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Data Transmission through Ultrasonic Sound

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Abstract

- This project is an approach towards establishing a secure data transmission using ultrasonic sound.
- Short-range connectivity among electronic devices is essential to build a connected world.
- The rapidly increasing technologies of communication have a common purpose of increasing data rates and a hack-proof communication.
- Radio Frequency based wireless communication rely on high power transmitters.
- This prototype consists of a simple transmitter and receiver circuit which employs ultrasonic transducers to transfer data

Introduction

- Data can be transmitted with standard speakers and microphones.
- Establishing a Bluetooth or Wi-Fi connection takes multiple seconds, whereas sound playback or recording can start in tens of milliseconds.
- Ultrasonic bypasses the physical limitation of short-range RF.
- Unlike RF, ultrasonic does not pass through walls, data is “within earshot.”
- Properties of sound enable quick localised data transfers which is key factor in sharing resources based on proximity.[3]

Problem Statement

Design a prototype that is able to transfer digital data using ultrasonic sound

#	Details	Value	Unit
1	Transmission Length	20	centimetre
2	Transmitter Power	100	Milli Watt
3	Power Supply	5	Volts
4	Transmission Speed	80	bps
5	Ultrasonic Sound frequency	40	kHz
6			

Literature Survey

- **Kerry D. Wong, "A Sensitive DIY Ultrasonic range sensor", 2011**

This paper discusses about ultrasonic transducers. This paper also introduces us to the transmitter circuit.

It uses a bridge circuit produces an output voltage roughly twice the Vcc. [6]

- **Pascal Getreuer , Chet Gnegy, Richard F. Lyon, Life Fellow, IEEE, and Rif A. Saurous. "Ultrasonic Communication Using Consumer Hardware", 2018**

The 18.5 to-20 kHz is inaudible to most humans and yet realizable with commodity speakers and microphones in mobile devices.

Speakers of common phone produces 74 dB SPL at 18 kHz whereas the threshold is 86 dB SPL to be audible. [1]

Literature Survey

- **Jonny Biguenet, "Ultrasonic data "transmission" , 2016**

This paper gives us an insight about the problems faced during the design of transmitter and receiver circuit.

Audio hardware limitations include inability of transmission of binary data through normal speakers.

- **V A Zhmud1, N O Kondratiev1, K A Kuznetsov1, V G Trubin1, L V Dimitrov, "Application of ultrasonic sensor for measuring distances in robotics", 2018**

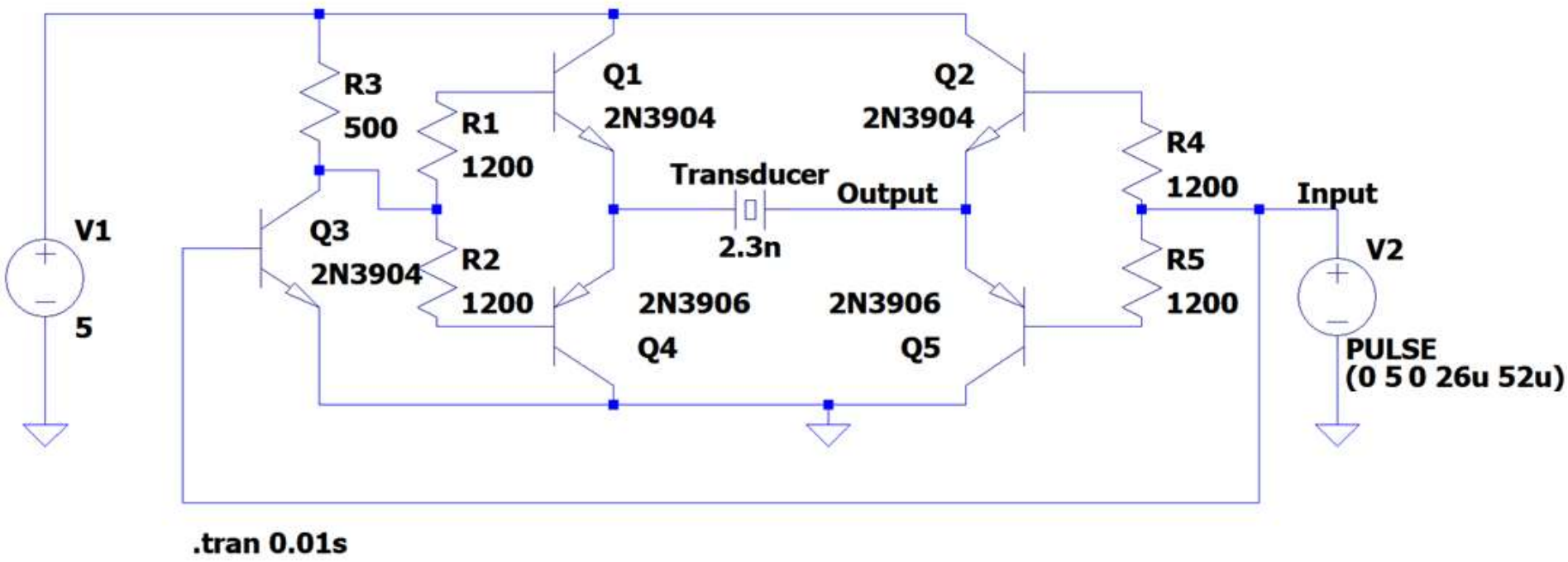
This paper gives an idea about working and internal circuits of ultrasonic sensor HC-SR04.

The ultrasonic transducers used in this sensor respond to binary data. The circuits assisted in designing the receiver and transmitter circuit.

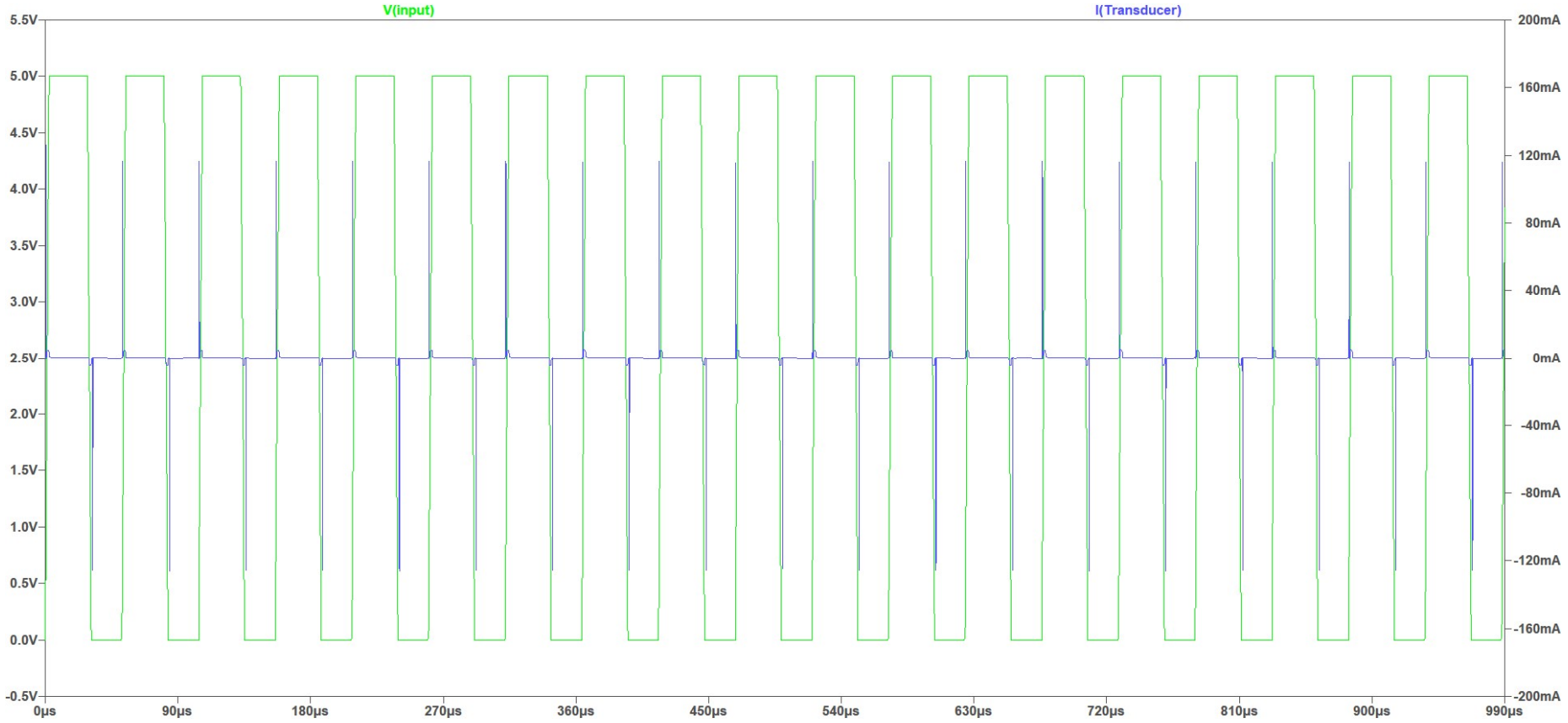
Approach


Microcontroller
Ultrasonic Transmitter
Ultrasonic Receiver
Microcontroller
Data to be sent
Data received

Transmitter Schematic

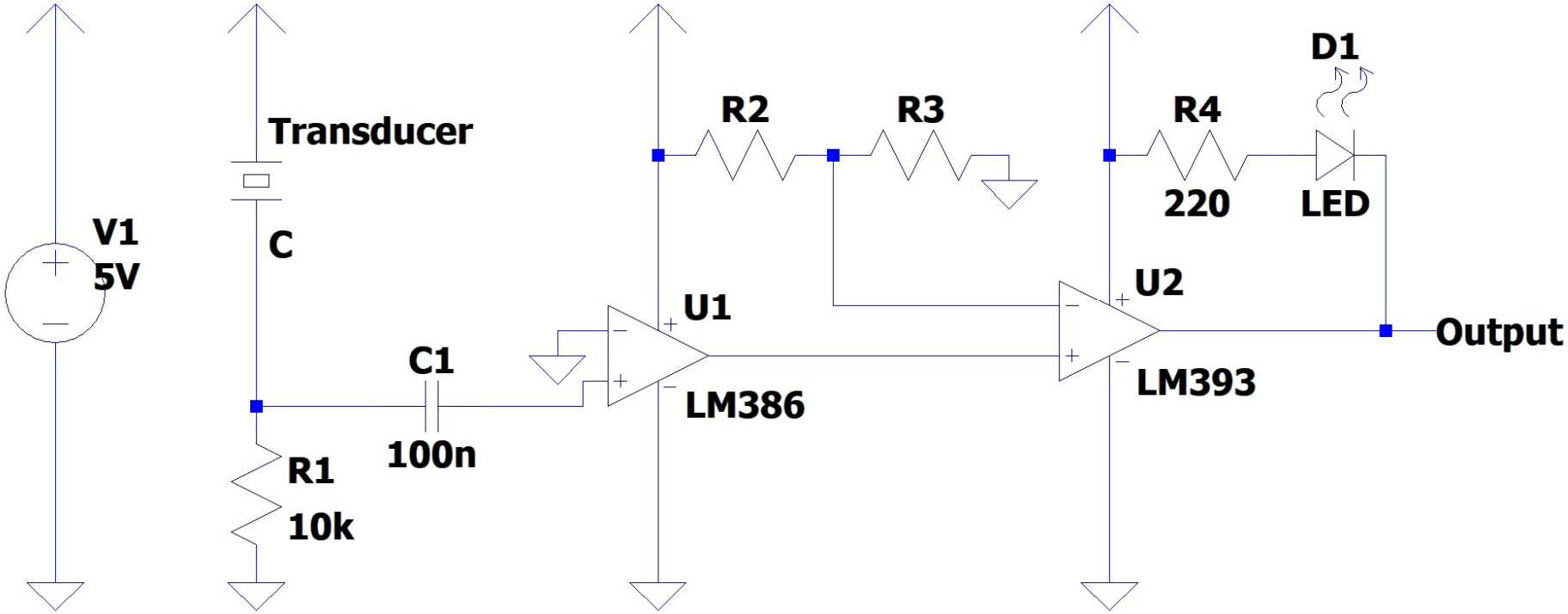


Transmitter Circuit Simulation

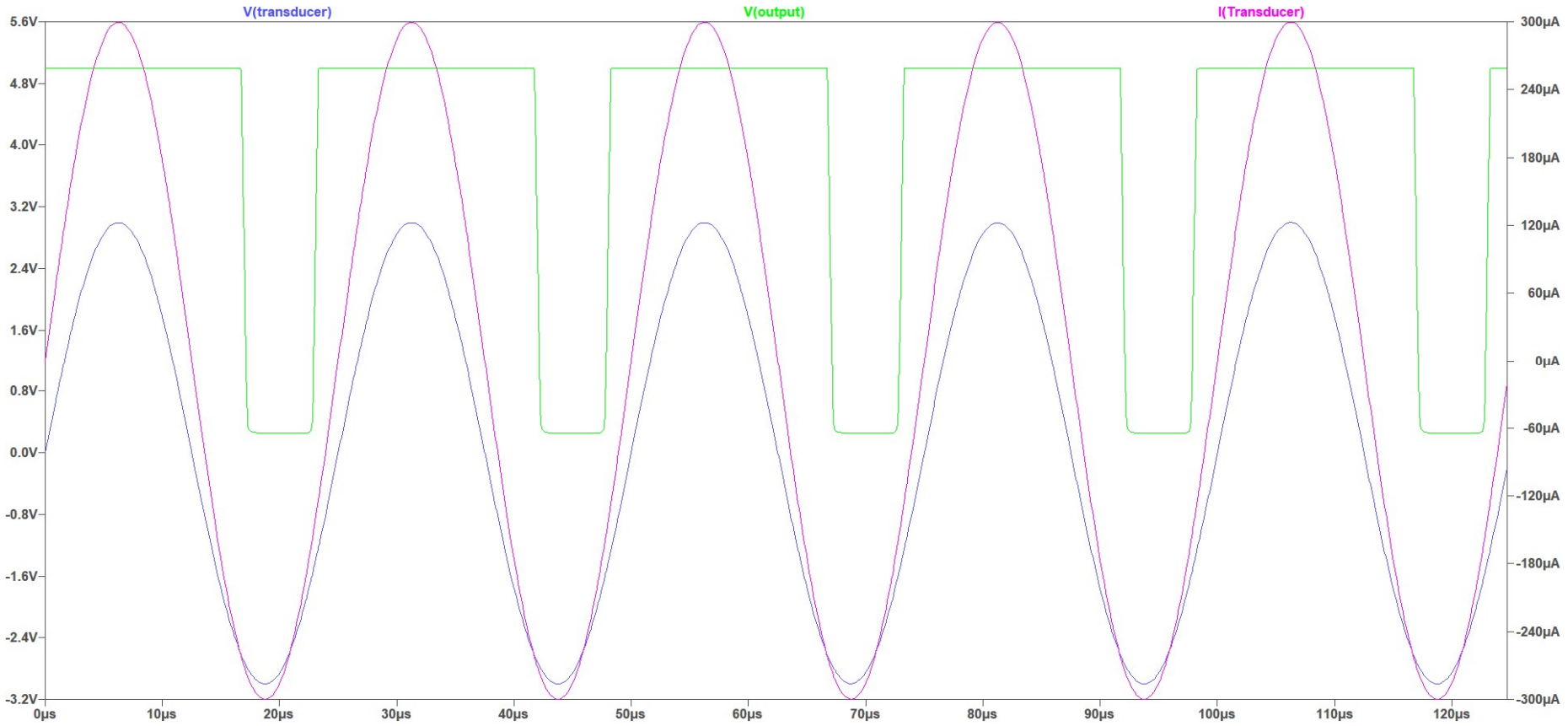


Simulation of Ultrasonic Transducer Driver Circuit on LTSpice software

Receiver Schematic

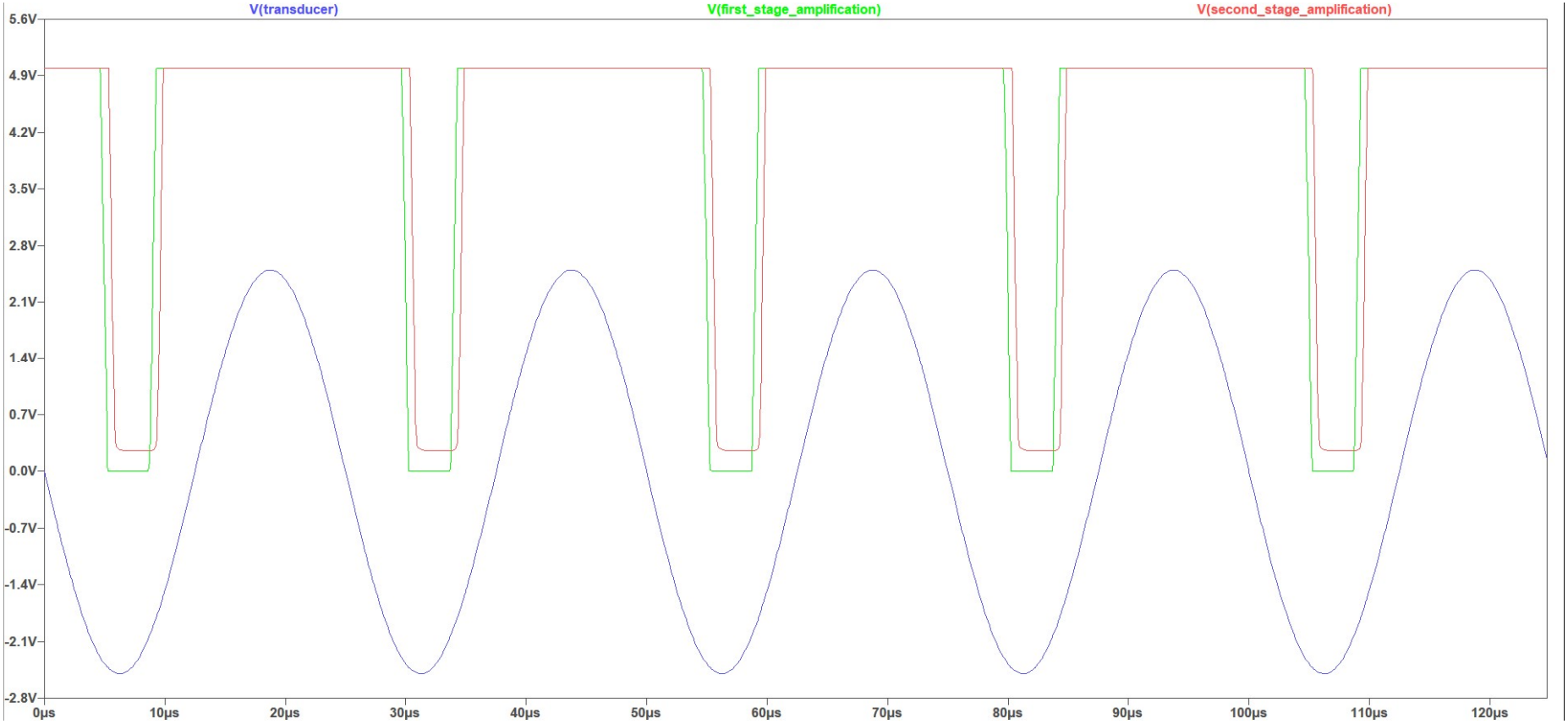


Receiver Circuit Simulation



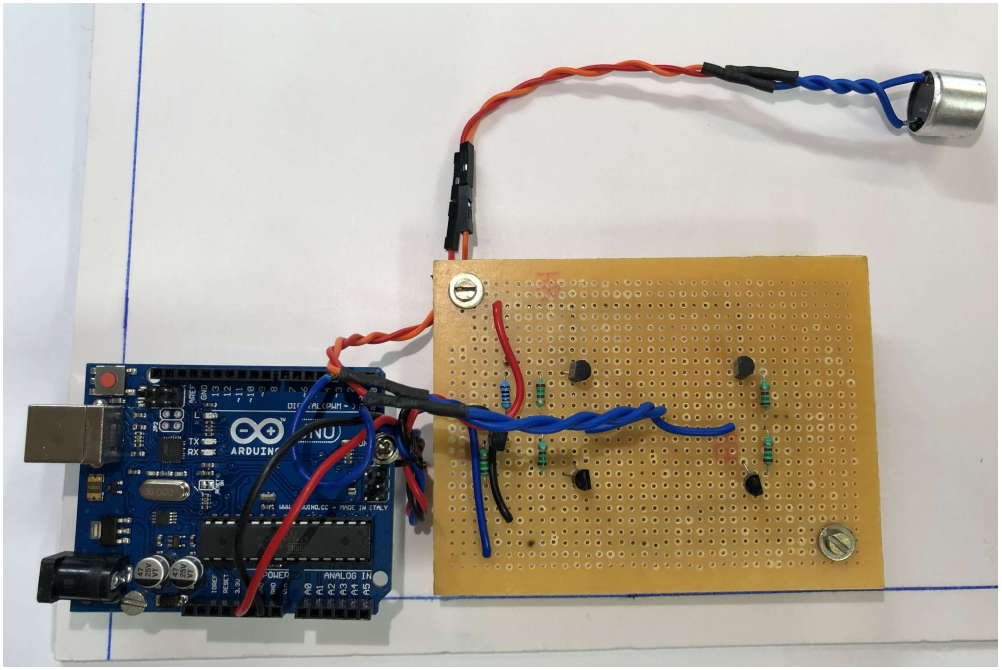
Simulation of Receiver Circuit on LTSpice software

Receiver Circuit Simulation

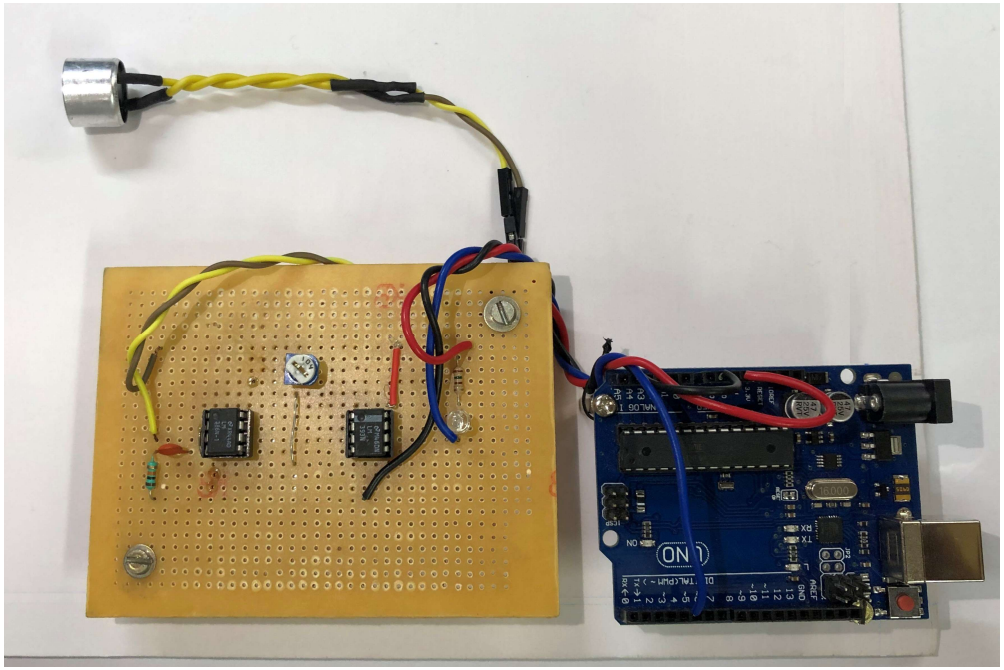


Simulation of Receiver Circuit on LTSpice software

Developed Hardware

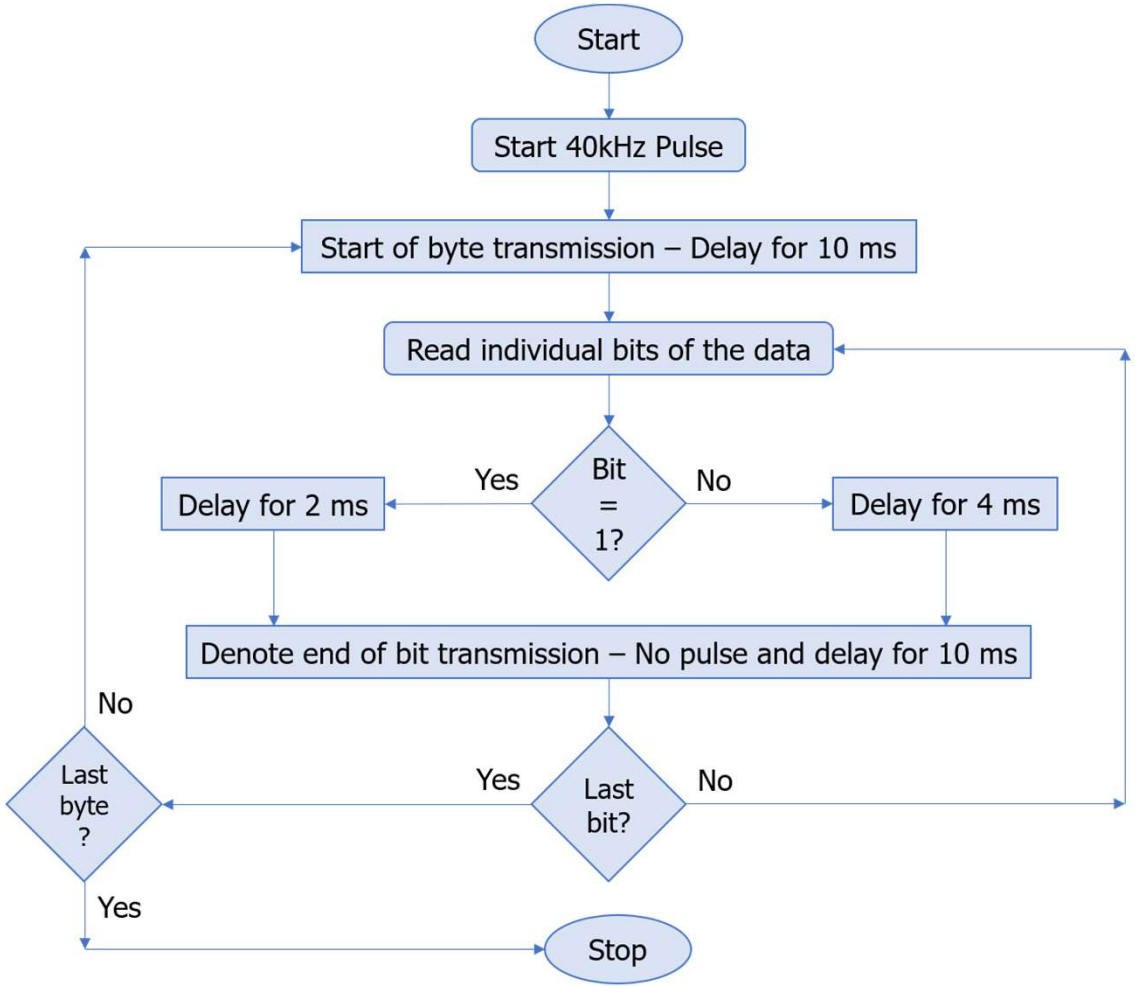


Transmitter Hardware

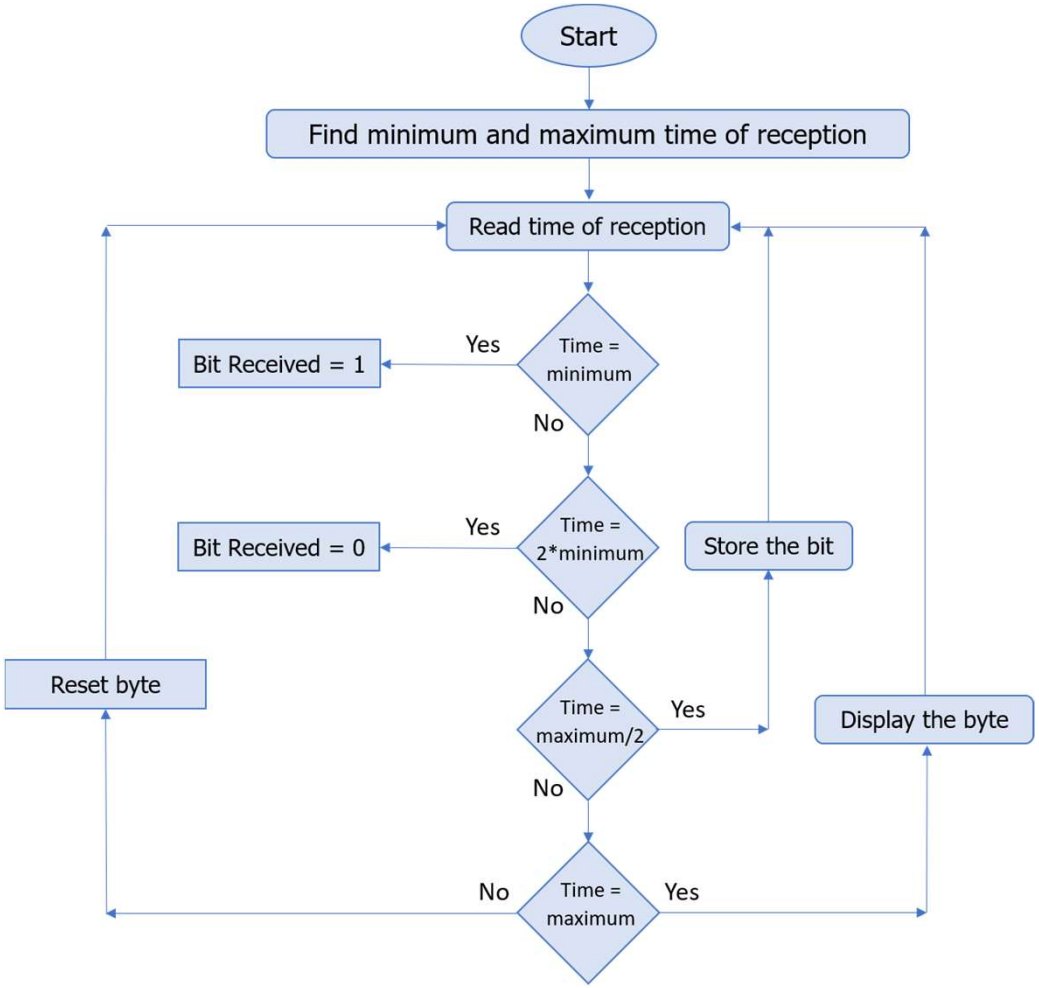


Receiver Hardware

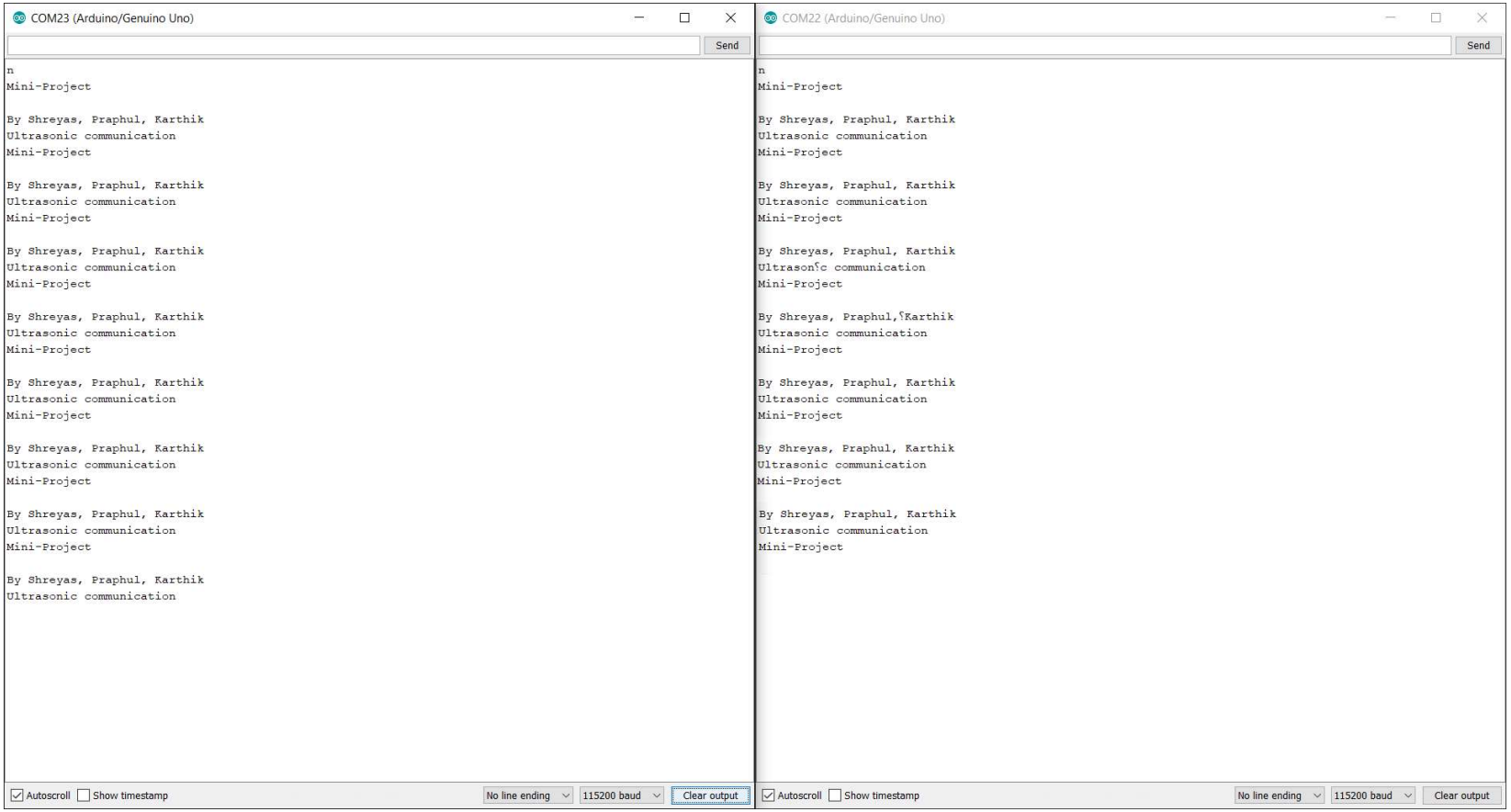
Transmission Algorithm



Reception Algorithm



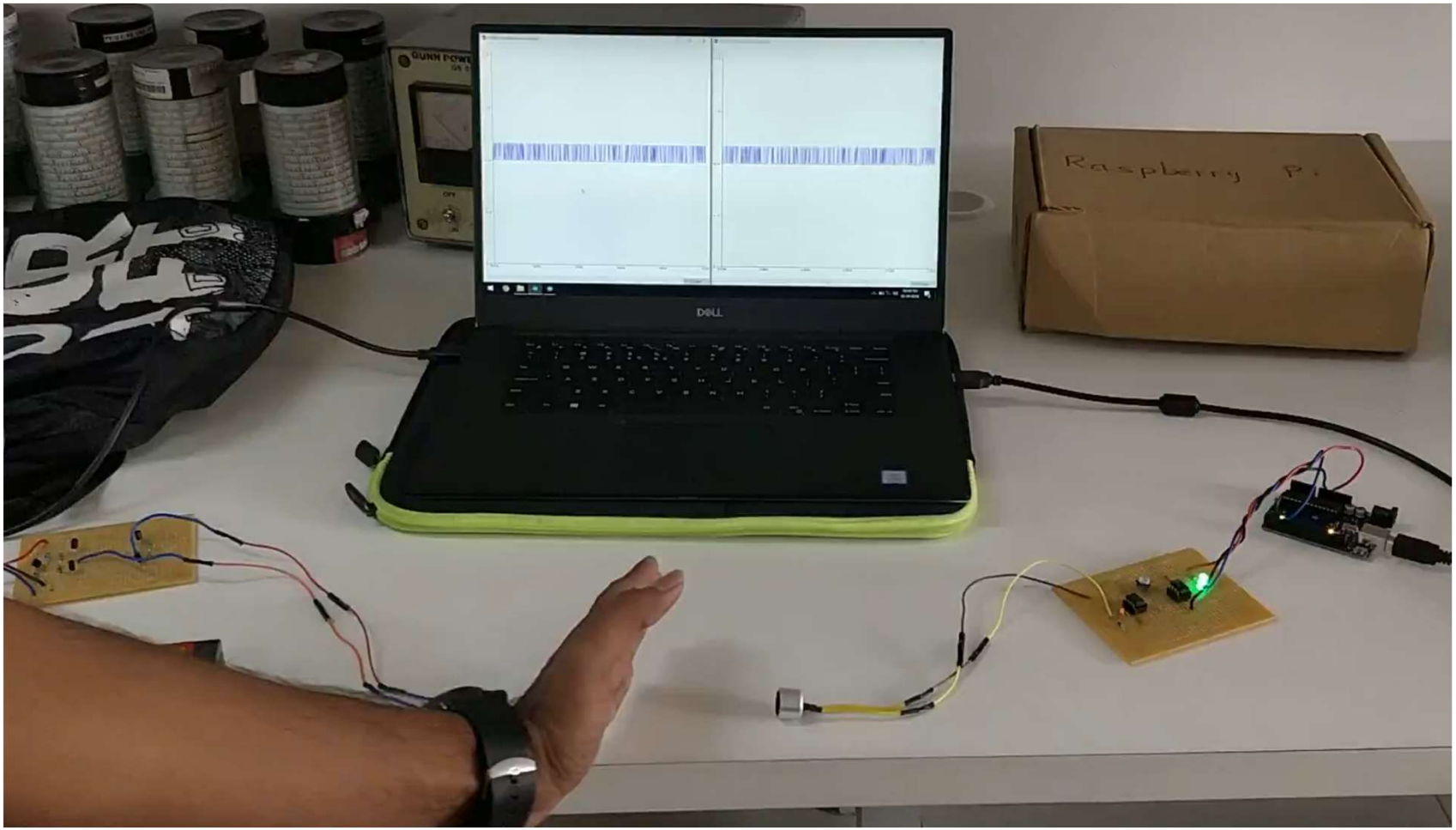
Results



Output in Serial Monitor of Transmitter of data transmitted

Output in Serial Monitor of Receiver of data received

Demo Video



Applications

- Ultrasonic data transmission can be used under-water.
- Short-range resource sharing between devices.[4]
- Data transmission in places where electromagnetic radiations are harmful e.g. Petrol bunks, Healthcare

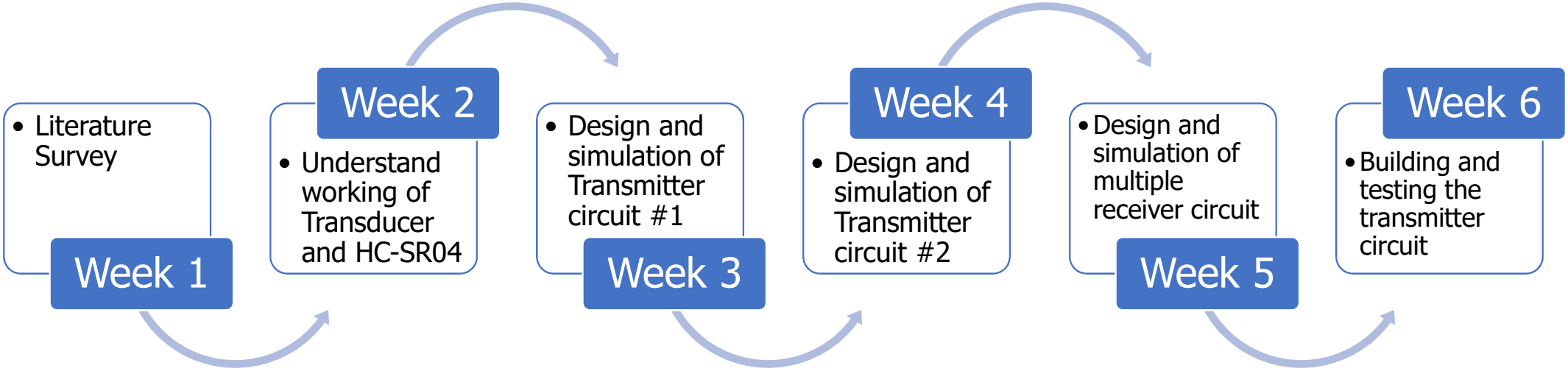
Conclusion

- Data can be effectively transmitted with ultrasonic sound with considerable transmission speed.
- Data Transmission through ultrasonic sound can be employed for short ranges and small data packets.
- The designed prototype works only when transmitter and receiver transducers are in line-of-sight.

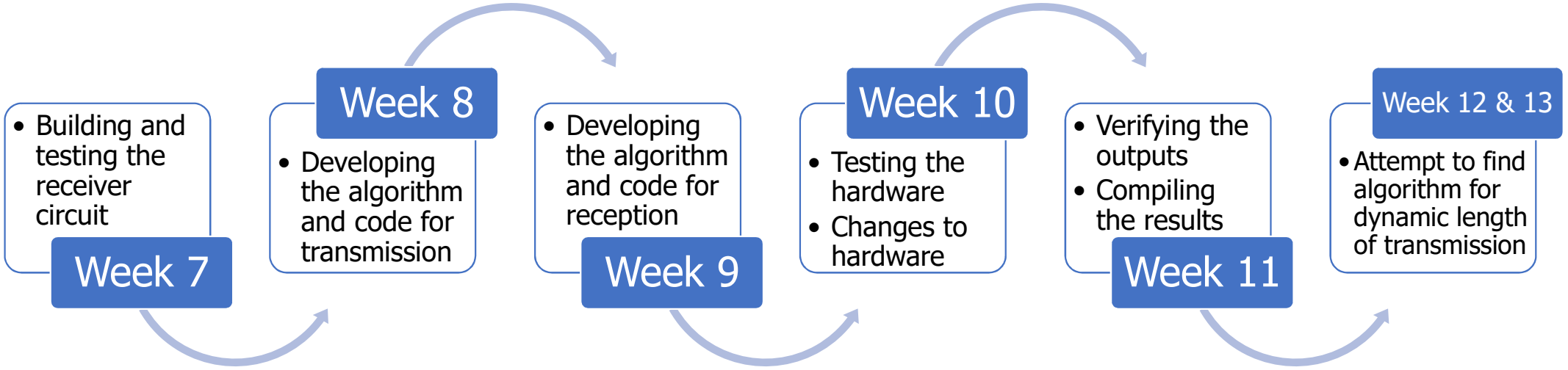
Future Scope

- To improve the prototype for dynamic length of transmission
- Find better, efficient algorithm to increase the speed of transmission
- Interface with smartphones
  - To help in transfer of data in electromagnetic sensitive zones.
  - To help in pairing of devices. [4]

Progress Timeline



Progress Timeline



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1. Pascal Getreuer, Chet Gnegy, Richard F. Lyon, Rif A. Saurous, “Ultrasonic Communication Using Consumer Hardware”, IEEE Transactions on Multimedia, Volume: 20, Issue: 6, pages: 1277 – 1290, 2017.
2. Igor Bisio, Alessandro Delfino, Aldo Grattarola, Fabio Lavagetto, Andrea Sciarrone, "Ultrasounds-Based Context Sensing Method and Applications Over the Internet of Things", Internet of Things Journal IEEE, vol. 5, no. 5, pp. 3876-3890, 2018.
3. Jafar Saniie, Boyang Wang, Xin Huang, "Information Transmission Through Solids Using Ultrasound Invited Paper", Ultrasonics Symposium (IUS) 2018 IEEE International, pp. 1-10, 2018.
4. Thuy Ong, The Verge, “Google’s new payment app for India uses sound to transfer money”, 2017.
5. TeamLisnr, “How Ultrasonic Data Transmission Compares to RF Protocols”, 2018.
6. Kerry D. Wong, “A Sensitive DIY Ultrasonic Range Sensor”, 2011.

References

kHz	Kilo Hertz
bps	bits per second
RF	Radio Frequency
dB	Decibels
dB SPL	Sound Pressure Level (1 Pascal is equal to SPL of 94 dB)
m	meter
SNR	Signal to Noise Ratio
GND	Ground

Thank You