ALERT

1. TITLE *(Class, Function, Type, etc.)*	2. DOCUMENT NUMBER
Intermittent Operating Life, QCI Group C6, Power MOSFET	**FV5-A-11-01A1 (Update)**
	3. DATE *(DD-MMM-YY)* **23 February 2011**

4. MANUFACTURER AND ADDRESS	5. PART NUMBER	6. NATIONAL STOCK NUMBER
International Rectifier **HiRel Business Unit** **205 Crawford Street** **Leominster, MA 01453**	**Table 6 and 7**	**FSC5961**
	7. SPECIFICATION **MIL-PRF-19500**	8. TYPE DESIGNATOR **QPL-19500**
	9. LOT DATE CODE START **0903**	10. LOT DATE CODE END **1006**

11. MANUFACTURER'S POINT OF CONTACT	12. CAGE	13. MANUFACTURER'S FAX
Soon Ng / Customer Services **Paul Hebert / Technical Contact**	**69210**	**(978) 537-4246**

14. MFR. POC PHONE	15. MANUFACTURER'S E-MAIL
(978) 534-5776	**Sng2@irf.com, phebert@irf.com**

16. CROSS REFERENCE VENDOR	17. CROSS REFERENCE CAGE	18. CROSS REFERENCE PART
NA		

19. PROBLEM DESCRIPTION / DISCUSSION / EFFECT

THIS REVISION (A1) PROVIDES FINAL INFORMATION FROM INTERNATIONAL RECTIFIER CONCERNING THE QCI GROUP C6 TEST STATUS. TABLE 6 SHOWS FINAL IOL TEST RESULTS.

This alert provides information on a failure investigation involving MIL-PRF-19500, QCI Group C6 Intermittent Operating Life testing on SMD packaged products at International Rectifier (IR). Intermittent Operating Life (IOL) is performed in accordance with MIL-STD-750, Test Method 1042, Condition D. IOL test is performed to investigate the reliability of devices subjected to extensive thermo mechanical stresses and consist of applying power to the device for the time necessary to achieve a +100°C (+15°C, -10C) rise in junction temperature followed by an off period for the time necessary for the junction to cool. Forced air cooling is applied to cool the device during the off period. The power level is chosen to ensure that at the end of the heating cycle, the case temperature is not more than 15°C below the junction temperature. The rise in junction temperature during the on period is calculated and monitored by thermocouple attached to the case. Refer to the Delta T graph herein to depicting typical IOL cycles (Fig. 1).

Section continued on page 2…

20. ACTION TAKEN/PLANNED

-In order to make the SMD part robust and improve the reliability margin, IR made the following changes to the bonding system;

1) *Use a more ductile wire* - Change the 20 and 15 mil aluminum wire type to a more ductile aluminum wire. The effect is better stress relief during temperature excursions.
2) *Bond Optimization* - Wire bond techniques were optimized to maximize the effective bond interface and post IOL strength.

-The new bond system was re-qualified and passed the QCI Group C6 (6,000 IOL Cycles) requirements.

- In addition to C6, to verify robustness and reliability margin, IOL was run up to 10,000 cycles with no failures.
- In addition to C6, post IOL destruct bond pull was performed by IR and showed passing results (10,000 IOL cycles).
- Three consecutive inspection lots were tested with passing results (6,000 IOL and post destruct bond pull).
- Effective part date code for wire bond system changes is 1022.
- Qualification data was submitted to DLA Land and Maritime for their review (DSCC).

-As a precaution, IR has conducted 6,000 IOL cycles with 100% post destruct bond pull on each inspection lot qualified in JANS B4.
-Failure Notification letters were issued to customers that procured parts listed in Table 2 and 3 herein.
-IR will offer replacement for parts listed in Table 2 and 3, if requested.

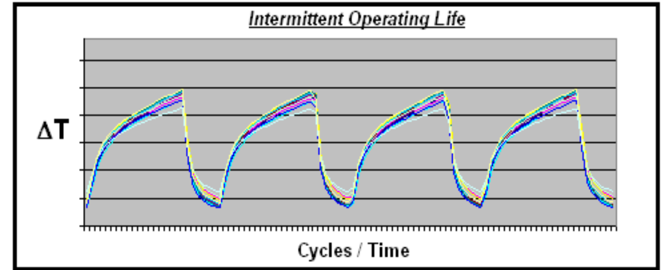
21. DATE MFR. NOTIFIED	22. MANUFACTURER'S RESPONSE	23. ORIGINATOR ADDRESS/POINT OF CONTACT
NA	☐ REPLY ATTACHED ☐ NO REPLY	**International Rectifier** **HiRel Business Unit** **205 Crawford Street** **Leominster, MA 01453**

24. GIDEP REPRESENTATIVE	25. SIGNATURE	26. DATE
Paul Hebert	[signature]	**Feb 23, 2011**

The "On" time for the system is fixed at 120 seconds and the "Off" time is fixed at 180 seconds. The system utilizes a 10-Amp 24V / 48V power supply for each device board. The device power is adjusted to reach a delta case temperature of approximately 100C at the end of the 120 sec "On" time. MOSFET devices are operated in the linear region to achieve the required power dissipation with minimal current flow.

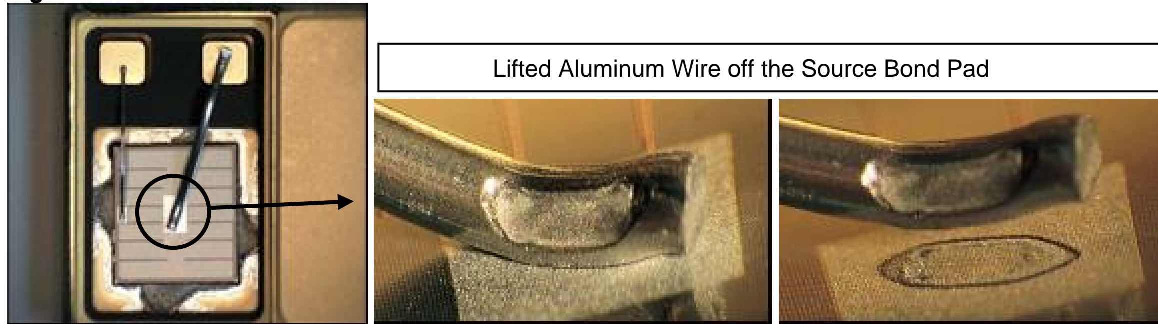
For MIL-PRF-19500 JANS QCI, IOL is performed on each inspection lot in Group B4, where devices are subjected to 2,000 IOL cycles (n=12 devices for small lot conformance inspection). In addition, IOL is performed on a periodic basis (once a year) in QCI Group C6, where devices are subjected to a total of 6,000 cycles. Note that both tests are classified as destructive.

Figure 1 - Typical IOL Cycles



On February 16, 2010, IR experienced a QCI Group C6 (periodic inspection) failure with the SMD package family. A MOSFET device lot failed Periodic Inspection electrical test following 6,000 Intermittent Operating Life cycles. The failure consisted of open circuit, due to a lifted wedge bond (20 mil aluminum) off the die source metallization interface (Reference Fig. 2). The lot date code was 0949.

Figure 2 – Bond Failure Exhibit



Due to time constraints in IOL, the initial reach back was only performed on select lot intervals to cover the production period of late 2008 and through 2009, to help identify the scope and bracket the range. The first level containment action indicated the containment scope of IOL failure was limited to Gen 4 MOSFET products built after DC 0949.

As a second level containment action and to use an abundance of care, the scope of problem (or risk) was further defined to include all power MOSFET devices packaged in SMD 1 and SMD 2 and constructed with either 20 or 15 mil aluminum wire. IR proceeded to conduct IOL testing on each inspection lots produced starting from end of 2008. IR also performed a 100% destruct wire bond pull test following the 6,000 IOL cycles to detect wire bond failures in accordance with MIL-STD-750, Test Method 2037 (condition D, post seal limits).

The summary of those post C6 electrical tests (as of January 7, 2011) are shown below in Table 1.

Table 1 – MIL-PRF-19500, QCI C6 IOL Electrical Test Summary

Package Type	Al Wire Size	Lots Pass	IOL Lot Failure	% Lots Pass
SMD 1	15 mil	4	0	100%
SMD 1	20 mil	13	2	87%
SMD 2	15 mil	5	0	100%
SMD 2	20 mil	19	9	68%

An analysis of the (9) SMD 2 inspection lots that failed post C6 IOL electrical test shows marginal device failure with the 20 mil source wires. The 9 lots consisted of a total of 127 samples of which 30 devices failed post C6 electrical. When accounting for all wire bonds, 47 out of 244 wires (20 mils source wires) failed post IOL (or ~20%) by lifting off the source bond pad. Also note that these devices passed all other JANS QCI test requirements including QCI Group B4 (2,000 IOL cycles), QCI Group B5 (accelerated life, and post bond strength) and Group B3 (100 temperature cycles, -55 to 150C, and post bond strength).

Notification:
Based on the C6 IOL tests conducted, it has been determined that the subject devices (listed below in Table 2) may present a reliability risk as it relates to the component wire bond interconnection during extended Intermittent Operating Cycles with a high delta T of 100C, or higher, and therefore should be reviewed in relation with the application and ratings. Refer to Table 3 herein for lots that passed electrical test post 6,000 IOL cycles, but exhibited some bond strength test failures when tested in accordance with MIL-STD-750, Test Method 2037 (condition D, post seal limits).

Table 2 – Post C6 IOL Test Results / Failures Detected

Part ID			Device Type				Construction		**Post C6 - 6,000 IOL Cycles**			
Lot #	Part #	LDC	**Gen**	**Size**	**Voltage**	**Type**	Package Type	Wire Size	Sample Qty	**Elect**	**Qty Fail**	# Weak Bond
H759199	IRFN054SCX	M0935	G3	4	60V	N-Ch	**SMD 1**	**20 mils**	7	fail	2	6
H917349	JANSR2N7394U	0949	G4	5	60V	N-Ch			12	fail	5	5
H917349	93-1631-R											
F914651	JANSR2N7467U2	0923	R5	6	30V	N-Ch	**SMD 2**		10	fail	2	3
F914651	IRHNA57Z60											
F914651	93-1508-R											
H915090	JANSR2N7425U	0925	G4	6	100V	P-Ch			10	fail	2	6
D913544	JANSR2N7473U2	0927	R5	6	200V	N-Ch			12	fail	2	2
F914716	JANSR2N7473U2	0927A	R5	6	200V	N-Ch			12	fail	3	6
F914680	JANSR2N7467U2	0929	R5	6	30V	N-Ch			20	fail	5	5
F914680	IRHNA57Z60SCS											
F914680	93-1555A-R											
F914680	93-1588D-R											
F914680	93-1676D-R											
F914680	93-1757D-R											
H787574	JANSR2N7472U2	1004	R5	6	130V	N-Ch			10	fail	1	1
H787574	93-1613A-R											
H787583	JANSR2N7473U2	1004A	R5	6	200V	N-Ch			23	fail	2	7
H787587	JANSR2N7473U2	1004B	R5	6	200V	N-Ch			20	fail	12	16
H917403	JANSR2N7468U2	1005	R5	6	60V	N-Ch			10	fail	1	1

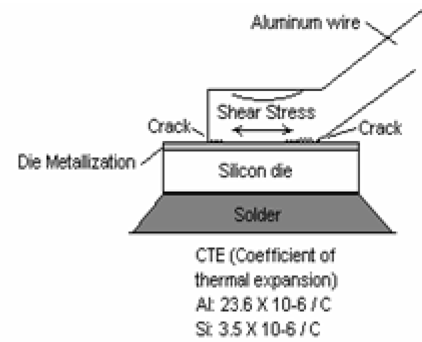
Table 3 – Parts Passed Post C6 IOL Test and Exhibiting Weakened Bonds (REV B)

Part ID			Device Type				Construction		**Post C6 - 6,000 IOL**		
Lot #	Part #	LDC	**Gen**	**Size**	**Voltage**	**Type**	Package Type	Wire Size	Sample Qty	Elect	**# Weak Bond**
H769068	JANTXV2N7236U	M0942	G3	4	100V	P-Ch	**SMD 1**	**15 mils**	6	pass	**3**
H769068	94-6282										
H916989	IRHSNA57064SCS	0929	R5	6	60V	N-Ch	**SMD 2**		12	pass	**3**
H916989	IRHSNA53064SCS										
H916989	97-7019-R										
F914803	IRHLNA797064SCS	0932	R7	6	60V	P-Ch			10	pass	**6**
H784081	IRHNA67260SCS	1005	R6	6	200V	N-Ch			9	pass	**9**
H915139	JANSR2N7468U2	0903	R5	6	60V	N-Ch		**20 mils**	10	pass	**2**
H915139	93-1535D-R										
H915139	93-1589D-R										
D913469	JANSR2N7550U2	0909	R5	6	100V	P-Ch			10	pass	**1**
H914611	JANSR2N7474U2	0911	R5	6	250V	N-Ch			10	pass	**1**
F914637	JANSR2N7469U2	0918	R5	6	100V	N-Ch			22	pass	**2**
F914637	93-1627-R										
H916100	JANSR2N7425U	0928	G4	6	100V	P-Ch			10	pass	**6**
F914756	JANSR2N7473U2	0943A	R5	6	200V	N-Ch			22	pass	**10**
F914756	93-1509-R										
H917357	JANSH2N7469U2	0951	R5	6	100V	N-Ch			45	pass	**6**
H917357	93-1777-H										
H917430	JANSR2N7472U2	1006	R5	6	130V	N-Ch			10	pass	**1**
H917430	93-1613A										

Root Cause:

The failure mechanism is associated to low cycle fatigue that occurs during the temperature excursions from the IOL (delta T=100C, 6,000 IOL cycles). Low cycle fatigue is the result of applied mechanical stress induced by the CTE (coefficient of thermal expansion) mismatch between the silicon and aluminum (see figure 3 herein). Due to the low profile wire loop in the SMD package style, a second applied stress is compounded at the bond heel during temperature excursions. Low cycle fatigue causes the eventual failure of the source bond at the die metal interface. This is driven largely by the large temperature excursions / cycles during IOL which causes metal fatigue (micro-crack) at the bond interface and heel. The stress at the bond heel is aggravated by the small bond exit angle of the large diameter wire, due to the low loop height of the low profile SMD package – this constraint results is minimizing the stress relief during IOL. See figure 4 below for the SMD style package and wire loop orientation.

Figure 3 - Failure Mechanism of Bond Interface with Temperature Cycling



Other contributors to the root cause were reviewed during the investigation:

1) Bonding factors that can act on wire bond life during IOL testing have been reviewed – these include wire bond parameters, wire hardness, wire bond machine changes, including package clamping mechanism. New wire bond clamping fixtures were adopted during the second half of 2009.

2) The IOL system and test set-up conditions were verified to ensure the device was not over stressed or over heated during IOL testing.

The exact root cause is inconclusive due to the marginal nature of the failures. The SMD device failure is likely due to a combination of factors as outlined above. Note that any IOL testing is destructive and the 6,000 IOL cycles performed in Group C6 serves to verify long term performance. In summary, the data presented herein indicates that a total of 771 parts have been tested through C6 IOL, and 37 have failed the post 6,000 cycle electrical test (or ~5%).

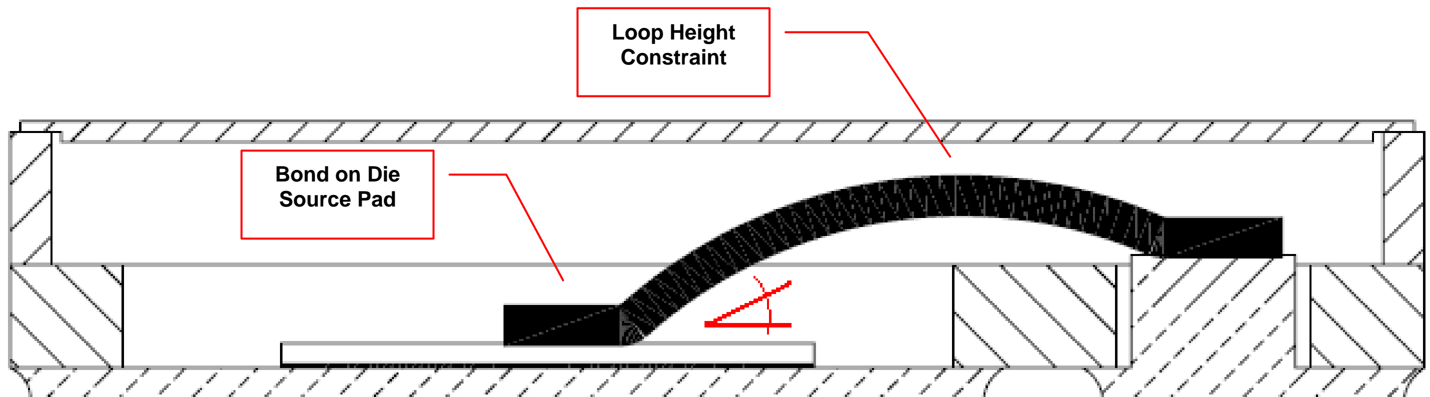


Figure 4 – SMD 2 Cross Sectional View

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TABLE 4 – POST C6 IOL TEST UPDATE (FINAL)

Part Identification			Part Description			Package		Post C6 IOL			
Lot #	Part #	LDC	Gen	Voltage	Type	Type	Wire Size	Test Qty	Elect Test	Qty Fail	# WB Fail
H913776	IRF5N3205SCV	0908	G5	55V	N-Ch	SMD 1	15 mils	4	pass	0	0
H915011	IRL7N1404SCV	0911	R7	40V	N-Ch	SMD 1	15 mils	22	pass	0	0
H638459	JANTX2N7236U	0913	G3	100V	P-Ch	SMD 1	15 mils	4	pass	0	0
H913267	JANTXV2N7219U	0917	G3	200V	N-Ch	SMD 1	15 mils	12	pass	0	1
H722190	JANTX2N7237U	0918	G3	200V	P-Ch	SMD 1	15 mils	4	pass	0	1
H915632	JANTX2N7219U	0926	G3	200V	N-Ch	SMD 1	15 mils	22	pass	0	0
Q918933	JANTX2N7236U	1009	G3	100V	P-Ch	SMD 1	15 mils	22	pass	0	0
H915136	JANSR2N7394U	0902	G4	60V	N-Ch	SMD 1	20 mils	12	pass	0	0
H703912	JANSR2N7269U	0904	G4	200V	N-Ch	SMD 1	20 mils	22	pass	0	0
H715625	93-1213-R	0907	R5	200V	N-Ch	SMD 1	20 mils	22	pass	0	0
H722207	94-6067	0910	G3	60V	N-Ch	SMD 1	20 mils	22	pass	0	0
H695662	JANTX2N7224U	0913	G3	100V	N-Ch	SMD 1	20 mils	7	pass	0	0
H710468	**94-5626**	**0916**	G3	60V	N-Ch	SMD 1	20 mils	10	fail	9	10
H916034	JANSR2N7422U	0917	G4	100V	P-Ch	SMD 1	20 mils	12	pass	0	0
H746712	JANSF2N7269U	0926	G4	200V	N-Ch	SMD 1	20 mils	12	pass	0	0
H746864	IRHN57250SESCS	0928	R5	200V	N-Ch	SMD 1	20 mils	10	pass	0	0
H753855	JANSR2N7422U	0930	G4	100V	P-Ch	SMD 1	20 mils	12	pass	0	0
H917349	**JANSR2N7394U**	**0949**	G4	60V	N-Ch	SMD 1	20 mils	12	fail	5	5
D913449	**JANSR2N7523U2**	**0906**	R5	30V	P-Ch	SMD 2	15 mils	4	fail	1	8
D913456	JANSR2N7524U2	0909	R5	60V	P-Ch	SMD 2	15 mils	6	pass	0	0
H915950	IRHNA597Z60SCS	0910	R5	30V	P-Ch	SMD 2	15 mils	10	pass	0	0
H730497	IRHNA67260SCS	0916	R5	30V	P-Ch	SMD 2	15 mils	10	pass	0	0
F914660	JANSR2N7524U2	0918	R5	60V	P-Ch	SMD 2	15 mils	33	pass	0	0
D913527	IRHNA67264SCS	0920	R6	150V	N-Ch	SMD 2	15 mils	10	pass	0	0
H916108	IRHNA67164SCS	0926	R6	250V	N-Ch	SMD 2	15 mils	10	pass	0	0
H916989	IRHSNA57064SCS	0929	R5	60V	N-Ch	SMD 2	15 mils	12	pass	0	3
H917502	JANSR2N7524U2	1012	R5	60V	P-Ch	SMD 2	15 mils	22	pass	0	0
H710339	JANSR2N7473U2	0903	R5	200V	N-Ch	SMD 2	20 mils	10	pass	0	0
H915139	JANSR2N7468U2	0903	R5	60V	N-Ch	SMD 2	20 mils	10	pass	0	2
H715722	JANSR2N7474U2	0907	R5	250V	N-Ch	SMD 2	20 mils	10	pass	0	0
D913469	JANSR2N7550U2	0909	R5	100V	P-Ch	SMD 2	20 mils	10	pass	0	1
H914611	JANSR2N7474U2	0911	R5	250V	N-Ch	SMD 2	20 mils	10	pass	0	1
H915983	JANSR2N7472U2	0914	R5	130V	N-Ch	SMD 2	20 mils	12	pass	0	0
D913482	JANSR2N7469U2	0915	R5	100V	N-Ch	SMD 2	20 mils	10	pass	0	0
F914641	JANSR2N7467U2	0915	R5	30V	N-Ch	SMD 2	20 mils	12	pass	0	0
H915997	JANSR2N7468U2	0916	R5	60V	N-Ch	SMD 2	20 mils	22	pass	0	0
F914637	JANSR2N7469U2	0918	R5	100V	N-Ch	SMD 2	20 mils	22	pass	0	2
D913497	JANSR2N7472U2	0918	R5	130V	N-Ch	SMD 2	20 mils	10	pass	0	0
H739669	JANSR2N7468U2	0921	R5	60V	N-Ch	SMD 2	20 mils	10	pass	0	0
F914651	**JANSR2N7467U2**	**0923**	R5	30V	N-Ch	SMD 2	20 mils	10	fail	2	3
H915090	**JANSR2N7425U**	**0925**	G4	100V	P-Ch	SMD 2	20 mils	10	fail	2	6
D913544	**JANSR2N7473U2**	**0927**	R5	200V	N-Ch	SMD 2	20 mils	12	fail	2	2
F914716	**JANSR2N7473U2**	**0927A**	R5	200V	N-Ch	SMD 2	20 mils	12	fail	3	6
H916100	JANSR2N7425U	0928	G4	100V	P-Ch	SMD 2	20 mils	10	pass	0	6
F914680	**JANSR2N7467U2**	**0929**	R5	30V	N-Ch	SMD 2	20 mils	20	fail	5	5
H916868	IRHNA7360SESCS	0936	G4	400V	N-Ch	SMD 2	20 mils	22	pass	0	0
F914904	**IRHSNA57Z60SCS**	**0942**	R5	30V	N-Ch	SMD 2	20 mils	12	fail	2	2
F914756	JANSR2N7473U2	0943A	R5	200V	N-Ch	SMD 2	20 mils	22	pass	0	10
H917357	JANSH2N7469U2	0951	R5	100V	N-Ch	SMD 2	20 mils	45	pass	0	6
H787579	JANSR2N7473U2	1004	R5	200V	N-Ch	SMD 2	20 mils	20	pass	0	0
H787583	**JANSR2N7473U2**	**1004A**	R5	200V	N-Ch	SMD 2	20 mils	23	fail	2	7
H787587	**JANSR2N7473U2**	**1004B**	R5	200V	N-Ch	SMD 2	20 mils	20	fail	12	16
H787574	**JANSR2N7472U2**	**1004**	R5	130V	N-Ch	SMD 2	20 mils	10	fail	1	1
H917403	**JANSR2N7468U2**	**1005**	R5	60V	N-Ch	SMD 2	20 mils	10	fail	1	1
H917430	JANSR2N7472U2	1006	R5	130V	N-Ch	SMD 2	20 mils	10	pass	0	1
H799193	JANSR2N7472U2	1011	R5	130V	N-Ch	SMD 2	20 mils	12	pass	0	0
H795377	JANSR2N7473U2	1014	R5	200V	N-Ch	SMD 2	20 mils	22	pass	0	0
								810		**47**	

Assembled in IR Mexico

Lot #	Part #	LDC	Gen	Voltage	Type	Type	Wire Size	Test Qty	Elect Test	Qty Fail	# WB Fail
H769068	JANTXV2N7236U	M0942	G3	100V	P-Ch	SMD 1	15 mils	6	pass	0	3
H727632	IRF5N054SCX	M0920	G5	60V	N-Ch	SMD 1	20 mils	22	pass	0	0
H752185	JANTXV2N7225U	M0931	G3	200V	N-Ch	SMD 1	20 mils	7	pass	0	4
H795231	**94-6067**	**M0935**	G3	60V	N-Ch	SMD 1	20 mils	6	fail	3	5
H759199	**IRFN054SCX**	**M0935**	G3	60V	N-Ch	SMD 1	20 mils	7	fail	2	6

TABLE 5 – POST C6 IOL - AFFECTED DERIVATIVE PART NO.

Part Identification		
Lot #	**Part #**	**LDC**
H915139	93-1535D-R	0903
H915139	93-1589D-R	0903
D913449	IRHNA597Z60SCS	0906
F914637	93-1627-R	0918
F914651	IRHNA57Z60	0923
F914651	93-1588D-R	0923
F914651	93-1508-R	0923
F914680	IRHNA57Z60SCS	0929
F914680	93-1555A-R	0929
F914680	93-1588D-R	0929
F914680	93-1676D-R	0929
F914680	93-1757D-R	0929
H916989	IRHSNA53064SCS	0929
H916989	97-7019-R	0929
F914904	IRHSNA57Z60SCSD	0942
F914904	IRHSNA57Z60D	0942
H917349	93-1631-R	0949
H917357	93-1777-H	0951
H787574	93-1613A-R	1004
H917430	93-1613A	1006
F914756	93-1509-R	0943A
H769068	94-6282	M0942

NOTE: IF REQUESTED, INTERNATIONAL RECTIFIER WILL OFFER REPLACEMENT FOR PARTS LISTED IN TABLE 4 THAT FAILED POST C6 IOL ELECTRICAL TEST AND/OR DESTRUCTIVE BOND STRENGTH SPECIFICATION LIMIT. DERIVATIVE PARTS THAT ARE LISTED IN TABLE 5 WILL ALSO BE REPLACED, IF REQUESTED.