ADS Interface for MATLAB SAW/BAW Models

Dr. Alexander Rukhlenko, SAW/BAW Consultant

1. Introduction

Dr. Alexander Rukhlenko proposed and implemented a universal modeling approach based on a generic ADS MATLAB® interface written in C/C++ for communication with external simulation environments. In particular, this approach enables simulation of Surface Acoustic Wave (SAW) or Bulk Acoustic Wave (BAW) devices in Keysight® Pathwave Advanced Design System (ADS), a widely used RF circuit simulator, using SAW/BAW MATLAB models. This interface integrates MATLAB-based SAW/BAW models into ADS component libraries. As a result, ADS users can develop custom models in MATLAB, including SAW transducers, multistrip couplers, reflecting gratings, FBARs, etc. Designers can then use these MATLAB models in ADS just like conventional RF circuit components.

2. ADS MATLAB Interface for SAW/BAW Modeling

The proposed approach combines MATLAB computational power with ADS convenience for RF circuit design. It also adds modeling flexibility and improves modeling accuracy. Traditionally, designers represent ADS SAW models in the form of closed-form equations (e.g. the canonical form of the Coupling-of-Modes SAW model). On the other hand, designers use BAW models presented either as closed-form equations or equivalent circuit models. Typically, these equivalent circuits comprise conventional lumped or distributed RF and microwave elements such as R, L, and C components or transmission-line sections. For example, designers model Film Bulk Acoustic Wave Resonators (FBARs) using the Mason equivalent circuit model or a simplified (m)BVD model. Using MATLAB-based SAW/BAW models together with the ADS

MATLAB interface removes these limitations.

3. ADS User-Compiled Models and Mixed Language Programming

Dr. Alexander Rukhlenko developed the ADS MATLAB interface using mixed-language programming in C/C++ and MATLAB. In programming, he intensively used undocumented (or poorly documented) ADS and MATLAB features, together with numerous workarounds and practical know-how. The author ensures backward and forward compatibility with previous, current, and future ADS and MATLAB versions, requiring only minimal customer effort when upgrading to new releases.

The core of the ADS MATLAB interface is the ADS concept of the User-Defined Model, or User-Compiled Model (UCM). The user implements this customized ADS component in C/C++. After compilation, the model can be used in the ADS circuit simulator like a standard ADS component. Furthermore, developers can implement a library of MATLAB SAW/BAW UCMs as an ADS Process Design Kit (PDK). This is the most convenient and recommended way to distribute SAW/BAW design tools to engineers.

4. MATLAB and ADS Versioning

Furthermore, SAW/BAW PDKs may contain single-version or multi-version UCMs compiled for one or multiple ADS releases. As a result, ADS detects its version automatically and selects the appropriate UCM library for simulation. For each new ADS or MATLAB release, developers can usually recompile the SAW/BAW PDK with little or no additional programming effort. Therefore, users do not need to worry about future compatibility, and the modeling approach remains stable over time.

5. UCM and MATLAB Model Parameters

The UCM input consists of a set of ADS parameters. The interface converts

them into MATLAB model parameters. MATLAB UCM then returns a set of Y-parameter values to ADS for all SAW/BAW components. In general, the interface imposes no restrictions on the number of input parameters or UCM ports.

6. MCR Installation and Licensing

The prerequisite for running SAW/BAW MATLAB simulations in ADS is the installation of MATLAB Compiler Runtime (MCR) on the user's machine. Users do not need a MATLAB license to run MATLAB-based SAW/BAW models in ADS.

7. Modeling Limitations

In its current form, ADS MATLAB modeling is limited to linear analysis of SAW/BAW devices. The next step could be extending the approach to nonlinear analysis.

Furthermore, ADS MATLAB UCMs are not limited to a specific class of SAW or BAW component models. This powerful and versatile RF circuit simulation approach can be easily extended to other technical areas.

Finally, designers and engineers can apply the same approach beyond ADS. The same concept also works with other circuit simulators that support user-defined C/C++ or Fortran models.

Web version: *https://intrasaw.com/if-saw-filter-design*