
SIXTEENTH ANNUAL
BiTS
Burn-in & Test Strategies Workshop
March 15 - 18, 2015
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive – Session 6
© 2015 BiTS Workshop – Image: BCEC/iStock

Session 6
Marc Mössinger
Session Chair

BiTS Workshop 2015 Schedule

Performance Day

Tuesday March 17 1:30 pm

Lord of the Dance

"Electrical circuit model for silicon wafer spring pin probe"
Mohamed Eldessouki - SV Probe

"Kelvin Sockets at Speed"
Gert Hohenwarter - GateWave Northern, Inc.

"Designing Sockets for Ludicrous Speed (80 GHz)"
Don Thompson - R&D Altanova
Jose Moreira - Advantest

"PCB Test Fixture and DUT Socket Challenges for 32 Gbps/GBaud ATE Applications"
Jose Moreira - Advantest
Christian Borelli & Fulvio Corneo - STMicroelectronics

Copyright Notice

Kelvin Sockets at Speed

Gert Hohenwarter
GateWave Northern, Inc.

2015 BiTS Workshop
March 15 - 18, 2015

Problem

- Kelvin sockets bring together two signal paths at the device under test (DUT)
- This presents challenges for testing and applications if used at higher speeds
- Identify ways to characterize Kelvin test sockets
  - Test configurations
  - Termination values
- Examine performance of Kelvin socket on a load board

Approach

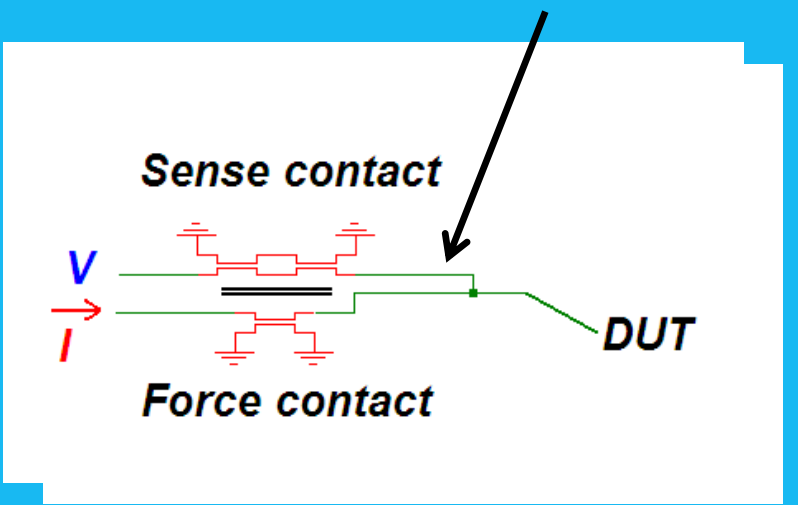
- Measure socket parameters
- Measure load board parameters
- Simulate characteristics of different configurations in SPICE based on measured characteristics

Tools

- 40 GHz VNA
- ANSYS HFSS
- Mentor HyperLynx
- SPICE simulator

A Kelvin Socket

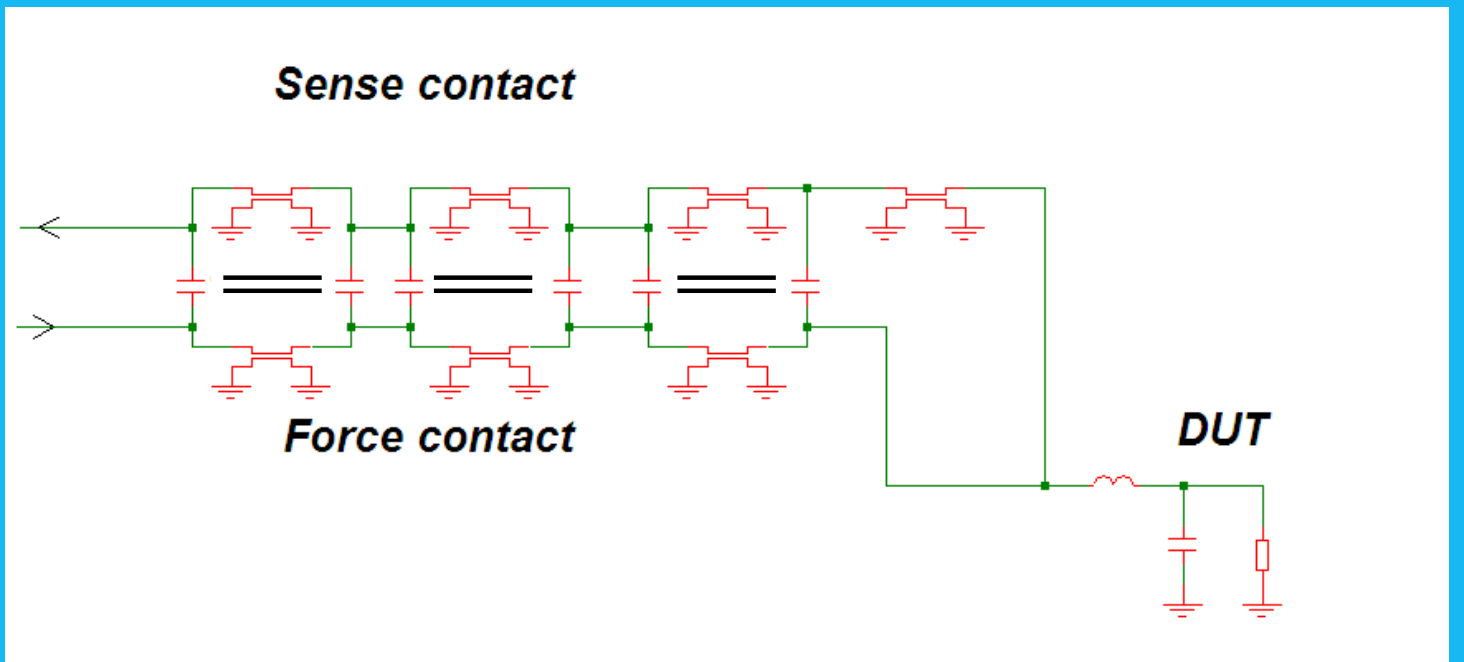
2 contacts are jointly touching one DUT pad/ball



Kelvin socket electrical model -

coupling exists between force and sense elements

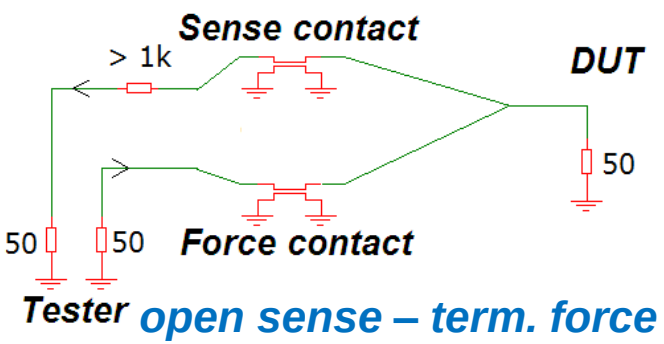
Circuit Diagram, Socket Only



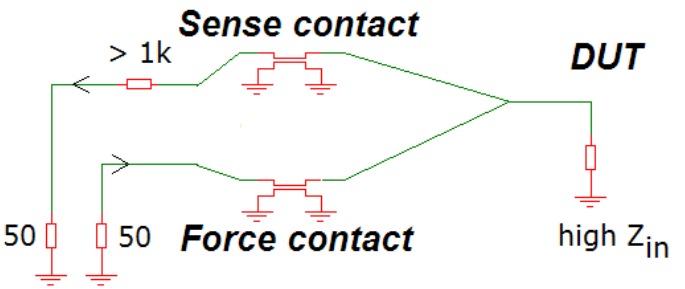
Kelvin socket model with force and sense contact

- the model was developed from measurements of an existing device

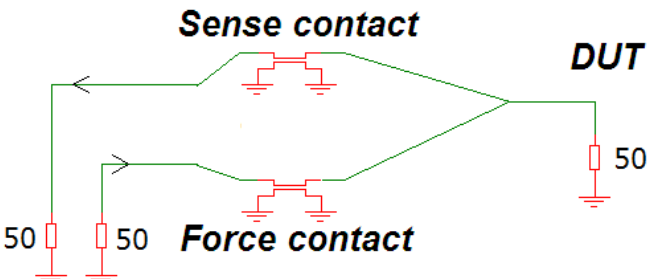
Possible Test Configurations



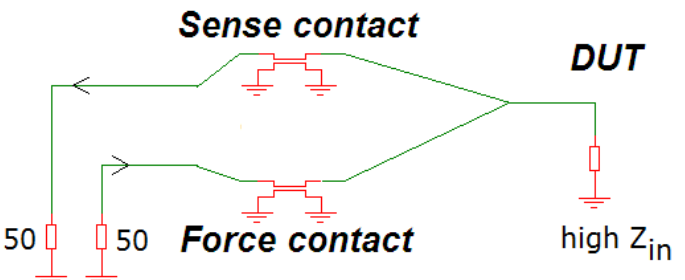
open sense – term. force



open sense – open force



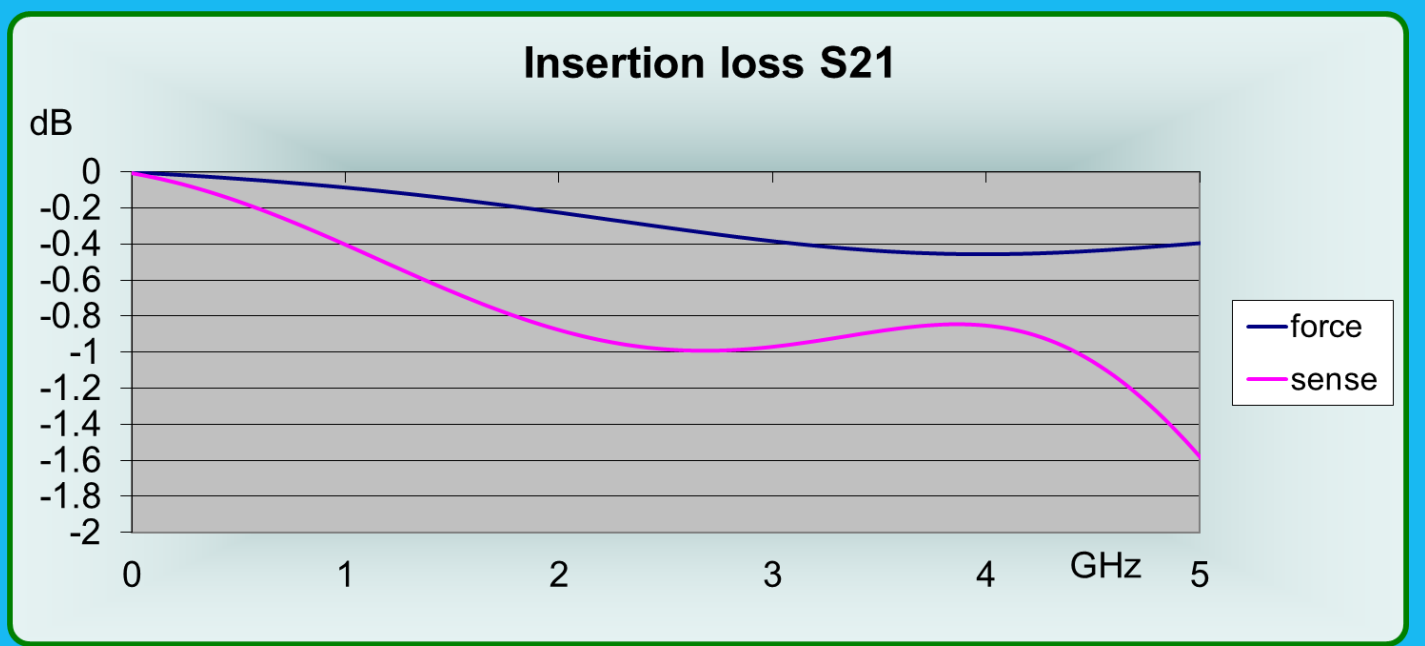
term. sense – term. force



term. sense – open force

Choice depends on DUT properties

Insertion loss S21 individual force and sense contacts

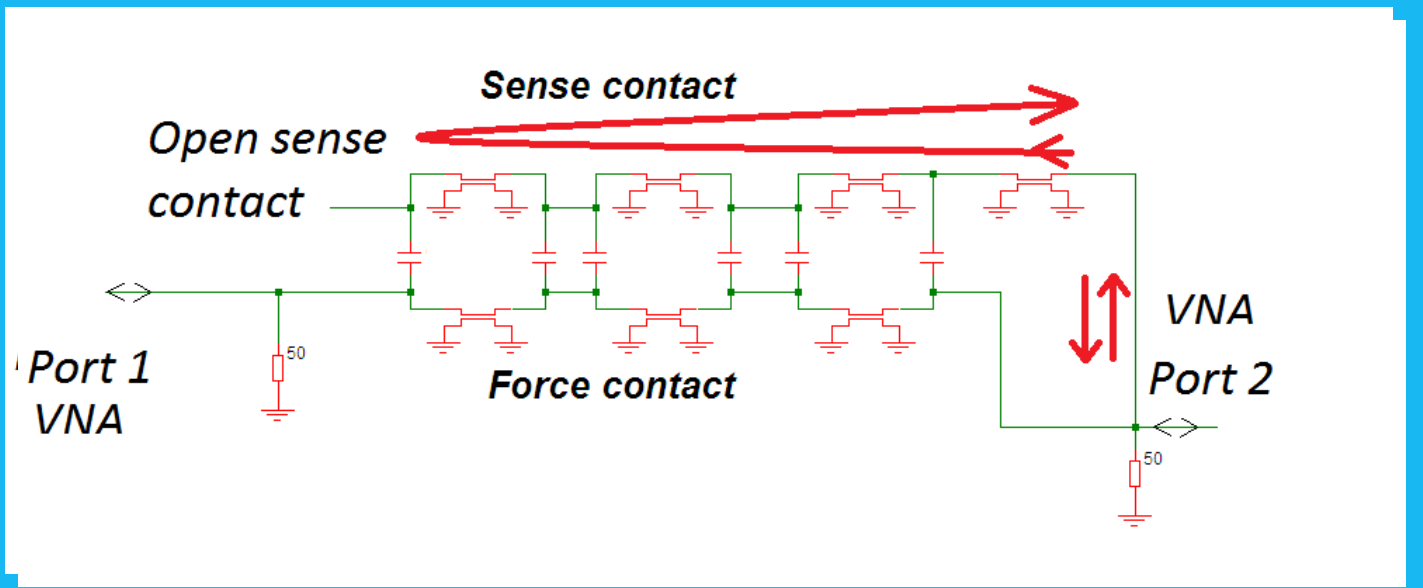


Insertion loss for individual contacts in separate sockets shows no problems to 5 GHz in this example

Insertion loss, force and sense contacts coupled, in Kelvin socket

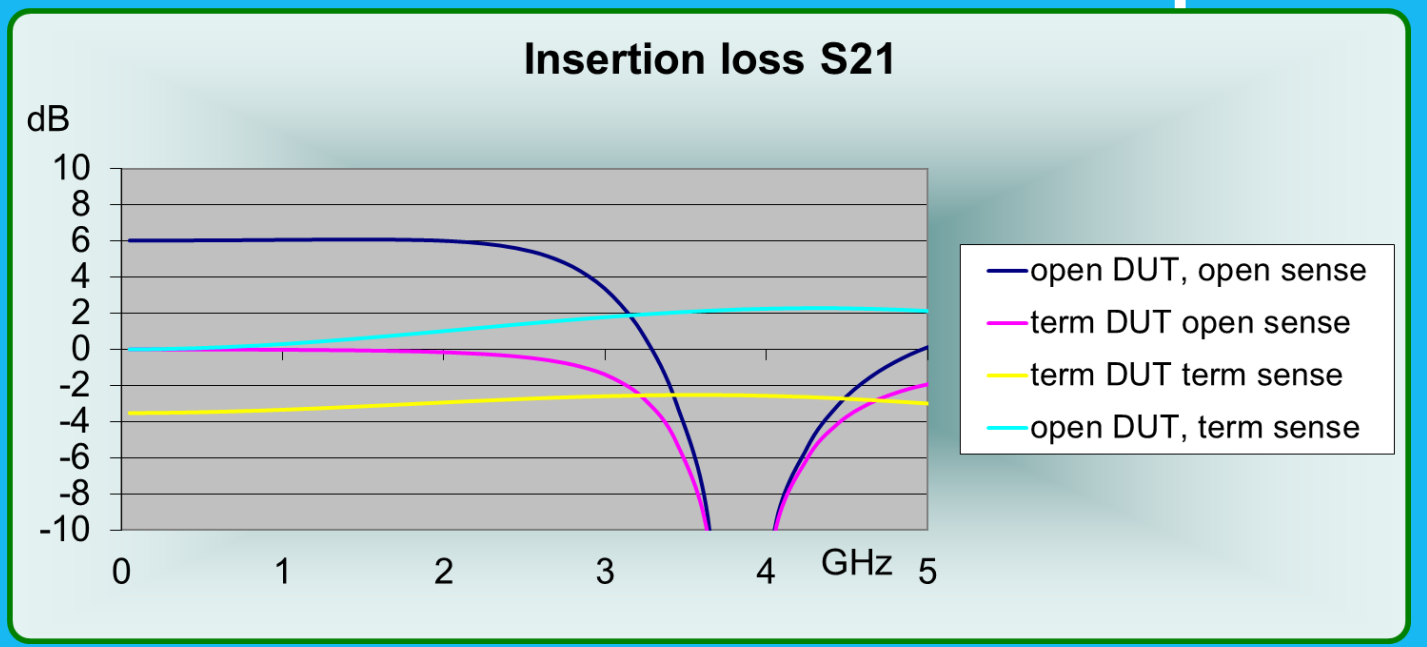
Unterminated force and sense line configurations have lowest frequency limits.

Limitation: Resonances



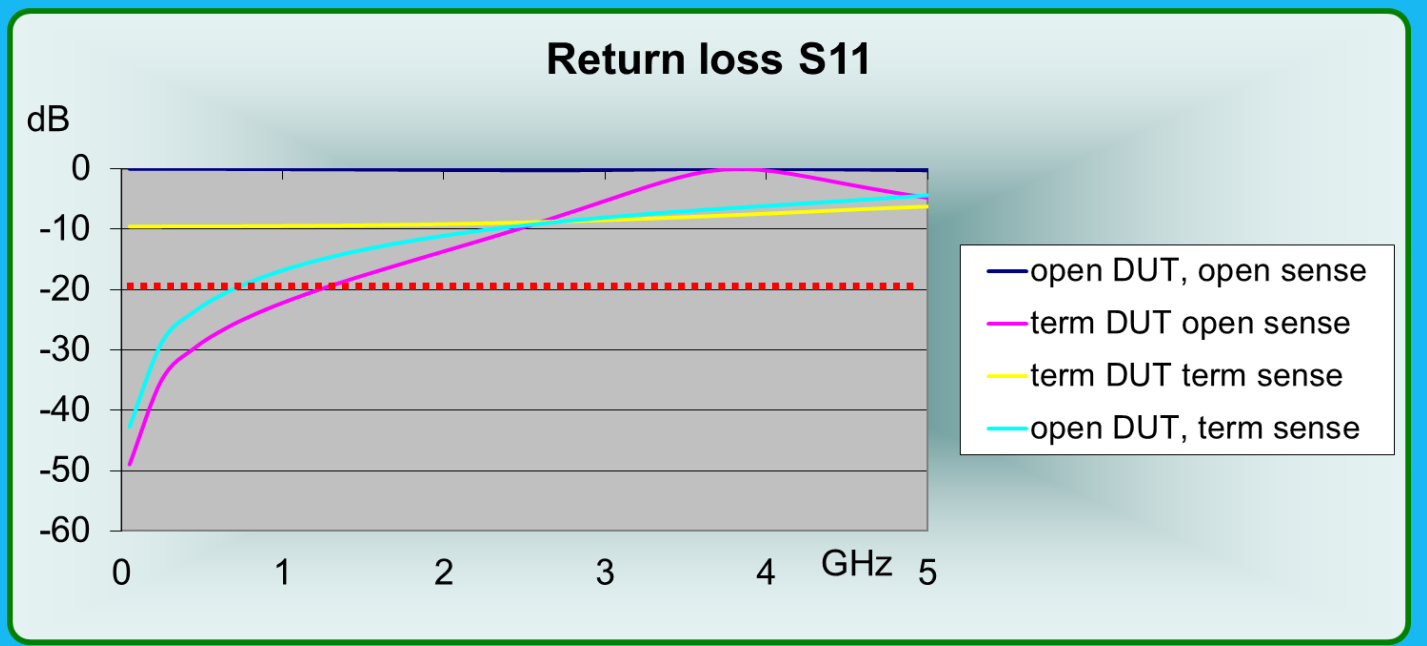
Kelvin socket terminations

Insertion loss S21
force and sense contacts coupled



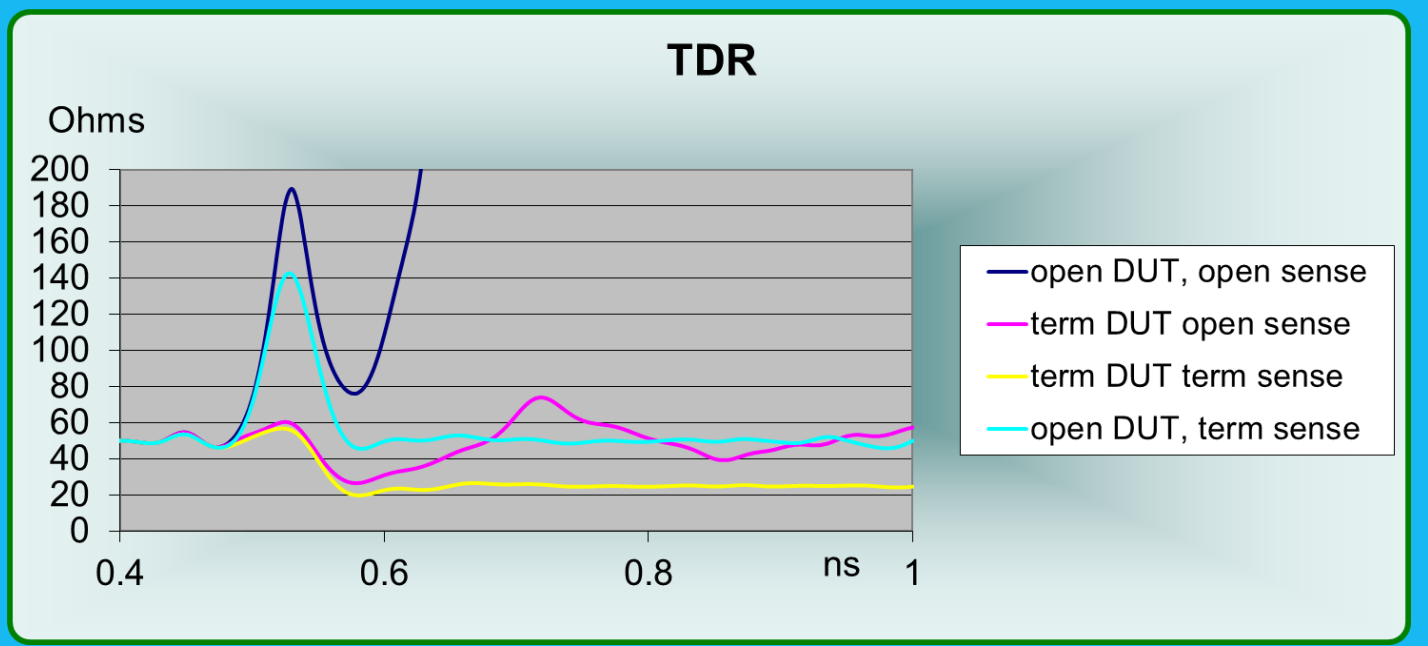
Values greater/less than 0 dB are due to the lack of proper 50 Ohm terminations at the site of the measurement

Return loss S11
force and sense contacts coupled



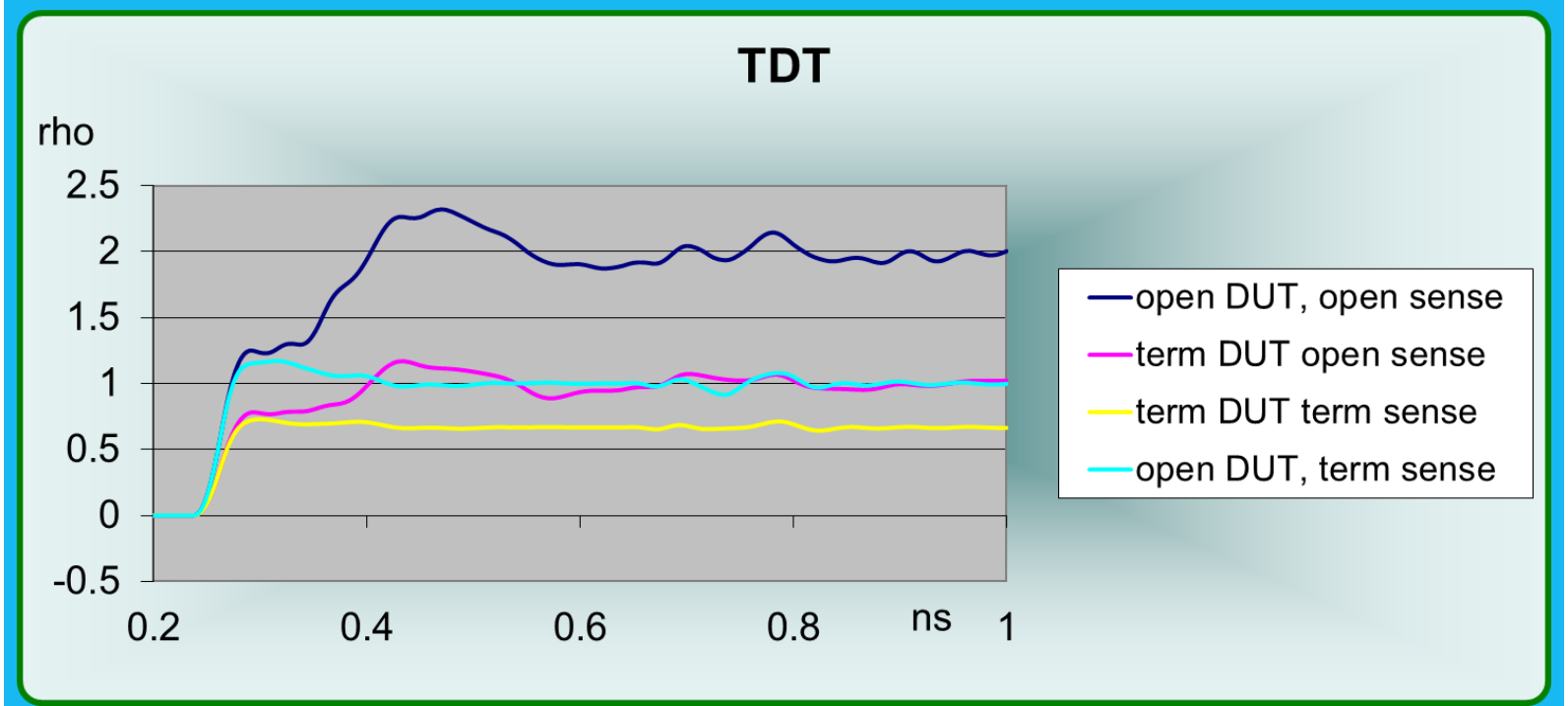
A value of -20 dB is often chosen as a useable frequency limit

TDR, force and sense contacts coupled, in socket



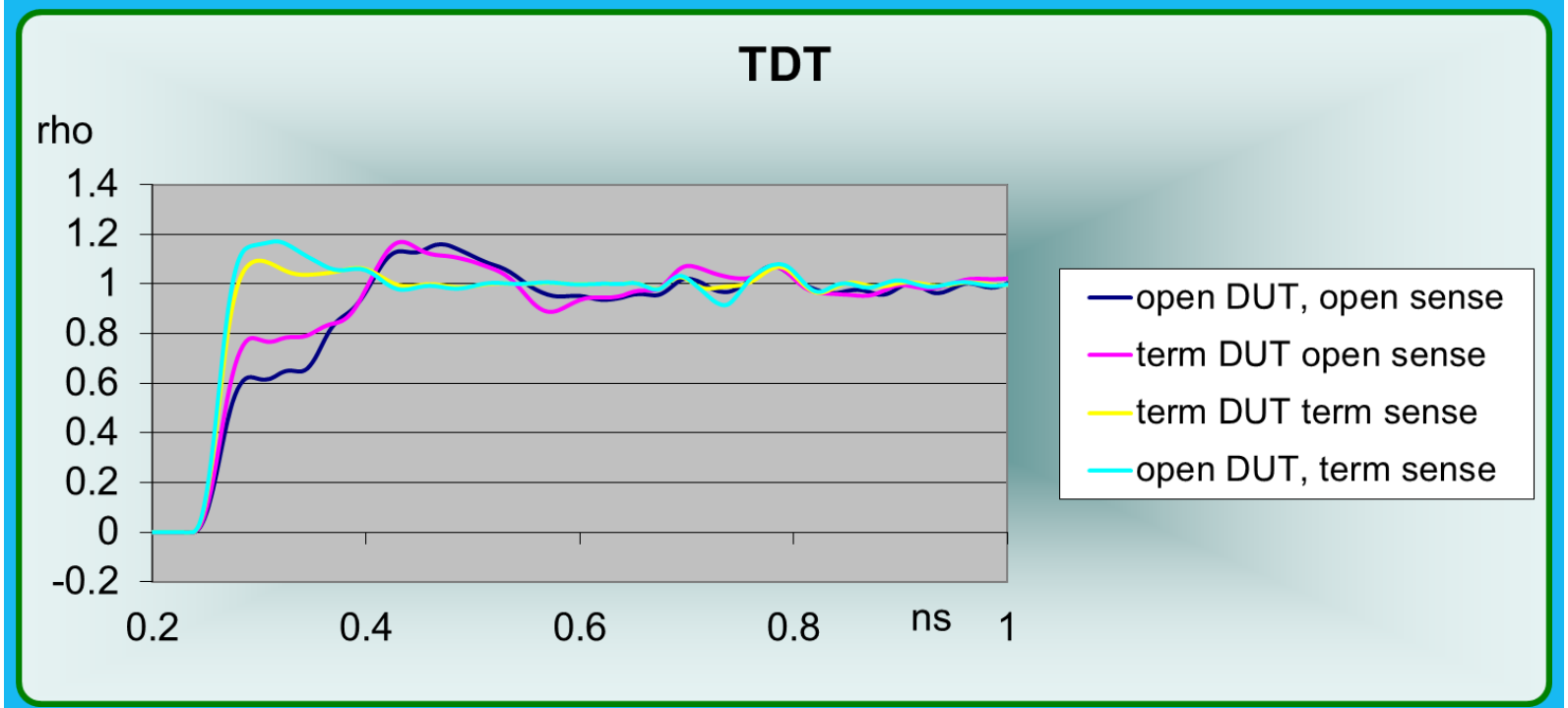
The configurations ‘open DUT, term. sense’ and ‘open DUT, open sense’ present a significant impedance discontinuity

TDT, force and sense contacts coupled, in socket



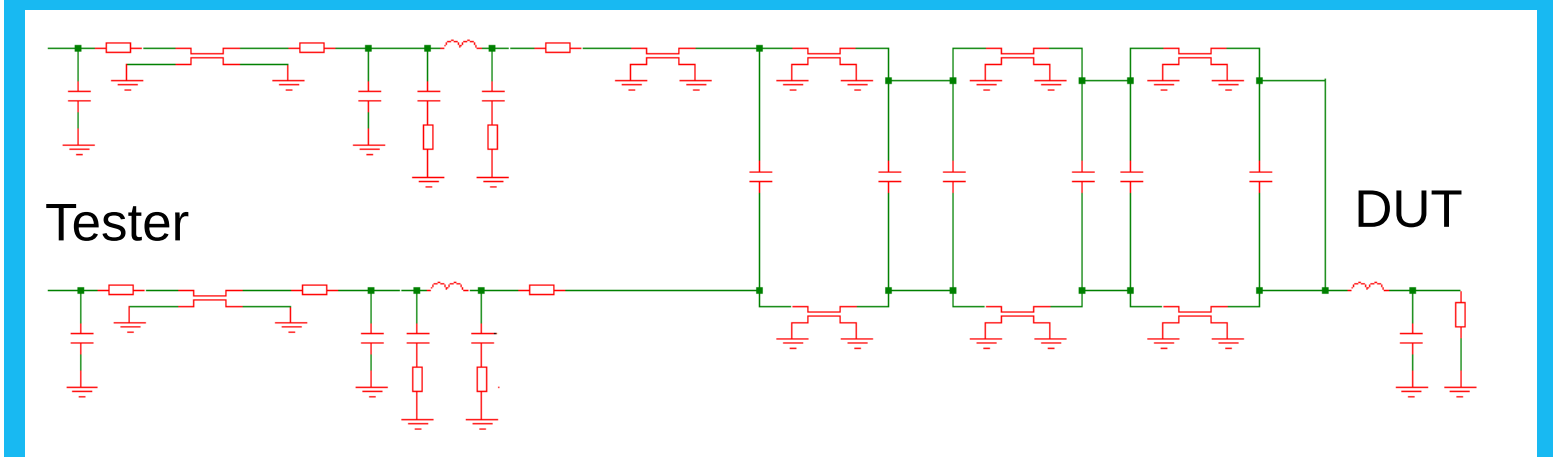
Amplitudes differ because of different combined termination resistance values

TDT, force and sense contacts coupled, in socket



Amplitudes adjusted for same end level

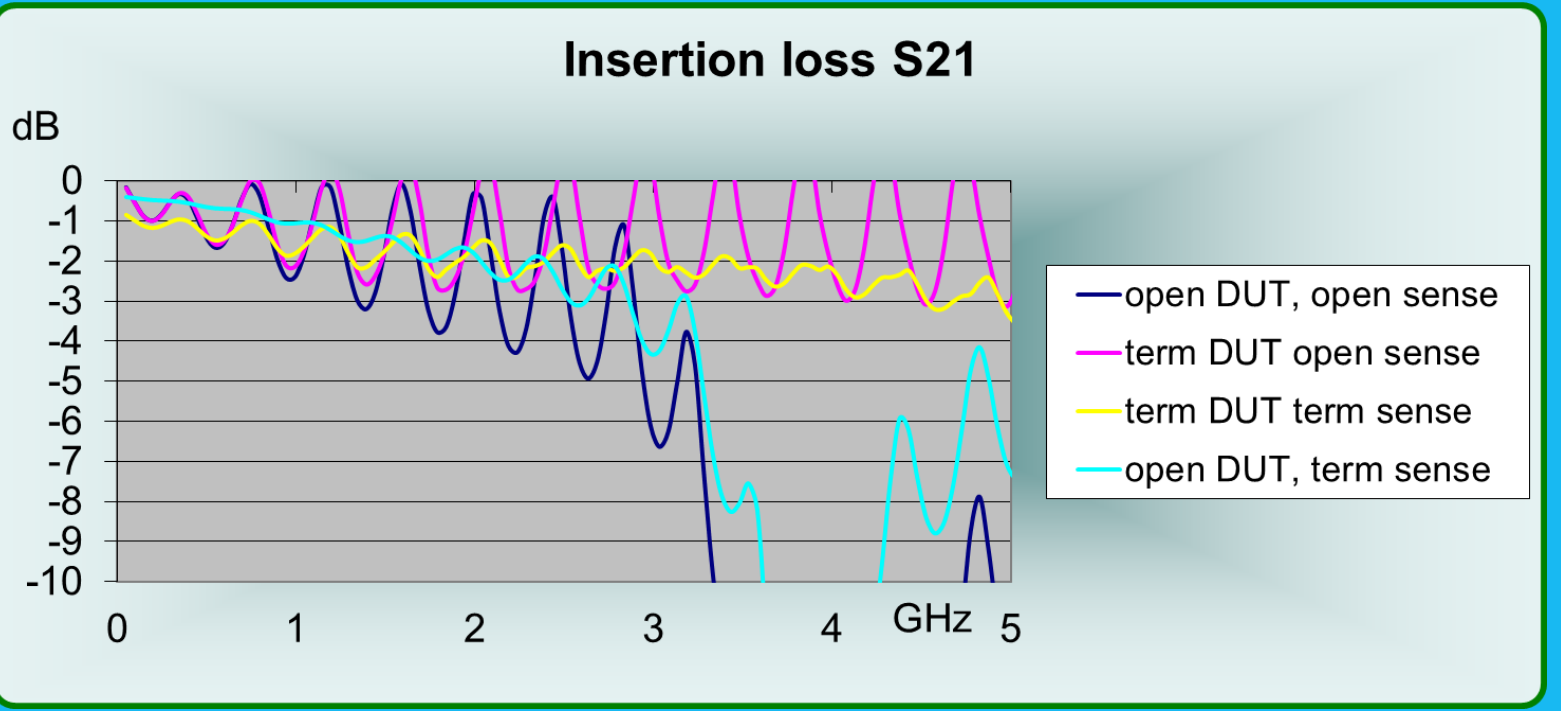
Circuit Diagram, Socket Plus PCB



Kelvin socket model with force and sense contact

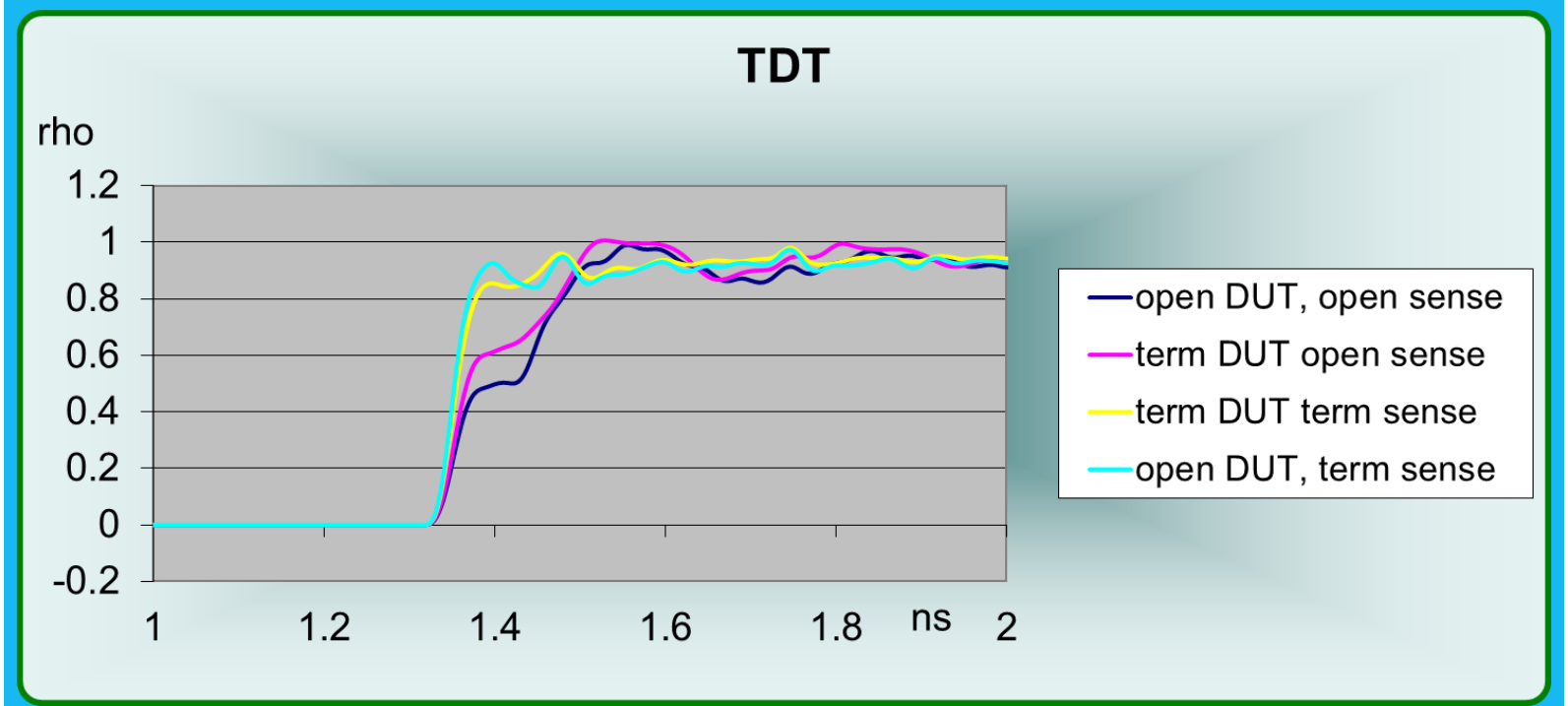
- the model was developed from measurements of an existing device and PCB

Insertion loss S21 socket with PCB



Values for 'open DUT, open sense' and 'term DUT, term sense' are amplitude adjusted

TDT, socket with PCB



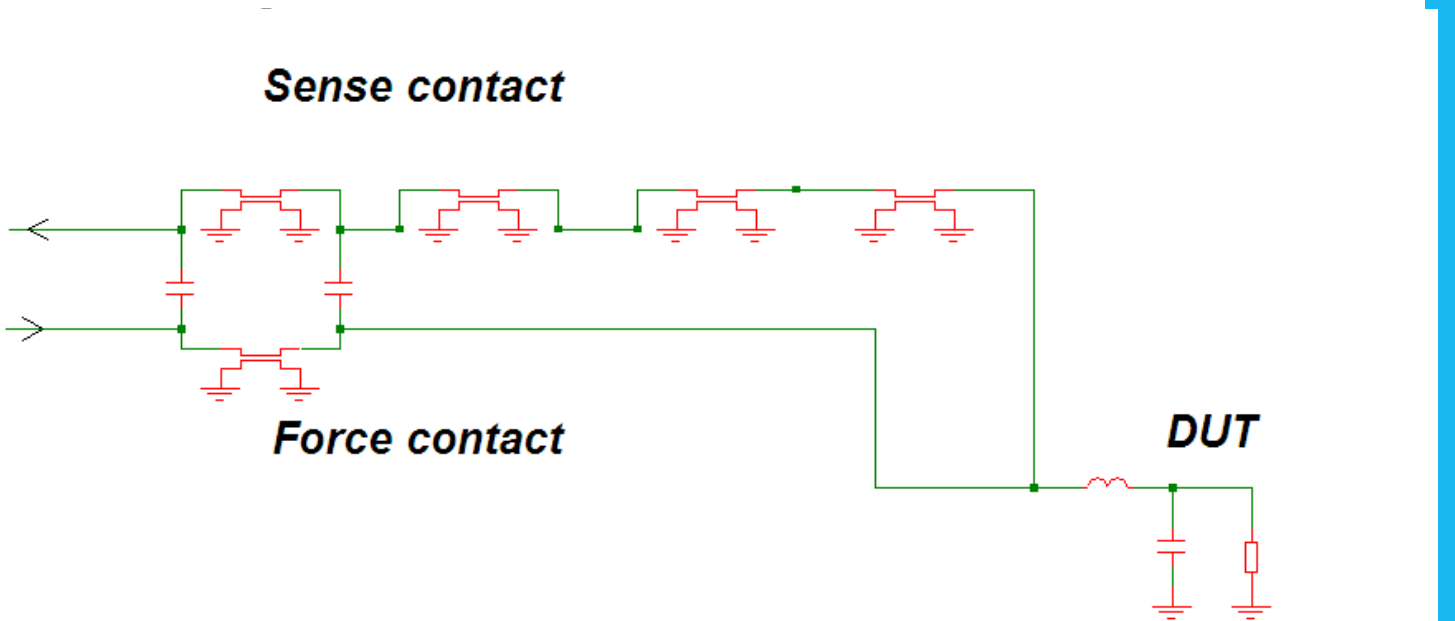
Amplitudes adjusted for same final voltage level

Observations

- Most configurations are saddled with resonances because of improper terminations
- A reasonably flat response is available if all ports are terminated, albeit at the expense of significantly reduced signal amplitude

What can be done to enhance high frequency performance?

Performance improvements

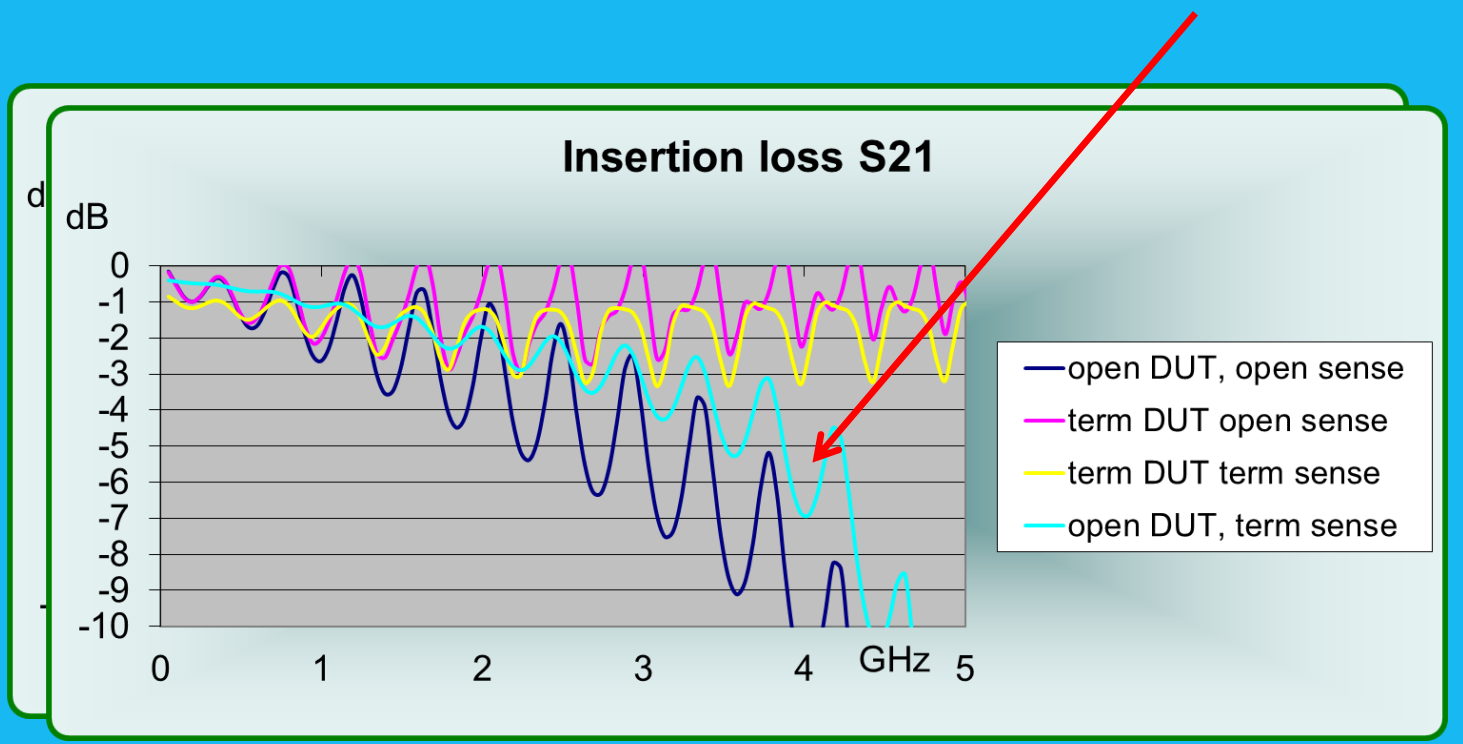


Use socket with short(er) contacts

(approximately 8 mm sense / 2 mm force in this case)

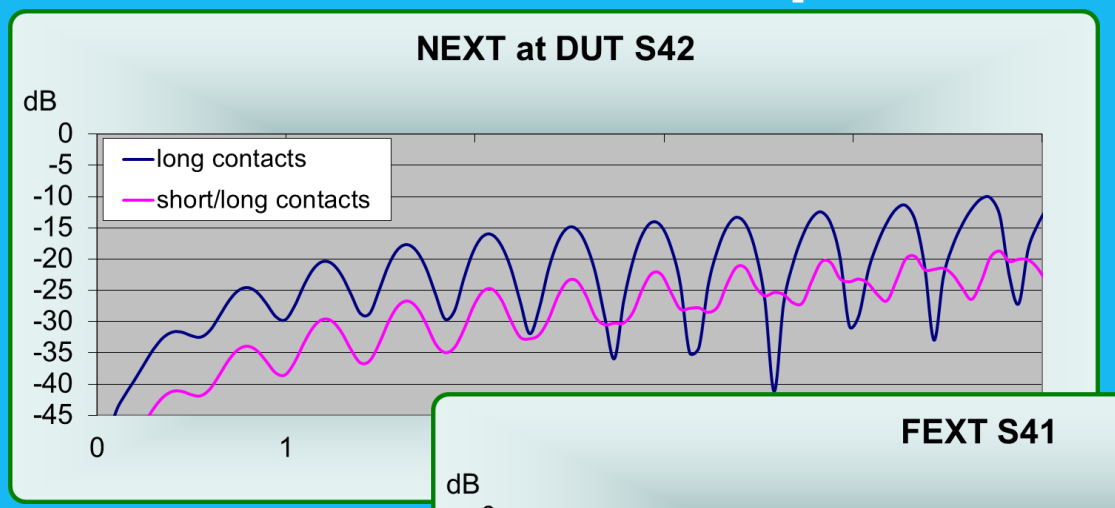
Insertion loss S21 socket with PCB

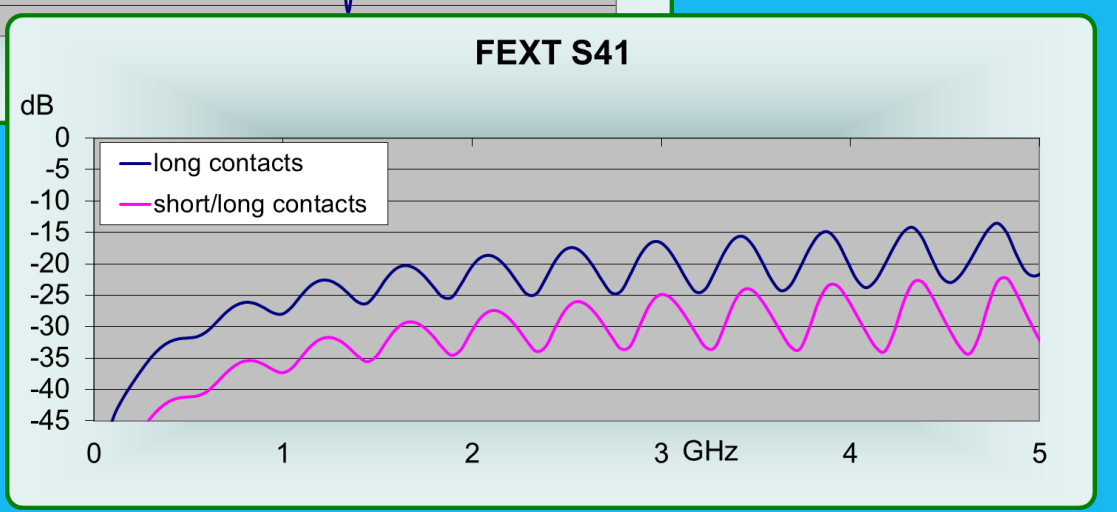
The deep dips are absent



Values for 'open DUT, open sense' and 'term DUT, term sense' are amplitude adjusted

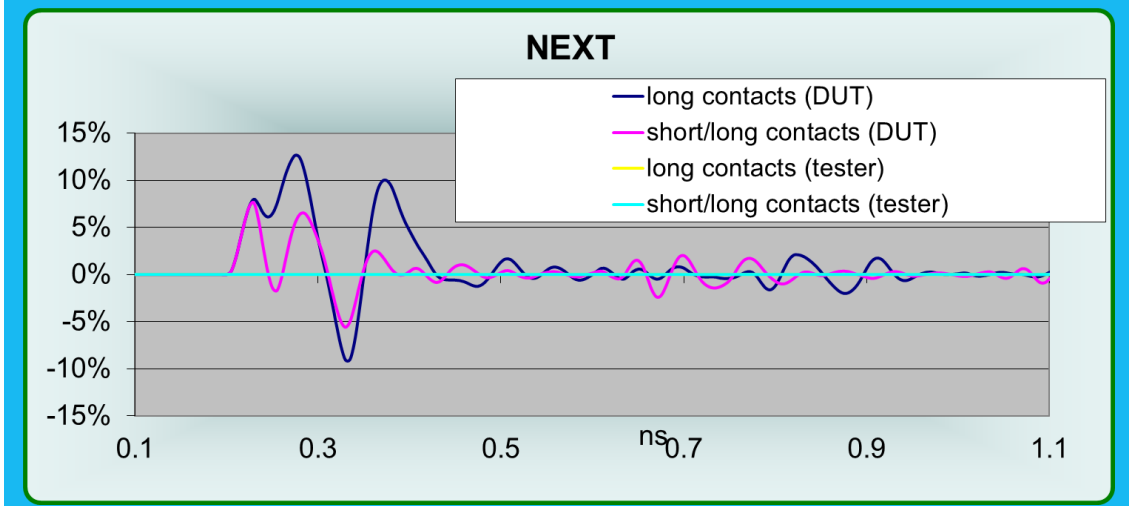
Crosstalk improvements





Crosstalk on the DUT side

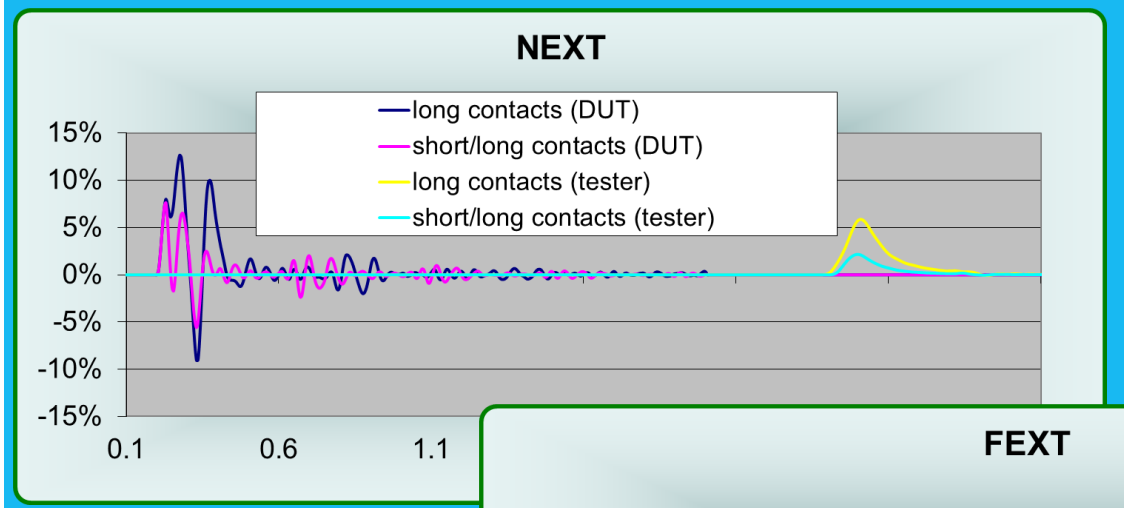
% Crosstalk

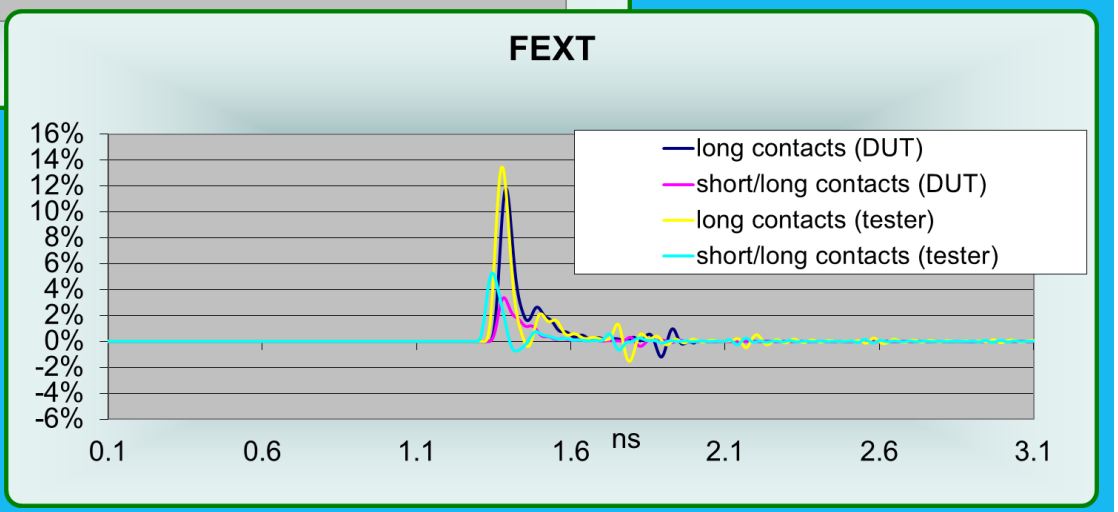


Where is the crosstalk from the tester end ?

Crosstalk on the DUT and tester sides

% Crosstalk





Crosstalk on the DUT and tester sides

Conclusion

- Kelvin sockets can not achieve the same high frequency performance as single connection sockets
- If some leeway is available, performance can be improved by selecting a suitable termination configuration and socket
- Choices must be carefully examined for overall test system impact