

APPLIED TECHNICAL SERVICES CORPORATION		Document No:	221-008
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Subject:	PCB Procurement Specifications	ISO9001 Ref:	7.4
		13485 Ref:	7.4

1.0 PURPOSE

The purpose of this procedure is to provide the necessary information to specify boards procured for use at ATS. These requirements are intended to ensure the receipt of high quality Printed Circuit Boards (PCBs) for production. This specification must be used for procurement and receiving inspection of all PCB's in conjunction with other customer specifications.

Questions from the PCB Manufacturer are expected to be presented in a timely manner to ATS Supplier Management for resolution and before fabrication proceeds.

2.0 SCOPE

This document specifies the procurement requirements for PCB's by ATS.

Special requirements or exemptions to the requirements of this document will be noted on any applicable Purchase order or customer specific documentation.

3.0 DEFINITIONS

SMOBC	Solder Mask Over Bare Copper
HASL	Hot Air Solder Level
LPI	Liquid Photoimageable
PCB	Printed Circuit Board
RoHS	Restriction of Hazardous Substances

4.0 REFERENCES & APPLICABLE DOCUMENTS

The latest revision of the following documents form a part of this procedure:

ANSI/IPC-A-600	Acceptability of Printed Boards
IPC-TM-650	Test Method Manual Method 2.4.22 Bow and Twist
IPC-SM-840	Qualifications and performance of Permanent Polymer Coating (Solder Mask) for Printed Boards
IPC-2221	Generic Standards for Printed Board Design
IPC-2222	Sectional Design Standards for Rigid Organic Printed Boards
IPC-2223	Sectional Design Standards for Flexible Printed Boards
IPC 6011	Generic Performance Specification for Printed Boards
IPC 6012	Quality and Performance Specifications for Rigid Printed Boards
12-108	Request for Deviation Form

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5.0 GENERAL PROVISIONS

1. Prior to being placed on ATS' Key Supplier List, the supplier must pass a qualification process (as defined by ATS Supplier Quality Engineering) and submit a letter or E-mail to ATS agreeing to comply with this document's specifications.
2. Failure to comply with this document may result in rejection of the supplied material at the supplier's expense (including the labor and material charges of the processed boards) and removal of the supplier from ATS' Key Supplier List.
3. When the supplier accepts a purchase order, such acceptance constitutes an agreement that the PCBs are built per this specification, the provided master drawing, board fabrication drawing, drill file, artwork, Gerber files, applicable IPC specifications, and any other specifications that are supplied by ATS or specified on the purchase order.
4. In the event that the board manufacturer is not able to meet any of the requirements of this specification (or other specifications associated with the board), the manufacturer should contact ATS Supplier Management and submit a request for deviation form (*Form 12-108*).
 - Supplier Management may either elect to move the production to another board manufacturer or work with engineering to process the request.
 - Supplier Management informs the manufacturer of the status of the request and whether the request has been approved or rejected.
 - If the request is approved, Supplier Management will send a copy of the deviation to the requestor and to ATS Receiving Inspection.

NOTE: Unless otherwise specified; the deviation(s), when granted, are issued on a case by case basis for each individual date code and are not transferable to other boards, products, or date codes without written approval from ATS Engineering. In addition, ATS requests that every deviation request file be named according to the "PO # / Part #" for ease of filing.

5. In case of a conflict between various documents the following order of precedence must be followed:
 1. ATS' Purchase Order
 2. Master Part Drawing
 3. Customer documents/specifications
 4. This procedure
 5. ATS' Engineering written communications
 6. Any other applicable documents
6. Board panelization, breakaway tab specifications, and other board features (i.e. tooling holes, fiducials, etc.) are obtained from ATS' Engineering with a copy to ATS Supplier Management prior to start of the board fabrication process. If this information is not specified, the supplier must contact ATS Supplier Management to obtain the required specifications. The supplier may provide suggestions and submit them to ATS for approval.
7. It is the supplier's responsibility to provide the complete panelized Gerber files (in electronic format) to ATS Engineering with a copy to ATS Supplier Management prior to fabrication of the boards. This requirement also applies to any revision to the PCB that changes the Gerber files.
8. The supplier must assure that all boards are free of fingerprints, oil, dirt, corrosion, corrosive material, salts or any other chemicals or foreign materials or defects that may impact the life (including shelf life), solderability, or appearance of the board. The supplier certifies to ATS that each shipment of PCB's meets the specified requirements including IPC ionic contamination limits.

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6.0 MATERIAL REQUIREMENTS

By shipping the PCBs the manufacturer acknowledges that:

1. Printed circuit boards (including solder mask and the ink used for board marking) are compatible with electronics' manufacturing processes.
2. RoHS boards must be compatible with RoHS manufacturing processes including higher (than Sn-Pb) processing temperatures.

6.1 Laminate:

- The laminate must meet or exceed UL94V-0 rating for flammability. Normally this logo is etched on the board as part of manufacturer's logo, date code, etc. If PCB's are not marked accordingly a Certification of Compliance (CofC) will be supplied with the shipment.
- Unless otherwise specified, base laminate must be FR-4 copper clad glass epoxy laminate.
- Tg = 135°C for SnPb processed PCB's. Unless PCB's are specified as lead-free or RoHS compliant this is the minimum standard.
- Tg = 150°C minimum for lead-free or RoHS compliant PCB's unless specified otherwise. Fabricators are expected to question any PCB they deem to be under specified.
- The copper foil must meet ANSI/IPC-A-600 Class 2 requirements.
- Copper foil thickness must be per the printed circuit board's specification. Unless otherwise specified the preferred foil thickness is ½ Oz (per in²).

6.2 Solder Mask:

- Solder mask must comply with IPC-A-6012 requirements, meeting the requirements of IPC-SM-840 Class T, and IPC-A-600 Class 2. Solder masks must be compatible with "no-clean" and "lead-free" processes.
- The circuitry of the PCB must be covered with solder mask over bare copper (SMOBC).
- Solder masks must be liquid photo-imageable (LPI).
- LPI solder mask must be matte finish unless approved by ATS Engineering.
- Color should be green unless otherwise specified by the customer.
- Solder mask (including bleed out) may abut the pad but may not encroach onto the top surface of the pad or interfere with soldering the entire pad. Exception to this rule is the solder mask defined pads.

6.3 Surface Finish:

- ATS prefers the following PCB surface finishes:
 - ENIG (Electroless Nickel / Immersion Gold)
 - HASL (Hot air solder level)
- Immersion silver, Immersion tin, and OSP (organic solderability preserver) are acceptable when specified by the customer.
- The surface finish of the PCB must be per the PCB's specification. If the surface finish is not properly specified in the board fabrication files or the purchase order, or is not one of ATS' preferred surface finishes, the PCB manufacturer must request clarification from ATS Engineering with a copy to ATS Supplier Management prior to fabrication.
- Gold must be plated over nickel for assemblies requiring gold finish (ENIG). Gold and nickel plating must meet the requirements of IPC-6012 for areas that require soldering.

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- For HASL boards, the solder (per QQ-S-571) must be deposited on external pads and on barrels of plated thru holes/vias per IPC-6012B. For tin-lead boards, the minimum solder thickness at the "knee" of the plated through hole is .00005".
- The surface coating thickness must meet the requirements of the latest revision of IPC-6012 specification.
- Unless otherwise specified, all holes and vias shall be copper flash plated through and over plated with tin-lead plating, ENIG, or with as specified surface finish. For tin-lead boards the minimum average copper thickness is 0.0008 inch. For lead-free boards, the absolute minimum thickness is 0.001 inches with 0.0012 as an average minimum.

6.4 Solderability:

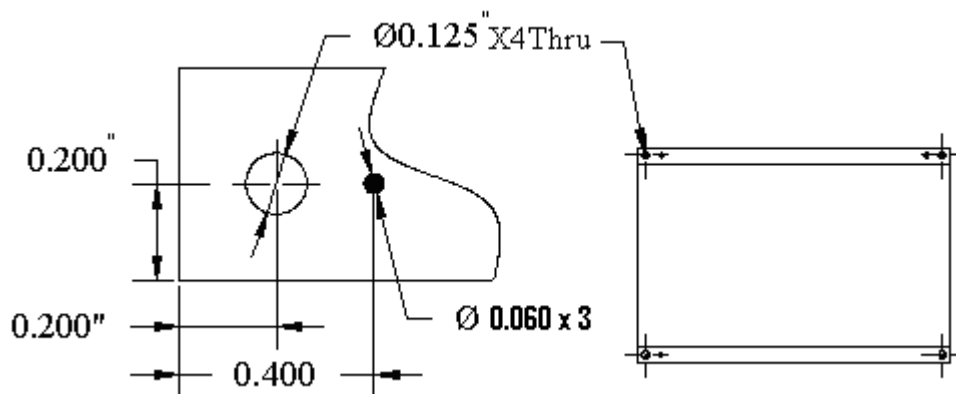
All PCBs shall meet the solderability requirements of ANSI/IPC-J-STD-003 (method C) at the time of shipment. Testing is recommended to be done by the supplier on at least one sample of each lot and each date code.

6.5 Cleanliness:

Cleanliness testing must be conducted per IPC-6012 specifications. The supplier must be able to provide proof of compliance upon request.

6.6 Fiducial marking:

- For boards that do not have fiducial marking, when possible, circular fiducials (.060" dia.) with a mask clearance twice the fiducial diameter, should be added to each side of the board. Preferably, fiducials should be located in three corners of the board. If board's real estate prohibits the presence of three fiducials, two fiducials can be placed on the board with one placed at the upper right and one at the lower left corners of the boards.
- The breakaway tabs should have fiducial markings (.060" dia), with mask clearance twice the fiducial diameter, one near each of 3 corners.



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6.7 X-out panels

6.7.1 Acceptance Criteria

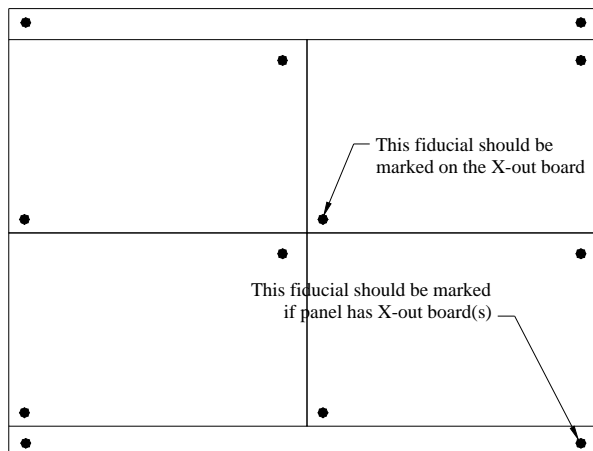
Panels with X-out boards are acceptable, provided they meet the following requirements:

- Panels with X-out boards are packaged separately from the rest of the lot and the package is clearly marked with part number and "X-Out".
- Maximum X-out boards per lot: 10%
- Maximum X-out boards per panel meet the following:

Boards per panel	Max. Acceptable X-out boards per panel
2 – 5	1
6 – 10	2
10 - up	20% or up to 5 boards per panel (which ever is less)

6.7.2 X-out marking requirements

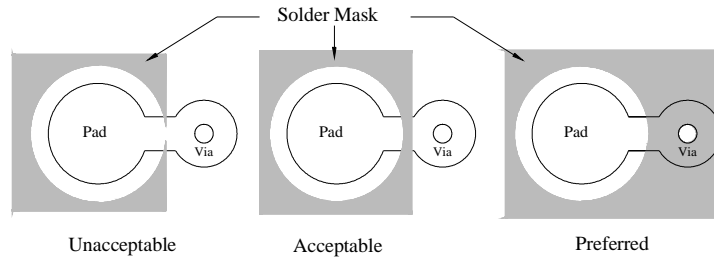
- The contrasting ink that is used to mark the boards must not be water soluble or ionic in nature. Ionic contaminating inks (such as permanent markers) tend to impact the ionic contamination testing that may be required at the time of assembly by ATS or at the time of incoming inspection of the PCB shipment at ATS.
- Contrasting permanent ink, preferably black, must be used to mark the "X-out" boards. Marking must be per the following:
 - **Panel:** The lower right corner fiducial of the panel must be covered with black ink.
 - **Board:** A large X will be marked on both sides of the "X-out" board. Additionally, the lower left corner fiducial of each "X-out" board must be covered with black ink.



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6.8 General requirements:

- Solder mask must be present between all pads. When process capabilities prohibit meeting this requirement the fabricator should contact ATS Engineering with a copy to ATS Supplier Management requesting a deviation.
- The vias under BGAs must be covered with solder mask to prevent the solder from traveling from pads into the vias and to prevent bridging between pads.



7.0 ELECTRICAL AND MECHANICAL SPECIFICATIONS

By shipping the PCB, the manufacturer acknowledges that:

1. Internal conductors, external conductors, and edge spacing of boards (including boards with breakaway tabs) meet the requirements of IPC-6012.
2. Unless otherwise specified, all PCB's pass the electrical and connectivity testing prior to shipment to ATS. Bare board testing is conducted in accordance with IPC-6012.
3. Component legend ink is electrically non-conductive and permanent. Markings are placed adjacent to the component locations and not on the component mounting pads.
4. Markings meet the requirements of IPC-4101 and IPC-2221.
5. When possible, markings are to be located such that they do not get obstructed by mounted components, vias, test pads, or other features on the board.
6. PCB part number and revision must be marked on the boards.
7. Date codes, trademarks, or manufacturer's name may be part of the PCB legend artwork and printed in ink or etched in copper. If a UL mark is required, the first option is that it should be etched in copper; the second option is to add it to the legend.
8. PCB's workmanship is in accordance with IPC-A-600, unless otherwise noted.
9. PCB's meet the requirements of IPC-6012.
10. Board flatness (bow and twist) are measured per IPC-TM-650 method 2.4.22 and meets the requirements of IPC-A-600 Class 2 specifications.
11. Delaminations and other defects are limited as per IPC-A-600 Class 2 specifications.
12. Fiducials in the Fabrication Specifications, global or local, have a mask opening larger than the diameter of the fiducials (typically twice the diameter of the fiducial as a minimum) and the field between them is free of masking, copper or traces, or silk screen markings (including inner layers).
13. When available the board supplier should provide a Design For Manufacturing (DFM) report to ATS on how well the board layout meets the requirements of this document and other industry standard design guidelines and good practices principals. The report should be sent with the finished (full panel) Gerber files noted above.

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8.0 SHIPPING REQUIREMENTS

By shipping the PCB's, the manufacturer acknowledges that:

1. Boards or panels are wrapped and packaged to protect the boards against damage during shipping.
2. Plastic bags and material used to package the boards are free of oils, silicon mold release, foreign substance, corrosive material, salt, grease, fingerprint, uncured material, flux residue, or any material that may impact the life (long term and shelf life) or solderability of the boards.
3. Boards and panels are protected and packaged to prevent board chafing during shipping or transport.
4. Boards or panels with allowable "X-outs" are segregated, packaged separately, and marked per this specification.
5. When production drops, rejects, or over-production are available for use as solder samples, at least one per production lot is included at no cost in the shipment and marked accordingly.

9.0 CERTIFICATE OF COMPLIANCE

The certificate of compliance must reference the board part number, date-code, quantity, and its revision. The following certifications may be required, per information contained in the Gerber data or fabrication files, for each production run: Electrical testing, Plating thickness in the holes, Cleanliness (ionic contamination), and if soldering samples are not provided Solderability. If the PCB's are specified RoHS compliant, then certification as to RoHS compliance must be provided.

10.0 FIRST ARTICLE REQUIREMENTS

A First Article board or panel will be required by ATS for the first production run for inspection and/or testing. First Article boards or panels are shipped with the production lot unless specified otherwise by ATS.

In any shipment the fabricator may provide to ATS "solder sample" boards or panels to be used in setting up or evaluating the various processes at ATS. These boards or panels are to be marked as "solder samples" and packaged separately. These boards or panels are assumed to be non-functional rejected stock, which allows the fabricator to provide for this purpose: boards or panels from their production fallout that are otherwise suitable for use in the assembly process setup.

11.0 PREVISION

If board fabrication or workmanship issues result in assemblies failing the ATS Quality standards or the requirements of this document, the board supplier may be held accountable for material and labor costs incurred by ATS including the costs associated with the failure analysis efforts.