Experience with Hicum L0 v1.2
(improved IFX version)

Joerg Berkner

IFAG AIM AP T PFM EDA
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Experience with Hicum L0 v1.2
Advantages (1)

- Improved model allows a better fit of $I_c$ in the high current range

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**HL0 v1.12**
IQF=7m, IQFH=3m, TFH=1f

**HL0 v1.2**
IQF=7m, IQFH=650µ, TFH=1f, AHQ=0.5

Note: All simulations with VA-code and hpeesofsim 2006A.403 Feb 7 2007
Experience with Hicum L0 v1.2
Advantages (2)

- Essential is the use of AHQ, which allows a better fit

**HL0 v1.2**
IQF=7m, IQFH=650µ, AHQ=0

**HL0 v1.2**
IQF=7m, IQFH=650µ, AHQ=0.5
Experience with Hicum L0 v1.2

Advantages (3)

- Improved model allows a better fit of $I_c$ in the high current range

```
HL0 v1.12
IQF=18m, IQFH=6m, TFH=1f

HL0 v1.2
IQF=24m, IQFH=1.2, TFH=1f, AHQ=0.5
```
Experience with Hicum L0 v1.2
Advantages (4)

- fwd output curve makes the advantage of AHQ clear visible

**HL0 v1.12**
IQF=18m, IQFH=6m, TFH=1f

**HL0 v1.2**
IQF=24m, IQFH=1.2m, TFH=1f, AHQ=0.5
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Experience with Hicum L0 v1.2 Reverse Early Effect

- HICUM L0 v1.2 includes a reverse early voltage again, which makes basically sense
- However, for the devices under investigation, the use of VER delivered no real advantage compared to the usage of MCF alone

\[ q_J = 1 + \frac{q_{JCI}}{\text{VEF}} + \frac{q_{je}}{\text{VER}} \]
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Problems (1)

For TFH=0 hpeesofsim delivered a range error

Often TFH is not necessary, that is why TFH=0 should not create an range error
Experience with Hicum L0 v1.2
Problems (2)

- The same problem appears for AHC=0
- AHC is the smoothing factor for the injection width, AHC=0.1 is default
- AHC>0 is usually applied, however AHC=0 should not create an range error
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Results: Technology 1

Ic, Ib, Bn = f(Vbe), Vc = Par

Note: All simulations with VA-code and hpeesofsim 2006A.403 Feb 7 2007
Experience with Hicum L0 v1.2
Results: Technology 1

\[ I_c = f(V_{be}), \ V_c = \text{Par} \]

\[ g_m = f(V_{be}), \ V_c = \text{Par} \]
Experience with Hicum L0 v1.2
Results: Technology 1

\[ I_c = f(V_{ce}), \ V_b = \text{Par} \]

\[ I_b = f(V_{ce}), \ V_b = \text{Par} \]
Experience with Hicum L0 v1.2
Results: Technology 1

\[ ft = f(V_b), \ V_{ce} = \text{Par} \]

\[ ft = f(I_c), \ V_{ce} = \text{Par} \]
Experience with Hicum L0 v1.2
Results: Technology 1

\[ Y_{11i} = f(f), \quad V_b = \text{Par} \]

\[ Y_{11r} = f(f), \quad V_b = \text{Par} \]
Experience with Hicum L0 v1.2

Results: Technology 1

Y12i=f(f), Vb=Par

Y12r=f(f), Vb=Par
Experience with Hicum L0 v1.2
Results: Technology 1

Y21i=f(f), Vb=Par

Y21r=f(f), Vb=Par
Experience with Hicum L0 v1.2

Results: Technology 1

Y22i=f(f), Vb=Par

Y22r=f(f), Vb=Par
Experience with Hicum L0 v1.2
Results: Technology 2

Ic, Ib, Bn = f(Vbe), Vc = Par

T3

M: 22, Vc = 250.0 mV, Vb = 670.0 mV, ic = 10.96 mV

Note: All simulations with VA-code and hpeesofsim 2006A.403 Feb 7 2007
Experience with Hicum L0 v1.2
Results: Technology 2

\[ I_c = f(V_{be}), \ V_c = \text{Par} \]

\[ g_m = f(V_{be}), \ V_c = \text{Par} \]

Joerg Berkner, AKB 2008 at NXP, Hamburg, Oct. 30, LB412 v081104b

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Experience with Hicum L0 v1.2
Results: Technology 2

Ic = f(Vce), Vb = Par

Ib = f(Vce), Vb = Par
Experience with Hicum L0 v1.2
Results: Technology 2

\[\text{ft} = f(V_b), \ V_{ce} = \text{Par}\]

\[\text{ft} = f(I_c), \ V_{ce} = \text{Par}\]
Experience with Hicum L0 v1.2
Results: Technology 2

Y11i=f(f), Vb=Par

Y11r=f(f), Vb=Par
Experience with Hicum L0 v1.2
Results: Technology 2

Y12i=f(f), Vb=Par

Y12r=f(f), Vb=Par
Experience with Hicum L0 v1.2
Results: Technology 2

\[ Y21_i = f(f), V_b = \text{Par} \]

\[ Y21_r = f(f), V_b = \text{Par} \]
Experience with Hicum L0 v1.2
Results: Technology 2

\[ Y22r = f(f), \ Vb = \text{Par} \]

\[ Y22i = f(f), \ Vb = \text{Par} \]
Experience with Hicum L0 v1.2
Summary

- Hicum L0 v1.2 delivers good results for modeling two Infineon technologies, especially with respect to
  1. Ic in high current range
  2. quasi-saturation in fwd output characteristic
  3. ft characteristics, especially fT roll off
  4. Y-parameters

- Minor problems observed with TFH=0, AHC=0 which may be solved with low effort

- Infineon request according to the agreement reached between ST, IFX and TUD on Hicum workshop 2008 (see email June 2, 2008) to deliver the improved Hicum model v1.2 to vendors Cadence, MENTOR and Agilent for implementation