

# Si9000e 2021 - 2024

Richard Attrill – February 2024 (Rev 6)



# Si9000e v24.02.08 (February 2024)

# New Frequency of Interest option enhancements

The screenshot displays the Polar Si9000 PCB Transmission Line Field Solver interface. The main window shows a graph titled "Edge-Coupled Offset Stripline 1B1A Differential" with the y-axis labeled "Attenuation - dB/line" and the x-axis labeled "Frequency - MHz". The graph plots several loss components: Smooth Conductor Loss (red), Dielectric Loss (green), Smooth Attenuation (blue), Conductor Loss with Roughness (yellow), Attenuation with Roughness (cyan), and Measured Attenuation : SPP (orange). The graph shows that attenuation increases with frequency, with the SPP measured attenuation showing the most significant loss at higher frequencies.

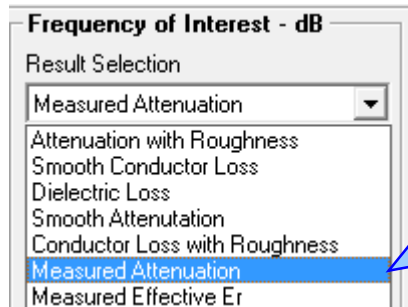
A blue callout box points to the parameter entry area, stating: "New Result Selection options have been introduced to display the Measured Attenuation and Measured Effective Er at the user-specified Frequencies of Interest".

A red box highlights the "Frequency of Interest - dB" panel on the right side of the interface. This panel includes a "Result Selection" dropdown set to "Measured Attenuation" and a list of frequencies with their corresponding attenuation values:

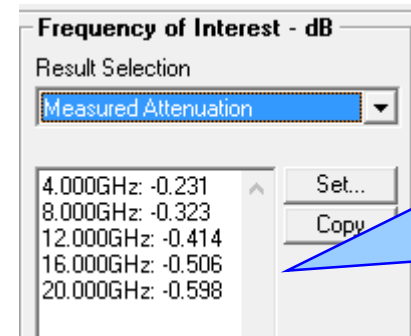
Frequency (GHz)	Attenuation (dB)
4.000GHz	-0.231
8.000GHz	-0.323
12.000GHz	-0.414
16.000GHz	-0.506
20.000GHz	-0.598

The panel also includes "Set..." and "Copy" buttons for each entry, and a "Picked Data Point Information" section at the bottom.

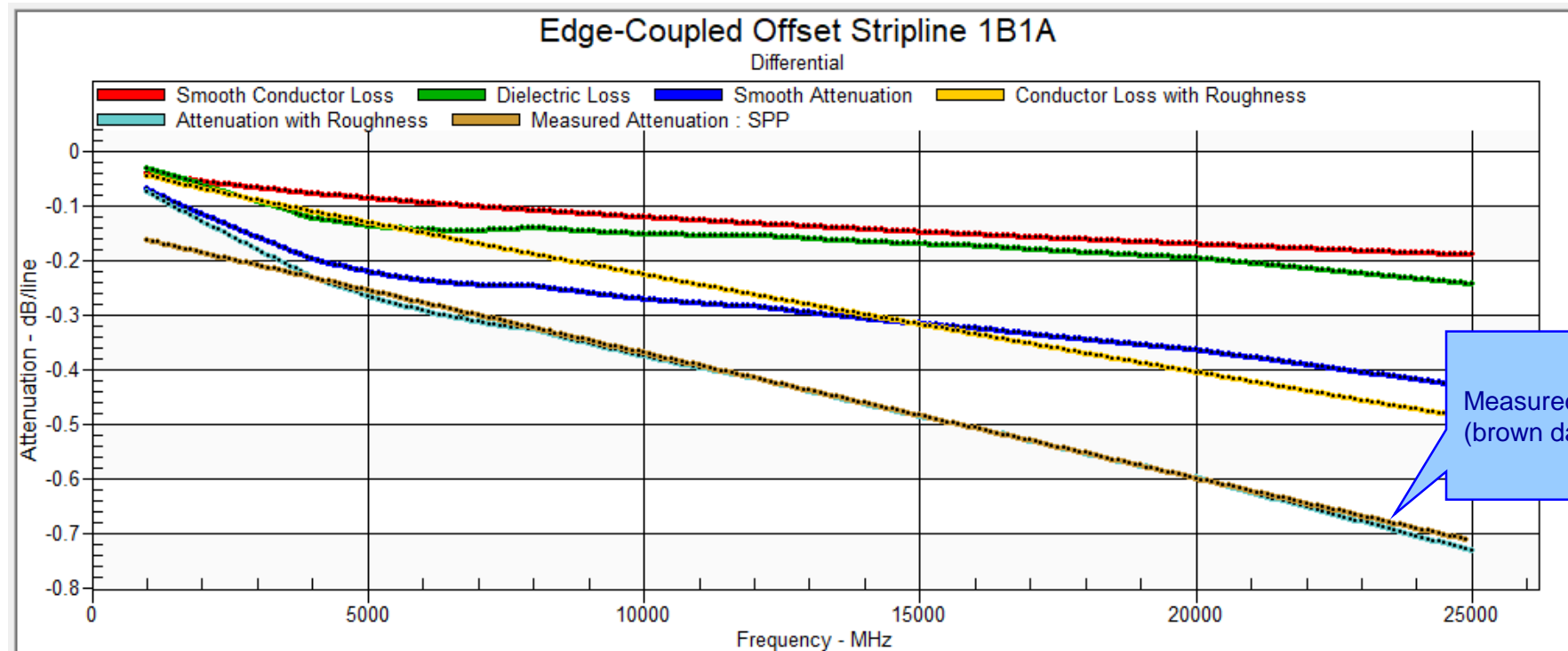
## New Frequency of Interest option enhancements



When importing insertion loss measurement data from the Polar Atlas it is often useful to know the exact measured attenuation dB values as specific frequencies. The new Result Selection options have been introduced to achieve this.

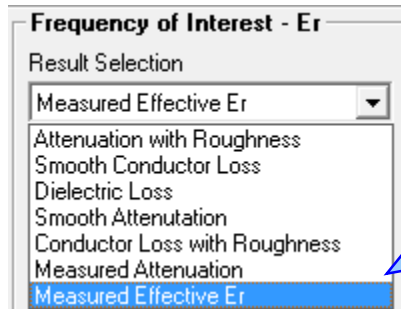


In this example the Frequency of Interest values have been set to 4, 8, 12, 16 and 20GHz. The measured attenuation (brown data series on the plot below) is examined and the dB loss values at those frequencies are displayed here

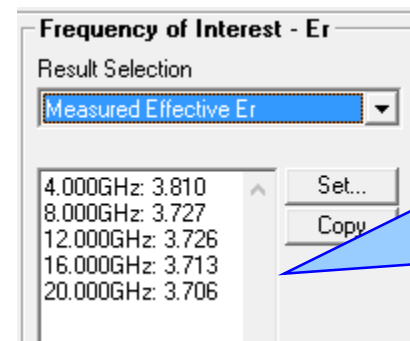


Measured Attenuation (brown data series)

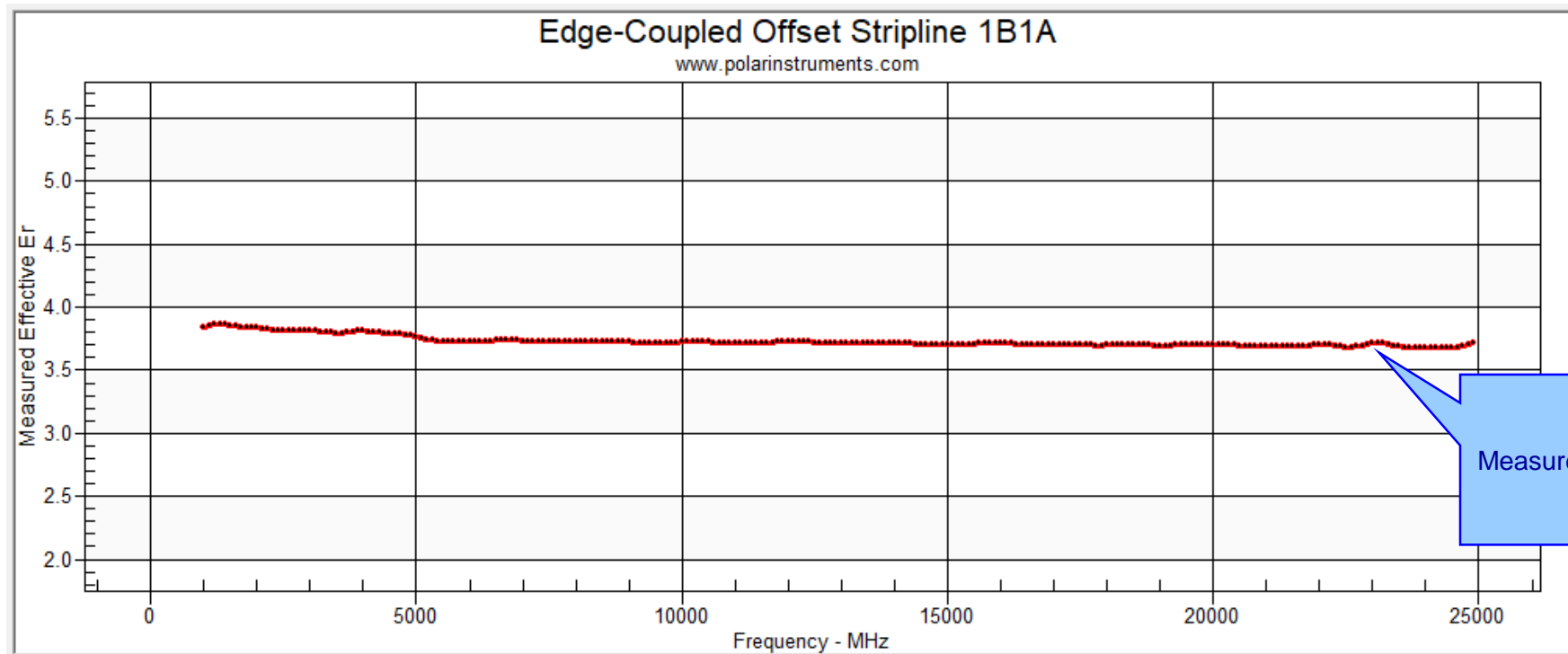
## New Frequency of Interest option enhancements



Similar to the new Measured Attenuation selection, it is now possible to select the Measured Effective Er.



Using the same Frequency of Interest values of 4, 8, 12, 16 and 20GHz, the imported measurement data is examined and the effective dielectric constant values at those frequencies are displayed here



Measured Effective Er

# New Loss Tangent Goal Seek – Multiple Frequency option

The screenshot displays the Polar Si9000 PCB Transmission Line Field Solver interface. The main window shows the configuration for an "Edge-Coupled Offset Stripline 1B1A". The configuration parameters include:

- Length of Line: 10.00
- Trace Conductivity (S/m): 5.80E+07
- Loss Tangent: 0.0082
- Rise Time (ps): 10
- Frequency Minimum (MHz): 1000.000
- Frequency Maximum (GHz): 25.000
- Frequency Steps: 241

The "Frequency Distribution" is set to Linear. The "Result Presentation" is set to Length of Line. The "Extended Substrate Data" section has "GoalSeek" enabled for "Constant Er / TanD". The "Surface Roughness Compensation" is set to Huray.

The graph shows "Attenuation - dB/line" versus "Frequency - MHz" for the "Edge-Coupled Offset Stripline 1B1A" in "Differential" mode. The graph displays several curves representing different loss components:

- Smooth Conductor Loss (Red)
- Dielectric Loss (Green)
- Smooth Attenuation (Blue)
- Conductor Loss with Roughness (Yellow)
- Attenuation with Roughness (Cyan)
- Measured Attenuation : SPP (Brown)

The graph shows that attenuation increases with frequency, with the "Measured Attenuation : SPP" curve showing the highest loss at 25 GHz, reaching approximately -0.598 dB/line.

Building upon the positive feedback for the existing Loss Tangent Goal Seek – Single Frequency facility, a new Multiple Frequency option has been introduced.

This allows for up to five Loss Tangent values to be calculated in a single process, with an option to export the calculated results to the Extended Substrate Data Library



The new Loss Tangent Goal Seek - Multiple Frequency option allows for up to five Loss Tangent values to be calculated in a single process. The input data and results for each frequency are contained in a separate column.

**Loss Tangent Goal Seek**

**Step 1 : Enter Total Attenuation from measurement and the Dielectric Constant values for each frequency**

Frequency	Hz	4.00E+09	8.00E+09	1.20E+10	1.60E+10	2.00E+10	Set from FOI
Total Attenuation (S21 / SDD21)	dB / LL	-0.2310	-0.3230	-0.4140	-0.5060	-0.5980	
Substrate 1 Dielectric	Er1	3.8100	3.7270	3.7260	3.7130	3.7060	Set from EEr
Substrate 2 Dielectric	Er2	3.8100	3.7270	3.7260	3.7130	3.7060	
Substrate 3 Dielectric	Er3	3.8100	3.7270	3.7260	3.7130	3.7060	
Substrate 4 Dielectric	Er4	3.8100	3.7270	3.7260	3.7130	3.7060	
Coating Dielectric	CEr	3.8100	3.7270	3.7260	3.7130	3.7060	
2nd Coating Dielectric	CSEr	3.8100	3.7270	3.7260	3.7130	3.7060	
Separation Region Dielectric	REr	3.8100	3.7270	3.7260	3.7130	3.7060	

Please Note: If you wish to Goal Seek less than five frequencies, set the Frequency in the unused columns to 0 Hz.

When using the 'Set from FOI' option the Total Attenuation data used will depend on Frequency of Interest Result Selection dropdown setting on the main interface. The first frequency / attenuation values will be supported. For differential structures, the differential / odd mode results will be used.

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

Conductor Loss with Roughness	dB / LL	-0.1102	-0.1872	-0.2618	-0.3334	-0.4030	Calculate
Dielectric Loss (Attenuation - Conductor Loss)	dB / LL	-0.1208	-0.1358	-0.1522	-0.1726	-0.1950	

**Step 3 : Calculate Loss Tangent**

Loss Tangent	TanD	0.0171	0.0095	0.0072	0.0061	0.0055	Calculate
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0.0055 Dielectric Loss: -0.1935

**Step 4 : Export Results as an Extended Substrate Data table (optional)**

Extended Substrate Data Table Name: Loss Tangent Goal Seek Results Export

<input checked="" type="radio"/> Er1	Frequency Hz	Dielectric Constant Er	Loss Tangent TanD
<input type="radio"/> Er2	4.00E+09	3.8100	0.0171
<input type="radio"/> Er3	8.00E+09	3.7270	0.0095
<input type="radio"/> Er4	1.20E+10	3.7260	0.0072
<input type="radio"/> CEr	1.60E+10	3.7130	0.0061
<input type="radio"/> CSEr	2.00E+10	3.7060	0.0055

Please Note: After you Export the results to an Extended Substrate Data Table it will be necessary to select this table using the Multiple Er / TanD - Edit option

**Setup Goal Seek Parameters**

Loss Tangent Goal Seek Parameters	Min	Max	Conv.
	0.0010	0.5000	0.0020

The calculated Conductor and Dielectric Loss results will be displayed here

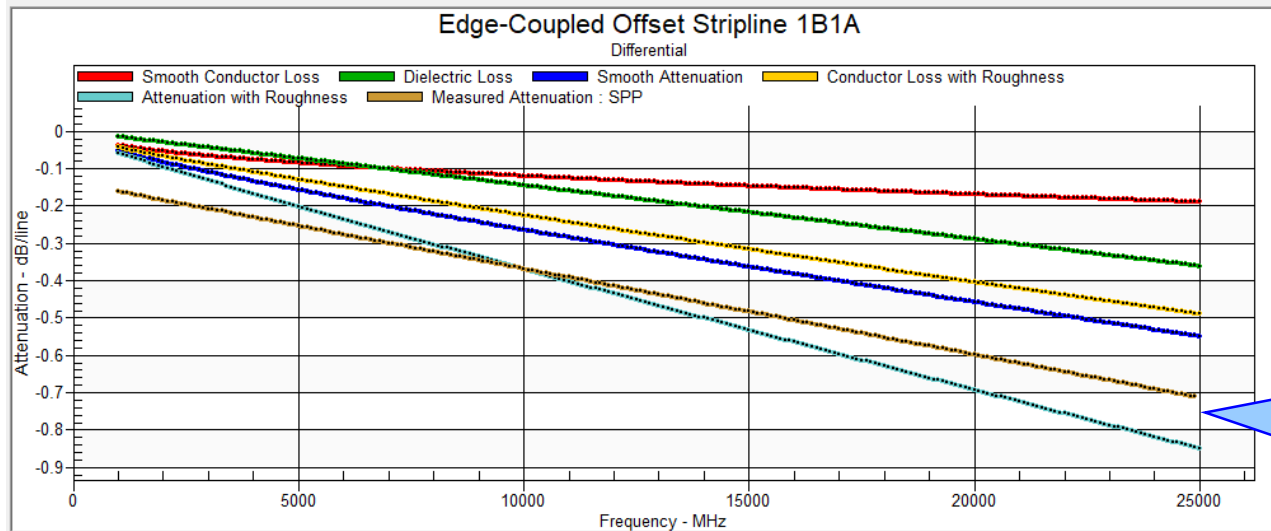
The calculated Loss Tangent results will be displayed here

The results can also be exported to the Extended Substrate Data Library

The input parameter data can be keyed in or the Set from FOI (Frequency of Interest) button will automatically set the Frequency and Total Attenuation values from the main dialog.

Dielectric Constant varies with frequency so the Set from EEr button will populate these fields from the Measured Effective Er data

# New Loss Tangent Goal Seek – Multiple Frequency option



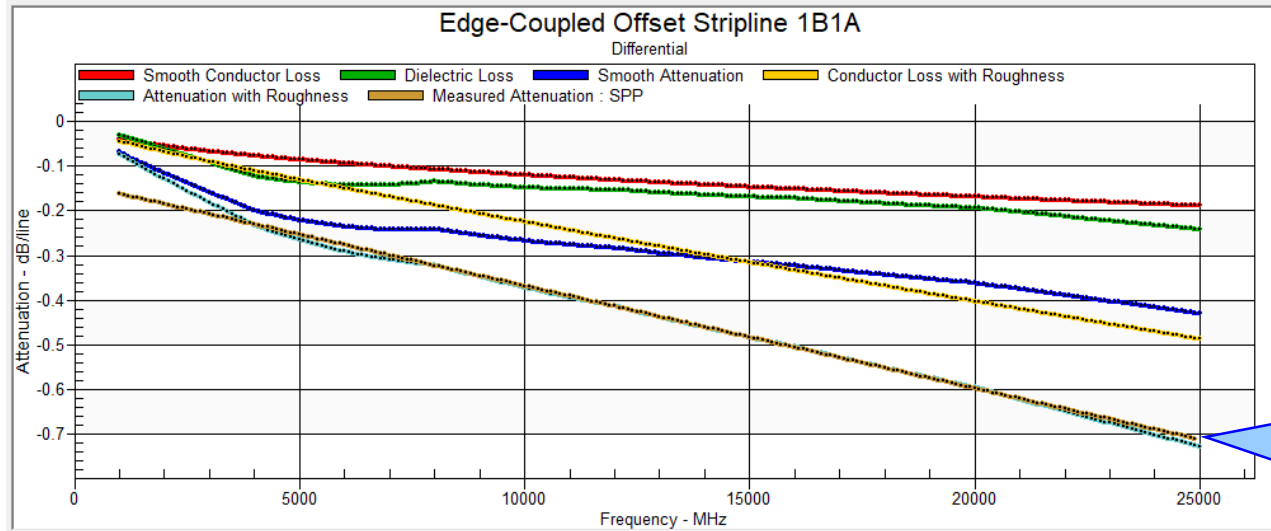
**Extended Substrate Data**

Constant Er / TanD GoalSeek

Causally Extrapolate Er / TanD Edit... GoalSeek

Multiple Er / TanD Edit... GoalSeek

The Attenuation with Roughness (cyan) and Measured Attenuation (brown) do not correlate very well when using Constant Er / TanD mode



**Extended Substrate Data**

Constant Er / TanD GoalSeek

Causally Extrapolate Er / TanD Edit... GoalSeek

Multiple Er / TanD Edit... GoalSeek

Once the Loss Tangent Goal Seek is complete it is possible to use the exported results to improve the correlation between the calculated Attenuation with Roughness (cyan) and Measured Attenuation (brown).



# Si9000e v24.01.01 (January 2024)

## Enhancements

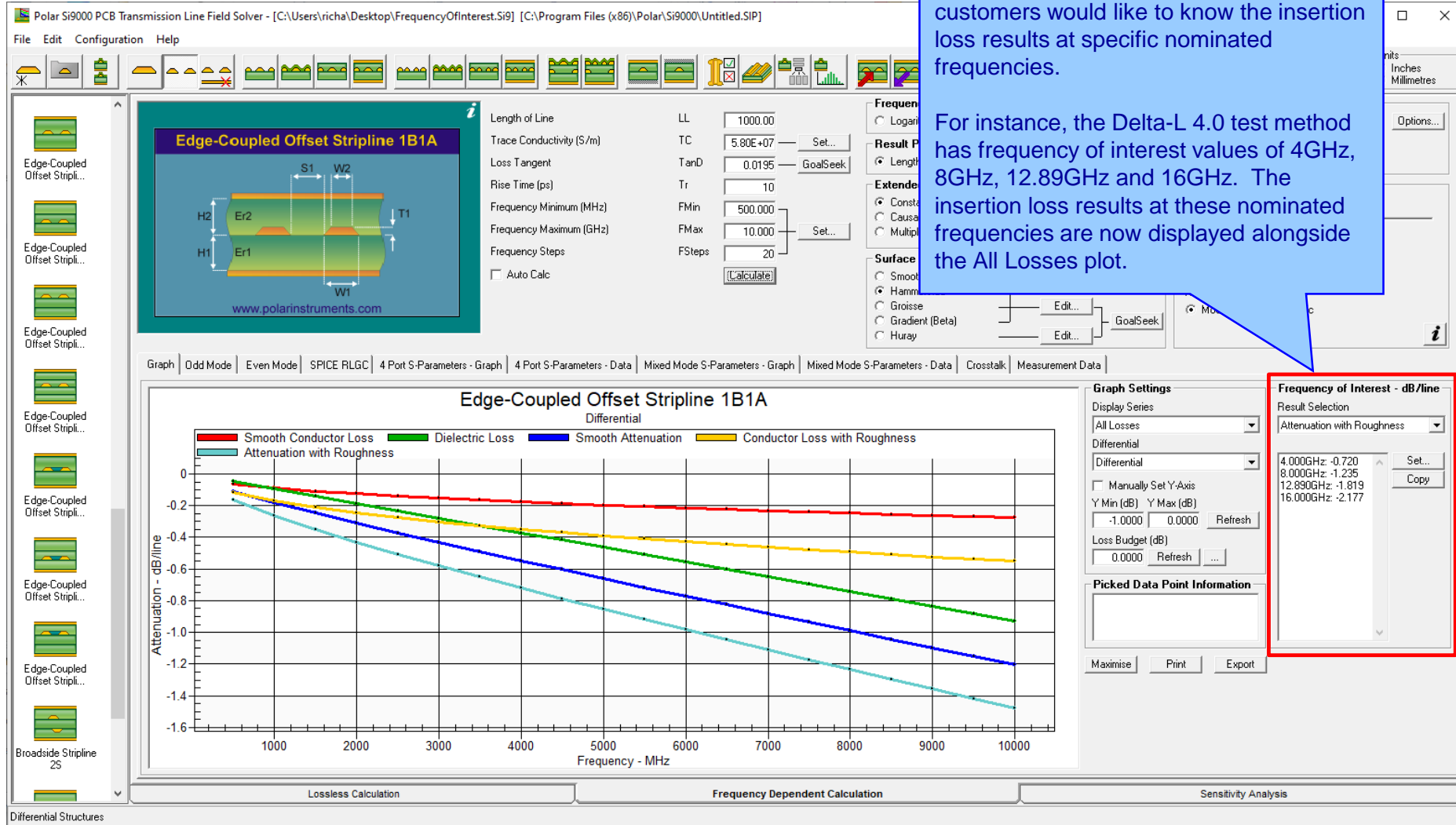
- From 2024 the Track Resistance Calculator (TRC) will be running on the Microsoft .Net Framework 4.8. It has migrated as a result of customer IT policy requests.

# Si9000e v23.09.21 (September 2023)

# New Frequency of Interest option added

In addition to the insertion loss plots that are generated with Si9000e, some customers would like to know the insertion loss results at specific nominated frequencies.

For instance, the Delta-L 4.0 test method has frequency of interest values of 4GHz, 8GHz, 12.89GHz and 16GHz. The insertion loss results at these nominated frequencies are now displayed alongside the All Losses plot.



## New Frequency of Interest option added

The screenshot shows two windows. On the left, the 'Frequency of Interest - dB/line' window displays a table of results and a 'Set...' button. On the right, the 'Frequency of Interest' dialog box is open, showing a diagram of an 'Edge-Coupled Offset Stripline 1B1A' and a list of 10 frequency values.

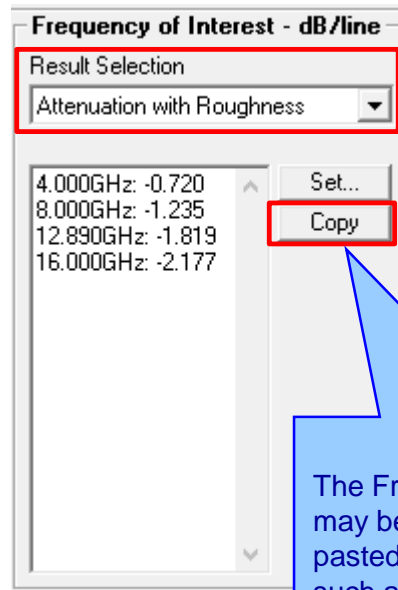
Frequency of Interest (GHz)	Value
Frequency 1	4.000
Frequency 2	8.000
Frequency 3	12.890
Frequency 4	16.000
Frequency 5	0.000
Frequency 6	0.000
Frequency 7	0.000
Frequency 8	0.000
Frequency 9	0.000
Frequency 10	0.000

Select the Set... button to load the Frequency of Interest dialog

This dialog allows the user to nominate 10 frequency values per structure, so each structure inside Si9000e can have 10 unique frequency values.

- Selecting Apply to Current Structure will place those frequency values with the current selected structure so the next time the structure is calculated the results for each specified frequency will be placed on the main dialog, giving immediate feedback of the results at those frequency values.
- Selecting Apply to All Structures will place those same nominated frequency values on all structures in the Si9000e, including those structures that exist in a Project.
- In this example we have keyed in the four Delta-L 4.0 frequencies of 4GHz, 8GHz, 12.89GHz and 16GHz

## New Frequency of Interest option added



Use the Result Selection dropdown to choose which loss result is displayed. The options available are Attenuation with Roughness, Smooth Conductor Loss, Dielectric Loss, Smooth Attenuation and Conductor Loss with Roughness.

Like the All Losses plots, the formatting of the dB results will match that as specified by Result Presentation, so the dB results will be by /Length or /inch or /metre

The Frequency of Interest results may be copied to the clipboard, then pasted to third-party applications such as Excel



# Si9000e v23.08.02 (August 2023)

# New Export to Touchstone Format for Multiple Length of Lines

The screenshot displays a software interface for 4-Port S-Parameters. The main window shows eight subplots arranged in a 4x2 grid, each representing a different S-parameter (S11, S12, S13, S14, S21, S22, S31, S41). Each plot shows Magnitude in dB versus Frequency in MHz on a logarithmic scale from 5000 to 10000. A dialog box titled 'Export to Touchstone Format for Multiple Length of Lines' is open in the center. It features a file explorer showing the destination folder 'C:\Users\richa\Desktop\TouchStone'. Below the folder selection, there are radio buttons for 'Touchstone Format' (dB / Deg, Mag / Deg, Real / Imaginary) and a 'Frequency Steps' field set to 200. A 'Length of Line : Mils' section contains a list box with values: 1000.0000, 2000.0000, 5000.0000, and 10000.0000. A blue callout box points to the dialog box with the following text:

New Export to Touchstone Format for Multiple Length of Lines

- Provides a facility to export multiple Touchstone files based upon the Length of Lines specified
- Length of Lines may be keyed in or pasted from third-party applications

# Si9000e v23.06.01 (June 2023)

# New Gradient Surface Roughness Compensation Method added

The screenshot displays the Polar Si9000 PCB Transmission Line Field Solver interface. The main window shows a cross-sectional diagram of an "Edge-Coupled Offset Stripline 1B1A" with parameters such as  $H1$ ,  $H2$ ,  $Er1$ ,  $Er2$ ,  $S1$ ,  $W1$ ,  $W2$ , and  $T1$ . The software settings are configured as follows:

- Frequency Distribution:** Linear
- Result Presentation:** Length of Line
- Extended Substrate Data:** Constant  $Er$  /  $TanD$
- Surface Roughness Compensation:** Gradient (Beta) (highlighted in a red box)

A blue callout box points to the "Gradient (Beta)" option with the text: "The Gradient method has been added to the Surface Roughness Compensation options".

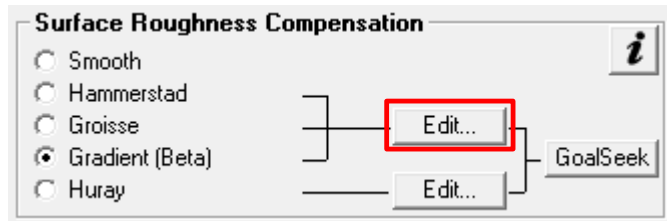
The graph at the bottom, titled "Edge-Coupled Offset Stripline 1B1A Differential", plots "Attenuation - dB/line" against "Frequency - MHz" (1000 to 10000). The graph includes five data series:

- Smooth Conductor Loss (Red line)
- Dielectric Loss (Green line)
- Smooth Attenuation (Blue line)
- Conductor Loss with Roughness (Yellow line)
- Attenuation with Roughness (Cyan line)

The "Attenuation with Roughness" series shows the highest attenuation, reaching approximately -2.0 dB/line at 10000 MHz. The "Conductor Loss with Roughness" series is also significantly higher than the smooth conductor loss.

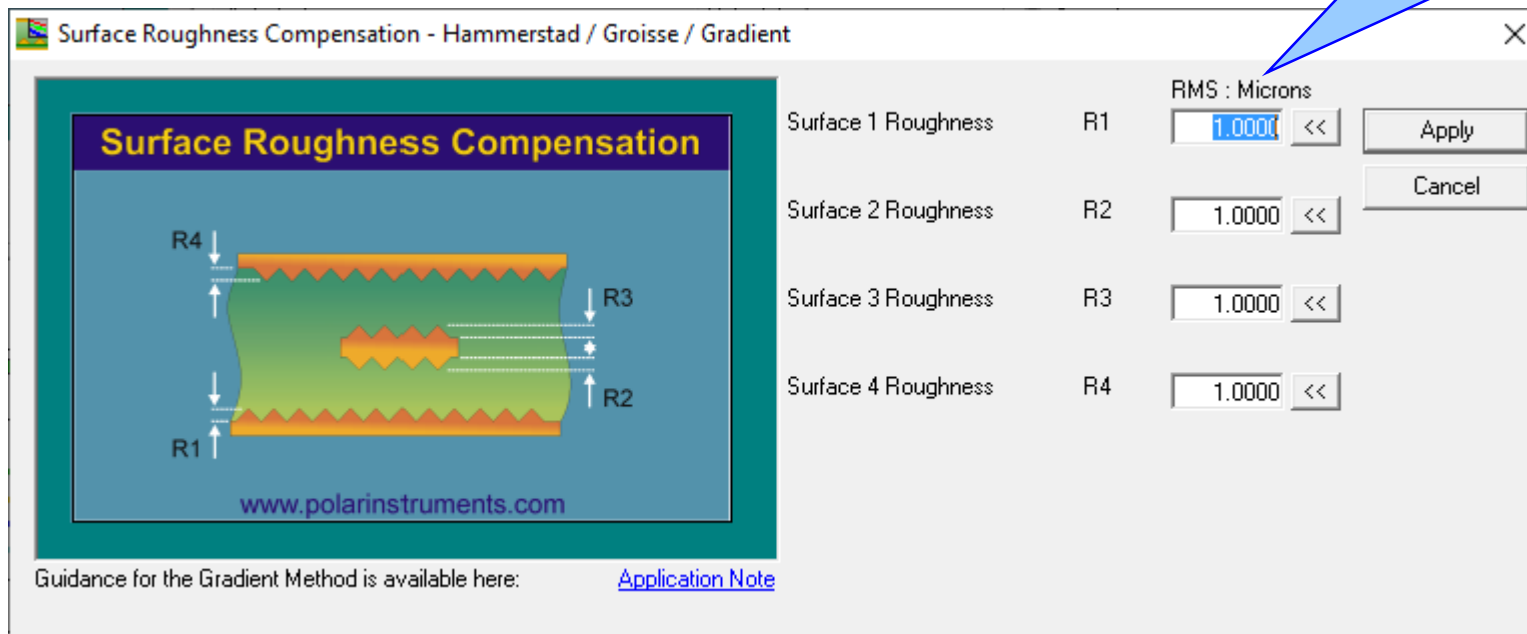
Graph Settings on the right include "Display Series" set to "All Losses", "Differential" mode, and a "Loss Budget (dB)" of 0.0000.

## New Gradient Surface Roughness Compensation Method added

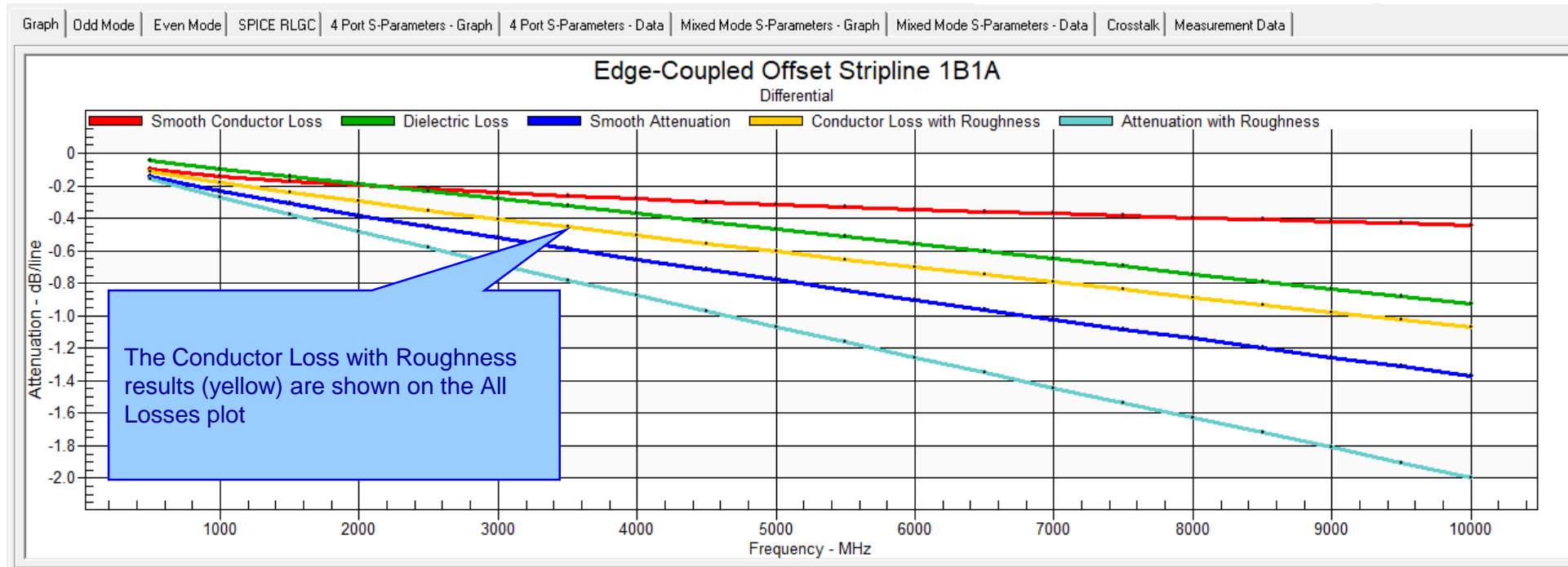


Selecting the Edit button will allow the RMS roughness values to be entered.

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

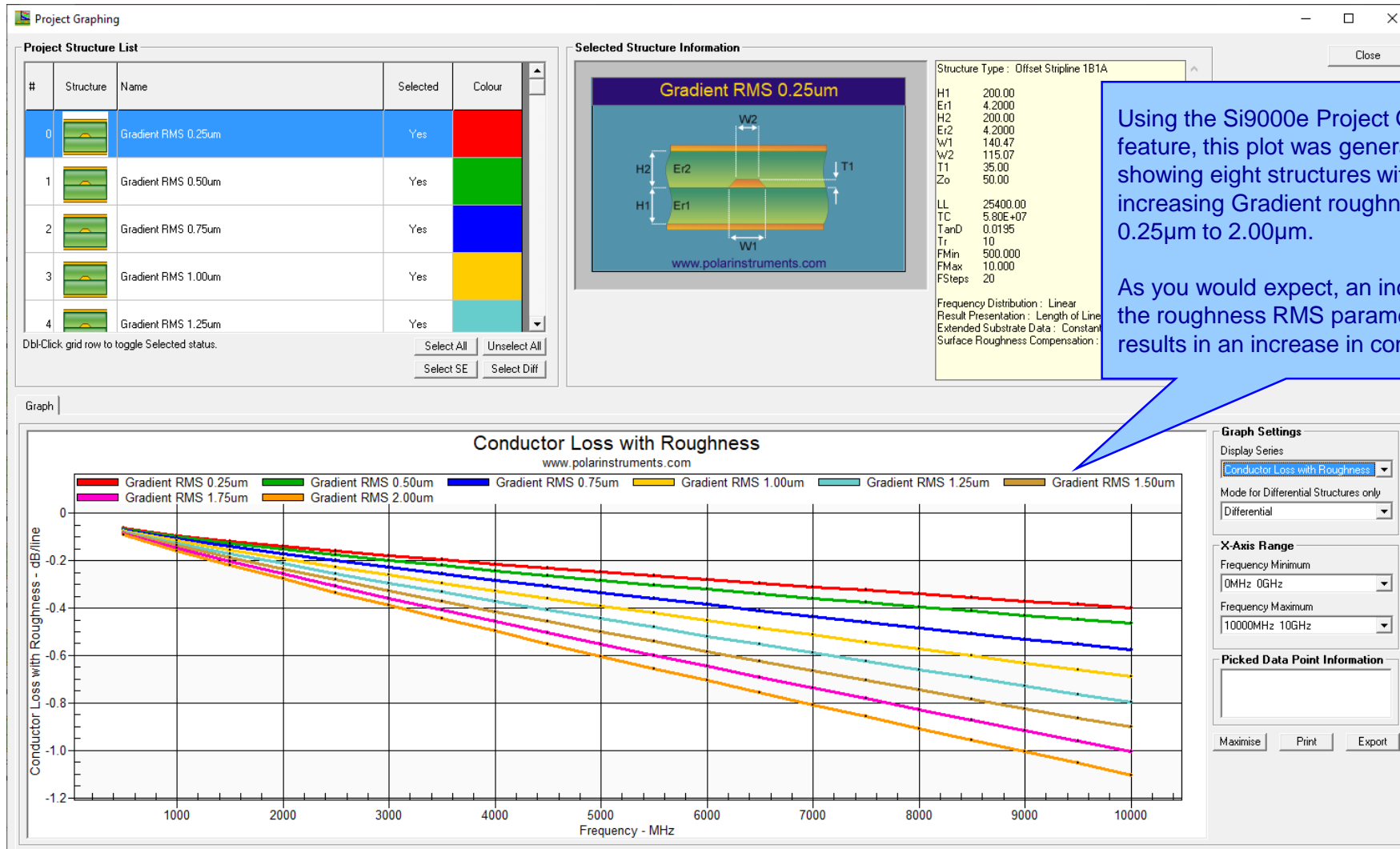
Frequency Hz	Impedance Real Ohms	Impedance Imaginary Ohms	Impedance Magnitude Ohms	Inductance H/line	Resistance Ohms/line	Capacitance F/line	Conductance S/line	Skin Depth m	Smooth Conductor Loss dB/line	Dielectric Loss dB/line	Smooth Attenuation dB/line	Conductor Loss with Roughness dB/line	Attenuation 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	8.105E+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	8.679E+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	-1.618E+00	1.379E+08	1.876E-01	-1.618E+00	9.253E+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	9.831E+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

Copy Results to Clipboard (for Excel)

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



Using the Si9000e Project Graphing feature, this plot was generated showing eight structures with an ever increasing Gradient roughness from 0.25µm to 2.00µm.

As you would expect, an increase in the roughness RMS parameter value results in an increase in conductor loss

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

**Project Structure List**

#	Structure	Name	Selected	Colour
0		2.5in Diff	Yes	Red
1		5in Diff	Yes	Green
2		7.5in Diff	Yes	Blue
3		10in Diff	Yes	Yellow

dbl-Click: grid row to toggle Selected status.

**Selected Structure Information**

Structure Type: Edge-Coupled Offset Stripline 1B1A

H1	7.0000
Er1	4.2000
H2	6.0000
Er2	4.2000
w1	3.7500
w2	2.7500
S1	8.0000
T1	1.2000
Zdiff	99.93
LL	2500.00
TC	5.80E+07
TanD	0.0195
Tr	10
FMin	500.000
FMax	10.000
FSteps	20

Frequency Distribution: Linear  
 Result Presentation: Length of Line  
 Extended Substrate Data: Constant Er / TanD  
 Surface Roughness Compensation: Huray

The Project Graphing feature now supports different Length of Lines. The four structures show loss increases as the length of line increases

**Graph**

**Attenuation with Roughness**  
www.polarinstruments.com

Attenuation with Roughness - dB/line

Frequency - MHz

**Graph Settings**

Display Series  
 Attenuation with Roughness

Mode for Differential Structures only  
 Differential

**X-Axis Range**

Frequency Minimum  
 0MHz 0GHz

Frequency Maximum  
 10000MHz 10GHz

**Picked Data Point Information**

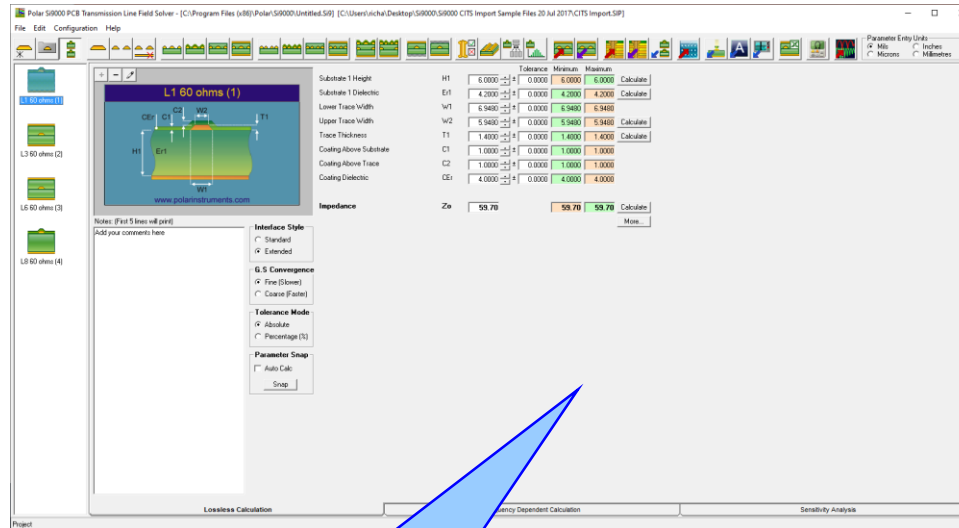
Maximise Print Export

## Other enhancements

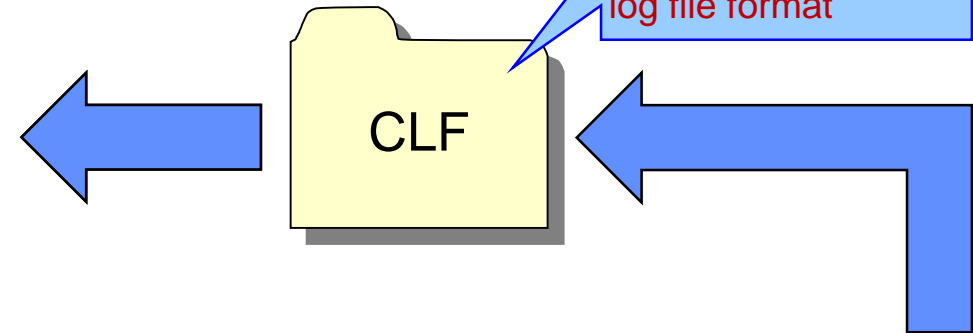
- FlexNet Publisher / FLEXIm v11.19.0.0 supported

# Si9000e v22.09.01 (September 2022)

# Enhancements to the Import Polar CITS Datalog File option

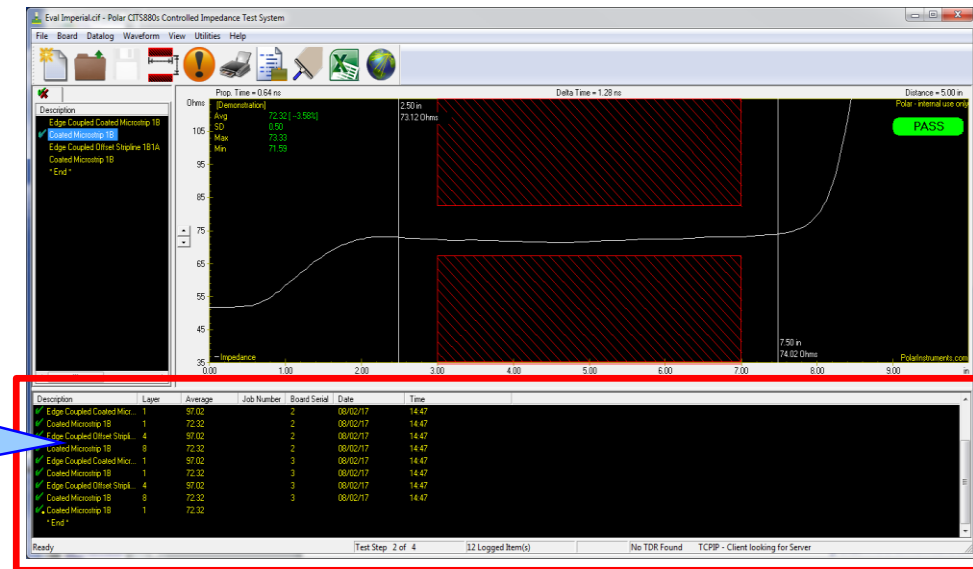


New for v22.09.01  
Now supports the latest CITS880s data log file format



**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

ansmission 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

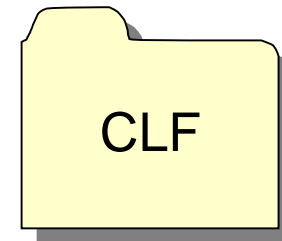
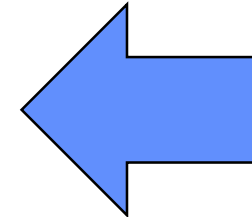
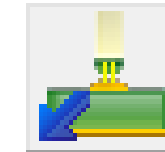
Notes: (First 5 lines will print)  
Add your comments here

**Interface Style**

Standard

Extended

		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>		



# 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...

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 Impedance: 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

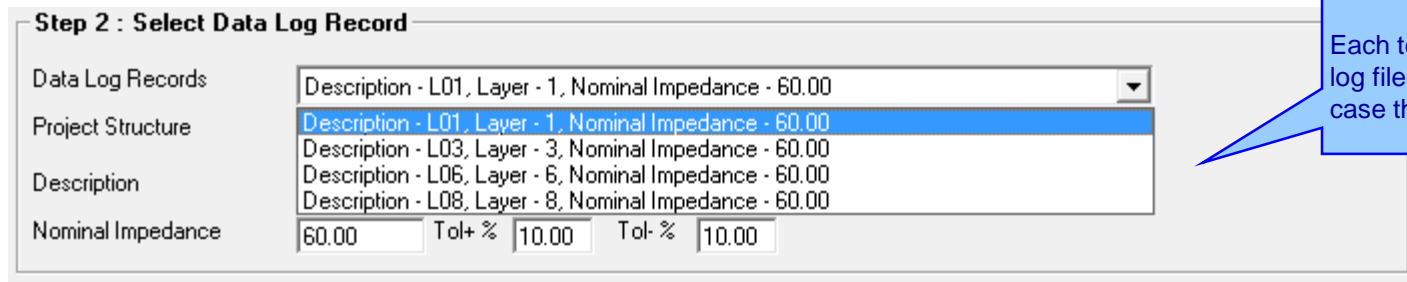
**Callout 1:** Once the CITS CLF data log file has been identified the software reads key information – Instrument Model, Serial Number, Data Log Record Count, Tests per Board / Coupon

**Callout 2:** 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

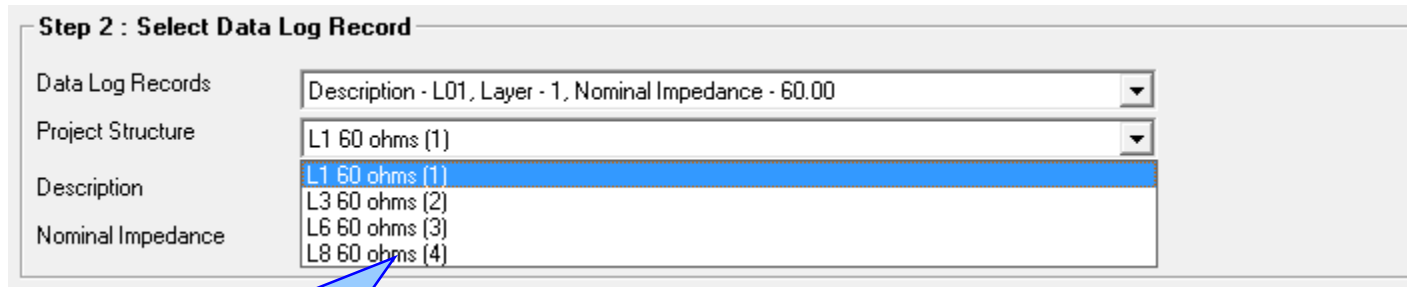
**Callout 3:** The Project Structure dropdown presents a list of structures currently available within the Project. Together with the Data Log Records dropdown it allows the user to quickly match the data log records against the correct structure

**Callout 4:** It is possible to plot the modelled and measured impedance data in a number of ways. The following slides provide more details

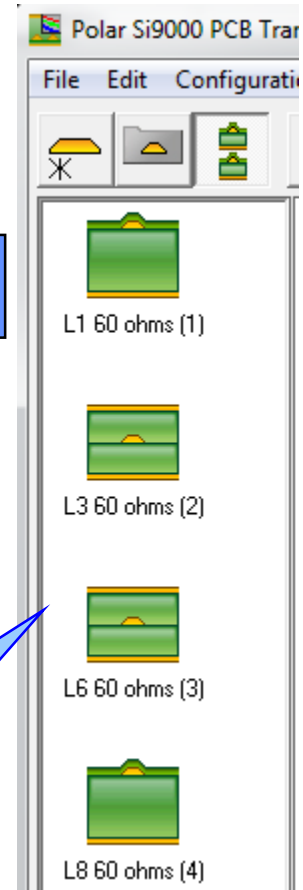
## Import CITS Datalog File option – feature recap



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



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

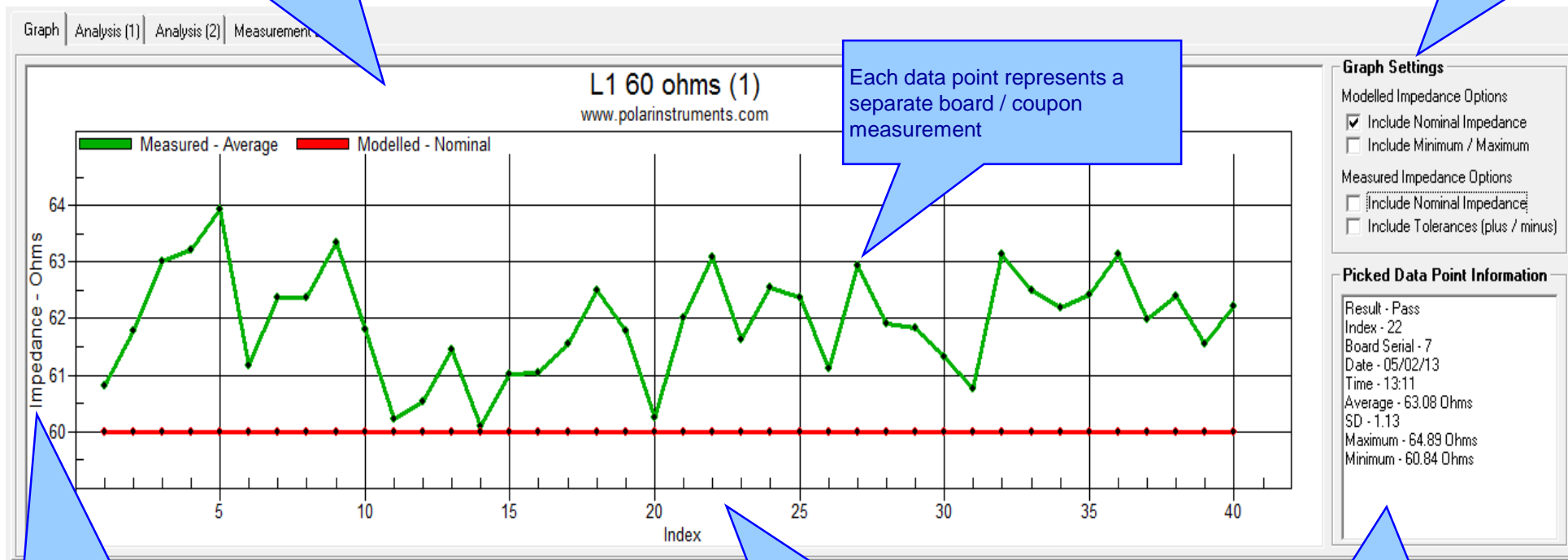


Four structures loaded into the Project group

# 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

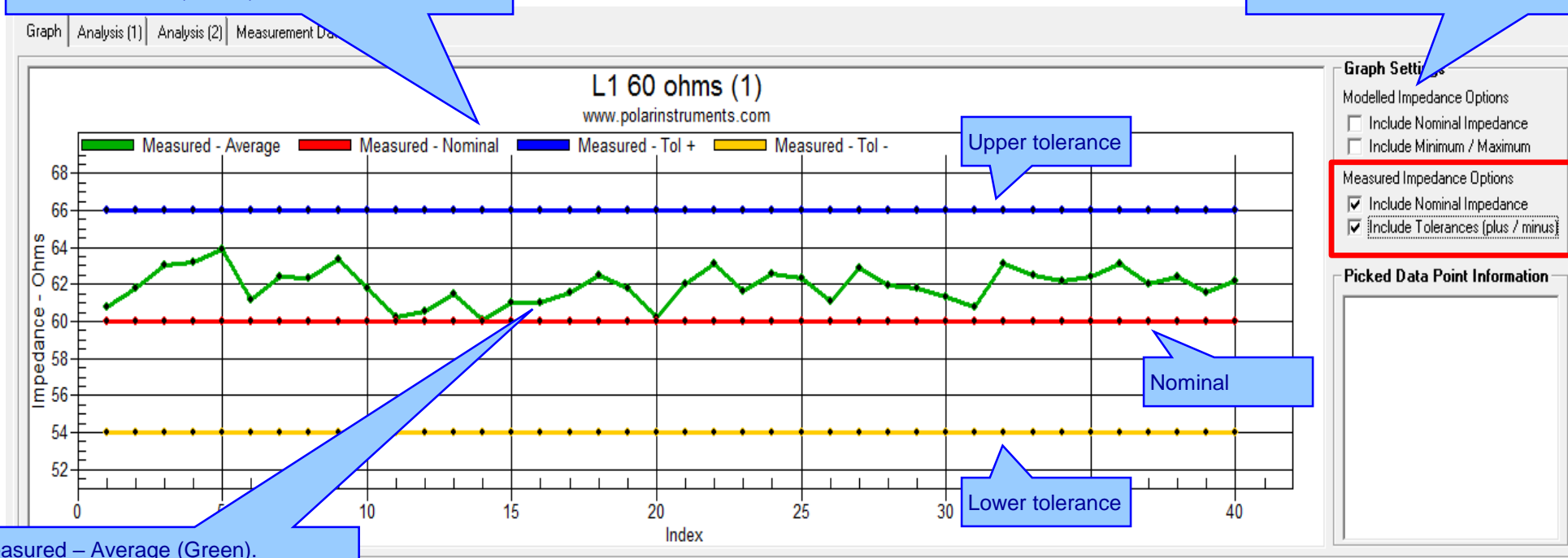
The x-axis is the identifying Index of the board / coupon read from the data log file

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

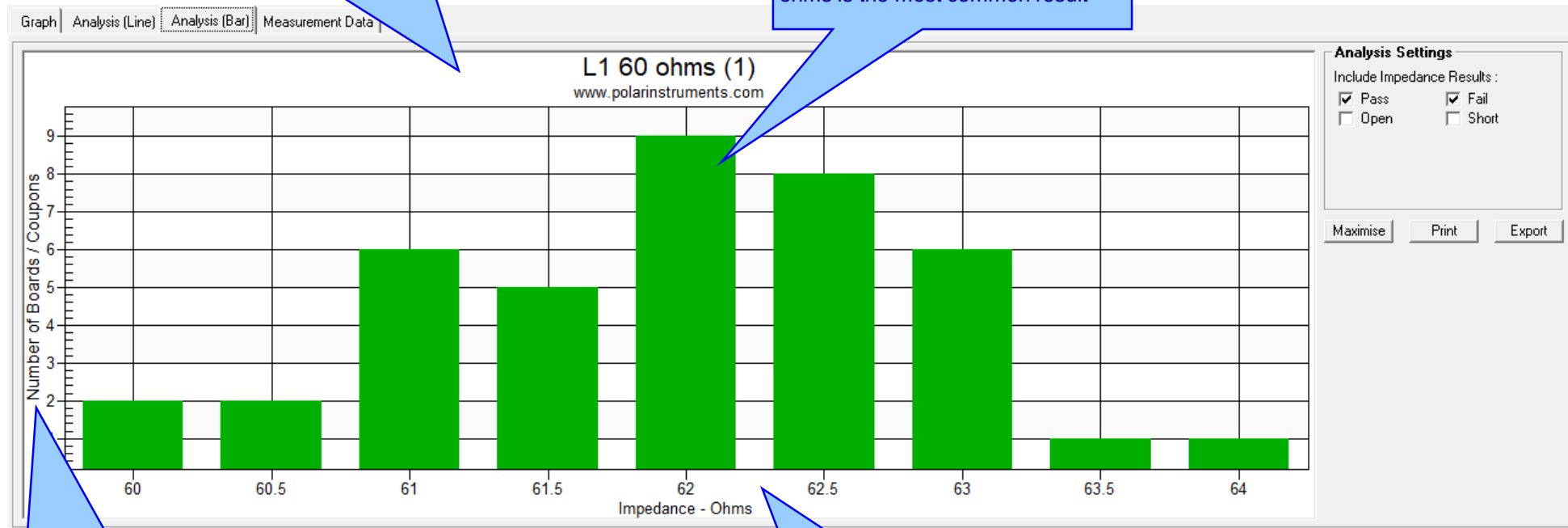


## Import CITS Datalog File option – feature recap

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)

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

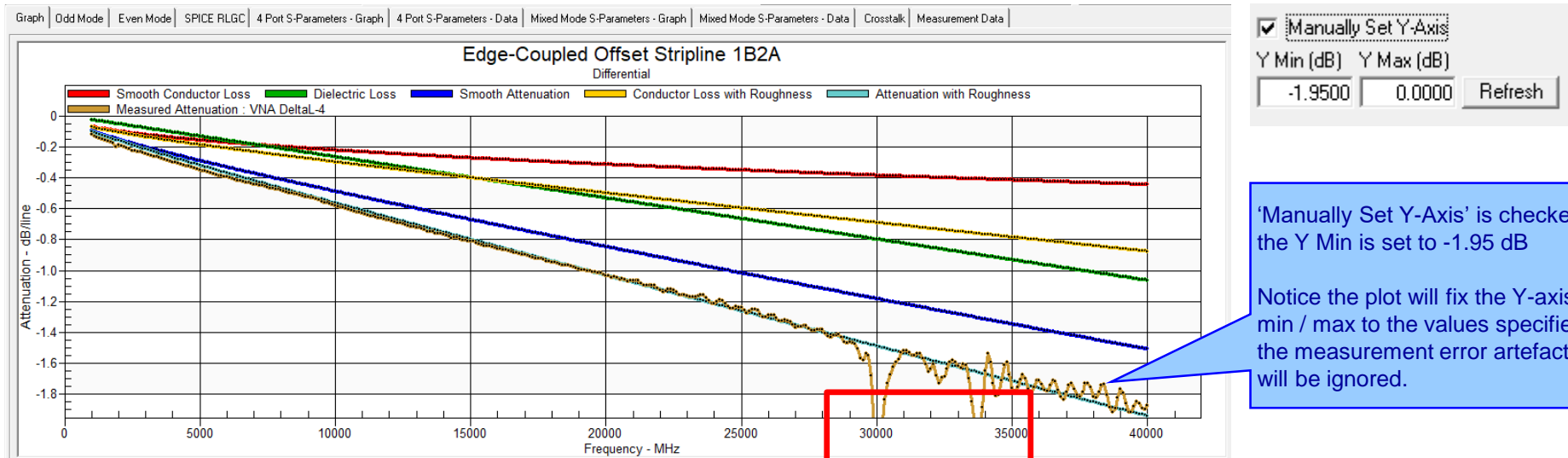
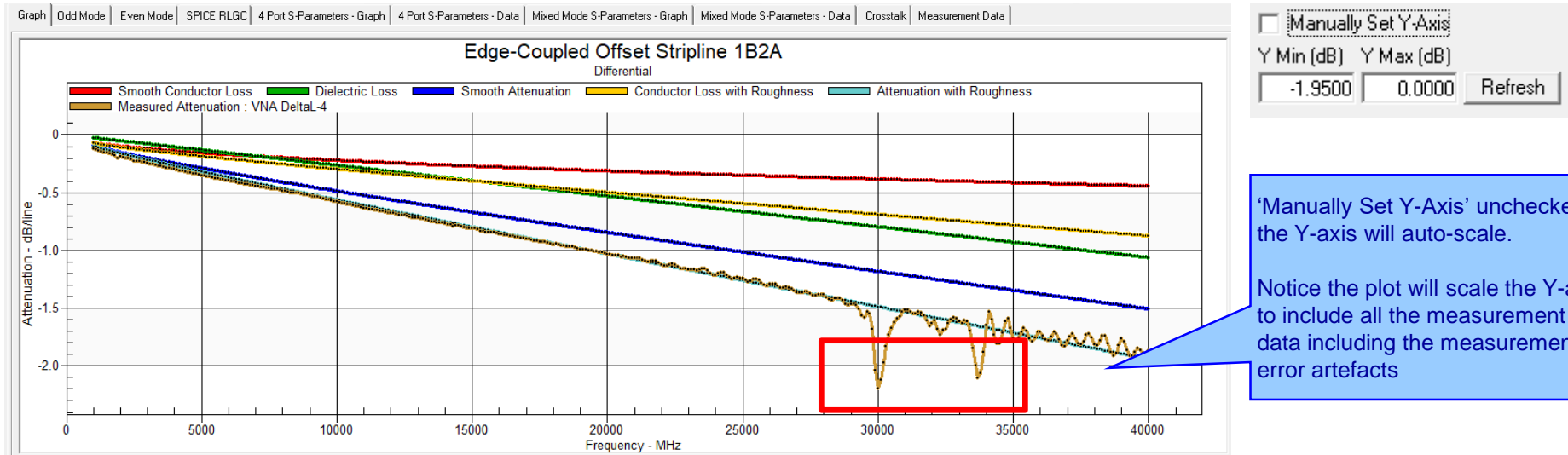
The new 'Manually Set Y-Axis' option provides more control over how the All Losses plot is presented.

The All Losses plot defaults to Y-axis auto-scale, where the Y-axis is resized to fit all data series.

When the 'Manually Set Y-Axis' option is checked, the Y-axis min and max values can be fixed to user-defined values.

This is especially useful after importing measurement data (brown) which often has measurement error artefacts that are not useful when comparing against the modelled data.

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



# Enhancements to the Import Touchstone Format option



**Edge-Coupled Coated Microstrip 2B**

www.polarinstruments.com

Read Touchstone File

Filename:

Overlay Calculated S-Parameter Data

Touchstone files contain S-Parameter data exported from VNA instruments and modelling software, including the Polar Si9000e.

The Si9000e allows a Touchstone file to be imported (green) and then compared against the structure currently being modelled (red).

Graphing options exist to display Magnitude, Phase and present S-Parameters as a Smith chart.

V22.09.01 enhances the Import Touchstone Format option to support S-Parameter data from a wider range of frequencies.

4 Port S-Parameters - Graph | 4 Port S-Parameters - Data

**S21**  
www.polarinstruments.com

Graph Options

Magnitude  Phase

Smith

Data Series

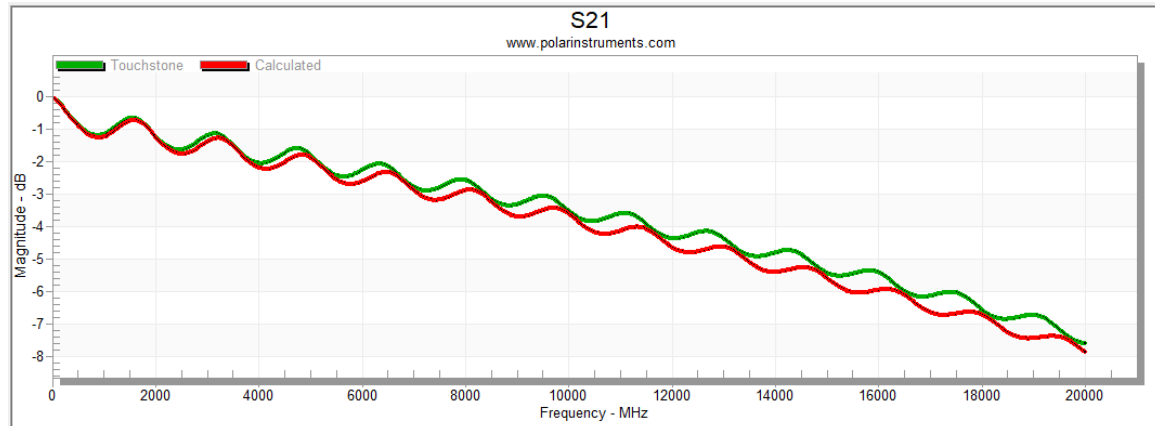
S11  S12  S13  S14

S21  S22  S23  S24

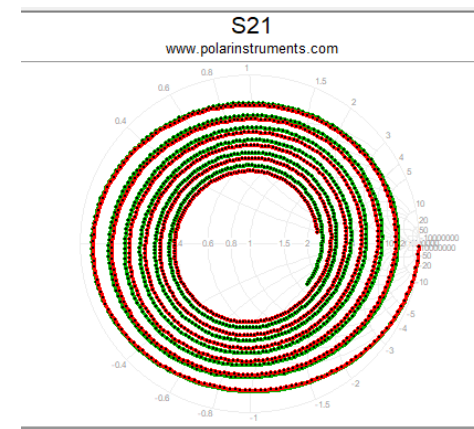
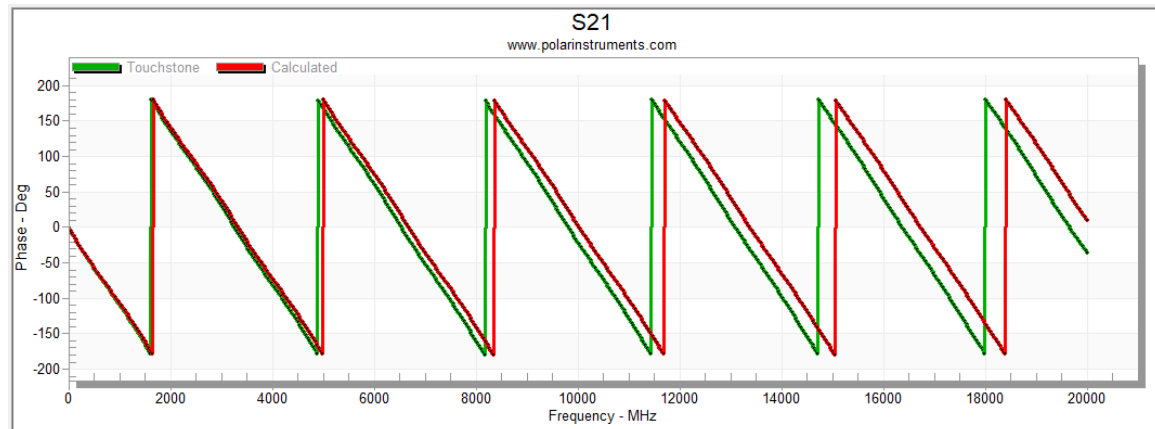
S31  S32  S33  S34

S41  S42  S43  S44

# 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

The screenshot shows the Polar Si9000 PCB Transmission Line Field Solver interface. The main window displays a cross-sectional diagram of an "Edge-Coupled Coated Microstrip 1B" with various parameters labeled: H1, Er1, W1, W2, S1, T1, C1, C2, C3, and CEr. The diagram is titled "Edge-Coupled Coated Microstrip 1B" and includes the website "www.polarinstruments.com".

On the right side, there is a parameter table with columns for "Tolerance", "Minimum", and "Maximum". The parameters listed are:

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

Below the table, the "Zdiff" parameter is set to 85.02. The "Interface Style" is set to "Extended", "G.S Convergence" is set to "Fine (Slower)", "Tolerance Mode" is set to "Absolute", and "Parameter Snap" is set to "Auto Calc".

A red box highlights the "Via Checks" toolbar icon. A blue callout box contains the following text:

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

At the bottom of the interface, there are three tabs: "Lossless Calculation", "Frequency Dependent Calculation", and "Sensitivity Analysis".



# New Differential Via Calculation

Via Checks
Close

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

**Anti-Pad Style**

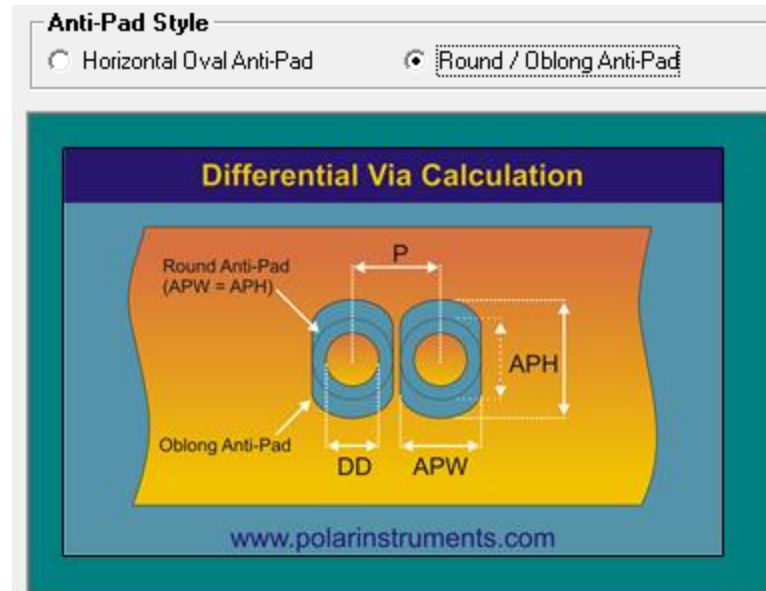
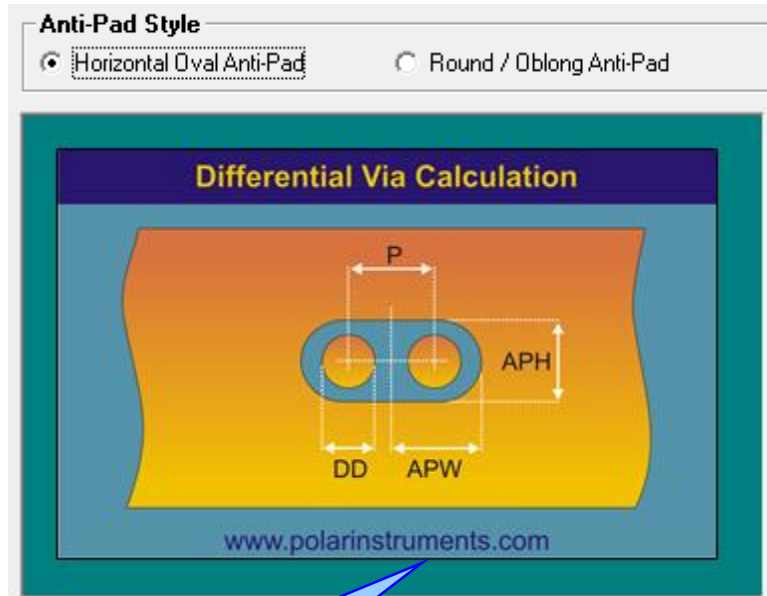
Horizontal Oval Anti-Pad     Round / Oblong Anti-Pad

Drill Diameter (t)	DD	<input type="text" value="15.0000"/>	<input type="range"/>
Via Pitch (S)	P	<input type="text" value="35.0000"/>	<input type="range"/>
Anti-Pad Width (b)	APW	<input type="text" value="50.8000"/>	<input type="range"/>
Anti-Pad Height (w')	APH	<input type="text" value="50.8000"/>	<input type="range"/>
Dielectric Constant (Dkz)	Dkz	<input type="text" value="3.6350"/>	<input type="range"/>
Dielectric Anisotropy (%)		<input type="text" value="0.00"/>	
Odd Mode Impedance (Z <sub>via</sub> )	Z <sub>odd</sub>	<input type="text" value="42.44"/>	
Differential Impedance	Z <sub>diff</sub>	<input type="text" value="84.88"/>	
Effective Dielectric Constant	Dk <sub>Eff</sub>	<input type="text" value="4.4430"/>	

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

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. If there will not be sufficient excess capacitance on the reference planes so the accuracy will be low.

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 interface. The Configuration menu is open, and the 'Surface Roughness Compensation Preset Values' option is highlighted with a red box. The dialog box for this option is open, displaying a table of preset values.

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

Buttons: Add Entry, Delete Entry, Edit Entry, Apply, Cancel

**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

The image shows two overlapping software dialog boxes. The top dialog, titled "Surface Roughness Compensation - Hammerstad / Groisse", contains a diagram of a PCB cross-section with surface roughness parameters R1 and R2. The R1 parameter is associated with the "Smooth Copper Laminate Side" and has a value of 2.2500. The R2 parameter is associated with the "Smooth Copper Oxide Side" and has a value of 2.3500. Red boxes highlight the '<<' and '<<<' buttons next to these values. The bottom dialog, titled "Select Surface Roughness Compensation Preset Values", displays a table of preset values for R1 and R2.

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 Hammerstad / Groisse 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.

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

**Cannonball-Huray Model**

Matte-side Roughness  
Rz Matte ( $\mu\text{m}$ ) 1.5000

Drum-Side Roughness  
Rz Drum ( $\mu\text{m}$ ) 1.6000

www.polarinstruments.com

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

# Si9000e v22.02 (February 2022)



# Track Resistance Calculator (TRC Plus) enhancements

Parameter Entry Units

- Mils
- Inches
- Microns
- Millimetres

		Tolerance	Minimum	Maximum	
Substrate 1 Height	H1	2.5000 ± 0.0000	2.5000	2.5000	Calculate
Substrate 1 Dielectric	Er1	4.2000 ± 0.0000	4.2000	4.2000	Calculate
Lower Trace Width	W1	3.9752 ± 0.0000	3.9752	3.9752	
Upper Trace Width	W2	2.9752 ± 0.0000	2.9752	2.9752	Calculate
Trace Thickness	T1	0.7000 ± 0.0000	0.7000	0.7000	Calculate
Coating Above Substrate	C1	1.0000 ± 0.0000	1.0000	1.0000	
Coating Above Trace	C2	1.0000 ± 0.0000	1.0000	1.0000	
Coating Dielectric	CEr	4.2000 ± 0.0000	4.2000	4.2000	
<b>Impedance</b>	<b>Zo</b>	<b>50.00</b>	<b>50.00</b>	<b>50.00</b>	Calculate More...

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
- Snap

Lossless Calculation      Frequency Dependent Calculation      Sensitivity Analysis

# Track Resistance Calculator (TRC Plus) enhancements

The screenshot displays the TRC Plus software interface. At the top left, there is a menu bar with 'File', 'Tools', and 'Help'. The main window is titled 'Si9000' and shows a 3D model of a 'Single Ended Coated Microstrip 1B'. The model is labeled with dimensions: LL (Length of Line), W1 (Lower Trace Width), W2 (Upper Trace Width), and T1 (Trace Thickness). The website 'polarinstruments.com' is visible on the side of the model.

Below the 3D model, there are several input fields and sections:

- Material & Calculated Impedance:** Material is set to '-- From Si8000 / Si9000 --'. Calculated Impedance (Zo) is 50. Resistivity (Ohm Metres) is 1.724E-08  $\Omega$ m and 5.80E+07 S/m. TCR is 0.00386.
- Units:** Mils is selected.
- Track Resistance  $\Omega$ :** Single Trace is 2.2323.
- Track Dimensions:** W1 is 3.9752, W2 is 2.9752, T1 is 0.7000, and LL is 8000.0000. This section is highlighted with a red box.
- Voltage Drop (Single Trace):** Current (Amps) is 1, and VD (Volts) is 2.232285.

On the right side, there is a graph titled 'Resistance  $\Omega$ ' vs 'Line Length (Mils)'. The y-axis ranges from 0.00 to 2.50 with a scale of 0.25 Ohms per division. The x-axis ranges from 0 to 9000. A blue line represents the track resistance, starting at (0,0) and ending at (8000, 2.2323). A blue callout box points to the graph with the text: 'This new TRC Plus graphing feature shows the track resistance (y-axis) plotted against the line length (x-axis)'.

# Track Resistance Calculator (TRC Plus) enhancements

TRC Plus

File Tools Help

Si9000

SingleEnded Coated Microstrip 1B

Material & Calculated Impedance

-- From Si8000 / Si9000 --

Calculated Impedance (Zo)

Resistivity (Ohm Metres)

Conductivity (Siemens / m)

Temp. Coefficient (/ °C) TCR

Reference Temp. (°C)

Operating Temp. (°C)

Units

Mils  Inches

Microns  Millimetres

Track Resistance Ω

Single Trace

Dual Trace

Voltage Drop (Single Trace)

Current (Amps)

VD (Volts)

Track Dimensions

Lower Trace Width W1

Upper Trace Width W2

Trace Thickness T1

Length of Line LL

Ohms per division : 1

TDR indicative Ω

Line Length (Mils)

Show Grid Lines

Tracking

Dark Mode

TDR View

On

Adjust Y Scale

# 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  $Z_0$  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 ...

		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	
<b>Impedance</b>	<b>Zo</b>		<b>0.00</b>	<b>0.00</b>	Calculate

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

**Project Structure List**

#	Structure	Name	Selected	Colour
0		TanD=0.010	Yes	Red
1		TanD=0.015	Yes	Green
2		TanD=0.020	Yes	Blue
3		TanD=0.025	Yes	Yellow
4		TanD=0.030	Yes	Cyan

Dbl-Click grid row to toggle Selected status.

Select All   Unselect All  
Select SE   Select Diff

**Selected Structure Information**

Structure Type : Coated Microstrip 1B

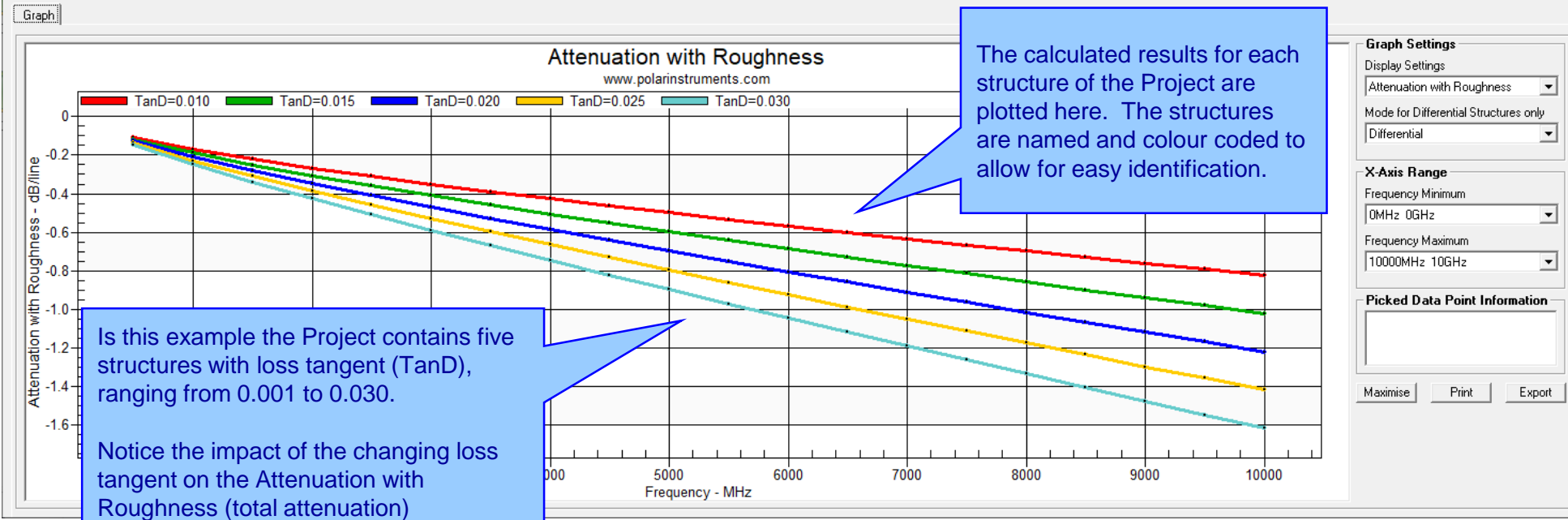
H1	4.3098
Er1	4.2000
W1	7.0000
W2	6.0000
T1	1.2000
C1	1.0000
C2	1.0000
CEr	4.2000
Zo	50.01

LL	1000.00
TC	5.80E+07
TanD	0.0100
Tr	10
FMin	500.000
FMax	10.000
FSteps	20

Frequency Distribution : Linear  
Result Presentation : Length of Line  
Extended Substrate Data : Constant Er / TanD  
Surface Roughness Compensation : Hammerstad

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

**Project Structure List**

#	Structure	Name	Selected	Colour
0		Roughness 0.5um	Yes	Red
1		Roughness 1.0um	Yes	Green
2		Roughness 1.5um	Yes	Blue
3		Roughness 2.0um	Yes	Yellow
4		Roughness 2.5um	Yes	Cyan

DoubleClick grid row to toggle Selected status.

### Selected Structure Information

Roughness 0.5um

www.polarinstruments.com

Structure Type : Offset Stripline 1B1A

H1	6.2992
Er1	4.2000
H2	6.2992
Er2	4.2000
W1	4.1339
W2	3.0709
T1	1.3780
Zo	50.02

LL	1000.00
TC	5.80E+07
TanD	0.0195
Tr	10
FMin	500.000
FMax	50.000
FSteps	100

Frequency Distribution : Linear  
 Result Presentation : Length of Line  
 Extended Substrate Data : Constant Er / TanD  
 Surface Roughness Compensation : Huray

**Graph Settings**

Display Settings

Mode for Differential Structures only

**X-Axis Range**

Frequency Minimum

Frequency Maximum

**Picked Data Point Information**

### Graph

#### Conductor Loss with Roughness

www.polarinstruments.com

Frequency (MHz)	0.5um (dB/line)	1.0um (dB/line)	1.5um (dB/line)	2.0um (dB/line)	2.5um (dB/line)
0	-0.1	-0.1	-0.1	-0.1	-0.1
25000	-0.4	-0.5	-0.6	-0.7	-0.8
50000	-0.8	-1.0	-1.2	-1.4	-1.6

Is this example the Project contains five structures with copper surface roughness ranging from 0.5  $\mu\text{m}$  to 2.5  $\mu\text{m}$ .

Notice the impact of the surface roughness on the Conductor with Roughness



### Project Graphing

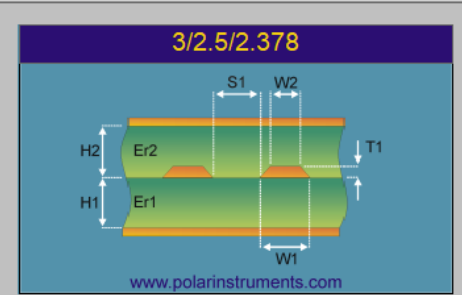
**Project Structure List**

#	Structure	Name	Selected	Colour
0		3/2.5/2.378	Yes	Red
1		3.5/3/2.7551	Yes	Green
2		4/3.5/3.1783	Yes	Blue
3		4.5/4/3.6647	Yes	Yellow
4		5/4.5/4.2267	Yes	Cyan

DoubleClick grid row to toggle Selected status.

One or more Structures has greater than 175 data points. Mouse over for more info.

### Selected Structure Information



Structure Type : Edge-Coupled Offset Stripline 1B1A

H1 8.0000  
Er1 3.5000  
H2 8.5000  
Er2 3.5000  
W1 3.0000  
W2 2.5000  
S1 2.3780  
T1 0.6000  
Zdiff 100.01

LL 1000.00  
TC 5.80E+07  
TanD 0.0020  
Tr 10  
FMin 100.000  
FMax 20.000  
FSteps 200

Frequency Distribution : Linear  
Result Presentation : Length of Line  
Extended Substrate Data : Causally Extrapolate Er / TanD  
Surface Roughness Compensation : Huray

### Graph

#### Attenuation with Roughness

www.polarinstruments.com

#### Graph Settings

Display Settings  
Attenuation with Roughness

Mode for Differential Structures only  
Differential

X-Axis Range  
Frequency Minimum: 0MHz 0GHz  
Frequency Maximum: 20000MHz 20GHz

Picked Data Point Information

10 differential structures using the same dielectric substrate materials but with differing trace widths / separations to achieve Zdiff = 100 ohms.

Notice that whilst all structures are 100 ohms, the structures with narrower trace widths are significantly more lossy than those with wider trace widths.

## 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

**Coated Microstrip 1B**

Diagram labels:  $C_{E1}$ ,  $C_1$ ,  $C_2$ ,  $W_2$ ,  $T_1$ ,  $H_1$ ,  $E_{r1}$ ,  $W_1$

**Impedance vs Changing Parameter(s)**

Parameter	H1	None	Calculate
Range Start Value	3.0000	4.0000	
Range Finish Value	12.0000		
Increment	1.0000	1.0000	

**Constant Impedance vs Changing Parameters**

Parameter	W1	Calculate
Target Impedance	50.0000	
Process Window: Minimum / Maximum	67.5000 / 82.5000	

**Graph Settings**

- 2D (selected) / 3D
- Display Series: Constant Impedance
- Target Impedance: 0.0000 (Refresh)

**Picked Data Point Information**

H1 (Mils)	5.000
W1	8.436

**Coated Microstrip 1B - 50 Ohms**

The plot shows Substrate Height (H1) X-axis and the Trace Width (W1) Y-axis. Each data point represents the H1 / W1 parameter values to achieve 50 ohms.

H1 - Mils	W1
3.0	4.5
4.0	6.0
5.0	8.436
6.0	10.5
7.0	12.5
8.0	14.5
9.0	16.5
10.0	18.5
11.0	20.5
12.0	22.5

# Populate a Project from Sensitivity Analysis Results

**Coated Microstrip 1B**

Parameter: H1 Range Start Value: 3.0000 Range End Value: 12.0000

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

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

# Populate a Project from Sensitivity Analysis Results

The structure name is auto-assigned from the sensitivity analysis parameters / result

Once the Project has been generated the structures within work in exactly the same way as if they were created manually.

The parameter values / results used for the structure name

Parameter	Tolerance	Minimum	Maximum	Calculate
H1	± 0.0000	5.0000	5.0000	Calculate
Er1	± 0.0000	4.2000	4.2000	Calculate
W1	± 0.0000	8.4360	8.4360	Calculate
W2	± 0.0000	7.4360	7.4360	Calculate
T1	± 0.0000	1.2000	1.2000	Calculate
C1	± 0.0000	1.0000	1.0000	Calculate
C2	± 0.0000	1.0000	1.0000	Calculate
CEr	± 0.0000	4.2000	4.2000	Calculate
<b>Zo</b>		<b>49.99</b>	<b>49.99</b>	Calculate

Structure Name: H1=5.0000 W1=8.4360 Zo=49.99

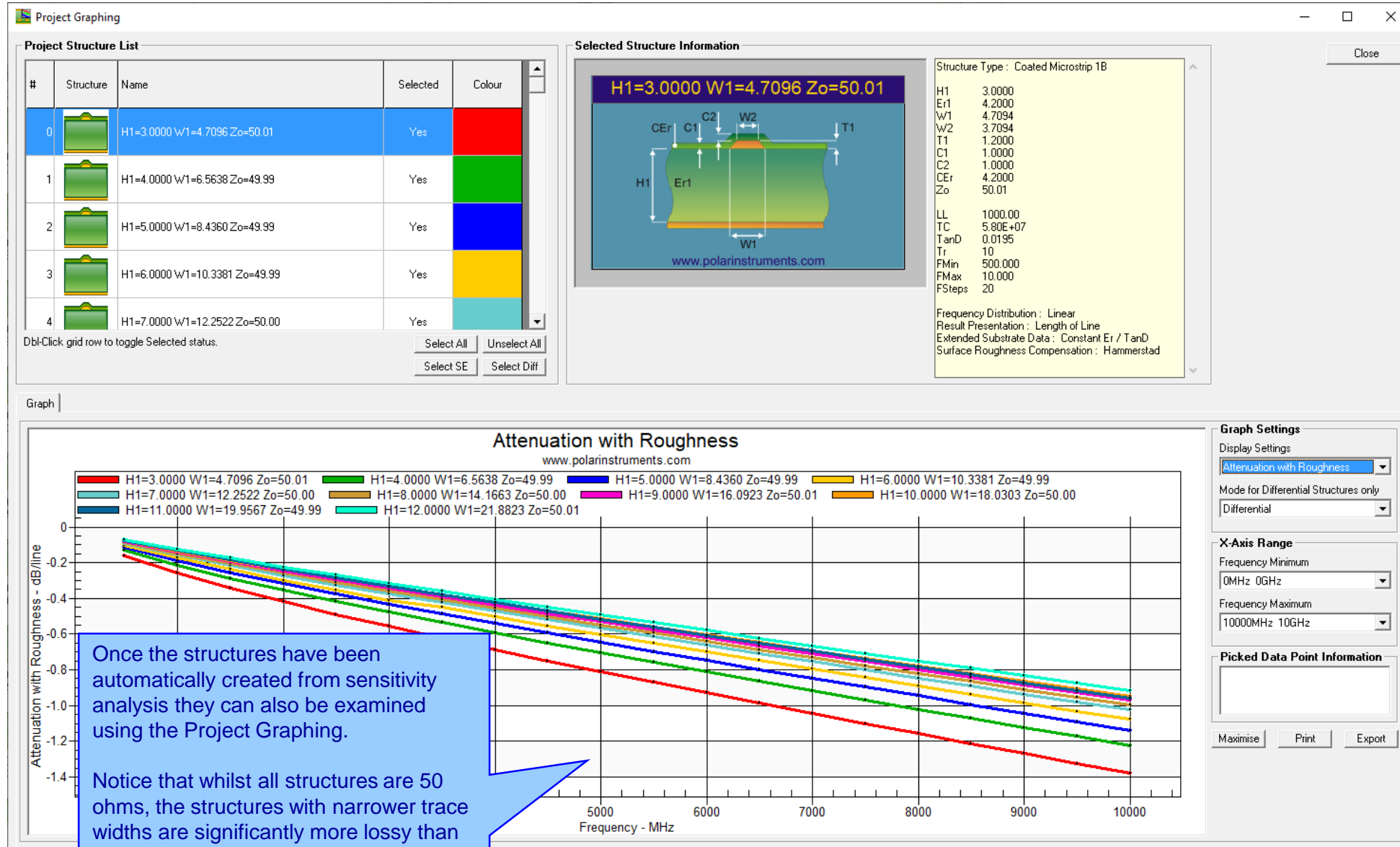
Parameter Entry Units:  Mils  Inches  Microns  Millimetres

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

Interface Style:  Standard

Parameter Step:  Auto Calc

Project: Lossless Calculation | Frequency Dependent Calculation | Sensitivity Analysis | Via Checks



# Populate a Project from Sensitivity Analysis Results

Substrate 1 Height: H1 = 5.0000

Substrate 1 Dielectric: Er1 = 4.2000

Lower Trace Width: W1 = 8.4360

Upper Trace Width: W2 = 7.4360

Trace Thickness: T1 = 1.2000

Coating Above Substrate: C1 = 1.0000

Coating Above Trace: C2 = 1.0000

Coating Dielectric: CEr = 4.2000

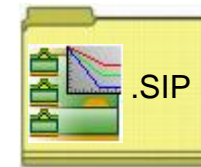
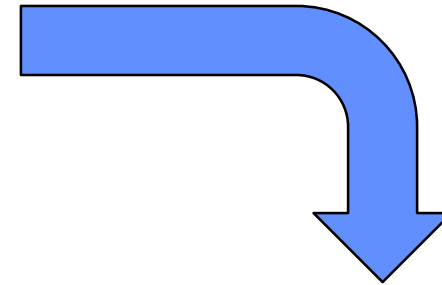
Impedance: Zo = 49.99

Interface Style:  Extended

G.S Convergence:  Fine (Slower)

Tolerance Mode:  Absolute

Parameter Snap:  Auto Calc



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

The screenshot shows the Polar Si9000 PCB Transmission Line Field Solver interface. The main window displays a graph titled "Edge-Coupled Offset Stripline 1B2A Differential". The graph plots Attenuation (dB/line) on the y-axis (ranging from 0 to -2.0) against Frequency (MHz) on the x-axis (ranging from 0 to 40,000). The graph includes several data series: Smooth Conductor Loss (red), Dielectric Loss (green), Smooth Attenuation (blue), Conductor Loss with Roughness (yellow), and Attenuation with Roughness (cyan). A brown line represents Measured Attenuation from VNA DeltaL-4. A blue callout box highlights the "GoalSeek" button in the "Surface Roughness Compensation" section of the software's settings panel.

**Edge-Coupled Offset Stripline 1B2A**

Length of Line LL: 1000.00  
 Trace Conductivity (S/m) TC: 5.80E+07  
 Loss Tangent TanD: 0.0195  
 Rise Time (ps) Tr: 10  
 Frequency Minimum (MHz) FMin: 1000.000  
 Frequency Maximum (GHz) FMax: 40.000  
 Frequency Steps FSteps: 391

**Surface Roughness Compensation**

- Constant Er / TanD
- Causally Extrapolate Er / TanD
- Multiple Er / TanD

**Surface Roughness Compensation**

- Smooth
- Hammerstad
- Groisse
- Huray

**Graph Settings**

Display Series: All Losses  
 Differential: Differential  
 Loss Budget (dB): 0.0000

**Picked Data Point Information**

Frequency (MHz): 25000.000  
 Measured Attenuation (dB): -1.240

## Surface Roughness Goal Seek option

**Surface Roughness Goal Seek** [Close]

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

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

<<

**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

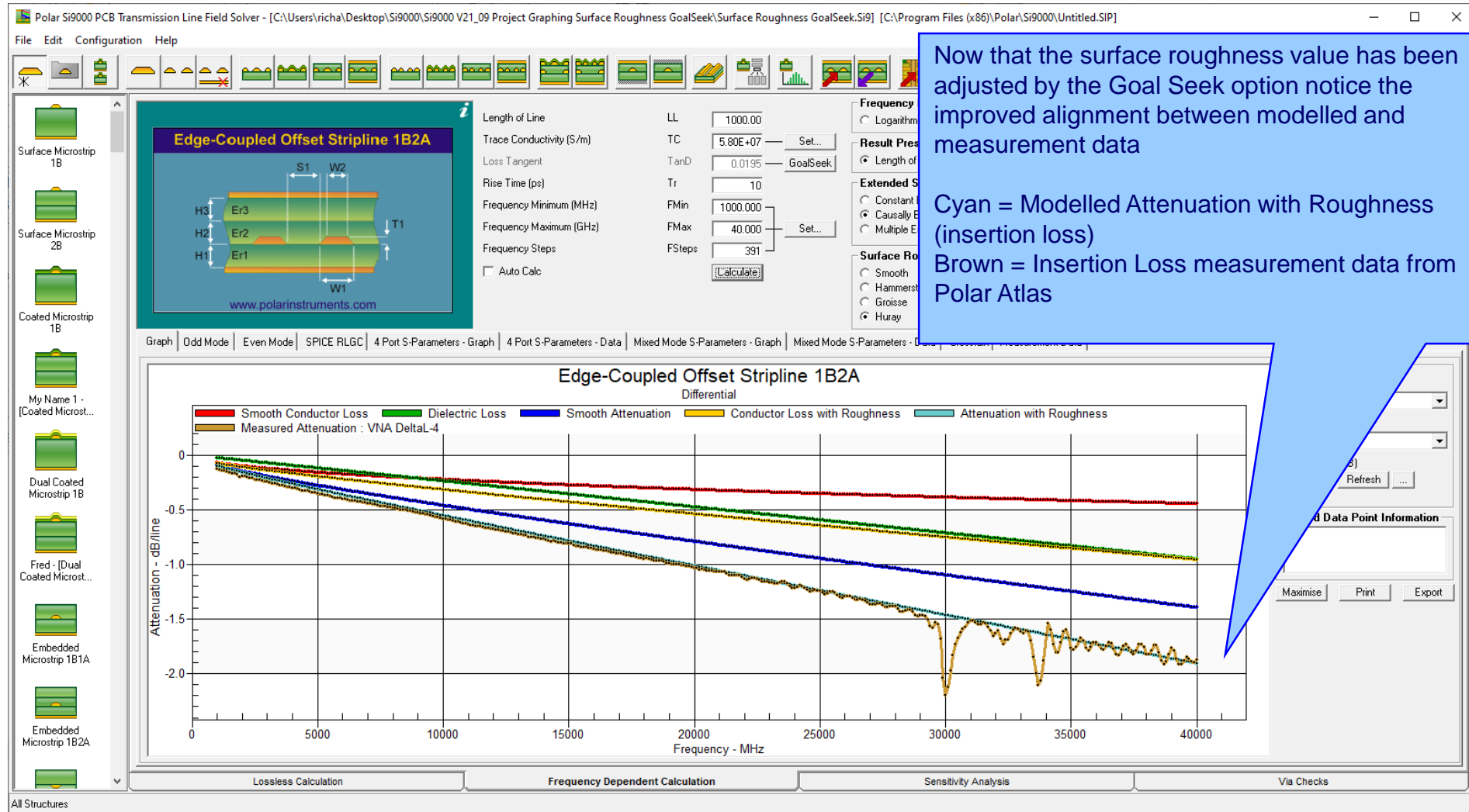
### Step 2

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)

The new TRC Plus calculator includes a number of enhancements including:

- Support for longer Length of Line (LL) values
- Support for Temperature Coefficient of Resistance

**Surface Microstrip 1B**

www.polarinstruments.com

Attenuation - dB/line

Frequency - MHz

Lossless Calculation | Frequency Dependent Calculation

Material: -- From Si9000 --

Resistivity (Ohm Metres): 1.724E-08  $\Omega$ m

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

Temp. Coefficient (/ °C) TCR: 0.00386

Reference Temp. (°C): 20

Operating Temp. (°C): 20

Units:  Mils  Inches  
 Microns  Millimetres

Track Resistance  $\Omega$ : 0.0870

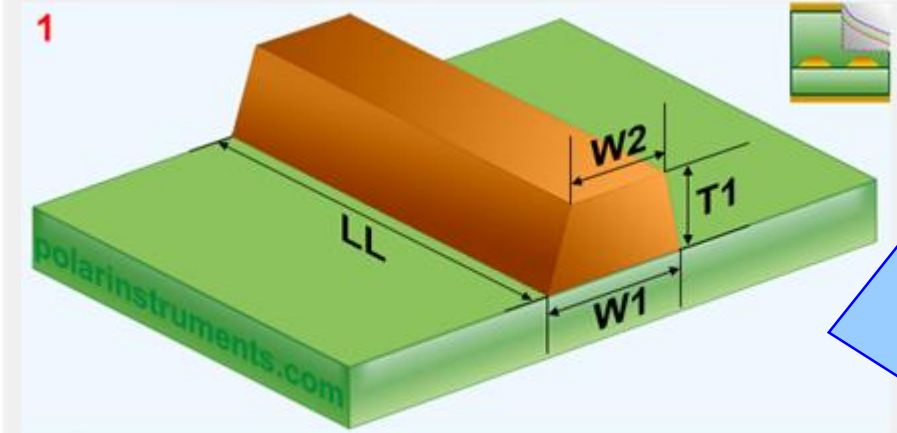
Voltage Drop Current (Amps): 1

VD (Volts): 0.087000

Track Dimensions:

- Lower Trace Width W1: 7.0000
- Upper Trace Width W2: 6.0000
- Trace Thickness T1: 1.2000
- Length of Line LL: 1000.0000

# Track Resistance Calculator (TRC Plus)



1

2

3

4

5

6

Material		Units	
-- From Si9000 --		<input checked="" type="radio"/> Mils	<input type="radio"/> Inches
Resistivity (Ohm Metres)	<input type="text" value="1.724E-08 Ωm"/>	<input type="radio"/> Microns	<input type="radio"/> Millimetres
Conductivity (Siemens / m)	<input type="text" value="5.80E+07 S/m"/>	Track Resistance Ω	
Temp. Coefficient (/ °C) TCR	<input type="text" value="0.00386"/>	<input type="text" value="0.5221"/>	
Reference Temp. (°C)	<input type="text" value="20"/>	Voltage Drop	
Operating Temp. (°C)	<input type="text" value="20"/>	Current (Amps)	
Track Dimensions		<input type="text" value="1"/>	
Lower Trace Width	W1 <input type="text" value="7.0000"/>	VD (Volts)	
Upper Trace Width	W2 <input type="text" value="6.0000"/>	<input type="text" value="0.522100"/>	
Trace Thickness	T1 <input type="text" value="1.2000"/>		
Length of Line	LL <input type="text" value="6000.0000"/>		
<input type="button" value="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

**Coated Microstrip 1B**

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	Nominal	Tol (Abs)	Minimum	Maximum	Mean	Std Dev
Substrate 1 Height	H1	8.5000 ± 0.0000	8.5000	8.5000	8.5000	1.0000
Substrate 1 Dielectric	Er1	4.2000 ± 0.0000	4.2000	4.2000	4.2000	0.0000
Lower Trace Width	W1	14.9629 ± 0.0000	14.9629	14.9629	7.0000	0.0000
Upper Trace Width	W2	13.9629 ± 0.0000	13.9629	13.9629	6.0000	0.0000
Trace Thickness	T1	1.2000 ± 0.0000	1.2000	1.2000	1.2000	0.0000
Coating Above Substrate	C1	1.0000 ± 0.0000	1.0000	1.0000	1.0000	0.0000
Coating Above Trace	C2	1.0000 ± 0.0000	1.0000	1.0000	1.0000	0.0000
Coating Dielectric	CEr	4.2000 ± 0.0000	4.2000	4.2000	4.2000	0.0000
<b>Impedance</b>	<b>Zo</b>	49.99	49.99	49.99		

**Settings**  
 Iterations:

It is now possible to run a Monte Carlo Analysis for 9,000 calculations on any selected structure

**Results Summary**  
**Impedance - Zo**  
 Nominal: 49.99  
 Minimum (worst case): 52.50  
 Maximum (worst case): 84.69  


---

**Monte Carlo Analysis**  
 Mean: 70.85  
 Standard Deviation: 3.93

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

The Polar Atlas VNA Delta-L insertion loss test system now exports measurement data up to 50 GHz.

The Si9000e Import from Atlas option allows the insertion loss measurement data (brown data series) to be overlaid on the All Losses plot.

In this example the Anritsu ShockLine™ instrument was used, Delta-L maximum frequency set to 40GHz

**Edge-Coupled Offset Stripline 1B2A**

Length of Line LL: 25.40  
 Trace Conductivity (S/m) TC: 5.80E+07  
 Loss Tangent TanD: 0.0195  
 Rise Time (ps) Tr: 10  
 Frequency Minimum (MHz) FMin: 1000.000  
 Frequency Maximum (GHz) FMax: 40.000  
 Frequency Steps FSteps: 391

Attenuation - dB/line vs Frequency - MHz

Legend: Smooth Conductor Loss, Dielectric Loss, Smooth Attenuation, Conductor Loss with Roughness, Measured Attenuation : VNA Delta-L-4

Graph Settings: Display Series: All Losses, Differential, Loss Budget (dB): 0.0000

# Si9000e v21.01 (January 2021)

# Monte Carlo support added for Dual Coated structures

Edge-Coupled Dual Coated Microstrip 1B

	Nominal	Tol (Abs)	Minimum	Maximum	Mean	Std Dev
Substrate 1 Height	H1	8.5000 ± 0.0000	8.5000	8.5000	8.5000	0.0000
Substrate 1 Dielectric	Er1	4.2000 ± 0.0000	4.2000	4.2000	4.2000	0.0000
Lower Trace Width	W1	7.0000 ± 0.0000	7.0000	7.0000	7.0000	0.0000
Upper Trace Width	W2	6.0000 ± 0.0000	6.0000	6.0000	6.0000	0.0000
Trace Separation	S1	5.9669 ± 0.0000	5.9669	5.9669	5.9669	0.0000
Trace Thickness	T1	1.2000 ± 0.0000	1.2000	1.2000	1.2000	0.0000
Coating Above Substrate	C1	1.0000 ± 0.0000	1.0000	1.0000	1.0000	0.0000
Coating Above Trace	C2	1.0000 ± 0.0000	1.0000	1.0000	1.0000	0.0000
Coating Between Traces	C3	1.0000 ± 0.0000	1.0000	1.0000	1.0000	0.0000
Coating Dielectric	CER	4.2000 ± 0.0000	4.2000	4.2000	4.2000	0.0000
2nd Coating Above Substrate	CS1	1.0000 ± 0.0000	1.0000	1.0000	1.0000	0.0000
2nd Coating Above Trace	CS2	1.0000 ± 0.0000	1.0000	1.0000	1.0000	0.0000

2nd Coating Between Traces CS3

Nominal	Tol (Abs)	Minimum	Maximum	Mean	Std Dev
1.0000 ± 0.0000	0.0000	1.0000	1.0000	1.0000	0.0000

2nd Coating Dielectric CSEr

Nominal	Tol (Abs)	Minimum	Maximum	Mean	Std Dev
4.2000 ± 0.0000	0.0000	4.2000	4.2000	4.2000	0.0000

Differential Impedance Zdiff

Nominal	Tol (Abs)	Minimum	Maximum	Mean	Std Dev
99.99	0.0000	99.99	99.99	99.99	0.0000

Settings

Iterations: 500

Uniform Distribution (Tol/Min/Max)

Normal Distribution (Mean/Std Dev)

Close

Nom -> Mean

Tol -> Std Dev

Graph | Iterations / Results

### Edge-Coupled Dual Coated Microstrip 1B - Monte Carlo Analysis

The Monte Carlo Analysis option now supports Dual Coated structures

**Results Summary**

Impedance - Zdiff

Nominal: 99.99

Minimum (worst case): 95.41

Maximum (worst case): 102.72

Monte Carlo Analysis

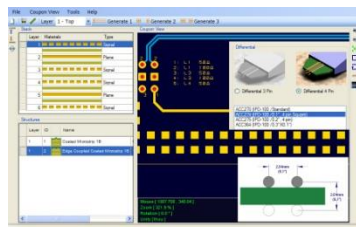
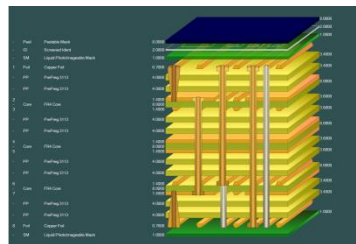
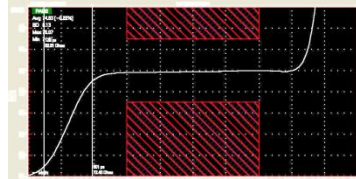
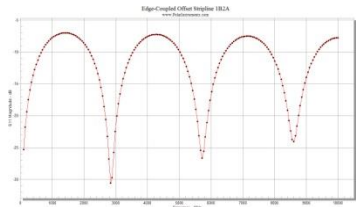
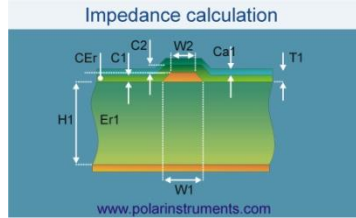
Mean: 99.94

Standard Deviation: 1.11

Maximise | Print | Export

## Other enhancements

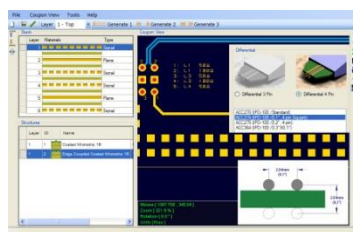
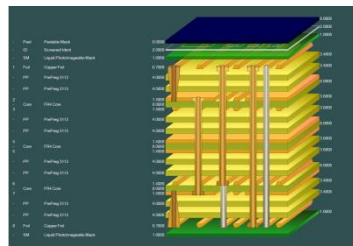
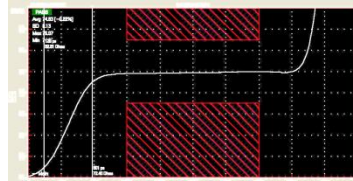
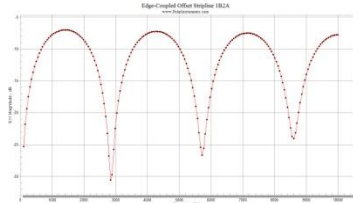
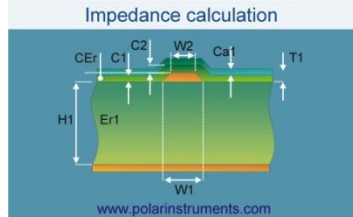
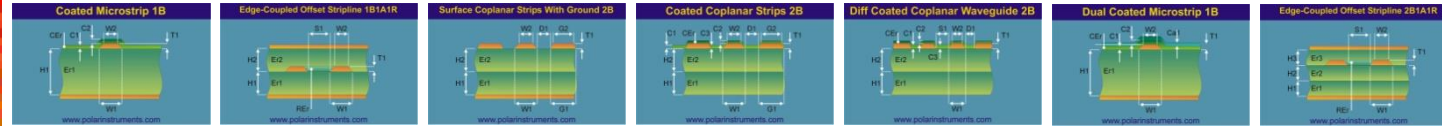
- FlexNet Publisher / FLEXIm v11.17.2.0 supported



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For more information:  
Contact Polar now:

Phone

USA / Canada / Mexico  
[Lupita Maurer](#)

(503) 356 5270

Asia / Pacific  
[Terence Chew](#)

+65 6873 7470

UK / Europe  
[Neil Chamberlain](#)

+44 23 9226 9113

Germany / Austria / Switzerland  
[Hermann Reischer](#)

+43 7666 20041-0

[www.polarinstruments.com](http://www.polarinstruments.com)

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