



1. PURPOSE & SCOPE

The purpose of this document is to establish Watlow's specific requirements and any exceptions to industry standards for manufacturing Printed Circuit Boards (PCBs).

The scope of this requirement applies to all suppliers manufacturing and/or supplying PCBs to Watlow, or to any of Watlow's sub-tier Printed Circuit Board Assembly (PCBA) suppliers who will be sourcing PCBs for use in Watlow product.

2. REFERENCE DOCUMENTS

- Various Watlow PCB fabrication print/drawings and Gerber files
- Watlow Document Number 10-14866 (QSP-7.4.10) Supplier Change Control and Communication Requirements <https://www.watlow.com/resources-and-support/Additional-Support/Supplier-Requirements>
- IPC 6012 (latest revision) Qualification and Performance Specification for Rigid Printed Boards
- IPC-A-600 (latest revision) Acceptability of Printed Boards
- IPC 1602 (latest revision) Standard for Printed Board Handling and Storage
- IPC/JEDEC J-STD-033 (latest revision) Handling, Packing, Shipping and Use of Moisture, Reflow, and Process Sensitive Devices
- IPC J-STD-003 (latest revision) Solderability Test for Printed Boards
- IPC TM-650 (latest revision) Test Methods Manuals
- RoHS 3 Directive, 2015/863/EU

In case of any requirement discrepancy, the following order shall be applied to define the requirement:

1. Requirements noted in a Watlow Purchase Order
2. Requirements defined by a Watlow PCB print/drawing
3. Requirements defined in this document
4. Other documents referred to by this requirement
5. Common/Typical Industry Standards developed and applied by the PCB Manufacturing Industry which establish the standard specifications/requirements of a manufactured PCB
6. PCB manufacturer's own Engineering and Manufacturing standards, as long as they meet or exceed various industry standards

3. DEFINITIONS / ACRONYMS

PCB: Printed Circuit Board (bare board, no components)
 PCBA: Printed Circuit Board Assembly (PCB with components)
 CTI: Comparative Tracking Index
 MBB: Moisture Barrier Bag
 ESD: Electrostatic Discharge

4. RESPONSIBILITY

Watlow:

- Responsible for ensuring this document is updated as requirements change
- Ensure the latest revision is communicated and available to Watlow's PCB suppliers
- Provide all required PCB fabrication prints/drawings, Gerber files, etc. to the PCB supplier

**Supplier:**

- Responsible for conforming to all requirements defined by this document or notification.
- Communicate and/or seek Watlow Approval of form, fit, function, and process changes and deviations to the manufacture of the PCB, as defined by Watlow Supplier Change Control and Communication Requirements document 10-14866 (QSP-7.4.10).

5. REQUIREMENTS**GENERAL REQUIREMENTS:**

- All manufacturing locations of PCBs for Watlow are expected to have ISO9001 registered quality management systems in operation, with an IATF16949 registered system preferred
- Allow access to manufacturing sites by Watlow personnel to conduct Quality Management System and Process Audits, as required, to approve new suppliers, different supplier manufacturing locations not previously qualified, and other audits/visits as needed to sustain quality performance by the supplier
- PCBs for Watlow shall be built in accordance with IPC 6012, IPC-A-600, IPC J-STD-003, and IPC 1602 (latest revisions) Class 2 requirements, unless otherwise specified in this document or Watlow PCB print/drawing
- X-OUT panels are NOT allowed to be shipped to Watlow without Watlow approval
- UL Logo, CTI, and Watlow part number location will be defined by Watlow on the PCB print/drawing or if not defined per material requirements below, can be etched in copper without violating spacing requirements or silk screened onto the board
- All PCB's supplied to Watlow must be electrically tested prior to shipping, with visible indication of the test status marked on each PCB, however Watlow may choose to waive the electrical test requirement by choosing not to purchase the electrical test fixture
 - The supplier's standard Outgoing Inspection Reports are required to be provided by the PCB manufacturer for each lot produced and shipped and include cross-section coupon, with information on where on the board the coupon was taken, Certificate of Compliance (including compliance to all applicable requirements noted in this document), and other parameters if requested by Watlow
 - If, Watlow has not defined the location of the cross-section in the print/drawing, the section location should be done on a group of the smallest diameter plated through holes
- Certificate of Compliance shall include reference to laminate manufacturer/type, solder mask manufacturer/type, date code of manufacture, and CTI rating of laminate.
 - The supplier's standard Outgoing Inspection Reports are required to be provided by the PCB manufacturer for each lot produced and shipped to be in accordance with the listed IPC standard tests to include but are not limited to the following:
 - Laminate (Material Type; Thickness; CTI)
 - Plating Thickness (Copper(PTH); Copper(Surface); Surface Finishing Method; Au THK(ENIG); Ni(ENIG))
 - Solder Mask (Material Type; Color; Single/Both sides; Thickness)
 - Component Mark (Material Type; Color; Single/Both sides)
 - Circuitry (Trace Width; Trace Spacing)
 - Identification (UL Mark; Company Logo; Date Code)
 - Reliability Tests (Solderability; Bonding; Ionic Contamination)
 - Functional Tests (Electrical)
 - Other (Punching/Routing; Warp and Twist; Tape Test(Solder Mask/Gold))
- Unless otherwise noted in print or purchase order, QSP-7.4.10 Supplier Change Control Requirements – Control Level 3 applies to all PCB's.



MATERIAL REQUIREMENTS and APPROVED LAMINATES:

- General Material Requirement:
 - UL-94-V-0 compliant
 - Comparative Tracking Index (CTI) of 175 volts, which shall be indicated on PCB and in Certificate of Compliance
- The following laminates are approved by Watlow:

GRACE GA-170LL (QMTS2 E18652) CTI 3, 94V-0	GUANGDONG SHENGYI S1170 (QMTS2 E109769) CTI 3, 94V-0
ISOLA FR-4 (QMTS2 E41625) CTI 3, 94V-0	ISOLA PCL-FR-370HR (QMTS2, E41625) CTI 3, 94V-0
ISOLA FR406 (QMTS2, E41625) CTI 3, 94V-0	ISOLA FR402 (QMTS2, E41625) CTI 3, 94V-0
ITEQ IT-180TC (QMTS2 E178114) CTI 3, 94V-0	ISOLA 185HR (QMTS2, E41625) CTI 3, 94V-0
NANYA UV Block FR-4-86 (QMTS2 E98983) CTI 3, 94V-0	NANYA NP-175FR (QMTS2 E98983) CTI 3, 94V-0
NANYA NP-175FTL (QMTS2 E98983) CTI 3, 94V-0	

- No changes shall be made from one laminate to another, even if the alternate is listed above, until the change request is approved by Watlow. Reference Watlow Supplier Change Control and Communication Requirements document 10-14866 (QSP-7.4.10)

SOLDERMASK REQUIREMENTS:

- Non-RoHS PCBs shall have a green solder mask applied
- RoHS PCBs shall have a blue or black solder mask applied (per print/drawing), with RoHS written in the artwork of the PCB, compliant with RoHS 3 2015/836/EU
- Gloss or semi-gloss mask finish is NOT allowed on Watlow PCBs, unless otherwise specified and/or approved by Watlow

IPC or OTHER INDUSTRY STANDARD EXCEPTIONS:

- ANNULAR RINGS: Annular rings for all plated through holes/vias must conform to IPC Class 3 requirements – No breakout allowed
- BARE BOARD CLEANLINESS: Maximum of 0.5 micrograms NaCl/square centimeter, when tested per standard IPC cleanliness testing methods

DATE CODE and MANUFACTURER LOGO REQUIREMENTS:

- Each PCB delivered to Watlow shall have a date code and manufacturer logo applied to each finished board, conforming to the following:
 - Date Code shall be in the year-week format: (YY/WW), i.e., a date code of 2033 would be the 33rd week of 2020
 - Date Code may be etched in copper, so long as IPC spacing requirements are maintained or in a “white” color silk screen, or other method if approved by Watlow
 - The location of the date code, manufacturer logo, and preferred size/font will be defined on the Watlow PCB print, if not, the information should be placed on the top/component side of PCB

PACKAGING REQUIREMENTS:



- PCBs shall be vacuum sealed in a MBB this is clean, dry, sulfur-free, and ESD dissipative packaging material with desiccant and humidity indicator strip inside sealed package that is in accordance with IPC/JEDEC J-STD-033
- All boards shall be oriented in the same direction within the package
- Each package shall be labeled with Watlow part number, date code/date of manufacture, supplier name, Purchase Order, and quantity

6. REVISION HISTORY

Revision	Date	Changes
D	4/10/96	Page 9 5.5a – changed wording
E	8/22/96	Page 10 6.3 – changed to refer to IPC-A-600
G	5/1/01	Changed title of 4.8.1, 4.8.2, TMM-650 to TM-650 in 3.5, IPC-R-700 to IPC7721 in 4.8, typo in 5.1.4
H	8/14/01	Added to 3.22 – Gold Flash
J	12/14/01	Added picture of PCB thickness to 2.1
K	3/26/02	Changed title from Multi-Layer to Circuit Board, updated 5.6 – Packaging and 5.7 - Cleanliness
L	12/17/03	Added 5.2.1 carbon ink tolerance
M	8/23/04	Added 3.1.1 measure copper thickness, 4.4.4 Plugged Via's
N	3/10/06	All sections modified to match current IPC-A-600 standards, provide clarification of Supplier Qualification, and provide detail for via, plating, RoHS, and solder mask requirements
O	5/11/06	Changed gold thickness in 3.2.1 from 5-15 u inches to 3-15 u inches
P	8/3/06	Clarified when black solder mask is applicable and added green to the standard as the default color in 5.1
Q	12/8/10	Alignment of PCB standard to reduce unnecessary information
R	12/16/11	Updated board types, packaging, solder mask type, and color
S	6/5/12	Updated Spec with MISC Changes
A	9/9/2020	<p>Transferred to PLM</p> <p>Complete re-write to specify the use of IPC-A-600 and IPC 6012 – Class 2, as the baseline requirements for Watlow PCB's, with Watlow exceptions noted.</p> <p>Eliminated table of contents.</p> <p>Eliminated referencing other standards not called out specifically in updated document.</p> <p>Eliminated details for carbon ink, solder mask thickness, plating thicknesses, now relying on industry standards</p> <p>Added QSP-7.4.10 (10-14866) Supplier Change Control – Control Level 3 baseline requirement</p> <p>Relieved cleanliness requirement to 0.5 ug/sq cm from 1 ug/sq inch, aligning to supplier recommendations.</p> <p>Updated approved laminate list.</p> <p>Added requirement for outgoing inspection reports to be provided with each lot</p> <p>Clarification of other general Watlow requirements for PCB not covered by other standards.</p>
B	4/12/2023	Clarified solder mask requirements and electrical test requirements, approvers updated
C	9/28/2023	<p>Updated packaging requirements</p> <p>Updated reference documents</p> <p>Updated inspection test report requirements</p>

Document Approvals

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