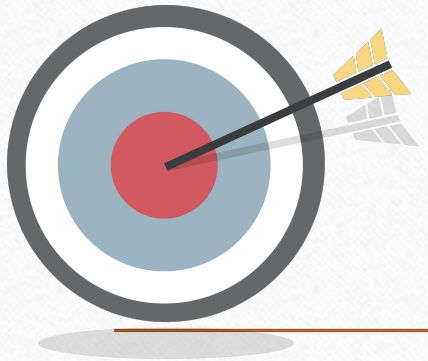
SURA-2019
INTERFERENCE MITIGATION IN LI-FI SYSTEMS

Presented By:
Ritvik Kapila (2017EE10484)
Varun Gupta (2017EE30551)

Facilitator:
Prof. Abhishek Dixit
Asstt. Professor
Electrical Engineering

Introduction

- Visible Light Communication(VLC): Visible light is used not only for illumination, but also for communication.
- Optical wireless technology.
- Secure, localized, safe and incredibly fast mode of communication.
- Uses Light Emitting Diodes(LEDs) and photo detectors at transmitter and receiver end respectively.
- Works by switching the current to LEDs at very high rates, too quick to be noticed by human eye.



Problem Statement

- Increasing the data rates in a Li-Fi model beyond the bound limited by the frequency of changing of ON-OFF state of LEDs using MIMO wireless communication to transmit independent and separately encoded signals, known as streams.
- Removing/mitigating the interference at the receiver end due to high correlation between channels. The high correlation makes the recovery of data very difficult. So the objective is to achieve a high data rate while maintaining a low Bit Error Rate.

Advantages

- Immunity to EM interface
- Larger bandwidth
- Reuse of existing infrastructure
- More secure than RF
- Ease of system installation
- Power efficient technology
- Less hazardous

Challenges in VLC

- Ambient light problem
- Short range of reliable data transfer
- Alignment problem
- Mobility
- Dimming and flickering
- Channel cross talk

Experimental Method

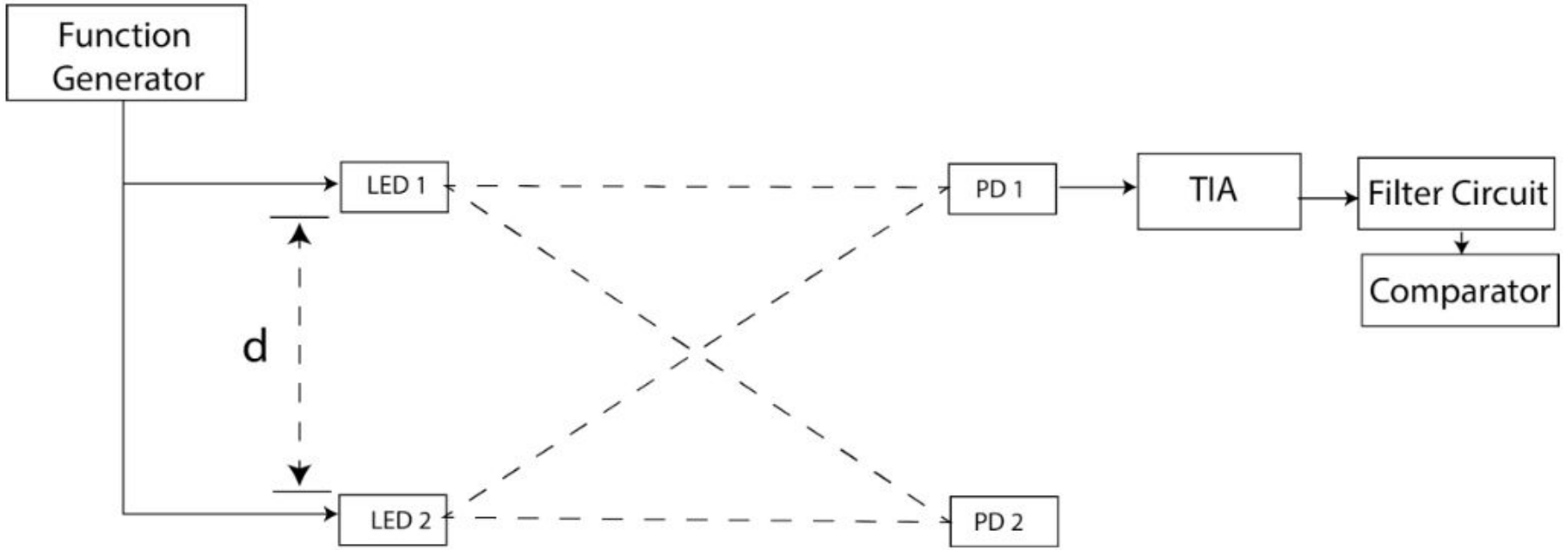


Fig. 1: Setup of the 2X2 model

Task 1: Setting up SISO Link

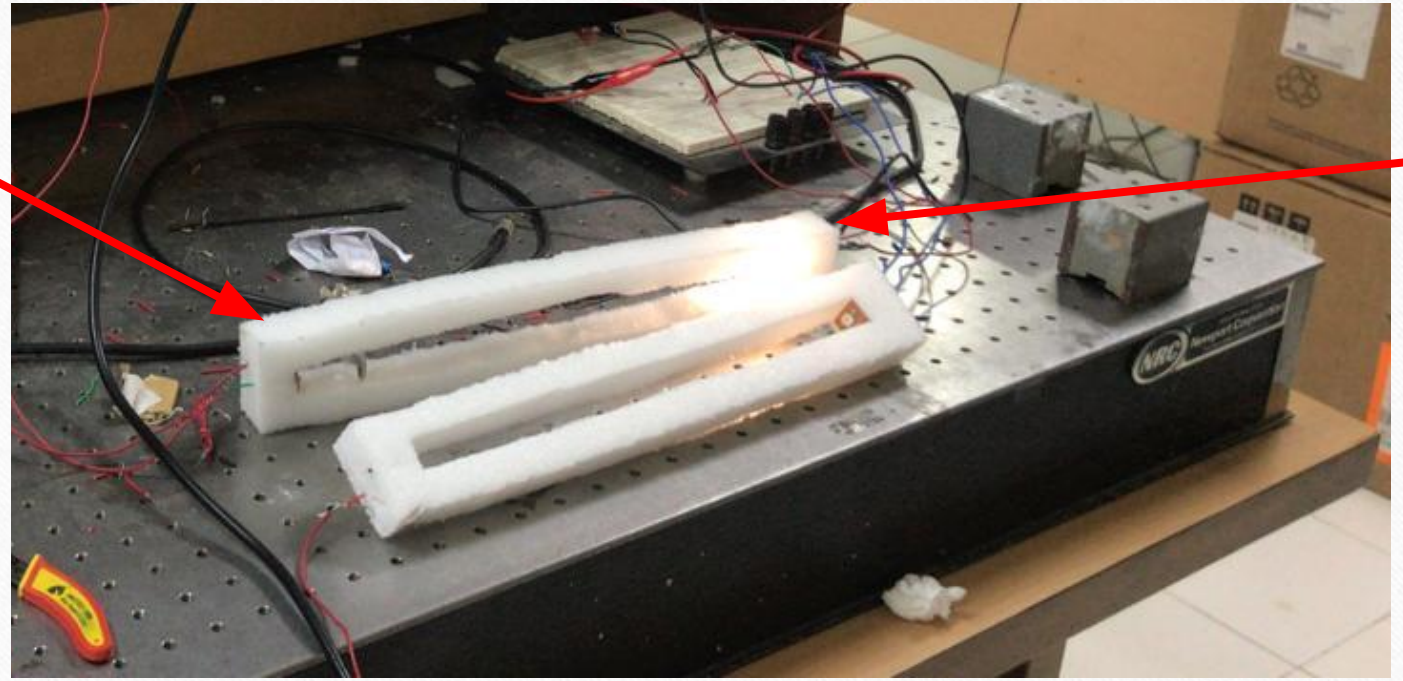


Fig. 2: SISO link of the model

Components used for the setup

- Trans Impedance Amplifier (TIA)

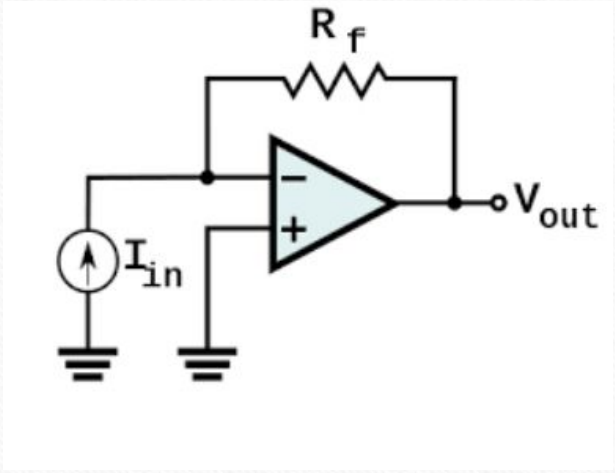


Fig. 3: Trans-Impedance Amp.

- Lense with a focal 5 cm was kept at a distance of 4 cm from the photodetector to focus the light signal received.

Received Signal on oscilloscope

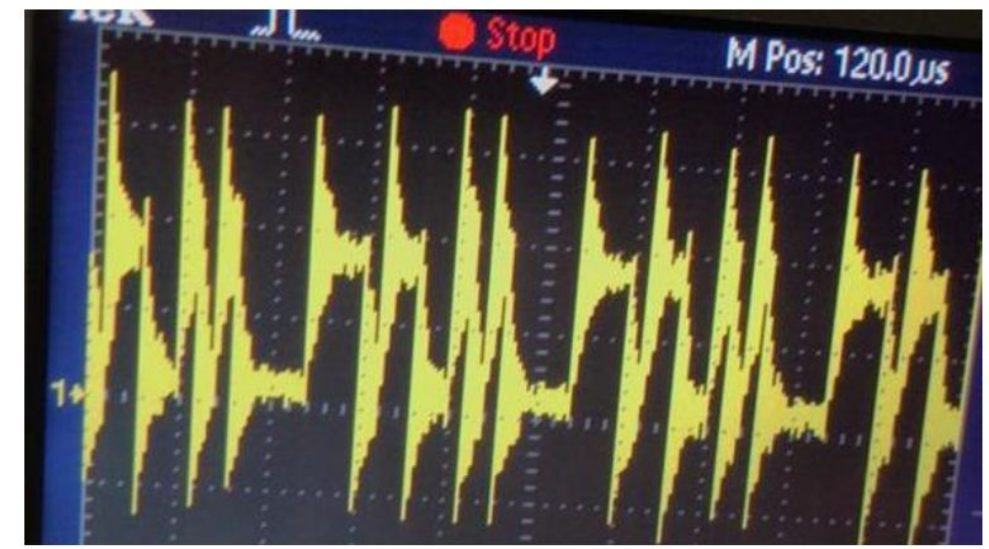


Fig. 4: Output using TIA

- The output signal had a lot of disturbance.
- To solve this problem we used a filter circuit to filter out the high frequency signal.

Filtered Output

- New TIA

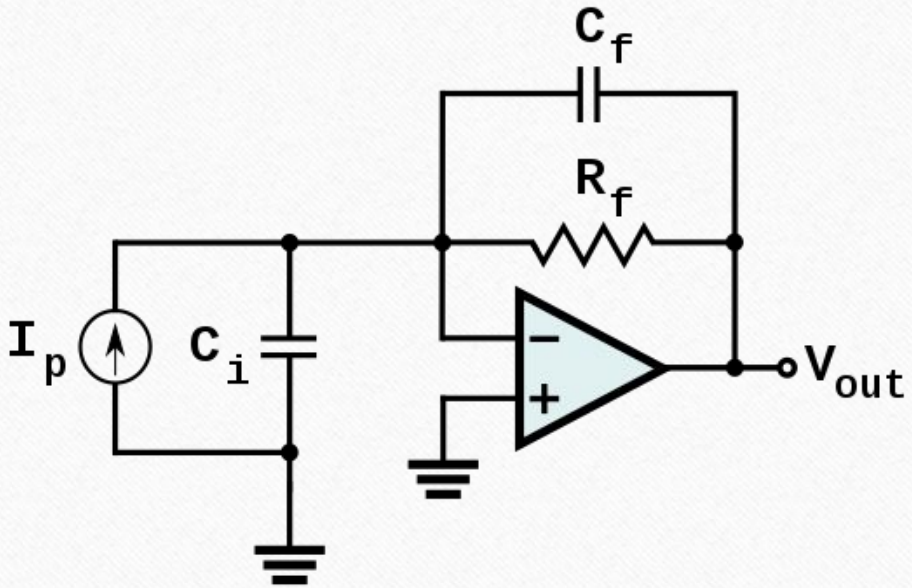


Fig. 4: New Amplifier

Fig. 5: Output for the new TIA

BER for SISO

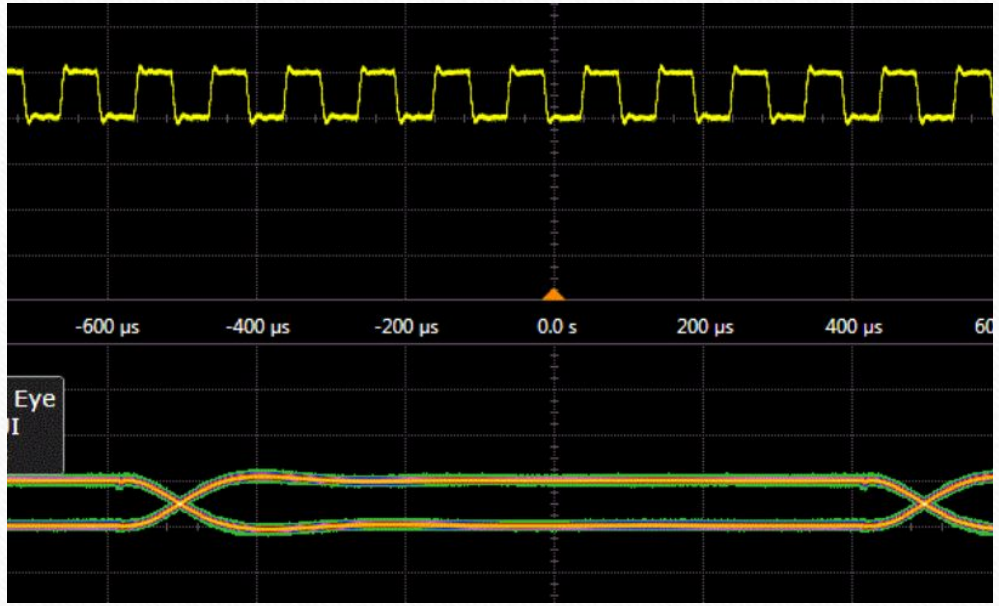


Fig. 6: Eye diagram of the output signal

- Bit error rate (BER) for SISO: $1.8 * 10^{-14}$

Eye Diagram for SISO system

Task 2: Generating Random Bits

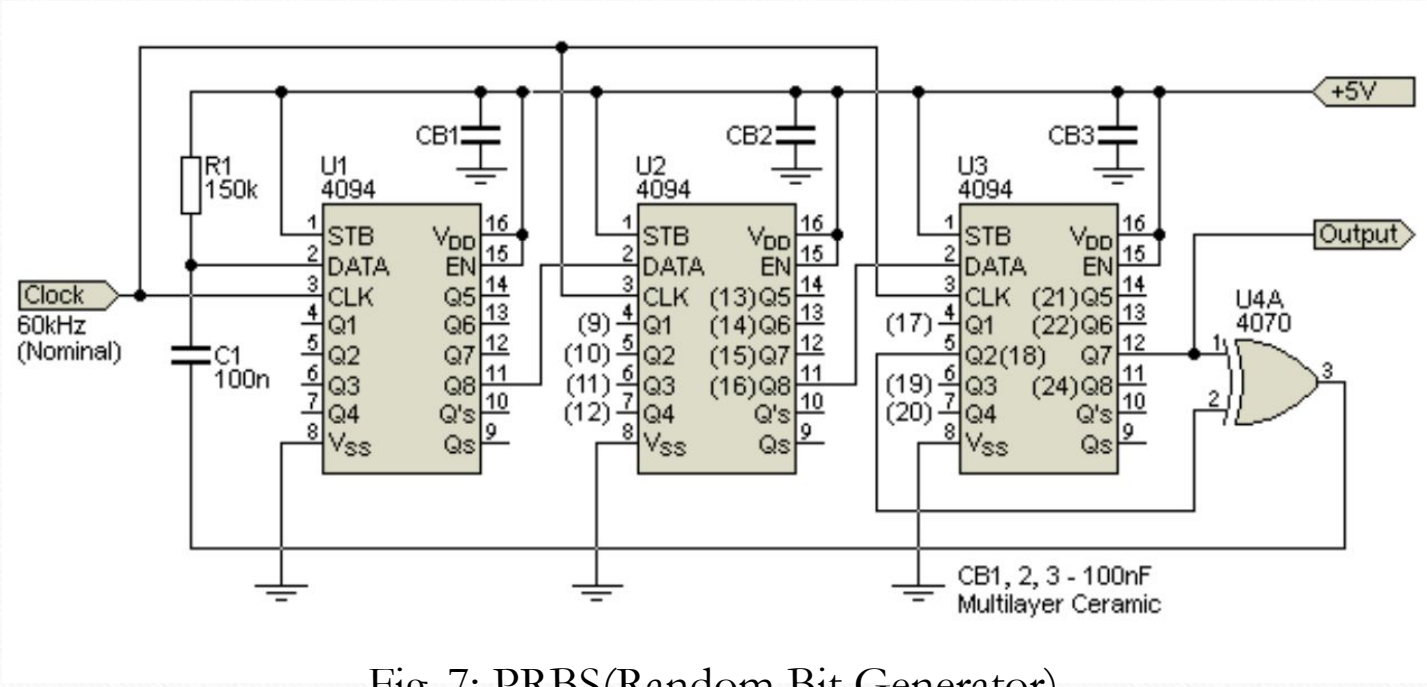


Fig. 7: PRBS(Random Bit Generator)

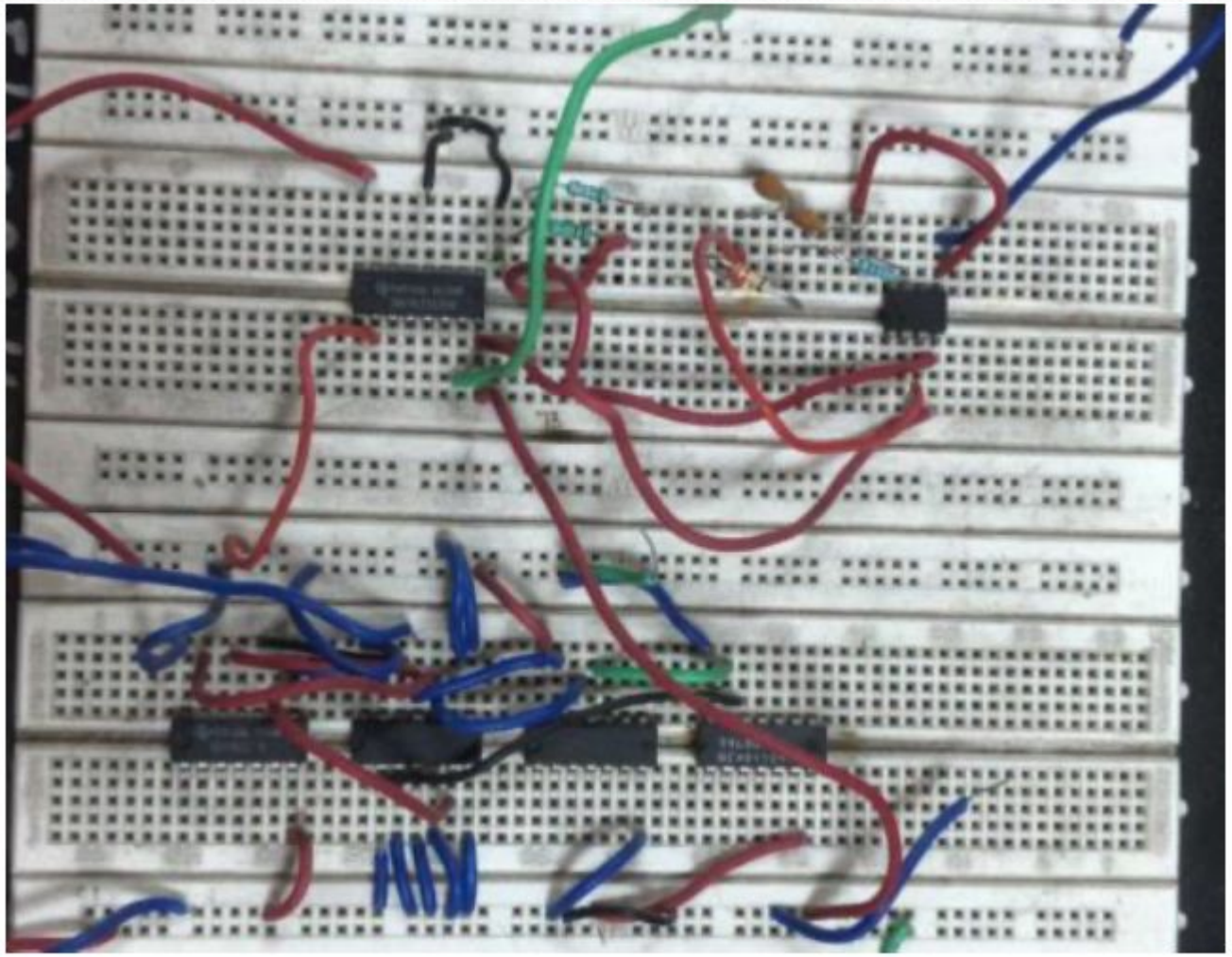


Fig. 8: Circuit of the PRBS

Task 3: Setting up MIMO Link

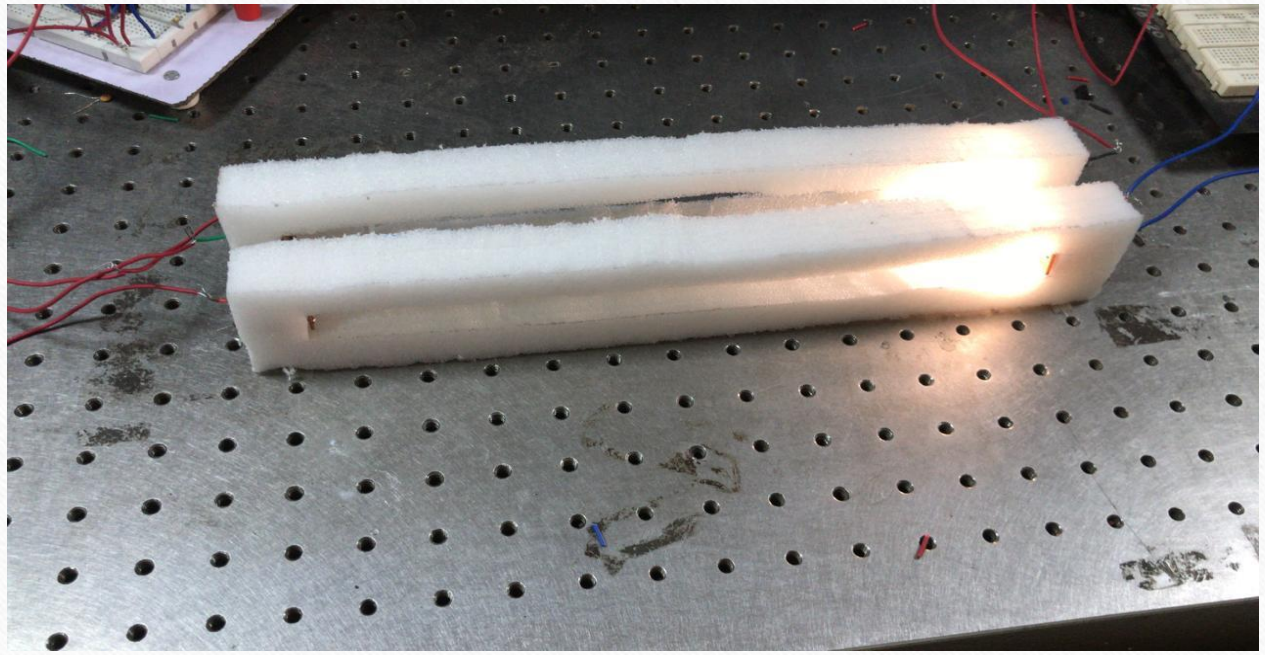


Fig. 9: MIMO setup of the 2X2 model

BER vs Separation

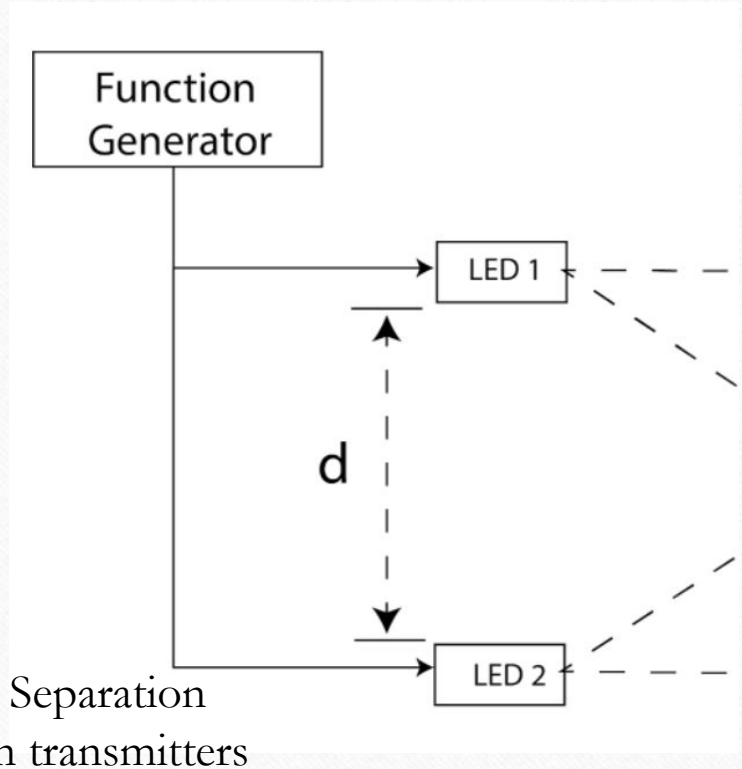


Fig. 10: Separation between transmitters

- The separation ‘d’ between the two transmitter is varied till an acceptable BER is achieved.

BER vs Separation

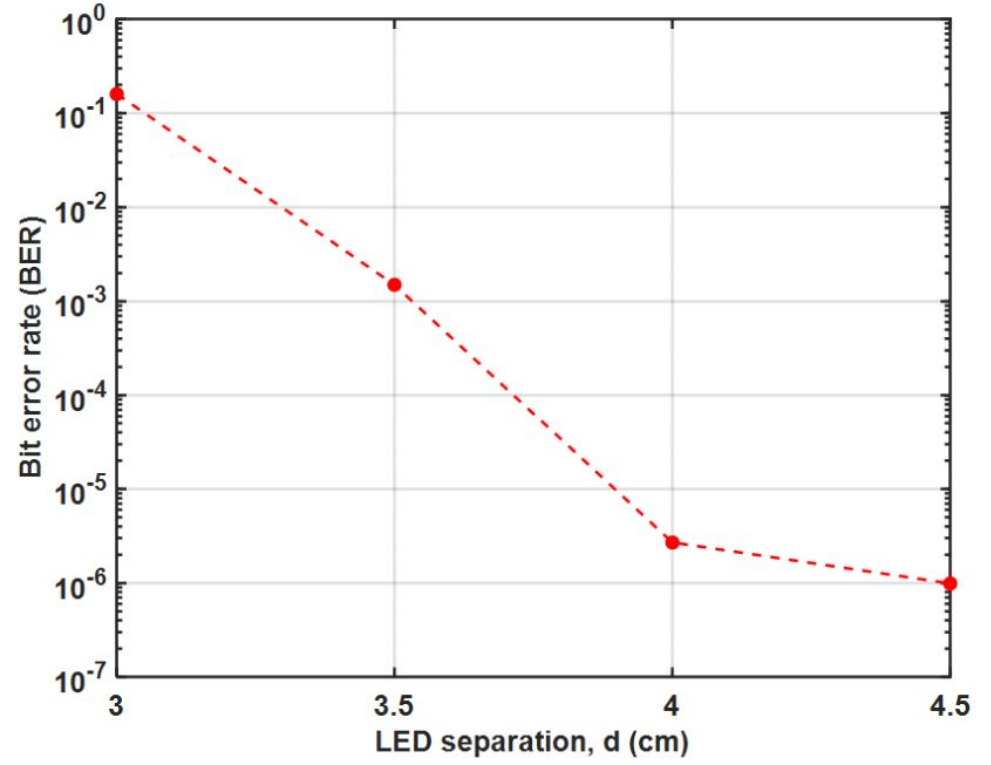
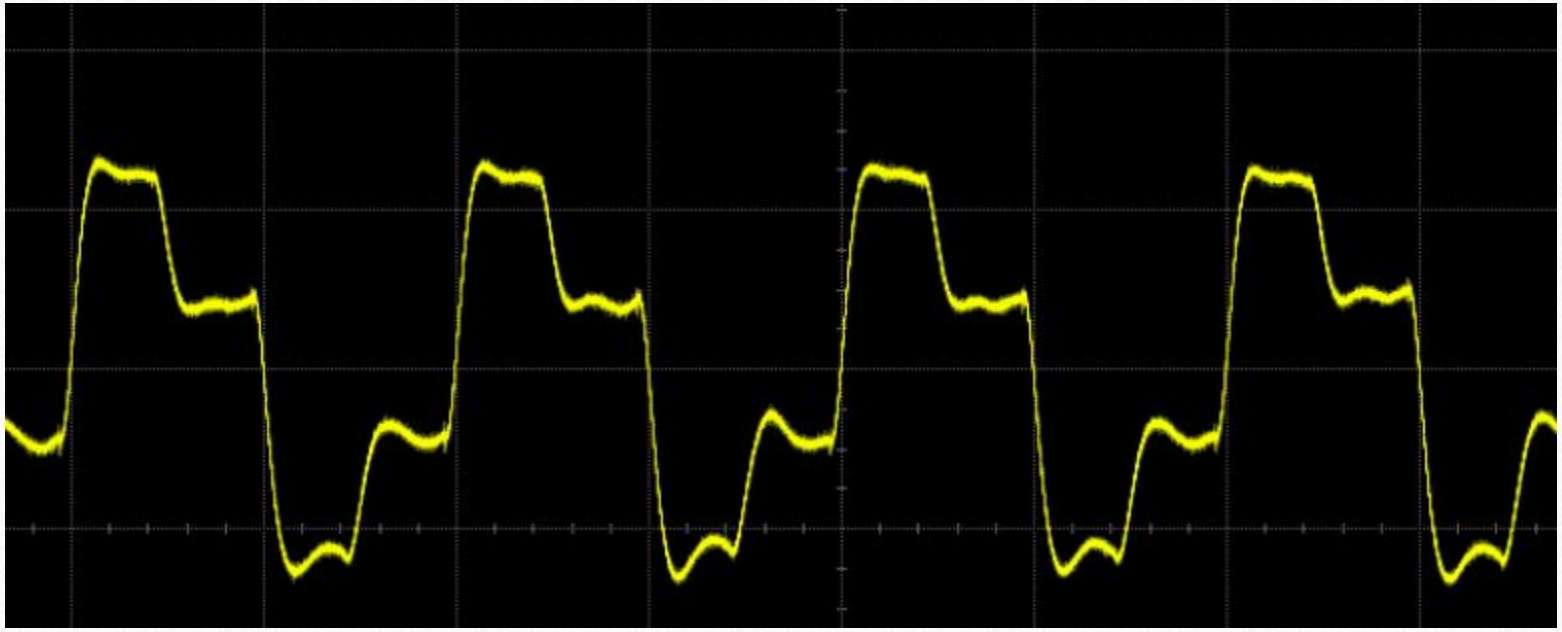
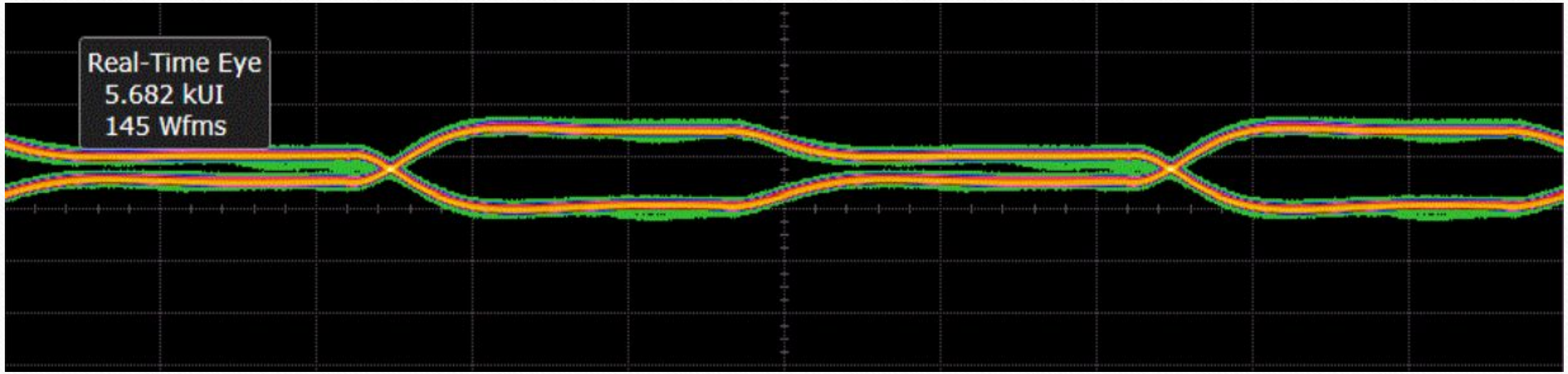


Fig. 11: Variation of BER vs Separation

Received signal MIMO



Eye Diagram of Received Signal



Conclusions

- Calculated the minimum distance between two transmitters in a 2×2 MIMO system.
- Sending different data on both the links and decode the data at the receiver using comparators.
- Minimum distance obtained: 4.5 cm
- Corresponding BER: $9.9 \times 10{-}7$
- Reducing separation between the transmitters increases BER.
- To reduce distance further, we need to apply MIMO decoding techniques like Zero Forcing.

Future Aspects

- A separation of 4.5 cm between the transmitters would lead to a very large panel size of the LI-Fi model.
- In order to reduce the distance further, we can use MIMO decoding to improve BER performance of the link.
- Compare the results obtained from MATLAB simulations with those obtained practically.
- Finding optimum value of semi angle analyzing the variation of BER
- Instead of 2×2 system, we can increase the complexity to a 2×3 system for increasing data rates and also reduce BER in MIMO.

Acknowledgment

We are grateful to **Prof. Abhishek Dixit** for giving us this opportunity to work under him. His guidance, advice and educative discussions have been imperative for the success of this project. His involvement with the project was a source of great motivation for us.

We would also like to thank **Industrial Research and Development (IRD) Unit** for giving us this unique learning opportunity to work on this project.

We also express our sincere gratitude to the **Department of Electrical Engineering** for providing us with all the necessary facilities required for the completion of this project.

Varun Gupta

Ritvik Kapila

Thank You!!

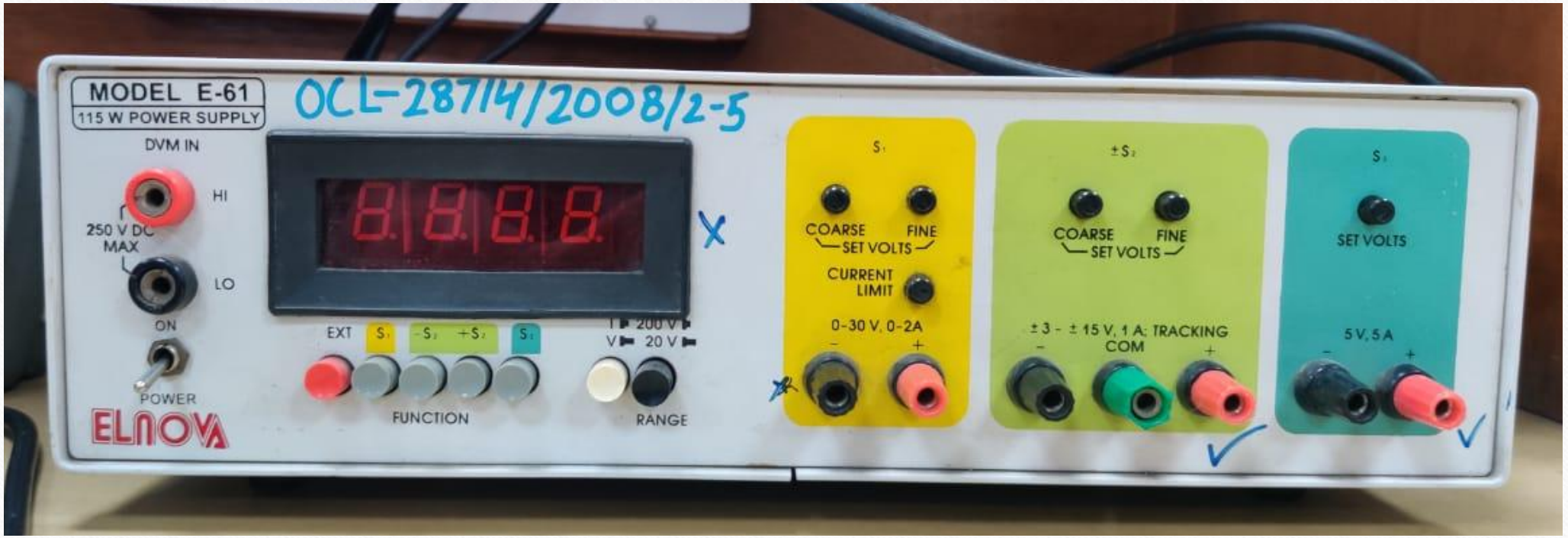
APPENDIX

Equipments Used

1. Multimeter

2. Function Generator

3. DC Voltage Source



4. Digital Storage Oscilloscope

Spectrum

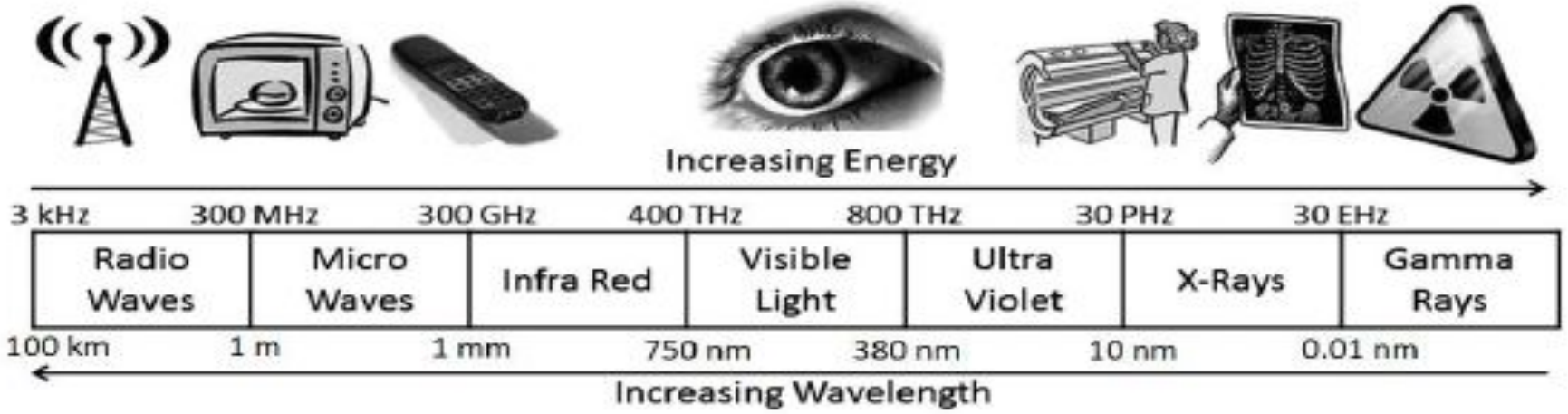


Fig 1: The electromagnetic spectrum