DCS REVIEW

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Performance study of chaos-based DSSS and FHSS multi-user communication systems

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WHAT ARE WE UPTO ?

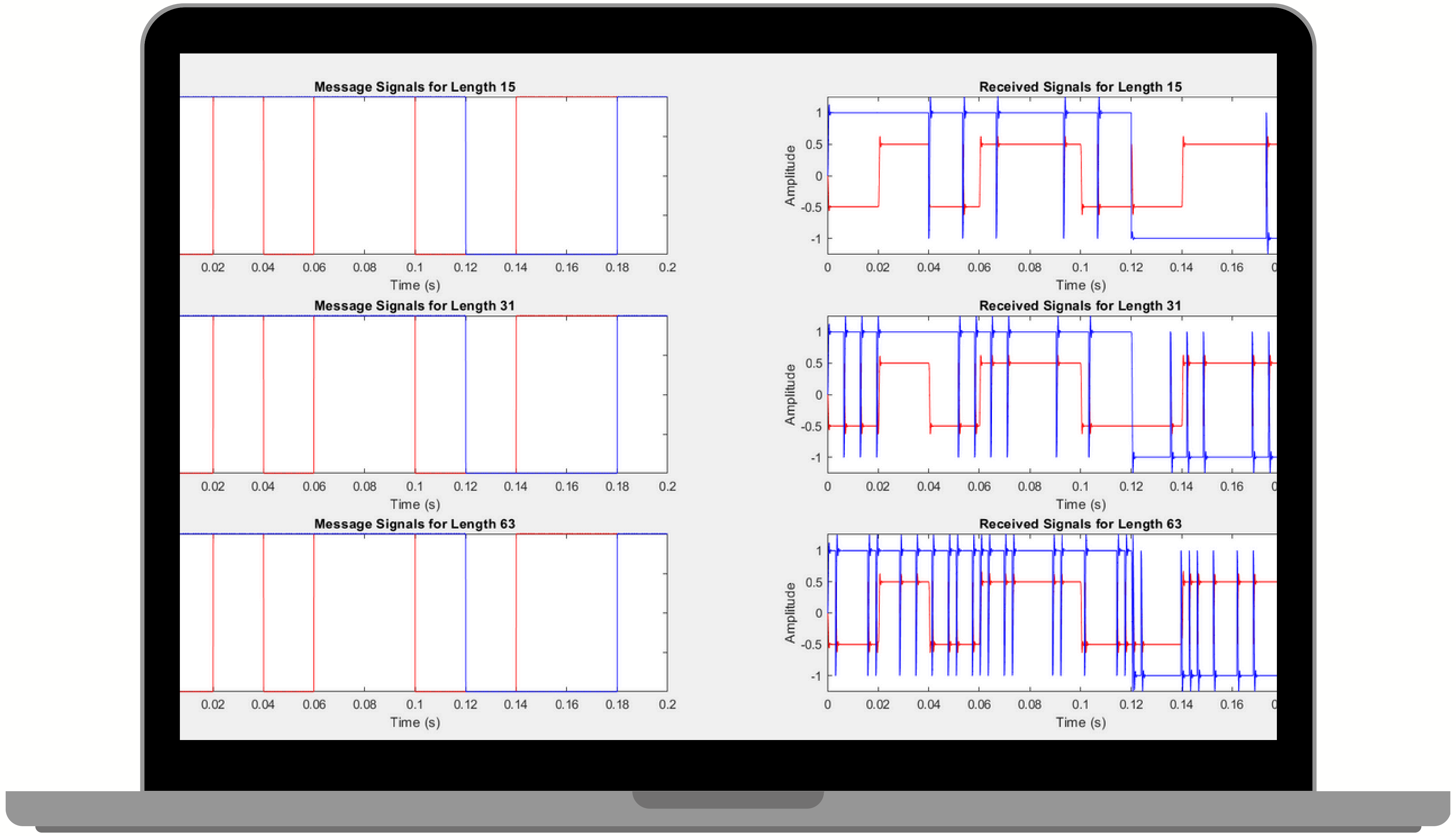
Precision in Multi-User Networks: Chaos-Based Spread Spectrum Communication

We’re developing a chaos-based spread spectrum communication system using **DSSS and FHSS** to enhance **multi-user performance**. Utilizing **chaotic sequences**, our system simulates bit error rates (**BER**) and signal-to-noise ratios (**SNR**) in MATLAB to optimize data transmission. This solution **reduces** multiple access interference (**MAI**), enabling **efficient** and **secure** communication in wireless networks.

PROBLEMS WE SOLVE

Problems We Solve:

- High interference and limited security in multi-user wireless communication.
- Inefficiency in handling multiple access interference (MAI) in traditional spread spectrum systems.
- Challenges in creating robust and scalable wireless systems for dense sensor networks.
- Lack of advanced, accessible solutions for exploring chaotic modulation techniques in wireless communications.



OUR SOLUTION

Our Chaos-Based Spread Spectrum Communication System uses chaotic sequences to improve multi-user wireless communication, ideal for researchers and educators. Simulating DSSS and FHSS, it enhances interference control, supports secure real-time data, and offers a scalable, noise-resistant platform for dense networks and digital communication training.

USP:

- **Real-time, robust multi-user communication** with chaos-based DSSS and FHSS.
- **Enhanced MAI mitigation** and **secure data transmission** in wireless networks.
- Scalable, noise-resistant design supporting **multi-user access and dense environments.**

Software Components:

- **MATLAB** – Platform for simulating and analyzing DSSS and FHSS systems.
- **Chaos-Based Code Libraries** – Implements chaotic sequences for DSSS and FHSS modulation.
- **Bit Error Rate (BER) Analysis Tools** – Measures system performance in varying noise and user scenarios.

WORKING

System Overview:
Chaos-Based Spread Spectrum Communication: This study explores chaos-based Direct Sequence Spread Spectrum (DSSS) and Frequency Hopping Spread Spectrum (FHSS) systems, which enhance multi-user communication by using chaotic sequences to reduce interference and improve security.

BER vs. SNR: MATLAB Simulink simulations track BER against SNR to analyze the performance of chaos-based DSSS and FHSS versus traditional PN sequences.

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Signal Capture and Transmission:
Data Acquisition & Chaos-Based Spreading: User nodes use chaotic sequences for secure, low-interference communication over multiple channels.

Modulation & Processing: BPSK is applied for DSSS and FM for FHSS in simulations to assess performance under varying sequence lengths, interference, and noise.

Decision-Making Mechanism: Modulation thresholds adapt based on user count, frequency offsets, and AWGN characteristics, with BER and MAI analyses guiding adjustments for improved signal clarity and reliability.

Chaos sequence VS PN sequence

Aspect	Chaos Sequence	Pseudo-Noise (PN) Sequence
Definition	Deterministic yet seemingly random sequences generated from chaotic systems.	Periodic deterministic sequences that appear random but eventually repeat.
Behavior and Properties	Exhibits non-repeating, aperiodic behavior, highly unpredictable and sensitive to initial conditions.	Exhibits periodicity and predictable behavior over time.
Application in Communication Systems	Enhances multi-user interference resistance and security in DSSS and FHSS systems with variable sequences.	Used in traditional spread spectrum systems; effective but can struggle with dense networks.
Performance	Offers improved Bit Error Rate (BER) and robust handling of multiple access interference (MAI).	Performs well but may be less effective under high-user or overlapping frequency conditions.

Block Diagram

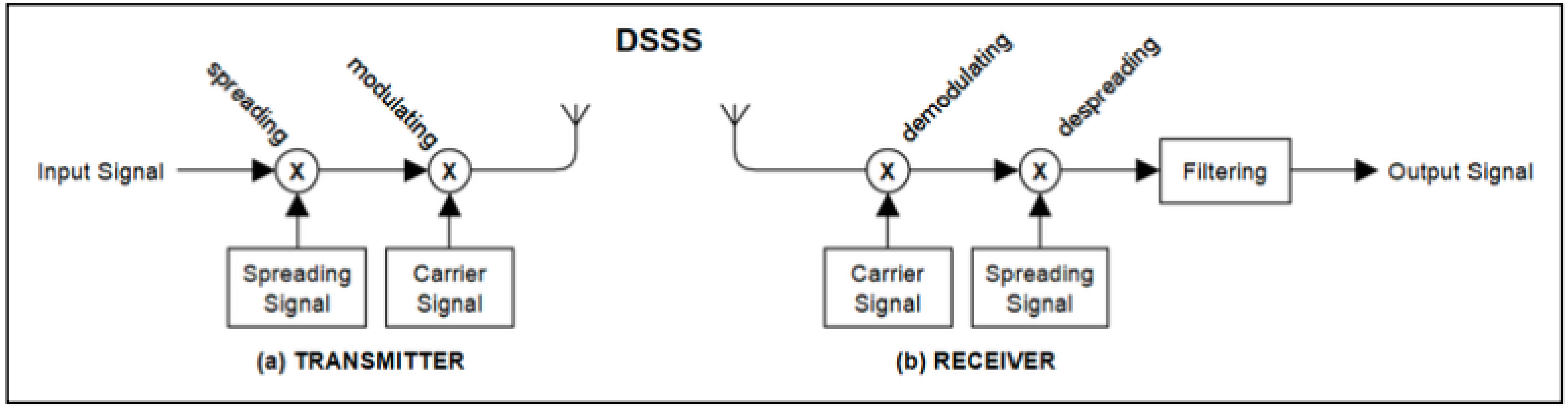

Fig. 2. Block diagram of the (a) transmitter and (b) receiver of the DSSS system

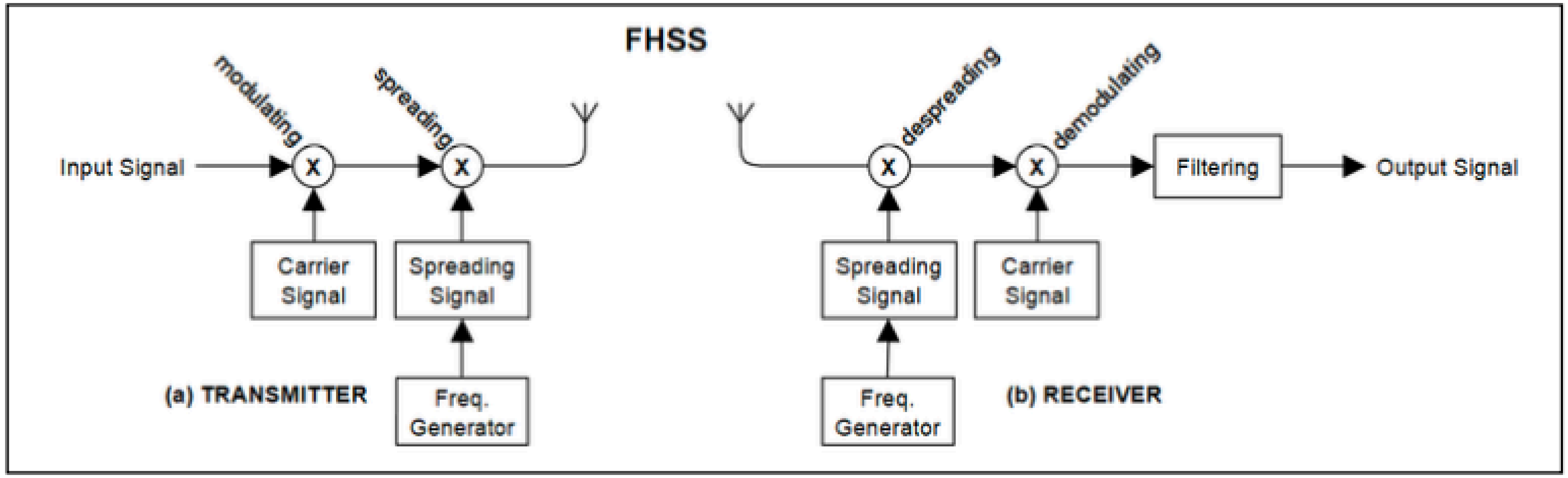

Fig. 3. Block diagram of the (a) transmitter and (b) receiver of the FHSS system

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MESSAGE AND RECIEVED SIGNAL

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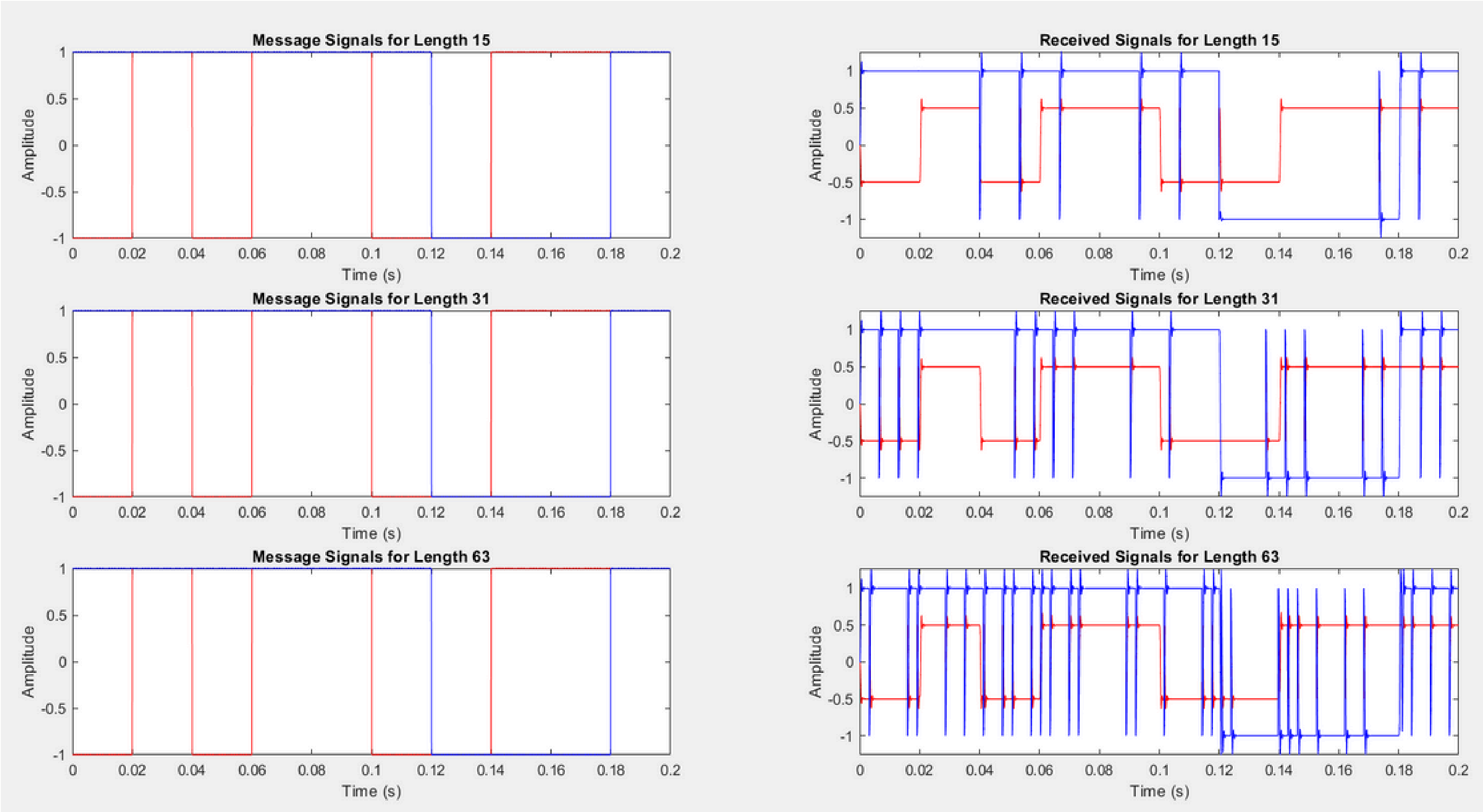

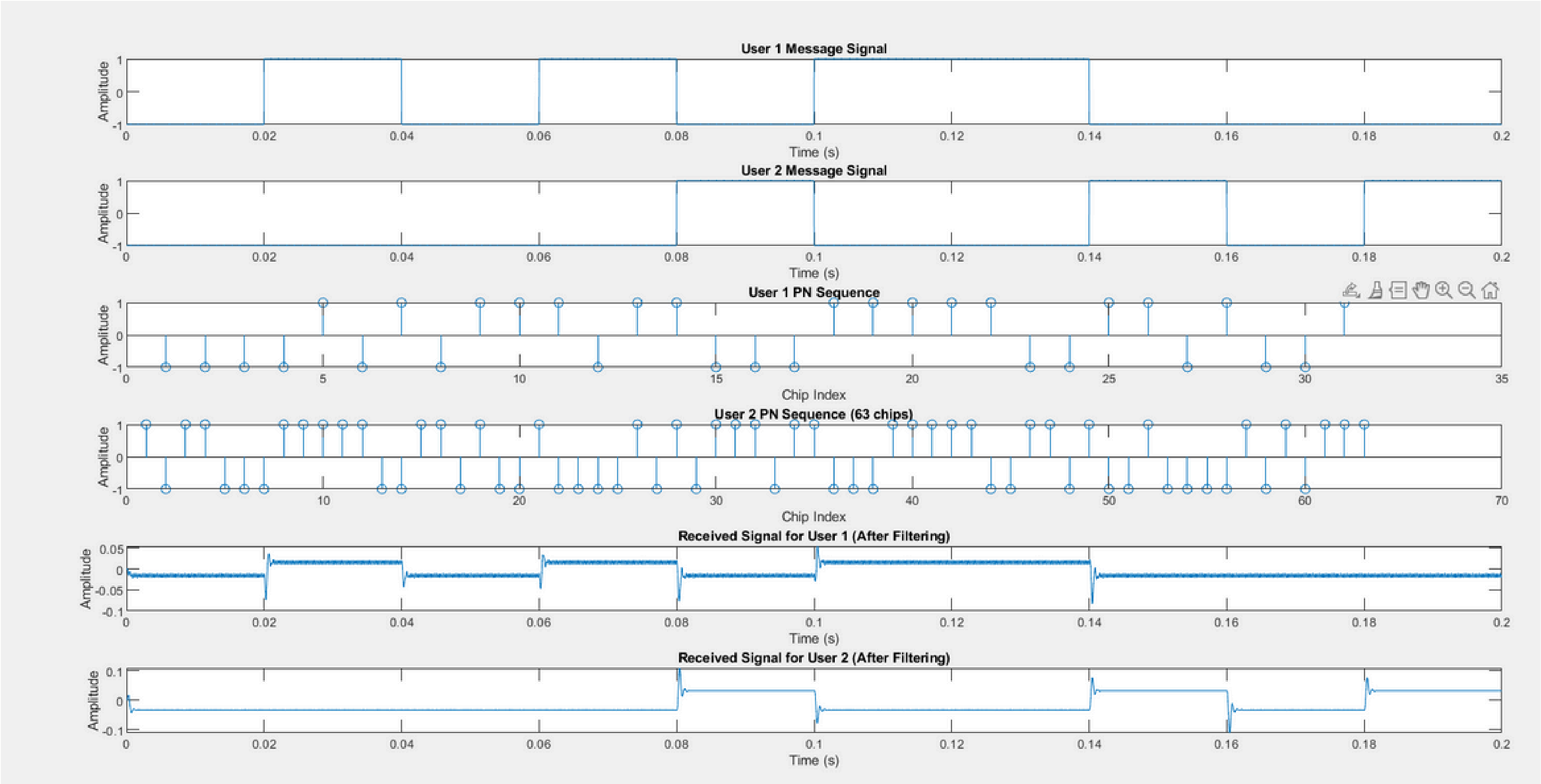

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DSSS BER VS SNR PLOT FOR CHAOS AND PN SEQUENCE

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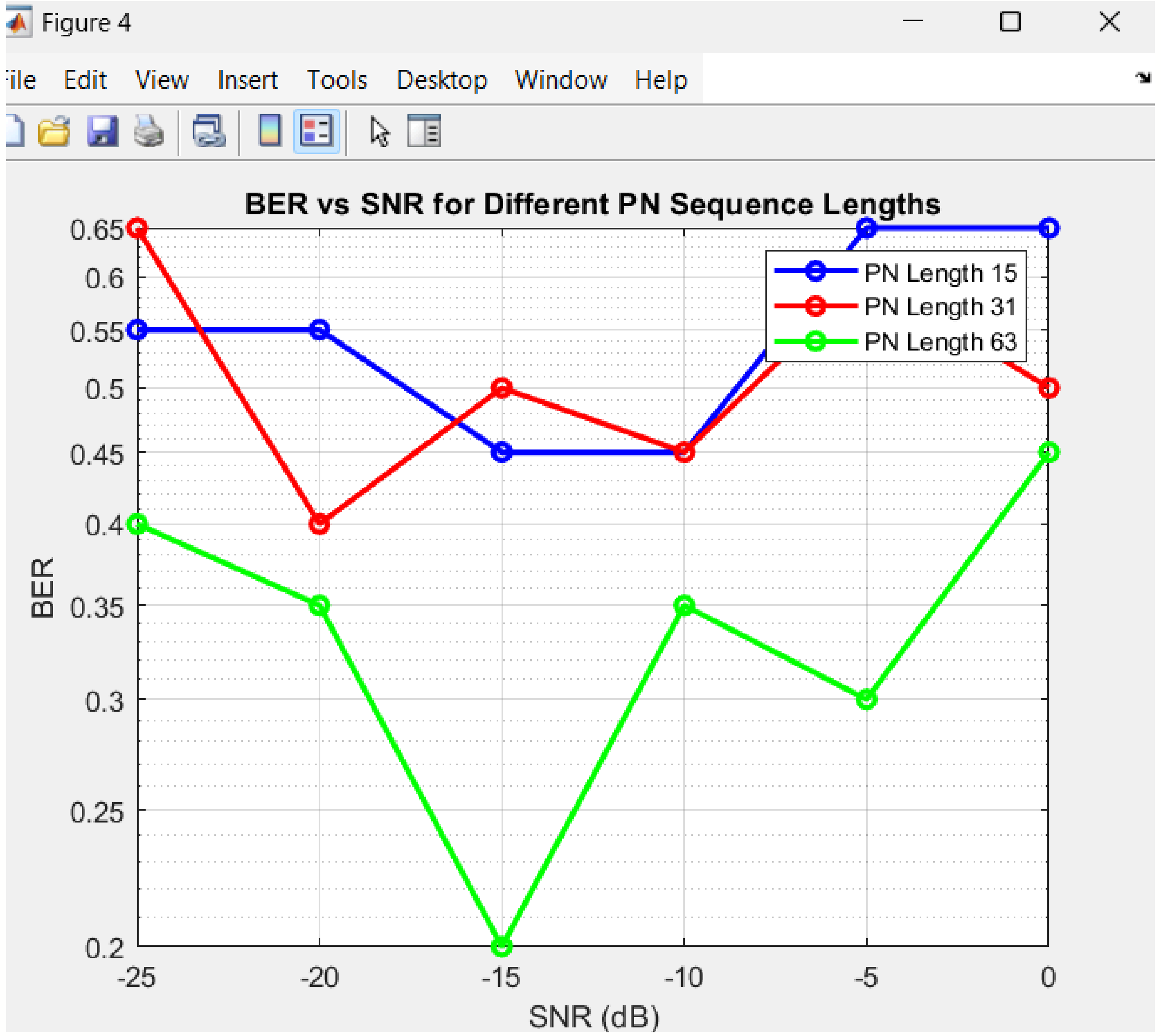

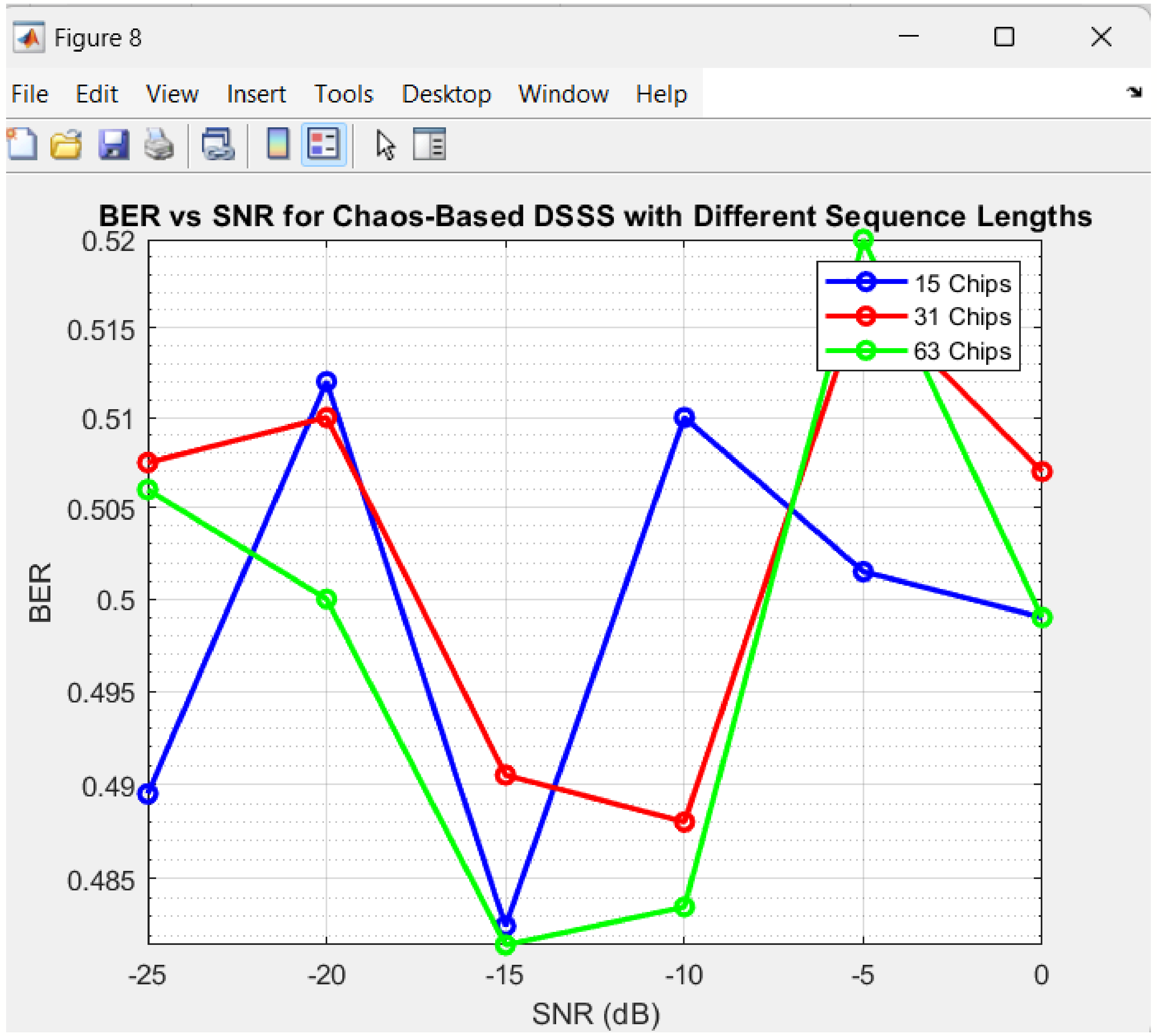

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FHSS BER VS SNR PLOT FOR CHAOS AND PN SEQUENCE

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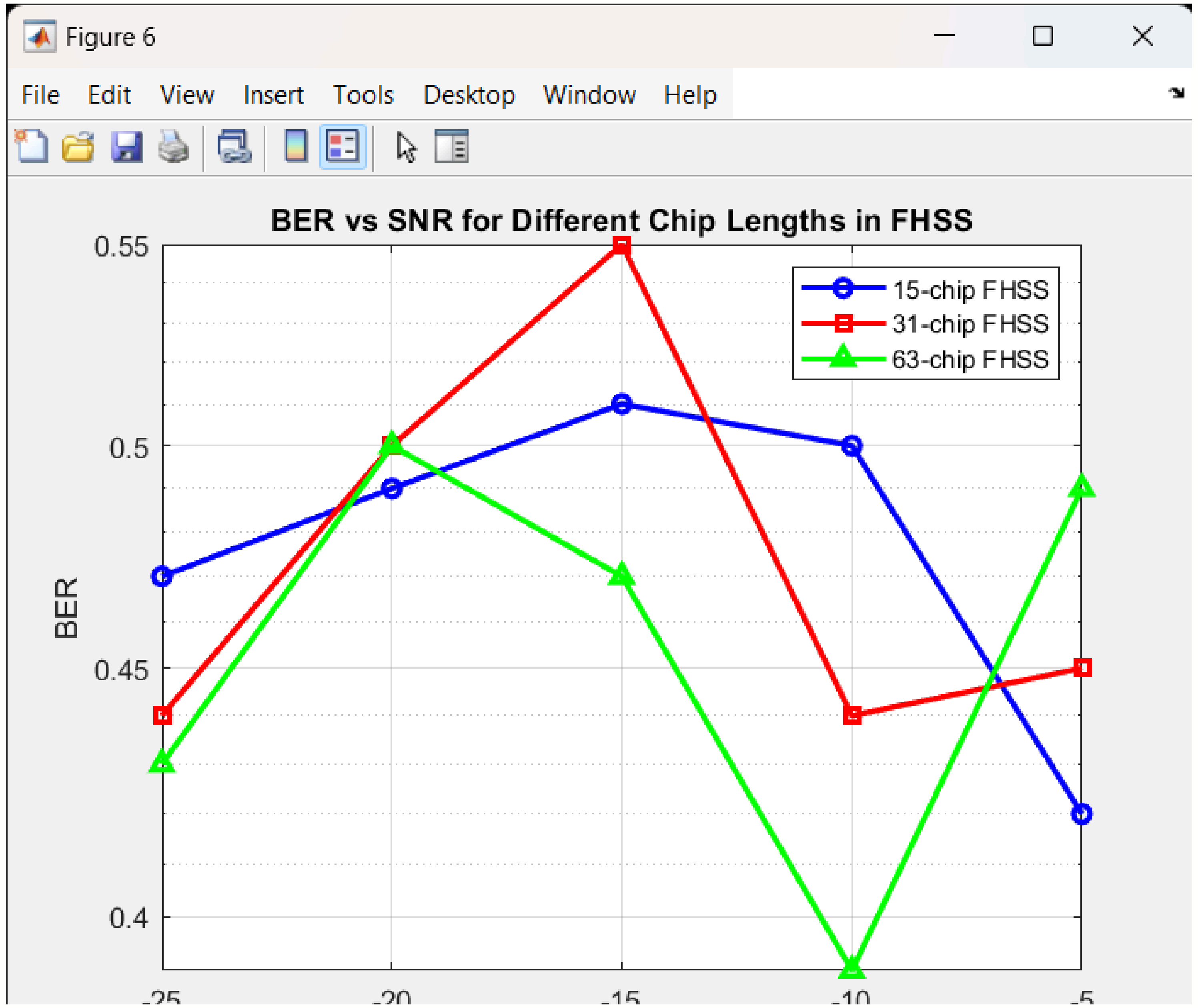
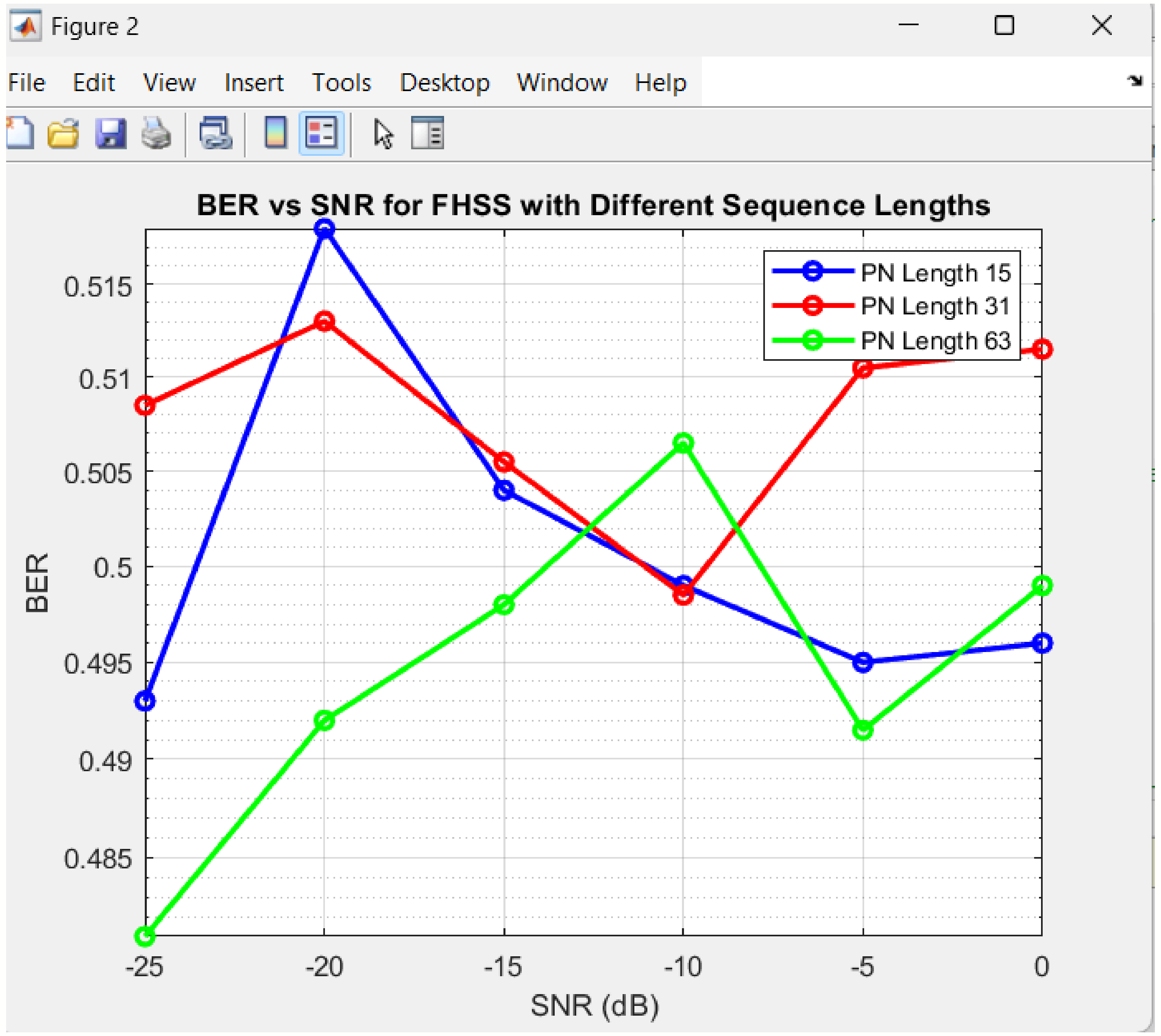


pn seq



chaos seq

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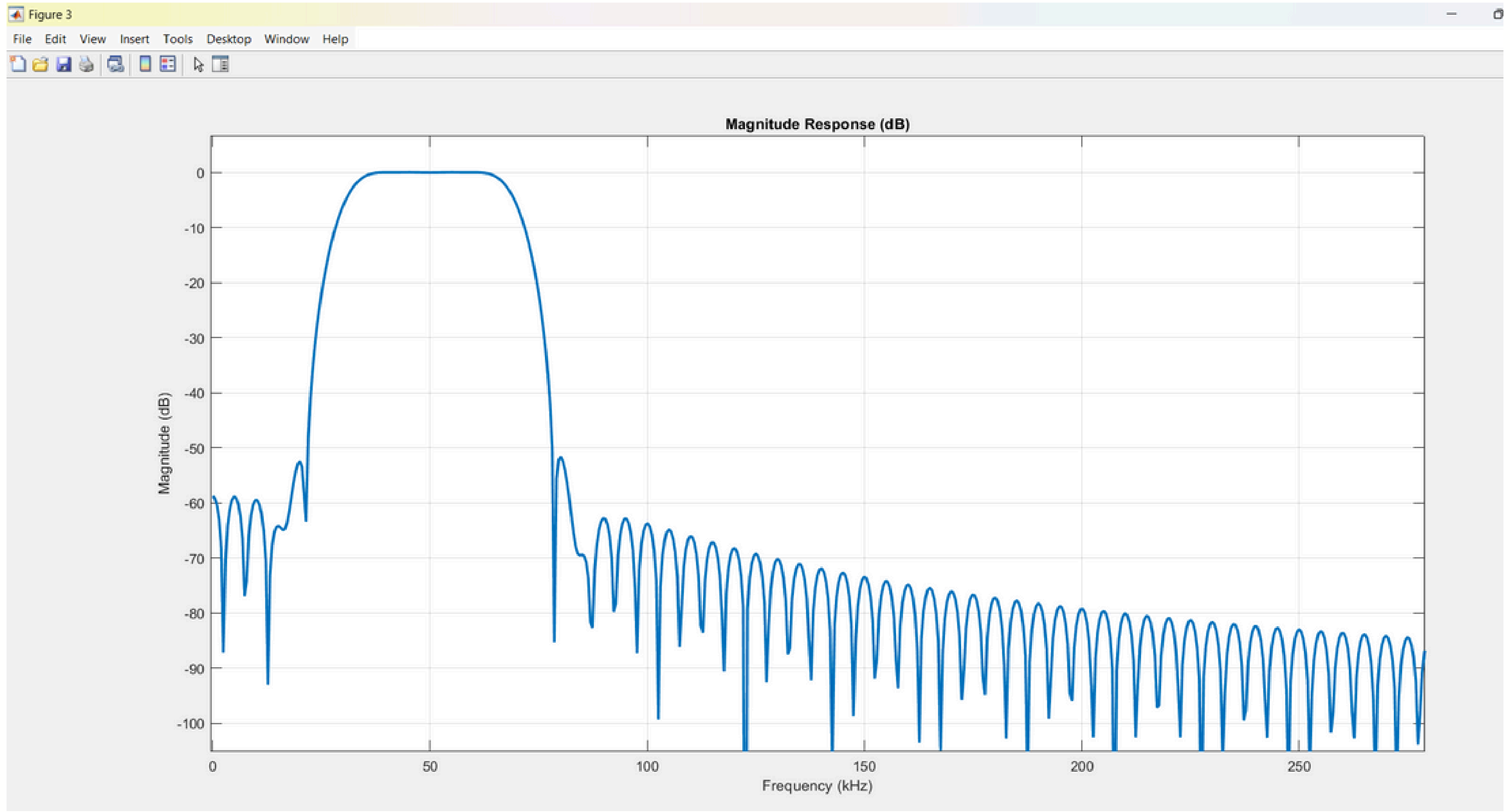
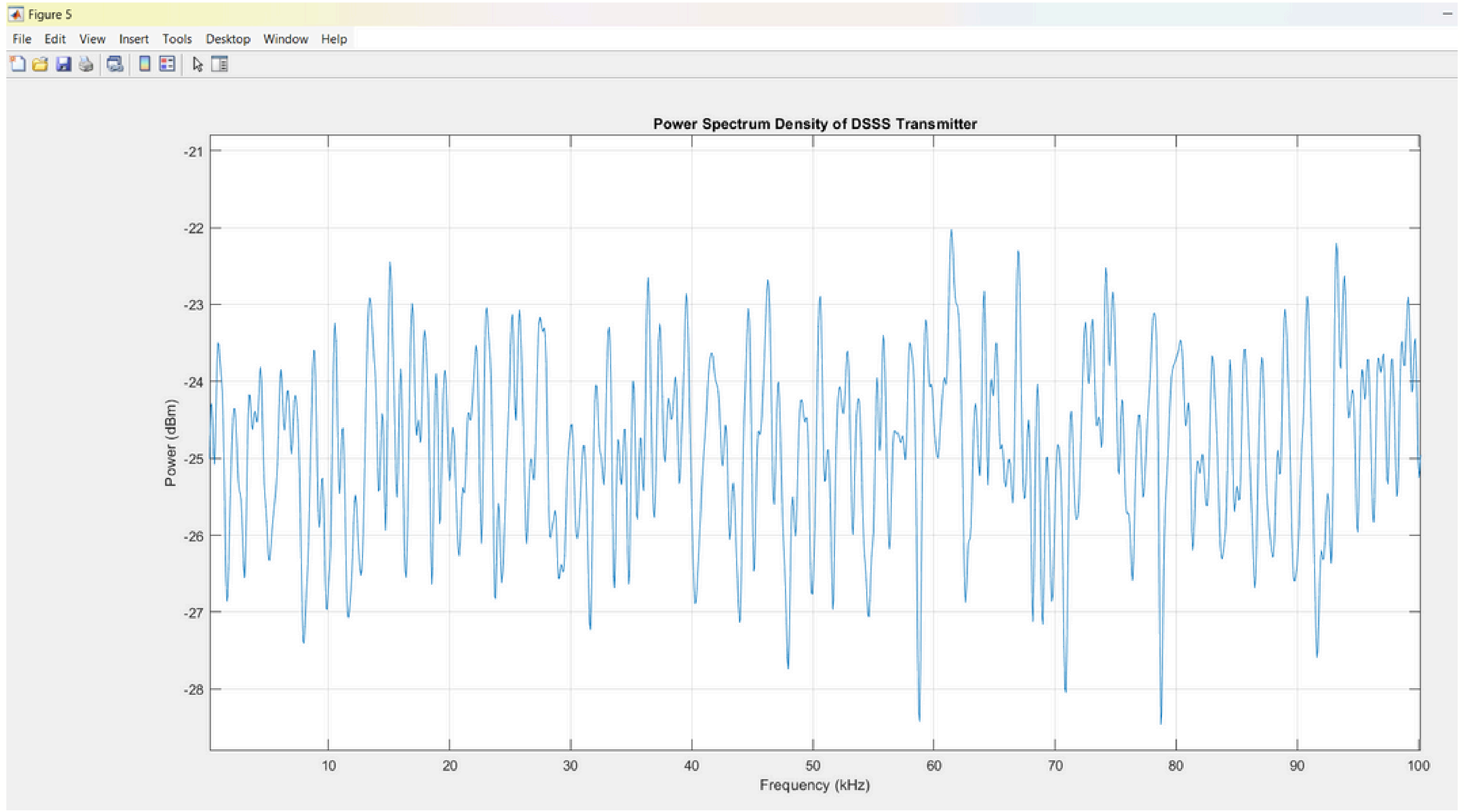
DSSS MAGNITUDE AND POWER SPECTRUM





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FHSS MAGNITUDE AND POWER SPECTRUM

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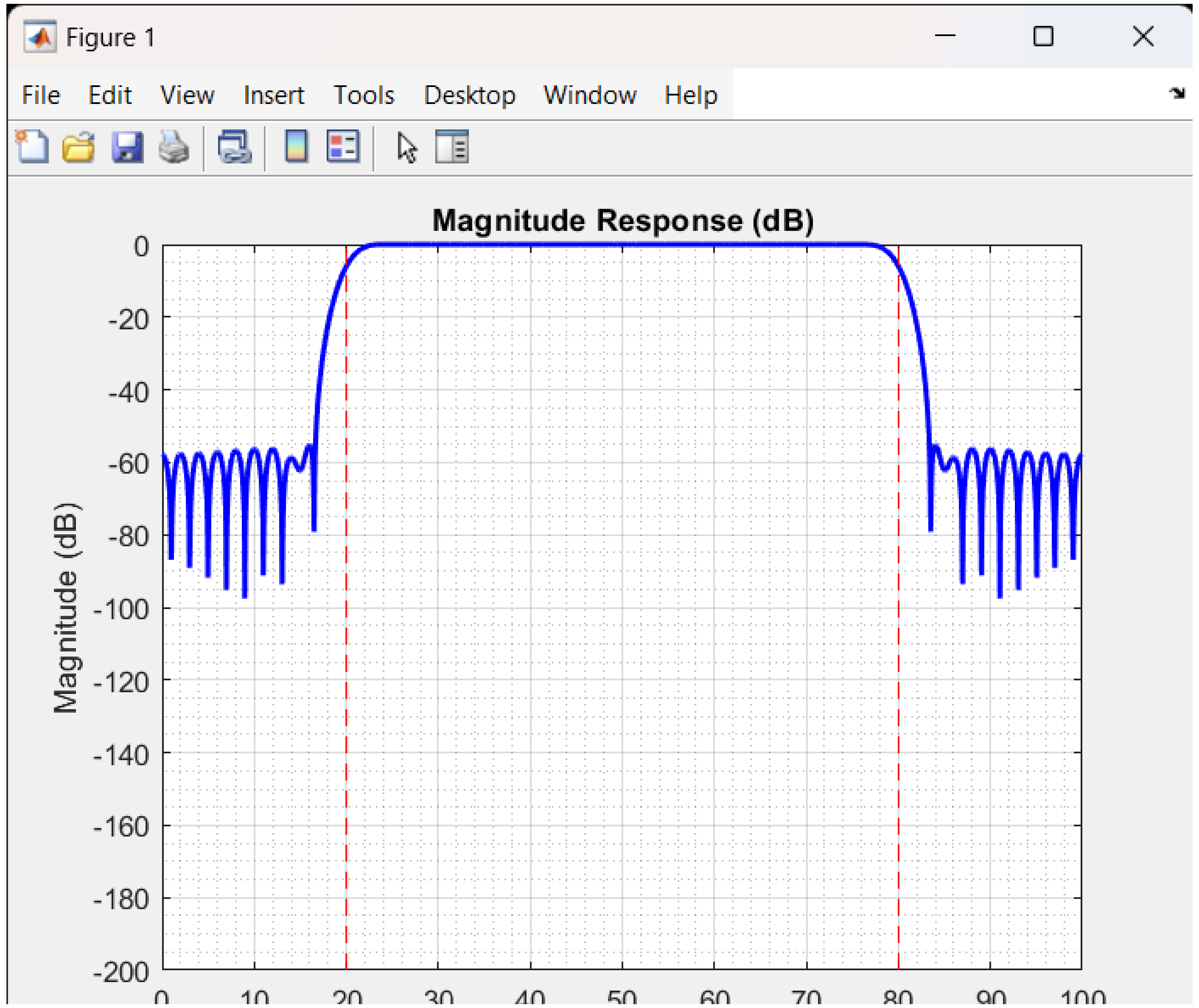

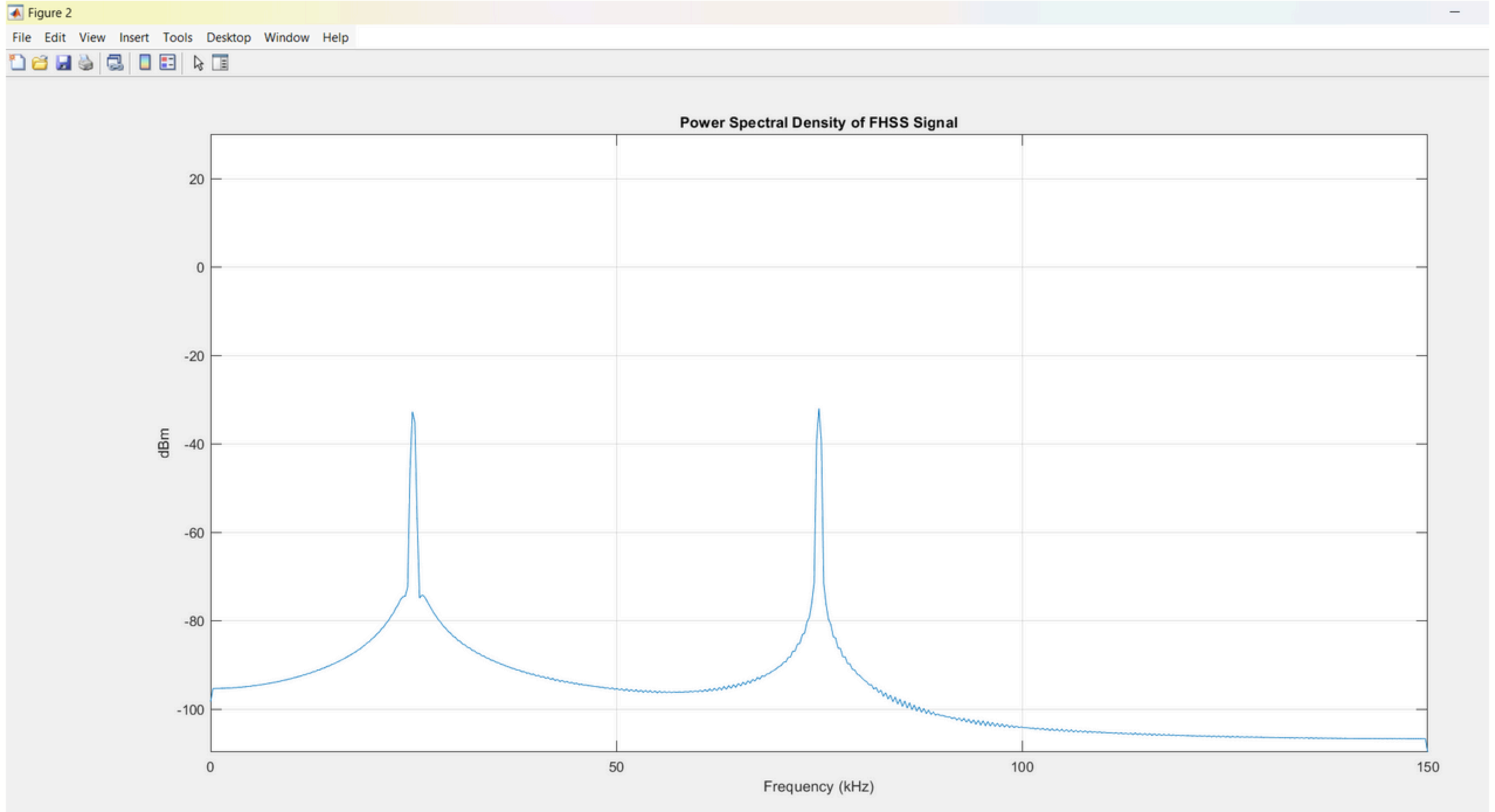

Conclusion

This study confirms that chaos-based DSSS and FHSS systems improve multi-user communication by reducing interference and enhancing security. Simulations show that chaotic sequences achieve similar or better Bit Error Rates (BER) than traditional pseudo-noise sequences, especially under high-user or overlapping frequency conditions. These results underscore the potential of chaos-based spreading to enable secure, interference-resistant communication in multi-user environments.

Thank You