

Signoff Preparation and Timing ECO Closure

A routed block fails a few timing and electrical checks. This handbook shows each issue, why it happens, the fix in Innovus, and how to prove the fix worked. One issue per card.

Design	stream_acc, routed, clock tree frozen, filler and metal fill in place
Views	ss_hot_rcmax (V_A), ff_cold_rcmin (V_B), ss_cold_rcmax (V_C, the failing one)
Target	Slack $\geq +0.010$ ns (guardband), transition ≤ 0.150 ns, cap ≤ 60.0 fF, fanout ≤ 16
Numbers	Illustrative, from the chapter's report model. Commands are Innovus Legacy UI; confirm options with <code>-help</code> in your release

Issue index

#	Issue	Fix	Result
1	Setup: weak driver on a loaded net	Upsize one drive step	-0.018 → +0.010
2	Setup: extra sinks on a critical stage	Buffer the non-critical sinks	-0.006 → +0.011
3	Setup: detoured long wire	Re-route on M5-M6	-0.009 → +0.012
4	Hold: short path, late capture clock	Delay cell on the failing sinks only	-0.014 → +0.024
5	Hold broken by a setup fix	Buffer on a single-sink net	-0.004 → +0.022
6	Max transition on a long wire	Buffer half-way	0.171 → 0.109 ns
7	Max capacitance / max fanout	Split the net with a buffer	61.2 → 41.7 fF · 22 → 12
T1-T8	Process traps	One line each	–

Before you edit: measure the baseline

You cannot prove a fix without a trusted "before". Restore, extract, then report all three views. Every fix ends the same way: route, `extractRC`, re-time all three views, compare.

INNOVUS TCL · BASELINE IN A FRESH SESSION

```

innovus> restoreDesign routed_input.enc.dat stream_acc
innovus> source setup/signoff_setup.tcl           # views, extraction and check modes
innovus> extractRC                               # checkpoint has no parasitics
innovus> timeDesign -postRoute -reportOnly -expandedViews -outDir timing_S0
innovus> timeDesign -postRoute -hold -reportOnly -expandedViews -outDir timing_S0
innovus> report_constraint -all_violators -drv_violation_type {max_transition max_capacitance max_fanout}
innovus> defOut S0_base.def -netlist -routing      # used later by defComp

```

What the baseline shows in V_C

Check	Failing	Worst
Setup	res_reg_3, res_reg_4, res_reg_9, res_reg_6	-0.018 (TNS -0.044)
Hold	state_reg_5, state_reg_6	-0.014 (TNS -0.023)
Electrical	n_5120 slew, n_6307 cap, n_7002 fanout	3 nets



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Signoff and ECO closure handbook / Introduction

Setup issues

ISSUE 1 Setup fails: weak driver on a loaded net

SYMPTOM `res_reg_3` -0.018 and `res_reg_4` -0.011 fail together. Report row:

Load	Slew	Delay	Arrival	Cell	Arc	Pin
17.7	0.141	0.571	1.853	XOR2X1	A v -> Y ^	U812/Y

WHY An X1 cell drives 17.7 fF. Its slow edge also slows the next cell. Both endpoints share this stage.

FIX `innovus> ecoChangeCell -inst U812 -cell XOR2X2`

CHECK `res_reg_3` → +0.010, `res_reg_4` → +0.017. The driver before it slows by 0.013 (bigger input pin); net gain is 0.028 ns.

AVOID Jumping to XOR2X4. Timing passes, but its input net hits 0.153 ns slew. One violation traded for another.

Setup check before and after the upsize

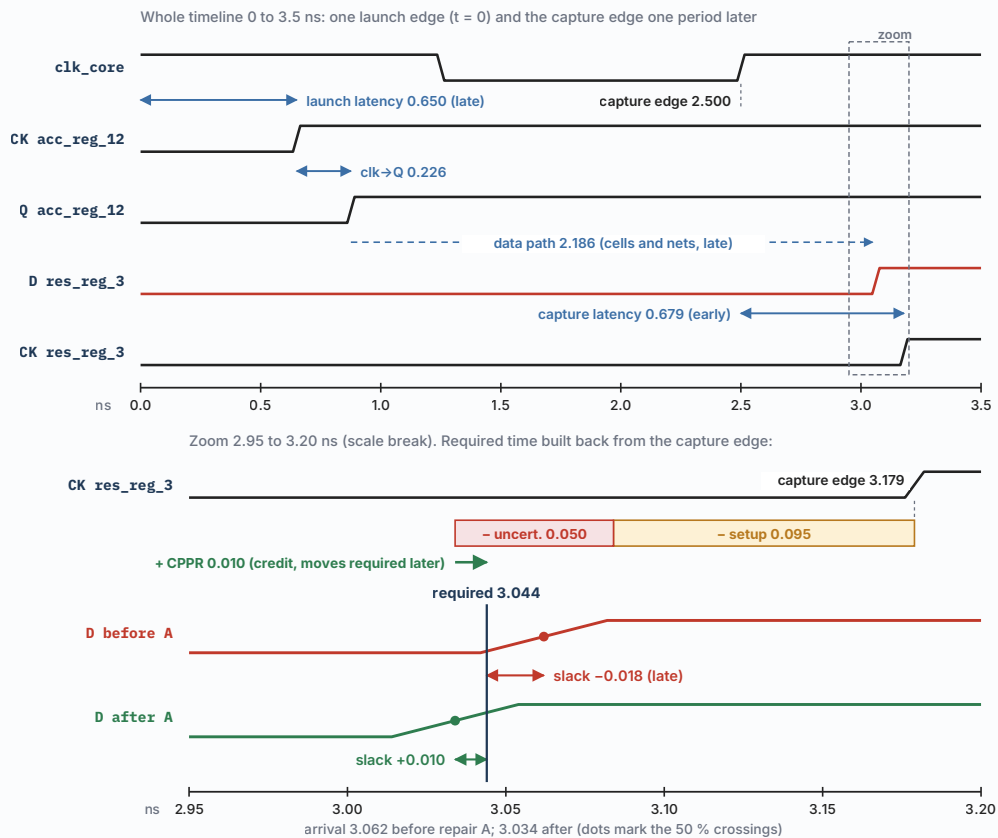


Figure 9.1 Arrival moves from 3.062 to 3.034 against a required time of 3.044.



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Signoff and ECO closure handbook / Setup issues

ISSUE 2 Setup fails: non-critical sinks load a critical stage

SYMPTOM `res_reg_6` -0.006. Driver `U905` carries 12.8 fF on net `n_5802` (four sinks).

WHY Only `U907/A` is on the failing path. The other three sinks add 7.8 fF the path does not need.

FIX

```
innovus> ecoAddRepeater -term {U931/A U932/A U933/A} -cell BUF2X2 \
               -name ISO_n5802 -newNetName n_5802_o           # U907/A stays direct
```

CHECK Load 12.8 → 7.5 fF, `res_reg_6` → **+0.011**. Re-check the three moved sinks; they now pay a buffer delay.

AVOID Buffering all four sinks (the critical one pays the delay) or upsizing `U905` (area for nothing).

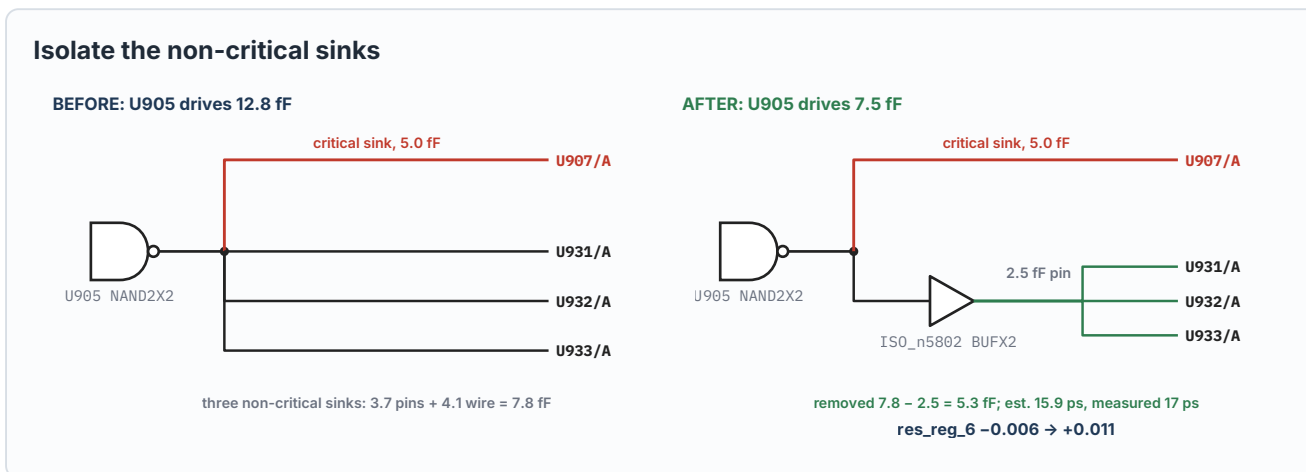


Figure 9.2 One BUF2X2 takes three sinks; the critical sink keeps its direct wire.



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Signoff and ECO closure handbook / Setup issues

ISSUE 3 Setup fails: a long detoured wire

SYMPTOM `res_reg_9` -0.009. Last net `n_6150` has 0.149 ns of wire delay.

WHY Routed 610 μm for pins 480 μm apart: a 160 μm M4 detour around a blockage.

FIX

```
innovus> editDelete -nets n_6150 -type Regular
innovus> setAttribute -net n_6150 -bottom_preferred_routing_layer 5 \
    -top_preferred_routing_layer 6 -preferred_routing_layer_effort high
innovus> selectNet n_6150
innovus> setNanoRouteMode -route_selected_net_only true
innovus> ecoRoute
innovus> report_net_wires -net n_6150 -file n_6150_wires.rpt # did it use M5?
```

CHECK 485 μm on M5, `res_reg_9` $\rightarrow$ +0.012. Now check hold on the same endpoint (see Issue 5).

AVOID Adding a buffer. It costs about 0.05 ns of cell delay; at 610 μm the wire is not long enough to need one.

n_6150 before and after the re-route

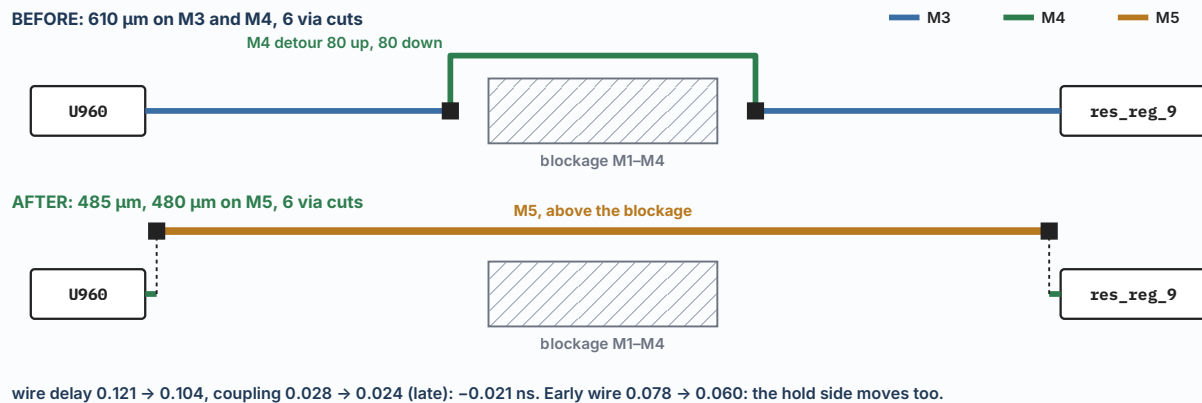


Figure 9.3 Shorter run on a lower-resistance layer; same via count.



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Signoff and ECO closure handbook / Setup issues

Hold issues

ISSUE 4 Hold fails: short data path, late capture clock

SYMPTOM `state_reg_5` -0.014 and `state_reg_6` -0.009. Data path only 0.223 ns; capture clock arrives 0.175 ns after launch.

WHY The clock tree is frozen, so the data path must get slower. Net `n_2210` has three sinks: two go to the hold endpoints, the third (`U303/A`) feeds `res_reg_11`, the tightest setup path (+0.008).

FIX

```
innovus> ecoAddRepeater -term {U301/A U302/A} -cell DLY1X2 \
    -name HLD_n2210 -newNetName n_2210_o # U303/A not in the list
innovus> report_timing -late -through HLD_n2210/Z -to u_ctl/state_reg_5/D
```

CHECK Hold → +0.024 and +0.029. Setup through the new cell 2.247 → 2.195 ns: plenty left.

AVOID A delay cell on the whole trunk. It pushes `res_reg_11` to -0.044 setup.

Hold check before and after the delay cell

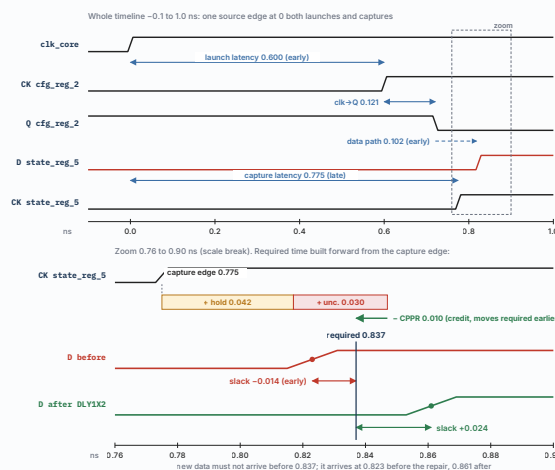
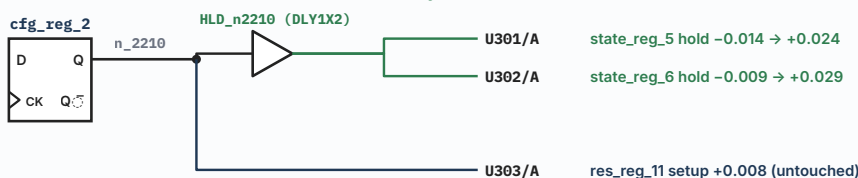


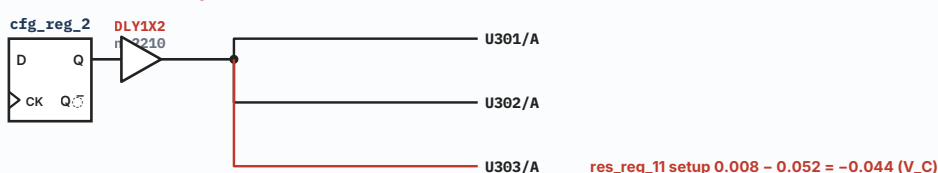
Figure 9.4 A hold fix makes data later; the setup paths through the same cell must be re-measured.

Where the delay cell goes

SELECTED: one DLY1X2 on U301/A and U302/A only



REJECTED X3: the delay cell on the whole trunk



The DLY1X2 input pin (4.2 fF) replaces U301/A + U302/A (2.0 + 2.2 fF): the load on `cfg_reg_2/Q` is unchanged.

Figure 9.5 Only the two hold sinks are delayed; the setup-critical sink keeps its direct connection.



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Signoff and ECO closure handbook / Hold issues

ISSUE 5 Hold breaks after a setup fix

SYMPTOM `res_reg_9` hold +0.014 → -0.004 right after Issue 3.

WHY The re-route made `n_6150` 0.018 ns faster in the early bound too. A faster net is faster for hold.

FIX

```
innovus> ecoAddRepeater -term {U960/B} -cell BUF2 \
               -name HLD_n5233 -newNetName n_5233_o      # n_5233 has one sink
```

CHECK Hold → **+0.022**. Setup through it 2.159 → 2.129 ns.

AVOID Adding delay on `n_6150` or undoing the re-route; both bring the setup failure back.

A buffer on a single-sink net

S1, before H2: hold -0.004



S2, after H2: hold +0.022

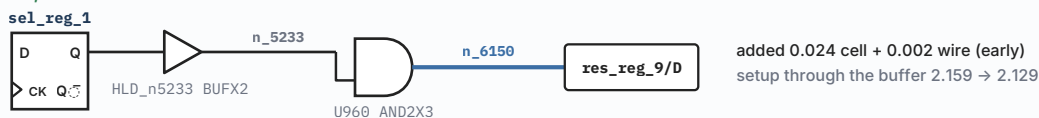


Figure 9.6 No other path shares `n_5233`, so the delay reaches only this endpoint.



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Signoff and ECO closure handbook / Hold issues

Electrical issues

ISSUE 6 Max transition on a long wire

SYMPTOM n_5120 slew 0.171 ns at the sink against 0.150. The driver itself is only 0.092.

WHY A 420 μm M3 run degrades the edge. Wire RC loss grows with length squared, so the wire dominates.

FIX

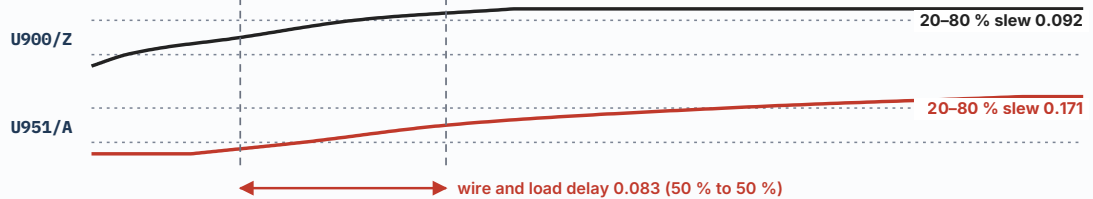
```
innovus> ecoAddRepeater -term {U951/A} -cell BUFX4 -relativeDistToSink 0.5 \  
-name ISO_n5120 -newNetName n_5120_o
```

CHECK Sink slew **0.109 ns**; the path gains 0.021 ns. Hold on res_reg_14 drops +0.052 $\rightarrow$ +0.031 (still safe).

AVOID A buffer near the driver; the long segment after it is almost the old wire.

Slew at driver, buffer and sink

No buffer



BUFX4 half-way (repair D1)

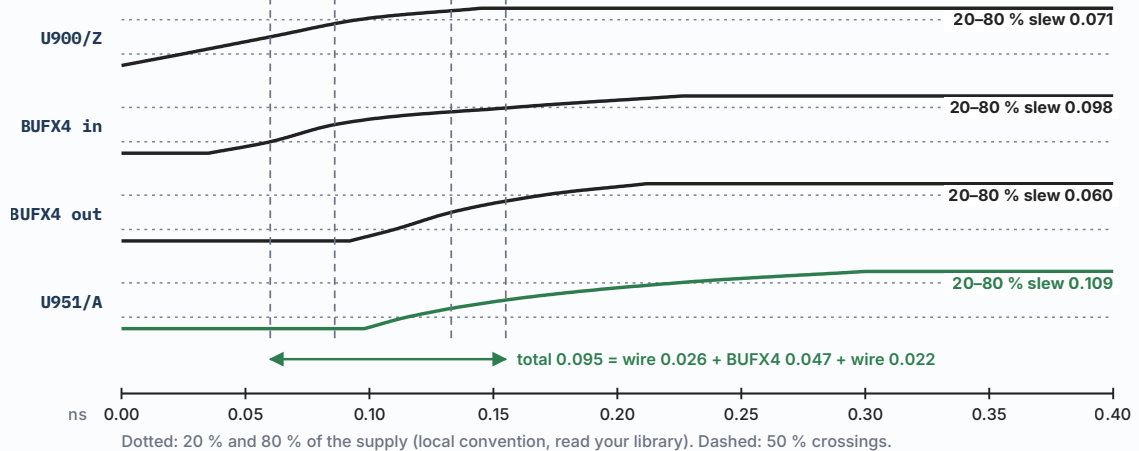


Figure 9.7 A mid-wire buffer restarts the edge; each half sees about a quarter of the loss.



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Signoff and ECO closure handbook / Electrical issues

SYMPTOM n_6307 carries 61.2 fF (limit 60.0). n_7002 drives 22 pins (limit 16).

WHY Too many sinks on one driver.

FIX

```
innovus> ecoAddRepeater -term {U731/A U732/B U733/A} -cell BUF3 \
    -name ISO_n6307 -newNetName n_6307_o # 3 of 6 sinks
innovus> set d3Sinks {U741/A U742/A U743/B U744/A U745/A U746/B \
    U747/A U748/A U749/B U750/A U751/A}
innovus> ecoAddRepeater -term $d3Sinks -cell BUF4 \
    -name ISO_n7002 -newNetName n_7002_o # 11 of 22 pins
```

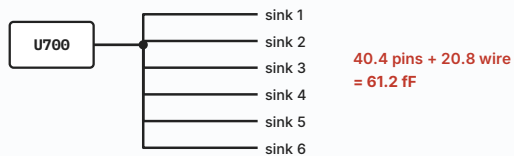
CHECK 41.7 fF and 26.1 fF (BUF3 library limit 45 fF). Fanout 12 and 11. Pick offloaded sinks that have slack.

AVOID One BUF3 on all six sinks: passes the 60 fF SDC limit, fails its own 30 fF library limit.

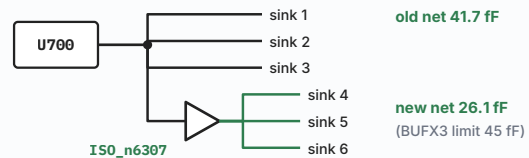
Split the heavy net and the wide net

D2 n_6307: 61.2 fF > 60.0 fF

before



after: BUF3 takes three sinks



Rejected X4: one BUF2 on all six sinks: $40.4 + 18.0 = 58.4$ fF passes the SDC 60 fF but fails the 30 fF library limit of BUF2.

D3 n_7002: 22 sink pins > fanout 16 (unit weight per pin)

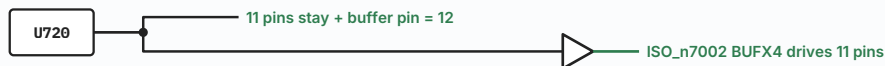


Figure 9.8 The new buffer's input pin counts on the old net.



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Signoff and ECO closure handbook / Electrical issues

Process traps

These break an ECO even when the fix itself is right.

#	You see	Cause	Do this
T1	Taps or end caps missing after making room	<code>deleteFiller</code> without <code>-prefix</code>	<code>deleteFiller -prefix FIN_FILL -area \$box</code> , then count taps
T2	<code>setEcoMode</code> option rejected	Set while batch mode is on	All options first, then <code>setEcoMode -batchMode true</code>
T3	New cell has no VDD/VSS	Global connect rules did not reach it	<code>applyGlobalNets ; verifyConnectivity -type all</code>
T4	DRC clean, but fill was never checked	Fill wires ignored	<code>get_verify_drc_mode -ignore_fill_wire</code> must read false
T5	Timing after restore looks wrong	No parasitics in the checkpoint	<code>extractRC</code> first; save with <code>saveDesign -rc</code>
T6	TNS does not match	Paths summed, not endpoints	Worst path per endpoint: -0.044, not -0.077
T7	WNS positive, yet checks untested	Case analysis (<code>test_mode = 0</code>)	<code>report_analysis_coverage -include_dyn_checks -verbose untested</code> ; log an open finding
T8	Fix passes timing, breaks a limit	Over-sized repair	Do not repair the repair. Restore the parent in a fresh session

Slack just under the guardband

`res_reg_11` ends at +0.008 against a 0.010 guardband. The path is balanced: six cells, none dominant, wire not the cause. There is no single cell to fix.

DECISION Record it as a proposed exception for an approver. Do not report "all views pass" while it, or the untested checks of T7, are open.



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Signoff and ECO closure handbook / Process traps

The ECO loop

Every fix runs the same loop. Edits are one step; the rest proves the edit.

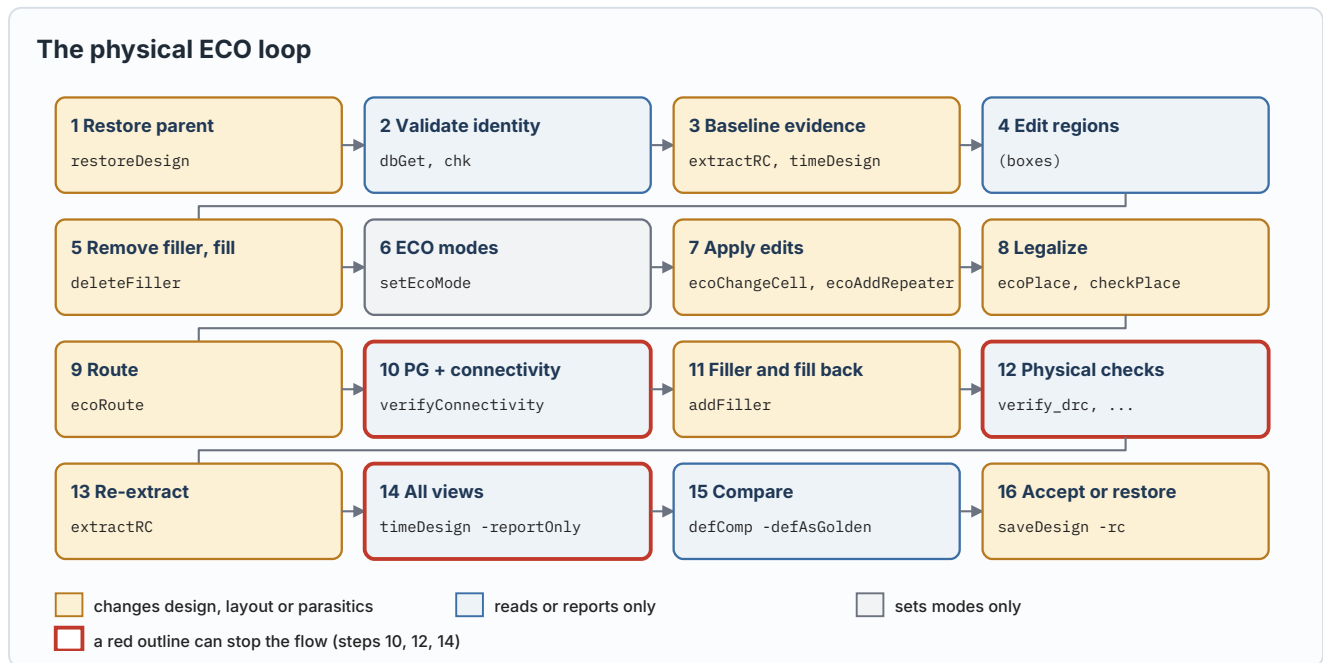


Figure 9.9 Amber steps change the design; blue steps only report.

The loop in commands

Step	Command
Make room	<code>deleteFiller -prefix FIN_FILL -area \$box; add_metal_fill_signoff -delete_fill -delete_area ...</code>
Edit	<code>setEcoMode ... → -batchMode true → ecoChangeCell / ecoAddRepeater → -batchMode false</code>
Place, route	<code>ecoPlace; checkPlace; ecoRoute</code>
Connect	<code>verifyConnectivity -type all</code>
Refill	<code>addFiller -prefix FIN_FILL -markFixed; add_metal_fill_signoff -incremental</code>
Check	<code>verify_drc; verify_antenna; checkFiller; verifyMetalDensity</code>
Measure	<code>extractRC; timeDesign -postRoute [-hold] -reportOnly -expandedViews</code>
Compare	<code>defComp S0_base.def -defAsGolden -reportFile changes.rpt</code>
Decide	<code>saveDesign <candidate>.enc -rc</code> , or restore the parent



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Scorecard

#	Target	Edit	Before	After	Side effect
1	res_reg_3/4	U812 → XOR2X2	-0.018 / -0.011	+0.010 / +0.017	U808 +0.013 ns
2	res_reg_6	BUFX2 on 3 sinks	-0.006	+0.011	Moved sinks slower
3	res_reg_9	Re-route M5-M6	-0.009	+0.012	Hold -0.004
4	state_reg_5/6	DLY1X2 on 2 sinks	-0.014 / -0.009	+0.024 / +0.029	Setup -0.052 (ample)
5	res_reg_9 hold	BUFX2 on n_5233	-0.004	+0.022	Setup -0.030 (ample)
6	n_5120	BUFX4 mid-wire	0.171 ns	0.109 ns	Hold +0.052 → +0.031
7	n_6307, n_7002	BUFX3, BUFX4	61.2 fF, 22	41.7 fF, 12	None measured

Open after the fixes: res_reg_11 +0.008 (proposed exception) and 18 setup + 12 hold checks untested by case analysis (open finding). Status: candidate for acceptance, not released.



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Signoff and ECO closure handbook / ECO loop