HICUM/L2 version 2.32

Release Notes

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Operating point values

- Operating point values are calculated in VA-code
  - Using a compiler flag CALC_OP

```
`define CALC_OP // turn off to remove complete OP sections from code
...
`ifdef CALC_OP
    (* desc="Base terminal current", units="A" *) real IB;
    ...
`endif
...
`ifdef CALC_OP
if (analysis("static")) begin: OPERATING_POINT
    IB   = I(<b>);
    ...
end
`endif
```

  - For a complete list of operating point values refer to manual or VA-code

Operating point values

- Impact on simulation time
  - 10 transistors in parallel, 7881 DC operating points, mean value of five simulations

CALC_OP	Simulator	Size C-code	Size compiled code	Simulation time
defined	ADS	1527 KB (1.48)	615 KB (1.18)	22.6 s (1.37)
	Spectre	3983 KB (1.34)	1308 KB (1.17)	44.35 (1.31)
not defined	ADS	1029 KB (1)	522 KB (1)	16.45 s (1)
	Spectre	2971 KB (1)	1118 KB (1)	33.9 (1)

Limiting of barrier effect

- Conditional statement for barrier term was changed the transistor specific values.
  - Original conditional statement

    ```
    ` if (icbar<1e-10) begin\
    ...
    ```
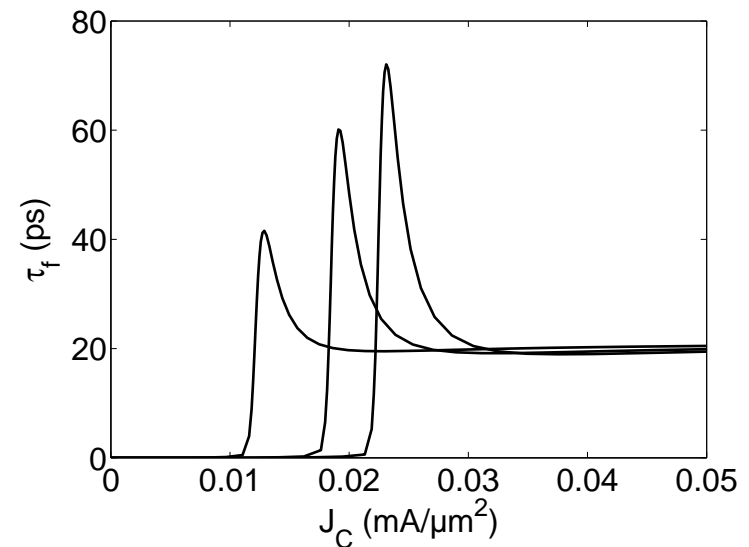
    has been changed to

    ```
    ` if (icbar<0.05*(vlim/rci0)) begin\
       ...
    ```

- V_{lim}/R_{Ci0} is a rough bias and temperature independent estimation of I_{CK}
  - Limitation of the transit time overshoot (maximum possible overshoot shown in plot), better convergence of GICCR iteration
  - Limit **FFib=0.05** for low currents, remove of numerical issues for too low **icbar** values (i.e. using non-physical values)

Bug in flicker noise calculation

- The bug in the calculation of the flicker noise was resolved.

```
flicker_Pwr      = kf*pow((ibei+ibep),af);
```

has been changed to

```
flicker_Pwr      = kf*pow(abs(ibei+ibep),af);
```

- Avoid numerical issues for reverse operating.

Test setup

- Procedure
  - Backward-compatibility tests are performed
  - parameters and test setups for complete testing of HICUM are provided
  - reference results for new HICUM version are provided

- Files provided on homepage
  - Model parameters for testing
  - Test cases (qaspec file)
  - Test results for backward-compatibility checks
  - Test documentation (parameters, test cases, sample results for test cases)
  - Reference results for test cases (to be used in QA tests by simulator vendors)

- Test cases
  - Different parameter sets enabling and disabling different parts of the model
  - Several test cases to cover a very wide range of operating points
  - Allows easy tracking of deviations while testing (if any exist)

Model change summary

- Improved convergence of internal GICCR iteration
  - Check for non-physical values of **icbar**

- Compiler flag CALC_OP
  - If defined, operating point values are calculated
  - If not defined, all operating point related code is removed

- Resolved bug for flicker noise calculation
  - No numerical issues for reverse operation