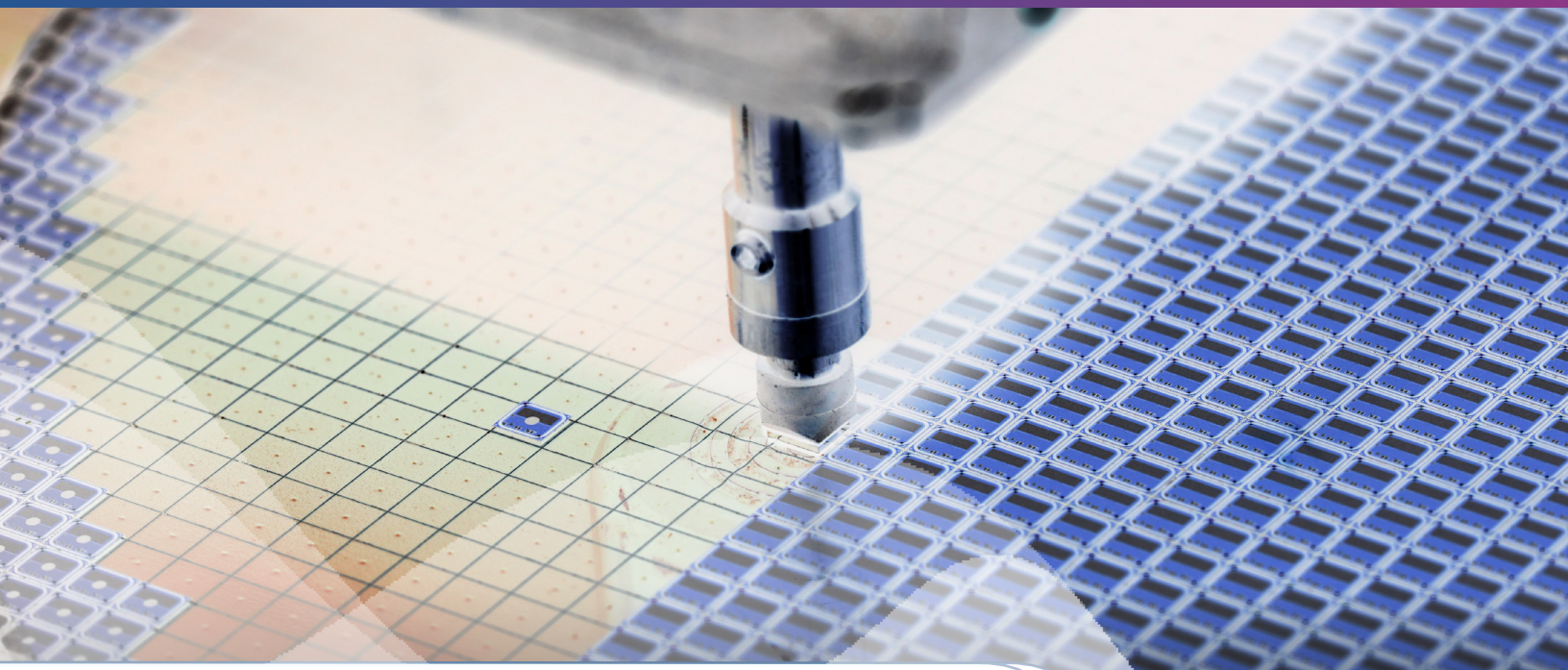

SOLUTION BRIEF

How Design Houses Qualify CMOS Foundry Models Using PathWave Model QA (MQA)

PATHWAVE

Introduction

Following Moore's Law, advanced CMOS process technology is driving IC designs to have smaller device scaling yet better performance. Smaller device sizes will create more unexpected effects and variation which are not considered in older technologies. Consequently, to describe all the new device electrical behaviors, device model libraries provided by foundries are becoming more and more complicated.

Due to the increased complexity of foundry model libraries and the huge cost of design failures, large IC design houses are starting to build internal scripts or to rely on EDA tools to automatically qualify foundry models.

In this paper, we will discuss why design houses need to qualify foundry models and how PathWave Model QA(MQA) can help to standardize the model qualification flow.

Design House Challenges and Requirements for Foundry Models

As the device scaling are shrinking to satisfy design goals, IC designers can no longer afford to ignore the complexity of side effects and variations caused by the fabrication process. Simulation model libraries, required to describe all the effects and variations, are becoming huge, complicated and difficult to read.

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In the meantime, design costs are continually increasing, driving design houses to look for ways to reduce the risk of a design failure. Even though the model should have been fully qualified by the foundry before delivery, design houses still need to verify the models to avoid human error, to be able to forecast process variation influences, and determine differences between different foundries.

To minimize late-stage design surprises, leading design houses have applied comprehensive acceptance quality assurance processes to every foundry model for years. The quality assurance rules cover a wide variety of criteria including, but not limited to, single transistor typical behavior, corner variation, statistical variation, design specific checks and standard circuit behavior verification. Only after the model passes all the checking rules will it be delivered to their design teams.

Large design houses often work with foundries to improve the accuracy of their models when discrepancies arise between measured and simulation results. Smaller design houses usually have to rely on themselves to resolve any model accuracy issues in most of the cases.

Small design houses normally maintain multiple foundries in order to drive down costs. This means that the alignment of foundries will be the most important check when they change supplier. Verifying the differences between foundries or processes will ensure that the design works. Furthermore, predicting the influences of these changes may help design houses to lower costs and avoid failures.

Model qualification is similar to an annual medical checkup. Errors are not expected but it's a necessary step to minimize the high cost of late-stage failures.

PathWave Model QA(MQA) Model Qualification Flow

When a model library has been obtained from a foundry, it should be checked against a variety of rules before it goes into the design flow. Due to the complexity of the model libraries and the large volume of data required for cross checking between SPICE types, model versions and foundries, the model qualification and documentation work often takes days or even weeks.

PathWave Model QA(MQA), Keysight Model Quality Assurance tool, provides the total solution from model qualification, model comparison, to documentation and result sharing.

Acceptance Checks

Acceptance checks are the first and most basic checks applied to the model. They contain model convergence, physical behavior and special effect checks. The acceptance checks will also compare the model simulation versus design documentation or measurement data if applicable. These checks ensure the basic simulation results of the model and avoid possible human mistakes that can occur during model assembly, model version updates or even during the generation of documentation.

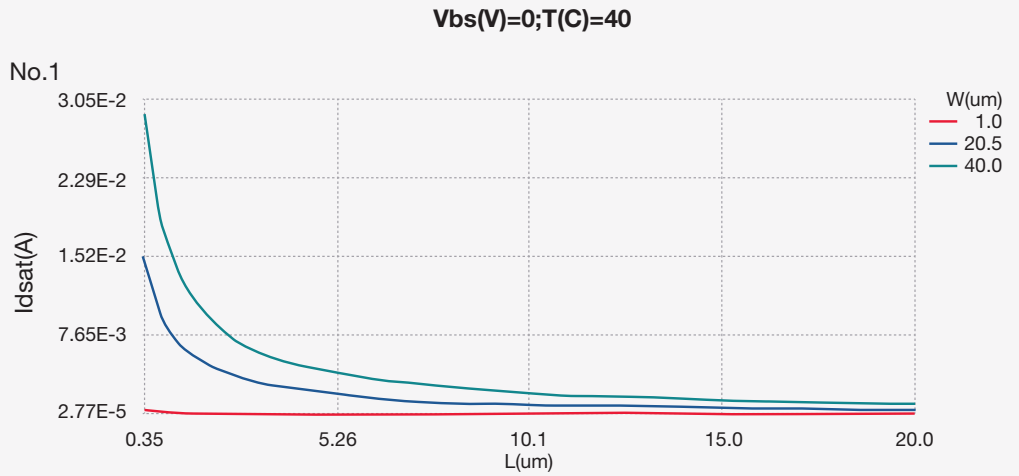

Figure 1. Target trend check: Idsat vs. L

Model Comparison

If design houses maintain multiple foundries, model comparison will be very important during the quality check. It will make sure that the design works for all the different foundry processes. Besides the check between foundries, the comparison cases will also apply to different versions of model libraries, different SPICE simulators, and different technologies.

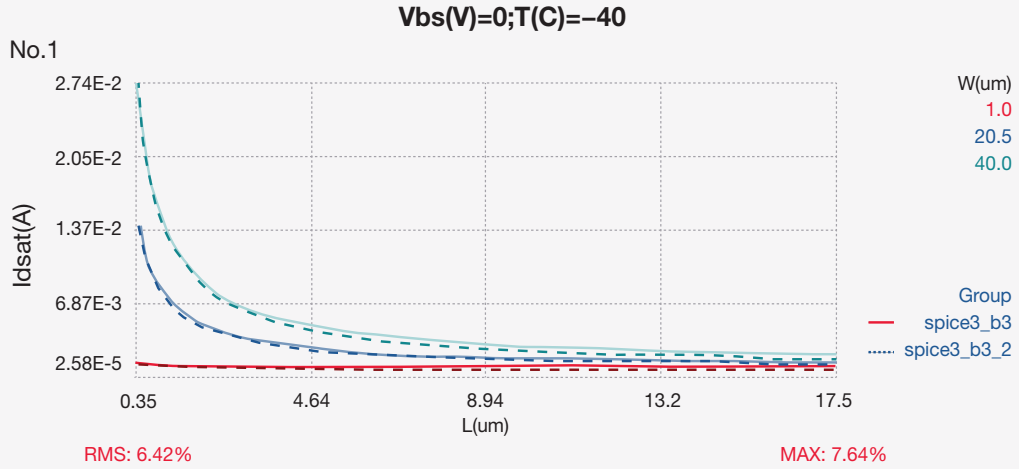

Figure2. Model comparison between two models

Corner and Statistical Model QA

All foundries provide corner models and for most of the new technologies, they also provide statistical models. Statistical models offer better accuracy for simulating the process variations associated with different dies, wafers, and lots, or the local variation describing the small mismatch between side-by-side devices.

Whereas corner models only show the best and worst corner cases, statistical models describe the total variation with Monte-Carlo simulations which help designers make tradeoffs between target specs and design limitation.

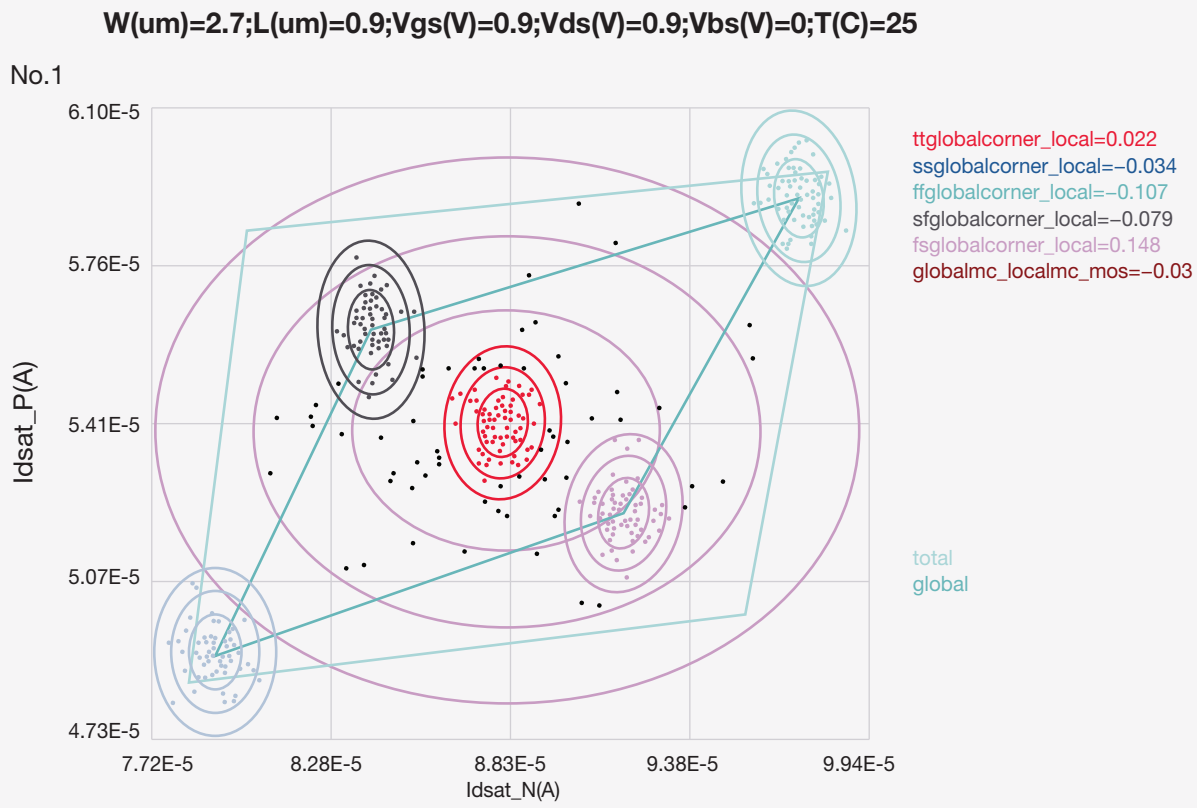

Figure3. Typical model, corner models, global variation, and local variation

Benchmark Check and Design Specific Check

PathWave Model QA(MQA) also allow users to setup small circuits as benchmarks to verify models, such as ring oscillators. MQA can standardize the benchmark process and allow it to be reused for all models received.

Foundries normally provide the same version of device models to all their customers. To ensure the best simulation results for their specific designs, design houses will often set specific design checks in addition to all the regular ones. If needed, they can also fine tune the model parameters to improve the model accuracy in the required design range.

Conclusion

By using PathWave Model QA(MQA) as the foundry interface solution, design houses can qualify the entire model library. Modeling engineers can make sure that the received models are verified and consistent before releasing them to their designers. They can identify any possible issues in the model and thereby avoid last minutes design surprises.

To standardize the model qualification flow, Keysight PathWave Model QA(MQA) provides the total solution for qualifying foundry model libraries. Based on the modeling engineer's experience, knowledge and the design requirements, checking routines can be created and then MQA will automatically run the simulations and generate reports. PathWave Model QA(MQA) flow greatly improves the model qualification and documentation process. It also standardizes the entire working flow on one platform.

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