IPC Get Interconnected.™ MIDWEST CONFERENCE & EXHIBITION

Using IPC/JEDEC-9704 & 9702 Standards for Strain Gage Testing of Printed Wiring Boards

Swapnil Padhye

National Instruments

IPC ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES®

IPC Get Interconnected.™ MIDWEST CONFERENCE & EXHIBITION

Agenda

- Problem Statement
- Solution
- How to Implement a Strain Gage Test
- Strain Gage Tests at National Instruments
- Conclusion

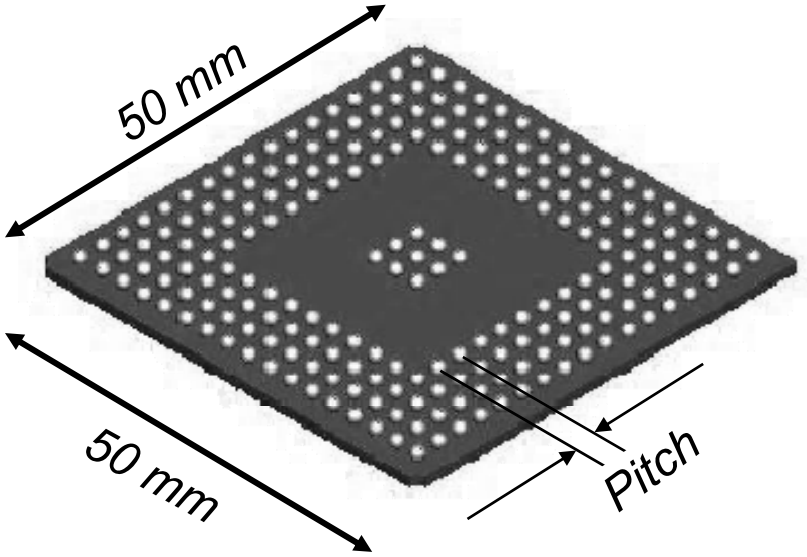
IPC ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES®

Problem Statement

- PCB failures due of **over-flexure** during various **assembly and test processes**
- **Partial cracks**
- **Field returns**

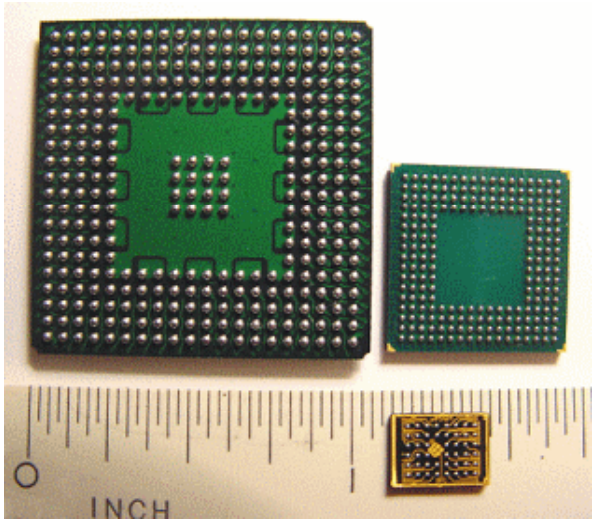
Trends: Finer Pitch BGAs

Before



Common Pitch: 1.27 mm, 1 mm

Today



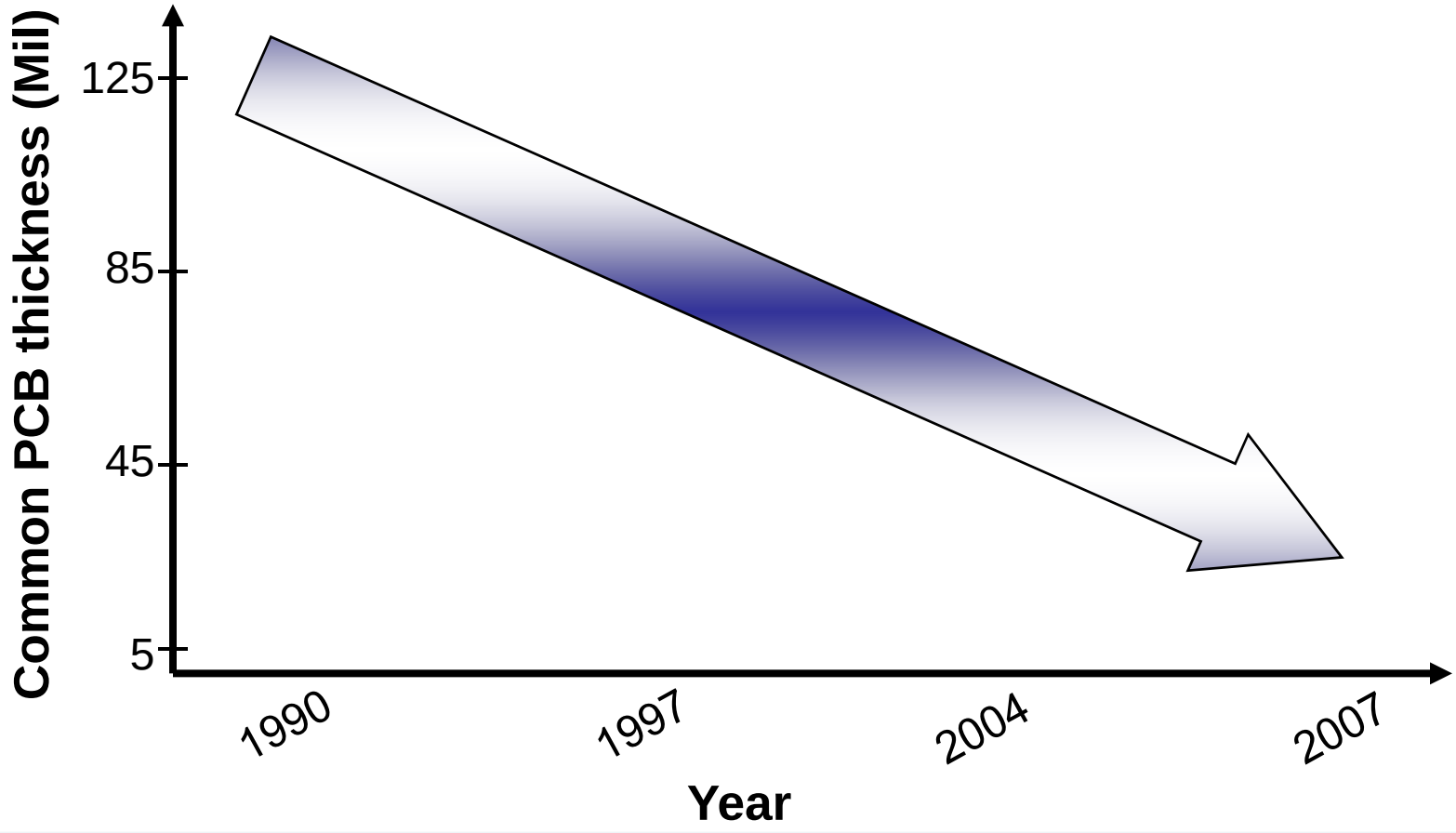
Common Pitch: 0.8 mm, 0.5 mm

Trends: Lead-free solder

Property \ Chemical Composition	Sn (37%) Pb (63%)		Sn (95.5%) Ag (0.5%) Cu (4%)
Tensile Strength	30.6 MPa	~	29.7 MPa
Young's Modulus (Stiffness)	31.5 GPa	<<	~52 GPa

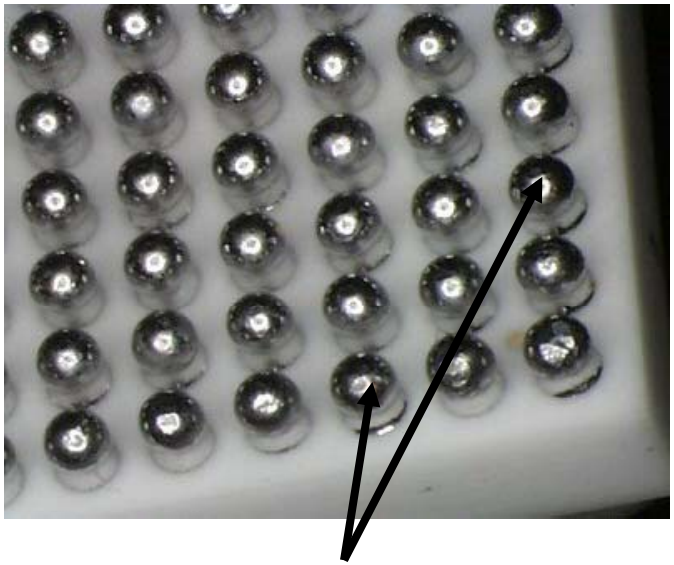
Brittle

Trends: PCB Thickness

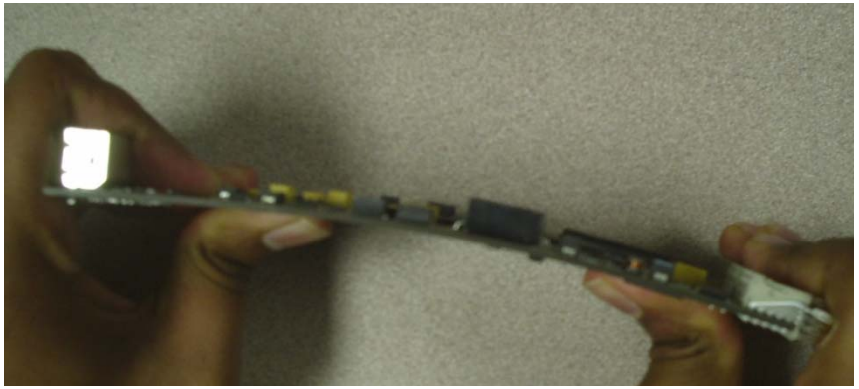


The Effect

BGA with RoHS compliant solder



Outer rows do not distribute as much stress to the adjacent rows



Thin PCBs bend more

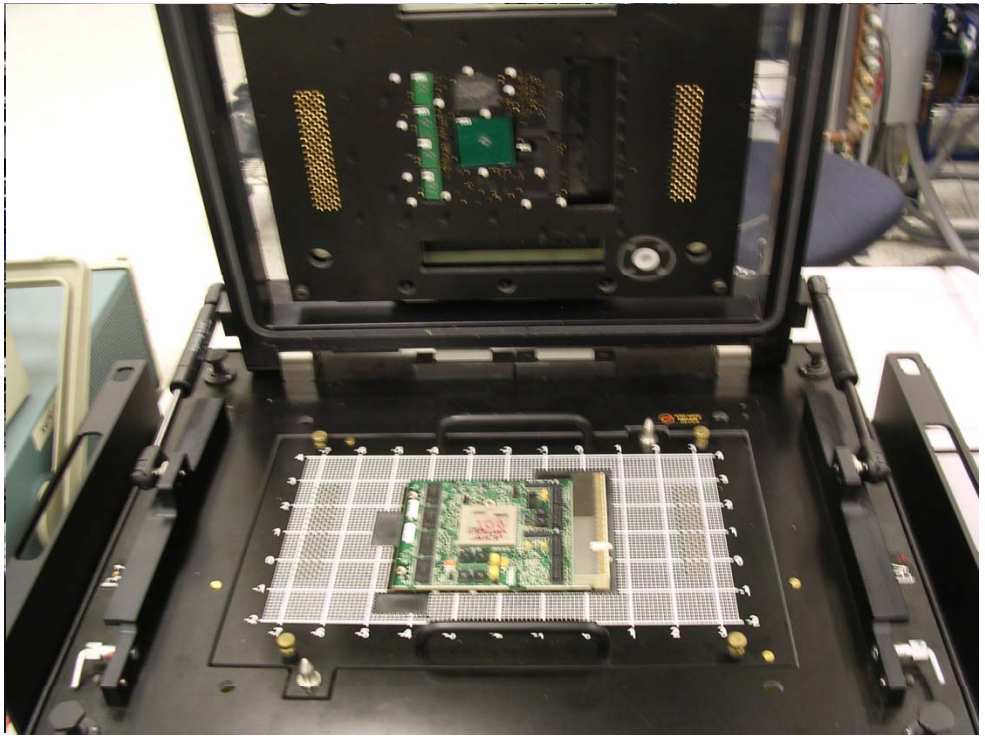
Solution:

Strain Gage Testing (SGT)

- Identify and correct problem processes
  - Assembly
  - Test

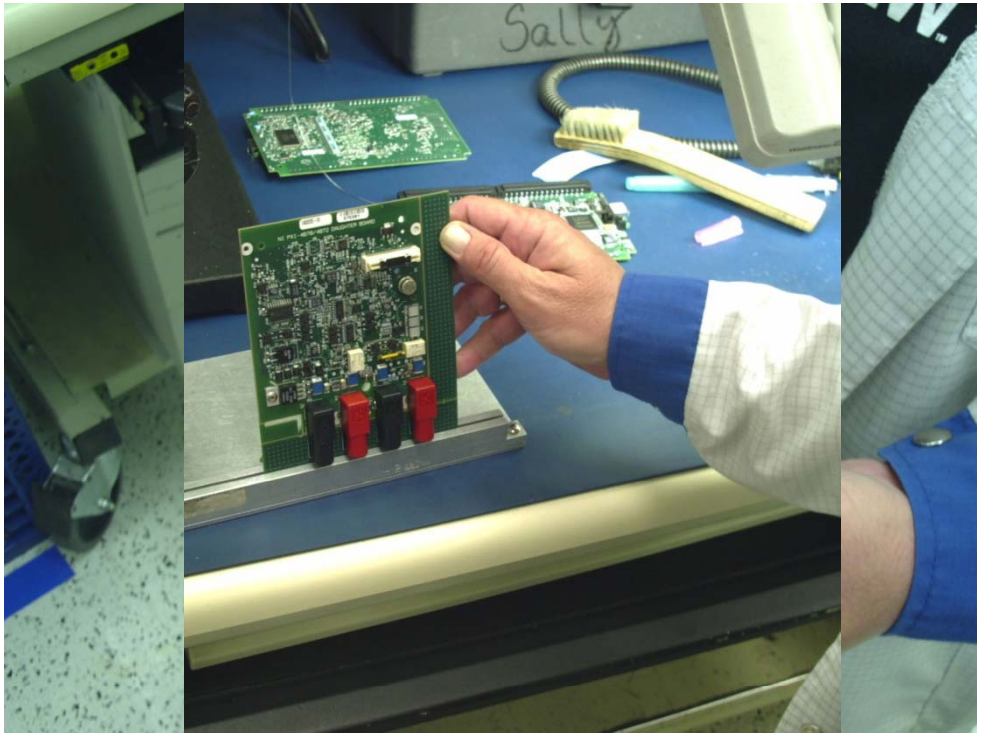
Problem Processes

- In Circuit Tests



Problem Processes

- De-panelizing (manual)



Problem Processes

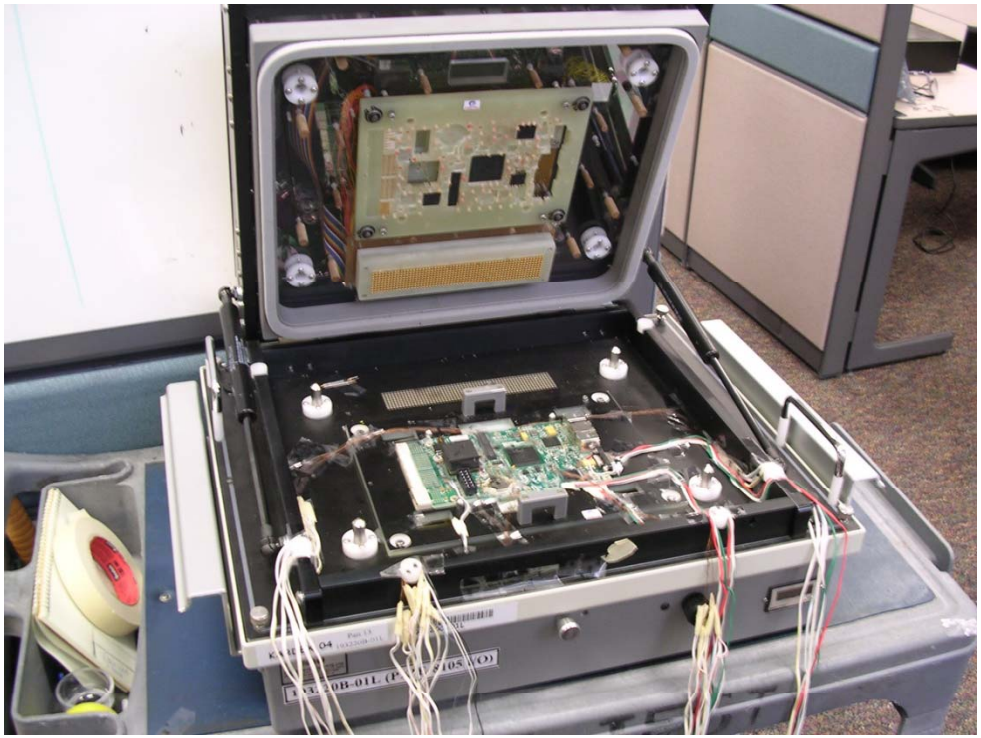
- Edge cutting machines

Problem Processes

- FVT

Solution: Strain Gage Testing (SGT)

- Correct problem processes

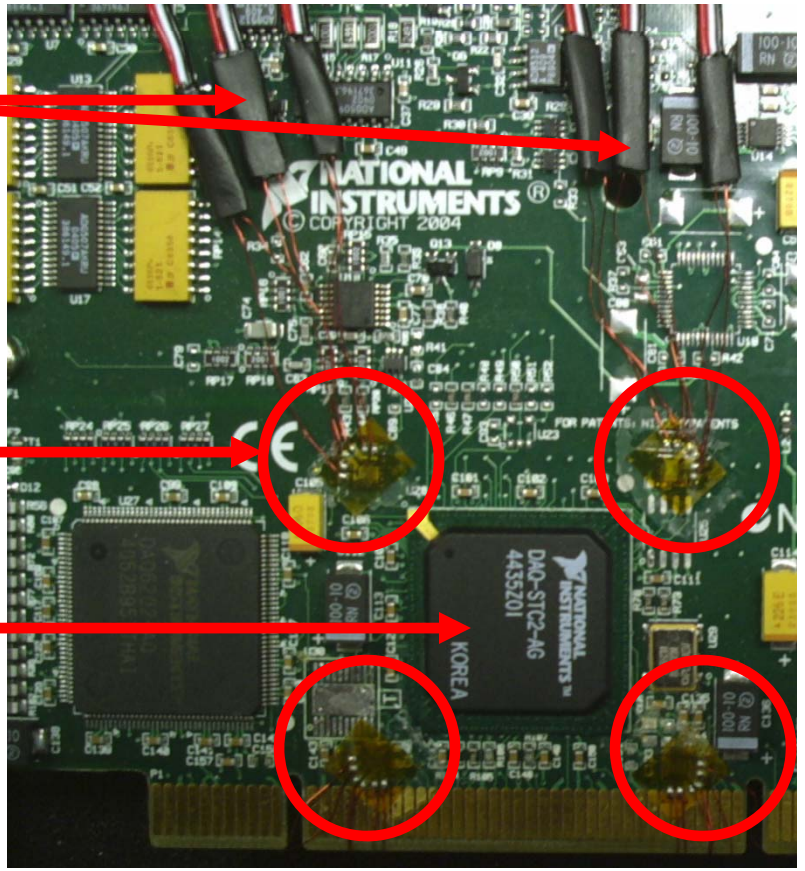


BGA With Strain Gages

To Data Acquisition System

Rosette Strain Gages

BGA

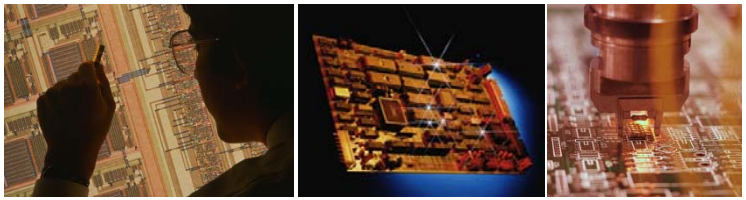


IPC Get Interconnected.™ MIDWEST CONFERENCE & EXHIBITION

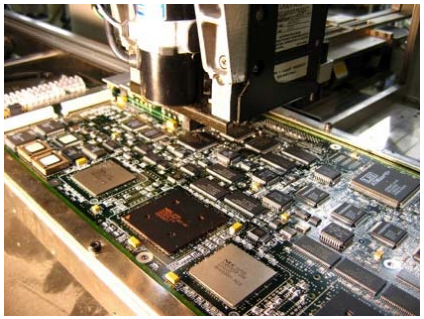
Who should be concerned

Test-fixture vendors

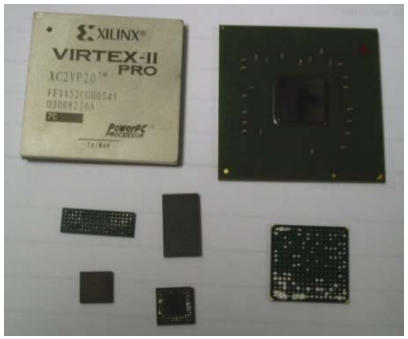
Contract manufacturers



PCB assemblers



Component suppliers



IPC ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES®

IPC/JEDEC Standards

- **IPC/JEDEC 9704**
  - Printed Wiring Board Strain Gage Test Guideline
- **IPC/JEDEC 9702**
  - Monotonic Bend Characterization of Board-Level Interconnects

Industry involvement

- Intel
- Cisco Systems
- Sun Microsystems
- Solectron
- Circuit Check
- ….

IPC Get Interconnected.™ MIDWEST CONFERENCE & EXHIBITION

IPC/JEDEC 9704

- Recommended strain gages
- Gage placement and attachment
- Measurement equipment
- Data analysis
- Reporting Template

IPC ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES®

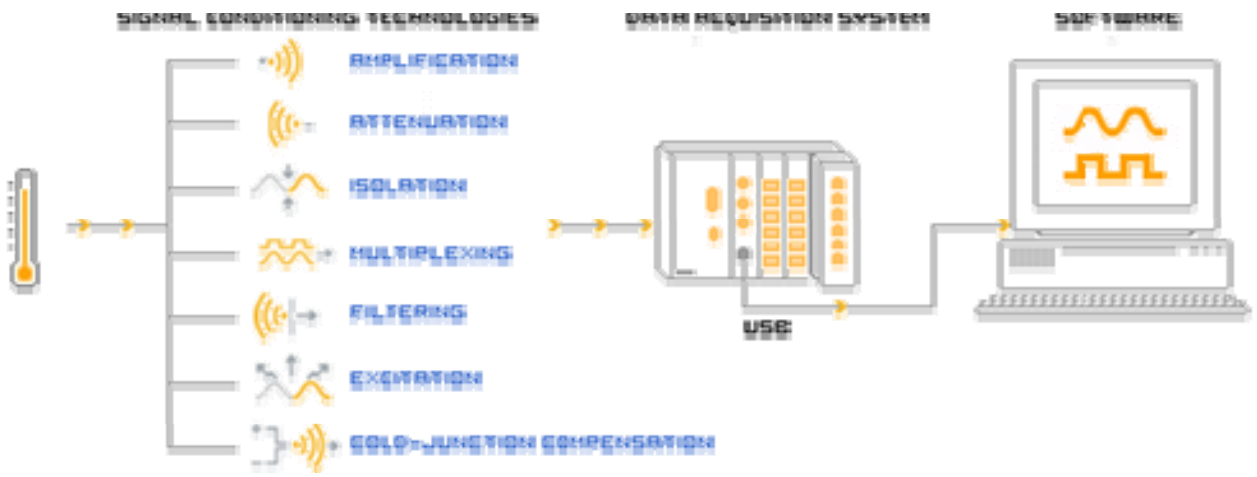
SGT System I/O Requirements

- Hardware
  - Sampling rate of 2KHz
  - At least 3 channels (12 or more recommended)
  - Simultaneous sampling of all channels
  - 12 to 16 bit input resolution
  - Low-pass filter
  - Gain

- Software
  - User Interface
  - Reporting

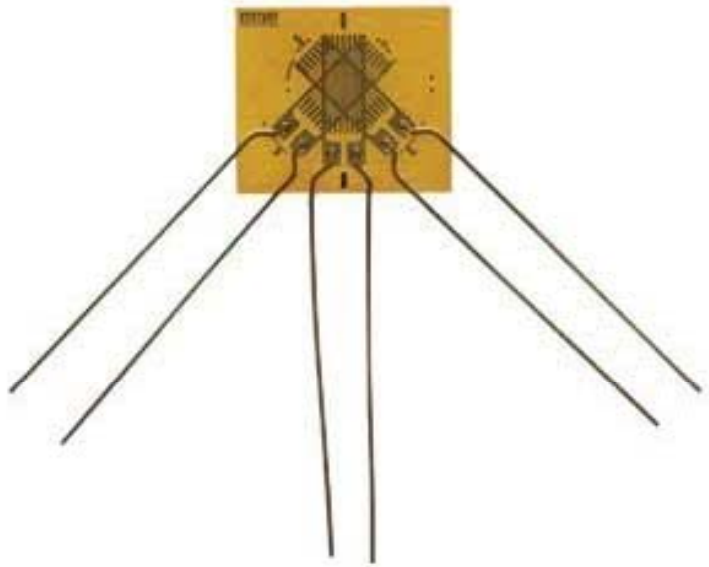
Components of a SGT

- Sensor
  - Rosette strain gages
- Signal Conditioning
- Data Acquisition
- Software
- Reporting



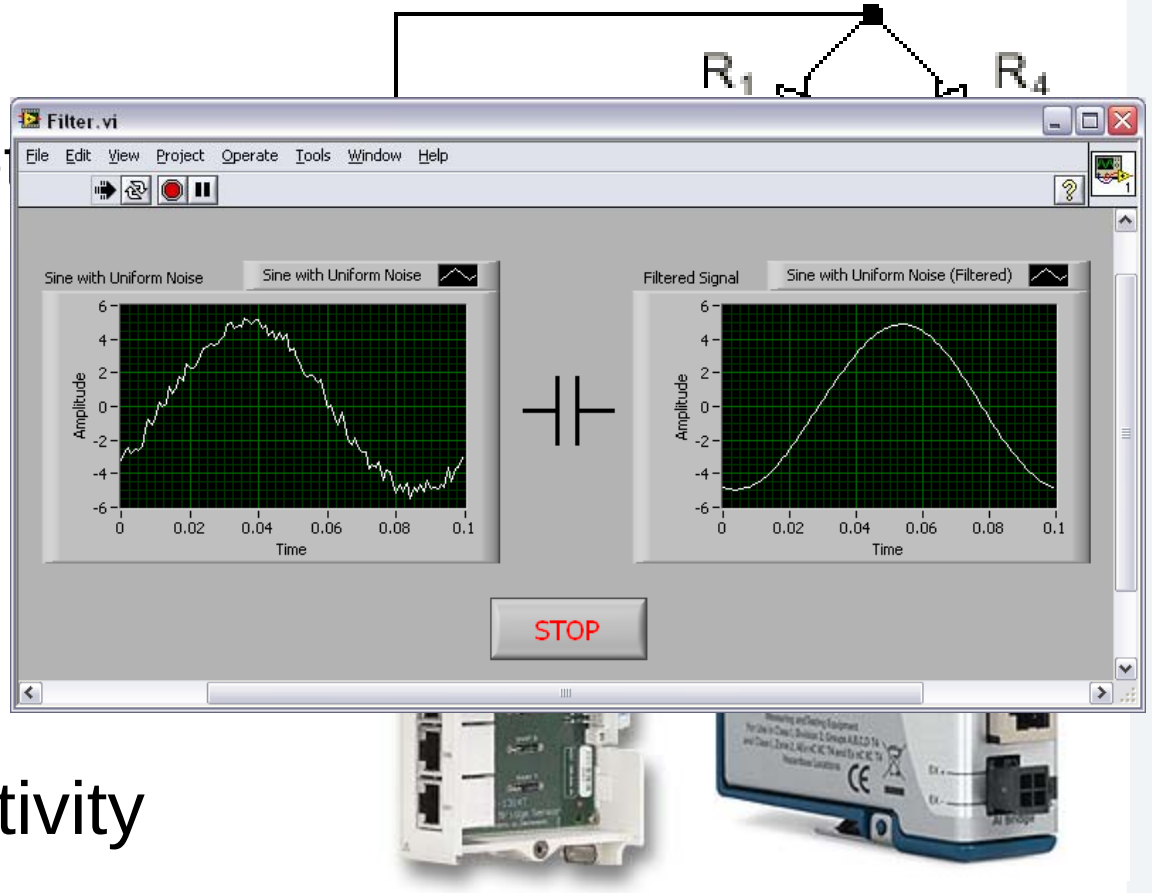
Sensor

- Stacked Rosette Strain Gages with pre-attached wires



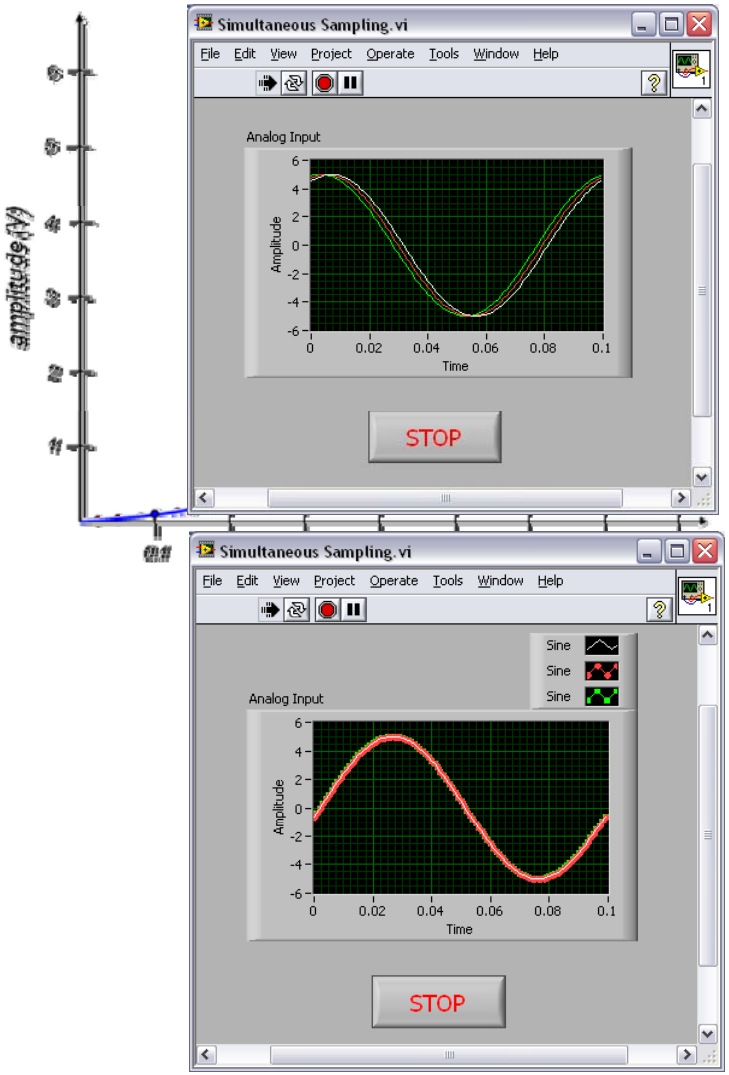
Signal Conditioning

- Bridge Comple
- Filter
- Signal Connectivity



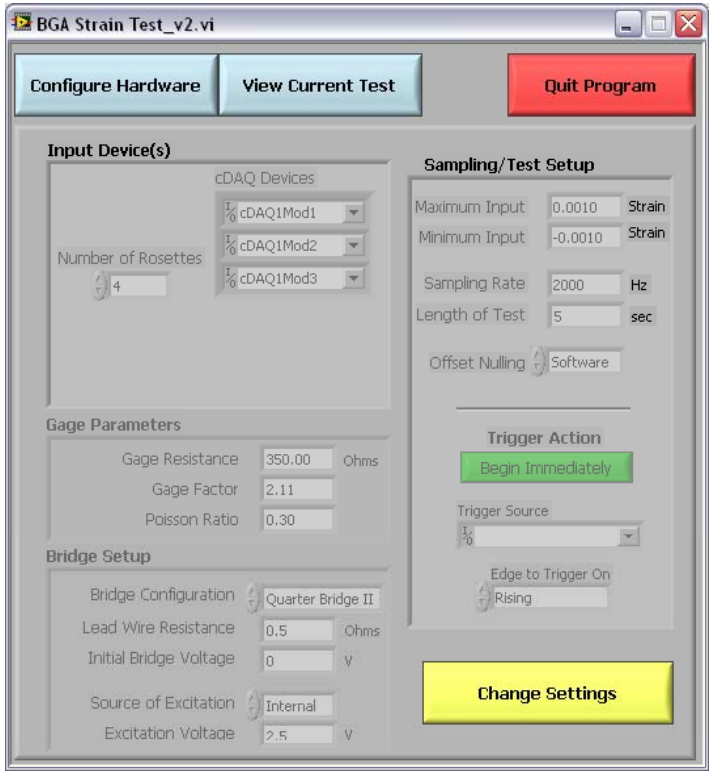
Data Acquisition

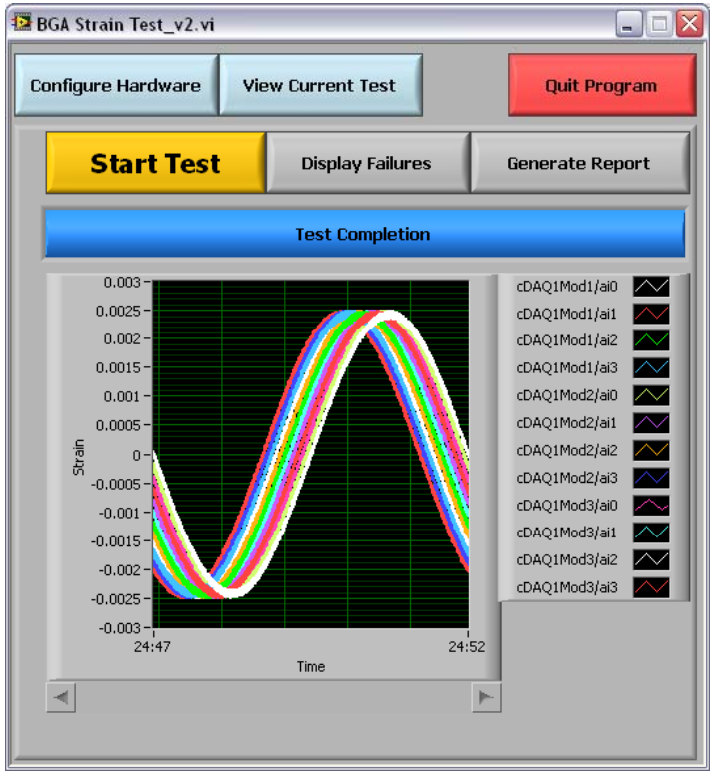
- Sampling Rate
- Number of Channels
- Simultaneous Sampling



Software

- User Interface

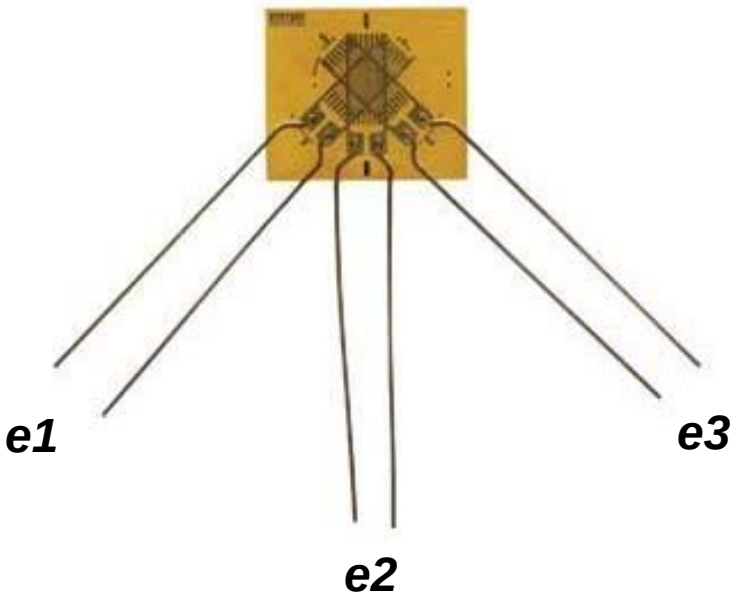


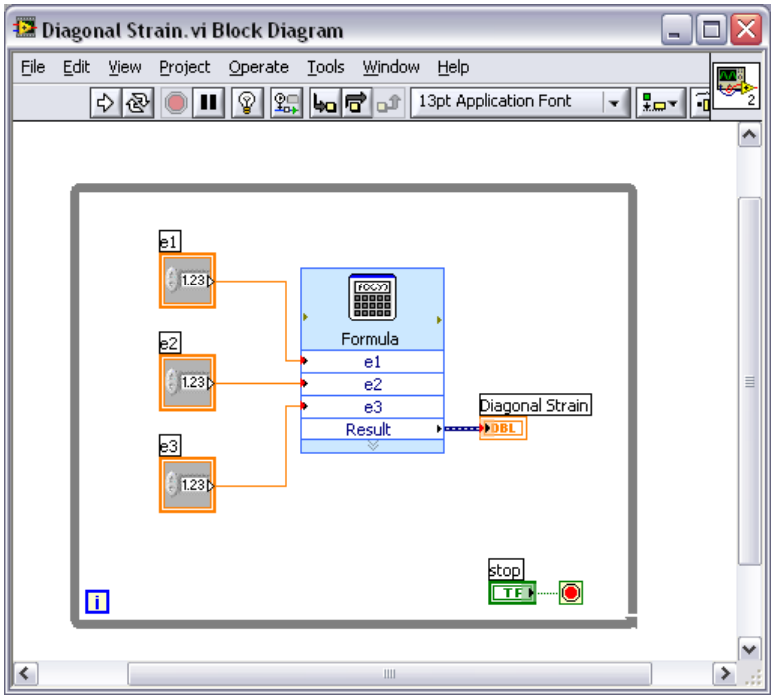


Software

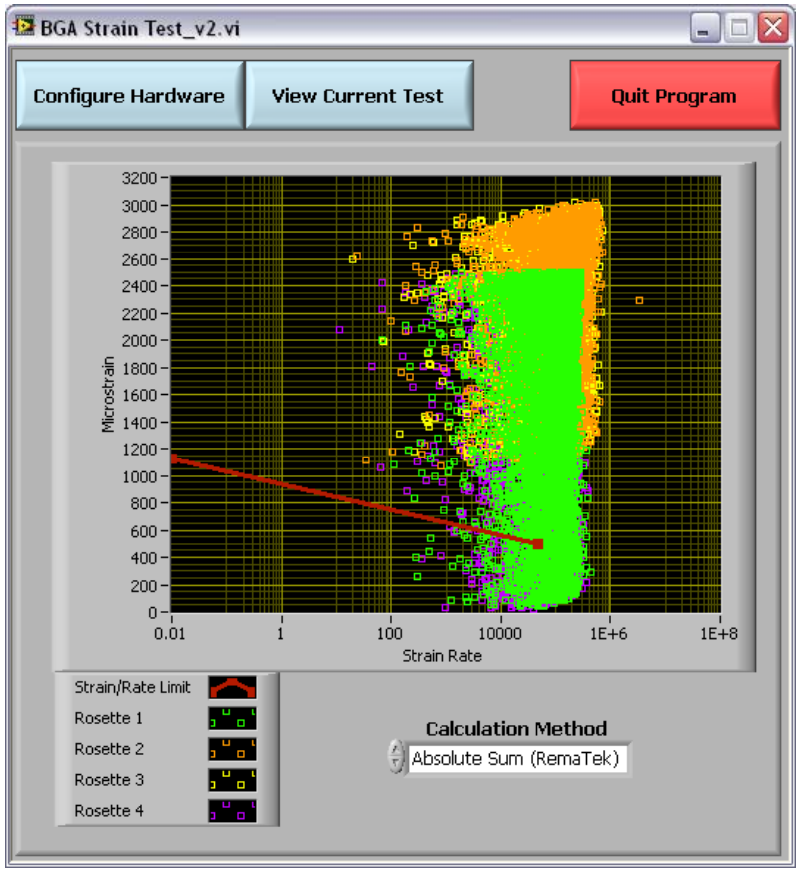
- Analysis

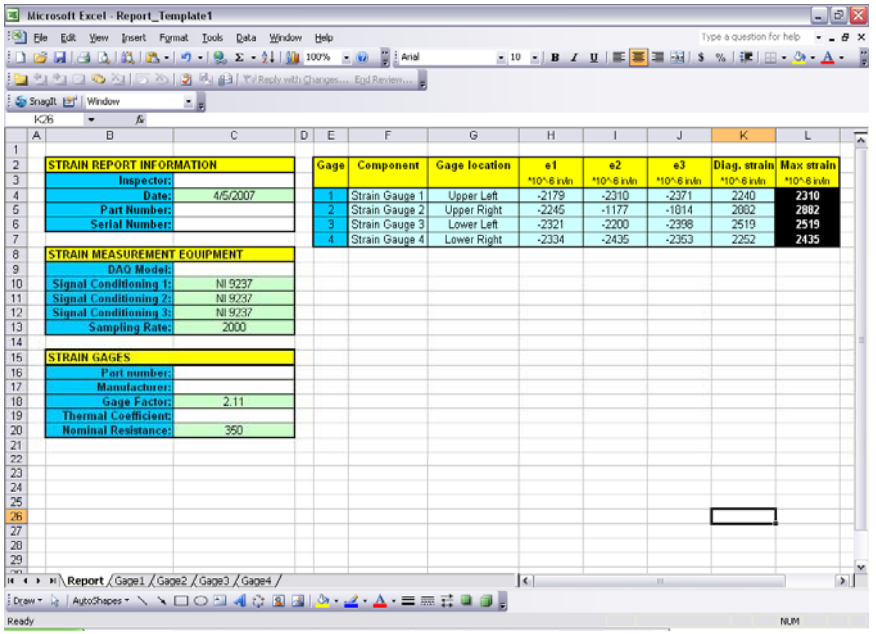
Diagonal strain = e1-e2+e3





Reporting


BGA Strain Test_v2.vi
Configure Hardware
View Current Test
Quit Program
Microstrain
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0.01
1
100
10000
1E+6
1E+8
Strain Rate
Strain/Rate Limit
Rosette 1
Rosette 2
Rosette 3
Rosette 4
Calculation Method
Absolute Sum (RemaTek)


Microsoft Excel - Report_Template1
STRAIN REPORT INFORMATION
Inspector:
Date: 4/5/2007
Part Number:
Serial Number:
STRAIN MEASUREMENT EQUIPMENT
DAQ Model:
Signal Conditioning 1: NI 9237
Signal Conditioning 2: NI 9237
Signal Conditioning 3: NI 9237
Sampling Rate: 2000
STRAIN GAGES
Part number:
Manufacturer:
Gage Factor: 2.11
Thermal Coefficient:
Nominal Resistance: 350
Gage
Component
Gage location
e1
e2
e3
Diag. strain
Max strain
1 Strain Gauge 1 Upper Left -2179 -2310 -2371 2240 2310
2 Strain Gauge 2 Upper Right -2245 -1177 -1014 2082 2082
3 Strain Gauge 3 Lower Left -2321 -2200 -2398 2519 2519
4 Strain Gauge 4 Lower Right -2334 -2435 -2353 2252 2435
Report
Gage1
Gage2
Gage3
Gage4
Ready

Results at National Instruments:

- Effectively use Strain Gage Testing for correcting ICT fixtures
  - Virtual Instrumentation solution
  - Flexible Software
  - Modular Hardware

Solutions Used by NI

NI CompactDAQ

Up to 32 simultaneous strain channels

NI SCXI

>32 simultaneous strain channels

Conclusion

- Critical to be Lead-free and RoHS compliant
- Adoption of strain gage testing for better PCB assembly yields

IPC Get Interconnected.™ MIDWEST CONFERENCE & EXHIBITION

Thank you

Swapnil Padhye

swapnil.padhye@ni.com

IPC ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES®