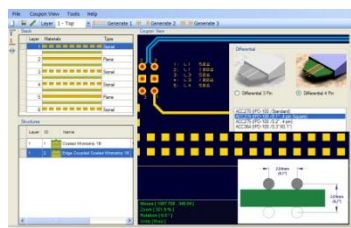
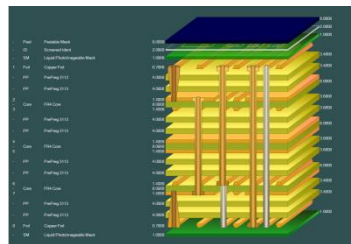
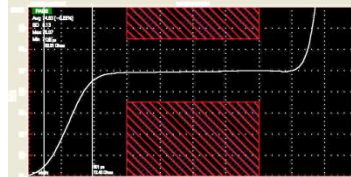
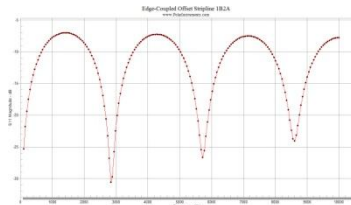
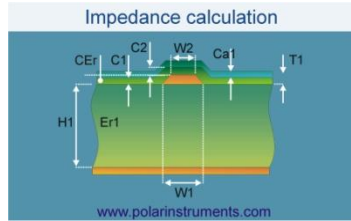




Si9000e – Graphing losses with changing trace separation dimensions

Mike Cotterill – March 2025



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.

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

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:



**Controlled Impedance
and Signal Integrity**
*field solving design tools
2025*

The image features a central globe with a microstrip circuit overlaid. A circular inset shows a cross-section of a microstrip labeled 'Microstrip' and 'W2'. To the right, a circular inset displays a graph with a logarithmic x-axis (1000, 2000) and a y-axis with values 10dB/m, -10dB/m, -20dB/m, and -30dB/m. Another circular inset shows a 3D rendering of a circuit board. The Polar logo is at the bottom left, and the website 'polarinstruments.com' is at the bottom right.

Project Graphing – Example using Edge-Coupled Offset Stripline

- Create a base structure
- Calculate the Impedance to ensure it fulfils requirements – e.g. $Z_{diff} = 100 \text{ ohms} \pm 10\%$

The screenshot displays the Polar Si9000 PCB Transmission Line Field Solver interface. The central window shows a cross-section of an "Edge-Coupled Offset Stripline 1B1A" structure with parameters labeled H1, H2, Er1, Er2, W1, W2, S1, and T1. The software is configured for "Lossless Calculation".

Parameters Table:

Parameter	Value	Tolerance	Minimum	Maximum	Action
Substrate 1 Height (H1)	50.00	± 0.00	50.00	50.00	Calculate
Substrate 1 Dielectric (Er1)	3.5000	± 0.0000	3.5000	3.5000	Calculate
Substrate 2 Height (H2)	50.00	± 0.00	50.00	50.00	Calculate
Substrate 2 Dielectric (Er2)	3.5000	± 0.0000	3.5000	3.5000	Calculate
Lower Trace Width (W1)	40.00	± 0.00	40.00	40.00	Calculate
Upper Trace Width (W2)	35.00	± 0.00	35.00	35.00	Calculate
Trace Separation (S1)	100.00	± 0.00	100.00	100.00	Calculate
Trace Thickness (T1)	9.00	± 0.00	9.00	9.00	Calculate
Differential Impedance (Zdiff)	100.33		100.33	100.33	Calculate / More...

Interface Style: Standard, Extended

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

Tolerance Mode: Absolute, Percentage (%)

Parameter Snap: Auto Calc, Snap

Project Graphing – Example using Edge-Coupled Offset Stripline

- Switch to the Frequency Dependent Calculation tab
- Set the Frequency Maximum (GHz) to 40GHz
- Set the Surface Roughness Compensation to your preferred method

Edge-Coupled Offset Stripline 1B1A

www.polarinstruments.com

Length of Line	LL	25400.00
Trace Conductivity (S/m)	TC	5.80E+07
Loss Tangent	TanD	0.0195
Rise Time (ps)	Tr	10
Frequency Minimum (MHz)	FMin	500.000
Frequency Maximum (GHz)	FMax	40.000
Frequency Steps	FSteps	20

Auto Calc

Frequency Distribution

Logarithmic Linear

Result Presentation

Length of Line / in / m

Extended Substrate Data

Constant Er / TanD

Causally Extrapolate Er / TanD

Multiple Er / TanD

Surface Roughness Compensation

Smooth

Hammerstad

Groisse

Gradient (Beta)

Huray

Frequency Max increased to a greater range than the default e.g. 40GHz

Choose Surface Roughness e.g. Huray

Project Graphing – Example using Edge-Coupled Offset Stripline

- Switch to the Sensitivity Analysis tab
- Under Impedance vs Changing Parameter(s) select Parameter | S1
- Range Start | 30.0000
- Range Finish Value | 300.0000
- Increment | 30.0000
- Under Control Impedance vs - Changing Parameters
- Set Parameter | W1
- Set Target Impedance to 100 ohms
- Click Calculate

2 - View the Results tab

The screenshot shows the 'Impedance vs Changing Parameter(s)' configuration window. The 'Parameter' is set to S1, 'Range Start Value' is 30.0000, 'Range Finish Value' is 300.0000, and 'Increment' is 30.0000. The 'Constant Impedance vs Changing Parameters' window shows 'Parameter' set to W1 and 'Target Impedance' set to 100.0000. A 'Calculate' button is highlighted with a blue box labeled '1 - Click Calculate'. Below the configuration windows is a 'Graph Results' table with columns for H1, Er1, H2, Er2, W1, W2, S1, T1, Zodd, Zeven, Zdiff, Zcommon, LL, Tr (ps), Kb (NEXT), Kfs/m, FEXT, and Calc Success. The table contains 12 rows of data, with the last row showing S1 = 300.0000 and Calc Success = Yes.

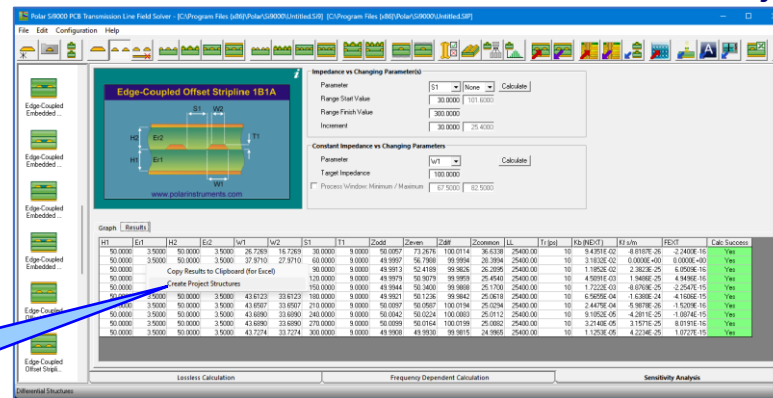
H1	Er1	H2	Er2	W1	W2	S1	T1	Zodd	Zeven	Zdiff	Zcommon	LL	Tr (ps)	Kb (NEXT)	Kfs/m	FEXT	Calc Success
50.0000	3.5000	50.0000	3.5000	26.7269	16.7269	30.0000	9.0000	50.0057	73.2676	100.0114	36.6338	25.0000	10	9.4351E-02	-8.8187E-26	-2.2400E-16	Yes
50.0000	3.5000	50.0000	3.5000	37.3710	27.3710	60.0000	9.0000	43.3337	36.7368	99.9994	28.3994	25.0000	10	3.1832E-02	0.0000E+00	0.0000E+00	Yes
50.0000	3.5000	50.0000	3.5000	41.6167	31.6167	90.0000	9.0000	49.9913	52.4189	99.9826	26.2095	25.0000	10	1.1852E-02	2.3823E-25	6.0509E-16	Yes
50.0000	3.5000	50.0000	3.5000	42.9215	32.9215	120.0000	9.0000	49.9979	50.9079	99.9959	25.4540	25.0000	10	4.5091E-03	1.9486E-25	4.9496E-16	Yes
50.0000	3.5000	50.0000	3.5000	43.4204	33.4204	150.0000	9.0000	49.9944	50.3400	99.9888	25.1700	25.0000	10	1.7222E-03	-8.8769E-25	-2.2547E-15	Yes
50.0000	3.5000	50.0000	3.5000	43.6123	33.6123	180.0000	9.0000	49.9921	50.1236	99.9842	25.0618	25.0000	10	6.5655E-04	-1.6380E-24	-4.1608E-15	Yes
50.0000	3.5000	50.0000	3.5000	43.6507	33.6507	210.0000	9.0000	50.0097	50.0587	100.0194	25.0294	25.0000	10	2.4475E-04	-5.9878E-26	-1.5209E-16	Yes
50.0000	3.5000	50.0000	3.5000	43.6890	33.6890	240.0000	9.0000	50.0042	50.0224	100.0083	25.0112	25.0000	10	9.1052E-05	-4.2811E-25	-1.0874E-15	Yes
50.0000	3.5000	50.0000	3.5000	43.6890	33.6890	270.0000	9.0000	50.0099	50.0164	100.0199	25.0082	25.0000	10	3.2140E-05	3.1571E-25	8.0191E-16	Yes
50.0000	3.5000	50.0000	3.5000	43.7274	33.7274	300.0000	9.0000	49.9908	49.9930	99.9815	24.9965	25.0000	10	1.1253E-05	4.2234E-25	1.0727E-15	Yes

1 - Click Calculate

- View the Results and see the increasing Separation (S1) from 30 to 300 microns

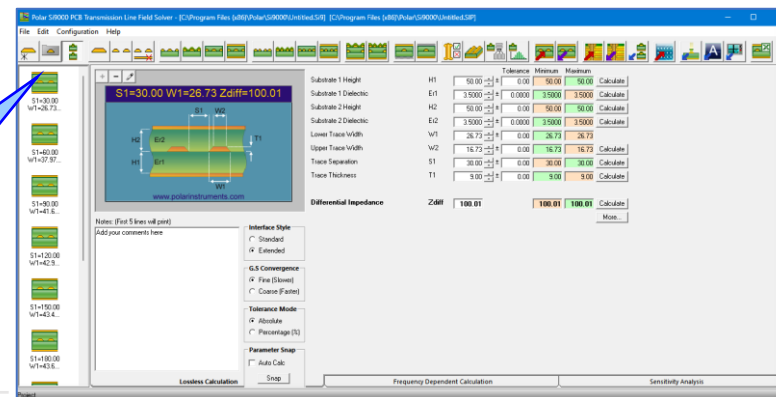
Project Graphing – Example using Edge-Coupled Offset Stripline

- Right click within the table of results and select Create Project Structures



Select Create Project Structure

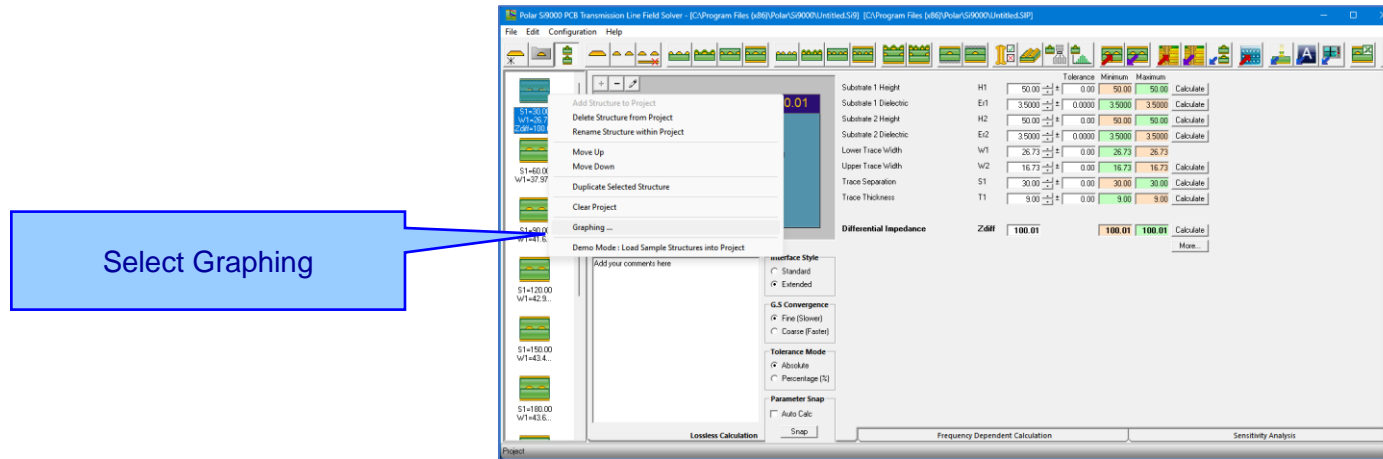
- 10 structures are created – one for each incremental Separation value with varying W1 (W2) value to maintain Zdiff
- Each structure is individually named with the S1 and W1 parameters



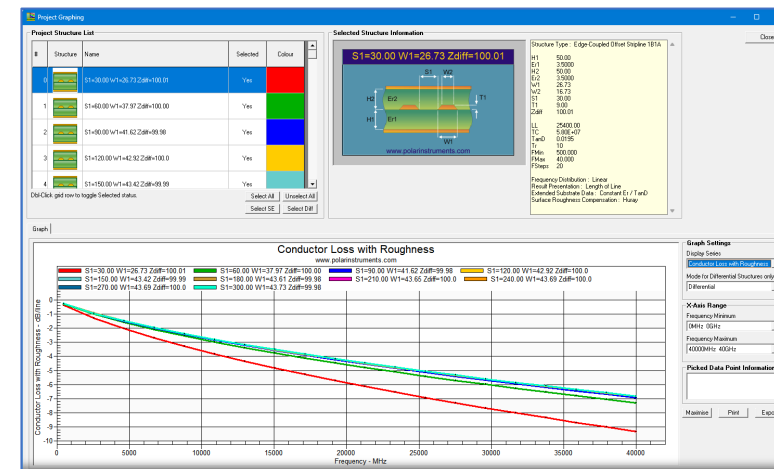
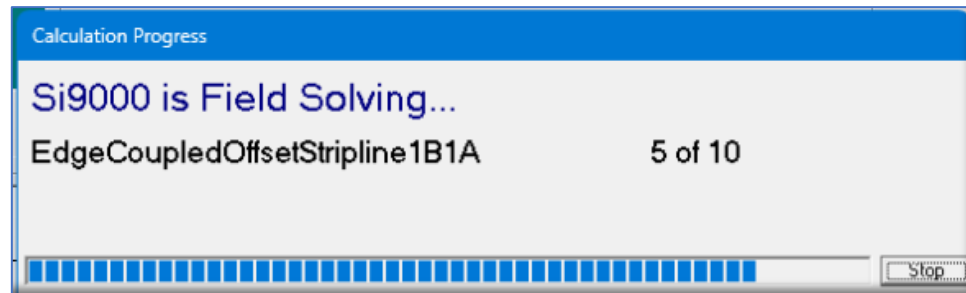
10 x Structures created each named with their S1 and W1 parameters

Project Graphing – Example using Edge-Coupled Offset Stripline

- Right click one of the new structures and select Graphing



- Si9000 field solver will calculate for each separate structure and graph the results



Project Graphing – Example using Edge-Coupled Offset Stripline

- Select one of the options under Graph Settings | Display Series to see how the structures compare
- The graph plots all structures for selected conductor losses, and shows how closely coupled pairs have greater loss at higher frequencies.

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

In this example the Project contains ten structures with track Separation (S1) ranging from 30 to 300

Notice the impact of the Conductor Loss with Roughness. The smaller the separation – the higher the loss at higher frequencies

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.

Choose which parameter to Graph

#	Structure	Name	Selected	Colour
1	S1=30.00 W1=26.73 Zdiff=100.01	S1=30.00 W1=26.73 Zdiff=100.01	Yes	Red
2	S1=60.00 W1=37.97 Zdiff=100.00	S1=60.00 W1=37.97 Zdiff=100.00	Yes	Green
3	S1=90.00 W1=41.62 Zdiff=99.98	S1=90.00 W1=41.62 Zdiff=99.98	Yes	Blue
4	S1=120.00 W1=42.92 Zdiff=100.0	S1=120.00 W1=42.92 Zdiff=100.0	Yes	Yellow
5	S1=150.00 W1=43.42 Zdiff=99.99	S1=150.00 W1=43.42 Zdiff=99.99	Yes	Cyan
6	S1=180.00 W1=43.61 Zdiff=99.98	S1=180.00 W1=43.61 Zdiff=99.98	Yes	Orange
7	S1=210.00 W1=43.65 Zdiff=100.0	S1=210.00 W1=43.65 Zdiff=100.0	Yes	Pink
8	S1=240.00 W1=43.69 Zdiff=100.0	S1=240.00 W1=43.69 Zdiff=100.0	Yes	Brown
9	S1=270.00 W1=43.69 Zdiff=100.0	S1=270.00 W1=43.69 Zdiff=100.0	Yes	Light Blue
10	S1=300.00 W1=43.73 Zdiff=99.98	S1=300.00 W1=43.73 Zdiff=99.98	Yes	Light Green

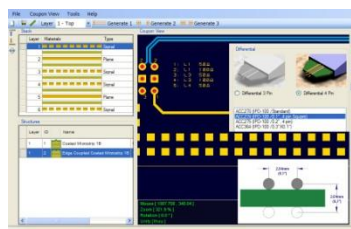
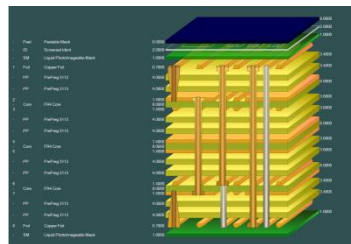
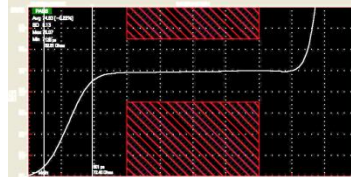
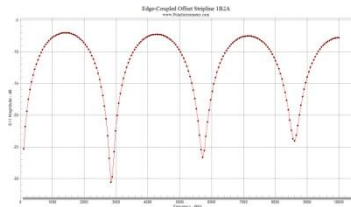
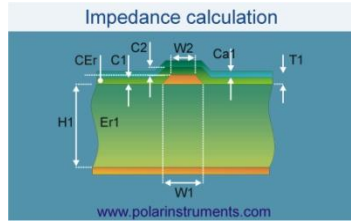
Structure Type: Edge-Coupled Offset Stripline 1B1A

Parameters: H1=50.00, Er1=3.5000, H2=50.00, Er2=3.5000, W1=26.73, W2=16.73, S1=30.00, T1=9.00, Zdiff=100.01

Graph Settings: Display Series: Conductor Loss with Roughness, Mode for Differential Structures only: Differential, X-Axis Range: Frequency Minimum: 0MHz, Frequency Maximum: 40000MHz, 40GHz

Project Graphing – Summary

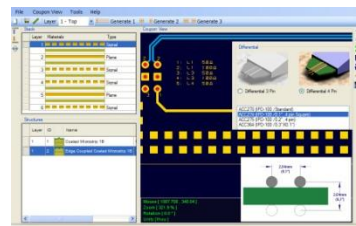
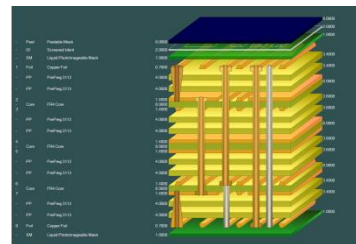
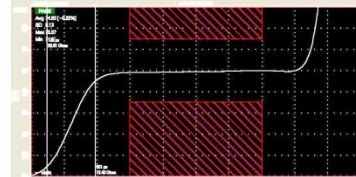
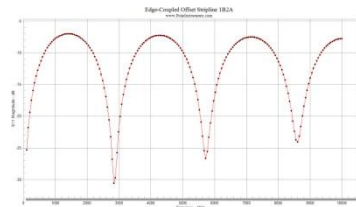
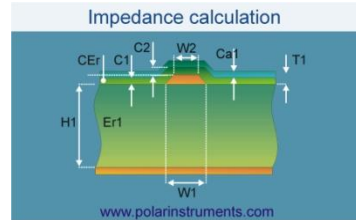
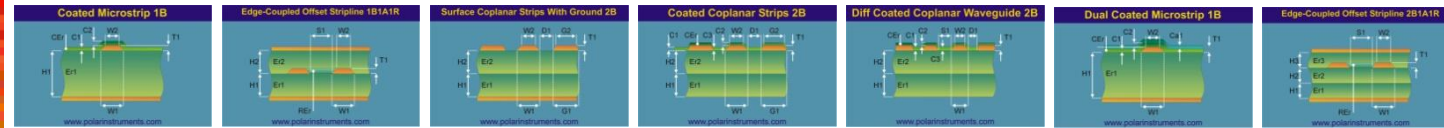
- The new Graphing option for Si Projects provides useful plots that contain data from multiple structures
- There are numerous uses for this type of option - comparing the impact of different dielectric materials, different roughness, sensitivity analysis for lossy calculations and more
- ‘What if’ 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



*If you have questions we would be delighted to help you.
Your local contact information is contained on the following slide*



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