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Transmission of Analog Audio Signal through Wireless Medium Using Radio Frequency

Group Number: D12
Nikhil Pande (04d07026) <nikhilhp@ee.iitb.ac.in>
Vishal Agarwal (04d07008) <vishalagr@ee.iitb.ac.in>
Saurabh Shintre (04d07006) <saurabh@ee.iitb.ac.in>

Supervisor: Girish Kumar
Course Instructor: H. Narayanan

Abstract

The report discusses details related to transmission of analog audio signals through wireless medium using Radio Frequency. The project is aimed at developing Wireless Headphones. Most of the presently available wireless headphones work on Infra Red frequencies. This restricts their range, directivity and issues regarding bandwidth. The device discussed in the report will be able to send the data over a range of 10 meters and a bandwidth of 100 Kbps. The range and bandwidth is much greater than the Infra Red headphones can be further increased with improved Antennas and higher carrier frequency. The micro-controller is used to configure the Transmitter and Receiver chips and also for signal processing. The circuit is tested to send analog data at above mentioned rate. The product is cost effective and the price can be reduced a lot in case of mass production.

1. Introduction

The product aims to develop a cost effective wireless headphone. This headphone will function in the same manner as that of the wired headphone. The features of the headphones are as follows:

1. Stereophonic sound
2. Range of 10 meter
3. A bandwidth of 100 Kbps

In this process the analog data coming out from computer is first digitized by sampling using the inbuilt ADC in the microcontroller. The data is then processed and each bit is converted into its Manchester Code [1] equivalent. This data is then serially transmitter using a RF transmitter operating at 433 MHz frequency. On the receiver side the data is buffered in the micro-controller and decoded back from the Manchester equivalent. The data is then fed into the DAC and from there to the headphone speakers. All the time the

two stereophonic lines (left and right) are separately dealt with. While transmission they are multiplexed with respect to time, hence retaining their originality.

For the RF transmission, the module used is Maxim 1472–1473 transmitter-receiver module. This is a 433 MHz Crystal operated Low Power, ASK module. The antenna used is a 5 ohm dipole antenna.

2. Circuit Diagram

2.1 Transmitter Circuit Diagram

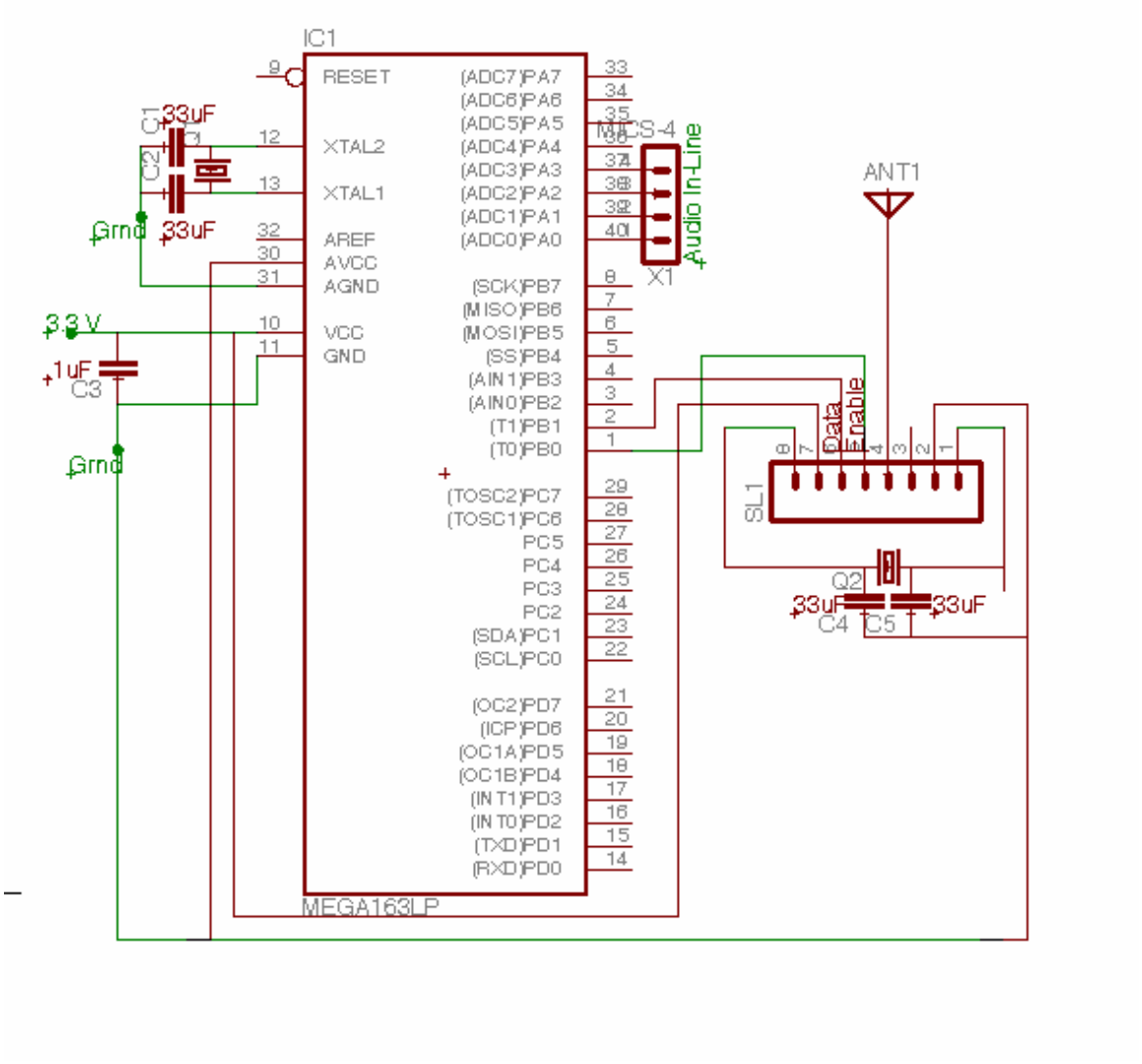

Fig. 1: The Transmitter Circuit

2.2 Receiver Circuit Diagram

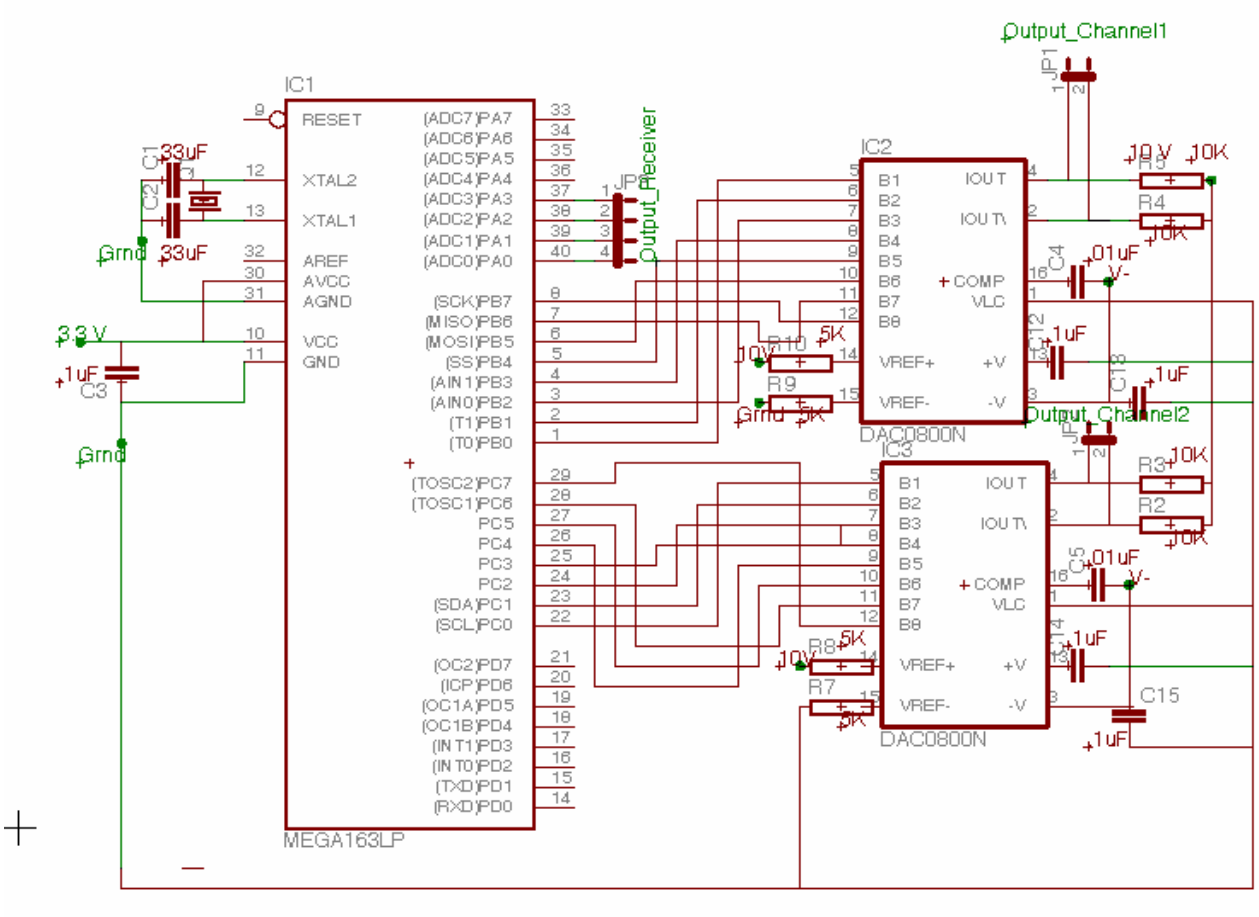

Fig. 2: The Receiver Circuit

3. Transmitter

3.1 Input Signal

This part of the circuit has an Audio Jack Plug [2] that is inserted into the audio port of the computer. The audio port has three terminals: The left line, the right line and the common ground. The left line and the right line work independently in the case of stereophonic sound and hence need independent processing. The output of the Jack plug is directly fed into the port A of the Microcontroller for sampling.

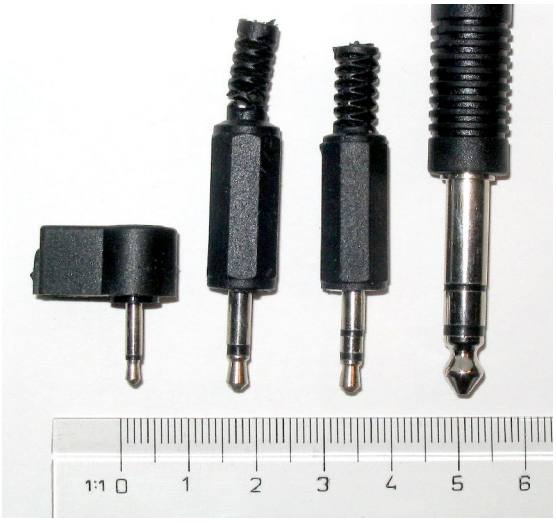

Fig 3: The Audio Jack Plug

3.2 Data Processing

This section of the transmitter involves sampling of data by the ADC at a rate of 4 MHz. The bits are then stored in the buffer of the microcontroller. These bits are then converted into the Manchester codes and then serially sent to the transmitter chip. To configure the transmitter chip, a high signal is given on the chip enable bit on the port B. This ensures the Max1472 chip in the transmission mode for the entire duration. The data is then serially transmitted through the chip.

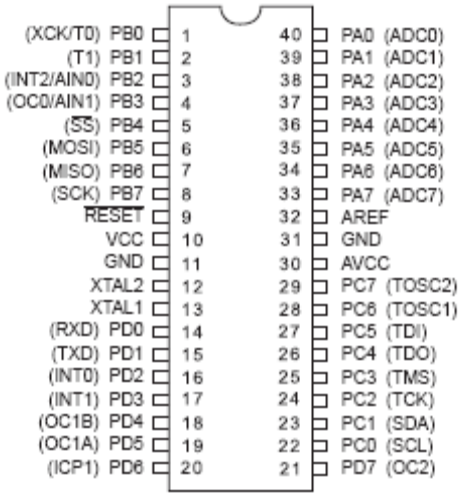

Fig.4 Pin configuration of ATMEGA 16 L Microcontroller.

3.3 Transmitter Chip MAX1472

For the transmission purpose, MAX 1472 is used. This module uses a 5 ohm antenna and transmits data at a crystal defined frequency. We have used a crystal so as to enable transmission at 433 MHz central band. The chip uses Amplitude Shift Keying (ASK) for the modulation of the data.

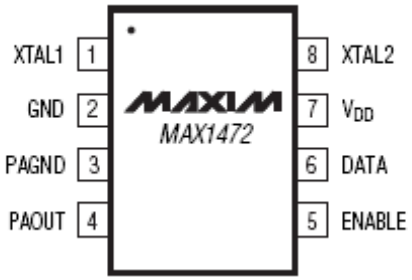

Fig.5 Pin configuration of MAX1472 Transmitter chip

4. Receiver

4.1 Receiver Chip MAX 1473

The receiver chip MAX1473 is configured in the reception mode using four ports. The receiver sends the received data to the microcontroller thought the data port serially after demodulation. The demodulation is done by the chip itself. The antenna used at the receiver is again a 5ohm, 433 MHz antenna.

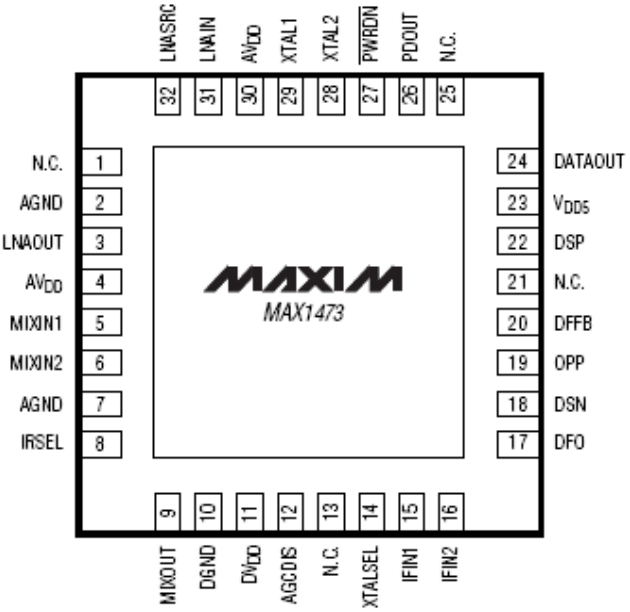

Fig. 6 Pin configuration of MAX1473

4.2 Data Processing

This state again involves use of the Microcontroller Atmega16. The data sent by the receiver is in the Manchester code format. This data is converted back into the initial bytes and then sent to the DAC for analog conversion. The data is put on the port C and B of the microcontroller for the two separate audio lines.

4.3 Analog Conversion

The next level makes use of DAC 0800 chip to convert the incoming digital signal into its analog equivalent. Two DAC's are used separately for different audio lines (Left and Right). The DAC's reconstructs the analog signal from the digital signal received. The output of the DAC is given to the headphones.

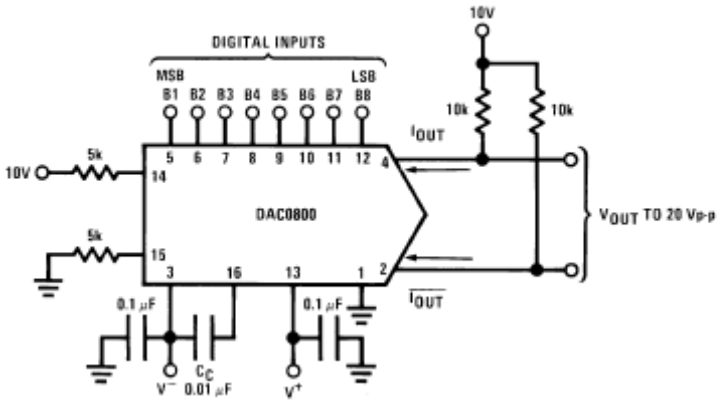

Fig. 7 Pin configuration of the DAC

5. Work Done on CC2500

While working on this EDL topic, a lot of work has also been done on the transreceiver chip CC2500. This chip used FSK for modulation at 2.4 GHz carrier wave and hence provided a high bit rate of 500 kbps. This module unfortunately did not worked and hence we had to shift to the MAX1472 MAX 1473 chips for the wireless mode.

Following is the configuration cycle of CC2500 from the data sheet. Also attached is the code written for CC2500 configuration.

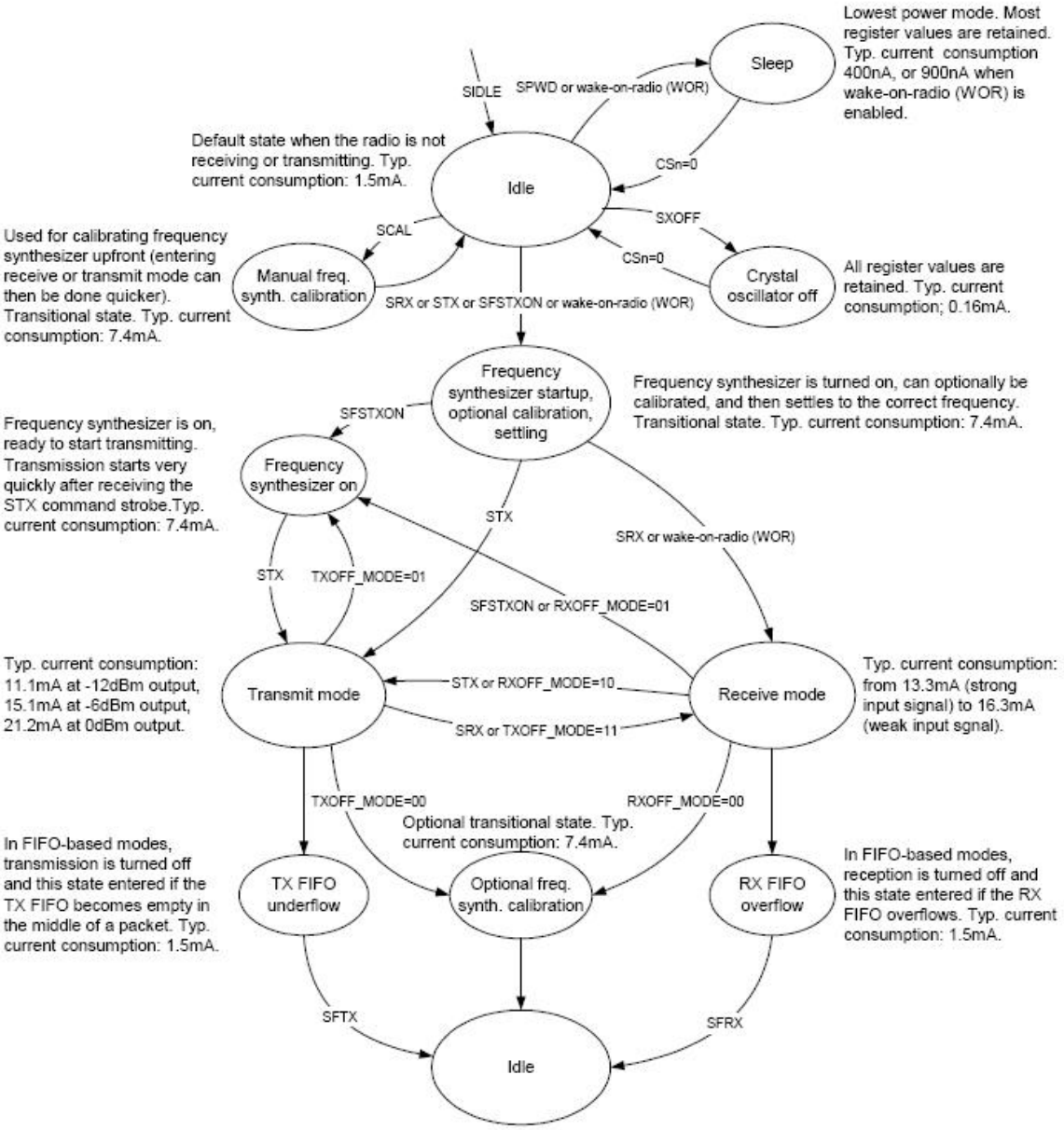

Fig 8. CC2500 configuration diagram.

6. Tests and Results

Following tests were planned and the expected results were obtained.

6.1 Configuration of the Microcontroller

The microcontrollers on both the sets were tested for their individual codes. The transmitter microcontroller was given a sinusoid input at the ADC of Port A. Then the signal was sampled there at 4MHz and was sent serially to the transmitter chip MAX1472. The output at the data input line of MAX1472 was observed on digital oscilloscope and was verified with the input signal.

The Microcontroller on the receiver side was tested as follows. A sinusoid signal was given at the port A of the microcontroller for ADC. The bits were then output at Port B. The samples were seen to be in accordance of the input signal.

6.2 Transmitter Chip MAX1472

The transmitter chip MAX1472 was tested with the microcontroller. The chip enable was given a high at the port for transmitting the data. And the data, the digital samples of a sine wave was sent over the wireless media. The output was observed on a spectrum analyser. The output saw a peak in the power at 433 MHz on the spectrum analyzer.

6.3 Receiver Chip MAX1473

The receiver chip MAX1473 was tested with the function generator. Using the transmitter signals (Samples of sine wave) were transmitted and were received by the receiver. The data was observed on the digital oscilloscope and was verified to be the original one.

6.4 DAC 0800

The DAC was tested using the microcontroller. A sine wave was sampled first in the Microcontroller and was then sent at the other port. The other port was connected to the DAC input pins. The output was observed and a approximate sine wave was seen on the output.

6.5 As a whole project

The product was not tested as a whole as the receiver chip got damaged after initial testing.

7. Conclusion

The project could not be completed within the given time as the receiver chip had got damaged. Following are the conclusions of the tests that were done.

1. Audio signals can be transmitted over the wireless media at a data rate of 40Kbps.
2. The circuit is suitable for the RF transmission for both its data rate and range.

8. Future Improvisations

Following things can be incorporated in the present module.

1. DAC's ought to be changed as the present one require a high range of voltage to operate upon.
2. Overall size of the circuit has to be reduced so as to give a product shape. Present microcontroller and DAC should be replaced by their QFN chips and low power equivalents
3. The Transmitter and Receiver have to be replaced by chips which can have micro strip antennas so as to reduce size and improve band rate.

9. Reference

[1] "Huffman Code" http://en.wikipedia.org/wiki/Manchester_code, accessed on March 2007
[2] "Audio Jack Plug" http://en.wikipedia.org/wiki/Jack_plug, accessed on February 2007