001	125	80	108	1000	0		2.0E+06	469
	Total				222		0		4.0E+06	228
<b>D-61</b>	85CNQ015ASM	2502	100	12	231	1000	0		5.6E+05	1641
	87CNQ020A	2502	100	16	105	1000	0		2.5E+05	3611
	112CNQ030A	2801	125	24	231	1000	0		4.2E+06	219
	111CNQ045	4001	125	36	70	1000	0		1.3E+06	724
	81CNQ045ASM	2301	125	36	144	1000	0		2.6E+06	352
	83CNQ100A	3002	125	80	120	1000	0		2.2E+06	422
Total					901		0		1.1E+07	83
<b>DO201</b>	31DQ04	2001	125	32	308	1000	0		5.6E+06	165
<b>DO204</b>	50SQ100	3701	125	80	154	1000	0		2.8E+06	329
<b>DO41</b>	11DQ10	3801	125	80	108	1000	0		2.0E+06	469
<b>DO5</b>	95HQ015	1902	100	12	112	1000	0		2.7E+05	3385
<b>D-Pak</b>	MBRB2045CT	3902	125	36	77	1000	0		1.4E+06	658
<b>D-Pak</b>	12CWQ06FN	2602	125	48	231	1000	0		4.2E+06	219
<b>Flip Chip Devices</b>	IR140CSP	NA	150	32	60	500	0		3.2E+06	287
	IR140CSP	NA	150	32	60	500	0		3.2E+06	287
	Total				120		0		6.4E+06	143
<b>SMA</b>	MBRA120	4501	100	16	154	1000	0		3.7E+05	2462
<b>SMB</b>	10BQ015	2702	100	12	231	1000	0		5.6E+05	1641
	10BQ040	4301	125	32	77	1000	0		1.4E+06	658
	Total				308		0		2.0E+06	470
<b>SMC</b>	30BQ015	3202	100	12	77	1000	0		1.9E+05	4924
	30BQ040	1002	125	32	231	1000	0		4.2E+06	219
	30BQ040	2702	125	32	231	1000	0		4.2E+06	219
	30BQ040	5001	125	32	77	1000	0		1.4E+06	658
	30BQ100	3202	125	80	77	1000	0		1.4E+06	658
	Total					693		0		1.1E+07
<b>SOD123</b>	MBR0520	4801	100	16	77	1000	0		1.9E+05	4924
	MBR0530	4001	125	24	231	1000	0		4.2E+06	219
	Total				308		0		4.4E+06	210
<b>SOD323</b>	MBRX540	2002	125	32	231	1000	0		4.2E+06	219
<b>SOT223</b>	20CJQ045	4401	125	36	231	1000	0		4.2E+06	219
	20CJQ100	4401	125	80	231	1000	0		4.2E+06	219
	Total				462		0		8.4E+06	110
<b>SOT23</b>	BAT54C	4201	125	32	231	1000	0		4.2E+06	219
<b>TO-220</b>	19TQ015	4801	100	12	72	1000	0		1.7E+05	5265
	42CTQ030	1001	125	24	144	1000	0		2.6E+06	352
	25CTQ045	2002	125	36	114	1000	0		2.1E+06	445
	30CTQ045	1301	125	36	72	1000	0		1.3E+06	704
	30CTQ045	4301	125	36	144	1000	0		2.6E+06	352
	30CTQ045	2002	125	36	114	1000	0		2.1E+06	445
	MBR2045CT	4801	125	36	154	1000	0		2.8E+06	329
	16CTQ100	1802	125	80	154	1000	0		2.8E+06	329
	63CTQ100	3801	125	80	231	1000	0		4.2E+06	219
	Total					1199		0		2.1E+07
<b>TO-247</b>	65PQ015	4501	100	12	308	1000	0		7.4E+05	1231
	80CP1015	1002	100	12	231	1000	0		5.6E+05	1641
	72CPQ030	1001	125	24	72	1000	0		1.3E+06	704
	72CPQ030	5001	125	24	77	1000	0		1.4E+06	658
	40CPQ100	4601	125	80	144	1000	0		2.6E+06	352
Total					832		0		6.6E+06	139
<b>SMB</b>	MURS120A	0901	150	160	231	1000	0		2.5E+07	37

### Fast Recovery Epitaxial Diode (FRED)

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL
<b>TO-220</b>	HFA15TB60	2801	150	480	231	1000	0		2.5E+07	37
	8ETH03	1901	150	240	231	1000	0		2.5E+07	37
	8CTF06	2801	150	480	154	1000	0		1.6E+07	56
	Total				616		0		6.6E+07	14
<b>TO-220 Fullpack</b>	15ETH06FP	0402	150	480	77	1000	0		8.2E+06	112
	8ETH06FP	0402	150	480	77	1000	0		8.2E+06	112
	Total				154		0		1.6E+07	56
<b>TO-247</b>	30EPH03	2201	150	240	154	1000	0		1.6E+07	56
	30EPH06	1201	150	480	154	1000	0		1.6E+07	56
	30EPH06	3401	150	480	308	1000	0		3.3E+07	28
	Total				616		0		6.6E+07	14
<b>D2Pak (TO-263)</b>	HFA04TB60S	3601	150	480	77	1000	0		8.2E+06	112
<b>SOT-227</b>	HFA80FA120	4201	150	960	27	1000	0		2.9E+06	318

### Other Input/Output Devices

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL
<b>SCR: D2Pak (TO-263)</b>	25TTS12S	0700	150	960	196	1000	0		2.1E+07	44
<b>SCR: TO-220</b>	10TTS08	2002	150	640	114	1000	0		1.2E+07	75
<b>Input Rectifier: TO-220</b>	20ETS16	1702	150	1280	77	1000	0		8.2E+06	112
	20ETS16	1901	150	1280	50	1000	0		5.3E+06	172
	Total				127		0		1.4E+07	68
<b>Input Rectifier: TO-247</b>	40EPS16	1901	150	1280	50	1000	0		5.3E+06	172

## 4.2.2 Temperature Cycling

### Schottky

Category	Part Number	Date Code	Temperature Excursion	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 250	# of failures @ 500	# of failures @ 1000
<b>D2Pak (TO-263) &amp; TO-262</b>	18TQ045S	0501	-55°C/150°C	0	154	1000	0		0	0	0
	20CTQ150S	1602	-55°C/150°C	0	154	1000	0		0	0	0
	30CTQ045S	1401	-55°C/150°C	0	84	1000	0		0	0	0
	40L15CT	4001	-55°C/150°C	0	231	1000	0		0	0	0
	42CTQ030S	0501	-55°C/150°C	0	154	1000	0		0	0	0
	43CTQ100	4001	-55°C/150°C	0	231	1000	0		0	0	0
	MBR2045CT	2002	-55°C/150°C	0	114	1000	0		0	0	0
	<b>Total</b>					1122		0	0	0	0
<b>D-Pak &amp; I-Pak (TO-252)</b>	12CWQ06FN	2602	-55°C/150°C	0	231	1000	0		0	0	0
	50WQ04FN	2501	-55°C/150°C	0	77	1000	0		0	0	0
	<b>Total</b>				308		0	0	0	0	
<b>D61</b>	111CNQ045	4001	-55°C/150°C	0	77	1000	0		0	0	0
	112CNQ030A	2801	-55°C/150°C	0	231	1000	0		0	0	0
	115CNQ015A	3001	-55°C/150°C	0	77	1000	0		0	0	0
	80CNT020ASM	3902	-55°C/150°C	0	77	1000	0		0	0	0
	83CNQ100A	3002	-55°C/150°C	0	231	1000	0		0	0	0
	<b>Total</b>				693		0	0	0	0	
<b>DO201</b>	31DQ04	2001	-55°C/150°C	0	308	1000	0		0	0	0
<b>DO41</b>	11DQ10	3801	-55°C/150°C	0	154	1000	0		0	0	0
	11DQ10	3802	-55°C/150°C	0	231	1000	0		0	0	0
	<b>Total</b>				385		0	0	0	0	
<b>DO5</b>	55HQ030	4302	-55°C/150°C	0	60	1000	0		0	0	0
	95HQ015	1902	-55°C/150°C	0	144	1000	0		0	0	0
	<b>Total</b>				204		0	0	0	0	
<b>Flip Chip Devices</b>	IR140CSP	NA	-40°C/125°C	0	60	500	0		0	0	0
	IR140CSP	NA	-40°C/125°C	0	60	500	0		0	0	0
	IR1H40CSP	NA	-40°C/125°C	0	60	500	0		0	0	0
	IR1H40CSP	NA	-40°C/125°C	0	60	500	0		0	0	0
	<b>Total</b>				240		0	0	0	0	
<b>SMA</b>	10MQ040N	0701	-55°C/150°C	0	308	1000	0		0	0	0
	10MQ100	2001	-55°C/150°C	0	308	1000	0		0	0	0
	10MQ100	0202	-55°C/150°C	0	308	1000	0		0	0	0
	MBRA120	4501	-55°C/150°C	0	77	1000	0		0	0	0
	<b>Total</b>				1001		0	0	0	0	
<b>SMB</b>	10BQ015	2702	-55°C/150°C	0	231	1000	0		0	0	0
	10BQ040	3801	-55°C/150°C	0	154	1000	0		0	0	0
	10BQ040	4301	-55°C/150°C	0	77	1000	0		0	0	0
	<b>Total</b>				462		0	0	0	0	
<b>SMC</b>	30BQ015	3202	-55°C/150°C	0	77	1000	0		0	0	0
	30BQ040	2702	-55°C/150°C	0	231	1000	0		0	0	0
	30BQ040	5001	-55°C/150°C	0	154	1000	0		0	0	0
	30BQ100	3202	-55°C/150°C	0	77	1000	0		0	0	0
	30BQ100	3801	-55°C/150°C	0	154	1000	0		0	0	0
	30BQ100	2001	-55°C/150°C	0	308	1000	0		0	0	0
	<b>Total</b>				1001		0	0	0	0	
<b>SOD123</b>	MBR0520	4801	-55°C/150°C	0	77	1000	0		0	0	0
	MBR0540	4401	-55°C/150°C	0	231	1000	0		0	0	0
	<b>Total</b>				308		0	0	0	0	
<b>SOD323</b>	BAT54WS	4001	-55°C/150°C	0	231	1000	0		0	0	0
	MBRX540	2002	-55°C/150°C	0	231	1000	0		0	0	0
	<b>Total</b>				462		0	0	0	0	
<b>SOT223</b>	20CJQ045	4401	-55°C/150°C	0	154	1000	0		0	0	0
	20CJQ100	4401	-55°C/150°C	0	77	1000	0		0	0	0
	<b>Total</b>				231		0	0	0	0	
<b>TO-220</b>	62CTQ030	3801	-55°C/150°C	0	77	1000	0		0	0	0
	19TQ015	4801	-55°C/150°C	0	154	1000	0		0	0	0
	25CTQ045	2002	-55°C/150°C	0	114	1000	0		0	0	0
	30CTQ045	4301	-55°C/150°C	0	308	1000	0		0	0	0
	MBR20100CT	0301	-55°C/150°C	0	60	1000	0		0	0	0
	MBR2045CT	4801	-55°C/150°C	0	77	1000	0		0	0	0
	<b>Total</b>				713		0	0	0	0	
<b>TO-244</b>	40CPQ060	2102	-55°C/150°C	0	231	1000	0		0	0	
<b>TO-247</b>	30CPQ100	0301	-55°C/150°C	0	60	1000	0		0	0	0
	65PQ015	4501	-55°C/150°C	0	308	1000	0		0	0	0
	65PQ015	3001	-55°C/150°C	0	154	1000	0		0	0	0
	72CPQ030	1001	-55°C/150°C	0	72	1000	0		0	0	0
	72CPQ030	5001	-55°C/150°C	0	77	1000	0		0	0	0
	80CPT015	1002	-55°C/150°C	0	231	1000	0		0	0	0
	80CPTN015	2002	-55°C/150°C	0	77	1000	0		0	0	0
	<b>Total</b>				979		0	0	0	0	

### Fast Recovery Epitaxial Diode (FRED)

Category	Part Number	Date Code	Temperature Excursion	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 250	# of failures @ 500	# of failures @ 1000
<b>D2Pak (TO-263) &amp; TO-262</b>	HFA04TB60S	3601	-55°C/150°C	0	77	1000	0		0	0	0
<b>SMB</b>	MURS120A	0901	-55°C/150°C	0	231	1000	0		0	0	0
	MURS120A	1702	-55°C/150°C	0	77	1000	0		0	0	0
	Total				308		0		0	0	0
<b>SOT227</b>	HFA80FA120	4201	-55°C/150°C	0	27	1000	0		0	0	0
<b>TO220</b>	8CTF06	2801	-55°C/150°C	0	72	1000	0		0	0	0
	HFA15TB60	2801	-55°C/150°C	0	108	1000	0		0	0	0
	Total				180		0		0	0	0
<b>TO220 Fullpack</b>	15ETH06FP	0402	-55°C/150°C	0	77	1000	0		0	0	0
	15ETL06FP	2302	-55°C/150°C	0	231	1000	0		0	0	0
	8ETH06FP	0402	-55°C/150°C	0	77	1000	0		0	0	0
	Total				385		0		0	0	0
<b>TO-247</b>	30EPH06	1201	-55°C/150°C	0	154	1000	0		0	0	0

### Other Input/Output Devices

Category	Part Number	Date Code	Test Temperature	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	Equivalent device hours @ 90C & 80% of rated voltage	Failure Rate in FITs at 60% UCL	
<b>SCR: D2Pak (TO-263) &amp; TO-262</b>	25TTS12S	0700	-55°C/150°C	0	200	1000	0		0	0	0
<b>Input Rectifier: D2Pak (TO-263) &amp; TO-262</b>	20ETS12S	2602	-55°C/150°C	0	80	1000	0		0	0	0
<b>Input Rectifier: D-Pak (TO-252)</b>	8EWS06S	2002	-55°C/150°C	0	231	1000	0		0	0	0
	8EWS16S	0201	-55°C/150°C	0	77	1000	0		0	0	0
	Total				308		0		0	0	0
<b>Input Rectifier: TO-220</b>	15ETS16	0205	-55°C/150°C	0	231	1000	0		0	0	0
	20ETS16	1702	-55°C/150°C	0	50	1000	0		0	0	0
	20ETS16	1901	-55°C/150°C	0	50	1000	0		0	0	0
	Total				331		0		0	0	0
<b>Input Rectifier: TO-247</b>	40EPS16	1901	-55°C/150°C	0	50	1000	0		0	0	0

### 4.2.3 Power Cycling

#### Schottky

Category	Part Number	Date Code	Junction Temperature Excursion	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ midpoint	# of failures @ end of test
<b>TO-247</b>	65PQ015	3902	100°C	0	80	5000	0		0	0
	72CPQ030	1001	100°C	0	72	5000	0		0	0
	80CPT015	1002	100°C	0	108	5000	0		0	0
	80CPTN015	2002	100°C	0	77	5000	0		0	0
	<b>Total</b>					<b>337</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>D2Pak (TO-263) &amp; TO-262</b>	18TQ045S	0501	100°C	0	154	8572	0		0	0
	20CTQ150S	1602	100°C	0	154	8572	0		0	0
	30CTQ045S	1401	100°C	0	84	8572	0		0	0
	32CTQ045S	2002	100°C	0	114	8572	0		0	0
	42CTQ030S	0501	100°C	0	154	8572	0		0	0
	43CTQ100	4001	100°C	0	108	8572	0		0	0
	MBRB2045CT	2002	100°C	0	114	8572	0		0	0
<b>Total</b>					<b>882</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>D61</b>	113CNQ100ASM	3001	100°C	0	72	5000	0		0	0
	80CNT020ASM	3902	100°C	0	77	5000	0		0	0
	83CNQ100A	3002	100°C	0	120	5000	0		0	0
	89CNQ150ASM	3601	100°C	0	38	5000	0		0	0
<b>Total</b>					<b>307</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>DO204</b>	50SQ100	3701	100°C	0	154	15000	0		0	0
<b>DO5</b>	95HQ015	2502	100°C	0	30	5000	0		0	0
<b>D-Pak &amp; I-Pak (TO-252)</b>	12CWQ06FN	2602	100°C	0	231	15000	0		0	0
	50WQ04FN	2501	100°C	0	77	15000	0		0	0
<b>Total</b>					<b>308</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>SMA</b>	10MQ040N	0701	100°C	0	308	15000	0		0	0
	10MQ100	0202	100°C	0	308	15000	0		0	0
	MBRA120	4501	100°C	0	108	15000	0		0	0
<b>Total</b>					<b>724</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>SMB</b>	10BQ015	2702	100°C	0	231	15000	0		0	0
	10BQ040	4301	100°C	0	77	15000	0		0	0
	10BQ100	1102	100°C	0	231	15000	0		0	0
	10BQ100	2902	100°C	0	231	15000	0		0	0
<b>Total</b>					<b>770</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>SMC</b>	30BQ015	3202	100°C	0	77	15000	0		0	0
	30BQ040	5001	100°C	0	108	15000	0		0	0
	30BQ100	3202	100°C	0	77	15000	0		0	0
	30BQ100	3801	100°C	0	72	15000	0		0	0
<b>Total</b>					<b>334</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>SOD123</b>	MBR0520	4801	100°C	0	77	15000	0		0	0
	MBR0540	4401	100°C	0	231	15000	0		0	0
	MBRX540	2002	100°C	0	231	15000	0		0	0
<b>Total</b>					<b>539</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>SOT223</b>	20CJQ045	4401	100°C	0	77	15000	0		0	0
	20CJQ100	4401	100°C	0	154	15000	0		0	0
	BAT54AW	4401	100°C	0	231	15000	0		0	0
<b>Total</b>					<b>462</b>		<b>0</b>	<b>0</b>	<b>0</b>	

#### Fast Recovery Epitaxial Diode (FRED)

Category	Part Number	Date Code	Junction Temperature Excursion	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ midpoint	# of failures @ end of test
<b>SOT227</b>	HFA80FA120	4201	100°C	0	27	15000	0		0	0
<b>TO-220</b>	8CTF06	2801	100°C	0	72	8572	0		0	0
	8ETH03	1901	100°C	0	231	8572	0		0	0
	HFA15TB60	2801	100°C	0	108	8572	0		0	0
	20ETS16	1702	100°C	0	50	8572	0		0	0
<b>Total</b>					<b>461</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>TO-220 Fullpack</b>	15ETH06FP	0402	100°C	0	77	8572	0		0	0
	8ETH06FP	0402	100°C	0	77	8572	0		0	0
<b>Total</b>					<b>154</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>D2Pak (TO-263) &amp; TO-262</b>	HFA04TB60S	3601	100°C	0	35	8572	0		0	0
<b>SMB</b>	MURS120A	0901	100°C	0	126	15000	0		0	0

#### Other Input/Output Devices

Category	Part Number	Date Code	Junction Temperature Excursion	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ midpoint	# of failures @ end of test
<b>Input Rectifier: D-Pak &amp; I-Pak (TO-252)</b>	8EWS06S	2002	100°C	0	231	15000	0		0	0
	8EWS16S	0201	100°C	0	42	15000	0		0	0
<b>Total</b>					<b>273</b>		<b>0</b>	<b>0</b>	<b>0</b>	



## 4.2.4 High Humidity, High Temperature Reverse Bias (H3TRB)

### Schottky

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 168 hours	# of failures @ 500 hours	# of failures @ 1000 hours
<b>D2Pak (TO-263) &amp; TO-262</b>	18TQ045S	0501	85°C/85%RH	45	154	1000	0		0	0	0
	42CTQ030S	0501	85°C/85%RH	24	154	1000	0		0	0	0
	43CTQ100	4001	85°C/85%RH	80	108	1000	0		0	0	0
	<b>Total</b>				<b>416</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>D61</b>	111CNQ045	4001	85°C/85%RH	36	76	1000	0		0	0	0
	112CNQ030A	2801	85°C/85%RH	24	108	1000	0		0	0	0
	80CNT020ASM	3902	85°C/85%RH	16	77	1000	0		0	0	0
	85CNQ015ASM	2502	85°C/85%RH	12	231	1000	0		0	0	0
	87CNQ020A	2502	85°C/85%RH	16	114	1000	0		0	0	0
<b>Total</b>				<b>606</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>	
<b>DO201</b>	31DQ04	2001	85°C/85%RH	32	308	1000	0		0	0	0
<b>DO204</b>	50SQ100	3701	85°C/85%RH	80	154	1000	0		0	0	0
<b>DO41</b>	11DQ10	3801	85°C/85%RH	80	72	1000	0		0	0	0
<b>DO5</b>	95HQ015	1902	85°C/85%RH	12	144	1000	0		0	0	0
<b>D-Pak &amp; I-Pak (TO-252)</b>	50WQ04FN	2501	85°C/85%RH	32	77	1000	0		0	0	0
<b>Flip Chip Devices</b>	IR140CSP	NA	85°C/85%RH	32	60	500	0		0	0	0
	IR140CSP	NA	85°C/85%RH	32	60	500	0		0	0	0
<b>Total</b>					<b>120</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>SMA</b>	10MQ100	2001	85°C/85%RH	80	308	1000	0		0	0	0
	MBRA120	4501	85°C/85%RH	16	231	1000	0		0	0	0
<b>Total</b>					<b>539</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>SMB</b>	10BQ040	3801	85°C/85%RH	32	72	1000	0		0	0	0
	10BQ040	2001	85°C/85%RH	32	308	1000	0		0	0	0
	10BQ040	4301	85°C/85%RH	32	77	1000	0		0	0	0
	10BQ100	2902	85°C/85%RH	80	231	1000	0		0	0	0
<b>Total</b>					<b>688</b>		<b>0</b>		<b>0</b>	<b>0</b>	
<b>SMC</b>	30BQ040	5001	85°C/85%RH	32	77	1000	0		0	0	0
	30BQ100	3202	85°C/85%RH	80	77	1000	0		0	0	0
	30BQ100	3801	85°C/85%RH	80	72	1000	0		0	0	0
<b>Total</b>					<b>226</b>		<b>0</b>		<b>0</b>	<b>0</b>	
<b>SOD123</b>	MBR0540	4401	85°C/85%RH	32	231	1000	0		0	0	0
<b>SOD323</b>	BAT54WS	4001	85°C/85%RH	32	231	1000	0		0	0	0
	MBRX540	2002	85°C/85%RH	32	231	1000	0		0	0	0
<b>Total</b>					<b>462</b>		<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>
<b>SOT223</b>	20CJQ045	4401	85°C/85%RH	36	77	1000	0		0	0	0
	20CJQ100	4401	85°C/85%RH	80	154	1000	0		0	0	0
<b>Total</b>					<b>231</b>		<b>0</b>		<b>0</b>	<b>0</b>	
<b>SOT323</b>	BAT54AW	4401	85°C/85%RH	32	231	1000	0		0	0	0
<b>TO-220</b>	19TQ015	4801	85°C/85%RH	12	72	1000	0		0	0	0
	30CTQ045	1301	85°C/85%RH	36	72	1000	0		0	0	0
	30CTQ045	4301	85°C/85%RH	36	144	1000	0		0	0	0
	40CPQ045	3401	85°C/85%RH	36	77	1000	0		0	0	0
	63CTQ100	3801	85°C/85%RH	80	77	1000	0		0	0	0
	MBR20100CT	0301	85°C/85%RH	80	60	1000	0		0	0	0
	MBR2045CT	4801	85°C/85%RH	36	154	1000	0		0	0	0
<b>Total</b>					<b>656</b>		<b>0</b>		<b>0</b>	<b>0</b>	
<b>TO-244</b>	40CPQ060	2102	85°C/85%RH	48	231	1000	0		0	0	0
<b>TO-247</b>	30CPQ100	0301	85°C/85%RH	80	60	1000	0		0	0	0
	65PQ015	4501	85°C/85%RH	12	308	1000	0		0	0	0
	65PQ015	3001	85°C/85%RH	12	154	1000	0		0	0	0
	72CPQ030	1001	85°C/85%RH	24	72	1000	0		0	0	0
	72CPQ030	5001	85°C/85%RH	24	77	1000	0		0	0	0
	80CPT015	1002	85°C/85%RH	12	231	1000	0		0	0	0
<b>Total</b>					<b>902</b>		<b>0</b>		<b>0</b>	<b>0</b>	

**Fast Recovery Epitaxial Diode (FRED)**

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 168 hours	# of failures @ 500 hours	# of failures @ 1000 hours
<b>D2Pak (TO-263) &amp; TO-262</b>	HFA04TB60S	3601	85°C/85%RH	100	35	1000	0		0	0	0
<b>SOT-227</b>	HFA80FA120	4201	85°C/85%RH	100	27	1000	0		0	0	0
<b>TO-220</b>	8ETH03	1901	85°C/85%RH	100	231	1000	0		0	0	0
	HFA15TB60	2801	85°C/85%RH	100	108	1000	0		0	0	0
	Total				339		0		0	0	0
<b>TO-220 Fullpack</b>	15ETH06FP	0402	85°C/85%RH	100	77	1000	0		0	0	0
	8ETH06FP	0402	85°C/85%RH	100	77	1000	0		0	0	0
	Total				154		0		0	0	0
<b>TO-247</b>	30EPH06	3401	85°C/85%RH	100	144	1000	0		0	0	0

**Other Input/Output Devices**

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode	# of failures @ 168 hours	# of failures @ 500 hours	# of failures @ 1000 hours
<b>D-Pak &amp; I-Pak (TO-252)</b>	8EWS16S	0201	85°C/85%RH	100	77	1000	0		0	0	0
<b>TO-220</b>	15ETS16	0205	85°C/85%RH	100	231	1000	0		0	0	0
	20ETS16	1702	85°C/85%RH	100	77	1000	0		0	0	0
	Total				308		0		0	0	0
<b>D2Pak (TO-263) &amp; TO-262</b>	25TTS12S	0700	85°C/85%RH	100	196	1000	0		0	0	0
<b>TO-220</b>	10TTS08	2002	85°C/85%RH	100	231	1000	0		0	0	0

## 4.2.5 Autoclave

### Schottky

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode
<b>D2Pak (TO-263) &amp; TO-262</b>	32CTQ045S	2002	121°C/15PSIG	0	114	96	0	
	40L15CT	4001	121°C/15PSIG	0	231	96	0	
	42CTQ030S	0501	121°C/15PSIG	0	154	96	0	
	MBRB2045CT	2002	121°C/15PSIG	0	114	96	0	
						613	0	
<b>D61</b>	112CNQ030A	2801	121°C/15PSIG	0	77	96	0	
	113CNQ100ASM	3001	121°C/15PSIG	0	77	96	0	
	80CNT020ASM	3902	121°C/15PSIG	0	77	96	0	
	83CNQ100A	3002	121°C/15PSIG	0	231	96	0	
	85CNQ015ASM	2502	121°C/15PSIG	0	231	96	0	
					693	0		
<b>DO201</b>	31DQ04	3302	121°C/15PSIG	0	231	96	0	
<b>SMB</b>	10BQ100	1102	121°C/15PSIG	0	231	96	0	
	10BQ100	2902	121°C/15PSIG	0	231	96	0	
					462	0		
<b>SMC</b>	30BQ015	3202	121°C/15PSIG	0	77	96	0	
	30BQ040	1002	121°C/15PSIG	0	231	96	0	
	30BQ100	3202	121°C/15PSIG	0	77	96	0	
					385	0		
<b>SOD323</b>	MBRX540	2002	121°C/15PSIG	0	231	96	0	
<b>SOT223</b>	20CJQ045	4401	121°C/15PSIG	0	154	96	0	
	20CJQ100	4401	121°C/15PSIG	0	77	96	0	
					231	0		
<b>TO-220</b>	19TQ015	4801	121°C/15PSIG	0	36	96	0	
	30CTQ045	2002	121°C/15PSIG	0	114	96	0	
	MBR20100CT	0301	121°C/15PSIG	0	60	96	0	
	MBR2045CT	4801	121°C/15PSIG	0	77	96	0	
					267	0		
<b>TO-247</b>	65PQ015	4501	121°C/15PSIG	0	231	96	0	

### Fast Recovery Epitaxial Diode (FRED)

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode
<b>SMB</b>	MURS120A	0901	121°C/15PSIG	0	231	96	0	
<b>TO-220 Fullpack</b>	15ETH06FP	0402	121°C/15PSIG	0	77	96	0	
	8ETH06FP	0402	121°C/15PSIG	0	77	96	0	
					154	0		
<b>TO-247</b>	HFA16TB120	4002	121°C/15PSIG	0	231	96	0	

### Other Input/Output Devices

Category	Part Number	Date Code	Environmental Conditions	Applied Voltage	Test Quantity	Test Duration	# of failures	Failure mode
<b>D2Pak (TO-263) &amp; TO-262</b>	20ETS12S	2602	121°C/15PSIG	0	80	96	0	
<b>TO-220</b>	15ETS16	0205	121°C/15PSIG	0	114	96	0	
	20ETS16	1702	121°C/15PSIG	0	77	96	0	
	10TTS08	2002	121°C/15PSIG	0	231	96	0	
					422	0		

## 5.0 SUMMARY OF RESULTS: ACCELERATED LIFE STRESS TESTING

The current results of experiments completed or being conducted at International Rectifier to determine the appropriate accelerated life stress models are presented in the following sections. The table below lists those experiments which have been completed and appear in the referenced Reliability Reports. Where applicable, the values of the activation energies reported in the corresponding references are included.

Acceleration Experiments	Activation Energy
HTRB - Thermal Acceleration	1.0 eV
HTRB - Bias Acceleration	311 V
Gate Stress- Thermal Acceleration	0.4 eV
Gate Stress- Bias Acceleration	0.065 MV/cm
Gate Stress - Bias Acceleration (n-channel)	0.108 MV/cm
Gate Stress - Bias Acceleration (p-channel)	0.048 MV/cm
Power Cycling / TO-220	0.31-0.4 eV

