DTEK™
Quantitative Optical Inspection

January 17th, 2012

COVISUS

Presentation Content

Section 1: The Counterfeit Problem & Resurfacing

- Project Background
- Anti-Counterfeit Team
- Problem Statement
- Surface Analysis

COVISUS

Anti-Counterfeit Project Background

- Supply chain security technology funded by the US Army Research Office
- Contract fulfilled by ChromoLogic LLC
- Project name: **DTEK**

- Problem statement:

"Counterfeiting, theft and diversion of military equipment are significant issues within the Army especially during times of warfare. The loss and falsification of equipment can severely hamper the Army in its ability to maintain readiness and can significantly compromise the safety of the warfighter. . . A rapid, unambiguous tool for identifying a variety of materiel for both military and civilian locations in which verification of the identity of that materiel is critical."

- US Army Research Office

Covisus Anti-Counterfeit Team

Covisus, Inc.

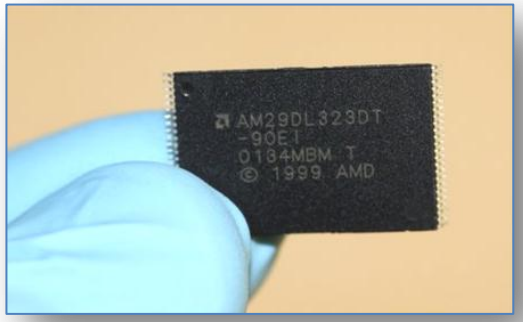
- Based in Pasadena, CA
- A spinoff from ChromoLogic LLC, an R&D company focused on physical and biological diagnostic technology.

Anti-Counterfeit R&D Team:

- Program Manager: Leonard Nelson
- Principal Investigator: Naresh Menon, PhD
- Contributing Scientists
  - Greg Bearman, PhD
  - Dan Reiley, PhD
- Project Manager: Skylar Gauss
- Engineering & Mechanical: Lawrence Yu
  - Andrew Dyer – Assembly and Test
  - Masha Belyi –Algorithm and Test

Covisus benefits from a diverse set of scientific and algorithm development resources at ChromoLogic LLC

Problem Statement



Suspected Counterfeit Component

- A growing number of fraudulent and counterfeit electronic components are entering the supply chain, raising public health, national security, and legal liability concerns.
  - Supply chains are increasing global and complex
  - Organizations must attempt to verify authenticity of both new **and** existing products already in inventories, legacy products, and customer returns.

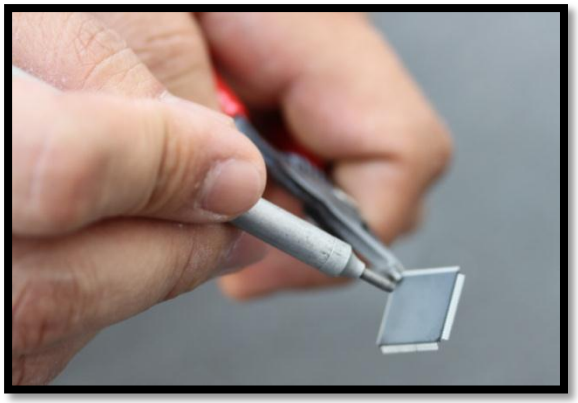
- **Note:** This document is intended for individuals who have some knowledge of the counterfeit issue and understand the severity of the threat.

The Importance of Surface Analysis

- In a major federal study of the defense industrial base, the most common types of counterfeit components identified are various forms of “re-marked” components. Counterfeiters alter or falsify the part markings on new or used components to increase the perceived market value[1]

- Remarking or resurfacing is accomplished by counterfeiters through variety of different techniques include, but are not limited to:

  - **Blacktopping:** Painting the surface of the component with a color matching the component packaging and then adding new part markings. The surface may be sanded prior to blacktopping to remove the old margins.
  - **Epoxy coatings:** The surface is coated with a compound resembling the original mold compound with a similar chemical composition prior to remarking
  - **Microblasting:** A micro-etching tool is used to remove the part markings and superficial surface layers of the component prior to remarking.



Microblasting can be used to alter component surfaces

[1]Defense Industrial Base Assessment: Counterfeit Electronics, January 2010, US Department of Commerce Bureau of Industry and Security

Section 2: Quantitative Optical Inspection - Introduction

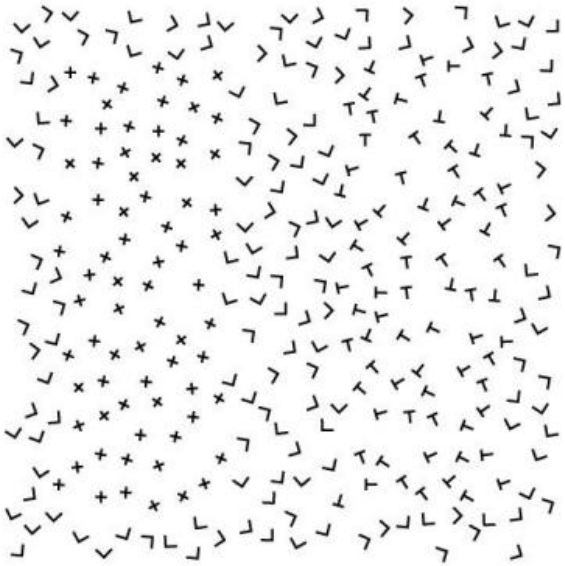
- Fundamental Limitations in Current Methods
- Distinguishing Characteristics of Counterfeits
- DTEK Introduction
- Quantitative Optical Inspection
- Performance on Common Counterfeit Methods
- Importance of Surface Patterns
- Visual Demonstration with SEM
- Summary

COVISUS

Fundamental Limitations in Current Methods

Question: Why is the boundary of the "T" pattern in the image on the right more difficult to perceive than the boundary of the "+" pattern?

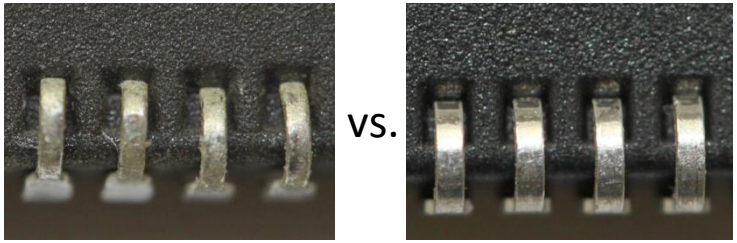
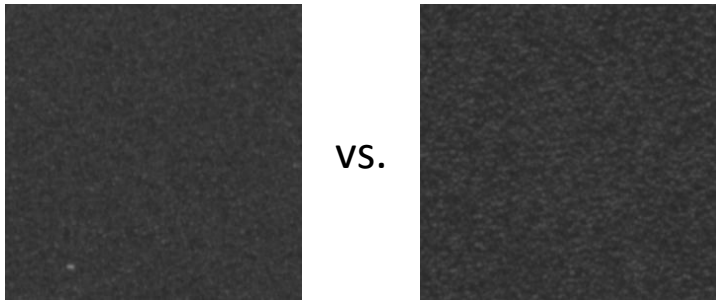
Answer: The human perceptual system is limited in it's ability to perform pattern recognition, even with the aid of microscopy and advanced analysis tools.[1]



Impact: Qualitative inspection methods by human inspectors can "miss" valid evidence of non-conformance due to pattern complexity.[2]

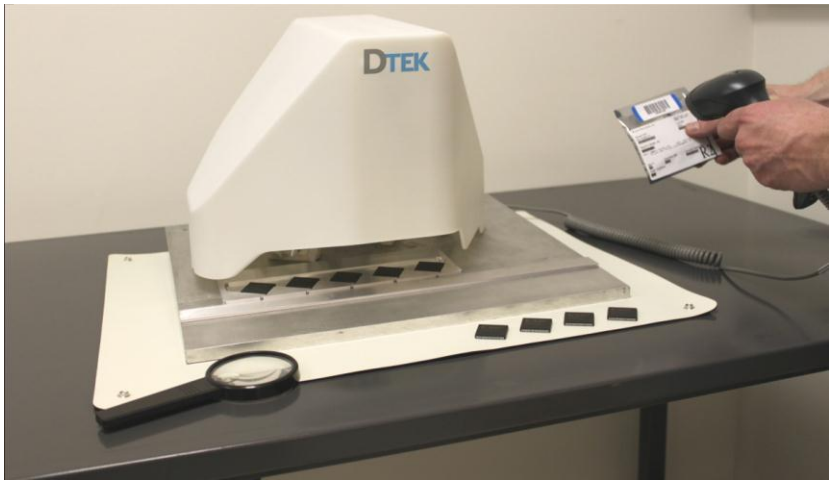
1. *Characterizing the Limits of Human Visual Awareness. Huang, L. Science. Vol. 317 no. 5839 (2007)*
2. *Visual Perception of Texture. Landy, M. New York University. 2002 (source of image above)*

Distinguishing Characteristics of Counterfeits

Comparison Type	Description	Example: Xilinx XC3030A Counterfeit vs. Authentic	Comments
Perceptive comparison	Difference obviously perceptible to trained human observer		Corrosion and non-coplanarity are instantly apparent upon visual inspection with our magnification aids
Cognitive comparison	Requires time and concentration for human observer to decipher or describe the difference		The difference between the logos can be deciphered by a trained visual inspector and compared to the datasheet. Concentration and experience is required
Quantitative Comparison (DTEK)	Quantitative analysis of seemingly random surface patterns that can not be easily characterized by a human observer		The surface patterns on the unmarked surfaces exhibit differences that can be described quantitatively, but are difficult to describe qualitatively.

DTEK Introduction

The DTEK information service ("DTEK") provides unambiguous ***quantitative*** information about external packaging of electronic components.



The DTEK 2.0 Benchtop Unit

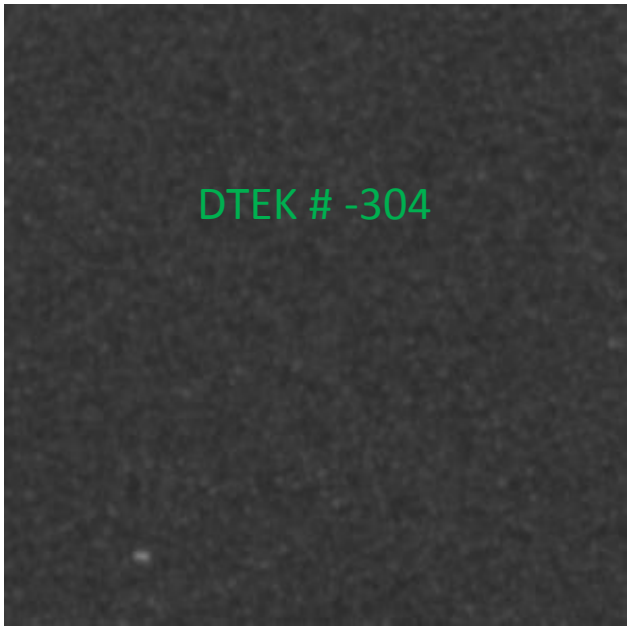
Goal: Provide a rapid, non-destructive tool to help identify suspect non-conforming, resurfaced, or remarked components

DTEK Quantitative Optical Inspection

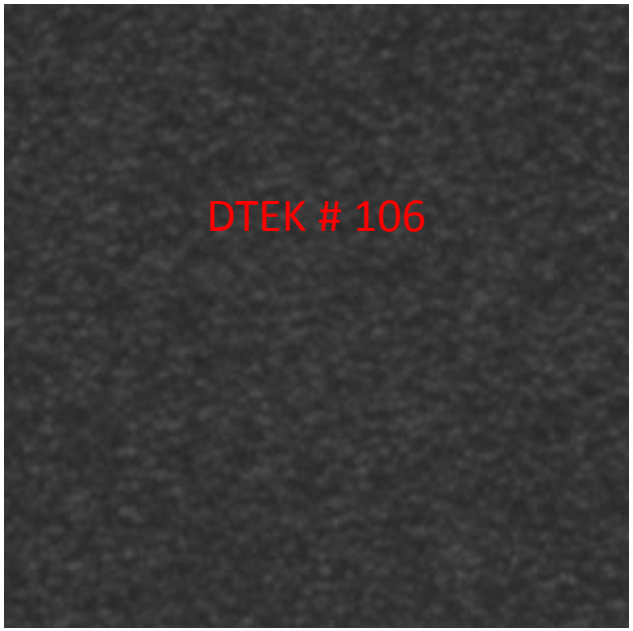
DTEK *quantifies* subtle patterns on the electronic component packaging:

1. Quantitative surface information used for comparative analysis
2. Able to store, recall, and apply conformance information across your supply chain

Authentic



Counterfeit



DTEK quantitatively identifies the component on the right as non-conforming

Performance on Common Counterfeit Methods for Electronic Components

- DTEK has demonstrated the capability to identify surface non-conformance due to component re-marking.
- Note - this does not imply that DTEK is capable of identifying these type of counterfeit components with 100% accuracy.

Surface Remarking (Counterfeit) Method	With an Authentic Reference Sample	Without an Authentic Reference Sample
Blacktopping and remarking *(Section 4: Part 1)*	Yes	Yes
Acetone-resistant epoxy coatings *(Section 4: Part 1)*	Yes	Yes
Microblasting *(Section 4: Parts 2 &3)*	Yes	Yes
Used components represented as new *(not re-marked)*	No	No

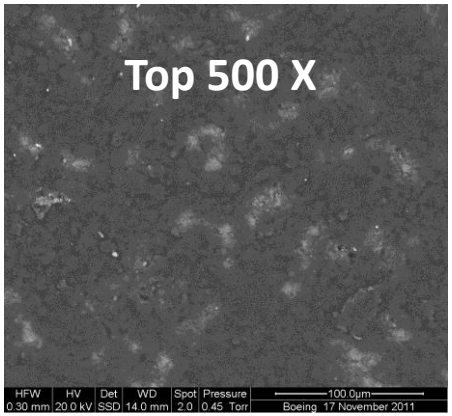
Visual Demonstration of the Importance of Surface Patterns

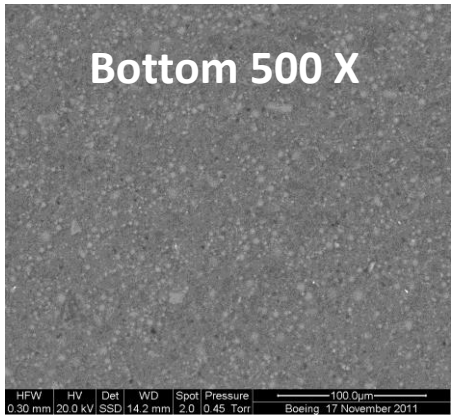
- The importance of surface patterns can be observed at high levels of magnification with tools such as scanning electron microscopy (SEM)
- The surface patterns measured by DTEK at low optical magnification can be visually distinguished with microscopy techniques such as SEM at higher magnification levels
- The following four (4) slides show an SEM surface analysis for two sets of counterfeit components and matching authentic samples
- The SEM is a FEI Quanta 600-F

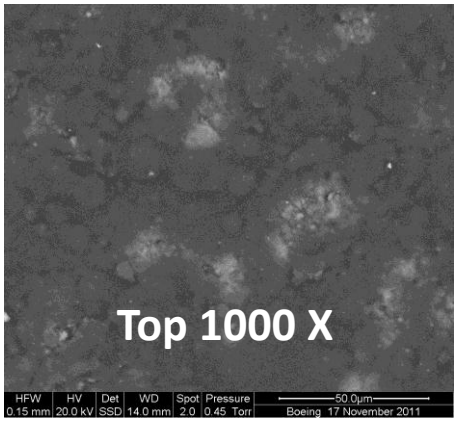
Component Set 1: SEM Inspection
AMD AM29DL323DT

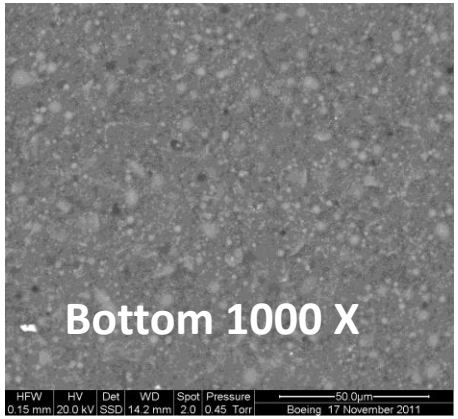
COVISUS

Blacktopped Counterfeits

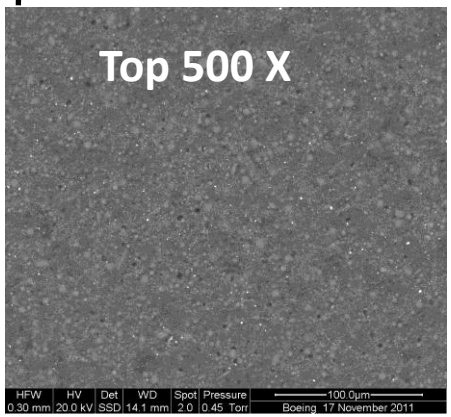


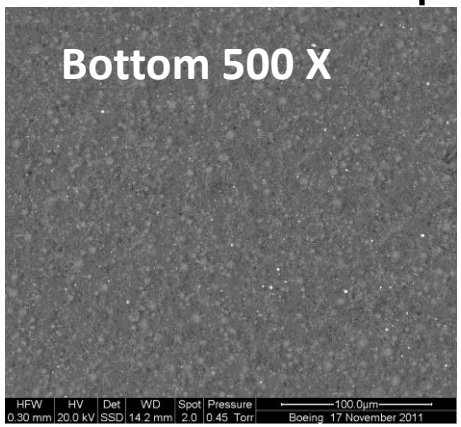


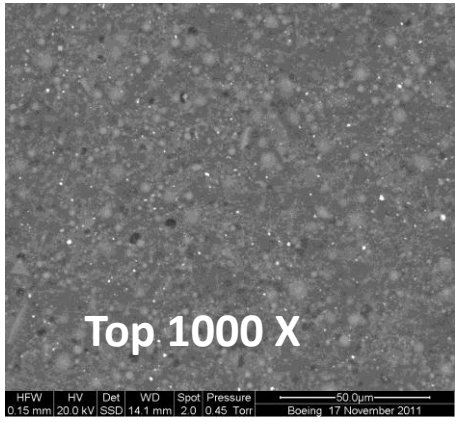


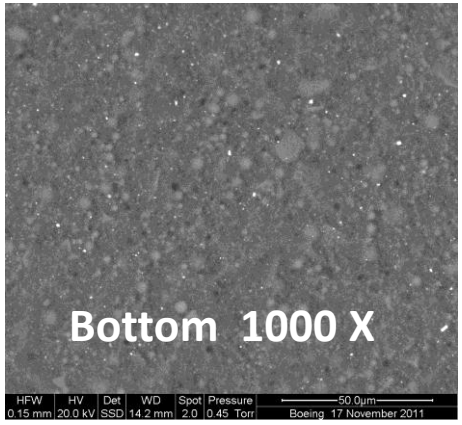


Authentic



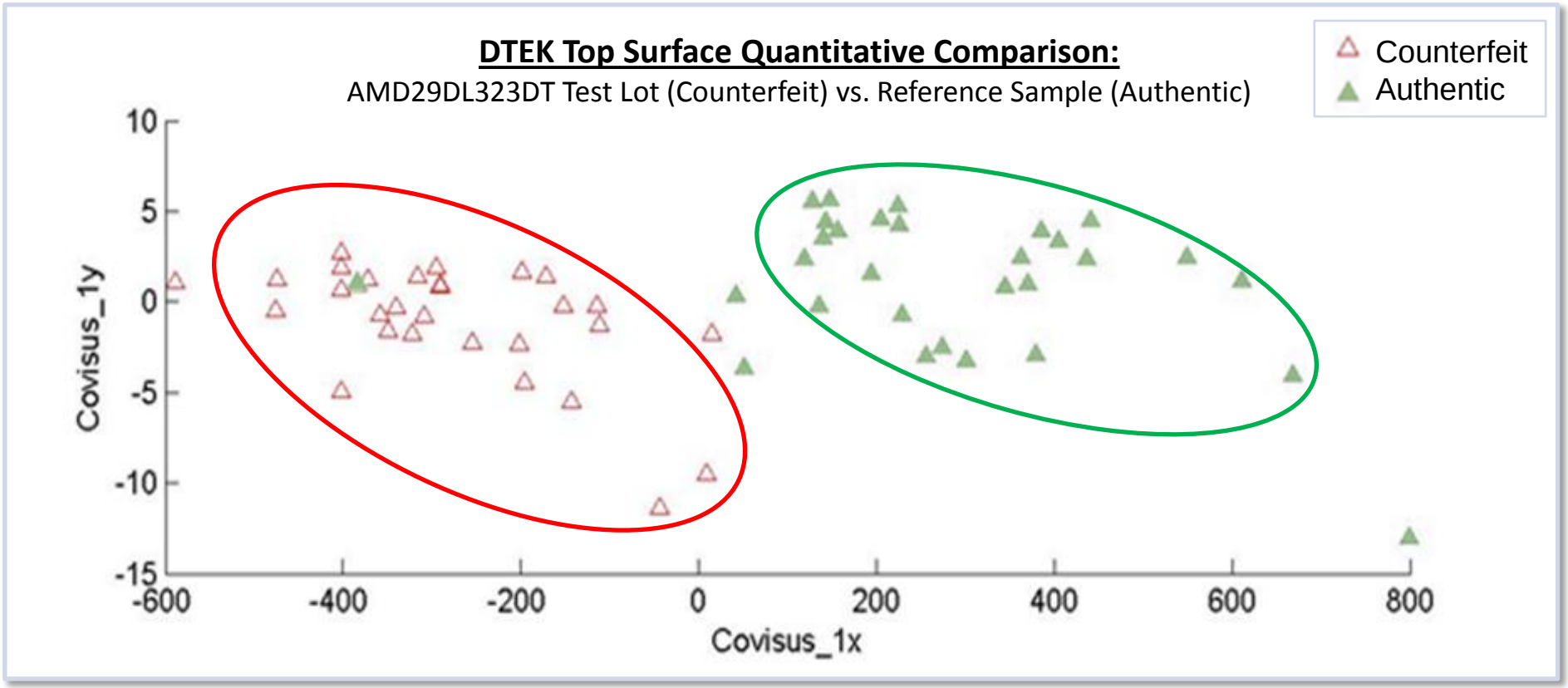






Component Set 1: DTEK Inspection
AMD AM29DL323DT

Quantitative Comparison: DTEK generates a pair of descriptive values (Covisus_1x and Covisus_1y) of sample surfaces surface to provide a quantitative basis for comparison.



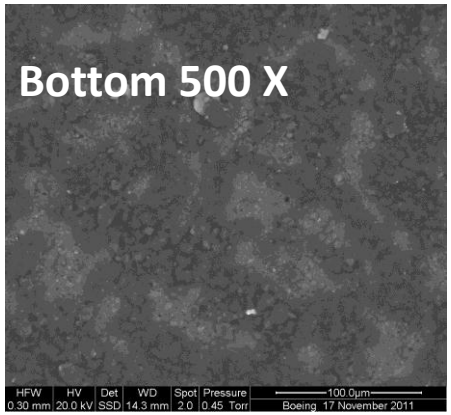
Clear difference between the re-marked counterfeit (red) and authentic (green) groupings.

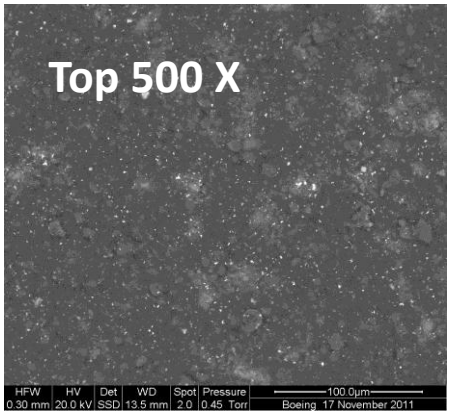
Component Set 2: SEM Inspection
Xilinx XC3030A

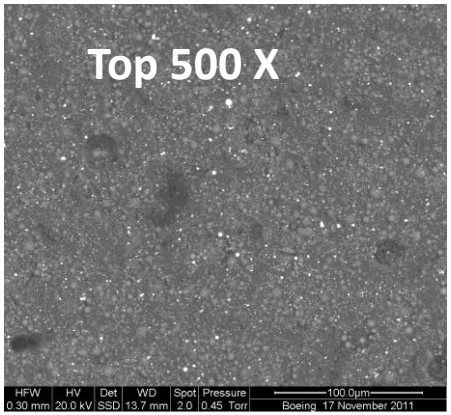
COVISUS

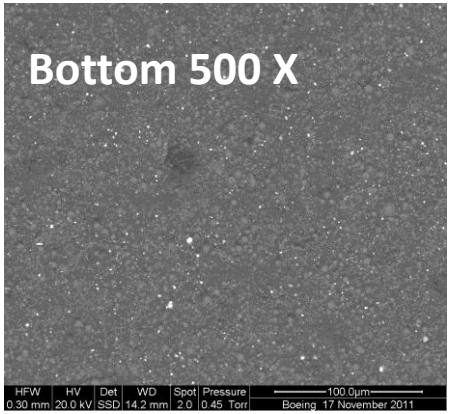
Epoxy-Coated Counterfeits

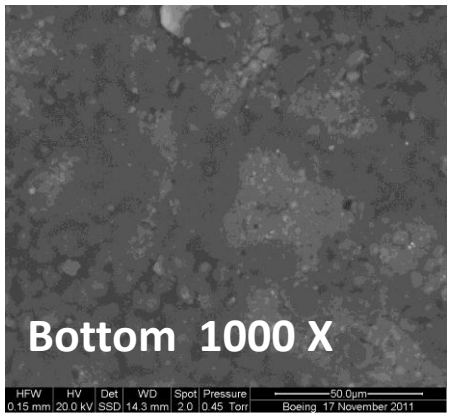
Authentic

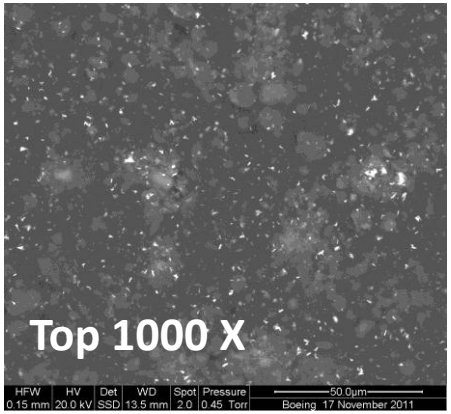


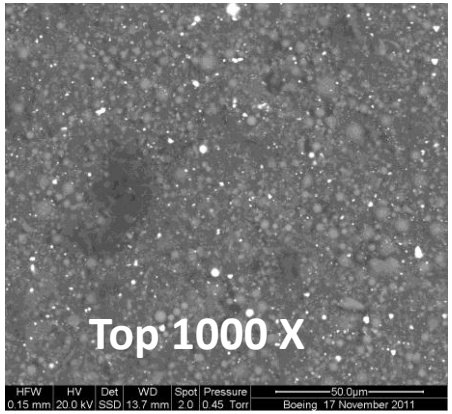


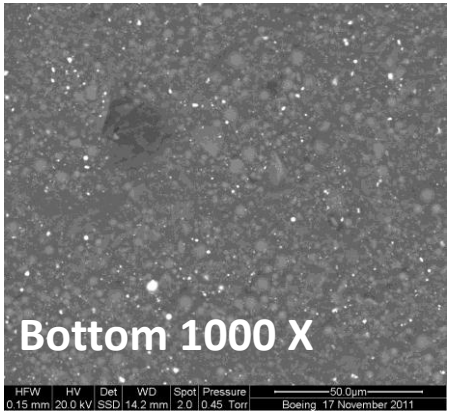






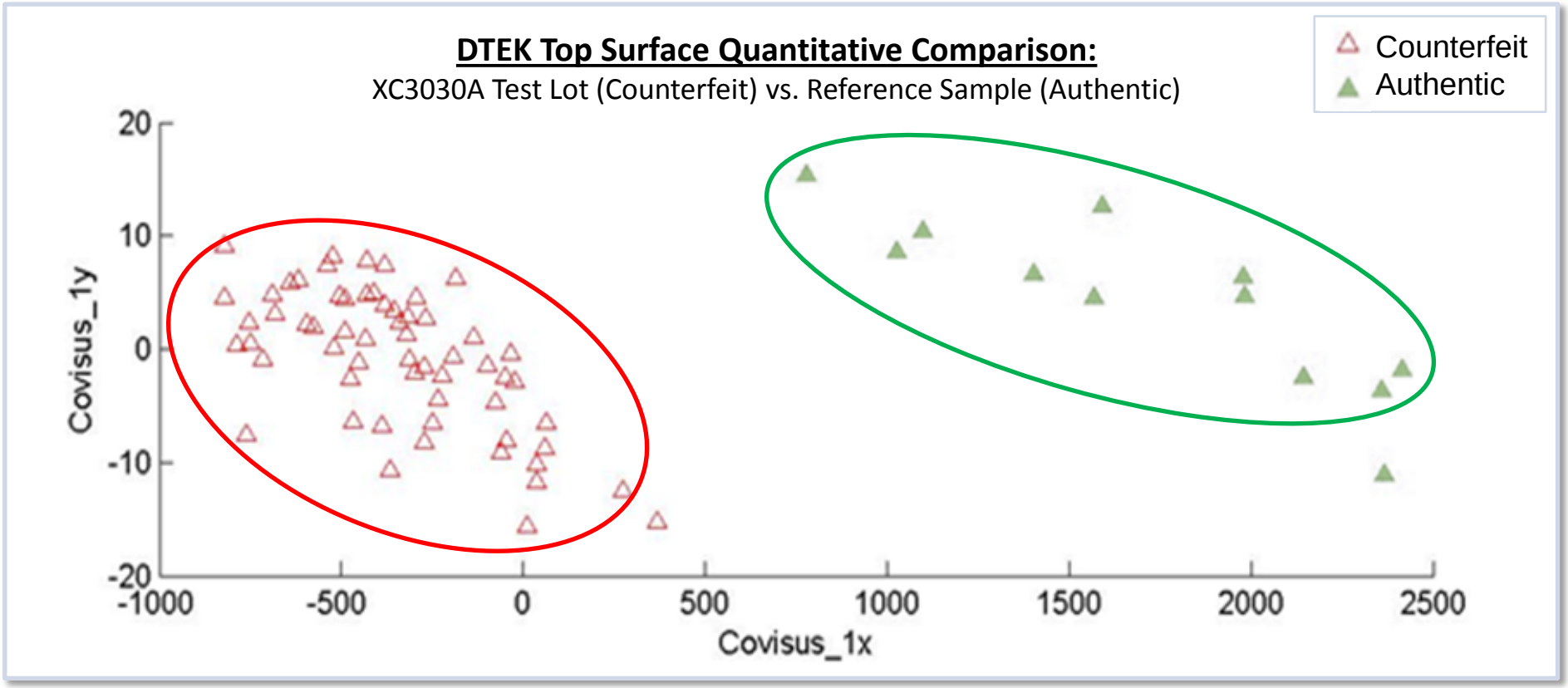






Component Set 2: DTEK Inspection
Xilinx XC3030A

Quantitative Comparison: Again, a plot of descriptive top surface quantitative values from a DTEK scan (Covisus_1x and Covisus_1y are generated by DTEK).



Again, a clear difference between re-marked counterfeit (red) and authentic (green) values.

SECTION 2: Summary

- The human perceptual system is limited in its ability to perform pattern recognition, even with advanced analysis tools. Thus, even an expert inspector can "miss" valid evidence of non-conformance.

- The DTEK information service ("DTEK") provides unambiguous ***quantitative*** information about external packaging of electronic components.

Section 3: DTEK Service Overview

- Design Considerations
- Terminology
- Usage Overview
- Reports
- Test Logic (DELTA TANGO ECHO KILO)
- Summary

DTEK Design Considerations

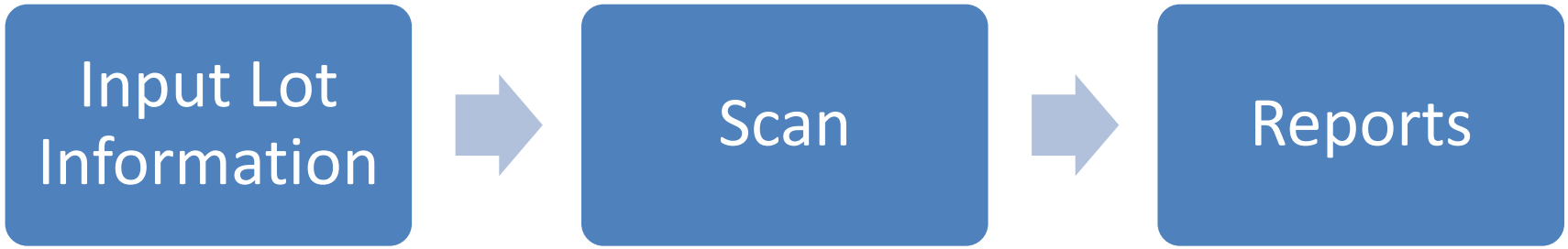
- **Rapid**: Scan time under 1 second and time to results average less than five (5) minutes
- **Non-destructive**: No harmful solvents, scraping, or invasive testing
- **Safe**: Does not emit any harmful byproducts
- **Efficient**: No change to existing manufacturing or distribution processes required
- **Practical:** Designed for benchtop use in the shipping, receiving, and quality inspection process

- **Use Scenario:** Designed to be used prior to external visual inspection and destructive remarking/resurfacing tests such as solvent testing

DTEK Terminology

- Device Under Test: “DUT” is the unknown part being tested
- Reference Control Sample: “RCS” is the Authentic Part or “Golden Sample.”
- Mean: The average DTEK result for a sample component surface.
- Separation: A value for the relative difference between the DTEK results for sampled electronic component surfaces.

Usage Overview



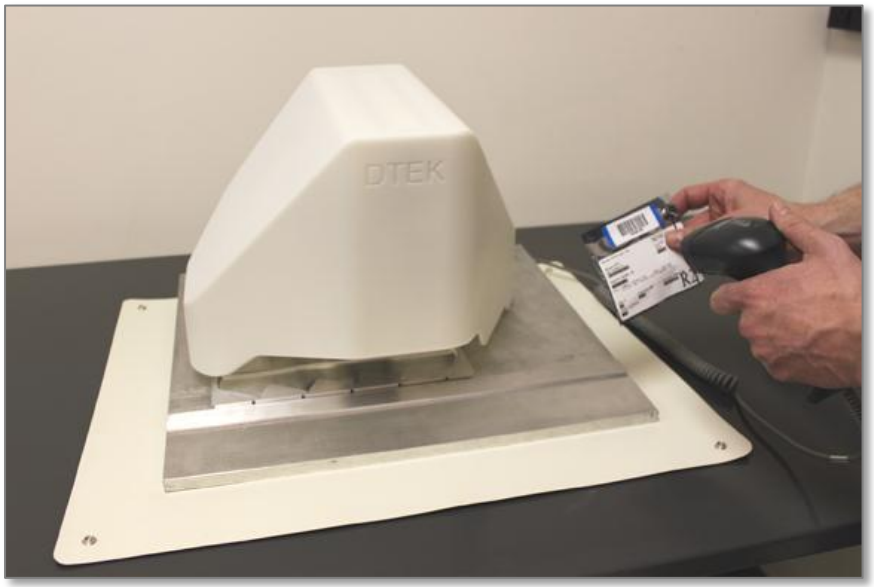
Barcode scan or manual data entry

Bench top unit with tray-based loading

Customizable HTML or PDF

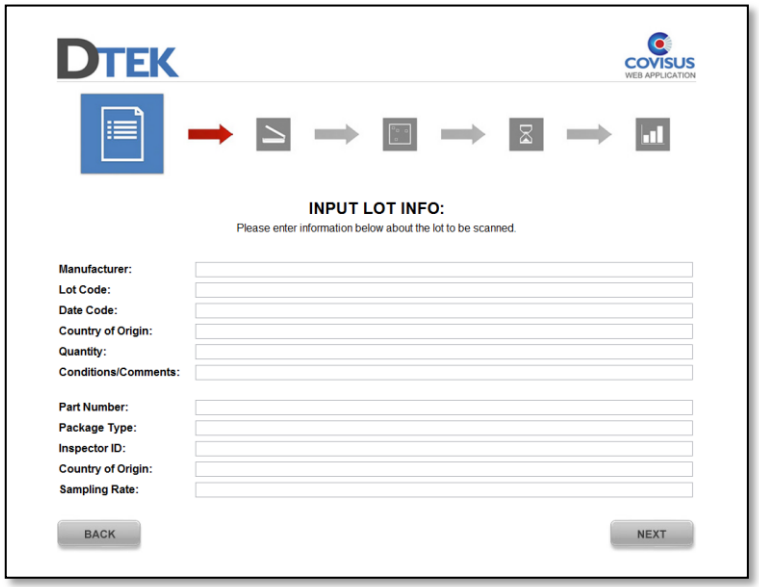
Usage Overview

Input Lot Information → Scan → Reports



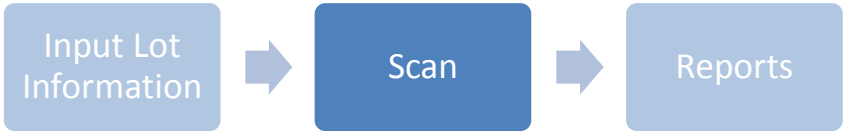
Step 1: Input Lot Information via barcode scanner

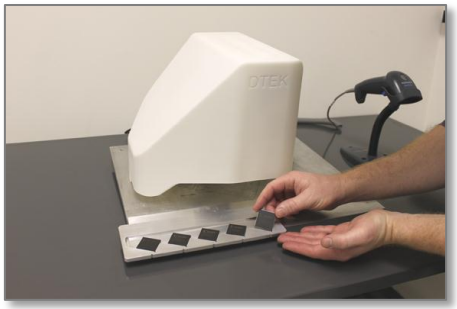
or



Input Lot Information via DTEK application

Usage Overview





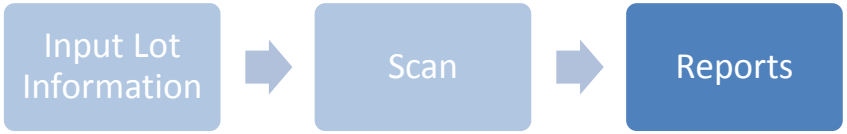
Step 2: Load Component Samples

Step 3: Scan Top Surfaces

Step 4: Flip Components

Step 5: Scan Bottom Surfaces

Usage Overview



Reports include summary results and data for four tests:

1. **DELTA:** Comparison vs. Reference Sample
2. **TANGO:** Top vs. Bottom Comparison
3. **ECHO:** Top Surface Conformance ("peppering test")
4. **KILO:** Bottom Surface Conformance ("peppering test")

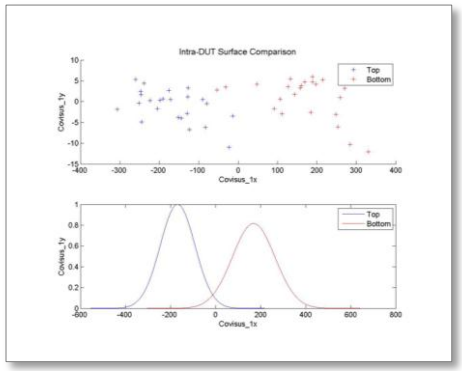
Summary results have three potential outcomes:

Pass

Fail

Not Applicable

Summary Results (First Page)



Drill-Down to Detail

Reports: Surface Values Considered

- Following a DTEK scan, the system generates up to four sets of descriptive quantitative surface values:
  - **DUT-Top:** Top surfaces of the test lot sample
  - **DUT-Bot:** Bottom surfaces of the test lot sample
  - **RCS-Top:** Top surface of the reference sample
  - **RCS-Bot:** Bottom surface of the reference sample

- DTEK result logic is based on a comparative analysis conducted using the central tendencies and variations of the above sets of quantitative surface values

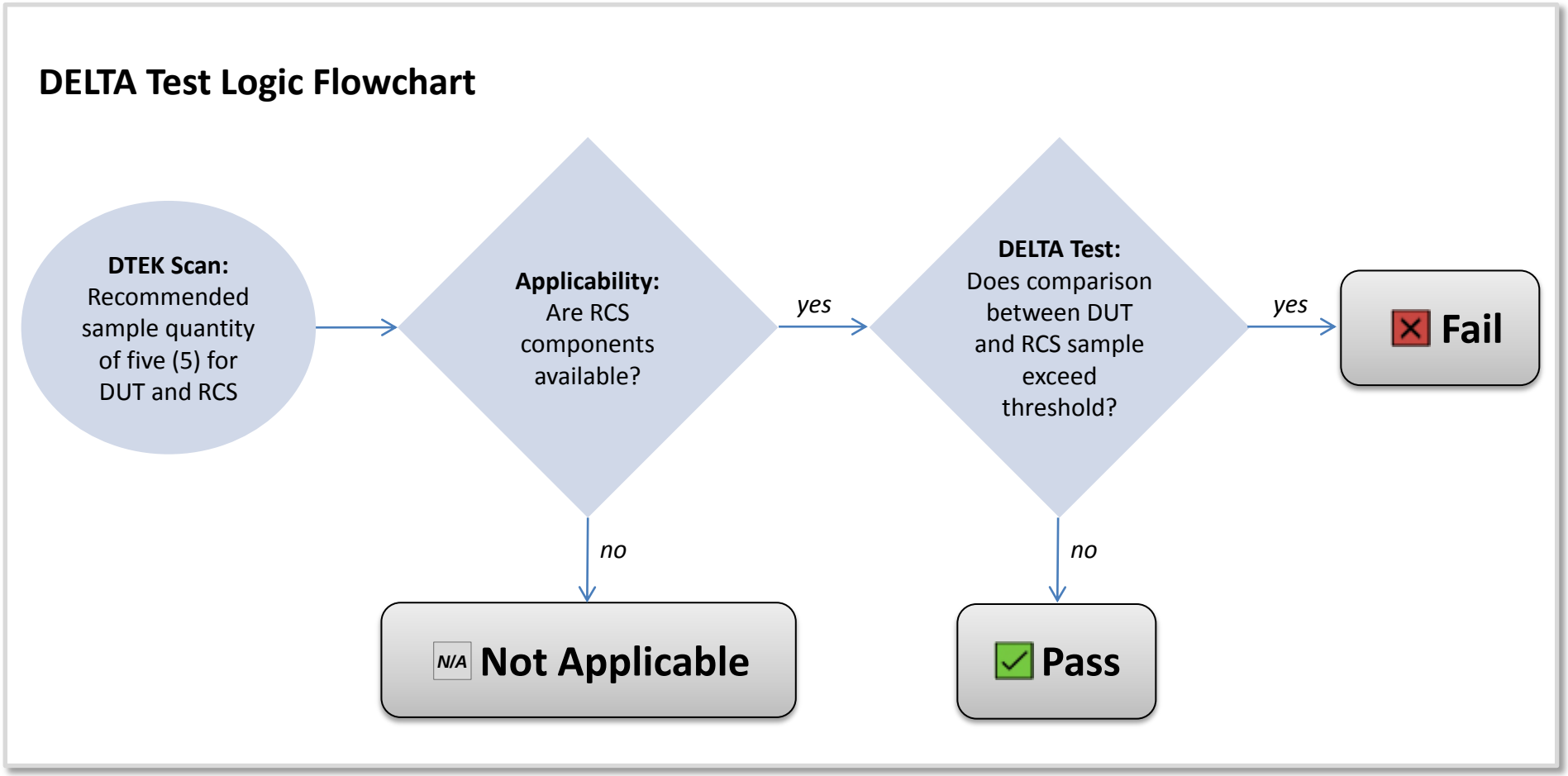
Reports: DTEK Comparative Tests

COVISUS

Test Name	Description of Comparative Test	Values Compared
DELTA	Compares the test lot sample versus a user-supplied reference sample of known quality	DUT-Top vs. RCS-Top
TANGO	Compares the top and bottom characteristics of the test lot components	DUT-Top vs. DUT-Bot
ECHO	Examines variations within the top surface characteristics of the test lot sample in order to identify lot mixing or “peppering”	DUT-Top (identifies extreme variance within the test sample)
KILO	Examines variations within the bottom surface characteristics of the test lot sample in order to identify lot mixing or “peppering”	DUT-Bot (identifies extreme variance within the test sample)

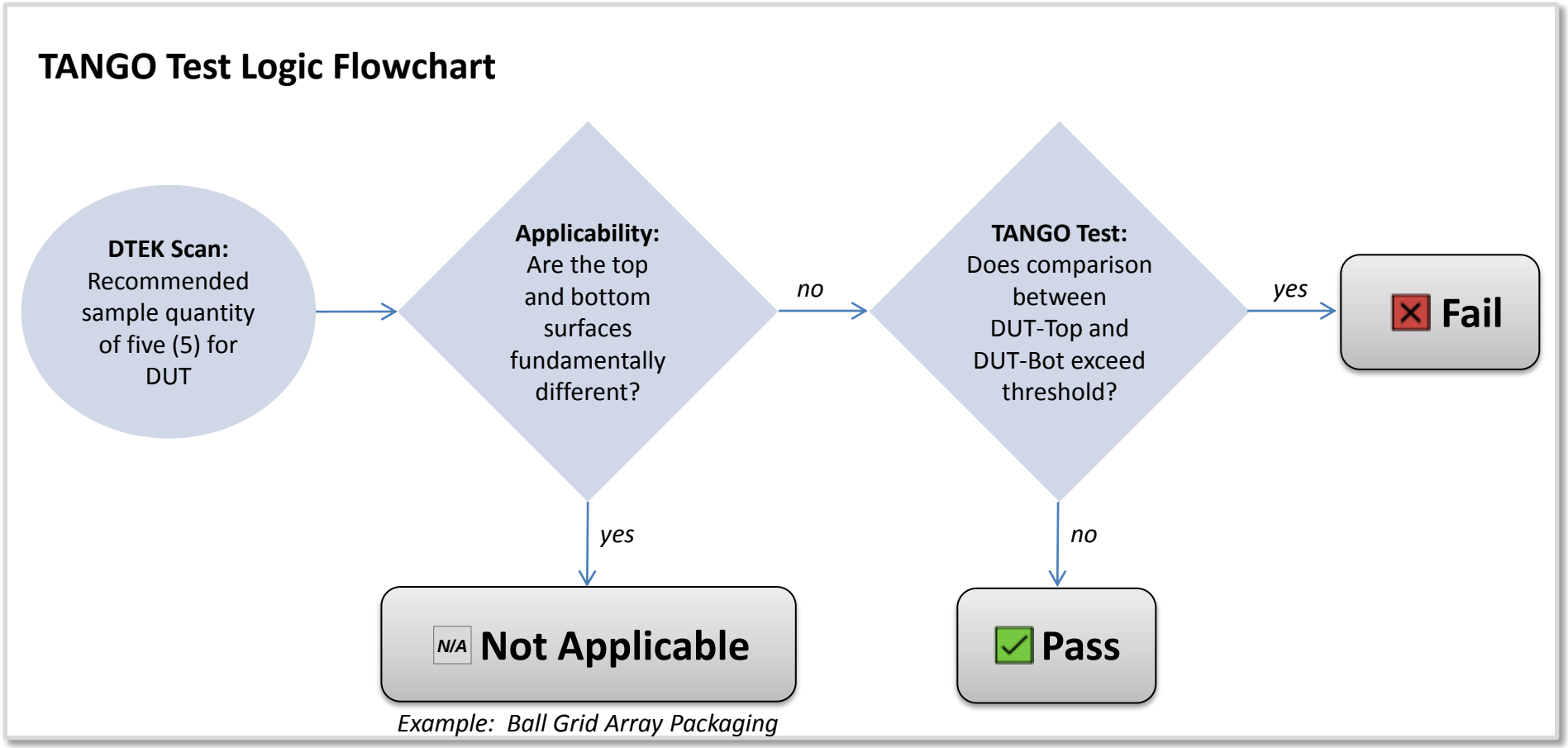
Test Logic: DELTA

DUT-Top vs. RCS-Top: Comparison to a reference sample



Test Logic: TANGO

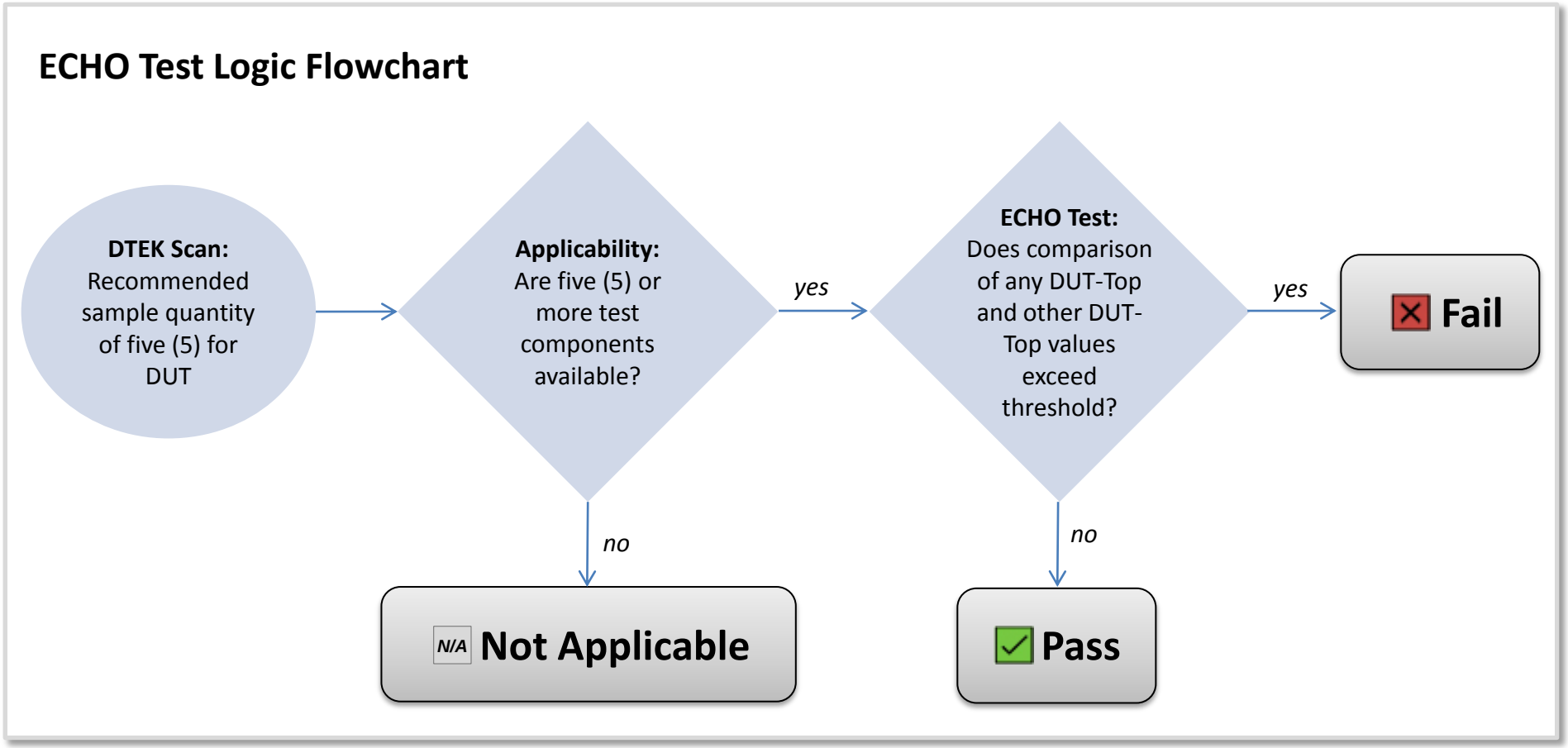
DUT-Top vs. DUT-Bot: Top versus bottom comparison



Note: If a reference sample is available, additional logic can be applied as part of the TANGO test.

Test Logic: ECHO

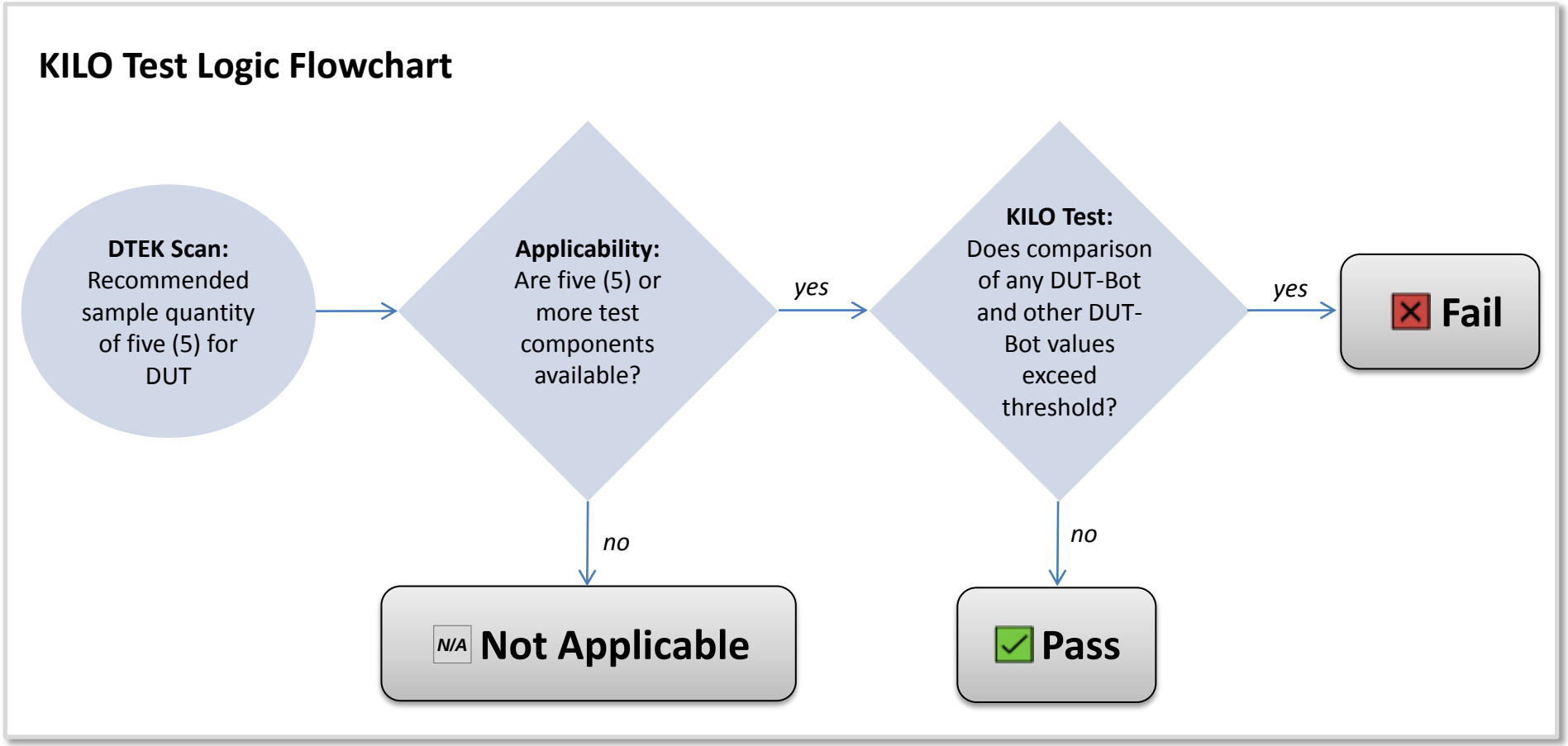
DUT-Top: Examines variance within the test sample top surfaces ("peppering" test)



Note: A failing result also indicates which specific component(s) in the test sample fail the DELTA test.

Test Logic: KILO

DUT-Bot: Examines variance within the test sample bottom surfaces ("peppering" test)



Note: A failing result also indicates which specific component(s) in the test sample fail the DELTA test.

SECTION 3: Summary

- DTEK is Rapid, Non-Destructive, and safe.
- DTEK performs **4 tests** and provides **3 results** (when applicable)
  - DELTA, TANGO, ECHO, KILO
- Users should expect some false positive and false negative results, and DTEK is not capable of identifying counterfeit components with 100% accuracy.

Section 4: Testing and Representative Results

Part 1: Global IC Trading Group

- **Test Method**
- **Result Classification**
- **Test Category 1 – Authentic vs. Counterfeit** ***(Blacktopping, Epoxy Resurfacing)***
- **Test Category 2 – Counterfeit Only** ***(Blacktopping, Epoxy Resurfacing)***
- **Test Category 3 – Authentic Only** ***(Factory Traceable)***
- **Summary**

Part 2: Microblast Testing – SMT Corp.

Part 3: Microblast Testing – G19A

Part 4: False Positives

COVISUS

Goals (Pre-Test) with Global IC Trading Group

Goal of Study:

The study was meant to determine the conformance of the test sample to a reference control sample ("golden sample"), or to identify evidence of known properties of counterfeit components in the absence of a golden sample. The proposed study will utilize the external packaging characteristics to test the following hypotheses:

- Components identified as suspect counterfeit components by other test methods can be identified by DTEK. This can be done with or without a golden sample.
- Authentic components share common characteristics and do not create false positives ("false alarms") by DTEK at a high rate.
- DTEK is able to quantify surface characteristics of both authentic and non-conforming (suspect counterfeit) electronic components.
- DTEK is able to identify "Peppering" or heterogeneous lots with both authentic and non-conforming (suspect counterfeit) electronic components in the sample.

Comparison Test (DELTA and TANGO) Passing Criteria:

In comparison tests, a "separation" value > 2 indicates a large separation between the two sets of data, and the sets are classified as *Non-Conforming*. Reference samples will be acquired with Global IC's assistance from authorized distribution or direct from the manufacturer.

Intra-Lot Conformance Tests (ECHO and KILO):

Tops and Bottoms of all chips in the lot are compared to each other. Outliers are flagged if any component(s) do not conform to the rest of the lot.

Result Classifications (Pre-Test) with Global IC Trading Group

Result Classification	Description
False Positive	The system flags an authentic, conforming lot of components as non-conforming by failing the lot incorrectly on one or more analysis modes.
False Negative	The system fails to flag a non-conforming lot of components by failing to identify non-conformance on at least one of the three analysis modes.
True Positive	The true identification of a non-conforming lot through one or more analysis modes.
True Negative	The true identification of a conforming lot through all available analysis modes.

Note: The result classification is evaluated against the conformance of the part, not the disposition of the lot as suspected counterfeit or conforming. As an example – if an component is identified as an outlier and the component surface itself is found to be marred or materially non-conforming, through another method, such as microscope inspection, that would not be a false positive determination, even if the overall lot is authentic.

Test Category 1: Authentic vs. Counterfeit

Part Name & Date Code	Type and Quantity	Special Notes	DELTA	TANGO	ECHO	KILO	Result Classification
Silicon Laboratories DC 0545	DUT (5)	Fail Visual Inspection	Separation = 5.97	Separation = 3.40	0	0	True Positive
	RCS (5)	Top/bot have plastic pkg. but visibly diff. surface		Separation = 3.29	0	0	
Sharp DC 0826	DUT (10)	Blacktopped on Top only	Separation = 4.72	Separation = 3.59	0	1	True Positive
	RCS (10)	Direct from factory		Separation = 0.53	0	0	
International Rectifier DC	DUT (14)	Used parts sold as new	Separation = 0.08	Separation = 1.48	1 (part 4, prob due to dirt)	0	True Positive
	RCS (5)			Separation = 1.68	0	0	

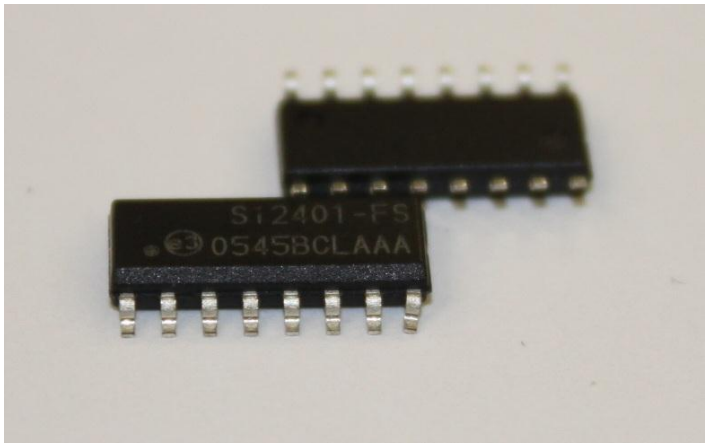
Note: All of these are pairs of Counterfeit and Golden Samples

Note: Slides 39-44 are representative results for the test lots.

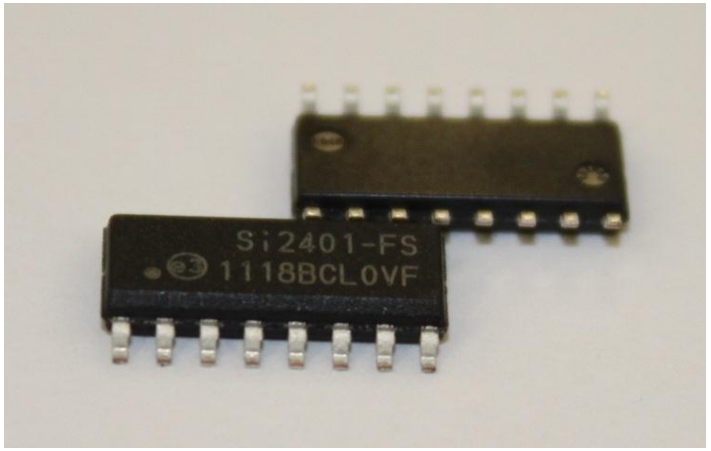
DTEK Report: Silicon Laboratories DC 0545

COVISUS

Authentic



Counterfeit



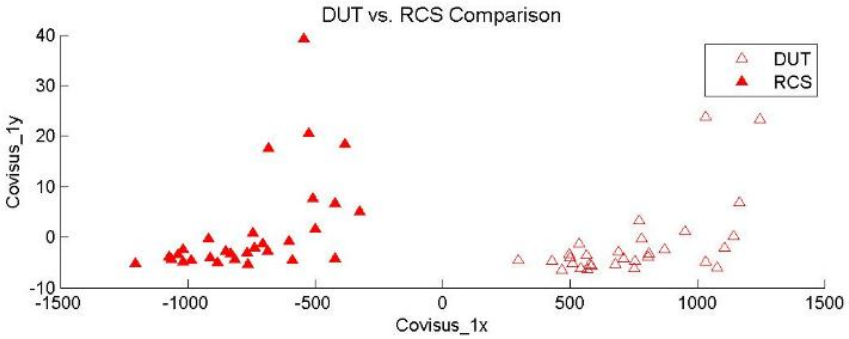
Correct Result (True Positive)

- ☒ **DELTA:** *The DUT and RCS do not conform*
- ☑ **TANGO:** *The top and bottom conform*
- ☑ **ECHO:** *Top outliers were not found*
- ☑ **KILO:** *Bottom outliers were not found*

Silicon Laboratories DC 0545 Graphs

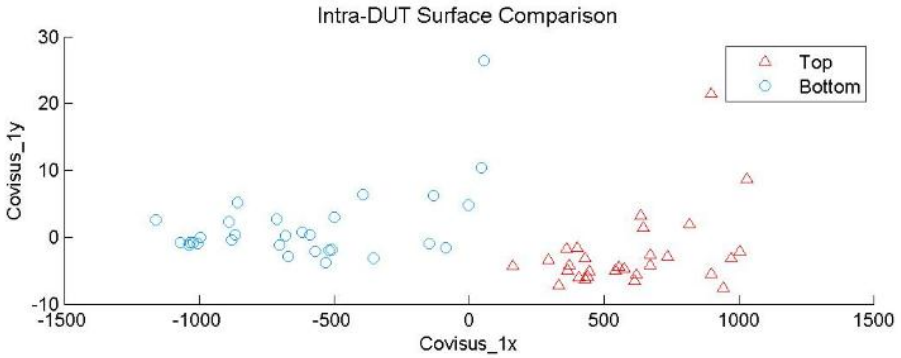
DELTA

DUT vs. RCS are dissimilar

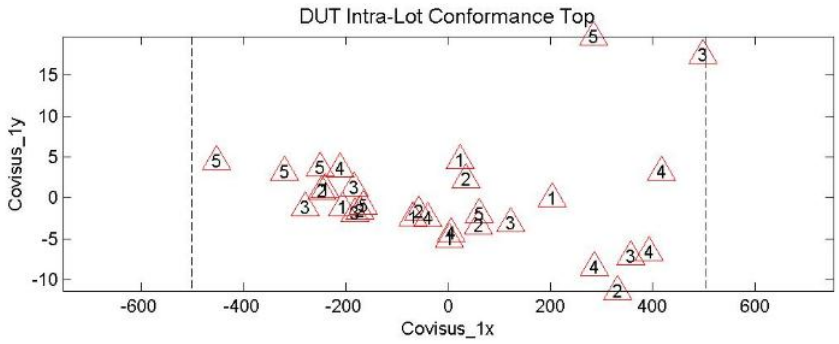


TANGO

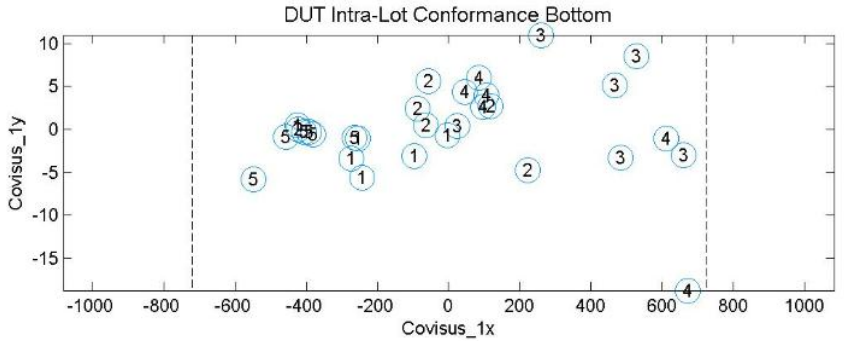
Top vs. Bottom of both component groups were expected to be different



ECHO



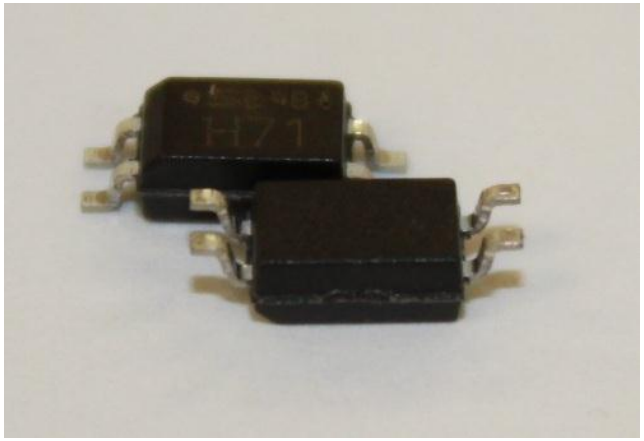
KILO



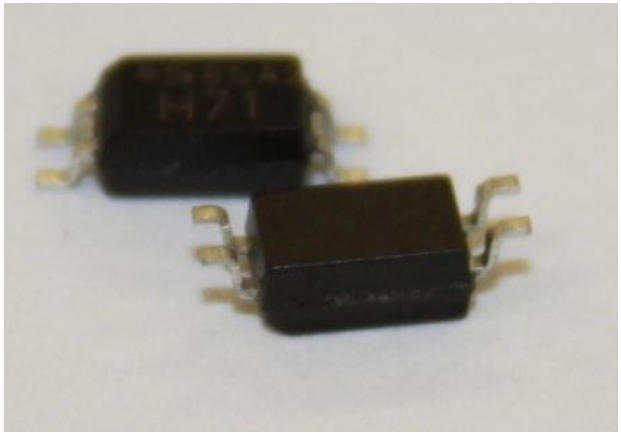
DTEK Report: Sharp DC 0826

COVISUS

Authentic



Counterfeit



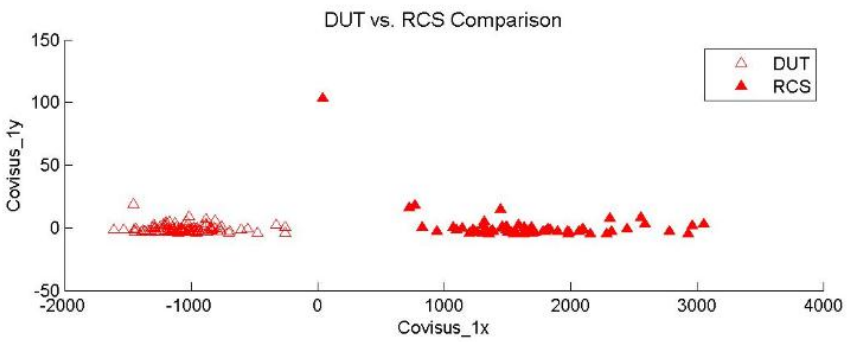
Correct Result (True Positive)

- ☒ **DELTA:** *The DUT and RCS do not conform*
- ☒ **TANGO:** *The top and bottom do not conform*
- ☑ **ECHO:** *Top outliers were not found*
- ☒ **KILO:** *Bottom outliers were found*

Sharp DC 0826 Graphs

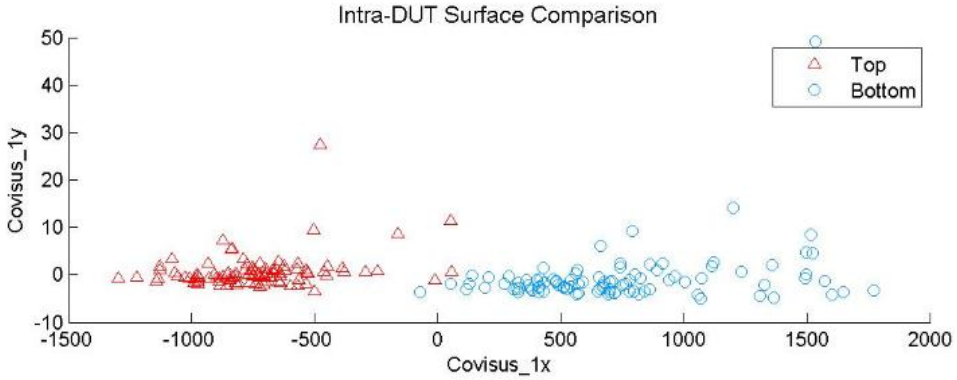
DELTA

DUT vs. RCS are dissimilar

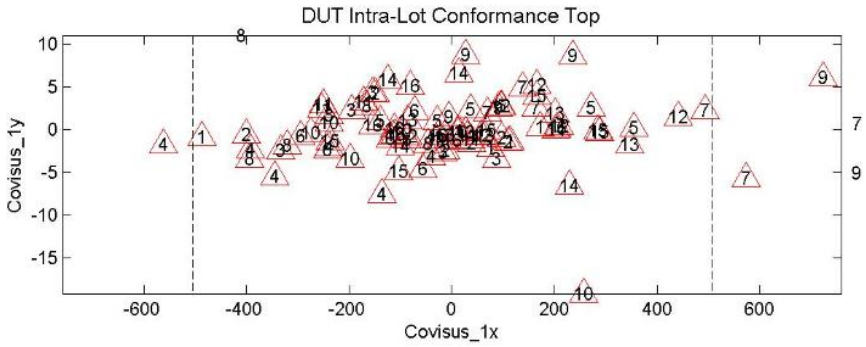


TANGO

Top vs. Bottom of the component groups do not conform to each other

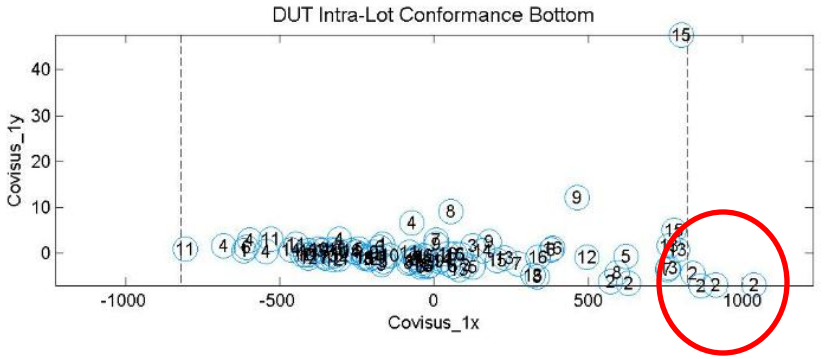


ECHO



KILO

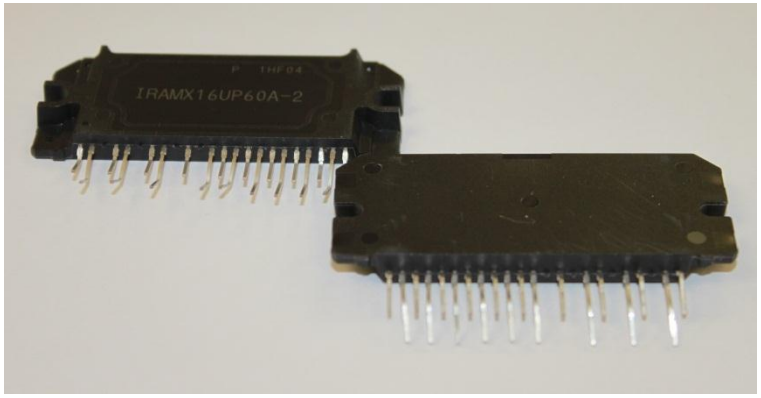
Part # 2 is an outlier



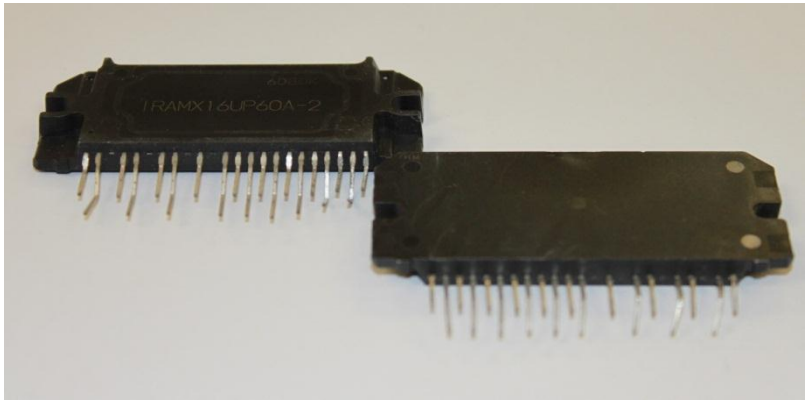
DTEK Report: International Rectifier

COVISUS

Authentic



Counterfeit



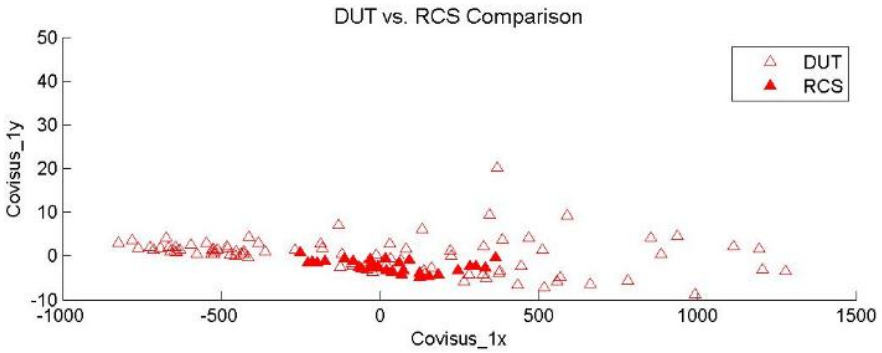
Correct Result (True Positive)

- ☑ **DELTA:** *The DUT and RCS conform*
- ☑ **TANGO:** *The top and bottom conform*
- ☒ **ECHO:** *Top outliers were found (Component #4)*
- ☑ **KILO:** *Bottom outliers were not found*

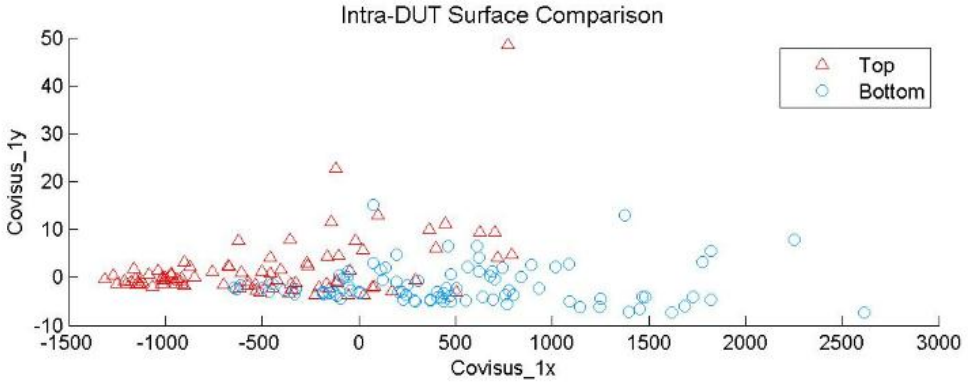
Authentic used parts sold and represented as new.
The ECHO Test likely failed due to dirt or scratch marks.

International Rectifier Graphs

DELTA

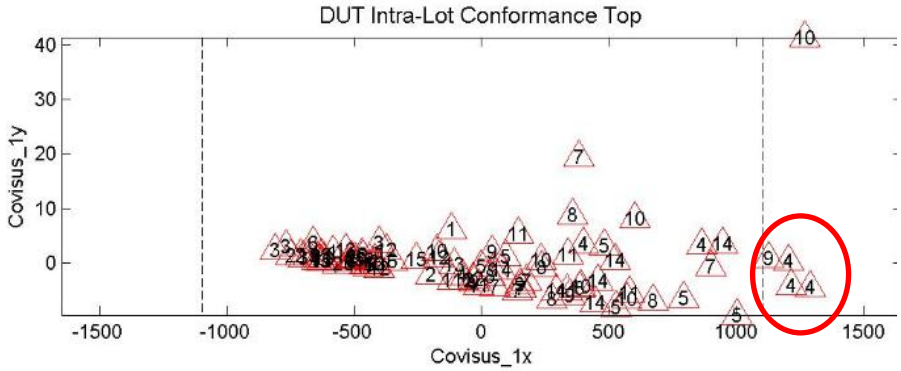


TANGO

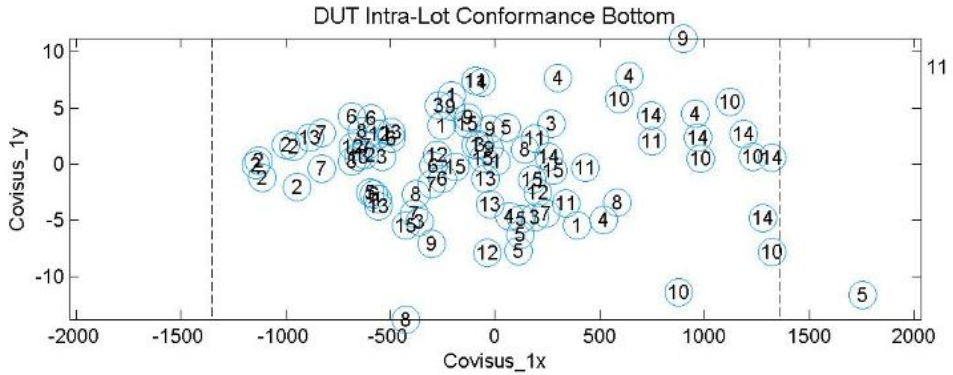


ECHO

Part # 4 is an outlier



KILO

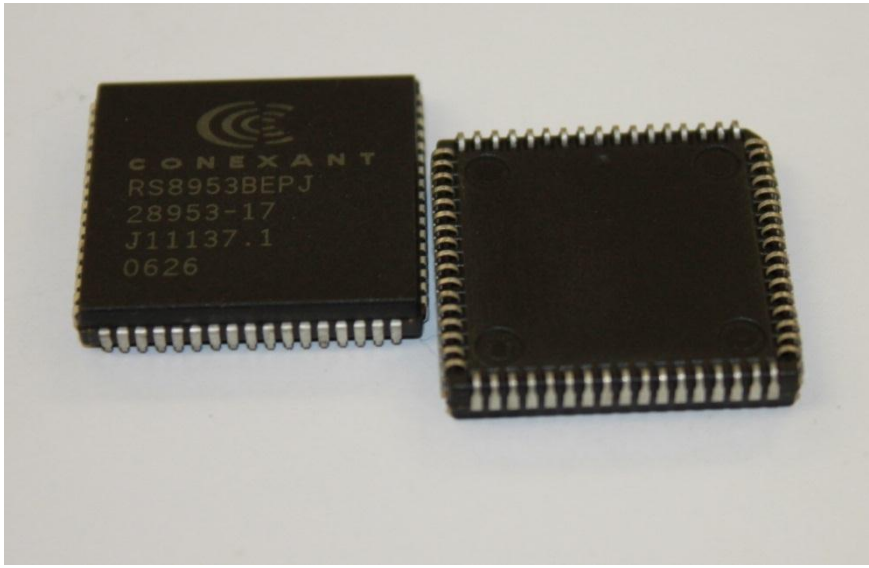


Test Category 2: Counterfeit Only

Part Name & Date Code	Type and Quantity	Special Notes	DELTA	TANGO	ECHO	KILO	Result Classification
Conexant DC 0626	DUT (20)	Sanded and sprayed top/bottom. Two different dies and Lead Frames	NA	Separation = 0.04	1	0	True Positive
Cypress DC 0523	DUT (8)	Blacktopped	NA	Separation = 2.82	1	0	True Positive
Conexant DC 9942	DUT (5)	Blacktopped	NA	Separation = 4.1	0	0	True Positive

Note: Slides 46-51 are representative results for the test lots.

DTEK Report: Conexant DC 0626



Correct Result (True Positive)

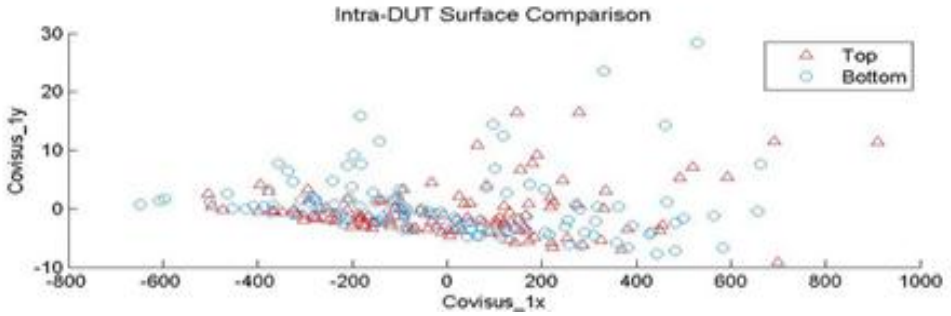
- N/A **DELTA:** *This test is Not Applicable*
- ✓ **TANGO:** *The top and bottom conform*
- ✗ **ECHO:** *Top outliers were found (Component #18)*
- ✓ **KILO:** *Bottom outliers were not found*

Conexant DC 0626 Graphs

DELTA

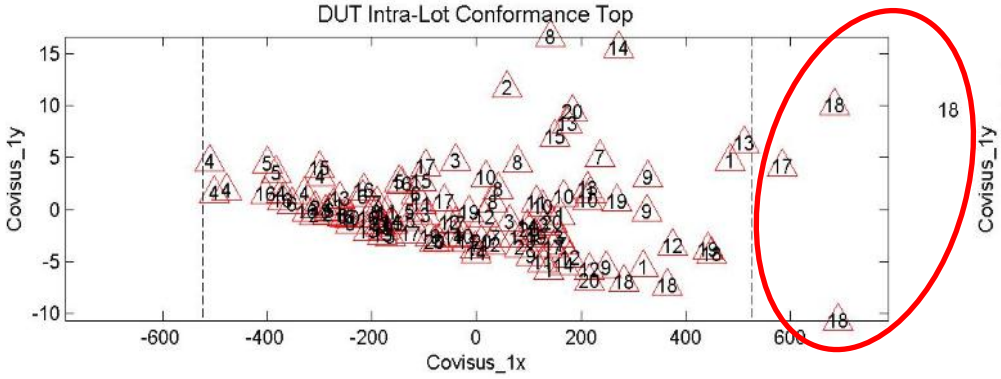
NA

TANGO

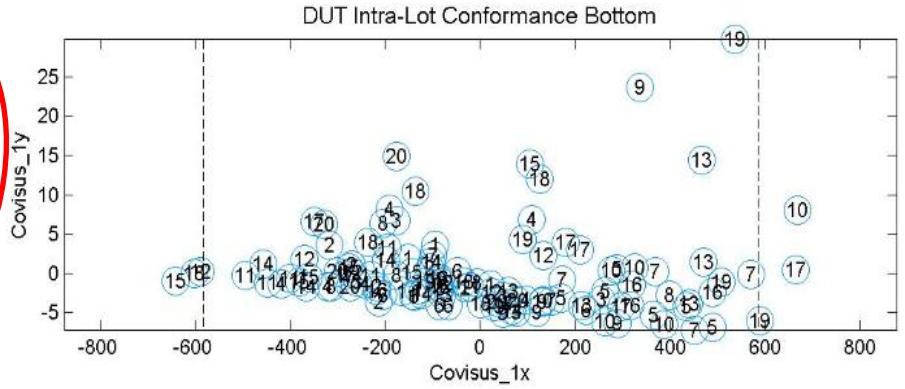


ECHO

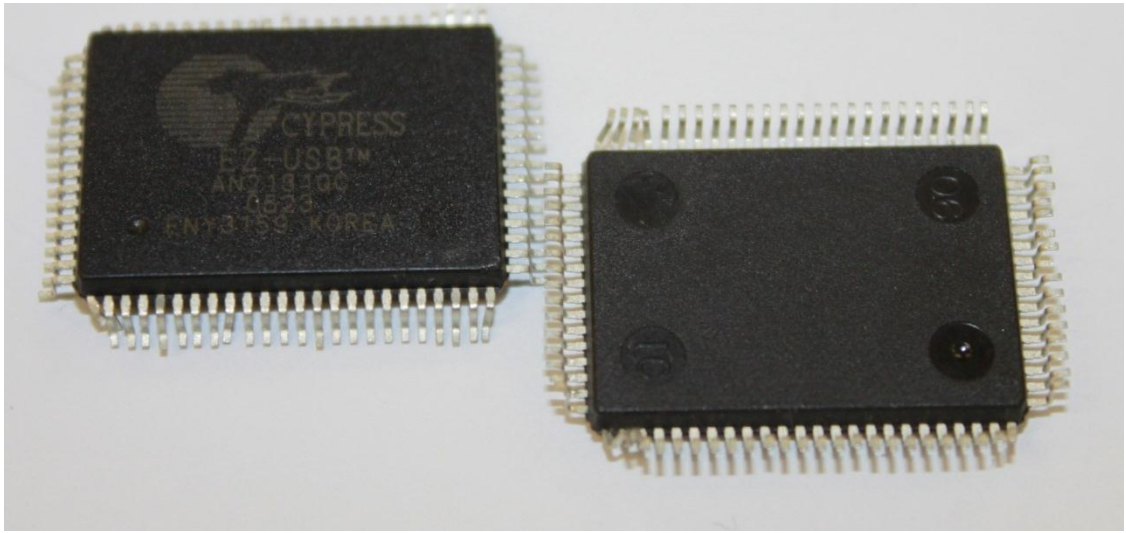
Part # 18 is an outlier



KILO



DTEK Report: Cypress DC 0523



Correct Result (True Positive)

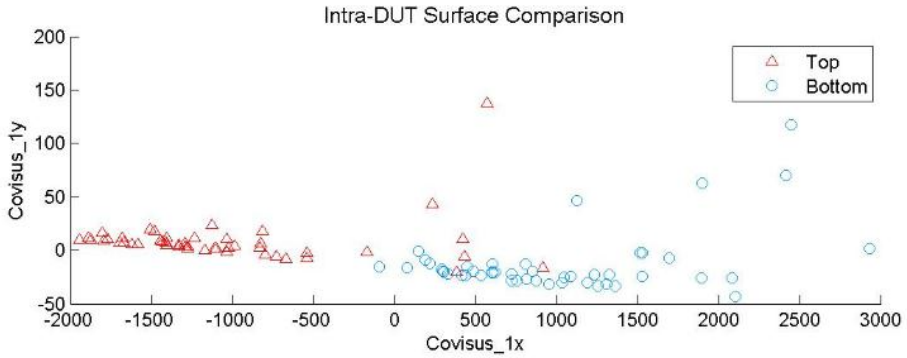
- N/A **DELTA:** *This test is Not Applicable*
- ✗ **TANGO:** *The top and bottom do not conform*
- ✗ **ECHO:** *Top outliers were found (Component #7)*
- ✓ **KILO:** *Bottom outliers were not found*

Cypress DC 0523 Graphs

DELTA

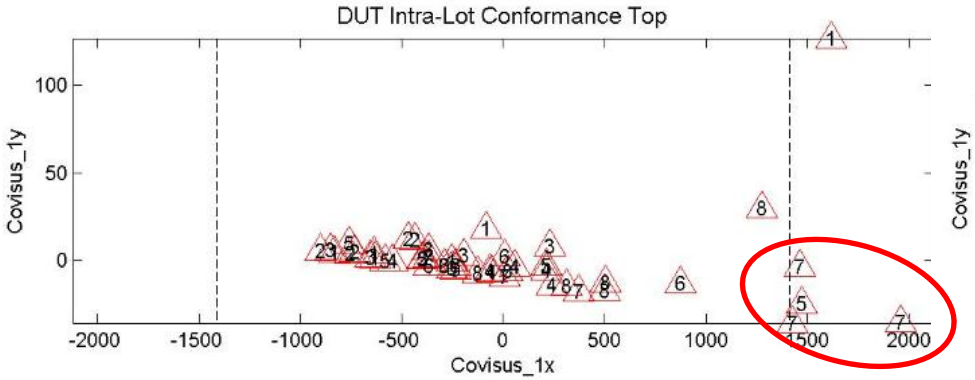
NA

TANGO

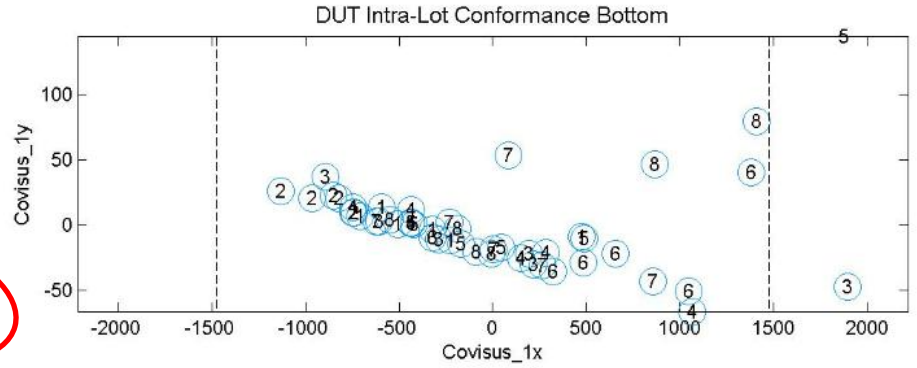


ECHO

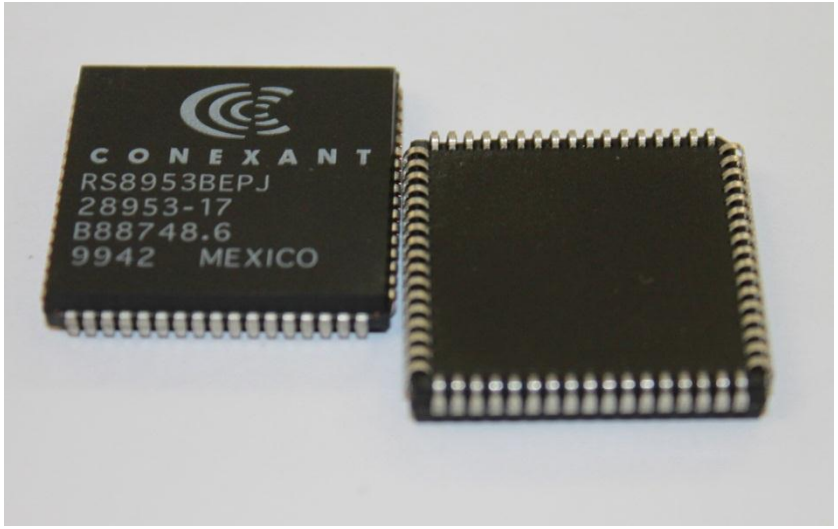
Component #7 is flagged as an outlier



KILO



DTEK Report: Conexant DC 9942



Correct Result (True Positive)

- N/A **DELTA:** *This test is Not Applicable*
- ✗ **TANGO:** *The top and bottom do not conform*
- ✓ **ECHO:** *Top outliers were not found*
- ✓ **KILO:** *Bottom outliers were not found*

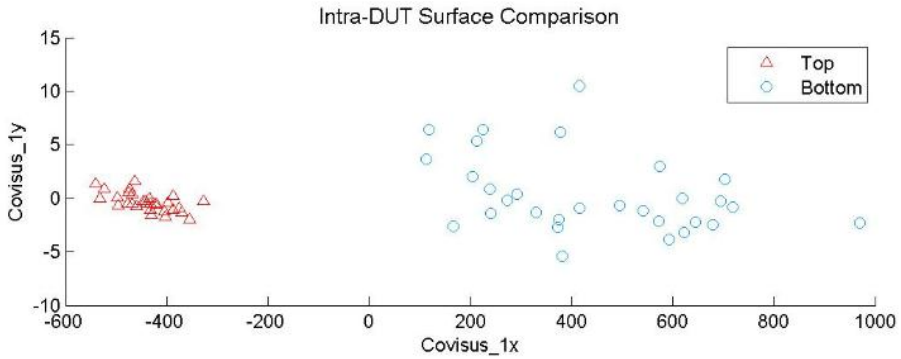
Conexant DC 9942 Graphs

DELTA

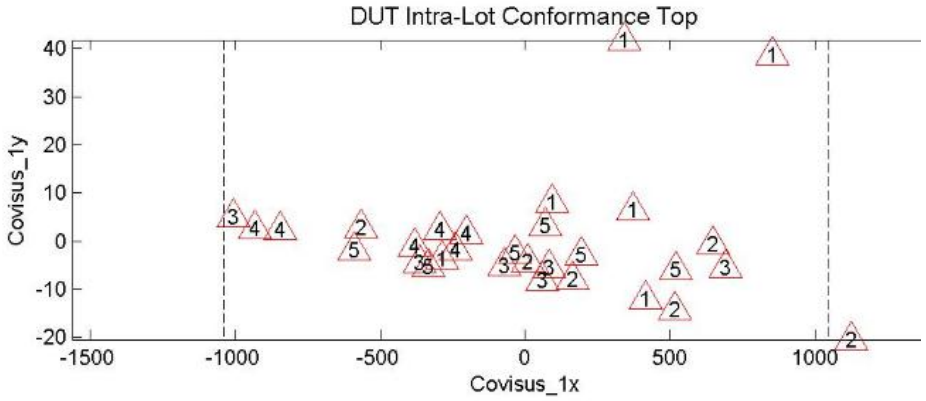
NA

TANGO

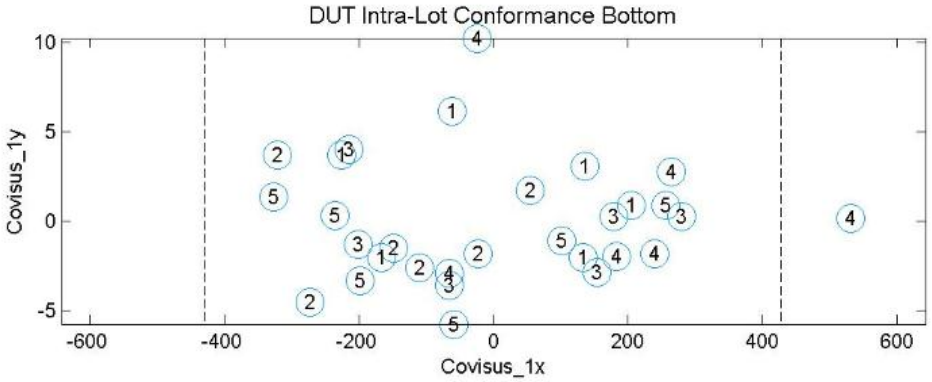
The top and bottom are dissimilar



ECHO



KILO



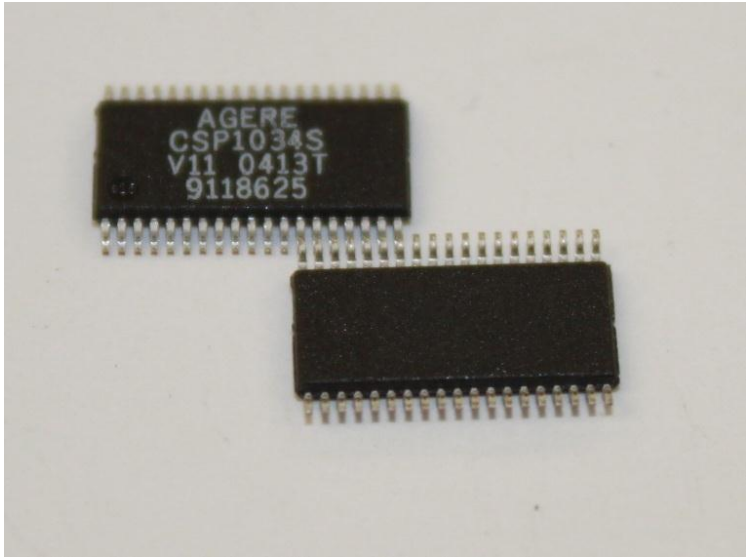
Test Category 3: Authentic Only

Part Name & Date Code	Type and Quantity	Special Notes	DELTA	TANGO	ECHO	KILO	Result Classification
Agere DC 0413	RCS (10)	Shipped from factory	NA	Separation = 0.65	0	0	True Negative
Agere DC 0511	RCS(10)	Factory authentic, but really bad mfg.	NA	Separation = 0.62	1	0	False Positive
International Rectifier DC 1037	RCS (10)	Factory authentic Sampled Stainless Steel Surface	NA	Separation = 0.62	0	0	True Negative
Sharp DC 0621	RCS (10)	Authorized from Franchise	NA	Separation= 0.07	0	0	True Negative

These components were tested to examine the prevalence of false positives on authentic components with full manufacturer traceability.

Note: All of these components are Authentic Samples with Factory Traceability
Note: Slides 53-60 are representative results for the test lots.

DTEK Report: Agere System DC 0413



Correct Result (True Negative)

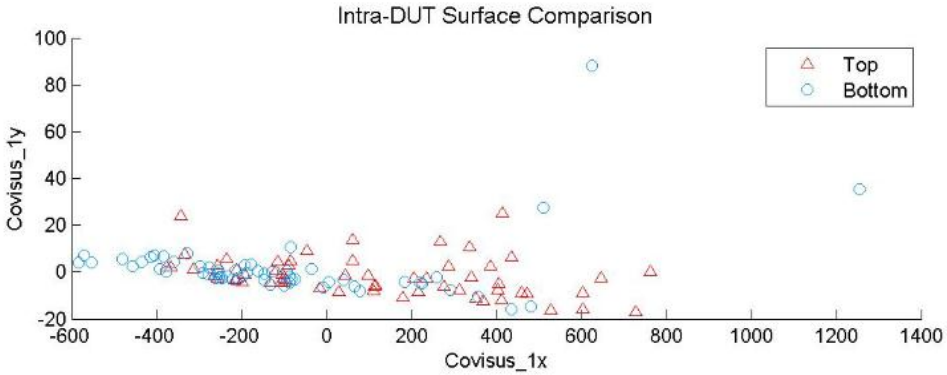
- N/A **DELTA:** *This test is Not Applicable*
- ✓ **TANGO:** *The top and bottom conform*
- ✓ **ECHO:** *Top outliers were not found*
- ✓ **KILO:** *Bottom outliers were not found*

Agere System DC 0413 Graphs

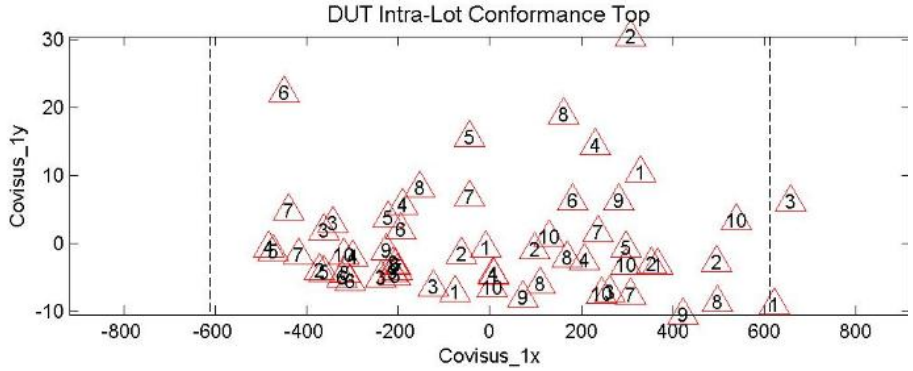
DELTA

NA

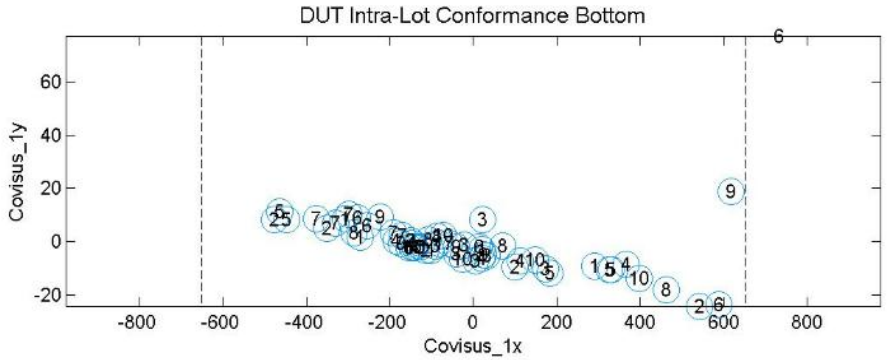
TANGO



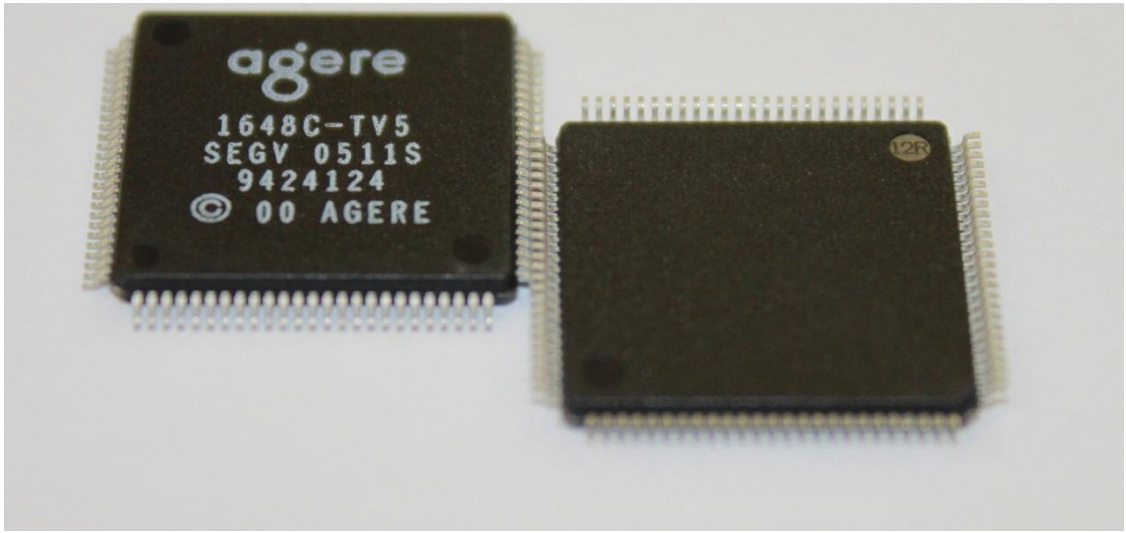
ECHO



KILO



DTEK Report: Agere System DC 0511



Incorrect Result (False Positive)

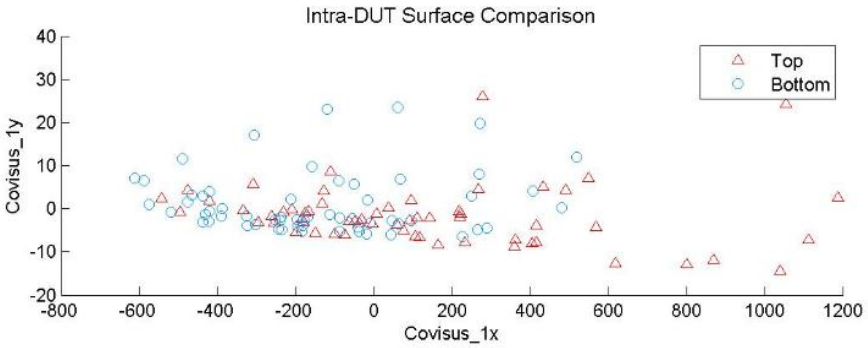
- N/A **DELTA:** *This test is Not Applicable*
- ✓ **TANGO:** *The top and bottom conform*
- ✗ **ECHO:** *Top outliers were found (Component #2)*
- ✓ **KILO:** *Bottom outliers were not found*

Agere System DC 0511 Graphs

DELTA

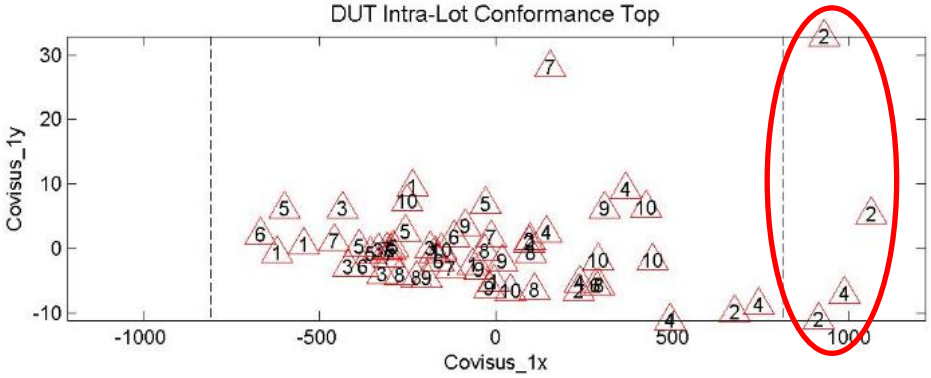
NA

TANGO

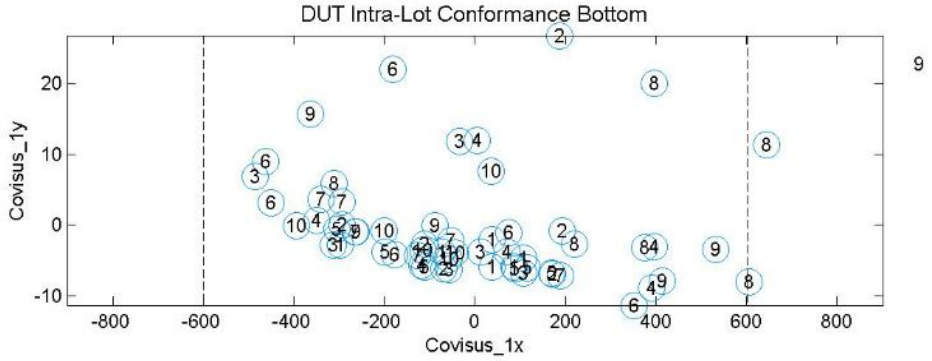


ECHO

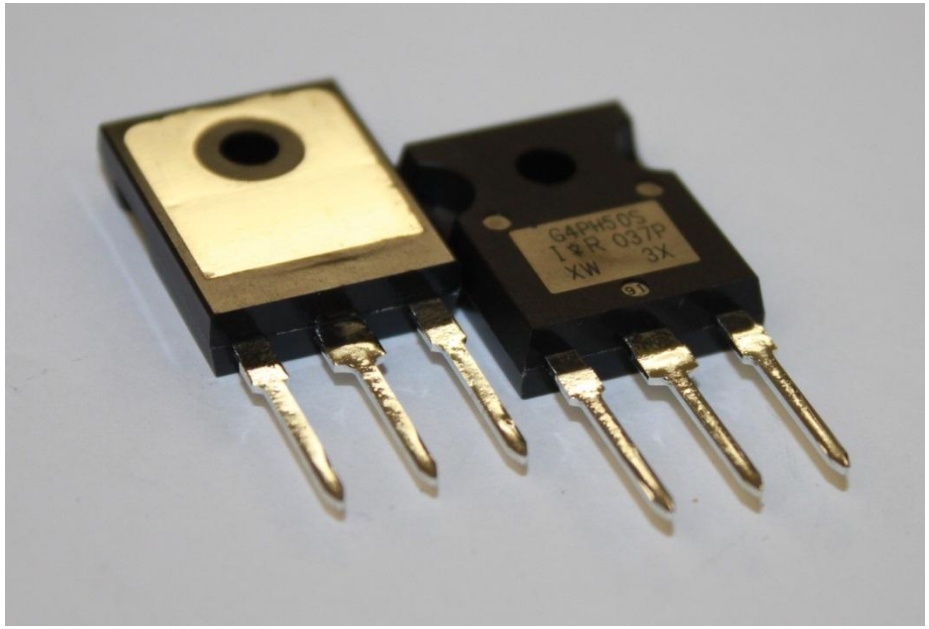
The system flagged component #2 as an outlier. Because these are Authentic parts, this results in a False Positive.



KILO



DTEK Report: International Rectifier DC 1037



Correct Result (True Negative)

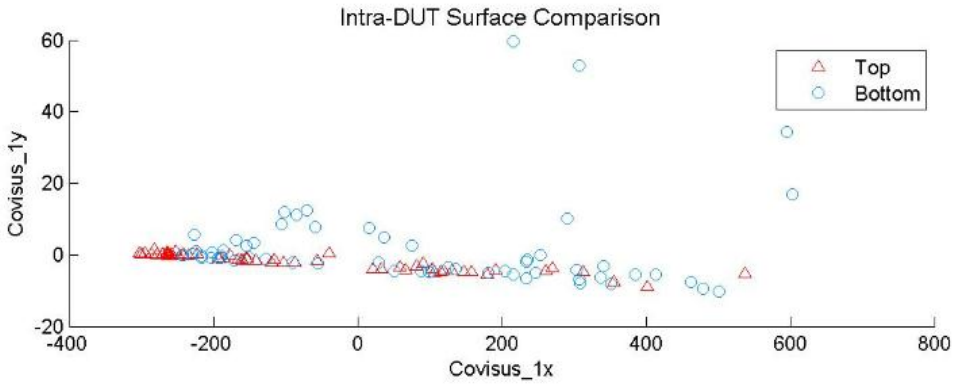
- N/A **DELTA:** *This test is Not Applicable*
- ✓ **TANGO:** *The top and bottom conform*
- ✓ **ECHO:** *Top outliers were not found*
- ✓ **KILO:** *Bottom outliers were not found*

International Rectifier DC 1037 Graphs

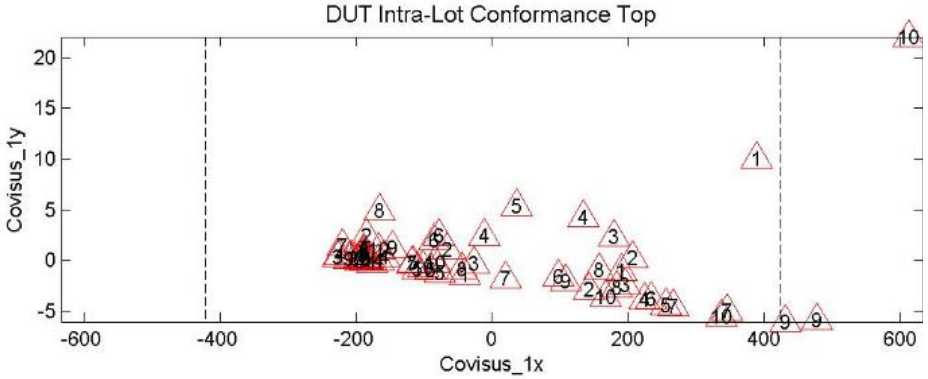
DELTA

NA

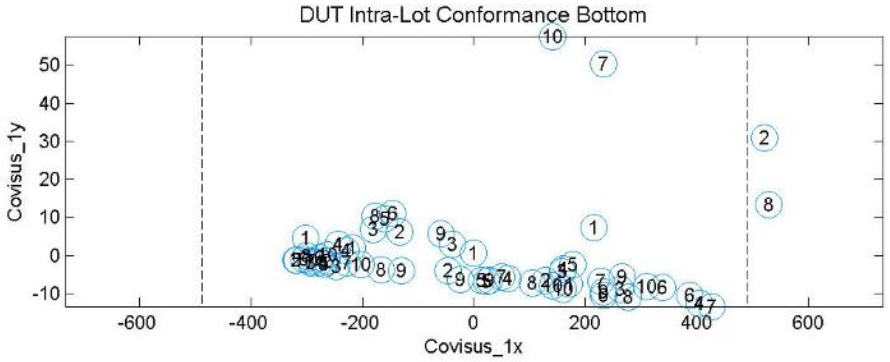
TANGO



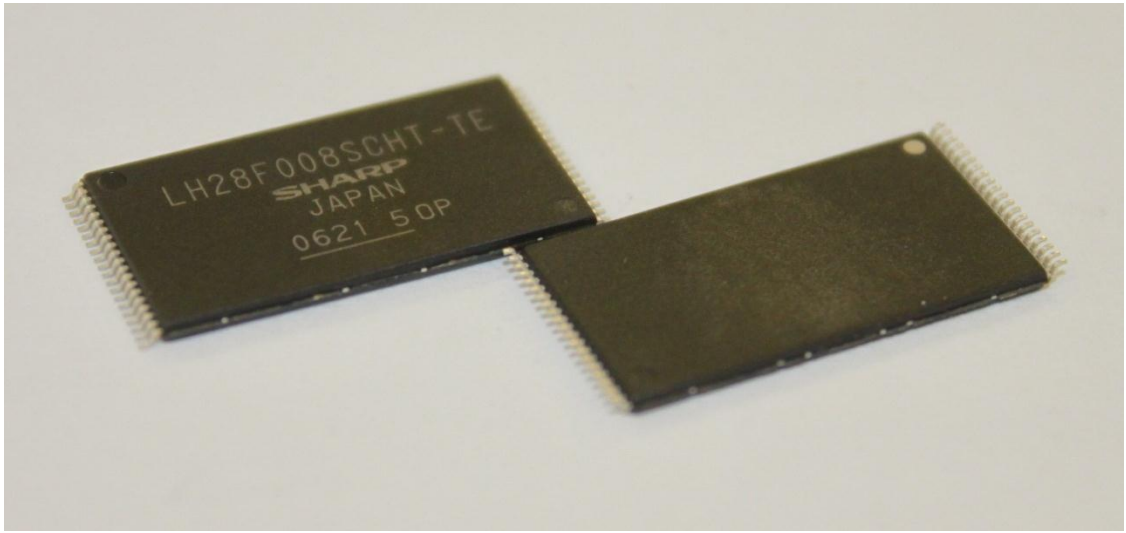
ECHO



KILO



DTEK Report: Sharp DC 0621



Correct Result (True Negative)

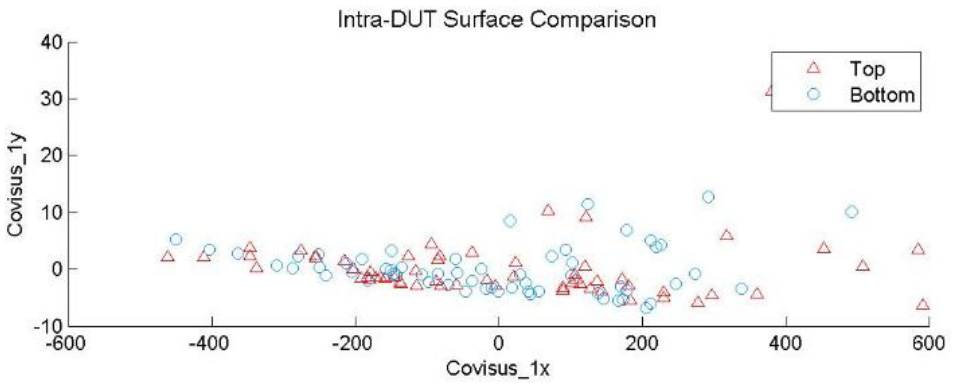
- N/A **DELTA:** *This test is Not Applicable*
- ☑ **TANGO:** *The top and bottom conform*
- ☑ **ECHO:** *Top outliers were not found*
- ☑ **KILO:** *Bottom outliers were not found*

Sharp DC 0621 Graphs

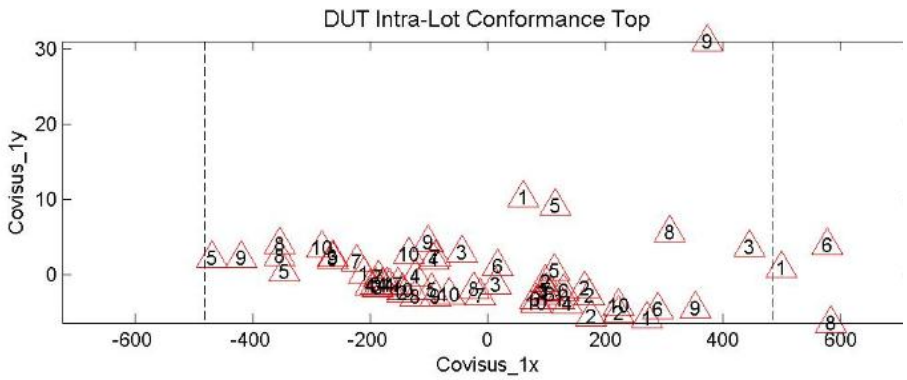
DELTA

NA

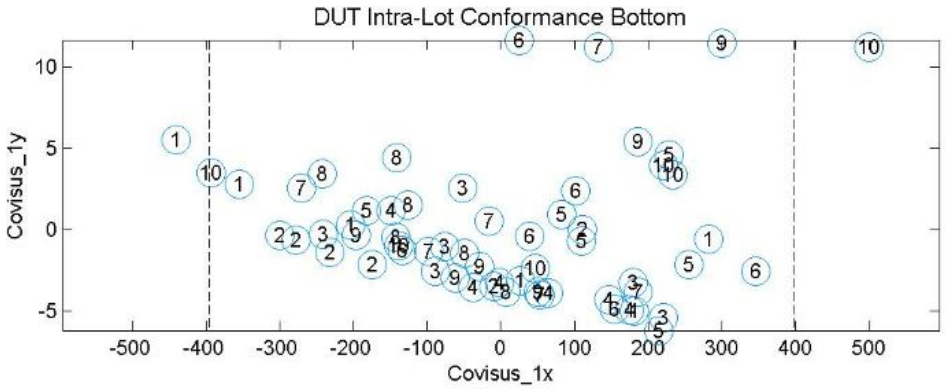
TANGO



ECHO



KILO



Part 1: Summary
Testing with Global IC Trading Group

COVISUS

- The DTEK correctly identified:
  - All 3 sets of Authentic and Counterfeit Parts
  - All 3 sets of Counterfeit Parts
  - 3 out of 4 sets of Authentic Parts
    - The False Positive that was identified had many visible manufacturing flaws in the surface packaging. Component #2 failed the outlier test.
    - In all 40 factory traceable components tested, only this part failed to pass the outlier test.

Section 4: Testing and Representative Results

Part 1: Global IC Trading Group

Part 2: Microblast Testing – SMT Corp.

- **CALCE West Anaheim Show**
- **Test Category 1** ***(Microblast - Stainless Steel, Ceramic, Plastic)***
- **Summary**

Part 3: Microblast Testing – G19A

Part 4: False Positives

COVISUS

Microblast Testing – SMT Corp.

- Samples provided by Tom Sharpe of SMT Corp at SMTA / CALCE West in Anaheim, December 7th, 2011
- Components scanned at the booth

Test Category 1: Microblasted Parts (SMT Corp.)

Part Name	Type and Quantity	Special Notes	DELTA	TANGO	ECHO	KILO	Result Classification
ALTERA 1 EPF81500ARC "Steel"	DUT (1)	Authentic part Microblasted. Have different top/bottoms	Separation =0.2	NA	NA	NA	False Negative
	RCS (1)	Have different top/bottoms		NA			
ALTERA 2 (Re-scan) EPF81500ARC "Steel"	DUT (1) – scanned five times	Authentic part Microblasted. Have different top/bottom	Separation =2.6	NA	NA	NA	True Positive
	RCS (1) – scanned five times	Have different top/bottom		NA			
Valpey-Fisher VF150-9152 "Metal Can"	DUT (1)	Authentic part was Microblasted. Have different top/bottom	Separation = 3.4	NA	NA	NA	True Positive
	RCS (1)	Have different top/bottom		NA			
M27C256b "Ceramic"	DUT(1)	Authentic part Microblasted.	Separation = 2.0	Separation = 3.2	NA	NA	True Positive
	RCS (1)			Separation = 1.9			
InnovASIC IMS402.400 "Plastic"	DUT(1)	Authentic part Microblasted.	Separation = 2.8	Separation = 1.4	NA	NA	True Positive
	RCS (1)			Separation = 0.1			

Note: Slides 64-73 are representative results for the test lots.

DTEK Report: Altera 1 Microblasted

Report 1

Comments: Initially, we scanned this component once. We failed to identify this part as non-conforming. Because it was under the recommended sample size of five, we then re-sampled it (results shown next)

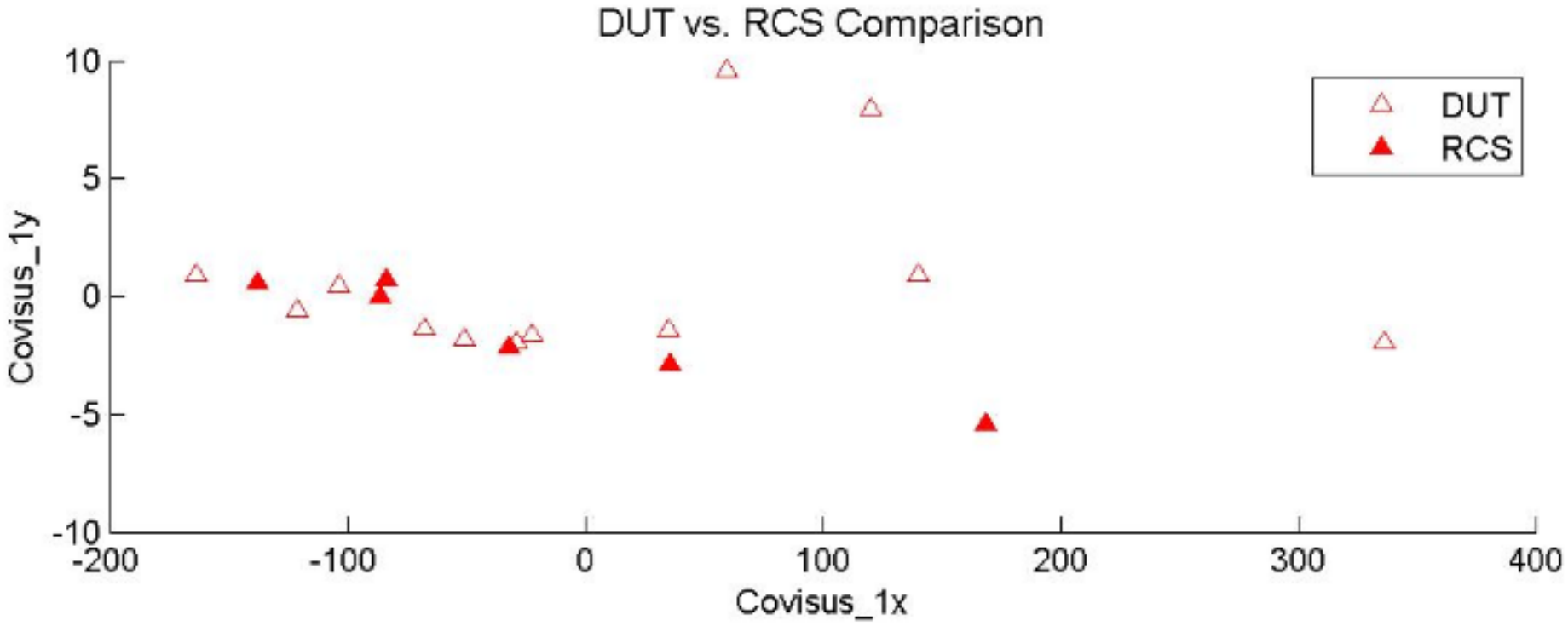
Incorrect Result (False Negative)

- ☑ **DELTA:** *The DUT and RCS conform*
- N/A **TANGO:** *This test is Not Applicable (different materials)*
- N/A **ECHO:** *This test is Not Applicable*
- N/A **KILO:** *This test is Not Applicable*

Graph for Altera (1) Microblasted

DELTA (False Negative)

Separation =0.24



DTEK Report: Altera 2 Microblasted (re-scan)

Report 2

Comments: We ran these components again and scanned them five times to achieve the recommended sample size of five.

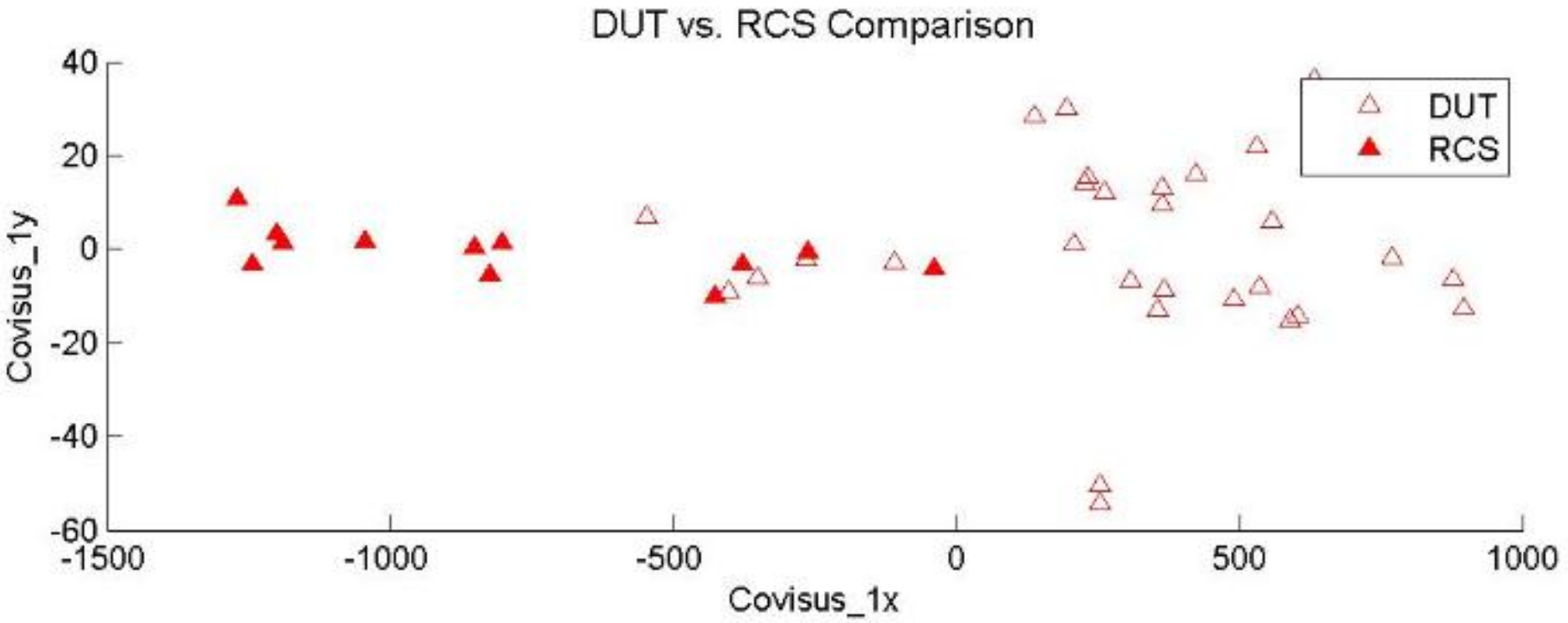
Correct Result (True Positive)

- **DELTA:** *The DUT and RCS do not conform*
- **TANGO:** *This test is Not Applicable (different materials)*
- **ECHO:** *This test is Not Applicable*
- **KILO:** *This test is Not Applicable*

Graph for Altera (2) Microblasted

DELTA

Separation =2.62



DTEK Report: Valpey-Fisher Microblasted

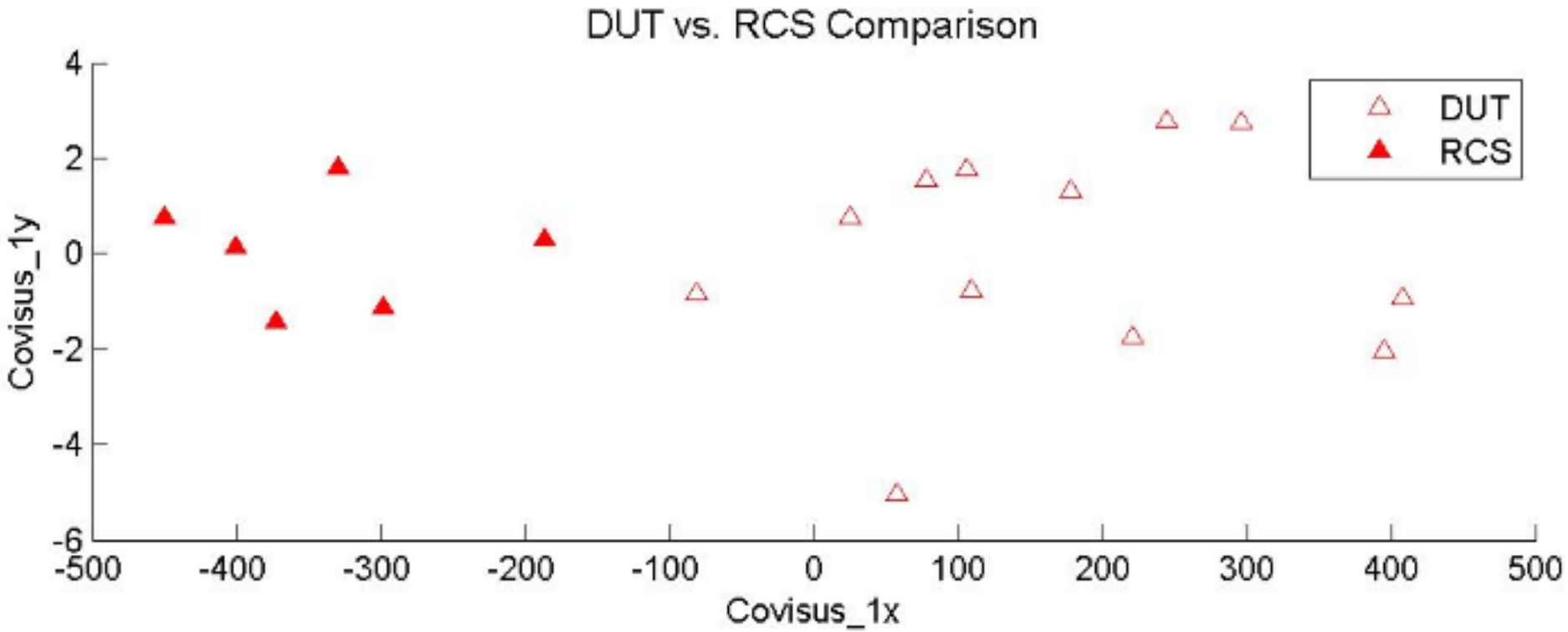
Correct Result (True Positive)

- **DELTA:** *The DUT and RCS do not conform*
- **TANGO:** *This test is Not Applicable*
- **ECHO:** *This test is Not Applicable*
- **KILO:** *This test is Not Applicable*

Graph for Valpey-Fisher Microblasted

DELTA

Separation = 3.41

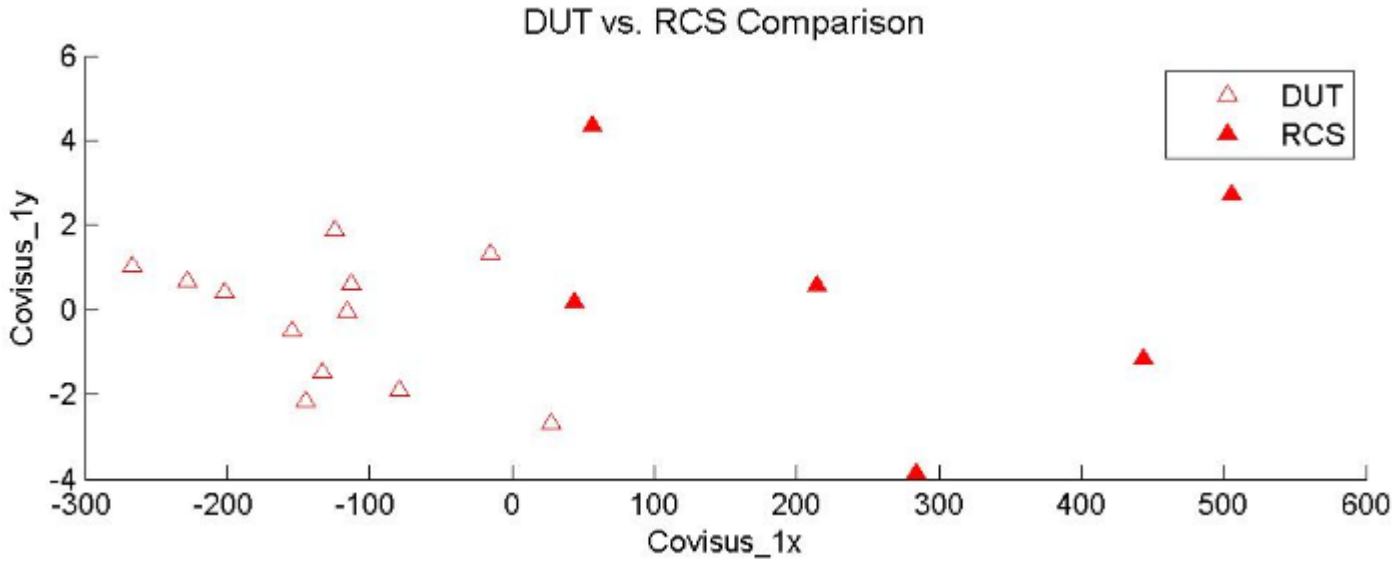


DTEK Report: Ceramic Microblasted

Correct Result (True Positive)

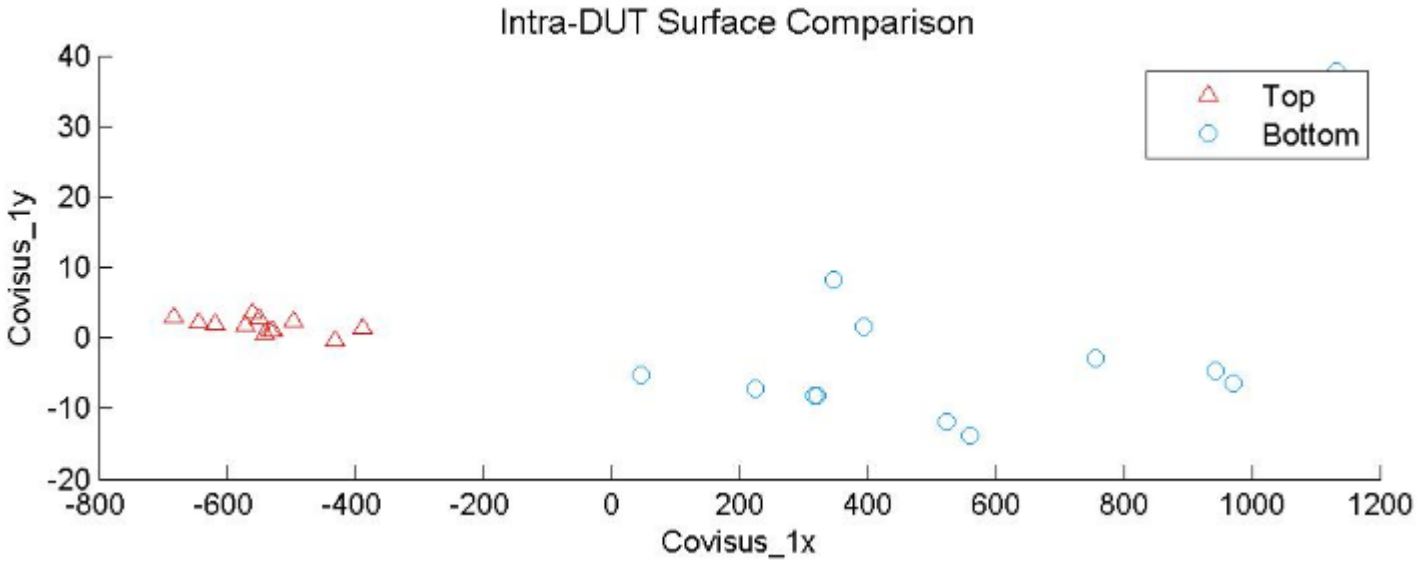
- ✗ **DELTA:** *The DUT and RCS do not conform*
- ✗ **TANGO:** *The top and bottom do not conform*
- N/A **ECHO:** *This test is Not Applicable*
- N/A **KILO:** *This test is Not Applicable*

Graphs for Ceramic Microblasted



DELTA

Separation = 2.01



TANGO

Separation = 3.24

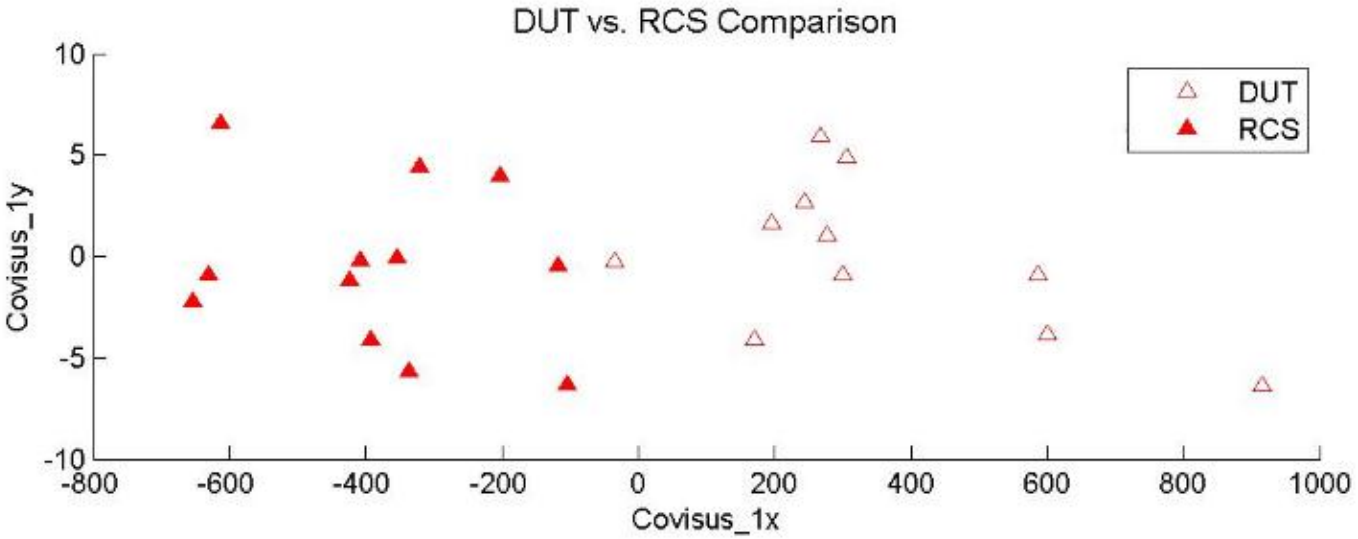
DTEK Report: InnovASIC "Plastic" Microblasted

Correct Result (True Positive)

- ✗ **DELTA:** *The DUT and RCS do not conform*
- ✓ **TANGO:** *The top and bottom conform*
- N/A **ECHO:** *This test is Not Applicable*
- N/A **KILO:** *This test is Not Applicable*

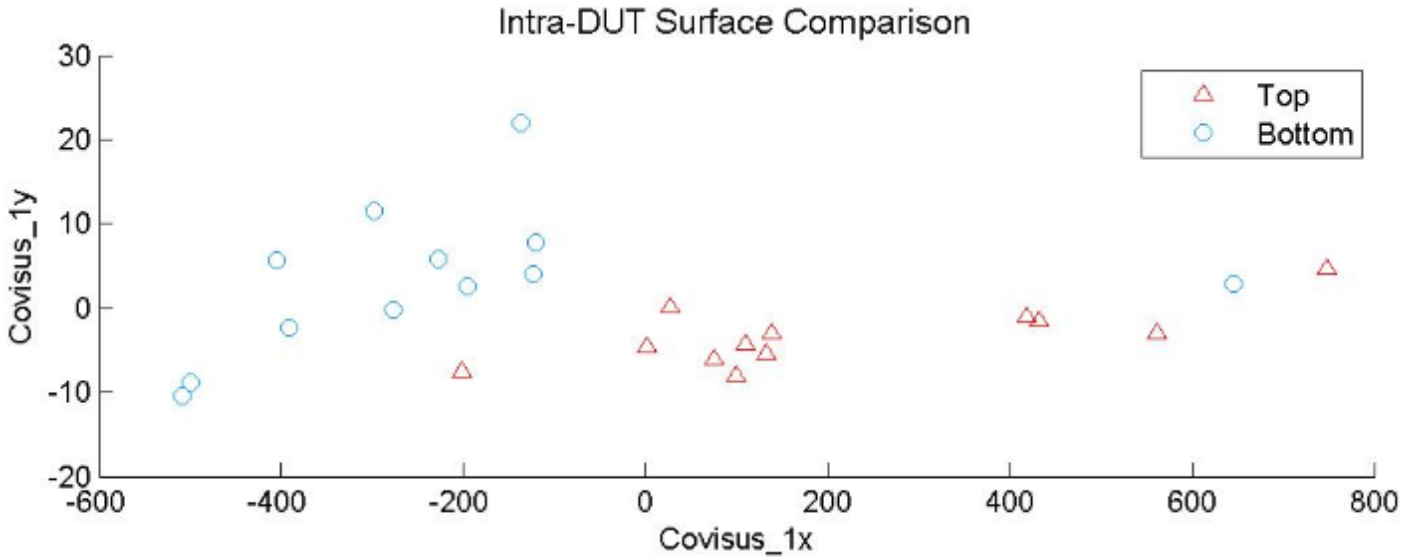
The TANGO test should not have passed. This could be because the sample size was small. However, because the DELTA test failed, DTEK does not pass this part

Graphs for InnovASIC Plastic Microblasted



DELTA

Separation = 2.81



TANGO

Separation = 1.397

Part 2: Summary
Microblast testing (SMT Corp.)

- DTEK was able to flag all 4 of 5 components correctly
- The small sample size may have been an issue, a re-scan of the Altera parts yielded the expected test result.
- The system is generally less effective with less than five components

Section 4: Testing and Representative Results

Part 1: Global IC Trading Group

Part 2: Microblast Testing – SMT Corp.

Part 3: Microblast Testing – G19A

- **Test Method**
- **Test Category 1** ***(Microblast – Metal Can)***
- **Test Category 1** ***(Microblast – Ceramic)***
- **Test Category 2** ***(Microblast – Plastic)***
- **Summary**

Part 4: False Positives

COVISUS

Test Method – G-19A Microblasted Parts

- 5 Metal Can Components and 1 RCS
- 4 Ceramic Components and 1 RCS
- 4 Plastic Components and 1 RCS

- Test designed and prepared by the G-19A Committee including Sultan Ali Lilani, Anthony Rinaldi and Bhanu Sood, et. al.
- Microblasting and component distribution executed by members of the G-19A Microblasting working group
- The DOE intent is to “replicate counterfeiters’ steps” and surface modification techniques in order to “evaluate effectiveness of test and analytical capabilities in detecting modified parts.”

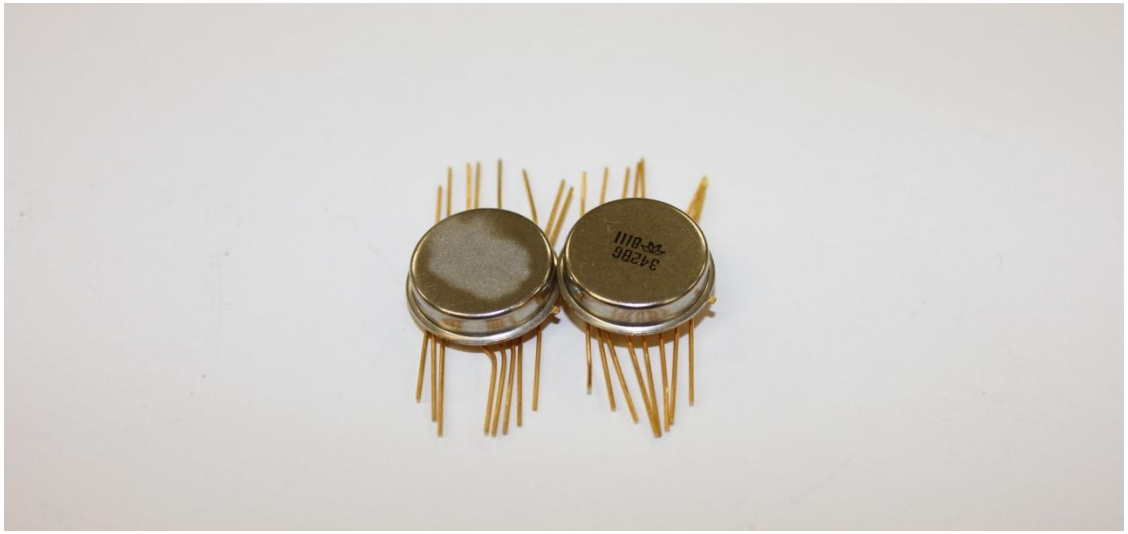
Test Category 1: Metal Can Microblasted (G-19A)

COVISUS

Note: All of these components were originally Authentic Samples but the DUT has been Microblasted

Part Name	Type and Quantity	Special Notes	DELTA	TANGO	ECHO	KILO	Result Classification
342BG Part 1 "Lead to Can"	DUT (1)	Top and Bottom are different	separation = 11.0	NA	NA	NA	True Positive
	RCS (1)	Top and Bottom are different		NA	NA	NA	
342BG Part 2 "Lead to Can"	DUT (1)	Top and Bottom are different	separation = 5.8	NA	NA	NA	True Positive
	RCS (1)	Top and Bottom are different		NA	NA	NA	
342BG Part 3 "Lead to Can"	DUT (1)	Top and Bottom are different	separation = 5.5	NA	NA	NA	True Positive
	RCS (1)	Top and Bottom are different		NA	NA	NA	
342BG Part 4 "Lead to Can"	DUT (1)	Top and Bottom are different	separation = 3.6	NA	NA	NA	True Positive
	RCS (1)	Top and Bottom are different		NA	NA	NA	
342BG Part 5 "Lead to Can"	DUT (1)	Top and Bottom are different	separation = 2.7	NA	NA	NA	True Positive
	RCS (1)	Top and Bottom are different		NA	NA	NA	

DTEK Report: Metal Can #1



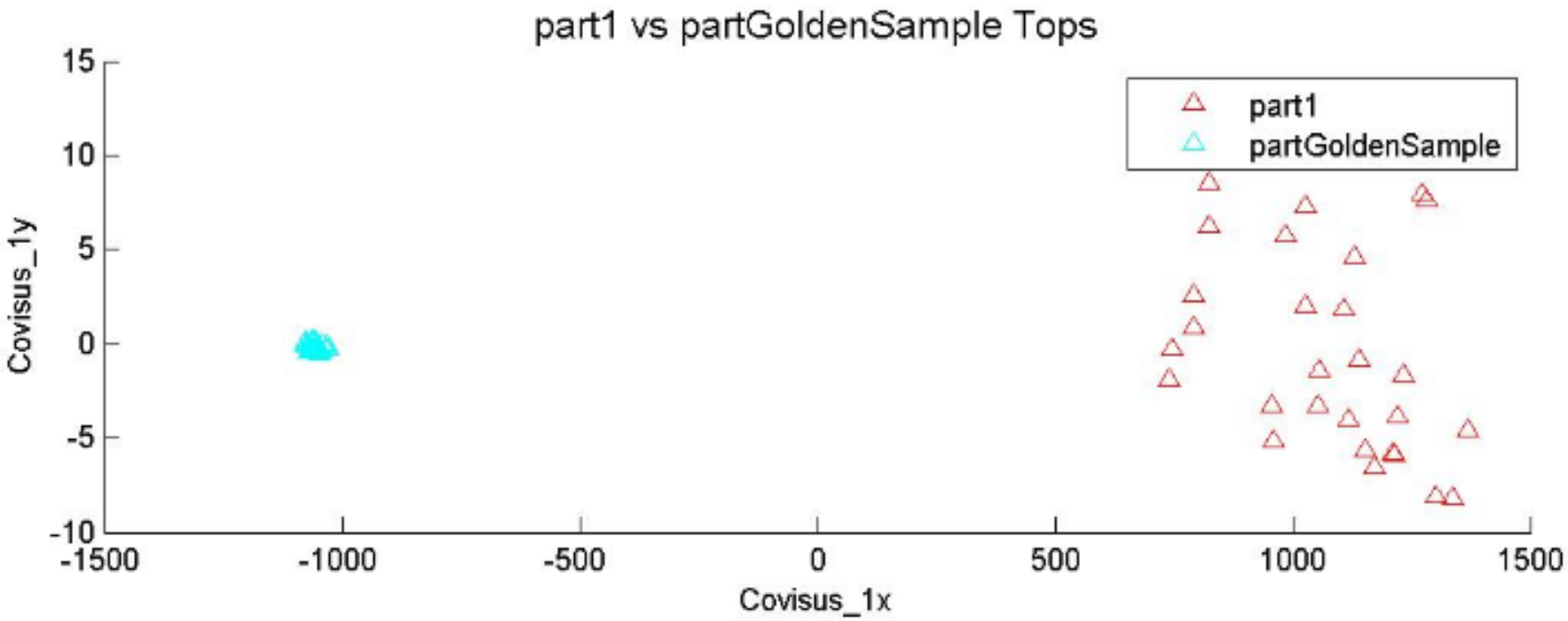
Correct Result (True Positive)

- **DELTA:** *The DUT and RCS do not conform*
- **TANGO:** *This test is Not Applicable (top and bottom are different materials)*
- **ECHO:** *This test is Not Applicable*
- **KILO:** *This test is Not Applicable*

Graph for Metal Can #1

DELTA

separation = 11.0



DTEK Report: Metal Can #2

Comments: Visually, it is difficult, but not impossible, to detect the evidence of Microblasting on this samples.

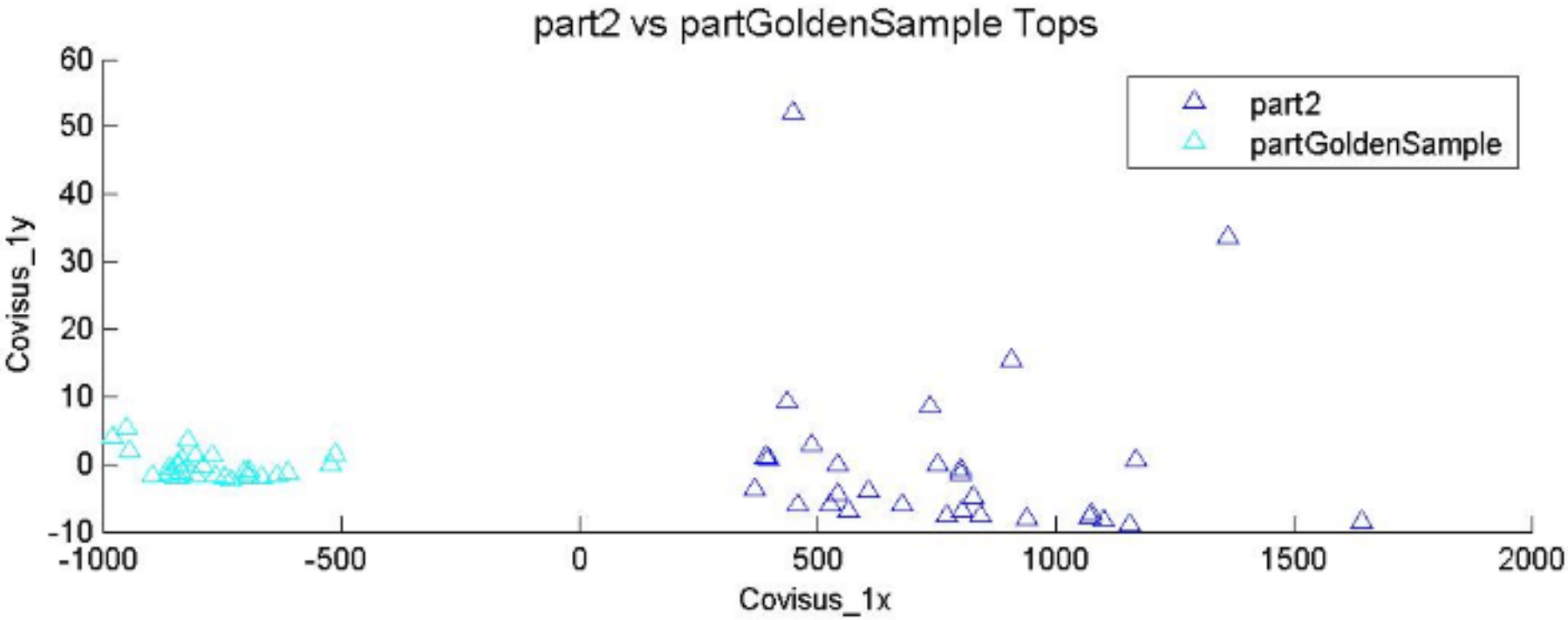
Correct Result (True Positive)

- ✕ **DELTA:** *The DUT and RCS do not conform*
- N/A **TANGO:** *This test is Not Applicable (and bottom are different materials)*
- N/A **ECHO:** *This test is Not Applicable*
- N/A **KILO:** *This test is Not Applicable*

Graph for Metal Can #2

DELTA

separation = 5.8



DTEK Report: Metal Can #3

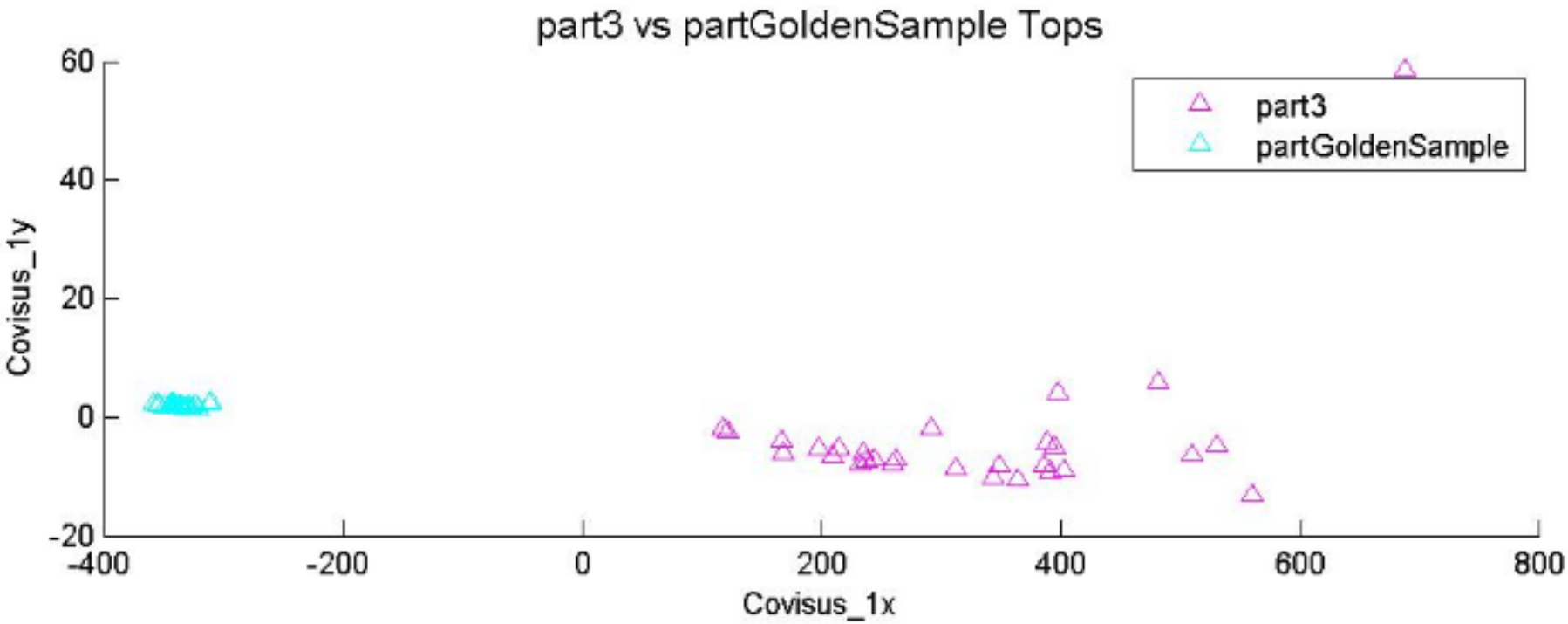
Correct Result (True Positive)

- **DELTA:** *The DUT and RCS do not conform*
- **TANGO:** *This test is Not Applicable (top and bottom are different materials)*
- **ECHO:** *This test is Not Applicable*
- **KILO:** *This test is Not Applicable*

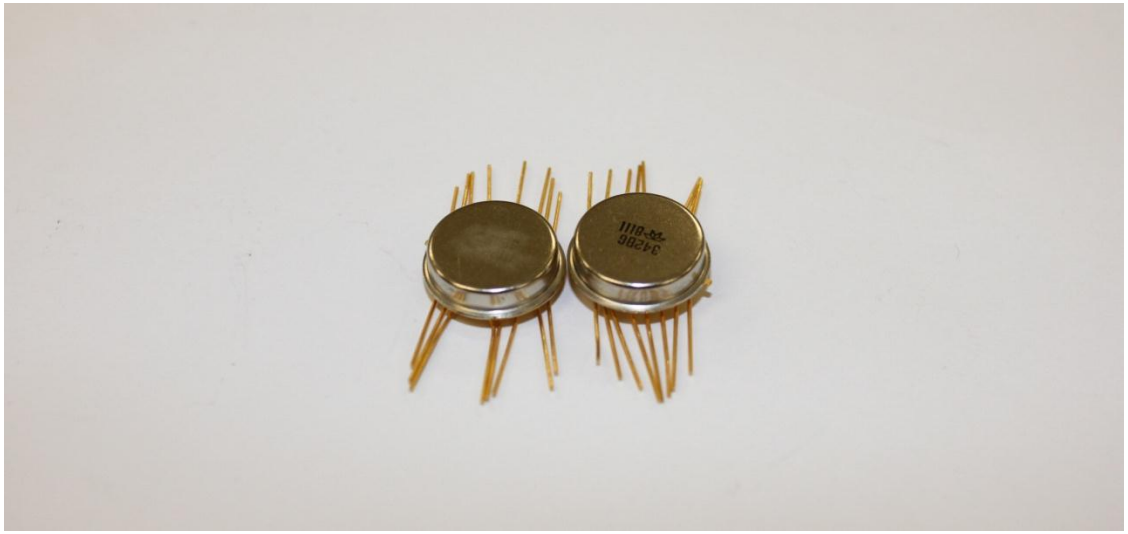
Graph for Metal Can #3

DELTA

separation = 5.5



DTEK Report: Metal Can #4



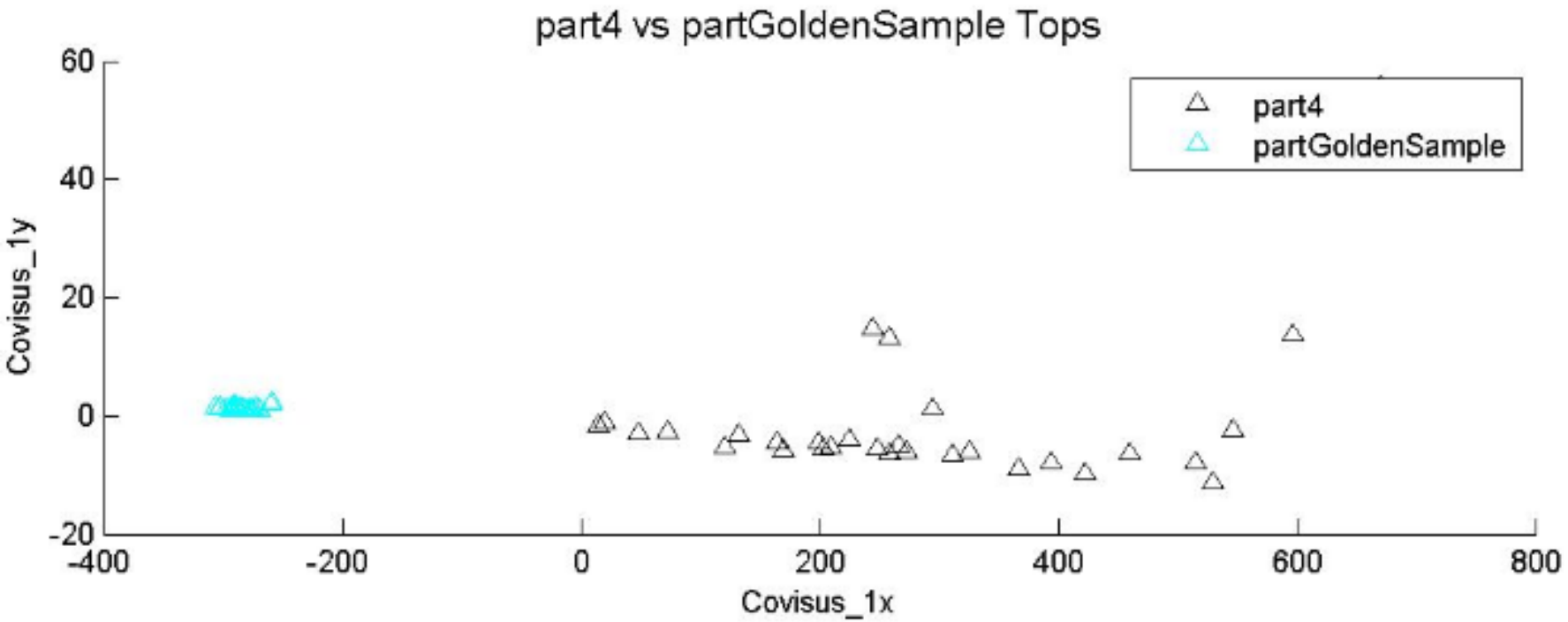
Correct Result (True Positive)

- **DELTA:** *The DUT and RCS do not conform*
- **TANGO:** *This test is Not Applicable (top and bottom are different materials)*
- **ECHO:** *This test is Not Applicable*
- **KILO:** *This test is Not Applicable*

Graph for Metal Can #4

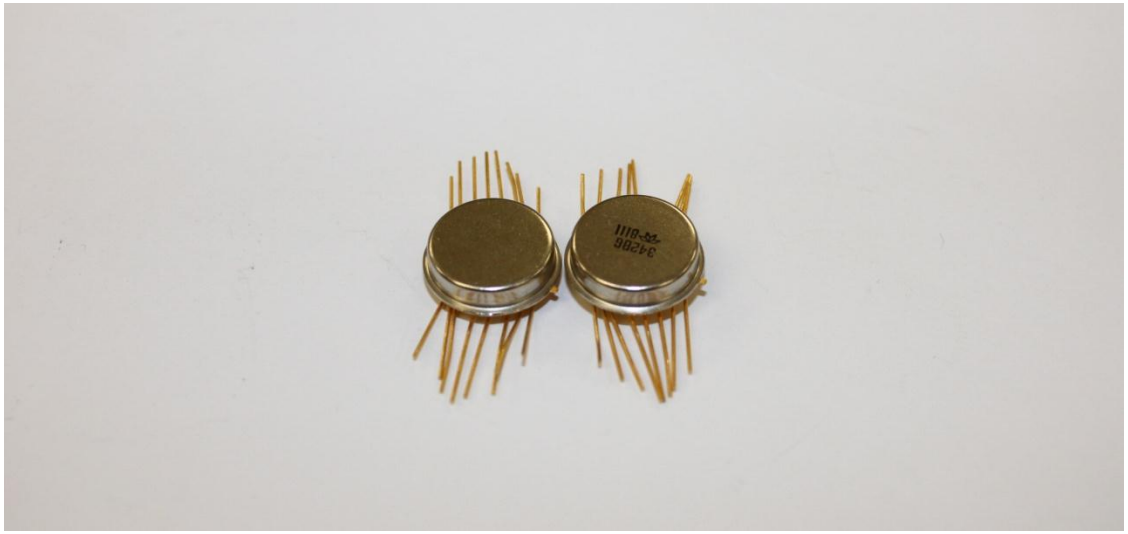
DELTA

separation = 3.6



DTEK Report: Metal Can #5

Comments: Visually, it is nearly impossible to detect the evidence of Microblasting on this samples without very high magnification.



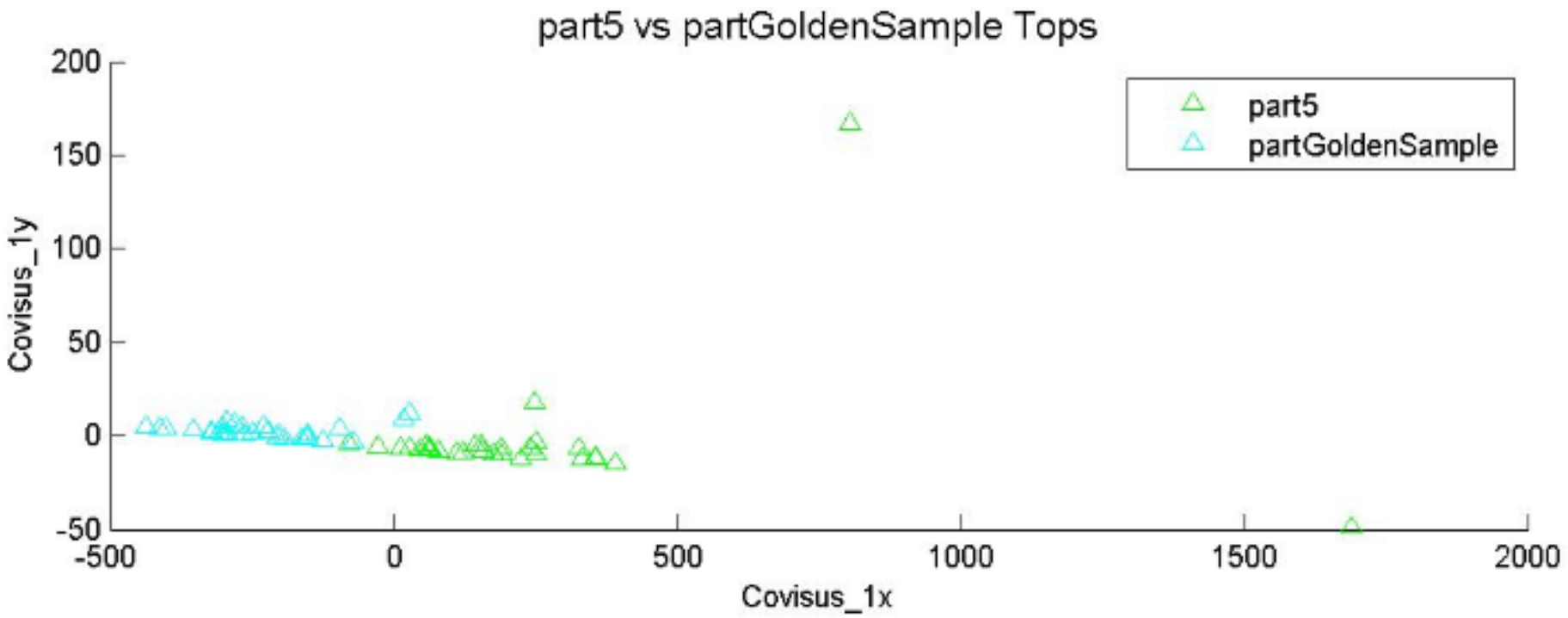
Correct Result (True Positive)

- **DELTA:** *The DUT and RCS do not conform*
- **TANGO:** *This test is Not Applicable (top and bottom are different materials)*
- **ECHO:** *This test is Not Applicable*
- **KILO:** *This test is Not Applicable*

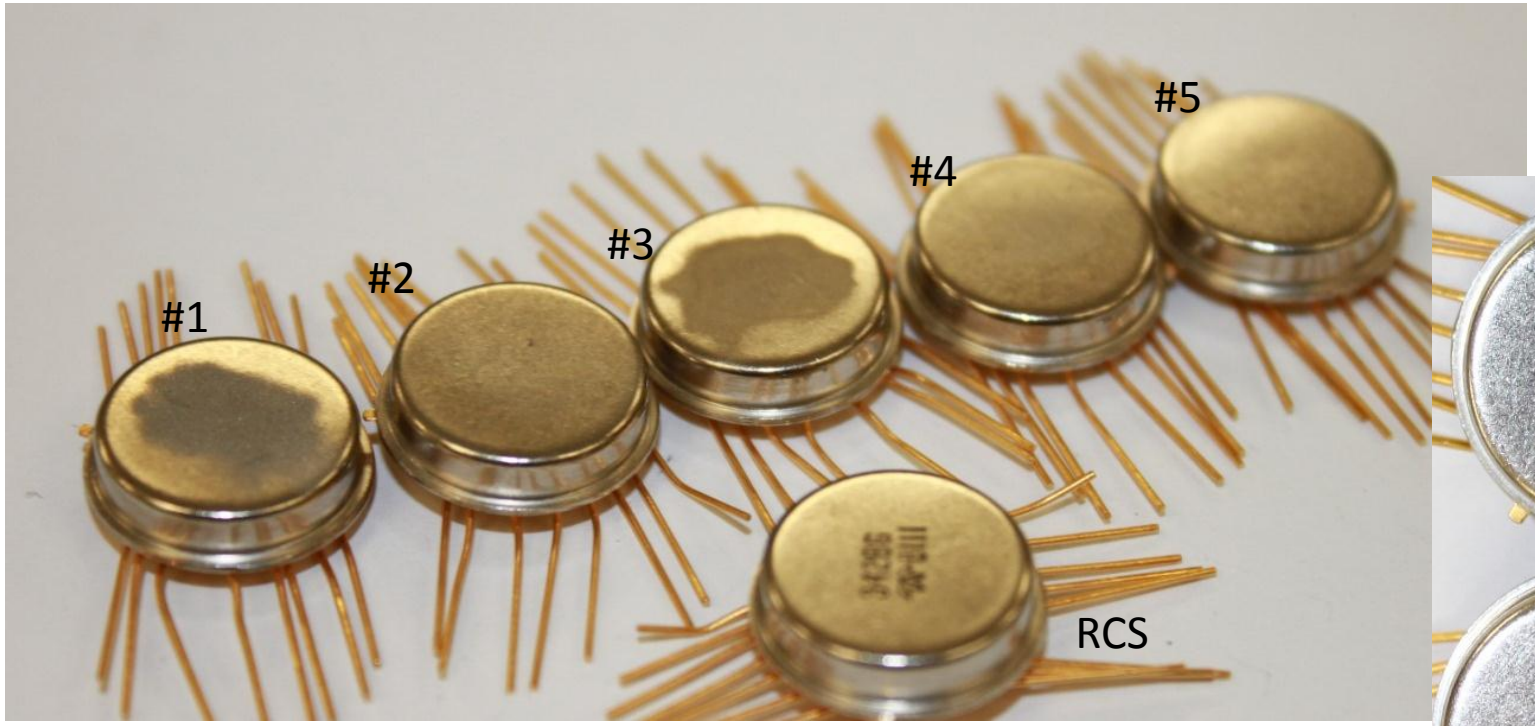
Graph for Metal Can #5

DELTA

separation = 2.7



Summary for G-19A Metal Can Tests



DTEK was able to correctly identify ALL parts (#1-5) as Non-Conforming.

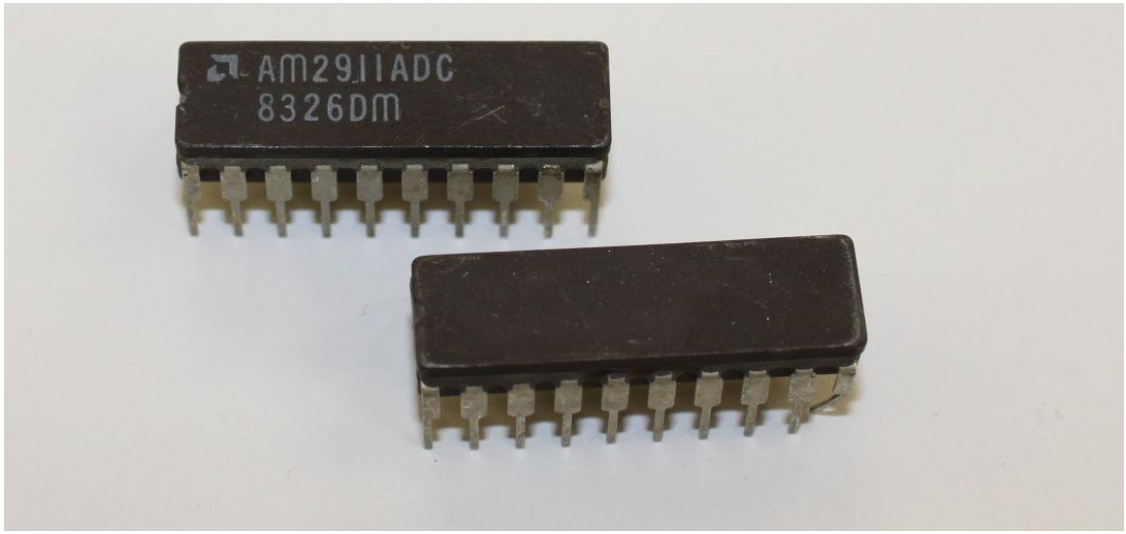
Test Category 2: Ceramic Microblasted (G-19A)

COVISUS

Note: All of these components were originally Authentic Samples but the DUT has been Microblasted

Part Name	Type and Quantity	Special Notes	DELTA	TANGO	ECHO	KILO	Result Classification
AMD AM2911ADC Part #1 "Ceramic"	DUT (1)		separation = 3.3	separation = 2.5	NA	NA	True Positive
	RCS (1)		NA	separation = 1.5	NA	NA	
AMD AM2911ADC Part #2 "Ceramic"	DUT (1)		separation = 0.7	separation = 0.4	NA	NA	False Negative
	RCS (1)		NA	separation = 1.5	NA	NA	
AMD AM2911ADC Part #3 "Ceramic"	DUT (1)		separation = 1.8	separation = 2.4	NA	NA	True Positive
	RCS (1)		NA	separation = 1.5	NA	NA	
AMD AM2911ADC Part #4 "Ceramic"	DUT (1)		separation = 0.67	separation = 2.5	NA	NA	True Positive
	RCS (1)		NA	separation = 1.5	NA	NA	

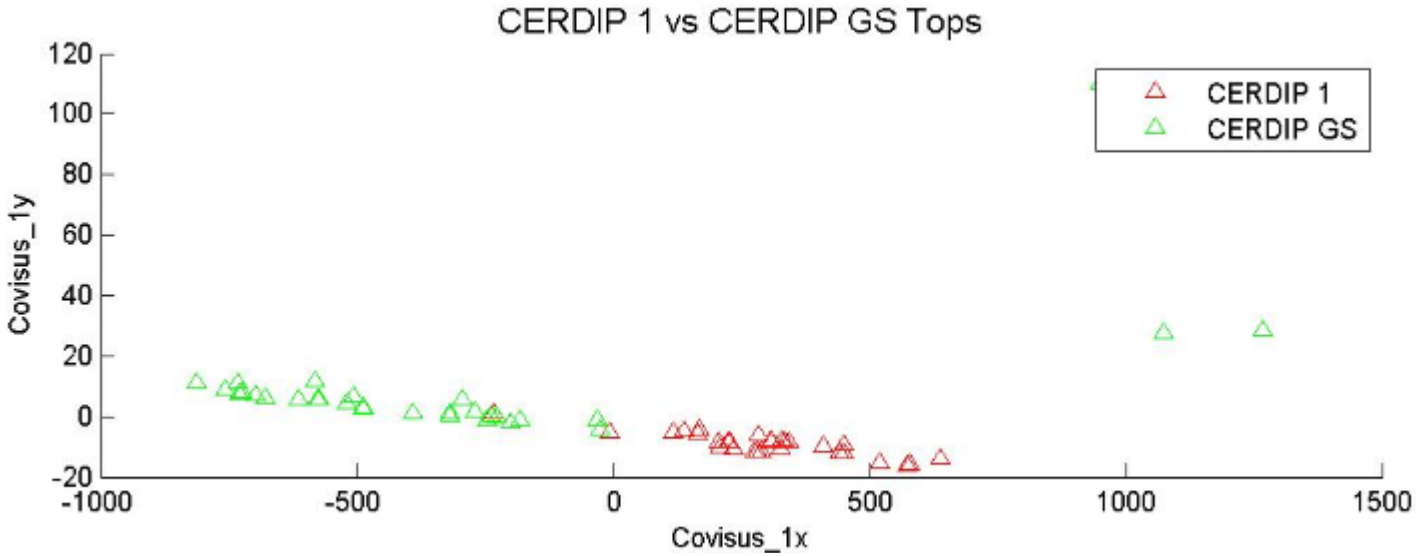
DTEK Report: Ceramic #1



Correct Result (True Positive)

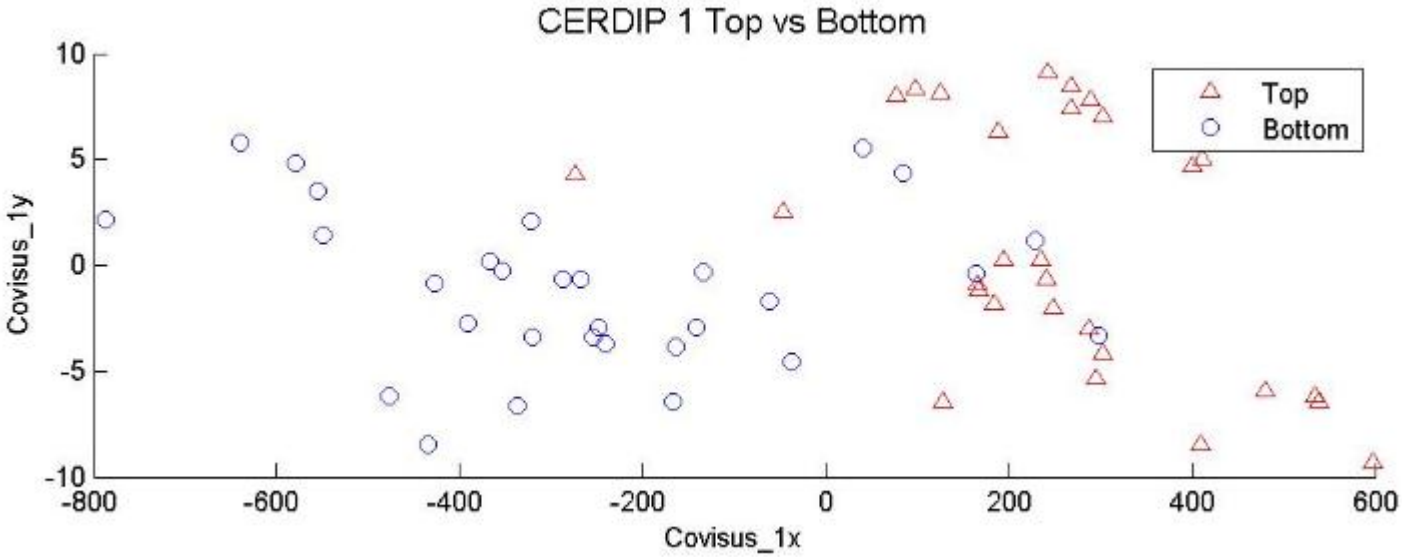
- ☒ **DELTA:** *The DUT and RCS do not conform*
- ☒ **TANGO:** *The top and bottom do not conform*
- N/A **ECHO:** *This test is Not Applicable*
- N/A **KILO:** *This test is Not Applicable*

Graphs for Ceramic #1



DELTA

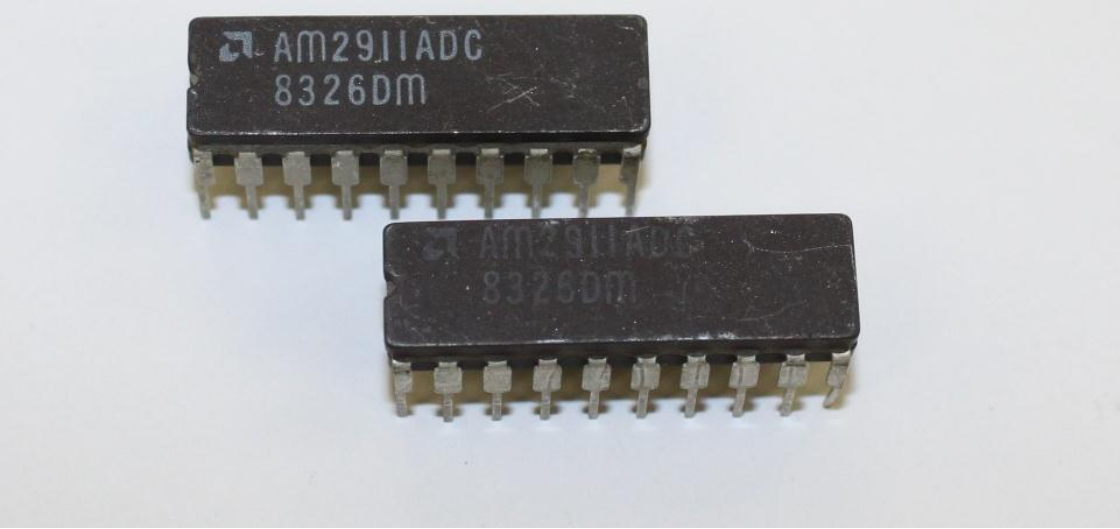
separation = 3.3



TANGO

separation = 2.5

DTEK Report: Ceramic #2

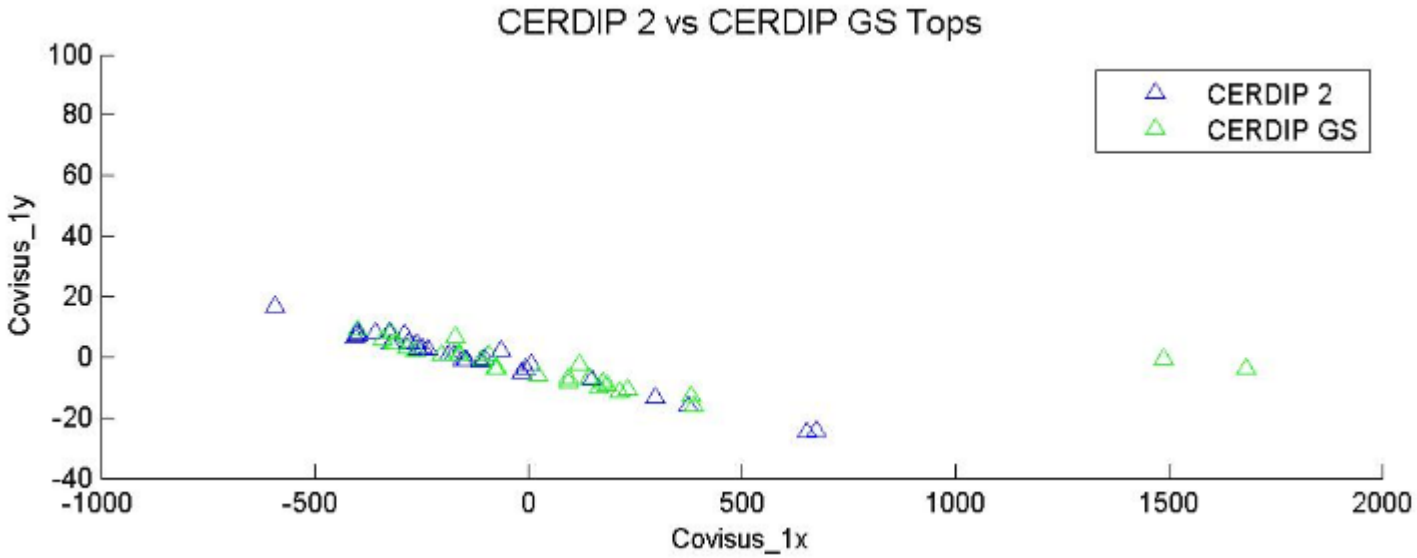


Incorrect Result (False Negative)

- ✅ **DELTA:** *The DUT and RCS conform*
- ✅ **TANGO:** *The top and bottom conform*
- N/A **ECHO:** *This test is Not Applicable*
- N/A **KILO:** *This test is Not Applicable*

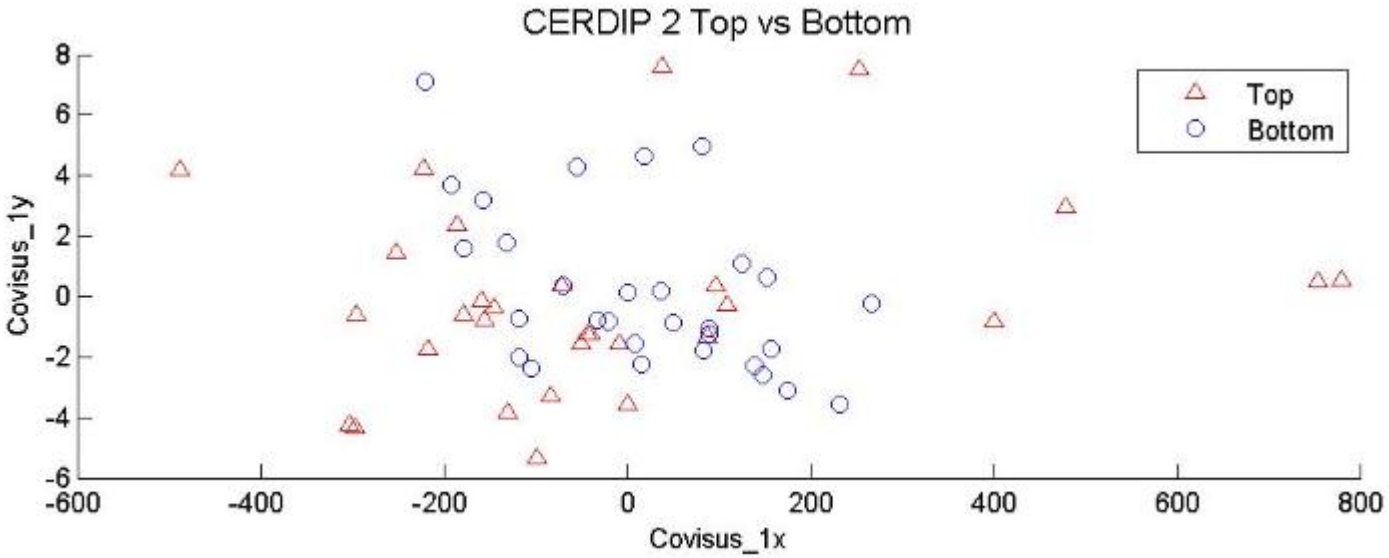
This is an incorrect result. This test may have passed because the original markings are still clearly visible, which means that very little surface has been Microblasted.

Graphs for Ceramic #2



DELTA

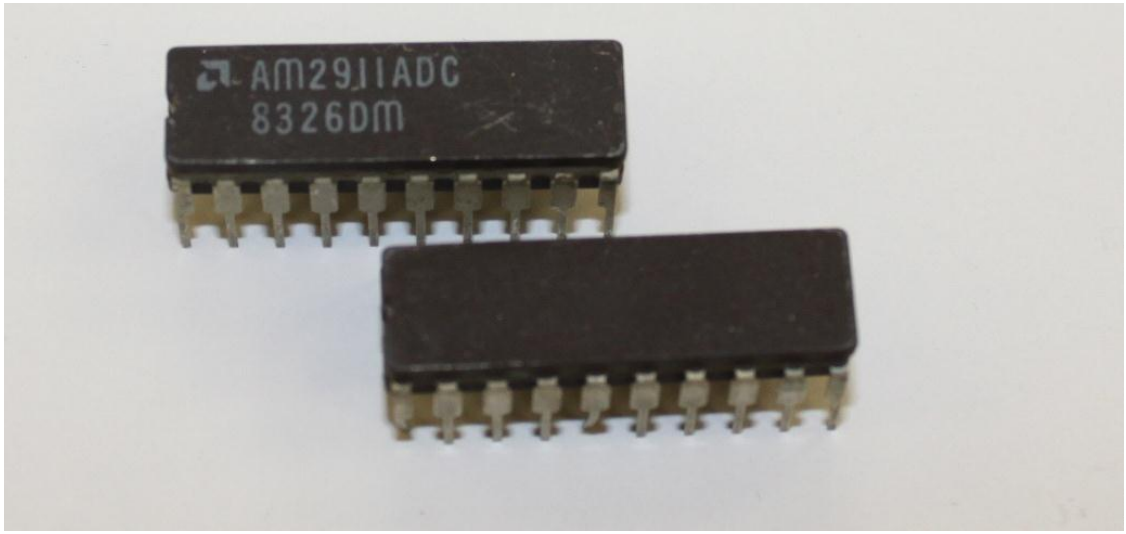
separation = 0.7



TANGO

separation = 0.4

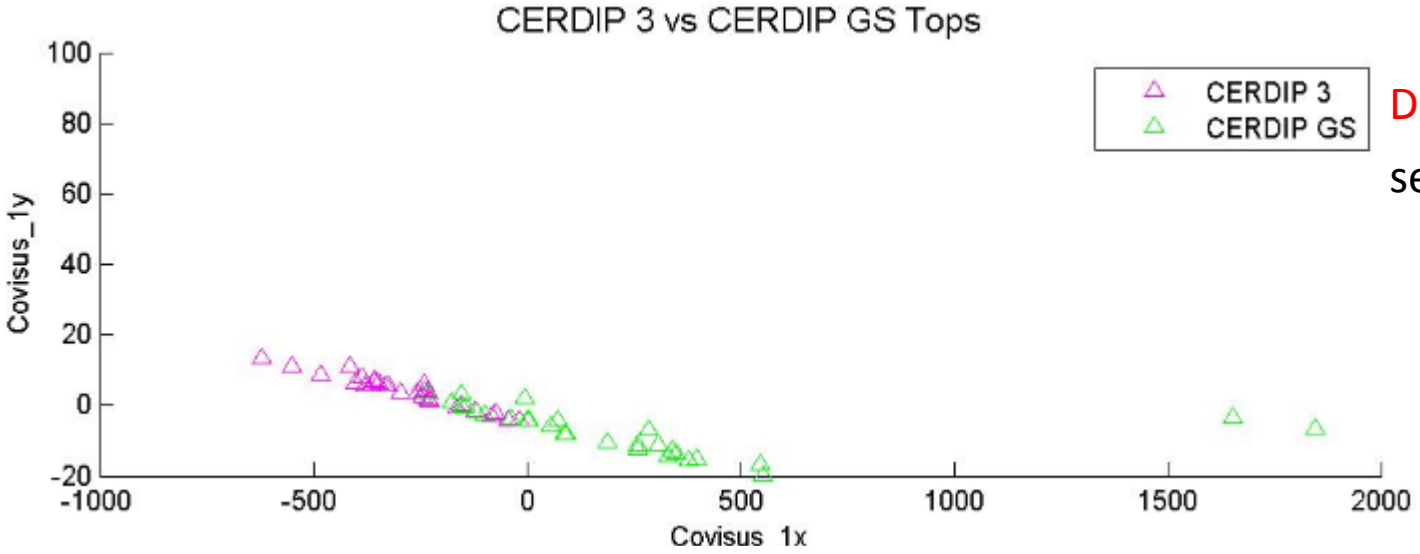
DTEK Report: Ceramic #3



Correct Result (True Positive)

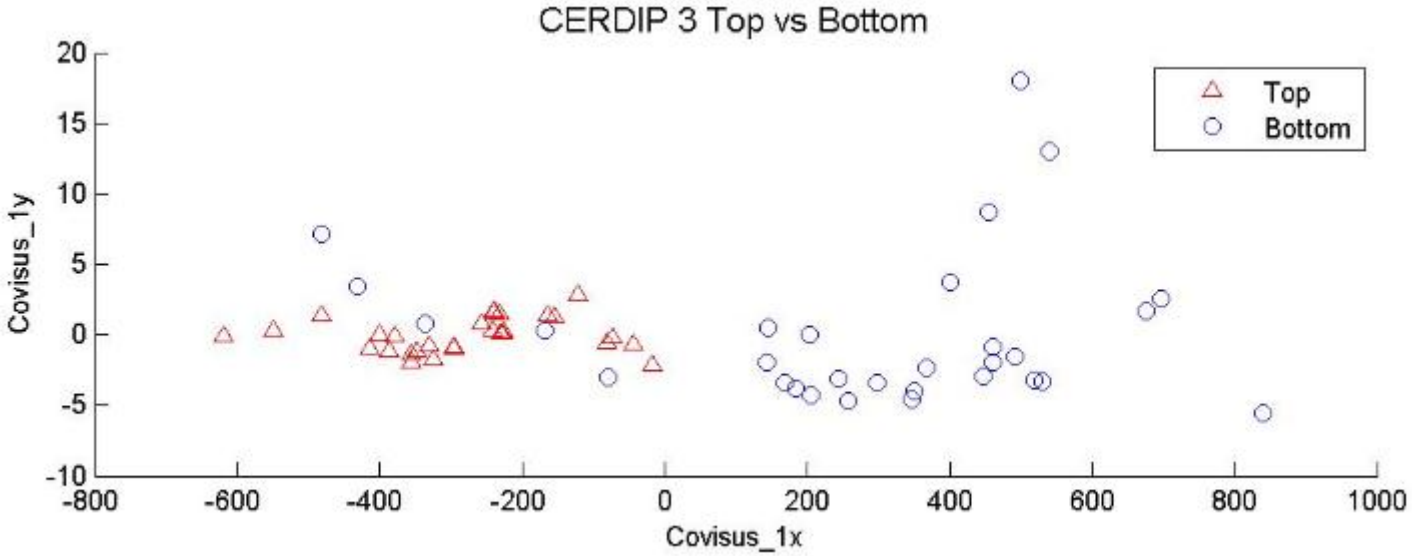
- ✕ **DELTA:** *The DUT and RCS do not conform*
- ✕ **TANGO:** *The top and bottom test do not conform*
- N/A **ECHO:** *This test is Not Applicable*
- N/A **KILO:** *This test is Not Applicable*

Graphs for Ceramic #3



DELTA

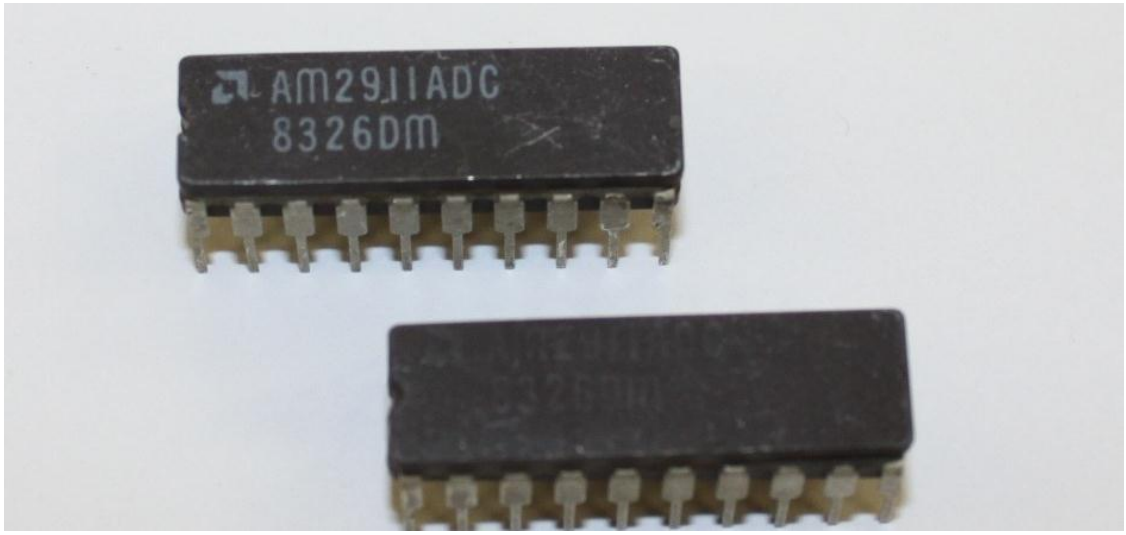
separation = 1.8



TANGO

separation = 2.4

DTEK Report: Ceramic #4

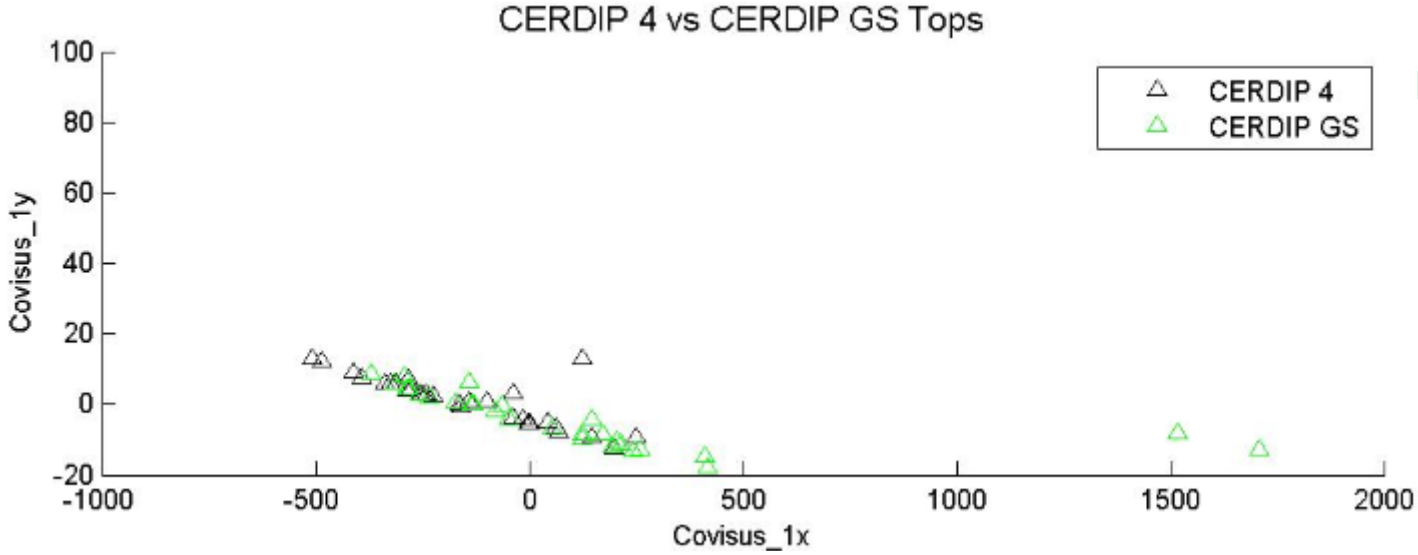


Correct Result (True Positive)

- ✓ **DELTA:** *The DUT and RCS conform*
- ✗ **TANGO:** *The top and bottom do not conform*
- N/A **ECHO:** *This test is Not Applicable*
- N/A **KILO:** *This test is Not Applicable*

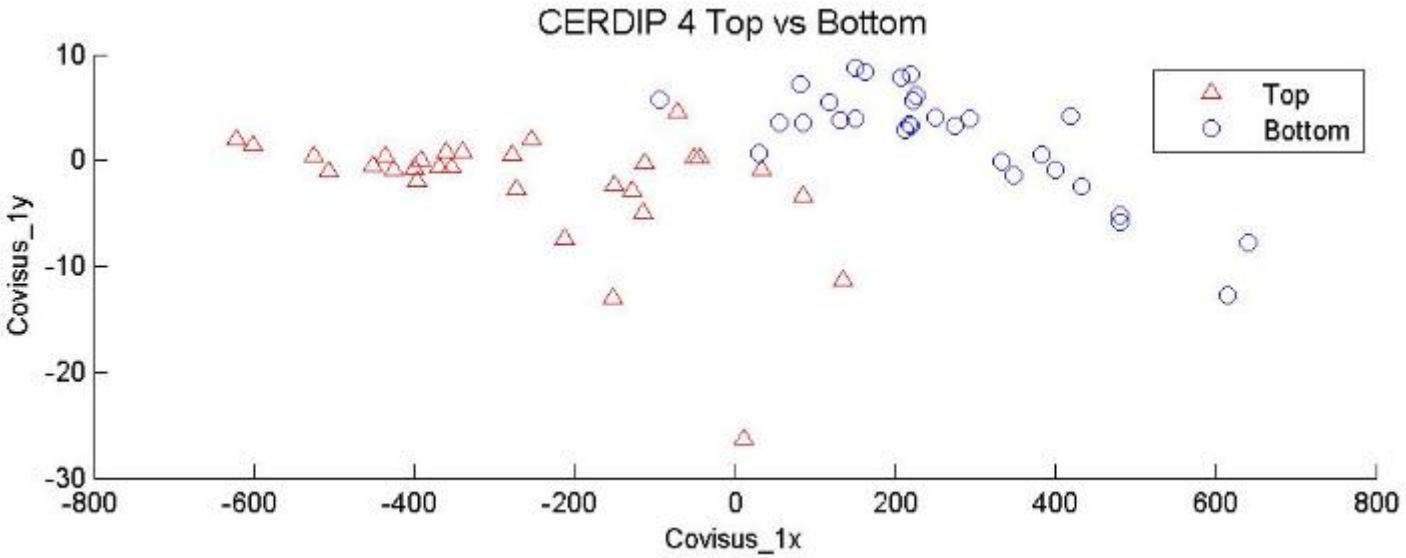
Even though this test correctly failed this component, it is interesting to note that the original marking can still be read.

Graphs for Ceramic #4



DELTA

separation = 0.67

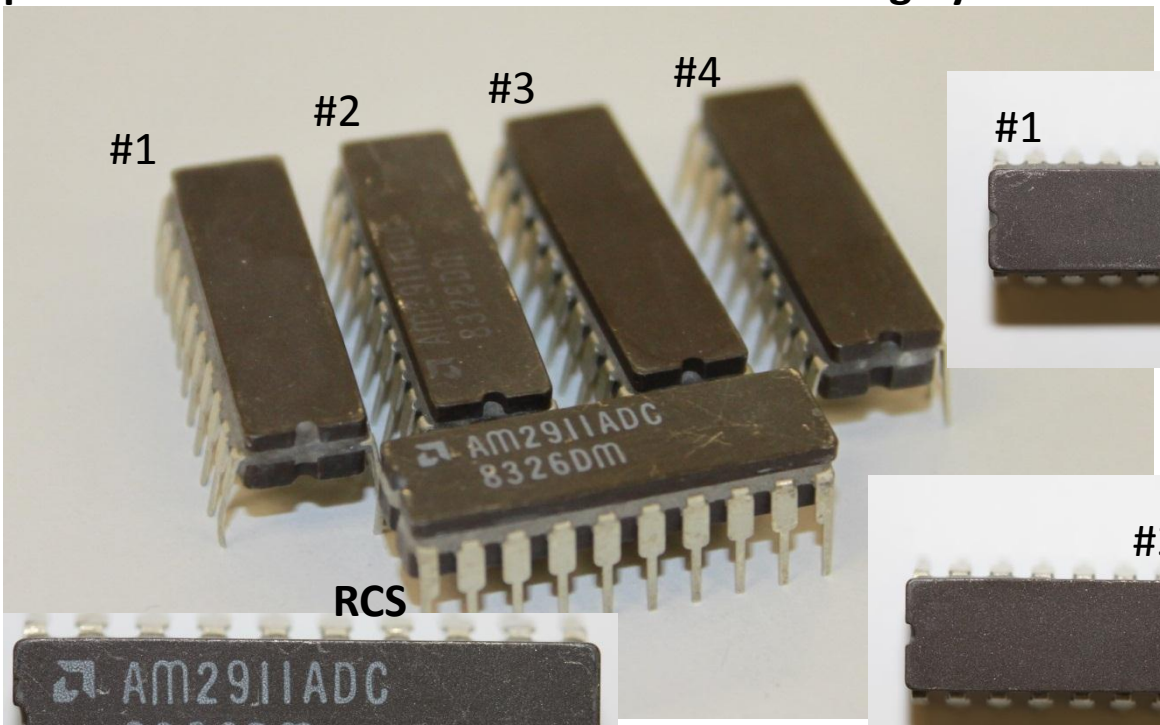


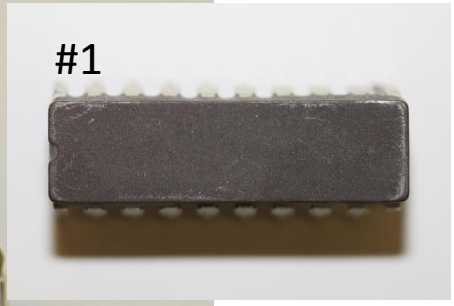
TANGO

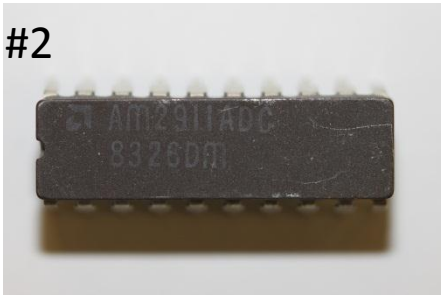
separation = 2.5

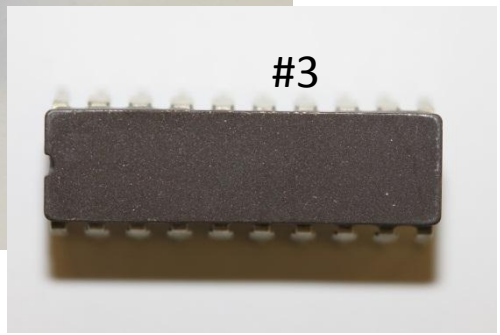
Summary for G-19A Ceramic Tests

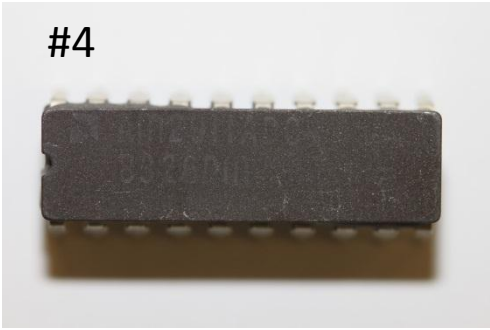
DTEK was able to correctly identify parts #1, 3, and 4 as Non-Conforming. However, part #2 was not identified as Non-Conforming by the DTEK.











RCS

In this case, the RCS packaging appears to be in very poor condition, likely from excessive handling.

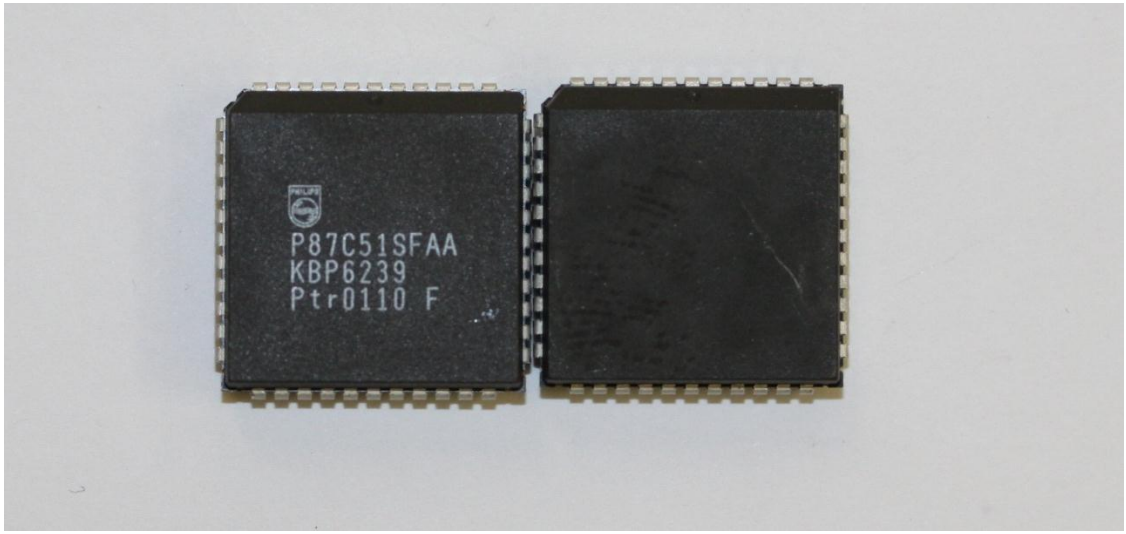
Test Category 3: Plastic Microblasted (G-19A)

COVISUS

Note: All of these components were originally Authentic Samples but the DUT has been Microblasted

Part Name	Type and Quantity	Special Notes	DELTA	TANGO	ECHO	KILO	Result Classification
Phillips P87C51SFAA "Plastic" Part #1	DUT (1)		separation = 4.1	separation = 3.9	NA	NA	True Positive
	RCS (1)			separation = 1.2	NA	NA	
Phillips P87C51SFAA "Plastic" Part #2	DUT (1)		separation = 0.4	separation =.9	NA	NA	False Negative
	RCS (1)			separation = 1.2	NA	NA	
Phillips P87C51SFAA "Plastic" Part #3	DUT (1)		separation = 3.8	separation = 3.8	NA	NA	True Positive
	RCS (1)			separation = 1.2	NA	NA	
Phillips P87C51SFAA "Plastic" Part #4	DUT (1)		separation = 1.5	separation = 2.8	NA	NA	True Positive
	RCS (1)			separation = 1.2	NA	NA	

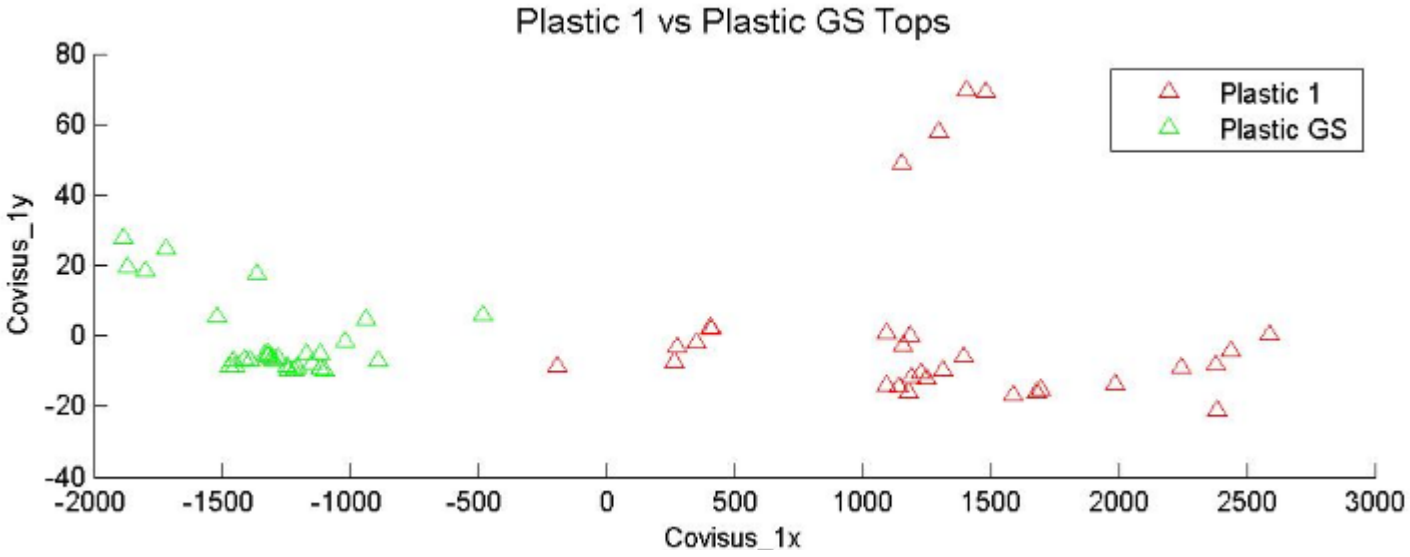
DTEK Report: Plastic #1



Correct Result (True Positive)

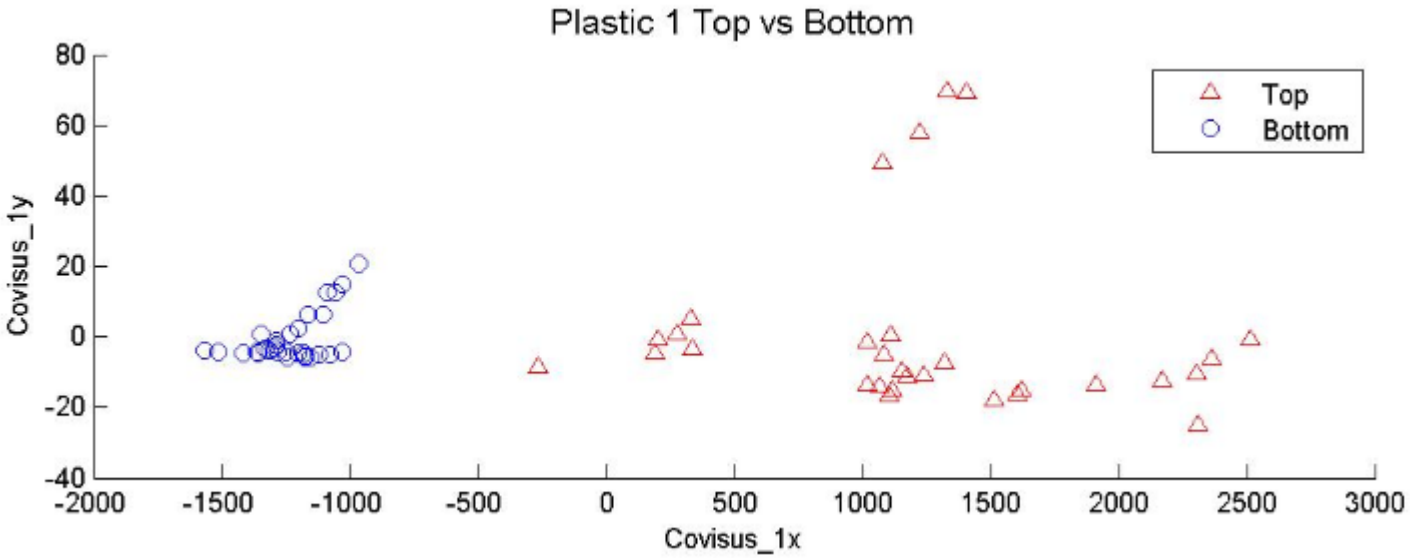
- ☒ **DELTA:** *The DUT and RCS do not conform*
- ☒ **TANGO:** *The top and bottom do not conform*
- N/A **ECHO:** *This test is Not Applicable*
- N/A **KILO:** *This test is Not Applicable*

Graphs for Plastic #1



DELTA

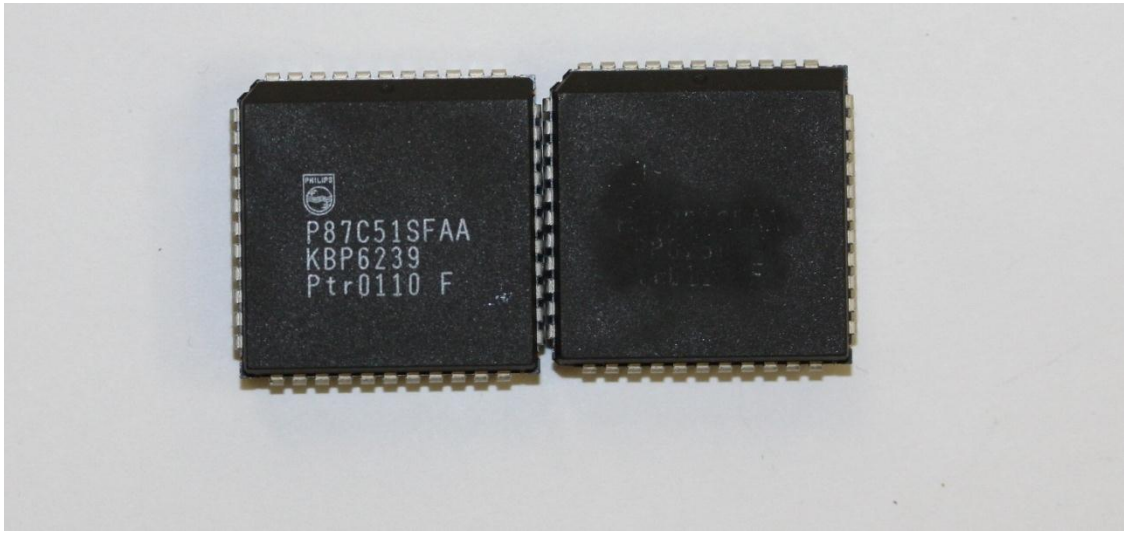
separation = 4.1



TANGO

separation = 3.9

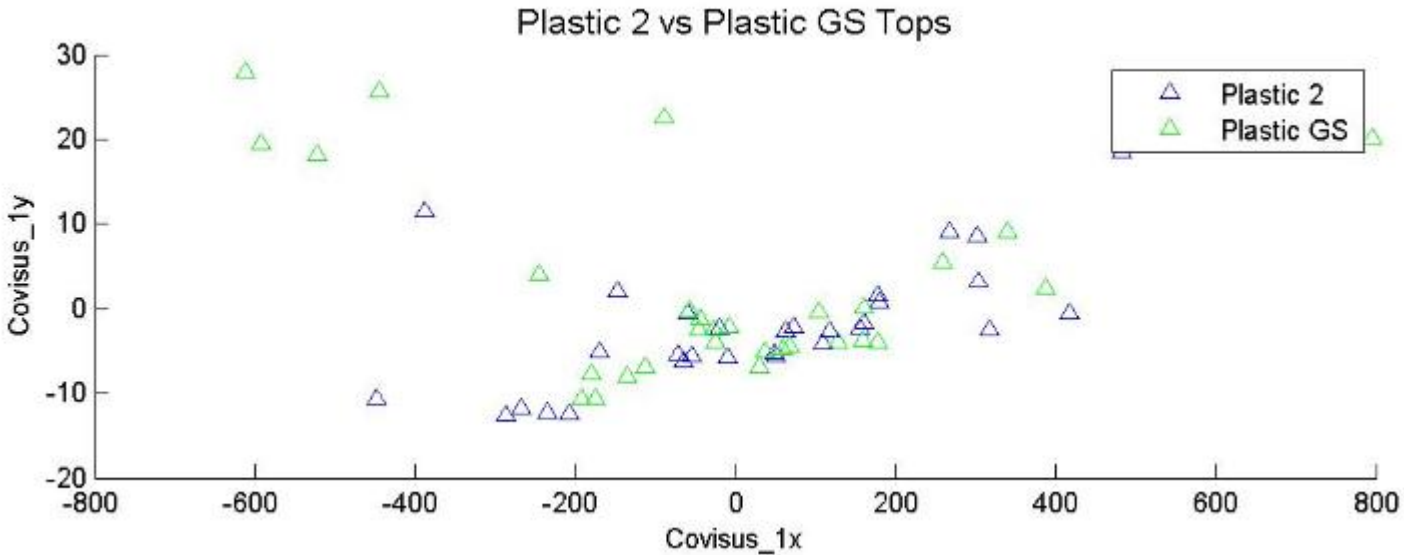
DTEK Report: Plastic #2



Incorrect Result (False Negative)

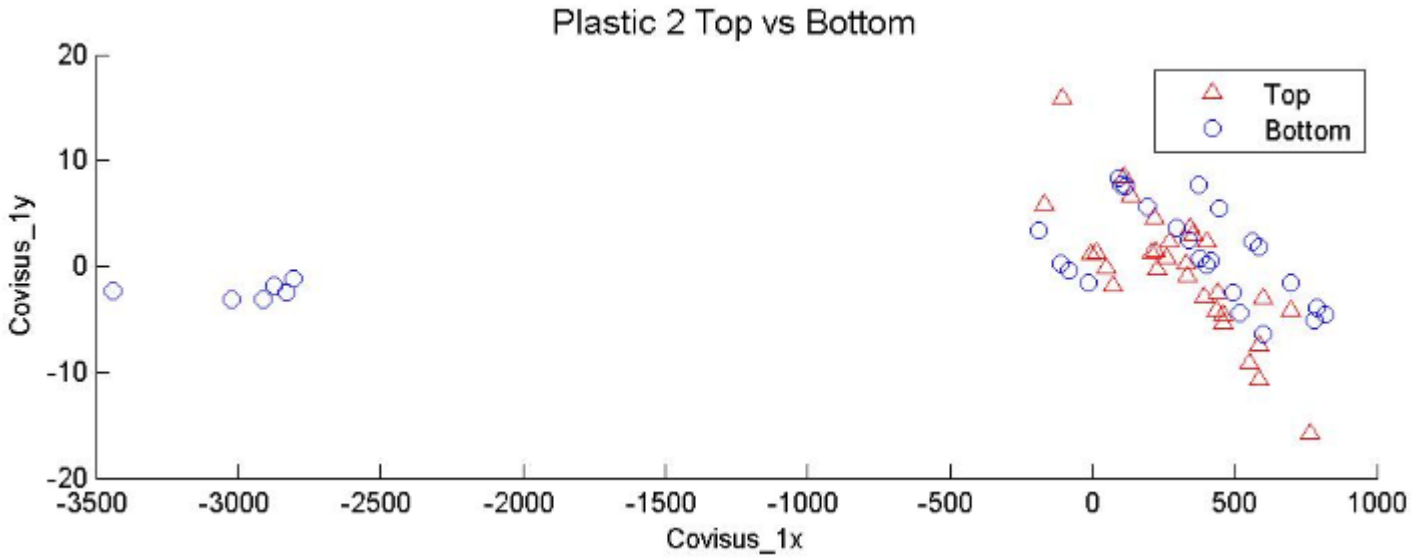
- ☑ **DELTA:** *The DUT and RCS conform*
- ☑ **TANGO:** *The top and bottom conform*
- N/A **ECHO:** *This test is Not Applicable*
- N/A **KILO:** *This test is Not Applicable*

Graphs for Plastic #2



DELTA

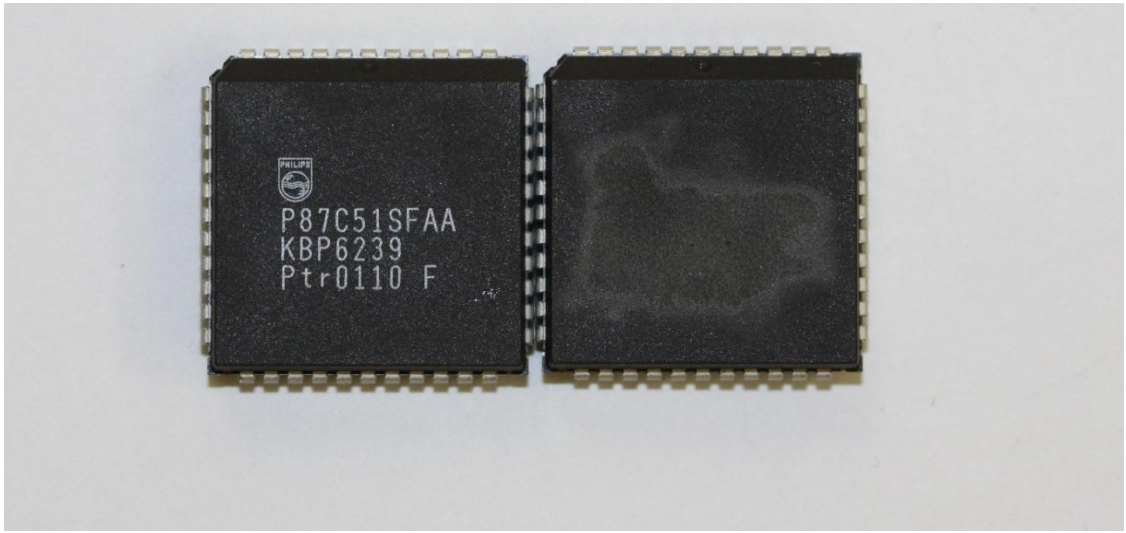
separation = 0.4



TANGO

separation =.9

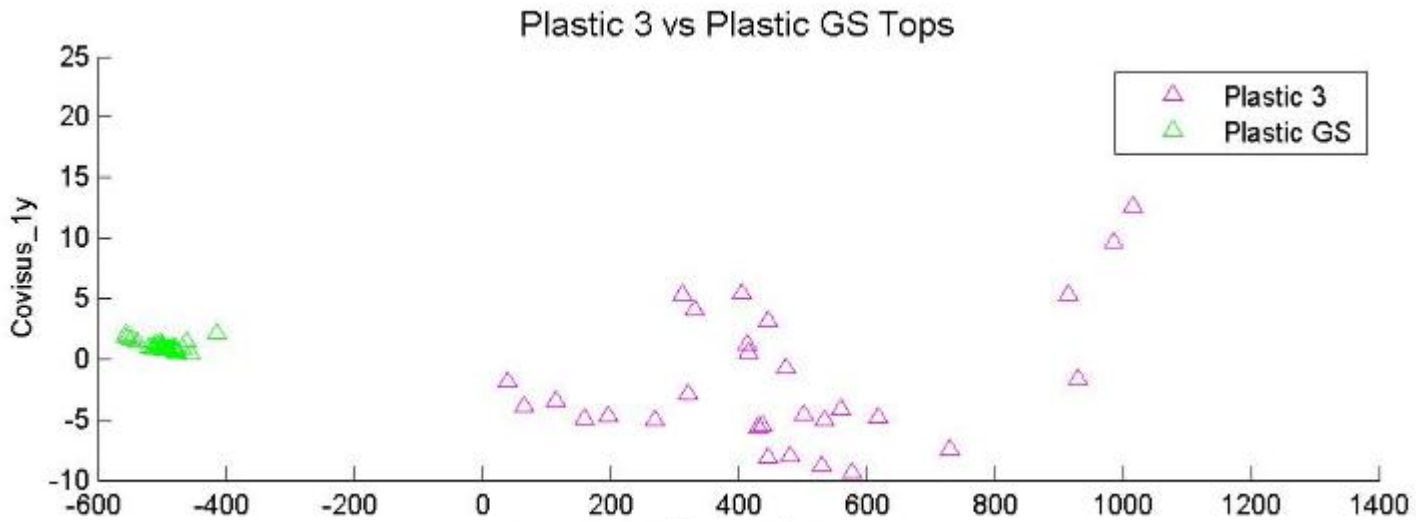
DTEK Report: Plastic #3



Correct Result (True Positive)

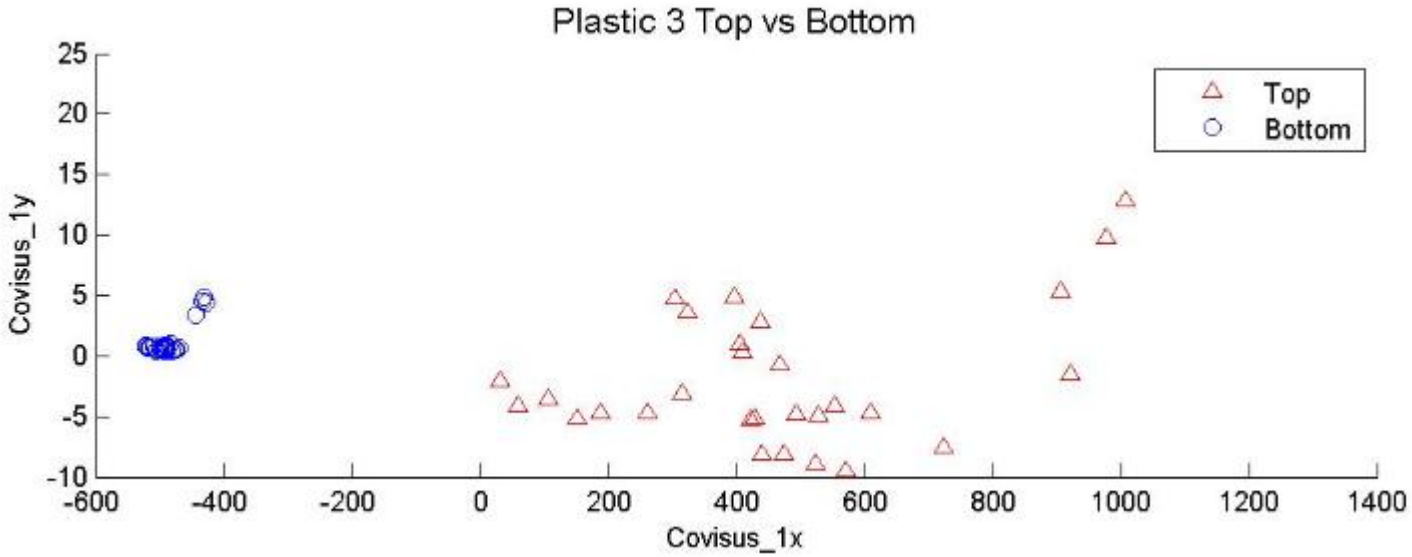
- ☒ **DELTA:** *The DUT and RCS do not conform*
- ☒ **TANGO:** *The top and bottom do not conform*
- N/A **ECHO:** *This test is Not Applicable*
- N/A **KILO:** *This test is Not Applicable*

Graphs for Plastic #3



DELTA

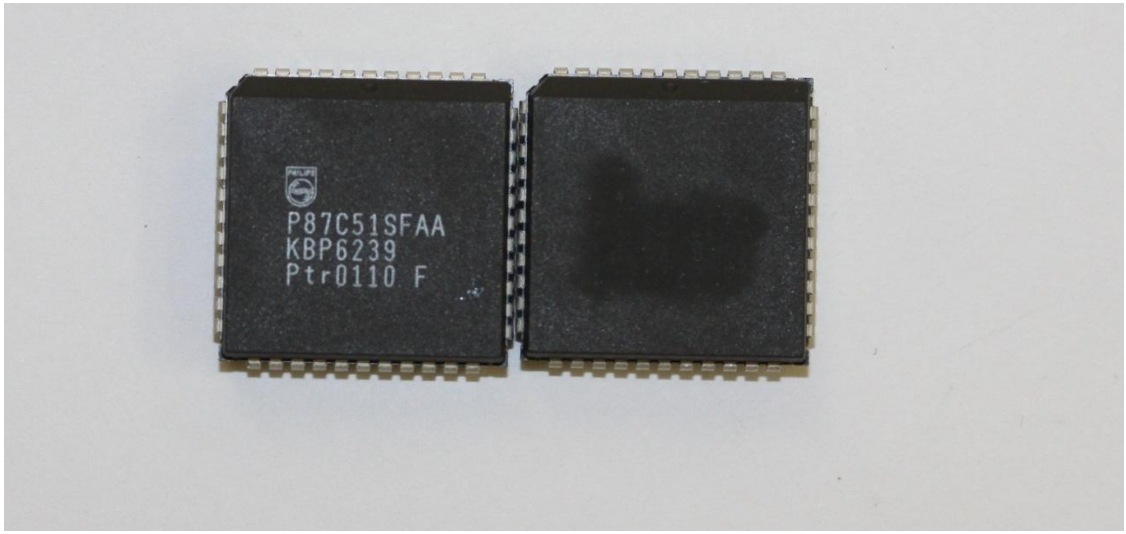
separation = 3.8



TANGO

separation =3.8

DTEK Report: Plastic #4

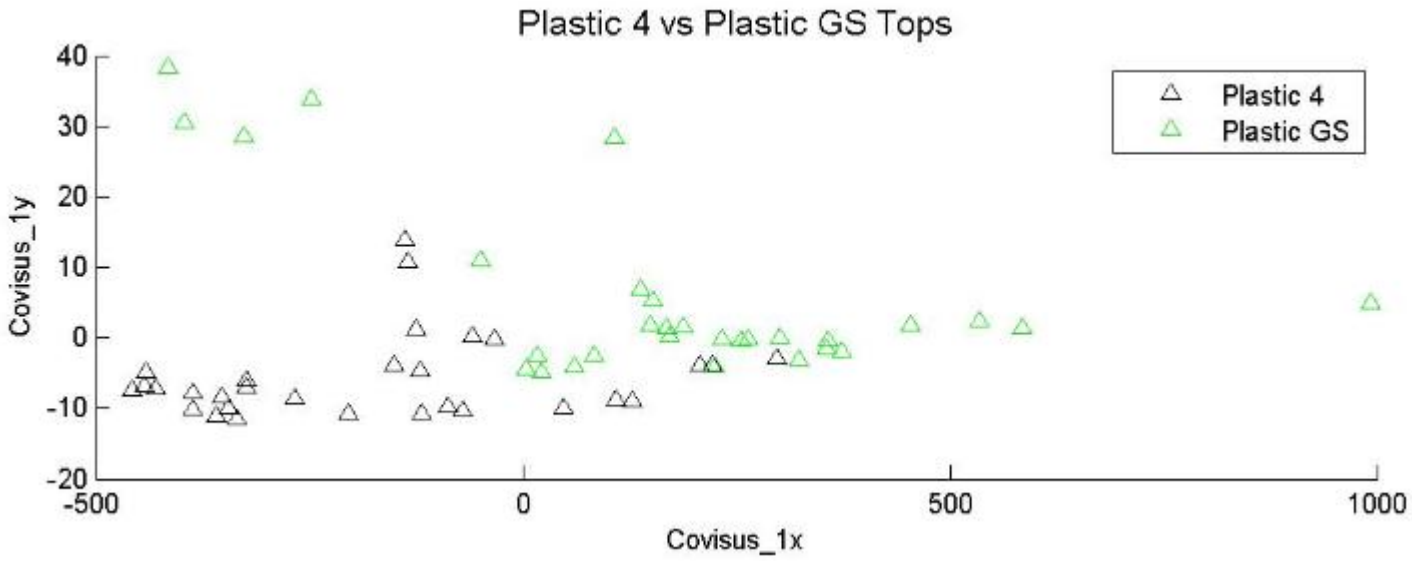


Correct Result (True Positive)

- ☑ **DELTA:** *The DUT and RCS conform*
- ☒ **TANGO:** *The top and bottom do not conform*
- N/A **ECHO:** *This test is Not Applicable*
- N/A **KILO:** *This test is Not Applicable*

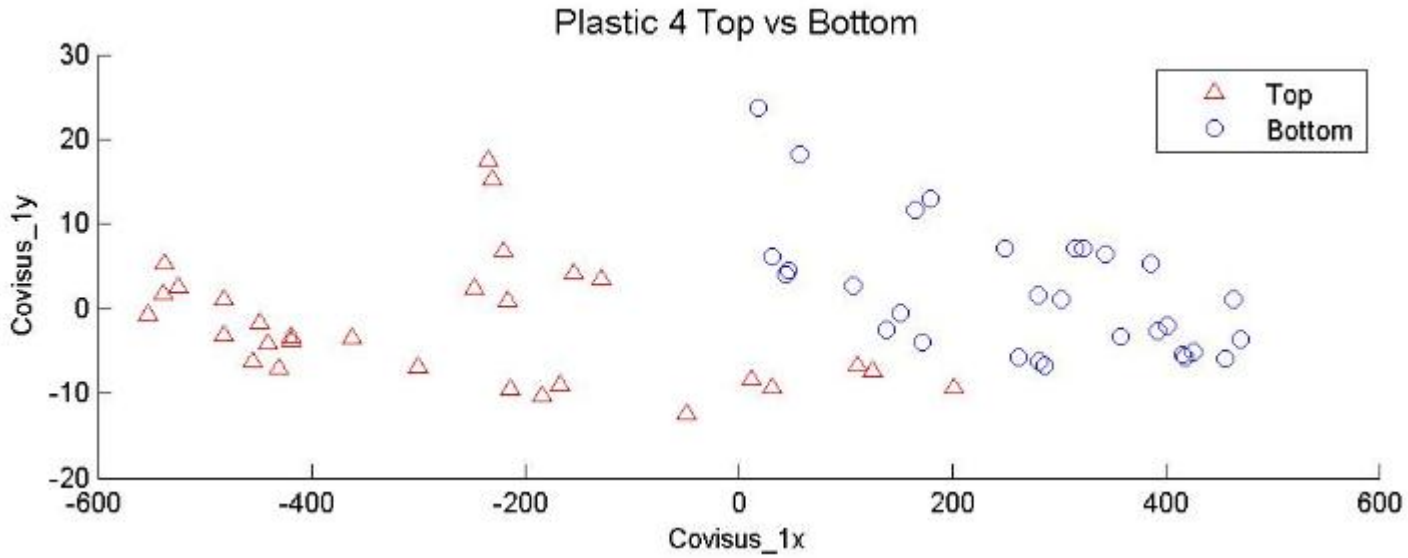
You can see from this image that the surface was very carefully Microblasted.

Graphs for Plastic #4



DELTA

separation = 1.5

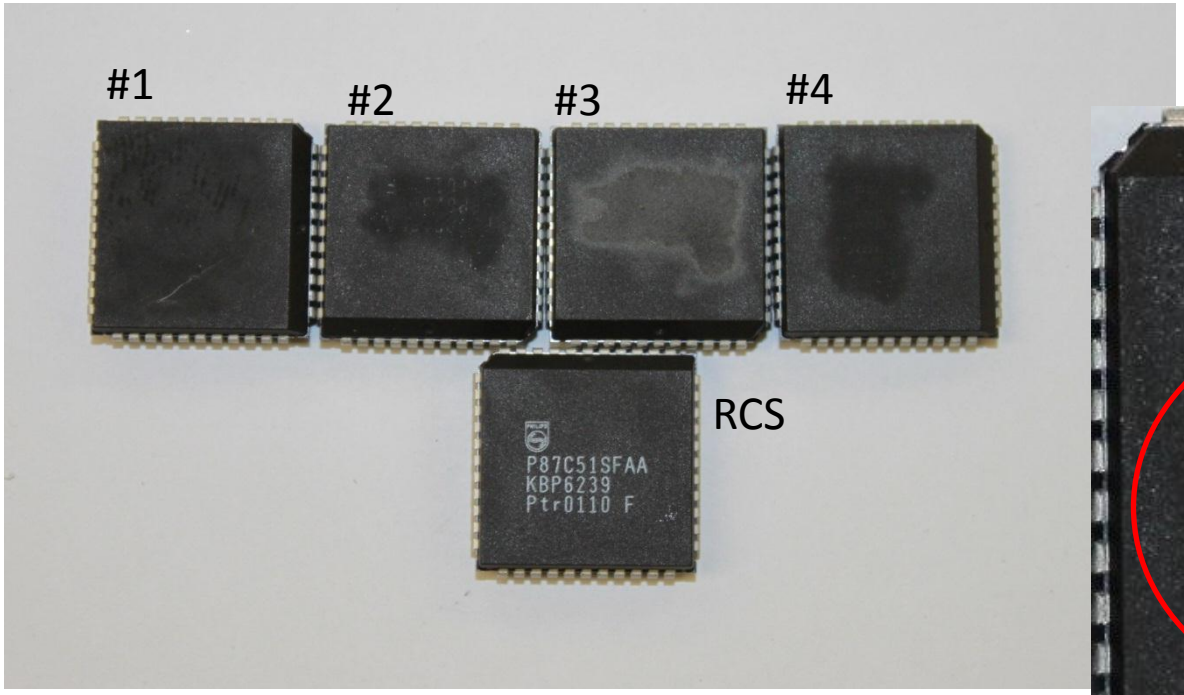


TANGO

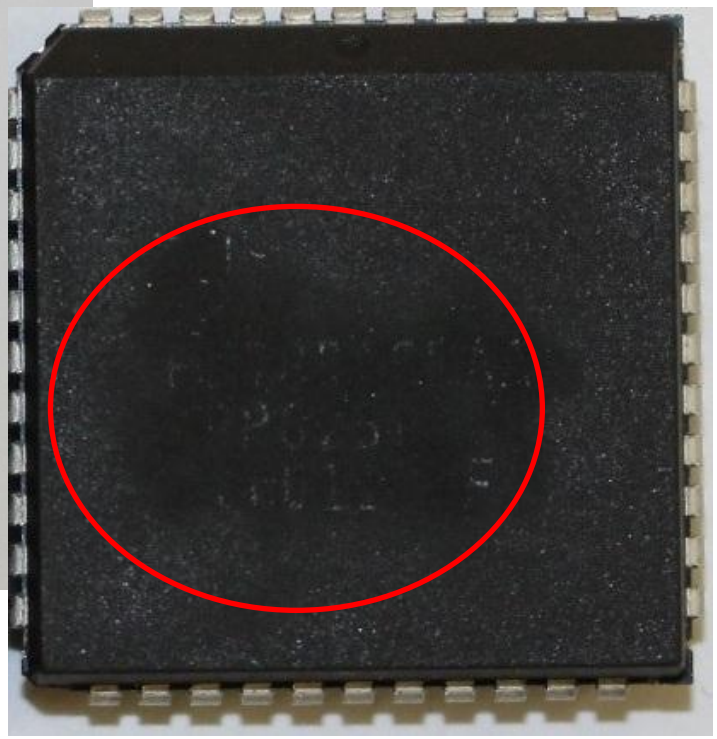
separation =2.8

Summary for G-19A Plastic Tests

DTEK was able to correctly identify part #1, 3, and 4 as Non-Conforming. However, part #2 was not identified as Non-Conforming by the DTEK.



#2



In the case of #2, you can still see the part markings

Part 3: Summary
G-19A Microblast Testing

- DTEK was able to flag all 5 Metal Can parts

- DTEK was able to flag 3 of the 4 Ceramic parts
  - Part #2 marking were still clearly visible

- DTEK was able to flag 3 of the 4 Plastic parts
  - Part #2 marking were still somewhat visible

Section 4: Testing and Representative Results

Part 1: Global IC Trading Group

Part 2: Microblast Testing – SMT Corp.

Part 3: Microblast Testing – G19A

Part 4: False Positives

- **False Positive Overview**
- **Test Results**
- **Summary**

COVISUS

DTEK False Positive Test

- **Does DTEK generate false positive results due to different date codes or countries of origin?**

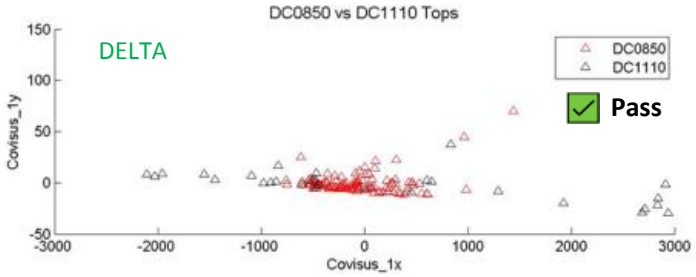
- Of the 10 comparison tests performed using the same part number, (5 different lots, 5 different date codes, 3 different sources, and 2 different countries of origin) the DTEK correctly identified all components.

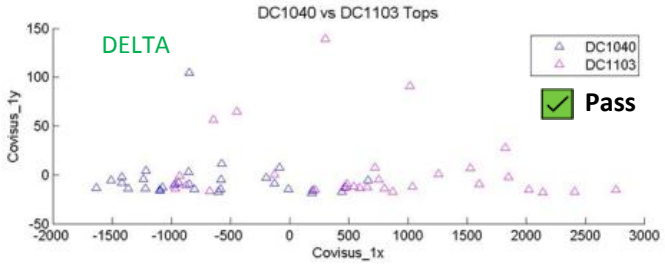
False Positives Tests

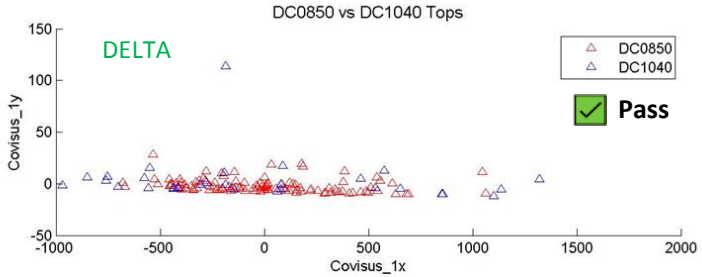
DELTA tests were performed using pairwise comparisons of 5 known authentic lots of ADUM5241 components with 5 different date codes, 2 different countries of origin.

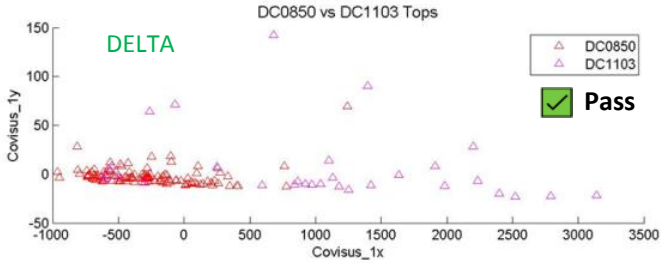
DUT Date Code and Quantity	DUT Country of Origin	RCS Date Code and Quantity	RCS Country of Origin	DELTA	Result Classification
DC 0850 QTY (19)	Ireland	1040 Qty (5)	Malaysia	Separation=.03	**True Negative**
	Ireland	1103 Qty (5)	Ireland	Separation=1.25	**True Negative**
	Ireland	1110 Qty (5)	Malaysia	Separation=.22	**True Negative**
	Ireland	1117 Qty (5)	Malaysia	Separation=1.81	**True Negative**
DC 1040 QTY (5)	Malaysia	1103 Qty (5)	Ireland	Separation=1.27	**True Negative**
	Malaysia	1110 Qty (5)	Malaysia	Separation=.23	**True Negative**
	Malaysia	1117 Qty (5)	Malaysia	Separation=1.8	**True Negative**
DC 1103 QTY (5)	Ireland	1110 Qty (5)	Malaysia	Separation=.57	**True Negative**
	Ireland	1117 Qty (5)	Malaysia	Separation=.02	**True Negative**
DC 1110 QTY (5)	Malaysia	1117 Qty (5)	Malaysia	Separation=.59	**True Negative**

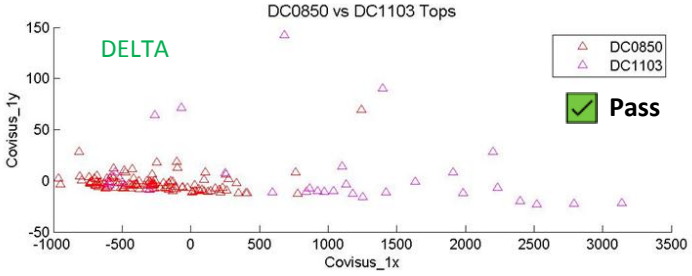
False Positive DELTA Test Results

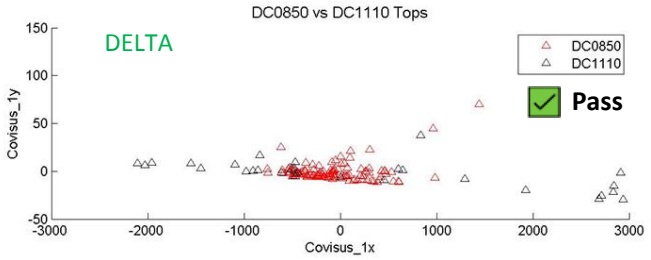


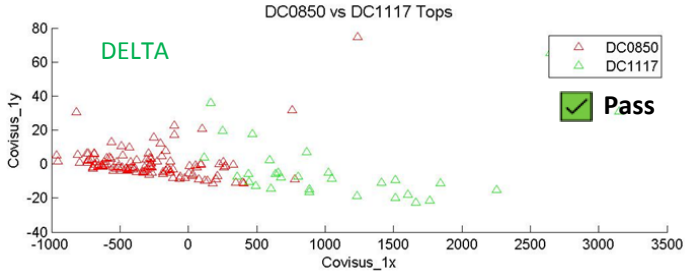


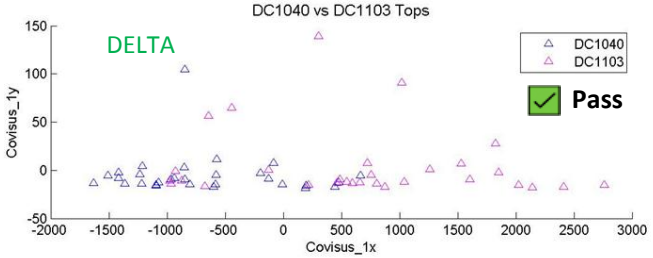




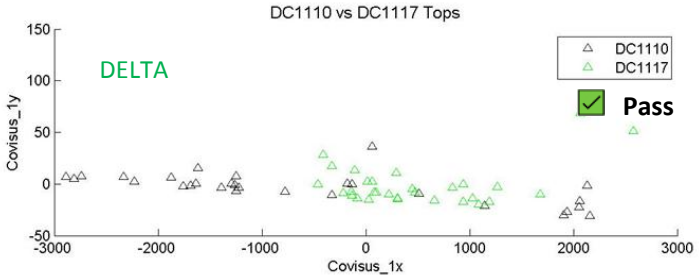


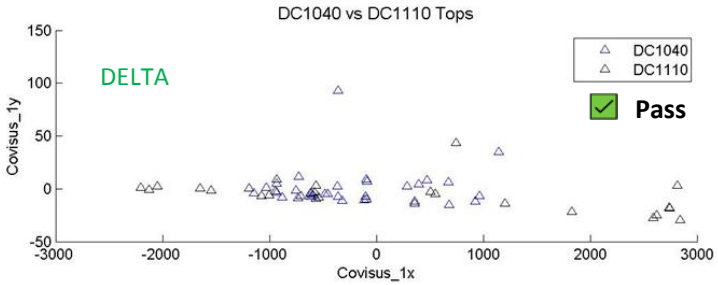


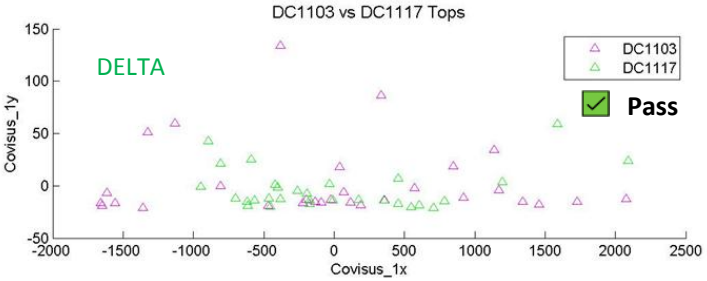


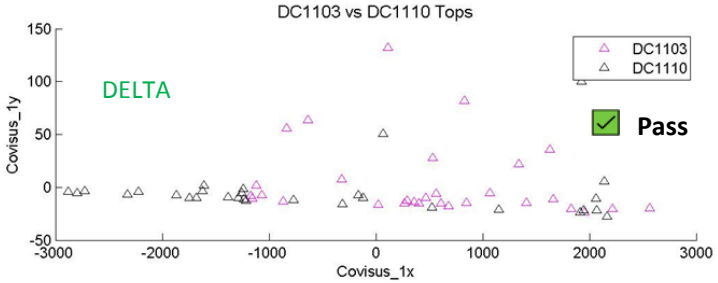


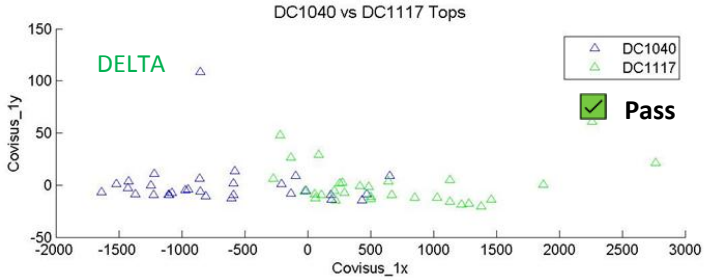
False Positive DELTA Test Results (continued)











Part 4: Summary
False Positives

- In this study, DTEK did not generate false positive results due to different date codes and countries of origin

- These results are consistent with earlier tests run on other components with varying date codes and countries of origin

- False positive rates for different countries of origin may be manufacturer-dependent

Appendix

Frequently Asked Questions - I

- **What is the DTEK 2.0?**

  DTEK 2.0 is a quantitative optical inspection tool for the inspection of monolithic integrated circuit (IC) packages. It is primarily intended for use as a counterfeit mitigation tool to identify resurfacing, re-marking, or non-conforming integrated circuit packaging.

- **What does it do?**

  The DTEK optically analyzes the surface of an electronic component and outputs unambiguous quantitative information about the surface for the purpose of comparative analysis.

- **How does the system work?**

  A trained DTEK operator inputs the component data into the Covisus software application and follows the guided steps to capture a scan of the component using the DTEK hardware. After completion of all steps, the system outputs a report. The report includes a "pass/fail/not-applicable" summary result and additional detailed data.

- **Can I use DTEK in instead of other analytical techniques?**

  DTEK is not designed to be a stand-alone counterfeit mitigation tool and should be used as part of a comprehensive quality system. DTEK is not a quality system. Users should refer to documentation published by ISO, ANSI, SAE International, IDEA, the University of Maryland Center for Lifecycle Engineering (CALCE), and others in addition to federal and customer directives for information on quality systems.

- **Do you need a golden sample for the system to work?**

  No. Having a golden reference does improve the amount of information available in the report, but useful analysis can be performed without a golden sample in many instances.

Frequently Asked Questions - II

- **Is training required?**

  DTEK is useable by a non-expert but does require a brief training session.

- **Can anyone use this?**

  DTEK training can be accomplished in under 1 hour and is operable by non-experts. Results interpretation is best accomplished by individuals with expertise and training in counterfeit screening and quality systems.

- **Is DTEK capable of analyzing all types of electronic components?**

  Quantitative optical inspection (as an analytical technique) is applicable to most common electronic components in metal, plastic, or ceramic packaging. DTEK 2.0 is designed to analyze single-piece monolithic integrated circuits within specific size ranges. See the DTEK 2.0 Test Component Specification Sheet for details (available upon request).

- **What is the recommended sample size?**

  The minimum recommended sample size is five (5) components. Analysis may be performed with less than five (5) components for the DELTA AND TANGO tests, but the quality of results will be lower. The ECHO and KILO tests, which test for variance within a sample of components, require a minimum of five (5) components.

- **Does it damage the test components?**

  If used properly, the DTEK test is nondestructive and does not damage the component.

- **Does the DTEK modify, tag, or change the component surface?**

  No. DTEK does not tag or add any marking to the components.

Frequently Asked Questions - III

- **How long does it take?**

  Each scan takes under 1 second. For a trained operator, a lot sample can be analyzed in as little as five (5) minutes from start to finish. Automatic entry of component information saves considerable time and reduces errors.

- **Does this tell me if the part works?**

  No. The DTEK is not a functional testing tool.

- **Does a "pass" result mean that components are authentic?**

  No.

- **Can DTEK identify all types of counterfeit electronic components?**

  No. DTEK is primarily intended as a tool to help identify surface characteristics seen with re-marked, re-surfaced, or non-conforming integrated circuit packaging. DTEK 2.0 may not identify certain types of counterfeit components such as used product that has not been remarked or counterfeits with pristine original packaging that illegally enters the supply chain.

- **Can the system be used for other types of products?**

  The DTEK 2.0 system is designed for electronic components. Quantitative optical inspection techniques can be applied to other products and commodities. Covisus and its parent company, ChromoLogic LLLC, have applied quantitative optical inspection techniques to other commodity areas such as medical device parts, aerospace turbine blades, weapons, and specialty materials.

Frequently Asked Questions - IV

- **Will scratches, dust, or fingerprints confound the results and cause errors?**

  DTEK 2.0 is designed to be resistant to common confounders such as scratches, dust, and fingerprints. However, reasonable steps should be taken to avoid unnecessary confounders. Highly damaged, scratched, or dirty surfaces may cause one or more components to fail, or to be flagged in the ECHO or KILO tests as non-conforming as compared to the other sample components. Wearing latex gloves or finger cots is not required, but is recommended.

- **Can lot-to-lot variation or different manufacturing facilities cause "false positive" results?**

  Yes. Quantitative optical inspection is based on comparative analysis. If manufacturing differences create different surface features, a "fail" summary result may occur when comparing one or more authentic components. Covisus testing on components from different date codes and countries of origin have not shown large variations in surface characteristics or high false positive error rates, but that may not be the case for all manufacturers.

- **Is it safe?**

  DTEK does not use any harmful chemicals or emit harmful radiation. However, the system emits high-intensity white light ("illumination"). Operators should not disassemble the system or look directly into the illumination banks. Users should follow all instructions in the user safety manual.

- **Can it be used by Component Manufacturers to protect their brands and products?**

  Yes, component manufacturers can implement Covisus technology to provide authorized references samples to customers. Covisus has also demonstrated optical "tag-free" track-and-trace. This allows supply chains to track individual components with a high degree of confidence throughout its lifecycle without the addition of markings, codes, tags, or any physical changes to the component at the time of initial data capture. DTEK 2.0 does not require an initial scan by a component manufacturer to operate.

Attribution & Recognition

- Primary R&D conducted by ChromoLogic LLC, funded by the US Army Research Office
- Collaboration and technical exchange: SAE G-19 Committee, the Independent Distributors of Electronics Association, The Boeing Company, Global IC Trading Group, SMT Corporation, PCX Corporation, American Electronic Resource, Inc.

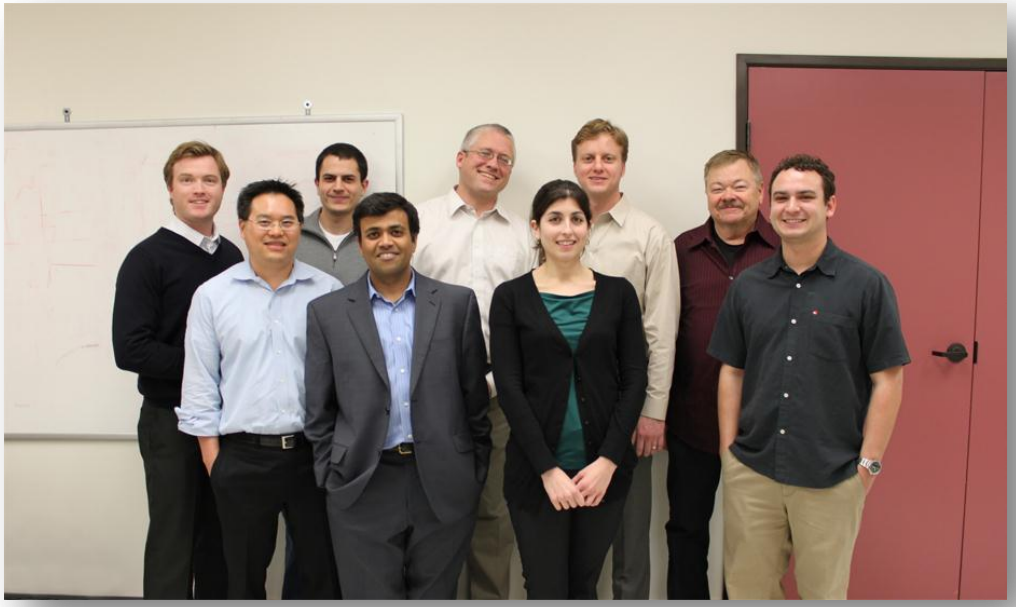
- All data and results presented for DTEK and other analytical techniques are presented on a commercial best efforts basis and are not warranted to be error free.

Thank You & Contact Information

Contact:
Covisus Corporation
180 N. Vinedo Ave.
Pasadena, CA 91107
www.covisus.com

(8am -6pm pst)
Leonard Nelson
lnelson@covisus.com
(626) 372-9787

Skylar Gauss
sgauss@covisus.com
(805) 452-7025



DTEK Design Team (from left): Skylar Gauss, Lawrence Yu, Jordan Crede, Naresh Menon, PhD, Dan Reiley, PhD, Masha Belyi, Leonard Nelson, Orin Serviss, Andrew Dyer. Not pictured – Theresa Nguyen, Greg Bearman, PhD