



# Hands-on 5G Filter Design from CAE to Measurement in the Sub 6 Band

## Sponsoring MTT-S Technical Committees & Organizations

MTT-1  
Sonnet Software  
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## Coordinators and Contacts

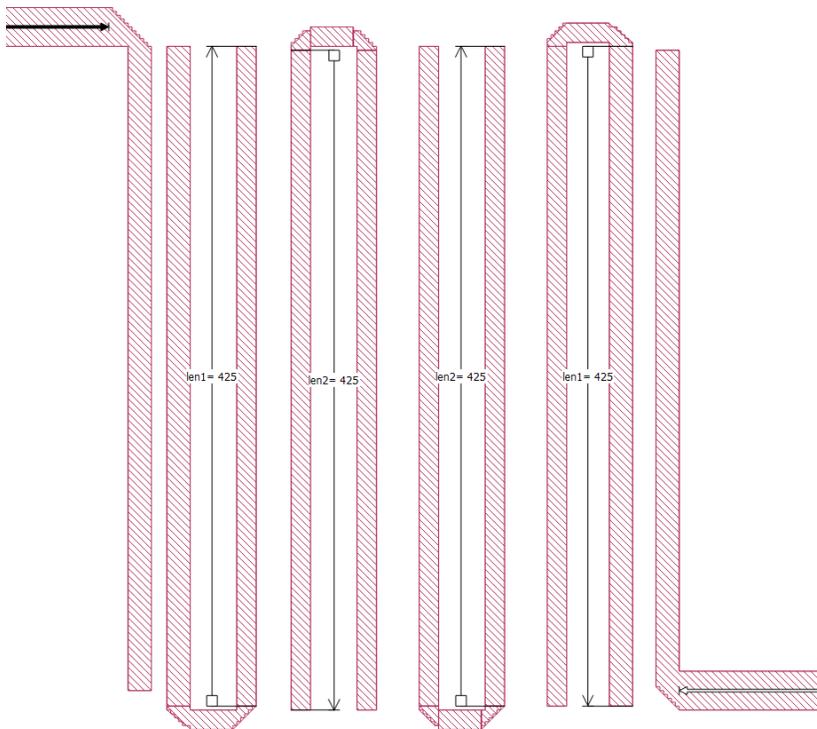
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To enter, please submit an application at : [www.sonnetsoftware.com/IMS2020SDC](http://www.sonnetsoftware.com/IMS2020SDC)

## Competition Summary

As demand for mobile data skyrockets, exceptional scientific and industrial efforts are being conducted to build 5G networks. For this contest, students will take the role of a filter designer at a high-technology engineering firm. Supervised access will be provided access to resources valued at over \$150,000, including access to Sonnet's CAE and simulation tools, LPKF's manufacturing tools, and other hardware and measurement equipment, all to emulate a workflow that students could expect to see in the 5G industry. Students will compete to reliably design and produce a high-performance filter device on the "Sub-6" band, and will be graded based on device performance, simulation accuracy, and craftsmanship. An example circuit in Sonnet is shown based on a hairpin topology in *Figure 1*. As students will only have one chance to produce the filter at the conference, it is important that simulation be used to hone and refine designs as much as possible, and that time and care be taken to set up the simulation precisely so that first pass success may be achieved with the design. A 30-minute demo webinar will be exclusively available to student entrants to help get familiar with the software and goals.





*Figure 1: An example circuit drawing in Sonnet*

## Detailed Competition Description and Rules

1. The circuit must be built on microstrip PCB based on the stack-up defined in the .son file template.
2. Nominal board size is 1.280" x 0.640", maximum is 2.5" x 2.5" with larger sizes discouraged in the Figure of Merit (FOM) due to material cost in mass production.
3. The circuit must be milled on-site in cooperation with LPKF. Clamp-on connectors will be available for measurement use.
4. No passive or active components of any kind may be attached to the microstrip or connectors.
5. Any planar filter topology may be used, however ground-vias (to be drilled by LPKF and soldered by hand) are discouraged in the FOM as they would increase complexity for mass production.

- The filter passband will be 4.0-4.5 GHz, representing a hypothetical 5G data band. The filter is intended for application in a distributed base station, so low cost and high performance are both important.

## Evaluation Criteria

### 1. (25 pts maximum) Measured Pass Band Return Loss for the produced device

It is important that the filter does not have an overly adverse effect on loss. -20dB S11 across the entire passband is considered nominal and receives full credit, i.e., all S11 points below the blue band in *Figure 2*.

*0.1 points removed from 25 per dB above nominal across 25 frequencies in the passband*

### 2. (25 pts maximum) Measured Stop Band Rejection for the produced device

The filter should exhibit steep roll-off and adequately filter the passband. -40dB S21 at 3.6 GHz and -27.5dB S21 at 4.9 GHz considered nominal, i.e., below the pink bands in *Figure 2*.

*1 point removed from 25 per dB above nominal at each frequency of the 25 frequencies in the stopband (3.6 GHz-4 GHz and 4.5 GHz-4.9 GHz).*

### 3. (25 pts maximum) Broadband Error in simulation vs. measurement

Percent error between simulation and measurement at 50 discrete frequency points between 3.6GHz and 4.9 GHz is calculated.

Error of 1% or better is considered nominal and receives full credit.

Error of 15% or more is considered unreliable and receives no credit.

*Percentage of 25 awarded commensurate with position between 1% and 15% average error*

### 4. (25 pts maximum) Qualitative Design and Craftsmanship

This category will be judged by a panel of 3 microwave experts.

Credit will be awarded based on design novelty, precision, and high-quality engineering effort, and craftsmanship regarding connector install and other construction efforts.

### 5. (100 pts) Total FOM

*FOM = Pass Band RL + Stop Band Rejection + Broadband Error + Qualitative Design – Penalty Factor*

*Penalty Factor = Length Over 2.5" (in 0.25" increments) + Width Over 2.5" (in 0.25" increments) + 3\*Number of Soldered Via Connections*

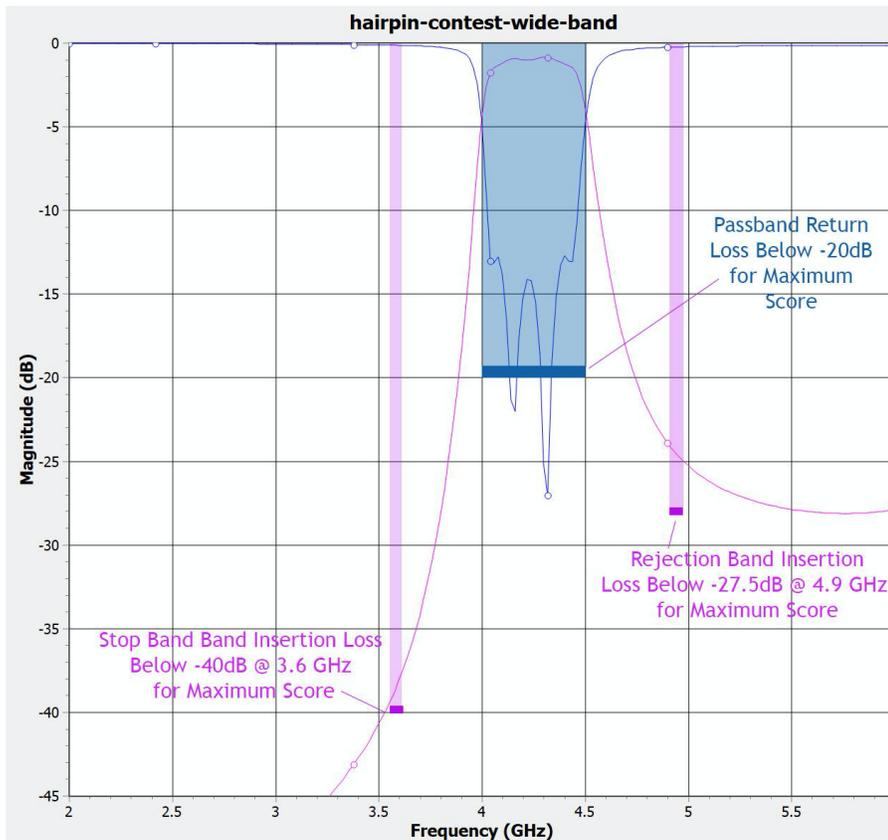


Figure 2: S-parameters from an example submission with goals overlain

## How to Participate

Participants must register to the IMS Student Design Competition according to the rules posted on the IMS-2020 homepage. At the same time as the registration to IMS-2020 is made, the competitors must also register with the organizers of the competition. This is done by completing the online entry form at [www.sonnetsoftware.com/IMS2020SDC](http://www.sonnetsoftware.com/IMS2020SDC) no later than the official deadline announced on the IMS-2020 SDC homepage and following the below format. Selected entrants will receive contest licenses of Sonnet.

## Student Eligibility Criteria

1. Students may enter as individuals or as a team. There may be no more than four students on a team. Each student may be a member of only one team. Each team may submit up to one entry.



2. To enter a competition, the student(s) must have been full-time student(s) (enrolled for a minimum of nine hours per term as graduate students or twelve hours per term as undergraduates) during the time the work was performed. There is no restriction on age.
3. The student(s) must have a signed statement from their academic advisor that the work is principally the effort of the student(s).
4. At least one of the students on a team must register for and attend the conference to demonstrate their design for evaluation during the contest day at IMS2020.
5. The students should use the email address issued by their respective institutions for all communication regarding the competitions, rather than their personal emails (e.g., Gmail, Hotmail).

## **Awards**

1<sup>st</sup> Place: \$1500 and 1 year Limited Term License (LTL) Sonnet Professional

2<sup>nd</sup> Place: \$500 and 6 months LTL Sonnet Professional

3<sup>rd</sup> Place: 3 months LTL Sonnet Professional

