OPEN LICENSE PARAMETER EXTRACTION TOOL - OVERVIEW AND DEMO FOR SIGE HBTS

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Outline

1 Motivation
2 Compact Modeling Toolkit
3 DMT
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Motivation

Modeling engineers require software to:

- Store and manipulate large amounts of data from different sources
- Perform circuit simulations with different simulators
- Perform TCAD simulations with different simulators
- Extract compact model parameters
- Fit data using models
Compact Modeling Toolkit - General Definitions

- Object orientation
- Framework
- Interface
- Toolkit

Different things, same behaviour

Use existing tools to create new things :)

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- Modular architecture
- Source code available and DOCUMENTED
- Toolkit for "core" functionality
- Circuit simulator interface
- TCAD simulator interface
- Framework for parameter extraction
- GUI

The right tool for the right task.
Issues with commercial solutions:

- Source code not necessarily available
- Licensing issues and cost
- Not in general physics based
- Some rely on GUI
- Bundled with other (proprietary) software

Issues with other existing solutions:

- Source code not maintained
- Limited documentation
- Relies on single "master" programmer
- Limited and complicated to extend functionality

→ far away from the "ideal" toolkit defined in the last slide!
▶ Do not build every tool from scratch!
▶ Provide examples and documentation!
▶ Use distributed version control in order to let engineers work together!
▶ Use an easy to learn, yet powerful high-level language!
▶ Do not rely on proprietary software!
Device Modeling Toolkit
Python + Git
Reasonable code quality with focus on readability
Automated code documentation
"Glue" together different (open-source) software components
Framework for extending functionality
Interface to include circuit and TCAD simulators
Toolkit for "core" functionality
Modular
Not restricted to a single model!
DMT - core package

- Data management and manipulation
- Simulation management
- TCAD interface
- Circuit simulator interface
DMT - extraction package

- Highly flexible parameter extraction framework
- Model equation framework

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DMT - gui package

- GUI for extraction framework
- Reusable widgets for new GUIs

DMT parameter widget.
- Implementation of many HICUM/L2 v2.4.0 model functions in Python
- HICUM/L2 data processor
- HICUM/L2 parameter extraction equations
- HICUM/L2 parameter extraction steps
- HICUM/L2.4.0 parameter extraction
- Compact model parameter management
- Evaluation and management of measurement data
- Circuit simulation with ADS and (in-house) Simu
- TCAD simulation with DEVICE
DMT - current state

- Code is developed using Gitlab
- Alpha version close to completion
- Pre-alpha already used in-house
Live demonstration!
Highly automated script based parameter extraction

MOSFET compact models

More circuit simulators (ngspice, spectre, Xyce, Qucs...)

More TCAD simulators (COOS, Sentaurus Device...)

More use-cases are possible, like automated benchmark circuit design.

Improve tests and documentation
Appendix - HL2 Extraction Flow Overview

- Measurement Data
- AC+DC deembedding
- PoA Separation
- Capacitance Extraction
- Series Resistances
- TRADICA
- External Transistor Elements
- Internal Deembedding
- Internal Transistor Elements
- Fine Tuning
- External Transistor Elements

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Appendix - List of Implemented Extraction Steps (1)

- External BC diode parameters
- External BE diode parameters
- Parasitic BE+BC capacitance
- Internal BE+BC junction capacitance parameters (also multi region for III-V)
- Peripheral BE+BC junction capacitance parameters from slope of measured total capacitance
- Emitter series resistance from $g_{mi}$ and $Z$ parameters
- Base series resistance from $Z$ parameters
- PoA separation considering different length, width and corner components as well as effective dimensions
- Generic resistance extraction from measured IV
Appendix - List of Implemented Extraction Steps (2)

- $r_{sbi}$ and $Q_{p0}$ from tetrodes
- Thermal resistance from forced $I_B$ measurements
- Sheet resistance parameters from TLM structures
- Low current density transfer time parameters
- Medium current density transfer time parameters
- High current density transfer time parameters
- Forward transfer current parameters
- High transfer current parameters
- Reverse transfer current parameters