Building the Next Generation Test Method Standard: Matching the production environment with in-house testing

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Agenda

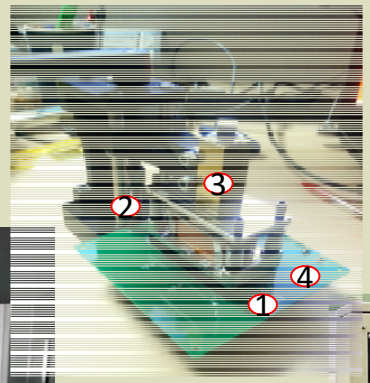
- Introduction
- Current Standards
- Improved Setup
- Results
- Conclusion
- Next Steps

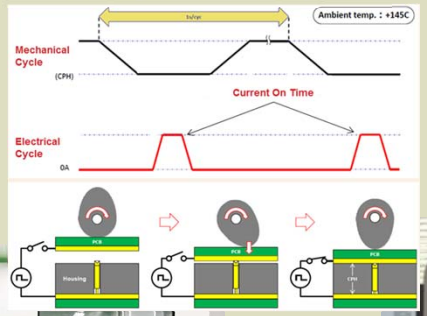
Vision

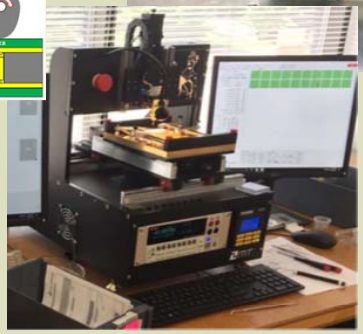
- Create a method for testing and qualifying new contact technologies that matches onsite production qualifications and minimizes time to market (TTM) and cost of test (COT)
- Work with anyone interested
  - Provide a service, equipment purchase, rental, informational, all arrangements considered
- Goal:
  - Realistic and Standardized Life Cycle Specs

Many Existing Life Cycle Standards

Courtesy life cycle panel member TestConX 2019







TwinSolution

smiths interconnect

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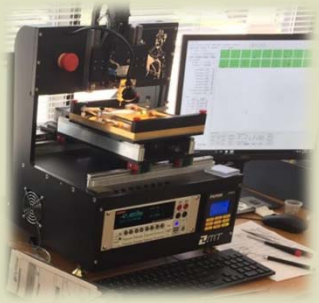
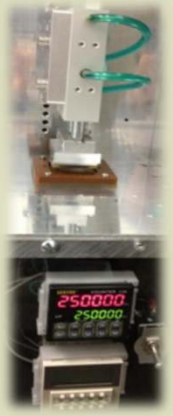
Example Life Cycle Standard

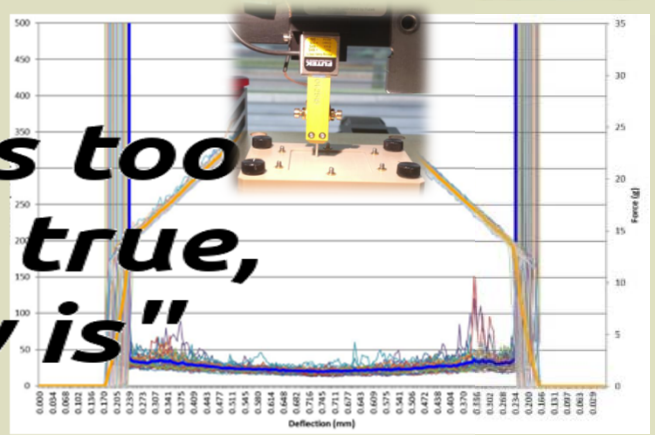
- FReD (Force Resistance Deflection) Tester:
  - Keithley source meter, force sensor, 3 axis robotic system
- Standardized cycle test fixtures – hardstop to test height
- Pneumatic Cycler with gold plated PCB coupons
- 1M cycles, offline Resistance/Force Tests at below intervals
- Good for Probe to probe comparison
- DOES NOT match Life of typical solder application





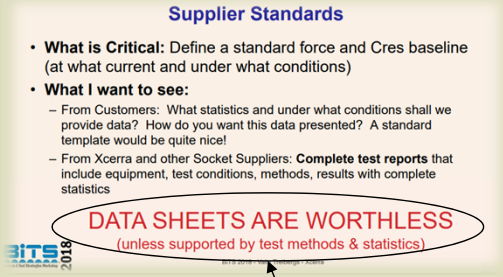
	Resistance (mΩ)					Force (g)				
Cycles	Min	Max	Median	Average		Min	Max			
0	141.3	405.8	204.8	213.6	42.5	4.0	4.8	4.4	4.4	0.1
10k	132.8	291.6	162.6	165.3	18.7	3.8	5.0	4.3	4.3	
50k	119.5	223.1	156.3	157.5						
100k	137.7	209.0	165.8	166.6	12.4	3.7	5.4	4.2	4.2	0.2
250k	128.2	234.2	155.9	157.1						
500k	126.8	210.1	153.3	154			5.6			
1000k	138.0	260.6	169.6	172.4	18.0	3.6	4.8	4.1	4.1	0.2

"If it seems too good to be true, it probably is"

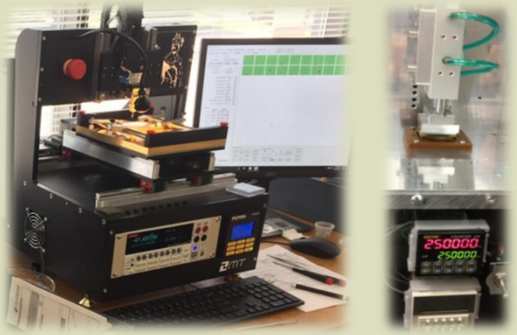


New Life Cycle Testing Introduction

- Current Vendor Test Standard (Spec Sheet)
  - Gold on Gold
  - No current applied
  - Offline data collection
  - Ambient temp



Valts Treibergs BiTS 2018



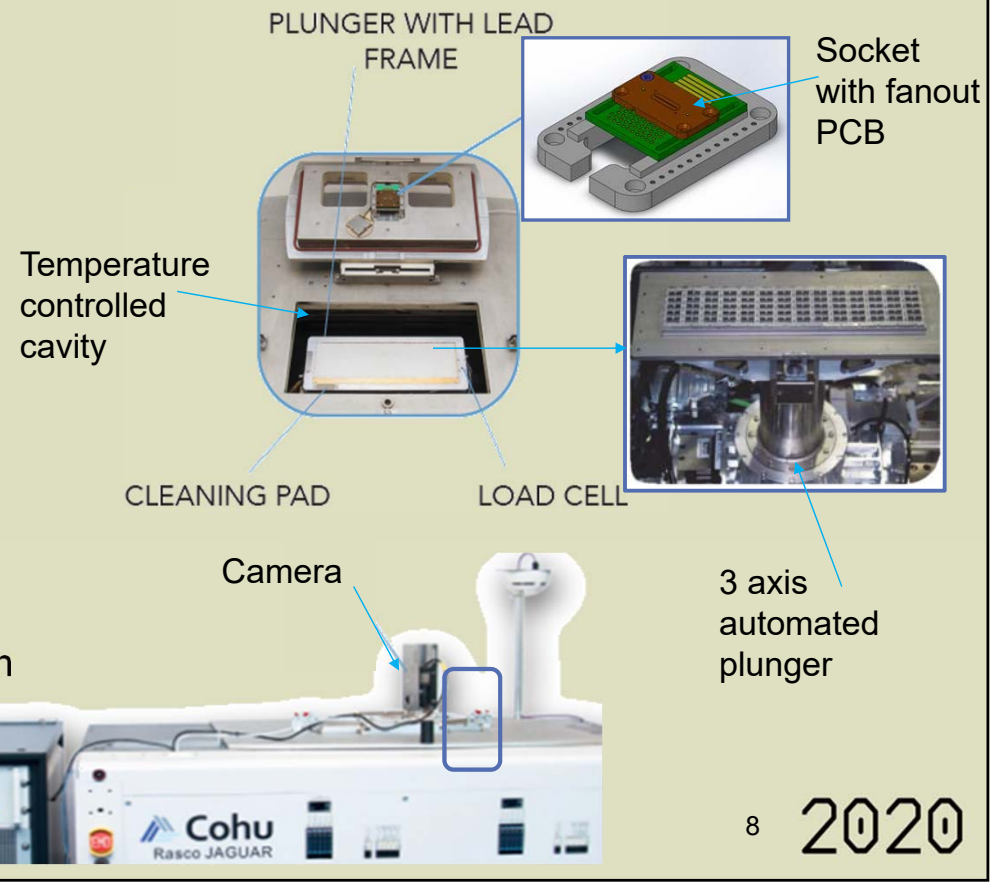
- Next Generation Test Setup
  - Device plating
  - Current applied
  - Online data collection
  - Tri-Temp

Next Generation Life Cycle Test Setup

- Base System
  - Cohu Jaguar Handler (sans loader unloader)
- Add-ons
  - Power Supply
  - 3rd Party Software
  - Keithley DVM

Next Generation Life Cycle Test Setup

- Detailed Handling Architecture
  - Socket on hinged and sealed top plate
  - Plunger
    - Holds contact material (Sn, NiPd, SACQ, etc.)
    - Moves on 3 axis robotic mechanism
    - Housed in Temp controlled sealed compartment
    - Incorporates a load cell for force measurements
    - Includes cleaning pad for online cleaning
  - camera for verifying probe contact location to contact material



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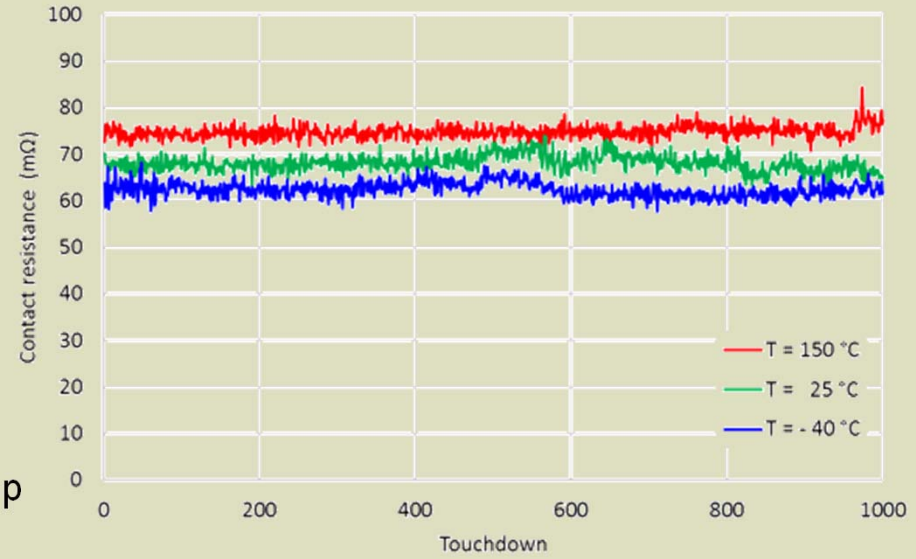
Next Gen Life Cycle Test Equipment Specs

- Temperature range
  - -40 °C till 160 °C
  - LN2 required for cold
- Throughput
  - Ambient and Hot 70k-80k cycles per day
  - Cold 5k- 7k insertions per day. (must be attended at all times – LN2)
- CRes measurement
  - Keithly 2700 multimeter
  - 8 channels can be sourced and measured
- Current pulses
  - minimum time length 0.1 ms, maximum current 250 A)
  - Current applied to one probe
- Interface
  - GPIB programming
  - calibrated load cell, DVM, handler movement at regular time intervals (twice a year)
  - Measure force only at room temperature

Contactor	PCB
1.27 mm pitch.	FR4
10 probes	8 routed channels
	1 current channel

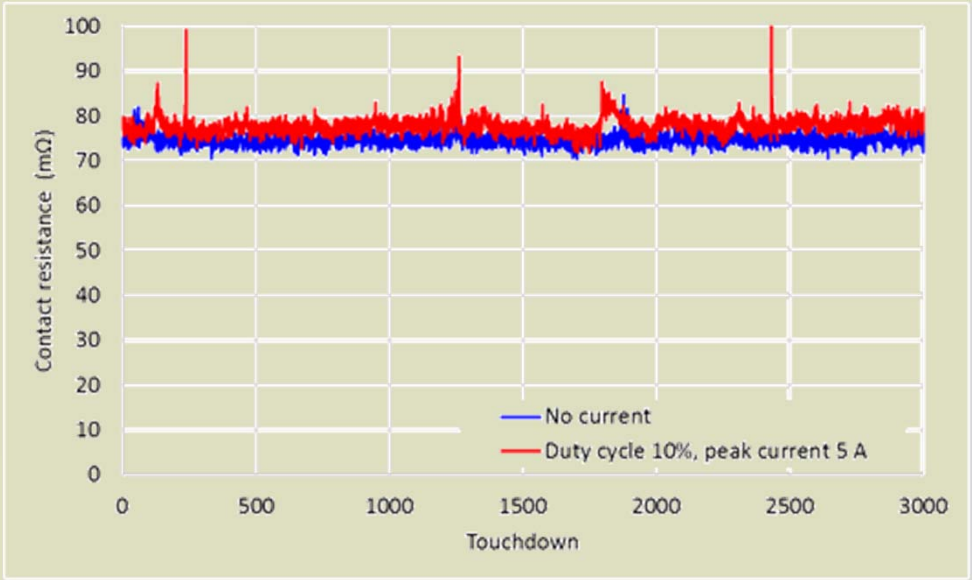
Results: Temperature Test

- Temperature impact on contact resistance
  - lowest contact resistance at lowest temp
  - Highest contact resistance at highest temp
  - ~15 mOhm impact due to temperature
- No significant impact on STD
  - Higher std at -40 startup possibly due to break-in period of probe at cold
  - Deviation from 400-600 cycles possibly setup related
- Limited example data to 1000 cycles



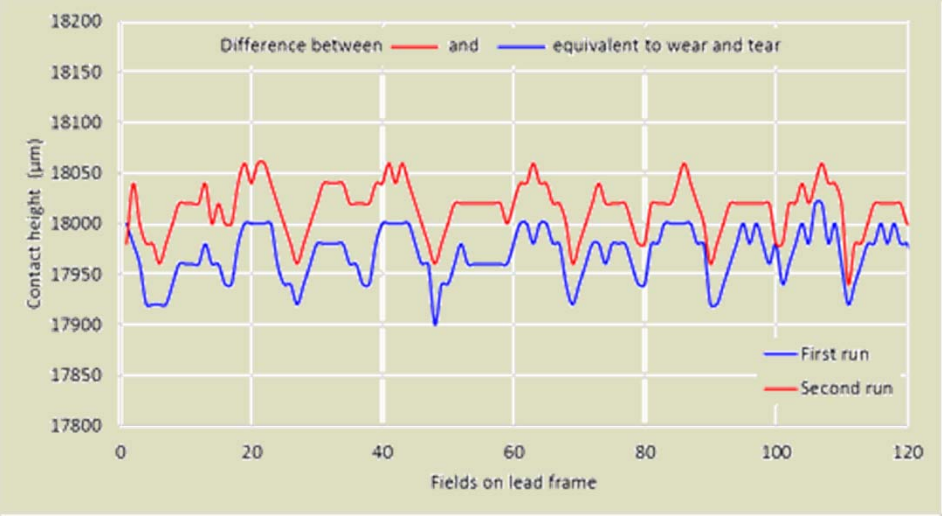
Results: No Current applied vs. Duty Cycle Current

- Effects of pulsed current (10% @ 5A) on resistance measurement
- Higher contact resistance seen on pulsed current results
- Pulsed current may be impacting accuracy of cRes measurement (spikes) - TBD



Results: Contact Element Wear

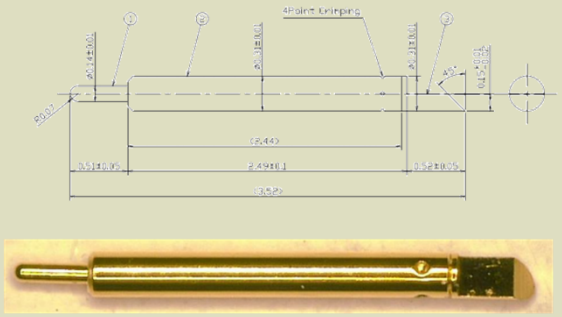
- Wear and tear detection for full temperature range
  - Measure tip wear after cycling
    - Search for first contact 0K
    - Search for first contact after cycling
  - Software detects first contact using cRes reading
  - Various materials and temperatures can be analyzed.



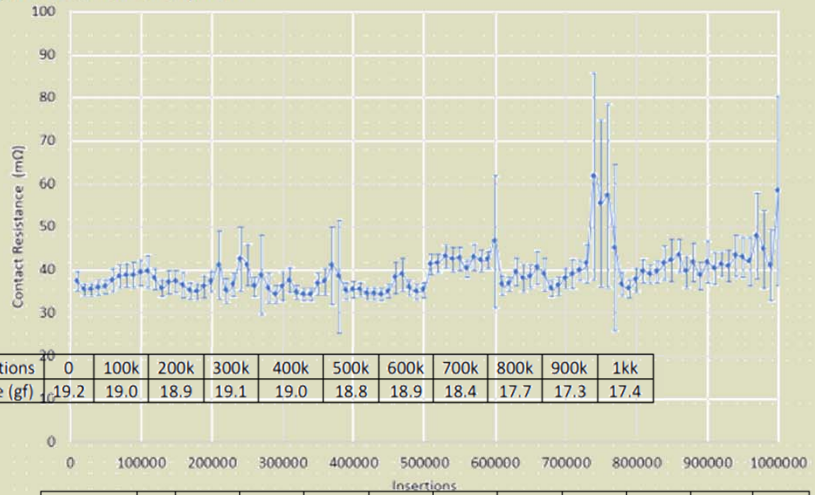
Example: Kelvin Probe on NiPdAu

- One Pin measured up to 1M cycles
- 8A 20ms pulse
- 2% duty cycle
- Contact material
  - NiPdAu plated panel
  - Provided by the customer

Pin drawing

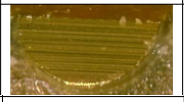
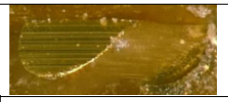
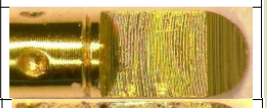
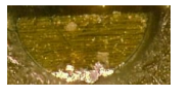


Average values for every 10k:

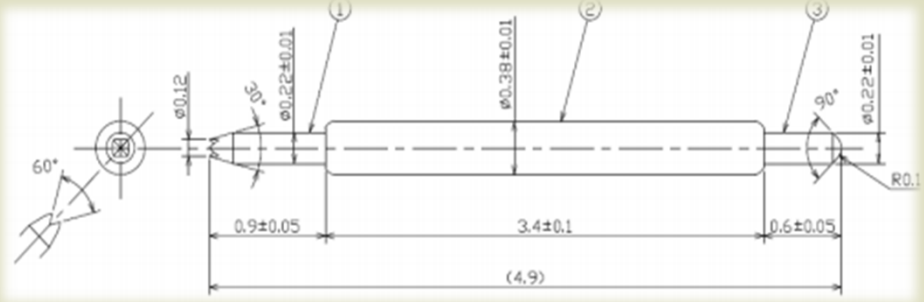


Insertions	0	100k	200k	300k	400k	500k	600k	700k	800k	900k	1kk
Force (gf)	19.2	19.0	18.9	19.1	19.0	18.8	18.9	18.4	17.7	17.3	17.4

Insertion	0	100k	200k	300k	400k	500k	600k	700k	800k	900k	1kk
ΔL (µm)	0	15	16	18	20	24	24	28	30	30	31

Insertions			
0			
1kk			

Example: cRes vs. Force on Matte Tin



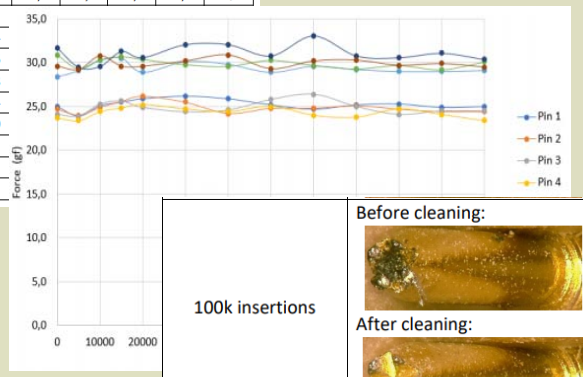
- Setup
  - 32 pins 100K insertions
  - Matte tin lead frame
  - Apply 1.6 A for 5 seconds on each probe during each insertion @ 125 °C
  - Take pin resistance and force measurements and pictures at defined intervals
  - Define cleaning schedule and method and use it during production test

- Reduced crown probe tip
- Preload: 0.15 mm
- Nominal stroke: 0.40 mm
- Force at nominal stroke:
  - A) 30 ± 7 g
  - B) 36 ± 9 g

Example: cRes vs Force on Matte Tin

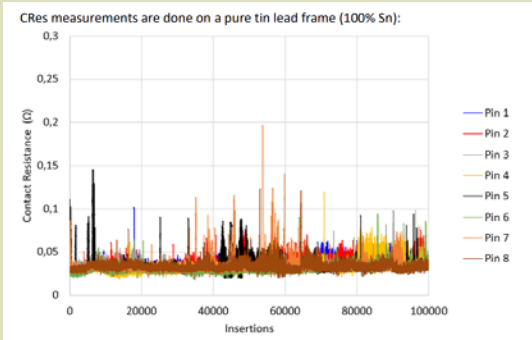
- Force
  - Pin 1-4 30 g Pin 5-8 36 g

Insertions	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
0	25,0	24,7	24,1	23,7	28,4	30,9	31,7	29,6
5k	23,9	24,0	23,9	23,4	29,1	29,3	29,5	29,2
10k	25,1	24,9	25,3	24,4	30,3	30,3	29,6	30,8
15k	25,5	25,6	25,6	24,8	30,5	30,7	31,3	29,6
20k	25,9	26,2	24,9					
30k	26,2	25,5	24,4					
40k	25,9	24,2	24,6					
50k	25,2	24,8	25,8					
60k	24,7	24,8	26,4					
70k	25,2	25,1	25,0					
80k	25,3	24,7	24,1					
90k	24,9	24,4	24,5					
100k	25,0	24,4	24,5					



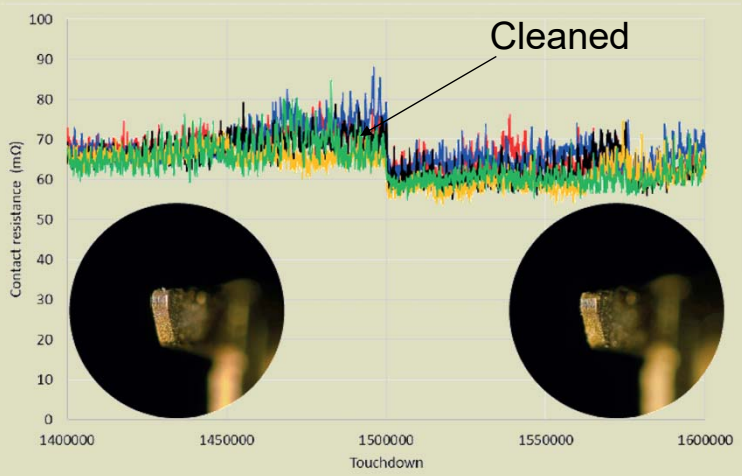
- Resistance:
  - Pin 1-4 30 g Pin 5-8 36 g

	KW1-038AH/BR-40				KW1-038AH/BR-41			
CRes values	**Pin 1**	**Pin 2**	**Pin 3**	**Pin 4**	**Pin 5**	**Pin 6**	**Pin 7**	**Pin 8**
Average (mΩ)	36.7	36.8	34.3	32.6	33.4	30.2	32.6	33.1
Standard dev. (mΩ)	4.0	4.6	3.0	4.9	6.0	3.3	3.9	3.6



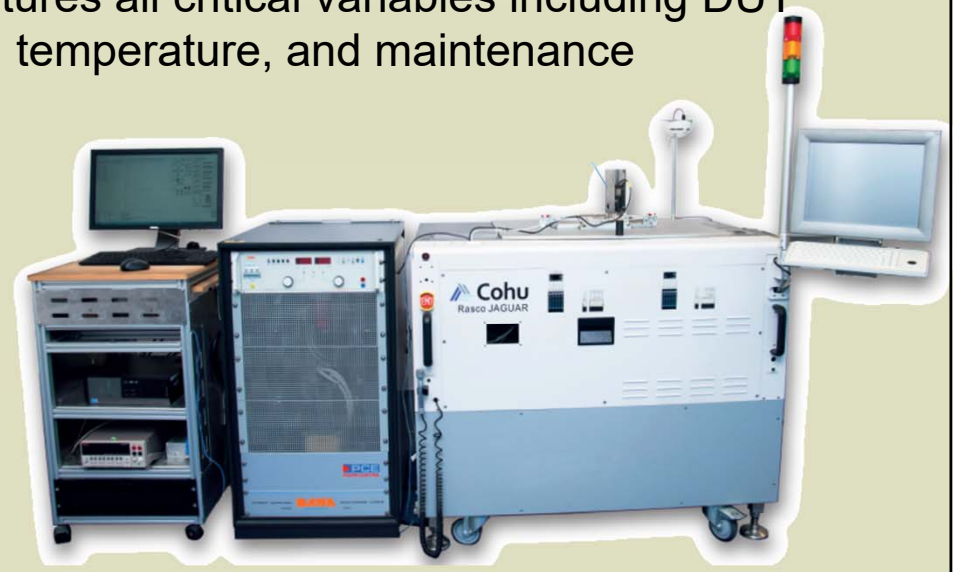
Example: Cleaning Impact

- Automated contactor cleaning pad on plunger
- Set cleaning interval based on cRes limit
- Compare different cleaning intervals



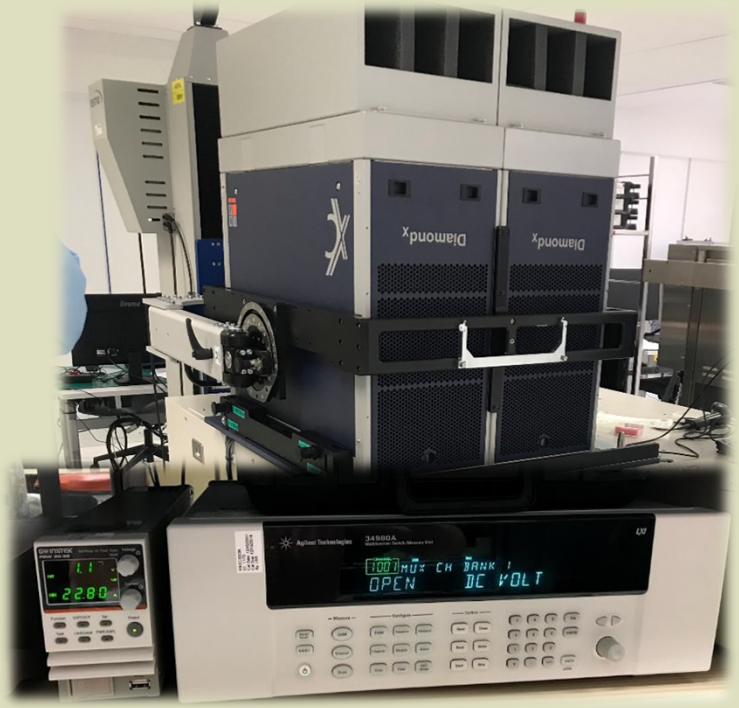
Conclusion

- Current cycle testing setups do not capture full production environment and therefore specified life cycles do not match production results
- The Cohu solution presented captures all critical variables including DUT contact material, applied current, temperature, and maintenance
- The Cohu solution presented provides confidence in contact technology while minimizing Time to Market and Cost of Test during development and into production



Next Steps

1. Increase channel count
2. Add multichannel current pulser or switch matrix to increase channels that can have current applied
3. Add DiamondX tester to increase channels to 2000+
4. Upgrade software to work with latest Handler/tester software
5. Online RF measurement



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