
SIXTEENTH ANNUAL
BiTS
Burn-in & Test Strategies Workshop
TM
March 15 - 18, 2015
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive – Session 8
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Session 8
Morten Jensen
Session Chair

BiTS Workshop 2015 Schedule

Solutions Day

Wednesday March 18 10:30 am

Looking For That Four Leaf Clover

"A Test-Cell-Solution for 81GHz Automotive Radar ICs"

Jason Mroczkowski, Peter Cockburn, & John Shelley - Xcerra Corporation

"Universal Device Interface DUT Solutions for ATE Test"

Bob Bartlett- Advantest Corporation

"Where No Tester Has Gone Before"

Roger Sinsheimer -Teradyne Inc.

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A Test-Cell-Solution for 81GHz Automotive Radar ICs

Jason Mroczkowski
Peter Cockburn
John Shelley
Xcerra Corporation

2015 BiTS Workshop
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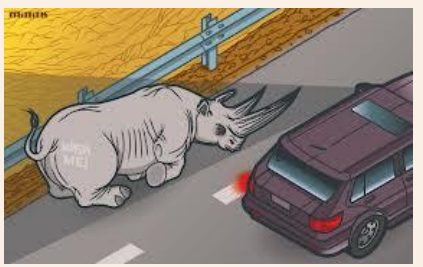
Agenda

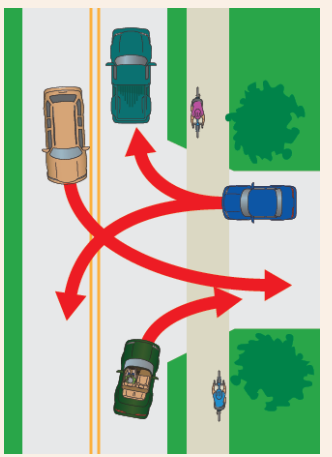
- Automotive Radar Introduction
- Evolution of Radar Test
- 81GHz Test Cell
- 81GHz Contactor
- Test Results
- Roadmap
- Summary

Why do we need Automotive Radar?

- Inattentive Driving
- Blind Spot Detection
- Preemptive Braking



http://www.motortrend.com

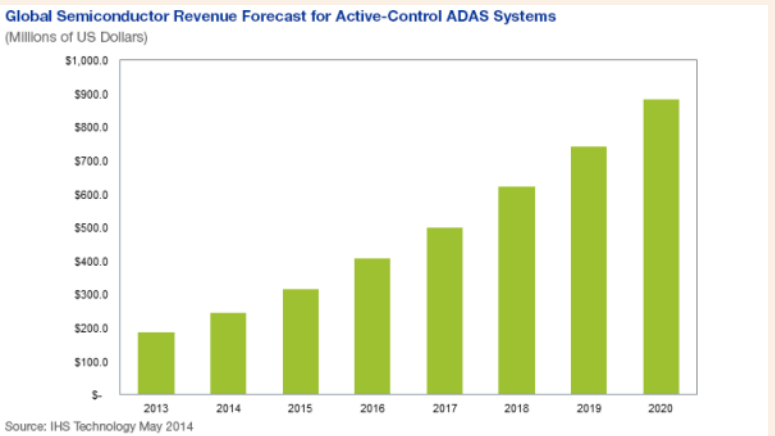


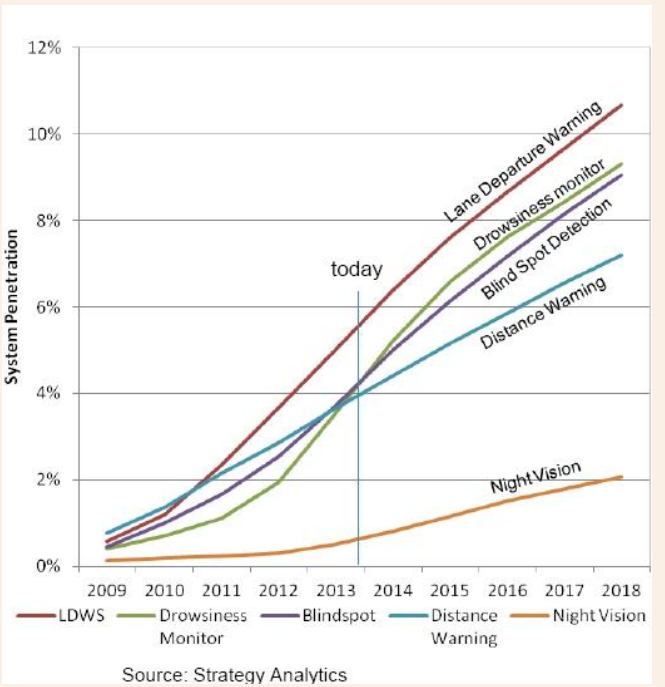
Drive Toward Autonomous Vehicles

http://floridabicycle.org/

Why do we need Automotive Radar?

- General trend towards safer, more autonomous vehicles
- Legislation to reduce car injuries is causing four-fold growth in ADAS (Advanced Driver Assistance Systems) chip revenue from 2010 - 2020

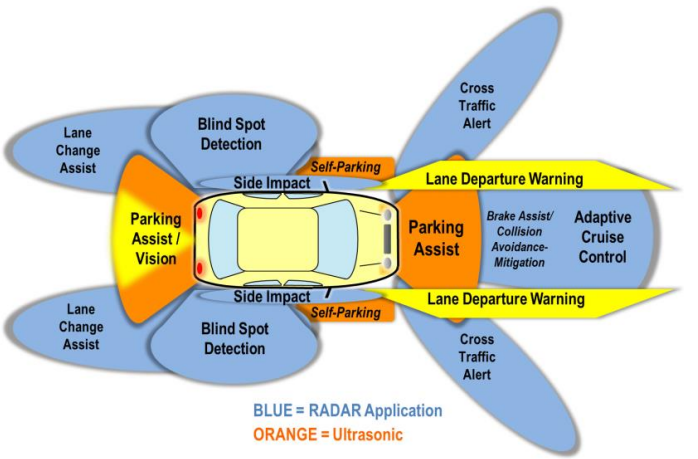




ADAS Offers A Safer Future

Automotive Radar Applications

- ADAS uses multiple technologies including Radar
- Radar systems are moving from 24GHz to 81GHz
  - Improved range
  - More bandwidth
  - Higher resolution

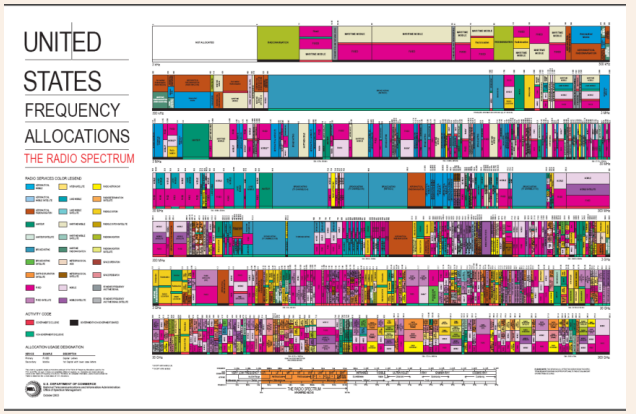


Application	Range	Safety Aspect	Technology
Adaptive Cruise Control	200 meters	accident avoidance	81 GHz
Pre-Crash	30 meters	impact mitigation	81 / 24 GHz
Blind Spot Detection	20 meters	accident avoidance	24 GHz / Vision
Lane Departure Warning	60 meters	accident avoidance	Vision
Stop and Go	30 meters	accident avoidance	81 / 24 GHz

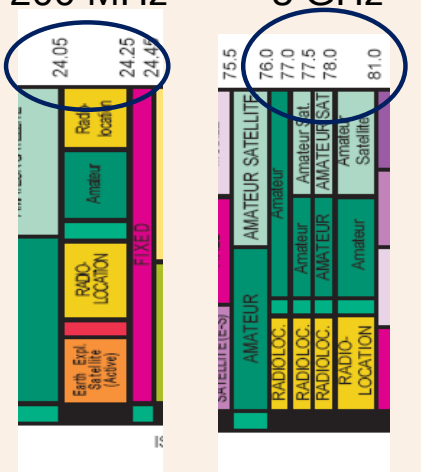
ADAS Systems Are Moving To 81GHz

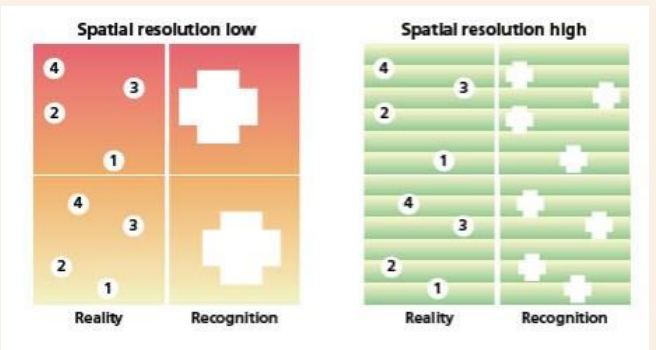
A Test-Cell-Solution for 81GHz Automotive Radar ICs

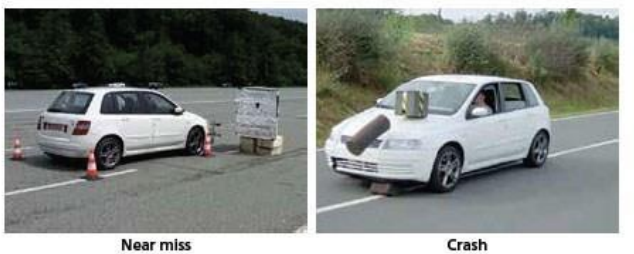
Push to Higher Bandwidth – 81 GHz



200 MHz 5 GHz





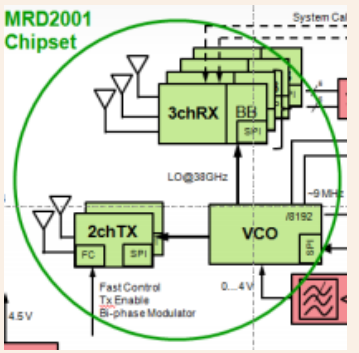


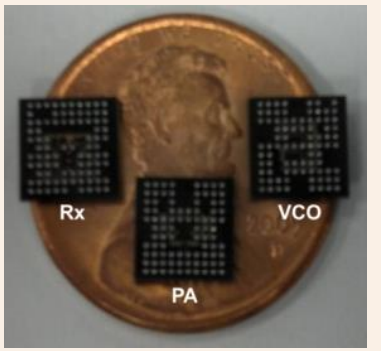
Source: ITU News

More Range, More Bandwidth, More Resolution

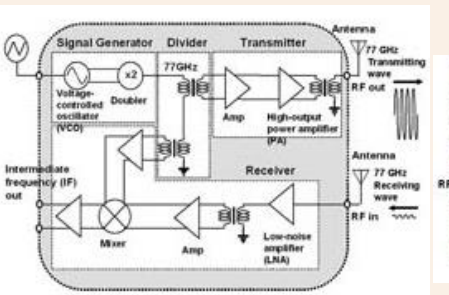
Packaging Technology

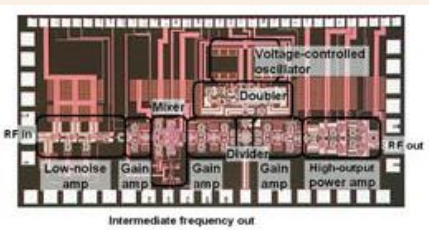
- Current Generation Packaging
  - fBGA
  - 3 package chipset
  - 0.5mm pitch
  - Package thickness 1mm
  - Single Ended Routing
- Next Generation Packaging
  - WLCSP
  - 0.5mm Pitch
  - Package thickness 0.25mm
  - Differential Routing





Source: Freescale





Source: Fujitsu

Thinner More Integrated Packaging

Test Challenge for Automotive Radar

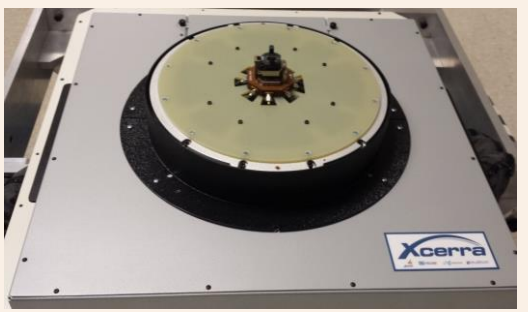
- Parts per billion allowable failure rates
  - Full functional test required at extreme frequencies
- Multi-temp testing for automotive temperature range (-45 to +125°C)
- Reliable and cost-effective HVM solution
  - Maximize re-use of test cell investment

Extreme Frequency, Extreme Temperature, Extreme Quality

ADAS Integrated Test Cell

- High volume production “at speed“ testing solution for ADAS Radar enabled devices
  - Commercial ATE with option for 24GHz or 81GHz
  - Automotive compliant Tri-temp handling solution
  - Fully-matched contactor and interfacing assembly
  - Integrated test cell communication

General Purpose ATE



Integrated test and contactor assembly

Tri-Temp Handler

Extreme Frequency, Extreme Temperature, Extreme Quality

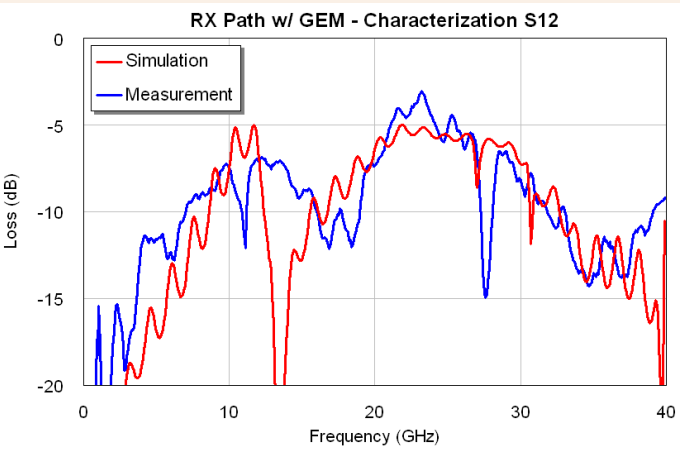
Existing ADAS Test Cell – 24GHz

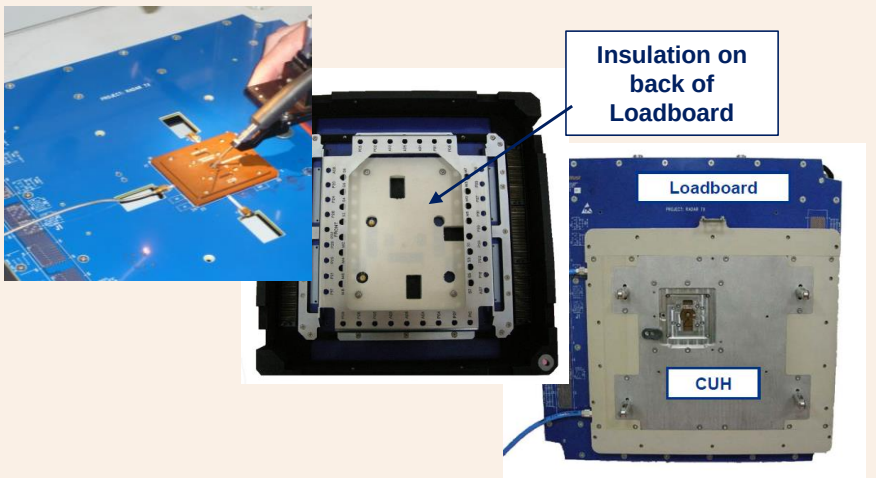
- Multiple 24GHz full functional test cells in HVM today
- Uses flexible test cell base that can be adapted for other requirements
- Same test cell base extended with new instrumentation and interface for 81GHz

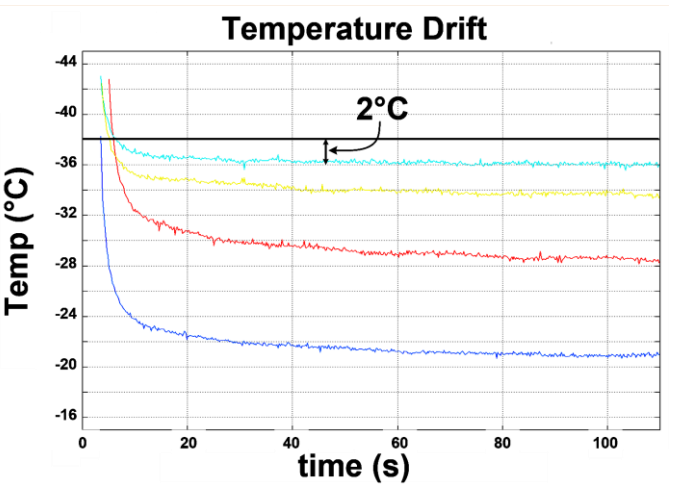
Production Proven Test Cell Base

24GHz Test Cell Signal Optimization

- Complete signal path from ATE to DUT optimized through simulation
  - Less than 8dB of loss
  - Less than 2dB of ripple
- Custom insulation results in stable multi-temp performance
  - Die temp. accuracy of ±2°C







Needs Met With Traditional Interface Technology

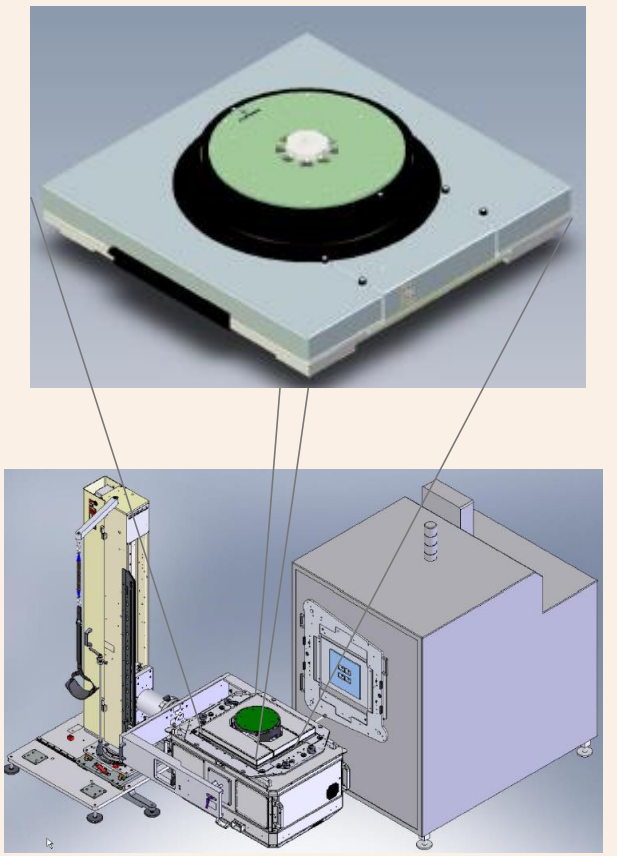
Going from 24 GHz to 81 Ghz

- Handler remains same
- Tester upgraded with new instrumentation
- Interface requires radical departure from existing design

Radical Advancement in Interface Technology Required

81GHz Complete Test Cell Solution

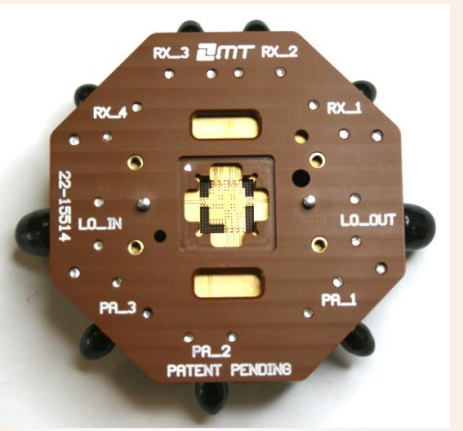
- Only fully integrated solution in the Industry
  - All components from one supplier (tester, loadboard, contactor and handler)
- Tester option for ADAS test (Kestrel)
  - Upgrade on scalable X-Series platform to balance flexibility and cost
  - 8 channel transmit /receive @ 81 GHz
  - Calibration up to the device pin
- Tri-temp handler integration
  - MT9510 pick and place handler with standard conversion kit
- Proprietary contacting solution (mmWave)

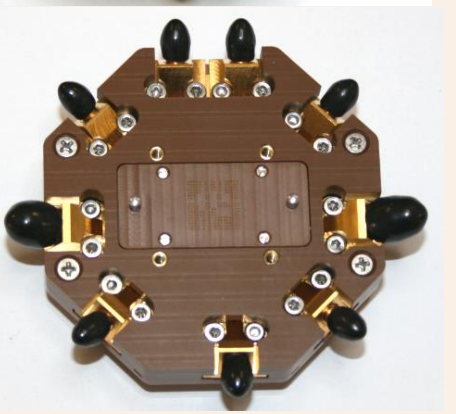


Fully Integrated Production Solution

Contactor Component for 81G Radar Test Cell

- Revolutionary mmWave Contactor
  - Impedance controlled Coplanar Waveguide for high speed signals
  - PCB and pogos for low speed and power
  - Fewer transitions than alternatives for best signal integrity
- PCB and contactor
  - Designed
  - Manufactured
  - Assembled
  - Tested



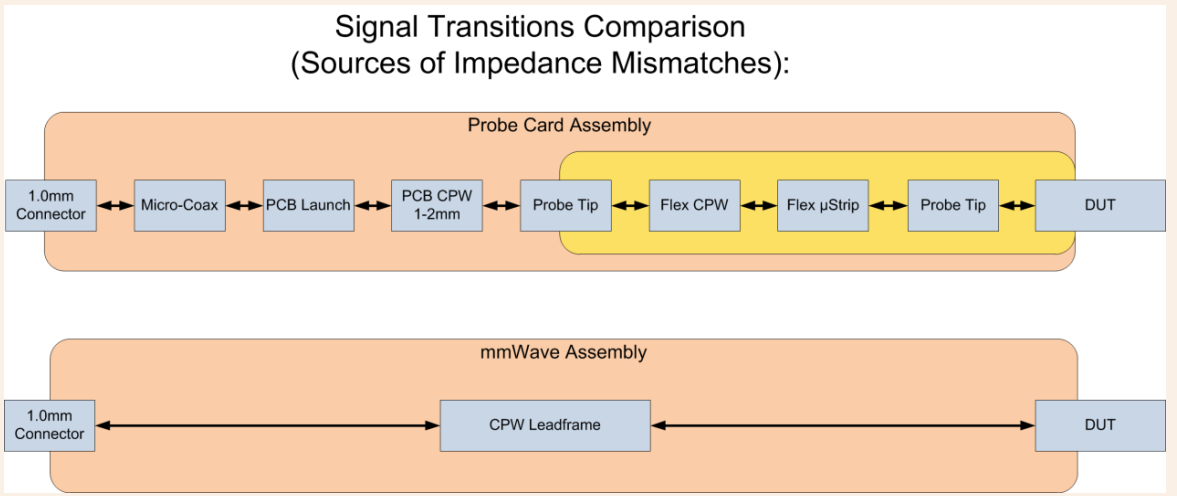


Reliable, Production-Ready Solution

Signal Path Optimization for 81GHz

- mmWave contactor Minimizes connection interfaces and maintains required 81GHz signal quality and robustness for production

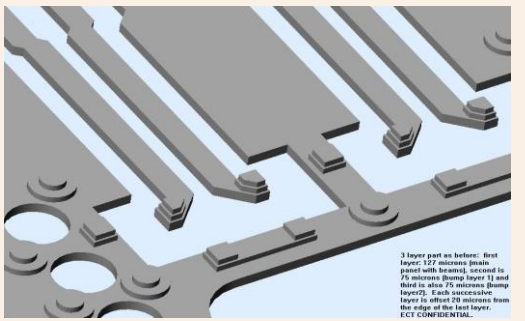
RF Instrument <-> Loadboard <-> Contactor <-> DUT

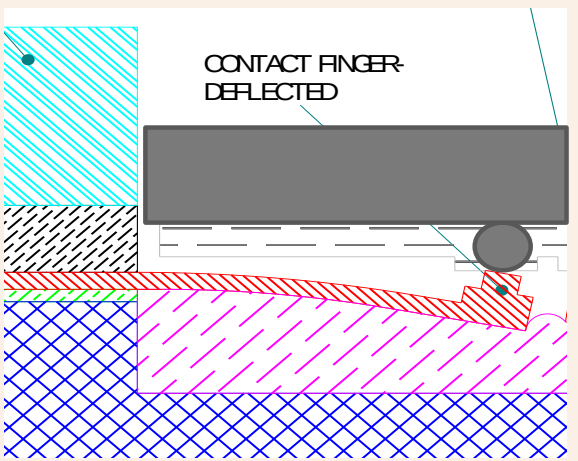


Interface and Contactor Design Reduces Signal Transitions

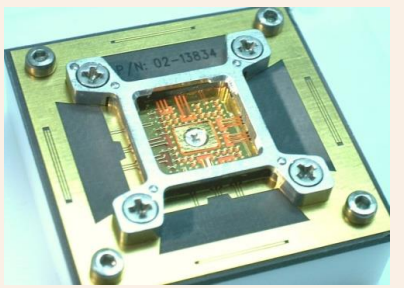
Background – Patented Multitest Contactor Solution

- High Speed Differential Coplanar Waveguide Leadframe Contactor
- Compliant Cantilever Design



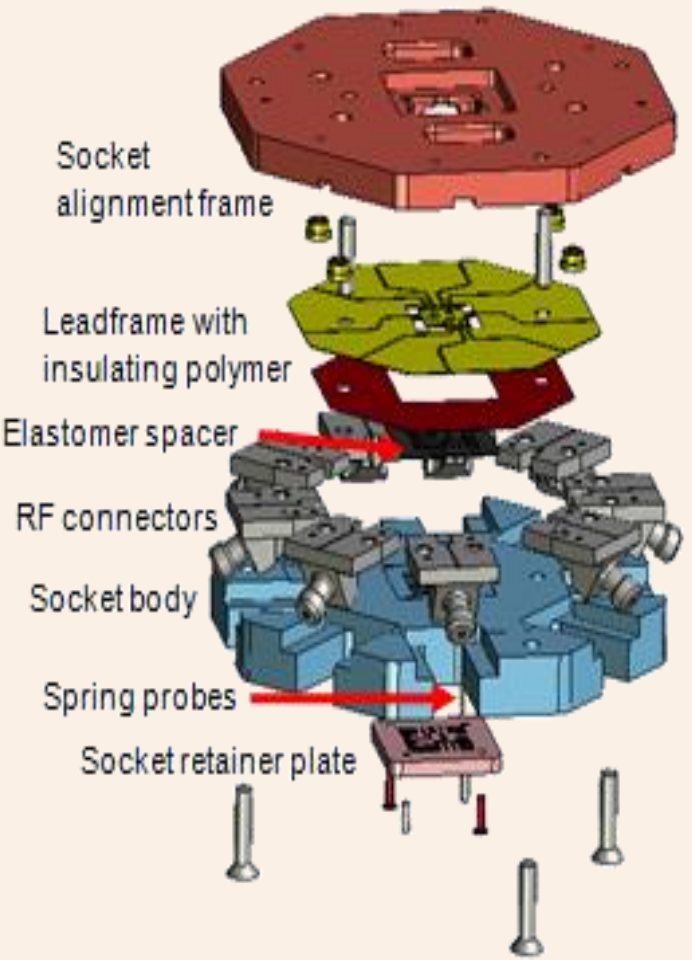


Patent # 7173442 B2



Patented Cantilever Design

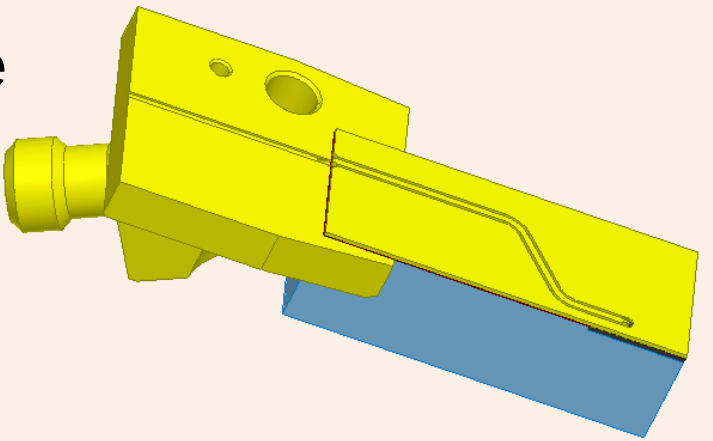
81GHz mmWave Contactor



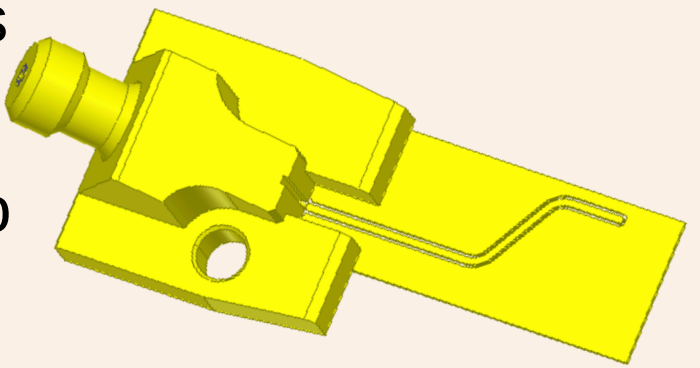
Additional Patent Pending

Simulation Model

3D EM Simulations include full path from 1mm connector to device pin



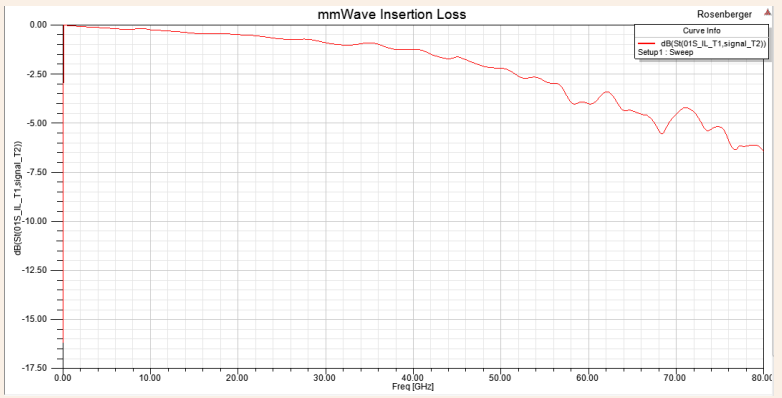
- Optimized Coplanar Waveguide geometries
- Optimized connector to leadframe interface

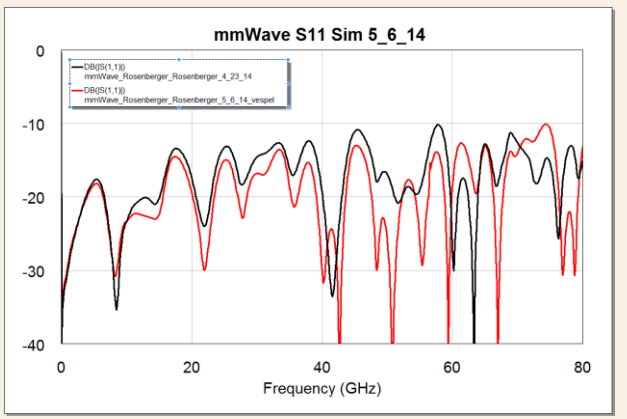


Optimized Through Simulation

RF Simulation Results

- Goal
  - Better than 8dB insertion loss @ 80GHz
  - Better than -10dB return loss @ 80GHz
- Simulated
  - -7dB insertion loss @ 80GHz
  - -10dB return loss @ 80GHz



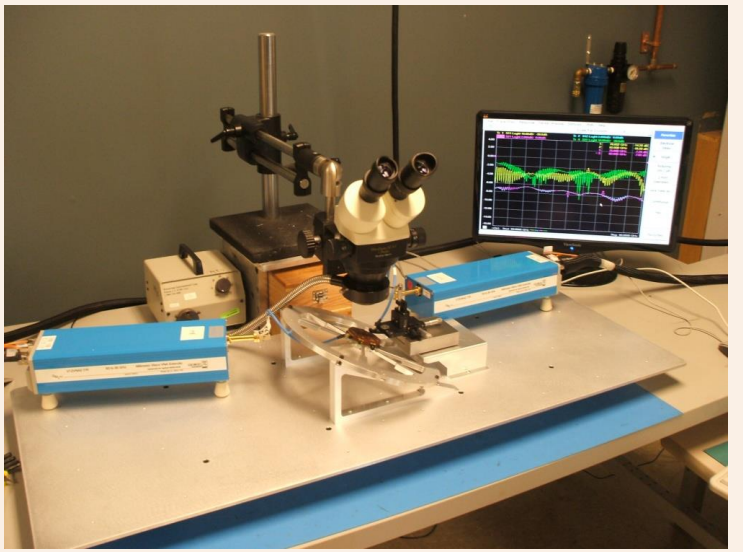


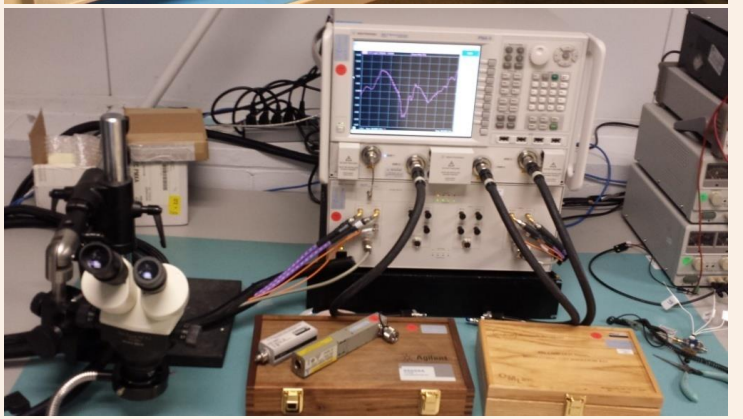
Broadband Performance From 0-80GHz

Test Results - RF to 90GHz

Measurements taken on RX, TX and LO Paths

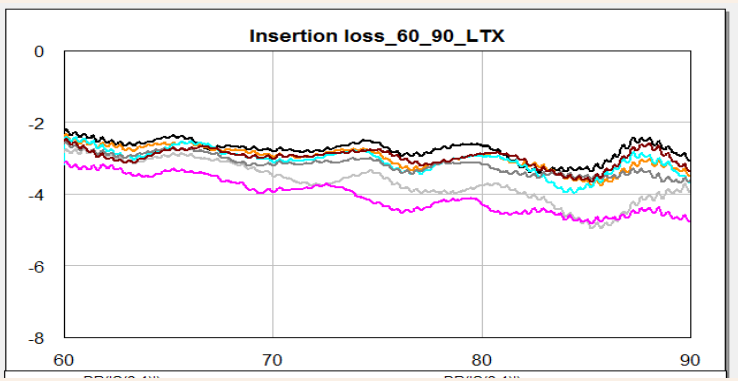
- Agilent 50GHz PNA-X with WR12 Waveguides (60-90GHz)
- 1mm coaxial to 0.4mm GSG CPW Picoprobe measurement (adapter removal)
- Insertion loss, return loss, impedance

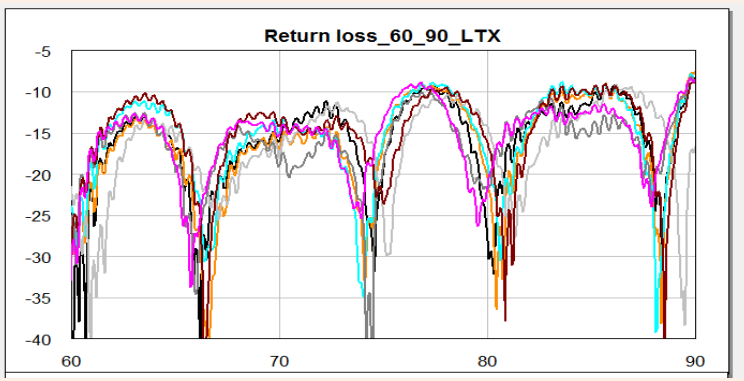




RF Measurement Results

- Broadband performance from 0-81GHz
- Impedance and phase matched
- -4.5dB insertion loss @ 80GHz
- -10dB return loss @ 80GHz

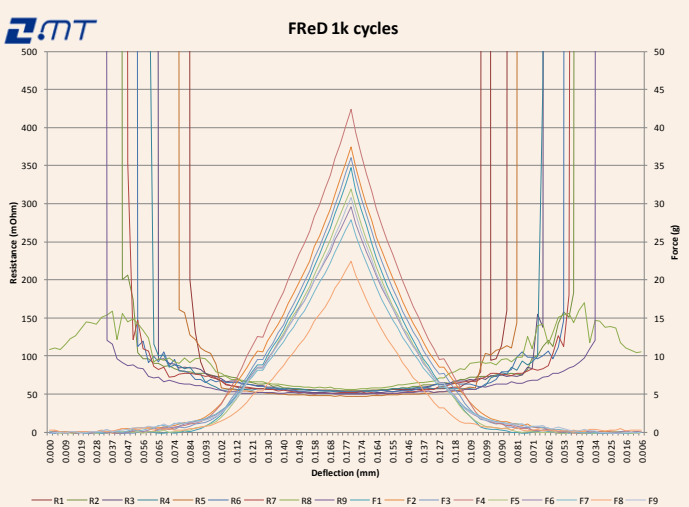


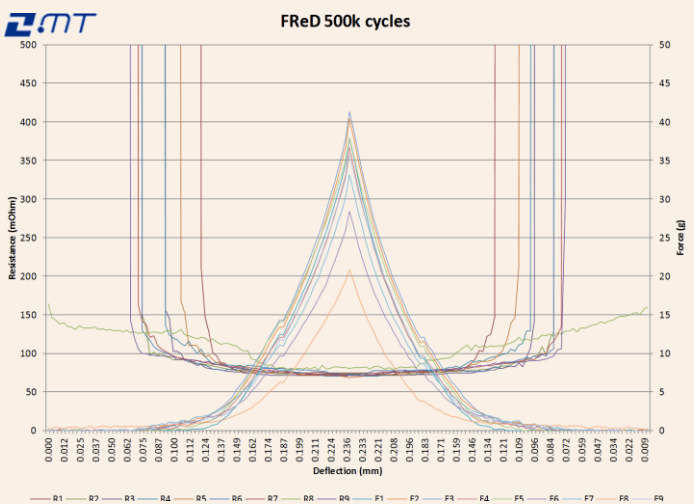


Measurement Correlates to Simulation

mmWave Life Cycle Test Summary

- Average resistance after 500K Cycles
  - 77 mΩ, 3 mΩ Standard Deviation
- Average Force after 500K Cycles
  - 32.3 g, 6.1 g Standard Deviation



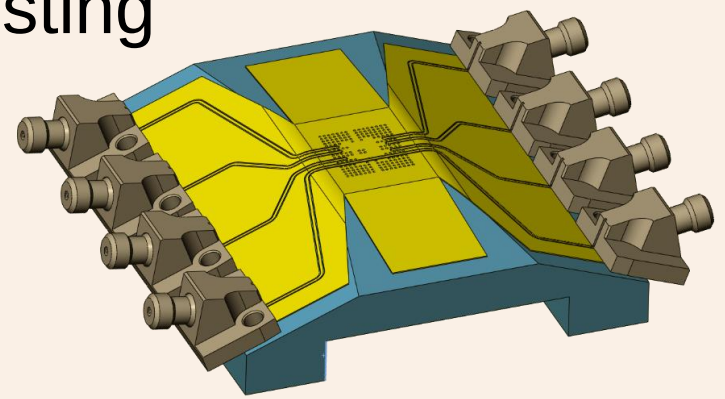


Stable Mechanical Performance

A Test-Cell-Solution for 81GHz Automotive Radar ICs

Roadmap: WLCSP

Solution for multisite WLCSP Automotive Radar Testing

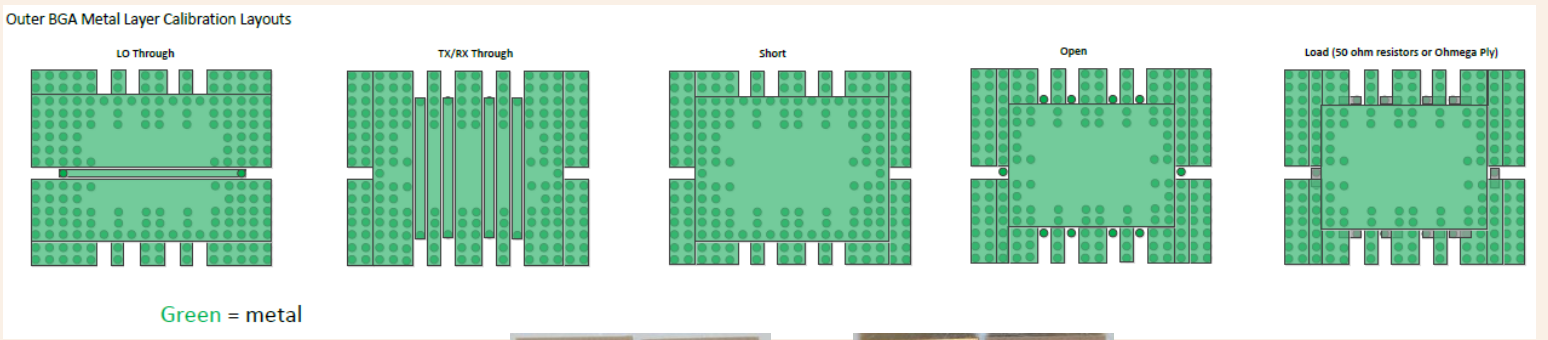


Multisite WLCSP contactor
(Concept Drawing)

Increased Throughput
Without Compromising Test Coverage

Roadmap: Calibration Substrates

- Simplified recalibration after fixture modifications/replacement of hardware, etc.
- Open, Short, Load , Through (OSLT)
- Simple two-layer PCB with coplanar waveguide traces
- PCB bumped with solder balls to replicate device



Efficient, In-Situ Calibration

Conclusions

- Test cell approach used in production since 2011 for full-speed 24GHz Automotive Radar testing.
- Same integrated approach is used for 81GHz automotive radar
- Radically advanced interface solution allows at speed multi-temperature production test
- Result: Automotive radar devices are tested with full coverage to guarantee premium quality to the Automotive OEMs.

A Fully Integrated Solution for 81 GHz Production Test