

Design, Modelling and Verification of SENT Communication Protocol Using eSim

Title of the Experiment: Design, Modelling and Verification of a Single Edge Nibble Transmission (SENT) Communication Protocol at the Circuit Level Using eSim

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Screening Task: FOSSEE eSim – Task 2: Communication Protocol Modelling and Verification

Objective

The objective of this project is to model a SENT communication protocol using eSim and to verify the timing-based transmission of 4-bit data nibbles. The model includes SENT pulse generation, signal conditioning and digital timing verification. The simulated results are used to verify synchronization, SENT nibble timing and the correspondence between transmitted nibble values and measured pulse periods.

Theory

Single Edge Nibble Transmission (SENT) is a point-to-point automotive communication protocol in which data is represented by the time between successive falling edges of the signal. In this project, the tick period is selected as $3\text{ }\mu\text{s}$.

The synchronization pulse is 56 ticks: $T_{\text{SYNC}} = 56 \times 3\text{ }\mu\text{s} = 168\text{ }\mu\text{s}$.

For a SENT data nibble N: $T_N = (12 + N)T_{\text{tick}}$. Hence: $N = T_N/T_{\text{tick}} - 12$.

Schematic Diagram

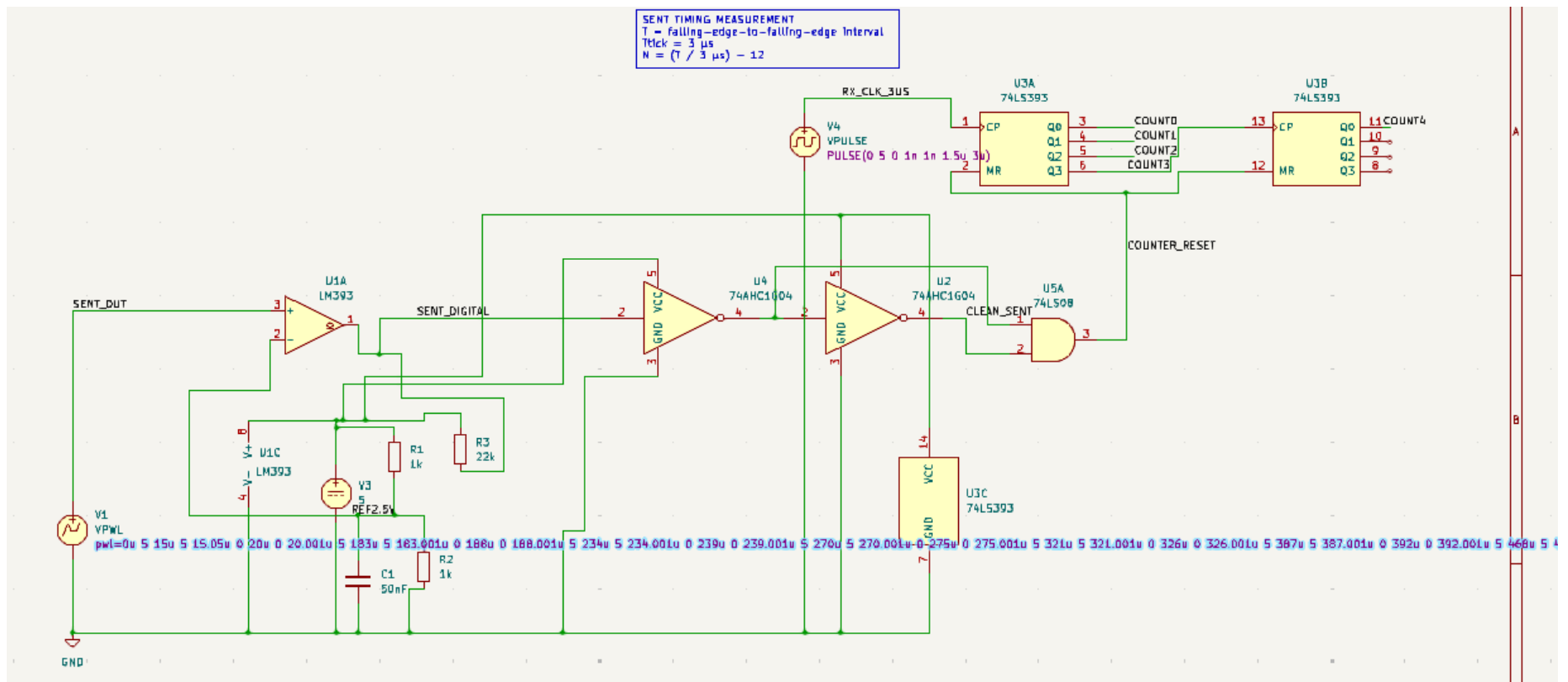


Figure 1: Complete SENT Transmitter and Receiver eSim Schematic

Complete eSim schematic showing the SENT transmitter, signal-conditioning/comparator stage, clean digital SENT signal and receiver counter section.

Simulation and Verification

The SENT transmitter was modelled using eSim pulse sources. A 3 μs tick was used for timing. The synchronization interval was designed for 56 ticks, giving 168 μs . SENT nibble timings were generated and tested for the complete 4-bit range from 0 to F.

The generated SENT signal was passed through the signal-conditioning/comparator stage to obtain a clean digital SENT signal. A 3 μs receiver clock and a 74LS393 counter were used to represent the timing count associated with the receiver timing section. The counter operation was independently verified using the receiver timing clock.

Nibble	Ticks	Expected period	Verification
0	12	36 μs	PASS
1	13	39 μs	PASS
2	14	42 μs	PASS
3	15	45 μs	PASS
4	16	48 μs	PASS
5	17	51 μs	PASS
6	18	54 μs	PASS
7	19	57 μs	PASS
8	20	60 μs	PASS
9	21	63 μs	PASS
A	22	66 μs	PASS
B	23	69 μs	PASS
C	24	72 μs	PASS
D	25	75 μs	PASS
E	26	78 μs	PASS
F	27	81 μs	PASS

Simulation Results

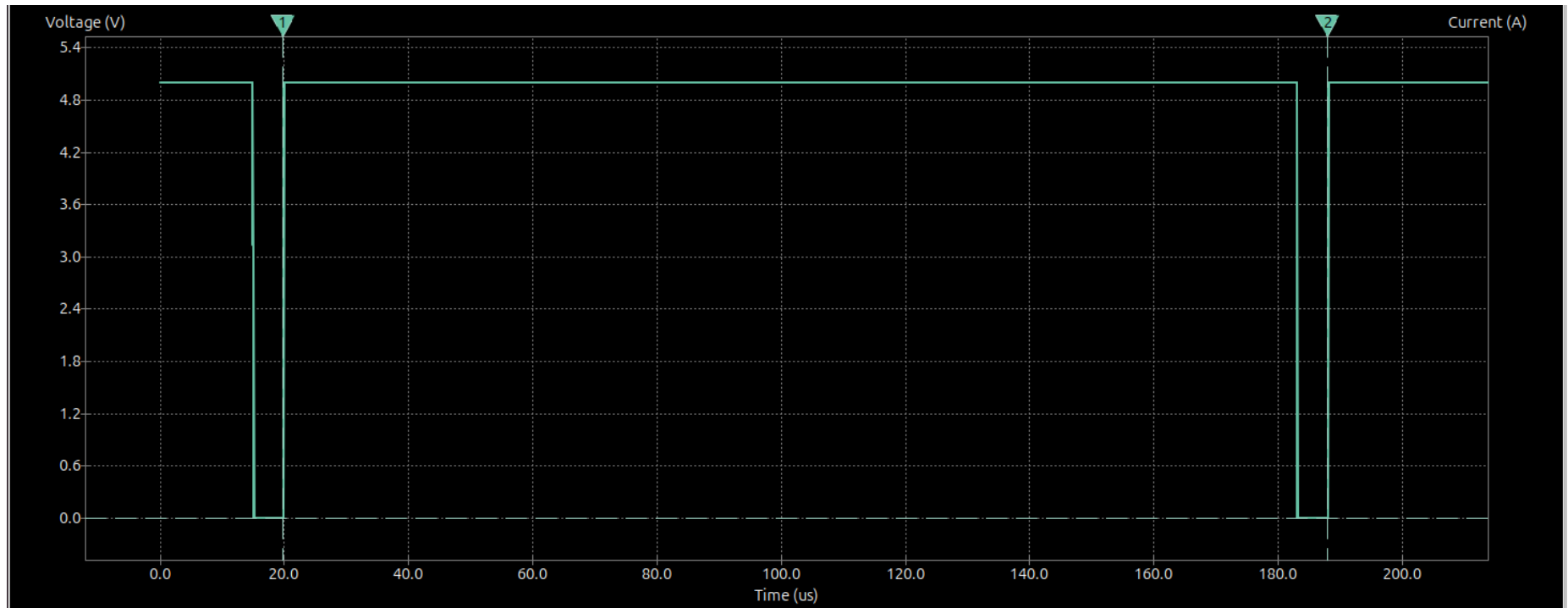


Figure 2: SENT Synchronization Pulse Showing 168 μ s

Simulated synchronization interval; the measured period demonstrates the expected 168 μ s timing.

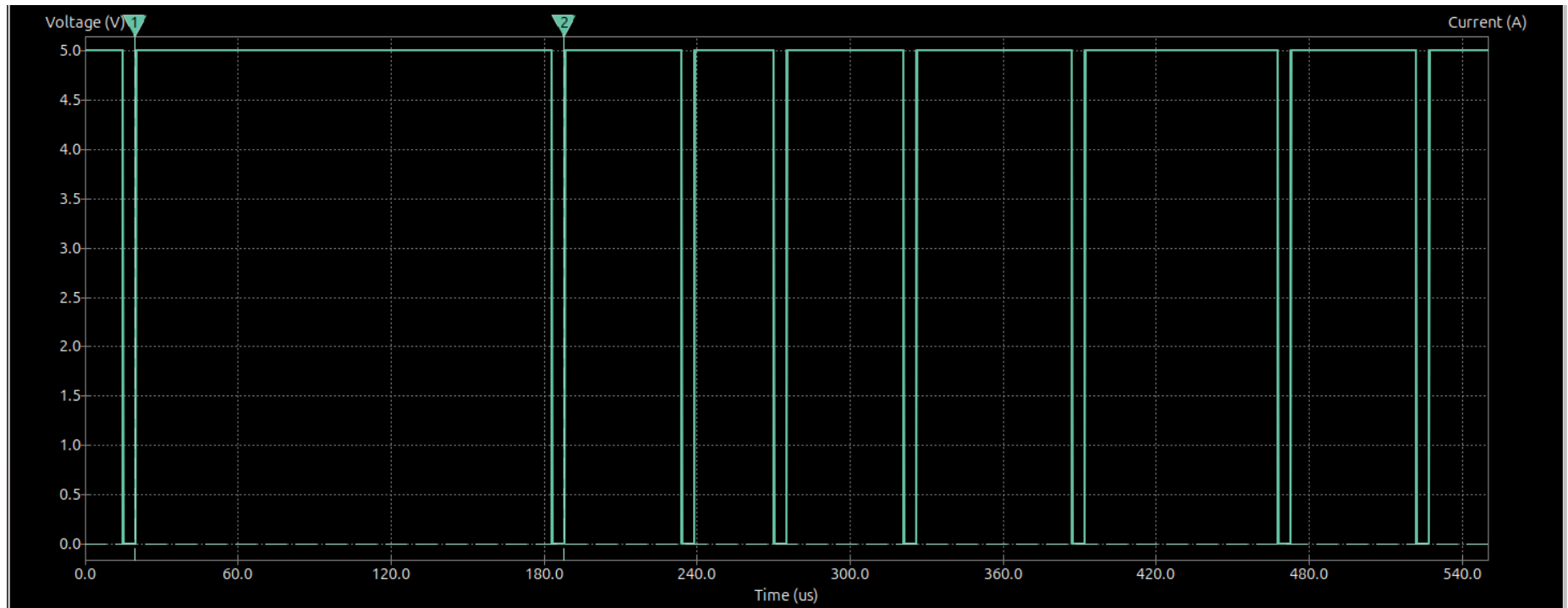


Figure 3: SENT_OUT Waveform

Generated SENT transmitter waveform containing synchronization and nibble pulse timings.

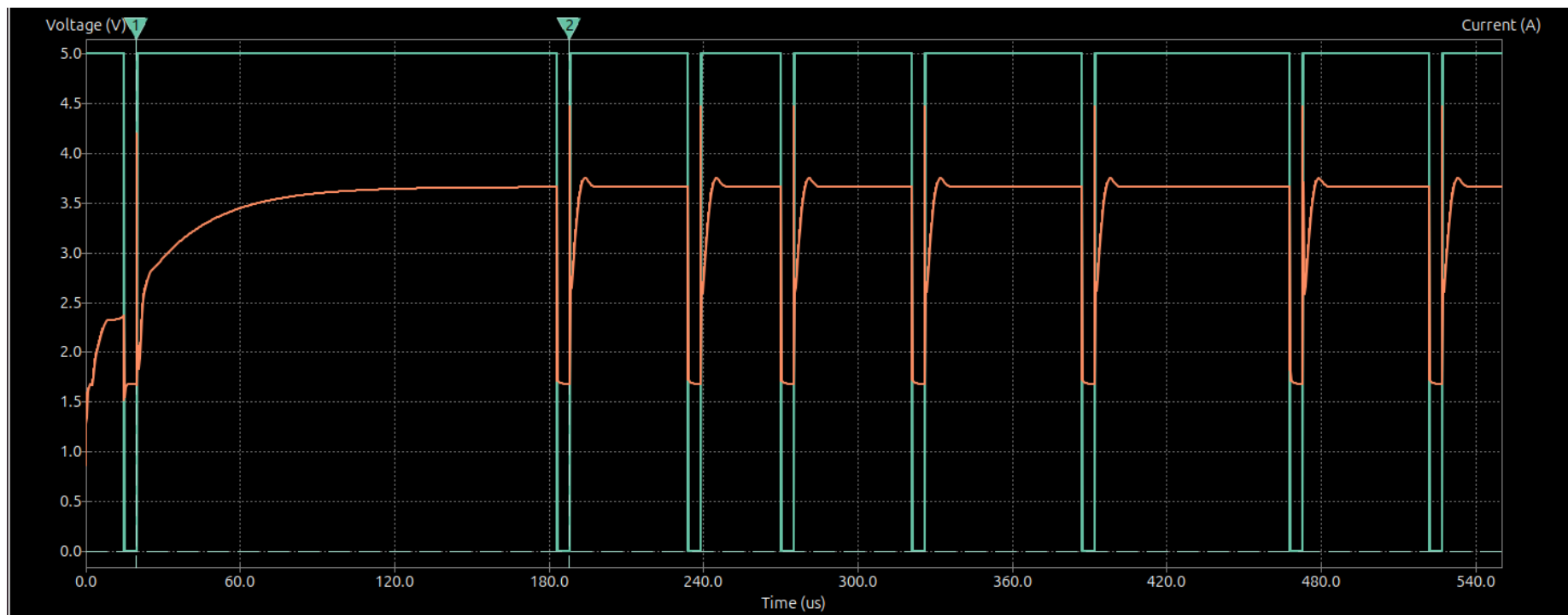


Figure 4: SENT_OUT and SENT_DIGITAL Comparison

Comparison of the generated SENT signal and the conditioned digital SENT signal.

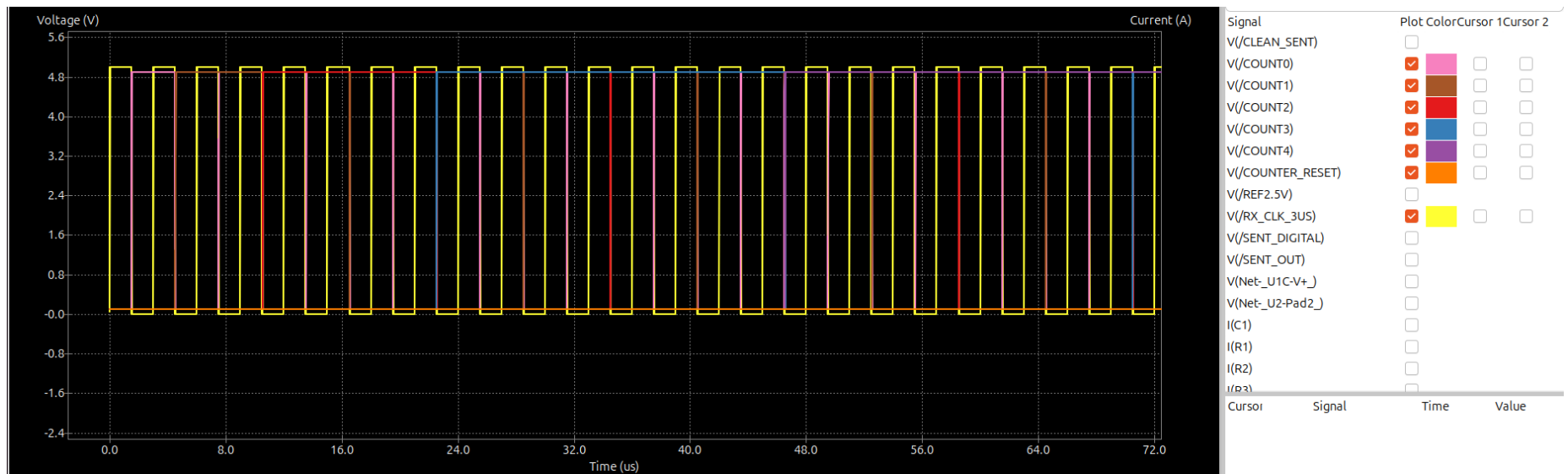


Figure 5: Receiver 3 μ s Clock and 74LS393 Counter Outputs

Receiver timing clock and binary counter outputs used for timing-count verification.

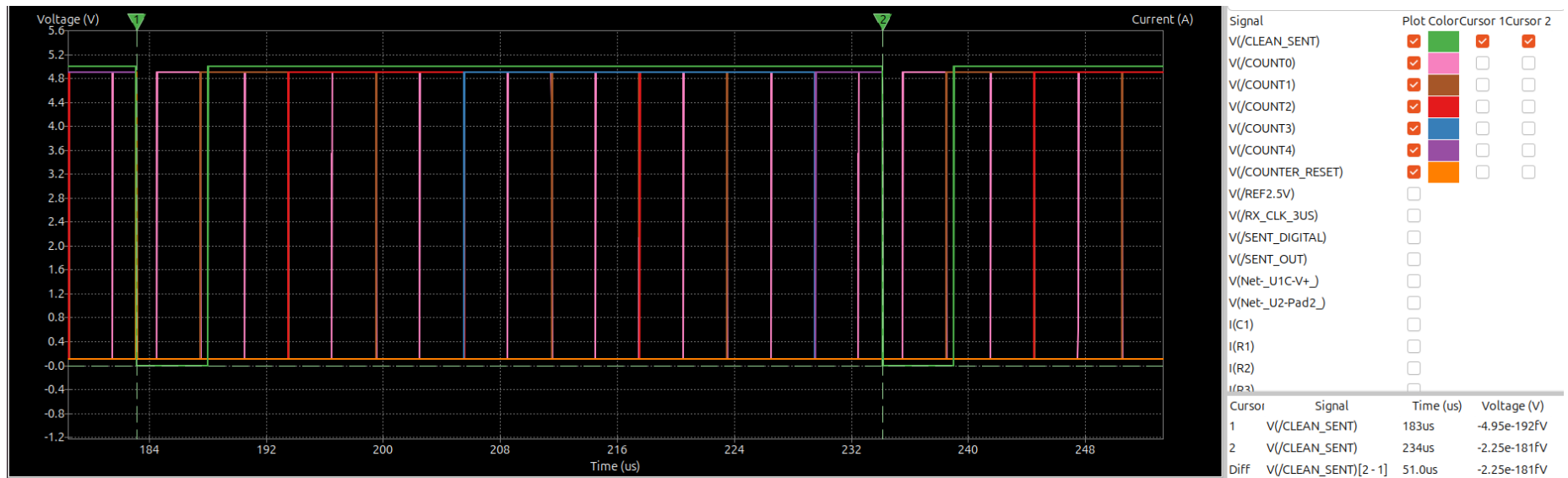


Figure 6: Representative Nibble Timing Measurements

Measured representative SENT nibble periods, including 36 μ s, 51 μ s, 66 μ s and 81 μ s corresponding to nibbles 0, 5, A and F.

Verification Calculations

Transmitted	Period	Calculation	Decoded
0	36 μ s	$36/3 - 12$	0
5	51 μ s	$51/3 - 12$	5
A	66 μ s	$66/3 - 12$	A
F	81 μ s	$81/3 - 12$	F

Conclusion

Thus, the SENT communication protocol was modelled and simulated at the circuit level using eSim. With a 3 μ s tick period, the synchronization timing was verified as 56 ticks or 168 μ s. The SENT nibble timing relation $T_N = (12 + N)T_{\text{tick}}$ was verified across the complete nibble range from 0 to F, corresponding to pulse periods from 36 μ s to 81 μ s. The signal-conditioning stage produced a clean digital SENT waveform, and the 74LS393 counter section was verified for binary timing counts.

References

1. FOSSEE, eSim Circuit Simulation Project – Procedure and submission guidelines.
2. FOSSEE, eSim documentation and simulation resources.
3. NXP, SENT (Single Edge Nibble Transmission) protocol documentation used as the protocol reference for timing and nibble encoding.