Implementation of Digital Stereo Amplifier for Mobile IT Devices based on Wireless Communication System using Bluetooth

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A design and implementation method of wireless digital amplifier for mobile IT devices.

- Efficiency of analog amplifier is low.
- Heat sink can not be used.
- Most IT devices have wireless communication functions.
Overview of Bluetooth

- Bluetooth is an example of a wireless PAN that allows devices within close proximity to join together in ad-hoc wireless networks in order to exchange information.

- A Bluetooth PAN is also called a piconet, and is composed of up to 8 active devices in a master-slave relationship.

- The first Bluetooth device in the piconet is the master, and all other devices are slaves that communicate with the master.

- A piconet typically has a range of 10 meters, although ranges of up to 100 meters can be reached under ideal circumstances.
Bluetooth: Characteristics

• 2.4 GHz ISM band, 79 RF channels, 1 MHz carrier
  Channel 0: 2402 MHz … channel 78: 2480 MHz

• FHSS /TDD /TDMA

  Frequency hopping with 1600 hops/sec fashion, determined by a master

  Time division duplex for send/receive separation
  Because more than 2 devices share the Piconet the access technique is TDMA.
FHSS

Graph showing frequency distribution with labels:
- $1 \text{ Mhz}$
- $83.5 \text{ Mhz}$
- $123$
- $79$

Diagram explaining:
- $r_w = \text{dwell time}$
- $f_c = \text{bandwidth}$
TDD/TDMA

![Diagram showing TDD/TDMA time slots](image-url)
Piconet
Bluetooth Connecting Process

- Inquiry
  - Page
  - Master Response
  - Connection

- Inquiry scan
  - Inquiry Response
  - Page scan
  - Slave Response
  - Connection

Master → Slave
Bluetooth Profiles

• A **Bluetooth profile** is a wireless interface specification for Bluetooth based communication between devices. In order to use Bluetooth technology, a device must be compatible with the subset of Bluetooth profiles necessary to use the desired services.

• **Advanced Audio Distribution Profile (A2DP)**
  This profile defines how high quality audio (stereo or mono) can be streamed from one device to another over a Bluetooth connection. For example, music streamed from a mobile phones to a wireless headset.
The profile defines two roles of an audio device: source and sink.

**Source (SRC)** – A device is the SRC when it acts as a source of a digital audio stream that is delivered to the SNK of the piconet.

**Sink (SNK)** – A device is the SNK when it acts as a sink of a digital audio stream delivered from the SRC on the same piconet.
IEEE 802.15-1 – Bluetooth Summary

• **Transmission range**
  POS (Personal Operating Space) up to 10 m
  with special transceivers up to 100 m

• **Frequency**
  Free 2.4 GHz ISM-band

• **Security**
  Challenge/response, hopping sequence

• **Advantages**
  Integrated into several products, available worldwide,
  free ISM-band, several vendors, simple system
Comparison of Bluetooth with other standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>802.11b</th>
<th>802.11g</th>
<th>802.15.1 Bluetooth</th>
<th>802.15.4 ZigBee</th>
<th>802.16 WiMax</th>
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<tbody>
<tr>
<td>Frequency Band</td>
<td>2.4 GHz</td>
<td>2.4 GHz</td>
<td>2.4 GHz</td>
<td>2.4 GHz</td>
<td>2-66 GHz</td>
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<tr>
<td>Maximum Range</td>
<td>~100 meters</td>
<td>~100 meters</td>
<td>~10 meters</td>
<td>~10 meters</td>
<td>~50 Km</td>
</tr>
<tr>
<td>Maximum Data Rate</td>
<td>11 Mbps</td>
<td>54 Mbps</td>
<td>3 Mbps</td>
<td>250 Kbps</td>
<td>134 Mbps</td>
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<tr>
<td>Access Method</td>
<td>DSSS</td>
<td>OFDM</td>
<td>FHSS</td>
<td>DSSS</td>
<td>SOFDMA</td>
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<tr>
<td>Modulation Method</td>
<td>DPSK, DBPSK, DQPSK</td>
<td>BPSK, QPSK, 16-QAM, 64-QAM, DBPSK, DQPSK</td>
<td>GFSK, 2PSK, DQSP, 8PSK</td>
<td>BPSK, OPSK</td>
<td>QPSK, QAM</td>
</tr>
</tbody>
</table>
System Components

- Transreceiver
- Class-D Amplifier
- Digital-to-Digital Converter (DDC)
Hardware Design
Software Design

Start

Port Setting

Baud Rate Setting

UCSRB Setting

LCD Initialize

Keypad Input?

In case of pressed '1'
Transmit toTx_data = 0x01
LCD display
LCD clear after delay time

In case of pressed '3'
Transmit toTx_data = 0x03
LCD display
LCD clear after delay time

In case of pressed '5'
Transmit toTx_data = 0x05
LCD display
LCD clear after delay time

In case of pressed '7'
Transmit toTx_data = 0x07
LCD display
LCD clear after delay time

In case of pressed '9'
Transmit toTx_data = 0x09
LCD display
LCD clear after delay time
Class D Amplifier
Design of Digital Stereo Amplifier

• The TPA3004D1/2 is a 12-W (per channel) efficient, Class-D audio amplifier for driving bridged-tied stereo speakers.
• The high efficiency of the TPA3004D2 eliminates the need for external heat sinks when playing music.
Conclusions

• The wireless class amplifier is designed and implemented using TPA3004D2 and Bluetooth chipset.
References


Questions