# Advanced VCO Design using Ansoft Designer

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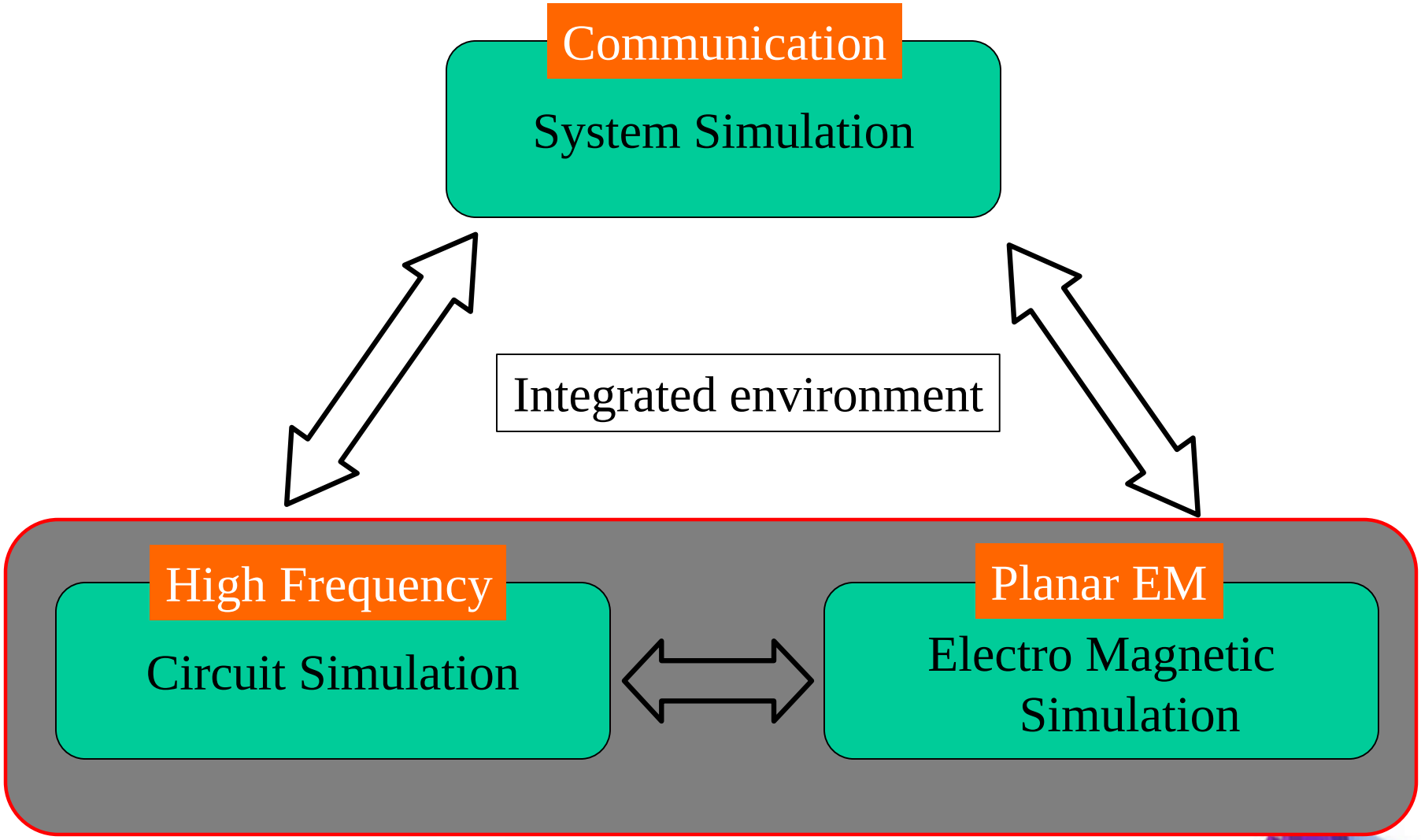
# Agenda

- About Ansoft Designer
- VCO specification
- Device library making
- Resonant Circuit design
- Oscillator Circuit design
- Buffer amp design
- Total analysis
- Conclusion

# About Ansoft Designer

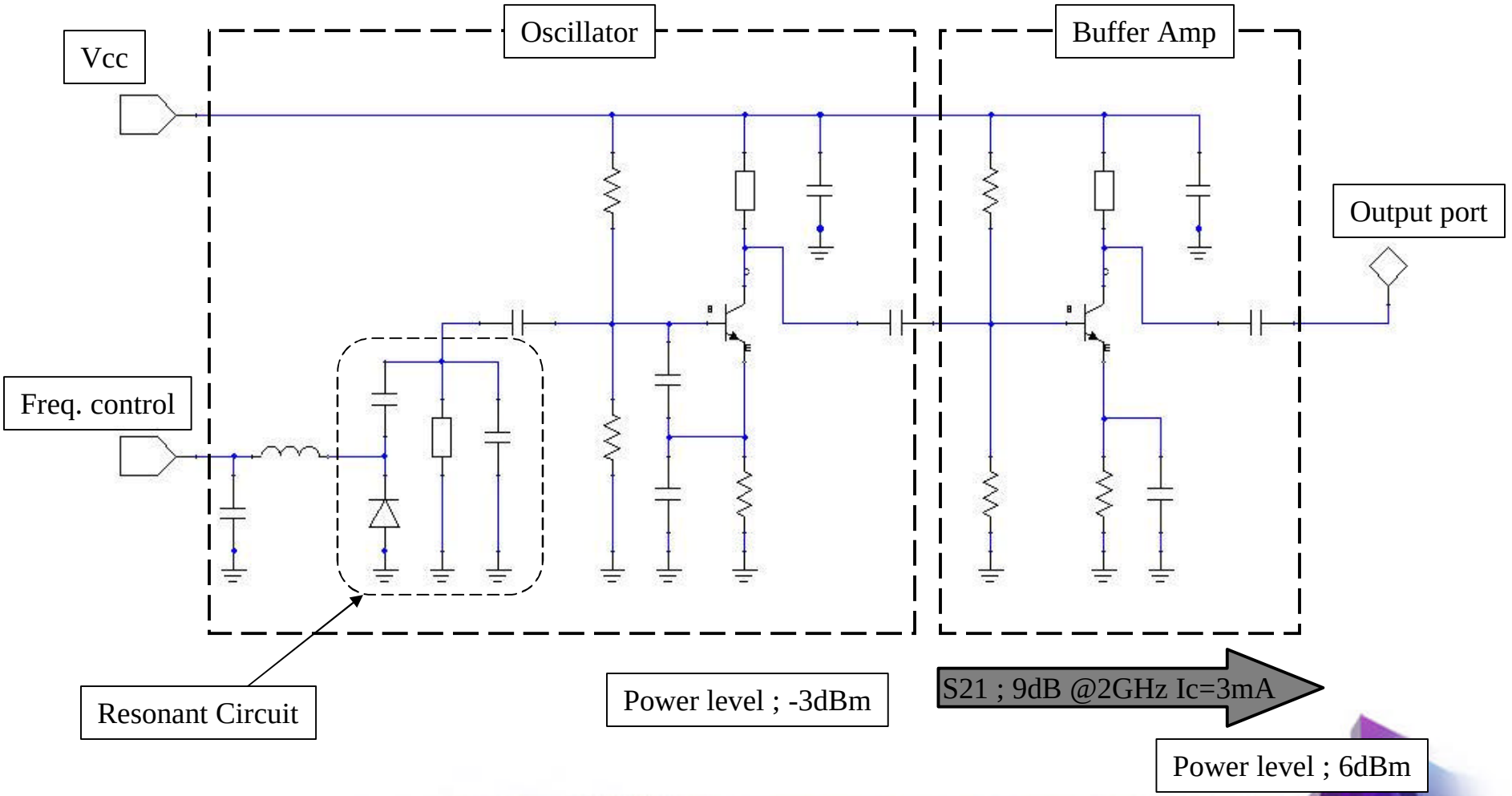


# VCO specifications

- We intend to design VCO for mobile communications.
  - Oscillation frequency 1800MHz +/- 30MHz
  - Output power more than 4dBm
  - Supply voltage 3V
  - Current consumption 8mA

# VCO circuit

- Circuit topology and power estimation

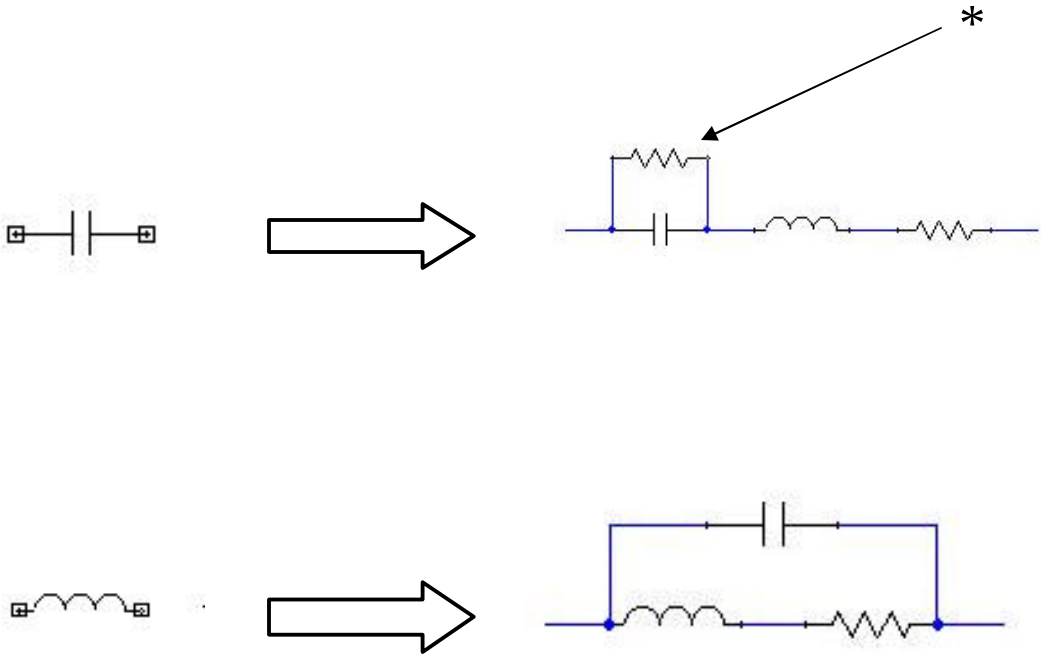


# VCO Circuit

- Parts to use
  - Transistor — 2SC5668(NE667M03) OSC<br>2SC5435(NE685M03) Buffer
  - Varicap — JDV2S13S
  - Condenser — GRP15, GRP18 series
  - Coil — LQW18 series
  - Substrate — TMM-4 t=0.8mm double sided

# Device library making

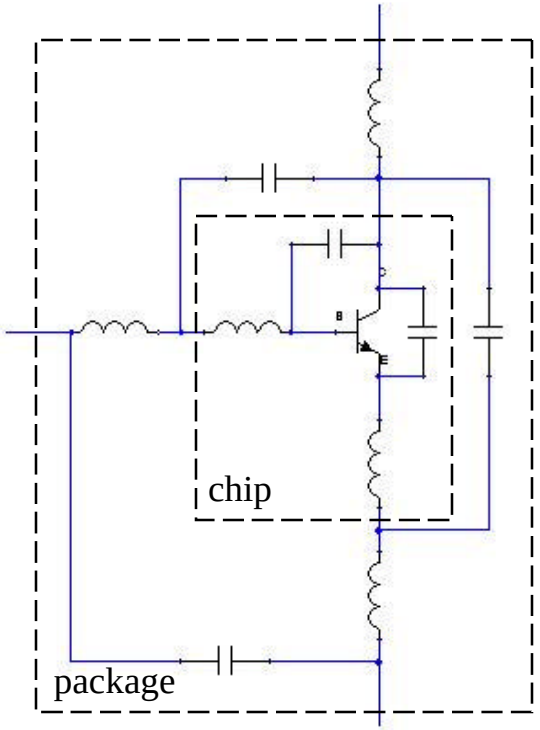
- Equivalent circuit for condenser and coil

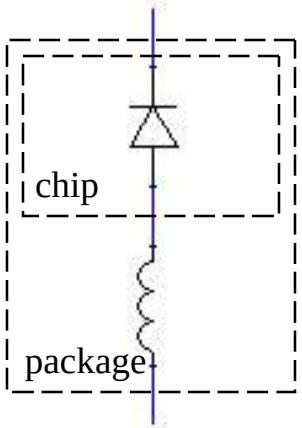



* Parallel resistor added for improve DC current convergence in Harmonic balance analysis

# Device library making

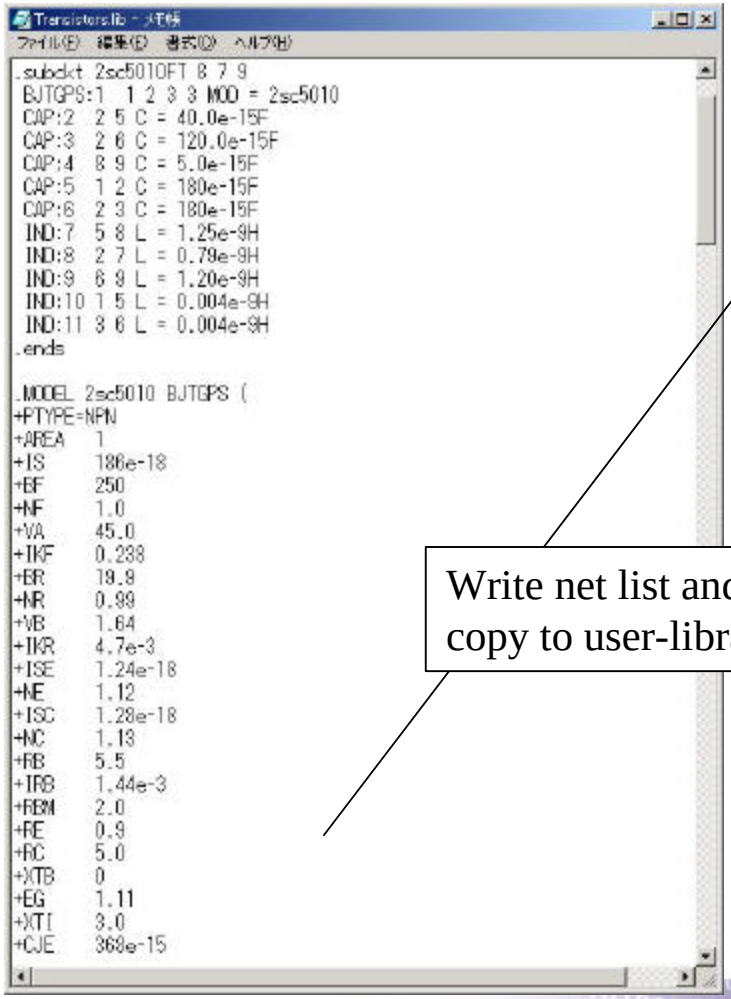
- Equivalent circuit for packaged transistor and diode

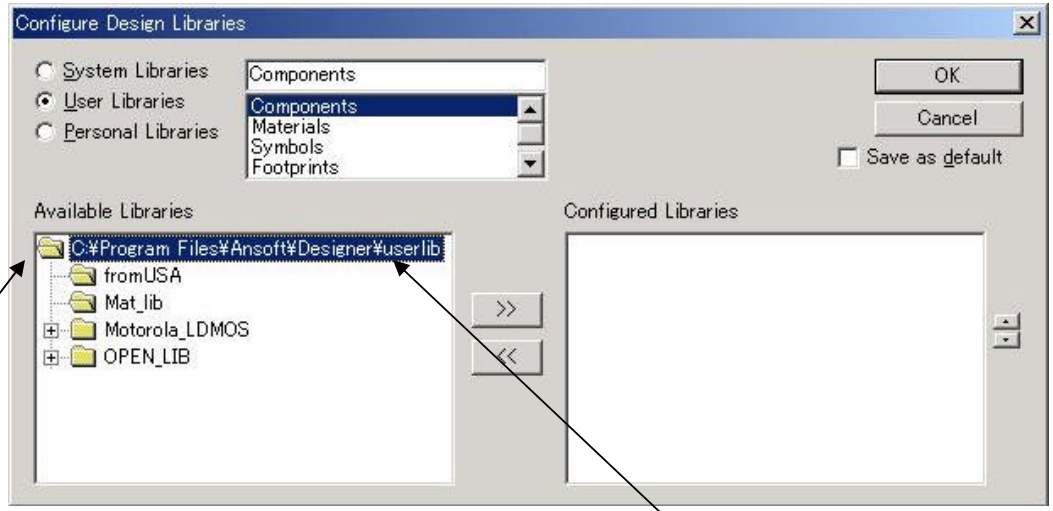


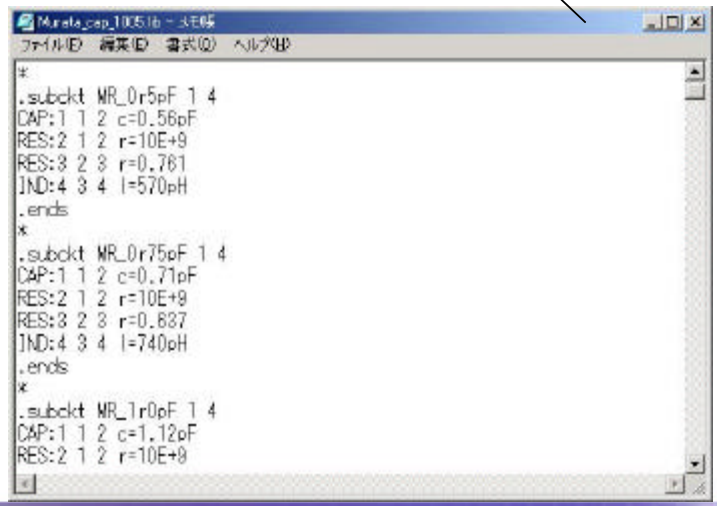
# Device library making

- Write net list and importing library to user-library



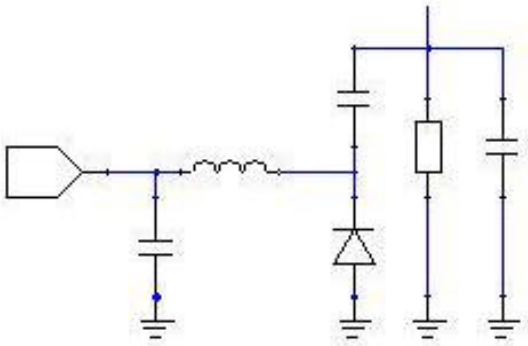




Write net list and copy to user-library

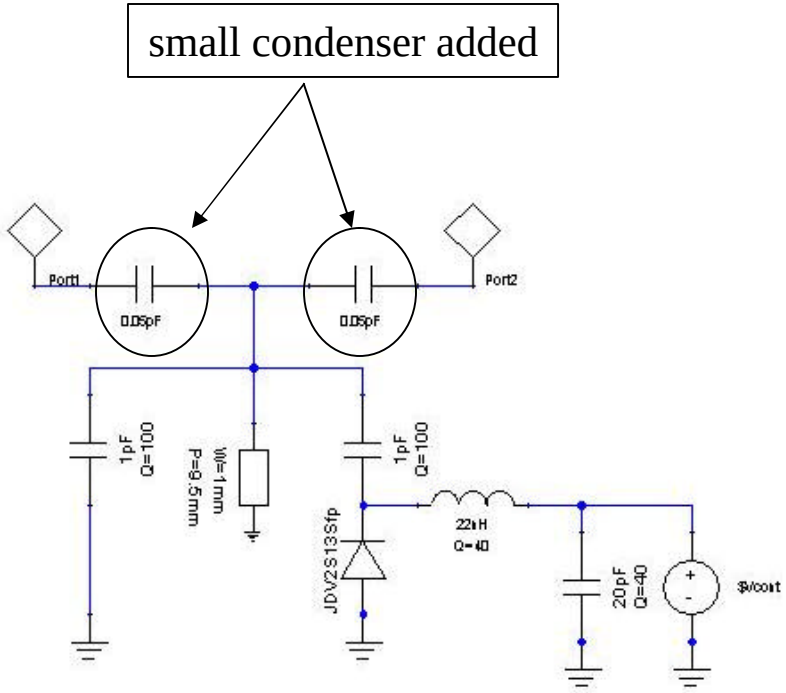


# Resonant Circuit

- Microstrip resonator

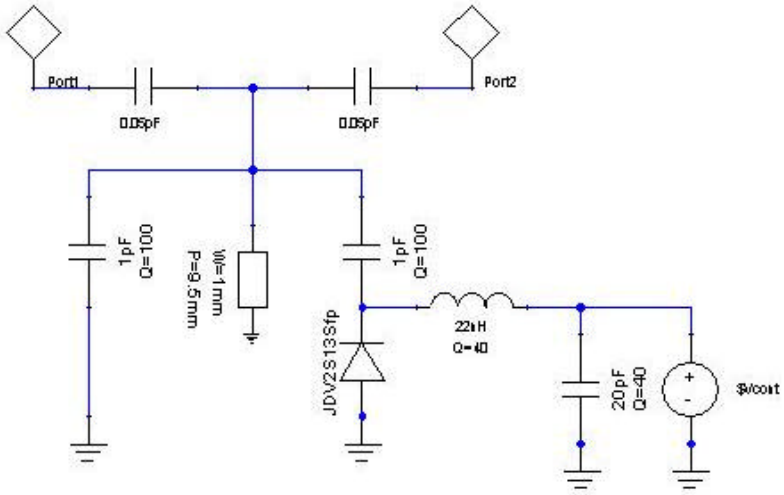


Practical resonant circuit

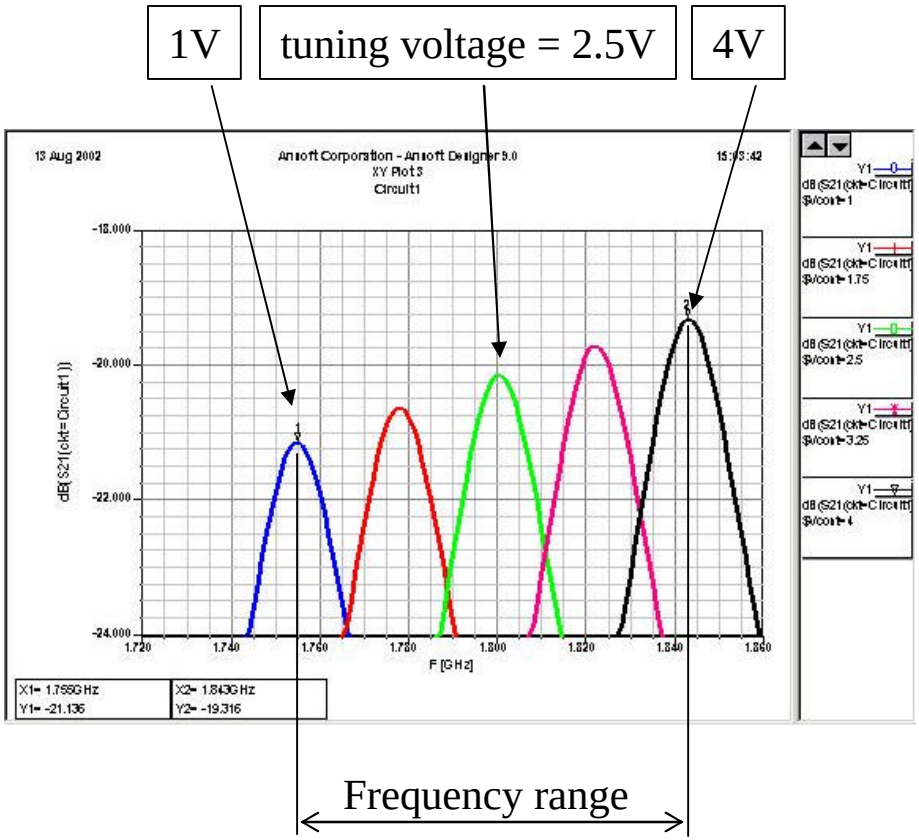



Evaluate resonant circuit

# Evaluate resonator circuit response

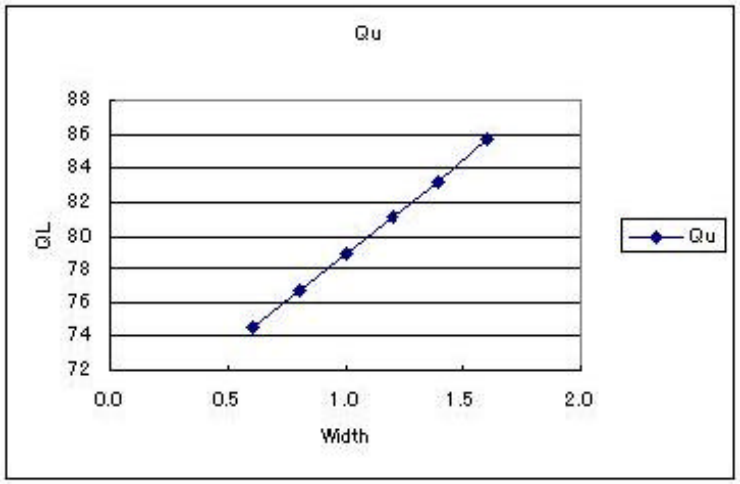


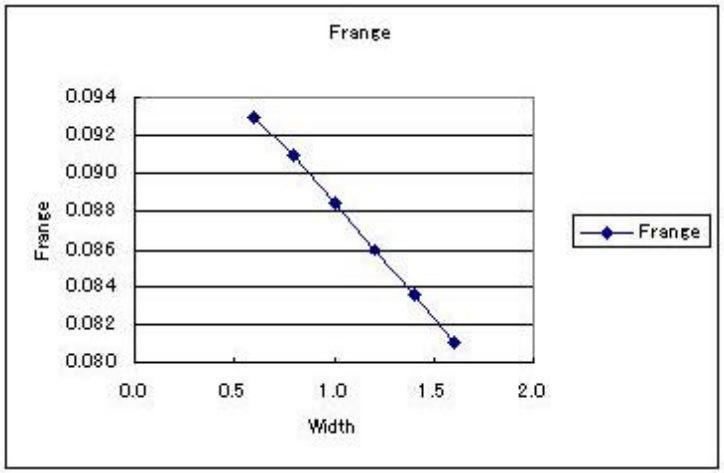

Evaluate resonant circuit



# Relation between unloaded Q (Qu) and Frequency range

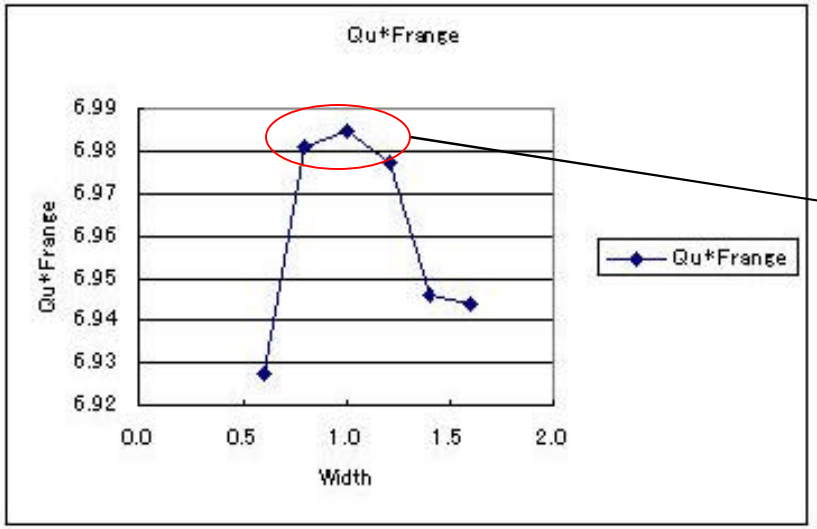
- Qu and Frequency range change according to microstrip width.
- As Qu increase, frequency range is decrease.



# Determine microstrip width

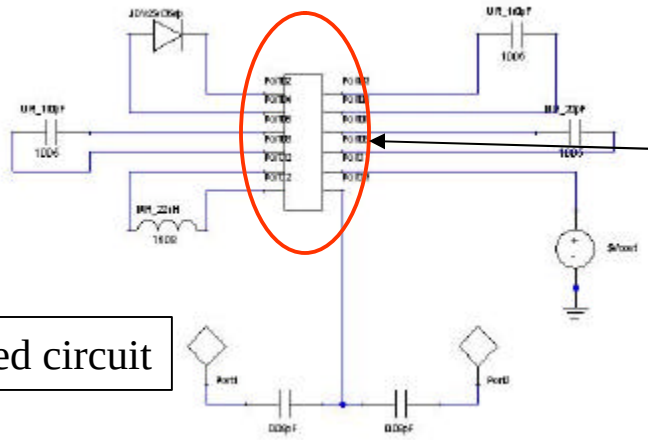
- “Qu*Frequency range” is introduced as a indicator to evaluate resonant circuit performance



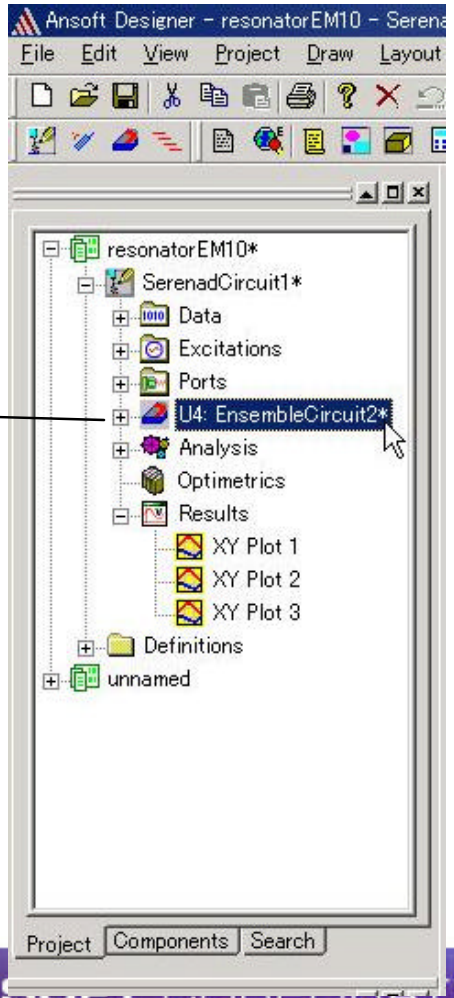

It shows 1.0mm is best

# Insert physical layout

- It can make layout by inserting EnsembleCircuit.

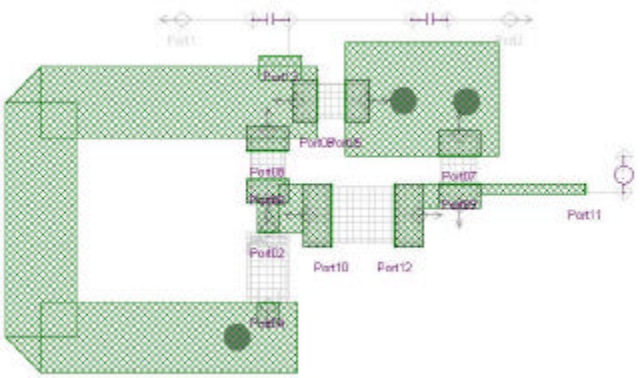


Revised circuit

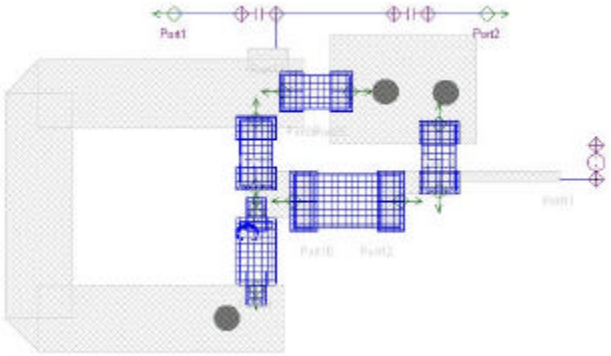


# Simulation with physical layout

- Make microstrip layout and simulate resonant circuit under co-simulation

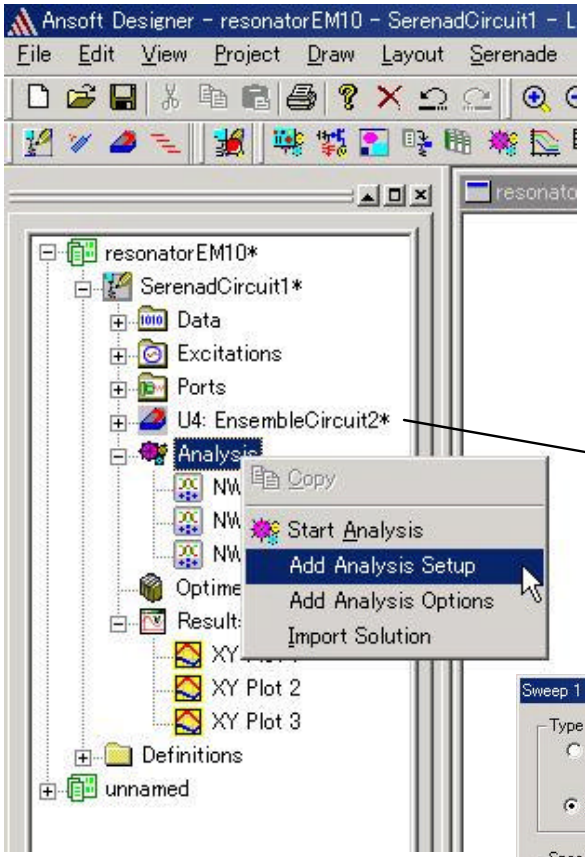


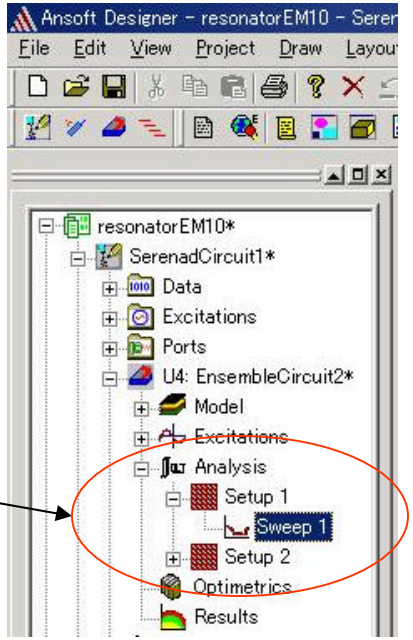
Pattern layout



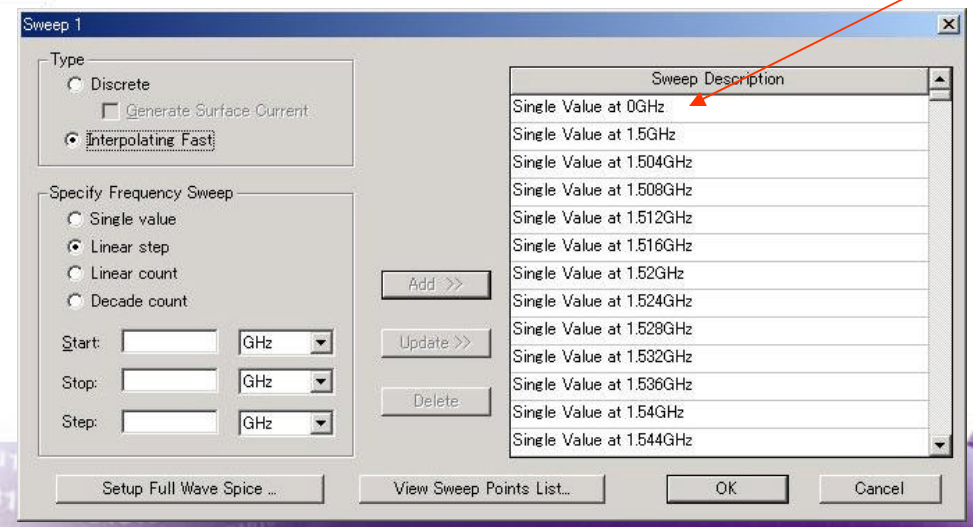
Parts layout

# Simulator setting

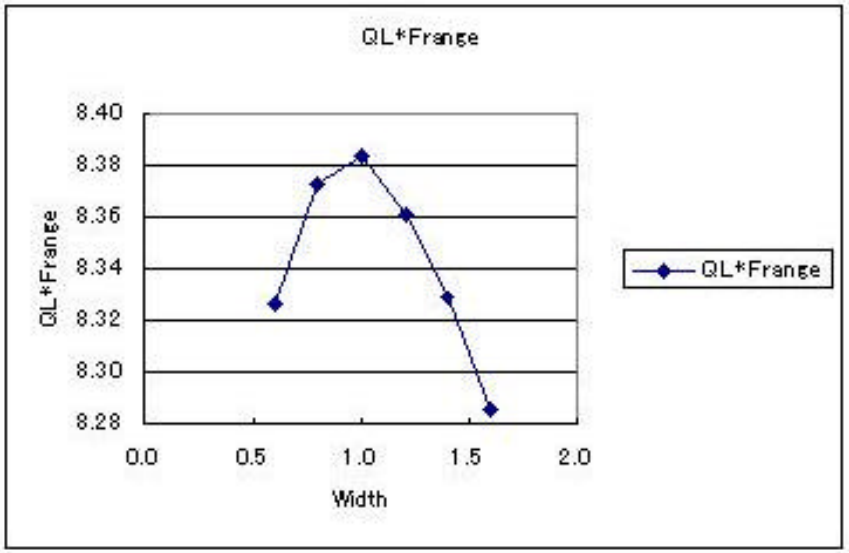


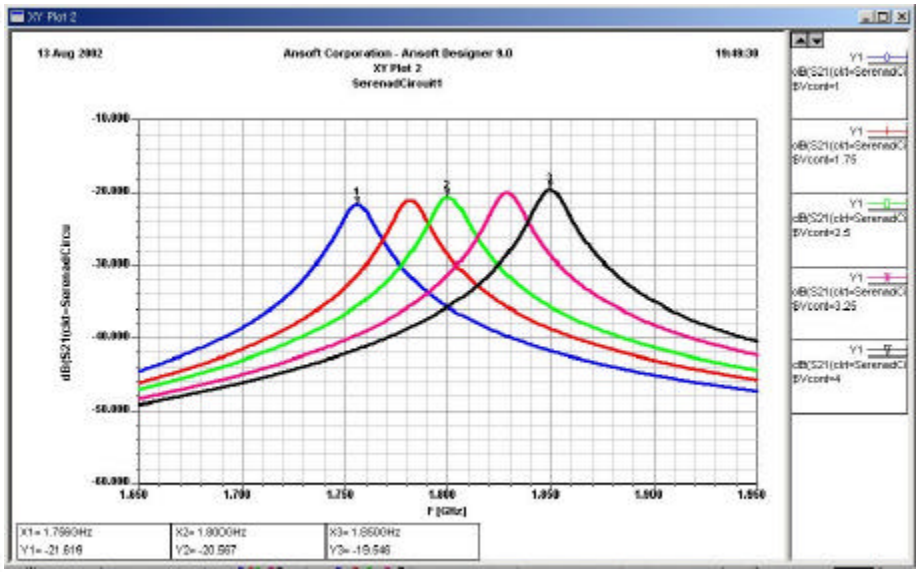




Include 0Hz

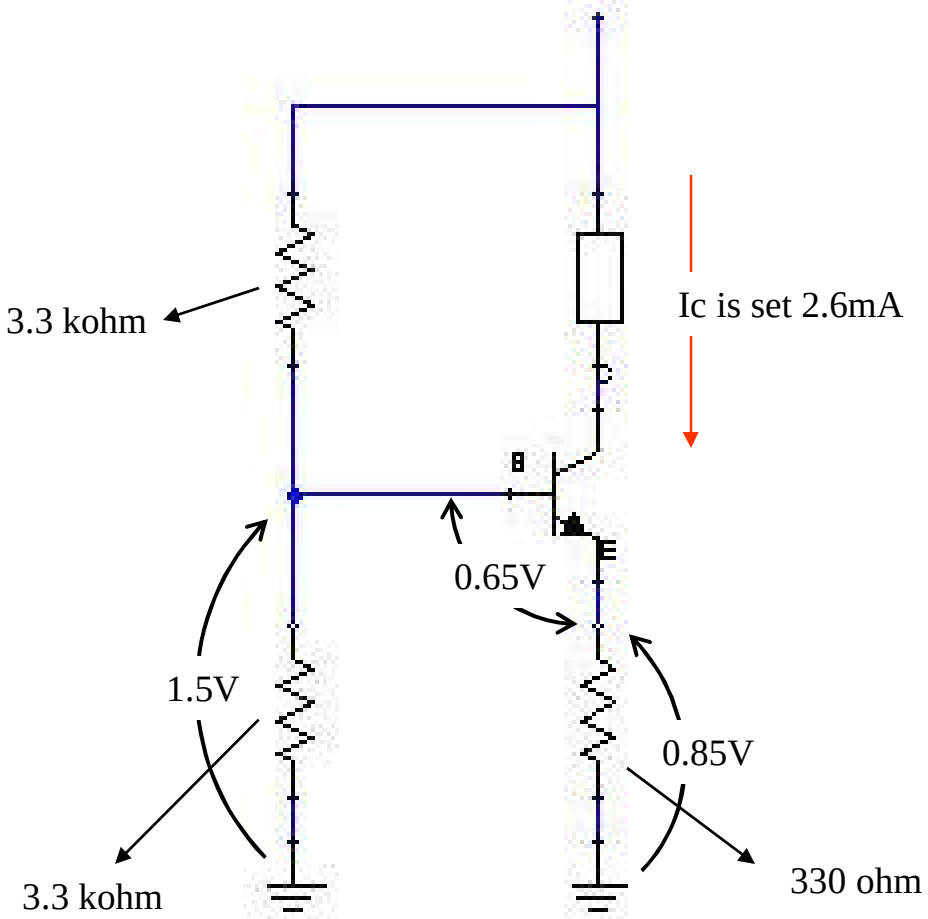


# Resonant circuit simulation result

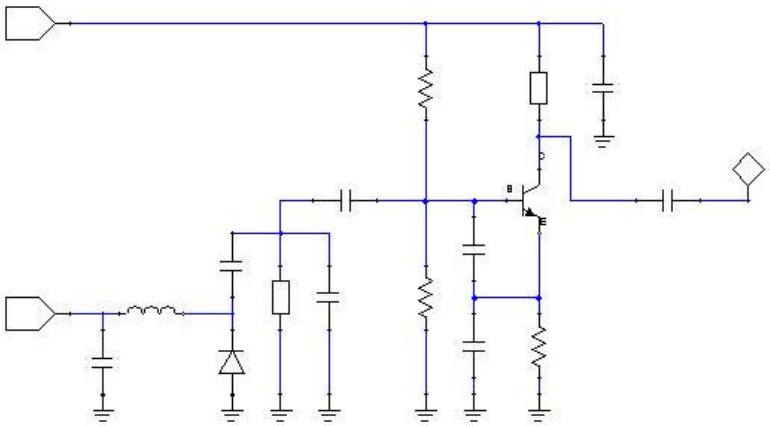


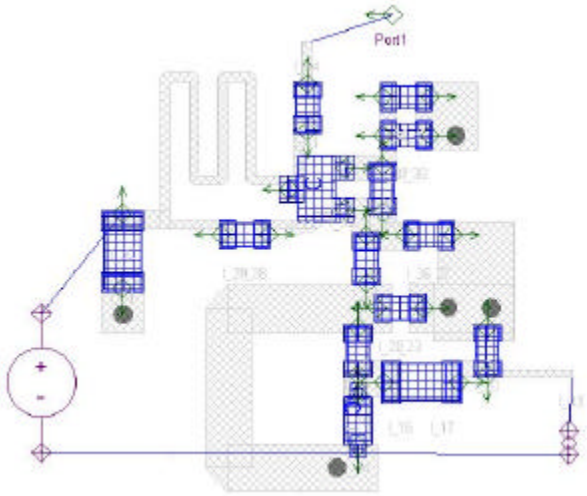
# DC bias calculation



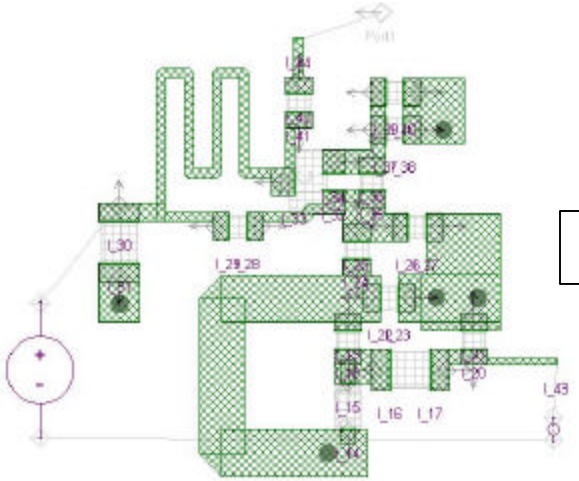
# Oscillator circuit



Oscillator circuit



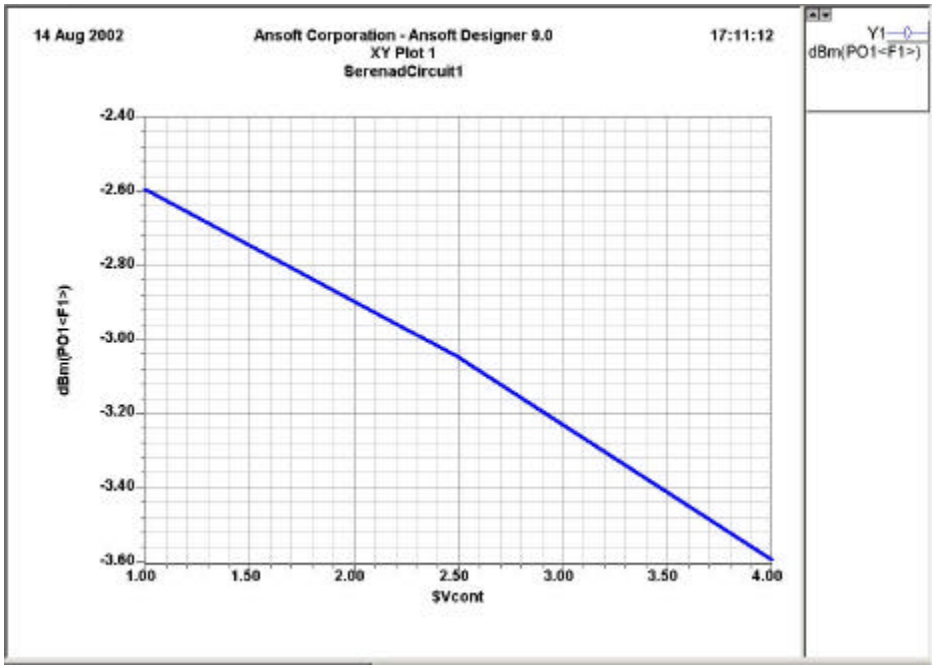

Parts layout

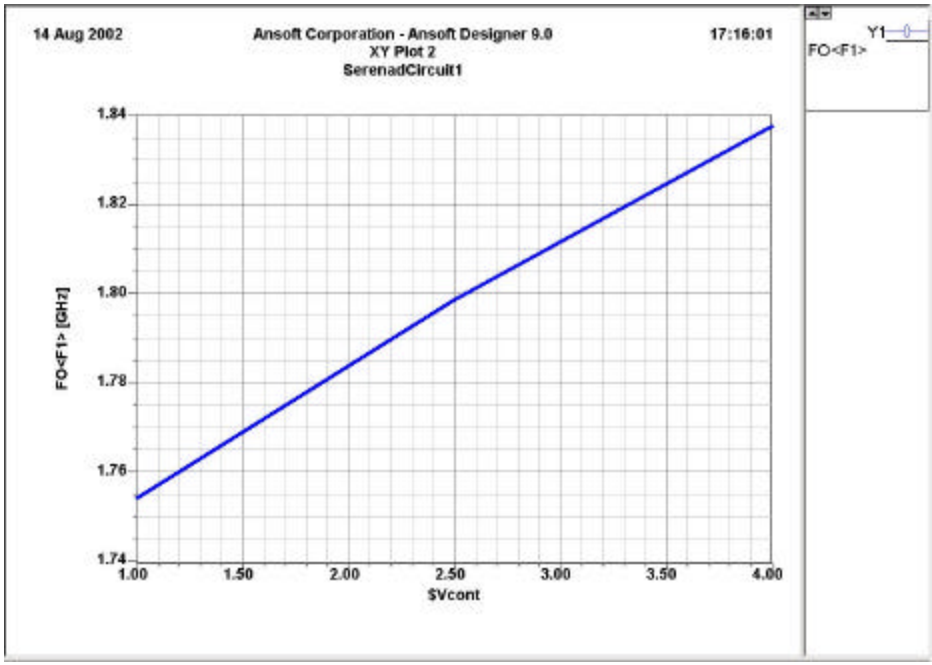


Pattern layout

# Simulation result

- After adjust resonant circuit



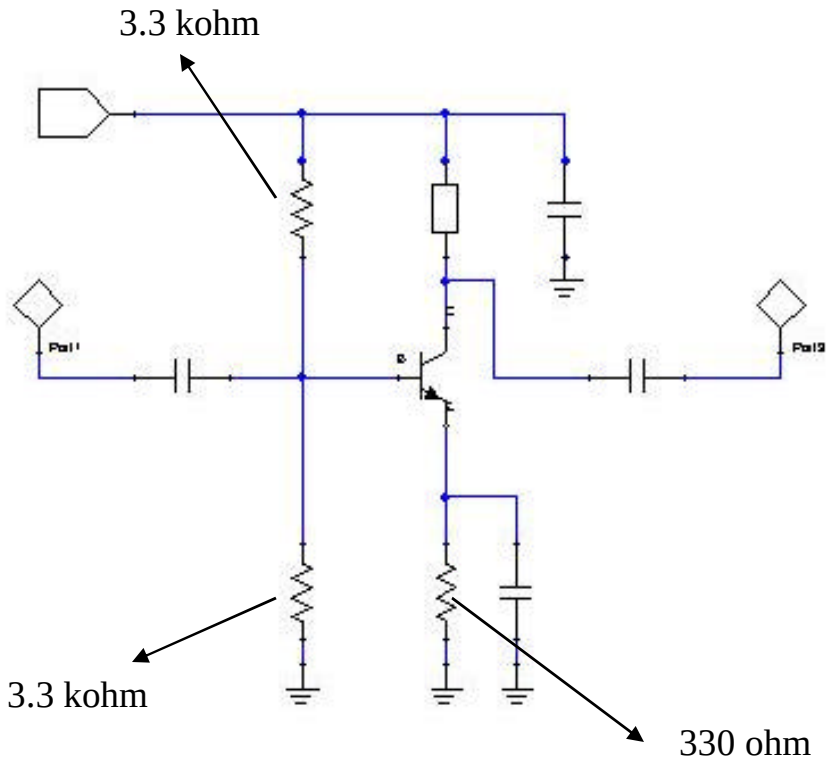




Output Level

Oscillation frequency

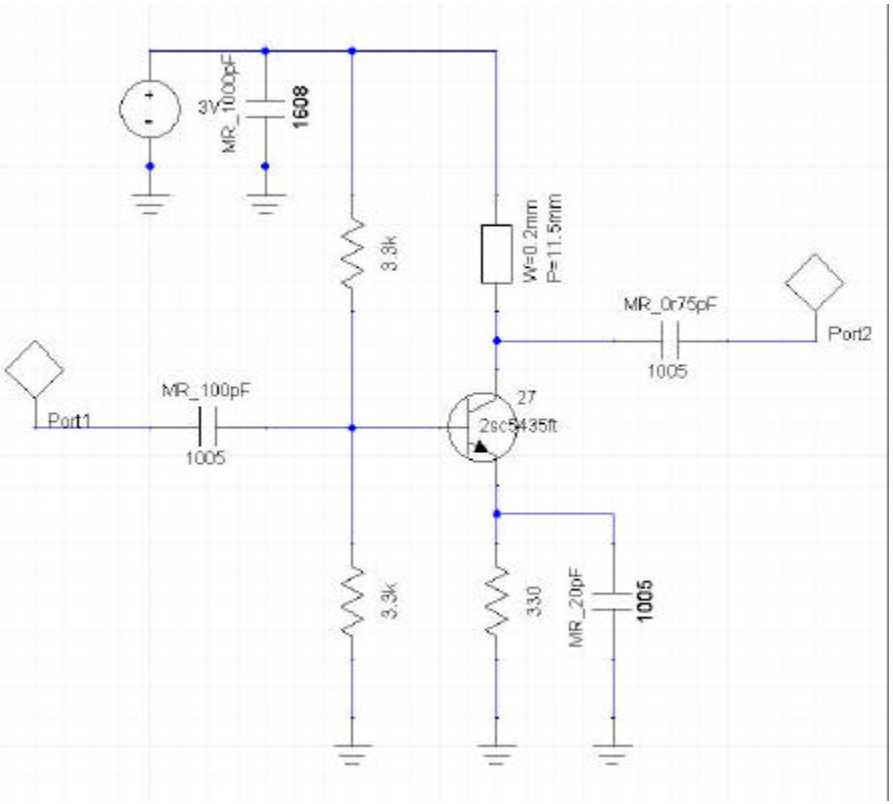
# Buffer amp design

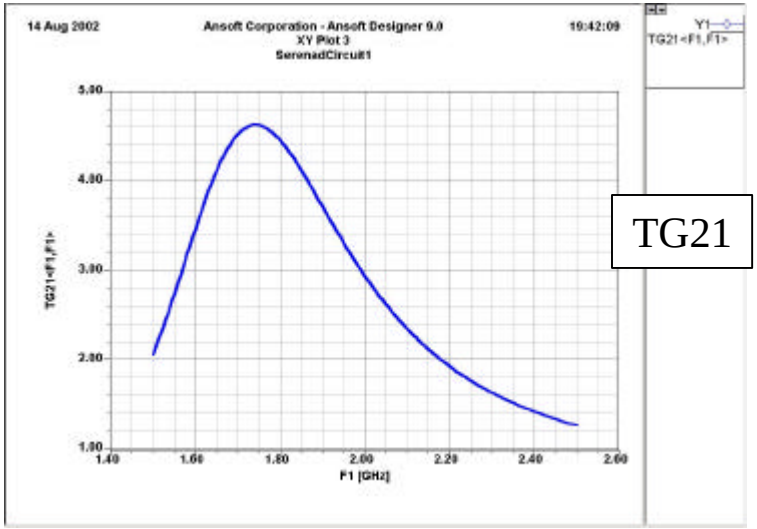
- DC bias

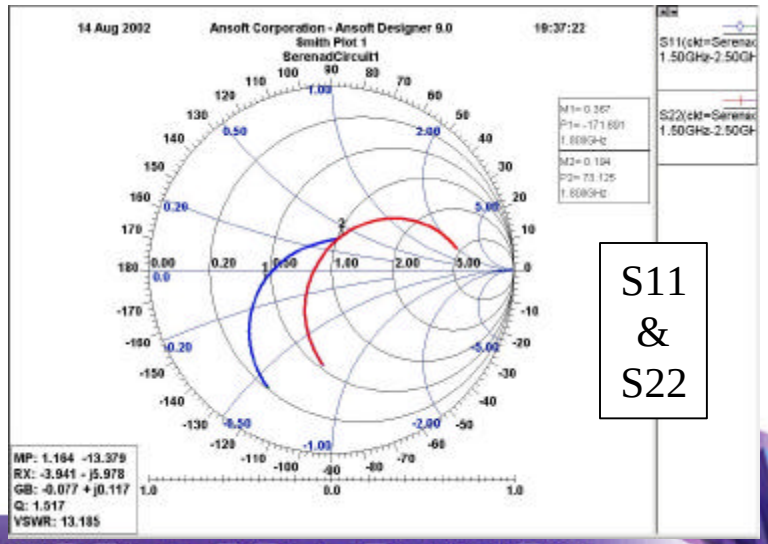


# Impedance matching

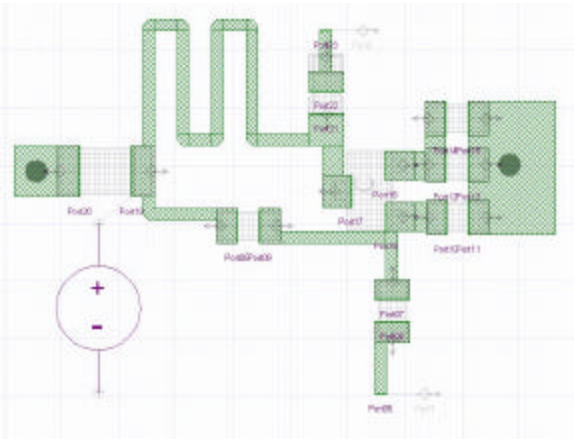
- Adjusted circuit



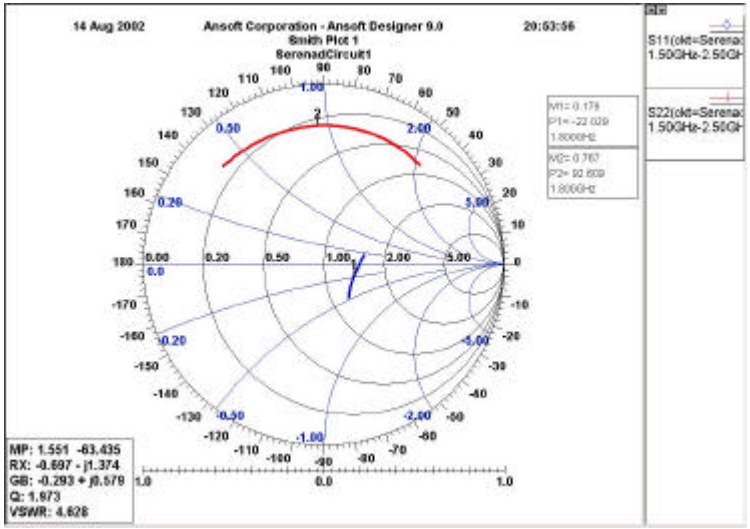



# Simulation result with physical layout

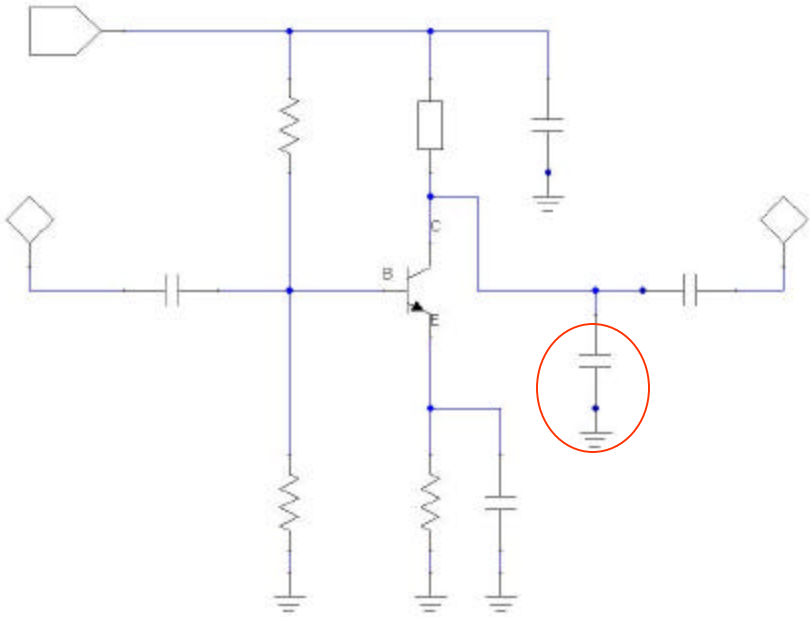


Pattern layout

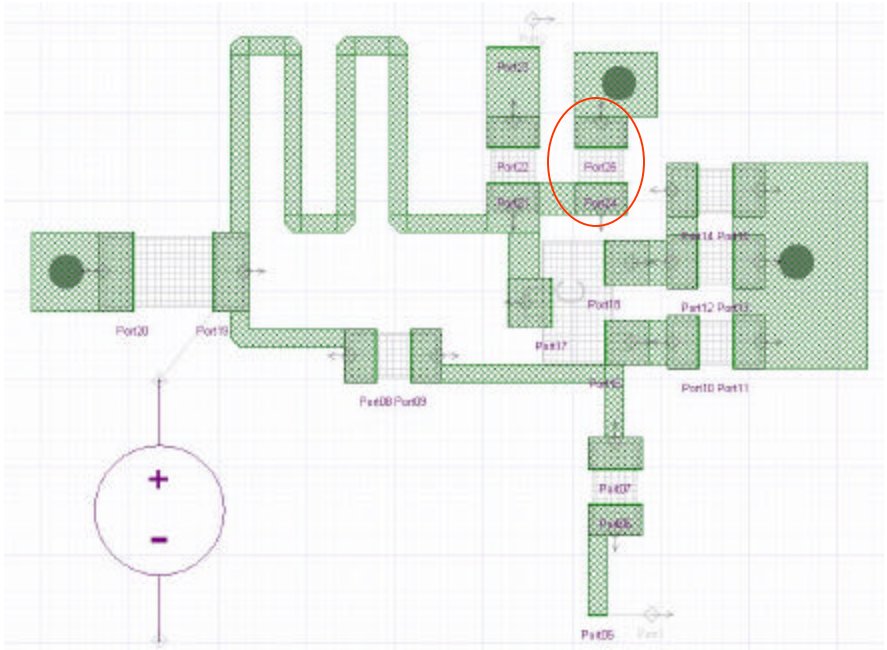



S11 & S22

# Revised circuit

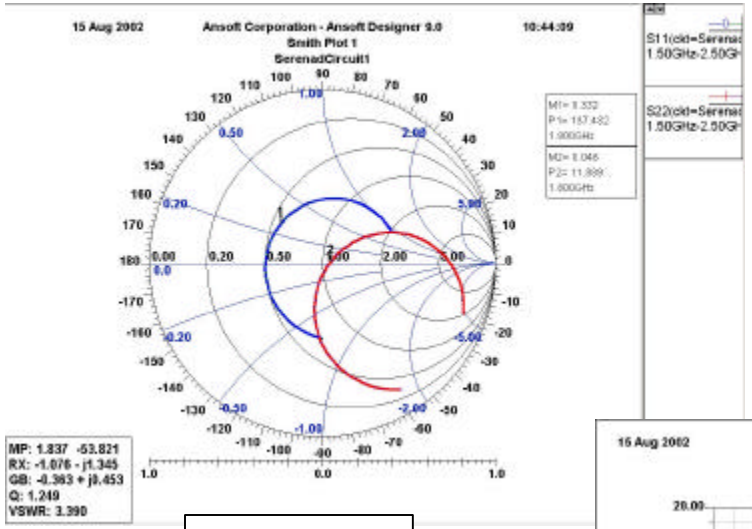



Final circuit

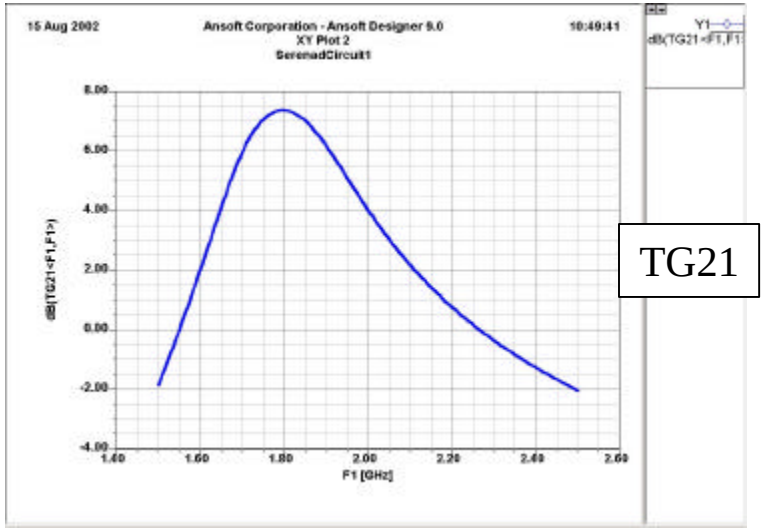



Pattern layout

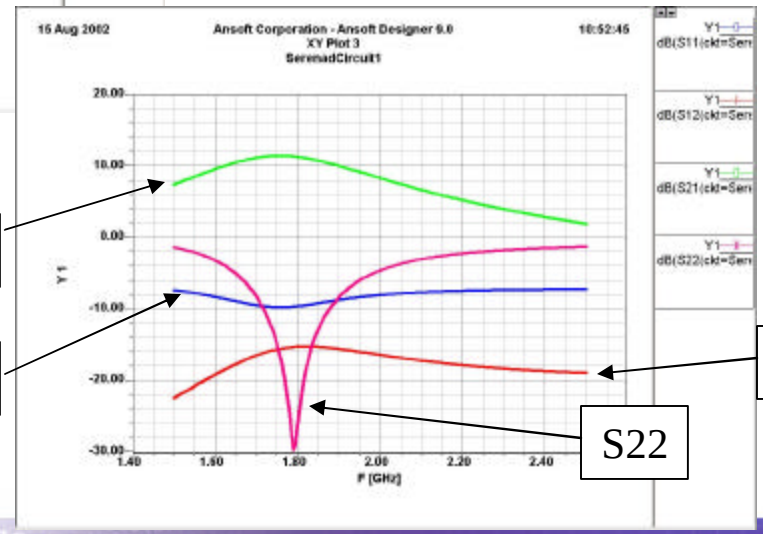
# Buffer amp performance




S11 & S22




TG21




S21

S11

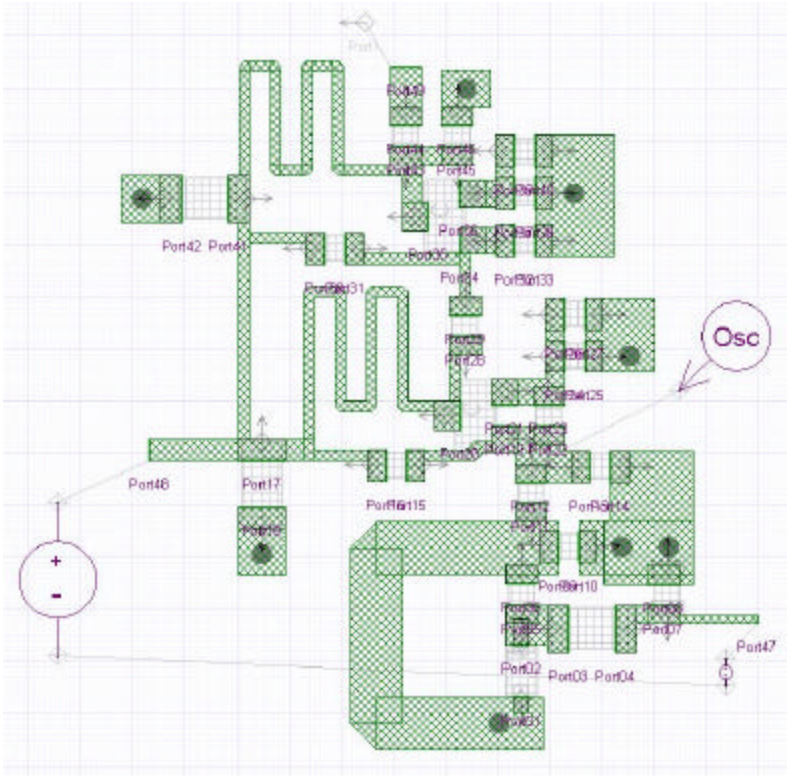
S12

S22

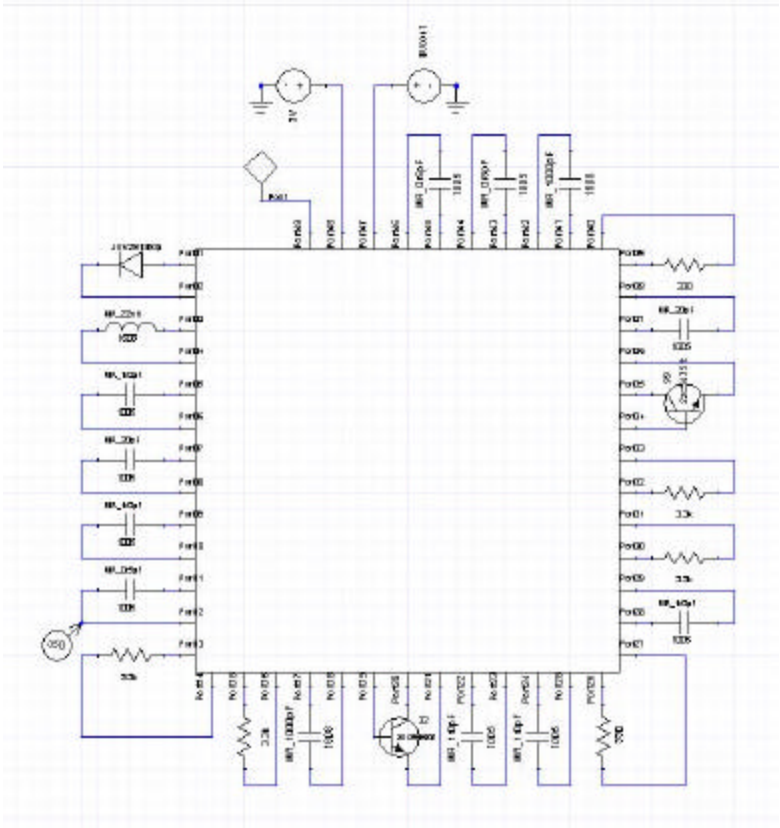
# Total simulation

- Final step of VCO design
  - Merge oscillator and buffer amp layout.
  - Make schematic which include EnsembleCircuit’s symbol
  - Adjust oscillation frequency
  - Adjust other performances.

# Merged layout and schematic

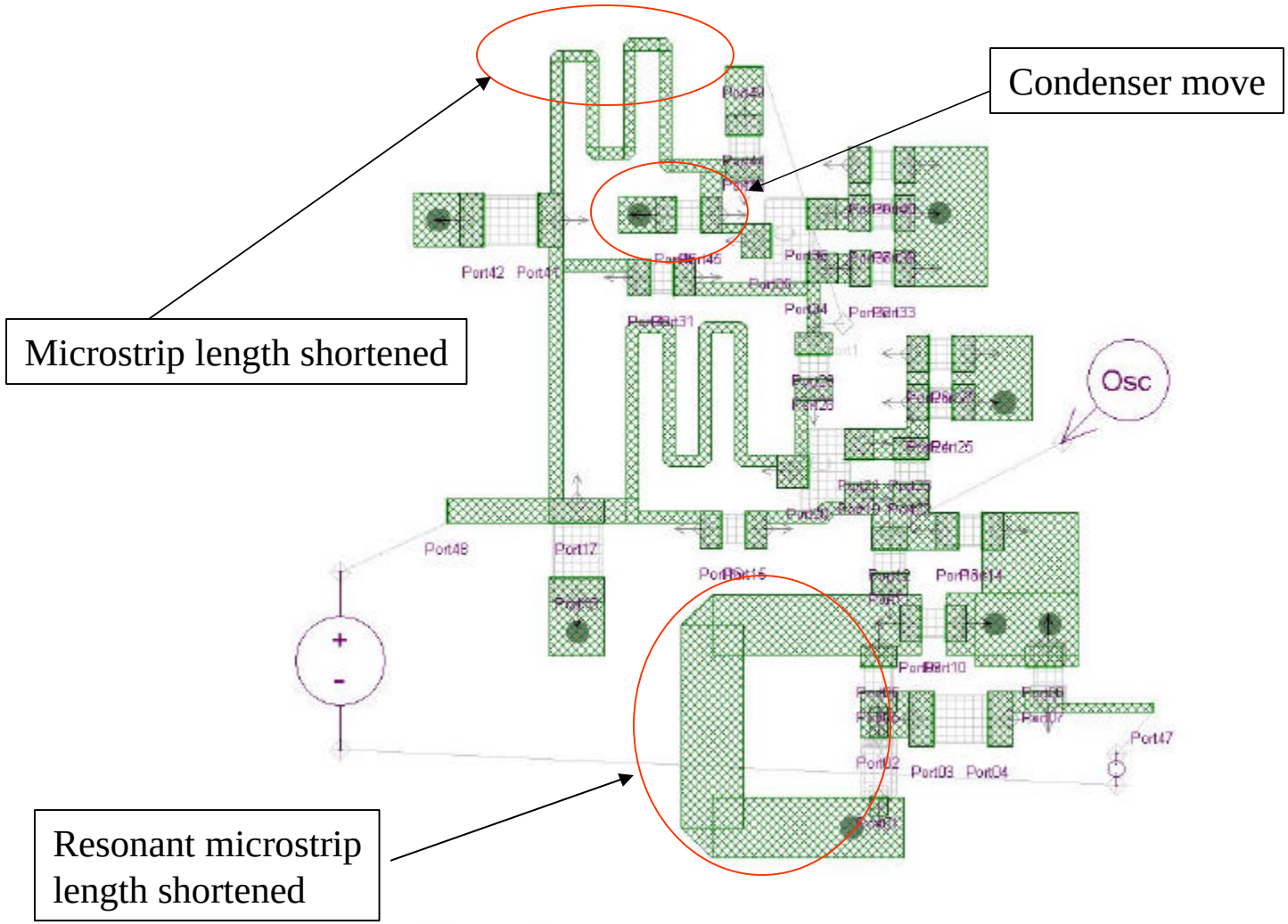



Merged layout



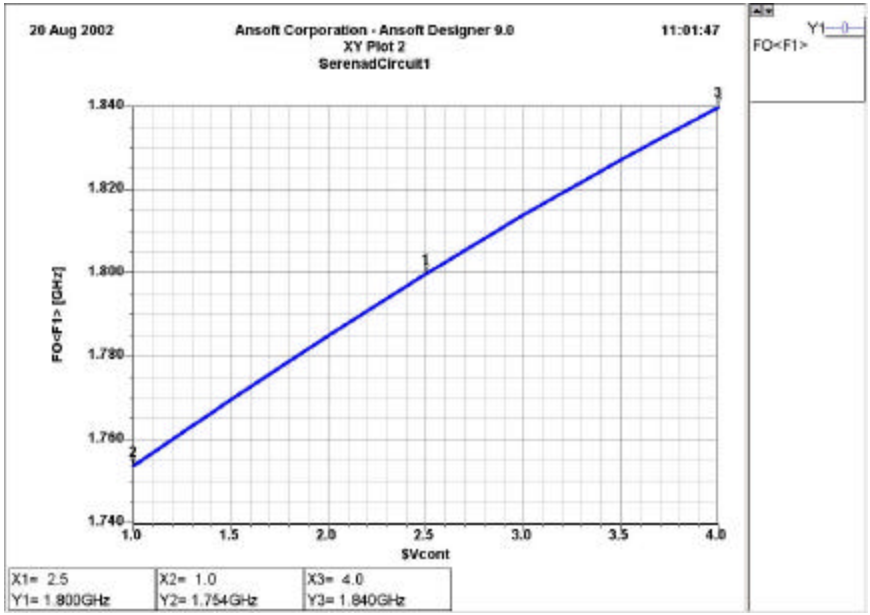
VCO schematic

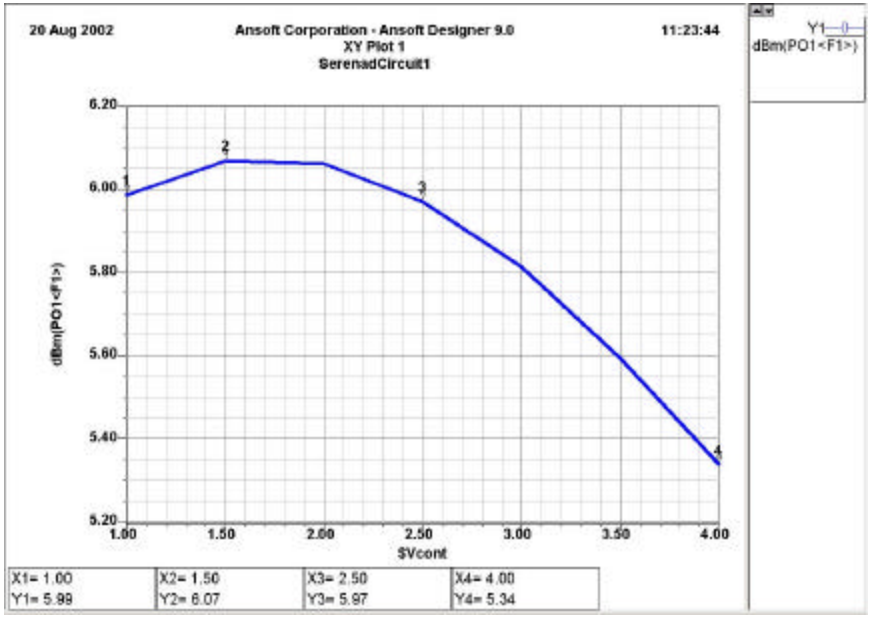
# Adjusted layout



# Final result

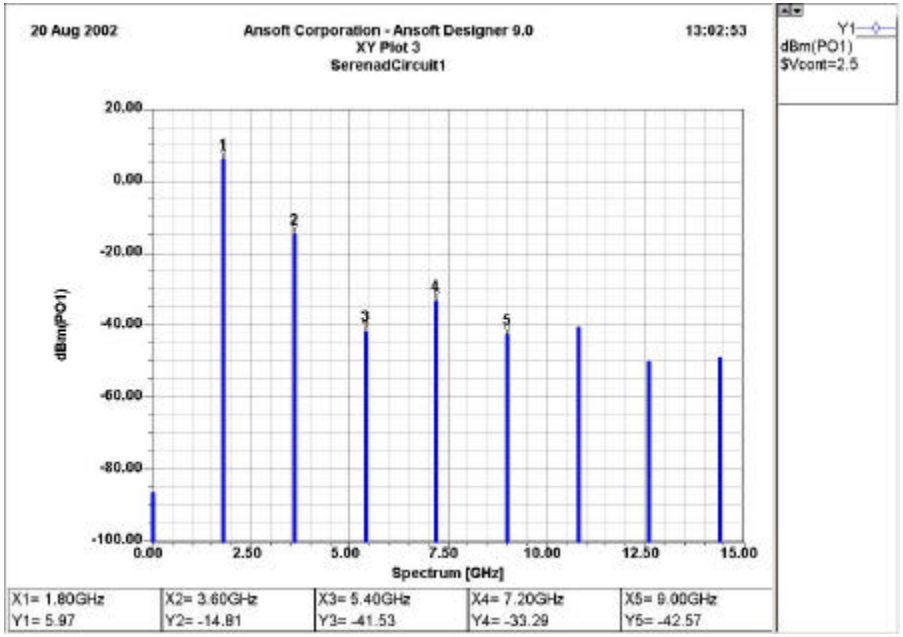
- Oscillation frequency and output power

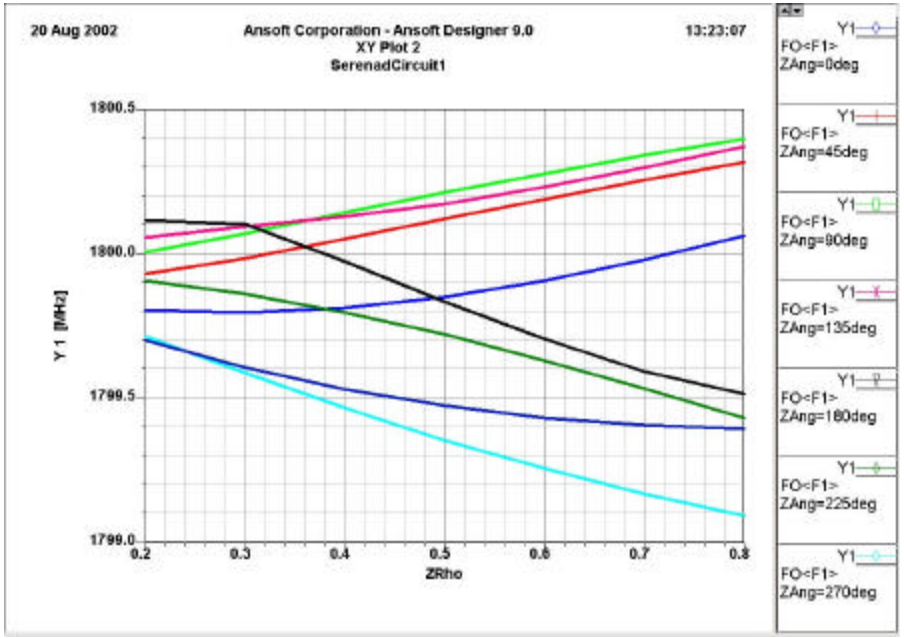


# Final result

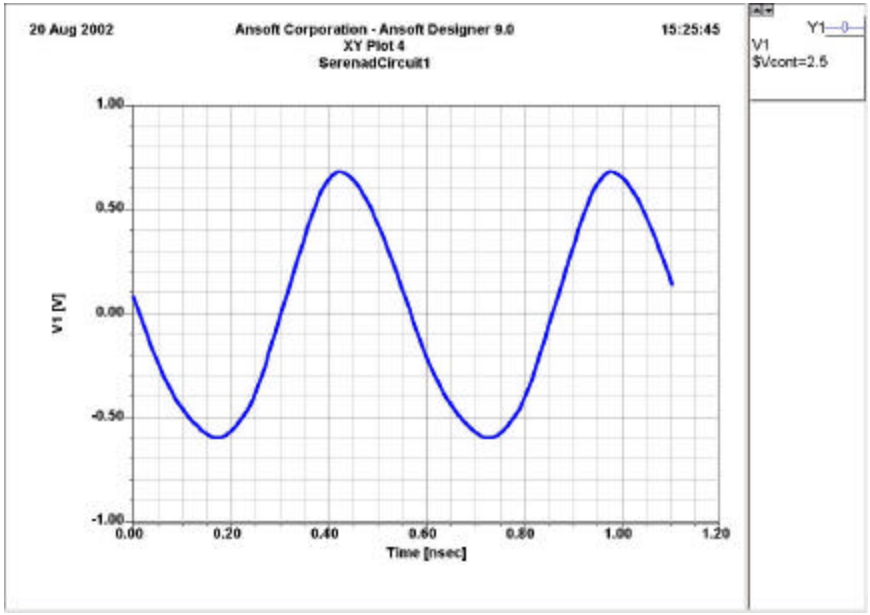
- Output spectrum and load-pull characteristics

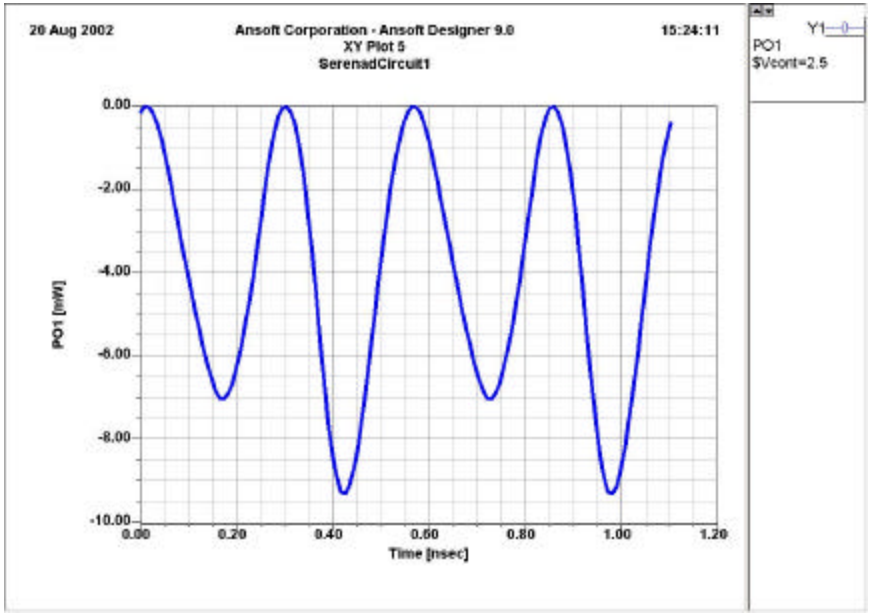


# Final result

- Output voltage and power waveform



# Conclusion

- VCO design is showed step by step
- Ansoft Designer™ is powerful tool
  - Seamless environment between circuit and electro magnetic simulator makes short time design.