## XBAR Filter Technology for 5G Handset Filters

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### Background, Motivation and Objective

New 5G mobile phone specifications utilize high frequencies (4-6 GHz) and very large relative bandwidths exceeding 10%, pushing the limits of standard SAW and BAW technologies presently in wide use for high-selectivity handset filters. We have created a simple and novel resonator structure called XBAR [1] to specifically address this challenge, including the key elements required for practical handset filter design: strong coupling, impedance near 50 ohms, controlled spurious, low losses, low harmonic distortion and good power handling. The resonator uses the shear A1 Lamb mode in a suspended 400nm thick membrane of Z-Y cut LiNbO3, excited by interdigitated electrodes with a relatively low metallization ratio.

### Statement of Contribution/Methods

In this work, we present the design, simulation, fabrication, and measurement of the first prototype XBAR bandpass ladder filters with 1 dB mid-band insertion loss . The filter was designed and optimized using Resonant's ISN acoustic wave filter design suite, built upon our highly-accurate FEM [2] tool. These models are highly predictive, as evidenced by the fact that simulated and measured filter performance show very good agreement for the first fabricated device of this fundamentally new technology.

### Results/Discussion

Wafer-probe measurements of the five-resonator filter with an area of 1.8 x 1.8 mm$^2$ demonstrate 600 MHz of bandwidth and 1 dB center-band insertion loss at 4.7 GHz. Hardware matching and mounting the filter in a test fixture increased the measured insertion loss to 1.5 dB. This device can be manufactured using standard optical photolithography despite the high frequency and is compatible with other existing high-volume production processes.

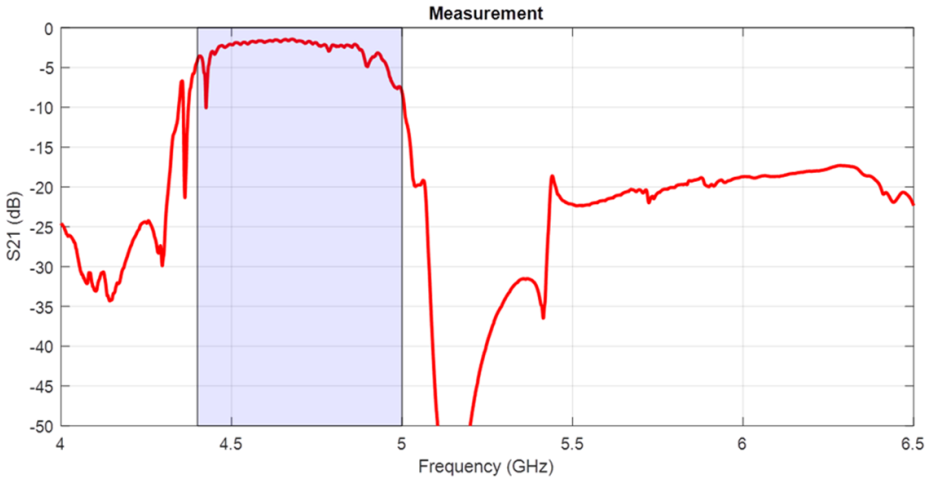


*Fig. 1. Measured XBAR n79 filter mounted in a custom test fixture operating at 4.7 GHz showing 600 MHz bandwidth and mid-band loss of 1.5 dB including physical matching elements.*

[1] V.P. Plessky et al., "5 GHz laterally-excited bulk-wave resonators (XBARs) based on thin platelets of lithium niobate", Electron. Lett. 55(2), November 2018, DOI: 10.1049/el.2018.7297.

[2] Koskela, Julius, et al. "Hierarchical Cascading Algorithm for 2-D FEM Simulation of Finite SAW Devices." IEEE Trans Ultrason. Ferroelectr. Freq. Control 65.10 (2018): 1933-1942.