

IR HiRel Constant Acceleration Optimization

By:

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And

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Background

IR HiRel went to DLA and questioned the value of the constant acceleration screen for their JANS Power MOSFET products and requested DLA review IR HiRel constant acceleration process and test data.

DLA Land and Maritime auditors reviewed the constant acceleration procedure and process during the previous DLA facility audit held in 2019. DLA reviewed the constant acceleration test history to evaluate IR HiRel's request.

DLA Land and Maritime completed their evaluation of the constant acceleration history and provided an approval letter to IR HiRel allowing them to omit the 100 percent constant acceleration screening for JANS POWER MOSFETs with stipulations.

IR HiRel is still performing 100 percent constant acceleration screening.

Rationale for IR HiRel Proposal

- IR HiRel had not experienced any constant acceleration failures during product screening other than setup (fixturing) problems for many years.
- Use of automated die attach equipment utilizing eutectic solder die attach.
 - Die placement accuracy.
 - Controlled temperature during the die attach process.
 - Wafer and waffle pack die handling capability.
- No manual handling of the die.

Constant Acceleration Failure History

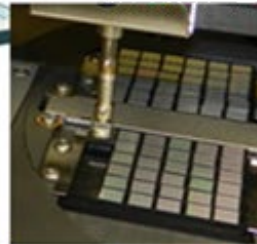
	A	B	C	D	E	F	G
1	Incident Number	Occurrence Date	Part Number	IMR#/Lot	Responsible Item	Title	Description
396	LM11729	11/11/2015 06:40 AM	IRHF6S7230SCS	1010SIO.1	2-2-08-19500-TestScr: Constant Acceleration	IRHF6S7230SCS, 1010SIO.1 ENVIRONMENTAL SCREENING	Lot was dropped with screening traveler D062191G REV A and it should have been D062194G REV L. Parts were ready to go on BURN-IN and because the traveler conditions didn't match the T06, we questions the engineering responsible for this part and the error was found. Lot was screened at temp cycle for -65 to 150 for 10 cycles instead of -55 to 150 for 20 cycles and acceleration was also incorrect _ parts were spun at 30 G with one minute dwell per the procedure instead of 20g . See attached traveler for both travelers. Parts were tested at preburn and one one unit failed out of 753.
174	LM7492	01/07/2014 01:00 AM	JANSF2N7587U3 C	100KX3E.1	2-2-08-19500-TestScr: Constant Acceleration	JANSF2N7587U3C 100KX3E.1 Constant acceleration	720 pcs. were spun at 20KG's and traveler says thay need to be done at 10KG
677	LM5067	03/01/2013 07:43 PM	JANSR2N7389U	100ER7H.1	2-2-08-19500-TestScr: Constant Acceleration	100ER7H.1 JANSR2N7389U Acceleration	Operator ran Constant Acceleration with out securing the lid to the fixture, causing the fixture to bounce around inside the machine. 128 parts were in the fixture at the time. Parts were accelerated again and will continue to process per Bob C. The following parts were in the machine at the time of error. 3/4/13: Parts are at Pind. No other issues with this lot.
640	LM1794	03/12/2012 07:43 AM	IR2130DSCB	1002668.1	2-2-08-19500-TestScr: Constant Acceleration	IR2130DSCB 1002668.1 34pcs Failed at Constant Accel 11.37%	34pcs out of 299 Failed at Constant Accel 11.37%. Reviewed material and spoke with technician, incorrect fixture was used when testing was being done, Technician was informed that we had no fixture for testing , so they tested the parts using a magnetic fixture which the parts slid out from the fixture and were destroyed. Proper fixtures were located and the remainder of the kit passed.
204							
205							

Die Attach Process Equipment

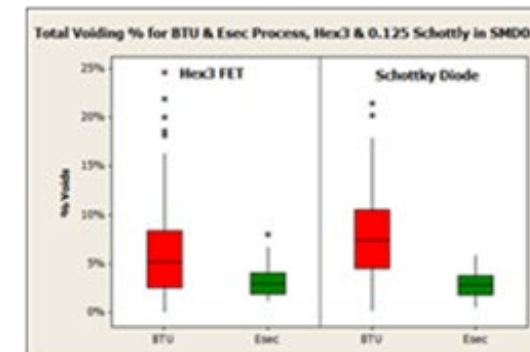
Automated Solder Die Attach – Discrete Products



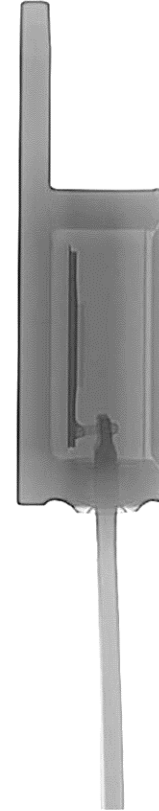
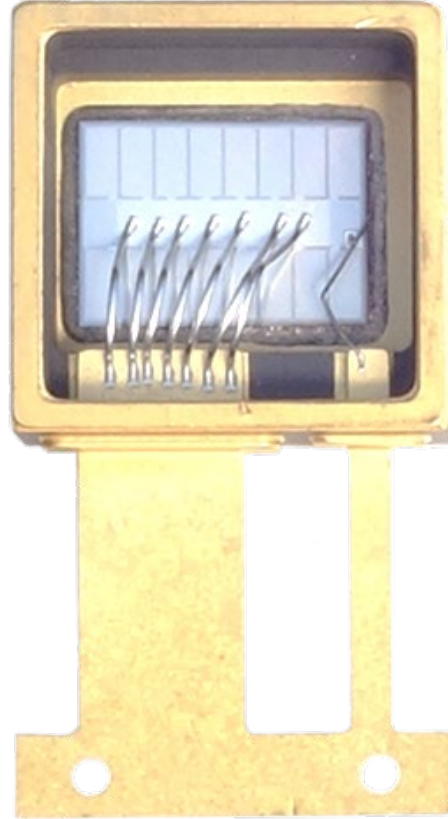
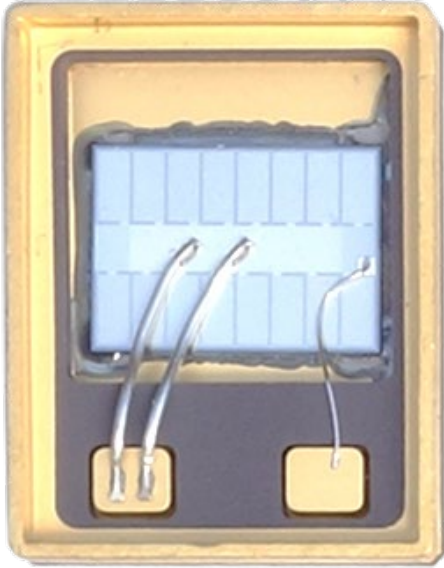
oerlikon esec
die bonder



- Solder dispense and die bonder
- Placement accuracy +/- 3mils
- Die Rotation +/- 3 Degrees
- Temp Control +/- 3 Degrees
- Wafer & waffle pack handling
- Solder wire diameter – 0.5 to 0.76 mm
- Minimum die size - 0.015" x 0.015"
- No manual handling of the semiconductor die



IR HiRel Packages



Example Calculation of Pull Force During Constant Acceleration

1. Calculate the worst case effects on the die attachment interface to package header during centrifuge.
2. Factor that a die attachment problem would likely present a systemic lot issue.

Worst case die (large size 6 MOSFET):

Size 6 die, 9.5 mil thick
Mass = 0.03395 grams

@ 20,000 G's, the Y1 pull force is 0.679 kilograms (die only)

Now assuming 100% lead for solder, 2mil thick, that adds about the same amount
Mass = 0.03374 grams

Size 6 die *plus* solder is let's say 0.07g

@ 20,000 G's, the Y1 pull force is 1.4 kilograms (die + solder)

During die shear in B3, the force spec limit is set at 5 kilograms.

We run the die shear test and stop the shear at ~ 10 kilograms (with no breaks or shears) to avoid breaking the load cartridge.

Rationale for Constant Acceleration Change For IR HiRel JANS Product

Defect mitigation of systemic lot problems is already in place. The following JANS inspections downstream would positively detect and prevent escape:

1. 100% thermal impedance test (this would detect die attach interface delamination, large voids in solder).
2. 100 percent X-ray for voids (this would detect voids in solder).
3. QCI B3 post 100 Temperature Cycles has thermal impedance (shift >15% is set as limit to detect poor die attach interface).
4. QCI B3 construction (die shear test would detect poor die attach interface).
5. QCI B4 post 6000 cycles of Intermittent Operating Life Test thermal impedance (shift >15% is set as limit to detect poor die attach interface).
6. Constant Acceleration will be performed on a sample basis in Group B of every JANS lot shipped and on a Group C annual basis.

DLA letter



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LAND AND MARITIME
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COLUMBUS, OH 43218-3990

June 07, 2022

Ms. Kelley Price
Quality Assurance Manager
International Rectifier HIREL, an Infineon Technologies Company
205 Crawford Street
Leominster, MA 01453

Dear Ms. Price:

Re: Removal of Constant acceleration for power MOSFET Transistors; MIL-PRF-19500 JANS Levels; FSC 5961; VQE-22-037131; CAGE Code 52GC4; Control Number; 080693

IR HiRel request to remove 100% constant acceleration screen specified in MIL-PRF-19500 table E-IV (screen 4) for JANS level products is approved. The performance of 100% constant acceleration shall not apply to IR semiconductor technology products due to package robustness of design and test history. The centrifugal force exerted on the die attach and wire bond interconnects is inconsequential to trigger defects.

IR has not experienced any device failure due to structural or mechanical weakness resulting from centrifugal force for greater than 15 years (reference IR HiRel retention reports). IR will continue to perform constant acceleration on a sampling bases on each JANS Group C conformance inspection lot performed on each package type, as part of C3 (post mechanical shock and vibration) before end-point electricals / thermal test.

The 100% constant acceleration will be required as part of new product qualification to validate package / design integrity.

In addition, this office has arrived at this technical position after reviewing the following additional criteria affecting constant acceleration:

- Mechanical structures of package technologies are fully qualified, carefully monitored by IR and changes are restricted by suppliers.
- All JANS devices are tested for thermal impedance during 100% screening, confirming assembly integrity.
- All JANS devices are inspected 100% during X-ray for critical interface voiding.
- In QCI, IR applies 15% delta shift limits for thermal impedance on all life tests; including B3 100TC, B4/C6 IOL, and B5 steady state accelerated life test.
- In QCI, destructive bond pull is performed as part of B3, B4 and B5 subgroups for each JANS inspection lot, the force used during the bond pull test is greater than force exerted by centrifugal force. Also die shear is performed in B3 to measure the die attach strength.

DLA Criteria for Allowing Constant Acceleration

IR HiRel will identify this exception within the summary cover page of each Documentation Package with the following statement:

“For IR HiRel discrete semiconductors, the performance of constant acceleration is omitted from the 100% screen 4 of table E-IV in MIL-PRF-19500 requirement. Constant Acceleration will be performed on a sample basis as part of QCI Group C3, post mechanic shock and vibration test, before end-point electricals/thermal testing”

DLA Criteria for Allowing Constant Acceleration

MIL-PRF-19500 Revision P, amendment 4, allows the manufacturer to propose alternate methods to DLA for approval. Allowance per paragraphs 4.4, D.1.1, and E3.7.1 in MIL-PRF-19500 is as follows:

- a. Paragraph 4.4 Tests and inspections may be modified, reduced, or eliminated with the approval of the preparing activity and the qualifying activity.
- b. Paragraph D.1.1 - Reduction and alternate test will be approved on a case-by-case basis.
- c. Paragraph E.3.7.1 - Alternative and equivalent test methods and requirements. Other test methods (flows, criteria, conditions) or circuits may be substituted for those specified in MIL-STD-750 provided equivalency is demonstrated to, and approved by, the qualifying activity.



Summary

IR HiRel has provided constant acceleration screening data to DLA to evaluate, and if approved, allow IR HiRel to omit 100 percent constant acceleration screening while requiring that constant acceleration be performed on a group C quality conformance inspection basis.

MIL-PRF-19500 paragraphs 4.4, D.1.1, and E.3.7.1 allow manufacturers with DLA approval to modify, reduce or eliminate testing if they have supporting data.

IR HiRel has demonstrated to DLA Land and Maritime that their JANS product construction, and automated die attach equipment can provide consistent reliable product with this equipment and process. Furthermore, downstream testing acts as mitigation and detection of escape (if any).