

An Introduction to Aplac

Dr. José Ernesto Rayas Sánchez

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Aplac Simulator

A comprehensive mixed-mode high frequency
circuit-based simulation and optimization system

It can realized EM-based simulation

www.aplac.com

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Aplac Circuit Analysis Modes

- DC analysis and DC sensitivity
- AC analysis and AC sensitivity
- Group delay analysis
- S-parameter analysis
- Stability analysis
- AC Noise analysis
- Transient analysis
- Harmonic Balance (Single-Multitone, Large Signal)
- Monte Carlo analysis

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Other Aplac Analysis Capabilities

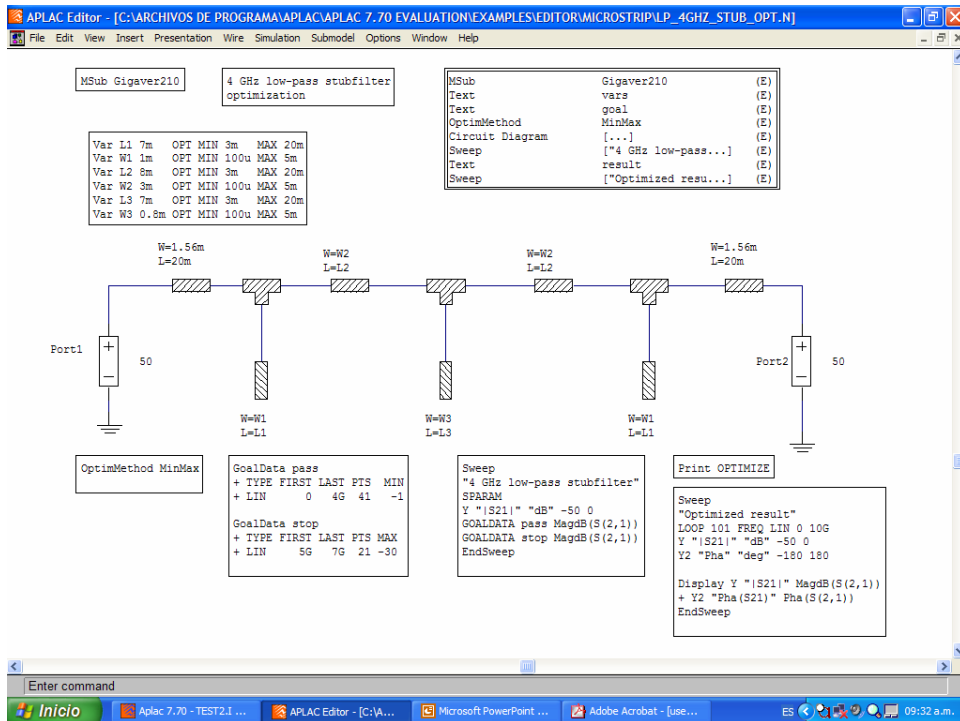
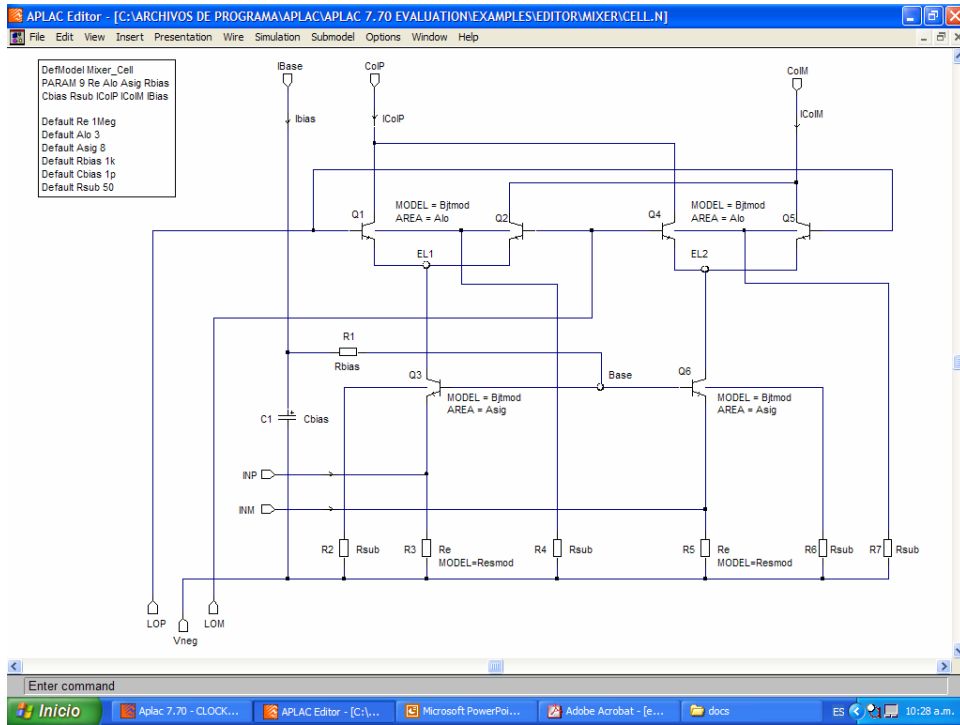
- System analysis
- Electromagnetic FDTD simulation
- Optimization and Design Centering

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Signal Integrity and High-Speed Interconnects

January-May 2006



Signal Integrity and High-Speed Interconnects

January-May 2006

The screenshot displays the APLAC Editor interface with a system diagram for a Bluetooth BER simulation. The diagram shows a signal path from an input 'In' through a BitGenerator (TYPE = 1), BitModulator, and a summing junction (+) to produce an RF signal (Rf). This signal passes through a delay block, a multiplier (X), a FreqDemodulator, and a Decision block to produce an output 'Out'. A BERMeter is connected to the output. The diagram also includes a BitSource, Delay, and DCclk blocks. A sweep configuration is shown on the right, and a list of variables is displayed at the top right.

Signal Type:
1 PN Sequence
2 Ones only
3 Zeros only
4 Alternating Ones and Zeros

Text
System Diagram
Text
Text

Variables
Sys
Sweep
BER

System Diagram Sys
D DELTAT Delat

TYPE = 1

Variables
Var Delat = 1/1Meg/10
Var NP = 1024*64
Var StartTime = 30u
Var MS = 10
Var PNC = -125
Var IF = 10Meg
Declare VECTOR VFrq REAL NP-1
+ VECTOR VSpec COMPLEX NP-1
+ VECTOR Res REAL 3

Sweep "In/Out"
+ LOOP 501 TIME LIN 0 80u
+ W 0
+ Y " " 0 5

Show W 0
+ Y Vsys(sys.in)
+ Y Vsys(sys.out)
EndSweep

Var Time = 0
Var Errors = 100
Sweep "BER"
+ LOOP 11 VAR PNC LIN -100 -50
+ X "PNC" "-100 -50"
+ NXTICKS = 11
+ Y " " 0 0.5
+ NYTICKS 11

Call REsetSystem(Sys)
Call Time = 80u
Call Signal(Sys.out,Time)
Repeat
Call Time = Time + 10u
Call Signal(Sys.out, Time)
Until (Res[1] > Errors)
Display XY "Ber" Pnc Res[0]
EndSweep

FC = 2.402G-IF AMP = UdBm(-10)/2
PHASE_NOISE = PNC
OFFSET = 100k
NOISE_FLOOR = -130

Enter command

Inicio Aplac 7.70 - CELL.I... APLAC Editor - [C:\... Microsoft PowerPal... Adobe Acrobat - [e... docs ES 10:31 a.m.

Aplac Programs

- Aplac Simulator (aplac.exe)
- Aplac Editor (aplaced.exe)

Aplac Editor

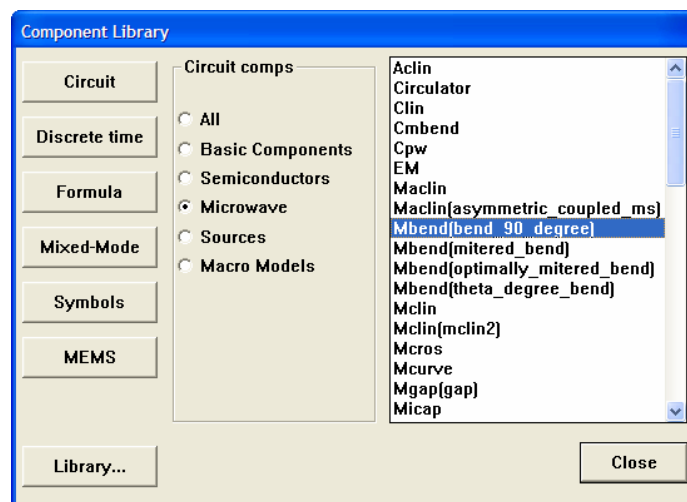
- Diagrams
 - Circuit diagrams
 - System diagrams
- Control objects

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Drawing Schematics

Insert > Component

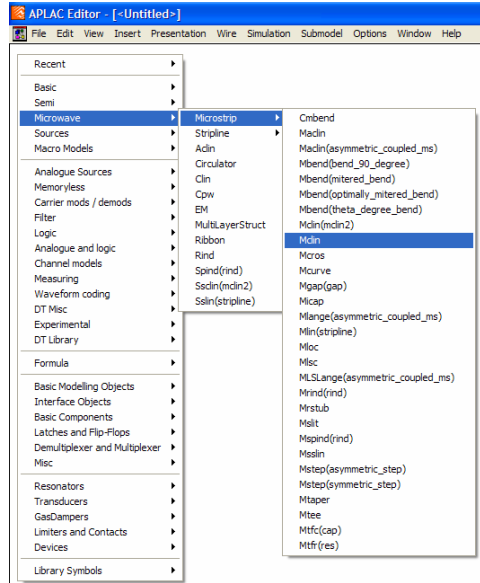


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Drawing Schematics (cont)

Right click:

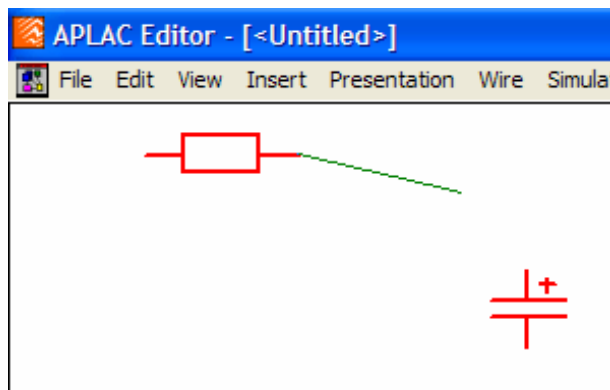


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Drawing Schematics (cont)

Double click: insert wire



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Aplac Control Objects

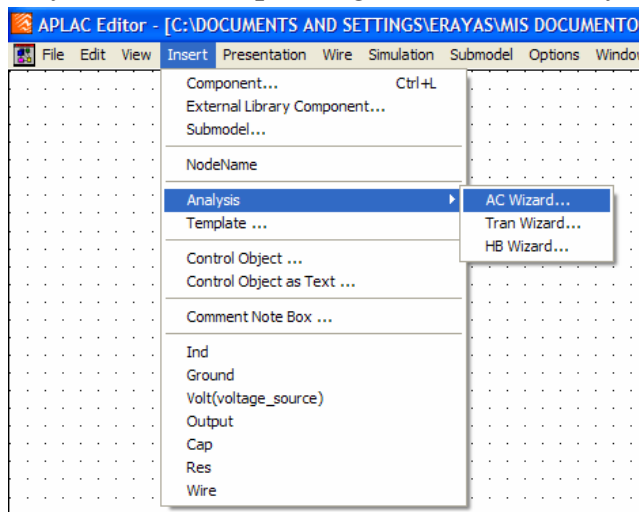
- Using Wizards
- Manually
- Using Analysis Templates

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Using Wizards to Setup an Analysis

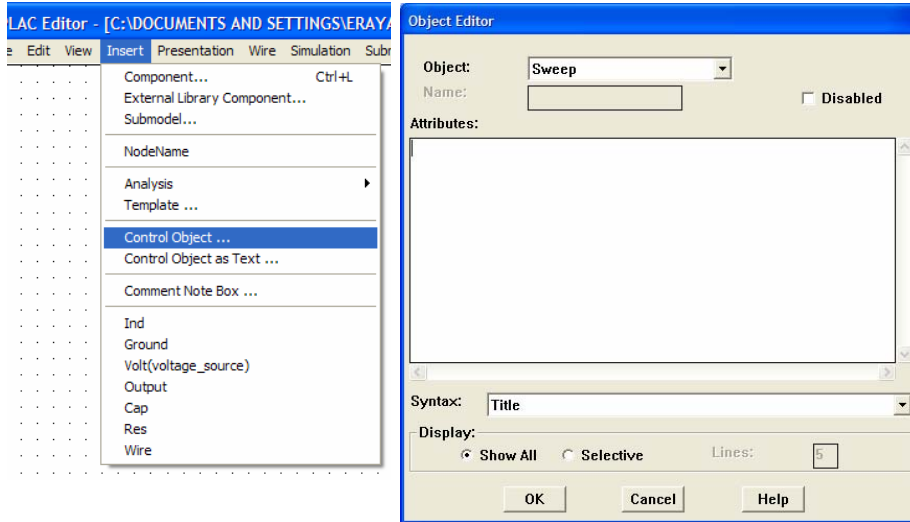
Type of analysis and corresponding sources are easily defined



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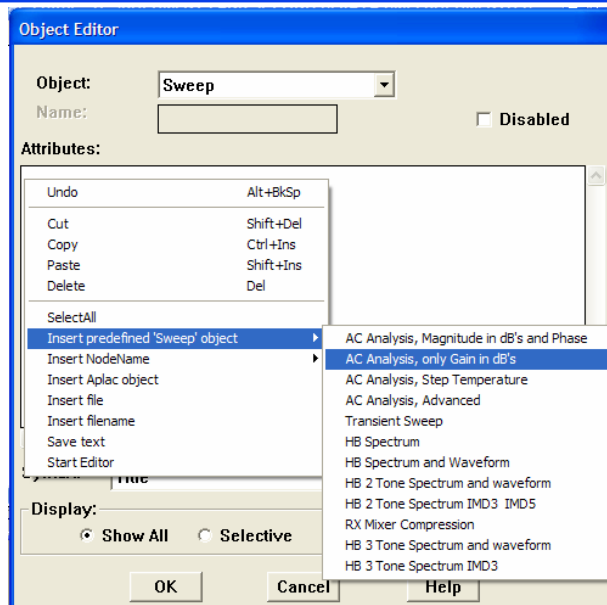
Setting up an Analysis Manually



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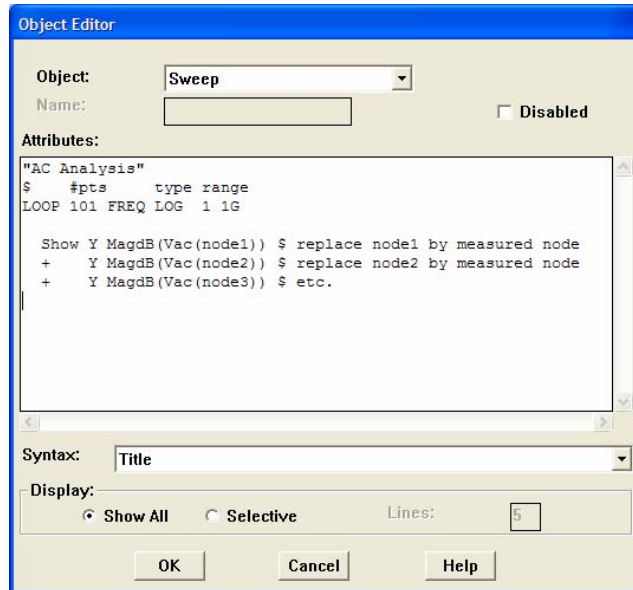
Setting up an Analysis Using Templates



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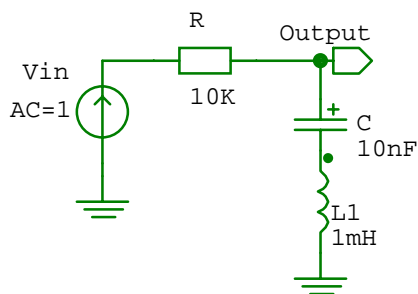
Setting up an Analysis Using Templates (cont)



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A Simple Example

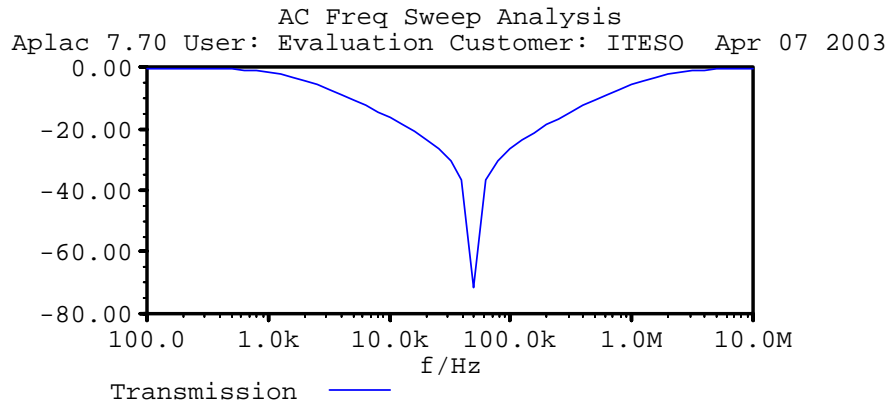


```
$ -----  
$ File : C:\APLAC\PROJECTS\TEST2.I  
$ Schema file : C:\APLAC\PROJECTS\TEST2.N  
$ Generated with APLAC Editor version 2.7.1  
$ Mon Apr 07 09:12:42 2003  
$ -----  
  
Res R node1 Output  
+ 10K  
Cap C Output node2  
+ 10nF  
Volt Vin node1 GND  
+ AC=1  
Ind L1 node2 GND  
+ 1mH  
Sweep "AC Freq Sweep Analysis"  
+ loop 51 freq log 100Hz 10MEGHZ  
Display Y "Transmission" MagDB(Vac(output))  
EndSweep
```

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A Simple Example (cont)



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Structure of the Input File

- Preprocessor directives
- Circuit description
- Variable and function definitions
- Mathematical expressions
- Simulation and optimization controlling statements

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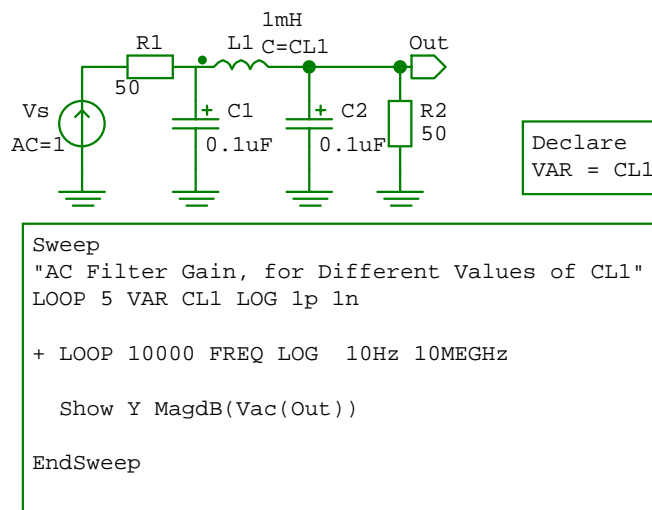
Types of Variables

- Constant
- A normal variable
- Statistical variables
- Optimization variables
- Functional variable

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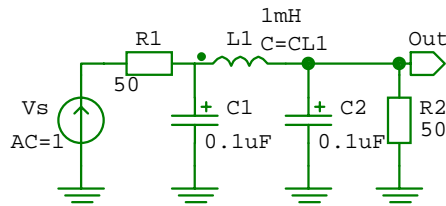
Declaring and Using Variables



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Declaring and Using Variables (cont)



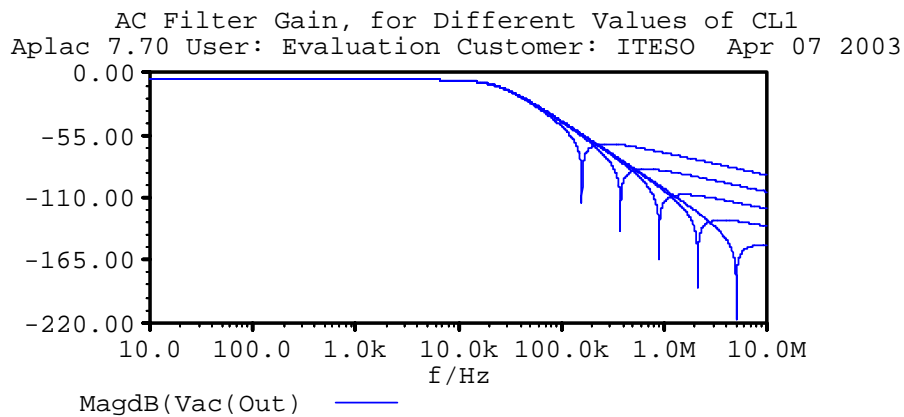
```
Declare VAR = CL1
Res R1 node1 node2
+ 50
Ind L1 node2 Out
+ 1mH
+ C=CL1
Res R2 Out GND
+ 50
Cap C1 node2 GND
+ 0.1uF
Cap C2 Out GND
+ 0.1uF
Volt Vs node1 GND
+ AC=1
Sweep "AC Filter Gain, for Different Values of CL1"
+ LOOP 5 VAR CL1 LOG 1p 1n
+ LOOP 10000 FREQ LOG 10Hz 10MEGHz
  Show Y MagdB(Vac(Out))

EndSweep
```

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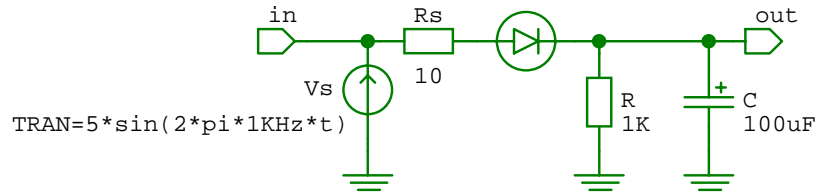
Declaring and Using Variables (cont)



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Transient Analysis - Example



```
Sweep
"Transient Analysis, Half-Wave Rectifier"
$ #pts end time
LOOP 10000 TIME LIN 0 20ms

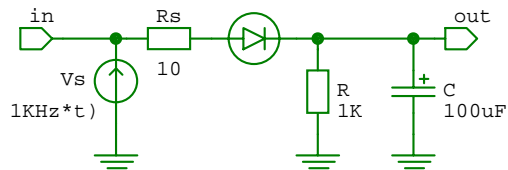
Show Y Vtran(in)
+ Y Vtran(out)

EndSweep
```

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Transient Analysis – Example (cont)



```
Res R out GND
+ 1K
Diode D1 node1 out

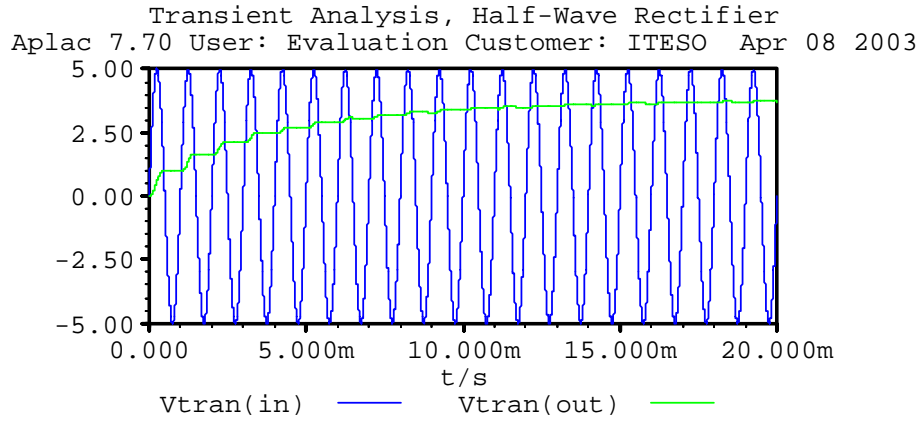
Volt Vs in GND
+ TRAN=5*sin(2*pi*1KHz*t)
Res Rs in node1
+ 10
Cap C out GND
+ 100uF
Sweep "Transient Analysis, Half-Wave
Rectifier"
+ LOOP 10000 TIME LIN 0 20ms
Show Y Vtran(in)
+ Y Vtran(out)

EndSweep
```

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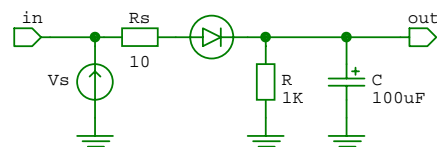
Transient Analysis – Example (cont)



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Harmonic Balance Analysis - Example



```
Sweep "Half-Wave Rectifier, HB Analysis"  
+ HB FC=1KHz  
+ W=1 TITLE="Spectrum, Half-Wave Rectifier"  
+ AUTOSCALE  
  
Show W=1 SPECTRUM Mag(Spectrum(out))  
EndSweep
```

```
Prepare  
TONE=1 10
```

```
Prepare TONE=1 10  
Res R out GND  
+ 1K  
Diode D1 node1 out
```

```
Res Rs in node1  
+ 10  
Cap C out GND  
+ 100uF  
Volt Vs in GND  
+ DC=0 R=0 TONE 1 (5V'0)
```

```
Sweep "Half-Wave Rectifier, HB Analysis"  
+ HB FC=1KHz  
+ W=1 TITLE="Spectrum, Half-Wave Rectifier"  
+ AUTOSCALE
```

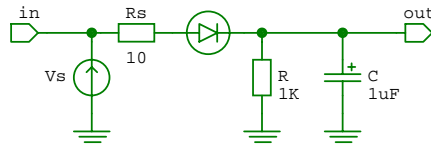
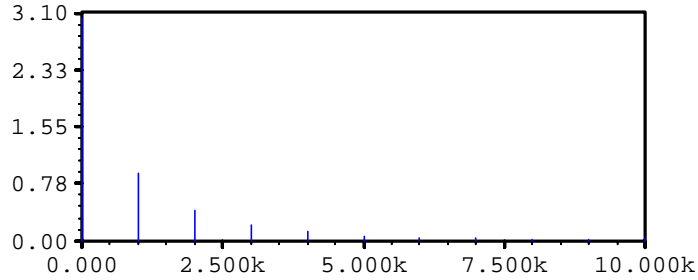
```
Show W=1 SPECTRUM Mag(Spectrum(out))  
EndSweep
```

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Harmonic Balance Analysis – Example (cont)

Spectrum, Half-Wave Rectifier
Aplac 7.70 User: Evaluation Customer: ITESO Apr 08 2003

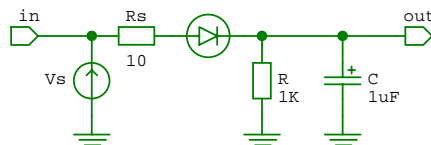
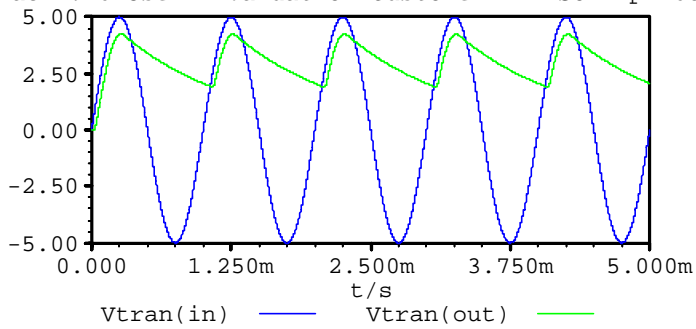


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Transient Analysis Verification

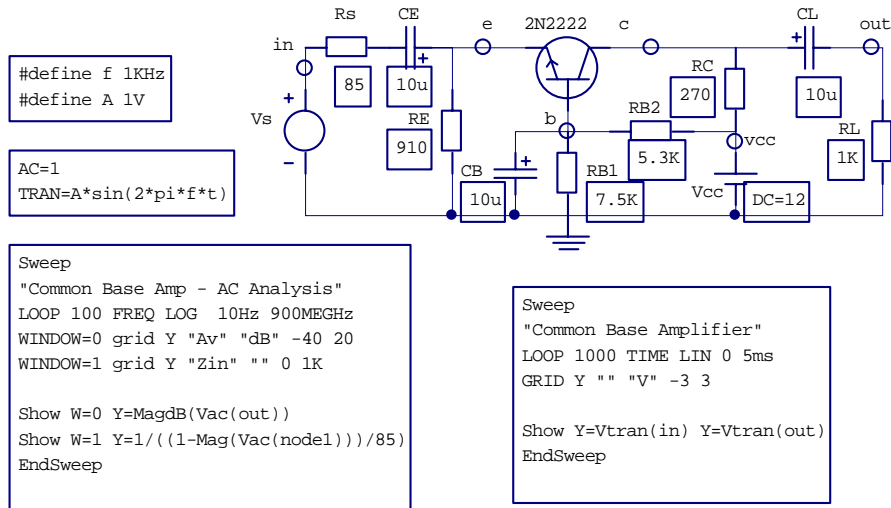
Transient Analysis, Half-Wave Rectifier
Aplac 7.70 User: Evaluation Customer: ITESO Apr 08 2003



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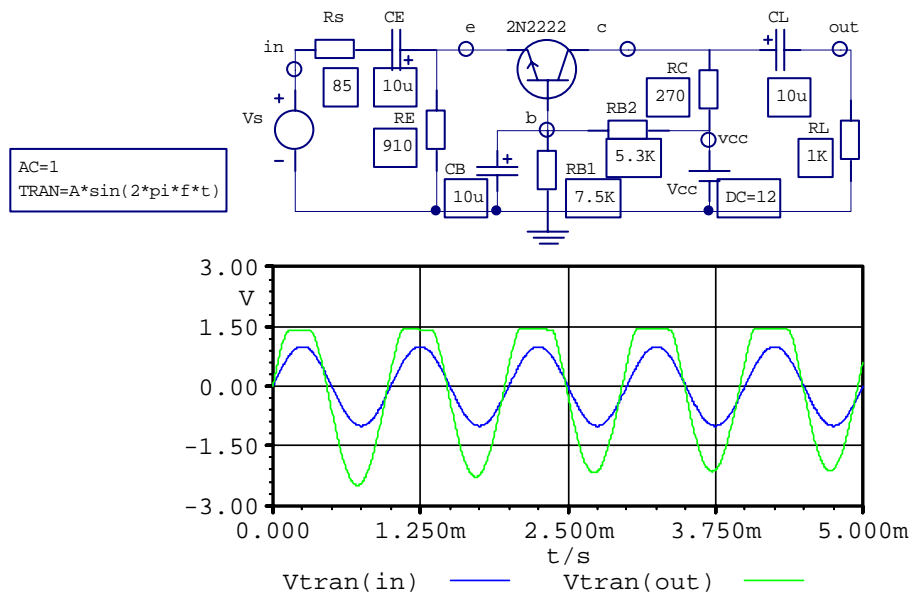
Combining Several Analysis – Example



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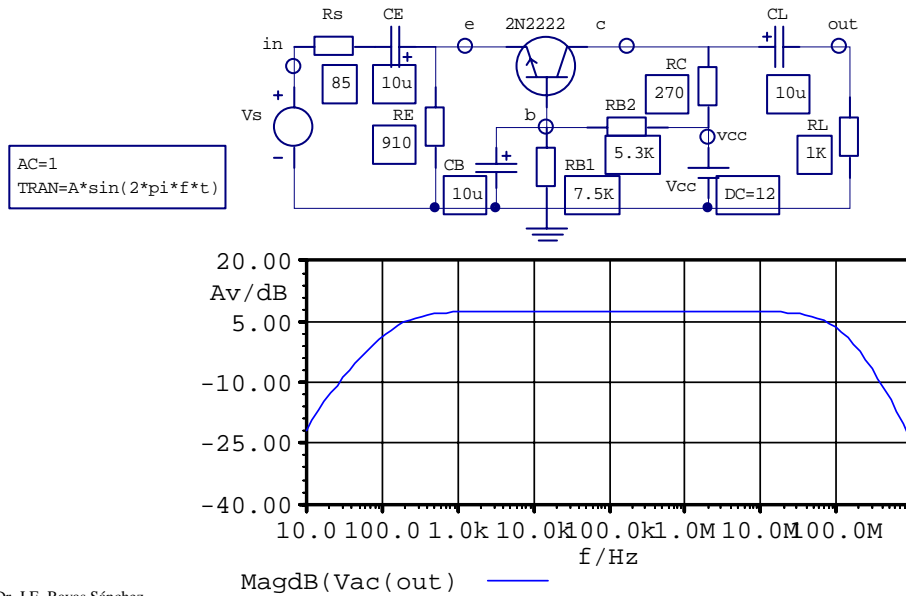
Combining Several Analysis – Example (cont)



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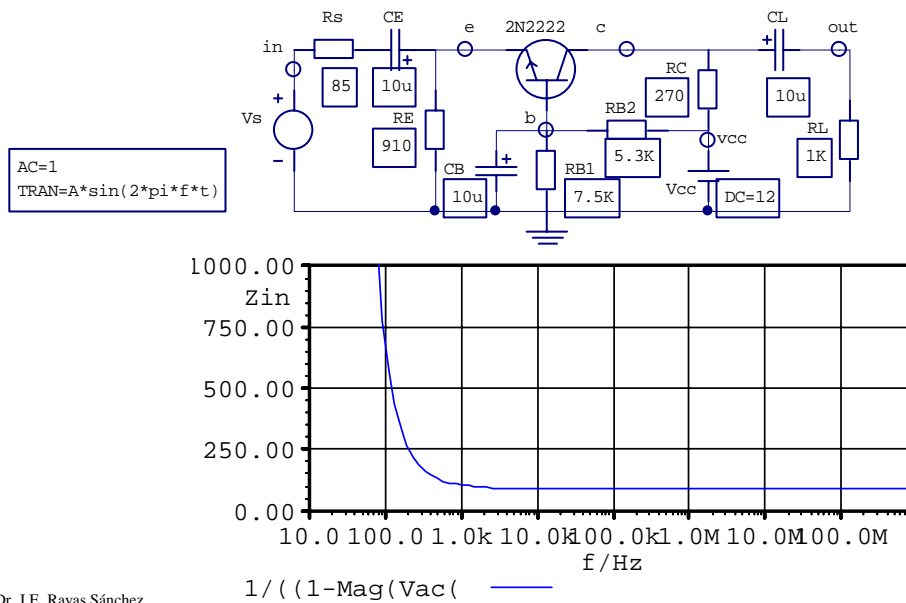
Combining Several Analysis – Example (cont)



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Combining Several Analysis – Example (cont)



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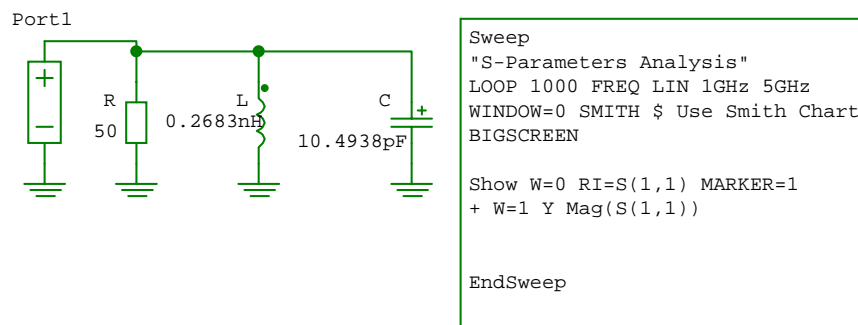
S-Parameter Analysis

- S-parameter analysis (and Y-, Z- and H-parameter analysis as well) is based on the AC analysis
- It is a small signal analysis (for linearized circuits)
- The circuit under simulation must be defined as a multiport network
- In Aplanac a multiport is defined with the statement DefNPort

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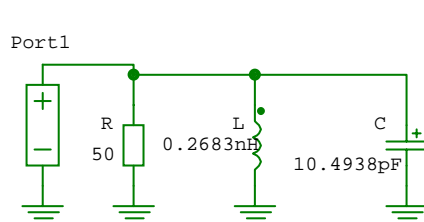
S-Parameter Analysis – Example 1



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S-Parameter Analysis – Example 1 (cont)



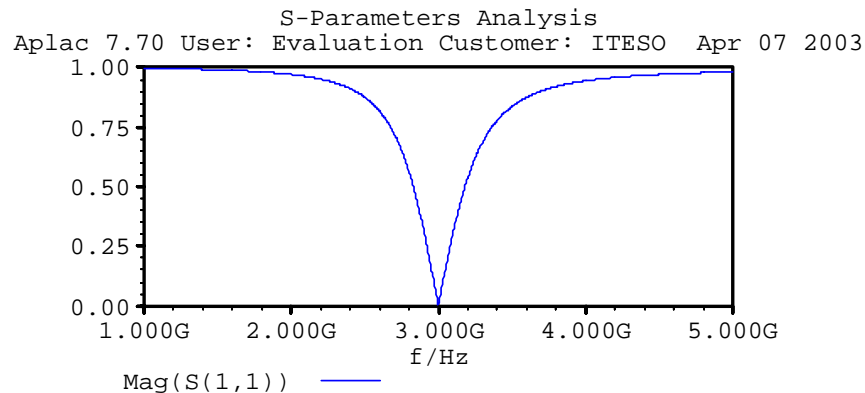
```
Res R Port10 GND
+ 50
Cap C Port10 GND
+ 10.4938pF
Ind L Port10 GND
+ 0.2683nH
DefNPort nport 1
+ Port10 GND 50
Sweep "S-Parameters Analysis"
+ LOOP 1000 FREQ LIN 1GHz 5GHz
+ WINDOW=0 SMITH $ Use Smith Chart
+ BIGSCREEN
Show W=0 RI=S(1,1) MARKER=1
+ W=1 Y Mag(S(1,1))

EndSweep
```

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S-Parameter Analysis – Example 1 (cont)

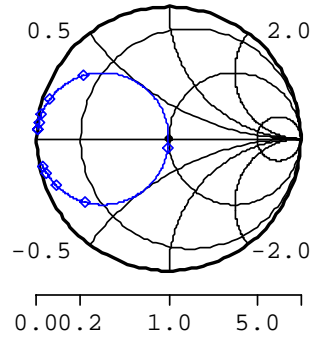


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S-Parameter Analysis – Example 1 (cont)

S-Parameters Analysis
aplac 7.70 User: Evaluation Customer: ITESO Apr 07 2001

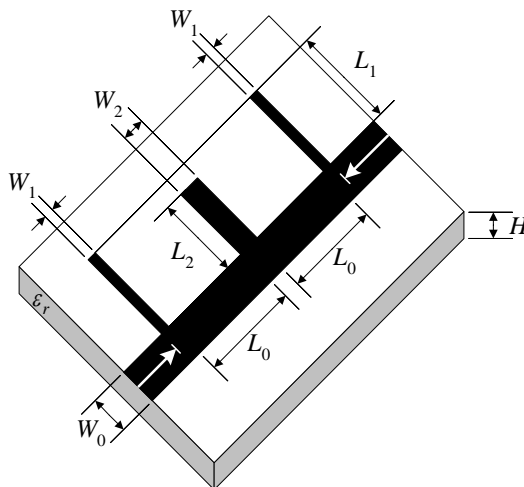


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S-Parameter Analysis – Example 2

Bandstop Microstrip Filter with Quarter-Wave Open Stubs

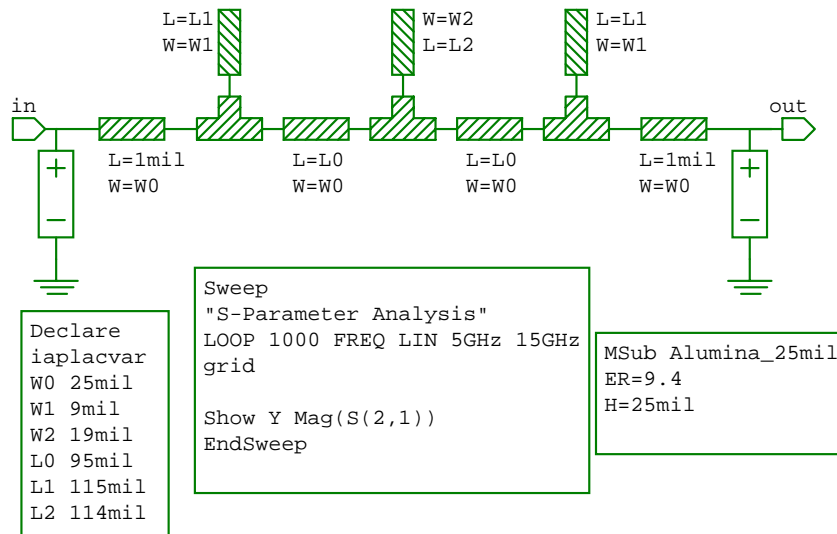


$H = 25$ mil
 $\epsilon_r = 9.4$ (alumina)
 $W_0 = 25$ mil
 $W_1 = 9$ mil
 $W_2 = 19$ mil
 $L_0 = 95$ mil
 $L_1 = 115$ mil
 $L_2 = 114$ mil

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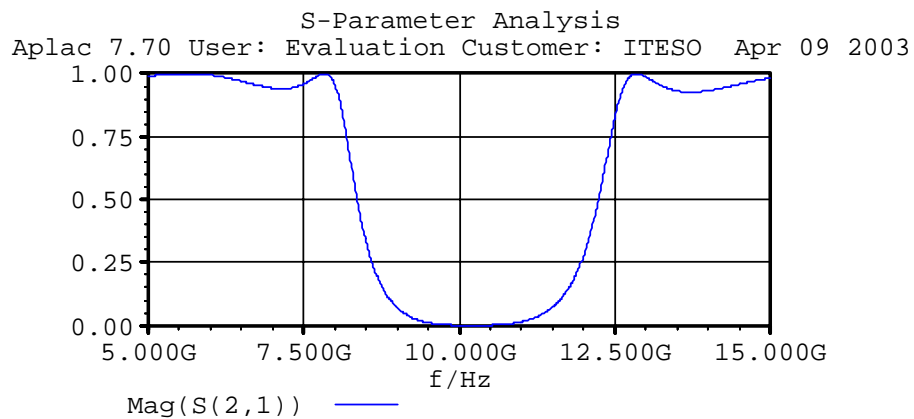
S-Parameter Analysis – Example 2 (cont)



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S-Parameter Analysis – Example 2 (cont)



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