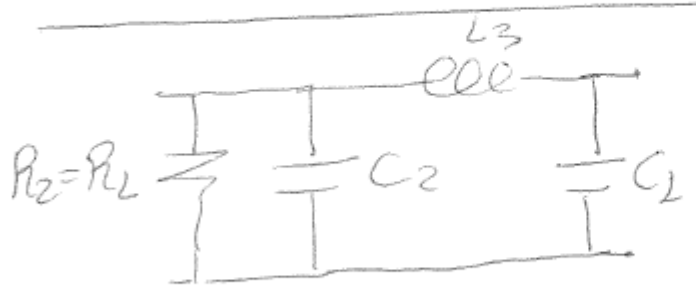
Progetto di base con MWO di un oscillatore Colpitts

Oscillatore $f = 1\,MHz$

carico $R_L = 1\,k\Omega$ $\quad V_p = 10\,V$



$$Q = Q_2 = \omega_0 C_2 R_2 > 10$$

$$2\pi \cdot 10^6 \cdot C_2 \cdot 10^3 > 10$$

$$C_2 > \frac{10}{2\pi \cdot 10^9} \simeq 1.6\,nF$$

$$\boxed{C_2 = 2.2\,nF}$$

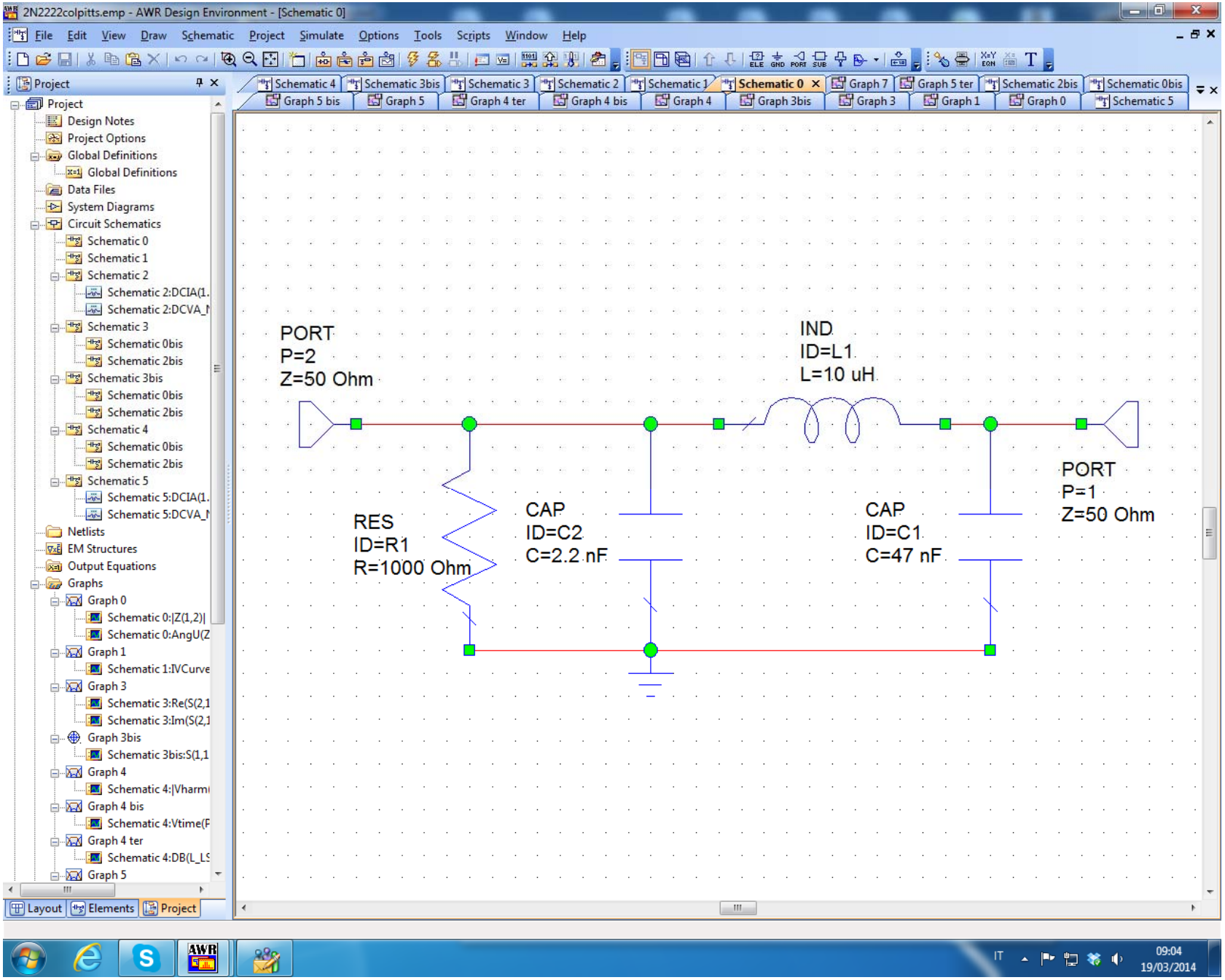
$$C_1 >> C_2 \simeq 20 C_2 \quad \Rightarrow \boxed{C_1 = 47\,nF}$$

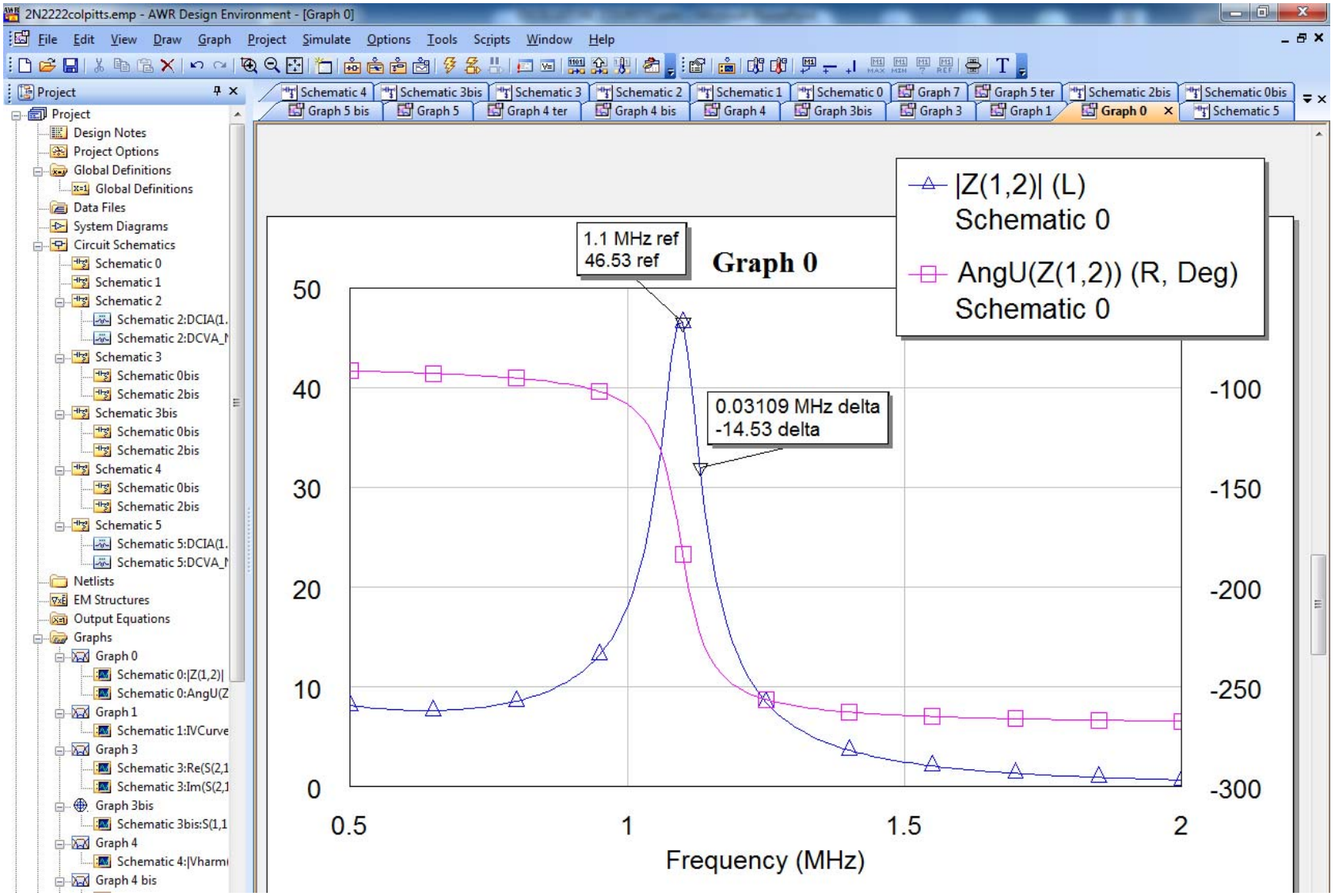
$$\omega_0^2 = \frac{1}{L\frac{C_1 C_2}{C_1 + C_2}} \simeq \frac{1}{L C_2}$$

$$f_0^2 (2\pi)^2 = \frac{1}{L C_2}$$

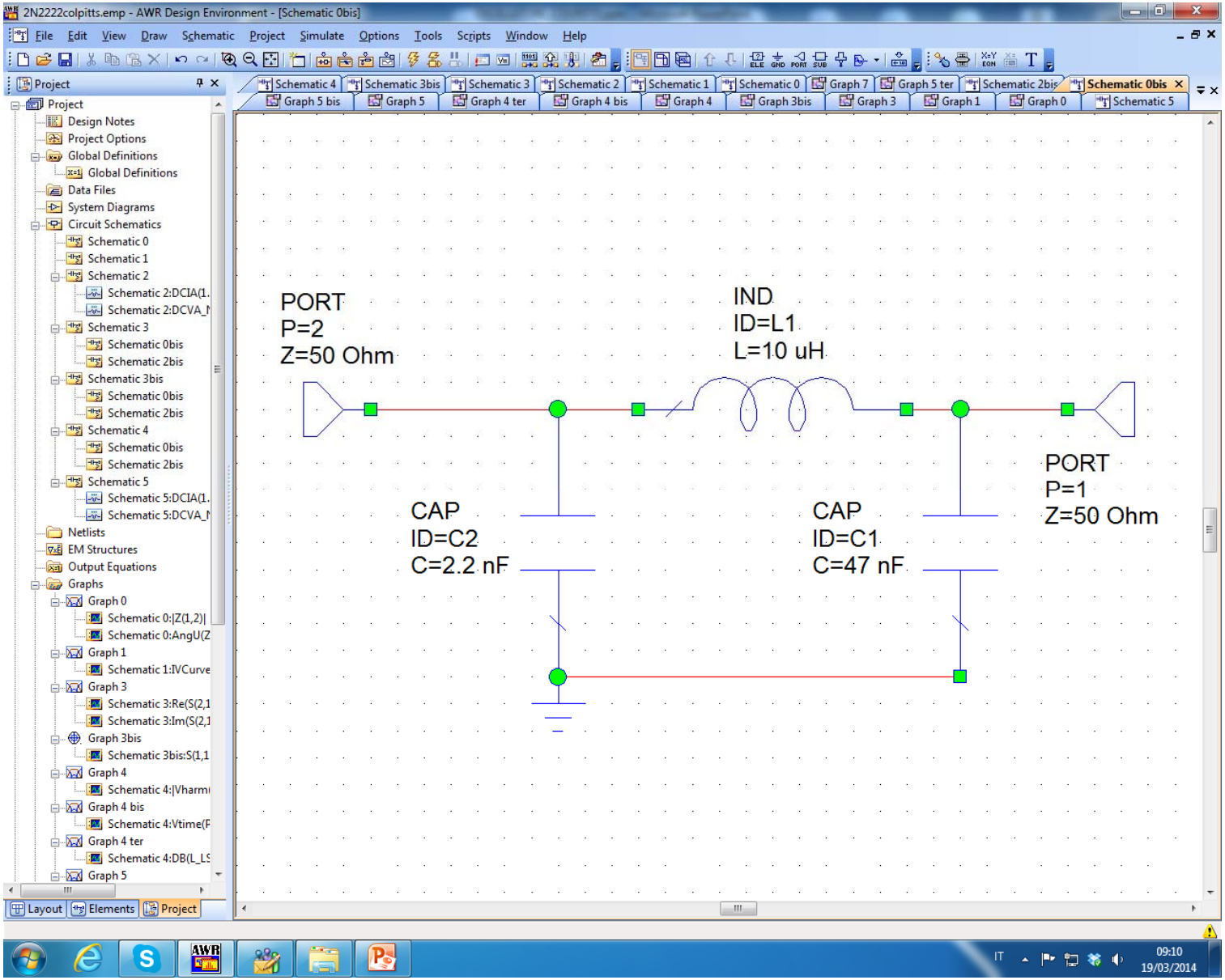
$$L = \frac{1}{f_0^2 (2\pi)^2 C_2} = \frac{1}{10^{12} 36 \; 22 \times 10^{-9}} \simeq 11\,\mu H$$

scegliamo $\boxed{L = 10\,\mu H}$

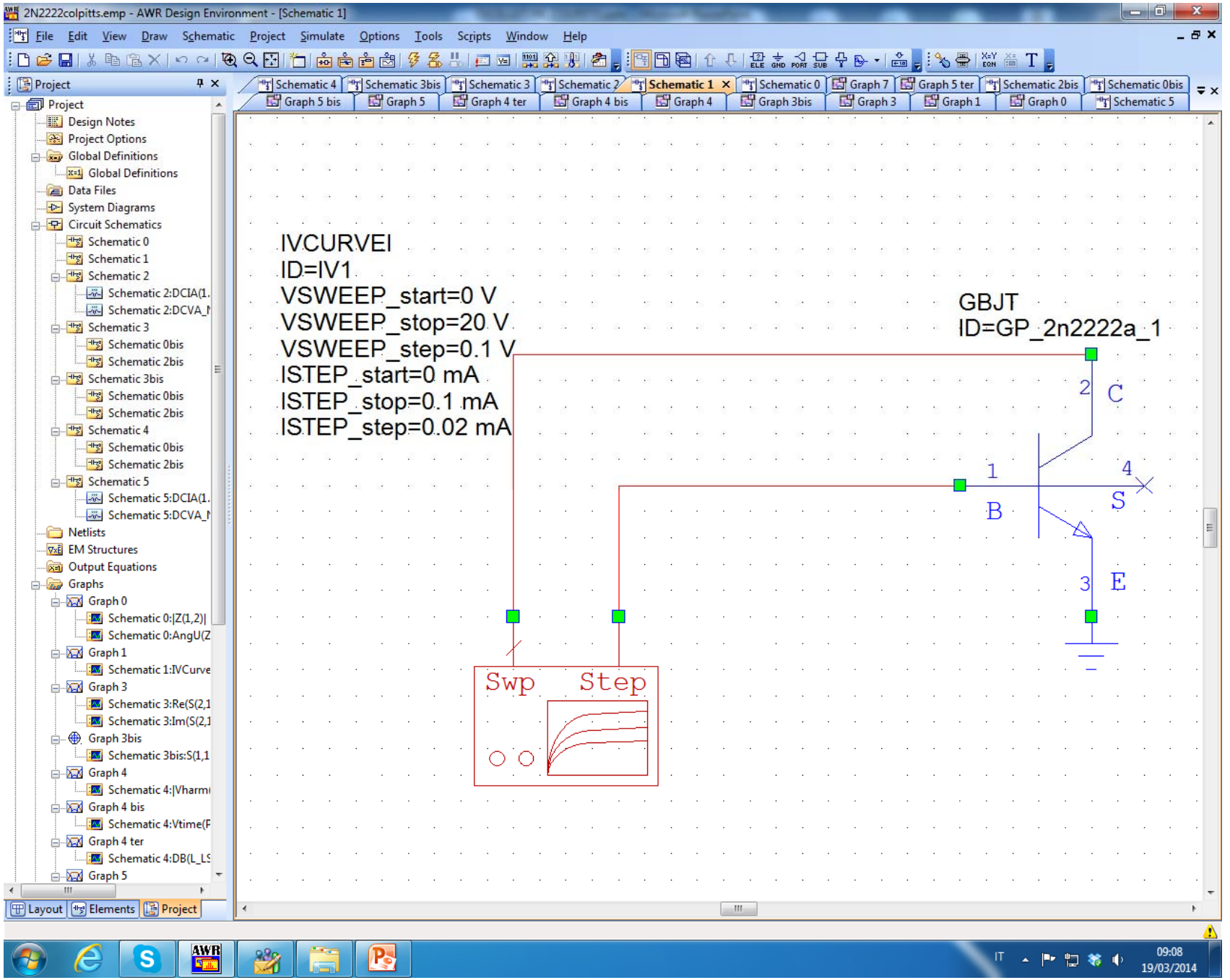

2N2222colpitts.emp - AWR Design Environment - [Schematic 0]
File Edit View Draw Schematic Project Simulate Options Tools Scripts Window Help
Project
Schematic 4 Schematic 3bis Schematic 3 Schematic 2 Schematic 1 Schematic 0 Graph 7 Graph 5 ter Schematic 2bis Schematic 0bis
Graph 5 bis Graph 5 Graph 4 ter Graph 4 bis Graph 4 Graph 3bis Graph 3 Graph 1 Graph 0 Schematic 5
Project
Design Notes
Project Options
Global Definitions
Global Definitions
Data Files
System Diagrams
Circuit Schematics
Schematic 0
Schematic 1
Schematic 2
Schematic 2:DCIA(1.
Schematic 2:DCVA_N
Schematic 3
Schematic 0bis
Schematic 2bis
Schematic 3bis
Schematic 0bis
Schematic 2bis
Schematic 4
Schematic 0bis
Schematic 2bis
Schematic 5
Schematic 5:DCIA(1.
Schematic 5:DCVA_N
Netlists
EM Structures
Output Equations
Graphs
Graph 0
Schematic 0:|Z(1,2)|
Schematic 0:AngU(Z
Graph 1
Schematic 1:IVCurve
Graph 3
Schematic 3:Re(S(2,1
Schematic 3:Im(S(2,1
Graph 3bis
Schematic 3bis:S(1,1
Graph 4
Schematic 4:|Vharm
Graph 4 bis
Schematic 4:Vtime(P
Graph 4 ter
Schematic 4:DB(L_LS
Graph 5
Layout Elements Project
PORT
P=2
Z=50 Ohm
IND
ID=L1
L=10 uH
PORT
P=1
Z=50 Ohm
RES
ID=R1
R=1000 Ohm
CAP
ID=C2
C=2.2 nF
CAP
ID=C1
C=47 nF
IT
09:04
19/03/2014

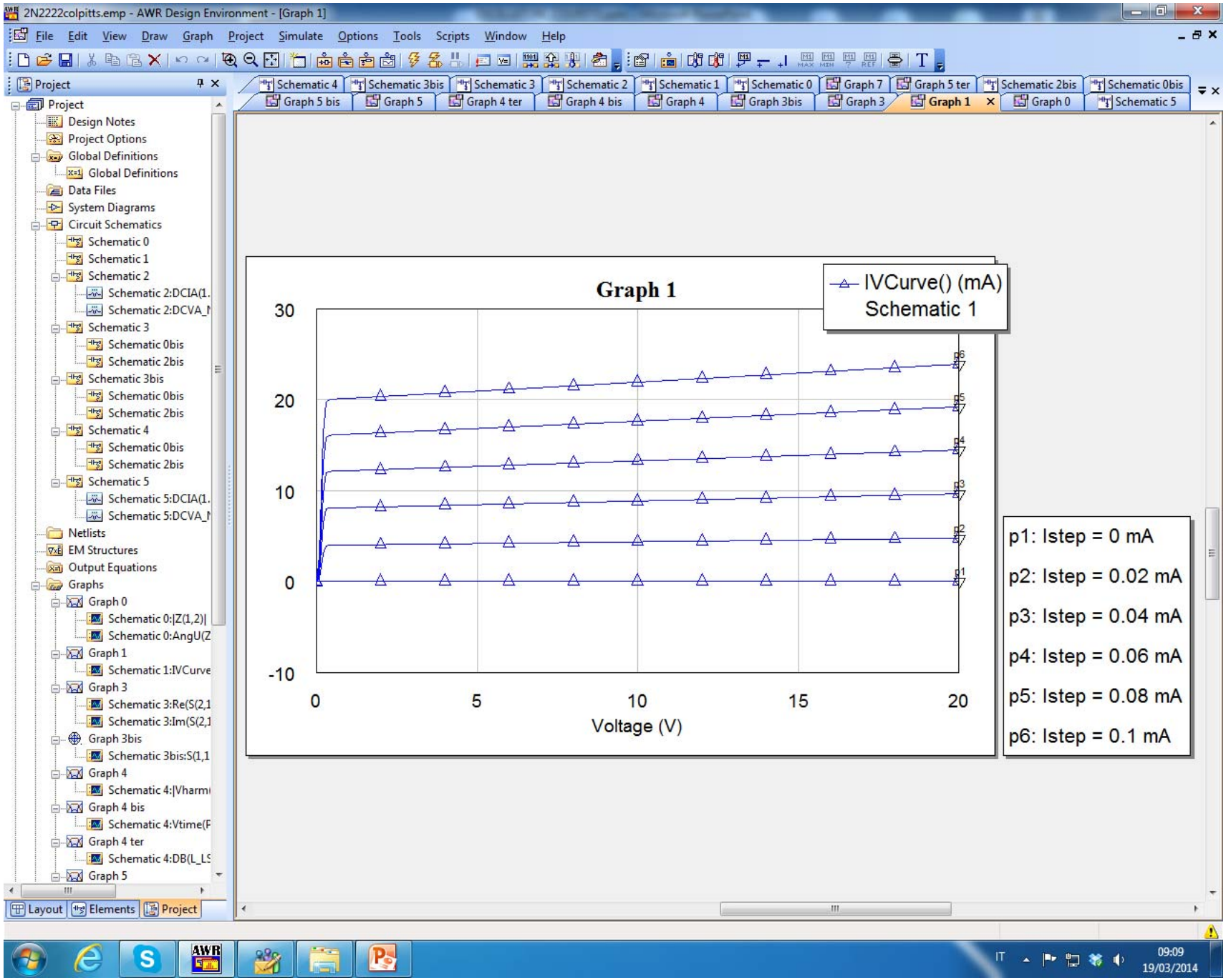


Il fattore di merito del circuito vale Q = 1.1/0.06 $\cong$ 18



Circuito bis senza il carico


2N2222colpitts.emp - AWR Design Environment - [Schematic 1]
File Edit View Draw Schematic Project Simulate Options Tools Scripts Window Help
Project
Design Notes
Project Options
Global Definitions
Data Files
System Diagrams
Circuit Schematics
Netlists
EM Structures
Output Equations
Graphs
Schematic 4 Schematic 3bis Schematic 3 Schematic 2 Schematic 1 Schematic 0 Graph 7 Graph 5 ter Schematic 2bis Schematic 0bis
Graph 5 bis Graph 5 Graph 4 ter Graph 4 bis Graph 4 Graph 3bis Graph 3 Graph 1 Graph 0 Schematic 5
IVCURVEI
ID=IV1
VSWEEP_start=0 V
VSWEEP_stop=20 V
VSWEEP_step=0.1 V
ISTEP_start=0 mA
ISTEP_stop=0.1 mA
ISTEP_step=0.02 mA
GBJT
ID=GP_2n2222a_1
2
C
1
B
4
S
3
E
Swp
Step
Layout Elements Project
IT
09:08
19/03/2014

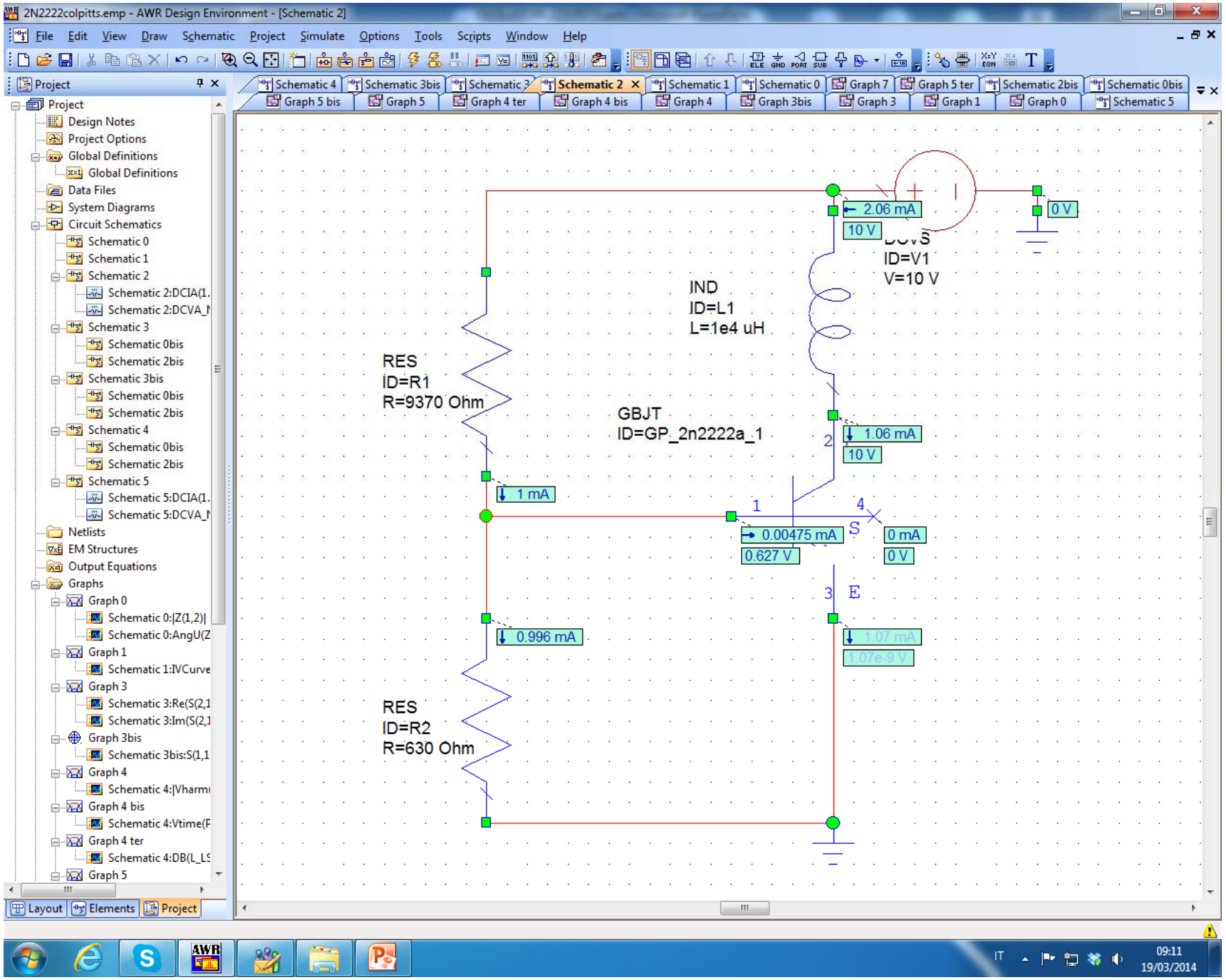

2N2222colpitts.emp - AWR Design Environment - [Graph 1]
File Edit View Draw Graph Project Simulate Options Tools Scripts Window Help
Project
Design Notes
Project Options
Global Definitions
Global Definitions
Data Files
System Diagrams
Circuit Schematics
Schematic 0
Schematic 1
Schematic 2
Schematic 2:DCIA(1.
Schematic 2:DCVA_N
Schematic 3
Schematic 0bis
Schematic 2bis
Schematic 3bis
Schematic 0bis
Schematic 2bis
Schematic 4
Schematic 0bis
Schematic 2bis
Schematic 5
Schematic 5:DCIA(1.
Schematic 5:DCVA_N
Netlists
EM Structures
Output Equations
Graphs
Graph 0
Schematic 0:|Z(1,2)|
Schematic 0:AngU(Z
Graph 1
Schematic 1:IVCurve
Graph 3
Schematic 3:Re(S(2,1
Schematic 3:Im(S(2,1
Graph 3bis
Schematic 3bis:S(1,1
Graph 4
Schematic 4:|Vharm
Graph 4 bis
Schematic 4:Vtime(F
Graph 4 ter
Schematic 4:DB(L_LS
Graph 5
Layout Elements Project
Schematic 4 Schematic 3bis Schematic 3 Schematic 2 Schematic 1 Schematic 0 Graph 7 Graph 5 ter Schematic 2bis Schematic 0bis
Graph 5 bis Graph 5 Graph 4 ter Graph 4 bis Graph 4 Graph 3bis Graph 3 Graph 1 Graph 0 Schematic 5
Graph 1
IVCurve() (mA)
Schematic 1
30
20
10
0
-10
0
5
10
15
20
Voltage (V)
p1: Istep = 0 mA
p2: Istep = 0.02 mA
p3: Istep = 0.04 mA
p4: Istep = 0.06 mA
p5: Istep = 0.08 mA
p6: Istep = 0.1 mA
IT
09:09
19/03/2014

$$g_m R_2 \geq \frac{C_1}{C_2}$$

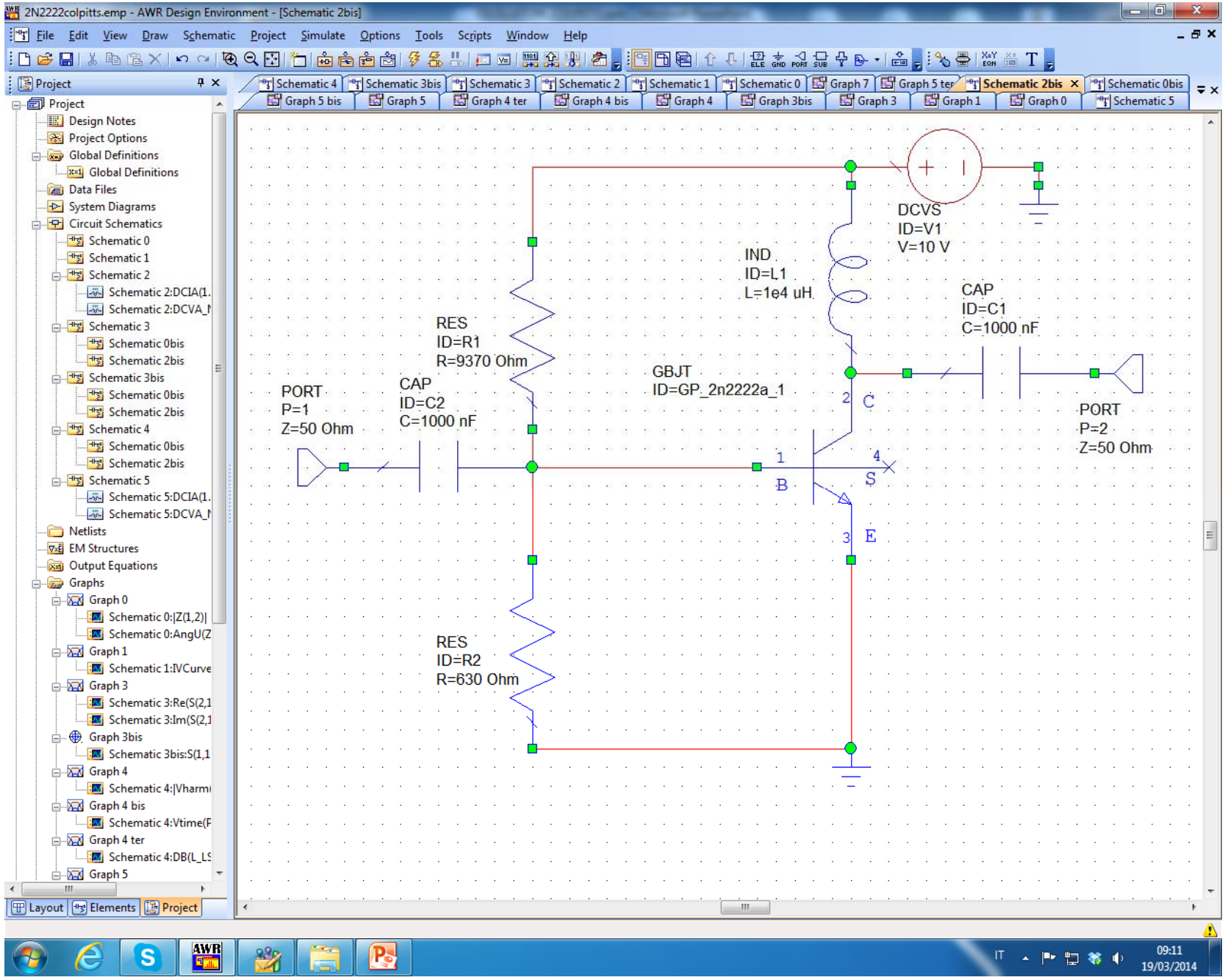
$$g_m = \frac{I_C}{V_T}$$

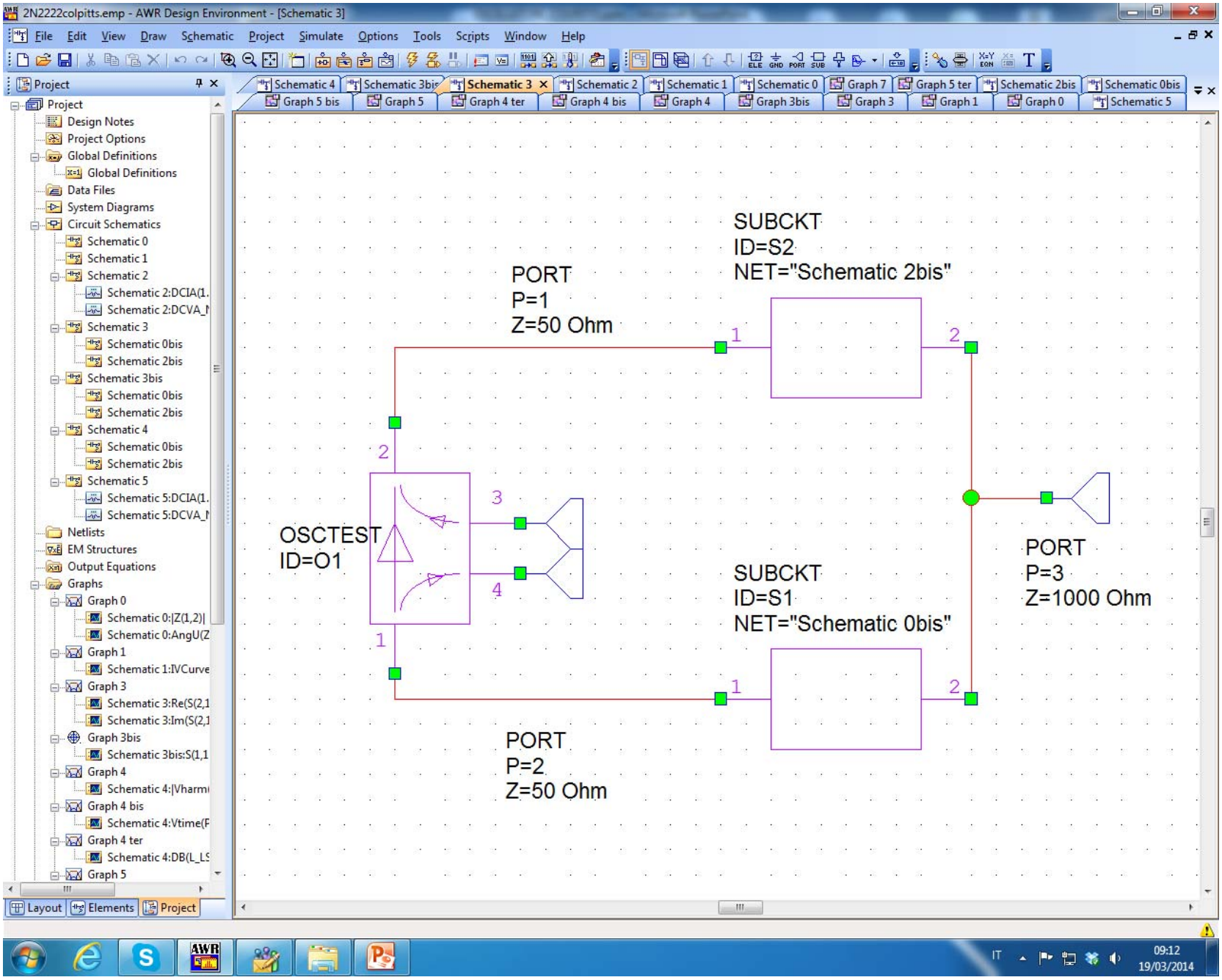
$$I_C \geq \frac{C_1}{C_2} \cdot \frac{V_T}{R_2} = \frac{47}{22} \cdot \frac{26 \times 10^{-3}}{10^3} = 0.56\,mA$$

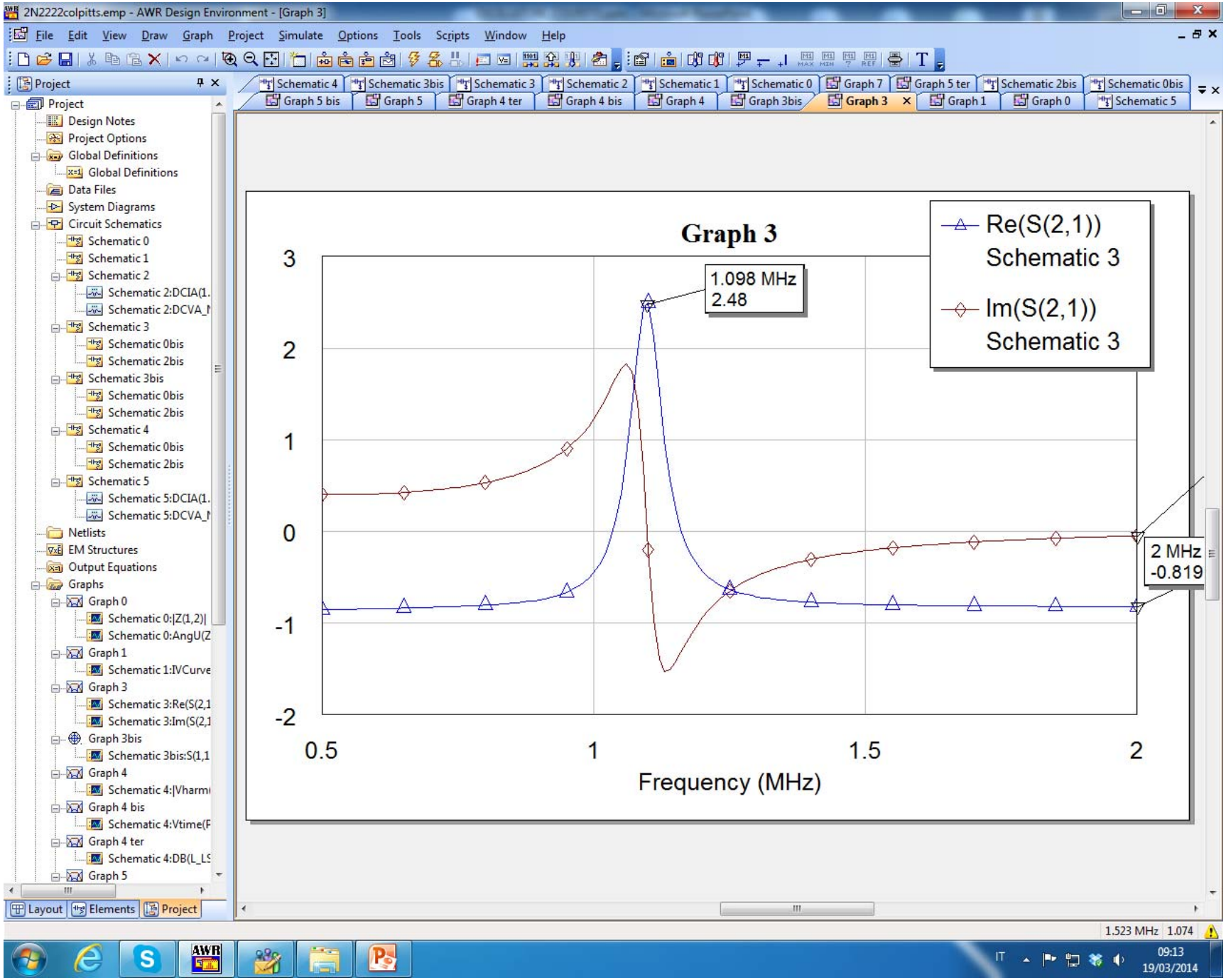
$$\boxed{I_C = 1\,mA} \qquad \boxed{V_{cc} = 10\,V}$$

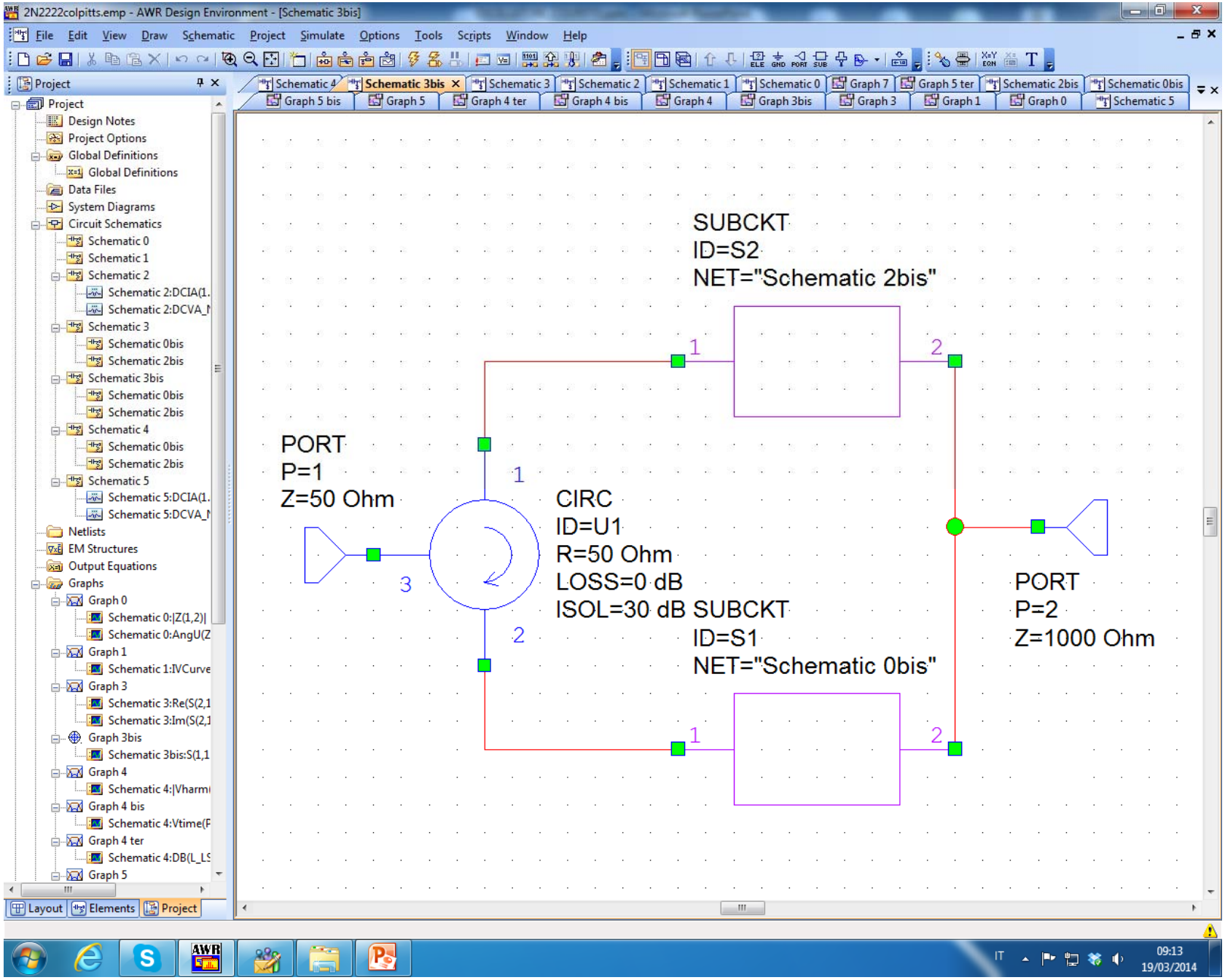

2N2222colpitts.emp - AWR Design Environment - [Schematic 2]
File Edit View Draw Schematic Project Simulate Options Tools Scripts Window Help
Project
Design Notes
Project Options
Global Definitions
Global Definitions
Data Files
System Diagrams
Circuit Schematics
Schematic 0
Schematic 1
Schematic 2
Schematic 2:DCIA(1.
Schematic 2:DCVA_N
Schematic 3
Schematic 0bis
Schematic 2bis
Schematic 3bis
Schematic 0bis
Schematic 2bis
Schematic 4
Schematic 0bis
Schematic 2bis
Schematic 5
Schematic 5:DCIA(1.
Schematic 5:DCVA_N
Netlists
EM Structures
Output Equations
Graphs
Graph 0
Schematic 0:|Z(1,2)|
Schematic 0:AngU(Z
Graph 1
Schematic 1:IVCurve
Graph 3
Schematic 3:Re(S(2,1
Schematic 3:Im(S(2,1
Graph 3bis
Schematic 3bis:S(1,1
Graph 4
Schematic 4:|Vharm
Graph 4 bis
Schematic 4:Vtime(P
Graph 4 ter
Schematic 4:DB(L_LS
Graph 5
Layout Elements Project
Schematic 4 Schematic 3bis Schematic 3 Schematic 2 Schematic 1 Schematic 0 Graph 7 Graph 5 ter Schematic 2bis Schematic 0bis
Graph 5 bis Graph 5 Graph 4 ter Graph 4 bis Graph 4 Graph 3bis Graph 3 Graph 1 Graph 0 Schematic 5
2.06 mA
10 V
0 V
DCVS
ID=V1
V=10 V
IND
ID=L1
L=1e4 uH
RES
ID=R1
R=9370 Ohm
GBJT
ID=GP_2n2222a_1
1.06 mA
10 V
1 mA
0.00475 mA
0.627 V
0 mA
0 V
0.996 mA
1.07 mA
1.07e-9 V
RES
ID=R2
R=630 Ohm
IT
09:11
19/03/2014

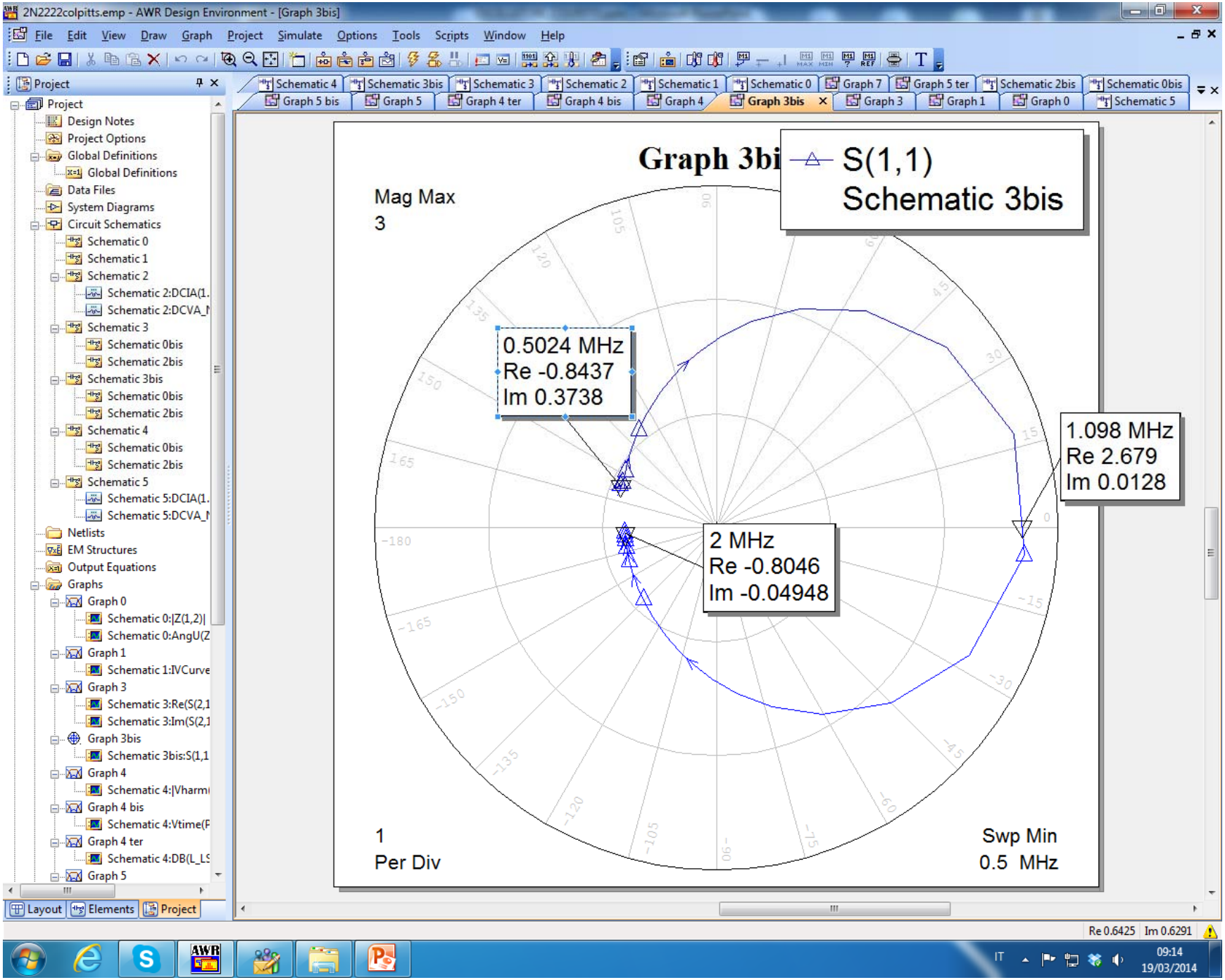
- La coppia di resistenze sulla base si determina a partire da una Vbe di circa 0.6 V e poi per tentativi si cerca il valore che realizza Ic = 1 mA
- (DRAW Add Annotation DCIA e DCVA_N
- L'induttanza L si dimensiona imponendo che la sua reattanza alla frequenza di oscillazione sia almeno 50 volte più grande della resistenza del carico
- I condensatori di blocco si dimensionano imponendo che la loro reattanza alla frequenza di oscillazione sia inferiore ad 1 Ω

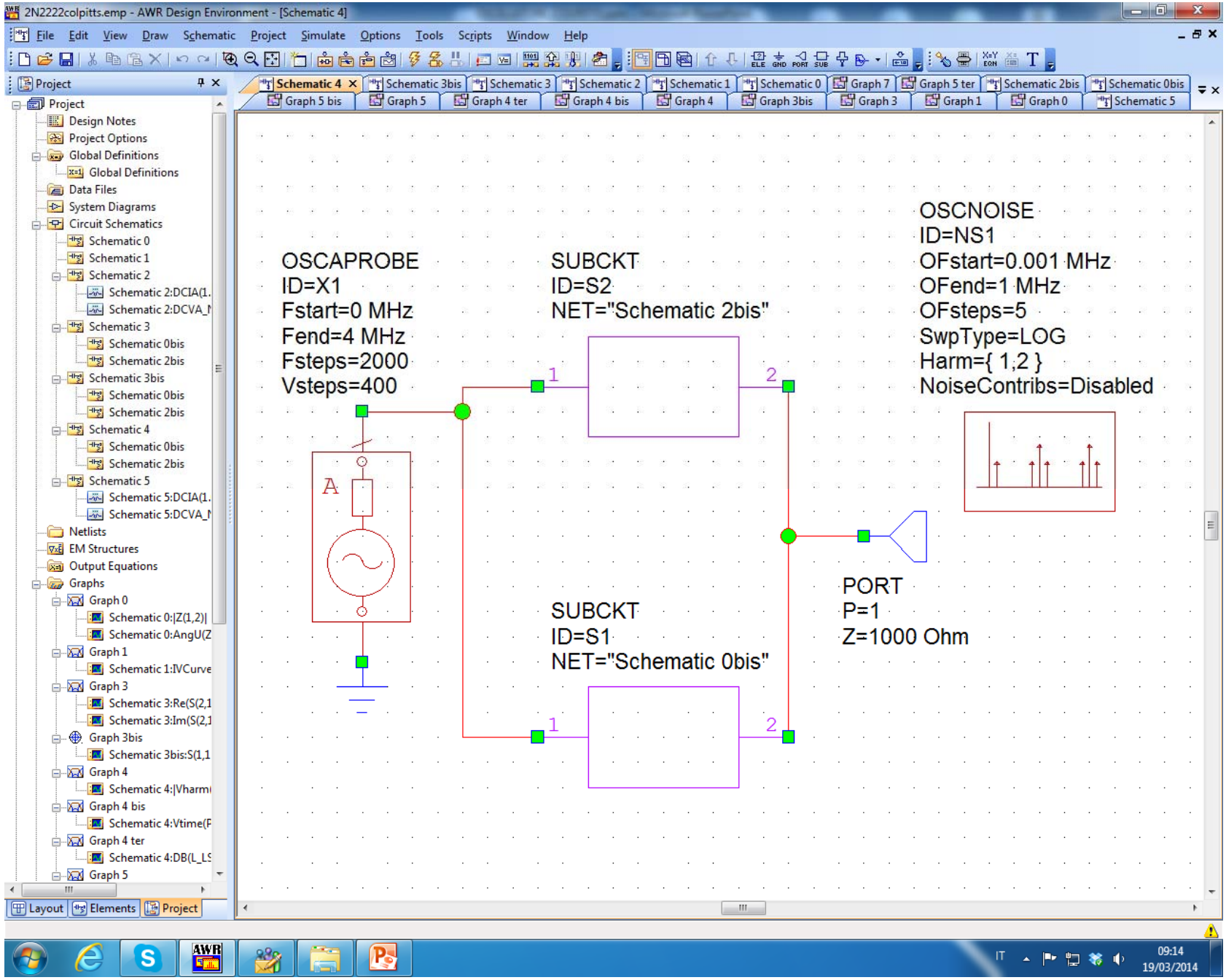

2N2222colpitts.emp - AWR Design Environment - [Schematic 2bis]
File Edit View Draw Schematic Project Simulate Options Tools Scripts Window Help
Project
Project
Design Notes
Project Options
Global Definitions
Global Definitions
Data Files
System Diagrams
Circuit Schematics
Schematic 0
Schematic 1
Schematic 2
Schematic 2:DCIA(1.
Schematic 2:DCVA_N
Schematic 3
Schematic 0bis
Schematic 2bis
Schematic 3bis
Schematic 0bis
Schematic 2bis
Schematic 4
Schematic 0bis
Schematic 2bis
Schematic 5
Schematic 5:DCIA(1.
Schematic 5:DCVA_N
Netlists
EM Structures
Output Equations
Graphs
Graph 0
Schematic 0:|Z(1,2)|
Schematic 0:AngU(Z
Graph 1
Schematic 1:IVCurve
Graph 3
Schematic 3:Re(S(2,1
Schematic 3:Im(S(2,1
Graph 3bis
Schematic 3bis:S(1,1
Graph 4
Schematic 4:|Vharmi
Graph 4 bis
Schematic 4:Vtime(P
Graph 4 ter
Schematic 4:DB(L_LS
Graph 5
Layout Elements Project
Schematic 4 Schematic 3bis Schematic 3 Schematic 2 Schematic 1 Schematic 0 Graph 7 Graph 5 ter Schematic 2bis Schematic 0bis
Graph 5 bis Graph 5 Graph 4 ter Graph 4 bis Graph 4 Graph 3bis Graph 3 Graph 1 Graph 0 Schematic 5
DCVS
ID=V1
V=10 V
IND
ID=L1
L=1e4 uH
CAP
ID=C1
C=1000 nF
RES
ID=R1
R=9370 Ohm
GBJT
ID=GP_2n2222a_1
PORT
P=1
Z=50 Ohm
CAP
ID=C2
C=1000 nF
2
C
1
B
4
S
3
E
PORT
P=2
Z=50 Ohm
RES
ID=R2
R=630 Ohm
IT
09:11
19/03/2014

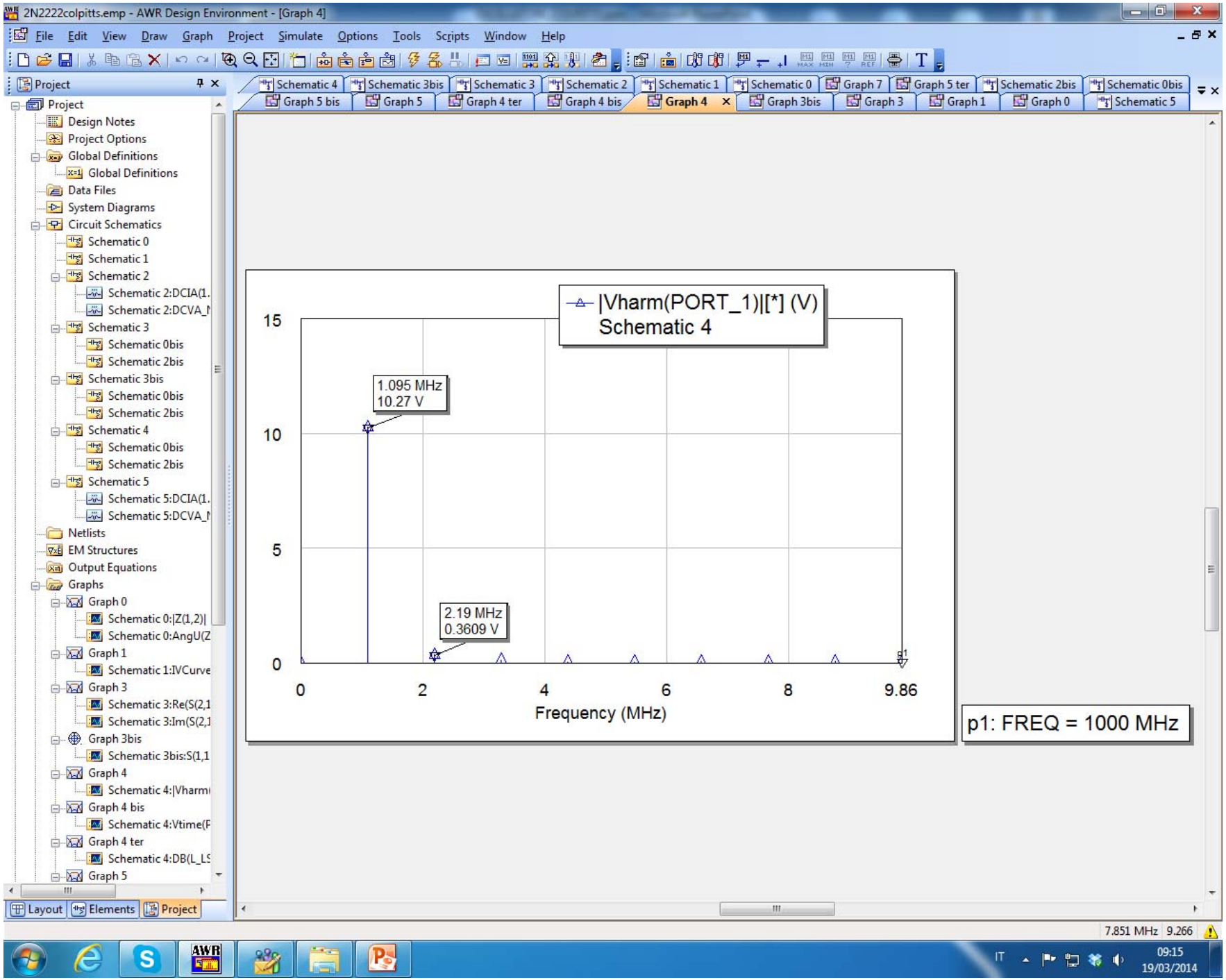

2N2222colpitts.emp - AWR Design Environment - [Schematic 3]
File Edit View Draw Schematic Project Simulate Options Tools Scripts Window Help
Project
Design Notes
Project Options
Global Definitions
Global Definitions
Data Files
System Diagrams
Circuit Schematics
Schematic 0
Schematic 1
Schematic 2
Schematic 2:DCIA(1.
Schematic 2:DCVA_N
Schematic 3
Schematic 0bis
Schematic 2bis
Schematic 3bis
Schematic 0bis
Schematic 2bis
Schematic 4
Schematic 0bis
Schematic 2bis
Schematic 5
Schematic 5:DCIA(1.
Schematic 5:DCVA_N
Netlists
EM Structures
Output Equations
Graphs
Graph 0
Schematic 0:|Z(1,2)|
Schematic 0:AngU(Z
Graph 1
Schematic 1:IVCurve
Graph 3
Schematic 3:Re(S(2,1
Schematic 3:Im(S(2,1
Graph 3bis
Schematic 3bis:S(1,1
Graph 4
Schematic 4:|Vharm
Graph 4 bis
Schematic 4:Vtime(P
Graph 4 ter
Schematic 4:DB(L_LS
Graph 5
Layout Elements Project
Schematic 4 Schematic 3bis Schematic 3 Schematic 2 Schematic 1 Schematic 0 Graph 7 Graph 5 ter Schematic 2bis Schematic 0bis
Graph 5 bis Graph 5 Graph 4 ter Graph 4 bis Graph 4 Graph 3bis Graph 3 Graph 1 Graph 0 Schematic 5
SUBCKT
ID=S2
NET="Schematic 2bis"
PORT
P=1
Z=50 Ohm
1
2
2
3
4
1
OSCTEST
ID=O1
PORT
P=3
Z=1000 Ohm
SUBCKT
ID=S1
NET="Schematic 0bis"
1
2
PORT
P=2
Z=50 Ohm
IT
09:12
19/03/2014

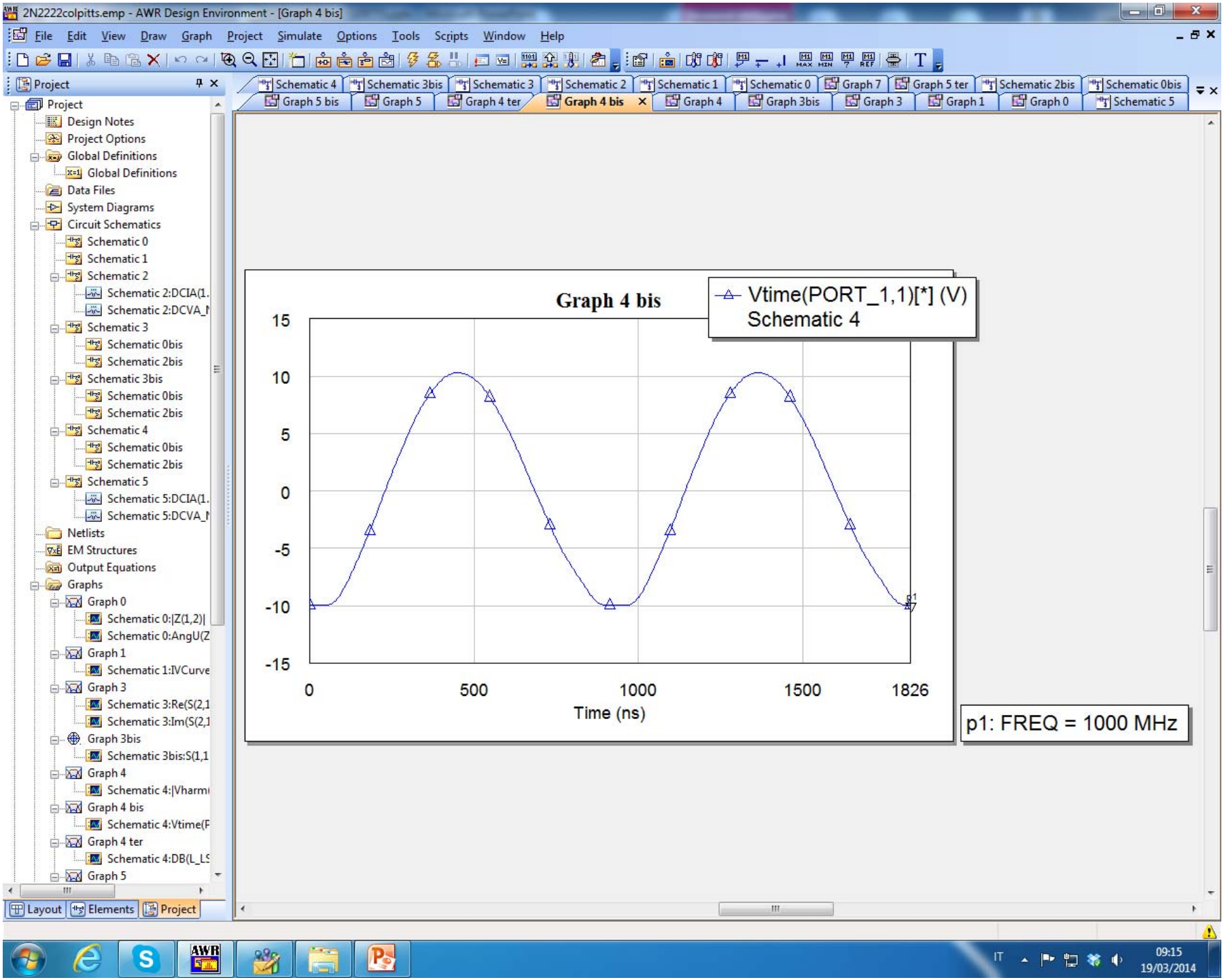

2N2222colpitts.emp - AWR Design Environment - [Graph 3]
File Edit View Draw Graph Project Simulate Options Tools Scripts Window Help
Project
Design Notes
Project Options
Global Definitions
Data Files
System Diagrams
Circuit Schematics
Netlists
EM Structures
Output Equations
Graphs
Schematic 4 Schematic 3bis Schematic 3 Schematic 2 Schematic 1 Schematic 0 Graph 7 Graph 5 ter Schematic 2bis Schematic 0bis
Graph 5 bis Graph 5 Graph 4 ter Graph 4 bis Graph 4 Graph 3bis Graph 3 Graph 1 Graph 0 Schematic 5
Graph 3
Re(S(2,1))
Schematic 3
Im(S(2,1))
Schematic 3
1.098 MHz
2.48
2 MHz
-0.819
3
2
1
0
-1
-2
0.5
1
1.5
2
Frequency (MHz)
Layout Elements Project
1.523 MHz 1.074
IT
09:13
19/03/2014

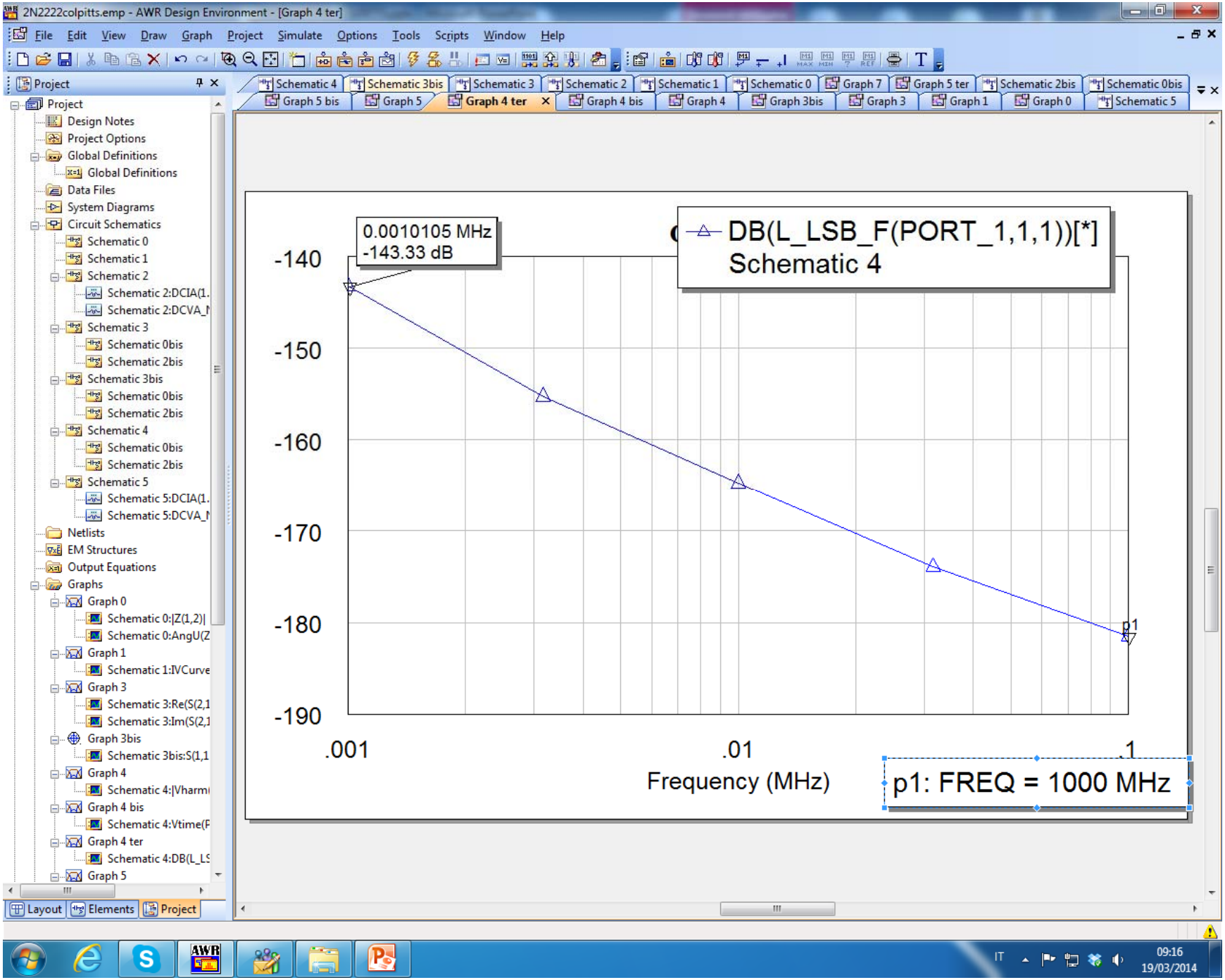

2N2222colpitts.emp - AWR Design Environment - [Schematic 3bis]
File Edit View Draw Schematic Project Simulate Options Tools Scripts Window Help
Project
Project
Design Notes
Project Options
Global Definitions
Global Definitions
Data Files
System Diagrams
Circuit Schematics
Schematic 0
Schematic 1
Schematic 2
Schematic 2:DCIA(1.
Schematic 2:DCVA_N
Schematic 3
Schematic 0bis
Schematic 2bis
Schematic 3bis
Schematic 0bis
Schematic 2bis
Schematic 4
Schematic 0bis
Schematic 2bis
Schematic 5
Schematic 5:DCIA(1.
Schematic 5:DCVA_N
Netlists
EM Structures
Output Equations
Graphs
Graph 0
Schematic 0:|Z(1,2)|
Schematic 0:AngU(Z
Graph 1
Schematic 1:IVCurve
Graph 3
Schematic 3:Re(S(2,1
Schematic 3:Im(S(2,1
Graph 3bis
Schematic 3bis:S(1,1
Graph 4
Schematic 4:|Vharmi
Graph 4 bis
Schematic 4:Vtime(F
Graph 4 ter
Schematic 4:DB(L_LS
Graph 5
Layout Elements Project
Schematic 4 Schematic 3bis Schematic 3 Schematic 2 Schematic 1 Schematic 0 Graph 7 Graph 5 ter Schematic 2bis Schematic 0bis
Graph 5 bis Graph 5 Graph 4 ter Graph 4 bis Graph 4 Graph 3bis Graph 3 Graph 1 Graph 0 Schematic 5
SUBCKT
ID=S2
NET="Schematic 2bis"
1
2
PORT
P=1
Z=50 Ohm
1
CIRC
ID=U1
R=50 Ohm
LOSS=0 dB
ISOL=30 dB
3
2
SUBCKT
ID=S1
NET="Schematic 0bis"
PORT
P=2
Z=1000 Ohm
1
2
IT
09:13
19/03/2014


2N2222colpitts.emp - AWR Design Environment - [Graph 3bis]
File Edit View Draw Graph Project Simulate Options Tools Scripts Window Help
Project
Project
Design Notes
Project Options
Global Definitions
Global Definitions
Data Files
System Diagrams
Circuit Schematics
Schematic 0
Schematic 1
Schematic 2
Schematic 2:DCIA(1.
Schematic 2:DCVA_N
Schematic 3
Schematic 0bis
Schematic 2bis
Schematic 3bis
Schematic 0bis
Schematic 2bis
Schematic 4
Schematic 0bis
Schematic 2bis
Schematic 5
Schematic 5:DCIA(1.
Schematic 5:DCVA_N
Netlists
EM Structures
Output Equations
Graphs
Graph 0
Schematic 0:|Z(1,2)|
Schematic 0:AngU(Z
Graph 1
Schematic 1:IVCurve
Graph 3
Schematic 3:Re(S(2,1
Schematic 3:Im(S(2,1
Graph 3bis
Schematic 3bis:S(1,1
Graph 4
Schematic 4:|Vharm
Graph 4 bis
Schematic 4:Vtime(P
Graph 4 ter
Schematic 4:DB(L_LS
Graph 5
Layout Elements Project
Schematic 4 Schematic 3bis Schematic 3 Schematic 2 Schematic 1 Schematic 0 Graph 7 Graph 5 ter Schematic 2bis Schematic 0bis
Graph 5 bis Graph 5 Graph 4 ter Graph 4 bis Graph 4 Graph 3bis Graph 3 Graph 1 Graph 0 Schematic 5
Graph 3bi
S(1,1)
Schematic 3bis
Mag Max
3
0.5024 MHz
Re -0.8437
Im 0.3738
1.098 MHz
Re 2.679
Im 0.0128
2 MHz
Re -0.8046
Im -0.04948
1
Per Div
Swp Min
0.5 MHz
Re 0.6425 Im 0.6291
IT
09:14
19/03/2014


2N2222colpitts.emp - AWR Design Environment - [Schematic 4]
File Edit View Draw Schematic Project Simulate Options Tools Scripts Window Help
Project
Design Notes
Project Options
Global Definitions
Data Files
System Diagrams
Circuit Schematics
Netlists
EM Structures
Output Equations
Graphs
Layout Elements Project
Schematic 4 Schematic 3bis Schematic 3 Schematic 2 Schematic 1 Schematic 0 Graph 7 Graph 5 ter Schematic 2bis Schematic 0bis
Graph 5 bis Graph 5 Graph 4 ter Graph 4 bis Graph 4 Graph 3bis Graph 3 Graph 1 Graph 0 Schematic 5
OSCAPROBE
ID=X1
Fstart=0 MHz
Fend=4 MHz
Fsteps=2000
Vsteps=400
SUBCKT
ID=S2
NET="Schematic 2bis"
OSCNOISE
ID=NS1
OFstart=0.001 MHz
OFend=1 MHz
OFsteps=5
SwpType=LOG
Harm={ 1,2 }
NoiseContribs=Disabled
PORT
P=1
Z=1000 Ohm
SUBCKT
ID=S1
NET="Schematic 0bis"
A
1
2
1
2
IT
09:14
19/03/2014


2N2222colpitts.emp - AWR Design Environment - [Graph 4]
File Edit View Draw Graph Project Simulate Options Tools Scripts Window Help
Project
Design Notes
Project Options
Global Definitions
Data Files
System Diagrams
Circuit Schematics
Netlists
EM Structures
Output Equations
Graphs
Schematic 4
Schematic 3bis
Schematic 3
Schematic 2
Schematic 1
Schematic 0
Graph 7
Graph 5 ter
Schematic 2bis
Schematic 0bis
Graph 5 bis
Graph 5
Graph 4 ter
Graph 4 bis
Graph 4
Graph 3bis
Graph 3
Graph 1
Graph 0
Schematic 5
|Vharm(PORT_1)|[*] (V)
Schematic 4
1.095 MHz
10.27 V
2.19 MHz
0.3609 V
15
10
5
0
0
2
4
6
8
9.86
Frequency (MHz)
p1: FREQ = 1000 MHz
Layout
Elements
Project
7.851 MHz
9.266
IT
09:15
19/03/2014


2N2222colpitts.emp - AWR Design Environment - [Graph 4 bis]
File Edit View Draw Graph Project Simulate Options Tools Scripts Window Help
Project
Project
Design Notes
Project Options
Global Definitions
Global Definitions
Data Files
System Diagrams
Circuit Schematics
Schematic 0
Schematic 1
Schematic 2
Schematic 2:DCIA(1.
Schematic 2:DCVA_N
Schematic 3
Schematic 0bis
Schematic 2bis
Schematic 3bis
Schematic 0bis
Schematic 2bis
Schematic 4
Schematic 0bis
Schematic 2bis
Schematic 5
Schematic 5:DCIA(1.
Schematic 5:DCVA_N
Netlists
EM Structures
Output Equations
Graphs
Graph 0
Schematic 0:|Z(1,2)|
Schematic 0:AngU(Z
Graph 1
Schematic 1:IVCurve
Graph 3
Schematic 3:Re(S(2,1
Schematic 3:Im(S(2,1
Graph 3bis
Schematic 3bis:S(1,1
Graph 4
Schematic 4:|Vharm
Graph 4 bis
Schematic 4:Vtime(P
Graph 4 ter
Schematic 4:DB(L_LS
Graph 5
Layout Elements Project
Schematic 4 Schematic 3bis Schematic 3 Schematic 2 Schematic 1 Schematic 0 Graph 7 Graph 5 ter Schematic 2bis Schematic 0bis
Graph 5 bis Graph 5 Graph 4 ter Graph 4 bis Graph 4 Graph 3bis Graph 3 Graph 1 Graph 0 Schematic 5
Graph 4 bis
Vtime(PORT_1,1)[*] (V)
Schematic 4
15
10
5
0
-5
-10
-15
0
500
1000
1500
1826
Time (ns)
p1
p1: FREQ = 1000 MHz
IT
09:15
19/03/2014


2N2222colpitts.emp - AWR Design Environment - [Graph 4 ter]
File Edit View Draw Graph Project Simulate Options Tools Scripts Window Help
Project
Schematic 4 Schematic 3bis Schematic 3 Schematic 2 Schematic 1 Schematic 0 Graph 7 Graph 5 ter Schematic 2bis Schematic 0bis
Graph 5 bis Graph 5 Graph 4 ter Graph 4 bis Graph 4 Graph 3bis Graph 3 Graph 1 Graph 0 Schematic 5
0.0010105 MHz
-143.33 dB
DB(L_LSB_F(PORT_1,1,1))[*]
Schematic 4
-140
-150
-160
-170
-180
-190
.001
.01
.1
Frequency (MHz)
p1
p1: FREQ = 1000 MHz
Layout Elements Project
09:16
19/03/2014