empfasis

A publication of the National Electronics Manufacturing Center of Excellence *May 2007*

Open Architecture and Software Defined Radio Technology Provide Affordability for Shipboard Electronics

The Department of Defense (DoD), in an effort to take advantage of the rapid advancement of technology, is increasingly turning to open architecture systems and software-defined radios (Figure 1-1) as an alternative to closed system designs. The Department of Navy formed the Naval Open Architecture Enterprise Team which created an open architecture assessment tool to analyze the adaptability of design projects. By using open architectures, component replacement can occur more easily than in a closed system. Through software-defined radios, new communication protocols can be utilized without the need to replace hardware. Open architecture is one key element in achieving more affordable electronics manufacturing aboard Navy ships.

Open systems, as defined by the Department of Defense Open Systems Joint Task Force, are those which conform to consensus based standards on all key interfaces. For example, if designing a system that requires access to a storage device, the system could be designed so that it utilizes USB (Universal Serial Bus) for said access, allowing simple upgrades or replacement in the future. USB is one example of an open standard, but there are many others such as PCI, RS232, and IEEE1394. Open standards are those which involve the participation of many interested industry parties that collaborate on an acceptable standard. An open standard must be freely available to all who wish to implement a system conforming to said standard. Use of the standard may have a nominal licensing fee, but it should not be so excessive that it is a barrier to wide-spread use. Utilizing these standards in system design will allow the system to be modified as new technology is developed with minimal impact on the existing system. For example, the effective processing power of a microprocessor doubles every eighteen months as a result of technology advances. A new processor could be placed in a system which utilized open standards with little or no impact to the display, or input/output modules. This allows for the military to keep pace with the changing technology without the cost of a

Figure 1-1 Systems conforming to open standards: SDR (left), single board computer (right)

continued on page 2

American Competitiveness Institute

ISO 9001-2000
Certified

American Competitiveness Institute
One International Plaza
Suite 600
Philadelphia, PA 19113
(610) 362-1200 • **FAX:** (610) 362-1290
HELPLINE: (610) 362-1320
WEBSITE: www.empf.org
www.aciusa.org

The EMPF is a U.S. Navy-sponsored National Electronics Manufacturing Center of Excellence focused on the development, application, and transfer of new electronics manufacturing technology by partnering with industry, academia, and government center and laboratories in the U.S.

Technical Editor
Michael D. Frederickson,
EMPF Director

Please direct comments and/or questions to the Editor at
empfasis-editor@aciusa.org
610-362-1336

In this Issue

Page 1: Open Architecture and Software Defined Radio Technology Provide Affordability for Shipboard Electronics
Page 3: Characteristics of Conformal Coatings
Page 4: Ask the EMPF Helpline!
Page 6: Challenges to Consider When Maintaining Deployed Military Electronic Systems
Page 8: 7711/7721 Printed Circuit Board Rework & Repair
Page 9: Tech Tips...Design for Sustainability
Page 11: Manufacturer's Corner: ERSA BGA Repair
Back Cvr: Upcoming Training Center Courses

Open Architecture and Software Defined Radio Technology Provide Affordability for Shipboard Electronics (Continued from page 1)

complete redesign.

An SDR (Software Defined Radio) is a radio whose functionality and waveforms are defined in software. The software can reside in a DSP, an FPGA (Field Programmable Gate Array), or in any other appropriate processor. There is an analog front end, which can handle the analog to digital and digital to analog conversions for transmission and reception of the desired radio communication protocol. After the conversion, all core functionality occurs in the software. Likewise, construction of the transmitted signal is performed in the software. Given the sampling rates for digital-to-analog (D/A) and analog-to-digital (A/D) converters, the signal may be mixed up or down to the desired carrier frequency depending on the application. As the sampling rates of D/As and A/Ds increase the analog portion of the radio design decreases. Since the radio functionality, modulation/demodulation, base band processing, and filtering are defined in software, the platform becomes very versatile. By using such a system, the radio can be reconfigured in the field for different protocols depending on the application.

Taking this a step further, several different communications protocols can be actively switched while in use. The number of protocols that are supported by a device is almost limitless. The Joint Tactical Radio System (JTRS) is a DoD initiative that uses these protocols to implement different waveforms for different applications and missons, allowing the warfighter with a single radio to communicate with the most appropriate protocol for the given situation.

Open architectures are being used in redesign to allow for modular components to be utilized for control and user input. A compact Peripheral Components Interconnect (cPCI) backplane is used to allow for the modular implementation of the receiver and transmitter RF sections as well as MIL-STD-1553 control, control processor and SDR. Through use of the cPCI backplane, additional bus devices can be added for increased functionality with minimal impact on the other components. For example, if it is determined that the unit is required to generate output to a monitor, a graphics controller could be added to the bus. The impact of this upgrade would be isolated to the controller software to generate output for this device. Utilizing open standards such as the cPCI backplane increases the versatility and the useful lifetime of the unit.

The AN/ARS-6 redesign, currently underway at U.S. Army CECOM, leverages SDR technology for implementing the transmitted waveform, utilizing a circuit card with some analog-to-digital converters, digital-to-analog converters, an FPGA, and a PCI interface. The FPGA is utilized for the digital signal processing. Implemented within the FPGA are the DME waveform modulation, time dependent control signaling, and DME demodulation. These provide the functionality for the combat search and rescue application of this unit. The unit could be expanded to communicate with other systems by implementing a different FPGA design to achieve that function. The unit could then be switched from one functional mode to another with a simple reconfiguration of the FPGA, which can occur while the unit is operational. This versatility could potentially reduce the amount of differing communication equipment needed.

Through the use of open architectures and SDR technologies the DoD can better keep pace with changing technology. Reconfigurable devices, such as SDRs, can help reduce the warfighter's need to carry multiple radio systems. The JTRS (Joint Tactical Radio System) program was set up for that purpose. By leveraging SDR technology, the DoD hopes to enable the modern warfighter to communicate using any method or protocol available without the need for multiple radios. The Department of Navy hopes to increase affordability of shipboard electronics through the use of open architectures. The Navy is accomplishing this through many projects such as the Littoral Combat Ship, on which the EMPF is collaborating.

By utilizing open architecture approaches to shipboard systems, the useful lifetime of those systems can be extended, and more importantly, can drive down the total ownership cost of electronics hardware aboard current and future ships. New advances in the electronics industry can be leveraged by changing only the necessary component - with little impact to other system components. Allowing for current technology to be introduced into a system will contain ever-increasing upgrade costs, which ultimately will lead to greater improvements in affordability of shipboard systems.

Mark Legutko - Digital Design Engineer

Characteristics of Conformal Coatings

A conformal coating is defined as a thin polymeric material which covers the surface of an electronic assembly. These coatings are used to provide an electrically insulative and environmentally protective seal or cover to a completed printed circuit board (PCB).

Conformal coatings protect the PCB from solids, vapors and fluids. They offer physical protection from assembly debris such as wire clippings, loose hardware, and solder splatter and can help protect the PCB from vibration damage. Given a single exposure, they will usually protect the surface against vapors. Different chemistries repel contaminants at different levels; material compatibility studies must be performed to determine the correct one for the application. Conformal coatings are divided into five classifications, based on their chemistry, as shown in Table 2-1.

Classification	Abbreviation
Acrylic Resin	AR
Epoxy Resin	ER
Silicon Resin	SR
Polyurethane Resin	UR
Parylene	XY

Table 2-1 Conformal Coating Classification

COATING TYPES

Acrylic Rosen (AR) - Acrylic rosin is a relatively hard material with a smooth, glossy finish. It has lower abrasion resistance and yields readily to scraping , chipping and flaking. Most acrylics can be softened by heat resulting in a gummy residue. These coatings are dissolved in solvent in the fully cured state, and as a result, they can be easily reworked. Acrylics can be applied by brush, spray or dip-coating.

Epoxy Resins (ER) - Epoxy resins offer good humidity resistance, high abrasion and chemical resistance as well as having good electrical properties (low dielectric). They are one of the hardest coatings and form a hard, smooth surface that will resist chipping, peeling, or cracking and form one of the strongest surface adhesion bonds. They are difficult to rework and require a soldering iron to penetrate the coating in order to replace a component. Epoxy resins are usually available as a two-part system and can be applied by brush, spray or dip-coating.

Silicone Resin (SR) - Silicon resins have excellent dielectric strength and high arc resistant. Cured, they are rubbery and pliable. Adhesive strengths range from easily detachable to tightly bonded. They have good moisture, humidity and UV resistance and good thermal endurance. They are difficult to rework because they are resistant to most common solvents. Customized thinners and solvents can be purchased from the manufacturer. Silicon resins can be applied by brush, spray or dip-coating.

Polyurethane Resin (UR) - Polyurethane resins offer good humidity and chemical resistance and have high dielectric properties. The coating surface finish is smooth, glossy and non-porous. Coating hardness ranges from extremely hard to relatively soft. They have medium bond strength and tend to peel or flake off in large pieces. Heat at or near the solder melting temperatures will soften polyurethanes and make them pliable. They can be soldered through for rework, but this produces an unsightly brown residue. Polyurethane resins can be applied by brush, spray or dip-coat application.

Parylene (XY) - Parylene coatings have good dielectric strength, low thermal expansion, good abrasion resistance and outstanding chemical resistance. These coatings form a strong surface bond and provide a thin, uniform coverage that conforms fully to the PCB contour. They are used to protect circuits against high humidity, intermittent immersion, salt fog, pollution and aggressive solvents. They are FDA approved for use in medical applications. They are effective in high voltage applications because they can coat sharp edges. Parylene coatings are applied by the vacuum deposition process.

SPECIFICATIONS AND STANDARDS

MIL-I-46058 - Insulating Compound, Electrical for Coating Printed Circuit Assemblies - MIL-I-46058 is an older military specification that lists the technical criteria for conformal coating characteristics. It also lists the quality assurance tests and how they are to be performed. A companion document, QPL-46058, lists coating materials that are in compliance with MIL-I-46058 and is used by the federal government for acquisition purposes.

IPC-CC-830B (with Amendment 1) - Qualification and Performance of Electrical Insulating Compounds for Printed Board Assemblies - This was derived from the MIL-I-46058 and establishes qualification and performance requirements for conformal coatings. This standard allows manufacturers to qualify conformal coating products and define product performance characteristics to the standard.

IPC-HDBK-830 - Guideline for Design, Selection and Application of Conformal Coatings - This document was designed to assist in the selection of a conformal coating. It outlines typical properties of each coating type and how they impact performance considering the intended end use. It also outlines processing steps to assure proper coating application.

COATING ACCEPTANCE CRITERIA

Appearance - coating appearance shall be visually inspected at all stages of evaluation, qualification, and conformance inspection

continued on page 5

Ask the EMPF Helpline!

A customer called into the EMPF Helpline requesting a bare board solderability evaluation...

Recently, an EMPF customer requested a bare board solderability evaluation after experiencing problematic wetting with a lot of FR4 substrates. The substrates were single sided PCB panels with a traditional tin-lead hot air solder level (HASL) finish, similar to the surface finishes observed on many legacy designs. The HASL finish did not appear to be processed correctly and needed testing to determine if the boards were solderable. The EMPF performed Solder Float Testing to establish the solderability of pads on samples of the PCB; X-ray Fluorescence testing to establish the finish thickness and composition; Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM/EDS) to evaluate the surface of various pads and through-holes and cross-sectional analysis with SEM/EDS of a pad for solder characteristics (i.e. grain structure, intermetallic compound formation, etc); Sequential Electrochemical Reduction Analysis (SERA) to determine what metal oxides were present.

Solder Float Test and XRF

The samples were tested to J-STD-003A, 4.2.3, Test C. A board section was placed on to the molten solder surface (pot temperature 235°C) and allowed to float on the surface for five seconds maximum. The sections were removed, cooled and examined. The testing indicated incomplete wetting (Figure 3-1). Composition and thickness measurements were taken at various surface features on a number of bare PCBs from the panels supplied. XRF analysis indicated that the HASL thickness varied from 3.7 to 711 micro-inches. The composition of the HASL was also inconsistent.

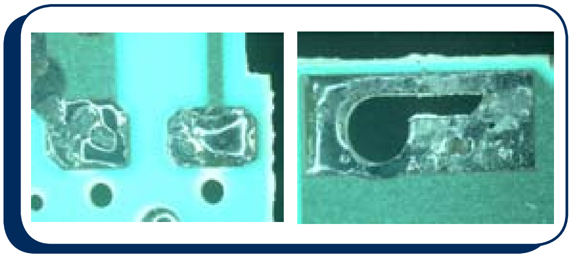


Figure 3-1 Dewetted solder surfaces observed after float testing.

SEM/EDS analysis

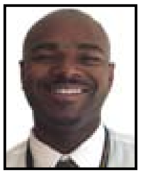
SEM images of the pads and other surface features on the PCB were captured before and after solder float testing. SEM images of the surface prior to testing showed further evidence of the wetting problem. There were distinct areas where the solder pulled away from the surface. Micro-sections and subsequent SEM/EDS analysis of a pad after Solder Float testing indicated good grain structure with lead (Pb) regions and tin (Sn) regions. Elemental analyses of the bulk solder and interface area were done through EDS and showed no evidence of metallic contamination.

Sequential Electrochemical Reduction Analysis (SERA)

SERA is a technique that uses electrochemistry to identify tin oxides, silver sulfides, and thin or porous gold finishes. SERA analysis of three pads indicated varied amounts of tin II (SnO) and tin IV (SnO2) oxides were present. SERA also verified that there was no copper-tin intermetallic oxide present. The presence of intermetallic oxide would indicate that the HASL was thin and failed to protect the underlying copper pad.

Testing of the panel of PCBs confirmed some solderability issues were present. This reaffirmed the customer's concerns that the boards were not suitable for assembly. There were many contributing causes for the solderability that were identified. However, the observations gained from testing indicated a questionable HASL finish was the main reason for the poor wetting. The pads and annular rings which made up the top layer circuitry on the board displayed an inconsistent appearance, with mottled textural differences in various places within the metal area. X-Ray Fluorescence confirmed large variations in HASL finish thickness. This inconsistent appearance was also revealed as de-wetting during solder float test in some instances. Both the appearance and large variation in thickness of the HASL finish of these boards indicated a significant concern with the HASL surface finish applied to the boards.

Boards showing such inconsistency in HASL finishes would not be appropriate for use in a sustainment application. The boards must establish excellent solderability at the time of manufacture to ensure that as time progresses, the storage conditions will not reduce the wetting performance to the point where the boards become unsolderable.



Blaine Partee - Senior Materials Engineer

Characteristics of Conformal Coatings

(continued from page 3)

at 1.75X minimum magnification. Test samples shall be prepared in accordance with paragraph 4.7 of IPC-CC-830B. The coating appearance on the PCB shall be smooth, uniform, transparent, free of bubbles (orange peel), pinholes, blisters, or cracks (mealing), and evidence of reversion (tackiness). Cured, coated assemblies shall be free of foreign material, changes in appearance, and separation from the substrate or components.

Shelf life - container(s) of coatings shall be stored at the temperature recommended by the coating vendor. Once a coating has reached the end of its shelf life, it should be discarded, unless the material can be requalified for continued use.

Coating Thickness - coating thickness shall be measured on a coupon in accordance with ASTM-D-1005. Measurements will be made using a micrometer or indicator that is accurate to 0.0005 ± 0.0001 inches.

Moisture and Insulation Resistance - Moisture and Insulation Resistance (M&IR) is a measure of how well the insulation properties are maintained when exposed to elevated temperature and humidity. M&IR is evaluated using test method 2.6.3.1 of IPC-TM-650. A material with a low M&IR would be a poor choice to protect a circuit in a high humidity application.

Dielectric Withstanding Voltage (DWV) - Dielectric Withstanding Voltage (DWV) is a measure of how well a coating resists conducting electricity at a high test voltage for a set period of time. Testing is performed in accordance with IPC-TM-650 2.5.7. Conditions are tested at 500 VDC (default) and 1000 VDC for thirty seconds. This test should be performed after the moisture and insulation resistance tests.

Thermal Shock - Exposure to rapid temperature change can stress a coating that has a slow delta temperature rise and can cause it to crack or delaminate from the substrate. IPC-TM-650 Method 2.6.7.1 is a thermal shock test that verifies the compatibility of a material with a specific temperature profile. It involves rapid cycling between cold and hot baths. Afterwards, the coating appearance is examined and the dielectric withstanding voltage is tested.

Adhesion - Adhesion of the coating to the circuit board can be tested on a go/no-go basis using a standard paint tape test (peel test) per IPC-TM-650 method 2.4.26.

The Coating Process - A PCB assembly must be cleaned and de-moisturized eight hours before conformal coating. De-moisturizing may be accomplished by an oven bake at 93 ˚C +/- 5.5 ˚C, for a minimum of four hours. The coating material is applied using a method that will yield complete coverage without excessive filleting or runs. Common coating methods include spraying, brushing, dipping or a combination thereof. Chemical vapor deposition is the process used for Parylene.

The EMPF uses a Concoat Systems DC 2002 Dip Coater for application of conformal coating. This model was selected for this process because of the controlled extraction rate of the PCB assembly from the conformal coating bath. The entire PCB Assembly is dipped into the holding tanks with a controlled removal from the conformal coating to obtain uniform thickness.

In conclusion, the following is a list of considerations to keep in mind when choosing a conformal coating:

- Raw material characteristics: viscosity, VOC free, one-part/two-part
- Final cured material characteristics: dielectric, chemical resistance
- Methods of application: capital equipment cost, speed/throughput
- Cure methods available: heat, ultra-violet (UV), vacuum deposition (Parylene)
- Cost of curing equipment: in-line heaters, deposition chambers, etc.
- Environmental impact: volatile organic compounds (VOCs)
- Cleanliness of PWB prior to coating
- Ease of rework
- Compatibility
- End use application

Dave Poulin - Senior Materials Engineer

Have a question concerning electronics manufacturing and don't know where to go?

Call the
HELPLINE
(610) 362-1320

Your Direct Connection to the Experienced Engineers on our staff.

Challenges to Consider When Maintaining Deployed Military Electronic Systems

Sustaining and maintaining aging shipboard electronics (i.e. radar and communications) equipment is a considerable challenge for the Navy. As electronics systems age, degradation can occur affecting the reliability of these systems. The need for these systems to be easily maintained and upgraded is critical to the safety and effectiveness of the warfighter.

Redesigning electronic equipment can be a difficult task if technical documents are not readily available to fully understand how the equipment operates in a system. Often, obtaining the documentation and test equipment needed for redesign is not possible. Technical questions to the original equipment manufacturer (OEM) cannot be answered since in many cases that resource may no longer be available. Additional requirements such as military electro-magnetic interference (EMI) and environmental qualification can also cause setbacks in the redesign schedule.

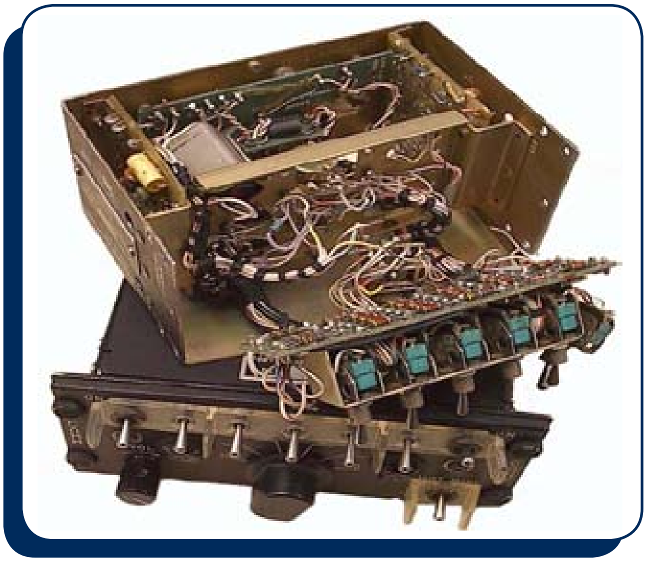


Figure 5-1 1960's C6533/ARC Intercom

Case Study

One such electronic system that the EMPF has recently improved the maintainability and affordability of is the C6533/ARC Intercommunication Control System (ICS). The ICS is a communication system that is currently deployed in the field, was originally designed in the late 1960s, and has seen service in many types of helicopter platforms including the AH-1, CH-47D, OH-58A/C, UH-1H/1V, and UH-60A/L. To allow the DoD to sustain the C6533/ARC for an additional twenty years, the EMPF has successfully re-engineered the C65533/ARC to improve reliability, increase availability, improve maintainability, and reduce total ownership cost.

Over twenty percent of the parts needed to build and repair the unit were obsolete and extremely difficult to procure. The unit also presented some other unique repair challenges since there were five sub-assemblies which were assembled and hard-wired between boards. Over time, severe aging had caused breaks in the internal wiring and brittle solder joints had a tendency to fracture during disassembly. The redesign of the ICS unit was mostly internal which allowed for the conversion of five separate printed circuit boards (that were assembled by hand soldering between the boards and an E terminal (Figure 5-1)), into two boards with surface mount technology. Unlike the original design which used all discrete components, the redesigned intercom uses commercial-off-the-shelf (COTS) parts including a microcontroller, an op-amp, and integrated components. The use of current technology reduced both the weight of the unit and the assembly and repair cost.

Lessons Learned

When considering changes to deployed systems to meet new requirements, it is critical to identify areas that can impact the system right at the interface to the platform. Power, interface, and control lines may contain few implementations of proper line filtering. New designs must make use of advanced line filtering to eliminate AC noise. For a typical system, these noise frequencies which can be problematic may range from 400 to 1000Hz. As an example of problems caused by insufficient filtering for audio application, unwanted sidetones within this frequency range of interest will be audible at the headset.

When designing new systems to deployed systems' requirements, it is important to take into account environmental and EMI testing standards that were in place when the system was designed. In many cases, the environmental EMI requirements for today's electronic systems are more stringent. In order to have final platform qualification acceptance, the redesign needs to conform to military standards such as MIL-STD-810F, MIL-STD-461E, MIL-STD-901D, and MIL-STD-704E. MIL-STD-810F is an environmental testing guideline that includes standards for temperature cycling, humidity, fungus, salt fog, sand & dust, vibration, explosive atmosphere, and rain. MIL-STD-461E establishes the interface and associated verification requirements for the emission and susceptibility control of EMI. MIL-STD 901D verifies the ability of shipboard installations to withstand shock loadings which may be incurred during wartime service

continued on page 7

Challenges to Consider When Maintaining Deployed Military Electronic Systems (continued from page 6)

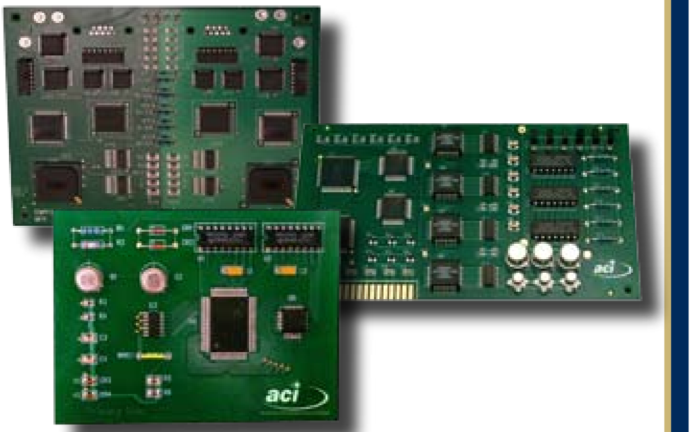
due to the effects of nuclear or conventional weapons. MIL-STD-704E lists a set of requirements that ensure compatibility between the aircraft electric system, external power, and airborne utilization equipment. It also defines the requirements and characteristics of aircraft electric power provided at the input terminals of equipment to control electromagnetic interference and voltage spikes induced by lightning, electromagnetic pulses and power switching.

For most redesigns of deployed systems, using ferrite beads and technologies such as embedded wafer bypass capacitor connectors on all input and output lines will enable the new system to meet EMI requirements. Other implementations such as utilizing EMI gaskets and seals can augment the mechanical design and prevent the system internal circuitry from being adversely affected by EMI test signals which are radiated into the enclosure.

Whether the system is designed to perform a navigational, electronic warfare, or communication function, it must be designed to ensure that the equipment is both maintainable and affordable for the Navy platform into which it is inserted.

In conclusion, the EMPF has re-engineered aging electronics equipment to extend its life, improve reliability, and make it more maintainable. This has resulted in a deployed system that is much easier to manufacture (by reducing five sub-assemblies down to two), has fewer moving parts, and has a reduced labor cost for repair and assembly. Stringent environmental and EMI testing has proven that COTS components can meet tough military requirements and field testing in the target environment has proven that the redesigned unit operates and performs equal to or better than the original design. Although the hardware in this case was designed for a communications system, the maintenance challenges and solutions are definitely applicable to shipboard sustainment.

Thuan Dinh - Design Engineer



IPC 7711/7721 Printed Circuit Board Rework & Repair

Today's manufacturing processes continue to improve manufacturing yields. This is due in part to manufacturing personnel being well trained and equipped with the best equipment and tools available on the market. However, due to constant evolving manufacturing technologies and the inevitable PCB defects caused by varying factors, there will always be a need for qualified and trained personnel to properly disposition assemblies that require rework or repair. The EMPF offers a comprehensive certification course that is part of the overall IPC certification program designed to meet these training needs.

The IPC 7711/7721 courses have been designed to meet the needs of manufacturing personnel with PCB rework, repair, or modification responsibilities. Participants will receive hands-on training in the correct methods for reworking, restoring, and modifying electronic boards and assemblies. Those who successfully complete the course will receive a certification that is valid for two years. Pre-requisites for the course include above-average soldering skills and analytical capabilities.

Students will be taught the general requirements and basic terminology of IPC-7711/7721. Additionally, students will also learn the basic considerations used in analyzing rework and repair, tool and material considerations, proper handling techniques, and basic cleaning procedures. Additional topics include:

Wire Splicing: Students will learn to determine the feasibility of repair, the four types of splices used, and tinning and soldering considerations.

Through-Hole Technology: In this module, students will learn the skills for removing, land preparation, and reinstalling axial-leaded, radial-leaded, and multi-leaded components on PWAs utilizing the continuous vacuum and wicking method.

Chip and MELF Components: Students will learn how to properly remove this component family and how to clean and prepare pads, and reinstall components.

SOIC and SOT Components: Students are instructed in the industry accepted procedures for removal, cleaning and prepping termination areas, and replacing components.

Quad Flat Paks (J-Leads & Gull Wing): Students focus on the removal, pad preparation, and reinstallation of fine pitched (20-30 mil), multi-leaded, J-leaded, and gull/L wing devices.

Laminate Rework and Repair: Students will learn the procedures, and develop and demonstrate the skills for repairing damaged laminate materials using the newest materials and tools available to the electronic manufacturing industry.

Conformal Coatings: Students focus on the procedures and processes for the removal and replacement of conformal coating. Students will learn about various conformal coating removal techniques, including mechanical, thermal, and solvent methods.

The modularized curriculum allows you to customize your training to select the modules that will best serve your specific needs. For example, a customized course would be best for a company that uses only through-hole technology and only needs their workers to be proficient in rework of through-hole components. Similarly, companies manufacturing surface mount devices need only select the modules that pertain to their specific manufacturing needs.

Courses are available in our classroom or on-site at your facility. For additional information, class schedules, or to register for a course, please contact the Registrar at (610) 362-1295 or via email at registrar@empf.org.

George Tristan - Engineering Technician/
Instructor

Have Questions? Need Answers?
Contact the Helpline
610.362.1320
helpline@empf.org

Tech Tips...
Design for Sustainability

The military electronics industry is constantly challenged to develop products with long life cycles using COTS components. The rapid technological advances have prompted designers to be ever vigilant about emerging technology trends and standards. For this reason, sustainability must be a comprehensive goal when developing new products.

New technology is driven by market demand. To accurately forecast future trends, it is necessary to remain current with the latest industry developments. The following list of recommendations can help manage the design process in a rapidly changing environment:

- Follow Industry Recognized Standards - A good method of collecting current information on design trends is to monitor standards that are developed by industry trade groups. These are consensus standards developed by committees, usually consisting of a consortium of the top tier companies with representatives in their respective disciplines. Once a standard is adopted, it definitely has a stabilizing effect on the technology. Some common military and commercial standards include cPCI, VME, MIL-STD-1553, WCDMA, and IEEE-802.11.

- Leveraging Supply Chain Knowledge Base – Component distributors are very connected to emerging technologies and industry trends. The same information they use to make business decisions regarding what product lines to sell can be used to mitigate component obsolesce and improve sustainability. Recognizing the possibility of a future payoff in manufacturing, distributors are very eager to provide data on product advancements and the OEM's technology roadmap for a particular product line. They have access to inside information that is not readily available to the general customer base. Obtaining knowledge of the suppliers' future product plans is an excellent way to maximize sustainability.

Emerging trends are not the only concern in the design for sustainability. Conventional design techniques can be targeted as well for extending product life.

- Component Selection – The key to any successful design is component selection. Functionality is obviously the first priority when designing new hardware. The product cost is usually second, with reliability following a close third. Future component availability usually isn't even a consideration. It's very difficult to predict what parts will and will not be available in the future, but selecting the more readily available COTS components that are mass produced by multiple manufacturers can clearly reduce the risk.

- Source Selection - To maximize a product's life cycle, it's important to avoid sole source items that control the overall design. Selecting multiple (two to three) vendors for critical components in advance assures that the product has flexibility in design after production. Most supply chain management systems will drive the need for alternate sources, but the key is to have a fully qualified, drop-in replacement part.

- Designing for the Future - Designers should anticipate component advancements or the need for an alternate component by incorporating alternate locations in their circuit design to accommodate a different package design. This method could also provide for future system expansion or additional functionality once the system is deployed.

- Package Standardization - It is recommended that the designers identify and select standard component packages and layout patterns when and wherever possible. Using standard packages with common pin counts for typical integrated circuits (IC) makes substituting components during the design process very simple. In the future, identifying replacement components for those that have been obsoleted can be simplified. For example, 14 or 16 pin devices are common IC packages, swapping out parts or manufacturers becomes very simple.

- Quality - Looking beyond the issues of product reliability and mean time between failure (MTBF) performance, a sustainable design needs to be sufficiently robust for a number of repair or refresh cycles. Selecting quality materials that can tolerate the environmental extremes with an adequate operational margin is one method of improving both reliability and sustainability. A good example of this is the selection of printed circuit board (PCB) materials and PCB workmanship class. A material such as polyimide provides greater thermal stability than FR4 and can better tolerate the localized extreme temperatures generated during the repair or upgrade process. IPC-A-600 is a workmanship standard

continued on page 10

✂ cut here and save!

Tech Tips...
Design for Sustainability

(continued from page 9

for PCB fabrication. It defines the workmanship requirements for three classes of PCBs. High reliability applications are defined as Class III products and are designed to maximize PCB reliability by requiring suppliers to have a very tightly controlled fabrication process. Designing systems with high quality materials is an excellent foundation for product sustainability.

In conclusion, designing for sustainability is not difficult, but it can be easily over looked. While the number one priority of a new design must be functionality, sustainability is arguably the second. When engineers plan for the inevitability of component obsolescence, system refresh and depot repair, the overall impact on the design process can be trivial and the long term benefits significant.

Ravi Patil - Design Engineer

Is there something you'd like to see covered in Tech Tips?
Contact the Editor
610.362.1320
empfasis-editor@aciusa.org

Manufacturing BOOT CAMP

Blending the most effective combination of theory and hands-on training, attendees to the Manufacturing Boot Camp will be exposed to the latest processes and techniques of setting up screen printers, using automated component placement equipment, profiling state-of-the-art market re-flow ovens and wave soldering machines, selecting and implementing the most effective cleaning processes, and more.

This course is ideal for design engineers, process engineers, quality engineers, supervisors and senior technicians desiring to increase their knowledge of electronics manufacturing through both classroom discussion and hands-on application. Design engineers will enhance their ability to design for manufacturing in a real world environment while process engineers will significantly enhance their process and manufactuing capability.

Boot Camp A

June 4-8
September 10-14
November 5-9

Boot Camp B

June 11-15
September 17-21
November 12-16

Classes fill up rapidly, so sign up early! Please contact the Registrar by phone at 610.362.1295 or by email at registrar@empf.org.

cut here and save!

Manufacturer’s Corner
ERSA BGA Repair

Current international studies reinforce the global trend to the use of area array packages. BGA, CSP and Flip Chip technology not only offer significantly more I/Os (input/output) per mm^2 of PCB real estate, but they also have distinct electrical, mechanical, and unit cost advantages. Increased density, reduced feature size and packaging all add up to shorter distances for signals to travel, hence increasing speed and performance. Advances in production equipment have allowed for an acceptable ppm failure rate during the production process. For many, however, the concept of quality repair remains an expensive nightmare. A more thorough understanding of the area array package and the production parameters can reduce fears of BGA repair, guarantee process control, and greatly save in rework costs.

While the desoldering process can be handled with the majority of hot air equipment available, it is the re-soldering process that is most difficult to control. In rework, as in production, quality is the ultimate goal. Quality BGA reflow can be achieved for production in the enclosed environment of a reflow oven. Rework, unfortunately, cannot be done in a completely enclosed environment since the heating conditions required for BGA reflow are difficult to achieve when blowing hot air through a nozzle. Success depends on uniform heat distribution across the package and PCB land pattern without blowing or moving the component during reflow. A convective heat transfer in a repair situation involves blowing heated air through a nozzle that has the shape of the component. Air flow dynamics, encompassing the effects of laminar flow (high and low pressure zones and circulation rate), is a complicated science in and of itself. When combining these physical effects with those of heat absorption and distribution, it is clear that the construction of a hot air nozzle for localized area heating is a difficult task at best. Any pressure fluctuations or problems with the compressed air source or pump required by hot air systems would radically decrease the performance of the machine. A viable repair alternative to the numerous convective heat transfer problems listed above is the use of medium wavelength infrared.

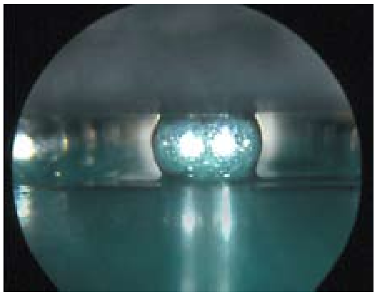


Figure 6-1 ERSAScope Image

Infrared is not new to the reflow oven and repair equipment arena. It has, however, lost some of its popularity due to the limiting physical effects of previously used short wavelength IR. The thermal radiation, while uniformly distributed, is unevenly absorbed and reflected by objects lighter or darker in color. Although such a heat source is perfectly acceptable for PCB preheating, the use of short wavelength IR for reflow often results in overheating of the dark component body and FR4 substrate material before the reflecting leads reach proper reflow temperatures. Medium wavelength or “dark” IR radiators (2-8 µ on the electromagnetic wavelength spectrum) not only transfer heat perfectly uniform across a surface, they also reveal an even absorption/reflection ratio between dark and light materials. With an optimal design of a medium wavelength IR BGA repair system, K-type thermocouples can be easily placed on the board in order to monitor and document precise thermal profiles during the actual reflow process.

Dark IR as a heating source alternative is an ideal solution for micro BGA, CSP, and Flip Chip repair applications. As there is no required air flow which could blow away or vibrate the component during reflow, the IR can be uniformly focused, directed, and transferred to an exact component size and location on the PCB. Adjacent component heating can be reduced or completely eliminated by covering components with reflective foil. Even components situated as close as 0.5 mm from the component to be repaired can be safely blocked from the heating source. Due to the escaping air and/or required nozzle thickness, this is impossible with a hot air system. Additionally, a top and bottom medium wave IR repair system can also act as an ideal “mini-reflow oven” for process controlled re-balling of all types of area array packages.

Medium wavelength IR is an ideal heat source alternative to hot air applications. It provides the most ideal heat transfer and distribution, is controllable, flexible, user-friendly, while also staying cost-effective.

For additional information on the above article or to schedule a demonstration of the ERSA equipment located at the EMPF, contact Robert N. Berta, 610-362-1200 ext 253 or via e-mail at rberta@aciusa.org.

Robert Berta - Business Development Representative

American Competitiveness Institute

National Electronics Manufacturing Technology Center of Excellence
Monthly Class Schedule for the Calendar Year 2007

Contact the Registrar for course information and pricing:
610-362-1295
FAX: 610-362-1289
registrar@empf.org

NEW COURSE!

CIT/Instructor Certification Enrollment Dates

Rework, Repair, & Modification of Electronic Assemblies

2007 IPC-7711/7721 CIT Certification

January 29-February 2	
March	5-9
May	7-11
July	9-13
September	24-28
November	26-30

2007 IPC-7711/7721 CIT Recertification

February	20-21
April	4-5
June	25-26
September	4-5
November	15-16
December	3-4

Call the EMPF Helpline for Free Electronics Manufacturing Assistance
610-362-1320
helpline@empf.org

Electronics Manufacturing

Boot Camp A
January 29-February 2
April 16-20
June 4-8
September 10-14
November 5-9

Boot Camp B
February 5-9
April 23-27
June 11-15
September 17-21
November 12-16

IPC Certifications CIT/Instructor

IPC J-STD-001
January 8-12
February 12-16
March 12-16
April 9-13
May 21-25
June 18-22
July 16-20
August 20-24
September 24-28
October 22-26
December 10-14

IPC-A-610
January 22-26
February 26-March 2
April 16-20
May 14-18
June 11-15
July 23-27
August 13-17
September 17-21
October 15-19
November 5-9
December 3-7

IPC-A-600 PWB Acceptability
January 3-5
February 27-March 1
April 9-11
May 29-31
July 31-August 2
August 27-29
October 10-12
November 19-21

IPC-A-610 Recertification
January 16-17
February 20-21
March 19-20
April 23-24
May 14-15
June 4-5
July 16-17
August 20-21
September 10-11
October 29-30
December 10-11

IPC J-STD-001 Recertification
January 17-18
February 21-22
March 21-22
April 25-26
May 16-17
June 6-7
July 18-19
August 22-23
September 12-13
October 31-November1
December 5-6

CIS/Operator

IPC/WHMA-A-620 Wire Harness Manufacturing
March 13-15
June 26-28
October 2-4
December 17-19

SMT Rework & Circuit Repair IPC-7711/7721 (Modules 1 &4-7)
February 12-15
May 7-10
August 13-16
October 29-Nov. 1

SMT Rework/ IPC-7711 (Modules 1, 4-6)
February 12-14
May 7-9
August 13-15
October 29-31

Surface Mount & Thru-Hole Rework of Electronic Assemblies IPC-7711 (Modules 1 & 3-6)
March 19-22
July 30-August 2
October 8-11

Repair & Modifications of PCB's IPC-7721 (Modules 1 &7-9)
February 5-8
April 30-May 3
August 6-9
November 12-15

Circuit Repair IPC-7721 (Modules 1 & 7)
February 5-6
April 30-May 1
August 6-7
November 12-13

IPC Challenge
January 19
February 23
March 23
April 27
May 18
June 8
July 20
August 24
September 14
November 2
December 7

Skills

Chip Scale Manufacturing
March 28-30
June 20-22
October 22-24

BGA Manufacturing Inspection & Rework
January 18-19
April 3-4
June 18-19
July 23-24
August 29-30
October 15-16
November 26-27

Continuing Professional Advancement in Electronics Manufacturing

Lead Free Manufacturing
January 16-17
February 26-27
March 26-27
April 30-May 1
May 30-31
June 27-28
July 25-26
August 27-28
October 17-18
November 19-20
December 12-13

Design for Manufacturability
February 22-23
April 11-12
May 24-25
August 6-7
October 8-9

Failure Analysis and Reliability Testing
January 3-5
March 6-8
May 21-23
July 9-11
September 5-7
November 28-30

Custom Courses and On-Site Training Available

Conveniently Located Next to the Philadelphia International Airport

All courses & dates subject to change without notice
LD0010