ULTRASONIC CAR BRAKING SYSTEM

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ABSTRACT

An ultrasonic car braking system includes; an ultrasonic wave emitter provided in a front portion of an automatic braking car producing and emitting ultrasonic waves frontward in a predetermined distance in front of the car. Ultrasonic receiver also formed in a front portion of the car operatively receiving a reflective ultrasonic wave signal as reflected by obstacles positioned within the pre-determined distance in front of the automatic braking car. The reflected wave (detection pulse) was measured to get the distance between the vehicle and the obstacle. Then PIC is used to control servo motor based on detection pulse information to push pedal brake to brake the car intermittently for automatically braking the car for a safe braking purpose.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Driving is a compulsory activity for most people. People use their car to move from one place to other place. The number of vehicle is increasing day by day. It is produced tacked tightly and risk to accident. Nowadays, the numbers of accident is so high and uncertainly. Accident will occurs every time and every where and cause worst damage, serious injury and dead. These accidents are mostly cause by delay of the driver to hit the brake.

This project is designed to develop a new system that can solve this problem where drivers may not brake manually but the vehicles can stop automatically due to obstacles. This project is about a system that can control braking system for safety. Using ultrasonic as a ranging sensor, its function based on ultrasonic wave. After transmit by transmitter, the wave can reflect when obstacle detected and receive by receiver.

The main target for this project is, car cans automatically braking due to obstacles when the sensor senses the obstacles. The braking circuit function is to brake the car automatically after received signal from the sensor.

1.2 OBJECTIVE

The objectives of this project are;

i. To develop a safety car braking system using ultrasonic sensor

ii. To design a vehicle with less human attention to the driving

1.3 SCOPE OF PROJECT

i. To develop an ultrasonic sensor to detect the obstacle

ii. To process the output from the ultrasonic sensor to drive the servo motor as an actuator.

1.4 METHODOLOGY

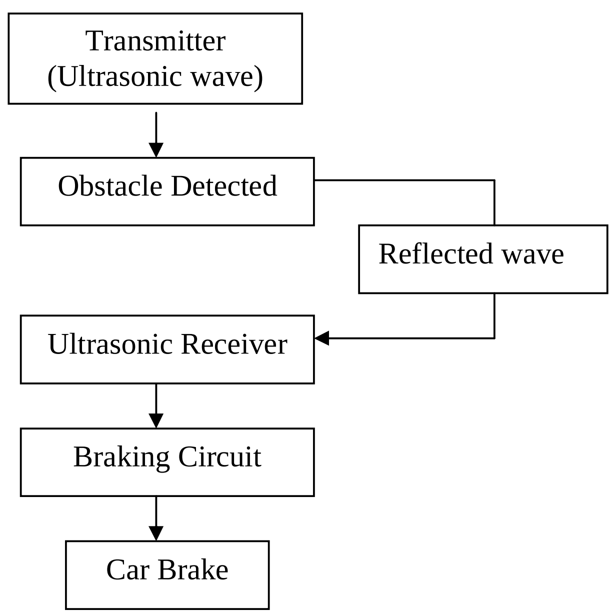

Figure 1.1: Block Diagram of the System

1.4.1 Ultrasonic Transmitter

Before transmit the ultrasonic wave, there is a part which is ultrasonic wave generator that function to generate ultrasonic wave. In that part, there is timing instruction means for generating an instruction signal for intermittently providing ultrasonic waves. This signal will send to an ultrasonic wave generator for generating ultrasonic waves based on the instruction signal from said timing instruction means (transform electrical energy into sound wave). After ultrasonic wave was produced, ultrasonic transmitter transmits the ultrasonic waves toward a road surface to find out the obstacle. The range that obstacle detected is depends on the range of ultrasonic sensors that used.

1.4.2 Ultrasonic Receiver

If the ultrasonic wave detect the obstacle, its will produce a reflected wave. An ultrasonic receiver is used for receiving the ultrasonic waves reflected from the road surface to generate a reception signal. There is ultrasonic transducer that will transform back the sound wave to electrical energy. This signal amplified by an amplifier. The amplified signal is compared with reference signal to detect components in the amplified signal due to obstacles on the road surface. The magnitude of the reference signal or the amplification factor of the amplifier is controlled to maintain a constant ratio between the average of the reference signal and the average of the amplified signal.

1.4.3 Braking Circuit

The processed signal will be send to the braking circuit. At the braking circuit, there is a controller that can process the signal and give the instruction to the output based on condition of the signal. For this project, controller that used is PIC

16F84A microcontroller (8-bit microcontroller). PIC 16F84A microcontroller use the high language and easy to do the programming.

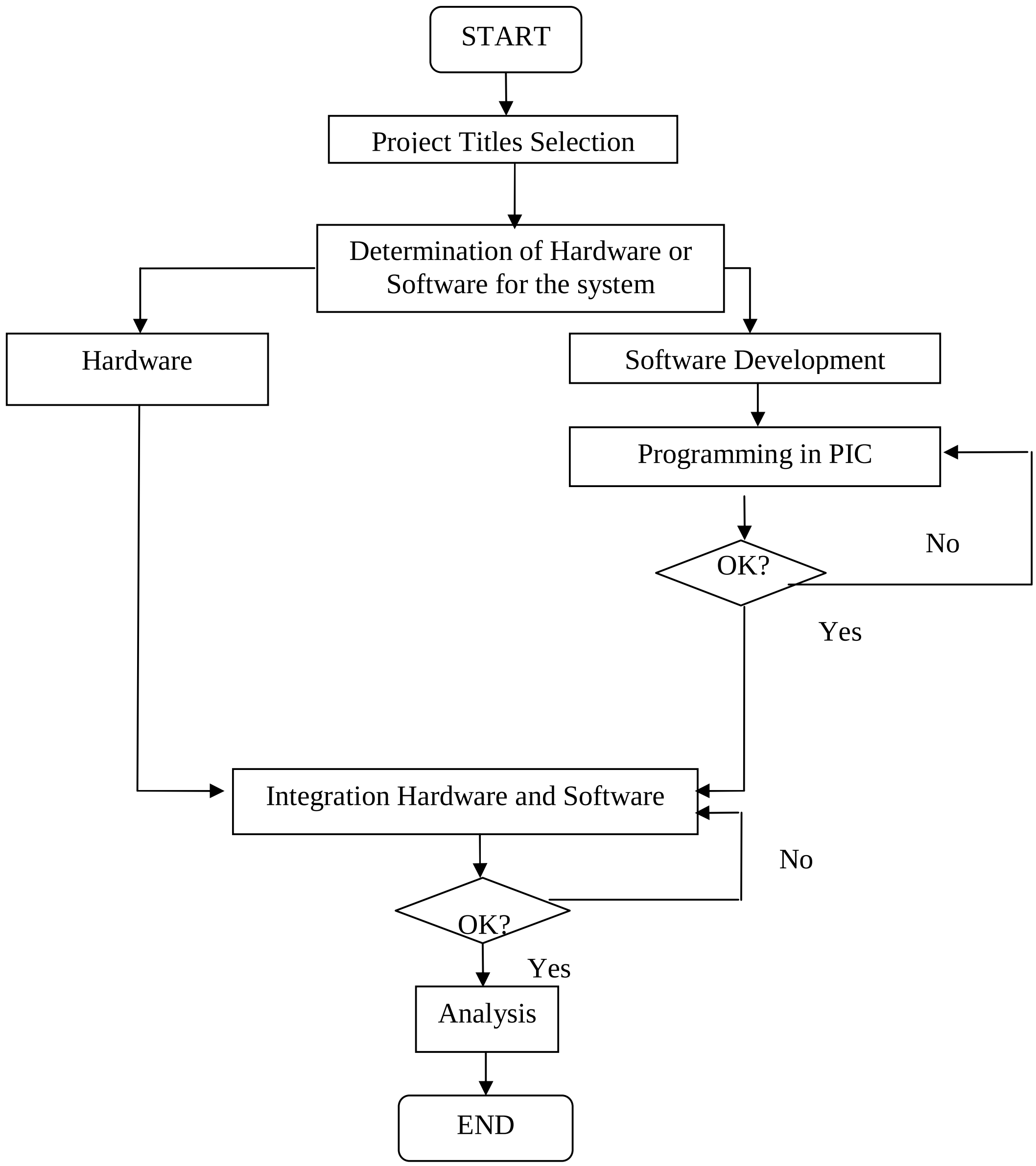

Figure 1.2: Flow Chart of Development

Figure 1.2 above is shown about Flow Chart of Development of this project. Once, the title of this project Ultrasonic Car Braking System is selected. The identifying and understanding process was done. In this process, I found out all notes and information related to the project.

The process was divided into two main groups which are software and hardware development. For the software development, the controller that prefers is PIC16F84A microcontroller (8-bit microcontroller). Therefore all programming must suitable and match with this controller. The process of software development is continuously done until get the perfect resulted.

For the hardware development, the focus is to develop the circuit and board for PIC16F84A microcontroller. Besides, focus is to develop ultrasonic circuit to implement to this project. After that, we must do the connection between ultrasonic sensor (transmitter & receiver), PIC16F84A microcontroller and lastly motor for the output.

The process of Integration Hardware and Software is very important because to interface the software and hardware is so hard. Although, the simulations will right output, it is not perfect for the real situation. The problem will exist after we try to interface both. So, doing analysis is compulsory to correct the software or hardware so that we can get the right result.

CHAPTER 2

LITERATURE REVIEW

2. This chapter reviews some of the work related to the study of the ultrasonic car braking system. The main reviews are about sensor, ultrasonic sensor, PIC microcontroller and servo motor.

2.1 The Fundamental of Sensor

Sensor is an electrical device that maps an environmental attribute to a quantitative measurement. It is created to collect information about the world. Each sensor is based on a transduction principle which is conversion of energy from one form to another form. [1]

2.1.1 The Fundamental of Ultrasonic Sensor

Ultrasonic ranging and detecting devices use high-frequency sound waves to detect the presence of an object and its range. The systems either measure the echo reflection of the sound from objects or detect the interruption of the sound beam as the objects pass between the transmitter and receiver.

An ultrasonic sensor typically utilizes a transducer that produces an electrical output in response to received ultrasonic energy. The normal frequency range for human hearing is roughly 20 to 20,000 hertz. Ultrasonic sound waves are sound waves that are above the range of human hearing and, thus, have a frequency above about 20,000 hertz. Any frequency above 20,000 hertz may be considered ultrasonic.

Most industrial processes, including almost all source of friction, create some ultrasonic noise. The ultrasonic transducer produces ultrasonic signals. These signals are propagated through a sensing medium and the same transducer can be used to detect returning signals.

Ultrasonic sensors typically have a piezoelectric ceramic transducer that converts an excitation electrical signal into ultrasonic energy bursts. The energy bursts travel from the ultrasonic sensor, bounce off objects, and are returned toward the sensor as echoes. Transducers are devices that convert electrical energy to mechanical energy, or vice versa. The transducer converts received echoes into analog electrical signals that are output from the transducer.

The piezoelectric effect refers to the voltage produced between surfaces of a solid dielectric (nonconducting substance) when a mechanical stress is applied to it. Conversely when a voltage is applied across certain surfaces of a solid that exhibits the piezoelectric effect, the solid undergoes a mechanical distortion. Such solids typically resonate within narrow frequency ranges. Piezoelectric materials are used in transducers, e.g., phonograph cartridges, microphones, and strain gauges that produce an electrical output from a mechanical input. They are also used in earphones and ultrasonic transmitters that produce a mechanical output from an electrical input.

Ultrasonic transducers operate to radiate ultrasonic waves through a medium such as air. Transducers generally create ultrasonic vibrations through the use of piezoelectric materials such as certain forms of crystal or ceramic polymers. [2]

2.1.2 Ultrasonic Sensing/Control Basics

Ultrasonic signals are like audible sound waves, except the frequencies are much higher. Our ultrasonic transducers have piezoelectric crystals which resonate to a desired frequency and convert electric energy into acoustic energy and vice versa. The illustration shows how sound waves, transmitted in the shape of a cone, are reflected from a target back to the transducer. An output signal is produced to perform some kind of indicating or control function. A minimum distance from the sensor is required to provide a time delay so that the "echoes" can be interpreted. Variables which can effect the operation of ultrasonic sensing include, target surface angle, reflective surface roughness or changes in temperature or humidity. The targets can have any kind of reflective form - even round objects. [3]

2.2 Basic of Ultrasonic Sensor

The ultrasonic transducer produces ultrasonic signal. These signals are propagated through a sensing medium and the same transducer can be used to detect returning signals. In most applications, the sensing medium is simply air. An ultrasonic sensor typically comprises al least one ultrasonic transducer which transforms electrical energy into sound and in reverse sound into electrical energy, a housing enclosing the ultrasonic transducer , an electrical connection and optionally, an electronic circuit for signal for signal processing also enclosed in the housing. [4]

2.3 Measurement Principle/Effective Use of Ultrasonic Sensor

Ultrasonic sensor transmits ultrasonic waves from its sensor head and again receives the ultrasonic waves reflected from an object. By measuring the length of time from the transmission to reception of the sonic wave, it detects the position of the object.

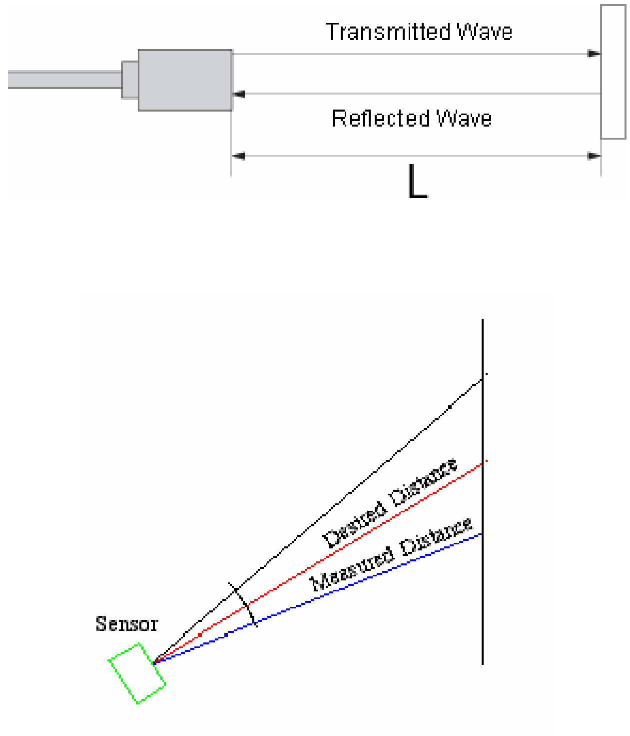

Figure 2.1: Basic ultrasonic operation

2.4 The advantages of Ultrasonic Sensor

Ultrasonic have a lot of advantages for using in real application. The advantages of ultrasonic sensor are:

i. Discrete distances to moving objects can be detected and measured.

ii. Less affected by target materials and surfaces, and not affected by color. Solid-state units have virtually unlimited, maintenance free life. Ultrasonic can detect small objects over long operating distances.

iii. Resistance to external disturbances such as vibration, infrared radiation, ambient noise, and EMI radiation.
iv. Measures and detects distances to moving objects.
v. Impervious to target materials, surface and color.
vi. Solid-state units have virtually unlimited, maintenance free lifespan.
vii. Detects small objects over long operating distance.
viii. Ultrasonic sensors are not affected by dust, dirt or high moisture environments.

2.5 The Disadvantages of Ultrasonic Sensor

Some disadvantages of ultrasonic sensor are:

i. Overheating of a wave emitter precludes the energy of ultrasonic waves emitted there from being enhanced to a practical level.
ii. Interference between the projected waves and the reflected waves takes place, and development of standing waves provides adverse effects.
iii. It is impossible to discern between reflected waves from the road surface and reflected waves from other places or objects. [5]

2.6 Target Angle and Beam Spread

2.6.1 Target Angle

This term refers to the "tilt response" limitations of a given sensor. Since ultrasonic sound waves reflect off the target object, target angles indicate acceptable amounts of tilt for a given sensor.

2.6.2 Beam Spread

This term is defined as the area in which a round wand will be sensed if passed through the target area. This is the maximum spreading of the ultrasonic sound as it leaves the transducer.

2.7 Environmental Factors Effect to Ultrasonic Sensor Performance

2.7.1 Temperature

The velocity of sound in air is 13,044 in./s at 0 C, it is directly proportional to air temperature. As the ambient air temperature increases, the speed of sound also increases. Therefore if a fixed target produces an echo after a certain time delay, and if the temperature drops, the measured time for the echo to return increases, even though the target has not moved. This happens because the speed of sound decreases, returning an echo more slowly than at the previous, warmer temperature. If varying ambient temperatures are expected in a specific application, compensation in the system for the change in sound speed is recommended.

2.7.2 Air Turbulence and Convection Currents

A particular temperature problem is posed by convection currents that contain many bands of varying temperature. If these bands pass between the sensor and the target, they will abruptly change the speed of sound while present. No type of temperature compensation (either temperature measurement or reference target) will provide complete high-resolution correction at all times under these circumstances. In some applications it may be desirable to install shielding around the sound beam to reduce or eliminate variations due to convection currents. Averaging the return times from a number of echoes will also help reduce the random effect of convection currents. Users addressing applications requiring high accuracy and resolution should evaluate these suggestions carefully.

2.7.3 Atmospheric Pressure

Normal changes in atmospheric pressure will have little effect on measurement accuracy. Reliable operation will deteriorates however, in areas of unusually low air pressure, approaching a vacuum.

2.7.4 Humidity

Humidity does not significantly affect the operation of an ultrasonic measuring system. Changes in humidity do have a slight effect, however, on the absorption of sound. If the humidity produces condensation, sensors designed to operate when wet must be used.

2.7.5 Acoustic Interference

Special consideration must be given to environments that contain background noise in the ultrasonic frequency spectrum. For example, air forced through a nozzle, such as air jets used for cleaning machines, generates a whistling sound with harmonics in the ultrasonic range. When in close proximity to a sensor, whether directed at the sensor or not, ultrasonic noise at or around the sensor's frequency may affect system operation. Typically, the level of background noise is lower at higher frequencies, and narrower beam angles work best in areas with a high ultrasonic background noise level. Often a baffle around the noise source will eliminate the problem. Because each application differs, testing for interference is suggested.

2.7.6 Radio Frequency Interference

Another possible source of noise is RFI emitting from SCR's in a variable speed drive. Shielding around the back and sides of the transducer may prevent RFI noise from entering the system.

2.7.7 Splashing Liquids

Splashing liquids should be kept from striking the surface of the sensor, both to protect the sensor from damage if it is not splash proof and to ensure an open path for the sound energy to travel.[6]

2.8 Sensor's Target Considerations

2.8.1 Composition

Nearly all targets reflect ultrasonic sound and therefore produce an echo that can be detected. Some textured materials produce a weaker echo, reducing the maximum effective sensing range. The reflectivity of an object is often a function of frequency. Lower frequencies can have reduced reflections from some porous targets, while higher frequencies reflect well from most target materials. Precise performance specifications can often be determined only through experimentation.

2.8.2 Shape

A target of virtually any shape can be detected ultrasonically if sufficient echo returns to the sensor. Targets that are smooth, flat, and perpendicular to the sensor's beam produce stronger echoes than irregularly shaped targets. A larger target relative to sound wavelength will produce a stronger echo than a smaller target until the target is larger than approximately 10 wavelengths across. Therefore, smaller targets are better detected with higher frequency sound. In some applications a specific target shape such as a sphere, cylinder, or internal cube corner can solve alignment problems between the sensor and the target.

2.8.3 Target Orientation to Sensor

To produce the strongest echoes, the sensor's beam should be pointed toward the target. If a smooth, flat target is inclined off perpendicular, some of the echo is deflected away from the sensor and the strength of the echo is reduced. Targets that are smaller than the spot diameter of the transducer beam can usually be inclined more than larger targets. Sensors with larger beam angles will generally produce stronger echoes from flat targets that are not perpendicular to the axis of the sound beam. Sound waves striking a target with a coarse, irregular surface will diffuse and reflect in many directions. Some of the reflected energy may return to the sensor as a weak but measurable echo. As always, target suitability must be evaluated for each application.

2.9 Servo Motor Operation

The servo motor has some control circuits and a potentiometer (a variable resistor) that is connected to the output shaft. In the picture above, the pot can be seen on the right side of the circuit board. This pot allows the control circuitry to monitor the current angle of the servo motor. If the shaft is at the correct angle, then the motor shuts off. If the circuit finds that the angle is not correct, it will turn the motor the correct robots direction until the angle is correct. The output shaft of the servo is capable of traveling somewhere around 180 degrees. Usually, it is somewhere in the 210 degree range, but it varies by manufacturer. A normal servo is used to control an angular motion of between 0 and 180 degrees. A normal servo is mechanically not capable of turning any farther due to a mechanical stop built on to the main output gear. [7]

The amount of power applied to the motor is proportional to the distance it needs to travel. So, if the shaft needs to turn a large distance, the motor will run at full speed. If it needs to turn only a small amount, the motor will run at a slower speed. This is called proportional control.

The control wire is used to communicate the angle. The angle is determined by the duration of a pulse that is applied to the control wire. This is called Pulse Coded Modulation. The servo expects to see a pulse every 20 milliseconds (.02 seconds). The length of the pulse will determine how far the motor turns. A 1.5 millisecond pulse, for example, will make the motor turn to the 90 degree position (often called the neutral position). If the pulse is shorter than 1.5 ms, then the motor will turn the shaft to closer to 0 degrees. If the pulse is longer than 1.5ms, the shaft turns closer to 180 degrees.

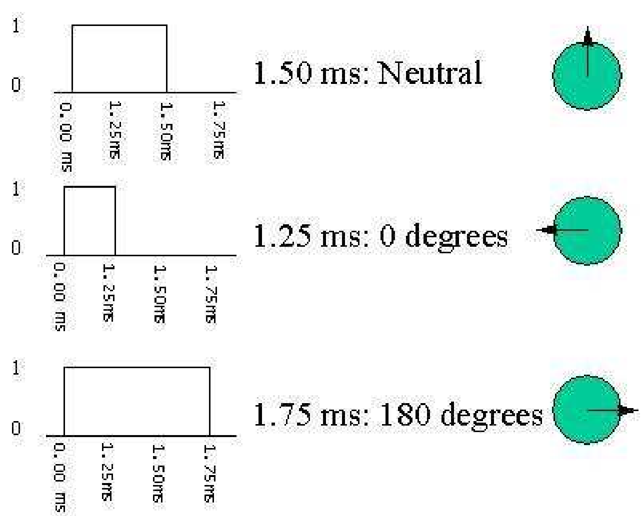

Figure 2.2: Servo Motor Movement Timing

From the figure above, the duration of the pulse dictates the angle of the output shaft (shown as the green circle with the arrow). Note that the times here are illustrative and the actual timings depend on the motor manufacturer. The principle, however, is the same.

2.10 Fundamental of PIC

PIC is a family of Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division.

PIC's are popular with developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability.

PICs were also commonly used to defeat the security system of popular consumer products (pay-TV, PlayStation), which attracted the attention of crackers.

2.10.1 Data Space (RAM)

PICs have a set of register files that function as general purpose ram, special purpose control registers for on-chip hardware resources are also mapped into the data space. The addressability of memory varies depending on device series, and all PIC devices have some banking mechanism to extend the addressing to additional memory. Later series of devices feature move instructions which can cover the whole addressable space, independent of the selected bank. In earlier devices, any register move had to be through the accumulator.

To synthesize indirect addressing, a "file select register" (FSR) and "indirect register" (INDF) are used. A read or write to INDF will be to the memory pointed to by FSR. Later devices extended this concept with post and pre increment/decrement for greater efficiency in accessing sequentially stored data. This also allows FSR to be treated like a stack pointer.

2.10.2 Stack

PICs have a hardware call stack, which is used to save return addresses. The hardware stack is not software accessible on earlier devices, but this changed with the 18 series devices.

Hardware support for a general purpose parameter stack was lacking in early series, but this greatly improved in the 18 series, making the 18 series architecture friendlier to high level language compilers.

2.10.3 Instruction Set

PICs instructions vary in number from about 35 instructions for the low-end PICs to about 70 instructions for the high-end PICs. The instruction set includes instructions to perform a variety of operations on registers directly, the accumulator and a literal constant or the accumulator and a register, as well as for conditional execution, and program branching.

Some operations, such as bit setting and testing, can be performed on any register, but bi-operand arithmetic operations always involve writing the result back to either W or the other operand register. To load a constant, it is necessary to load it into W before can be moved into another register. On the older cores, all register moves needed to pass through W, but this changed on the "high end" cores.

PIC cores have skip instructions which are used for conditional execution and branching. The skip instructions are 'skip if bit set’ and 'skip if bit not set'. Because cores before PIC18 had only unconditional branch instructions, conditional jumps are synthesized by a conditional skip (with the opposite condition) followed by a branch. Skips are also of utility for conditional execution of any immediate single following instruction.

The PIC architecture has no (or very meager) hardware support for saving processor state when servicing interrupts. The 18 series improved this situation by implementing shadow registers which save several important registers during an interrupt.

2.10.4 Word Size

All PICs feature Harvard architecture, so the code space and the data space are separate. PIC code space is generally implemented as EPROM, ROM, or FLASH ROM. In general, external code memory is not directly addressable due to the lack of an external memory interface.

CHAPTER 3

SYSTEM DESIGN

3.1 Ultrasonic Ranging Circuit

For this circuit, it can be divided into several parts, which are process to produced ultrasonic wave part, transmitter part, receiver part, amplifier part and lastly output part.

3.1.1 Transmitter

The supply circuit is needed to supply a short 10µs pulse to the trigger input to start the ranging. The sensor will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo line high. It then listens for an echo, and as soon as it detects one it lowers the echo line again. The echo line is therefore a pulse whose width is proportional to the distance to the object. By timing the pulse it is possible to calculate the range in inches/centimeters or anything else. If nothing is detected then the sensor will lower its echo line anyway after about 36 ms.

It uses a PIC12C508 to perform the control functions and standard 40 kHz piezo transducers. The drive to the transmitting transducer could be simplest driven directly from the PIC. The transducer can handle 20V of drive the transmitting wave.

A MAX232 IC, usually used for RS232 communication makes and ideal driver, providing about 16V of drive.

3.1.2 Receiver

The receiver is a classic two stage op-amp circuit. The input capacitor C8 blocks some residual DC which always seems to be present. Each gain stage is set to 24 for a total gain of 576-ish. This is close the 25 maximum gain available using the LM1458. The gain bandwidth product for the LM1458 is 1 MHz. The maximum gain at 40 kHz is 1000000/40000 = 25. The output of the amplifier is fed into an LM311 comparator. A small amount of positive feedback provides some hysterisis to give a clean stable output.

A convenient negative voltage for the op-amp and comparator is generated by the MAX232. Unfortunately, this also generates quite a bit of high frequency noise, therefore shut it down whilst listening for the echo. The 10uF capacitor C9 holds the negative rail just long enough to do this.

3.1.3 Operation

In operation, the processor waits for an active low trigger pulse to come in. It then generates just eight cycles of 40 kHz. The echo line is then raised to signal the host processor to start timing. The raising of the echo line also shuts of the MAX232. After a while (no more than 10-12ms normally), the returning echo will be detected and the PIC will lower the echo line. The width of this pulse represents the flight time of the sonic burst. If no echo is detected then it will automatically time out after about 30ms (it is two times the WDT period of the PIC). Because the MAX232 is shut down during echo detection, you must wait at least 10ms between measurement cycles for the +/- 10V to recharge.

3.2 List of Component in Ultrasonic Ranging Sensor Circuit

3.2.1 IC MAX232

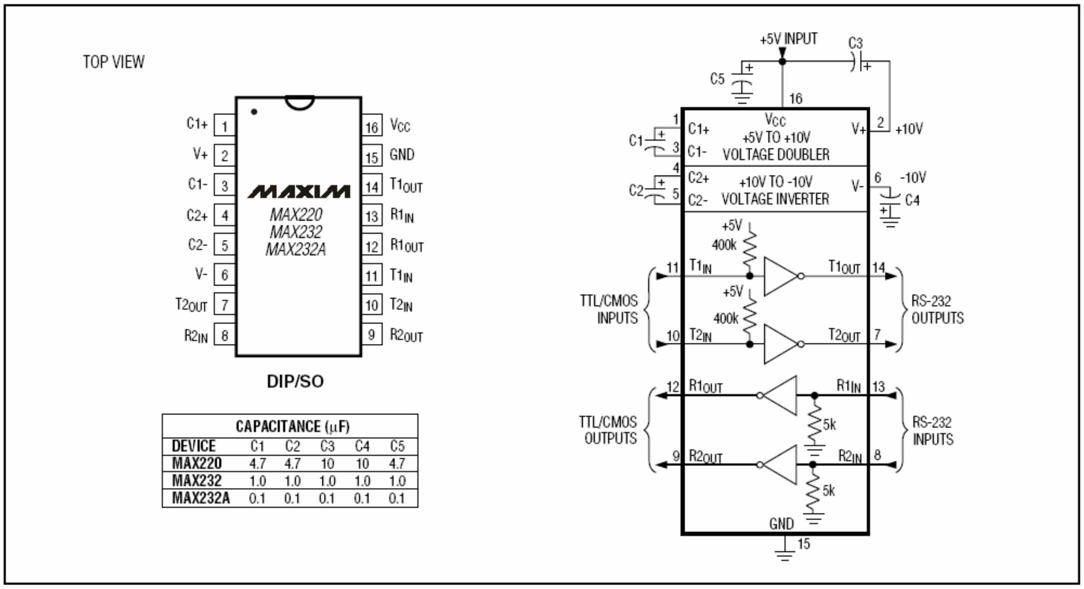

Figure 3.1: Block Diagram MAX232

MAX232 is an integrated circuit (IC) that acts as RS232. RS232 is a common interface standard for data communications equipment. RS232 was specified signal voltages, signal timing, signal function, a protocol for information exchange, and mechanical connectors.

In an asynchronous sampling scheme both transmitter and receiver have their own clocks running at the same frequency. Generally, the start of the transmission synchronous the clock at the receiver end with that of the transmitter and from this point on both clocks run asynchronously from one another. RS232 works on this principle.

In MAX232, there are four sections which are dual charge-pump DC-DC voltage converters, RS-232 drivers, RS-232 receivers, and receiver and transmitter enable control inputs.

The important section in this IC is a charge-pump DC-DC voltage converter. This integrated circuit has two internal charge pumps that convert +5V to ±10V (unloaded) for RS-232 driver operation. The first converter uses capacitor C1 to double the +5V input to +10V on C3 at the V+ output. The second converter uses capacitor C2 to invert +10V to -10V on C4 at the V- output. For this project the voltage input is a 5V and it connected to pin 16. Voltage doublers will double this voltage to 10V. After that, this 10 V will invert to -10V by voltage inverter. So that, we can use the output -10V easily connect to pin 6.

3.2.2 LM1458

LM1458 is a dual operational amplifier. The two amplifiers share a common bias network and power supply leads. Otherwise, their operation is completely independent. Basically, operational amplifier builds as a signal conditioning applications.

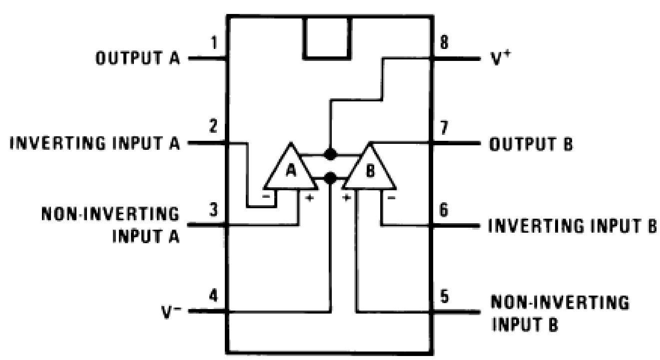

Figure 3.2: IC Connection for LM1458

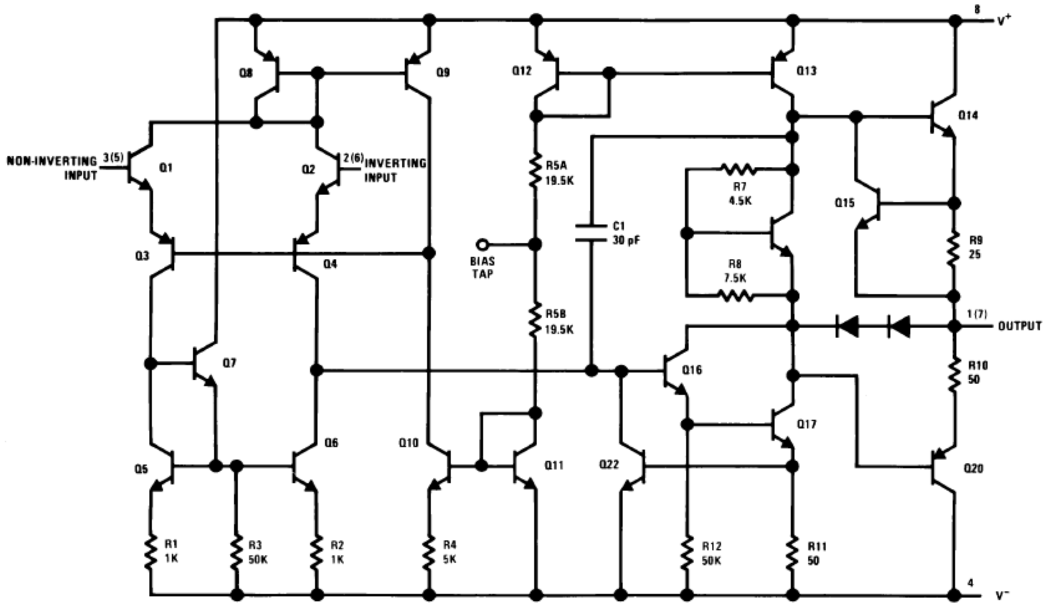

Figure 3.3: Circuit Diagram for IC LM1458

An op amp is a circuit composed of resistor, transistor, diodes and capacitor. It typically requires connection of bipolar power supplies with respect to ground. An operational amplifier, usually referred to as an op-amp for brevity, is a DC-coupled high-gain electronic voltage amplifier with differential inputs and, usually, a single output.

In its ordinary usage, the output of the op-amp is controlled by negative feedback which, because of the amplifier's high gain, almost completely determines the output voltage for any given input.

3.2.2.1 Basic operation

The amplifier's differential inputs consist of an inverting input and a non-inverting input and ideally the op-amp amplifies only the difference in voltage between the two. This is called the “differential input voltage”. In its most common use, the op-amp's output voltage is controlled by feeding a fraction of the output signal back to the inverting input. This is known as negative feedback. If that fraction is zero, there is no negative feedback, the amplifier is said to be running "open loop" and its output is the differential input voltage multiplied by the total gain of the amplifier, as shown by the following equation;

$$V_{\mathrm{out}} = (V_+ - V_-) \cdot G_{\mathrm{openloop}}$$

Because the open-loop gain is typically very large, op-amps are not usually used without negative feedback. Unless the differential input voltage is extremely small, open-loop operation results in op-amp saturation (see below in nonlinear imperfections). An example of how the output voltage is calculated when negative feedback exists is shown below in basic non-inverting amplifier circuit.

Another typical configuration of op-amps is the positive feedback, which takes a fraction of the output signal back to the non-inverting input. An important application of it is the comparator with hysteresis.

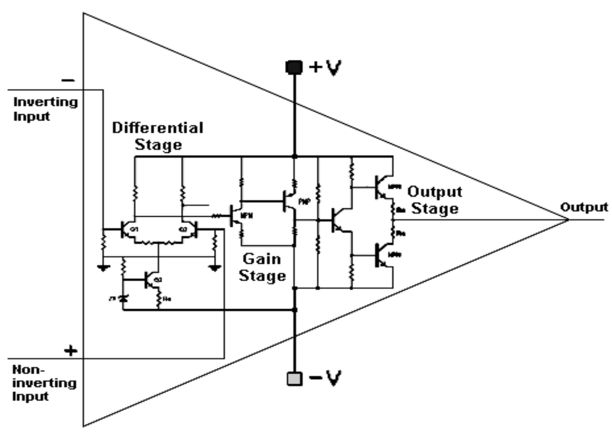

Figure 3.4: Op Amp Stages