Design for Manufacturability
Suggestions and Guidelines

Cirtronics Corporation offers design for manufacturability review services throughout the design, manufacturing and re-design phases of your project. We offer recommendations to reduce cost and increase throughput.

General:

- Cirtronics warrantees our workmanship to be free of manufacturing defects for up to one year. This excludes failures due to design problems, customer supplied components and customer secondary operations.
- Cirtronics Corporation utilizes IPC-A-610 Level II as our in-house workmanship standard. Level III or other special requirements relating to manufacturing and/or quality can be adopted through specification on customer documentation and purchase order.
- Board assemblies are soldered using organic acid, water-soluble flux and cleaned using a closed loop aqueous system. Parts that are not compatible with these processes should be specified on the customer-supplied documentation.
- Customer specified chemicals require the submission of MSDS sheets for review of handling, safety and process analysis.
- No clean fluxes are utilized on secondary operations.
- Board layouts and component specifications should allow for auto-insertion. When designing in test points, fasteners, wires, etc, consider the labor costs of manual assembly and the reduction in throughput time.
- Consider the need for and cost of tooling when specifying components that require special processing like swaging, pressing, or crimping. Use similar tooling whenever possible.
- Avoid special preforming requirements or the use of spacers to elevate components off the board.
- When BGA's are incorporated in the design, the BGA specified on the Bill of Materials must contain a sphere alloy that is compatible with the alloy of the solder that will be used during manufacturing. RoHS BGA's should not be specified for a leaded soldering process.
- Try to keep components on one side of the board especially those that cannot withstand going through a wave solder process.
- "First run" assemblies should have a sacrificial sample board to set process, profiles and test.
- "First run" assemblies should have a first piece approval by the customer.

Additional General Guidelines for RoHS Compliant Assemblies

1. The Bare Board drawing should explicitly specify all materials to be RoHS compliant.
2. Materials specification should include a minimum T_d rating. We recommend a minimum T_d of 340°C with a maximum CTE Z-axis expansion of 3.5% so as to provide for materials sufficient to withstand the higher processing temperatures demanded by the Lead-Free solders. A higher T_d may be required for more thermally challenged boards with more than 4 layers.
3. Plating specification must also be RoHS compliant. ENIG is most highly recommended with a 12-month shelf life. Immersion Silver is also recommended (6-9 month shelf life). OSP Entek Plus provides for a good solution as well (6 month shelf life). Do Not specify Immersion Tin as the shelf life is only 3 months and does not provide for a "manufacturing friendly" finish.
4. Outer layers with SMT components MUST have a minimum of 3 locating fiducials. Local fiducials are also requested for Fine Pitch QFP's as well as BGA's.
5. Boards should be designed with a .200" keep-out area around the perimeter of the board. This will allow for board Panelization/De-Panelization.
6. Assemblies should be designed in such a way that they are "Thermally Balanced".
7. All BOM's must be scrubbed and RoHS components identified.
    a. All Hardware must be RoHS compliant (ex: screws, nuts, washers, etc.). Stainless Steel is recommended.
    b. Any components that are not RoHS compliant must be identified as such on the BOM and/or Assembly Drawing.
    c. It is critical that all BGA's incorporated in a RoHS design contain a sphere alloy that is compatible with the RoHS processing.
    d. Any components that have tin-lead in the component lead finish must be explicitly identified as such on the BOM and/or Assembly Drawing.
    e. Any components that cannot withstand the higher temperatures demanded by the lead-free solders (SAC305) must be identified on the BOM and/or Assembly Drawing.
8. The Assembly Drawing should have a note explicitly stating the use of RoHS compliant solder and manufacturing processes.
9. If RoHS Compliance labeling is required, we recommend adding this information to the bare board silkscreen and to the BOM.
10. A fully populated "scrap" board for process establishment should be provided. Be aware that some RoHS compliant "functional equivalents" may not be technically equivalent. A thorough deign validation is highly recommended.

PC Board Fabrication:

- PC boards should be designed and fabricated to IPC standards and include electrical test.
- Appropriate component spacing, tooling holes & fiducials should be available on bare boards to utilize automated equipment.
- Incorporate silk-screening with reference designators on the surface of the board to aid assembly. Follow a logical and consistent pattern whenever possible and never allow silkscreen to cover a pad. Add silkscreen to the back of boards if test technician interaction will be significant.
- Have pc boards masked and keep mask back away from pads approximately .005". Mask in-between leads of fine pitch and BGA surface mount parts.
- Have multi-layered pc boards electrically tested.
- Surface mount pad finish should be flat on bare pc boards.
- Traces should be parallel to axial components and perpendicular to IC's.
- Leave at least 1/8th" clearance from foil to board edge. Include breakaway tabs when parts overhang a board edge either in a finished circuit board or within a panel.
- Panelize circuit boards when the size, shape or quantity will affect throughput. Through-hole boards should not exceed 18" x 18". Surface mount and mixed technology boards should not exceed 20"x 18". Scoring is preferred over routing due to the stiffness, cost and ease of de-palletizing. The number of boards per panel should be related to the lot sizes being manufactured.
- Add break-away tabs under overhanging parts or to add additional clearance between adjacent panelized boards.
- Leave a minimum .25" x 1" open space to affix a Cirtronics serial number label.

Through-Hole Specifications:

- There should be a side to side clearance of the component body thickness plus .008th to allow for auto-insertion for axial and radial equipment; .100th between holes of adjacent parts for Multimod.
- Through-hole boards requiring automatic insertion need tooling holes; .125" is standard within .250" from edge.
- Layout components in parallel with consistent hole spacing and utilizing the same center to center distance based on .100th spacing.
- Maximum height of components through wash and wave is 3.5".
- Boards that are not self supporting in the wave solder process due to thickness or weight may require custom fixturing.
- Minimum board width for wave solder is 3" for manual feed, 5" for conveyorized.
- Board thickness parameters for auto-insertion are between .032" - .093".
- Hole sizing for auto-insertion should be .019" larger than the major diameter of the component lead. (Square leads require the following formula: ".019" + lead thickness x 1.4").

- Lead clinching on through-hole equipment is preformed typically at a 45 degree angle. The physical clinch adheres to IPC specifications and are as follows:
  - Multi-mod – clinches in or out.
  - Radial (2 & 3 leads) – clinches both leads out at 45 degree bends.
  - VCD – clinches in.
- Min/Max specifications for through-hole equipment:
  - Multi-mod spacing requires range of .300th or .600th
  - Radial (2 & 3 leads) spacing requires – inline at .100th or .200th
  - VCD requires spacing range of .300th - .900th.
  - VCD requires lead diameter between .015th and .032th.
  - VCD maximum height spec is .420th minus board thickness.
- Use zero ohm resistors in place of buss wire. Avoid the use of hairpin or Japanese mount resistors.

Surface Mount Specifications:

- Have fiducials available on 3 adjacent corners of the board.
- All vias should be masked or have tented tops.
- Bottom side chip caps should be layed out perpendicular to the wave solder flow. Parts should be layed out in sequence with small parts proceeding large parts to avoid shadowing.
- Maximum height specification on components is 15mm.

Box Build Specifications:

- Critical dimensions on custom fabricated parts that require compliance level incoming inspection need to be identified and documented by the customer to certify they are accepted in to specification.

In-circuit/Functional Test Specifications:

- Refer to Cirtronics Manufacturing Assumptions and Requirements for the list of data required for test.
- Bottom vias should be exposed or access points available for in-circuit testing.
- Fixture and program generation are quoted as non-recurring engineering charges.
- New incircuit tests require an initial throughput to debug the program and may not give optimum coverage at the onset.
- Cirtronics will troubleshoot non-functioning product for manufacturability. Product that cannot be debugged will be turned over to the customer for design analysis and the customer will be responsible for dispositioning it for rework or scrap.