Data Acquisition Unit for a CVT Dynamometer

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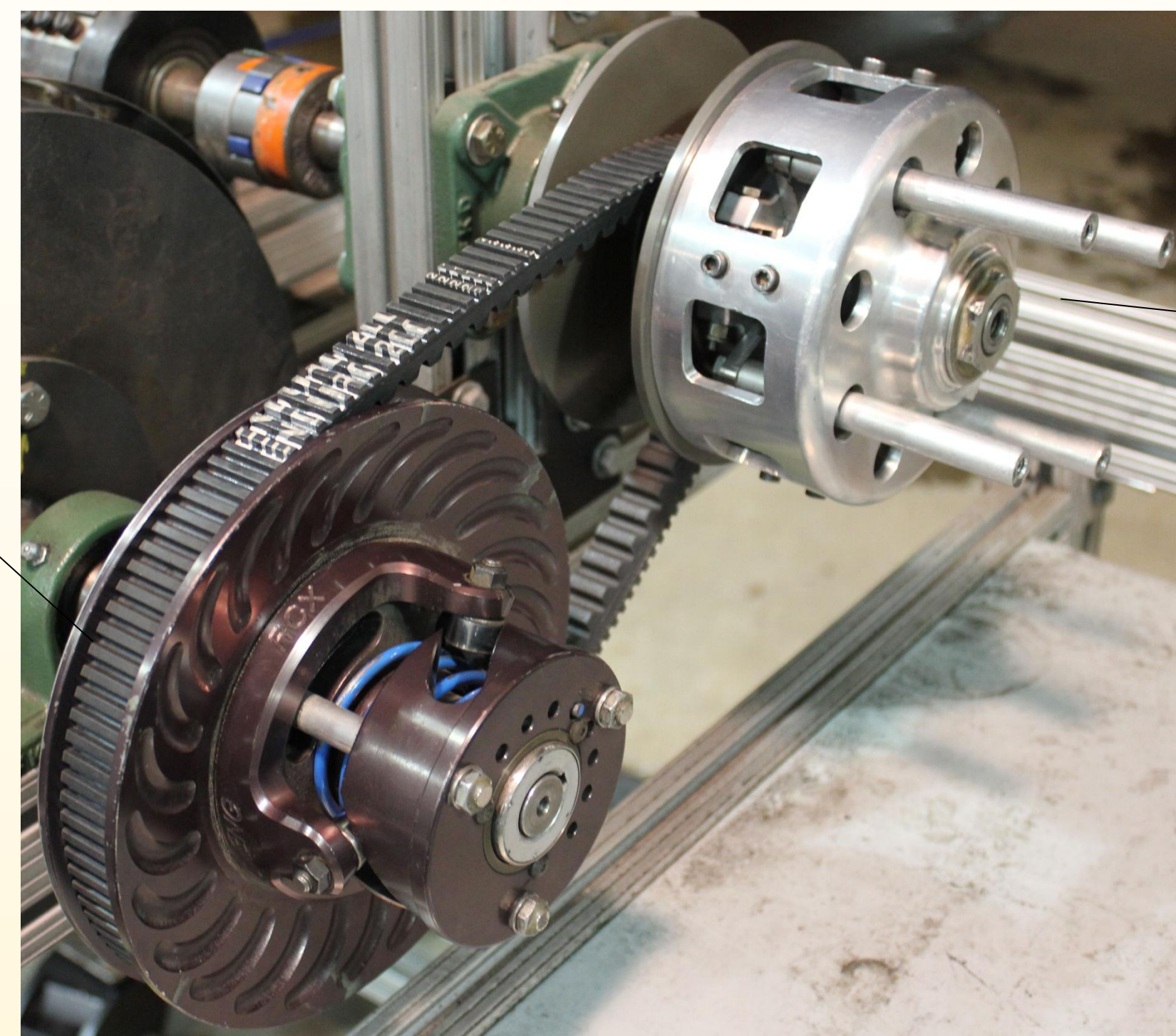mjk277@cornell.edu
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What is a CVT?

Secondary Pulley

Primary Pulley

A continuously variable transmission works through a system of clutches, flyweights, springs, and a belt. Clutches are attached to the motor and the drivetrain of the Baja vehicle. In each clutch is a spring and flyweight system. These springs and flyweights are tuned such that they exert forces on the sheaves of the clutches to push a belt along the radius of the clutch as they spin. Through changing the radii, the belt traverses a continuum of gear ratios between the engine and drivetrain after the motor reaches a certain RPM.
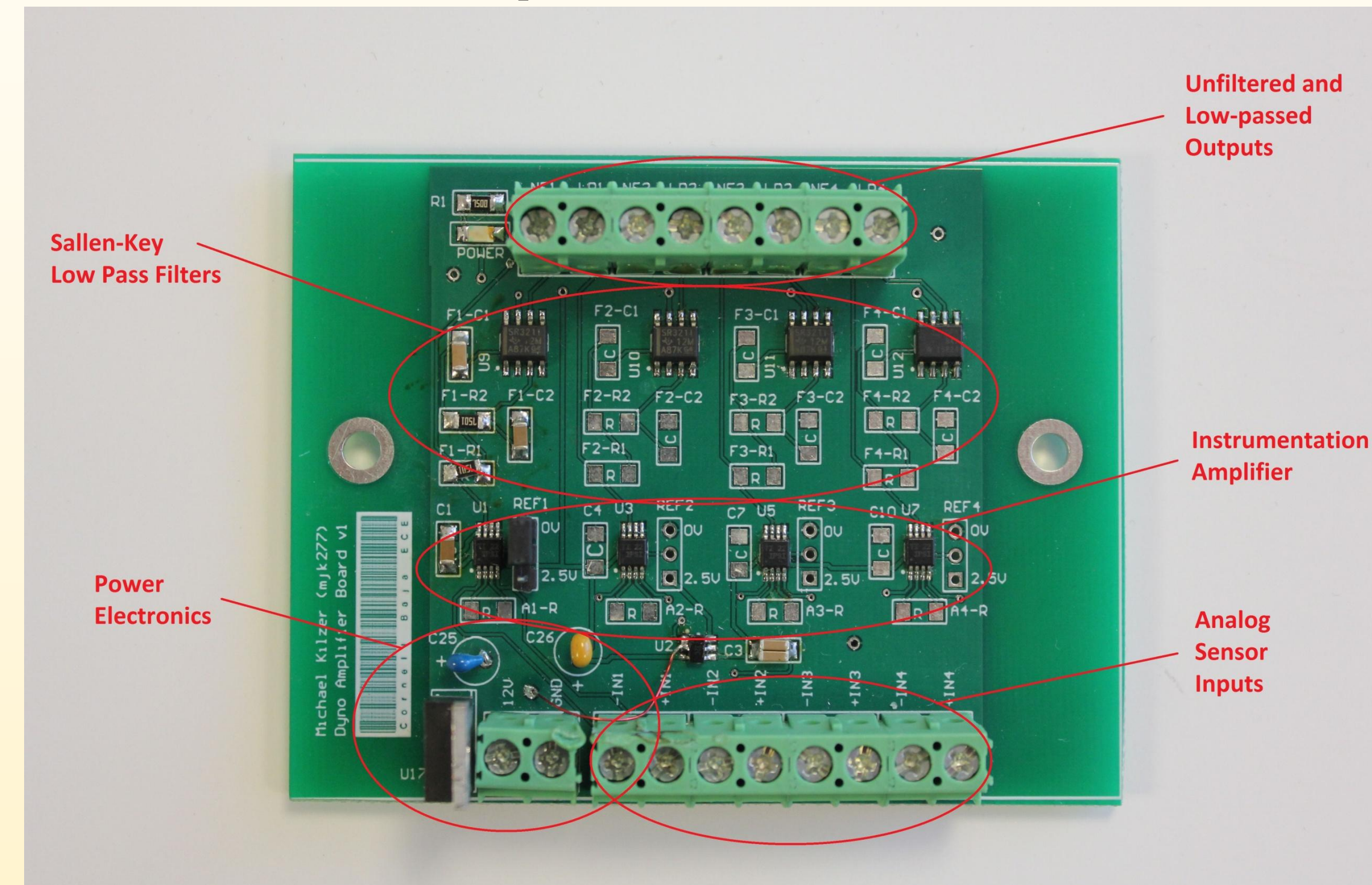
Motivation
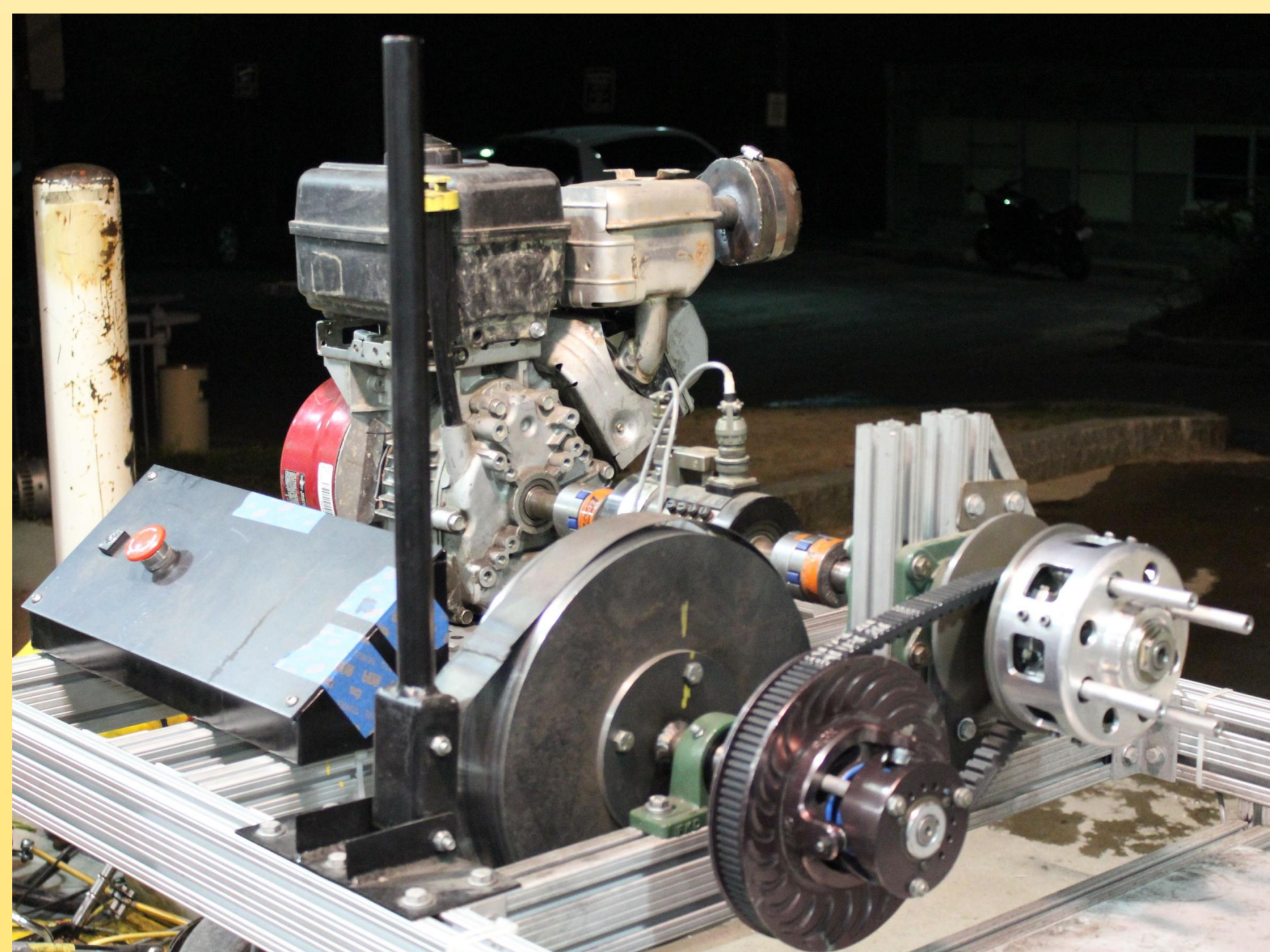
The data acquisition system for the CVT dynamometer now only takes 3 inputs, limiting the amount of data the Baja team can measure in any particular run. The filters also saturate, which can cause problems when attempting to record accurate data. The current DAQ only samples at 10 samples/second. While this is adequate, it is a bit slow.
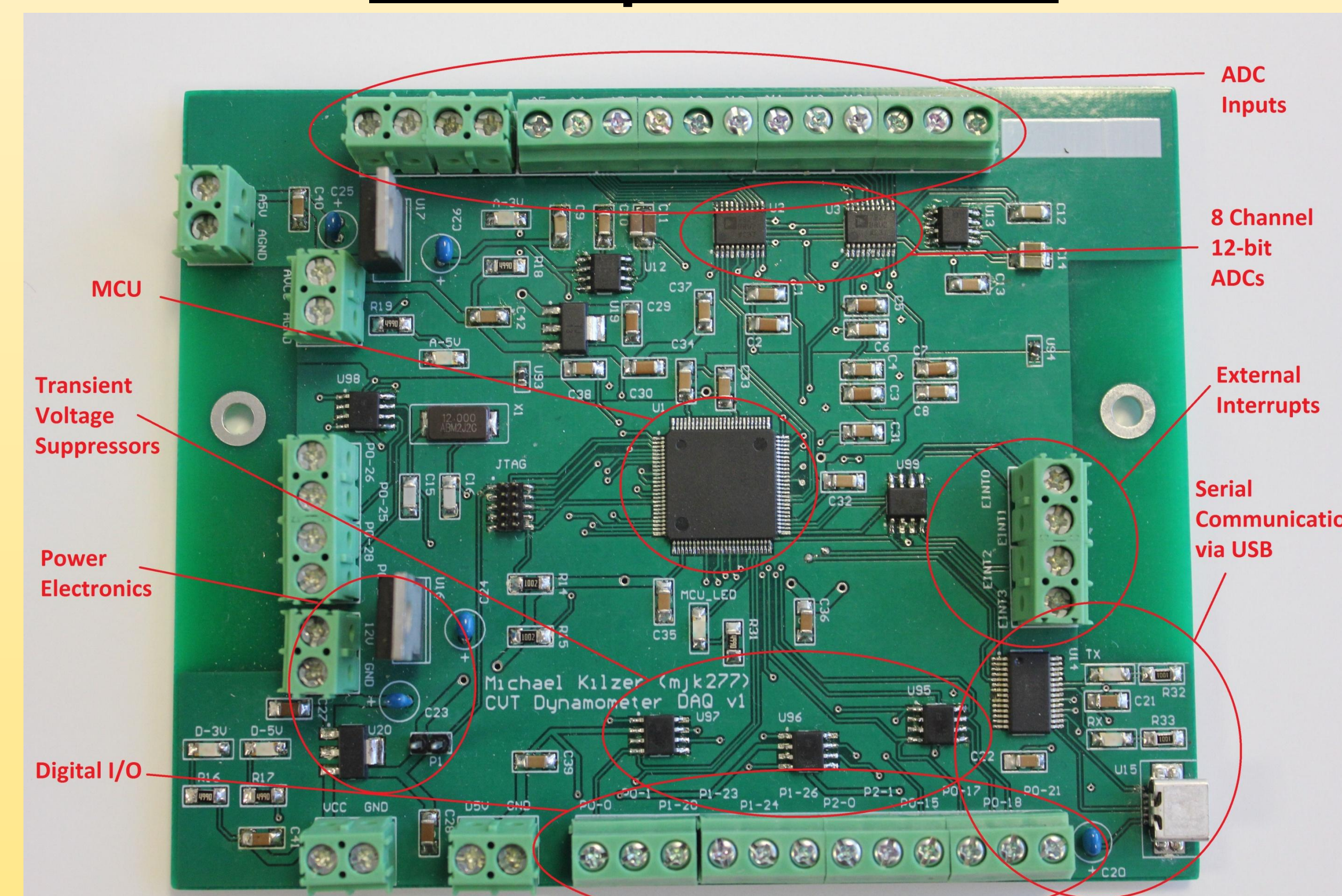
Implementation

Analog data is amplified and passed through a Sallen-Key low pass filter with unity gain…

Amplification Board

Unfiltered and Low-passed Outputs

Sallen-Key Low Pass Filters

Instrumentation Amplifier

Power Electronics

Analog Sensor Inputs

… and then sent to external ADCs and a microcontroller for processing.

Data Acquisition Board

ADC Inputs

8 Channel 12-bit ADCs

MCU

External Interrupts

Transient Voltage Suppressors

Serial Communication via USB

Power Electronics

Digital I/O

This data is then sent via USB to a computer for further processing to help the team tune the CVT.

The board can also take inputs from digital sensors via the connectors at the bottom of the data acquisition board.

These new boards can sample sensor data at rates up to 500 Hertz. There are also 16 analog channels (15 more than the old system). The user can switch analog and interrupt channels on/off via a command string sent via serial over USB.
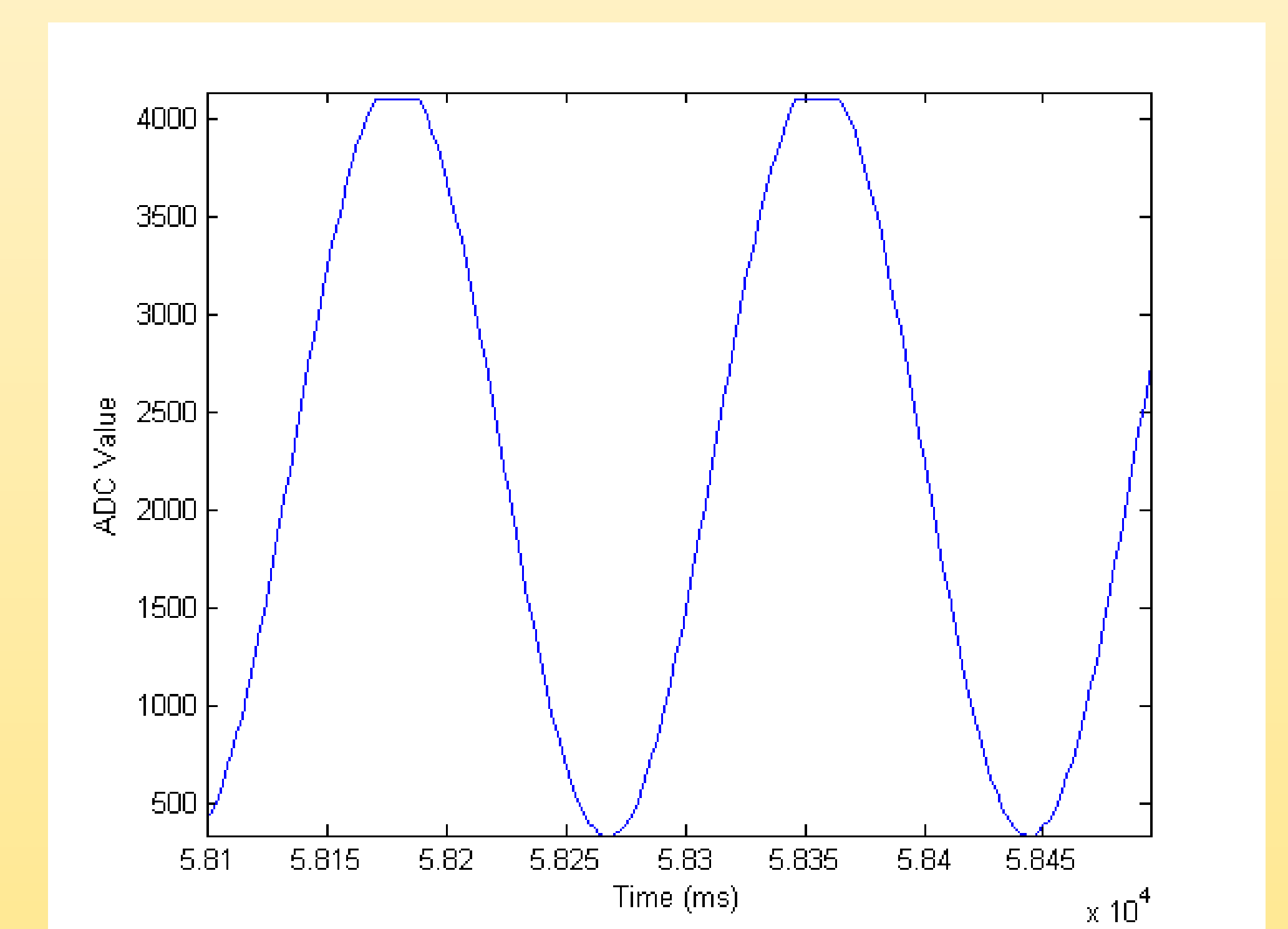
Results

Frequency Response of Sallen-Key LPF
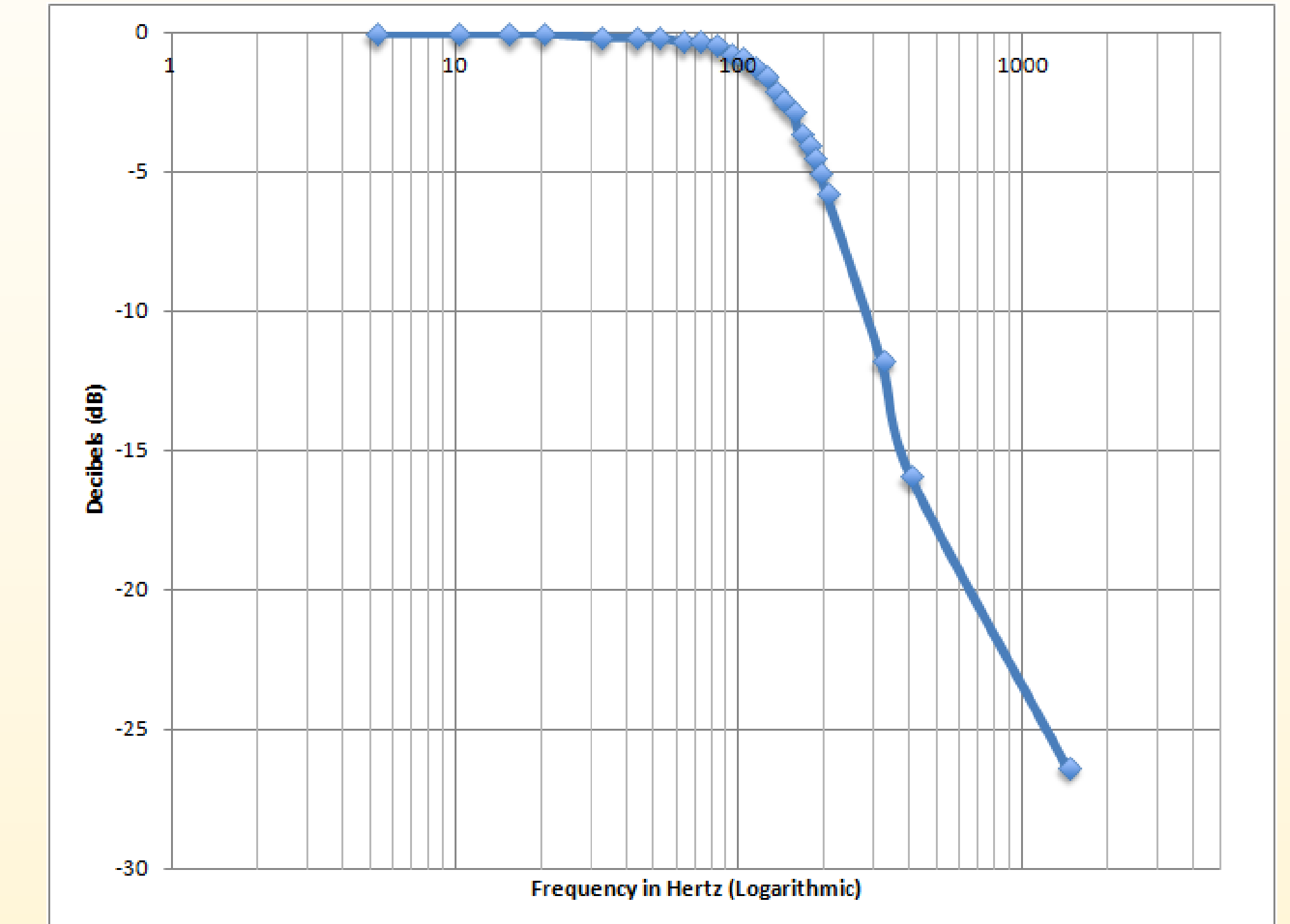
A 1V sinusoidal signal with frequencies from 5 to 1500 Hz were passed through one of the Sallen-Key low pass filters with a cutoff frequency of 150 Hz. Note the -3dB roll-off and subsequent -40dB/decade attenuation.

Plot of 5.7 Hz Sinusoid Signal Sampled at 500 Hz

User Interface

User sends ASCII characters via UART to configure and start the data collection: $(sample period),(EINT Enable),(ADC Enable)#

Example: $5,0xFF,0xFFFF# tells the DAQ board to sample with a period of 5ms, sample all external interrupts and sample all ADC channels.

Example Output:

Time	EINT	ADC															Checksum
11260	0 0 0 1	1599 1575 1571 1572 1570 1569 1561 1560 1476 1562 1547 1543 1543 1544 1538 1536															@D
11265	0 0 0 1	1599 1608 1609 1607 1605 1606 1619 1616 1497 1602 1608 1600 1596 1594 1602 1602															@@
11270	0 0 0 1	1616 1562 1559 1559 1559 1561 1553 1555 1487 1558 1543 1540 1540 1541 1542 1545															@E
11275	0 0 0 0	1597 1583 1583 1578 1578 1577 1575 1571 1480 1568 1562 1557 1552 1553 1551 1548															@@