

Electronic Assembly Warranties Challenge the Industry to Improve Risk Mitigation Test Methods

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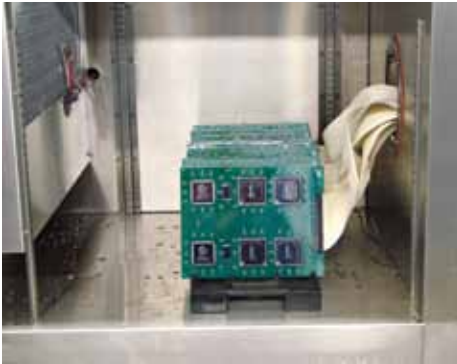
Abstract

Circuit/System PCB designer's objective is to increase device functionality in a smaller form factor with a higher density electronic layout. Higher density and smaller form factor components are driving the industry toward a higher risk situation in intermittent electronic performance. Voltage leakage and even current leakage can lead to signal integrity loss and even flip bit issues or drops in processing commands. As the density increases and the miniaturization drops in size and spacing so does the increase in failure mode opportunities for signal integrity/signal loss. The spacing between conductors and pads in the past has been our friend and saving grace by giving us greater insulation between these conductors and pads. Even

the standoff heights within the Z-Axis of miniaturized components are approaching one mil. This drop in z-axis means there is smaller cubic volume area to outgas volatiles or insure the volatilization/boil off effect of flux additives such as inhibitors (against oxidation/corrosion), activators (promotes wetting) and thermal stabilizers (insures fluxing action at peak reflow temps) during reflow, flux residues can become entrapped under the component itself in a state that has not fully deactivated. Mobile ions within the flux residues form leakage currents and/or voltages, especially when the device is operating within humid environments. Flux residue can contain halide/ionic materials which, when trapped under a part can lead to shorts across adjacent pads, or voltage/current leakage pathways.



Companies who require devices to meet long term reliability/warranty expectations need an improved industry test specification that allows for an accurate risk assessment. The problem is that the risk assessment is a multi-variable issue influenced by flux type, flux make up (activators and inhibitors), activation temperature, component type and placement; the type and criticality of the circuit in which the component is operating



in, wash characteristics if not a no-clean flux system, solder paste volume, PCB cleanliness and component contamination. Current measures of “clean” do not indicate if the product is clean enough in a critical area, which is what we hope to do. The goal is to design a test and test vehicle which encompasses the challenges of today so the System Design Engineer can define and characterize risk within his/her electronic assembly for long term reliability associated with cleanliness of the finished electronic assembly and final system warranty expectation. This is a tall order but there is a concern within critical industries such as Military, Medical, Automotive, Aerospace and safety critical industrial applications and industries to better define the risk and measure the risk associated with cleanliness. Cleanliness is a broad term for the mitigation and measurement of Electrochemical Migration (ECM) and pitting and creep

corrosion, and general surface insulation breakdown due to free ionics.

This paper will report ongoing research to study these multi-variant issues using a new test vehicle with sensors placed under and near bottom terminations such as QFN and LGA components. The test vehicles are designed to track impedance where it matters most. The goal of this research is to develop an improved method for studying multi-variables that may impact circuit/component reliability. This is not a single event/variable equation but a very complex multi - variable problem with varying degrees of interaction. Some of the main variables are processing equipment temperature controls/profiles; construction of the flux system and its chemical formulation; volume of flux residue remaining; and the type of component and its design as well as the plating finishes used on pads as well as the type of solder alloys used. This list was not all inclusive but gives an insight to the multi-variable problem statement. Data findings, inferences from the data findings, and recommendations will be documented and presented.

Introduction to the Problem

Field failures on highly critical systems are not acceptable for some industries such as military where there is a son, daughter, father, and/or mother depending on that electronic system to protect them from harm's way. Automotive and aerospace applications have the ability for loss of life and in multiples depending on when and where it happens. Medical reliability is critical at the personal level as well as to the person counting on everything to optimally work and not produce false readings or complete failure which can drive wrong conclusions or death in the worst case. All of these have personal accountability but also business liability concerns. Product designs that are faulty or do not meet consumer expectation will ultimately go out of business, but equally important is the failure mode or warranty failure of products not meeting design life expectations or warranty expectations. This business risk via liability is essential to company's long term success or failure.

System designers first test performance factors in an effort to screen in reliability and then once those factors are understood, design in

reliability. To properly screen in reliability, definition of end product life expectancy is critical. What is the finished product designed to do? What are key performance objectives such as size, speed, cost, mass, style and efficiency? Having a good feel or understanding for the product warranty objective up front from a reliability standpoint, helps to properly meet the definition stage for screening and designing in reliability.

A critically important factor during the reliability screening stage is to properly consider and design the product for the environment in which the device will be exposed and used. This is usually overlooked or performed too late in the design cycle. If the environment subjects the device to moisture/humidity above 60% RH, ions can be mobilized. Ion mobilization is one of the critical attributes to a number of failure modes associated with creep and pitting corrosion and electrochemical migration and a breakdown in surface insulation due to free ionic mobility. The issue today is that few system designers worry about environmental conditions such as humidity but concentrate on larger environmental conditions of temperature and CTE movement extremes which are

important but the most basic concept for ion mobilization and metal dissolution is overlooked. Humidity is an ever changing constant in all environments and water is the greatest solvent of all solutions which aids in dissolution of metal ions and ion mobility. This area of concern is what this paper is designed to address, cleanliness and its multifaceted/multivariable interaction and how design engineers need the data and test specification to determine how to design in safety measures to insure defect free products that meet their warranty and long term reliability objectives when cleanliness and contamination under components interferes with the circuit/component performance.

Designing in reliability for cleanliness starts by defining the assembly process conditions and material sets used and their interaction. Characterizing risks due to material choices and their interaction with processing parameters provides the OEM/design engineer with data for defining component types, solder material selection, processing/building requirements, cleaning conditions and protective sealants. Designing the product layout is not trivial and processing rules

and requirements help to accurately build a risk assessment. At this point, having test data that defines the optimal material choice and processing steps along with cleaning specification that defines handling, cleaning and coating levels required for a product that works as promised and meets its long term objectives. By minimizing and understanding the risks of the multivariable issues associated with cleanliness where it counts the most in the electronic circuitry and under its individual components that make up and operate at the electronic system is essential to meeting long term reliability and warranty expectations. Any mistake in this realm could jeopardize the long term reliability of the product and thus jeopardize human life as well as the OEM's financial viability.

The last part of the equation after the process specification is in place and material choice is chosen is to minimize cleanliness risk by process monitoring and traceability. The ability to monitor and verify processes and traceability needs to be captured to insure lot to lot repeatability. This allows the OEM to monitor and perform design verification and product reviews as well as periodic audits to insure that everything

is still in control and no variable has deviated from the norm or process control parameters. This process of monitoring insures electronic designs meet its reliability expectation by understanding quantitative failure rates, evidence of product and test capabilities, sound procedures for process control and a defined material control policy to insure product and corrective action plans for identified weaknesses on a lot by lot basis. Taking this level of discipline enables sound procedures for building products that will meet and exceed expectations. Again the goal of this research is in defining test methodologies and techniques that gives system design engineers the data necessary to choose the right solder alloy and solder paste system as well as a way of measuring process controls to insure and address the cleanliness objectives of the



final electronic assembly. **Why Do Electronics Fail?**

Failure mechanisms/modes can be classified into four categories:³

1. Chemical/Contaminant
 - a. Moisture Penetration
 - b. Electro-Chemical Migration
 - c. Pitting/Crevise Corrosion
 - d. Free ionics not bound or cross linked
2. Electrical
 - a. Electro-Migration
 - b. Conductive Filament Formation
 - c. Thermal Degradation
3. Mechanical
 - a. Fatigue
 - b. Creep
 - c. Wear
4. Over Stressed Issues
 - a. Supplier compliance to material specs
 - b. Field loading
 - c. Product durability

The nature of the research within this paper focuses on Chemical Contaminants. When ions are mobilized, the corrosion process is initiated through oxidation and reduction of metal ions. When the device is biased, mobilized metal ions migrate from the cathode to the anode. The metallic ions plate out until a dead short occurs. The corrosion rate tends to be dominated by the mobility of the ions which depends on temperature, ionic

concentration, and the material that the ions are dissolved in, among other factors. In most cases water will be the mobilizing fluid although in certain circumstances boards may be exposed to other fluids, such as organics.

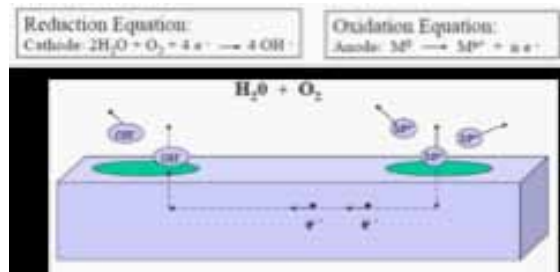


Figure 1 Mobilizing Ions Initiates Oxidation/Reduction⁴

There are two categories of ions: cations and anions. Cations are atoms or molecules that have a positive charge due to the atom or molecule "donating" one or more electrons to another chemical species. The most common cations encountered in electronics are metal cations. Anions are atoms or molecules which have an abundance of electrons. In electronics the most common anions are halogens as well as weak organic acids.

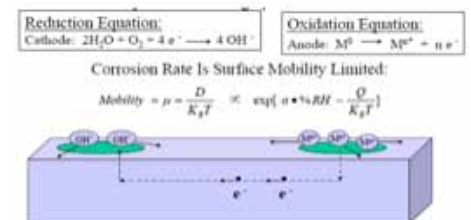


Figure 2 Corrosion rate versus surface mobility³



Ionic residues are mobilized based on the strength of the ion-dipole forces of attraction with water. The intermolecular bond with water creates an electrolytic solution, which can be acidic or basic but can be neutral as well. The ions present in the monolayers of water form an electrolytic solution.

When the electrolyte solution comes in contact with solder alloy, component metallization and plated PCB pads, metal oxides can dissolve into the electrolyte. Some ions are more active, meaning they are more reactive and likely to dissolve metals than others. The activity of an ion depends on the environmental conditions as well as the electrochemistry of the materials that it is exposed to. These positively charged metal cations are attracted to the negative pole when the part is biased.

The metals mobilized within the electrolyte can plate out in the form of dendrites. The leakage current from these dendrites reduces resistivity. Over time the dendrite can migrate until the metal migration creates a dead short causing the device to fail or cause intermittent operation. Thus, voltage leakage from one circuit to another becomes the



Figure 3 Ions Dissolve in Water

failure mechanism. In a power circuit, current leakage is the mechanism that triggers failure.

Some ions are more active than others. For example, the Cl⁻ ion forms coordination complexes with metals and metal ions. These coordination complexes tend to be positively charged. When biased, the positively charged metal complex is attracted to the negative pole. Over time the metal ion plates from the anode back to the cathode (Figure 4). These metal fragments form leakage currents which reduce resistivity. Over time the metal fragments will short the component, which leads to performance failures.

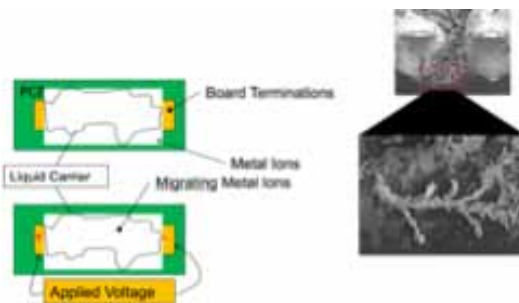


Figure 4 Metal Migration forming Dendrites

ANSI/ASRAE water standards finds that 3 monolayers of adsorbed water will mobilize an ion.⁶ They also report environmental conditions require roughly 50-60% RH

(relative humidity) to obtain 3 monolayers of moisture (Figure 5). As circuits continue to miniaturize, the distance between conductors narrows. This has relevance in that shorter distances results in lower levels of ions needed to be mobilized in ≥ 3 monolayers of water to create a reliability issue. As such, residues residing under Bottom Terminated Components (QFN and LGA style components) increase reliability risks.

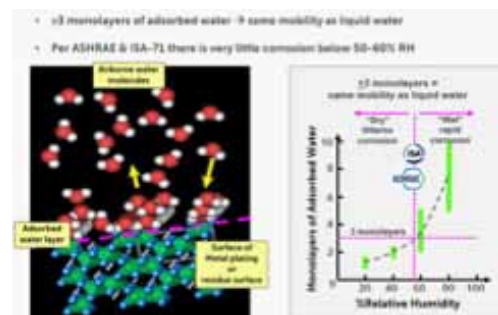


Figure 5 ANSI/ASHRAE Monolayers as a function of RH⁵

The driving forces for mobile ion diffusion depends on several factors:⁶

- Diffusing species
- Medium through which the mobile ions diffuse
- The concentration of the contaminant



- Temperature
- Bias

Momentum exchange between current-carrying electrons and metal ions drift in the direction of the electron current. In the presence of flux, a stress gradient is induced that is proportional to the current density. Pitch reduction between conductors creates increased electric field strength causing leakage currents that can impact product performance. The acceleration factors can lead to a shorter mean time to failure.

Tighter spacing, active flux residues, higher voltage and end use environment create higher risk of electrical leakage. As OEMs work to develop a risk profile, better information and knowledge of residues residing under Bottom Terminated Components is needed. The purpose of this research is to develop research methods for quantifying the activity of residues under the bottom termination and to improve the ability to make risk assessments.



Figure 6 Product Failure Factors

Defining Cleanliness Specifications

Cleanliness specifications are needed to assure that a high reliability product can meet the engineering drawing; be produced with the candidate material set and assembled using defined manufacturing parameters. The objective is to meet the contractual requirements and customer expectations for quality and reliability. Customers want assurances that they can meet their warranty and long term reliability goals. From a cleanliness perspective, key questions should be considered:

- How clean is clean?
- Is the assembly clean enough to meet long term reliability?
- Who warrants the product over time?
- What is the definition of clean electronics?
- What is the level of cleanliness needed?

The research in this document presents new test methods designed to quantify the level of contamination that may be problematic at specific line spacing. The test method evaluates the drop in resistance levels from residue under a bottom terminated component.

EXPERIMENT Round 2 Results as well as Initial Results

Bottom Terminated Component (QFN/LGA Style)

Real Time Surface Insulation Resistance (RT SIR) test vehicles were used to evaluate the cleanliness levels of a quad flat bottom termination (QFN) component. These component packages are increasing in popularity due to their versatility in size, pin count, and power dissipation capabilities. BTCs present a challenge to cleaning practices in that the pin pitch (or spacing) decreases, while the proportional volume of solder pastes increases. The challenge comes in the form of effectively removing solder flux residues trapped under the part. Due to the component style (QFN), the Z-axis standoff height inhibits proper flux outgassing, which in turn traps unactivated flux residue. Though they are undetectable



to the naked eye, these residues have measurable electrical properties that can be characterized using the RT SIR Test vehicle.

The electrical properties of paramount concern are the resistive and capacitive effects of any residue trapped between the part and the board. The presence of mildly conductive residues tends to drop the resistance between adjacent pins, permitting current/voltage leakage during operation. The presence of mildly capacitive residues tends to provide a potential source of charge storage that undermines the integrity of high frequency circuits. Any foreign substance will have some potentially measurable electrical property that deviates from that of air and/or PCB dielectric substrate material. This deviation is what the real time SIR test vehicle seeks to isolate and illuminate.

The test vehicle utilizes a QFN package with a large ground lead in the center. The part is 7mm square with 0.5 mm pin pitch. The ground lead serves as an electrical reference, and commonly as a thermal path for the part. A relatively large volume of solder paste is used to connect the ground lead/lug to the PCB. As a consequence, the flux within the solder paste

must activate, vaporize, and evacuate/outgas in order to render the volume devoid of flux residues and activators/inhibitors. Given the quantity of flux, short reflow duration and relatively long route to evacuation, it is not uncommon for flux residues to be trapped between the ground lead and perimeter leads. The impact of conductive or capacitive material in this area can adversely affect any of the pins on the perimeter of the component.

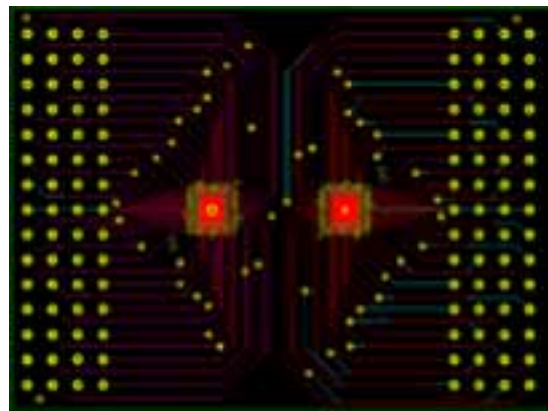


Figure 7 RT SIR Test Vehicle

The test vehicle employs an exposed sensor trace that circumscribes the area between the ground lead and perimeter leads. This trace is 20-mil wide on two (2) sides and 10-mil wide on the adjacent sides, leaving a 10- and 15-mil space to adjacent conductors, respectively. The spaces are exposed to any materials in the area, allowing remote electrical access to the volume. With

equal spacing between the traces, ground lead and perimeter leads, these traces provide information regarding conductivity and capacitance between any combinations of leads.

Perimeter leads are connected in an alternating pattern, permitting an understanding of residue characteristics between conductors on the perimeter of the component. The test vehicle includes two configurations of plated through holes beneath the ground lead/lug. One configuration (U1) has an open plated through hole, while the adjacent configuration (U2) is plated shut. As it turns out in this case post analysis showed the open plated hole to fill with solder and minimize the outgassing affect and thus the results were not discernible in our initial test results. Because both configurations are contained on the same test vehicle, they undergo nearly identical manufacturing processes and materials, and thus minimize processing variability.

DOE Factors: The factors considered in this phase of testing included

1. The influences of humidity on resistance measurements
2. The performance of varying no-clean flux types (Halogen-Free vs. Standard Halide) as test vehicles are exposed to similar test protocols
3. The propensity of test vehicles to return to baseline conditions after exposure to environmental accelerants (hysteresis)
4. Document the effectiveness of outgas-encouraging design features as it relates to flux residue

The testing was conducted using two (2) circuit boards described previously, differing only in flux type. These boards were built using pick-and-place and screen printer machines capable of precisely locating solder paste and components without unintended solder connections. The boards were then run through a reflow oven using thermal profiles recommended by the solder paste manufacturer.

The boards were subjected to a series of extended environmental stresses, in order to induce any flux residue-related electrochemical changes.

The environment used to accelerate these changes was 40°C and 95% relative humidity (non-condensing) for 168 hours (1 week). A 5VDC voltage bias was applied between the ground terminal and perimeter leads, in order to provide a consistent and prolonged electromotive force to the residue. The intent was to coax the alignment of ionic compounds using a persistent electric field. High impedance measurements were taken prior to, during, and after the environmental exposure, at regular time

intervals, in order to identify any degradation. After the 168 hour exposure, the boards were return to ambient conditions (25°C and 40% RH) to dry out. Measurements were again taken at regular intervals to capture any subsequent recovery of electrical properties. After stabilization, the boards were returned to the environmental chamber for a final round of identical stresses and regular measurements.

Data Findings: INITIAL TESTING

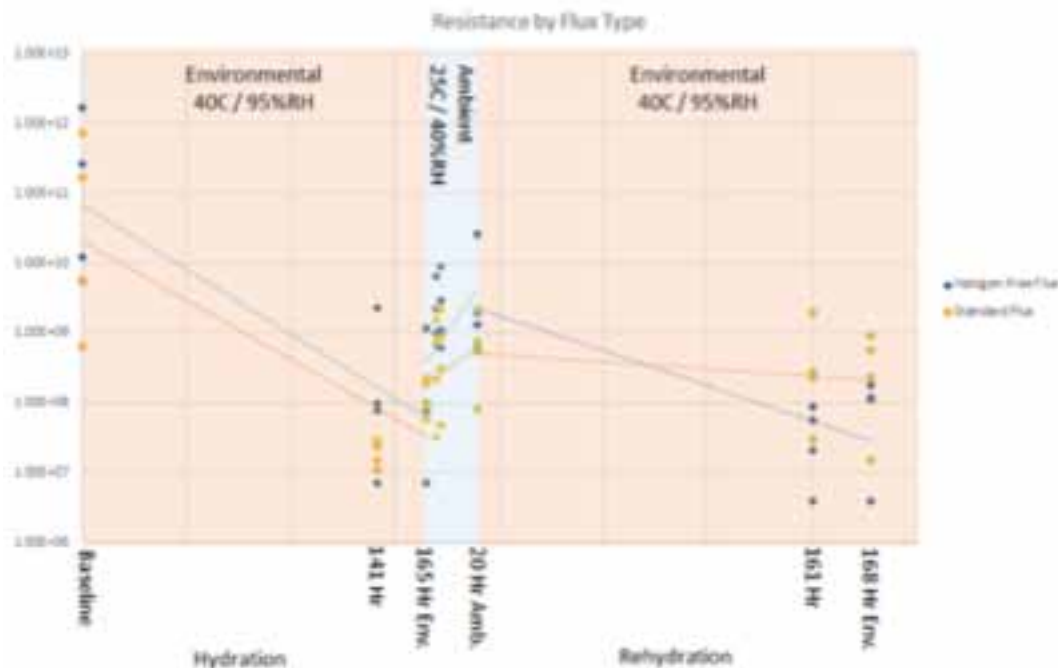


Figure 8: Resistance by Flux

Figure 8 shows the data generated during each phase of environmental testing, delineated by flux tape. The straight lines depict the best-fit trend of the data. Because the resistance is on a log-scale, the straight line indicates an exponential rate of change. The decline in resistance occurs at a dramatic rate, while recovering at similar rates while it dries out.

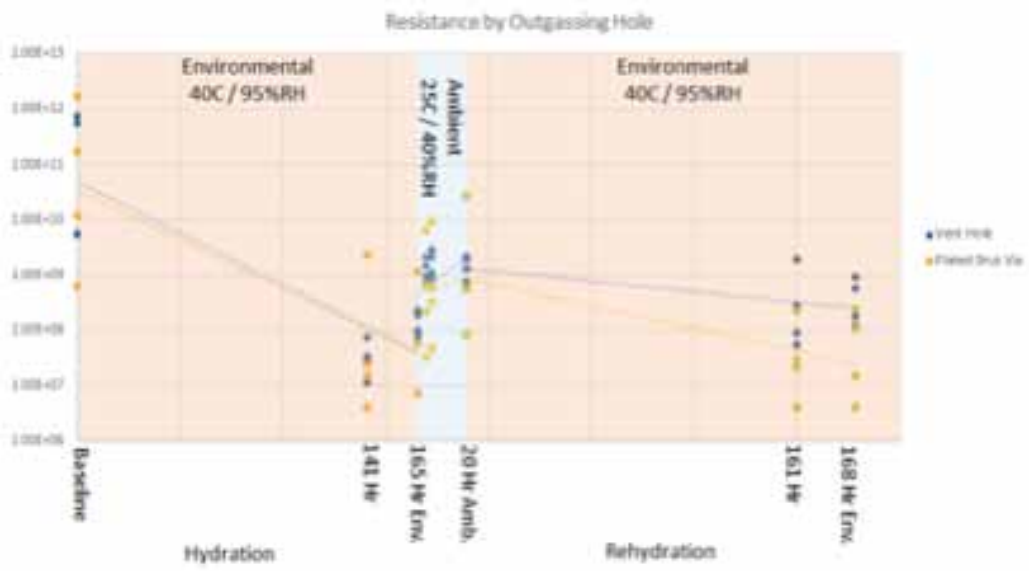


Figure 9: Resistance by Outgassing Hole

Figure 9 shows the data generated during each phase of environmental testing, delineated by vent hole. The vent hole, in theory, would have provided a means for volatile flux gasses to escape during reflow, resulting in presumably less volatile flux residues. The absence of this vent hole would have the effect of impeding proper outgassing, thus resulting in more volatile flux residues. Post analysis showed via holes filled with solder and thus eliminated the outgassing effect thus minimizing the expected effect of reducing the inhibitors/activators inside the flux residue.

Second Test: Halogen Free vs. STD Halide

(More in depth review of flux system type)

Halogen Free HF Study

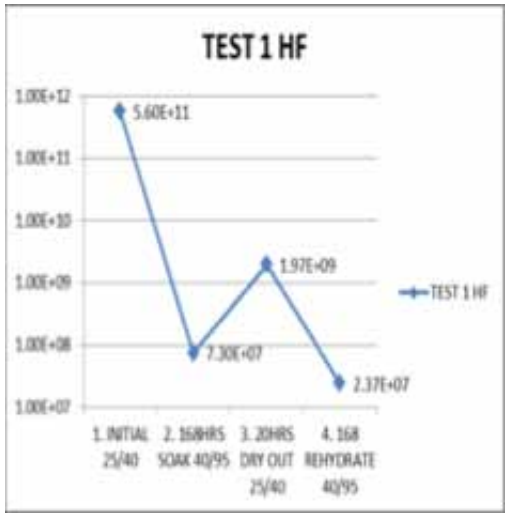


Figure 10: Test 1 Halogen Free Flux Test 1 Sensor 1

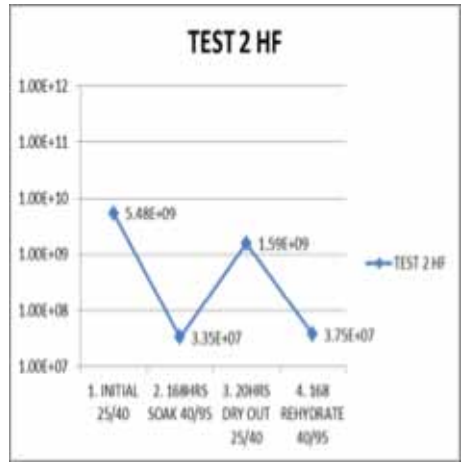


Figure 11: Test 2 Halogen Free Flux Test 2 Sensor 2

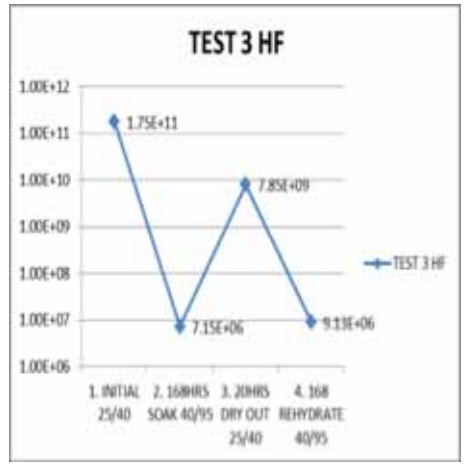


Figure 12: Test 3 Halogen Free Flux Test 3 Sensor 1

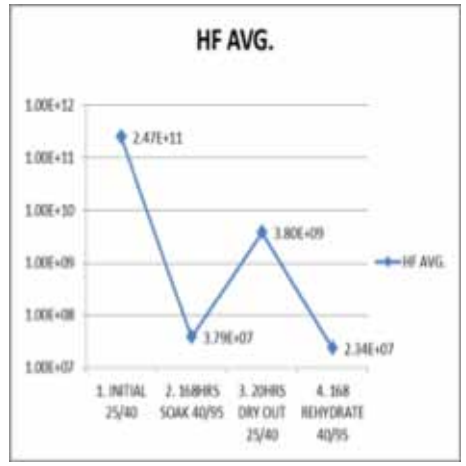


Figure 13: HF AVG. Halogen Free Flux average of Test 1 thru 3

HF OVERLAY

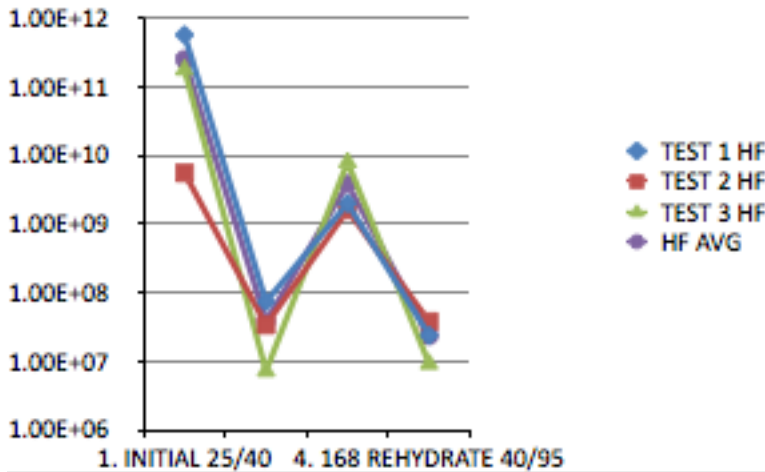
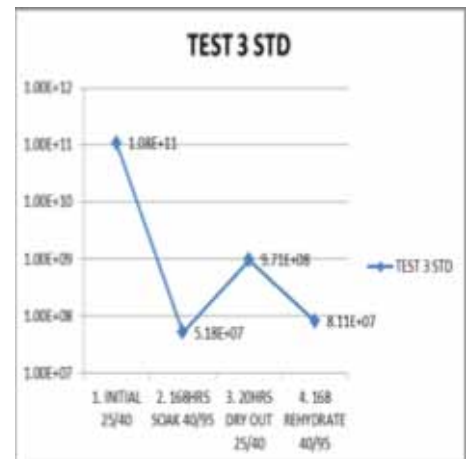
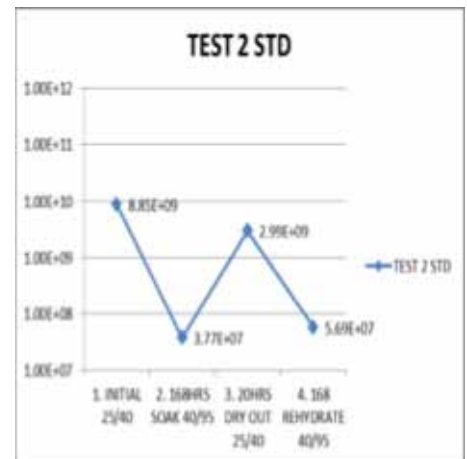
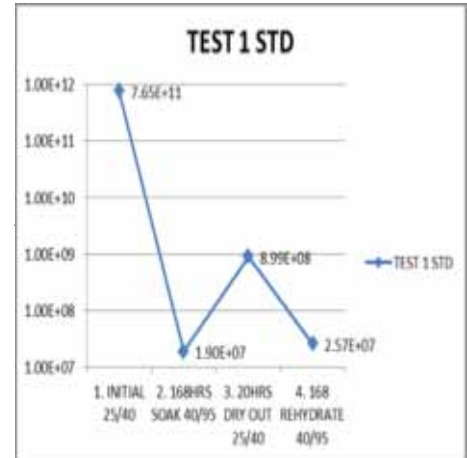


Figure 14: HALOGEN FREE HF FLUX HF Overlay comparison of Test 1 thru 3 with STD AVG.

Figure 10 thru Figure 14 shows the test data for Halogen Free flux system used in this real time SIR test. Key points are the initial resistance before environmental testing is $>1.00E+11$ for sensor 1 and $>1.00E+9$ for sensor 2 which has a lower gap distance between adjacent pads on the QFN component where sensor 1 was between the ground lug and an inner sensor trace. After the first 168 hour environmental test of 40 degrees C and 90 plus humidity, one can see a drop in resistance from a safe $1.00E+11/+9$ to resistance readings in the $1.00E+7/+6$. This drop in resistance in surface insulation is below industry thresholds of $1.00E+8$ for safe operating surface insulation resistance (SIR)

parameters. The next cycle shows a drying out period to see what happens when the humidity drops to below 50% and the test specimen dries out at the surface and below the components themselves. The surface insulation resistance increases back from a non- acceptable state back above $1.00E+8$ industry threshold. Again if the test vehicle is rehydrated in a humid 40 degrees c/90% plus humidity then the surface insulation resistance will drop from acceptable back to non-acceptable SIR ranges in the $1.00E+7/+6$ ohms. This confirms the need for a temperature and high humidity test that allows for ion mobility i.e. 40 degrees C and 90% plus Relative Humidity environmental test protocol.



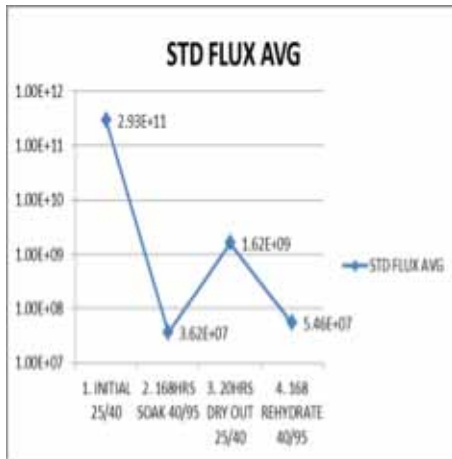


Figure 18: STD FLUX AVG. STD Halogen Flux Average Test 1 thru 3

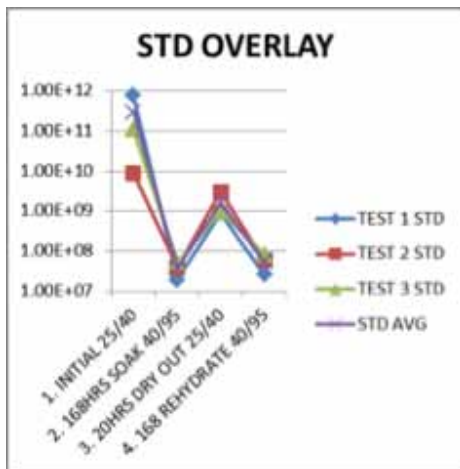


Figure 19: STD HALOGEN FLUX STD Halogen Flux overlay comparison of Test 1 thru 3 with STD average

Figure 15 thru Figure 19 shows the test data for a STD Halide based flux system used in this real time SIR test. Key points are the initial resistance before environmental testing is $>1.00E+11$ for sensor 1 and $>1.00E+9$ for sensor 2 which has a lower gap distance between adjacent pads on the QFN component where sensor 1 was between the ground lug and an inner

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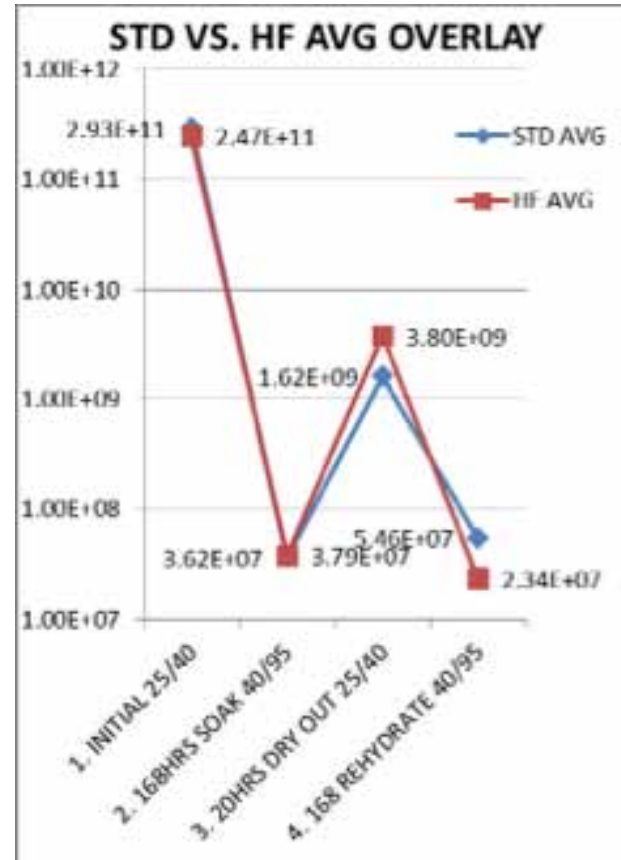


Figure 20: STD HALIDE FLUX vs. HALOGEN FREE FLUX AVERAGE OVERLAY COMPARISON

Figure 20 STD Halide Flux vs. Halogen Free Flux is an overlay of the average of each flux type system for a visual comparison. The averages allow us to normalize the data and draw trend analysis within the data and population. Note that we do not see a large discrepancy between these flux families when averaging the HF - Halogen Free Flux System vs. STD - Standard Halide Flux System. This comparison was using the same solder family from the same solder paste vendor with the difference being HF- Halogen Free vs.

STD. -Halide based. This data further shows that there is very little difference in SIR test results between environmental exposures initially and after a second rehydration exposure. Finally, 20 hours of drying out at 25 degrees C and 40% RH shows that it does not take very much time for ions to become non mobile and SIR test results recover back to safe SIR industry limits. This type of swing above and below the SIR Limit can explain why intermittent failure modes can be very difficult to find and verify.

Inferences from Data Findings:

Though the sample size is limited, certain trends can be identified in the data. These trends relate to humidity, flux type, and outgassing design features for bottom termination parts and their corresponding relationships to resistance.

The most prevalent observation has been the need for humidity in order to coax electrochemical phenomenon to manifest in a measurable way. In fact, the absence of moisture in samples can mask the presence of flux residue by rendering it immobile, allowing potentially innocuous compounds to lay dormant until sufficiently hydrated. It

is also important to note that pure water has a practical upper limit to its electrical resistance when it meets air. This limit is on the order of 106 (Mega) Ohms. Therefore, measurements above these values are attributed to causes other than water (i.e. flux residues).

Another observation that bears mentioning is the Test Vehicles/ Samples propensity to dry out and normalize at customarily acceptable SIR levels. After returning to a dry environment, the boards tend to dry out over the course of 20 hours, allowing SIR levels to generally return to above 108 (100 Mega) Ohms. This tendency to recover underscores the need for humidity for accurate measurements. Subsequent environmental exposure, however, induces a rapid return to less-than-acceptable SIR levels.

An interesting observation has also been made in the area of flux type, in that the Halogen-Free flux appears to be no better than Halide based flux systems in preventing a humidity-induced decrease in resistance; at least for the first and second round of environmental exposure. Subsequent exposure exhibited similar declines in resistance between halogen-free and standard halide

flux types. This further infers that halide free substitutes in halogen free fluxes such as an organic amine structures if not properly activated/boiled off tend to have the same negative attribute of inducing voltage leakage via metal dissolution of the solder alloys and or pad plating that are present in and near the flux residue. Again the key attribute is the source of a mobilizing fluid such as water from humidity that helps promote the metal ion dissolution.

The data shows that both flux types if not properly outgassed due to component type and low z axis height attributes causes the residue to be active and mobile when presented an environment whereby the humidity is above 50 to 60% which seems to be floor for hydrating the active residue flux remaining on the underside of the BTC style components.

Further research is ongoing with halogen free and halide based flux systems to better define test methodologies that better quantify and identify their key attributes that affect long term reliability. Real time SIR testing along the manufacturing process and material introductions allows for the identification of material and processes that negatively impact SIR thresholds. The

key is SIR data that defines which material set and/or manufacturing processes that induce negative SIR data results which helps define and quantify the negative SIR results below the industry acceptable standard of 1.00 to the 8th ohms.

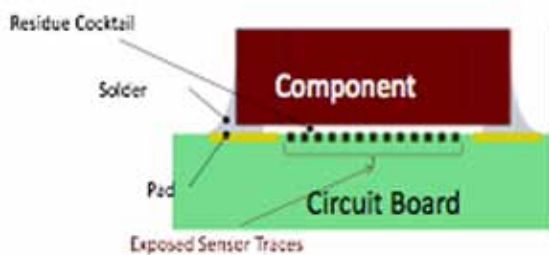


Figure 22: Real Time SIR Sensor

Conclusions

Highly dense and low profile interconnects and environmental factors speed the mean time to failure. To build in quality, definition of the finished product performance expectations is the starting point. What are the performance objectives in relation to size, speed, cost, mass, style and efficiency? By first screening in reliability the product can be designed for the end use environment. It is critical to plan for the environment in which the device will be used.

When ions are mobilized, the corrosion process is initiated through oxidation and reduction of metal ions.

Ionic residues are mobilized based on the strength of the ion-dipole forces of attraction with water. The intermolecular bond with water creates an electrolytic solution, which can be acidic or basic but can be neutral as well. When the electrolyte solution comes in contact with solder alloy, component metallization and pad plating, metal oxides can dissolve into the electrolyte. The metals mobilized within the electrolyte can plate out in the form of dendrites. The leakage current from these dendrites reduces resistivity.

Real Time Surface Insulation Resistance (RT SIR) test vehicles can be used to evaluate the cleanliness levels under bottom termination components. Humidity is needed in order to coax electrochemical phenomenon to manifest in a measurable way. The absence of moisture in samples can mask the presence of flux residue by rendering it immobile, allowing potentially innocuous compounds to lay dormant until sufficiently hydrated. Outgassing flux residues under bottom terminations provides a channel to reduce active residues under the bottom termination. The challenge is in the creation of outgassing pathways via thru hole- vias and increasing the z-axis height of the component off the

printed circuit board surface. One such method being used today is solder mask removal under low profile parts to help with the z-axis height limitations.

The paper and its research is outlining the need for a more detailed industry test protocol which addresses the different electronic assemblies failure modes that are entering and effecting Highly Critical Electronic assemblies and their corresponding industries that need design guidance in how to make long term reliable electronic hardware that can meet warranty expectations of 10 to 25 years. This is a tall order but the need for identification and assessment of material choices along with the manufacturing guidelines/processes which together can be used to insure warranty objectives in excess of 10 year life. STI and Kyzen believes the future to miniaturization revolves around having test protocols capable of testing for cleanliness levels under critical components and critical circuitry such as high frequency RF and low voltage control circuitry. Real Time SIR measurements under key component types and high density layouts allows for the verification of material choices and their interrelationships with manufacturing processes to insure the material choice

along with processes does not create a flux concoction/mixture residue that is not benign and is thus detrimental to long term reliability.

Future Tests Protocols

STI is designing a test vehicle with 8 to 10 different component types/family of parts that can have real time SIR Sensors under them which will allow for future tests to evaluate material choices and manufacturing processes to insure cleanliness under components to insure electronic manufacturers can verify their processes as well as flux and material choices. The QFN/LGA style component was chosen first due to its complexity and difficulty for cleaning and thus it is an ideal candidate for showing the problems with long term reliability and how real time SIR measurements can help design/system engineers understand the importance of designing circuit boards that address cleanliness from the beginning of the design process. This approach also allows the design engineer a test protocol that can help them gather data on their material choices for solder alloys and its corresponding flux system as well as an outline for defining manufacturing processes and their control process guidelines to insure

a clean electronic assembly that meets its long term warranty expectation. There are a number of material choices and manufacturing processes that influence board cleanliness levels and having a new test standard and protocol is a necessary tool for future designers designing miniaturized high density electronic assemblies.

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