COPYRIGHT NOTICE

www.bitsworkshop.org

The Importance of Registration in PCB Manufacturing Processes

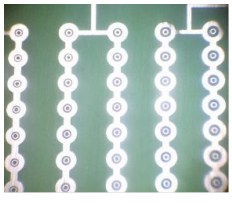
Brandon Sherrieb
Integrated Test Corporation

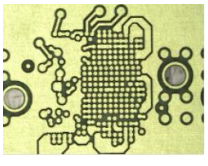
Agenda

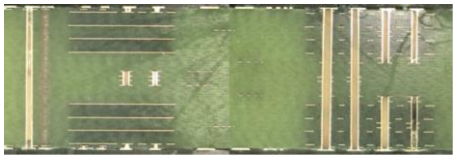
•Purpose: To outline how design attributes affect registration of PCB manufacturing processes and how mis-registration of these processes can have an effect on the finished product.

•Agenda:

- DFM: Items to Consider to Improve Manufacturability
- Functional Registration/Layer to Layer
- Registration Defects in Manufacturing







Registration

•Definition: Capability of manufacturing processes to properly align layers and features (PTHs, traces, pads, mask clearances, etc.) within a PCB and relative to one another.

•Why is Registration Important to End Customer?

↑ Layer Counts + ↓ PTH Pitch = ↑ Importance of Layer & PTH Positioning

↑ Drill Structures to reduce stub = ↑ Difficulty of Aligning Final Pad Pattern

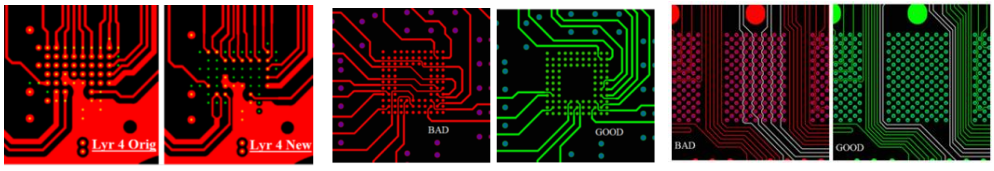
•Potential Effects to End Customer:

- Delays due to scrap discovered late in the manufacturing process or scout lots to determine process parameters.
- Necessary deviations to customer specification (via breakout, etc).
- Signal integrity issues due to feature alignment issues compared to the designed model (PTH to plane, stub drill to PTH, trace to adjacent traces or planes.

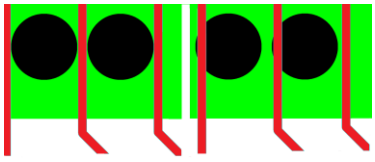
DFM

•Items to Consider to Improve Manufacturability:

- Trace Routing (Ideally trace routing is around tight pitch pins instead of through them and is equidistant between adjacent pins.)
- Drill Structures Affecting outer layer (Can drill spans be increased or stacked lasers utilized?)
- Grouped GND Pins (Can grouped ground pins be used to reduce drill hits and open space for trace routing on inner layers?)



Functional Registration/Layer to Layer

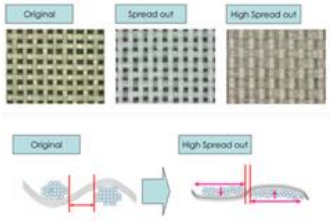


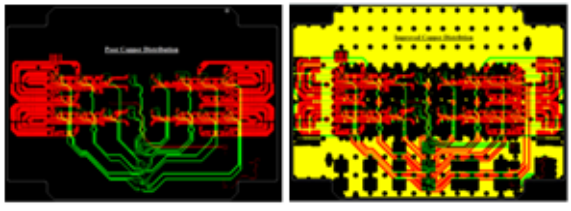
•Definition: Worst case measurement between adjacent S-G or S-S layers within a PCB.

•Mis-registration between these layers can lead to the transmission line losing part or all of its adjacent reference.

•Design Related Contributing Factors:

- Material (B-Stage Resin Content, Glass Style & Type, Core Thickness, etc.)
- Manufacturing Stack-up (Hybrid Materials, Sequential Laminations)
- Material Scale Factors (vary significantly between standard FR4 and exotics)
- Copper %, Weight & Distribution by Layer

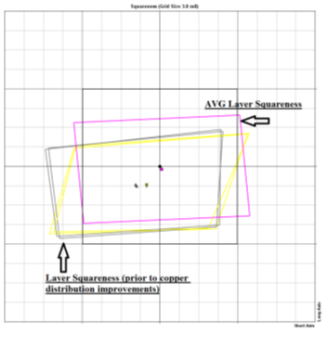




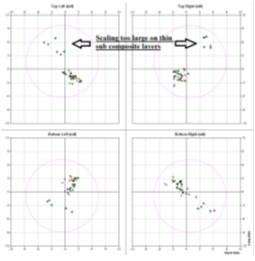
Functional Registration/Layer to Layer

•Operations Contributing to Layer to Layer Registration Alignment:

- Layer Etch and Post Etch Punch
- Layup
- Lamination



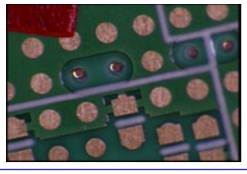
Functional Registration/Signal Integrity

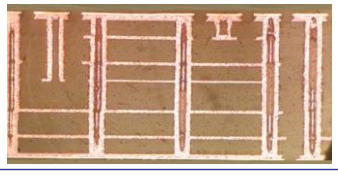


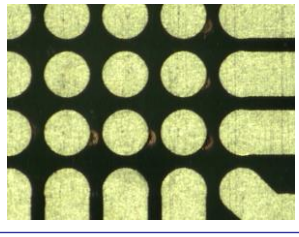
- Layer Etch and Post Etch Punch (PEP = +/-0.0004")
  - KPIV: Copper %, Weight & Distribution
  - Must be factored into initial layer scaling prediction.
- Layup (Layer to Layer +/-0.0004", Overall 0.002")
  - KPIV: Tooling Maintenance (pins, bushings & lamination plates)
  - Processing methods must be clearly documented to reduce variation.
- Lamination Recipe and Process
  - KPIV: Recipe (temperature ramp rates, hold times & pressures) & Process (lamination book construction, press condition)
  - Processing methods must be clearly documented to reduce variation.
- Scaling data collection is necessary after lamination to ensure accurate future predictions.

Registration Defects in Manufacturing

- PTH Drill Alignment (PTH to Panel = +/- 0.0004" utilizing x-ray alignment)
  - KPIV: Equipment (x-ray, camera & spindle) & Process (F/S, pilot peck or flip drilling, bit design & entry/exit material)
  - Potential Defects: Inner layer Shorting & Plating Voids
- NPTH Drill Alignment (NPTH to Fiducial = +/- 0.0007" utilizing camera alignment)
  - KPIV: Equipment (camera) & Process (Fiducial Quality & Operation Sequence)
  - Potential Defects: Socket Misalignment & Signal Integrity (Excessive Stubs)
- Outer layer Imaging (Image to PTH Feature = +/- 0.0014")
  - KPIV: Design (QTY of PTH Features & Annular Ring Requirements) & Process (Target Design and Acquisition)
  - Potential Defects: Image Breakout to PTH Features







Conclusions

- Final Thoughts: Registration is a critical process variable whose effects compound and can have a significant effect on the final customer product. Considerable effort must be expended monitoring critical processes and variables.
- Some Items to Consider:
  - Can improvements be made to ease manufacturing? (Increased pads or clearances, reduced trace widths, extended drill spans or stacked lasers)
  - Can tight pitch layers be limited into thinner sub composites?
  - Can hybrid material stack-ups be limited or more manufacturing time be allotted to dial in scaling results?