Atmospheric Profiling Sensing Module

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Abstract

High-altitude balloons represent an ideal way to engage students (middle school – university) in the study of the vertical structure of our atmosphere. Two of the most measured quantities are pressure and temperature as they have very predictable characteristics as altitude changes. While these variables are easily measured with readily available commercial products, a major drawback to these devices is that they operate individually and log their data via time. To relate this information to altitude requires computation of altitude from the pressure data or the use of a GPS to acquire altitude data. The end result is a series of independent measurements, each typically in a different time base, which makes the analysis of how temperature and pressure changes versus altitude difficult. While the university student may find the exercise of interpolating the different data sets onto the same time base stimulating so that pressure/temperature can be plotted directly versus altitude, middle or high school students typically don't possess these skills. A simple solution to this problem is to have a data logger that simultaneously records all of the data. We present here a module based on the ATMega32A microcontroller that contains an on-board GPS system and sensor inputs for the measurement of temperature, pressure, and outputs from other sensors. The module is flight compatible, and the data output is inherently all on the same time base which facilitates the examination of how temperature, pressure, and other experimental variables change as a function of altitude.

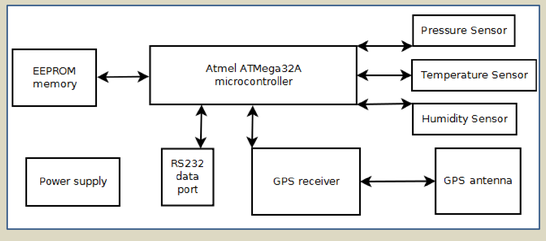
Module Overview

- Polling both GPS and sensors at the same time allows for easily relating sensor data to position in the same time base
- Extra analog-digital converter channels allow for expanding sensing capabilities
- Wide range of operating temperatures and high GPS ceiling make module suitable for high-altitude applications
- Low-voltage operation

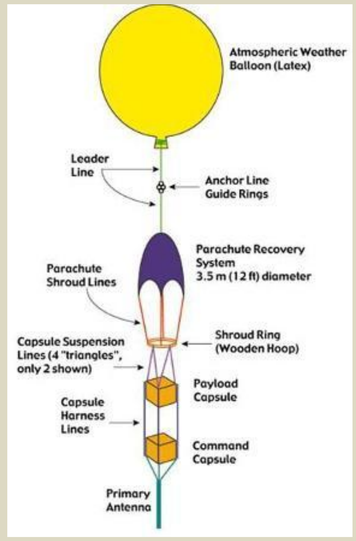
Features

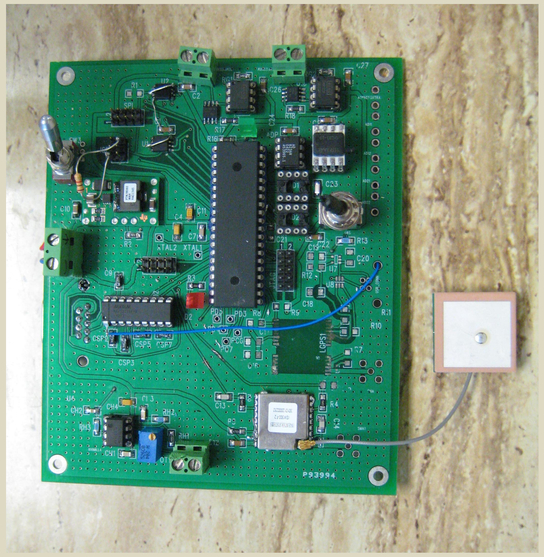
- Dual 16Mb flash memory
- Time-stamped position and sensor data
- GPS receiver functional up to 135,000 feet
- Easy data retrieval and parsing
- Easy to program additional functionality
- Add-on ADC ports for additional sensors

Module diagram



Prototype Setup





Sample Raw Data

Time	Latitude	Longitude	Altitude (Meters)	Sensor data (ADC counts)

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Acknowledgements

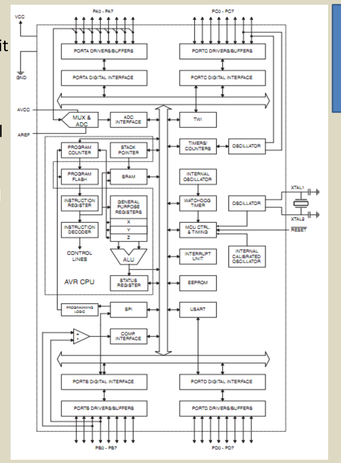
Advisor: Berk Knighton
Department: Montana Space Grant Consortium

Flash Memory

- SST25VF016B
- 16 megabits of storage per chip
- 2 redundant chips on module
- Serial Peripheral Interface
- -40°C to +85°C
- 100+ years of data retention
- 100,000 Read/Write cycles
- 4 hours of data @ 1Hz sample rate

Atmel ATMega32A

- 8-channel, 10-bit Analog-Digital Converter
- Two-wire and serial peripheral interfaces supported
- USART for serial communication



Block diagram from Atmel ATMega32A datasheet. www.atmel.com

AVR Architecture

- High resolution for reading analog sensors
- Additional digital sensors easily added
- Interfaces with PC

GPS Receiver

- Inventek ISM300F2-C5
- High-altitude firmware with GPS ceiling of 135,000 feet
- NMEA-0183 and SiRF Binary output through UART
- -40°C to +85°C
- Position reports once per second

Module Operation