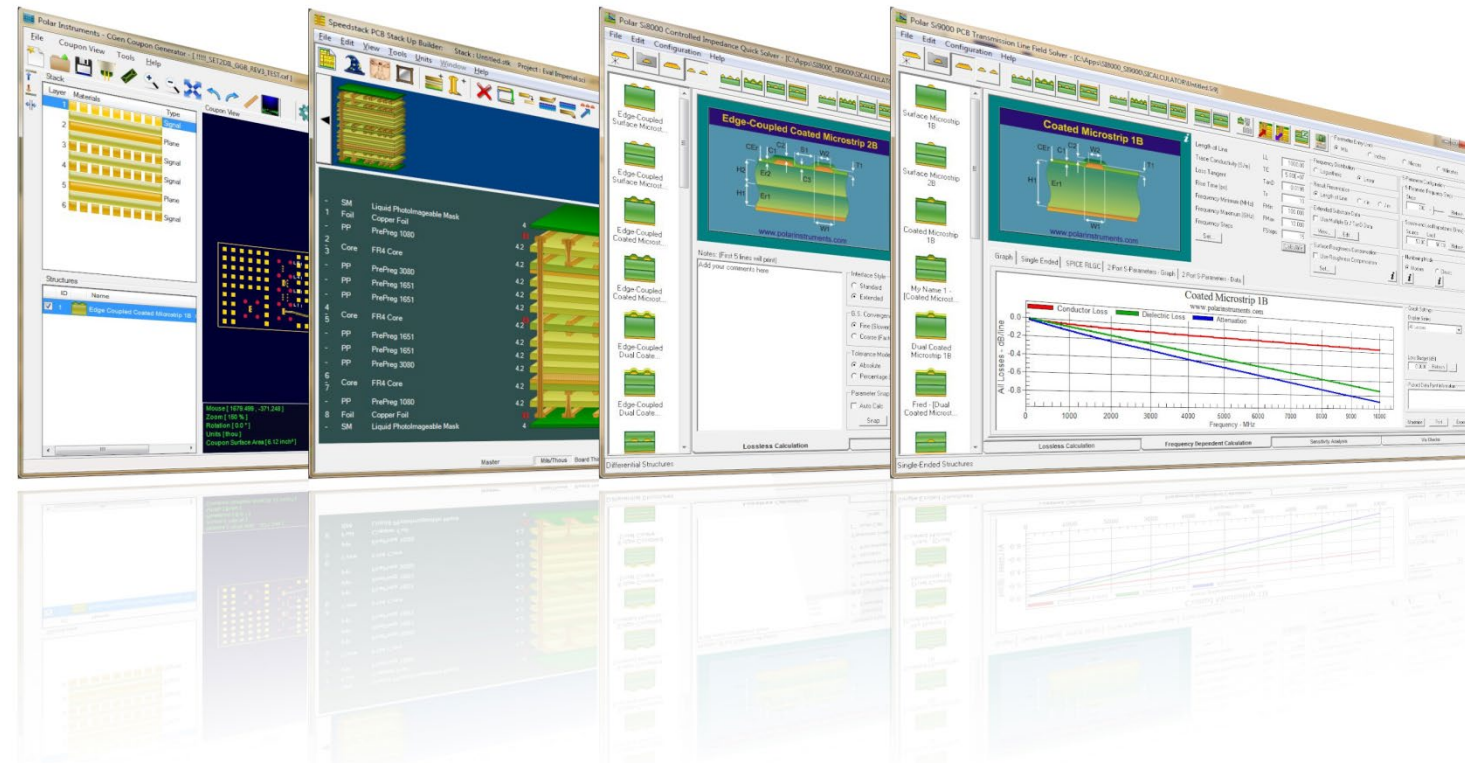


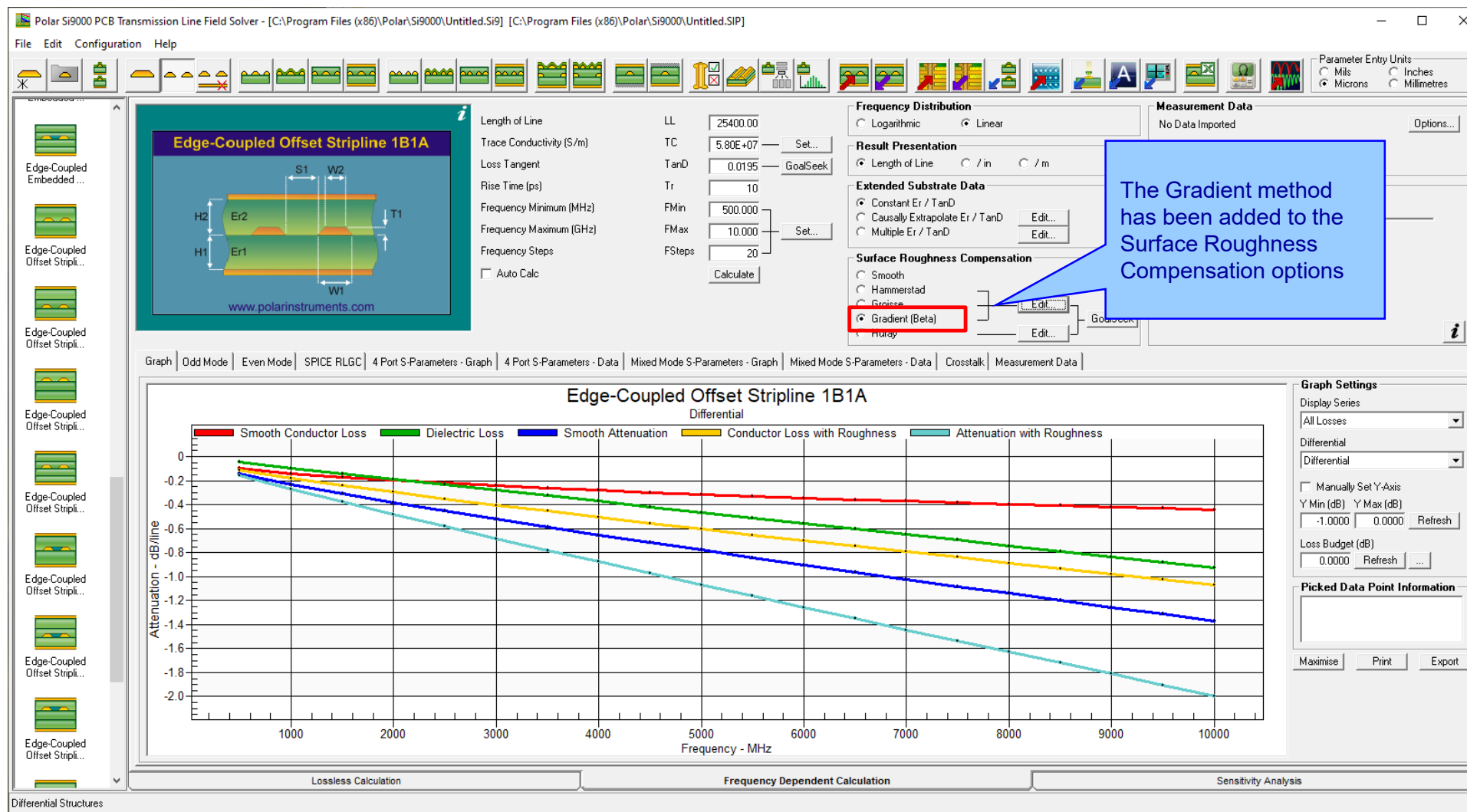
# Si9000e 2021 - 2023 Updates

Richard Attrill – June 2023 (Rev 4)

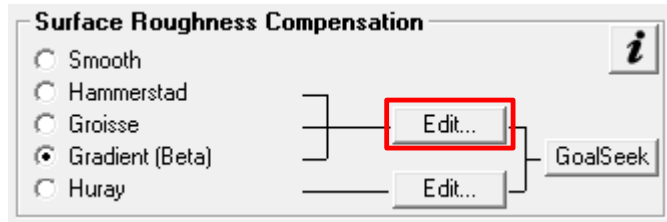


# Si9000e v23.06.01 (June 2023)

# New Gradient Surface Roughness Compensation Method added

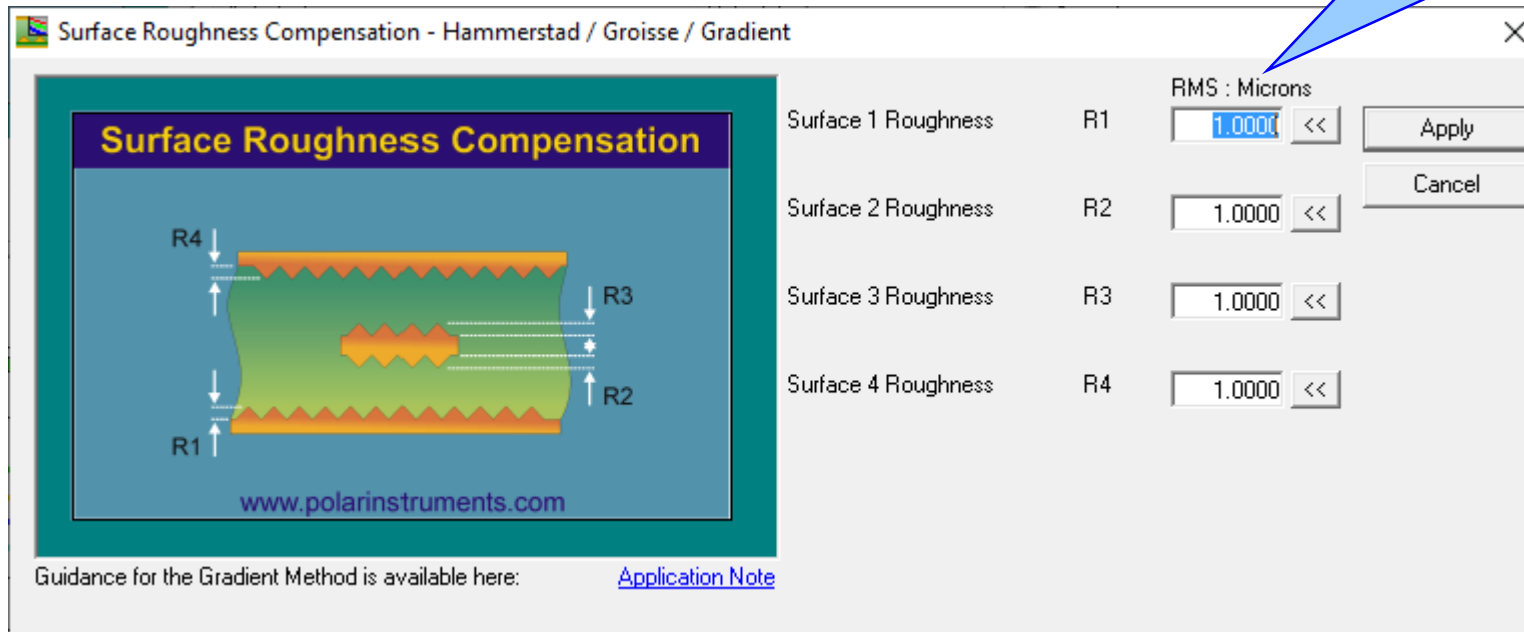


## New Gradient Surface Roughness Compensation Method added

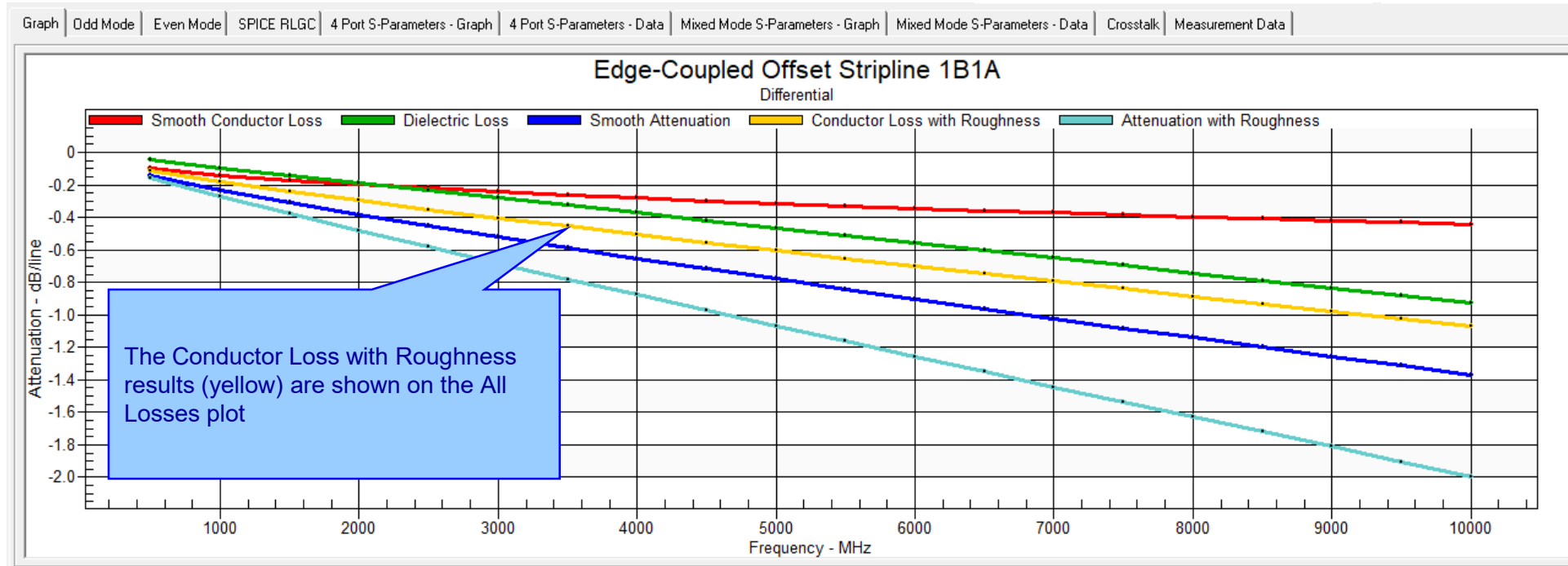


Selecting the Edit button will allow the RMS roughness values to be entered.

In this example 1 $\mu$ m roughness for all significant surfaces



## New Gradient Surface Roughness Compensation Method added



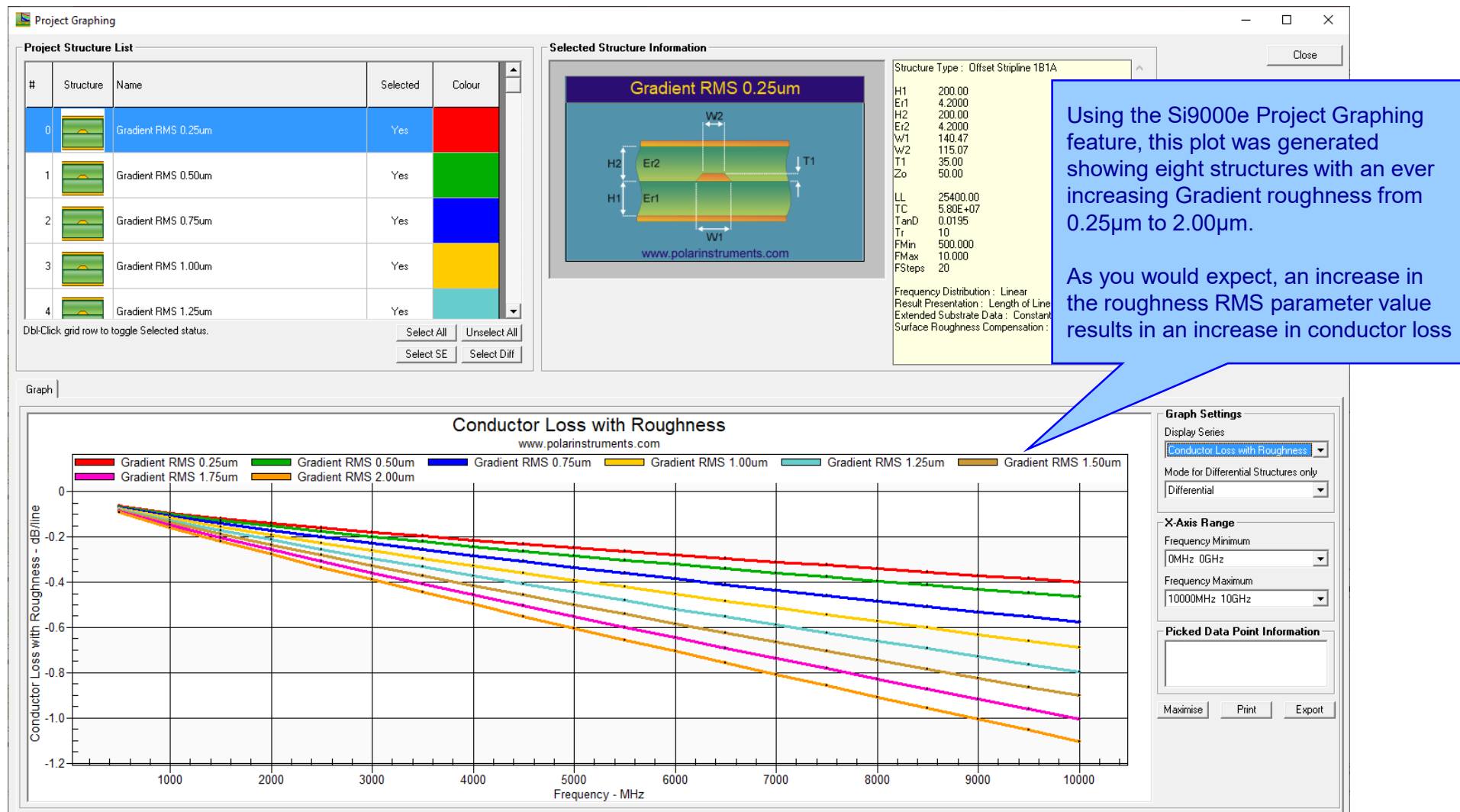
# New Gradient Surface Roughness Compensation Method added

Graph Odd Mode Even Mode SPICE RLGC 4 Port S-Parameters - Graph 4 Port S-Parameters - Data Mixed Mode S-Parameters - Graph Mixed Mode S-Parameters - Data Crosstalk Measurement Data																	
Frequency Hz	Impedance Real Ohms	Impedance Imaginary Ohms	Impedance Magnitude Ohms	Inductance H/line	Resistance Ohms/line	Capacitance F/line	Conductance S/line	Skin Depth m	Smooth Conductor Loss dB/line	Dielectric Loss dB/line	Smooth Attenuation dB/line	Conductor Loss with Roughness dB/line	Attenuation with Roughness dB/line	Modal Phase Velocity m/s	Alpha Np/line	Alpha dB/line	Beta rad/line
5.000E+08	3.161E+01	-3.664E-01	3.161E+01	5.955E-09	7.989E-01	5.964E-12	3.653E-04	2.955E-06	-9.873E-02	-4.717E-02	-1.459E-01	-1.128E-01	-1.599E-01	1.348E+08	1.841E-02	-1.599E-01	5.921E-01
1.000E+09	3.138E+01	-2.268E-01	3.138E+01	5.869E-09	1.253E+00	5.964E-12	7.307E-04	2.090E-06	-1.399E-01	-9.376E-02	-2.337E-01	-1.792E-01	-2.730E-01	1.358E+08	3.142E-02	-2.730E-01	1.176E+00
1.500E+09	3.126E+01	-1.675E-01	3.126E+01	5.827E-09	1.660E+00	5.964E-12	1.096E-03	1.706E-06	-1.715E-01	-1.403E-01	-3.118E-01	-2.391E-01	-3.794E-01	1.363E+08	4.368E-02	-3.794E-01	1.757E+00
2.000E+09	3.119E+01	-1.330E-01	3.119E+01	5.799E-09	2.043E+00	5.964E-12	1.461E-03	1.478E-06	-1.982E-01	-1.867E-01	-3.849E-01	-2.957E-01	-4.824E-01	1.366E+08	5.554E-02	-4.824E-01	2.337E+00
2.500E+09	3.113E+01	-1.097E-01	3.113E+01	5.779E-09	2.410E+00	5.964E-12	1.827E-03	1.322E-06	-2.217E-01	-2.331E-01	-4.548E-01	-3.501E-01	-5.832E-01	1.368E+08	6.714E-02	-5.832E-01	2.916E+00
3.000E+09	3.109E+01	-9.260E-02	3.109E+01	5.763E-09	2.766E+00	5.964E-12	2.192E-03	1.207E-06	-2.429E-01	-2.795E-01	-5.224E-01	-4.028E-01	-6.823E-01	1.370E+08	7.856E-02	-6.823E-01	3.495E+00
3.500E+09	3.105E+01	-7.937E-02	3.105E+01	5.750E-09	3.112E+00	5.964E-12	2.557E-03	1.117E-06	-2.624E-01	-3.259E-01	-5.883E-01	-4.543E-01	-7.802E-01	1.372E+08	8.982E-02	-7.802E-01	4.072E+00
4.000E+09	3.102E+01	-6.871E-02	3.102E+01	5.739E-09	3.452E+00	5.964E-12	2.923E-03	1.045E-06	-2.806E-01	-3.723E-01	-6.529E-01	-5.047E-01	-8.770E-01	1.373E+08	1.010E-01	-8.770E-01	4.650E+00
4.500E+09	3.100E+01	-5.988E-02	3.100E+01	5.730E-09	3.785E+00	5.964E-12	3.288E-03	9.851E-07	-2.976E-01	-4.187E-01	-7.163E-01	-5.543E-01	-9.730E-01	1.374E+08	1.120E-01	-9.730E-01	5.227E+00
5.000E+09	3.097E+01	-5.241E-02	3.097E+01	5.721E-09	4.114E+00	5.964E-12	3.653E-03	9.346E-07	-3.138E-01	-4.650E-01	-7.788E-01	-6.032E-01	-1.068E+00	1.375E+08	1.230E-01	-1.068E+00	5.803E+00
5.500E+09	3.095E+01	-4.597E-02	3.095E+01	5.714E-09	4.437E+00	5.964E-12	4.019E-03	8.911E-07	-3.291E-01	-5.114E-01	-8.405E-01	-6.515E-01	-1.163E+00	1.376E+08	1.339E-01	-1.163E+00	6.379E+00
6.000E+09	3.094E+01	-4.034E-02	3.094E+01	5.707E-09	4.757E+00	5.964E-12	4.384E-03	8.532E-07	-3.438E-01	-5.577E-01	-9.015E-01	-6.992E-01	-1.257E+00	1.377E+08	1.447E-01	-1.257E+00	6.955E+00
6.500E+09	3.092E+01	-3.536E-02	3.092E+01	5.702E-09	5.073E+00	5.964E-12	4.750E-03	8.197E-07	-3.579E-01	-6.040E-01	-9.619E-01	-7.464E-01	-1.350E+00	1.377E+08	1.555E-01	-1.350E+00	7.531E+00
7.000E+09	3.091E+01	-3.091E-02	3.091E+01	5.696E-09	5.387E+00	5.964E-12	5.115E-03	7.899E-07	-3.714E-01	-6.503E-01	-1.022E+00	-7.931E-01	-1.442E+00	1.378E+08	1.662E-01	-1.442E+00	8.095E+00
7.500E+09	3.089E+01	-2.691E-02	3.089E+01	5.691E-09	5.697E+00	5.964E-12	5.480E-03	7.631E-07	-3.845E-01	-6.967E-01	-1.081E+00	-8.395E-01	-1.530E+00	1.378E+08	1.769E-01	-1.530E+00	8.639E+00
8.000E+09	3.088E+01	-2.327E-02	3.088E+01	5.686E-09	6.005E+00	5.964E-12	5.846E-03	7.389E-07	-3.971E-01	-7.430E-01	-1.140E+00	-8.855E-01	-1.612E+00	1.379E+08	1.875E-01	-1.612E+00	9.161E+00
8.500E+09	3.087E+01	-1.995E-02	3.087E+01	5.682E-09	6.310E+00	5.964E-12	6.211E-03	7.168E-07	-4.093E-01	-7.893E-01	-1.199E+00	-9.311E-01	-1.720E+00	1.380E+08	1.981E-01	-1.720E+00	9.631E+00
9.000E+09	3.086E+01	-1.690E-02	3.086E+01	5.678E-09	6.613E+00	5.964E-12	6.576E-03	6.966E-07	-4.212E-01	-8.356E-01	-1.257E+00	-9.764E-01	-1.812E+00	1.380E+08	2.086E-01	-1.812E+00	1.041E+01
9.500E+09	3.085E+01	-1.409E-02	3.085E+01	5.674E-09	6.914E+00	5.964E-12	6.942E-03	6.780E-07	-4.328E-01	-8.819E-01	-1.315E+00	-1.021E+00	-1.903E+00	1.381E+08	2.191E-01	-1.903E+00	1.098E+01
1.000E+10	3.084E+01	-1.148E-02	3.084E+01	5.671E-09	7.213E+00	5.964E-12	7.307E-03	6.609E-07	-4.441E-01	-9.282E-01	-1.375E+00	-1.066E+00	-1.994E+00	1.381E+08	2.296E-01	-1.994E+00	1.155E+01

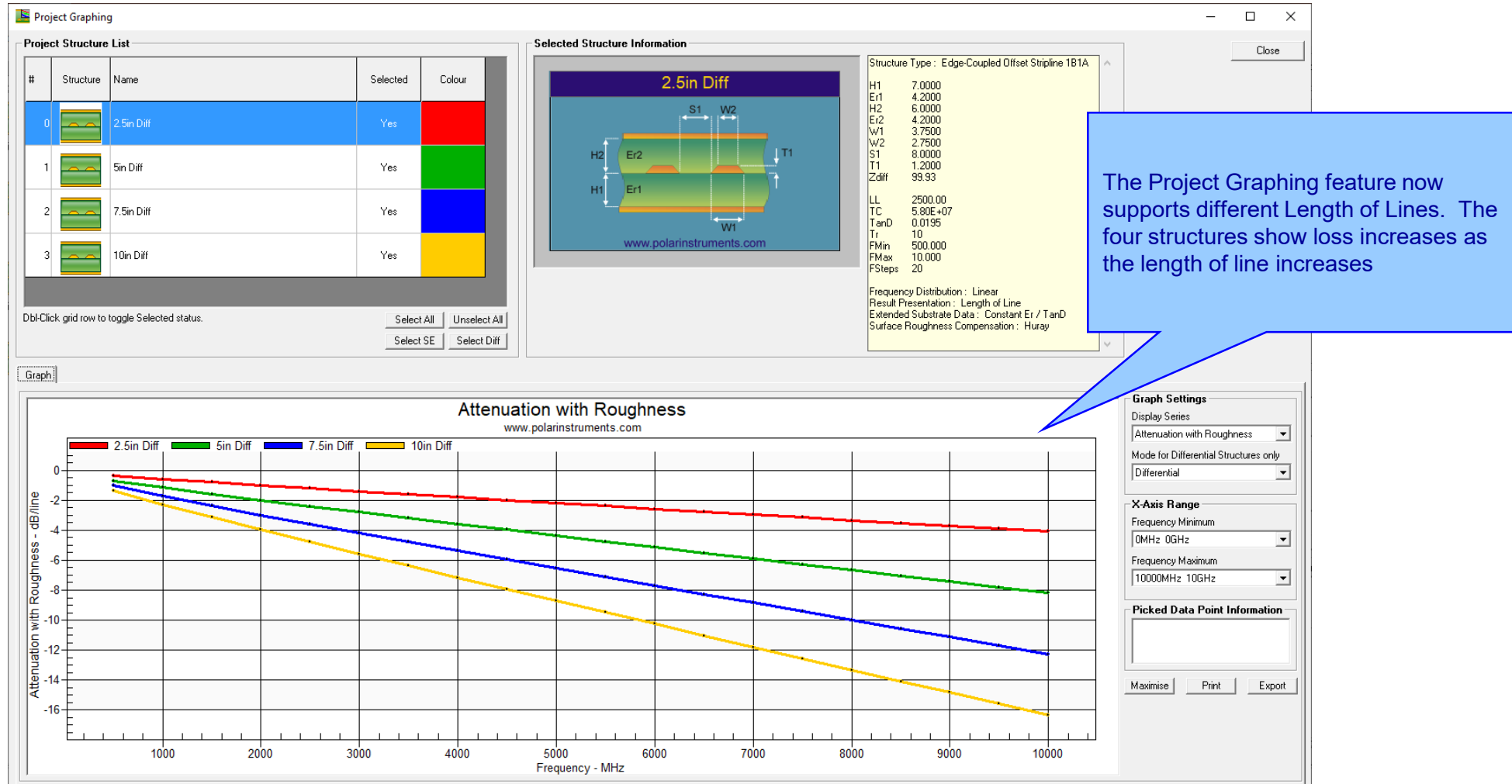
The Conductor Loss with Roughness results data is also shown alongside the other field solver results.

The complete set of results can be exported to third-party tools like Excel using the right-click menu | Copy Results to Clipboard

# New Gradient Surface Roughness Compensation Method added



## Project Graphing Enhancements - now supports structures within the Project with varying Length of Line

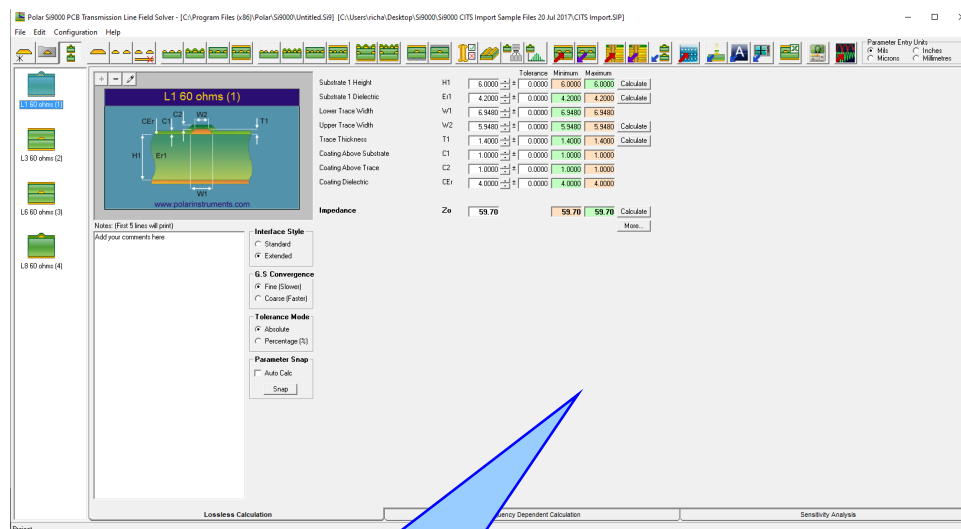


## Other enhancements

- FlexNet Publisher / FLEXIm v11.19.0.0 supported

# Si9000e v22.09.01 (September 2022)

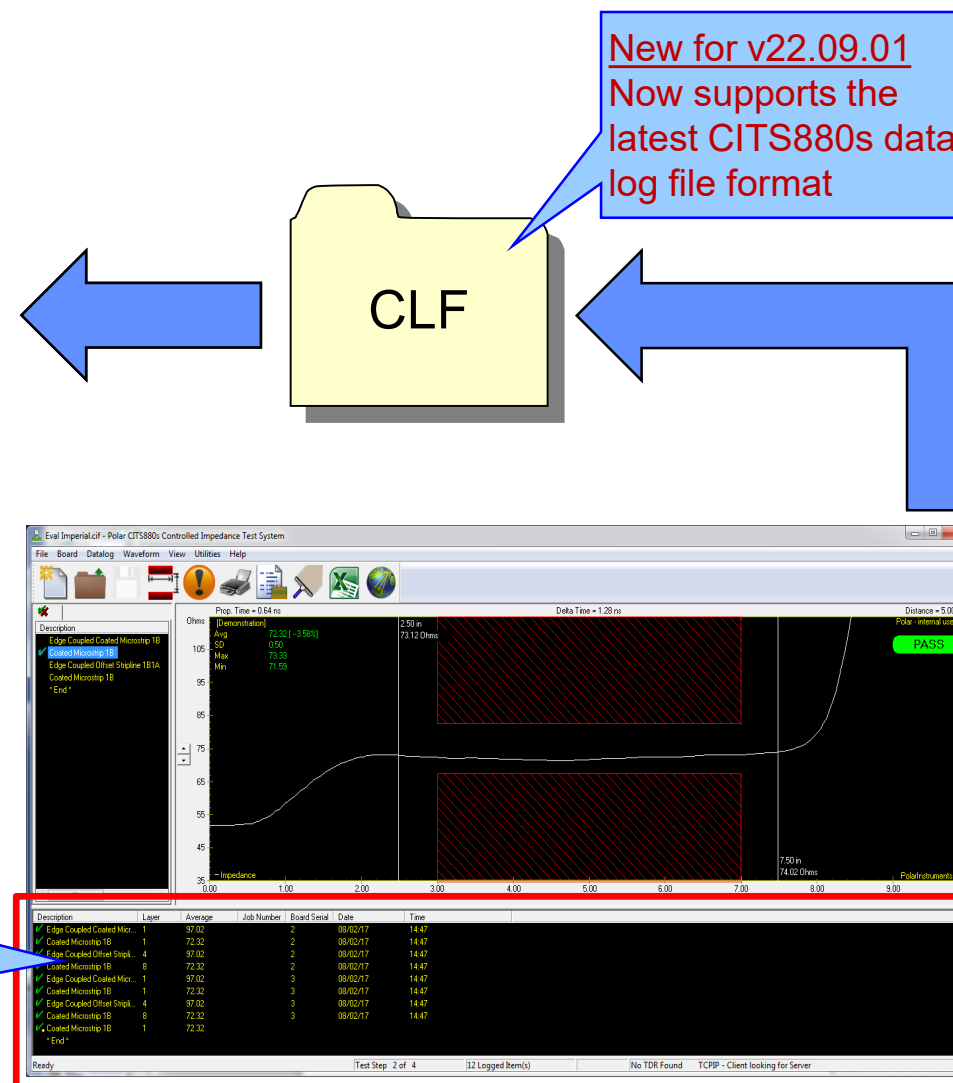
# Enhancements to the Import Polar CITS Datalog File option



## Overview

The Polar Si8000m / Si9000e field solver products have the capability to read a Polar CITS Data Log File (.CLF). This file contains comprehensive impedance measurement data and, along with existing modelled structure information, offers graphing capabilities and statistical analysis where the modelled and measured data can be presented together.

The Data Log of the CITS software is stored in a CLF file



## Import CITS Datalog File option – feature recap

Whilst working with controlled impedance designs it is often desirable to compare the reality of the measurement data against the modelled structure.

‘Closing the loop’ between the predicted and actual measured results has a number of benefits for both the design and fabrication environments. It allows for fine tuning of the structure parameters in future manufacturing batches, statistical analysis and improved overall process control.

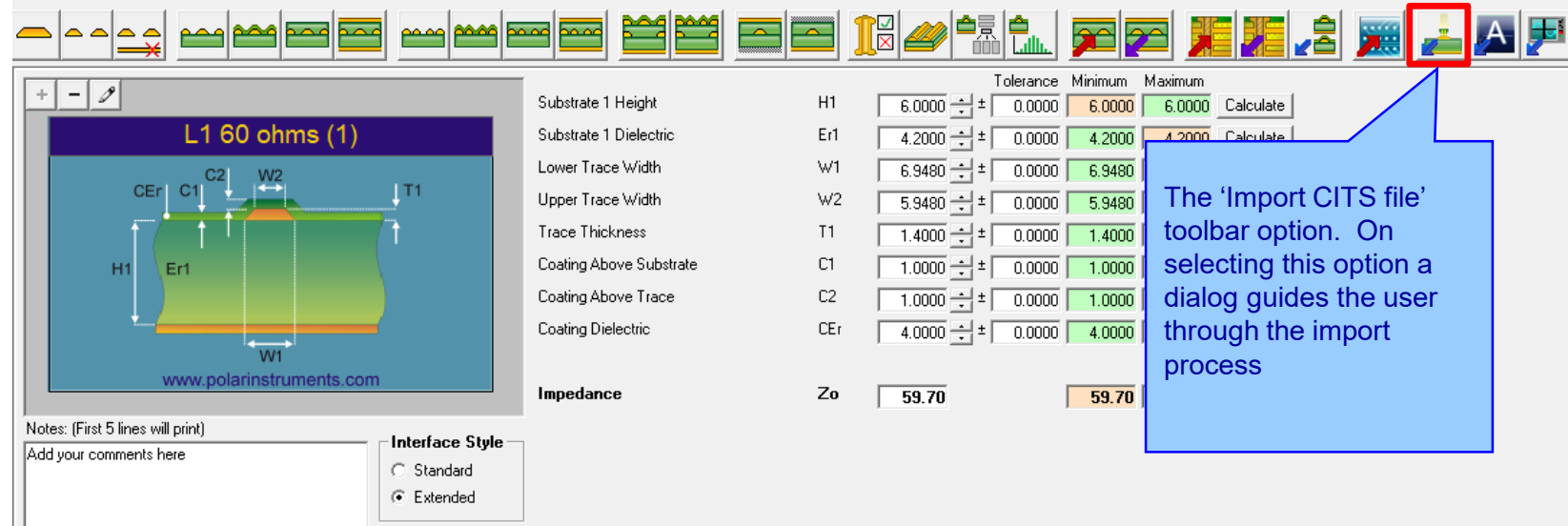
This capability within the Polar’s Si8000m / Si9000e field solver products allows the user to quickly import measurement data directly from the industry-standard Polar Controlled Impedance Test System (CITS).

If you are a design customer using the Si8000m / Si9000e and would like to use this feature, please request the Polar CITS Datalog File from your fabricator.

## Import CITS Datalog File option – feature recap

Transmission Line Field Solver - [C:\Program Files (x86)\Polar\Si9000\Untitled.Si9] [C:\Users\richa\Desktop\Si9000\Si9000 CITS Import Sample Files 25 Aug 2022\CITS Import.SIP]

on Help

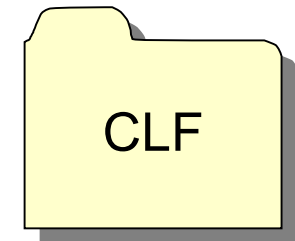
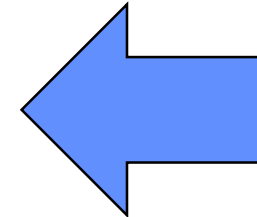
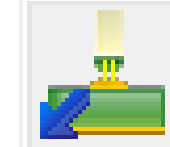


The 'Import CITS file' toolbar option. On selecting this option a dialog guides the user through the import process

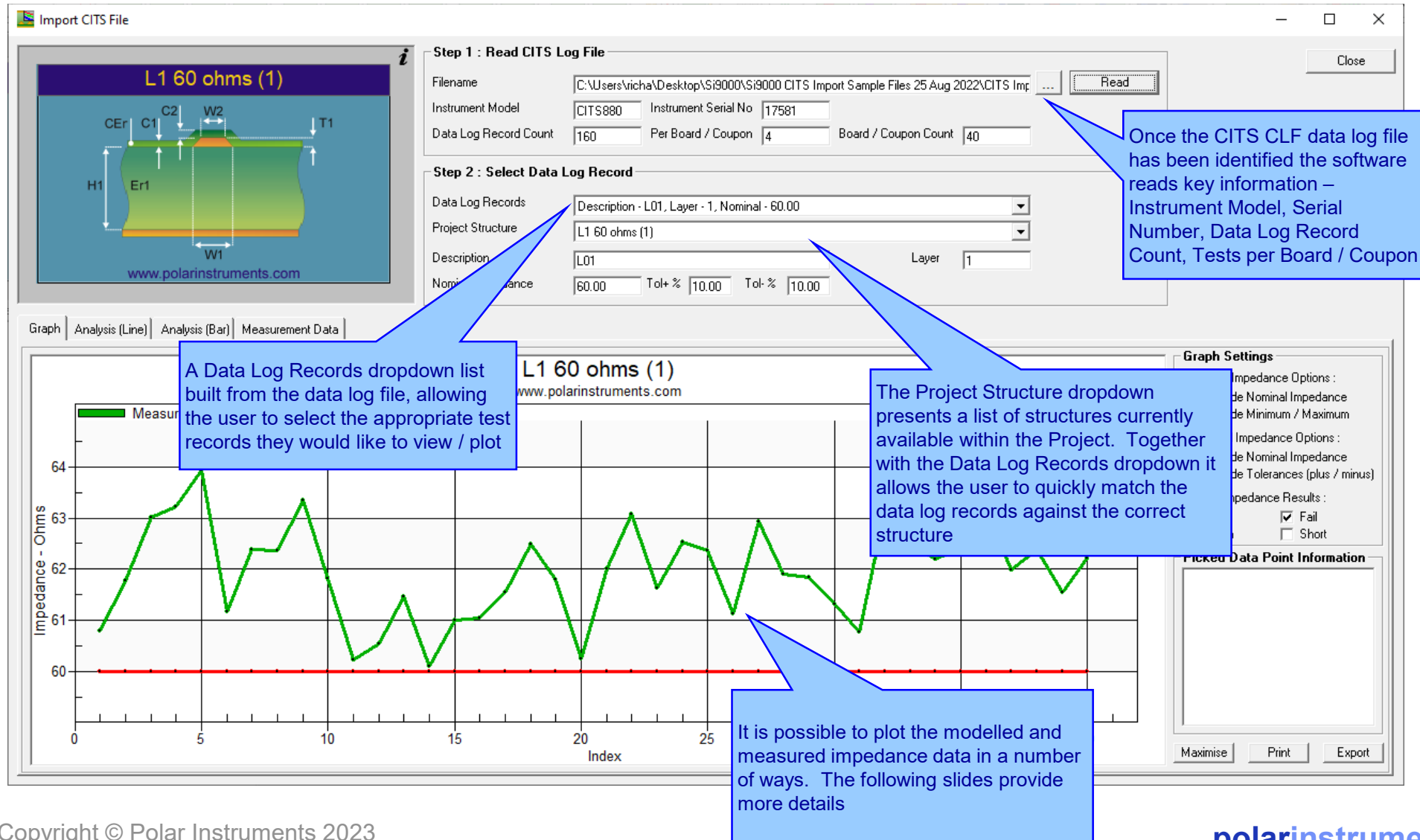
		Tolerance	Minimum	Maximum	
Substrate 1 Height	H1	6.0000 ± 0.0000	6.0000	6.0000	Calculate
Substrate 1 Dielectric	Er1	4.2000 ± 0.0000	4.2000	4.2000	Calculate
Lower Trace Width	W1	6.9480 ± 0.0000	6.9480		
Upper Trace Width	W2	5.9480 ± 0.0000	5.9480		
Trace Thickness	T1	1.4000 ± 0.0000	1.4000		
Coating Above Substrate	C1	1.0000 ± 0.0000	1.0000		
Coating Above Trace	C2	1.0000 ± 0.0000	1.0000		
Coating Dielectric	CEr	4.0000 ± 0.0000	4.0000		
<b>Impedance</b>	<b>Zo</b>	<b>59.70</b>	<b>59.70</b>		

Notes: (First 5 lines will print)  
Add your comments here

Interface Style  
☐ Standard  
☒ Extended



## Import CITS Datalog File option – feature recap



**Step 1: Read CITS Log File**

Filename: C:\Users\richa\Desktop\Si9000\Si9000 CITS Import Sample Files 25 Aug 2022\CITS Imp... **Read**

Instrument Model: CITS880 Instrument Serial No: 17581

Data Log Record Count: 160 Per Board / Coupon: 4 Board / Coupon Count: 40

**Step 2: Select Data Log Record**

Data Log Records: Description - L01, Layer - 1, Nominal - 60.00

Project Structure: L1 60 ohms (1)

Description: L01 Layer: 1

Nominal: 60.00 Tol+: 10.00 Tol-: 10.00

**Graph Settings**

Impedance Options:

- ☐ de Nominal Impedance
- ☐ de Minimum / Maximum

Impedance Options:

- ☐ de Nominal Impedance
- ☐ de Tolerances (plus / minus)

Impedance Results:

- ☒ Fail
- ☐ Short

**Picked Data Point Information**

Maximise Print Export

**Callouts:**

- Once the CITS CLF data log file has been identified the software reads key information – Instrument Model, Serial Number, Data Log Record Count, Tests per Board / Coupon
- A Data Log Records dropdown list built from the data log file, allowing the user to select the appropriate test records they would like to view / plot
- The Project Structure dropdown presents a list of structures currently available within the Project. Together with the Data Log Records dropdown it allows the user to quickly match the data log records against the correct structure
- It is possible to plot the modelled and measured impedance data in a number of ways. The following slides provide more details

## Import CITS Datalog File option – feature recap

**Step 2 : Select Data Log Record**

Data Log Records: Description - L01, Layer - 1, Nominal Impedance - 60.00

Project Structure: Description - L01, Layer - 1, Nominal Impedance - 60.00

Description: Description - L03, Layer - 3, Nominal Impedance - 60.00

Nominal Impedance: 60.00 Tol+ % 10.00 Tol- % 10.00

Each test record type found in the data log file is listed in the drop down. In this case there are four tests.

**Step 2 : Select Data Log Record**

Data Log Records: Description - L01, Layer - 1, Nominal Impedance - 60.00

Project Structure: L1 60 ohms (1)

Description: L1 60 ohms (1)

Nominal Impedance: L3 60 ohms (2)

L6 60 ohms (3)

L8 60 ohms (4)

To match one of the four modelled structures from the Project group against a data log test record simply select the structure from the Project Structure dropdown

Polar Si9000 PCB Tran

File Edit Configurati

L1 60 ohms (1)

L3 60 ohms (2)

L6 60 ohms (3)

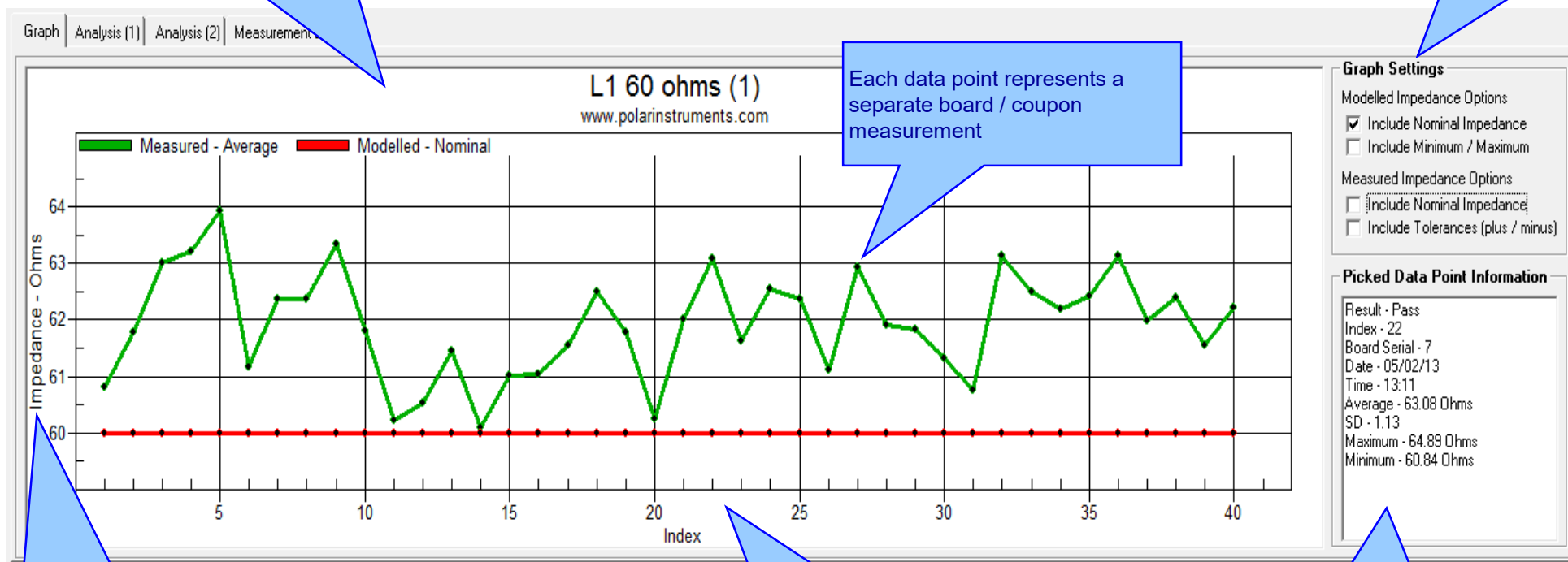
L8 60 ohms (4)

Four structures loaded into the Project group

## Import CITS Datalog File option – feature recap

The Graph tab provides a number of plot options. In this case the measured data is shown in Green, the modelled data in Red

Graph Settings allow the selection of modelled / measured data to be plotted



Each data point represents a separate board / coupon measurement

The y-axis is the measured impedance for each board / coupon

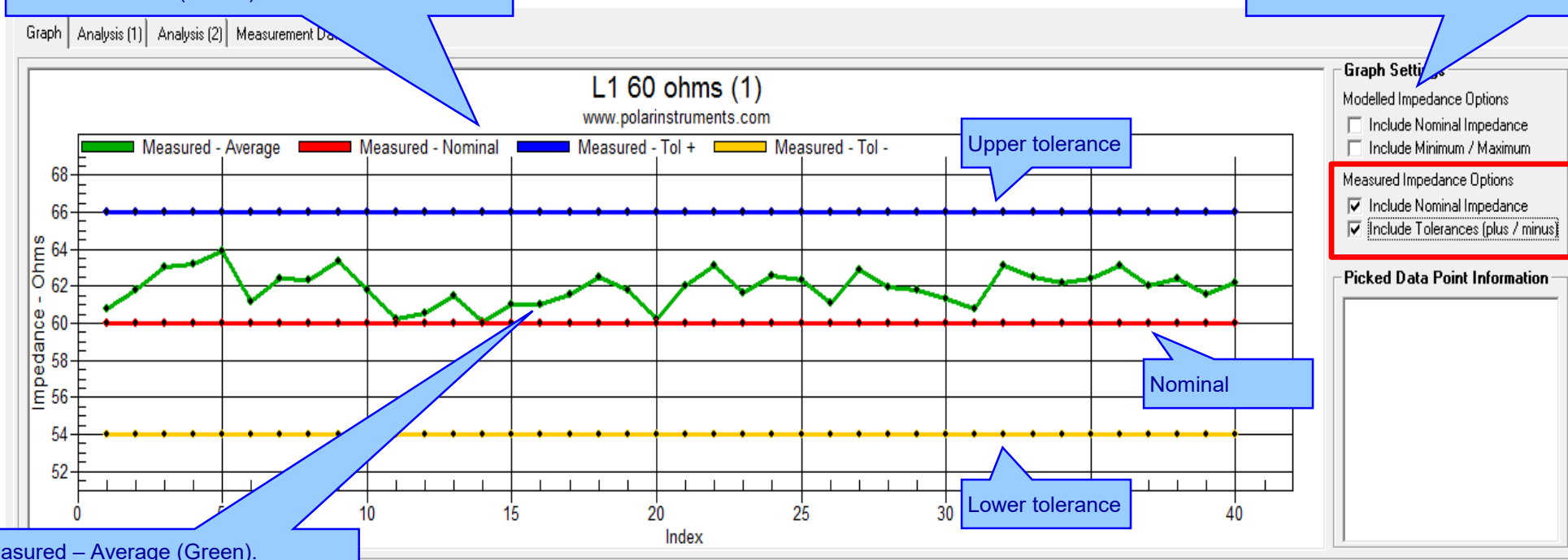
The x-axis is the identifying Index of the board / coupon read from the data log file

It is possible to pick a measured data point, key information is displayed here

## Import CITS Datalog File option – feature recap

In this case the Graph contains:  
Measured – Average (Green)  
Nominal (Red)  
Upper Tolerance (Blue)  
Lower Tolerance (Yellow)

Graph Settings allow the selection of modelled / measured data to be plotted



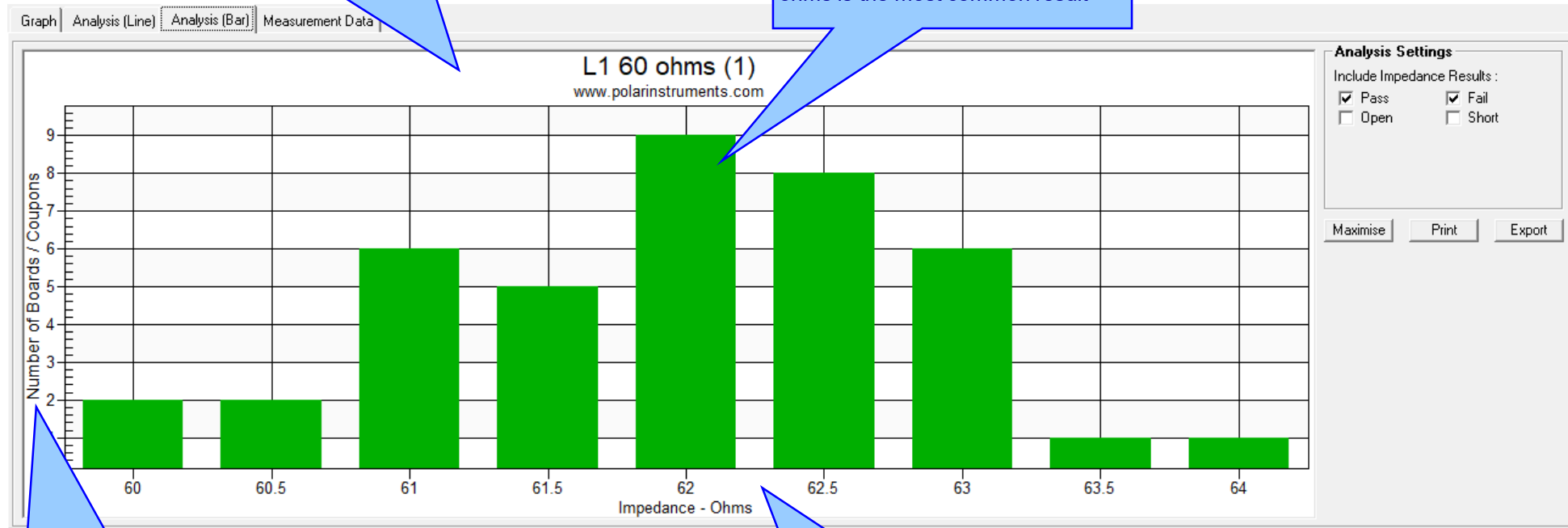
Measured – Average (Green).  
Whilst reading slightly higher than the Nominal (60 ohms) all measured data points are within the upper and lower tolerance bands

## Import CITS Datalog File option – feature recap

Analysis options:

This bar chart shows the distribution of measurement results over an impedance range

From this batch of 40 board / coupon measurements, 62 +/- 0.25 ohms is the most common result



The y-axis is the number of boards / coupons that fall within a given impedance as detailed on the x-axis

The x-axis is the measured impedance in 0.5 ohm increments

## Import CITS Datalog File option – feature recap

### Measurement Data:

The CITS Data Log data may also be viewed in a data grid layout. This is especially useful for viewing the Result data (Pass / Fail)

Graph

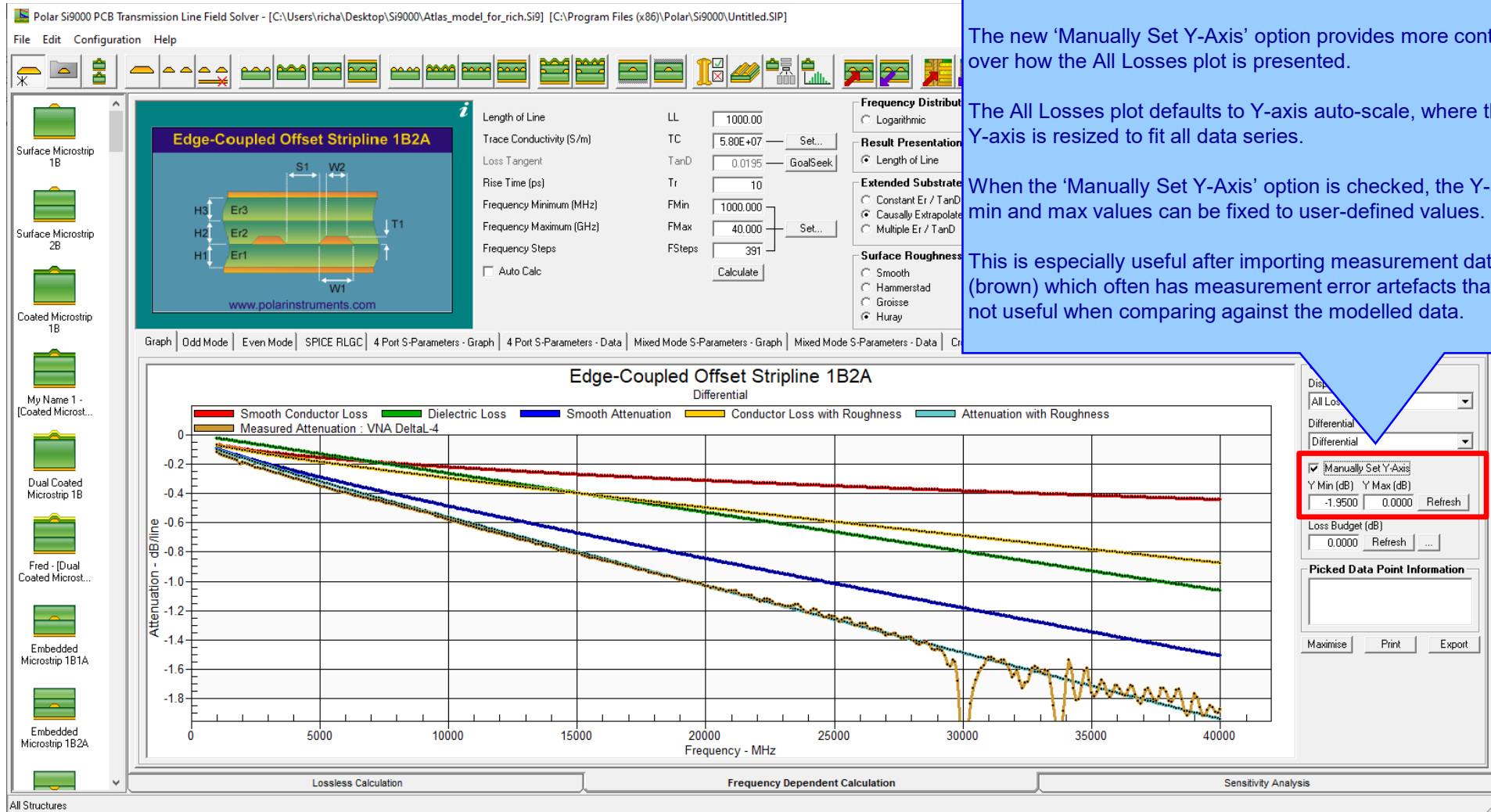
Analysis (Line)

Analysis (Bar)

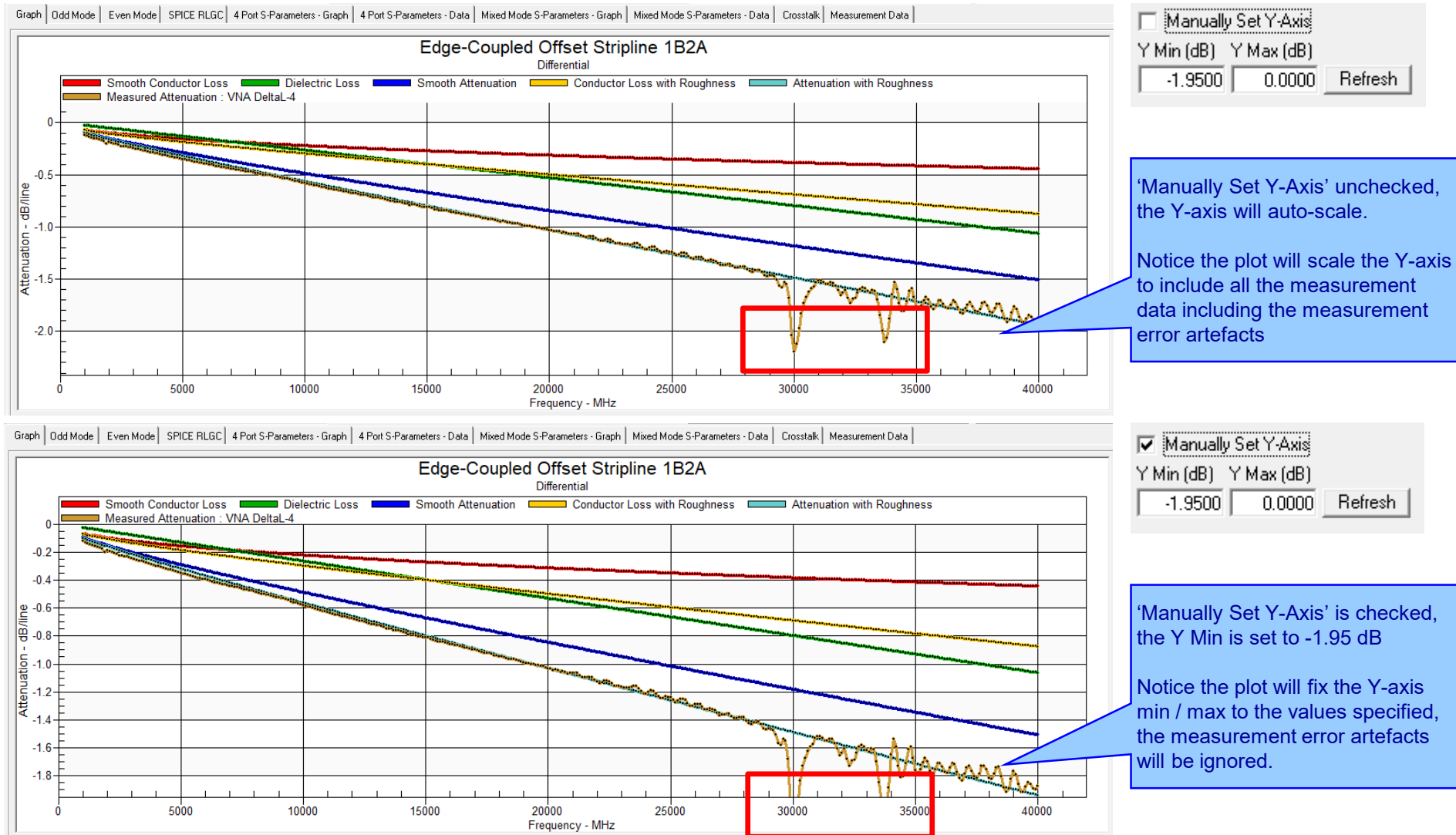
Measurement Data

Result	Index	Board Serial	Date	Time	Average	SD	Maximum	Minimum	Station	Description	Layer	Nominal	Tol+ %	Tol- %	Instrument	Serial No
Passed	1	24	05/02/13	12:48	60.8	0.8	61.9	59.56	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	2	29	05/02/13	12:50	61.77	0.95	63.21	59.93	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	3	17	05/02/13	12:51	63.01	0.94	64.48	61.68	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	4	39	05/02/13	12:52	63.22	1.07	64.62	61.29	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	5	8	05/02/13	12:59	63.93	0.95	65.32	62.2	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	6	10	05/02/13	13:00	61.17	0.89	62.69	59.63	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	7	32	05/02/13	13:01	62.38	0.88	63.58	60.72	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	8	21	05/02/13	13:01	62.37	0.82	63.88	60.98	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	9	4	05/02/13	13:02	63.35	0.68	64.41	61.75	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	10	33	05/02/13	13:03	61.81	0.78	62.95	60.09	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	11	18	05/02/13	13:03	60.22	0.62	61.48	59.09	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	12	3	05/02/13	13:04	60.54	0.75	62.1	59.19	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	13	15	05/02/13	13:05	61.46	0.73	62.83	60.12	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	14	2	05/02/13	13:05	60.09	0.67	61.24	58.57	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	15	23	05/02/13	13:06	61.01	0.78	62.4	59.69	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	16	5	05/02/13	13:07	61.05	0.63	62.14	59.49	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	17	6	05/02/13	13:07	61.54	0.8	62.98	60.11	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	18	76	05/02/13	13:08	62.49	0.92	63.44	60.32	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	19	11	05/02/13	13:09	61.79	0.83	63.08	60.37	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	20	31	05/02/13	13:09	60.25	0.65	61.37	58.85	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	21	12	05/02/13	13:10	62.01	0.69	63.24	60.65	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	22	7	05/02/13	13:11	63.08	1.13	64.89	60.84	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581
Passed	23	19	05/02/13	13:11	61.63	0.72	62.81	60.19	_TEST STATION 1_	L01	1	60	10	10	CITS880	17581

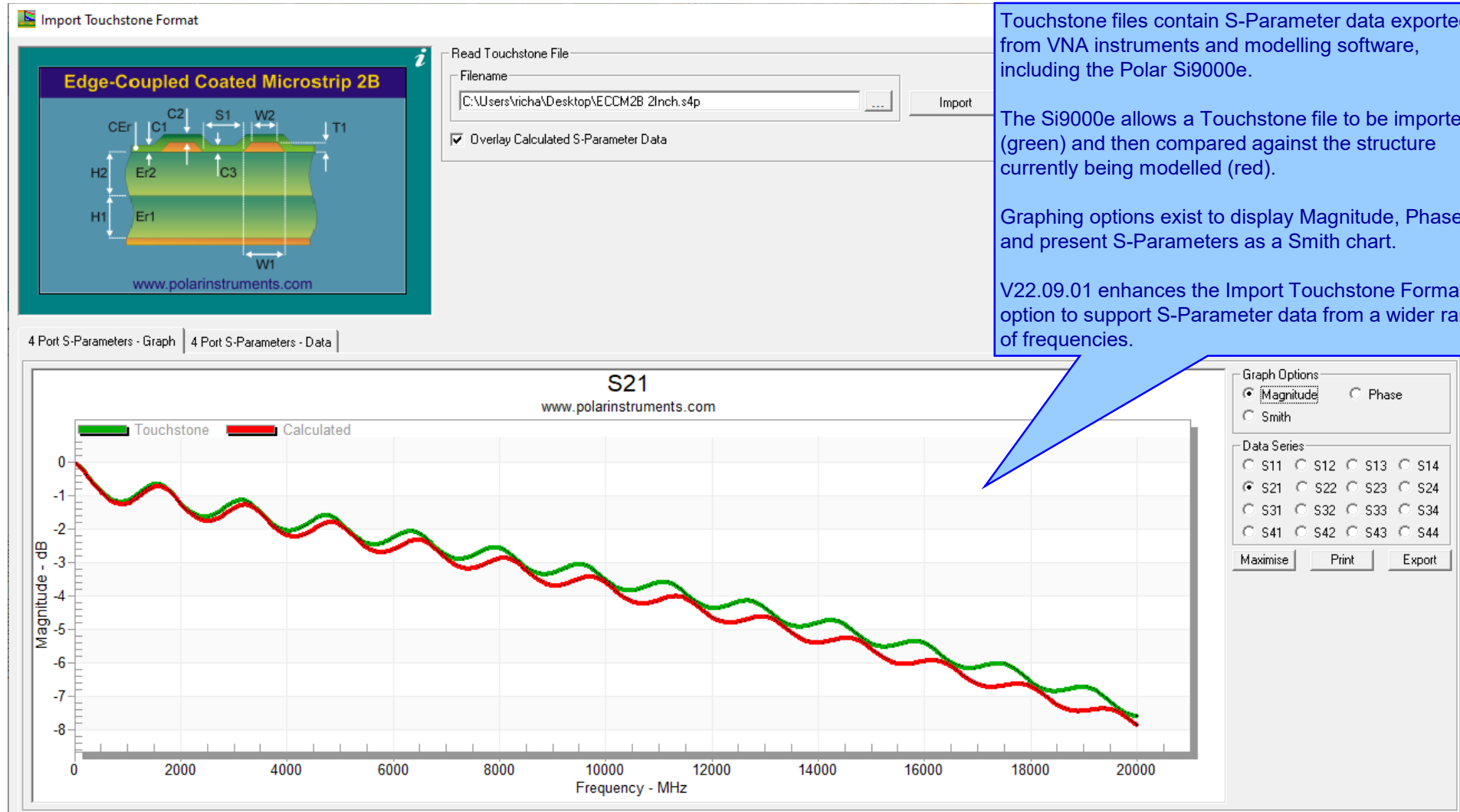
# New Manually Set Y-Axis option for the All Losses plot



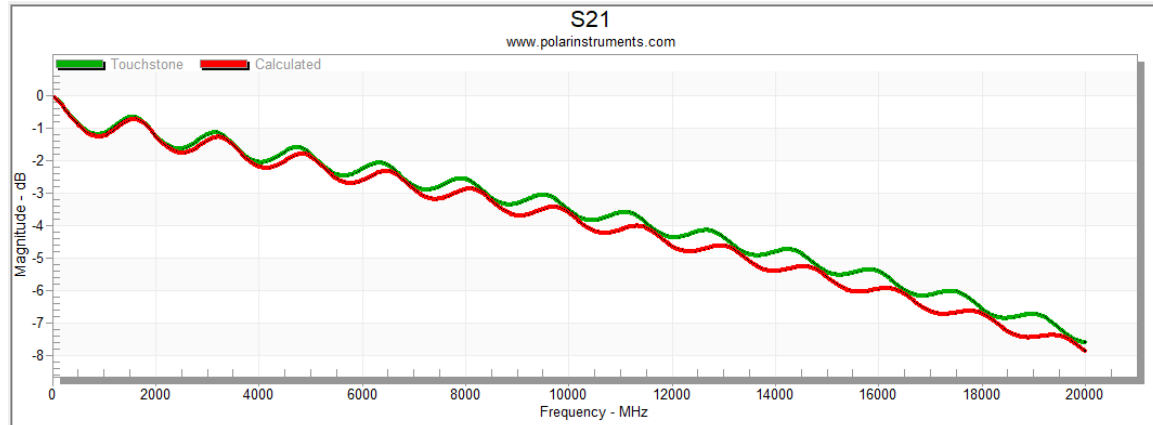
## New Manually Set Y-Axis option for the All Losses plot



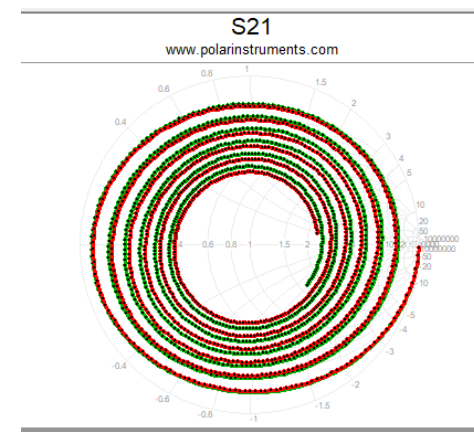
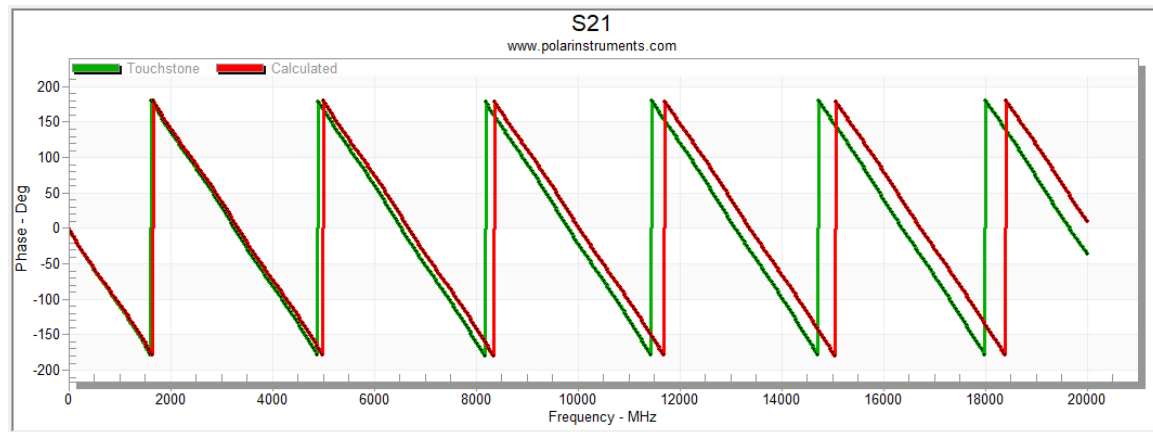
## Enhancements to the Import Touchstone Format option



## Enhancements to the Import Touchstone Format option

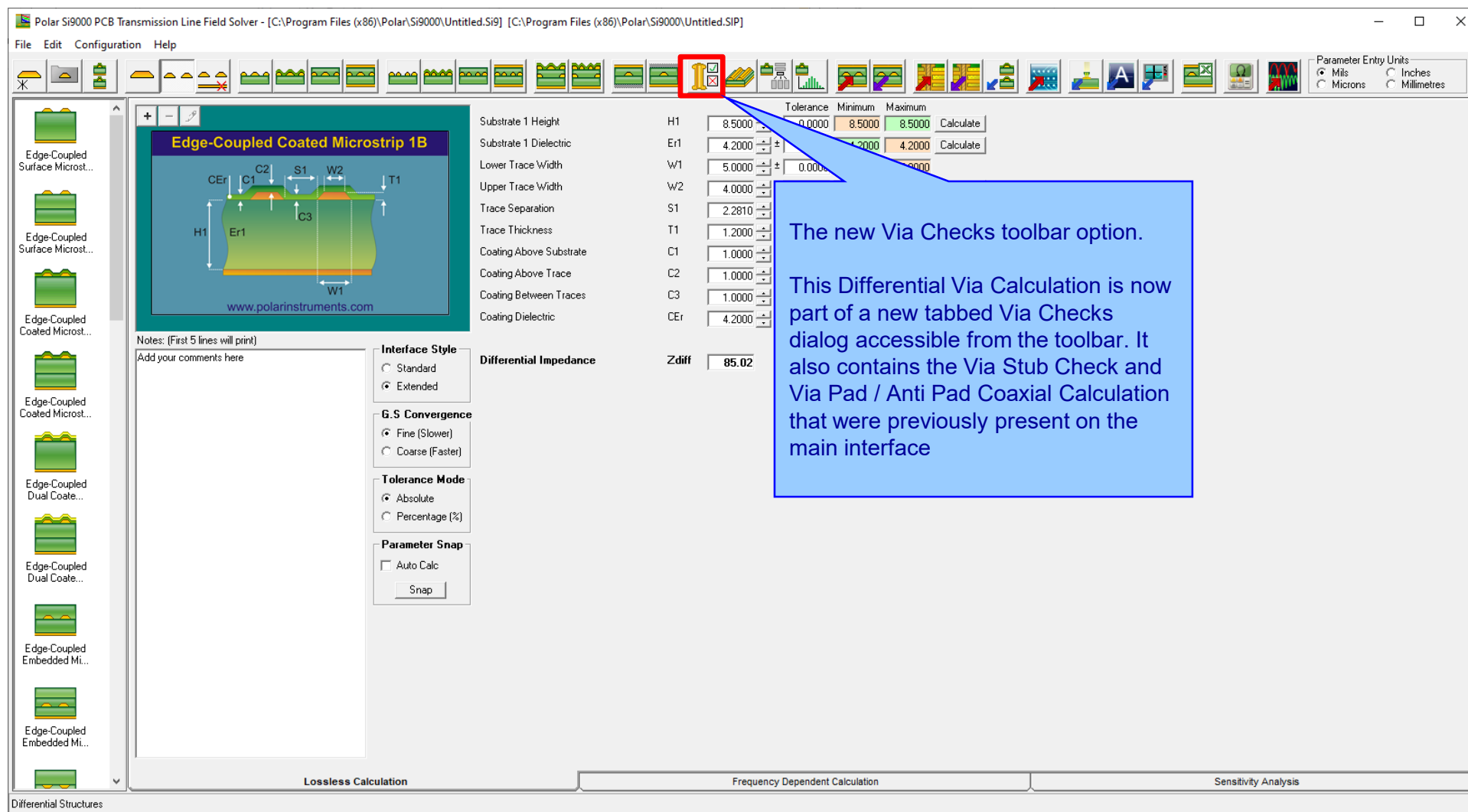


In this example a Touchstone 4-port file (.S4P) has been imported into the Si9000e. Magnitude, Phase and Smith Chart are shown for S21



# Si9000e v22.04 (April 2022)

## New Differential Via Calculation capability



Polar Si9000 PCB Transmission Line Field Solver - [C:\Program Files (x86)\Polar\Si9000\Untitled.Si9] [C:\Program Files (x86)\Polar\Si9000\Untitled.SIP]

File Edit Configuration Help

Parameter Entry Units  
☒ Mils ☐ Inches  
☐ Microns ☐ Millimetres

Edge-Coupled Surface Microst...  
Edge-Coupled Surface Microst...  
Edge-Coupled Coated Microst...  
Edge-Coupled Coated Microst...  
Edge-Coupled Dual Coate...  
Edge-Coupled Dual Coate...  
Edge-Coupled Embedded Mi...  
Edge-Coupled Embedded Mi...

**Edge-Coupled Coated Microstrip 1B**

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Notes: (First 5 lines will print)  
Add your comments here

**Interface Style**  
☐ Standard  
☒ Extended

**G.S Convergence**  
☒ Fine (Slower)  
☐ Coarse (Faster)

**Tolerance Mode**  
☒ Absolute  
☐ Percentage [%]

**Parameter Snap**  
☐ Auto Calc

**Differential Impedance**

	Tolerance	Minimum	Maximum	Calculate
H1	8.5000	0.0000	8.5000	Calculate
Er1	4.2000	4.2000	4.2000	Calculate
W1	5.0000	0.0000	5.0000	Calculate
W2	4.0000			
S1	2.2810			
T1	1.2000			
C1	1.0000			
C2	1.0000			
C3	1.0000			
CEr	4.2000			
Zdiff			85.02	

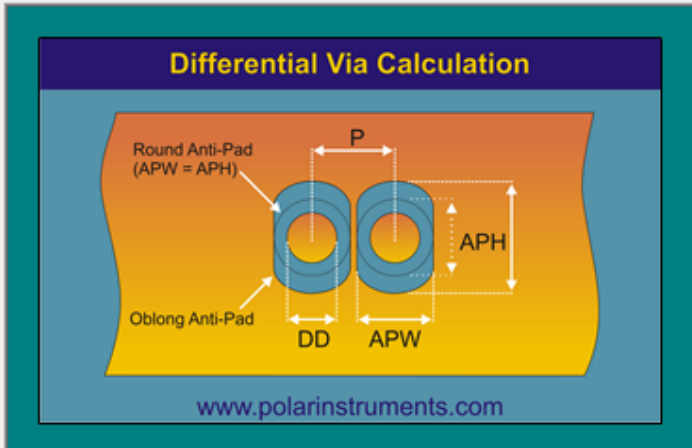
Lossless Calculation Frequency Dependent Calculation Sensitivity Analysis

Differential Structures

The new Via Checks toolbar option.

This Differential Via Calculation is now part of a new tabbed Via Checks dialog accessible from the toolbar. It also contains the Via Stub Check and Via Pad / Anti Pad Coaxial Calculation that were previously present on the main interface

## New Differential Via Calculation



**Differential Via Calculation**

Round Anti-Pad (APW = APH)

Oblong Anti-Pad

DD, APW, APH, P

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Via Checks

Via Stub Check | Via Pad / Anti-Pad Calculation | **Differential Via Calculation**

**Anti-Pad Style**

☐ Horizontal Oval Anti-Pad ☒ Round / Oblong Anti-Pad

Drill Diameter (t) DD 15.0000

Via Pitch (S) P 35.0000

Anti-Pad Width (b) APW 50.8000

Anti-Pad Height (w) APH 50.8000

Dielectric Constant (Dkz) Dkz 3.6350

Dielectric Anisotropy (%) 0.00

Odd Mode Impedance (Zvia) Zodd 42.44

Differential Impedance Zdiff 84.88

Effective Dielectric Constant DkEff 4.4430

Close

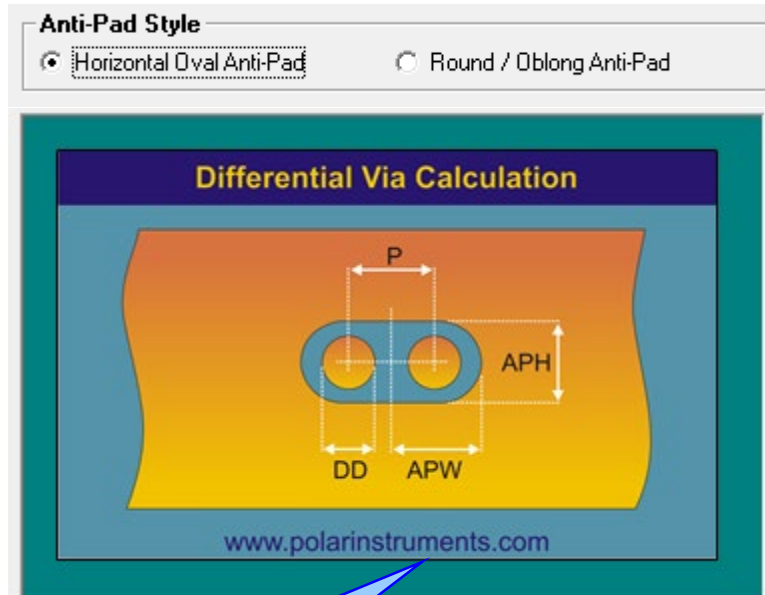
Please refer to the parameters in parentheses when reading [Application Note](#)  
 Courtesy of Bert Simonovich, Lamsim Enterprises Inc

Note: The model works for a simple differential pair structure with no pads and several planes throughout the board. If there is, say, only a 4 or 6 layer stackup, there will not be sufficient excess capacitance from the planes so the accuracy will suffer. When planes are spaced like modern designs it will be more accurate.

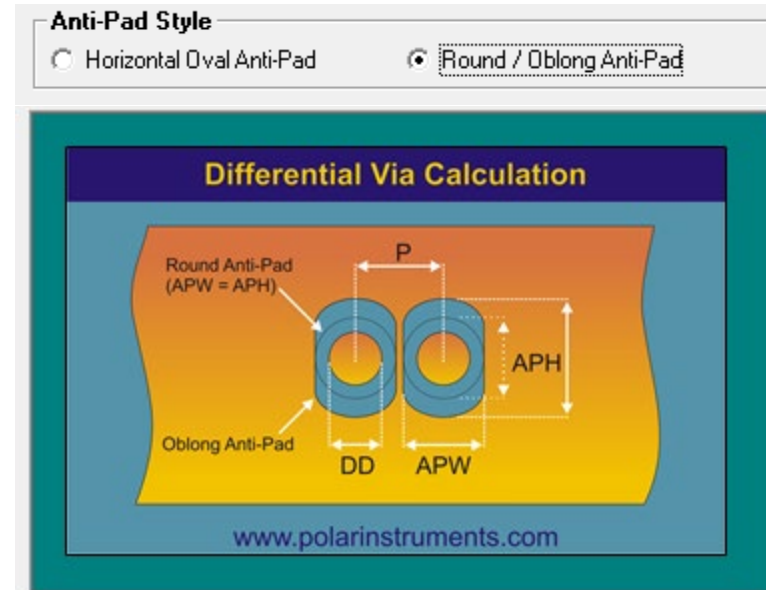
Calculation results are presented here

Enter via structure parameters by either keying the dimension values or use sliders to gauge the impact of varying each parameter

## New Differential Via Calculation



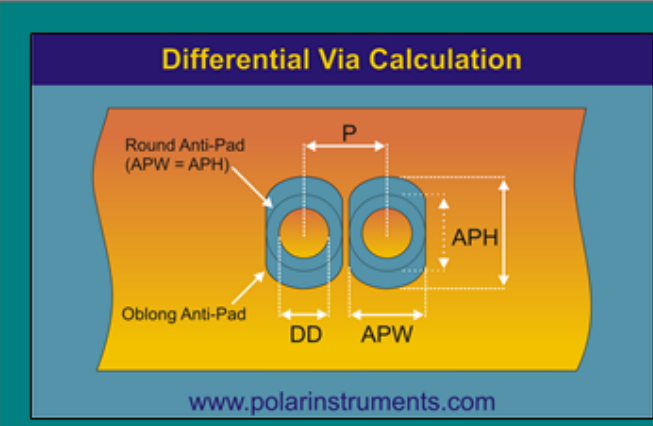
Two different selectable  
Anti-Pad Styles available



## New Differential Via Calculation

Via Checks

Via Stub Check | Via Pad / Anti-Pad Calculation | Differential Via Calculation



www.polarinstruments.com

Please refer to the parameters in parentheses when reading [Application Note](#)  
 Courtesy of Bert Simonovich, Lamsim Enterprises Inc

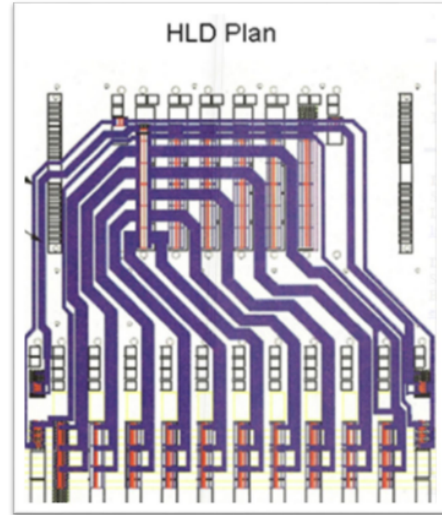
Note: The model works for a simple differential pair structure with no pads and several reference planes so the accuracy will be high.

The Application Note link provides further details of how the model works

AP8204.pdf 1 / 9 100% +

### A Practical Alternative to 3D Via Modeling

You are a backplane designer and have been assigned to engineer a new high-speed, multi-gigabit serial link architecture from several line cards to multiple fabric switch cards across a backplane. These links must operate at 6GB/s day one and be 10GB/s (IEEE 802.3KR) ready for product evolution. The schedule is tight, and you need to come up with a backplane architecture to allow the rest of the program to progress on schedule.



HLD Plan

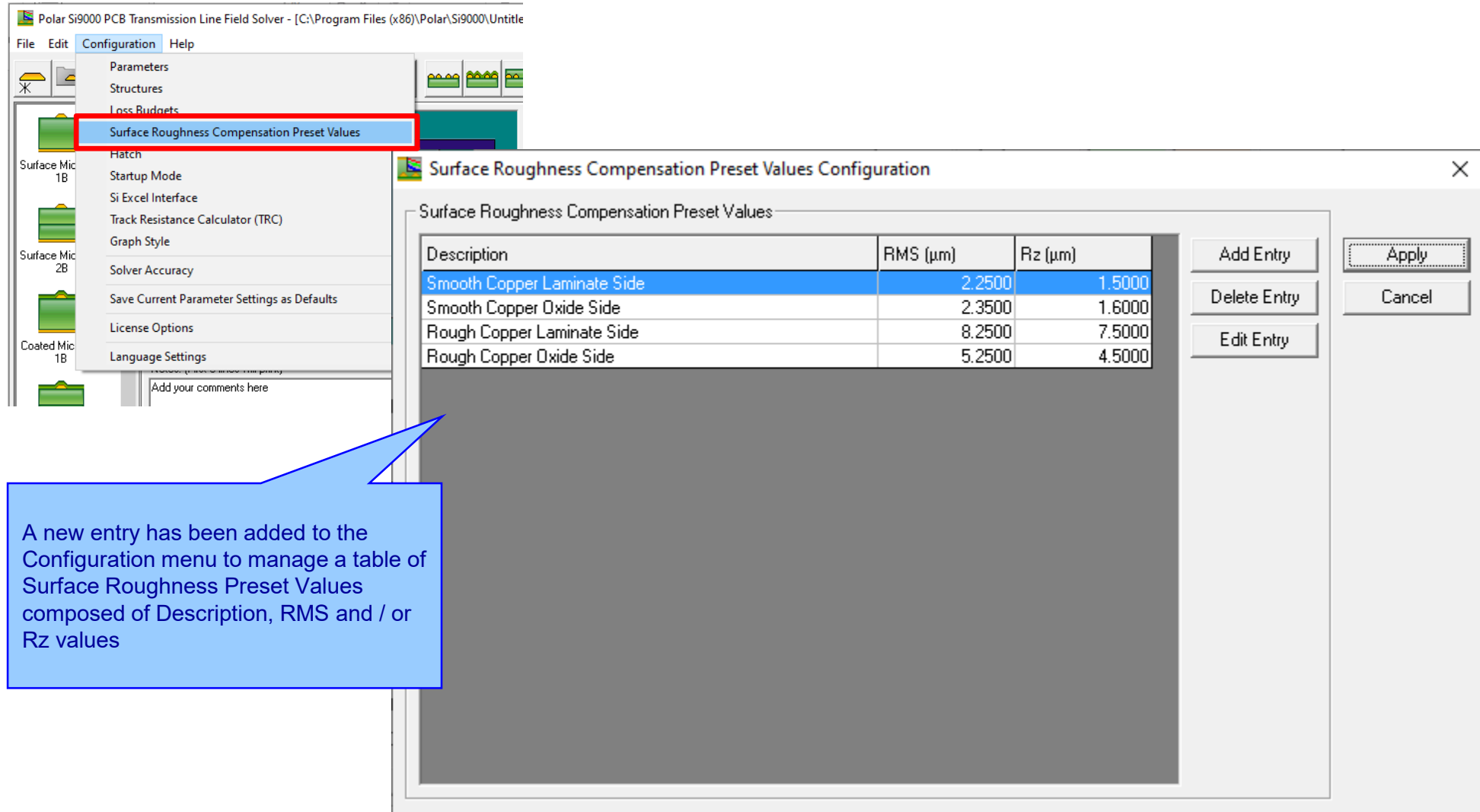
You come up with a concept you think will work, but the backplane is thick with over 30 layers. There are some long traces over 30 inches and some short traces of less than 2 inches between card slots. There is strong pressure to reuse the same connector you used in your last design, but your gut tells you its design may not be good enough for this higher speed application.

Finally, you are worried about the size and design of the differential via footprint used for the backplane connectors because you know they can be devastating to the quality of the received signal. You want to maximize the routing channel through the connector field, which requires you to shrink the anti-pad dimensions, so the tracks will be covered by the reference planes, but you can't easily quantify the consequences on the via of doing so.

You have done all you can think of, based on experience, to make the vias as transparent as possible without

# Si9000e v22.03 (March 2022)

## New Surface Roughness Compensation Preset Values option



The screenshot shows the Polar Si9000 PCB Transmission Line Field Solver software. The 'Configuration' menu is open, and the 'Surface Roughness Compensation Preset Values' option is highlighted. A dialog box titled 'Surface Roughness Compensation Preset Values Configuration' is displayed, showing a table of preset values for surface roughness compensation.

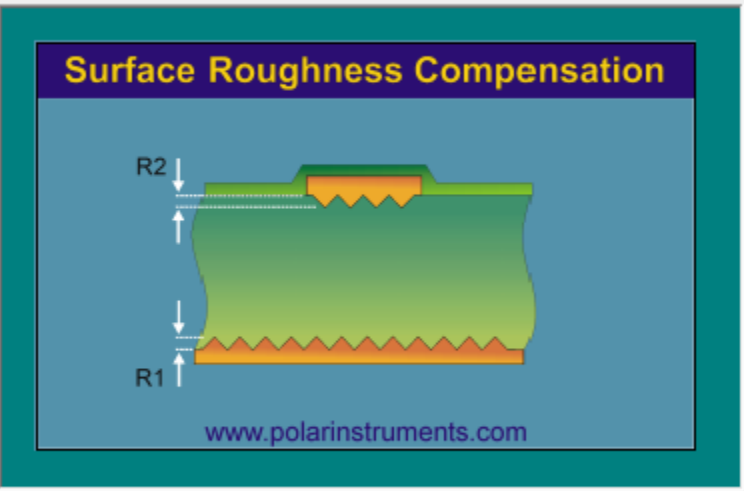
Description	RMS ( $\mu\text{m}$ )	Rz ( $\mu\text{m}$ )
Smooth Copper Laminate Side	2.2500	1.5000
Smooth Copper Oxide Side	2.3500	1.6000
Rough Copper Laminate Side	8.2500	7.5000
Rough Copper Oxide Side	5.2500	4.5000

The dialog box also includes buttons for 'Add Entry', 'Delete Entry', 'Edit Entry', 'Apply', and 'Cancel'. A blue callout box points to the 'Add Entry' button, indicating that a new entry has been added to the configuration menu.

A new entry has been added to the Configuration menu to manage a table of Surface Roughness Preset Values composed of Description, RMS and / or Rz values

## New Surface Roughness Compensation Preset Values option

Surface Roughness Compensation - Hammerstad / Grosse



Surface 1 Roughness R1 RMS : Microns 2.2500 << Apply

Smooth Copper Laminate Side

Surface 2 Roughness R2 2.3500 <<< Cancel

Smooth Copper Oxide Side

Select Surface Roughness Compensation Preset Values

Description	RMS (μm)	Rz (μm)
Smooth Copper Laminate Side	2.2500	1.5000
Smooth Copper Oxide Side	2.3500	1.6000
Rough Copper Laminate Side	8.2500	7.5000
Rough Copper Oxide Side	5.2500	4.5000

Select Cancel

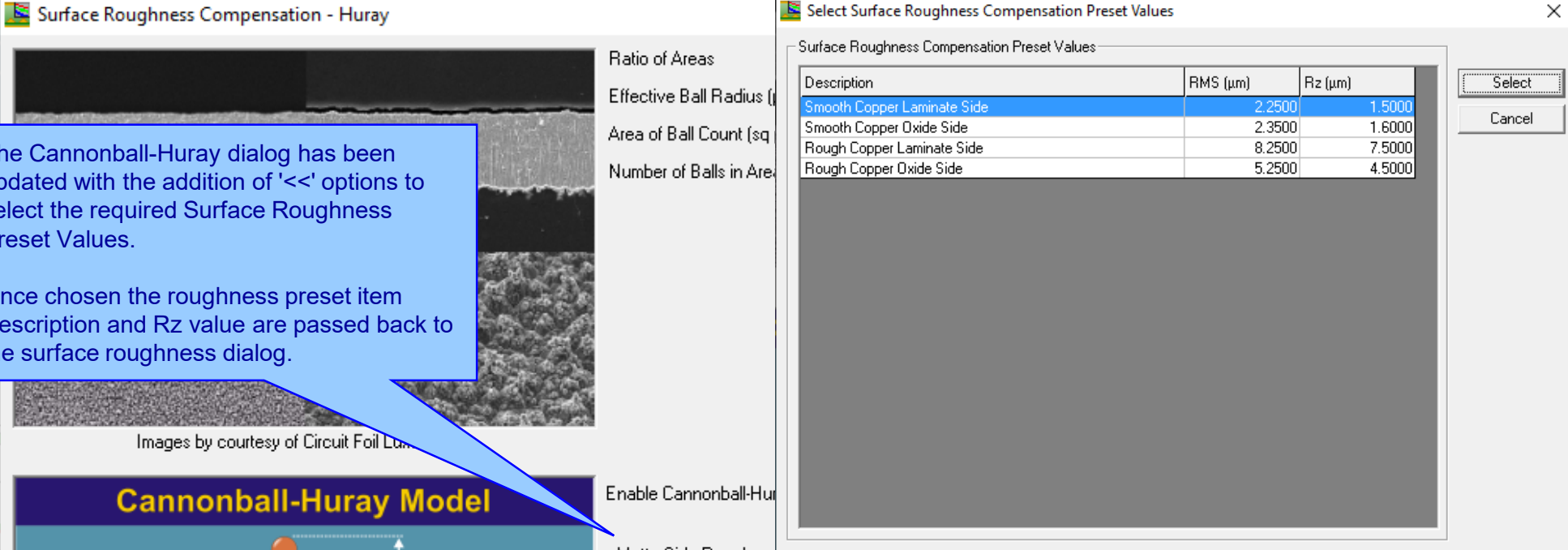
The Hammerstad / Grosse dialog has been updated with the addition of '<<' options to select the required Surface Roughness Preset Values.

Once chosen the roughness preset item Description and RMS value are passed back to the surface roughness dialog.

## New Surface Roughness Compensation Preset Values option

The Cannonball-Huray dialog has been updated with the addition of '<<' options to select the required Surface Roughness Preset Values.

Once chosen the roughness preset item Description and Rz value are passed back to the surface roughness dialog.



Images by courtesy of Circuit Foil Ltd

**Cannonball-Huray Model**

Enable Cannonball-Huray

Matte-Side Roughness

Rz Matte (µm) 1.5000 <<

Smooth Copper Laminate Side

Drum-Side Roughness

Rz Drum (µm) 1.6000 <<

Smooth Copper Oxide Side

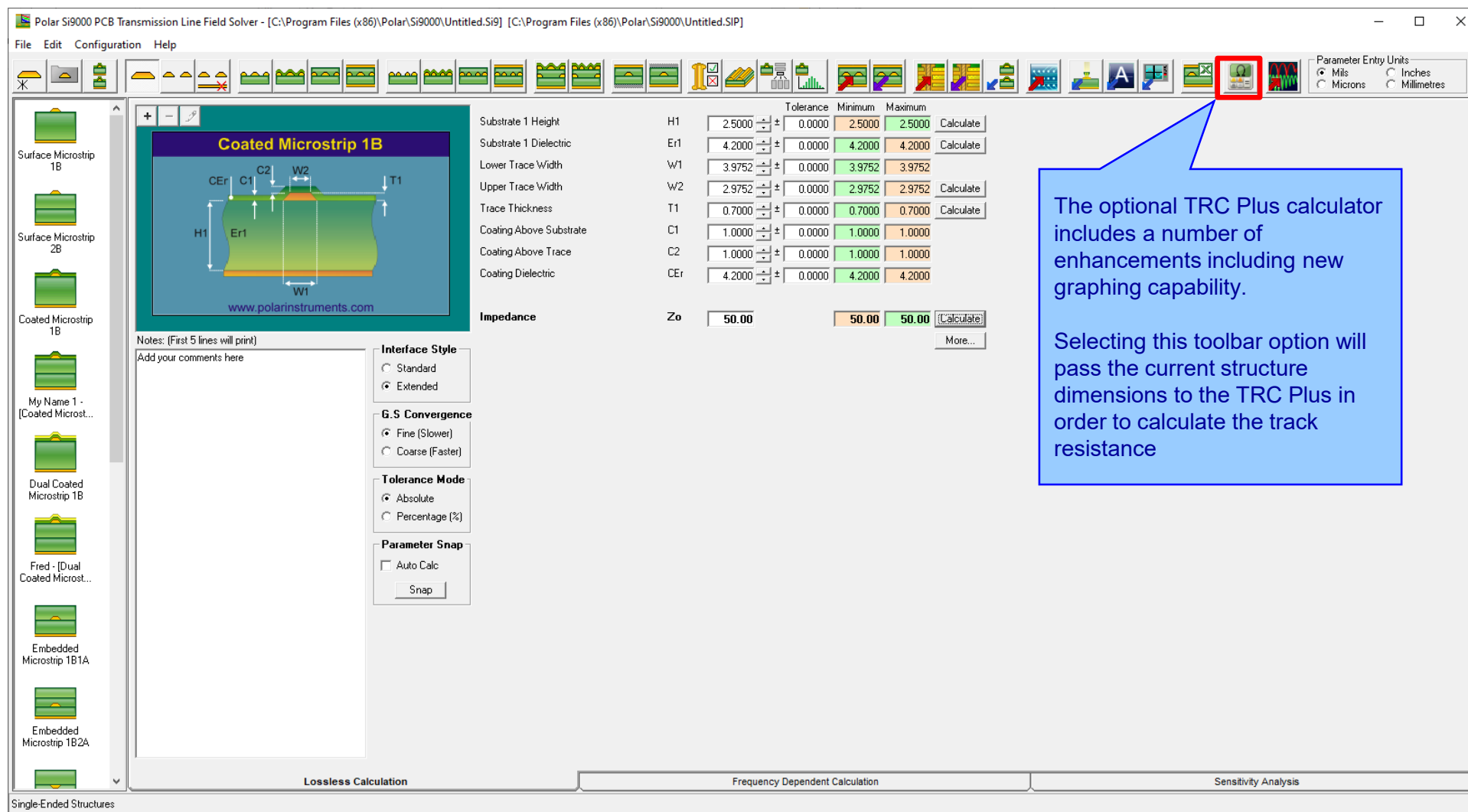
Calculate

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Courtesy of Bert Simonovich, Lamsim Enterprises Inc [Application Note](#)

# Si9000e v22.02 (February 2022)

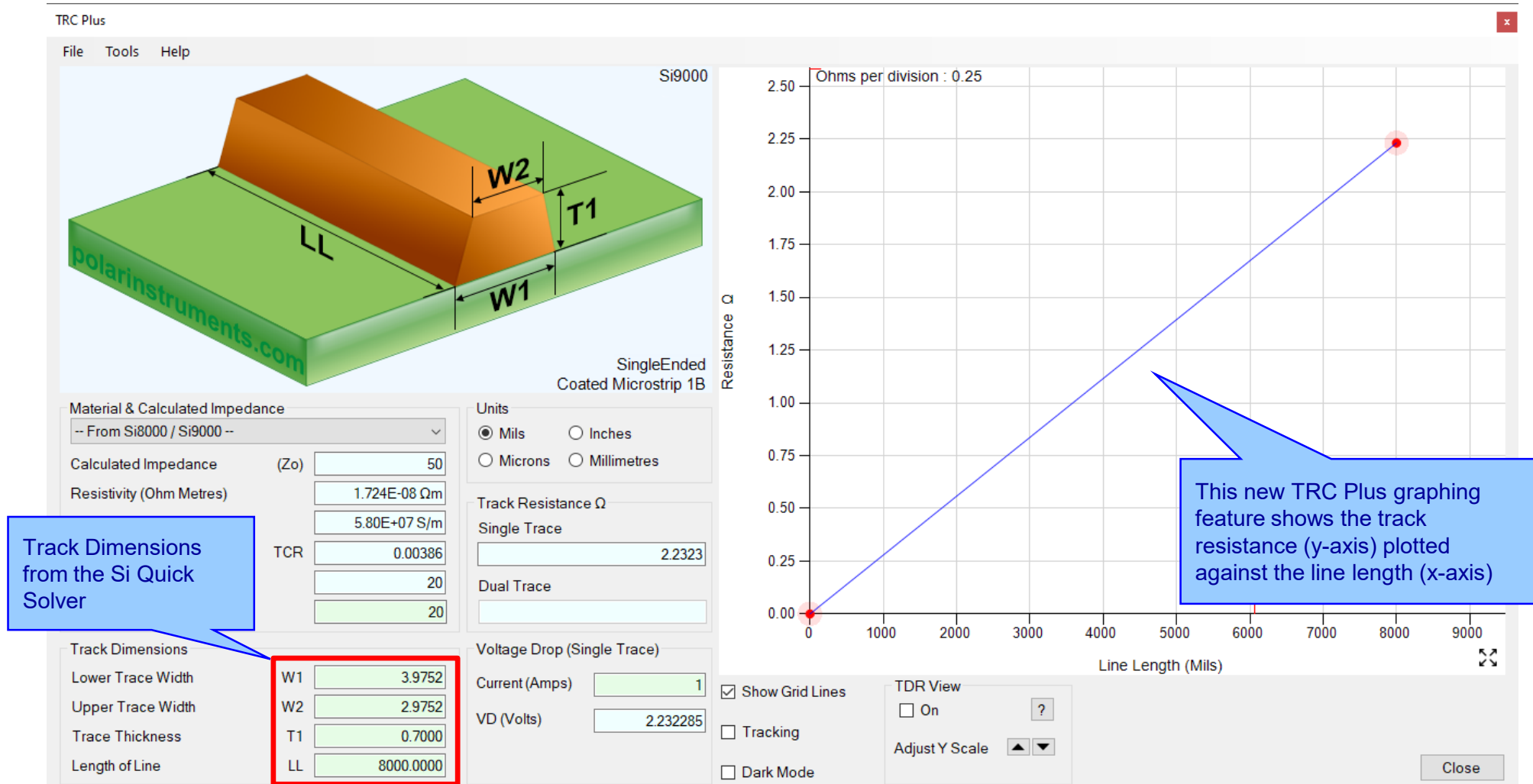
# Track Resistance Calculator (TRC Plus) enhancements



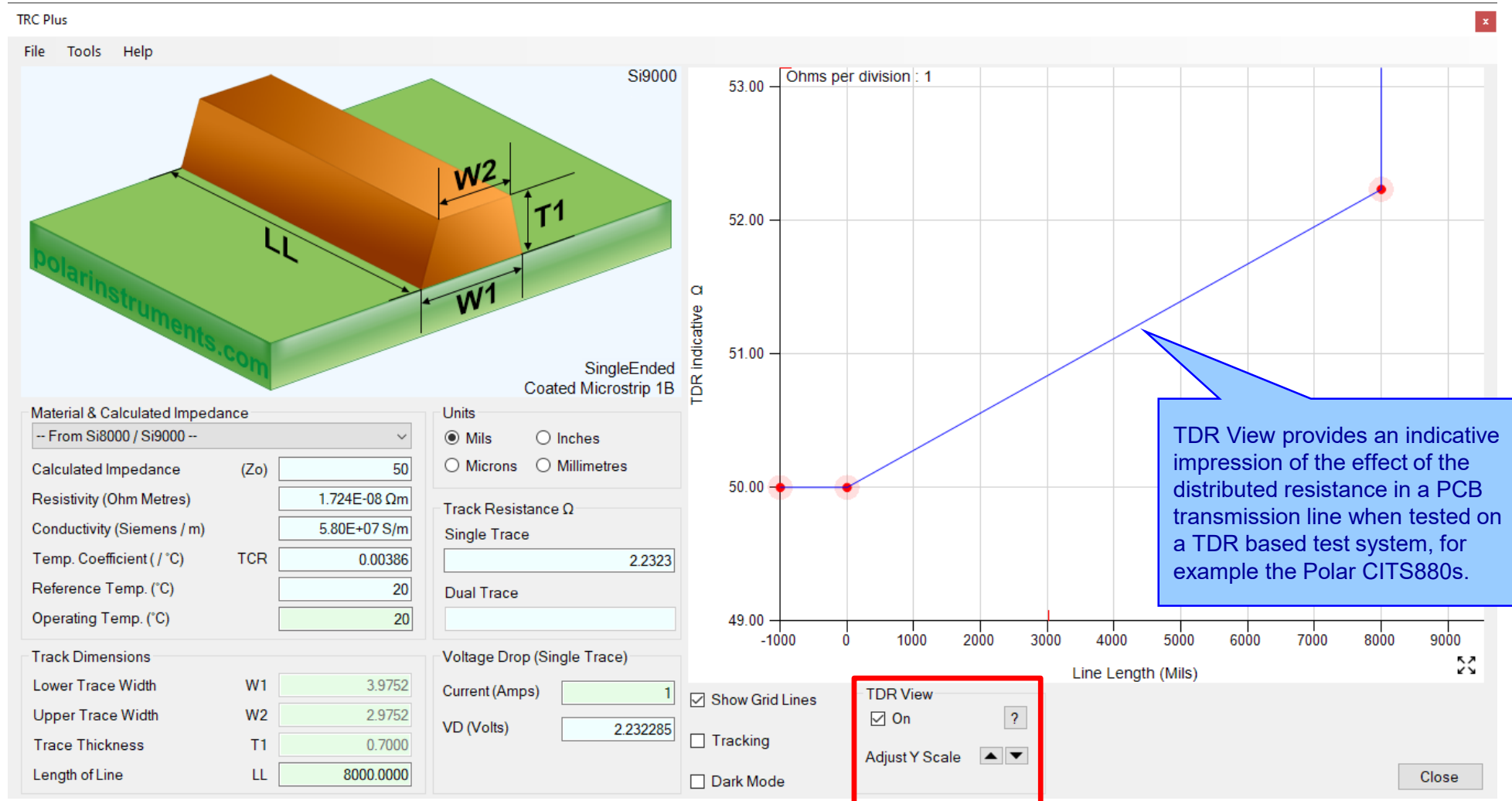
The optional TRC Plus calculator includes a number of enhancements including new graphing capability.

Selecting this toolbar option will pass the current structure dimensions to the TRC Plus in order to calculate the track resistance

# Track Resistance Calculator (TRC Plus) enhancements



# Track Resistance Calculator (TRC Plus) enhancements



# Si9000e v21.09 (Sept 2021)

## Project Graphing – Introduction *(requires the Si Projects feature)*

It is often useful to compare the results from similar structures, especially with frequency dependent calculations where changing just one or two parameters can have significant impact.

Until now the Si9000e Quick Solver graphing has focused on a single structure, for instance the All Losses graph will display a single plot that includes multiple data series for the same structure.

The new Project Graphing option calculates all the results for a group of structures contained in the Project and then plots the selected data series (total attenuation, conductor loss or dielectric loss etc) on the same graph.

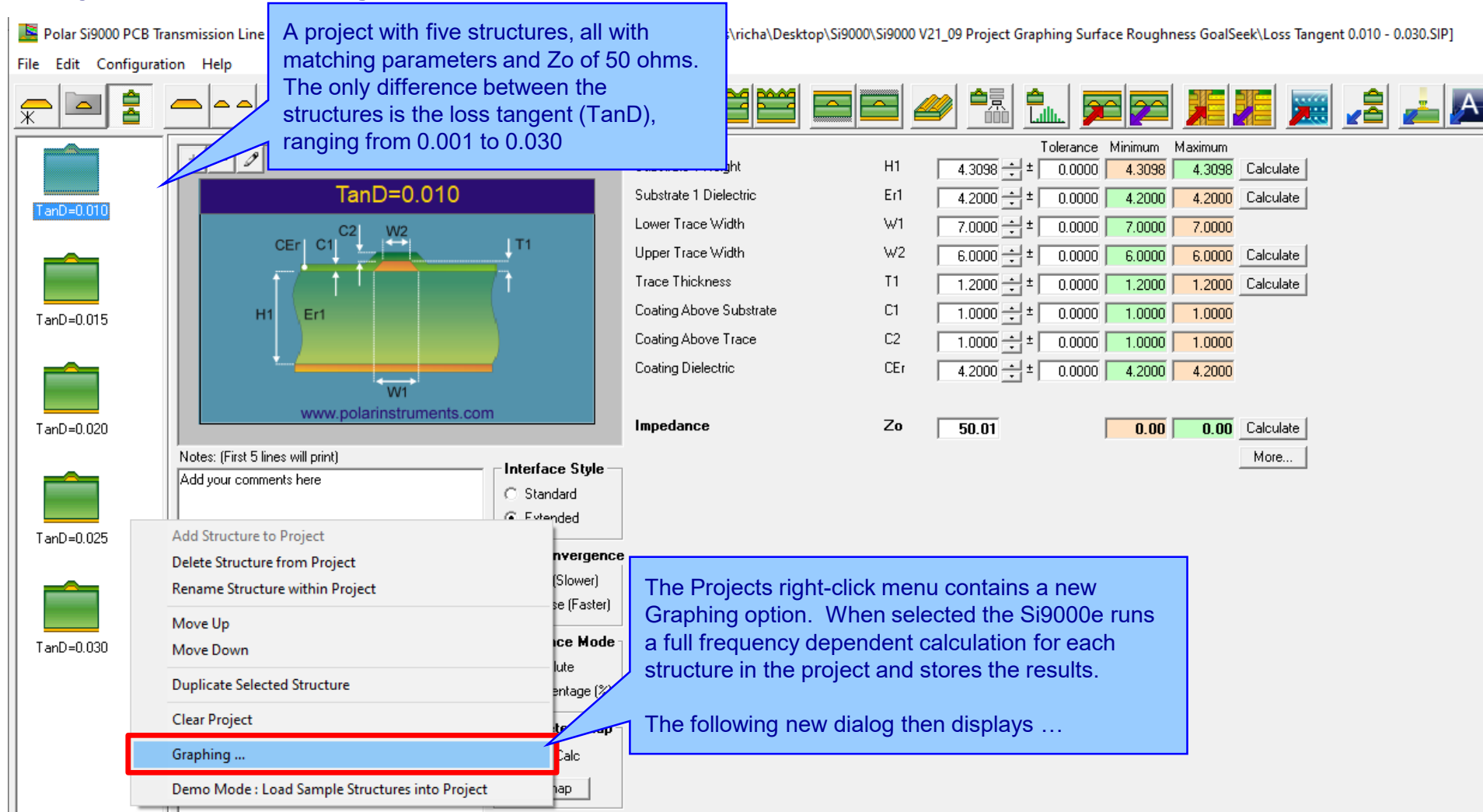
A single graph that combines results from multiple structures is useful in a number of ways. Comparing the impact of different dielectric materials, different roughness, sensitivity analysis for lossy calculations and many more uses.

## Project Graphing

A project with five structures, all with matching parameters and Zo of 50 ohms. The only difference between the structures is the loss tangent (TanD), ranging from 0.001 to 0.030

The Projects right-click menu contains a new Graphing option. When selected the Si9000e runs a full frequency dependent calculation for each structure in the project and stores the results.

The following new dialog then displays ...



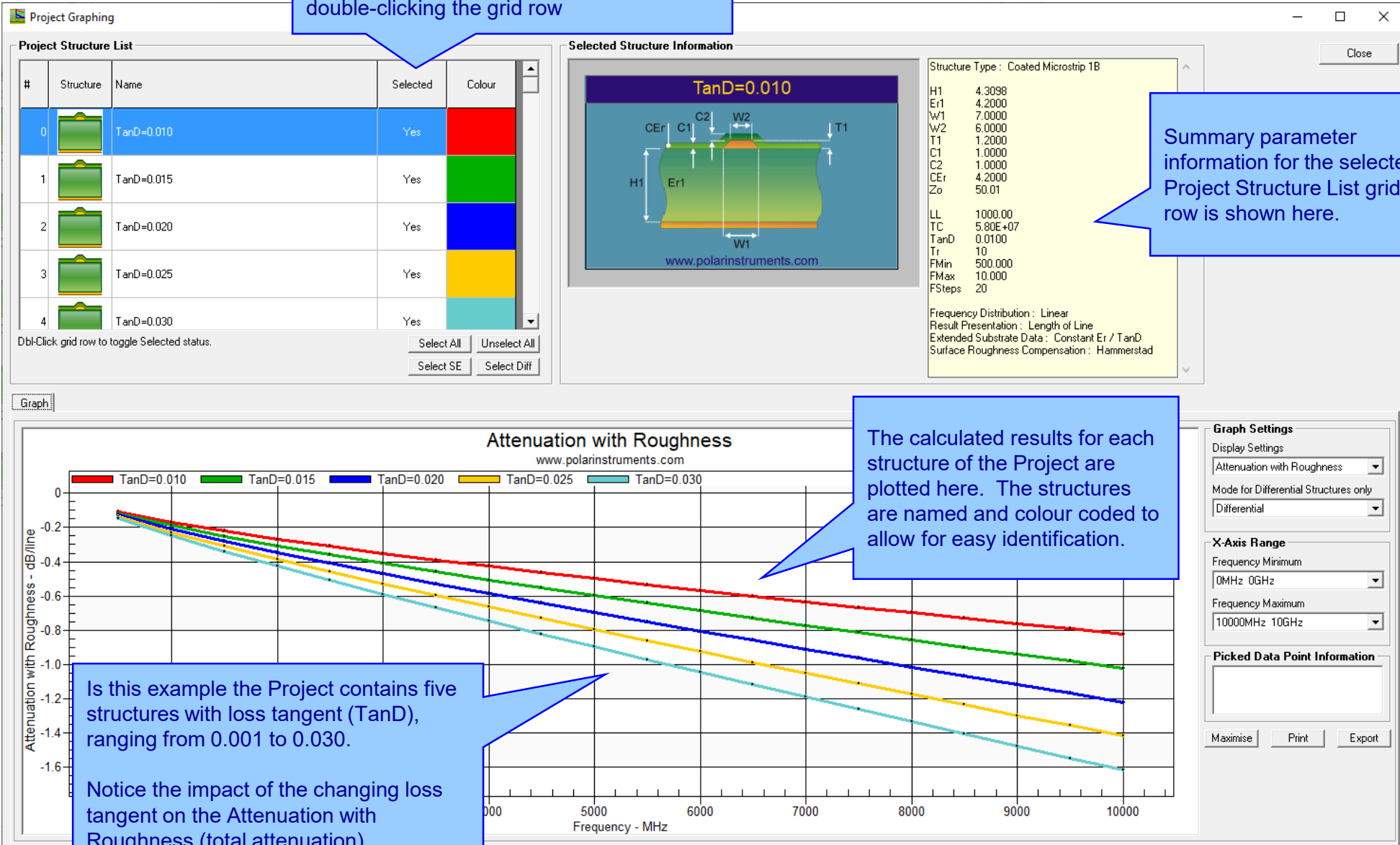
The screenshot shows the Polar Si9000 PCB Transmission Line software interface. The main window displays a cross-section diagram of a PCB structure with parameters: TanD=0.010, H1, Er1, C1, C2, W2, T1, W1. The left sidebar shows a list of structures with TanD values: 0.010, 0.015, 0.020, 0.025, and 0.030. The right sidebar shows a table of parameters and their values.

		Tolerance	Minimum	Maximum	
H1	4.3098	± 0.0000	4.3098	4.3098	Calculate
Er1	4.2000	± 0.0000	4.2000	4.2000	Calculate
W1	7.0000	± 0.0000	7.0000	7.0000	
W2	6.0000	± 0.0000	6.0000	6.0000	Calculate
T1	1.2000	± 0.0000	1.2000	1.2000	Calculate
C1	1.0000	± 0.0000	1.0000	1.0000	
C2	1.0000	± 0.0000	1.0000	1.0000	
CEr	4.2000	± 0.0000	4.2000	4.2000	
Impedance	Zo	50.01	0.00	0.00	Calculate

The right-click menu is open, showing the following options:

- Add Structure to Project
- Delete Structure from Project
- Rename Structure within Project
- Move Up
- Move Down
- Duplicate Selected Structure
- Clear Project
- Graphing ...**
- Demo Mode : Load Sample Structures into Project

The Project Structure List provides options to choose which structures from the Project are plotted. Individual structures can be toggled between selected / deselected by double-clicking the grid row

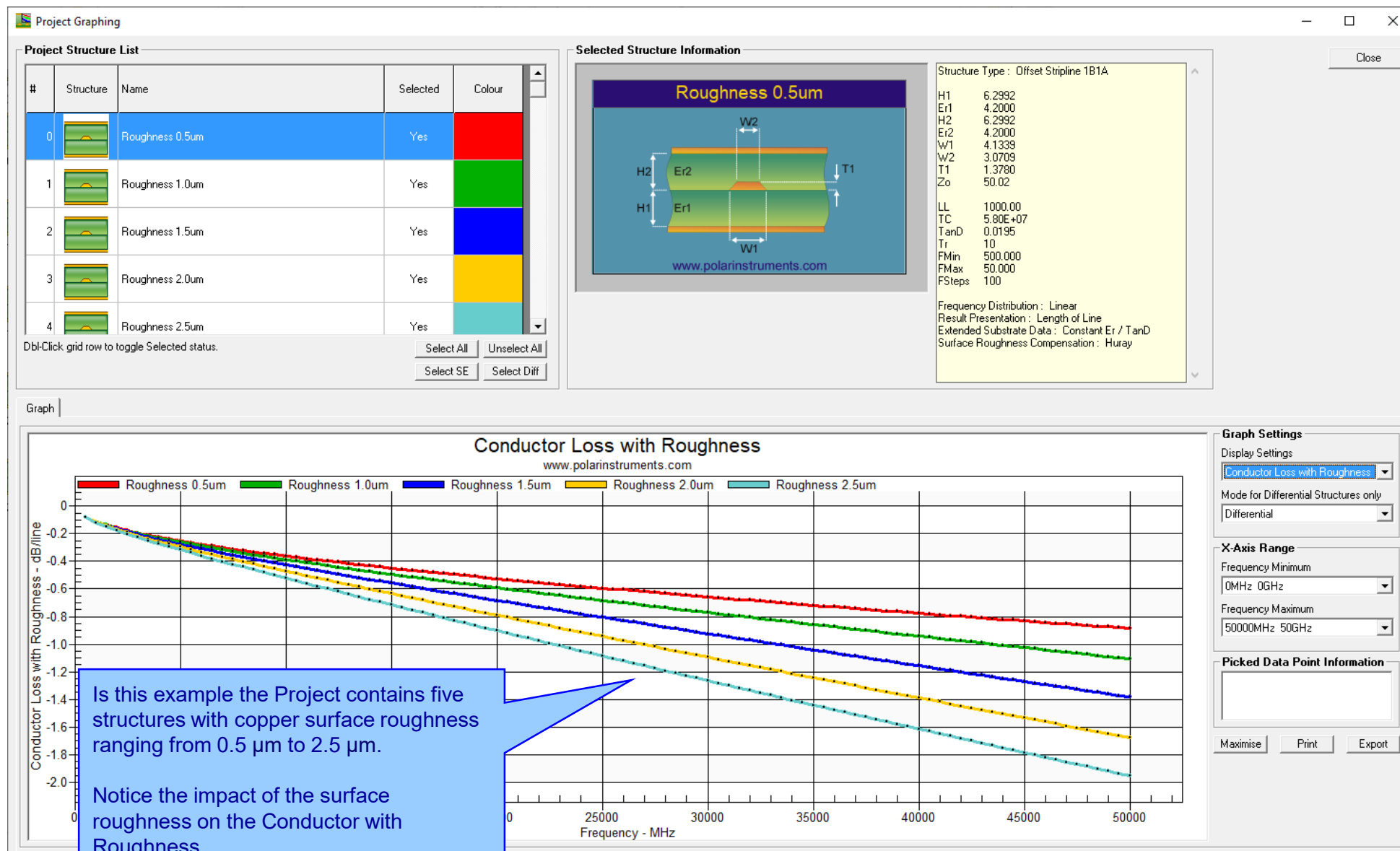


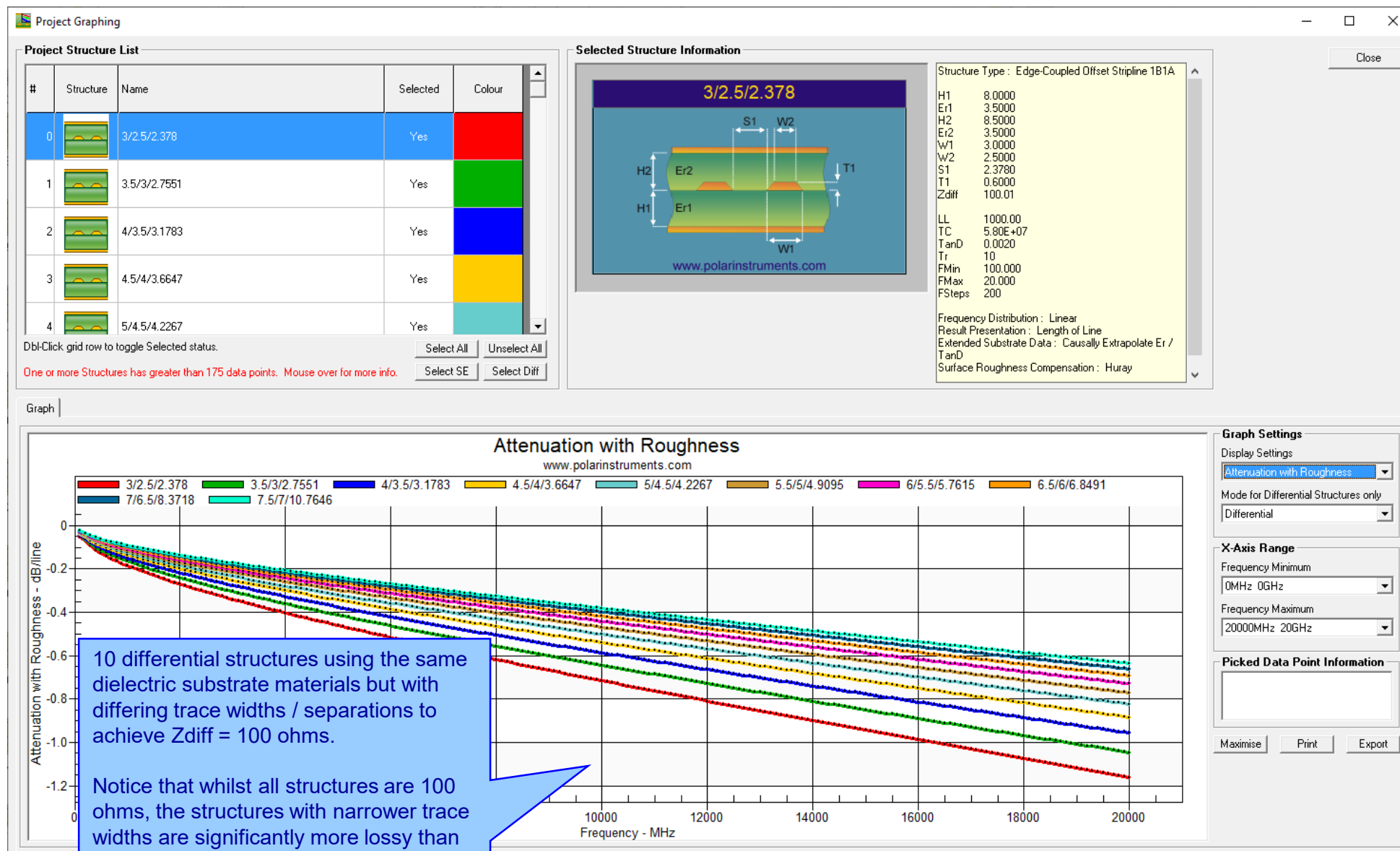
Summary parameter information for the selected Project Structure List grid row is shown here.

The calculated results for each structure of the Project are plotted here. The structures are named and colour coded to allow for easy identification.

Is this example the Project contains five structures with loss tangent (TanD), ranging from 0.001 to 0.030.

Notice the impact of the changing loss tangent on the Attenuation with Roughness (total attenuation)





## Project Graphing – Summary

- The new Graphing option for Si Projects provides useful plots that contain data from multiple structures
- There are numerous uses for this type of option - comparing the impact of different dielectric materials, different roughness, sensitivity analysis for lossy calculations and more
- ‘What if’ scenarios where one structure in the project would use the current design parameters and the second structure would contain a modified set based on a newer material. The plots comparing the original versus the new material will instantly show the impact
- Useful to both fabricators and design companies

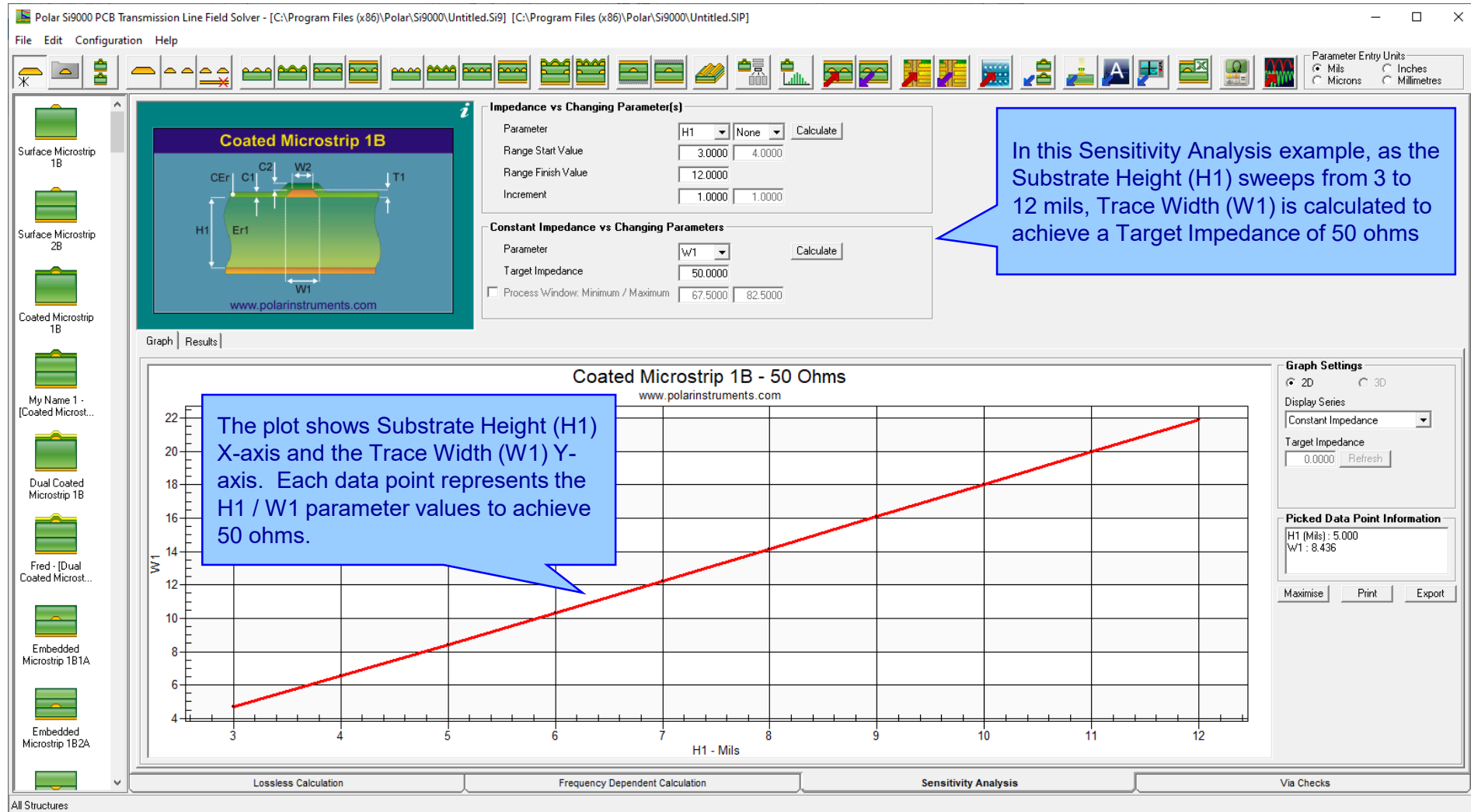
## Populate a Project from Sensitivity Analysis Results

*(requires the Si Projects feature)*

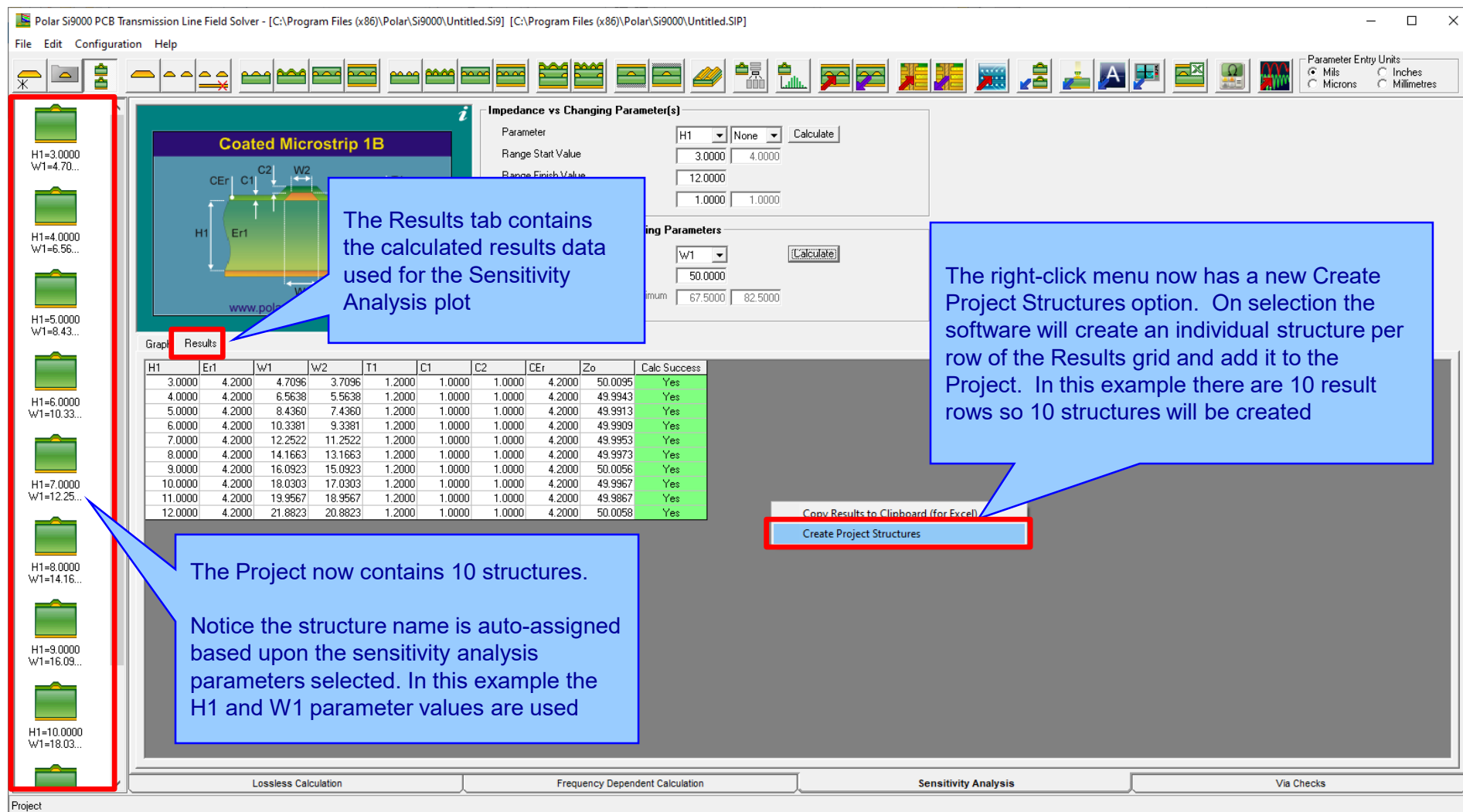
When using the Sensitivity Analysis option it is often useful to examine the calculated results in more details. It is now possible to auto-create a Project containing structures based upon the Sensitivity Analysis results data.

The following slides provide further details:

# Populate a Project from Sensitivity Analysis Results



# Populate a Project from Sensitivity Analysis Results



The Results tab contains the calculated results data used for the Sensitivity Analysis plot

The right-click menu now has a new Create Project Structures option. On selection the software will create an individual structure per row of the Results grid and add it to the Project. In this example there are 10 result rows so 10 structures will be created

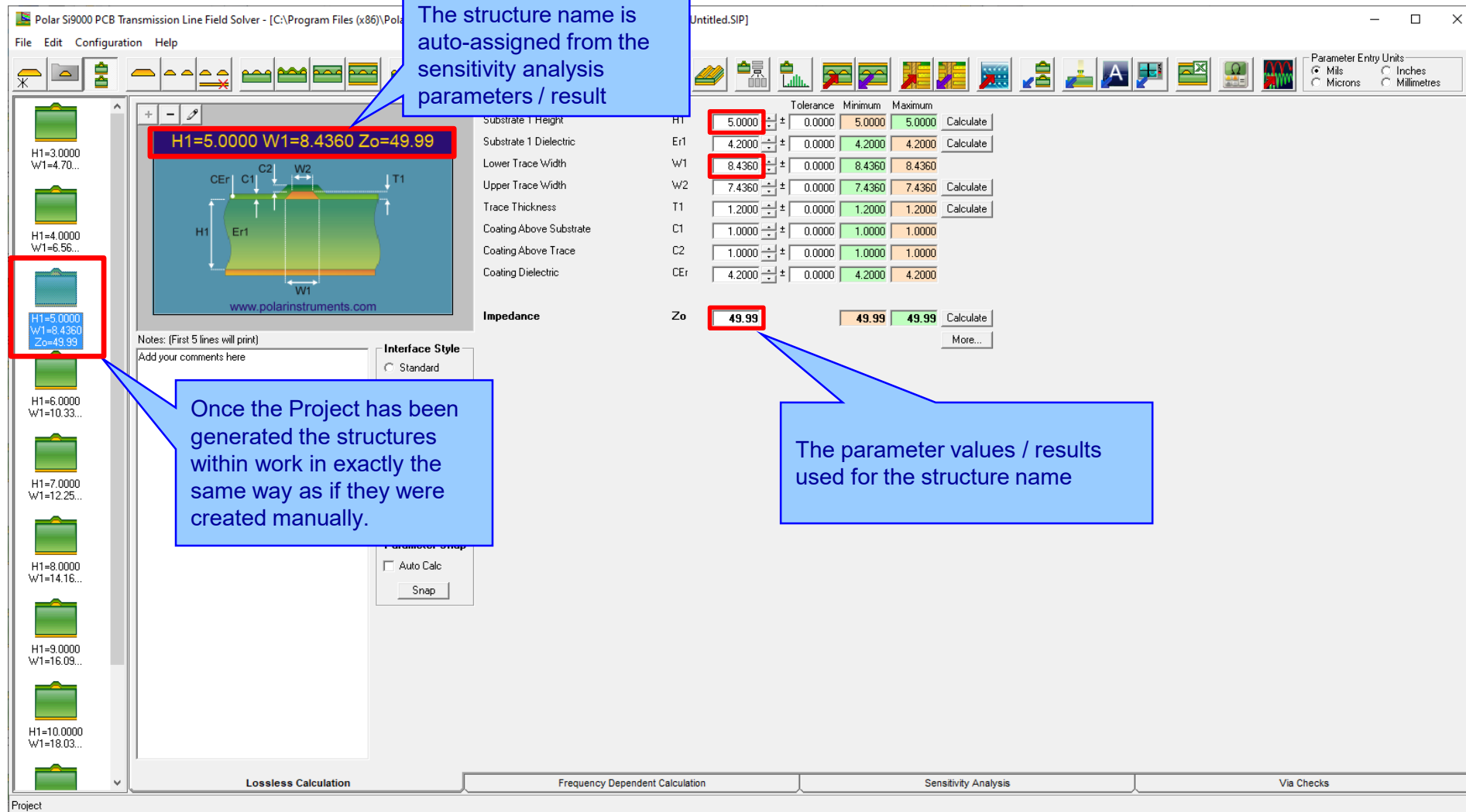
The Project now contains 10 structures. Notice the structure name is auto-assigned based upon the sensitivity analysis parameters selected. In this example the H1 and W1 parameter values are used

H1	Er1	W1	W2	T1	C1	C2	CEr	Zo	Calc Success
3.0000	4.2000	4.7096	3.7096	1.2000	1.0000	1.0000	4.2000	50.0095	Yes
4.0000	4.2000	6.5638	5.5638	1.2000	1.0000	1.0000	4.2000	49.9943	Yes
5.0000	4.2000	8.4360	7.4360	1.2000	1.0000	1.0000	4.2000	49.9913	Yes
6.0000	4.2000	10.3381	9.3381	1.2000	1.0000	1.0000	4.2000	49.9909	Yes
7.0000	4.2000	12.2522	11.2522	1.2000	1.0000	1.0000	4.2000	49.9953	Yes
8.0000	4.2000	14.1663	13.1663	1.2000	1.0000	1.0000	4.2000	49.9973	Yes
9.0000	4.2000	16.0923	15.0923	1.2000	1.0000	1.0000	4.2000	50.0056	Yes
10.0000	4.2000	18.0303	17.0303	1.2000	1.0000	1.0000	4.2000	49.9967	Yes
11.0000	4.2000	19.9567	18.9567	1.2000	1.0000	1.0000	4.2000	49.9867	Yes
12.0000	4.2000	21.8823	20.8823	1.2000	1.0000	1.0000	4.2000	50.0058	Yes

Copy Results to Clipboard (for Excel)

Create Project Structures

# Populate a Project from Sensitivity Analysis Results



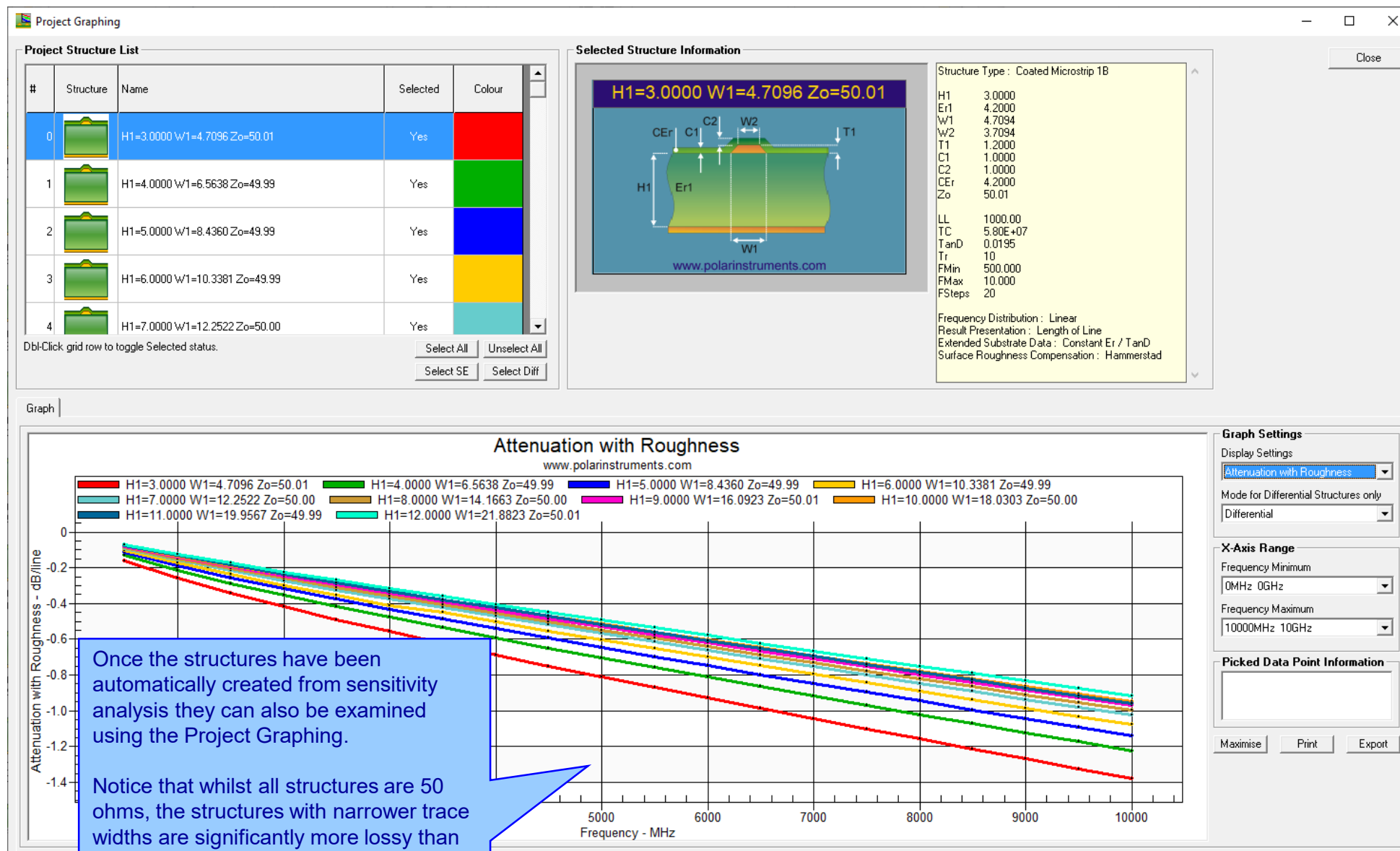
The screenshot displays the Polar Si9000 PCB Transmission Line Field Solver interface. The main window shows a cross-sectional diagram of a PCB structure with parameters labeled:  $H1=5.0000$ ,  $W1=8.4360$ , and  $Zo=49.99$ . A red box highlights these values in the diagram. A blue callout points to the diagram, stating: "The structure name is auto-assigned from the sensitivity analysis parameters / result".

On the left, a list of project structures is shown, with one structure highlighted in a red box:  $H1=5.0000$ ,  $W1=8.4360$ ,  $Zo=49.99$ . A blue callout points to this structure, stating: "Once the Project has been generated the structures within work in exactly the same way as if they were created manually."

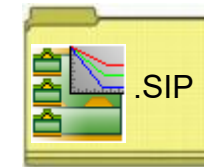
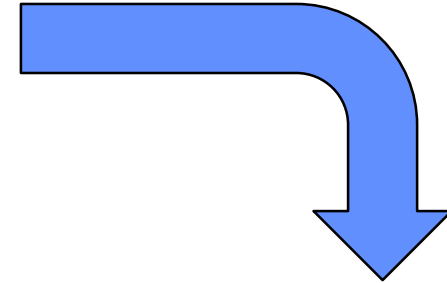
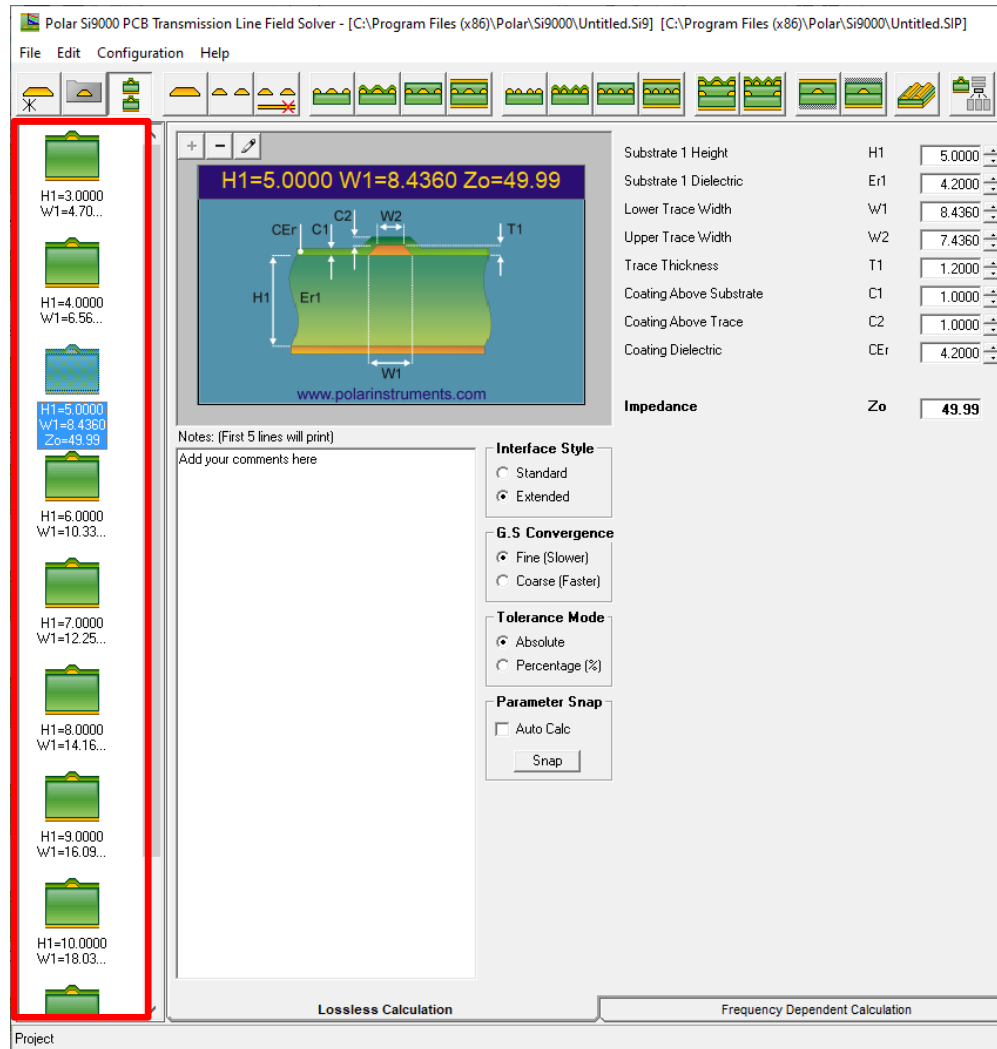
On the right, a table of sensitivity analysis results is displayed. The table has columns for Parameter, Tolerance, Minimum, Maximum, and Calculate. The parameter  $Zo$  is highlighted in a red box, with its value  $49.99$  also highlighted. A blue callout points to this value, stating: "The parameter values / results used for the structure name".

Parameter	Tolerance	Minimum	Maximum	Calculate
H1	5.0000	5.0000	5.0000	Calculate
Er1	4.2000	4.2000	4.2000	Calculate
W1	8.4360	8.4360	8.4360	Calculate
W2	7.4360	7.4360	7.4360	Calculate
T1	1.2000	1.2000	1.2000	Calculate
C1	1.0000	1.0000	1.0000	Calculate
C2	1.0000	1.0000	1.0000	Calculate
CEr	4.2000	4.2000	4.2000	Calculate
<b>Zo</b>	<b>49.99</b>	<b>49.99</b>	<b>49.99</b>	Calculate

The bottom of the interface shows tabs for "Lossless Calculation", "Frequency Dependent Calculation", "Sensitivity Analysis", and "Via Checks". The "Sensitivity Analysis" tab is currently selected.



## Populate a Project from Sensitivity Analysis Results



Save the newly created project to the Si Project file format (.SIP) so that it can be recalled at a later date.

## Populate a Project from Sensitivity Analysis Results - Summary

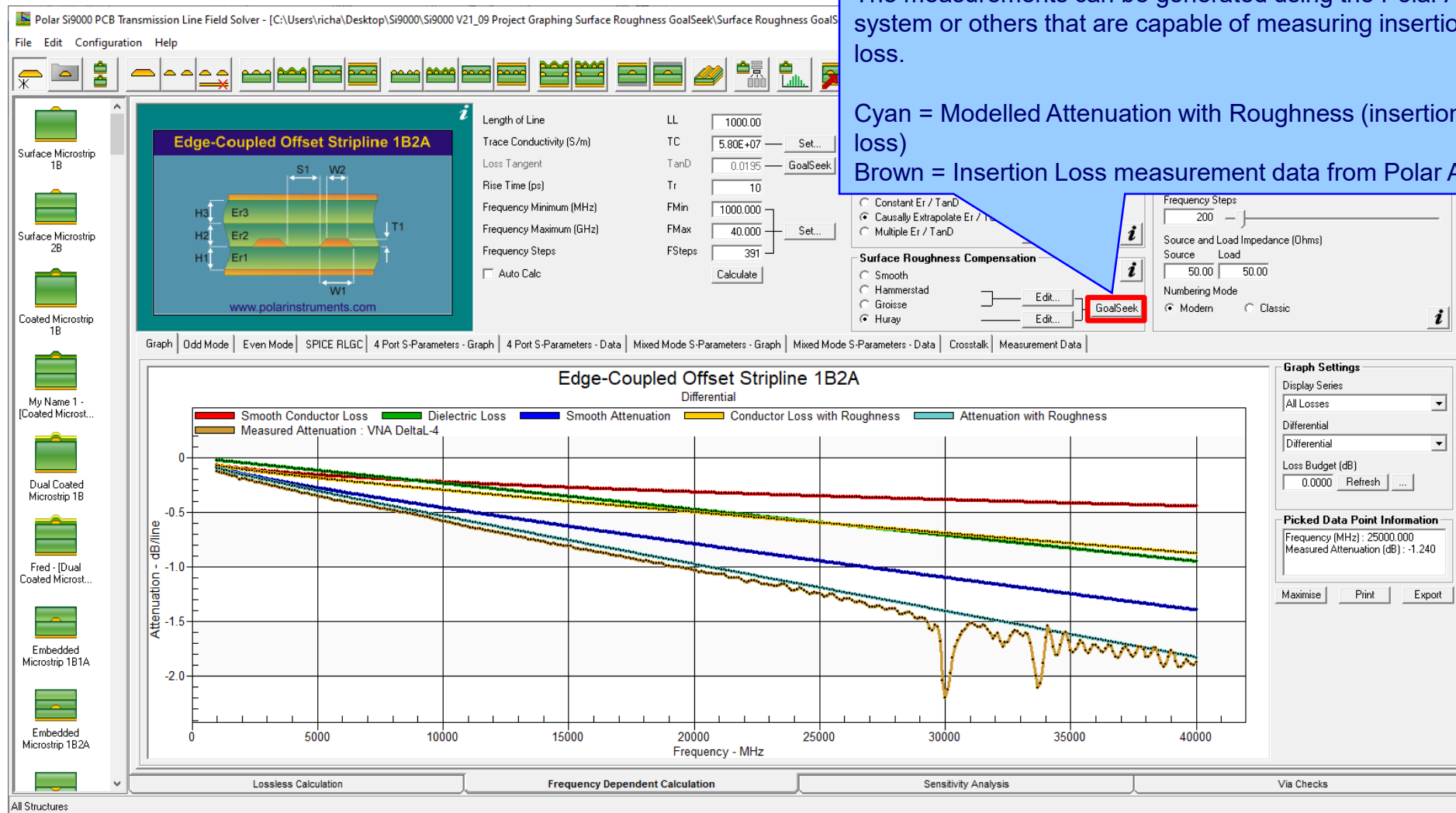
- As separate structure in a Project it is now possible to examine the results in a lot more detail than when in sensitivity analysis
- Lossy calculations can be performed and compared
- As a Project the structure data can be stored as a .SIP file and recalled later
- Useful to both fabricators and design companies

# Surface Roughness Goal Seek option

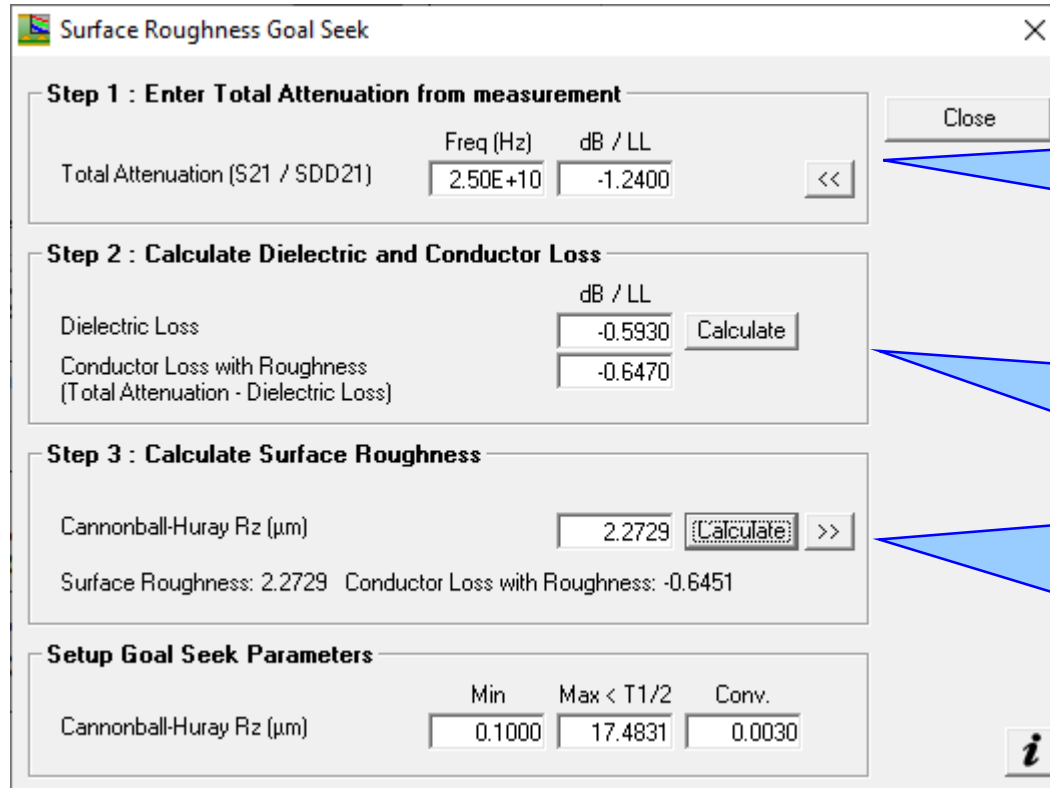
New option to back calculate the surface roughness value for a structure from the insertion loss measurement data. The measurements can be generated using the Polar Atlas system or others that are capable of measuring insertion loss.

Cyan = Modelled Attenuation with Roughness (insertion loss)

Brown = Insertion Loss measurement data from Polar Atlas



## Surface Roughness Goal Seek option



**Surface Roughness Goal Seek**

**Step 1 : Enter Total Attenuation from measurement**

	Freq (Hz)	dB / LL
Total Attenuation (S21 / SDD21)	2.50E+10	-1.2400

Close

**Step 2 : Calculate Dielectric and Conductor Loss**

	dB / LL
Dielectric Loss	-0.5930
Conductor Loss with Roughness (Total Attenuation - Dielectric Loss)	-0.6470

Calculate

**Step 3 : Calculate Surface Roughness**

Cannonball-Huray Rz ( $\mu\text{m}$ )	2.2729
---------------------------------------	--------

Calculate

Surface Roughness: 2.2729 Conductor Loss with Roughness: -0.6451

**Setup Goal Seek Parameters**

	Min	Max < T1/2	Conv.
Cannonball-Huray Rz ( $\mu\text{m}$ )	0.1000	17.4831	0.0030

i

### Step 1

Key in or pick the total attenuation (S21 / SDD21) at a given frequency from the insertion loss measurement data

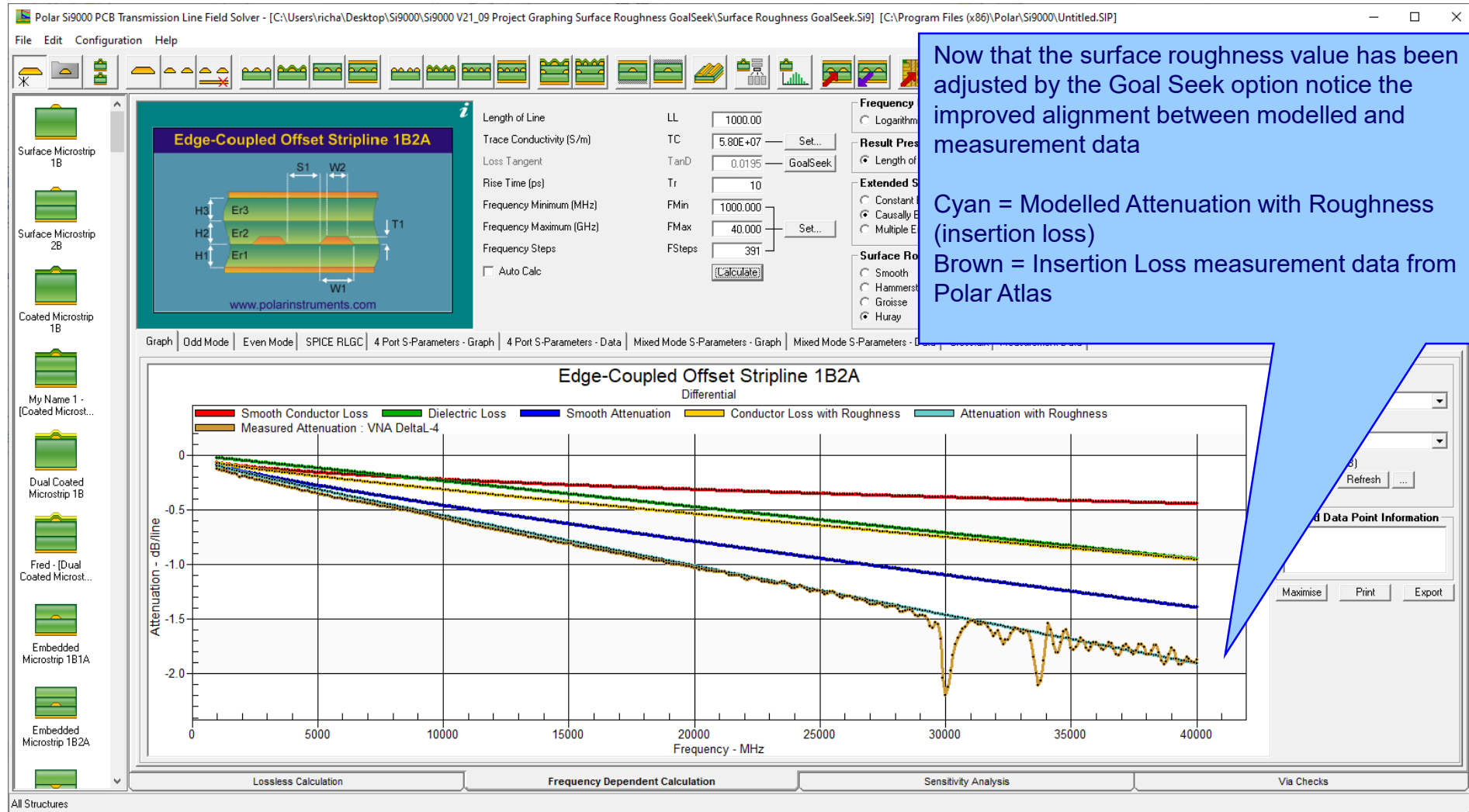
### Step 2

Calculate the dielectric loss for the frequency entered from the current structure parameters. Subtracting this calculated dielectric loss from the total attenuation will leave the target conductor loss

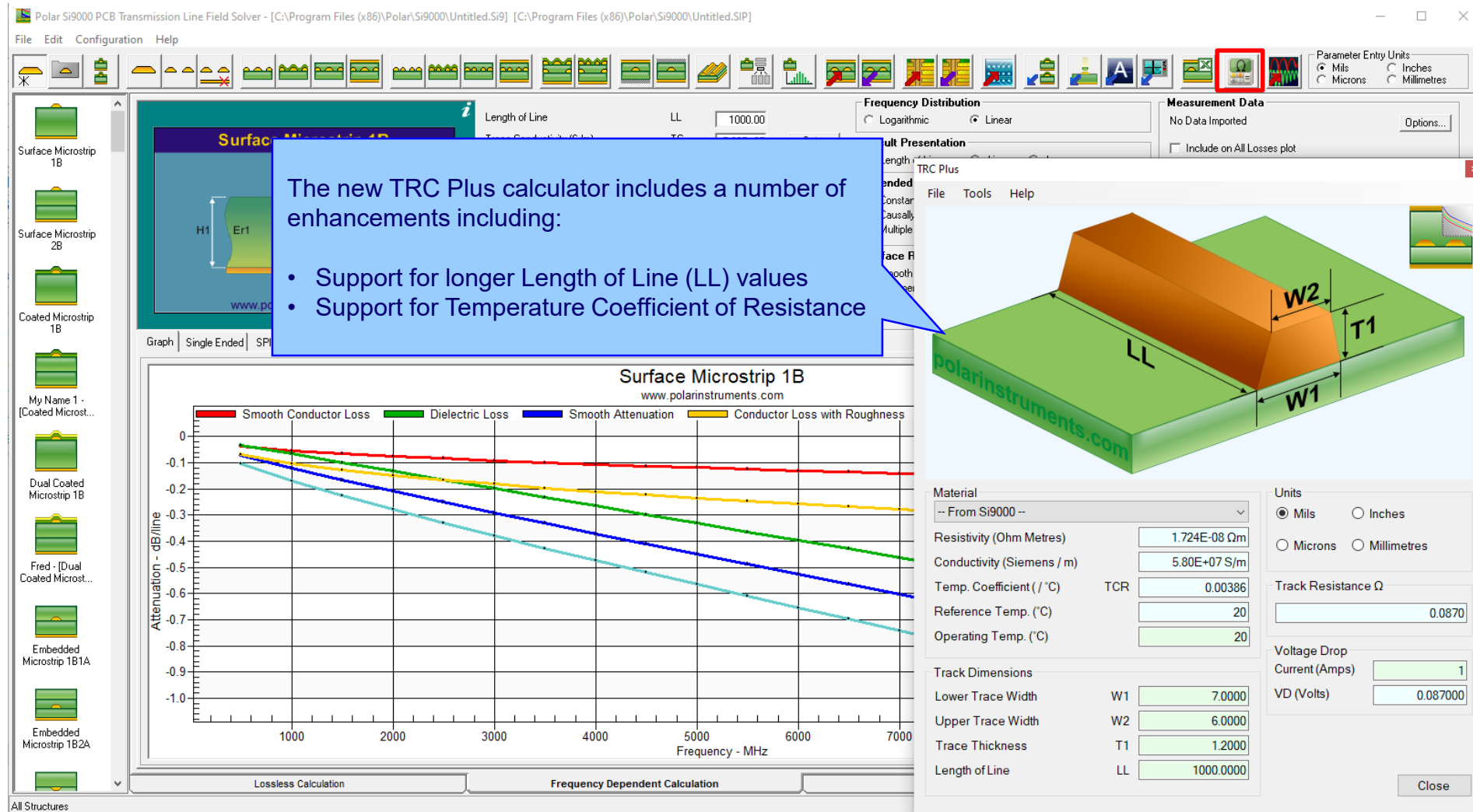
### Step 3

Use the Si9000 Goal Seek algorithm to vary the surface roughness until it matches the required value to achieve the conductor loss as calculated in Step 2. In this example a Surface Roughness of 2.2729  $\mu\text{m}$  is required

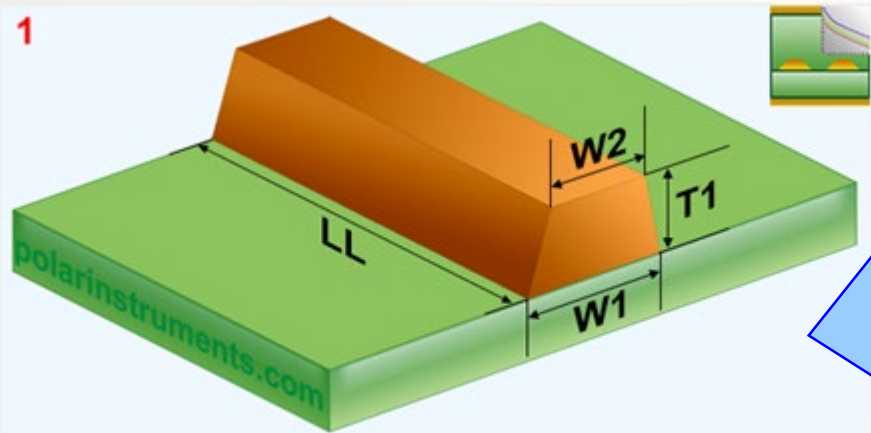
# Surface Roughness Goal Seek option



# Track Resistance Calculator (TRC Plus)



# Track Resistance Calculator (TRC Plus)



**1**

**2**

Material: -- From Si9000 --

Resistivity (Ohm Metres): 1.724E-08 Ωm

Conductivity (Siemens / m): 5.80E+07 S/m

Temp. Coefficient ( / °C): TCR 0.00386

Reference Temp. (°C): 20

Operating Temp. (°C): 20

**4**

Track Dimensions

Lower Trace Width W1: 7.0000

Upper Trace Width W2: 6.0000

Trace Thickness T1: 1.2000

Length of Line LL: 6000.0000

Units: ☒ Mils ☐ Inches  
☐ Microns ☐ Millimetres

Track Resistance Ω: 0.5221

Voltage Drop

Current (Amps): 1

VD (Volts): 0.522100

**5**

**6**

Close

## 1. Interactive track material image.

Clicking on a track parameter label will highlight the associated Track Dimension field (text box). Enter data into the active field.

Double-clicking anywhere on the image will bring up the Materials Editor.

## 2. Material selection and properties

Select the material via the drop-down list.

Fields coloured in light-blue are not directly editable but the field values can be in the Materials Editor.

Fields coloured in light-green are editable by the user. For example, Operating Temperature will determine a material's resistivity at that temperature, which in turn will be applied in calculating the track resistance.

## 3. Units

Switch to your preferred units by clicking the associated option button – imperial units include Mils (Thou) and Inches; for metric units choose Microns (Micrometres) or Millimetres.

## 4. Track or trace dimensions

Enter or change track dimensions in the Track Dimensions in the chosen units.

## 5. Resistance result

Calculation of the track resistance. The result should update immediately upon any changes to the editable (light-green) fields.

## 6. Voltage Drop calculation result

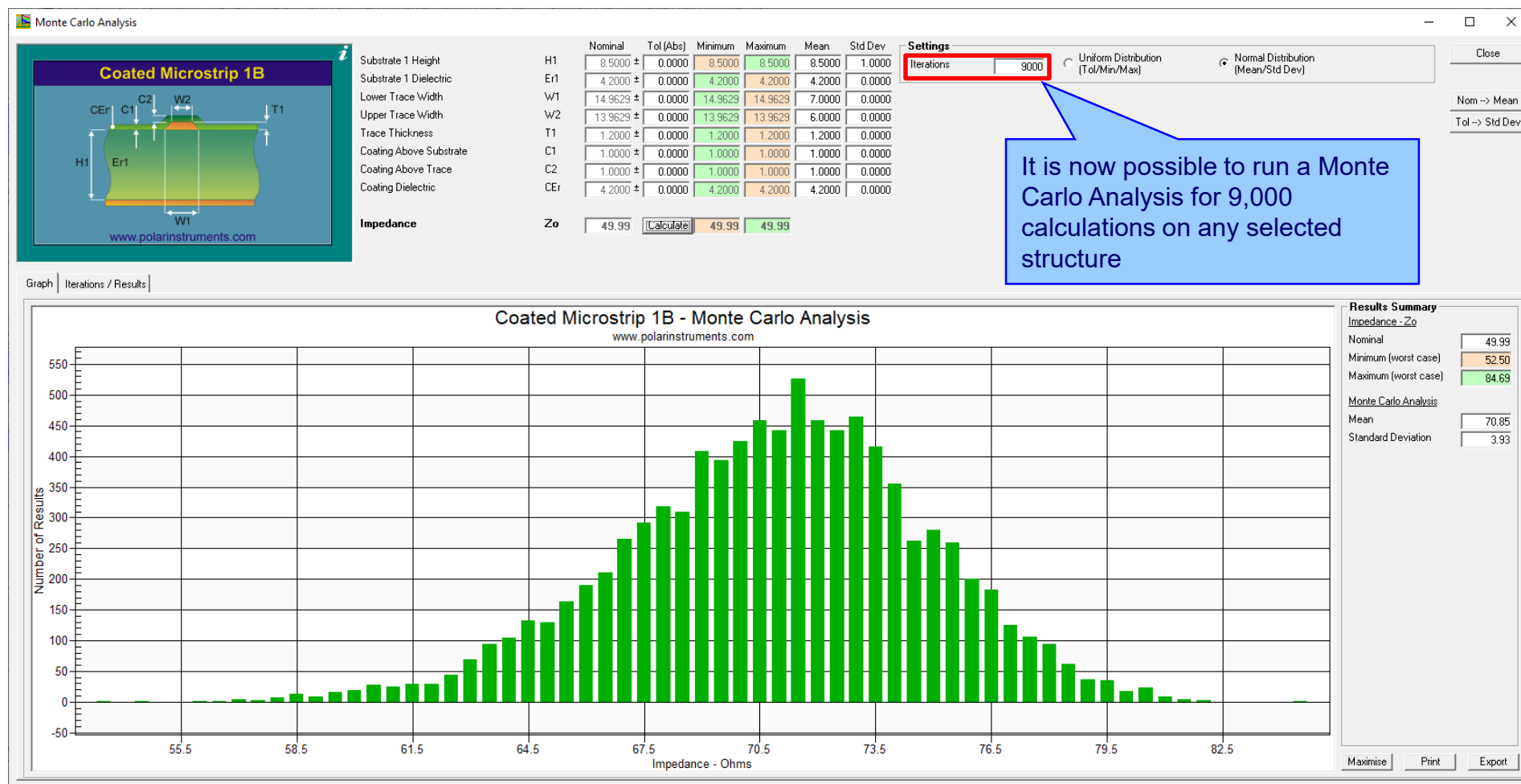
The calculated Voltage Drop is displayed in the VD (Volts) text box

## Other enhancements

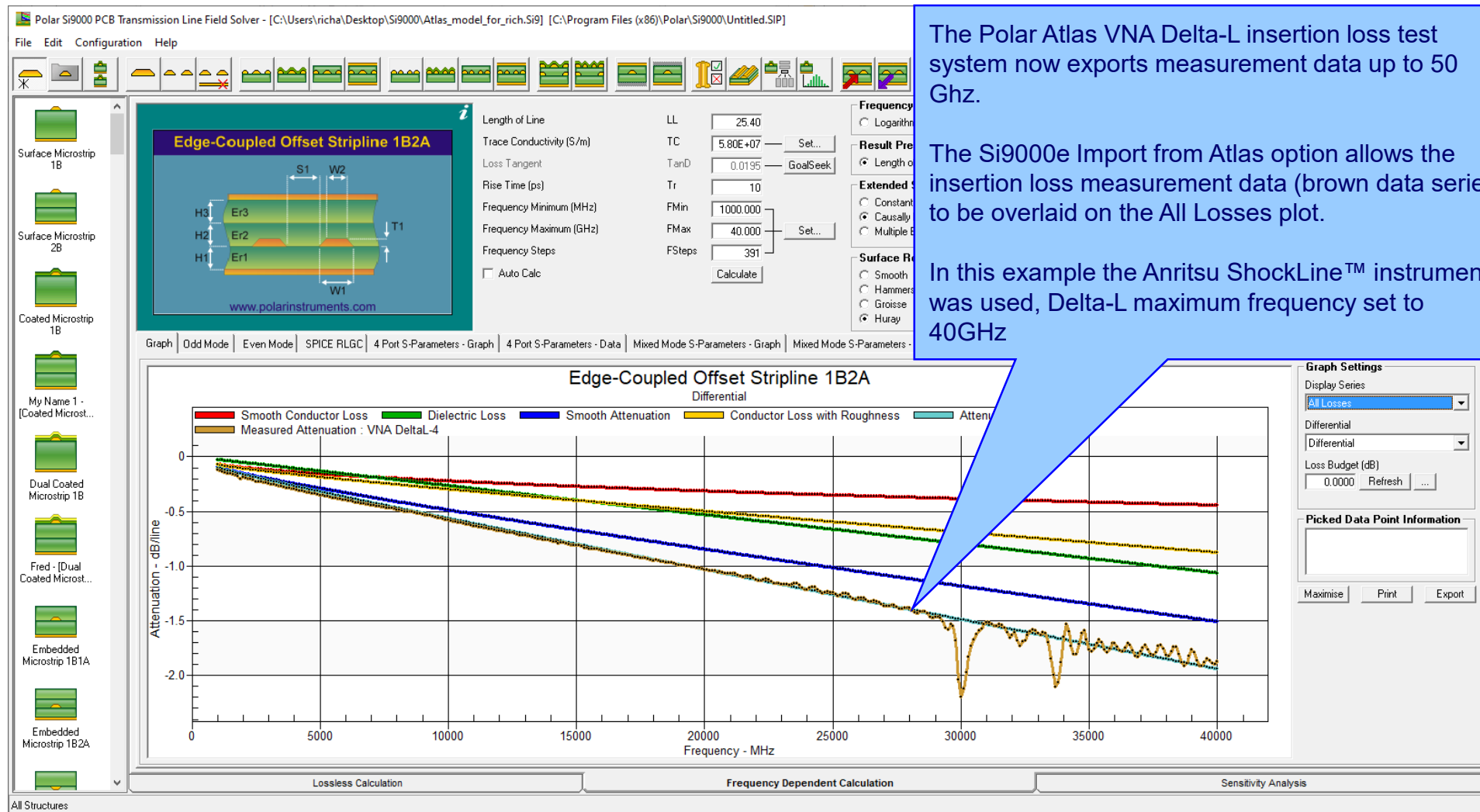
- Monte Carlo Analysis. New option added to export the Iterations / Results to Clipboard (for Excel), accessible from the right-click menu
- Causally Extrapolated Substrate Data. New option added to export the Results to Clipboard (for Excel), accessible from the right-click menu

# Si9000e v21.04 (April 2021)

# Monte Carlo Analysis maximum iteration increased to 9000

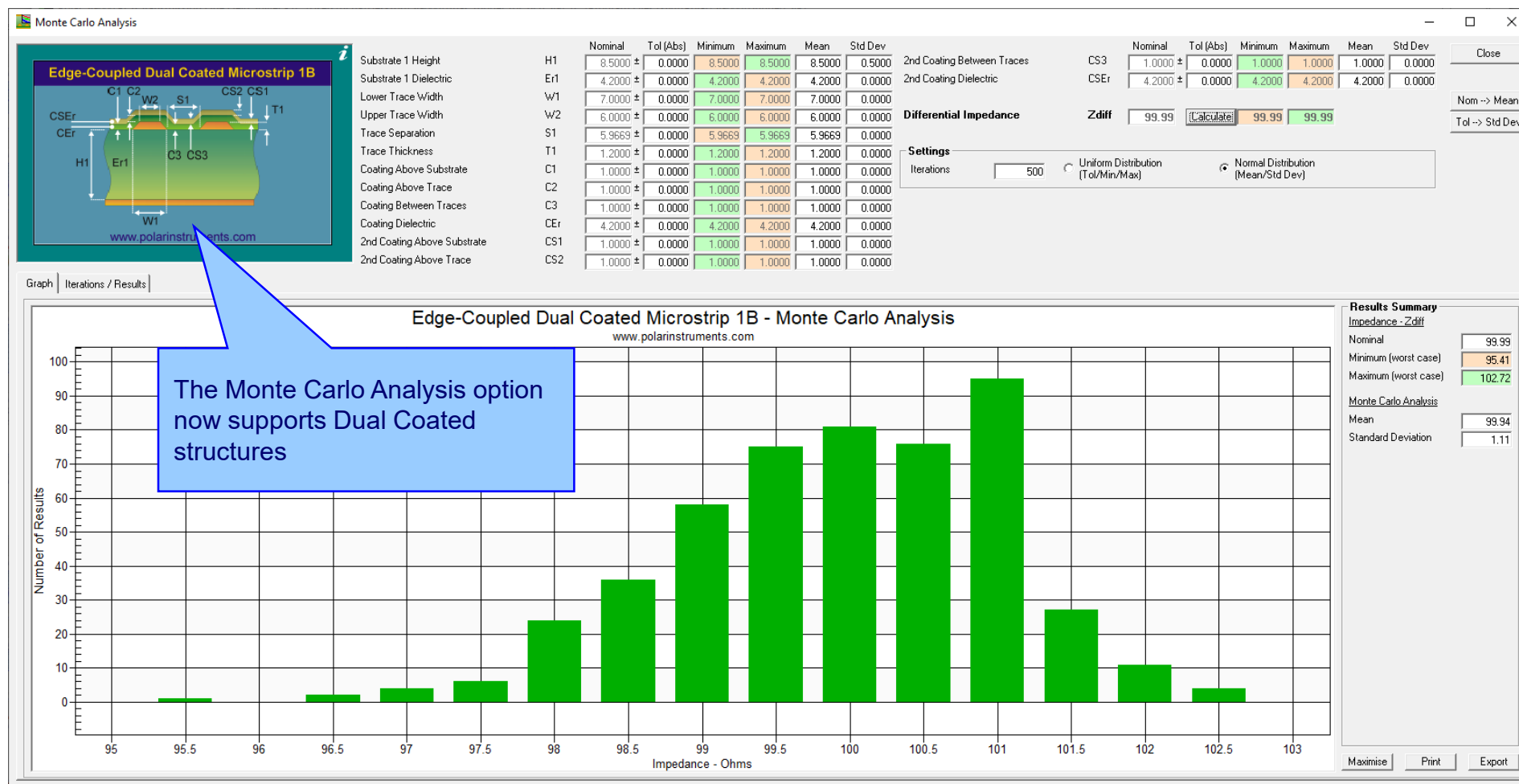


# Import from Atlas enhanced to support measurement data to 50GHz



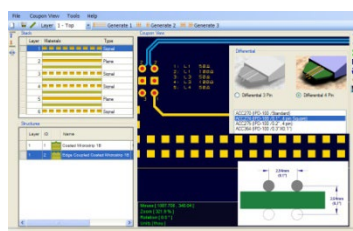
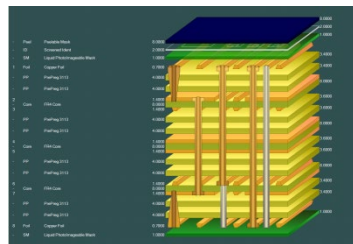
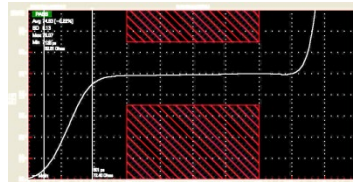
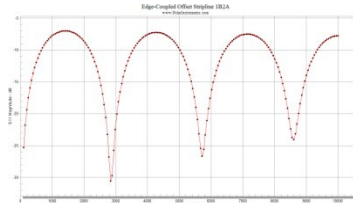
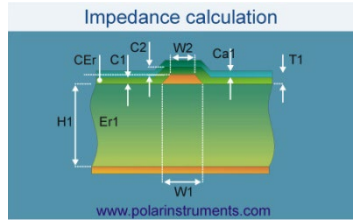
# Si9000e v21.01 (January 2021)

# Monte Carlo support added for Dual Coated structures

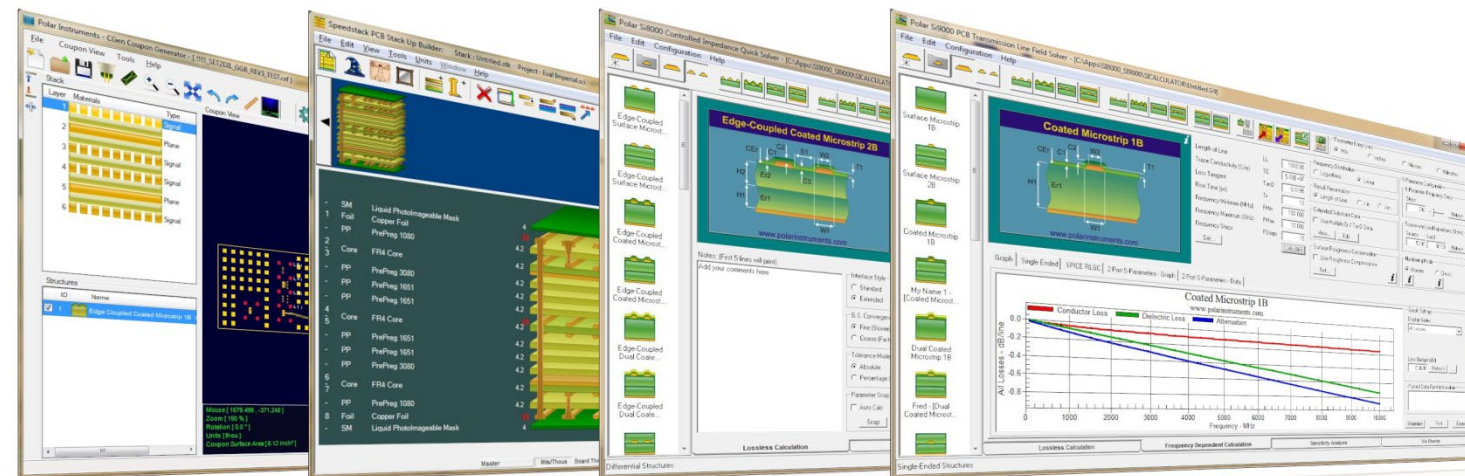


## Other enhancements

- FlexNet Publisher / FLEXIm v11.17.2.0 supported

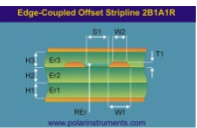
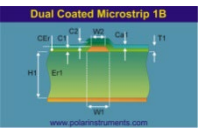
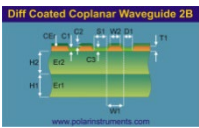
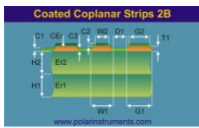
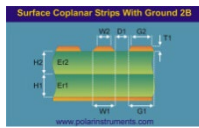
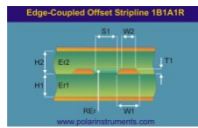
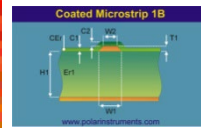
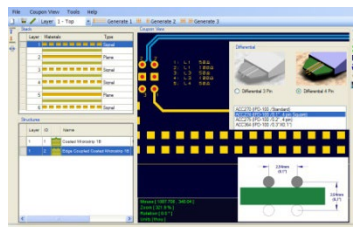
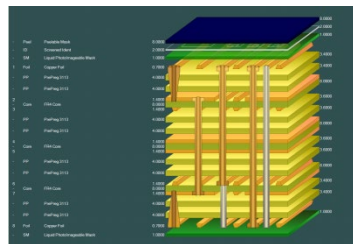
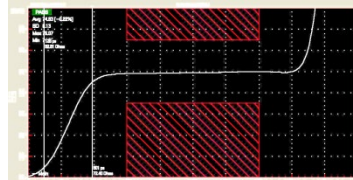
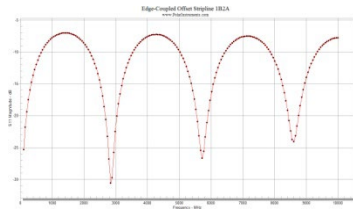
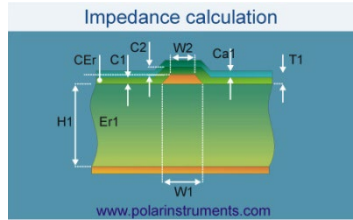


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