IMS2025 Student Design Competition
Submission Form for the Organizers

Template

Switched Acoustic Filter Module

Detailed description and rules

Introduction

Microwave acoustic filters (SAW, BAW) are the prevailing filter technology in RF frontends of mobile handsets, due to their compactness, low price, and high selectivity. To keep up with the demand for multiplexers, engineers are usually required to combine (off-the-shelf) SAW/BAW components with RF switches for a multi-band multiplex filter. In this competition, our sponsors Qorvo and Menlo Microsystems will provide the contestants with appropriate BAW and RF-MEMS components. The students are required to design and assemble a band 1/2/3/7 switched multiplexer module. The measurements will be taken at IMS 2025 with support by Keysight Technologies.

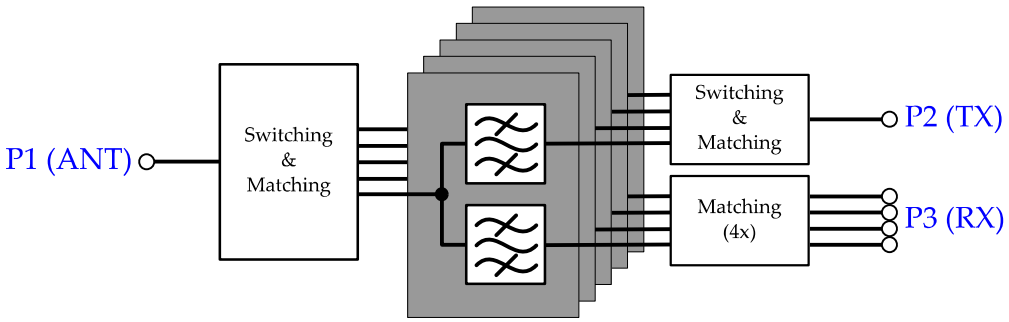

Figure 1. Schematic of multiplexer module to be designed

For simplification, only antenna and TX ports are switched. The RX bands are fed separately. Thus, the final circuit will have 6 ports (1× Tx; 1× Ant; 4× Rx).

Design specifications and rules

- The circuit must incorporate RF passive components only. Use of amplifiers in the RF path is not allowed.
- The design must incorporate the QM23002 and QM26001 from Qorvo and MM5120 from Menlo Microsystems. Designs that deliberately spoil the isolation and stop-band rejection of the BAW components (e.g., bypass them or not use them at all), or use other high Q filter technology other than provided, are subject to disqualification.
- Components and their s-parameter data as well as additional information will be sent to the participants after registration. Please send an email to mtt2sdc@listserv.ieee.org.

- The circuit must be designed using commercially available components only.
- The circuit board must have a rectangular outline. Only the actual PCB size is measured (protruding RF and DC connectors are excluded). For handling simplification, boards shall have a size of 5 × 5 cm². The module should be planar.
- The mechanical design should allow for internal inspection of all relevant components and circuit elements.
- Female 50Ω SMA end-launch connectors must be used. The connectors must be placed at the outer dimension of the board. Please allow enough space between the SMA connectors for proper connection with test cables.
- The frequency bands are defined as:

Band	**TX band / MHz**	**RX band / MHz**
1	1,920 – 1,980	2,110 – 2,170
2	1,850 – 1,910	1,930 – 1,990
3	1,710 – 1,785	1,805 – 1,880
7	2,500 – 2,570	2,620 – 2,690

- All measurements are referenced to 50 Ω impedance.
- We provide a standard DC power supply with 0 to 100 V DC for powering the RF-MEMS components. The connection will be 4mm banana plugs.
- The board must contain at least proper DC switches to select the band of interest. The implementation of a microcontroller with switching logic is optional.

Evaluation process

The designs will be evaluated by a commission at IMS 2025 based on measurements taken on site. For the evaluation, only small signal parameters and the board design will be considered. In case of equal or very close results, the jury may consider additional criteria such as practicability and workmanship.

The performance will be evaluated based on six different states:

State	Antenna Switch	TX-Switch
I	Bands 1/3/7, carrier aggregated	Band 1
II	Bands 1/3/7, carrier aggregated	Band 3
III	Bands 1/3/7, carrier aggregated	Band 7
IV	Band 2	Band 2
V	Bands 2/7, carrier aggregated	Band 2
VI	Bands 2/7, carrier aggregated	Band 7

Scoring

The figure of merit (in logarithmic domain) is defined as follows:

$$\mathrm{FoM} = \sum_{\forall\ \mathrm{States}} |s_{21}| + |s_{31}| - (VSWR_{11} + VSWR_{22} + VSWR_{33})$$

The s-parameter measurements will be taken at room temperature and -10 dBm power level at all ports. The values are the minimum/maximum values in all (carrier aggregated) bands assigned to the state/ports. The values will be rounded towards lower performance to the first decimal, e.g., $|s_{21}| = -1.53\mathrm{dB} \Longrightarrow -1.6\mathrm{dB}$ and $|s_{11}| = -10.53\mathrm{dB} \Longrightarrow -10.5\mathrm{dB}$.

The board size must be 5 × 5 cm² at least. Boards, smaller in one or both dimensions, will be disqualified.

The device will be considered in case that,

- all transmission parameters ($|s_{21}|$, $|s_{31}|$) ≥ -5 dB across the bands,
- matching at all ports ($|s_{11}|$, $|s_{22}|$, $|s_{33}|$) ≤ -6 dB across the individual bands.

In case one of the previous criteria is not met by the circuit presented at IMS 2025 the circuit is not qualified for the contest.

Name and number of supporting MTT-S Technical Committee

TC6 – RF MEMS and Microwave Acoustics Committee

Contact information

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- Casey Latham: casey.latham@keysight.com

Participation estimate

In the past there were about 3 – 5 groups registered.

Equipment information

Ideally the following equipment is required:

- VNA up to 8GHz with 6 ports
- RF cables with 50 Ohm impedance and SMA connectors
- DC power supply with up to 100V operation voltage
- DC cables with 4mm banana plugs

Additional comments

It is planned, that this competition will be supported by Keysight for the student licenses of Keysight's ADS/Pathwave. Furthermore, we are planning to apply for MTTS funds to organize contract assembly for the students, so that the commercial parts listed above will be assembled professionally onto the boards of the students.

Please submit this form to ims2025.sdc@gmail.com no later than 8 September 2024.