Top 10 New Features in the SmartSpice 2022 Baseline Release

Introduction

Silvaco's SmartSpice™ is a high-performance, parallel SPICE simulator that provides a proven and comprehensive circuit analysis solution. Applications range from complex, high-precision analog and mixed-signal circuits to flat panel displays and TFT arrays, image sensors, memory designs, custom digital circuits, and characterization of standard cell libraries of advanced semiconductor processes, among many others.

SmartSpice offers multiple simulation flavors:

- **SmartSpice HPP**: Silvaco's High-Performance Parallel engine, for Fast Analog (a.k.a. Quasi-SPICE) engine;
- **SmartSpice Pro**: Silvaco's FastSPICE engine;
- **SmartSpice RF**: Silvaco's bundled solution with several specialized engines needed for RF analyses;
- **SmartSpice Server**: Silvaco's solution for distributed simulation across nodes in a network;
- **Harmony**: Silvaco's solution for general analog/digital co-simulation;

and many more, as listed on www.silvaco.com/.

Silvaco's SmartSpice team around the world has been working continuously to deliver top-notch quality and address customer requests. The team strives to make SmartSpice an industry-leading SPICE simulator, and they have been successful in achieving a significant measure towards this goal over the last year.

In this document, we describe the top 10 new features and improvements implemented by the SmartSpice team during the past year; we are comparing the 2022 Baseline Release (SmartSpice 5.2.0.R) to the 2021 Baseline Release (SmartSpice 5.0.3.R).

The top 10 new features and improvements are focused on the following aspects:

1. **Performance and capacity improvements:** Up to 25x speedup and 2x less memory;
2. **Improved user experience**: Better interface for the user;
3. **Improved Graphical User Interface (GUI)**: Faster and more robust;
4. **New built-In text editor**: Faster, more stable, and full of new features;
5. **Improvements in SmartSpice RF**: Enhanced Shooting Newton and Harmonic Balance;
6. **Improved Spectre® compatibility mode**: New features and better integration with Cadence® ADE;
7. **Improvements in SmartSpice Pro**: New features and improvements;
8. **Improved Signal Integrity (SI) solution**: More accurate simulation of S-Elements and a brand-new Touchstone file converter;
9. **New measurement capabilities**: Added TOP, BASE, MID, and SETTLING measurements to better support Pulse signals; and
10. **Improved SOA checks**: New features and improvements.

Continue reading and watch the embedded videos to learn more about each of these features.

1. Performance and Capacity Improvements

Performance (the ability to complete simulations in a shorter turnaround time without losing accuracy) and capacity (the ability to simulate larger circuits) have always been two of the main R&D focuses of any SPICE simulator. This is certainly no different for the Silvaco SmartSpice products.

Over the last year, great improvements have been made with this regard, and the SmartSpice team is happy to announce that SmartSpice 5.2.0.R (Baseline 2022) is much faster and memory optimized when compared to SmartSpice 5.0.3.R (Baseline 2021) for out-of-the-box simulations. In some cases, 7x performance speedup and 2x memory reduction are seen, simultaneously. In other cases, by adopting a brand-new solver, speedups can get up to 25x when compared to the 2021 Baseline Release, and up to 37x when compared to the 2020 Baseline Release.

The following video presents more details about these improvements.

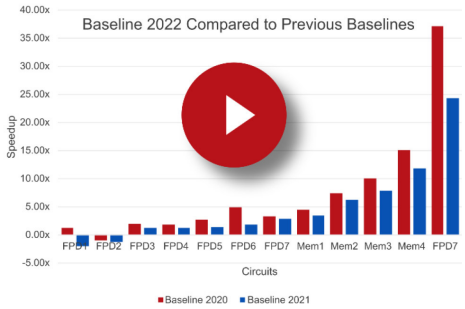

Figure 1. Baseline 2022 Compared to Previous Baselines

2. Improved User Experience

User experience can be defined as the way a person interacts with and feels about a system. In the 2022 Baseline Release, the SmartSpice team has made significant improvements in the tool's user experience.

From this yearly release on, the SmartSpice users will start experiencing more similar behaviors when using the tool from different operating systems, or when interacting with it through different flows (e.g., standalone vs. through Gateway, Silvaco's schematic editor). Also, new command-line arguments are available, and the team is adopting a two-step approach to enable more meaningful behaviors. Finally, new messages are being printed to the terminal and the log file in order to improve the overall user experience.

Find more details about these improvements in the following video.

Figure 2. Improved User Experience in the 2022 Baseline Release

3. Improved Graphical User Interface (GUI)

In the 2021 Baseline Release, the SmartSpice team added a major change with a new GUI technology. This year, in the 2022 release, the team continues the process of improving GUI-related aspects of the tool.

By taking advantage of the new GUI technology, SmartSpice's performance and robustness have been improved. In case of simulations that print many messages to the GUI, the overall performance can be up to 2.5x faster when compared to the 2021 release.

After listening to multiple requests from customers, functionalities such as the Toolbar Editor and the Icon Editor were brought back in the 2022 Baseline Release.

More details about these improvements are presented in the video in Figure 3.

4. New Built-In Text Editor

The new GUI technology introduced last year, along with the GUI improvements brought this year (see Section 3), allowed the SmartSpice team to deliver a brand-new built-in text editor. This new version brings a variety of improvements.

The most important improvements and fixes include better user-interface response while handling large files, fixes related to the lack of support for variable-width fonts, and the addition of a series of functionalities not supported before, such as the support for regular expressions for the "Find & Replace" feature, rectangular block selection, and much more.

Learn more about these improvements in the following video.

Figure 3. Improved Graphical User Interface and New Built-In Text Editor

5. Improvements to SmartSpice RF

The 2022 Baseline Release also brings several enhancements for SmartSpice RF. These enhancements are not only focused on improving the tool's overall phase noise simulation flow, but also entail specific improvements in both the Shooting-Newton-based and the Harmonic-Balance-based phase noise computations.

Starting with some of the general improvements, SmartSpice RF now offers a much-improved Noise Contribution Table. With this, users can not only simulate accurate phase noise analyses, but also understand precisely from which devices the noise contributions are coming from. Additionally, the internal implementation of switch elements was improved, making it less convergence prone.

Focusing on Shooting Newton first, the handling of the multiplicity factor "M" is greatly improved in the 2022 release, now delivering even more accurate results, as it is demonstrated in Figure 4. Also, the recently released Perturbation Projection Vector (PPV) algorithm for phase noise can now specify the relative harmonic for which the noise is to be simulated at.

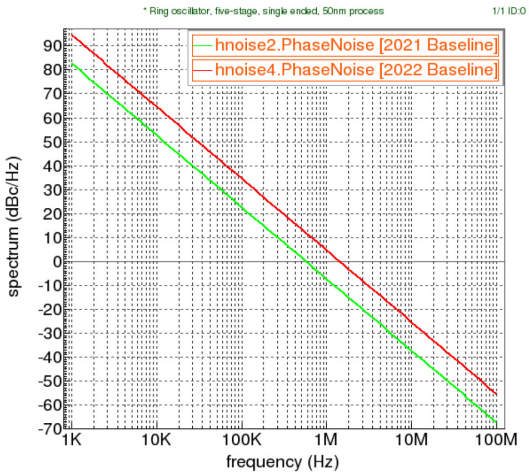

Figure 4. Improved Phase Noise Results Considering the 'M' Multiplicity Factor

Now, focusing on the Hamonic Balance (HB) method, the 2022 Baseline Release improves the convergence of its transient initial guess (TIG). An accurate TIG is often crucial for HB methods, especially considering circuits with digital signals, which have a dense spectrum.

6. Improved Spectre Compatibility Mode

The SmartSpice team continues to focus on extending the tool's compatibility with Spectre. In this 2022 Baseline Release, much has been done in this regard.

Among the important improvements in this year's release, SmartSpice now supports the ANALOGMODEL feature, allowing users to bind an instance to a model using a parameterized model name. Furthermore, a collection of smaller improvements adds much value to this compatibility mode, such as the support for protect/unprotect statements and the plotting of small-signal parameters.

Also, the SmartSpice integration with Cadence ADE has also been improved. Now, users can start using SmartSpice from within ADE for many more tasks.

The following is a list of short videos about SmartSpice's Spectre Compatibility Mode and its integration with ADE:

- SmartSpice in Spectre compatibility mode
- Installing SmartSpice's ADE Integration
- Running SmartSpice from within Cadence ADE
- SmartSpice accuracy settings from ADE
- Parametric and Corner analyses with SmartSpice from ADE

7. Improved SmartSpice Pro

With the ever-growing complexity of circuit designs, the challenges of electrical verification are intensified. In some cases, regular SPICE simulation cannot deliver the desired set of results in due time, and FastSPICE engines become necessary. This is when SmartSpice Pro comes into play.

Over the last year, SmartSpice Pro has also received good attention from Silvaco's R&D team. With this, a variety of improvements are being made available on its 2022 Baseline release, such as:

- Support for External Sampling;
- Support for ".LET" statements;
- Improved support for ".option autostop";

and much more.

We strongly encourage you to download the tool and check it out by yourself.

8. Improved Signal Integrity (SI) Solution

Each and every electrical signal, analog or digital, is subject to degrading effects, such as noise, distortion, and/or loss. This problem becomes even more important when dealing with signals traveling over long distances or at high frequencies in the design. Signal integrity solutions allow circuit designers to analyze and mitigate these undesired effects at simulation time.

In this 2022 Baseline Release, SmartSpice's Signal Integrity (SI) solution is much improved. The SI team has added three major enhancements.

First, the simulations based on S elements are much more accurate. This is due to enhancements in time domain convolution algorithm, better impulse response smoothing, and a new method to enforce causality of S parameters.

Additionally, the 2022 Baseline Release adds support for Touchstone 2.0 features. This includes triangle formats, multiple reference resistances, mixed-mode order parameters, among others.

Finally, SmartSpice 5.2.0.R introduces a multipurpose Touchstone File Converter feature. With this, users can now perform any kind of Touchstone data conversions consistent with Touchstone formats 1.0 and 2.0.

Learn more about the very useful Touchstone File Converter in the video embedded in Figure 5.

Figure 5. Introduction to the Multipurpose Touchstone File Converter

9. New Measurement Capabilities

Working with devices and designing components and systems that operate in pulsed conditions is something ordinary in the day-to-day work of IC designers. Measuring pulsed signals is a critical step for the characterization and validation of such devices, components, and systems. Find below a few important signal characteristics measured in these cases:

- TOP, BASE, and MID: voltage levels corresponding to high, low, and middle states of a signal; and
- SETTLING: how long a signal transition takes to reach a steady state.

These measurements, although basic from a designer's perspective, usually require a collection of measurements in SPICE level.

The SmartSpice 2022 Baseline Release adds new measurement capabilities that allow designers to reach the aforementioned measurements in a much simpler way. Learn more about it in the video embedded in Figure 6.

Figure 6. Introduction to the New Pulse Measurement Capabilities

10. Improved SOA Checking

In circuit design, the safe operating area (SOA), defines the voltage and current conditions over which devices are expected to operate properly. In circuit simulation, model vendors can implement SOA checking mechanisms to report when devices are being operated under unsafe conditions.

In the SPICE world, one of the most important SOA checks is related to the command ".biaschk". These are some of the improvements brought by the SmartSpice team in the 2022 Baseline Release:

- Added support for ".biaschk" under DC analyses; and
- Extended the ".biaschk" functionality to monitor expressions for subcircuit definitions.

Additionally, the SOA checks performed by the simulators when using ".biaschk" can be time consuming. In some cases, the designers are aware of reports coming from the SOA checks and would like to ignore the warnings and proceed with their simulations. In cases such as these, turning off the SOA-checking mechanisms can represent a significant speedup. This can now be done in the 2022 Baseline Release by adding ".option biaswarn=2" to input decks.