5. VBIC Modeling Strategy

For a good modeling result, it is essential to follow a good parameter extraction strategy. It is especially important to follow a certain sequence of extractions, since most model parameters depend on each other. Usually, the first parameters to be extracted are those, which do not or only lightly depend on others. Then, when proceeding through the extraction strategy, the more nested parameters are extracted subsequently, and the model fits more and more accurately.

Related to the VBIC model, the following parameter extraction sequence is proposed.
See also the VBIC toolkit VBIC_EXTRACT.mdl file and its macros.

CV:

Since the Base charge is the basic relationship of the VBIC Early effect description, it is the **space charge capacitors** which have to be modeled first.

DC:

First, the **ohmic parasitics** are extracted from specific measurement setups.

Then, the **Early voltages** are extracted from the DC output characteristics for non-quasisaturation and no avalanche effect. The parameters, however, are not yet optimized. This is due to the fact that the other DC parameters are not yet know.
We will optimize the Early parameters after the fitting of the Gummel plots.

The diode parameters ISx and Nx as well as the knee currents IKx of the **main NPN transistor** are extracted from forward and reverse **Gummel-Poon** measurements. The transistor should not be in quasi-saturation.

From measurements with either an open Emitter contact, or vEC=0 for the main NPN, the diode parameters ISx and Nx and the knee current IKP of the **parasitic PNP transistor** are extracted.

The **quasi-saturation** parameters, except QC0, are calculated from the output characteristics iC(vCE, vBE), as well as the **avalanche** parameters, and the selfheating parameter **RTH**

DC Finetuning:

Finally, the output characteristics, especially the quasi-saturation region fitting, is fine-tuned by optimization.

S-parameters:

The transit time parameters **TF, XTF, ITF, VTF** are extracted from S-parameter measurements in setup 'tf_vbe_vce' with non-quasi-saturated bias conditions. Since the dynamic model description for this bias conditions are identical to the SPICE Gummel-Poon model, the same extraction strategy is applied here too. For this condition, we set **QTF**=0

In VBIC, the Base resistance is modeled by RBB'=RBX + RBI/qb. Since qb represents a quite complex formula (see equ.(VBIC-1 ff.), the 'input-impedance-circle method' from the Gummel-Poon model cannot applied easily to get a starting value for the inner Base resistance **RBI**. Therefore, RBI is obtained by optimizing the S11 plot of setup 'biased_Spar'.

The S-parameter quasi-saturation parameter **QCO**, which affects the high frequency performance, is determined from S-parameter measurements under quasi-saturation DC bias condition. This is done in setup 'biased_Spar', referring only to the highest vBE, including the saturated vCE bias condition.

S-Parameter Finetuning:

The S-parameter fitting for all DC bias conditions is fine-tuned using optimization.