

GENESIS TECH PROJECT



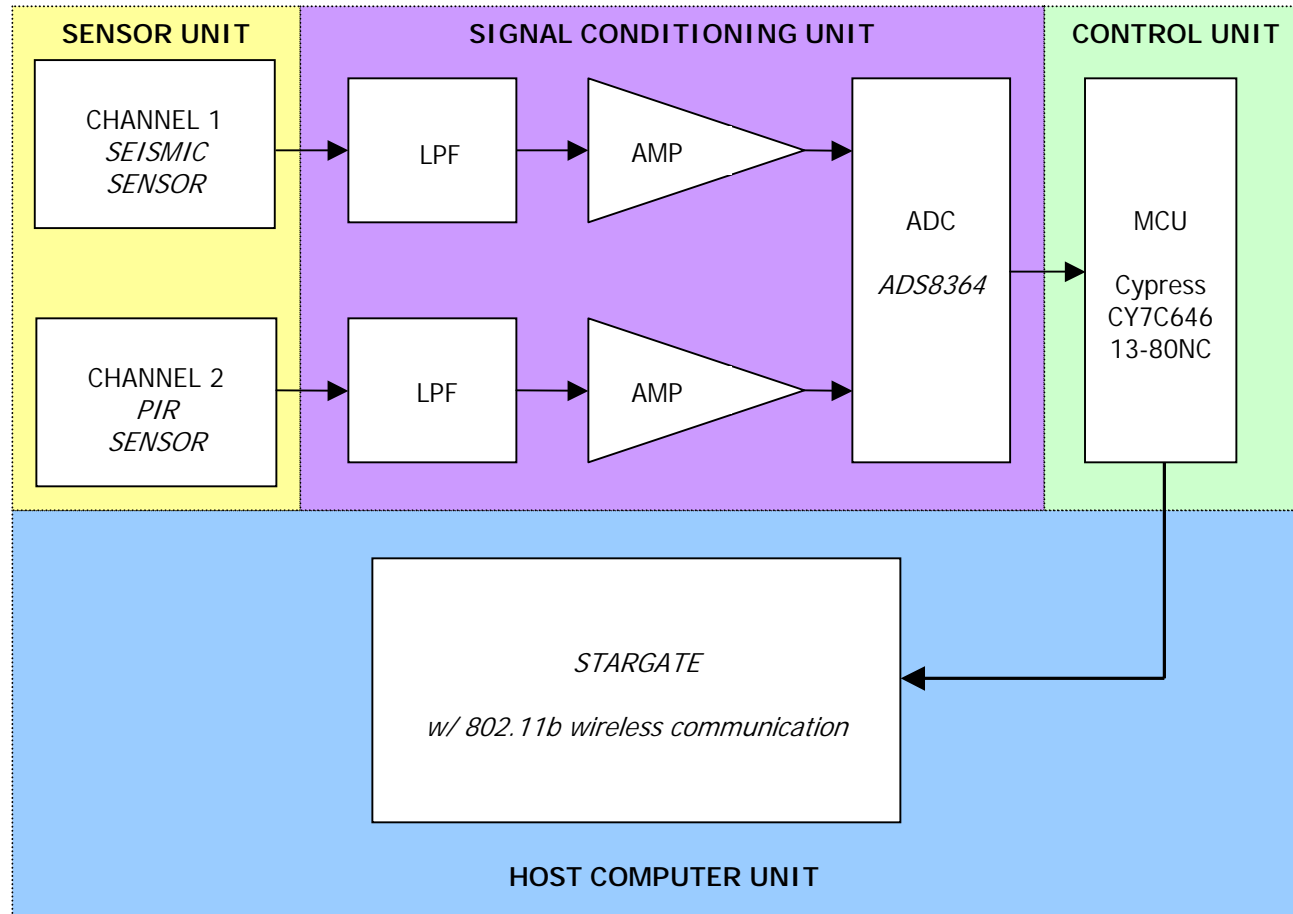
- Director Albert Byun
- Assistant Director Amar Bhayani
- Consultant Engineer Abdul Kalash
- Microcontroller Engineer Hirenkumar Patel
- Sensor Engineer Shih-Yang Yen



Introduction

- Problem Statement
 - The project challenge is to design, build, and test the DAQ device with multi-sensors, software controls, and USB interface
- Market Research
 - Current detection systems are evaluated at \$2000 vs. our design will be less than \$137.40
 - 1/10th the current cost
- Project Goals
 - Construct a working prototype of a wireless DAQ node

Design Approach Overview





Sensor Unit Overview

- Seismic Sensor
 - Larger Range of Detection
- Passive Infrared Sensor
 - Moderate Range of Detection
 - Identification of objects
- How each sensors complement each other?



Seismic Sensor

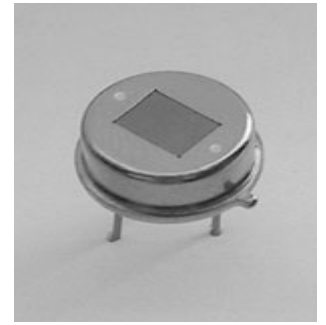
- Purpose:
 - Measures ground vibrations
 - Examples:
 - Detection of an earthquake
 - Military surveillance and security purposes
- Cycle of operation:
 - Measures ground motion relative to an inertial reference
 - The Suspended Mass used for reference inertial
 - Inside the sensor's casing
 - Geophone has a suspended coil in a magnetic field

Seismic Sensor



- Factors for selection of the Product: Telonics SP-500
 - Range of detection: 100 ft long & 360 degrees wide
 - Signal Characteristics: Output Frequency- 300 Hz
 - Supply Voltage: None
 - Operating Temperature: -40°C ~ 70°C
- Interlink with near components
 - Activates the PIR upon detecting an object
- Limitations
 - Cannot identify the type of object
 - Cannot determine the location & distance of an object

Passive Infrared Sensor



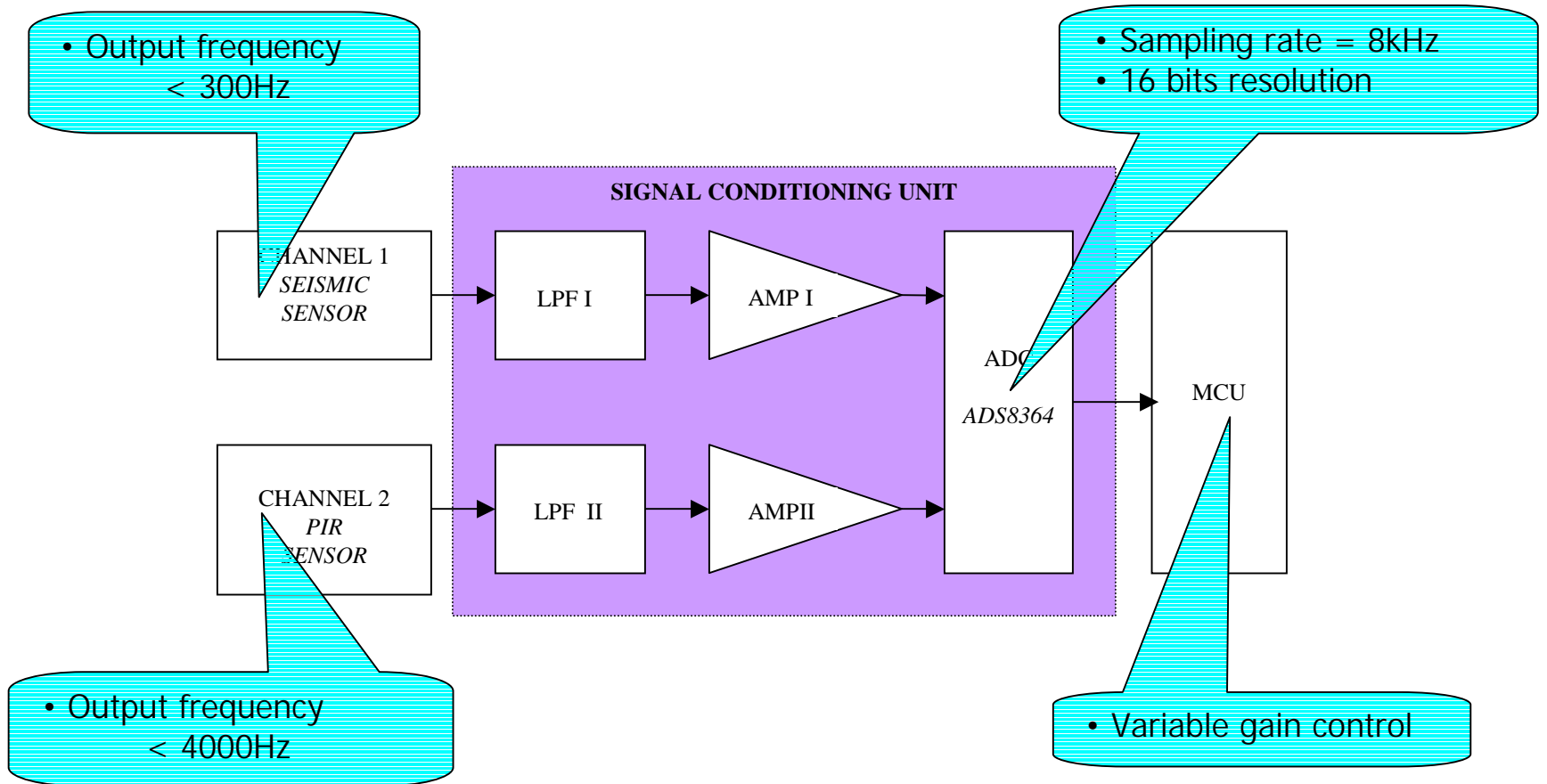
- Purpose: Detect objects based on the infrared energy that they emit
 - Examples:
 - Automatic Doors in a supermarket
 - Security Systems to detect an intruder
- Cycle of operation:
 - PIR monitors an area to sense infrared energy
 - An object moves into its detection zone
 - PIR detects a change in the infrared energy level
 - It reports the presence of an object in its zone



Passive Infrared Sensor (Cont)

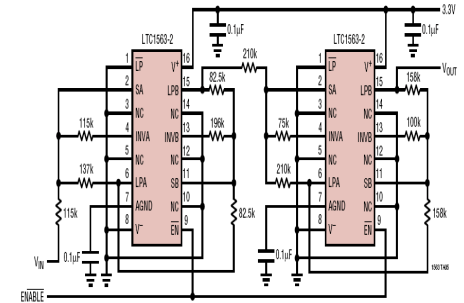
- Factors for selection of the Product: Nicera RE200B
 - Range of operation--50 ft long & 180 degrees wide
 - Signal Characteristics: V_{pp} -3.9V ; Frequency-3.3 KHz
 - Supply voltage-- 2.2 [V] to 15 [V]
 - Operating temperature-- $-30^{\circ}\text{C} \sim 70^{\circ}\text{C}$
- Interlink with near components
 - Activates only once a seismic sensor detects an object
- Limitations
 - Omni-directional detection is unavailable

Signal Conditioning Unit Overview



Low Pass Filter

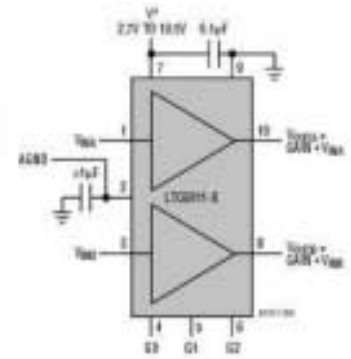
Single 3.3V, 2mA Supply Current, 20kHz 8th Order Butterworth Lowpass Filter



- Purpose
 - Eliminate unwanted frequency signals
 - No distortion in frequency range of interest
 - Lowest order & Filter type satisfying frequency limitations
- Product Specifications: Linear Technology LTC1563-2
 - Cut-off Frequency: Seismic -> 300Hz ; PIR -> 4000Hz
 - Stopband Frequency & Attenuation
 - Seismic → -96dB at 15.7 KHz ; PIR → -96dB at 12 KHz
 - 8th order Chebyshev I

Amplifier

| DIGITAL INPUT | | | GAIN IN V/V | |
|---------------|----|----|-------------|-----------|
| G2 | G1 | G0 | LTC6911-1 | LTC6911-2 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 2 | 2 |
| 0 | 1 | 0 | 3 | 3 |
| 0 | 1 | 1 | 10 | 10 |
| 1 | 0 | 0 | 20 | 20 |
| 1 | 0 | 1 | 50 | 50 |
| 1 | 1 | 0 | 100 | 100 |
| 1 | 1 | 1 | 100 | 100 |



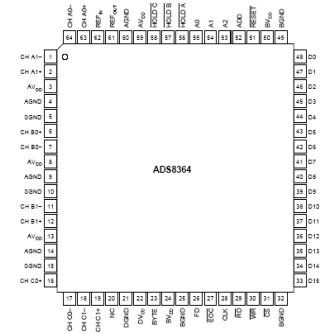
- Purpose
 - Minimize data lost from sampling
 - Have variable controlled gains
 - Prevent clipping caused by over amplification
- Product Specifications: Linear Technology LTC6911-1
 - Wide selection of gains : 0, 1, 2, 3, 10, 20, 50, 100V/V
 - 3-bit Digital Gain Control : G2, G1, G0 pins
 - Internal Vref automatically set to half of Vs



Analog-to-Digital Converter

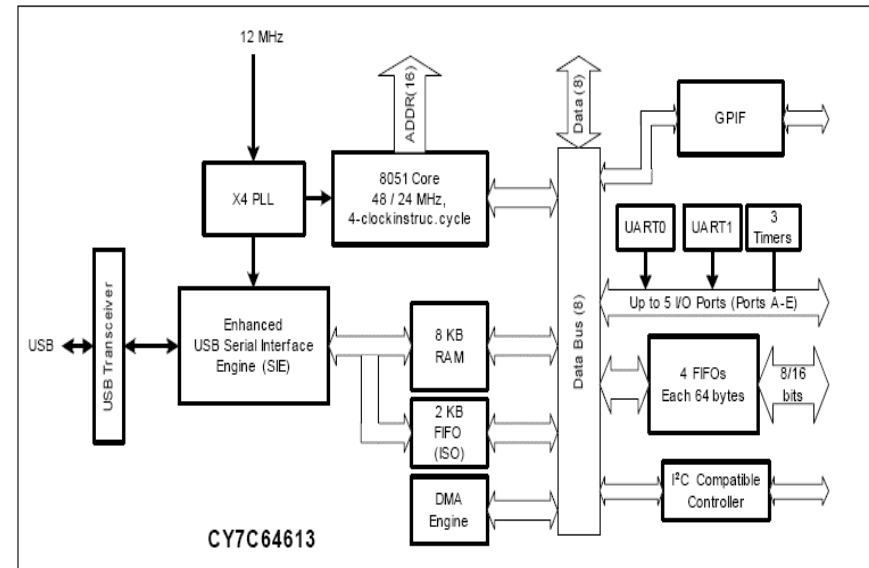
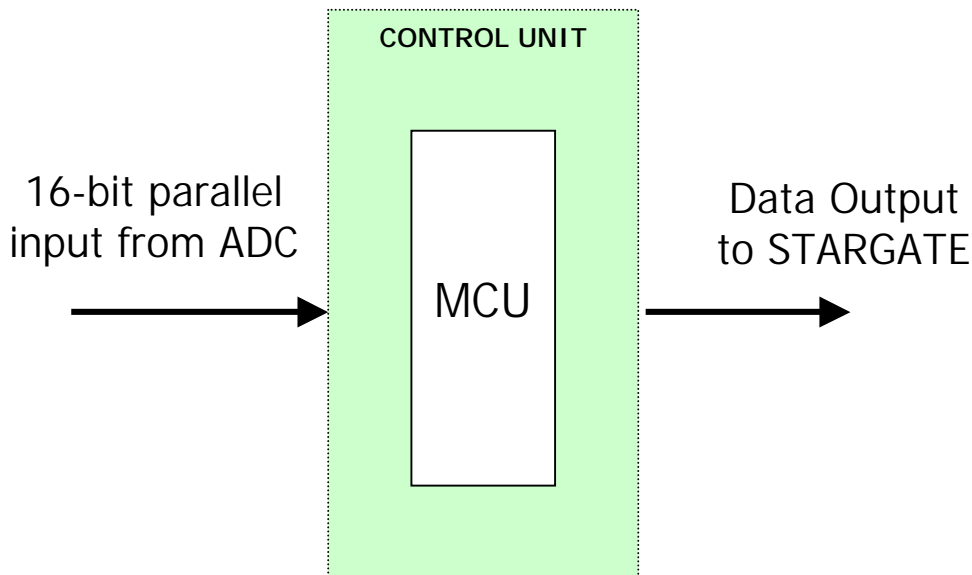
- Purpose
 - Minimum 16-bit resolution
 - Differential input channels with separate ADCs for simultaneous sampling
 - Input analog range: 0-5V
 - Multi-channels for multi-sensors
 - Minimum sampling rate: 8kHz
 - Operating temperature: $-10^{\circ}\text{C} \sim 40^{\circ}\text{C}$

A/D Converter



- Texas Instruments ADS8364
 - 6 fully differential channels
 - One 16-bit output
 - 6 ADCs (1 per channel) for simultaneous sampling
 - Maximum sampling rate: 250kHz
 - Analog input range: $-/+ 2.5V$ at $2.5V$
 - Operating temperature: $-40^{\circ}C \sim 85^{\circ}C$
 - The chip is upgradeable for futuristic designs

Control Unit Overview





Microcontroller

- Purpose
 - Use the data from the ADC to our advantage
- Algorithm
 - Receives information from ADC--16-bit parallel interface
 - Checks for motion detection
 - If motion detected, sends information to Stargate
- Features
 - USB Compatibility
 - Enhanced 8051 Processor
 - Runs code from internal or external RAM
 - Code can be downloaded via USB, EEPROM, Flash



Microcontroller

- Product Specification: Cypress CY7C64613-80NC
 - Number of pins: 80
 - Supply Voltage: 3.3 V
 - I/O Ports: 4 ports with 8-bits each
 - USB interface with Stargate
- Limitations
 - None, meets all specifications

Stargate



- Product Specifications
 - A powerful signal computer
 - Transmit data wirelessly through 802.11b PCMCIA card
 - Small (3.5" by 2.5"), light and low power consumption
 - 400MHz X-Scale processor (PXA255)
 - USB, serial, Ethernet connectors
 - Linux embedded



Cost Analysis

| Components | Item No. | Price(\$)/each | Quantity | Updated Cost (\$) |
|------------------------|-----------------------|-----------------------|-----------------|--------------------------|
| Seismic Sensor | SP-500 | 90.00 | 1 | 90.00 |
| PIR Sensor | Nicera RE200B | 15-60 | 1 | 10.00 |
| MCU | CY7C64613-80NC | 9.00 | 1 | 9.00 |
| ADC | ADS8364 | 18.10 | 1 | 18.80 |
| Amplifier | LTC6911-1 | 2.45 | 2 | 4.90 |
| Low Pass Filter | LT1563-2 | 2.35 | 2 | 4.70 |
| Total Cost | | | | 137.40 |

* Stargate and the 802.11b PCMCIA card are not included



Future Perspective

- Future Plans
 - ECE 682 or 683 – building the system
 - Ordering & receiving products: 1 week
 - Testing products & integrating to form a coherent system: 2 weeks
 - Experimenting: 3 weeks
 - Debugging to obtain accurate results: 4 weeks
 - Sell our idea to a corporate and make millions so that we can retire in early 30's!



Summary

- Future applications
 - Integrate with GPS Localization
 - Possible intruder localization and identification
- Final thoughts / Product Design Experience:
 - Albert: "Helped me to learn the fun of teamwork!"
 - Amar: "Learnt the importance of system integration"
 - Eric: "Gained more knowledge in product research"
 - Abdul: "Sometimes u gotta have a design experience"
 - Hiren: "No design is perfect, you need to have tradeoffs"

Any Questions?



Group Pictures on 10/20/04