Burn-in & Test Socket Workshop

March 3-6 , 2002
Hilton Phoenix East/Mesa Hotel
Mesa, Arizona

IEEE

IEEE COMPUTER SOCIETY

Sponsored By The IEEE Computer Society
Test Technology Technical Council

Burn-in & Test Socket Workshop

Technical Program

Session 8
Wednesday 3/06/02 10:30AM

New Products

"Kelvin Contacting Solutions For Leadless Device Types"
Gerhard Gschwendtberger - Multitest Elektronische Systeme GmbH

"Interconnecting At 40 GHz and Beyond"
Roger Weiss, PhD - Paricon Technologies Corporation

"Electro-chemical Cleaning Process"
Erik Orwoll - Nu Signal LLC

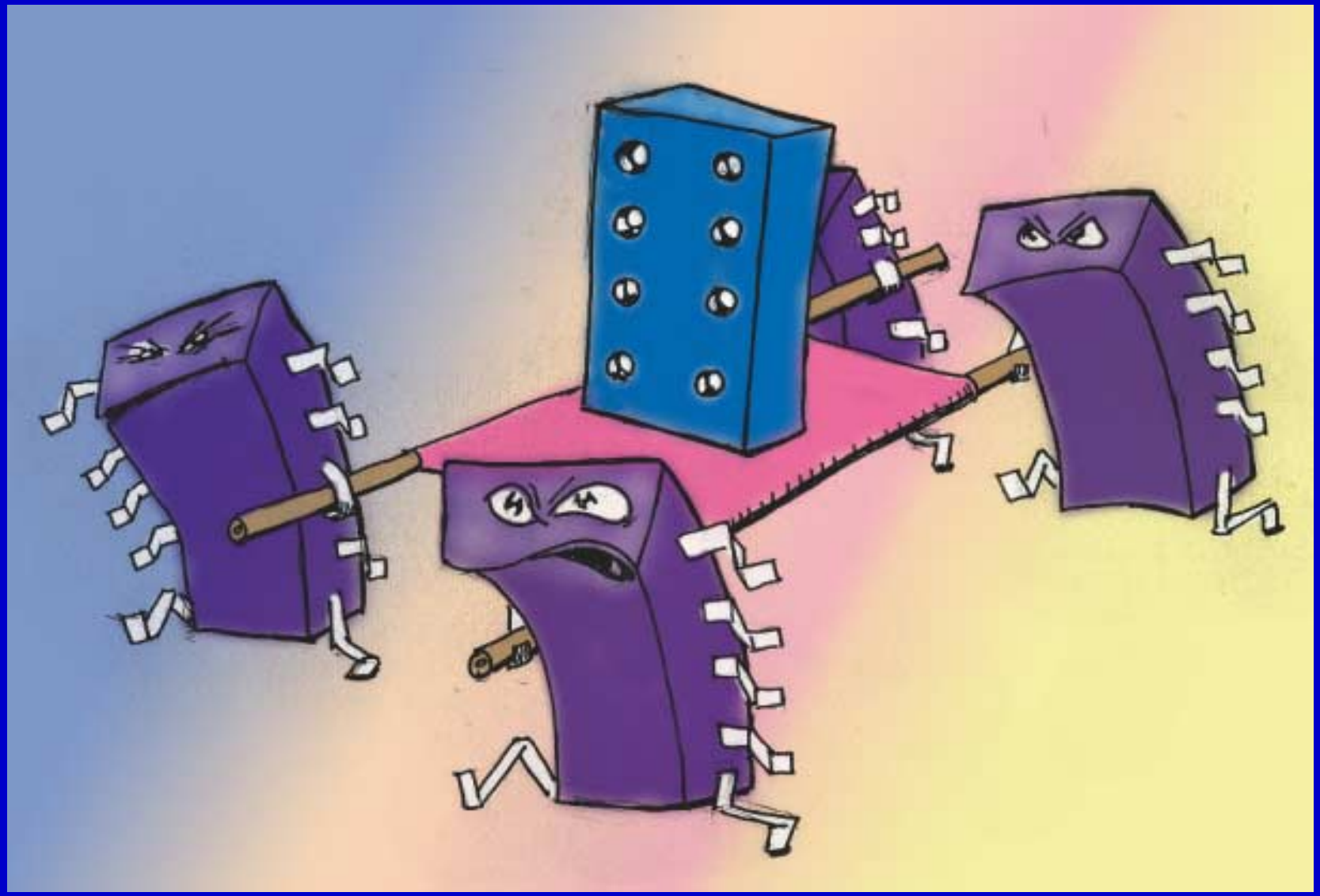
Kelvin Contacting Solutions for Leadless Device Types

Gerhard Gschwendtberger
Product Manager Contactors

Multitest elektronische Systeme GmbH & Co.KG

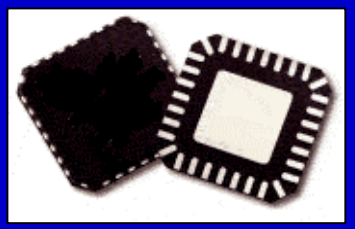
BiTS
BURN-IN & TEST SOCKET WORKSHOP

Leadless Packages



Leadless Packages

Leadless Packages = JEDEC compliant QFN plastic package MO-220/MO-229



MLF

MLP

VQFN

VQPFN

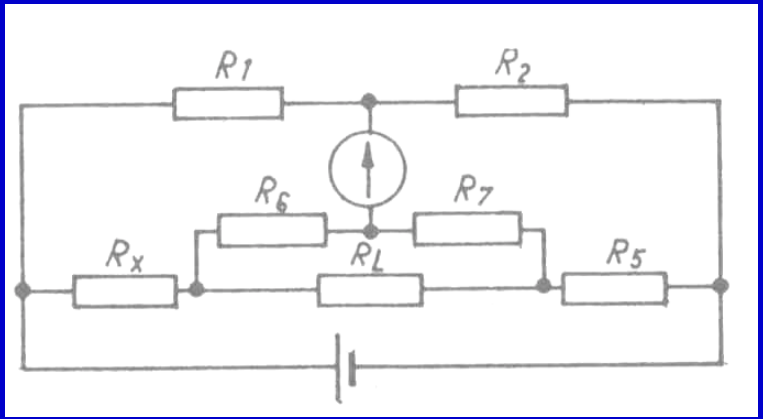
etc.

Typical Package Sizes:
2x1mm 3/5 lead up to 9x9mm 64 lead
Body thickness ~1mm
Lead Pitch from 1.27mm down to 0.4mm

Kelvin Contactors

Kelvin contactors are typically used for sensitive resistance measurements at Analog/Mixed Signal- and Automotive applications

Electrical principle: Two independent electrical connections to the device lead allow to compensate parastic resistances between DUT and Tester.



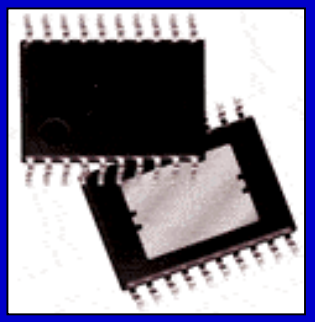
if $\frac{R_1}{R_2} = \frac{R_6}{R_7}$

then $R_X = \frac{R_1 \times R_5}{R_2}$

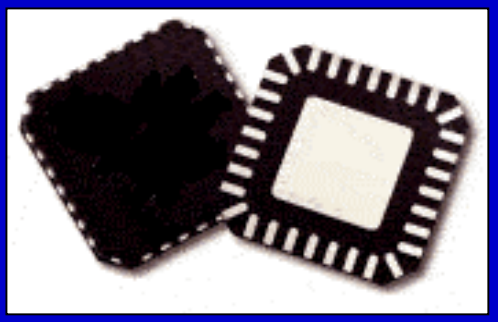
IC Package Trends

Down Sizing
device size, lead pitch/size

DIP, TO
SOJ



SOP, SSOP
TSSOP



Leadless

Current Kelvin contactor technologies

New technology required

Kelvin Contactors for Leadless Devices

Typical Kelvin Contactor Solution for
SOP, SSOP, TSSOP Packages

- contact springs on the top and bottom of the device lead
- contact spring wider than device lead

Typical SOP Kelvin contacting technolgies are not suitable for leadless packages

Kelvin Contactors for Leadless Devices
Design Objectives

Mechanical

- Leadless packages down to 0.4mm lead pitch
- Modular design to enable multi-site testing
- Integrated solution at Pick & Place and Gravity test handlers
- High durability & lifespan
- Field serviceable
- Cost effective

Kelvin Contactors for Leadless Devices
Design Objectives

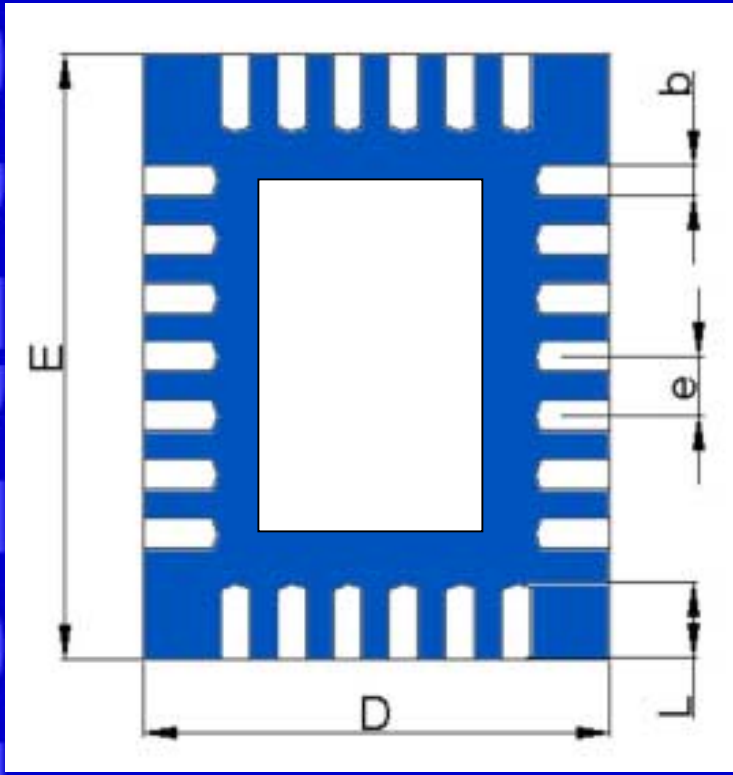
Electrical:

- High current capability
- Repeatable contact resistance values
- Low inductance

Thermal:

- Temperature range -55°C through 155°C
- Low DUT temperature drift during test

Contactor Design - Package Dimensions

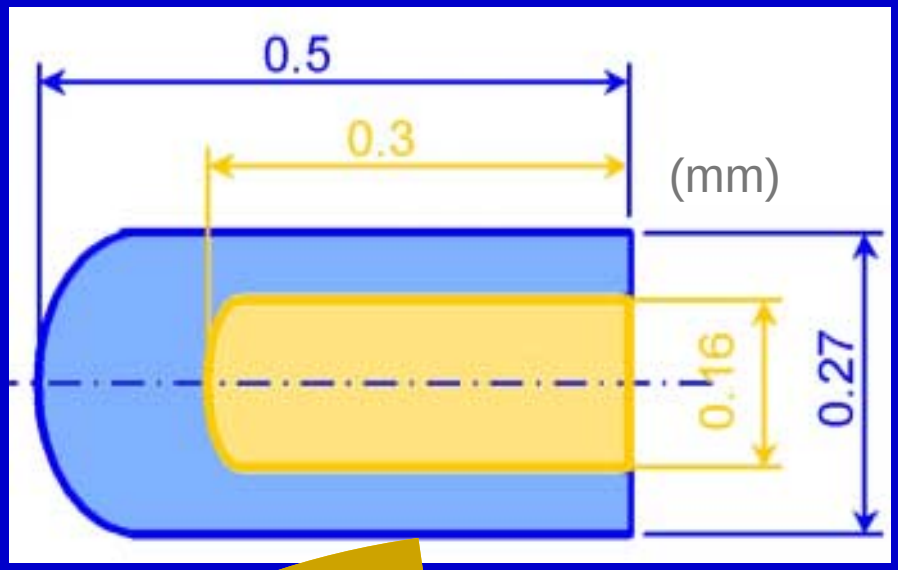


Package Dimensions - Tolerances				
Lead Pitch e	b (min)	B (max)	L (min)	L (max)
1,27	0,35	0,47	0,5	0,75
0,8	0,28	0,4	0,5	0,75
0,65	0,23	0,35	0,3	0,5
0,5	0,18	0,3	0,3	0,5
0,4	0,16	0,27	0,3	0,5

Tolerances on D & E

dimensions
typically +/- 0.15mm

Contactor Design - Technology



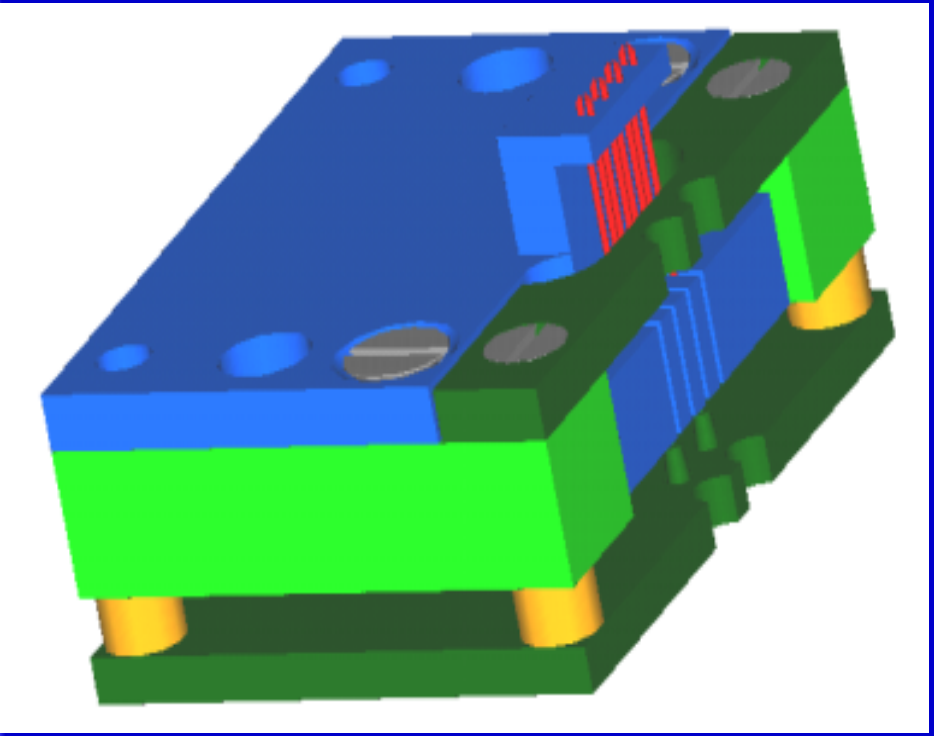
Pad dimensions
lead pitch 0.4mm

Contact area worst case:
$0.16 \times 0.3 = 0.048 mm^2$

Kelvin contact spring geometry / arrangement

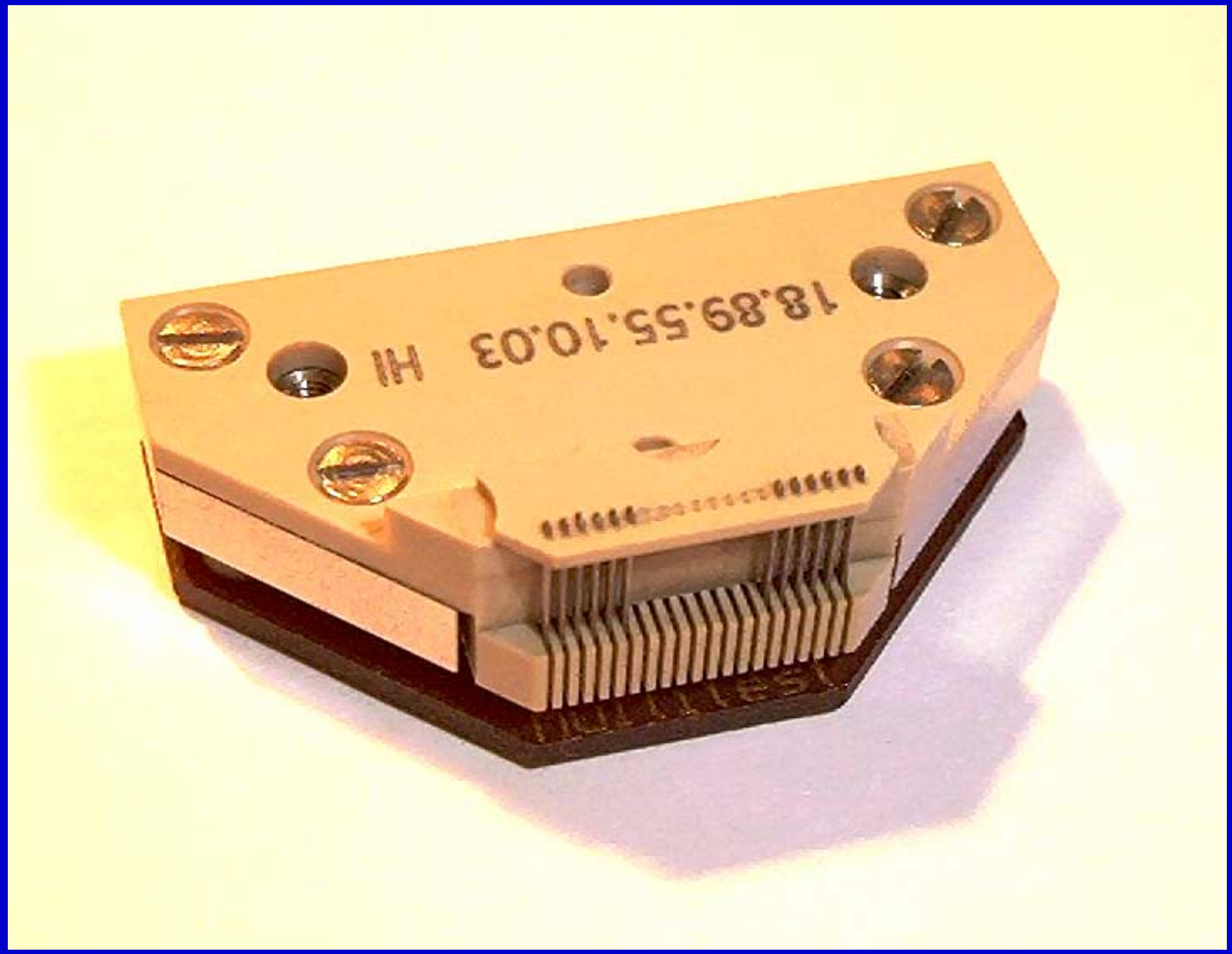
Contactor Design - Features

Kelvin contact spring block



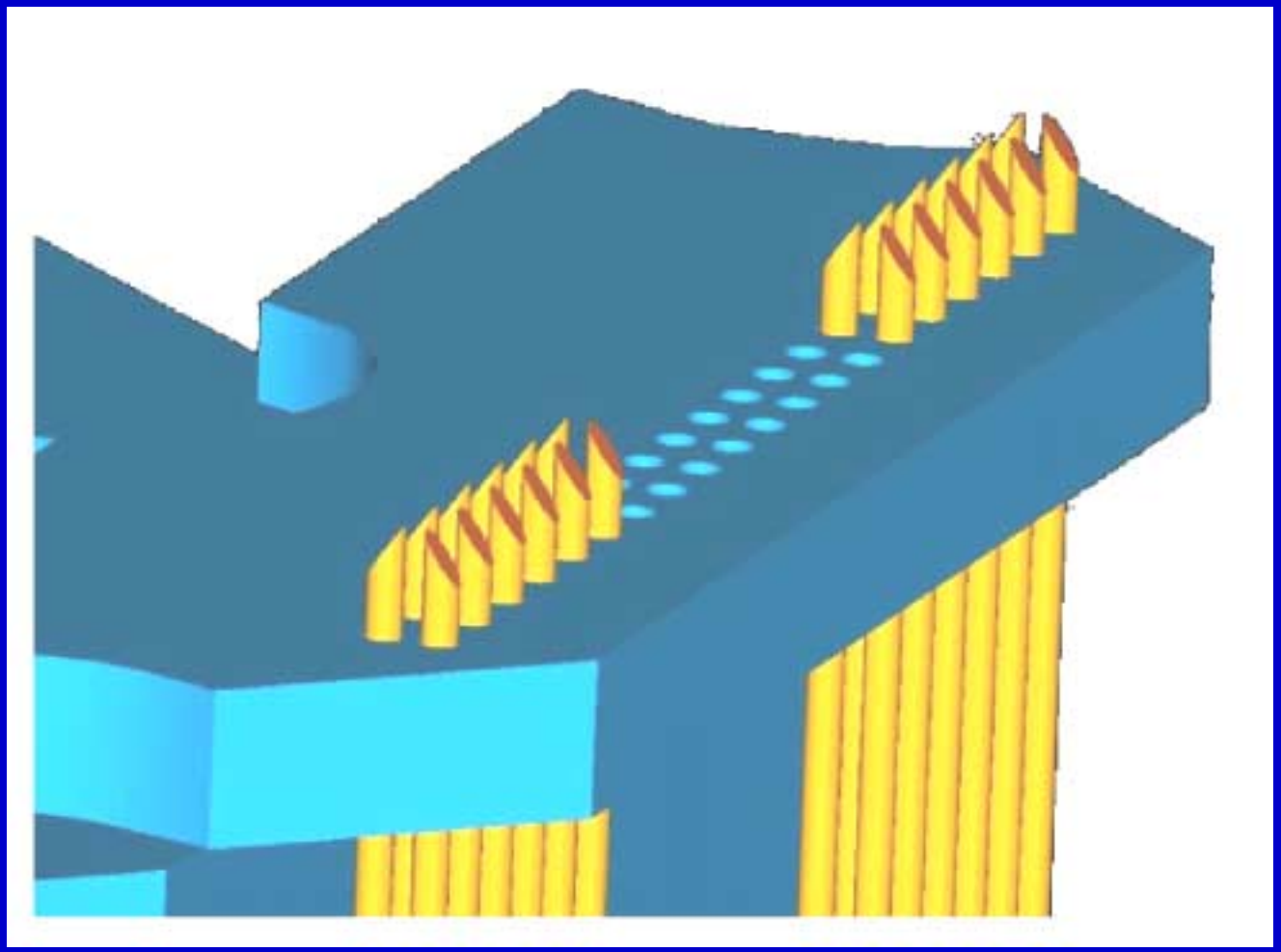
- Molded tungsten needles
- No scrub
- Needles penetrate oxide
- 0.3N @ 0.3mm deflection
- 0.1mm distance between adjacend needles
- Minimum spring pitch 0.4mm
- PC board 10mm distance to DUT

Contactor Design - Features



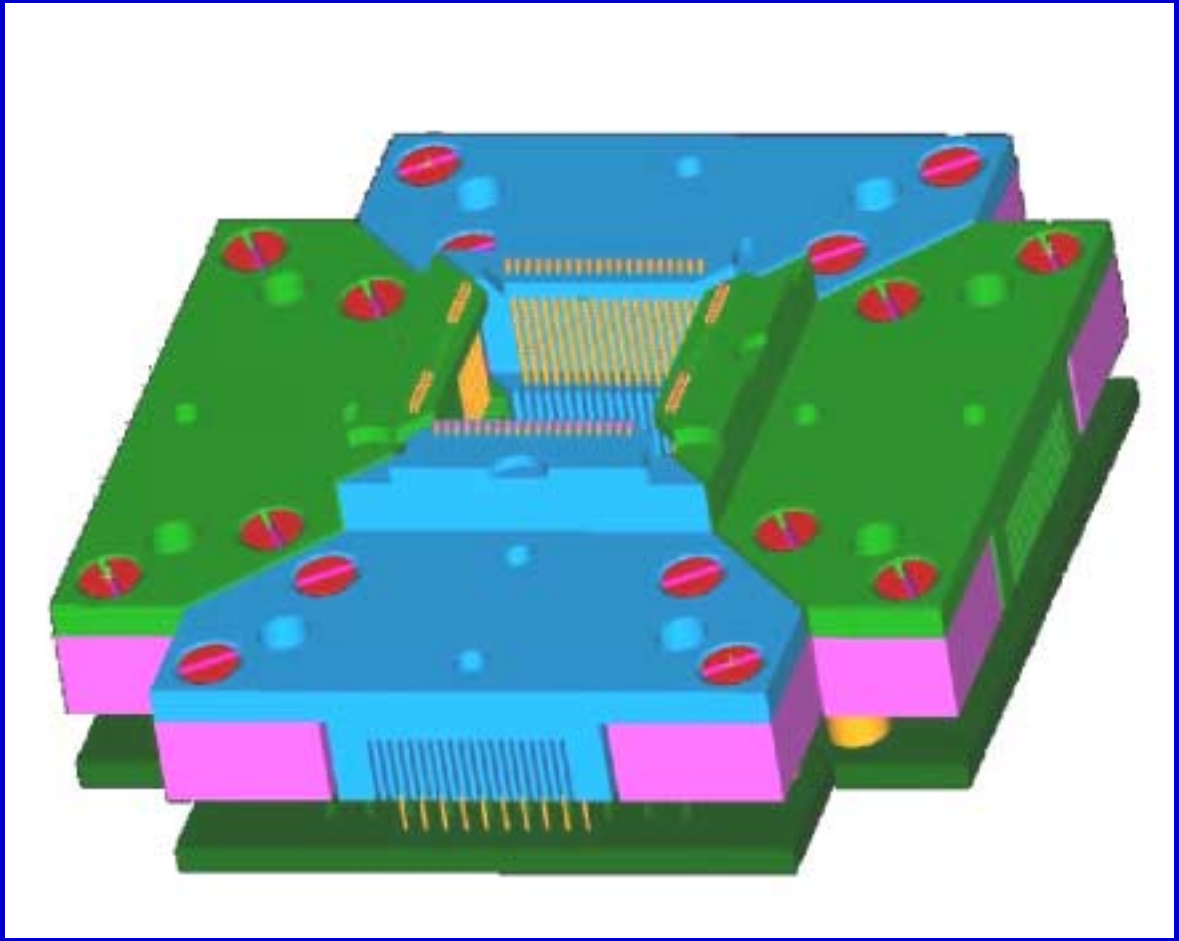
Contactor Design - Features

Kelvin contact spring block - detail

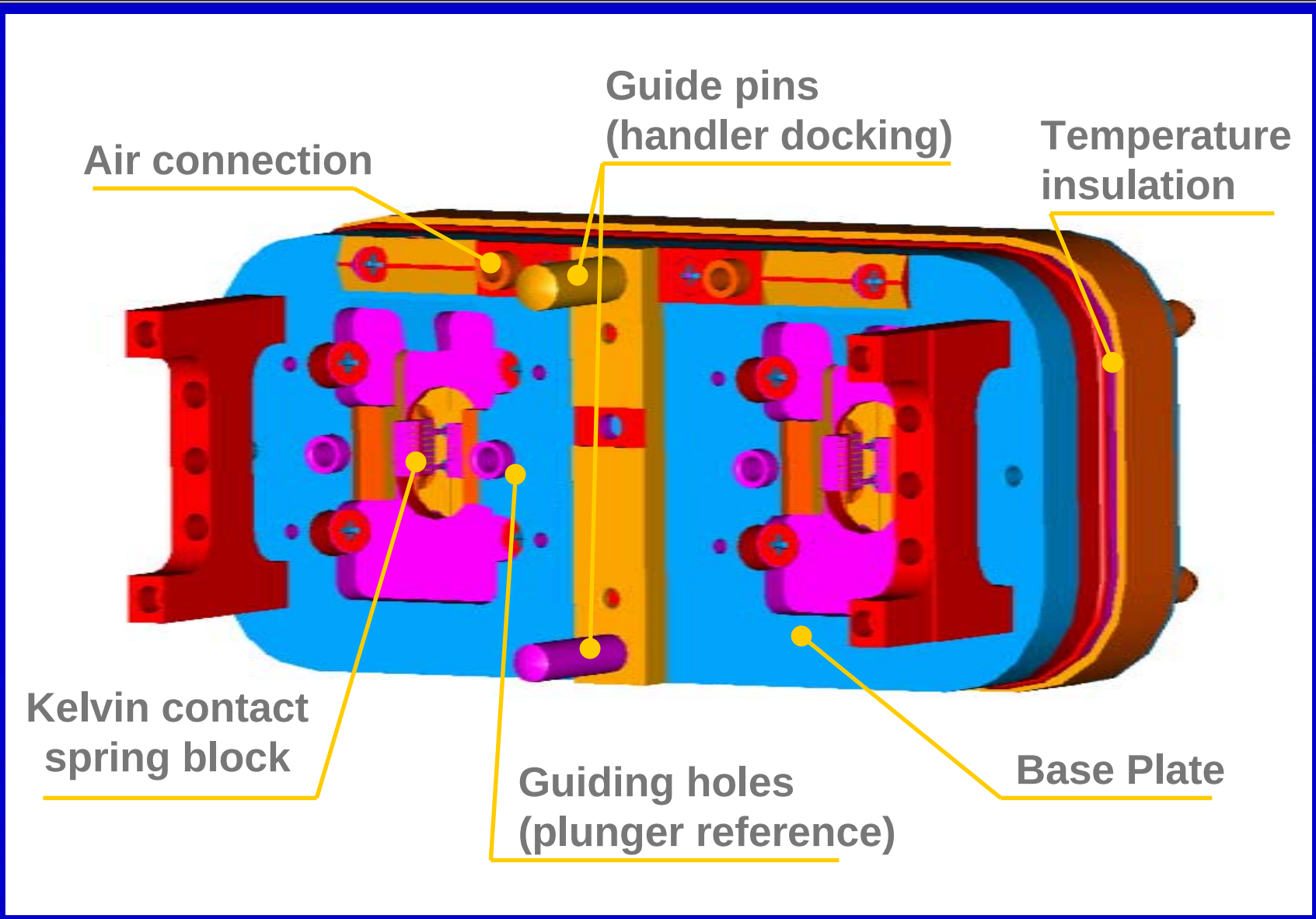


Contactor Design - Socket Arrangement

Rectangular arrangement for leadless packages

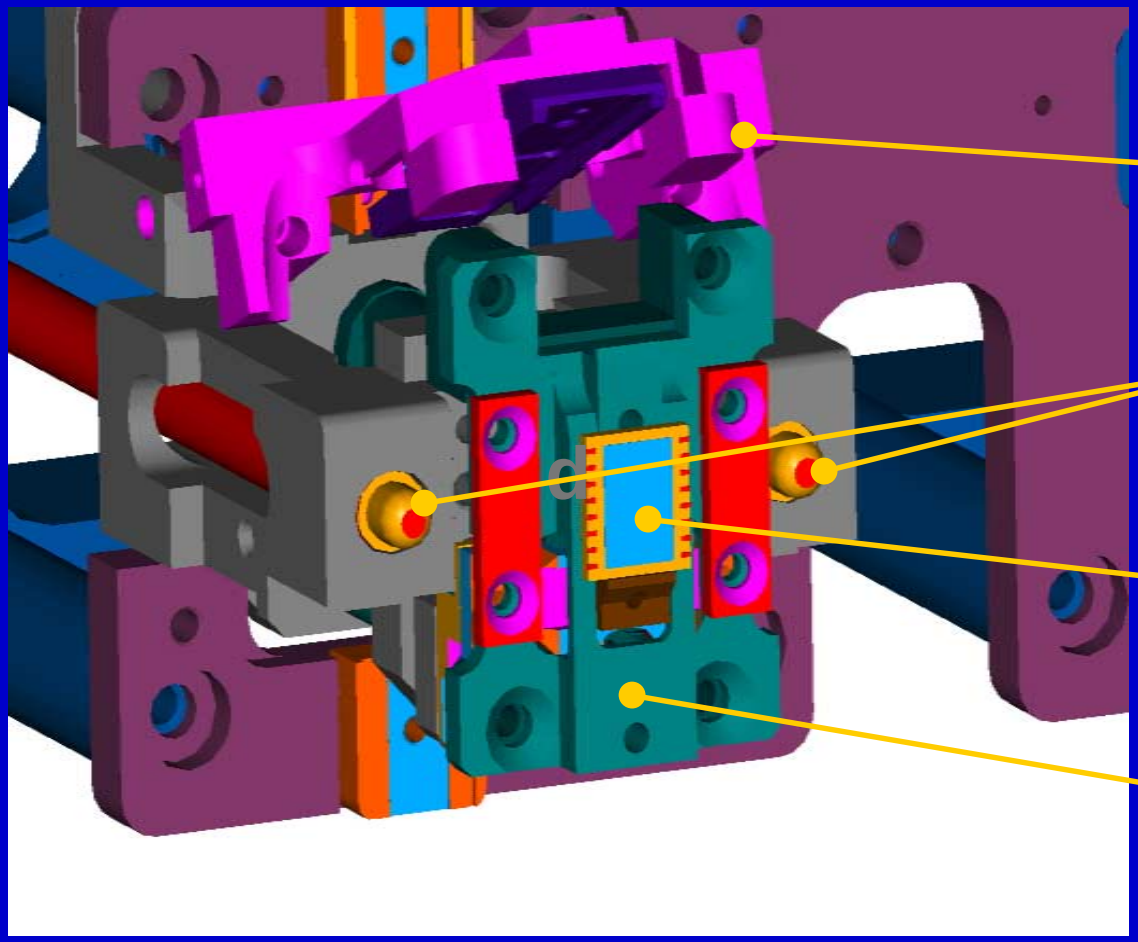


Contactor Design - Dual Contact Unit

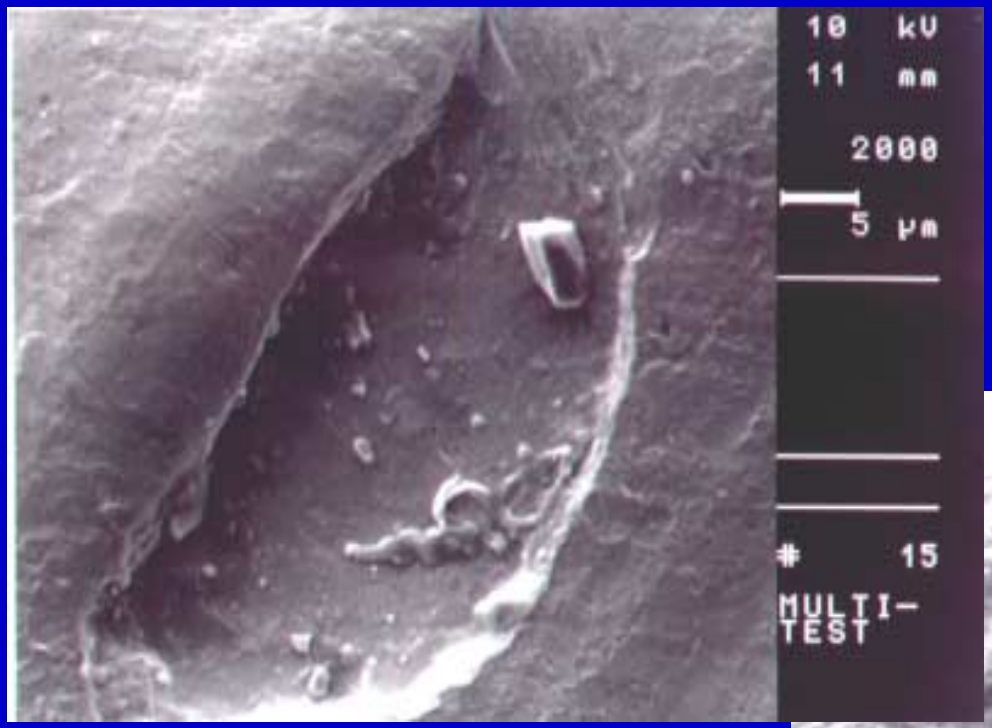


Contactor Design - Device Positioning

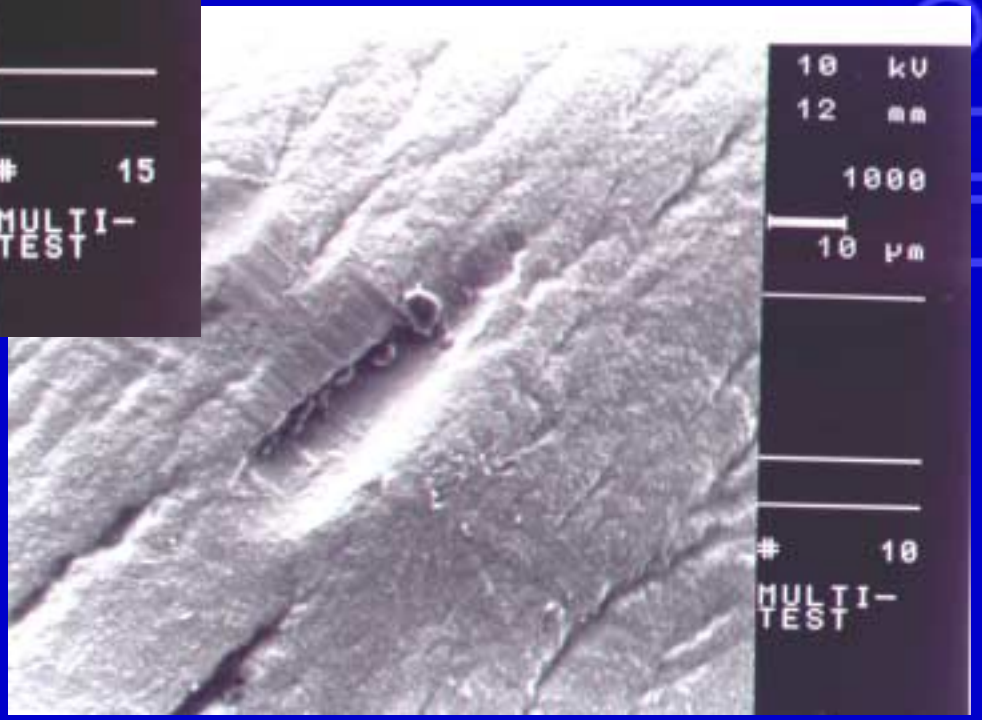
Gravity test handler - vacuum plunger



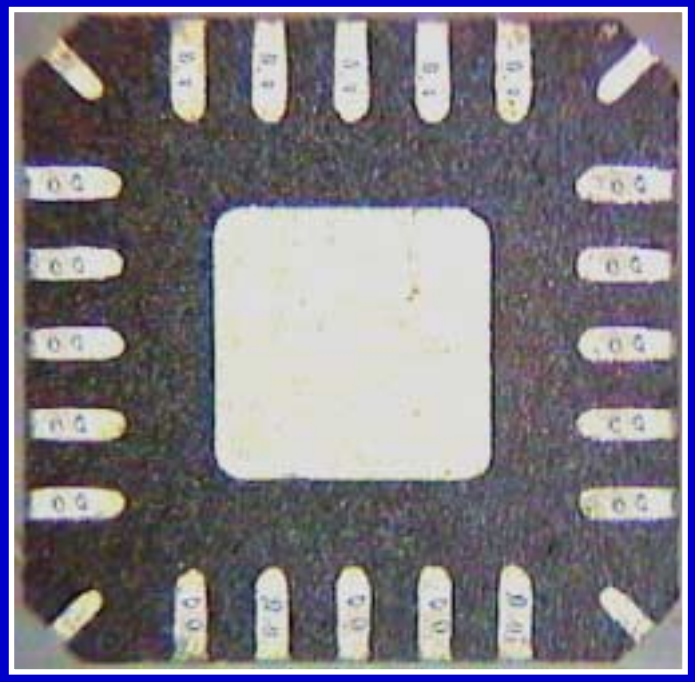
Design Evaluation - Contact Springs



Contact spring marks
on device pads



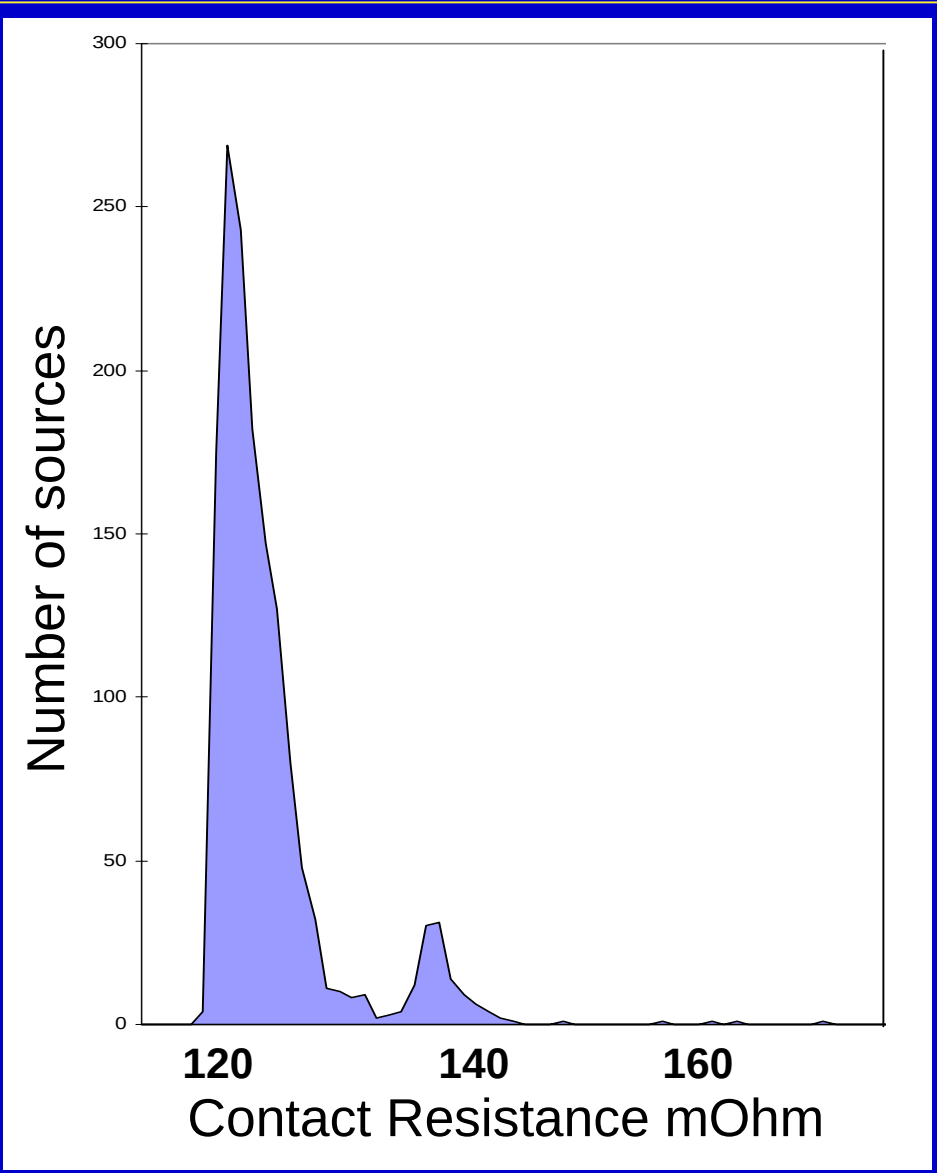
Design Evaluation - Contact Springs



Contact spring marks
MLF 4x4 20lead 0.5mm

Contact springs
after 500k insertions

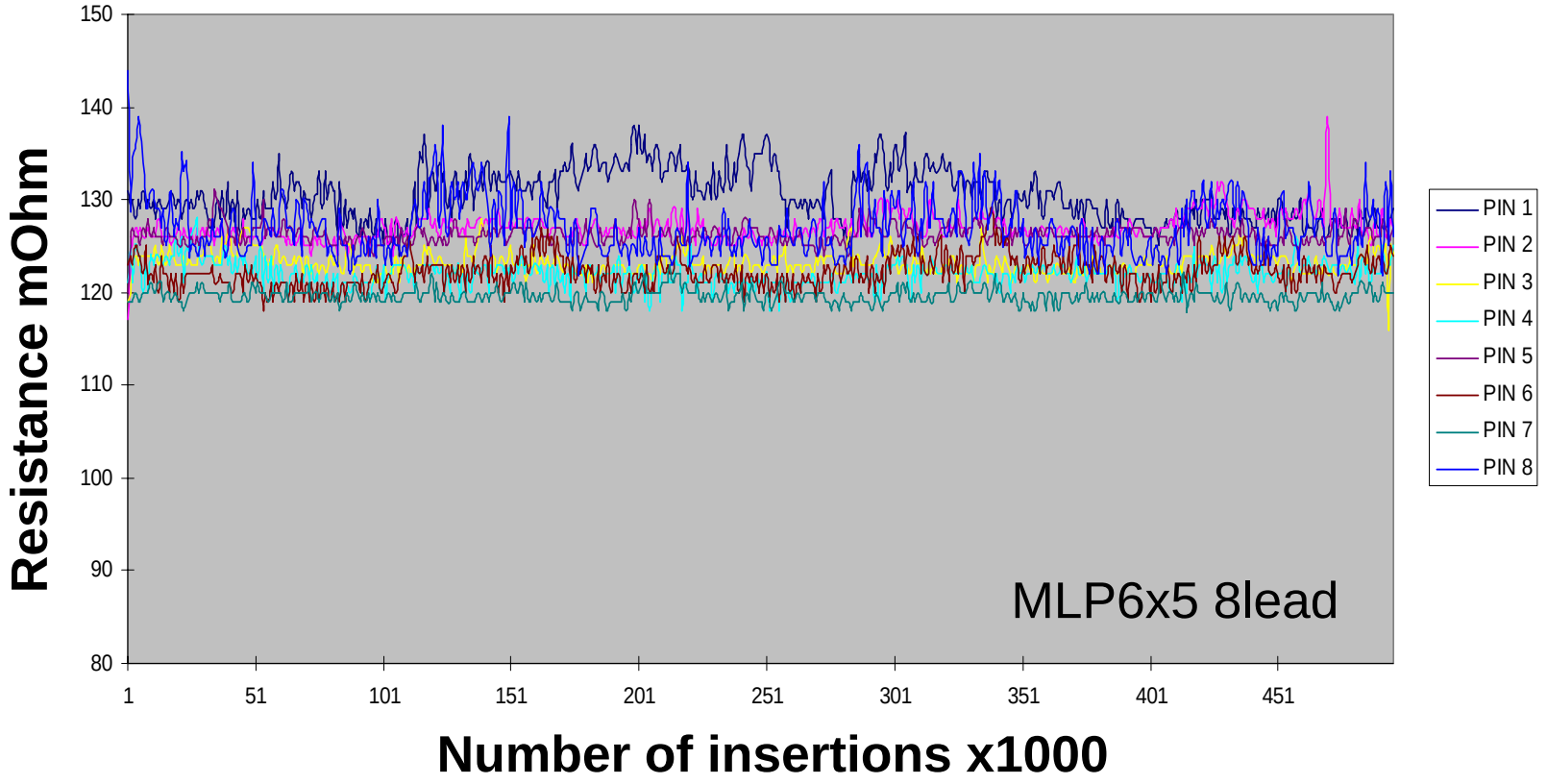
Design Evaluation - Resistance Distribution



Contact resistance measurements taken from 100 Devices
MLP6x5 8lead
Temperature ambient

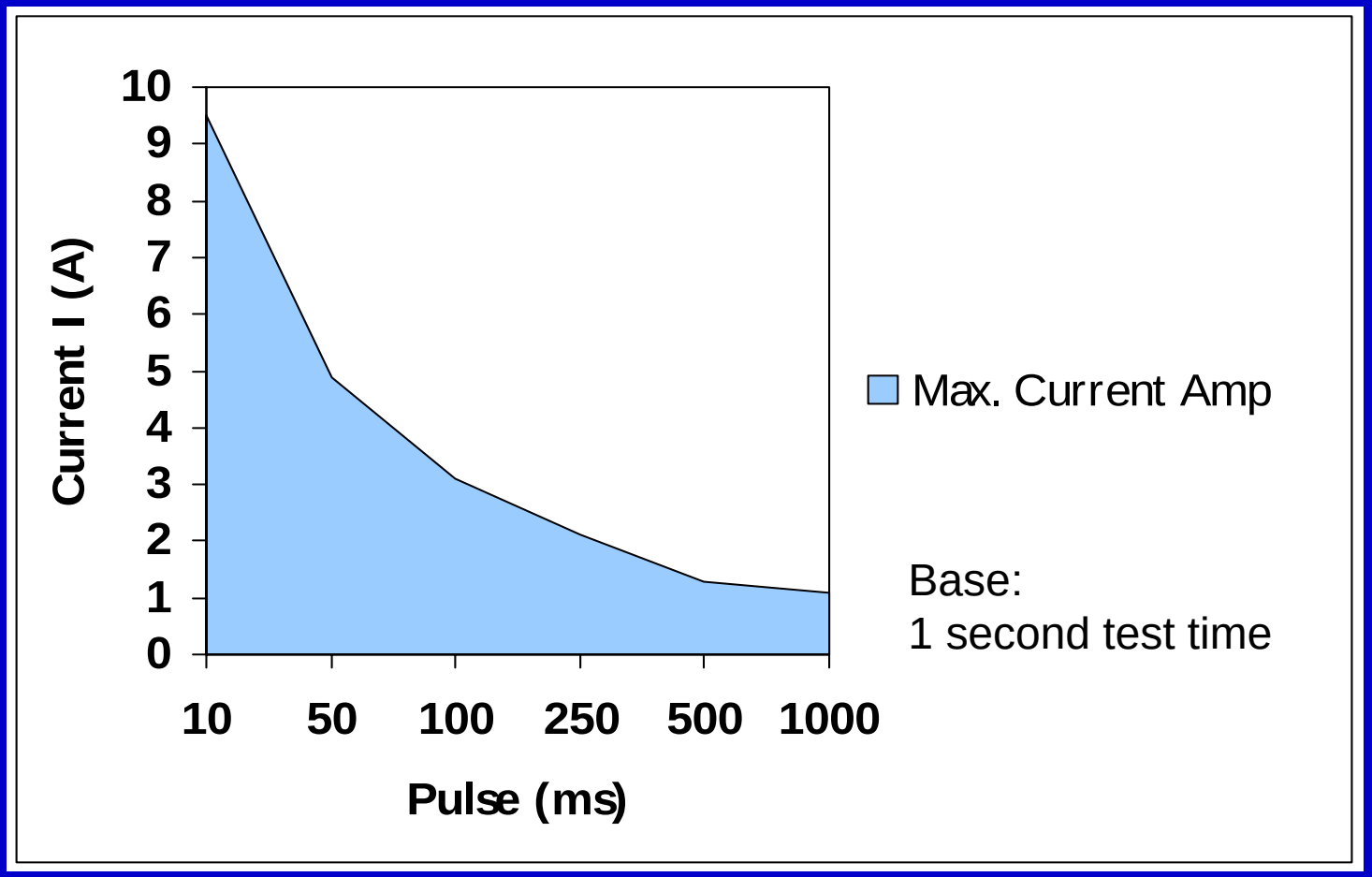
Design Evaluation - Contact Resistance

Contact resistance versus number of insertions (ambient)

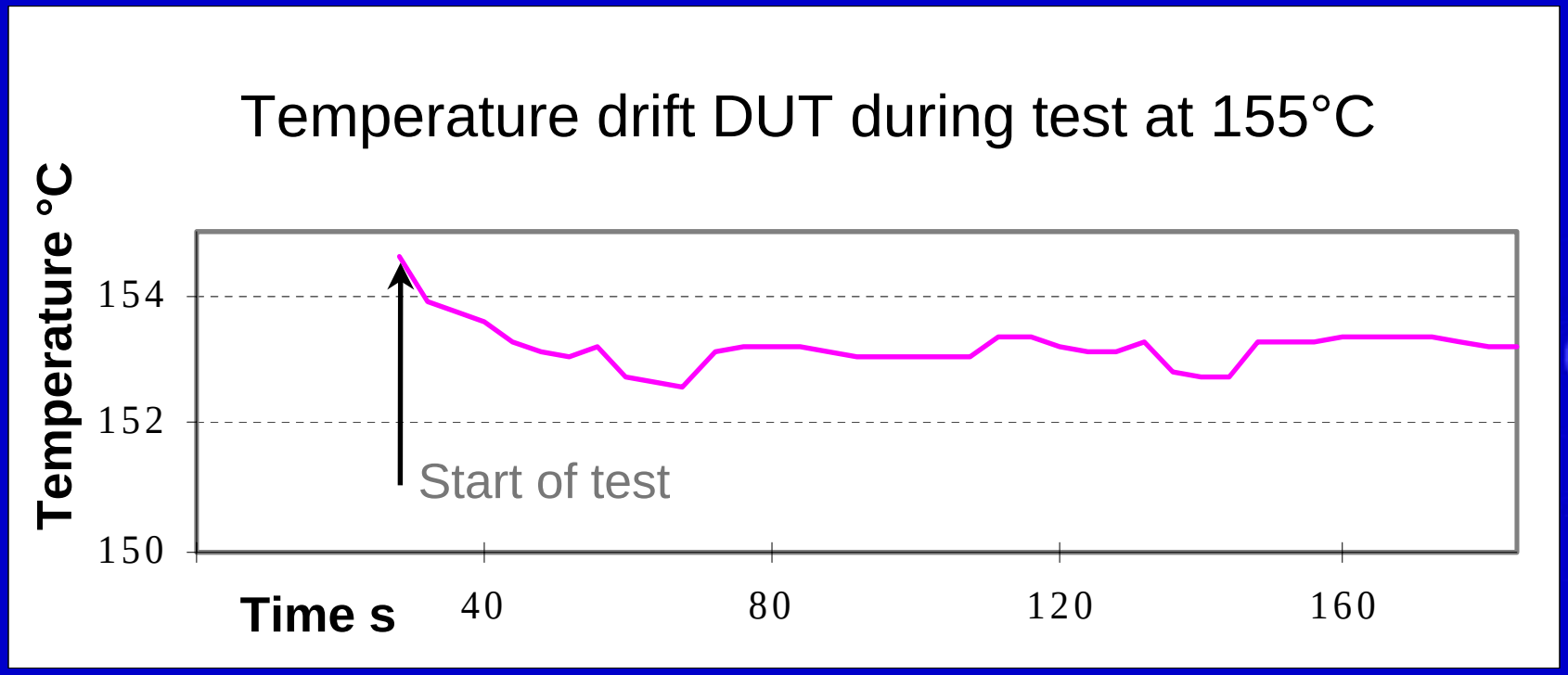


Evaluation Results - Maximum Current

Maximum test current versus pulse duration

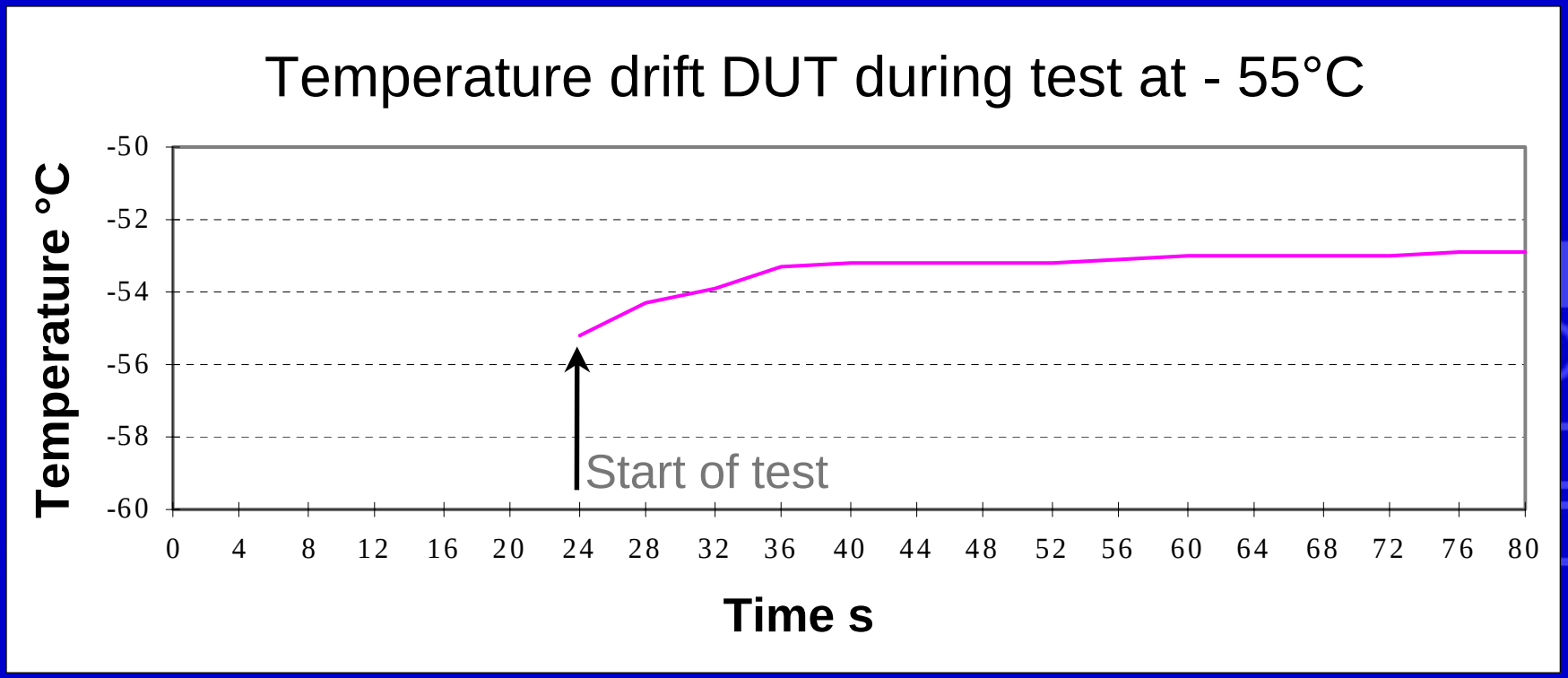


Evaluation Results - Temperature Accuracy



DUT temperature after 30 seconds testtime = 152,5°C

Evaluation Results - Temperature Accuracy



DUT temperature after 30 seconds testtime = - 53°C

Design Evaluation - Summary

Mechanical:	
Package	JEDEC MO220 / MO229
Lifespan	min 1Mio insertions
Contact force	0.3N
Contact deflection	0.3mm

Electrical:	
Contact resistance	typ. 130mOhm
Maximim current	continuous 1 Amp

Thermal:	
Temperature range	-55°C up to 155°C
Temperature accuracy	+/- 3°C

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Interconnecting at 40 GHz and Beyond

Roger Weiss, PhD

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Problem Definition

<u>Electronic Capability Continuously Evolves</u>

Smaller, Faster, Better Performance, Lower Cost and More Functionality

- **Computer Speed and Size**
- **Wireless and Telecom**
- **Military**
- **Medical**

Conventional Connectivity is Running out of Speed

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Core Technology

Paricon's Interconnect Technology Based on Controlled Electromagnetic Alignment of Ferro-Magnetic Particles Within a Polymer Matrix

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Core Technology

After Several Years of Research Paricon Has Perfected a Long Promised Capability

- **Core Technology Acquired From Bell Labs**
- **High Performance Materials Developed**
- **Improved Manufacturing Methods Introduced**
- **Mechanical Interactions Understood**

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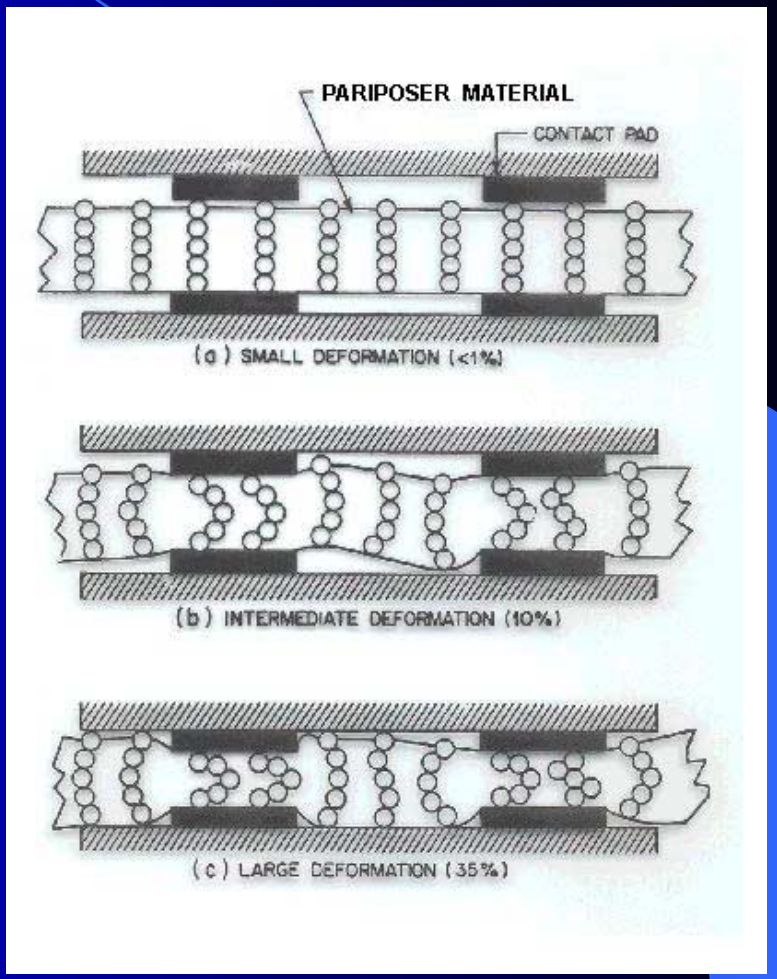
PariPoser® Interconnect



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®

Our Name

PARTICLE
INTER–
CONNECTION

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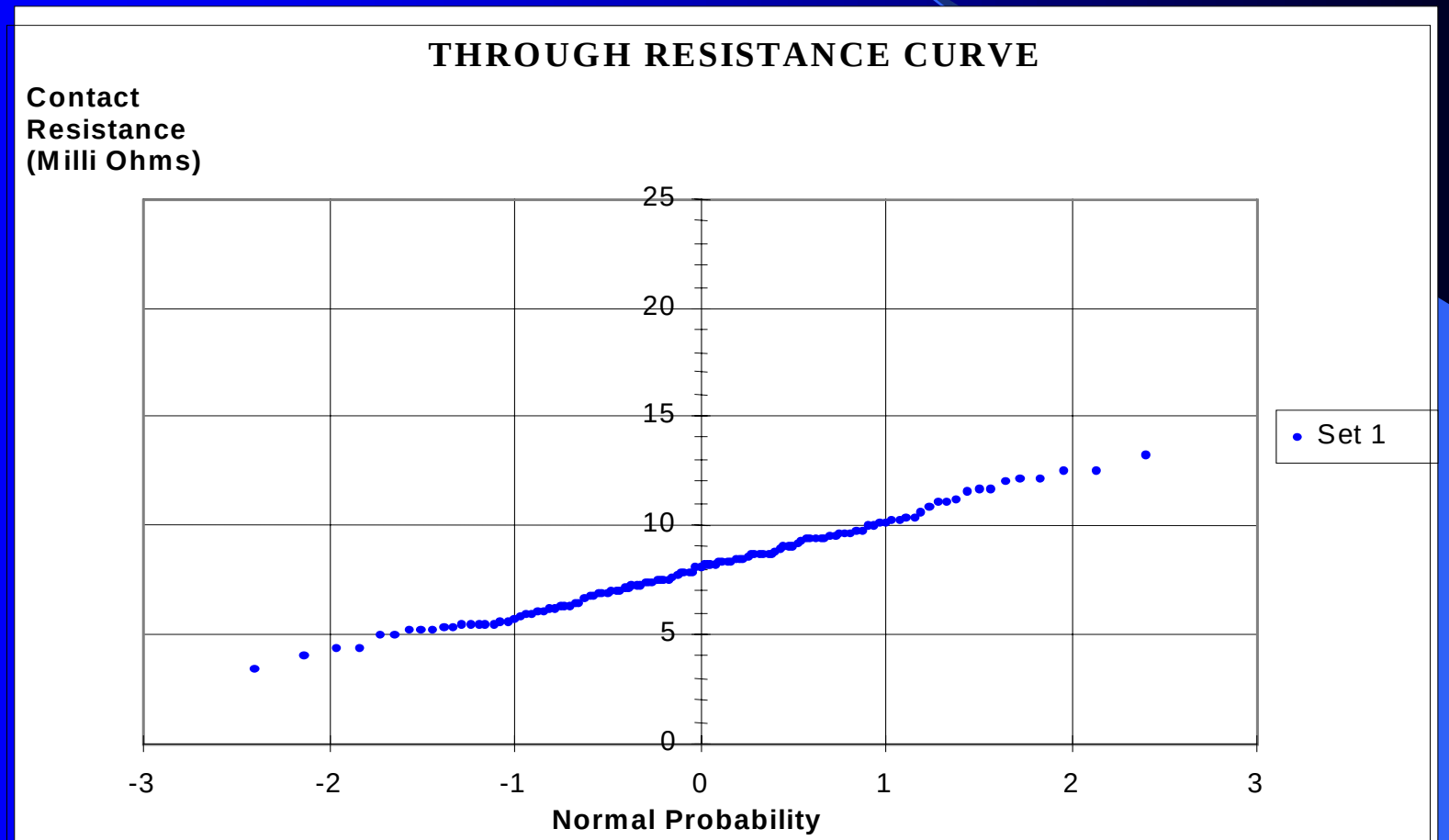
Contact Resistance



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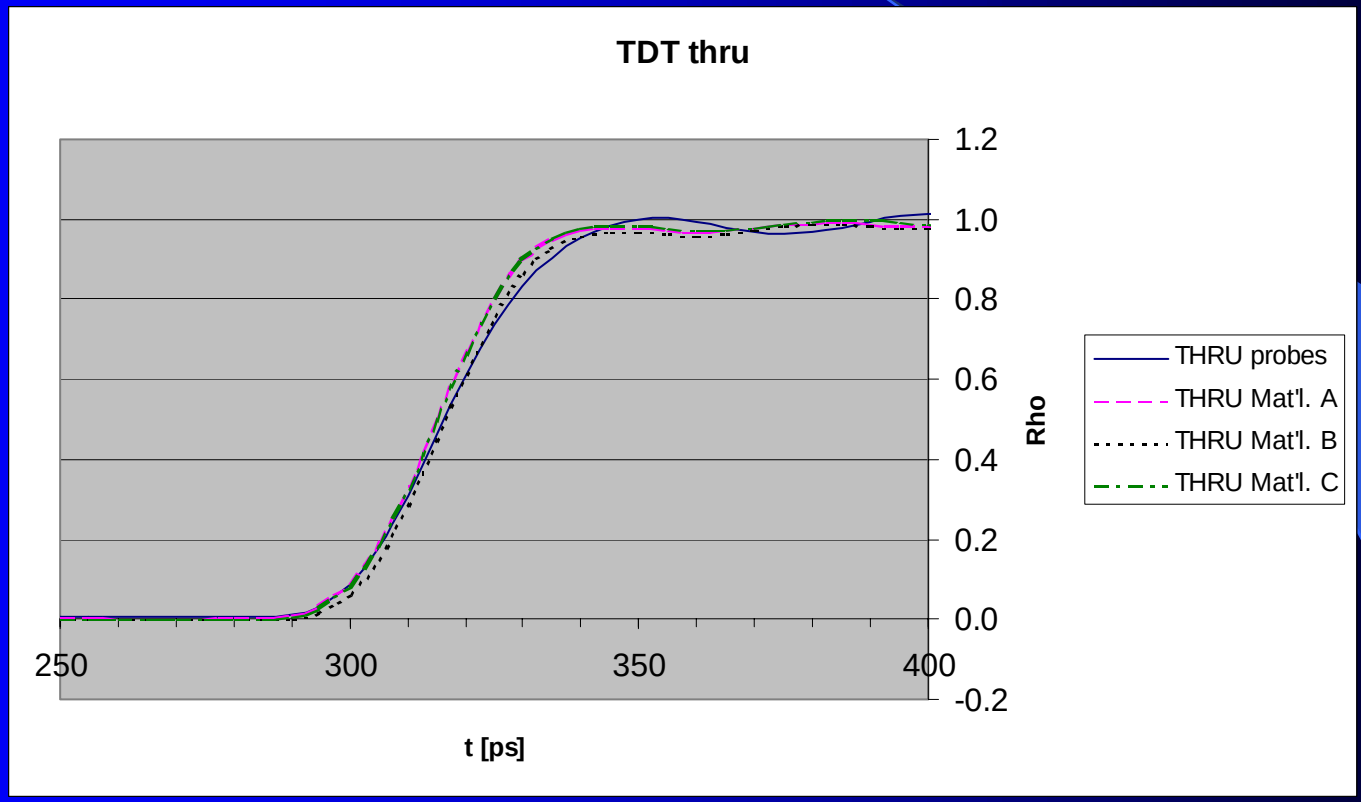
Rise Time



Time domain response for transmitted signal

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Electrical Parameters

Shunt Capacitance (G-S-G)	**30 femto Farad**
Self Inductance	**70 pico Henry**
Rise Time (Same as Test System)	**32 ps**
Delay	**1.5 ps**

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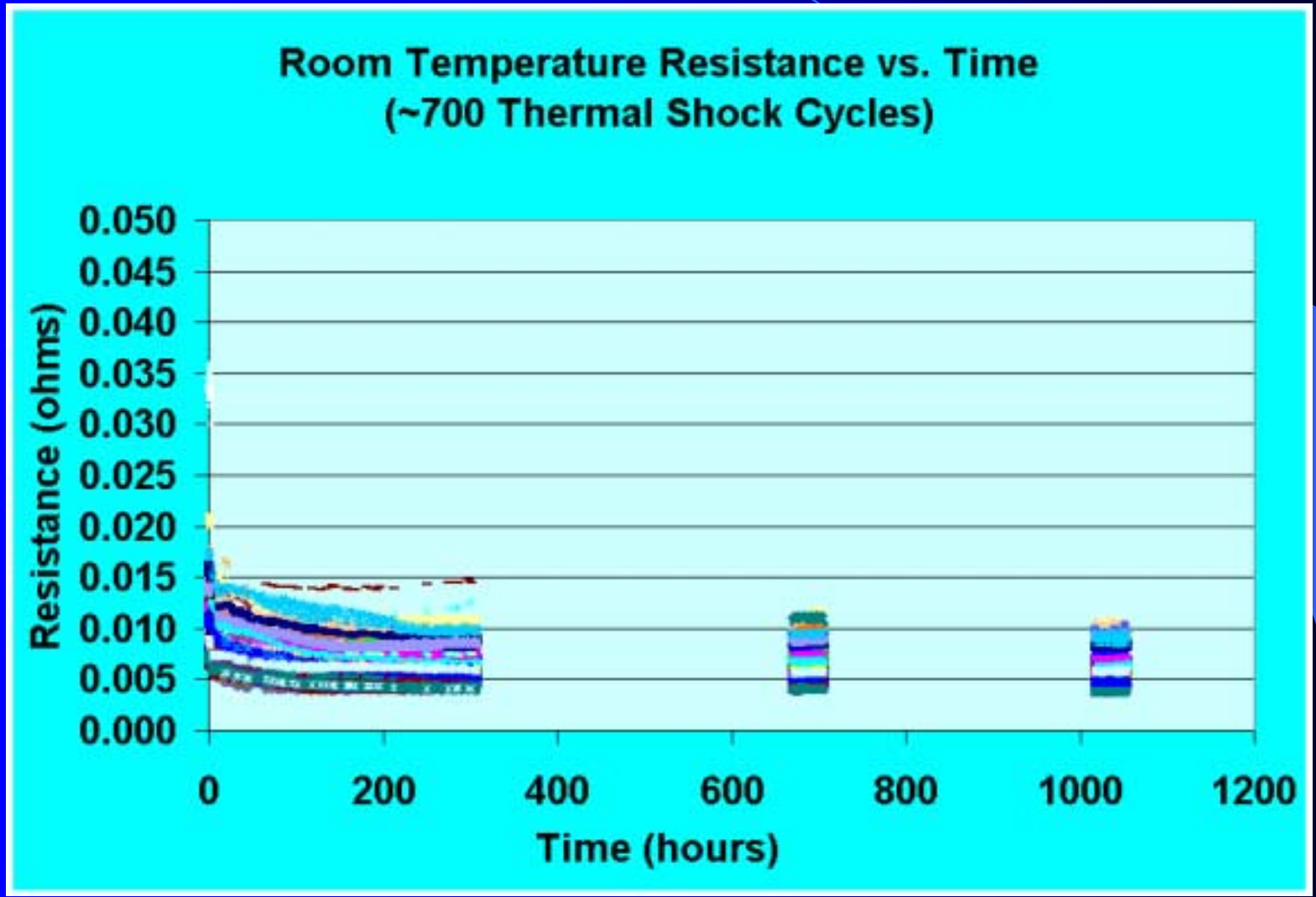
Thermal Cycling



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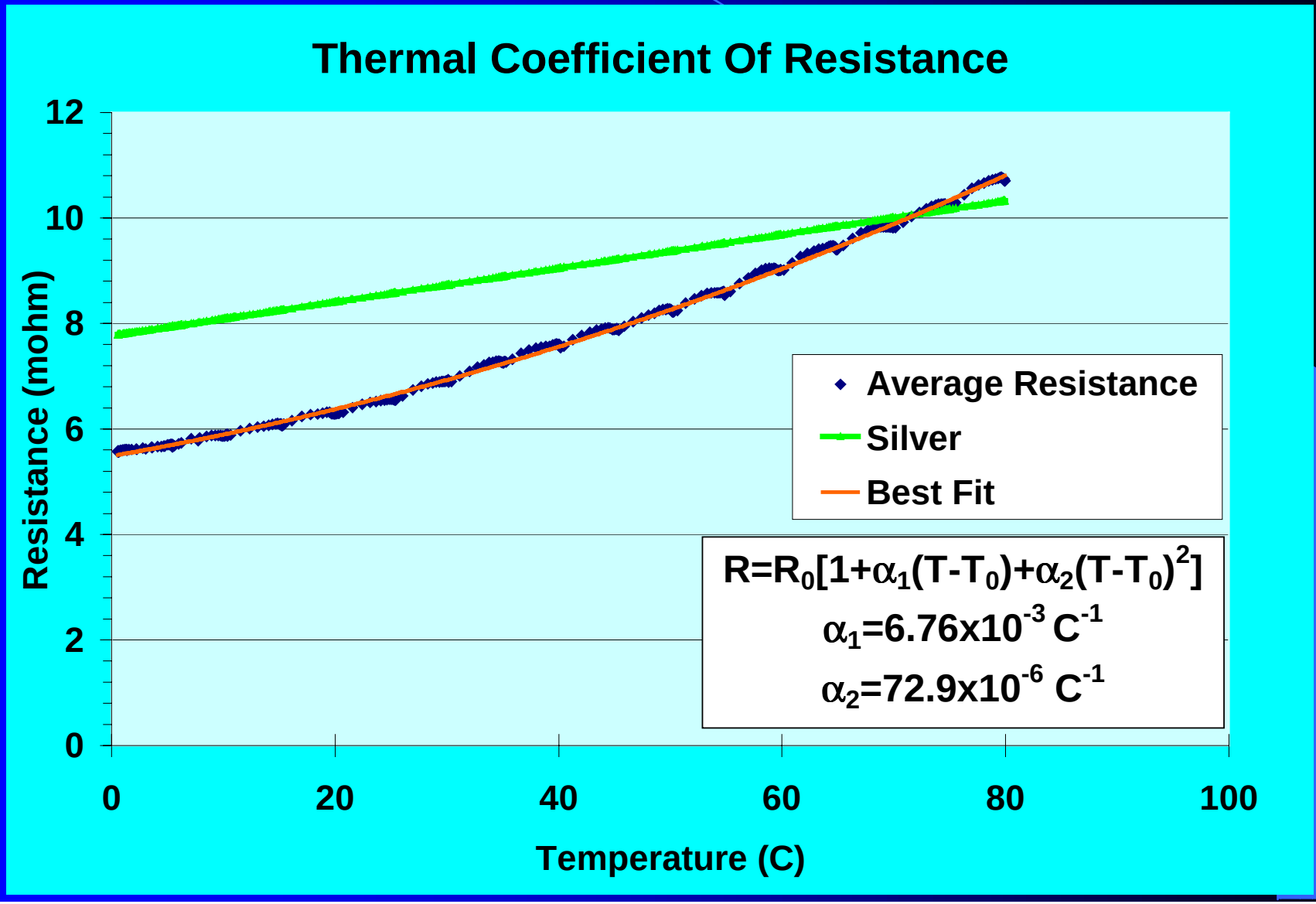
Resistance vs. Temperature



Formulation Dependent Material Properties

❖ Isolation Gap*:	As low as 0.010”
❖ Nominal Operating PSI:	15 - 100 PSI
❖ Current Capability*:	Up to 1 Amp for 25 mil pad
❖ Environmental Seal:	Silicone Gasket
❖ Size/Shape:	Any shape < 12” x 30”
❖ Pad size*:	.025 inches Typical
❖ Contact Materials:	Noble Metals

*Data for 1mm LGA Array

Formulation Dependent Material Properties

❖ Solvent Resistance:	Excellent
❖ Thermal Conductivity:	2 W/m -°C
❖ Pitch:	Engineered
❖ Thickness:	8-15 mils
❖ Op. Temperature Range:	- 40 to 160 C
❖ Storage Temperature:	-170 to 160 C
❖ Durability:	>500,000 cycles at 18 PSI

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Formulation Dependent Material Properties

❖ Burn-in Cycles	>500 to 150 C
❖ Contact Resistance	<20 milliohms
❖ Inductance:	70 pH
❖ Capacitance:	.03 Pico farads
❖ Insulation Resistance:	> 1 gig ohm
❖ Frequency Range:	At least 40 GHz
❖ Glitch	>2500 Hours per EIA-540

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Technical/Market Advantage

- Performance
- Scalability
- Cost
- Quick Time to Market
- Highly Configurable
- Enables New Approaches

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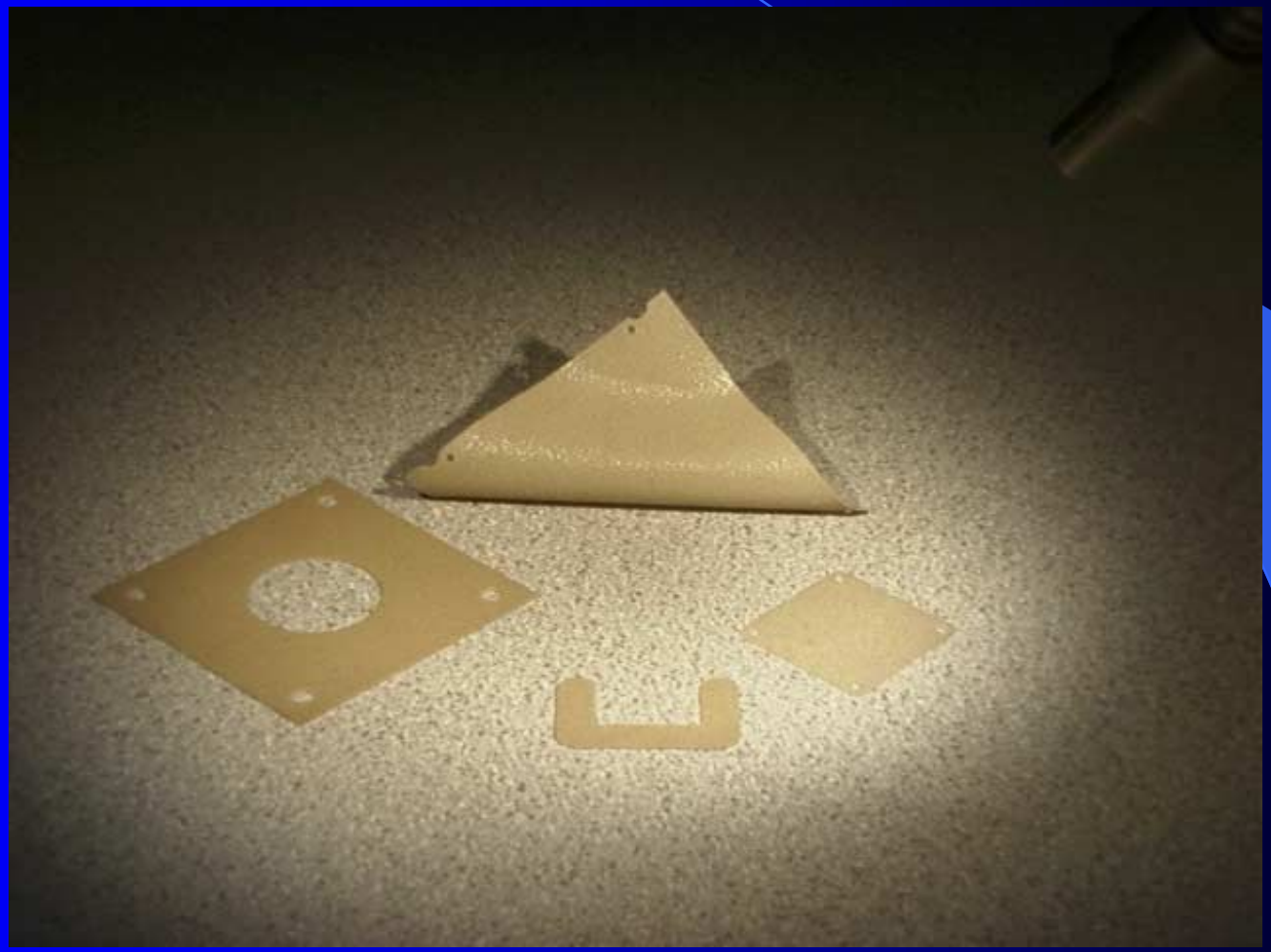
PariPoser® Components



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Development Test Socket

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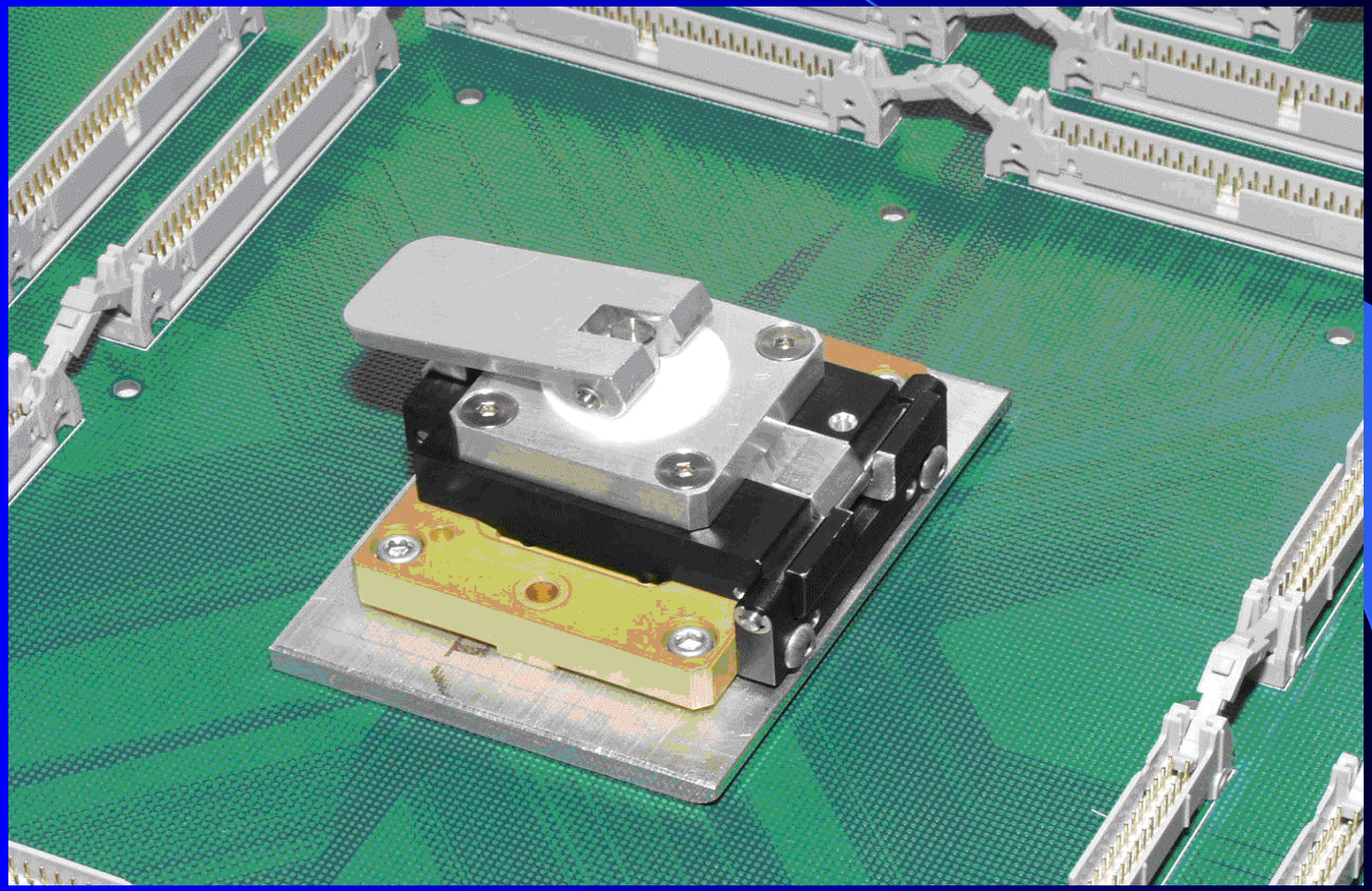
10 GHz Test Socket



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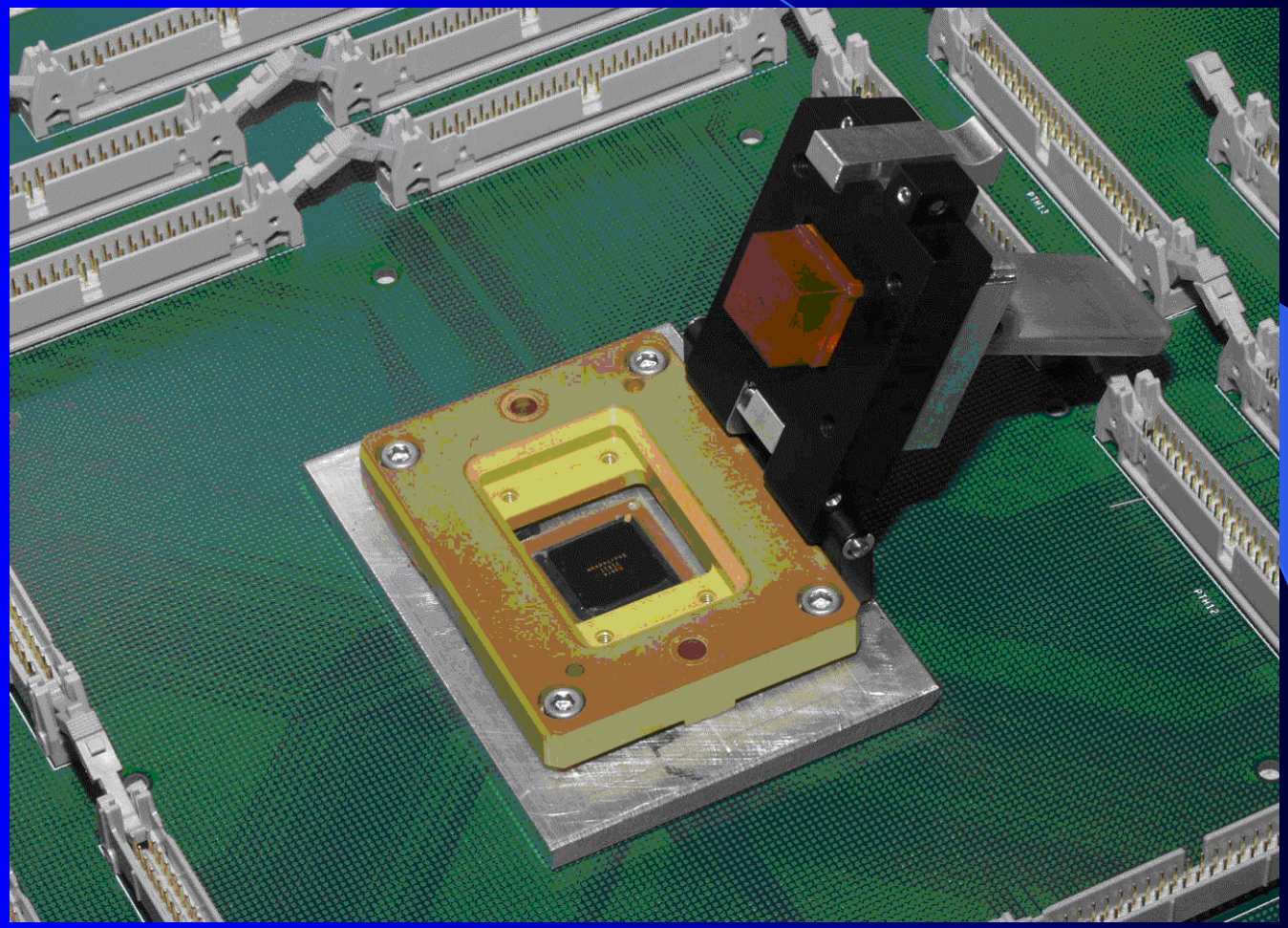
10 GHz Test Socket



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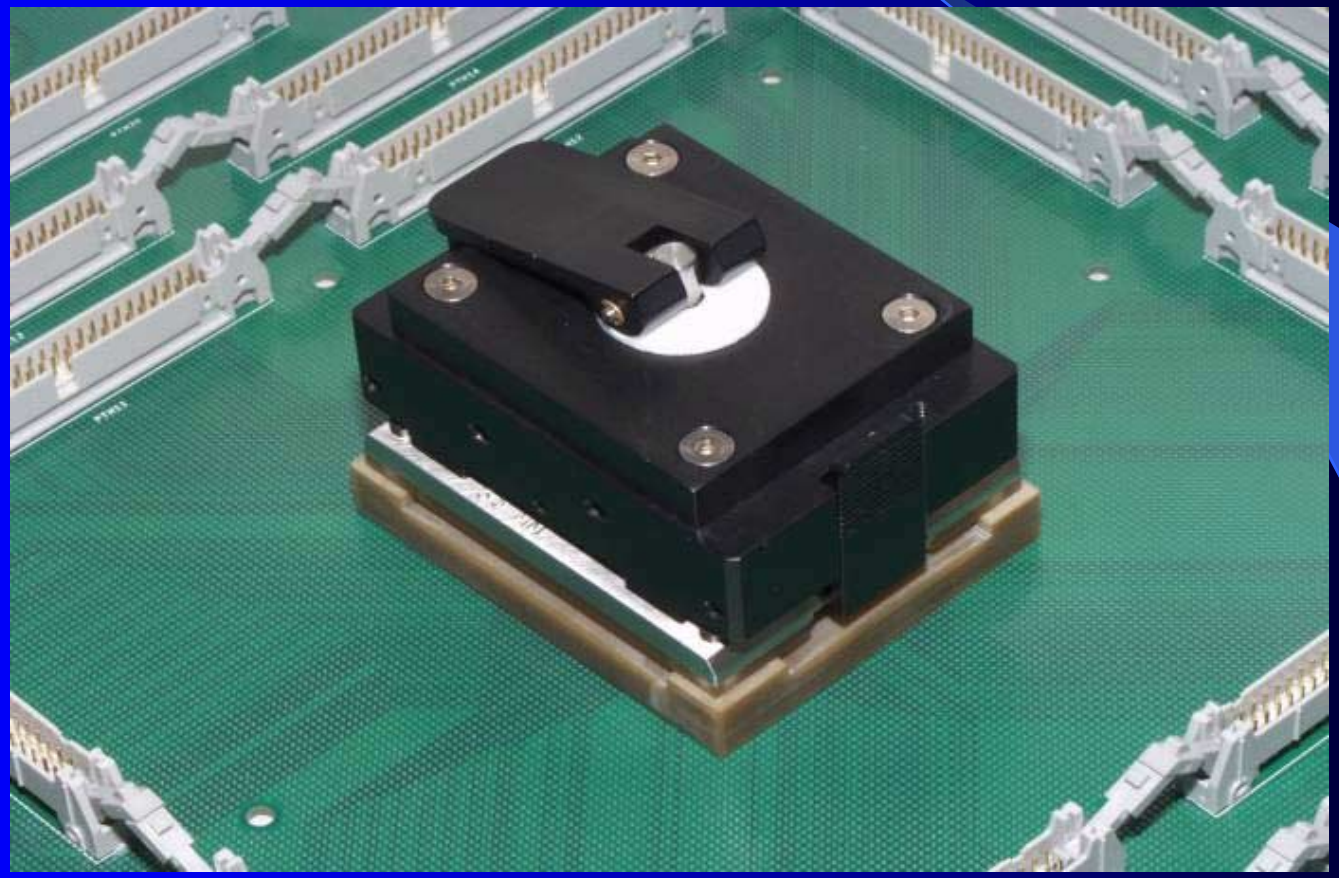
10 GHz Translation Socket



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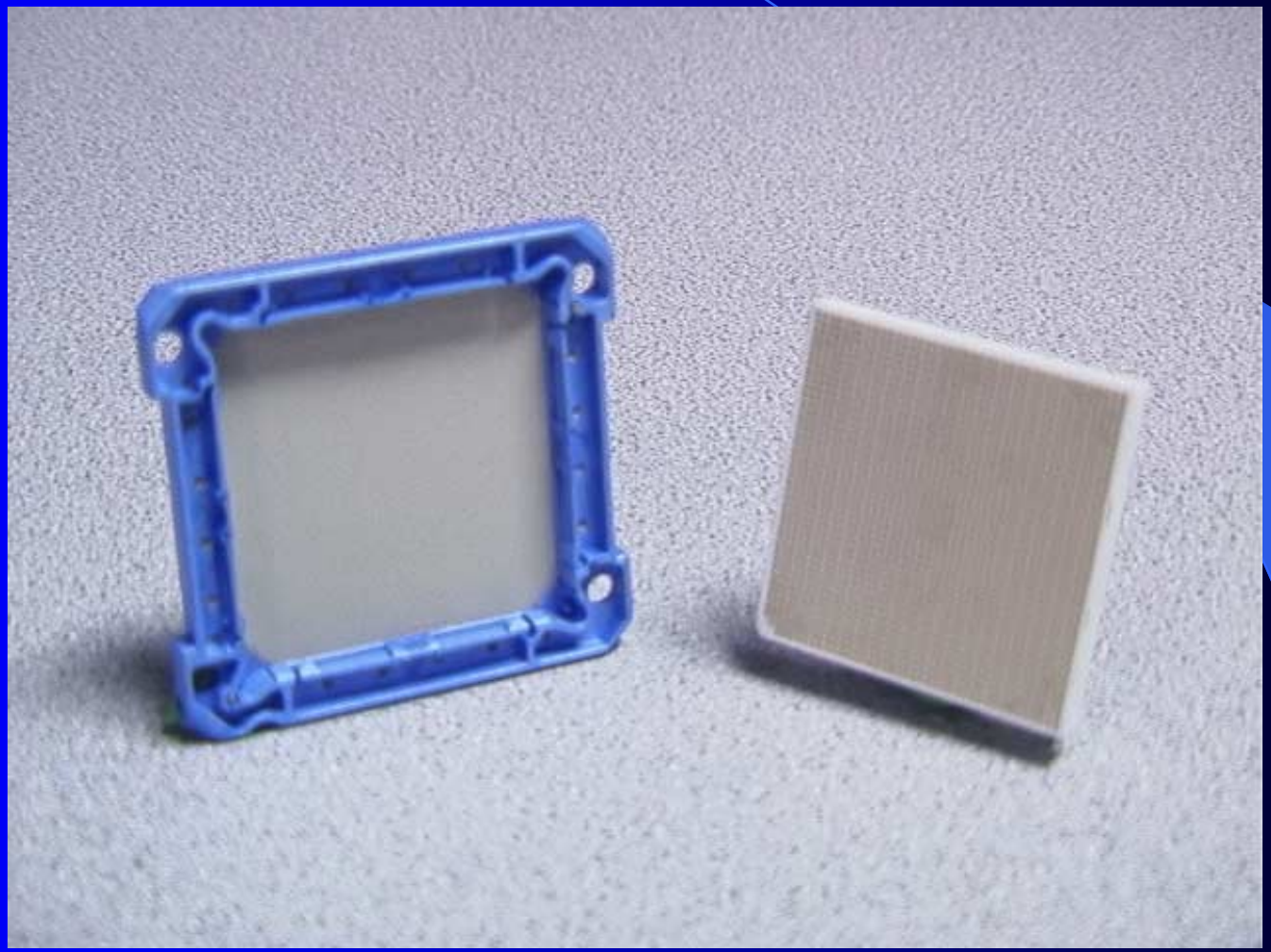
Production Socket



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Summary

Benefits of the PariPoser® Anisotropic Conductive Interconnection Fabric.

- **Conducts Only in the Z-Axis**
- **Provides Multiple Signal Paths per Pad.**
- **Exceeds Industry Electronic Needs.**
- **Extendable to Very High Density.**
- **Interconnect at 40 GHz and Beyond**
- **Extends Interconnection capabilities to new dimensions.**

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The Future

Projected Capability

- Die scale interconnection
  - 0.004” pitch demonstrated
- Wafer Scale Test Probe for 300mm

ELECTRO-CHEMICAL CLEANING PROCESS

March 2002 BiTS Workshop

Presented by Erik Orwoll
President
Nu Signal LLC

INTERCONNECT DEGRADATION

Causes:

➔Tin Lead Transfer (Metallic Formation)

➔Mechanical Wear (Surface finish change)

➔Localized areas of plating are removed

➔Poor Plating adhesion

➔Oxidation

TOPICS TO BE ADDRESSED

➔Removal of Tin Lead Transfer & Oxidized Metallics

➔Method for Detecting Exposed Base Metal

➔Lead Free Solder

➔Process can be applied to both Burn-In and Test

CURRENT METHODS FOR TIN/LEAD REMOVAL

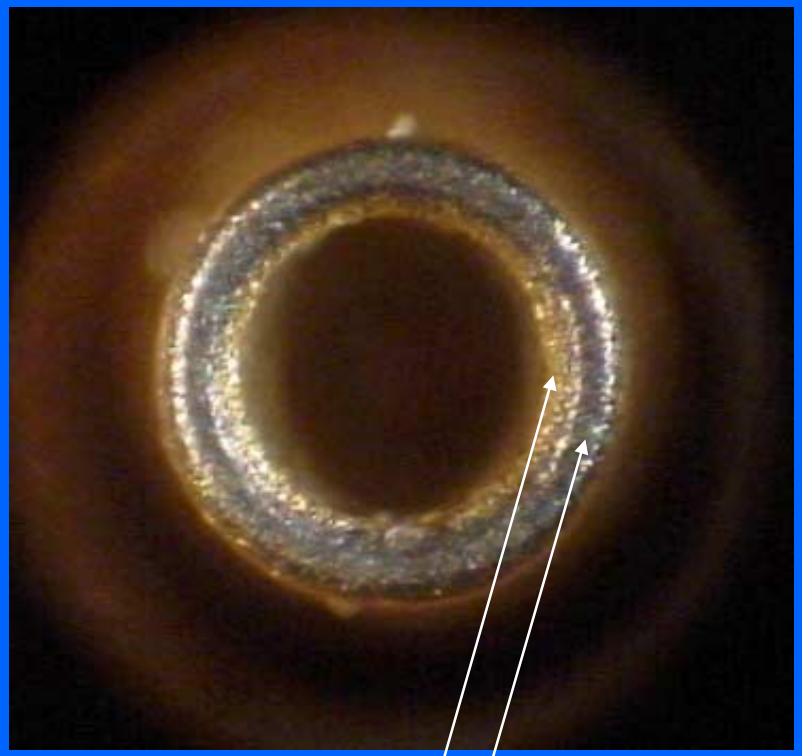
➔Mechanical Removal - Typically brass or nylon brushes. Consistency is difficult and damage can occur.

➔Chemical Cleaners - Can be harmful to contactor plating, base metal, and socket housings. Also volatile & toxic.

➔Abrasive - Ceramic or similar material. Can cause damage to plating or base metal.

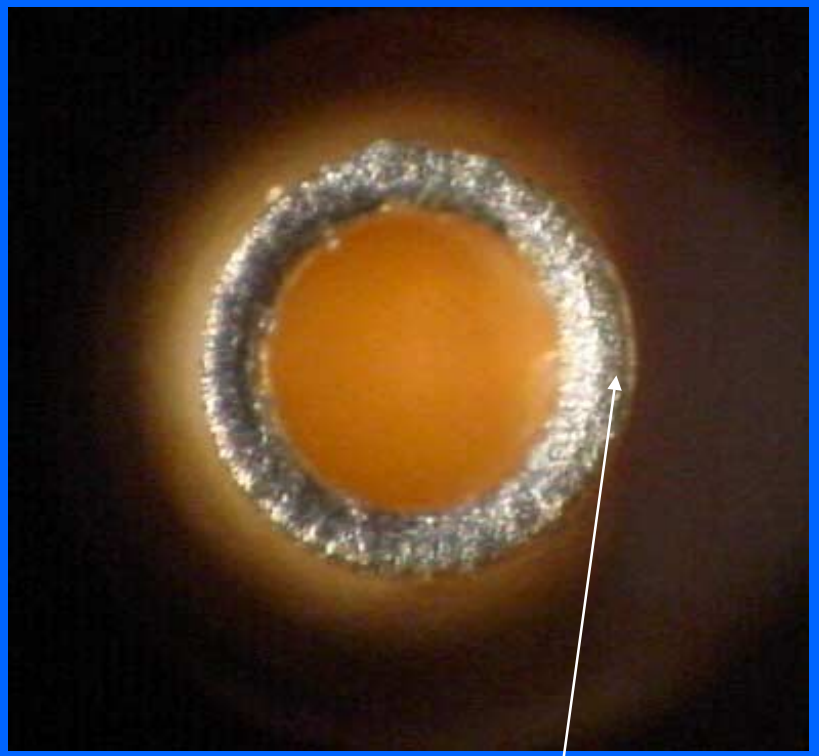
➔Ultra-Sonic Cleaning - Removes dirt and loose particles, but has little or no effect on transferred metals.

TIN LEAD DEPOSITS



Gold Plating

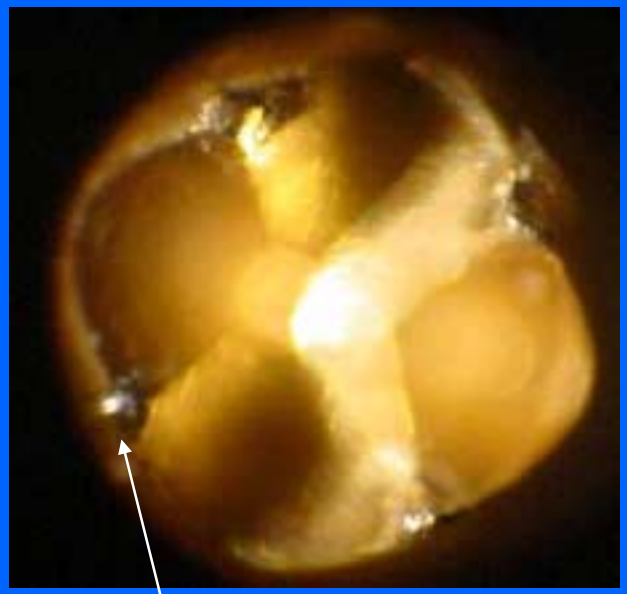
Solder Build-Up

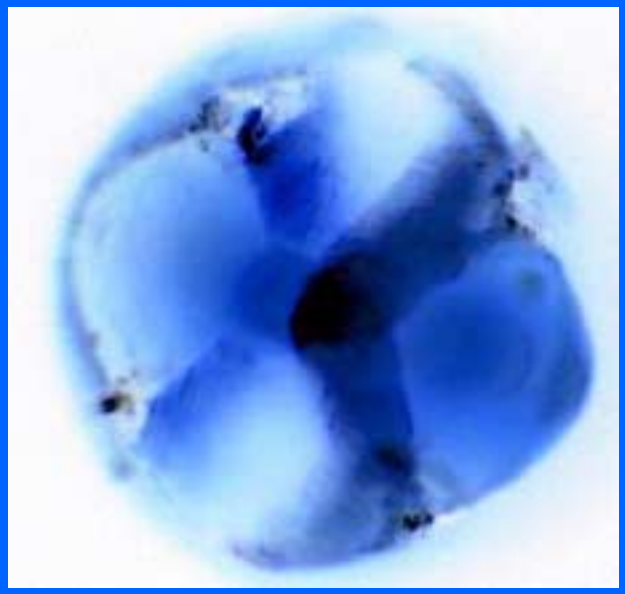


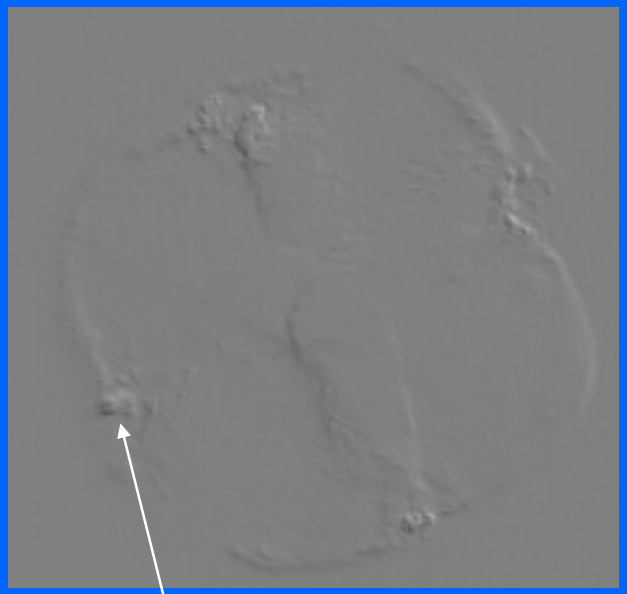
Excessive
Solder Build-Up

TIN LEAD DEPOSITS

4 Point Crown Pogo Pin







Solder Build-Up

Solder Build-Up

ELECTRO-CHEMICAL CLEANING PROCESS

➔Metal fouling, which is deposited on the contactor, is selectively removed by an electrochemical process which is innocuous to the connector base metal

➔An electrolyte is suspended between the base metal and a collection plate, and a potential is applied

➔Tin Lead deposits are solubilized and deposited on the collection plate

➔The potential is maintained until process is complete

“REVERSE” PLATING PROCESS

➔This process is similar to standard electro-plating. However, the potential is reversed, causing the Tin/Lead deposits to be removed from the base metal and released into solution (See Figures 1 & 2)

➔Tin/Lead deposits form on a “collection” plate

FIGURE 1

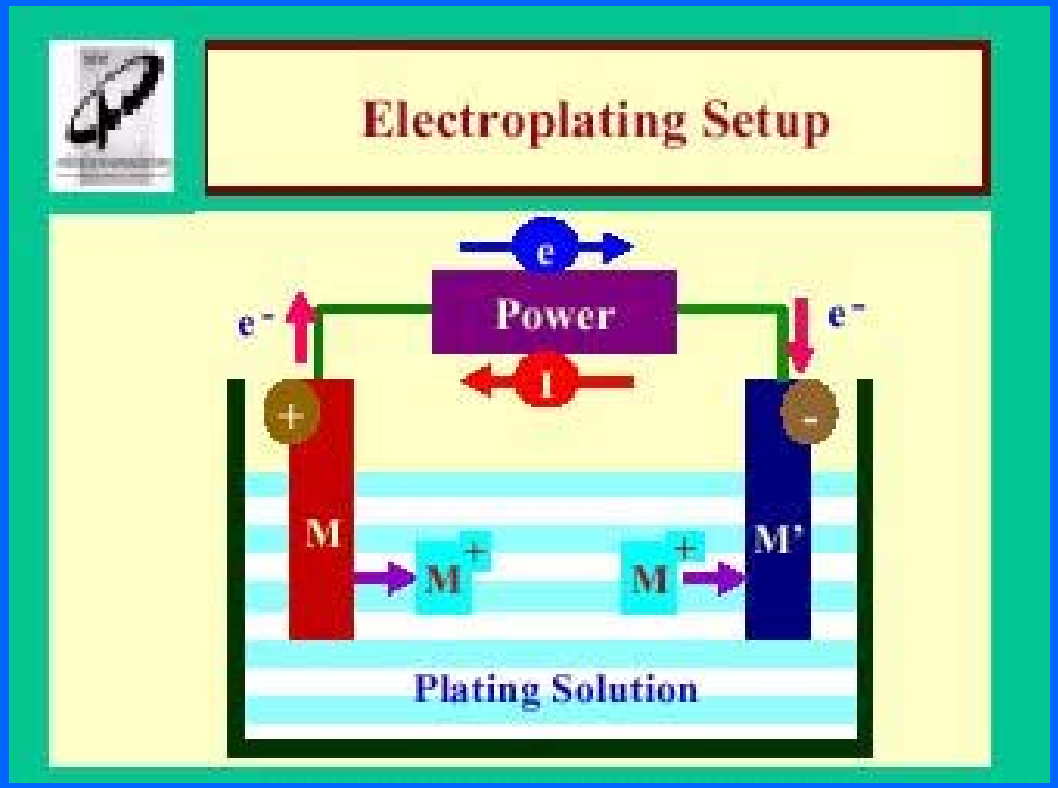
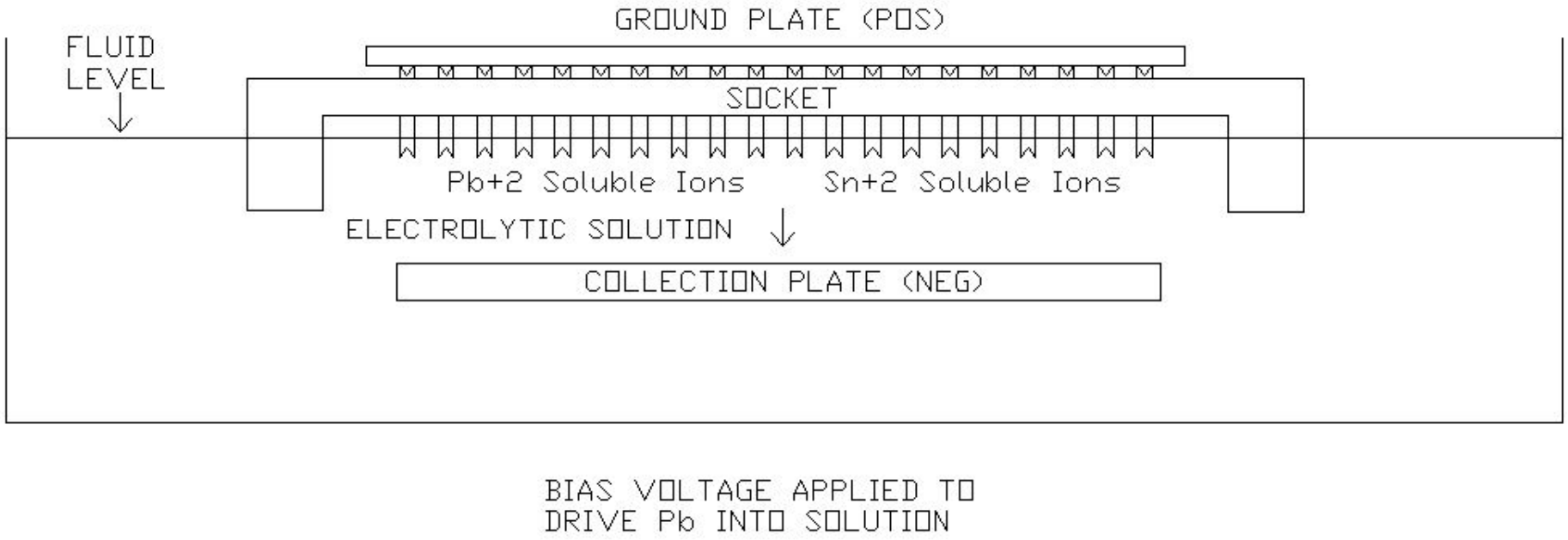


Diagram of typical plating process

FIGURE 2 (Socket Inverted)



BIAS VOLTAGE APPLIED TO
DRIVE Pb INTO SOLUTION

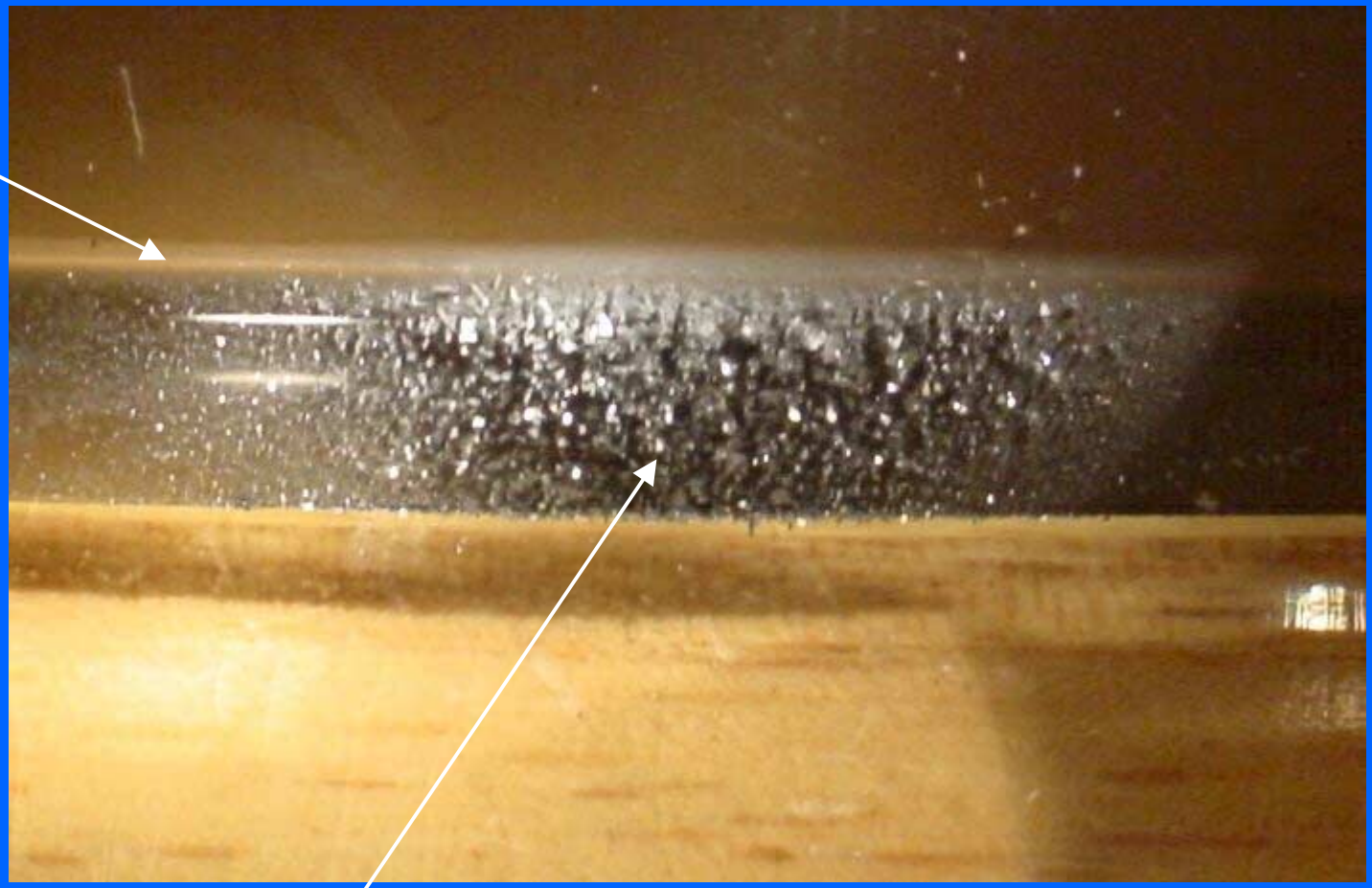
ELECTROCHEMICAL TRANSFER

Test Set-up

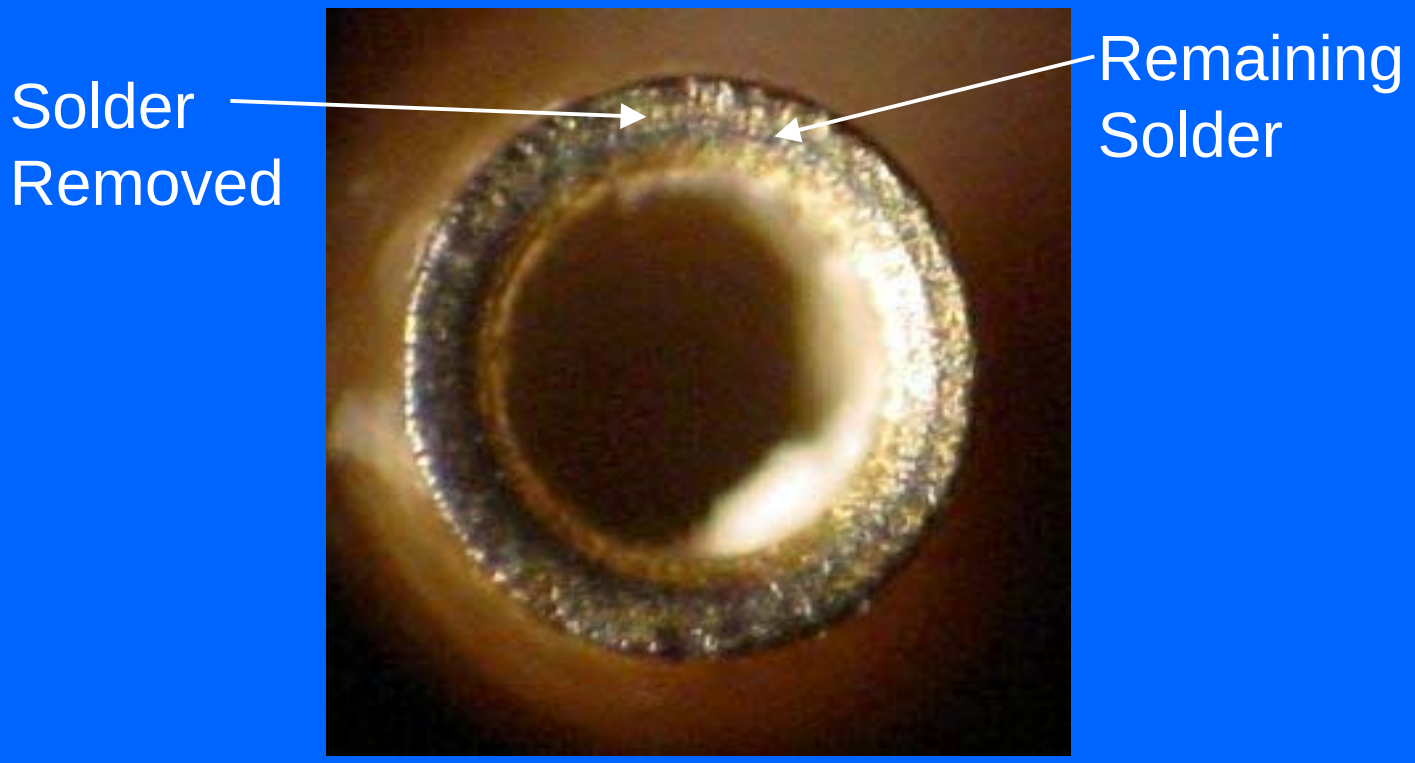
Collection Plate

Shorted BGA Device

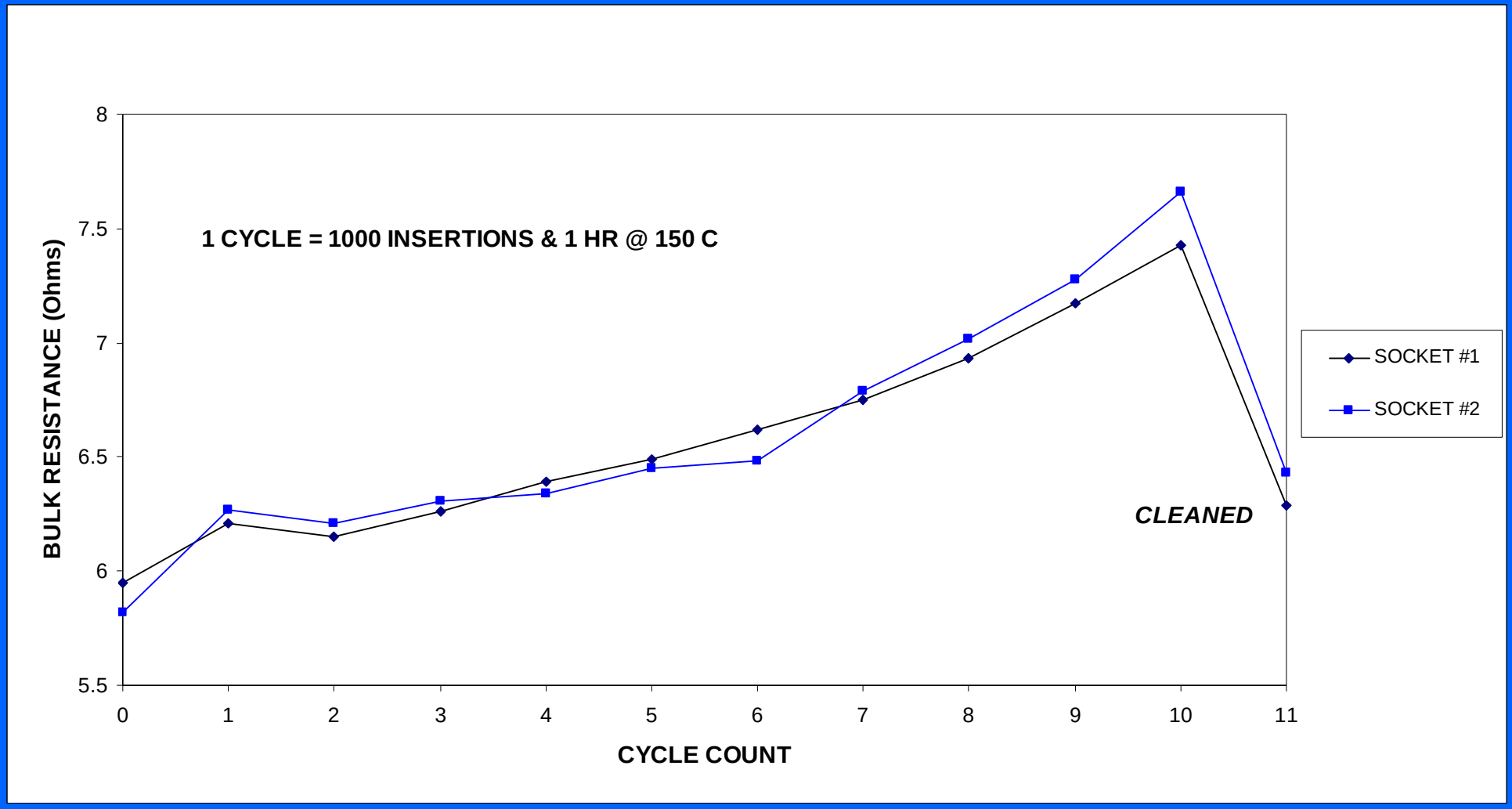
DEPOSITS ON COLLECTION PLATE



MID-PROCESS CONTACT CONDITION



ELECTRICAL DATA



BASE METAL DETECTION

➔A special solution is applied to the socket after it has been cleaned to detect the presence of copper. If plating is not present (typically Nickel/Gold), the exposed area will be highlighted with a stain

➔The purpose is to highlight the damaged contacts and to assess replacement

PERIODIC CLEANING

➔Cleaning should occur at regular intervals to avoid interconnect failures

➔The number of cycles and conditions of use determine the interval

➔Common Values:

Test Contactor - 20,000 cycles

Burn-In Connector - 1000 cycles

LEAD FREE SOLDER

➔Lead Free Solder can be accommodated with minor modifications to the electrolytic solution

➔Concentrations of up to 5% Copper or Silver are acceptable

PROS / CONS

Advantage

➔Solder is removed without risk of mechanical damage to base metal or gold plating

➔Connector life is extended

Disadvantage

➔Process requires connectors to be cleaned “off-line”

Patent Pending