EECS E6693 - Design Assignment 1

fpu_double | Genus design-space exploration

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Tool: Cadence Genus 21.16-s062_1
Design conditions: slow library corner; global interconnect estimation.

Method and scope

Each trial starts from the supplied RTL and flow in a separate directory. Only clk_period is varied within each effort configuration. All periods lie on the 0.010 ns grid. The original SDC expressions are retained, so input/output delays and transition constraints scale with the period. Timing feasibility is based on the final reg2reg WNS and failing-endpoint count; cell area excludes net area. ADP equals cell area multiplied by the requested clock period in ns.

Configuration	GEN_EFF	MAP_EFF	OPT_EFF
Default	medium	high	high
Higher effort	high	high	extreme

Coarse sampling was followed by local refinement near the timing boundary and the best ADP region. Results are the best observed among sampled points, not an exhaustive proof of global optimality. Genus optimization is nonmonotonic: for example, higher-effort WNS is -6.4 ps at 2.700 ns but -36.4 ps at 2.720 ns. Displayed metric precision is 0.1 ps; 0.0 ps is reported as timing met only when there are no failing reg2reg endpoints.

Results at a glance

Metric	Default	Higher effort
Minimum observed feasible period (ns)	2.810	2.730
Cell area at that period	133285.249	150778.959
Best sampled ADP period (ns)	3.500	3.500
Cell area at best sampled ADP	89305.759	89289.617
Best sampled ADP (area units x ns)	312570.1565	312513.6595

Source evidence: final_area.rpt, final metrics_syn.csv and console.log for each trial. Complete trial provenance is listed in data/all_trials.csv. The archive contains duplicate successful runs; these are retained in that table and consolidated by effort and period for the exploration plots.

Q1. Minimum feasible period with default effort

The minimum observed feasible period is **2.810 ns**, with cell area **133285.249**. Final reg2reg WNS and TNS are 0.0 ps, with zero failing endpoints. The adjacent sampled period, 2.800 ns, violates timing. The supplied 1.000 ns starting point also violates timing. This identifies the local boundary at 10 ps resolution; unsampled periods outside the refined neighborhood are not exhaustively ruled out.

Q2. Minimum sampled ADP with default effort

The best sampled feasible point is **3.500 ns**, with cell area **89305.759** and **ADP = 312570.1565** area units x ns. It is better than the sampled neighboring periods 3.450 and 3.550 ns. The minimum-period design has a larger ADP; timing closure alone does not minimize area-delay product.

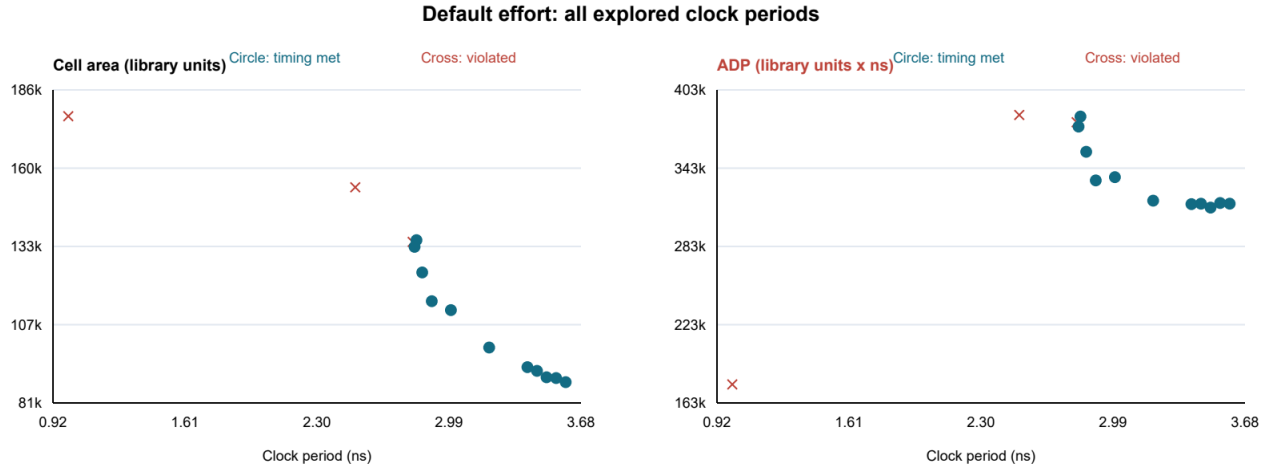


Figure 1. Actual default-effort sample points. Crosses mark infeasible points, which are excluded from the ADP optimum. Scatter markers are used because interpolation would hide nonmonotonic behavior.

Q3. Higher-effort results and comparison

With GEN_EFF=high, MAP_EFF=high and OPT_EFF=extreme, the minimum observed feasible period is **2.730 ns**. Its cell area is **150778.959**, with reg2reg WNS/TNS of 0.0 ps and zero failing endpoints. Periods 2.700, 2.710 and 2.720 ns all violate timing. The best sampled ADP remains at **3.500 ns**, with cell area **89289.617** and **ADP = 312513.6595**.

The minimum observed feasible period decreases by **0.080 ns (2.847%)**. The best sampled ADP decreases by **56.4970 (0.0181%)**. Thus higher effort provides a meaningful observed timing improvement but a very small ADP improvement in this sample set. Area at the minimum-period design increases by approximately 13.13%; these two designs target different periods.

Q3. Higher-effort exploration plots

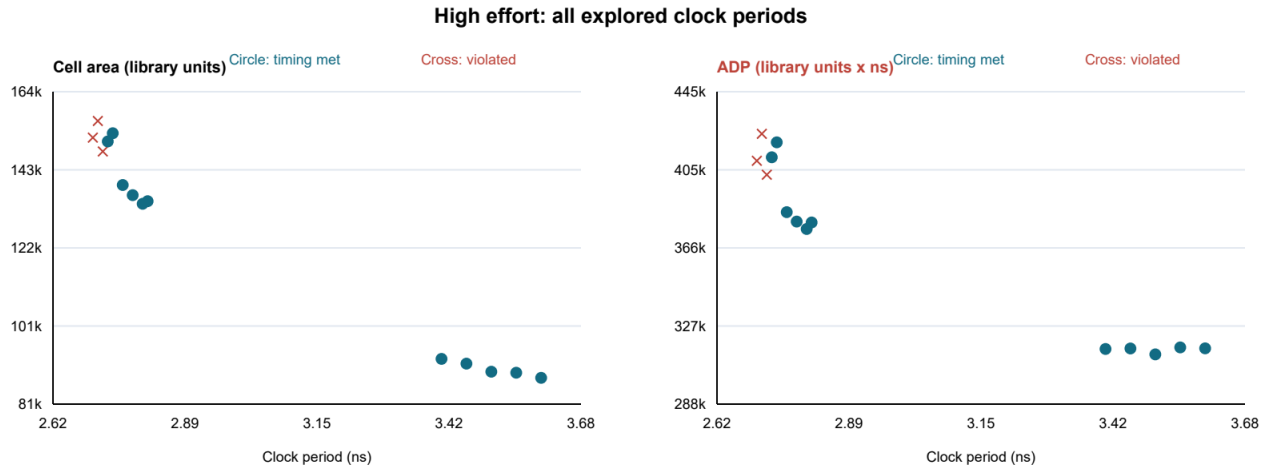


Figure 2. Actual higher-effort sample points; only nonnegative reg2reg points are eligible for the reported ADP minimum. The ADP search was refined at 3.450, 3.500 and 3.550 ns. No claim is made that every 10 ps point was evaluated.

Q4. Comparable wall-clock runtimes

The four selected scenarios were rerun together on cadpc01 using the same tool version and unmodified threading settings. Their final cell areas match the exploration runs and all four satisfy reg2reg timing. TAT is measured around bash ./run.sh using elapsed wall-clock seconds; it includes tool startup, synthesis, report generation and shutdown. It is not CPU time and does not include the preceding file-copy preparation.

Scenario	Period (ns)	TAT (s)	TAT (min:s)
Minimum period, default	2.810	4440	74:00
Minimum ADP, default	3.500	1627	27:07
Minimum period, higher	2.730	6232	103:52
Minimum ADP, higher	3.500	1712	28:32

Requested ratio	Calculation	Result
(a) Tmin default / ADPmin default	4440 / 1627	2.7289
(b) Tmin higher / ADPmin higher	6232 / 1712	3.6402
(c) Tmin higher / Tmin default	6232 / 4440	1.4036
(d) ADPmin higher / ADPmin default	1712 / 1627	1.0522

Comparability limit: all jobs started together on one shared host, following the assignment suggestion, but host load was not constant. The 1-minute load average was 52.84 before the batch and 20.74 after it. Short jobs finished before the long jobs, changing contention. The ratios describe this batch and should not be interpreted as isolated tool-speed measurements or evidence that effort alone caused the full runtime difference. No repeated-batch uncertainty estimate is available.

Appendix. Complete unique exploration points

Area is cell area from final_area.rpt. WNS is the final reg2reg metric in ps. ADP is shown for all trials for plotting; only MET rows qualify for optimization. Duplicate trials and Q4 repetitions are separately retained in all_trials.csv.

Default effort

Period (ns)	Cell area	WNS (ps)	Status	ADP
1.000	177338.252	-1848.7	VIOLATED	177338.2520
2.500	153368.737	-324.0	VIOLATED	383421.8425
2.800	134953.679	-27.3	VIOLATED	377870.3012
2.810	133285.249	0.0	MET	374531.5497
2.820	135542.312	0.0	MET	382229.3198
2.850	124654.605	0.0	MET	355265.6242
2.900	114957.965	0.0	MET	333378.0985
3.000	111953.050	0.0	MET	335859.1500
3.200	99337.713	0.0	MET	317880.6816
3.400	92717.055	0.0	MET	315237.9870
3.450	91465.232	0.0	MET	315555.0504
3.500	89305.759	0.0	MET	312570.1565
3.550	89037.682	0.0	MET	316083.7711
3.600	87660.175	0.0	MET	315576.6300

Appendix. Higher-effort exploration points

High effort

Period (ns)	Cell area	WNS (ps)	Status	ADP
2.700	151800.240	-6.4	VIOLATED	409860.6480
2.710	156245.162	-2.8	VIOLATED	423424.3890
2.720	148107.409	-36.4	VIOLATED	402852.1525
2.730	150778.959	0.0	MET	411626.5581
2.740	152972.428	0.0	MET	419144.4527
2.760	139144.119	0.0	MET	384037.7684
2.780	136436.745	0.0	MET	379294.1511
2.800	134130.245	0.0	MET	375564.6860
2.810	134822.556	0.0	MET	378851.3824
3.400	92715.413	0.0	MET	315232.4042
3.450	91445.636	0.0	MET	315487.4442
3.500	89289.617	0.0	MET	312513.6595
3.550	89019.163	0.0	MET	316018.0286
3.600	87652.514	0.0	MET	315549.0504