



# OpenSIPI: An Open Source Platform to Automate S-para Extraction and Post-processing

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# Introduction

- S-parameter (S-para) is the most fundamental yet critical metric for SIPI engineers to evaluate the quality of a high-speed channel or PDN design.
- S-para the result itself is way more important than how the result is obtained.
- However, setting up a simulation model so as to get the S-para, post-processing the results, and generating a report usually cost most of the time.
- Iterative rounds of simulations are required before the design converges.

-> Automation is King!

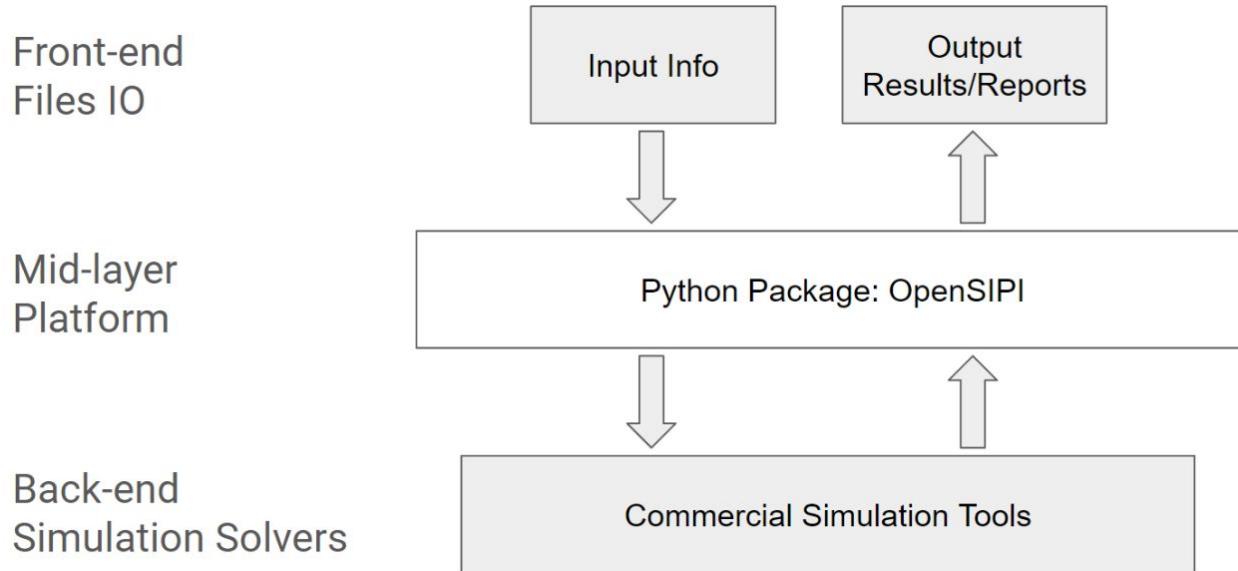


# What's OpenSIPI Platform?

- OpenSIPI serves as a platform
  - to read and parse input info that is needed to set up simulation models
  - to generate scripts that can be executed by the EDA tools
  - to launch and monitor simulations running through the EDA tools
  - to post-process the extracted results and create reports
- OpenSIPI currently is developed with a focus on S-parameter extraction
- Users of OpenSIPI can obtain simulation results w.o. having to open the simulation tool
  - Great for SIPI engineers to boost working efficiencies
  - Even greater for non-SIPI engineers by lowering the bars of running simulations



# OpenSIPI: Overview



# OpenSIPI : Input Info

- What information do we need to set up a simulation model for PCB or PKG?
  - Net names -> nets to be included in the model
  - Component RefDes and pins -> ports setup
  - Stack-up and materials -> stack-ups, material Dk/Df or conductivity, surface roughness etc.
- Configurations for the simulation tools
- The above-mentioned info can be stored and reused again and again

Unique_Key	Check_Box	Spec_Type	Positive_Nets	Negative_Nets	Positive_Main_Ports	Negative_Main_Ports	Positive_Aux_Ports	Negative_Aux_Ports
PE_CPU_RX_L0	<input checked="" type="checkbox"/>	Spclie6	PE_CPU_RX_DP<0>, PE_CPU_RX_C_DP<0>	GND	U1	J5	J5	
			PE_CPU_RX_DN<0>, PE_CPU_RX_C_DN<0>	GND	U1			



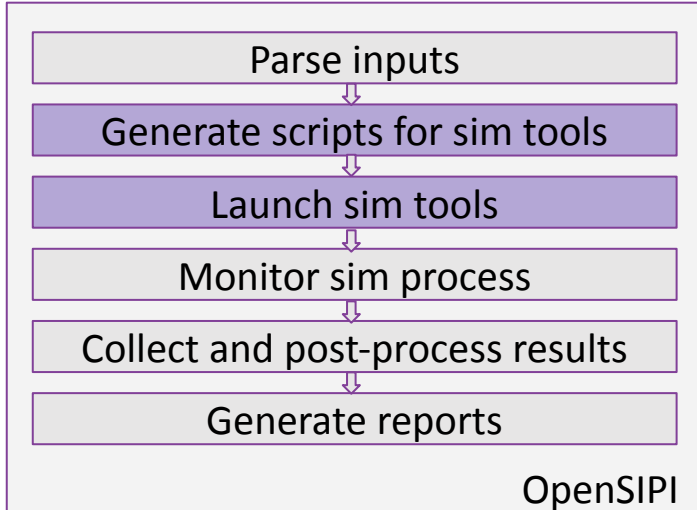
Materials							
Name	Type	Conductivity (Sim)	Frequency (MHz)	Dk	Df		
Cu	Metal	5.80E+07					
Core	Dielectric			1.00E+03	3.6	0.007	
PP	Dielectric			1.00E+03	3.5	0.007	
SM	Dielectric			1.00E+03	3.7	0.023	
SurfaceRoughness							
Name	Type	SurfaceRatio/RoughnessFactor	SnowballRadius/RMSValue (um)				
HonyModel_1	Hony	2.5	5.00E-01				
ModifiedHammerstadModel_1	ModifiedHammerstad	2	1.00E+00				
ModifiedGrossesModel_1	ModifiedGrosses	2	1				
Stackup							
Layer #	Layer Name	Thickness(mm)	Material	Conductivity(Sim)	Fill-in Dielectric	Er	Loss Tangent
	SMS TOP	0.013	SM				
1	Signal510P	0.069	Cu		SM		
	Medium541	0.069	PP				
2	Signal512	0.033	Cu		PP		
	Medium543	0.102	PP				
3	Signal513	0.033	Cu		PP		
	Medium545	0.381	PP				
4	Plane514	0.069	Cu		PP		
	Medium547	0.102	Core				
5	Plane515	0.069	Cu		PP		
	Medium549	0.381	PP				
6	Plane516	0.033	Cu		PP		
	Medium551	0.102	PP				
7	Signal517	0.033	Cu		PP		
	Medium553	0.069	PP				
8	Signal518	0.048	Cu		SM		
	SMS BOTTOM	0.013	SM				





## OpenSIPI: Include Circuit Components

- Currently, including circuit components in the S-para extraction is a tool specific feature.
- There isn't a cross-tool library format for circuit components.
  - Maybe a library format can be developed in the IBIS Forum?
- OpenSIPI is designed to accept multiple library formats associated with each extraction tool.

# OpenSIPI : Flow Description



-  Sim tool independent
-  Sim tool dependent

- The sim tool independent steps are common to all users.
- To integrate any new tools, just add additional classes in Python for sim tool dependent steps.

# OpenSIPI : Post-Processing and Reporting

- SI S-para
  - Quality check for passivity and causality etc.
  - S-para to SPICE conversion, ready to pair with IBIS models for transient simulations
  - TDR plotting
  - IL, RL, and xtalk plotting and comparing against specs if applicable
- PDN S-para
  - S-para to SPICE conversion, ready to pair with IBIS models for transient simulations
  - Plotting self impedance after shorting/opening certain ports and comparing to target impedance
  - Extracting parasitic RLC from PDN frequency domain (FD) curves.

Fig.1 snp\_dcfitted\_dir\_SIM1\_CLK\_100M\_CPU1\_IL

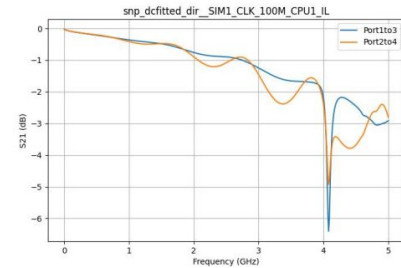
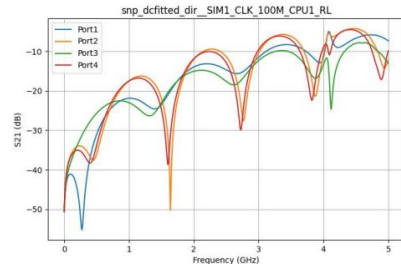


Fig.2 snp\_dcfitted\_dir\_SIM1\_CLK\_100M\_CPU1\_RL





# OpenSIPI : Auxiliary Features (1)

- Pre-check for the input info

Unique_Key	Check_Box	Spec_Type	Positive_Nets	Negative_Nets	Positive_Main_Ports	Negative_Main_Ports	Positive_Aux_Ports	Negative_Aux_Ports
PE_CPU_RX_L0	<input checked="" type="checkbox"/>	Spcie6	PE_CPU_RX_DP<0>, PE_CPU_RX_C_DP<0> PE_CPU_RX_DN<0>, PE_CPU_RX_C_DN<0>	GND GND	U1 U1		J5 J5	



Ensure the net and component names in the input sheet can be found in the design file.

- Initial check starts.
- No known input format errors found.
- All input net names in Sheet Col POSITIVE\_NETS exist in the design file.
- All input net names in Sheet Col NEGATIVE\_NETS exist in the design file.
- Netname comparison is done.
- All input component names in Sheet Col POSITIVE\_MAIN\_PORTS exist in the design file.
- All input component names in Sheet Col NEGATIVE\_MAIN\_PORTS exist in the design file.
- All input component names in Sheet Col POSITIVE\_AUX\_PORTS exist in the design file.
- All input component names in Sheet Col NEGATIVE\_AUX\_PORTS exist in the design file.
- Component name comparison is done.
- Initial check completes successfully.



## OpenSIPI : Auxiliary Features (2)

- Fast mode for model setup check

Before directly jumping to S-para extractions, which is typically time-consuming, just quickly check whether the simulation models including ports, capacitors models etc. are set up correctly.

```
- Check is running for SIM1_P0V9 ...  
- Check is done for SIM1_P0V9 after 0 mins and 9 secs!  
- Check is done for 1 out of total 2!  
- Check is running for SIM1_P1V8 ...  
- Check is done for SIM1_P1V8 after 0 mins and 5 secs!  
- Check is done for 2 out of total 2!  
- Successfully finished all runs!  
- Total elapsed time is 0 hours, 0 mins, and 14 secs!  
- Port counts are checked. Everything is correct!  
- Cap models are checked. All uses SPICE type models!
```



## OpenSIPI : Auxiliary Features (3)

- Auto restart simulations

Automatically restart simulations if the commercial tool crashes before completing a simulation.

```
- Check is running for SIM1_P0V9 ...
- powersi.exe is not running! Detected for 1 times. Will retry in 2 mins.
- powersi.exe is not running! Detected for 2 times. Will retry in 2 mins.
- powersi.exe is not running! Detected for 3 times. Will retry in 2 mins.
- powersi.exe is not running in the past 6 mins. Restart the tool 1 times.
- Check is done for SIM1_P0V9 after 6 mins and 11 secs!
- Check is done for 1 out of total 2!
- Check is running for SIM1_P1V8 ...
- Check is done for SIM1_P1V8 after 0 mins and 5 secs!
- Check is done for 2 out of total 2!
- Successfully finished all runs!
- Total elapsed time is 0 hours, 6 mins, and 16 secs!
- Port counts are checked. Everything is correct!
- Cap models are checked. All uses SPICE type models!
```

## OpenSIPI : Auxiliary Features (4)

- Resume simulation queue from where it stopped

The queue stopped after the first simulation is done.

Restart the platform and the queue resumes from where it stopped.

```
- Sim is running for SIM1_P0V9 ...  
- Sim is done for SIM1_P0V9 after 2 mins and 12 secs!  
- Sim is done for 1 out of total 2!  
- Sim is running for SIM1_P1V8 ...
```

```
- Sim is running for SIM1_P1V8 ...  
- Sim is done for SIM1_P1V8 after 2 mins and 17 secs!  
- Sim is done for 1 out of total 1!
```

Extremely helpful for a long queue!

# Call for Volunteers

- To adopt OpenSIPI for your daily work
  - <https://github.com/rivosinc/opensipi>
  - Installation guide and a demo case are provided along with the repo
- Volunteers as
  - Contributors to scripts and documentation
    - To integrate more simulation tools
    - To add more post-processing items
    - To include more reporting templates
    - To improve developers' and users' guides
  - Users to use the platform and come back with improvement feedbacks.

The screenshot displays the GitHub interface for the repository `rivosinc / opensipi`. The main content area shows a file browser view with the following files and folders:

- `.github/workflows`: update version of pre-commit github action to remove ... (3 months ago)
- `LICENSES`: move license file to top level so github sees it and symlin... (3 months ago)
- `docs`: update integrated\_flow.md (2 days ago)
- `examples`: change key config\_dir to input\_dir (3 days ago)
- `opensipi`: add html template for reports (2 days ago)
- `.flake8`: initial public release (4 months ago)
- `.gitignore`: Make the HOME dir as the root for Linux/Mac (last week)
- `.pre-commit-config.yaml`: update reuse cli to use the reuse spec 3.2 release (last week)
- `CONTRIBUTING.md`: revise CONTRIBUTING.md (4 days ago)
- `LICENSE`: fix mixed EOL files and pre-commit hook to prevent futu... (2 months ago)
- `README.md`: update linux docs (3 days ago)
- `REUSE.toml`: add\_tests (last week)
- `poetry.lock`: update reuse cli to use the reuse spec 3.2 release (last week)
- `poetry.lock.license`: initial public release (4 months ago)
- `pyproject.toml`: Update version to 0.1.5 (3 days ago)

The right sidebar provides repository statistics and contributor information:

- About**: Automates signal integrity (SI) and power integrity (PI) related simulations.
- Contributors**: 4 contributors listed: Belwether889, kbloch-rivosinc, and dependabot[bot].
- Languages**: Python 95.4%, HTML 1.7%.



# Conclusions

- OpenSIPI is an open-source platform to automate the S-para extraction, post-process the results, and generate reports
  - SIPI experts: boost working efficiencies
  - Non-SIPI engineers: lower the bars to run extractions
- A cross-tool library format for circuit components is to be developed.
- OpenSIPI auxiliary features
  - Pre-check for the input info
  - Fast mode for model setup check
  - Auto restart simulations
  - Resume simulation queue from where it stopped
- OpenSIPI framework has been established. But help is greatly needed to further improve the platform.
  - Contributors
  - Users



**Thanks!**