DESIGN FOR MANUFACTURABILITY AND ASSEMBLY (DFMA)

1.0 Scope

This document prescribes requirements for design for manufacturability and assembly. The manufacturing issues covered are drawn from a list of findings from investigations of non conformances observed. Other issues were also drawn from available literature. While the issues discussed here form part of a list of requirements to be met during board design for assembly, it is recommended that other relevant literature be consulted for more requirements.

1.1 Purpose

Logas recognizes the significant cost and time savings achievable when products are built right the first time. This cost reduction, clearly, cannot be controlled by manufacturing engineers alone. Logas strongly recommends a review of the IPC guidelines for design for manufacturability (DFM) when planning for Type I, II and III SMT assemblies.

1.2 General Requirements

Logas believes that the DFM considerations for printed circuit board assembly should include the following:

i. Panelization/Board routing: This minimizes handling.

ii. Breakaways and holes for SMEMA equipments.

iii. Fiducials

iv. CAD and BOM data formats.

v. Parts packaging.

vi. Land pattern design/dimension.

vii. BOM and placement file data precedence and Revision changes.

1.2.1 *Panelization/Board routing*

The shape of PCB's impacts handling and assembly time. Small PCB's, <10mm length and <10mm width, present difficulties during assembly. Placement of parts on such PCB's becomes more difficult when automated. For this reason, it is recommended that such PCB's be panelized. (See Fig. 1)

However, the grouping should also consider the structural integrity of the panel as a whole as the robots will treat each panel as an individual board. The grouping should not be such that the entire panel becomes flimsy. This situation creates another placement problem. (See Fig. 2)

For boards designed to have parts protrude from the edge, grouping is also possible. In most situations, it is advised that clients consult Logas before routing the boards. However, figure 3 can serve a guide.

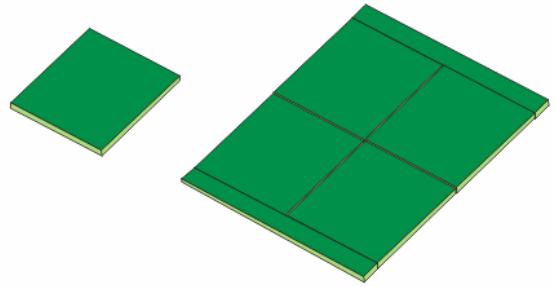

Fig 1: Board Panelization

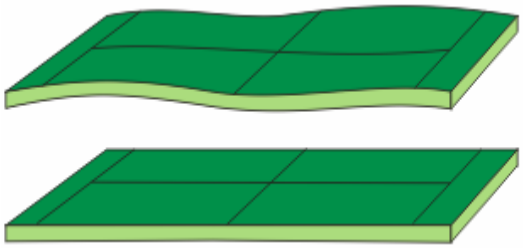

Fig 2: Structural integrity of panelized PCB's

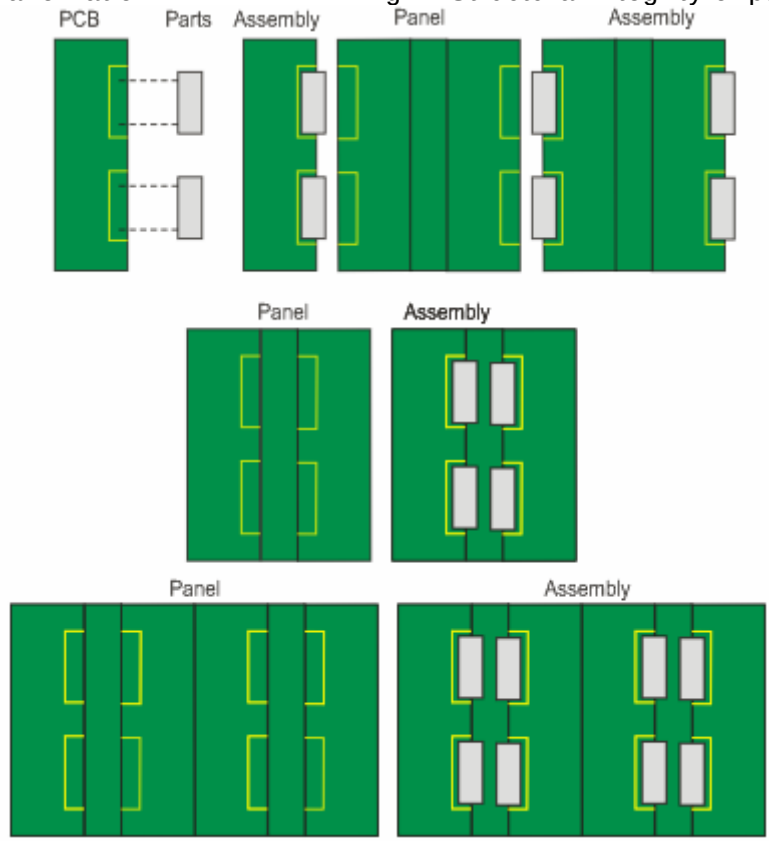

Fig 3: Panelization: Boards with protruding parts

1.2.2: Breakaways *and Holes for SMEMA equipment*

Logas uses SMEMA robots. The equipment has restrictions for component height at certain portions of the PCB; holes with specific shapes for locate pins; clearances on edges for clamps etc. Clients are advised to consult the drawings below during board design.

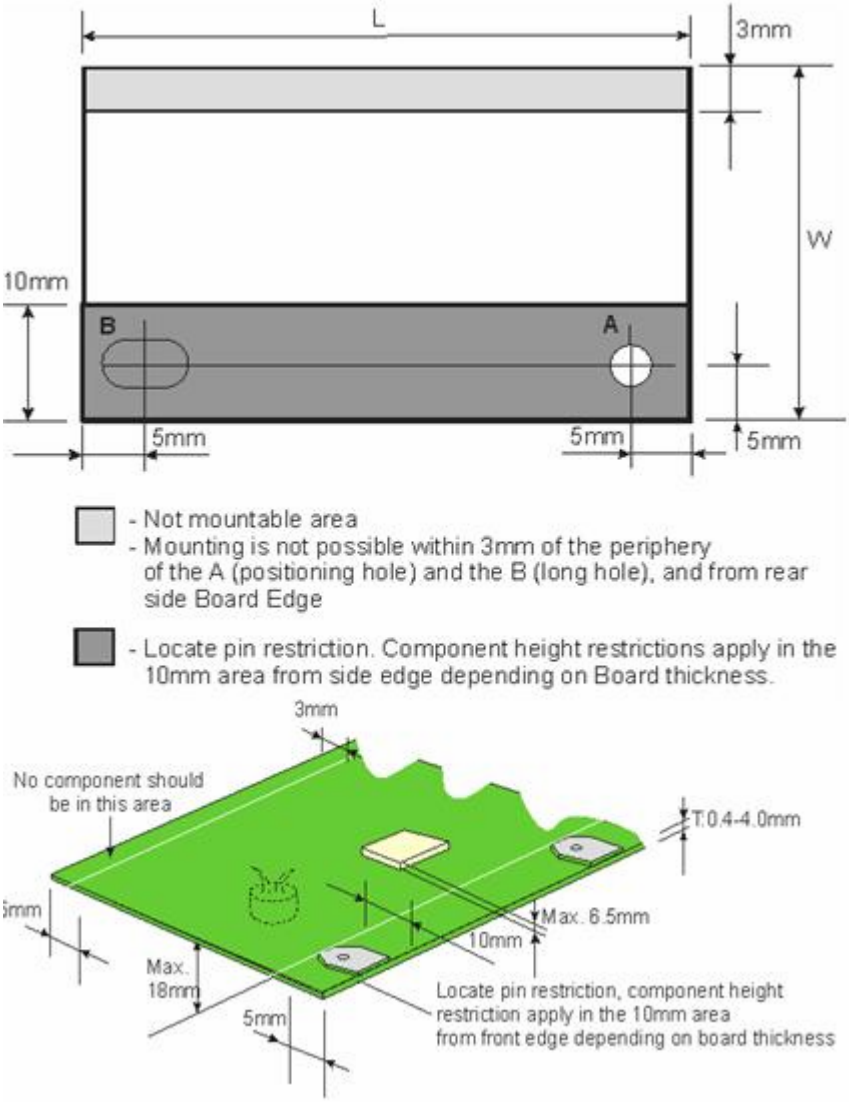

Fig 4: SMEMA requirements for PCB design

1.2.3: *Fiducials*

The top camera of placement vision systems scans the surface of the board to locate fiducials. The fiducials serve as targets used by the placement system to offset the coordinates in the computer for any variation in true board location. Logas recommends that 'local' and 'universal' fiducials be added to PCB's. There is also an option to ignore this step during component mounting, but that will cause the placement system to assume that the PCB, while clamped or held firm for placement, is in the accurate position.

The option of ignoring the fiducial check before placement is not ideal for PCB's with fine pitch components, BGA's etc. or heavily populated boards. 'Scattered' fiducials could be local to individual parts as well as group of parts in a region. Figure 5 illustrates the fiducial requirements.

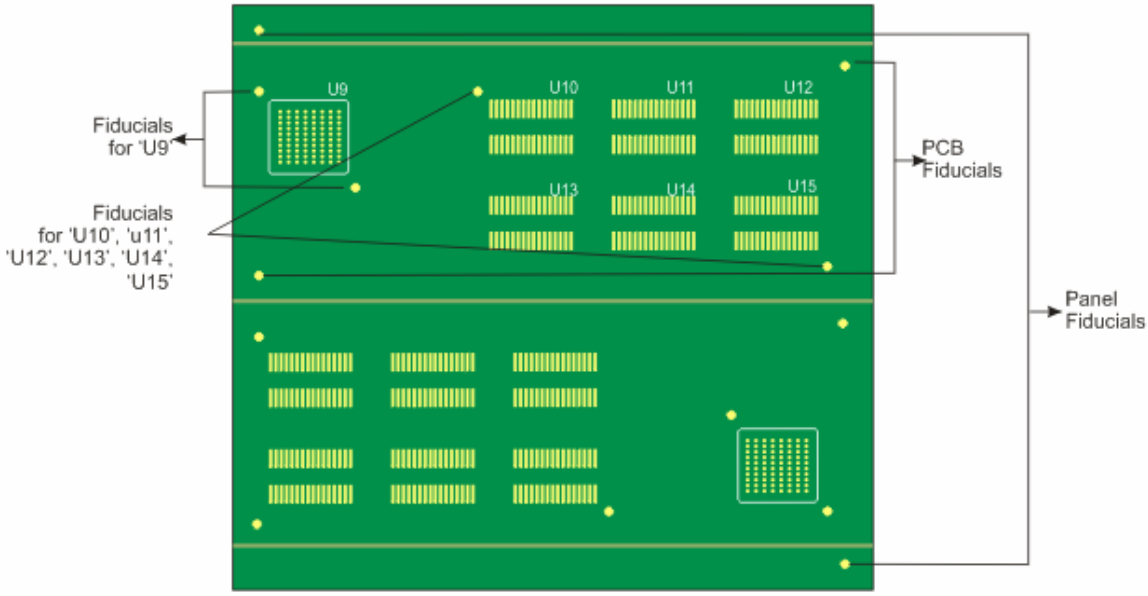

Fig 5: Fiducials

1.2.4: CAD data and BOM format

The placement robots used at Logas require intermediate programming. This programming involves the conversion of x-y data provided by the client (as generated by their CAD software) to a format to be used by the robots' database to execute placement. The process can take days depending on the density of the PCB (parts per board). Consequently, the data supplied will determine the level of programming required. The two scenarios described below amplify the programming nightmare experienced due to poor CAD data formatting.

a. **Inconsistent Data:** This is when a part occur in two or more locations on a PCB but are being assigned different package names:

REF. ID	P/N	PACKAGE	X	Y	R
R1	RM1000	R0603	54	44	180
R2	RM1000	0603	65	77	90

The database conversion software will not complete the conversion. This is a control mechanism to minimize placement error which may be in the form of placing a part in the location meant for another type of part but with similar package size.

The package name for part number 2 will be corrected to read R0603 for the program to run.

b. **Use of only part value as part number:** This will also create additional programming requirements. The database conversion program assumes that part numbers are unique. Hence, if a part occurs more than once on a PCB, each occurrence would be mapped to the unique part number. Therefore, if a part value is used to denote part number in the CAD program, the software will map package type to part value. It is common knowledge that two or more parts can have the same value, rating and tolerance but different package sizes.

Programming problems of the kinds described above introduce defects; since manual adjustments becomes necessary to prepare the CAD data in a format that the conversion

software will accept. Consequently, the practice of adjusting CAD data impacts data integrity. Logas quality system does not allow for CAD data adjustment of this nature.

Clients are advised to assign their own unique part identifiers and to incorporate these into their CAD system. Common format could be in the form of the table below:

Ref.ID.	Part No.	Package	x	y	r	Side
R1	RM1000	R0603	76	88	180	TOP
R2	RM1000	R0603	89	73	90	TOP
R3	RM1200	R0805	43	33	0	BOTTOM
C3	CA1000	C0603	80	44	0	TOP
C4	CA1302	C1206	26	10	90	BOTTOM
...	...	...	...	...	...	...

For the bill of materials (BOM), it is recommended that the same format be adopted as the one described above (use of unique part identifiers and differentiating package types).

1.2.5: *Parts packaging*

Logas aims at reducing setup and in-process times, and completely eliminating materials handling to assure the reliability of assembled PCB's. ESD requirements are strictly observed. However, good practice needs to be adopted when parts meant for assembly are sent to Logas.

Logas recommends the use of appropriate ESD bags, containers, reels and sticks for handling parts to assure the reliability of electronics products. The products not handled properly may not fail at our customers' test rooms only to fail later in field. There are costs associated with these failures and Logas is committed to eliminating these costs by preventing the failures.

When parts are sent to Logas, the following requirements need to be observed:

a. **Extra leaders and tapes:** For parts on reels, it is recommended that at least 16" of tape and 6" of leads be left unused. This is required for feeder attachment.

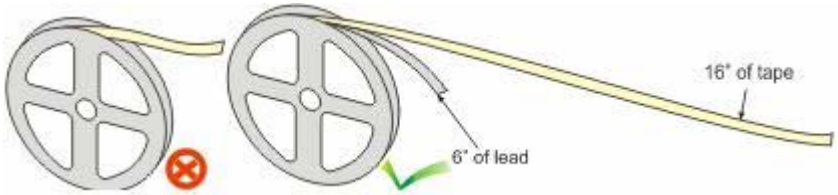

Fig 6: Reels with extra tapes and leads

b. **Matching ESD trays:** Use ESD trays with partitioning that matches the shape of the parts. This prevents the parts from getting damaged on slight impact. It is also recommended that parts in trays follow uniform orientation. The robots may not check for orientation hence good practice should be adopted in this regard. See figure 7.

When two trays with different partitioning are used to hold parts together, the probability of parts leads or even entire parts getting damaged is very high. This results from movements of parts inside the package which is exactly what the

package is meant to prevent. The damaged leads will not pass component recognition test by the placement robots bottom vision cameras. See figure 8.

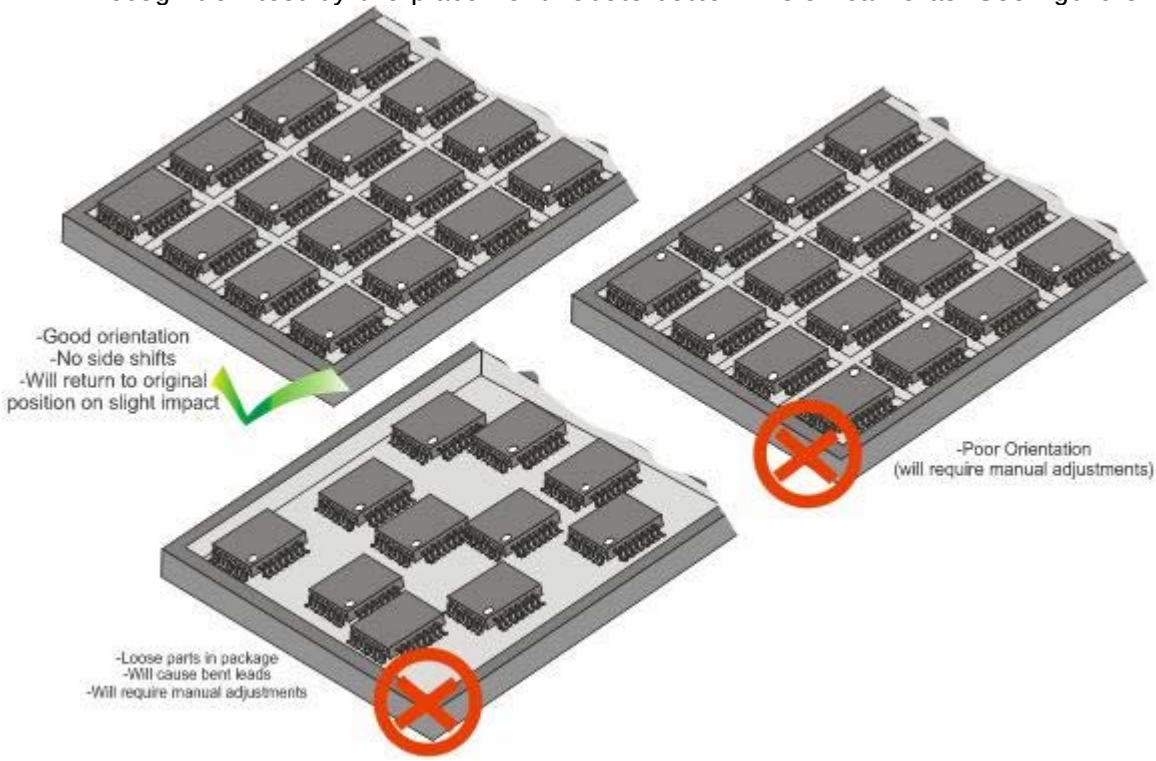

Fig 7: ESD trays with partitioning to hold parts in transit and parts placed with orientation.

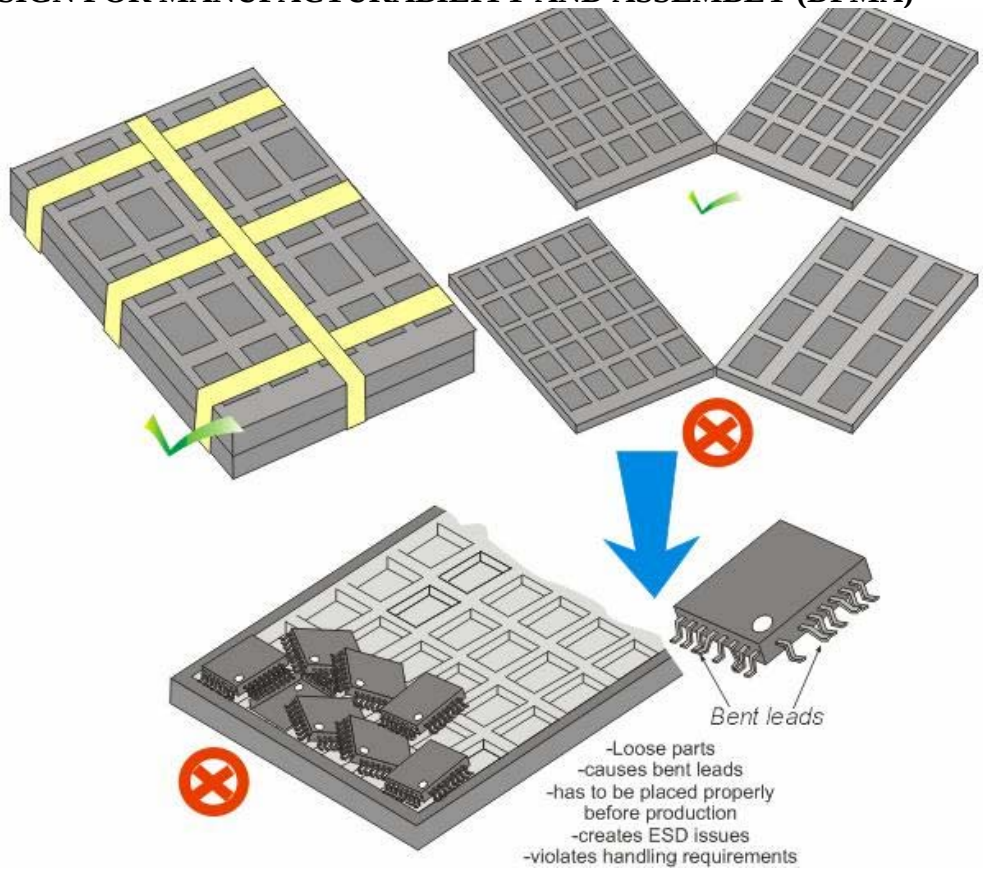

Fig 8: Damaged leads created by use of non-matching ESD trays.

c. **Proper alignment of parts inside tapes:** Logas suggests that parts arrive at production plant in their original packaging from parts suppliers. However, clients may decide to repackage parts for cost or availability reasons. In such situations, Logas suggests that those parts be clearly marked or the information indicated on the kit summary documentation which usually accompanies the assembly kit to Logas production facility. Inspection of repackaged parts revealed occurrence of wrong polarities and multiple part types in a single reel. This will normally require additional inspection be carried out on the reels before they are programmed for placement. In other cases it was observed that parts are reeled with tapes that are meant for a different sized component. This causes pickup and placement problems. See figure 9.

Fig 9: Repackaged parts with poor orientations and wrong tape sizes.

d. Parts labeling

Logas quality management system requires the identification of customer supplied equipment and materials for traceability. The basic information expected for each part package include the following:

- Part number
- Assembly No. (including revision if necessary)
- Quantity
- Work order/Purchase order number

See figure 10.

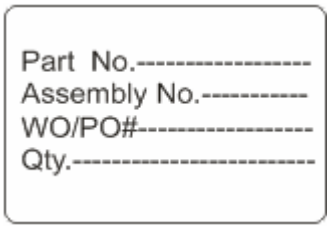

Fig 10: Recommended Part label.