REDUCTION OF KELVIN CHECK FAILURE OF DEVICE A AT QFN TEST

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ABSTRACT

Yield in semiconductor manufacturing is a critical metric, directly impacting production efficiency and cost-effectiveness. During electrical testing, semiconductor devices undergo various assessments to ensure they meet specified electrical characteristics and performance requirements. Some devices will undergo the Kelvin Check Test, it is performed to measure and check the electrical contact resistance or connection between the test probes and the device under test (DUT).

Device A is a Quad Flat No-Lead (QFN) which undergoes rigorous testing procedures to ensure its electrical integrity and performance. However, Kelvin check Test failures during testing presents significant challenges, potentially compromising test accuracy and the efficiency of production.

This paper presents a Six Sigma approach to reduce Kelvin Check Test failures during testing of device A. Through the Define, Measure, Analyze, Improve, and Control (DMAIC) approach, critical parameters influencing Kelvin Check failures are identified, analyzed, and optimized. Statistical methods and process optimization techniques are applied to enhance test socket design, material selection, testing and setup procedures. Validation demonstrates a substantial reduction in Kelvin Check failures, leading to improved test yield and efficiency. Implementation of this Six Sigma methodology enables semiconductor manufacturers to achieve enhanced consistency, reduced testing costs, and improved quality assurance in QFN testing.

1. 0 INTRODUCTION

1.1 Historical Background

The QFN Final Test process has historically been fundamental in ensuring product quality and operational efficiency. However, the device A is the top yield killer among devices posed a significant challenge from January 2022 to December 2022. The historical data analysis reveals that device A incurred a substantial scrap cost of $179,115 during the specified period, underscoring its significance as the primary contributor to Overall QFN Final Test process yield degradation. Despite efforts to maintain a targeted Final Test Electrical Yield of 97.50%, the Kelvin Check emerged as the principal driver of failure and associated scrap costs, underscoring the necessity for a proactive approach to confront these challenges.

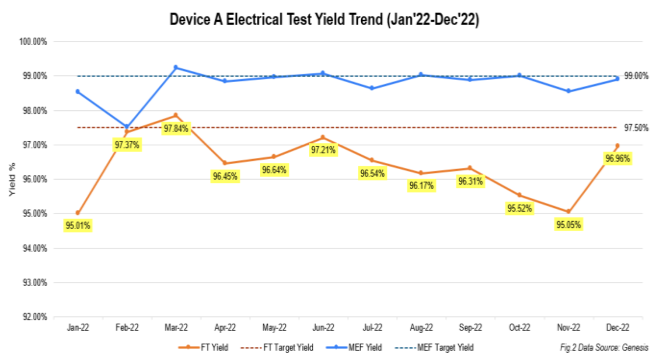


Fig 1 QFN Final Test – Electrical Test Yield Trend (Low Yield). Target yield of device A = 97.50%, target is not met.

1.2 Kelvin Check Test Fail

The term "Kelvin Check Test Failure" typically refers to a situation where the Kelvin Check, a type of test used in electronics manufacturing to verify the integrity of electrical connections, has produced results indicating a failure or anomaly. This failure could signify various issues such as improper contact between the test points as shown in Fig 2. and the device under test, electrical continuity problems, or deviations from specified parameters.

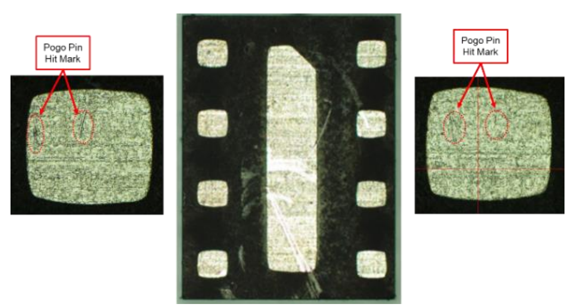


Fig 2. This is a sample unit of device contact pad that resulted to Kelvin Check Fail during Electrical Test using Pogo Pin (force and sense) Test Socket.

2. 0 REVIEW OF RELATED WORK

Not Applicable.

3.0 METHODOLOGY

3.1 Define Phase

Based on reject bin analysis, Top 1 Contributor comes from rejects of Electrical Rejects and streamlining on Electrical Rejects, 65% of rejects are from Parametric Rejects.

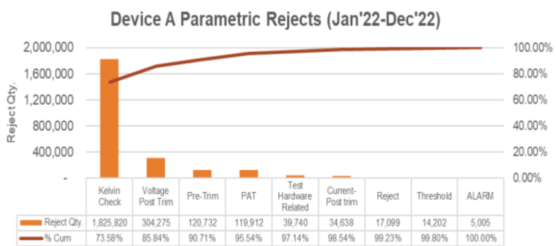


Fig. 3, Kelvin Check Failure is the Top 1 Contributor for Parametric Rejects.

The project target to reduce the defect PPM of Kelvin Check Failure is 16,334 PPM, aiming for a 30% reduction, PPM will be presumed to drop to 11,434 PPM per month.

3.2 Measure Phase

3.2.1 Process and Process Step Analysis

The SIPOC and Top chart show the three (3) sub-process critical to the occurrence of Kelvin Check Failure.

3.2.2 Tester Machine MSA

MSA was performed on the Pilot machine and other Tester on which these machines have the same version and are being used by the operation. Overall MSA in terms of BIAS and GR&R result passed wherein the tester is a reliable measurement system in terms of accuracy and precision. As a result, equipment is fit for use in detecting the occurrence of Kelvin Check Failure. The results were summarized as presented on below table:

KPIV / KPOV (Parameter)	Equipment	MSA Method	Test Method	Acceptability Criteria	Actual Result	Remark
Kelvin Check Failure	Tester (A & B)	Bias (4V)	One-sample t Test	p-value > 0.05 or mean<permissible error	mean=0.00142	Pass
		Bias (-4V)	One-sample t Test	p-value > 0.05 or mean<permissible error	0.5823 > 0.05	Pass
		Bias (10V)	One-sample t Test	p-value > 0.05 or mean<permissible error	mean=0.00019	Pass
		Bias (-10V)	One-sample t Test	p-value > 0.05 or mean<permissible error	mean=-0.000142	Pass
		Bias (20V)	One-sample t Test	p-value > 0.05 or mean<permissible error	0.2920 > 0.05	Pass
		Bias (-20V)	One-sample t Test	p-value > 0.05 or mean<permissible error	mean=-0.00219	Pass
		Bias (36V)	One-sample t Test	p-value > 0.05 or mean<permissible error	mean=-0.070182	Pass
		Bias (-36V)	One-sample t Test	p-value > 0.05 or mean<permissible error	0.0744 > 0.05	Pass
		Bias (108V)	One-sample t Test	p-value > 0.05 or mean<permissible error	0.03451 > 0.05	Pass
		Bias (-108V)	One-sample t Test	p-value > 0.05 or mean<permissible error	0.1390 > 0.05	Pass
		GR&R	ANOVA (Crossed)	%GR&R < 10%	0.33253% < 10%	Pass
				ndc ≥ 5	424 ≥ 5	Pass

Table 1 Overall MSA result of Tester machine.

3.3 Analyze Phase

3.3.1 Fishbone Diagram, Cause and Effect Analysis & Matrix

Thirty-five (35) probable root causes related to the occurrence of Kelvin Check Failure were identified and listed through Fishbone diagram and Cause and Effect Analysis Matrix. After scoring, prioritization, grouping and validation, Twelve (12) major root causes were known valid. (1) Unstable measurement and in good condition of Load Board (2)Broken/ Damaged Socket (3) Worn out Pogo Pins (4) Out of specs of device Pad Cutting (5) Misalign X and Y Precisor jaw (6) Misaligned Turret Pickup Head vs. device (7) High Contact Resistance on Pogo Pins (8) Incomplete and Worn-out Screws (9) Insufficient Z-Axis Height and Misaligned X and, Y-axis Test Stand (10) Unoptimized Machine Parameter Setting (11) No Time limit of Ionizing of Lot (12) Dirty Canister

3.3.2 Potential root cause 1: Unstable measurement and in good condition of Load Board

Components on the load board, such as resistors, capacitors, or connectors, may degrade over time, affecting their performance and introducing instability in measurements. Despite the load board being physically intact, there could be issues with the contacts. Over time, contacts can degrade due to oxidation or wear and tear, leading to intermittent connections and unstable measurements. Load boards may vary responses causing failures on specific boards. This failure may lead to kelvin Check failures on specific boards.

3.3.2.1 Verification

Through actual checking of historical data of defective load board used during production that resulted to Kelvin Check Failure, there are cases of defective load board that was used during setup to production.

TEST#	RESULT	UNITS	LOWER	UPPER	ALARM	TEST NAME
9000.0	10005		0	99999		Selected test mode
9001.0	4		0	7		Read test board ECD#
9002.0	4		0	7		Read test board BID#
9010.0	0.109	Ohm	0.025	2.000		Kelvin resistance of IN1 pin
9011.0	0.108	Ohm	0.025	2.000		Kelvin resistance of IN2 pin
9012.0	0.017	Ohm	0.025	2.000	FAIL	Kelvin resistance of OUT1 pin

Fig. 4, result of Kelvin Failure of the load board during setup isolation.

3.3.3 Potential root cause 2: Broken/ Damaged Socket

Test Socket involves connecting electronic components or devices to testing equipment for Testing purposes. These sockets contain spring-loaded pogo pins that make temporary electrical connections with the device under test (DUT) when it's inserted into the socket.

3.3.3.1 Validation on Good and damaged Socket through Chi-Square Test Hypothesis testing.

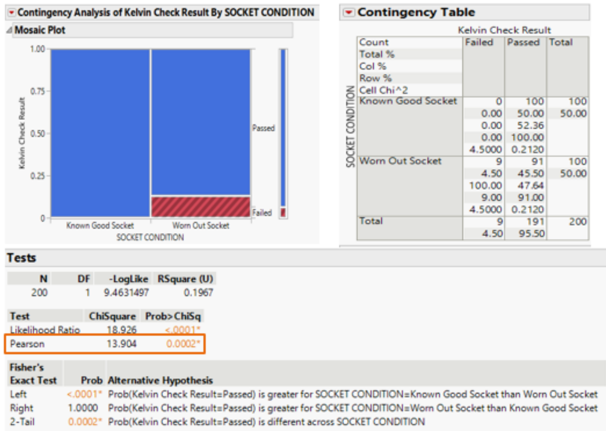


Fig. 5, The use of worn-out sockets is significantly different in using known good sockets and has significant variation. The use of worn-out sockets will result in Kelvin Check Failure.

3.3.4 Potential root cause 3: Worn out Pogo Pins

Pogo pins play a vital role in electronic testing by providing a convenient, efficient, and reliable means of making temporary electrical connections with the DUT. Their spring-loaded design, high contact force, and versatility make them essential components in testing. Over time, the repeated compressions and releases they undergo during testing can cause wear and tear on the spring mechanism and the contacting surface of the pin.

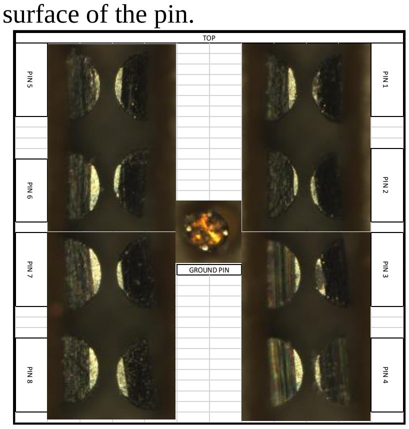


Fig. 6, Sample worn-out Pogo Pins

3.3.4.1 Validation on Good and Worn out Pogo Pins through Chi-Square Test Hypothesis testing.

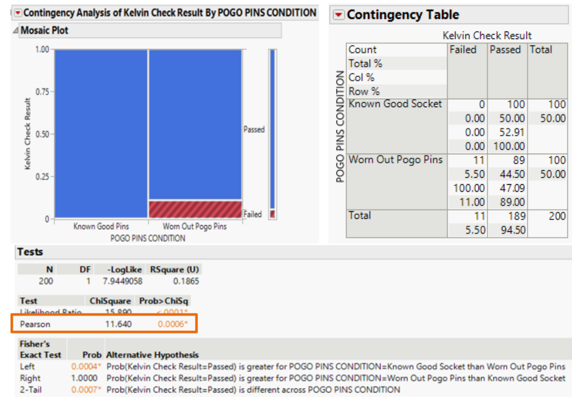


Fig. 7, The use of worn-out pogo pins is significantly different in using known Good Pogo Pins and has significant variation. The use of worn-out pogo pins will result in Kelvin Check Failure.

3.3.5 Potential root cause 4: Out of specs of device Pad Cutting

A reliable package saw ensures uniform cutting across the entire wafer, resulting in consistent dimensions and quality of the individual QFN packages. This consistency is essential for accurate and reliable testing results.

3.3.5.1 Verification

Through actual dimension analysis on the historical data of Low Yield due to Kelvin Check Failure, there are cases of device Pad Cutting which are relax specs since 0 is the minimum specs criteria.

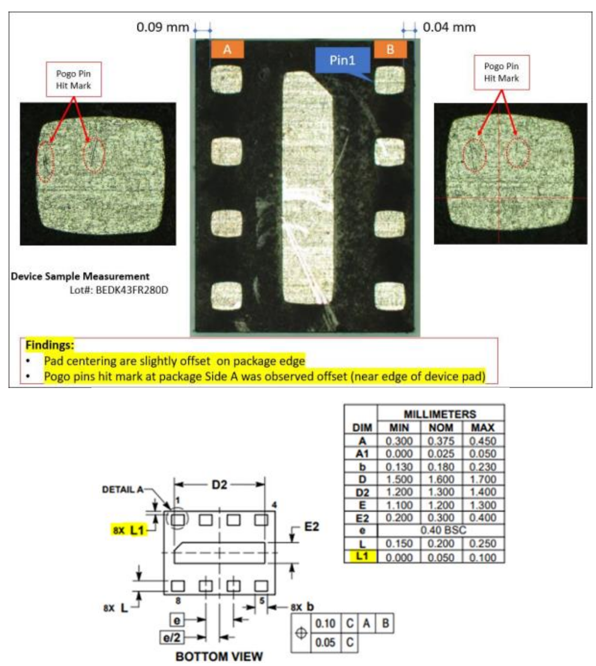


Fig. 8, Actual Dimensional Checking of device Pad Centering

3.3.6 Potential root cause 5: Misalign X and Y Precisor Jaw

Precisor Jaws or Rotor jaws securely hold the device or unit in place prior transferring to orientation table then to test site prior Electrical testing operations. This ensures stability and accuracy throughout the Test process, preventing movement that could compromise the Alignment of device prior going to testing site /socket. Any misaligned unit during testing is automatically tagged kelvin check failure during Testing as reject.

3.3.6.1 Verification

Through actual checking of historical data of mis-aligned X and Y precisor jaw used prior production or after Preventive Maintenance that resulted to Kelvin Check Failure.

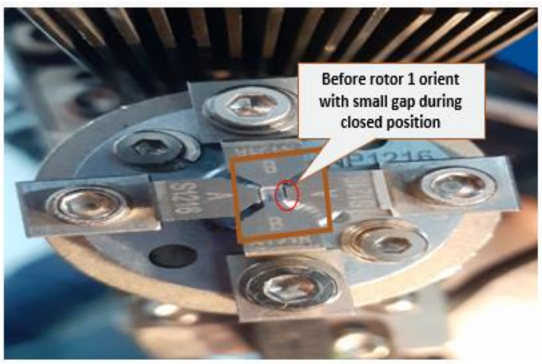


Fig. 9, Actual Misaligned Precisor Jaw

3.3.7 Potential root cause 6: Misaligned Turret Pickup Head vs. device

The Pick-Up Head (PUH) serves as the arm of a test and tape turret machine, responsible for lifting and transferring each unit sequentially throughout the machine until the testing and taping processes are completed.

3.3.7.1 Validation

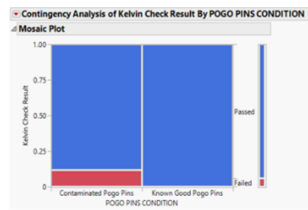
Upon reviewing historical data, occurrences of misalignment between the Turret Pickup Head and the device have been identified through actual checks.

Fig. 10, Misaligned Turret Pickup Head vs. device A

3.3.8 Potential root cause 7: High Contact Resistance on Pogo Pins

High contact resistance on pogo pins occurs when there is difficulty in establishing a reliable electrical connection between the pins and the contact of device. This increased resistance can occur due to various factors such as corrosion, contamination, mechanical wear, or insufficient pressure exerted by the pogo pins during contact. High contact resistance can lead to unreliable electrical connections, signal degradation, or even complete failure of the system or device utilizing the pogo pins.

3.3.8.1 Validation on Good and Worn out Pogo Pins through Chi-Square Test Hypothesis testing.



Contingency Table

POGO PINS CONDITION	Count / Total % / Col % / Row %	Kelvin Check Result: Failed	Passed	Total
Contaminated Pogo Pins	Count	12	88	100
	Total %	6.00	44.00	50.00
	Col %	100.00	46.81	
	Row %	12.00	88.00	
Known Good Pogo Pins	Count	0	100	100
	Total %	0.00	50.00	50.00
	Col %	0.00	53.19	
	Row %	0.00	100.00	
Total	Count	12	188	200
	Total %	6.00	94.00	

Tests

N	DF	-LogLike	RSquare (U)
200	1	8.7010054	0.1917

Test	ChiSquare	Prob>ChiSq
~~Likelihood Ratio~~	~~17.402~~	~~<.0001*~~
Pearson	12.766	0.0004*

Fisher's Exact Test	Prob	Alternative Hypothesis
Left	1.0000	Prob(Kelvin Check Result=Passed) is greater for POGO PINS CONDITION=Contaminated Pogo Pins than Known Good Pogo Pins
Right	0.0002*	Prob(Kelvin Check Result=Passed) is greater for POGO PINS CONDITION=Known Good Pogo Pins than Contaminated Pogo Pins
2-Tail	0.0003*	Prob(Kelvin Check Result=Passed) is different across POGO PINS CONDITION

Fig. 11, The use of contaminated foreign material on Pogo Pin tips is significantly different in using known Good Pogo Pins and have significant variation. The use of contaminated foreign material on Pogo Pin will result in Kelvin Check Failure.

3.3.9 Potential root cause 8: Incomplete and Worn-out Screws

Incomplete screws refer to those that are not fully installed or tightened properly. This can happen due to human error during assembly or maintenance. Incomplete screws can result in loose connections, which may lead to vibrations, misalignment, or even disassembly of mechanical parts over time.

Worn-out screws occur when the threads or heads of the screws degrade due to friction, corrosion, or overuse.

3.3.9.1 Verification

After checking the historical data, instances of Kelvin check failures have been attributed to the use of incomplete and worn-out screws during production.

STATUS	STATUS OWNER	COMMENTS
LSG REPAIR	LSG	PR: LOW YIELD SITE 2 DUE TO TEST HARDWARE > DONE REPAIR- CHECK SC SOCKET ON SITE 2 OK- RE-CLEANED BY HW- SEEN INCOMPLETE SCREW ON SOCKET- REPLACED - OK RE-INSTALLED LB- AUTO RAN PASSED STAT: RTP

STATUS	STATUS OWNER	COMMENTS
BUY OFF (OPERATOR VALIDATION - OPERATIONAL)	PRODUCTION	check socket at site 1_perform cleaning_remount socket seen incomplete screw_align and check contact_result consistent pass_for lot monitoring_machine endorse to production

Fig. 12, Actual Machine Setup downtime for incomplete

3.3.10 Potential root cause 9: Insufficient Z-Axis Height and Misaligned X, Y and Z-axis Test Stand

The test stand's misaligned X, Y, and Z axes, along with insufficient Z-axis height, can lead to inaccuracies and failures in testing. If the Z-axis height is inadequate, it may prevent the test equipment from reaching or properly contacting the Test Socket or DUT. This limitation can hinder the testing process, leading to incomplete or inaccurate results and definitely can cause kelvin check failure.

3.3.9.1 Verification

After checking historical records, it has been found that Kelvin check failures during production were caused by a Test Stand with Misaligned X, Y, and Z axes and Insufficient Z-Axis Height.

STATUS	STATUS OWNER	COMMENTS
LSG REPAIR	LSG	pr: site 4 low yield open fail ad: reset up alignment at z-axis in test stand at site 4-ok*ran and monitor_ok_stable running st: operational/rtp
SPEEDLOSS DUE TO HARDWARE	HARDWARE	open fail site 3-ongoing check z-axis new installed test stand

STATUS	STATUS	COMMENTS
LSG REPAIR	LSG	PB : CONTINUOUS FAIL AT SITE 4 c/a : 1.cleaed socket - still kelvin fail_ 2.realign test stand - still_ 3.interchange socket of site3 to site4 - still fail at site4_ 4.verify using board at SRM12 - stable pass_ 5.confirmed dut board fail st : production
LSG REPAIR	LSG	PB : SITE1_ 3 AND 4 LOW YIELD C/A : 1.CLEANED SOCKET_ 2.REALIGN TEST STAND_ 3.AUTO RUN - SITE1 AND SITE3 IS NOW OK_ SITE4 STILL LOW YIELD ST : FOR CONTINUE REPAIR
LSG REPAIR	LSG	frequent fail all sites (kelvin failure) site 1-serial#31(26534K-cleaning only) site2-serial#4-(106264k-done replacement) site 3-serial#34(83670-done replacement) site 4-serial#27(149495K-done replacement) -realign test stand - rtp
LSG REPAIR	LSG	PB: LOW YIELD ALL SITES DUE TO KELVIN AD: REALIGN ALL SITES TEACHSTROKE OK BUT ERROR ON SITE 3. ASK SIR CHRISTIAN T. TO ADJUST TEST STAND OK TEACHSTROKE SITE 3. OK AUTORUN AND MONITOR ALL SITES STABLE PASS
LSG REPAIR	LSG	pr: encountered continuous fail site 2 due to kelvin resistance of GND pin ad: replaced new pins by Cshop HW 2. installed socket and reset up alignment test stand (x and y axis) 3.run auto-ok st: rtp for monitoring
LSG REPAIR	LSG	PR:ENCOUNTERED SITE 3 CONTINUOUS FAIL DUE TO KELVIN RESISTANCE OF GND PIN AD: 1.REPLACED NEW PINS BY CSHOP HW 2.RESET UP ALIGNMNET TEST STAND (Y-AXIS) 3. AUTO RUN-OK ST: RTP FOR MONITORING

Fig. 13, Actual Machine Setup downtime for incomplete

3.3.11 Potential root cause 10: Unoptimized Machine Parameter Setting

Machine parameter settings that are not optimized can lead to various inefficiencies and issues in manufacturing processes especially in Testing.

3.3.11.1 Validation

Review historical data of unoptimized machine parameter settings on Test Force, Over Press and Over Travel using DOE to identify the height parameters significant to Kelvin Check Failure. Significant test result: Based on DOE, Test Stand Height and Over Travel are significant to the occurrence of Kelvin Check Failure rejects and the model is behaving linear.

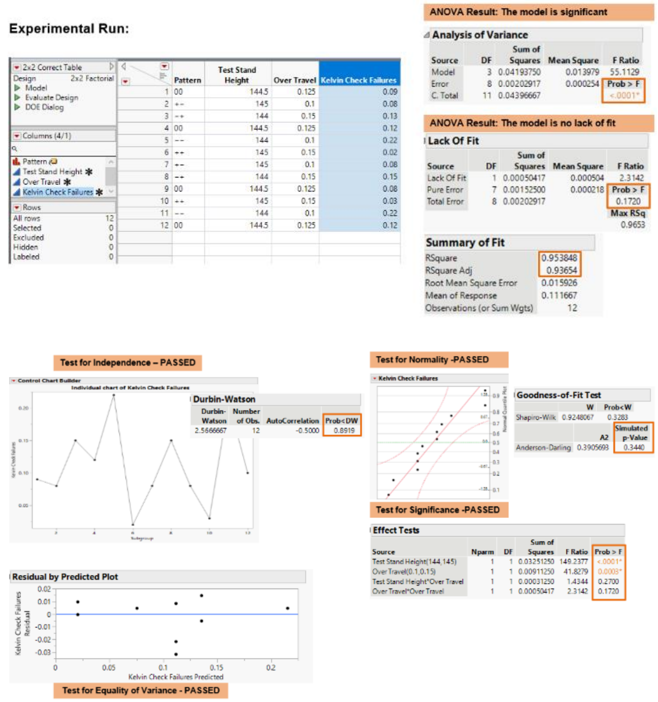


Fig. 14, DOE Result, The model is adequate and Passed the test based on the Statistical assumption result

3.3.12 Potential root cause 11: No Time limit of Ionizing of Lot

Ionizing is a process used in various industries, such as semiconductor manufacturing or pharmaceutical production, to neutralize static charges on materials or components. This helps prevent damage to sensitive electronic devices or ensure product quality and safety. When there's no time limit for ionizing a lot, it means the duration of exposure to ionization is not regulated and the adhesive on the device pads will not be removed.

3.3.12.1 Verification

Historically, there has been a persistent issue of low yield during the Testing process, primarily kelvin check failure due Insufficient time of ionizing of lot.

STATUS	STATUS	COMMENTS
LSG REPAI	LSG	PB: OPEN FAIL SITE 1 AND 3 AD: REPLACED POGO PINS ON SITE1_ CLEANED SCOKET OF TEST SITE3_ BOTH REALIGNED TEST SITE (X-Y AXIS POSITION)_ AUTORUN THEN MONITORRED ST: RTP (CANISTER #2 IS SUBJECT FOR IONIZING)

Fig. 15, Actual Machine Setup downtime for Ionizing Concern

3.3.13 Potential root cause 12: Dirty Canister

A "dirty canister for QFN packages" refers to a container or holder used to store QFN (Quad Flat No-leads) semiconductor packages that has become contaminated or soiled. When the canister used to store QFN packages becomes dirty or contaminated, it means that it has accumulated dirt, dust, or other foreign particles. This contamination can potentially affect the cleanliness and integrity of the QFN packages stored inside.

3.3.13.1 Verification

A recurring challenge has been observed in the testing process, with low yield rates primarily attributed to Kelvin check failures resulting from a dirty canister.

STATUS	STATUS	COMMENTS
PROCESS I	PROCESS I	pr: all site low yield due to open fail ad: site 1.2_3 replace new pins site 4 clean only by hw... perform alignment -ok .. auto run but encounter sudden fail allsites...seen canister foriengmatt..down to pe for further isloation
LSG REPAI	LSG	prob: LOW YIELD AT SITE 1 DUE TO OPEN isolation: tf#1.3 pat check socket condition good cleaned socket auto run pass/fail realign x and y axis same_ try to unload canister #3 with wafer lot#FR240092 try to load canister #4 with wafer lo#FR239071 AUTO RUN STABLE PASS ST: ENDORSE TO PE FOR VERIFICATION
PROCESS I	PROCESS I	prob: TF#1.3 PAT fail all sites _CHECK SOCKET CONDITION GOOD CLEANED SOCKET AUTO RUN PASS/FAIL REALIGN X AND Y AXIS SAME_ TRY TO UNLOAD CANISTER #3 WITH WAFER LOT#FR240092 TRY TO LOAD CANISTER #4 WITH WAFER LO#FR239071 AUTO RUN STABLE PASS ST: ENDORSE TO PE FOR VERIFICATION
BUY OFF (I	PRODUCTI	FOR QA RELEASE DUE TO DUST ACCUMULATION OF CANISTER
LSG REPAI	LSG	PB:OPEN FAIL SITE 1 AND 3 AD: SOCKET CLEAN-SAME_SOCET CHANGE PINS-SAME_REALINED TESS STATION-SAME_ADJUST STROKE-SAME_CLEAN DUT PAD-SAME_ ALIGNMENT SENSITIVE-ALL SITES AFFECTED OF LOW YIELD_FOR CANISTER CHECK OUT POSSIBLE DEVICE ISSUE

ATUS	STATUS	COMMENTS
ROCESS ENGG WA	PROCESS I	pb: all sites low yield kelvin and open fail ad: check units on canister seen dust p
ANDLER REPAIR	EQUIP EN	PB: ALL SITES LOW YIELD KELVIN AND OPEN FAIL AD: CHECK UNITS ON CANISTER
G REPAIR	LSG	LOW YIELD AD: 1.SUDDEN FAIL OF KELVIN ALL SITE_SOCKET AND ALIGNMENT OK 2.NOTICE 2ND CANISTER W/ MOSTLY FAIL STAT:RTP
G REPAIR	LSG	kelvin fail all sites ad:1.aligned test site/offset device at socket pocket_same 2. low yield encountered during 2nd canister_checked device pads and package seen some are unenven to other side stat:rtp for monitoring
G REPAIR	LSG	Running Canister 2 Devices from LOT FK46FR290R from SRM16/QT8001. Cross va

Fig. 16, Actual Machine Setup downtime for Dirty Canister

4.0 RESULTS AND DISCUSSION

4.1 Improve Phase

4.2 Unstable measurement and in good condition of Load Board: Inclusion of PASSED Data log reference of Load board prior issuance to Production.

Issuance to production means including a record that confirms the load board has successfully passed testing or inspection. This process guarantees that the load board adheres to necessary standards and specifications prior to its deployment in production. Additionally, data logs are stored in a system for future reference, ensuring the integrity of the recorded readings.

REMARK 8	LINE	CLIENT	8 FILE
	QFN-FT	99520569	
	QFN-FT	19713797	23.05.27_0042_LE8V
for load board repair	QFN-FT	99522896	23.03.30_1304_le8vn
	QFN-FT	19701723	23.03.20_2218_LE8V

Fig. 17, Actual System that Saves Data logs

4.3 Broken/ Damaged Socket: Redesign socket

The previous design has a Unibody type and a risk of pogo pin rotation thus improvement of design was implemented into modular design which is more cost-efficient in terms of replacement and anti- rotation pogo pin was used. By implementing these redesign strategies, the test socket can be significantly improved in terms of durability, reliability, and resistance to damage, thereby enhancing its performance and longevity in testing applications.

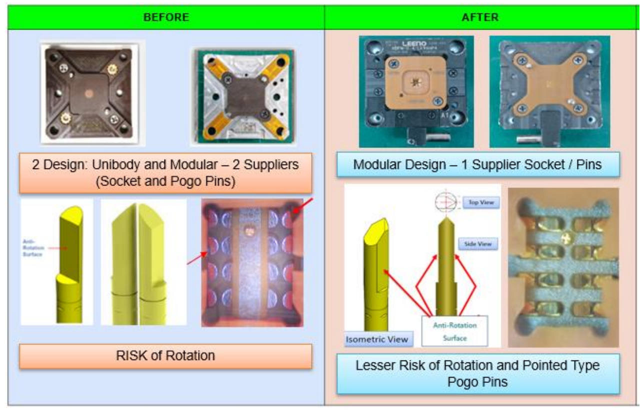


Fig. 18, GAP Analysis and comparison of the Socket and Pogo Pin Design

4.4 Worn out Pogo Pins: Established Pogo Pins Tool life thru Handler Shot Count Alarm

Set the Handler Shot count / Tool life based on Regression Analysis which is 250K and thus will be triggered once reach the shot count set on the Handler, it will prompt the operator to ask assistance to line sustaining personnel (LSG) for replacement and reset the alarm. By implementing a handler shot count alarm system, you can proactively monitor the health of pogo pins, minimize the risk of unexpected failures during testing operations, and prolong the lifespan of your automated testing equipment.

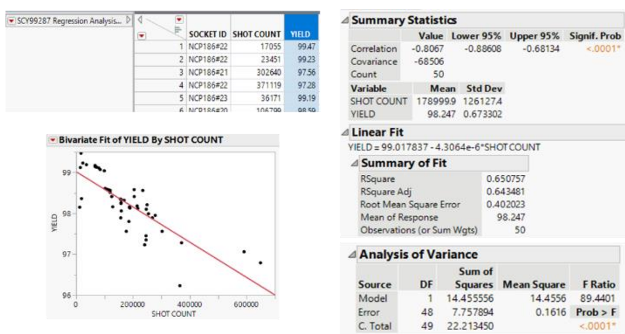


Fig. 19, JMP Analysis, shot count of 250K is recommended. to achieve 97~97.5% Electrical Target Yield

4.5 Out of specs of device Pad Cutting: Improve the Frequency & Sample Size of QFN Package Singulation Measurement Procedure

Existing Procedure for Non-Periodical Sampling is being done after Change of Operation Instruction only. Improving into after Change of Package is the new frequency and sample size of the QFN package singulation measurement procedure and implementing systematic enhancements, you can enhance product quality, minimize out-of-spec occurrences, and ensure the reliability of your manufacturing process.

4.6 Misaligned X and Y Precisor jaw, Misaligned Turret Pickup Head vs. device: Execution of Precisor Alignment Jig and Turret Alignment Jig during Set-up Conversion and PM

Enhance the regularity of conducting precisor jaw and turret pickup head alignment not solely during preventive maintenance (PM) but also throughout handler and setup conversion. By implementing these steps to execute precisor and turret alignment during setup conversion and PM, you can proficiently rectify misalignments, enhance equipment performance, and uphold the precision and dependability of the manufacturing operations.

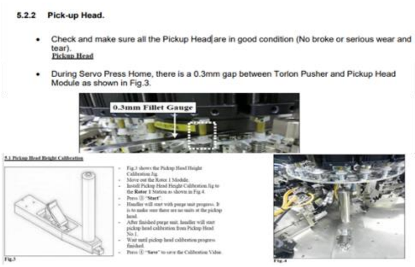


Fig. 20, Pickup Head Calibration Procedure

4.7 High Contact Resistance on Pogo Pins: Installation of Inline Air-Blow cleaning of socket

To address high contact resistance on pogo pins, consider implementing inline air-blow cleaning for the socket. By installing inline air-blow cleaning for the socket pogo pins, high contact resistance on pogo pins as part of mitigation thus enhance overall reliability, and optimize the performance of your production line.


Fig. 21, Air Blow on Socket Pogo Pins

4.8 Incomplete and Worn-out Screws: Inclusion of Socket Crews as a Check Item of line sustaining personnel during the Setup/Repair buy-off

REPAIR / SET UP

9	Check DUT Name vs SO	☐Match ☐Mismatch ☐N/A	☐Match ☐Mismatch ☐N/A	
10	Check Interface cable connection	☐Match ☐Mismatch ☐N/A	☐Match ☐Mismatch ☐N/A	
11	Carrier Tape Type: ☐3M ☐C-pak ☐Advantek ☐ENR	Description or Part Number: ________	Description or Part Number: ________	Description or Part Number: ________
12	Cover Tape Type for SRM/UENO: ☐3M 2671A =180±5°c ☐Sumitomo Z7302 = 180±5°c ☐E&R F4DR SP =160±5°c Cover Tape Type for TSCP1 (PICKER): ☐E&R –F4DR SP = 170±5°c	Actual Temp: ________°C	Actual Temp: ________°C	Actual Temp: ________°C
13	Check Actual Carrier Tape vs SO	☐Match ☐Mismatch ☐N/A	☐Match ☐Mismatch ☐N/A	☐Match ☐Mismatch ☐N/A
14	Check Actual Cover Tape vs SO	☐Match ☐Mismatch ☐N/A	☐Match ☐Mismatch ☐N/A	☐Match ☐Mismatch ☐N/A
15	PBFT: 40gF – 90gF	☐Pass ☐Fail ☐N/A		
16	Sealing Appearance	☐Pass ☐Fail	☐Pass ☐Fail	☐Pass ☐Fail
17	Check In-pocket Taping Orientation vs SO	☐Match ☐Mismatc ☐N/A	☐Match ☐Mismatch ☐N/A	☐Match ☐Mismatch ☐N/A
18	Conduct Open Socket Test to ALL Test Sites.	☐ Pass ☐Fail ☐N/A		
19	Check Actual Socket Screws	☐ Complete ☐ Worn-out ☐ Incomplete		
2019	Stray unit Inspection on Test Site,			

Fig. 22, Check Items and Setup/Repair buy-off

4.9 Insufficient Z-Axis Height and Misaligned X and, Y-axis Test Stand: Redesign of Test Stand with fixed Z-Height and micrometer adjustment on X and Y-axis.

To address the issues of insufficient Z-axis height and misaligned X and Y-axis on the test stand, consider redesigning the test stand with fixed Z-height and micrometer adjustments on the X and Y-axis. By redesigning the test stand with fixed Z-height and micrometer adjustments on the X and Y-axis, you can effectively address issues of insufficient height and misalignment, resulting in improved accuracy, reliability, and efficiency in your testing processes.

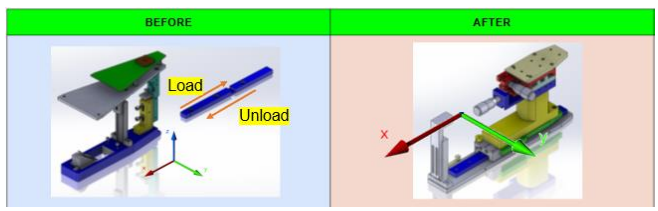
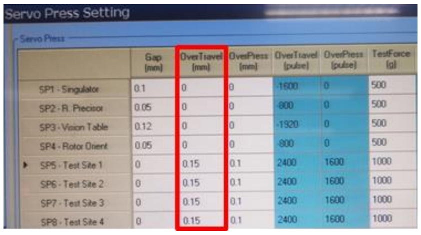


Fig. 23, GAP Analysis and comparison of the Socket and Pogo Pin Design

4.10 Utilizing a DOE method employing a 2x2 factorial design for optimizing test stand height and overtravel settings enables the systematic identification of the most impactful factors and their ideal levels. This approach promotes improved effectiveness and efficiency throughout your testing protocols. To prevent unauthorized modifications, the overtravel setting was configured on machine settings to include a high level secured by password protection.

Fig. 24 Based on the profiler of the refined model with predictive capability of 94% the best parameter combination to be used to achieve maximum desirability are, Over Travel= 0.15 mm & Stand height = 145.



Servo Press Setting

Servo Press

	Gap (mm)	OverTravel (mm)	OverPress (mm)	OverTravel (pulse)	OverPress (pulse)	TestForce (g)
SP1 - Singulator	0.1	0	0	-1600	0	500
SP2 - R. Precisor	0.05	0	0	-800	0	500
SP3 - Vision Table	0.12	0	0	-1920	0	500
SP4 - Rotor Orient	0.05	0	0	-800	0	500
SP5 - Test Site 1	0	0.15	0.1	2400	1600	1000
SP6 - Test Site 2	0	0.15	0.1	2400	1600	1000
SP7 - Test Site 3	0	0.15	0.1	2400	1600	1000
SP8 - Test Site 4	0	0.15	0.1	2400	1600	1000

Fig. 24. Machine Setting on Over Travel

4.11 No Time limit of Ionizing of Lot and Dirty Canister: Automated Ionizing

Through the transition from manual ionizing to automated ionizing, greater control and efficiency can be introduced into the ionization process. This shift also eliminates the risk of prolonged exposure due to the absence of a time limit, while enhancing overall cleanliness and quality control throughout the production line.

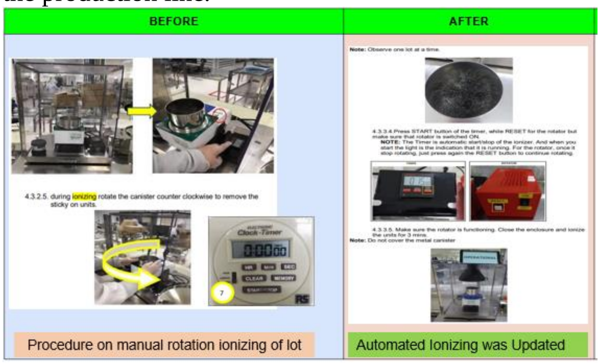


Fig. 25, Manual ionizing to Automated ionizing

4.12 Before and After Performance Comparison after Pilot run

Upon initiating the implementation of CAPAs to address the Kelvin Check Failure of device A during QFN testing, notable advancements were achieved. Within a span of three months, the ppm level fell below the baseline, successfully meeting the target of 11,434 ppm, with the actual count recorded at 4,844 ppm.

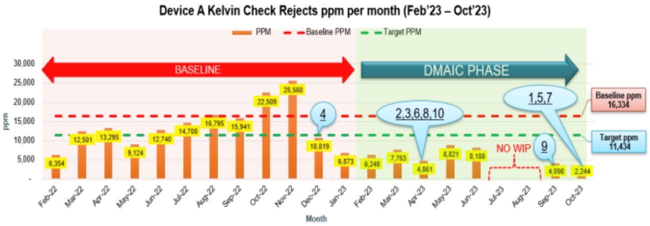


Fig. 26, Performance of Machine after completing all actions.

4.13 Control Phase

All actions and controls were documented and implemented. Furthermore, the PFMEA & Control Plan underwent a thorough review and alignment with the project.

Additionally, a Project Transition Plan for Sign of Black Belt has been developed following the review process.

The project has yielded actual cost savings of 499 USD, meeting the goal of reducing Kelvin Check Failure of device A at QFN Test by at least 30%, from 16,334 PPM to 11,434 PPM. The projected annual cost savings amount to 5,990 USD.

5.0 CONCLUSION

In conclusion, to address the objective of reducing Kelvin Check Failures of device A, a comprehensive approach was adopted. This included the implementation of Corrective and Preventive Actions (CAPAs) chosen from the valid Key Process Input Variables (KPIVs). Additionally, various measures were enacted, such as integrating into the system the PASSED data log references for load boards, redesigning sockets, establishing monitoring for pogo pins tool life, enhancing frequency and sample size in QFN package singulation measurements, executing precisor and turret alignment jigs during setup and maintenance, installing inline air-blow cleaning for sockets, Check Item enhancement of line sustaining personnel during the buy-off during Setup/Repair, redesigning of Test Stand with fix Z-Height and micrometer adjustment on X and Y-axis, optimizing test stand height and overtravel through a Design of Experiments (DOE), and transitioning from manual to automated ionizing of lots.

6.0 RECOMMENDATIONS

In light of the validated impact, this technical paper proposes assessing the potential applicability of the implemented measures to alternative machines and packages.

7.0 ACKNOWLEDGMENT

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Lastly, heartfelt appreciation is extended to all the team members involved in this project, whose selfless dedication and time contributed significantly to its success.

8.0 REFERENCES

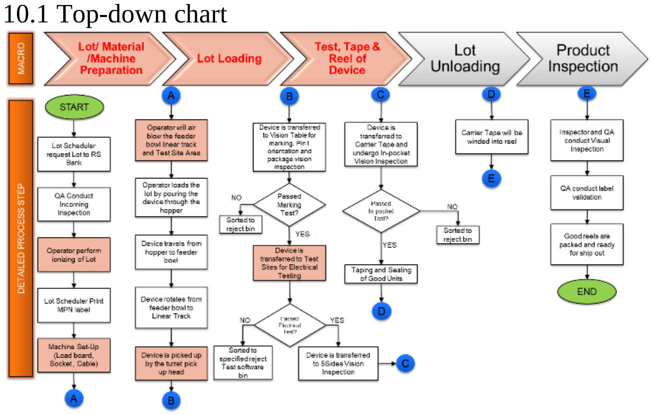
1. LSS Training Material- Lean Six Sigma Pocket Tool Book Michael L. George, David Rowlands, Mark Price and John Maxey

9.0 ABOUT THE AUTHORS

Gimberlyne Joyce L. Barcarse holds the position of Equipment Engineer in the Final Test Department at Onsemi, six years of tenure with the company. She graduated with a degree in Mechatronics Engineering.

10.0 APPENDIX

10.1 Top-down chart



10.2 Fishbone Diagram