

Team LuGER

Laser Guided Energy Receiver



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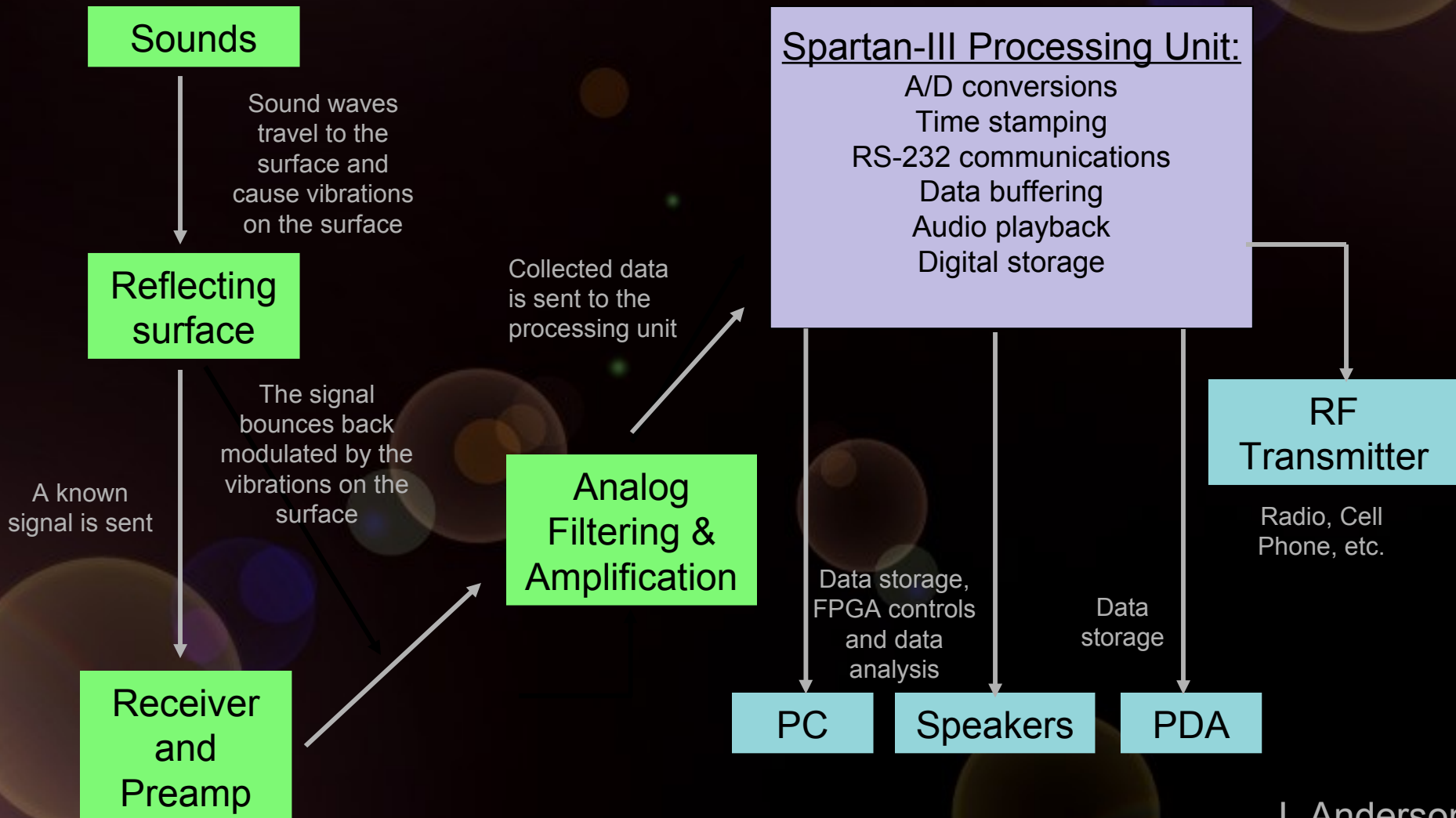
Basic Project Description:

- Use a laser to sense vibrations on a window
- Demodulate the reflected signal to get audio data
- Process and filter the audio data
 - Analog filtering
 - Digital filtering
- Store both analog and digital sound files of the recorded data
- Interface with a Pocket PC
- Wirelessly transmit the digital data to alternate locations such as surveillance vehicles or cell phones via radio or laser

Tasks:

- Laser Send/Receive
- Analog Preamplification
- Analog Filtering and Storage
- Analog Playback (real-time)
- Digital Filtering and Storage
- Digital Playback
- VGA output of waveforms
- Distance Finder
- RF transmission of stored data

System Diagram:

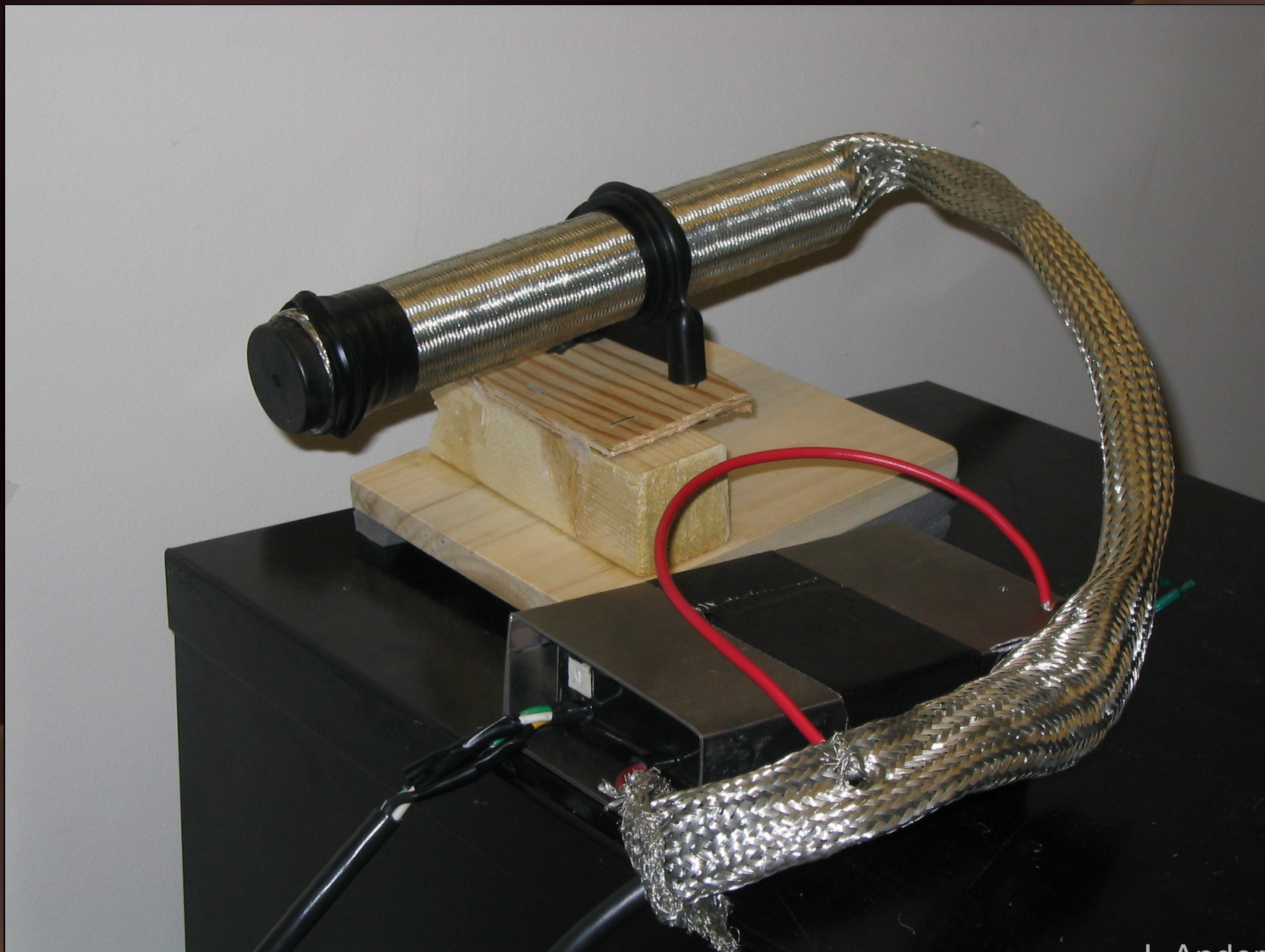


Laser

- What the device needs to do:
 - Send a known signal
 - High powered enough to get a good signal back
- What we need to do:
 - Mount laser on a tripod for an ideal situation
 - Determine the range of angles that can be used
 - Determine what the difference will be between the sent signal and the received signal
 - Ensure safe conditions for indoor and outdoor laser operation
 - Shield the power transformer

Laser Test Results

- Signal Tests
 - The average power output of the 5mW laser was 1.2mW
 - The voltage detected from the laser is 800mV
 - The laser test with the receiver unit displayed noise caused by the AC - power transformer. This was solved by shielding the laser and supply.
- Beam Scatter Tests
 - The laser scatters very little
- Shielding of the Laser
 - Eliminated high frequency noisy from the beam and isolated a problem with the noise coming from the lights at 120Hz



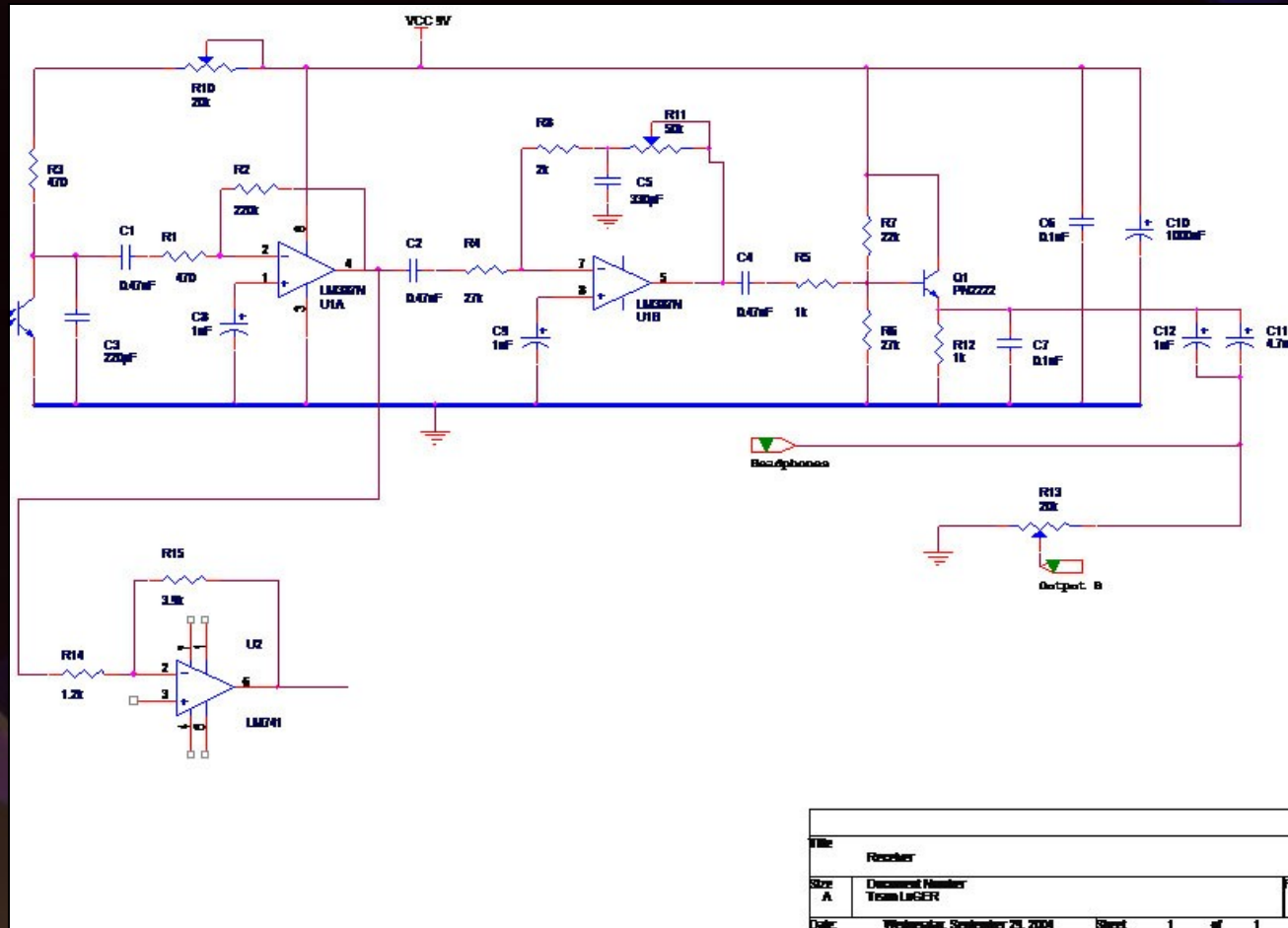
Receiver

- Functional Description
 - Receive modulated signal
 - Converts the signal into voltages
 - Amplify the signal into the 0-5V range
 - Send analog data to the back plane
- Parts and Interfaces
 - LM387 Preamp, LM741 & LM348 amplifiers, L14R3 phototransistor
 - Interface with the back plane will be via a 2 X 20 female edge connector installed on a PCB

Receiver

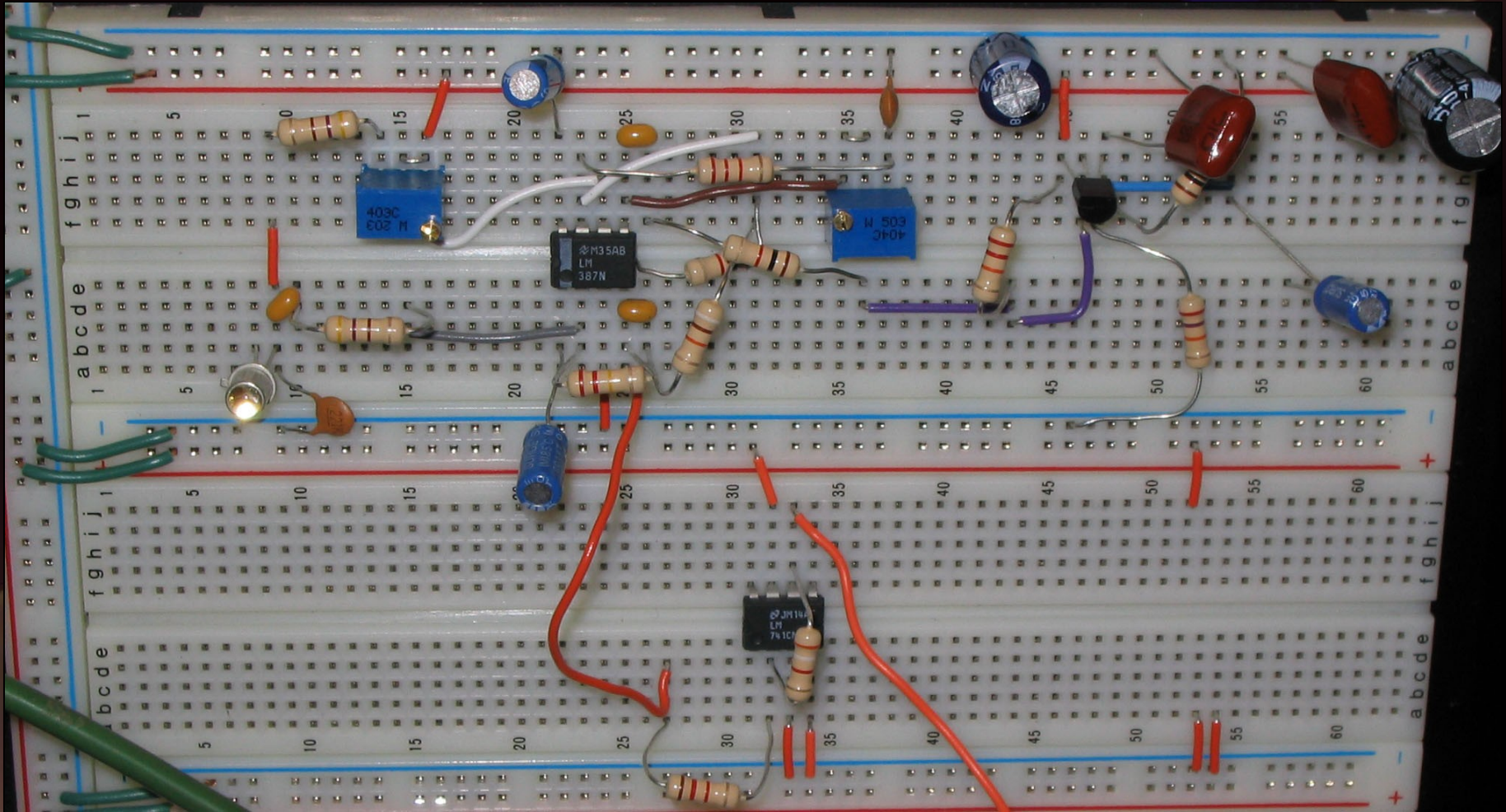
- Reflected Signal Tests
 - The laser reflected approximately 60% of its power
 - Sinusoid waves detected clearly with minimal noise on the lower voltage peaks if the amplifier is saturated
 - Scattering of the laser beam doesn't affect the phototransistor's ability to correctly sense signal amplitudes
- Noise Tests
 - Background noise caused by fluorescent lights and power transformer
 - Vibrations from surrounding area affect the signal

Receiver



Title		Receiver
Size	Document Number	Team LaSER
A		
Date	Wednesday, September 23, 2004	Sheet 1 of 1

Receiver



Receiver Module



Analog Filtering

- Functional Description

- Filters the analog signal from the receiver unit for audible human voices
- Divide the signal into regions to correct frequency response problems
 - Obtain signals in the 0-20KHz range
 - Bandstop filters
 - Signal Pumping Cards

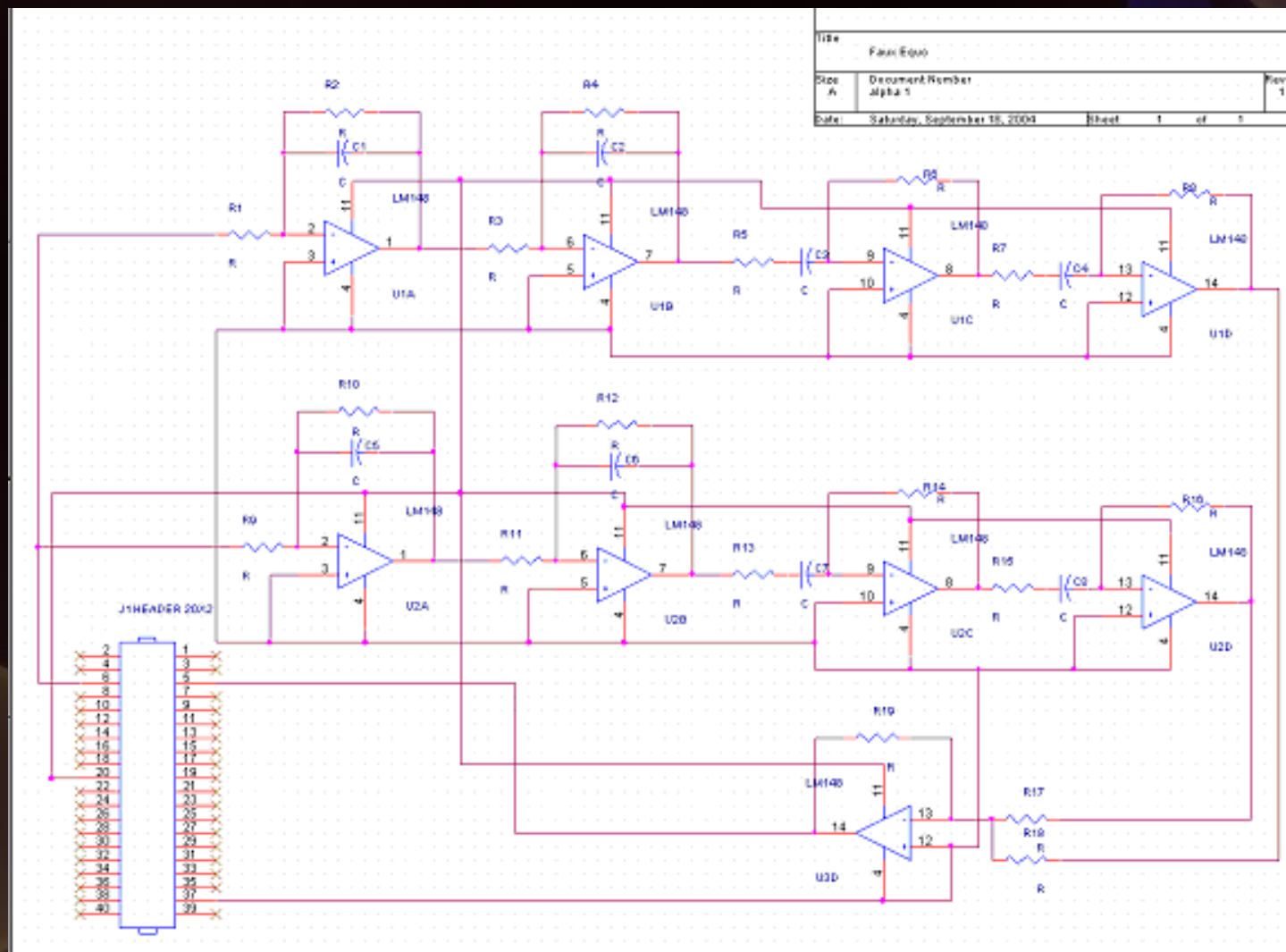
- Parts and Interfaces

- OP-amps for 2nd order Chebychev bandpass filters
- Interfaces with the back plane through a 2X20 female edge connector

Faux Equo

- Functional Description
 - Analog filters will use a high-pass filter on signals greater than 12KHz
 - Low-pass signals below 100Hz
 - Divide the remaining signal into 4 divisions: 100, 1K, 2K, 4K and 12K.
- Parts Lists and Interfaces
 - Op Amps, resistors, capacitors and circuit card construction
 - 2X20 female edge connectors

Analog Filter Circuit Design



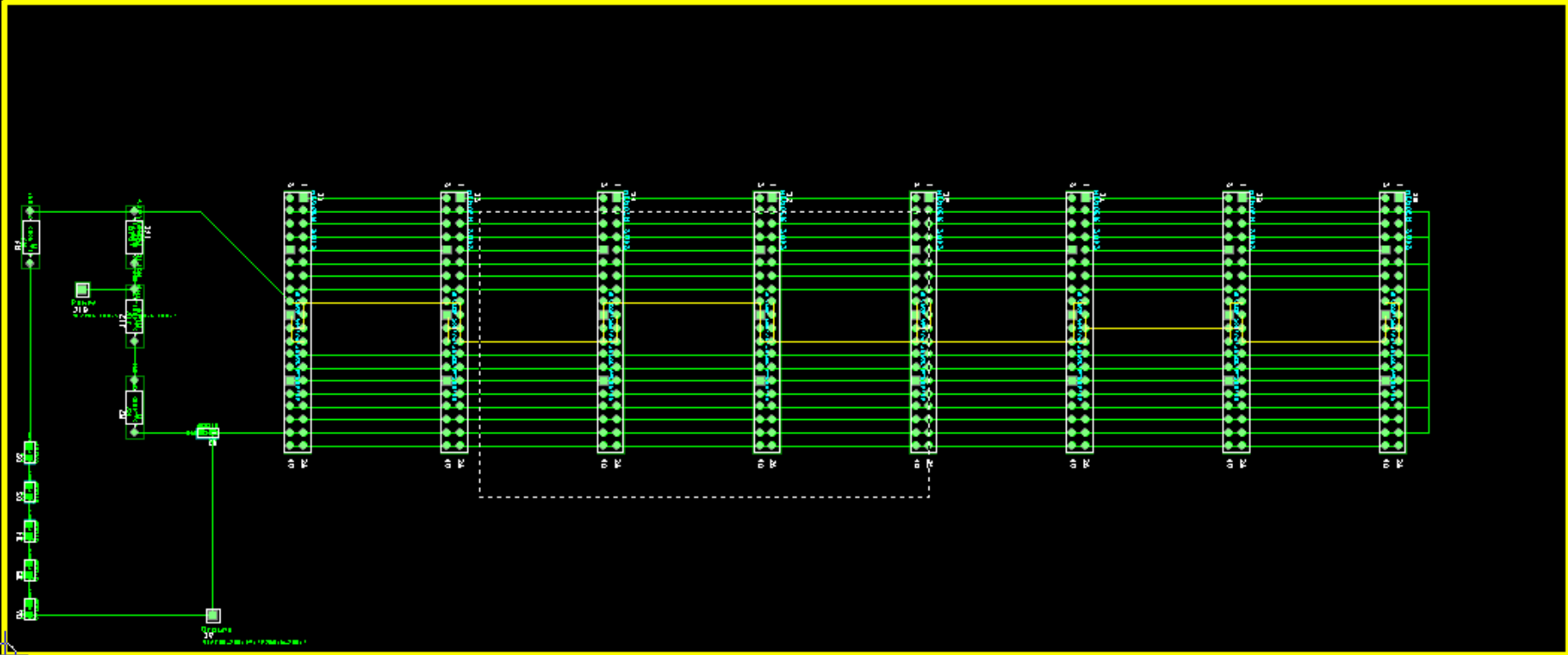
Faux MoBo

(pseudo Motherboard)

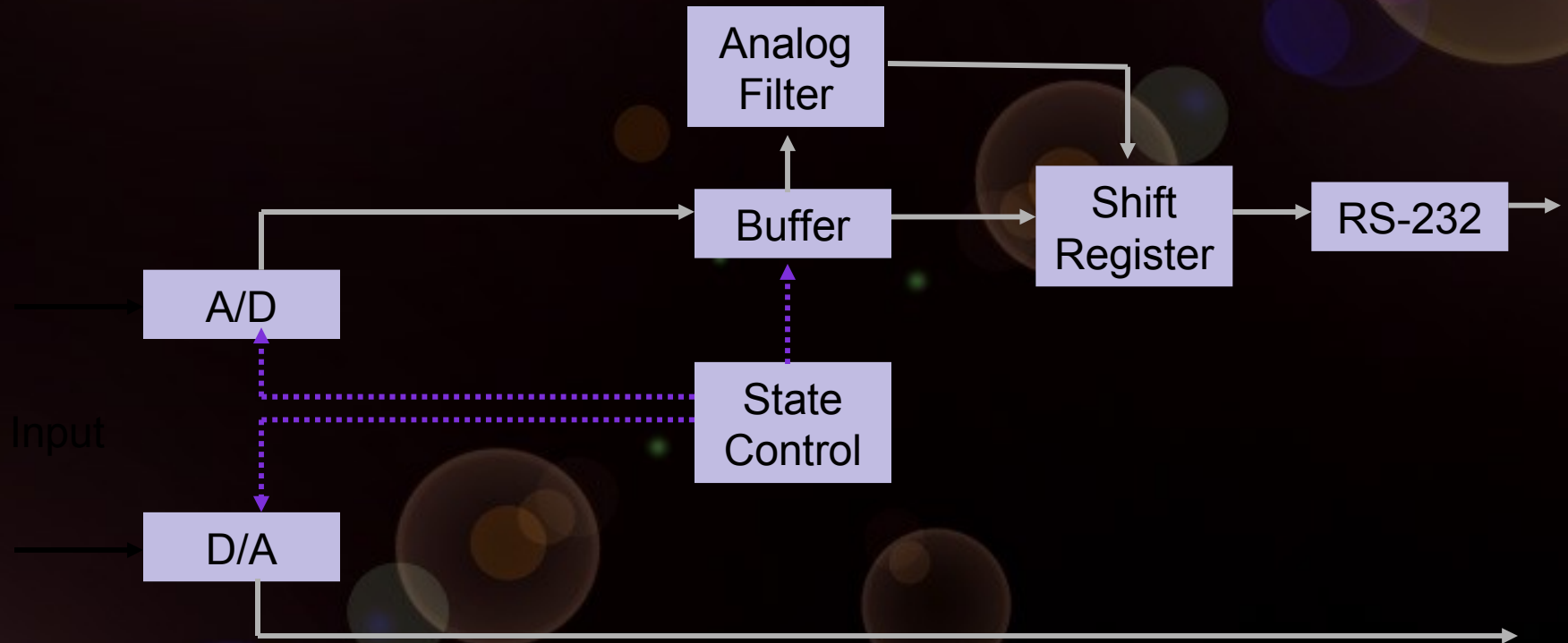
- Functional Description
 - The back plane for all interface modules to connect to
 - Allows for modular bandpass filters through replacement of slot cards
 - Provide power to the bandpass filters
 - Supply voltage of 0-9V for the connecting cards
- Parts and Interfaces
 - 2X20 male edge connectors
 - PCB layout and population

Faux MoBo

(pseudo Motherboard)



FPGA



The diagram displays three different operation modes:

- Digital Filtering

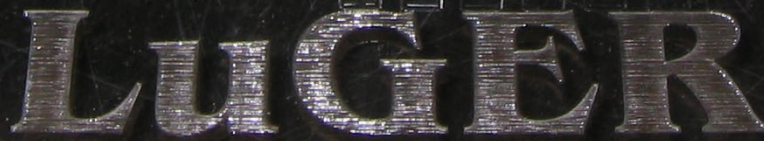
- Digital Storage (through RS-232 output)

- Digital output to analog signal (Real time digital playback)

FPGA

- Functional Description
 - Receive the filtered data
 - Buffer the data
 - Control the communications between each modular unit
 - Control of audio playback
- Parts and interfaces
 - Connects to the back plane through female ribbon cables

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FPGA Test Results

- I/O verification
 - List of I/O verified
 - Confirmation of I/O voltage settings
- Memory Tests
 - FPGA and memory were programmed successfully
 - Use of the memory established

DSP

- Functional Description
 - Will smooth digital signal
 - Will provide squelch
 - Possibly perform Fourier analysis
- Parts and Interfaces
 - Verilog and schematics in Xilinx on FPGA

DSP

- Smoothing
 - May use a low order non-recursive smoothing function such as

$$y_n = \frac{x_n + x_{n-1}}{2}$$

- Squelch
 - Will use a simple time delay coupled with a event failure enable for a given sample length
- Fourier Analysis
 - May provide details on amplitudes of different frequencies graphically

Sampling

- Functional Description
 - 8-bit A/D and 8-bit D/A converts
 - 18.9K sampling rate, the same rate as a CD-ROM
 - Send the sampled data to storage
- Parts and Interfaces
 - MAX108, MAX533 and RAM

Communications

- RS-232 Functional Description
 - 56.6kbps rate will be use in conjunction with a data storage.
 - 9 bit even parity
 - Signal levels on the FauxMobo will utilize 0-9V and converter to RS-232 binary
- Tests Results
 - Verified control of outputs

Communications

- What will be sent?
 - Start string of 11111110 will start a “Chunk”
 - Next 9 bits will be timestamp from last transmission in secs.
(deals with squelch)
 - 9 bit even parity digital voltage value will be sent
- When will it be sent?
 - We will store the values to RAM, and send a string at 56.6k across RS-232 serial cable to receiving computer/PDA after storage, and after a given signal.
 - Eventually, if time allows, this will also be able to be sent via RF using same bit patterns.

PDA

- Functional Description
 - Data storage unit
 - Analog playback from digital storage
 - Our PDA uses windows CE, so programming will be in C type environment for proprietary digital signal input.
- Parts and Interfaces
 - RS-232 connection

Schedule

ID	Task Name	Duration	Start	Finish
1	PDR presentation	0 days	Tue 9/7/04	Tue 9/7/04
2	Preliminary user manual	5 days	Wed 9/1/04	Tue 9/7/04
3	Laser mounting	14 days	Mon 8/23/04	Thu 9/9/04
4	Initial design of analog filter	8 days	Tue 8/31/04	Thu 9/9/04
5	Test plan of system	8 days	Wed 9/8/04	Fri 9/17/04
6	Functional receiver unit	16 days	Tue 8/31/04	Tue 9/21/04
7	Analog storage design	11 days	Thu 9/9/04	Thu 9/23/04
8	Analog filtering functional	19 days	Thu 9/9/04	Tue 10/5/04
9	Integration of receiver and FPGA	11 days	Tue 9/21/04	Tue 10/5/04
10	CDR presentation	0 days	Tue 10/5/04	Tue 10/5/04
11	Minimum functionality of FPGA state machine	27 days	Tue 9/7/04	Tue 10/12/04
12	Analog storage tested	16 days	Fri 9/24/04	Thu 10/14/04
13	Modular interface complete	21 days	Thu 9/23/04	Tue 10/19/04
14	Integration of modular unit with receiver and FPGA	25 days	Tue 9/21/04	Thu 10/21/04
15	Digital filtering and storage designed	11 days	Tue 10/12/04	Mon 10/25/04
16	First Mile Stone	0 days	Tue 10/26/04	Tue 10/26/04
17	Basic system completed	27 days	Wed 9/22/04	Tue 10/26/04
18	Decide upon project expansions	3 days	Tue 10/26/04	Thu 10/28/04
19	Preliminary technical manual	13 days	Sun 10/17/04	Tue 11/2/04
20	Digital filtering, storage and playback complete	16 days	Wed 10/13/04	Tue 11/2/04
21	Second Milestone	0 days	Tue 11/16/04	Tue 11/16/04
22	Complete project expansions	11 days	Tue 11/2/04	Tue 11/16/04
23	Final technical manual	11 days	Tue 11/2/04	Tue 11/16/04
24	Final testing	13 days	Tue 11/16/04	Thu 12/2/04
25	Design expo	0 days	Thu 12/9/04	Thu 12/9/04

Safety

- This project uses class II and class IIIa lasers
- Laser safety goggles will be worn if direct beam contact may occur
- Indirect laser radiation is not harmful
- Standard red laser pointers are rated class II-IIIa

Safety

Class II laser products

- Cannot harm the retina as blink reaction is sufficient protection
- Power output < 1 mW
- Generally in the wavelength range of 630-680 nm

Class IIIa laser products

- Safe for momentary viewing, are a recognized eye hazard if viewed through optics (telescopes, magnifiers)
- Power output between 1-5 mW
- Generally in the wavelength range of 630-680 nm

Parts List

Receiver	L14G3 Phototransistor, LM387, LM741 OP-Amp, 9V battery, tripod, and protoboard
Transmitter	Laser, acrylic, mounting braces, speakers and signal generator
Faux MoBo	Male 2X20 edge connectors, switches, LED's, buttons, banana cable connectors, 5" x 12" PCB
FPGA	Xilinx Spartan 3
Playback	PC computer, Pocket PC PDA and speakers
Testing	D/A converters, A/D converters, OP amps, shielding, Casing materials and LED's
Various Cards	PCB and edge connecting 2X20 females. Parts as needed (many op amps)

Bill of Parts

Part	Cost
1mW and 5mW Lasers	\$250
Xilinx Spartan-III FPGA	\$150
Xilinx FPGA Accessories	\$200
Dell Axim X3 Pocket PC (PDA) and Data Cable	\$300
Safety Equipment	\$200
Miscellaneous ICs and Components	\$200
Miscellaneous Prototyping Materials	\$300
Battery and Portable Equipment	\$200
Total	\$1800

Division of Labor

- **Ryan Schnell**
 - FPGA Programming
 - Modular Unit Interface
 - Analog filter design
 - Faux MoBo design
- **Mike Weimer**
 - Receiver power supply
 - Analog filter testing
 - Parts procurement
 - Receiver testing
 - Silkscreening of CU logo and Scooby Doo on PCB
- **Mike Wong**
 - FPGA Programming
 - Faux MoBo layout
 - Test plans
 - CDR presentation
- **Jeremy Anderson**
 - RX and TX with PC
 - User manual
 - Accounting funds
 - Receiver testing

Current Status

Tasks	Status
Receiver Unit	70% complete
Analog Filter	60% complete
RS-232	40% complete
Analog Storage	30% complete
Digital Designs	20% complete