DRIVING APLAC FROM MATLAB – RLC RESONATOR EXAMPLE

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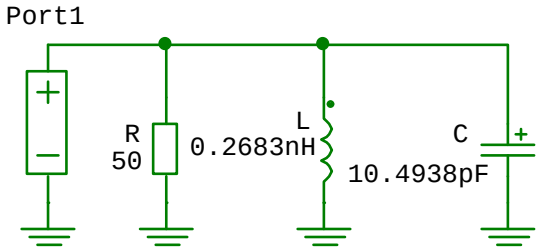
APLAC can be driven from Matlab in the following manner:

1. Create the APLAC simulation file (`*.i`) either with a text editor or using APLAC's schematic editor. Test the APLAC simulation file and make sure it works fine.
2. Redirect the output to text files: substitute "show" commands by "print" commands in the `*.i` file, so that the results are saved in text files.
3. Write a parameterized Matlab file to drive APLAC simulation: a) generate a new `*.i` file using Matlab capabilities for manipulating strings; b) use a Matlab statement to run APLAC from the command line with the `*.i` filename as a parameter; c) read the `*.txt` files and assign the output data to the corresponding vectors of responses.

Example: RLC Resonator Example

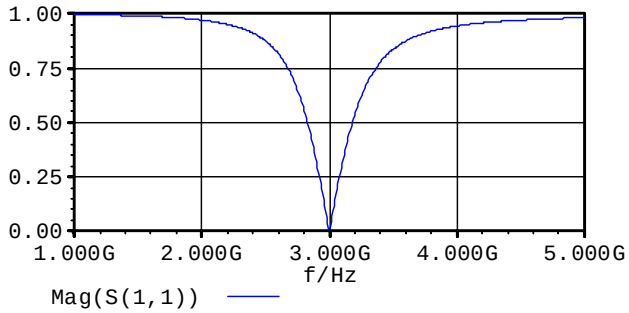
1. Create a conventional APLAC project using APLAC's schematic editor.

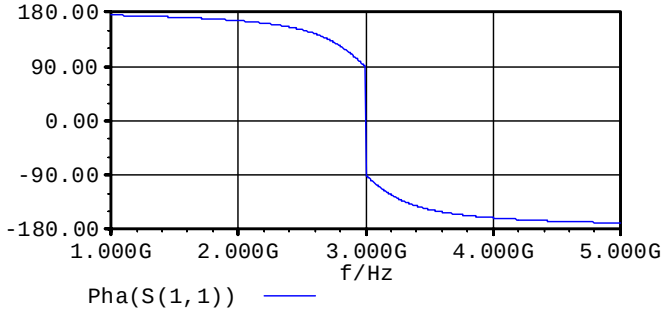



```
Sweep
"RLC Resonator"
LOOP 500 FREQ LIN 1GHz 5GHz
WINDOW=0 grid Y "" "" 0 1
WINDOW=1 grid Y "" "" -180 180

Show W=0 Y Mag(S(1,1))
Show W=1 Y Pha(S(1,1))
EndSweep
```

Responses:





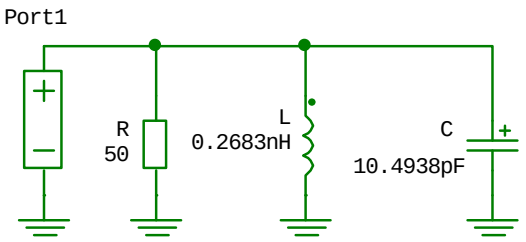
Simulation file (contents of file `RLC_resonator_S-param.i`)

```
$ ------------------------------------------------------------
$ File     : C:\... \RLC_resonator_S-param.i
$ Schema file  : C:\... \RLC_resonator_S-param.n
```

```
$ Generated with APLAC Editor version 3.1.2
$ Wed Apr 20 17:00:28 2016
$ ------------------------------------------------------------

Res R Port10 GND
+ 50
Cap C Port10 GND
+ 10.4938pF
Ind L Port10 GND
+ 0.2683nH
DefNPort nport 1
+ Port10 GND 50
Sweep "RLC Resonator"
+ LOOP 500 FREQ LIN 1GHz 5GHz
+ WINDOW=0 grid Y "" "" 0 1
+ WINDOW=1 grid Y "" "" -180 180
Show W=0 Y Mag(S(1,1))
Show W=1 Y Pha(S(1,1))
EndSweep
```

2. Re-directing output to text files




```
Sweep
"RLC Resonator"
LOOP 500 FREQ LIN 1GHz 5GHz

Print appendfile "ac_results.txt" real f bl real Mag(S(1,1)) bl real Pha(S(1,1)) lf
EndSweep
```

New simulation file:

```
$ ------------------------------------------------------------
$ File     : C:\... \RLC_resonator_S-param_txt_out.i
$ Schema file  : C:\... \RLC_resonator_S-param_txt_out.n
$ Generated with APLAC Editor version 3.1.2
$ Wed Apr 20 17:00:28 2016
$ ------------------------------------------------------------}

Res R Port10 GND
+ 50

Cap C Port10 GND
+ 10.4938pF
Ind L Port10 GND
+ 0.2683nH
DefNPort nport 1
+ Port10 GND 50
Sweep "RLC Resonator"
+ LOOP 500 FREQ LIN 1GHz 5GHz
Print appendfile "ac_results.txt" real f bl real Mag(S(1,1)) bl real Pha(S(1,1)) lf
EndSweep
```

4. Write a parameterized Matlab file to drive APLAC simulation

```
% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
%                    Driving RLC_resonator_m.i from Matlab
%
% This function drives the APLAC file RLC_resonator_m.i from Matlab, and
% returns the S-parameters simulation results.
%
% Usage: [f,mS11,pS11] = RLC_resonator_Aplac(x)
%       x = [R(ohms)  L(nH)  C(pf)].
%       f: column vector of FP simulated frequency points (Hz).
%       mS11: magnitude of S11 (column vector of length FP).
%       pS11: phase of S11 in degrees (column vector of length FP).

function [f,mS11,pS11] = RLC_resonator_Aplac(x)

% APLAC Executable File in Command Line Mode
APLACroot = 'C:\"Program Files (x86)"\APLAC\';
APLACexe = [APLACroot '"APLAC 8.10 Student"\bin\aplac.exe']; % Student ver.
% APLACexe = [APLACroot '"APLAC 8.10 FLEXlm"\bin\aplac.exe']; % Professional ver.

% APLAC Project File Name
AplacProjectFileName = 'RLC_resonator_m.i';

% Define APLAC Script, as
as{1} = '$ ------------------------------------------------------------';
as{2} = '$ File     : C:\...\CB_AMP_txt_out_student_ver.i';
as{3} = '$ Schema file  : C:\...\CB_AMP_txt_out_student_ver.N';
as{4} = '$ Generated with APLAC Editor version 3.1.2';
as{5} = '$ Wed May 07 13:10:56 2014';
as{6} = '$ ------------------------------------------------------------';
as{7} = ['Res R Port10 GND ' mat2str(x(1))];
as{8} = ['Cap C Port10 GND ' mat2str(x(3))];
as{9} = ['Ind L Port10 GND ' mat2str(x(2))];
as{10} = 'DefNPort nport 1 Port10 GND 50';
as{11} = 'Sweep "RLC Resonator"';
as{12} = '+ LOOP 500 FREQ LIN  1GHz 5GHz';
as{13} = 'Print appendfile "ac_results.txt" real f bl real Mag(S(1,1)) bl real Pha(S(1,1))
lf';
as{14} = 'EndSweep';

% Save APLAC Script as a Circuit File in Matlab Working Directory
ckt_file = char(as);
[rows,~] = size(ckt_file);
fid = fopen(AplacProjectFileName,'w+');  % File identifier opened.
for i = 1:rows
   fprintf(fid, '%s', ckt_file(i,:)); % Save each row of ckt_file.
   fprintf(fid, '%s\r\n', '');
end
fclose(fid);  % File identifier closed.

% Run APLAC
system([APLACexe ' ' AplacProjectFileName ' -aq']);

% Read APLAC Output Files
load ac_results.txt
f = ac_results(:,1);
mS11 = ac_results(:,2);
pS11 = ac_results(:,3);

% Erase APLAC Output Files
delete ac_results.txt;
```

Testing the APLAC driver

```
% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
%     Ploting Responses of a Lumped RLC Resonator Simulated with APLAC

R = 50;          % Resistance (Ohms)
L = 0.2683e-9;   % Inductance (H).
C = 10.4938e-12; % Capacitance (F).

% Calculate Responses
x = [R L C];
[f,mS11,pS11] = RLC_resonator_Aplac(x);

% Plot Responses
figure
set(axes,'FontName','Times','FontSize',14,'Position',[0.15 0.15 0.75 0.7]);
grid on
hold on
plot(f*1e-9,mS11,'-k')
title('Lumped RLC Resonator')
xlabel('frequency (GHz)')
ylabel('{|\itS}_1_1|');

figure
set(axes,'FontName','Times','FontSize',14,'Position',[0.15 0.15 0.75 0.7]);
grid on
hold on
plot(f*1e-9,pS11,'-k')
title('Lumped RLC Resonator')
xlabel('frequency (GHz)')
ylabel('phase({\itS}_1_1)  (degrees)');
```