
SEVENTEENTH ANNUAL
BiTS
Burn-in & Test Strategies Workshop
March 6 - 9, 2016
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive- Session 2
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Session 2
Ashok Kabadi
Session Chair

BiTS Workshop 2016 Schedule

Frontiers Day

Monday March 7 - 1:30 pm

Material Matters

"Long Life Probe Pin by Electroforming Process"

Makota Kondo & Hirotada Teranishi - Omron Corporation
Takahiro Sakai & Naoyuki Kimura - Omron Corporation

"Carbon Nanotube Polymer Composites as High Performance Thermal Interface Materials for Burn in and Test Applications"

Leonardo Prinzi - Georgia Institute of Technology
Craig Green & Baratunde Cola - Carbice Nanotechnologies, Inc.

"Requirements and Solutions for Test PCBs"

Markku Jamsa - Aspocomp Group Oyj

"PCB Test Fixture and Socket Challenges for mmWave Applications"

Don Thompson Jose - R&D Altanova
Jose Moreira - Advantest Europe GmbH
Giovanni Bianchi - Advantest

BiTS 2016 Burn-in & Test Strategies Workshop

PCB Test Fixture and Socket Challenges for mmWave Applications

Don Thompson, R&D Altanova
Jose Moreira and Giovanni Bianchi, Advantest

2016 BiTS Workshop
March 6 - 9, 2016

Outline

Elastomeric Socket Evaluation at 77 GHz

- Review from last year
- Test Setup Interesting things
  - Material evaluation
  - Balun
- Measurement Results
  - Insertion Loss
  - Soldered down vs Socket
  - Cycle Testing
- Conclusions

mmWave Integrated ATE Solution PCB Test Fixture/Socket Challenge

mmW DUT

Major Challenge 75-85 GHZ

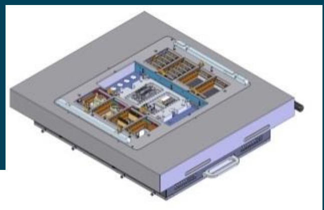
DUT PCB TEST FIXTURE AND SOCKET

UDI (Universal DUT Interface) Framework

mmW components located between DUT and ATE

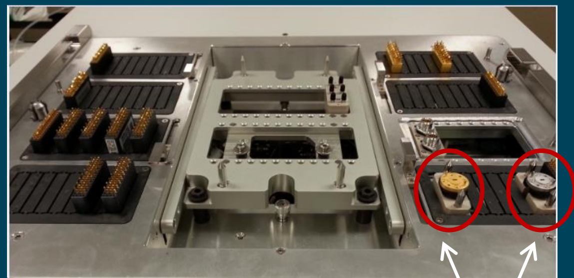
Maintains high-performance ATE functionalities

- HVM handler/prober integration
- High fidelity and short signal connections
- Calibration/diagnostics



ATE 6GHz RF

UDI TEST FIXTURE INTERFACE



Waveguide Blind Mate Interface

The Challenge

The Need:

- Automotive radar (77-85 GHz) and some high frequency Near Field Communication (60 GHz) applications are way outside the envelope of traditional socket capabilities
- ATE test cells need a low loss, low cost, and well behaved socket that works at these frequencies

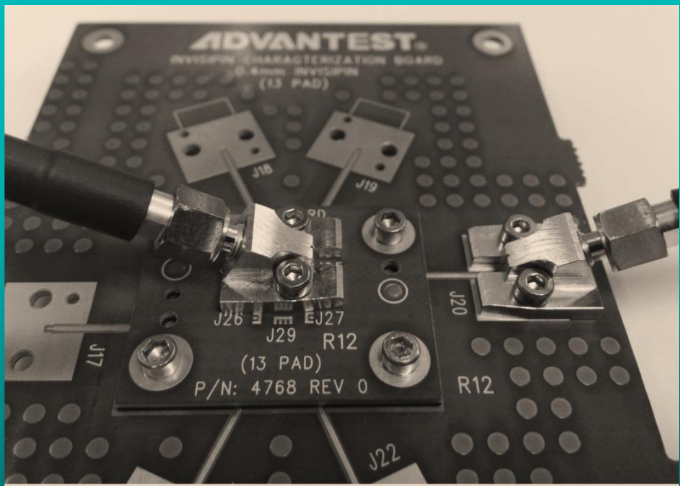
The Challenge:

- Build and verify a proof of concept 76-77 GHz socket for a 0.5 mm fine pitch package

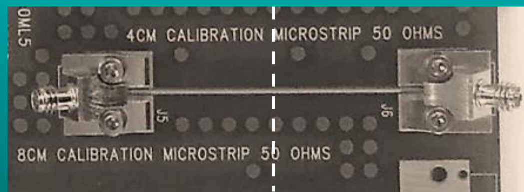
Results from BiTS 2015

- Confirmed Proof of Concept
- Results were Single Ended (Need Differential)
- Evaluation Board only

Good performance to 90 GHz



De-embedding Structures



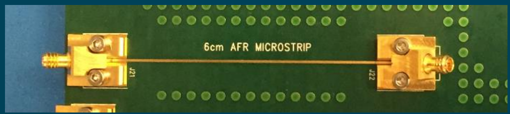
Invisipin 77 GHz Socket Solution

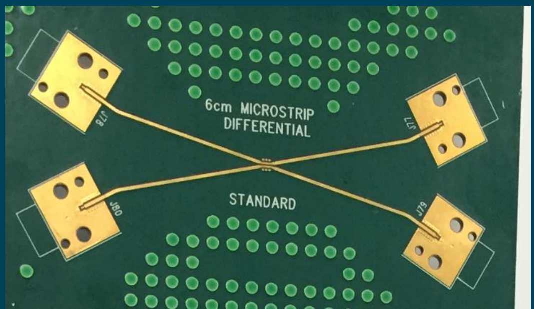
- ~~Step 1: Proof of Concept in lab~~
- Step 2: Demonstrate performance using actual part in lab
  - Select test part and evaluate for that part using exact part footprint
  - Create full socket
- Step 3: Evaluate on a Customer Test floor

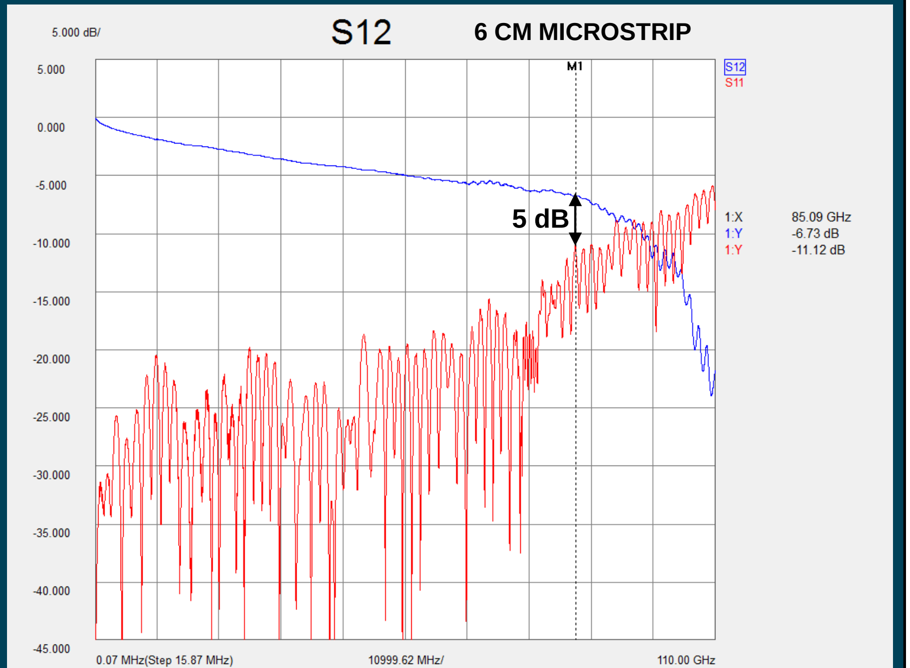
Test Environment

1. Trace construction
2. Balun construction

Signal Trace Loss



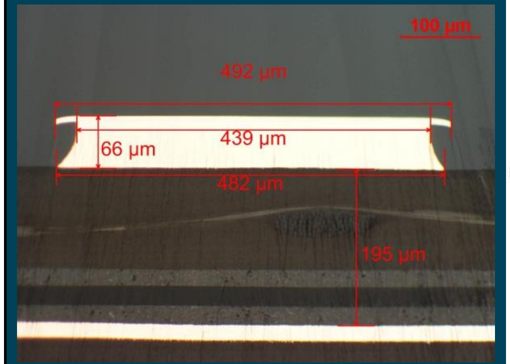


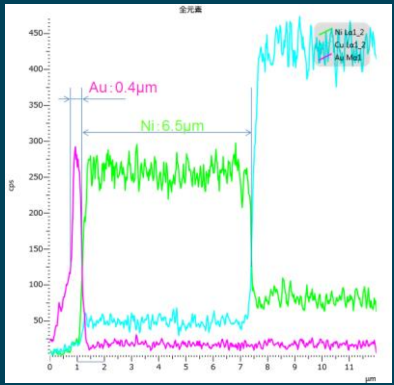


- 17.8 mil microstrip
- Taconic EZ-IO dielectric
- Rolled copper

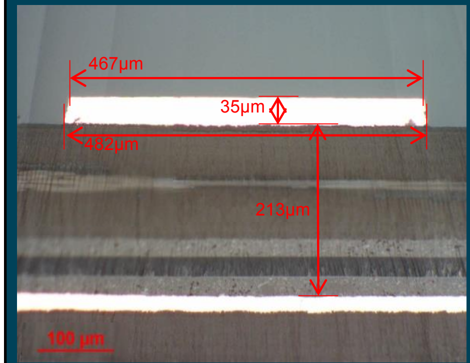
Nickel-Gold vs. Silver Plating

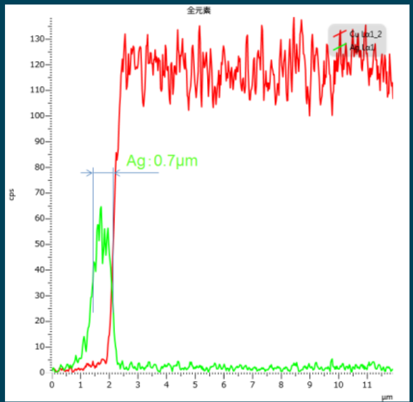
NiAu

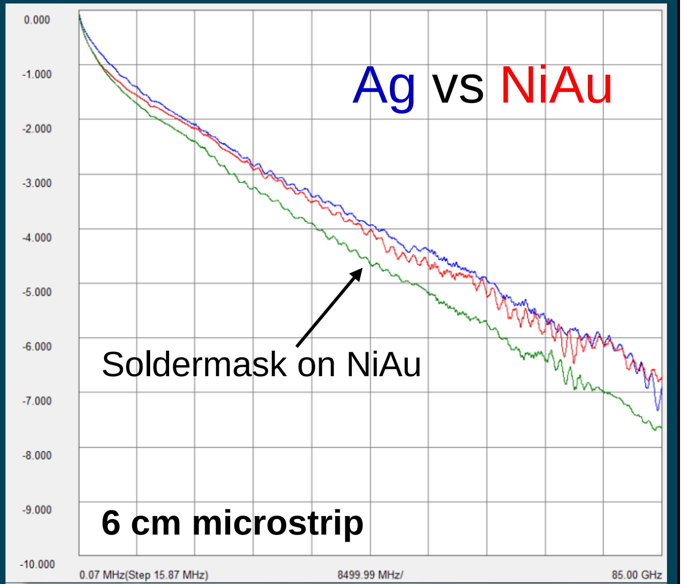




Ag



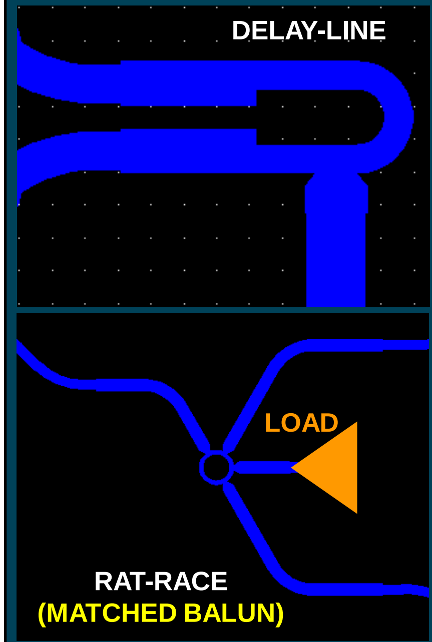


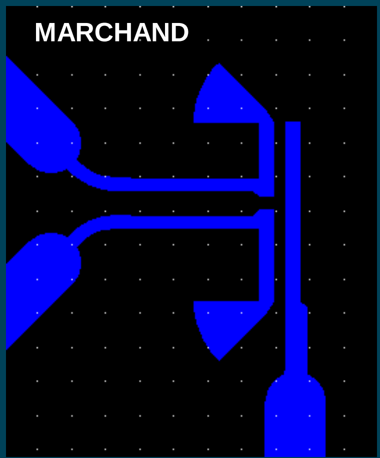


- Silver plating does not show any significant loss improvement.
- Adding soldermask has a significant impact.

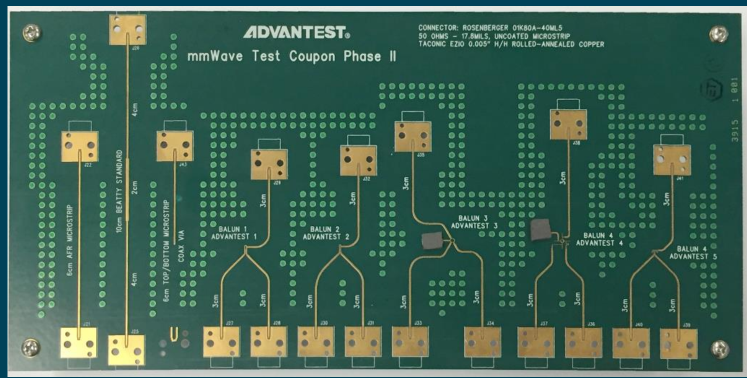
mmWave Baluns (1)

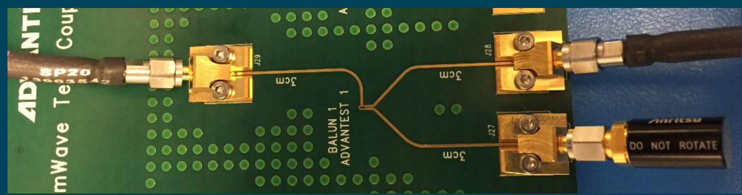
- Automotive radar ICs use differential mmWave signals
- mmWave measurement instrumentation uses single-ended inputs
- This requires the use of baluns for coaxial connectors (waveguide transitions can be designed to function as a balun).
- Three designs were evaluated: “Delay-Line”, “Rat-Race” and “Marchand”





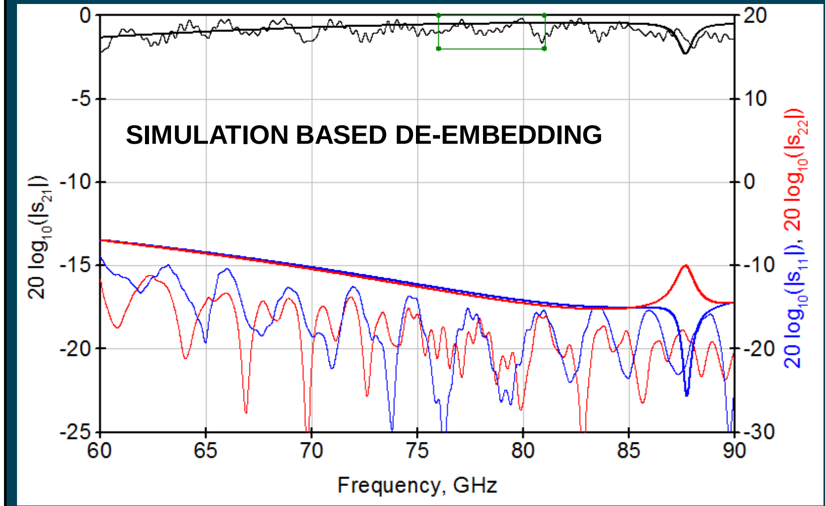
NOTE THAT PICTURES HAVE DIFFERENT SCALES

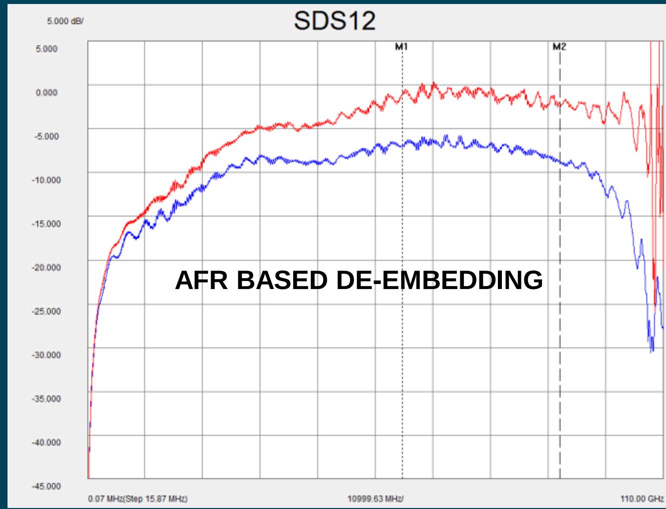




mmWave Baluns (2)

DELAY-LINE





	Delay-line	Rat-race	Marchand
Simulated insertion-loss	0.5±0.1	1.7±0.05	0.5±0.1
Measured insertion-loss	0.9±0.8	2.4±0.65	3.1±0.2
Simulated minimum return-loss	12	25	15
Measured minimum return-loss	13	11	7

- AFR based de-embedding presented problems due to the small loss of the delay-line balun
- Delay-line balun showed the best performance and was used for the socket measurements

Socket vs Solder

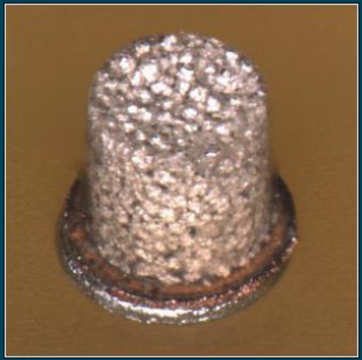
Performance of a Live Part

- Create a fully functional test board for a customer part and test two ways
  - Socketed device
  - Soldered device
- Compare results against de-embedded VNA measurements (76 GHz – 77 GHz)

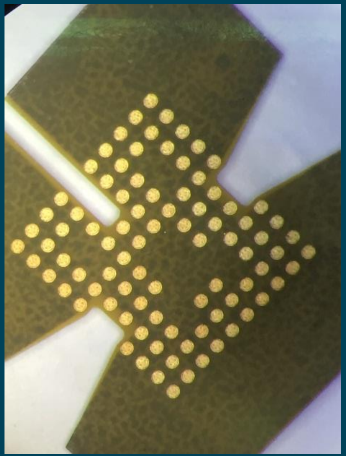
Invisipin Socket

- Discrete elastomeric column
- Pick-and-place solder-able contact
- Available in multiple sizes for different package pitches
- **** Can have an air dielectric ****

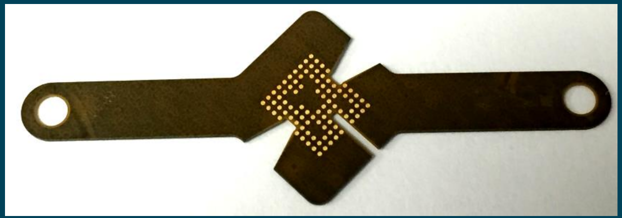
BUT We're still limited to package pinout



TOP View



TOP View



Socket vs. Soldered Part

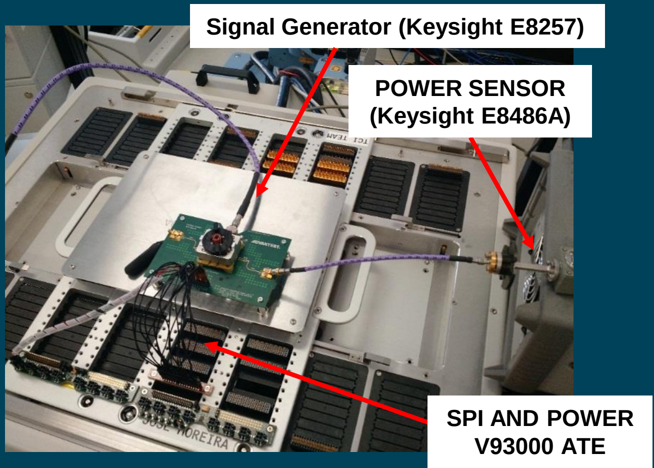
Soldered Part

Socketed Part

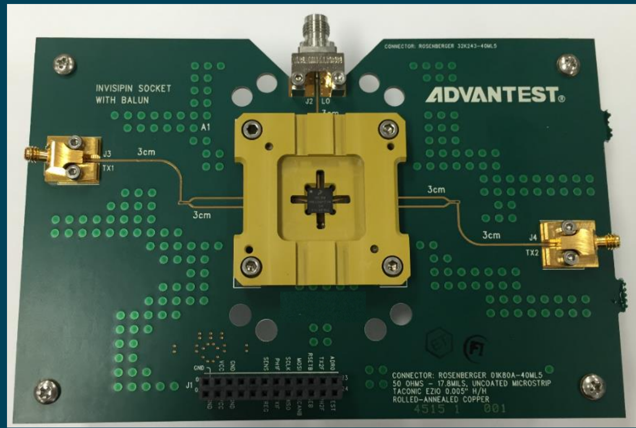
BASELINE (0 dB) → **Compare**

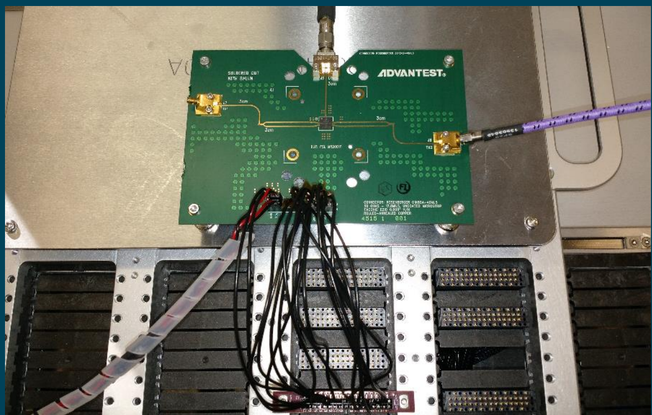
- All comparison data was normalized to 0 dB using the soldered part output power average as baseline
- Programmed Device on Advantest Tester
- Output frequency varied from 76 to 77 GHz and recorded in 0.25 GHz steps
- Same part was used in both tests

DUT Measurements

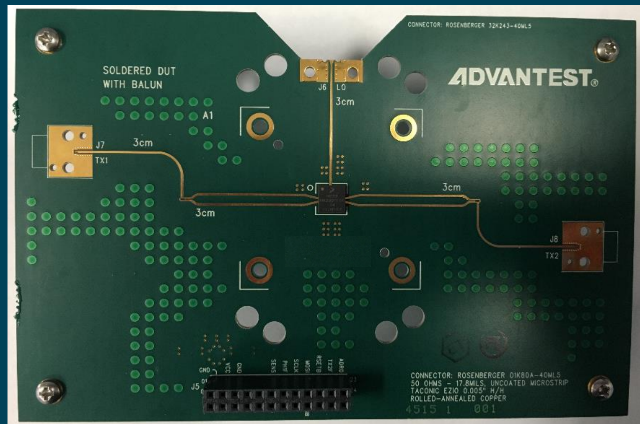


WITH DUT IN SOCKET

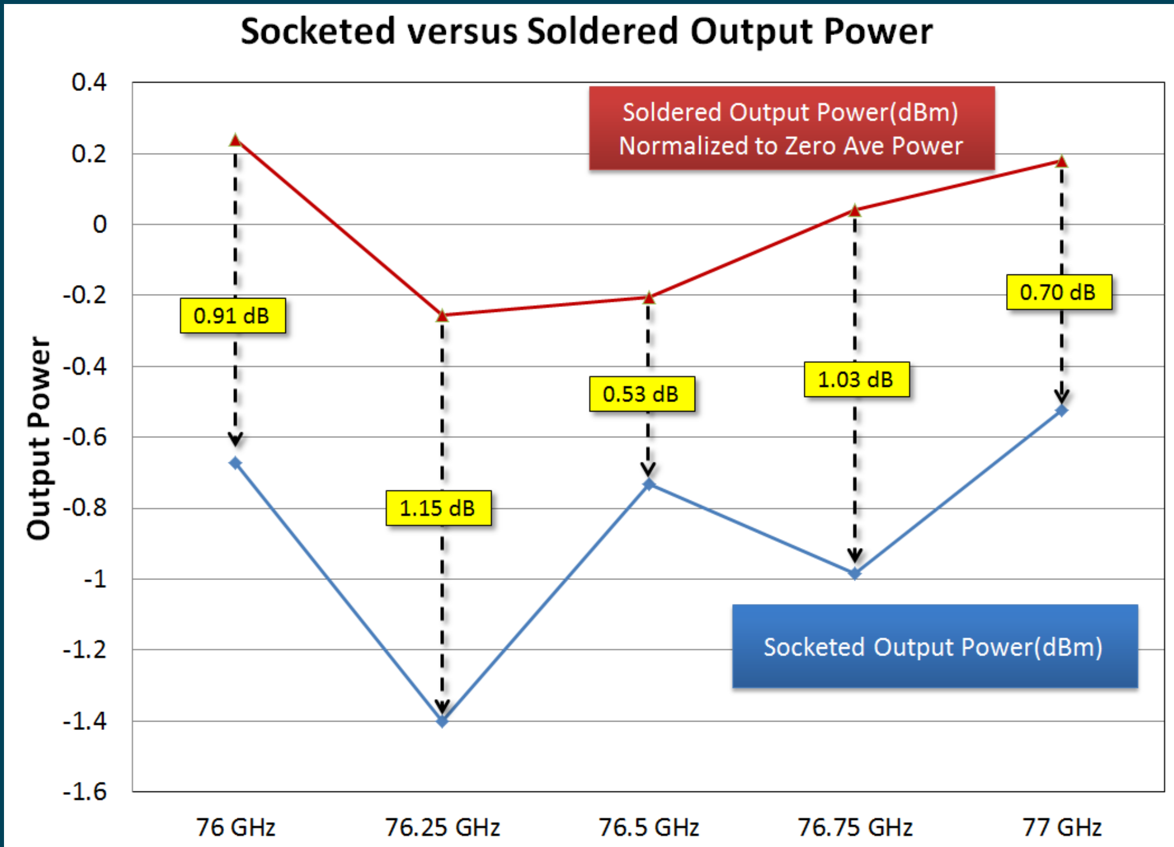




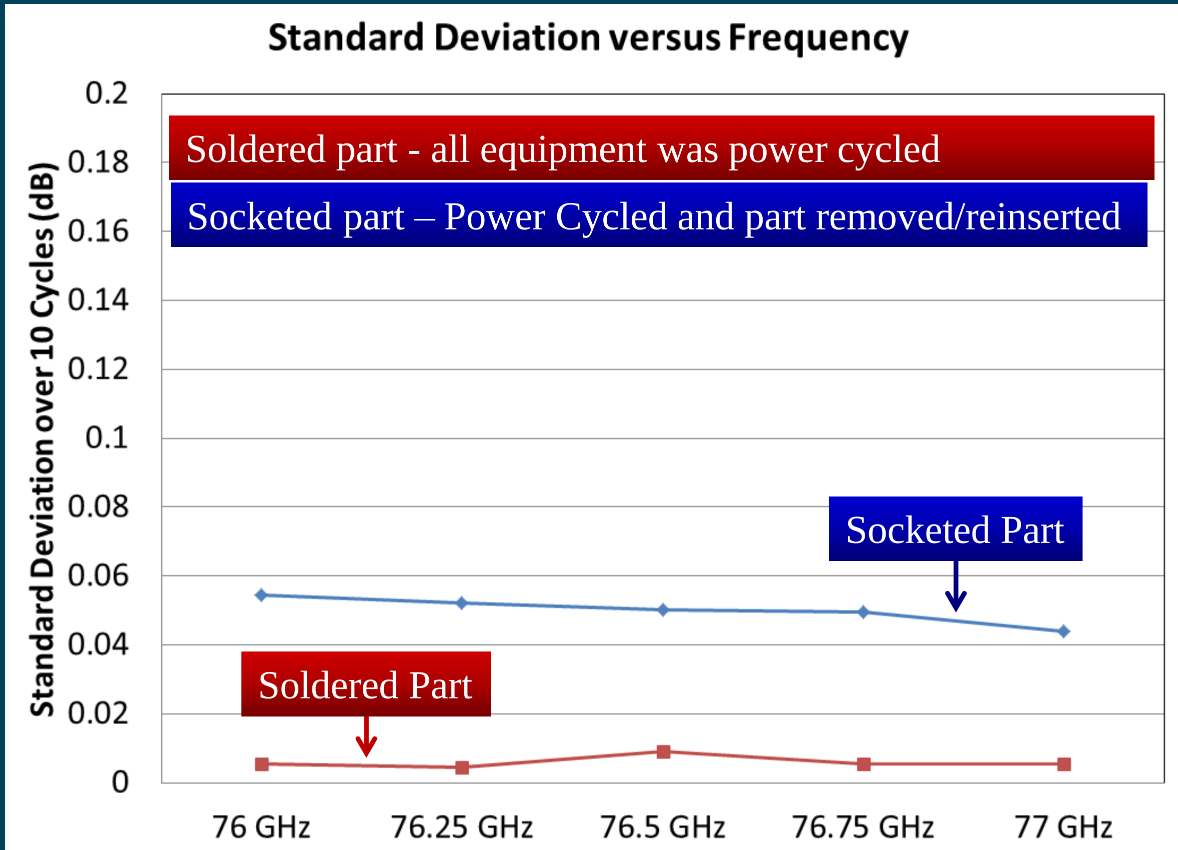
WITH DUT SOLDERED



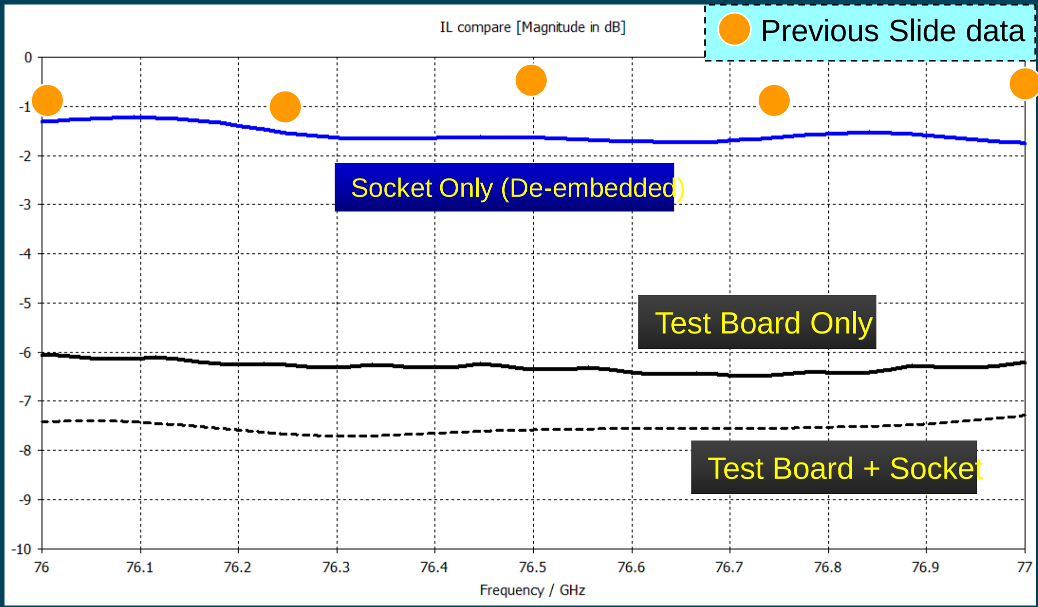
Soldered vs. Socketed Output Power

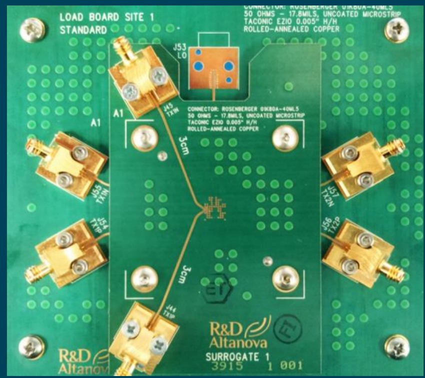


Standard Deviation

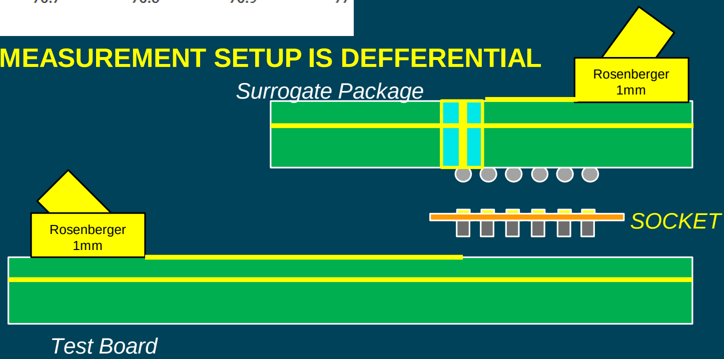


VNA Measured Insertion Loss 76 to 77 GHz



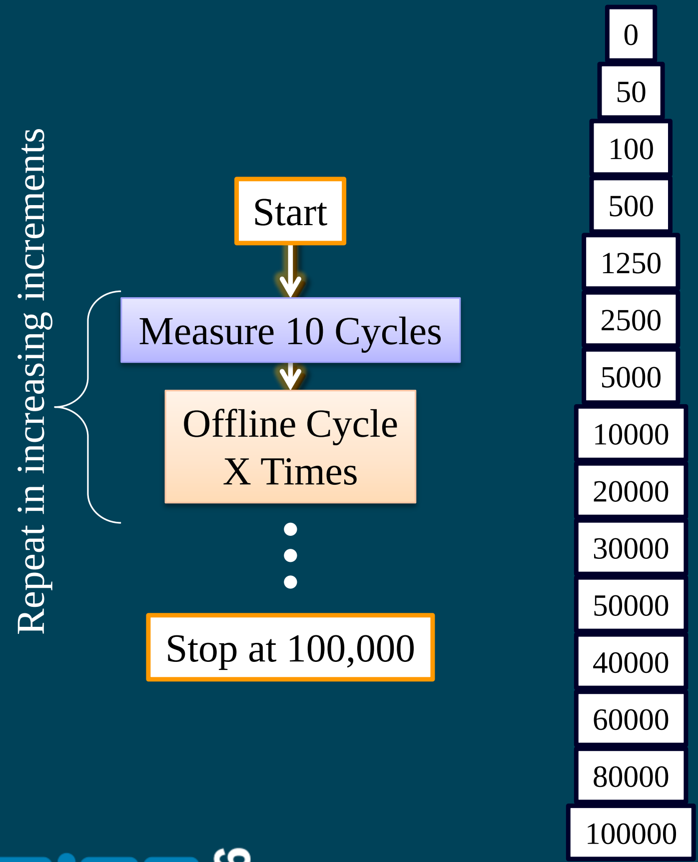


MEASUREMENT SETUP IS DEFFERENTIAL



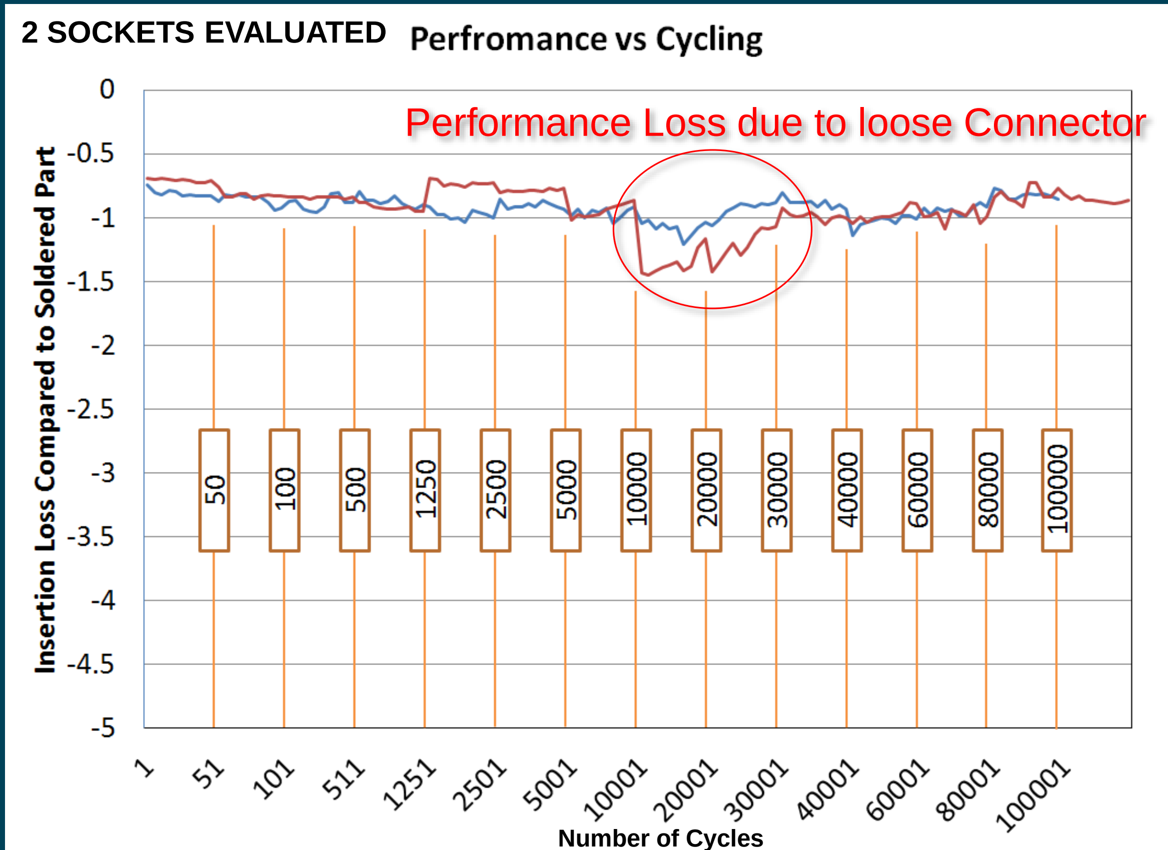
Performance vs Cycling

Cycle Testing Process



- Every time offline cycling is done everything must be disassembled and reassembled
- Offline cycling was done rapidly, ~ 1 second per cycle
- Offline cycling is a test of the elastomer, not the solder ball and contact surface. Solder ball and contact surface test must be done at customer site.

Part Measured Versus Cycling



Conclusions

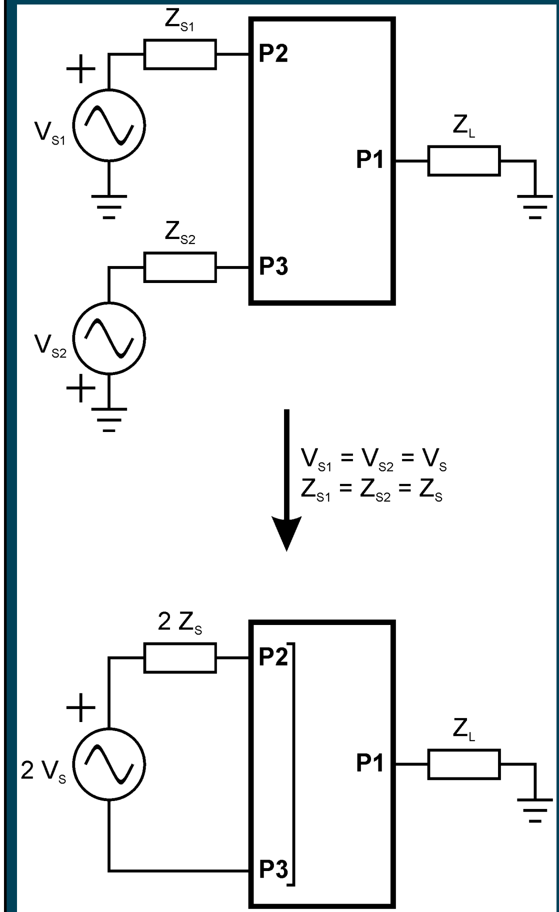
- Socket Loss < 1.15dB between 76-77 GHz
- Adjusting for assembly variations:
  - Standard Deviation = < 0.1 dB over 100,000 cycles
- No loss in RF performance seen up to 100,000 cycles

Acknowledgments

- We would like to thank Sui-Xia Yang and Roger McAleenan for their measurement support.
- We would also like to thank Yoko Kato and the FA team at Advantest Gunma for the cross section analysis.

Reference Material

Balanced to Unbalanced Transduction



$$[S]_{Balun,3P} = \begin{bmatrix} 0 & j\cdot\frac{1}{\sqrt{2}} & -j\cdot\frac{1}{\sqrt{2}} \\ j\cdot\frac{1}{\sqrt{2}} & \frac{1}{2} & \frac{1}{2} \\ -j\cdot\frac{1}{\sqrt{2}} & \frac{1}{2} & \frac{1}{2} \end{bmatrix}$$

P2, P3 of the balun (seen as 3-port) are not isolated and not matched. One problem on one generator affects also the transmission of the other one.

$$[S]_{Magic-T,3P} = \begin{bmatrix} 0 & j\cdot\frac{1}{\sqrt{2}} & -j\cdot\frac{1}{\sqrt{2}} \\ j\cdot\frac{1}{\sqrt{2}} & 0 & 0 \\ -j\cdot\frac{1}{\sqrt{2}} & 0 & 0 \end{bmatrix}$$

On a magic-T, P2, P3 are matched and isolated ($s_{22}=s_{33}=s_{23}=s_{32}=0$).
Balun is a loss-free network while a magic-T is a dissipative network.

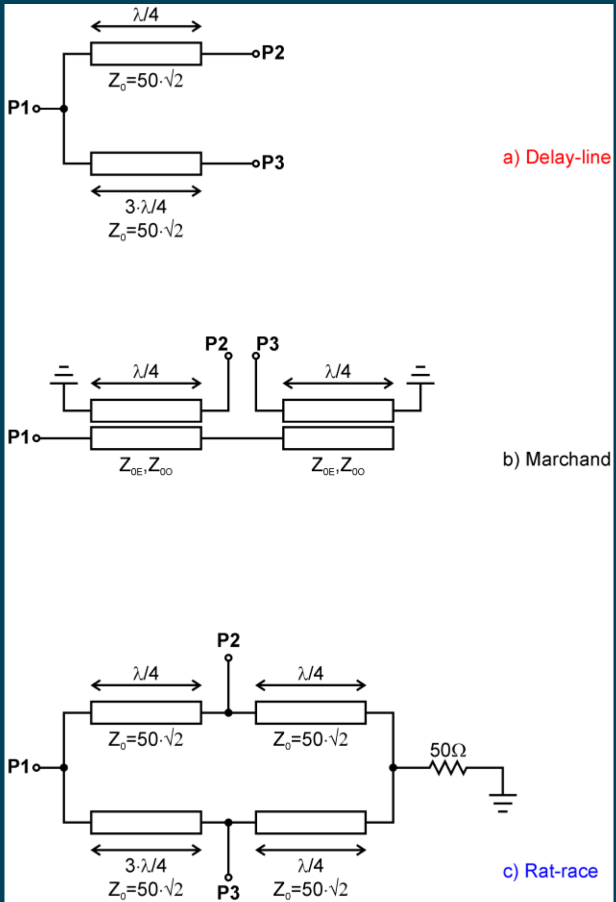
.

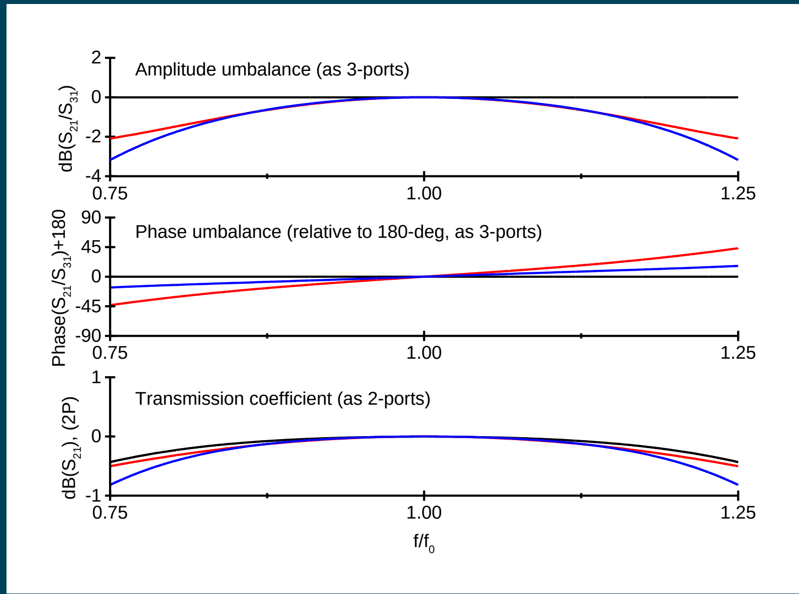
$$[S]_{Balun,2P} = [S]_{Magic-T,2P} = \begin{bmatrix} 0 & j \\ j & 0 \end{bmatrix}$$

Balun and magic-T behaves identically in **the case of antisymmetric excitation**.

Our problem is to combine two antisymmetric sources to one single-ended port. This is totally equivalent to deliver the signal of a single generator to two identical loads, with a 180-deg phase shift between them.

Semi-Ideal Baluns and Magic-T





a), b) are baluns: if P2 (P3) is open-CKT there is no transmission from P3 (P2) to P1 too. c) is a magic-T. The first one is the most simple. b) presents zero phase and amplitude unbalance.
In our realizations,

a) the line from P2 to P3 is folded
b) The short-circuits are replaced by radial stubs
c) The load operates at RF only