# AWARD WINNING PERFORMANCE

High performance devices call for high performance test and burn-in solutions and require participation by the entire test ecosystem including contactors, sockets, the DUT board, along with the environment that testing takes place in and the methodology applied. This session provides insight to each step beginning with the development of a statistical model to identify the optimized bandwidth for spring probes. Next up is a look at environmental factors that can readily impact socket performance and thus indirectly test yield. The third presentation verifies test methodology to troubleshoot a device that is having issues in a very high performance test contactor to determine the cause of the issues and affect changes to prevent them from reoccurring. Lastly, we'll hear about the unique challenges to create an optimized test methodology for 25 to 40 GHz RF amplifiers, mixers, and down converters in LFCSP (QFN) and WLCSP packages, considering connectivity issues between DUT board and sockets.

## Design of Experiments Using Spring Probe Parameters for Optimized Socket Bandwidth

Mike Fedde, Ila Pal—Ironwood Electronics, Inc.

This Paper

## Socket Performance vs. Environmental Conditions

Gert Hohenwarter—GateWave Northern, Inc.

## Troubleshooting Test Oscillation Problems

Jeff Sherry—Johnstech International Corporation

## Optimization of Package, Socket and PC Board for 25 to 40GHz RF Devices

Carol McCuen, Phil Warwick—R&D Circuits, Inc.

# Socket Performance vs. Environmental Conditions

Gert Hohenwarter
GateWave Northern, Inc.

2013 BiTS Workshop
March 3 - 6, 2013

## Background

- DC Socket performance expected to change with 'external contributions'
- RF performance changes can range from imperceptible to very noticeable

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## Objective

- Demonstrate impact of condensation and ice formation
- Examine contributions from metal build-up

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## Approach

- Set up test environment as used in standard RF characterization, record performance
- Introduce ‘contaminants’ and record changes
- Corroborate findings via 3D finite element analysis

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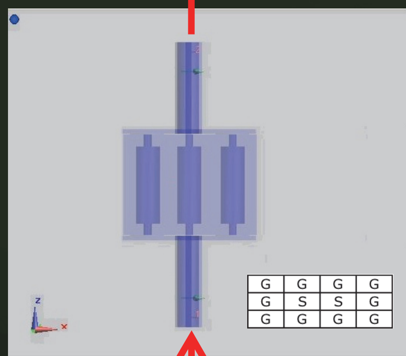
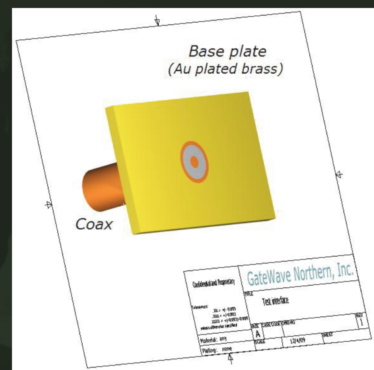
## Test setup

Signal out (S21)




Signal in and reflection (S11)

**Setup reflects typical RF characterization environment**

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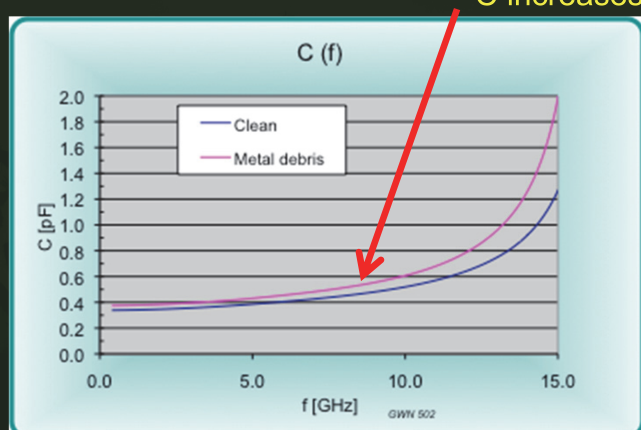
## Contaminant: Metal – Capacitance

C increases




**Capacitance C to ground before and after contamination**

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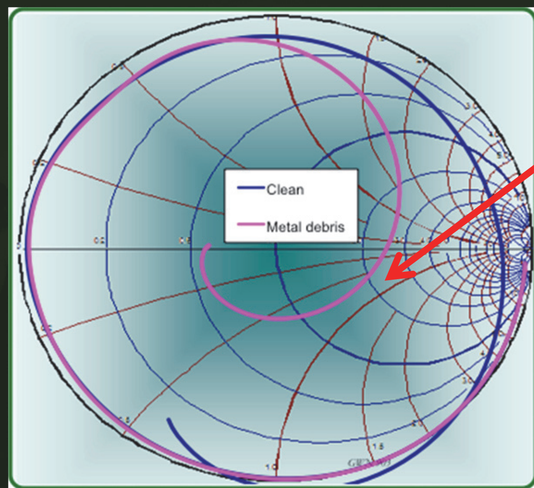
## Contaminant: Metal – Smith chart




Loss increases at elevated frequencies

**Open circuit S11 before and after contamination**

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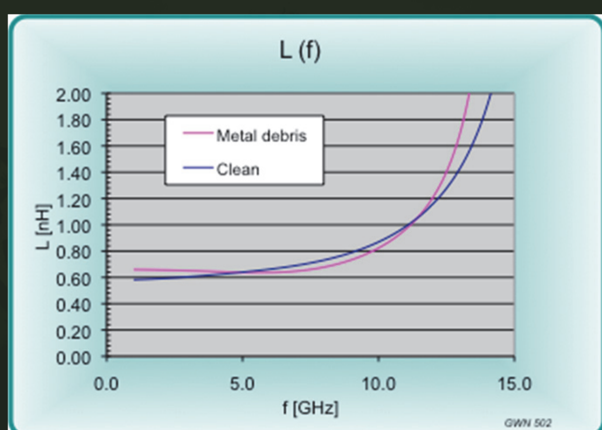
## Contaminant: Metal – Inductance




L -> ?

**Loop inductance before and after contamination**

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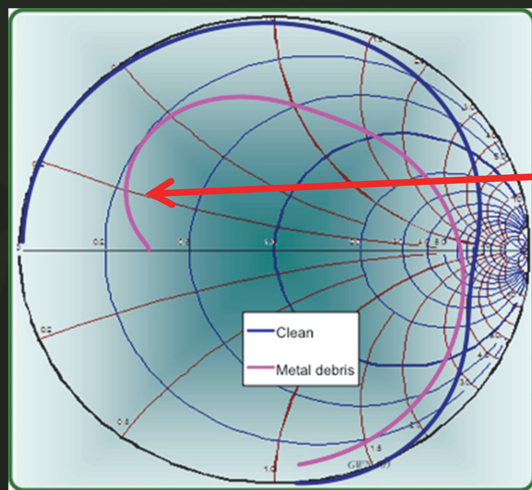
## Contaminant: Metal – Smith chart




Resistance increases at DC and low frequencies

**Short circuit S11 before and after contamination**

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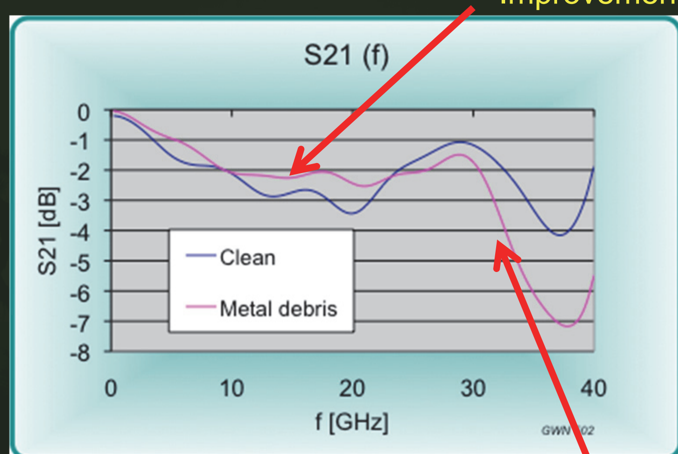
## Contaminant: Metal – S21

Improvement




Deterioration

**S21 insertion loss before and after contamination**

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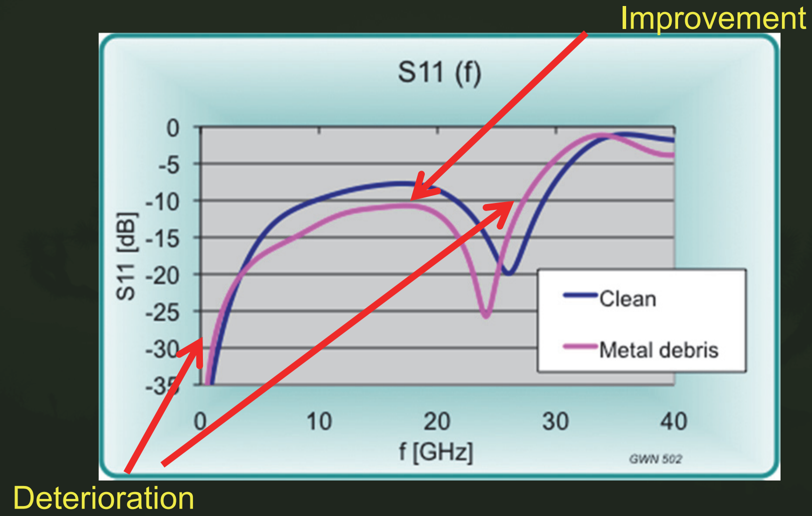
## Contaminant: Metal – S11




S11 return loss before and after contamination

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## Contaminant: Metal - TDT


Time domain transmission trace before and after contamination

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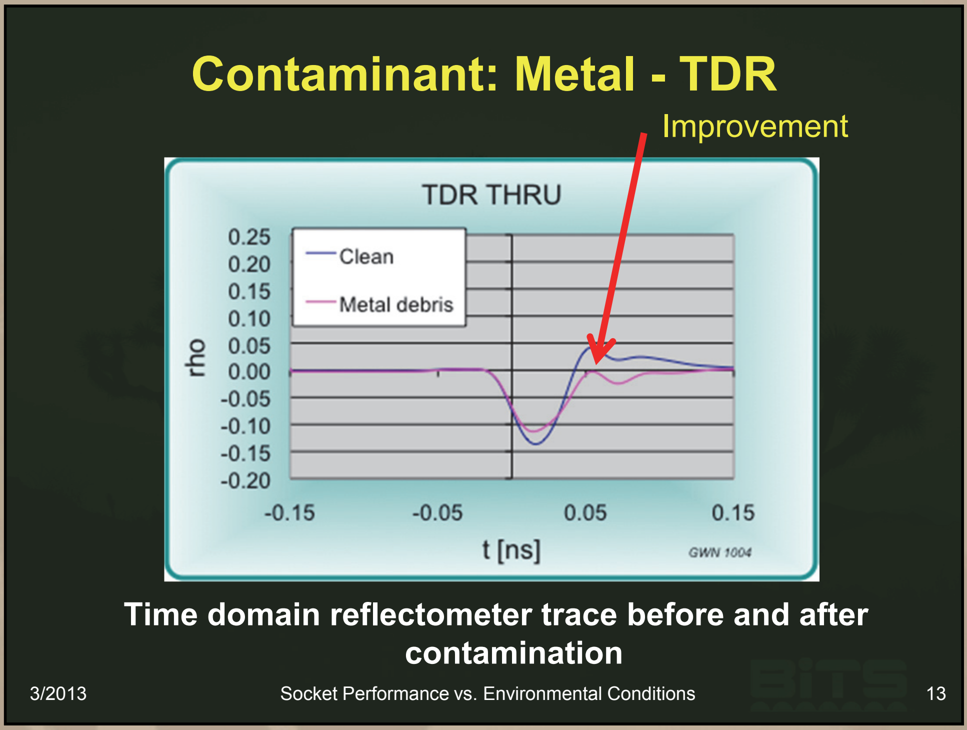
Contaminant: Metal - TDR
Improvement
TDR THRU
Clean
Metal debris
rho
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.15
-0.05
0.05
0.15
t [ns]
GWN 1004
Time domain reflectometer trace before and after contamination
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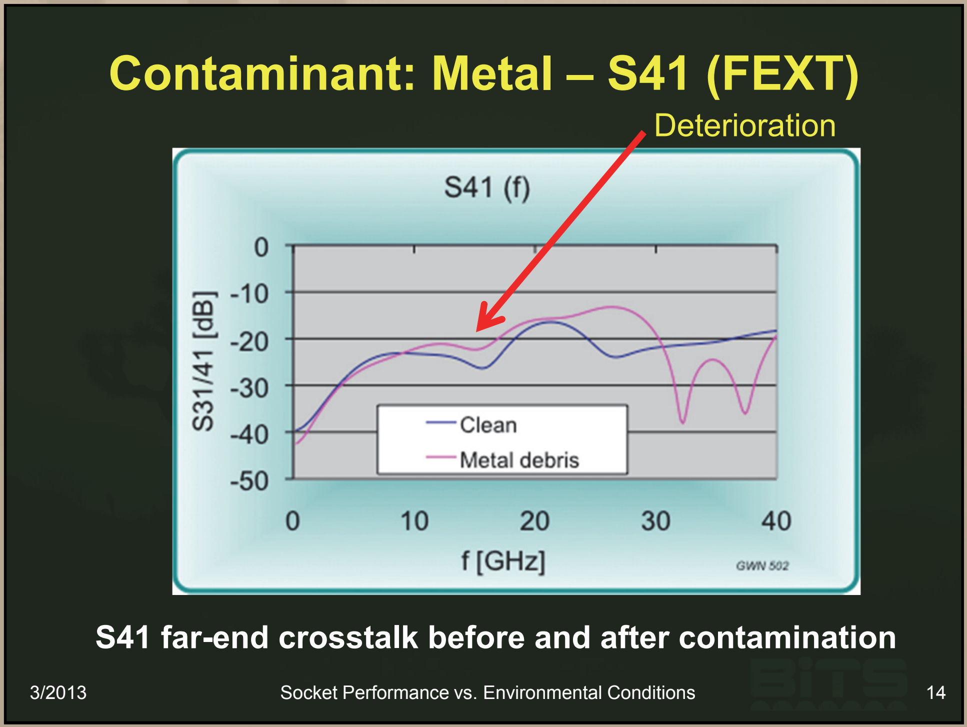
Contaminant: Metal – S41 (FEXT)
Deterioration
S41 (f)
S31/41 [dB]
0
-10
-20
-30
-40
-50
Clean
Metal debris
0
10
20
30
40
f [GHz]
GWN 502
S41 far-end crosstalk before and after contamination
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## Contaminant: Metal - Comments

- In this case metal build-up results in a performance improvement at low frequencies and a deterioration at elevated frequencies
- Results ***are specific*** to a particular socket and test environment
- Low frequency increases in resistance did interfere with inductance characterization

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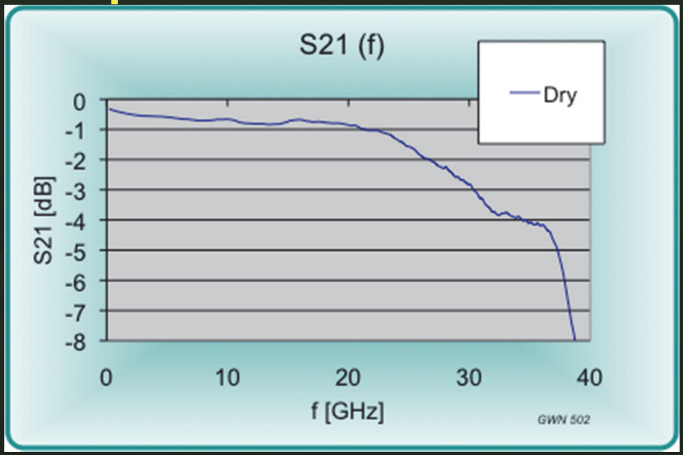
## Impact of moisture: S21




**S21 insertion loss before and after condensation**

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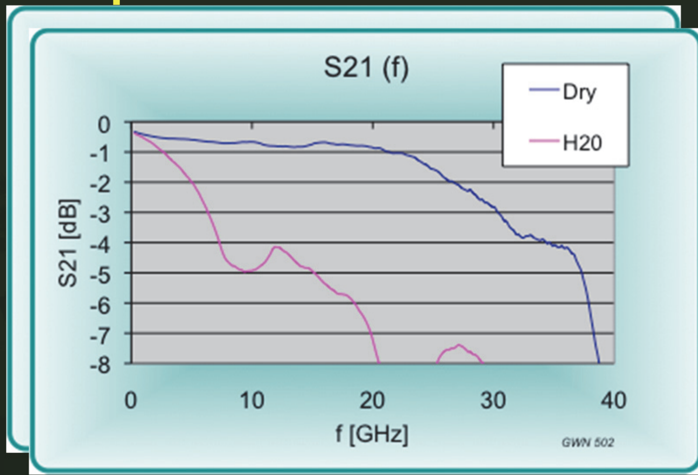
## Impact of moisture: S21




**S21 insertion loss before and after condensation**

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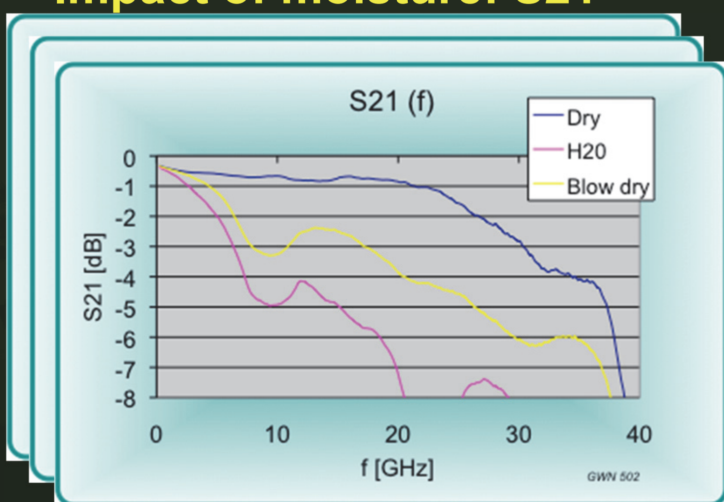
## Impact of moisture: S21




| | | | |
|---|---|---|---|
| -1 dB: | 21.3 | 2.6 | 4.2 GHz |

**S21 insertion loss before and after condensation**

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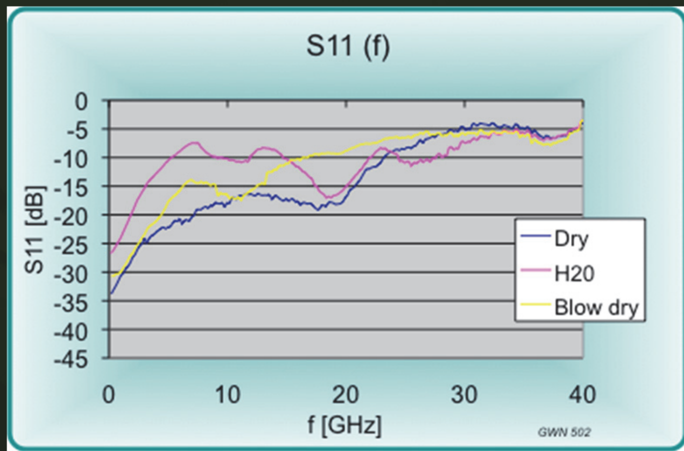
## Impact of moisture: S11




**S11 return loss before and after condensation**

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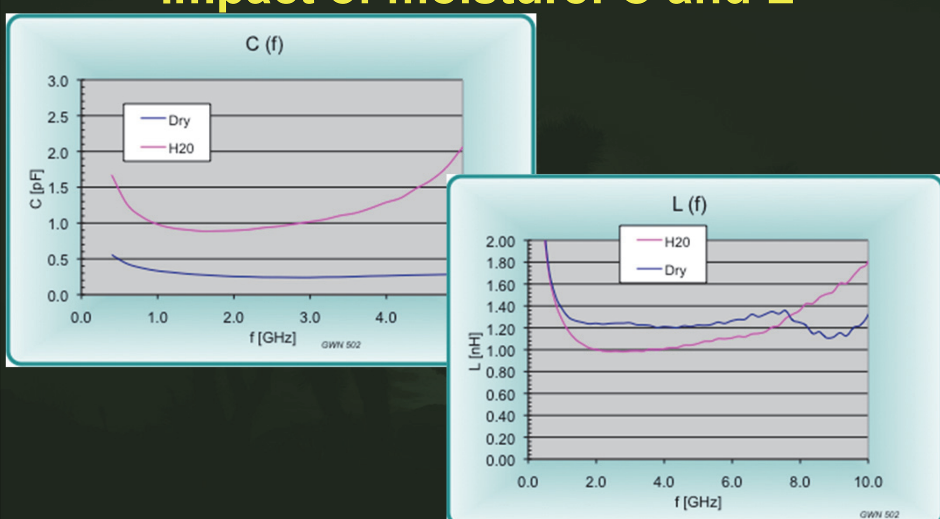
## Impact of moisture: C and L




**Capacitance and inductance before and after condensation**

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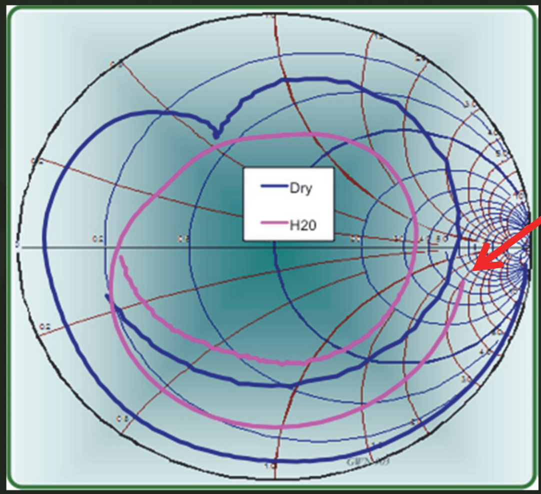
## Impact of moisture: Smith chart




Significant loss at low frequencies means also increased leakage at DC

**Open circuit S11 before and after moisture exposure**

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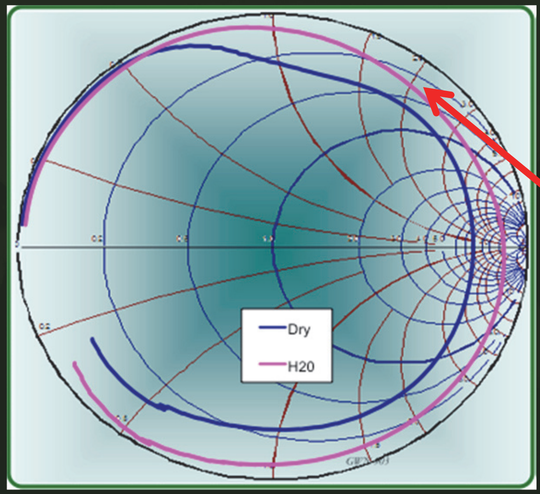
## Impact of moisture: Smith chart




Less loss at elevated frequencies for short circuit condition

**Short circuit S11 before and after condensation**

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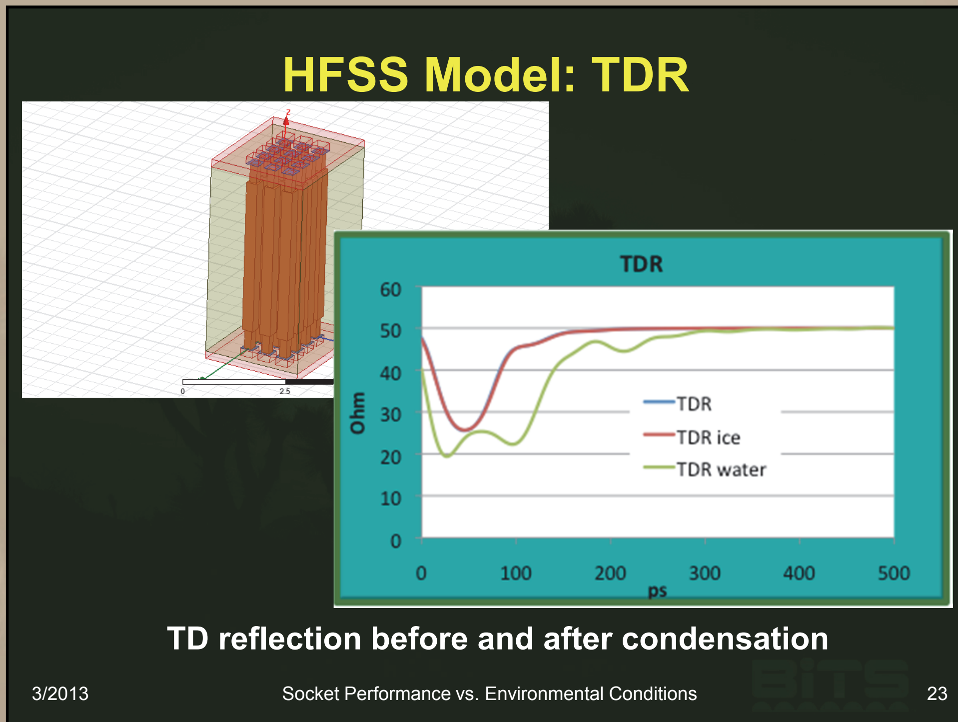
HFSS Model: TDR
TDR
60
50
40
30
20
10
0
Ohm
TDR
TDR ice
TDR water
0
100
200
300
400
500
ps
TD reflection before and after condensation
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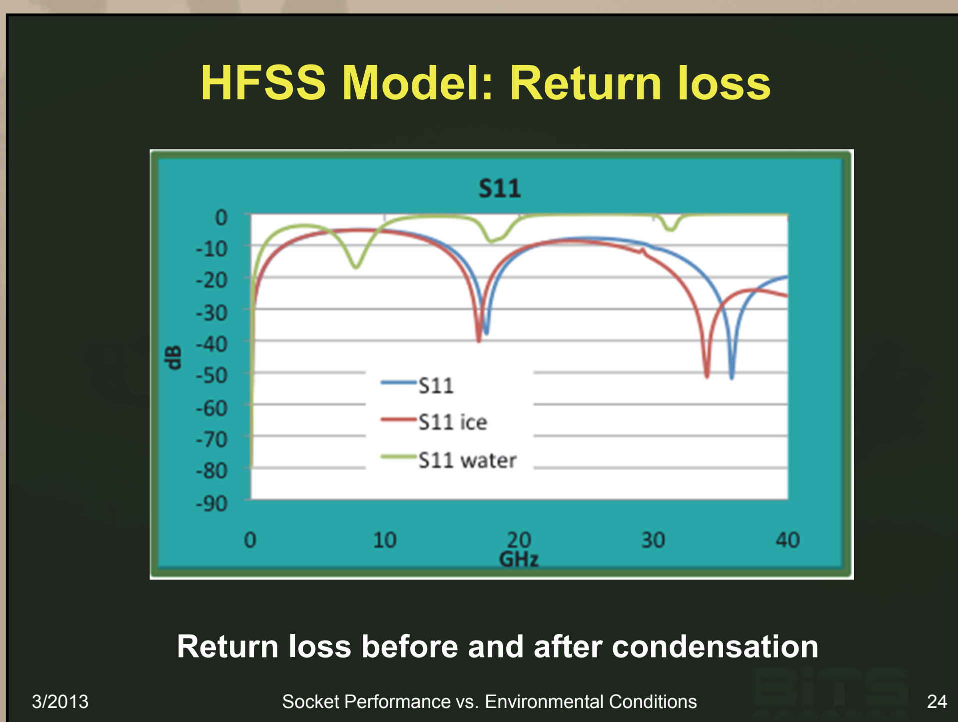
HFSS Model: Return loss
S11
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
dB
S11
S11 ice
S11 water
0
10
20
30
40
GHz
Return loss before and after condensation
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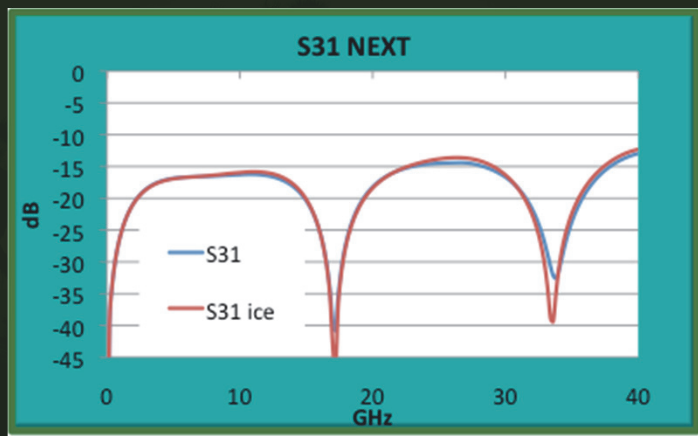
## HFSS Model: Crosstalk




NEXT crosstalk before and after condensation

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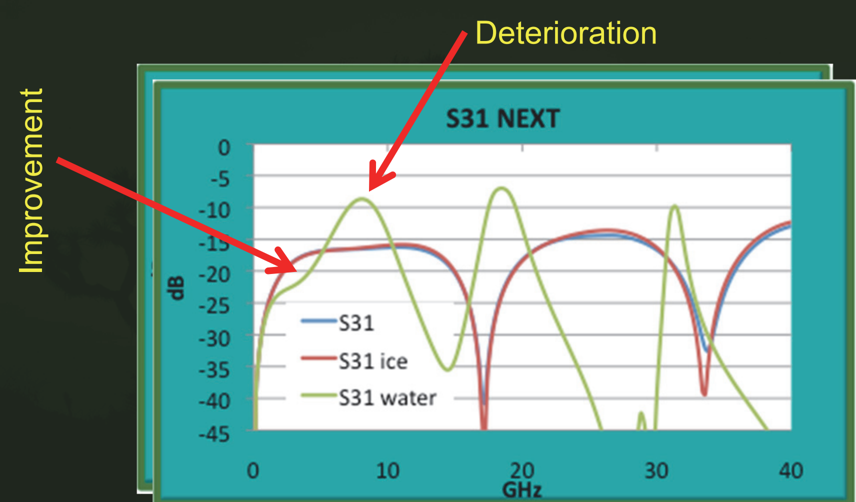
## HFSS Model: Crosstalk




NEXT crosstalk before and after condensation

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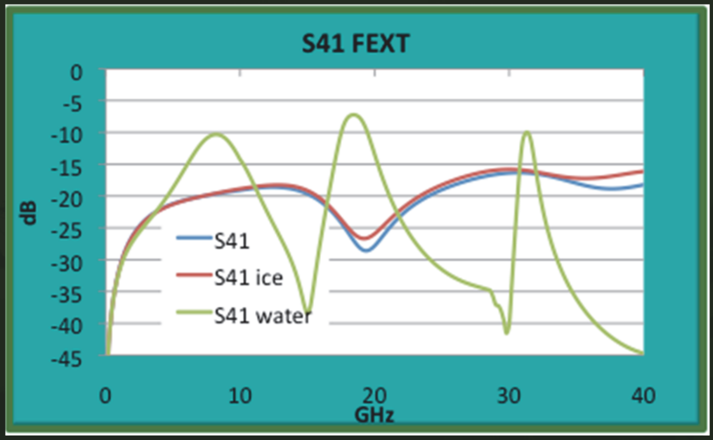
## HFSS Model: Crosstalk




**FEXT crosstalk before and after condensation**

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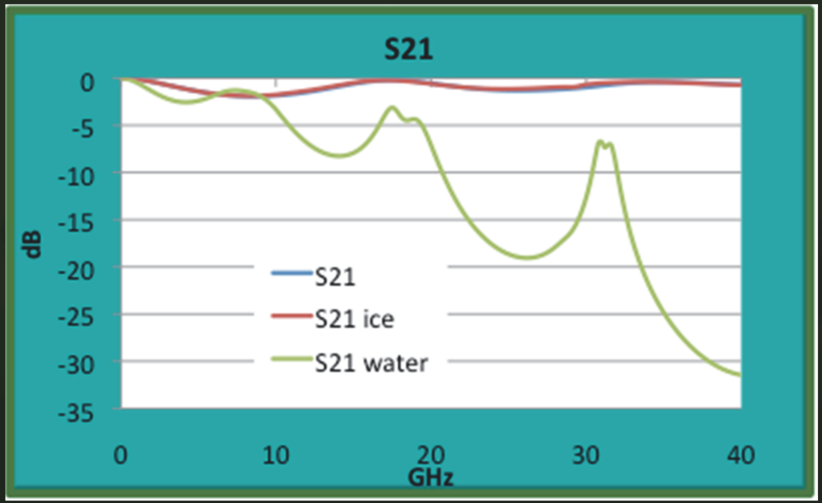
## HFSS Model: Insertion loss




**Insertion loss S21 before and after condensation**

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## Conclusion

- Even small amounts of moisture can severely reduce socket RF performance
- Metal buildup can have noticeable effect on RF performance, but impact is not guaranteed to be negative.
- Experimental performance changes can be predicted by 3D FEA model
- Contamination and condensation do not always result in performance deterioration.

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