# Modeling of broadband cavities in PSpice

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**PSpice models for the SIS100 barrier bucket cavity and the ESR barrier bucket cavity have been created and compared with measurements.**

## Introduction

At GSI, barrier bucket systems are planned for the SIS100 synchrotron and the ESR storage ring. In order to achieve a single-sine gap signal of the desired amplitude and quality, effects in the linear and nonlinear region of the system have to be investigated. Therefore, the cavities and the amplifier stages are to be modeled in PSpice.

## PSpice model of the cavity

As the frequency-dependent properties of the ring cores highly dominate the properties of the cavity, the cores have to be modeled in a first step. In a second step, these models are used to build up the whole cavity.

### *Modeling of MA ring-cores*

In a first step the admittance of the ring core is measured in the frequency range 100 kHz - 30 MHz in a measurement setup shown in figure 1. After influences from the measurement environment are subtracted from the data, the measured admittance is fitted by a rational function of the form using a vector-fitting algorithm [1].

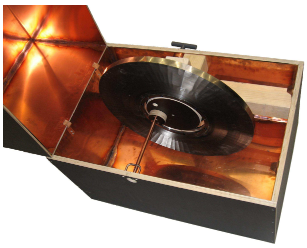

Figure 1: Measurement setup for ring cores

$$f(s) = \sum_{i=1}^{N} \frac{r_i}{s - p_i} + d + se. \qquad (1)$$

From this fit function an equivalent circuit can be derived as shown in figure 2. Each branch of the circuit represents one summand of (1).

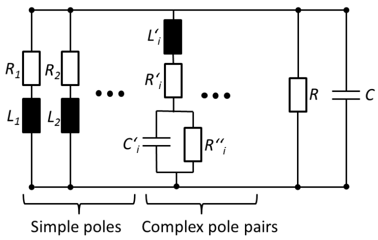


Figure 2: Equivalent circuit for one ring core

### *Model for the ESR cavity*

The final cavity will consist of two halves of one gap and four ring cores each. Via these cores connected in parallel, the desired voltage will be induced to the gap. In the PSpice model, the windings are realised by a parallel circuit of ring cores and couplers. The gaps are modeled by a capacitance. In additiont, stray capacitances have been included to the coupling loop based on measurement results. The PSpice model of the cavity is shown in figure 3.

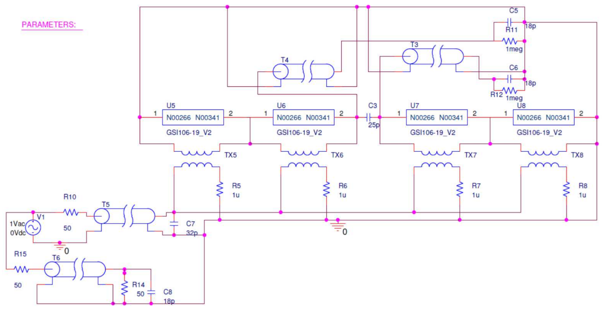

Figure 3: PSpice model for one cavity half including measurement devices

## Simulation results

For small signal barrier-bucket generation, the transfer function of the system is measured. Using this transfer function, the signal will be predistorted to generate a single-sine gap voltage. Transfer functions and the predistorted signals from measurement and simulation are shown in figure 4 and 5.

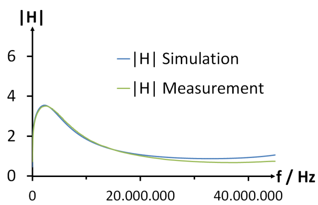


Figure 4: Transfer function

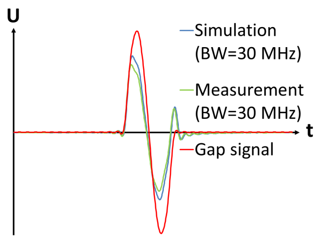


Figure 5: Predistorted signals and gap signal

## References

[1] B.Gustavsen and A. Semylen, "Rational approximation of frequency domain responses by vector fitting", EPAC'96, Sitges, June 1996, p. 798IEEE Trans. Power Delivery, vol. 14 no. 3, 1999

DOI:10.15120/GR-2016-1