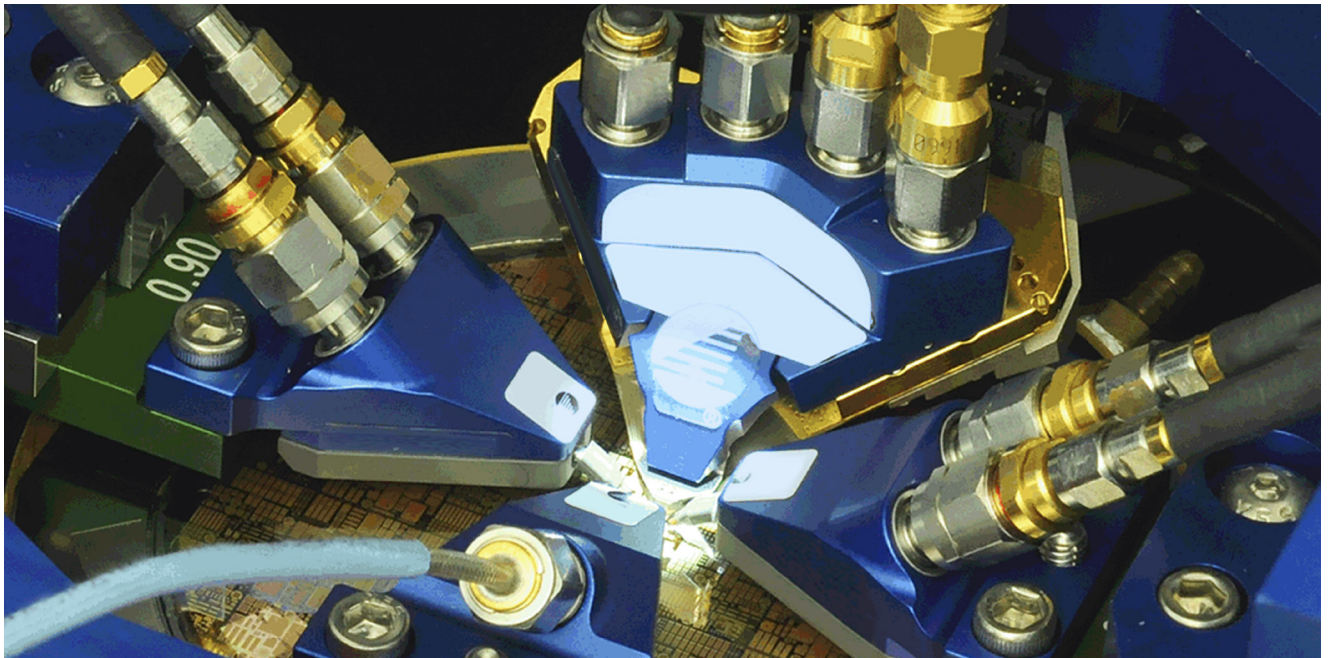


# Keysight Technologies

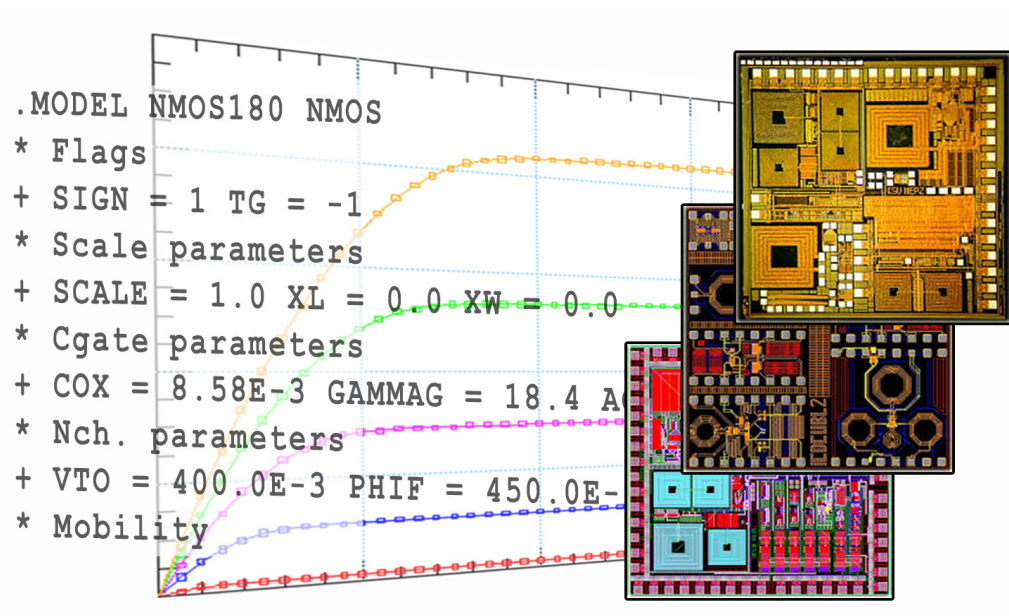
## Global Device Modeling Services



# Introduction

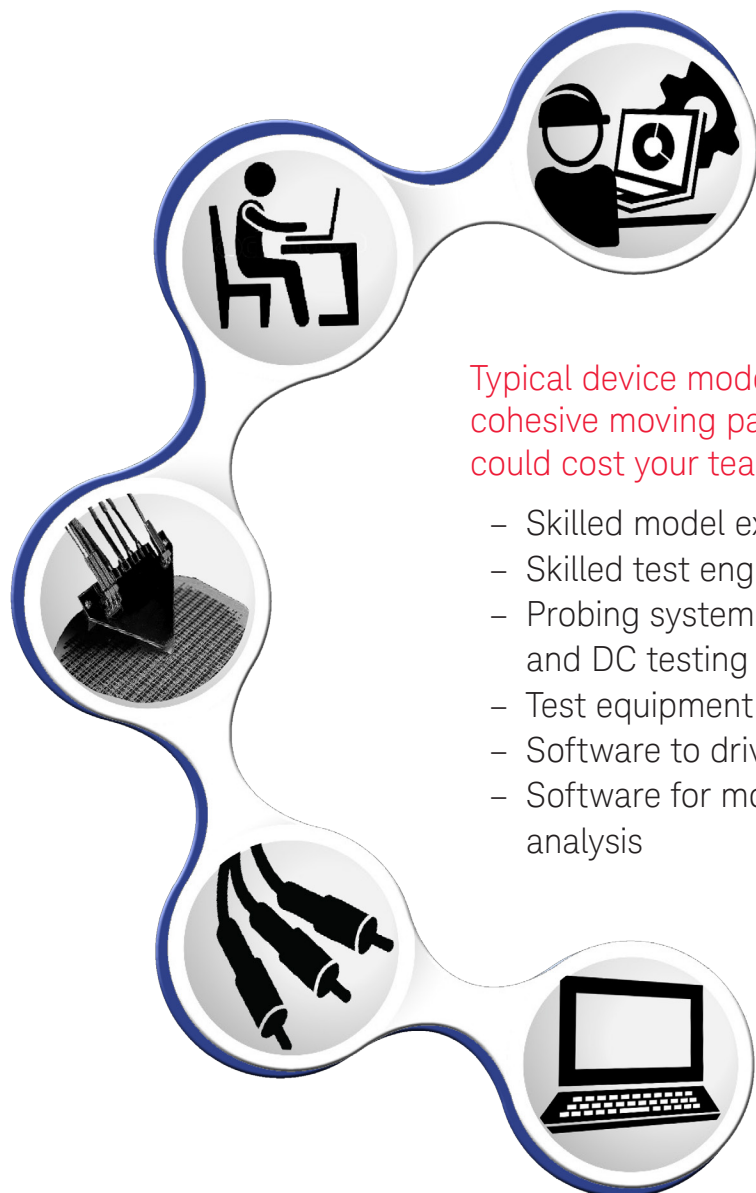
Integrated Circuit (IC) design stands on the shoulders of device modeling and characterization. The semiconductor industry requires fast and accurate device models. Circuits are being pushed to higher frequencies as device geometries are becoming smaller with higher chip device count. Without adequate models, designers cannot accurately simulate their circuits. This leads to poor circuit performance on the lab bench. Some large companies designate entire groups to device characterization and model extraction. This requires measuring and deciphering mountains of data as semiconductor processes are fine-tuned. To overcome these challenges, combined expertise in the following areas are required.

- Low leakage DC measurements with pA accuracy
- Highly sensitive RF measurements to 100 GHz and beyond
- Wafer probing methodologies – RF, DC, probe card, etc.
- The latest advances in device models – BSIMCMG, HiSIM\_HV, etc.
- Model extractions using IC-CAP or Model Builder Program
- Assure models will provide accurate results across multiple simulators
- Designing on-wafer test structures to expose process parameters
- Understanding and modeling the variation of device parameters within a process and across the wafer
- Model and predict device reliability
- Refining model libraries provided by foundries
- Comparing devices from different foundries using existing models
- Measurement automation software and data handling



## Be First To Market

Time-to-market is critical, especially in fast-moving areas of the semiconductor industry like mobile phone platforms, IoT sensors, or automotive circuits. Increasingly, companies are requiring customer delivery of first prototypes due to cost and closing market opportunities. This makes the modeling and characterization crucial. Characterizing an unfamiliar model can take months to perfect and result in the loss of an entire market window. Accurate characterization and validation of device models provides the confidence to successfully deliver today's products to market.



Typical device modeling and characterization labs require cohesive moving parts – getting any of these wrong could cost your team time and money.

- Skilled model extraction engineers
- Skilled test engineers
- Probing systems with appropriate probes for both RF and DC testing
- Test equipment with cables and accessories
- Software to drive measurements and analysis
- Software for model extraction and model quality analysis

## Accurate Measurements and Device Models



Advanced device modeling knowledge for various devices and device models, qualified engineering resources, and accurate measurement environments are all essential to perform model extractions. We understand these objectives and have the experience to assist companies to navigate these challenges — providing advanced device modeling services for the most sophisticated requirements, all based on a long history of working at RF and microwave frequencies. With device modeling services, you can choose from a variety of options including model extractions for state of the art models such as BSIM6, BSIM-CMG or DynaFET; cutting edge technologies like GaN or valuable characterization; and, analysis of 1/f behavior, reliability and statistics. Keysight's device modeling service centers and university lab partnerships are placed globally to provide training classes that will bring your modeling expertise to the next level.

### Service Scope

- Device characterization service: DC, CV, RF, 1/f noise, RTS noise
- RF modeling
- Statistical and mismatch modeling
- 1/f noise modeling
- Reliability modeling
- Customized modeling
- Nominal modeling
- Corner modeling
- Modeling knowledge, training, and consulting
- Test Elements Group (TEG) layout design assistance
- Analog and mixed signal modeling
- High-temperature analysis (25 °C up to 300 °C)

## Supported Devices, Device Models and Extraction Parameters

Wide range of devices/device models support

| Device                 | Model                           | DC | CV | RF | Corner | LPE | Aging | 1/f noise | Mismatch | Statistical |
|------------------------|---------------------------------|----|----|----|--------|-----|-------|-----------|----------|-------------|
| <b>Bulk CMOS</b>       | BSIM3v3                         | •  | •  |    | •      |     |       | •         | •        | •           |
|                        | BSIM4 and BSIM6                 | •  | •  | •  | •      | •   | •     | •         | •        | •           |
|                        | HiSIM and HiSIM2                | •  | •  | •  | •      | •   | •     | •         | •        | •           |
|                        | PSP                             | •  | •  | •  | •      | •   | •     | •         | •        | •           |
|                        | RF Macro model                  | •  | •  | •  | •      | •   | •     | •         | •        | •           |
| <b>FinFET</b>          | BSIM-CMG                        | •  | •  |    |        |     |       |           |          |             |
|                        | BSIM-IMG                        | •  | •  |    |        |     |       |           |          |             |
| <b>HVMOS<br/>LDMOS</b> | HiSIM_HV                        | •  | •  | •  |        |     |       |           |          |             |
|                        | BSIM or PSP, etc. + Macro model | •  | •  | •  |        |     |       |           |          |             |
|                        | Level66                         | •  | •  | •  |        |     |       |           |          |             |
| <b>SOI CMOS</b>        | BSIM-SOI                        | •  | •  | •  | •      | •   |       | •         | •        | •           |
| <b>GaAs HEMT</b>       | Angelov                         | •  | •  | •  | •      |     |       | •         |          |             |
| <b>GaN HEMT</b>        | Angelov-GaN                     | •  | •  | •  | •      |     |       | •         |          |             |
|                        | EEFET/EEHEMT                    | •  | •  | •  | •      |     |       | •         |          |             |
|                        | DynaFET                         | •  | •  | •  |        |     |       |           |          |             |
| <b>TFT</b>             | RPI a-Si TFT                    | •  | •  |    |        |     |       |           |          |             |
|                        | RPI Poly Silicon TFT            | •  | •  |    |        |     |       |           |          |             |
| <b>BJT</b>             | SPICE Gummel-Poon               | •  | •  | •  | •      |     |       | •         |          |             |
|                        | VBIC                            | •  | •  | •  | •      |     |       | •         |          |             |
|                        | Mextram                         | •  | •  | •  | •      |     |       | •         |          |             |
|                        | HICUM                           | •  | •  | •  | •      |     |       | •         |          |             |
|                        | Keysight HBT                    | •  | •  | •  | •      |     |       | •         |          |             |
| <b>MOS Cap.</b>        | PSP-Based MOSVAR v1.0.0         | •  | •  | •  | •      |     |       |           |          |             |
| <b>MIM Cap.</b>        | Macro model                     |    |    | •  | •      |     |       |           |          |             |
| <b>MOM</b>             | Macro model                     |    |    |    | •      |     |       | •         |          |             |
| <b>Resistor</b>        | Macro model                     |    |    | •  | •      |     |       |           |          |             |
| <b>Inductor</b>        | Macro model                     |    |    | •  | •      |     |       |           |          |             |
| <b>ESD diode</b>       | Macro model                     | •  |    | •  |        |     |       |           |          |             |
| <b>Pad</b>             | Macro model                     |    |    | •  |        |     |       |           |          |             |

All models rest on the shoulders of highly accurate measurements. Through the Keysight labs around the world and partnerships with universities, government labs and other third parties, we offer measurement services in the following areas.

- Wafer probing systems
- DC measurements
- CV measurements
- RF measurements
- 1/f noise measurements
- Noise figure measurements
- Large signal measurements

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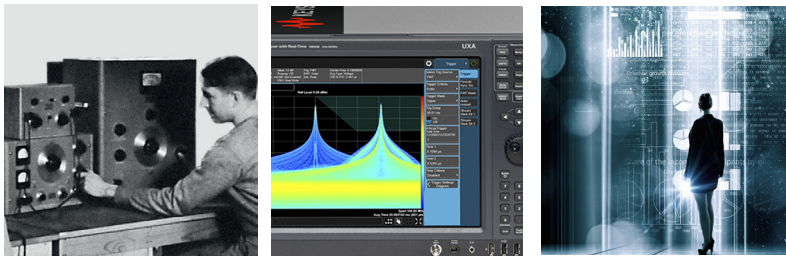
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