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iNEMI
International Electronics Manufacturing Initiative

Circularity Challenges in Electronics Manufacturing

Kelly Scanlon, IPC and Mark Schaffer, iNEMI

17 July 2024

Welcome, we'll get started soon

Photos from Berlin, June 2024

by Mark Schaffer

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Agenda

- **Purpose of today's webinar**

Share with you what your industry peers discussed at the Circularity Workshop, ask you to identify the most important problems, and invite you to sign up for working groups.

- **Methodology**
  - Review of the Circularity Workshop at Electronics Goes Green 2024
- **Results**
  - Problems and possible remedies from the pre-workshop survey and workshop
- **Next Steps**
  - Sign up!

Today, we will ask you:

1. What is the most important problem in circularity for electronics?
2. What is the second most important problem in circularity for electronics?
3. Which working groups are you signing up for today?

The International Electronics Manufacturing Initiative (iNEMI) is an R&D consortium of 86 leading electronics manufacturers, suppliers, associations, government agencies and universities.

iNEMI **roadmaps** the future technology requirements of the industry, identifies and prioritizes technology and infrastructure gaps, and helps eliminate those gaps through **timely, high-impact deployment projects**.

These include **new technologies**, developing **industry infrastructure**, **stimulating standards development**, and **disseminating efficient business practices**.

IPC is the global association for electronics manufacturing.

IPC helps OEMs, EMS, PCB manufacturers, cable and wire harness manufacturers and electronics industry suppliers **build electronics better**.

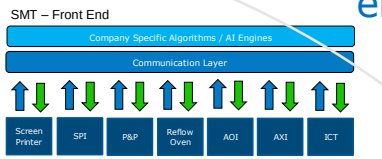
IPC members – more than 3,200! – strengthen their bottom line and build more reliable, high-quality products through proven **standards, certification, education and training, thought leadership, advocacy, innovative solutions and industry intelligence.**

iNEMI Projects - Value

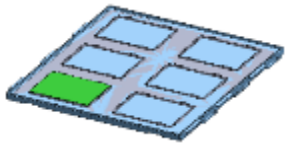
Examples of Project Outputs & Impact

Web based LCA tool

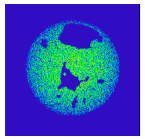
Best practices for data management enabling Smart Manufacturing adoption



Design recommendations for effective handling tray for large formfactor packages

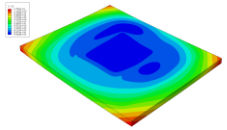


Cost model and best practices for Data Center implementation

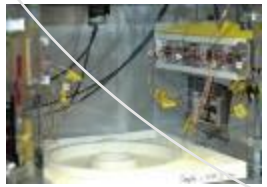


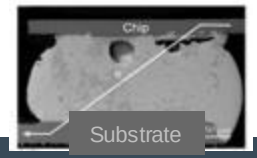
New industry test method

Characterization data to help develop model and drive design and manufacturing improvements

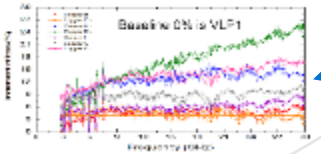


Validating faster more cost effective test methods





Characterization data to drive design and manufacturing improvements

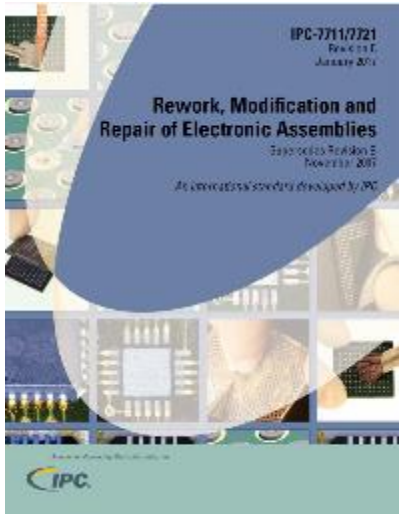


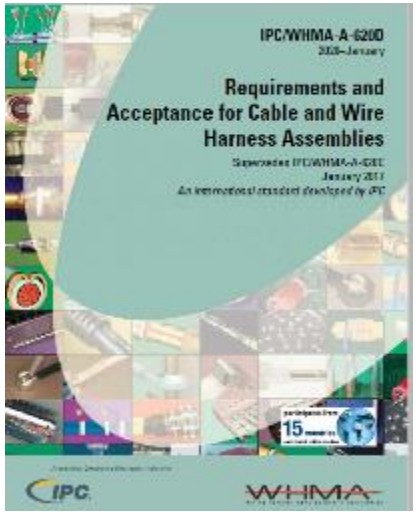
Characterization of technology & equipment capabilities

Infrastructure to Support Industry

IPC supports the industry through proven standards, certification, education and workforce training, thought leadership, advocacy, innovative solutions and industry intelligence.

- More than 300 standards, dozens of workforce training courses, advocacy with policymakers in North America, Europe, and Asia
- Worldwide presence, worldwide solutions for designing and manufacturing electrical and electronic products and their materials





Purpose

- Review the Circularity for Electronics problems and possible remedies generated during the Electronics Goes Green workshop on 17 June 2024
- Evaluate the problems and rank them
- Create at least three new “solutions” working groups

- Today’s webinar = Valuable to all!
  - Hear what your peers said
  - Weigh-in (via poll questions!)
  - Be part of the solution by joining working groups

Solutions driven by industry will help enable efficient and effective adoption of circularity through the electronics manufacturing value chain.

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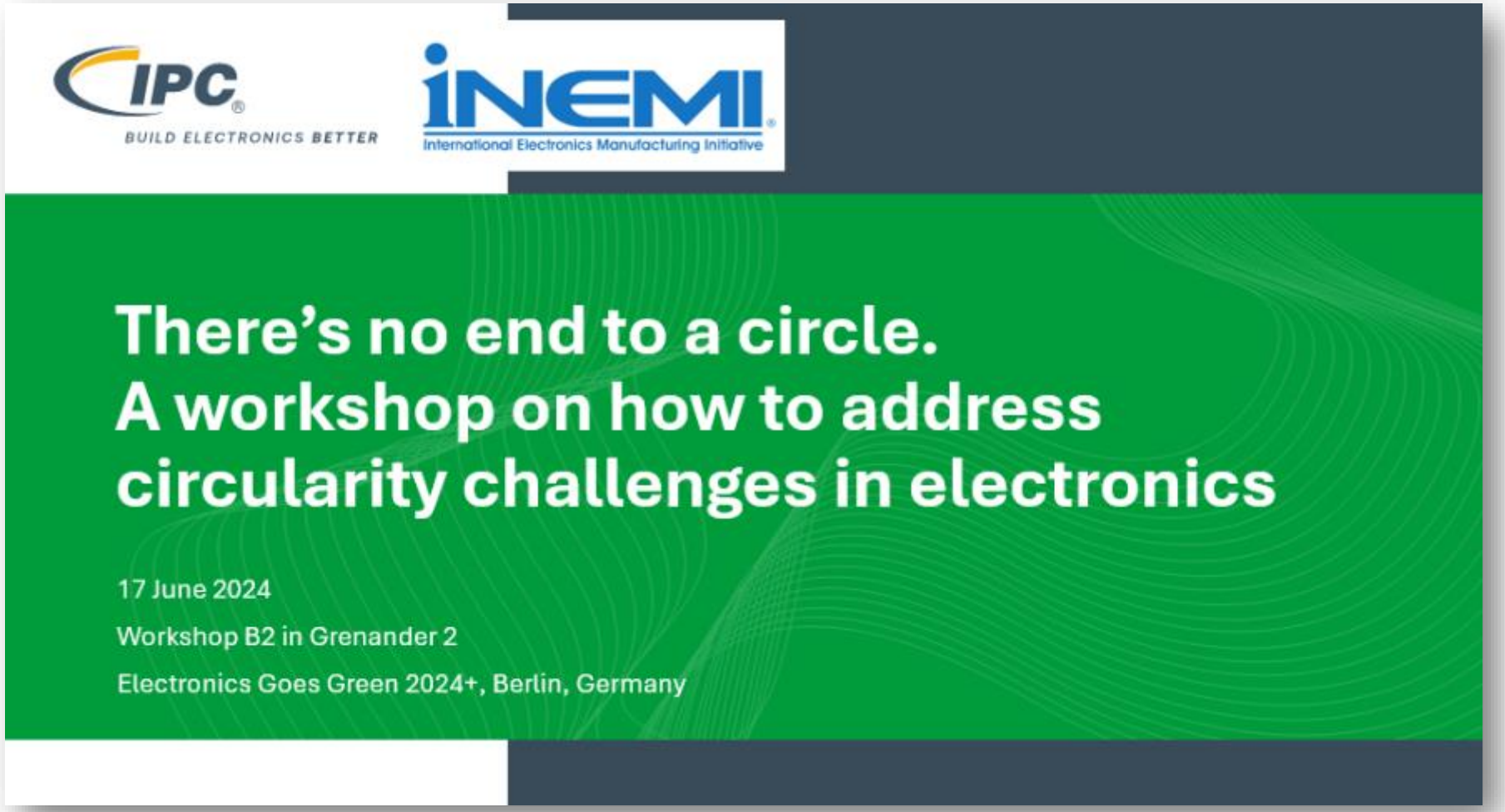
Review of the Circularity Workshop held on 17 June

Pre-workshop survey

SurveyMonkey survey distributed to all registered attendees as ~2 weeks before the workshop

10 questions asked

1. What does circularity mean to your company?
2. What does circularity mean to your supply chain segment?
3. What does circularity mean to your customers?
4. Where is the opportunity for improvement for electronics manufacturers?
5. Are there specific material, data, or product roadblocks preventing improvement?
6. How should we enable remanufacturing, recycling, reparability, reusability, upgradability, and resource efficiency?
7. And at what life cycle stage? Design, Manufacture, Use, End-of-Life?
8. What are your suggestions for specific industry standards, tools, and workforce education to address circularity challenges for electronics manufacturers?
9. Do you have other solutions you'd like to suggest?
10. What is your circularity story today? Tell us about what you're doing now -- or have tried to do -- to address circularity challenges in electronics manufacturing?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International Electronics Manufacturing Initiative
There's no end to a circle.
A workshop on how to address
circularity challenges in electronics
17 June 2024
Workshop B2 in Grenander 2
Electronics Goes Green 2024+, Berlin, Germany

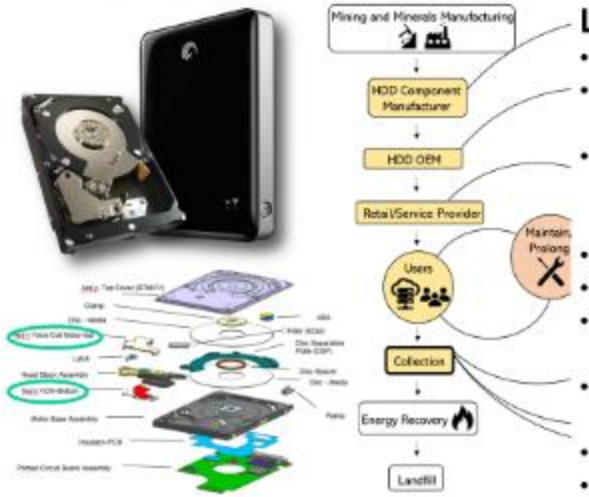
Workshop Co-hosts

Fran Fourcade, IPC
Grade O'Malley, iNEMI
Kelly Scanlon, IPC
Mark Schaffer, iNEMI

Inspiring Keynotes

Carol Handwerker, Purdue University
Stephan Harkema, Holst Centre

Creating a Circular Economy for HDDs



Lessons Learned

- Project made us all smarter
- Have the full supply chain at the table – decision makers required
- Proof test the value for all companies in the supply chain – everyone must be honest
- Aim for the highest value
- Aim for the highest volumes
- Don't underestimate the difficulty or time to execute
- Analyze the logistics, LCA,TEA early and often
- Work fast - situations change
- Play the long game

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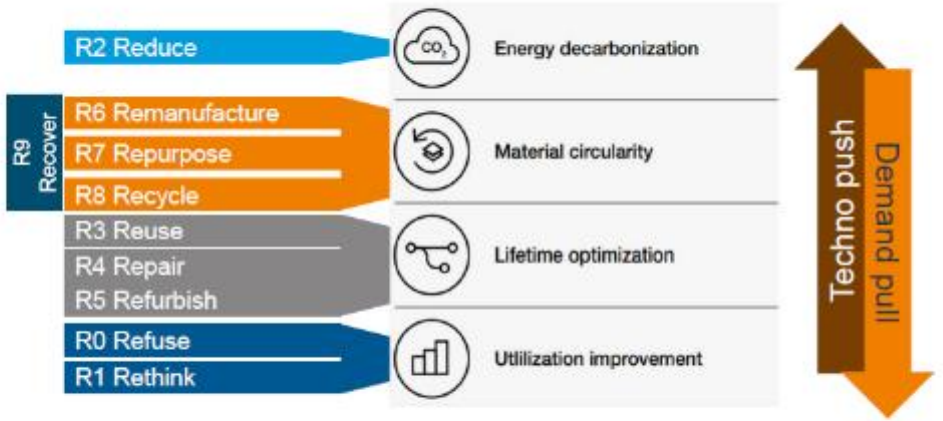
Combining circular pathways

Holst Centre



The 10 R's framework is a powerful instrument to reach higher circularity along the 4 pathways

Source: Raising ambitions: A new roadmap for the automotive circular economy (Circular Car Initiative, Accenture)

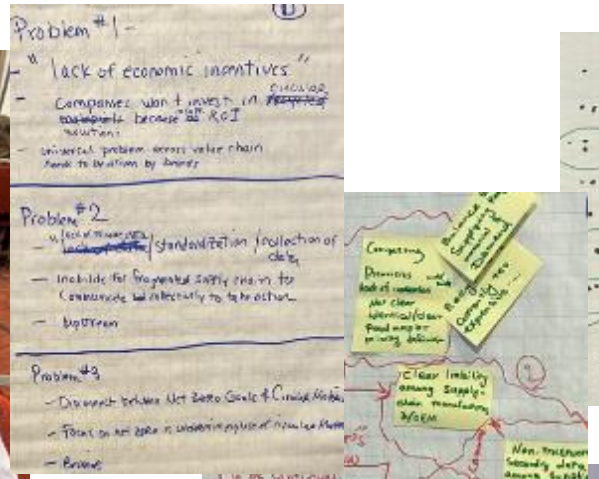
Credits slide: Nicolas Gouze, VDI/VDT IT

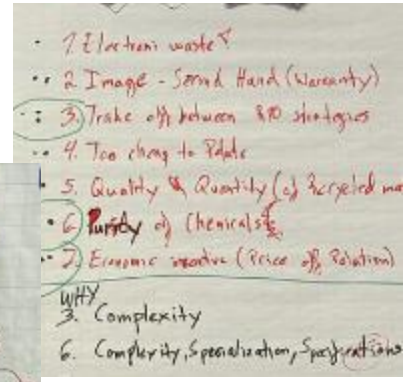
IME: a circular technology?

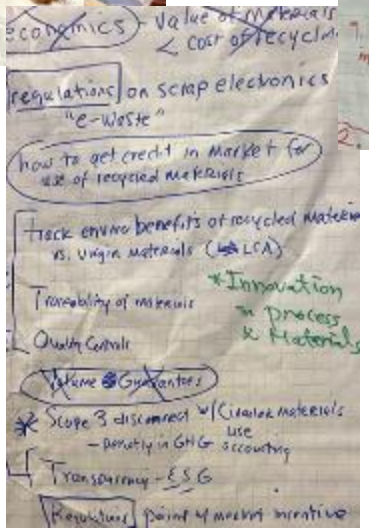
Holst Centre

- Circular strategies successfully applied to a challenging and encapsulated type of H&PE

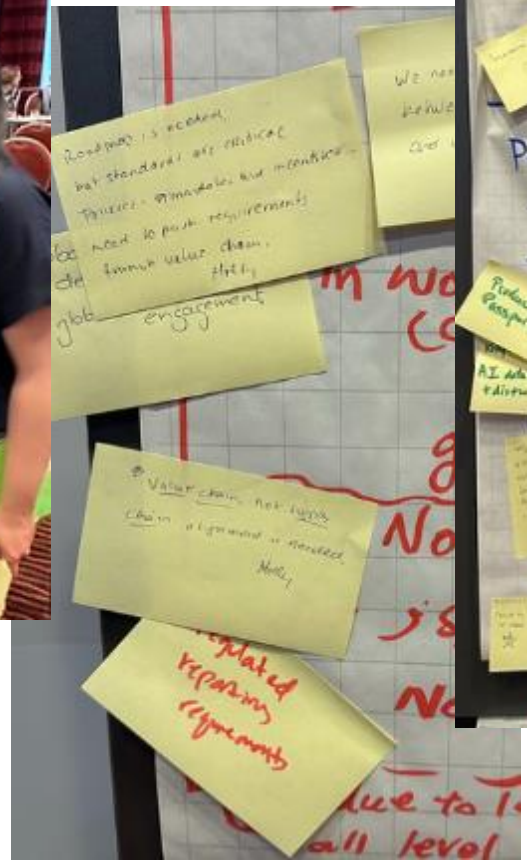
4-hour workshop with 33 active participants from ~27 organizations working together to create 14 problem statements

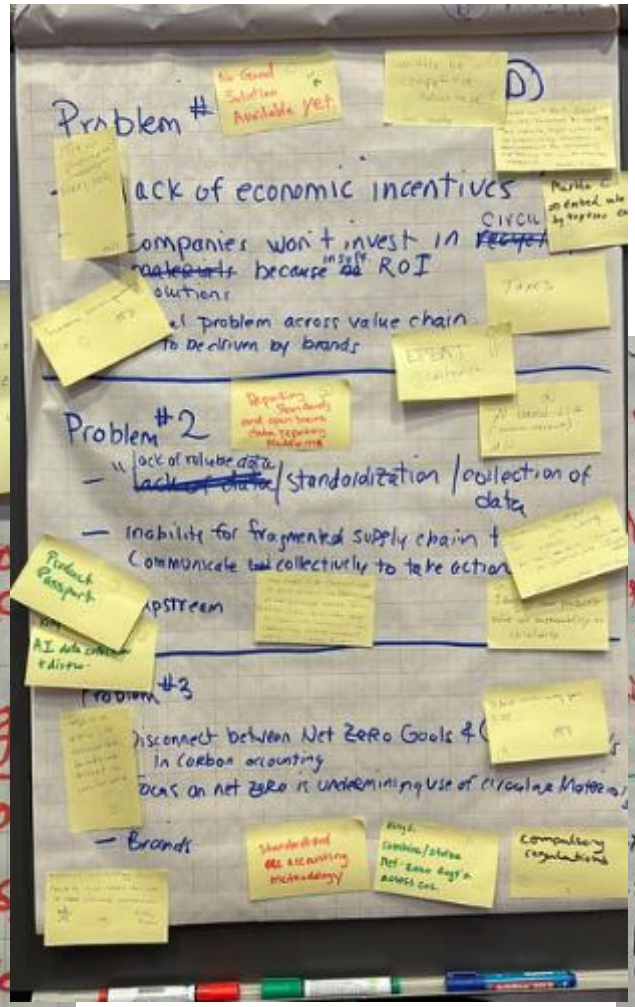


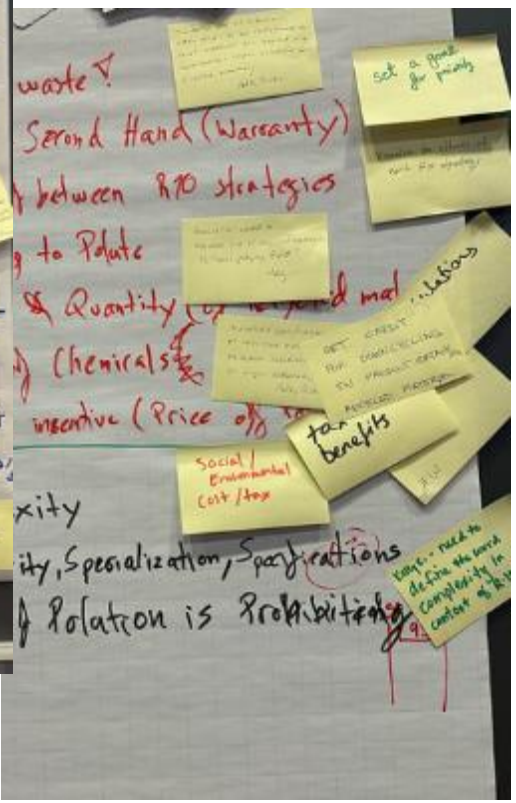




We discussed the problems and identified 59 possible remedies







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Q&A and Insights from Attendees

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Results: Problems

Pre-workshop survey

What does circularity mean to your company, your supply chain segment, your customers?

- Recycle, Refurbish or Reuse
- It is about closing the loop on the product life cycle and keeping materials at highest value as long as practical. This will ensure we meet the requirements of stakeholders and make progress to our circularity and climate goals.
- When done well, the opportunity for a comprehensive sustainable transformation
- Repairability, Usage of secondary materials, Reuse, Product pass, Resource efficiency during manufacturing
- It means to be able to use materials again in the next generation of products and avoiding the landfill
- Important target and future business model
- Downstream materials are able to be tracked in a credible and standardized way to upstream material processors

> **Summary: Feedback was focused on material circularity, less so on full product or component level recovery**

Pre-workshop survey

Where is the opportunity for improvement for electronics manufacturers?

> Tracking (assessing, documenting, disclosing), market incentives to utilize secondary chemicals/materials/components/PCB, design

Are there specific material, data, or product roadblocks preventing improvement?

> Communication and data exchange about what is available for reuse etc. R-10 words, lack of knowledge about their own products, reusability materials (plastics, reused chemicals), technology, repairability index

How should we enable remanufacturing, recycling, reparability, reusability, upgradability, and resource efficiency?

> Market/financial, incentives, technology/capability, education about what is currently possible, central repository of information

And at what life cycle stage? Design, Manufacture, Use, End-of-Life?

> All stages are fair game

Working Session: Problems

Ingredients for Successful Problem Formulation

- Write it down, appoint a notetaker
  - Paper and markers provided
- Evidence and data to support your claim that this is a problem
  - No complaints allowed
- Creativity
- Consider possible solutions as you create the problems
- Stay on time, appoint a timekeeper

Process for Successful Problem Formulation

1. What is the problem?
2. Why is it problem?
3. Where is it a problem?
   - By geography, supply chain segment, company size?
4. Rank your problems to identify top 3
   - Consider the severity of the problem: how bad is it (e.g., financial impacts, number of companies impacted), how much time does it take from daily tasks/operations
   - Consider the urgency of the problem: is this a compliance issue, is this affecting companies now or in the future?
5. Refine the list to be a specific as needed.
6. Create one statement per problem.

Example of a Problem Statement

The most pressing problem in circularity for electronics is _____.

This is a problem for the electronics manufacturing industry because _____.

This problem affects the industry most in _____ (company size, supply chain segment, geography).

4-hour workshop with 33 active participants from ~27 organizations working together to create 14 problem statements

Problem: Lack of economic incentives (ROI)

- The most pressing problem in circularity for electronics is **Economic Incentives (price of pollution)**.

- The most pressing problem in circularity for electronics is **Lack of economic incentives**. This is a problem for the electronics manufacturing industry because **Companies won't invest in circular solutions because of insufficient ROI**. This problem affects the industry most as a **Universal problem across value chain; needs to be driven by brands**.

Problem: Lack of Data

- The most pressing problem in circularity for electronics is **Trust, accuracy, security format and availability of data**. This is a problem for the electronics manufacturing industry because **Data is needed for everything**. This problem affects the industry most for **Everyone**.
- The most pressing problem in circularity for electronics is **Lack of Digital Twin for design and sustainability**. This is a problem for the electronics manufacturing industry because **Data is needed for everything, 80% of impacts attributable to design, need for reusability of components**. This problem affects the industry most for **Everyone**.
- The most pressing problem in circularity for electronics is **No access to trustworthy data, specification among supply chain**. This is a problem for the electronics manufacturing industry because **no clear liability among supply chain**.
- The most pressing problem in circularity for electronics is **Lack of reliable data/standardization/collection of data**. This is a problem for the electronics manufacturing industry because **Inability for fragmented supply chain to communicate collectively to take action**. This problem affects the industry most **Upstream**.

Problem: Lack of Clear and Consistent Definition

- The most pressing problem in circularity for electronics is **Design for circularity**. This is a problem for the electronics manufacturing industry because **80% of impacts attributable to design**. This problem affects the industry most for **Everyone**.
- The most pressing problem in circularity for electronics is **Standardizing form, fit and function**. This is a problem for the electronics manufacturing industry because of the **need for reusability of components**. This problem affects the industry most for **manufacturers, consumers, recyclers**.
- The most pressing problem in circularity for electronics is the **Lack of clear, consistent, defined roadmap, priorities, and policies in world-wide level**. This is a problem for the electronics manufacturing industry because **non-transparency and confusion**.
- The most pressing problem in circularity for electronics is **Trade-offs between R-10 strategies**.

“Other” Problems in Circularity

The most pressing problem in circularity for electronics is **Rate of tech change**. This is a problem the electronics manufacturing industry because **Circular pathways close**. This problem affects the industry most for **manufacturers, consumers, recyclers**.

The most pressing problem in circularity for electronics is the **lack of maturity and good practice, lack of all level expertise, complexity of system**.

The most pressing problem in circularity for electronics is **Purity of chemicals**.

The most pressing problem in circularity for electronics is **Disconnect between Net Zero goals and Circular Materials**. This is a problem for the electronics manufacturing industry because **Focus on net zero is undermining use of circular materials**. This problem affects the industry most in **Brands**.

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Poll Questions

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Results: Possible Remedies and Industry Solutions

Pre-workshop survey

What are your suggestions for specific industry standards, tools, and workforce education to address circularity challenges for electronics manufacturers?

- Considering the implementation of international environmental standards, which includes the education towards a sustainable development. Implementing ISO 14001 could be a good start and considering the r
  production (recovered, recycled or alternative ma
- We have to start sharing on a much more detailed
  of, "recycling Score, Degree and demand"
- A standard simplified data collection format to col
  content any pertinent material related informatio
  Educate supplier on importance of circularity and their role in enabling it.
- Setting up third party to facilitate the recycling.
- Traceability for material flows is really important.

Industry standards
Tools (e.g., scoring)
Workforce education and training

- Scientists, not only those working in the environmental and sustainability departments, should be made aware of the environmental impacts so that
  an important part of the thrusts in research and
- e area between repair and remanufacturing should be
  nfortunately, this is still quite unspecific: modularity will
- s are needed for improved comparability of circular products.
- Need assurance systems (standards for chain of custody, data disclosure across value chain).

Working Session: Solutions

Ingredients for a Successful Solution

- Walk around the room and socialize
- Advocate, appoint someone who can talk about the problem statements at your table
  - Be able to convince others that this is a problem that needs to be solved
- Creativity
  - Consider solutions that can take the form of industry standards, workforce education, advocacy to policymakers, research, software tools, databases
- Sticky notes and Markers

Process for Creating Solutions

- Write down your idea for a solution to the problem
  - Identify how this solution will address the problem
  - Use sticky notes to document your idea
  - Put your name(s) on your idea

We discussed the problems and identified 59 possible remedies

Possible Solutions: Economic Incentives

- Get credit for downcycling in product containing recycled materials
- Social/Environmental Cost/Tax, Taxes, Tax Benefits
- The definition of electronic waste needs to be redefined so that materials are treated as commodities when valuable for circular economy D1 Incentivize demanufacturing
- Tie to procurement – EPEAT / RFPs
- Brands won't do it unless they are rewarded by the market. The inability to get credit can be remedied by consistent methodologies for measuring and sourcing the use of circular materials

Get Credit, Tax Benefits Definition

Solutions: Data

- Standard of standards
- Block chain for data transfer
- Common data framework for increased use of circular materials
- Data from production point of view
- Product passport
- AI data collection and Distro
- Quantum computing
- Industry, academia, NGO, government collaboration to develop accurate models
- Value chain, not supply chain, alignment is needed
- Regulated reporting requirements
- Identify own product's value on sustainability or circularity
- Connecting suppliers with industry and tools
- Reporting standards and open source data reporting platforms

Standards
Technology: AI, Block Chain, Quantum

Solutions: Definition

- Benchmark other company's circular design initiatives can be a first step
- Information determination and training of designers
- Education at all levels of what (design for) circularity means
- Standards for Design for Circularity for various electronics, components, PCBA; Can we create and industry standard that defines circularity for electronics?
- Integrate the end of life in the design phase
- Regulation; Make policies that encourage reuse; policy drivers needed
- Push requirements through the value chain
- Global roadmap development
- Global stakeholder engagement; Closer nexus between downstream processors and upstream entities
- Academic/non-profit institutions help each other to set up open-access data (i.e., LCA data, etc)
- Need to define the word complexity in context of R-10; Visualize the effects of each R-10 strategy

Benchmark
Standards
Advocacy

“Other” Solutions in Circularity

- Material specifications of recycled materials need to match material specifications of virgin materials
- Regulations, e.g., mandate use of recycled materials to “level the playing field”
- Change in a new LCA emission factor to take into account the circular nature
- Carbon accounting rules need to give credit for use of circular materials
- Standardized accounting methodology
- Combine/standardize net zero requirements across companies
- Compulsory regulations
- Block chain

Standards
Advocacy
Technology

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Next Steps

IPC and iNEMI offer a variety of solutions “infrastructure” to the electronics industry

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Next Steps

Establish Working Groups

- Distribute webinar recording and slides and call for participation (July, August)
- Call meetings for the new working groups (July, August)
- Convene working groups (September-November)
- Propose “solutions statements” (December)

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Poll Question

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Thank You

Points of Contact

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IPC: Kelly Scanlon, kellyscanlon@ipc.org

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Convenings

We will continue to socialize possible remedies and work on solutions

> **Examples of convenings:**

- American Center for Life Cycle Assessment conference, Utah, September 2024
- Electronics Sustainability Summit, Texas, October 2024
- electronica, Germany, November 2024
- Pan-European Electronics Design Conference, Austria, January 2025
- IPC APEX EXPO, California, March 2025

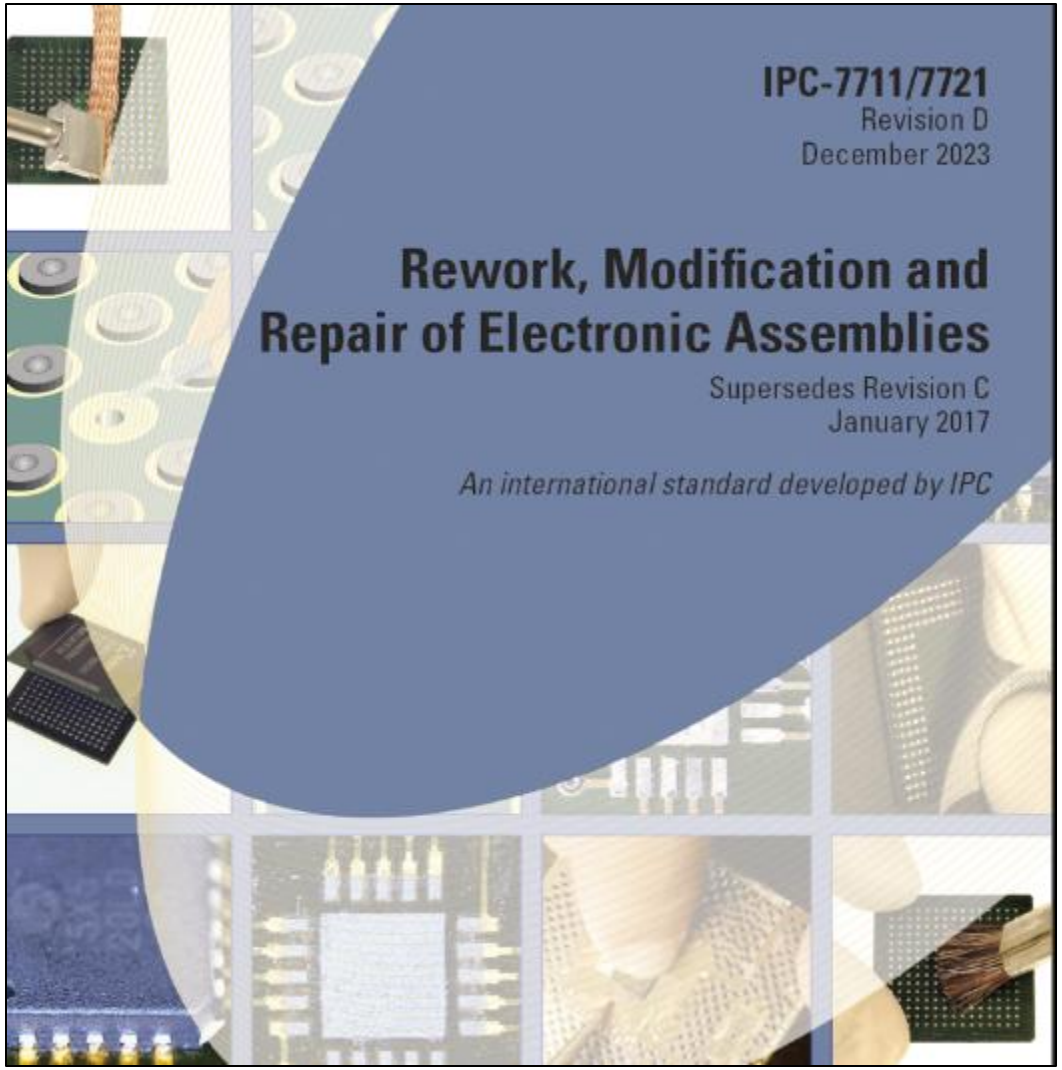
IPC-7711/21 - Leading Standard for Rework, Modification and Repair of Electronic Assemblies

IPC-7711/21 is a key document in the rework and repair of electronic assemblies.

The acceptance criteria of the reprocessed assembly must comply with IPC-A-610 or J-STD-001 acceptance standards.

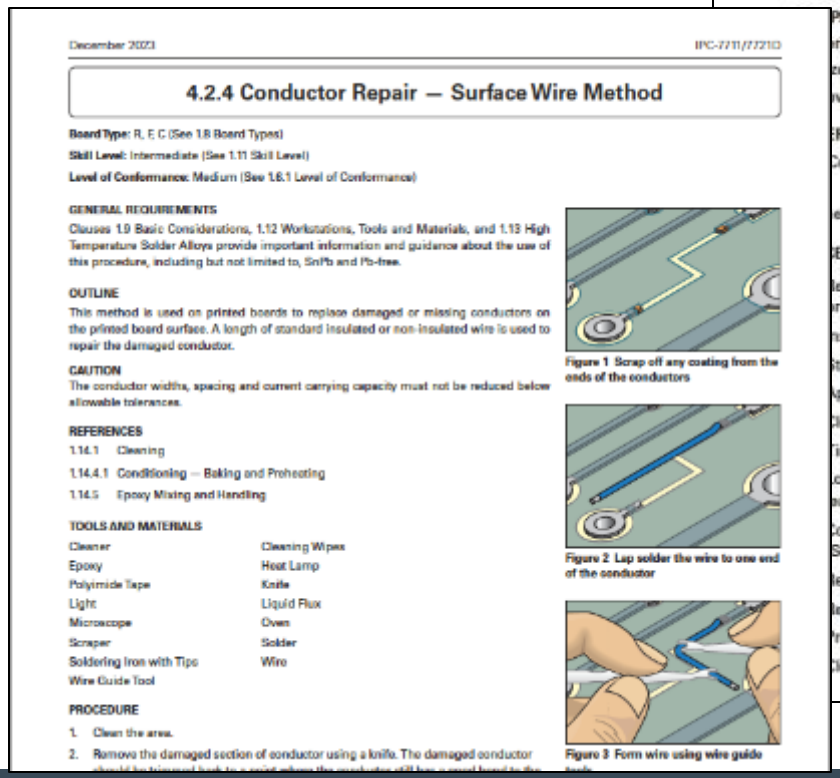
Defines the levels of conformance in relation to the classification of the assembly as well as the skill levels that operators require to perform the repair procedure.

IPC-7711/21 REVISION D RELEASED DECEMBER 2023



IPC-7711/21 - Methods and Procedures

Provides criteria, material selection, methodology and procedures to ensure the reliability of products subject to rework, modification and repair.



December 2023 IPC-7711/7721D

4.2.4 Conductor Repair — Surface Wire Method

Board Type: R, F, C (See 1.8 Board Types)
Skill Level: Intermediate (See 1.11 Skill Level)
Level of Conformance: Medium (See 1.6.1 Level of Conformance)

GENERAL REQUIREMENTS
Clauses 1.9 Basic Considerations, 1.12 Workstations, Tools and Materials, and 1.13 High Temperature Solder Alloys provide important information and guidance about the use of this procedure, including but not limited to, SnPb and Pb-free.

OUTLINE
This method is used on printed boards to replace damaged or missing conductors on the printed board surface. A length of standard insulated or non-insulated wire is used to repair the damaged conductor.

CAUTION
The conductor widths, spacing and current carrying capacity must not be reduced below allowable tolerances.

REFERENCES
1.14.1 Cleaning
1.14.4.1 Conditioning — Baking and Preheating
1.14.5 Epoxy Mixing and Handling

TOOLS AND MATERIALS

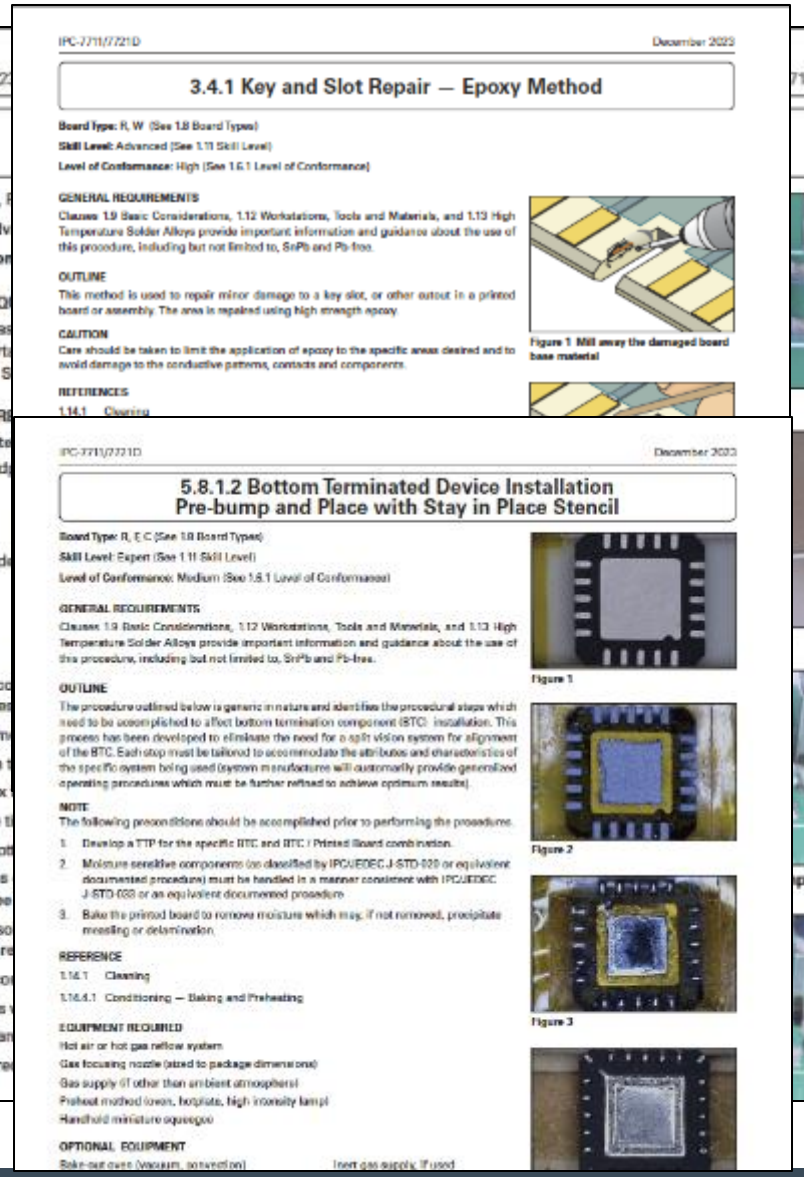
Cleaner	Cleaning Wipes
Epoxy	Heat Lamp
Polyimide Tape	Knife
Light	Liquid Flux
Microscope	Oven
Scraper	Solder
Soldering Iron with Tips	Wire
Wire Guide Tool	

PROCEDURE
1. Clean the area.
2. Remove the damaged section of conductor using a knife. The damaged conductor

Figure 1 Scrap off any coating from the ends of the conductors

Figure 2 Lap solder the wire to one end of the conductor

Figure 3 Form wire using wire guide



IPC-7711/7721D December 2023

3.4.1 Key and Slot Repair — Epoxy Method

Board Type: R, W (See 1.8 Board Types)
Skill Level: Advanced (See 1.11 Skill Level)
Level of Conformance: High (See 1.6.1 Level of Conformance)

GENERAL REQUIREMENTS
Clauses 1.9 Basic Considerations, 1.12 Workstations, Tools and Materials, and 1.13 High Temperature Solder Alloys provide important information and guidance about the use of this procedure, including but not limited to, SnPb and Pb-free.

OUTLINE
This method is used to repair minor damage to a key slot, or other cutout in a printed board or assembly. The area is repaired using high strength epoxy.

CAUTION
Care should be taken to limit the application of epoxy to the specific areas desired and to avoid damage to the conductive patterns, contacts and components.

REFERENCES
1.14.1 Cleaning

Figure 1 Mill away the damaged board base material

IPC-7711/7721D December 2023

5.8.1.2 Bottom Terminated Device Installation Pre-bump and Place with Stay in Place Stencil

Board Type: R, F, C (See 1.8 Board Types)
Skill Level: Expert (See 1.11 Skill Level)
Level of Conformance: Medium (See 1.6.1 Level of Conformance)

GENERAL REQUIREMENTS
Clauses 1.9 Basic Considerations, 1.12 Workstations, Tools and Materials, and 1.13 High Temperature Solder Alloys provide important information and guidance about the use of this procedure, including but not limited to, SnPb and Pb-free.

OUTLINE
The procedure outlined below is generic in nature and identifies the procedural steps which need to be accomplished to affect bottom termination component (BTC) installation. This process has been developed to eliminate the need for a split vision system for alignment of the BTC. Each step must be tailored to accommodate the attributes and characteristics of the specific system being used (system manufacturers will customarily provide generalized operating procedures which must be further refined to achieve optimum results).

NOTE
The following preconditions should be accomplished prior to performing the procedure.
1. Develop a TTP for the specific BTC and BTC / Printed Board combination.
2. Moisture sensitive components (as classified by IPC/JEDEC J-STD-020 or equivalent documented procedure) must be handled in a manner consistent with IPC/JEDEC J-STD-033 or an equivalent documented procedure.
3. Bake the printed board to remove moisture which may, if not removed, precipitate measling or delamination.

REFERENCE
1.14.1 Cleaning
1.14.4.1 Conditioning — Baking and Preheating

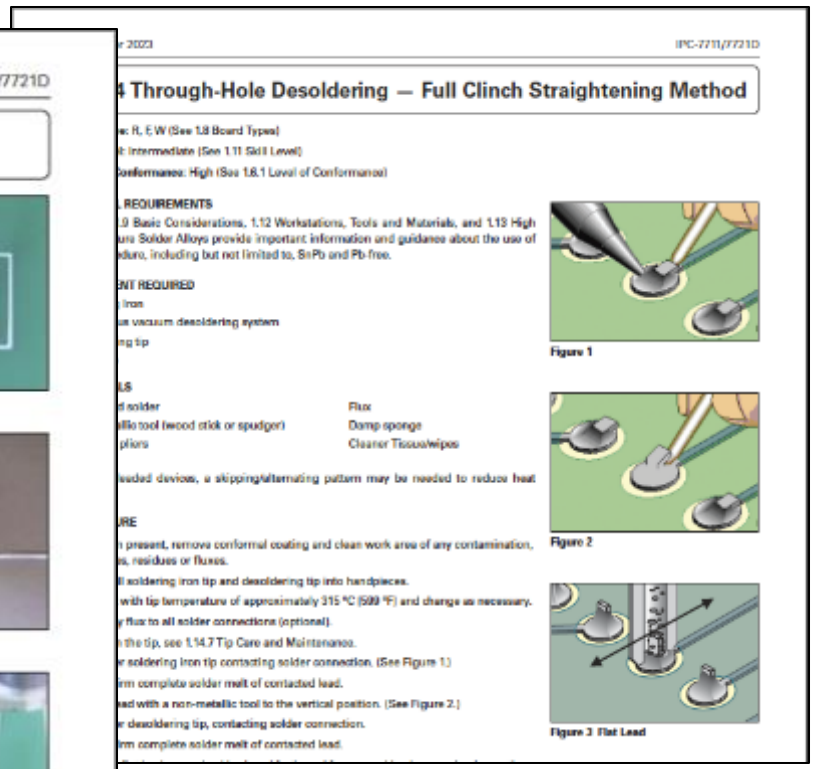
EQUIPMENT REQUIRED
Hot air or hot gas reflow system
Gas focusing nozzle (sized to package dimensions)
Gas supply (if other than ambient atmosphere)
Preheat method (oven, hotplate, high intensity lamp)
Handheld miniature squeegee

OPTIONAL EQUIPMENT
Bake-out oven (vacuum, convection) Inert gas supply, if used

Figure 1

Figure 2

Figure 3



2023 IPC-7711/7721D

4 Through-Hole Desoldering — Full Clinch Straightening Method

R, E, W (See 1.8 Board Types)
Intermediate (See 1.11 Skill Level)
Conformance: High (See 1.6.1 Level of Conformance)

REQUIREMENTS
9 Basic Considerations, 1.12 Workstations, Tools and Materials, and 1.13 High ure Solder Alloys provide important information and guidance about the use of dure, including but not limited to, SnPb and Pb-free.

NT REQUIRED
Iron
ve vacuum desoldering system
ng tip

LS
f solder — Flux
llo tool (wood stick or spudger) — Damp sponge
pliers — Cleaner Tissue/wipes

ded devices, a skipping/alternating pattern may be needed to reduce heat

RE
present, remove conformal coating and clean work area of any contamination, s, residues or fluxes.
soldering iron tip and desoldering tip into handpieces.
with tip temperature of approximately 315 °C (599 °F) and change as necessary.
flux to all solder connections (optional).
the tip, see 1.14.7 Tip Care and Maintenance.
r soldering iron tip contacting solder connection. (See Figure 1.)
rm complete solder melt of contacted lead.
ad with a non-metallic tool to the vertical position. (See Figure 2.)
r desoldering tip, contacting solder connection.
rm complete solder melt of contacted lead.

Figure 1

Figure 2

Figure 3 Flat Lead

Some Standardization Activities Supporting Sustainability Data

- 2-10 Electronic Product Data Description Committee
  - 2-12 Digital Twin Subcommittee
    - 2-12a Generic Requirements for Digital Twin Task Group
    - 2-12b Model Based Definition (MBD) for Digital Twins Task Group
    - 2-12d Digital Sustainability Credentials Standard Task Group
- 2-16 Digital Product Model Exchange (DPMX) Subcommittee
  - 2-16d IPC-2581 Users Task Group
- 2-17 Connected Factory Initiative Subcommittee
  - 2-17a IPC-CFX Standard Task Group
- 2-18 Supplier Declaration Subcommittee
  - 2-18h Conflict Minerals Data Exchange Task Group
  - 2-18j Lab Report Declaration Task Group
  - 2-18k Materials and Substances Declaration for the Aerospace, Defense, HE and Other Industries
- 2-19 Supply Chain Traceability and Trust Subcommittee
  - 2-19a Critical Components Traceability Task Group
  - 2-19b Trusted Supplier Task Group
  - 2-19c Component-Level Authentication (CLA) Standard Task Group