Four-Channel Switchable/Reconfigurable Filter Bank

Contact information for competition organizers:

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Contest Description and Rules:

A switchable or reconfigurable filter bank can be required in RF front ends that need to accommodate changes in the spectrum and provide adaptive filtering. This type of filter is commonly used in military and high-end commercial applications needing signal integrity, including communication systems. The objective of this competition is to demonstrate effective channel filter design in conjunction with switching circuits to provide the required filter performance. The proposed design for this student competition is a switchable filter bank for the bandwidth of 1.0 - 3.0 GHz with four-channel bandpass filter performance. Each channel has a 500 MHz passband bandwidth. The filter has RF connectorized finishing and control signal connectors.

Design Specifications and Rules:

The switchable filter bank could be composed of any type of lumped, planar, or cavity resonators for a channel filter design along with RF or Microwave switch circuits. The RF switches must be controlled electronically to make each channel state. RF switch could be any type of circuitry using solid state switches or RF relays. The filter bank must have female SMA connectors on the edges of the filter for the measurement. The filter will be evaluated based on the performance measured between the SMA connector interface reference planes. A network analyzer and two power voltage sources (0-20 Volts, 0-100 mA) will be available for measurements and filter reconfiguration. The filter bank size should be as small as possible. The size factor will be considered for the scoring. The total score will be calculated based on the following four filter specifications.

Channel Filter specifications:

- Channel 1 :
  - Passband :1- 1.5 GHz, Bandwidth 500 MHz
  - Insertion loss: as low as possible
  - Stopband : > 20 dB for DC - 0.75 GHz and 1.75 – 3 GHz

- Channel 2 :
  - Passband :1.5 – 2.0 GHz, Bandwidth 500 MHz
  - Insertion loss: as low as possible
  - Stopband : > 20 dB for DC - 1.25 GHz and 2.25 – 3 GHz

- Channel 3 :
  - Passband :2.0 – 2.5 GHz, Bandwidth 500 MHz
  - Insertion loss: as low as possible
  - Stopband : > 20 dB for DC - 1.75 GHz and 2.75 – 4 GHz

- Channel 4 :
  - Passband :2.5 – 3.0 GHz, Bandwidth 500 MHz
  - Insertion loss: as low as possible
  - Stopband : > 20 dB for DC - 2.75 GHz and 3.25 – 4 GHz

The Measurement Process:

The final phase of this competition will be conducted during the IMS 2019 Symposium through measurements at the conference exhibition for each competing submission. A member of each student team must be in attendance and will be required to switch their filter into the four filter states for measurement. A score will be calculated based on filter performance for each measured state. The total score will be the cumulative score for four states.

Scoring:

The goal of this competition is to design a low loss and high rejection switchable or reconfigurable filter bank that meets the required specifications.

A score will be calculated based on the filter performance in each measured state. Each channel filter will be measured in four states according to the given specifications. The following formulae will be used for the scoring. The accumulated points for each filter state will be added up, and then the area in cm^2 will be subtracted for the final score.
The entries with the highest number of points will win the prizes.

Final score = (Ch.1 filter response + Ch.2 filter response + Ch.3 filter response + Ch.4 filter response) – 0.5*size

Where
Ch.1 filter response = (m4+m5) – 2* (m1 + m2 +m3)
Ch.2 filter response = (m4+m5) – 2* (m1 + m2 +m3)
Ch.3 filter response = (m4+m5) – 2* (m1 + m2 +m3)
Ch.4 filter response = (m4+m5) – 2* (m1 + m2 +m3)

Where m1, m2, and m3 are the insertion loss (s21(dB)) in the passband, and m4, m5 are insertion loss (s21(dB)) in the stopband of each channel filter at the maker frequencies, respectively.

Score Example:

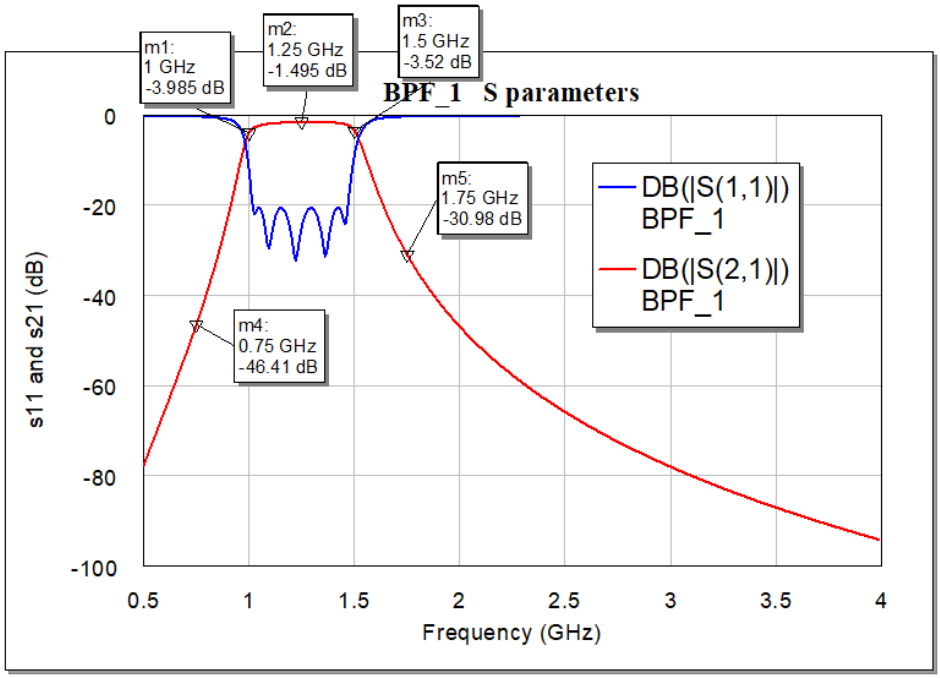


Fig.1 Channel 1 estimated response: s21 (dB) reading will be rounded to the first decimal point at each marker frequencies.
Ch.1 = [m4(46.4) + m5(31.0)] – 2* [m1(4.0) + m2(1.5) +m3(3.5)] = 59.4

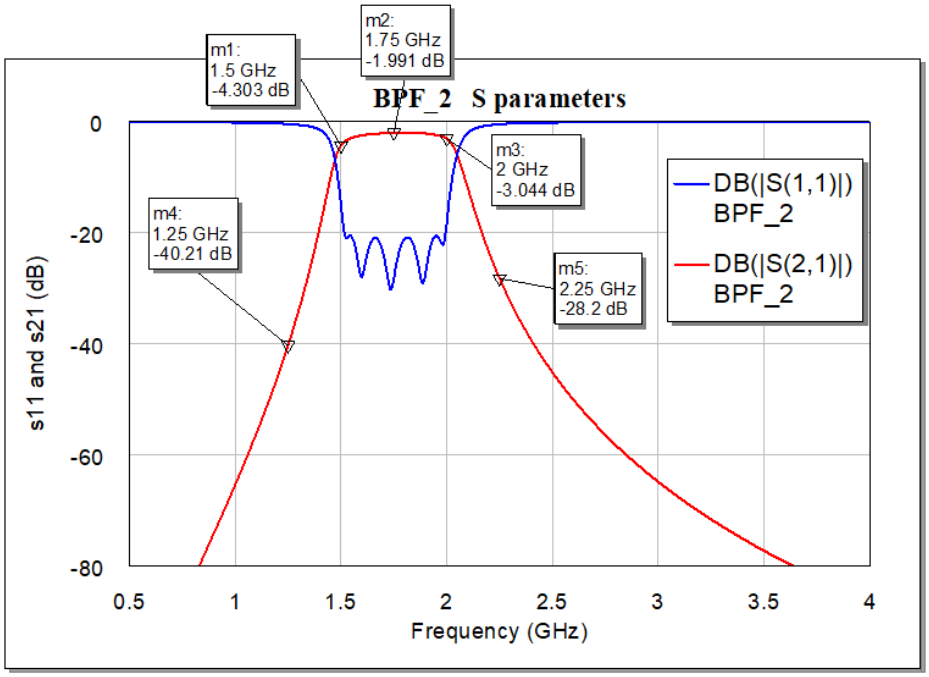


Fig.2 Channel 2 estimated response, s21 (dB) reading will be rounded to the first decimal point at each marker frequencies.
Ch.2 = [m4(40.2) + m5(28.2)] – 2* [m1(4.3) + m2(2.0) +m3(3.0)] = 49.8

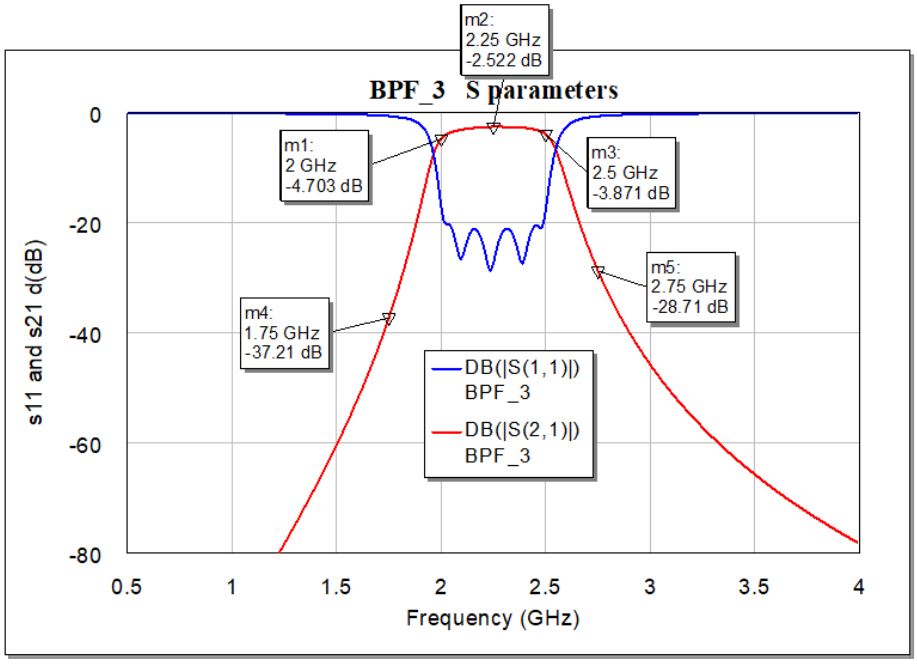


Fig.3 Channel 3 estimated response, s21 (dB) reading will be rounded to the first decimal point at each marker frequencies.

Ch.3 = [m4(37.2) + m5(28.7)] – 2* [m1(4.7) + m2(2.5) +m3(3.9)] = 43.7

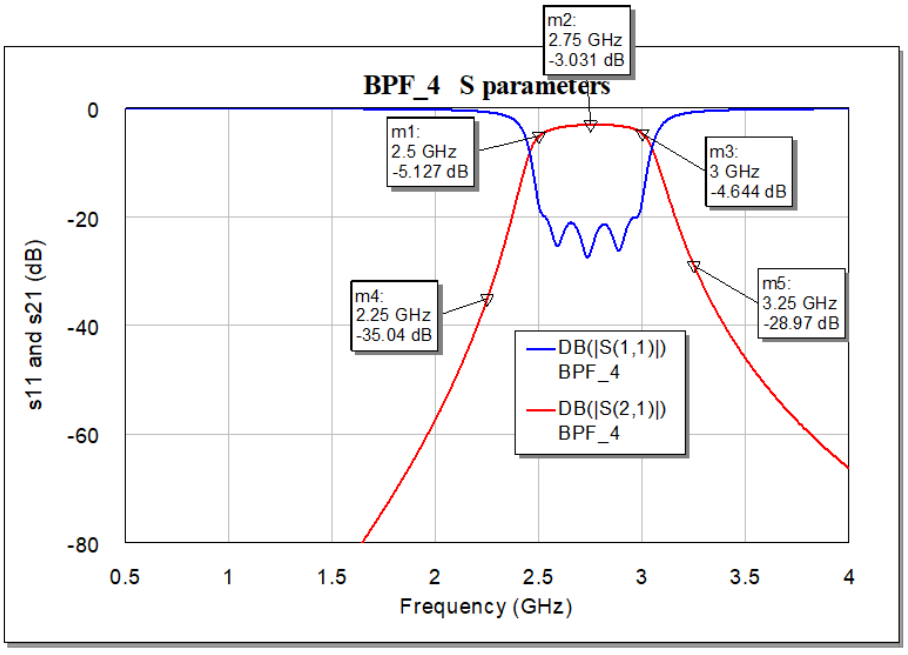
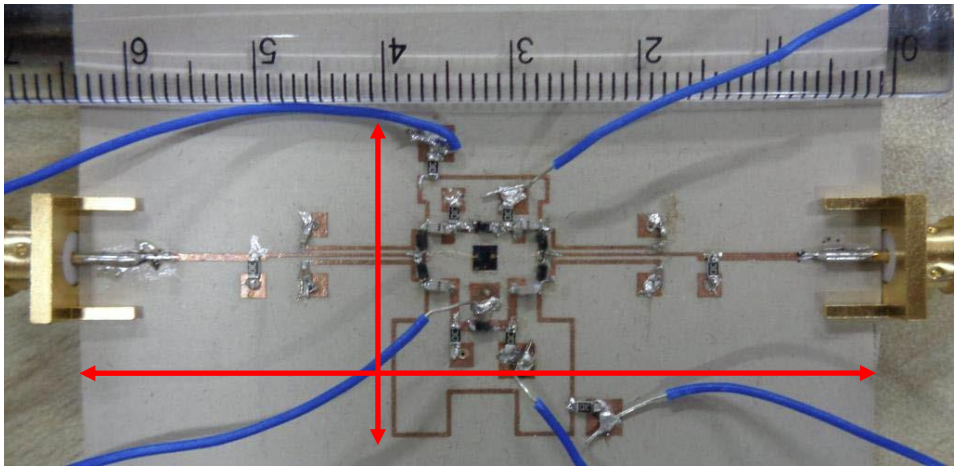


Fig.4 Channel 4 estimated response, s21 (dB) reading will be rounded to the first decimal point at each marker frequencies.

Ch.4 = [m4(35.0) + m5(29.0)] – 2* [m1(5.1) + m2(3.0) +m3(4.6)] = 38.6

Size: The following design will be used to demonstrate how size will be measured:



This filter will be measured to be 6.3 cm wide and (approximately) 2.5 cm long, for a total size of 15.75 cm^2. Red arrows have been added to show the measurements.
Please note that showing this filter to demonstrate size measurement is not a suggestion or relevant way to implement your filter for the competition. It is merely a convenient image for demonstrating size measurement. A packaged finishing would be preferable.

The final score will be calculated by adding up each channel filter score and subtracting the size.

Final score = (ch.1 + ch.2 + ch.3 + ch.4) - size = (59.6 + 49.8 + 43.7 + 38.6) – 0.5*(15.75) = 183.8

The entries with the highest number of points will win the prizes.

Sponsoring MTT-S Technical Committee:

- *MTT-8 (Filters and Passive Components)*