

## 1. PURPOSE AND APPLICABILITY

This document (hereinafter referred to as "the Specifications") integrates on the technical level the general requirements of the General Specifications SQ 400 already in the hands of the Supplier for the supply of printed circuits (hereinafter "PCBs") to be used when manufacturing electronic boards for SPEA S.p.A. (hereinafter "SPEA").

The requirements of these Specifications extend to the raw materials purchasing and managing, industrialization, manufacturing, finishing and quality process of PCBs, conducted by the Supplier against the Purchase Order issued by SPEA.

## 2. SPECIFIC REFERENCE DOCUMENTS

In addition to the binding contractual documents in the SQ 400 General Specifications mentioned above, the technical requirements of the supply might be represented in the documents listed below, if referenced in the Order Form issued by SPEA:

originated by SPEA:

- Purchase Order;
- technical drawings;
- Gerber files, in RS274X format;
- mechanical drawing;
- Technical Specification for the manufacturing of Printed Supports (No. Drawing 036xxx ...),

standards originated by standardization bodies:

- Standard IPC 2221 (\*) "Generic Standard on Printed Board Design";
- Standard IPC 2222 (\*) "Sectional Design Standard for Rigid Organic Printed Boards";
- Standard IPC 4101 (\*) "Specification for Base Materials for Rigid and Multilayer Printed Boards";
- Standard IPC JPCA 4104 "Specification for HighDensity Interconnect (HDI)and Microvia Materials";
- Standard IPC-A-600 (\*) "Acceptability of Printed Boards"; it includes an explicit reference to class 2;
- Standard IPC-SM-840(\*) Class H "Qualification and Performance Specification of Permanent Solder Mask";
- Standard IPC -4204(\*) "Flexible Metal-Clad Dielectrics for Use in Fabrication of Flexible Printed Circuitry";

(\*): When there is no indication of the document version referred, it is implied to be the version in effect.

Additional documents (specifications, standards, etc.) may be added to the technical documents listed above, according to the specific needs of SPEA that acquire contractual obligation for the supply to the supplier at the time they are recalled in the order document issued by SPEA.

Please note that, as specified in General Specification SQ 400 to § 2, all supplies to SPEA must comply with the applicable legal and regulatory requirements and related to the quality and conformity of products and services, their safety and environmental preservation before, during and after their realization.

In addition, as specified in General Specifications SQ 400 to § 3, the Supplier must:

- carry out the supply respecting the indications contained in the order and in the associated documents;
- purchase (when expected in the terms of supply) raw materials in compliance with the quality requirements in the technical documents provided by SPEA;
- request a waiver grant from SPEA, using Form 092 ("Supplier Deviation Request"), for any products that have

an allegedly acceptable non-conformity with the documentation;

- may not bring to the attention of third parties information relating to SPEA documentation and products.

As foreseen in the § "Introduction" of the SQ 400 General Specification already mentioned, in the event of non-compliance by the supplier with this Specification and other binding contractual documents for the execution of the supply, SPEA reserves the right to take any protective action it deems appropriate.

## 3. ENVIRONMENT-RELATED PROCESS REQUIREMENTS

Where feasible, energy efficiency and waste production targets must be sought and achieved in production processes. SPEA requires that the Productive Site of the Supplier operates in compliance with applicable environmental legislation whether it is binding at national or local level (e.g., regional).

PCBs must be "RoHS 2 compliant": in accordance with Directive 2011/65/EU, on "restriction of the use of certain hazardous substances in electrical and electronic equipment".

According to "REACH" Regulation (1907/2006/EU and s.m.i.), SPEA understands PCBs as an article or as a set of articles, depending on their configuration: regardless of whether the individual article or the entire PCB comes from EU countries or non-EU countries, in any case the supplier must ensure that the requirements of Regulation "REACH" (1907/2006/EU) are met; in particular, before proceeding with the supply the supplier must ensure that he has already made:

- registration of any regulated substances;
- the provision of sufficient information for the safe use of the PCB where the presence of an SVHC substance in concentrations greater than 0,1 % in the weight/weight ratio is expected.

No PCBs are allowed for the production of which raw materials are used from countries in which conflicts occur for their control or for their fields, pursuant to Regulation (EU) 2017/821 (of the European Parliament and of the Council of 17 May 2017 laying down obligations of due diligence in the supply chain for importers in the Union of tin, tantalum and tungsten, their minerals, and gold, originating in conflict zones or high risk areas) and the U.S.A. "Dodd-Frank Wall Street Reform Act" of July 2010.

Wherever possible, the use of raw materials, components and production processes that weigh on the ecosystem, from extraction to disposal at the end of life, must be avoided or at least reduced or at least shared with SPEA.

## 4. SPECIFIC ORGANIZATIONAL, ENGINEERING AND MANUFACTURING REQUIREMENTS

The Supplier must have UL certification.

PCBs must be "RoHS 2 compliant", as already mentioned in § 3 above.

PWBs must be at least Class 2, as referred in the IPC-A-600 standard already mentioned in § 2 of these Specifications.

To create the PCB, the Supplier receives by e-mail the engineering and manufacturing documents related to:

- the internal and external sides of the printed circuit board;
- solder resist on soldering side and component side;
- the list of the apertures with information on the units of measurement (only for older PCBs); Unless otherwise

specified, Gerber files can be loaded directly without using the specific aperture table;

- silk screen printing on components side and soldering side (where needed);
- peelable solder mask (where needed);
- drilling files.

#### 4.1. Laminates

The laminates used by SPEA can be: single face, double face, multilayer, flexible-rigid, flexible.

The basic material must be FR4 (glass-filled epoxy laminate), flame retardant, RoHS 2 complaint, compliant to the IPC 4101 standard referred to in §2 of this Standard, of the following types:

- for PCBs with less than 8 layers without BGA via pad: FR4 tg 135°C minimum, compliant with IPC4101-B characteristics on pg. 21;
- For PCBs with 8 or more layers, with BGA via pad, or with 0.3 mm holes or smaller: FR4 tg 180°C minimum, compliant with IPC4104-B.

In the construction of a multilayer PCB, no inner or core formed by a single sheet of prepreg can be used.

If thickness problems make use necessary, it must be agreed with SPEA.

Thickness tolerance for laminates is  $\pm 10\%$ .

#### 4.2. Copper

Unless otherwise specified in the engineering and manufacturing technical documents mentioned above, the related thicknesses and tolerances must be as follows.

The base copper thicknesses required by SPEA can be 12  $\mu\text{m}$ , 17  $\mu\text{m}$ , 35  $\mu\text{m}$ , 70  $\mu\text{m}$ , 105  $\mu\text{m}$ .

The copper sheet must be electrodeposited with a 95.5% purity minimum.

The outer copper layer of the laminates has a minimum thickness of 12 $\mu\text{m}$  for multilayered PCBs and 17 $\mu\text{m}$  for double face PCBs. For the applicable tolerance, see paragraph 10.0 of the IPC-2221 referred to in §2 of these Specifications.

#### 4.3. Holes

The tolerance for holes is:

- for metallic holes -50  $\mu\text{m}$  / + 100  $\mu\text{m}$ ;
- for non-metallic holes  $\pm 50\ \mu\text{m}$ .

Hole eccentricity with respect to the pitch must guarantee a minimum crown of 50  $\mu\text{m}$ .

#### 4.4. Tracks

Tolerance of the width defined in Gerber files for tracks is -20%.

#### 4.5. Insulating distances

Compared to the value defined in Gerbers, the maximum allowable reduction is 20%.

#### 4.6. Solder

The product used is a greenish-black liquid photo mask.

The minimum track width must be 100  $\mu\text{m}$ .

Unless otherwise specified, the solder insulation diameter is 15  $\mu\text{m}$  larger than the pad size (ref IPC 840 standard).

Cleaning of vias in printed circuit boards under BGA components to ensure the following specifications:

- it must be ensured that the vias are completely closed on both sides;
- if they cannot be guaranteed, they must remain open;
- no processing residues (copper, holes occluded by sawdust, base material chips generated by circuit processing) shall be ensured in the holes.

## 5. FINISHING

The standard finish used by SPEA is chemical gilding (Ref. 5.1). If the PCB has to undergo mechanical stress by lamellar contacts or spring probes, SPEA will request electrogilding (Ref. § 5.2, 5.3).

### 5.1 Chemical gilding

For its productive needs, SPEA indicates limitations of treatment at the following points:

- surface of flat pads;
- nickel thickness on pad: min 4  $\mu\text{m}$ , max 7  $\mu\text{m}$ ;
- gold thickness on pad: min. 0.05  $\mu\text{m}$ , max 0.15  $\mu\text{m}$ ;
- nickel thickness in the hole: min 4  $\mu\text{m}$ ;
- gold thickness in the hole: min 0.08  $\mu\text{m}$ .

### 5.2 Electroplating

For its productive needs, SPEA indicates limitations of treatment at the following points:

- surface of flat pads;
- nickel thickness on pad: min 4  $\mu\text{m}$ , max 7  $\mu\text{m}$ ;
- gold thickness on pad: min. 1  $\mu\text{m}$ , max 2  $\mu\text{m}$ ;
- nickel thickness in the hole: min 4  $\mu\text{m}$ ;
- gold thickness in the hole: min 1  $\mu\text{m}$ .

### 5.3 Electroplating of lamellas

For its productive needs, SPEA indicates limitations of treatment at the following points:

- perfect planarity of the treated part;
- nickel thickness on pad: min 4  $\mu\text{m}$ ;
- gold thickness on pad: min 0.7  $\mu\text{m}$ .

### 5.4 Metallization

The thicknesses of the metallization must be as follows:

- external copper:  $\geq 35\ \mu\text{m}$ ;
- copper inside metallized holes: average value  $\geq 20\ \mu\text{m}$ , according to IPC class 2.

In the case of PCBs made up of FR4 tg180 ° C (see § 4.1), in addition to copper, nickel and gold must be deposited on the vias to ensure better metallization.

## 6. DIMENSIONS

Whenever possible, the dimensions are measured in golden metallized areas used for insertion connectors.

### 6.1 Position of the holes

In relation to the theoretical point, all holes must be within a 50  $\mu\text{m}$  radius and at the center of the theoretical point itself.

### 6.2 External dimensions

A final tolerance of  $\pm 150\ \mu\text{m}$  is applied to the final cut-off of the PCB, unless otherwise stated.

### 6.3 Beveling

The bevel is made on a contact edge, with a minimum angle of 30 degrees and a minimum height of 0.30 mm.

### 6.4 Planarity

With reference to the test method defined by the IPC-A-600 standard for the flatness characteristic, the maximum tolerable error is 0.75% of the length of the considered side.

## 7. DEFECTS

### 7.1 Metallized holes

Vacuum defects in metallized holes are accepted if:

- the surface missing is no more than 10% of the total;
- they are not round;
- are present in less than 10% of all boards;
- are less than 10% for each PCB.

Metallization defects, such as holes and nodules, are acceptable if the hole diameter is not reduced below the required value. The annular deficiencies are not accepted.

### 7.2 Metallized surfaces

On metallized surfaces, defects are accepted if:

- the minimum space is not reduced;
- they are present on less than 10% of the surface of the PCB and on less than the 10% of all PCBs;
- solderability remains good;
- the lower metal layer remains covered.

### 7.3 Base material

Imperfections, burns and heat exposures are accepted if they are present on less than 0.1% of the surface of the PCB.

### 7.4 Track Borders

Narrowing and enlargements of the tracks are permitted under the above conditions:

- insulation is not reduced by more than 25% and below the minimum required;
- the length of the defect must be less than 1 mm;
- the width of the tracks must not be reduced by more than 25%.

### 7.5 Solder

10% of the surface of the soldering pads can be covered with solder masks.

No defects are acceptable for BGAs.

All metallic holes for the soldering of components must be free. Solder holes may be present, but not adjacent metal points.

### 7.6 Soldering

The soldering must be guaranteed for six months if the PCBs are kept and sealed in rooms with temperatures below 30° C and with humidity less than 60%.

We propose to heat ENIG boards in the oven at 120° C for 1 hour and HAL boards for 2 hours before soldering, in order to improve the solderability.

### 7.7 Peelable solder mask

The film, when present in the SPEA documentation, must withstand the wave solder temperature and must not leave residues on the PCB when removed.

## 8. REPAIR OF PRINTED CIRCUITS

SPEA does not accept repairs of broken tracks, short circuits or retouching of solder resist on its printed circuit boards.

In special cases, and only after the approval of the Quality Service or the SPEA Engineering Body, the Supplier may deliver printed circuit boards repaired for interruptions (no more than one per printed circuit) in respect of the dimensional tolerances of track and insulation, keeping them separated and distinct from the rest of the lot delivered.

Authorized repair must be retouched with the same solder-resist used for production with subsequent repolymerization.

## 9. FRAMES OR PANELS

The frame is the support made around the single figure or multiple figures (panel of boards) designed to allow the assembly of the PCB on P&P machines.

In case of panel of boards, the percentage of waste cannot exceed 10% of the production lot.

In special cases and only after approval of the SPEA Quality Service or the SPEA Engineering Body, there may be exceptions if the single FAIL figure is always in the same position.

## 10. ELECTRICAL TEST

All PCBs must be electrically tested.

Each lot must be accompanied by a guarantee certificate attesting that the PCB passed the electrical test.

## 11. TRACEABILITY

### 11.1 Supplier logo and manufacturing date

The logo of the manufacturer must be printed on each panel.

The manufacturing date is the key for the identification of the documents.

The supplier must enter his trademark and the manufacturing date as follows:

2 digits for the fiscal week and 2 digits for the year, TE to mark the passing of the electric test, and the UL mark.

In case of panel of boards, each single figure must be marked.

## 12. PACKING AND SHIPMENT

PCBs shall be properly stacked in parcels of not more than 10 PCBs (or PCB frames) and enclosed in heat-shrink film (other material must be agreed in advance with SPEA) to be protected from external atmospheric agents or contamination during the storage period before entering production and carefully placed in the container (cardboard) so that they do not get damaged during transport.

Shipping and delivery arrangements for printed circuits must be agreed upon with the SPEA Purchasing Office.

The delivery times are those indicated in the RDA; the supplier must keep in mind that the delivery time is as important as quality of the product and any delay or advance with respect to the dates indicated must be agreed beforehand with the SPEA Purchasing Department.

**13. QUALITATIVE CLAUSES****13.1 Support to inspections**

SPEA reserves the right, upon prior notice, to:

- a. inspect the materials, equipment and installations used during the production and control phases of the supply;
- b. perform process or product audits during the delivery or control phases of the supply;
- c. consult the documentation about the materials, the dimensions of the constituent elements of the PCB and its parts, the tests.

**13.2 Acceptance criteria**

The acceptance of the supply is subject to the passing of the checks provided for by SPEA PR-19 procedure and the acceptance tests provided for by SPEA PR-21 procedure, as well as the presence of the documents provided for accompanying the supply.

In cases where the Supplier or its representatives, requested to provide information or to fill in documents or questionnaires necessary to SPEA in its relations with its customers or other interested parties, fail to provide the requested cooperation, It is the right of the requesting SPEA entity, in agreement with the SPEA Purchasing Office, to block the acceptance of the supply.

**14. WARRANTY**

For the PCBs covered by this document, by way of derogation from the second paragraph of § 13.3 of the SQ 400 General Conditions, the guarantee period insured by the Supplier shall be 24 months from the date of delivery.

For defects, defects or non-conformities detected during the warranty period, the conditions of General Specification SQ 400, § 13.3, second bullet point list apply.