Infineon

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A Simple Model Extension for Reverse Recovery Effect in Spectre Syntax

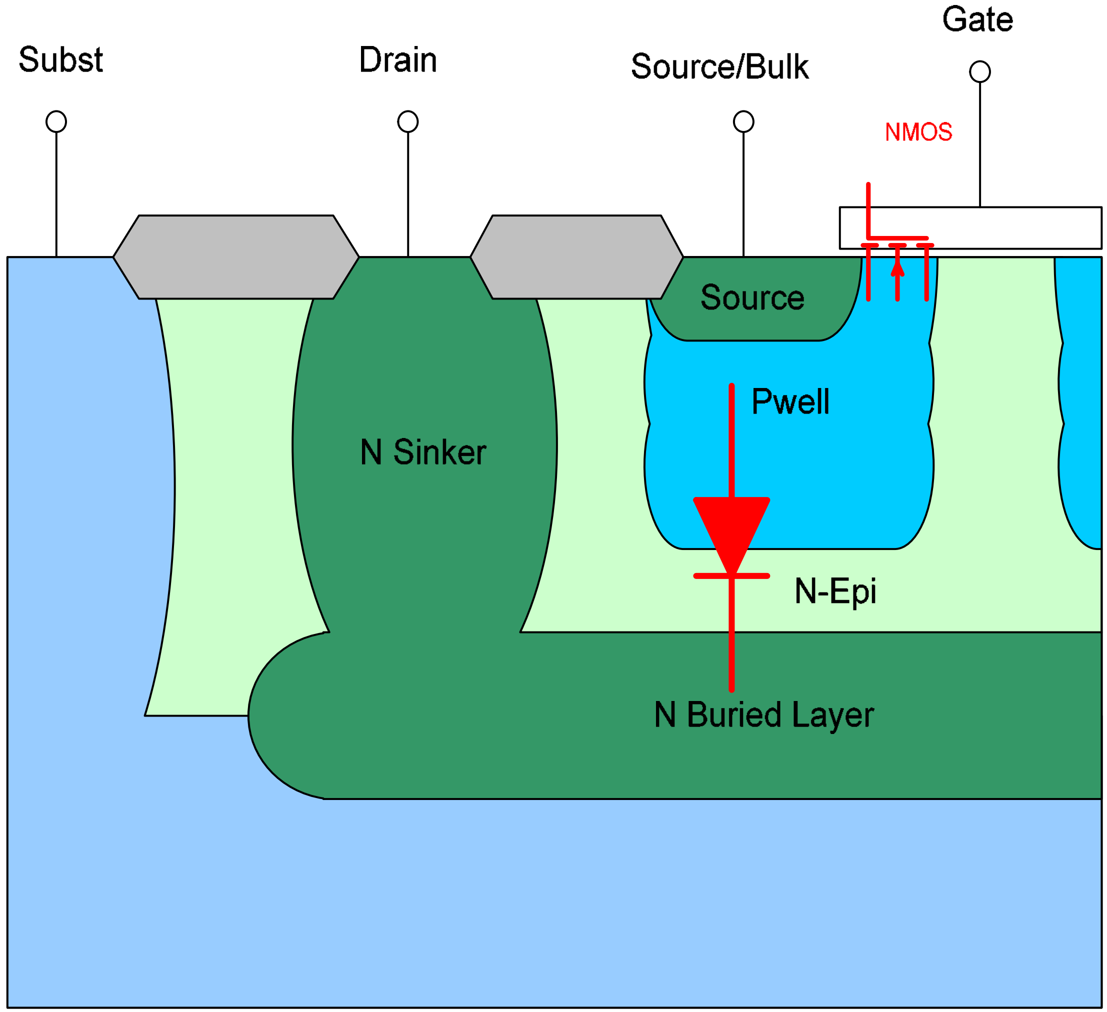
Infineon technologies

Never stop thinking.

Motivation

- Reverse Recovery Behavior is important in Some Smart Power Circuits
- No Measurements are available
- Charge Carrier Lifetime known from literature Tau=1.0e-07, if N>5.0e+16 cm**-3
- A Model extension is needed for Diodes and DMOS Transistors

Device Example DMOS



Equations

Charge Control Continuity Equation

$$I_{tot} = \frac{dq}{dt} + \frac{q}{Tau} \qquad (1)$$

Charge Storage — Recombination

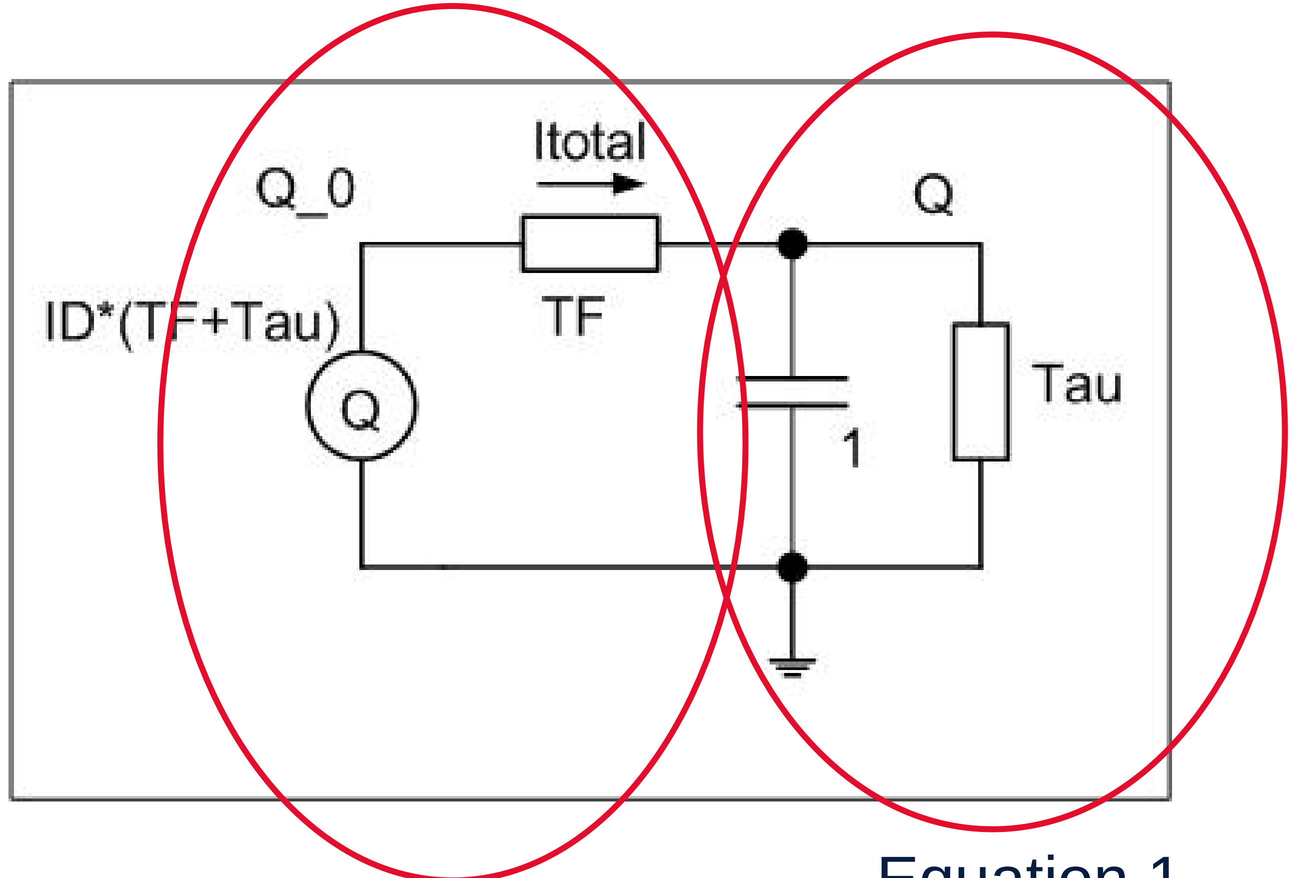
$$I_{tot} - I_D = \frac{q_0 - q}{T_F} \qquad (2)$$

$$q_0 = Tau \cdot I_D \qquad (3)$$

Itot: total current   ID: Diode current   TF: Transit Time

q0: charge in equilibrium state

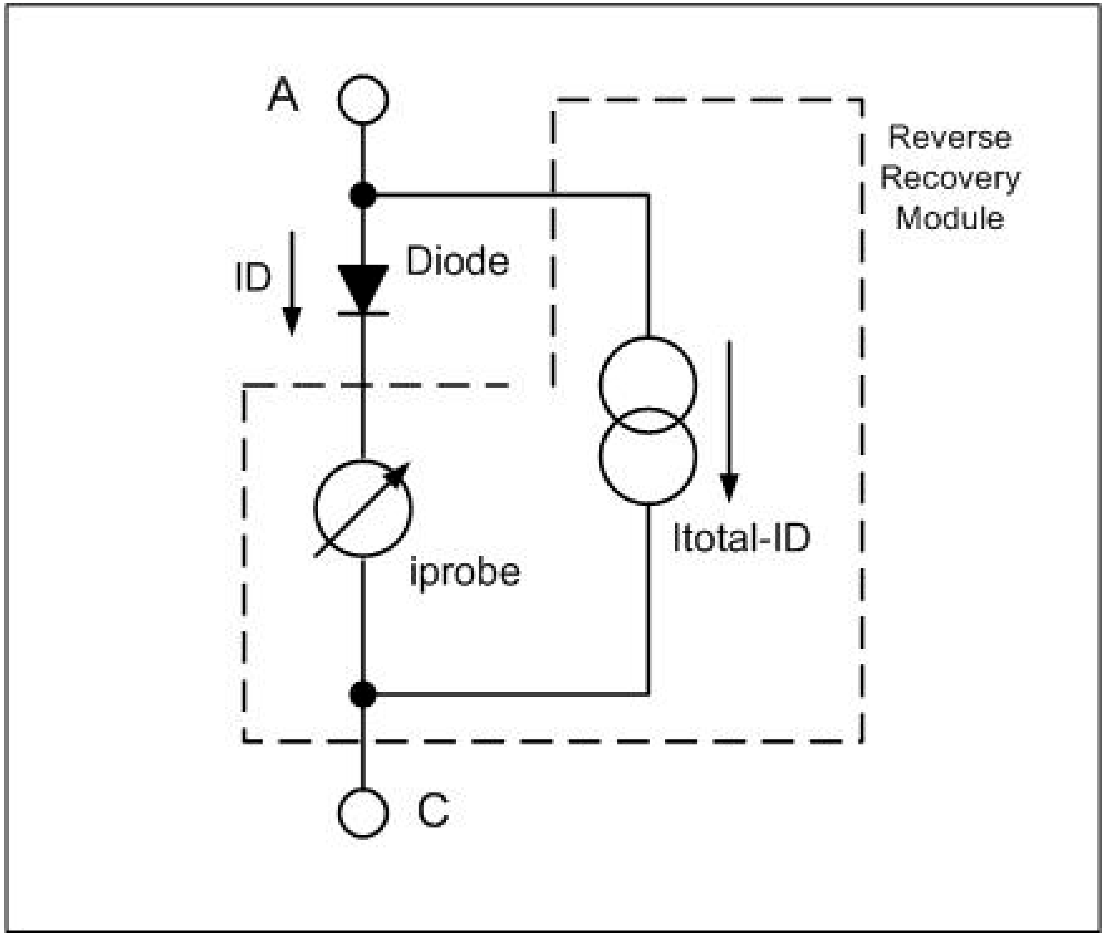
Circuit 1



Equation 1

Equations 2 and 3

Circuit 2



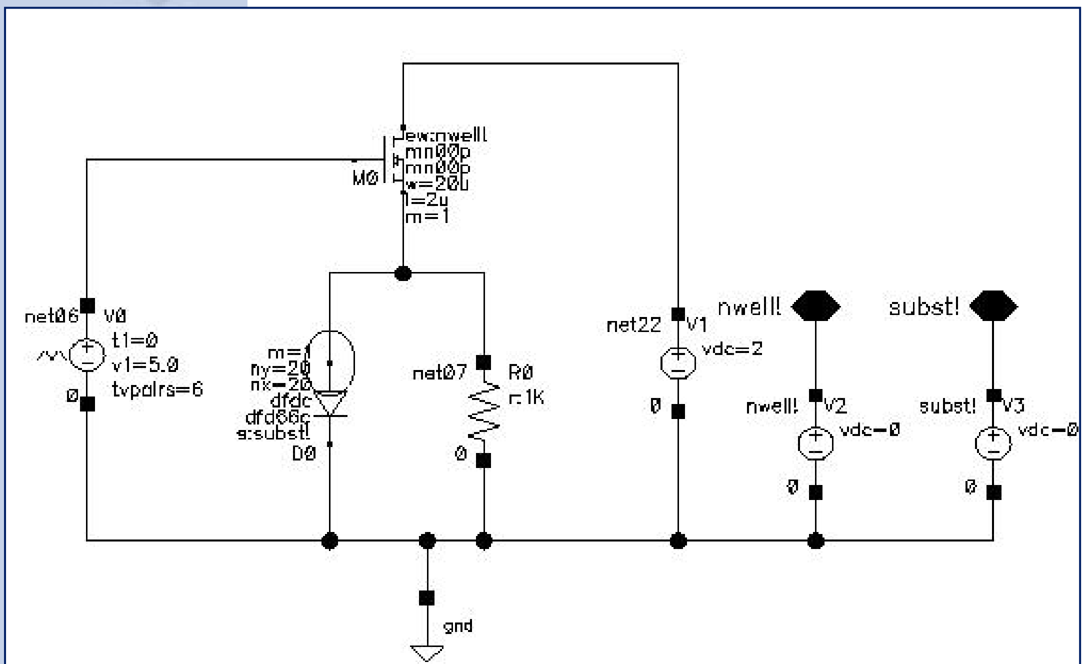
Itot comes from Circuit 1

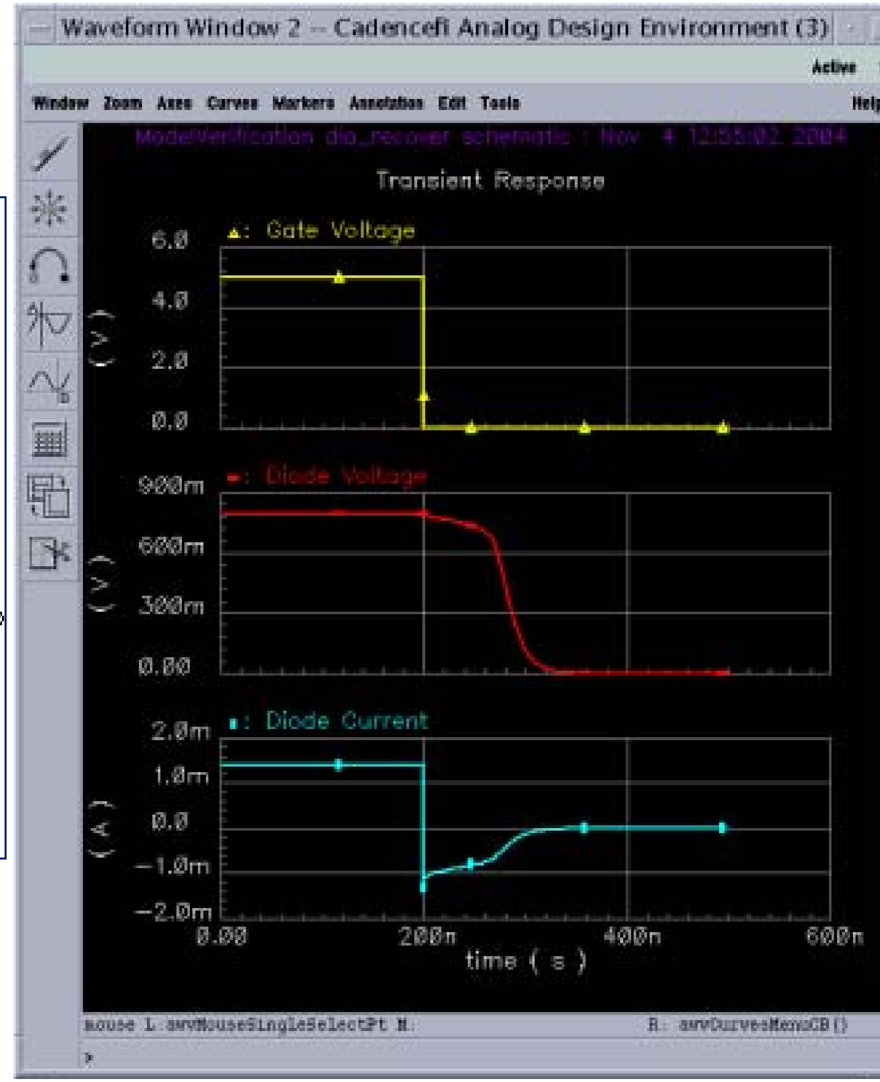
Spectre Implementation

```
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





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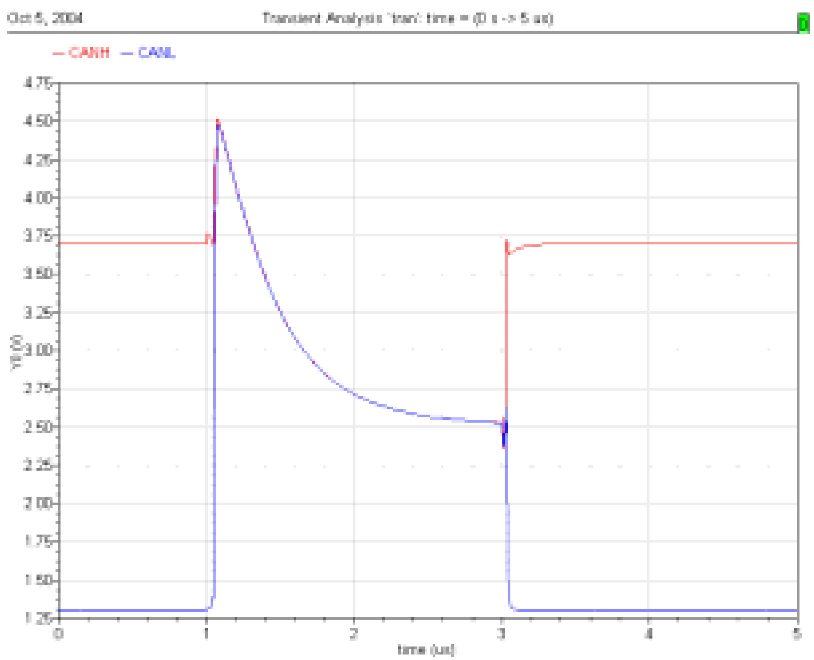
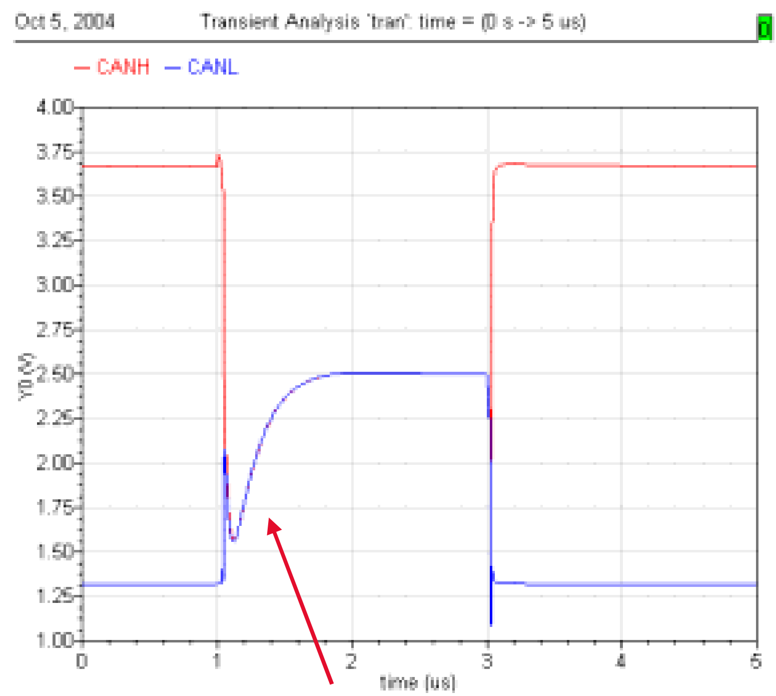
Design Example High Speed CAN (Controller Area Network, Data Bus in a car)

without Rev. Recovery Effect



with Rev. Recovery Effect



Additional dynamical measurements of diodes are necessary

Fits to Measurement

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Bibliography

A simple Diode Model with Reverse Recovery from Peter O. Lauritzen and Cliff L. Ma (IEEE Transactions on Power Electronics, Vol. 6, No. 2, April 1991)

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)

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