SDC 2: Packaged C-band Filter

1. Your Technical Committee number and name: TC-5 (Eric Naglich, Sanghoon Shin, and Hjalti Sigmarsson) and TC-16 (Kamal Samanta and Carlos Carceller)
2. Description of competition and rules: This competition will require students to design a compact filter to fit within a small ceramic package provided by Kyocera. The center frequency of the filter will be 7.3 GHz, and the 3-dB bandwidth will be 8% or 584 MHz. These specifications were chosen with the size of the package in mind as well as the size, availability, and performance of relevant lumped elements and distributed resonators on substrates with high dielectric constants. The filter must be passive, and no bias voltages or connections other than an RF input and an RF output will be allowed. Students will design and fabricate the filters, integrate them into the provided package, and mount the package onto a substrate or in an enclosure with SMA female/jack connectors. While the filter must fit within the closed provided package, there are no requirements for the size of the substrate/enclosure on which the package will be mounted. The only requirements for this substrate/enclosure are that its input and output interfaces are SMA female/jack connectors and that visual verification that the provided package was used in construction of the filter is possible (i.e., it cannot be a sealed box that cannot be taken apart at the competition). The challenges of this competition include: Package integration and parasitic management, circuit design with space constraint, modelling of the package and its effect on the filter from the physical and material properties of the package, and choice of topology and resonator type for optimal performance given size constraints. Students should note any resonances of the package and how they may impact the filter design.

Students will also be required to bring either an unpackaged version of their filter or a diagram of the layout to facilitate explanation of their design to the competition judges and other student competitors.

1. Contact names, email addresses, and phone numbers of the competition organizers:

Eric Naglich ([eric.naglich@gmail.com](mailto:eric.naglich@gmail.com), +1 219-789-0230), and

Kamal Samanta ([kksamanta@ieee.org](mailto:kksamanta@ieee.org), +44 787-210-6120).

1. Criteria for judging: Passband insertion loss will be measured at 7.1, 7.3, and 7.5 GHz and rounded to the nearest 0.1 dB. Stopband rejection will be measured at 4.6, 6.6, 8, and 10 GHz and rounded to the nearest 0.1 dB. The measured values at 4.6 and 10 GHz will be taken as a positive number and divided by a factor of 20. The measured values at 6.6 and 8 GHz will be taken as a positive number and divided by a factor of 5. The measured values at 7.1, 7.3, and 7.5 GHz will be taken as negative values. The sum of all of scaled measurements will be the score for the filter entry. The highest score will win the competition. An example of scoring for a representative filter is below:

Example measured values: Example scaled values:

4.6 GHz: -55 dB 2.75 (2.75 = 55/20)

6.6 GHz: -19 dB 3.8

7.1 GHz: -4.2 dB -4.2

7.3 GHz: -4 dB -4.0

7.5 GHz: -4.3 dB -4.3

8 GHz: -22 dB 4.4

10 GHz: -53 dB 2.65

The total score for this filter is the sum of the example scaled values: 2.75+3.8-4.2-4.0-4.3+4.4+2.65 = 1.1.

1. Detailed description of all equipment needed at the day of the competition: This competition will require a network analyzer capable of measuring 2-port S parameters over 4-10 GHz, two RF cables that interface with the network analyzer on one side and the SMA female connectors of the students’ filters on the other side, power and power cables for the network analyzer, a table and chairs, and paper on an easel for record keeping of scores.

A drawing for the package to be provided by Kyocera is pasted below and will be available as a PDF to all entrants:



A measured response of a transmission line integrated into the package is shown below. The purpose of providing this response is to note that package resonances exist above the desired filter passband and may influence design choices.

