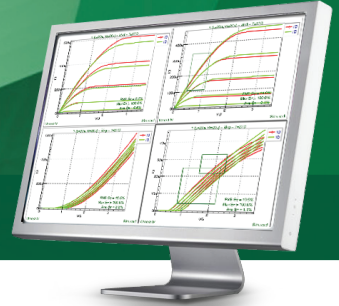


# Utmost IV

## Device Characterization and SPICE Modeling



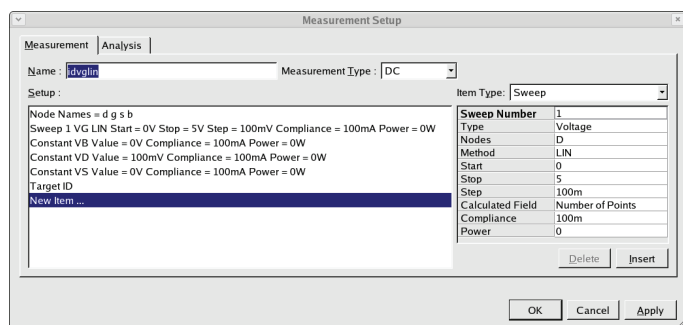
Building on many years experience, Utmost IV provides a powerful yet easy-to-use tool for the characterization of devices and the generation of accurate, compact models, macro-models and Verilog-A models for analog and RF applications.

- Store your data in either the file system or in a database
- Automated measurement and SPICE model extraction of any device type
- Full control of all measurement conditions
- Over 100 different measurement instruments
- Open architecture instrument drivers can be modified or created by user
- Extract any compact, macro-model or Verilog-A SPICE model
- Combine direct extraction and parameter optimization techniques
- Simulate and optimize any combination of data including extracted data values
- Family of advanced optimizers, including genetic type optimizers
- High-speed multi-threaded SmartSpice interface
- Supports SmartSpice, HSPICE, Eldo and Spectre simulators
- Verilog-A model and extraction sequence co-development platform
- Integration with TCAD tools provides process simulation to SPICE model development flow
- Store, share and re-use data using optional Firebird relational database
- Easy data import from Utmost III legacy data, TCAD simulation files or competitor data files

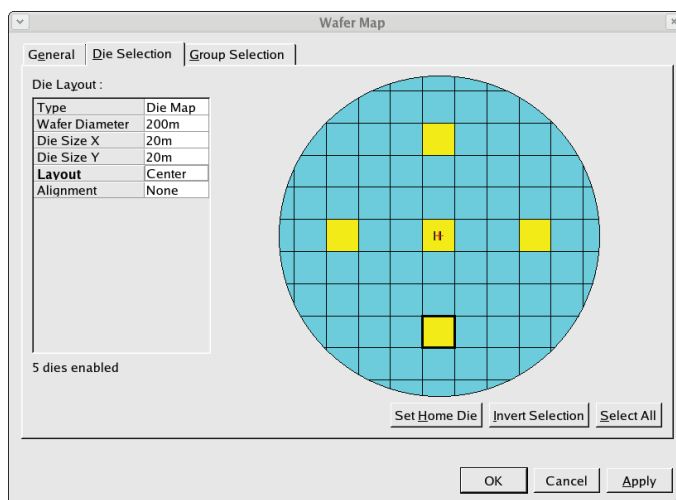
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## Measuring Devices in the Acquisition Module

- Supports all types of semiconductor devices
- Perform any measurement and control all measurement conditions
- Variables can be used within measurement setups to increase re-usability
- Embed extractions in measurement sequence so that extracted result from one measurement can be fed into the conditions of another measurement
- Supports over 100 measurement instruments
- Open interface allows user to create new or modify existing instrument drivers
- Data can also be generated from simulation, which is useful when converting one model type to another



Flexible, easy-to-use interface can define any measurement.



Fully automated sequence of measurements.

## Supported Measurement Instruments Include

### DC Instruments

agilent\_b1500  
agilent\_b1505  
agilent\_e5260  
agilent\_e5270  
agilent\_hp\_4155a  
agilent\_hp\_4155b  
agilent\_hp\_4155c  
agilent\_hp\_4156a  
agilent\_hp\_4156b  
agilent\_hp\_4156c  
hp\_4141  
hp\_4142  
hp\_4145  
keithley\_4200  
keysight\_b1500  
keysight\_b1505  
keysight\_e5260  
keysight\_e5270  
tektronic\_370  
tektronic\_371

### LCR (Capacitance) Instruments

agilent\_b1500  
agilent\_b1505  
agilent\_e4980  
hp\_4274  
hp\_4275  
hp\_4276  
hp\_4277  
hp\_4279  
hp\_4280  
hp\_4284

### LCR (Capacitance) Instruments (con't)

hp\_4285  
hp\_4294  
keithley\_590  
keithley\_595  
keysight\_b1500  
keysight\_b1505  
quadtech\_7600

### AC (s-parameter) Instruments

agilent\_ena  
agilent\_pna  
anritsu\_37xxxD  
hp\_8510c  
hp\_8719d  
hp\_8719es  
hp\_8720d  
hp\_8720es  
hp\_8722d  
hp\_8722es  
hp\_8753a  
hp\_8753b  
hp\_8753c  
hp\_8753d  
hp\_8753e  
hp\_8753es  
keysight\_ena  
keysight\_pna  
rohde\_schwarz\_znb

### Scanners

agilent\_b2200  
agilent\_b2201  
agilent\_hp\_e5250  
hp\_3235  
hp\_3488  
hp\_3495  
hp\_3852  
hp\_4084  
hp\_4085  
hp\_4086  
keithley\_7001  
keithley\_7002  
keithley\_705  
keithley\_706  
keithley\_707  
keithley\_708  
keysight\_b2200  
keysight\_b2201  
keysight\_e5250

### Probers

alessi\_rel2500  
alessi\_rel4500  
alessi\_rel5500  
alessi\_rel6171  
cascade\_summit\_11500  
cascade\_summit\_12000  
electroglas\_1034  
electroglas\_2001  
electroglas\_4080  
electroglas\_commander  
karl\_suss\_pa200  
karl\_suss\_pe100

### Probers (con't)

mpi\_sentio  
rucker\_kolls\_680  
rucker\_kolls\_681  
rucker\_kolls\_691  
signatone\_wavelink\_350  
tokyo\_seimitsu\_3000  
tokyo\_seimitsu\_4000  
tokyo\_seimitsu\_5000  
tokyo\_seimitsu\_6000  
tokyo\_seimitsu\_amp90a  
wentworth\_uk  
wentworth\_us

### Thermal Controllers

cascade\_velox  
delta\_9010  
delta\_9388  
electroglas\_tc2000  
ers\_sp53  
ers\_sp62  
etac\_fx4050  
micronics\_wec10  
ransco\_900  
tempronic\_tp03000  
tempronic\_tp03100  
tempronic\_tp04100  
tenney\_junior  
thermonics\_t2420  
thermonics\_t2500  
thermonics\_t2600  
thermonics\_t2820  
thermotron  
triotech\_tc1000  
triotech\_tc2800

## Generating SPICE models in the Optimization Module

- SPICE model generation using any combination of direct parameter extraction or parameter optimization
- Supports all technologies
- Supports compact, macro-model or Verilog-A model extraction
- High-speed interface to SmartSpice simulator performs hundreds of simulations per second
- No simulation slowdown when using macro-models
- Selection of any combination of data targets to perform optimization
- Extract and display any device figure of merit, such as threshold voltage
- Plot, simulate and optimize device figures of merit
- Optimization sequence provides fully automated SPICE model generation mode
- Interactive rubberband sliders instantly show the effect of changing model parameters on the simulated characteristics
- Family of advanced local and global optimizers include:
  - Levenberg-Marquardt
  - Hooke-Jeeves
  - Genetic Optimizer,
  - Simulated Annealing
  - Parallel Tempering
  - Differential Evolution
- Hybrid optimization combines the power of the global optimizer with the speed of the local optimizer
- Define model parameters as values or as expressions
- Directly import models from hierarchical SPICE library files, including parameters defined as expressions
- Import and simulate process corner or other complex model formats
- Perform simulations using external model libraries

The image displays two screenshots from the SmartView software interface. The left screenshot shows the 'Model Library: project1' window with a table of parameters for an NMOS model. The right screenshot shows the 'Parameter Optimization' window with a list of parameters and their values, and the 'SmartView' window with four plots showing the optimization of various targets.

**Model Library: project1**

Mark	Name	Optimized	Fit Initial	User Initial	Minimum	Maximum
1	LEVEL	3	3	3		
2	VERSION	3.3	3.3	3.3		3.3
3	TNOM	27	27	27	-100	300
4	TOX	14n	14n	14n	5n	50n
5	XJ	150n	150n	150n	100n	1u
6	NCH	1.7e+17	1.7e+17	1.7e+17	5e+16	5e+17
7	NSUB				5e+15	3e+17
8	VTH0	700m	700m	700m	-2	2
9	K1	500m	500m	500m	0	1
10	K2	-18				
11	K3	80				
12	KCB	0				
13	WO	2.5e				
14	NLX	174				
15	DVT0W	0				
16	DVT1W	0				
17	DVT2W					

**Parameter Optimization**

Model: nmos Optimized Parameters: Iteration: 207 Error = 4.0%

Model/Parameter	Value	Minimum	Maximum
nmos/TOX	7.3043n	5n	50n
nmos/VTH0	444.98m	-2	2
nmos/K1	639.28m	0	1
nmos/K2	-21.136u	-19	14.901n
nmos/K3	100	1m	100
nmos/U0	40.697m	10m	100m
XJ	100p	100p	10n
nmos/UA	100p	100p	10n
nmos/UB	8.9745e-19	1e-21	5a
nmos/UC	45.958p	-100p	10n

**SmartView**

Four plots showing the optimization of various targets (ID, VD, VG) over time. The plots show the relationship between the target and the parameter being optimized, with the optimization process converging to a minimum error.

Rubberband optimization of any number of parameters. View and optimize any number of targets.

## Custom Automation using the Script Module

- Combine the power of Utmost IV with the customization capability of JavaScript programming language
- Perform any measurement, simulation, extraction or optimization
- Access any database or file
- Export a script version of any Acquisition or Optimization project for rapid script development

### Developing Verilog-A Models and Extraction Strategies

- Utmost IV is the perfect Verilog-A model development tool
- Modify Verilog-A model code and instantly see effect on simulated characteristics
- Use data from any source including measurement, TCAD process simulation or other SPICE model simulation to develop new Verilog-A model code and parameters
- Interactive rubberband sliders allow parameter limits to be quickly explored
- Compare model versions
- Side-by-side development of the Verilog-A model and the extraction strategy for the model

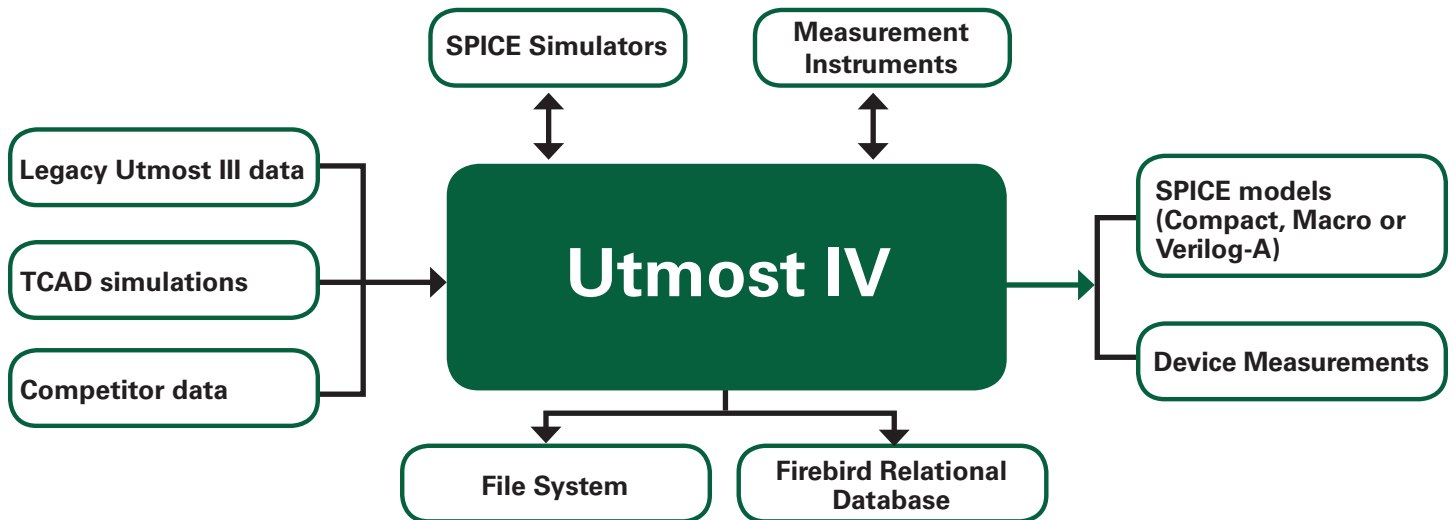
### Using TCAD Simulations to Generate SPICE Models

- Full TCAD process simulation to SPICE model generation flow
- Provide 'level 0' SPICE models to designers even before the process is available
- Compare TCAD simulations with measured data from the process
- Combine TCAD and measured data to develop SPICE models
- Seamless integration with DeckBuild and VWF tools

### Optional Relational Database Organizes Your Work

- As well as normal file storage, Utmost IV offers a relational database to store your measurement data and projects
- Avoids storage and duplication of thousands of separate data files in difficult to locate file systems
- Provide controlled access to information with full user and group permission settings
- Facilitates sharing and easy retrieval of data
- Database is proven Borland Firebird relational database

## Utmost IV Inputs/Outputs



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