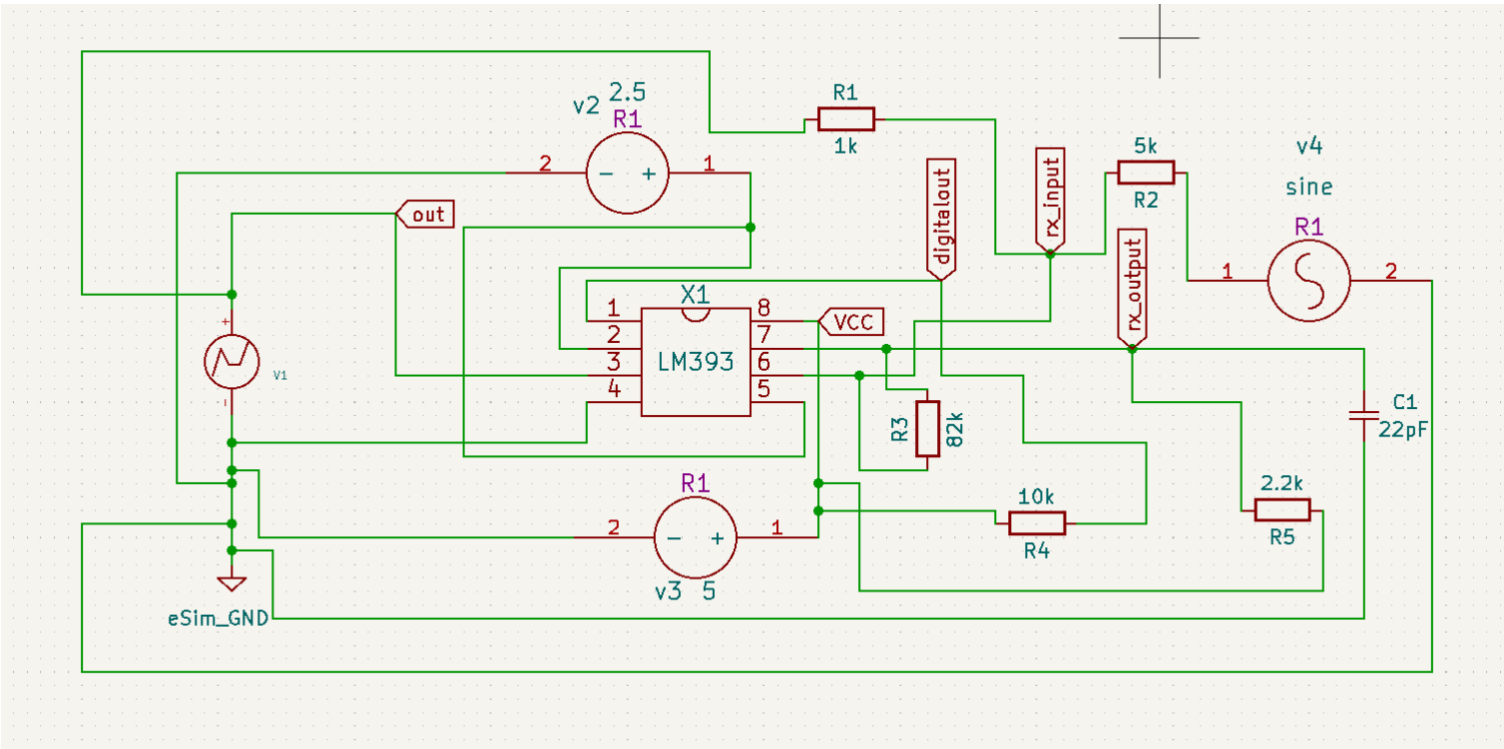
Title: Circuit Level Verification of UART Signal Integrity Using LM393 Voltage Comparator

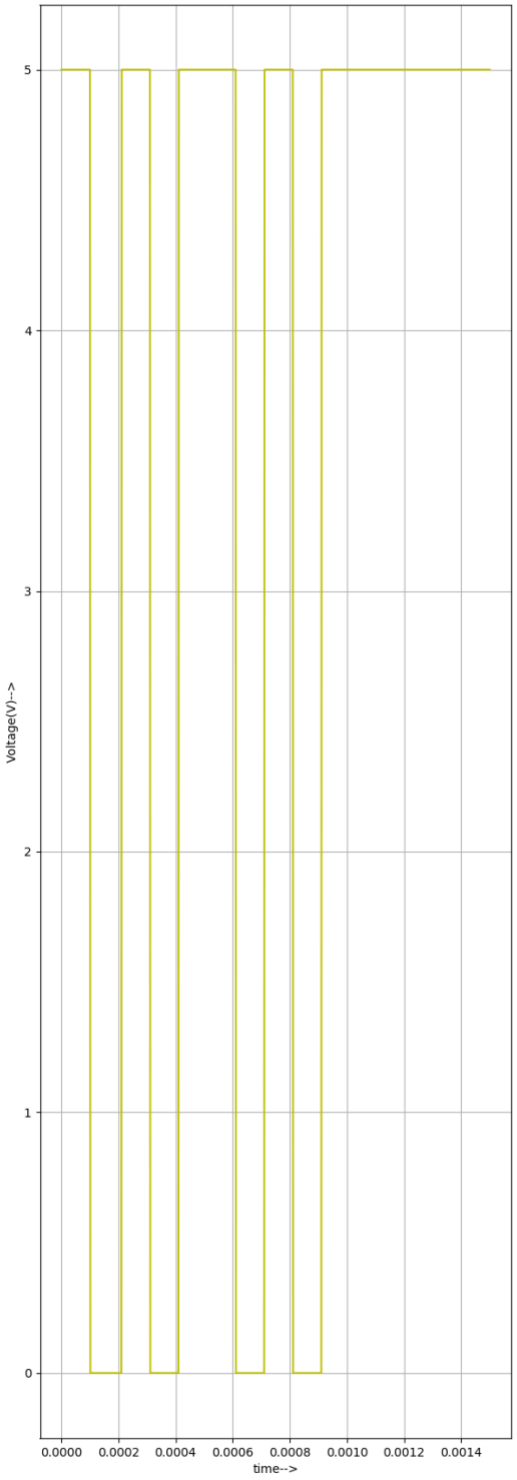
In UART communication, transmitted signals can get corrupted due to noise during transmission, leading to incorrect data detection. This project simulates a noisy UART environment by combining a digital waveform with a sinusoidal noise source.

The UART signal is generated at the transmitter node (out) as a 0–5V square waveform consisting of start, data, and stop bits. At the receiver side, the noisy signal is processed using an LM393 comparator with a reference threshold of 2.5V. The comparator evaluates whether the input is above or below this threshold and regenerates a clean digital signal at the digitalout node.

Thus, the system successfully recovers each transmitted bit from the noisy input, ensuring accurate and reliable UART communication



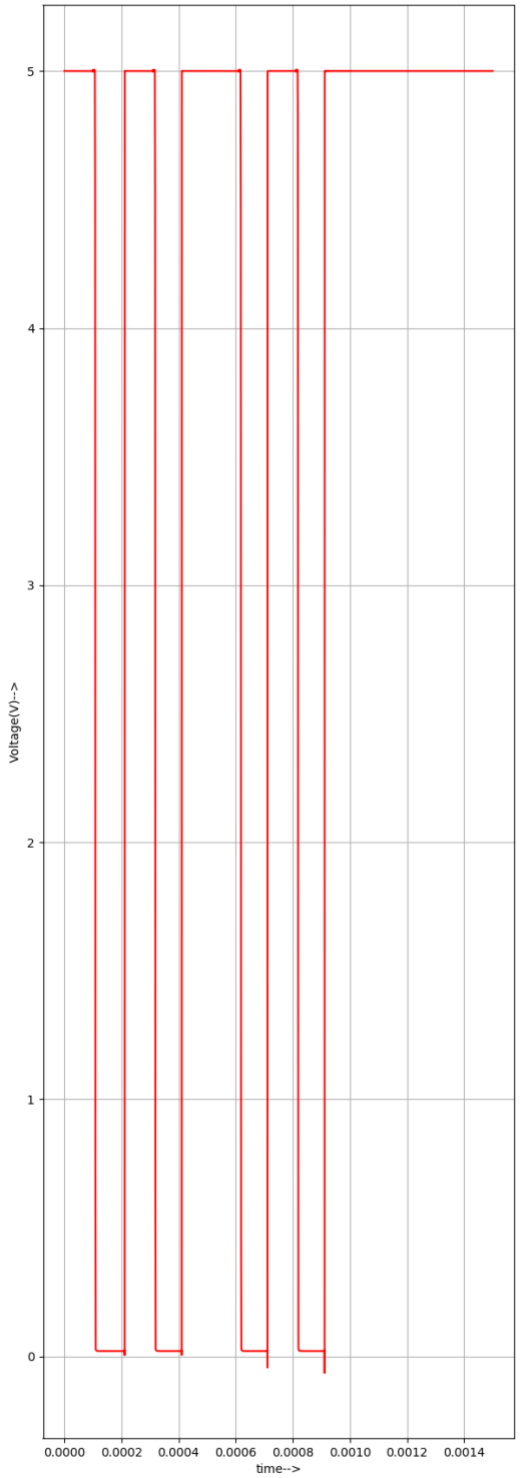
Simulation plots:



Out (Tx signal)

Clean 0–5V UART waveform generated using PWL source.

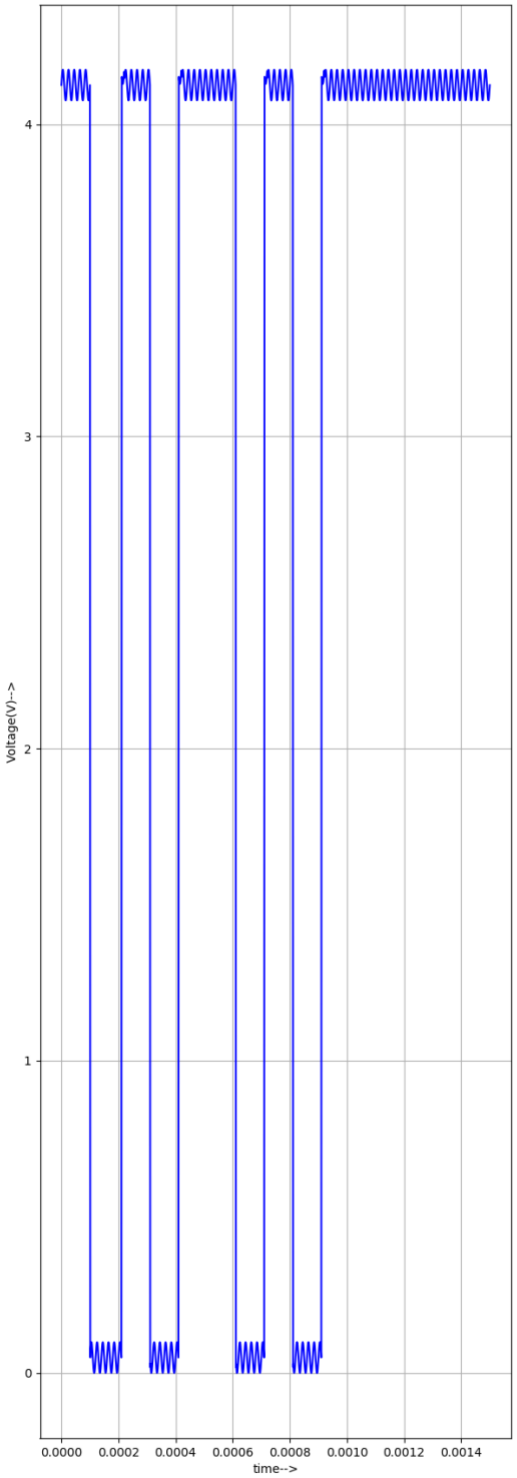
Represents original transmitted bits (start, data, stop).



digitalout (Comparator output – verification)

Output of first comparator showing reconstructed UART signal.

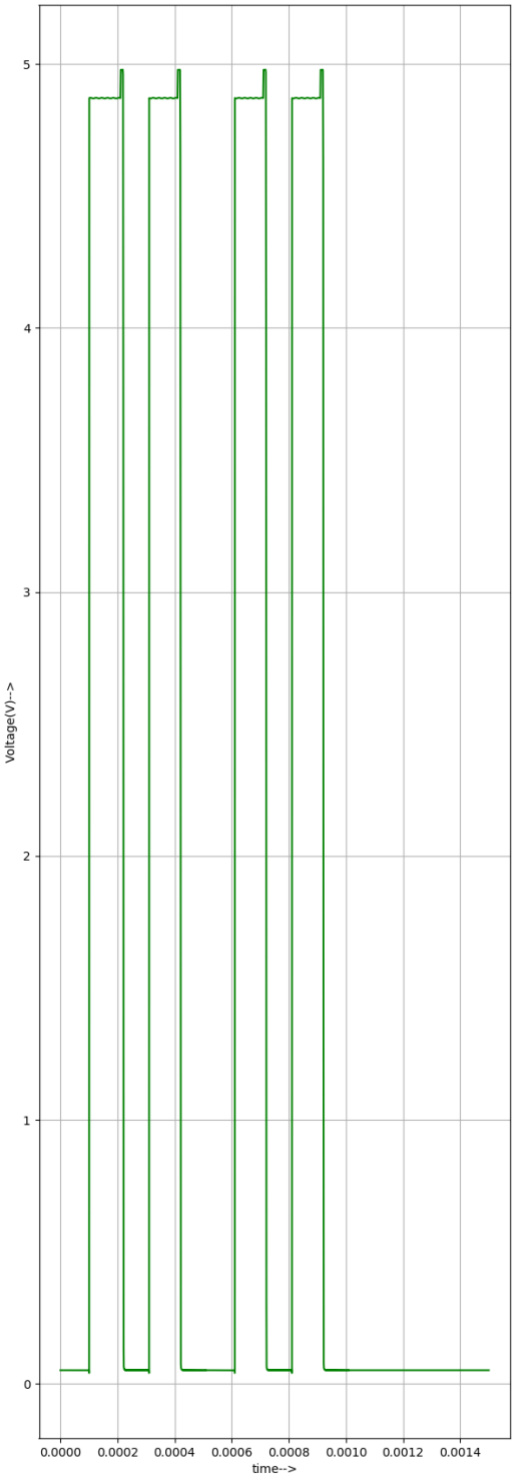
Closely matches out with slight delay and switching spikes.



rx_input (Noisy channel signal)

UART signal combined with sinusoidal noise (visible ripple).

Simulates real transmission channel disturbances.

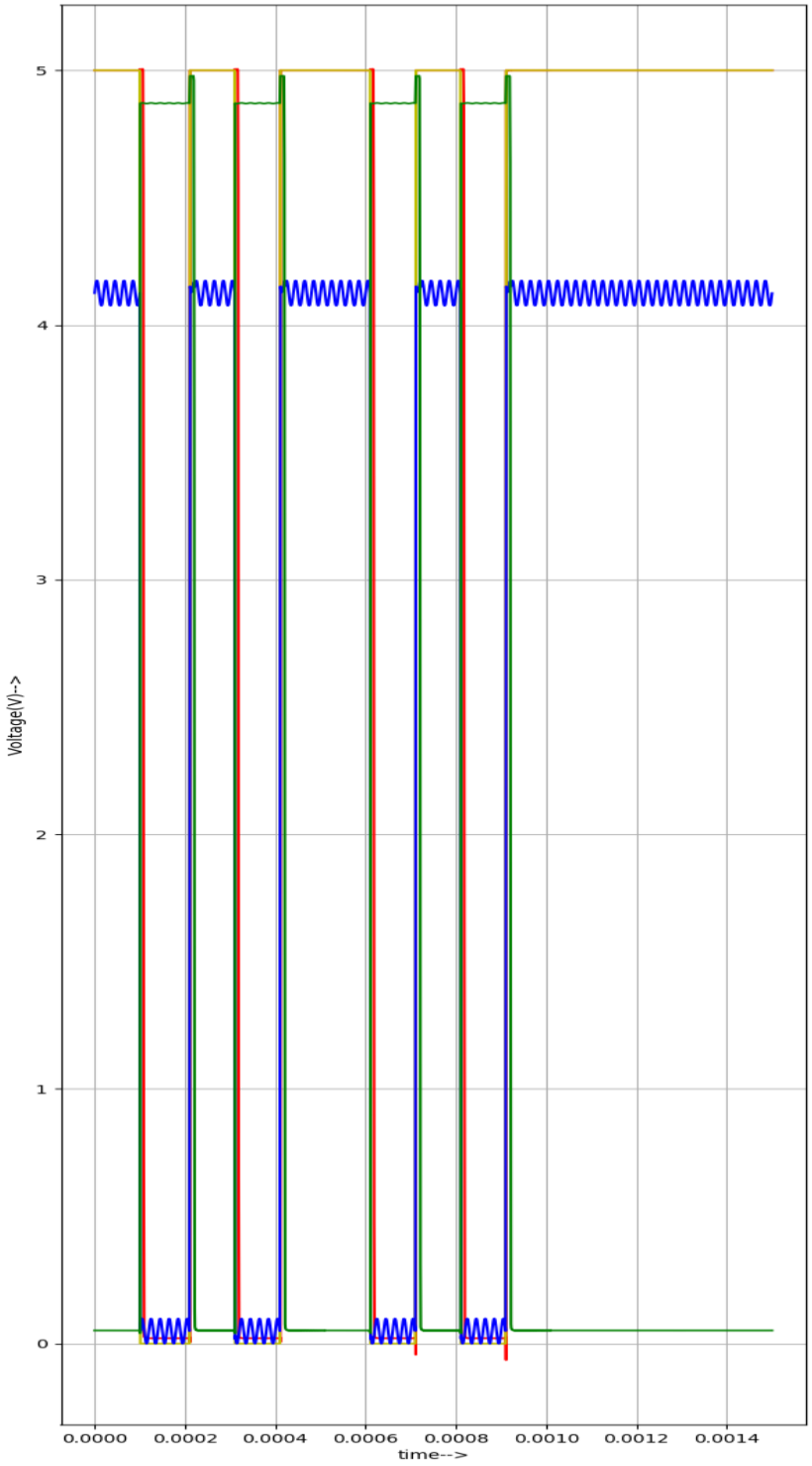


rx_output (Filtered output)

Output after second comparator removes noise using thresholding.

Produces clean square waveform with correct bit pattern.

The output is not perfectly flat at 5V due to the non-ideal behavior of the LM393 comparator. Since it has an open-collector output, the HIGH level is achieved through a pull-up resistor, which causes slower rise time and small ripples. Additionally, switching transients and residual noise near the threshold introduce slight spikes and fluctuations at the HIGH level, making it appear not perfectly clean.


5
4
3
2
1
0
Voltage(V)-->
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
0.0014
time-->

Conclusion: The circuit-level verification of UART communication was successfully achieved using the LM393 comparator. The transmitted byte 0x5A, consisting of start, data, and stop bits, was correctly generated at the out node and accurately reproduced at the digitalout/rx_output node.

Despite the presence of noise at the rx_input, the comparator with a 2.5V threshold effectively filtered the disturbances and ensured correct detection of each bit. The output waveform closely matches the transmitted signal with only minor delay and switching transients, confirming reliable and error-free data transfer.