

Innovations in Package Testing of 5G mmWave Applications

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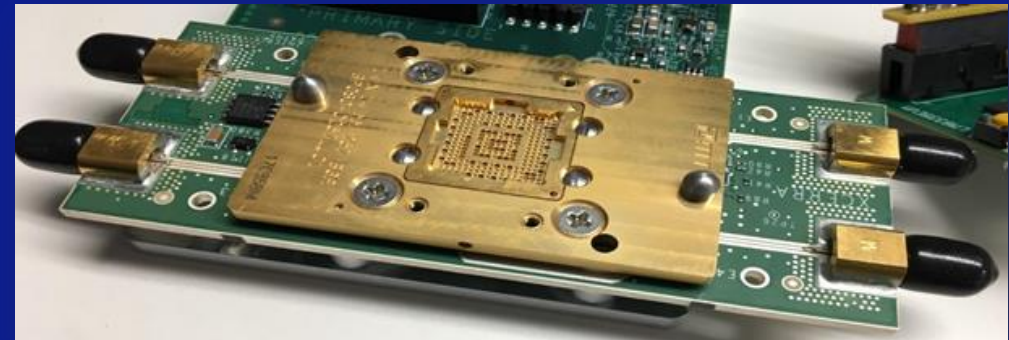


Challenges

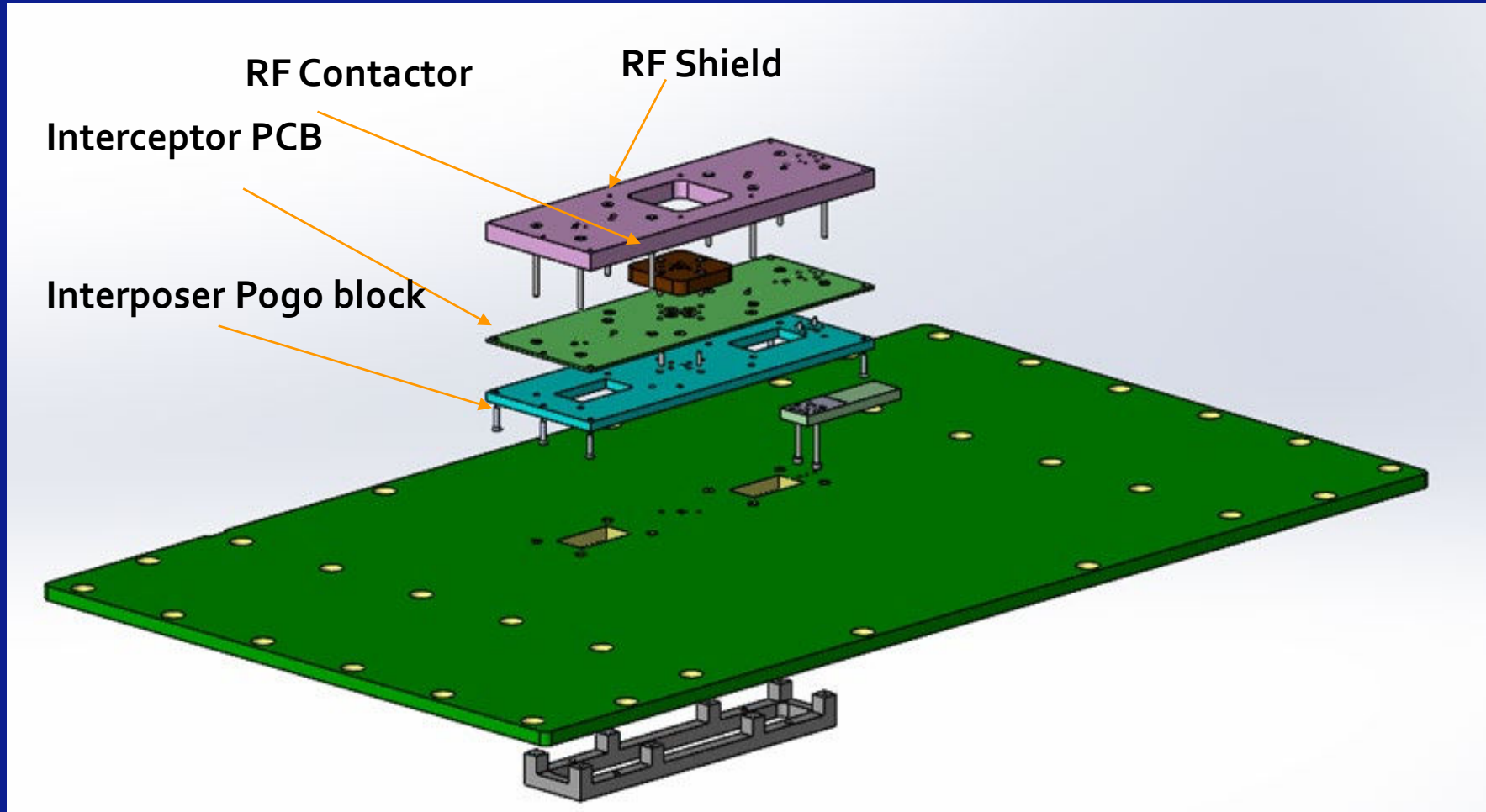
- Testing 5G devices at mmWave (55+ GHz)
- Calibration to the DUT
- Signal integrity with minimal loss from tester to DUT
- Implementation costs
- mmWave interfacing (cable “jungle”)

Interceptor Technology

- Interceptor concept
 - Intercepts the RF signals and routes the signals to bypass the loadboard
 - Integrates a small RF focused PCB into the contactor itself
 - Reduces the cost and complexity on the tester loadboard
 - Minimizes interfacing requirements
- 5G Interceptor contactor includes:
 - 55+ GHz switching for up to 32 channels
 - MIPI controller
 - ID tracking chip (Protrace)

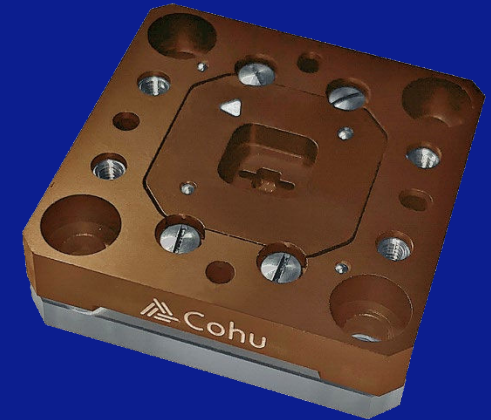


Interceptor Loadboard Assembly



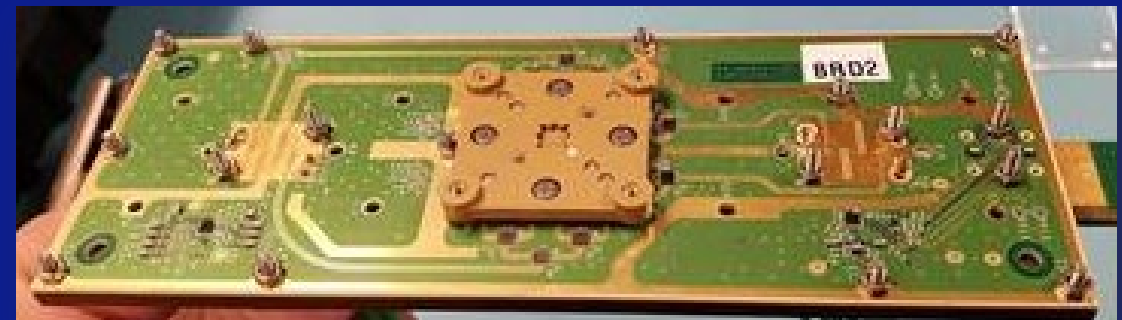
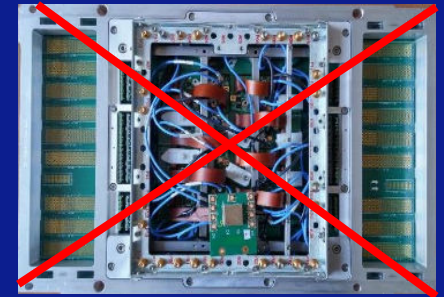
Enabling Technologies

- 60 GHz spring probes (cRacer)
- RF optimized PCB
 - Coaxial vias
 - Precision feature control
- Calibration substrates (DUT surrogates)
 - Optimized for each application
 - Measures the test system to allow de-embedding system parasitics
 - Open short load and configurable thru



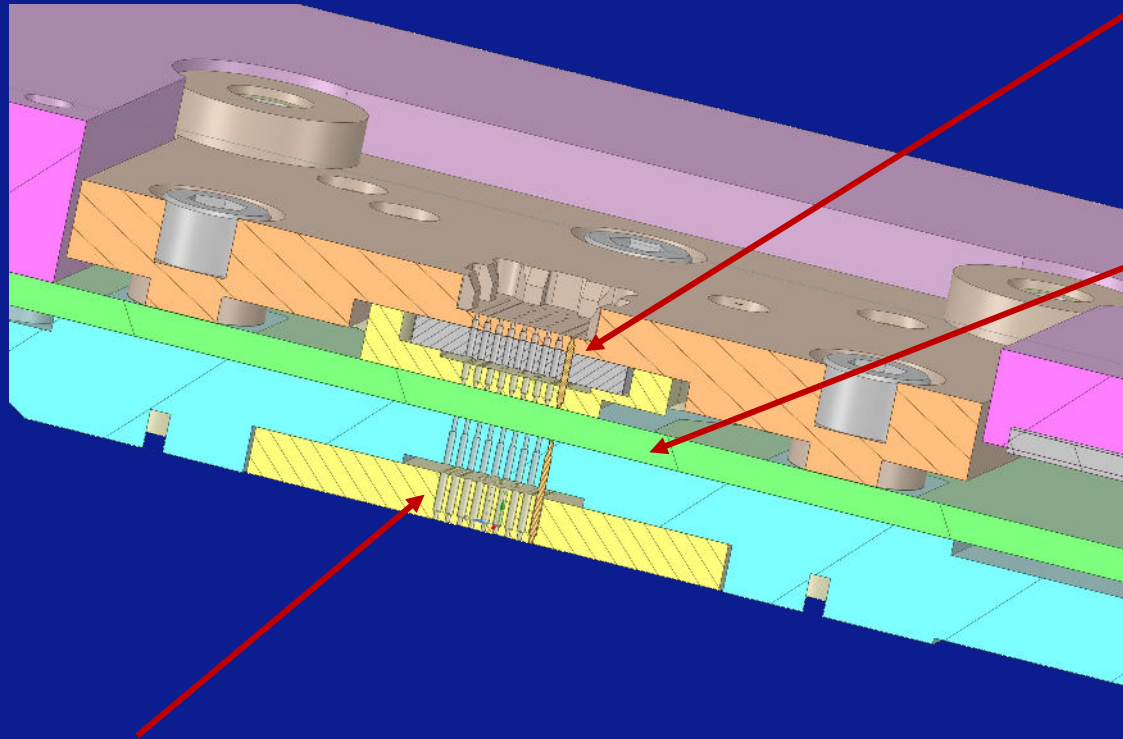
5G Interceptor: Part of Cohu 5G Test Cell

- Performance
 - Shortest fanout distance from source to DUT - lowest loss
 - Shielded and low loss cables, switches connector, Interceptor, and contactor
- Density
 - 2.5 mm RF cable pitch
 - Order of magnitude finer pitch
 - Up to 32 RF pins per DUT
- Universal
 - Generic socket board
 - Only Interceptor board customized for DUT
- Calibration
 - Cal substrate, calibration from tester to DUT
- Simplicity
 - Blind mate loadboard - No cable routing jungle on back of loadboard
 - Low frequency laminate for socket board
- Cost
 - Minimized mmWave hardware
 - OEE test floor efficiency
 - Less time in calibration
 - Switch over time



Interceptor Construction

- 55+ GHz

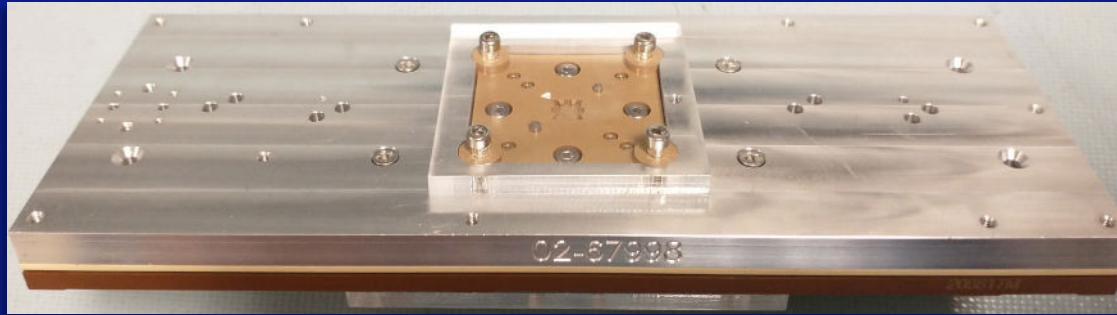


cRacer RF
optimized contactor

Embedded RF
fanout PCB

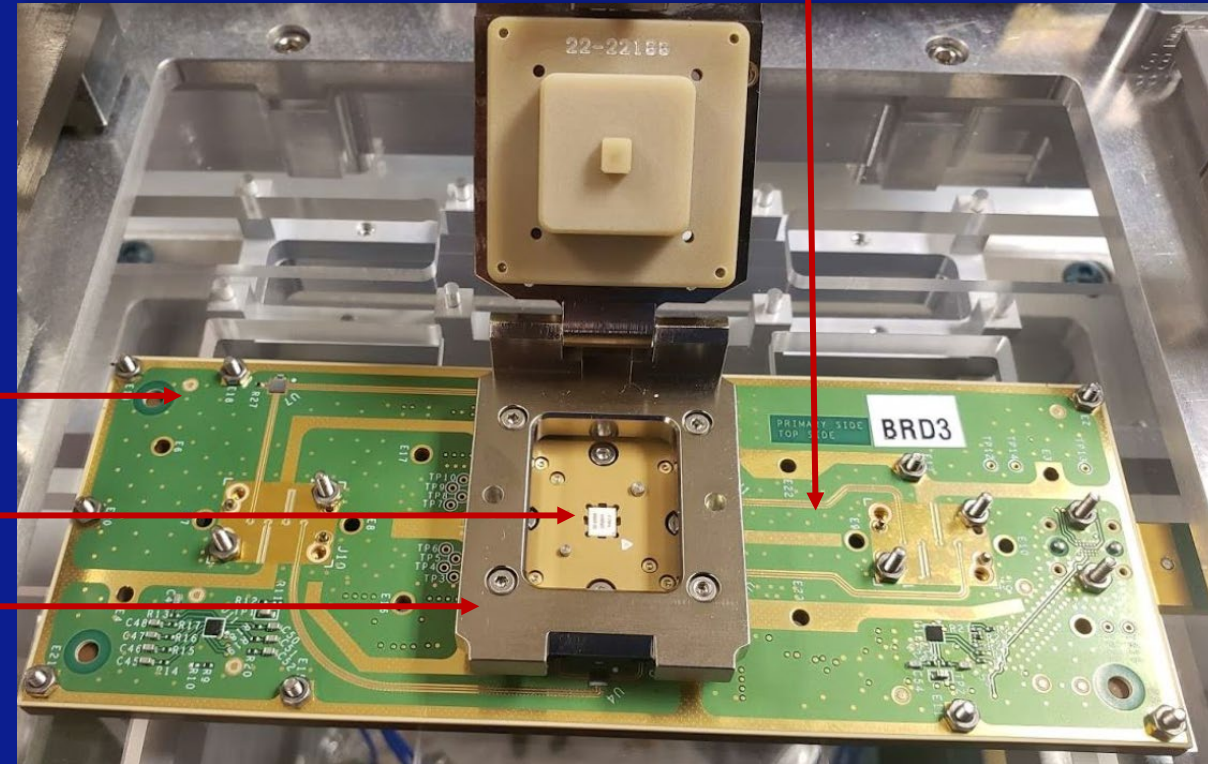
Standard spring probe interposer connects low frequency signals to loadboard

Interceptor Construction



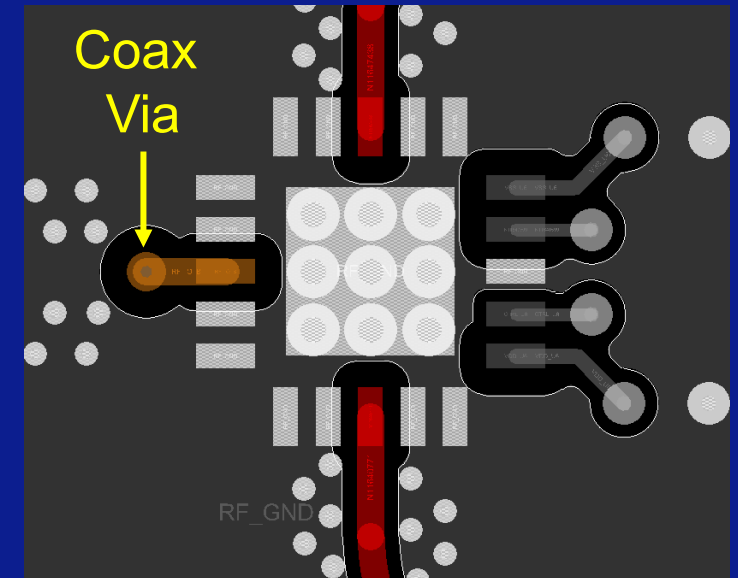
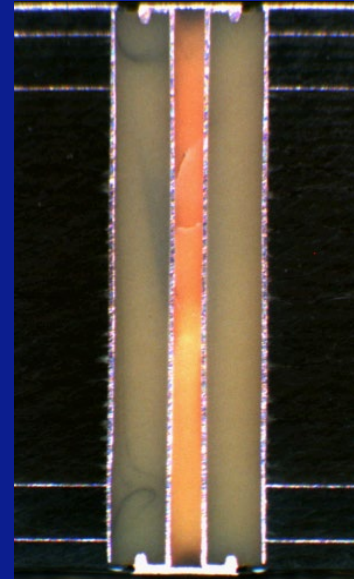
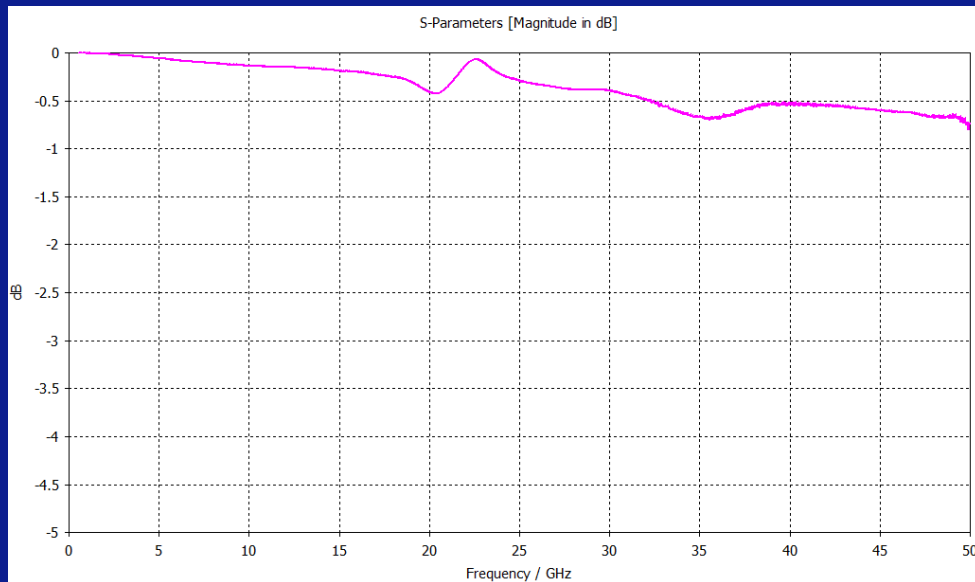
- The embedded RF PCB
- Cal substrate
- Manual actuator

- Low loss optimized RF traces



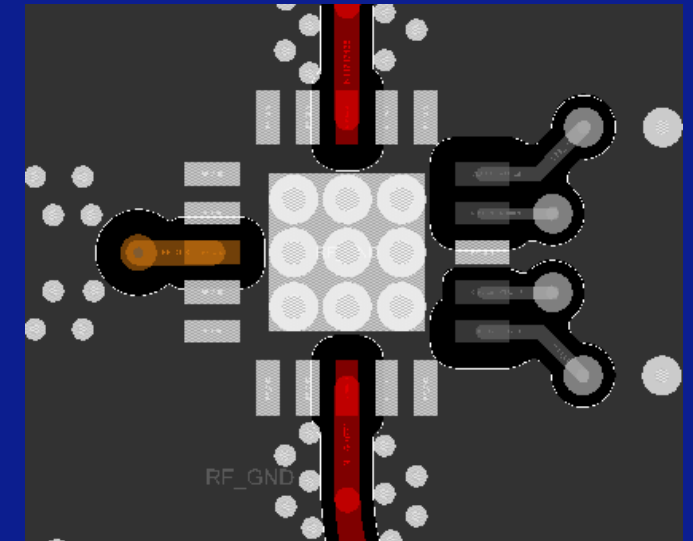
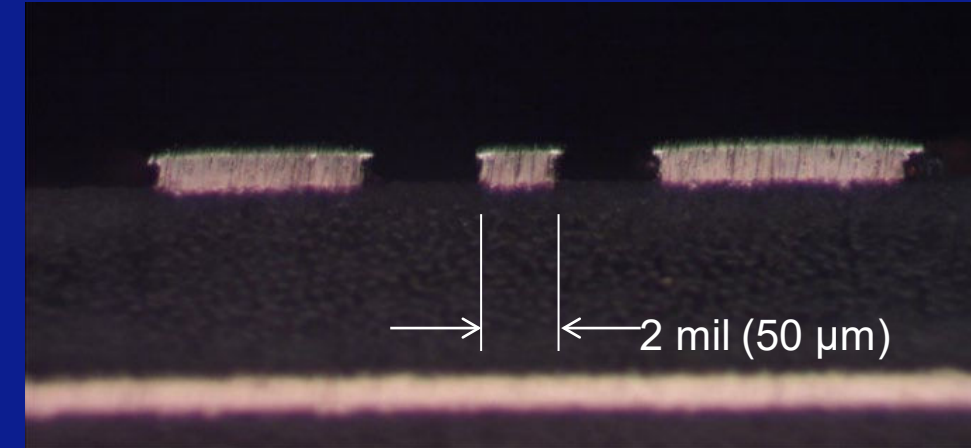
R&D Altanova: RF Coax Vias

- “Tuned impedance vias” typically are only good to ~30 GHz
- Coax vias are good to 90 GHz
- 0.7dB of loss up at 50 GHz for 150 mil fine pitch via



R&D Altanova: Precision Feature Control

- High quality outer layer improved feature process
- RF structures require high quality outer layer structures
 - Low discontinuity RF transitions
 - Strong correlation between simulation and PCB
 - Allows for trace structures like Baluns, combiners, and filters

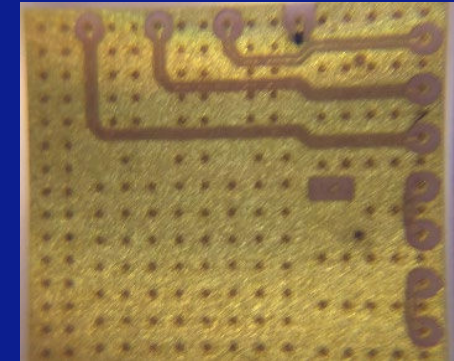
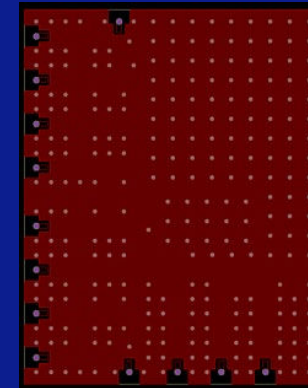


Calibration Substrates

- 2 Calibration types
 - Scalar calibration (magnitude only)
 - Vector calibration (magnitude and phase)
- 3 Calibration methods
 1. S-Parameter (provided by Cohu)
 2. Known-Good (“Golden”) Device (Customer provided)
 3. OSLT Calibration Substrates
 - Open Short Load (OSL) or thru-reflect-line (TRL or thru) structures embedded on a DUT surrogate
- Calibration substrates
 - Provide most inclusive and accurate calibration
 - Incorporate the entire signal chain from source to measure modules

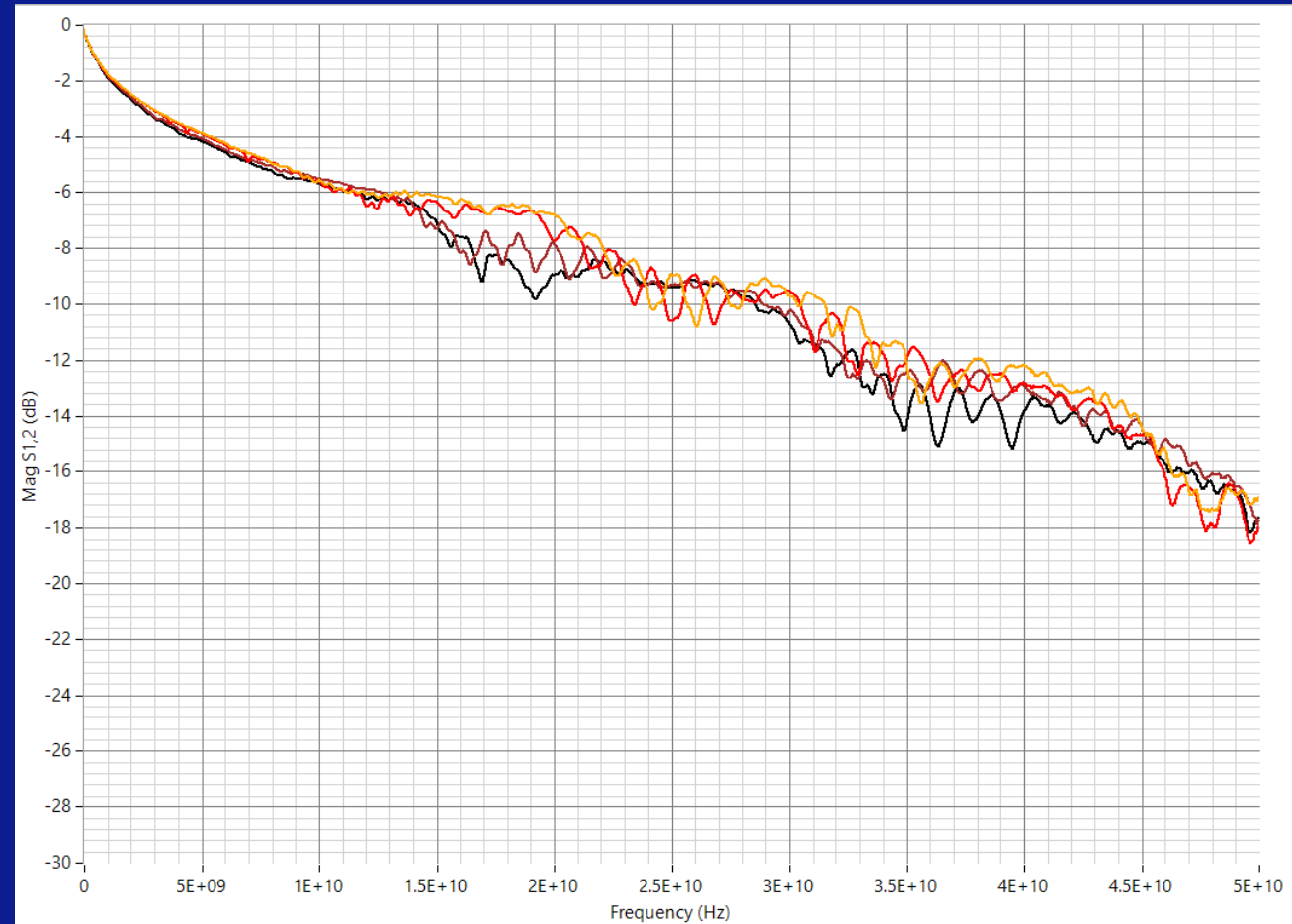


xWave S-parameters
are shipped with
contactor on USB



Performance

- Insertion loss shown on right is roundtrip through:
 - Interceptor PCB -> THRU Cal Substrate -> Interceptor PCB



Summary / Conclusion

- Interceptor supports 5G test strategies for any package type from 150 μm to 800 μm pitch
- Calibration substrates allow the tester to have a calibrated RF path to the device ball
- Signal integrity with minimal loss from tester to DUT
- Improved mmWave signal interface to the tester
- Eliminates the cable “jungle”
- Thank you to R & D Altanova for the opportunity and collaboration!