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JUDUL: **AUTONOMOUS ROBOT**

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AUTONOMOUS ROBOT

GOW MOH KEE

This thesis is submitted as partial fulfillment of the requirement
for the award of the
Bachelor Degree of Electrical Engineering
(Control and Instrumentation)

Faculty of Electrical & Electronics Engineering
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"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Control and Instrumentation)"

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DEDICATION

Specially dedicated to
My beloved parents, brother, sister
and all of my best friends.

ACKNOWLEDGEMENT

I am greatly indebted to my supervisor, Miss Zainah binti Mohd. Zain for her advice and guidance throughout my project. Thank you Miss.

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Finally, I would like to express my thanks to those who involves directly or indirectly in completion of my project.

ABSTRACT

Recently, mini robots in the form of pets, cleaners and others are available in market. Robots are utilized for many applications to assist human-being. The purpose of this project is to develop an autonomous robot that can move on itself without continuous human guidance. This autonomous robot is overall in two parts: Electronic parts and mechanical parts. Electronic parts are the controller board, infrared sensors and ISD 2560 ChipCoder. The controller board consists of microcontroller PIC 16F877A, power supply unit and motor driver ST L293D. The mechanical parts are the gear-box with DC motors and the case of the robot. When the robot is ON, it will sound “Autonomous robot ON” and move forward. When it senses obstacle in front, it will sound “Obstacle at front, reversing” and reverse then turn right before it continues to move forward. When it senses obstacle at right, it will sound “Obstacle at right, turning left” then turn left and when it senses obstacle at left, it will sound “Obstacle at left, turning right” then turn right before it continues to move forward. As a result, this robot is useful as a guide for blind people as it is also economic.

ABSTRAK

Kebelakangan ini, robot mini dalam bentuk binatang peliharaan, pembersih dan lain-lain lagi telah boleh didapati di pasaran. Robot adalah dipakai untuk pelbagai kegunaan bagi membantu manusia. Tujuan projek ini adalah untuk membangunkan sebuah "autonomous robot" yang boleh bergerak dengan sendiri tanpa pimpinan manusia yang berterusan. Robot ini secara keseluruhannya terbahagi kepada dua bahagian: Bahagian elektronik dan bahagian mekanikal. Bahagian elektronik adalah terdiri daripada papan kawalan, pengesan "infrared" dan ISD 2560 ChipCoder. Papan kawalan mengandungi pengawal PIC 16F877A, unit pembekal kuasa dan pemandu motor ST L293D. Bahagian mekanikal adalah terdiri daripada kotak gear dengan motor arus terus dan rangka robot. Apabila robot dihidupkan, ia akan mengeluarkan bunyi "Autonomous robot ON" dan bergerak ke hadapan. Apabila ia mengesan rintangan di hadapannya, ia akan mengeluarkan bunyi "Obstacle at front, reversing" dan bergerak ke belakang kemudian berpusing kanan sebelum ia bersambung untuk bergerak ke hadapan. Apabila ia mengesan rintangan di kanan, ia akan mengeluarkan bunyi "Obstacle at right, turning left" kemudian berpusing kiri dan apabila ia mengesan rintangan di kiri, ia akan mengeluarkan bunyi "Obstacle at left, turning right" kemudian berpusing kanan sebelum ia bersambung untuk bergerak ke hadapan. Sebagai kesimpulan, robot ini adalah berguna sebagai pemandu untuk orang buta di mana ia juga ekonomi.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

PIC	Programmable Interface Controller
ISD	Information Storage Devices
Hz	Hertz
kHz	Kilo Hertz
MHz	Mega Hertz
IC	Integrated circuit
V	Volt
dc	Direct current
I/O	Input/Output
PM	Permanent magnet
A	Ampere
mw	Milliwatt
IR	Infrared
PVC	Polyvinyl Chloride
cm	Centimeter
MSB	Most Significant Bit
LSB	Least Significant Bit
CD-R	Compact Disc-Recordable

LIST OF APPENDIXES

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The word robot is used to refer to a wide range of machines, the common feature is that they are all capable of movement and can be used to perform physical tasks. The word robot was first introduced by a Czech dramatist, Karel Capek in his 1921 play “Rossum's Universal Robots”. He was referring to a perfect and tireless worker performing manual labour jobs for human beings. Then, famous science fiction writer Isaac Asimov coined the word robotics as the science of the study of robots in his science fiction stories about robots in 1940s. In Webster's New World Dictionary, robotics is defined as “the science or technology of robots, their design, manufacture, application, use etc”. But in Europe, robotics is defined as “the science of robotology” and robotology is defined as “the means by which robot machines are put together and made to work” [1].

Autonomous robots are robots which can perform desired tasks in unstructured environments without continuous human guidance. Many kinds of robots are autonomous to some degree. Different robots can be autonomous in different ways. A high degree of autonomy is particularly desirable in fields such as space exploration, where interruptions and communication delays are unavoidable [2].

Before the autonomous robots were invented, there were only ordinary robots. Those robots were all depending on human control. Besides, those robots also did not have any self avoiding systems toward obstacles as their avoiding systems were totally controlled by human. Therefore, to overcome those problems, autonomous robots were invented. But due to the lack of technologies at that time, the circuits of those autonomous robots were complexes directly increased the cost of the robot. Those autonomous robots were invented to replace human in doing hazardous works such as denoting bomb and exploring unknown places. Lately, autonomous robots were also utilized as guides to blind man.

Therefore, this project is to develop an autonomous robot that can move forward and backward and produce sound. The basic concept of this project is to design a robot which can move forward and backward without human guidance or control as the robot can produce sound when it reaches certain point. Microcontroller PIC 16F877A will be used as the "brain" of this robot as it controls the systems of the robot. For improvements, this robot will not only move forward and backward but it can also turn left and right or even backward yet play different pre-recorded messages when it reaches different points. Sensors are also added to direct the robot yet to prevent the robot from crashing obstacles.

Overall, this project is divided into two main sections: the electronic design and the mechanical design. This two designed are integrated together to perform the task. Below is the flow chart of the whole project:

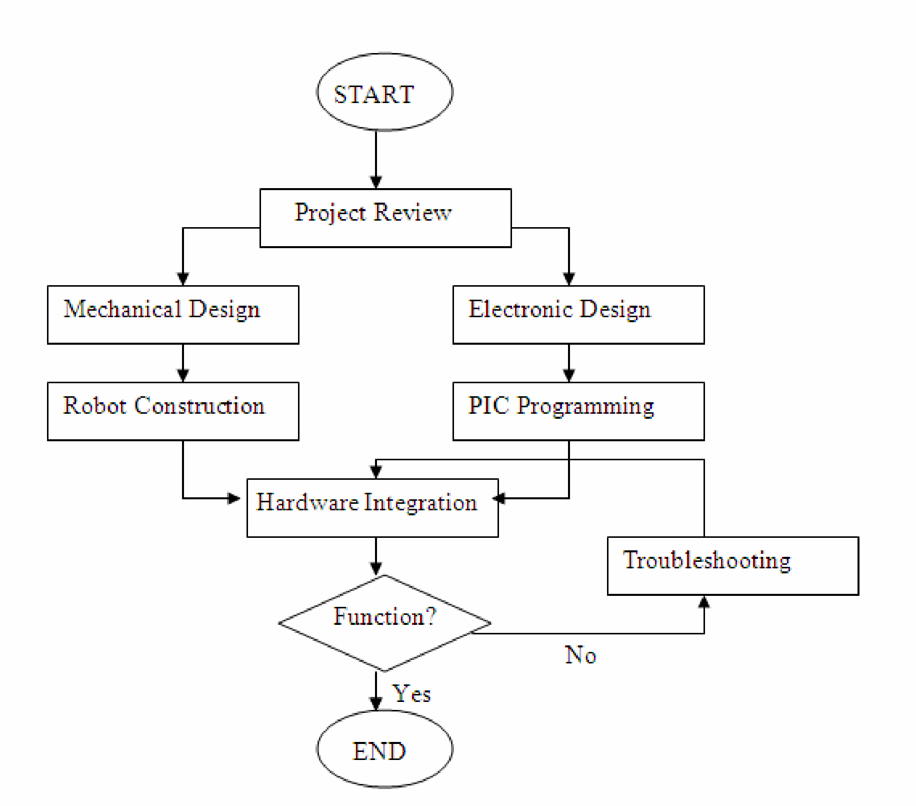


Figure 1.1 : Flow chart for the whole project

1.2 OBJECTIVES

The objectives of this project are:

i. To develop an autonomous robot which will move by itself when it is ON.

Basically this autonomous robot is a mobile robot. So, when it is switched ON, it will move by itself according to the program that has been written as it does not need continuous human guidance or navigation.

ii. To produce a robot that has the ability to avoid obstacles by spinning left or right or even backward before it continues to move forward.

Infrared sensors will be installed at the main chassis of the robot. These sensors will sense the surroundings of the robot. When obstacle is detected, signal will be sent to the microcontroller unit to enable the robot to avoid the obstacle.

iii. To produce a robot that will play different pre-recorded messages.

Winbond ISD 2560 ChipCoder® is also used to store various messages that will be played by the robot. So whenever the robot is switched ON or detecting obstacle, it will play the assigned pre-recorded messages.

1.3 SCOPES OF PROJECT

Four scopes are proposed for this project:

i. The robot will move forward at the starting.

When the robot is switched ON, left motor will rotate forward and right motor will rotate forward producing the robot to move forward. Message assigned at address 0000000000 of ISD 2560 which is "Autonomous robot ON" will be played.

ii. When it senses obstacle at left, it will play "Obstacle at left, turning right" and turn right before it continue to move forward.

To enable the robot to spin right, left motor will be rotating forward and right motor will also be rotating backward. At the same time, message assigned at address 0100000000 of ISD 2560 which is "Obstacle at left, turning right" will be played. Then the robot will continue to move forward after it passes the obstacle at the left side.

iii. When it senses obstacle at right, it will play "Obstacle at right, turning left" and turn left before it continue to move forward.

To enable the robot to spin left, left motor will be rotating backward and right motor will also be rotating forward. At the same time, message assigned at address 0010000000 of ISD 2560 which is "Obstacle at right, turning left" will be played. Then the robot will continue to move forward after it passes the obstacle at the right side.

iv. When it senses obstacle at front, it will play "Obstacle at front, reversing" and reverse then spin right before it continue to move forward.

To enable the robot to reverse, left motor will be rotating backward and right motor will be rotating backward. At the same time, message assigned at address 1000000000 of ISD 2560 which is "Obstacle at front, reversing" will be played. Then the robot will spin right before continue to move forward.

1.4 THESIS OVERVIEW

This thesis is a combination of 6 chapters that contains the Introduction, Literature Review, Hardware & Software Design, Result & Discussion and Conclusion.

Chapter 1 is the introduction of the project. In this chapter, background and objectives of the project are explained. The scopes of the project are also stated in this chapter.

Chapter 2 focuses on the literature review and the methodologies for the development of the Autonomous Robot.

Chapter 3 is the explanation of hardware & software design of the project. This chapter is divided into two main sections: hardware design and software design. In hardware design, electronics part and mechanical part are explained. Electronics part is focusing on the development of the controller board, infrared sensor and ISD 2560 ChipCoder. Mechanical part is explaining the construction of the robot such as chassis and tires. While in software design, steps of programming the PIC 16F877A are explained.

Chapter 4 shows the all the results and performance of the project. Each result obtained will be analyzed and discussed. This chapter also mentions the limitations of the project.

Chapter 5 discusses the conclusion and future development of the project.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In a science fiction story of Isaac Asimov, a robot must fulfill the 3 laws of robotics.

1. Robots must not injure humans
2. Robots must obey orders
3. Robots must protect their own existence [1]

From the laws stated above, autonomous robot seems to fulfil all the laws. First, autonomous robot is not a robot designed to harm humans. But in fact it is designed to help humans to do the hazardous works. Then, the robot is controlled by the microcontroller unit which is programmed by its programmer. So without any question the robot will certainly do what it is “told” to do. Besides, the robot is always protecting itself from crashing with obstacles because it always detects the surroundings with its sensors.

Meanwhile, an autonomous robot in the real world must have the ability to:

- Gain information about the environment.
- Work for months or years without human intervention.
- Travel from point A to point B, without human navigation assistance.
- Avoid situations that are harmful to people, property or itself
- Repair itself without outside assistance [2].

A robot may also be able to learn autonomously. Autonomous learning includes the ability to:

- Learn or gain new capabilities without outside assistance.
- Adjust strategies based on the surroundings.
- Adapt to surroundings without outside assistance.

Autonomous robots still require regular maintenance, as do other machines [2].

2.2 WHY BUILD AUTONOMOUS ROBOT

Mobile robotics is a relatively new research area that deals with the control of autonomous and semiautonomous vehicles. There are some important differences between the requirements of traditional fixed robotic installations and the requirements of mobile robotic systems. One of it is the environmental uncertainty in which the vehicle might operate in. For fixed robotic systems, a small workspace can usually be engineered to facilitate the task being undertaken. For mobile robotic systems, it is difficult to engineer the environment where the system needs to operate in because the world is dynamic and unpredictable. This required improved sensor technology and the ability for the system to cope with uncertainty. The design of mobile robotic systems considers the ability to carry all necessary resources such as power sources and all of the sensing and processing hardware within the mobile itself [3].

2.3 PREVIOUS AUTONOMOUS ROBOT PROBLEM

Before this, almost all autonomous robots do not have the ability to play real sound. Buzzer is used to produce sound instead of playing real sound. The example is Autonomous Flocking & Singing Robot which only uses buzzers as the sounding part. It uses two buzzers of different frequencies: 600 Hz and 2.5 kHz [4]. So in order to overcome this problem, survey based on IC that can store sound is done.

2.4 METHODOLOGY

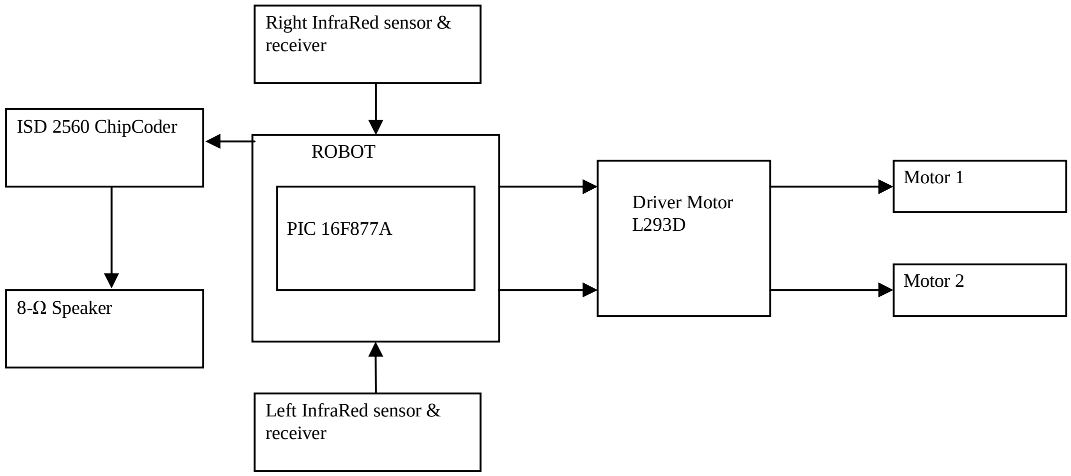


Figure 2.1 : Block diagram for the project

2.4.1 POWER SUPPLY

The goal of this project will be the development of a mobile autonomous sounding robot. The robot will move itself and produce sound after it is programmed. The movement of the robot will be navigated by two wheels which are driven by two independent motors. For an autonomous robot it is obviously important that it can operate from batteries. Since the microcontroller run with 4.5V the motors also must work with 3-4.5V. They must also not take too much current otherwise the batteries and the control circuit will get too big and heavy [5]. So when using a 9V battery, voltage regulator LM78L05 which produces +5Vdc will used as the power supply to the main controller board.

2.4.2 MICROCONTROLLER

The PIC family of chips has a wide variety of options. The differences between chips include the amount of memory, the number of I/O ports, the number of internal registers, and the speed of the crystal. Thus PIC16F84 and PIC16F877 were considered for research as these PICs meet the project requirements.

Complexity of external circuitry: The PIC circuitry is simple as it only requires a crystal oscillator and voltage regulator to operate. There is no extra circuitry needed, making the circuitry less complex.

Ease of Programming: The PIC can be programmed in assembler code, C code or PICBASIC languages. For the high level language such as C code and PICBASIC language, a compiler is needed to convert them to assembler language. The compilers for these languages are readily available for downloading from the internet. Hence, it is clear that the range of languages supported by the PIC is larger than that of the 68HC11 chips. However, the PIC requires a special programmer that links to a PC through either parallel port or serial port. The chip must be placed in the programmer every time a new program (the compiled hex code) is loaded. This is more troublesome than the 68HC11 [6].

According to above comparisons, the PIC range offers less complicated external circuitry, accepts more types of programming languages and is cheaper than the 68HC11. Thus the PIC range was preferred to be the brain of the project system. When comparing the two PIC options it is noted that the 16F84 is not as powerful as the newer 16F877. PIC16F877 with larger memory and more I/O ports can fulfill all the projects requirements with a reasonable price. Thus 16F877 was selected as micro-controller to be used in the self learning mobile.

2.4.3 MOTOR

The direct current (DC) motor is one of the first machines devised to convert electrical power into mechanical power. Permanent magnet (PM) direct current converts electrical energy into mechanical energy through the interaction of two magnetic fields. One field is produced by a permanent magnet assembly; the other field is produced by an electrical current flowing in the motor windings. These two fields result in a torque which rotates the rotor. As the rotor turns, the current in the windings is commutated to produce a continuous torque output. The stationary electromagnetic field of the motor can also be wire-wound like the armature (called a wound-field motor) or can be made up of permanent magnets (called a permanent magnet motor).

Some of the advantages are:

i. Easy to understand design

ii. Easy to control speed

iii. Easy to control torque

iv. Simple, cheap drive design

Some of the disadvantages are:

i. Can't reliably control at lowest speeds

ii. Physically larger

iii. High maintenance [7]

2.4.4 MOTOR DRIVER

Besides, for this design we use an integrated motor driver chip, called L293d. The L293d motor driver chip can drive peak loads up to 0.5A. The motors should therefore need less than 0.5A under worst conditions [5]. The advantages of using L293d are it can provide bidirectional drive currents high enough to operate motors and it can prevent the reverse current from motors to the microcontroller. Besides, the circuit of the L293d is also simple.

2.4.5 SENSOR

Sensors are used for object detection in most of the robotics system. The sensors help by translating physical world attributes into values that the computer on a robot can read and operates on. The translation produces output value that the microcontroller can detect and make decisions due to the data flow in from the sensor. Among all the sensors available in the market, infrared sensors are used for the robot. Infra-red detection is a common addition to a robot. It allows the robot to determine when it has come in to close proximity to an object without coming into physical contact.

2.4.6 SPEECH IC

After considering various technologies used to implement the message archive function, i.e., analog tape loop devices, traditional digital to analog conversion techniques, personal computer voice recorder systems, and stand alone analog recording devices, we have decided to use the Information Storage Devices, Inc. ISD2560 ChipCoder Device. [8]

The ISD 2560 device contains built-in audio signal processing, a microphone preamplifier, a 500 mw audio output amplifier, and a simple level or edge-triggered interface (user selectable). This makes it possible to use in applications ranging from single chip stand alone designs to multiple chip microprocessor control designs. In addition, all control pins to the 2560 are internally debounced and driven by a high precision internal clock that reduces the external parts count considerably. The ISD 2560 has large total storage with small array sizes, in our case 60 seconds and 1,000 locations [9].

2.4.7 SPEAKER

The speaker is a medium-sized 8-ohm, 2 watt speaker that can produce a loud signal and is relatively inexpensive. Its power consumption requires the Amplifier/Driver part to use a larger medium-power transistor. The speaker can be driven directly out of the IC, but to allow for amplification and volume control it is driven out of the amplifier circuit [10].

CHAPTER 3

HARDWARE & SOFTWARE DESIGN

3.1 ELECTRONICS DESIGN

3.1.1 CIRCUIT OVERVIEW

The autonomous robot schematic circuit diagram is shown in Figure 5. Port D0, D1, D2 and D3 (pin 19, 20, 21 and 22) are connected to the I1, I2, I3 and I4 of the motor driver ST L293D. O1 and O2 of the L293D are connected to the right motor while O3 and O4 are connected to the left motor. ENABLE1 (pin1) and ENABLE2 (pin9) of L293D are connected to +5V so they are enabled. Vs (pin8) and Vss (pin16) are connected to the 4AA batteries while pin4, 5, 12 and 13 are grounded. Port B0, B1, B2, B3 and B4 are connected to the pin A9, A8, A7, A6 and CE* of the ISD 2560. Port C0 and C1 (pin 15 and 16) are connected to the left and right infrared receivers. Pin 1, 11 and 32 of microcontroller are connected to the output of power supply unit and Pin 12 and 31 of microcontroller are connected to the ground. 8 MHz oscillating crystal is connected to pin 13 and 14 of microcontroller. There are two unused ports (port A and E) in the circuit. Those remaining ports can be used for future development.

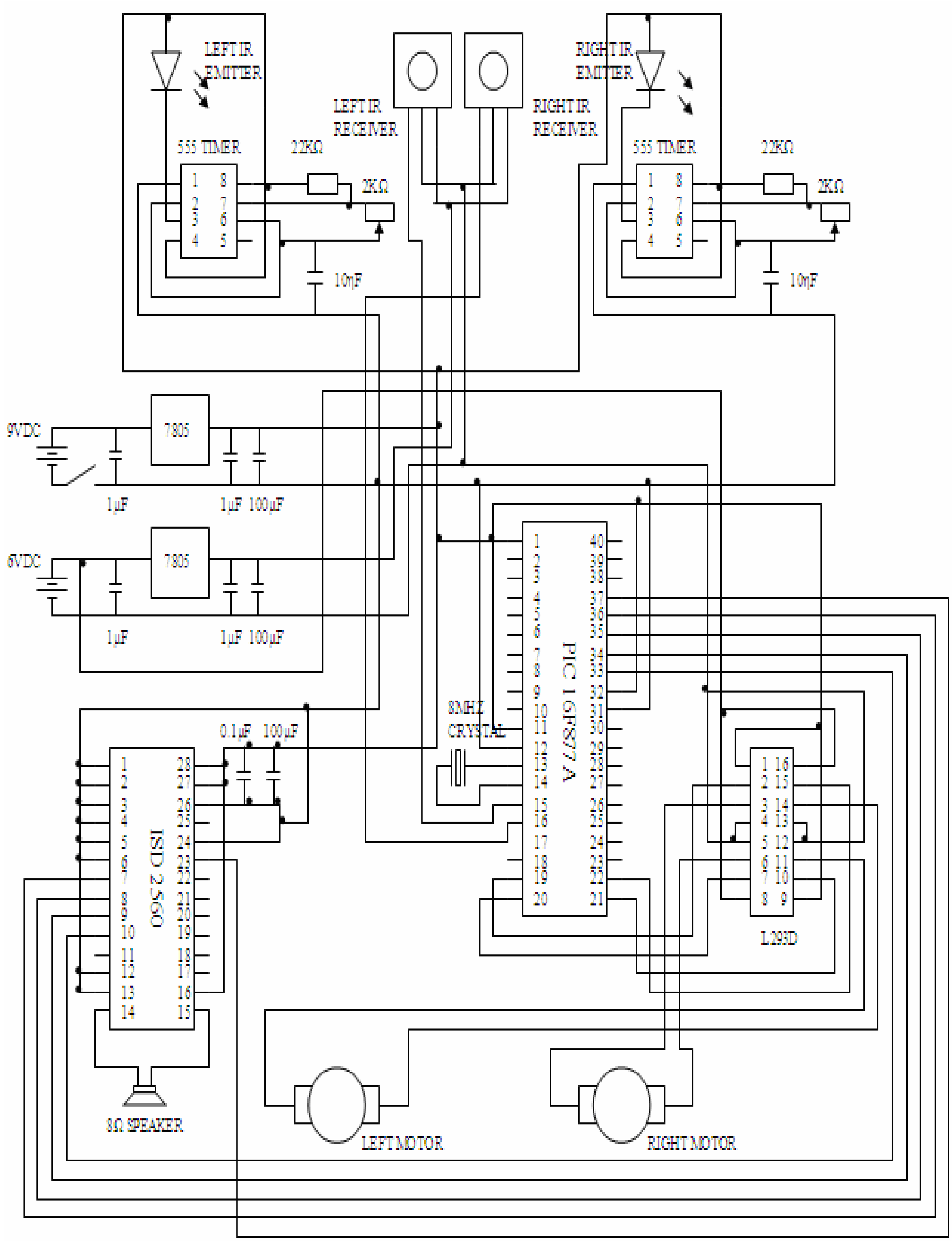


Figure 3.1 : Autonomous Robot schematic circuit diagram

3.1.2 CONTROLLER BOARD

The autonomous robot controller board is shown in Figure 3.3. The main component of the controller board is the PIC 16F877A. Then is the power supply unit which supplies voltage for the whole controller board. Motor driver L293D is used to drive the DC motors of the Tamiya Twin-Motor Gearbox.

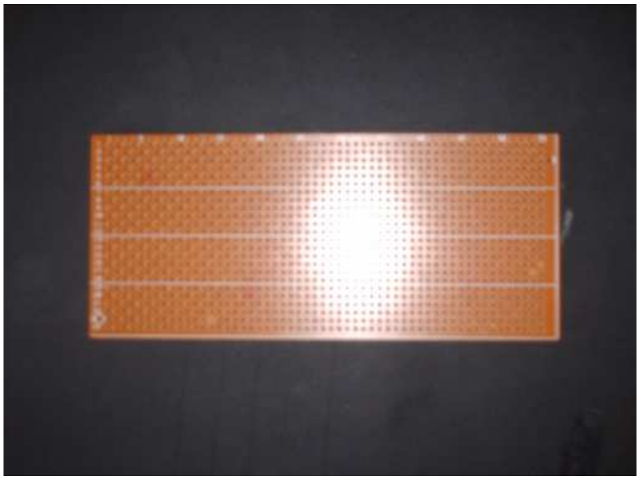


Figure 3.2 : Blank controller board

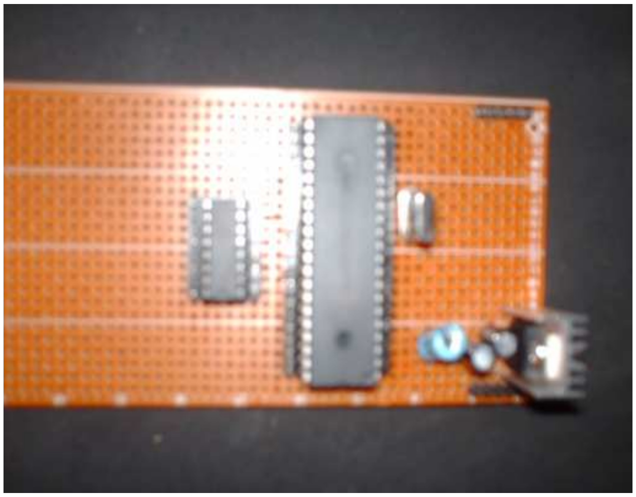


Figure 3.3 : Controller board with PIC 16F877A, power supply unit and motor driver L293D

3.1.3 INFRARED EMITTER AND RECEIVER

There are two pairs of infrared sensors are used in the autonomous robot. Each pair consists of one IR emitter and receiver. The sensors are placed at the left and right side to detect the obstacle at left and right. Each IR emitter is oscillated by a 555 Timer. The frequency is adjusted by the potentiometer. Those IR emitters are covered with a PVC pipe so that the IR beam from each emitter will only focus on each side. The IR detecting range is set to 8cm which enable the robot to detect the obstacle before it crashes them. The range must not be set at too far because it will make the robot to become too sensitive to the surrounding. So whenever the IR beam bounced from the obstacle and detected by the receiver, logic ‘0’ will be produced at the output of the receiver. Figure 3.4 shows the schematic diagram of IR emitter and receiver. Figure 3.5 shows the infrared emitter and receiver while Figure 3.6 shows the components of oscillator.

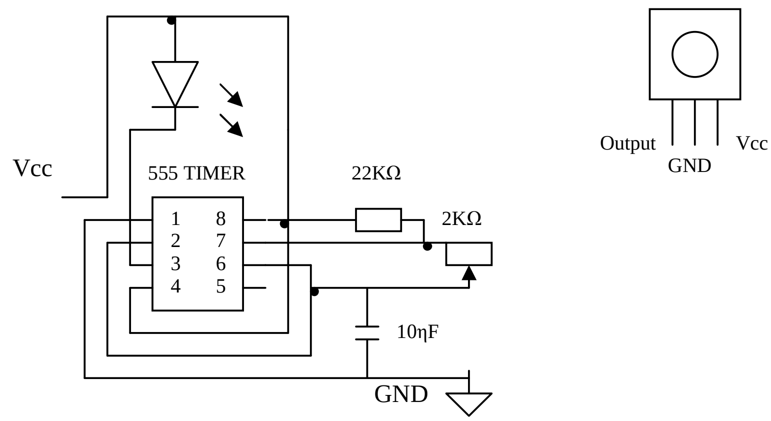


Figure 3.4 : Schematic diagram of IR emitter and receiver

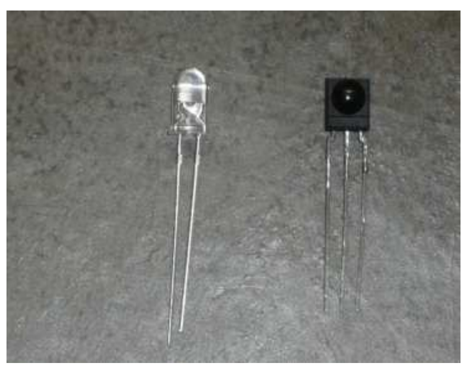


Figure 3.5 : IR emitter (left) and receiver (right)

Figure 3.6 : Components of oscillator
(from left to right: 22kΩ resistor, 10ηF capacitor,
555 Timer and 2kΩ potentiometer)

3.1.4 WINBOND ISD 2560 CHIPCODER®

Winbond ISD 2560 ChipCoder® is used in address input in the robot. The address of the ISD 2560 is determined by pin A0 to A9. Either one or both MSBs (A8 and A9) are taken low will set the ISD 2560 into address input. For this project, the messages are recorded on the other circuit while the circuit on the robot is for playback function only. P/R* (pin 27) is taken high for playback function while low for record function. Four addresses are selected: (MSB-LSB) 0000000000 (0 second), 0010000000 (12.8 second), 0100000000 (25.6 second) and 1000000000 (51.2 second) to store the messages. For this project, only four address pins (A9, A8, A7 and A6) are selected to be connected to the PIC 16F877A because each recording durations are adequate to record each message directly save more I/O ports of the microcontroller for future enhancement. Address pins A0 to A5 are grounded. CE* (pin 23) is also connected to the microcontroller because each ‘0’ logic given will trigger the ISD 2560 to play the corresponding message. Figure 3.7 shows the recording circuit and Figure 3.8 shows the schematic diagram of the recording circuit. Figure 3.9 shows the schematic diagram for the playback circuit that is used in this project.

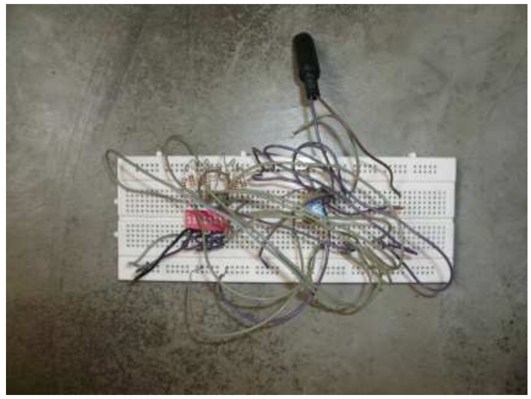


Figure 3.7 : Recording circuit

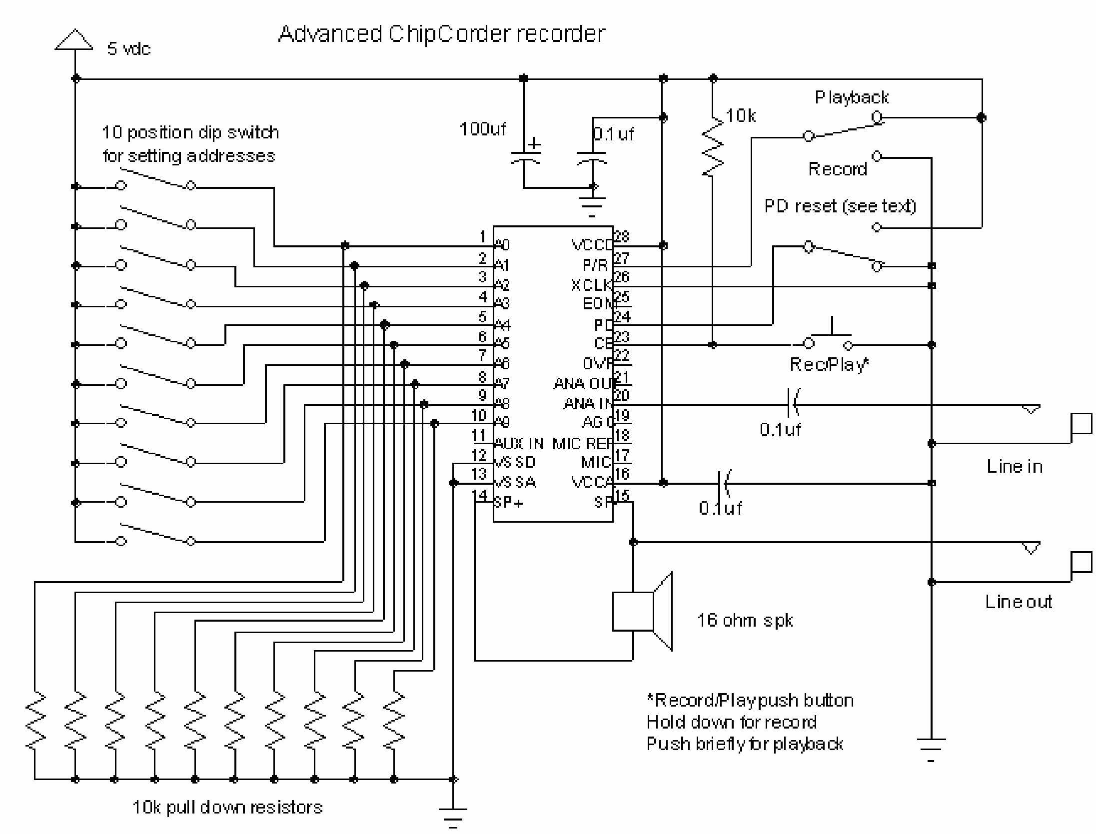


Figure 3.8 : Schematic diagram of the recording circuit

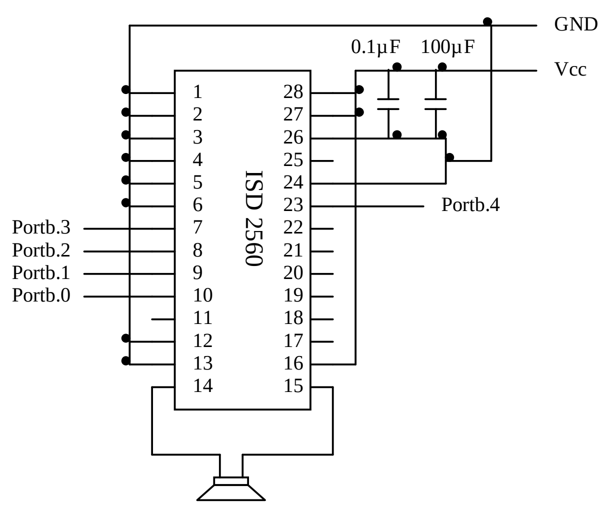


Figure 3.9 : Schematic diagram of the playback circuit used in the project

3.1.5 POWER SUPPLY UNIT

Two power supply units are used in this project. Each power supply unit is assembled by a voltage regulator L7805CV, heat sink, two 1 μF and a 100 μF capacitor. The schematic diagram of power supply unit is shown in Figure 3.10. Voltage source above 5V is supplied to the power supply unit and the output is 5.03V. The components of power supply unit are shown in Figure 3.11.

Table 3.1 : Input and Output voltage values of power supply unit

Input(V)	Output(V)
9	5.02
6	5.03

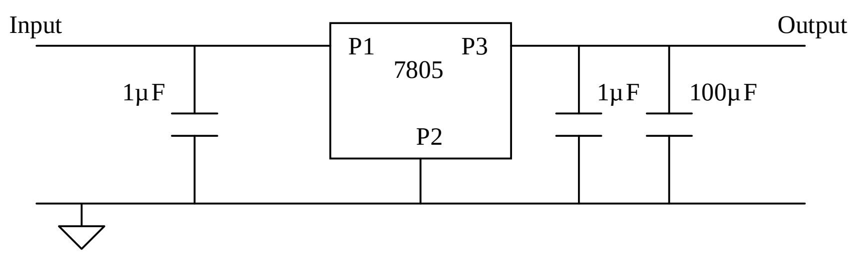


Figure 3.10 : Schematic diagram of the power supply unit

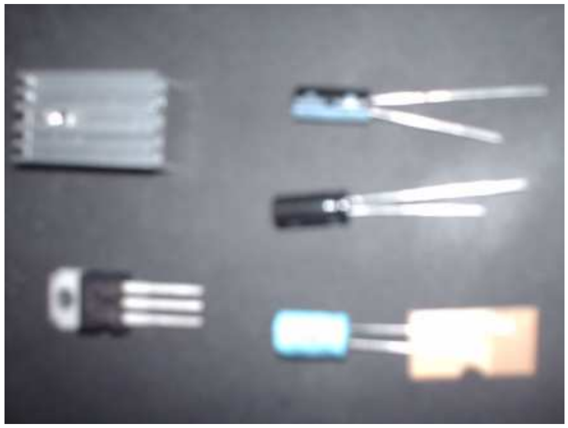


Figure 3.11 : Components of the power supply unit
(from left top to bottom: heat sink, LM78L05
from right top to bottom: 1μF, 1μF and 100μF)

3.1.6 MICROCONTROLLER PIC 16F877A

PIC 16F877A is 200 nanosecond instruction execution yet easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-bit microcontroller. The PIC16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions and five I/O ports (Port A, B ,C, D and E). The pin diagram and the figure of PIC 16F877A is shown in figure 3.12 and 3.13.

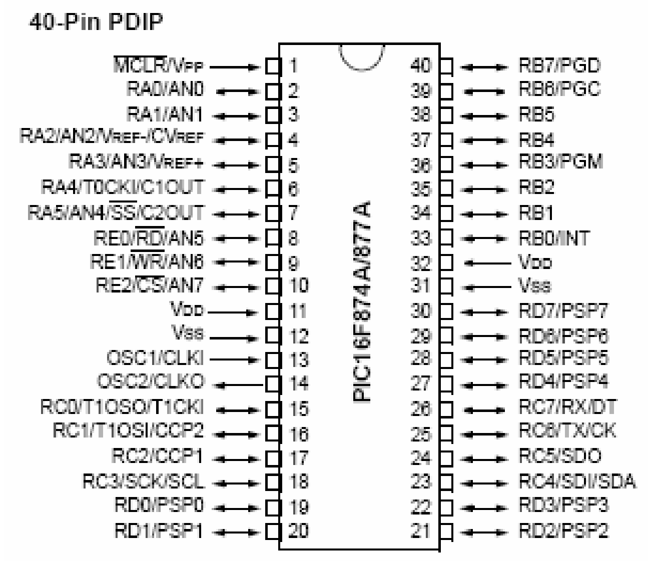


Figure 3.12 : Pin diagram of PIC 16F877A

Figure 3.13 : PIC 16F877A

3.1.7 MOTOR DRIVER ST L293D

Motor driver is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoids, DC and stepping motors) and switching power transistors. To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and internal clamp diodes are included. This device is suitable for use in switching applications at frequencies up to 5 kHz. Enable 1 (pin 1) and Enable 2 (pin 9) are connected to +5V while pin 4, 5, 12 and 13 are grounded. Inputs from microcontroller are connected to pin 2, 7, 10 and 15. Pin 3 and 6 are connected to the Right motor and pin 11 and 14 are connected to the Left motor. The pin diagram of L293D is shown in Figure 3.14.

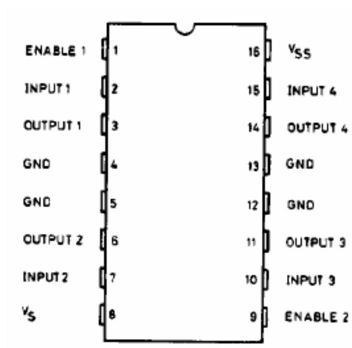


Figure 3.14 : Pin diagram of L293D

3.1.8 CONNECTION CABLE

Due to two boards are used in this project, a 12-strands and 6-strands rainbow cables are used to complete the connection of those boards. The 12-strands rainbow cable is used for connecting the output of IR receiver and the input of ISD 2560 to the PIC 16F877A and their corresponding power supply. The 6-strands rainbow cable is used to connect between the L293D and motors and the 4 AA batteries. Figure 3.15 shows the 12-strands rainbow cable.

Figure 3.15 : 12-strands rainbow cable with connectors

3.2 MECHANICAL DESIGN

3.2.1 TIRES

In order for the robot to move, two toy truck tires are installed to the gearbox. Figure 3.16 shows the tires. Then a non-driven roller wheel is attached to the robot to support the chassis of the robot to prevent the robot from scratching the floor.

Figure 3.16 : Toy truck tires

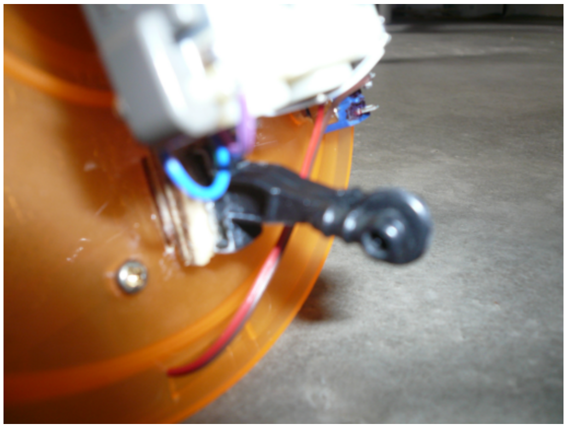


Figure 3.17 : A non-driven wheel

3.2.2 TAMIYA TWIN-MOTOR GEARBOX

The gearbox has two configuration option of standard speed with gear ration of 58:1 or low speed with gear ratio of 203:1. For Autonomous robot, the gearbox is assembled in low speed configuration with the gear ratio of 203:1.

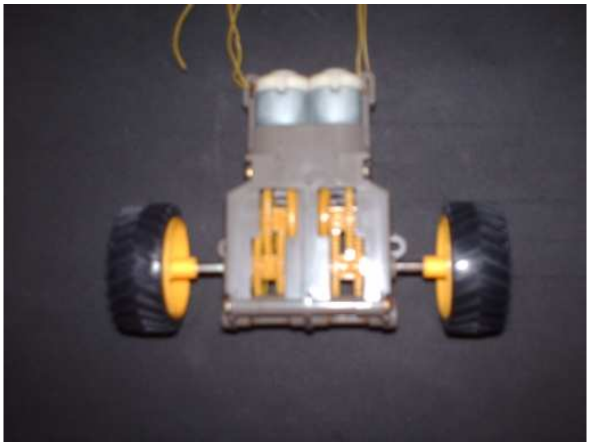


Figure 3.18 : Completed Tamiya Twin-motor gearbox with toy truck tires

3.2.3 CHASSIS OF THE ROBOT

In order to reduce cost, an idea of using recyclable material to construct the chassis of the robot has come to mind. Therefore, after surveys are done and collection of material is made, case of CD-R is chosen to be constructed into the chassis of the robot. Reason of choosing the case of CD-R is firstly the case is easily obtained. Then the space of the case is also sufficiently to install the controller board and the twin-motor gearbox as it is also hard enough to protect the controller board from external pressure.

Figure 3.19 : Top view of the case

Figure 3.20 : Overview of the case

3.2.4 INTEGRATION OF THE ROBOT

The gearbox is installed at the bottom of the CD-R case. The center pile of the case is removed for boards' installation. Then board spacers are use to space between the case and board and between the board and board. Figure 3.21 shows the completed gearbox with tires and non-driven wheel.

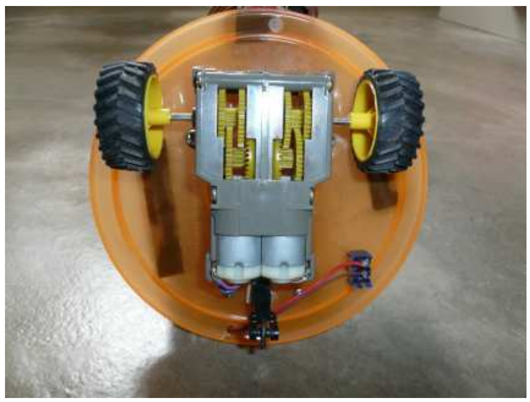


Figure 3.21 : Gearbox with tires and non-driven wheel

Figure 3.22 : Board spacer

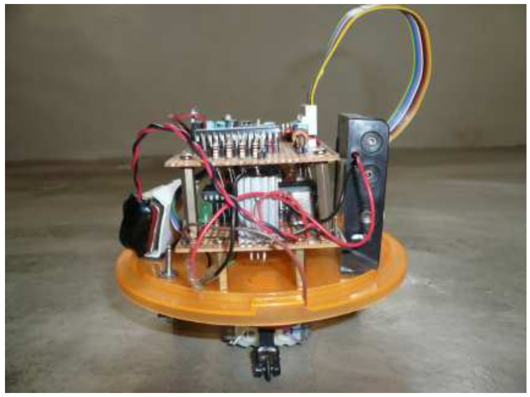


Figure 3.23 : Application of board spacers

3.3 SOFTWARE DESIGN

3.3.1 BACKGROUND

A microcontroller is nothing without software to run it. To program the PICs, a binary file of coded ones and zeros is required. In this project, the programming language used is PicBasic. Although PICs usually has to be programmed using assembly language, it is possible to program the PIC using PicBasic because of the availability of the compiler. It will convert the PicBasic language to assembly language that PIC is recognizable.

3.3.2 ALGORITHM

Autonomous Robot Algorithm shown as below will be programmed into the microcontroller unit. When the robot is ON, it will play "Autonomous robot ON", then the robot moves forward when there are no obstacles. Every time it spins, right or left, or reverses, it will play the assigned messages. Then it will continue to move forward when it passes through the obstacles.

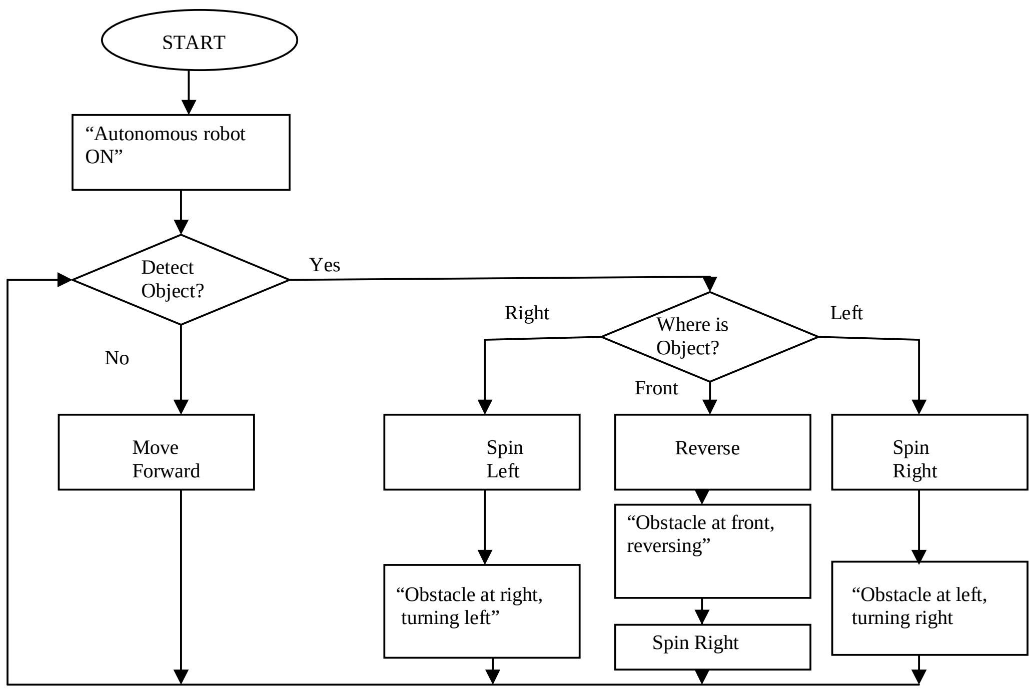


Figure 3.24 : Autonomous robot algorithm

3.3.3 PICBASIC PRO COMPILER

PICBASIC PRO Compiler is developed by MicroEngineering Labs. The programming language makes it quick and easy to program Microchip Technology's powerful PICmicro microcontrollers.

The BASIC language, which is English-like, is much easier to read and write or more understandable than Microchip assembly language. Example of the language is IF..THEN..ELSE..ENDIF which directly shows the antecedent and consequent of the program.

First, to start using the PICBASIC PRO Compiler, we must run the MicroCode Studio. Then we press CTRL+N for a new editor. Type of PIC microcontroller and oscillator frequency must be defined at the beginning of the program. In this project, PIC 16F877A is the microcontroller and 8 MHz crystal is used as the oscillator. Then, we will set the ports or pins of PIC 16F877A to input or output by using TRIS command followed by defining the pin names (VAR command). Then we can begin to write the program. A full listing of autonomous robot's program is shown in Appendix.

After we have finished writing the program, we need to save the program in .pbp file. Then only we can compile the program. During the compilation, errors of the program will be detected. If errors occur in the program, the compilation will be terminated. The error will be listed. After the error has been undone and if there is no more error in the program, then only the compilation will be completed. Three files (.ASM, .HEX and .MAC) will be generated in the same location of the .pbp file after compilation. .HEX file will be used to be programmed into the PIC 16F877A.

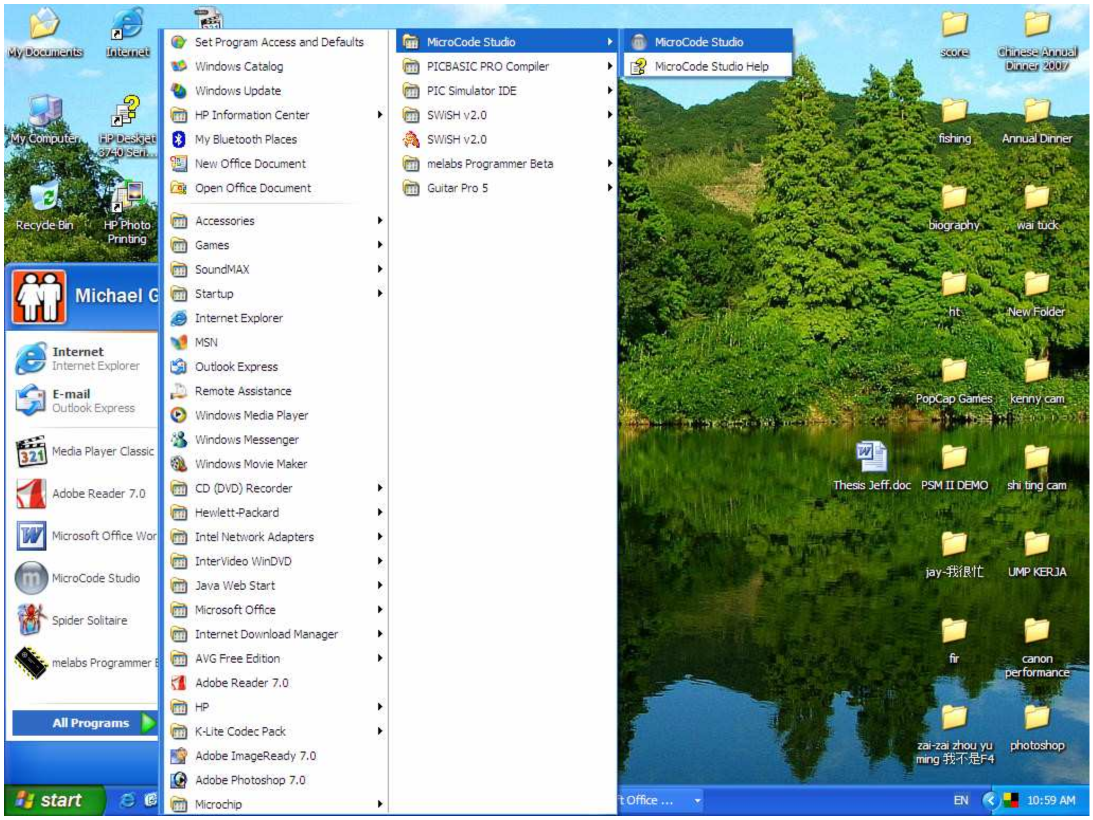


Figure 3.25 : Selecting MicroCode Studio

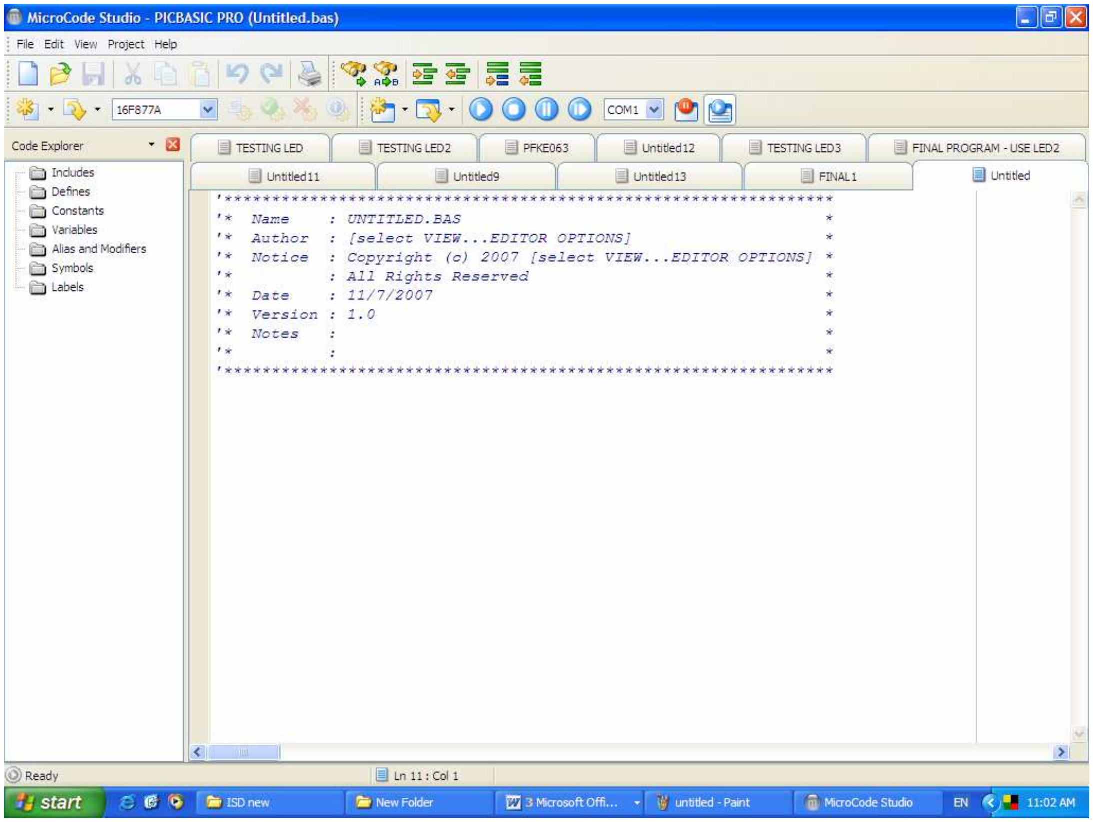


Figure 3.26 : New Editor with PIC 16F877A selected

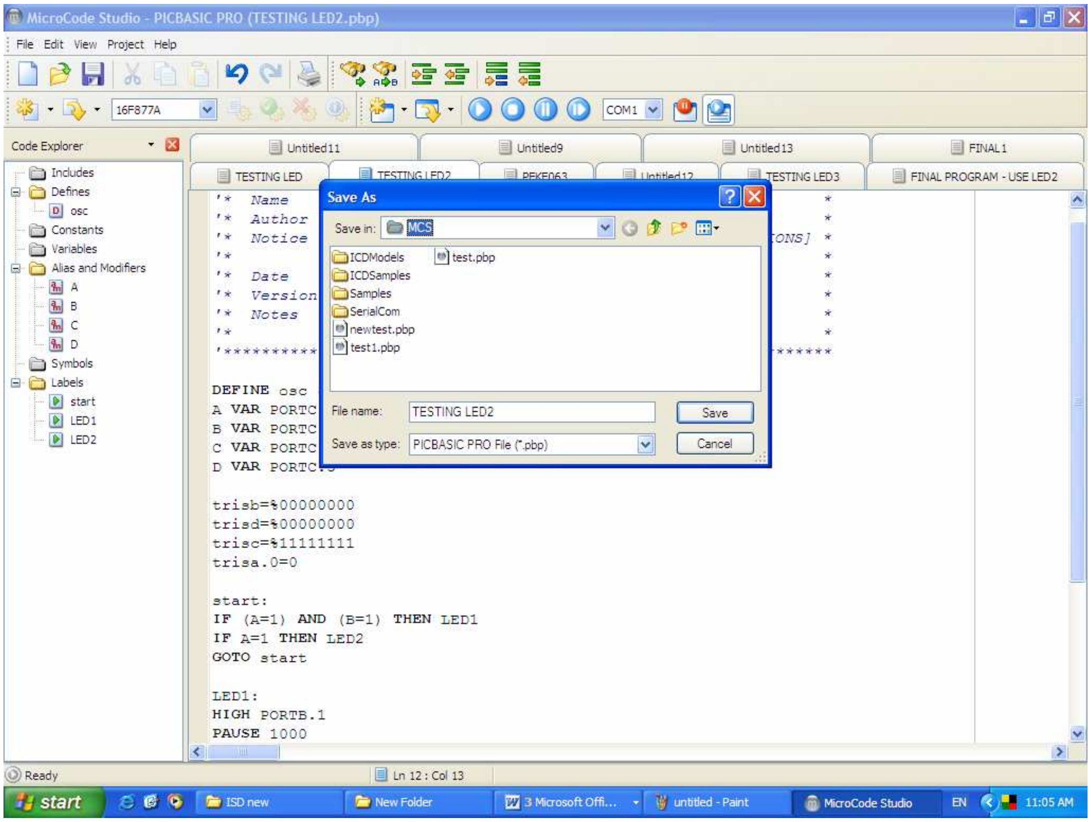


Figure 3.27 : Saving the file in .pbp

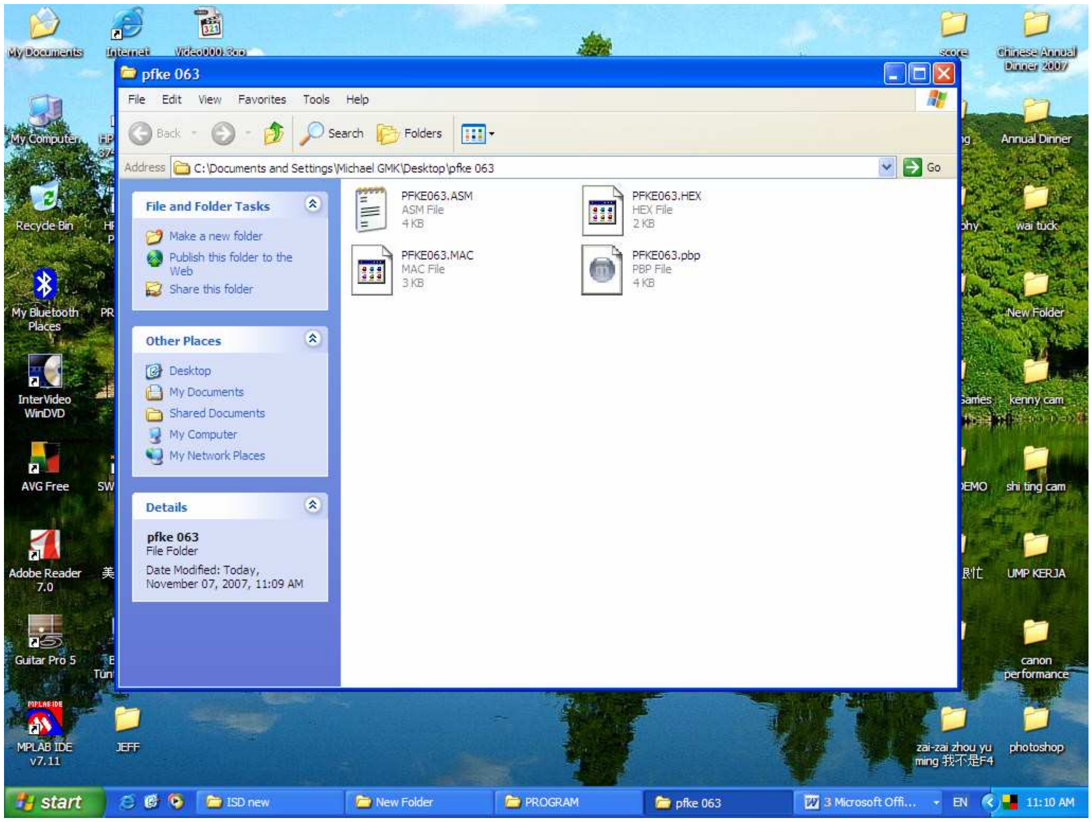


Figure 3.28 : .ASM, .HEX and .MAC are generated

3.3.4 MELABS PROGRAMMER

In order to program the .HEX file into the PIC 16F877A, melabs Programmer is used. The melabs USB Programmer and melabs U2 Programmer connect to a PC USB port or powered USB hub.

First, we run the melabs programmer software by selecting melabs Programmer from the Start menu. *Melabs Programmer* and *meProg-Configuration* windows will appear. On the *Melabs Programmer* window, firstly we must select the type of PIC we are using. For this project, PIC 16F877A is selected. Then we press

CTRL+N to reset the software followed by CTRL+O to open the .HEX file that will be programmed into the microcontroller. On the *meProg-Configuration* window, we set the Oscillator to HS, Watchdog Timer to Disabled, Power-up Timer to Enabled, Brown-out Reset to Disabled, Low Voltage Programming to Disabled, Flash Program Memory Write to All, Code to Not Protected and Data EEPROM to Not Protected.

After that, PIC 16F877A is inserted into the programmer socket. Then connect the cable between the programmer and 8-40 ZIF Adapter to the proper connector on the adapter for the number of pins (-40 pins). Blank Check and Erase are necessary if the target PIC still contains previous program. Then after the PIC is blank, we will program the .HEX file into the PIC by clicking Program.

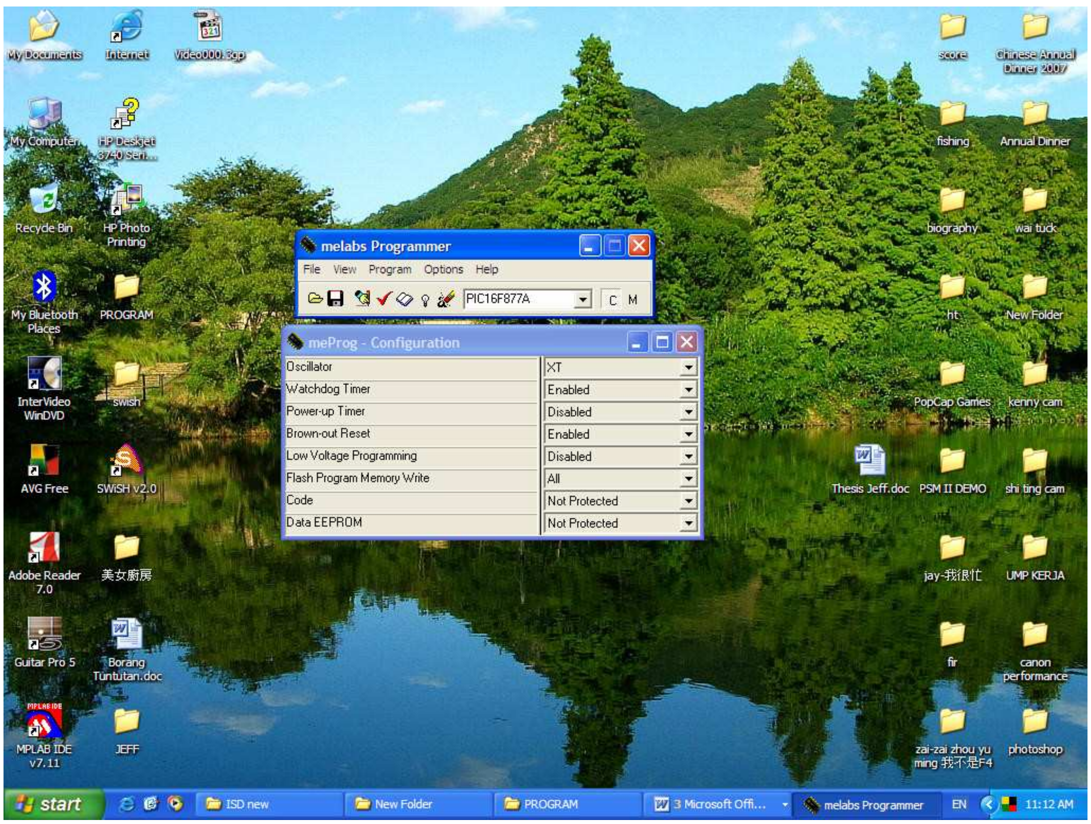


Figure 3.29 : melabs Programmer software

Figure 3.30 : melabs U2 programmer

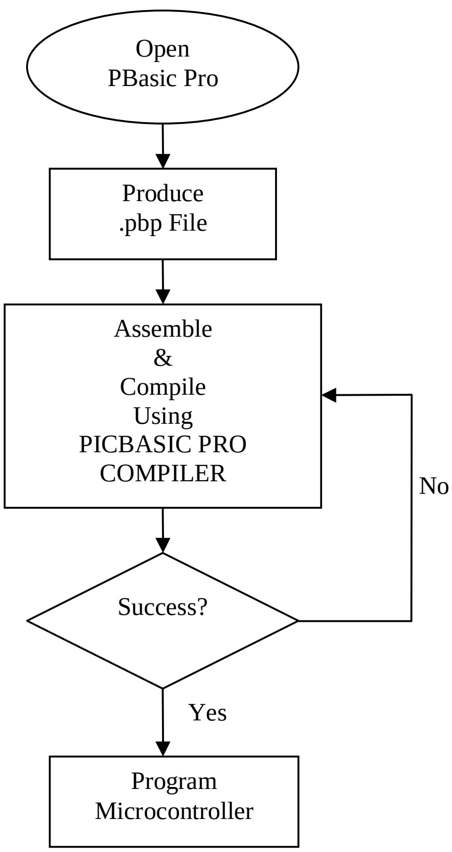


Figure 3.31 : Flow chart of programming PIC 16F877A

CHAPTER 4

RESULT AND DISCUSSION

4.1 DC MOTOR TESTING

Simple programs are used to test the motor driver. Voltage values are measured at the output pins of the motor driver while both motors are moving forward, turning left, turning right and reversing. Input 1, 2, 3 and 4 of motor driver are tested by a logic probe. Digital multimeter is used to measure the voltage values at output 1, 2, 3 and 4 of the motor driver.

4.1.1 ROBOT MOVING FORWARD

In order to make the robot to move forward, both motors must rotate forward. Right motor rotates forward when portd.0 is HIGH and portd.1 is LOW while left motor rotates forward when portd.2 is HIGH and portd.3 is LOW. Program shown as below is used:

high portd.0
low portd.1
high portd.2
low portd.3

Table 4.1 : Logic and voltage values of L293D when robot moving forward

INPUT	Result	OUTPUT	Voltage/V
1	H	1	4.91
2	L	2	0.01
3	H	3	4.91
4	L	4	0.02

Input 1 and 3 are High show that logics “1” are sent by the portd.0 and portd.2 to the L293D. Input 2 and 4 are Low show that logics “0” are sent by the portd.1 and portd.3 to the L293D. The results match the program. While output 1 and 2 show 4.91V and 0.01V when tested by the digital multimeter prove that the right motor will rotate forward due to the voltage difference between the two terminals of the right motor. Voltage difference between output 3 and 4 also cause the left motor to rotate forward. With both motors rotating forward, the robot will move forward.

4.1.2 ROBOT TURNING LEFT

In order to make the robot to turn left, right motor must rotate forward but left motor must rotate backward. Right motor rotates forward when portd.0 is HIGH and portd.1 is LOW while left motor rotates backward when portd.2 is LOW and portd.3 is HIGH. Program shown as below is used:

```
high portd.0
low portd.1
low portd.2
high portd.3
```

Table 4.2 : Logic and voltage values of L293D when robot turning left

INPUT	Result	OUTPUT	Voltage/V
1	H	1	4.91
2	L	2	0.01
3	L	3	0.01
4	H	4	4.92

Input 1 and 4 are High show that logics "1" are sent by the portd.0 and portd.3 to the L293D. Input 2 and 3 are Low show that logics "0" are sent by the portd.1 and portd.2 to the L293D. The results match the program. While output 1 and 2 show 4.91V and 0.01V when tested by the digital multimeter prove that the right motor will rotate forward due to the voltage difference between the two terminals of the right motor. Voltage difference between output 3 and 4 cause the left motor to rotate backward. With right motor rotates forward and left motor rotates backward, the robot will turn left.

4.1.3 ROBOT TURNING RIGHT

In order to make the robot to turn right, right motor must rotate backward but left motor must rotate forward. Right motor rotates backward when portd.0 is LOW and portd.1 is HIGH while left motor rotates forward when portd.2 is HIGH and portd.3 is LOW. Program shown as below is used:

```
low portd.0
high portd.1
high portd.2
low portd.3
```

Table 4.3 : Logic and voltage values of L293D when robot turning right

INPUT	Result	OUTPUT	Voltage/V
1	L	1	0.01
2	H	2	4.91
3	H	3	4.91
4	L	4	0.02

Input 1 and 4 are Low show that logics “0” are sent by the portd.0 and portd.3 to the L293D. Input 2 and 3 are High show that logics “1” are sent by the portd.1 and portd.2 to the L293D. The results match the program. While output 1 and 2 show 0.01V and 4.91V when tested by the digital multimeter prove that the right motor will rotate backward due to the voltage difference between the two terminals of the right motor. Voltage difference between output 3 and 4 cause the left motor to rotate forward. With right motor rotates backward and left motor rotates forward, the robot will turn right.

4.1.4 ROBOT REVERSING

In order to make the robot to reverse, both motors must rotate backward. Right motor rotates backward when portd.0 is LOW and portd.1 is HIGH while left motor rotates backward when portd.2 is LOW and portd.3 is HIGH. Program shown as below is used:

```
high portd.0
low portd.1
low portd.2
high portd.3
```

Table 4.4 : Logic and voltage values of L293D when robot reversing

INPUT	Result	OUTPUT	Voltage/V
1	L	1	0.01
2	H	2	4.92
3	L	3	0.01
4	H	4	4.91

Input 1 and 4 are High show that logics “1” are sent by the portd.0 and portd.3 to the L293D. Input 2 and 3 are Low show that logics “0” are sent by the portd.1 and portd.2 to the L293D. The results match the program. While output 1 and 2 show 0.01V and 4.91V when tested by the digital multimeter prove that the right motor will rotate backward due to the voltage difference between the two terminals of the right motor. Voltage difference between output 3 and 4 also cause the left motor to rotate backward. With right motor rotates backward and left motor rotates backward, the robot will reverse.

4.2 IR EMITTER AND RECEIVER TESTING

IR sensors are tested by measuring the voltage values of the receivers’ output. The functionality of the IR emitter can be checked through lens of camera as shown in Figure 4.1 & 4.2. When no obstacle is detected, the output of the IR receiver is HIGH but is obstacle detected, the output of IR receiver will be LOW. Figures 4.3 to 4.6 show the voltage values of the IR receiver when detecting and not detecting obstacle. The detection range of the IR sensors is set to 8cm because the range is adequate for the robot to spin and avoid the obstacles before it crashes them.

Figure 4.1 : IR emitter OFF

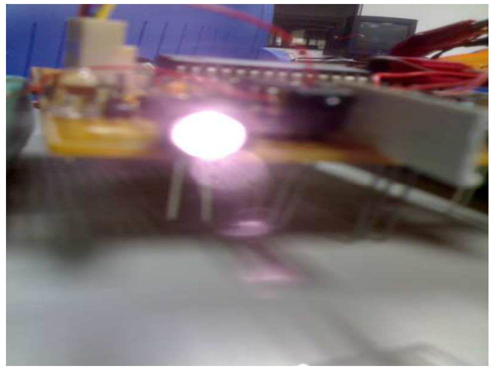


Figure 4.2 : IR emitter ON and checked by camera lens

Figure 4.3 : No obstacle

Figure 4.4 : Obstacle at LEFT

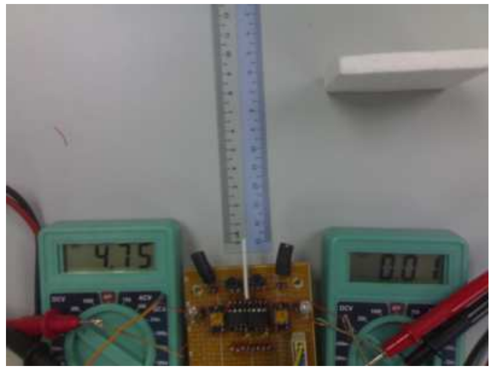


Figure 4.5 : Obstacle at RIGHT

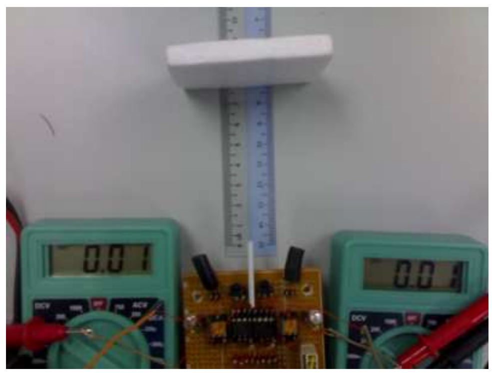


Figure 4.6 : Obstacle at FRONT

4.3 WINBOND ISD 2560 CHIPCODER TESTING

A simple program is written to the functionality of the ISD 2560. The program is shown in Appendix. Firstly when the robot is ON, it will play “Autonomous robot ON”. Then when the right IR sensor senses obstacle, it will play “Obstacle at Right, turning LEFT” and when the left IR sensor senses obstacle, it will play “Obstacle at left, turning RIGHT”. If both IR sensors sense obstacle, it will play “Obstacle at front, reversing”. All messages are clearly heard.

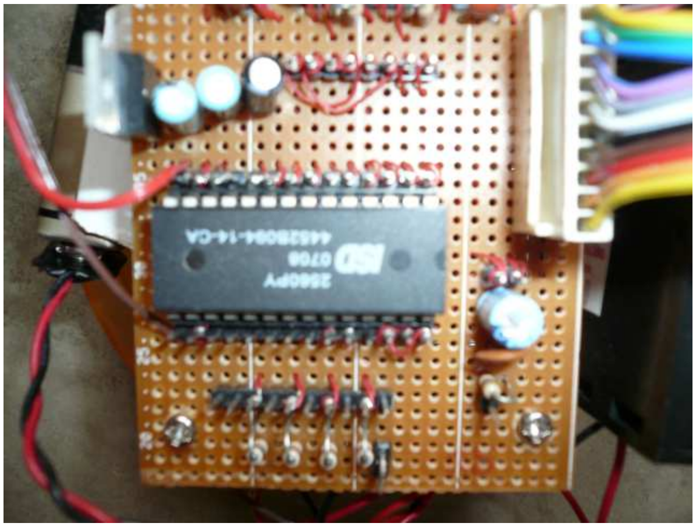


Figure 4.7 : Winbond ISD 2560 ChipCoder

4.4 LIMITATION OF THE PROJECT

By observing the results, there are some limitations we need to consider. Firstly is the duration for the movement of this robot. Before the integration of the robot, each part is connected to laboratory’s power supply to do the testing. After the integration is done, batteries are used as the power supply for the robot. Those batteries are easily exhausted directly reduce the duration for the movement of the robot. So, good quality batteries should be used to prolong the duration. Another limitation is the sound produced by speaker is very low compared to the noise produced by the gearbox. Therefore the messages are quite not heard when the robot is moving. Amplifier circuit can be added to overcome this limitation.

CHAPTER 5

CONCLUSION

5.1 CONCLUSION

As a conclusion, this autonomous robot achieves the objectives after the integration is done while it also fulfills the scopes of this project. This autonomous robot is extremely useful as a blind man guide. Therefore limitations of this project should be overcome and improvements should be added to enhance this autonomous robot.

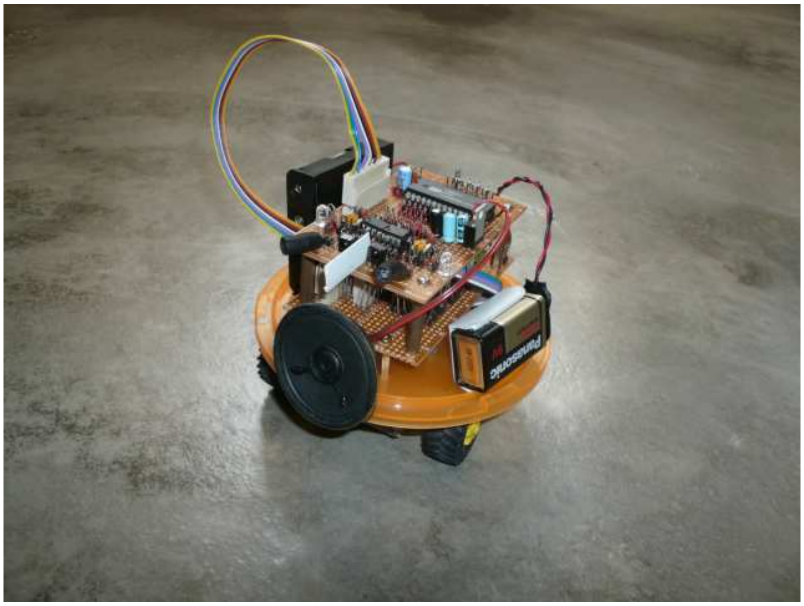


Figure 5.1 : Complete Autonomous robot

5.2 FUTURE DEVELOPMENT

Future works can also be implemented to this autonomous robot to enhance its function:

- More sensors such as light sensor, temperature sensor can be added to the robot to sense the surrounding. Then the messages regarding to the conditions of the surrounding can be played.
- More object sensors can be added to improve robot obstacle-avoidance ability. Examples of object sensor are such as bumper switches and sonar sensor. By having more object sensors, the robot will be more efficient in avoiding obstacles.

- ChipCoder with higher sampling rate and recording duration can be used to increase the sound quality and length. By having the longer sounds recording duration, more messages can be recorded into the ChipCoder. Therefore more addresses can be assigned to be used.

5.2.1 COSTING AND COMMERCIALIZATION

The costs of each part and the overall cost for one autonomous robot are shown in table below.

Table 5.1 : Cost for the controller board

Unit name	**Component**	**Qty**	**Price/ RM**	**Total price/ RM**
Controller Board	PIC 16F877A	1	30.00	30.00
	40-pin IC holder	1	1.00	1.00
	8 MHz Crystal	1	8.00	8.00
	L293D	1	10.00	10.00
	16-pin IC holder	1	0.80	0.80
	L7805CV	1	1.50	1.50
	Heat sink	1	1.50	1.50
	1µF capacitor	2	0.30	0.60
	100µF capacitor	1	0.40	0.40
	LED	1	0.20	0.20
	Jig Saw Switch	1	2.00	2.00
	PCB	1	2.00	2.00
			Total	RM 58.00

Table 5.2 : Cost for the Infrared sensors and ISD 2560

Unit name	**Component**	**Qty**	**Price/ RM**	**Total price/ RM**
Infrared Sensors and ISD 2560	Infrared transmitter	2	2.00	4.00
	Infrared receiver	2	10.00	20.00
	555 Timer	2	1.50	3.00
	16-pin IC holder	1	0.80	10.00
	10ηF capacitor	2	0.60	1.20
	22kΩ Resistor	2	0.10	0.20
	2KΩ Variable Resistor	2	0.50	1.00
	LED	2	0.60	1.20
	L7805CV	1	1.50	1.50
	Heat sink	1	1.50	1.50
	1µF capacitor	2	0.30	0.60
	100µF capacitor	1	0.40	0.40
	ISD 2560	1	45.00	45.00
	28-pin IC holder	1	0.80	0.80
	0.1µF capacitor	1	0.20	0.20
	100µF capacitor	1	0.40	0.40
	8- speaker	1	2.00	2.00
	PCB	1	2.00	2.00
			Total	RM 95.00

Table 5.3 : Cost for the connection

Unit name	**Component**	**Qty**	**Price/ RM**	**Total price/ RM**
Connection	11 stands rainbow cable	1	4.00	4.00
	11 pin connector	2	2.00	4.00
	6 strands rainbow cable	1	2.00	2.00
	6 pin connector	1	2.00	2.00
	Wrapping wire	1	15.00	15.00
	1/2" Board spacer	4	1.20	4.80
	1" Board spacer	4	1.20	4.80
			Total	RM 36.60

Table 5.4 : Cost for the motor

Unit name	**Component**	**Qty**	**Price/ RM**	**Total price/ RM**
Motor	TAMIYA twin-motor gearbox	1	47.25	47.25
	Truck tires	2	5.00	10.00
			Total	RM 57.25

Table 5.5 : Overall cost for one autonomous robot

Unit name	**Total price/ RM**
Controller board	58.00
Infrared Sensors and ISD 2560	95.00
Connection	36.60
Motor	57.25
Total cost	RM 246.85

Below are the commercialization potentials for the autonomous robot:

- As the guide for the blind people. This autonomous has the ability to avoid obstacles as it also can play pre-recorded messages. So it can guide the blind people through the messages.
- As the toy for children. This autonomous robot is low cost compared to other robots available in the market. So it is suitable to be commercialized as a toy.
- As home surveillance or security robot. Improvement such as visual ability and sound detector can de added to the robot so that the robot can help human to do the security work.

REFERENCES

1. Mahfuzah Mustafa, Chapter 1 BEE4393 Robotics & Automation, FKEE, 2007

2. Autonomous robot available at: http://en.wikipedia.org/wiki/Autonomous_robot

3. Design of a Self Learning Mobile (Software), Koh Hwei Zse Degree Thesis

4. Ching Chang, Chandanit Lausoonthorn and Nancy Wu, Presentation slide of Autonomous Flocking and Singing Robots, April 2006

5. Katja and Guido Socher, Building an autonomous light finder robot, 2003. Available at: http://www.linuxfocus.org/English/July2003/article297.shtml

6. TV Genie Design and Implementation (2001), Jason Rudolph Degree thesis, University of Queensland

7. Motor selection available at: http://www.epanorama.net/links/motorcontrol.html

8. Julie Anderson, Jamie Keairns, Ryan Kivimagi, Steve Meyer and Patrick Weeks Final Project Report of Expressionist, December 1998

9. Datasheet of ISD 2560 ChipCoder available at:

   http://www.alldatasheet.com

10. Hans Anderson, Optimization of a Sound Module Compatible with the Lego™ Programmable Brick, Research Science Institute, July 2003

APPENDIX A

Autonomous robot program listing

```
'*****************************************************************
'*  Name    : Autonomous Robot.BAS                               *
'*  Author  : GOW MOH KEE                                        *
'*  Notice  : Copyright (c) 2007 [select VIEW...EDITOR OPTIONS]  *
'*          : All Rights Reserved                                *
'*  Date    : 10/30/2007                                         *
'*  Version : 1.0                                                *
'*  Notes   :                                                    *
'*          :                                                    *
'*****************************************************************
define osc 8                    '8MHz CRYSTAL

trisd=%00000000                 'PORTD=OUTPUT
trisb=%00000000                 'PORTB=OUTPUT
trisc=%11111111                 'PORTC=INPUT

A9 VAR PORTB.0
A8 VAR PORTB.1
A7 VAR PORTB.2
A6 VAR PORTB.3
CE VAR PORTB.4
RF VAR PORTD.0
RR VAR PORTD.1
LF VAR PORTD.2
LR VAR PORTD.3
LIR VAR PORTC.0
RIR VAR PORTC.1

low PORTB
low PORTD
pause 3000

start:                          'MAIN PROGRAM STARTS

low A9                          'A9=0
low A8                          'A8=0
low A7                          'A7=0
low A6                          'A6=0
high CE                         'CE=1
HIGH RF
low RR                          'RIGHT MOTOR FORWARD
high LF
low LR                          'LEFT MOTOR FORWARD
if (RIR=0) and (LIR=0) then gosub reversing     'RIGHT AND LEFT SENSOR
                                                 DETECT?
if LIR=0 then gosub RIGHT             'RIGHT SENSOR DETECTS?
if RIR=0 then gosub LEFT              'LEFT SENSOR DETECTS?
pause 500                       'PAUSE 500ms
goto start
```

```
left:

low A9                          'A9=0
low A8                          'A8=0
high A7                         'A7=1
low A6                          'A6=0
low CE                          'CE=0
pause 100                        'PAUSE 100ms
high RF
low RR                          'RIGHT MOTOR FORWARD
low LF
high LR                         'LEFT MOTOR REVERSE
pause 500                        'PAUSE 500ms
goto start

right:

low A9                          'A9=0
high A8                         'A8=1
low A7                          'A7=0
low A6                          'A6=0
low CE                          'CE=0
pause 100                        'PAUSE 100ms
low RF
high RR                         'RIGHT MOTOR REVERSE
high LF
low LR                          'LEFT MOTOR FORWARD
pause 500                        'PAUSE 500ms
goto start

reversing:

high A9                         'A9=1
low A8                          'A8=0
low A7                          'A7=0
low A6                          'A6=0
low CE                          'CE=0
pause 100                        'PAUSE 100ms
low RF
high RR                         'RIGHT MOTOR REVERSE
low LF
high LR                         'LEFT MOTOR REVERSE
pause 2000                        'PAUSE 2000ms
gosub right                      'SPIN RIGHT
pause 500                        'PAUSE 500ms
goto start
```

```
'****************************************************************
'*  Name    : SPEECH TESTING.BAS                                 *
'*  Author  : GOW MOH KEE                                        *
'*  Notice  : Copyright (c) 2007 [select VIEW...EDITOR OPTIONS]  *
'*          : All Rights Reserved                                *
'*  Date    : 10/29/2007                                         *
'*  Version : 1.0                                                *
'*  Notes   :                                                    *
'*          :                                                    *
'****************************************************************

define osc 8

trisb=%00000000
trisc=%11111111
low portb
pause 500

start:

low portb.0
low portb.1
low portb.2
low portb.3
high portb.4
if portc.0=0 then gosub speech2
if portc.1=0 then gosub speech1
if portc.0=0 and portc.1=0 then gosub speech3

goto start

speech1:
low portb.0
low portb.1
high portb.2
low portb.3
low portb.4
pause 100

goto start

speech2:

low portb.0
high portb.1
low portb.2
low portb.3
low portb.4
pause 100
```

```
goto start

speech3:
high portb.0
low portb.1
low portb.2
low portb.3
low portb.4
pause 100

goto start
```

```
'***************************************************************
'*  Name    : MOTOR TESTING.BAS                                 *
'*  Author  : [select VIEW...EDITOR OPTIONS]                    *
'*  Notice  : Copyright (c) 2007 [select VIEW...EDITOR OPTIONS] *
'*          : All Rights Reserved                               *
'*  Date    : 10/29/2007                                        *
'*  Version : 1.0                                               *
'*  Notes   :                                                   *
'*          :                                                   *
'***************************************************************

define osc 8

trisd=%00000000
trisb=%00000000
trisc=%11111111

low portd

start:

high portd.0
low portd.1
high portd.2
low portd.3
if portc.0=0 and portc.1=0 then reversing
If portc.0=0 then right
IF portc.1=0 then left
goto start

right:
low portd.0
high portd.1
high portd.2
low portd.3
return

left:
high portd.0
low portd.1
low portd.2
high portd.3
return

reversing:
low portd.0
high portd.1
low portd.2
high portd.3
return
```

APPENDIX B

Photos of Autonomous robot

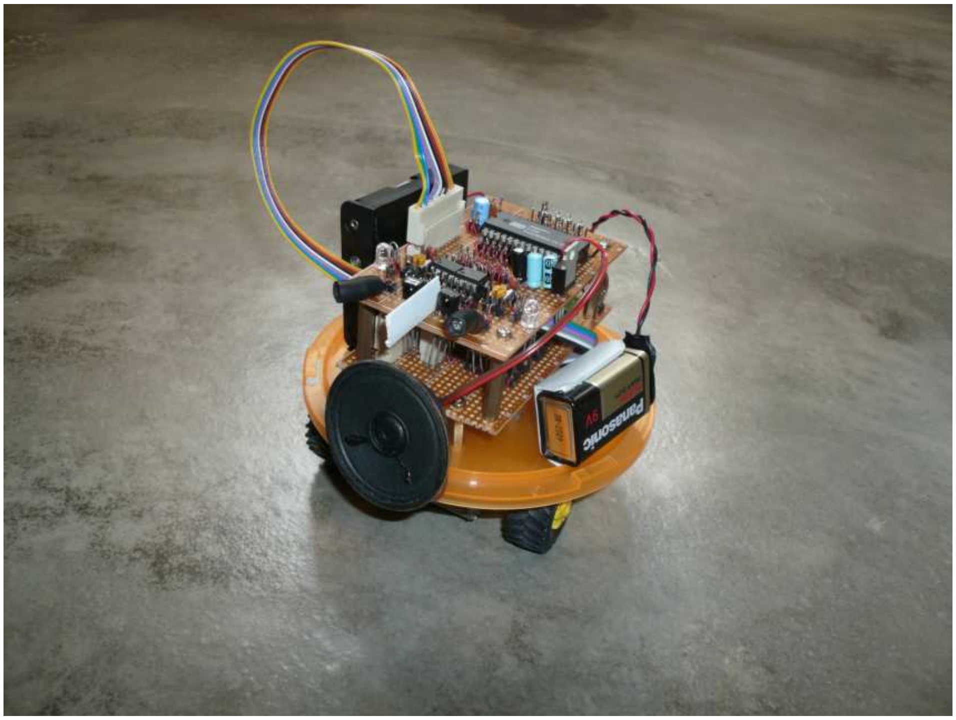


Photo A : Overview of the Autonomous robot (left)

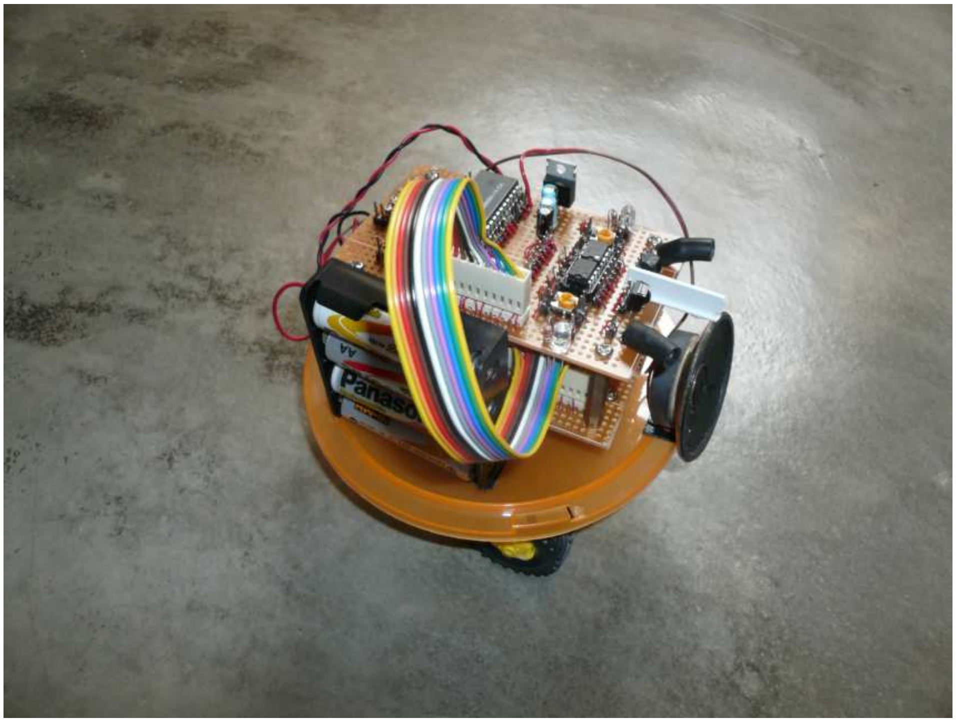


Photo B : Overview of the Autonomous robot (right)

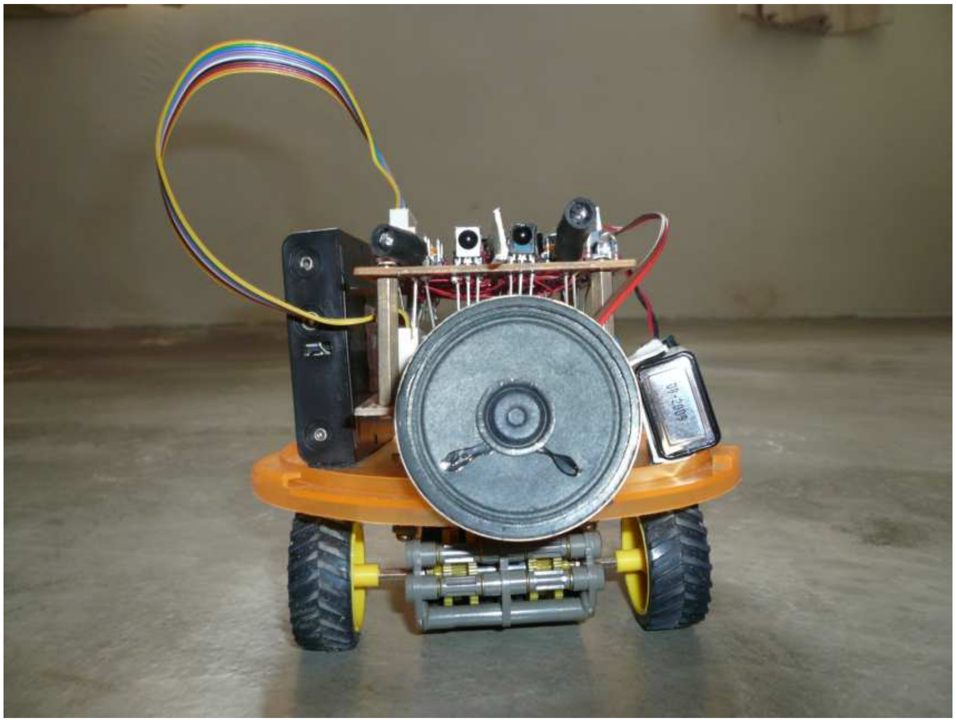


Photo C : Front view of the Autonomous robot

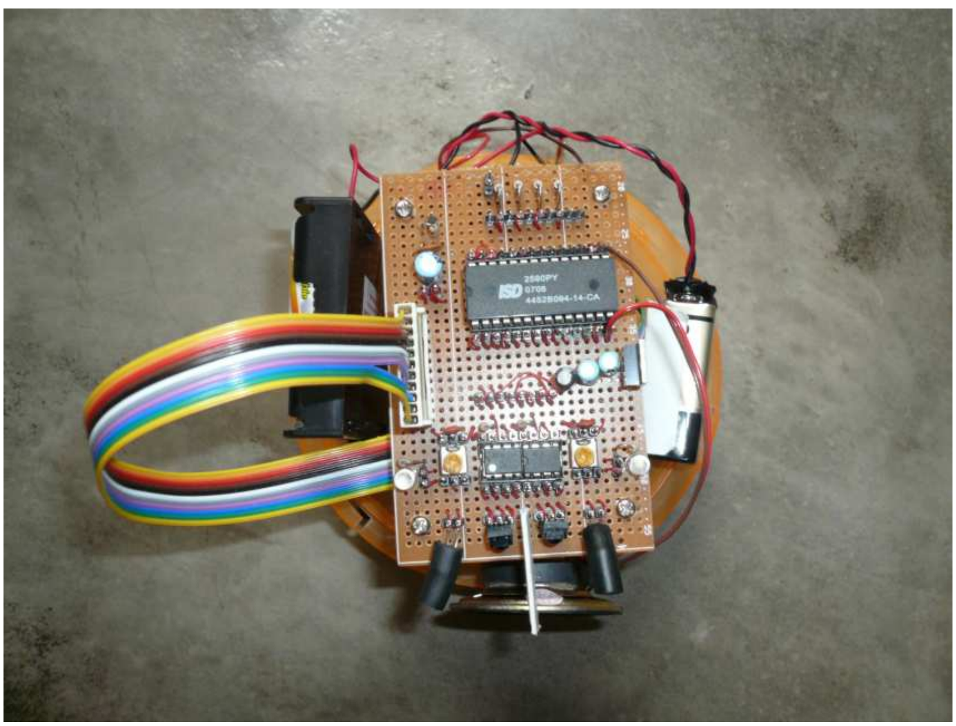


Photo D : Upper view of the Autonomous robot

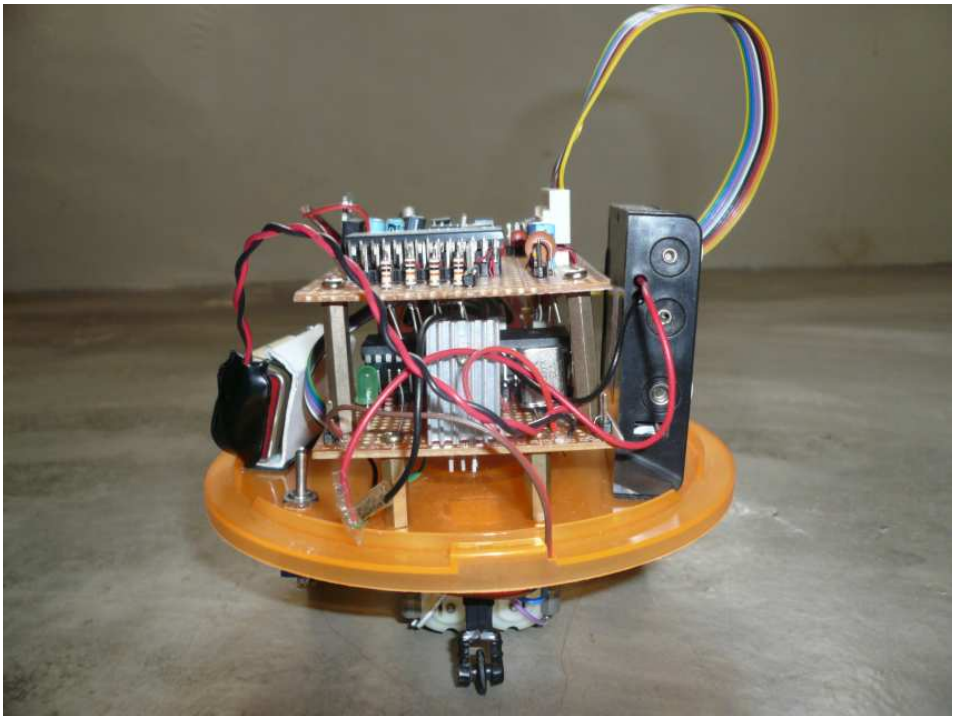


Photo E : Rear view of the Autonomous robot

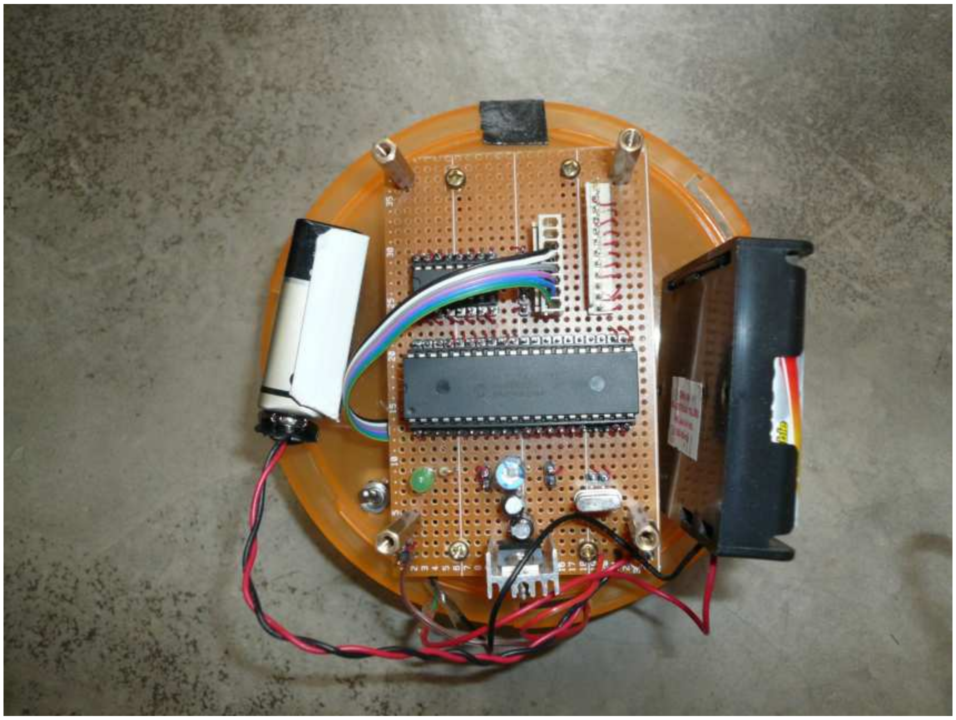


Photo F : Upper view of the controller board

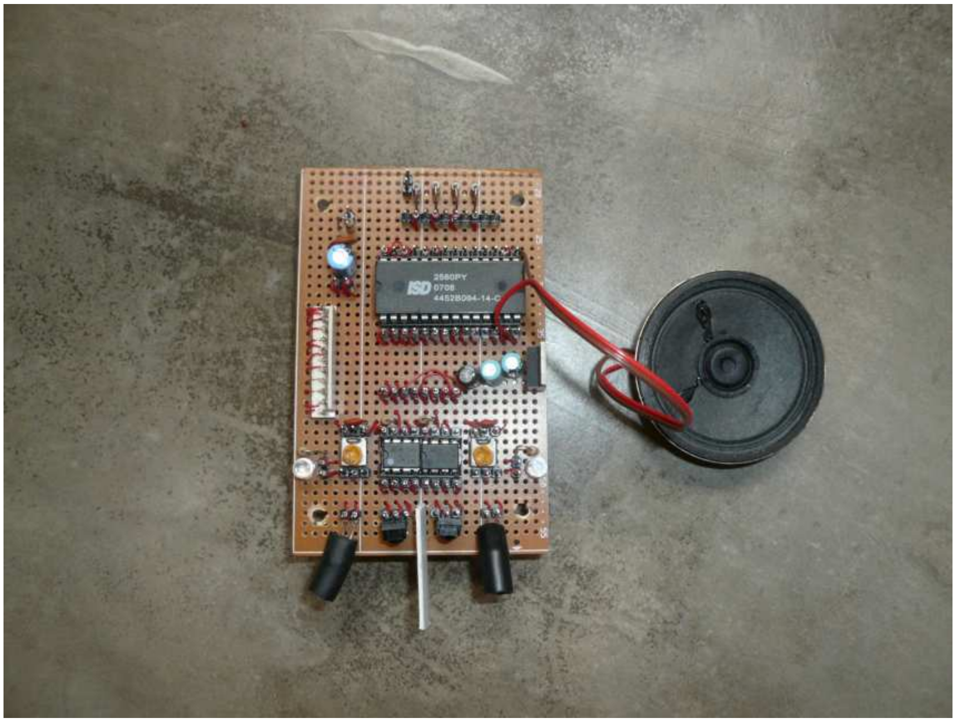


Photo G : Upper view of Infrared sensor and ISD 2560

Photo H : Bottom view of the Autonomous robot

APPENDIX C

Datasheets

PIC16F87XA
Data Sheet

28/40/44-Pin Enhanced Flash Microcontrollers

MICROCHIP

PIC16F87XA

28/40/44-Pin Enhanced Flash Microcontrollers

Devices Included in this Data Sheet:

- PIC16F873A
- PIC16F874A
- PIC16F876A
- PIC16F877A

High-Performance RISC CPU:

- Only 35 single-word instructions to learn
- All single-cycle instructions except for program branches, which are two-cycle
- Operating speed: DC – 20 MHz clock input
  DC – 200 ns instruction cycle
- Up to 8K x 14 words of Flash Program Memory, Up to 368 x 8 bytes of Data Memory (RAM), Up to 256 x 8 bytes of EEPROM Data Memory
- Pinout compatible to other 28-pin or 40/44-pin PIC16CXXX and PIC16FXXX microcontrollers

Peripheral Features:

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during Sleep via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- Synchronous Serial Port (SSP) with SPI™ (Master mode) and I^2C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) – 8 bits wide with external $\overline{RD}$, $\overline{WR}$ and $\overline{CS}$ controls (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)

Analog Features:

- 10-bit, up to 8-channel Analog-to-Digital Converter (A/D)
- Brown-out Reset (BOR)
- Analog Comparator module with:
  - Two analog comparators
  - Programmable on-chip voltage reference (V_{REF}) module
  - Programmable input multiplexing from device inputs and internal voltage reference
  - Comparator outputs are externally accessible

Special Microcontroller Features:

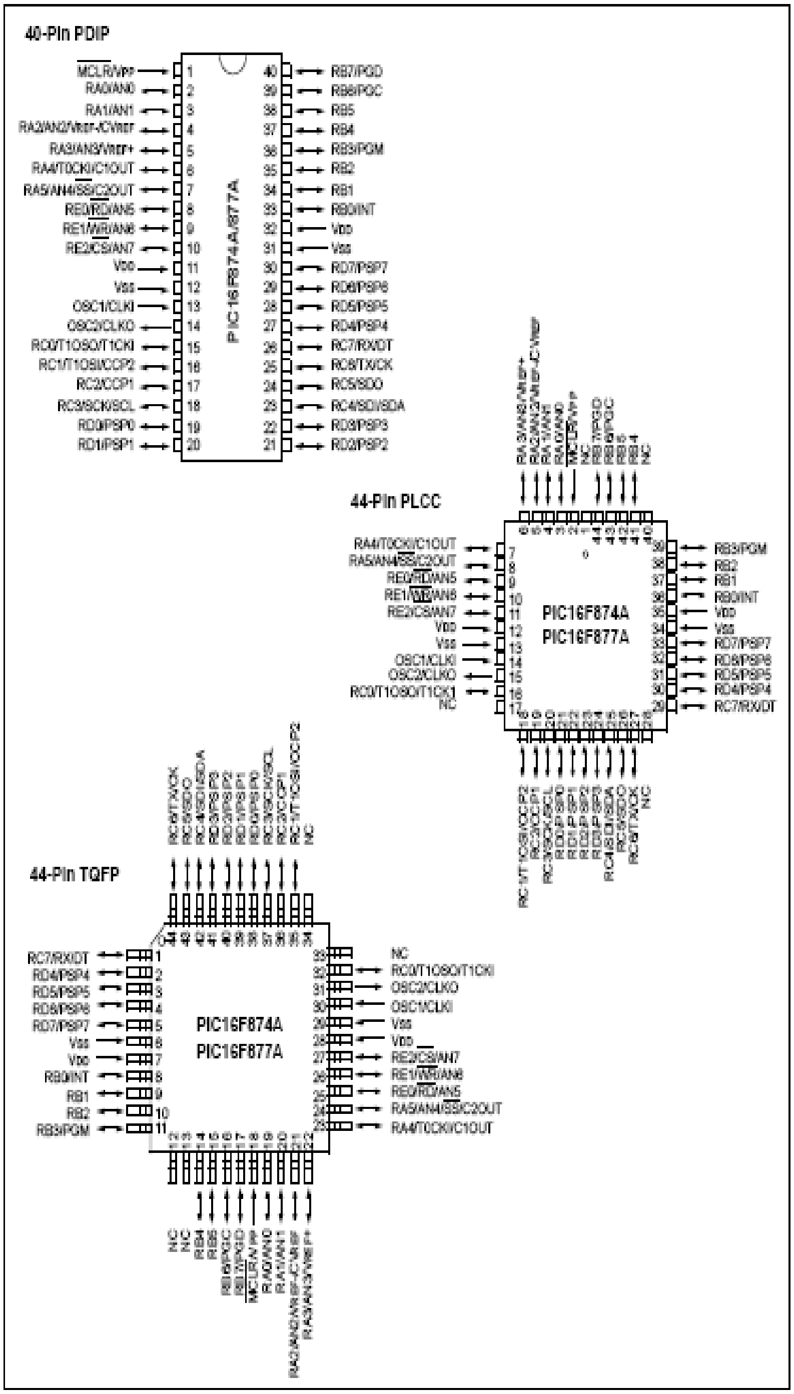
- 100,000 erase/write cycle Enhanced Flash program memory typical
- 1,000,000 erase/write cycle Data EEPROM memory typical
- Data EEPROM Retention > 40 years
- Self-reprogrammable under software control
- In-Circuit Serial Programming™ (ICSP™) via two pins
- Single-supply 5V In-Circuit Serial Programming
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving Sleep mode
- Selectable oscillator options
- In-Circuit Debug (ICD) via two pins

CMOS Technology:

- Low-power, high-speed Flash/EEPROM technology
- Fully static design
- Wide operating voltage range (2.0V to 5.5V)
- Commercial and Industrial temperature ranges
- Low-power consumption

Device	Program Memory		Data SRAM (Bytes)	EEPROM (Bytes)	I/O	10-bit A/D (ch)	CCP (PWM)	MSSP		USART	Timers 8/16-bit	Comparators
	Bytes	# Single Word Instructions						SPI	Master I^2C			
PIC16F873A	7.2K	4096	192	128	22	5	2	Yes	Yes	Yes	2/1	2
PIC16F874A	7.2K	4096	192	128	33	8	2	Yes	Yes	Yes	2/1	2
PIC16F876A	14.3K	8192	368	256	22	5	2	Yes	Yes	Yes	2/1	2
PIC16F877A	14.3K	8192	368	256	33	8	2	Yes	Yes	Yes	2/1	2

Pin Diagrams (Continued)



1.0 DEVICE OVERVIEW

This document contains device specific information about the following devices:

- PIC16F873A
- PIC16F874A
- PIC16F876A
- PIC16F877A

PIC16F873A/876A devices are available only in 28-pin packages, while PIC16F874A/877A devices are available in 40-pin and 44-pin packages. All devices in the PIC16F87XA family share common architecture with the following differences:

- The PIC16F873A and PIC16F874A have one-half of the total on-chip memory of the PIC16F876A and PIC16F877A
- The 28-pin devices have three I/O ports, while the 40/44-pin devices have five
- The 28-pin devices have fourteen interrupts, while the 40/44-pin devices have fifteen
- The 28-pin devices have five A/D input channels, while the 40/44-pin devices have eight
- The Parallel Slave Port is implemented only on the 40/44-pin devices

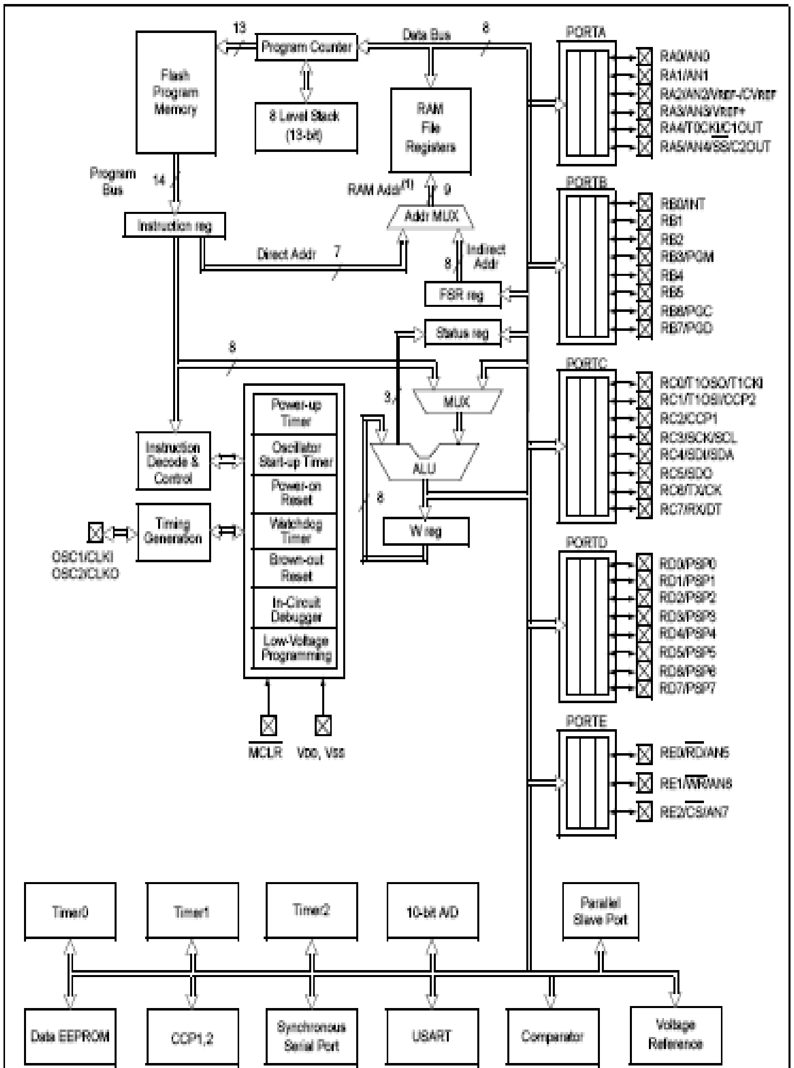
The available features are summarized in Table 1-1. Block diagrams of the PIC16F873A/876A and PIC16F874A/877A devices are provided in Figure 1-1 and Figure 1-2, respectively. The pinouts for these device families are listed in Table 1-2 and Table 1-3.

Additional information may be found in the PICmicro® Mid-Range Reference Manual (DS33023), which may be obtained from your local Microchip Sales Representative or downloaded from the Microchip web site. The Reference Manual should be considered a complementary document to this data sheet and is highly recommended reading for a better understanding of the device architecture and operation of the peripheral modules.

TABLE 1-1: PIC16F87XA DEVICE FEATURES

Key Features	PIC16F873A	PIC16F874A	PIC16F876A	PIC16F877A
Operating Frequency	DC – 20 MHz	DC – 20 MHz	DC – 20 MHz	DC – 20 MHz
Resets (and Delays)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)
Flash Program Memory (14-bit words)	4K	4K	8K	8K
Data Memory (bytes)	192	192	368	368
EEPROM Data Memory (bytes)	128	128	256	256
Interrupts	14	15	14	15
I/O Ports	Ports A, B, C	Ports A, B, C, D, E	Ports A, B, C	Ports A, B, C, D, E
Timers	3	3	3	3
Capture/Compare/PWM modules	2	2	2	2
Serial Communications	MSSP, USART	MSSP, USART	MSSP, USART	MSSP, USART
Parallel Communications	—	PSP	—	PSP
10-bit Analog-to-Digital Module	5 input channels	8 input channels	5 input channels	8 input channels
Analog Comparators	2	2	2	2
Instruction Set	35 Instructions	35 Instructions	35 Instructions	35 Instructions
Packages	28-pin PDIP 28-pin SOIC 28-pin SSOP 28-pin QFN	40-pin PDIP 44-pin PLCC 44-pin TQFP 44-pin QFN	28-pin PDIP 28-pin SOIC 28-pin SSOP 28-pin QFN	40-pin PDIP 44-pin PLCC 44-pin TQFP 44-pin QFN

FIGURE 1-2: PIC16F874A/877A BLOCK DIAGRAM



Device	Program Flash	Data Memory	Data EEPROM
PIC16F874A	4K words	192 Bytes	128 Bytes
PIC16F877A	8K words	368 Bytes	256 Bytes

Note 1: Higher order bits are from the Status register.

PIC16F87XA

TABLE 1-3: PIC16F874A/877A PINOUT DESCRIPTION

Pin Name	PDIP Pin#	PLCC Pin#	TQFP Pin#	QFN Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKI	13	14	30	32		ST/CMOS(4)	Oscillator crystal or external clock input.
OSC1					I		Oscillator crystal input or external clock source input. ST buffer when configured in RC mode; otherwise CMOS.
CLKI					I		External clock source input. Always associated with pin function OSC1 (see OSC1/CLKI, OSC2/CLKO pins).
OSC2/CLKO	14	15	31	33		—	Oscillator crystal or clock output.
OSC2					O		Oscillator crystal output. Connects to crystal or resonator in Crystal Oscillator mode.
CLKO					O		In RC mode, OSC2 pin outputs CLKO, which has 1/4 the frequency of OSC1 and denotes the instruction cycle rate.
MCLR/VPP	1	2	18	18		ST	Master Clear (input) or programming voltage (output).
MCLR					I		Master Clear (Reset) input. This pin is an active low Reset to the device.
VPP					P		Programming voltage input.
							PORTA is a bidirectional I/O port.
RA0/AN0	2	3	19	19		TTL	
RA0					I/O		Digital I/O.
AN0					I		Analog input 0.
RA1/AN1	3	4	20	20		TTL	
RA1					I/O		Digital I/O.
AN1					I		Analog input 1.
RA2/AN2/VREF-/CVREF	4	5	21	21		TTL	
RA2					I/O		Digital I/O.
AN2					I		Analog input 2.
VREF-					I		A/D reference voltage (Low) input.
CVREF					O		Comparator VREF output.
RA3/AN3/VREF+	5	6	22	22		TTL	
RA3					I/O		Digital I/O.
AN3					I		Analog input 3.
VREF+					I		A/D reference voltage (High) input.
RA4/T0CKI/C1OUT	6	7	23	23		ST	
RA4					I/O		Digital I/O – Open-drain when configured as output.
T0CKI					I		Timer0 external clock input.
C1OUT					O		Comparator 1 output.
RA5/AN4/SS/C2OUT	7	8	24	24		TTL	
RA5					I/O		Digital I/O.
AN4					I		Analog input 4.
SS					I		SPI slave select input.
C2OUT					O		Comparator 2 output.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

TABLE 1-3: PIC16F874A/877A PINOUT DESCRIPTION (CONTINUED)

Pin Name	PDIP Pin#	PLCC Pin#	TQFP Pin#	QFN Pin#	I/O/P Type	Buffer Type	Description
							PORTB is a bidirectional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	33	36	8	9		TTL/ST(1)	
RB0					I/O		Digital I/O.
INT					I		External interrupt.
RB1	34	37	9	10	I/O	TTL	Digital I/O.
RB2	35	38	10	11	I/O	TTL	Digital I/O.
RB3/PGM	36	39	11	12		TTL	
RB3					I/O		Digital I/O.
PGM					I		Low-voltage ICSP programming enable pin.
RB4	37	41	14	14	I/O	TTL	Digital I/O.
RB5	38	42	15	15	I/O	TTL	Digital I/O.
RB6/PGC	39	43	16	16		TTL/ST(2)	
RB6					I/O		Digital I/O.
PGC					I		In-circuit debugger and ICSP programming clock.
RB7/PGD	40	44	17	17		TTL/ST(2)	
RB7					I/O		Digital I/O.
PGD					I/O		In-circuit debugger and ICSP programming data.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

TABLE 1-3: PIC16F874A/877A PINOUT DESCRIPTION (CONTINUED)

Pin Name	PDIP Pin#	PLCC Pin#	TQFP Pin#	QFN Pin#	I/O/P Type	Buffer Type	Description
							PORTC is a bidirectional I/O port.
RC0/T1OSO/T1CKI	15	16	32	34		ST	
RC0					I/O		Digital I/O.
T1OSO					O		Timer1 oscillator output.
T1CKI					I		Timer1 external clock input.
RC1/T1OSI/CCP2	16	18	35	35		ST	
RC1					I/O		Digital I/O.
T1OSI					I		Timer1 oscillator input.
CCP2					I/O		Capture2 input, Compare2 output, PWM2 output.
RC2/CCP1	17	19	36	36		ST	
RC2					I/O		Digital I/O.
CCP1					I/O		Capture1 input, Compare1 output, PWM1 output.
RC3/SCK/SCL	18	20	37	37		ST	
RC3					I/O		Digital I/O.
SCK					I/O		Synchronous serial clock input/output for SPI mode.
SCL					I/O		Synchronous serial clock input/output for I²C mode.
RC4/SDI/SDA	23	25	42	42		ST	
RC4					I/O		Digital I/O.
SDI					I		SPI data in.
SDA					I/O		I²C data I/O.
RC5/SDO	24	26	43	43		ST	
RC5					I/O		Digital I/O.
SDO					O		SPI data out.
RC6/TX/CK	25	27	44	44		ST	
RC6					I/O		Digital I/O.
TX					O		USART asynchronous transmit.
CK					I/O		USART1 synchronous clock.
RC7/RX/DT	26	29	1	1		ST	
RC7					I/O		Digital I/O.
RX					I		USART asynchronous receive.
DT					I/O		USART synchronous data.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

TABLE 1-3: PIC16F874A/877A PINOUT DESCRIPTION (CONTINUED)

Pin Name	PDIP Pin#	PLCC Pin#	TQFP Pin#	QFN Pin#	I/O/P Type	Buffer Type	Description
							PORTD is a bidirectional I/O port or Parallel Slave Port when interfacing to a microprocessor bus.
RD0/PSP0	19	21	38	38		ST/TTL(3)	
RD0					I/O		Digital I/O.
PSP0					I/O		Parallel Slave Port data.
RD1/PSP1	20	22	39	39		ST/TTL(3)	
RD1					I/O		Digital I/O.
PSP1					I/O		Parallel Slave Port data.
RD2/PSP2	21	23	40	40		ST/TTL(3)	
RD2					I/O		Digital I/O.
PSP2					I/O		Parallel Slave Port data.
RD3/PSP3	22	24	41	41		ST/TTL(3)	
RD3					I/O		Digital I/O.
PSP3					I/O		Parallel Slave Port data.
RD4/PSP4	27	30	2	2		ST/TTL(3)	
RD4					I/O		Digital I/O.
PSP4					I/O		Parallel Slave Port data.
RD5/PSP5	28	31	3	3		ST/TTL(3)	
RD5					I/O		Digital I/O.
PSP5					I/O		Parallel Slave Port data.
RD6/PSP6	29	32	4	4		ST/TTL(3)	
RD6					I/O		Digital I/O.
PSP6					I/O		Parallel Slave Port data.
RD7/PSP7	30	33	5	5		ST/TTL(3)	
RD7					I/O		Digital I/O.
PSP7					I/O		Parallel Slave Port data.
							PORTE is a bidirectional I/O port.
RE0/$\overline{RD}$/AN5	8	9	25	25		ST/TTL(3)	
RE0					I/O		Digital I/O.
$\overline{RD}$					I		Read control for Parallel Slave Port.
AN5					I		Analog input 5.
RE1/$\overline{WR}$/AN6	9	10	26	26		ST/TTL(3)	
RE1					I/O		Digital I/O.
$\overline{WR}$					I		Write control for Parallel Slave Port.
AN6					I		Analog input 6.
RE2/$\overline{CS}$/AN7	10	11	27	27		ST/TTL(3)	
RE2					I/O		Digital I/O.
$\overline{CS}$					I		Chip select control for Parallel Slave Port.
AN7					I		Analog input 7.
VSS	12, 31	13, 34	6, 29	6, 30, 31	P	—	Ground reference for logic and I/O pins.
VDD	11, 32	12, 35	7, 28	7, 8, 28, 29	P	—	Positive supply for logic and I/O pins.
NC	—	1, 17, 28, 40	12,13, 33, 34	13	—	—	These pins are not internally connected. These pins should be left unconnected.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

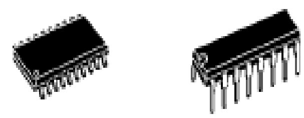
Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

SGS-THOMSON MICROELECTRONICS

L293D
L293DD

PUSH-PULL FOUR CHANNEL DRIVER WITH DIODES

- 600mA OUTPUT CURRENT CAPABILITY PER CHANNEL
- 1.2A PEAK OUTPUT CURRENT (non repetitive) PER CHANNEL
- ENABLE FACILITY
- OVERTEMPERATURE PROTECTION
- LOGICAL "0" INPUT VOLTAGE UP TO 1.5 V (HIGH NOISE IMMUNITY)
- INTERNAL CLAMP DIODES



SO(12+4+4) **Powerdip (12+2+2)**

ORDERING NUMBERS:

L293DD L293D

DESCRIPTION

The Device is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoides, DC and stepping motors) and switching power transistors.

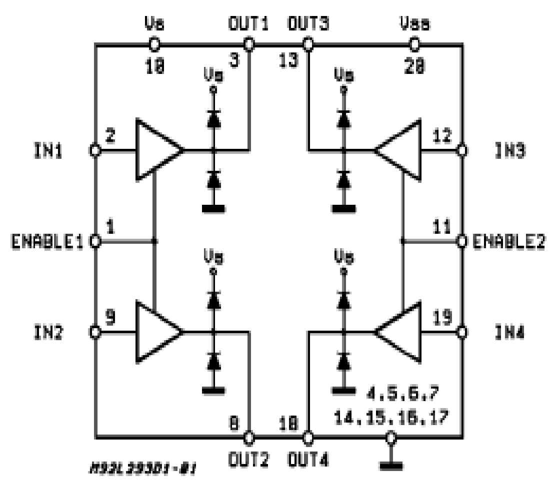
To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and internal clamp diodes are included.

This device is suitable for use in switching applications at frequencies up to 5 kHz.

The L293D is assembled in a 16 lead plastic packaage which has 4 center pins connected together and used for heatsinking

The L293DD is assembled in a 20 lead surface mount which has 8 center pins connected together and used for heatsinking.

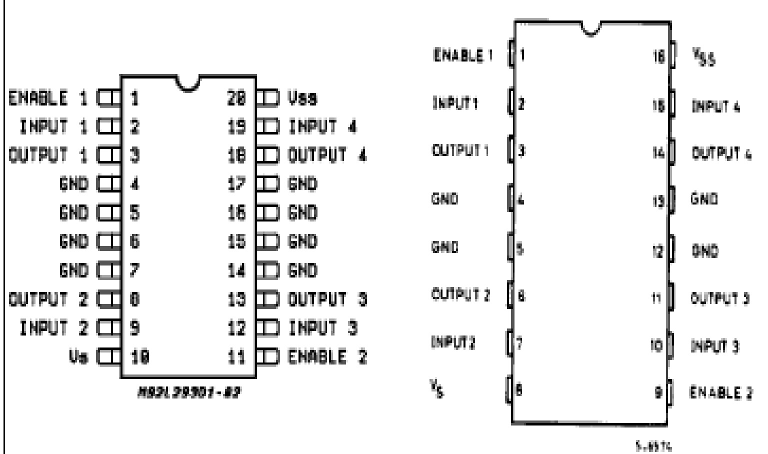
BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_S	Supply Voltage	36	V
V_{SS}	Logic Supply Voltage	36	V
V_i	Input Voltage	7	V
V_{en}	Enable Voltage	7	V
I_o	Peak Output Current (100 μs non repetitive)	1.2	A
P_{tot}	Total Power Dissipation at T_{pins} = 90 °C	4	W
T_{stg}, T_j	Storage and Junction Temperature	– 40 to 150	°C

PIN CONNECTIONS (Top view)



SO(12+4+4)   Powerdip(12+2+2)

THERMAL DATA

Symbol	Decription		DIP	SO	Unit
$R_{th\ j-pins}$	Thermal Resistance Junction-pins	max.	–	14	°C/W
$R_{th\ j-amb}$	Thermal Resistance junction-ambient	max.	80	50 (*)	°C/W
$R_{th\ j-case}$	Thermal Resistance Junction-case	max.	14	–	

(*) With 6sq. cm on board heatsink.

ELECTRICAL CHARACTERISTICS (for each channel, Vs = 24 V, Vss = 5 V, T_{amb} = 25 °C, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_S	Supply Voltage (pin 10)		V_{SS}		36	V
V_{SS}	Logic Supply Voltage (pin 20)		4.5		36	V
I_S	Total Quiescent Supply Current (pin 10)	V_i = L ; I_O = 0 ; V_{en} = H		2	6	mA
		V_i = H ; I_O = 0 ; V_{en} = H		16	24	mA
		V_{en} = L			4	mA
I_{SS}	Total Quiescent Logic Supply Current (pin 20)	V_i = L ; I_O = 0 ; V_{en} = H		44	60	mA
		V_i = H ; I_O = 0 ; V_{en} = H		16	22	mA
		V_{en} = L		16	24	mA
V_{IL}	Input Low Voltage (pin 2, 9, 12, 19)		– 0.3		1.5	V
V_{IH}	Input High Voltage (pin 2, 9, 12, 19)	$V_{SS} \le 7$ V	2.3		V_{SS}	V
		$V_{SS} > 7$ V	2.3		7	V
I_{IL}	Low Voltage Input Current (pin 2, 9, 12, 19)	V_{IL} = 1.5 V			– 10	μA
I_{IH}	High Voltage Input Current (pin 2, 9, 12, 19)	2.3 V ≤ V_{IH} ≤ V_{SS} – 0.6 V		30	100	μA
$V_{en\,L}$	Enable Low Voltage (pin 1, 11)		– 0.3		1.5	V
$V_{en\,H}$	Enable High Voltage (pin 1, 11)	$V_{SS} \le 7$ V	2.3		V_{SS}	V
		$V_{SS} > 7$ V	2.3		7	V
$I_{en\,L}$	Low Voltage Enable Current (pin 1, 11)	$V_{en\,L}$ = 1.5 V		– 30	– 100	μA
$I_{en\,H}$	High Voltage Enable Current (pin 1, 11)	2.3 V ≤ $V_{en\,H}$ ≤ V_{SS} – 0.6 V			± 10	μA
$V_{CE(sat)H}$	Source Output Saturation Voltage (pins 3, 8, 13, 18)	I_O = – 0.6 A		1.4	1.8	V
$V_{CE(sat)L}$	Sink Output Saturation Voltage (pins 3, 8, 13, 18)	I_O = + 0.6 A		1.2	1.8	V
V_F	Clamp Diode Forward Voltage	I_O = 600nA		1.3		V
t_r	Rise Time (*)	0.1 to 0.9 V_O		250		ns
t_f	Fall Time (*)	0.9 to 0.1 V_O		250		ns
t_{on}	Turn-on Delay (*)	0.5 V_i to 0.5 V_O		750		ns
t_{off}	Turn-off Delay (*)	0.5 V_i to 0.5 V_O		200		ns

(*) See fig. 1.

Winbond Electronics Corp.

ISD2560/75/90/120

SINGLE-CHIP, MULTIPLE-MESSAGES,

VOICE RECORD/PLAYBACK DEVICE

60-, 75-, 90-, AND 120-SECOND DURATION

Publication Release Date: May 2003

Revision 1.0

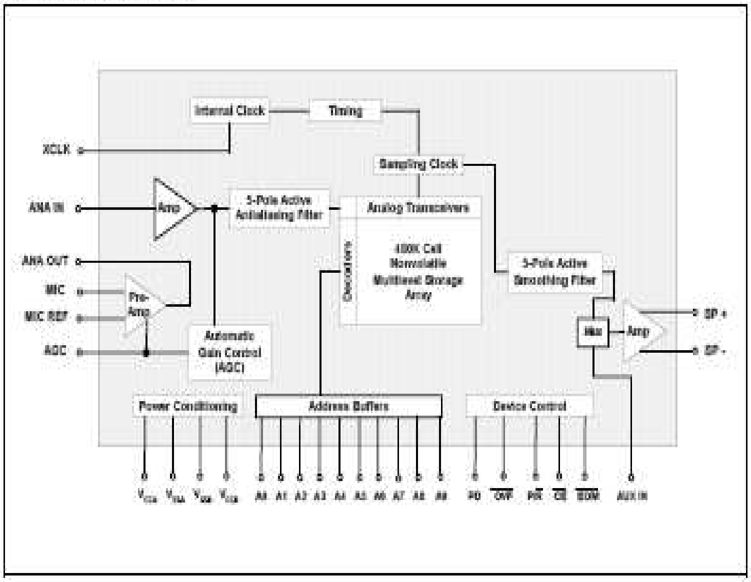
1. GENERAL DESCRIPTION

Winbond's ISD2500 ChipCorder® Series provide high-quality, single-chip, Record/Playback solutions for 60- to 120-second messaging applications. The CMOS devices include an on-chip oscillator, microphone preamplifier, automatic gain control, antialiasing filter, smoothing filter, speaker amplifier, and high density multi-level storage array. In addition, the ISD2500 is microcontroller compatible, allowing complex messaging and addressing to be achieved. Recordings are stored into on-chip nonvolatile memory cells, providing zero-power message storage. This unique, single-chip solution is made possible through Winbond's patented multilevel storage technology. Voice and audio signals are stored directly into memory in their natural form, providing high-quality, solid-state voice reproduction.

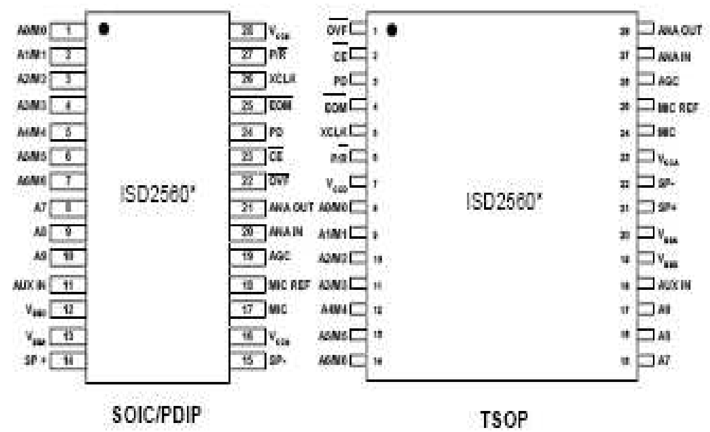
2. FEATURES

- Easy-to-use single-chip, voice record/playback solution
- High-quality, natural voice/audio reproduction
- Single-chip with duration of 60, 75, 90, or 120 seconds.
- Manual switch or microcontroller compatible
- Playback can be edge- or level-activated
- Directly cascadable for longer durations
- Automatic power-down (push-button mode)
  - Standby current 1 µA (typical)
- Zero-power message storage
  - Eliminates battery backup circuits
- Fully addressable to handle multiple messages
- 100-year message retention (typical)
- 100,000 record cycles (typical)
- On-chip clock source
- Programmer support for play-only applications
- Single +5 volt power supply
- Available in die form, PDIP, SOIC and TSOP packaging
- Temperature = die (0°C to +50°C) and package (0°C to +70°C)

3. BLOCK DIAGRAM



5. PIN CONFIGURATION



* Same pinouts for ISD2575 / 2590 / 25120 products

6. PIN DESCRIPTION

PIN NAME	PIN NO.		FUNCTION
	SOIC/ PDIP	TSOP	
Ax/Mx	1-10/ 1-7	8-17/ 8-14	**Address/Mode Inputs:** The Address/Mode Inputs have two functions depending on the level of the two Most Significant Bits (MSB) of the address pins (A8 and A9). If either or both of the two MSBs are LOW, the inputs are all interpreted as address bits and are used as the start address for the current record or playback cycle. The address pins are inputs only and do not output any internal address information during the operation. Address inputs are latched by the falling edge of $\overline{CE}$. If both MSBs are HIGH, the Address/Mode inputs are interpreted as Mode bits according to the Operational Mode table on page 12. There are six operational modes (M0…M6) available as indicated in the table. It is possible to use multiple operational modes simultaneously. Operational Modes are sampled on each falling edge of $\overline{CE}$, and thus Operational Modes and direct addressing are mutually exclusive.
AUX IN	11	18	**Auxiliary Input:** The Auxiliary Input is multiplexed through to the output amplifier and speaker output pins when $\overline{CE}$ is HIGH, P/$\overline{R}$ is HIGH, and playback is currently not active or if the device is in playback overflow. When cascading multiple ISD2500 devices, the AUX IN pin is used to connect a playback signal from a following device to the previous output speaker drivers. For noise considerations, it is suggested that the auxiliary input not be driven when the storage array is active.
V_{SSA}, V_{SSD}	13, 12	20, 19	**Ground:** The ISD2500 series of devices utilizes separate analog and digital ground busses. These pins should be connected separately through a low-impedance path to power supply ground.
SP+/SP-	14/15	21/22	**Speaker Outputs:** All devices in the ISD2500 series include an on-chip differential speaker driver, capable of driving 50 mW into 16 Ω from AUX IN (12.2mW from memory). [1] The speaker outputs are held at V_{SSA} levels during record and power down. It is therefore not possible to parallel speaker outputs of multiple ISD2500 devices or the outputs of other speaker drivers. [2] A single-end output may be used (including a coupling capacitor between the SP pin and the speaker). These outputs may be used individually with the output signal taken from either pin. However, the use of single-end output results in a 1 to 4 reduction in its output power.

[1] Connection of speaker outputs in parallel may cause damage to the device.
[2] Never ground or drive an unused speaker output.

PIN NAME	PIN NO.		FUNCTION
	SOIC/ PDIP	TSOP	
V_{CCA}, V_{CCD}	16, 28	23, 7	**Supply Voltage**: To minimize noise, the analog and digital circuits in the ISD2500 series devices use separate power busses. These voltage busses are brought out to separate pins and should be tied together as close to the supply as possible. In addition, these supplies should be decoupled as close to the package as possible.
MIC	17	24	**Microphone**: The microphone pin transfers input signal to the on-chip preamplifier. A built-in Automatic Gain Control (AGC) circuit controls the gain of this preamplifier from –15 to 24dB. An external microphone should be AC coupled to this pin via a series capacitor. The capacitor value, together with the internal 10 KΩ resistance on this pin, determines the low-frequency cutoff for the ISD2500 series passband. See Winbond's Application Information for additional information on low-frequency cutoff calculation.
MIC REF	18	25	**Microphone Reference**: The MIC REF input is the inverting input to the microphone preamplifier. This provides a noise-canceling or common-mode rejection input to the device when connected to a differential microphone.
AGC	19	26	**Automatic Gain Control**: The AGC dynamically adjusts the gain of the preamplifier to compensate for the wide range of microphone input levels. The AGC allows the full range of whispers to loud sounds to be recorded with minimal distortion. The "attack" time is determined by the time constant of a 5 KΩ internal resistance and an external capacitor (C2 on the schematic of Figure 5 in section 11) connected from the AGC pin to V_{SSA} analog ground. The "release" time is determined by the time constant of an external resistor (R2) and an external capacitor (C2) connected in parallel between the AGC pin and V_{SSA} analog ground. Nominal values of 470 KΩ and 4.7 µF give satisfactory results in most cases.
ANA IN	20	27	**Analog Input**: The analog input transfers analog signal to the chip for recording. For microphone inputs, the ANA OUT pin should be connected via an external capacitor to the ANA IN pin. This capacitor value, together with the 3.0 KΩ input impedance of ANA IN, is selected to give additional cutoff at the low-frequency end of the voice passband. If the desired input is derived from a source other than a microphone, the signal can be fed, capacitively coupled, into the ANA IN pin directly.
ANA OUT	21	28	**Analog Output**: This pin provides the preamplifier output to the user. The voltage gain of the preamplifier is determined by the voltage level at the AGC pin.

PIN NAME	PIN NO.		FUNCTION
	SOIC/ PDIP	TSOP	
$\overline{OVF}$	22	1	**Overflow:** This signal pulses LOW at the end of memory array, indicating the device has been filled and the message has overflowed. The $\overline{OVF}$ output then follows the $\overline{CE}$ input until a PD pulse has reset the device. This pin can be used to cascade several ISD2500 devices together to increase record/playback durations.
$\overline{CE}$	23	2	**Chip Enable:** The $\overline{CE}$ input pin is taken LOW to enable all playback and record operations. The address pins and playback/record pin ($P/\overline{R}$) are latched by the falling edge of $\overline{CE}$. $\overline{CE}$ has additional functionality in the M6 (Push-Button) Operational Mode as described in the Operational Mode section.
PD	24	3	**Power Down:** When neither record nor playback operation, the PD pin should be pulled HIGH to place the part in standby mode (see I_{SB} specification). When overflow ($\overline{OVF}$) pulses LOW for an overflow condition, PD should be brought HIGH to reset the address pointer back to the beginning of the memory array. The PD pin has additional functionality in the M6 (Push-Button) Operation Mode as described in the Operational Mode section.
$\overline{EOM}$	25	4	**End-Of-Message:** A nonvolatile marker is automatically inserted at the end of each recorded message. It remains there until the message is recorded over. The $\overline{EOM}$ output pulses LOW for a period of T_{EOM} at the end of each message. In addition, the ISD2500 series has an internal V_{CC} detect circuit to maintain message integrity should V_{CC} fall below 3.5V. In this case, $\overline{EOM}$ goes LOW and the device is fixed in Playback-only mode. When the device is configured in Operational Mode M6 (Push-Button Mode), this pin provides an active-HIGH signal, indicating the device is currently recording or playing. This signal can conveniently drive an LED for visual indicator of a record or playback operation in process.

<table>
<tr><th rowspan="2">PIN NAME</th><th colspan="2">PIN NO.</th><th rowspan="2">FUNCTION</th></tr>
<tr><th>SOIC/ PDIP</th><th>TSOP</th></tr>
<tr><td>XCLK</td><td>26</td><td>5</td><td>External Clock: The external clock input has an internal pull-down device. The device is configured at the factory with an internal sampling clock frequency centered to ±1 percent of specification. The frequency is then maintained to a variation of ±2.25 percent over the entire commercial temperature and operating voltage ranges. If greater precision is required, the device can be clocked through the XCLK pin as follows:
<table>
<tr><th>Part Number</th><th>Sample Rate</th><th>Required Clock</th></tr>
<tr><td>ISD2560</td><td>8.0 kHz</td><td>1024 kHz</td></tr>
<tr><td>ISD2575</td><td>6.4 kHz</td><td>819.2 kHz</td></tr>
<tr><td>ISD2590</td><td>5.3 kHz</td><td>682.7 kHz</td></tr>
<tr><td>ISD25120</td><td>4.0 kHz</td><td>512 kHz</td></tr>
</table>
These recommended clock rates should not be varied because the antialiasing and smoothing filters are fixed, and aliasing problems can occur if the sample rate differs from the one recommended. The duty cycle on the input clock is not critical, as the clock is immediately divided by two. If the XCLK is not used, this input must be connected to ground.</td></tr>
<tr><td>P/$\overline{R}$</td><td>27</td><td>6</td><td>Playback/Record: The P/$\overline{R}$ input pin is latched by the falling edge of the $\overline{CE}$ pin. A HIGH level selects a playback cycle while a LOW level selects a record cycle. For a record cycle, the address pins provide the starting address and recording continues until PD or $\overline{CE}$ is pulled HIGH or an overflow is detected (i.e. the chip is full). When a record cycle is terminated by pulling PD or $\overline{CE}$ HIGH, then End-Of-Message ($\overline{EOM}$) marker is stored at the current address in memory. For a playback cycle, the address inputs provide the starting address and the device will play until an $\overline{EOM}$ marker is encountered. The device can continue to pass an $\overline{EOM}$ marker if $\overline{CE}$ is held LOW in address mode, or in an Operational Mode. (See Operational Modes section)</td></tr>
</table>

ISD®

ChipCorder®
TECHNOLOGY BY ISD

APPLICATION INFORMATION FOR ALL ISD ChipCorder PRODUCTS

Address Segment Resolution

	Address Inputs											Sample Rates							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
												1016A 1416 2532	1110 1210 1020A 1420 2540	1212 2548	2564	33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
0	0	0	0	0	0	0	0	0	0	0	0 0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	1	0 1	0.1	0.125	0.15	0.2	0.15	0.1875	0.225	0.3
2	0	0	0	0	0	0	0	0	1	0	0 2	0.2	0.25	0.3	0.4	0.3	0.375	0.45	0.6
3	0	0	0	0	0	0	0	0	1	1	0 3	0.3	0.375	0.45	0.6	0.45	0.5625	0.675	0.9
4	0	0	0	0	0	0	0	1	0	0	0 4	0.4	0.5	0.6	0.8	0.6	0.75	0.9	1.2
5	0	0	0	0	0	0	0	1	0	1	0 5	0.5	0.625	0.75	1	0.75	0.9375	1.125	1.5
6	0	0	0	0	0	0	0	1	1	0	0 6	0.6	0.75	0.9	1.2	0.9	1.125	1.35	1.8
7	0	0	0	0	0	0	0	1	1	1	0 7	0.7	0.875	1.05	1.4	1.05	1.3125	1.575	2.1
8	0	0	0	0	0	0	1	0	0	0	0 8	0.8	1	1.2	1.6	1.2	1.5	1.8	2.4
9	0	0	0	0	0	0	1	0	0	1	0 9	0.9	1.125	1.35	1.8	1.35	1.6875	2.025	2.7
10	0	0	0	0	0	0	1	0	1	0	0 A	1	1.25	1.5	2	1.5	1.875	2.25	3
11	0	0	0	0	0	0	1	0	1	1	0 B	1.1	1.375	1.65	2.2	1.65	2.0625	2.475	3.3
12	0	0	0	0	0	0	1	1	0	0	0 C	1.2	1.5	1.8	2.4	1.8	2.25	2.7	3.6
13	0	0	0	0	0	0	1	1	0	1	0 D	1.3	1.625	1.95	2.6	1.95	2.4375	2.925	3.9
14	0	0	0	0	0	0	1	1	1	0	0 E	1.4	1.75	2.1	2.8	2.1	2.625	3.15	4.2
15	0	0	0	0	0	0	1	1	1	1	0 F	1.5	1.875	2.25	3	2.25	2.8125	3.375	4.5
16	0	0	0	0	0	1	0	0	0	0	1 0	1.6	2	2.4	3.2	2.4	3	3.6	4.8
17	0	0	0	0	0	1	0	0	0	1	1 1	1.7	2.125	2.55	3.4	2.55	3.1875	3.825	5.1
18	0	0	0	0	0	1	0	0	1	0	1 2	1.8	2.25	2.7	3.6	2.7	3.375	4.05	5.4
19	0	0	0	0	0	1	0	0	1	1	1 3	1.9	2.375	2.85	3.8	2.85	3.5625	4.275	5.7
20	0	0	0	0	0	1	0	1	0	0	1 4	2	2.5	3	4	3	3.75	4.5	6
21	0	0	0	0	0	1	0	1	0	1	1 5	2.1	2.625	3.15	4.2	3.15	3.9375	4.725	6.3
22	0	0	0	0	0	1	0	1	1	0	1 6	2.2	2.75	3.3	4.4	3.3	4.125	4.95	6.6
23	0	0	0	0	0	1	0	1	1	1	1 7	2.3	2.875	3.45	4.6	3.45	4.3125	5.175	6.9

	Address Inputs											Sample Rates							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
												1016A 1416 2532 2560	1110 1210 1020A 1420 2540 2575	1212 2548 2590	2564 25120	33060 33120	33075 33150	33090 33180	33120-4 33240
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0									
24	0	0	0	0	0	1	1	0	0	0	1 8	2.4	3	3.6	4.8	3.6	4.5	5.4	7.2
25	0	0	0	0	0	1	1	0	0	1	1 9	2.5	3.125	3.75	5	3.75	4.6875	5.625	7.5
26	0	0	0	0	0	1	1	0	1	0	1 A	2.6	3.25	3.9	5.2	3.9	4.875	5.85	7.8
27	0	0	0	0	0	1	1	0	1	1	1 B	2.7	3.375	4.05	5.4	4.05	5.0625	6.075	8.1
28	0	0	0	0	0	1	1	1	0	0	1 C	2.8	3.5	4.2	5.6	4.2	5.25	6.3	8.4
29	0	0	0	0	0	1	1	1	0	1	1 D	2.9	3.625	4.35	5.8	4.35	5.4375	6.525	8.7
30	0	0	0	0	0	1	1	1	1	0	1 E	3	3.75	4.5	6	4.5	5.625	6.75	9
31	0	0	0	0	0	1	1	1	1	1	1 F	3.1	3.875	4.65	6.2	4.65	5.8125	6.975	9.3
32	0	0	0	0	1	0	0	0	0	0	2 0	3.2	4	4.8	6.4	4.8	6	7.2	9.6
33	0	0	0	0	1	0	0	0	0	1	2 1	3.3	4.125	4.95	6.6	4.95	6.1875	7.425	9.9
34	0	0	0	0	1	0	0	0	1	0	2 2	3.4	4.25	5.1	6.8	5.1	6.375	7.65	10.2
35	0	0	0	0	1	0	0	0	1	1	2 3	3.5	4.375	5.25	7	5.25	6.5625	7.875	10.5
36	0	0	0	0	1	0	0	1	0	0	2 4	3.6	4.5	5.4	7.2	5.4	6.75	8.1	10.8
37	0	0	0	0	1	0	0	1	0	1	2 5	3.7	4.625	5.55	7.4	5.55	6.9375	8.325	11.1
38	0	0	0	0	1	0	0	1	1	0	2 6	3.8	4.75	5.7	7.6	5.7	7.125	8.55	11.4
39	0	0	0	0	1	0	0	1	1	1	2 7	3.9	4.875	5.85	7.8	5.85	7.3125	8.775	11.7
40	0	0	0	0	1	0	1	0	0	0	2 8	4	5	6	8	6	7.5	9	12
41	0	0	0	0	1	0	1	0	0	1	2 9	4.1	5.125	6.15	8.2	6.15	7.6875	9.225	12.3
42	0	0	0	0	1	0	1	0	1	0	2 A	4.2	5.25	6.3	8.4	6.3	7.875	9.45	12.6
43	0	0	0	0	1	0	1	0	1	1	2 B	4.3	5.375	6.45	8.6	6.45	8.0625	9.675	12.9
44	0	0	0	0	1	0	1	1	0	0	2 C	4.4	5.5	6.6	8.8	6.6	8.25	9.9	13.2
45	0	0	0	0	1	0	1	1	0	1	2 D	4.5	5.625	6.75	9	6.75	8.4375	10.125	13.5
46	0	0	0	0	1	0	1	1	1	0	2 E	4.6	5.75	6.9	9.2	6.9	8.625	10.35	13.8
47	0	0	0	0	1	0	1	1	1	1	2 F	4.7	5.875	7.05	9.4	7.05	8.8125	10.575	14.1
48	0	0	0	0	1	1	0	0	0	0	3 0	4.8	6	7.2	9.6	7.2	9	10.8	14.4
49	0	0	0	0	1	1	0	0	0	1	3 1	4.9	6.125	7.35	9.8	7.35	9.1875	11.025	14.7
50	0	0	0	0	1	1	0	0	1	0	3 2	5	6.25	7.5	10	7.5	9.375	11.25	15
51	0	0	0	0	1	1	0	0	1	1	3 3	5.1	6.375	7.65	10.2	7.65	9.5625	11.475	15.3
52	0	0	0	0	1	1	0	1	0	0	3 4	5.2	6.5	7.8	10.4	7.8	9.75	11.7	15.6
53	0	0	0	0	1	1	0	1	0	1	3 5	5.3	6.625	7.95	10.6	7.95	9.9375	11.925	15.9
54	0	0	0	0	1	1	0	1	1	0	3 6	5.4	6.75	8.1	10.8	8.1	10.125	12.15	16.2
55	0	0	0	0	1	1	0	1	1	1	3 7	5.5	6.875	8.25	11	8.25	10.3125	12.375	16.5
56	0	0	0	0	1	1	1	0	0	0	3 8	5.6	7	8.4	11.2	8.4	10.5	12.6	16.8
57	0	0	0	0	1	1	1	0	0	1	3 9	5.7	7.125	8.55	11.4	8.55	10.6875	12.825	17.1
58	0	0	0	0	1	1	1	0	1	0	3 A	5.8	7.25	8.7	11.6	8.7	10.875	13.05	17.4
59	0	0	0	0	1	1	1	0	1	1	3 B	5.9	7.375	8.85	11.8	8.85	11.0625	13.275	17.7
60	0	0	0	0	1	1	1	1	0	0	3 C	6	7.5	9	12	9	11.25	13.5	18

	Address Inputs											Sample Rates							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
												1016A 1416 2532 2560	1110 1210 1020A 1420 2540 2575	1212 2548 2590	2564 25120	33060 33120	33075 33150	33090 33180	33120-4 33240
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0									
61	0	0	0	0	1	1	1	1	0	1	3 D	6.1	7.625	9.15	12.2	9.15	11.4375	13.725	18.3
62	0	0	0	0	1	1	1	1	1	0	3 E	6.2	7.75	9.3	12.4	9.3	11.625	13.95	18.6
63	0	0	0	0	1	1	1	1	1	1	3 F	6.3	7.875	9.45	12.6	9.45	11.8125	14.175	18.9
64	0	0	0	1	0	0	0	0	0	0	4 0	6.4	8	9.6	12.8	9.6	12	14.4	19.2
65	0	0	0	1	0	0	0	0	0	1	4 1	6.5	8.125	9.75	13	9.75	12.1875	14.625	19.5
66	0	0	0	1	0	0	0	0	1	0	4 2	6.6	8.25	9.9	13.2	9.9	12.375	14.85	19.8
67	0	0	0	1	0	0	0	0	1	1	4 3	6.7	8.375	10.05	13.4	10.05	12.5625	15.075	20.1
68	0	0	0	1	0	0	0	1	0	0	4 4	6.8	8.5	10.2	13.6	10.2	12.75	15.3	20.4
69	0	0	0	1	0	0	0	1	0	1	4 5	6.9	8.625	10.35	13.8	10.35	12.9375	15.525	20.7
70	0	0	0	1	0	0	0	1	1	0	4 6	7	8.75	10.5	14	10.5	13.125	15.75	21
71	0	0	0	1	0	0	0	1	1	1	4 7	7.1	8.875	10.65	14.2	10.65	13.3125	15.975	21.3
72	0	0	0	1	0	0	1	0	0	0	4 8	7.2	9	10.8	14.4	10.8	13.5	16.2	21.6
73	0	0	0	1	0	0	1	0	0	1	4 9	7.3	9.125	10.95	14.6	10.95	13.6875	16.425	21.9
74	0	0	0	1	0	0	1	0	1	0	4 A	7.4	9.25	11.1	14.8	11.1	13.875	16.65	22.2
75	0	0	0	1	0	0	1	0	1	1	4 B	7.5	9.375	11.25	15	11.25	14.0625	16.875	22.5
76	0	0	0	1	0	0	1	1	0	0	4 C	7.6	9.5	11.4	15.2	11.4	14.25	17.1	22.8
77	0	0	0	1	0	0	1	1	0	1	4 D	7.7	9.625	11.55	15.4	11.55	14.4375	17.325	23.1
78	0	0	0	1	0	0	1	1	1	0	4 E	7.8	9.75	11.7	15.6	11.7	14.625	17.55	23.4
79	0	0	0	1	0	0	1	1	1	1	4 F	7.9	9.875	11.85	15.8	11.85	14.8125	17.775	23.7

"End of Message Storage Space for ISD1110, ISD1210, and ISD1212 Devices"

												Sample Rates							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
												1016A 1416 2532	1020A 1420 2540	2548	2564	33060	33075	33090	33120-4
	Address Inputs																		
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
80	0	0	0	1	0	1	0	0	0	0	5 0	8	10	12	16	12	15	18	24
81	0	0	0	1	0	1	0	0	0	1	5 1	8.1	10.125	12.15	16.2	12.15	15.1875	18.225	24.3
82	0	0	0	1	0	1	0	0	1	0	5 2	8.2	10.25	12.3	16.4	12.3	15.375	18.45	24.6
83	0	0	0	1	0	1	0	0	1	1	5 3	8.3	10.375	12.45	16.6	12.45	15.5625	18.675	24.9
84	0	0	0	1	0	1	0	1	0	0	5 4	8.4	10.5	12.6	16.8	12.6	15.75	18.9	25.2
85	0	0	0	1	0	1	0	1	0	1	5 5	8.5	10.625	12.75	17	12.75	15.9375	19.125	25.5
86	0	0	0	1	0	1	0	1	1	0	5 6	8.6	10.75	12.9	17.2	12.9	16.125	19.35	25.8
87	0	0	0	1	0	1	0	1	1	1	5 7	8.7	10.875	13.05	17.4	13.05	16.3125	19.575	26.1
88	0	0	0	1	0	1	1	0	0	0	5 8	8.8	11	13.2	17.6	13.2	16.5	19.8	26.4
89	0	0	0	1	0	1	1	0	0	1	5 9	8.9	11.125	13.35	17.8	13.35	16.6875	20.025	26.7
90	0	0	0	1	0	1	1	0	1	0	5 A	9	11.25	13.5	18	13.5	16.875	20.25	27
91	0	0	0	1	0	1	1	0	1	1	5 B	9.1	11.375	13.65	18.2	13.65	17.0625	20.475	27.3
92	0	0	0	1	0	1	1	1	0	0	5 C	9.2	11.5	13.8	18.4	13.8	17.25	20.7	27.6
93	0	0	0	1	0	1	1	1	0	1	5 D	9.3	11.625	13.95	18.6	13.95	17.4375	20.925	27.9
94	0	0	0	1	0	1	1	1	1	0	5 E	9.4	11.75	14.1	18.8	14.1	17.625	21.15	28.2
95	0	0	0	1	0	1	1	1	1	1	5 F	9.5	11.875	14.25	19	14.25	17.8125	21.375	28.5
96	0	0	0	1	1	0	0	0	0	0	6 0	9.6	12	14.4	19.2	14.4	18	21.6	28.8
97	0	0	0	1	1	0	0	0	0	1	6 1	9.7	12.125	14.55	19.4	14.55	18.1875	21.825	29.1
98	0	0	0	1	1	0	0	0	1	0	6 2	9.8	12.25	14.7	19.6	14.7	18.375	22.05	29.4
99	0	0	0	1	1	0	0	0	1	1	6 3	9.9	12.375	14.85	19.8	14.85	18.5625	22.275	29.7
100	0	0	0	1	1	0	0	1	0	0	6 4	10	12.5	15	20	15	18.75	22.5	30
101	0	0	0	1	1	0	0	1	0	1	6 5	10.1	12.625	15.15	20.2	15.15	18.9375	22.725	30.3
102	0	0	0	1	1	0	0	1	1	0	6 6	10.2	12.75	15.3	20.4	15.3	19.125	22.95	30.6
103	0	0	0	1	1	0	0	1	1	1	6 7	10.3	12.875	15.45	20.6	15.45	19.3125	23.175	30.9
104	0	0	0	1	1	0	1	0	0	0	6 8	10.4	13	15.6	20.8	15.6	19.5	23.4	31.2
105	0	0	0	1	1	0	1	0	0	1	6 9	10.5	13.125	15.75	21	15.75	19.6875	23.625	31.5
106	0	0	0	1	1	0	1	0	1	0	6 A	10.6	13.25	15.9	21.2	15.9	19.875	23.85	31.8
107	0	0	0	1	1	0	1	0	1	1	6 B	10.7	13.375	16.05	21.4	16.05	20.0625	24.075	32.1
108	0	0	0	1	1	0	1	1	0	0	6 C	10.8	13.5	16.2	21.6	16.2	20.25	24.3	32.4
109	0	0	0	1	1	0	1	1	0	1	6 D	10.9	13.625	16.35	21.8	16.35	20.4375	24.525	32.7
110	0	0	0	1	1	0	1	1	1	0	6 E	11	13.75	16.5	22	16.5	20.625	24.75	33
111	0	0	0	1	1	0	1	1	1	1	6 F	11.1	13.875	16.65	22.2	16.65	20.8125	24.975	33.3
112	0	0	0	1	1	1	0	0	0	0	7 0	11.2	14	16.8	22.4	16.8	21	25.2	33.6
113	0	0	0	1	1	1	0	0	0	1	7 1	11.3	14.125	16.95	22.6	16.95	21.1875	25.425	33.9
114	0	0	0	1	1	1	0	0	1	0	7 2	11.4	14.25	17.1	22.8	17.1	21.375	25.65	34.2
115	0	0	0	1	1	1	0	0	1	1	7 3	11.5	14.375	17.25	23	17.25	21.5625	25.875	34.5
116	0	0	0	1	1	1	0	1	0	0	7 4	11.6	14.5	17.4	23.2	17.4	21.75	26.1	34.8

												Sample Rates							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
	Address Inputs											1016A 1416 2632 2560	1020A 1420 2640 2575	2548 2590	2564 25120	33060 33120	33075 33150	33090 33180	33120-4 33240
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0									
117	0	0	0	1	1	1	0	1	0	1	7 5	11.7	14.625	17.55	23.4	17.55	21.9375	26.325	35.1
118	0	0	0	1	1	1	0	1	1	0	7 6	11.8	14.75	17.7	23.6	17.7	22.125	26.55	35.4
119	0	0	0	1	1	1	0	1	1	1	7 7	11.9	14.875	17.85	23.8	17.85	22.3125	26.775	35.7
120	0	0	0	1	1	1	1	0	0	0	7 8	12	15	18	24	18	22.5	27	36
121	0	0	0	1	1	1	1	0	0	1	7 9	12.1	15.125	18.15	24.2	18.15	22.6875	27.225	36.3
122	0	0	0	1	1	1	1	0	1	0	7 A	12.2	15.25	18.3	24.4	18.3	22.875	27.45	36.6
123	0	0	0	1	1	1	1	0	1	1	7 B	12.3	15.375	18.45	24.6	18.45	23.0625	27.675	36.9
124	0	0	0	1	1	1	1	1	0	0	7 C	12.4	15.5	18.6	24.8	18.6	23.25	27.9	37.2
125	0	0	0	1	1	1	1	1	0	1	7 D	12.5	15.625	18.75	25	18.75	23.4375	28.125	37.5
126	0	0	0	1	1	1	1	1	1	0	7 E	12.6	15.75	18.9	25.2	18.9	23.625	28.35	37.8
127	0	0	0	1	1	1	1	1	1	1	7 F	12.7	15.875	19.05	25.4	19.05	23.8125	28.575	38.1
128	0	0	1	0	0	0	0	0	0	0	8 0	12.8	16	19.2	25.6	19.2	24	28.8	38.4
129	0	0	1	0	0	0	0	0	0	1	8 1	12.9	16.125	19.35	25.8	19.35	24.1875	29.025	38.7
130	0	0	1	0	0	0	0	0	1	0	8 2	13	16.25	19.5	26	19.5	24.375	29.25	39
131	0	0	1	0	0	0	0	0	1	1	8 3	13.1	16.375	19.65	26.2	19.65	24.5625	29.475	39.3
132	0	0	1	0	0	0	0	1	0	0	8 4	13.2	16.5	19.8	26.4	19.8	24.75	29.7	39.6
133	0	0	1	0	0	0	0	1	0	1	8 5	13.3	16.625	19.95	26.6	19.95	24.9375	29.925	39.9
134	0	0	1	0	0	0	0	1	1	0	8 6	13.4	16.75	20.1	26.8	20.1	25.125	30.15	40.2
135	0	0	1	0	0	0	0	1	1	1	8 7	13.5	16.875	20.25	27	20.25	25.3125	30.375	40.5
136	0	0	1	0	0	0	1	0	0	0	8 8	13.6	17	20.4	27.2	20.4	25.5	30.6	40.8
137	0	0	1	0	0	0	1	0	0	1	8 9	13.7	17.125	20.55	27.4	20.55	25.6875	30.825	41.1
138	0	0	1	0	0	0	1	0	1	0	8 A	13.8	17.25	20.7	27.6	20.7	25.875	31.05	41.4
139	0	0	1	0	0	0	1	0	1	1	8 B	13.9	17.375	20.85	27.8	20.85	26.0625	31.275	41.7
140	0	0	1	0	0	0	1	1	0	0	8 C	14	17.5	21	28	21	26.25	31.5	42
141	0	0	1	0	0	0	1	1	0	1	8 D	14.1	17.625	21.15	28.2	21.15	26.4375	31.725	42.3
142	0	0	1	0	0	0	1	1	1	0	8 E	14.2	17.75	21.3	28.4	21.3	26.625	31.95	42.6
143	0	0	1	0	0	0	1	1	1	1	8 F	14.3	17.875	21.45	28.6	21.45	26.8125	32.175	42.9
144	0	0	1	0	0	1	0	0	0	0	9 0	14.4	18	21.6	28.8	21.6	27	32.4	43.2
145	0	0	1	0	0	1	0	0	0	1	9 1	14.5	18.125	21.75	29	21.75	27.1875	32.625	43.5
146	0	0	1	0	0	1	0	0	1	0	9 2	14.6	18.25	21.9	29.2	21.9	27.375	32.85	43.8
147	0	0	1	0	0	1	0	0	1	1	9 3	14.7	18.375	22.05	29.4	22.05	27.5625	33.075	44.1
148	0	0	1	0	0	1	0	1	0	0	9 4	14.8	18.5	22.2	29.6	22.2	27.75	33.3	44.4
149	0	0	1	0	0	1	0	1	0	1	9 5	14.9	18.625	22.35	29.8	22.35	27.9375	33.525	44.7
150	0	0	1	0	0	1	0	1	1	0	9 6	15	18.75	22.5	30	22.5	28.125	33.75	45
151	0	0	1	0	0	1	0	1	1	1	9 7	15.1	18.875	22.65	30.2	22.65	28.3125	33.975	45.3
152	0	0	1	0	0	1	1	0	0	0	9 8	15.2	19	22.8	30.4	22.8	28.5	34.2	45.6
153	0	0	1	0	0	1	1	0	0	1	9 9	15.3	19.125	22.95	30.6	22.95	28.6875	34.425	45.9

												Sample Rates							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
	Address Inputs											1016A 1416 2532 2560	1020A 1420 2540 2576	2548 2590	2564 25120	33060 33120	33075 33150	33090 33180	33120-4 33240
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0									
154	0	0	1	0	0	1	1	0	1	0	9 A	15.4	19.25	23.1	30.8	23.1	28.875	34.65	46.2
155	0	0	1	0	0	1	1	0	1	1	9 B	15.5	19.375	23.25	31	23.25	29.0625	34.875	46.5
156	0	0	1	0	0	1	1	1	0	0	9 C	15.6	19.5	23.4	31.2	23.4	29.25	35.1	46.8
157	0	0	1	0	0	1	1	1	0	1	9 D	15.7	19.625	23.55	31.4	23.55	29.4375	35.325	47.1
158	0	0	1	0	0	1	1	1	1	0	9 E	15.8	19.75	23.7	31.6	23.7	29.625	35.55	47.4
159	0	0	1	0	0	1	1	1	1	1	9 F	15.9	19.875	23.85	31.8	23.85	29.8125	35.775	47.7
"End of Message Storage Space for ISD1416, ISD1420, ISD1016A, and ISD1020A Devices"																			

												Sample Rates							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
	Address Inputs											2532 2560	2540 2576	2548 2590	2564 25120	33060 33120	33075 33150	33090 33180	33120-4 33240
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0									
160	0	0	1	0	1	0	0	0	0	0	A 0	16	20	24	32	24	30	36	48
161	0	0	1	0	1	0	0	0	0	1	A 1	16.1	20.125	24.15	32.2	24.15	30.1875	36.225	48.3
162	0	0	1	0	1	0	0	0	1	0	A 2	16.2	20.25	24.3	32.4	24.3	30.375	36.45	48.6
163	0	0	1	0	1	0	0	0	1	1	A 3	16.3	20.375	24.45	32.6	24.45	30.5625	36.675	48.9
164	0	0	1	0	1	0	0	1	0	0	A 4	16.4	20.5	24.6	32.8	24.6	30.75	36.9	49.2
165	0	0	1	0	1	0	0	1	0	1	A 5	16.5	20.625	24.75	33	24.75	30.9375	37.125	49.5
166	0	0	1	0	1	0	0	1	1	0	A 6	16.6	20.75	24.9	33.2	24.9	31.125	37.35	49.8
167	0	0	1	0	1	0	0	1	1	1	A 7	16.7	20.875	25.05	33.4	25.05	31.3125	37.575	50.1
168	0	0	1	0	1	0	1	0	0	0	A 8	16.8	21	25.2	33.6	25.2	31.5	37.8	50.4
169	0	0	1	0	1	0	1	0	0	1	A 9	16.9	21.125	25.35	33.8	25.35	31.6875	38.025	50.7
170	0	0	1	0	1	0	1	0	1	0	A A	17	21.25	25.5	34	25.5	31.875	38.25	51
171	0	0	1	0	1	0	1	0	1	1	A B	17.1	21.375	25.65	34.2	25.65	32.0625	38.475	51.3
172	0	0	1	0	1	0	1	1	0	0	A C	17.2	21.5	25.8	34.4	25.8	32.25	38.7	51.6
173	0	0	1	0	1	0	1	1	0	1	A D	17.3	21.625	25.95	34.6	25.95	32.4375	38.925	51.9
174	0	0	1	0	1	0	1	1	1	0	A E	17.4	21.75	26.1	34.8	26.1	32.625	39.15	52.2
175	0	0	1	0	1	0	1	1	1	1	A F	17.5	21.875	26.25	35	26.25	32.8125	39.375	52.5
176	0	0	1	0	1	1	0	0	0	0	B 0	17.6	22	26.4	35.2	26.4	33	39.6	52.8
177	0	0	1	0	1	1	0	0	0	1	B 1	17.7	22.125	26.55	35.4	26.55	33.1875	39.825	53.1
178	0	0	1	0	1	1	0	0	1	0	B 2	17.8	22.25	26.7	35.6	26.7	33.375	40.05	53.4
179	0	0	1	0	1	1	0	0	1	1	B 3	17.9	22.375	26.85	35.8	26.85	33.5625	40.275	53.7
180	0	0	1	0	1	1	0	1	0	0	B 4	18	22.5	27	36	27	33.75	40.5	54
181	0	0	1	0	1	1	0	1	0	1	B 5	18.1	22.625	27.15	36.2	27.15	33.9375	40.725	54.3

												Sample Rates							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
	Address Inputs											2532	2540	2548	2564	33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2576	2590	25120	33120	33150	33180	33240
182	0	0	1	0	1	1	0	1	1	0	B 6	18.2	22.75	27.3	36.4	27.3	34.125	40.95	54.6
183	0	0	1	0	1	1	0	1	1	1	B 7	18.3	22.875	27.45	36.6	27.45	34.3125	41.175	54.9
184	0	0	1	0	1	1	1	0	0	0	B 8	18.4	23	27.6	36.8	27.6	34.5	41.4	55.2
185	0	0	1	0	1	1	1	0	0	1	B 9	18.5	23.125	27.75	37	27.75	34.6875	41.625	55.5
186	0	0	1	0	1	1	1	0	1	0	B A	18.6	23.25	27.9	37.2	27.9	34.875	41.85	55.8
187	0	0	1	0	1	1	1	0	1	1	B B	18.7	23.375	28.05	37.4	28.05	35.0625	42.075	56.1
188	0	0	1	0	1	1	1	1	0	0	B C	18.8	23.5	28.2	37.6	28.2	35.25	42.3	56.4
189	0	0	1	0	1	1	1	1	0	1	B D	18.9	23.625	28.35	37.8	28.35	35.4375	42.525	56.7
190	0	0	1	0	1	1	1	1	1	0	B E	19	23.75	28.5	38	28.5	35.625	42.75	57
191	0	0	1	0	1	1	1	1	1	1	B F	19.1	23.875	28.65	38.2	28.65	35.8125	42.975	57.3
192	0	0	1	1	0	0	0	0	0	0	C 0	19.2	24	28.8	38.4	28.8	36	43.2	57.6
193	0	0	1	1	0	0	0	0	0	1	C 1	19.3	24.125	28.95	38.6	28.95	36.1875	43.425	57.9
194	0	0	1	1	0	0	0	0	1	0	C 2	19.4	24.25	29.1	38.8	29.1	36.375	43.65	58.2
195	0	0	1	1	0	0	0	0	1	1	C 3	19.5	24.375	29.25	39	29.25	36.5625	43.875	58.5
196	0	0	1	1	0	0	0	1	0	0	C 4	19.6	24.5	29.4	39.2	29.4	36.75	44.1	58.8
197	0	0	1	1	0	0	0	1	0	1	C 5	19.7	24.625	29.55	39.4	29.55	36.9375	44.325	59.1
198	0	0	1	1	0	0	0	1	1	0	C 6	19.8	24.75	29.7	39.6	29.7	37.125	44.55	59.4
199	0	0	1	1	0	0	0	1	1	1	C 7	19.9	24.875	29.85	39.8	29.85	37.3125	44.775	59.7
200	0	0	1	1	0	0	1	0	0	0	C 8	20	25	30	40	30	37.5	45	60
201	0	0	1	1	0	0	1	0	0	1	C 9	20.1	25.125	30.15	40.2	30.15	37.6875	45.225	60.3
202	0	0	1	1	0	0	1	0	1	0	C A	20.2	25.25	30.3	40.4	30.3	37.875	45.45	60.6
203	0	0	1	1	0	0	1	0	1	1	C B	20.3	25.375	30.45	40.6	30.45	38.0625	45.675	60.9
204	0	0	1	1	0	0	1	1	0	0	C C	20.4	25.5	30.6	40.8	30.6	38.25	45.9	61.2
205	0	0	1	1	0	0	1	1	0	1	C D	20.5	25.625	30.75	41	30.75	38.4375	46.125	61.5
206	0	0	1	1	0	0	1	1	1	0	C E	20.6	25.75	30.9	41.2	30.9	38.625	46.35	61.8
207	0	0	1	1	0	0	1	1	1	1	C F	20.7	25.875	31.05	41.4	31.05	38.8125	46.575	62.1
208	0	0	1	1	0	1	0	0	0	0	D 0	20.8	26	31.2	41.6	31.2	39	46.8	62.4
209	0	0	1	1	0	1	0	0	0	1	D 1	20.9	26.125	31.35	41.8	31.35	39.1875	47.025	62.7
210	0	0	1	1	0	1	0	0	1	0	D 2	21	26.25	31.5	42	31.5	39.375	47.25	63
211	0	0	1	1	0	1	0	0	1	1	D 3	21.1	26.375	31.65	42.2	31.65	39.5625	47.475	63.3
212	0	0	1	1	0	1	0	1	0	0	D 4	21.2	26.5	31.8	42.4	31.8	39.75	47.7	63.6
213	0	0	1	1	0	1	0	1	0	1	D 5	21.3	26.625	31.95	42.6	31.95	39.9375	47.925	63.9
214	0	0	1	1	0	1	0	1	1	0	D 6	21.4	26.75	32.1	42.8	32.1	40.125	48.15	64.2
215	0	0	1	1	0	1	0	1	1	1	D 7	21.5	26.875	32.25	43	32.25	40.3125	48.375	64.5
216	0	0	1	1	0	1	1	0	0	0	D 8	21.6	27	32.4	43.2	32.4	40.5	48.6	64.8
217	0	0	1	1	0	1	1	0	0	1	D 9	21.7	27.125	32.55	43.4	32.55	40.6875	48.825	65.1
218	0	0	1	1	0	1	1	0	1	0	D A	21.8	27.25	32.7	43.6	32.7	40.875	49.05	65.4
219	0	0	1	1	0	1	1	0	1	1	D B	21.9	27.375	32.85	43.8	32.85	41.0625	49.275	65.7
220	0	0	1	1	0	1	1	1	0	0	D C	22	27.5	33	44	33	41.25	49.5	66

												Sample Rates							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
	Address Inputs											2532	2540	2548	2564	33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
221	0	0	1	1	0	1	1	1	0	1	D D	22.1	27.625	33.15	44.2	33.15	41.4375	49.725	66.3
222	0	0	1	1	0	1	1	1	1	0	D E	22.2	27.75	33.3	44.4	33.3	41.625	49.95	66.6
223	0	0	1	1	0	1	1	1	1	1	D F	22.3	27.875	33.45	44.6	33.45	41.8125	50.175	66.9
224	0	0	1	1	1	0	0	0	0	0	E 0	22.4	28	33.6	44.8	33.6	42	50.4	67.2
225	0	0	1	1	1	0	0	0	0	1	E 1	22.5	28.125	33.75	45	33.75	42.1875	50.625	67.5
226	0	0	1	1	1	0	0	0	1	0	E 2	22.6	28.25	33.9	45.2	33.9	42.375	50.85	67.8
227	0	0	1	1	1	0	0	0	1	1	E 3	22.7	28.375	34.05	45.4	34.05	42.5625	51.075	68.1
228	0	0	1	1	1	0	0	1	0	0	E 4	22.8	28.5	34.2	45.6	34.2	42.75	51.3	68.4
229	0	0	1	1	1	0	0	1	0	1	E 5	22.9	28.625	34.35	45.8	34.35	42.9375	51.525	68.7
230	0	0	1	1	1	0	0	1	1	0	E 6	23	28.75	34.5	46	34.5	43.125	51.75	69
231	0	0	1	1	1	0	0	1	1	1	E 7	23.1	28.875	34.65	46.2	34.65	43.3125	51.975	69.3
232	0	0	1	1	1	0	1	0	0	0	E 8	23.2	29	34.8	46.4	34.8	43.5	52.2	69.6
233	0	0	1	1	1	0	1	0	0	1	E 9	23.3	29.125	34.95	46.6	34.95	43.6875	52.425	69.9
234	0	0	1	1	1	0	1	0	1	0	E A	23.4	29.25	35.1	46.8	35.1	43.875	52.65	70.2
235	0	0	1	1	1	0	1	0	1	1	E B	23.5	29.375	35.25	47	35.25	44.0625	52.875	70.5
236	0	0	1	1	1	0	1	1	0	0	E C	23.6	29.5	35.4	47.2	35.4	44.25	53.1	70.8
237	0	0	1	1	1	0	1	1	0	1	E D	23.7	29.625	35.55	47.4	35.55	44.4375	53.325	71.1
238	0	0	1	1	1	0	1	1	1	0	E E	23.8	29.75	35.7	47.6	35.7	44.625	53.55	71.4
239	0	0	1	1	1	0	1	1	1	1	E F	23.9	29.875	35.85	47.8	35.85	44.8125	53.775	71.7
240	0	0	1	1	1	1	0	0	0	0	F 0	24	30	36	48	36	45	54	72
241	0	0	1	1	1	1	0	0	0	1	F 1	24.1	30.125	36.15	48.2	36.15	45.1875	54.225	72.3
242	0	0	1	1	1	1	0	0	1	0	F 2	24.2	30.25	36.3	48.4	36.3	45.375	54.45	72.6
243	0	0	1	1	1	1	0	0	1	1	F 3	24.3	30.375	36.45	48.6	36.45	45.5625	54.675	72.9
244	0	0	1	1	1	1	0	1	0	0	F 4	24.4	30.5	36.6	48.8	36.6	45.75	54.9	73.2
245	0	0	1	1	1	1	0	1	0	1	F 5	24.5	30.625	36.75	49	36.75	45.9375	55.125	73.5
246	0	0	1	1	1	1	0	1	1	0	F 6	24.6	30.75	36.9	49.2	36.9	46.125	55.35	73.8
247	0	0	1	1	1	1	0	1	1	1	F 7	24.7	30.875	37.05	49.4	37.05	46.3125	55.575	74.1
248	0	0	1	1	1	1	1	0	0	0	F 8	24.8	31	37.2	49.6	37.2	46.5	55.8	74.4
249	0	0	1	1	1	1	1	0	0	1	F 9	24.9	31.125	37.35	49.8	37.35	46.6875	56.025	74.7
250	0	0	1	1	1	1	1	0	1	0	F A	25	31.25	37.5	50	37.5	46.875	56.25	75
251	0	0	1	1	1	1	1	0	1	1	F B	25.1	31.375	37.65	50.2	37.65	47.0625	56.475	75.3
252	0	0	1	1	1	1	1	1	0	0	F C	25.2	31.5	37.8	50.4	37.8	47.25	56.7	75.6
253	0	0	1	1	1	1	1	1	0	1	F D	25.3	31.625	37.95	50.6	37.95	47.4375	56.925	75.9
254	0	0	1	1	1	1	1	1	1	0	F E	25.4	31.75	38.1	50.8	38.1	47.625	57.15	76.2
255	0	0	1	1	1	1	1	1	1	1	F F	25.5	31.875	38.25	51	38.25	47.8125	57.375	76.5
256	0	1	0	0	0	0	0	0	0	0	10 0	25.6	32	38.4	51.2	38.4	48	57.6	76.8
257	0	1	0	0	0	0	0	0	0	1	10 1	25.7	32.125	38.55	51.4	38.55	48.1875	57.825	77.1
258	0	1	0	0	0	0	0	0	1	0	10 2	25.8	32.25	38.7	51.6	38.7	48.375	58.05	77.4
259	0	1	0	0	0	0	0	0	1	1	10 3	25.9	32.375	38.85	51.8	38.85	48.5625	58.275	77.7

												Sample Rates							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
	Address Inputs											2532	2540	2548	2564	33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2576	2590	25120	33120	33150	33180	33240
260	0	1	0	0	0	0	0	1	0	0	10 4	26	32.5	39	52	39	48.75	58.5	78
261	0	1	0	0	0	0	0	1	0	1	10 5	26.1	32.625	39.15	52.2	39.15	48.9375	58.725	78.3
262	0	1	0	0	0	0	0	1	1	0	10 6	26.2	32.75	39.3	52.4	39.3	49.125	58.95	78.6
263	0	1	0	0	0	0	0	1	1	1	10 7	26.3	32.875	39.45	52.6	39.45	49.3125	59.175	78.9
264	0	1	0	0	0	0	1	0	0	0	10 8	26.4	33	39.6	52.8	39.6	49.5	59.4	79.2
265	0	1	0	0	0	0	1	0	0	1	10 9	26.5	33.125	39.75	53	39.75	49.6875	59.625	79.5
266	0	1	0	0	0	0	1	0	1	0	10 A	26.6	33.25	39.9	53.2	39.9	49.875	59.85	79.8
267	0	1	0	0	0	0	1	0	1	1	10 B	26.7	33.375	40.05	53.4	40.05	50.0625	60.075	80.1
268	0	1	0	0	0	0	1	1	0	0	10 C	26.8	33.5	40.2	53.6	40.2	50.25	60.3	80.4
269	0	1	0	0	0	0	1	1	0	1	10 D	26.9	33.625	40.35	53.8	40.35	50.4375	60.525	80.7
270	0	1	0	0	0	0	1	1	1	0	10 E	27	33.75	40.5	54	40.5	50.625	60.75	81
271	0	1	0	0	0	0	1	1	1	1	10 F	27.1	33.875	40.65	54.2	40.65	50.8125	60.975	81.3
272	0	1	0	0	0	1	0	0	0	0	11 0	27.2	34	40.8	54.4	40.8	51	61.2	81.6
273	0	1	0	0	0	1	0	0	0	1	11 1	27.3	34.125	40.95	54.6	40.95	51.1875	61.425	81.9
274	0	1	0	0	0	1	0	0	1	0	11 2	27.4	34.25	41.1	54.8	41.1	51.375	61.65	82.2
275	0	1	0	0	0	1	0	0	1	1	11 3	27.5	34.375	41.25	55	41.25	51.5625	61.875	82.5
276	0	1	0	0	0	1	0	1	0	0	11 4	27.6	34.5	41.4	55.2	41.4	51.75	62.1	82.8
277	0	1	0	0	0	1	0	1	0	1	11 5	27.7	34.625	41.55	55.4	41.55	51.9375	62.325	83.1
278	0	1	0	0	0	1	0	1	1	0	11 6	27.8	34.75	41.7	55.6	41.7	52.125	62.55	83.4
279	0	1	0	0	0	1	0	1	1	1	11 7	27.9	34.875	41.85	55.8	41.85	52.3125	62.775	83.7
280	0	1	0	0	0	1	1	0	0	0	11 8	28	35	42	56	42	52.5	63	84
281	0	1	0	0	0	1	1	0	0	1	11 9	28.1	35.125	42.15	56.2	42.15	52.6875	63.225	84.3
282	0	1	0	0	0	1	1	0	1	0	11 A	28.2	35.25	42.3	56.4	42.3	52.875	63.45	84.6
283	0	1	0	0	0	1	1	0	1	1	11 B	28.3	35.375	42.45	56.6	42.45	53.0625	63.675	84.9
284	0	1	0	0	0	1	1	1	0	0	11 C	28.4	35.5	42.6	56.8	42.6	53.25	63.9	85.2
285	0	1	0	0	0	1	1	1	0	1	11 D	28.5	35.625	42.75	57	42.75	53.4375	64.125	85.5
286	0	1	0	0	0	1	1	1	1	0	11 E	28.6	35.75	42.9	57.2	42.9	53.625	64.35	85.8
287	0	1	0	0	0	1	1	1	1	1	11 F	28.7	35.875	43.05	57.4	43.05	53.8125	64.575	86.1
288	0	1	0	0	1	0	0	0	0	0	12 0	28.8	36	43.2	57.6	43.2	54	64.8	86.4
289	0	1	0	0	1	0	0	0	0	1	12 1	28.9	36.125	43.35	57.8	43.35	54.1875	65.025	86.7
290	0	1	0	0	1	0	0	0	1	0	12 2	29	36.25	43.5	58	43.5	54.375	65.25	87
291	0	1	0	0	1	0	0	0	1	1	12 3	29.1	36.375	43.65	58.2	43.65	54.5625	65.475	87.3
292	0	1	0	0	1	0	0	1	0	0	12 4	29.2	36.5	43.8	58.4	43.8	54.75	65.7	87.6
293	0	1	0	0	1	0	0	1	0	1	12 5	29.3	36.625	43.95	58.6	43.95	54.9375	65.925	87.9
294	0	1	0	0	1	0	0	1	1	0	12 6	29.4	36.75	44.1	58.8	44.1	55.125	66.15	88.2
295	0	1	0	0	1	0	0	1	1	1	12 7	29.5	36.875	44.25	59	44.25	55.3125	66.375	88.5
296	0	1	0	0	1	0	1	0	0	0	12 8	29.6	37	44.4	59.2	44.4	55.5	66.6	88.8
297	0	1	0	0	1	0	1	0	0	1	12 9	29.7	37.125	44.55	59.4	44.55	55.6875	66.825	89.1
298	0	1	0	0	1	0	1	0	1	0	12 A	29.8	37.25	44.7	59.6	44.7	55.875	67.05	89.4

											Sample Rates							
											8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
											ISD Part Numbers							
	Address Inputs										2532	2540	2548	2564	33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
299	0	1	0	0	1	0	1	0	1	1	12 B	29.9	37.375	44.85	59.8	44.85	56.0625	67.275	89.7
300	0	1	0	0	1	0	1	1	0	0	12 C	30	37.5	45	60	45	56.25	67.5	90
301	0	1	0	0	1	0	1	1	0	1	12 D	30.1	37.625	45.15	60.2	45.15	56.4375	67.725	90.3
302	0	1	0	0	1	0	1	1	1	0	12 E	30.2	37.75	45.3	60.4	45.3	56.625	67.95	90.6
303	0	1	0	0	1	0	1	1	1	1	12 F	30.3	37.875	45.45	60.6	45.45	56.8125	68.175	90.9
304	0	1	0	0	1	1	0	0	0	0	13 0	30.4	38	45.6	60.8	45.6	57	68.4	91.2
305	0	1	0	0	1	1	0	0	0	1	13 1	30.5	38.125	45.75	61	45.75	57.1875	68.625	91.5
306	0	1	0	0	1	1	0	0	1	0	13 2	30.6	38.25	45.9	61.2	45.9	57.375	68.85	91.8
307	0	1	0	0	1	1	0	0	1	1	13 3	30.7	38.375	46.05	61.4	46.05	57.5625	69.075	92.1
308	0	1	0	0	1	1	0	1	0	0	13 4	30.8	38.5	46.2	61.6	46.2	57.75	69.3	92.4
309	0	1	0	0	1	1	0	1	0	1	13 5	30.9	38.625	46.35	61.8	46.35	57.9375	69.525	92.7
310	0	1	0	0	1	1	0	1	1	0	13 6	31	38.75	46.5	62	46.5	58.125	69.75	93
311	0	1	0	0	1	1	0	1	1	1	13 7	31.1	38.875	46.65	62.2	46.65	58.3125	69.975	93.3
312	0	1	0	0	1	1	1	0	0	0	13 8	31.2	39	46.8	62.4	46.8	58.5	70.2	93.6
313	0	1	0	0	1	1	1	0	0	1	13 9	31.3	39.125	46.95	62.6	46.95	58.6875	70.425	93.9
314	0	1	0	0	1	1	1	0	1	0	13 A	31.4	39.25	47.1	62.8	47.1	58.875	70.65	94.2
315	0	1	0	0	1	1	1	0	1	1	13 B	31.5	39.375	47.25	63	47.25	59.0625	70.875	94.5
316	0	1	0	0	1	1	1	1	0	0	13 C	31.6	39.5	47.4	63.2	47.4	59.25	71.1	94.8
317	0	1	0	0	1	1	1	1	0	1	13 D	31.7	39.625	47.55	63.4	47.55	59.4375	71.325	95.1
318	0	1	0	0	1	1	1	1	1	0	13 E	31.8	39.75	47.7	63.6	47.7	59.625	71.55	95.4
319	0	1	0	0	1	1	1	1	1	1	13 F	31.9	39.875	47.85	63.8	47.85	59.8125	71.775	95.7
"End of Message Storage Space for ISD2532, ISD2540, ISD2548, and ISD2564 Devices"																			

											Sample Rating							
											8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
											ISD Part Numbers							
	Address Inputs														33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
320	0	1	0	1	0	0	0	0	0	0	14 0	32	40	48	64	48	60	72	96
321	0	1	0	1	0	0	0	0	0	1	14 1	32.1	40.125	48.15	64.2	48.15	60.1875	72.225	96.3
322	0	1	0	1	0	0	0	0	1	0	14 2	32.2	40.25	48.3	64.4	48.3	60.375	72.45	96.6
323	0	1	0	1	0	0	0	0	1	1	14 3	32.3	40.375	48.45	64.6	48.45	60.5625	72.675	96.9
324	0	1	0	1	0	0	0	1	0	0	14 4	32.4	40.5	48.6	64.8	48.6	60.75	72.9	97.2
325	0	1	0	1	0	0	0	1	0	1	14 5	32.5	40.625	48.75	65	48.75	60.9375	73.125	97.5
326	0	1	0	1	0	0	0	1	1	0	14 6	32.6	40.75	48.9	65.2	48.9	61.125	73.35	97.8
327	0	1	0	1	0	0	0	1	1	1	14 7	32.7	40.875	49.05	65.4	49.05	61.3125	73.575	98.1

												Sample Rating							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
	Address Inputs											ISD Part Numbers				33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
328	0	1	0	1	0	0	1	0	0	0	14 8	32.8	41	49.2	65.6	49.2	61.5	73.8	98.4
329	0	1	0	1	0	0	1	0	0	1	14 9	32.9	41.125	49.35	65.8	49.35	61.6875	74.025	98.7
330	0	1	0	1	0	0	1	0	1	0	14 A	33	41.25	49.5	66	49.5	61.875	74.25	99
331	0	1	0	1	0	0	1	0	1	1	14 B	33.1	41.375	49.65	66.2	49.65	62.0625	74.475	99.3
332	0	1	0	1	0	0	1	1	0	0	14 C	33.2	41.5	49.8	66.4	49.8	62.25	74.7	99.6
333	0	1	0	1	0	0	1	1	0	1	14 D	33.3	41.625	49.95	66.6	49.95	62.4375	74.925	99.9
334	0	1	0	1	0	0	1	1	1	0	14 E	33.4	41.75	50.1	66.8	50.1	62.625	75.15	100.2
335	0	1	0	1	0	0	1	1	1	1	14 F	33.5	41.875	50.25	67	50.25	62.8125	75.375	100.5
336	0	1	0	1	0	1	0	0	0	0	15 0	33.6	42	50.4	67.2	50.4	63	75.6	100.8
337	0	1	0	1	0	1	0	0	0	1	15 1	33.7	42.125	50.55	67.4	50.55	63.1875	75.825	101.1
338	0	1	0	1	0	1	0	0	1	0	15 2	33.8	42.25	50.7	67.6	50.7	63.375	76.05	101.4
339	0	1	0	1	0	1	0	0	1	1	15 3	33.9	42.375	50.85	67.8	50.85	63.5625	76.275	101.7
340	0	1	0	1	0	1	0	1	0	0	15 4	34	42.5	51	68	51	63.75	76.5	102
341	0	1	0	1	0	1	0	1	0	1	15 5	34.1	42.625	51.15	68.2	51.15	63.9375	76.725	102.3
342	0	1	0	1	0	1	0	1	1	0	15 6	34.2	42.75	51.3	68.4	51.3	64.125	76.95	102.6
343	0	1	0	1	0	1	0	1	1	1	15 7	34.3	42.875	51.45	68.6	51.45	64.3125	77.175	102.9
344	0	1	0	1	0	1	1	0	0	0	15 8	34.4	43	51.6	68.8	51.6	64.5	77.4	103.2
345	0	1	0	1	0	1	1	0	0	1	15 9	34.5	43.125	51.75	69	51.75	64.6875	77.625	103.5
346	0	1	0	1	0	1	1	0	1	0	15 A	34.6	43.25	51.9	69.2	51.9	64.875	77.85	103.8
347	0	1	0	1	0	1	1	0	1	1	15 B	34.7	43.375	52.05	69.4	52.05	65.0625	78.075	104.1
348	0	1	0	1	0	1	1	1	0	0	15 C	34.8	43.5	52.2	69.6	52.2	65.25	78.3	104.4
349	0	1	0	1	0	1	1	1	0	1	15 D	34.9	43.625	52.35	69.8	52.35	65.4375	78.525	104.7
350	0	1	0	1	0	1	1	1	1	0	15 E	35	43.75	52.5	70	52.5	65.625	78.75	105
351	0	1	0	1	0	1	1	1	1	1	15 F	35.1	43.875	52.65	70.2	52.65	65.8125	78.975	105.3
352	0	1	0	1	1	0	0	0	0	0	16 0	35.2	44	52.8	70.4	52.8	66	79.2	105.6
353	0	1	0	1	1	0	0	0	0	1	16 1	35.3	44.125	52.95	70.6	52.95	66.1875	79.425	105.9
354	0	1	0	1	1	0	0	0	1	0	16 2	35.4	44.25	53.1	70.8	53.1	66.375	79.65	106.2
355	0	1	0	1	1	0	0	0	1	1	16 3	35.5	44.375	53.25	71	53.25	66.5625	79.875	106.5
356	0	1	0	1	1	0	0	1	0	0	16 4	35.6	44.5	53.4	71.2	53.4	66.75	80.1	106.8
357	0	1	0	1	1	0	0	1	0	1	16 5	35.7	44.625	53.55	71.4	53.55	66.9375	80.325	107.1
358	0	1	0	1	1	0	0	1	1	0	16 6	35.8	44.75	53.7	71.6	53.7	67.125	80.55	107.4
359	0	1	0	1	1	0	0	1	1	1	16 7	35.9	44.875	53.85	71.8	53.85	67.3125	80.775	107.7
360	0	1	0	1	1	0	1	0	0	0	16 8	36	45	54	72	54	67.5	81	108
361	0	1	0	1	1	0	1	0	0	1	16 9	36.1	45.125	54.15	72.2	54.15	67.6875	81.225	108.3
362	0	1	0	1	1	0	1	0	1	0	16 A	36.2	45.25	54.3	72.4	54.3	67.875	81.45	108.6
363	0	1	0	1	1	0	1	0	1	1	16 B	36.3	45.375	54.45	72.6	54.45	68.0625	81.675	108.9
364	0	1	0	1	1	0	1	1	0	0	16 C	36.4	45.5	54.6	72.8	54.6	68.25	81.9	109.2
365	0	1	0	1	1	0	1	1	0	1	16 D	36.5	45.625	54.75	73	54.75	68.4375	82.125	109.5

												Sample Rating							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
	Address Inputs															33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
366	0	1	0	1	1	0	1	1	1	0	16 E	36.6	45.75	54.9	73.2	54.9	68.625	82.35	109.8
367	0	1	0	1	1	0	1	1	1	1	16 F	36.7	45.875	55.05	73.4	55.05	68.8125	82.575	110.1
368	0	1	0	1	1	1	0	0	0	0	17 0	36.8	46	55.2	73.6	55.2	69	82.8	110.4
369	0	1	0	1	1	1	0	0	0	1	17 1	36.9	46.125	55.35	73.8	55.35	69.1875	83.025	110.7
370	0	1	0	1	1	1	0	0	1	0	17 2	37	46.25	55.5	74	55.5	69.375	83.25	111
371	0	1	0	1	1	1	0	0	1	1	17 3	37.1	46.375	55.65	74.2	55.65	69.5625	83.475	111.3
372	0	1	0	1	1	1	0	1	0	0	17 4	37.2	46.5	55.8	74.4	55.8	69.75	83.7	111.6
373	0	1	0	1	1	1	0	1	0	1	17 5	37.3	46.625	55.95	74.6	55.95	69.9375	83.925	111.9
374	0	1	0	1	1	1	0	1	1	0	17 6	37.4	46.75	56.1	74.8	56.1	70.125	84.15	112.2
375	0	1	0	1	1	1	0	1	1	1	17 7	37.5	46.875	56.25	75	56.25	70.3125	84.375	112.5
376	0	1	0	1	1	1	1	0	0	0	17 8	37.6	47	56.4	75.2	56.4	70.5	84.6	112.8
377	0	1	0	1	1	1	1	0	0	1	17 9	37.7	47.125	56.55	75.4	56.55	70.6875	84.825	113.1
378	0	1	0	1	1	1	1	0	1	0	17 A	37.8	47.25	56.7	75.6	56.7	70.875	85.05	113.4
379	0	1	0	1	1	1	1	0	1	1	17 B	37.9	47.375	56.85	75.8	56.85	71.0625	85.275	113.7
380	0	1	0	1	1	1	1	1	0	0	17 C	38	47.5	57	76	57	71.25	85.5	114
381	0	1	0	1	1	1	1	1	0	1	17 D	38.1	47.625	57.15	76.2	57.15	71.4375	85.725	114.3
382	0	1	0	1	1	1	1	1	1	0	17 E	38.2	47.75	57.3	76.4	57.3	71.625	85.95	114.6
383	0	1	0	1	1	1	1	1	1	1	17 F	38.3	47.875	57.45	76.6	57.45	71.8125	86.175	114.9
384	0	1	1	0	0	0	0	0	0	0	18 0	38.4	48	57.6	76.8	57.6	72	86.4	115.2
385	0	1	1	0	0	0	0	0	0	1	18 1	38.5	48.125	57.75	77	57.75	72.1875	86.625	115.5
386	0	1	1	0	0	0	0	0	1	0	18 2	38.6	48.25	57.9	77.2	57.9	72.375	86.85	115.8
387	0	1	1	0	0	0	0	0	1	1	18 3	38.7	48.375	58.05	77.4	58.05	72.5625	87.075	116.1
388	0	1	1	0	0	0	0	1	0	0	18 4	38.8	48.5	58.2	77.6	58.2	72.75	87.3	116.4
389	0	1	1	0	0	0	0	1	0	1	18 5	38.9	48.625	58.35	77.8	58.35	72.9375	87.525	116.7
390	0	1	1	0	0	0	0	1	1	0	18 6	39	48.75	58.5	78	58.5	73.125	87.75	117
391	0	1	1	0	0	0	0	1	1	1	18 7	39.1	48.875	58.65	78.2	58.65	73.3125	87.975	117.3
392	0	1	1	0	0	0	1	0	0	0	18 8	39.2	49	58.8	78.4	58.8	73.5	88.2	117.6
393	0	1	1	0	0	0	1	0	0	1	18 9	39.3	49.125	58.95	78.6	58.95	73.6875	88.425	117.9
394	0	1	1	0	0	0	1	0	1	0	18 A	39.4	49.25	59.1	78.8	59.1	73.875	88.65	118.2
395	0	1	1	0	0	0	1	0	1	1	18 B	39.5	49.375	59.25	79	59.25	74.0625	88.875	118.5
396	0	1	1	0	0	0	1	1	0	0	18 C	39.6	49.5	59.4	79.2	59.4	74.25	89.1	118.8
397	0	1	1	0	0	0	1	1	0	1	18 D	39.7	49.625	59.55	79.4	59.55	74.4375	89.325	119.1
398	0	1	1	0	0	0	1	1	1	0	18 E	39.8	49.75	59.7	79.6	59.7	74.625	89.55	119.4
399	0	1	1	0	0	0	1	1	1	1	18 F	39.9	49.875	59.85	79.8	59.85	74.8125	89.775	119.7
"End of Message Storage Space for ISD33060, ISD33075, ISD33090, and ISD33120-4 Devices"																			

												Sample Rating							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
	Address Inputs															33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
400	0	1	1	0	0	1	0	0	0	0	19 0	40	50	60	80	60	75	90	120
401	0	1	1	0	0	1	0	0	0	1	19 1	40.1	50.125	60.15	80.2	60.15	75.1875	90.225	120.3
402	0	1	1	0	0	1	0	0	1	0	19 2	40.2	50.25	60.3	80.4	60.3	75.375	90.45	120.6
403	0	1	1	0	0	1	0	0	1	1	19 3	40.3	50.375	60.45	80.6	60.45	75.5625	90.675	120.9
404	0	1	1	0	0	1	0	1	0	0	19 4	40.4	50.5	60.6	80.8	60.6	75.75	90.9	121.2
405	0	1	1	0	0	1	0	1	0	1	19 5	40.5	50.625	60.75	81	60.75	75.9375	91.125	121.5
406	0	1	1	0	0	1	0	1	1	0	19 6	40.6	50.75	60.9	81.2	60.9	76.125	91.35	121.8
407	0	1	1	0	0	1	0	1	1	1	19 7	40.7	50.875	61.05	81.4	61.05	76.3125	91.575	122.1
408	0	1	1	0	0	1	1	0	0	0	19 8	40.8	51	61.2	81.6	61.2	76.5	91.8	122.4
409	0	1	1	0	0	1	1	0	0	1	19 9	40.9	51.125	61.35	81.8	61.35	76.6875	92.025	122.7
410	0	1	1	0	0	1	1	0	1	0	19 A	41	51.25	61.5	82	61.5	76.875	92.25	123
411	0	1	1	0	0	1	1	0	1	1	19 B	41.1	51.375	61.65	82.2	61.65	77.0625	92.475	123.3
412	0	1	1	0	0	1	1	1	0	0	19 C	41.2	51.5	61.8	82.4	61.8	77.25	92.7	123.6
413	0	1	1	0	0	1	1	1	0	1	19 D	41.3	51.625	61.95	82.6	61.95	77.4375	92.925	123.9
414	0	1	1	0	0	1	1	1	1	0	19 E	41.4	51.75	62.1	82.8	62.1	77.625	93.15	124.2
415	0	1	1	0	0	1	1	1	1	1	19 F	41.5	51.875	62.25	83	62.25	77.8125	93.375	124.5
416	0	1	1	0	1	0	0	0	0	0	1A 0	41.6	52	62.4	83.2	62.4	78	93.6	124.8
417	0	1	1	0	1	0	0	0	0	1	1A 1	41.7	52.125	62.55	83.4	62.55	78.1875	93.825	125.1
418	0	1	1	0	1	0	0	0	1	0	1A 2	41.8	52.25	62.7	83.6	62.7	78.375	94.05	125.4
419	0	1	1	0	1	0	0	0	1	1	1A 3	41.9	52.375	62.85	83.8	62.85	78.5625	94.275	125.7
420	0	1	1	0	1	0	0	1	0	0	1A 4	42	52.5	63	84	63	78.75	94.5	126
421	0	1	1	0	1	0	0	1	0	1	1A 5	42.1	52.625	63.15	84.2	63.15	78.9375	94.725	126.3
422	0	1	1	0	1	0	0	1	1	0	1A 6	42.2	52.75	63.3	84.4	63.3	79.125	94.95	126.6
423	0	1	1	0	1	0	0	1	1	1	1A 7	42.3	52.875	63.45	84.6	63.45	79.3125	95.175	126.9
424	0	1	1	0	1	0	1	0	0	0	1A 8	42.4	53	63.6	84.8	63.6	79.5	95.4	127.2
425	0	1	1	0	1	0	1	0	0	1	1A 9	42.5	53.125	63.75	85	63.75	79.6875	95.625	127.5
426	0	1	1	0	1	0	1	0	1	0	1A A	42.6	53.25	63.9	85.2	63.9	79.875	95.85	127.8
427	0	1	1	0	1	0	1	0	1	1	1A B	42.7	53.375	64.05	85.4	64.05	80.0625	96.075	128.1
428	0	1	1	0	1	0	1	1	0	0	1A C	42.8	53.5	64.2	85.6	64.2	80.25	96.3	128.4
429	0	1	1	0	1	0	1	1	0	1	1A D	42.9	53.625	64.35	85.8	64.35	80.4375	96.525	128.7
430	0	1	1	0	1	0	1	1	1	0	1A E	43	53.75	64.5	86	64.5	80.625	96.75	129
431	0	1	1	0	1	0	1	1	1	1	1A F	43.1	53.875	64.65	86.2	64.65	80.8125	96.975	129.3
432	0	1	1	0	1	1	0	0	0	0	1B 0	43.2	54	64.8	86.4	64.8	81	97.2	129.6
433	0	1	1	0	1	1	0	0	0	1	1B 1	43.3	54.125	64.95	86.6	64.95	81.1875	97.425	129.9
434	0	1	1	0	1	1	0	0	1	0	1B 2	43.4	54.25	65.1	86.8	65.1	81.375	97.65	130.2
435	0	1	1	0	1	1	0	0	1	1	1B 3	43.5	54.375	65.25	87	65.25	81.5625	97.875	130.5
436	0	1	1	0	1	1	0	1	0	0	1B 4	43.6	54.5	65.4	87.2	65.4	81.75	98.1	130.8
437	0	1	1	0	1	1	0	1	0	1	1B 5	43.7	54.625	65.55	87.4	65.55	81.9375	98.325	131.1

												Sample Rating							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
	Address Inputs															33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
438	0	1	1	0	1	1	0	1	1	0	1B 6	43.8	54.75	65.7	87.6	65.7	82.125	98.55	131.4
439	0	1	1	0	1	1	0	1	1	1	1B 7	43.9	54.875	65.85	87.8	65.85	82.3125	98.775	131.7
440	0	1	1	0	1	1	1	0	0	0	1B 8	44	55	66	88	66	82.5	99	132
441	0	1	1	0	1	1	1	0	0	1	1B 9	44.1	55.125	66.15	88.2	66.15	82.6875	99.225	132.3
442	0	1	1	0	1	1	1	0	1	0	1B A	44.2	55.25	66.3	88.4	66.3	82.875	99.45	132.6
443	0	1	1	0	1	1	1	0	1	1	1B B	44.3	55.375	66.45	88.6	66.45	83.0625	99.675	132.9
444	0	1	1	0	1	1	1	1	0	0	1B C	44.4	55.5	66.6	88.8	66.6	83.25	99.9	133.2
445	0	1	1	0	1	1	1	1	0	1	1B D	44.5	55.625	66.75	89	66.75	83.4375	100.125	133.5
446	0	1	1	0	1	1	1	1	1	0	1B E	44.6	55.75	66.9	89.2	66.9	83.625	100.35	133.8
447	0	1	1	0	1	1	1	1	1	1	1B F	44.7	55.875	67.05	89.4	67.05	83.8125	100.575	134.1
448	0	1	1	1	0	0	0	0	0	0	1C 0	44.8	56	67.2	89.6	67.2	84	100.8	134.4
449	0	1	1	1	0	0	0	0	0	1	1C 1	44.9	56.125	67.35	89.8	67.35	84.1875	101.025	134.7
450	0	1	1	1	0	0	0	0	1	0	1C 2	45	56.25	67.5	90	67.5	84.375	101.25	135
451	0	1	1	1	0	0	0	0	1	1	1C 3	45.1	56.375	67.65	90.2	67.65	84.5625	101.475	135.3
452	0	1	1	1	0	0	0	1	0	0	1C 4	45.2	56.5	67.8	90.4	67.8	84.75	101.7	135.6
453	0	1	1	1	0	0	0	1	0	1	1C 5	45.3	56.625	67.95	90.6	67.95	84.9375	101.925	135.9
454	0	1	1	1	0	0	0	1	1	0	1C 6	45.4	56.75	68.1	90.8	68.1	85.125	102.15	136.2
455	0	1	1	1	0	0	0	1	1	1	1C 7	45.5	56.875	68.25	91	68.25	85.3125	102.375	136.5
456	0	1	1	1	0	0	1	0	0	0	1C 8	45.6	57	68.4	91.2	68.4	85.5	102.6	136.8
457	0	1	1	1	0	0	1	0	0	1	1C 9	45.7	57.125	68.55	91.4	68.55	85.6875	102.825	137.1
458	0	1	1	1	0	0	1	0	1	0	1C A	45.8	57.25	68.7	91.6	68.7	85.875	103.05	137.4
459	0	1	1	1	0	0	1	0	1	1	1C B	45.9	57.375	68.85	91.8	68.85	86.0625	103.275	137.7
460	0	1	1	1	0	0	1	1	0	0	1C C	46	57.5	69	92	69	86.25	103.5	138
461	0	1	1	1	0	0	1	1	0	1	1C D	46.1	57.625	69.15	92.2	69.15	86.4375	103.725	138.3
462	0	1	1	1	0	0	1	1	1	0	1C E	46.2	57.75	69.3	92.4	69.3	86.625	103.95	138.6
463	0	1	1	1	0	0	1	1	1	1	1C F	46.3	57.875	69.45	92.6	69.45	86.8125	104.175	138.9
464	0	1	1	1	0	1	0	0	0	0	1D 0	46.4	58	69.6	92.8	69.6	87	104.4	139.2
465	0	1	1	1	0	1	0	0	0	1	1D 1	46.5	58.125	69.75	93	69.75	87.1875	104.625	139.5
466	0	1	1	1	0	1	0	0	1	0	1D 2	46.6	58.25	69.9	93.2	69.9	87.375	104.85	139.8
467	0	1	1	1	0	1	0	0	1	1	1D 3	46.7	58.375	70.05	93.4	70.05	87.5625	105.075	140.1
468	0	1	1	1	0	1	0	1	0	0	1D 4	46.8	58.5	70.2	93.6	70.2	87.75	105.3	140.4
469	0	1	1	1	0	1	0	1	0	1	1D 5	46.9	58.625	70.35	93.8	70.35	87.9375	105.525	140.7
470	0	1	1	1	0	1	0	1	1	0	1D 6	47	58.75	70.5	94	70.5	88.125	105.75	141
471	0	1	1	1	0	1	0	1	1	1	1D 7	47.1	58.875	70.65	94.2	70.65	88.3125	105.975	141.3
472	0	1	1	1	0	1	1	0	0	0	1D 8	47.2	59	70.8	94.4	70.8	88.5	106.2	141.6
473	0	1	1	1	0	1	1	0	0	1	1D 9	47.3	59.125	70.95	94.6	70.95	88.6875	106.425	141.9
474	0	1	1	1	0	1	1	0	1	0	1D A	47.4	59.25	71.1	94.8	71.1	88.875	106.65	142.2
475	0	1	1	1	0	1	1	0	1	1	1D B	47.5	59.375	71.25	95	71.25	89.0625	106.875	142.5
476	0	1	1	1	0	1	1	1	0	0	1D C	47.6	59.5	71.4	95.2	71.4	89.25	107.1	142.8

												Sample Rating							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
	Address Inputs															33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
477	0	1	1	1	0	1	1	1	0	1	1D D	47.7	59.625	71.55	95.4	71.55	89.4375	107.325	143.1
478	0	1	1	1	0	1	1	1	1	0	1D E	47.8	59.75	71.7	95.6	71.7	89.625	107.55	143.4
479	0	1	1	1	0	1	1	1	1	1	1D F	47.9	59.875	71.85	95.8	71.85	89.8125	107.775	143.7
480	0	1	1	1	1	0	0	0	0	0	1E 0	48	60	72	96	72	90	108	144
481	0	1	1	1	1	0	0	0	0	1	1E 1	48.1	60.125	72.15	96.2	72.15	90.1875	108.225	144.3
482	0	1	1	1	1	0	0	0	1	0	1E 2	48.2	60.25	72.3	96.4	72.3	90.375	108.45	144.6
483	0	1	1	1	1	0	0	0	1	1	1E 3	48.3	60.375	72.45	96.6	72.45	90.5625	108.675	144.9
484	0	1	1	1	1	0	0	1	0	0	1E 4	48.4	60.5	72.6	96.8	72.6	90.75	108.9	145.2
485	0	1	1	1	1	0	0	1	0	1	1E 5	48.5	60.625	72.75	97	72.75	90.9375	109.125	145.5
486	0	1	1	1	1	0	0	1	1	0	1E 6	48.6	60.75	72.9	97.2	72.9	91.125	109.35	145.8
487	0	1	1	1	1	0	0	1	1	1	1E 7	48.7	60.875	73.05	97.4	73.05	91.3125	109.575	146.1
488	0	1	1	1	1	0	1	0	0	0	1E 8	48.8	61	73.2	97.6	73.2	91.5	109.8	146.4
489	0	1	1	1	1	0	1	0	0	1	1E 9	48.9	61.125	73.35	97.8	73.35	91.6875	110.025	146.7
490	0	1	1	1	1	0	1	0	1	0	1E A	49	61.25	73.5	98	73.5	91.875	110.25	147
491	0	1	1	1	1	0	1	0	1	1	1E B	49.1	61.375	73.65	98.2	73.65	92.0625	110.475	147.3
492	0	1	1	1	1	0	1	1	0	0	1E C	49.2	61.5	73.8	98.4	73.8	92.25	110.7	147.6
493	0	1	1	1	1	0	1	1	0	1	1E D	49.3	61.625	73.95	98.6	73.95	92.4375	110.925	147.9
494	0	1	1	1	1	0	1	1	1	0	1E E	49.4	61.75	74.1	98.8	74.1	92.625	111.15	148.2
495	0	1	1	1	1	0	1	1	1	1	1E F	49.5	61.875	74.25	99	74.25	92.8125	111.375	148.5
496	0	1	1	1	1	1	0	0	0	0	1F 0	49.6	62	74.4	99.2	74.4	93	111.6	148.8
497	0	1	1	1	1	1	0	0	0	1	1F 1	49.7	62.125	74.55	99.4	74.55	93.1875	111.825	149.1
498	0	1	1	1	1	1	0	0	1	0	1F 2	49.8	62.25	74.7	99.6	74.7	93.375	112.05	149.4
499	0	1	1	1	1	1	0	0	1	1	1F 3	49.9	62.375	74.85	99.8	74.85	93.5625	112.275	149.7
500	0	1	1	1	1	1	0	1	0	0	1F 4	50	62.5	75	100	75	93.75	112.5	150
501	0	1	1	1	1	1	0	1	0	1	1F 5	50.1	62.625	75.15	100.2	75.15	93.9375	112.725	150.3
502	0	1	1	1	1	1	0	1	1	0	1F 6	50.2	62.75	75.3	100.4	75.3	94.125	112.95	150.6
503	0	1	1	1	1	1	0	1	1	1	1F 7	50.3	62.875	75.45	100.6	75.45	94.3125	113.175	150.9
504	0	1	1	1	1	1	1	0	0	0	1F 8	50.4	63	75.6	100.8	75.6	94.5	113.4	151.2
505	0	1	1	1	1	1	1	0	0	1	1F 9	50.5	63.125	75.75	101	75.75	94.6875	113.625	151.5
506	0	1	1	1	1	1	1	0	1	0	1F A	50.6	63.25	75.9	101.2	75.9	94.875	113.85	151.8
507	0	1	1	1	1	1	1	0	1	1	1F B	50.7	63.375	76.05	101.4	76.05	95.0625	114.075	152.1
508	0	1	1	1	1	1	1	1	0	0	1F C	50.8	63.5	76.2	101.6	76.2	95.25	114.3	152.4
509	0	1	1	1	1	1	1	1	0	1	1F D	50.9	63.625	76.35	101.8	76.35	95.4375	114.525	152.7
510	0	1	1	1	1	1	1	1	1	0	1F E	51	63.75	76.5	102	76.5	95.625	114.75	153
511	0	1	1	1	1	1	1	1	1	1	1F F	51.1	63.875	76.65	102.2	76.65	95.8125	114.975	153.3
512	1	0	0	0	0	0	0	0	0	0	20 0	51.2	64	76.8	102.4	76.8	96	115.2	153.6
513	1	0	0	0	0	0	0	0	0	1	20 1	51.3	64.125	76.95	102.6	76.95	96.1875	115.425	153.9
514	1	0	0	0	0	0	0	0	1	0	20 2	51.4	64.25	77.1	102.8	77.1	96.375	115.65	154.2

												Sample Rating							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
	Address Inputs															33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
515	1	0	0	0	0	0	0	0	1	1	20 3	51.5	64.375	77.25	103	77.25	96.5625	115.875	154.5
516	1	0	0	0	0	0	0	1	0	0	20 4	51.6	64.5	77.4	103.2	77.4	96.75	116.1	154.8
517	1	0	0	0	0	0	0	1	0	1	20 5	51.7	64.625	77.55	103.4	77.55	96.9375	116.325	155.1
518	1	0	0	0	0	0	0	1	1	0	20 6	51.8	64.75	77.7	103.6	77.7	97.125	116.55	155.4
519	1	0	0	0	0	0	0	1	1	1	20 7	51.9	64.875	77.85	103.8	77.85	97.3125	116.775	155.7
520	1	0	0	0	0	0	1	0	0	0	20 8	52	65	78	104	78	97.5	117	156
521	1	0	0	0	0	0	1	0	0	1	20 9	52.1	65.125	78.15	104.2	78.15	97.6875	117.225	156.3
522	1	0	0	0	0	0	1	0	1	0	20 A	52.2	65.25	78.3	104.4	78.3	97.875	117.45	156.6
523	1	0	0	0	0	0	1	0	1	1	20 B	52.3	65.375	78.45	104.6	78.45	98.0625	117.675	156.9
524	1	0	0	0	0	0	1	1	0	0	20 C	52.4	65.5	78.6	104.8	78.6	98.25	117.9	157.2
525	1	0	0	0	0	0	1	1	0	1	20 D	52.5	65.625	78.75	105	78.75	98.4375	118.125	157.5
526	1	0	0	0	0	0	1	1	1	0	20 E	52.6	65.75	78.9	105.2	78.9	98.625	118.35	157.8
527	1	0	0	0	0	0	1	1	1	1	20 F	52.7	65.875	79.05	105.4	79.05	98.8125	118.575	158.1
528	1	0	0	0	0	1	0	0	0	0	21 0	52.8	66	79.2	105.6	79.2	99	118.8	158.4
529	1	0	0	0	0	1	0	0	0	1	21 1	52.9	66.125	79.35	105.8	79.35	99.1875	119.025	158.7
530	1	0	0	0	0	1	0	0	1	0	21 2	53	66.25	79.5	106	79.5	99.375	119.25	159
531	1	0	0	0	0	1	0	0	1	1	21 3	53.1	66.375	79.65	106.2	79.65	99.5625	119.475	159.3
532	1	0	0	0	0	1	0	1	0	0	21 4	53.2	66.5	79.8	106.4	79.8	99.75	119.7	159.6
533	1	0	0	0	0	1	0	1	0	1	21 5	53.3	66.625	79.95	106.6	79.95	99.9375	119.925	159.9
534	1	0	0	0	0	1	0	1	1	0	21 6	53.4	66.75	80.1	106.8	80.1	100.125	120.15	160.2
535	1	0	0	0	0	1	0	1	1	1	21 7	53.5	66.875	80.25	107	80.25	100.3125	120.375	160.5
536	1	0	0	0	0	1	1	0	0	0	21 8	53.6	67	80.4	107.2	80.4	100.5	120.6	160.8
537	1	0	0	0	0	1	1	0	0	1	21 9	53.7	67.125	80.55	107.4	80.55	100.6875	120.825	161.1
538	1	0	0	0	0	1	1	0	1	0	21 A	53.8	67.25	80.7	107.6	80.7	100.875	121.05	161.4
539	1	0	0	0	0	1	1	0	1	1	21 B	53.9	67.375	80.85	107.8	80.85	101.0625	121.275	161.7
540	1	0	0	0	0	1	1	1	0	0	21 C	54	67.5	81	108	81	101.25	121.5	162
541	1	0	0	0	0	1	1	1	0	1	21 D	54.1	67.625	81.15	108.2	81.15	101.4375	121.725	162.3
542	1	0	0	0	0	1	1	1	1	0	21 E	54.2	67.75	81.3	108.4	81.3	101.625	121.95	162.6
543	1	0	0	0	0	1	1	1	1	1	21 F	54.3	67.875	81.45	108.6	81.45	101.8125	122.175	162.9
544	1	0	0	0	1	0	0	0	0	0	22 0	54.4	68	81.6	108.8	81.6	102	122.4	163.2
545	1	0	0	0	1	0	0	0	0	1	22 1	54.5	68.125	81.75	109	81.75	102.1875	122.625	163.5
546	1	0	0	0	1	0	0	0	1	0	22 2	54.6	68.25	81.9	109.2	81.9	102.375	122.85	163.8
547	1	0	0	0	1	0	0	0	1	1	22 3	54.7	68.375	82.05	109.4	82.05	102.5625	123.075	164.1
548	1	0	0	0	1	0	0	1	0	0	22 4	54.8	68.5	82.2	109.6	82.2	102.75	123.3	164.4
549	1	0	0	0	1	0	0	1	0	1	22 5	54.9	68.625	82.35	109.8	82.35	102.9375	123.525	164.7
550	1	0	0	0	1	0	0	1	1	0	22 6	55	68.75	82.5	110	82.5	103.125	123.75	165
551	1	0	0	0	1	0	0	1	1	1	22 7	55.1	68.875	82.65	110.2	82.65	103.3125	123.975	165.3
552	1	0	0	0	1	0	1	0	0	0	22 8	55.2	69	82.8	110.4	82.8	103.5	124.2	165.6
553	1	0	0	0	1	0	1	0	0	1	22 9	55.3	69.125	82.95	110.6	82.95	103.6875	124.425	165.9

												Sample Rating							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
												ISD Part Numbers							
	Address Inputs															33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
554	1	0	0	0	1	0	1	0	1	0	22 A	55.4	69.25	83.1	110.8	83.1	103.875	124.65	166.2
555	1	0	0	0	1	0	1	0	1	1	22 B	55.5	69.375	83.25	111	83.25	104.0625	124.875	166.5
556	1	0	0	0	1	0	1	1	0	0	22 C	55.6	69.5	83.4	111.2	83.4	104.25	125.1	166.8
557	1	0	0	0	1	0	1	1	0	1	22 D	55.7	69.625	83.55	111.4	83.55	104.4375	125.325	167.1
558	1	0	0	0	1	0	1	1	1	0	22 E	55.8	69.75	83.7	111.6	83.7	104.625	125.55	167.4
559	1	0	0	0	1	0	1	1	1	1	22 F	55.9	69.875	83.85	111.8	83.85	104.8125	125.775	167.7
560	1	0	0	0	1	1	0	0	0	0	23 0	56	70	84	112	84	105	126	168
561	1	0	0	0	1	1	0	0	0	1	23 1	56.1	70.125	84.15	112.2	84.15	105.1875	126.225	168.3
562	1	0	0	0	1	1	0	0	1	0	23 2	56.2	70.25	84.3	112.4	84.3	105.375	126.45	168.6
563	1	0	0	0	1	1	0	0	1	1	23 3	56.3	70.375	84.45	112.6	84.45	105.5625	126.675	168.9
564	1	0	0	0	1	1	0	1	0	0	23 4	56.4	70.5	84.6	112.8	84.6	105.75	126.9	169.2
565	1	0	0	0	1	1	0	1	0	1	23 5	56.5	70.625	84.75	113	84.75	105.9375	127.125	169.5
566	1	0	0	0	1	1	0	1	1	0	23 6	56.6	70.75	84.9	113.2	84.9	106.125	127.35	169.8
567	1	0	0	0	1	1	0	1	1	1	23 7	56.7	70.875	85.05	113.4	85.05	106.3125	127.575	170.1
568	1	0	0	0	1	1	1	0	0	0	23 8	56.8	71	85.2	113.6	85.2	106.5	127.8	170.4
569	1	0	0	0	1	1	1	0	0	1	23 9	56.9	71.125	85.35	113.8	85.35	106.6875	128.025	170.7
570	1	0	0	0	1	1	1	0	1	0	23 A	57	71.25	85.5	114	85.5	106.875	128.25	171
571	1	0	0	0	1	1	1	0	1	1	23 B	57.1	71.375	85.65	114.2	85.65	107.0625	128.475	171.3
572	1	0	0	0	1	1	1	1	0	0	23 C	57.2	71.5	85.8	114.4	85.8	107.25	128.7	171.6
573	1	0	0	0	1	1	1	1	0	1	23 D	57.3	71.625	85.95	114.6	85.95	107.4375	128.925	171.9
574	1	0	0	0	1	1	1	1	1	0	23 E	57.4	71.75	86.1	114.8	86.1	107.625	129.15	172.2
575	1	0	0	0	1	1	1	1	1	1	23 F	57.5	71.875	86.25	115	86.25	107.8125	129.375	172.5
576	1	0	0	1	0	0	0	0	0	0	24 0	57.6	72	86.4	115.2	86.4	108	129.6	172.8
577	1	0	0	1	0	0	0	0	0	1	24 1	57.7	72.125	86.55	115.4	86.55	108.1875	129.825	173.1
578	1	0	0	1	0	0	0	0	1	0	24 2	57.8	72.25	86.7	115.6	86.7	108.375	130.05	173.4
579	1	0	0	1	0	0	0	0	1	1	24 3	57.9	72.375	86.85	115.8	86.85	108.5625	130.275	173.7
580	1	0	0	1	0	0	0	1	0	0	24 4	58	72.5	87	116	87	108.75	130.5	174
581	1	0	0	1	0	0	0	1	0	1	24 5	58.1	72.625	87.15	116.2	87.15	108.9375	130.725	174.3
582	1	0	0	1	0	0	0	1	1	0	24 6	58.2	72.75	87.3	116.4	87.3	109.125	130.95	174.6
583	1	0	0	1	0	0	0	1	1	1	24 7	58.3	72.875	87.45	116.6	87.45	109.3125	131.175	174.9
584	1	0	0	1	0	0	1	0	0	0	24 8	58.4	73	87.6	116.8	87.6	109.5	131.4	175.2
585	1	0	0	1	0	0	1	0	0	1	24 9	58.5	73.125	87.75	117	87.75	109.6875	131.625	175.5
586	1	0	0	1	0	0	1	0	1	0	24 A	58.6	73.25	87.9	117.2	87.9	109.875	131.85	175.8
587	1	0	0	1	0	0	1	0	1	1	24 B	58.7	73.375	88.05	117.4	88.05	110.0625	132.075	176.1
588	1	0	0	1	0	0	1	1	0	0	24 C	58.8	73.5	88.2	117.6	88.2	110.25	132.3	176.4
589	1	0	0	1	0	0	1	1	0	1	24 D	58.9	73.625	88.35	117.8	88.35	110.4375	132.525	176.7
590	1	0	0	1	0	0	1	1	1	0	24 E	59	73.75	88.5	118	88.5	110.625	132.75	177
591	1	0	0	1	0	0	1	1	1	1	24 F	59.1	73.875	88.65	118.2	88.65	110.8125	132.975	177.3

												Sample Rating							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
	Address Inputs											ISD Part Numbers							
																33060	33075	33090	33120-4
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0		2560	2575	2590	25120	33120	33150	33180	33240
592	1	0	0	1	0	1	0	0	0	0	25 0	59.2	74	88.8	118.4	88.8	111	133.2	177.6
593	1	0	0	1	0	1	0	0	0	1	25 1	59.3	74.125	88.95	118.6	88.95	111.1875	133.425	177.9
594	1	0	0	1	0	1	0	0	1	0	25 2	59.4	74.25	89.1	118.8	89.1	111.375	133.65	178.2
595	1	0	0	1	0	1	0	0	1	1	25 3	59.5	74.375	89.25	119	89.25	111.5625	133.875	178.5
596	1	0	0	1	0	1	0	1	0	0	25 4	59.6	74.5	89.4	119.2	89.4	111.75	134.1	178.8
597	1	0	0	1	0	1	0	1	0	1	25 5	59.7	74.625	89.55	119.4	89.55	111.9375	134.325	179.1
598	1	0	0	1	0	1	0	1	1	0	25 6	59.8	74.75	89.7	119.6	89.7	112.125	134.55	179.4
599	1	0	0	1	0	1	0	1	1	1	25 7	59.9	74.875	89.85	119.8	89.85	112.3125	134.775	179.7
"End of Message Storage Space for ISD2560, ISD2575, ISD2590, and ISD25120 Devices"																			

												Sample Rates							
												8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz	8.0 KHz	6.4 KHz	5.3 KHz	4.0 KHz
	Address Inputs											ISD Part Numbers							
DEC	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0						33120	33150	33180	33240
600	1	0	0	1	0	1	1	0	0	0	25 8					90	112.5	135	180
601	1	0	0	1	0	1	1	0	0	1	25 9					90.15	112.6875	135.225	180.3
602	1	0	0	1	0	1	1	0	1	0	25 A					90.3	112.875	135.45	180.6
603	1	0	0	1	0	1	1	0	1	1	25 B					90.45	113.0625	135.675	180.9
604	1	0	0	1	0	1	1	1	0	0	25 C					90.6	113.25	135.9	181.2
605	1	0	0	1	0	1	1	1	0	1	25 D					90.75	113.4375	136.125	181.5
606	1	0	0	1	0	1	1	1	1	0	25 E					90.9	113.625	136.35	181.8
607	1	0	0	1	0	1	1	1	1	1	25 F					91.05	113.8125	136.575	182.1
608	1	0	0	1	1	0	0	0	0	0	26 0					91.2	114	136.8	182.4
609	1	0	0	1	1	0	0	0	0	1	26 1					91.35	114.1875	137.025	182.7
610	1	0	0	1	1	0	0	0	1	0	26 2					91.5	114.375	137.25	183
611	1	0	0	1	1	0	0	0	1	1	26 3					91.65	114.5625	137.475	183.3
612	1	0	0	1	1	0	0	1	0	0	26 4					91.8	114.75	137.7	183.6
613	1	0	0	1	1	0	0	1	0	1	26 5					91.95	114.9375	137.925	183.9
614	1	0	0	1	1	0	0	1	1	0	26 6					92.1	115.125	138.15	184.2
615	1	0	0	1	1	0	0	1	1	1	26 7					92.25	115.3125	138.375	184.5
616	1	0	0	1	1	0	1	0	0	0	26 8					92.4	115.5	138.6	184.8
617	1	0	0	1	1	0	1	0	0	1	26 9					92.55	115.6875	138.825	185.1
618	1	0	0	1	1	0	1	0	1	0	26 A					92.7	115.875	139.05	185.4
619	1	0	0	1	1	0	1	0	1	1	26 B					92.85	116.0625	139.275	185.7
620	1	0	0	1	1	0	1	1	0	0	26 C					93	116.25	139.5	186
621	1	0	0	1	1	0	1	1	0	1	26 D					93.15	116.4375	139.725	186.3