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Spectre® Circuit Simulator What's New

Product Version 19.1
July 2020

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What’s New in Spectre Circuit Simulator 19.1

Product Version 19.1
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This document contains the following sections:

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Supported Platforms and Operating Systems

The following platforms and operating systems are supported:

Platform and Architecture	**Linux (64)** x86_64 (lnx86)
Development OS	RHEL 6.5
Additional Supported OS	RHEL 6.5 and above RHEL 7 SLES 11 SLES 12 Ubuntu 14.04

Note: Starting with SPECTRE19.1, support for 32-bit operating system has been discontinued.

Licensing Changes

For information on licensing, refer to the *Licensing* section of the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

New and Enhanced Features in the SPECTRE 19.1 ISR8

The SPECTRE 19.1 ISR8 release contains the following new and enhanced features:

- Weighting in Fault Analysis Enhanced
- LDS Sampling Parameter Generation Enhanced

Weighting in Fault Analysis Enhanced

In this release, fault weighting has been enhanced to be compatible for faults being rerun. Now, weighting is not saved in fault list when it is generated with `spectre_ddmrpt`. Instead, the `faultsid` information is saved to retrieve the original weighting value.

LDS Sampling Parameter Generation Enhanced

In earlier Spectre releases, the same random number sequence was applied to process and mismatch variations when `variations=all` was used. This caused mismatch in variables between `variations=mismatch` and `variations=all`.

Starting with this release, different random number sequences are applied to process and mismatch variations. With this change, the mismatch variables are consistent between `variations=mismatch` and `variations=all`.

This may cause the Monte Carlo results to be different in earlier Spectre releases and the current release. However, the statistic std, mean, max, min summary for large samples is not affected.

You can use the `force_consistent_mismatch_sequence=no` option for backward compatibility.

New and Enhanced Features in SPECTRE 19.1 ISR7

The SPECTRE 19.1 ISR7 release contains the following new and enhanced features:

- LX and VX modes of Spectre X Enhanced
- Support for Open Faults Collapsing Added in Fault Analysis
- Device Model Change

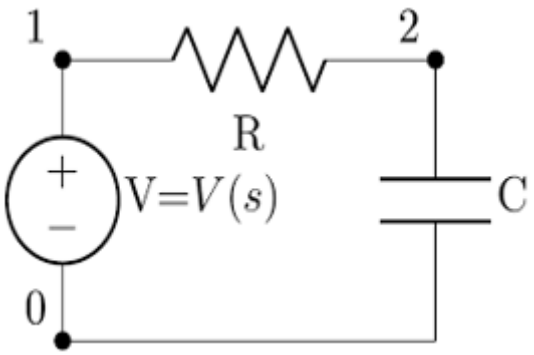
LX and VX modes of Spectre X Enhanced

The LX and VX modes of Spectre X have been enhanced to support the Spectre `save`/`recover` feature. The CX, AX, and MX modes already support `save`/`recover` since the SPECTRE 19.1 base release.

Support for Open Faults Collapsing Added in Fault Analysis

When two open faults are equivalent, they can be collapsed only if the union of all terminals from `{…}` of both statements is exactly the full set of terminals connected to the given node.

Examples



- Open faults defined on the same node but contain no identical terminals disconnected from the given node, as shown below.

```
open_1 ( 2 ) r=1e9 { R }
open_2 ( 2 ) r=1e9 { C }
```

- For two terminal primitives, open faults for each terminal are identical

```
open_1 ( 2 ) r=1e9 { R }
open_3 ( 1 ) r=1e9 { R }
```

For more information, refer to the *Fault Collapsing and Weighting Function* in the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

Device Model Change

Starting with this release, support for the b3soipd device model has been discontinued. There is no change in any other Spectre SOI device model.

New and Enhanced Features in SPECTRE 19.1 ISR6

The SPECTRE 19.1 ISR6 release contains the following new and enhanced features:

- Support for Global Time Window Added
- Fault Analysis Enhanced

Support for Global Time Window Added

In this release, a new global option, `save_time_window`, has been added to define the time window for which all waveform data needs to be saved.

Note: The local `time_window` option has higher priority than the global `save_time_window` option.

Fault Analysis Enhanced

In this release, following enhancements have been made in fault analysis

- Fault Events Triggered by Asserts (ETA) are now supported in fault analysis. A fault event is specified as follows:

  `"@(basic_event, N) + delay"`

  Here:

`basic_event`	Name of the assert.
`N`	Selector of the event.
	If `N>0`, it means to select the Nth occurrence of the event.
	If `N<0`, it means to select the first occurrence to the Nth occurrence of the event.
	If `N=0`, it means to select all occurrences
	If `N` is not specified, it means to select the first occurrence only.
`delay`	Delay time after the selected event occurrences.

  For more information, refer to the *Performing Event-Triggered Analysis during Transient Analysis* section in the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

- A new parameter, `faultic`, with possible values of `no` and `yes`, has been added in transient analysis. If the value of the parameter is set to `no`, Spectre uses the nominal solution as an initial guess to start fault simulation with the fault injected. If the value of the parameter is set to `yes`, dc analysis is enabled with each fault injection when the value of the `faultmethod` is set to `leadtime`.
- Now, when the `faultstrobe` parameter is set to `yes`, the following parameters are expanded in transient fault analysis to add an array of time points for fault simulation:
  - `strobestart` | `strobestop` | `strobestep`

- `strobeperiod`
- `skipstart` | `skipstop`

The fault result at the time points above is also saved in the fault table file.

- A new parameter, `faultrampinterval`, with possible values of `0` and `1`, has been added that specifies the coefficient (between 0 and 1) to define the size of the time interval to ramp fault conductance after fault injection, when the value of the `faultmethod` parameter is set to `leadtime`.

New and Enhanced Features in SPECTRE 19.1 ISR5

The SPECTRE 19.1 ISR5 release contains the following enhanced feature:

- Support for Parameterized dist Added in Monte Carlo Statistical Block

Support for Parameterized dist Added in Monte Carlo Statistical Block

Starting with this release, parameter `dist` of Monte Carlo analysis can be assigned a global parameter as value, as shown below.

```
parameters SIGMASCALE_snd = 1
parameters DIST_snd =gauss
statistics {
    process {
        vary AGIDL_snd dist=DIST_snd std = SIGMASCALE_snd
        vary ALIGN1_snd dist=DIST_snd std = SIGMASCALE_snd
        vary ALIGN2_snd dist=DIST_snd std = SIGMASCALE_snd
        vary CAP_snd dist=DIST_snd std = SIGMASCALE_snd
    }
}
```

New and Enhanced Features in SPECTRE 19.1 ISR4

The SPECTRE 19.1 ISR4 release contains the following new and enhanced features:

- Support for +query=mtinfo Added in Spectre X
- Device Model Change

Support for +query=mtinfo Added in Spectre X

In this release, like Spectre APS, Spectre X supports `+query=mtinfo` for recommending the optimum number of cores for a given design.

```
spectre +preset=mx input.scs +query=mtinfo
```

A message is displayed in the Spectre X logfile recommending the optimum number of cores required for the given design.

Device Model Change

In this release, the `hbt` model master in Spectre has been changed to `ucsd_hbt` to use the AWR-based HBT model.

If you are using SPECTRE 19.1 ISR4 or later versions, you can use the following option to use the `hbt` model master name for USCD HBT:

`opt1 options hbt_model=ucsd_hbt` (default `hbt` value uses the AWR-based model)

New and Enhanced Features in SPECTRE 19.1 ISR3

The SPECTRE 19.1 ISR3 release contains the following new and enhanced features:

- New Options Added to Filter Assert Violations
- Assert mod Parameter Enhanced to Support Subcircuit Device Models
- Fault Analysis Enhanced
- Device Models Support

New Options Added to Filter Assert Violations

In this release two new options, `min_peak` and `max_peak`, have been added to the assert statement that report the violations that violate the assert and cross the `min_peak` or `max_peak` limit.

Assert mod Parameter Enhanced to Support Subcircuit Device Models

Spectre asserts use the `mod=nch` parameter to apply asserts to devices with the given device model name `nch`. By default, the `mod` parameter does not apply to device model subcircuit or inline subcircuit names.

In this release a new global option, `mod_assert_expand` with possible values of `yes` and `no` (default) has been added that enables you apply the mod parameter to device models or inline subcircuit names if the model statement with the specified name is not found.

Fault Analysis Enhanced

In this release, Spectre fault analysis has been enhanced as follows:

- Following new methods are supported for fault sampling: `random`, `randomweighted`, `randomuniform`, and `weightedsorted`.
- Confidence interval is now supported in post-processing
- Parameters `fmin` and `fmax` have been added in `weight_expr`.

  For more information, see *Limiting in Weight Expression* in *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.
- Parameter `weight_factor` is now supported in fault generation with `info` statement

Device Models Support

In this release, support for the following device models has been added in Spectre:

- BSIMCMG 106.1 TMEMOD 105.1
- BSIMBULK TMEMOD1.3
- JFET100q

New and Enhanced Features in SPECTRE 19.1 ISR2

The SPECTRE 19.1 ISR2 release contains the following new and enhanced features:

- Spectre X Enhanced
- EMIR Analysis Enhanced
- Reliability Analysis Enhanced
- Fault Analysis Enhanced
- Device Models Enhancement

Spectre X Enhanced

In this release, following enhancements have been made in Spectre X:

- Support for EMIR analysis has been added. The Spectre X solver provides improved performance and capacity for large EMIR designs when using the following EMIR methods:
  - Direct EMIR method
  - Iterated EMIR method, dominated by first stage circuit simulation

  Note: When Spectre X is used in simulation, `+postlpreset=no` setting is applied.
- Support for aging analysis has been added for all preset modes.

EMIR Analysis Enhanced

The behavior of direct EMIR analysis has been changed. Now, when `+postlayout` or `postlayout=hpa` command-line options are specified in Spectre APS, both are ignored with a warning message.

Reliability Analysis Enhanced

Aging reliability analysis now supports the following Spectre RF analyses:

- PAC
- PXF

Fault Analysis Enhanced

In this release, following enhancements have been made in fault analysis:

- Support for parametric fault definition has been added. A new option `what=faultparam` has been added in `info` analysis that is used to generate parametric fault list.

  Note: Parametric fault simulation is also supported in the automated three-step process with `+fsa`.

  For more information, refer to the *Parametric Faults* section in *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

- Faults can now be generated as per the IEEE 2427 standard. A new option `faultrule` with possible values of `2427` and `none` has been added in `info` analysis. When the value of the `faultrule` parameter is specified as `2427`, device terminals for fault injection are predefined according to the IEEE 2427 standard.

  For more information, refer to the *Generating Faults According to IEEE P2427 Standard* section in the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

Device Models Enhancement

The PSP103 model has been updated to version=103.7.

New and Enhanced Features in SPECTRE 19.1 ISR1

The SPECTRE 19.1 ISR1 contains the following new and enhanced features:

- Checklimit Statement Enhanced
- Fault Analysis Enhanced on page 22

Checklimit Statement Enhanced

Spectre, by default, reports many violations for a given assert when the violations occur multiple times during transient simulation. A new option, `filter`, with the possible values of `none`, `progressive`, and `extreme` has been added to the `checklimit` statement that enables you to reduce the number of violations to the most significant ones.

Fault Analysis Enhanced

In this release, fault analysis has been enhanced as follows:

- *Support for fault collapsing and weighting* – Spectre now supports fault collapsing in which two equivalent faults are collapsed into one fault during fault generation with `info` statement. This improves the accuracy of detection coverage. In addition, support for fault weighting has been added that is specified in the `faults` statement as an expression. For more information, see *Fault Collapsing and Weighting Function* in *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.
- S*upport for fault weighted likelihood for single and multiple fault blocks* – The weighted likelihood of the `nth` fault is calculated using the formula $W_n=w_n/\sum_1^N w_i$ where `N` is the number of faults. In addition, a constant parameter `weight_factor` is available for weighting multiple fault blocks. For more information, see *Weighted Likelihood Calculation* in *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.
- *Support for Defect Detection Using Weighted Likelihood* – Spectre calculates the weighted likelihood for each fault based on its ratio to the total weights within the block. The value of weighted likelihood is saved in a fault table file. The weighted likelihood is used to compute the defect coverage in the generation of both detection matrix and functional safety reports. For more information, see *Defect Detection Using Weighted Likelihood* in *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.
- *Support for Weighted Likelihood Sampling* – When parameter `weight` or `weight_expr` is defined in the fault list, Spectre chooses the large weighted likelihood for fault simulation instead of random sampling. For more information, see *Weighted Likelihood Sampling* in *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

New and Enhanced Features in SPECTRE 19.1

The SPECTRE 19.1 release contains the following new and enhanced features:

- New Spectre X Simulator Introduced
- New Dynamic Check Added
- Dynamic Checks Enhanced
- New Static Check Added
- Assert Statement Enhanced
- Checklimit Statement Enhanced
- Info Statement Enhanced
- Spectre Fault Analysis Enhanced
- Spectre Thermal Analysis Enhanced

New Spectre X Simulator Introduced

Recent technology developments, advanced node adoption, and "More than Moore" design have forced analog and custom IC designers to adopt new design practices to benefit from these advancements. These changes have resulted in the need to simulate larger designs with more postlayout parasitics. In addition, many custom IC designs such as flash memory, MRAM, sensor arrays, and so on, now require SPICE accurate simulations.

To meet these demands, a new SPICE engine with much more performance and capacity than the current generation of circuit simulators is needed. The Cadence® Spectre® X Simulator, the next generation of the Spectre circuit simulator, has been developed to address the need for a simulator capable of simulating the next generation of analog, mixed-signal, and custom IC designs.

Spectre X includes two major technologies – enhanced multi-core simple use model simulation capacity and performance with `+preset` and a highly distributed circuit simulation with `+xdp`.

For more information on the Spectre X simulator, refer to the *The Spectre X Circuit Simulator* chapter in the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

Note: With the introduction of Spectre X in this release, the name of the Spectre manual has been changed to *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

EMIR Analysis Enhanced

The rail-to-rail EMIR feature `r2rvmin` has been enhanced to support advanced filtering, based on tap device instance, and model name, boundary box, and layer name. In addition, a name can be assigned to each `r2rvmin` check, and an enhanced `r2rvmin` report that shows how the filtering is applied has been added.

New Dynamic Check Added

In this release, a new dynamic check, `dyn float tran stat`, has been added. The check identifies the nodes that are in high impedance state at a user-specified time. It deploys a statistical method of forcing (pinging) different voltage levels or voltage ramp ups to all nodes and detecting the floating nodes based on the changes in current in the connecting devices.

Dynamic Checks Enhanced

The following dynamic checks have been enhanced:

Check Name	Description
dyn_setuphold	Following new parameters have been added: ■ setup_chk_time: Specifies the setup time checking window. ■ hold_chk_time: Specifies the hold time checking window. ■ report: Reports all checks or only the violations.
dyn_floatdcpath	The dyn_floatdcpath now supports distributed processing for sweep=single method. Following two parameters have been added to support distributed processing: ■ numprocess: Specifies the number of processes for distributed processing. ■ distribute: Specifies the method to use for distributed processing. Possible values are no and fork.
dyn_highz	Following new parameters have been added: ■ debug_format: Specifies the format in which to write the debug report. Possible values are sql, txt, and both. The default value is txt. ■ debug_report: Specifies the type of nodes to include in the debug report. Possible values are lowz, highz, and both. The default value is both.

New Static Check Added

In this release, a new static check, static highfanout, has been added that detects MOSFETs that have a gate connected to a highfanout node.

Assert Statement Enhanced

In this release, the assert statement has been enhanced as follows:

- The global option, devcheck stat controls whether and how the enabled asserts in a Spectre simulation are reported in the log file. In SPECTRE 19.1 the default value of devcheck_stat has been changed to none to eliminate large assert related output being in the log file.
- A new option skip_dev_inside_subckt has been added that enables you to skip the devices inside a subcircuit. For example:

  ```
  chk_assert assert subs=[...] skip_dev_inside_subckt=[sub1.inst1
  subt2.inst2..]...
  ```

Checklimit Statement Enhanced

The param option now supports skip_dev_inside_subckt as value that enables you to skip individual devices or subckt instances for the selected subcircuits for the specified assert(s). For example:

```
set1 checklimit asserts=[name of asserts] param=skip_dev_inside_subckt
value=[sub1.inst1 sub2.inst2...]
```

Info Statement Enhanced

The what parameter of the info statement now supports new values netcap and moscap These two new features enable you to print the net and MOSFET capacitance reports. For example:

```
info1 info what=netcap where=file
info2 info what=moscap where=file
```

For more information, refer to the *Printing the Capacitance Values of Nets* and *Printing the Terminal Capacitances of MOSFETs* sections in the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

Spectre Fault Analysis Enhanced

The Spectre fault analysis has been enhanced as follows:

- Support for custom faults added

  Spectre supports three types of custom faults: custom insertion, custom replacement and custom open. The custom fault model is specified as a subcircuit and defined outside the fault block. The custom subcircuit instances are specified in the custom fault block. Spectre injects the custom instances into the original netlist when fault simulation is requested and applies the connectivity accordingly.

For more information, refer to the *Custom Faults* section in the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

- Support for Verilog-A asserts added

  In addition to the device base asserts, Spectre supports Verilog-A asserts that can be used for fault detection and functional safety analysis.

  For more information, refer to the *Verilog-A Asserts* section in the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

- Random sampling added for fault selection

  Spectre provides the capability to enable part of the fault list, or some fault blocks to be selected only for fault analysis. You can now apply simple random sampling to the faults selected using the `faults` block(s). You may use either `faultsamplenum` to set the specific number of samples, or `faultsampleratio` to set the percentage (in the range from 0 to 100) to perform random sampling.

  For more information, refer to the *Fault Selection and Sampling* section in the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

- Support for automated three-step process added for performing functional safety analysis

  You can use the `+fsa` command-line option to automate the process of performing functional safety analysis. You need at least one assert statement with the safecheck parameter specified in the netlist to run the automated flow.

  For more information, refer to the *Using the Automated Three-Step Process* section in the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

- Support for *Single Point Fault (SPF)* and *Latent Fault (LF)* definitions added to analyze failure modes in the design.

- Support for distributed processing added in transient fault analysis.

  For more information, refer to the *Job Distribution in Transient Fault Analysis* section in the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.

Spectre Thermal Analysis Enhanced

Starting with the SPECTRE 19.1 release, Spectre Thermal Analysis supports the following in the package file:

- Support for thermal capacitance and ambient temperature has been added in the thermal package file. For more information, refer to the *Thermal Package File* section in the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.
- Support for trench structures has been added in the thermal package file. For more information, refer to the *Trench Structure Support* section in the *Spectre Classic Simulator, Spectre APS, Spectre X, and Spectre XPS User Guide*.