Technical Approach to Zero Defects
May 10, 2006 - AEC Reliability Workshop
Tom Siegel
Different approach needed for quality improvement of ICs
- Previous approach:
  » At best, an incremental improvement
  » Reactive, needs to be proactive
  - Started in early 2003

Needed to make significant progress to get to zero defects
- Technical approach to focus on processes up front to ensure success from the start
- This was not a quick fix for current day issues as it focused on products and processes in design or development

Zero Defects is a mentality from the start
- Starts with design...need to design for zero defects
- Need to understand the process and test capability because fabs aren’t defect free ---- need to contain defects while improving fab capability
Technology Teams

- Non-Volatile Memory
- Smart Power
- Microwave Technologies
- IGBT/Power FETs
- Sensors
- CMOS
- IC Packaging
Output

- Approved suppliers for each technology
  - Develop a technology evaluation matrix to compare suppliers
  - Output used to rationalize future supply base by respective technology
  - Work with IC Portfolio and Purchasing Commodity Teams
  - Approval based on:
    » Technology
    » Design Flow
    » Test
    » Packaging
    » Quality
    » Reliability
Measures of success

- Factors for success
  - Program timing - meeting commitments successfully
  - Number of turns to production (design, process)
  - Start-up issues
  - Defect rates
  - Spills
  - Errata
  - Capability measurements (Cp, Cpk, etc.), proactive use of data
  - New process metrics (test die, process stability criteria, supplier qualification criteria/process, customer visibility of new process validation, etc.)
  - Pre-qual/qual/validation success
  - Anomaly identification/correction/prevention feedback process
Each team developed an extensive questionnaire to focus on:

- **Process Technology / Capability**
  - Process validation procedure, capability indexes, lessons learned, across companies

- **Design Methodology**
  - Design for test, scan test, IDDQ/Stress, success of design that matches models and process, design capable over process widow

- **Test**
  - Stress testing and burn – in, 100% functional test coverage, known good die, feedback and use of data to impact process or design improvements (SBL, PAT, etc.)

- **Packaging**
  - Package process at supplier, Delphi mounting/application of package, fab process impact on packaging, package influence on IC performance

- **Technology Roadmaps**
  - Process availability and longevity

- **Application**
  - Application reviews, de-rating guidelines, manufacturing test plans, manufacturing process effects
Zero Defect Methodology

**Design**
- Design for Manufacture
- Design for Test
- Design for FA
- Design for Reliability

**Manufacture**
- Robust Process
  - Cpk > 2.0
- Outlier Control Plan
- Defect Monitor / Gates
- Product Tracking
- Equipment Monitor

**Test**
- Full Scan Chain Capable
- 99.x % Scan Stuck At
- 99.x % Scan at Speed
- 99.x % Functional Coverage
- Voltage Stress Test
- Hard / Dynamic SBL
- Hard / Dynamic PAT
- Iddq / DeltaIddq / VST
- Intelligent Burn-In
- NVM Full Test

Feedback – Containment - Corrective Actions
Zero Defect Summary
Zero Defects – Main Points

- Zero defects is a cultural change
  - **Musts:**
    » **Driven from the start of development of device/process**
    » **Thoroughly understand all steps of the process**
      - Steps that complete properly
      - Steps that do not complete properly
        - Understand impacts/interactions of all steps
      - Understand variability and monitor for elimination

- Need to drive to contain problems before they get to your customer

- Quality driven
  - **Do**
    » Take personally
    » Understand details
    » Reduce variation
    » Be critical of yourself
  - **Don’t**
    » Get complacent
    » Ignore the data – it speaks volumes
Summary

- Delphi and our suppliers are spending significant engineering resources on this activity
- Suppliers have embraced this methodology and have offered suggestions for improvement
  - It starts with a commitment of the supplier management team
- This is a journey, it is not a quick fix, but we have seen significant quality improvements from these activities
- Proactive vs Reactive
- Customer Expectations:

  Zero Defects!!!