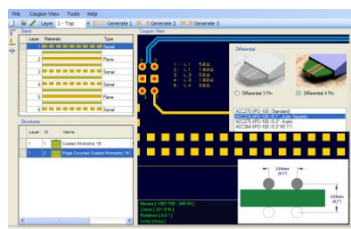
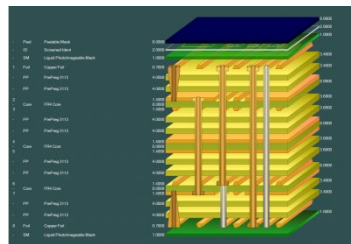
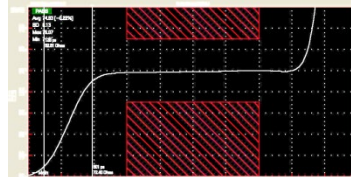
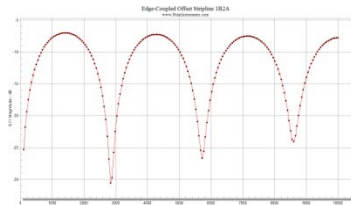
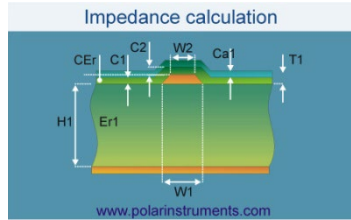


Si9000e 2021 - 2022 Preview

Richard Attrill – May 2022 (Rev 2)



Introducing the latest features of Si9000e

Welcome to a preview of Si9000e.

Since January 2021 we have released six versions of Si9000e, each introducing a number of new features that have been requested through our Polarcare software maintenance service. A slide containing the version number and release date precedes information detailing the new features contained in each release.

If you would like to have a web-based demonstration please contact your local Polar office, details are shown on the last slide of this presentation

Please note: the Si9000e units have been set to Mils in the following screen grabs

Si9000e v22.04 (April 2022)

New Differential Via Calculation capability

Parameter Entry Units
 Mils Inches
 Microns Millimetres

Parameter	Value	Tolerance	Minimum	Maximum	Action
Substrate 1 Height	H1	8.5000	0.0000	8.5000	Calculate
Substrate 1 Dielectric	Er1	4.2000	4.2000	4.2000	Calculate
Lower Trace Width	W1	5.0000	0.0000	5.0000	
Upper Trace Width	W2	4.0000			
Trace Separation	S1	2.2810			
Trace Thickness	T1	1.2000			
Coating Above Substrate	C1	1.0000			
Coating Above Trace	C2	1.0000			
Coating Between Traces	C3	1.0000			
Coating Dielectric	CEr	4.2000			
Differential Impedance	Zdiff	85.02			

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

Lossless Calculation | Frequency Dependent Calculation | 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

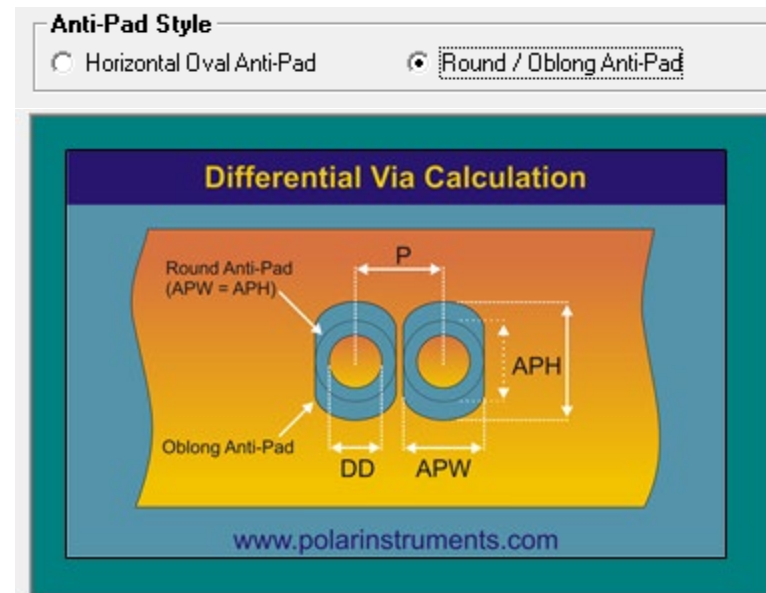
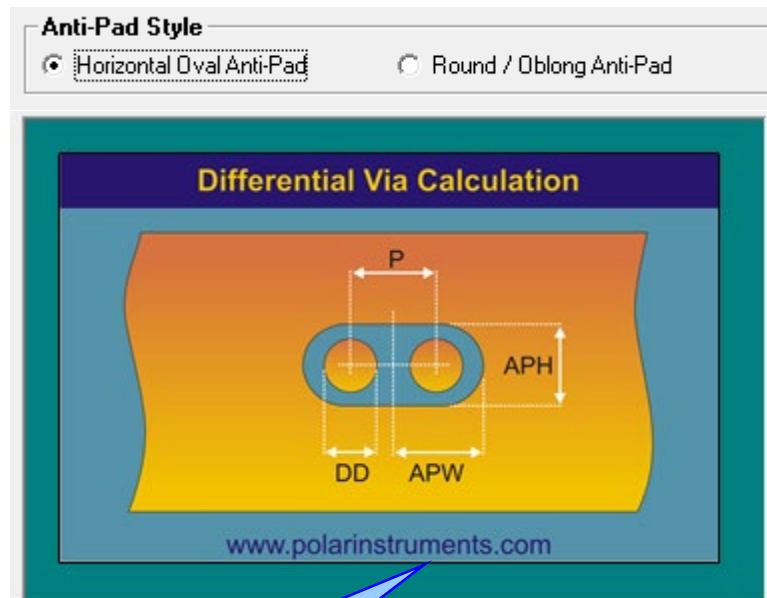
Horizontal Oval Anti-Pad
 Round / Oblong Anti-Pad

Drill Diameter (t)	DD	<input type="text" value="15.0000"/>	
Via Pitch (S)	P	<input type="text" value="35.0000"/>	
Anti-Pad Width (b)	APW	<input type="text" value="50.8000"/>	
Anti-Pad Height (w')	APH	<input type="text" value="50.8000"/>	
Dielectric Constant (Dkz)	Dkz	<input type="text" value="3.6350"/>	
Dielectric Anisotropy (%)		<input type="text" value="0.00"/>	
Odd Mode Impedance (Zvia)	Zodd	<input type="text" value="42.44"/>	
Differential Impedance	Zdiff	<input type="text" value="84.88"/>	
Effective Dielectric Constant	DkEff	<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.

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

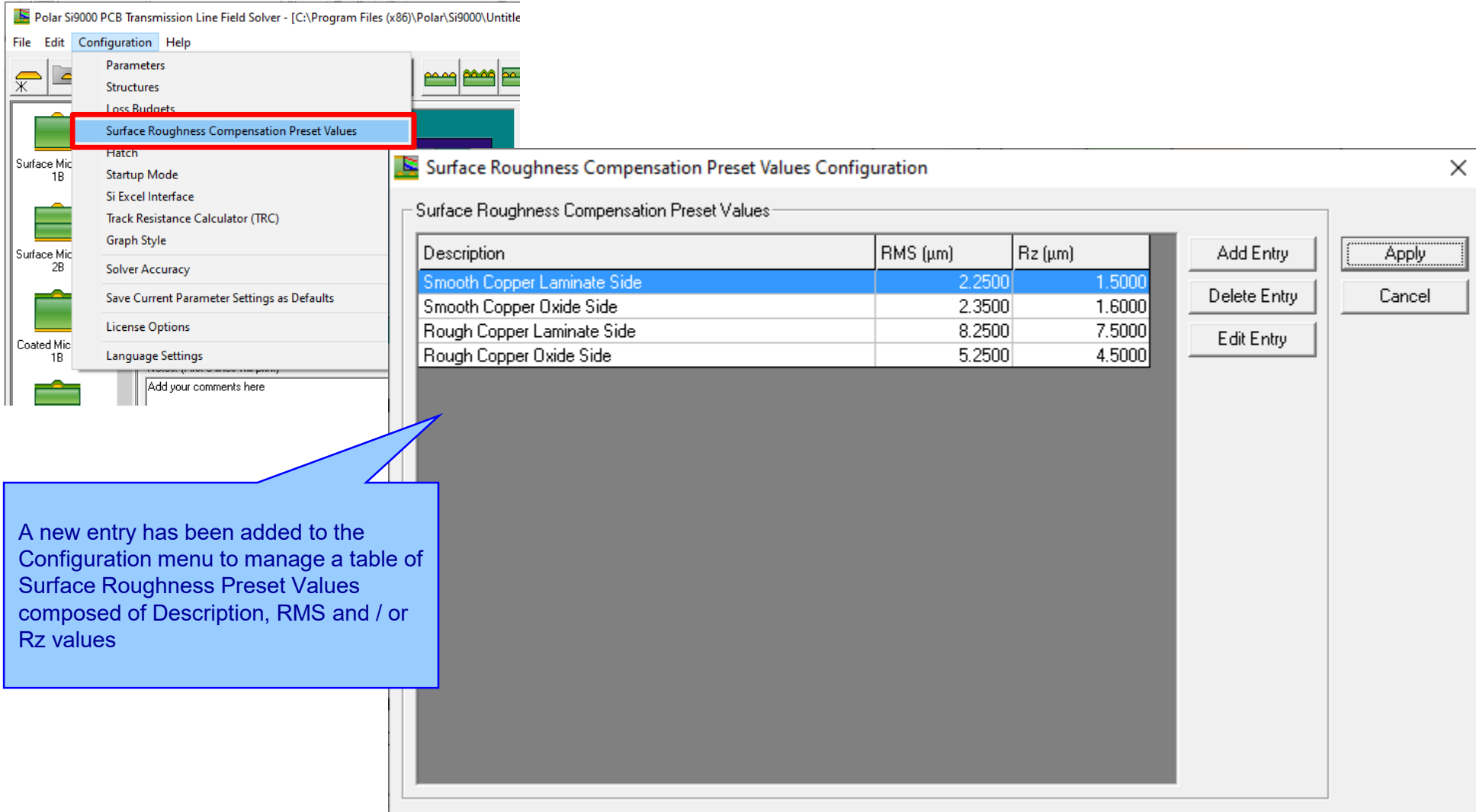
You come up with a concept you think will work, but the backplane is thick with over 30 layers. There are some long traces over 30 inches and some short traces of less than 2 inches between card slots. There is strong pressure to reuse the same connector you used in your last design, but your gut tells 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 feature



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, showing 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: 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 feature

The image shows two overlapping dialog boxes from the Polar Instruments software. The top dialog, titled "Surface Roughness Compensation - Hammerstad / Groisse", contains a diagram of a PCB cross-section with 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, indicating the new preset selection options. The bottom dialog, titled "Select Surface Roughness Compensation Preset Values", displays a table of preset values for R1 and R2.

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

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 feature

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

Enable Cannonball-Huray

Matte-Side Roughness
 Rz Matte (μm)

Smooth Copper Laminate Side

Drum-Side Roughness
 Rz Drum (μm)

Smooth Copper Oxide Side

Images by courtesy of Circuit Foil Ltd

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

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.

Si9000e v22.02 (February 2022)

Track Resistance license option (TRC Plus) enhancement

The screenshot shows the Polar Si9000 PCB Transmission Line Field Solver interface. The main window displays a cross-section of a 'Coated Microstrip 1B' structure with parameters: H1, Er1, W1, W2, T1, C1, C2, and CEr. A table on the right lists these parameters with their values, tolerances, and minimum/maximum values. A red box highlights a toolbar icon, and a callout box explains its function.

Parameter	Value	Tolerance	Minimum	Maximum	Action
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

Callout Box: The optional TRC Plus calculator includes a number of enhancements including new graphing capability. Selecting this toolbar option will pass the current structure dimensions to the TRC Plus in order to calculate the track resistance.

Track Resistance license option (TRC Plus) enhancements

The screenshot displays the TRC Plus software interface. On the left, a 3D model of a microstrip is shown with dimensions labeled: LL (Length of Line), W1 (Lower Trace Width), W2 (Upper Trace Width), and T1 (Trace Thickness). Below the model is a control panel with several sections:

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

On the right, a graph plots Resistance Ω against 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 shows a linear relationship, with a red dot at approximately (8000, 2.23). 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 license option (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

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

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

Show Grid Lines

Tracking

Dark Mode

TDR View

On ?

Adjust Y Scale ▲ ▼

Close

TDR indicative Ω

Ohms per division : 1

Line Length (Mils)

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.

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	
Impedance	Zo		0.00	0.00	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

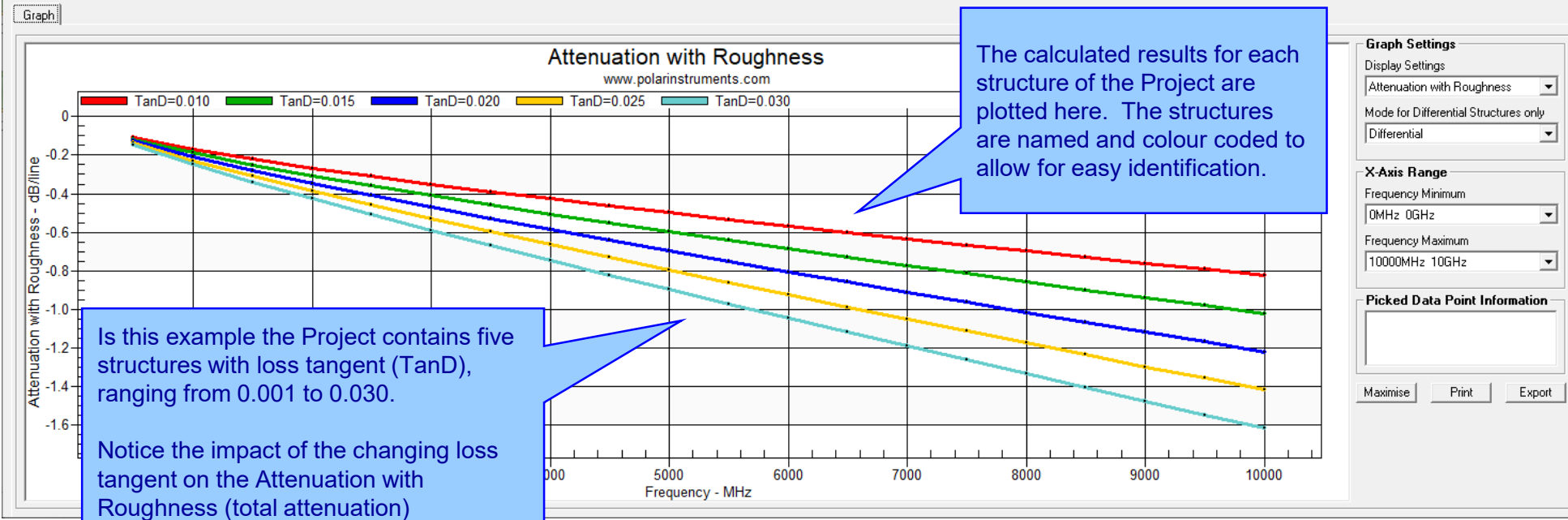
Selected Structure Information

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

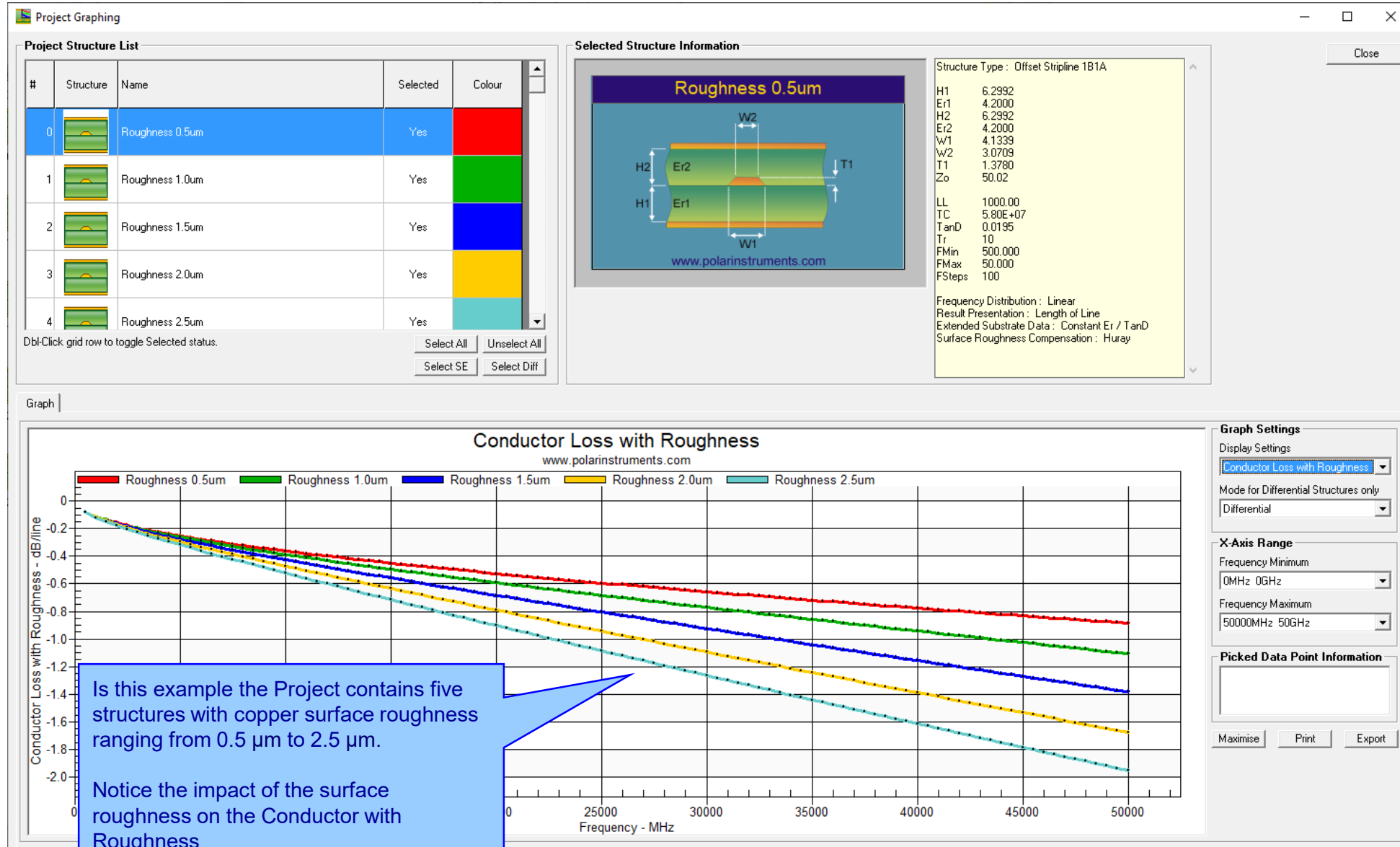
Frequency Distribution : Linear
Result Presentation : Length of Line
Extended Substrate Data : Constant Er / TanD
Surface Roughness Compensation : Hammerstad

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		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.

Select All Unselect All
Select SE Select Diff

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

Close

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

Maximise Print Export

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

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

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 (Mils)
3.0000	4.836
4.0000	6.436
5.0000	8.036
6.0000	9.636
7.0000	11.236
8.0000	12.836
9.0000	14.436
10.0000	16.036
11.0000	17.636
12.0000	19.236

Picked Data Point Information
 H1 (Mils): 5.000
 W1 : 8.436

Populate a Project from Sensitivity Analysis Results

The screenshot shows the Polar Si9000 PCB Transmission Line Field Solver interface. The main window displays a 'Coated Microstrip 1B' diagram with parameters H1, Er1, W1, C1, C2, and CEr. A 'Results' tab is selected, showing a table of calculated results. A right-click context menu is open over the table, with the 'Create Project Structures' option highlighted. A sidebar on the left shows a list of 10 project structures created from the results, each with a unique name based on the H1 and W1 parameters.

Results Table:

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

Project Structures List (Left Sidebar):

- H1=3.0000 W1=4.70...
- H1=4.0000 W1=6.56...
- H1=5.0000 W1=8.43...
- H1=6.0000 W1=10.33...
- H1=7.0000 W1=12.25...
- H1=8.0000 W1=14.16...
- H1=9.0000 W1=16.09...
- H1=10.0000 W1=18.03...

Annotations:

- 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
Impedance Zo		49.99	49.99	Calculate

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

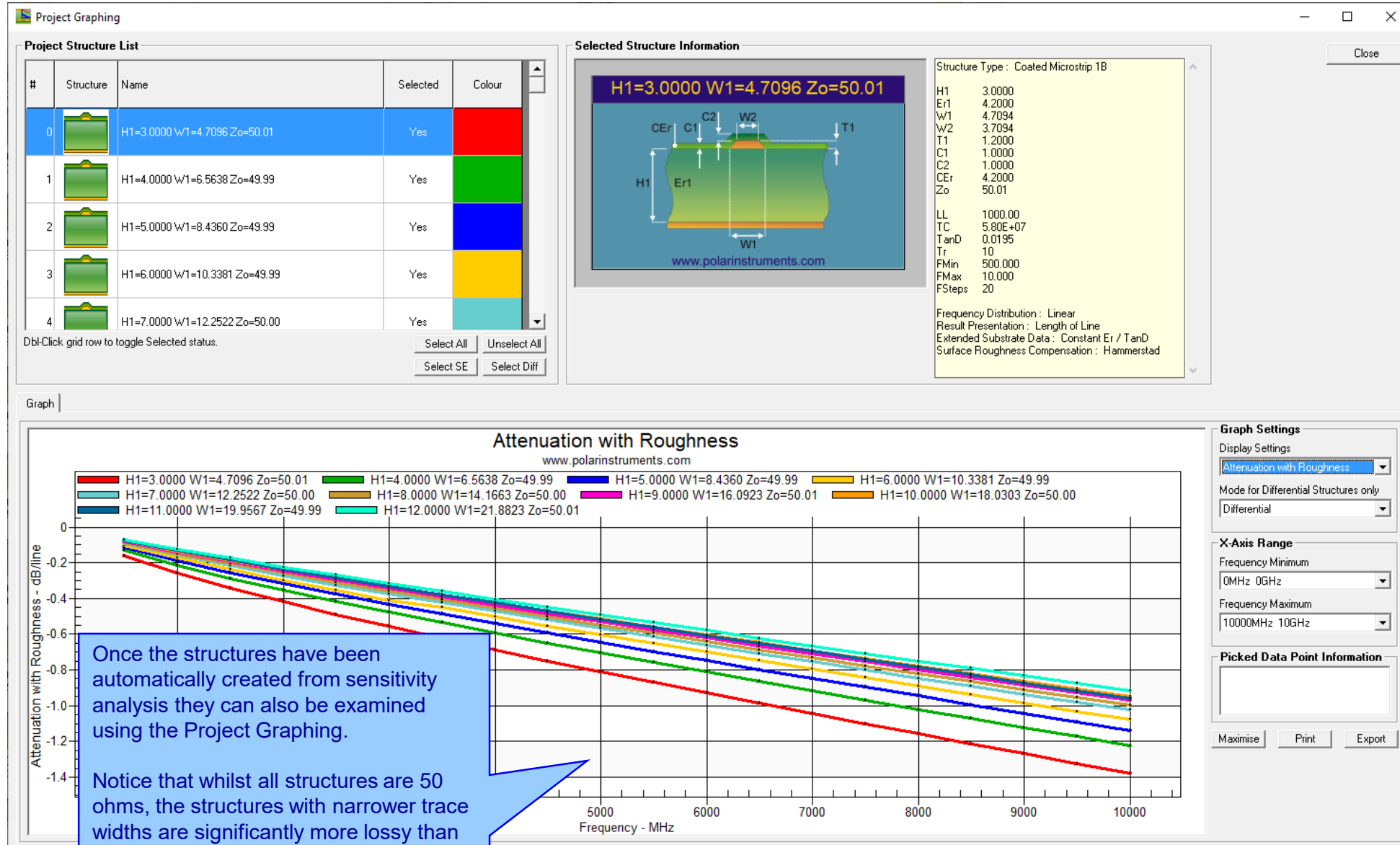
Parameter Entry Units:
 Mils
 Inches
 Microns
 Millimetres

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

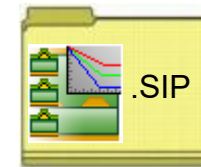
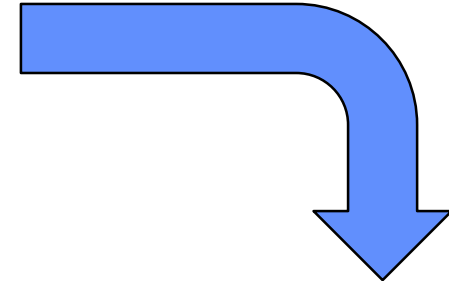
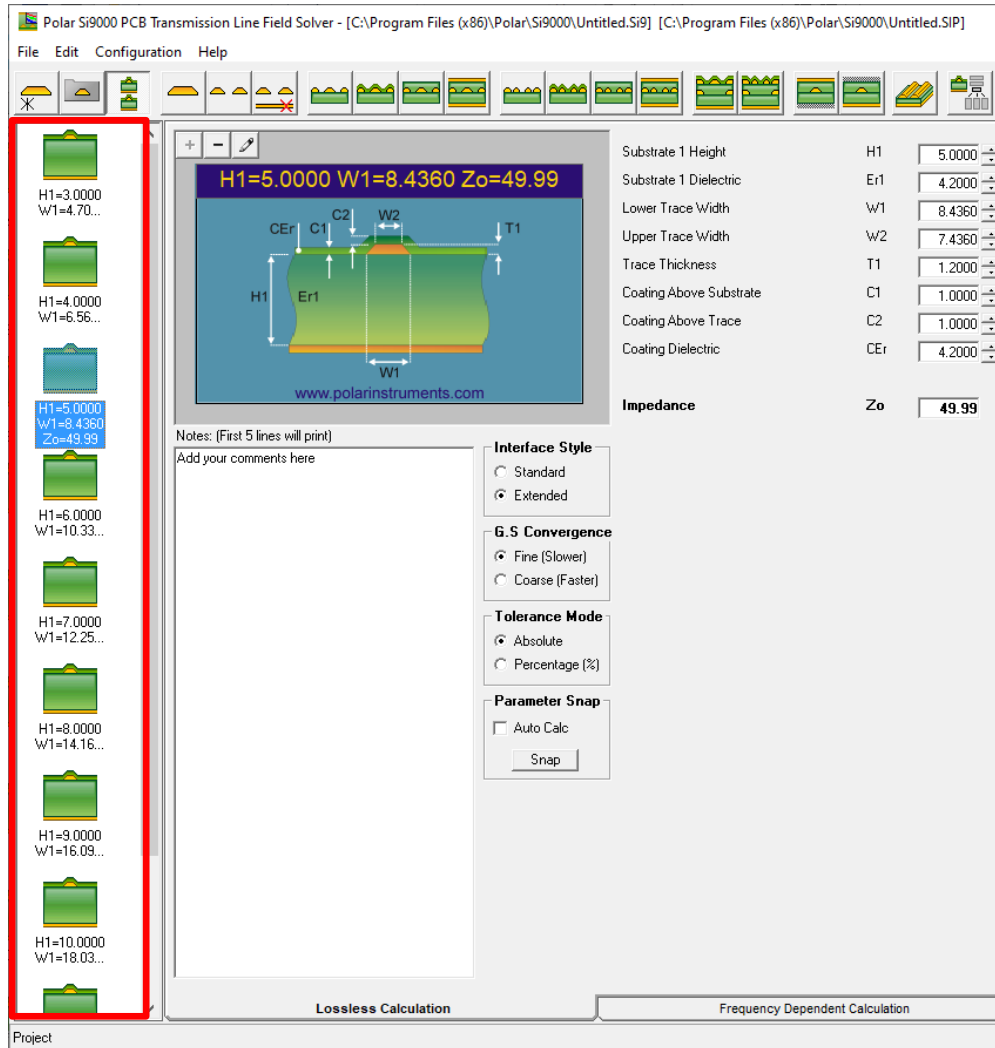
Interface Style
 Standard

Parameter Step
 Auto Calc
 Snap

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



Populate a Project from Sensitivity Analysis Results



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

Populate a Project from Sensitivity Analysis Results - Summary

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

Surface Roughness Goal Seek option

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

Cyan = Modelled Attenuation with Roughness (insertion loss)

Brown = Insertion Loss measurement data from Polar Atlas

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 legend includes: Smooth Conductor Loss (red), Dielectric Loss (green), Smooth Attenuation (blue), Conductor Loss with Roughness (yellow), Attenuation with Roughness (cyan), and Measured Attenuation : VNA DeltaL-4 (brown). The graph shows that the measured attenuation (brown) closely follows the modelled attenuation with roughness (cyan). A sharp dip in the measured data is visible around 30,000 MHz.

On the right side of the interface, the "Surface Roughness Compensation" section is visible, with the "GoalSeek" option selected and highlighted by a red box. Other parameters like "Length of Line" (LL: 1000.00), "Trace Conductivity (S/m)" (TC: 5.80E+07), and "Loss Tangent" (TanD: 0.0195) are also shown.

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 (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

i

Step 1

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

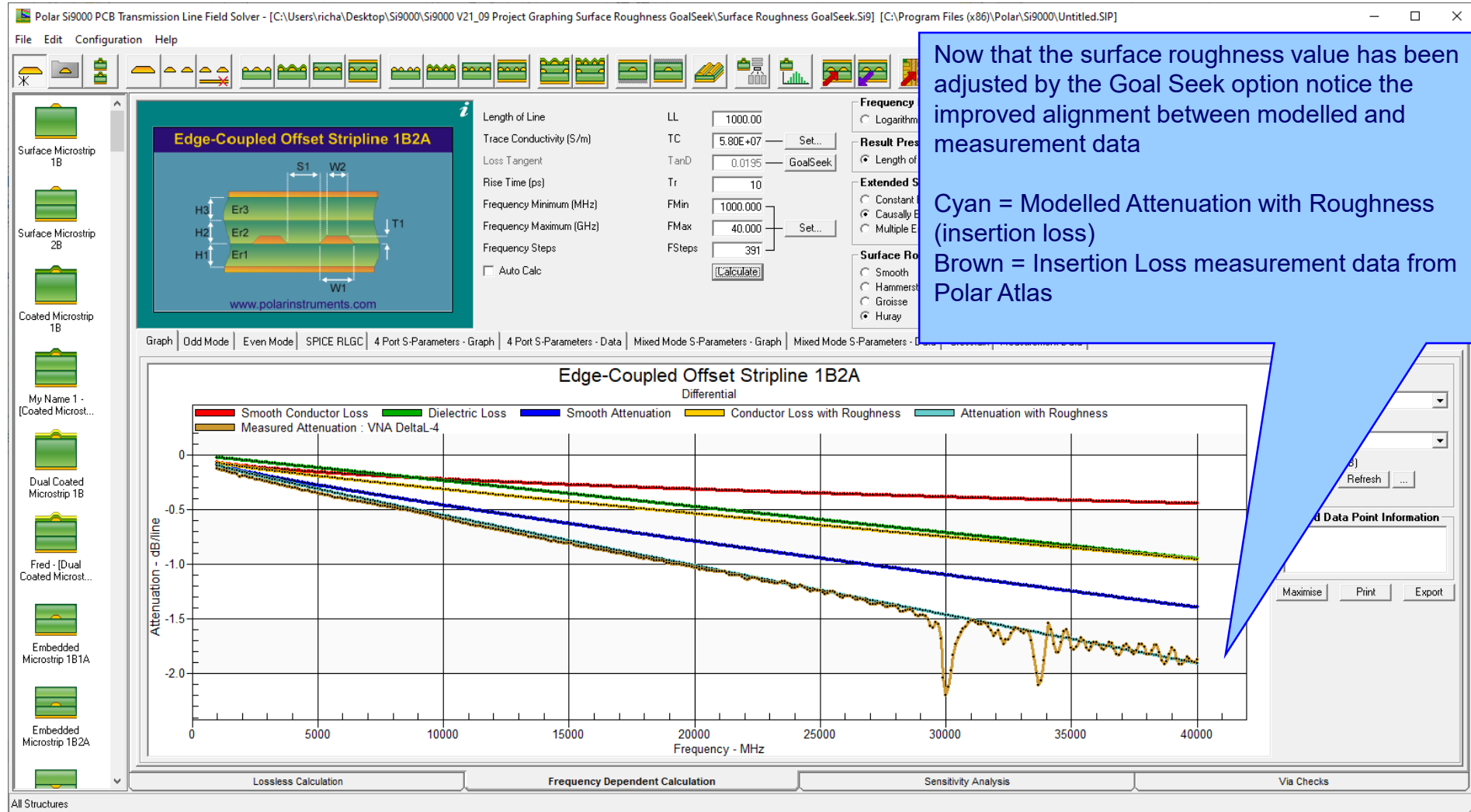
Step 2

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 μm is required

Surface Roughness Goal Seek option



Now that the surface roughness value has been adjusted by the Goal Seek option notice the improved alignment between modelled and measurement data

Cyan = Modelled Attenuation with Roughness (insertion loss)
 Brown = Insertion Loss measurement data from Polar Atlas

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 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

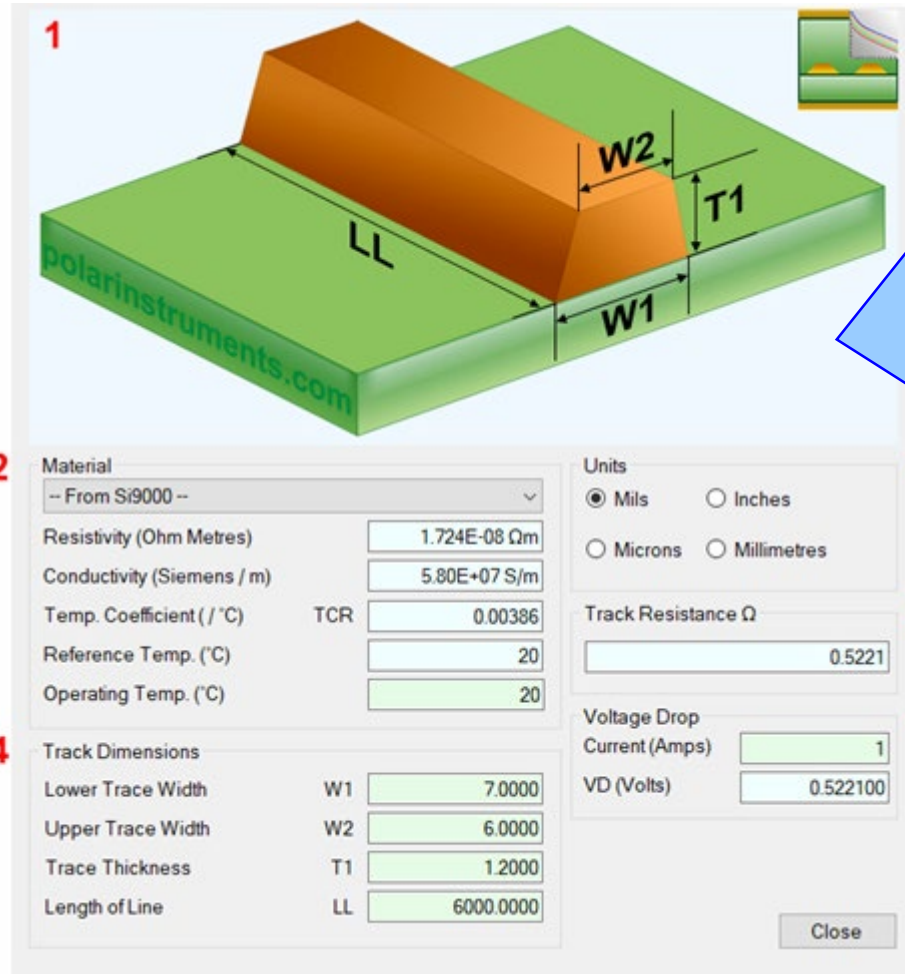
Lower Trace Width	W1	7.0000
Upper Trace Width	W2	6.0000
Trace Thickness	T1	1.2000
Length of Line	LL	1000.0000

Track Resistance Ω: 0.0870

Voltage Drop Current (Amps): 1

VD (Volts): 0.087000

Track Resistance Calculator (TRC Plus)



The image shows a 3D perspective view of a track on a substrate. The track is a raised rectangular block with a top width of $W2$ and a bottom width of $W1$. The thickness of the track is $T1$. The length of the track is LL . Below the 3D view is a software interface with several sections:

- Material:** A dropdown menu set to "-- 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:** Radio buttons for Mils (selected), Inches, Microns, and 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

A "Close" button is located at the bottom right of the interface.

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

www.polarinstruments.com

	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

	Nominal	Minimum (worst case)	Maximum (worst case)
Impedance	Zo	49.99	49.99

Settings

Iterations: **9000**

Uniform Distribution (Tol/Min/Max)

Normal Distribution (Mean/Std Dev)

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

Graph | Iterations / Results

Coated Microstrip 1B - Monte Carlo Analysis

www.polarinstruments.com

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 screenshot displays the Polar Si9000 PCB Transmission Line Field Solver interface. The main window shows a graph titled "Edge-Coupled Offset Stripline 1B2A" with the following parameters:

- 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

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 40000). The legend includes:

- Smooth Conductor Loss (Red)
- Dielectric Loss (Green)
- Smooth Attenuation (Blue)
- Conductor Loss with Roughness (Yellow)
- Measured Attenuation : VNA Delta-L-4 (Brown)

On the right side of the interface, there are several control panels:

- Frequency:** Logarithmic scale selected.
- Result Pre:** Length of Line selected.
- Extended:** Causally selected.
- Surface R:** Huray selected.
- Graph Settings:** Display Series set to "All Losses", Differential mode, Loss Budget (dB) set to 0.0000.
- Picked Data Point Information:** Maximize, Print, and Export buttons.

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

Si9000e v21.01 (January 2021)

Monte Carlo support added for Dual Coated structures

	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

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

Settings

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

Results Summary

Impedance - Zdiff

Nominal	99.99
Minimum (worst case)	95.41
Maximum (worst case)	102.72

Monte Carlo Analysis

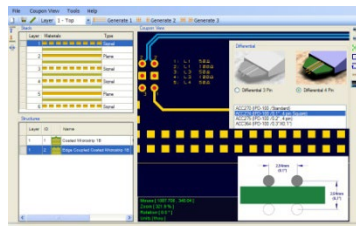
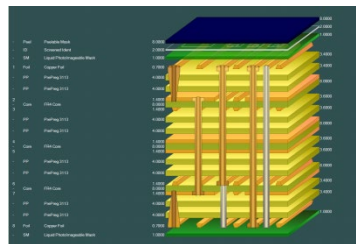
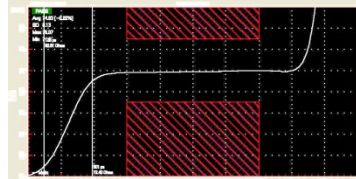
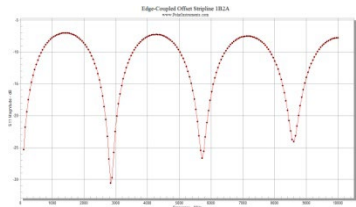
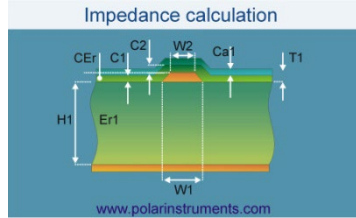
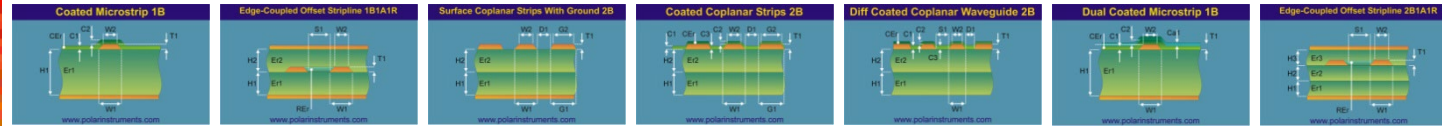
Mean	99.94
Standard Deviation	1.11

Graph | Iterations / Results

The Monte Carlo Analysis option now supports Dual Coated structures

Other enhancements

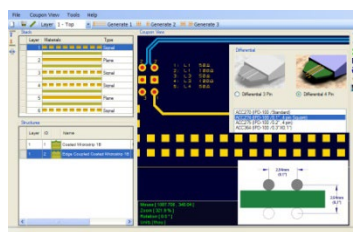
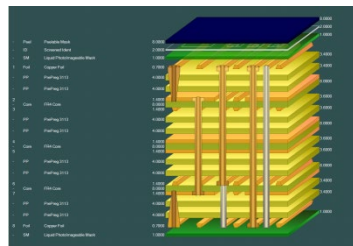
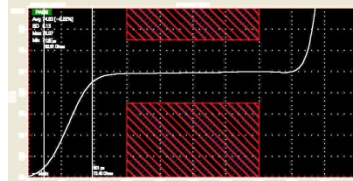
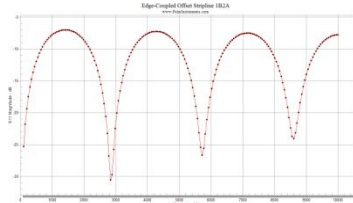
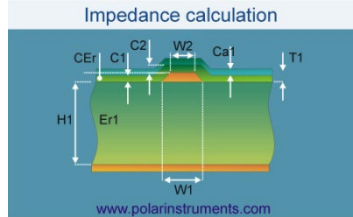
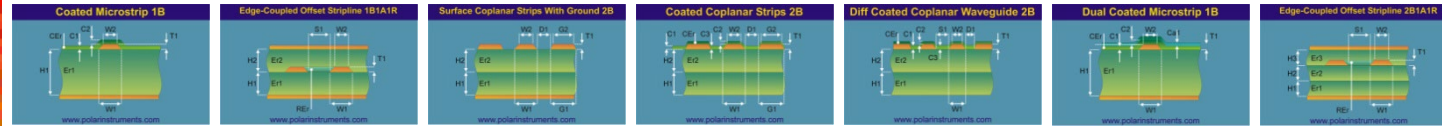
- FlexNet Publisher / FLEXIm v11.17.2.0 supported



Thank you for viewing this Si9000e 2021 – 2022 preview. If you have questions we would be delighted to help you. Your local contact information is contained on the following slide



Polar Logo & graphic devices are registered trade marks of Polar Instruments Ltd.
Copyright Polar Instruments Ltd (c) 2022



**For more information:
Contact Polar now:**

Phone

**USA / Canada / Mexico
[Geoffrey Hazelett](#)**

(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

Polar Logo & graphic devices are registered trade marks of Polar Instruments Ltd.
Copyright Polar Instruments Ltd (c) 2022

polarinstruments.com