Utilizing a High Performance Analog-to-Digital Converter for Improved Environmental Measurements and Faster Setup

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Background

- The Integrated Surface Flux Systems (ISFS) team uses various sensors to collect data on the atmosphere and the Earth's surface
- The Wisard Combo board contains an Analog-to-Digital Converter (ADC) and a PIC microcontroller to convert voltages from the sensors into a digital format
- Revision B of the Wisard board uses an ADC that requires a temperature correction for each reading
- An updated design, Revision C, with a more precise ADC was designed to simplify software and minimize calibrations
- Software needed to be developed to allow the new (rev C) ADC to interface with the microcontroller

Objectives

- Integrate ADC into existing software
- Develop a SPI interface for communication between ADC and microcontroller
- Determine if rev C ADC can replace rev B ADC
- Evaluate settings of new (rev C) ADC

Tools

MPLAB X IDE

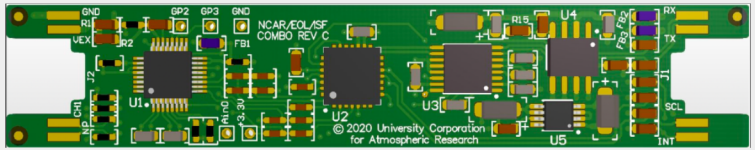
MPLAB XC Compiler

MPLAB Code Configurator

Old ADC

New ADC

Digital Poster



Developing a SPI Interface

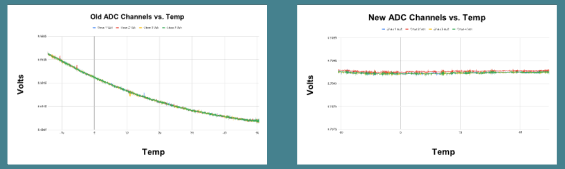
- The ports dedicated for Serial Peripheral Interface (SPI) on the microcontroller were already occupied by other peripherals
- Software was developed to allow SPI communication on arbitrary digital ports. This process is known as bit-banging
- Three ports were used: Serial Clock (SCLK), Master Out Slave In (MOSI), and Master In Slave Out (MISO)
- Functions were created to send commands, read the ADC channels, and read the internal temperature sensor
- Registers and voltage readouts from the ADC had different bit widths. Correct variable types must be used to avoid data destruction

```
//Reads the ADC channel and writes the raw count to pointer ADCout.
//Channel defines are in the TI_ADC.h file
//Returns 1 if there is a CRC error. Returns 0 otherwise
char TI_READCHANNEL(long int* ADCout, unsigned char chan, unsigned char gain);
```

Function header for reading voltage from one of the ADC channels

Temperature Dependency

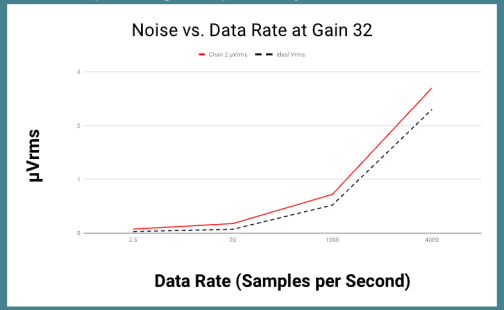
- The previous (rev B) ADC required temperature corrections for each voltage reading which added complexity and setup time
- To test for temperature dependency in the new (rev C) ADC, the boards were subjected to an oil bath with temperatures ranging from -20°C to 50°C while a constant voltage was input



Voltage vs. Temp comparison. Notice new ADC on right has very little curve. N ≈ 17000

Mitigating Noise

- EMI from outside and inside sources can interfere with voltage readings
- ADC settings such as sample rate and the gain of the internal amplifier can be changed to reduce noise
- Lowering sample rate and increasing gain will reduce the effect of noise at the cost of added time and reduced input range respectively



Noise vs. Data Rate. Dashed line is ideal noise while red is measured. Separation of ideal and measured increases as data rate increases. N = 250

Conclusion

- Successful integration of new (rev C) ADC into Wisard board and existing software
- ADC exhibits decreased temperature dependence and acceptable noise parameters

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