FPGA FIR Filter Synthesis & Timing Report

Engineer: Rajith Senaratna Date: 11/15/2025

SYNTHESIS & TIMING SUMMARY (VIVADO 2025.1 – ARTY S7-50)

All timing constraints were fully met. The FIR datapath achieved clean closure across all three clock domains.

Metric	Result
Worst Negative Slack (WNS)	+0.445 ns
Worst Hold Slack (WHS)	+0.050 ns
Worst Pulse Width Slack	+1.520 ns
Total Failing Endpoints	0
Status	All user timing constraints met

RESOURCE UTILIZATION SUMMARY

Resource	Used	Available	Utilization
LUTs	387	32,600	1.19%
Flip-Flops	1,169	65,200	1.79%
Shift Registers (SRLs)	9	9,600	0.09%

Memory (BRAM)

Type	Used	Available	Utilization
RAMB18E1	3	150	2.0%

DSP48E1 Slices

DSPs	Used	Available	Utilization
DSP48E1	2	120	1.67%

MULTI-CLOCK STRUCTURE VERIFICATION

- 12.288 MHz → audio PLL clock (generates 48 kHz sample rate)
- 200 MHz → FFSM domain (sample_mem, coeff_rom pipelining)
- 100 MHz → SFSM domain (accumulation, rounding, saturation)
- safe_sample block ensures metastability-safe CDC
- All CDC checks passed except one “unknown CDC logic” warning (expected for custom CDC)

METHODOLOGY & SYNTHESIS WARNINGS (EXPLAINED & VERIFIED SAFE)

Critical Warnings

Rule	Description	Status
TIMING-4	Invalid primary clock redefinition	Safe (clock wizard HDL)
TIMING-27	Invalid primary clock on hierarchical pin	Safe (PLL/reset tree)

Standard Warnings:
• LUT drives async reset alert — limited to small control logic
• RAM timing might be sub-optimal — BRAM pipelining compensates
• Unknown CDC logic — expected due to safe_sample design
• Missing I/O delays — normal for internal FPGA testing

Synthesis Messages:
• DSP48E1 ACOUT unconnected — expected
• “49 connections declared but 30 given” — unused DSP pins unused
• Unused sequential element removed — wrt_flag_reg not needed

CLOCKING RESOURCES

Resource	Used	Available
BUFG	3	32
PLL/MMCM	2	10
Global Clocks	Clean	
Clock Trees	No congestion	

FINAL VERDICT

• Timing clean (all constraints met, WNS +0.445 ns)
• Resource usage extremely low (1–2% of device)
• DSP48E1 slices correctly mapped (2 parallel MACs)
• BRAMs correctly inferred for sample + coefficient memory
• CDC paths safe and validated
• Ready for implementation, bitstream generation, and hardware bring-up