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2024 CONFERENCE

Probing Technologies for KGD Testing: Choosing Between Needle Probes and Pogo Pins

SPEA
YOUR BEST WAY TO TEST

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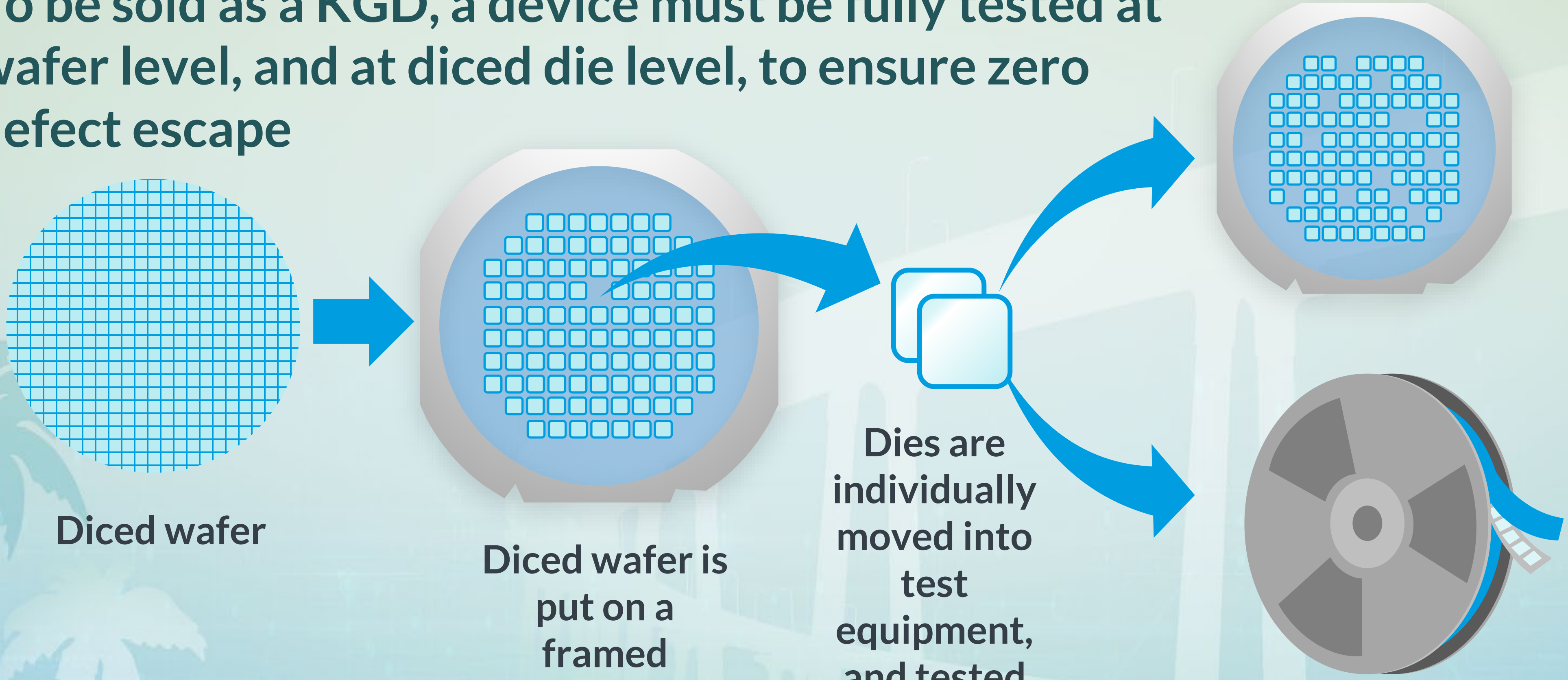
SPEA

Overview

- KGD Testing
- Probing technologies for KGD
- Needle vs. pogo technology
- Impact on testing: Lab investigation
  - Mechanical Performances Comparison
    - Compression range
    - Contacting marks
    - Force comparison
  - Electrical Performances Comparison:
    - Resistance and Robustness for High Current Applications
- Conclusions

KGD Testing

- **KNOWN GOOD DIES** are devices fully supported by suppliers to meet or exceed quality, reliability and functional data sheet specifications
- To be sold as a KGD, a device must be fully tested at wafer level, and at diced die level, to ensure zero defect escape



Diced wafer

Diced wafer is put on a framed adhesive film

Dies are individually moved into test equipment, and tested

Tested dies are put into a reconstructed wafer film frame, or they are directly placed into a tape reel

Why KGD Testing

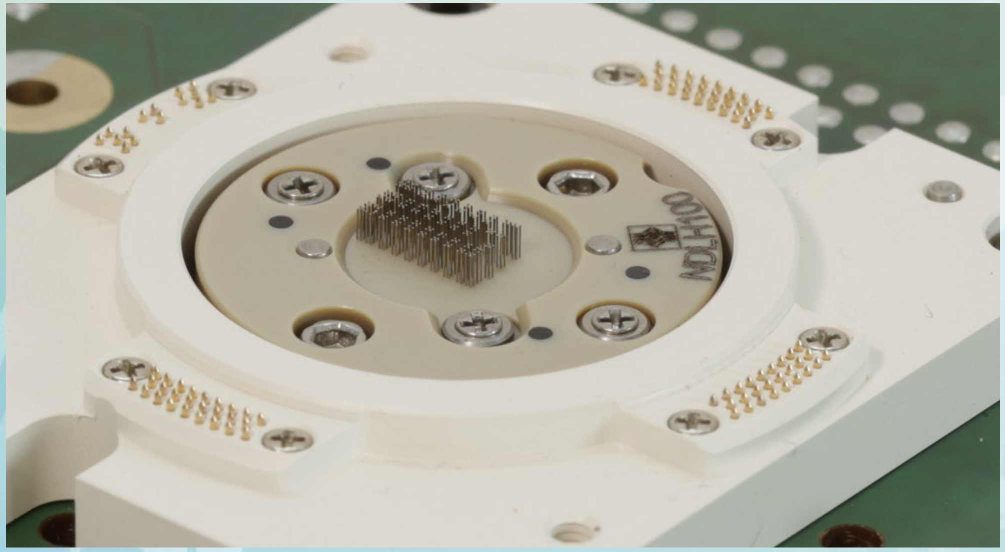
The parametric testing executed at wafer level (not diced), is not sufficient to eliminate the failure rate, especially on power components:

- It is very hard to reach high voltage and high current at probe level
- It is very hard to perform all the dynamic measurements to ensure that the device performances meet the datasheet specifications
- Die-to-die interference can affect the test performance

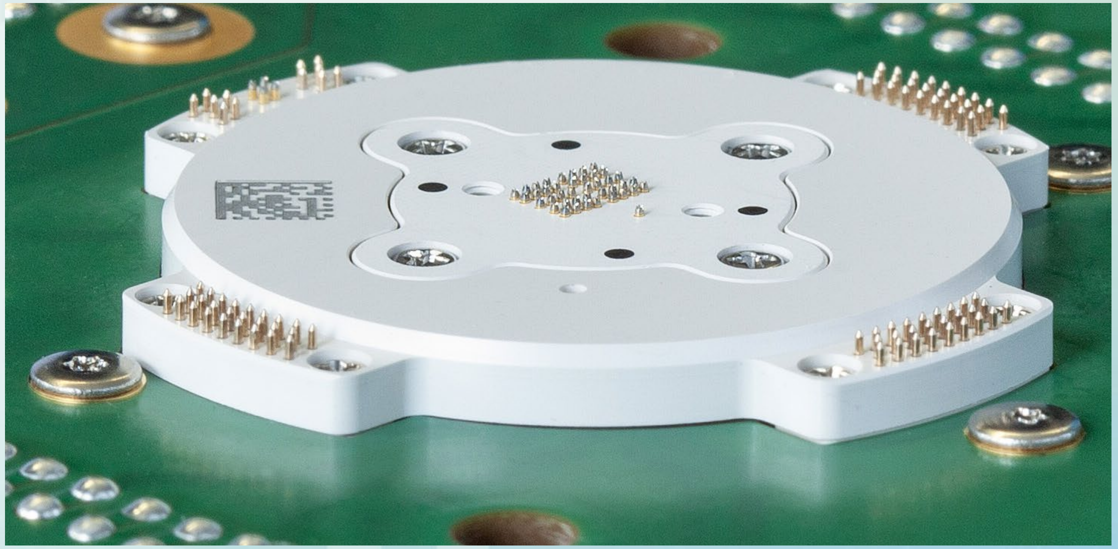
Probing Technologies for KGD Testing

- Selecting the appropriate probing technology is essential
- Two prominent choices are needle probes and pogo pins

Example of needle head



Example of pogo head



Needle vs. Pogo at a Glance

	NEEDLE	POGO
Layout Density	👍	👍
Contact Resistance	👍	👍
Risk of mechanical deformation	👎	👍
Ease of maintenance	👎	👍
Ease of Cleaning	👎	👍
Durability for high current/voltage	👍	👍
Cost per unit	👍	👍

What is the Impact on Testing?

How the advantages and limitations of the two technologies impact the production testing?

Impact on Testing – Lab Investigation

We have arranged a laboratory setup to make a quantitative comparison between the two technologies, on the key mechanical and electrical parameters that can impact the testing performances:

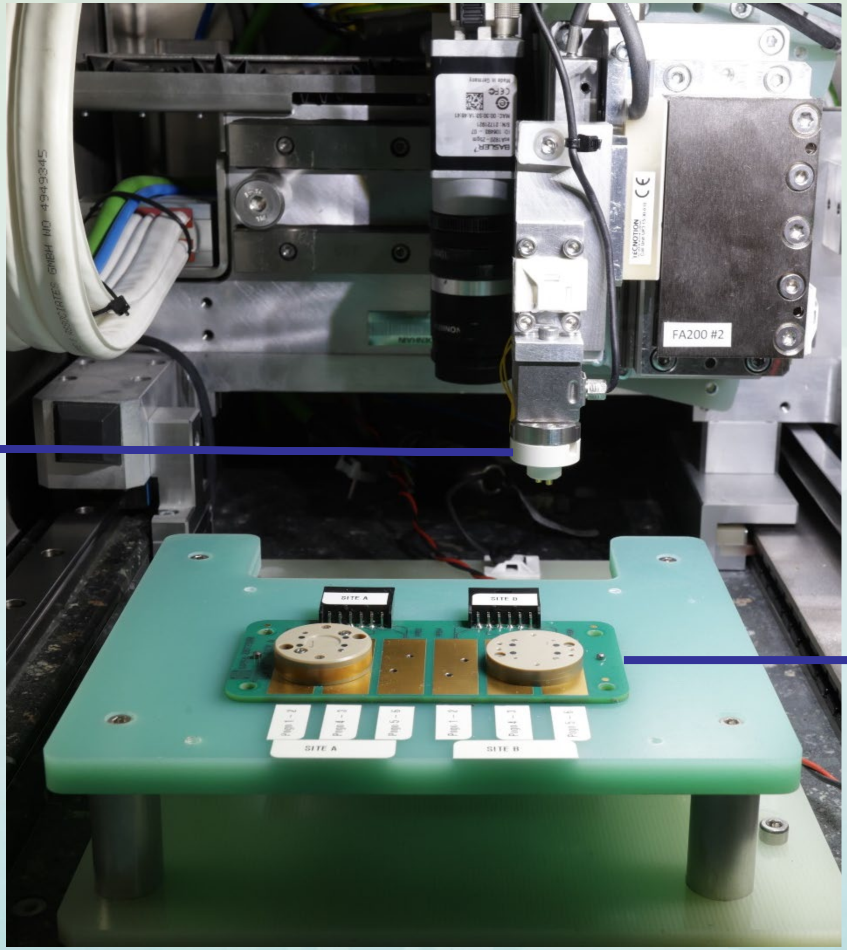
- Compression Range
- Contacting Marks
- Force Comparison
- Resistance and Robustness for High Current Applications

Technical Comparison - Setup

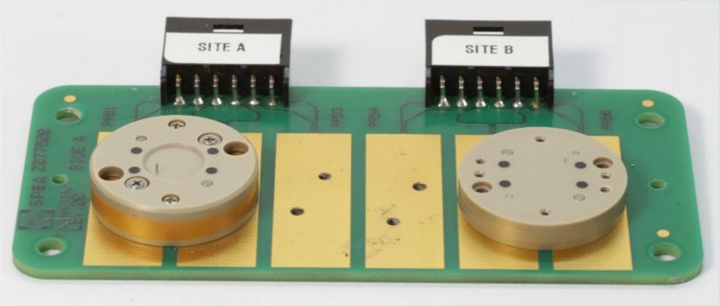
DOUBLE-TIP INSERT

- Load cell tip for mechanical deformation
- Tip for electrical measures

X-Y-Z benchtop setup



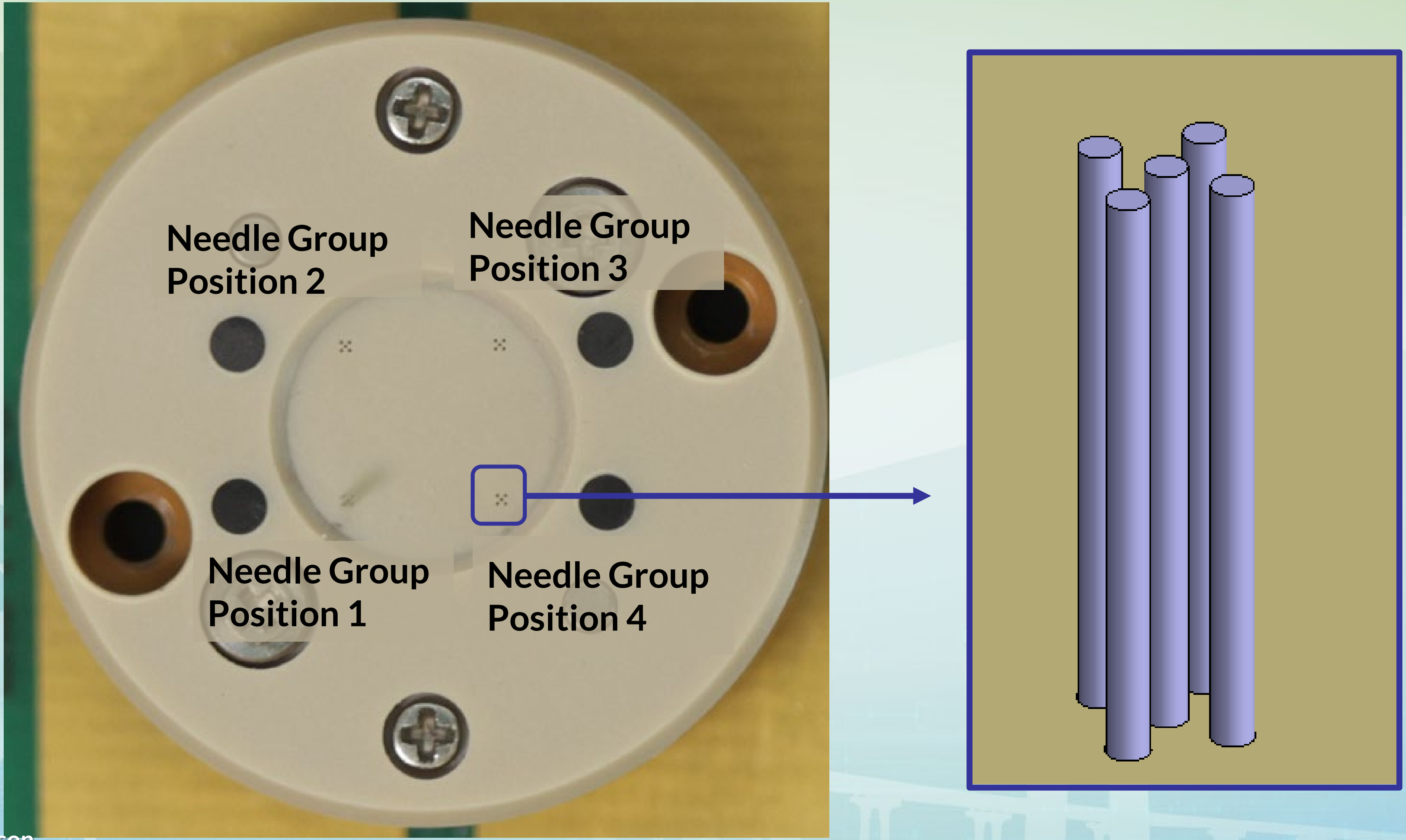
DUT BOARD



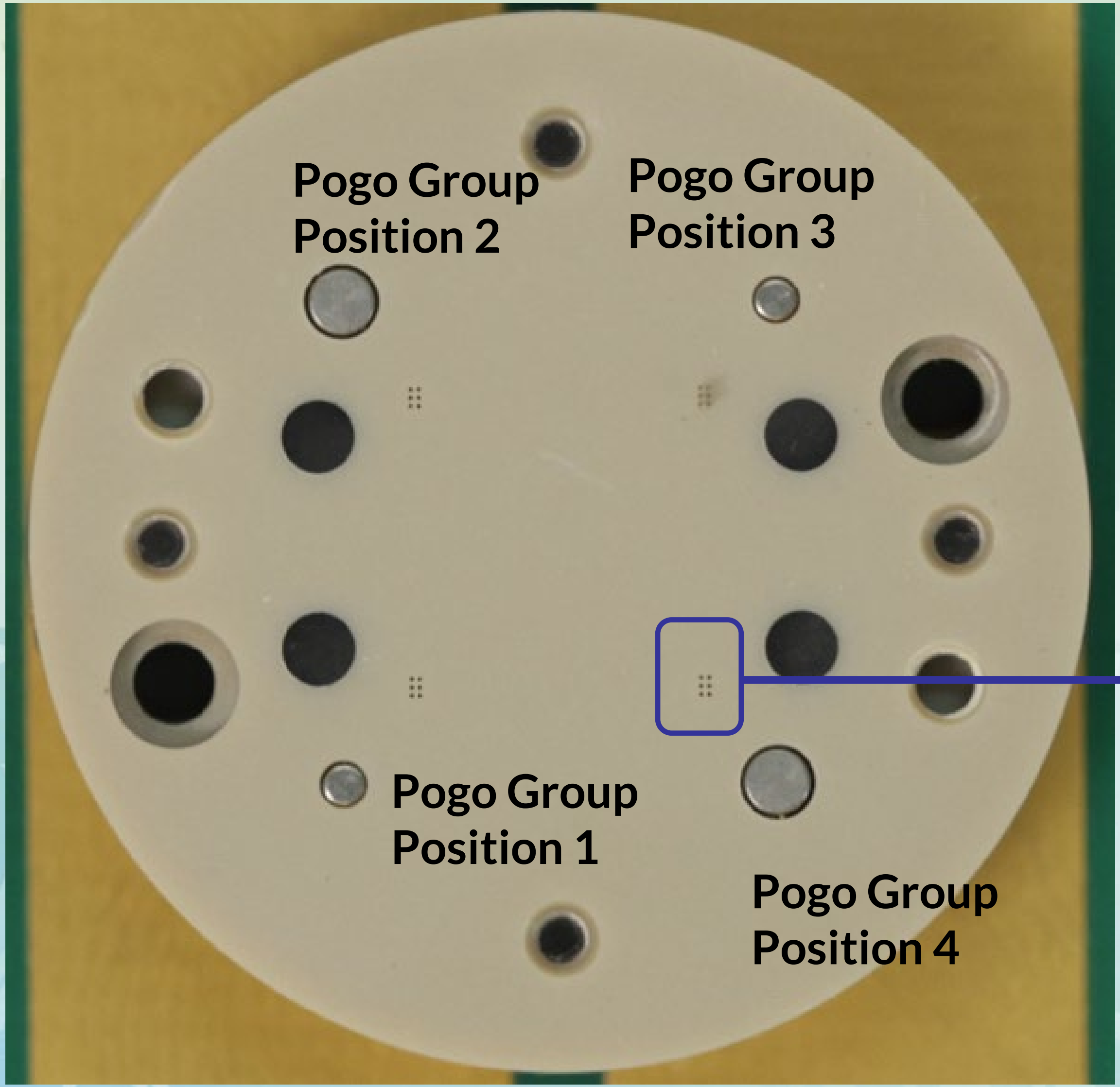
Needle Head

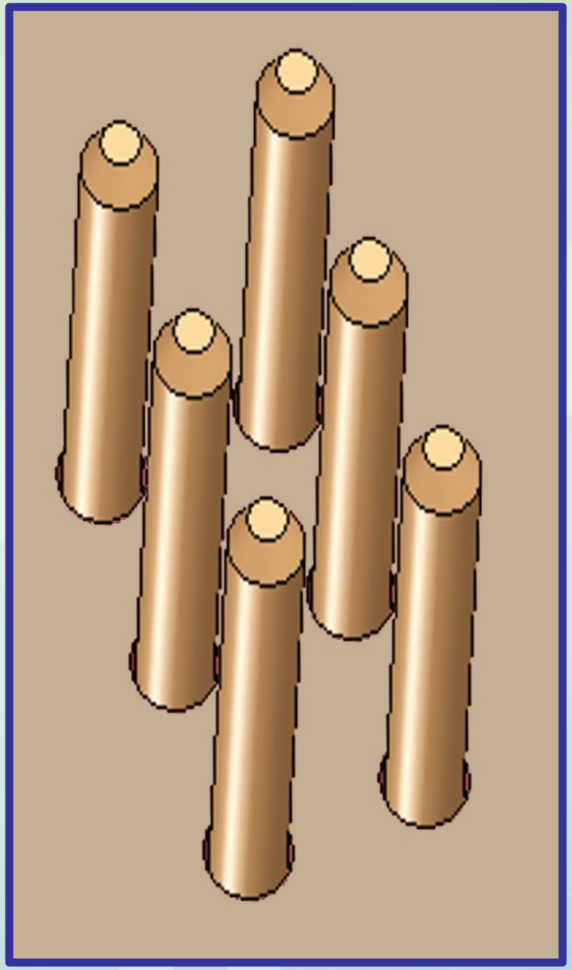
Pogo Head

Needle head pins layout



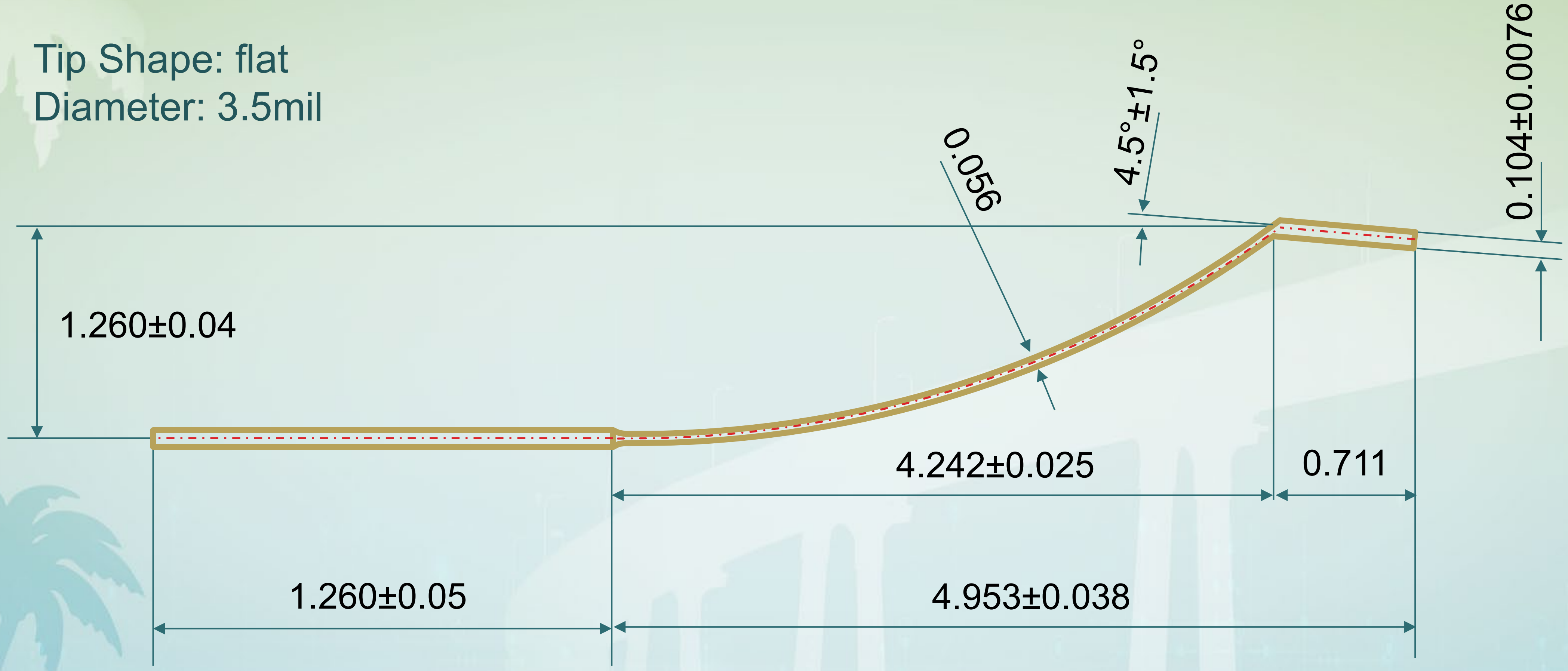
Pogo head pins layout





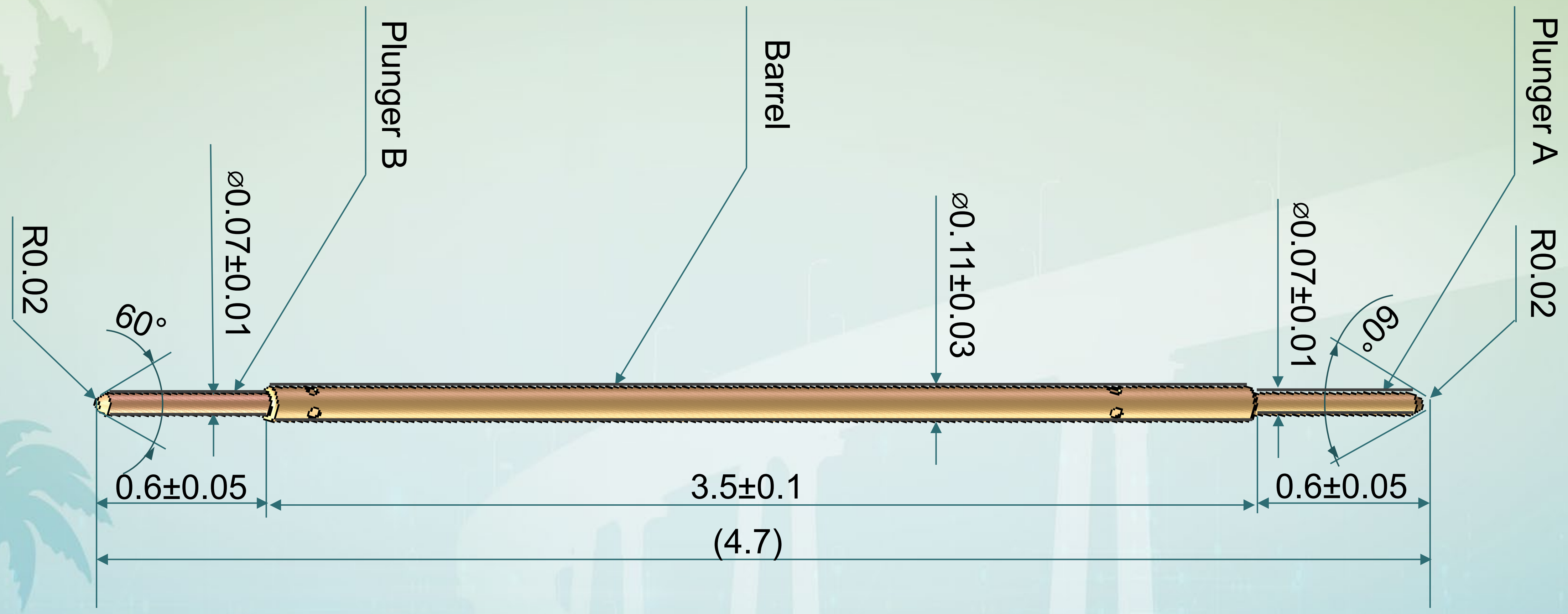
NEEDLE Specifications

Tip Shape: flat
Diameter: 3.5mil



Quotes are in mm

POGO Specifications



Quotes are in mm

Needle vs probe

COMPRESSION RANGE

Compression range specifications

POGO

Length	4,7 mm
Preload	1,7 cN
Nominal Force	6 cN +-20%
Nominal travel	0,4 mm
Maximum travel	0,5 mm

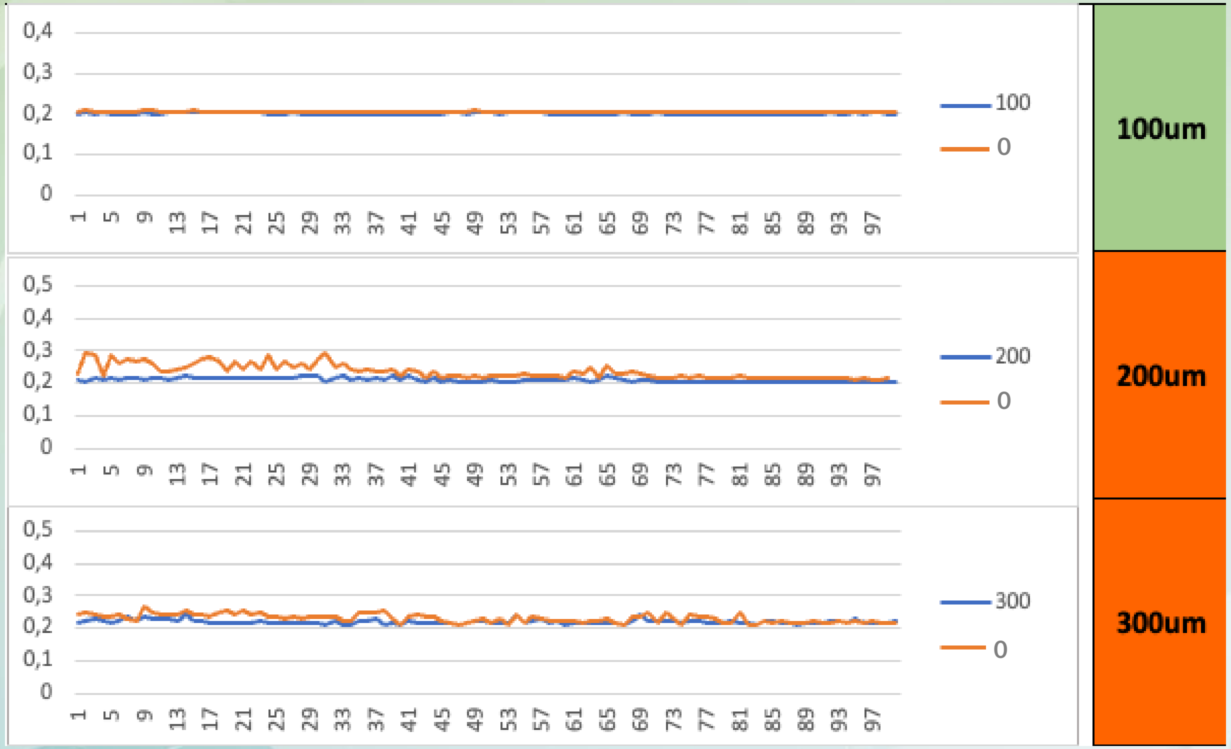
Data from datasheet

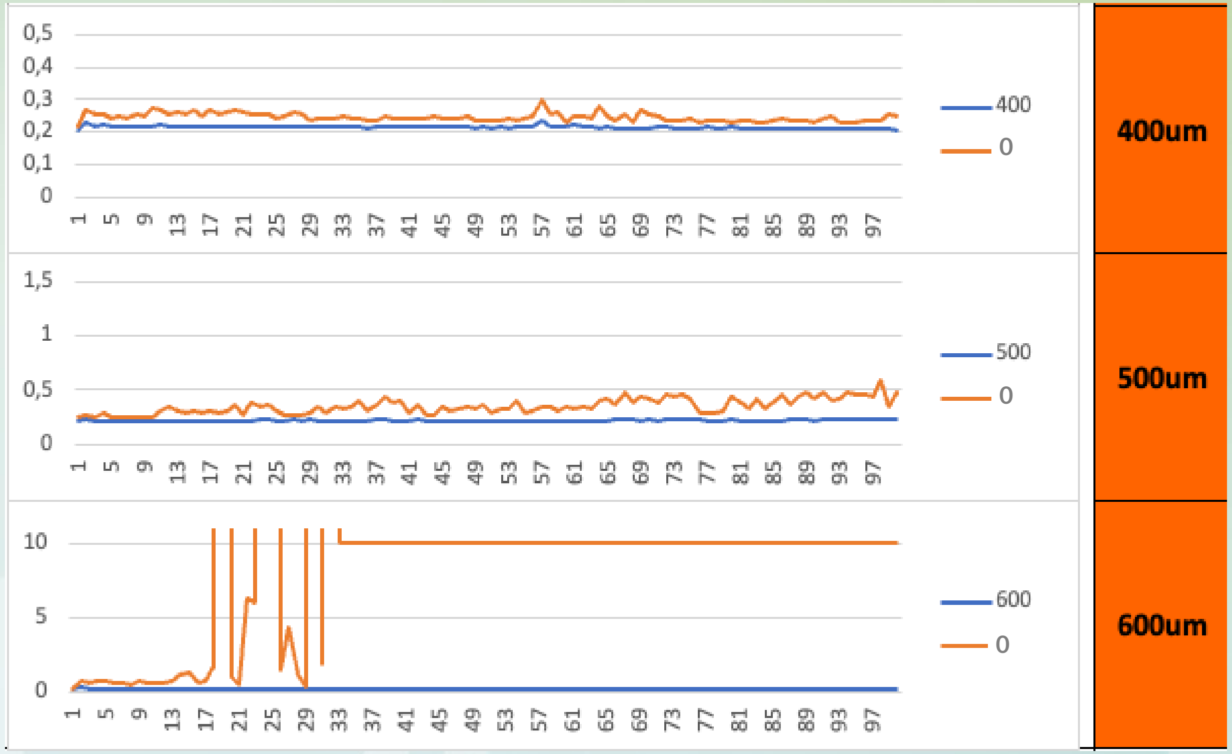
NEEDLE

Length	6.213 mm
Preload	0
Nominal Force	5,061 cN
Nominal travel	0,1 mm
Maximum travel	0,1 mm

Data from experimental characterization (see next slide)

Needle Compression Range Characterization





- For each compression range, two resistance measurements were made. One at maximum compression, and one at zero compression. The objective is to evaluate the capability of the needle to return in its initial position after being compressed
- The experiment showed that, with compressions higher than 100µm, the needles progressively degrade, losing their elasticity

Results

It is shown that the compression range of pogo technology is four times bigger when compared with that of needle.

This promotes design flexibility for high voltage and current contactors.

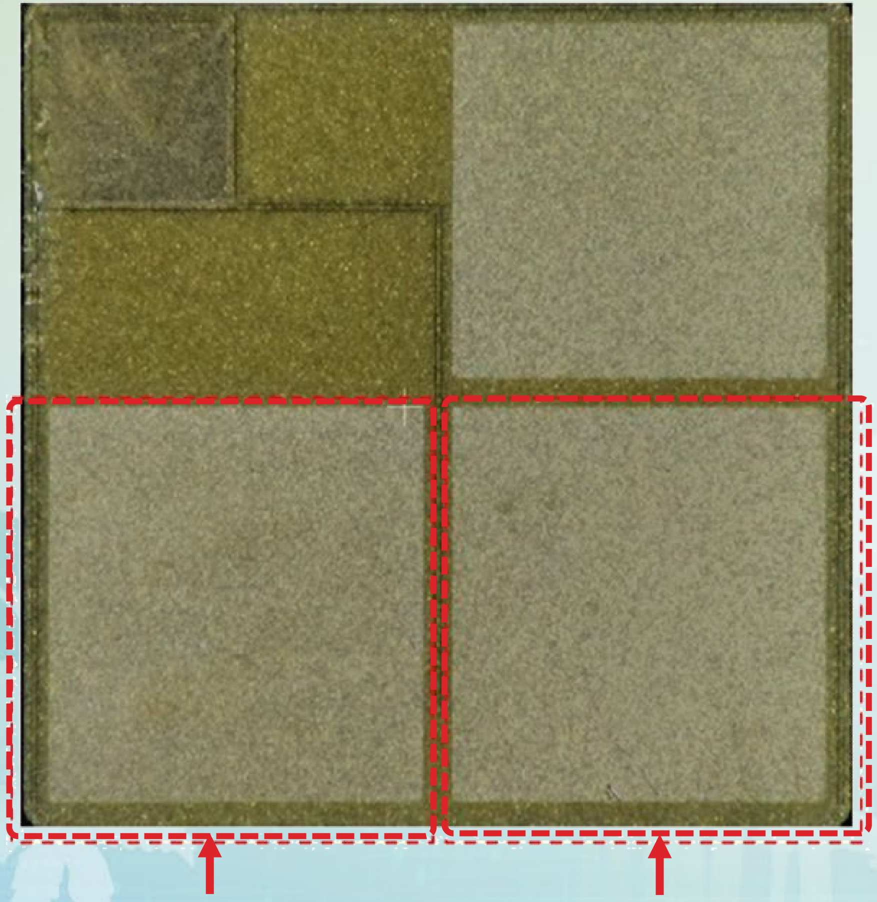
Needle vs probe

CONTACTING MARKS

Contacting Marking Comparison

NEEDLE

(1 group of 5 needles)

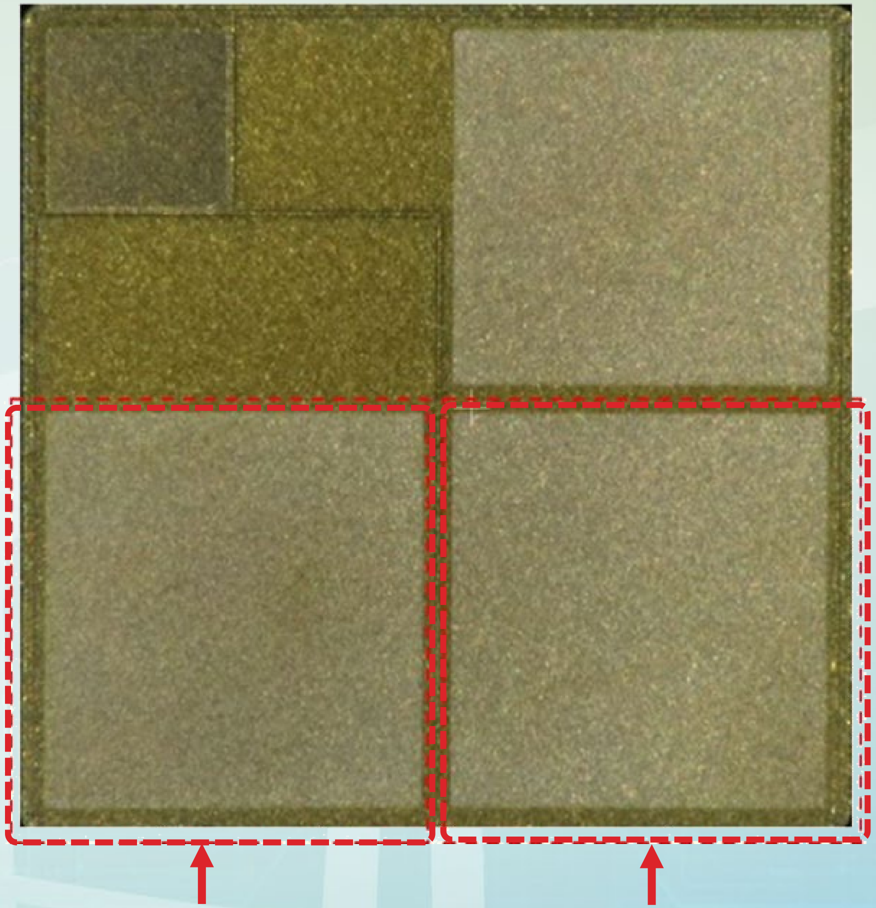


2 touches

10 touches

POGO

(1 group of 6 pogos)



2 touches

10 touches

Test Method and Results

We used our lab setup to touch 10 times every pad on a real KGD device (never touched before).

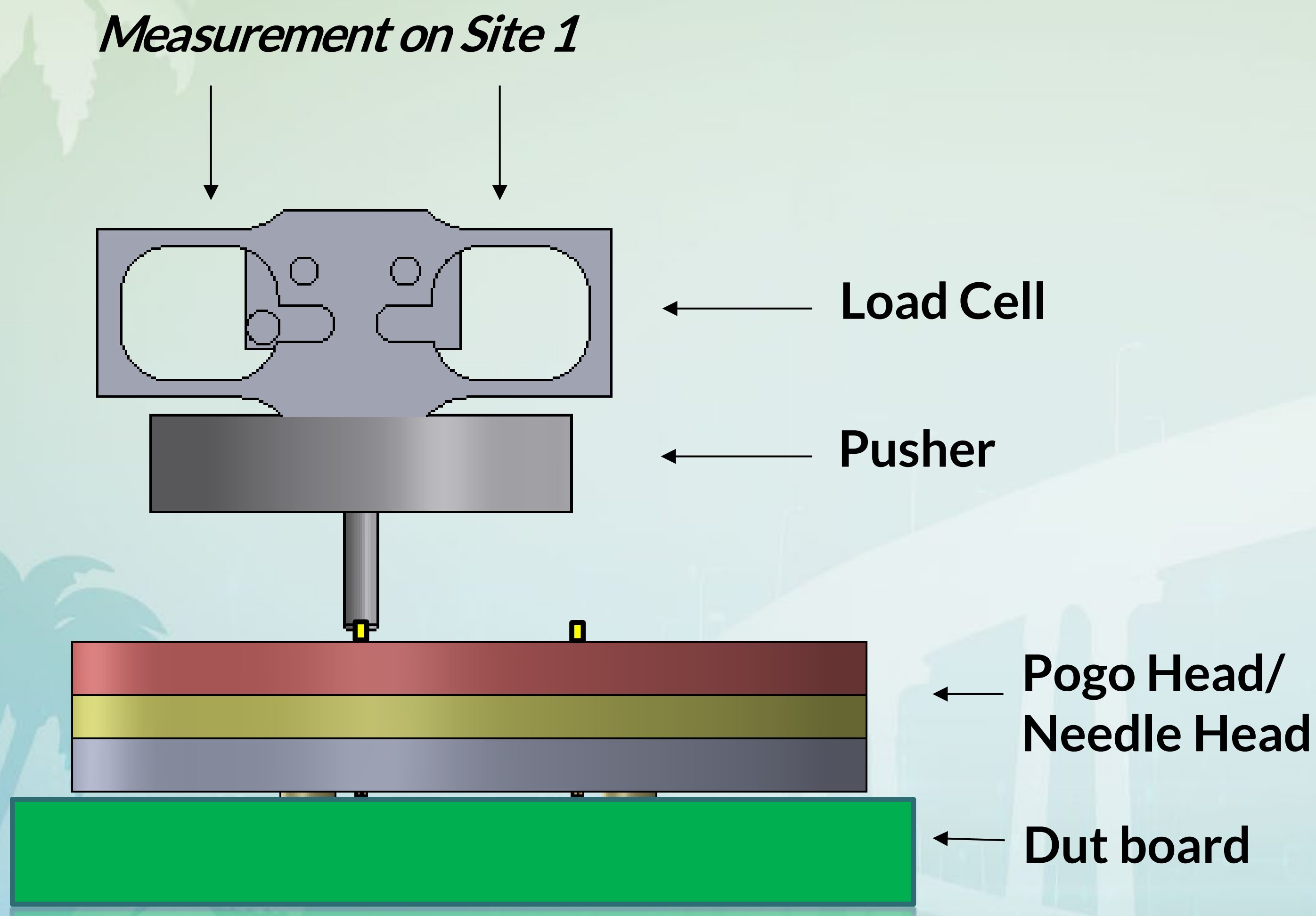
Neither technology caused any visible or measurable damage on the device surface.

Therefore, we conclude that the two technologies are interchangeable with respect to testing marks on pads.

Needle vs probe

FORCE COMPARISON

Test method for force measure



Pogo Head

- Used 6 *pogos for each position*
- The measurements are acquired at 250µm compression

Needle Head

- Used *5 needles for each position*
- The measurements are acquired at 100µm compression

NEEDLE HEAD – Force Measurements

20 measurements for each position with 100µm compression

Force	
Statistics	**[gF]**
Min	24,12
Max	27,9
Δ	3,78
Avg	25,80725
STDV	1009,4248

Force for each position

$$F_{SP} = \frac{Avg}{number\ of\ needles\ for\ each\ group}$$

$$F_{SP}@100\ \mu m = 25{,}80725 : 5 = 5{,}161\ \mathrm{gF}$$

POGO HEAD – Force Measurements

20 measurements for each position, with 250µm compression (excluding pre-load)

Force	
Statistics	[gF]
Min	23,05
Max	25,64
Δ	2,59
Avg	24,21175
STDV	734,3439

Force for each position

$$F_{SP} = \frac{Avg}{number\ of\ pogos\ for\ each\ group}$$

$$F_{SP}@250\ \mu m = 24{,}21175 : 6 = 4{,}035\ \text{gF}$$

Results

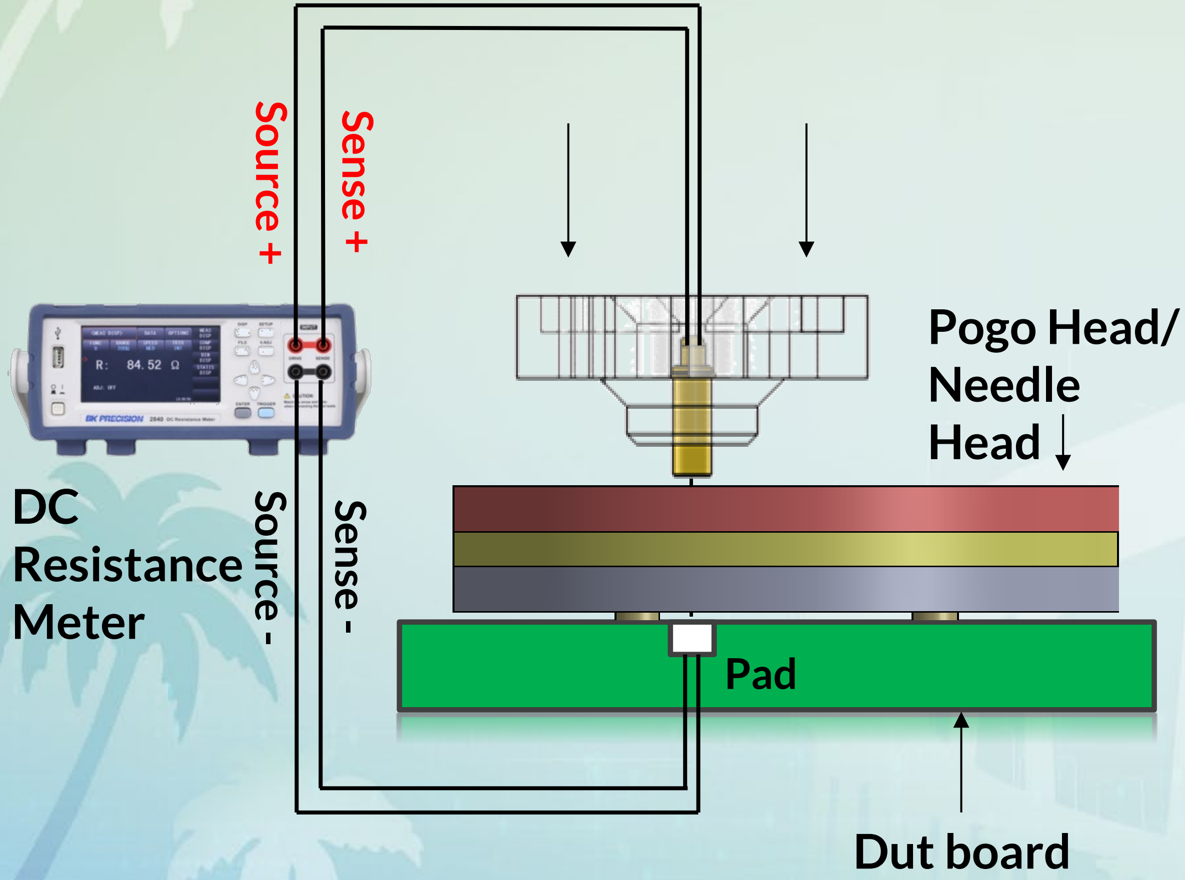
With a constant compression (which is different for the two technologies), it is shown that the force applied with pogo technology is equivalent to the force applied with needle technology, despite the presence of elastic elements and internal friction inside the pogo.

Needle vs probe

RESISTANCE AND ROBUSTNESS

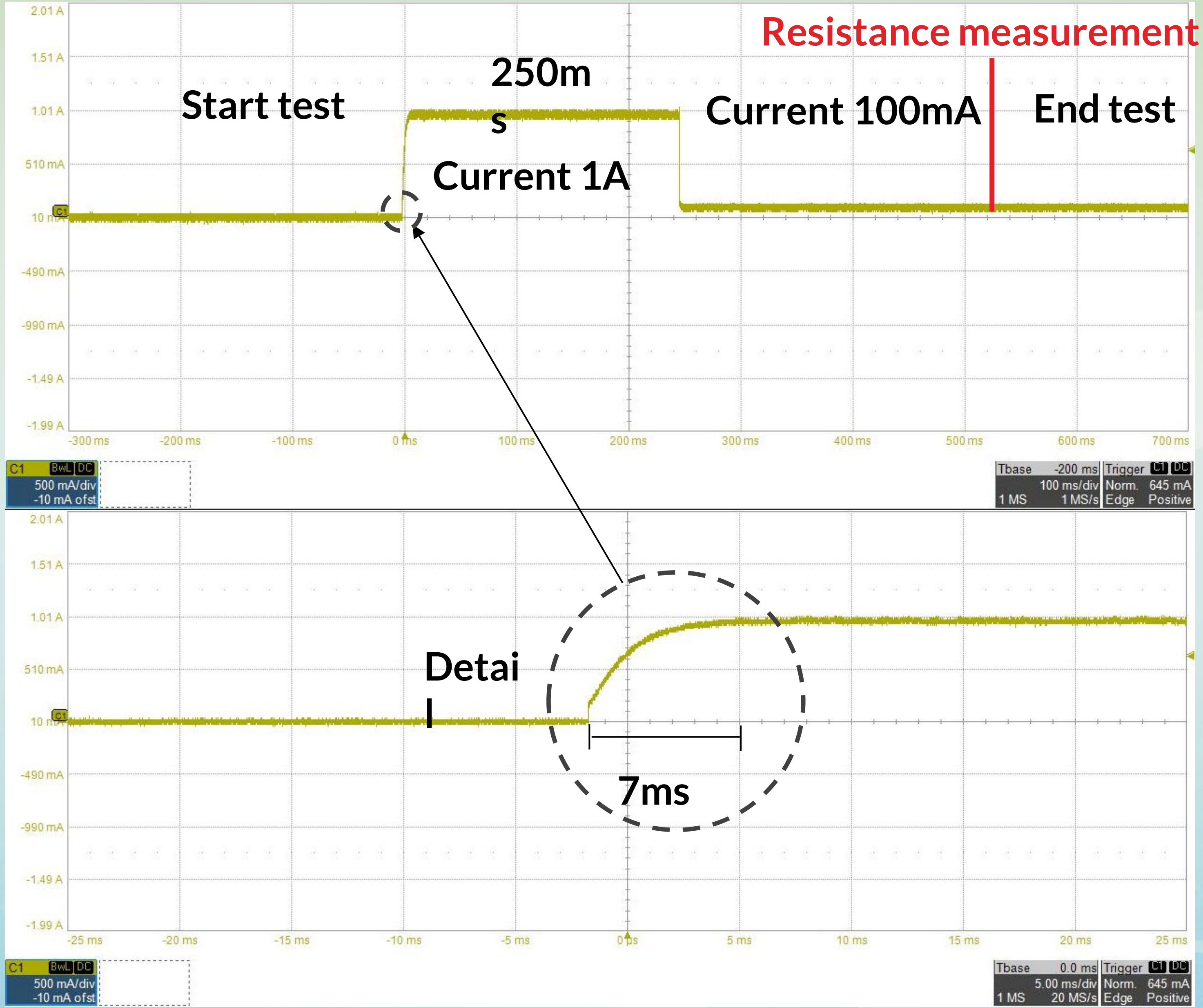
Test method for resistance measures

Example of measurement on Pogo 1 – Kelvin Method



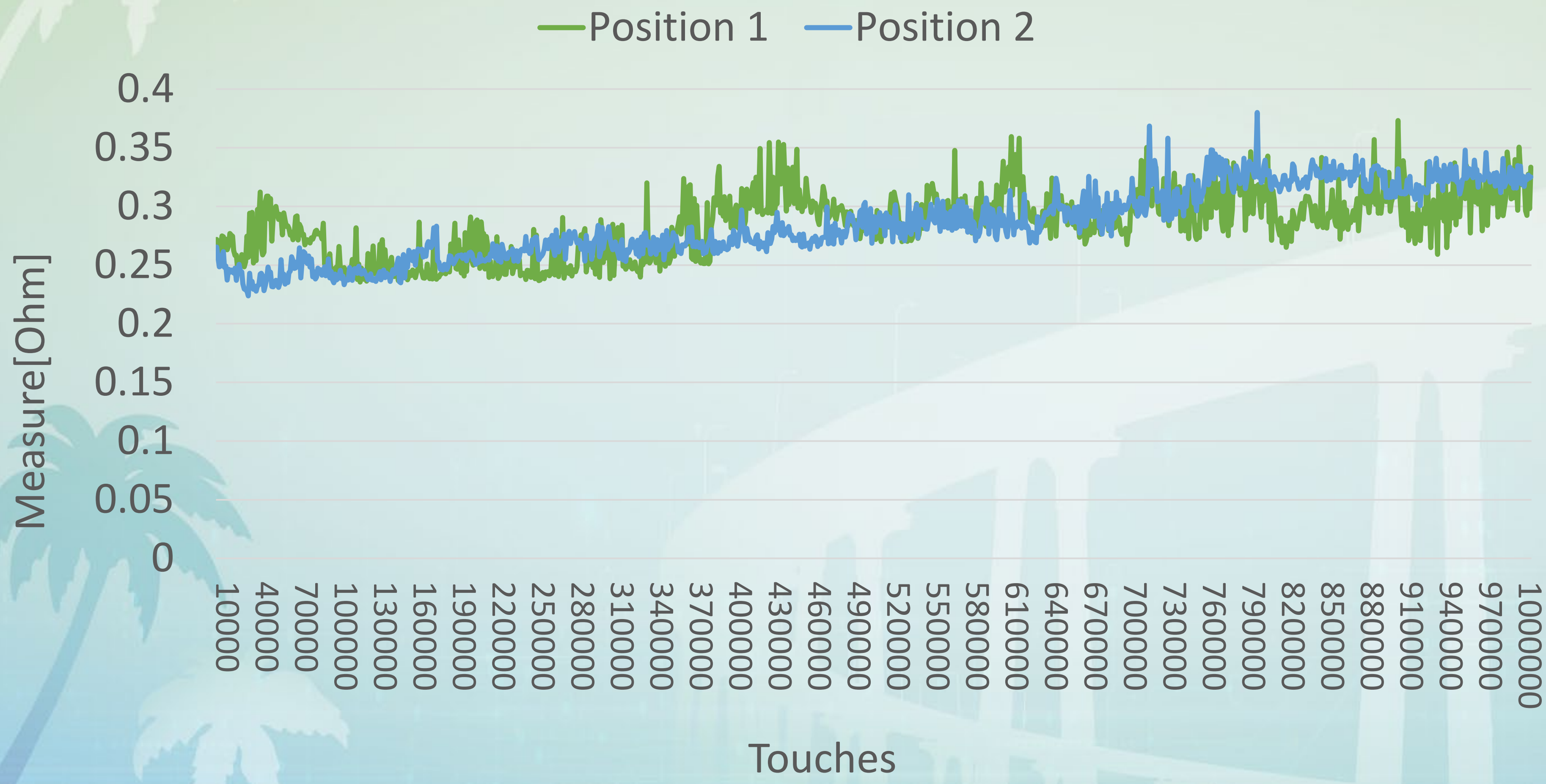
Resistance Range	Current	Resolution	Accuracy (rdg% + digits)	Max Open Terminal Voltage
20 mΩ	1 A	1 µΩ	0.1 + 3	0.7 V
200 mΩ	100 mA	10 µΩ	0.1 + 2	0.7 V
2 Ω	100 mA	100 µΩ	0.1 + 2	0.7 V

Test method for current measurement



POGO HEAD –Resistance Measurements

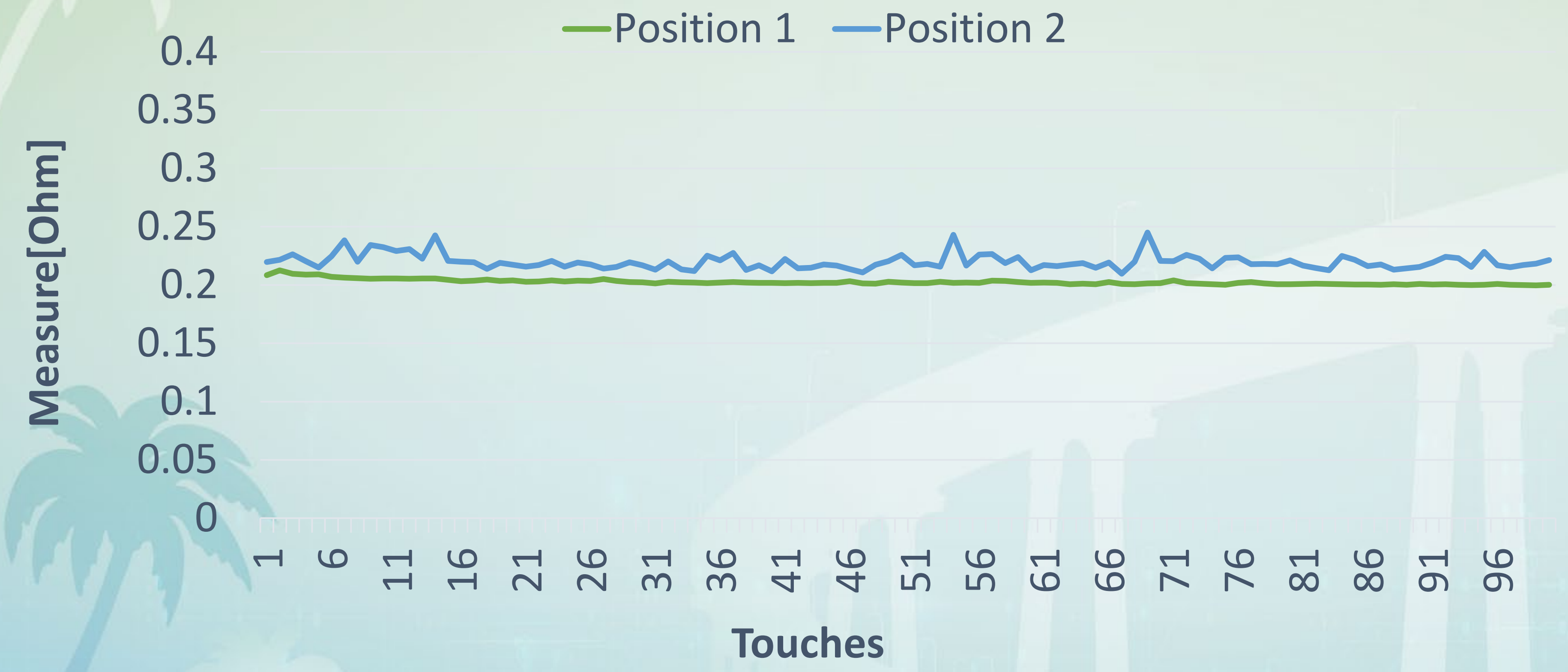
**Resistance measurements every 1K touches on 1 million acquisitions
@ 250µm compression, on one pogo per position**



Resistance	
Statistics	**[Ohm]**
Min	**0,223747**
Max	**0,380012**
Δ	**0,156265**
Avg	**0,284916**
STDV	**28,53252**

NEEDLE HEAD –Resistance Measurements

100 Resistance measurements @ 100µm compression, on one needle per position



Resistance	
Statistics	[Ohm]
Min	0,199695
Max	0,2449829
Δ	0,0452879
Avg	0,2112719
STDV	10,023965

Results

With a constant compression (which is different for the two technologies), it is shown that:

- the contact resistance between the two technologies is essentially equivalent
- pogo technology possesses the same robustness as needle technology on the transport of high currents over time

CONCLUSIONS

Conclusions

This laboratory investigation demonstrates that pogo pins are a suitable alternative to needles for KGD testing:

- Enhanced Design Flexibility: Pogo pins offer a significantly wider compression range compared to needles. This translates to greater freedom for designing high voltage and current contactors.
- Minimal Device Impact: Neither technology caused any visible or measurable damage to the Device Under Test (DUT) surface after 10 contacts.
- Equivalent Contact Force: Despite the presence of internal springs and friction, pogo pins deliver a comparable force to needles, ensuring reliable connections.
- Equivalent Electrical Performance: Contact resistance and high-current handling capabilities were essentially equivalent between pogo and needle probes. This indicates pogo pins can effectively handle high currents over extended periods.

Cost and Throughput Considerations

- **Cost considerations: While needle probes might have a lower upfront cost, their frequent replacements due to wear and tear can lead to higher overall maintenance expenses. Pogo pins, with their longer lifespan, might offer a more cost-effective solution in the long run.**
- **Throughput considerations: As needle probes do not tolerate misalignments or mispositioning, they may require a longer time for the test equipment to adjust before probing. This longer time would affect the overall throughput and make pogo pins preferrable in mass-production environments.**