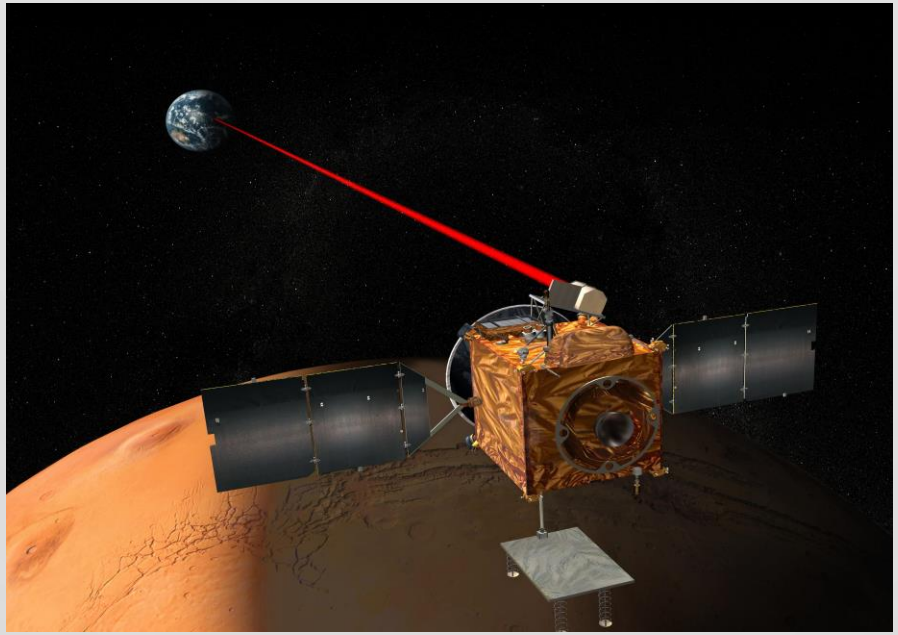
MICRO PROJECT 2020-2021

LASER COMMUNICATION SYSTEM



NITIN THORAT 111907031
YADNESH GUJAR 111907064
HRISHIKESH KEMBHAVI 111907019

INTRODUCTION

Reason to think about Laser Communication System:

- Conventional methods of communication are inefficient for fast data Transmission.
- Also, conventional wire communication causes complexity in circuit.
- They are expensive, large , high power consuming and require radio interference studies keeping these problems in mind, this project introduces LASER COMMUNICATION SYSTEM which helps to resolve above problems

WHAT IS LASER COMMUNICATION SYSTEM?

- Laser communications systems are wireless connections through the atmosphere.
- The light speed is the fastest speed than anything can travel, so laser communications and laser sensing are important in mortar defense and other crucial aerospace and defense applications.
- Lasers can see through the dense foliage, and they can allow for space communication from distances measured in millions of miles.
- Laser communications are better than radio as light wavelengths are packed much more tightly and they transmit more information per second with a stronger signal

Aim :

This project aims to achieve communication link by laser communication with help of laser transmitter and receiver.

Objective:

Demonstrating the transmission of the data through the laser beam and retrieving data on the receiver side. And building the circuit and simulation model for the same.

Literature survey

THEORETICAL BACKGROUND

- 1. The principle of laser communication system is , “the intensity of the laser beam is varying according to instantaneous amplitude of the message signal”, which is like the principle of amplitude modulator.

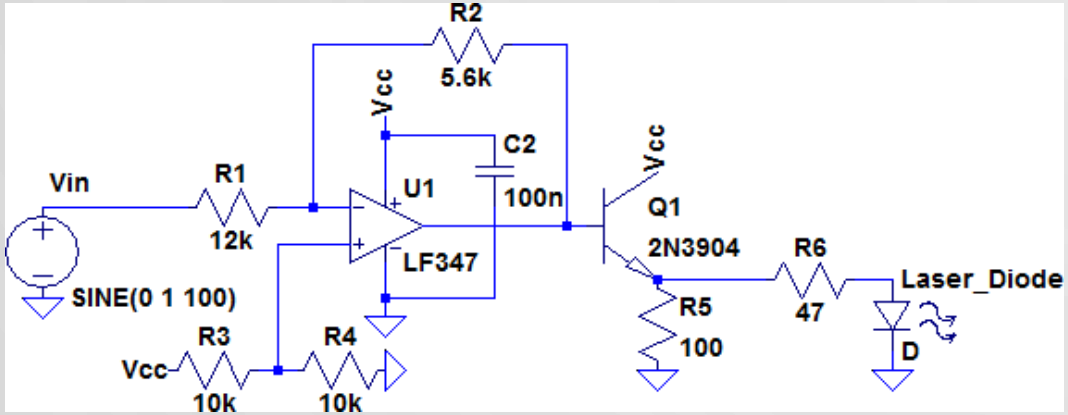
- 2. But unlike AM , it doesn't have a conventional adder or mixer of carrier and message signal as both carrier and message signal are in different forms (optical and electrical respectively)

- 3. Thus laser communication system is similar to amplitude modulation but not same.

SYSTEM ARCHITECTURE

1. HARDWARE ARCHITECTURE

Transmitter



Components:

- **Operational amplifier(LF347):**

Require for giving the bias voltage level of input signal and attenuate signal as per requirement of laser diode.

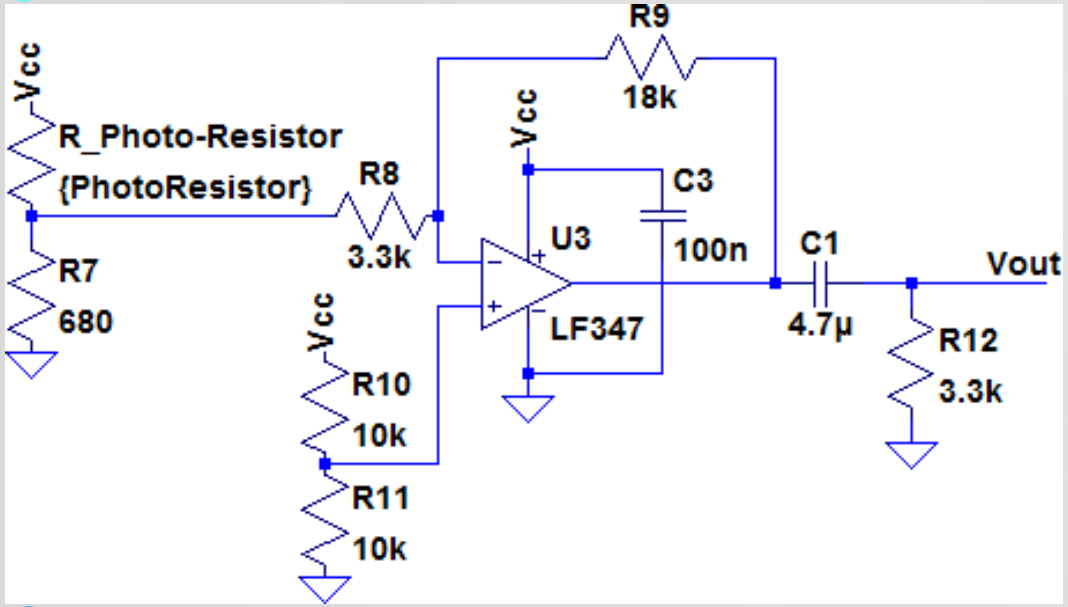
- **NPN transistor:**

It is used as voltage follower for adjusting current levels for op amp and laser diode

- **Laser diode:**

Used as a transmitter. Intensity of the laser light is changing according to the message signal.

Receiver



Components:

- **LDR/ photodetector :**

LDR is a light dependent resistor , in which resistance is changed according to intensity falling on it.

- **Operational amplifier (LF347) :**

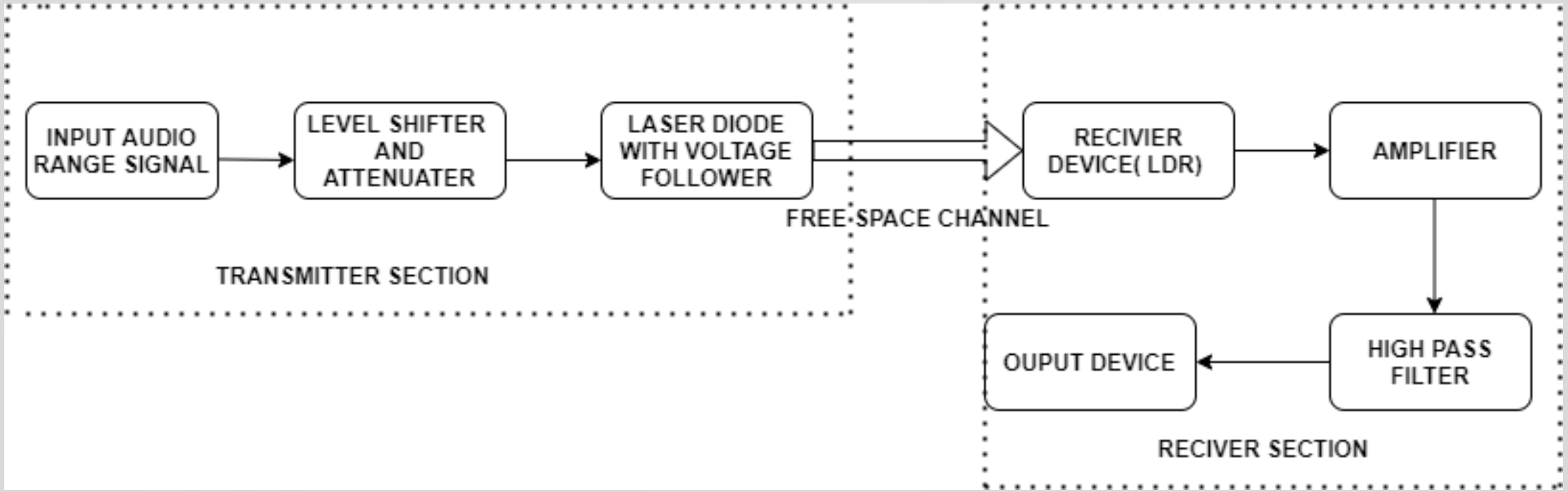
In receiver it is used for providing gain as signal is attenuated because of transmitter opamp.

- **High Pass RC filter:**

To attenuate the lower frequency noise and DC voltages high pass filter is used. The cutoff frequency is set to 10Hz.

SYSTEM ARCHITECTURE

2. SYSTEM FLOWCHART



SYSTEM ARCHITECTURE
3. WORKING

Transmitter:

- In the transmitter side mainly, electrical signal is converted into optical signal
- For this, firstly analog data signals get processed with level shifter and level attenuator for the voltage bias requirement of laser diode with operational amplimer .
- Then a signal is sent to the voltage follower transistor for adjusting current levels of diode and amplifier .
- Signal then sent with the laser beam through the air medium or any optical communication channel like optical fiber.

Receiver:

- On the receiving side , LDR and voltage divider circuit is used as a main receiver circuitry for converting optical signals into electrical signals.

- As LDR changes its resistance value according to intensity of the light falling on it, voltage across voltage divider changes input of the amplifier.

- Amplifier again is adjusted according to attenuation provided in the transmitter
- then signal is passed through the high pass filter for vanishing DC bias given in transmitter section.

- And then finally output of a high pass filter is provided to output devices like microphone or speaker.

Results and Simulations:

There are two parts in the simulation ie.

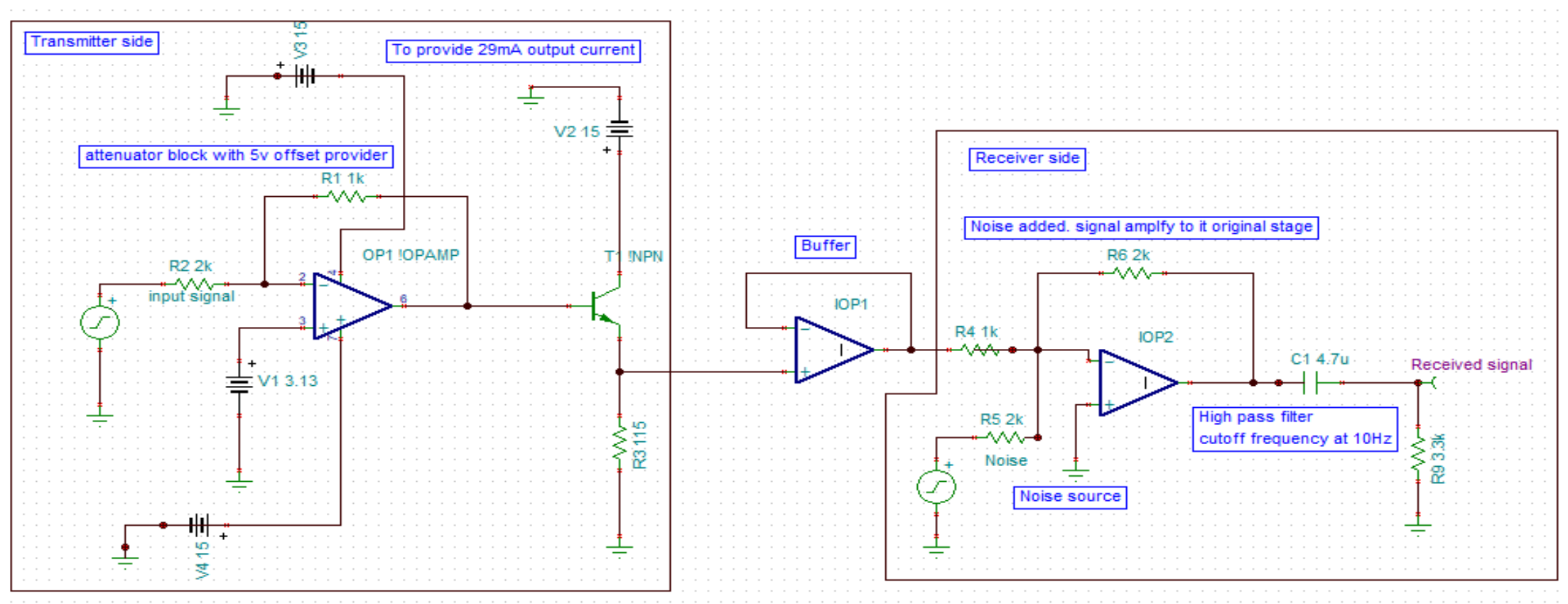
- TINA and PROTEUS software are used to test the working of the main circuit components which consists of op amps and transistors.

- OptiSystem software is used to simulate the channel and lasers which is not possible in above mentioned softwares.

- Combining both the simulations gives a clear picture about how these circuits function and give the end results which are desired.

TINA CIRCUIT

- Transmitter circuit generate signal with 4V DC level and +-1 V variation.
  - Receiver circuit provide Gain and attenuate high Noise content.
    - Buffer is used to Isolate transmitter and Receiver circuits.



TINA Simulation:

Transmitter:

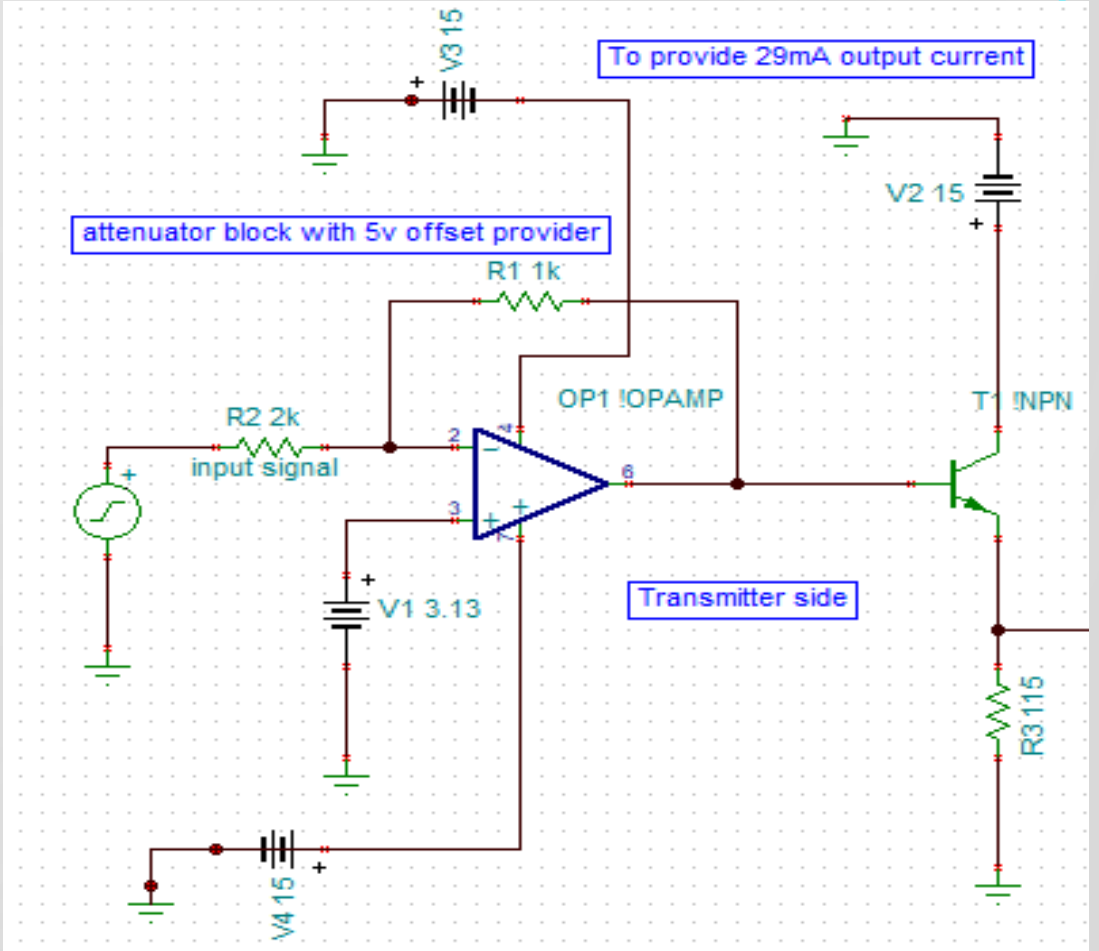
Op amp :

- Provide 4.7V DC offset to turn on laser continuously for transmit data continuously
- Limit the signal variation in 2V. i.e signal variation from 1v to –1v.

Transistor :

- Fulfilled current requirement (>26mA) of the laser in voltage follower configuration
- To turn ON transistor 0.7V is drop across base-emitter junction.

Output of Transmitter is signal at 4V DC level and +-1V variation in that.



TINA Simulation:

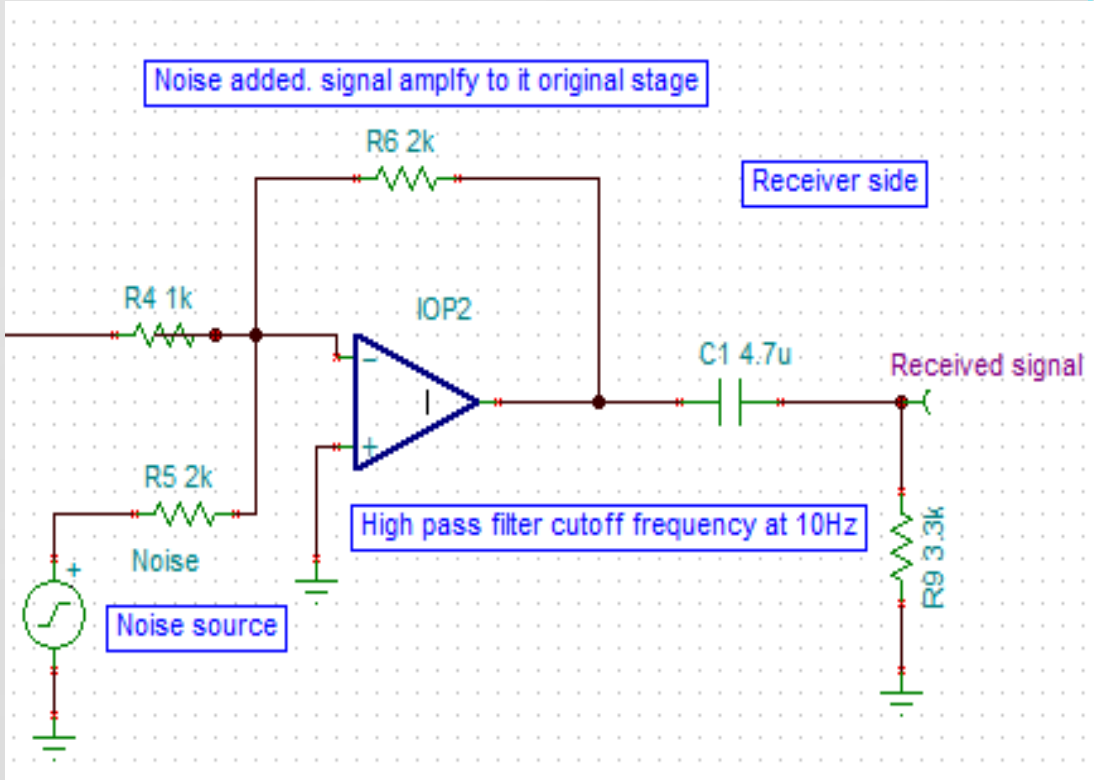
Receiver:

Amplifier :

- It provide gain 2 to signal and 180 phase shift.
- In practical circuit Gain must be greater than 2 because attenuated in communication channel

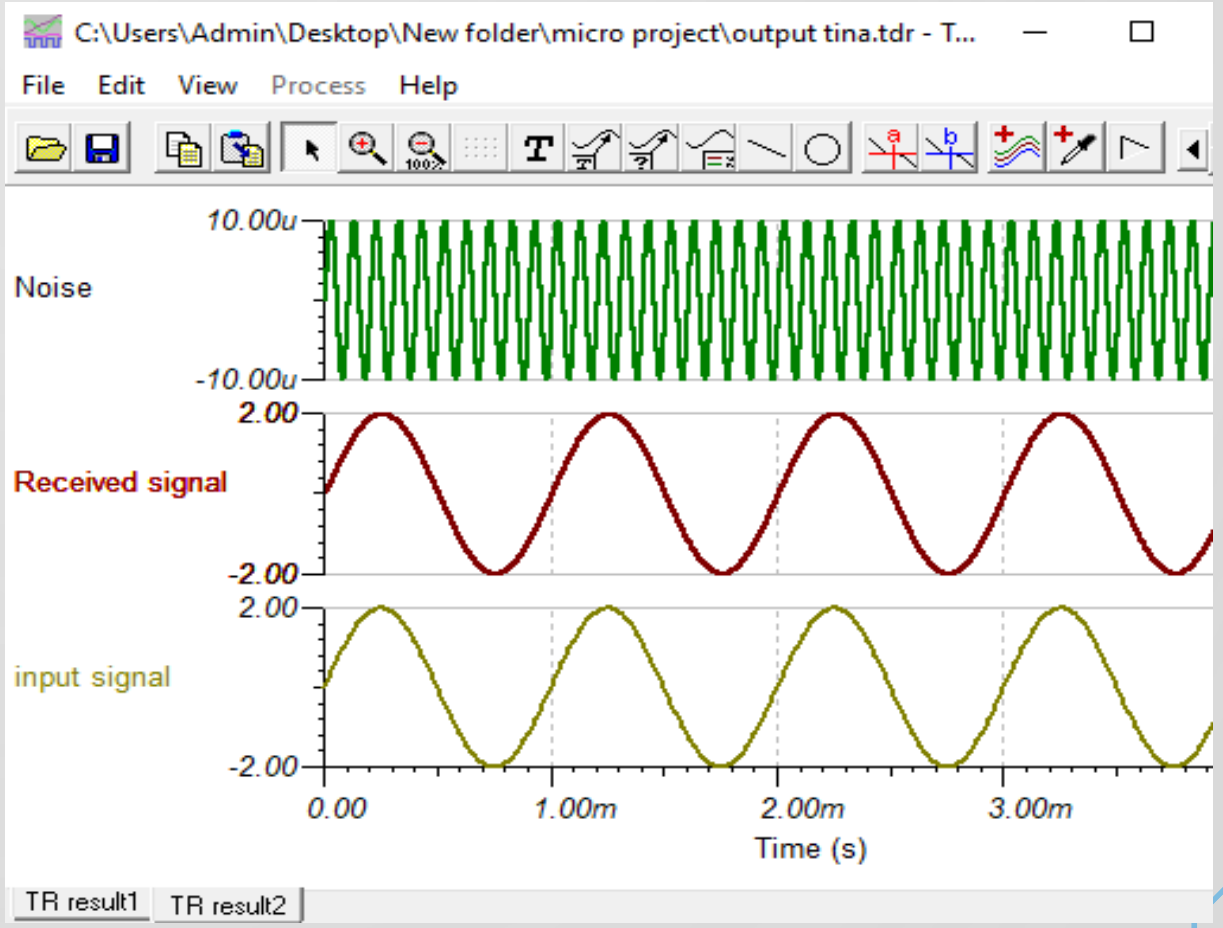
High Pass filter:

- Nullify DC offset voltage and attenuate the Noise component in the signal.
- Cutoff frequency set to 10Hz



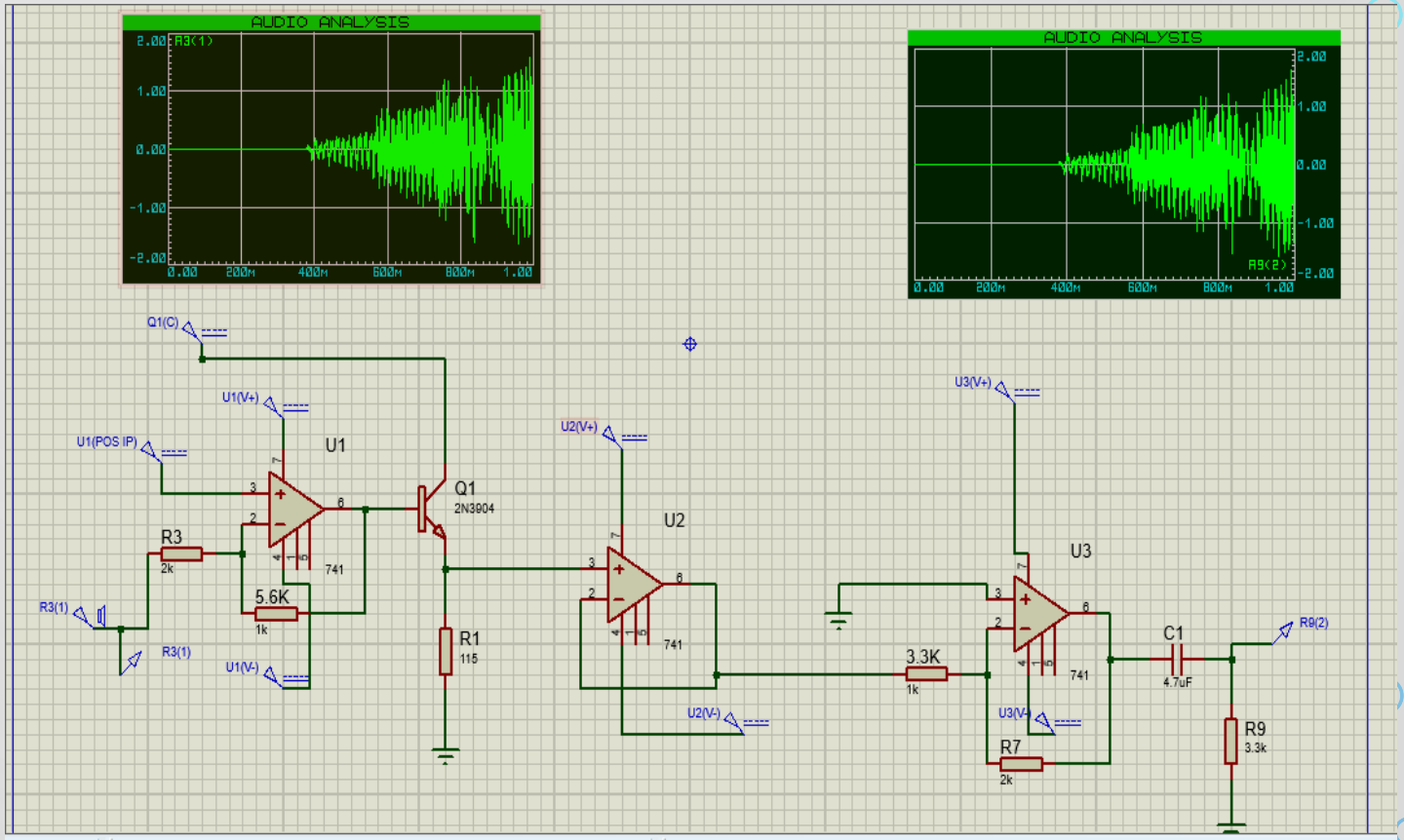
TINA Result:

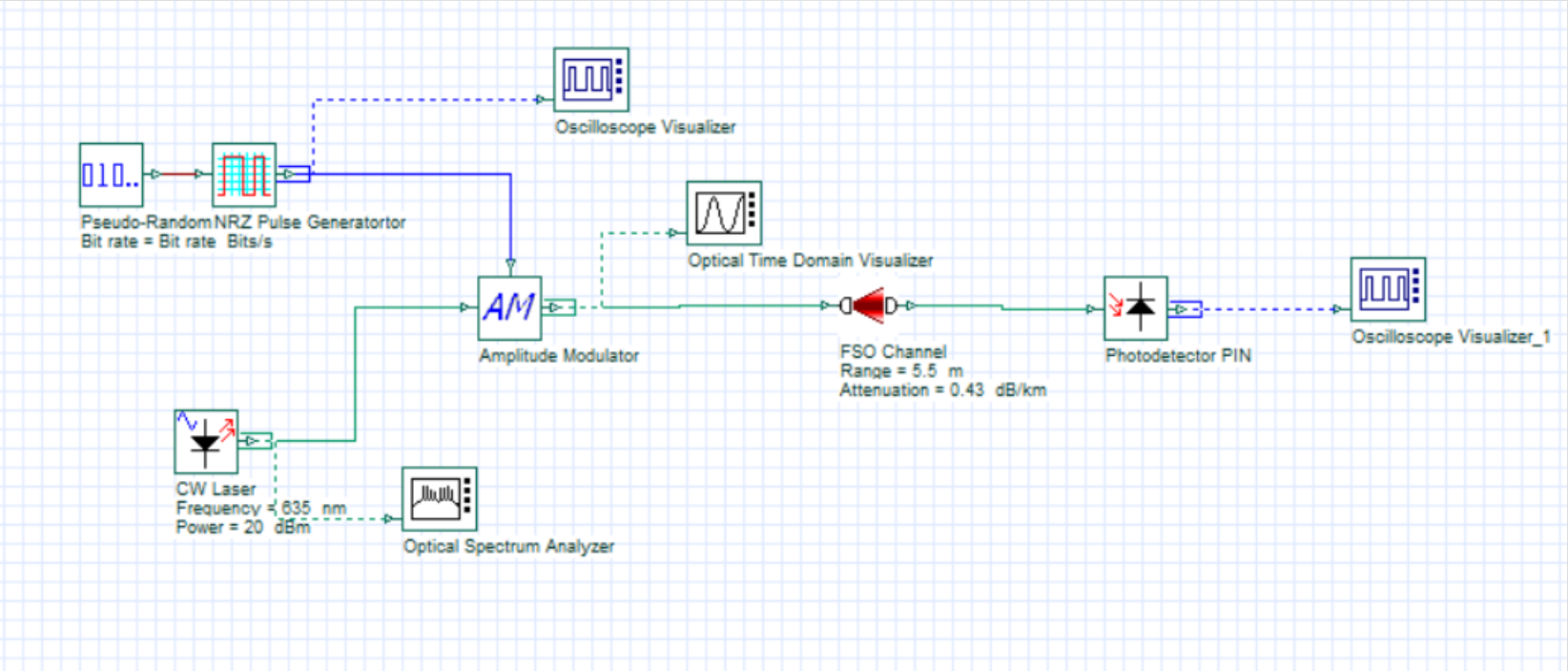
- To simulate Design 4V peak to peak sine wave i.e (+2V to –2V) is given as input.
- Noise of 10uv and frequency of 10khz is given to the op amp.
- Both message signal and received signal are identical.



Audio Analyzer in PROTEUS :

- Same circuit is simulated in Proteus by using audio analyzer.
- Input to this circuit is WAP audio file.
- Both Input audio signal and Received audio change are identical.

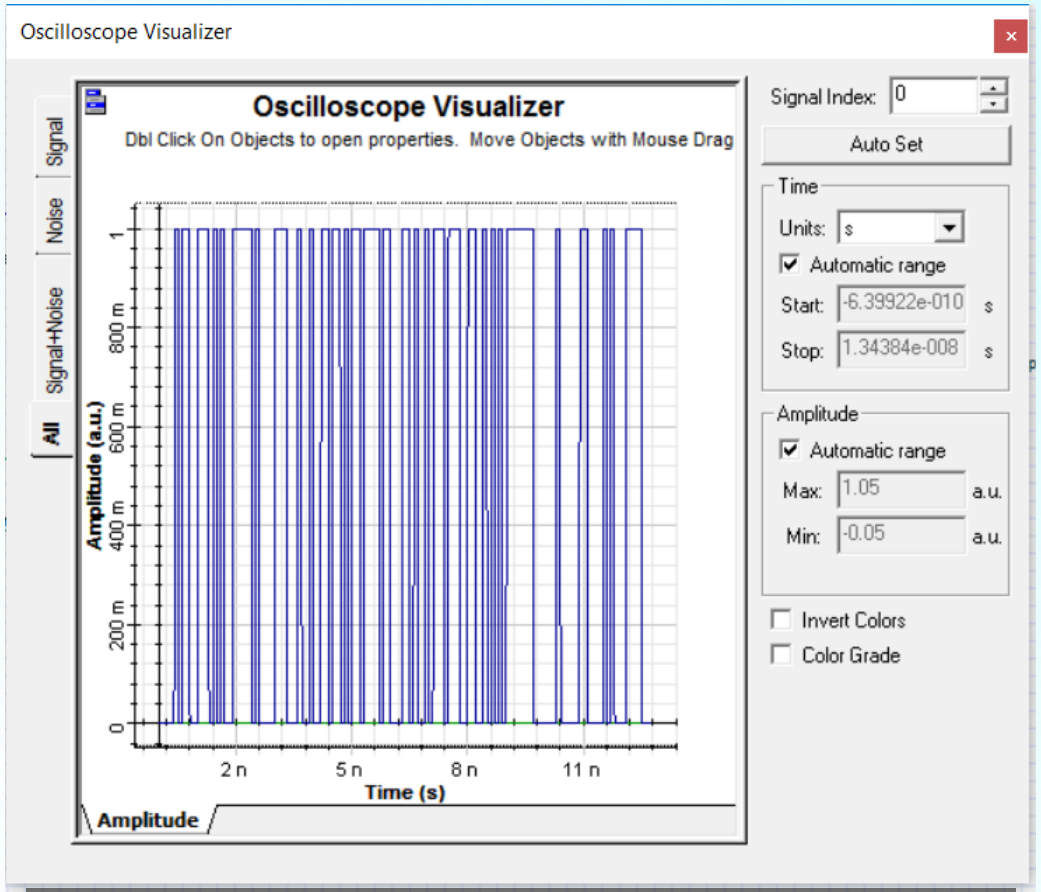




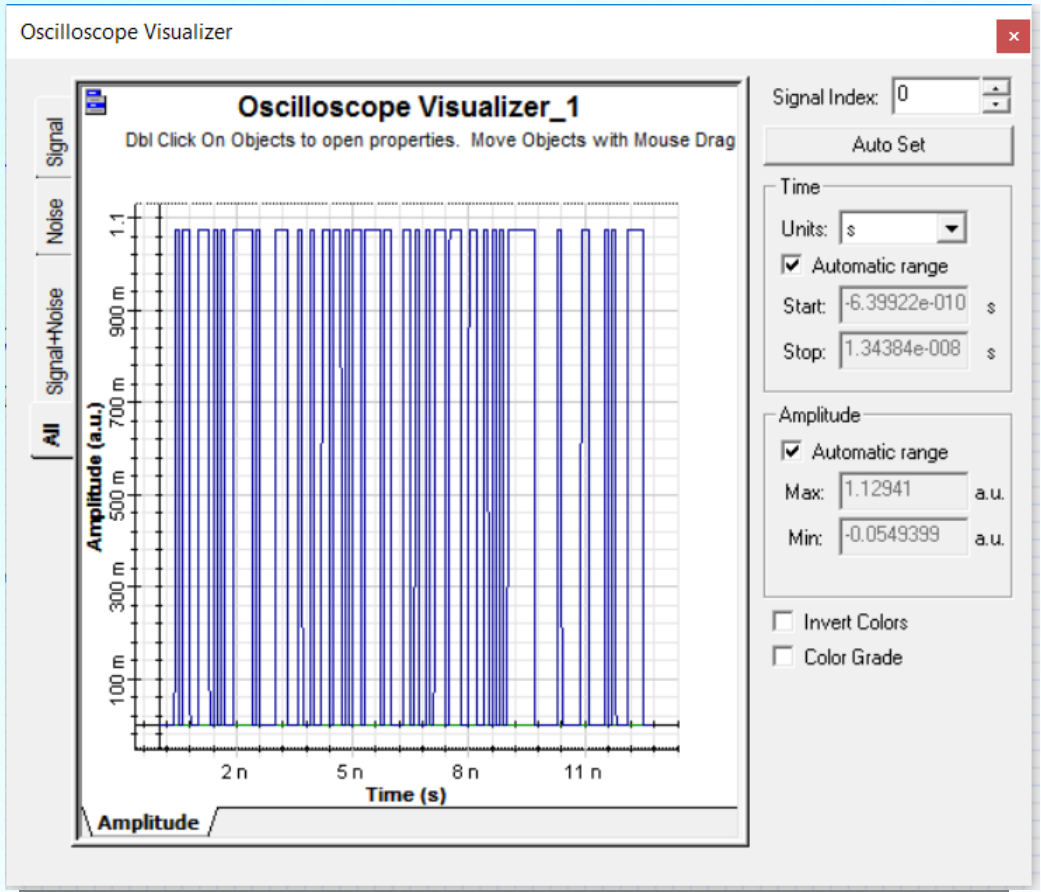
OptiSystem Simulation:

- CW Laser provides continuous laser output .
- NRZ pulse generator converts the random bit sequence into electrical signal.
- Amplitude modulator block is used to change the intensity of laser according to given pulse.
- FSO channel provides a channel for laser beam to travel.
- Photodetector gives us the output .

Results of OptiSytem Oscilloscope Visualizer:

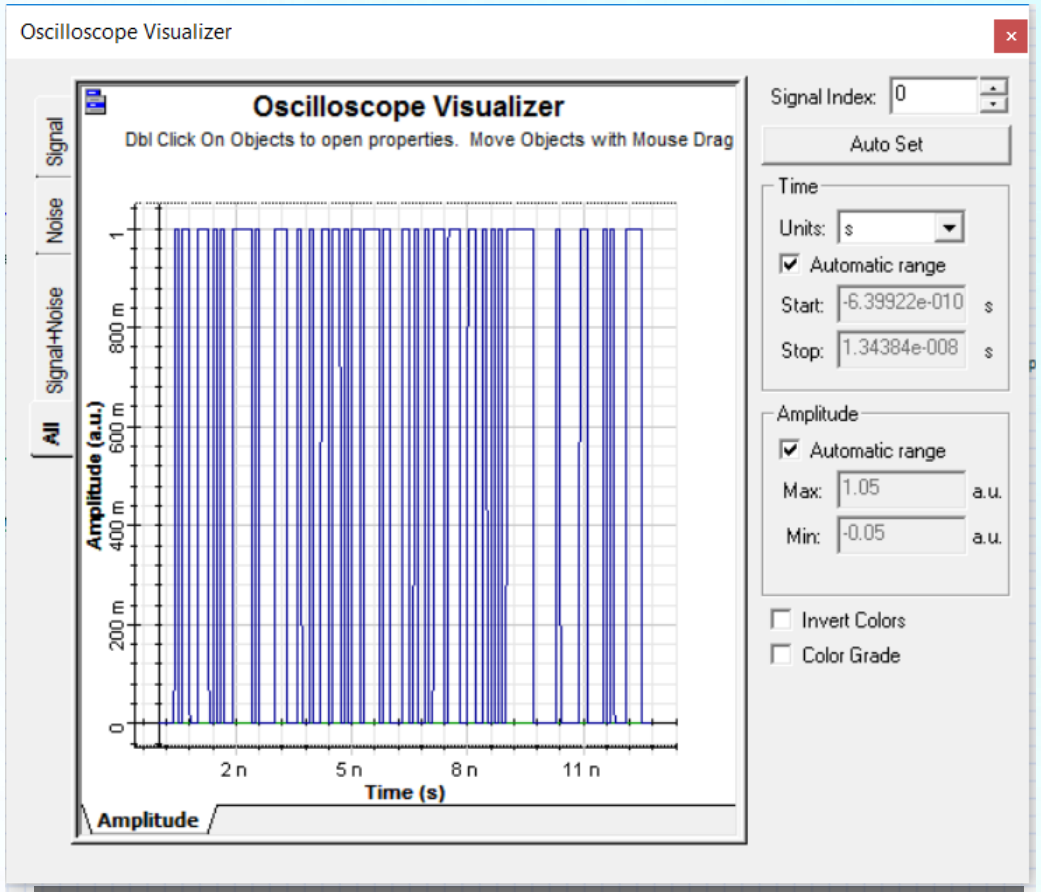


Input Signal:

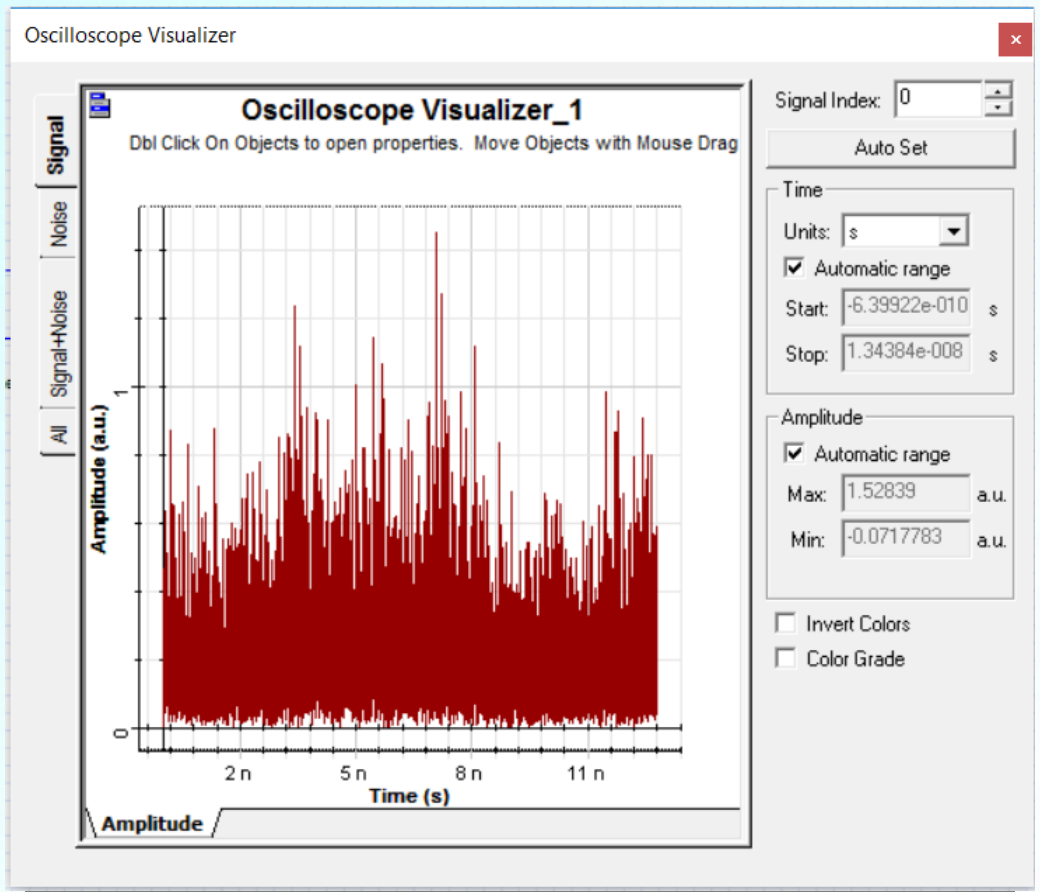


Output Signal:

Results of OptiSytem Oscilloscope Visualizer, when led is used instead of Laser Diode



Input Signal:



Output Signal:

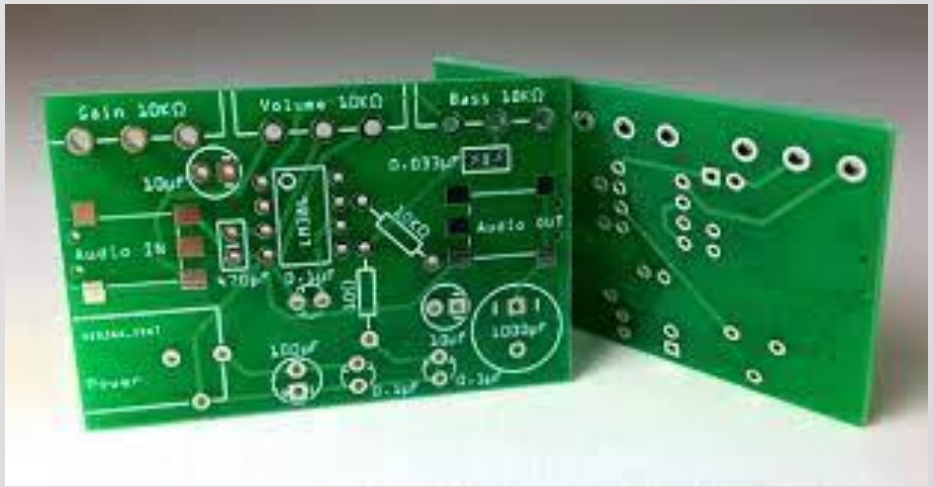
Significant amount of noise seen in receiver

PCB design and Circuit Board making:

- Altium Circuit Maker which is a freeware is used to design the PCBs for both the transmitter and receiver circuits.

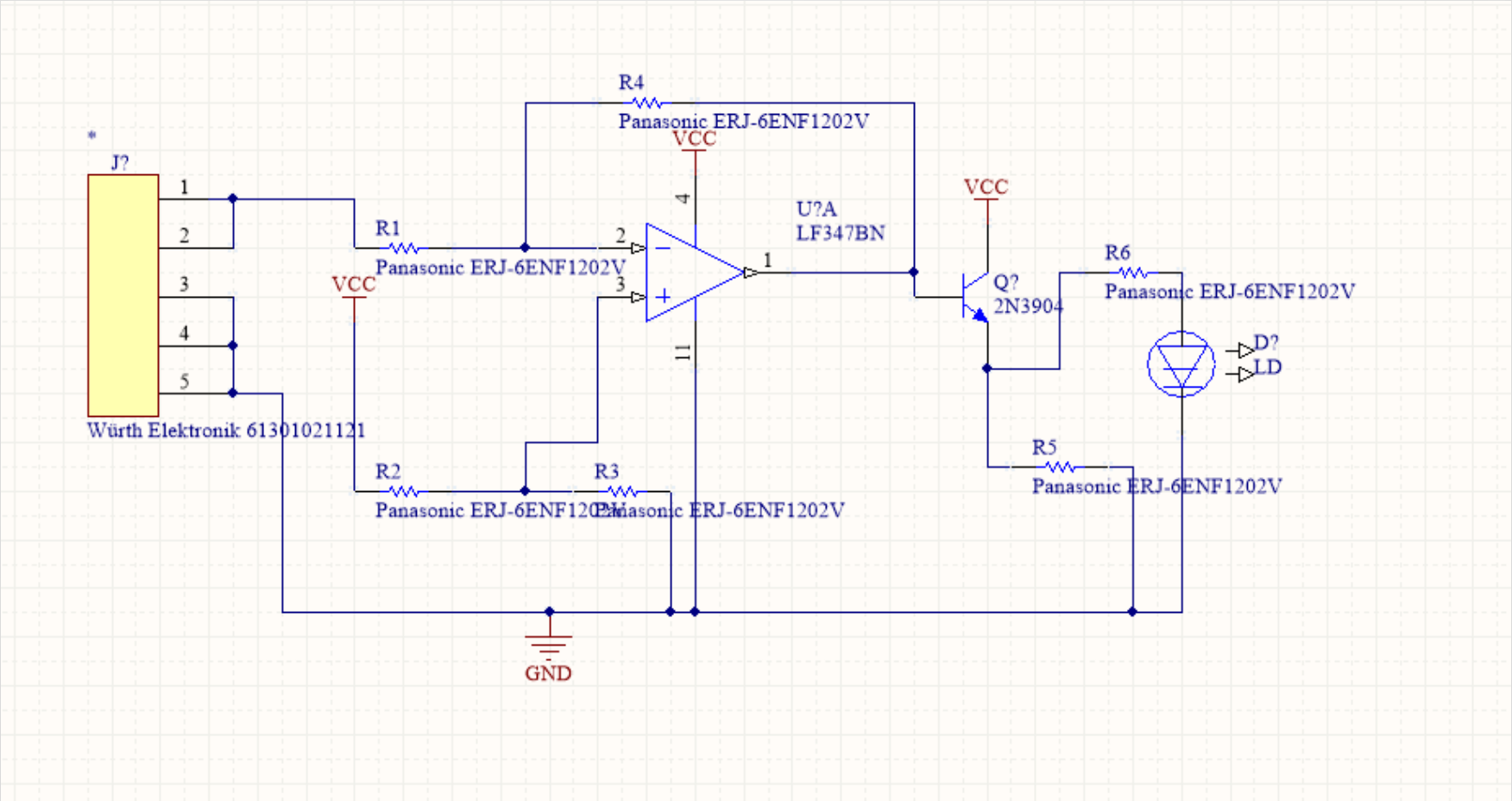
- Specifications:
- Transmitter
  6x 3.9 cm sqr

- Receiver
  3.6 x 2.6 cm sqr

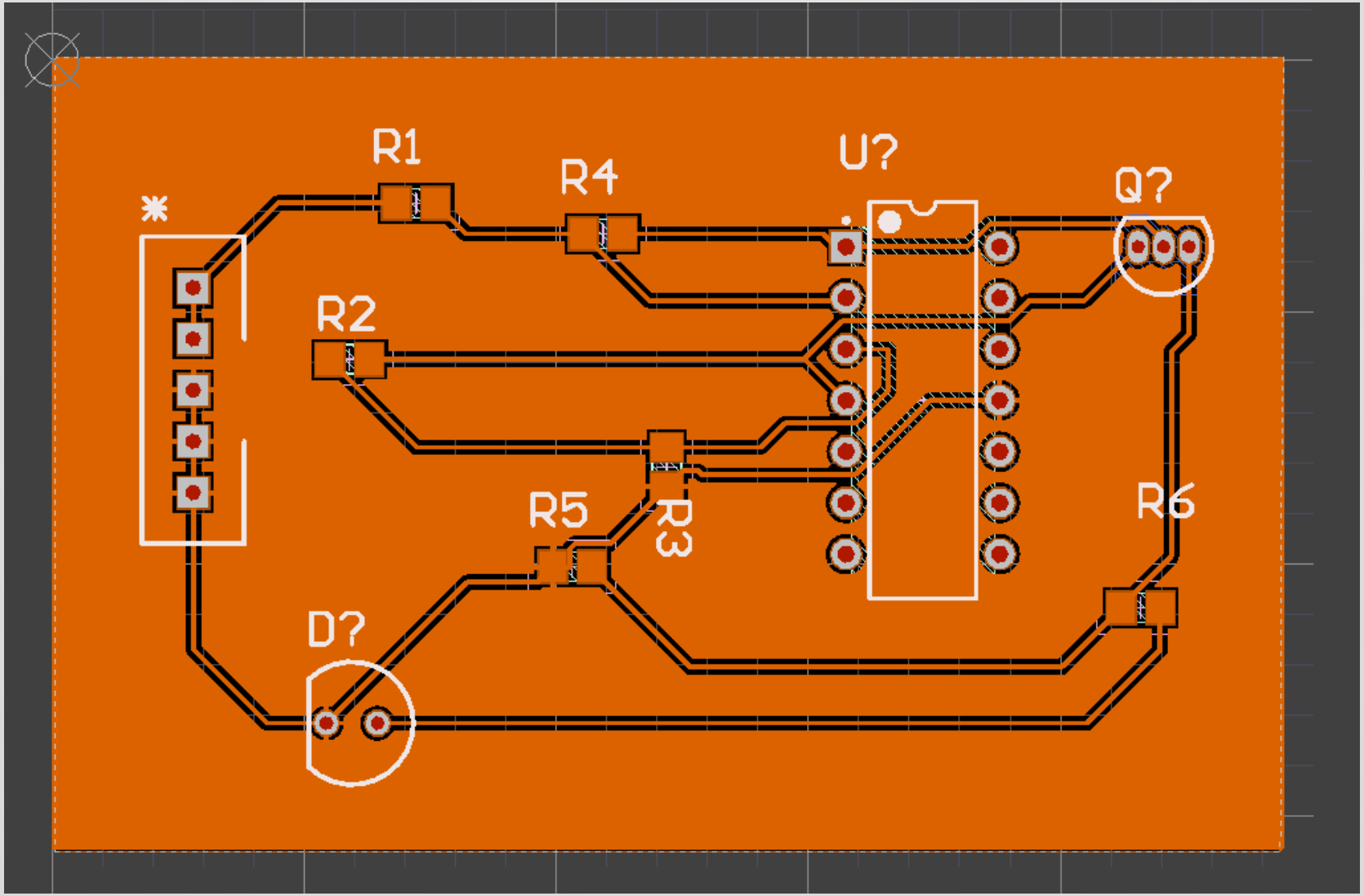


Transmitter:

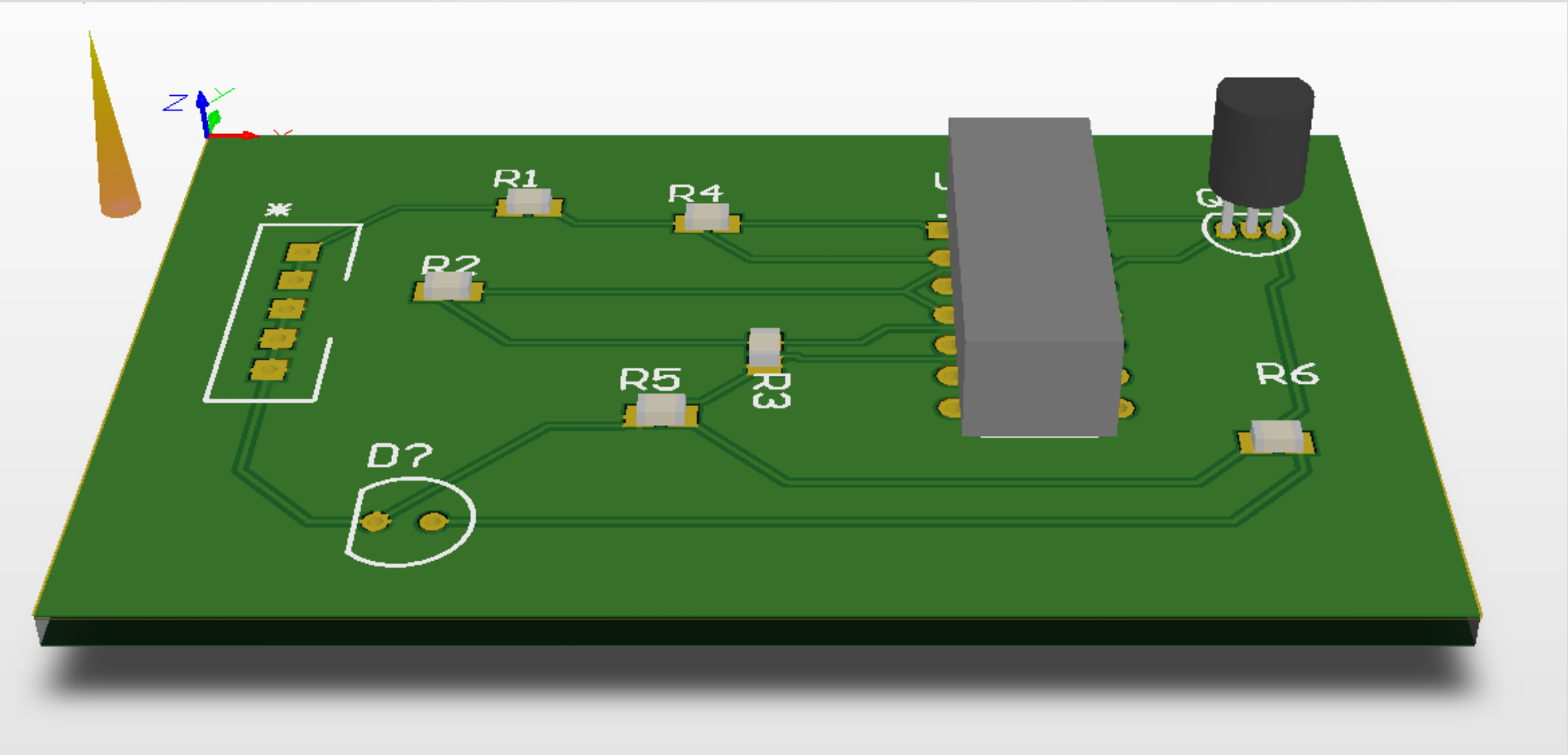
Schematic:



PCB Layout:

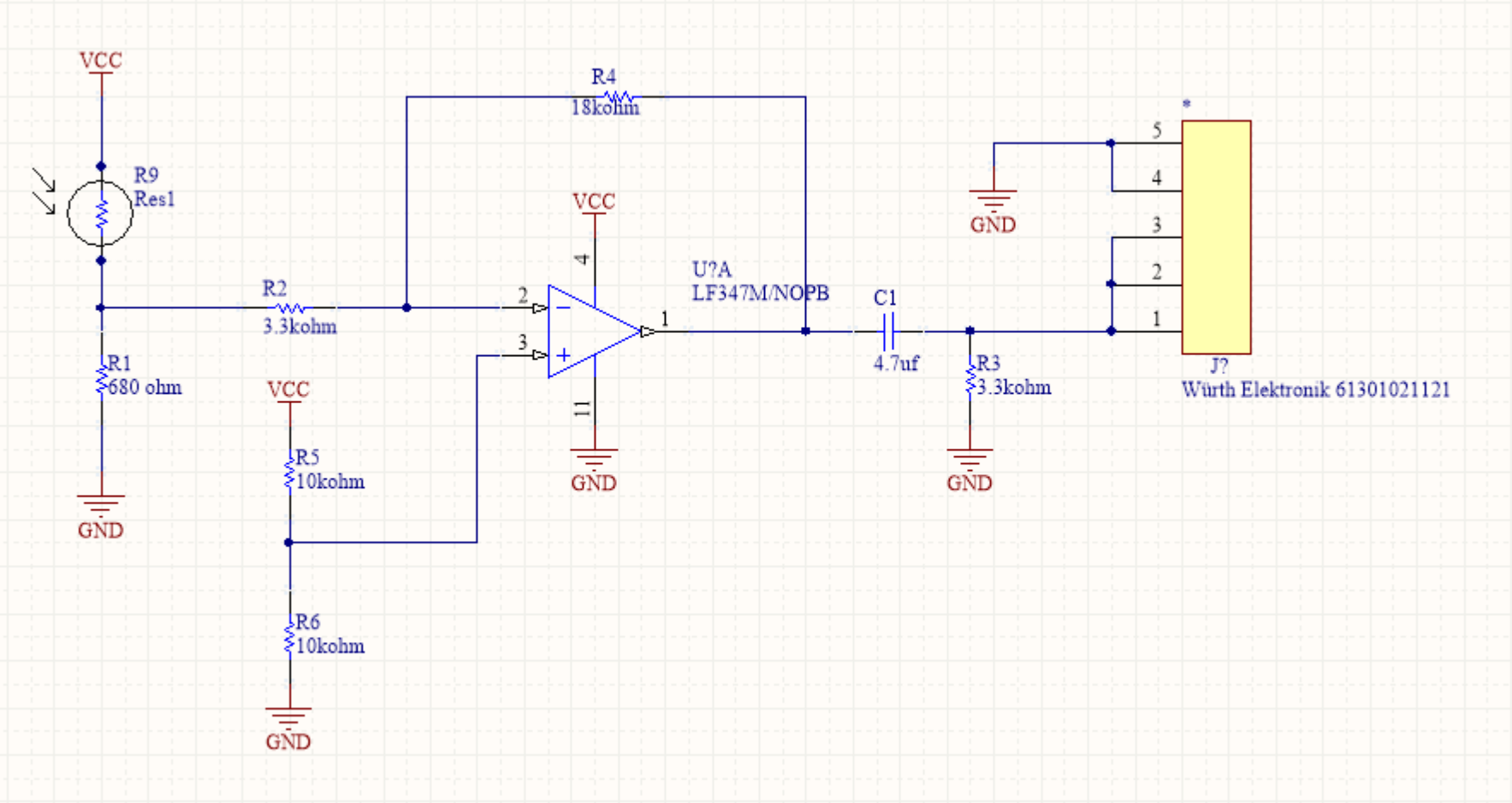


3D View:

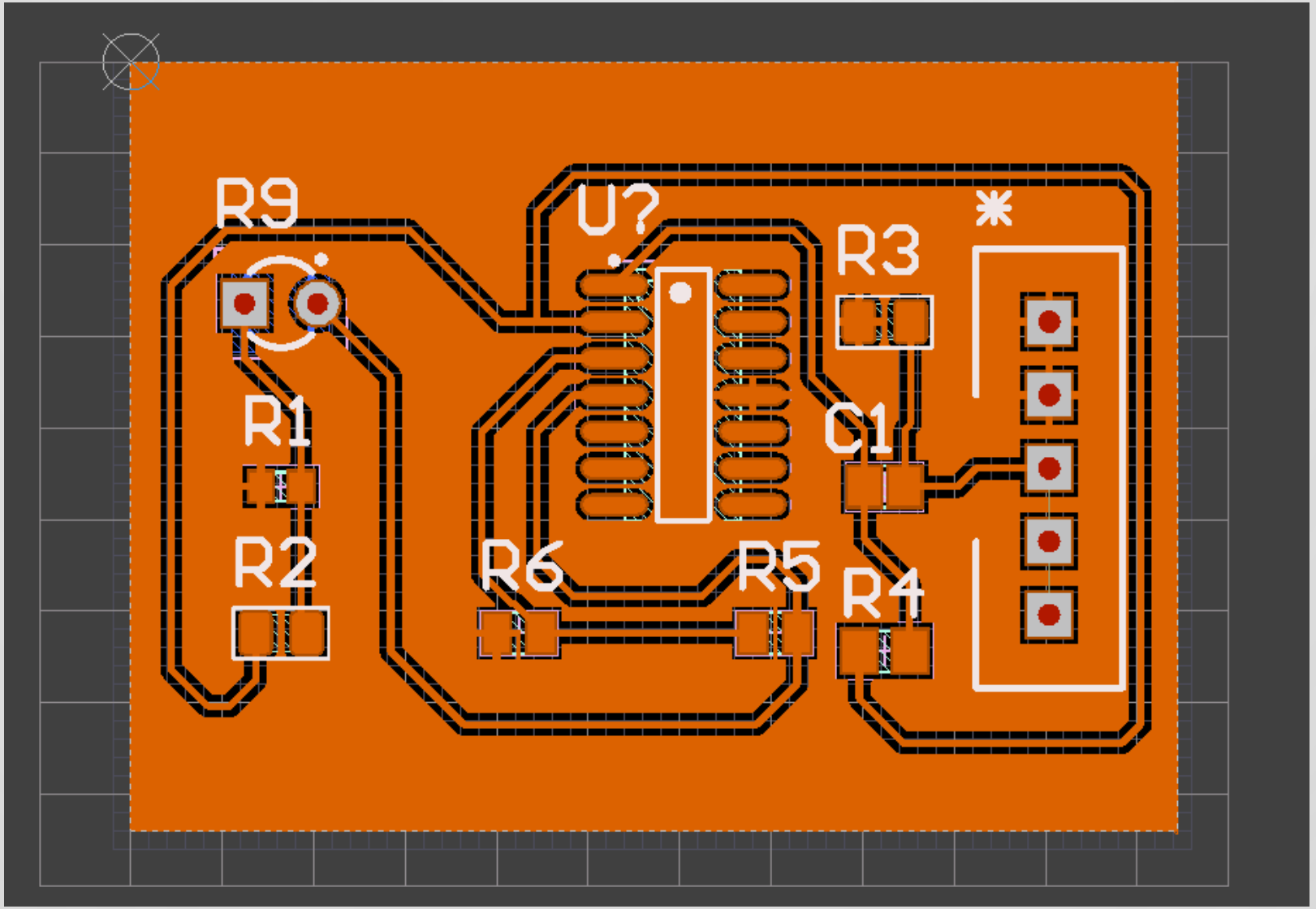


Receiver:

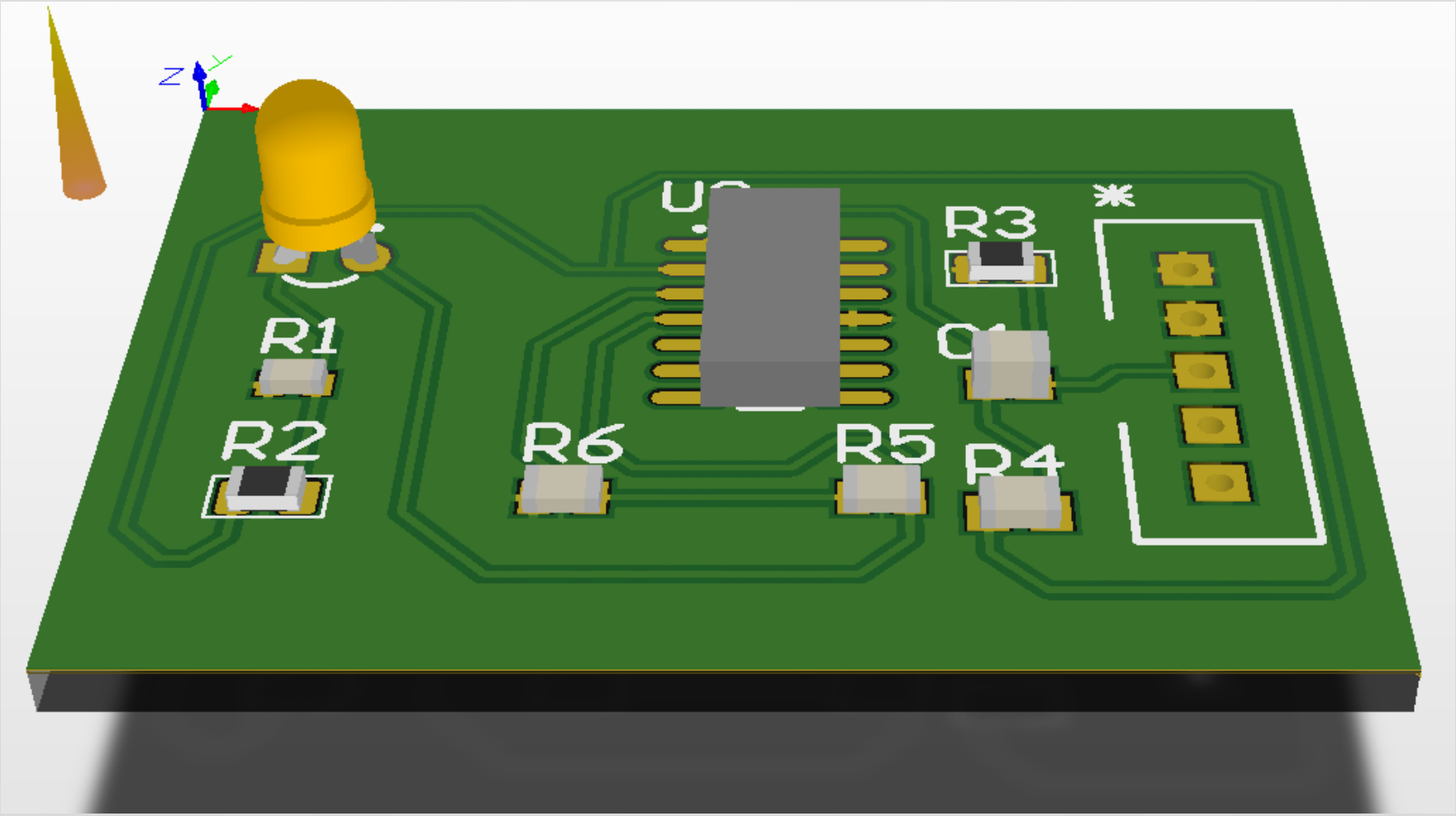
Schematic:



PCB Layout:



3D View:



Conclusion:

- From the results obtained from simulation on both the soft wares , output and input contains same waveform as shown in slide 18 with negligible amount of noise in output

- Also, we can conclude that though it has advantages like high efficiency, high speed but it requires source and receiver in line of sight, also it is costly.

Conclusion:

- From the simulation results with LED in place of laser we can say that output obtained same with significant amount of noise. Hence communication link is established efficiently between transmitter and receiver in case laser instead LED.

- For obtaining high accuracy results , high power LEDs can be used . Popularly known as LI-fi technology

References:

- https://www.allaboutcircuits.com/projects/build-a-laser-communication-system/
- https://www.online-sciences.com/the-waves/the-importance-of-lasers-in-communication-and-advantages-of-fiber-optics-cables/
- Youtube videos for PCB design making.