Chris Dzombak, Mike Metzger

EECS373 W11 Project Proposal: **Music Visualizing DMX Controller**

A DMX512 (stage lighting and effects) controller which can be used at concerts, clubs, etc. to quickly and easily create a light show synchronized to music. The product could be marketed to small music venues (like Ann Arbor's Blind Pig), clubs, and concert lighting companies.

Introduction

The protocol commonly used to control lighting and effects in theaters and other installations, DMX512, is a very simple unidirectional standard atop RS485 differential signaling. (For more information, see “DMX512” on Wikipedia.) During the weeks before a play or concert, the production's lighting designer typically preprograms tens or hundreds of “looks” for the stage (“cues”) into a dedicated DMX controller, and the cues are played back sequentially.

Our project will take an audio input from a line-level source (such as an iPod). The audio stream will be split into approximately 15 frequency bands (much like a graphic equalizer). The user will program (using a keypad) a set of DMX addresses (9-bit unsigned integers) which will respond to each frequency band. It will provide a DMX output which can be fed into a standard dimmer rack or intelligent lighting fixtures.

The output level for each light (DMX address) will be determined by the magnitude of the input signal in the associated frequency band. (In the case where a light is associated with multiple bands, the maximum value from any of those bands is assigned to the light.) We may also implement code which causes lights' brightness to fall slowly rather than sharply.

In addition to the RS485 transmitter, our project will implement an RS485 receiver. This will receive an incoming DMX signal (from a standard lighting controller) to be merged with our output DMX signal. A designer might use this input to control specific lights (perhaps a spotlight) independently of the music-controlled lights; in more complicated designs he might use it to control complex intelligent lighting fixtures, moving-head projectors, etc (which can use 30 or more DMX addresses per unit).

Challenges

Specific challenges which we anticipate solving with this project include:

- DSP algorithm (FFT + support) will be developed and tested in Matlab before we do much work on the hardware. DSP algorithm will be implemented in software on the ARM.
- DMX/RS485 transmission compliant with timing requirements, etc
- Using eval board's flash as nonvolatile storage for user settings (via SPI)
- interfacing with and debouncing a keypad
- interfacing with the OLED display on the SmartFusion board (to ease mapping DMX addresses to frequency bands)
- software will likely be fairly complex
- ADC on the SmartFusion
- receiving DMX/RS485

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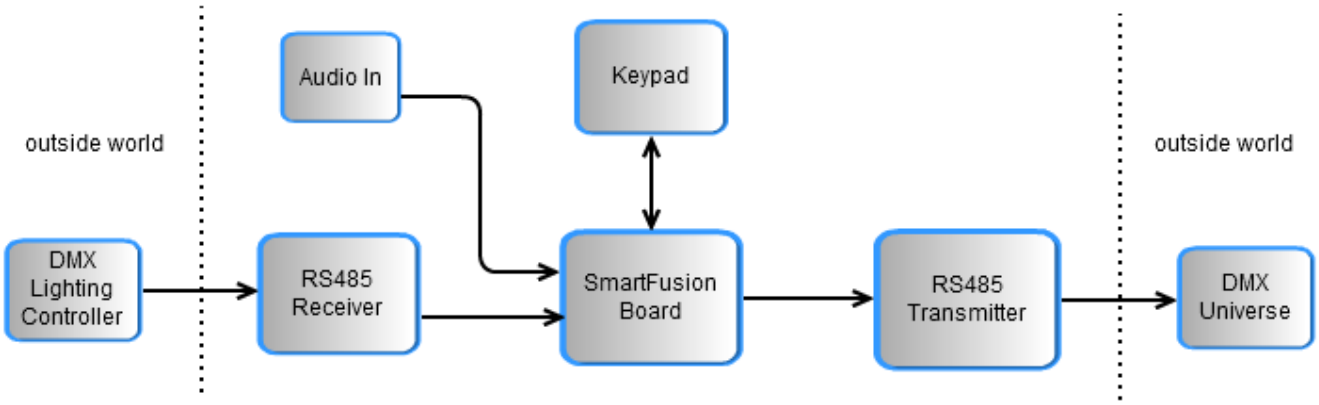
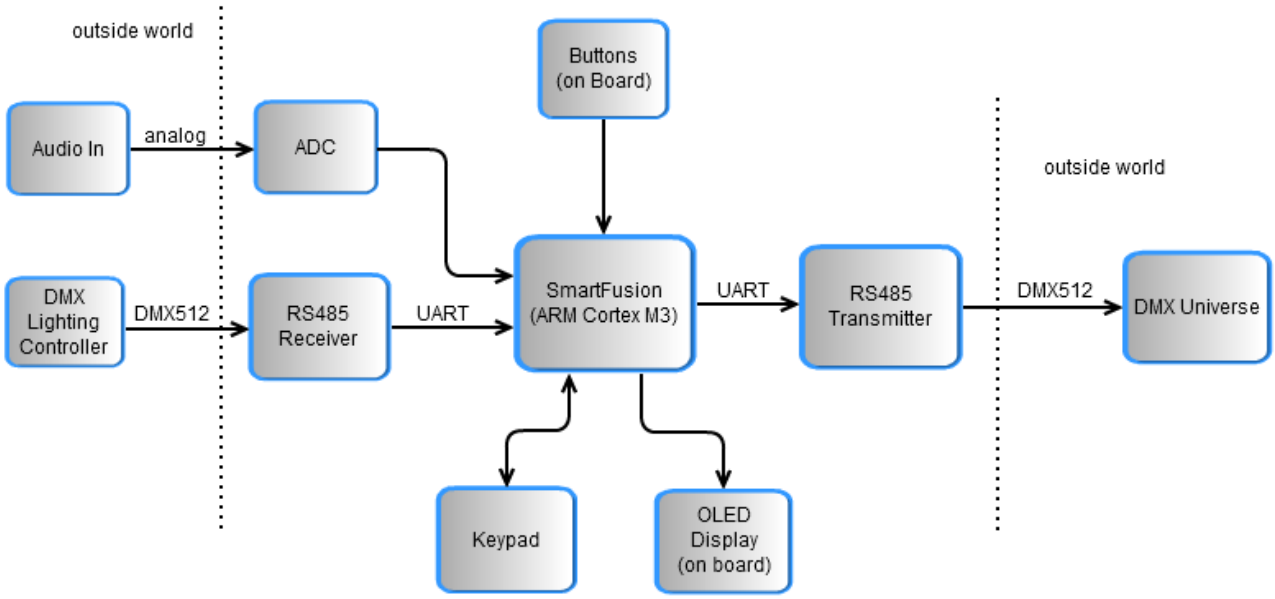
Functional Diagram



Component Level Diagram



Note: depending on how many "control" (non-numeric) keys are available on the keypad, we may not need to use the onboard buttons.

Note: RS485 receiver and transmitter are the same physical part (transceiver) and are connected to one UART; they are displayed as separate components here for clarity. (They will still talk to completely separate RS485 buses, though.)

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Preliminary Component List

- Actel SmartFusion eval board (373 lab stock)
- keypad (373 lab stock)
- RS485 Transceiver
  - MAX1490EB: full-duplex 250kbps isolated RS485 transceiver with ESD protection
  - cost ~ $25
  - http://www.mouser.com/Semiconductors/Interface-ICs/RS-422-RS-485-Interface-IC/_/N-7e3jc?Keyword=max1490eb&FS=True
- DMX connectors
  - male 5-pin XLR: Neutrik NC5MAH
    - http://www.mouser.com/ProductDetail/Neutrik/NC5MAH/?qs=43pPWqpsSNtpdAMzqMXlkw%3d%3d
  - female 5-pin XLR: Neutrik NC5FAH
    - http://www.mouser.com/ProductDetail/Neutrik/NC5FAH/?qs=sGAEpiMZZMv0W4pxf2HiV0%252bKdhvD8lQRjIlJtc/03cU%3d
- audio input connector (may require additional analog filter/protection circuitry)
  - 3.5mm stereo phone jack, STX-3200-3NB or similar
  - http://www.mouser.com/ProductDetail/Kycon/STX-3200-3NB/?qs=sGAEpiMZZMv0W4pxf2HiVwWP6ujO54M5nnxE4N8lBHs%3d
- DF3A6.8FU ESD protection diodes for audio interface
  - http://www.mouser.com/ProductDetail/ON-Semiconductor/DF3A68FUT1G/?qs=sGAEpiMZZMsYiK5PgaDog39H7jj66OvaZiYPnnUNzRk%3d
- resistors for summing 2-channel audio input to mono
  - 2x 475 ohm 1%
  - 1x 20 K ohm 1%
- various resistors, capacitors for connection of transceiver, stabilizing VCC bus, etc

Though we believe isolation on the DMX interfaces is important, we do not plan to provide isolation on the audio input. ESD protection will be provided on all external interfaces.

Specific questions/discussion topics for course instructors:

- How will our custom circuitry be assembled and connected to the SmartFusion board?
- How will the SmartFusion board and associated components be powered outside of the lab?
- We will likely want a custom PCB (and connector) for this.
  - Any parts (such as connectors) related to this aspect of the project will be added to the parts list.

Implementation Steps

Our project can be broken down into these components:

- Hardware assembly (audio summing, DMX and audio connectors, RS485 transceiver)
- interface with onboard flash memory
- DMX transmitting
- DMX receiving
- ADC and DSP – algorithm development and implementation on ARM (Thumb-2)
- keypad interface/debouncing
- (maybe) button interface/debouncing
- OLED display interfacing
- system integration
  - programming user interface
  - DMX merging
  - fading lights slowly

More specific implementation plans/details and specifications for each component are included in a separate document.

During development of each component, a set of notes will be maintained containing an overview of the component's design, specific problems faced and their resolutions, and other information to ease composition of the final report.

Additional Links

- DMX512: http://en.wikipedia.org/wiki/DMX512

- A commercial DMX music visualizer which requires PC support: http://dmx512.svetla.org/Music_Visualization_english.htm

- A collection of useful information and documentation will be kept at http://www.delicious.com/cdzombak/373proj