A Seminar report on

ADVANCED HEARING AID

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Submitted by

K. SATWIK

17HP1A04B3

Under the Esteemed Guidance of

Mr. Md. Baig, M. Tech

Assistant Professor

Department of Electronics and Communications Engineering

Andhra Loyola Institute of Engineering and Technology

(Approved by AICTE & Affiliated to JNTUK, Kakinada)

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERINGANDHRA LOYOLA INSTITUTE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE & Affiliated to JNTUK, Kakinada)An ISO 9001-2008 Certified Institution

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CERTIFICATE

This is to certify that the project report entitled **"ADVANCED HEARING AID"** is a bonafide record of the work carried out by **K. SATWIK (17HP1A04B3**) under our guidance and supervision in partial fulfillment of therequirements for the award of degree of **Bachelor of Technology** in **Electronics andCommunications Engineering** of **Jawaharlal Nehru Technological University Kakinada, Kakinada** during the academic year **2017-2021.**

Mr. Md. Baig, **M.Tech**
PROJECT GUIDE

Mr. M. Rama Krishna, **M.E.**
HEAD OF THE DEPARTMENT

EXTERNAL EXAMINER

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K. SATWIK (17HP1A04B3)

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ABSTRACT

Hearing aids have advanced significantly over the past decade, primarily due to the maturing of digital technology. The next decade should see an even greater number of innovations to hearing aid technology, and this article attempts to predict in which areas the new developments will occur. Both incremental and radical innovations in digital hearing aids will be driven by research advances in the following fields: (1) wireless technology, (2) digital chip technology, (3) hearing science, and (4) cognitive science. The opportunities and limitations for each of these areas will be discussed. Additionally, emerging trends such as connectivity and individualization will also drive new technology, and these are discussed within the context of the areas given here.

CHAPTER 1
INTRODUCTION

1.1 Introduction

Hearing loss that's due to problems with the ear canal, eardrum, or middle ear is called conductive hearing loss. Most of the time, surgery or other medical help can make it better. But those options aren't right for everyone. If you have an open ear canal and a relatively normal external ear, a hearing aid may help.

Some people are born without an external ear or ear canal, which means they can't use a typical hearing aid. Instead, they may be able to use a device that sends sound to the inner ear through the bone of their skull.

Early devices, such as ear trumpets or ear horns were passive amplification cones designed to gather sound energy and direct it into the ear canal. Modern devices are computerized electroacoustic systems that transform environmental sound to make it audible, according to audio metrical and cognitive rules.

1.2 What is a hearing aid?

In spite of the great variety of types, designs and technical features, hearing aids can all be described as small, wearable electronic devices which enable a person to hear sounds better and understand speech more clearly, providing an overall improvement in communication ability. A **hearing aid** is a device designed to improve hearing by making sound audible to a person with hearing loss. Hearing aids are classified as medical devices in most countries, and regulated by the respective regulations. Small audio amplifiers such as PSAPs or other plain sound reinforcing systems cannot be sold as "hearing aids".

Early devices, such as ear trumpets or ear horns, were passive amplification cones designed to gather sound energy and direct it into the ear canal. Modern devices are computerised electroacoustic systems that transform environmental sound to make it audible, according to eudiometrical and cognitive rules. Modern devices also utilize sophisticated digital signal processing to try and improve speech intelligibility and comfort for the user. Such signal processing includes feedback management, wide dynamic range compression, directionality, frequency lowering, and noise reduction.

Modern hearing aids require configuration to match the hearing loss, physical features, and lifestyle of the wearer. The hearing aid is fitted to the most recent audiogram and is programmed by frequency. This process is called "fitting" and is performed by a Doctor of Audiology, also called an audiologist (AuD), or by a Hearing Instrument Specialist (HIS). The amount of benefit a hearing aid delivers depends in large part on the quality of its fitting. Almost all hearing aids in use in the US are digital hearing aids. Devices similar to hearing aids include the Osseo integrated auditory prosthesis (formerly called the bone-anchored hearing aid) and cochlear implant.

1.3 Types of hearing aid

1. In-the-ear (ITE) hearing aids

ITE aids are worn in the ear canal and are usually custom-fit, based on an impression that is taken by your hearing care professional at the time of your hearing aid consultation. These styles are typically available in different skin tones to blend with the outer ear. Some types of ITE hearing aids fit very deeply within the ear canal, while others are closer to the outer ear...

2. Behind-the-ear (BTE) hearing aids

BTE aids sit behind or on top of the outer ear with tubing that routes the sound down into the ear canal via a custom-fit earhole or a dome style that doesn't block the entire ear canal opening. BTE styles are available in different colours to match hair or skin tone, as well as flashier designs for personalized flair.

For either ITE or BTE, most devices come with standard button batteries that must be replaced anywhere from 3-20 days. However, rechargeable batteries are becoming more common. Learn more about the pros and cons of rechargeable batteries.

3. In-the-canal (ITC) hearing aids

ITC hearing aids sit in the lower portion of the outer ear bowl, making them comfortable and easy to use. Because they're slightly larger than IIC and CIC styles, they tend to have a slightly longer battery life and can fit a wider range of hearing losses. Their size also allows them to host additional features such as directional microphones for better understanding in noisy environments and manual controls, like a volume wheel, if desired.

4. Low-profile hearing aids

Low-profile hearing aids are similar to ITC styles, and range from *half-shell* designs that fill half the bowl of the outer ear to *full-shell* designs that fill almost the entire outer ear bowl. Like ITC styles, low-profile designs are large enough to feature directional microphones and manual controls, such as a volume wheel and a push-button for changing programs. The size of a low-profile style makes it desirable for people with dexterity issues because it is easier to handle than the smaller sizes.

5. Receiver in the ear (RITE*)*

This style is typically known as either as "receiver in the ear" (RITE) or "receiver in canal" (RIC), depending on the manufacturer. But they essentially mean the same thing—an open-fit hearing aid style that has the speaker built into an insert able ear dome, instead of the main body of the hearing aid. In other words, the speaker of the hearing aid rests in the ear canal, but the microphone and processor sit in a tiny case *behind* the ear. They are connected by a thin wire. This style of hearing aid tends to have above-average sound quality and is made by all major hearing aid manufacturers. If it gets damaged, the speaker portion of the hearing aid that fits in the ear can often be replaced at the hearing aid centre, instead of having to be shipped off to the manufacturer for repair.

6. Behind-the-ear with ear mold

BTE styles that come with ear molds can fit any type of hearing loss, from mild to profound. Their longer shape follows the contour behind the outer ear and can generally house more features, controls and battery power than any other style of hearing aid. A BTE with ear mold style is commonly used for children because the BTE can be reprogrammed as needed and the ear mold can be replaced as the child grows.

1.4 *Challenges for hearing aid*

1. **Public announcements**

Remember the last time you were at the airport and over a loudspeaker you were told boarding was in progress—or that the flight was delayed? Public address systems notify us of what’s going on all the time, but a hearing impaired individual probably won’t get the message.

2. **Slow talkers**

When someone realizes they’re interacting with a hearing impaired person, they often switch to a slower form of speech. While it’s done with the best intentions, it can actually hinder lip reading. Over time, the hearing impaired has learned to understand words when people speak naturally, so slowing it down intentionally can result in miscommunication.

3. **Being in the dark**

Whether it’s a dimly-lit room or a noisy dark club, the absence of light makes it difficult for the hearing impaired to engage with others. They generally rely on visual stimuli, such as lip reading or sign language, so darkness poses a challenge.

4. **being “jumpy”**

Have you ever been startled by someone approaching you from behind? It happens to the hearing impaired all the time. Without visual cues or vibrations on the floor, they can be easily startled. For some, this leads to a constant "jumpy" feeling, as they can rarely be completely comfortable no one is sneaking up on them from behind.

5. **Relying on touch**

When most of us want someone’s attention, we can simply call out their name. When a person is hearing impaired, however, they won’t hear their name called. That’s why in deaf culture, firm but polite tapping on the shoulder is normal in order to gain attention. However, those not familiar with the deaf community may be unaware of this, leading to confrontation.

6. **Sign language misunderstandings**

Sign language is far from universal, and different standards exist in different countries (for example, the differences between American and British Sign Language are quite significant). In addition, regional areas have their own specific variations—just like accents or slang—leading to further difficulty. There are many instances of professional interpreters using the wrong words due to the variations across regions and country; while this may not seem like a big deal, it has led to lasting harm, such as in legal situations or miscommunication during hospital visits.

7. **Job applications and interviews**

Job interviews are already stressful situations; now consider being hearing impaired. Those who are hard of hearing or deaf may sometimes feel completely ignored when they reveal their hearing status on application forms, possibly because recruiters see it as too much extra work to accommodate them. When they do reach the interview stage, more complications arise. Telephone interviews are nearly impossible without an interpreter, and in-person interviews can be difficult to carry out if an interviewer is unprepared for the situation.

8. **Going to a movie**

Seeing the newest films at a theatre is no easy feat. Often, theatre chains are unreliable with setting up films with subtitles; if they do have subtitled films available, they're often only on films that have been out for months or shown at unusual times, such as 10am on a Wednesday.

9. **Caring for hearing aids**

While hearing aids have helped millions to better hear sounds and communicate more effectively with others, they also have to be well maintained to keep the equipment working optimally. The hearing impaired often has to keep spare batteries when traveling or commuting, and because the devices can’t get wet, even a mid-afternoon rainstorm can pose a problem.

10. **Depression and anxiety**

Studies reveal that deaf people are around twice as likely to suffer from psychological problems such as depression and anxiety. Research suggests this stems from feelings of isolation. Making matters worse, the most effective treatment for these types of issues is usually talking with a therapist. Of course, finding a doctor or therapist with the means necessary to effectively work with those who have hearing challenges is no easy feat.

While the hearing impaired and the deaf have learned to adjust too many situations, there will always be challenges. Thankfully, technology is helping change lives (for example, many public announcements are now also sent to cell phones). While many deaf people don't want hearing and consider deafness their own unique culture, the larger hearing world still views them with pity. The fact is, most deaf people or hearing impaired individuals don’t want pity, but just want to be treated with respect. As individuals with hearing, that is the most important thing we can provide

CHAPTER-2

LITERATURE SURVEY

2.1 Literature Survey

2.1.1 History

Hearing loss is not a new condition. People have been suffering from it for centuries.

Up until the 16th century, it was commonly accepted that individuals with hearing loss also suffered from multiple other disabilities; this led to them being heavily discriminated against. It was not until a Spanish monk named Pedro Ponce taught a nobleman’s deaf sons how to read, write, speak and do math that this fact was disproven.

The ear trumpet was invented in the 17th century and is considered the first device used to help the hearing impaired. These trumpets came in a number of shapes and sizes and were made of everything from sheet iron to animal horns.

The next advancement did not appear until the late 18th century with the invention of the collapsible ear trumpet. Frederick C. Rein was the first to commercially produce these trumpets in 1800. In order to make the devices less noticeable, Rein created acoustic headbands, which hid the hearing devices within the user’s hair.

2.1.2 Existing Methodology

The first hearing aid was designed thanks to Alexander Graham Bell’s 1876 invention of the telephone, which included technology that could control the loudness, frequency and distortion of sounds.

The first electric hearing aid was invented in 1898 by Miller Reese Hutchison. His design used an electric current to amplify weak signals.

In 1913, the world was introduced to the first commercially manufactured hearing aids. These devices were cumbersome and not very portable. In the 1920s vacuum-tube hearing aids were produced; these tubes were able to turn speech into electric signals and then the signal itself was amplified.

The idea of miniaturization was ushered in with other technological advances spurred by WWII; this was crucial to the advancement of hearing aids. The transistor was invented in 1948. Transistors were able to replace the vacuum tubes in previous models of hearing aids and were smaller, needed less battery power and had less distortion.

The microprocessor and the multi-channel amplitude compression were created in the 1970s. The microprocessor brought miniaturization to a new level and the compression ushered in the use of digital technology.

From there, hearing aids began evolve at a steady clip. The 1980s saw the creation of high-speed processors and microcomputers. The 1990s saw the appearance of the first all-digital hearing aid. And the 2010s brought the idea of Bluetooth® enabled devices into the mix.

2.1.3 Proposed Methodology

It often happens that a person using a hearing aid for the first time cannot quickly make use of all its advantages. Structure and characteristics of hearing aids are thoroughly devised by specialists in order to make the period of adaptation to the hearing aid as simple and quick as possible. However, despite this, a beginning hearing aid user certainly needs time to get used to it.

The process of hearing prostheses consists of the following steps:

- Initial adjustment of the device;
- Adaptation to new sounding;
- Fine adjustment.

Due to plasticity of central nervous system inactive hearing centres of the brain cortex switch over to processing of sound stimuli of another frequency and intensity. The brain start perceiving sounds amplified by the hearing aid right after the initial adjustment, however, it may not process them correctly at once.

Feeling the hearing aid in the user's ear may seem unusual. It also takes time to adapt to the new way of hearing perception. The ear has to be gradually adjusted to the new sounding.

The sound may seem unnatural, metallic, too loud or too quiet. Whistling sound may also appear which a rather unpleasant irritant is.

Hearing aid does not provide immediate improvement. The adaptation period can last from several hours to several months.

A patient is offered a schedule of wearing their hearing aid ensuring gradual adaptation to it. If the patient starts permanently wearing the hearing aid, unfamiliar sound may cause a headache, and as a result the user refuses to wear a hearing aid despite the fact that it helps. Surd-teachers often run a quick preparation course for the patients. As a rule, users have inflated expectations of using hearing aids. They expect that hearing aids will help them to hear in the same way as before hearing loss, but it is not like that. Conducted trainings help hearing aid users to get accustomed to new sound feelings. A user is strongly recommended to regularly visit a serologist, including for the purposes of additional hearing aid adjustment.

Hearing aid application, in contrast to a traditional hearing aid, allows implementing nonspecific options, such as a built-in adaptation course.

The functions of the course may include:

- control over the sequence of performed exercises according to the calendar;
- control of the amount of time spent on learning (exceeding or lacking);
- Reminders of daily exercises and so on.

The goal of the course is to help a user adapt to hearing aid application.

The adaptation course includes a certain number of stages, starting from listening to a set of low everyday sounds in a quiet environment, getting accustomed to one's own speech and other people's speech, getting accustomed to speech in the noise, etc.

CHAPTER-3

CIRCUIT BLOCKS

3. Circuit Blocks

3. Circuit Blocks

3.1. Wireless Transceiver

For the compressed 32-kbps audio stream, if the full-duplex transceiver is used, the transceiver module has to work continuously, which is not optimal for reducing the power consumption or reducing the complexity of the system design. In this design, intermittent information exchange is utilized with a much higher bit rate. Thus, the transceiver module is duty cycled to reduce the average power consumption. For RF circuits, increasing the bit rate would not significantly increase the power consumption and would help shorten the communication latency. A 2-Mbps communication bit rate is used to reduce the average power consumption by more than 80%. As is shown in Figure 4, the transceiver uses a carrier frequency of 434 MHz near the Industrial Scientific Medical (ISM) band. A higher carrier frequency such as 2.4 GHz or 5 GHz leads to higher power consumption and higher path loss around the human body, while a lower frequency is challenging because of the need for a miniaturized antenna.

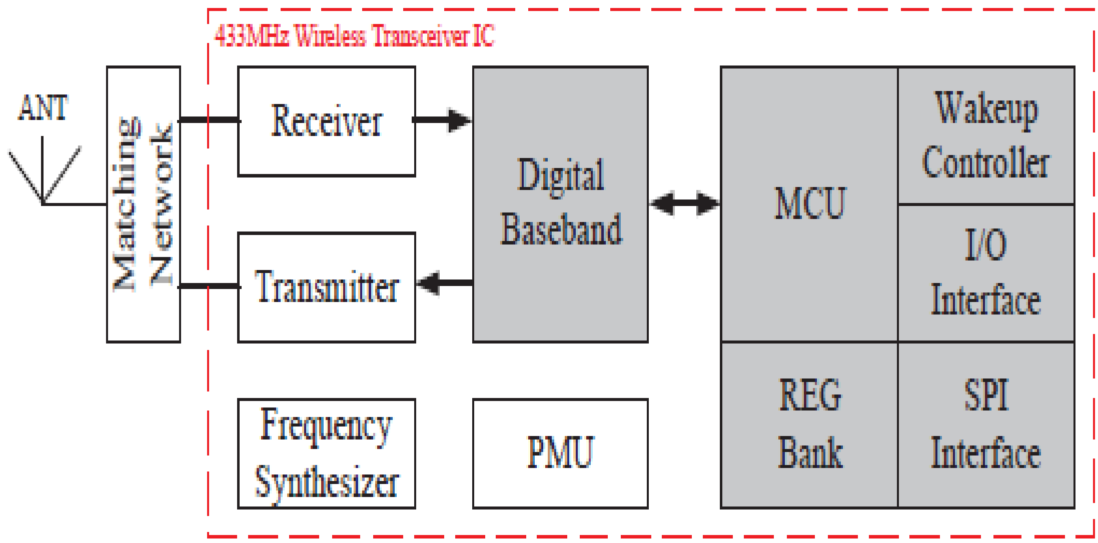


Figure 4. Block diagram of the wireless transceiver.

The transmitter uses a polarized structure. Compared to the traditional orthogonal modulation of the transmitter, a polarized transmitter can effectively reduce the circuit complexity, eliminating the building blocks required in the traditional structure, such as the DAC, IF filter, and mixer. The transmitter power consumption can be reduced accordingly. The receiver employs a zero-IF structure, which simplifies the receiver's IF circuit and digital baseband; however, the main drawback is the degradation of the dynamic range due to the DC offset. In this design, a novel DC offset calibration method is utilized, which can eliminate the DC offset with barely any extra power consumption. In addition to the employed power-efficient transceiver architecture, some low-power building-block techniques are also adopted. In the intermittent information exchange mode, each communication cycle is roughly composed of an operation state and an idle state. Thus, two effective methods for reducing the average power consumption involve shortening the duration of the operation state in each communication cycle and lowering the idle state power consumption. When the communication bit rate (2 Mbps) is much higher than the audio stream bit rate (32 kbps), the duty cycle of the operation state is relatively low. On the other hand, the period of intermittent information exchange should not be longer than several milliseconds to keep the communication latency within an acceptable threshold. In this condition, the duration of the operation state in each cycle is tens of microseconds, which is comparable with the communication setup time between two transceivers. Therefore, in this design, the communication setup time is especially optimized to shorten the operation state duration in each cycle, using the two corresponding techniques. The first one is utilized to shorten the Phase Lock Loop (PLL) setup time. Since the PLL setup time is decided by its loop bandwidth and has a trade-off with its phase noise, a dynamic loop bandwidth technique is adopted, which helps to reduce the setup time by one order of magnitude while having almost no effect on noise performance. Another technique is utilized to shorten the Auto Gain Control (AGC) loop setup time. Since the zero-IF receiver architecture is employed, the signal magnitude detection speed at the IF circuit output is limited by its bit rate. Here, we utilize the combination of RF-AGC and IF-AGC. The RF-AGC has a fast speed and provides a coarse gain range for IF-AGC. Then, the IF-AGC sets the gain accurately. This technique shortens the setup time significantly compared with conventional AGC circuits while still having a comparable precision. When the transceiver works in the idle state, all the power-consuming circuits are powered off except for an ultra-low-power wake-up controller. The wake-up controller includes a low-frequency oscillator, a simple state machine, and several counters. It powers the transceiver on and off periodically according to a schedule. Because of its simplicity and low frequency, it consumes less than 50µW, which contributes very little to the average power consumption of the whole system

3.2. Digital Acoustic Baseband Processor

The DABB processor is an integrated control and interface unit coordinating the functions of the surrounding modules including the ADC, DAC, and the wireless transceiver, which are shown in below Figure

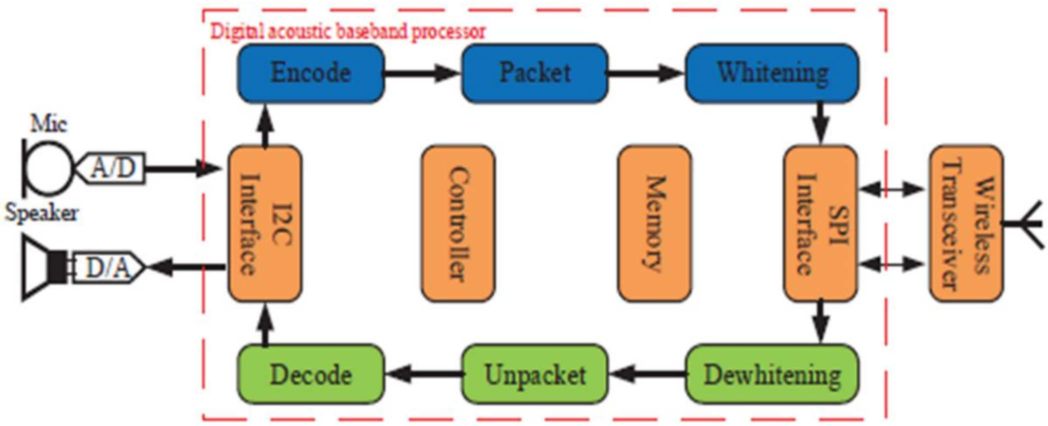


Figure 5. Block diagram of the Digital Acoustic Baseband (DABB).

The instruction structure of the SPI allows reading and writing of the register unit of the radio Transceiver to set the status, to monitor whether there is an error in the transmission, to send Interruptions, and to adjust the working mode. In the SPI communication, the wireless transceiver functions as the slave, and the DABB as the master. The SPI protocol is for an 8-bit packet transmission. Each packet includes a prefix and a number of data packets. The prefix contains the access type and the register address, followed by several read and write packets. The DABB controls the working modes of the ADC and DAC through the I2C bus. The data from the ADC is retrieved by the optionally selectable I2C bus or the SPI interface to the processor

3.3. Battery and Power Management

The Battery/Power Management Unit (BPMU) in the proposed system mainly acts as the friendly charger for the built-in rechargeable batteries and the voltage generator for the hearing aid devices. In this case, the users do not need to change the batteries frequently. The diagram of the BPMU is illustrated in Figure

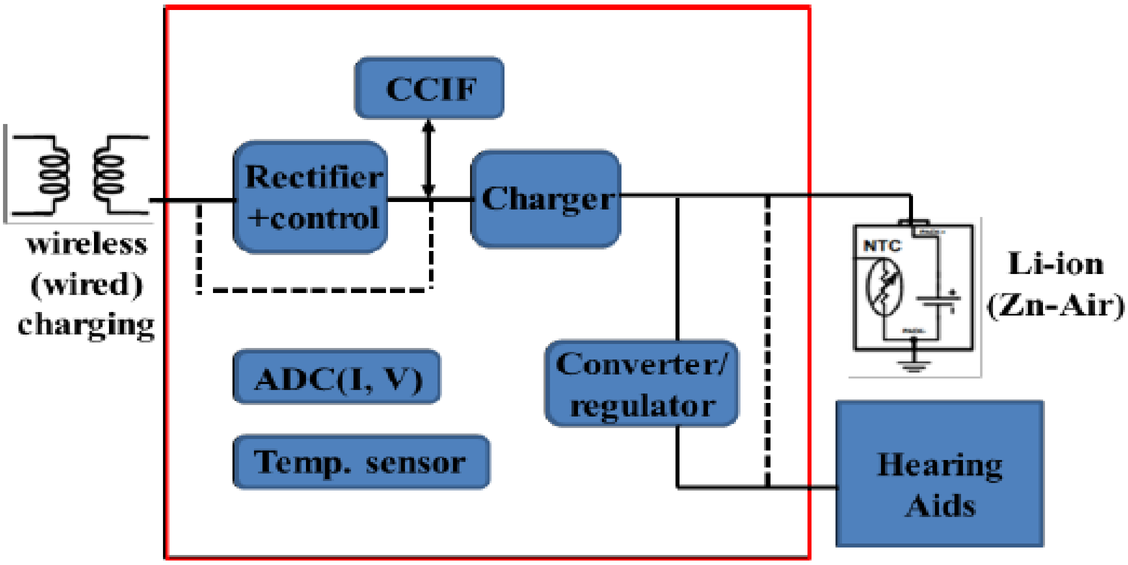


Figure 6. Block diagram of the battery/power management unit.

The BPMU is supplied by two methods. When the wireless charging system is adopted,
The transferred AC voltage from the outside coils is firstly rectified by an internal high-performance rectifier before being sent to the charger.
In order to enhance the power efficiency, control techniques are used in the rectifier design.
When only wired charging is available, the input voltage of the internal charger is directly supported from the outside cable. The supported rechargeable battery type is the widely-used lithium-ion (Li-ion). The BPMU can also detect the popular disposable zinc-air (Zn-air) battery, but does not charge it. Charging algorithms are proposed in the BPMU to control the charging processes for high efficiency and battery protection. In addition, the BPMU includes a Charger Communication Interface (CCIF) to provide the battery charging information for the user with the BPMU. There are three working modes in the BPMU as illustrated in Figure 7. They are Deep Sleep Mode (DSM), Hearing Aid Mode (HAM), and Charging Mode (CM). The three modes transit with each other For practical working situations. When the BPMU is

in DSM, all the blocks are turned off to save power, and the system current is no more than 200 an

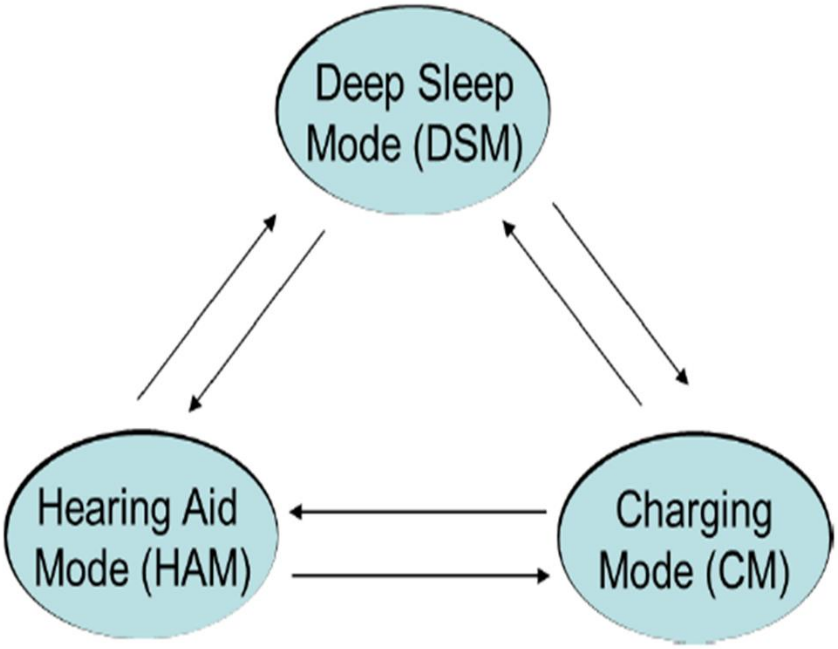


Figure 7. The three working modes in the battery/power management unit.

When the BPMU enters into HAM, the hearing aids are in the normal operation condition and receive their supply voltage from the BPMU. If a Li-ion battery is used, an internal high-efficiency converter or regulator is activated to provide an output voltage between 1.0 V and 1.4 V to the hearing aids. If a Zn-air battery, whose normal voltage is between 1.1 V and 1.5 V, is used, the BPMU canals directly provide the battery voltage to the hearing aids. In HAM, voltage monitoring is also used to prevent turn-on if the battery voltage is not suitable. According to the Li-ion discharge curve, the battery is nearly discharged when the battery voltage is less than 3 V, and so, a threshold of around3 V is chosen as a turn-off threshold when the Li-ion battery is used. When the BPMU works in CM, the battery is being charged. Note that the hearing aids will turnoff while charging. For Li-ion batteries, the charging process is managed by a state machine containing start-up, initialization or a so-called trickle pre-charge, constant-current charging, constant-voltage charging, and completion. The maximum charging current is around 21 mA. With the aim of protecting the battery and maximizing the battery life, the precise charging control loop involves monitoring both the current and voltage with the help of the internal ADCs and temperature sensor. The CCIF will communicate the status of the charging process in CM to allow user interaction. The communicated information includes the charging process, the voltage and current levels, the temperature, and failure conditions. When wireless charging is used, this communication supports bidirectional data transfer between the BPMU and the outside transmitter. The communication from the BPMU to the transmitters based on load modulation, and the communication from the transmitter to the BPMU uses voltage modulation. If a Zn-air battery is used, the battery type is detected in the start-up state, and the state machine moves directly to the completion phase.

CHAPTER-4

HARDWARE IMPLEMENTATION

4.Hardware Implementation

The block diagram of the earpieces is shown in Figure 9. It mainly includes the following modules: electronic to digital, system data exchange, digital to electronic, accessory circuits, transmitter, interface, First in, First Out (FIFO) buffer, FIFO for processing input, output, and intermediate data. Accessory circuits include power management and the interrupt controller. The transmitter is used mainly forcible/wireless transmission. The interface supports various types of external communications. In the following subsections, we introduce the remaining modules separately.

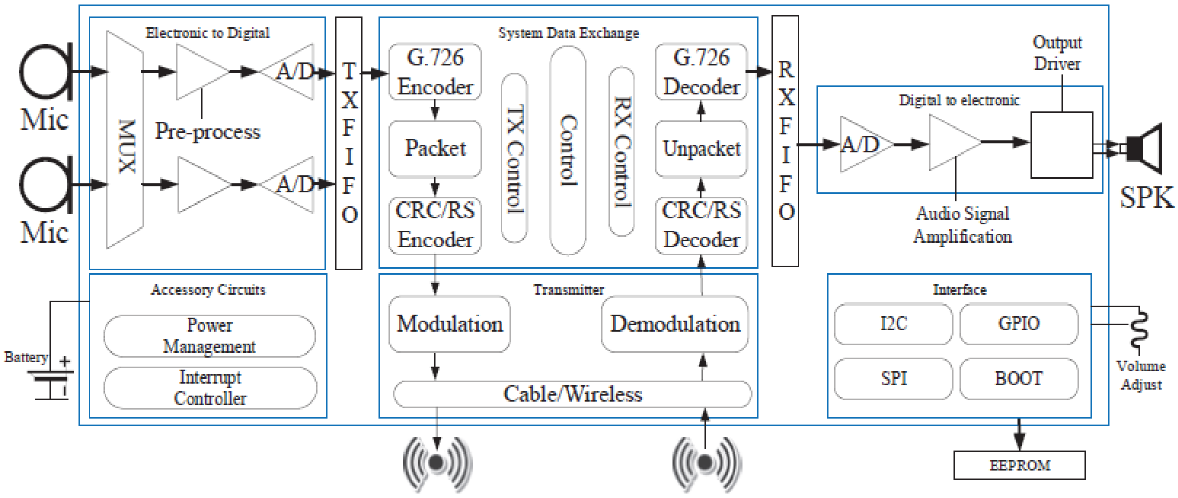


Figure 9. Top-level system block diagram of the earpiece.

4.1. The Electronic to Digital

The electronic to digital signal module comprises a pre-process and the 16-bit, 2-MHz A/D. The pre-process amplifies and adjusts the signal from the microphones to meet the requirements of the A/D, which converts the analog data to digital data and then outputs them for further processing.

4.2. The Signal Data Exchange

The system data exchange module controls data flow. Firstly, the frame structure is Introduced. Then, the circuit design of the data exchange module implementation is presented. Finally, the optimized operating scheme for reducing power consumption is discussed. There are two separate controllers: one is for the transmitter, which sends a control signal to start the transmission process, while the other is for the receiver, which receives "to-do" signals if it detects a packet in the receiver FIFO.

4.2.1. The Packet Definition

The packet definition has been designed for minimum delay with excellent detection error abilities, as shown in Figure 10. A complete packet consists of three parts: the packet preamble, the packet header, and packet data. The same data structure is used in both systems, i.e., from the earpiece side tithe MCP and from the computing side to the earpiece side. In order to increase the effective data rate, the packet preamble and the packet header are both as small as possible.

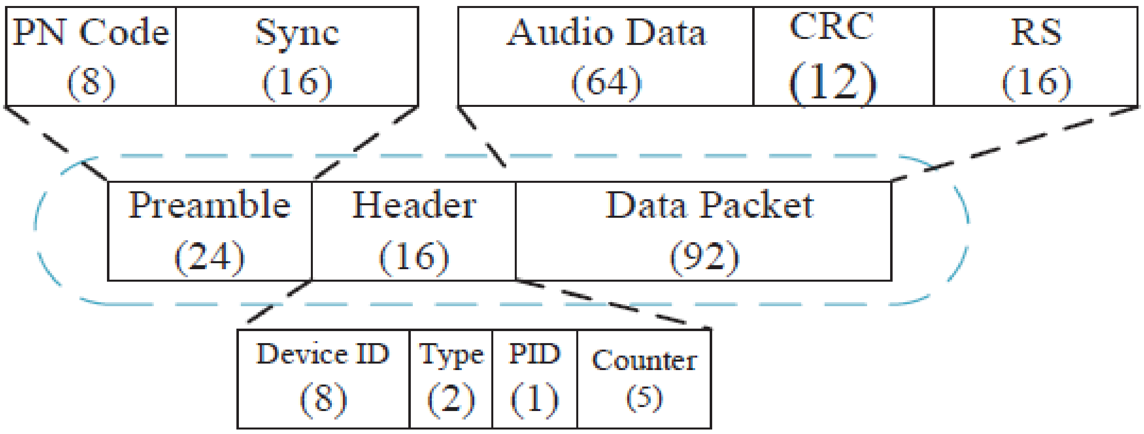


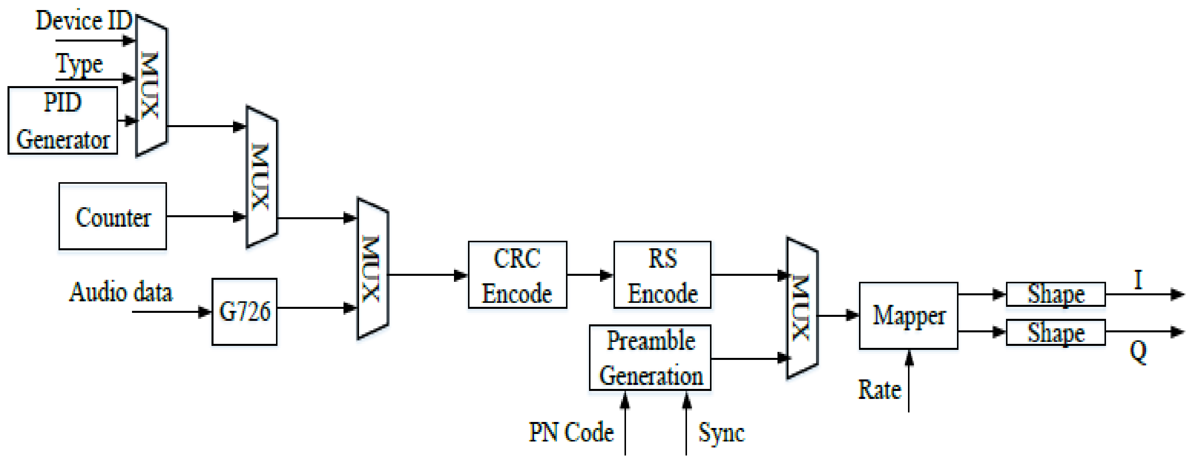
Figure 10. Packet definition.

The packet preamble mainly contains two parts: The Node and sync. The purpose of the PN Code is frequency offset estimation and automatic gain control during receiver demodulation, and then code is the 8-bit content sequence. Sync provides receiver clock synchronization, and the receiver uses the correlate to perform correlation matching according to the 16-bit synchronization judgment word defined in the register in advance. When the matched bit number is greater than a certain set value (such as seven), it is considered during synchronization and starts receiving a packet. The packet header consists of the device ID, the type, the Packet Identification (PID), and the counter. The Device ID is a unique 8-bit code that identifies the individual HA and MCP. The type indicates the type of packet that is sent, such as control data or audio data. The PID is a single bit that normally alternates with each new packet sent, but it only appears if the previous packet header was received correctly and its PID bit has the expected value. If the received PID bit is the same as that in The previously-received packet, retransmission is required. The counter is the easiest and fastest way to judge whether to lose packets. Packet data contain user data, the Cyclic Redundancy Code (CRC), and Reed–Solomon (RS) Code. User data are loaded by the audio data. A 12-bit CRC (polynomial X12+X11+X3+X2 + X + 1) is adopted to detect errors in each user data block (the user data and the CRC) protected by an Error-correcting code. Whenever there is active voice data of 2 mms in the TX_FIFO, "TX_data_already", and a packet is automatically constructed with the preamble and the header. After a complete packet has been successfully constructed and transmitted, this process will be performed continuously and automatically.

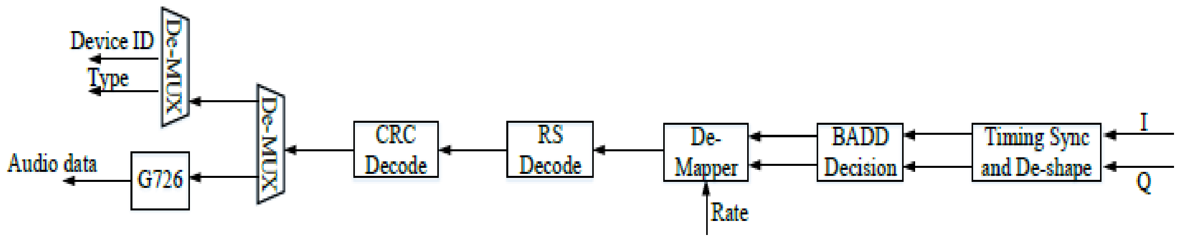
4.2.2. Transmit Processing

As shown in Figure 11a, transmission processing is mainly composed of the following steps: First, the audio data from "TX_fifo" is compressed by the G.726 encoder to reduce the data rate. Then, the controller constructs a data packet whenever there is more than one block of data from Step 1.

Finally, A CRC and RS are joined to the data. In this way, a complete data transmission package is constructed and sent to the transmitter device. There are two paths: the first path is to generate the packet preamble and the packet header, while the second path decodes the audio data and CRC Reoperation's that are required before transmission.



(a) Proposed transmitter



(b) Proposed receiver

Figure 11. Proposed diagram of the system data exchange module.

4.2.3. Receive Processing

As shown in Figure 11b, I and Q signals are received through timing sync and de-shape, while the BADDidentifies the relevant word indicating the start of the packet. De-mapper processing starts after receiving this. The RS decoder performs forward error correction on the entire packet. After error correction, the CRC decodes the data and identifies uncorrectable errors. Data are discarded or retransmitted according to the rules we have established. If the data packet has no wrong block, the restored data of G.726 are stored in “RX_FIFO” for further processing

4.2.4. The Operating Scheme

We designed the system as a memory-mapped hardware state machine, which can reduce power consumption. The signal data exchange module control state machine is shown in Figure 12. We optimized the operation scheme to reduce the power consumption. Clock gating was

used to reduce system power. There are four states: powering off, idling, transmitting, and receiving. In the powering off state, the whole system power is shut down, and there is no power consumption. In the idle state, there is only the controller with the clock, while the other blocks are turned off. In the transmitting and receiving states, the uncorrelated clock of blocks is turned off. The system default state is power off. When there is power supply and the command “power on” is detected, the idle state appears. The powering off instruction is to close the controller. In the idle state, “TX start” and “RX_start” refer to entering the transmitting or receiving state, while “TX complete” and “RX_complete” refer to entering the idle state. In the transmitting state, the instructions
“Tx_complete” and “RX_start” are detected simultaneously, and then, it directly jumps to the receiving state. Similarly, in the receiving state, it can jump directly to the Transmitting state.

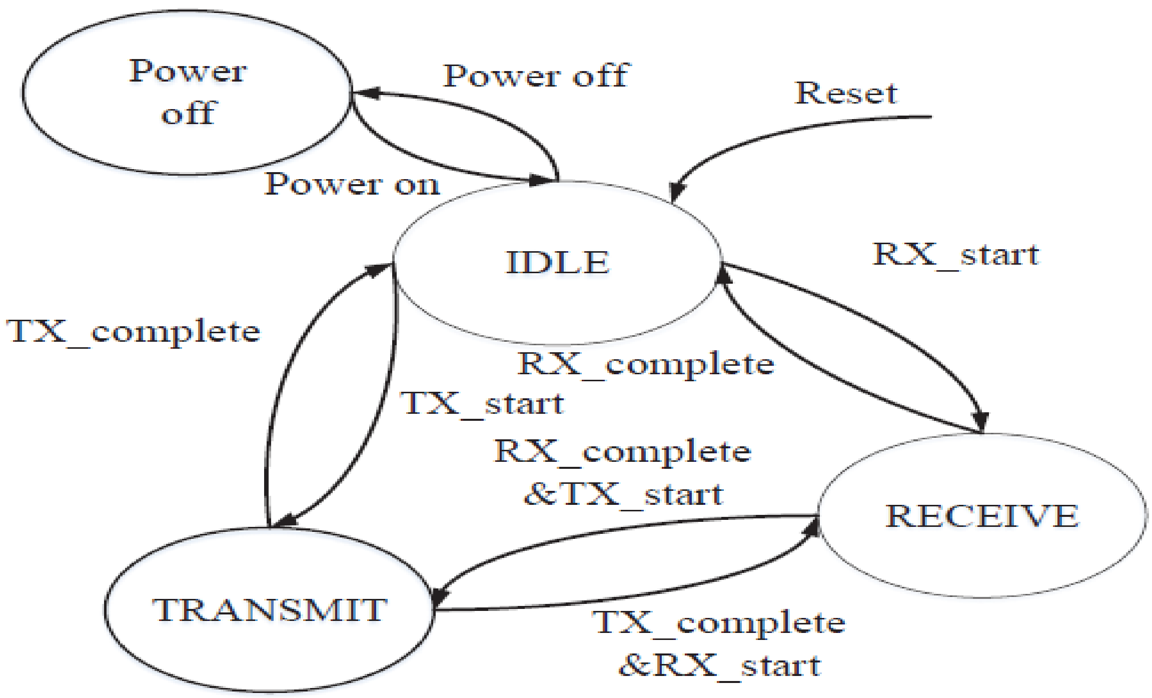


Figure 12. Signal data exchange control state machine.

4.2.5. Packet Exchange

As already described in the packet structure definition, we define whether a bit a Packet is Identification (PID) and the role of this bit are mainly to detect whether there is packet loss. When the previous packet header is correctly received and its PID bit has the expected value, this bit will be inverted when the next transmission is performed. If the received PID bit is not expected, this may also be considered as packet loss. As shown in Figure 13, T (Time) 1–T4 show the normal packet exchange, where the PID bits sent in each direction alternate between zero and one. T5–T9 show one of two ways of losing packets, whereby the earpiece has received a packet from the MCP with the same PID as that in the previously-received packet. This PID shows that the MCP did not receive the last packet. Another way of losing packets is shown in T10–T15, whereby the MCP has not received a response packet from the earpiece within the configured timeout (the adjustable preset value in the register). Then, the MCP will repeat the last sent packet without changing the PID bit, until receiving the response from the earpiece.

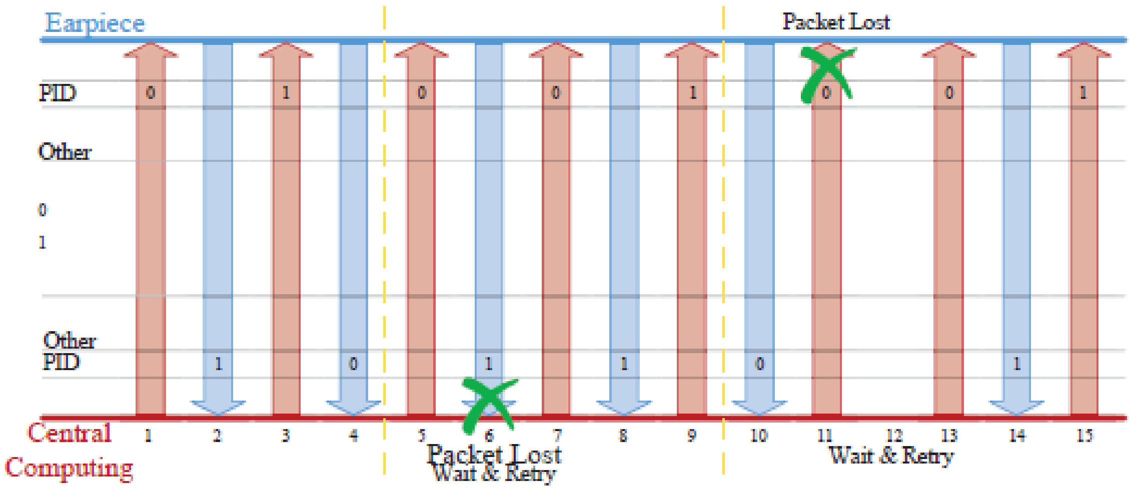


Figure 13. Flow of packet exchange.

4.3. Digital to Electronic Module

The digital-to-analog converter and the up-sampling and output driver constitute the Digital-to-electronic module, which converts digital pure audio data to analog signals; the housingspeaker regenerates the voice playback

4.4 Advantages

1. Improve your communication
2. Stay safe
3. Maintain your brain health
4. Fix your tinnitus
5. Spend quality time with family
6. Take charge of your hearing health
7. Hear better

4.5 Disadvantages

1. Expensive
2. too small for directional mikes
3. can be hard to change batteries
4. prone to feedback
5. Fits deeper into the ear canal.

4.6 Applications

1. the large distance between the microphone and the speaker prevents the occurrence of acoustic feedback
2. possibility to implement more convenient application control functions for people with poor motor skills
3. using of various types of headphones and headsets
4. it is possible to achieve the highest sound pressure level and get high sound quality (due to large speakers and a long battery life)
5. resistant to ingress of earwax and moisture;
6. it is possible to use more complex audio signal processing algorithms and a higher sampling rate (because of capacious batter)
7. software flexibility

CHAPTER -5
CONCLUSION

- We developed a smart binaural HA structure based on an MCP. Compared to the traditional algorithms, the proposed architecture can design more complex algorithms without being limited by power consumption and complexity, thereby enhancing speech intelligibility.
- Through designing advanced speech algorithms and accessible applications, there is a great potential for customized HA.

Removing built-in processors and combining HA with MCPs led to these advances. Objective data analysis and theoretical analysis showed an improvement in the user experience. These test results will arouse the interest of HA designers

CHAPTER-6
FUTURE SCOPE

In the future, hearing aids will be wirelessly connected to a wide array of audio products. This will be possible because digital wireless technology is becoming ubiquitous in consumer electronics. An increasing number of products are being produced with wireless capabilities. More importantly, audio products that hearing aid wearers want to listen to are being made with digital wireless technology embedded in the product, making them easier to connect to hearing aids wirelessly. If a television, for example, is transmitting its audio wirelessly, then a wireless receiver can be added to the hearing aid so that the hearing aid wearer can listen to television audio that is not subject to room reverberation and not worry about bothering others in the room with a loud television.

All of this wireless development would still not make connectivity easier for hearing aid wearers if every device transmitted sound with different technology. Bluetooth, however, has become a standard that manufacturers have agreed to use when they digitally transmit their audio. This allows other products with a Bluetooth receiver to pick up the transmitted audio and play it without any specialized design requirements. A single Bluetooth receiver in or attached to a hearing aid can receive sound from all sorts of sound sources: televisions, radios, cell phones, MP3 players. The use of Bluetooth for public broadcast systems as an alternative to loop systems has also been suggested.

Hearing aid companies are now creating Bluetooth accessories that plug into a BTE hearing aid's direct audio input. These accessories provide a wireless link between hearing aids and cell phones such that the cell phone audio is transmitted directly to the hearing aid for listening.

CHAPTER-7

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