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eAR Inc.

eAR™ Design Specifications

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Date March 7, 1999

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March 7, 1999

Dr. Andrew Rawicz
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RE: ENSC 370 Project *e*ARä **Design Specifications**

Dear Dr. Rawicz:

The attached document is the Design Specification for an assistive device for the hearing impaired. This project is to design a pager that uses vibration to notify hearing impaired people in cases of doorbell ring, incoming phone calls or even in case of fire or toxic gas.

This document lists the technical design details for the various components of our system. It provides a technical overview of our system, therefore assists in the implementation stages later in this project.

eAR™ Inc. is a team of five creative, motivated, gregarious, versatile SFU engineering students. They are George Tsai; Minhong Zhou; Rick Liu; Daniel Tang; Aaron Lee. Regarding to any questions or concerns about our project, please contact me by phone at 294-2290 or by email at ctsaia@sfu.ca.

Sincerely,

George Tsai
CEO of ***e***AR Inc.

Abstract

***e*AR™ is a device that is designed to provide convenience to hearing impaired users in case of sound alert or alarm devices such as telephone, doorbell or alarms. This device will consist of a receiver that will vibrate whenever it receives a signal, and a transmitter that will send the signal when it is activated by an external device. The receiver will also have a LCD display to inform user the source of the signal. With the help from this device, the user can move around freely in the house and concentrate on other things without worrying about missing any of the signals.

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Introduction

In 1991, 5.5% of the total Canadian population are hearing impaired[1]. They do not have the luxury of using the things that most people take for granted. For instance, in the case of the smoke detector, hearing-impaired people can not hear the sound alarm. For another instance of the doorbell, the hearing-impaired people have to look at a special light (which turns on when doorbell is pressed) installed above the door to know whether there is a guest at the door. What if they have diverted their attention away from the light, e.g. watching TV? Then the guest would be left waiting outside. This could apply to many other situations, such as carbon monoxide detector ring, telephone ring, etc.

The list of examples could go on and on. Fundamentally, the light oriented solutions for hearing-impaired population provided by the companies today are not practical solutions. These devices cause not only inconveniences but also possibly endanger users' lives in some extreme cases.

The objective of our project is to develop a pager that will allow hearing-impaired people to be notified by devices that use radio signal as the carrier. The pager will receive a signal from the devices and inform user which device transmitted the signal. The user will then be able to respond to that event.

This document is the design specifications of our proposed device. It provides a technical overview of our system, therefore assists in the implementation stages later in this project.

[1] Source: Statistics Canada, Health and Activity Limitation Survey, 1991

System Overview

Figure 1 shows the basic function of ***e*AR™**. Transmitters will be implemented into the desired devices, and the pager will act as the receiver. The device will transmit the signal when there are input signals. For example, if the phone (device) rings (input signal), the transmitter connected to the phone will broadcast out a signal. The pager will receive the signal and vibrate to let the user know there is a device requiring immediate attention.

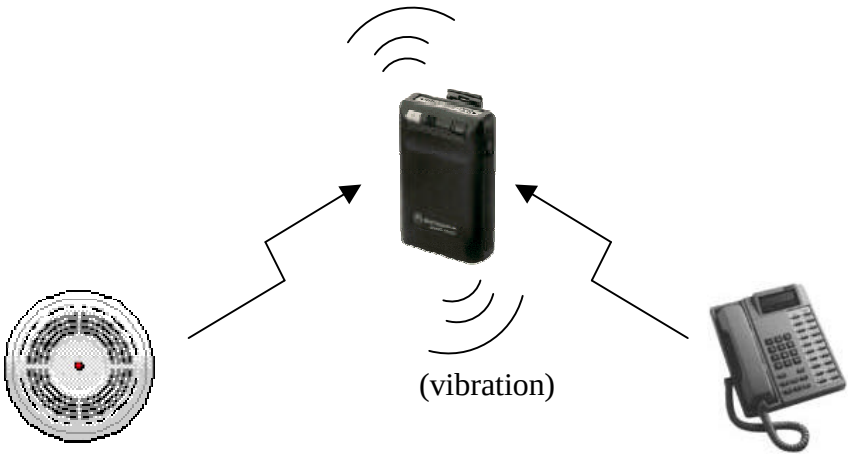

Figure 1 System Overview

Figure 2 illustrates the basic control blocks of this system.

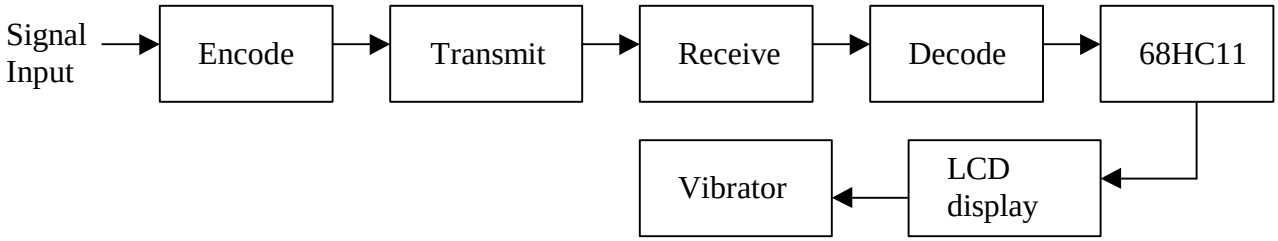

Figure 2 System Block Diagram

The reason that encoding and decoding processes are required is to be able to distinguish which device is sending the signal since there are more than one device. Also, it will not pick up noise at that particular frequency and treat it as a signal.

We will use a Motorola 68HC11 micro-controller on the receiver to process the signals from the transmitters, to drive the Liquid Crystal Display module and to control the vibrator. The power of 68HC11 is more than enough to accomplish above tasks, nevertheless, it is chosen for the possible future improvements which might require the extra processing power provided by 68HC11 controller.

Signal Transmission

eAR is the wireless solution, that consists an eAR pager and several transmitters. It can receive signals within an effective distance of 300 ft. The maximum data rate is 5,000 bps. Figure 3 shows the basic block diagram of the transmitter/receiver connectivity.

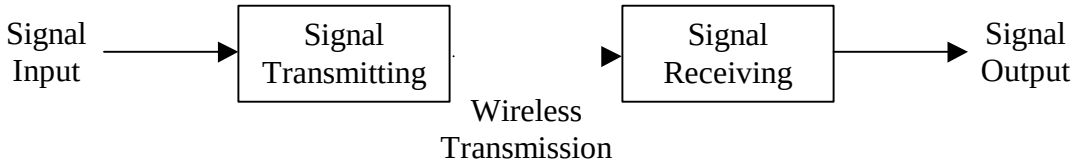

Figure 3 Prototype of Signal Transmission of Ear

Transmitter

The LC transmitter modulates its data using Carrier-Present Carrier-Absent (CPCA) modulation, with logic low being represented by '0', and logic high being represented by '1'. The main advantage is that it draws a small amount of current. Figure 4 shows the circuit configuration for the transmitter.

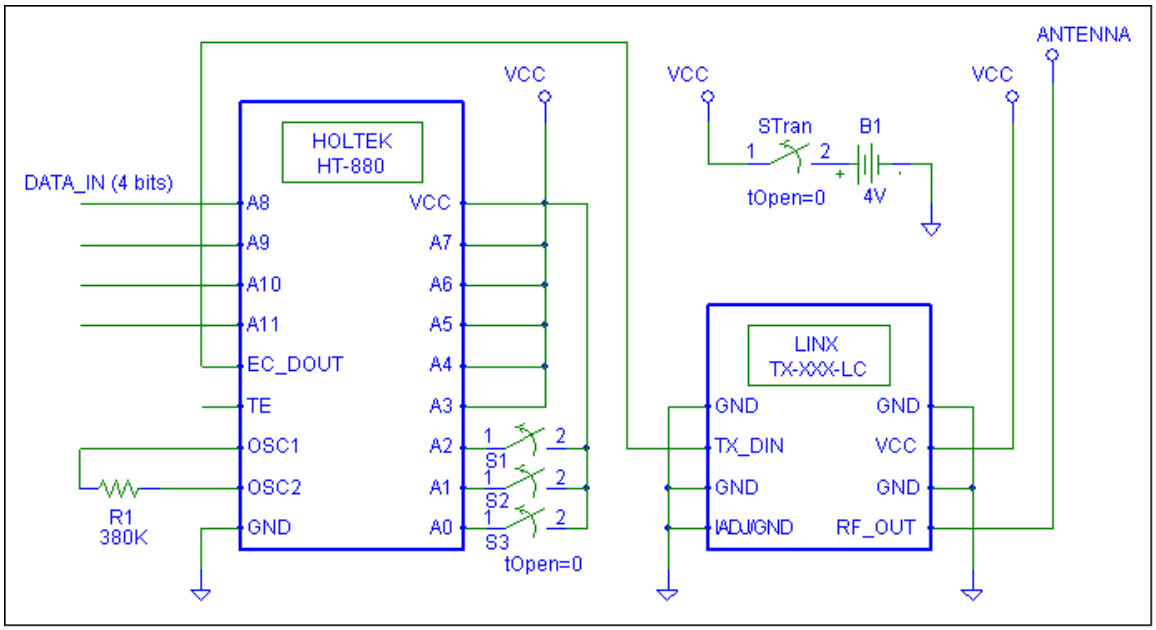

Figure 4 Basic Remote Control Transmitter Circuit

The basic components of the transmitter are a 4-bit input data bus, an encoder (Holtek HT-880), a 3-bit signal address switch, a transmitter module (Linx TX-418-LC) and an antenna. Before any data is fed to the transmitter, the 3-bit signal address switch is set to match that in the receiver configuration. Through the 4-bit data bus, the signal will go to the encoder that converts the signal in a stream of bits. Then, the digital data stream is

sent to the RF module, and becomes FM. Table 1 lists some of the important parameter for the RF module.

Table 1 Transmitter Parameters

Parameter	*Valid Range*	Units
Operating Voltage	2.7~5.2	Volts
Current Average	1.5	mA
Current in Sleep	< 1.5	μA
Transmit Frequency	417.96~418.08	MHz
Data Input Voltage	2.7~4.0	Volts

Receiver Configuration

Figure 5 shows the circuit configuration for the receiver.

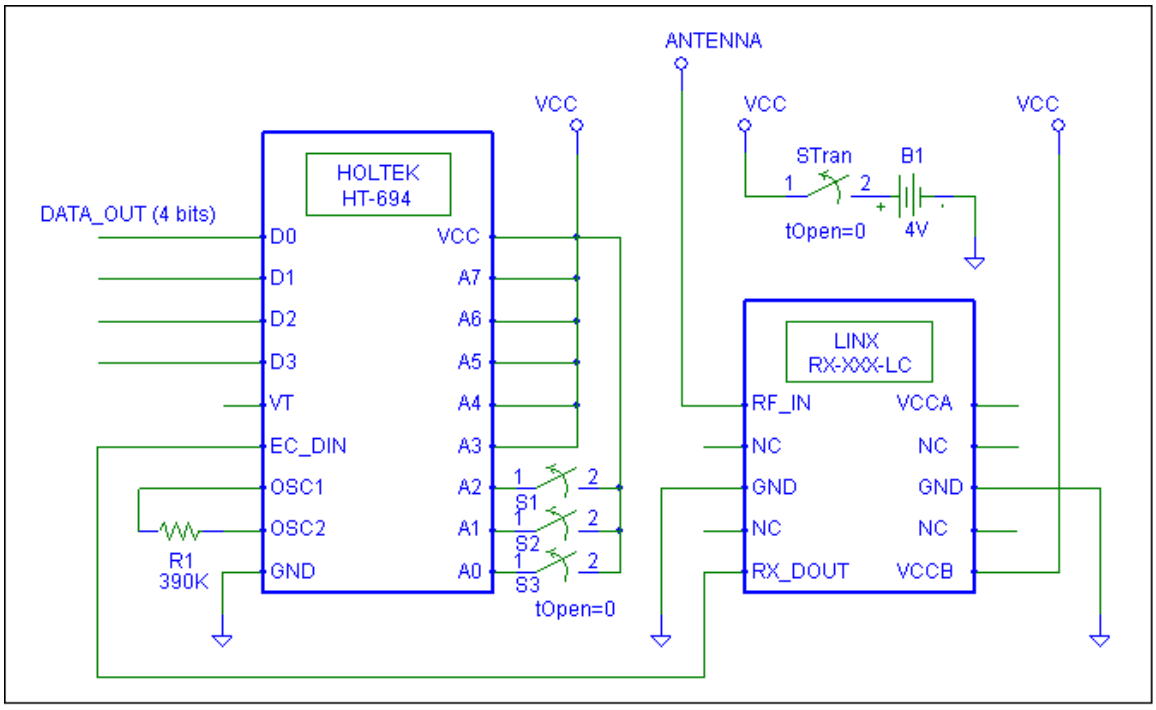

Figure 5 Basic Remote Control Receiver Circuit

The basic components of the receiver configuration are a 4-bit output data bus, an decoder (Holtek HT-694), a 3-bit signal address switch, a transmitter module (Linx RX-418-LC) and an antenna as well. Its operation is similar to the transmitter, except that it decodes the data, rather than encodes it. Also, there is minimum settling time for the data to be correctly received. Table 2 lists some of the important parameters for the receiver unit.

Table 2 Receiver Parameters

Parameter	*Valid Range*	Units
Operating Voltage	4.0~5.2	Volts
Current Sleep	< 1.5	µA
Settle Time	5~10	mSec
Transmit Frequency	417.96~418.08	MHz
Data Output Voltage	3.2~3.4	Volts

Micro-controller

The heart of the receiver is the 68HC11 micro-controller. Its functions are explained in the flow chart below.

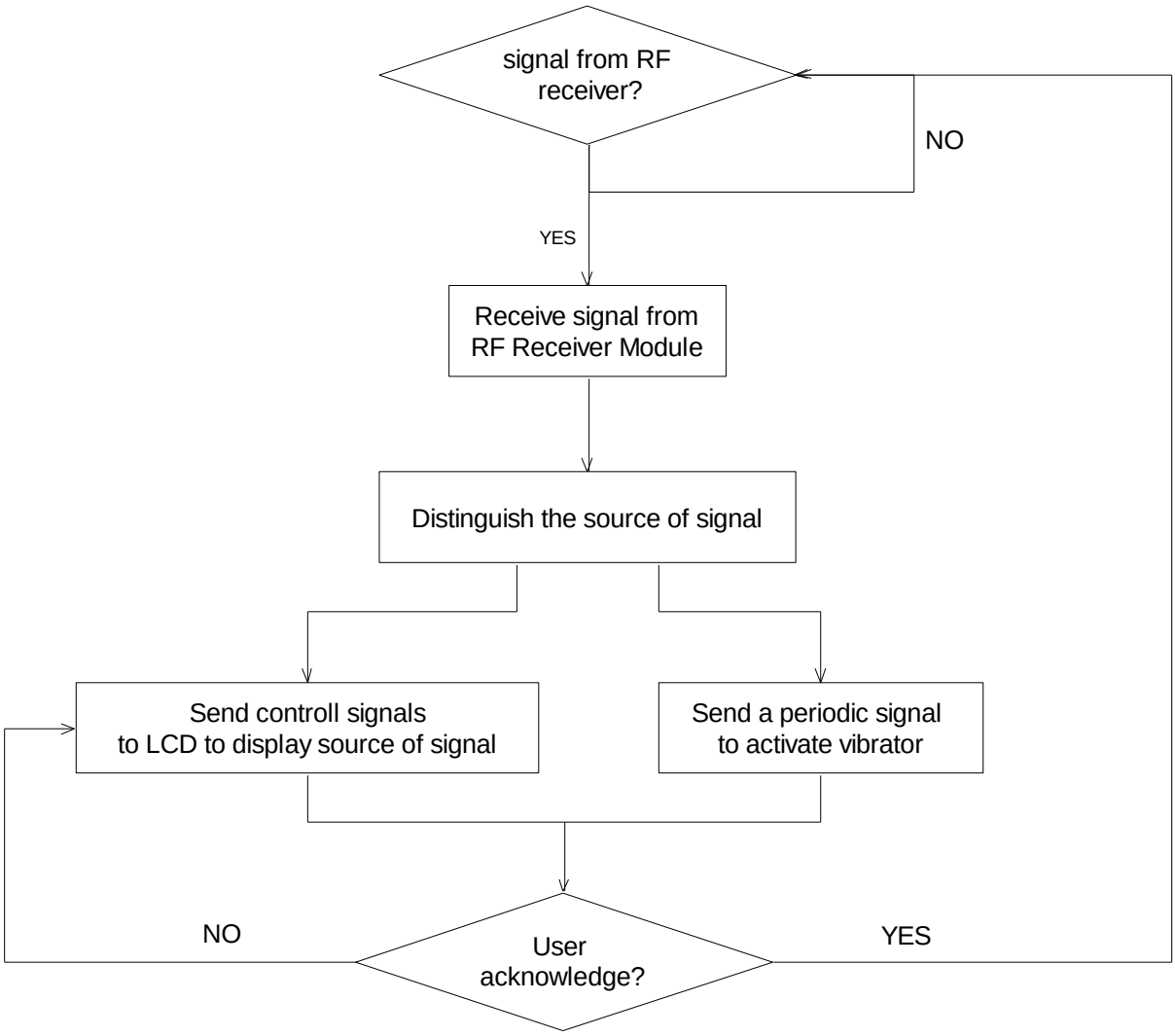

Figure 6 Flow Chart for Micro-controller Unit

The receiver will be in sleep mode while waiting for a signal from the transmitter. Once a signal is detected, it will be decoded (HT-6042) into a 4-bit message. The decoded message is then sent to the HC11 micro-controller, which will recognize the source of the signal. Depending on the content of the message, different characters will be displayed on the LCD. The micro-controller will also activate the vibrator periodically until the user acknowledges it or timed out.

LED Indicators

In order to alert the user that batteries are low in advance, two LED (light emitter diode) indicators (red and green) are implemented into the pager. Green LED indicates the power is on, red LED indicates that battery power is low. A voltage comparator will be incorporated to determine the changes of voltage drops, and thus to determine which LED (red/green) will be turned on.

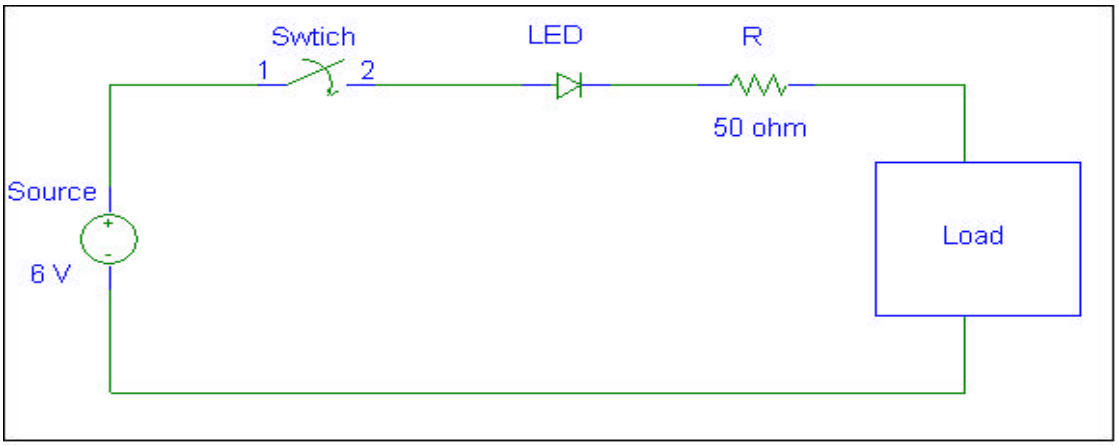

Figure 7 Basic Circuit for LED Power On

Figure 7 shows the basic system diagram for LED power on indicator. The 6 volt source comes from two lithium coin batteries with each supplying 3 volts. Because the load will draw voltage of 5 volts, at least 5.1 volts is needed to keep the system (pager) active. The small resister "R" is implemented to prevent LED from overdrawing currents from the source. The manual slide switch is the power switch for the receiver. Table 3 shows the voltage and current necessary to turn on the LED.

Table 3 LED Characteristics

Parts	Part Number	Min Voltage V_f (V)	Min Currents draw I_f (mA)
Switch (Slide)	EG1919-ND	N/A	N/A
LED (red)	160-1124-ND	1.7	20
LED (green)	160-1130-ND	2.1	20

Voltage Comparator

When source voltage drops below 5.1 volts, a voltage comparator will be activated to turn on the low-power LED. The voltage comparator is built by a 741 op-amp to compare the voltage drop from the source with the reference voltage. Since reference voltage V_f is the positive input and the battery source is the negative input (see Figure 8) of the op amp, signal output will equal to the negative V_{cc} when the source is still greater than V_f. When

the batteries start to die, the source voltage will begin to drop. Once the source drops below V_f, the output signal becomes positive V_{cc}, which then turns on the low-power LED that is connected directly to the comparator output. The V_f can be set up by the battery source (6 V) with an addition of zenner diode and resistor. For positive and negative V_{cc}, the source voltage will be used again. Positive V_{cc} will be connected to the positive sign of source (6 v), and the negative V_{cc} will be connected to the ground.

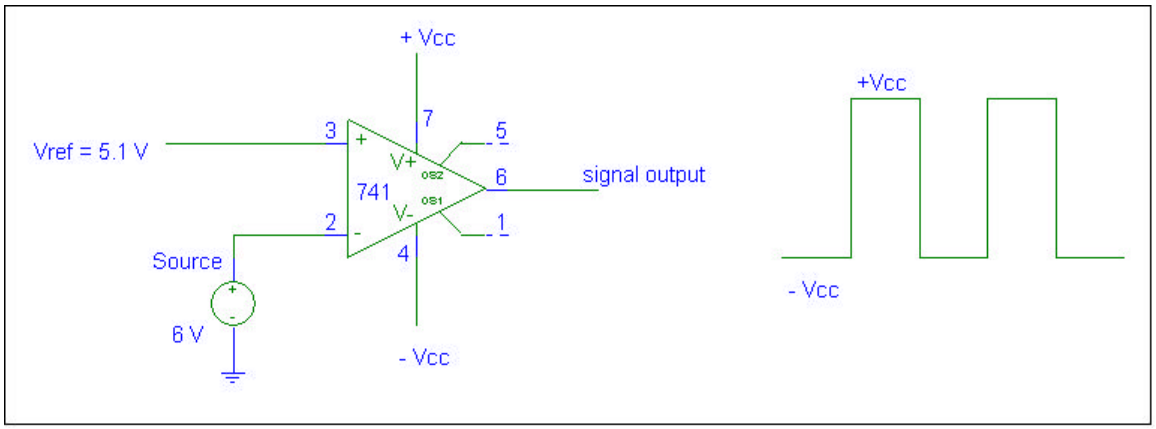

Figure 8 Comparator (741 Op Amp) for Testing Low Power

Voltage Regulator

Linear voltage regulators of part numbers TK71315CT-ND, TK71240CT-ND, and TK71351CT-ND are used to generate 1.5V, 4V and 5 V voltage sources for vibrator, transmitter and receiver, and LCD display respectively.

The dropout voltage of the voltage regulators is required to be very low, making it possible to maintain stable output voltage as the battery decreases. Hence, allow longer battery life. Moreover, the voltage regulator has a noise bypass pin available for noise reduction. A basic connection is shown in Figure 9. Note that input and output decoupling capacitors Cin and CL are included in the circuit to reject ripple effect.

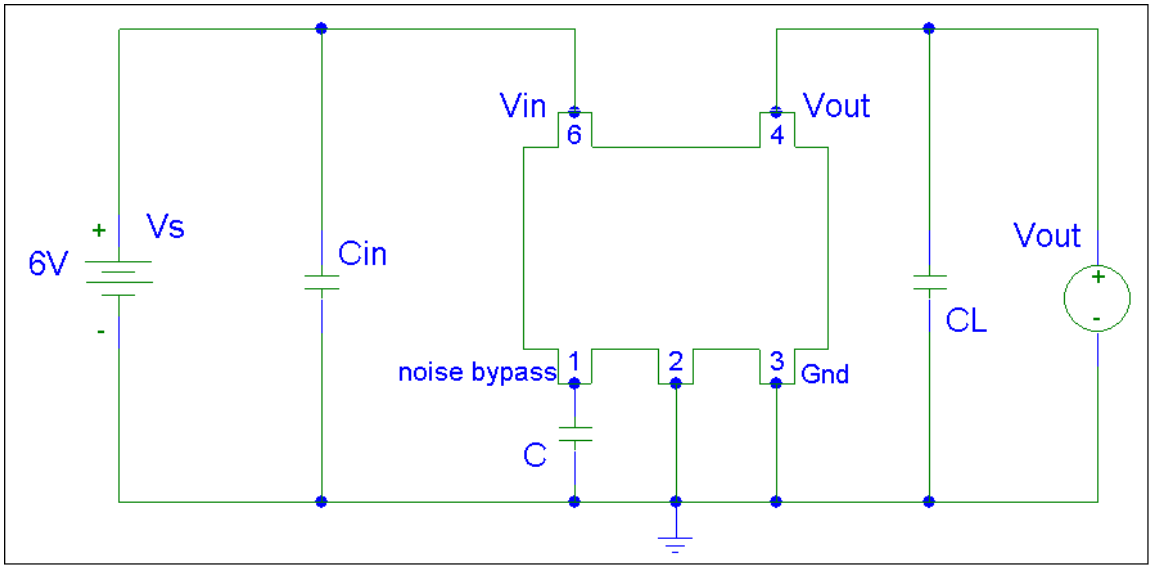

Figure 9 Basic Connections of Voltage Regulator

The power dissipation range is 350mW, the operating voltage range is from 1.4 to 14 V. Other electrical characteristics based on Vin 4.6V and temperature at 25 °C included:

Table 4 Electrical characteristics

Symbol	Parameter	Min	Typical	Max	Units
I_Q	Quiescent Current		130	300	uA
V_{OUT}	Regulated Output Current	1.9	2.0	2.1	V
V_{DROP}	Dropout Voltage		100	200	MV
RR	Ripple Rejection		63		dB
V_{REF}	Noise bypass terminal voltage		1.27		V
$\Delta V_{OUT}/\Delta T$	Temperature Coefficient			0.15	mV/°C

Conclusion

At ***e*AR™** Inc, we dedicate our lives to the welfare of the entire human race, especially those with disabilities. We believe our society has not placed enough emphasis on people with disabilities. All we need is to pay a little more attention, together with innovation and technology, we can make this world a better place to live in for people with disabilities. We are amazed that after vigorous search on Internet, we can not find similar products available for hearing-impaired people. Thanks to George, who first came up with this idea, we believe that this will be a project that will not only make hearing-impaired people's life a little more convenient, but possibly also enrich the group members financially. With these two excellent motivations, it will be unthinkable and inexcusable for us not to complete this project in the shortest time possible.

Appendix

Table 5 Parts List

Description	Manufacturer	Part Number	Quantity	Note
IC ENCODER	HOLTEK	HT-6010-ND	3	
IC DECODER	HOLTEK	HT-6042-ND	1	
4V VOLTAGE REGULATOR	TOKO	TK71240CT-ND	1	
1.5V VOLTAGE REGULATOR	TOKO	TK71315CT-ND	1	
SLIDE SWITCH	E-SWITCH	EG1919-ND	1	Power switch for the receiver
MOMENTARY SWITCH	E-SWITCH	EG1418-ND	1	For use as the door bell
3V CELL BATTERY	PANASONIC	P189-ND	2	
LCD MODULE	VERONIX	153-1031-ND	1	
TRANSMITTER MODULE	LINX		3	
RECEIVER MODULE	LINX		1	
GREEN LED	LITE ON	160-1142-ND	1	Power-on
RED LED	LITE ON	160-1136-ND	1	Low-battery
VIBRATOR			1	
68HC11E2	MOTOROLA		1	