



# Elrad Group PCB Requirement & Specification

Quality assurance document for PCBs

## Abstract

The PCB must conform to the IPC600 standard. For automotive PCB, IPC 600 class 2 minimum is required. The document describes the target, acceptable and nonconforming conditions that are either externally or internally observable on printed boards.

Prepared by: Tomaž Ciglar,  
Supplier Quality Engineer

Approved by: David Mlakar,  
Head of Global Quality



## Content

1. Purpose and scope .....	1
2. Normative references.....	1
3. Basic.....	1
3.1. Quality agreement.....	1
3.2. Initial sampling .....	2
3.3. PPAP .....	2
3.4. Safe launch requirements .....	2
3.5. COC (Certificate of Compliance).....	2
3.6. Temperature classes.....	3
3.7. Modification of production processes .....	4
3.8. Rework/Repair.....	4
3.9. Rejects in an array (Multipanel) .....	4
3.10. Traceability - production date and manufacturer code .....	5
4. General requirements .....	5
4.1. Holes and openings on single-sided PCBs .....	5
4.2. Plated Through Holes (PTHs).....	5
4.3. Plated Through Holes – visual requirements (PTHs) .....	5
4.4. Visual requirements .....	6
4.5. Automatic optical Inspection (AOI) .....	6
4.6. Adhesion of solder resist .....	7
4.7. Adhesion of strippable paint .....	7
4.8. Warp / twist.....	7
4.9. Electrical test .....	7
4.10. Dielectric strength .....	7
4.11. Chemical requirements .....	7
5. Dimensions and tolerances .....	7
5.1. Non-tolerated geometries.....	8
5.2. Array and single PCB tolerance .....	8
5.3. Board thickness and tolerances .....	8
5.4. Diameter of final hole.....	8
5.5. Thickness of solder resist .....	8
5.6. Scoring tolerances .....	8
5.7. Conductive carbon.....	9
6. Solderability of PCB (Shelf-life / Expire date) .....	9



6.1.	Surface finishes of solderable areas .....	9
6.2.	Solderability of interface areas and PTHs .....	9
6.3.	Susceptibility to fluxing agent and soldering heat .....	10
6.4.	Parameters of soldering .....	10
7.	Additional test .....	10
7.1.	CAF test (only if specifically required) .....	10
8.	Packaging.....	11
8.1.	Quality Guarantee .....	11
8.2.	Loading .....	12
8.3.	Storage of PCBs .....	12
8.4.	Marking.....	13
8.5.	X-out PCB.....	13
9.	Changes in relation to previous issue.....	13

***List of figures***

Figure 1: Temperature classes .....	3
Figure 2: rework of SM not allowed .....	4
Figure 3: Date code example .....	5
Figure 4: PTH requirement .....	6
Figure 5: Thickness of solder resist .....	8
Figure 6: V-cut for Base Materials FR4, CEM3 .....	9
Figure 7: V-cut for Base Materials FR2, FR3, CEM1 .....	9
Figure 8: Reflow profile lead-free .....	10
Figure 9: Example of packing with Humidity indicator .....	11
Figure 10: Humidity indicator which you can use. ....	11
Figure 11: packing example not recommended .....	12



## 1. Purpose and scope

The PCBs must be manufactured so as to produce a uniform quality, free from any defect and/or flaw which could affect the lifespan, the appearance or the performance of the product. This document is valid within the Elrad group.

The PCB must conform to the IPC-600 standard. For automotive PCB, IPC 600 class 2 minimum is required. The document describes the target, acceptable and nonconforming conditions that are either externally or internally observable on printed boards.

For the project, where Elrad customers have own definition for Circuit Board acceptability, Elrad customers definition is valid. For example ( HELLA HN67036, LEM co-60-04-046-0 ...)

## 2. Normative references

All requirements, which are not specified in this document, must meet followed IPC standard.

- Solderability test for PCB
  - ANSI/J-STD-003
- Criteria for the Acceptance of Electronic Assemblies
  - IPC-A-610
- Acceptability of Printed Boards
  - IPC-A-600
- Printed Board Performance Specifications
  - IPC-6010
- Test Methods
  - IPC-TM-650
- Surface treatment
  - IPC-4552
  - IPC-4553
  - IPC-4554
- Base material
  - IPC-4101
- Solder Mask
  - IPC-SM-840
- Test for flammability of plastic materials for parts in devices and appliances
  - UL 94
- Rework/Repair
  - IPC-7711

## 3. Basic

### 3.1. Quality agreement

The specifications of this corporate standard are a quality agreement between the PCB manufacturer



and Elrad. Also apply quality agreement document between Elrad and suppliers. The PCB Manufacturer is obligated to supply faultless products. Faults are *systematically* handled by means of 8D reports. The 8D reports must contain root cause analysis like 5 why or Ishikawa.

### 3.2. Initial sampling

Initial sampling consists of the supplier doing all of the specified tests and documenting them in an initial sample inspection report.

### 3.3. PPAP

For all new products or engineering changes Elrad will define required PPAP level.

Elrad required PPA process in followed cases:

- New parts or product
- Process or product change
- Relocation of production to another factory
- Long-term production stop for more than 12 months

### 3.4. Safe launch requirements

If defined by Elrad, supplier needs to establish Safe Launch Plan.

Safe launch activities are valid for suppliers with following aspects:

- Potential new supplier and first project
- Critical suppliers with high ppm rate
- Special new PCB requirements

Safe launch activities:

For the first 5 deliveries, the supplier has to carry out additional tests according to the request.

To each of 5 first deliveries, the supplier must send a test report. In the event that the result had been rejected, the supplier has to define corrective actions and has to prove the effectiveness.

Elrad is responsible to notify the supplier if the Safe Launch is required, otherwise the Safe Launch is not needed.

### 3.5. COC (Certificate of Compliance)

Every delivery must contain COC report.

COC report shall contain following information:



- UL Flammability Rate.
- Base Material type.
- Solder Mask type.
- Surface Finishing.
- Dimensional Measurement Report.
- Hole Size Measurement Report.
- Board Thickness Measurement Report.
- Solderability Test Report.
- Report of Electric Test.
- Micro-section Inspection Report.
- Cross section sample (physically delivered).
- Micro-section of V-cut.
- Thermal Test Report (if extra required).
- Ionic Containment Test Report (if extra required).
- CAF (if extra required).

### 3.6. Temperature classes

Required only for automotive.

In the vehicle, the following temperature classes and reliability requirements for PCBs are existent:

Application temperature including self-generated heat PCB	Temperature class		
Temperature class	250 cycles 1000 h	500 cycles 1000 h	500 cycles 1000 h
Thermal shock			
Humid heat/ high temperature			
85°C			
105°C	<b>B1</b>		
125°C	<b>C1</b>	<b>C2</b>	<b>C3</b>
140°C		<b>D2</b>	<b>D3</b>
150°C		<b>E2</b>	<b>E3</b>
160°C		<b>F2</b>	<b>F3</b>
Special requirements	S + min. application temperature / max. application temperature + lower temp./+upper		

Figure 1: Temperature classes

Unless otherwise specified in the material field, temperature class C2 applies. The supplier chooses materials suitable for the respective temperature class. Unless noted otherwise on the drawing, lead free soldering processes must be used.

Special requirements are noted on the drawing or in the PCB Datasheet.



### 3.7. Modification of production processes

Prior to changing the production process (manufacturing method or materials used such as Base Material, inks etc.), the manufacturer is obligated to notify Elrad in due time using Process Change Notification (PCN). The PCN must be sent to and approved by Elrad Purchasing Department. Elrad specifies the volume of samples and type of initial sample inspection report during processing of the PCN. This also applies if several alternative materials or methods have been permitted. If materials or processes are changed or if any other change is carried out, the supplier is expected to do the relevant tests. If production is moved to another plant, advance notification must be given through a PCN. Use and the placing of part or entire orders with or changing sub-suppliers is only permitted after the PCN has been approved.

### 3.8. Rework/Repair

Unless otherwise stated in written format, for Elrad Automotive PCB, rework is **FORBIDDEN**. Rework may be allowed for non-automotive PCBs, only where the supplier has written procedure for rework and inspection, and these are agreed with Elrad prior to reworking. Retouching the solder resist is admissible only if the final product meets all requirements specified in this corporate standard document. Maximum permissible area for solder resist repairs: 2 mm x 3 mm. Two solder resist repairs are permitted per 100 cm<sup>2</sup> of area. Solder resist repairs of scratches across circuits where the copper has been revealed are not permissible. Solder resist repairs in the area of the DMC field, fiducials and in the fine pitch area are not permissible. Repairs of shorts are permissible. Welding is not allowed. In special cases Welding on Inner layers are permitted, after customer approval. Rework is always forbidden in the following cases:

- Retouching due to electrical discontinuity (conductor cut-of, faulty via)
- Rework of ENIG finishing
- Rework of solder mask when the proximity is < 1cm from an exposed conductor.

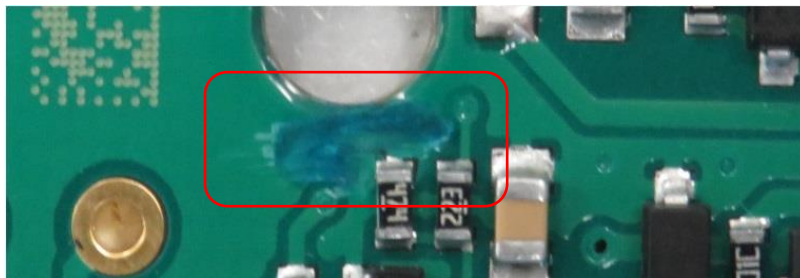


Figure 2: rework of SM not allowed

Each reworked product must be retested, re-inspected and identified (Double control is mandatory). In case of doubt, the supplier must contact Elrad immediately in order to agree on the action to take. PTH: rework of PTH is not allowed.

### 3.9. Rejects in an array (Multipanel)

Rejects are normally not allowed in Elrad.

Exceptions can only be permitted on a product-specific basis following discussion with Elrad's plant specific departments. Released rejects (not OK parts) must be:

- marked with a black 2 - 4 mm marker pen cross
- The design and position of bad marks must be agreed with the respective product plant.



- Delivered in separate packages with "Schlechtteile/ Rejects" legibly written or labeled onto them.

### 3.10. Traceability - production date and manufacturer code

Traceability information (raw materials, COC, production data, test and inspection result, tests coupon, solderability test result...) shall be kept by the PCB supplier for a minimum of 10 years for automotive applications, and 5 years for non-automotive application, after delivery of the conforming PCB, and shall be readily available upon request.

The production date appears on the PCB in the following format: WW.YY (week.year) or DDD.YY (day.year) in legible and smudge-proof writing.

In case of large quantities, it is recommended to use DDD.YY or WW.YY-01

- On Each PCB must be a date code, if one date code contains more than 100 panels the date code must include additional reference No. (example below).

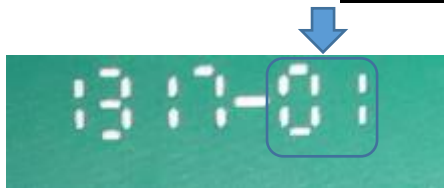


Figure 3: Date code example

If at all possible or defined by Elrad, every PCB has the manufacturer's code on it.

The manufacturer's code can be printed next to the production date.

Elrad will provide the appropriate HC fielding in the Gerber data either in the solder resist or in the copper layer.

The manufacturer code is assigned by Elrad Purchasing and is plant-specific.

## 4. General requirements

The circuit boards meet the general requirements of IPC-6010 Series Performance Class 2 and comply with IPC-A-600 Class 2. For automotive class 3 is recommended.

### 4.1. Holes and openings on single-sided PCBs

Holes and openings are punched, drilled or cut from the CU side (underside).

### 4.2. Plated Through Holes (PTHs)

All holes and openings connecting conductive patterns or soldering lands of both PCB sides must be copper plated.

Non-Plated Trough Holes are marked on the drawing or in the data model

### 4.3. Plated Through Holes – visual requirements (PTHs)

- If there is clearance in the solder resist, no residual ink is permitted in the hole that blocks the hole (see pictures 4)
- Holes with clearances and with finished hole diameters  $\geq 0,8$  mm must be free of solder resist







Figure 4: PTH requirement

Left side of picture permissible

Right side of picture not permissible

#### 4.4. Visual requirements

**The following items are not allowed:**

- Residual dust, drilling chips or metal on the circuit board
- Fluff, hair and other matter trapped on or in the solder resist mask
- Solder clots
- Spots or residue from solder resist masks on SMD pads
- PCBs must be free of oil, grease and silicone

**Visual requirements of solder resists** (if no other specified must meet IPC A 600)

- Blisters/faulty spots up to max. size of 1x1 mm permissible on Ground and Base Material. Up to 2 such faults 100 cm<sup>2</sup> are permitted.
- No voids permitted on connectors.
- A max. of 2 pinholes per cm<sup>2</sup> is permissible.
- Up to two scratches per 100 cm<sup>2</sup> area are permitted in the solder resist.
- Any scratches must not damage any SMD pads or lands or bare any copper.
- Maximum permissible length of a scratch 2.0 cm
- Maximum permissible width of a scratch 0.5 mm
- Scratches across connectors that reveal the copper are not permitted
- Scratches on DMC code areas that impair legibility are not permissible.
- The conductor edges must be covered in solder resist
- Creeping through finished surfaces must not exceed 35 µm
- Solder resist is not permitted on pad surfaces
- Maximum permissible undercut for white and black solder resists: 100 µm to 50 µm base copper.
- For copper thicknesses > 70 µm max. permissible undercut 125µm
- Max. Permissible undercut for all other solder resists: 50 µm to 50 µm base copper.
- For copper thicknesses > 70 µm max. permissible undercut 75µm.
- Unless otherwise specified on the drawing, green or green-blue solder resist must be used.

#### 4.5. Automatic optical Inspection (AOI)

Interior areas must be 100% checked with AOI.



If the PCB drawing has a note "AOI outer areas", the outer areas must (also) be 100 % checked with AOI.

#### 4.6. Adhesion of solder resist

The adhesion of the solder resist is tested compliant to IPC-TM-650.

#### 4.7. Adhesion of strippable paint

The strippable varnish must allow to be pulled off without leaving any residue following: one-time reflow soldering process of printed circuit boards and subsequent two fold wave soldering process.

#### 4.8. Warp / twist

The inspection of warp / twist is determined as specified in IPC TM 650 section 2.4.22.

For the Delivery Condition as individual board or the array is valid:

For PCB prepared for SMD the max. allowed warp/bow is 0,75 % in delivery condition, for all other PCB the max. allowed warp/bow is 1,5 % in delivery condition according to IPC A 600 section 2.11.

#### 4.9. Electrical test

Every circuit board undergoes an electric test. Short and opens are not allowed. Tested boards shall be identified with a mark on the side of the pcb.

#### 4.10. Dielectric strength

The test is done compliant to IPC 6012 section 3.10.8.

#### 4.11. Chemical requirements

The PCB must be free of oil, grease and silicon. Solder resist for PCB which go in process conformal coating must achieve min. 38 mN/m of surface tension. This tension must be also achieved after 3 reflow process. For controlling of surface tension must be used Testink or test pen. This test result must be also included in Quality inspection report in COC documentation.

### 5. Dimensions and tolerances

**All manufactured parts must be exact copy of the Elrad Data sheet and gerber files.** Any change affecting the production of the PCB will be permitted after notification and official acceptance from company Elrad. **The data sheet is mandatory.**

The supplier/manufacturer must make sure that all the circuit delivered to Elrad conform dimensionally to the tolerances indicated within the approved design. The method used by supplier, to guarantee that the printed circuit conform with respect to dimensional requirements and current drawing plans, is their own responsibility (control 100%, SPC etc.). A record of dimensional conformity must accompany the printed circuit with each delivery.

The supplier will also provide an outgoing report with each batch delivered to demonstrate the conformity of supplied part with respect to functionality, appearance and engineering requirements.



### 5.1. Non-tolerated geometries

The requirements specified in DIN ISO 2768 mH must be met for all non-tolerated geometries.

### 5.2. Array and single PCB tolerance

Unless specified otherwise, the permissible tolerance for the array length and width, and/or in case of delivery as individual PCBs, for the length and width is acc. ISO M (medium).

### 5.3. Board thickness and tolerances

The PCB thicknesses stated in the Elrad drawings relate to the thickness of the entire circuitry including the solder resist. The tolerance of the PCB thickness for nominal thicknesses > 1.4 mm must not exceed + 10% of the nominal thickness.

The tolerance of the PCB thickness for nominal thicknesses < 1.4 mm must not exceed + 0.14 mm of the nominal thickness.

### 5.4. Diameter of final hole

Unless otherwise specified on the drawing, the tolerance of the through-plated final hole is + 0.1mm 0.05 mm, and + 0.1 -0,0 mm for a non-through-plated final hole.

### 5.5. Thickness of solder resist

The thickness of the solder resist must not be less than 10 µm at position 1, 3, 4, 5 and 6.

The copper edge cover (position 2) with solder resist must be high enough to meet a dielectric strength requirement of min. 500 Volt DC voltage compliant with IPC-TM-650 2.5.6.1, but at least 4 µm. The thickness of the solder resist on the base material (for example, positions 3 and 4, Figure 5) must not exceed the pad height.

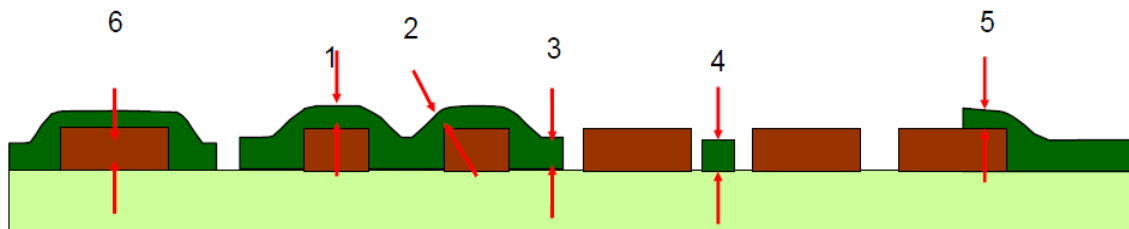


Figure 5: Thickness of solder resist

### 5.6. Scoring tolerances

The figures below illustrate the scoring tolerances:



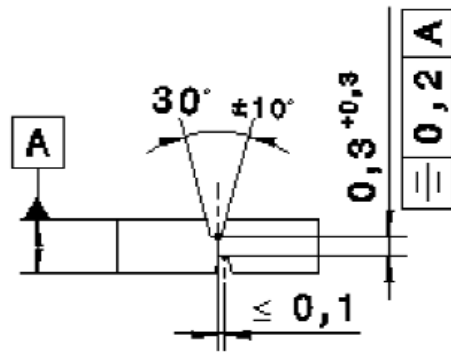


Figure 6: V-cut for Base Materials FR4, CEM3

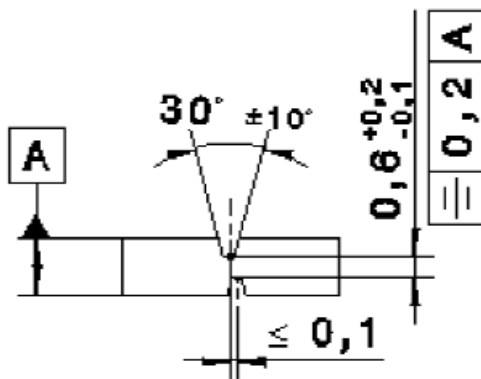


Figure 7: V-cut for Base Materials FR2, FR3, CEM1

## 5.7. Conductive carbon

Unless otherwise specified on the drawing, the minimum thickness of the conductive carbon is 10 µm, its maximum thickness is 30 µm.

## 6. Solderability of PCB (Shelf-life / Expire date)

Supplier must clearly state the shelf life of all surface finish types in an official document. Any changes to this agreement shall be communicated to Elrad before delivery is shipped. Regardless of the finish, the PCB must preserve its solder ability features for at least 6 months (this duration will be extended to 12 months for ENIG or HASL finishing).

### 6.1. Surface finishes of solderable areas

The surface finish is as specified on the drawing. Application of surface finishes must not negatively influence the properties of the Base Materials.

### 6.2. Solderability of interface areas and PTHs

This test examines the wave soldering ability of the solder pads and the PTH drills following aging and



reflow soldering. The test complies with ANSI/J-STD-003, similar to test C.

### 6.3. Susceptibility to fluxing agent and soldering heat

This test examines the circuit board's susceptibility to the fluxing agent used and the maximum temperatures possible are determined. The test complies with ANSI/J-STD-003, similar to test C.

### 6.4. Parameters of soldering

Figure 8 shows the reflow test profile for the qualifications of the PCB. This reflow profile must be used as pretreatment prior to the solderability and reliability testing.

#### - Reflow profile lead-free

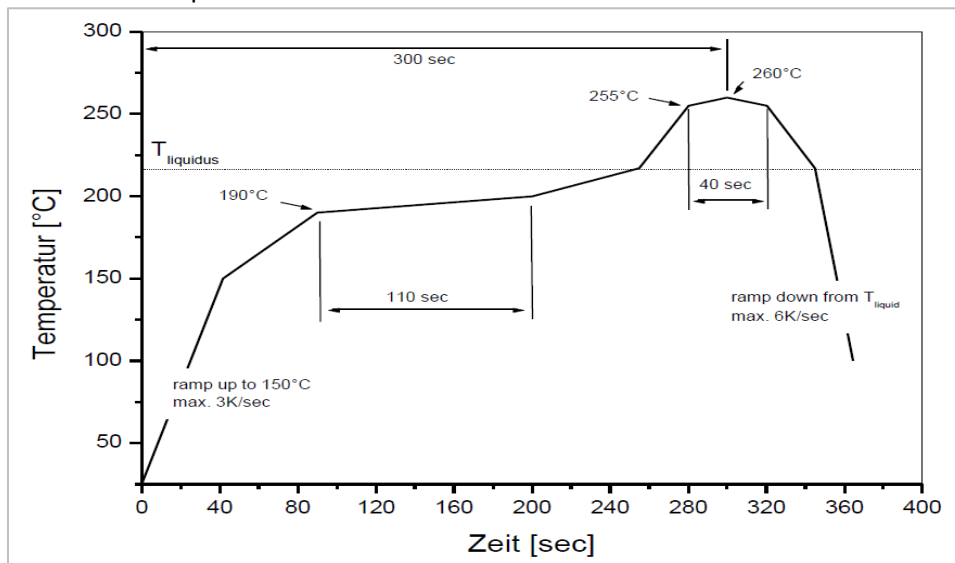


Figure 8: Reflow profile lead-free

#### - Wave soldering parameters

The lead free dual-wave is to comply with the following parameters:

Temperature of solder bath: 280 °C + 5 °C

Conveying speed: 1 m/min + 0.1 m/min

Preheating: 130 °C + 5 °C

## 7. Additional test

### 7.1. CAF test (only if specifically required)

The test is carried out in compliance with IPC TM 650 2.6.25 .

Resistance must be measured in the initial state and after 500 hours.

The following test conditions must be met according to below Table.

CAF test conditions
---------------------

Test voltage	100 Volt + 5 % direct current
Measuring time	60 sec, the value meas. must remain constant
Storage temperature	85 °C + 2 °C
Humidity (storage)	85 % + 5 % rel. humidity
Storage	vertical

Requirements:

The insulation resistance must be > 500 MΩ

## 8. Packaging

### 8.1. Quality Guarantee

The printed circuit delivered to Elrad must be packed in a way in which they cannot be damaged, and should also be protected against humidity, it's preferred vacuum packing.

All PCBs delivered by sea must be vacuum packed with moisture absorb material (Silica Gel) and Humidity indicator.

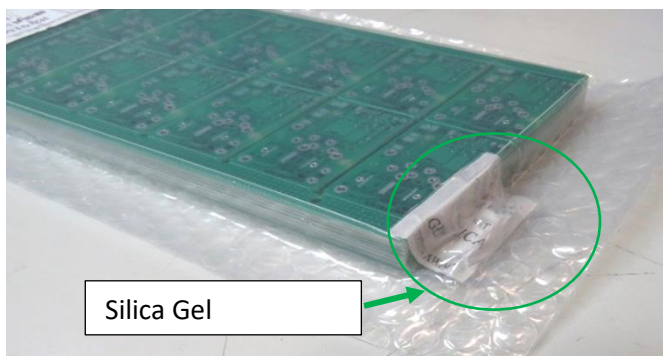


Figure 9: Example of packing with Silica Gel

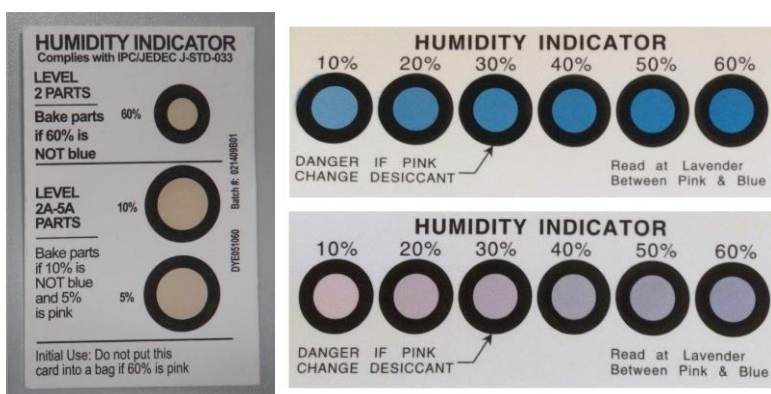


Figure 10: Humidity indicator which you can use.

They should not be able to float inside their packaging during the transport. There must be protective layer between the circuit and the outside the package (bubble wrap etc.). All packages



must remain intact and preserve its original shape until its point of use, whatever the climatic condition.

The principal conditioning and packing of the printed circuits must be sufficiently robust so that they can be transported on pallets. Packing must ensure that the PCBs are held in place and are kept flat throughout transportation. Packaging must be free of grease and/or mark of acid.

## 8.2. Loading

The weight of principal package should not exceed 12 kg.

All packaging must be manageable and be able to handled manually.

The height of the palletized loads should not exceed 1 m.

On each pallet or in box must be only one Date Code of PCB, in one box or on pallet shall not be mixed two or more date codes of PCB as show pictures below.



Figure 11: packing example not recommended

## 8.3. Storage of PCBs

The storage of PCB with the supplier must be carried out using thermoplastic film, in a temperature controlled room 20°C +/- 5°C with the level of humidity not exceeding 60%. The date code of manufacture of the printed circuit which will be delivered to Elrad, should not be greater than 6 month old. The supplier is requested provide Elrad their expiry date commitment for the shelf life expectancy for each surface finish type provided by the supplier. This document is required at the same time as the approval submission.





#### 8.4. Marking

- Elrad Part Number.
- Quantity.
- Production Number.
- Manufacturer name.
- Manufacturer date code.
- Validity date (named also on delivery note).

#### 8.5. X-out PCB

If with Elrad agreed to accept x-out PCB, followed packing instruction must be considered.

- Panels with X-out PCB must be packed separately and visible marked.
- Panels with X-out PCB must be sorted according to position X-out PCB in panel.

Accepted X-out PCB per panel.

PCBs per Panel	Defect PCBs
1	0
2– 4	1
5– 10	2
11– 20	3
21 – 35	5
>35	7

If there is small amount of X-out PCB, you can gather pcs. for some period and then send to us larger amount. But this period must be limited regarding to Shelf life for PCB according to surface finish, but no longer than 6 months.

Max X-out amount PCB from order is 5%.

#### 9. Changes in relation to previous issue

*2022-05: 1.0 issue/ added point 8.5, X-out PCB*

*2022-05: 1.0 issue/ update point 1, added requirement regarding customer PCB specification.*

*2022-05: 1.0 issue/ update point 4.11, added requirement regarding clean less of solder mask.*

*2023-07: 2.0 issue/ update point 8.1, added requirement for Humidity indicator.*

