

Title

Carrier Aggregation BAW Quadplexer Module

Sponsors

- MTT-2 Microwave Acoustics
- Qorvo
- Keysight Technologies

Competition Coordinator(s)

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Abstract

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 for a multiplex filter. In this competition, our sponsor Qorvo will provide the contestants with appropriate BAW components. The students are required to design and assemble a band 3/7 quadplexer module. The measurements will be taken at the IMS'18 with support by Keysight Technologies.

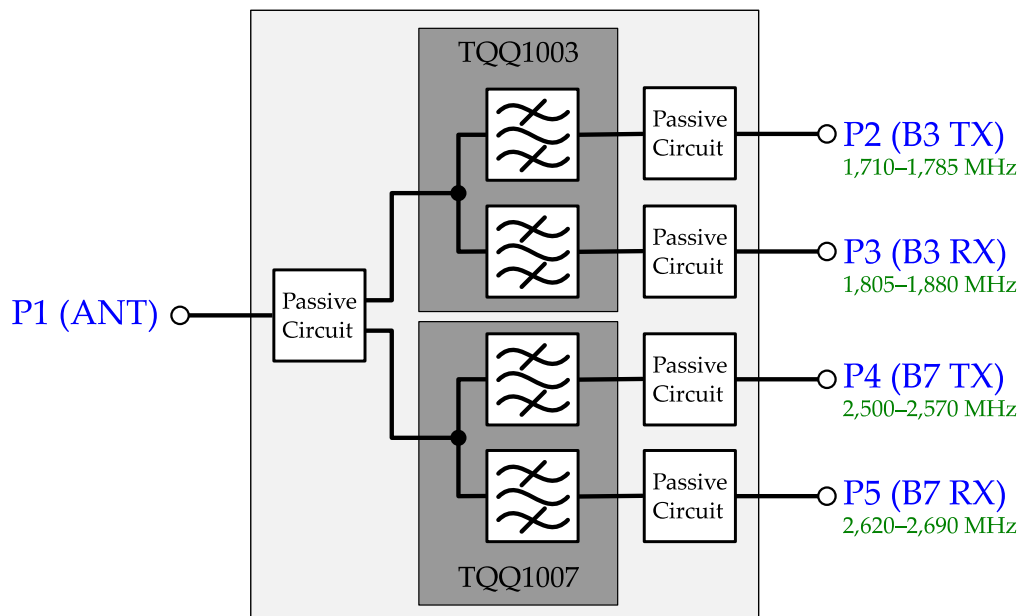


Figure 1: Schematic of the quadplexer module to be designed.

Evaluation Criteria (preliminary)

The designs will be evaluated by a commission at the IMS'18 based on measurements taken on site. For the evaluation, 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 figure of merit (in logarithmic domain) is defined as follows

$$\text{FoM} = -2(s_{11} + s_{22} + s_{33} + s_{44} + s_{55}) + 15(s_{21} + s_{31} + s_{41} + s_{51}) - 4(s_{23} + s_{24} + s_{25} + s_{34} + s_{35} + s_{45}) - \eta$$

The board size should be $2.5 \times 3 \text{ cm}^2$. For boards, larger or smaller in one or both dimensions, we will take a penalty factor η into account, which will be calculated as follows

$$\eta = 300 \cdot \log \left[\frac{\max\{w, 2.5\text{cm}\} \cdot \max\{l, 3\text{cm}\}}{9 \text{ cm}^2} \right] \text{ dB} + 75 \text{ dB} \cdot \frac{(5.5 \text{ cm} - \min\{w, 2.5\text{cm}\} - \min\{l, 3\text{cm}\})}{1 \text{ cm}} \geq 0 \text{ dB}$$

with w and l ($w \leq l$) being the width and length of the board without protruding connectors, respectively.

The s-parameter measurements will be taken at 0 dBm power level at all ports. The values are the minimum/maximum values in the band assigned to the ports, e.g.

$$s_{22} = \max_{\text{B3 TX}} |s_{22}^m(f)| \quad \dots \quad s_{21} = \min_{\text{B3 TX}} |s_{21}^m(f)| \quad \dots \quad s_{23} = \max_{\substack{\text{B3 TX} \\ \text{B3 RX}}} |s_{23}^m(f)| \quad \dots$$

with the measured values $s_{ij}^m(f)$.

The device will be considered, on in case that

- all transmission parameters ($s_{21}, s_{31}, s_{41}, s_{51}$) ≥ -6 dB across the individual bands
- matching at all ports ($s_{11}, s_{22}, s_{33}, s_{44}, s_{55}$) ≤ -10 dB across the bands assigned to the ports
- isolation between ports ($s_{23}, s_{24}, s_{25}, s_{34}, s_{35}, s_{45}$) ≤ -30 dB over the bands assigned to the ports

In case one of the previous criteria is not met by the circuit presented at IMS'18 the circuit is not qualified for the contest.

Design Specification/Rules

- The circuit must incorporate passive components only. Using of amplifiers is not allowed.
- The design must incorporate the TQQ1003 and TQQ1007 from Qorvo. 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.
- BAW 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 connectors are excluded). For handling simplification, boards might shall have a size of $2.5 \times 3 \text{ cm}^2$. For larger or smaller boards, a penalty will be added to the figure of merit. 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:
 - B3 TX = 1,710–1,785 MHz
 - B3 RX = 1,805–1,880 MHz
 - B7 TX = 2,500–2,570 MHz
 - B7 RX = 2,620–2,690 MHz
- All measurements are referenced to 50 Ω impedance.

Eligibility

- 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 two entries, but can receive an award for only one entry.
- 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.
- The student(s) must have a signed statement from their academic advisor that the work is principally the effort of the student(s).
- 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 IMS'18.
- The student(s) must submit an entry form to the Student Design Competition co-chairs, who will also provide the form. Please send a copy of the form also to mtt2sdc@listserv.ieee.org to receive the components.
- 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).

Prizes

There will be two prizes awarded. The first and second place winner will receive \$1,500 and \$500, respectively. The winner is invited to submit a paper describing the design in the MTT's Microwave Magazine.