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Interpretation and Application of Test Contactor Specification

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Suzhou ■ October 23, 2018
Shenzhen ■ October 25, 2018

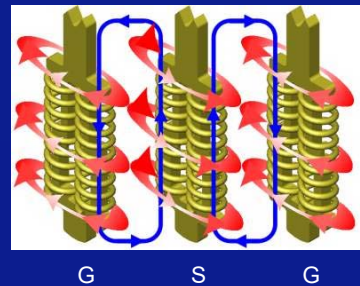
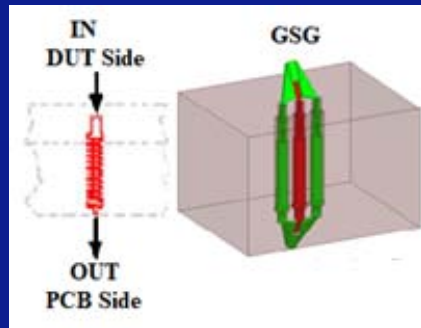


Overview

- Key Performance Measures
 - Electrical
 - SPICE Models, Inductance and Capacitance
 - Crosstalk and Impedance
 - Eye Diagrams / Patterns
 - Insertion Loss and Return Loss
 - Spring Force and Probe Resistance
 - Current Carrying Testing
 - Contactor Inspection Report
- Conclusion

SPICE Models

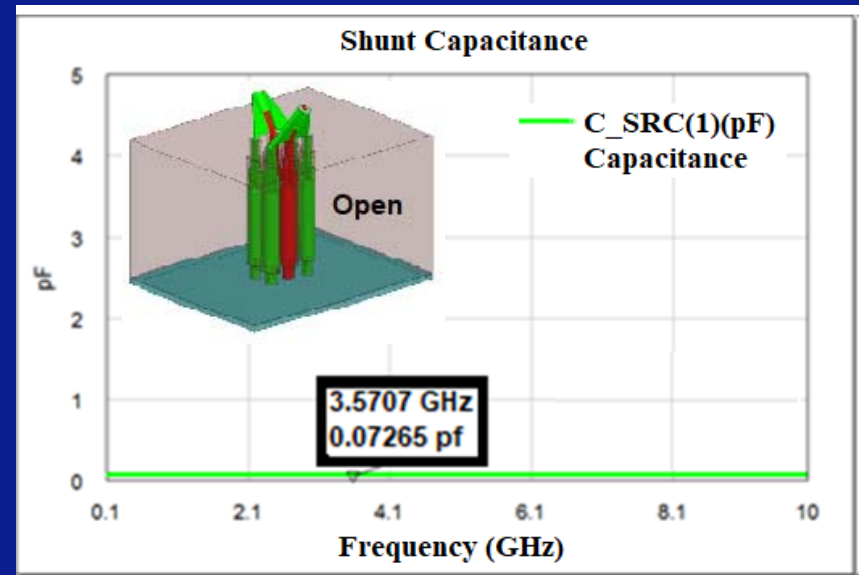
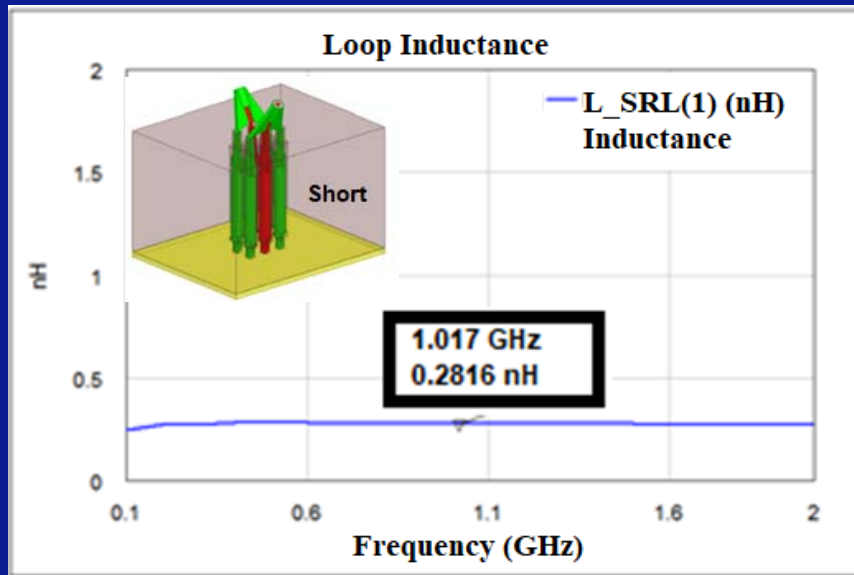
1. Most contactor suppliers have equivalent circuit SPICE (Simulation Program with Integrated Circuit Emphasis) compatible models.
2. Inductance should be specified as loop inductance:
 - a) Loop inductance relates to the actual performance at all frequencies and all probe spacing pitches
 - b) Self inductance is close to impossible to measure, and most often determined using approximations



Electric Fields and Current Flow

L_s	Loop Inductance	Measured (VNA) and Simulated (HFSS) GSG
C_s	Shunt Capacitance	Measured (VNA) and Simulated (HFSS) GSG
C_c	Mutual Capacitance	Simulated (HFSS) (GSSG)
L_m	Mutual Inductance	Simulated (HFSS) (GSSG)

Inductance and Capacitance

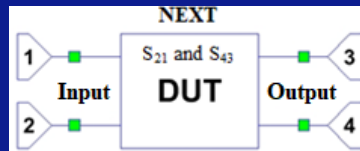
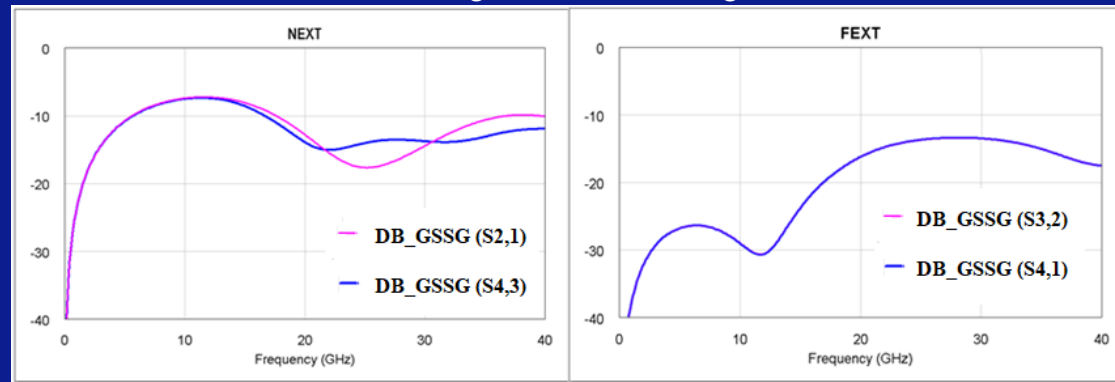


- Loop inductance is measured
- Self inductance is calculated, not measured

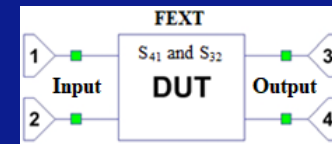
- Shunt capacitance is measured

Crosstalk

- Near-End Crosstalk is the crosstalk measured from the input of one signal pin to the input of the adjacent signal pin. It is determined from $S_{2,1}$ and $S_{4,3}$ as shown on this slide
- Far-End Crosstalk is the crosstalk measured from the input of one signal pin to the output of the adjacent signal pin. It is determined from $S_{4,1}$ and $S_{3,2}$ as shown on this slide
- Crosstalk results shown are determined through 3D Electromagnetic simulation

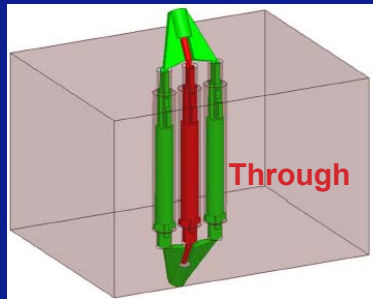
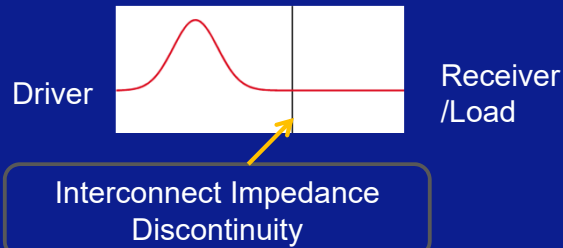


Crosstalk (dB)	Power Ratio	NEXT	FEXT
-20 dB	0.01	1.5 GHz	16.9 GHz
-10 dB	0.1	5.6 GHz	>40 GHz

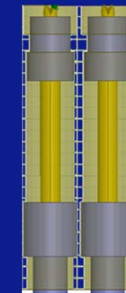
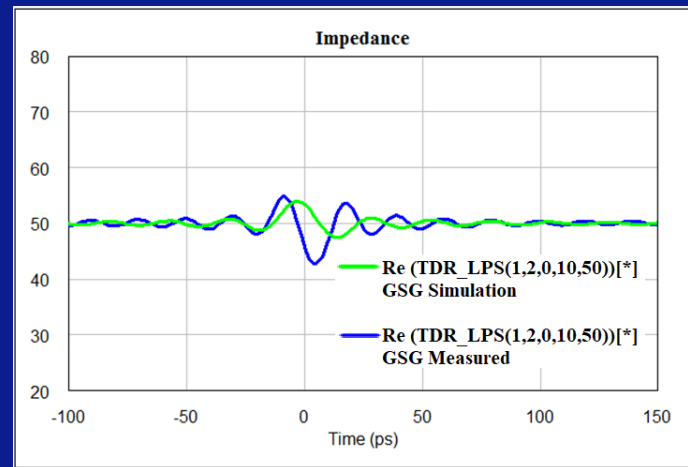


Impedance

Impedance matching is the practice of designing the path to match the impedance of the signal source and destination. This maximizes power transfer and minimizes reflections



All of These Resist Current



Impedance Controlled Interconnect: Coaxial Solution

$$Z = \sqrt{R^2 + (X_L + X_C)^2}$$

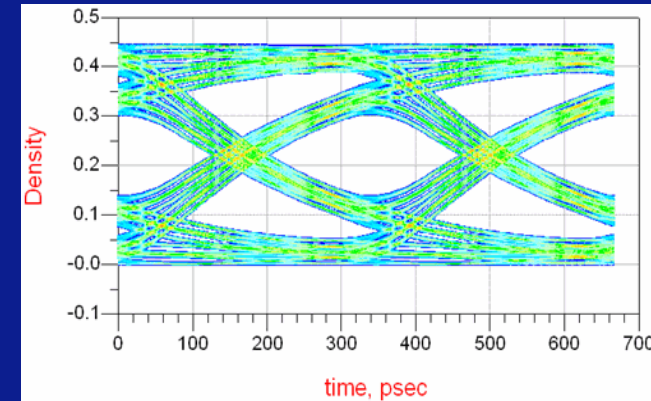
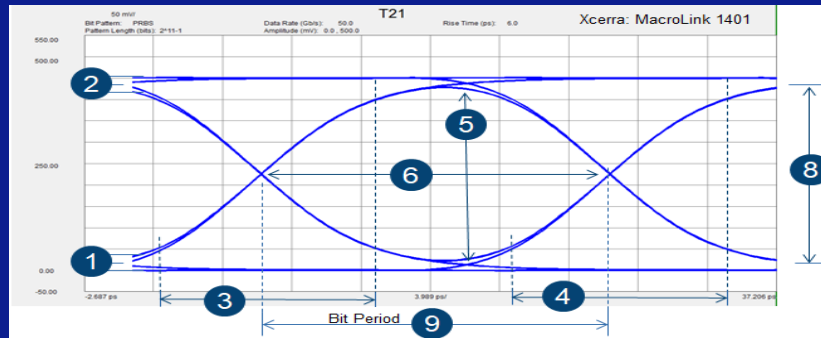
Circuit Impedance Z

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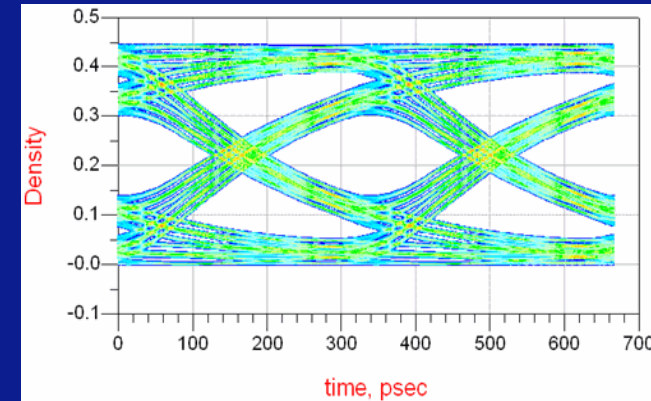
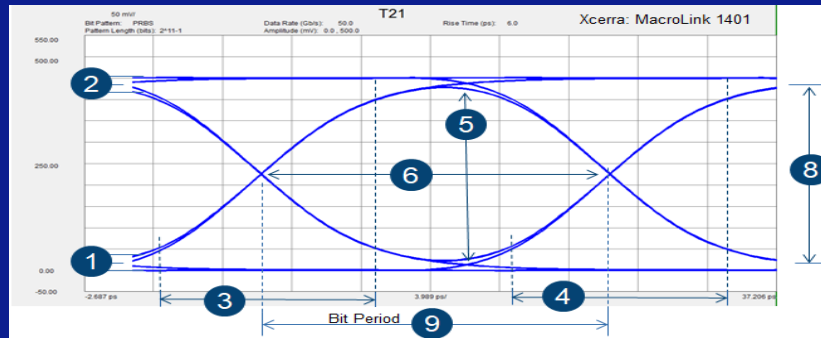
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Eye Diagrams / Patterns



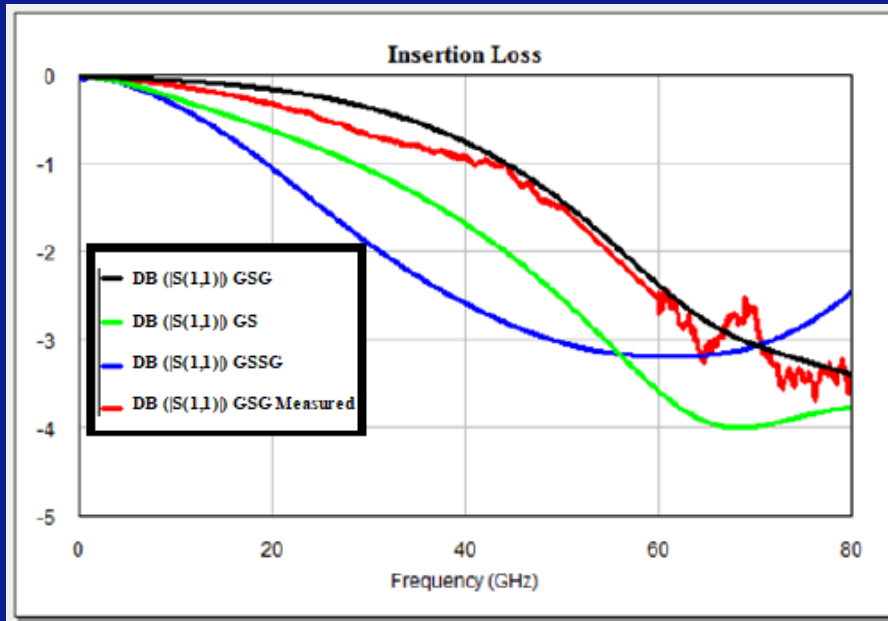
1. Zero Level: The measure of the mean value of the logical 0 of an eye diagram. *Voltage amplitude variations*
2. One Level: The measure of the mean value of the logical 1 of an eye diagram. *Voltage amplitude variations*
3. Rise Time: The measure of the transition time of the data from the 10% level to the 90% level on the upward slope of an eye diagram
4. Fall Time: The measure of the transition time of the data from the 90% level to the 10% level on the downward slope of an eye diagram.
5. Eye Height: The measure of the vertical opening of an eye diagram.

Eye Diagrams / Patterns



- 6. Eye Width: is a measure of the horizontal opening of an eye diagram
- 7. Deterministic Jitter: is the deviation of a transition from its ideal time caused by reflections relative to other transitions. *How far is my edge from the ideal.*
- 8. Eye Amplitude: is the difference between the logic 1 level and the logic 0 level histogram mean values of an eye diagram
- 9. Bit Rate: is the inverse of bit period ($1 / \text{bit period}$). The bit period is a measure of the horizontal opening of an eye diagram at the crossing points of the eye

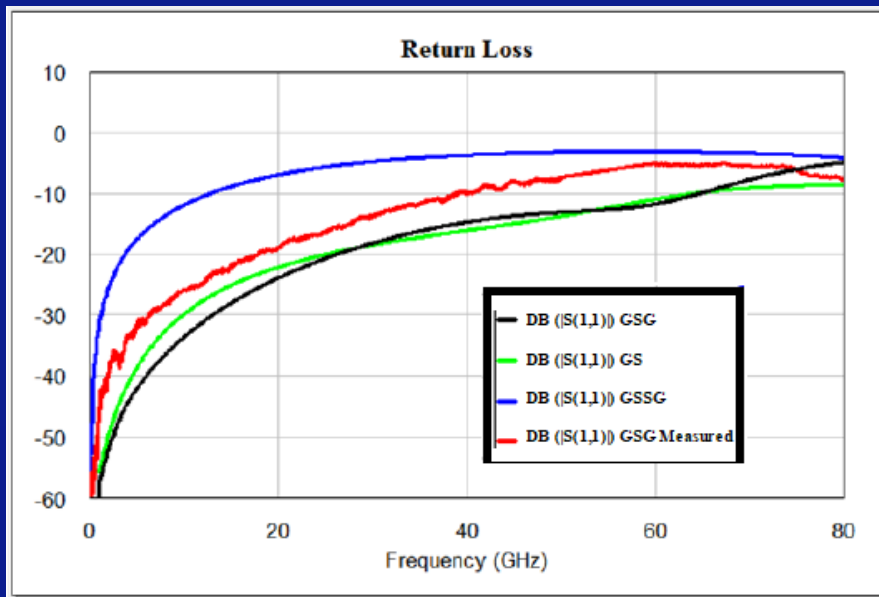
Insertion Loss



Insertion Loss (dB)	Power Ratio	Single Ended G-S	Single Ended G-S-G	Differential G-S-S-G
-1 dB	0.794	28.6 GHz	42 GHz	19.4 GHz
-3 dB	0.501 \approx 1/2	54.5 GHz	64 GHz	49 GHz

- Insertion loss is the:
- Ratio of Power Out to Power In
 - P_{out}/P_{in} = Power Ratio
 - $IL = \log_{10} (P_{out}/P_{in}) = \text{xdB}$

Return Loss

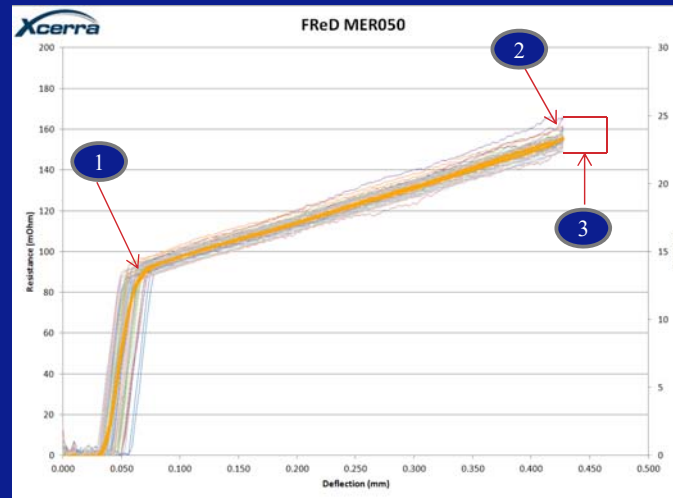
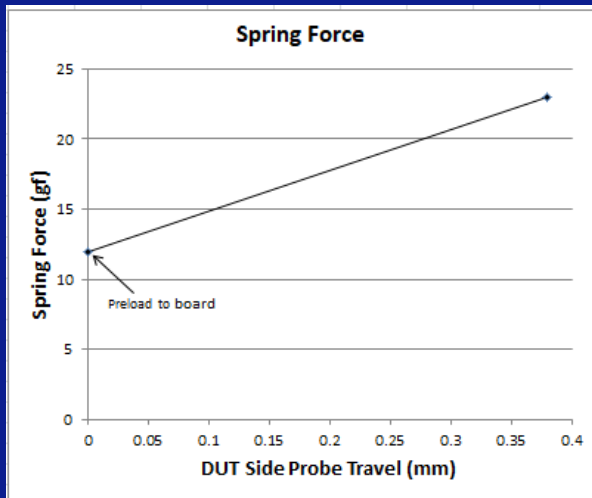


Insertion Loss (dB)	Power Ratio	Single Ended G-S	Single Ended G-S-G	Differential G-S-S-G
-20 dB	0.01	24.8 GHz	25.8 GHz	3.7 GHz
-10 dB	0.1	64 GHz	65.2 GHz	12.3 GHz

Return loss is the:

- Ratio of Power Returned to Power In
- $P_{\text{returned}} / P_{\text{in}} = \text{Power Ratio}$
- $RL = \log_{10} (P_{\text{return}} / P_{\text{in}})$

Probe / Spring Force



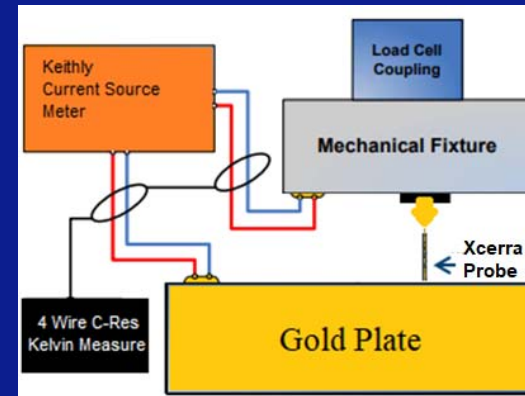
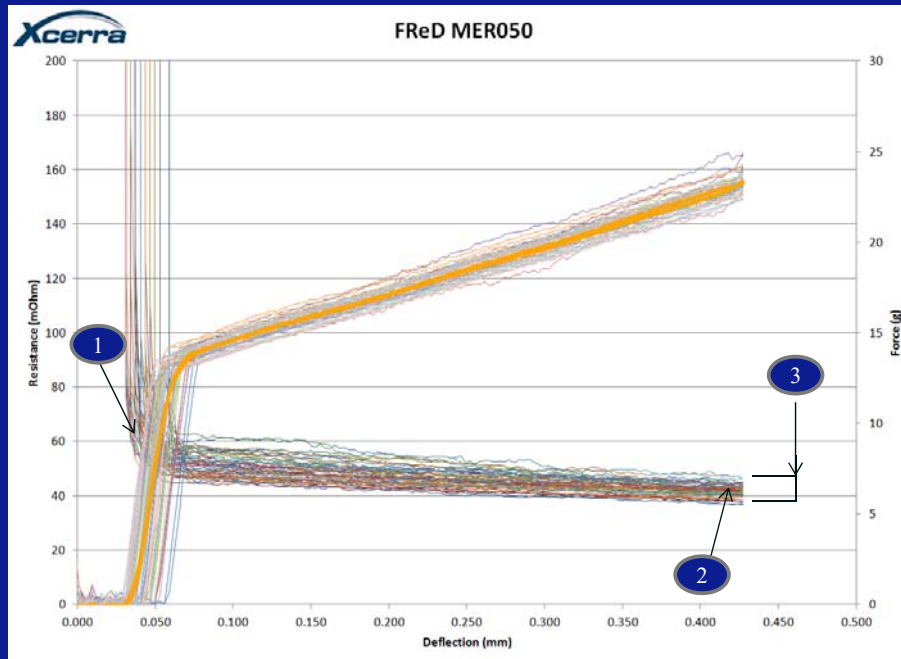
- Force
- Resistance
- e
- Deflection

1. Force at Preload
2. Force at Test Height
3. Distribution of Force at Test Height

Force Plot (FReD)

Development of the FReD plot includes the random selection of a number of probes that are mounted in a fixture and then compressed to test height. The result is a systematic measure of the probes performance in the force domain. The sample size is determined to statistically represent a population

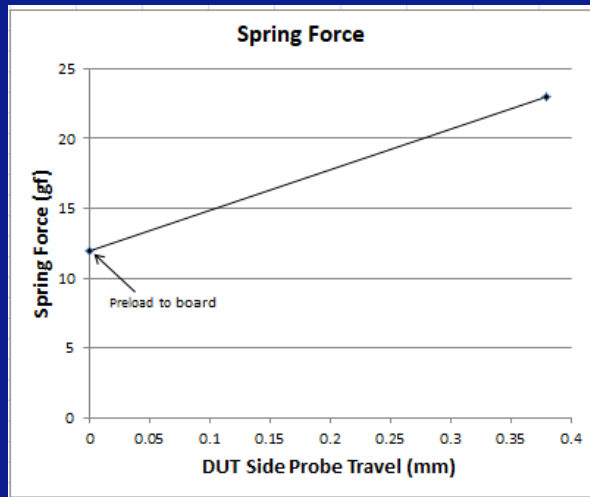
Spring Force and Probe Resistance



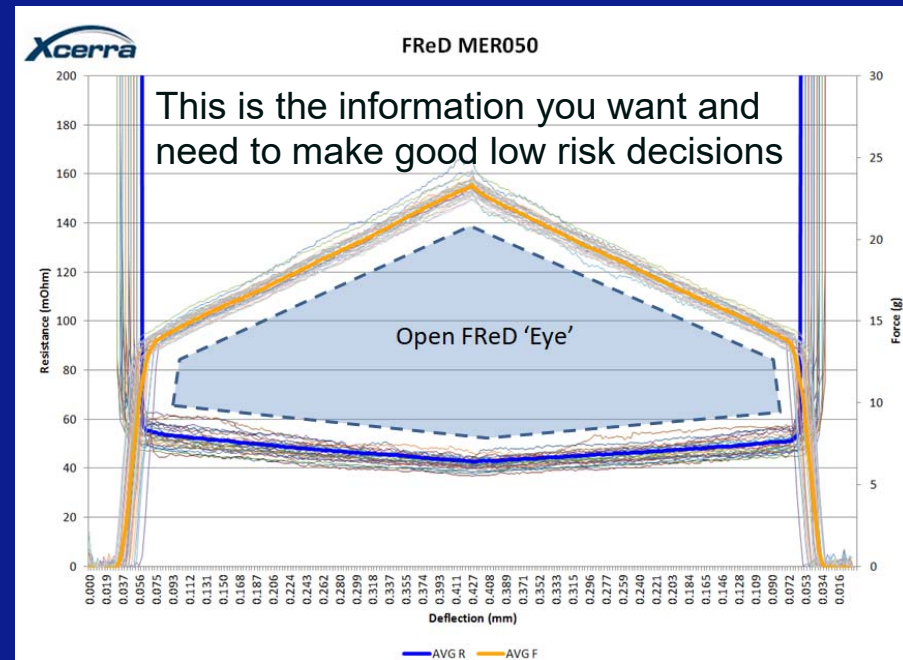
1. Probe Resistance at First Point of Contact
2. Probe Resistance at Test Height
3. Distribution of Probe Resistance

The FReD setup allows for measurement of probe resistance during probe compression. This process emulates the resistance of the probe as it contacts a Device-Under-Test.

Force-Resistance and Deflection



Is this enough
Information?
I don't think so

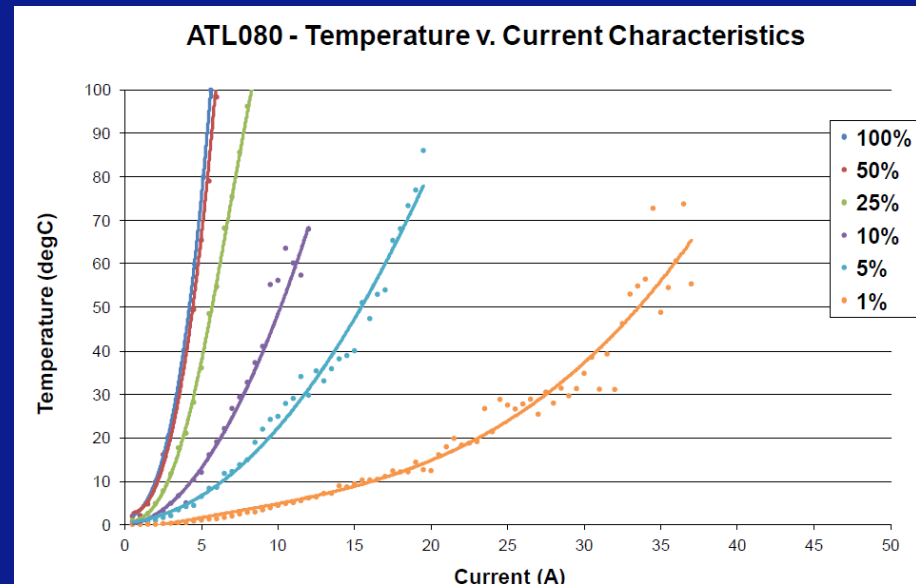


Current Carrying Testing

DC Specification	
Pin Type	Atlas 080
20° T-Rise Current	2.81 Amps
40° T-Rise Current	3.84 Amps
60° T-Rise Current	4.55 Amps
20° T-Rise Current @1% Duty Cycle	21.56 Amps

Pulsed Current Testing

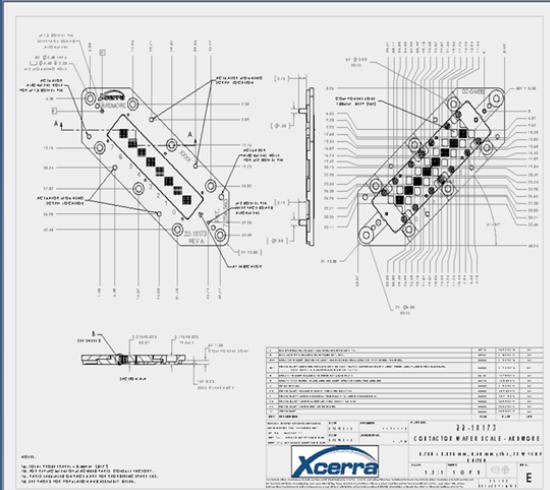
Ten probes are tested under pulsed current in one-half amp increments. The tests are run with the following duty cycles: 1%, 5%, 10%, 25%, and 50%, using a one-second period. For example, the 50% duty cycle is produced by repeatedly turning the current on for 500ms and off for 500ms.



Contactor Inspection Report

Assembly Number: 22-18173
Serial Number: SNXXXXXX
Inspection Date: 21-May-2018
Probe Used: 07-0615 XXXXXXX
Tester: MTMN FRd 7
Tested by: MBB

Probe Head Drawing (First Page Only)



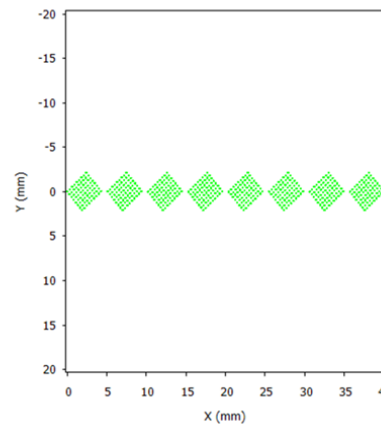
The drawing shows a detailed view of a probe head with various dimensions and labels. It includes a table of dimensions at the bottom right.

NO.	DESCRIPTION	UNIT	VALUE
1	PROBE HEAD WIDTH	MM	10.00
2	PROBE HEAD HEIGHT	MM	10.00
3	PROBE HEAD LENGTH	MM	10.00
4	PROBE HEAD THICKNESS	MM	10.00
5	PROBE HEAD DIAMETER	MM	10.00
6	PROBE HEAD RADIUS	MM	10.00
7	PROBE HEAD AREA	MM ²	10.00
8	PROBE HEAD PERIMETER	MM	10.00
9	PROBE HEAD VOLUME	MM ³	10.00
10	PROBE HEAD WEIGHT	MM	10.00

Assembly Number: 22-18173
Serial Number: SNXXXXXX
Inspection Date: 21-May-2018
Probe Used: 07-0615 XXXXXXX
Tester: MTMN FRd 7
Tested by: MBB

Probe Head Planarity/Force/Resistance

22-18173 SN178503M (Full Skew) All Probe Failures - Top View



Legend:
PASS (Green circle)
Force FAIL (Red circle)
Resistance FAIL (Blue circle)
Planarity FAIL (Black circle)

Force Range - Min: 23g Max: 55g
Resistance Range - Max: 100 mOhms
Min Tip Height: 3.545 mm

The scatter plot shows a grid of points from 0 to 40 mm on the X-axis and -20 to 20 mm on the Y-axis. All points are green, indicating a PASS result.

Report Page Two

First test Pass/Fail

- Open
- Force
- Resistance
- Planarity

Report Cover Sheet: Probehead drawing

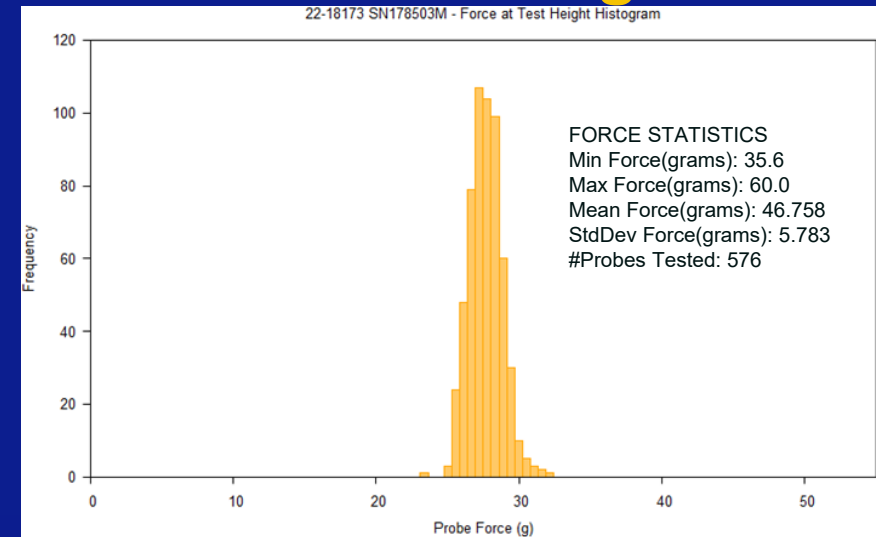
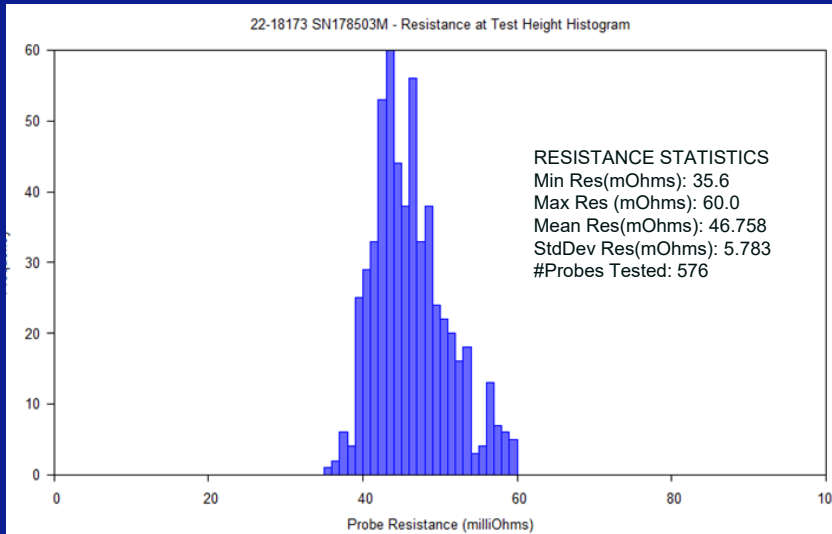


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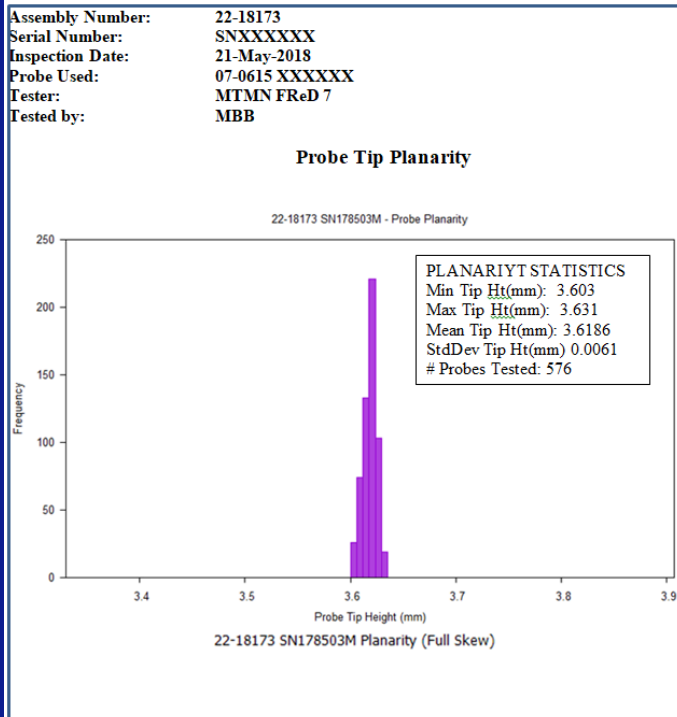
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Contactors Inspection Report Probe Resistance and Force at Test Height

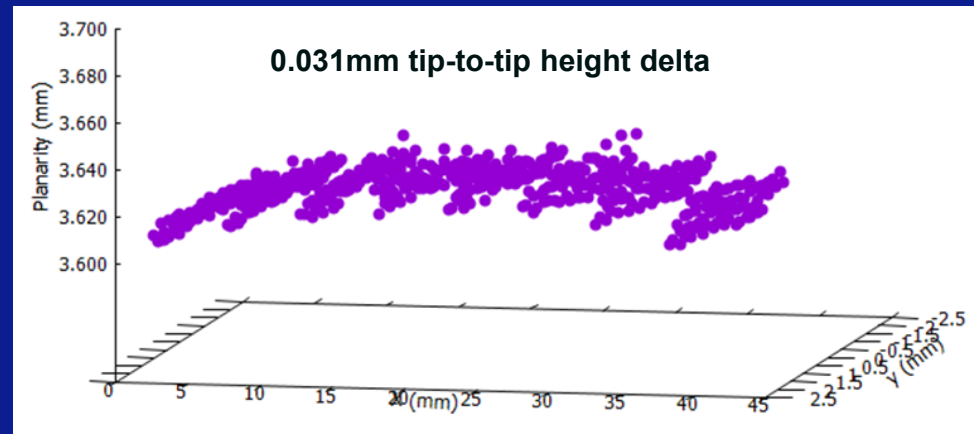


- The graphs show the contactor probe head full probe count population measures
 - Resistance and Force
- The full population is the way to show meaningful pattern in the data and the application of the probe
- The tight distribution show low variability (variability is the opposition to great results)

Contactors Inspection Report Probe Tip-to-Tip Planarity



- Coplanarity is the comparison of all vertical heights of the probe tips
- The vertical height is the “seating plane” for contacting each device across eight sights in this example



Conclusion

- Not all specification are created equal
- Make sure you understand how the contactor is being specified.
- Don't be afraid to say "Show me the Data"