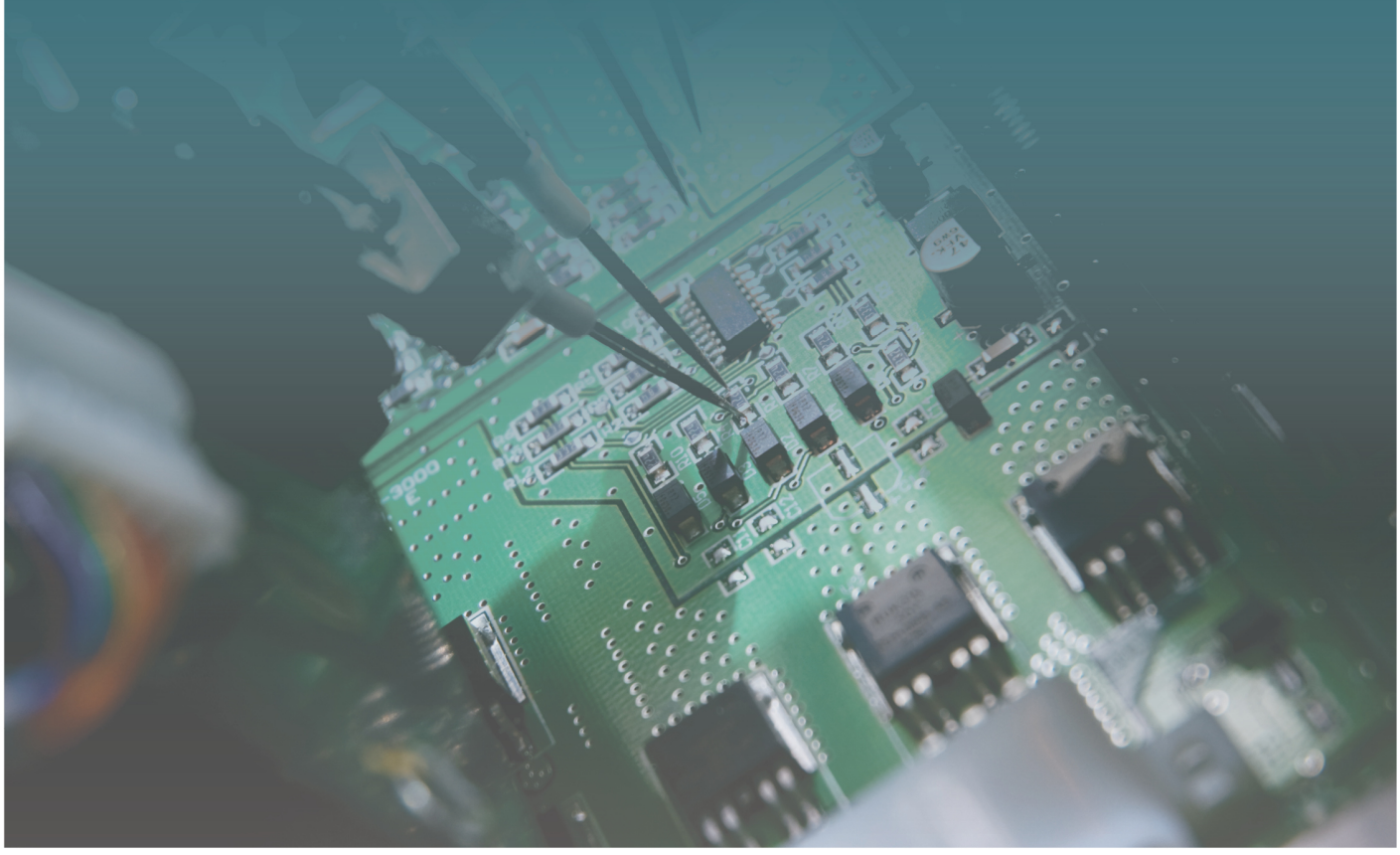
MAGNALYTIX

Leading The Reliability Revolution

Magnalytix®
OE-200 Series

Real-time reliability solutions for electronics manufacturing

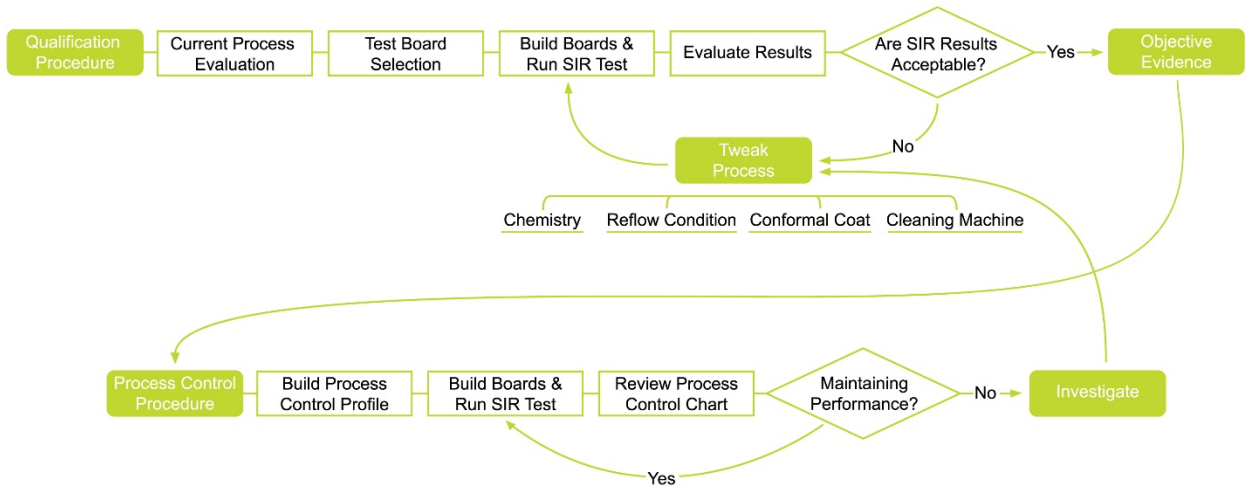
SIR WORKFLOW GUIDE



QUALIFICATION PROCEDURE 1

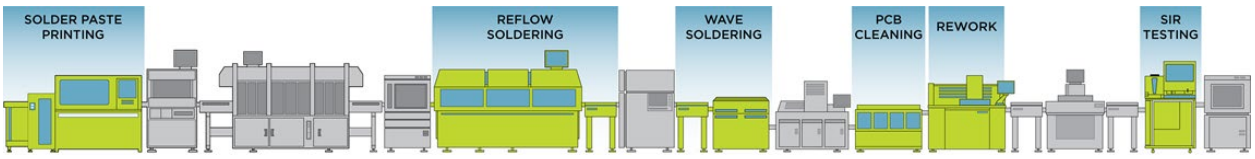
IPC J-STD-001G, Amendment 1 – Section 8 requires an OEM and EMS to qualify soldering and/or cleaning processes that result in acceptable levels of flux and other residues. A record of the testing that provides “objective evidence” to confirm that the process results in acceptable levels of flux and other residues shall be available for review.

The standard requires that the results shall be confirmed electrically when tested in hot/humid conditions. This is accomplished using Surface Insulation Resistance testing. Once qualified, the process is to be controlled using an objective sampling plan. A flow chart of the Qualification Procedure is listed below.



CURRENT PROCESS EVALUATION 1.1

All manufacturing processes result in residues on circuit assemblies in one form or another, and most of these processes see a variation in their process or materials daily. During assembly, the residue condition on the manufactured product can change from residue trapped under or next to signal pins and at the component’s bottom termination. Residues and their activity for electrochemical failures can also result from the soldering material, reflow, rework, and cleaning processes.



SIR testing is the gold standard for characterizing the material set and assembly process.

- Solder Paste Characterization
  - Supplier to Supplier activity of the flux residue
  - Reflow parameters
  - The activity of the residue at specific component sites
  - Multiple soldering processes used to build the top and bottom side
  - Selective soldering
  - Wave soldering
  - Rework
- Cleaning Materials
  - Cleanliness at specific component sites (both signal pins and beneath the component)
  - Cleaning agent comparisons to determine the best material for the process
  - SIR is effective at dialing in process conditions to achieve the desired cleanliness level
- Cleaning Machines
  - Impingement energy
  - Wash temperature
  - Wash time
  - Wash concentration
  - Rinsing
  - Bath life
  - Process Drift
- Bare Board Cleanliness
  - Conductive Anodic Filament (CAF)
  - Solder Mask
  - Plating chemicals
  - Metallization
  - Thermal via structures
- Identifying Conditions that lead to Electrochemical Failures
  - Harsh Environments
    - Atmospheric moisture
    - Temperature swings
    - Voltage bias

COMPONENTS

The industry is moving toward leadless components with near chip-scale packages. The fastest-growing package types include leadless, passives, and a proliferation of new package styles that are larger in size with a higher number of connections. The advantages of these small components are well documented; however, concerns arise from the small overall dimensions, reliability, and manufacturability. Users must carefully select and validate whether these components are suitable in their intended use environments and customer applications. Soldering and cleanliness issues have been causal factors for many failures seen in production and in the field.

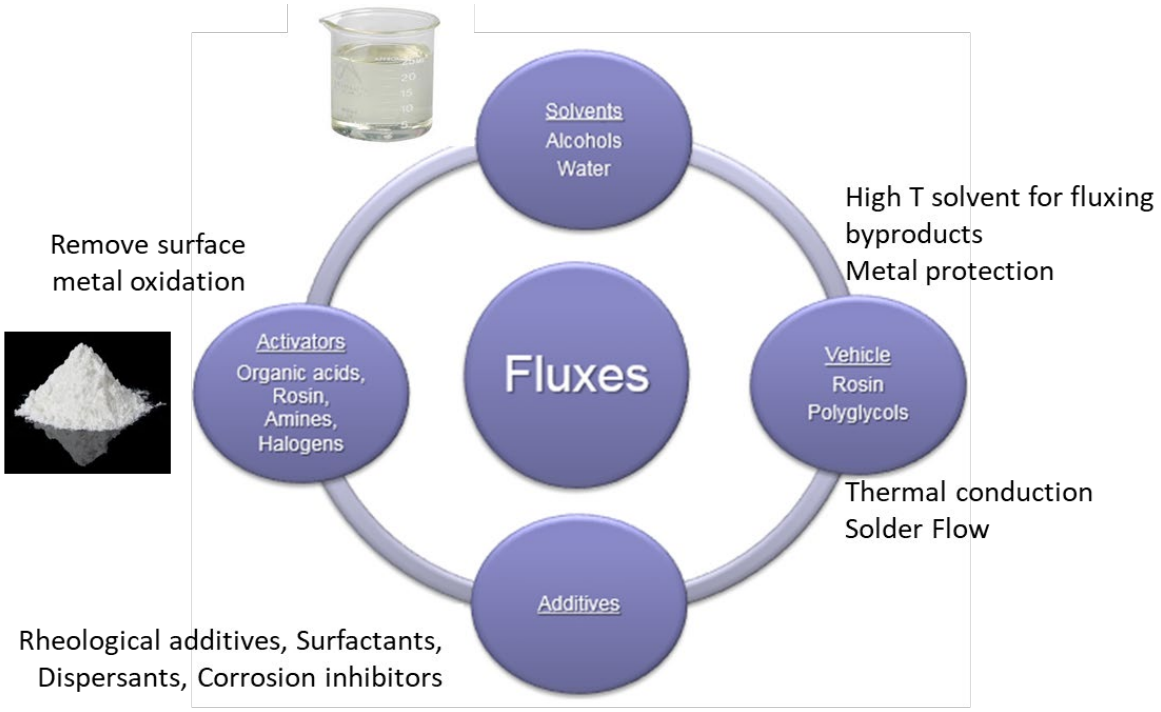
Electrochemical failures occur from the volume of residual flux residues present under leadless and bottom terminated components. During reflow, low standoff heights can prevent proper flux outgassing.

Flux activators, carrier solvents, and functional additives can be present in the remaining flux residue. SIR is the best method for determining if the residue activity will mobilize metal ions that may result in electrochemical failures.

SOLDERING MATERIALS

Flux is a chemically active component of solder paste designed to remove minor surface oxidation, reduce oxidation of metals during the course of the soldering operation, protect the cleaned metal, reduce surface tension of the molten metals, and promote an intermetallic layer between solder and metal.

Flux selection depends on the application such as the product type and soldering environment, surfaces to be soldered (PCB and components), solderability of the component, and flux application method.



Flux compositions are highly complex engineered materials. Whether soldering with a no-clean, washable no-clean or water-soluble flux, the propensity of the remaining residues to cause electrochemical failures needs to be quantified. SIR is the best test method for determining activity of these residues.

IPC TM-650 J-STD 004 is the standard used to classify the activity of the flux composition. An open comb test board is used to classify these materials. For low residue solder pastes, the residue is non-conductive and benign when reflowed in air, but the nature of the residue changes when a low-profile component is soldered. Characterizing these materials with properly placed components is critical to making the right selection.

MULTIPLE SOLDERING PROCESSES

Most PCBs have components placed on both sides of the board such as SMT with components on the top and bottom and through-hole with components placed selectively on the top and bottom. The combination of these soldering materials creates a mixture of materials that may be active. Wave and selective soldering can leave active residues when not properly heat activated.

REFLOW PROFILE

A reflow profile consists of four stages: Pre-heat, Thermal Soak, Reflow, and Cool Down. Dialing in the proper profile including the ramp rate, temperature within each zone, and time duration is critical for properly outgassing and catalyzing the remaining flux residues. The pre-heat stage is used to bring the entire assembly (printed circuit board, components, solder alloy and flux) up to temperature. The thermal soak stage starts at the end of the preheat stage and allows the temperature across the surface of the board to equilibrate at a level near the melting point of the solder. The reflow stage is the time period above liquidus where the solder changes from a solid to a liquid, and will flow in the areas where solder paste has been applied and solder mask is not present. During the reflow stage temperature control is critical.

No-clean soldering fluxes are composed of organic acids (succinic, citric acids, benzoic acid). These organic acids are designed to decompose by the molten solder temperatures during the soldering process. Flux that is shielded from the molten solder may not reach the deactivation temperature during the soldering process. Non-activated flux residues can lead to corrosion because they are ionic and acidic in nature. SIR testing using component specific test boards that are representative of production hardware is the best method to test for acceptable levels of flux and other residues. The component temperature that is reached during the reflow stage is determined by the temperature of the equipment chamber and associated dwell time, but also by the package volume and whether the component is surface mount or through hole.

CLEANING

It's important to match the cleaning agent to the cleaning machine. To clean, process conditions must be dialed in. This includes the wash concentration, time, and temperature as well as the impingement energy, rinse time and temperature, and wash bath loading. Each of these cleaning factors and conditions needs to be well known.

Residues present under component terminations are not visually detectable. During cleaning operations, residues that are not fully cleaned can also lead to electrochemical failures.

Cleaning Agents are engineered fluids designed to perform in a highly pressurized environment. Wash fluids contain functional additives and saponified agents. Residual wash fluids can leave residues that could lead to electrochemical failures. As such, rinsing the wash fluids is a critical part of the cleaning process. Poorly rinsed electronics will drop surface insulation resistance.

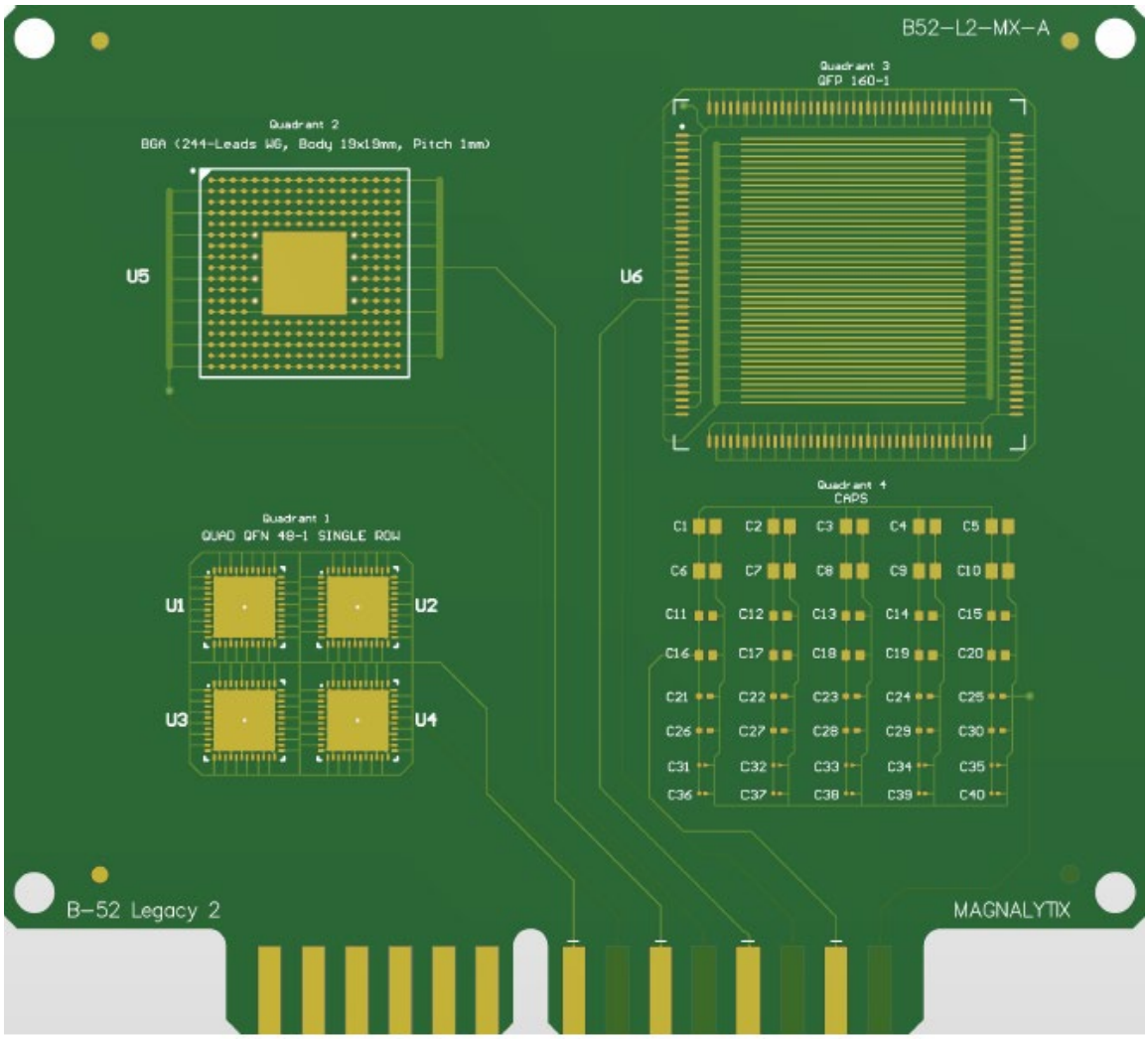
Wash compositions are designed to perform over an extended period. As soils load into the wash batch, cleaning performance will start to decline. This leads to process creep as process conditions re adjusted to compensate for the soil load + bath age.

SIR is the best method for qualifying the wash process. SIR is also the best method to monitor each of these factors to prevent process creep.

TEST BOARD SELECTION 1.2

Test vehicles need to be representative of the electronic circuits used on production hardware and should demonstrate that a manufacturing process or a process change has only positive affects on assembled product quantity. Not every component used in your circuit assembly is needed for you to understand where you stand in terms of cleanliness and reliability. The low standoff height on leadless and bottom terminated components increases the levels of flux residues left under the bottom termination. Test boards should be populated with components that have the highest risk of an electrochemical failure.

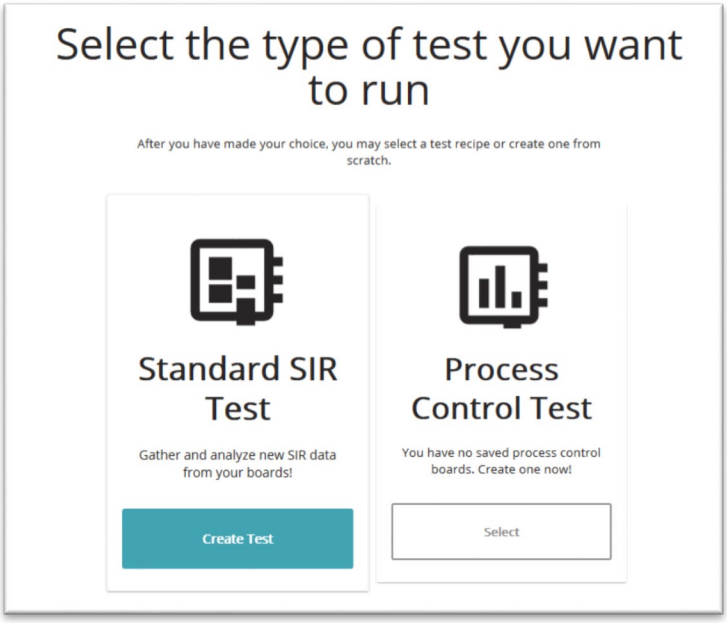
Testing with component specific test vehicles, you can understand the nature of the residue or the lack of residue as it drives into reliability within different environmental conditions.



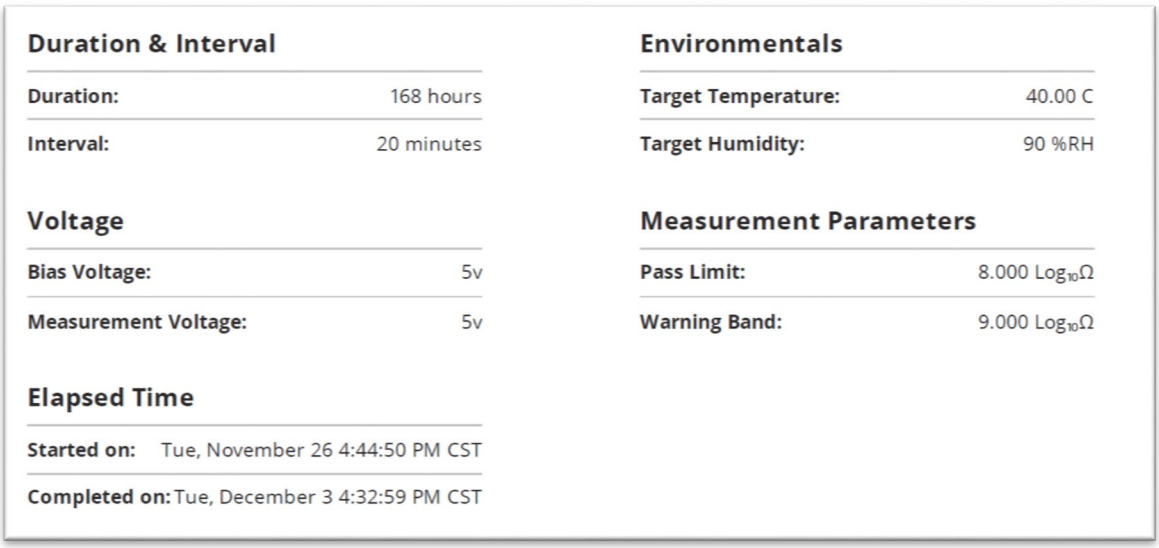
Magnalytix test boards are designed in four quadrants, varying the component and bare board features from each quadrant for comparison. These comparisons can be done on a single component or different component sets. Magnalytix offers test vehicles and dummy components that are representative of modern electronic circuits that allow you to quantify any harmful effects from solder flux, determine other process residues left on external surfaces after soldering and demonstrate that a manufacturing process or process change can and will produce acceptable electronic hardware. A library of leaded, leadless, bottom terminated and connectors is available for building custom test boards representative of your production hardware.

BUILD BOARDS AND RUN SIR 1.3

After selecting or designing your test boards, a Gerber file will be provided allowing you to populate the boards in your assembly process. If you are unable to build your tests boards, arrangements can be made to build the boards for you; however, this option may not accurately reflect your assembly process. Once the boards are built, you are ready to run an SIR test. SIR is an electrical test method that measures insulation resistance across conductors of opposite polarity. The Magnalytix OE-200 Series' software makes designing and executing an SIR test incredibly easy. The software offers an easy step by step guidance through the test creation process.



Once your test parameters have been entered, the user is provided with a summary of the test conditions. The summary allows the user to review their chosen parameters as well as gives them the ability to step back through the process to make any needed changes.



Duration & Interval

Duration:	168 hours
Interval:	20 minutes

Voltage

Bias Voltage:	5v
Measurement Voltage:	5v

Elapsed Time

Started on:	Tue, November 26 4:44:50 PM CST
Completed on:	Tue, December 3 4:32:59 PM CST

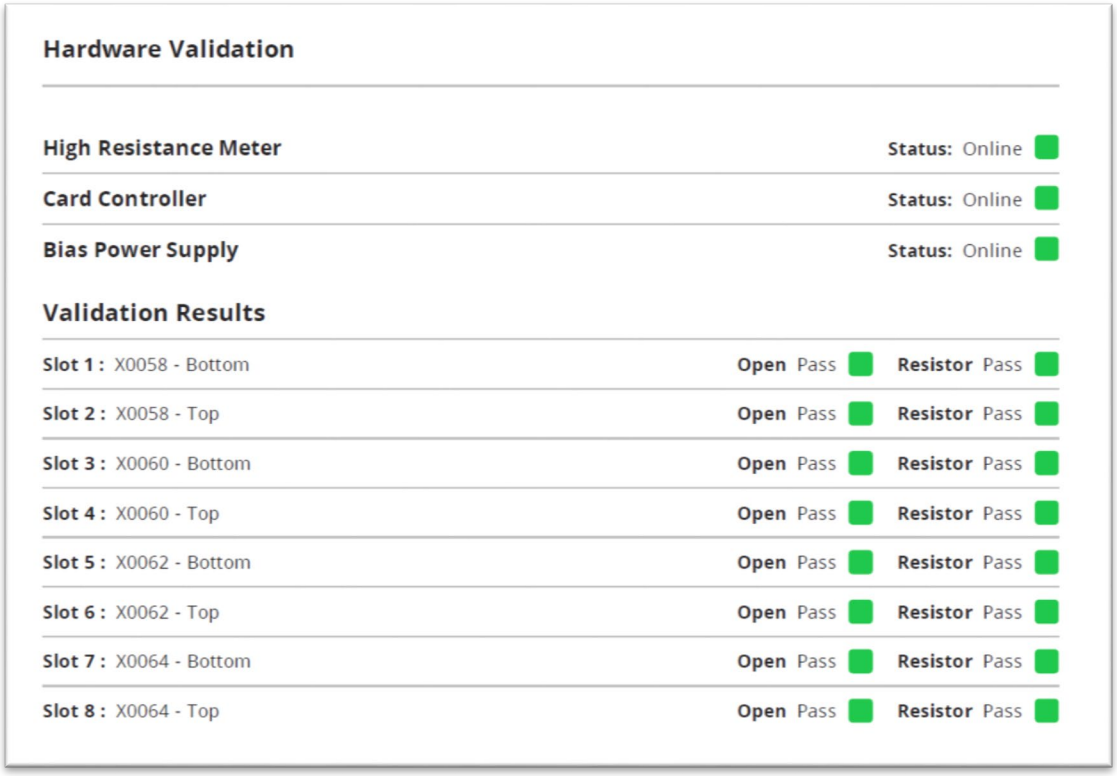
Environmentals

Target Temperature:	40.00 C
Target Humidity:	90 %RH

Measurement Parameters

Pass Limit:	8.000 $Log_{10}\Omega$
Warning Band:	9.000 $Log_{10}\Omega$

Also included in the test summary is a validation procedure. This procedure ensures that the user's hardware is online and functioning as expected, including slot by slot validation results. Integrated device validation procedure is unique to the Magnalytix OE-200 Series and provides an additional layer of objective evidence that the test measurements will be accurate.



Hardware Validation

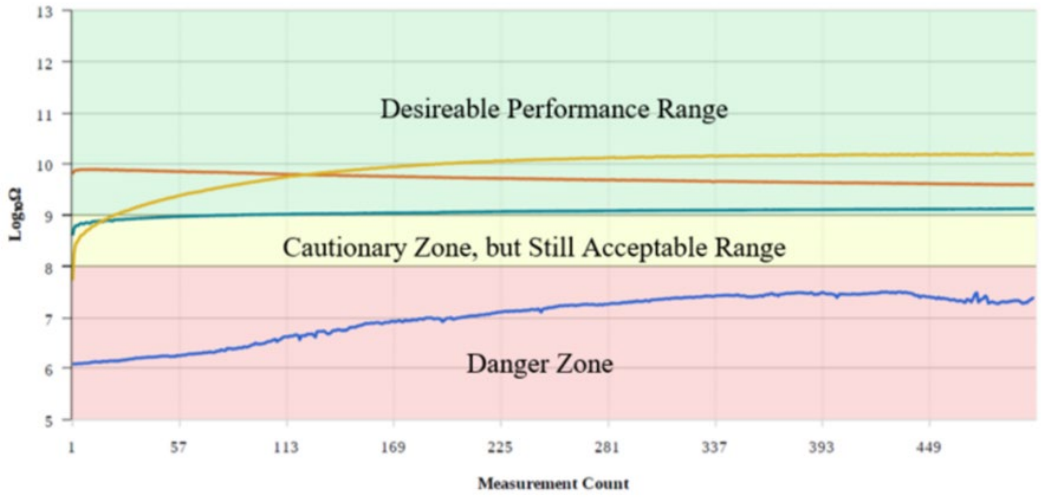
High Resistance Meter	**Status:** Online
Card Controller	**Status:** Online
Bias Power Supply	**Status:** Online

Validation Results

Slot 1 : X0058 - Bottom	**Open** Pass	**Resistor** Pass
Slot 2 : X0058 - Top	**Open** Pass	**Resistor** Pass
Slot 3 : X0060 - Bottom	**Open** Pass	**Resistor** Pass
Slot 4 : X0060 - Top	**Open** Pass	**Resistor** Pass
Slot 5 : X0062 - Bottom	**Open** Pass	**Resistor** Pass
Slot 6 : X0062 - Top	**Open** Pass	**Resistor** Pass
Slot 7 : X0064 - Bottom	**Open** Pass	**Resistor** Pass
Slot 8 : X0064 - Top	**Open** Pass	**Resistor** Pass

EVALUATION – ARE SIR RESULTS ACCEPTABLE? 1.4

Your next steps are determined by your SIR test results. If the test measurement readings are in the desired performance range without significant variation, you are ready to move to process control. Otherwise, your process will need to be adjusted until the desired performance is achieved.



PROCESS ADJUSTMENT

Adjusting your process may include selecting a new solder material, changing your reflow parameters, or another factor outlined during your process evaluation. After adjusting your process, build new boards and run SIR until the desired results are achieved.

OBJECTIVE EVIDENCE STANDARD

The Objective Evidence Standard requires an OEM and EMS to qualify soldering and/or cleaning processes that result in acceptable levels of flux and other residues. Major changes requiring objective evidence proof include change of flux or flux bearing material, cleaning agents, cleaning machines, supplier, or solder alloys. The use of ROSE with no other supporting evidence is not considered acceptable for objective evidence for qualifying a manufacturing process. Acceptable SIR test results qualify as objective evidence for your process.

PROCESS CONTROL PROCEDURE 2

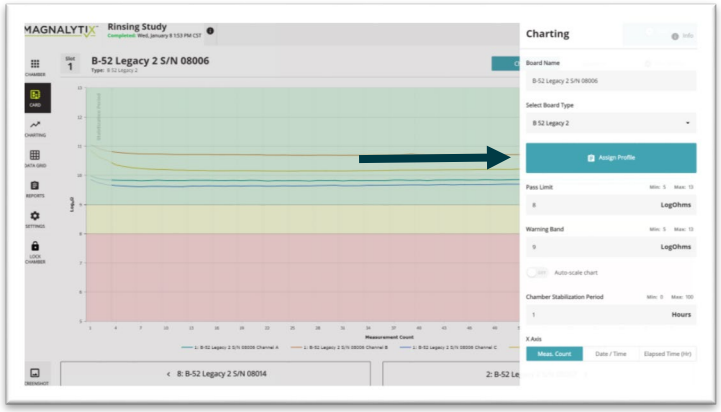
IPC J-STD –001G, Amendment 1 requires that the assembler have a sampling plan to assure that the process remains in control once qualified and validated. It is well documented that electrochemical failures occur at component sites where flux residues are not fully activated. It is also well known that certain components have a greater risk of electrochemical failure.

Selecting a control plan that monitors the process and it performance on challenging components provides assurance that the process maintains control that was established during process qualification.

The test board that was used to qualify the process provides an upper and lower spec limit for each of the component types on the test board. These SIR limits are set locally, and can be changed for different customer requirements. This becomes the intended result on the metric that is measured. Once the process is placed into production, a small sample of control test boards are assembled weekly and SIR tests conducted to establish control limits that provide indicators of the variation in the performance of the process. A recommended test time for process control is between 24 –72 hours.

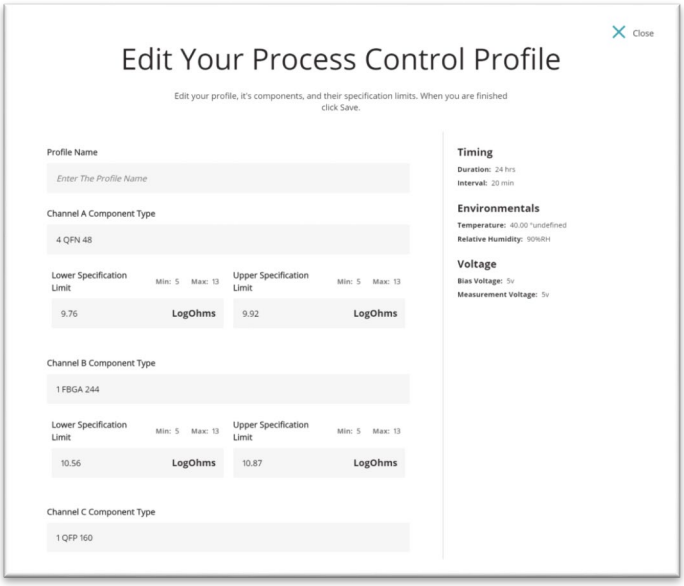
BUILD PROCESS CONTROL PROFILE 2.1

The OE-200 Series interface provides two simple methods for creating a Process Control Profile. You can base your new profile on a previously run board by opening the test and selecting the board. In the card settings, select **Assign Profile**.

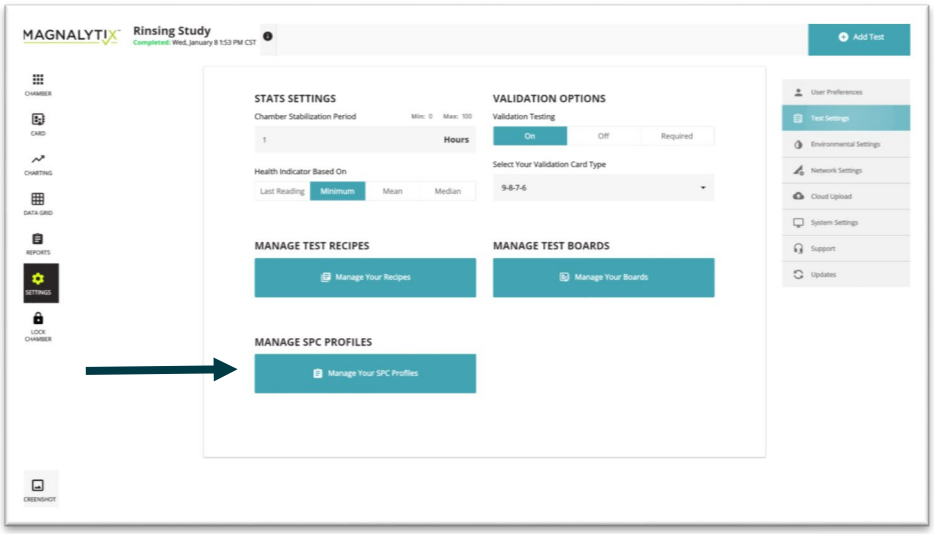


The Assign Profile form will automatically import your board and test information as well as calculate the six-sigma upper and lower specification limits for each channel.

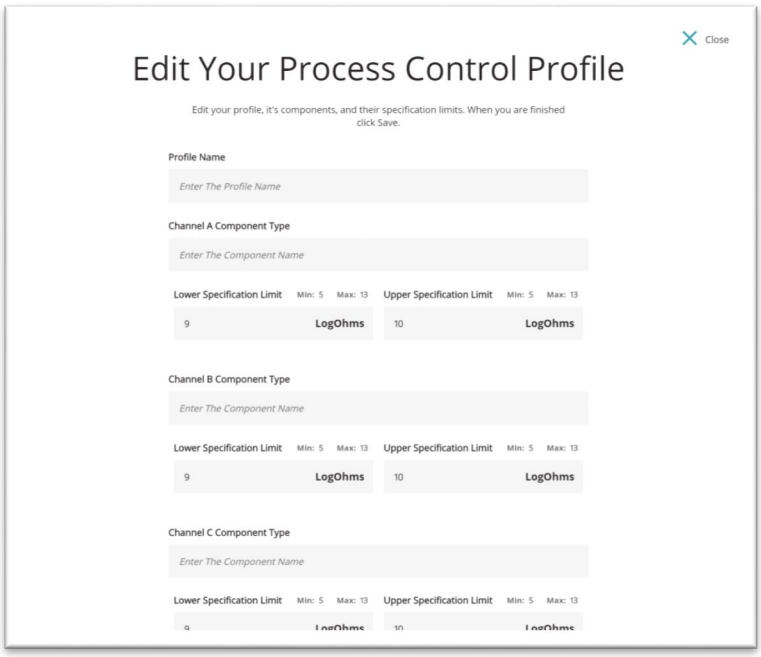
You also can create a profile from scratch, navigate to Test Settings in the Settings menu and select edit your process control profile.



Manage Your SPC Profiles.



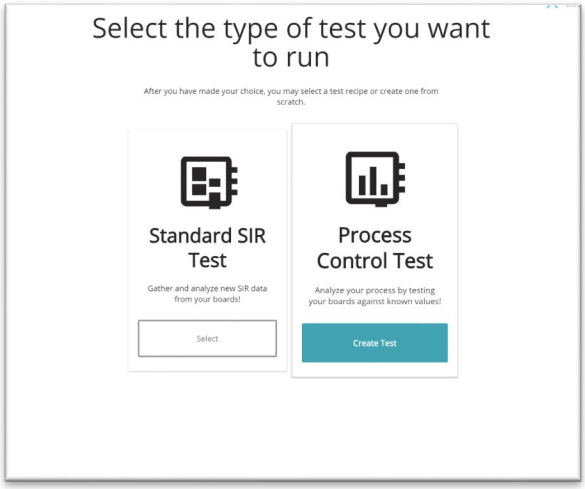
In the Create New SPC Profile form, you can customize your profile's name and component types for each channel. Each channel is also given an upper and lower specification limit that can be updated after saving.



You will also need to enter the test parameters (environment, voltage, duration, and intervals) to ensure each test created with this profile is consistently run under the same conditions.

BUILD AND RUN SIR TEST BOARDS 2.2

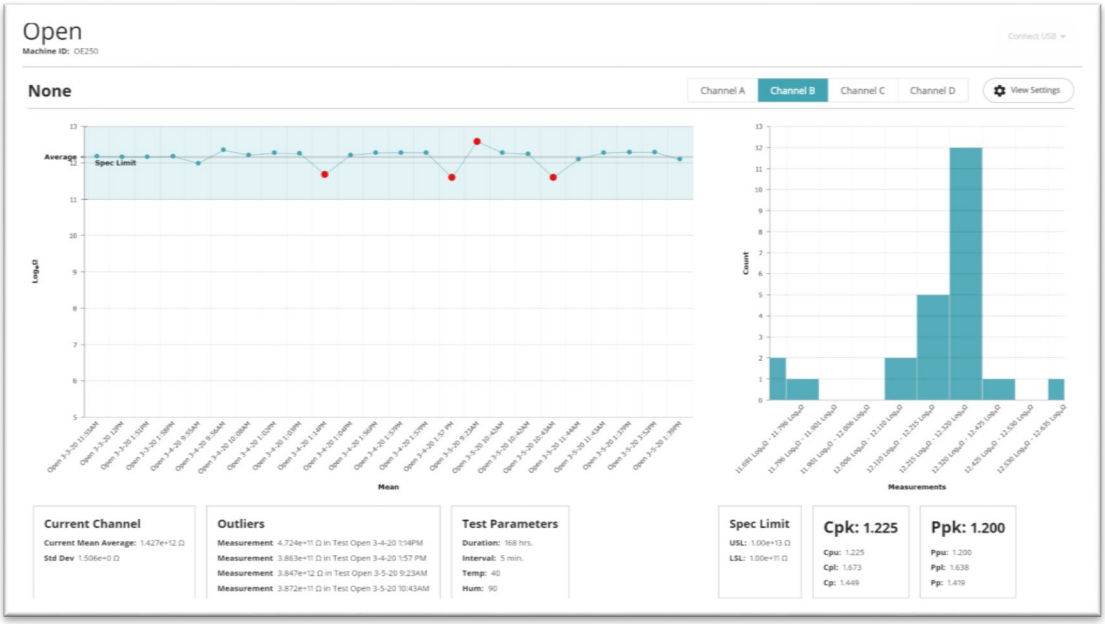
Your test boards should continue to be built periodically during the qualification procedure. Changes in board assembly design or technique may impact your SIR test results. Once your boards are ready for process control testing, you can begin by pressing the **Create Test** button located under the “Process Control” section on the Test Creation form.



Next, select the profile you would like to run and give your test a unique name. All the test parameters created with the profile will automatically be imported for you.

REVIEW PROCESS CONTROL CHART 2.3

The process control chart allows the user to view their performance over time. By assigning a process profile to tests, the user gains insight into their overall performance over time. They also can customize how they view and download their data.

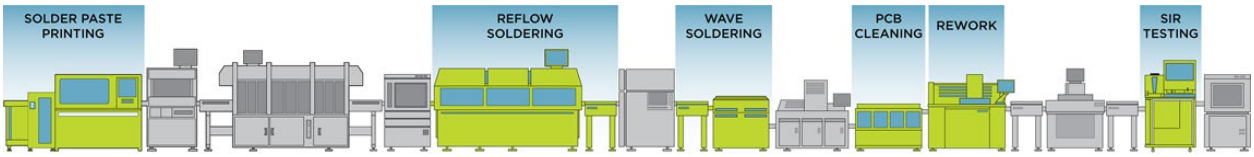


MAINTAINING PERFORMANCE? 2.4

The process control chart makes it easy to track your performance over time. Once an outlier has been detected, we will highlight that in the test results in red for you so you can focus on investigating the issue.

INVESTIGATE – WHY DO PROCESSES DRIFT?

Process variation can result in residues on circuit assemblies during the day to day processing. Residue conditions that result from process variation on the manufactured product are most problematic on highly dense components. Data-driven decision making through the use of SIR process monitoring is the best method for reducing process drift. SIR testing can detect issues related to the soldering materials, solder paste printing, reflow process, wave soldering, selective soldering, rework and the cleaning process.



CONCLUSION 3

Surface Insulation Resistance (SIR) testing has been with the electronics industry since the advent of the transistor and the printed board. The tool has been used for incoming inspection, materials investigations and qualifications, qualify conformance, prediction of long-term failure mechanisms and as a predictive tool for estimated service life. The tool was commonly used at Failure Analysis Labs.

Magnalytix has simplified this powerful test method by integrating all of the hardware required for SIR testing with software to automate and control the SIR testing process. This software not only allows you real time visibility into the testing status as a test is performed, but also automatically processes the extensive data collected after an SIR test completes.

The current approach requires Ph.Ds and engineers to do the work and analysis. These guys are not going to catch problems or even diagnose them accurately everytime. The new approach using Magnalytix hardware and software integration makes it less difficult to run the test that can be run by technicians on the floor. The system interface allows for real time data analytics enables as the test is running. More than 80% of the effort is done for the engineer. The design features proves the system worth by driving process innovations, simplified data and insight gathering, and processes measurements using Key Performance Indicators.

CONTACT INFORMATION 4

We are always available should you require any additional support. To get in touch with our Magnalytix support team, please utilize the following information:

Sales:
Phone: 615-983-8866
Email: info@magnalytix.com

Tech Support:
Phone: 615-983-8867
Email: techsupport@magnalytix.com

Or visit our website at **https://magnalytix.com/**