Case Study

Reasons for Doing Thorough Failure Analysis

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Biography

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30 years in all phases of ASIC business

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Agenda

- Introductory Remarks
- Scenario
- Outcome
- Lessons Learned
- Q & A
What is Failure Analysis?

- Identifying *and* solving problems with all prototype or production products

- Driving all issues to resolution, including documentation (for Manufacturing, ISO)

- Problems can occur *anywhere* and lead *anywhere*: design, manufacturing, component procurement, contractors, etc.
Why do Failure Analysis?
Part 1

- Streamline the manufacturing process
- Reduce product manufacturing costs
- Improve product quality and reliability
- Provide closure to Design Engineering
- Maintain revenue stream (we get to keep our jobs!!)
Why do Failure Analysis?
Part 2

- Ensures manufacturing repeatability
- Provides valuable design, manufacturing lessons
- Prevents (in theory) making the same mistake twice
Scenario

- A data storage company is procuring custom ASICs for a flagship tape drive product.
- The ASIC processes analog data from magnetic tape.
- The tape drive manufacturing process is stable.
- PPMs are monitored, driven to closure.
Who is Responsible for FA?

- Engineering support groups monitor PPMs, inputs from field or sub contract manufacturers
- Component, subassembly responsibilities
- Engineering support coordinates FA work.
The Problem

- Out of spec PPMs for a printed circuit board
- Failures are *repeatable*.
- In-circuit test indicates ASIC is at fault.
- Problem was (thankfully) caught at Incoming Inspection, *not* in the field.
Engineering Support’s Response

- Failing boards are retested, results documented.
- ASIC is in a BGA.
- It is *carefully* removed from the board, not a trivial process.
ASIC Tests

- ASIC tests show no malfunctions

- ASIC - mixed signal part, extensive signal conditioning, programmable filtering.

- ASICs are replaced on boards; boards still fail
What do we do now?

- Design Engineering contacted
- Possible design margining problem?
- Design cycle pressures may have precluded Monte Carlo, worst case simulation analyses.
- Check board before contacting chip supplier.
Board Check
Part 1

- Microscopic (and X-ray) analyses to look for:
  - Solder joint problems
  - Board cracks
  - Opens or shorts (e.g. whiskering)

- Check all circuit paths related to the ASIC

- The ASIC has AC-coupled, differential amplifier inputs
Board Check
Part 2

- All circuit board traces to the ASIC were checked – no problems.
- Board components in ASIC circuit path were removed and tested.
- One of the AC coupled SMT capacitors was shorted.
All failed boards were tested.

One or both input capacitors were shorted.

SMT caps cost less than 1 cent.

ASIC costs around $12 dollars.
Corrective Actions

- Component engineer switches to alternate supplier. (Always have multiple sources!)

- Failed parts sent to manufacturer for FA, follow up report

- Capacitor failure was due to bad batch of dielectric material.

- Capacitor manufacturer had to issue a recall.
Outcome

- Alternate supplier’s parts were used, product manufacturing resumed with minimal delays.

- Full FA report provided to prove root cause.

- “Corrected” capacitors must be recertified before use.

- Replacement costs borne by supplier
Lessons
Part 1

- Occam’s Razor – look for simple solutions first

- Board-ASIC combination was stable, low likelihood of a design margin error

- Start with board and components related to the part failure.

- Designers must be aware of all circuit performance and manufacturing aspects.
Lessons
Part 2

The problem is not solved until:

- Root cause is proven
- *Proven* fix(s) are found
- Fix(s) are implemented and,
- Proven to solve the problem at the *manufacturing* level
Last Comments

- Not all problems are solved this easily.

- Far East manufacturers sometimes deny access to their manufacturing staff.

- There may be no documented closure.

- Risk of recurrence.

- Economic factors prevent switching suppliers.
Q & A
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