Generic 8D REPORT

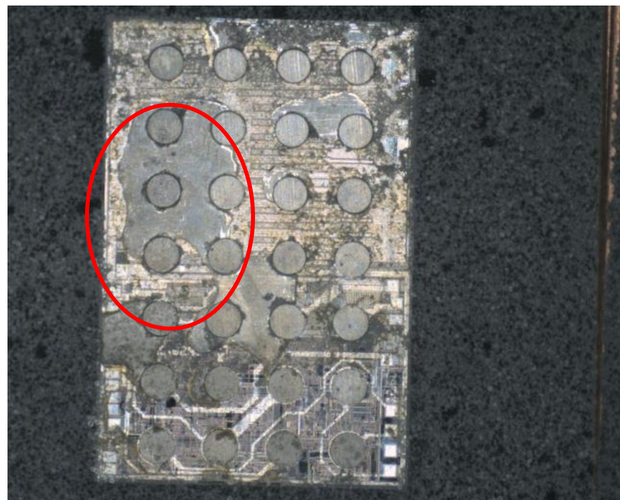
Power Module LMZ12xxx & LMZ14xxx

07/11/2014 - Rev. B

D1) TEAM MEMBERS:

Process Role	Name
Customer Quality Engineering Manager	Hartsell, Michelle
Packaging Engineering Manager	Prabhu, Ashok
Packaging Engineering Manager	Lim, CH
Package Engineering	Chua, CS
Failure Analyst	Huerta, Rafael

D2) PROBLEM DESCRIPTION:
TI has verified that some devices may exhibit solder extrusion causing failures during inline testing after SMT. When solder extrusion bridges the neighboring bump (or die edge), it will result in electrical failure. Below is the picture of the observed solder extrusion after parallel lapping.



D3) IMPLEMENT AND VERIFY CONTAINMENT ACTIONS:

TI implemented 1st Test ==> 1X Reflow @245C ==> 2nd Test to screen out marginal units (May 2012).

TI would also recommend customers to read the updated Power Module SMT guideline (**SNAA214** - http://www.ti.com/lit/an/snaa214/snaa214.pdf) to minimize solder extrusion:

Solder Paste:
- TI recommends the use of type 3 or finer solder paste when mounting on the board.

Reflow Profile:
- Measure peak reflow temperature by placing a fine gauge thermocouple (Type K) on top of the package body center.
- Ensure the peak reflow temperature does not exceed 245°C max (240°C +/- 5°C). Exceeding the max temperature may damage the part.
- Reflow time within 5°C Peak Temp must not exceed 20 seconds
- Reflow time above liquidus must not exceed 60 seconds
- Minimizing the number of reflow cycles seen by the LMZxxx power module is recommended
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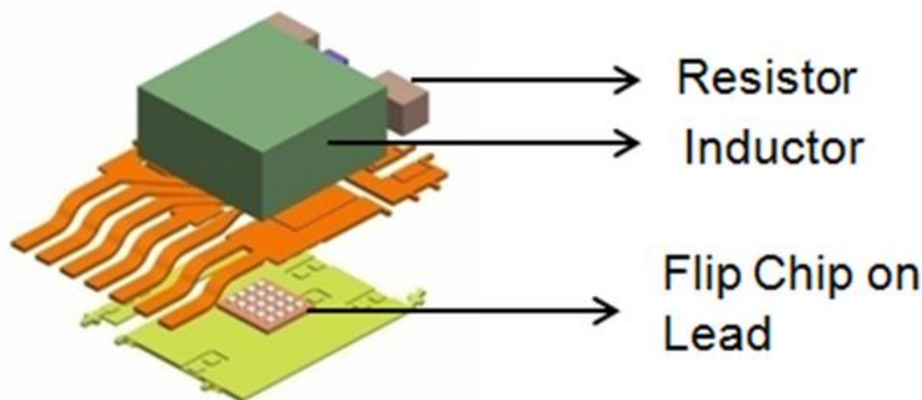
Moisture Handling:

- LMZxxx Power Module is classified as MSL3 and requires special handling due to moisture sensitivity. MSL 3 parts have a max floor life of 168 hours.
- Parts must be reflowed prior to 168 hour floor life after removing from the moisture barrier bag. Parts must be baked per JEDEC recommendations once the 168 hour floor life has been exceeded.

D4) ROOT CAUSE:

The power module family of devices from Texas Instruments (TI) undergoes a complex assembly process which involves passive components (inductor, resistors) along with a flip chip on lead bare die packaged together.



TI has verified that some devices from lots may exhibit solder extrusion causing failures during inline testing after SMT. When solder extrusion bridges the neighboring bump (or die edge), it will result in electrical failure.

Solder extrusion requires a molten solder and a path for the solder to extrude into. The path is created by a delamination between the mold compound and the die.

D5) IMPROVEMENT ACTIONS:

Improvement Actions	Owner	Date
1. **Optimize de-flux process**: The process to clean off the flux residue after bump operation on the flip chip die was optimized to ensure no flux residue is left behind.	A/T Site	Completed: Feb 2012
2. **Bake after de-flux**: To further ensure that any remaining flux residue is inactivated; a bake process using a dedicated oven was implemented.	A/T Site	Completed: March 2012
3. **Batch Plasma** operation before mold: The weakness at the interface of the mold compound and the flip chip die surface provide a path for the solder to extrude during reflow. The plasma process roughens the die surface enabling better adhesion of the mold compound with this surface.	A/T Site	Completed: August 2012
4. Use **dedicated Oven** for bake and **dedicated machine for Plasma** operation. This prevents variations through contaminants and helps achieve consistency.	A/T Site	Completed: August 2012
5. TI has introduced an improved plasma process **(Strip Plasma).** This process provides improved roughening quality and homogeneous cleaning for the die surface which helps in better	A/T Site	Completed: April 2013

Improvement Actions	Owner	Date
adhesion. Also, it provides improved control due to the reduced lot size in the cleaning chamber as compared to the Batch Plasma process.		
6. **Stainless Steel butterfly clip** on flux wash jig. Previous clip made out of aluminum based material coated with Zn caused Zn flakes to deposit on die surface during flux clean.	A/T Site	Completed: April 2013
7. **Tuned Solder Paste Improvement**. Improvements were made to the mixing time of the solder paste to reduce the activity of the flux, reducing the chance for mold compound delamination	A/T Site	Completed: August 2014

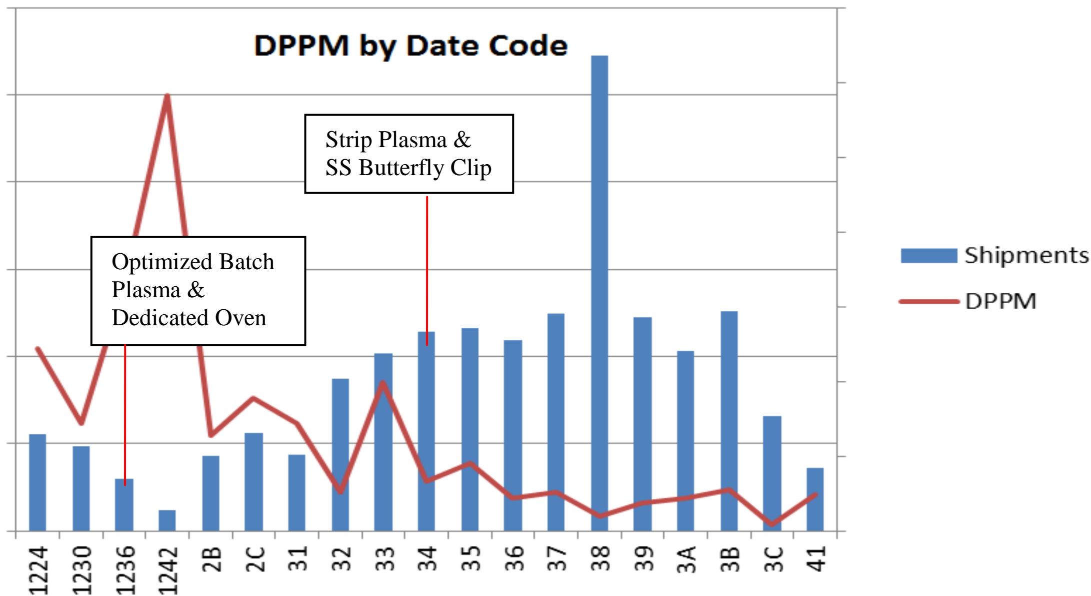
Other factors that affect the delamination include reflow peak temperature and moisture absorption during storage. TI would also recommend customers to read the updated Power Module SMT guideline (**SNAA214** - http://www.ti.com/lit/an/snaa214/snaa214.pdf) to minimize solder extrusion.

Field Reliability:

- The parts affected by solder extrusion will manifest as non-functional failures during customer inline testing post SMT reflow process.
- No further extrusion is expected if no additional high temperature process that is over ~220C is present; this is the physical property of the internal solder.
- The units that pass have not been observed to degrade under normal operating conditions based on internal evaluation of this issue.
- No field reliability failures have been reported to date over multiple batches.
- Thermal Cycling was performed (-45 to 125C) on 45 units of material from affected lot after subjecting these units to 4X reflow cycles. No TMCL failures were observed after 500 cycles

D6) VALIDATE CORRECTIVE ACTION:

Improvements were made in the manufacturing process to minimize solder extrusion and improve outgoing quality.
Data suggests that all these improvements have helped address the high failure rate at the customer line and not necessarily reduce it to zero.



The data was collected by data mining the shipment info and customer returns as of July 2014.
The graph shows the high DPPM rate in 2012. The shipments significantly increased in 2013 while the DPPM rate has significantly reduced.

TI attribute this to continuous improvements implemented in TIEM (latest ones being Strip Plasma & Stainless Steel butterfly jig) to make this package family more robust

D7) ACTION TAKEN TO PREVENT RECURRENCE:
See D5 & D6

D8) CONGRATULATE THE TEAM: