ARGESIM BENCHMARKS

A Graphical Modelling Approach to ARGESIM Benchmark C3 'Generalized Class-E Amplifier' with Simplorer

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Simulator: Simplorer, developed by ANSOFT, offers a way of modelling and simulation which is quite different from the common known block oriented modelling. The Simplorer simulation software adheres to the VHDL – AMS standard, therefore one can use the predefined modelling libraries and draw schematics in the graphical interface, it is not necessary to implement the component's behaviour manually. Furthermore optimization and statistical analysis are offered.

It is also possible to enter initial conditions for the circuit, which is used in the second part of the exercise. The questions defined in ARGESIM Benchmark 3 are all solved using Simplorer SV, the student version of the software. Thus we cannot assure that features absent in this version are not included in the professional version. In Figure 1 the schematic of the problem defined in benchmark 3 as implemented in Simplorer is shown:

The circuit below is equivalent to the following equations:

$$dx1/dt = (-x2 + VDC)/L1$$
$$dx2/dt = (x1 - x2/R(t) - x3)/C2$$
$$dx3/dt = (x2 - RL*x3 - x4)/L3$$
$$dx4/dt = x3/C4$$

Model: Even if drawing the schematic in Simplorer is quite easy, the ease of this way of

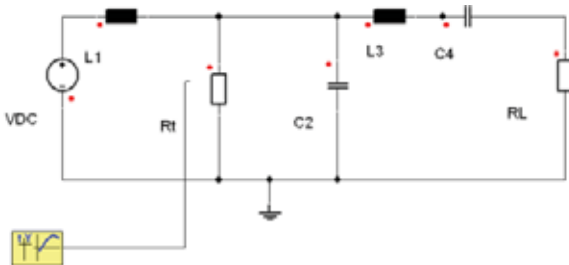**Figure 1**. The Simplorer model of the amplifier with standard components
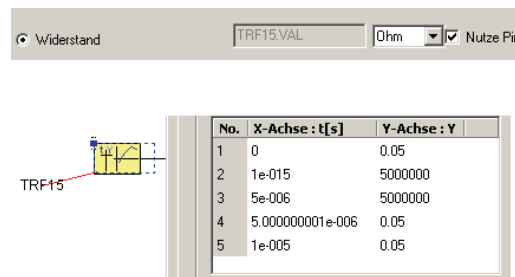

Figure 2. Modelling of the tome dependent resistor $R(t)$ using a 2D table

model implementation comes at the prize of less flexibility. Anyway, we succeed in doing the modelling correctly, even if we have to come to a compromise in some parts of the model.

First we implement the switching resistor $R(t)$, a key part of the model. The variable resistors value can be defined by its input pin, which we connect to a 2D value table. This table specifies the periodic switching function. The following screenshot (Figure 2) shows these setups. In addition, the 2D value table has to be switched to periodic, which is not shown in the picture.

The other components of the model are configured by a right-click on the icon; choose *Properties* from the context menu and then enter the components parameters, like voltage, resistance, capacitance or inductance.

We have to make sure that the polarity of the components is chosen correctly. One has to keep in mind that the way of modelling used in this approach is physical component oriented modelling and simulation and therefore for example reservoirs like a capacitor have a defined polarity.

The context menu of each component has a *Rotate* and *Mirror* entry which can be used for this purpose.
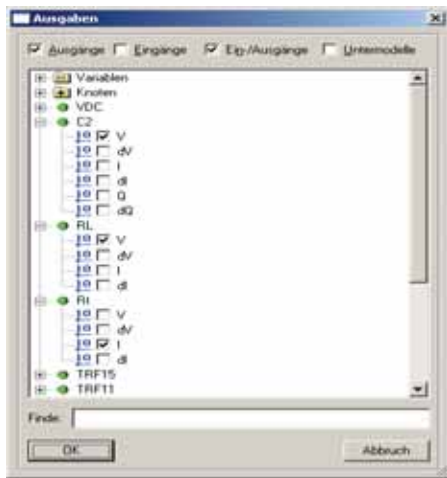
Figure 3. Interface of value selection for the plot. The selected values can then be plotted together in one plot with different colors.

One of the aforementioned compromises is that we do not succeed in getting one plot with all the rise/fall times. For that reason we use four 2D value tables, one for each *TRF* and connect them one after the other.

Now we want to describe briefly how we obtained the plots. Simplorer has a widget called 2DGraphSel. One can easily add different values to be plotted, see Figure 3.

A**-Task:** This task cannot be realized with the used version of Simplorer.

B**-Task:** In this task simulation of the system over the time interval $[0,100\mu]$ sec with the zero – solution as initial state was calculated. We are interested in the time dependent values of $IR(t) = x2 / R(t)$ and $VL = x3 * RL$. The graphical interface offers easy handling and plotting of calculated data after simulation. The results are shown in Figure 4, whereby the red curve depicts $IR(t)$ and the black one shows the voltage at RL in Volt.
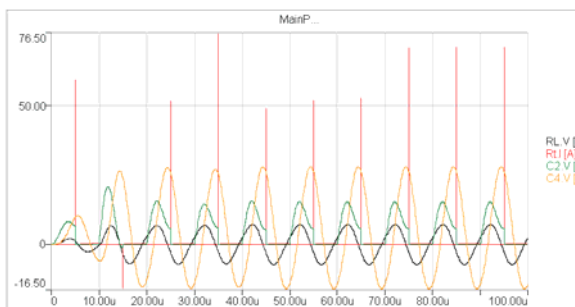
Figure 4. Solution of task B
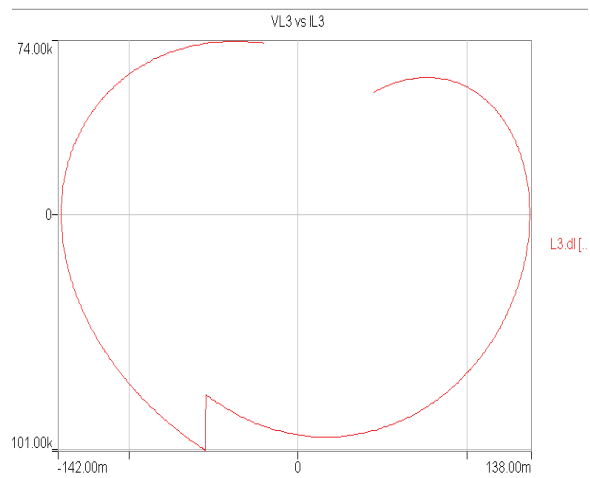
Figure 5. Resulting phase plot of the voltage at coil $L3$ and the current at the inductor

C**-Task:** Doing the phase plots for the last part of the exercise can be performed in a similar manner. One just has to choose another variable for the x-axis, so that time is not used. For the y-axis one can easily choose the relevant derivate. In addition, the initial values can be changed for the simulation using the graphical modelling interface of each component.

The results of one setting as defined in task C of the benchmark can be seen in Figure 5. A convenient way to add all of the phase plots into one graphical representation was not found; instead we had to do one after the other.

R**esumé:** Simplorer is a tool that offers intuitive modelling of physical systems. Although features like eigenvalue calculation are missing in the student version, the product is easy to handle.

The calculated results fit the results given by the sample solution of the comparison. The reinitializations in task C were done manually. No script files were used.

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