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Sonnet EM Simulator

- A 3-D planar EM analysis software
- Based on the Method of Moments
- Intended for frequency-domain analysis of planar circuits (microstrip, stripline, PCBs, and integrated circuits)
- Not intended for completely arbitrary 3-D problems
- Development started in 1983 by Dr. James C. Rautio
- Commercial introduction in 1989

https://www.sonnetsoftware.com/



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Basic Sonnet Tools

- 'xgeom', for drawing the circuit to be analyzed
- 'em' to perform the EM analysis (main engine)
- 'emgraph' to plot the results (S-parameters, etc.)
- 'emvu' to view and animate current distributions (for a given exciting frequency)
- 'patvu' to compute the far-field radiation pattern of radiating structures (such as patch antennas)

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The Project Editor – Example 1 (cont.)

Box Settings-filt	wall.son			1	? 🗙
	x	Y		Top Metal	
Cell Size	2.0	2.0	Lock	Lossless	•
Box Size	390.0	224.0	Lock		
Num Celle	105	112	- 1 h	Bottom Meta	I
	135	112	LOCK	Lossless	•
Se	et Box Size v Cell Size Ca	vith Mouse alculator		Symmetry	,
Current	t Units: r	nils		Estimate Memo	iry
ОК	Аррі	у	Cancel	Help]
1					

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iele	ctric Layers-f	iltwall.son				?
	Thickness (mils)	Mat. Name	Erel	Dielectric Loss Tan	Diel Cond (S/m)	Add Above
0	100.0	Air	1.0	0.0	0.0	Below
	15.0	Alumina	9.8	0.0	0.0	Edit Delete
						Library
			1		•	Z-Parts
	ОК		Cancel		Help	

Settin	g-up the Analysis – I	Example 1	
ſ	Analysis Setup-filtwall.son Options Compute Current Density Memory Save	Speed/Memory Advanced	
	Analysis Control Adaptive Sweep (ABS) Start Stop (GHz) (GHz) 4.7 5.5	•	
L	OK Cancel	Help	
Dr. J. E. Rayas-Sánchez			12

<u>File Edit View Run Proj</u>	GHz Finished on ERAYAS-TOSHIBA (Local) ject <u>H</u> elp	
filtwall.son	4 Frequencies Done Ti	me/Frequency: 6 seconds
Subs: 986 Memory: 5 MB	100%	
	Analysis successfully completed.	Status Only <<
	View: 🔽 Detailed Timing Information 🗖 Parame	ters
Response Data	Run 1: Sun Apr 13 13:16:27 2003. Adaptive Band Synt Em version 8.52 on ERAYAS-TOSHIBA (Windows) 1	hesis. ocal.
Errors/Warnings	Subsectioning time: 0.090 seconds.	
	Circuit requires 986 subsections and 5 MB of me	mory.
Timing Info	Matrix fill time: 3 seconds.	
	Matrix solve time: 0.431 seconds. Total time per frequency: 6 seconds.	
	Post-Analysis:	





Setting-up the Analysis – Example 1 (cont.)

Options Compute Curr Memory Save	II.son rent Density	Speed/Memory Advanced
Analysis Control	weep	 -
Start (GHz)	Stop (GHz) 5.5	Step (GHz) 0.0125
ОК	Cancel	Help
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File Edit View Run Proje	Finished on ERAYAS-TOSHIBA (Local) ect Help			
filtwall.son	65 of 65 Frequencies Done	Finish Time:	Sun Apr 13 01:28 PM	
Subs: 986 Memory: 5 MB	100%			
	Analysis successfully completed.		Status Only <<	
	View: 🔽 Detailed Timing Information	Parameters		
Response Data	Run 1: Sun Apr 13 13:22:35 2003. Frequ Em version 8.52 on ERAYAS-TOSHIB	aency Sweep. 3A (Windows) local.	<u>^</u>	
Errors/Warnings	Pre-Analysis: Subsectioning time: 0.090 seconds	۶.		
· ·	Frequency: 4.7 GHz Circuit requires 986 subsections a	and 5 MB of memory.		
Timing Info	Waveguide mode time: 0.121 seconds.			
	Matrix solve time: 0.420 seconds. Total time per frequency: 6 secon	ids.		
Batch List	Post-Analysis: Total time for 65 frequencies: 5	minutes 56 seconds		
	Analysis successfully completed			













- Sonnet encloses the circuit in a metal box
- The substrate covers the bottom area of the box
- Cell Size, Box Size and Number of Cells in each direction (*x* or *y*) are related as

Cell Size × Number of Cells = Box Size

- The EM analysis starts by automatically subdividing the circuit into small rectangular subsections
- Sonnet uses variable size subsections (small subsections are used where needed)
- A Cell is the building block for all subsections, and each subsection is built from one or more cells
- To reduce memory requirements use a cell size as large as possible

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Analysis Setup-dfolstub.son
Compute current bensity Speeu/Memory Memory Save Advanced
Analysis Control
Start Stop [GHz] (GHz) 3.0 8.0
OK Cancel Help





Increasing Resolution – Example 2

Sizes	×	¥	Ton Metal
Cell Size	2.5	2.5 C Lock	Lossless -
Box Size Num. Cells	330.0 2 132 8	200.0 V Lock	Bottom Metal
	Set Box Size with Cell Size Calcu	Mouse Ilator	Symmetry
Cur	rent Units: mils	;	Estimate Memory
ОК	Apply	Cancel	Help

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Vias

- A special kind of subsection which allows current to flow in the z-direction between metals
- "Ground via" connect metal on the surface of the substrate to the ground plane beneath the substrate
- "Level-to-level via" connect metalization between any two adjacent levels

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m square_spiral_induct File Edit View Run Projec	pr.son 0.36 GHz Finished on ERAYAS-TOSHIBA (Local)	
square_spiral_indu	6 Frequencies Done T	ime/Frequency: 11 seconds
Subs: 915 Memory: 4 MB	100%	
	Analysis successfully completed.	Status Only <<
	View: 🗖 Detailed Timing Information 🗖 Param	reters
Response Data	Pre-Analysis: Subsectioning time: 0.040 seconds. Frequency: 0.2 GHz	×
Errors/Warnings	Circuit requires 915 subsections and 4 MB of m Waveguide mode time: 0.261 seconds. Matrix fill time: 6 seconds. Matrix solve time: 0.741 seconds. Total time are freemony: 11 seconds.	emory.
Timing Info	Post-Analysis: Total time for 6 frequencies: 1 minute 2 seco	onds.
Batch List	Analysis successfully completed.	

1





Example 4 Bandstop Microstrip Filter with Quarter-Wave Open Stubs H = 25 mil $k_{0} = 25 \text{ mil}$ $W_{0} = 25 \text{ mil}$ $W_{1} = 9 \text{ mil}$ $W_{2} = 19 \text{ mil}$ $L_{0} = 95 \text{ mil}$ $L_{1} = 115 \text{ mil}$ $L_{2} = 114 \text{ mil}$

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	Onz Finished on ERATAS-TOSHIDA (Eddal)	
ile Edit View Run Proj	ect Help	
bs_mcsqwrf.son	9 Frequencies Done	Time/Frequency: 51 seconds
Subs: 1368 Memory: 10 MB	100%	
	Analysis successfully completed.	Status Only <<
	View: 🗖 Detailed Timing Information	Parameters
Response Data	Pre-Analysis: Subsectioning time: 0.180 seconds.	
Errors/Warnings	Frequency: 5 GHz Circuit requires 1368 subsections and Waveguide mode time: 0.461 seconds. Marriy fill time: 21 seconds	d 10 MB of memory.
	Matrix solve time: 14 seconds.	
Timing Info	Post-Analysis: Total time for 9 frequencies: 6 minu	utes 42 seconds.







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Exercise: A Simple Microstrip Line Characteristic Impedance of a Microstrip Line 400 h Gupta Walker 350 300 250 Z_o (ohms) Е, w 200 = 1 £ 150 $\varepsilon_r = 2.2$ = 4.5 • If *h* = 0.66 mm and 100 $\varepsilon_r = 9$, select *w* for a 50- Ω line 50 0L 1.5 2 w/h 2.5 0.5 3.5 1 3 4 • Simulate in Sonnet from 0.15-15 GHz (assume L = 10 mm, neglect losses) Dr. J. E. Rayas-Sánchez