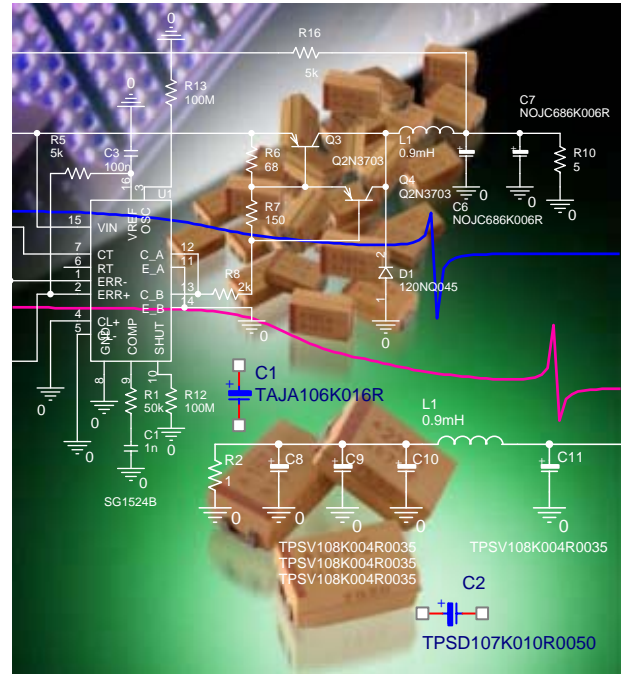


TANTALUM AND NIOBIUM OXIDE DATA LIBRARIES FOR INSERTION INTO PSpice SIMULATION SOFTWARE

Tantalum and Niobium Oxide Data library introduction

AVX has developed equivalent circuits for tantalum and niobium oxide chip capacitors in PSpice library format. These libraries are suitable for directly importing into PSpice software. The libraries include all electrical parameters for AVX tantalum and niobium oxide series capacitors, that allow fast, flexible creation and simulation of practical circuit designs. While these library components have analogous electrical behavior to actual components, it is important to verify the design by use of the simulated ratings in the completed circuit in order to achieve the best solution. These libraries are intended for use for both frequency and transient simulations over the full operating temperature range for each device. This article details the content of the data libraries, their models, insertion of the library data into PSpice and case studies for some typical designs. The PSpice library can be a powerful tool that enables the realization of flexible design solutions with minimum physical breadboarding, resulting in reduced overall time-to-market.



Description of equivalent circuit diagram

The capacitor's equivalent circuit diagram has been modeled from ideal passive and semiconductor components (C, R, L, and diode), which describe the capacitor's in-circuit behavior, including its typical self-resonance. The equivalent circuit model does include temperature dependence, even though this is less significant for tantalum and niobium dielectrics than for some other high dielectric constant ceramic devices. There is no voltage dependence included in the library, as tantalum and niobium oxide dielectric characteristics are independent of DC bias voltage. The reverse mode for tantalum and niobium oxide dielectrics is modeled by a diode integrated within the equivalent circuit diagram, as tantalum and niobium oxide dielectrics are polar components having an MIS (Metal Insulator Semiconductor) structure. Modeled Frequency characteristics faithfully reproduce actual device measurements as shown in figure 1. Likewise, the simulated responses track identically over temperature as shown in figure 2.

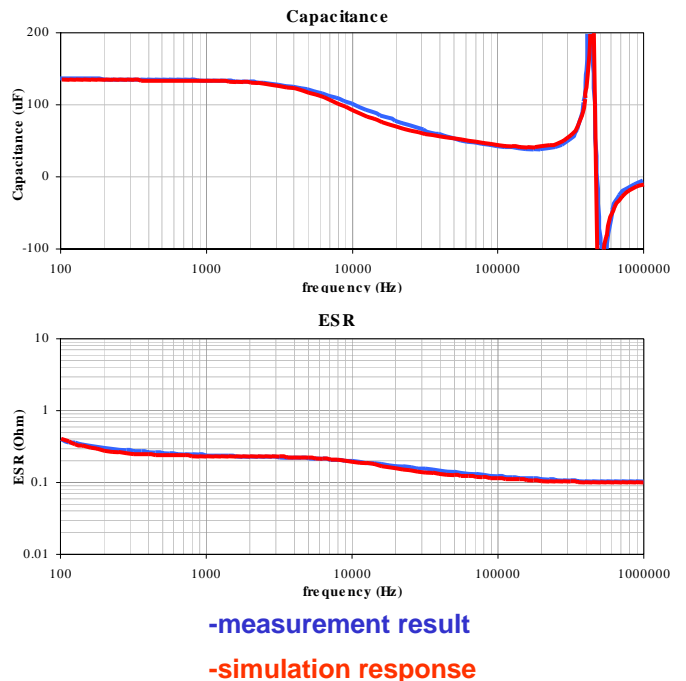


Figure 1. Comparison of actual device measurement and library result for the same rating.

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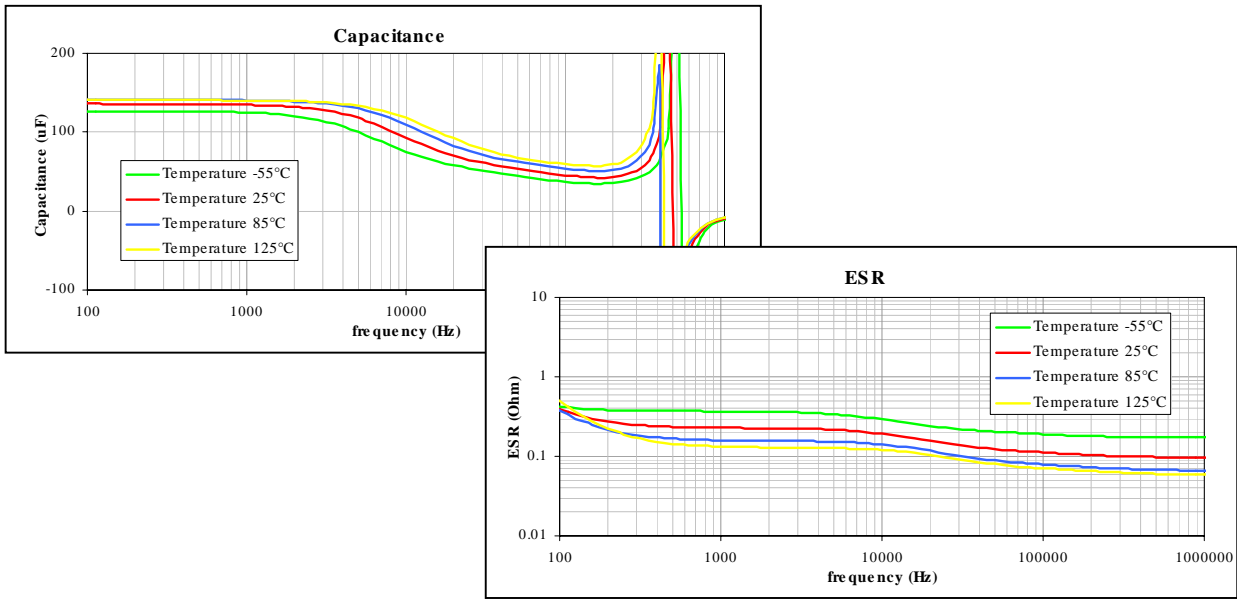


Figure 2. Simulated temperature dependence of capacitance and ESR

The graphs in figure 3 shown actual measurement of tantalum capacitors versus temperature and DC bias. Neither tantalum nor niobium oxide capacitors exhibit DC bias dependence. Both tantalum and niobium oxide capacitors show small parametric dependence on temperature which is included in PSpice models.

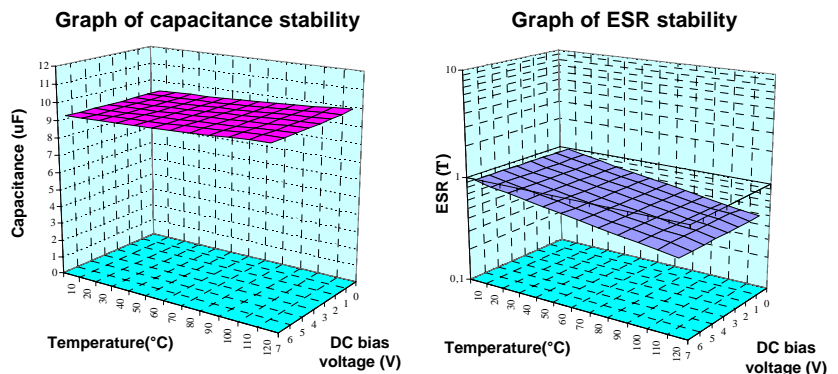


Figure 3. Capacitance and ESR stability as a function of temperature and DC bias

The structure and description of MicroSim and OrCAD PSpice simulation software libraries

Each library consists of two files for implementation into PSpice simulation software.

OrCAD Capture PSpice includes files with .LIB and .OLB file extensions.

Files with a .LIB extension contain electrical parameters and equivalent circuit diagrams for tantalum and niobium oxide devices. The devices' part number with circuit symbol is included in .OLB files. A view of those files is shown in the figure 4 together with parts symbol.

These libraries can be implemented into OrCAD Capture software and used for schematic circuit design and subsequent simulation of all electrical parameters as described at the next section.

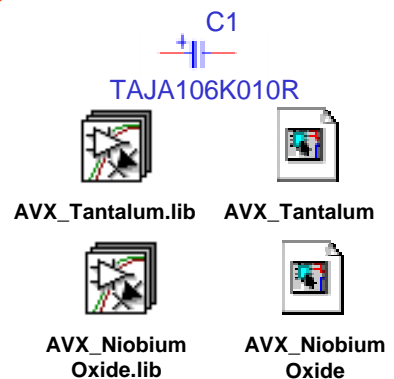


Figure 4. Symbol image view with OrCAD Capture library files for both Tantalum and Niobium Oxide

TANTALUM AND NIOBIUM OXIDE DATA LIBRARIES FOR INSERTION INTO PSpICE SIMULATION SOFTWARE

A second file format was designed for using within MicroSim and OrCAD versions of Schematics PSpice.

This library has a similar structure to OrCAD Capture. The first library file has a .LIB file extension; it includes the model structure for tantalum or niobium oxide components. The second file is file has a .SLB extension and includes The devices' part number and circuit symbol for each tantalum or niobium oxide part. A view of the .LIB, .SLB and symbol image structure is shown in figure 5.

The Libraries are completely compatible with all versions of both MicroSim and OrCAD Schematics PSpice software.

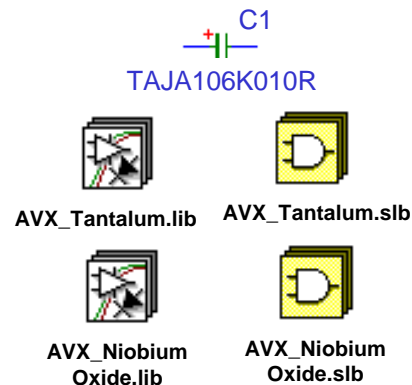


Figure 5. OrCAD and MicroSim Schematics library file extensions and circuit symbols

Installation both Tantalum and Niobium Oxide libraries into MicroSim and OrCAD PSpice versions

Note: Library file insertion is similar for PSpice MicroSim, OrCAD Schematics and OrCAD Capture.

Library insertion into MicroSim and OrCAD Schematics PSpice versions

1. Load MicroSim or OrCAD Schematics before starting to insert the library.
2. It is recommended to save the .LIB and .SLB library files into the PSpice library directory.
3. At the "Analysis menu", go to "Libraries and included files" and choose the "browse" option. Highlight the desired library (eg AVX_Tantalum.LIB or AVX_NiobiumOxide.LIB), then click to open.
4. Install the library into PSpice by "Add Library*" button. Installation of the AVX_NiobiumOxide.LIB can be done in the same way. When complete, click "OK".
5. The next step is to install the .SLB files. At the top menu, choose "Options" then "Editor Configuration" and "Library settings"
6. Using the "browse" option, choose the desired file (AVX_Tantalum.SLB or AVX_NiobiumOxide.SLB), click "open" and in the "Library Settings" window click "Add*". Finally click to OK to complete installation.

Insertion of library into OrCAD Capture.

1. Open OrCAD Capture design page.
2. Save required .LIB and .OLB library files into the PSpice library directory.
3. At the top Menu click "PSpice" menu and choose "Edit Simulation Profile".
4. In the setting window, click "Libraries", select "browse" button, choose desired AVX_Tantalum.LIB or AVX_NiobiumOxide.LIB file, then click to open and go back to the "Simulation setting" window.
5. Install the file into PSpice by clicking "Add as Global" button. Repeat these steps for AVX_NiobiumOxide.LIB installation.
6. For .OLB file installation, click "Place" at the top of the main menu then click "Part...". At the "Place Part" window. Choose "Add Library..." then "Browse" to select desired file (AVX_Tantalum.OLB or AVX_NiobiumOxide.LIB) and click "Open". The OLB file will be installed into the part browser. Repeat to install the AVX_NiobiumOxide.OLB file.
7. To complete installation, click OK .

Once installation is complete, circuit design and simulation functions can be run.

Example of circuit design creation, consequential simulation and components evaluation

This section gives 3 worked examples (case studies I.-III.) of OrCAD Capture used to create PSpice circuit diagram simulations.

Case study I.

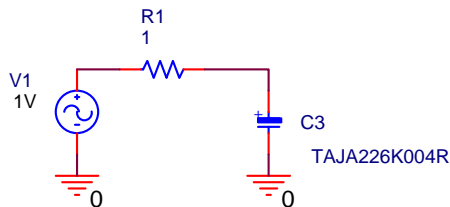
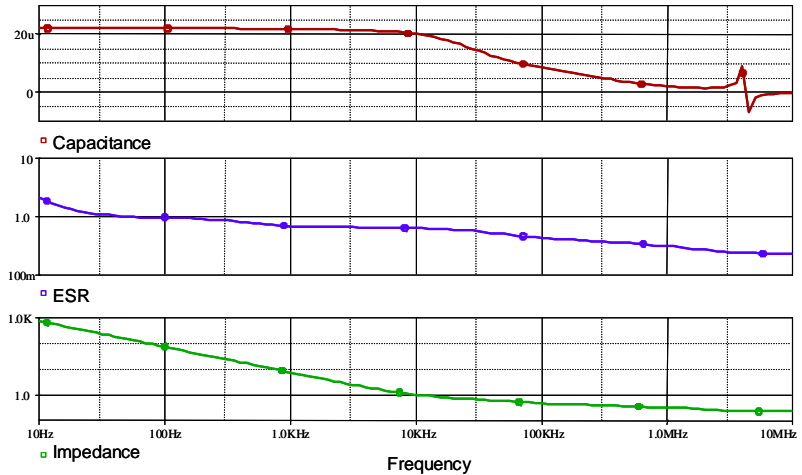
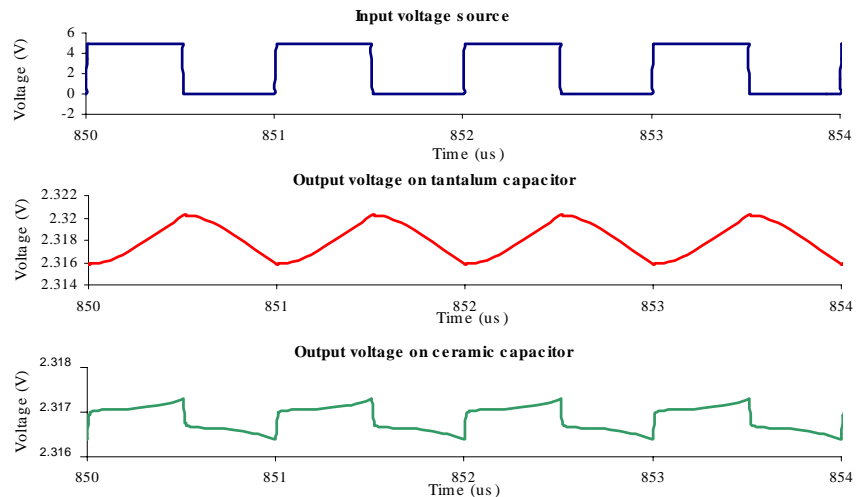
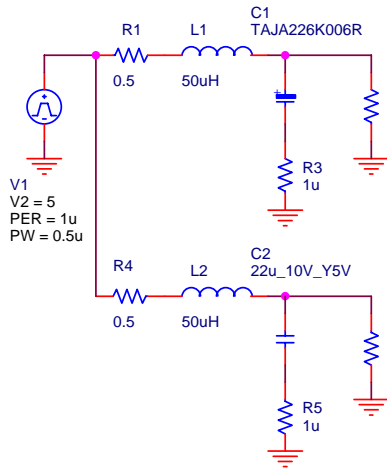


Figure 6. Basic circuit diagram for frequency behavior measurement; frequency response is shown in the following graphs:



A component's frequency characteristics are inserted into a basic filter circuit, which is then evaluated and simulated in PSpice. The circuit design is evaluated with an AC source with frequency sweeping to demonstrate output response. The frequency response is shown in the graphs below. All electrical parameters of the capacitor can be simulated (the example shows capacitance, ESR and Impedance).

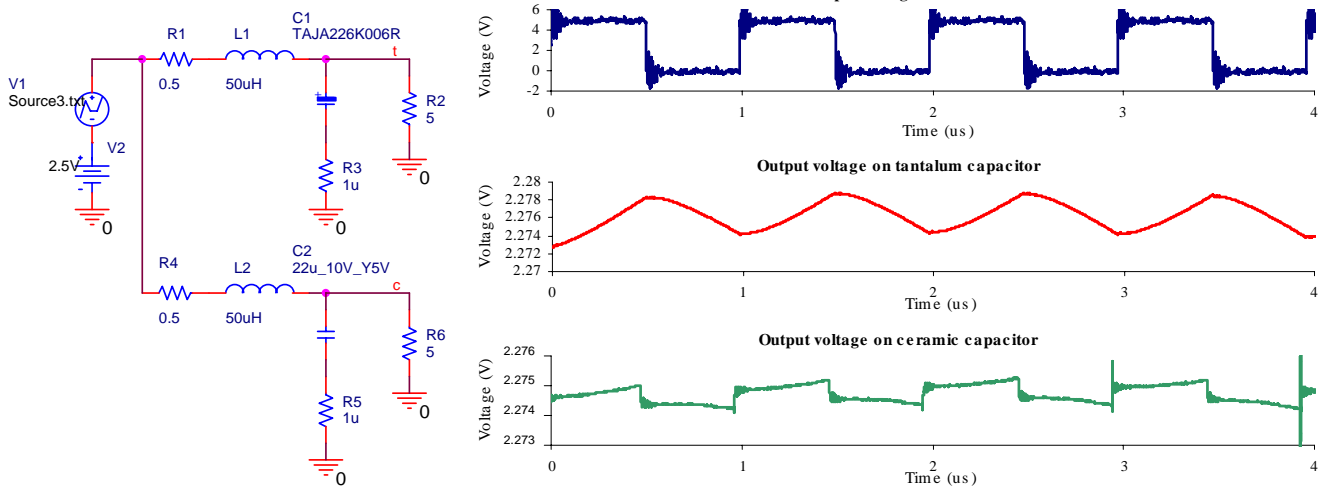
Case study II a.



The next examples are case studies II a) and II b). These compare the calculated PSpice source behavior with measured parameters from real source. Case study II a) demonstrates how capacitors can filter an ideal source voltage at the output stage. The ripple voltage is also shown for a tantalum and ceramic device. In this case, tantalum capacitor has a smoother ripple characteristic than the ceramic, where voltage spikes are present, although overall output filtering is similar. The same simulation is shown for the same components in real voltage source (Case study II b), which was both measured and simulated in PSpice. Most PSpice programs allow the insertion of a real signal source from an oscilloscope into a circuit design. The resultant filtering is very similar to that obtained by simulation IIa.

TANTALUM AND NIOBIUM OXIDE DATA LIBRARIES FOR INSERTION INTO PSpICE SIMULATION SOFTWARE

Case study II b.



Case study III.

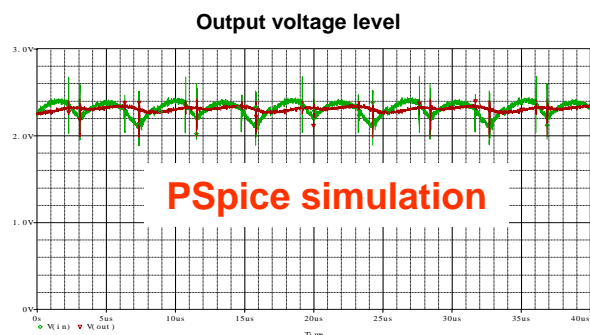
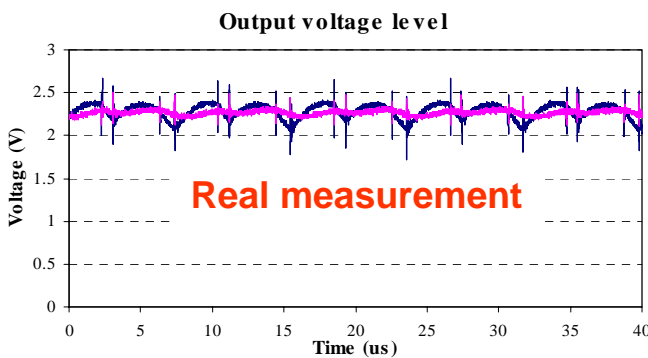
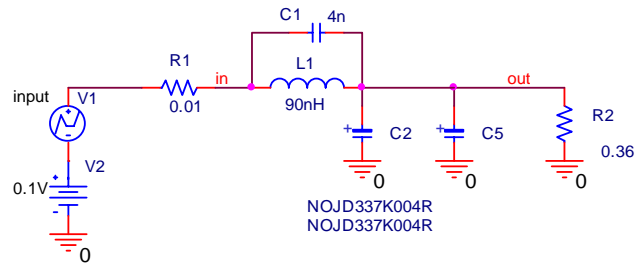


Figure 7. Actual measurement (DC/DC converter o/p) **Figure 8.** Simulated response (DC/DC converter o/p)

The last example (Case study III) demonstrates the flexibility of simulating a real DC/DC converter application. An actual DC/DC converter was measured; the converter was overloaded because of high output ripple voltage. The output voltage level was re-measured after inserting an LC (inductor and Niobium Oxide) filter as shown in the “Real measurement” graph above. Next, the data from the DC/DC converter output was fed into the PSpice simulator as the real source (green curve in figure 8). The LC filter circuit used above was then created and the output simulated based the real source input data. The simulation displays an identical response. This demonstrates how quickly a circuit design change can be evaluated by the designer, using real equivalent circuits for all components in developmental circuit.

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Summary

A PSpice library of electronic components is a useful tool for fast, flexible electronic circuit design and development. Component files from the library can be used for frequency and temperature analysis in wide range of applications, also including transient investigation. Worked examples were used to demonstrate the flexibility of these libraries; circuit designs can be evaluated using variety of components together with tantalum and niobium oxide capacitors. Libraries are an integral part of any PSpice program, which can incorporate equivalent circuit models for all real passive and active components.

An additional software program developed by AVX is SpiTanII. This software enables the designer to view all basic characteristics and parameters for all ratings in all tantalum and niobium oxide capacitor series. The designer can select a component by actual part number, or by reference to the desired capacitance, rated voltage or case size, then display all basic parameters such as frequency dependence of capacitance, ESR, Impedance, DF, plus ripple voltage and ripple current ratings. These parameters can be saved and copied into other software programs or printed out. The SpiTanII software is aimed at providing the designer a brief overview of all parameters of interest before starting the real simulation or design.

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