Abstract

Compact models for Si-heterostructure bipolar transistors are developed and SiGe/SiGe:C bipolar active inductors are designed for radio frequency (RF) applications. SiGe heterojunction bipolar transistors (HBTs) on insulator (SOI) and SiGe:C-HBTs fabricated in bipolar complementary metal oxide semiconductor (BiCMOS) technologies are modeled using Vertical Bipolar Inter-Company (VBIC) model including the thermal behavior within ±10% error limit. A new kind of technology-independent model for SiGe:C-HBT is developed using Adaptive Neuro-Fuzzy Inference System (ANFIS) with average error less than 4%. Comparison of VBIC with SPICE Gummel Poon (SGP) and HIgh CUrrent Model (HICUM) is presented for SiGe-HBT on SOI. Results of VBIC and ANFIS modeling are compared for SiGe:C-HBT. A simple but accurate scalable VBIC model is developed for SiGe:C-HBTs (f_T~$75GHz$) with variation in emitter length (from $0.84\mu m$ to $3.36\mu m$) and number of emitter stripes (from 1 to 16). Here, full parameter extraction is performed only for a single transistor followed by the extraction of the scaling parameters, based on the geometry and measured electrical data. The model shows error within ±10% and for overall S-parameters it is within ±15%. Also scalable small-signal Artificial Neural Network (ANN) model is developed for a set of SiGe:C-HBTs. The average validation error of the model is less than 2%. SiGe:C vertical pnp HBTs fabricated in a complementary BiCMOS technology with $f_T/f_{max}/BV_{CE0}$ values of $80GHz/120GHz/2.6V$ are modeled using VBIC-GP sub-circuit. Treating the transistor as four-terminal device, single transistor model is developed. Temperature and geometry scalability of the model is also tested for DC and RF data. The modeling error does not exceed the ±10% limit up to peak f_T and f_{max}. A five-terminal model is also developed for a separate pnp transistor, where the DC behavior of two parasitic transistors along with the main pnp transistor is investigated and modeled accurately (error within ±10%). Using SiGe/SiGe:C transistors, both one- and two-port bipolar active inductors are designed. Using frequency-dependent and frequency-independent negative resistances, quality factor value of the order of 100 and 0.2 to $1nH$ inductances are obtained in the frequency ranges from about 5 to $9GHz$.