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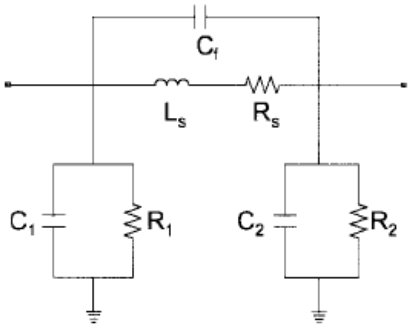
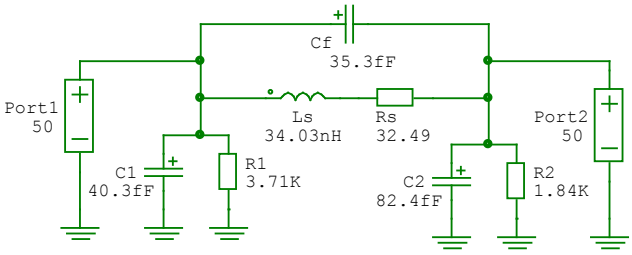
S-PARAMETERS OF A SPIRAL INDUCTOR

The following equivalent circuit can be used to model squared spiral inductors on standard CMOS technology. The circuit parameter values are given in the table for different values of N (number of turns in the spiral). Simulate in APLAC the case for $N = 12$. Measure $|S_{11}|$ and $|S_{21}|$ in dB, from 20 MHz to 20 GHz in logarithmic scale, assuming a reference impedance of 50 Ω.



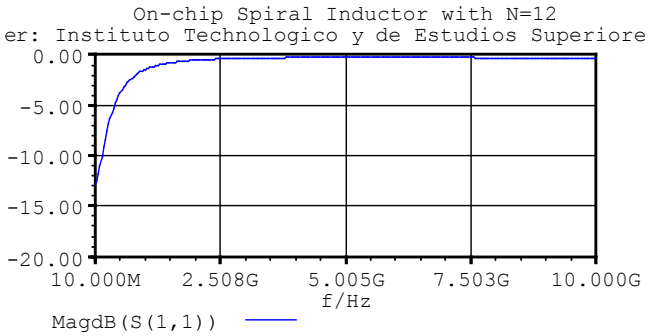
SUMMARY OF EXTRACTED EQUIVALENT CIRCUIT MODEL PARAMETERS FOR THE VARIOUS KINDS OF RECTANGULAR SPIRAL INDUCTORS WITH THE DIFFERENT N AT INNER DIAMETER OF 100 μm. THE METAL WIDTH AND SPACING OF INDUCTORS ARE 10 AND 2 μm, RESPECTIVELY

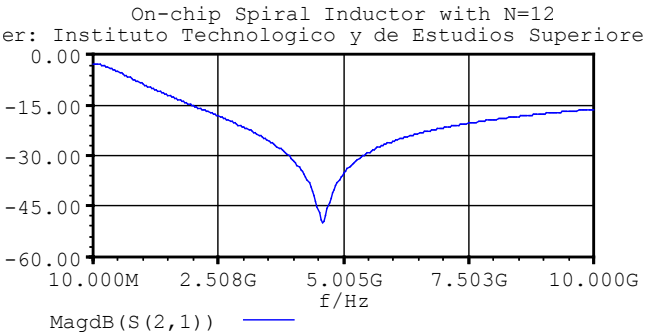
N	L_s (nH)	R_s (Ω)	C_f (fF)	C_1 (fF)	C_2 (fF)	R_1 (KΩ)	R_2 (KΩ)
12	34.03	32.49	35.3	40.3	82.4	3.71	1.84
10	22.05	26.31	31.4	26.2	52.7	5.49	3.26
8	13.10	19.26	25.6	20.9	37.1	7.11	5.97
6	6.84	13.06	18.0	15.5	23.0	6.63	5.57
4	2.85	7.87	9.0	12.6	14.8	12.26	18.78



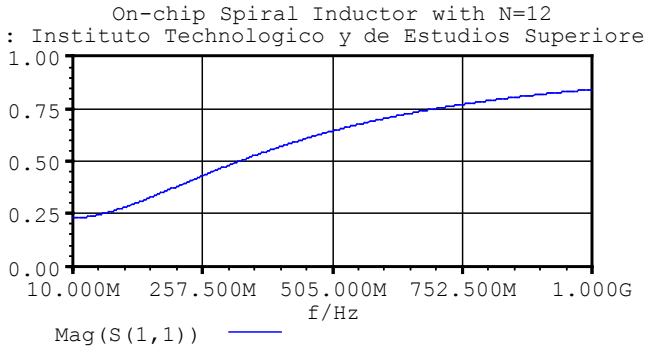

```
Sweep
"On-chip Spiral Inductor with N=12"
LOOP 300 FREQ LIN 10MEGHz 10GHz
WINDOW=0 grid Y "" "" -20 0
WINDOW=1 grid Y "" "" -60 0

Show W=0 Y MagdB(S(1,1))
Show W=1 Y MagdB(S(2,1))
EndSweep
```

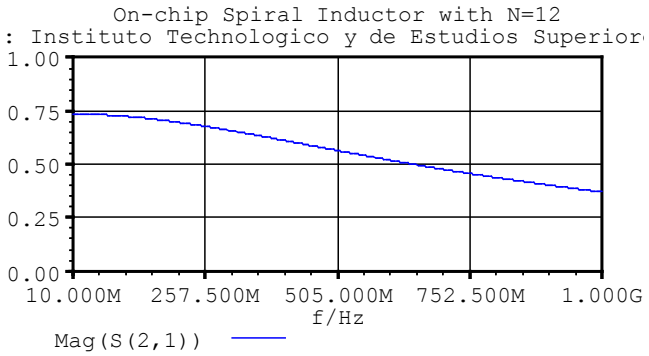
```
Cap C2 Port20 GND
+ 82.4fF
Cap C1 Port10 GND
+ 40.3fF
Ind Ls Port10 node1
+ 34.03nH
Res R2 Port20 GND
+ 1.84K
Res Rs Port20 node1
+ 32.49
Res R1 Port10 GND
+ 3.71K
Cap Cf Port10 Port20
+ 35.3fF
DefNPort nport 2
+ Port10 GND 50
+ Port20 GND 50
Sweep "On-chip Spiral Inductor with N=12"
+ LOOP 300 FREQ LIN 10MEGHz 10GHz
+ WINDOW=0 grid Y "" "" -20 0
+ WINDOW=1 grid Y "" "" -60 0
Show W=0 Y MagdB(S(1,1))
Show W=1 Y MagdB(S(2,1))
EndSweep
```

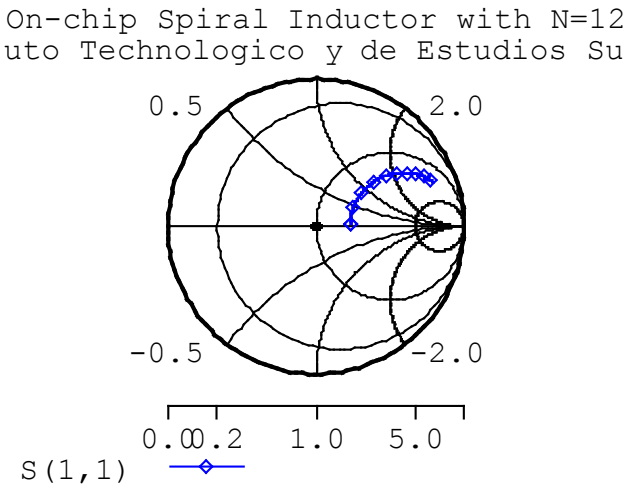




Modify your APLAC simulation file such that you obtain the following results:







Assuming that the above S-parameters where obtained from measurements, how could you derive the value of L_s and R_s in the equivalent circuit?