Two Way Phone Communicator

F. Johnson
Senior, Electrical Engineering Department
Southern University, Baton Rouge

Abstract

Student's projects undertaken during an electronics laboratory course can be an excellent learning experience to prepare the students for future circuit design projects. Participation in such courses allows the students to become familiar with electronic equipment as well as receive hands-on training that may be beneficial in the engineering field. A two way electronic phone communicator is used as a communication device between two persons. Furthermore the communicator can assist in presenting educational materials to hearing-impaired students. Through the use of a two-way phone communicator, the instructor can converse with an impaired student easier than compared to communicating without a special device. The communicator will not only provide a linkage between the students and the educator, but it will also give the students an opportunity to express any problems that they are having with the subject at hand. This communication device is built using a commercial power op-amp, a dual two-position switch, a master station, and other external components necessary for an effective communicator. The master station can be used as a speaker or microphone depending on the specifications of the user and the operation of the switch. Communication involving two or more people in the same building can be accomplished by using two or more different frequency settings. Further development can be made through use of proper filters and instruments.

Introduction

While pursuing a degree in Electrical Engineering, there are many core courses that help aide students in the engineering field. Some of those courses include Electrical Network Theory I & II, Electrical Network Laboratory, Engineering Electronics I & II, and Engineering Electronics Laboratory I & II. In Electrical Network Theory I & II, a student can receive an analysis of electrical networks in terms of natural response through methods of nodal and mesh analysis, superposition, and Thevenin's theorem, from dc to steady sinusoidal responses, and phasor analysis. The student is also able to cover the applications of forcing functions to networks, power, and energy; polyphase circuits, complex frequency and frequency responses; transformers, and other two-port networks. In Electrical Network Laboratory, the student is able to construct experiments demonstrating principles taught in the lecture classes. In Engineering Electronics I & II, the student receive an introduction to electronic devices, transistors, field-effect

transistors, vacuum tubes, and solid state power control devices, while studying the characteristics, uses, and models for each and computer modeling of these employing ECAP or its equivalent. The student is also able to study equivalent circuits of devices, "h" parameters, frequency, and transient response of small signal amplifiers, introduction to communication systems, and computer modeling of electronic systems using PSPICE or its equivalent. In Engineering Electronics Laboratory I & II, the student is able to construct practical experiments that relates to the topics introduced in the lecture classes.

Participation in those courses provides essential hands-on training beneficial to one's future. In Engineering Electronics Laboratory I & II, the student is required to do an electronics project relevant to the course subject. Those required projects can prepare the students for future design projects. The projects endeavored by the students help strengthen their design and technical engineering skills. Working on those projects also provides the student with familiarity with electronic equipment and components. Those same electronic equipment and components can be used to build a device suited for consumer use.

One such project that can be done in electronics laboratory courses is a two-way communicator. The two-way communicator is built using components that can be found in an electronics lab.

Uses of Two-Way Communicator

Communicator for Long Distance Communication

A two-way electronic phone communicator can be used as a communication device between two people. When two people are in the same building but not within a reasonable distance, the device can be used to help relay information. Person 1 holds the two way communicator distributor end while person 2 holds the receiver end. As person 1 talks into the distributor end, person 2 is able to hear through the receiver end. The process can easily be reversed by switching the switch. Once the switch is switched, the receiver end becomes the distributor end and vice versa.

Communicator for Hearing-Impaired Students

The two-way communicator can also assist in presenting educational materials to students with a hearing disability. With use of the communication device, those students can be placed in a typical classroom setting so not to interfere with the learning process of the other students. Students with hearing disabilities who are not using the device must be placed in a special class so that the instructor can communicate with the student easily but the subject matter is usually at a lower education level. The instructor must make preparations for the child that is not necessary for students without a hearing disability. The instructor must also spend more time on a particular subject matter in order to make sure that the information is explained thoroughly and accurately to the student. With help of the communicating device, students with a hearing disability can work at their aged-defined education level while receiving the same instruction as non-impaired students.

Types of Hearing Disabilities

Hearing-Impaired

The general term used to describe and encompass all types of hearing deficits, ranging from a very minute loss to profound deafness. Hearing impairment is the single most prevalent chronic physical disability in the United States, affecting more than 22 million persons.

Hard-of-Hearing

A condition where the sense of hearing is impaired but functional for ordinary life purposes (usually with the help of a hearing aid). The degree of hearing impairment does not always correspond with the individual's functional use of hearing or their ability to communicate. This is comparable to the individual skill and ability differences within every person. Therefore, not all suggestions for accommodations will be relevant for every person with a hearing impairment. Legislation and government support for these resources shows both the need and the desire to accommodate those students needing accommodation in the classroom. Hard of Hearing refers to those individuals who may use speech, lip reading and hearing aids to enhance oral communication.

The two-way communicator can be used in both cases. It sole objective is to help transfer information to the students from the instructor to generate better understanding. Students who are deaf or hard of hearing may use a wide range of services depending on the language or communication system they use. Hearing aids or amplification systems may include public address systems and transmitter/receiver systems with a clip-on microphone for the instructor. For people who are deaf or hard of hearing who choose to speak, feedback mechanisms are limited; therefore, vocal control, volume, and articulation may be affected.

Most times a student with a hearing disability has trouble communicating due to auditory disturbances. The two-way communicator can help eliminate noises that can interfere with the learning process.

Incorporating One-on-One Communication in the Classroom

When a student with a hearing disability is placed in a classroom setting, they often have trouble distinguishing auditory disturbances from the voice of an instructor. The two-way communicator will help diminish auditory noises and accentuate the voice of the instructor. The student places the receiver end into their ear and the instructor places the distributor end on their clothing or somewhere close to their mouth. As the instructor speaks, that information is sent directly to the receiver end that is placed in the student's ear. The student receives the adequate education while being placed in a typical setting and understanding what is being taught to them.

Not only does the communicator provide quality instruction to the students but it also can work as a linkage between student and instructor. By simply pressing a button, the

student will be able to communicate with the instructor. The receiver end that is placed in the student's ear also serves as a microphone. Students with a learning disability not only have trouble hearing noises, but they also may have trouble communicating. With help of the two-way communicator, the students can relay any difficult information to the instructor. When the student speaks through the receiver end, their voice is amplified and digitally undistorted to make it understandable for the instructor. The instructor is then able to fully understand what the student is saying and will be able identify the student's problem or concern and respond.

Technical Approach

Components

This communication device is built using a commercial power op-amp, a dual two-position switch and a master station. Other external components used necessary for an effective communicator consists of a potentiometer, resistors, capacitors, and a DC voltage supply. A microphone and speaker is also used to enable effective communication.

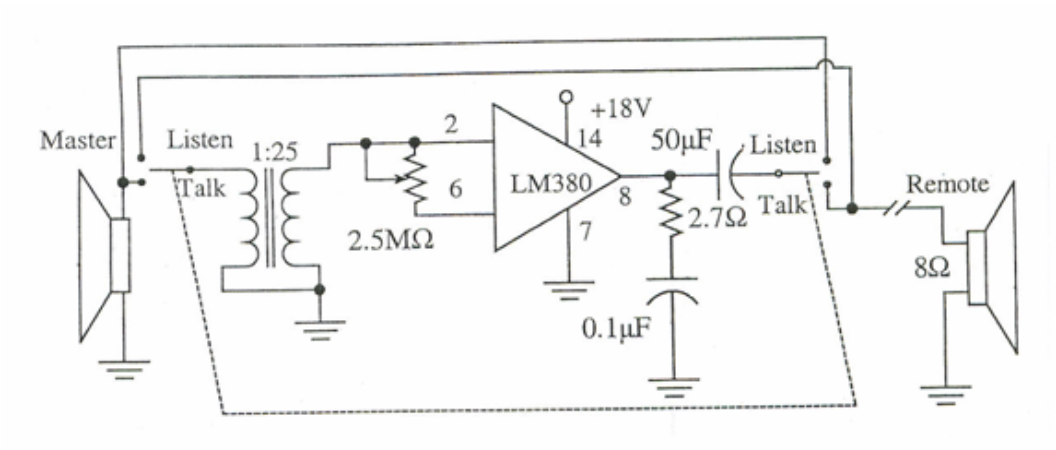

Figure 3.1 Two-Way Communicator Schematic

Dual Two-Position Switch

With the dual two-position switch in the talk position, the speaker of the master station performs the function of a microphone. This action will result in driving the power op-amp through a step-up transformer. The remote speaker is driven from the output of the power op-amp. Switching to the listen position, using the dual two-position switch, will reverse the role of master and remote. The remote speaker now plays the role of the microphone. The speaker at that instant drives the power amplifier through a step-up transformer. The master speaker is presently being driven from the output of the power op-amp. [1]

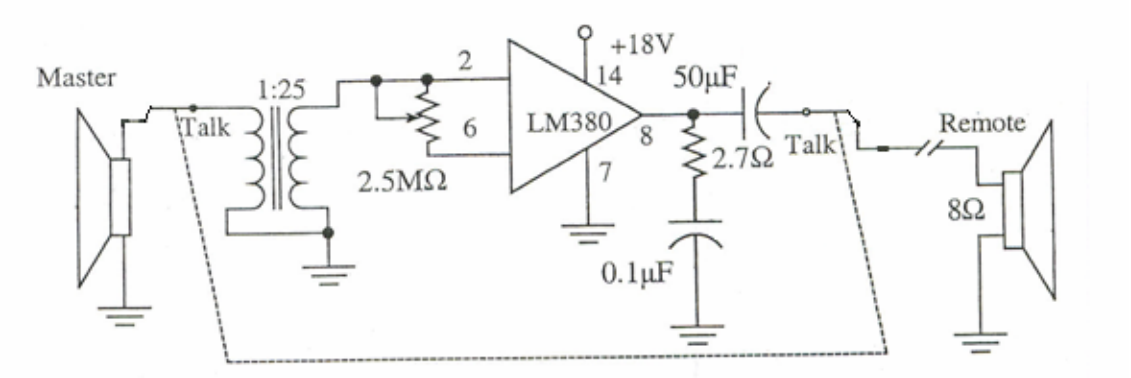

Figure 3.2 Two-Way Communicator in the Talk Position

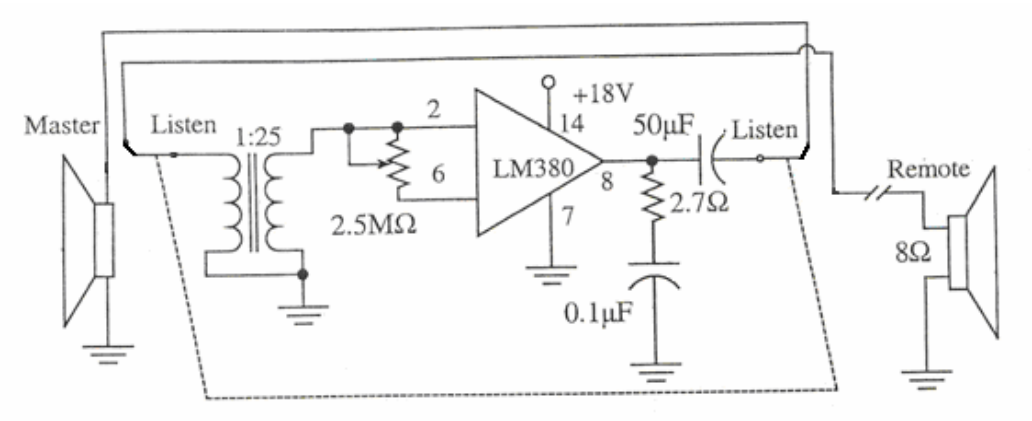

Figure 3.3 Two-Way Communicator in the Listen Position

Op-Amp Configurations

The op-amp used in the two-way communicator is a LM393. The LM393 is characterized for operation from 0°C to 70°C. The LM393 series consists of two independent precision voltage comparators with an offset voltage specification as low as 2.0 mV max for two comparators which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. This comparator also has a unique characteristic in that the input common-mode voltage range includes ground, even though operated from a single power supply voltage. When using the LM393, pin 2 and 3 connects to the potentiometer, pin 4 connects to the power supply, pin 11 connects to ground, and pin 1 connects to the output the circuit.

Transformer and Potentiometer Configurations

A step-up transformer with a turns ratio of 1:25 is used. The transformer is used to decrease the AC voltage and current in the circuit. The operation of transformers is based

on the principal of mutual inductance. The primary coil is the input coil of the transformer and the secondary coil is the output coil. Mutual induction causes voltage to be induced in the secondary coil.

The volume of the speaker or microphone can be tuned to a desired level by use of the potentiometer. It is a three terminal resistor where the position of the sliding connection is user adjustable via a knob. The knob, also called a rotary potentiometer, adjusts loudness, frequency attenuation and other characteristics of audio signals. It acts as a filter thus attenuating the signal that continues on past the control. A 2.5MΩ potentiometer is used.

Microphone and Speaker Configurations

To power the microphone an additional 4.5 voltage is required. A battery clip was also used to hold the batteries. Besides the voltage, a capacitor valued at 0.1 microfarad is also needed. To power the microphone, the red wire will be connected to the 4.5 voltage, the white wire will be connected to the 0.1 μF capacitor, and gray wire will be connected to ground. The only additional requirement for the speaker is a 24-volt power supply.

PSPICE Design & Analysis

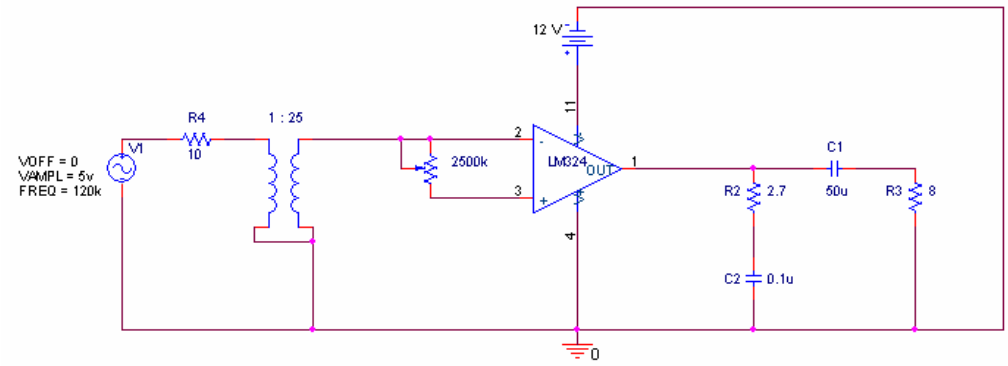

Figure 3.4 PSPICE Pre-Analysis for Two-Way Communicator

While working in PSPICE, there are a couple of specifications that must be filled. VSIN is used as the input voltage. The following settings apply when using VSIN: VOFF is set to 0V, VAMPL is set to 5V, and FREQ is set to 120k. To use the transformer, XFRM_Linear is chosen. The coupling must be set to 1, L1_Value is set to 1, and L2_Value is set to 25. The value for the potentiometer is set to 2500k and is noted with POT. When using the op-amp, the op-amp must first be vertically reversed and the proper op-amp must be chosen. Doing this project LM324 was chosen. When placing the needed voltage sources, it must be aligned with the op-amp. All of the other pieces correspond to the original schematic. [2]

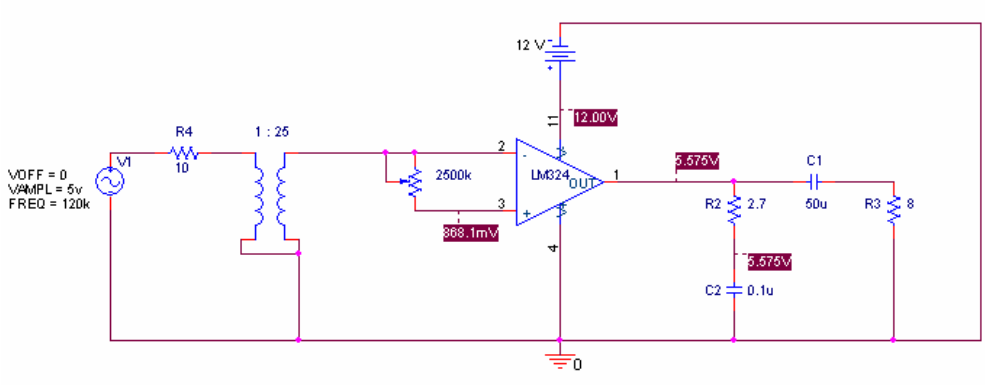

Figure 3.5 PSPICE Post-Analysis with voltages for Two-Way Communicator

After running the schematic, the voltages through the circuit are as follows: through the potentiometer, 868.1 mV, through the output, 5.575 V, and into the op-amp, 12 V. The following are input and output signals of the above schematics.

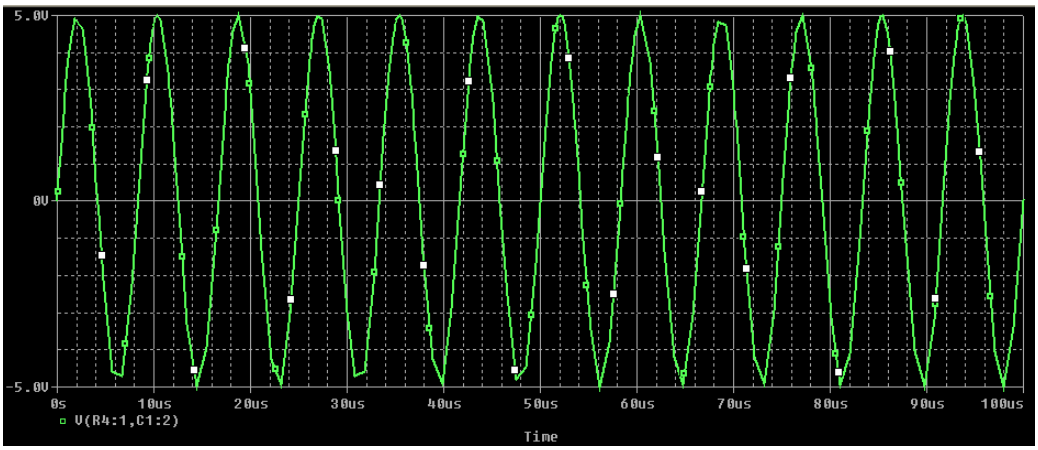

Figure 3.6 Input Signal of Two-Way Communicator

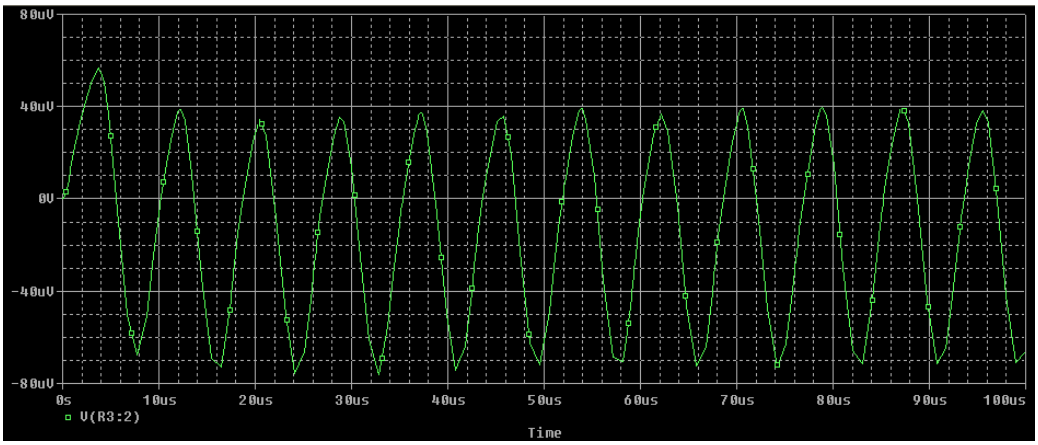

Figure 3.7 Output Signal of Two-Way Communicator

Conclusion

In conclusion, projects done by students in an electronics design class can not only provide the necessary experience for a successful future but it can also help with communication in situations when communicating is hard. The two-way communicator can help two people communicate if they are not within reasonable talking distance and it can also help students with hearing disabilities in a contemporary classroom setting. Through PSPICE analysis and actual hands-on demonstrations and troubleshooting, the two-way communicator is a feasible communicating tool for long distance communicators and students with hearing disabilities.

References

1. "Electronic Design" From Concept to Reality, M.S. Roden, G.L.Carpenter, and W.R.Wieserman, 4th ed. Discovery Press 2002
2. PSPICE by Cadence PSD 15.1

FRENIKA JOHNSON

Ms. Frenika Johnson is a senior in the Electrical Engineering Department at Southern University in Baton Rouge. She is currently a Gates Millennium Scholars as well as a TOPS Award recipient. She also received the honor of being an All-Collegiate Scholar. Ms. Johnson recently interned at Delphi Steering Saginaw where she worked as an assistant product engineer.