
EIGHTEENTH ANNUAL
BiTS
Burn-in & Test Strategies Workshop
March 5 - 8, 2017
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive – Session 1
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Session 1
Marc Moessinger
Session Chair

BiTS Workshop 2017 Schedule

Performance Day

Monday March 6 - 10:30 am

Driving Performance

"Design for performance and advanced characterization of new contactors"
Markus Wagner – Cohu & Milen Cheshmedjiev – Melexis

"Investigation into Various Via Structures in High Speed Interconnect"
Carol McCuen - R&D Altanova

"Contactor and Package Design Effects on Crosstalk"
Noureen Sajid & Jeff Sherry - Johnstech International

"Contactor Based Final Test at 77 GHz on a Multi-Channel Radar Transceiver Chipset"
Brian Nakai & Jeffrey Finder - NXP Semiconductors

Contactor Based Final Test at 77 GHz on a Multi-Channel Radar Transceiver Chipset

Brian Nakai, Jeffrey Finder
NXP Semiconductors

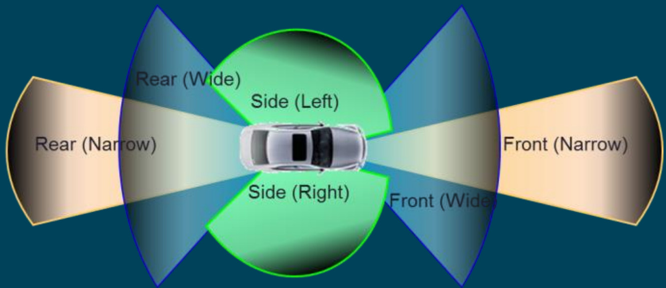
BiTS Workshop
March 5 - 8, 2017

Agenda

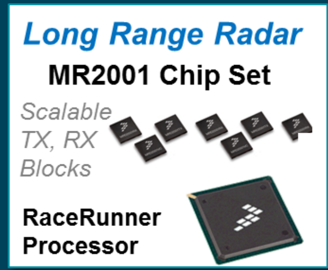
- NXP Radar Device Overview
- Package
- Hardware Setup
- Mechanical Performance
- Current Challenges
- Future Improvements

NXP Radar Device Overview

Applications



Product Line

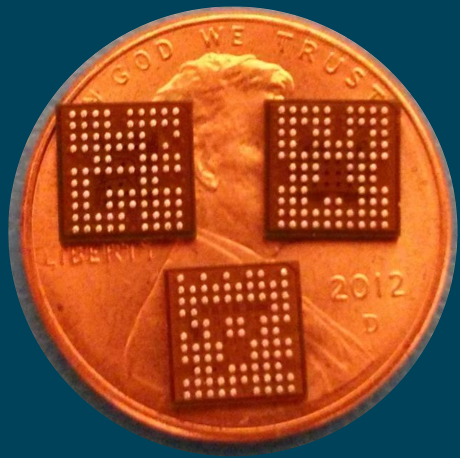


- ✓ **Increasing applications for radar**
  - Value added Parking solutions
  - Pedestrian Detection
  - Cross Traffic Alert
- ✓ **Increasing performance with small size**
  - Transition 24 GHz → 77 GHz: improved resolution
- ✓ **Increasing attach rate per car**
  - Radar initially for safety emergency braking
  - Now moving to corner sensors, "cocoon radar"

Features	Benefits
Scalable to Four Tx and 12 Rx Channels	Enables single radar platform with electronic beam steering over wide field of view, supporting LRR, MRR and SRR applications for budget to luxury vehicles
Integrated Rx BB Filter and VGA	Saves system BOM cost
Optimized for Radar Processor MPC577xK	Receiver path optimization with MPC577xK, including unique built-in system test features. Ensures the best receiver sensitivity required for excellent detection accuracy
Advanced Packaging Technology	Easiest to use, handle and manufacture for customers. Ensures highest performance and minimum signal interference on the customer PCB
Low Power Consumption of 2.5 W for the Total Transceiver. Best phase noise < -85 dBc/Hz at 100 kHz offset	Low power consumption saves energy and heat. Best phase noise enables precise discrimination of objects for automatic cruise control, blind spot detection, lane departure warning and pedestrian detection

Radar Package Description

- 6 x 6 mm 0.5 mm Pitch RCP (Redistributed Chip Package)
- Similar to a thin BGA
- Three separate ball maps for the chipset products, VCO, Rx, Tx



Objective

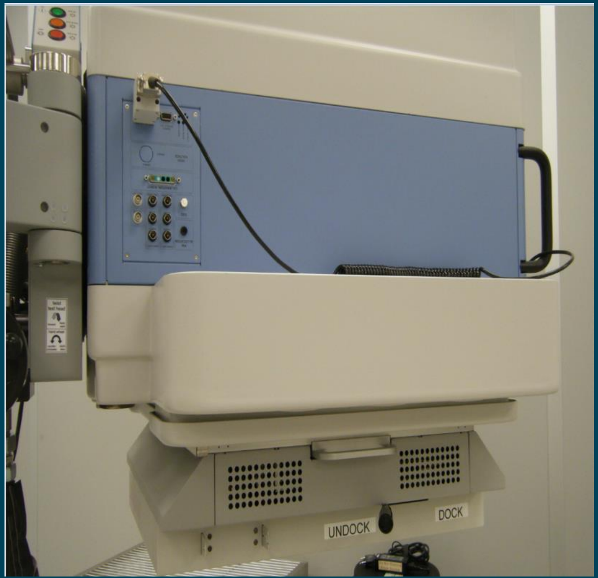
- Develop a Final Test ATE solution for singulated 77 GHz testing.
- Needs to be standardized and robust for transfer into high volume manufacturing.
- Develop stable, high yielding process.

Initial Hardware Setup

- The 93K is a mature test platform retrofitted with a millimeter wave interface to extend RF frequencies to maximum frequency of 82 GHz
- Additional user power supplies inside: +/- 5V, +/- 12V and -3V
- 1 DPS128
- 6 digital channel cards

Stimulus Power	Frequency	Level	Accuracy	Phase Noise (Typical)
Low Band	37.5 – 41GHz	-15 to +15dBm	±1.0dB	-112dBc/Hz@1MHz -122dBc/Hz@10MHz
High Band	75 – 82GHz	-15 to +12dBm	±1.0dB	-106dBc/Hz@1MHz -116dBc/Hz@10MHz

Measure Power	Frequency	P1dB	Dynamic Range (100kHz BW)	Accuracy	Phase Noise (Typical)
Low Band	37.5 – 41GHz	+5dBm	55dB	±1.0dB	-121dBc/Hz@1MHz -140dBc/Hz@10MHz
High Band	75 – 82GHz	+1dBm	50dB	±1.0dB	-114dBc/Hz@1MHz -134dBc/Hz@10MHz

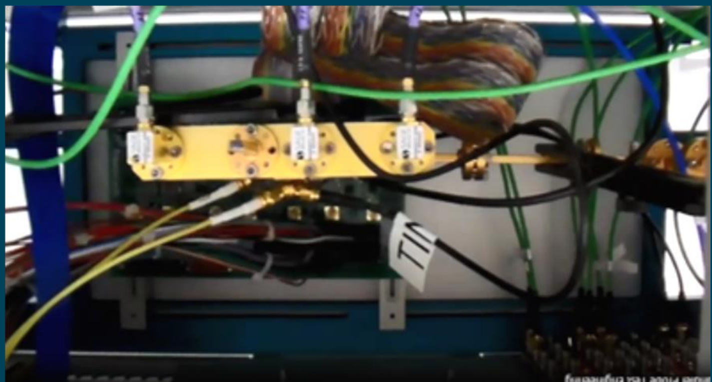


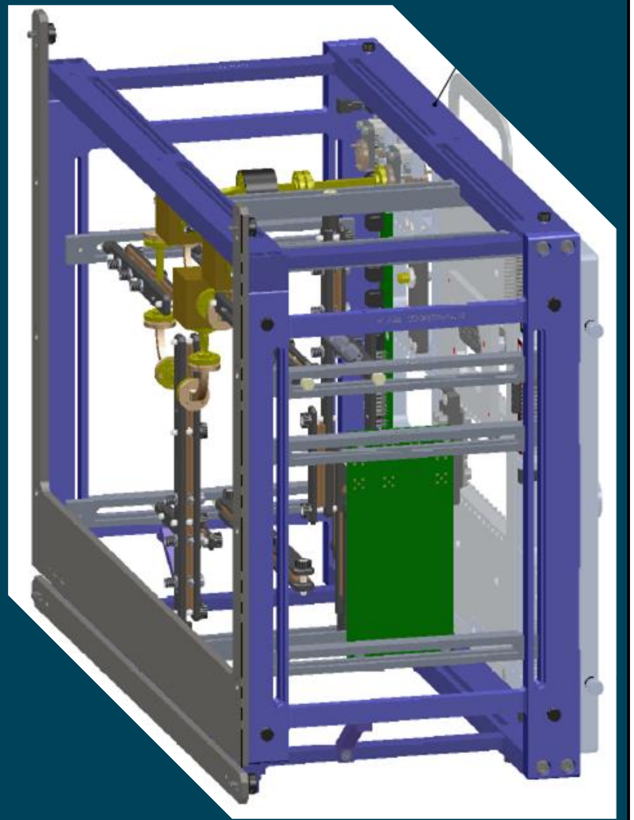
Initial Hardware Setup

- Delta Castle Pick and Place handler
  - Tri-Temp Capable
  - Tray to Tray handling
  - Vertical docking plane
  - Established handler within NXP

Initial Hardware Setup

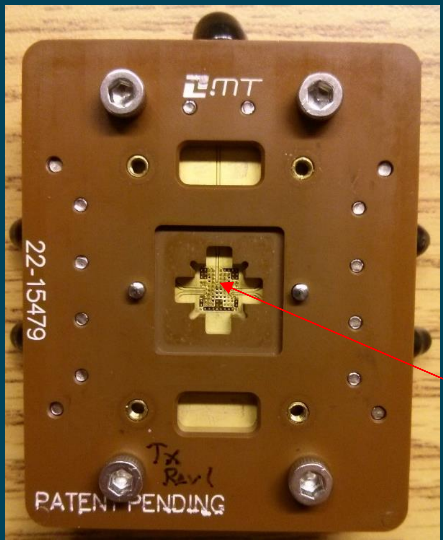
- Waveguide Cage
  - Interface between Tester and DUT board/socket
  - NXP designed
  - Contains mmWave components

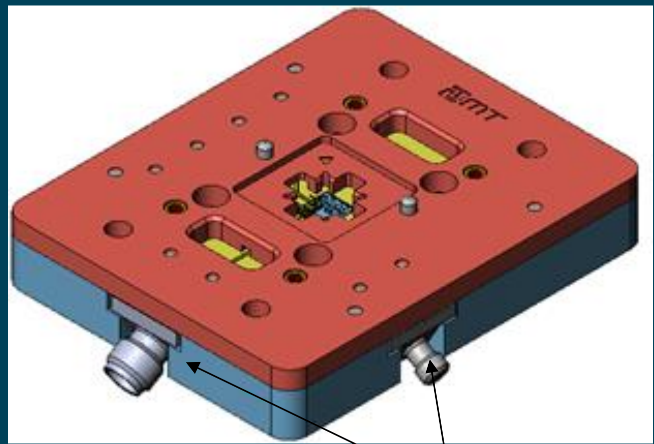




Initial Hardware Setup

- Xcerra mmWave Socket
  - Leadframe for mmWave signal connection
  - Spring pins for power, ground, and digital signals



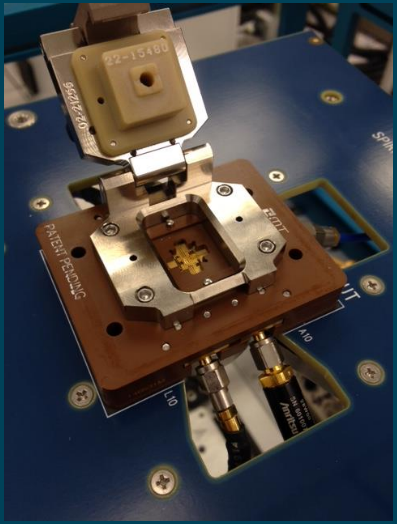


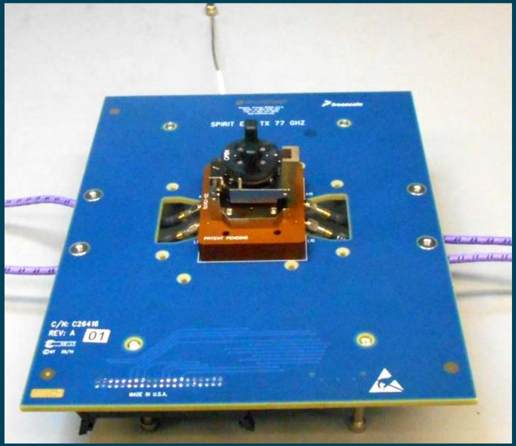
RF Leadframe

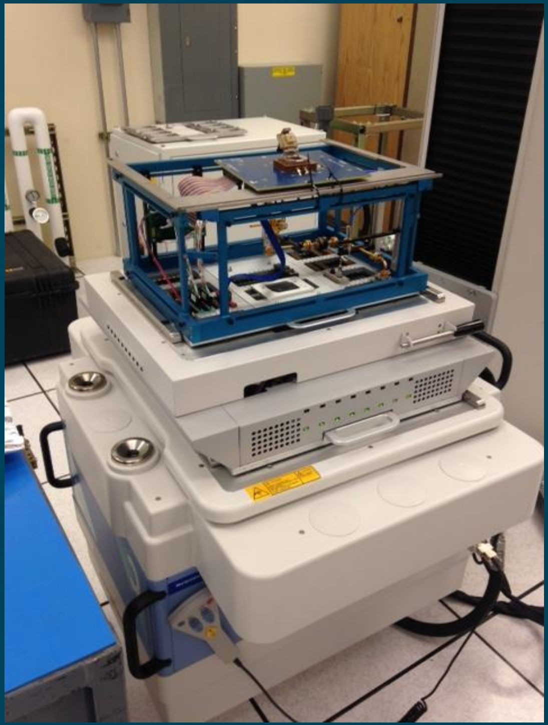
RF Connectors

Initial Hardware Setup

- Socket/Board/Cage Connection







Mechanical Performance (Gen1)

- Handler
  - Single Site Test
  - No issues handling RCP, no damage
  - Temperature stability needed to be characterized for each device
- Waveguide cage
  - Can bolt to the handler, tester docks to it
  - Each product requires a different cage

Mechanical Performance (Gen1)

Castle Handler

93K Tester

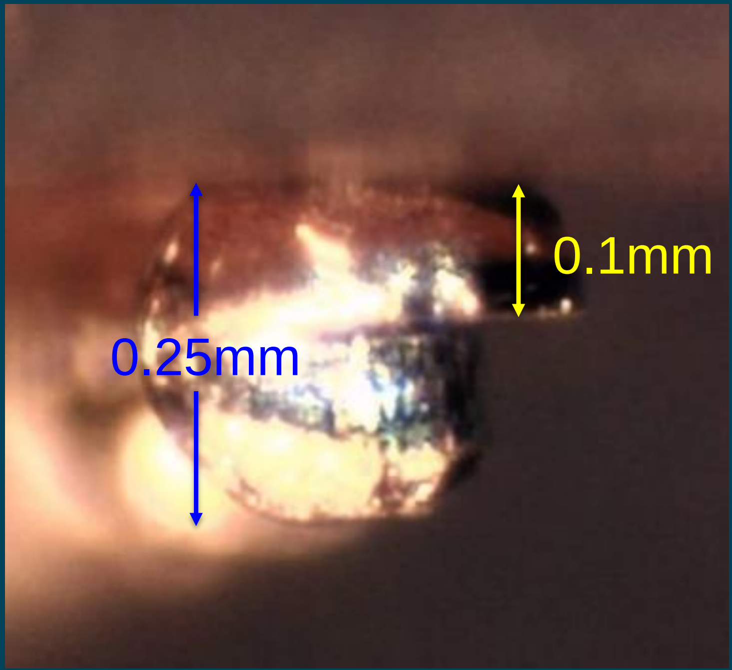
Waveguide Cage

mmWave UDI

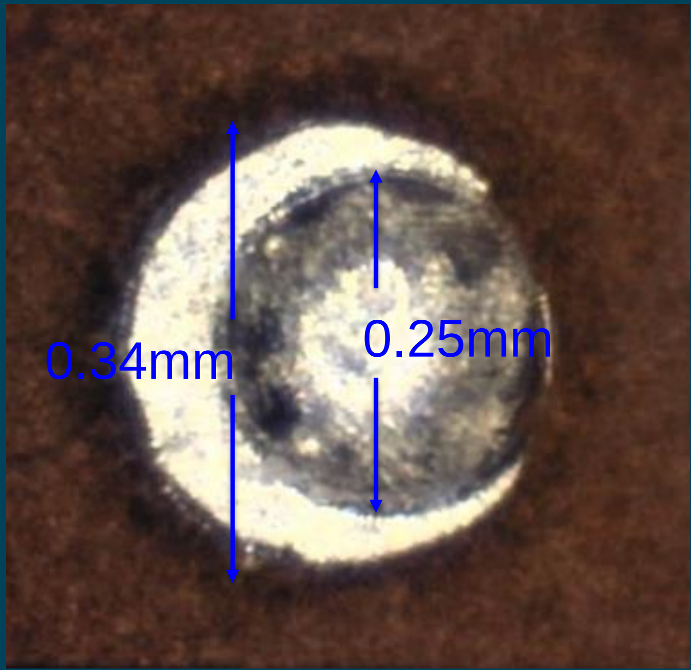
Mechanical Performance (Gen1)

- Socket
  - Good electrical performance
  - Solder ball deformation observed
    - Ball extruding through leadframe holes
    - Passed automated outgoing inspection but were visual defects that should not be passed onto the customer
  - Elastomer cycle life was short causing yield issues

Solder Ball Deformation



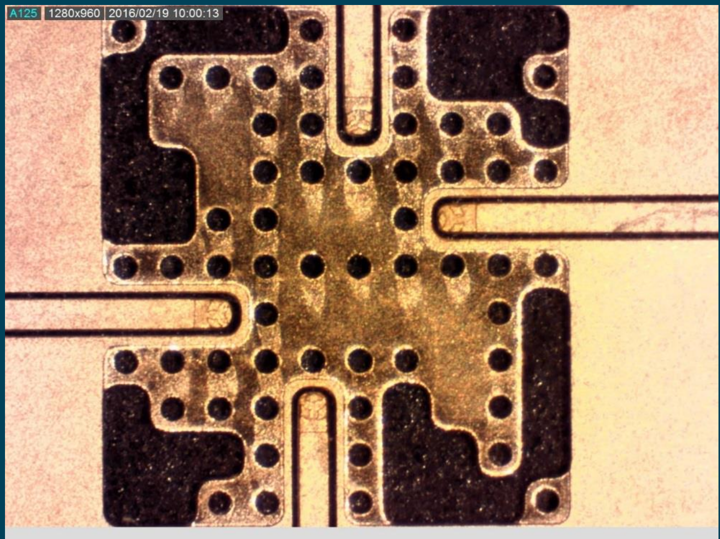
Ball height spec is 0.25mm +/-0.07



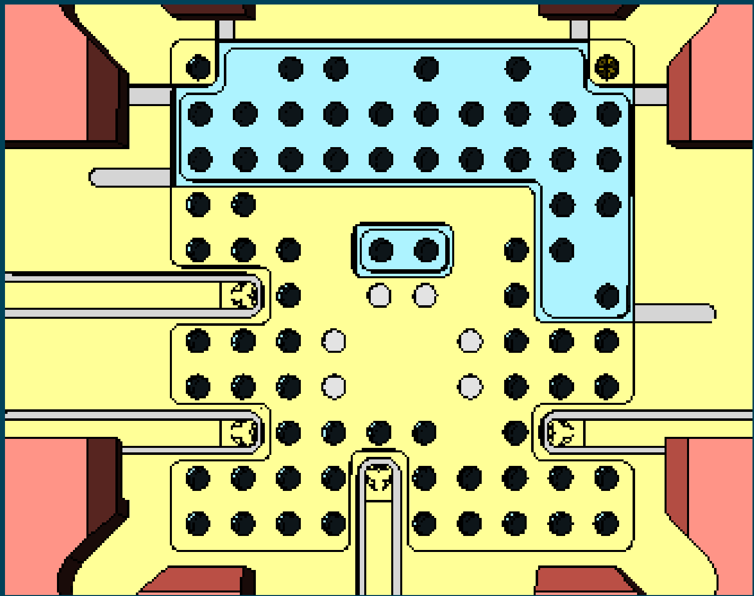
Ball diameter spec is 0.3mm +/-0.05

Solder Ball Deformation Cause

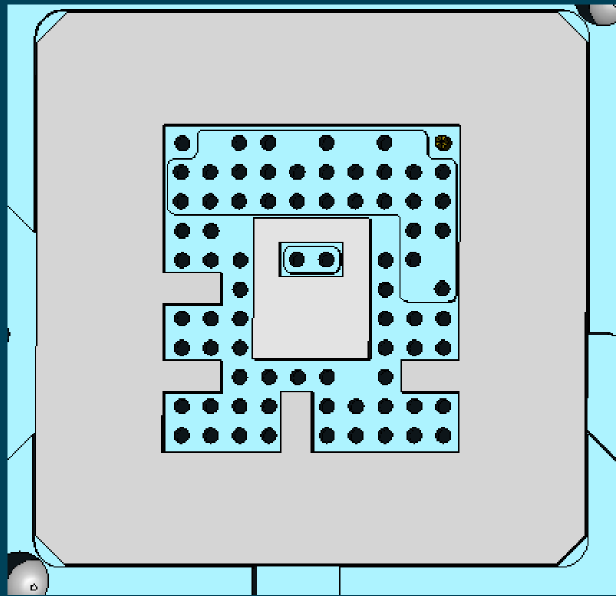
- Socket leadframe design contacted all solder balls
  - Leadframe stiffness and elastomer caused high contact force on the solder balls



Solder Ball Deformation Cause



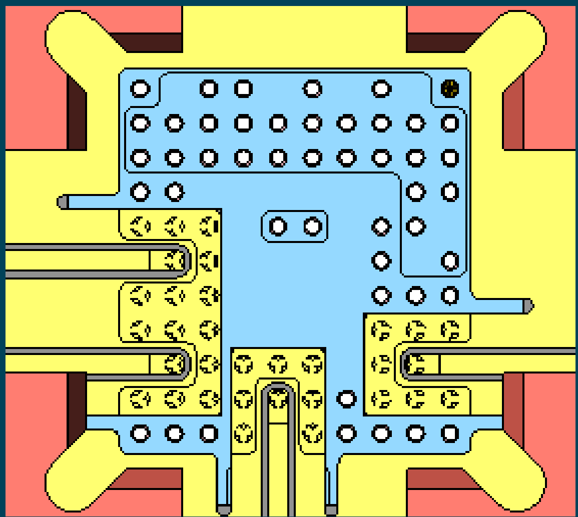
Leadframe

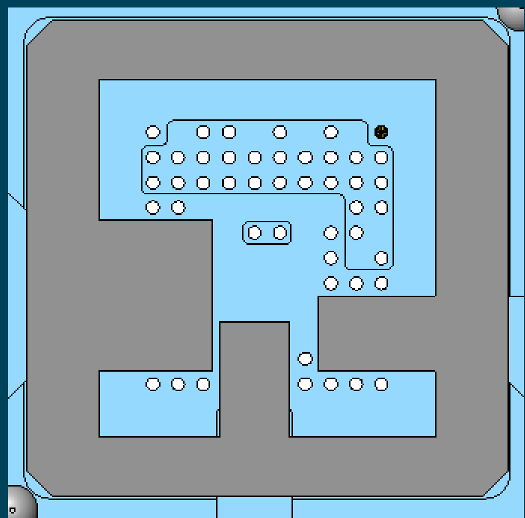


Elastomer

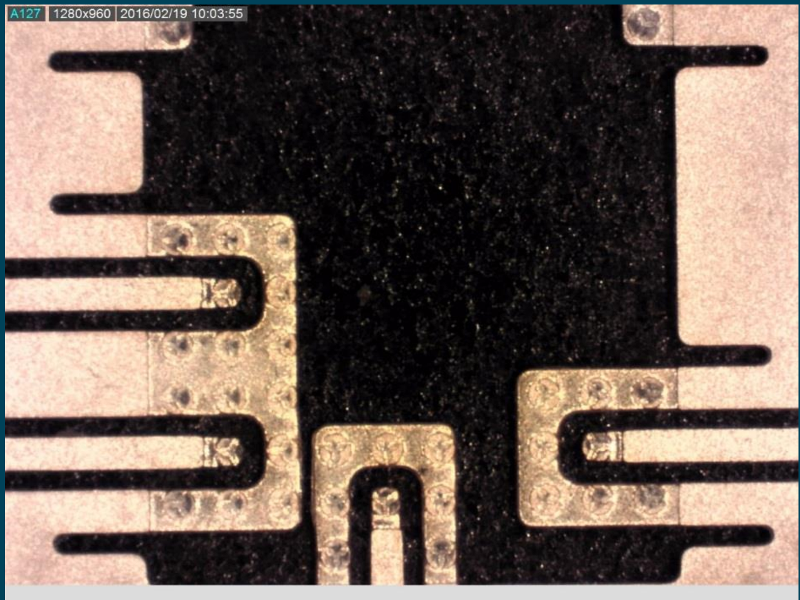
Socket Improvements

- New leadframe design implemented
  - Only contacts the RF Ground signals, ground island
  - Cantilevered design allows more flexibility

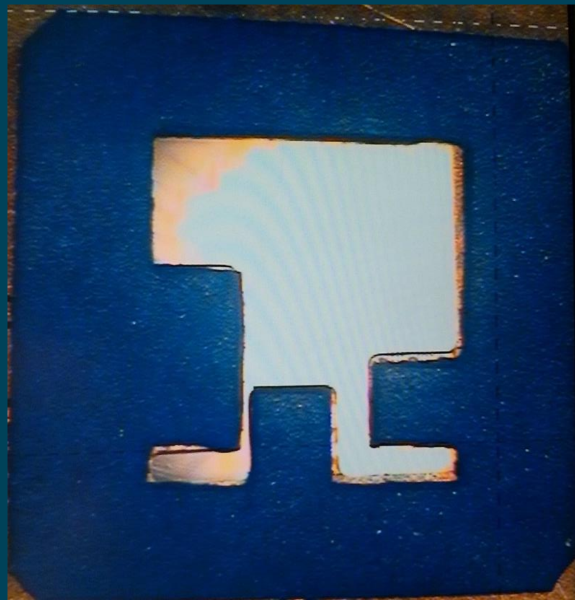




Socket Improvements



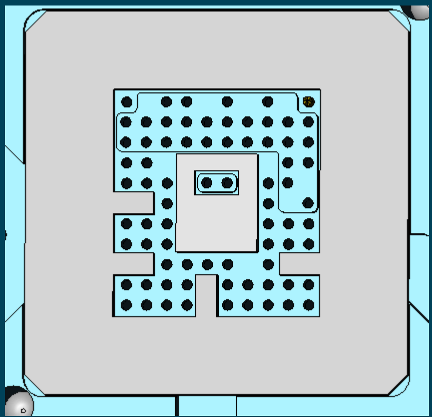
Leadframe



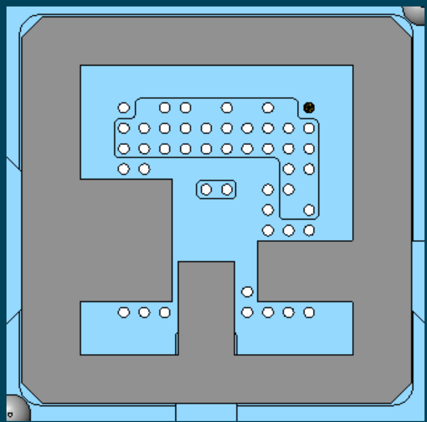
Elastomer

Socket Improvements

- Elastomer design changes
  - Material was changed from Silicone to Viton
  - Design was changed to support the entire ground island, not just the RF signal trace



Gen1

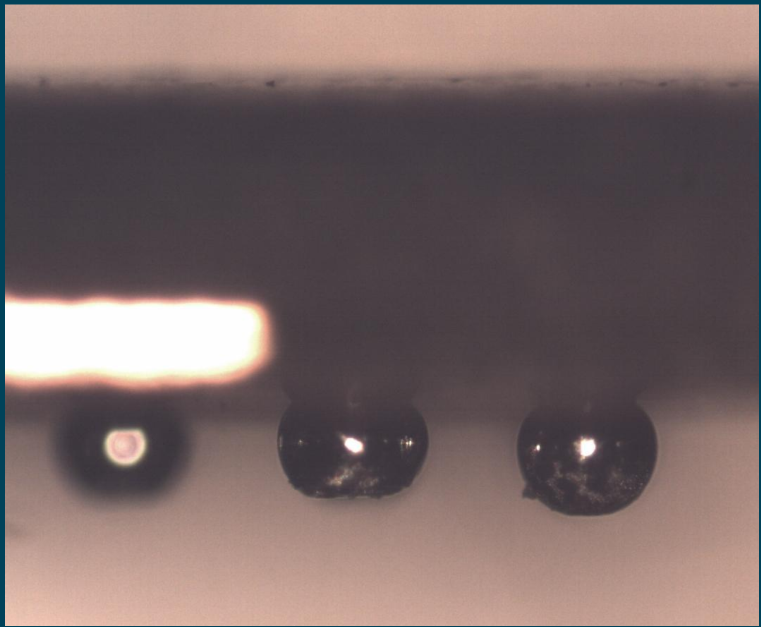


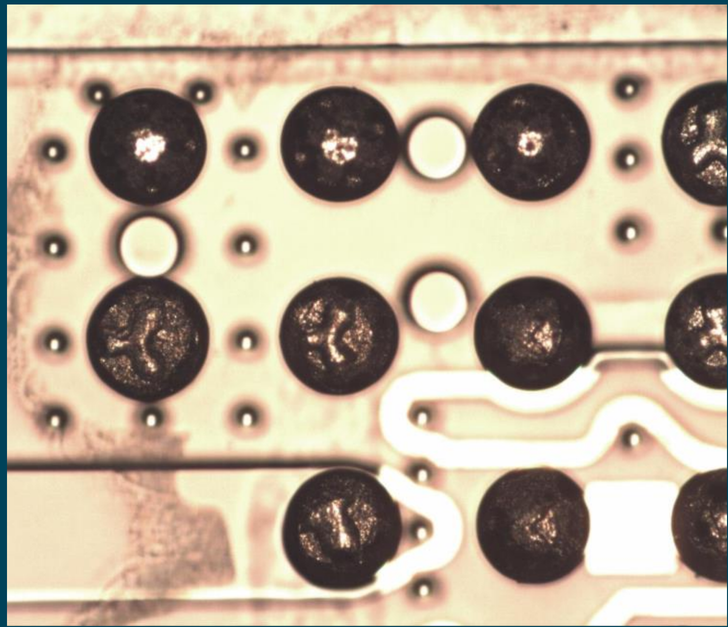
Gen2

Mechanical Performance (Gen2)

- Socket
  - Good electrical performance
  - Solder ball deformation observed
    - Resolved the ball "extruding" but "flattening" of the solder balls still occurred
    - Worst case along the outer edge
  - Elastomer cycle life
    - Improved but still required frequent maintenance
    - Elastomer would shift from under the leadframe

Mechanical Performance (Gen2)

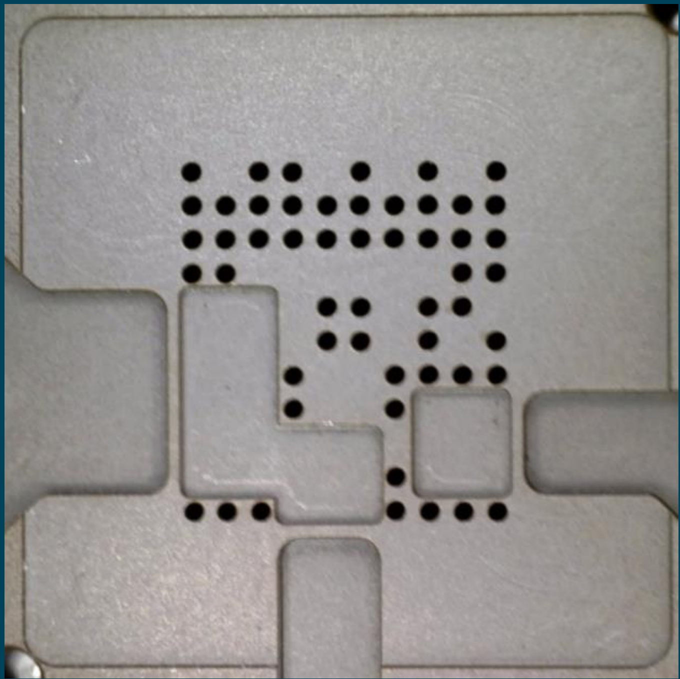


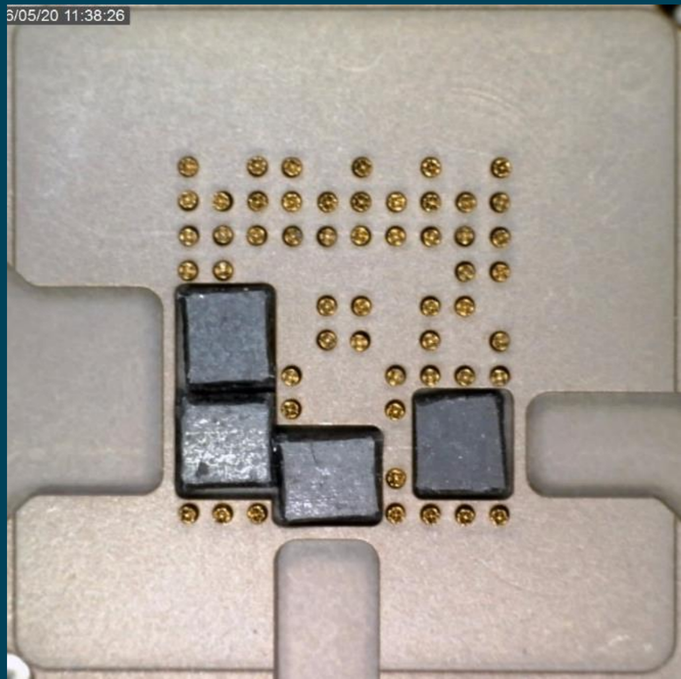


Socket Improvements

- Elastomer design changes
  - Elastomer was changed to a "pocket" design.
  - Outer perimeter of elastomer removed to limit the elastomer to only the contact point regions of the leadframe.
  - Elastomer thickness increased to allow pockets to be machined into the socket floor to contain the elastomer islands.

Socket Improvements





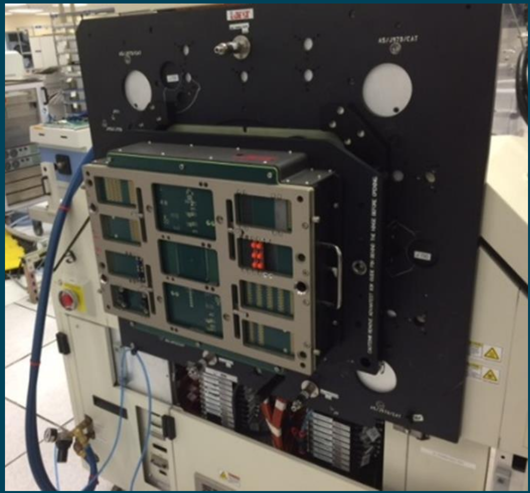
Gen2.1 Socket with Pocket Elastomers

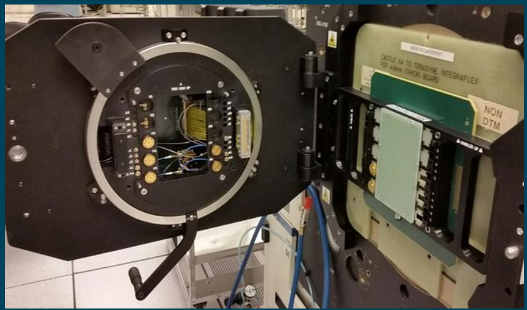
Mechanical Performance (Gen2.1)

- Socket
  - Good electrical performance
  - Solder ball deformation minimized
    - Still see some flattening of the ball
  - Elastomer lifetime
    - Improved but still requires replacement
  - Leadframe Lifetime >1M cycles

Waveguide Cage Improvements

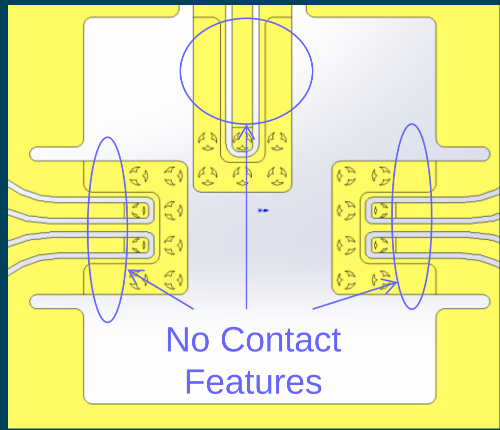
- Implementation of Universal Hard Dock (UHD)
  - Worked with inTEST to integrate components for all three products into one UHD cage.
    - Only the socket and DUT board are changed.
    - Allows easier and faster product changes in production.
    - Sockets can be maintained offline.





Current Challenges

- Some ball deformation still seen
  - Remove edge ball contacts
- Elastomer lifetime
  - Need to improve replacement frequency, currently 100-150K cycles.
- Handler variability
  - Chuck to Chuck yield variation
  - Handler jams causing socket damage



Future Improvements

- Elastomer alternative
  - Replace elastomer with non-conductive spring pins
- Socket Maintainability
  - Need improved socket assembly to allow replacement of leadframe and elastomer without removing the RF cables
- Reducing failure modes
  - Cable failures