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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
Leadless Packages
Leadless Packages

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

MLF

MLP

VQFN

VQPFPN

eetc.

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.

\[
\frac{R_1}{R_2} = \frac{R_6}{R_7} \\
R_X = \frac{R_1 \times R_5}{R_2}
\]
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 technologies 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

<table>
<thead>
<tr>
<th>Lead Pitch e</th>
<th>b (min)</th>
<th>B (max)</th>
<th>L (min)</th>
<th>L (max)</th>
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<tbody>
<tr>
<td>1.27</td>
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<td>0.47</td>
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<td>0.8</td>
<td>0.28</td>
<td>0.4</td>
<td>0.5</td>
<td>0.75</td>
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<td>0.5</td>
<td>0.18</td>
<td>0.3</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>0.4</td>
<td>0.16</td>
<td>0.27</td>
<td>0.3</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Tolerances on D & E dimensions typically +/- 0.15mm
Contactor Design - Technology

Pad dimensions lead pitch 0.4mm

Contact area worst case:
0.16 x 0.3 = 0.048mm²

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 adjacent 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

- Air connection
- Guide pins (handler docking)
- Temperature insulation
- Kelvin contact
- Spring block
- Guiding holes (plunger reference)
- Base Plate

Guide pins (handler docking)
Contactor Design - Device Positioning

Gravity test handler - vacuum plunger

Guiding door
Guiding bar
Device
Plunger head
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)

MLP6x5 8lead

Resistance mOhm vs Number of insertions x1000
Evaluation Results - Maximum Current

Maximum test current versus pulse duration

![Graph showing the relationship between pulse duration and maximum current. The x-axis represents pulse duration in milliseconds (ms), ranging from 10 to 1000 ms. The y-axis represents current in Amps (A), ranging from 0 to 10 A. The graph shows a decreasing trend, indicating a decrease in maximum current as pulse duration increases. The base is set at 1 second test time.]
Evaluation Results - Temperature Accuracy

Temperature drift DUT during test at 155°C

DUT temperature after 30 seconds test time = 152.5°C
Evaluation Results - Temperature Accuracy

Temperature drift DUT during test at -55°C

DUT temperature after 30 seconds test time = -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
Interconnecting at 40 GHz and Beyond

Roger Weiss, PhD
Electronic Capability Continuously Evolves 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
Paricon’s Interconnect Technology Based on Controlled Electromagnetic Alignment of Ferro-Magnetic Particles Within a Polymer Matrix
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
PariPoser® Interconnect
Contact Resistance

THROUGH RESISTANCE CURVE

Contact Resistance (Milli Ohms)

Normal Probability

Set 1
Rise Time

Time domain response for transmitted signal
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
Thermal Cycling

Room Temperature Resistance vs. Time
(~700 Thermal Shock Cycles)
Resistance vs. Temperature

Thermal Coefficient Of Resistance

\[ R = R_0 [1 + \alpha_1 (T - T_0) + \alpha_2 (T - T_0)^2] \]

\[ \alpha_1 = 6.76 \times 10^{-3} \text{ C}^{-1} \]

\[ \alpha_2 = 72.9 \times 10^{-6} \text{ C}^{-1} \]
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
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
Formulation Dependent Material Properties

- Burn-in Cycles: >500 to 150 C
- Contact Resistance: <20 milliohms
- Inductance: 70 pH
- Capacitance: 0.03 Pico farads
- Insulation Resistance: > 1 gig ohm
- Frequency Range: At least 40 GHz
- Glitch: >2500 Hours per EIA-540
Technical/Market Advantage

- Performance
- Scalability
- Cost
- Quick Time to Market
- Highly Configurable
- Enables New Approaches
PariPoser® Components
Development Test Socket
10 GHz Test Socket
10 GHz Test Socket
10 GHz Translation Socket
Production Socket
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.
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)

FLUID LEVEL \downarrow

GROUND PLATE (POS)

Pb+2 Soluble Ions Sn+2 Soluble Ions

ELECTROLYTIC SOLUTION \downarrow

COLLECTION PLATE (NEG)

BIAS VOLTAGE APPLIED TO
DRIVE Pb INTO SOLUTION
ELECTROCHEMICAL TRANSFER

Test Set-up

Collection Plate

Shorted BGA Device
DEPOSITS ON COLLECTION PLATE

Collection Plate

Solder Deposits
MID-PROCESS CONTACT CONDITION

Solder Removed

Remaining Solder
ELECTRICAL DATA

1 CYCLE = 1000 INSERTIONS & 1 HR @ 150 C

CLEANED

CYCLE COUNT

BULK RESISTANCE (Ohms)
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*