Smart Assist System for Blind People

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Smart Assist System for Blind People

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According to the orientations of the supervisor on the project and the examined committee is by the agreement of a staffers all, sending in this project to the Electrical Engineering Department are in the College of the Engineering by the requirements of the department for the step of the bachelor's degree.

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الإهـــــــداء

السلام عليكم ورحمه الله وبركاته

سبحانك اللهم لا علم لنا إلا ما علمتنا إنك أنت السميع العليم

الصلاة والسلام على أشرف الخلق والمرسلين سيد البشر أجمعين سيدنا وحبيبنا النبي الأمي

محمد بن عبد الله صلوات الله وسلامه عليه وعلى صحابته الميامين .

إلى أصل البدايات .. وأصل النهايات

إلى أحب الأماكن إلى قلوبنا ، إلى مسرى محمد صلى الله عليه وسلم ومهد المسيح عليه السلام

إلى أرض الشهداء .. والأسرى .. والجرحى

إلى وطننا فلسطين

إلى كل الكلام .. وأصل الكلام

إلى منبع الحب والحنان

إلى صانعات الأمم و مربيات الأجيال

إلى أمهاتنا الحبيبات

إلى منارة العطاء .. وشمس العمل المتواصل

إلى ضوء الليل .. و بوصلة النهار

إلى كل شيء يفنى في قلوبنا ولا يفنى انتمائنا له

إلى آبائنا الأفاضل

لمن أمسك بيدينا وعلمنا حرفا ..حرفا ، إلى من كانوا سندا لنا ، إلى من لهم الفضل

بإرشادنا إلى طريق العلم والمعرفة إلى أساتذتنا الأفاضل كم نحن فخورون بكم

إلى زملائنا وزميلاتنا ، رفقاء درب مسيرتنا التعليمية

إليكم جميعاً ، نهديكم نجاحنا هذا أمليين من المولى عز وجل أن نكون قد وفقنا فيه

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Abstract

This project presents an electronic smart navigation system for visually impaired and blind people. This system detects obstacles around the user in front, left and right direction using a network of ultrasonic sensors. It effectively calculates the distance of detected object from the user and prepares navigation path accordingly avoiding obstacles. It uses speech feedback and vibration notification to aware the user about the detected obstacle direction and its distance . It has a battery low indication system which will notify the user and offer an audio player for the user in the rest mode by using a remote controller which can switch between a navigation system and rest mode.

مُـلَــخّـص

تصميم نظام ذكي يقوم على خدمة ذوي الاحتياجات الخاصة (المكفوفين منهم) و الذين يعانون من صعوبة في الرؤية على التحرك في البيئة المحيطة باستخدام عدة مجسات موضوعة على سترة يرتديها الشخص أثناء حركته و يقوم النظام بتوجيه حركة الشخص الكفيف و تحديد المسافة بينه و بين العوائق حوله من خلال فحص الثلاث جهات المحيطة بالمستخدمة (اليمين ، اليسار ، الأمام) و ذلك عبر أوامر صوتية من خلال سماعات توضع على الرأس يتم وصلها بالنظام و يقوم النظام بتوفير نظام تنبيه آخر باستخدام محركات الاهتزازات الصغيرة الموضوعة على الجانب الأيمن و الأيسر و الأمام في النظام ، و يوفر النظام أيضاً مشغل موسيقى يمكن استخدامه في حالة الراحة و يتم التحكم به عبر متحكم لاسلكي موضوع على يد المستخدم و الذي يمكن التحويل من خلاله أيضاً بين النظام الصوتي و نظام التوجيه ، كما يوفر النظام ميزة تنبيه المستخدم حول سعة البطارية في حالة انخفاضها و يتم التحويل عندها إلى نظام حفظ الطاقة المعد في الجهاز لإكساب الجهاز وقتاً إضافياً آخر قبل نفاذ البطارية .

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Introduction

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1.1 Problem Statement

According to survey conducted in 2009 by World Health Organization on disability, there are 269 million visually impaired and 45 million blind people worldwide. Those people suffer from disability of Mobility freely in their environment according to loss of their vision sense.

Mobility is one of the main problems encountered by the blind in their daily life. Over time, blind and visually impaired people have some methods and devices such as the long white cane and guide dog, to aid in mobility and to increase safe and independent travel. These traditional tools are appreciated tools, but nevertheless these tools do not adequately solve the local navigation problems and do not suit the modern technology improvement.

1.2 Motivation

Many advanced electronic navigation aids are available these days for visually impaired and blind people, very few of them are in use. Therefore user acceptability assessment of such systems is very important. The most influencing parameters in this regard are size, portability, reliability, useful functionalities, simple user interface, training time, system robustness and affordability in terms of cost.

This project will effectively guide the blind user without the need of a walking stick. The idea became because as technology has helped many disabilities, the guiding walking stick has been the same as time goes on. This belt will tell the user where obstacles are located and detect the best route for the blind to navigate through it and differentiate between the human and other obstacles.

1.3 Objectives

The project objectives can be summarized as:

- Design a Light weight wearable Vest device.
- Design an Accurate circuit detection of obstacles using ultrasonic transducers.
- Design an Accurate detection circuit of human PIR sensors.
- Design different modes of operation (Navigation Mode & Rest Mode).
- Design a battery level indication system with power saving mode.

1.4 Literature Review

The First project was done by Pradyut Paul and Christopher Cheung in Illinois University in United States of America. This project help blind people to navigate through the medium based on a matrix of ultrasonic sensors basically concentrated on ground obstacles detection by using Maxbotix ultrasonic sensor , the project components was put on a belt wearable by a user, this project suffer from the stability of components on the belt during movement and concentrated on ground obstacles .

The second project was done by Ayat Al-Awer and Suha Dababseh . This project was done in Palestine Polytechnic University as graduation project the name of the project was (Design of Navigation Tool for Blind People) , the main idea of the project was to detect the obstacles in front of blind using double ultrasonic sensor o a wearable belt that will make a sound tune using buzzer if there an obstacles in front of user before 3 m.

The third project was done by Mohammad Al-Hroub , Deema Salheia and Mohammad Melhem . This project was done in Berziet University which help the blind people to navigate based on image processing using a camera that transform the obstacles into an audio message to the user that there is an obstacles in front of him but this method of detection doesn’t work in darkness and high intensity light environment.

1.5 Project cost.

Table 1.1: Project Estimated Cost.

Price	Quantity	Equipment
70 $	1	Microcontrollers
350 $	6	Ultrasonic Sensor
100 $	1	Wireless Remote Controller & Decoding Receiver Board
100 $	2	Music Shield
20 $	1	Headphones
50 $	6	Vibration Motor
50 $	-	Documentations
150 $		Vest Design
100 $	1	Battery (10400 mAh)
30 $	-	Others (Resistors, capacitors , Switches, LEDs, Relays, ICs.. etc)
1020 $		**Total Cost**

1.6 Project schedule

Now let us review the project schedule involving the main activities with which the project will be developed by. The project schedule is divided in two schedules:

1) **First semester project schedule**: Schedule refers to the activities that should be complete in the first semester. Table 1.1 shows first semester activities.
2) **Second semester project schedule**: Schedule refers to the activities should be done in the second semester. Table 1.2 shows second semester activities

Table 1.2: First semester project schedule

Activity description	2-Feb	9-Feb	16-Feb	23-Feb	2-Mar	9-Mar	16-Mar	23-Mar	30-Mar	6-Apr	13-Apr	20-Apr	27-Apr	4-May	11-May	25-May
	Week's Number															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Submit Proposal																
Specify project activities																
Collect related information																
Prepare project documentation																
Search suitable chips																
Prepare initial design																
Prepare project presentation																
Submit project document																

Table 1.3: Second semester project schedule.

Activity description	1-Sep	8-Sep	15-Sep	22-Sep	29-Sep	6-Oct	13-Oct	20-Oct	27-Oct	3-Nov	10-Nov	17-Nov	24-Nov	1-Dec	8-Dec	15-Dec
	Week's Number															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Electronic chips buying and shopping																
Electronic chips testing																
Preparing circuit schematics																
Connecting circuits																
Implementing software programs																
System testing																
Preparing full project documentation																
Submitting project documentation																

Chapter Two

Human Eye : Anatomy & Physiology

2.1 Introduction

The human eye is the organ which gives us the sense of sight, allowing to observe and learn more about the surrounding world than we do with any of the other four senses. We use our eyes in almost every activity we perform, whether reading, working, watching television, writing a letter, driving a car, and in countless other ways. Most people probably would agree that sight is the sense they value more than all the rest.

2.2 Human Eye Anatomy

The human eye is very nearly spherical, with a diameter of approximately 24 millimeters (nearly 1 inch),or slightly smaller than a Ping-Pong ball. It consists of three concentric layers, each with its own characteristic appearance, structure, and functions [1].

From outermost to innermost, the three layers are the fibrous tunic, which protects the eyeball; the vascular tunic, which nourishes the eyeball; and the retina, which detects light and initiates neural messages bound for the brain [2].

The eye is made up of three coats, enclosing three transparent structures. The outermost layer, known as the fibrous tunic, is composed of the cornea and sclera. The middle layer, known as the vascular tunic or uvea, consists of the choroid, ciliary body, and iris. The innermost is the retina, which gets its circulation from the vessels of the choroid as well as the retinal vessels, which can be seen in an ophthalmoscope [3].

Within these coats are the aqueous humour, the vitreous body, and the flexible lens. The aqueous humour is a clear fluid that is contained in two areas: the anterior chamber between the cornea and the iris, and the posterior chamber between the iris and the lens. The lens is suspended to the ciliary body by the suspensory ligament (Zonule of Zinn), made up of fine transparent fibers. The vitreous body is a clear jelly that is much larger than the aqueous humour present behind the lens, and the rest is bordered by the sclera, zonule, and lens. They are connected via the pupil [4].

Figure 2.1 illustrate the main components of human eye.

Conjunctiva: is a thin protective covering of epithelial cells. It protects the cornea against damage by friction (tears from the tear glands help this process by lubricating the surface of the conjunctiva).

Cornea: is the transparent, curved front of the eye which helps to converge the light rays which enter the eye.

Sclera: is an opaque, fibrous, protective outer structure. It is soft connective tissue, and the spherical shape of the eye is maintained by the pressure of the liquid inside. It provides attachment surfaces for eye muscles.

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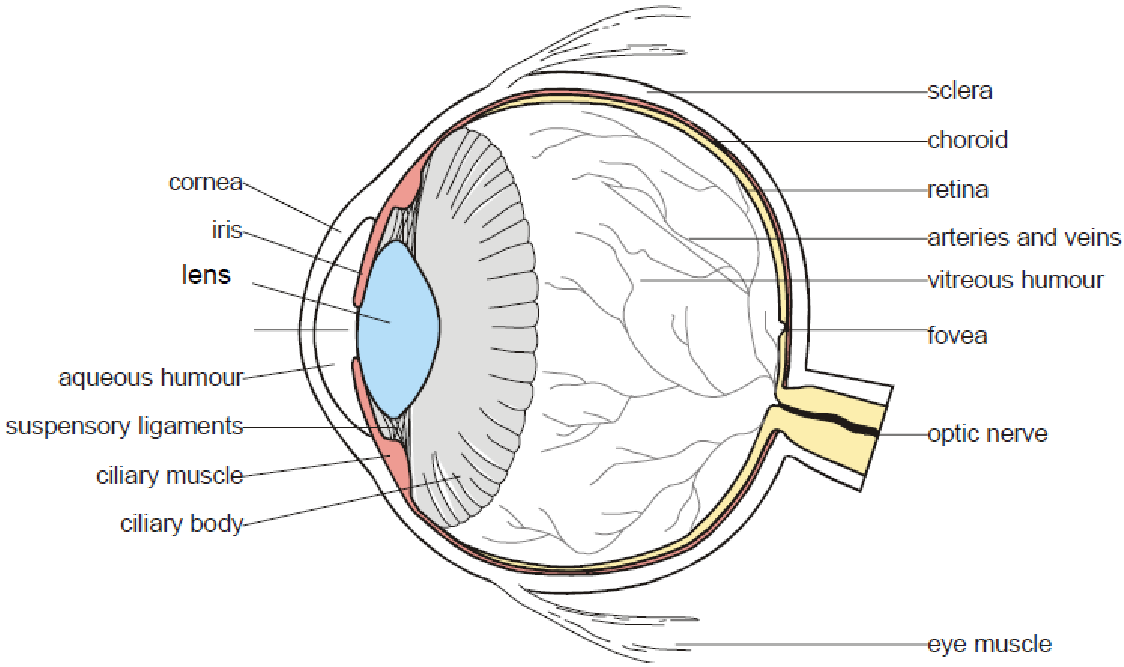


Figure 2.1: Components of Eye [5].

Choroid: has a network of blood vessels to supply nutrients to the cells and remove waste products. It is pigmented that makes the retina appear black, thus preventing reflection of light within the eyeball.

Ciliary body: has suspensory ligaments that hold the lens in place. It secretes the aqueous humour, and contains ciliary muscles that enable the lens to change shape, during accommodation (focusing on near and distant objects).

Iris: is a pigmented muscular structure consisting of an inner ring of circular muscle and an outer layer of radial muscle.

Pupil: is a hole in the middle of the iris where light is allowed to continue its passage. In bright light it is constricted and in dim light it is dilated.

Lens: is a transparent, flexible, curved structure. Its function is to focus incoming light rays onto the retina using its refractive properties.

Retina: is a layer of sensory neurones, the key structures being photoreceptors (rod and cone cells) which respond to light. Contains relay neurones and sensory neurones that pass impulses along the optic nerve to the part of the brain that controls vision.

Fovea (yellow spot):a part of the retina that is directly opposite the pupil and contains only cone cells. It is responsible for good visual acuity (good resolution).

Blind Spot: is where the bundle of sensory fibres form the optic nerve; it contains no light-sensitive receptors.

Vitreous Humour: is a transparent, jelly-like mass located behind the lens. It acts as a ‘suspension’ for the lens so that the delicate lens is not damaged. It helps to maintain the shape of the posterior chamber of the eyeball.

Aqueous Humour : Helps to maintain the shape of the anterior chamber of the eyeball.

2.3 Visual Processing

The ability to see clearly depends on how well these parts work together. Light rays bounce off all objects. If a person is looking at a particular object, such as a tree, light is reflected off the tree to the person's eye and enters the eye through the cornea (clear, transparent portion of the coating that surrounds the eyeball) [6].

Next, light rays pass through an opening in the iris (colored part of the eye), called the pupil. The iris controls the amount of light entering the eye by dilating or constricting the pupil. In bright light, for example, the pupils shrink to the size of a pinhead to prevent too much light from entering. In dim light, the pupil enlarges to allow more light to enter the eye [7].

Light then reaches the crystalline lens. The lens focuses light rays onto the retina by bending (refracting) them. The cornea does most of the refraction and the crystalline lens fine-tunes the focus. In a healthy eye, the lens can change its shape (accommodate) to provide clear vision at various distances. If an object is close, the ciliary muscles of the eye contract and the lens becomes rounder. To see a distant object, the same muscles relax and the lens flattens [8].

Behind the lens and in front of the retina is a chamber called the vitreous body, which contains a clear, gelatinous fluid called vitreous humor. Light rays pass through the vitreous before reaching the retina. The retina lines the back two-thirds of the eye and is responsible for the wide field of vision that most people experience. For clear vision, light rays must focus directly on the retina. When light focuses in front of or behind the retina, the result is blurry vision [9].

The retina contains millions of specialized photoreceptor cells called rods and cones that convert light rays into electrical signals that transmitted to the brain through the optic nerve. Rods and cones provide the ability to see in dim light and to see in color, respectively [10].

The macula, located in the center of the retina, is where most of the cone cells are located. The fovea, a small depression in the center of the macula, has the highest concentration of cone cells. The macula is responsible for central vision, seeing color, and distinguishing fine detail. The outer portion (peripheral retina) is the primary location of rod cells and allows for night vision and seeing movement and objects to the side (i.e., peripheral vision) [11].

The optic nerve, located behind the retina, transmits signals from the photoreceptor cells to the brain. Each eye transmits signals of a slightly different image, and the images are inverted. Once they reach the brain, they are corrected and combined into one image. This complex process of analyzing data transmitted through the optic nerve is called visual processing [12].

2.4 Visual Impairment and Blindness

The World Health Organization (WHO) defines *Visual impairment* Decrease or severe reduction in vision that cannot be corrected with standard glasses or contact lenses and reduces an individual's ability to function at specific or all tasks.

Blindness as severe sight loss, where a person is unable to see clearly how many fingers are being held up at a distance of 3m (9.8 feet) or less, even when they are wearing glasses or contact lenses. However, someone who is blind may still have some degree of vision.

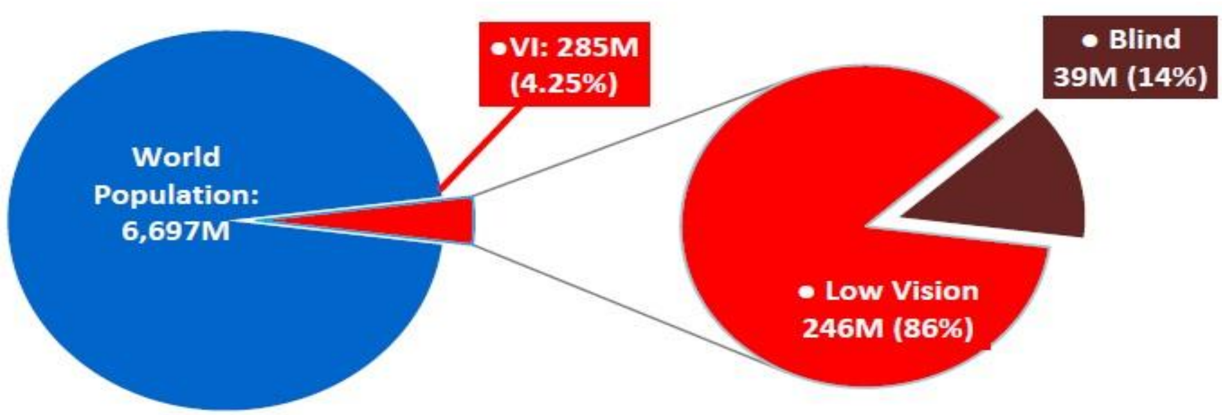


Figure 2.2: Global estimates of visual impairment [13].

According to WHO criteria, global estimate predict that there are 285 million people with visual impairment approximately 14% (39 million) are blind.

Most people (87%) who are visually impaired live in developing countries. In developing countries, cataracts (a cloudy area that forms in the lens of the eye) are responsible for most cases of blindness (48%). Visual impairment usually affects older people. Globally, women are more at risk than men. With the right treatment, about 85% of visual impairment cases are avoidable, and approximately 75% of all blindness can be treated or prevented.

2.4.1 Causes of Visual Impairment and Blindness

In spite of the progress made in surgical techniques in many countries during the last ten years, cataract (47.9%) remains the leading cause of visual impairment in all areas of the world, except for developed countries.

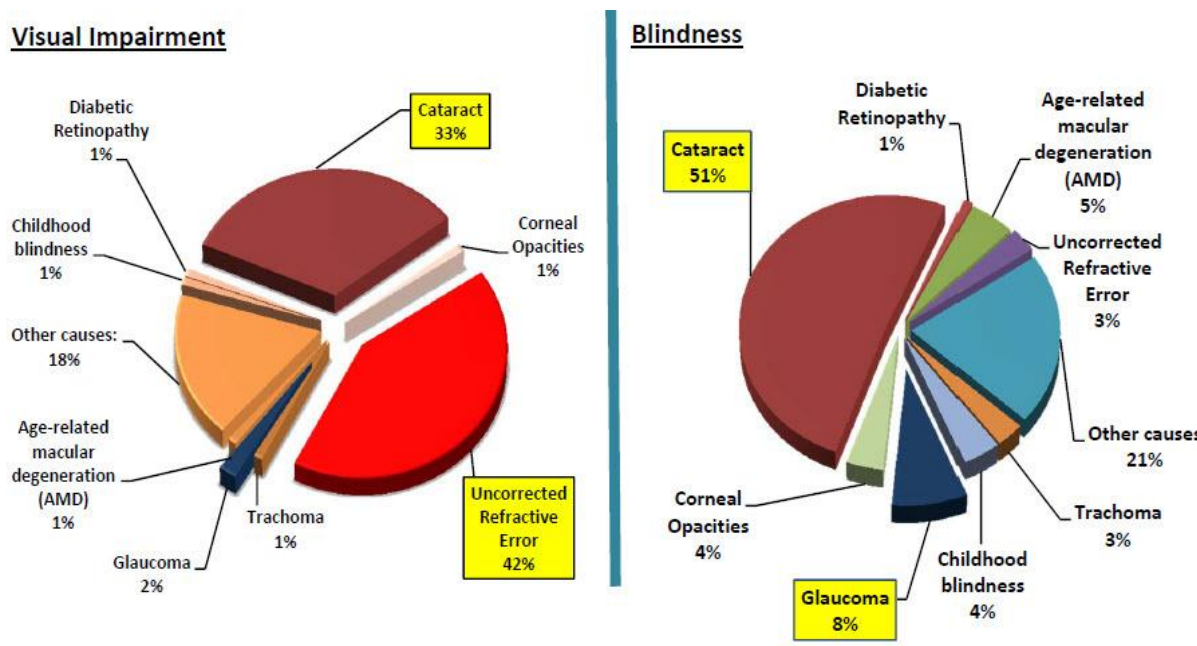


Figure 2.3: Causes of Visual Impairment and Blindness [14].

Other main causes of visual impairment in 2010 are glaucoma (2%), age-related macular degeneration (AMD) (1%), corneal opacities (1%), diabetic retinopathy (4.8%), childhood blindness (1%), trachoma (1%), and onchocerciasis (0.8%). The causes of avoidable visual impairment worldwide are all the above except for AMD. In the least-developed countries, and in particular Sub-Saharan Africa, the causes of avoidable blindness are primarily, cataract (51%), glaucoma (8%), corneal opacities (4%), trachoma (3%), childhood blindness (4%) and onchocerciasis (1%).

Looking at the global distribution of avoidable blindness based on the population in each of the WHO regions, we see the following: South East Asian 28%, Western Pacific 26%, African 16.6%, Eastern Mediterranean 10%, the American 9.6%, and European 9.6%.

In addition to uncorrected refractive errors, these six diseases or groups of diseases which have effective known strategies for their elimination, make up the targets of the WHO Global Initiative to Eliminate Avoidable Blindness, "VISION 2020: The Right to Sight", which aims to eliminate these causes as a public health problem by the year 2020. Cataract, onchocerciasis, and trachoma are the principal diseases for which world strategies and programmes have been developed. For glaucoma, diabetic retinopathy, uncorrected refractive errors, and childhood blindness (except for xerophthalmia), the development of screening and management strategies for use at the primary care level is ongoing at WHO.

Chapter Three

Ultrasonic : Physics, Measurements and Application

3.1 Overview.

3.2 Basic Ultrasonic Principles.

- 3.2.1 Introduction.
- 3.2.2 History.
- 3.2.3 Measurements.
- 3.2.4 Ultrasonic Transducer.
  - 3.2.4.1 Overview .
  - 3.2.4.2 Theory of Operation.

3.1 Overview

This chapter presents the fundamentals of ultrasonic sensing for object localization, landmark measurement and transmitter and receiver includes their operations, parts, and main parameters and Infrared principles and sensing for human detection and the technique that used for that purpose including PIR sensor and it's operation and specifications.

3.2 Basic Ultrasonic Principles

3.2.1 Introduction

Ultrasound is a Sound generated above the human hearing range (typically 20 kHz) is called ultrasound.

However, the frequency range normally employed in ultrasonic nondestructive testing and thickness gagging is 100 kHz to 50 MHz. Although ultrasound behaves in a similar manner to audible sound, it has a much shorter wavelength. Ultrasound or Ultrasonic, derived from Latin word" ULTRA" which meaning beyond and "SONIC" meaning sound [15].

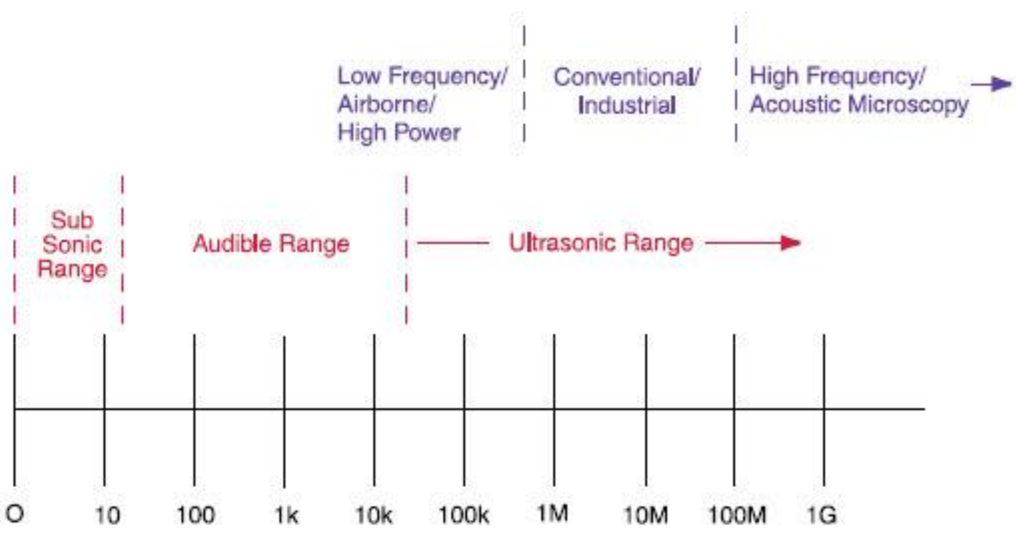


Figure 3.1: The Ultrasonic Range [16].

3.2.2 History

Acoustics, the science of sound, starts as far back as Pythagoras in the 6th century BC, who wrote on the mathematical properties of stringed instruments. Sir Francis Galton constructed a whistle producing ultrasound in 1893. The first technological application of ultrasound was an attempt to detect submarines by Paul Langevin in 1917. The piezoelectric effect, discovered by Jacques and Pierre Curie in 1880, was useful in transducers to generate and detect ultrasonic waves in air and water. Echolocation in bats was discovered by Lazzaro Spallanzani in 1794, when he demonstrated that bats hunted and navigated by inaudible sound and not vision [17].

3.2.3 Measurements

A. Frequency, Period and Wavelength

Ultrasonic vibrations travel in the form of a wave, similar to the way light travels. However, unlike light waves, which can travel in a vacuum (empty space), ultrasound requires an elastic medium such as a liquid or a solid. Shown in Figure 3.2 are the basic parameters of a continuous wave (cw). These parameters include the wavelength (l) and the period (T) of a complete cycle[18].

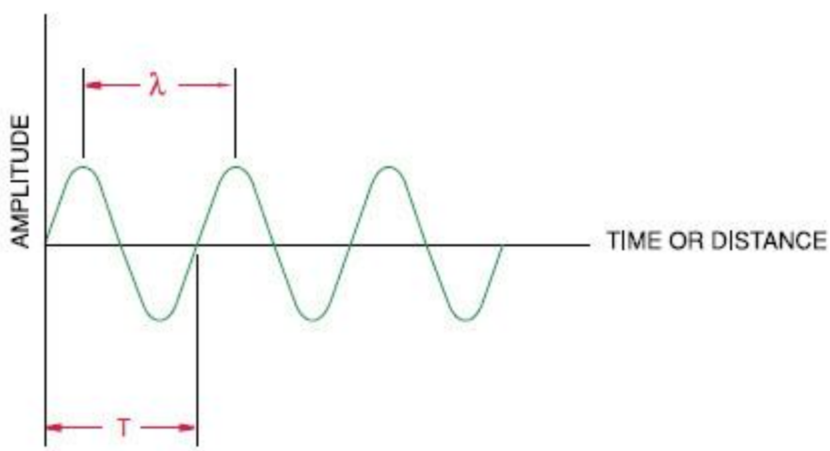


Figure 3.2: The basic parameters of a continuous wave [18].

The number of cycles completed in one second is called frequency (f) and is measured in Hertz (Hz), some examples follow;

- 1 cycle/second= 1Hz
- 1000 cycles/second= 1 kHz
- 1,000,000 cycles/second= 1MHz

The time required to complete a full cycle is the period (T), measured in seconds. The relation between frequency and period in a continuous wave is given in Equation (3.1).

$f = \frac{1}{T}$	Equation (3.1)

f = Frequency
T = Period of time

B. Velocity of Ultrasound and Wavelength

The velocity of ultrasound (c) in a perfectly elastic material at a given temperature and pressure is constant. The relation between c, f, l and T is given by Equations (3.2) and (3.3) [19]:

$\lambda = \frac{c}{f}$	Equation (3.2)
$\lambda = cT$	Equation (3.3)

λ = Wavelength
c = Material Sound Velocity
f = Frequency
T = Period of time

C. Wave Propagation and Particle Motion

The most common methods of ultrasonic examination utilize either longitudinal waves or shear waves. Other forms of sound propagation exist, including surface waves and Lamb waves.

• The longitudinal wave is a compressional wave in which the particle motion is in the same direction as the propagation of the wave [20].

• The shear wave is a wave motion in which the particle motion is perpendicular to the direction of the propagation.

• Surface (Rayleigh) waves have an elliptical particle motion and travel across the surface of a material. Their velocity is approximately 90% of the shear wave velocity of the material and their depth of penetration is approximately equal to one wavelength.

• Plate (Lamb) waves have a complex vibration occurring in materials where thickness is less than the wavelength of ultrasound introduced into it.

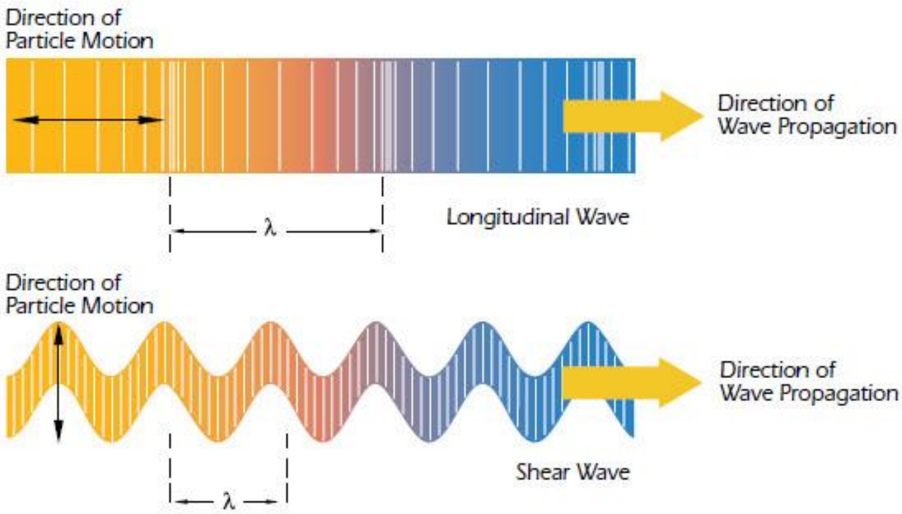


Figure 3.3: Illustration of the particle motion versus the direction of wave propagation for longitudinal waves and shear waves [21].

D. Applying Ultrasound

Ultrasonic nondestructive testing introduces high frequency sound waves into a test object to obtain information about the object without altering or damaging it in any way. Two basic quantities are measured in ultrasonic testing; they are time of flight or the amount of time for the sound to travel through the sample, and amplitude of received signal. Based on velocity and round trip time of flight through the material the material, thickness can be calculated as follows [22]:

$$T = \frac{ct}{2} \qquad \text{Equation (3.4)}$$

T = Material Thickness
c = Material Sound Velocity
t = Time of Flight

3.2.4 Ultrasonic Transducer

3.2.4.1 Overview

Ultrasonic sensors are often called transducers; the function of the transducers is to convert electrical energy into mechanical energy which directly corresponds to ultrasonic vibration, and vice versa. The most common way of generating and detecting ultrasonic waves utilizes the piezoelectric effect of a certain crystalline material such as quartz. Since the piezoelectric effect is reciprocal, it produces a deformation (a mechanical stress) in a piezoelectric material when an electrical voltage is applied across the material, and conversely, it produces an electrical voltage when a deformation (a mechanical stress) is applied to the material. Thus, the piezoelectric materials can be used for generating and detecting ultrasonic waves that are related to the mechanical stresses.

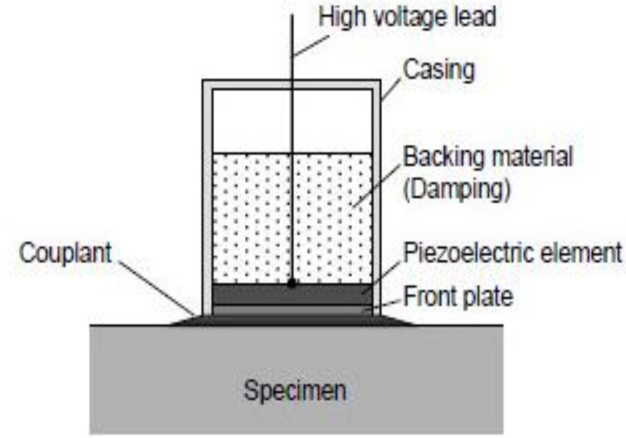


Figure 3.4: Piezoelectric Element [23].

A piezoelectric transducer consists of a piezoelectric element, electrical connections, backing materials, front layers and a casing. The typical construction is shown in Figure 3.4.

The front layer is to protect the piezoelectric element against external stresses and environmental influences, and also must function as an impedance matching layer with which the transfer of ultrasonic energy to the target medium is optimized. The backing material functions as a damping block that alters the resonance frequency of the piezoelectric element and deletes unwanted ultrasonic waves reflected from the back wall [24]. The electrical line is connected AC or DC voltage supplies that are often operated at the resonant frequency of the piezoelectric element.

3.2.4.2 Theory of Operation

Ultrasonic sensors work in ways that are similar to radar and sonar utilizing the Doppler principle. A piezoelectric transducer converts electrical energy into an ultrasonic wave typically between 40-50 kHz. This high frequency sound wave, which is beyond the capability of human hearing, hits an object and is reflected back toward another transducer which converts the sound wave back into electrical energy. The distance of an object can be evaluated once this echo is received back using the following equation where ***d*** – is the distance, ***c*** – is the speed of sound, and ***t*** – is the elapsed time of the signal [25].

$$d = \frac{t.c}{2} \qquad \text{Equation (3.5)}$$

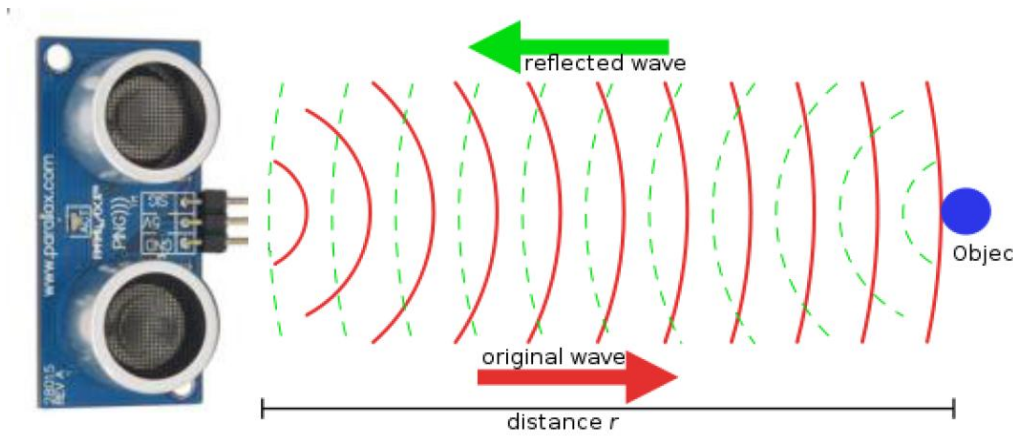


Figure 3.5: Ultrasonic Doppler Effect

When the medium of propagation is air c is equal to 340.29 m/s. The control circuitry on the ultrasonic sensor can determine between stationary objects and objects in motion by interpreting change in frequency as motion in the space. Figure 3.5 below shows the operation and sensitivity for an ultrasonic sensor [26].

Chapter Four

Project Components

4.1 Overview

In this chapter will describe the system main parts and the design concepts. And illustrate the system main components. Then describe some details of the inner blocks or components and how it is related to other components will be described.

4.2 Sonar Technology (Ultrasonic Transducer)

4.2.1 Introduction

Sonar or "sound navigation and ranging" is an application of ultrasonic that uses propagation of these high-frequency sound waves to navigate and detect obstacles, sonar has a wide verity of applications and wide variety of users.

The figure 4.1 below shows the block diagram of Ultrasonic transducers (SONAR) main components

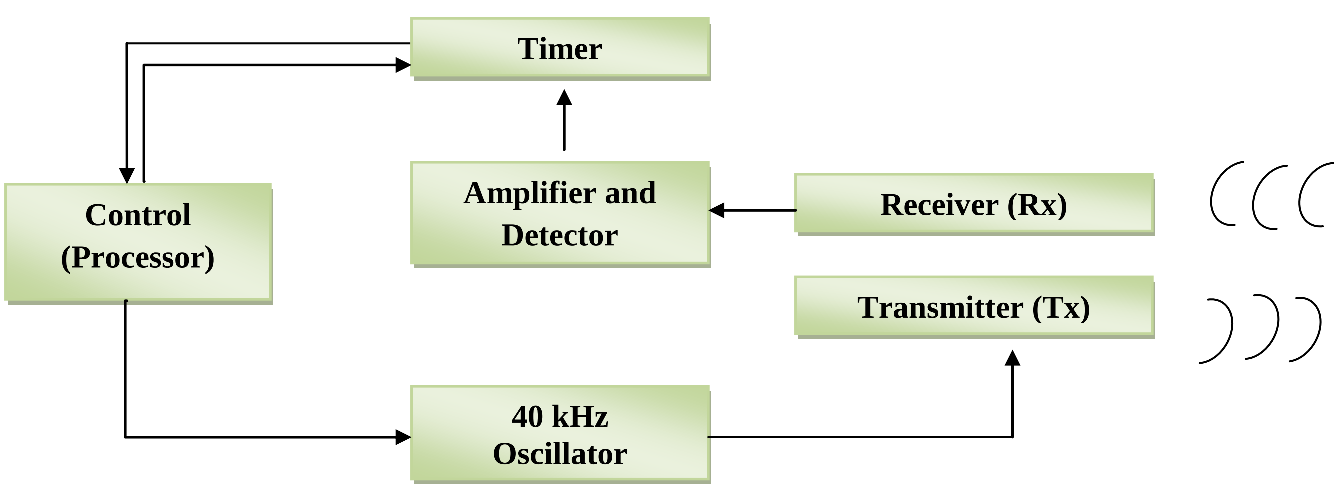


Figure 4.1: Block diagram of Ultrasonic (SONAR)

Transmitter (Tx): transmitting an 40 kHz (10 cycle burst is generated every 100 milliseconds).
Receiver (Rx): Receiving Ultrasonic sound.
Amplifier and detector: Filter the reflected signal (echo signal) and amplifying it.
Timer: Measure the time (distance) between the burst Tx and the echo signal.
Control (Processor): (analog to digital, digital to analog) Processing, measuring flight time, serial (bit by bit) data transfer by using RS232 etc.
40 KHz Oscillator: Generate Ultrasonic of 40 KHz frequency.

In this project, three types of U.S transducers (SONAR) will be compared in terms of (Power Supply, Current Consumption, Maximum Ranges, Resolutions and

Prices).The table 4.1showsthe differences between these U.S Transducers, and then LV-MaxSonar-EZ1 is selected.

Table 4.1: Differences between three common types of U.S Transducers [32].

Brand Name	 HC-SR04	 Maxbotix LV-EZ0/EZ1/EZ3	 URM37
Power Supply	5 V DC	3.3 V DC	5 V DC
Current Consumption	2 mA	2 mA	2 mA
Maximum Range	100cm	625 cm	300 cm
Resolutions	3cm	2.5 cm	1 cm
Price	35$	50 $	45$

4.2.2 Principle of Operation

In this project focus on the LV-MaxSonar-EZ1 which is a High Performance Ultrasonic Range Finder is shown below in figure 4.2. This particular sensor is very useful for obstacles detection as it balances high sensitivity while using a relative narrow beam width. The MaxSonar has the capability of outputting an analog voltage or serial data stream. This again is very useful because it does not limit the choice of usable microprocessors and interfaces. In addition to this, it implements a free run operation which can continually measure and output range information. This device has 7 pin outs, but the majority of these are unnecessary for a simple serial hook up to measure distance. However it is necessary to understand each for unseen future operations of the device [33].

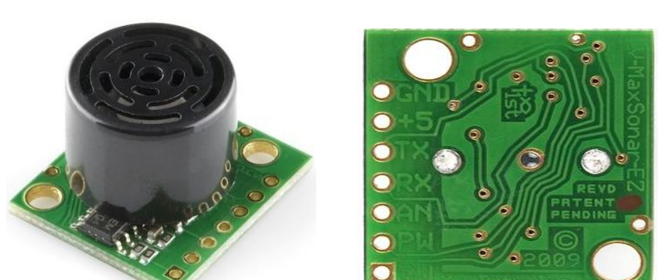


Figure 4.2: LV-MaxSonar-EZ1

Table 4.2: LV-MaxSonar-EZ1 Pin out Specifications [34]

Pin Out	Description
GND	Circuit common and DC return
+5	Vcc: 2.5V-5.5V DC
TX	Serial out when BW is set low
RX	High (open) for ranging. Low to stop ranging.
AN	Analog Voltage Output A 5V supply yields ~9.8mV/in
PW	Pulse width representation
BW	Low (open) for serial output of TX. High for chaining.

The MaxSonar sensor, by default, will operate in a free run mode. What this means is the sensor will continue to range until power is removed from the sensor. This is generally the easiest way to operate in a single sensor setup. The MaxSonar sensor have the capability to operate with a trigger. What this means is the sensor can be connected to a microcontroller, a computer, or anything else that is capable of telling the sensor to start a ranging cycle. The device that triggers the sensor connect to pin 4 of the sensor [35].

When Pin 4 is left open the sensor will range at the sampling rate of the sensor as defined in the sensor's data sheet. To trigger the sensor to range when programmed or needed, connection of Pin 4 to a logic low. As stated above this can be done with a microcontroller, a 555 timer, a computer, or anything else capable of pulling Pin 4 to a logic low (ground) [36].

When the sensor operate to range pull Pin 4 high. This will allow the sensor to complete a ranging cycle. The Controller that is programmed to trigger the sensor needs to be programmed to pull Pin 4 to logic high for a minimum of 20uS. If the trigger does not pull pin 4 high for that amount of time, the sensor may not range when commanded to. For the LV-MaxSonar-EZ sensor, the sensor can be triggered as frequently as 50mS (20 Hz rate) [37].

The analog voltage pin outputs a voltage which corresponds to the distance. The further away an object is from the sensor the higher the output voltage becomes which in turn will be measured by the Digital Multimeter. The sensor is designed to report the range to the closest detectable object [38].

4.2.3Limitations

One of the most common limitations of ultrasonic sensors is its flexibility in detecting. Because the sensor operates on the echo principle as described above it cannot accurately distinguish between, say, a human and a chair, as both of these objects will return an echo. Most sensor application attempt to overcome this conflict by instilling two sensors. These sensors are either adjacent each other, as shown in the left-most figure below, or spaced a distance apart, as shown in the right-most figure below. The advantage of this is if both sensors sense the object (in the shaded area) one can have a better idea of its location and relative size, increasing the accuracy of the sensor [39].

4.3 Wireless Remote Controller &Decoding Receiver Board

4.3.1 Remote Controller

A typical RF remote control's PCB is comprised of many electronic components, such as SAW resonator which controls the transmitting frequency and encoder IC which encodes the transmitting data. The typical inner photo of RF remote control is listed as show in figure 4.3

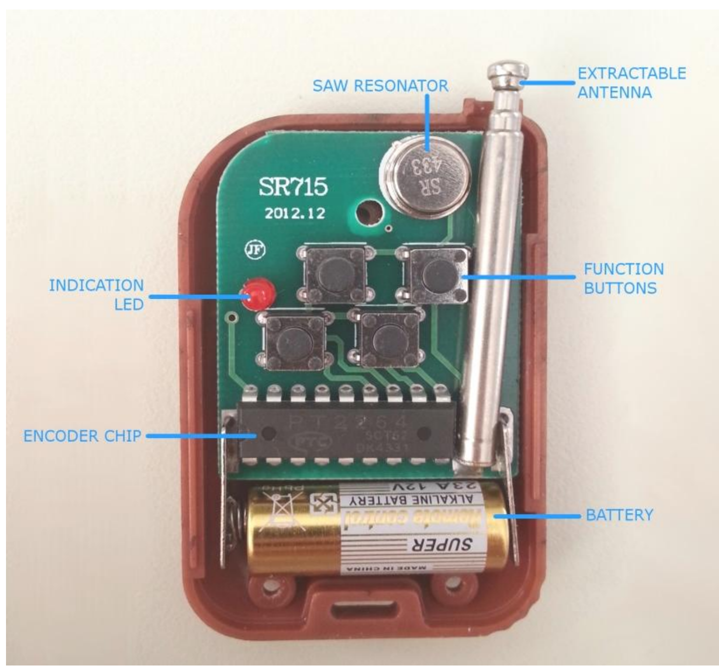


Figure 4.3: RF remote control.

Encoder chip (PT2264) is a remote control encoder paired with PT2294 utilizing CMOS Technology. It encodes data and address pins into a serial coded waveform suitable for RF modulation.

FEATURES

- CMOS technology
- Low power consumption
- Very high noise immunity
- Up to 12 Tri-State code address pins

• Up to 4 data pins
• Wide range of operating voltage: VCC=8 ~ 15V
• Single resistor oscillator
• Latch or momentary output type
• Available in DIP and SOP package

4.3.2 Decoding Receiver Board

Beside antenna and some ICS, SC2272 is the most important chip which is a remote control decoder paired with SC2262and SC2260 utilizing CMOS technology. It has 12 bits of tri-state address pins providing a maximum of 531,441 address codes; thereby, drastically reducing any code collision and unauthorized code scanning possibilities.

Figure 4.4: Decoding Receiver Board

FEATURES

- Low power consumption
- Wide operating temperature range: -30~70 °C
- Up to 12 tri-state code address pins
- Up to 6 data pins
- Single resistor oscillator
- Latch or momentary output type

4.4 Arduino Mega Microcontroller

4.4.1 Introduction

The Arduino Mega is a microcontroller board based on the ATmega1280. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a

AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila [49].

Figure 4.5: Arduino Mega Microcontroller [50].

4.4.2 Microcontroller Power

The Arduino Mega can be powered via the USB connection or with an external power supply. The power source is selected automatically [51].

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and VIN pin headers of the POWER connector [52].

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows [53]:

- **VIN**: The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V**: The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.

- **3V3**: A 3.3 volt supply generated by the on-board FTDI chip. Maximum current draw is 50 mA.
- **GND**: Ground pins.

4.4.2 Memory

The ATmega1280 has 128 KB of flash memory for storing code (of which 4 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library) [54].

4.4.3 Input and Output

Each of the 54 digital pins on the Mega can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions [55]:

- **Serial** : 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX). Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.

- **External Interrupts** : 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2). These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

- **PWM** : 2 to 13 and 44 to 46. Provide 8-bit PWM output with the analogWrite() function.

- **SPI**: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Duemilanove and Diecimila.

- **LED** : 13 There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
  I2C: 20 (SDA) and 21 (SCL). Support I2C (TWI) communication using the Wire library (documentation on the Wiring website). Note that these pins are not in the same location as the I2C pins on the Duemilanove or Diecimila.

The Mega has 16 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the **AREF** pin and analogReference() function.

There are a couple of other pins on the board [56]:

- **AREF:** Reference voltage for the analog inputs. Used with analogReference().

- **Reset:** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

4.5 Vibration Motor

A disk coin vibration motor which is a small, tiny, shaftless vibratory motor which is perfect for non-audible indicators. Use in many number of applications to indicate to the wearer when a status has changed.

Figure 4.6: Vibration Motor

Brushed coin vibration motors are constructed from a flat PCB on which the 3-pole commutation circuit is laid out around an internal shaft in the centre. The vibration motor rotor consists of two 'voice coils' and a small mass that are integrated into a flat plastic disc with a bearing in the middle, which sits on a shaft. Two brushes on the underside of the plastic disc make contact to the PCB commutation pads, to provide power to the voice coils which generate a magnetic field. This field interacts with the flux generated by a disc magnet that is attached to the motor chassis.

The commutation circuit alternates the direction of the field through the voice coils, and this interacts with the N-S pole pairs that are built into the neodymium magnet. The disc rotates, and due to the built in off-centred eccentric mass, the motor vibrates [57].

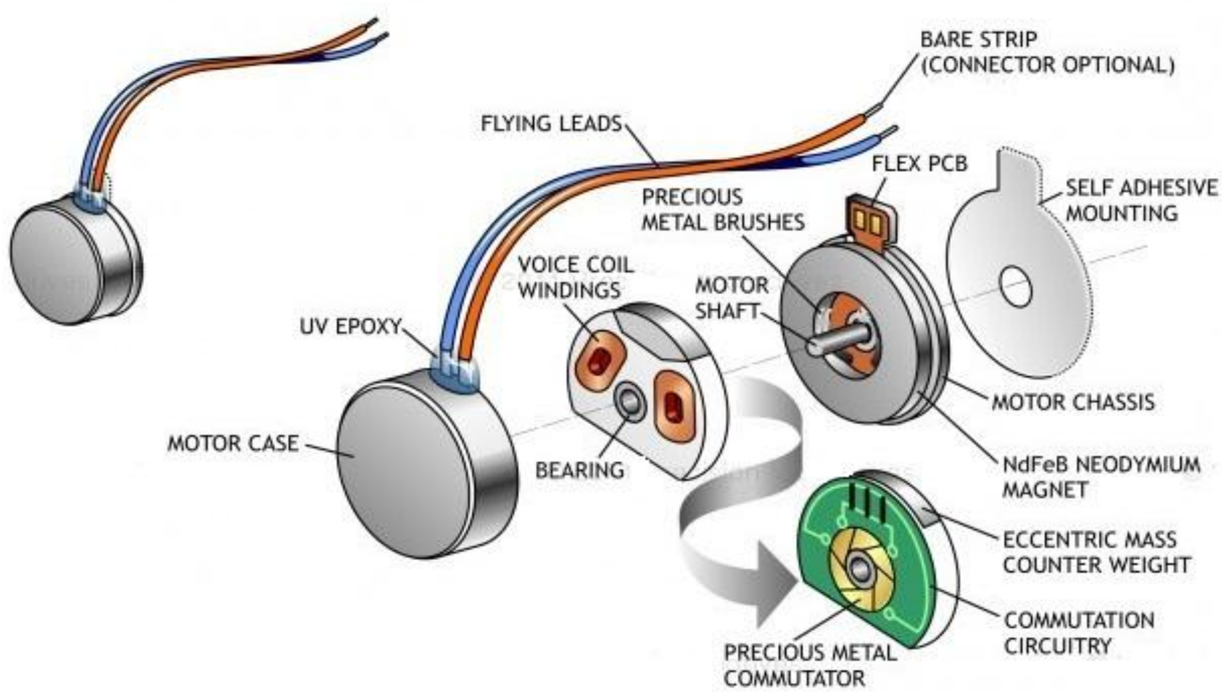


Figure 4.7: Disk Coin Vibration Motor Components [58].

4.6 Music Shield

4.6.1 Seeed Studio Shield

Music Shield for Arduino Microcontroller is used to play a recordable sound files from an SD Card based on programmable code this shield support Arduino Mega and optimal choice for this project.

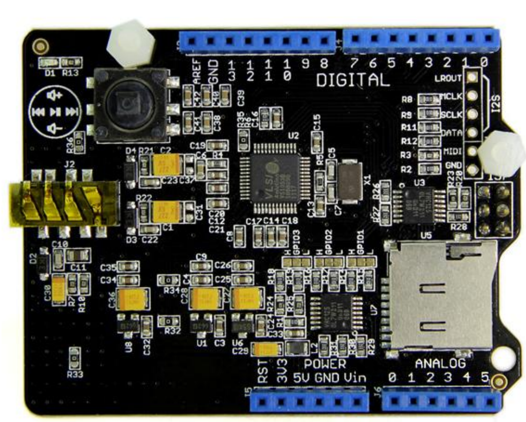


Figure 4.8: Music Shield [59].

4.6.1.1 Shield Hardware Details

It can play a variety of music formats stored on MicroSD cards: MP3,WAV,MIDI,Ogg Vorbis with Excellent sound quality.

- **Specification of music shield**
-

Table 4.3: Music Shield Specification [60].

Item	Min	Typical	Max	Unit
Voltage	4.5	5	5.5	VDC
Current	/	/	70	mA
Output S/N Ratio (With A-Weighting)	/	60	/	dB
Channel Isolation (With A-Weighting)	/	50	/	dB
Frequency Response	-1	/	1	dB
Signal Distortion	/	/	0.5%	/
Maximum output(each channel with 16 ohm load)	500	/	/	mV
Audio Interface	3.5mm Audio Jack			/
Supporting Format	MP3, WAV, MIDI, Ogg			/
Supported SD Card	Micro SD Card			/
ESD contact discharge	±4			KV
ESD air discharge	±8			/
Dimension	80.4x52.5x13.9			mm
Net Weight	11±2			g

4.6.1.2 Features [61]

- Arduino,Seeeduino, Arduino Mega, and Seeeduino Mega compatible
- 2 control-push buttons and 1 knob switch
- Plays music from micro SD cards Decodes:MP3,WAV,MIDI,Ogg Vorbis
- I2S interface for external DAC
- Headphone/Line Out for playback
- Line In for recording in OGG format
- Excellent sound quality with ±1dB Frequency Response
- FCC verification

4.6.2.1 ITEAD Music Player Shield

New ITEAD Music Player Shield basic on CECL08D. The CECL08D chip can be used to decode MP3/WAV format audio file. The music player shield has SD card socket and USB interface, supporting USB and SD card play. When plug the SD card or U Dist in, the chip will source the care and disk, and just need to use some I/O operation.

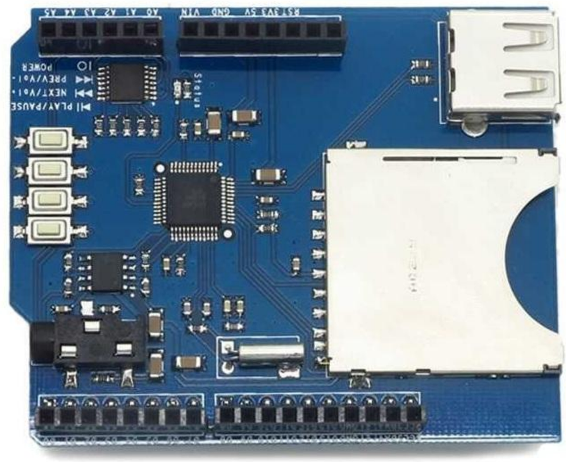


Figure 4.9:ITEAD Music Player Shield

4.7 Battery

In this section will be discussed the differences of the most common batteries that used in portable systems, so that the choice of the battery in this project will be based on this differences.

The Table 4.5 Shows these differences between five types of (Lead Acid, NiCd, NiM, Alkaline and Li-Ion) in terms of Cell Voltage, Relative Cost, Internal Resistance, Self-Discharge, Cycle Life, Over Charge Tolerance, Energy Density by Volume, and Energy Density by Weight.

Table 4.4: Differences between common batteries type [62].

Parameter	Lead Acid	NiCd	NiMH	Alkaline	Li-Ion
Cell Voltage (V)	2.0	1.2	1.2	1.5	3.6
Relative Cost	Low	Moderate	High	Very low	Very high
Internal Resistance	Low	Very low	Moderate	Varies	High
Self Discharge (%/month)	2% to 4%	15% to 30%	18% to 20%	0.3%	6% to 10%
Cycle Life (Charge Cycles to Reach 80% of Rated Capacity)	500 to 2000	500 to 1000	500 to 800	Low	1000 to 1200
Overcharge Tolerance	High	Medium	Low	Medium	Very low
Energy Density by Volume (Wh/L)	70 to 110	100 to 120	135 to 180	220	280 to 320
Energy Density by Weight (Wh/kg)	30 to 45	45 to 50	55 to 65	80	90 to 110

In this project the required battery must be light weight and small size according to the battery capacity so can be hold by the belt in a suitable way, more safety and more efficiency.

Lithium-ion batteries can achieve these requirements by offering high energy density- more energy for a given size- and do not require prolonged charging to "prime" new batteries, have lower self-discharge rates than nickel-based batteries.

Figure 4.10 shows one of the Rechargeable Li-Ion Battery that can be used in this project.

Figure 4.10: Rechargeable Li-Ion Battery

4.8Accessories

- ### Earphones

The Headphone supported is 32 ohm earphone which is comfortable for a user to use it and has a clearly sound output.

Figure 4.11: Earphones.

- **Vest**

The Vest will be designed using material that is flexible while still able to hold allparts. Each sensor will be set on the vest at a predetermined angle from the ground.

Figure 4.12: Wearable Vest

Chapter Five

Project Conceptual Design

5.1 Overview

In this chapter will illustrate the general block diagram of the system, then described how every components will implement based on accurate calculation and given some picture examples to operations of every components

5.2 General Block Diagram

The main parts of the system as shown in general system block diagram figure 4.1 are:the Ultrasonic Transducers, PIR Module, SD Card Module, Audio box, Vibration motors, Battery, Battery level monitor and Headphones.

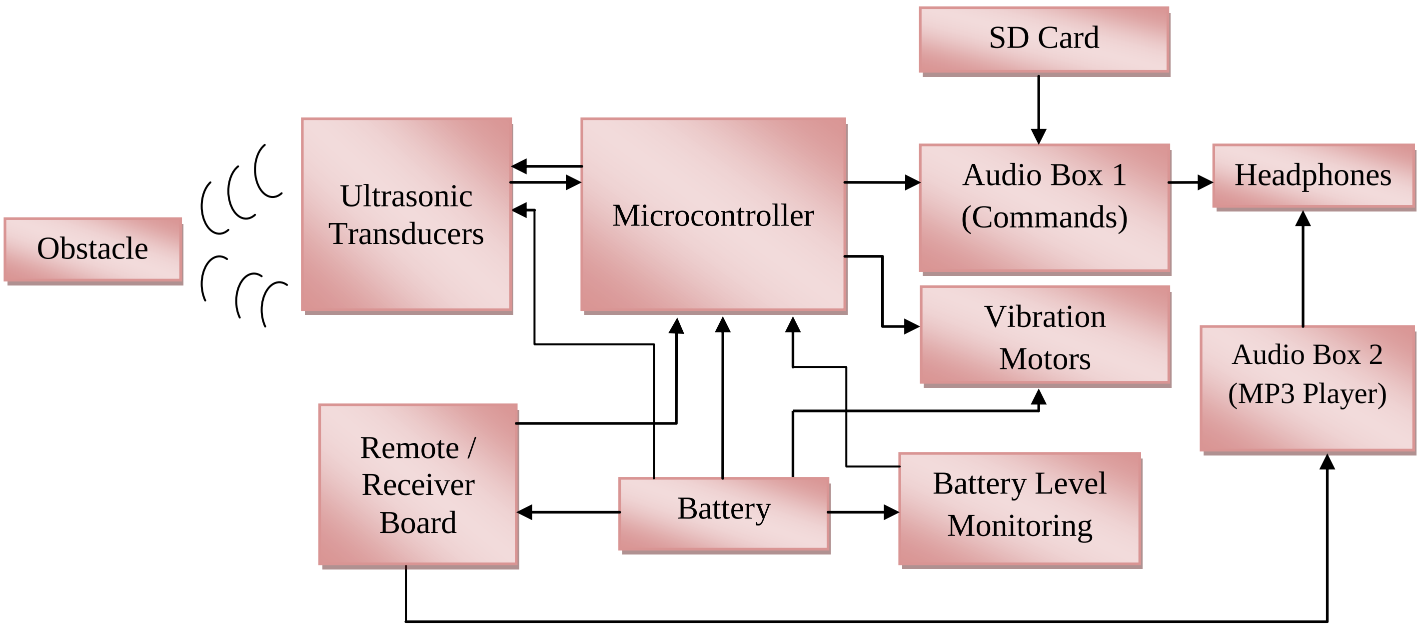


Figure 5.1: General block diagram.

Ultrasonic Transducers: detect if there is any obstacle in front, right and left of the patient.

SD Card Module: Stores the voice commands that will guide and warning.

Audio Box1&2: Analysis the voice that stored on SD Card that will send to headphone.

Vibration Motors: Get a vibration alarm to warning in (silent mode).

Remote/Receiver Controller: Wireless controlling to(play/pause, next/prev, shut on/down system).

Battery level monitoring: Detect life of the battery in (discharging mode).

Battery: Power source of the project (Li-ion).

Microcontroller: The processing and controlling unit.

5.3 Sonar (LV-MAXSONAR Ultrasonic Sensors)

5.3.1 Introduction

The sensors we're currently looking at using are the LV-Maxsonar-EZ1 High Performance Sonar Range Finders, These sensors are cost effective, have appealing beam widths, and function with an Arduino microcontroller.

The sensors only use 2mA power and have a very high resolution (512 point resolution). This means that the reading vary from 0-VCC by increments of VCC/512. After further research, this can read differences of up to 1cm.

Figure 5.2: LV-MaxSonar-EZ1.

5.3.2 Implementations

In this project, four of (LV-MaxSonar-EZ1) will be used, one for detect the obstacles in front of the person , two for detect the obstacles from left and right and one for detect the stoppable from ground as shown in figure 5.2

Figure 5.3: Transverse and Sagittal view for U.S implementation.

5.3.3 Calculations

Because the LV-MaxSonar-EZ1 output is scaled to the input power that is provided to the sensor, it is important to know the voltage scaling before calculating the range.

The formula for the voltage scaling on an LV-MaxSonar-EZ1 is:

$$Vi = \frac{\text{Vcc}}{512} \qquad \text{Equation (5.1)}$$

Vcc = Supplied Voltage
Vi = Volts per inch (Scaling)

- **Calculating the Range**

By knowing the voltage scaling it is easy to properly calculate the range.

The range formula is:

$$Ri = \frac{\text{Vm}}{Vi} \qquad \text{Equation (5.2)}$$

Vm = Measured Voltage
Vi = Volts per Inch (Scaling)
Ri = Range in inches

In this project, front LV-MaxSonar-EZ1should detect the obstacles which lies about (300,200 and 100) Centimeter from the patient and warning them.

Read in the analog voltage output that is being sent by the MaxSonar device.

Scale factor is (Vcc/512) per inch. A 3.3V supply yields ~6.4mV/in. Arduino analog pin goes from 0 to 1023(1024 value), so the value has to be divided by 2 to get the actual inches:

By using Equation (5.1)

Let Vcc=5 volt
Vi=5/1024
Vi=4.88 mV/inch

1cm=0.39In

200 cm=78.74In
100 cm= 39.37In

From Equation (5.2)
At 200 cm range

78.74(inch)=Vm/4.88(mv / Inch)
Vm=384.25 mv

At 100 cm (78.4 In)

Vm=192.12 mV

The right and left LV-MaxSonar-EZ1 should detect the obstacles which lies less than 1 meter.

At 100 cm (39.37 In)

Vm=192.12 mV

Ground sensor will work based on the tallest of the person (distance between the sensor and the ground), in this project the system will automatically detect the tall of the user and set the detection threshold.

Let the distance about 90cm, then the sensor should give alarm when the range between the ground and sensor change (less or more than 90cm (+-10cm).

5.3.4 Install on Arduino Microcontroller

One of the biggest issues facing with this sensors is hooking up multiple sensors and receiving cross-talk, To eliminate that we will cycle through the sensors, When the BW pin of the sensor is held low or not connected the TX pin on the sensor will always output a high, But when it is held high, the TX pin will only output a high for 20us, after a reading has been made.

The readings on the sensor will only read when the RX pin is unconnected or held high. But when low, the reading will stop, and it requires a minimum of 20us to read a value so by this logic a circuit which will cycle the sensors through figure 5.3 has created.

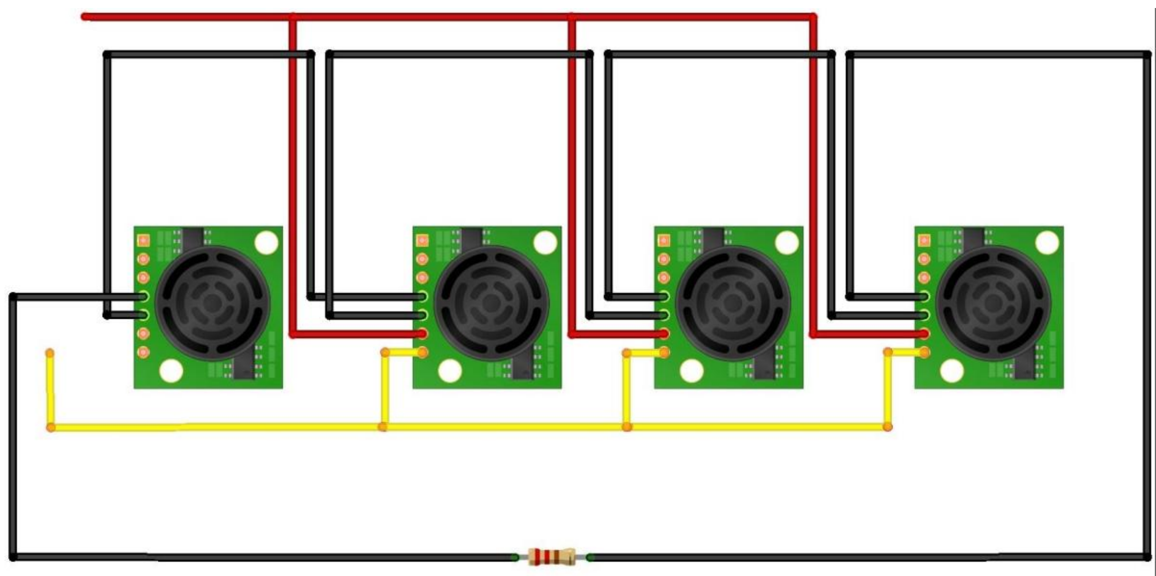


Figure 5.4: Schematic to cycle the sensors.

Note that the time of cycle is equal to20us*(number of sensors). To work this (kickstart) is needed for this cycle, this will happen through a quick high coming from one of the Arduino outputs.

1K resistor, this is because to reset the RX pin to a high impedance state when connected to the Arduino.

Figure 5.4 Shown the full schematic diagram of interfacing four (LV-MaxSonar-EZ1) with Arduino.

Output from the sensors is an analogue input to Arduino Mega.

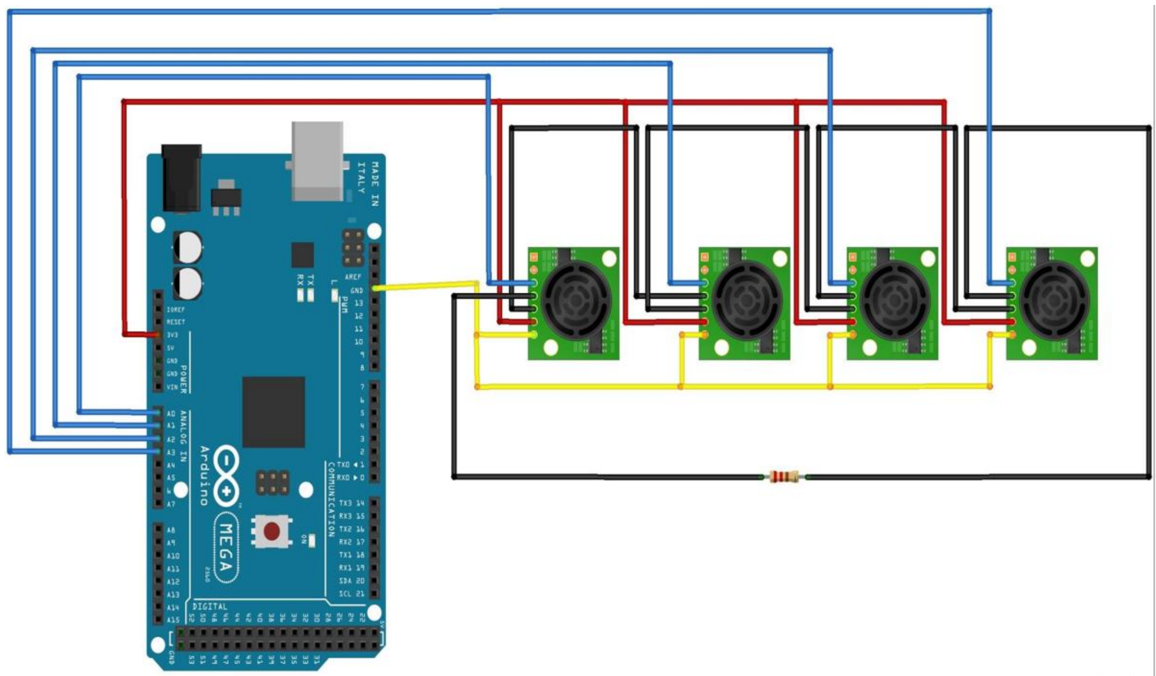


Figure 5.5: Schematic diagram to LV-MaxSonar-EZ1 sensors with Arduino Mega.

5.4 Implementation of Wireless Remote Controller &Decoding Receiver Board

5.4.1 Introduction

As well known, some features in project should be to control like (play/pause) music, so some switches need to use.

Instead of using fixed switches on vest, this technology used to give project many features, wireless remote controlling, reduce number of switches, and to give user more friendly interface for controlling.

5.4.2 Wireless Remote Controller

Wireless Remote Controller used to control these features:

1- Music controlling (Play/Pause,Next/Prev,Vol+/Vol-).

2- Turn ON/OFF the navigation system in rest mode.

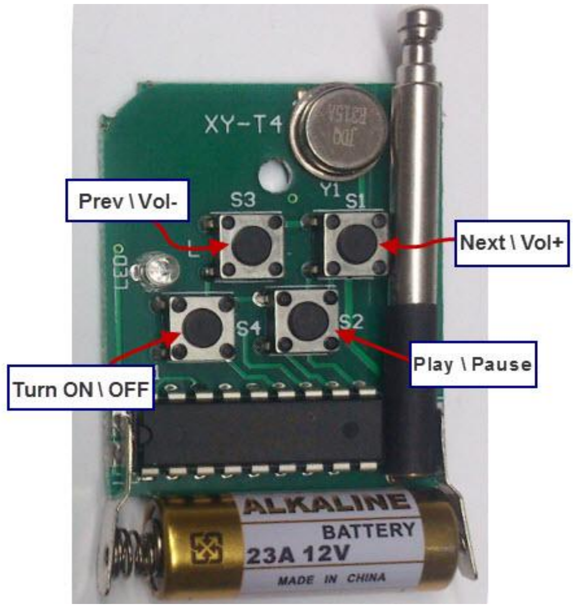


Figure 5.6: Functions Keys for remote controller.

5.4.3 Install Decoding Receiver Board on Arduino

Basically this hardware is used to receive a message signal in frequency of 4.8MHz from remote controller and decoding it, then Digital controlling pulses send to music shield (audio box 2) and Arduino.

The figure 5.6 below shows how the receiver board implemented with Arduino Mega and music shield.

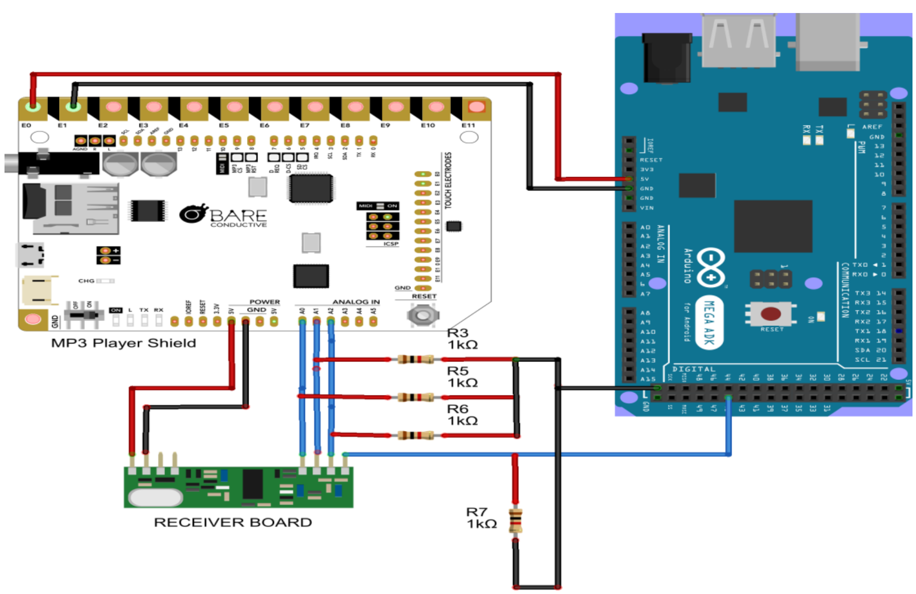


Figure 5.7: Schematic diagram to Receiver Board with Arduino Mega and music shield**.**

A 1 kΩ Pull-down resistor used in electronic logic circuits to ensure that inputs to the Arduino settle at expected logic levels if external devices are disconnected or high-impedance.
Just because nothing is connected to an input pin doesn't mean it is a logical zero.

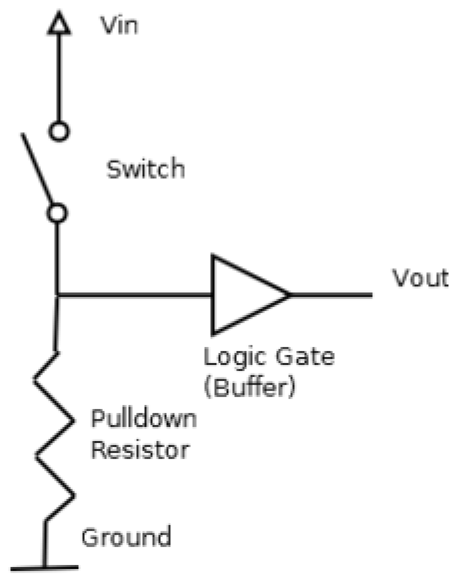


Figure 5.8: Pull-Down Resistor circuit.

As shown in figure 5.8, it holds the logic signal near zero volts when no other active device is connected.

5.5 Disk Coin-Type Vibration Motor (ROB-08449)

5.5.1 Introduction

For a feedback device to the user, settled on the sense of feel, the best way to send this is using a vibrations motor, the motor that settled on was the ROB-08449 Coin-Type Vibration Motor.

These motors were selected because they are fairly small in size and they do not consume a whole lot of power (roughly 20mA), even though they consume more power than the sensors, the power consumption is low because it has a physical moving device in it.

These vibrations motors have wire leads which can be easily connected to the output pins of an Arduino microcontroller.

5.5.2 Implementation

Vibrations motors will put in three sides of belt (front, left and right) so that when there are any obstacles in front of the person, the front one will vibrate and the same thing will happen if there is any obstacles in left or right, figure 5.9 below illustrate

Figure 5.9: Transverse view for Vibrations motors implementation.

5.5.3 Install on Arduino Mega

When driving a motor with a microcontroller such as the Arduino Megaas in this project, it is important to connect a diode reverse biased in parallel to the motor. This is also true when driving it with a motor controller or transistor, the diode acts as a surge protector against voltage spikes that the motor may produce, the windings of the motor notoriously produce voltage spikes as it rotates, without the diode, these voltages could easily destroy your microcontroller, or motor controller IC or zap out a transistor. The 0.1µF capacitor absorbs voltage spikes produced when the brushes, which are contacts connecting electric current to the motor windings, open and close. The reason of use a transistor (a 2N2222) is because most microcontrollers have relatively weak current outputs, meaning they don't output enough current to drive many different types of electronic devices, To make up for this weak current output, using a transistor to provide current amplification.

The vibration motor needs about 55mA of current to be driven, the transistor allows this and we can drive the motor, to make sure that too much current does not flow from the output of the transistor.

Place a 1KΩ in series with the base of the transistor. This attenuates current to a reasonable amount so that too much current isn't powering the motor.

Figure 5.10 below show the optimal way of interface Disk coin-type vibration motor (ROB-08449) with Arduino Mega.

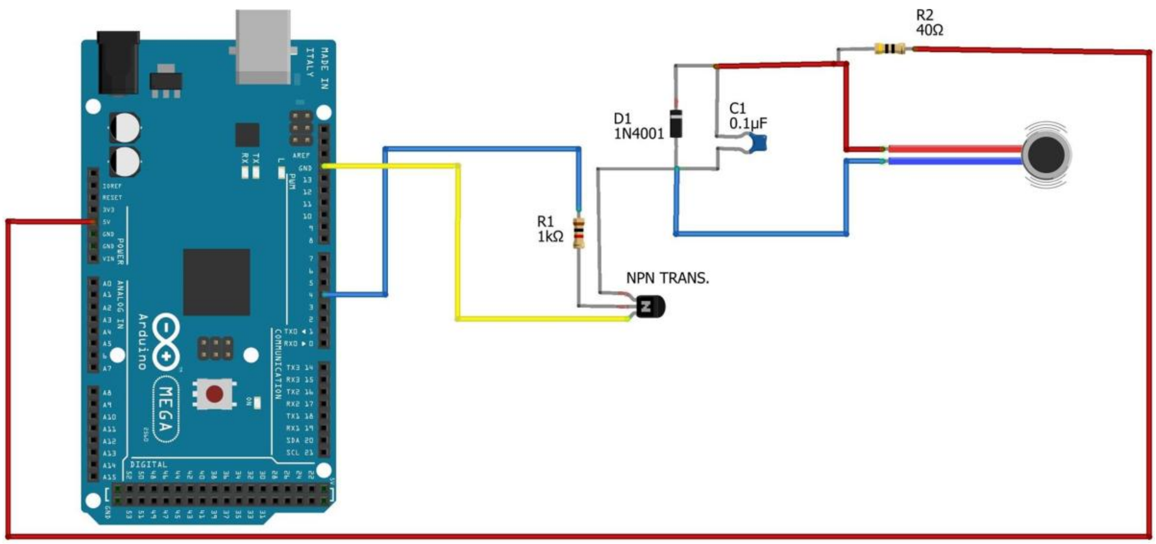


Figure 5.10: Schematic diagram of Disk coin vibration motor sensors with Arduino Mega.

5.6 Music Shield

5.6.1 Introduction

Music Shield is the best choice to serve this project because the easy of implantations, compatibility with project microcontroller and the more important thing is the free run mode which means that the shield can run music in rest mode as planned.

5.6.2 Implementation

The main idea of use music shield that is can give an voice commands to the person who use this system , where a set of voice commands will recorded and stored in (SD Card : a storage unit in shield) that inserted in the shield, this voice commands will used by microcontroller to warning and navigate , as example if an obstacles detect by front US sensor, microcontroller will receive a signal from US sensors and analysis it, then by using music shield through earphone will say (AN THREE METER AWAY OBJECT DETECT IN FORNT OF YOU, STOP, TERUN LEFT, TERUN RIGHT …etc).

5.6.3 Install on Arduino Mega

As motioned previously, music shield can be implemented easily with Arduino Mega.
This shield can install in several way on Arduino Mega, the figure 5.10below shows how implemented in this project.

Figure 5.11: Music shield installed on Arduino Mega.

5.7 Power Supply

5.7.1 Introduction

It is necessary to find an appropriate power source to feed the system by current and voltage required. The power source must be light in weight, rechargeable, safe and easy to use because the system is portable.

5.7.2 Power Consumption Calculation

In this subsection will be reviewing the calculations of the expected power consumption of each part according to the manufacturer's instructions and then will calculate the total consumption of the system so that the battery specifications required to run the project efficiently can be determined.

For all components the voltage did not exceed from5V, so that 5V battery will be appropriate choice to this project.

Power consumption can be determined by equation 5.3

P = I * V	Equation (5.3)

Where:

P is the Power (W)
I is the Current (A)
V is the Voltage (V).

- **Current Consumption:**
  1. Arduino Mega: 1 * 300mA = 300mA
  2. Maxbotix LV-EZ1: 4 * 2mA = 8mA
  3. Receiver Controller 1 * 10= 10mA
  4. Music Shield(Seeed Studio Shield): 1 * 70mA = 70mA
  5. Music Shield(ITEAD Music Player Shield): 1*80=80mA
  6. Vibration Motor : 3 * 20mA =60mA

  SUM : 528 mA
- **Voltage:**
  1. Arduino Mega: 12 V
  2. Maxbotix LV-EZ1: 3.3 V
  3. Remote/Receiver Controller: : 12V/5V
  4. Music Shield 1&2: 5 V
  5. Vibration Motor : 3.3 V
  6. LEDs : 5 V
- **Power consumption:**
  1. Arduino Mega: 300 mA * 10 V = 3 W
  2. Maxbotix LV-EZ1: 4 * (2mA * 3.3 V)= 0.0264 W
  3. Remote/Receiver Controller: 0.001 W
  4. Music Shield(Seeed Studio Shield): 1 * (70mA* 5 V) = 0.35 W
  5. Music Shield(ITEAD Music Player Shield): 1*(80mA * 5V)= 0.40W
  6. Vibration Motor : 3 * (20mA * 3.3 V)=0.198W

  SUM = 3.9754 W

5.7.3 Battery

Referring to the previously calculated current, 530 mA was a total system current consumption. The design required supplying all the components with a required current and voltage for 8 hours (for one chargeable cycle), the equation 5.4will determine the capacity of the battery that can operate the project for 8 hours [63].

$T = \left(\frac{C_h}{I}\right) * 0.7$ Equation (5.4)

Where:

T is the Battery Life (hour)

C_h is the Battery Capacity (amperes . hour)

I is the Load Current (amperes)

The factor of 0.7 makes allowances for external factors which can affect battery life.

For T = 13 hour:
13.7 = (C_h/528 mA) * 0.7
C_h = 10400mAh

So that 5V battery with capacity of 10400mAh is the optimal choice to serve this project.
Note: 13 hours and 47 minutes is the (continuous hardware running time.

5.8 SASB Logo

A logo shown in Figure 5.12 was designed by project teamwork.

Figure 5.12: SASB Logo

SASB is stand for the title of project- **S**mart **A**ssist **S**ystem for **B**lind.

5.9 Vest Design

5.9.1 Introduction

The design of vest was completed by specialists in fashion and sewing fields. Several aspects such as light weight, safety, beauty, efficiency, friendly user, easy to dressed and undressed and comfortable is taken in consideration in vest design.

5.9.2 Outer Design

Outer design is based on combining between beauty and efficiency.

Figure 5.13: Outer Vest Design.

Every single part in vest design to certain purpose, therefore front sensor and ground sensor set on light and flexible metal piece so that to ensure proper work.

Figure 5.14: Front and Ground sensor metal holder.

Ultrasonic sensors are fixed in it, then it covered by carton layer to avoid any attenuation in ultrasonic waves.

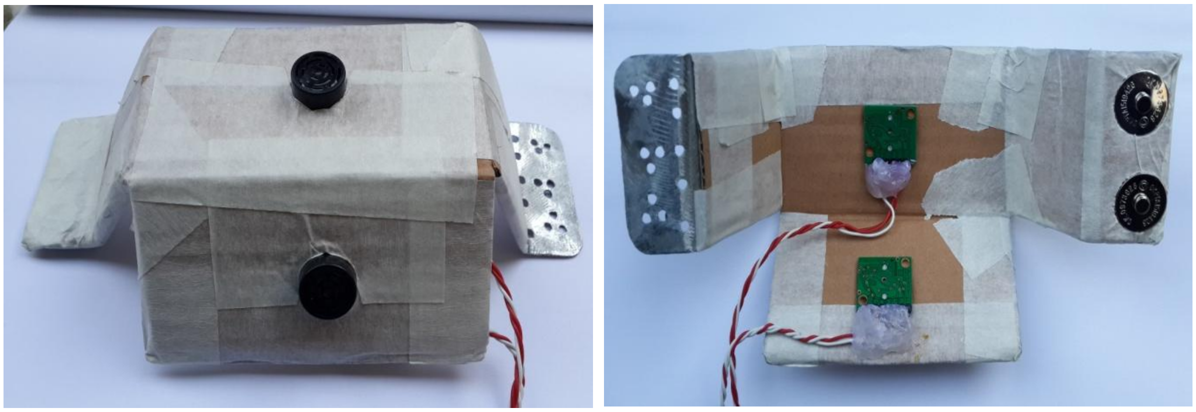


Figure 5.15: Front and Ground sensor metal holder covered by carton.

Then it covered by a red fabric and fixed on vest by magnetic stapler.

Figure 5.16: Front and Ground sensor metal holder covered by red fabric.

Now after fixed front and ground sensors, left and right sensors holders placed in 15 cm from the front sensor based on beam structure of U.S sensors to prevent interfering between U.S waves.

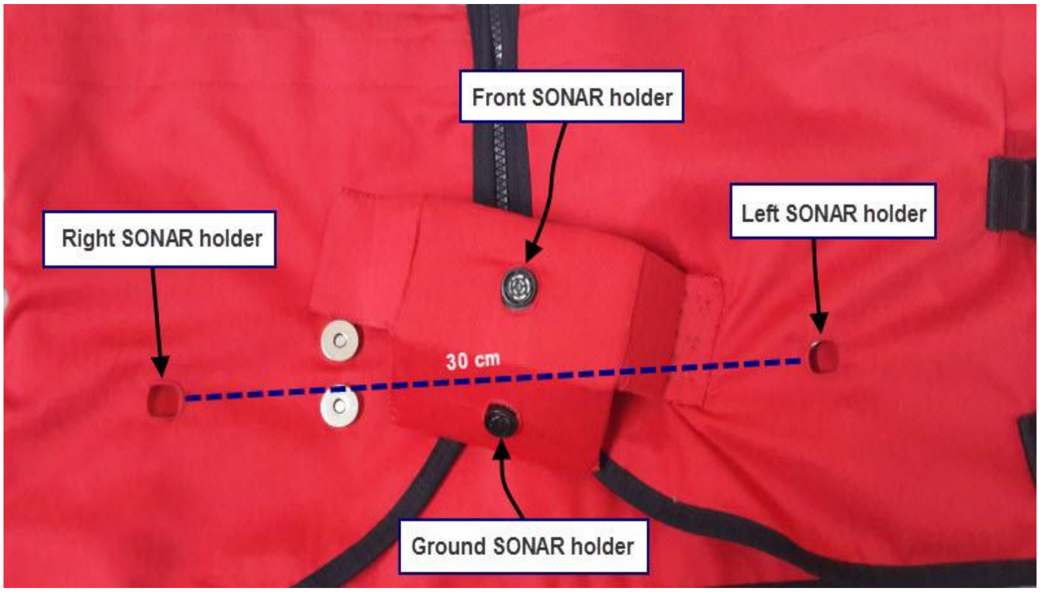


Figure 5.17: Front, ground, left and right sensors holders.

For behind side of vest, the logo of project has a largest back area, in lower there is an light reflector to attenuate vehicle drivers, a large pocket it set to hold other components (Arduino Mega, Vibration motor drive circuits … etc).

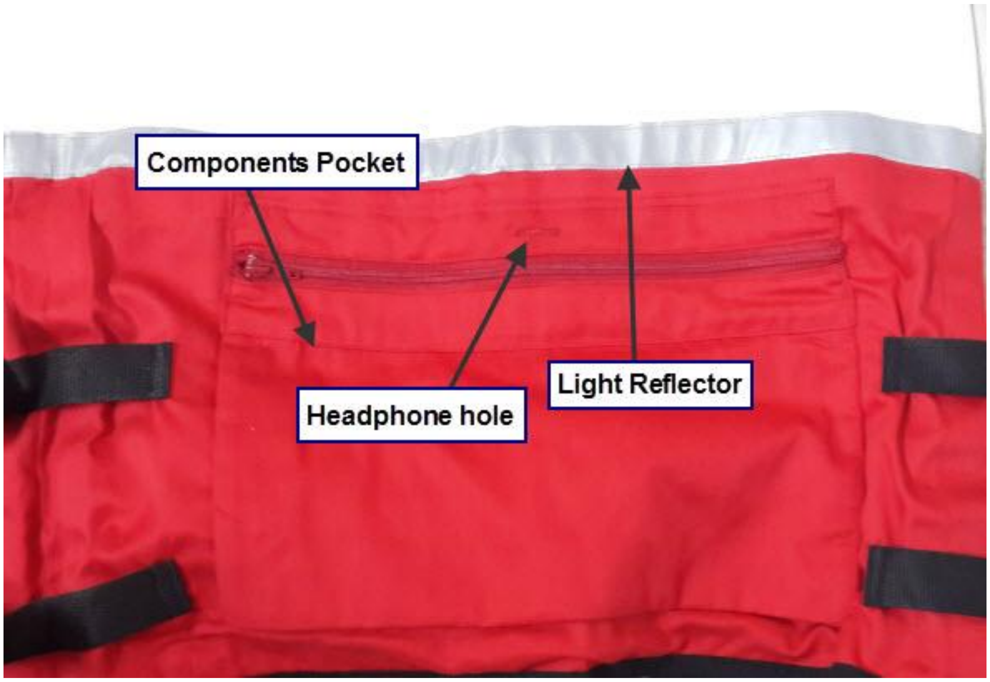


Figure 5.18: Vest back.

To prevent any errors in sensor measurements and reading causes by user motion, webbing sizing is used to fit the vest size to the user body.

Figure 5.19: Webbing Sizing.

5.9.3 Inner Design

As motioned in previous section, the inner design constructed to achieve flexibility in installation of system components.

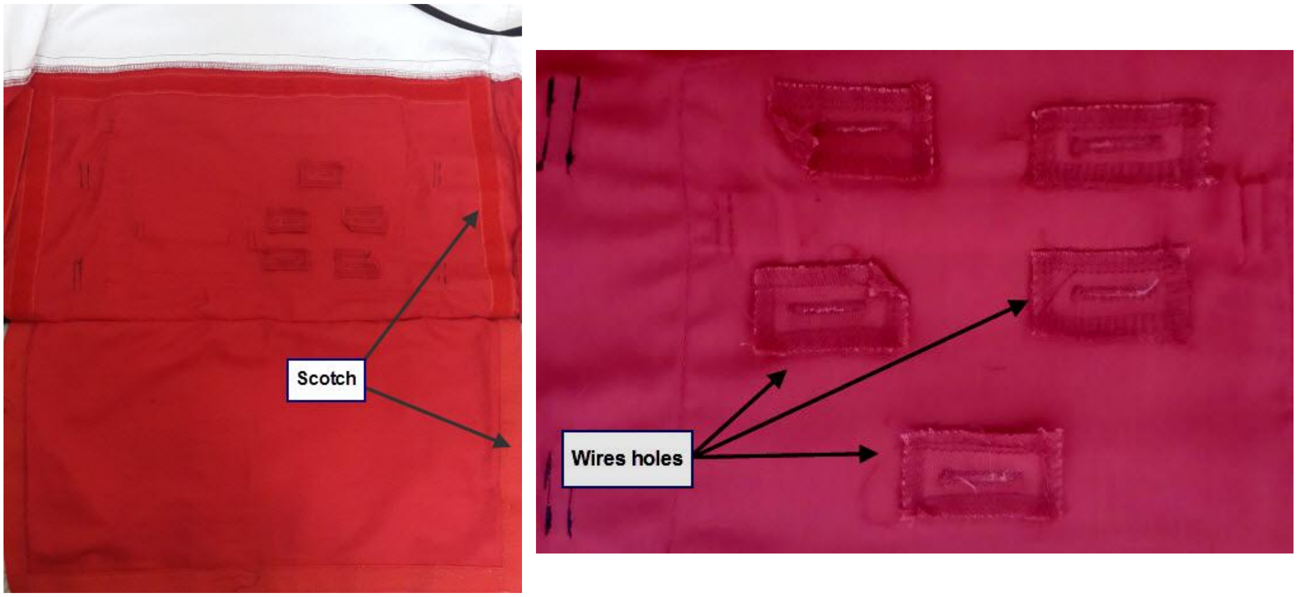


Figure 5.20: Inner view of vest

Wire hole shown in figure 5.20 to pass sensor wires to pocket of components.

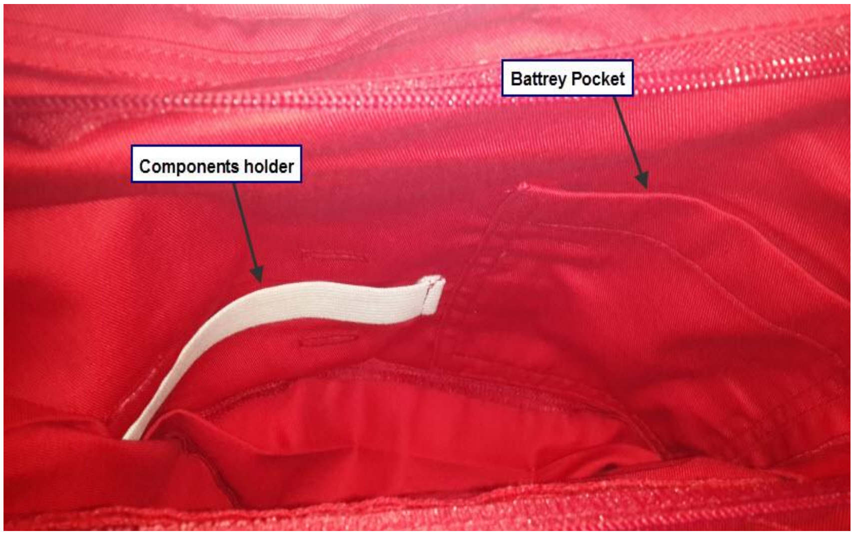


Figure 5.21: Inner view for components pocket.

Figure 5.21 shows Inner views for components pocket, components holder use to fixed components into the pocket and the battery pocket use to hold battery.

Figure 5.22: USB cable hole.

USB cable hole use to pass the USB cable over the front pocket

5.10 Full System Diagram

Figure 5.23 shows full system diagram.

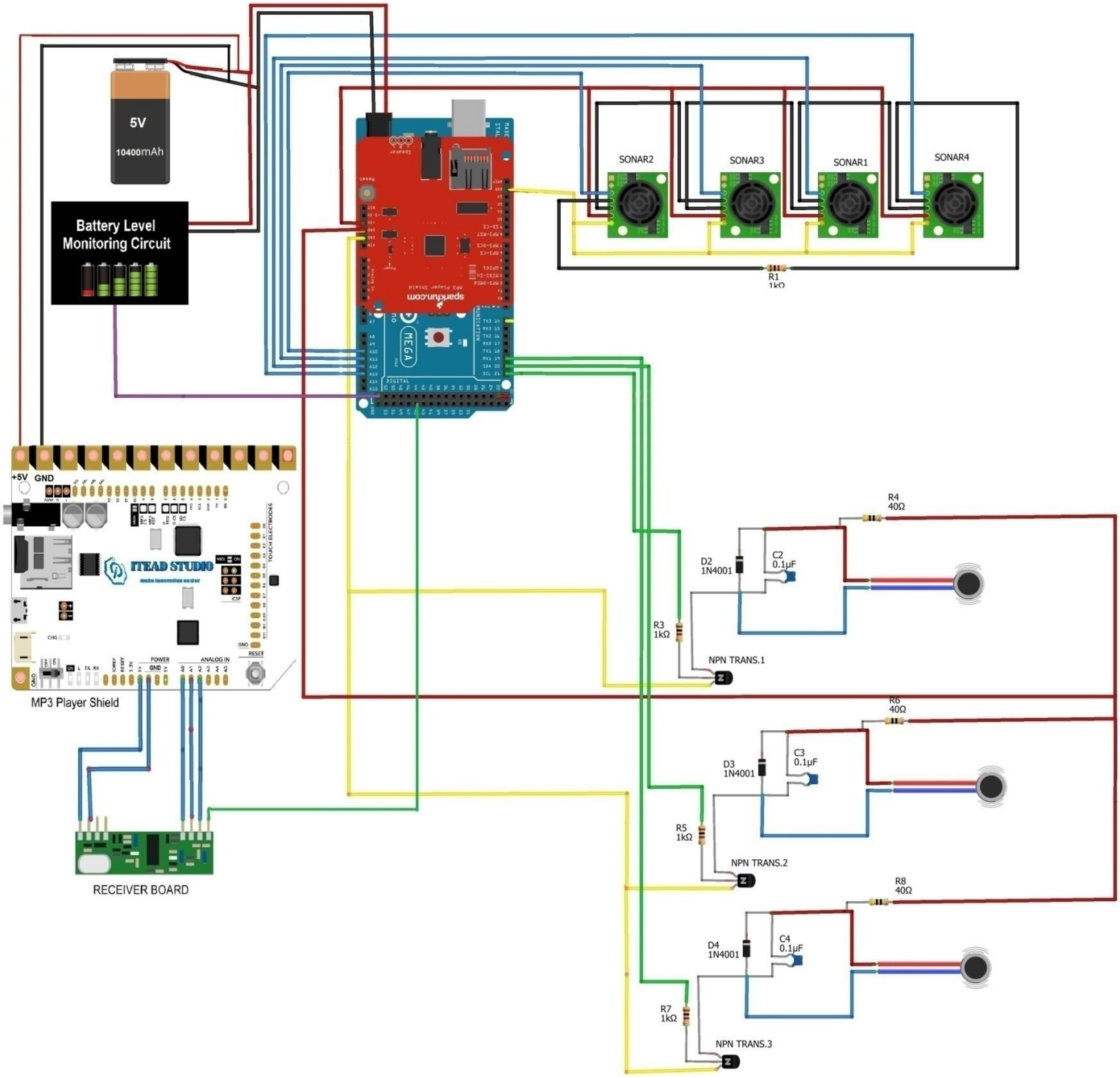


Figure 5.23: Full System Diagram.

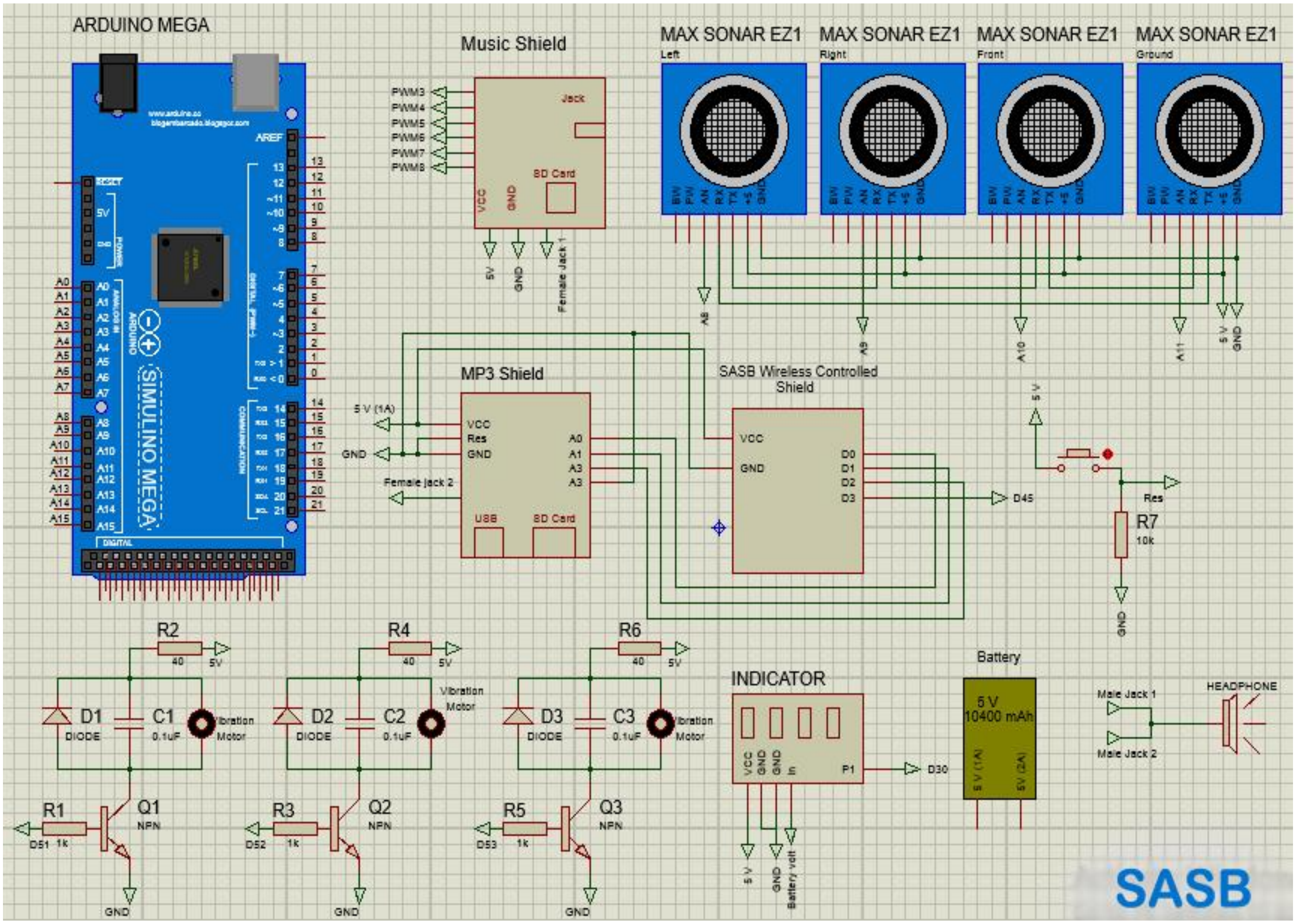


Figure 5.24: Full System Schematic Diagram.

5.11 System Flow Chart

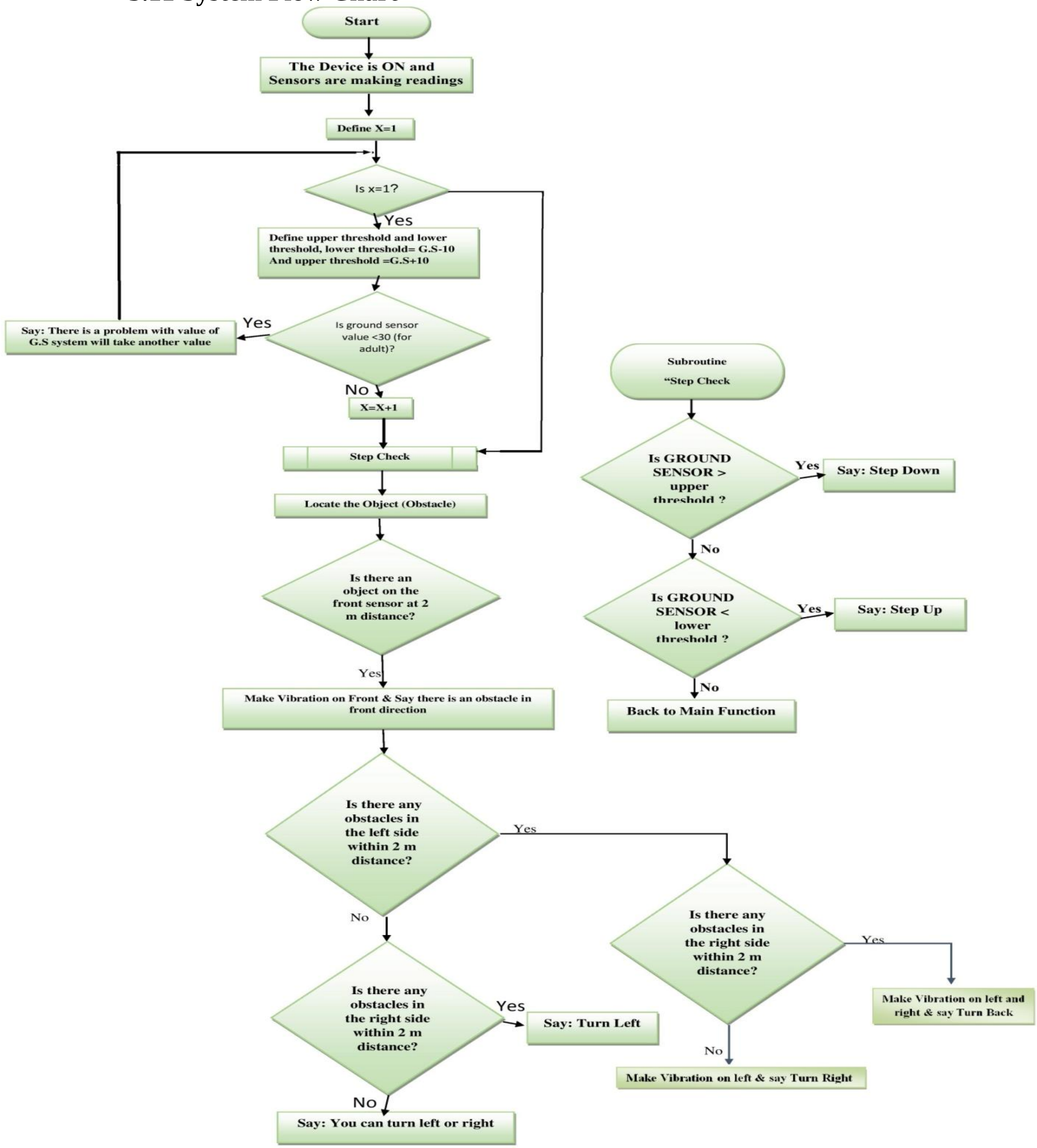


Figure 5.25: System Flow Chart.

Chapter Six

Implementation, Experiments and Results

6.1 Introduction

Practical implementation of the project has been done in the second semester. Implementation started by implementing each individual subsystem and testing it, after the testing is successfully done; the subsystems are connected together in certain way to complete the whole system.

6.2 Sub Systems Circuits

In this section, subsystems circuits will implemented before final implementations to the system.

6.2.1 Vibration Motor Drive Circuit

As mentioned in previous chapter, drive circuit is important to prevent any damages to vibration motor, figure 6.1 shows vibration motor drive circuit.

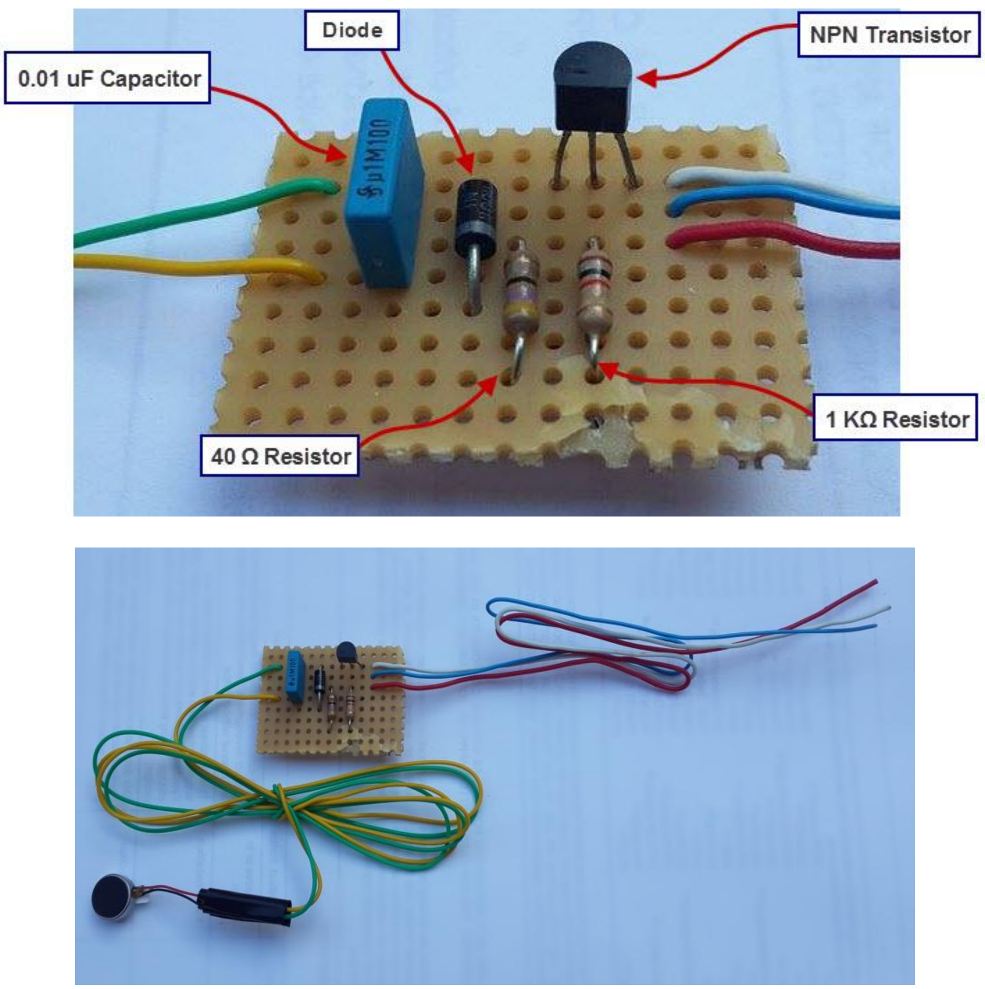
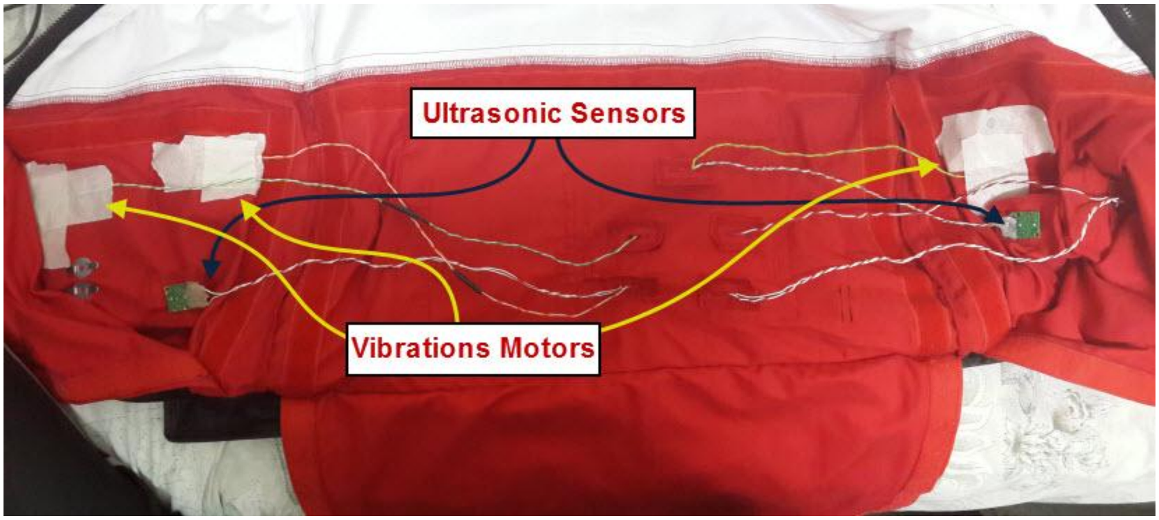


Figure 6.1: Vibration Motor Drive Circuit

6.2.2 Ultrasonic Sensors Connections Circuit

Ultrasonic sensors connector pins welded to plastic shielded wire so that to avoid any noise and data lose.

The ultrasonic sensors are set and fixed in there previously designed holders. The wires take a path across the back of vest to wires holes as planned and mentioned in chapter five, figures



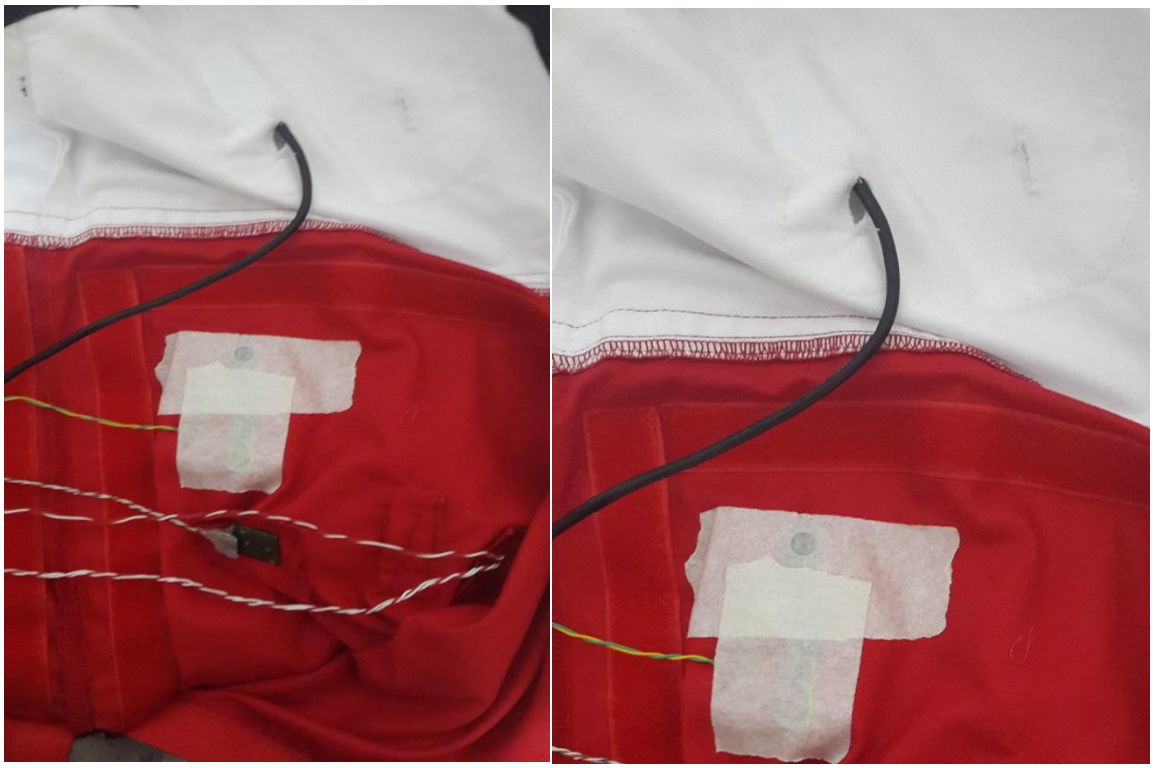


Figure 6.2: Inner View for Connections.

Components pocket connections as shown in figure 6.3

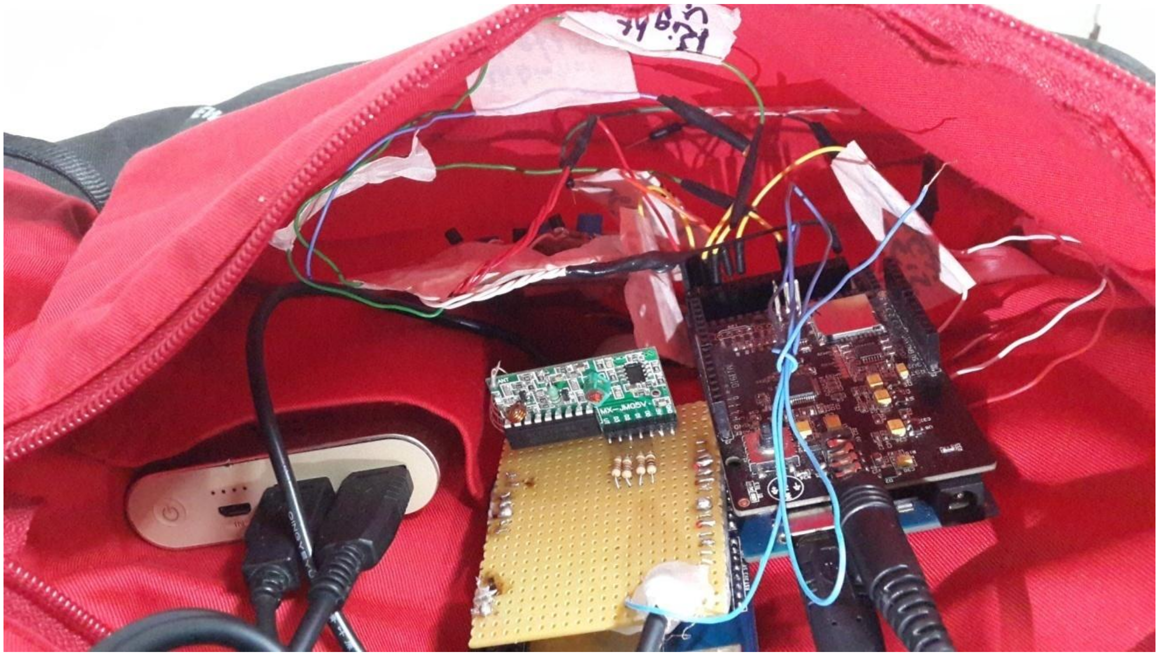


Figure 6.3: Components in back Pocket

6.2.3 SASB Wireless Controlling Shield

This shield was built by SASB teamwork to interface with (ITEAD) Music Shield to provide Wireless controlling as mentioned in previous chapter

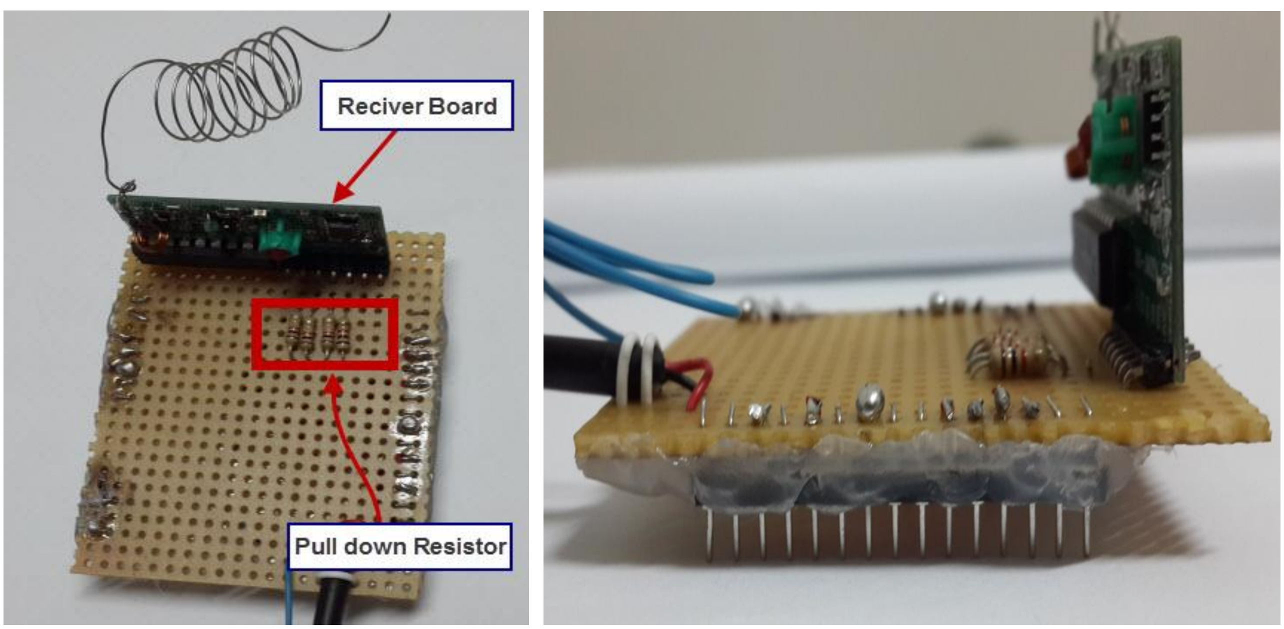


Figure 6.4: SASB Wireless Controlling Shield

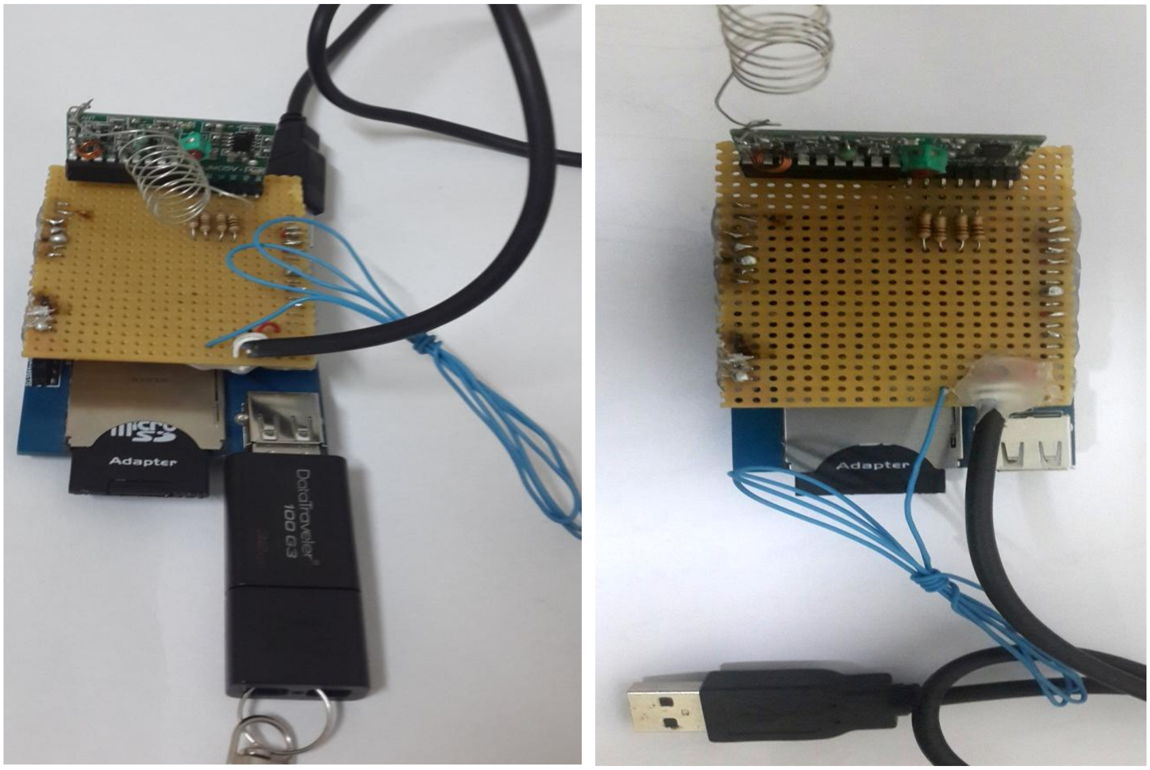


Figure 6.5: SASB Wireless Controlling Shield on (ITEAD) Music Shield

6.2.4 SASB Hand Assist

This Hand Assist was built by SASB teamwork to give the user an easily method to control rest mode function as mentioned previously.

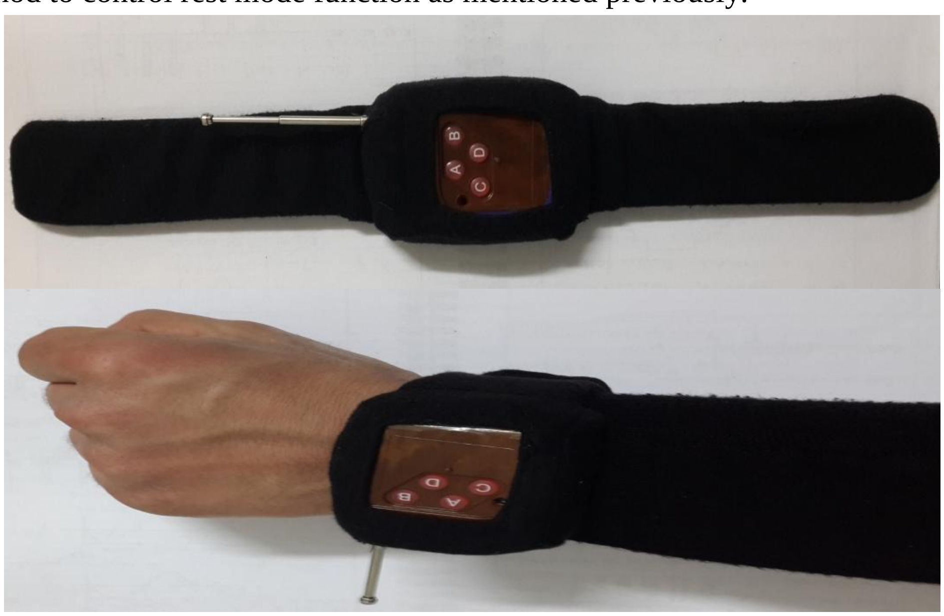


Figure 6.6: SASB Hand Assist

6.3 SASB Circuit

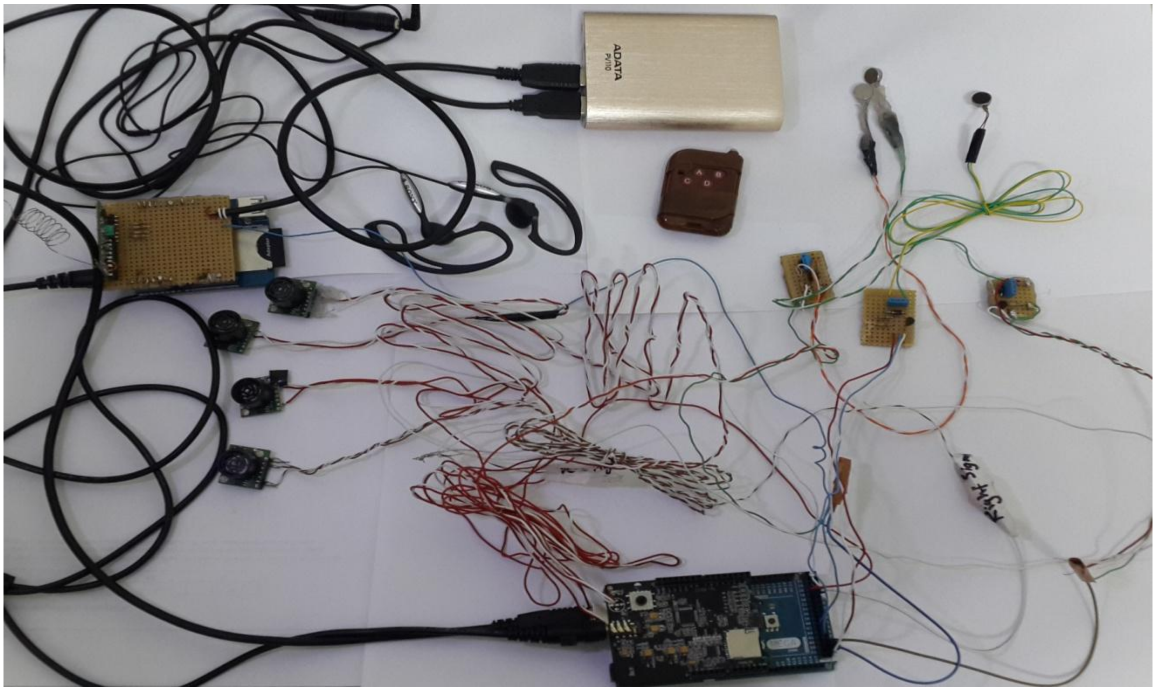


Figure 6.7: Overall System Circuits Connections

Figure 6.8: Overall System Circuits Connections on the Vest

6.4 System Testing

6.4.1 Introduction

System testing was done by serial motoring of Arduino MEGA program, testing show the logic of system as shown in the figures below

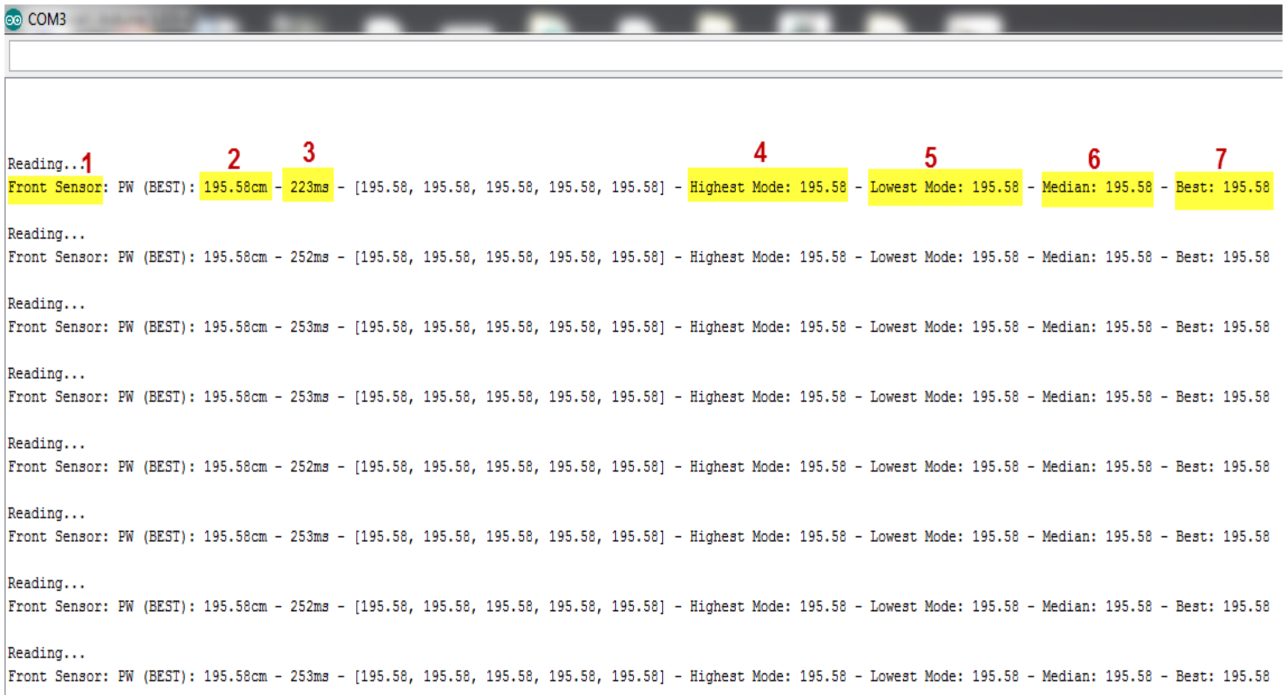


Figure 6.9: Simple Testing for Front Sensor.

1: Front sensor.

2: Distance in cm between obstacle and sensor.

3: Distance measuring time.

4: Highest filter mode: obtain the largest value for distance.

5: Lowest filter mode: obtain the lowest value for distance.

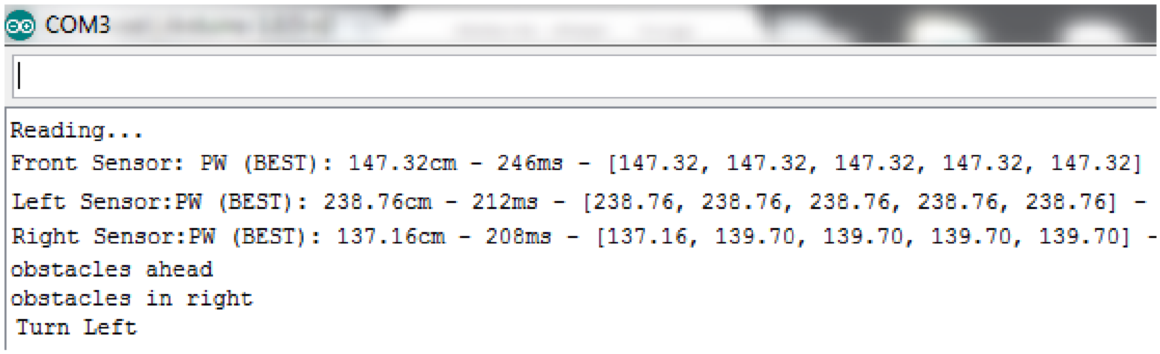
6: Median filter mode: obtain the median value for distance.

7: Best filter mode: obtain the best value for distance.

6.4.2 System Navigation Testing

6.4.2.1 Front, Left and Right cases

Case 1: Obstacles in Front and in Right

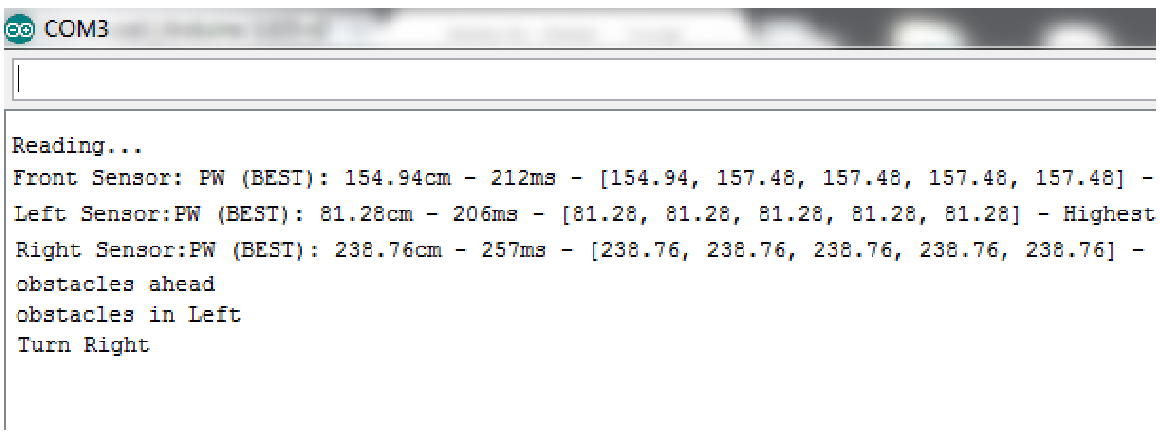


```
COM3

Reading...
Front Sensor: PW (BEST): 147.32cm - 246ms - [147.32, 147.32, 147.32, 147.32, 147.32]
Left Sensor:PW (BEST): 238.76cm - 212ms - [238.76, 238.76, 238.76, 238.76, 238.76] -
Right Sensor:PW (BEST): 137.16cm - 208ms - [137.16, 139.70, 139.70, 139.70, 139.70] -
obstacles ahead
obstacles in right
 Turn Left
```

Figure 6.10: Case one.

Case 2: Obstacles in Front and in Left

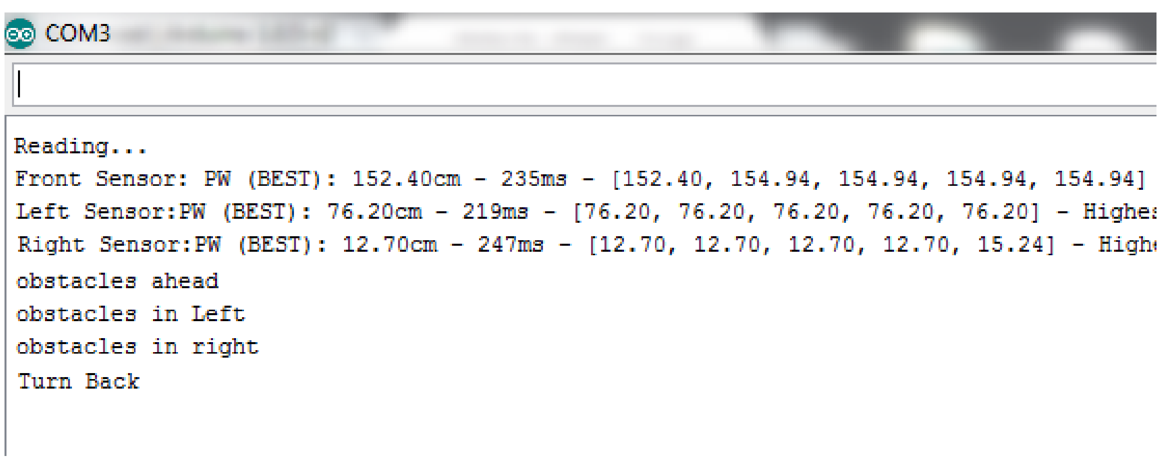


```
COM3

Reading...
Front Sensor: PW (BEST): 154.94cm - 212ms - [154.94, 157.48, 157.48, 157.48, 157.48] -
Left Sensor:PW (BEST): 81.28cm - 206ms - [81.28, 81.28, 81.28, 81.28, 81.28] - Highest
Right Sensor:PW (BEST): 238.76cm - 257ms - [238.76, 238.76, 238.76, 238.76, 238.76] -
obstacles ahead
obstacles in Left
Turn Right
```

Figure 6.11: Case two.

Case 3: Obstacles in Front Left and Right



```
COM3

Reading...
Front Sensor: PW (BEST): 152.40cm - 235ms - [152.40, 154.94, 154.94, 154.94, 154.94]
Left Sensor:PW (BEST): 76.20cm - 219ms - [76.20, 76.20, 76.20, 76.20, 76.20] - Highe
Right Sensor:PW (BEST): 12.70cm - 247ms - [12.70, 12.70, 12.70, 12.70, 15.24] - High
obstacles ahead
obstacles in Left
obstacles in right
Turn Back
```

Figure 6.12: Case three.

Case 4: Obstacles in Front, no obstacles in Left and Right.

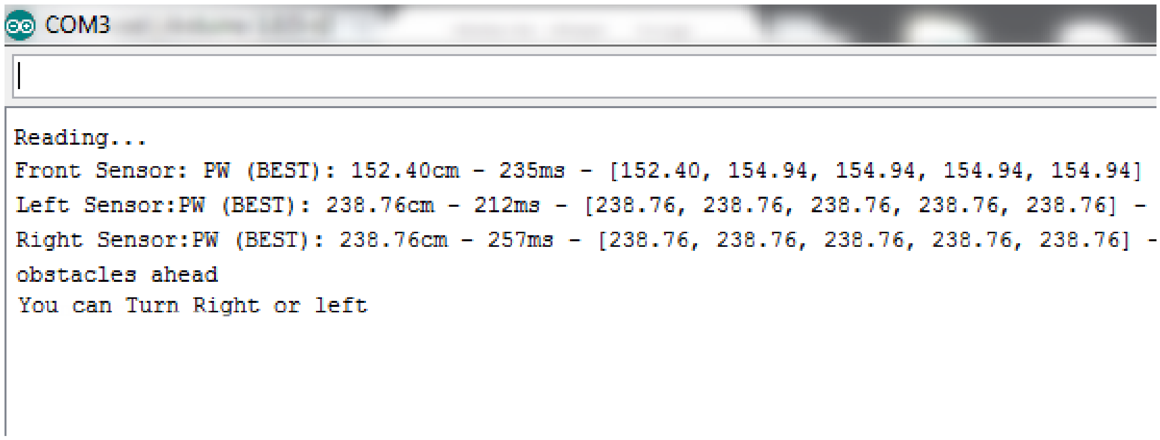


Figure 6.13: Case four.

6.4.2.2 Ground Sensor Cases

As mentioned in previous chapter, ground sensors working based on the user tall, as example 90 cm taken as threshold.

Case 1: Step Down

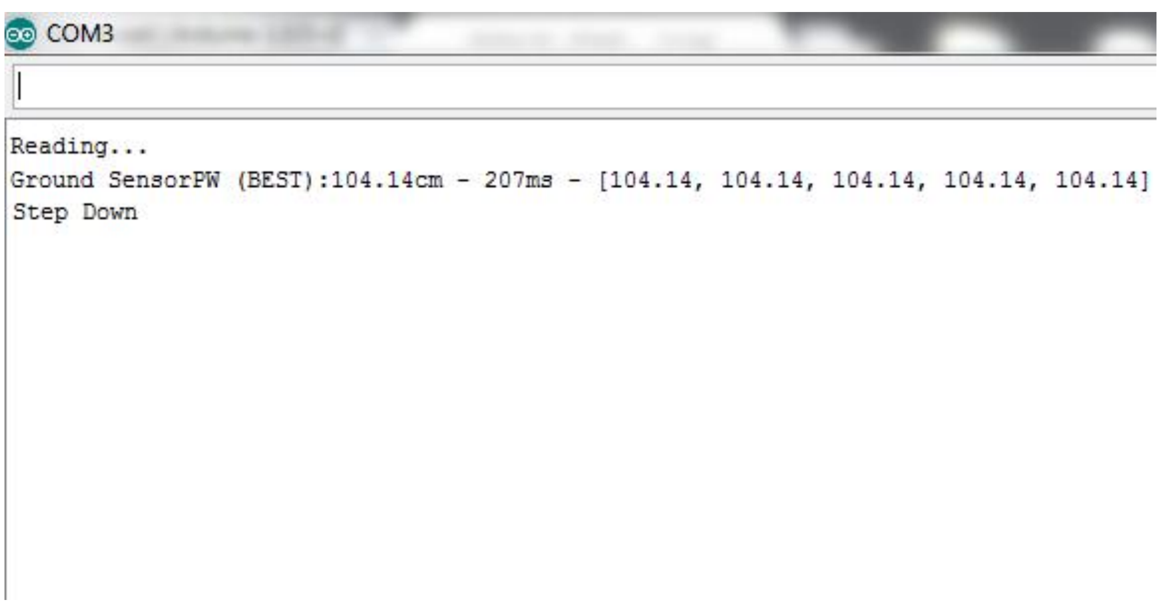


Figure 6.14: Case One Step Up.

Case 2: Step Up

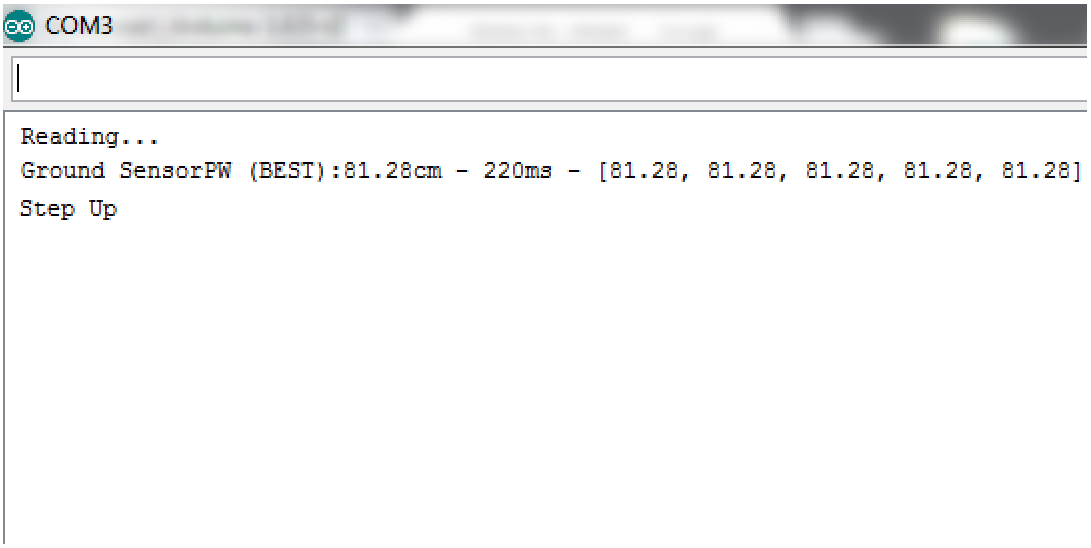


Figure 6.15: Case Two Step Down.

6.5 Challenges

While designing the system, there are many challenge were faced, such as:

- Some of required components for the project are not available in the local market.
- Some of the project components are expensive.
- Accuracy of Ultrasonic Sensors still not ideal as it should be, therefore the efficiency of the system affect negatively.
- GPS Navigation in Palestine still not working probably which could be added to the system.
- Size of Vest is not appropriate for all ages.
- Importing some components from the United States which take more time than it planned (more than 60 days of shipping).
- Project budget support was not appropriate as it should be.
- Human Detection Sensor is special for military usage so it was not available in Palestine for a political reasons.
- Some components are sent back by Israeli security check for unknown reasons.

6.6 Recommendations

This project needs more research time to improve its efficiency and some features could be added like GPS Navigation, Talking Watch and Human Detection. Government & Private Sector Supporting is needed to improve the project.

6.7 Conclusion

- In this project a navigation system has been built using a network of ultrasonic sensors which calculate the distance of obstacles from the user and using a notification system including voice commands and vibration motor notification.
- Vibration motor driving circuit , wireless receiving board and ultrasonic connections have been tested and worked properly.
- This system will support blind people to encourage them to be more active in the society.
- The vest design was light as possible and combined between beauty and efficiency.

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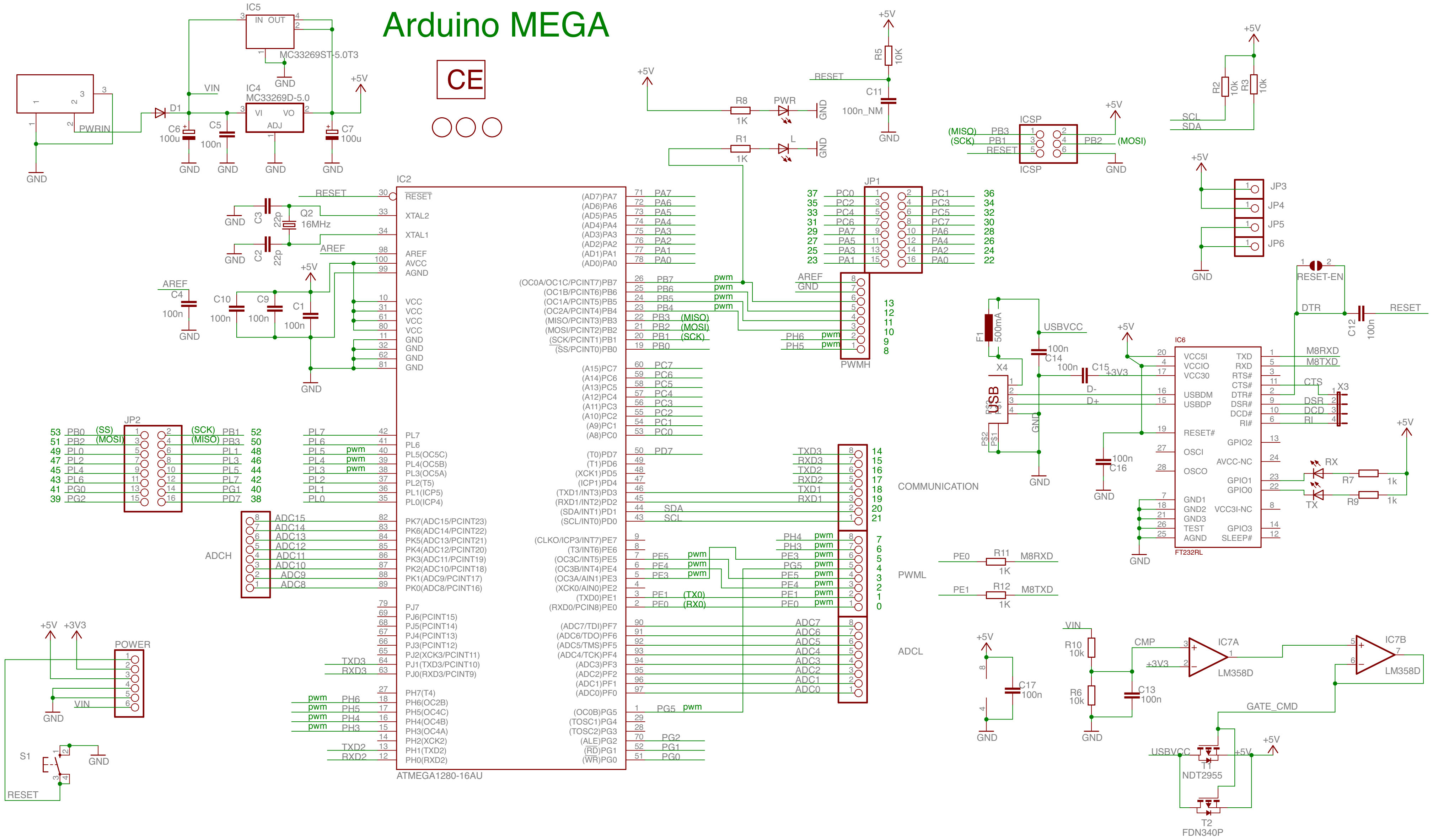
Appendix

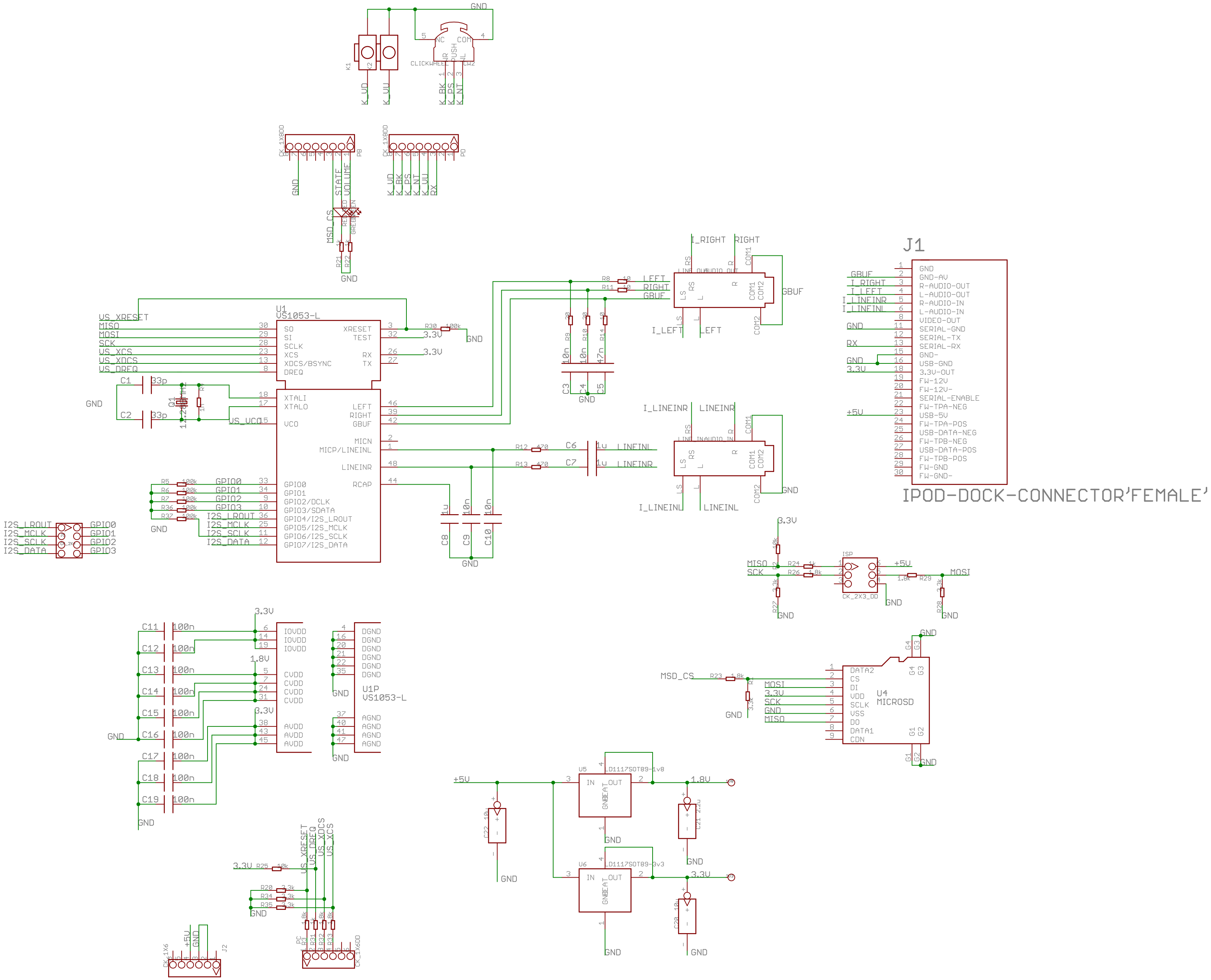
A

Schematics

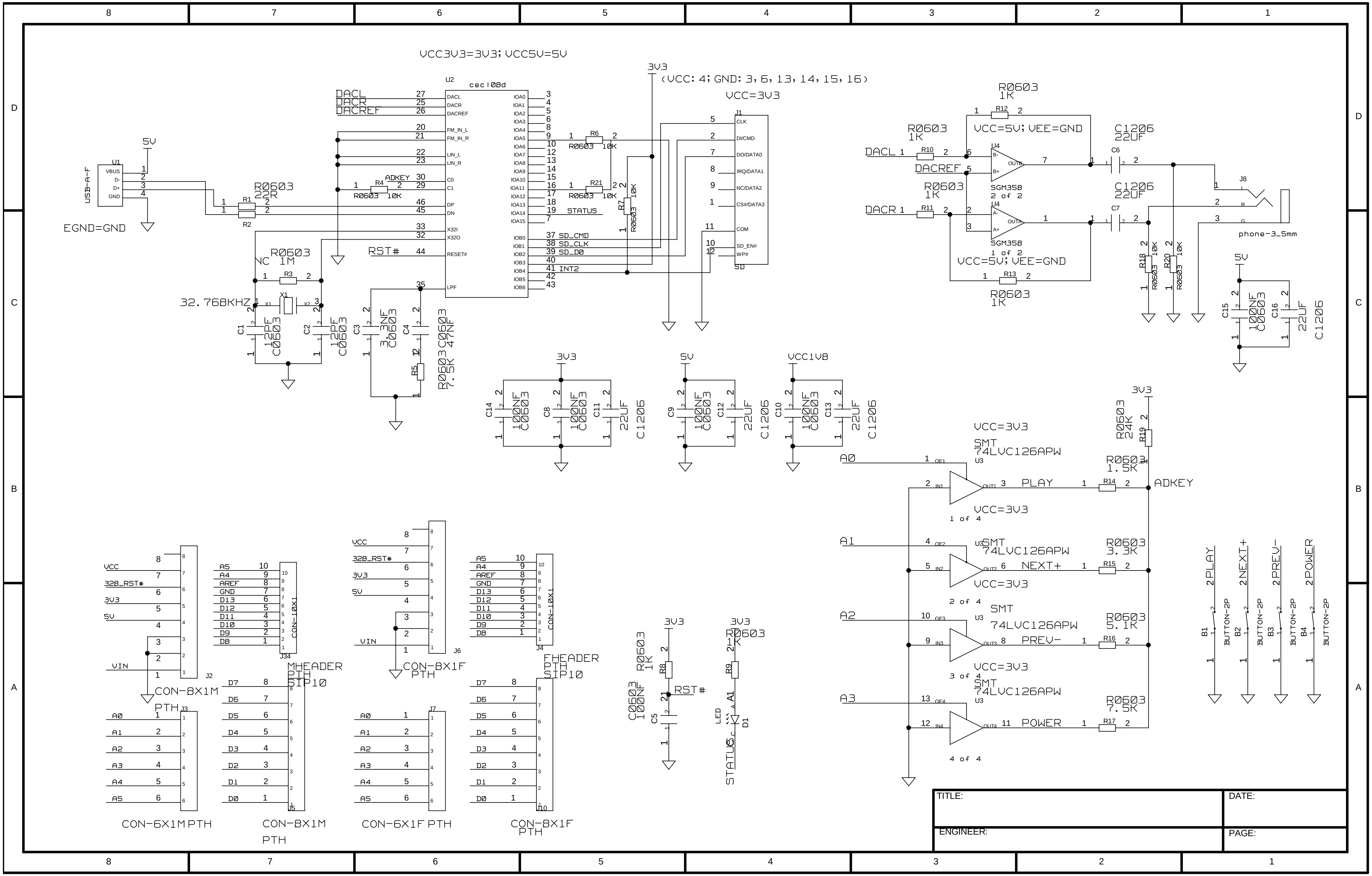
Arduino MEGA


Arduino MEGA
CE
IC5
MC33269ST-5.0T3
IC4
MC33269D-5.0
PWRIN
VIN
IC2
ATMEGA1280-16AU
Q2
16MHz
JP1
JP2
ICSP
PWMH
PWML
COMMUNICATION
ADCH
ADCL
POWER
RESET-EN
IC6
FT232RL
USB
X4
X3
F1
500mA
IC7A
IC7B
LM358D
GATE_CMD
T1
NDT2955
T2
FDN340P
S1
RESET

Seeed
Music Shield


J1
IPOD-DOCK-CONNECTOR'FEMALE'
U1
VS1053-L
U1P
VS1053-L
U4
MICROSD

(ITEAD)
Music Shield



VCC3V3=3V3; VCC5V=5V
U2
cec108d
DACL
DACR
DACREF
FM_IN_L
FM_IN_R
LIN_L
LIN_R
ADKEY
C0
C1
DP
DN
X32I
X32O
RST#
RESET#
LPF
STATUS
SD_CMD
SD_CLK
SD_D0
INT2
3V3
(VCC: 4; GND: 3, 6, 13, 14, 15, 16)
VCC=3V3
J1
CLK
DI/CMD
DO/DATA0
IRQ/DATA1
NC/DATA2
CS#/DATA3
COM
SD_EN#
WP#
SD
5V
U1
USB-A-F
VBUS
D-
D+
GND
EGND=GND
R0603
22R
R1
R2
R3
1M
NC
32.768KHZ
X1
C1
C2
12PF
C0603
C3
3.3NF
C4
47NF
R5
7.5K
R4
10K
R6
R21
R7
R0603
1K
R12
R10
R11
R13
VCC=5V; VEE=GND
U4
SGM358
2 of 2
1 of 2
C1206
22UF
C6
C7
J8
phone-3_5mm
R18
R20
C15
C16
100NF
3V3
5V
VCC1V8
C14
C8
C11
C9
C12
C10
C13
R19
24K
VCC=3V3
SMT
74LVC126APW
U3
A0
A1
A2
A3
PLAY
NEXT+
PREV-
POWER
ADKEY
R14
1.5K
R15
3.3K
R16
5.1K
R17
7.5K
1 of 4
2 of 4
3 of 4
4 of 4
B1
B2
B3
B4
BUTTON-2P
2PLAY
2NEXT+
2PREV-
2POWER
VCC
328_RST#
3V3
5V
VIN
J2
CON-8X1M
PTH
A5
A4
AREF
GND
D13
D12
D11
D10
D9
D8
J34
CON-10X1
J6
CON-8X1F
J4
MHEADER
PTH
SIP10
FHEADER
J3
J5
J7
J10
D7
D6
D5
D4
D3
D2
D1
D0
CON-6X1M PTH
CON-8X1M
PTH
CON-6X1F PTH
CON-8X1F
PTH
R8
C5
R9
D1
LED
STATUS
TITLE:
DATE:
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Appendix

B

Datasheets

LV-MaxSonar®-EZ™ Series

High Performance Sonar Range Finder

MB1000, MB1010, MB1020, MB1030, MB1040

With 2.5V - 5.5V power the LV-MaxSonar-EZ provides very short to long-range detection and ranging in a very small package. The LV-MaxSonar-EZ detects objects from 0-inches to 254-inches (6.45-meters) and provides sonar range information from 6-inches out to 254-inches with 1-inch resolution. Objects from 0-inches to 6-inches typically range as 6-inches[1]. The interface output formats included are pulse width output, analog voltage output, and RS232 serial output. Factory calibration and testing is completed with a flat object. ***[1]See Close Range Operation***

Features

- Continuously variable gain for control and side lobe suppression
- Object detection to zero range objects
- 2.5V to 5.5V supply with 2mA typical current draw
- Readings can occur up to every 50mS, (20-Hz rate)
- Free run operation can continually measure and output range information
- Triggered operation provides the range reading as desired
- Interfaces are active simultaneously
- Serial, 0 to Vcc, 9600 Baud, 81N
- Analog, (Vcc/512) / inch
- Pulse width, (147uS/inch)
- Learns ringdown pattern when commanded to start ranging
- Designed for protected indoor environments
- Sensor operates at 42KHz
- High output square wave sensor drive (double Vcc)

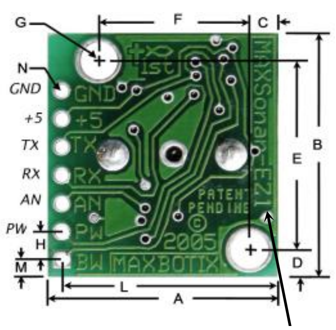
Benefits

- Very low cost ultrasonic rangefinder
- Reliable and stable range data
- Quality beam characteristics
- Mounting holes provided on the circuit board
- Very low power ranger, excellent for multiple sensor or battery-based systems
- Fast measurement cycles
- Sensor reports the range reading directly and frees up user processor
- Choose one of three sensor outputs
- Triggered externally or internally

Applications and Uses

- UAV blimps, micro planes and some helicopters
- Bin level measurement
- Proximity zone detection
- People detection
- Robot ranging sensor
- Autonomous navigation
- Multi-sensor arrays
- Distance measuring
- Long range object detection
- Wide beam sensitivity

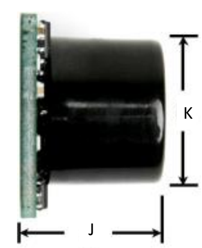
LV-MaxSonar-EZ Mechanical Dimensions



Paint Dot Location

A	0.785"	19.9 mm	H	0.100"	2.54 mm
B	0.870"	22.1 mm	J	0.610"	15.5 mm
C	0.100"	2.54 mm	K	0.645"	16.4 mm
D	0.100"	2.54 mm	L	0.735"	18.7 mm
E	0.670"	17.0 mm	M	0.065"	1.7 mm
F	0.510"	12.6 mm	N	0.038" dia.	1.0 mm dia.
G	0.124" dia.	3.1 mm dia.	weight, 4.3 grams		

Part Number	MB1000	MB1010	MB1020	MB1030	MB1040
Paint Dot Color	Black	Brown	Red	Orange	Yellow



Close Range Operation

Applications requiring 100% reading-to-reading reliability should not use MaxSonar sensors at a distance closer than 6 inches. Although most users find MaxSonar sensors to work reliably from 0 to 6 inches for detecting objects in many applications, MaxBotix® Inc. does not guarantee operational reliability for objects closer than the minimum reported distance. Because of ultrasonic physics, these sensors are unable to achieve 100% reliability at close distances.

Warning: Personal Safety Applications

We do not recommend or endorse this product be used as a component in any personal safety applications. This product is not designed, intended or authorized for such use. These sensors and controls do not include the self-checking redundant circuitry needed for such use. Such unauthorized use may create a failure of the MaxBotix® Inc. product which may result in personal injury or death. MaxBotix® Inc. will not be held liable for unauthorized use of this component.

About Ultrasonic Sensors

Our ultrasonic sensors are in air, non-contact object detection and ranging sensors that detect objects within an area. These sensors are not affected by the color or other visual characteristics of the detected object. Ultrasonic sensors use high frequency sound to detect and localize objects in a variety of environments. Ultrasonic sensors measure the time of flight for sound that has been transmitted to and reflected back from nearby objects. Based upon the time of flight, the sensor then outputs a range reading.

Pin Out Description

Pin 1-BW-*Leave open or hold low for serial output on the TX output. When BW pin is held high the TX output sends a pulse (instead of serial data), suitable for low noise chaining.

Pin 2-PW- This pin outputs a pulse width representation of range. The distance can be calculated using the scale factor of 147uS per inch.

Pin 3-AN- Outputs analog voltage with a scaling factor of (Vcc/512) per inch. A supply of 5V yields ~9.8mV/in. and 3.3V yields ~6.4mV/in. The output is buffered and corresponds to the most recent range data.

Pin 4-RX– This pin is internally pulled high. The LV-MaxSonar-EZ will continually measure range and output if RX data is left unconnected or held high. If held low the sensor will stop ranging. Bring high for 20uS or more to command a range reading.

Pin 5-TX- When the *BW is open or held low, the TX output delivers asynchronous serial with an RS232 format, except voltages are 0-Vcc. The output is an ASCII capital "R", followed by three ASCII character digits representing the range in inches up to a maximum of 255, followed by a carriage return (ASCII 13). The baud rate is 9600, 8 bits, no parity, with one stop bit. Although the voltage of 0-Vcc is outside the RS232 standard, most RS232 devices have sufficient margin to read 0-Vcc serial data. If standard voltage level RS232 is desired, invert, and connect an RS232 converter such as a MAX232. When BW pin is held high the TX output sends a single pulse, suitable for low noise chaining. (no serial data)

Pin 6-+5V- Vcc – Operates on 2.5V - 5.5V. Recommended current capability of 3mA for 5V, and 2mA for 3V.

Pin 7-GND- Return for the DC power supply. GND (& Vcc) must be ripple and noise free for best operation.

Range "0" Location

The LV-MaxSonar-EZ reports the range to distant targets starting from the front of the sensor as shown in the diagram below.

The range is measured from the front of the transducer.

In general, the LV-MaxSonar-EZ will report the range to the leading edge of the closest detectable object. Target detection has been characterized in the sensor beam patterns.

Sensor Minimum Distance

The sensor minimum reported distance is 6-inches (15.2 cm). However, the LV-MaxSonar-EZ will range and report targets to the front sensor face. Large targets closer than 6-inches will typically range as 6-inches.

Sensor Operation from 6-inches to 20-inches

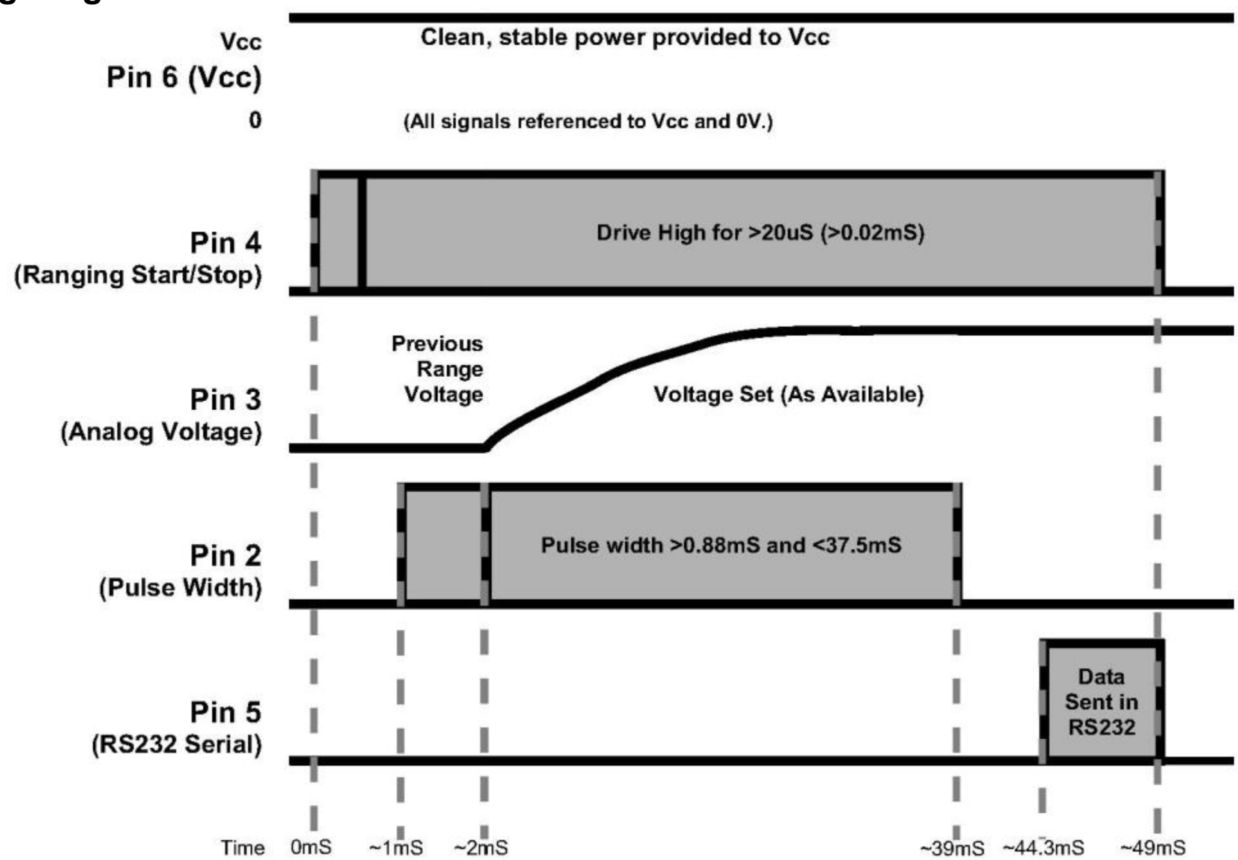
Because of acoustic phase effects in the near field, objects between 6-inches and 20-inches may experience acoustic phase cancellation of the returning waveform resulting in inaccuracies of up to 2-inches. These effects become less prevalent as the target distance increases, and has not been observed past 20-inches.

General Power-Up Instruction

Each time the LV-MaxSonar-EZ is powered up, it will calibrate during its first read cycle. The sensor uses this stored information to range a close object. It is important that objects not be close to the sensor during this calibration cycle. The best sensitivity is obtained when the detection area is clear for fourteen inches, but good results are common when clear for at least seven inches. If an object is too close during the calibration cycle, the sensor may ignore objects at that distance.

The LV-MaxSonar-EZ does not use the calibration data to temperature compensate for range, but instead to compensate for the sensor ringdown pattern. If the temperature, humidity, or applied voltage changes during operation, the sensor may require recalibration to reacquire the ringdown pattern. Unless recalibrated, if the temperature increases, the sensor is more likely to have false close readings. If the temperature decreases, the sensor is more likely to have reduced up close sensitivity. To recalibrate the LV-MaxSonar-EZ, cycle power, then command a read cycle.

Timing Diagram



Timing Description

250mS after power-up, the LV-MaxSonar-EZ is ready to accept the RX command. If the RX pin is left open or held high, the sensor will first run a calibration cycle (49mS), and then it will take a range reading (49mS). After the power up delay, the first reading will take an additional ~100mS. Subsequent readings will take 49mS. The LV-MaxSonar-EZ checks the RX pin at the end of every cycle. Range data can be acquired once every 49mS.

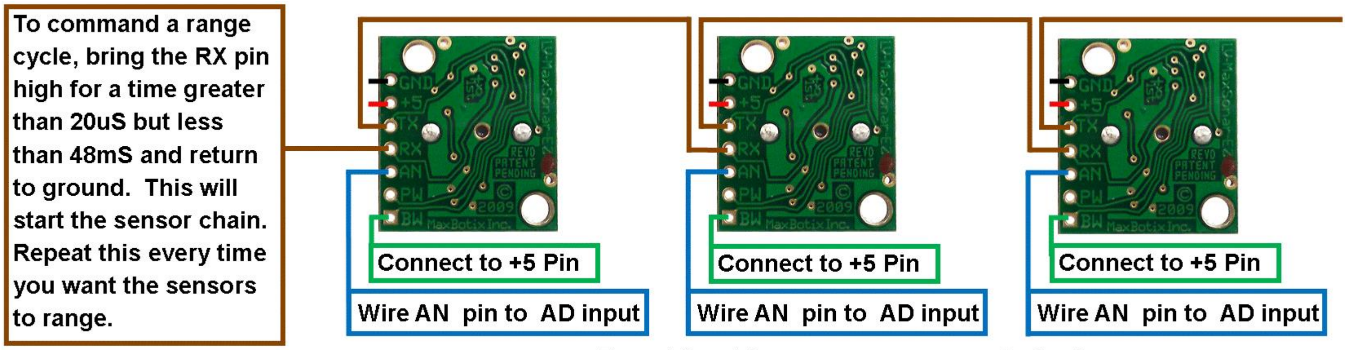
Each 49mS period starts by the RX being high or open, after which the LV-MaxSonar-EZ sends the transmit burst, after which the pulse width pin (PW) is set high. When a target is detected the PW pin is pulled low. The PW pin is high for up to 37.5mS if no target is detected. The remainder of the 49mS time (less 4.7mS) is spent adjusting the analog voltage to the correct level. When a long distance is measured immediately after a short distance reading, the analog voltage may not reach the exact level within one read cycle. During the last 4.7mS, the serial data is sent.

The LV-MaxSonar-EZ timing is factory calibrated to one percent at five volts, and in use is better than two percent. In addition, operation at 3.3V typically causes the objects range, to be reported, one to two percent further than actual.

Using Multiple Sensors in a single system

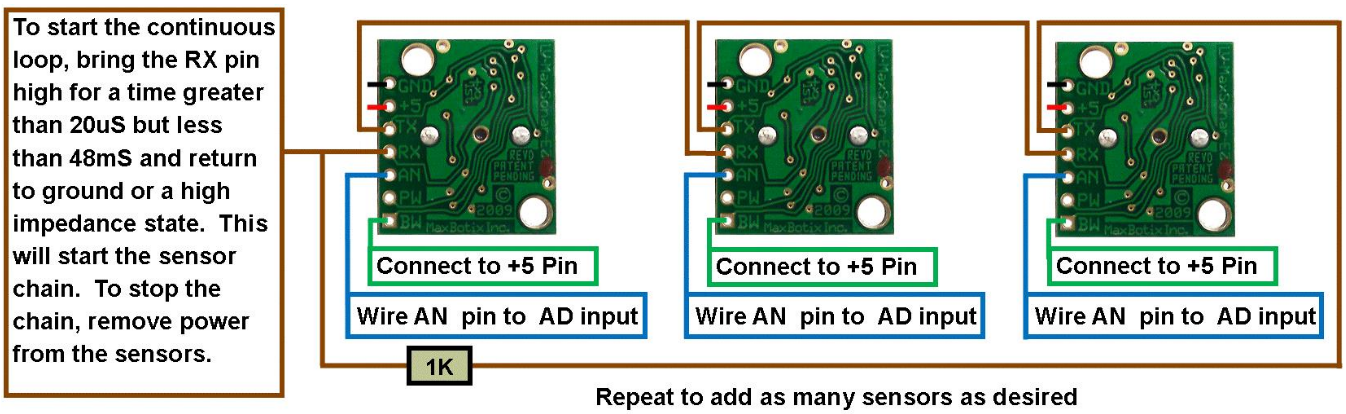
When using multiple ultrasonic sensors in a single system, there can be interference (cross-talk) from the other sensors. MaxBotix Inc., has engineered and supplied a solution to this problem for the LV-MaxSonar-EZ sensors. The solution is referred to as chaining. We have 3 methods of chaining that work well to avoid the issue of cross-talk.

The first method is AN Output Commanded Loop. The first sensor will range, then trigger the next sensor to range and so on for all the sensor in the array. Once the last sensor has ranged, the array stops until the first sensor is triggered to range again. Below is a diagram on how to set this up.



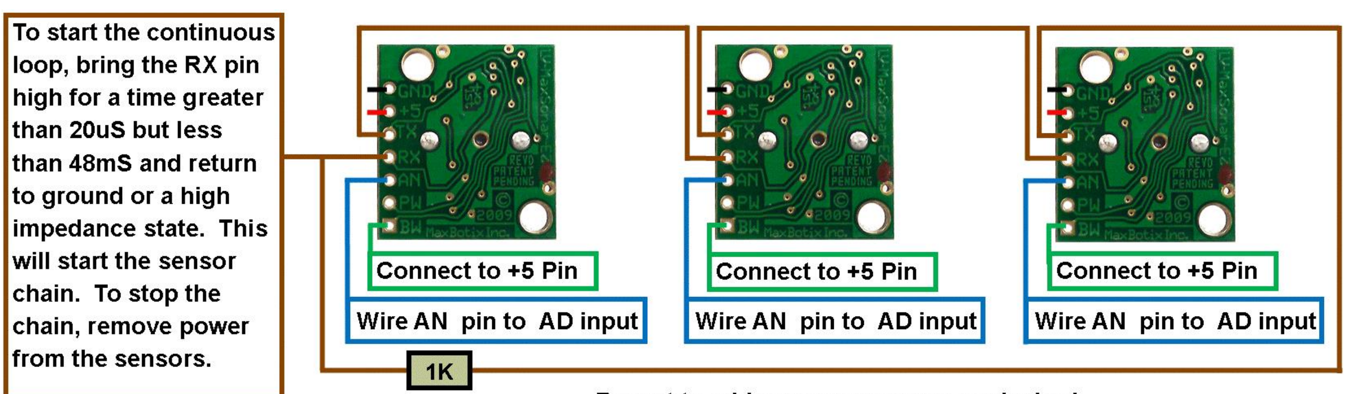
Repeat to add as many sensors as desired

The next method is AN Output Constantly Looping. The first sensor will range, then trigger the next sensor to range and so on for all the sensor in the array. Once the last sensor has ranged, it will trigger the first sensor in the array to range again and will continue this loop indefinitely. Below is a diagram on how to set this up.



Repeat to add as many sensors as desired

The final method is AN Output Simultaneous Operation. This method does not work in all applications and is sensitive to how the other sensors in the array are positioned in comparison to each other. Testing is recommend to verify this method will work for your application. All the sensors RX pins are conned together and triggered at the same time

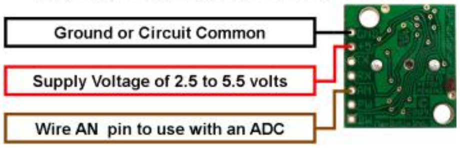


Repeat to add as many sensors as desired

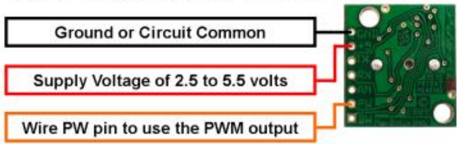
Independent Sensor Operation

The LV-MaxSonar-EZ sensors have the capability to operate independently when the user desires. When using the LV-MaxSonar-EZ sensors in single or independent sensor operation, it is easiest to allow the sensor to free-run. Free-run is the default mode of operation for all of the MaxBotix Inc., sensors. The LV-MaxSonar-EZ sensors have three separate outputs that update the range data simultaneously: Analog Voltage, Pulse Width, and RS232 Serial. Below are diagrams on how to connect the sensor for each of the three outputs when operating in a single or independent sensor operating environment.

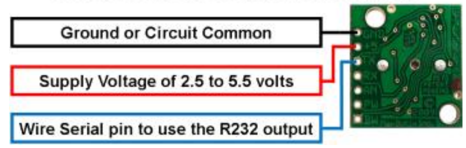
Analog Output Sensor Operation



Pulse Width Output Sensor Operation



Serial Output Sensor Operation



Selecting an LV-MaxSonar-EZ

Different applications require different sensors. The LV-MaxSonar-EZ product line offers varied sensitivity to allow you to select the best sensor to meet your needs.

The LV-MaxSonar-EZ Sensors At a Glance

People Detection Wide Beam High Sensitivity		Best Balance		Large Targets Narrow Beam Noise Tolerance
MB1000	MB1010	MB1020	MB1030	MB1040

The diagram above shows how each product balances sensitivity and noise tolerance. This does not effect the maximum range, pin outputs, or other operations of the sensor. To view how each sensor will function to different sized targets reference the LV-MaxSonar-EZ Beam Patterns.

Background Information Regarding our Beam Patterns

Each LV-MaxSonar-EZ sensor has a calibrated beam pattern. Each sensor is matched to provide the approximate detection pattern shown in this datasheet. This allows end users to select the part number that matches their given sensing application. Each part number has a consistent field of detection so additional units of the same part number will have similar beam patterns. The beam plots are provided to help identify an estimated detection zone for an application based on the acoustic properties of a target versus the plotted beam patterns.

Each beam pattern is a 2D representation of the detection area of the sensor. The beam pattern is actually shaped like a 3D cone (having the same detection pattern both vertically and horizontally). Detection patterns for dowels are used to show the beam pattern of each sensor. Dowels are long cylindered targets of a given diameter. The dowels provide consistent target detection characteristics for a given size target which allows easy comparison of one MaxSonar sensor to another MaxSonar sensor.

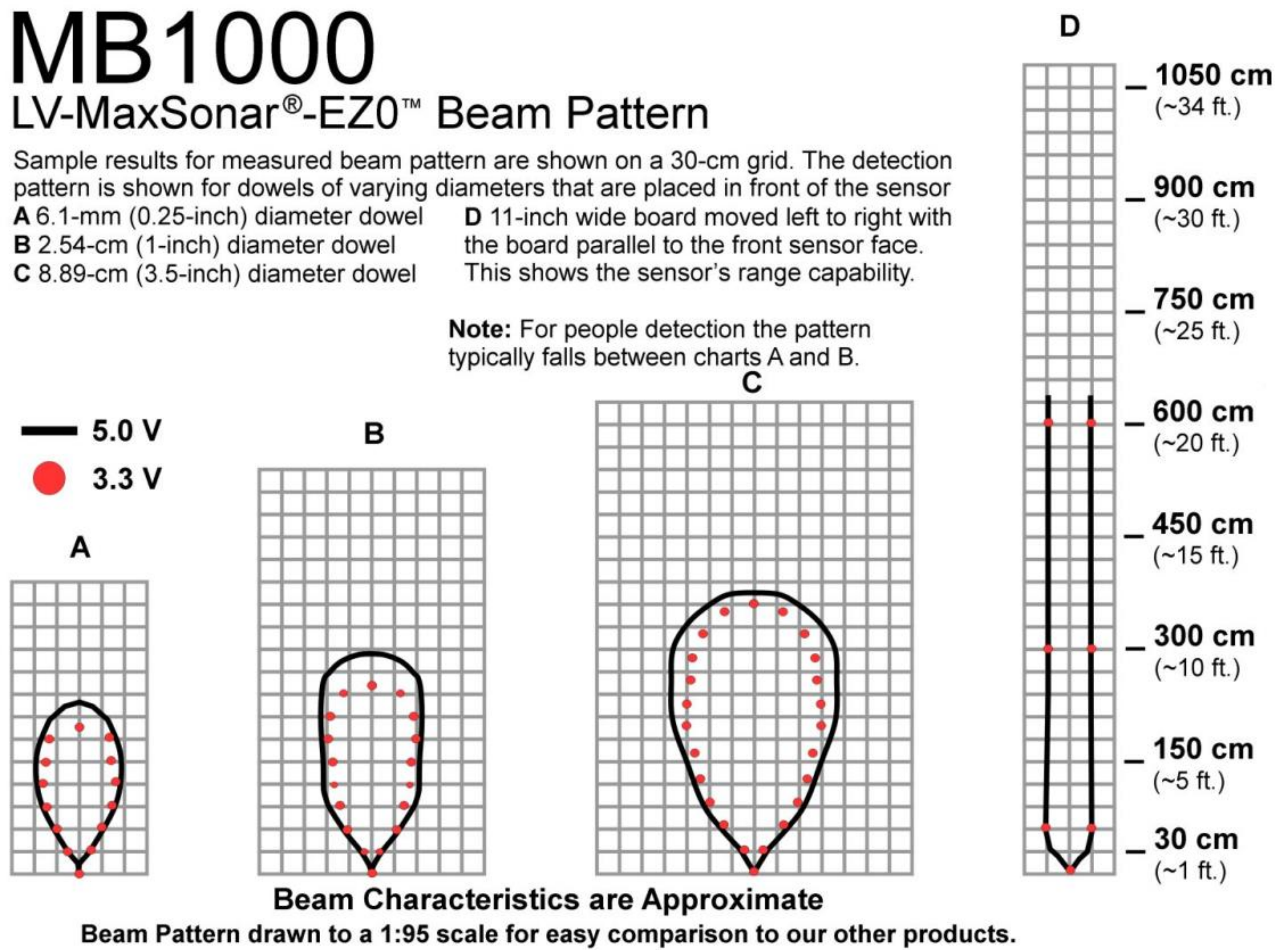
People Sensing: For users that desire to detect people, the detection area to the 1-inch diameter dowel, in general, represents the area that the sensor will reliably detect people.

For each part number, the four patterns (A, B, C, and D) represent the detection zone for a given target size. Each beam pattern shown is determined by the sensor's part number and target size.

The actual beam angle changes over the full range. Use the beam pattern for a specific target at any given distance to calculate the beam angle for that target at the specific distance. Generally, smaller targets are detected over a narrower beam angle and a shorter distance. Larger targets are detected over a wider beam angle and a longer range.

MB1000 LV-MaxSonar-EZ0

The LV-MaxSonar-EZ0 is the highest sensitivity and widest beam sensor of the LV-MaxSonar-EZ sensor series. The wide beam makes this sensor ideal for a variety of applications including people detection, autonomous navigation, and wide beam applications.



MB1000 Features and Benefits

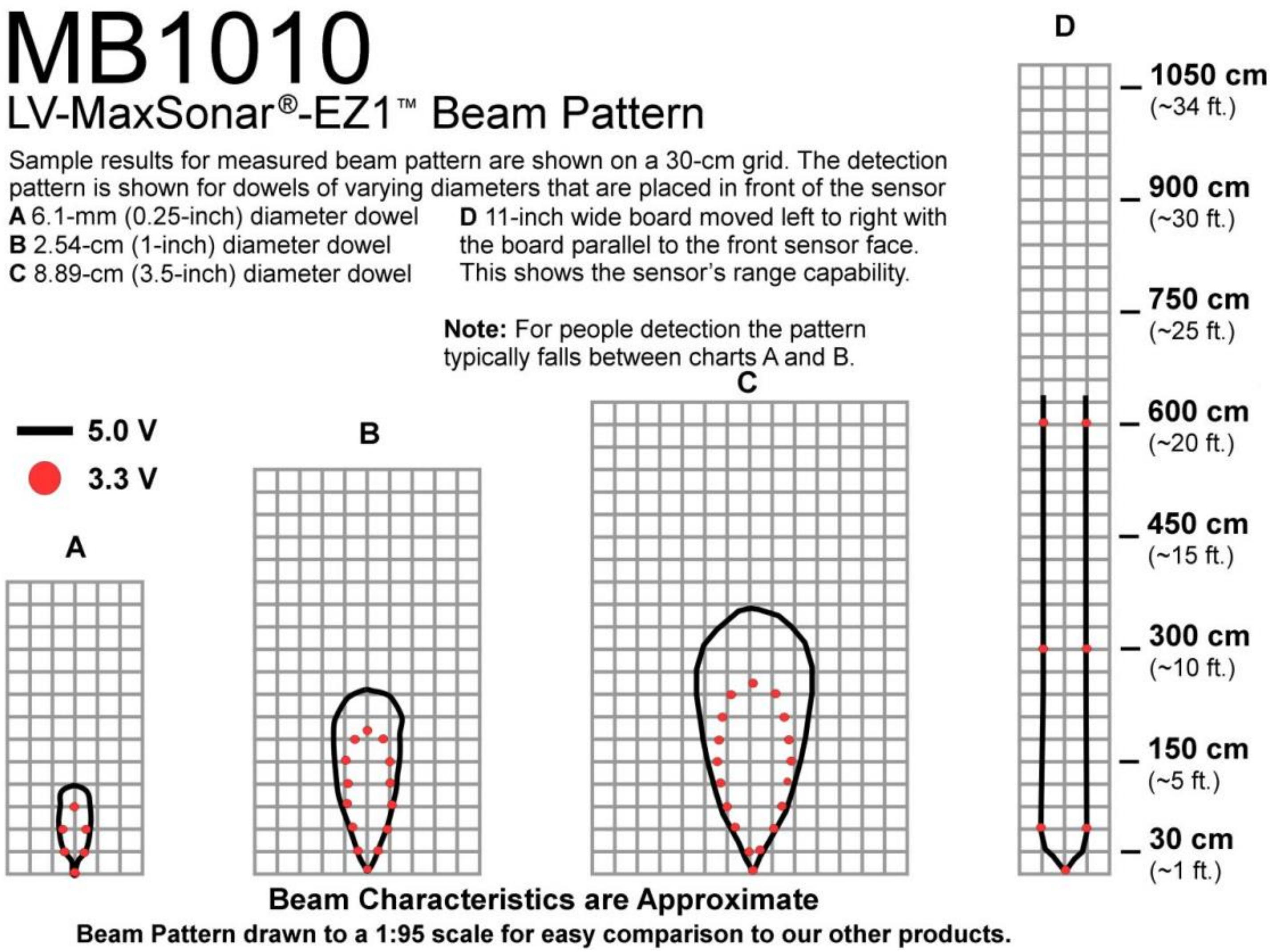
- Widest and most sensitive beam pattern in LV-MaxSonar-EZ line
- Low power consumption
- Easy to use interface
- Will pick up the most noise clutter when compared to other sensors in the LV-MaxSonar-EZ line
- Detects smaller objects
- Best sensor to detect soft object in LV-MaxSonar-EZ line
- Requires use of less sensors to cover a given area
- Can be powered by many different types of power sources
- Can detect people up to approximately 10 feet

MB1000 Applications and Uses

- Great for people detection
- Security
- Motion detection
- Used with battery power
- Autonomous navigation
- Educational and hobby robotics
- Collision avoidance

MB1010 LV-MaxSonar-EZ1

The LV-MaxSonar-EZ1 is the original MaxSonar product. This is our most popular indoor ultrasonic sensor and is a great low-cost general-purpose sensor for a customer not sure of which LV-MaxSonar-EZ sensor to use.



MB1010 Features and Benefits

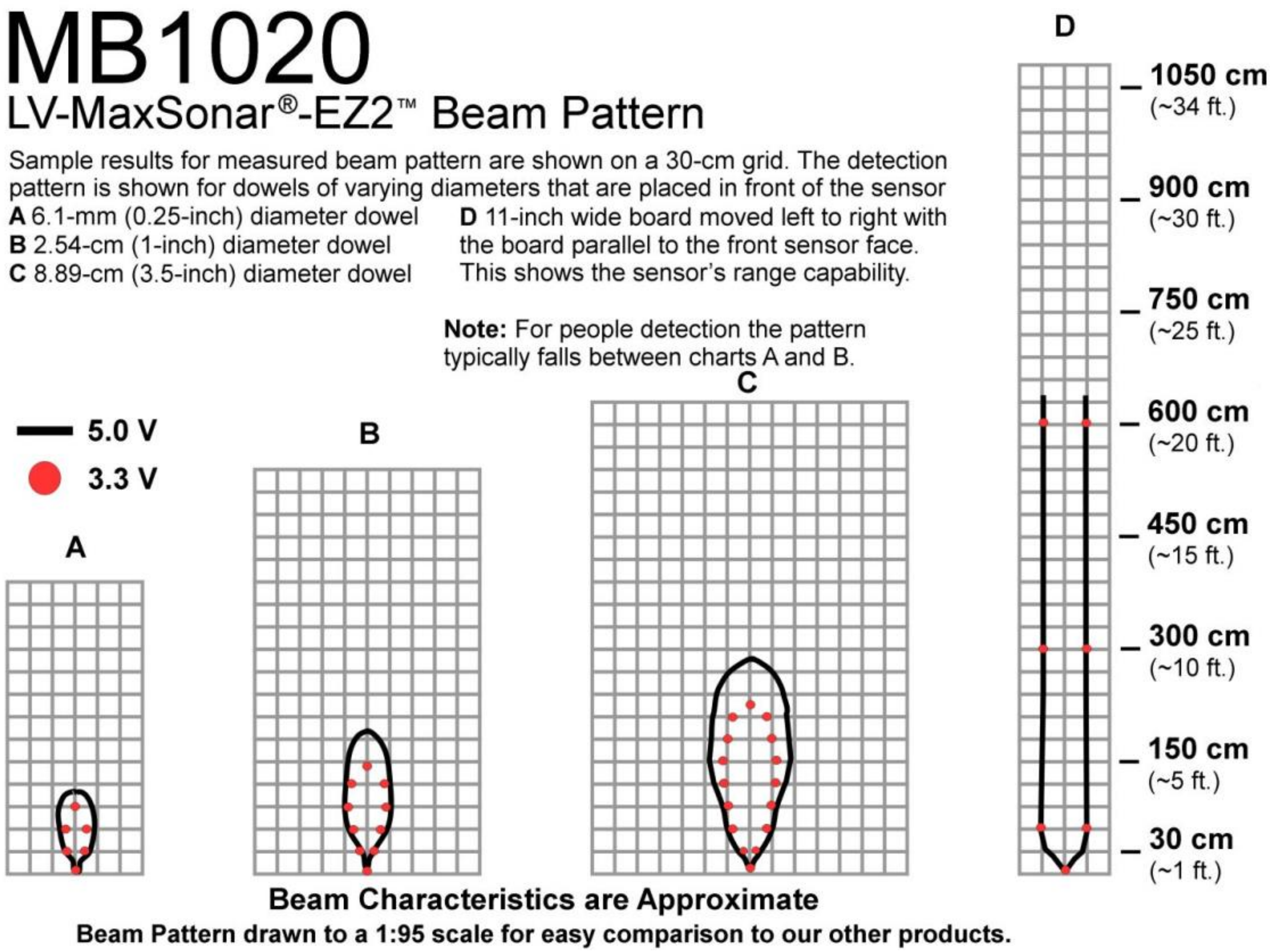
- Most popular ultrasonic sensor
- Low power consumption
- Easy to use interface
- Can detect people to 8 feet
- Great balance between sensitivity and object rejection
- Can be powered by many different types of power sources

MB1010 Applications and Uses

- Great for people detection
- Security
- Motion detection
- Used with battery power
- Autonomous navigation
- Educational and hobby robotics
- Collision avoidance

MB1020 LV-MaxSonar-EZ2

The LV-MaxSonar-EZ2 is a good compromise between sensitivity and side object rejection. The LV-MaxSonar-EZ2 is an excellent choice for applications that require slightly less side object detection and sensitivity than the MB1010 LV-MaxSonar-EZ1.



MB1020 Features and Benefits

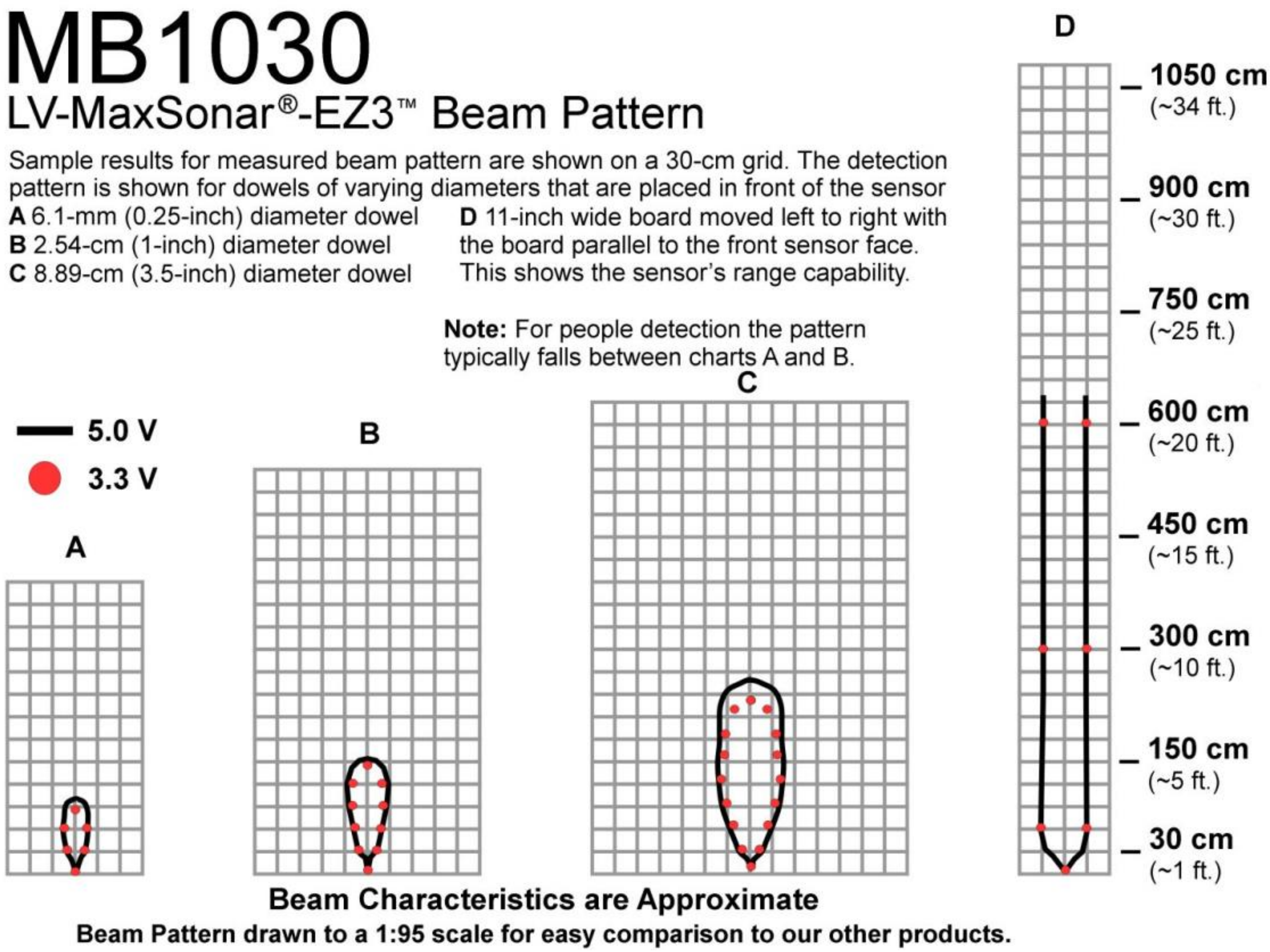
- Great for applications where the MB1010 is too sensitive.
- Excellent side object rejection
- Can be powered by many different types of power sources
- Can detect people up to approximately 6 feet

MB1020 Applications and Uses

- Landing flying objects
- Used with battery power
- Autonomous navigation
- Educational and hobby robotics
- Large object detection

MB1030 LV-MaxSonar-EZ3

The LV-MaxSonar-EZ3 is a narrow beam sensor with good side object rejection. The LV-MaxSonar-EZ3 has slightly wider beam width than theMB1040 LV-MaxSonar-EZ4 which makes it a good choice for when the LV-MaxSonar-EZ4 does not have enough sensitivity for the application.



MB1030 Features and Benefits

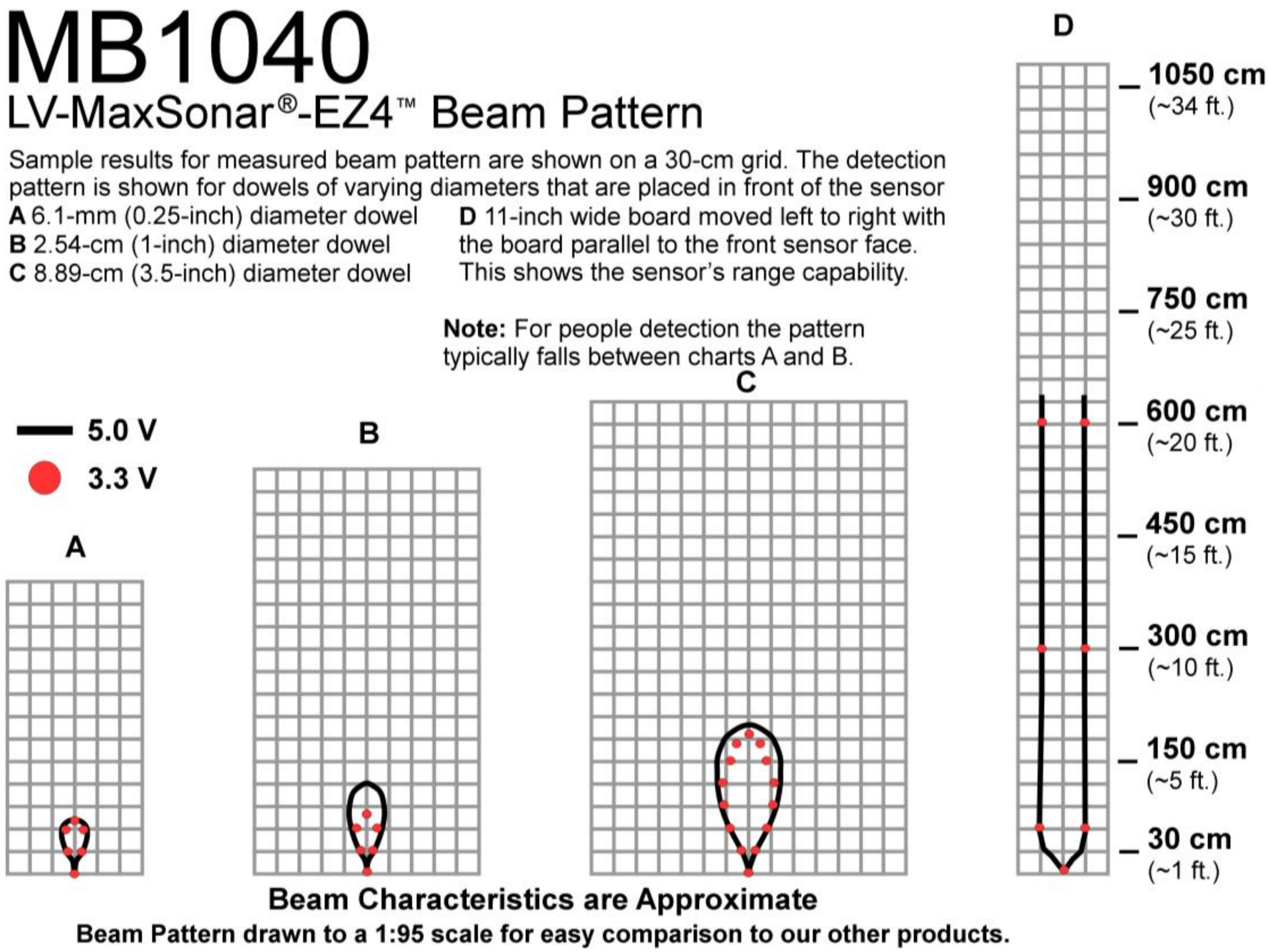
- Excellent side object rejection
- Low power consumption
- Easy to use interface
- Great for when MB1040 is not sensitive enough
- Large object detection
- Can be powered by many different types of power sources
- Can detect people up to approximately 5 feet

MB1030 Applications and Uses

- Landing flying objects
- Used with battery power
- Autonomous navigation
- Educational and hobby robotics

MB1040 LV-MaxSonar-EZ4

The LV-MaxSonar-EZ4 is the narrowest beam width sensor that is also the least sensitive to side objects offered in the LV-MaxSonar-EZ sensor line. The LV-MaxSonar-EZ4 is an excellent choice when only larger objects need to be detected.



MB1040 Features and Benefits

- Best side object rejection in the LV-MaxSonar-EZ sensor line
- Low power consumption
- Easy to use interface
- Best for large object detection
- Can be powered by many different types of power sources
- Can detect people up to approximately 4 feet

MB1040 Applications and Uses

- Landing flying objects
- Used with battery power
- Autonomous navigation
- Educational and hobby robotics
- Collision avoidance

Have the right sensor for your application?

Select from this product list for Protected and Non-Protected Environments.

Protected Environments

1 mm Resolution
HRLV-MaxSonar-EZ

1 in Resolution
LV-MaxSonar-EZ
LV-ProxSonar-EZ

1 cm Resolution
XL-MaxSonar-EZ
XL-MaxSonar-AE
XL-MaxSonar-EZL
XL-MaxSonar-AEL

1 mm Resolution
HRUSB-MaxSonar-EZ

1 in Resolution
USB-ProxSonar-EZ

Non-Protected Environments

1 mm Resolution
HRXL-MaxSonar-WR
HRXL-MaxSonar-WRS
HRXL-MaxSonar-WRT
HRXL-MaxSonar-WRM
HRXL-MaxSonar-WRMT
HRXL-MaxSonar-WRL
HRXL-MaxSonar-WRLT
HRXL-MaxSonar-WRLS
HRXL-MaxSonar-WRLST
SCXL-MaxSonar-WR
SCXL-MaxSonar-WRS
SCXL-MaxSonar-WRT
SCXL-MaxSonar-WRM
SCXL-MaxSonar-WRMT
SCXL-MaxSonar-WRL
SCXL-MaxSonar-WRLT
SCXL-MaxSonar-WRLS
SCXL-MaxSonar-WRLST
4-20HR-MaxSonar-WR

1 cm Resolution
XL-MaxSonar-WR
XL-MaxSonar-WRL
XL-MaxSonar-WRA
XL-MaxSonar-WRLA
I2CXL-MaxSonar-WR

1 mm Resolution
HRXL-MaxSonar-WRC
HRXL-MaxSonar-WRCT

1 cm Resolution
XL-MaxSonar-WRC
XL-MaxSonar-WRCA
I2CXL-MaxSonar-WRC

1 cm Resolution
UCXL-MaxSonar-WR
UCXL-MaxSonar-WRC
I2C-UCXL-MaxSonar-WR

Chemical Shield

F-Option. Available for WR models except UCXL. For additional protection when necessary in hazardous chemical environments.

Accessories — More information is online.

MB7954 — Shielded Cable

The MaxSonar Connection Wire is used to reduce interference caused by electrical noise on the lines. This cable is a great solution to use when running the sensors at a long distance or in an area with a lot of EMI and electrical noise.

MB7950 — XL-MaxSonar-WR Mounting Hardware

The MB7950 Mounting Hardware is selected for use with our outdoor ultrasonic sensors. The mounting hardware includes a steel lock nut and two O-ring (Buna-N and Neoprene) each optimal for different applications.

MB7955 / MB7956 / MB7957 / MB7958 / MB7972 — HR-MaxTemp

The HR-MaxTemp is an optional accessory for the HR-MaxSonar. The HR-MaxTemp connects to the HR-MaxSonar for automatic temperature compensation without self heating.

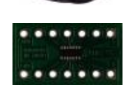
MB7961 — Power Supply Filter

The power supply filter is recommended for applications with unclean power or electrical noise.

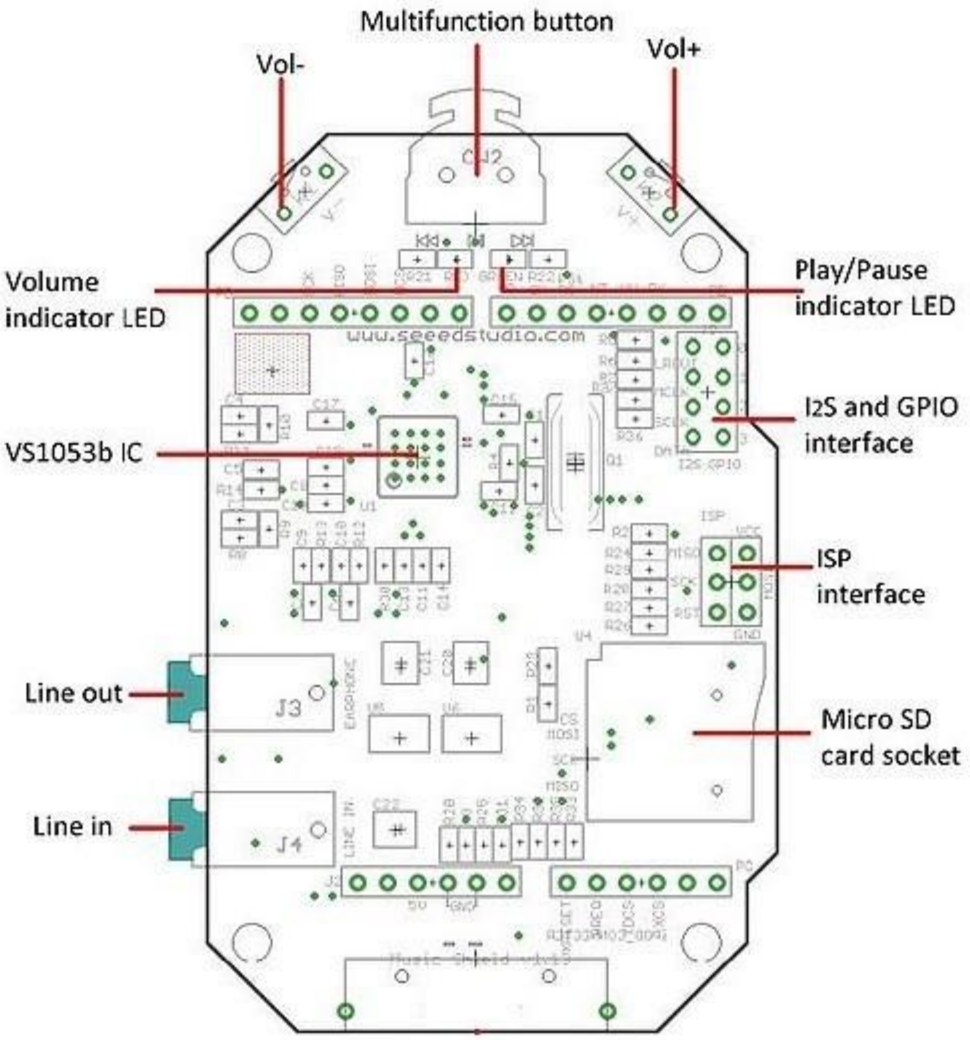
MB7962 / MB7963 / MB7964 / MB7965 — Micro-B USB Connection Cable

The MB7962, MB7963, MB7964 and MB7965 Micro-B USB cables are USB 2.0 compliant and backwards compatible with USB 1.0 standards. Varying lengths.

MB7973 — CE Lightning/Surge Protector



The MB7973 adds protection required to meet the Lightning/Surge IEC61000-4-5 specification.



Multifunction button: Turn left to play previous song, and right to next song, while .pressing it down to pause and resume

.Volume indicator LED (RED): If volume+, the red LED will be brighter

.Play/Pause indicator LED (GREEN): If playing, the green LED blinks

.Line out can drive 16 ohm or 32 ohm earphone

.Line in is used to record audio from other resources

Micro SD card can be FAT16 or FAT32, and the size more than 2GB is not supported. (PLEASE NOTE: Example code included with library will only use FAT16 formatted (cards

.I2S and GPIO are for digital audio output

.ISP interface is kept for bringing SPI port when using with Mega

Pins usage on Arduino

.D0 - Unused

.D1 - Unused

D2 - Used for receiving signal from iPod dock(could be used for your own application .(if iPod dock is not used

D3 - Used for receiving signal from button for Volume Up(could be used for your .(own application if the switch is not used

D4 - Used for receiving signal from switch for Next Song function(could be used for .(your own application if the switch is not used

D5 - Used for receive signal from switch for Play&Stop and Record function(could be .(used for your own application if the switch is not used

D6 - Used for receive signal from switch for Previous Song function(could be used for .(your own application if the switch is not used

D7 - Used for receiving signal from button for Volume Down(could be used for your .(own application if the switch is not used

D8 - Used for Green Led instructions(could be used for your own application if the .(switch is not used

D9 - Used for Red Led instructions(could be used for your own application if the .(switch is not used

.D10 - Used for SPI Chip Select

.D11 - Used for SPI MOSI

.D12 - Used for SPI MISO

.D13 - Used for SPI SCK

.D14(A0) - Used for Reset of VS1053

.D15(A1) - Used for Data Require of VS1053

.D16(A2) - Used for Data Select of VS1053

.D17(A3) - Used for Chip Select of VS1053

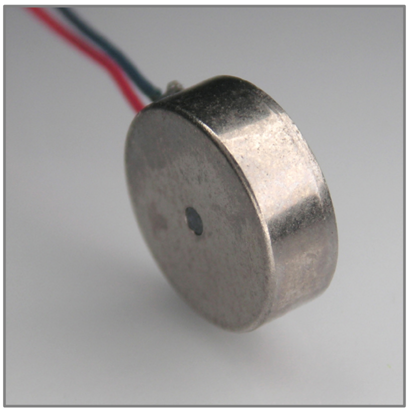
.D18(A4) - Unused

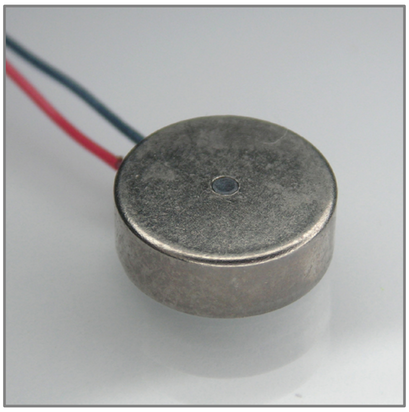
.D19(A5) - Unused

310-101

10mm Shaftless Vibration Motor
3.4mm Button Type

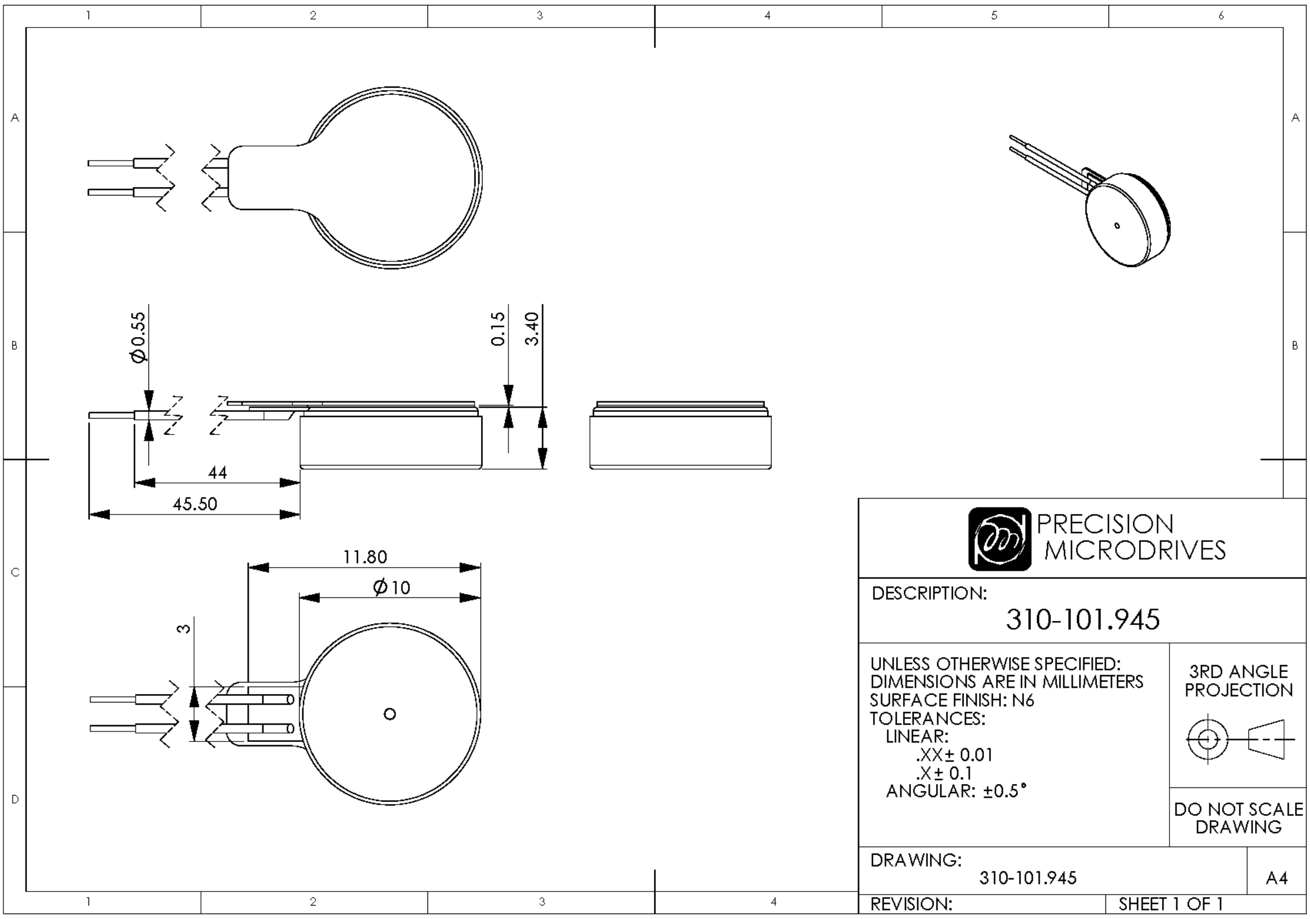
Specification	Value
Voltage [V]	3
Frame Diameter [mm]	10
Body Length [mm]	3.4
Weight [g]	1.2
Voltage Range [V]	2.5~3.8
Rated Speed [rpm]	12000
Rated Current [mA]	75
Start Voltage [V]	2.3
Start Current [mA]	85
Terminal Resistance [Ohm]	75
Vibration Amplitude [G]	0.8





www.precisionmicrodrives.com

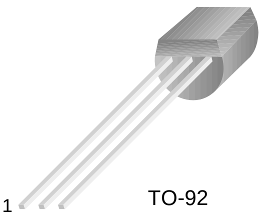
Tel: +44 (0) 1932 252482
Fax: +44 (0) 1932 325353
Email: sales@precisionmicrodrives.com



FAIRCHILD
SEMICONDUCTOR®

PN2222

General Purpose Transistor



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TO-92

1. Emitter 2. Base 3. Collector

NPN Epitaxial Silicon Transistor

Absolute Maximum Ratings T_a=25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CBO}	Collector-Base Voltage	60	V
V_{CEO}	Collector-Emitter Voltage	30	V
V_{EBO}	Emitter-Base Voltage	5	V
I_C	Collector Current	600	mA
P_C	Collector Power Dissipation	625	mW
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	-55 ~ 150	°C

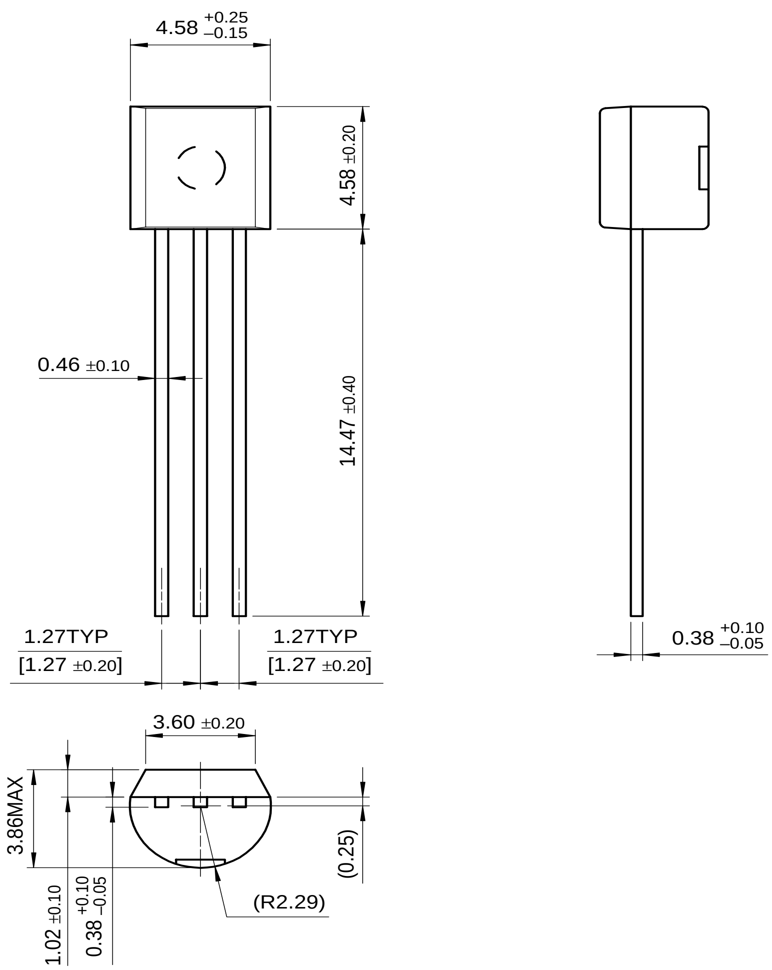
Electrical Characteristics T_a=25°C unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Max.	Units
BV_{CBO}	Collector-Base Breakdown Voltage	I_C=10μA, I_E=0	60		V
BV_{CEO}	Collector Emitter Breakdown Voltage	I_C=10mA, I_B=0	30		V
BV_{EBO}	Emitter-Base Breakdown Voltage	I_E=10μA, I_C=0	5		V
I_{CBO}	Collector Cut-off Current	V_{CB}=50V, I_E=0		0.01	μA
I_{EBO}	Emitter Cut-off Current	V_{EB}=3V, I_C=0		10	nA
h_{FE}	DC Current Gain	V_{CE}=10V, I_C=0.1mA V_{CE}=10V, *I_C=150mA	35 100	 300	
V_{CE} (sat)	* Collector-Emitter Saturation Voltage	I_C=500mA, I_B=50mA		1	V
V_{BE} (sat)	* Base-Emitter Saturation Voltage	I_C=500mA, I_B=50mA		2	V
f_T	Current Gain Bandwidth Product	V_{CE}=20V, I_C=20mA, f=100MHz	300		MHz
C_{ob}	Output Capacitance	V_{CB}=10V, I_E=0, f=1MHz		8	pF

* Pulse Test: Pulse Width≤300μs, Duty Cycle≤2%

Package Dimensions

TO-92



Dimensions in Millimeters

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Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
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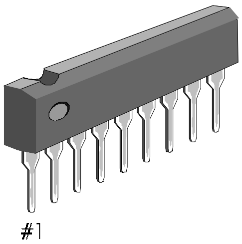
INTRODUCTION

The KA2284B and KA2285B are monolithic integrated circuits designed for 5-dot LED level meter drivers with a built-in rectifying amplifier. It is suitable for AC/DC level meters such as VU meters or signal meters.

9–SIP



FEATURES

- High gain rectifying amplifier included (G_V = 26dB)
- Low radiation noise when LED turns on
- Logarithmic indicator for 5-dot bar type LED (–10, –5, 0, 3, 6dB)
- Constant current output
  KA2284B: Io = 15mA (Typ)
  KA2285B: Io = 7mA (Typ)
- Wide operating supply voltage range:
  V_{CC} = 3.5V ~ 1 6V
- Minimum number of external parts required

ORDERING IN FORMATION

Device	Package	Operating Temperature	I_D
KA2284B	9–SIP	– 20°C ~ + 80°C	15mA
KA2285B			7mA

BLOCK DIAGRAM

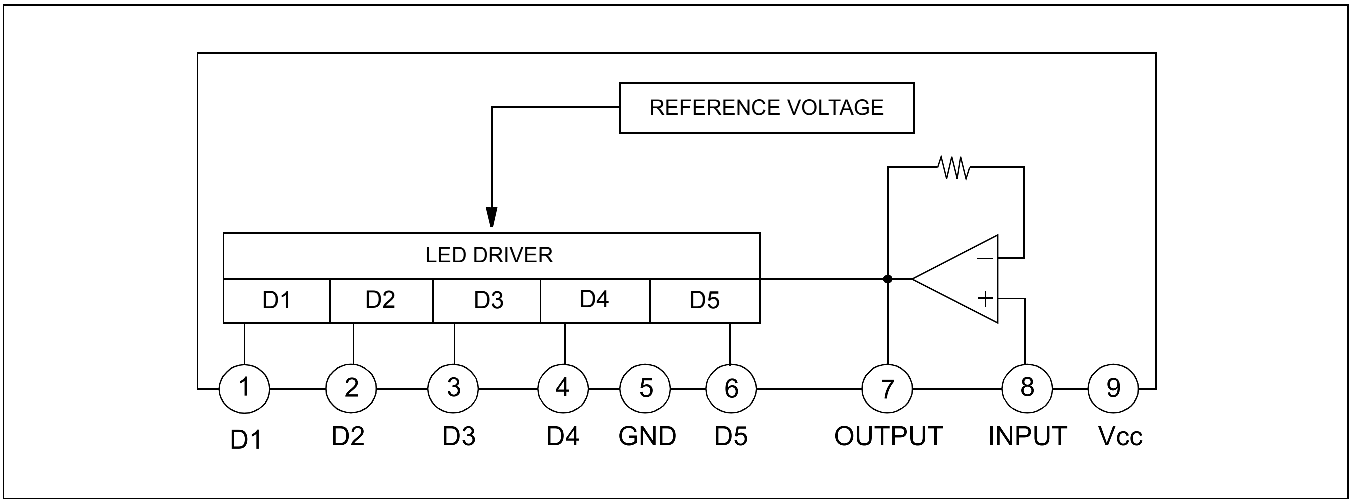


Figure 1.

NOTE: Capacitor to be omitted when used as a DC input signal meter

ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)

Characteristic	Symbol	Value	Unit
Supply Voltage	V_{CC}	18	V
Amp Input Voltage	V_{8-5}	–0.5 ~ V_{CC}	V
Pin 7 Voltage	V_{7-5}	6	V
D Terminal Output Voltage	V_D	18	V
Circuit Current	I_{CC}	12	mA
D Terminal Output Current	I_D	20	mA
Power Dissipation	P_d	1100	mW
Operating Temperature	T_{OPR}	–20 ~ + 80	°C
Storage Temperature	T_{STG}	–40 ~ + 125	°C

NOTE: 11mW/°C is decreased at higher temperature than T_a = 25°C.

ELECTRICAL CHARACTERISTICS

(T_a = 25°C, V_{CC} = 6V, f = 1kHz, unless otherwise specified)

Characteristic		Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Circuit Current		I_{CCQ}	V_i = 0V	–	6	8.5	mA
D Output Current	KA2284B	I_O	V_i = 0.15V	11	15	18.5	mA
	KA2285B			5	7	9.5	
Input Bias Current		I_{BIAS}	–	–1	–	0	µA
Amp Gain		G_V	V_I = 0.1 V	24	26	28	dB
Comparator ON Level	$V_{CL\ (ON)}$	$V_{CL(ON)1}$	–	–12	–10	–8	dB
		$V_{CL(ON)2}$		–6	–5	–4	
		$V_{CL(ON)3}$		–	0	–	
		$V_{CL(ON)4}$		2.5	3	3.5	
		$V_{CL(ON)5}$		5	6	7	

NOTE: Definition of 0dB: input voltage level when $V_{CL\ (ON)3}$ turn ON (50mV)

TEST CIRCUIT

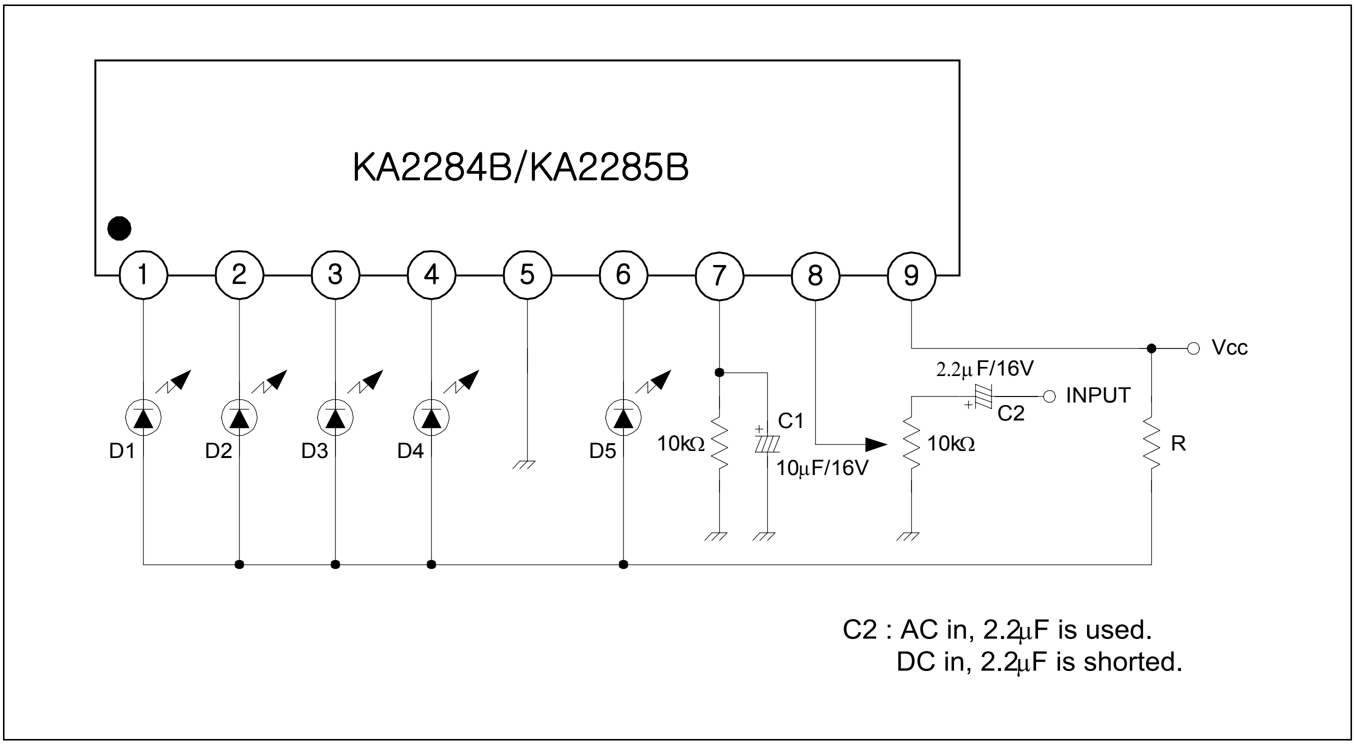


Figure 2.

The recommended value of R at T_a (max) = 60°C.

V_{CC} (V)	8 ~ 12	10 ~ 14	12 ~ 16
R(Ω)	47	68	91

By changing the time constant C_1 and C_2, the response, attack and release time may be varied. In the above application conditions, power dissipation may be operated at higher levels than the absolute maximum ratings.
The wattage of R is to be determined by the total LED current and R value recommended by the R table.