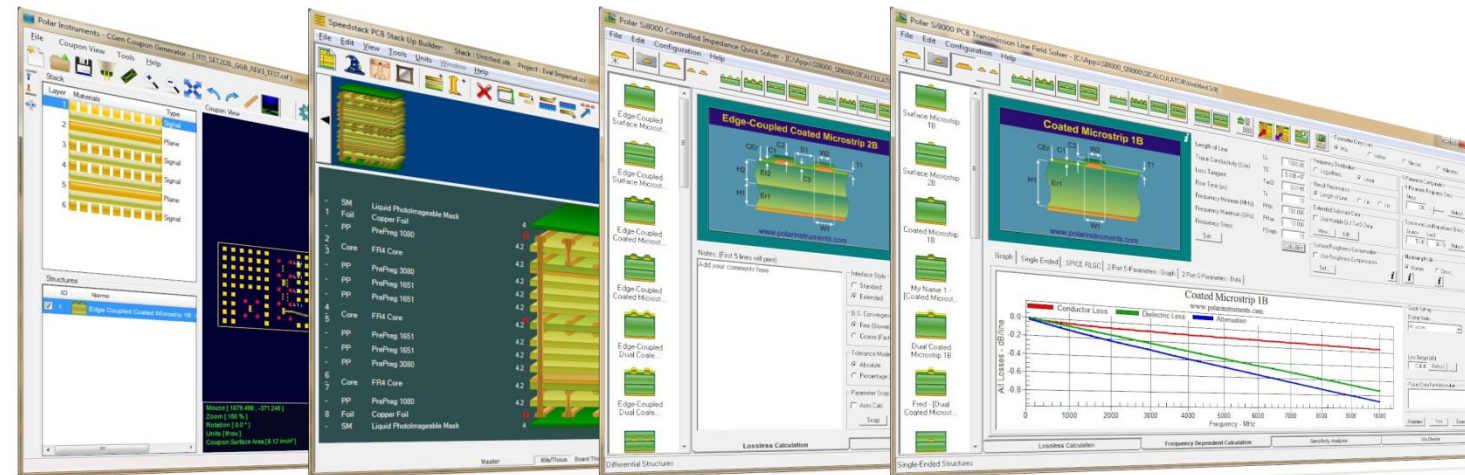
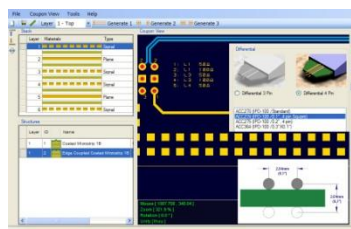
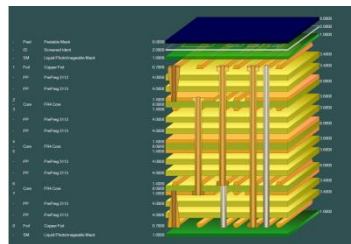
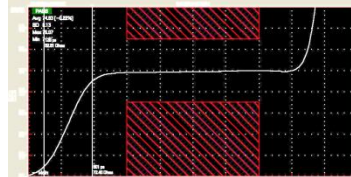
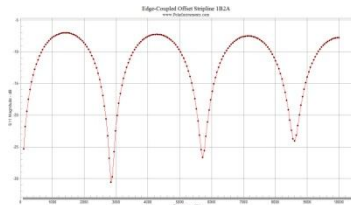
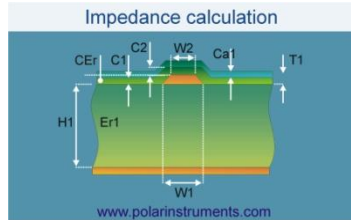




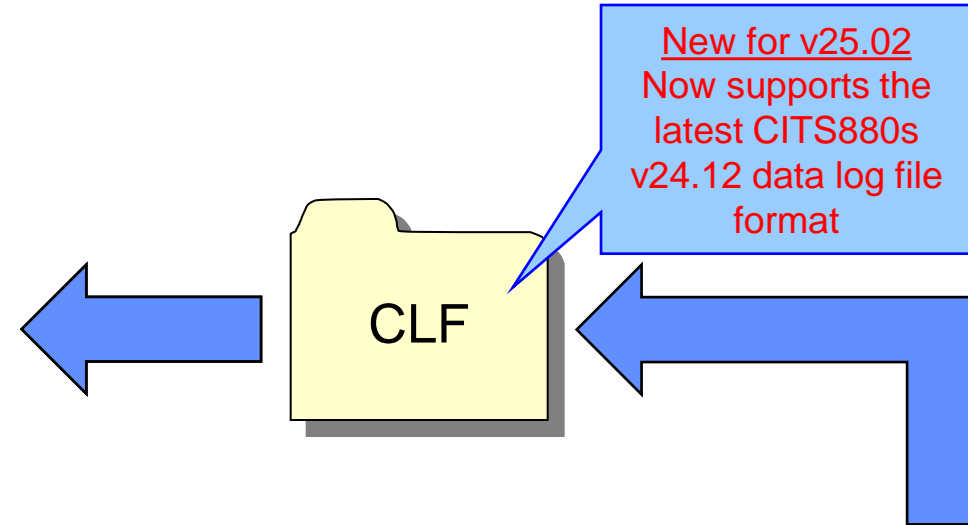
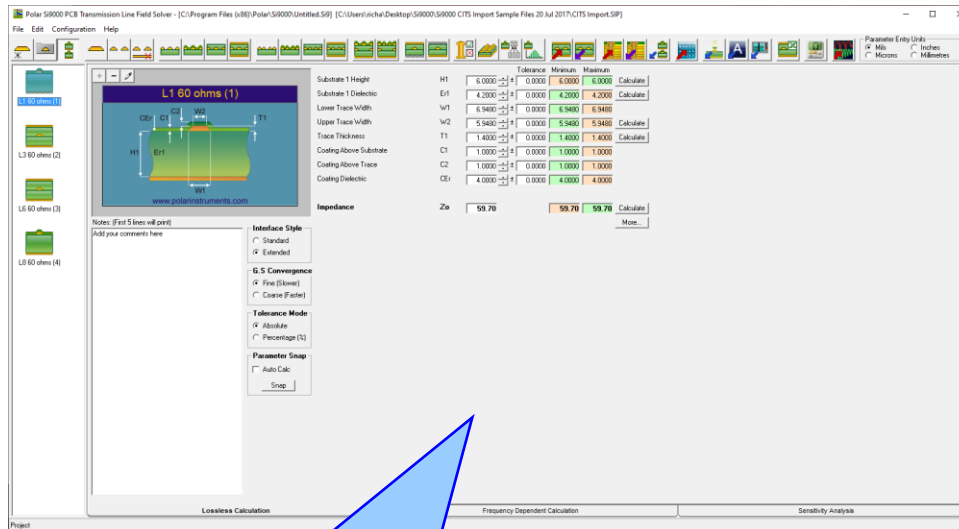
Si8000m / Si9000e 2021 – 2025

Richard Attrill – March 2025 (Rev 9)



v25.02.01 (February 2025)

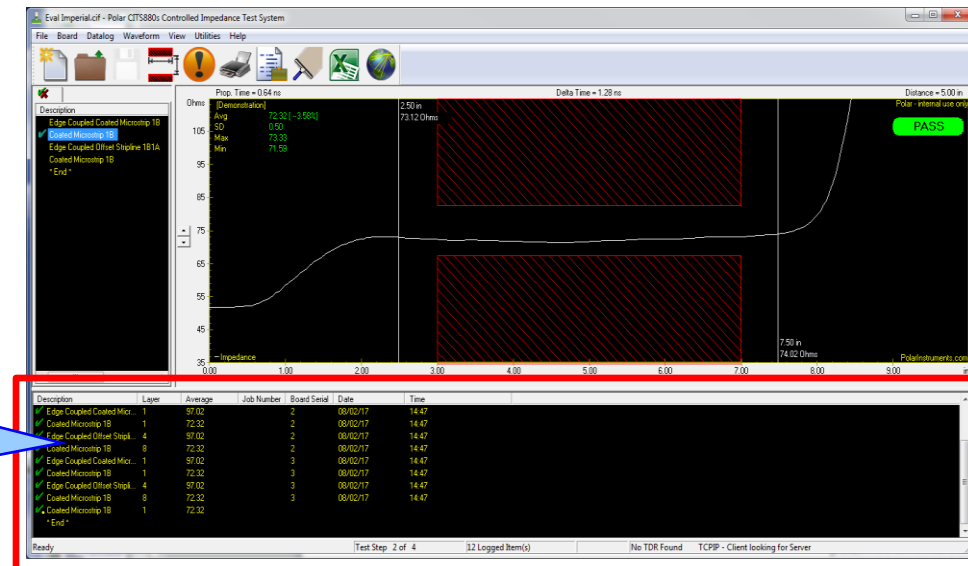
Enhancements to the Import Polar CITS Datalog File option



New for v25.02
Now supports the latest CITS880s v24.12 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.
****See slide #34 onwards for further information on this feature**

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



v25.01.01 (January 2025)

TRC Plus - Edit Materials option now improved

The screenshot shows the TRC Plus software interface. At the top, there is a 3D model of a trace with dimensions labeled: $W2$ (width), $T1$ (thickness), and LL (length). To the right of the model is a grid with the text "Ohms per division : 0.005". Below the model is a "Material Properties" dialog box. This dialog box contains a table with the following data:

Material Name	Resistivity	Conductivity	Reference Temperature °C	Operating Temperature °C	Temperature Coefficient of Resistance
-- From Si8000 / Si9000 --	1.7241E-08	5.800E+07	20.0	20.0	0.00386
Aluminium	2.650E-08	3.7736E+07	20.0	20.0	0.00429
Copper	1.680E-08	5.9524E+07	20.0	20.0	0.00386
Copper (Electro Deposited)	2.200E-08	4.5455E+07	20.0	20.0	0.00386
Gold	2.440E-08	4.0984E+07	20.0	20.0	0.00340
Lead	2.200E-07	4.5455E+06	20.0	20.0	0.00390
Nickel	6.990E-08	1.4306E+07	20.0	20.0	0.00587
Silver	1.590E-08	6.2893E+07	20.0	20.0	0.00382
Tin	1.090E-07	9.1743E+06	20.0	20.0	0.00450

The dialog box also includes a "Close" button at the bottom right. On the left side of the dialog box, there are icons for adding, editing, and deleting materials. On the far left, a vertical list of options is visible, including "Material & C...", "-- From Si8...", "Calculated I...", "Resistivity (...", "Conductivity...", "Temp. Coef...", "Reference T...", "Operating T...", "Track Dimer...", "Lower Trac...", "Upper Trac...", "Trace Thick...", and "Length of Li...".

The Edit Materials option allows for a table of materials to be added to the Si8000m / Si9000e Trace Resistance Calculator (TRC).

It is possible to predict the trace resistance for a variety of conductive materials and varying temperatures

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

DbI-Click grid row to toggle Selected status.

Select All Unselect All
Select SE Select Dif

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

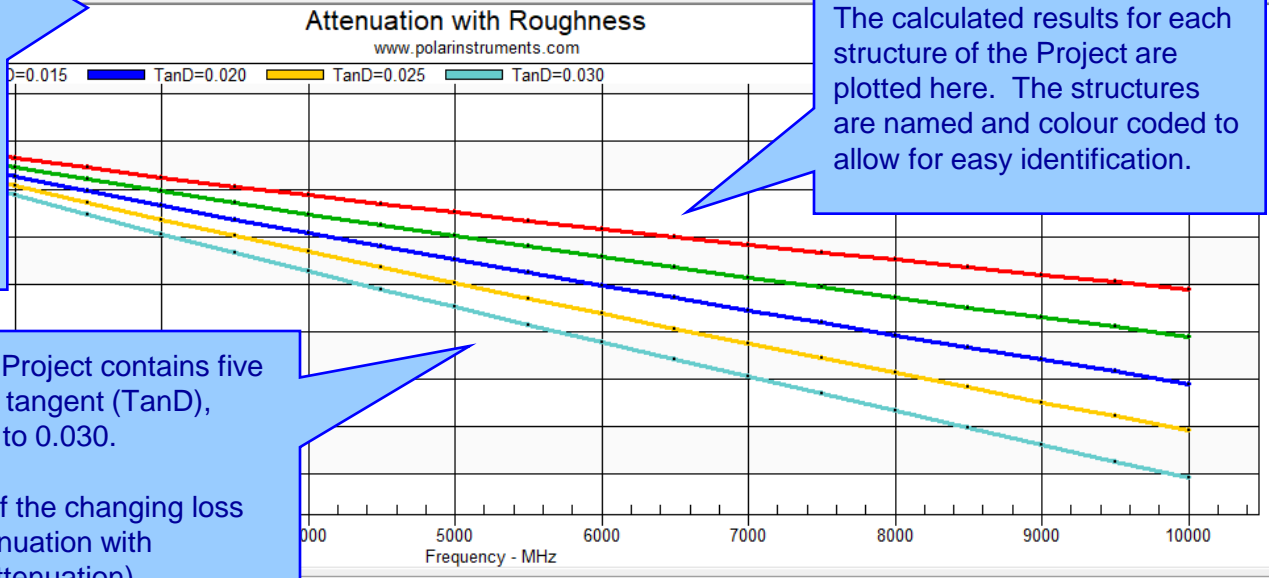
Frequency Distribution : Linear
Result Presentation : Length of Line
Extended Substrate Data : Constant Er / TanD
Surface Roughness Compensation : Hammerstad

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

New for v25.01

Numerous Project Graphing improvements included in the latest edition of Si9000e

**See slide #61 onwards for further information on this feature



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)

Graph Settings

Display Settings
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

v24.10.01 (October 2024)

Multilingual Support - Thai language added

Si9000e now supports English, German, Japanese, Simplified Chinese, Traditional Chinese and Thai language packs

หน้าจอแสดงการตั้งค่า PCB Polar Si9000 - [C:\Program Files (x86)\Polar\Si9000\Untitled.Si9] [C:\Program Files (x86)\Polar\Si9000\Untitled.SiP]

ไฟล์ แก้ไข การกำหนดค่า ศูนย์ช่วยเหลือ

Surface Microstrip 1B

Surface Microstrip 2B

Coated Microstrip 1B

My Name 1 - [Coated Microst...]

Dual Coated Microstrip 1B

Fred - [Dual Coated Microst...]

Embedded Microstrip 1B1A

My Name 2 - [Embedded M...]

ความสูงชั้นสเตรต 1 H1 8.5000 0.0000 8.5000 8.5000 จำนวน

ไดอิเล็กทริกชั้นสเตรต 1 Er1 4.2000 0.0000 4.2000 4.2000 จำนวน

ความกว้างเทรซด้านบน W1 7.0000 0.0000 7.0000 7.0000

ความกว้างเทรซด้านล่าง W2 6.0000 0.0000 6.0000 6.0000 จำนวน

ความหนาของเทรซ T1 1.2000 0.0000 1.2000 1.2000 จำนวน

อิมพีแดนซ์ Zo 75.18 75.18 75.18 จำนวน

เพิ่มเติม...

หมายเหตุ: (จะมีการพิมพ์ 5 บรรทัดแรก)

เพิ่มคอมเมนต์ของคุณที่นี่

รูปแบบอิมพีแดนซ์เฟด

มาตรฐาน

ชยาย

การสูญเสียของ G.S

ละเอียด (ช้ากว่า)

พยายาม (เร็วกว่า)

โหมดค่าที่ก่อดความถี่

ค่าสัมบูรณ์

เปอร์เซ็นต์ (%)

พารามิเตอร์แคป

จำนวน

อัตโนมัติ

สรุป

ข้อมูลเพิ่มเติม

อิมพีแดนซ์	Zo	75.178	75.178	75.178	ปิด
ความหน่วง (ps/in)	D	144.113	144.113	144.113	
การเหนี่ยวนำ (nH/in)	L	10.834	10.834	10.834	
ความจุ (pF/in)	C	1.917	1.917	1.917	
ค่าคงตัวไดอิเล็กทริกที่ใช้งาน	EEr	2.893	2.893	2.893	
ความเร็วของการแพร่กระจาย (CITS)	Vp	0.588	0.588	0.588	

การคำนวณแบบไม่สูญเสียข้อมูล

การคำนวณตามค่า

การวิเคราะห์ความถี่

โครงสร้างทั้งหมด

v24.03.13 (March 2024)

Update Cannonball-Huray Method to Simonovich-Cannonball Method

Surface Roughness Compensation - Huray

Ratio of Areas: 1.0000
Effective Ball Radius (μm): 0.2240
Area of Ball Count ($\text{sq } \mu\text{m}$): 1.8060
Number of Balls in Area: 14

Images by courtesy of Circuit Foil Luxembourg

Simonovich-Cannonball Model

Enable Simonovich-Cannonball

Matte-Side Roughness
Rz Matte (μm): 4.4430

Drum-Side Roughness
Rz Drum (μm): 3.0480

Calculate

Update / rebrand of the Cannonball-Huray Method to Simonovich-Cannonball Method.
Application Note now links to two papers

v24.02.08 (February 2024)

New Frequency of Interest option enhancements

Edge-Coupled Offset Stripline 1B1A

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
 Auto Calc

LL: 10.00
 TC: $5.80E+07$
 TanD: 0.0082
 Tr: 10
 FMin: 1000.000
 FMax: 25.000
 FSteps: 241

Measurement Data
 SPP: dB Loss per 10.00 Millimetres
 Include on All Losses plot

S-Parameter Configuration
 Frequency Steps: 200
 Source and Load Impedance (Ohms): 50.00 / 50.00
 Numbering Mode: Modern

Frequency of Interest - dB

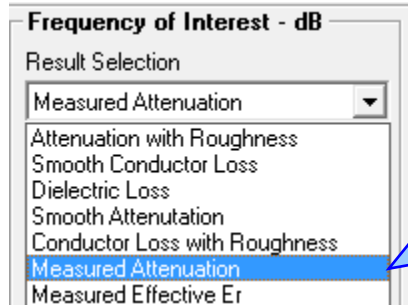
Frequency (GHz)	Measured Attenuation (dB)
4.000GHz	-0.231
8.000GHz	-0.323
12.000GHz	-0.414
16.000GHz	-0.506
20.000GHz	-0.598

Edge-Coupled Offset Stripline 1B1A Differential

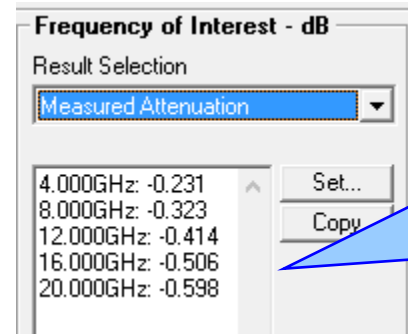
Attenuation - dB/line vs Frequency - MHz

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

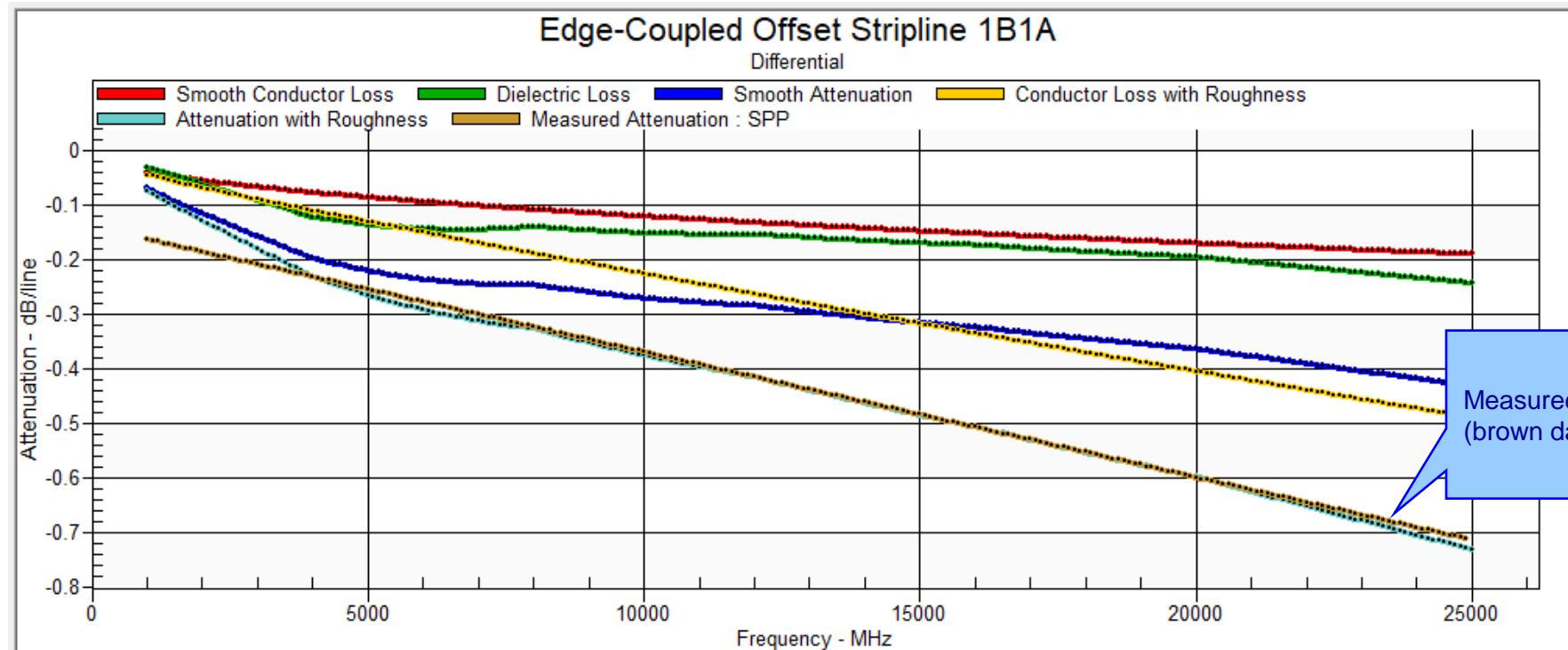
New Frequency of Interest option enhancements



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.

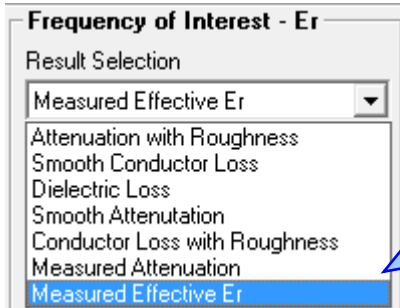


In this example the Frequency of Interest values have been set to 4, 8, 12, 16 and 20GHz. The measured attenuation (brown data series on the plot below) is examined and the dB loss values at those frequencies are displayed here

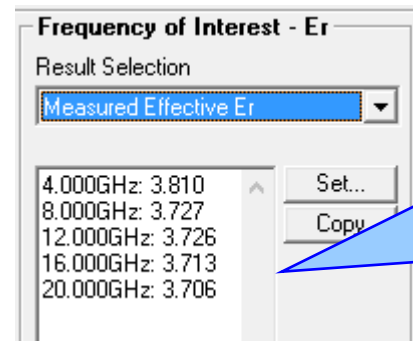


Measured Attenuation (brown data series)

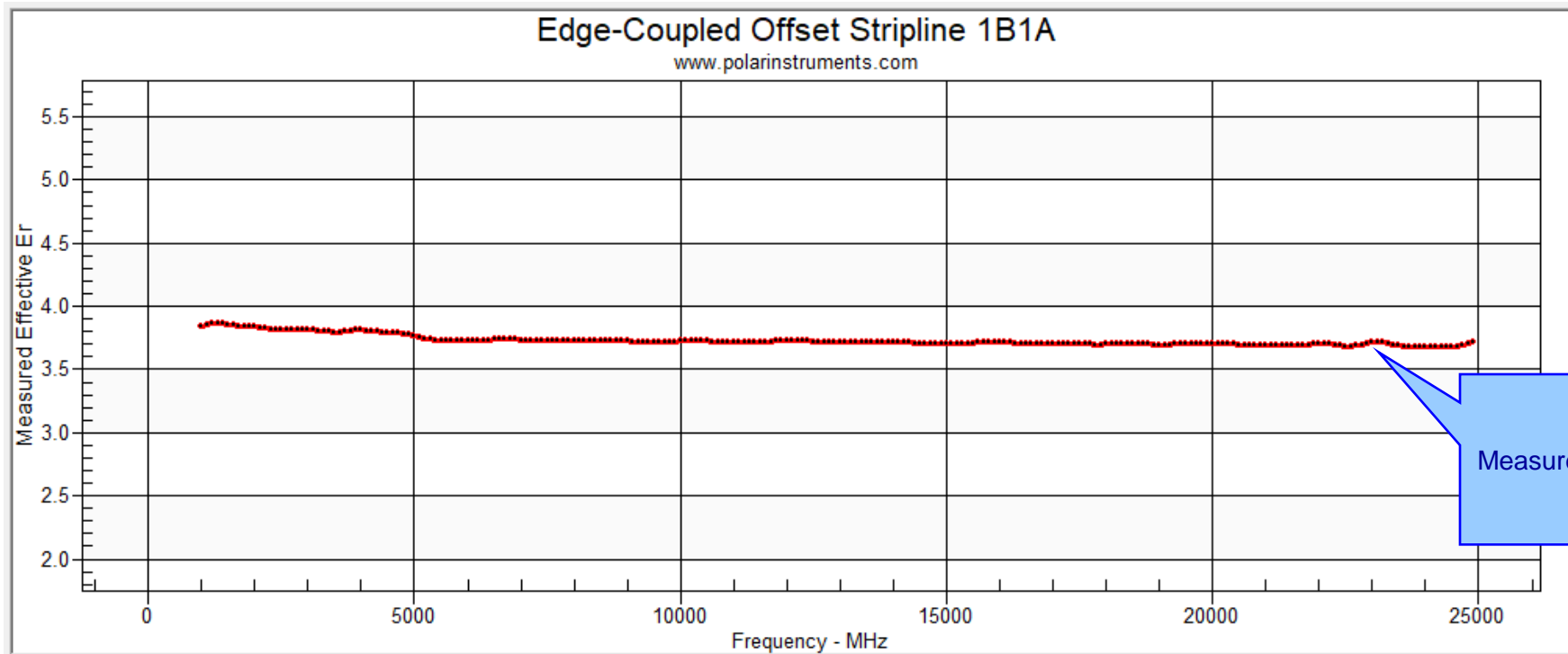
New Frequency of Interest option enhancements



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, Dielectric Loss, Smooth Attenuation, Conductor Loss with Roughness, Attenuation with Roughness, and Measured Attenuation : SPP. The attenuation values range from approximately -0.2 dB/line at 0 MHz to -0.9 dB/line at 25,000 MHz.

The 'Graph Settings' panel on the right shows 'Display Series' set to 'All Losses' and 'Differential'. The 'Loss Budget (dB)' is set to 0.0000. The 'Picked Data Point Information' panel shows the following data points:

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

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
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

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

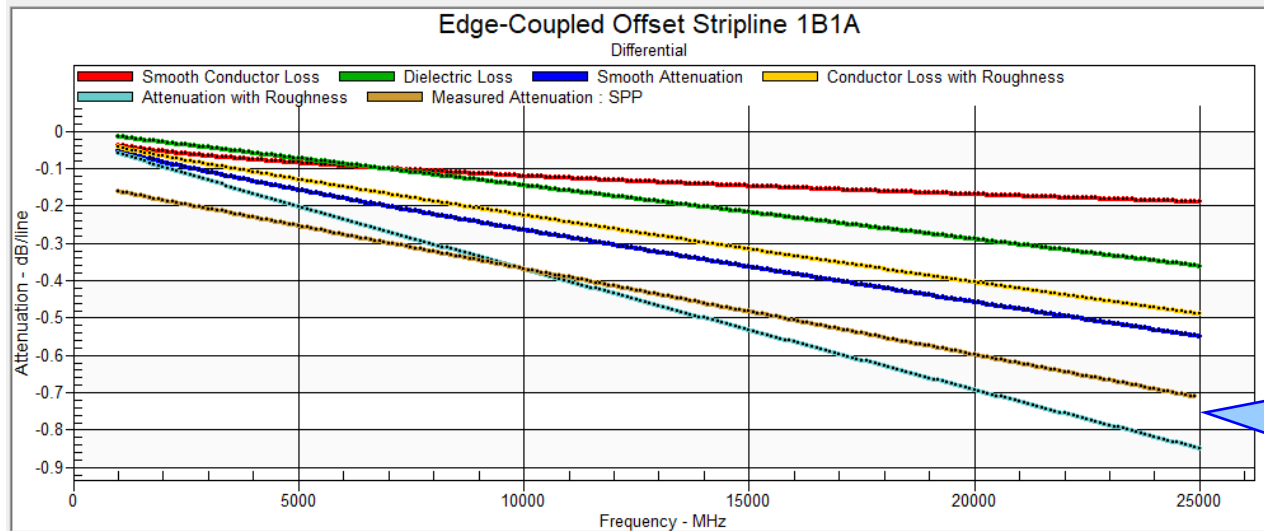
The calculated Loss Tangent results will be displayed here

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

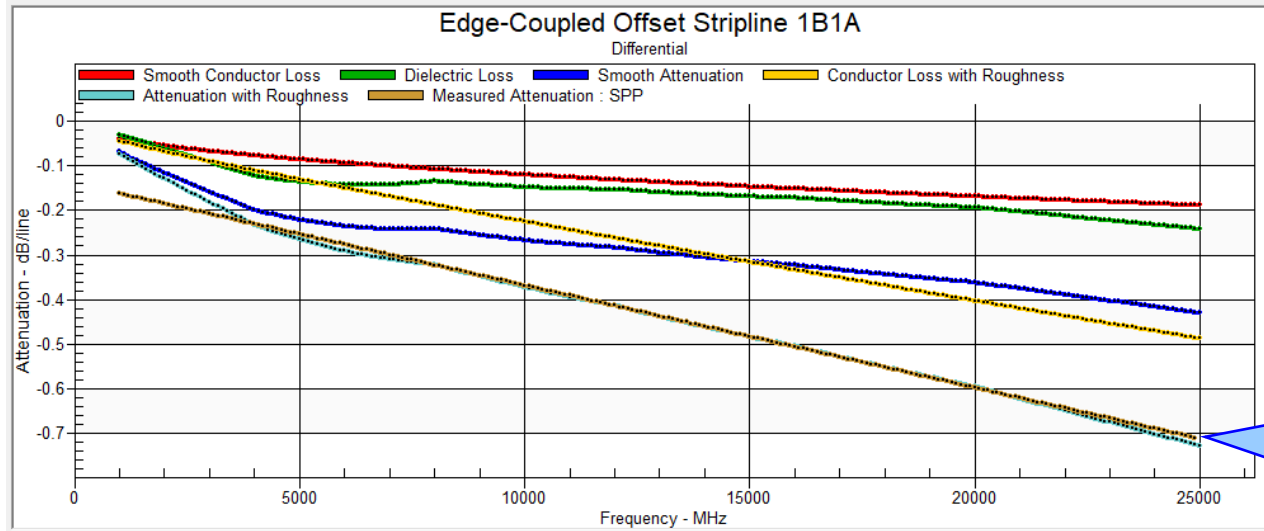
New Loss Tangent Goal Seek – Multiple Frequency option



Extended Substrate Data

- Constant Er / TanD GoalSeek
- Causally Extrapolate Er / TanD Edit...
- 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...
- 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).

v24.01.01 (January 2024)

Enhancements

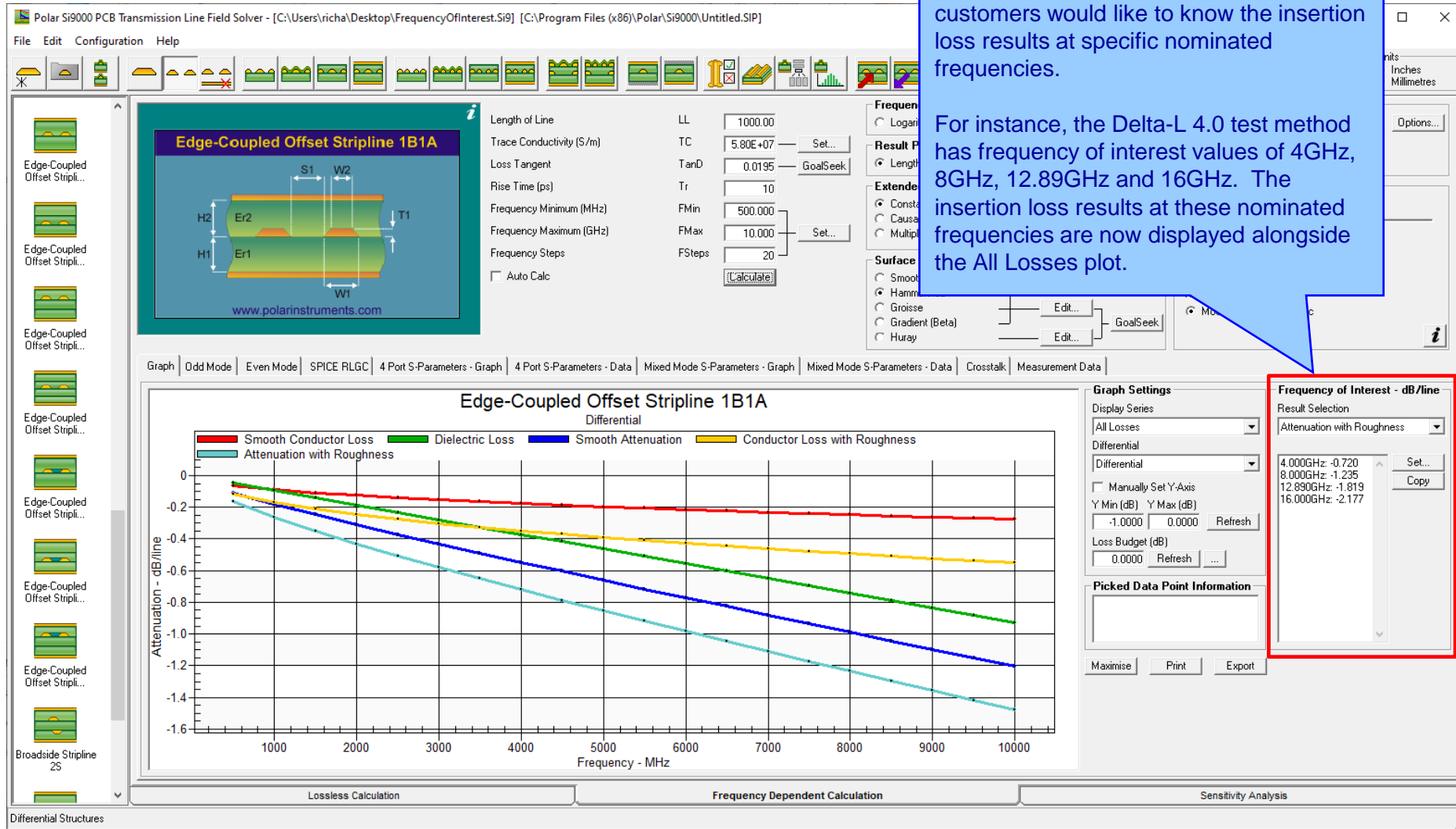
- From 2024 the Track Resistance Calculator (TRC) will be running on the Microsoft .Net Framework 4.8. It has migrated as a result of customer IT policy requests.

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

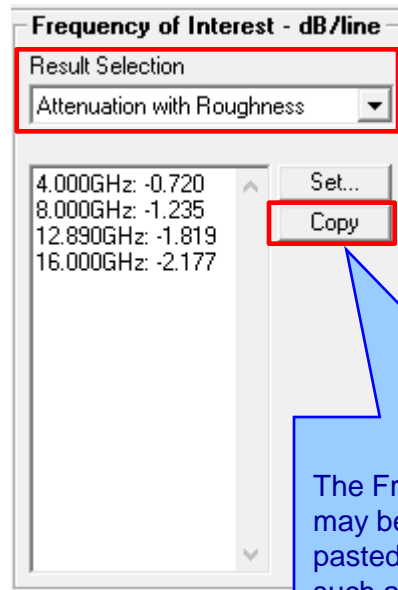
The screenshot shows the 'Frequency of Interest' dialog box in the software. On the left, a table displays results for four frequencies: 4.000GHz (-0.720), 8.000GHz (-1.235), 12.890GHz (-1.819), and 16.000GHz (-2.177). A red box highlights the 'Set...' button next to the table. The main dialog box contains a diagram of an 'Edge-Coupled Offset Stripline 1B1A' with parameters S1, W2, H2, Er2, H1, Er1, W1, and T1. To the right of the diagram is a table for 'Frequency of Interest (GHz)' with 10 rows, where the first four rows are filled with 4.000, 8.000, 12.890, and 16.000, and the remaining six are 0.000. Below the table are buttons for 'Apply to Current Structure', 'Apply to All Structures', and 'Cancel'.

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

v23.08.02 (August 2023)

New Export to Touchstone Format for Multiple Length of Lines

The screenshot displays the '4-Port S-Parameters' software interface with eight magnitude plots for different S-parameters (S11, S12, S13, S14, S21, S22, S31, S41). A dialog box titled 'Export to Touchstone Format for Multiple Length of Lines' is open in the center. The dialog box contains the following fields and options:

- Touchstone Files Destination Folder (requires read / write permissions):** C:\Users\richa\Desktop\TouchStone
- Touchstone Format:**
 - dB / Deg
 - Mag / Deg
 - Real / Imaginary
- Frequency Steps:** Steps: 200
- Length of Line : Mils:**
 - 1000.0000
 - 2000.0000
 - 5000.0000
 - 10000.0000

Place each Length of Line required as a separate line in the list box

Right-click on the Length of Line text box to Paste data from third-party tools

Buttons for 'Export' and 'Cancel' are visible at the bottom of the dialog box.

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

v23.06.01 (June 2023)

New Gradient Surface Roughness Compensation Method added

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

Parameter	Value
Length of Line	25400.00
Trace Conductivity (S/m)	5.80E+07
Loss Tangent	0.0195
Rise Time (ps)	10
Frequency Minimum (MHz)	500.000
Frequency Maximum (GHz)	10.000
Frequency Steps	20
Auto Calc	<input type="checkbox"/>
LL	25400.00
TC	5.80E+07
TanD	0.0195
Tr	10
FMin	500.000
FMax	10.000
FSteps	20

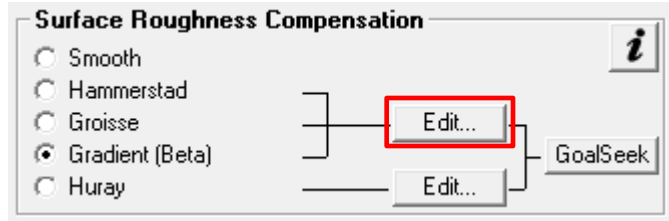
The "Surface Roughness Compensation" section is highlighted, showing the "Gradient (Beta)" method selected. A blue callout box points to this option with the text: "The Gradient method has been added to the Surface Roughness Compensation options".

The graph below shows the "Differential" attenuation in dB/line versus Frequency in MHz. The graph compares five different loss models:

- 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 graph shows that the "Attenuation with Roughness" (Cyan line) is the highest, indicating the most significant loss at higher frequencies. The "Smooth Attenuation" (Blue line) is the lowest, indicating the least loss. The "Conductor Loss with Roughness" (Yellow line) and "Dielectric Loss" (Green line) are intermediate. The "Smooth Conductor Loss" (Red line) is the lowest among the conductor loss models.

New Gradient Surface Roughness Compensation Method added

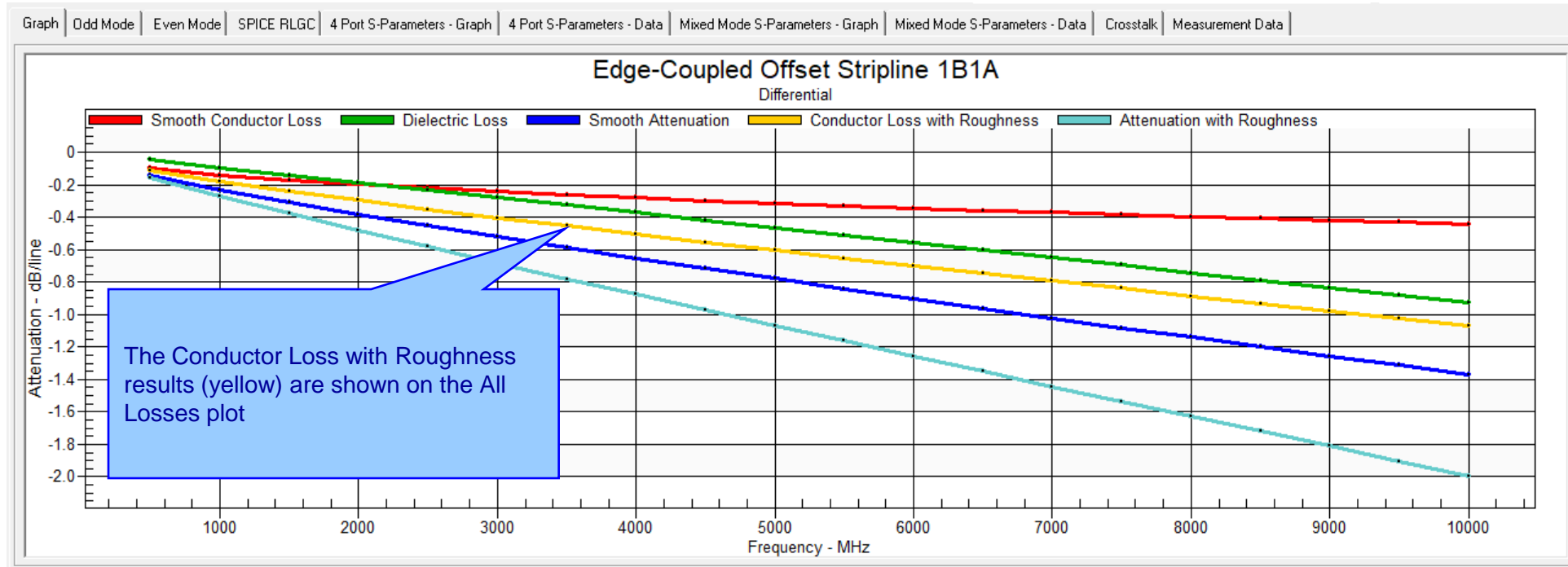


Selecting the Edit button will allow the RMS roughness values to be entered.
In this example 1µm roughness for all significant surfaces

Surface	Parameter	RMS : Microns
Surface 1 Roughness	R1	1.0000
Surface 2 Roughness	R2	1.0000
Surface 3 Roughness	R3	1.0000
Surface 4 Roughness	R4	1.0000

Guidance for the Gradient Method is available here: [Application Note](#)

New Gradient Surface Roughness Compensation Method added



New Gradient Surface Roughness Compensation Method added

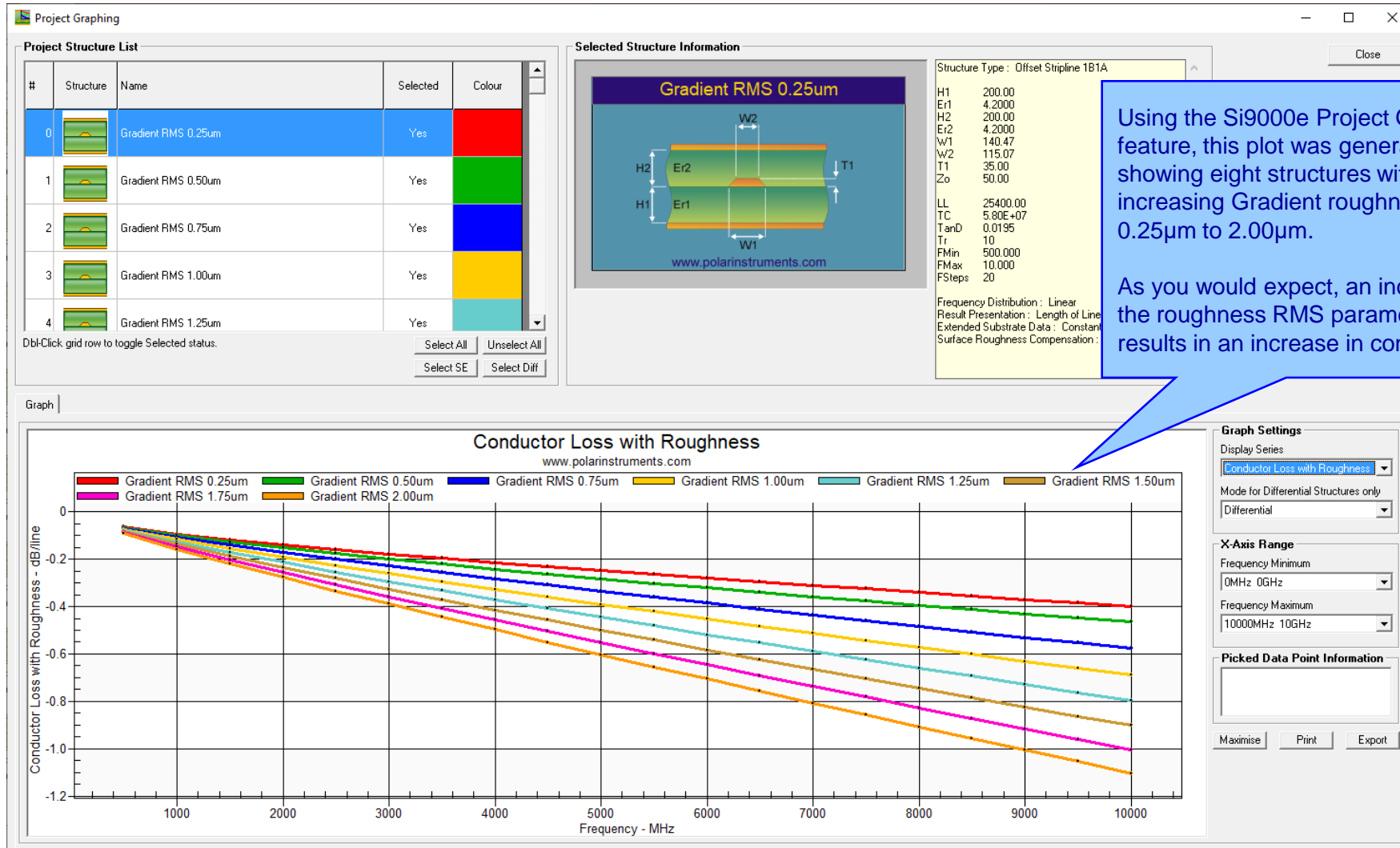
Frequency Hz	Impedance Real Ohms	Impedance Imaginary Ohms	Impedance Magnitude Ohms	Inductance H/line	Resistance Ohms/line	Capacitance F/line	Conductance S/line	Skin Depth m	Smooth Conductor Loss dB/line	Dielectric Loss dB/line	Smooth Attenuation dB/line	Conductor Loss with Roughness dB/line	Attenuation 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

Ctrl-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	2.7500
w2	8.0000
S1	1.2000
T1	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

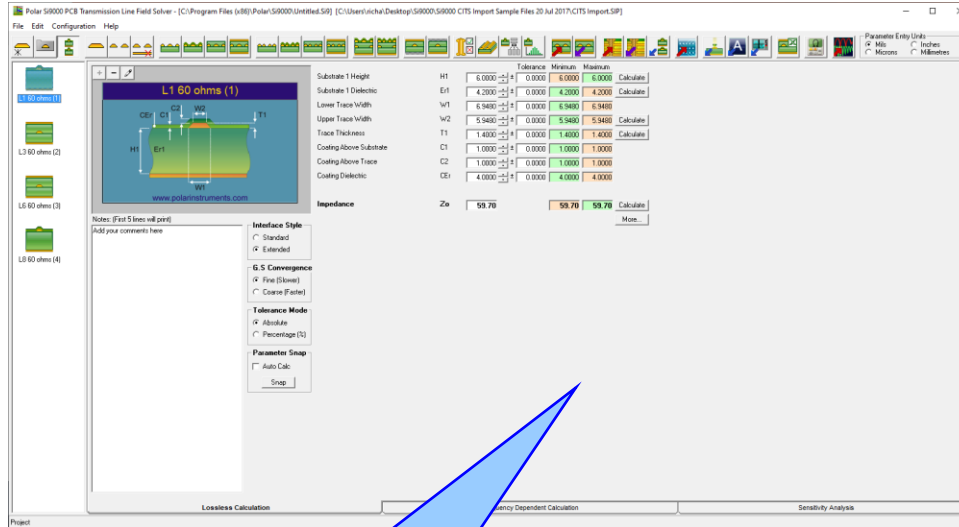
Attenuation with Roughness
www.polarinstruments.com

Other enhancements

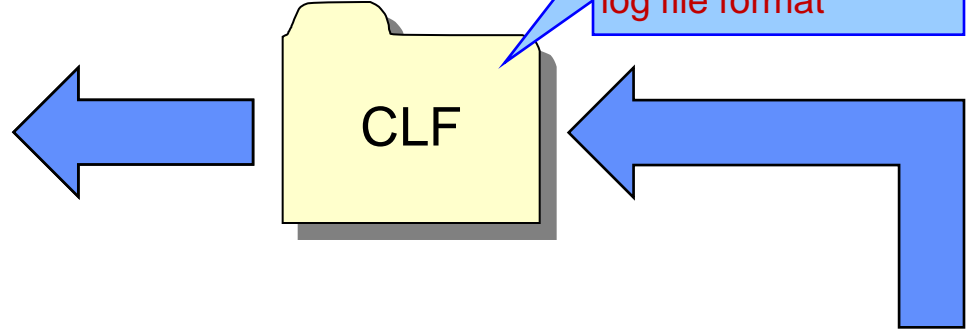
- FlexNet Publisher / FLEXIm v11.19.0.0 supported

v22.09.01 (September 2022)

Enhancements to the Import Polar CITS Datalog File option

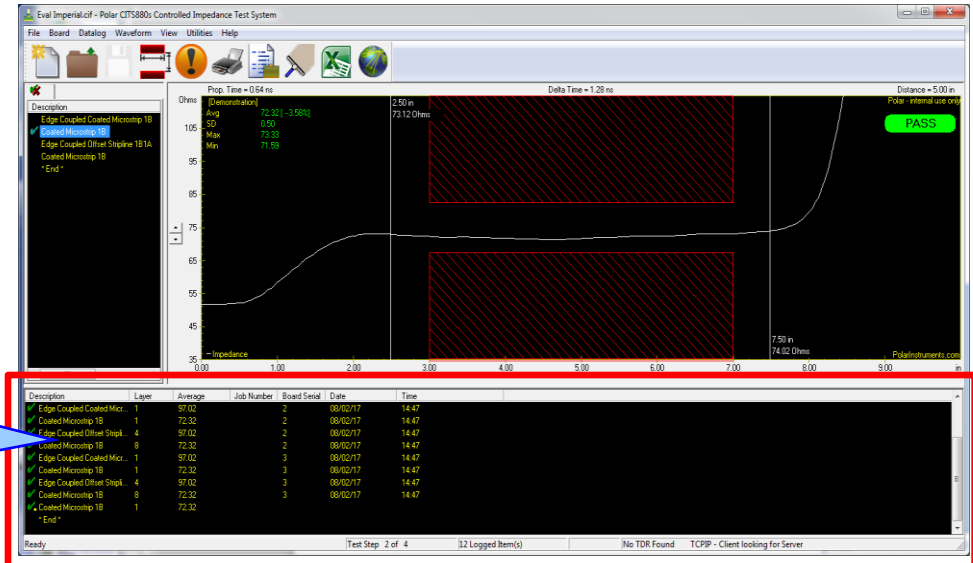


New for v22.09.01
Now supports the latest CITS880s data log file format



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

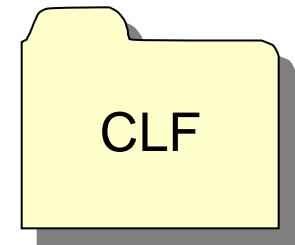
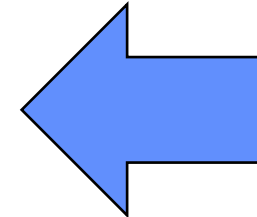
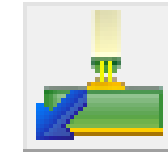
ansmission Line Field Solver - [C:\Program Files (x86)\Polar\Si9000\Untitled.Si9] [C:\Users\richa\Desktop\Si9000\Si9000 CITS Import Sample Files 25 Aug 2022\CITS Import.SIP]

on Help

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

Interface Style
 Standard
 Extended

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



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

Graph Data: The graph shows Impedance - Ohms on the y-axis (ranging from 60 to 64) and Index on the x-axis (ranging from 0 to 25). A green line represents measured data, and a red horizontal line at 60 Ohms represents the nominal impedance. The measured data fluctuates around the nominal value, with peaks reaching approximately 63.5 Ohms and troughs dipping to about 60.5 Ohms.

Import CITS Datalog File option – feature recap

Step 2 : Select Data Log Record

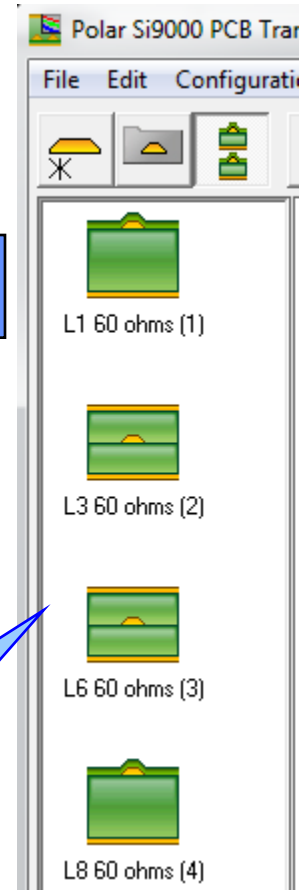
Data Log Records	Description - L01, Layer - 1, Nominal Impedance - 60.00
Project Structure	Description - L01, Layer - 1, Nominal Impedance - 60.00
Description	Description - L03, Layer - 3, Nominal Impedance - 60.00
Nominal Impedance	60.00 Tol+ % 10.00 Tol- % 10.00

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

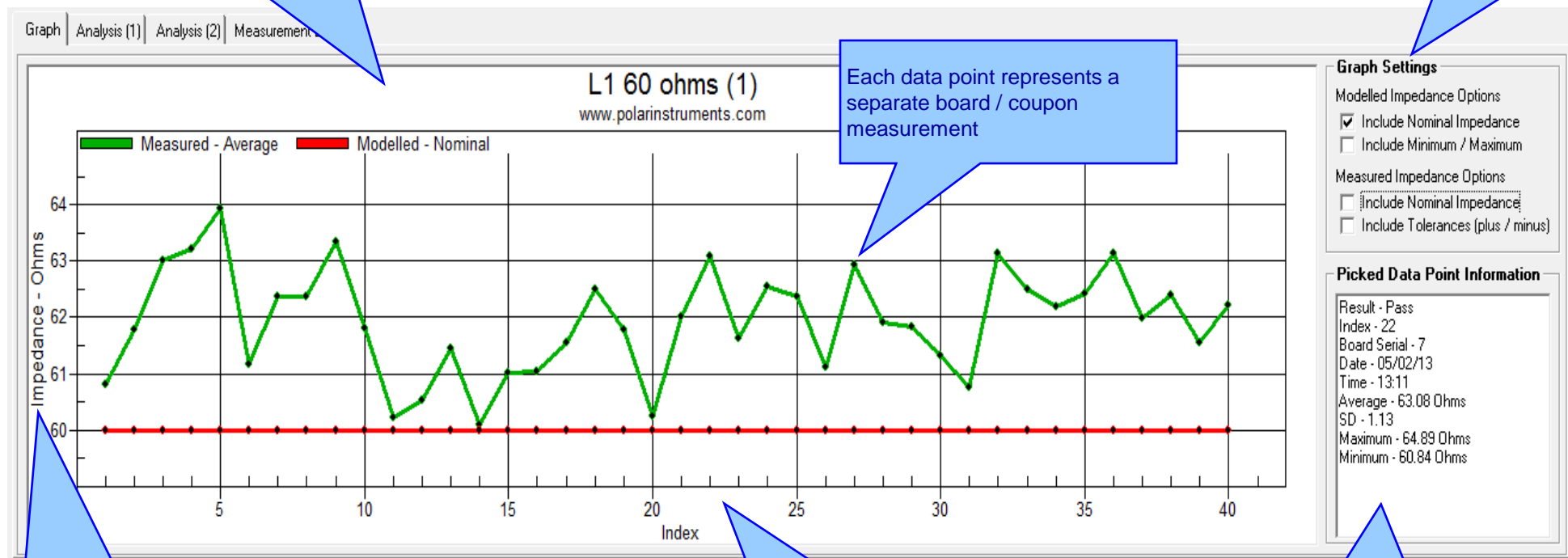


Four structures loaded into the Project group

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

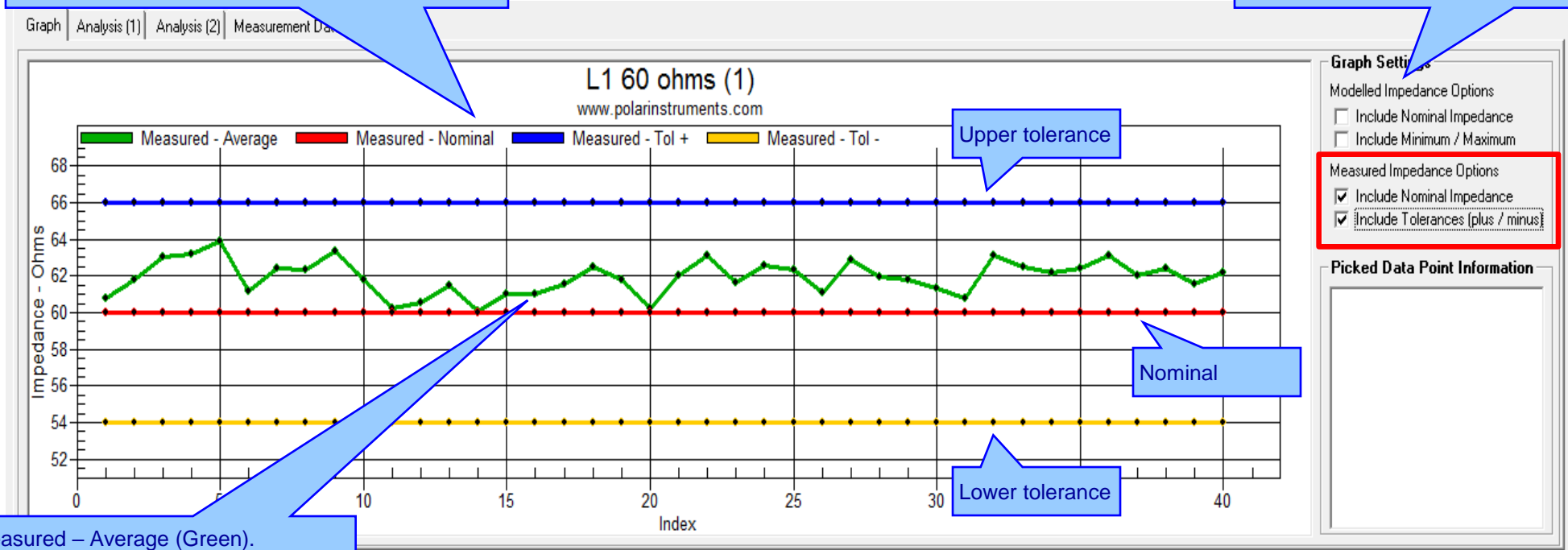
The x-axis is the identifying Index of the board / coupon read from the data log file

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

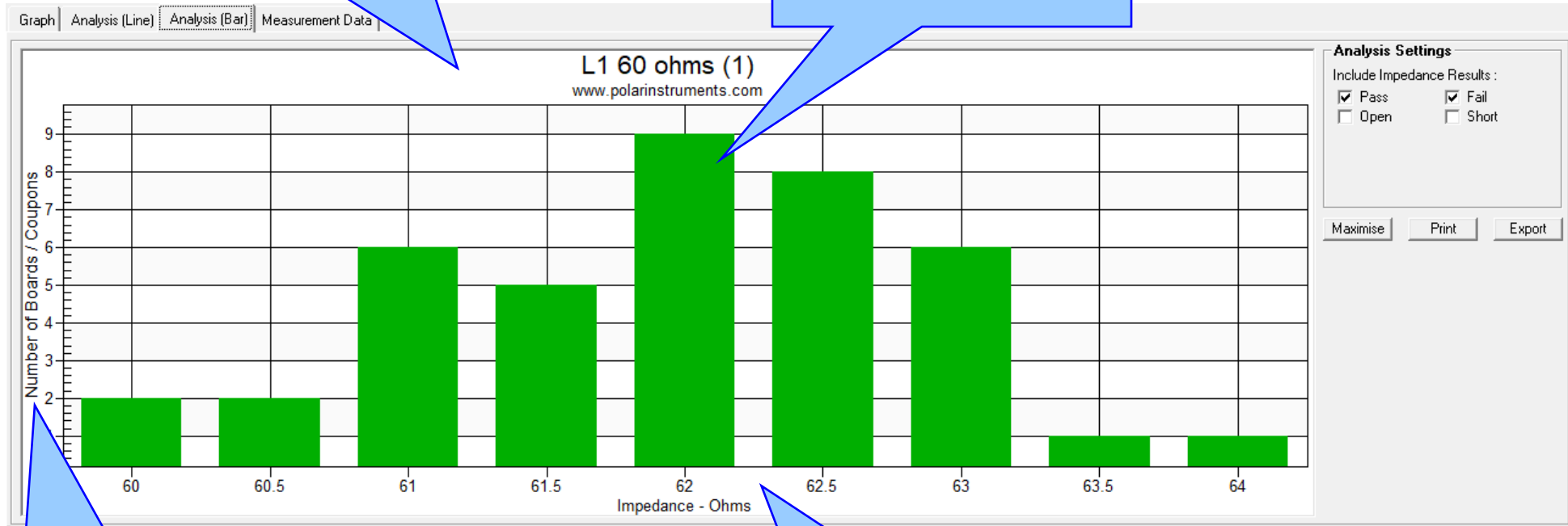


Measured – Average (Green). Whilst reading slightly higher than the Nominal (60 ohms) all measured data points are within the upper and lower tolerance bands

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 screenshot displays the Polar Si9000 PCB Transmission Line Field Solver interface. The central window shows a 3D model of an 'Edge-Coupled Offset Stripline 1B2A' with parameters like Length of Line (LL), Trace Conductivity (TC), and Loss Tangent (TanD). Below the model is a plot titled 'Edge-Coupled Offset Stripline 1B2A Differential' showing 'Attenuation - dB/line' on the Y-axis (ranging from 0 to -1.8) versus 'Frequency - MHz' on the X-axis (ranging from 0 to 40,000). The plot includes several data series: Smooth Conductor Loss (red), Dielectric Loss (green), Smooth Attenuation (blue), Conductor Loss with Roughness (yellow), Attenuation with Roughness (cyan), and Measured Attenuation: VNA Delta-4 (brown). A callout box on the right highlights the 'Manually Set Y-Axis' option in the software's settings panel, which is checked and shows Y Min (dB) set to -1.9500 and Y Max (dB) set to 0.0000.

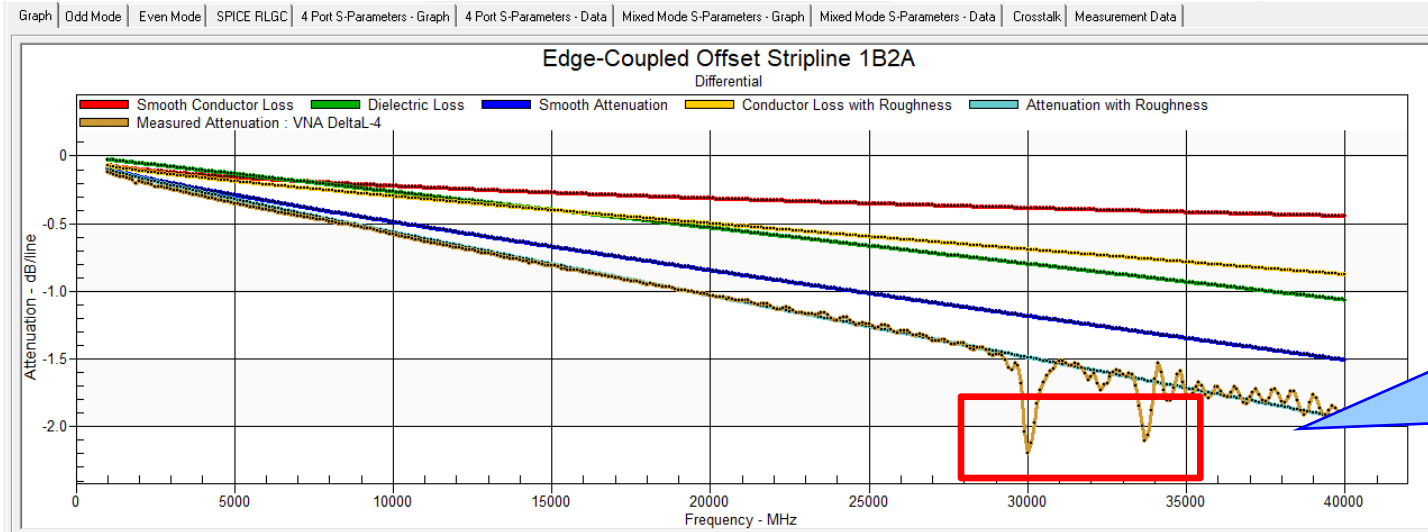
The new 'Manually Set Y-Axis' option provides more control over how the All Losses plot is presented.

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



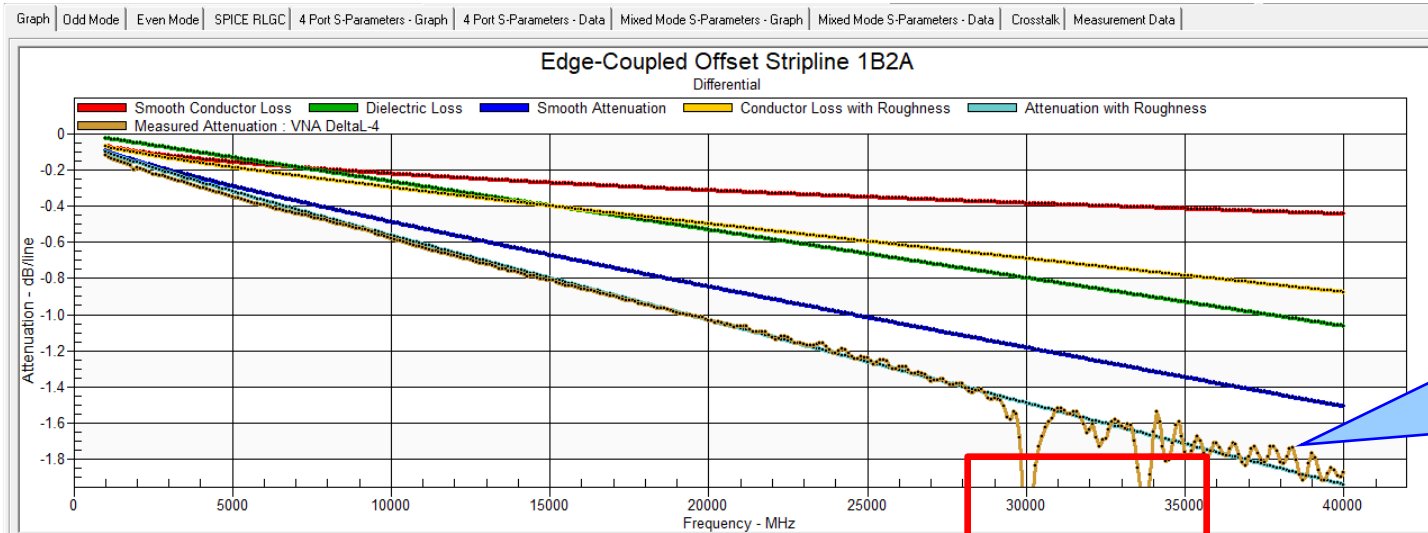
Manually Set Y-Axis

Y Min (dB) Y Max (dB)

-1.9500 0.0000 Refresh

'Manually Set Y-Axis' unchecked, the Y-axis will auto-scale.

Notice the plot will scale the Y-axis to include all the measurement data including the measurement error artefacts



Manually Set Y-Axis

Y Min (dB) Y Max (dB)

-1.9500 0.0000 Refresh

'Manually Set Y-Axis' is checked, the Y Min is set to -1.95 dB

Notice the plot will fix the Y-axis min / max to the values specified, the measurement error artefacts will be ignored.

Enhancements to the Import Touchstone Format option



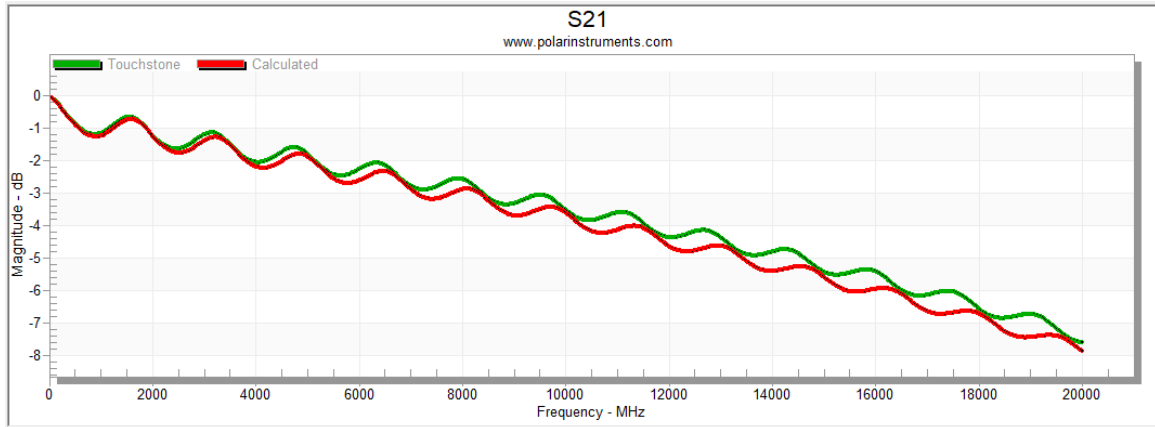
Touchstone files contain S-Parameter data exported from VNA instruments and modelling software, including the Polar Si9000e.

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

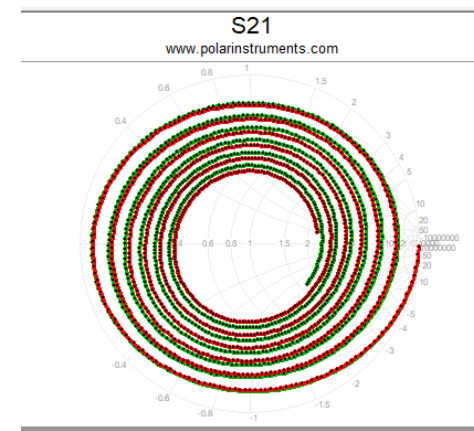
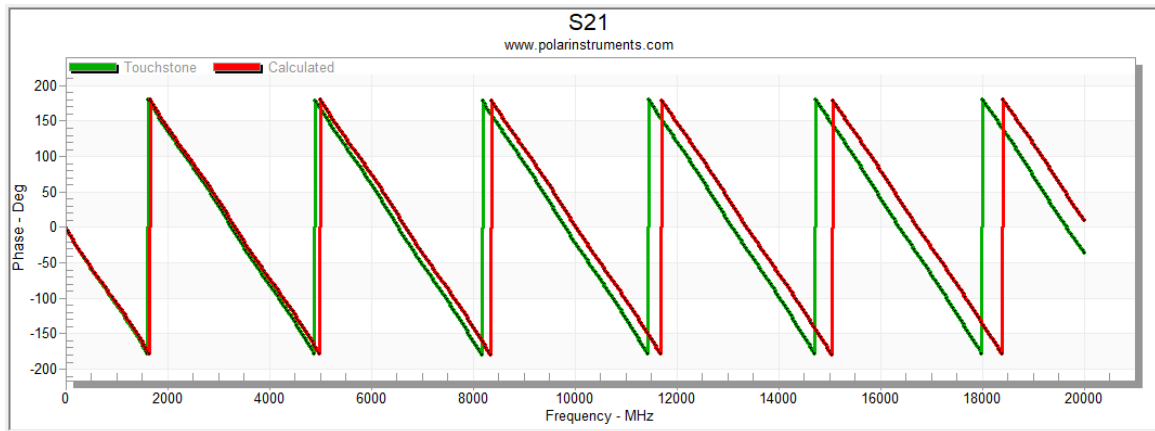
Graphing options exist to display Magnitude, Phase and present S-Parameters as a Smith chart.

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

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



v22.04 (April 2022)

New Differential Via Calculation capability

The screenshot shows the Polar Si9000 PCB Transmission Line Field Solver interface. A red box highlights a new toolbar icon labeled 'Via Checks'. A blue callout box points to this icon with the 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".

The main interface displays a cross-sectional diagram of an "Edge-Coupled Coated Microstrip 1B" with various parameters labeled: $H1$, $Er1$, $C1$, $C2$, $S1$, $W2$, $T1$, $W1$, 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	Tolerance	Minimum	Maximum	Action
H1	8.5000	0.0000	8.5000	Calculate
Er1	4.2000	4.2000	4.2000	Calculate
W1	5.0000	0.0000	5.0000	
W2	4.0000			
S1	2.2810			
T1	1.2000			
C1	1.0000			
C2	1.0000			
C3	1.0000			
CEr	4.2000			

Below the table, the "Zdiff" parameter is set to 95.02.

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

Anti-Pad Style

Horizontal Oval Anti-Pad
 Round / Oblong Anti-Pad

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

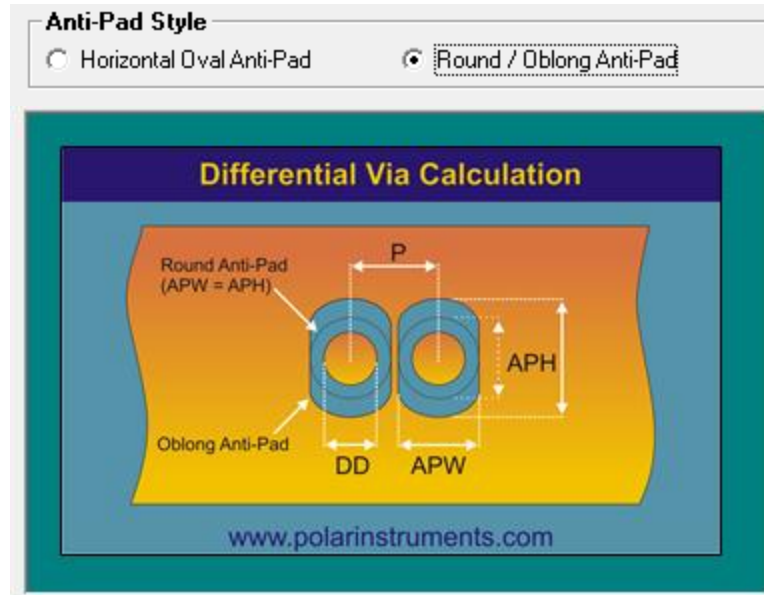
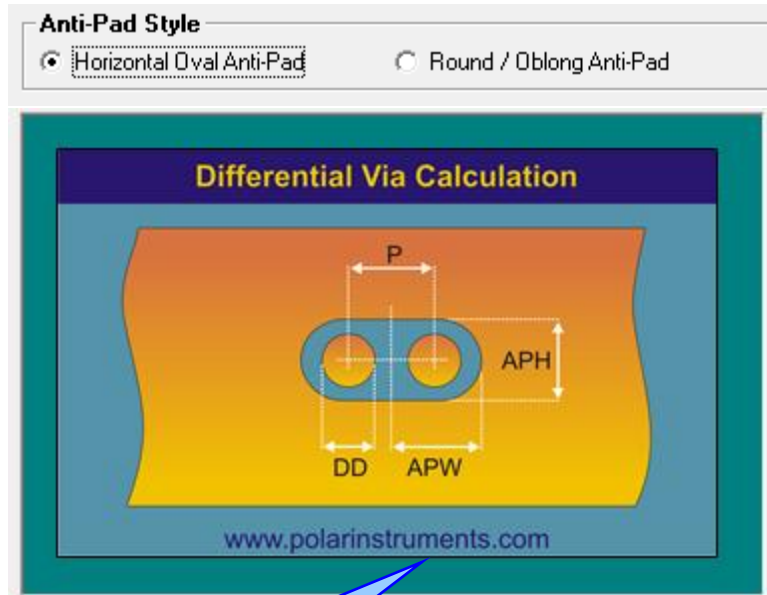
Please refer to the parameters in parentheses when reading [Application Note](#)
 Courtesy of Bert Simonovich, Lamsim Enterprises Inc

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. 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

v22.03 (March 2022)

New Surface Roughness Compensation Preset Values option

The screenshot shows the software interface with the Configuration menu open. The 'Surface Roughness Compensation Preset Values' option is highlighted in red. A dialog box titled 'Surface Roughness Compensation Preset Values Configuration' is displayed, containing a table of 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

Buttons in the dialog include 'Add Entry', 'Delete Entry', 'Edit Entry', 'Apply', and 'Cancel'. A blue callout box points to the dialog with the following text:

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 background dialog is titled "Surface Roughness Compensation - Hammerstad / Groisse". It features a diagram on the left showing a cross-section of a surface with two roughness parameters, R1 and R2, indicated by vertical arrows. The R1 parameter is associated with the bottom surface, and R2 is associated with the top surface. The diagram is labeled "Surface Roughness Compensation" and includes the website "www.polarinstruments.com". To the right of the diagram are input fields for "Surface 1 Roughness R1" (value: 2.2500) and "Surface 2 Roughness R2" (value: 2.3500). Both fields have a red box around them, and the R1 field has a red box around the '<<' button. There are "Apply" and "Cancel" buttons to the right of the input fields.

The foreground dialog is titled "Select Surface Roughness Compensation Preset Values". It contains a table with the following data:

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

There are "Select" and "Cancel" buttons to the right of the table.

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

Ratio of Areas

Effective Ball Radius (μm)

Area of Ball Count (sq μm)

Number of Balls in Area

Enable Cannonball-Huray

Images by courtesy of Circuit Foil Ltd

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.

Matte-Side Roughness

Rz Matte (μm) <<

Smooth Copper Laminate Side

Drum-Side Roughness

Rz Drum (μm) <<

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

v22.02 (February 2022)

Track Resistance Calculator (TRC Plus) enhancements

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

Impedance Zo 50.00 50.00 50.00 Calculate More...

Parameter Entry Units
 Mils Inches
 Microns Millimetres

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

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 'TRC Plus' and 'Si9000'. On the left, a 3D model of a 'Single Ended Coated Microstrip 1B' is shown with dimensions labeled: LL (Length of Line), W1 (Lower Trace Width), W2 (Upper Trace Width), and T1 (Trace Thickness). Below the model are several input fields and sections:

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

On the right, a graph plots 'Resistance Ω ' on the y-axis (0.00 to 2.50) against 'Line Length (Mils)' on the x-axis (0 to 9000). A blue line shows a linear relationship, with a red dot at approximately (8000, 2.23). A 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)'. The graph also includes a 'Show Grid Lines' checkbox (checked), 'Tracking' and 'Dark Mode' checkboxes (unchecked), and a 'TDR View' section with 'On' selected and an 'Adjust Y Scale' control.

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) 50

Resistivity (Ohm Metres) 1.724E-08 Ω 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 Ω

Single Trace 2.2323

Dual Trace

Voltage Drop (Single Trace)

Current (Amps) 1

VD (Volts) 2.232285

Track Dimensions

Lower Trace Width W1 3.9752

Upper Trace Width W2 2.9752

Trace Thickness T1 0.7000

Length of Line LL 8000.0000

TDR indicative Ω

Ohms per division : 1

Line Length (Mils)

TDR View

On

Adjust Y Scale

Close

TDR View provides an indicative impression of the effect of the distributed resistance in a PCB transmission line when tested on a TDR based test system, for example the Polar CITS880s.

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
Substrate 1 Dielectric	Er1	± 0.0000	4.2000	4.2000	Calculate
Lower Trace Width	W1	± 0.0000	7.0000	7.0000	
Upper Trace Width	W2	± 0.0000	6.0000	6.0000	Calculate
Trace Thickness	T1	± 0.0000	1.2000	1.2000	Calculate
Coating Above Substrate	C1	± 0.0000	1.0000	1.0000	
Coating Above Trace	C2	± 0.0000	1.0000	1.0000	
Coating Dielectric	CEr	± 0.0000	4.2000	4.2000	
Impedance	Zo		0.00	0.00	Calculate
					More...

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 Dif

Selected Structure Information

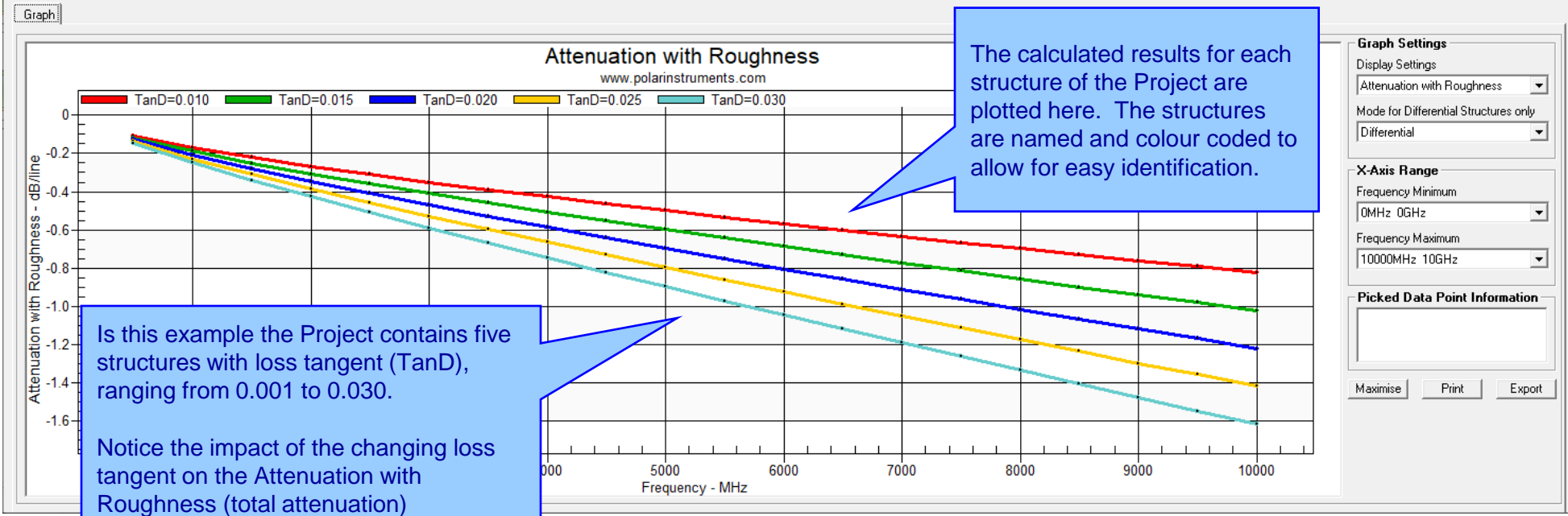
Structure Type : Coated Microstrip 1B

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

Db-Click 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
 Differential

X-Axis Range
 Frequency Minimum: 0MHz 0GHz
 Frequency Maximum: 50000MHz 50GHz

Picked Data Point Information

Graph

Conductor Loss with Roughness

www.polarinstruments.com

Is this example the Project contains five structures with copper surface roughness ranging from 0.5 μm to 2.5 μm .

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

Dbf-Click grid row to toggle Selected status.

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

Selected Structure Information

3/2.5/2.378

www.polarinstruments.com

```

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

■ 3/2.5/2.378 ■ 3.5/3/2.7551 ■ 4/3.5/3.1783 ■ 4.5/4/3.6647 ■ 5/4.5/4.2267 ■ 5.5/5/4.9095 ■ 6/5.5/5.7615 ■ 6.5/6/6.8491
■ 7/6.5/8.3718 ■ 7.5/7/10.7646

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

The screenshot displays the Polar Si9000 PCB Transmission Line Field Solver interface. The main window shows a cross-sectional diagram of a "Coated Microstrip 1B" structure with parameters labeled: C_{Er} , C_1 , C_2 , W_2 , T_1 , H_1 , E_{r1} , and W_1 . The diagram includes the website www.polarinstruments.com.

Two control panels are visible:

- Impedance vs Changing Parameter(s):**
 - Parameter: H1
 - Range Start Value: 3.0000
 - Range Finish Value: 12.0000
 - Increment: 1.0000
- Constant Impedance vs Changing Parameters:**
 - Parameter: W1
 - Target Impedance: 50.0000
 - Process Window: Minimum / Maximum: 67.5000 / 82.5000

A blue callout box on the right states: "In this Sensitivity Analysis example, as the Substrate Height (H1) sweeps from 3 to 12 mils, Trace Width (W1) is calculated to achieve a Target Impedance of 50 ohms".

The main graph area shows a plot titled "Coated Microstrip 1B - 50 Ohms" with the following axes:

- X-axis: H1 - Mils (ranging from 3 to 12)
- Y-axis: W1 (ranging from 4 to 22)

A red line represents the calculated trace width (W1) for each substrate height (H1) to maintain a 50 Ohm impedance. A blue callout box on the graph states: "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." The graph also includes the website www.polarinstruments.com.

On the right side of the graph, there is a "Graph Settings" panel with "2D" selected and a "Target Impedance" of 50.0000. Below it, the "Picked Data Point Information" shows:

- H1 (Mils): 5.000
- W1: 8.436

Buttons for "Maximise", "Print", and "Export" are located at the bottom of the graph area.

The bottom of the interface shows a navigation bar with tabs: "Lossless Calculation", "Frequency Dependent Calculation", "Sensitivity Analysis" (which is currently selected), and "Via Checks".

Populate a Project from Sensitivity Analysis Results

Coated Microstrip 1B

Parameter: H1 None Calculate
 Range Start Value: 3.0000 4.0000
 Range End Value: 12.0000
 Range First Value: 1.0000 1.0000

Changing Parameters: w1 Calculate
 Minimum: 67.5000 82.5000

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	Action
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
Impedance Zo		49.99	49.99	Calculate

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

Project Tree Item: H1=5.0000 W1=8.4360 Zo=49.99

Project Graphing

Project Structure List

#	Structure	Name	Selected	Colour
0		H1=3.0000 W1=4.7096 Zo=50.01	Yes	Red
1		H1=4.0000 W1=6.5638 Zo=49.99	Yes	Green
2		H1=5.0000 W1=8.4360 Zo=49.99	Yes	Blue
3		H1=6.0000 W1=10.3381 Zo=49.99	Yes	Yellow
4		H1=7.0000 W1=12.2522 Zo=50.00	Yes	Cyan

DbI-Click grid row to toggle Selected status.

Selected Structure Information

H1=3.0000 W1=4.7096 Zo=50.01

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Structure Type : Coated Microstrip 1B

H1	3.0000
Er1	4.2000
W1	4.7094
W2	3.7094
T1	1.2000
C1	1.0000
C2	1.0000
CEr	4.2000
Zo	50.01
LL	1000.00
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 : Hammerstad

Graph

Attenuation with Roughness

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■ H1=3.0000 W1=4.7096 Zo=50.01
 ■ H1=4.0000 W1=6.5638 Zo=49.99
 ■ H1=5.0000 W1=8.4360 Zo=49.99
 ■ H1=6.0000 W1=10.3381 Zo=49.99
■ H1=7.0000 W1=12.2522 Zo=50.00
 ■ H1=8.0000 W1=14.1663 Zo=50.00
 ■ H1=9.0000 W1=16.0923 Zo=50.01
 ■ H1=10.0000 W1=18.0303 Zo=50.00
■ H1=11.0000 W1=19.9567 Zo=49.99
 ■ H1=12.0000 W1=21.8823 Zo=50.01

Graph Settings

Display Settings

Mode for Differential Structures only

X-Axis Range

Frequency Minimum

Frequency Maximum

Picked Data Point Information

Once the structures have been automatically created from sensitivity analysis they can also be examined using the Project Graphing.

Notice that whilst all structures are 50 ohms, the structures with narrower trace widths are significantly more lossy than those with wider trace widths.

Populate a Project from Sensitivity Analysis Results

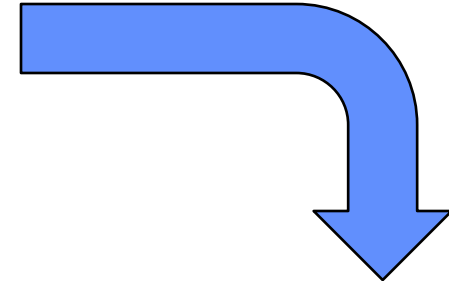
Substrate 1 Height H1 5.0000
Substrate 1 Dielectric Er1 4.2000
Lower Trace Width W1 8.4360
Upper Trace Width W2 7.4360
Trace Thickness T1 1.2000
Coating Above Substrate C1 1.0000
Coating Above Trace C2 1.0000
Coating Dielectric CEr 4.2000
Impedance Zo 49.99

Interface Style
 Standard
 Extended

G.S Convergence
 Fine (Slower)
 Coarse (Faster)

Tolerance Mode
 Absolute
 Percentage (%)

Parameter Snap
 Auto Calc
Snap



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" showing Attenuation (dB/line) vs Frequency (MHz). 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 Delta-L4. The graph shows a general downward trend in attenuation as frequency increases, with a notable dip around 30,000 MHz. The interface also features a parameter table on the right with fields for Length of Line (LL), Trace Conductivity (TC), Loss Tangent (TanD), Rise Time (Tr), Frequency Minimum (FMin), Frequency Maximum (FMax), and Frequency Steps (FSteps). The "Surface Roughness Compensation" section is expanded, showing options for Smooth, Hammerstad, Groisse, and Huray, with "GoalSeek" highlighted in a red box. The "Graph Settings" panel on the right shows "All Losses" selected for the display series, and "Differential" for the mode. The "Picked Data Point Information" panel shows a frequency of 25,000.000 MHz and a measured attenuation of -1.240 dB.

Surface Roughness Goal Seek option

Surface Roughness Goal Seek
✕

Step 1 : Enter Total Attenuation from measurement

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

Close

Step 2 : Calculate Dielectric and Conductor Loss

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

Step 3 : Calculate Surface Roughness

Cannonball-Huray Rz (μm)	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 (μm)	0.1000	17.4831	0.0030

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 μm 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
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Attenuation - dB/line vs Frequency - MHz

Material	Resistivity (Ohm Metres)	Conductivity (Siemens / m)	Temp. Coefficient (/ °C)	Reference Temp. (°C)	Operating Temp. (°C)
-- From Si9000 --	1.724E-08 Ωm	5.80E+07 S/m	TCR 0.00386	20	20

Track Dimensions

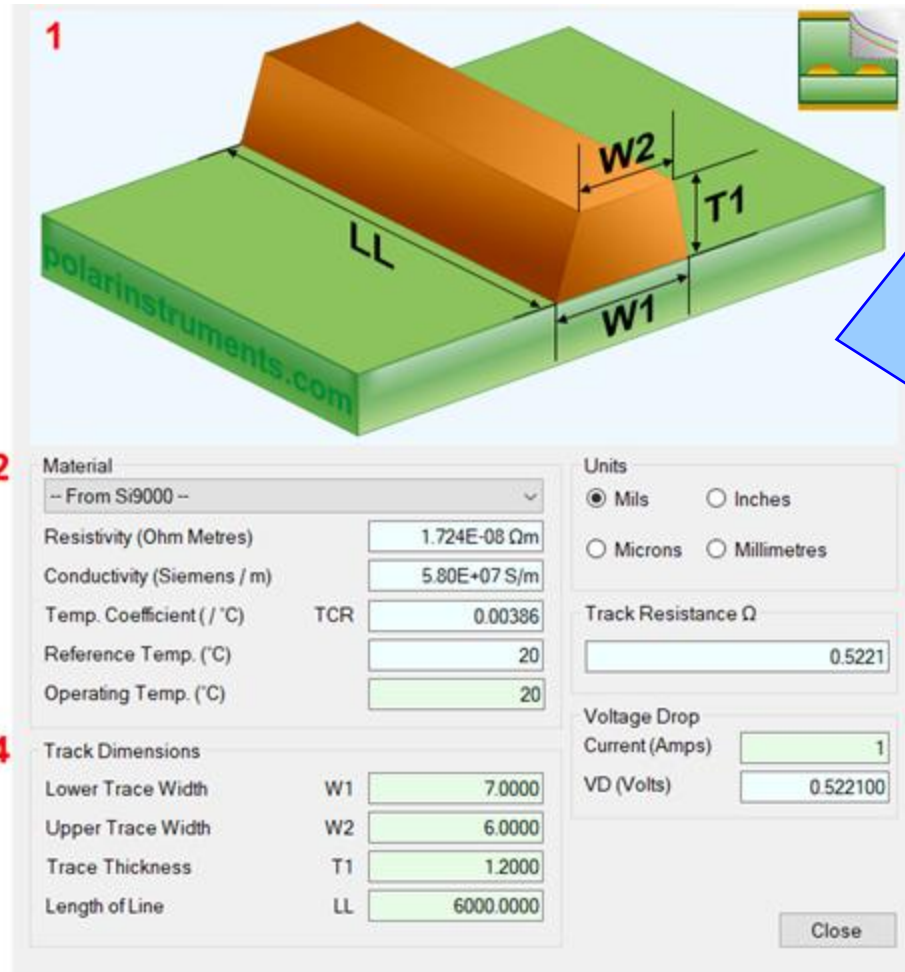
Lower Trace Width	W1	7.0000
Upper Trace Width	W2	6.0000
Trace Thickness	T1	1.2000
Length of Line	LL	1000.0000

Track Resistance Ω: 0.0870

Voltage Drop Current (Amps): 1

VD (Volts): 0.087000

Track Resistance Calculator (TRC Plus)



1 Interactive track material image.

2 Material selection and properties.

3 Units.

4 Track or trace dimensions.

5 Resistance result.

6 Voltage Drop calculation result.

Field	Value
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
Units	<input checked="" type="radio"/> Mils <input type="radio"/> Inches
	<input type="radio"/> Microns <input type="radio"/> Millimetres
Track Resistance Ω	0.5221
Voltage Drop	
Current (Amps)	1
VD (Volts)	0.522100
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

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

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
Impedance	Zo	49.99	49.99	49.99		

Settings
 Iterations:

Uniform Distribution (Tol/Min/Max)
 Normal Distribution (Mean/Std Dev)

Graph | Iterations / Results

Coated Microstrip 1B - Monte Carlo Analysis

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Results Summary

Impedance - Zo

Nominal:

Minimum (worst case):

Maximum (worst case):

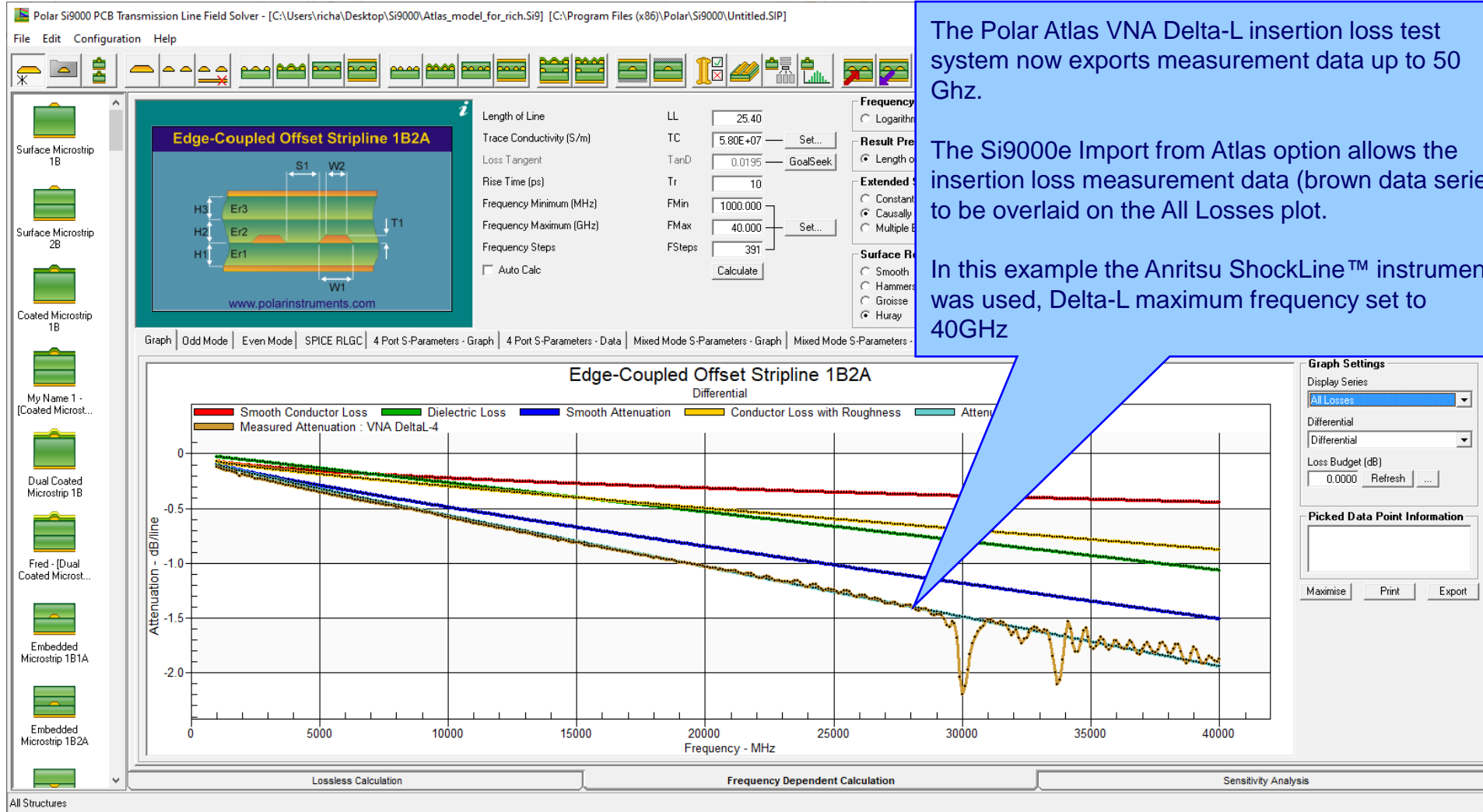
Monte Carlo Analysis

Mean:

Standard Deviation:

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

Import from Atlas enhanced to support measurement data to 50GHz



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	0.5000
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

	Nominal	Tol (Abs)	Minimum	Maximum	Mean	Std Dev
2nd Coating Between Traces	CS3	1.0000 ± 0.0000	1.0000	1.0000	1.0000	0.0000
2nd Coating Dielectric	CSEr	4.2000 ± 0.0000	4.2000	4.2000	4.2000	0.0000

Differential Impedance

Zdiff: 99.99

Settings: Iterations: 500, Normal Distribution (Mean/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

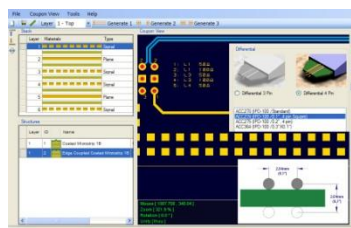
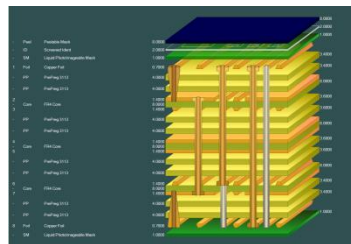
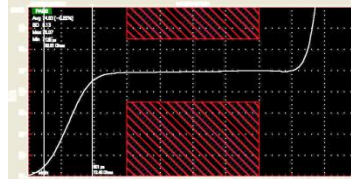
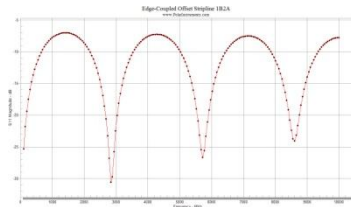
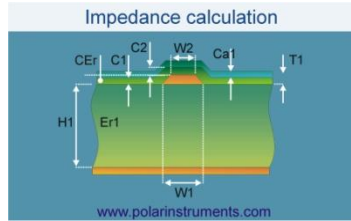
Monte Carlo Analysis

Mean: 99.94

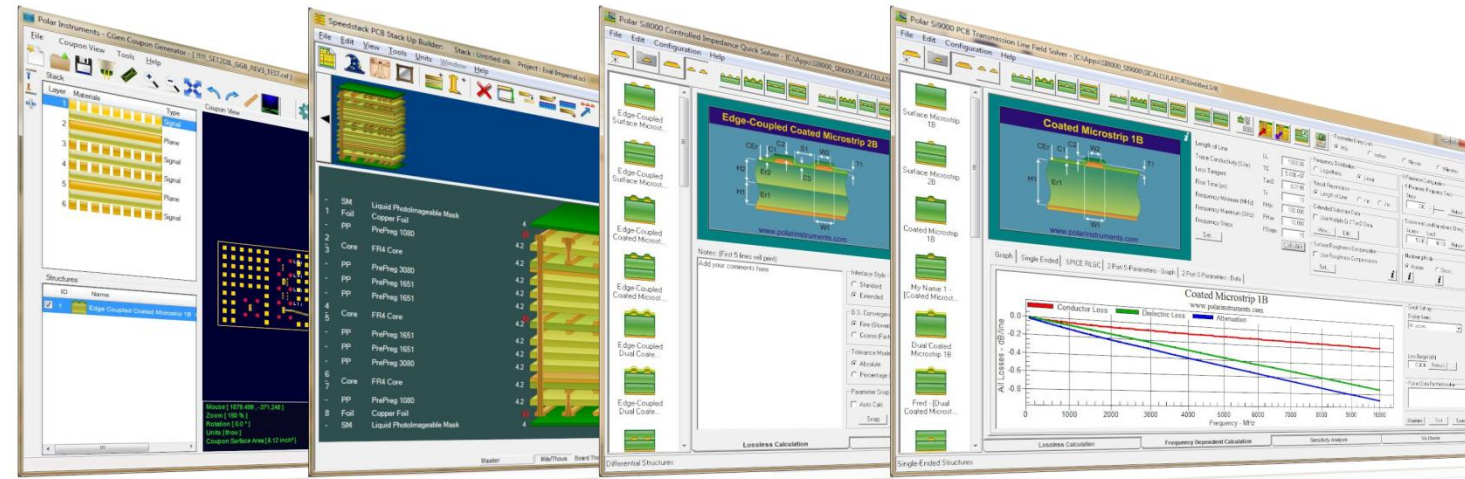
Standard Deviation: 1.11

Other enhancements

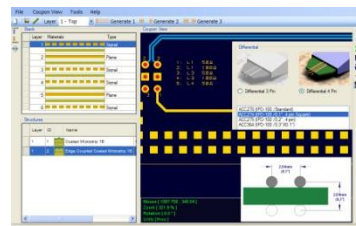
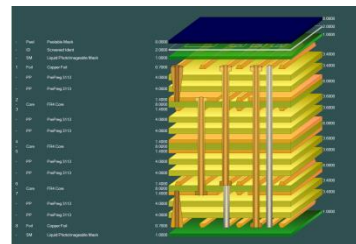
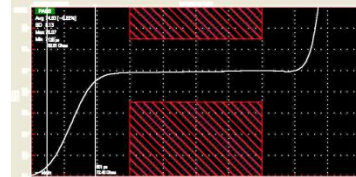
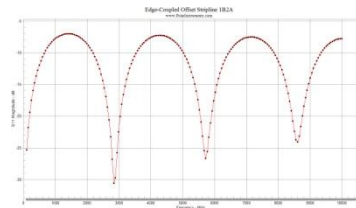
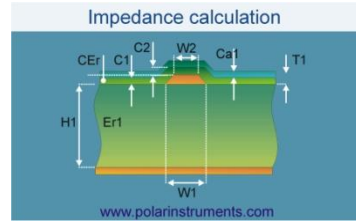
- FlexNet Publisher / FLEXIm v11.17.2.0 supported



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