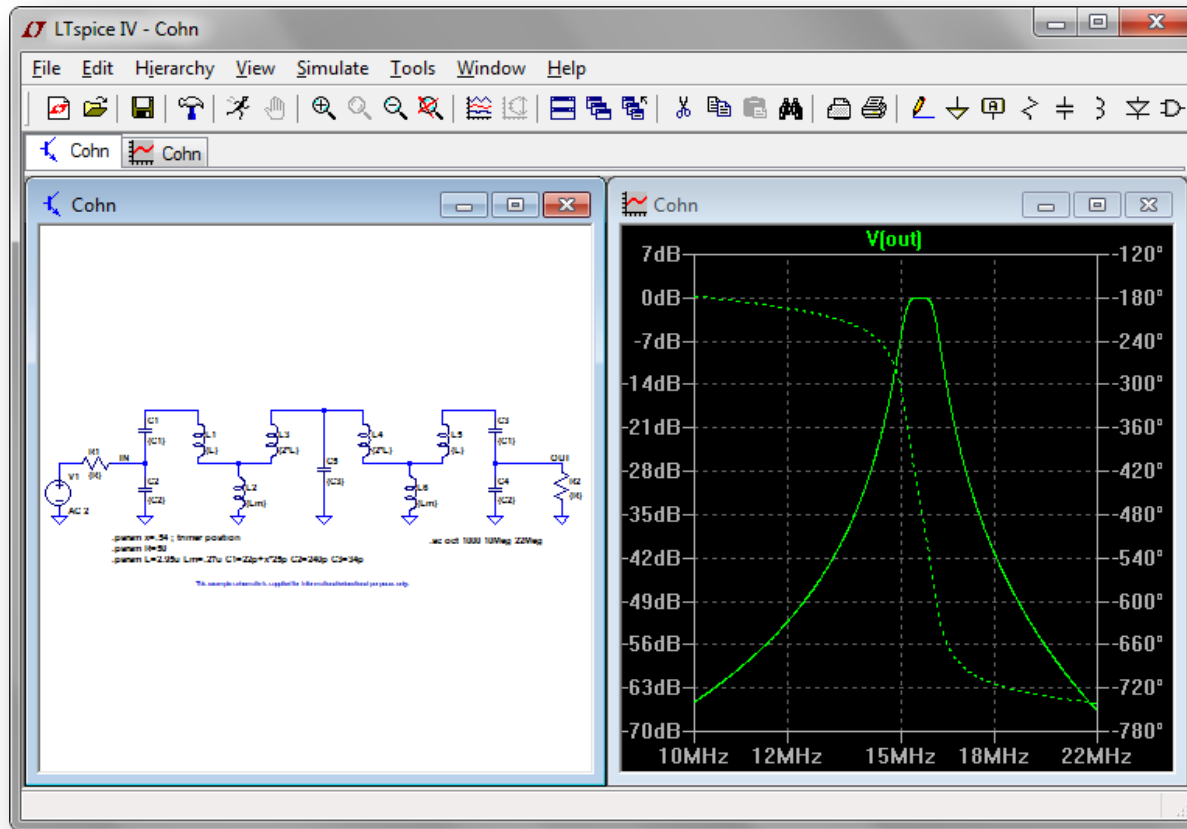
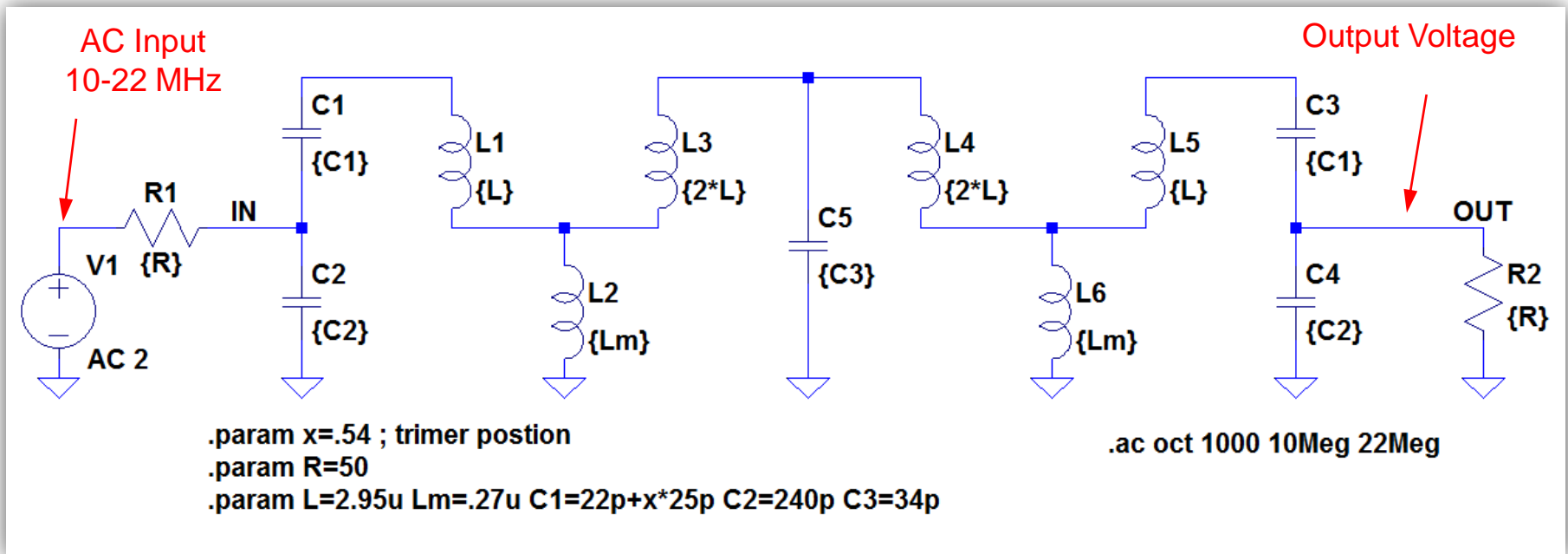


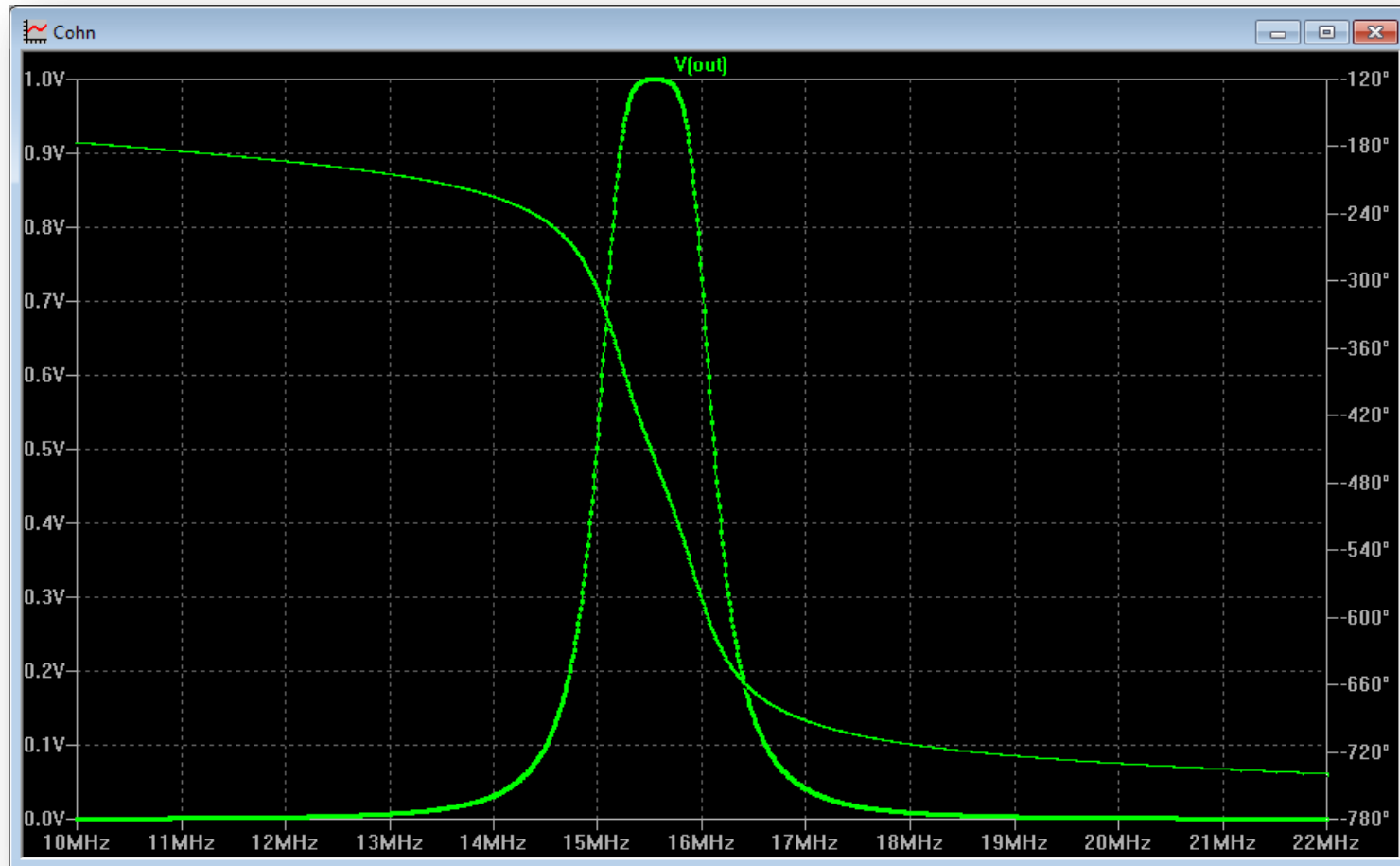
# Robust Design of a Cohn Filter Circuit



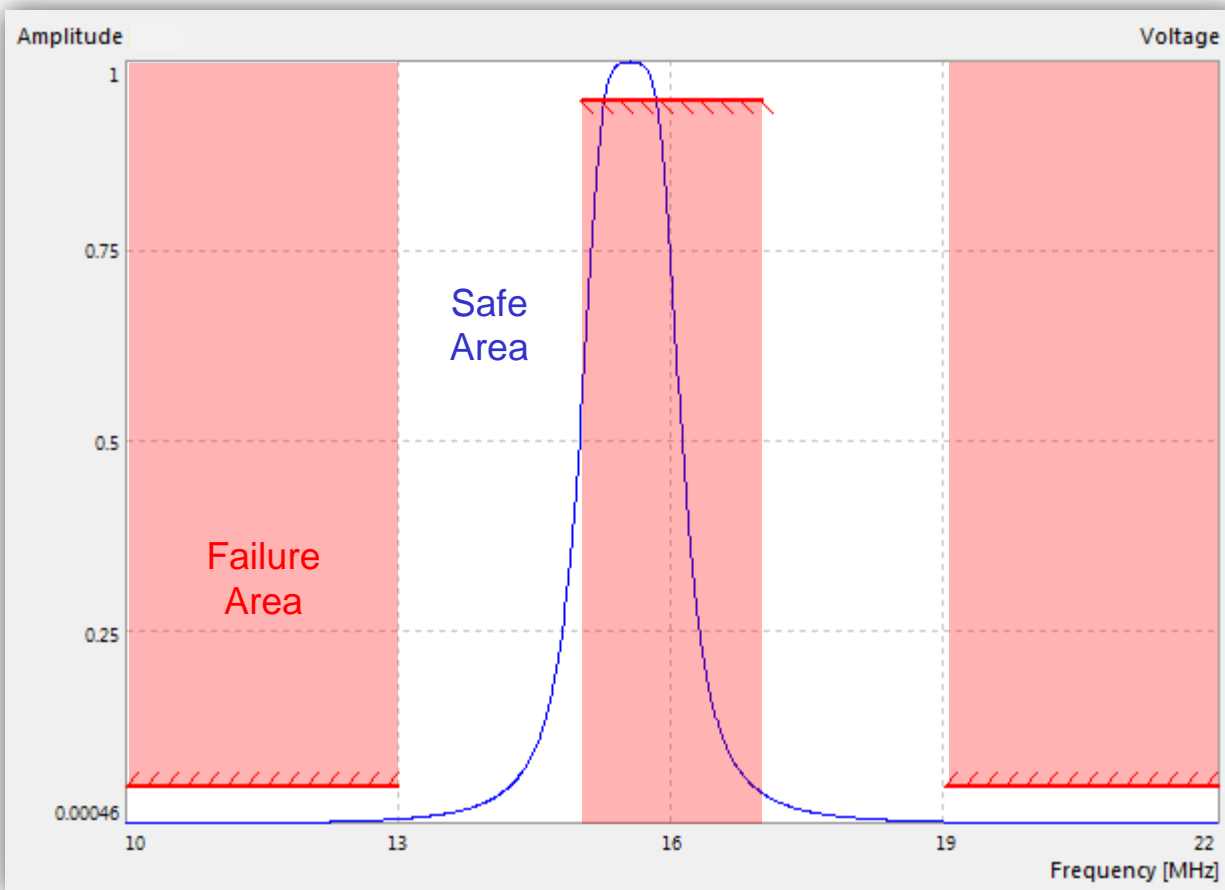
### Cohn Filter Circuit



### Output Voltage through Circuit Simulation



## Filter Design Specifications

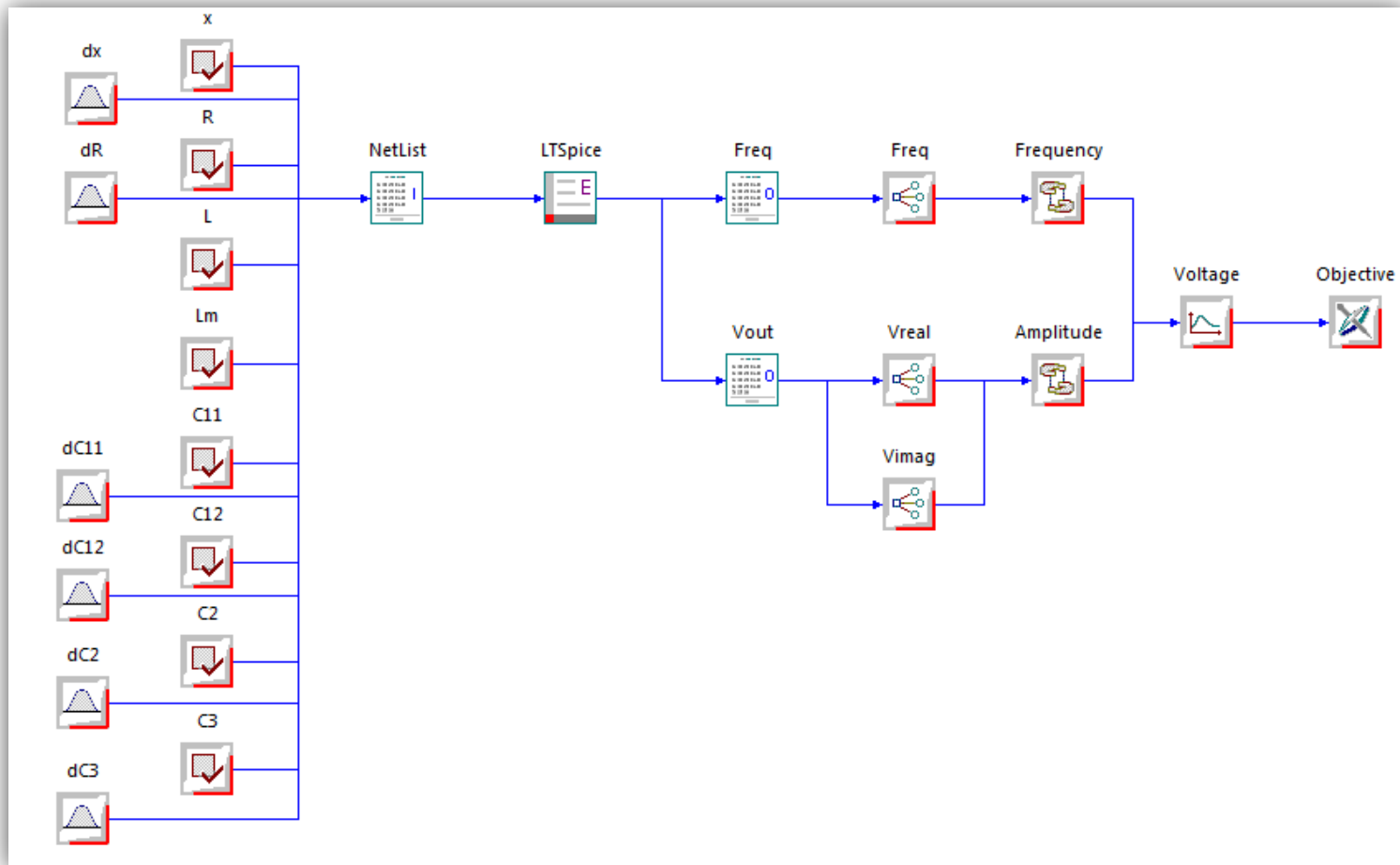


### Output Voltage U

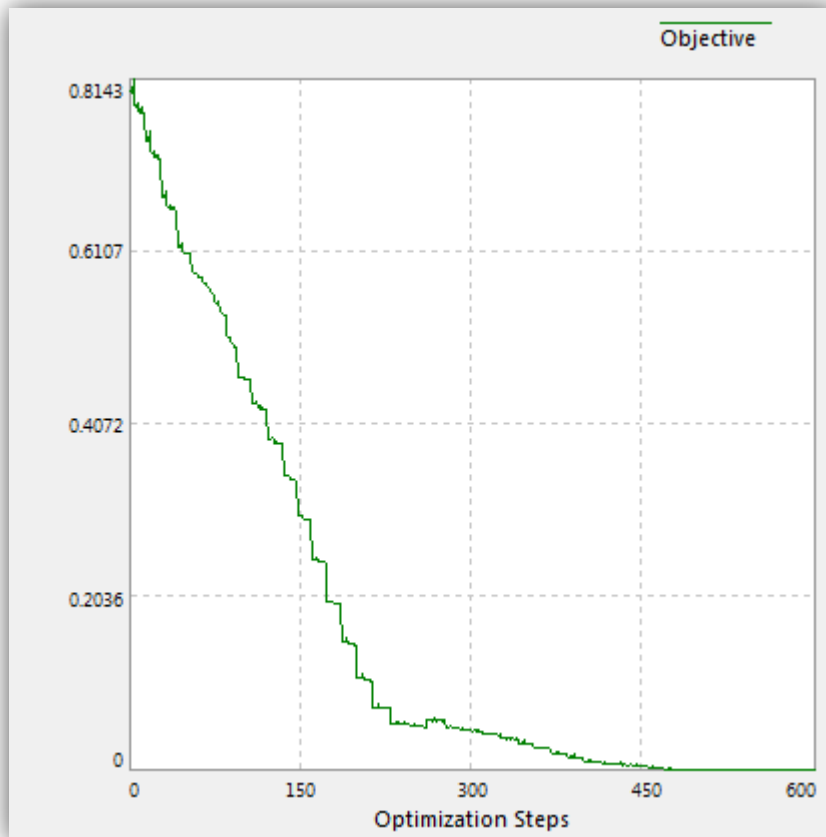
- $U < 0.05 \text{ V}$  for  $F < 13 \text{ MHz}$
- $U > 0.95 \text{ V}$  for  $F = [15-17] \text{ MHz}$
- $U < 0.05 \text{ V}$  for  $F > 19 \text{ MHz}$

**Output Frequency: 15-17 MHz**

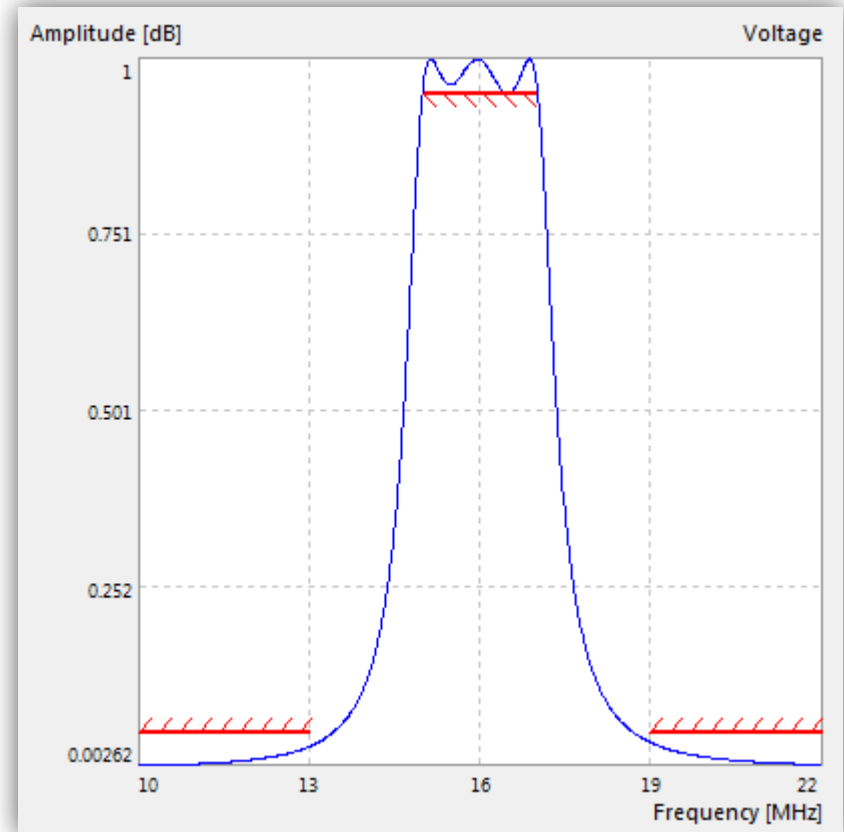
### Process Work Flow



### Nominal Design Optimization



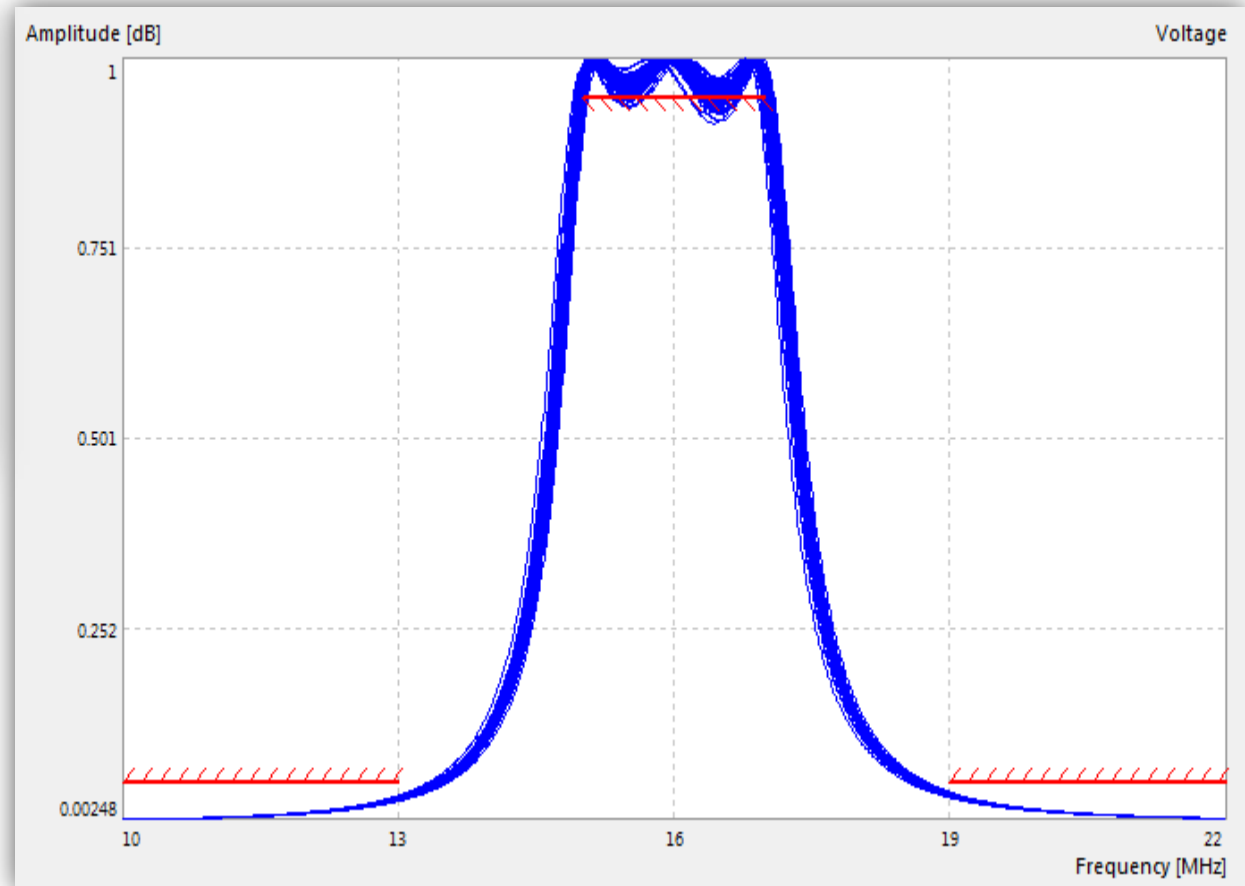
Nominal Optimization Process



Final Nominal Design

## Robustness Evaluation of Nominal Design

Name	Nominal	Tolerance	Unit
x	0.586	0.01	
R	38.93	1	
L	2.113	0.01	u
Lm	0.468	0.01	u
C11	28.03	1	p
C12	24.64	1	p
C2	237.2	1	p
C3	42.37	1	p

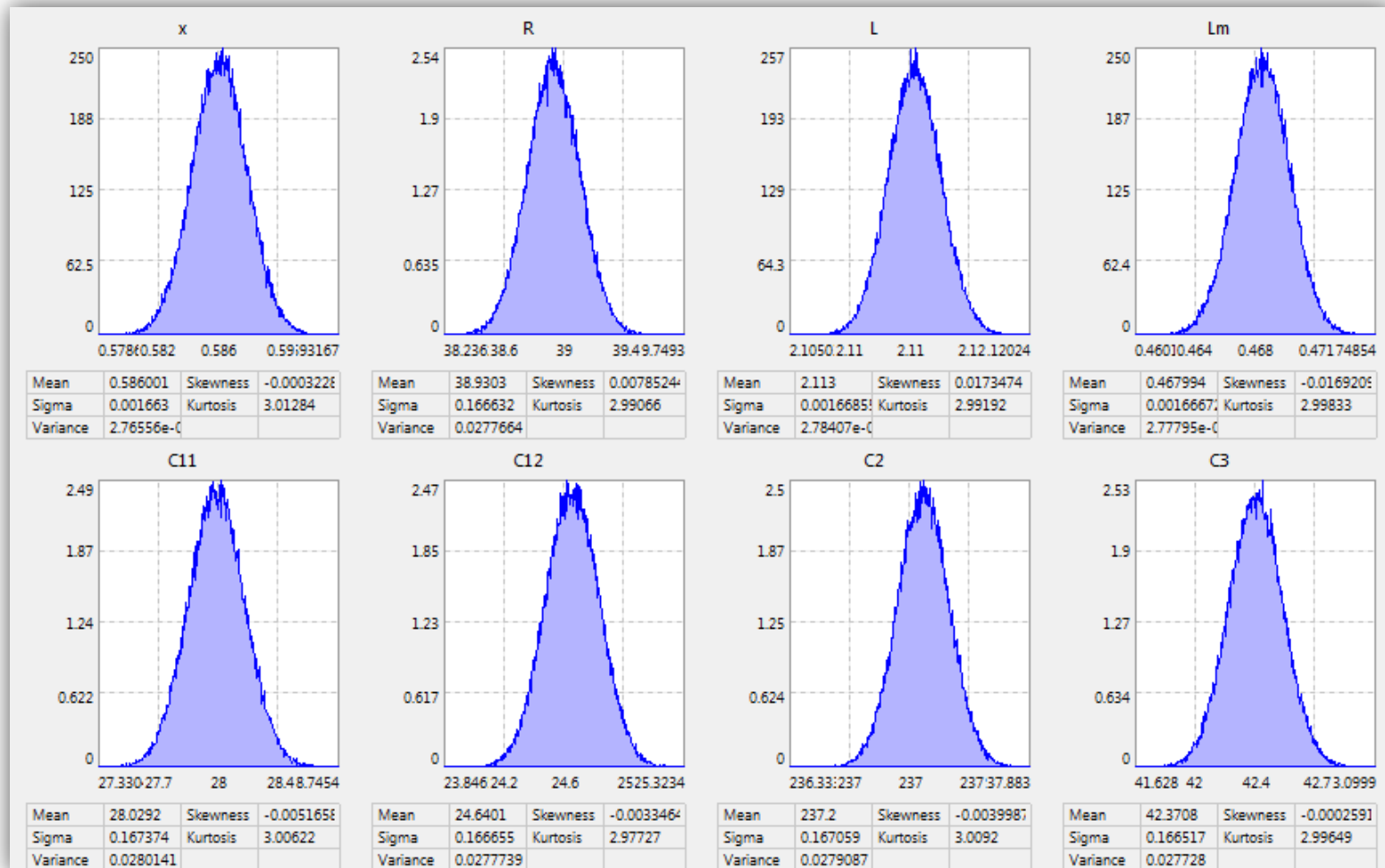


Uncertainties or Tolerances  
for Design Parameters of  
the Nominal Design

Design of Experiment  
(DOE)

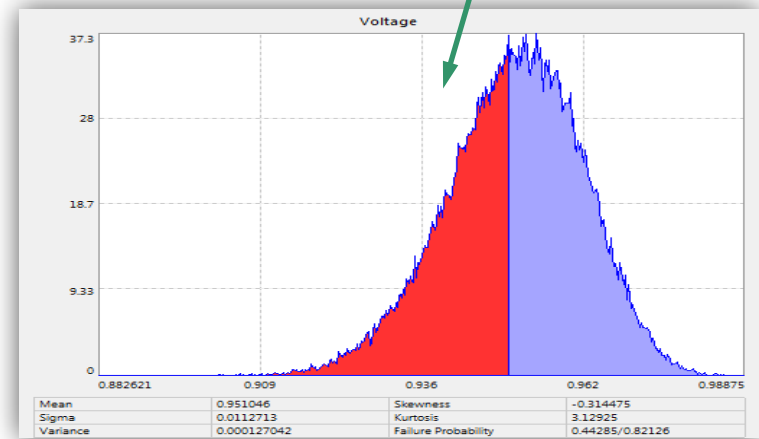
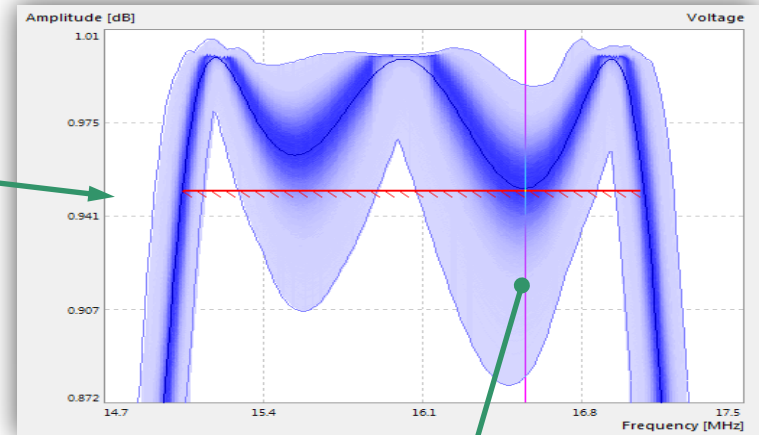
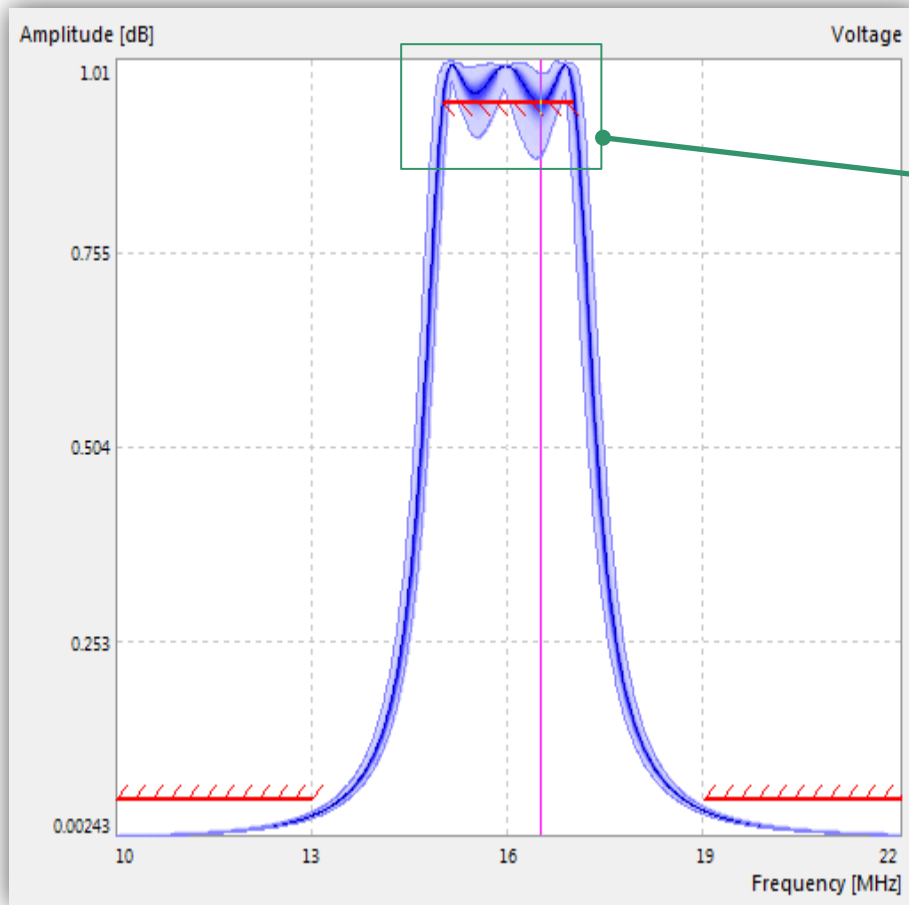
100 Model-Calculations

## Stochastic Distribution of Design Parameters

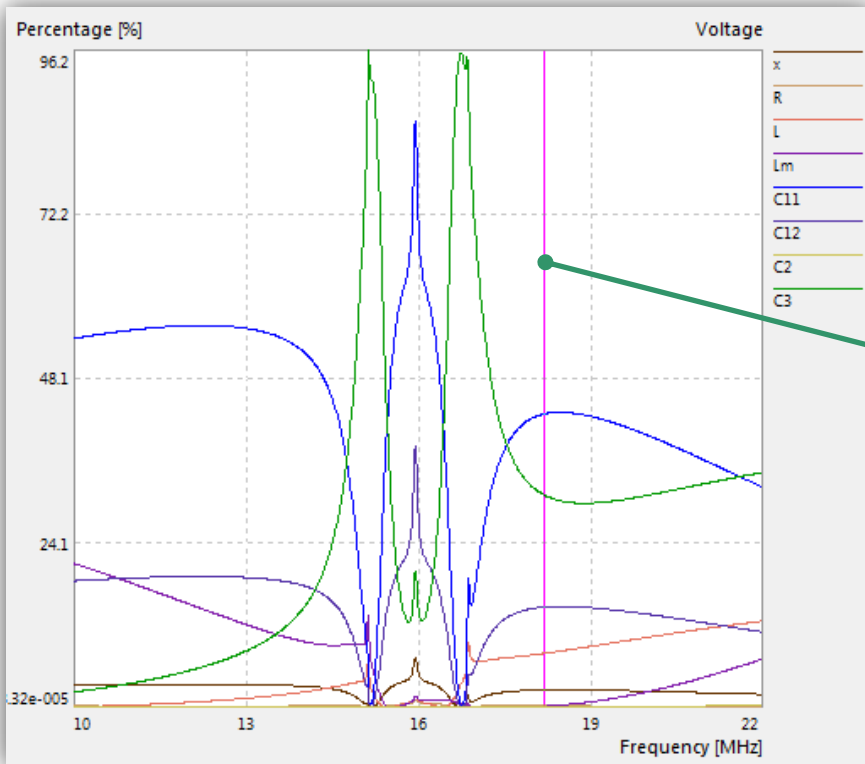




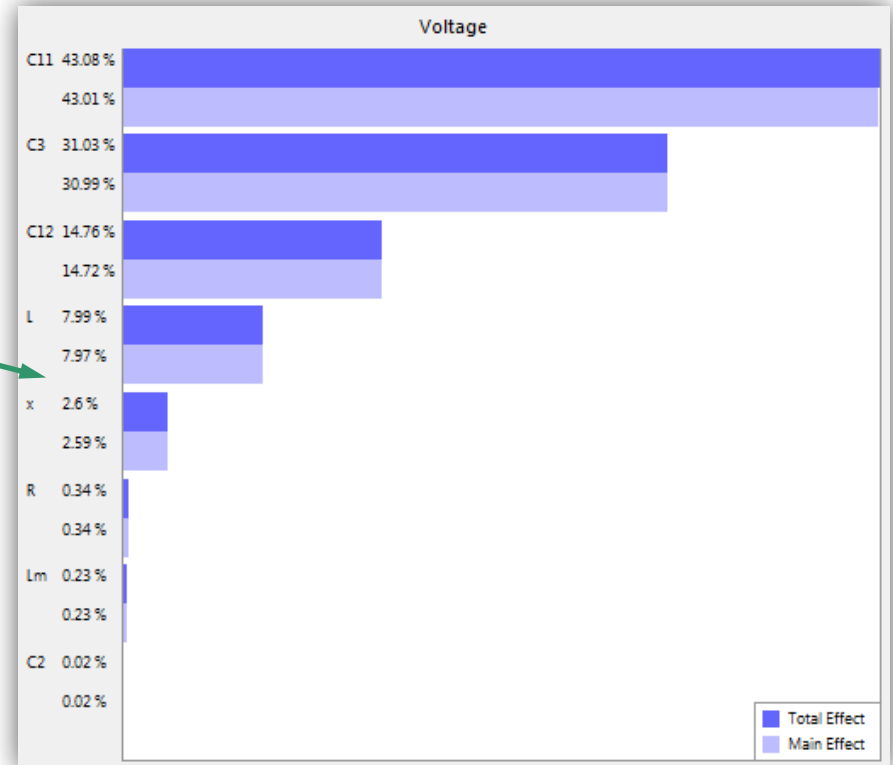
## Probabilistic Simulation of Nominal Design



## Sensitivity of Nominal Design

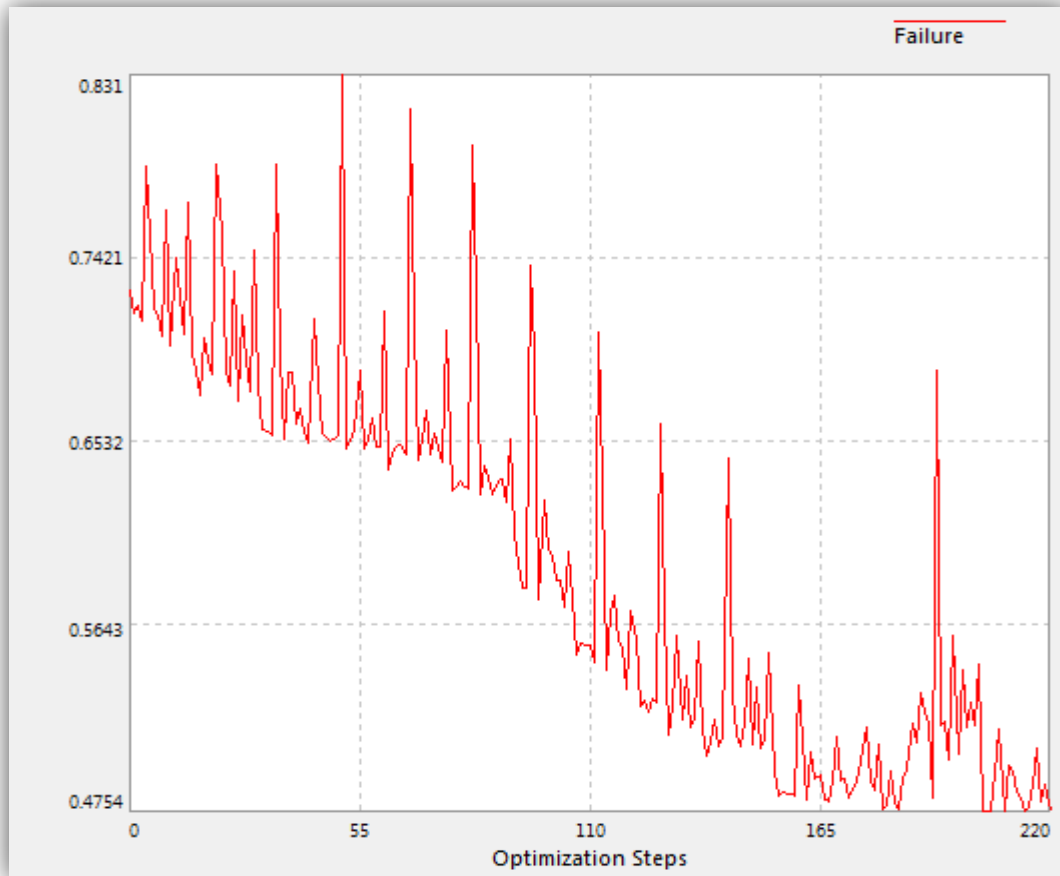


1D Frequency Sensitivity



0D Sensitivity at 18 MHz

## Robust Design Optimization

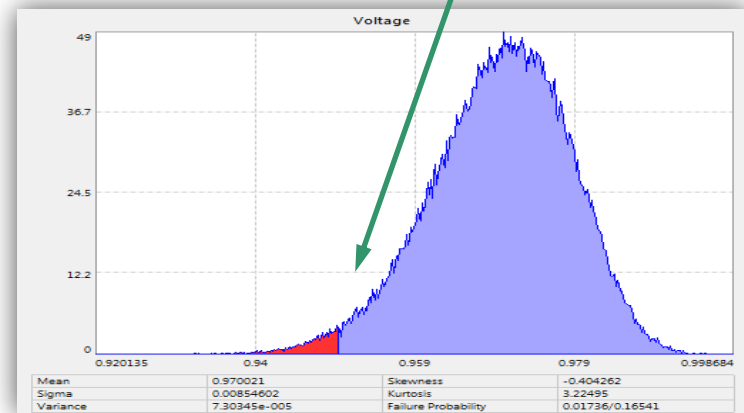
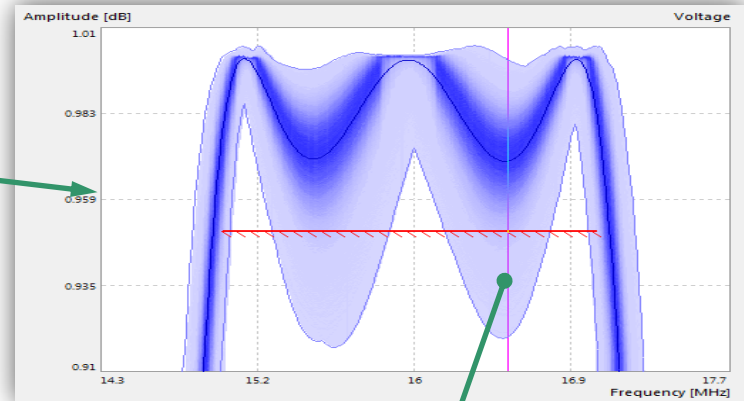
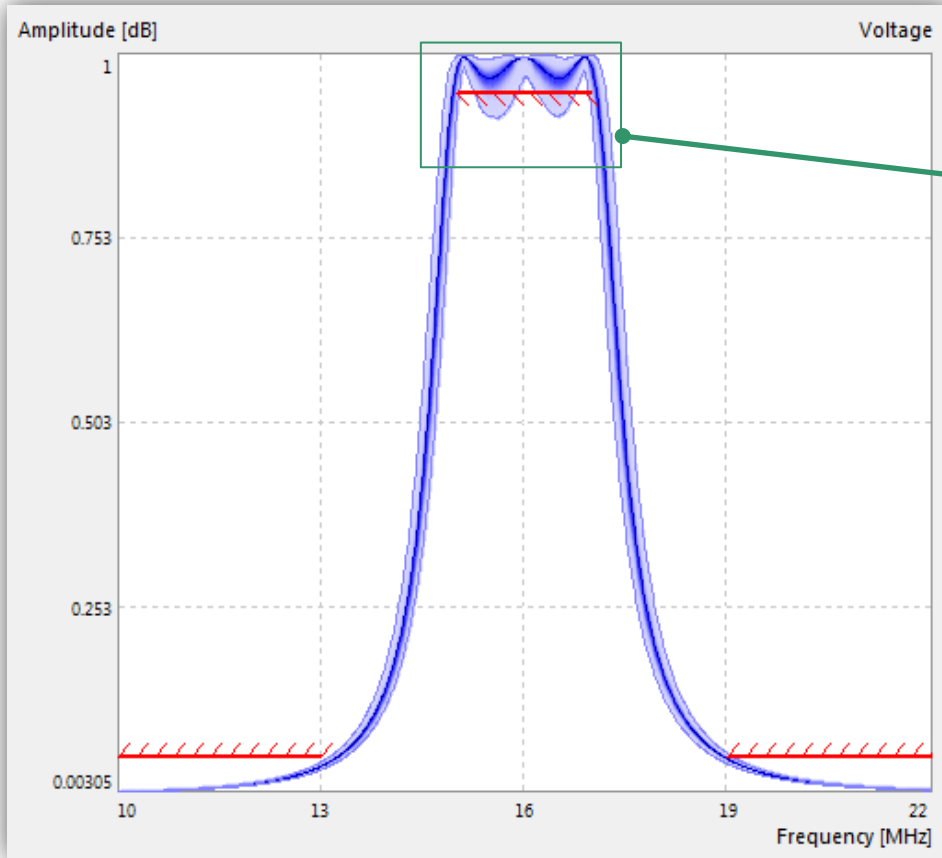


### Design Parameters for Final Robust Design

Name	Nominal	Tolerance	Unit
x	0.604	0.01	
R	41.09	1	
L	2.113	0.01	u
Lm	0.5058	0.01	u
C11	27.13	1	p
C12	24.64	1	p
C2	203.6	1	p
C3	42.1	1	p

### Optimization Process to Minimize the Failure Probability

## Evaluation of Robust Design



## Conclusion

Nominal design using classical nominal simulation cannot warranty the reliability and quality of the products, because the nominal parameters are only one fix value.

Robust design is a power-full tool for design of reliable and quality product in the early design stage without any cost. It considers the uncertainty parameters as stochastic distributions.

In the case of the Cohn filter circuit, the failure probability has been reduced from **82,1% to 16,5%** for the mass manufacturing.

**OptiY®** is the leading software platform for robust design of all engineering fields using different commercial CAD/CAE-software or in-house codes.