A Simple Model Extension for Reverse Recovery Effect in Spectre Syntax
Motivation

• Reverse Recovery Behavior is important in Some Smart Power Circuits

• No Measurements are available

• Charge Carrier Lifetime known from literature
  \[ \text{Tau}=1.0\times10^{-7}, \text{ if } N>5.0\times10^{16} \text{ cm}^{-3} \]

• A Model extension is needed for Diodes and DMOS Transistors
Device Example DMOS
Equations

Charge Control Continuity Equation

\[ I_{tot} = \frac{dq}{dt} + \frac{q}{\text{Tau}} \]  \hspace{1cm} (1)

Charge Storage \hspace{2cm} \text{Recombination}

\[ q_0 = \text{Tau} \cdot I_D \]  \hspace{1cm} (3)

\[ I_{tot} - I_D = \frac{q_0 - q}{T_F} \]  \hspace{1cm} (2)

Itot: total current \hspace{1cm} ID: Diode current \hspace{1cm} TF: Transit Time

q0: charge in equilibrium state
Circuit 1

Equation 1

Equations 2 and 3
Circuit 2

Itot comes from Circuit 1
Spectre Implementation

inline subckt recoverdio (p1 p2 n)
parameters
+ tau= 1.000e-07  // carrier life time
+ tf = 1.000e-08  // transit time
+ factor=1.0e+09  // factor for better convergency, no effect on result

n1         ( tq t1    ) node value="Q" flow="I"
ip1        ( p1 p2   ) iprobe
h0         ( t1  0    ) ccvs   rm=tf+tau probe=ip1
r1         ( t1 tq   ) resistor r=tf*factor
r2         ( tq  0    ) resistor r=tau*factor
recoverdio (tq 0   ) capacitor c=1.0/factor
cc1        ( p2  n   ) cccs gain=factor probe=h0
cc2        ( p2  n   ) cccs gain=1 probe=ip1
ends recoverdio
Reverse Recovery Characteristics

[Diagram showing a circuit with labels and a waveforms window showing transient response.]
Design Example High Speed CAN (Controller Area Network, Data Bus in a car)

without Rev. Recovery Effect

with Rev. Recovery Effect

Additional dynamical measurements of diodes are necessary

Fits to Measurement
Bibliography


Physics-Based Models of Power Semiconductor Devices for the Circuit Simulator SPICE from R. Kraus, P. Tuerkes and J. Sigg (SIEMENS Power Semiconductor Appl. Note AN_PSM3)

MEDICI Handbook