

# Verification of the assembly per ECSS-Q-ST-70-38C and passive devices associated failures

C. Villette (ESA/ESTEC-TEC-QTM)

Noordwijk

26/09/2013

1. ECSS-Q-ST-70-08: The manual soldering of high reliability electrical connections
2. ECSS-Q-ST-70-07: Verification and approval of automatic machine wave soldering
3. ECSS-Q-ST-70-18: Preparation, assembly and mounting of RF cables
4. ECSS-Q-ST-70-20: Determination of the susceptibility of silver plated copper wire and cables to 'red plague' corrosion.
5. ECSS-Q-ST-70-26: Crimping of high reliability electrical connections
6. ECSS-Q-ST-70-28: repair and modification of printed circuit board assembly for space applications
7. ECSS-Q-ST-70-30: Wire wrapping of high reliability electrical connections
8. **ECSS-Q-ST-70-38**: High reliability soldering for surface mount and mixed technology

# ESA-ESTEC team in charge of verification in compliance with the ECSS-Q-ST-70-XX



## 1. TEC-Q (W. Veith)

### a. TEC-QT (M. Nikulainen)

- TEC-QTM (T. Ghidini)

- C. Villette

- J. Hokka

- G. Corocher

- D. Collins (100%)

- N. Beadle (100%)

- R. Dohmen (50%)

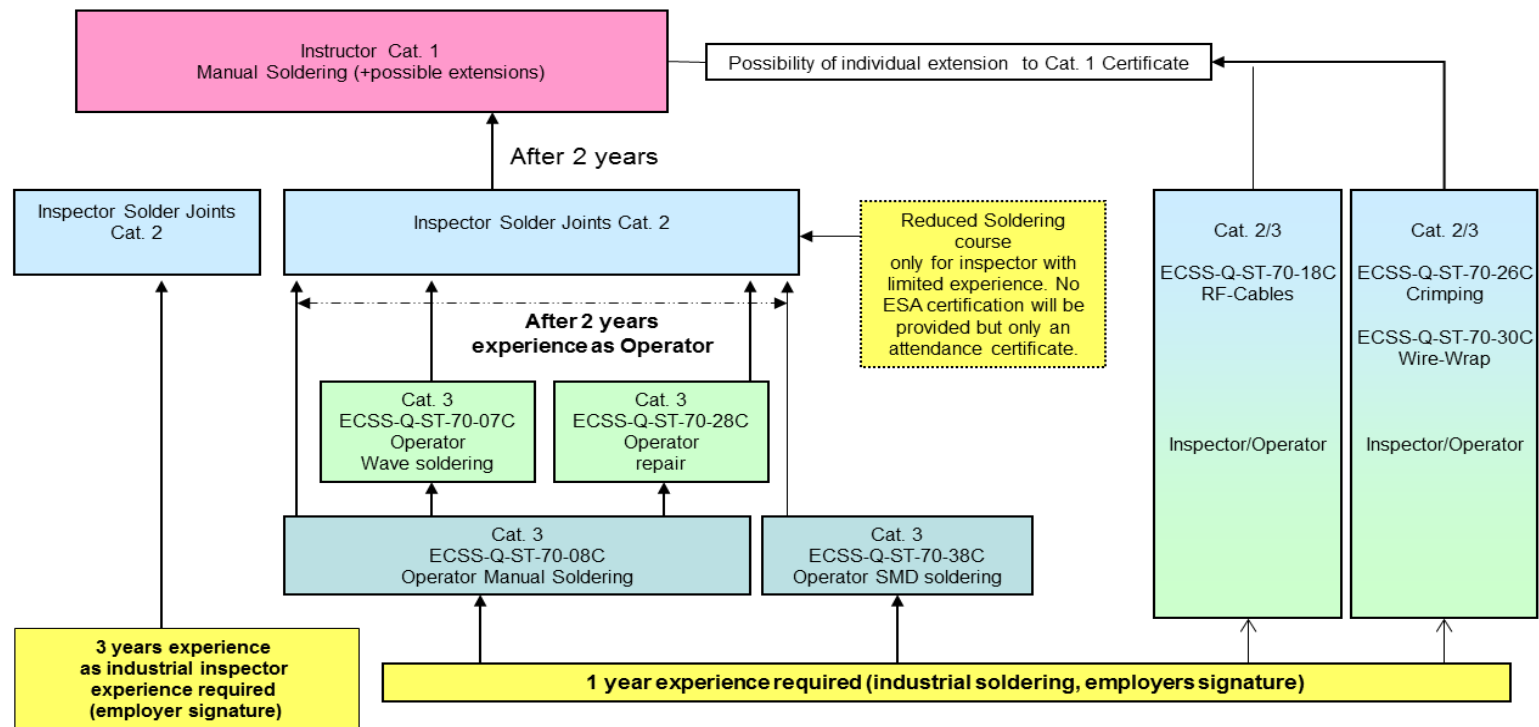
- D. Adams (on demand)



# Certification status of the operators and inspectors



## ESA Training Structure – ESA STR-258 (Skill Training Schools) Progression route for certification



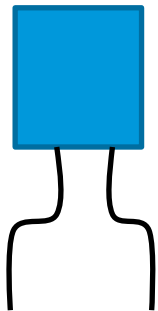
- ASTA (UK)
- Hytek (Denmark)
- IFE (Germany)
- IS (France)
- IIS (I)
- ZVE (Germany)
  
- New interest from 2 schools
  - SWI in Switzerland
  - Renex in Poland



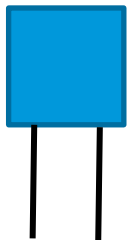
- **Mechanical Vibration stresses**
  - Unit acceptance tests
  - System acceptance tests
  - Satellite acceptance tests
  - Launch
  
- **Mechanical shocks stresses**
  - Stages separation
  - Solar Array deployment

- Curing of adhesive
- In step PCB bake out
- Acceptance thermal cycles at unit level
- Acceptance thermal cycles at system level
- Acceptance thermal cycles at satellite level
- Temperature variation during the mission
- On-Off

## Assembly of component assembled through hole by hand



- No verification



- Verification (Vibration + 200 thermal cycles + microsectioning)



Assembly by hand or by machine of SMDs in compliance with the ECSS-Q-ST-70-38C and TEC-QT/2013/398/CV

- Technology sample to be provided for inspection at TEC-QTM
- Assembly of a populated verification board with representative devices in compliance with the TEC-QT/2013/398/CV
  - a. Assembled by hand (repair to be demonstrated)
  - b. Assembled by machine (when applicable applicable)
- Audit of the manufacturing line
- Final verification review
- ESA Approval of the Summary Table

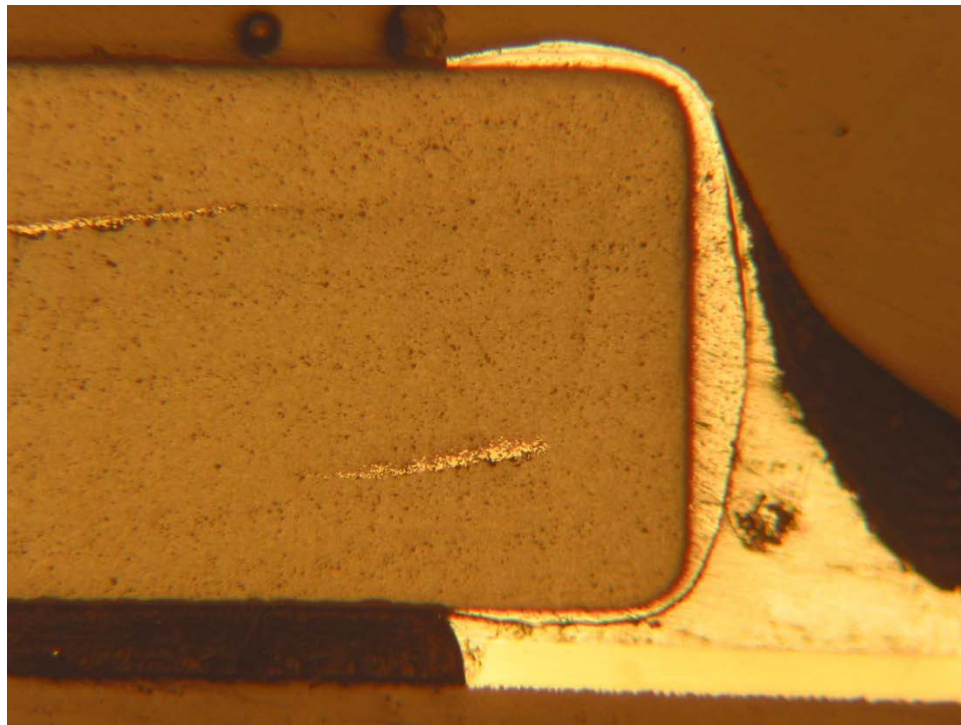
- **ESA Assembly verification procedure**

<https://escies.org/webdocument/showArticle?id=981>

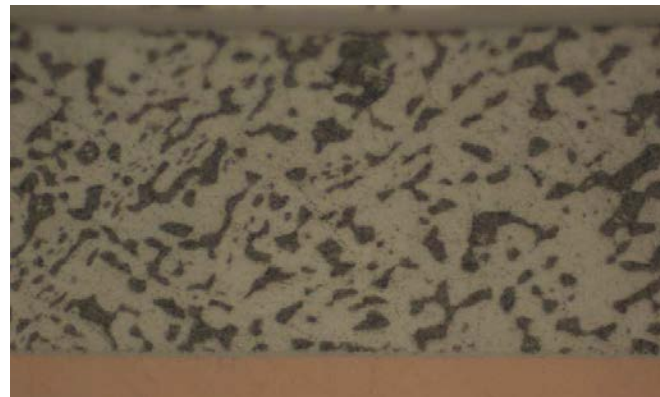
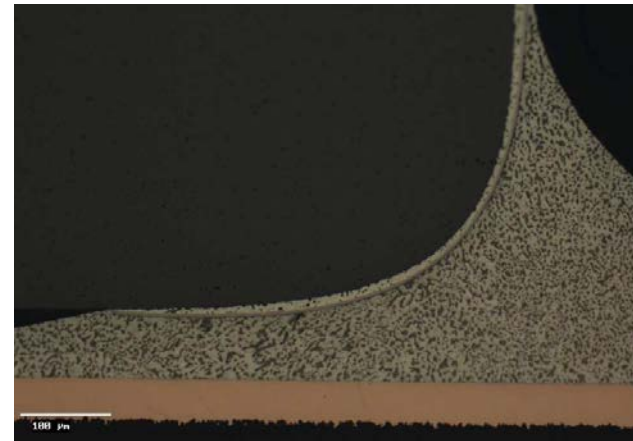
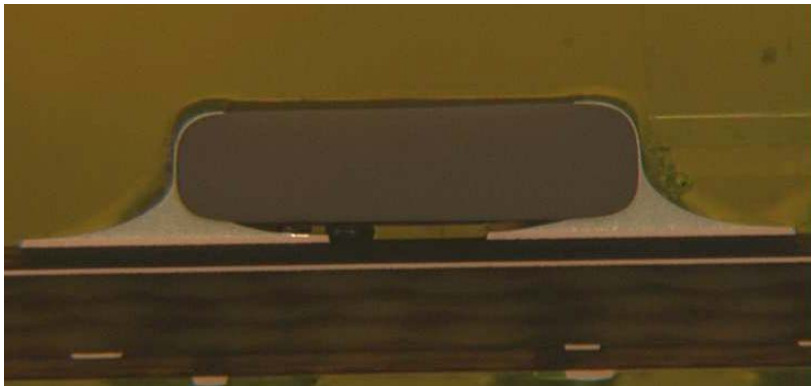
- Verification programme content ( list of materials, PCB built up...)
- Additional requirement compared to the ECSS-Q-ST-70-38C
  - Number of devices to be assembled (3 machine reflow + 3 HS) except for critical devices
  - Critical devices (from R1206, LCCs, SMDs packages, Chip capacitors, CWR06)- 5 machine reflow and 5 HS
  - Requirements for microsectioning at completion of tests.
    - All critical devices to be microsectioned
    - ESA recommended companies
      - Serma, Hytek, ZVE, IIS,

*Tailoring is possible. The verification programme, approved by ESA, takes precedence on the TEC-QT/2013/398/CV*

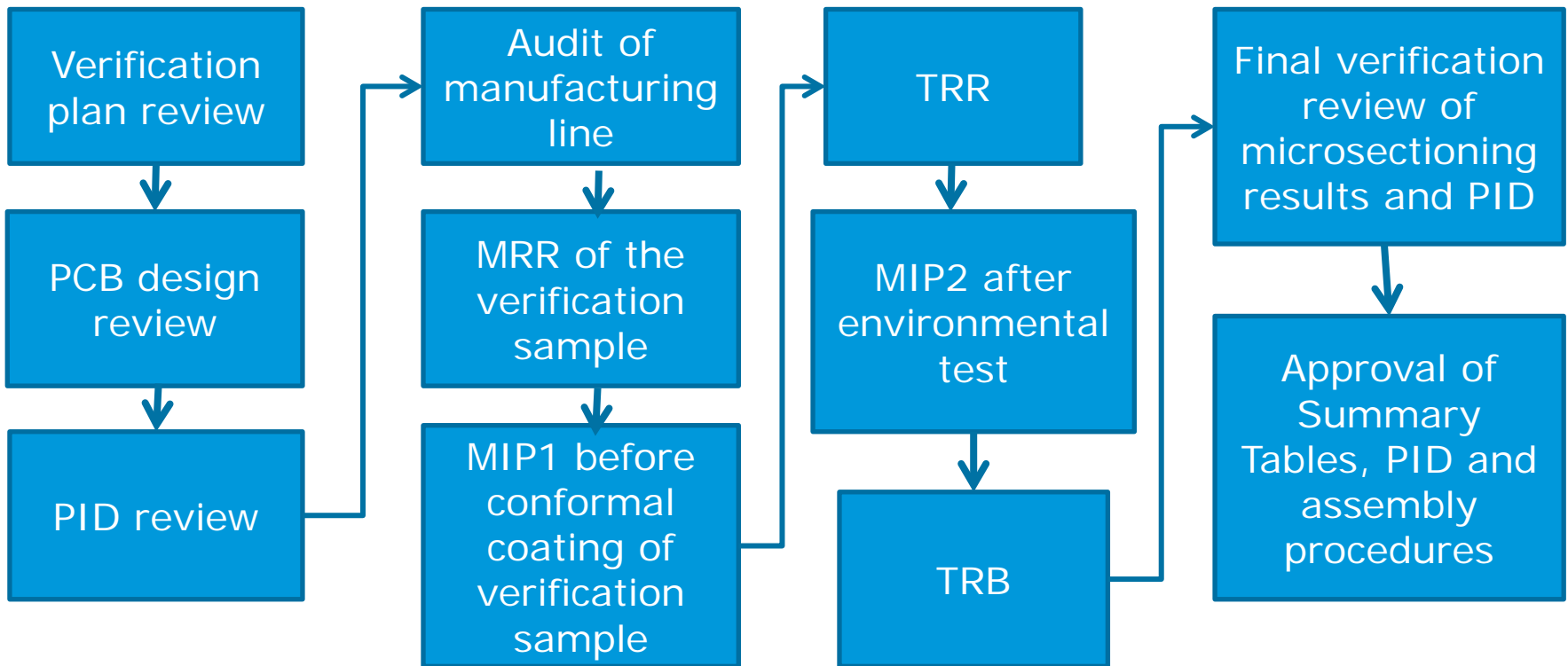
# Previous quality of microsectioning



# Actual Microsections quality



# Verification programme flow



# List of critical devices (TEC- QT/2013/206/CV)



- Memo issued by ESA and uploaded on Escies website

<https://escies.org/webdocument/showArticle?id=981>

*The list will be updated when needed.*

# Companies ESA Approved for the assembly (TEC-QT/2013/335/CV)



Document available on the Escies website

<https://escies.org/webdocument/showArticle?id=981>

➡ Rakon: Verification programme of the Oscillator assembly line.

*The list is at the moment under update.*

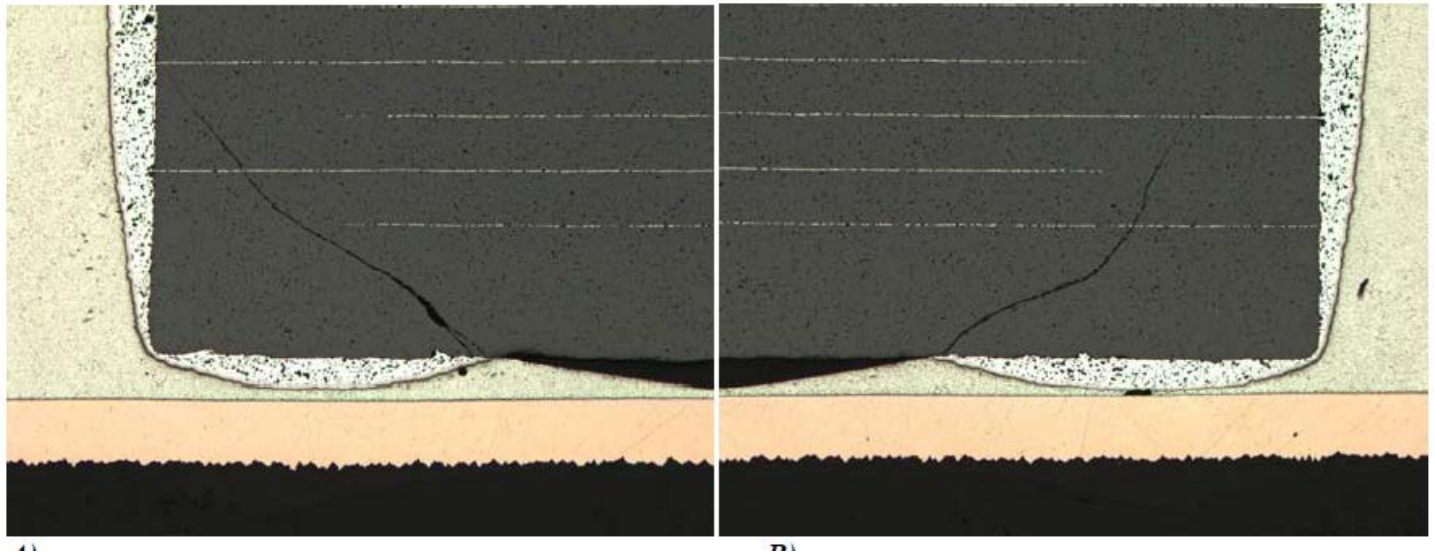
Creation of a pool of companies available for assembly as subcontractor.

Some companies such as Matra electronique, Patria, RESA, RSA, RSE, SPUR, Syderal, Thales Espana, ... have already assembled flight hardware for other companies.

*-Still to be done: Organization of a workshop to define the rules to be followed*



## Chip capacitors

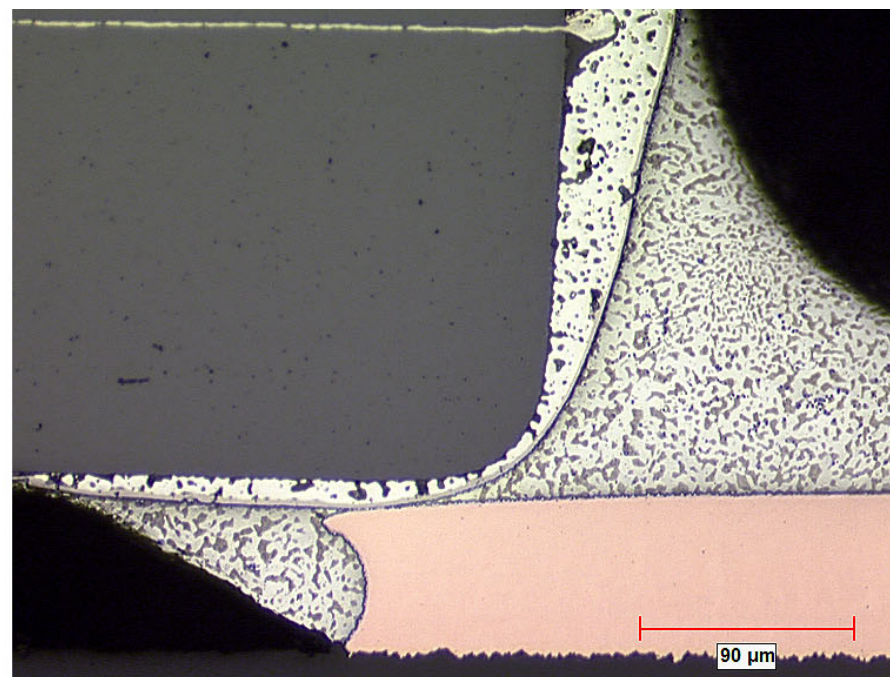
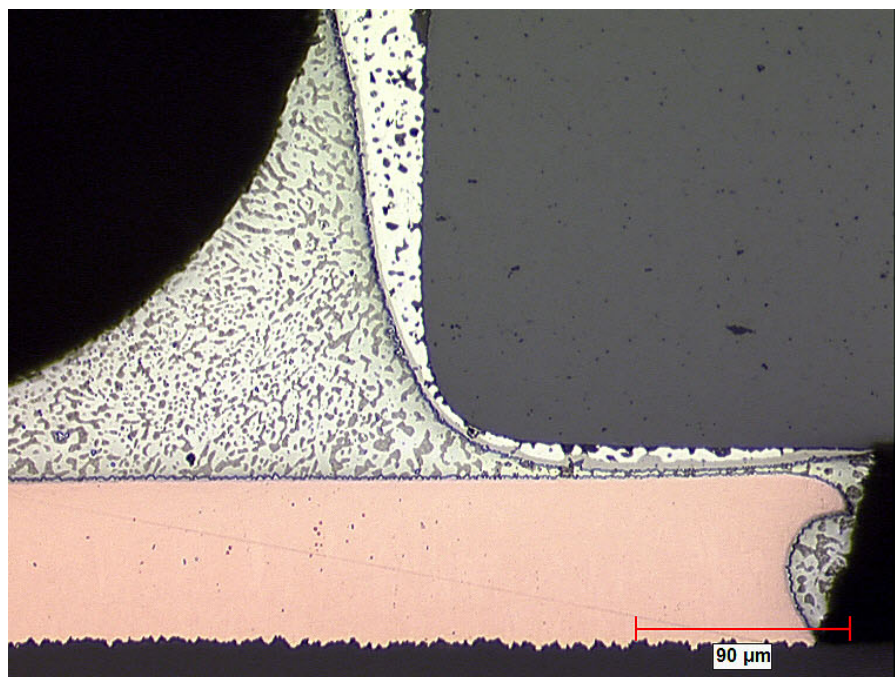


- Excessive soldering temperature
- Contact between the soldering tip and the termination due to not adapted foot print
- Cracks already present in the ceramic prior to assembly
  - ➡ Change request of the ESCC criteria
  - ➡ Forbidden of chip capacitors rework

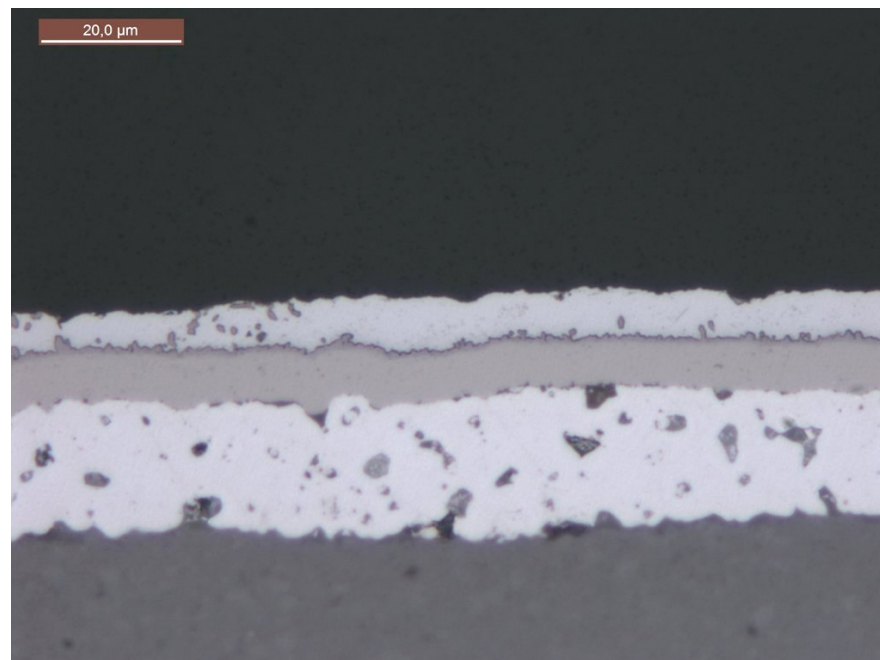
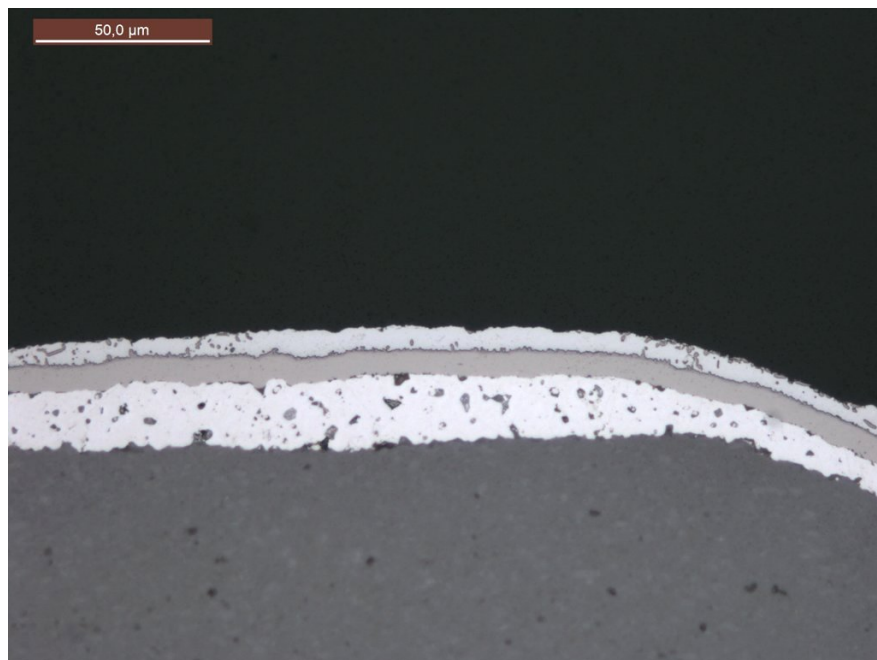
## Ceramic chip capacitor: detachment of the termination



## Unacceptable pad layout



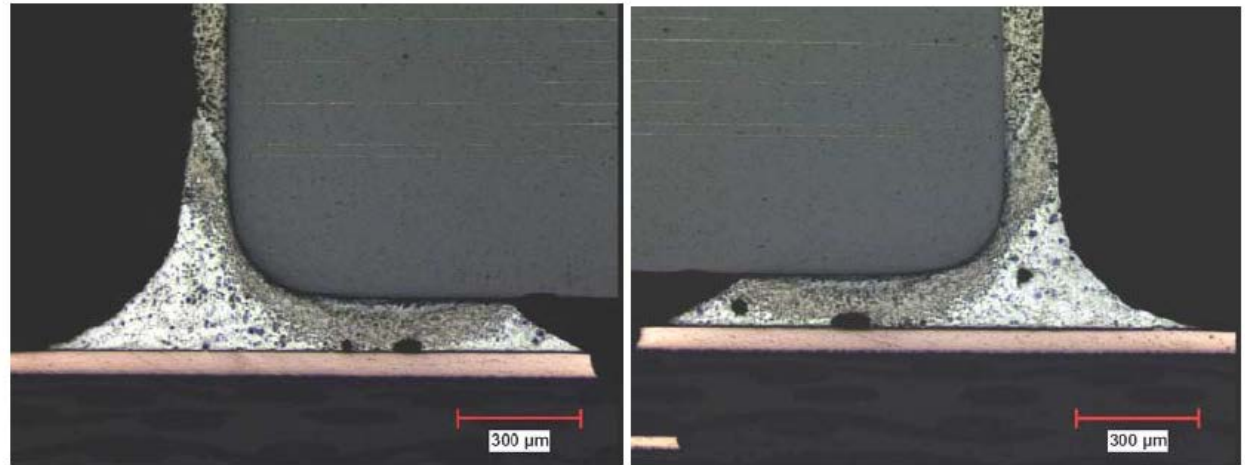
## Pure tin finish



**Need for LFCP**



## Chip capacitors



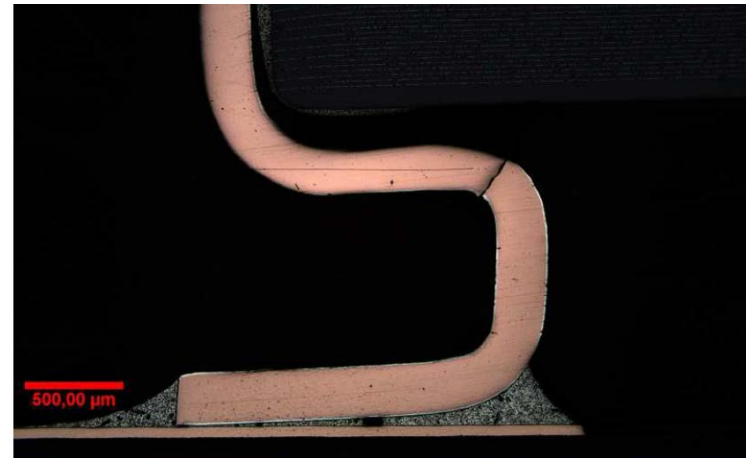
Assembly by machine of Ag/Pd finish without diffusion layer



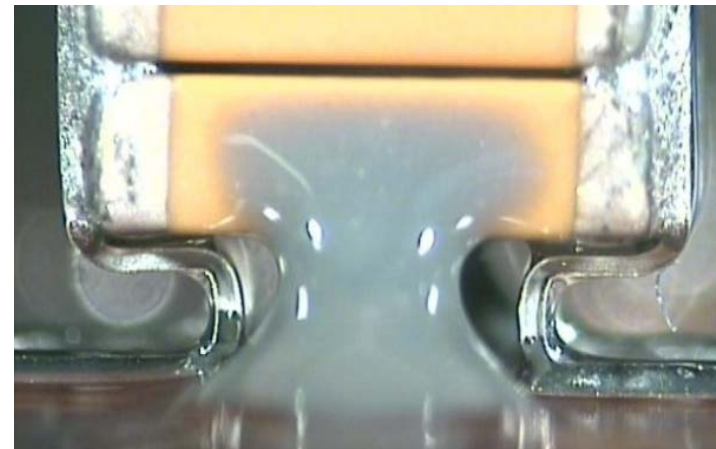
Such termination shall not be used for soldering

# Example of failures

Stack capacitors

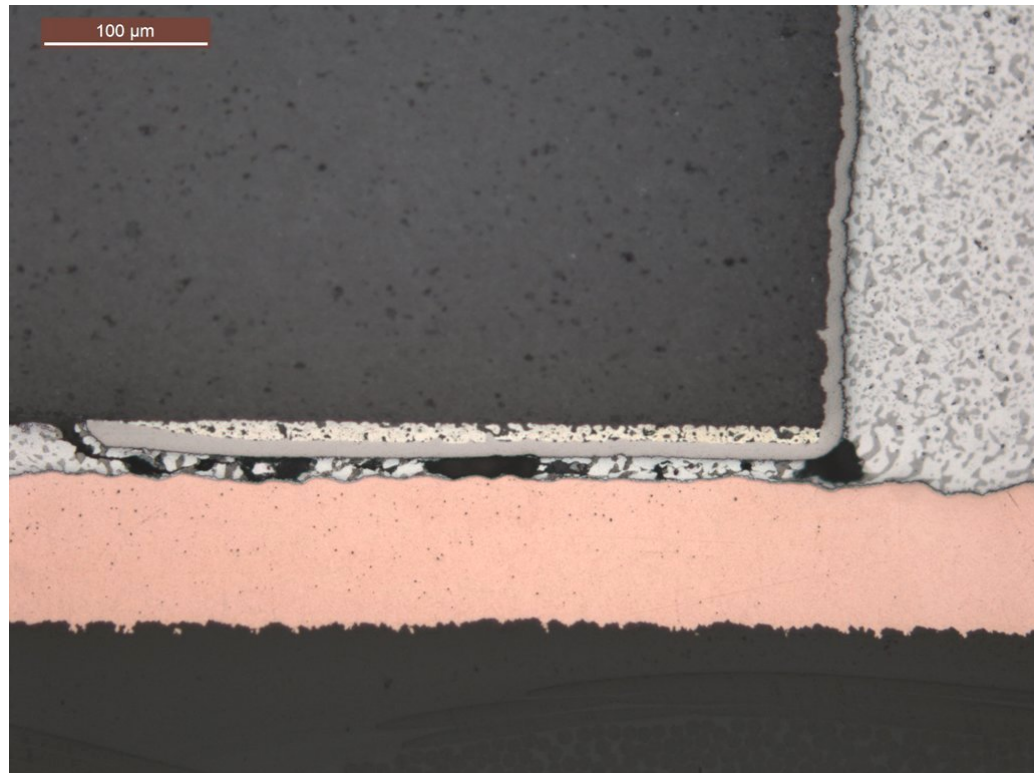


Corrective action

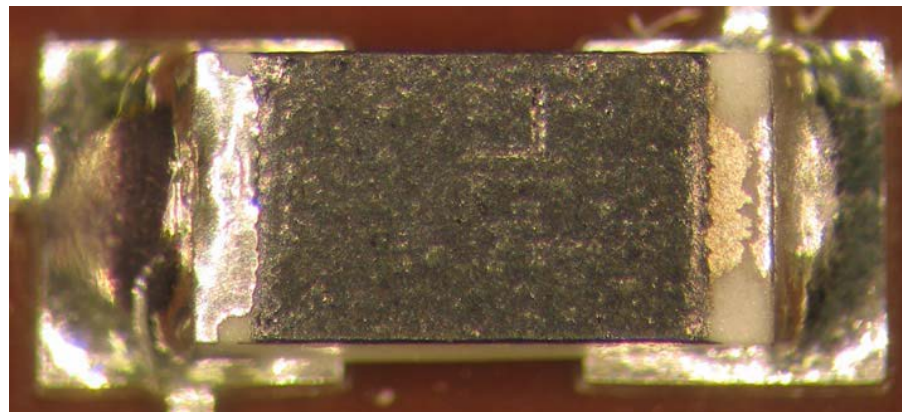


# Example of failures

R2512



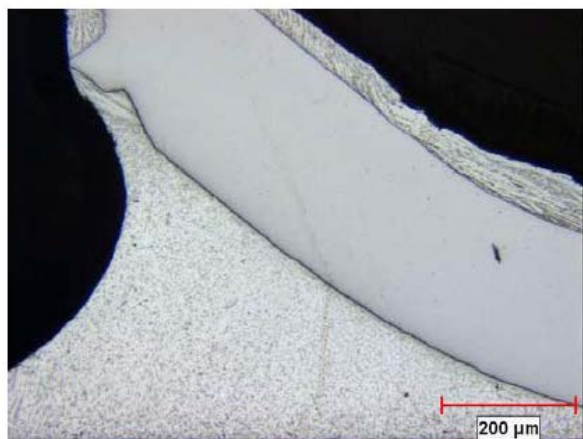
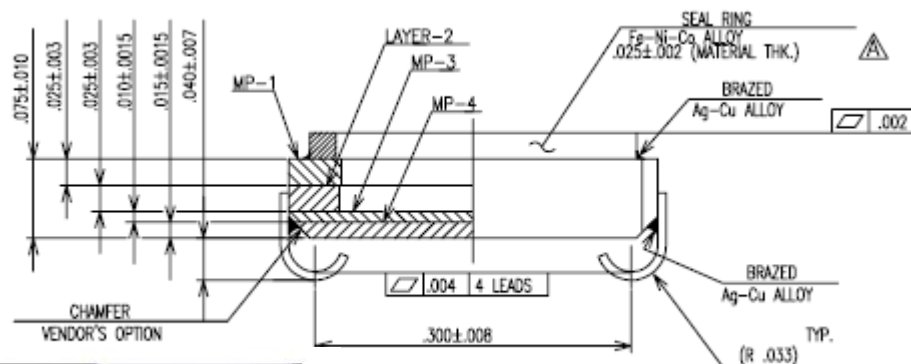
## Failure in the metallization of the ceramic chip resistor



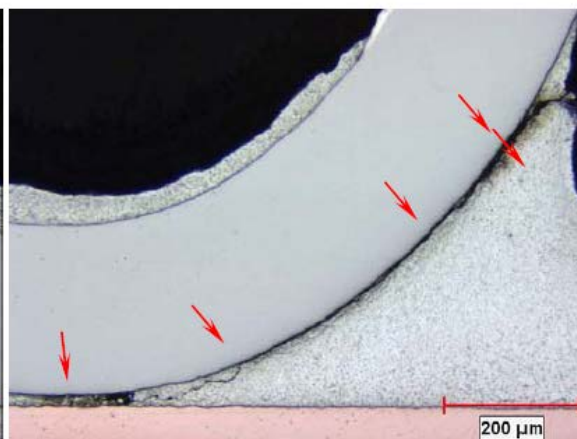


# Oscillators JLCC4 packages

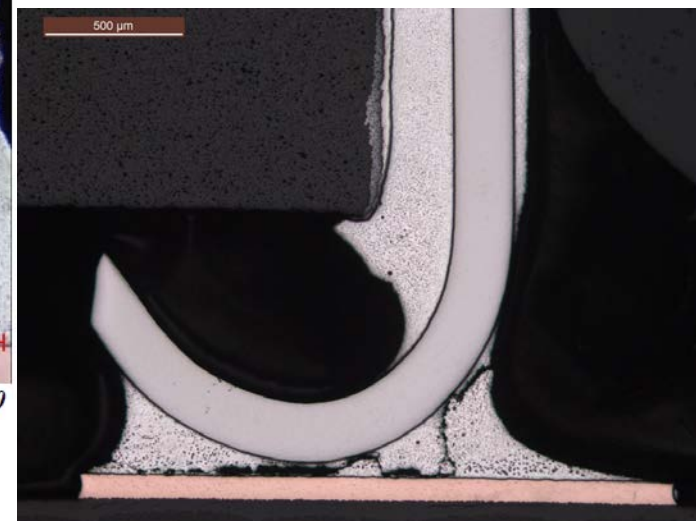
Crack in solder joint after 50 cycles



A) Magnification x100



B) Magnification x100



500 thermal cycles

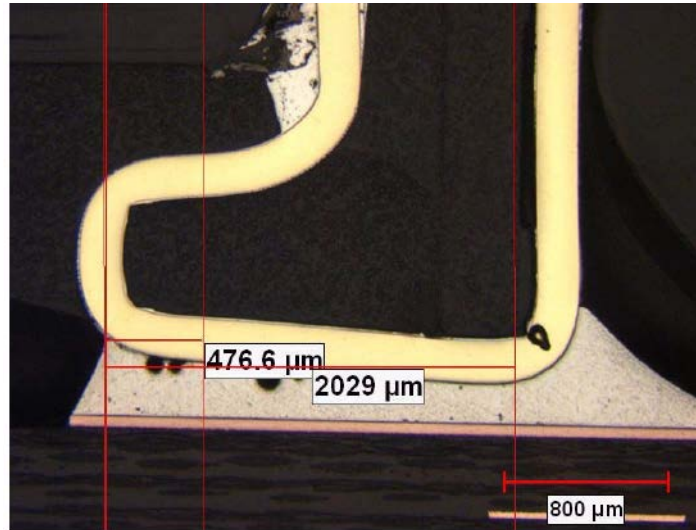


New design from Rakon

# Example of failures

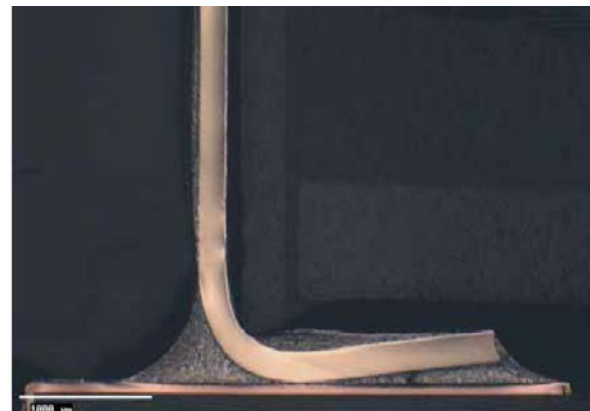
## Film capacitors

Excessive crack after 50 cycles.

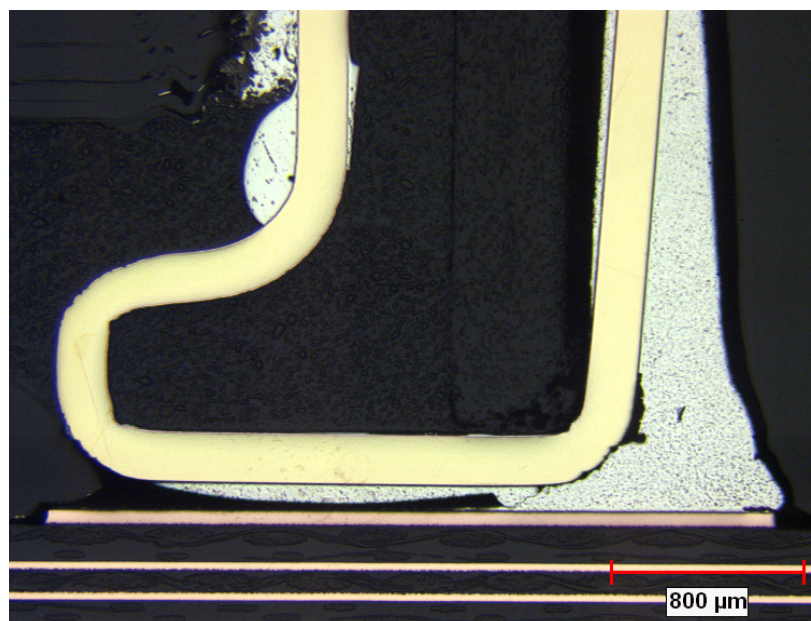


*Magnification x25*

Change of lead attachment design



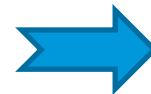
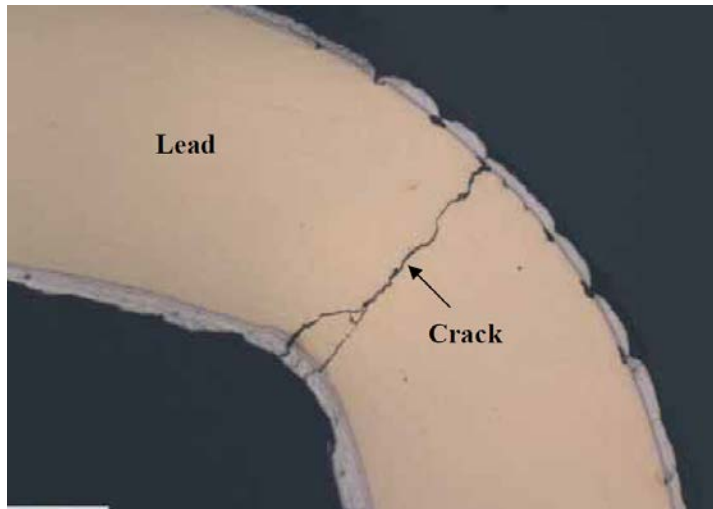
## Insufficient wetting:



# Example of failures

## Transformer

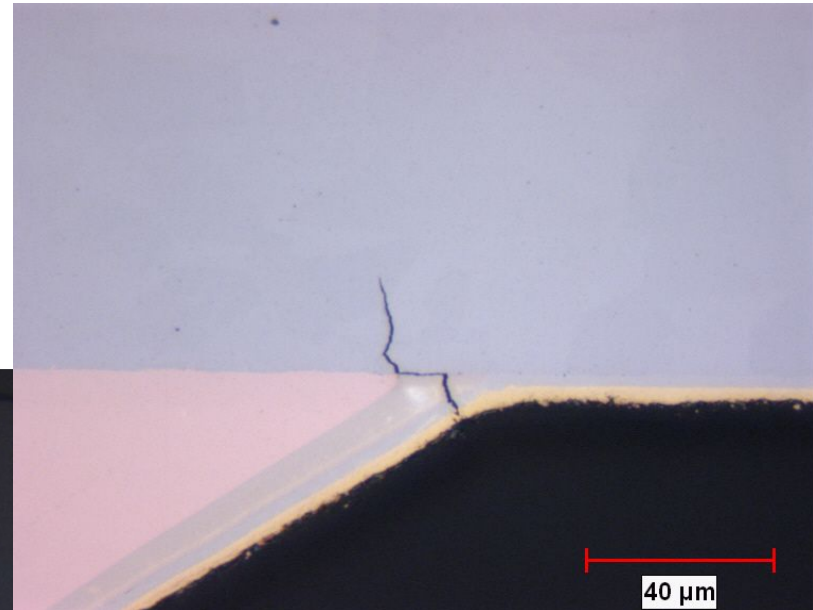
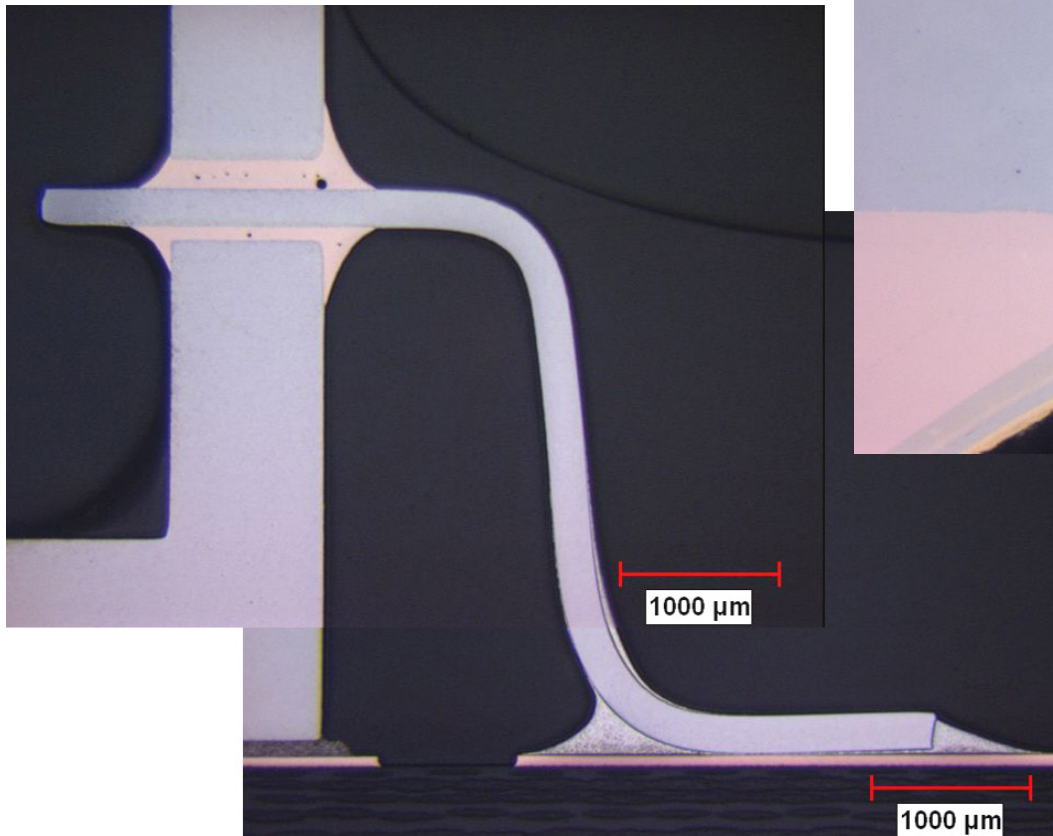
Insufficient mechanical support



Reinforced mechanical support

# Example of failures

## Oscillator



Additional mechanical support



# Example of failures

## Tantalum capacitor

Crack or lifting of the conductive  
Adhesive



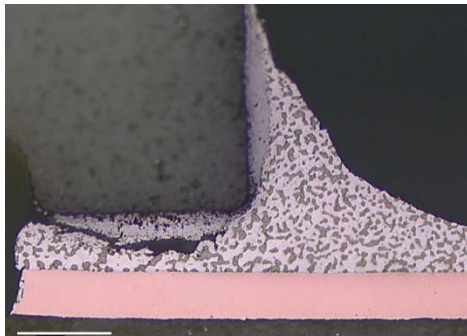
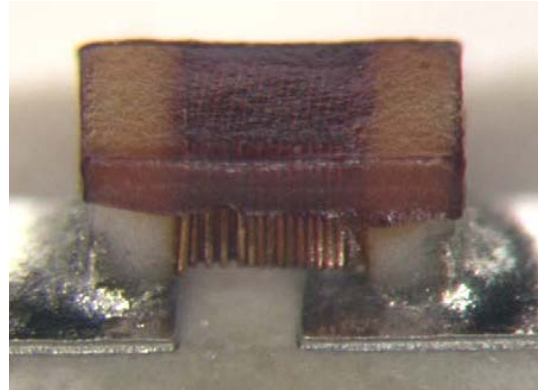
Electrical measurement at cold,  
room temperature and hot temperature  
to ensure that the device is still  
under specification.



Not preferred device. May still be used for recurrent hardware.

# Example of failures

inductors



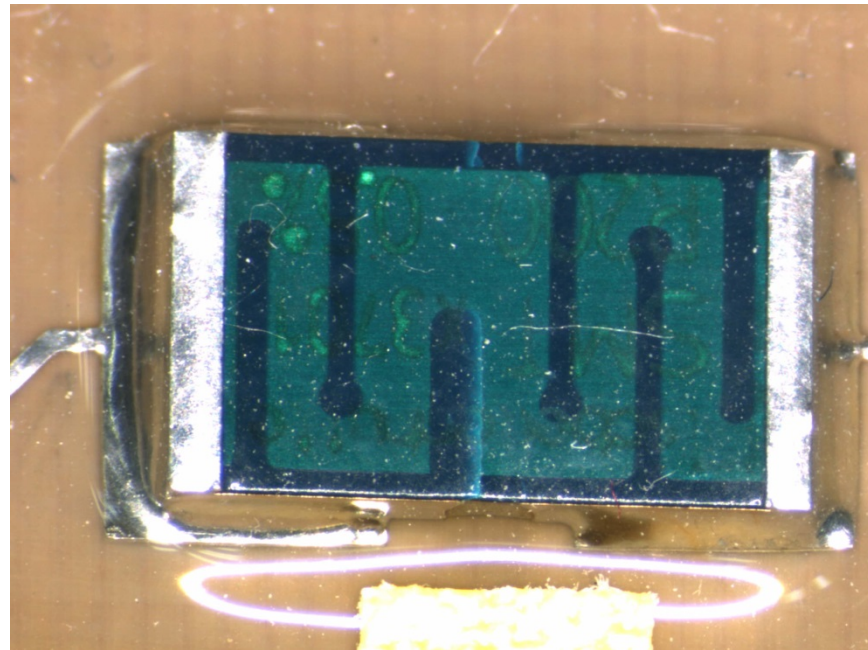
Contamination from enamel wire



Request of additional cleaning to remove enamel contamination.

# Example of failures

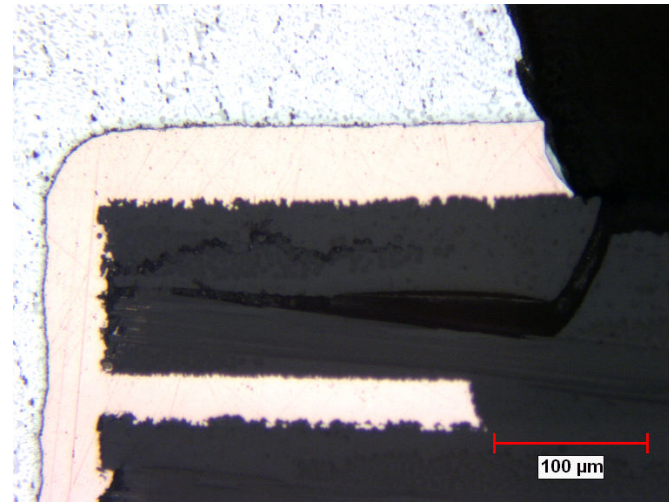
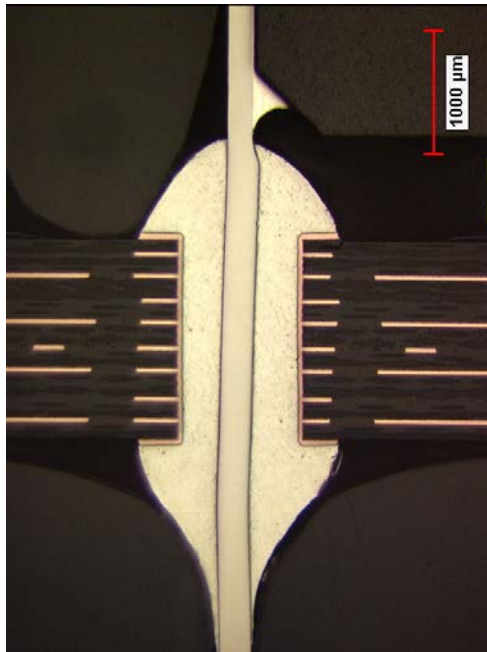
## Shunt Resistors





# Example of failures

- DIP 16



Excess of stiffness from the connection due to excessive solder.

- Verification of the assembly performed during the evaluation phase of the devices
  - Coordination with TEC-QTC
    - Passive: D. Lacombe, O. Perat
- Contact with component manufacturer
  - Rakon, 3D+
- Update of the list of critical devices
  - Proposed corrective actions
- Close contact with component users
  - Close follow up of the verification programme
  - Creation of a CTB Splinter meeting related to PCB/SMT
- Assessment of the device package risk during verification of the assembly
- Early verification programme

- Embedded Passive components: A way to miniaturize
- High temperature SMD
- Solderless connections
- High temperature wiring
- Long storage application

1. Interest from ESA (TEC-QTC/TEC-QTM) to issue a Harness ECSS standard: No real interest from now from Industry
2. Current update of the ECSS-Q-ST-70-38C  
Some requirements from ESA have already been included.
3. ECSS-Q-ST-70-12: Design of PCB- Submitted for public review

# Thank you for your time and attention

Any questions?