Digital Audio Evolution
Simon Fraser University
Burnaby, BC
V5A 1S6
Email: ensc-340@sfu.ca

October 18th, 1999

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC
V5A 1S6

Re: ENSC 340 Functional Specification: The iDAC (Digital Audio Cassette)

Dear Dr. Rawicz:

The attached document, *ENSC 340 Functional Specification: The iDAC (Digital Audio Cassette)*, details the functional specifications for our project for ENSC 340 (Engineering Science Project Course).

The purpose of the functional specification is to detail the problem that we are attempting to solve with the iDAC device. Within the specification, it is indicated which specifications will be completed for the project deadline in December and which specifications will be left to be completed during future development.

Digital Audio Evolution consists of four motivated, innovative, and talented third-year engineering students—Paul Gurney, President and CEO; Bill England, VP Finance; Scott Wakelin, VP Engineering; and Michael Hutchison, VP Production. The company can be contacted by phone at 294-0095 or by e-mail at ensc-340@sfu.ca should you have any questions.

Sincerely,

Paul Gurney, President and CEO
Digital Audio Evolution

Enclosure: *ENSC 340 Functional Specification: The iDAC (Digital Audio Cassette)*

Digital Audio Evolution

ENSC 340 Functional Specification: The iDAC (Digital Audio Cassette).

Submitted By	Digital Audio Evolution Paul Gurney, Bill England, Scott Wakelin, Michael Hutchison
Contact	Paul Gurney School of Engineering Science Simon Fraser University ptgurney@sfu.ca
Submitted To	Andrew Rawicz School of Engineering Science Simon Fraser University Steve Whitmore School of Engineering Science Simon Fraser University
Date	October 18th, 1999

Executive Summary

Advances in technology have made it possible to store near CD-quality music in digital form using a consumer device at an affordable cost. The emergence of the Internet as a viable music distribution medium has created the consumer need for devices that are capable of storing the music in a simple form that is compatible with current systems. The iDAC fills this niche market, allowing consumers the ability to store audio files in a device compatible with existing tape cassette players.

The development of the iDAC will occur in two phases. After the completion of the first phase of development, the iDAC will support three modes of operation, including play, stop, and record. In addition, the device will have the following features:

1. The playback of ADPCM, MPEG1 Layer 1 and Layer 2, and MPEG2 Layer 1 and Layer 2 encoded audio files.
2. The transfer of ADPCM encoded files from a Windows 95 compatible host computer to the device.
3. A bandwidth of 12 kHz at the audio output.
4. The storage of audio files for up to 30 years.

After the second phase of development, the device will also:

1. Conform to a tape cassette form factor.
2. Allow for increased modes of operation, including fast forward, rewind, and pause.
3. Support MPEG1 Layer 3, MPEG2 Layer 3, and AAC encoded data.
4. Include an improved Windows 95/NT graphical user interface.

The first phase of development in the iDAC will be completed in December 1999.

Table of Contents

Table of Figures

Revision History

Revision	Date	Description	Name
0.1	October.1.1999	Initial Version.	Michael Hutchison
1.0	October.14.1999	Added requirements, descriptions of sub-headings.	Paul Gurney
1.1	October.16.1999	Added executive summary.	Scott Wakelin
1.2	October.17.1999	Editing and proof-reading.	Bill England

Acronyms

AAC	Advanced Audio Coding
ADPCM	Advanced Differential Pulse Code Modulation
DAC	Digital to Analogue Converter
MP3	MPEG Layer 3
MPEG	Moving Pictures Experts Group
MTBF	Mean Time Before Failure
PC	Personal Computer
PCA	Printed Circuit Assembly

1. Introduction

The iDAC is a digital device capable of storing MPEG2 data for playback. The device resides in a standard tape cassette form factor and can store approximately 30 minutes of compressed music. Users treat the iDAC like a standard tape cassette, inserting it into a standard tape player for playback. The project will be developed in stages with a proof of concept device to be completed by December of 1999 and further development continuing after that.

1.1. Scope

This document describes the functional requirements that must be met by the iDAC device. These requirements are verifiable.

The requirements drive the iDAC design. The requirements are traceable into the design documents.

1.2. Intended Audience

Design Engineers will use this document to drive the requirements of the various subsystems.

The Project Manager will use this document to verify the project design.

1.3. Reference Specification

1.3.1. Applicable Documents

[1] *Engineering Science Communications Handbook 6th Edition,* S. Stevenson, S. Whitmore, 1996.

1.3.2. Reference Documents

[2] *ENSC340 Proposal: The iDAC (Digital Audio Cassette),* M. Hutchison, S. Wakelin, P. Gurney, W. England, September 20th, 1999.

[3] ISO/IEC 13818-1: Information Technology – Generic Coding of Moving Pictures and Associated Audio – Part 1: Systems, International Standards Organisation, N0801, November 13th, 1994.

1.4. Objectives

The following notations are used throughout this document:

[R#.#] A functional requirement.

[#] A document reference number.

To denote the prioritization of requirements, the symbol (*n*) is appended to the beginning of each requirement, where (*n*) means:

(1) Requirement will be met in proof of concept design.

(2) Requirement will be met during future development.

2. System Requirements

2.1. System Overview

This section is informative, and thus does not contain any strict requirements.

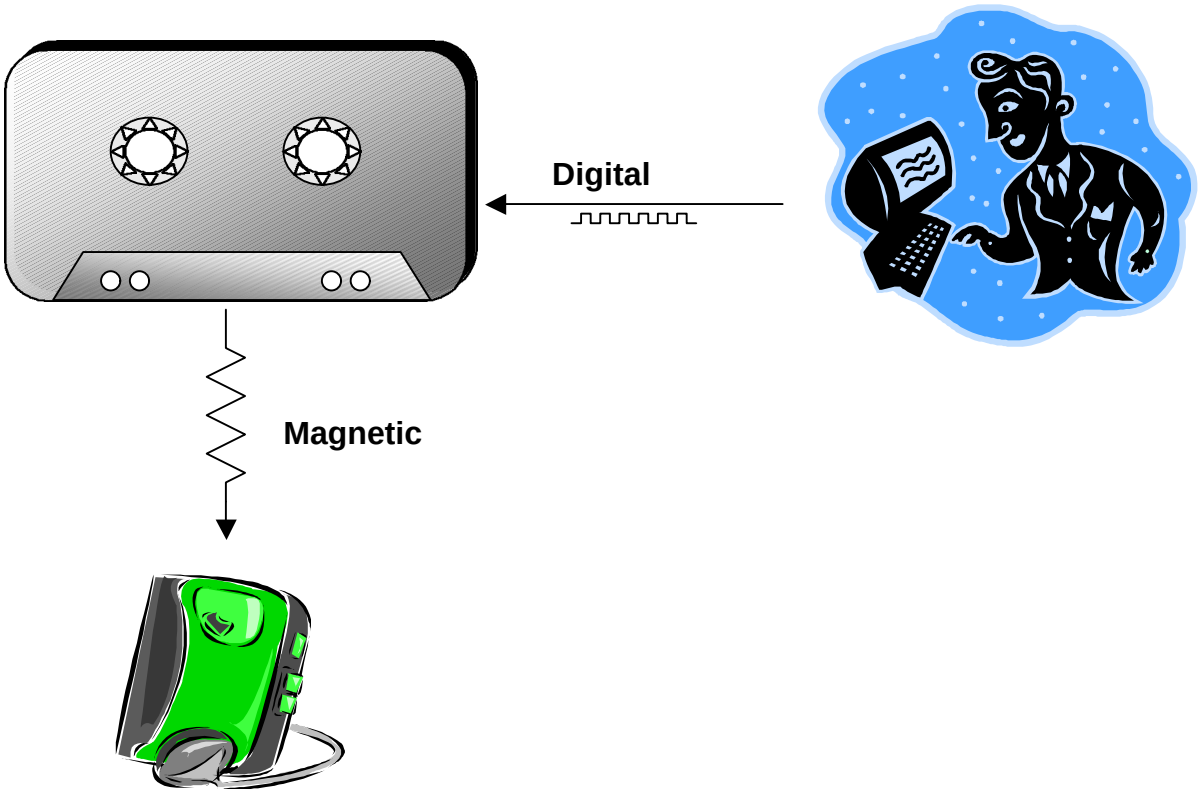

Figure 1 System Overview

The unit shall accept digital audio data from the user through the interface described in Section 3.1. The unit then stores this information in non-volatile memory onboard the device.

When the user wants to play the digital information, the unit is inserted into a standard tape player. When the unit senses a “Play” motion on the tape reels it begins decoding the digital audio into analog format and transmits it to the tape player through a magnetic transducer.

2.2. Physical Requirements

[R1.1] (2) The hardware PCA shall be able to reside within the form factor of a standard audio cassette.

[R1.2] (1) The unit shall connect to the host computer using a 100 mil spaced, single row, three-pin header.

[R1.3] (2) The unit shall contain two standard tape reel gears.

2.3. System Requirements

2.3.1. General

[R1.4] (2) The unit shall perform self-tests as requested by the host computer including:

a) Full read/write test of memory

b) Functionality of MPEG decoding hardware

c) Functionality of DAC hardware

d) Functionality of tape-drive sense hardware.

[R1.5] (2) Unexpected power failure shall not cause incorrect operation when unit power is restored.

[R1.6] (2) The unit shall detect the speed of the tape reels and select the appropriate mode of operation based on that speed, as per Section 2.4.

2.3.2. Performance

The iDAC will continue to function in a consumer environment. It will be used in the presence of vibration. It may also be accidentally dropped or stepped on. It must also operate under normal conditions without recharging for a reasonable amount of time.

[R1.7] (1) The host interface program shall be able to run concurrently with other host computer tasks.

[R1.8] (1) The unit shall recover gracefully from unexpected events, such as being ejected while playing.

[R1.9] (1) The unit shall continue to operate correctly in the presence of vibrations of up to 9Gs.

[R1.10] (1) The unit shall not be harmed by shocks of up to 100Gs

[R1.11] (2) The unit shall operate correctly at temperatures from -20^{o} to 50^{o} C.

[R1.12] (2) The unit shall operate from internal power for eight hours before recharging is required.

2.3.3. Sound Quality

The iDAC will have better sound quality than a standard tape cassette. The perceived quality will be the same as a CD player in noisy environments (such as outdoors or in a running car).

[R1.13] (1) The unit shall have a bandwidth of at least 12kHz.

[R1.14] (1) The unit shall receive a ranking of at least 3.5 on the standardised 5-point perceptual quality scale. (A tape cassette has a ranking of 2).

2.3.4. Compatibility

The iDAC will interact well with existing products and systems.

[R1.15] (1) The host interface software shall run on any standard Windows 95 or 98 computers.

[R1.16] (2) The host interface software shall run on any standard Windows NT computer.

[R1.17] (2) The unit shall be compatible with all tape cassette players. No adapters or modifications to existing systems will be required.

2.3.5. Reliability

The iDAC will be much more reliable than current storage schemes because of its solid state digital nature. Existing tape cassette quality starts to degrade after only 5-10 record cycles, and Compact Discs start to decompose after 15 years.

[R1.18] (1) The unit shall retain its data for 30 years.

[R1.19] (1) The unit shall allow up to 50,000 erase/write cycles. This allows the data to be changed 4 times a day for 30 years.

[R1.20] (2) The unit shall meet a MTBF of 5,000 hours.

[R1.21] (2) The unit firmware continuous up time shall exceed eight hours.

2.3.6. Serviceability

[R1.22] (2) The self-test shall identify sub-systems at fault and relay that information to the user.

2.4. Unit Modes

Unit Modes describe the operational states of the unit.

[R1.23] (1) The unit shall have a playback mode.

[R1.24] (1) The unit shall have a stop mode.

[R1.25] (1) The unit shall have a record mode (induced by the host computer user interface).

[R1.26] (2) The unit shall have a fast-forward mode.

[R1.27] (2) The unit shall have a rewind mode.

[R1.28] (2) The unit shall have a pause mode.

3. Interface Requirements

3.1. Host Computer User Interface

The host computer user interface section details the requirements of the interface that will be presented to the user on the host computer while programming the iDAC device with information.

[R1.29] (2) The host computer user interface shall be a graphical interface.

[R1.30] (2) The host computer interface shall allow users to select a song on a compact disc and transfer it to the device with no more than one step.

[R1.31] (2) The host computer interface shall allow viewing of the current contents of the attached iDAC.

[R1.32] (1) The host computer interface shall not allow transfer of data (songs) from the iDAC to a host computer.

[R1.33] (2) The host computer interface shall provide an option for advanced users who wish to control MPEG2 Layer3 encoding options.

3.2. Device User Interface

The device user interface section details the requirements for interaction between the user and the device.

[R1.34] (2) The device user interface shall work like a standard tape cassette interface.

[R1.35] (2) The device user interface shall not require training to use.

3.3. Device Host Computer Connection Interface

The device host computer connection interface section details the requirements for connection of the iDAC device to the host computer.

[R1.36] (2) The connection interface shall be capable of transferring data at 1Mbps.

[R1.37] (2) The connection interface shall use no more than three wires.

[R1.38] (2) The connection interface shall consist of a single cable.

[R1.39] (2) The connection interface shall be a standard interface available on all consumer computers made in the past 2 years.

4. Compression Protocol Requirements

The compression protocol requirements section details the compression protocols that the iDAC device will support. The section is divided into device capabilities and host computer capabilities for further clarity.

4.1. Device Capabilities

[R1.40] (1) The unit shall support all standard sample rates from 11kHz to 44.1kHz.

[R1.41] (1) The unit shall be able to decode ADPCM data.

[R1.42] (1) The unit shall be able to decode MPEG1 Layer 1, and Layer 2 data.

[R1.43] (1) The unit shall be able to decode MPEG2 Layer 1, and Layer 2 data.

[R1.44] (2) The unit shall be able to decode MPEG1 Layer 3 data.

[R1.45] (2) The unit shall be able to decode MPEG2 Layer 3 data.

[R1.46] (2) The unit shall be able to decode AAC encoded data.

4.2. Host Computer Capabilities

[R1.47] (1) The host computer shall be able to transfer ADPCM file data to the attached iDAC device.

[R1.48] (2) The host computer shall be able to transfer MPEG1 Layer 1, Layer 2, and Layer 3 data to the attached iDAC device.

[R1.49] (2) The host computer shall be able to transfer MPEG2 Layer 1, Layer 2, and Layer 3 data to the attached iDAC device.

[R1.50] (3) The host computer shall be able to transfer AAC data to the attached iDAC device.

5. Regulatory Requirements

This section details the regulatory requirements that the iDAC will be required to pass.

[R1.51] (2) The system shall comply with the following electromagnetic compatibility standards:

a) EN 55011:1991/CISPR 11:1992 +A2:1992 (Group 1, Class A) – RE/CE

b) EN 50082-1:1997 – Radiated, EFT/Burst, ESD Surge, Conducted, Voltage dips/interrupts

[R1.52] (2) The system shall comply with the following safety standards:

a) CSA C22.2 No 1010.1-92

b) IEC 1010-1:1990 +A1:1992 +A2:1995

c) UL 3111-1

[R1.53] (2) The system shall comply with the following environmental standards:

a) HP Class C1 device.

b) HP 757 - Temperature

c) HP 758 - Humidity

d) HP 759 - Vibration

e) HP 760 – Shock

6. Conclusion

This paper has detailed the functional requirements for the iDAC project. The requirements preceded by a (1) will be completed as part of the proof of concept device for December of 1999. Requirements preceded by a (2) will be completed as part of future device development.

Notes: