Tin Whisker Mitigation by Sn/Pb Plating Method

28th Annual Components for Military and Space Electronics Conference and Exhibition Los Angeles, CA
April 29 – May 1, 2025

Jeff Montgomery, AEMI Holdings, LLC

Tin Whisker Mitigation

Content Focus

- ✓ Sn/Pb Electroplating Applicability
- ✓ Advantages of Sn/Pb Plating
- ✓ Overview of Typical Sn/Pb Plating Conversion Process Flow
- ✓ Component Types Generally Compatible with Sn/Pb Plating Conversion Process
- ✓ Case Studies for a Wide Range of Component Types (other than chip styles) where Sn/Pb Plating Conversion Processing Has Been Proven Successful
- ✓ Minimum Recommended Component Verifications (Pre and Post Sn/Pb Plating Conversion)

Tin Whisker Mitigation

Sn/Pb Electroplating Applicability

- Sn/Pb plating is ideally suited for the Sn/Pb conversion of surface mount “chip style” components.
- Sn/Pb plating is an effective means of Sn/Pb conversion for many other surface mount component types which have external terminals that wrap closely around the component body.
- Sn/Pb plating is an effective means of Sn/Pb conversion for many plastic encapsulated components with sealed body construction.
- Sn/Pb plating is an effective means of Sn/Pb conversion for many QFN or other high pad count components where PCB mounting coplanarity is a concern.
- Sn/Pb plating may be an effective means of Sn/Pb conversion when the surface mount component type is susceptible to soldering heat and/or susceptible to the thermal shock of RHSD processing.
- Sn/Pb plating is not suitable for Sn/Pb conversion of most through hole (radial/axial terminated devices) or surface mount components with terminals extending away from the component body.
- Sn/Pb plating is not suitable for BGA Sn/Pb conversion.
- Sn/Pb plating may not be an effective means for Sn/Pb conversion when the component construction is not compatible with plating bath and processing chemistries.

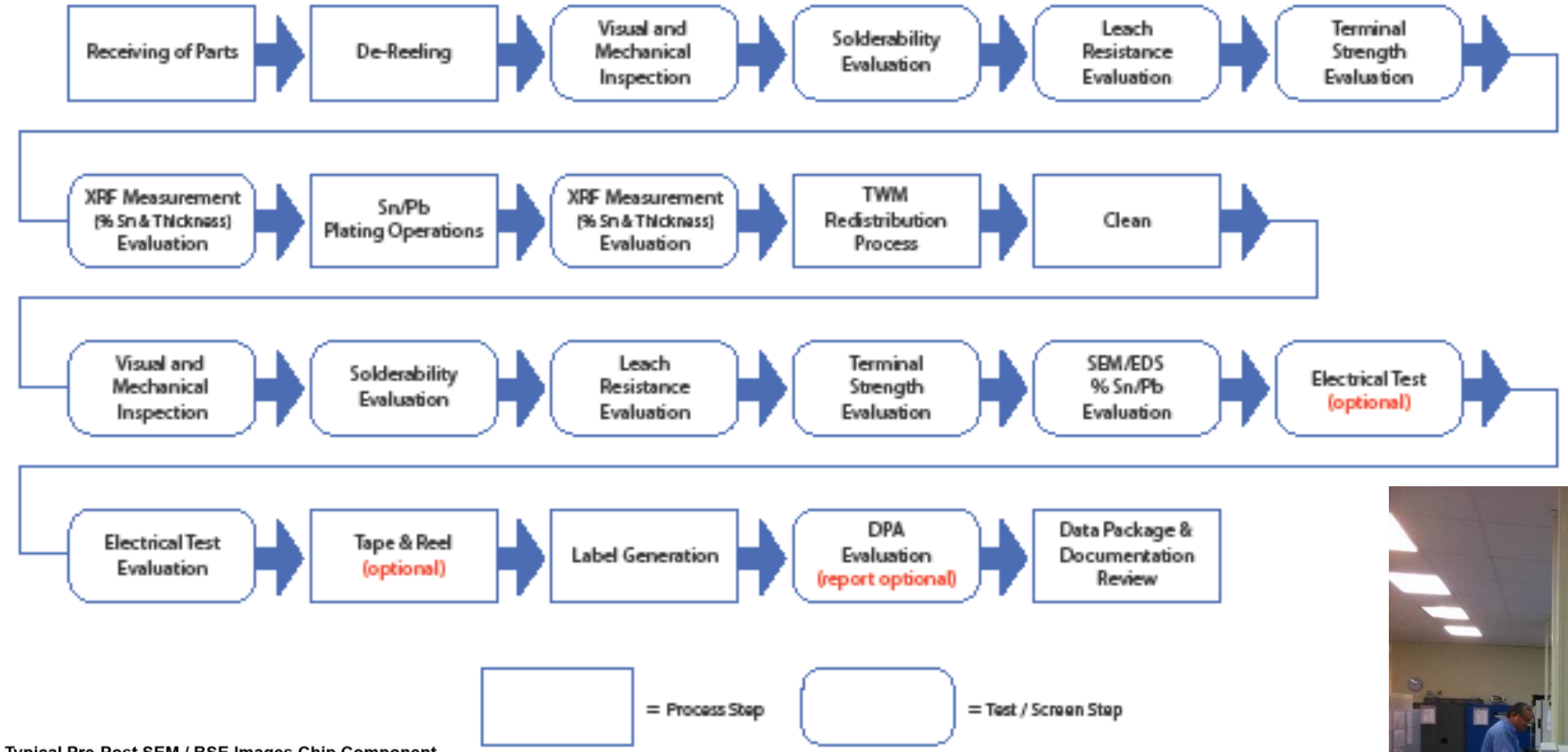
Tin Whisker Mitigation

Advantages of Sn/Pb Electroplating

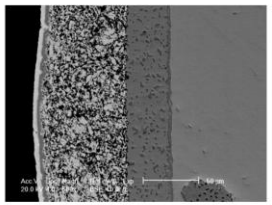
- For most chip style packages (chip capacitors, chip resistors, chip inductors, chip ferrite beads etc.) the Sn/Pb electroplating processing for Sn/Pb conversion follows closely the OEM's Sn electroplating process.
- The component under processing is not subject to the thermal shock and temperature extremes typically associated with RHSD Sn/Pb conversion.
- OEM's mechanical outline dimensional limits are maintained post Sn/Pb plating.
  - Coplanarity and mounting integrity following Sn/Pb conversion processing are assured
  - Components can be repackaged in OEM original carrier tape
- Metallization surfaces are completely Sn/Pb covered (no Sn surfaces remaining).
- Sn/Pb Plating is also effective as a means of converting Au plated and thick film terminations.

Tin Whisker Mitigation (TWM)

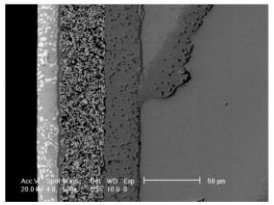
Sn/Pb Conversion – Typical Process Flow of Standard Operations



Sn/Pb Conversion Process – Typical Pre-Post SEM / BSE Images Chip Component



100% Sn Termination ("As Received")



Sn/Pb Converted Termination ("Post Processing")

TWM Processing

Performed to certify a minimum of 5% Pb in the post-processed component terminations. Typically, Sn/Pb conversion process targets 10-30% Pb.

Tin Whisker Mitigation

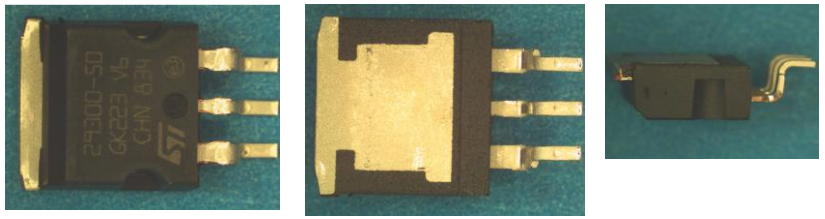
Most Common Component Types Suitable for Sn/Pb Plating Conversion Processing

- Chip Capacitors – SMD, 01005 to 2220 package size or larger
- Chip Resistors – SMD, 0201 to 2220 package size or larger
- Chip Inductors – SMD, 0201 to 1812 package size or larger
- Chip Beads – SMD, 0201 to 1812 package size or larger
- Fuses – SMD, 0402 to 1812 package size or larger
- Varistors – SMD, 0603 to 1812 package size or larger
- Resistor Arrays / Capacitor Arrays / Chip Bead Arrays
- Molded Body Diodes – SMA, SMB, SMC, SMD pkgs with reverse J Leads
- Molded Body MOSFETS
- DPAK packages
- SOT-23 / SOT-223 packages
- DO-214AB packages / QFN packages
- Tantalum Capacitors – All standard sizes
- Lug Connectors
- EMIFL packages and most chip and molded body filters
- Active Components – Mosfets, Diodes, QFN's, etc..

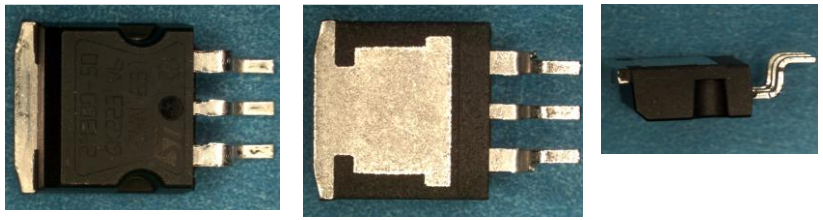
TWM Case Study

Plastic Encapsulated and FR4 Sn/Pb Plating Conversion Examples

- **Voltage Regulators**



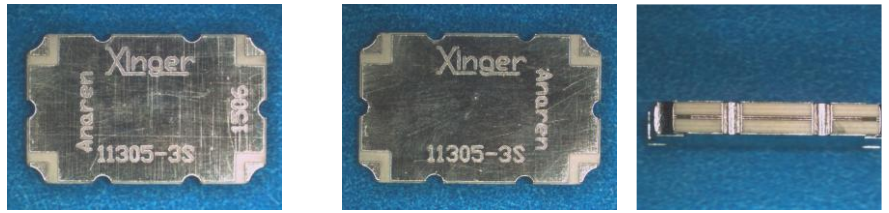
As Received



Post TWM

- **Hybrid Coupler**

As Received



Post TWM

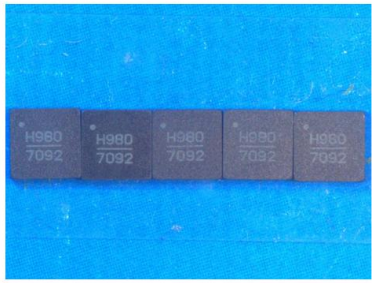
- **OEM specified dimensions are maintained following Sn/Pb plating processing**
- **Previous exposed copper/base metal areas covered with Sn/Pb solder plating**

TWM Case Study

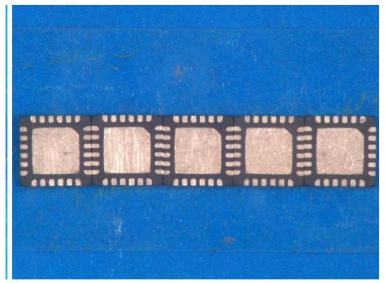
QFN / UMAX-8 Sn/Pb Plating Conversion Examples

IC Active Bias Controller 24-QFN

Top View

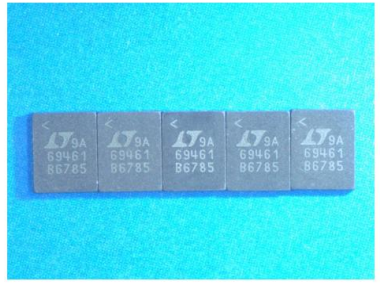


Bottom View

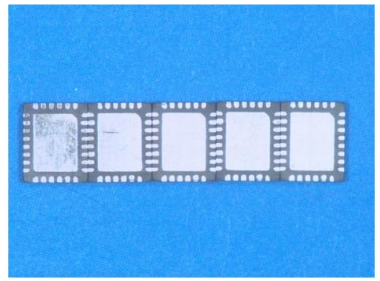


IC Integer-N PLL – 28-QFN

Top View

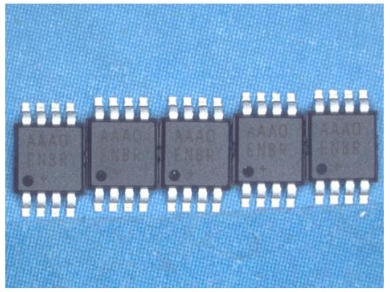


Bottom View

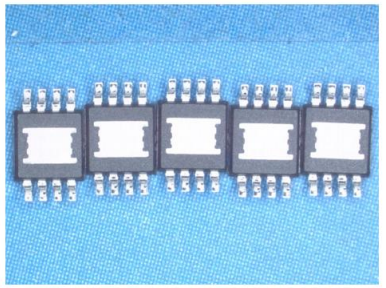


IC Switch SPDT 8UMAX

Top View



Bottom View

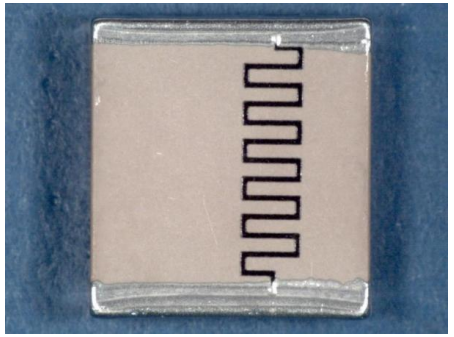


Coplanarity is maintained for terminals and ground pad following Sn/Pb Conversion

TWM Case Study

Capacitor Sn/Pb Plating Conversion Examples

Pulse Power Capacitor

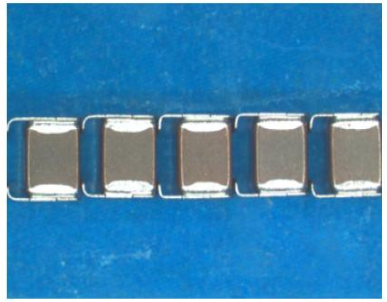


Conversion from Thick Film to Sn/Pb Solder

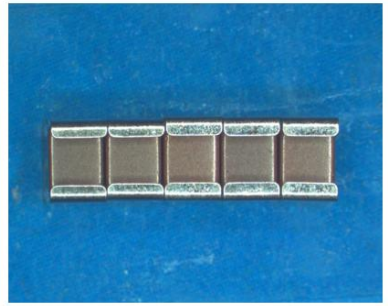
(Pd/Ag terminals are first Ni plated and then Sn/Pb plated)

L-Terminal Capacitor

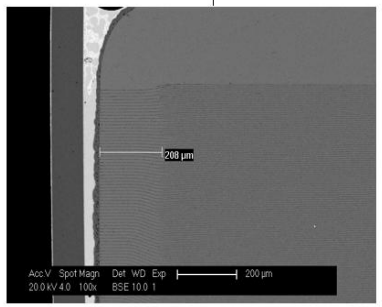
Side View

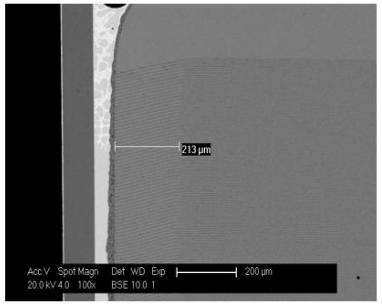


Bottom View



Sectional SEM View Showing Regions of Sn/Pb Mixing
AEM Preserving Center Solder Connection Integrity for High Temp Solder

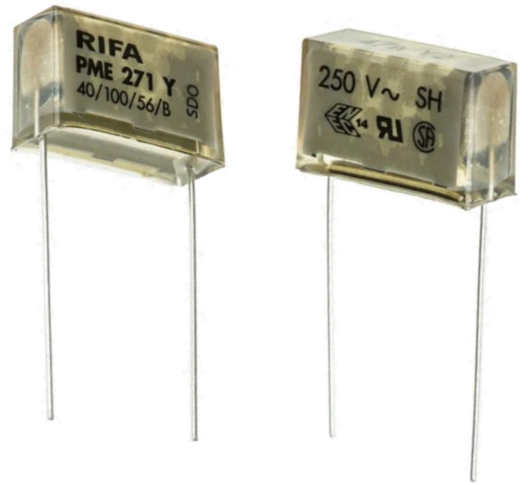




Special consideration to preserve high temperature solder in L-Terminal-to-End Capacitor Interface

(Also applicable to stacked capacitors)

Metallized Impregnated Paper Radial Leaded Capacitor

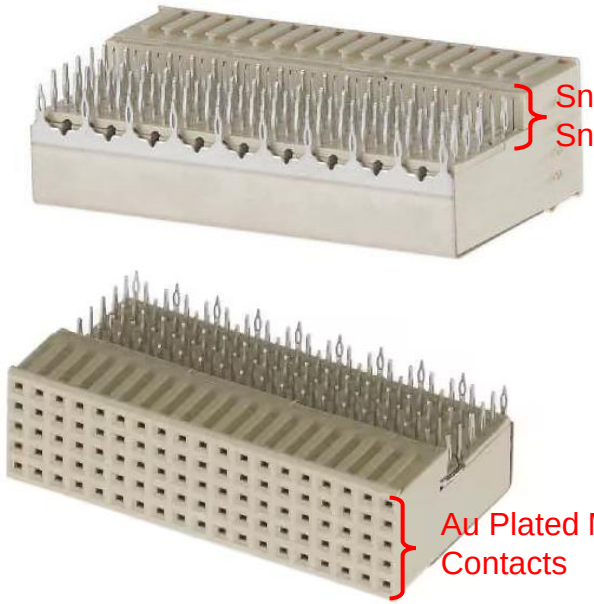


RHSD prohibited due to heat sensitivity limitations

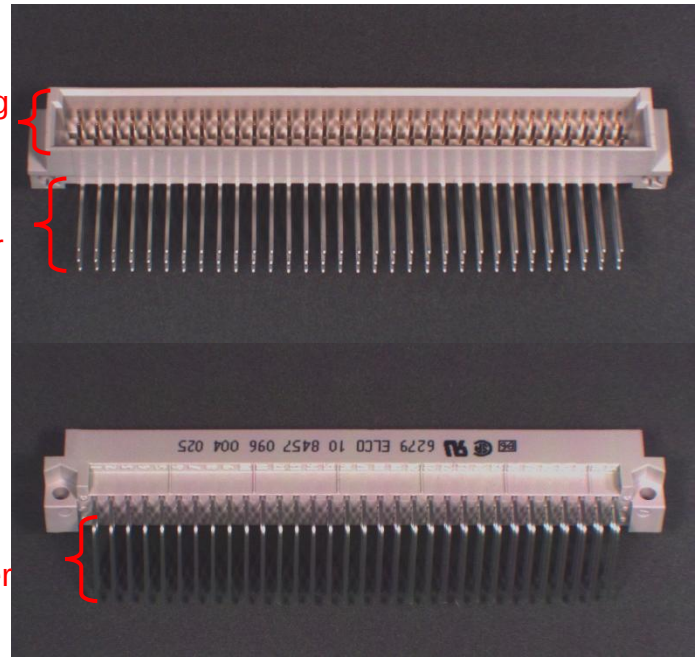
TWM Case Study

Connector Sn/Pb Plating Conversion Examples

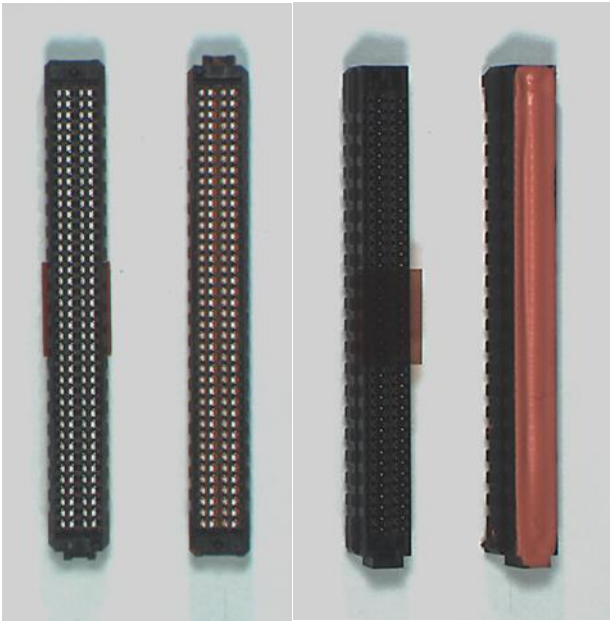
Backplane Connector
Through Hole – Right Angle



Right Angle Din Connector



Board-to-Board Connector



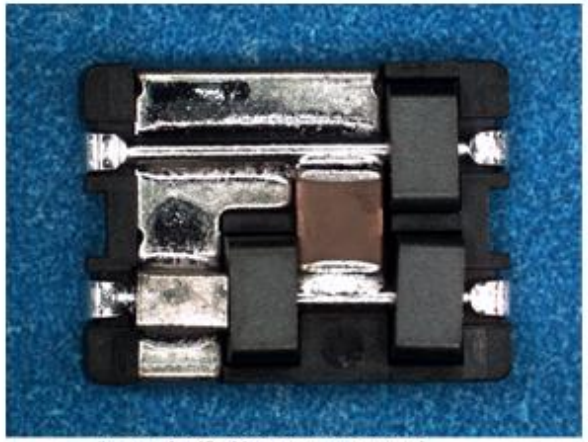
Masking Examples

- **Sn plated pins (for PCB mounting) extend into hollow portions of the connector housing**
- **Au plated mating contacts must be masked prior to Sn/Pb plating operations**

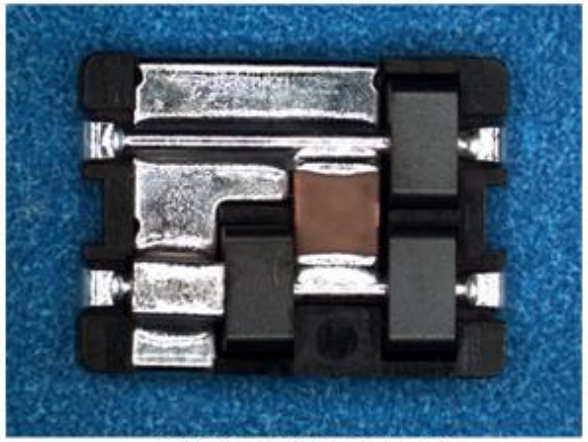
TWM Case Study

EMI Block Filter Sn/Pb Conversion Example

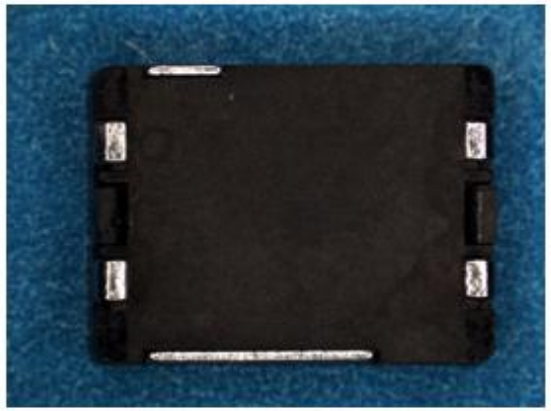
BNX Series Filter – Sn/Pb Converted in Open Frame Configuration

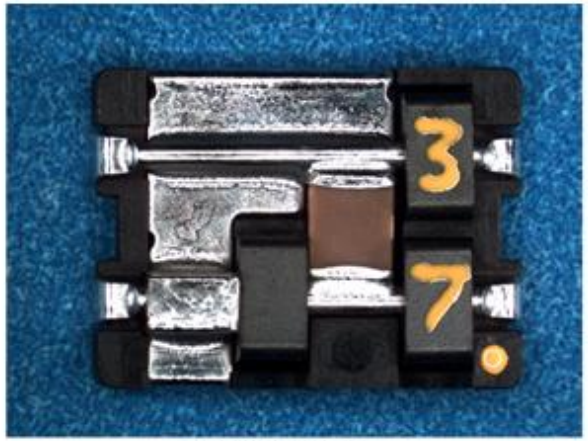


"As Received" with Top Cover Removed

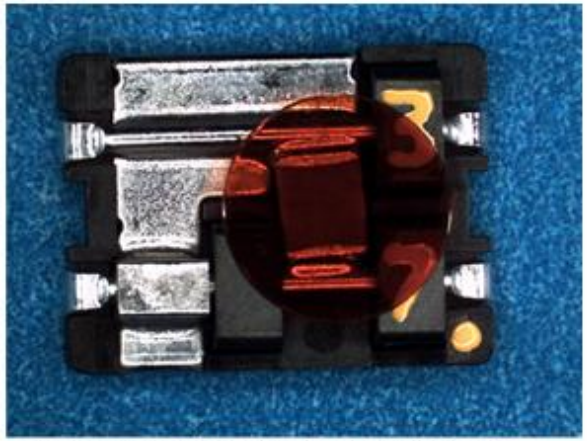


Sn/Pb Plated and Fusion Processed





Epoxy Marking Added



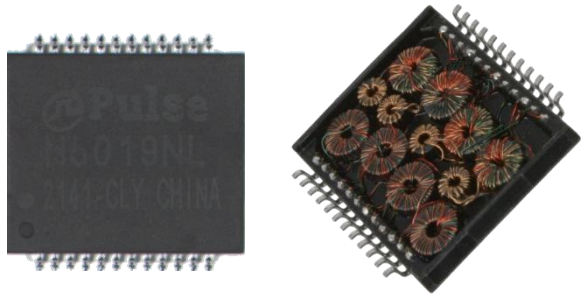
Kapton Pad Added for Raytheon Pick and Place Equipment

- Housing cover is latched and allows for removal to Sn/Pb plate internal portions of the filter
- Customer opted to leave cover off (aqueous PCB cleaning) and Kapton pad added for pick and place assembly

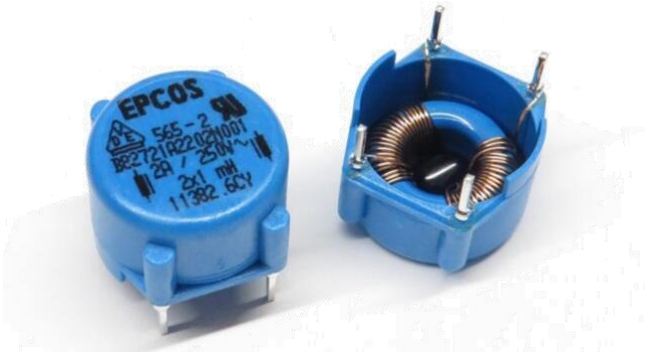
TWM Case Study

Open Frame and Connector Sn/Pb Conversion Examples

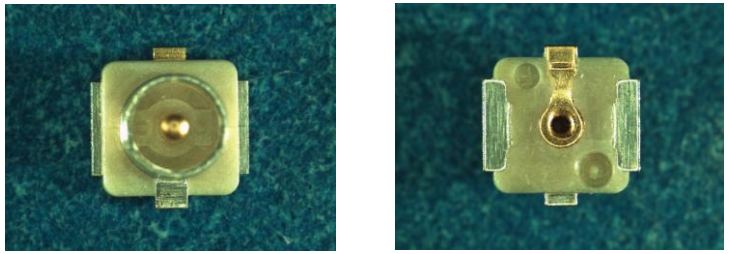
Open Frame Transformer Module



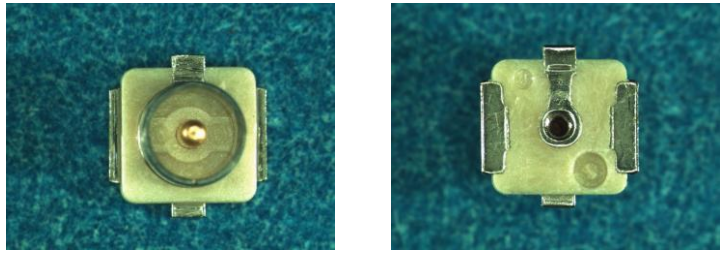
Open Frame Common Mode Choke



Coaxial RF Connector
(Sn and Au Embrittlement Mitigation)



"As Received" Surface Mount Connector



Sn/Pb Converted Surface Mount Connector

Sn/Pb conversion of Au and Sn surfaces
(Masking of Au plated center pin required)

TWM Case Study

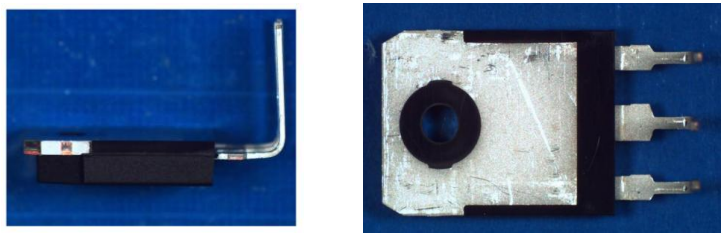
Custom Sn/Pb Conversion Examples

Press Fit PCB Terminals - Through Hole

Solid State Relay

Mount Clip (metal hardware)

Pre-Formed MOSFET

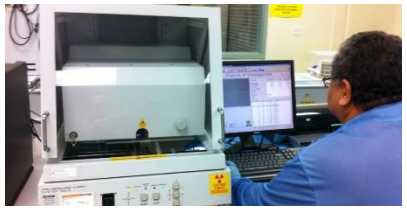


Tin Whisker Mitigation

Minimum Standardized Incoming / Outgoing Quality & Performance Verification

Visual / Electrical Inspection

SEM / EDS Verification



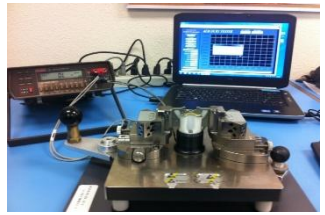
XRF Verification

QA1 Sequence Incoming Inspection Evaluations

- Sample XRF and EDS verification of terminations
- Sample Solderability verification of terminations
- Sample Leach Resistance verification of terminations
- Sample Terminal Strength verification of terminations
- Sample Destructive Physical Analysis (DPA)
- AS9102 Form 3 Characteristic Evaluation

QA2 Sequence Outgoing / Post TWM Evaluations

- Sample XRF and EDS verification of terminations
- Sample Solderability verification of terminations
- Sample Leach Resistance verification of terminations
- Sample Terminal Strength verification of terminations
- Sample Destructive Physical Analysis (DPA)
- Sample electrical verifications
- AS9102 Form 3 Characteristic Evaluation



Capacitance/DF/DCR Testing

Diode Testing

Impedance / Inductance Testing

Thank You

Questions?