iNEMI

International Electronics Manufacturing Initiative

Pb-Free Defects Per Million Opportunities (DPMO) Project Proposal

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Agenda

- Background & Motivation
- Scope of Work
- Database Structure
- Sample of Results
- Accomplishments
- Lessons Learned
- Possible Future Activities

Background and Motivation

Background and Motivation:

- **Benchmarking information of Pb-Free DPMO rates for PCB is now more readily available**
- **This project plans to build on iNEMI's original DPMO project results - by package and technology**
- **Pb-Free DPMO data by package and technology type will allow manufactures to better estimate manufacturing costs and delivered quality**

Objective

Objective

- Create an effective environment to improve the delivered and quality of ROHS compliant manufacturing processes
- Assist in reducing costs of assembly, test, rework, scrap, and warranty
- Help improve line utilization and reduce cycle time

Scope of Work

- Implement methods to protect confidentiality of data
- Define how data will be shared between team members and with outside parties
- Define data collection methods around existing IPC standards
  - IPC 9261 In-Process DPMO and Estimated Yield for PWAs
  - IPC 7912 Calculation of DPMO and Manufacturing Indices for PCBAs

Scope of Work - continued

- Define data stratification and classification methods
- Gather data from several component types into database
- Summarize data and generate reports and documents
- Lay foundation for ongoing DPMO metric efforts

Data Sharing Policies

- Data shared with the industry
  - Methodology, database format, & data classifications
  - Statistics detailing the size and content of the database
  - DPMO level for all board types averaged together within each company
- Package-level DPMO data will not be shared with the industry
- Project participants receive the entire database

Confidentiality of Data

- Participants submitted data to a neutral party in the pre-defined formats
- The neutral party replaced the company names with non-descript IDs
- The data was combined into a single database
- The combined database was distributed to project participants
- Georgia Tech was the neutral party

Original iNEMI DPMO

- Defect Types
- Package Types
- Database Statistics - Board Types
- Accomplishments

Defect Types

Defect Types

- Agreed to 22 defects categories
- Where possible, aligned NEMI defect categories to other industry initiatives:
  - The SMART Group's PPM project
  - Classified defect categories per IPC Defect Classification for DPMO calculations (Appendix A of IPC9261)
- Defect was defined as anomaly that required a repair/rework action
- False calls, process indicators, or "self-correcting defects" that are not reworked/repaired were not logged

Package Types

Package Types

- Agreed to 36 package type categories based on input from several participants
- Targeted a list that would cover most package types while maintaining a significant number of opportunities per package type

Package Types - continued

Package Name	Package Description
BGA	Ball Grid Array. Standard pitch is 1mm (or 0.039"). Includes plastic, ceramic, eutectic, high-melt.
BGA FP	BGA - Fine Pitch. Anything less than standard BGA pitch (1mm or 0.039") may require special handling. Includes CSPs
BGA CONN	Includes any BGA connector regardless of pitch.
CGA	Column Grid Array, similar to BGA except terminations are small columns of solder
CGA FP	Column Grid Array, fine pitch, Anything less than standard BGA pitch (1mm or 0.039") may require special handling.
FLIP CHIP ARRAY	FCA - Flip Chip Array - a chip on board technology that has bumps attached to the silicon die, is flipped, and mounted directly to a printed wiring board.
PGA	Ball Grid Array. Standard pitch is 1mm (or 0.039"). Includes plastic, ceramic, eutectic, high-melt.
GW 16 MIL	16 mil gull wing QFP, SOIC, SOP, SSOP, TSOP, TSSOP and hardware (sockets, switches), also includes 12 mil gull wing
GW 20 MIL	20 mil gull wing QFP, SOIC, SOP, SSOP, TSOP, TSSOP and hardware (sockets, switches)
GW 25 MIL	25 mil gull wing QFP, SOIC, SOP, SSOP, TSOP, TSSOP and hardware (sockets, switches)
GW GT 25 MIL	greater than 25 mill gull wing components and hardware (sockets, switches), SOT - Small Outline Transitors, SOD, DPAKs
GW CONN	Gullwing connectors, regardless of pitch, (does not include Mictor or Straddle Mount)

Package Types - continued

Package Name	Package Description
J LEAD	SOJ - Small Outline J-leads, PLCC - Plastic Leaded Chip Carriers, sockets
LABEL	Labels
LAND GRID ARRAY	land grid array
LCC	LCC- Leadless Chip Carrier, also LCCC- leadless ceramic chip carrier, both have solderable castellations for terminations
MECH ASSEM	Bearing, chassis, faceplates, fan guard, fuse holder, handle, heatsink, plastic part, RF sheilds,
MECH FASTENER	Bolt, clip, kit, nut, pin, rivet, screw, spacer, spring, standoff, washer,
MICTOR CONN	Mictor connector has both SMT and PTH pins
STRADDLEMOUNT CONN	Edge connector with SMT leads on both sides of the board, Includes Straddlemount Mictors
MULTICHIP MODULE	Consider 1 component
OPTIC	Fiber Optic cables and components
SMT MISC	A SMT component that falls into no other category (EMI shields, ground planes, inductors, MELF components, non-leaded)
PRESS FIT	Press fit connectors and components that are hand pluged, includes ICs hand placed into chip carriers

Package Types - continued

Package Name	Package Description
PTH COMP	Pin Through Hole Componenet, SIP, DIP, radial and axial mount components, Also jumpers,
PTH CONN	Pin Through Hole Array, connectors, sockets - above 50 mil
PTH CONN FP	Pin Through Hole Array, connectors, sockets - 50 mil and below
PWB	Printed Wiring (or PCB-Circuit) Board, includes gold fingers, buried capacitors/resistors
SMT PASSIVE NETWORKS	Resistor networks, capacitor networks, RPACK, (only if device has solderable castellations, if leaded falls into corresponding category (PTH COMP, GW, etc)
0201	0201 chip components
0402	0402 chip components
0603	0603 chip components
0805	0805 chip components
GT 0805	greater than 0805 chip components (excluding Tantalum)
TANT	Tantalum capacitors
WIRE ADDS / CUTS	Wire additions and/or trace cuts due to design modifications

DPMO Calculations

d_c = # of component defects

d_p = # of placement defects

d_t = # of termination defects

d_a = # of assembly defects

o_c = # of component opportunities

o_p = # of placement opportunities

o_t = # of termination opportunities

o_a = # of assembly opportunities

Example: Component DPMO = $DPMO_c = [\sum d_c / \sum o_c] \times 10^6$

$$DPMO\,Index_1 = \left[\frac{\sum d_c + \sum d_p + \sum d_t}{\sum o_c + \sum o_p + \sum o_t}\right] \times 10^6$$

$$DPMO\,Index_2 = \left[\frac{\sum d_c + \sum d_p + \sum d_t + \sum d_a}{\sum o_c + \sum o_p + \sum o_t + \sum o_a}\right] \times 10^6$$

Database Statistics - Board Types

Data contributing companies / mfg sites	**8 / 11**
# of different board types	**380**
Number of boards	**335,467**
Average volume per board type	**883**
Minimum volume per board type	**2**
Maximum volume per board type	**42,967**

Accomplishments

Met project purpose and scope:

- Database with significant defect opportunities for 20 package types and 8 processes across 8 companies
- Team members feel data will be useful in supporting:
  - Quality improvement
    - DFX efforts / component selection
    - Applying test and inspection where needed
    - Identify potential problem areas / justify necessary changes
  - Cost estimation/reduction
    - Improved DPMO/Yield estimates, conversion cost estimates
    - Throughput improvements through better application of constrained resources

iNEMI Pb-Free DPMO Discussion

ALL

- **Feedback Discussion**
  - **How will original DPMO data be compared to Pb-Free DPMO Data?**
    - **What are we looking for. . .**
  - **Database of original DPMO was in raw form. . .it was up to the project participants to develop/render the data to meet their needs. . .**

    Should software be developed by the project to do data rendering?

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