Team Power Audio Solutions
School of Engineering Science
Simon Fraser University
Burnaby, BC, V5A 1S6
tp-audio@sfu.ca

February 17, 2004

Dr. Lakshman One
School of Engineering Science
Simon Fraser University
Burnaby, BC, V5A 1S6

Re: ENSC 440 Functional Spec for Digital Audio Input Speakers

Dear Dr. One,

Attached is the document, *Functional Spec for Digital Audio Input Speakers*, which describes the functionality of our project as described in the proposal submitted previously. This proposal can be found at http://www.sfu.ca/~bmpun/teampower/documents/TeamPower_proposal_rev4.pdf for reference purposes.

Currently, we are designing and building a speaker with a built in amplifier that accepts a digital input signal. This allows the speaker to interface directly with a computer, CD, or DVD player with digital output, which eliminates the need for a separate amplifier enclosure and reduces noise introduced into the signal between the amplifier and speaker.

This functional specification will lay out a detailed explanation of each component in our system as well as the system as a whole. It will give a concise definition of our project goals as well as clearly reiterate our project budget and timeline as defined in the latest revision of our project proposal.

Team Power Audio consists of a group of three motivated engineering students of diverse abilities and a common goal in our proposed project. Members of Team Power include **Dave Steele**, **Brandon Pun**, and **James Lu**.

Should you have any questions, comments, or concerns, please feel free to contact us at our group e-mail: 440-team-power@sfu.ca. Or please contact our CEO, Dave Steele, by phone at 604-944-2626 or 604-944-6716 after hours. We thank you for your time and effort.

Sincerely,

Dave Steele

Dave Steele
President and CEO

Team Power Audio Solutions

Enclosure: Functional Specification for Digital Audio Input Amplified Speakers

Functional Specification for

Digital Audio Input Amplified Speakers

Project Team: Dave Steele
Brandon Pun
James Lu

Contact Person: Dave Steele
440-team-power@sfu.ca

Submitted to: Dr. Lakshman One – ENSC 440
Nakul Verma – ENSC 440
Michael Henri Sjoerdsma – ENSC 305
School of Engineering Science
Simon Fraser University

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Date: Feb 18, 2004

Executive Summary

A stereo system composed of CD player, amplifier and speakers makes up a common appliance that is found in almost every household in one form or another. Ranging from a simple all-in-one CD player to a full-scale surround sound system, music and the ability to play it on demand, is an integral component of North American culture. Common problems with existing amplifier systems come from interference in the wires between speaker and amp as well as heat and lifting issues that come from having a localized amp.

The *Team Power Audio Solution* is an amplifier and power supply built into a speaker box that decodes a low-power digital audio input signal rather than the high-power analogue signal that is common to systems today. By using this system, we decentralize power amplification allowing for better heat reduction and mobility of an audio setup, as well as eliminate audio interference in the wires connecting the speakers to their source.

This functional specification will deal with the *Team Power Audio Solution* on many levels but with priority given to describing the first two prototyping stages. The purpose of this project is to be taken primarily as a proof of concept, and our progress should be viewed as such. Care will be taken, however, to point out differences between prototype and final production product where it is important to distinguish.

The *Team Power Audio Solution* ultimately makes for a simpler, more versatile home audio setup by removing the middleman that is the stereo amplifier of the olden-days. At *Team Power*, we strongly believe that our system is the way of the future for home and industrial audio electronics and we are committed to make that belief a reality.

Table of Contents

1) Introduction

1.1) General

The *Team Power Audio Solution* is a next generation home or industrial audio system that is based on moving the amplifier stage away from a centralized amp unit and into the individual speakers themselves. By doing so, we enable the audio signal to be sent to speakers by means of a low power digital signal rather than a relatively high power analogue signal. This will lead to a drastic reduction in signal interference that can occur on the line between speakers and traditional centralized amps.

In addition to simply moving the amplifier stage within the speaker, we are attempting a fairly novel amplifier design that uses a switch mode power regulator to behave as a single stage amplification circuit by feeding the digitized audio signal into the control algorithm in place of a steady reference voltage (see Figure 1). By designing it in this way, we hope to improve the overall efficiency of the device as well as further reduce interference that may introduce itself between amplification stages of a traditional audio amp.

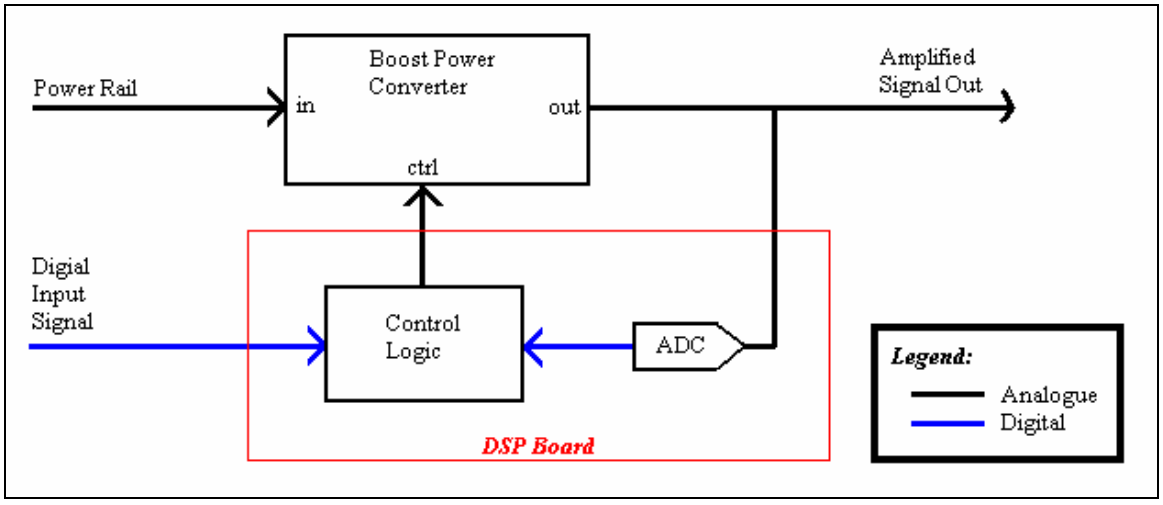

Figure 1: Logic Flow

This functional specification will define the functional requirements of the system as defined in Figure 1.

1.2) Scope

As was previously mentioned, the scope of this project is limited to two prototype phases and does not cover that of the production device. With this in mind, however, the final production model is discussed frequently in this document, as it is necessary to have the long term goal in mind at all times when writing specifications for early prototypes.

The first prototype is expected to be complete on time for presentation March 11th, 2004, and is intended as a bare-bones proof of concept model. The second prototype is expected to be complete near the beginning of April 2004, and will be essentially a scaled-up version of the first prototype, hopefully capable of amplifying an audio sample without significant distortion. These requirements will be further discussed at a later point in this document.

1.3) Notation

To maintain consistency with sample project documentation, throughout this document, we will use the notation **R[#]** to denote functional requirements.

Ex: **R[0]** The production unit will sell for under $300

This notation is intended to improve ease of reading as well as quantify our design goals in a way that promotes timeline tracking and self-evaluation as the project progresses.

2) Requirements

2.1) System Overview

In the final production product, the amplifier will be housed in the speaker enclosure. Each speaker will need to be plugged into a standard 120VAC house outlet for power. To provide an audio signal, a digital SPDIF (Sony/Phillips Digital Interface) connection is made from a computer, CD, or DVD player to the speaker. To adjust the volume, the user simply moves the volume knob on the top of the speaker. Figure 2 shows these connections conceptually.

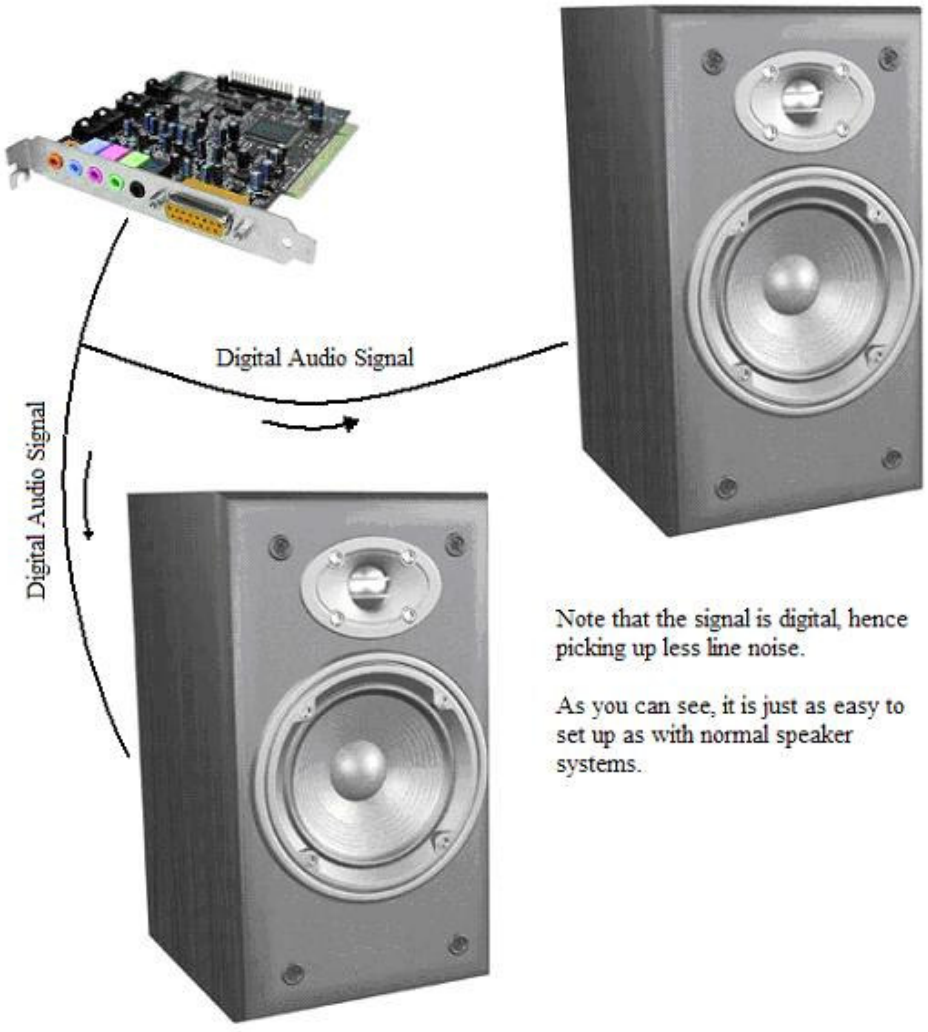

Figure 2: System Overview Concept Drawing

2.2) Physical Requirements

The physical requirements **[R1]** through **[R8]** stated below are for the production unit. They do not apply to the proof of concept prototype.

R[1] The production unit dimensions will be 15.50(W) x 31(H) x 22(D) cm

R[2] Power and SPDIF connections shall be made at the rear of the unit

R[3] A volume control and power switch shall be provided on the top of the unit

R[4] An LED mounted on the top of the unit will signal that the unit is on

R[5] A speaker driver will be mounted on the front of the unit.

R[6] The unit shall be powered by 120VAC from a standard wall outlet

R[7] The enclosure will have sufficient ventilation for the electronic components inside

R[8] The enclosure will be strong enough for the system to not be damaged during normal setup

The physical requirements **R[9]** and **R[10]** are specific to the proof of concept prototype.

R[9] The poof of concept prototype will be ventilated sufficiently.

R[10] The system will be powered by 120VAC from a standard wall outlet as well as 2 linear DC power supplies.

2.3) System Requirements

2.3.1) Environmental

The environmental requirements apply to both the production unit and the proof of concept prototype.

[R11] The production unit will operate in temperatures between 10 – 40 degrees Celsius

[R12] The unit will function in humidity of 10-80% (non-condensing)

2.3.2) Performance

The production unit requirements are **R[13]** – **R[17]**

R[13] The unit will be able to output 5 watts output power per channel

R[14] The unit will be able to output frequencies between 100Hz-10kHz

R[15] The Total Harmonic Distortion of the system less than 1%

R[16] Amplifier efficiency will be greater than 80%

[R17] Less than 2 seconds system start up time

Proof of concept prototype requirements are **R[18] – R[19]**

R[18] The proof of concept prototype will have 500mW output power

R[19] The prototype will be able to output frequencies between 100Hz-1kHz

2.3.3) Compatability

R[20] The production unit will accept an SPDIF digital audio signal from a computer, CD player, or DVD player.

R[21] The proof of concept prototype will accept an analog input signal

2.4.4) Reliability and Serviceability

R[22] The production unit shall be able to be left on for 24 hours without failure

R[23] The production unit will not be serviceable by the user

3) Interface Requirements

The requirements **R[24]** – **R[26]** apply to the production unit.

R[24] The production until will have an on / off button on each speaker enclosure

R[25] A LED will illuminated when the speaker is turned on

R[26] There will be a control to raise and lower the volume of each speaker

4) Standards and Certifications

The proof of concept prototype will not be required to pass certifications or adhere to standards. However, the production unit will be built to meet relevant safety standards.

R[27] – The production system will adhere to CSA [1], CE [2], ETL [3] standards for consumer electronics

R[28] – The product will be certified by CSA and/or ETL

5) Testing Requirements

R[29] – Verify that the production unit can function for a 12 hour period over a range of output frequencies between 500Hz-5kHz with 1 watt output power.

R[30] – Verify the proof of concept prototype can output a 500Hz signal at 250mV

6) Documentation Requirements

A production unit will require documentation as explained in **R[31] – R[33].** The proof of concept prototype will have no formal user manual as its functionality will be explained during the demo.

R[31] The production unit will come with a "Quick Start" graphical user manual with step-by-step instructions showing user setup

R[32] The production unit user manual will be written in English

R[33] The production user manual will state the system's rated output specifications and operating conditions.

7) Conclusion

Due to the experimental nature of our project, we expect a high probability of unforeseen roadblocks to arise during our construction of the first prototype. With this in mind, requirements and goals for the first and second prototype may have to be slightly adjusted "on the fly". We are strongly committed, however, to producing a final product that fulfills the functionality requirements of this document, and we have high confidence that our proof of concept will be a success.

8) References

8.1) General References

[1] "Canadian Standards Association" February 2004, http://www.csa.ca
[2] "The Consumer Electronics Association" February 2004, http://www.ce.org
[3] "Intertek ETL SEMKO" February 2004, http://www.intertek-etlsemko.com