

Best performance for riscv32i core

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Abstract – This paper discusses the experience of using OpenROAD Flow Scripts (ORFS) on the riscv32i core. ORFS is a set of integrated scripts allowing RTL-to-GDSII flow using open-source tools. The effect of environment variables and the scope of implementing autotuner for improving and simplifying the automated design flow are covered.

I. INTRODUCTION

OpenROAD is an integrated chip physical design tool that takes a design from RTL to GDSII. OpenRoad Flow Scripts is a flow controller that supports the ASAP7 PDK for various designs. With the availability of open-source RISC-V cores along with powerful tools such as ORFS, it is possible to bring a paradigm shift in the current silicon industry.

II. ORFS FLOW EXPERIENCE

The ability to add multiple PDKs along with minimal steps for RTL to GDSII makes ORFS an incredibly powerful tool for physical design. Another remarkable feature is that each flow stage is highly configurable through tcl files, resulting in numerous log and report files for in-depth analysis.

III. COMPARING RISC-V CORES

ORFS offers to add your own design and has three RISC-V cores for testing. The ORFS flow was executed on each core to compare runtimes and roughly analyse the design and performance metrics. **Riscv32i** was chosen for further analysis and understanding of the flow mainly because it is a smaller design with more online documentation. *Table 2* highlights the average runtime for each of the available cores.

Design	Runtime (sec)
riscv32i	35600
ibex	56006
swerv_wrapper	Insufficient computation resource

Table 2

IV. ENVIRONMENT VARIABLES

Environment variables provide an easy method to modify various stages during the various stages of the flow. By modifying the *clk_period* and *PLACE_DENSITY* among a few of the variables, it was possible to achieve **0 wns and DRC clean** design for riscv32i with a **2498 u² 23% design area utilisation**. The design can be further optimised but requires tweaking multiple parameters, which results in multiple runs leading to increased development time.

V. AUTOTUNER

The autotuner takes advantage of AI/ML models to predict the best values for various environment variables for the most optimised design. This reduces the development time and prevents the requirement of multiple iterations to achieve the best performance. Currently, the autotuner is not implemented for the riscv32i design and can be included by analysing the available autotuner files for ibex. Furthermore, there is little documentation on how to run the autotuner, and it will be documented.

VI. REFERENCES

- [1] Environment Variables for the OpenROAD Flow Scripts
<https://openroad-flow-scripts.readthedocs.io/en/latest/user/FlowVariables.html>
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<https://github.com/The-OpenROAD-Project/OpenROAD-flow-scripts/tree/master/flow/designs/src/riscv32i>