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How Does the Electronics Industry Define "Cleanliness"? opinion by Mark McMeen and Mike Bixenman

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The industry does not define "Cleanliness" in absolute terms or by defining a pass or fail criteria or even how to quantitatively measure it. The industry specification as defined by J-STD-001 Rev. H Section 8 Cleanliness defines "Cleanliness" as an open ended definition that must be determined and defined by each individual manufacturer and end user. The definition requires each manufacturer and end user to develop its own "Objective Evidence" which again opens the definition up to each manufacturer and end user to define its own interpretation and definition. The goal of the specification was to put ownership of objective evidence on the manufacturer to provide data that was measurable and conclusive that the products they were building were clean enough to meet their customer fielded use state. It also said that ROSE testing and IC testing without other supporting data was not sufficient to satisfy the section 8 requirement for objective evidence.

Here at STI and MGX we believe in defining "Cleanliness" with data that allows one to understand the electro chemical signature of the final residue on and underneath your components after the final processes are completed. What is the state of cleanliness once all manufacturing processes are complete and the electronic product is considered completed in its final state after manufacturing? Data is required to determine cleanliness because without it how would one know if the product is reliable and repeatable from lot to lot and that the process is stable and repeatable. SIR (Surface Insulation Resistance) testing is one of the tools in the tool belt that is used to get an electro – chemical signature or data set that allows one to get a hard data number or data point that can be correlated to actual

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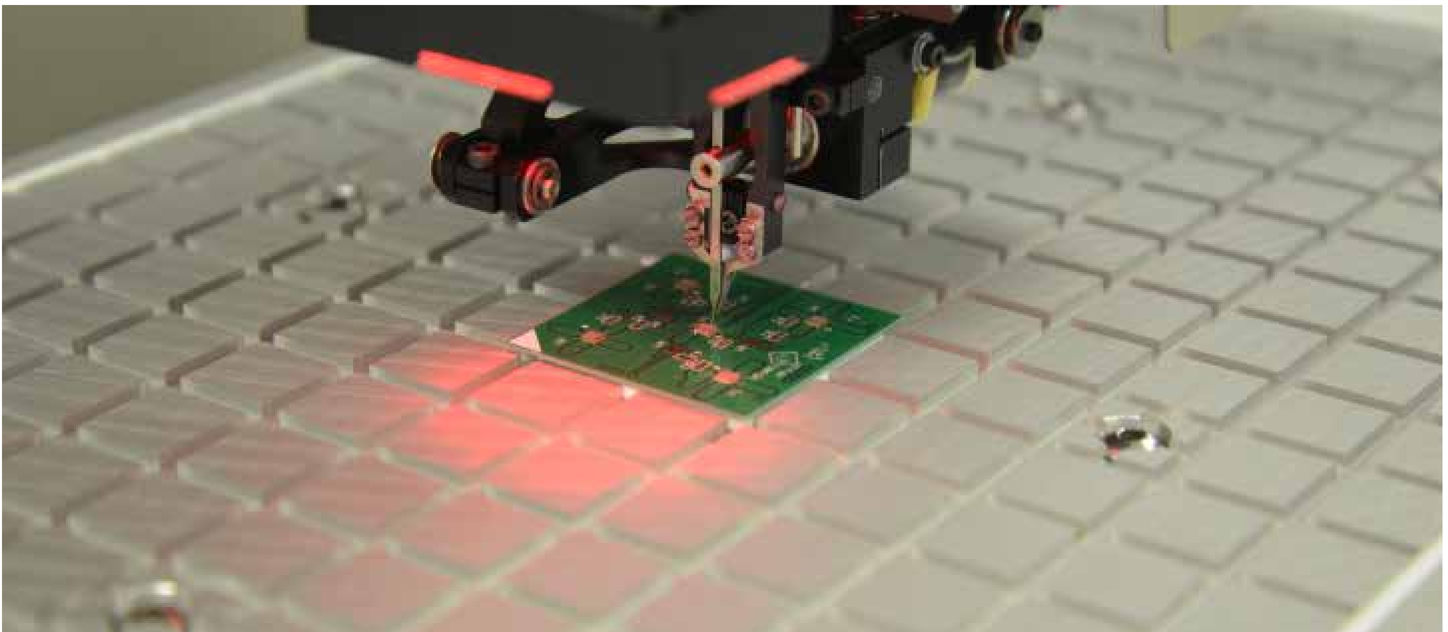
hardware. A second tool in the tool set is IC (Ion Chromatography) to help define or quantitatively discern the ionic species present and its corresponding concentration level. The ability to measure both the SIR data to the corresponding IC data allows one to correlate the ionic species causing the SIR value and thus correlate back to the actual hardware. IC measures the anion, cation and weak organic acids in a quantitative measuring tool so one can now correlate SIR values in log ohm scale back to ionic species found on and underneath components. This data correlation goes a long way to using data as a way to quantify and qualify "Cleanliness" which can then be used on a regular basis to insure repeatability and reliability. The ability to use data as a qualification tool and then use the same data as a process control tool is the essence of 'Objective Evidence". The same can be said for defining Cleanliness – it is the ability to use real data that is measurable to define cleanliness as it relates to your finished electronic product.

The J-STD-001 Rev. H Section 8 allows each company the ability to define its definition of Cleanliness by using data as objective evidence to show it understands its end product cleanliness level. The ability to measure SIR underneath your most difficult and critical components such as BTC – Bottom Terminated Components – and then quantify the ionic species and concentration levels goes a long way to defining cleanliness because one now has a baseline measurement in SIR – LOG OHM as well as the correlating ionic species to know if they are deviating from the original qualification levels as they produce on a lot-to-lot basis. The goal of the J-STD-001 Rev.H specification was to allow the industry and companies the ability to define cleanliness as it relates to their product uniqueness and product reliability objectives. Obviously, Medical, Military and Aerospace would have far different reliability objectives and cleanliness levels than say consumer products and industrial products that were not considered Human Critical Electronic Hardware. We know from our customers in different industries that 8 log ohms and higher is good for general purpose electronic hardware that is not Human Critical, but other clients want their SIR values to be 9 log ohms and 10 log ohms minimum when it is Human Critical or the asset or electronics must work all the time with zero defects or anomalies. This is why the specification was written so that the definition and cleanliness level could match the expected end use environment and its corresponding reliability objective.

Cleanliness is an end condition or state of a number of manufacturing processes, material choices / influences, and environmental impacts on the final electronic hardware. It is not defined by industrial specifications in hard terms or limits, Government mandates or levels, or by trade associations and consortiums. This open-ended



self-definition to define “Cleanliness” through the use of objective evidence requires one to take charge and perform a self-assessment and define “Cleanliness” as it relates to your own manufacturing processes and techniques / parameters and material choices and expected environmental conditions.

This is why STI / MGX believes in data driven product qualifications, material evaluations and characterizations and process control measures such as ion process deviation monitoring using SIR testing as the gold standard for gathering real measurable and actionable data. The use of data driven test methodologies allows one to use the data to make decisions and action plans on defining “Cleanliness” that is the foundation of your objective evidence.

How to define Acceptable “Pass” Cleanliness – All electronics has some levels of ionic contamination and organic residues present on them after assembly and manufacturing. One must use a number of historical test parameters to determine “Acceptable” Cleanliness such as historical warranty data, field performance data, environmental stress testing of actual hardware, SIR data on a correlated test vehicle using your most challenging components and circuit layout areas, and IC data to define and quantitatively discern what Ionics are present but cannot be seen. The above data set allows one to define Cleanliness and its corresponding level and then define “ACCEPTABLE CLEANLINESS” quantitatively and allow one to use the data as its own “Objective Evidence” to show its customers that it understands its Cleanliness level. Thus, it now meets the intent and definition of the J-STD-001 Rev.H Section 8 by allowing the manufacturer to define and measure its cleanliness level.

How to define Unacceptable “Failed” Cleanliness- As defined above for acceptable – unacceptable is the inverse by which ionic contamination and organic residues are too high or in combination together react negatively or adversely to create intermittent parasitic leakage or a detrimental effect such as dendritic growths or formations. Both of these outcomes are unacceptable levels of cleanliness that impact overall electrical performance and can be measured and quantified by SIR testing and correlated with IC testing to discern what ionic species is causing these detrimental problems. This inverse definition of unacceptable cleanliness is a measurable attribute that can be validated at qualification testing and further controlled thru periodic process control monitoring.

In conclusion, the ability to define and use quantifiable data to determine “Acceptable” and “Cleanliness” is the key to answering the question, “Are my electronic assemblies clean enough to meet my customer end use environment and reliability objectives?” as they relate to cleanliness. The ability to have the data correlate from product qualification thru process control is the objective evidence goal as defined by J-STD-001. The use of SIR data and IC data as it relates to actual warranty data and environmental stress testing hardware allows one the ability to correlate and answer the question – Is my electronic hardware clean enough for its end use environment.

Thanks for taking the time to read and if you would like further information or have any questions please contact

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