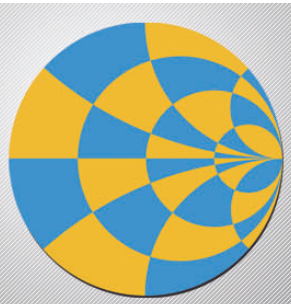


Insight SiP

System-in-Package (SiP) approach

Insight SiP Production Ready Design

An IPD based GSM Low Pass Filter Design Example

Summary

- Design Flow
- Specifications
- Project Component Library
- Idealized Filter Schematic
- Filter Schematic with Components from Library
- Layout Generation
- Tune Layout to meet specifications

Design Flow

One pass success

Electrical Schematic

Choose Layer Structure

Generate Parametric Mechanical Objects

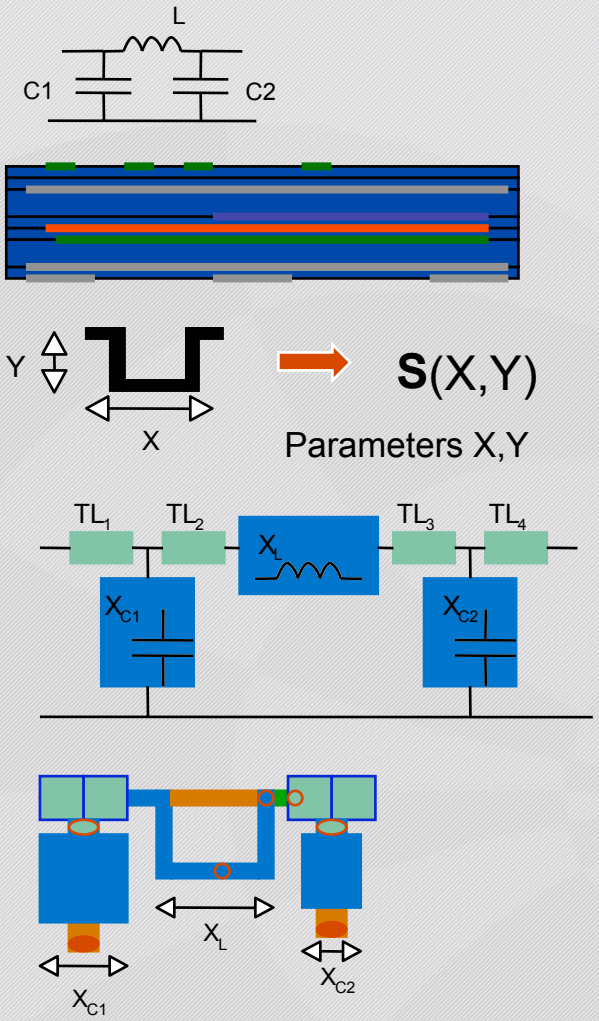
Optimise Circuit with Mechanical Parameters

Auto Layout Generation

EM Check Layout

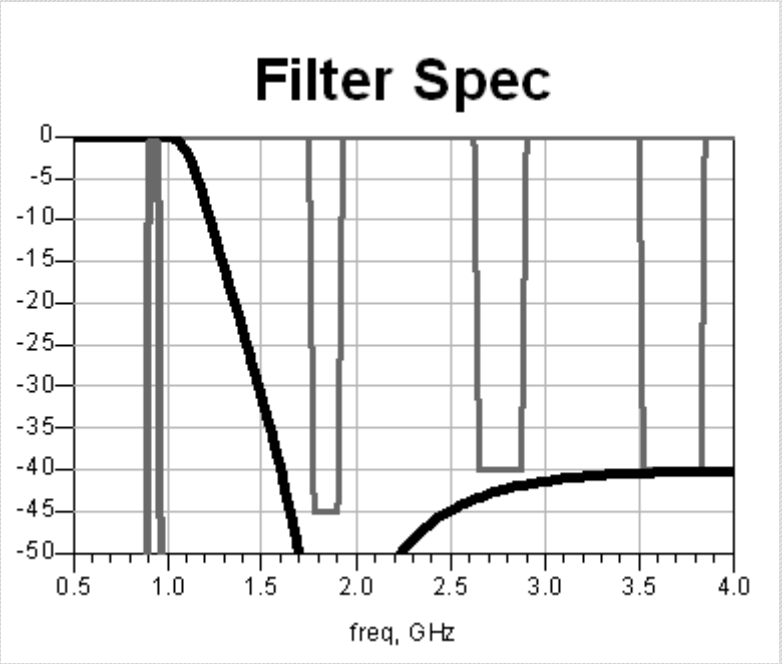
Optimise Layout

OK



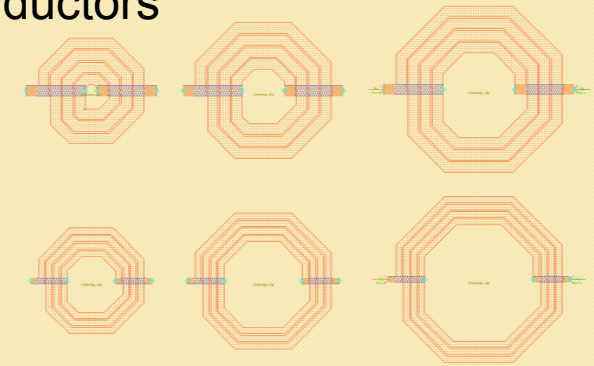
Specifications

- GSM Low Pass Filter
  - Passes GSM low band (880-960MHz)
  - Rejects harmonics (n=2,3,4)
- Low Insertion Loss
  - IL < 0.7dB @ 800 -1000MHz
- High Rejection of 2,3,4 Harmonics
  - Rejection > 40dB @ 1760-38400MHz
- 50 Ohm Input Output Impedance
  - Return Loss < -17dB @ 880-960MHz
- Small Size
  - Surface Area < 2mm²
  - Thickness < 0.3 mm



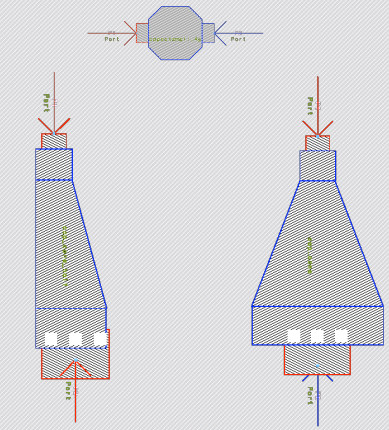
Component Library

Inductors

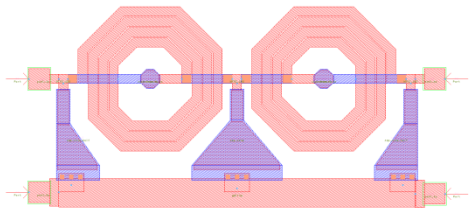


- Parameterized Black Box Modeling
  - Create Component Models
  - Automatized process
  - Perform Electromagnetic simulations of inductors and capacitors for a set of geometries covering the target component values.
  - Create Component Models from EM simulations
  - Ready for Fast schematic simulations with all local parasitic effects.

Capacitors

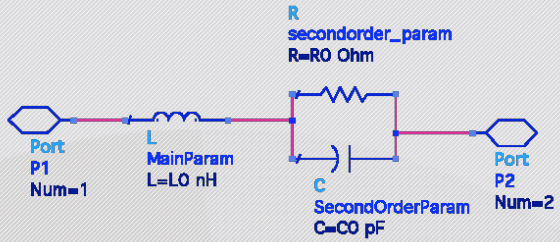


The component geometry is chosen, bearing in mind the complete layout

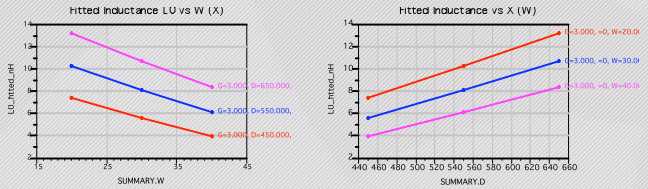


LC Component Models

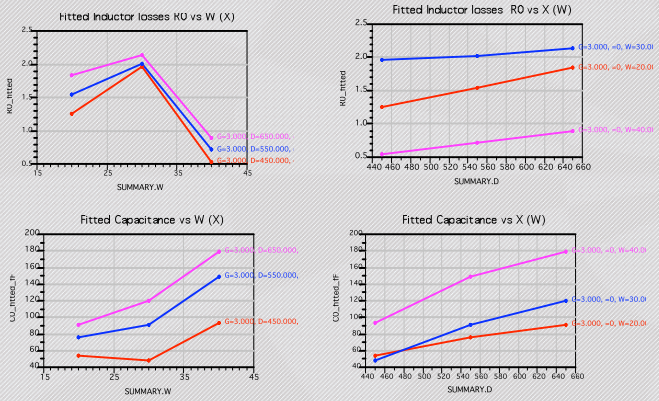
- Evaluate component model
  - Over range of dimensions
  - Main values
  - Parasitic element values
- Use component model
  - To set start point for optimization
  - Verify that parasitic effects are acceptable



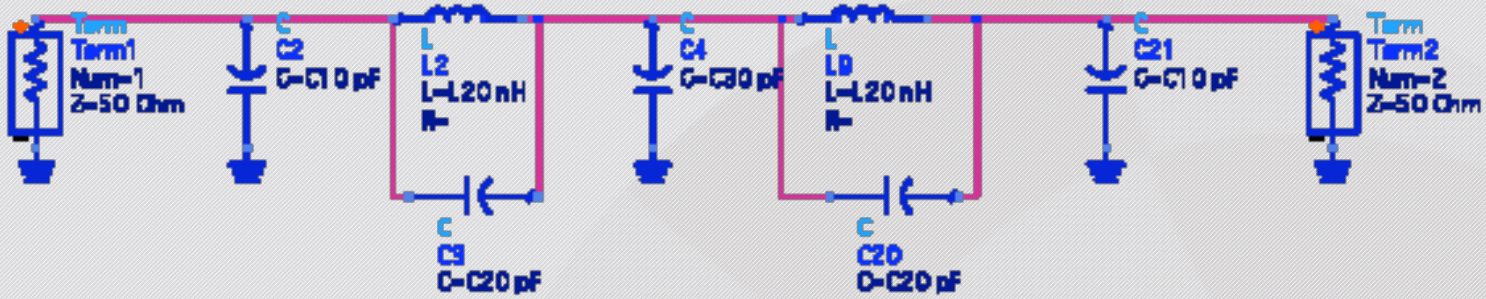
Main Model parameters : L0



Secondary Model parameters : R0, C0

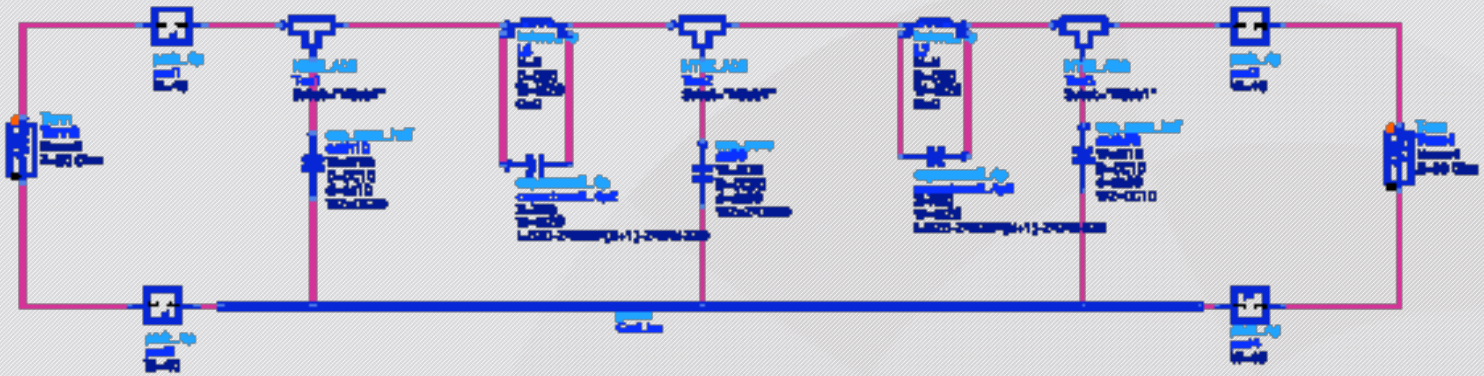


Idealized Schematic



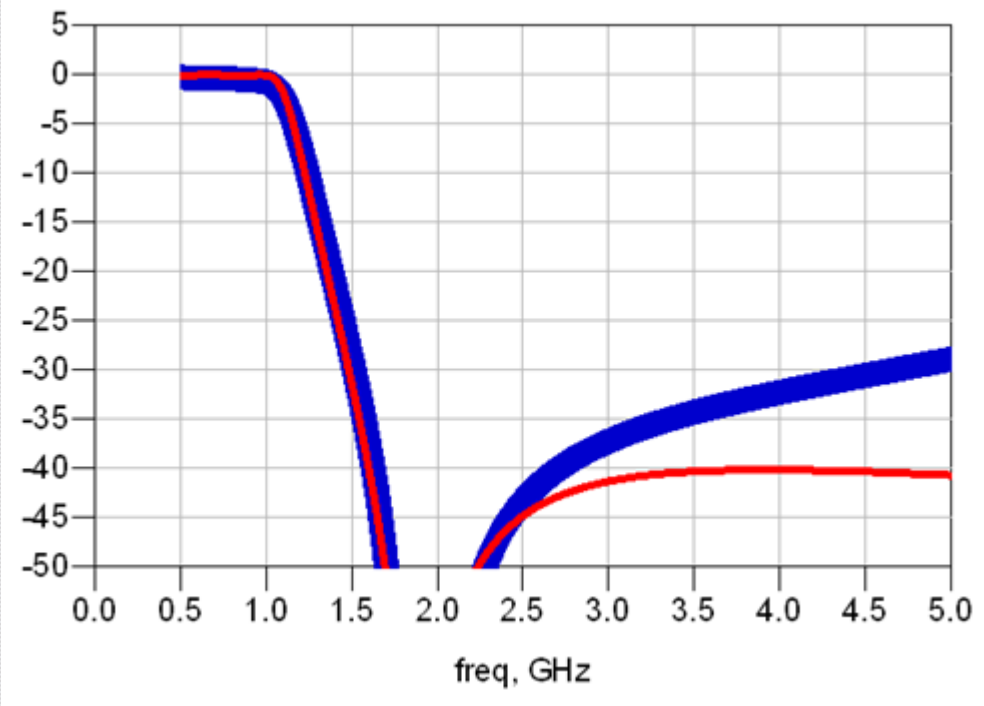
5 pole Low Pass Filter with 2 zeros for added rejection
All components are idealized Ls and Cs
Parameters are inductance and capacitance

Schematic with Models



5 pole 2 zero filter with modeled components
All components are modeled using EM simulation
Parameters are mechanical dimensions of objects

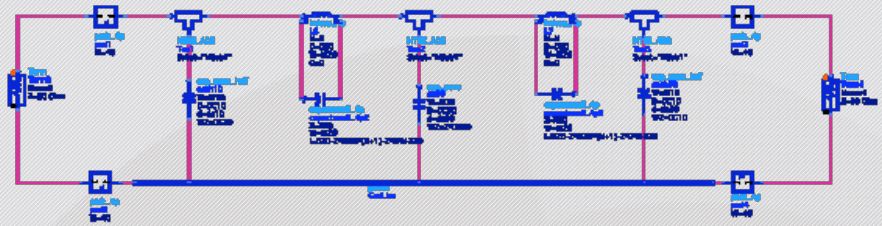
Filter responses



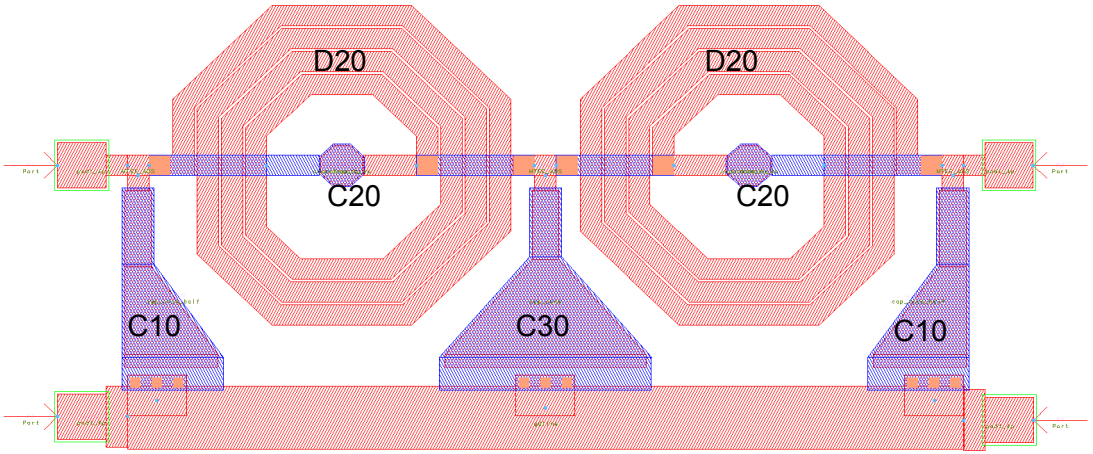
- Ideal response
- Modeled response

Layout Creation

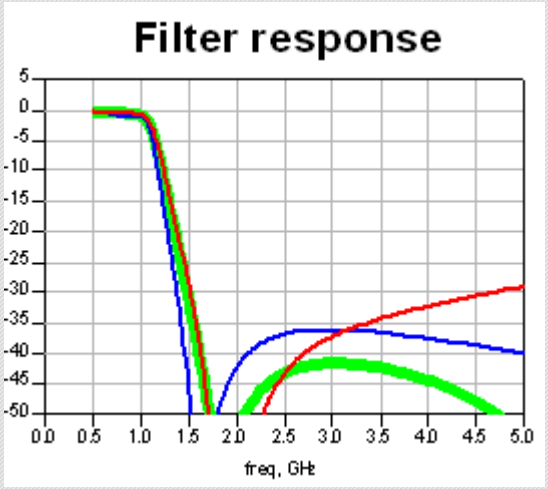
- Create the layout of the complete circuit
- Run EM simulations of full layout

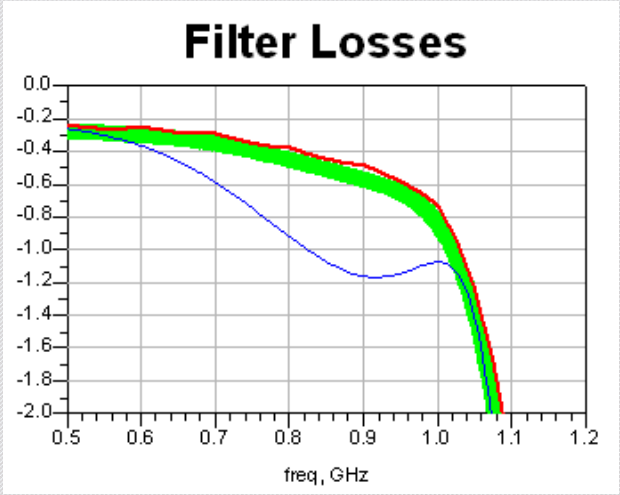


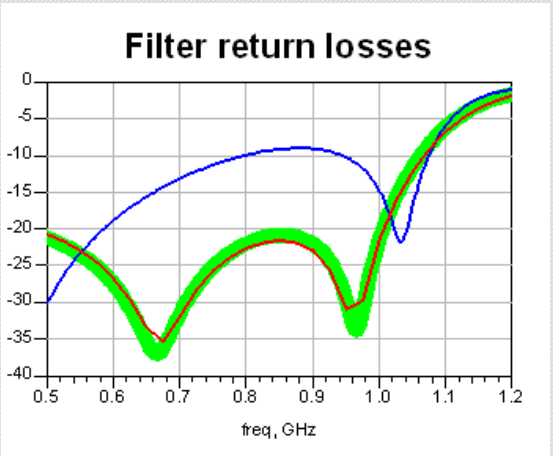
Auto Layout



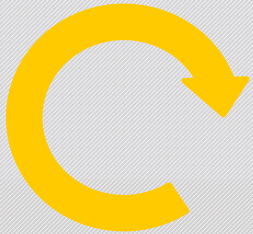
Layout Optimization







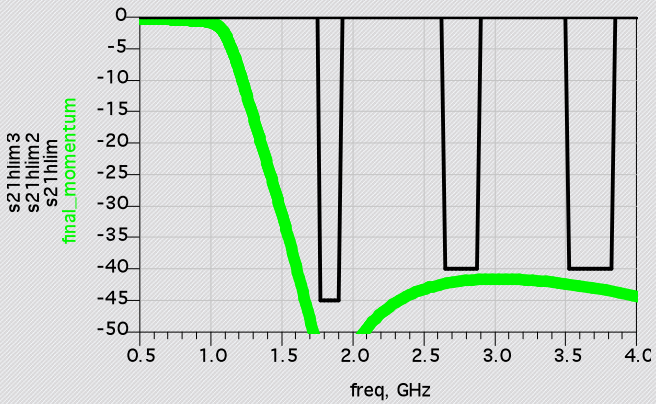
Idealized
First EM
Final

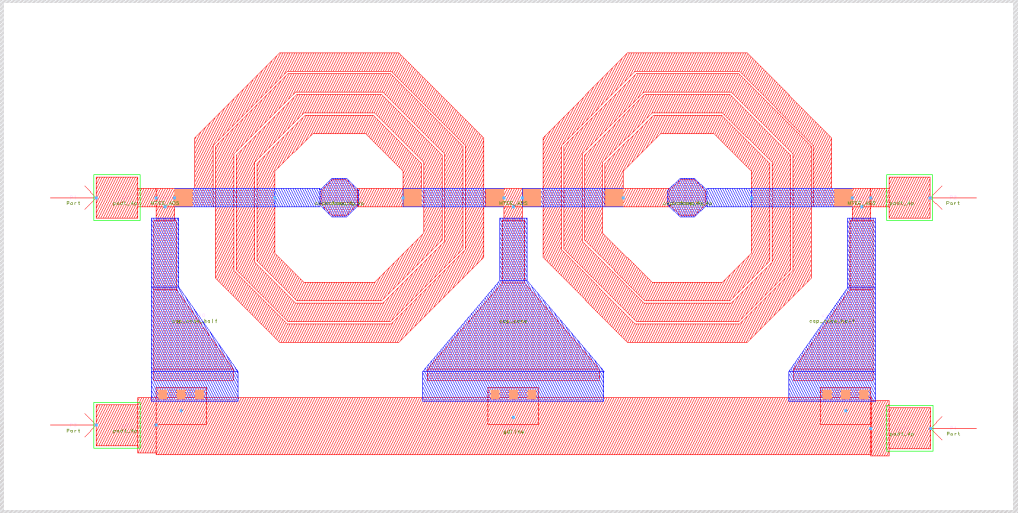


Iterative process

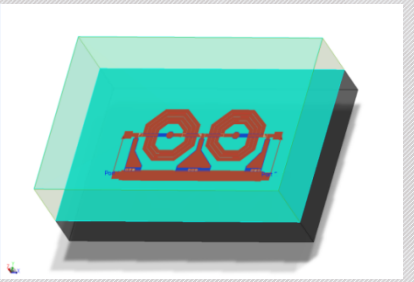
Final Results

Filter Response

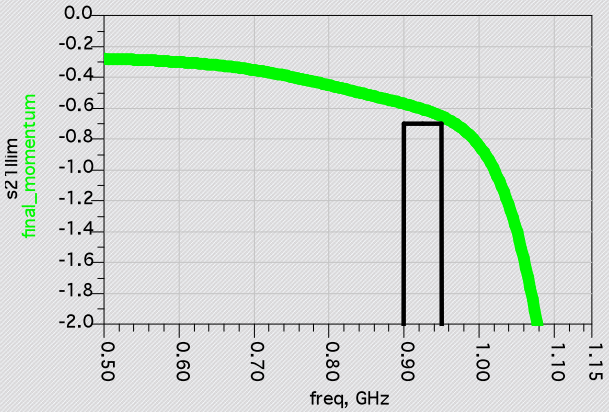




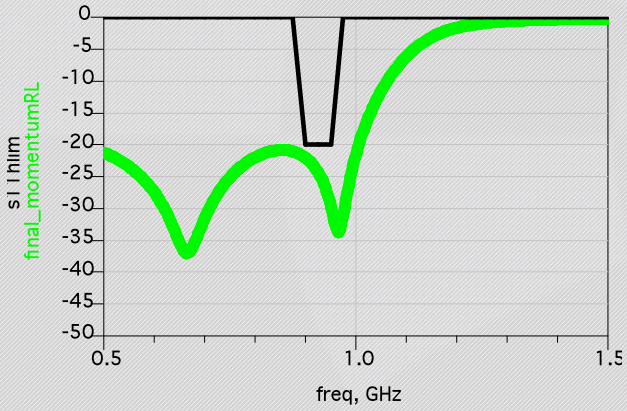
Filter Dimensions :
1.6mm x 1.1mm x 0.3 mm
1.76mm²



Filter Losses



Return Loss



Conclusions

- GSM harmonic filter designed in IPD technology
  - Small overall dimensions
    - 1.6mm x 1.1mm x 0.3 mm
    - 1.76 mm²
  - Performance meets specification
    - < 0.7dB insertion loss,
    - > 50dB rejection (2nd Harmonic)
    - > 40dB rejection (3rd and 4th Harmonics)
    - < -20dB return loss.
- Simple and Powerful Design methodology.
  - From schematics to layout in small reversible steps
  - Geometry optimization through a Fast Iterative Process
  - Final Layout is fully EM simulated
  - Includes all parasitic effects before prototype build