

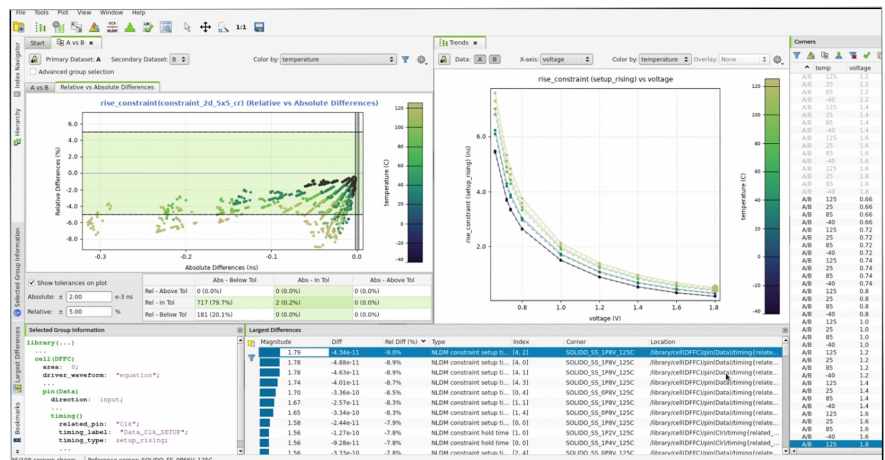
DIGITAL INDUSTRIES SOFTWARE

Solido Characterization Suite Library Characterization

Features and benefits

Solido Characterization Suite

- Massive speedup in library characterization and verification
- Better quality libraries, improved power, performance, and area
- Supports standard cells, IOs, memories, and custom cells
- Works with all characterization tools and flows
- Works on all .lib data types: timing, power, noise, and variation



Solido Characterization Suite enables faster and more accurate library characterization and verification, resulting in better quality libraries for improved power, performance, and area.

Features and benefits

Solido Analytics

- Comprehensive .lib verification in hours instead of weeks
- Finds issues undetectable by traditional checks
- Supports hundreds of standard checks and custom checks
- Compares all library metrics and summarizes information for the user
- Supports custom plots with user-defined functions and variables

Features and benefits

Solido Generator

- Uses machine learning to accelerate characterization
- Produces new PVTs .libs in minutes, 100x+ faster than SPICE
- Works using .libs as input; does not need SPICE simulation or characterizer calibration
- 2x+ speedup for characterization across all PVTs

Summary

Modern static timing analysis (STA)-based design flows rely on characterized Liberty® models of standard cells, IOs, memories, and custom blocks. However, traditional library characterization and validation have become increasingly expensive in terms of computation and engineering effort, due to complexity and the amount of characterized data.

The Solido™ Characterization Suite™ provides fast and accurate library characterization tools powered by machine learning. This suite significantly reduces standard cell, custom cell, and memory characterization time and resources, while delivering production-accurate Liberty models and statistical data, and performing comprehensive validation for characterized Liberty files. It achieves this using machine learning (ML) methods that adaptively model the full characterization space, boosting accuracy where needed to achieve production targets, while saving large amounts of simulation time in other areas.

The Solido Characterization Suite works with any existing characterization solution. It works on standard cells, IOs, memories as well as custom cells – anything that is described by a Liberty model. It supports all .lib data types, including timing, power, noise and variation, and supports all .lib data structures such as NLDM, CCS, LVF, and Moments.

Solido Characterization Suite

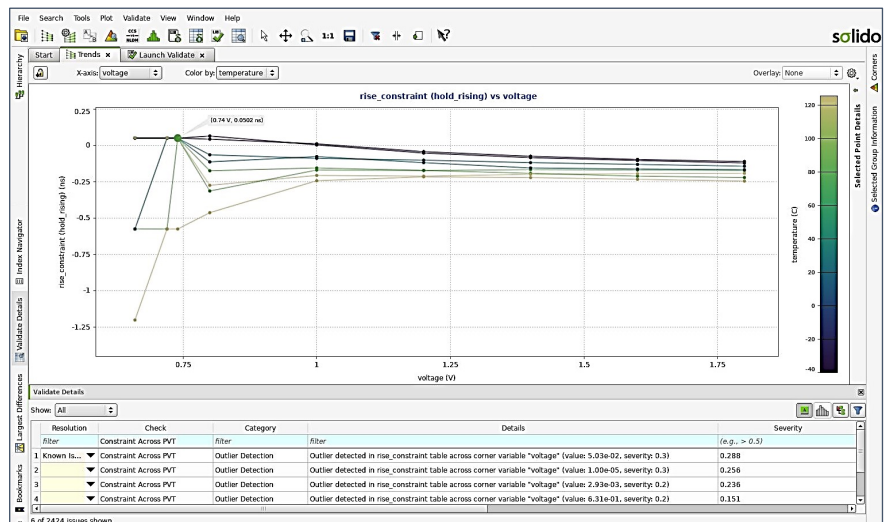
Generator

Accurate .libs 100x+ faster than SPICE
Uses machine learning to produce additional PVT .libs

Analytics

Comprehensive Liberty verification
Uses ML outlier detection, .lib visualization and comparison for validation

Supports standard cells, I/O, memory & analog blocks
Works with 3rd party .libs



Analytics combines comprehensive Liberty model validation with advanced Library Visualization, enabling full .lib verification in hours instead of weeks.

Solido Generator

Solido Generator uses machine learning methods to generate production-accurate Liberty models at new PVT corners in minutes, using existing PVT .libs as anchor data.

Generator produces new PVTs 100x+ faster than SPICE-based characterization, is production-accurate, and works with any existing characterization flow. In a characterization run for a full library, the tool speeds up characterization runs by 2x+ over all PVT corners.

Generator builds a machine learning model of the library to produce production-accurate Liberty models at new PVT corners 100x+ faster than SPICE. The tool:

- Uses machine learning to accelerate characterization: by building a machine learning model to produce .libs at new PVT corners. It does not require SPICE simulation and does not require characterization environment calibration.
- Creates production-accurate Liberty models at a fraction of runtime: by generating new .libs 100x+ faster than SPICE, with accuracy equivalent to SPICE-characterized .libs.
- Generates all .lib data types and constructs: including timing, power, noise, and variation data in all .lib data constructs including NLDM, CCS, LVF, and Moments.
- Works with all characterization tools and flows: to provide massive speedup to characterization runtime.
- The Solido Characterization Suite empowers teams to bring products to market quicker and with less schedule volatility. By improving the quality of IP libraries, it helps improve power, performance, and area metrics, and increases silicon yield

Solido Analytics

Solido Analytics is the next-generation comprehensive library validation and debugging solution. It provides outlier detection using an ML engine, combined with an information visualization approach for reviewing and verifying data. Analytics enables full verification of Liberty files in hours instead of weeks.

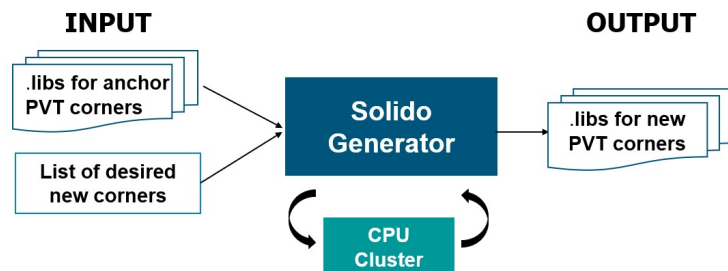
Analytics results in better quality libraries and much faster library verification schedules. Using Analytics, design teams can reduce schedule time, improve power, performance, and area metrics of the final design, as well as increase silicon yield. The solution includes:

- Machine Learning Outlier Analysis: finds critical issues in Liberty data automatically, including those undetectable by traditional methods. It can detect issues not only across PVTs but also in the slew-load tables within a single PVT.
- Rule-based Checks: employs fast and parallelized rule-based checks, including hundreds of standard checks, and support for custom checks using an API.
- Library Comparison: provides full-coverage comparisons between libraries or library revisions. Compares all timing, power, noise, and variation aspects of libraries and summarizes differences in an easy-to-understand and analyze format.
- Advanced Library Visualization: uses advanced information visualization methods linked to library data to minimize the time and effort for library analysis, and to allow users to seamlessly trace issues to their source.
- Custom Plots: allows users to create their own plots and display multiple measurements against multiple variables, making it the most effective method for understanding and analyzing .libs
- High performance, high capacity .lib handling: parallelizable up to 1000s of CPUs, able to handle .lib files 10GB+ in size.

.lib Variation Modeling (LVF)

Statistical modeling in Liberty Variation Format (LVF) is used for .libs at 20nm and smaller process nodes to model on-chip variation. For 7nm and 5nm timing libraries, LVF values may impact overall timing characteristics by 100 percent or more.

LVF .libs contain statistical variation information per timing arc, so each data point requires Monte Carlo-equivalent analysis at 3 sigma or above. As a result, even with aggressive runtime optimization, SPICE-characterized LVF data requires between 3x and 10x characterization runtime compared to nominal .lib data.



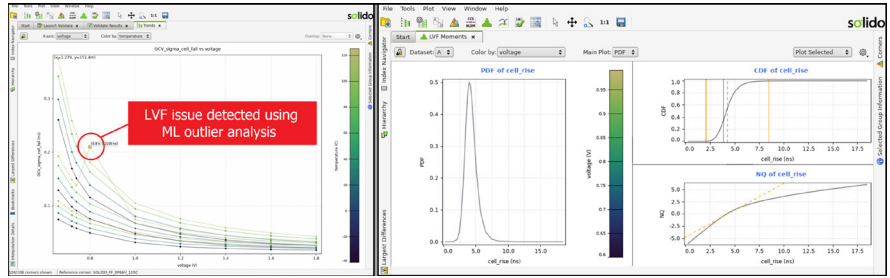
Generator builds a machine learning model of the library to produce production-accurate Liberty models at new PVT corners 100x+ faster than SPICE.

LVF .libs are also more prone to errors and inaccuracies, due to approximations taken to reduce characterization runtime. Due to the statistical nature of LVF, as well as the large amount of data in .libs, verification of LVF .libs is a significant challenge that requires the correct tools to address.

Issues in LVF data, such as characterization inaccuracies leading to spikes or noisy results, cannot be identified reliably using rule-based checks. In addition, verification by checking against reference SPICE-simulated Monte Carlo results is only feasible for a small number of sampled points, and does not provide adequate coverage for production usage.

Verifying LVF .libs and accelerating LVF characterization using Solido Analytics and Generator

Solido Analytics’ machine learning outlier analysis detects LVF issues across the entire LVF .lib dataset in a fraction of time required by other methods, allowing users to verify entire LVF .libs within 24 hours. Solido Analytics also allows users to visualize LVF moments (standard deviation, skewness, mean shift) by displaying probability density functions, normal quantile plots and other information that helps users understand LVF moments data in an intuitive way.



Analytics detects LVF issues across the entire .lib dataset using machine learning outlier analysis, and also helps users visualize and understand LVF data using intuitive plots.

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Solido Generator provides massive acceleration to characterizing LVF .libs using machine learning, using SPICE-characterized anchor LVF data. Since LVF characterization runtime dominates total characterization turnaround time for advanced process node .libs, Generator enables library teams to significantly speed up characterization times.

Overall, Solido Analytics and Generator provide a comprehensive solution to accelerating library characterization schedules and verifying LVF .libs, resulting in less LVF-related silicon production issues, and faster time-to-market.

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