

Data Logger

Michael Jang
Jacob Drewniak
Team #10



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Objective

- Data acquisition for Illini Motorsports FSAE Team Data
- Current logger is very expensive and difficult to use
- New data logger will reduce cost from \$6000 to \$250 with better functionality

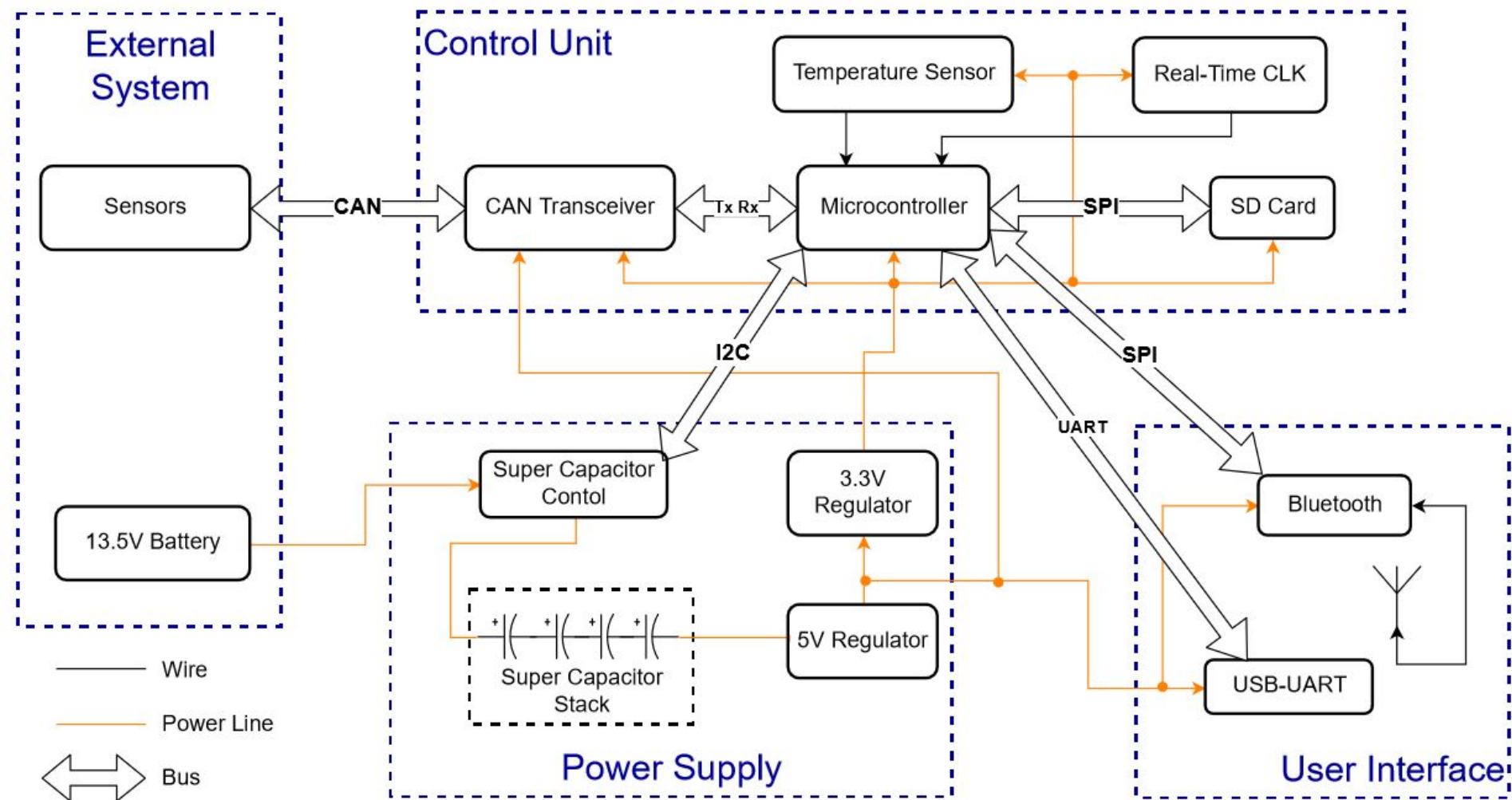




Introduction and Requirements

- Intake CAN protocol messages and store into an SD card.
- Read the stored data through USB and Bluetooth
- Prevent data loss or corruption during power failure







Power Supply Requirements

1. Battery supply voltage (13.5V) stepped down to 5V and 3.3V
2. Supercapacitors power the board for sufficient time when battery voltage is lost



Super Capacitor Controller

- Monitors cell current and voltages and relays to microcontroller over I2C
- Performs cell balancing
- Programmable protection (overage/underage) levels
- Power failure detection

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Super Capacitor Design

$$I = C \frac{dV}{dt} = -500mA$$

$$\frac{dV}{dt} = \frac{6.5 - 12}{2} = -2.75 = \text{constant}$$

$$C = 0.18F$$

$$\frac{4}{C_{individual}} = \frac{1}{C_{stack}} \rightarrow C_{individual} = 0.72F$$

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Michael Jang



5V Regulator

- Buck Converter
- Wide input voltage range
- High efficiency with large input-output voltage difference



3.3V Regulator

- Low-Dropout (LDO) Linear Regulator
- More power dissipation than Buck Converter
- Less complex than Buck converter
- More stable output

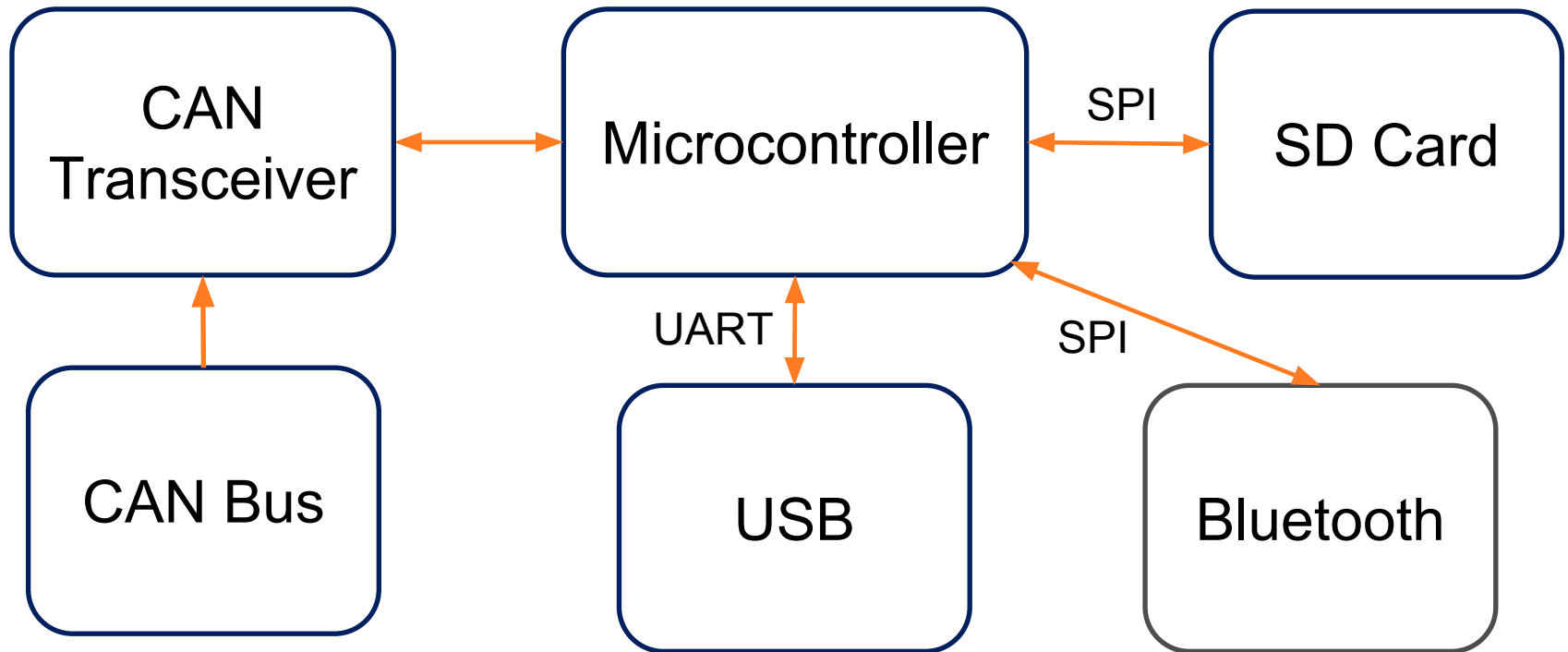


Control Unit Requirements

1. Store incoming CAN (Controller Area Network) messages to SD card
2. Microcontroller reads SD card data and sends to Bluetooth SoC or UART-USB IC



Data Flow



PIC32 Microcontroller

- Sends CAN data to Bluetooth module and SD card through SPI
- Sends CAN data to USB-UART chip through UART
- Communicates with Supercapacitor Controller with I2C protocol

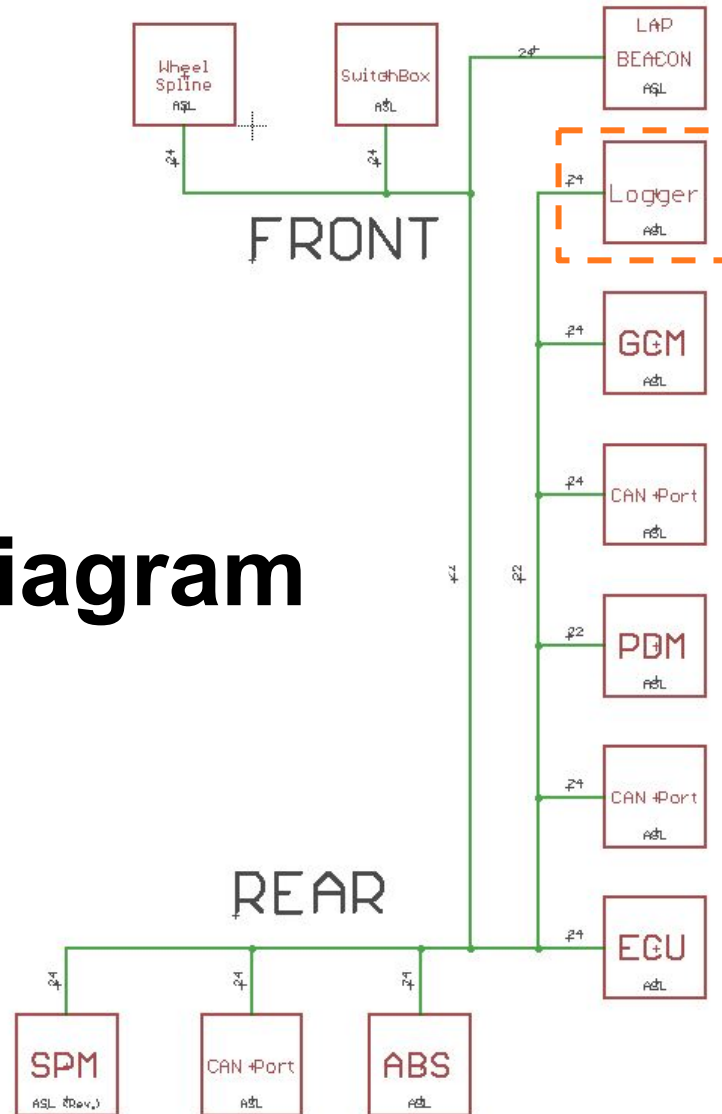


CAN Transceiver

- Accepts messages from car's CAN Bus
- Converts 5V differential signal to 3.3V single-ended signal



CAN Bus Diagram



CAN Spec Examples

Origin	ID	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
Motec	0x100	RPM		Throttle Position		Lambda		Battery Voltage	
Motec	0x101	Engine Temp		Oil Temp		Air Temp		Fuel Temp	
ABS	0x24A	Whee Speed FL		Wheel Speed FR		Wheel Speed RL		Wheel Speed RR	



SD Card

- Stores raw CAN data
- Communicates with microcontroller through SPI
- Optimum storage size and physical size
- At least 4GB

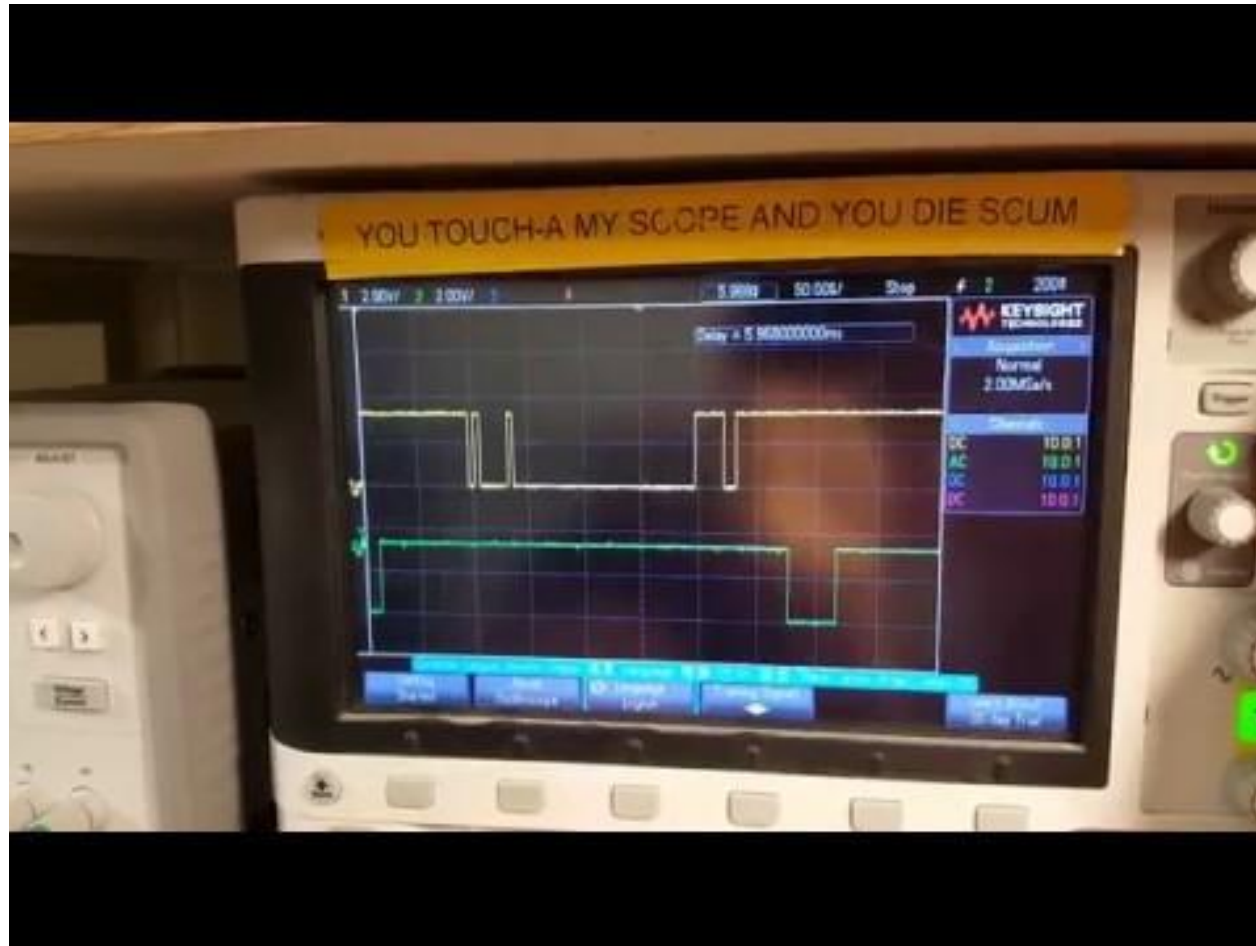


SD Card Protocol

- 6 byte commands
 - 1 byte command
 - 4 byte argument
 - 1 byte CRC (cyclic redundancy check)
- 1 byte response
- 512 bytes of data transmission
- Initialization at 100 - 400kHz, data transmission up to several MHz



SD Card Write



Jacob Drewniak
Michael Jang



Real Time Clock

- Keeps track of actual time and date
- Associate each data point with a time
- Constantly power by 3V coin cell battery
- Lasts over 4 years:

$$\frac{37mAh}{1\mu A} * \frac{1 \text{ year}}{8760 \text{ hours}} = 4.22 \text{ years}$$



Temperature Sensor

- Keep track of all PCB temperatures for car reliability
- Analog input read by uC ADC
- -40°C to 125°C



User Interface Requirements

1. UART signals converted to USB protocol
2. Bluetooth relays data wirelessly
3. Antenna transmits Bluetooth signal within a 10m range



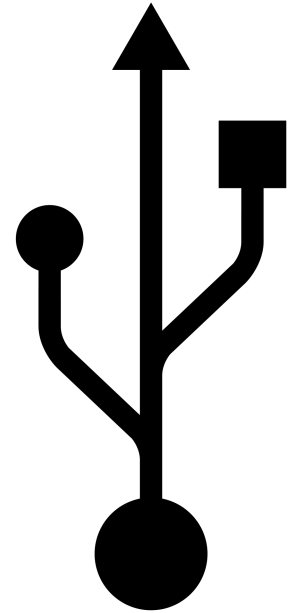
USB-UART

- UART communication originates from the microcontroller
- Converts UART to USB protocol
- High-speed data transmission for large data sets



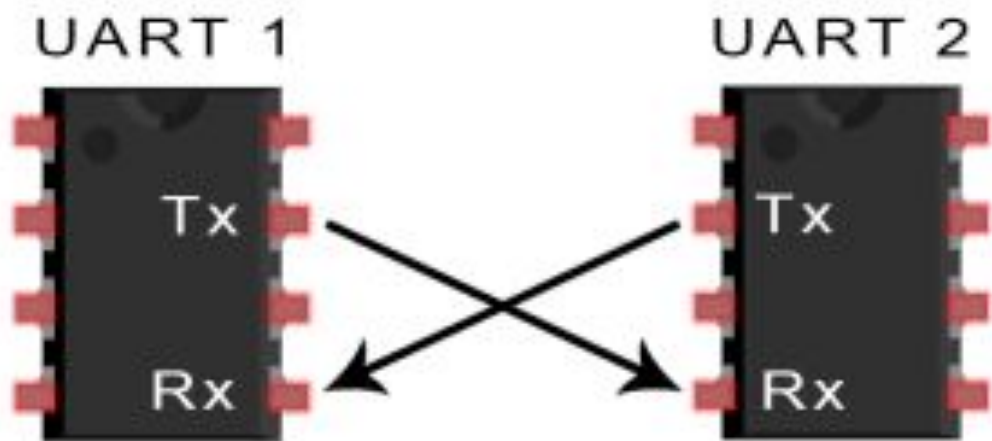
USB Protocol

- Universal Serial Bus
- 2 Byte Token, 2 Byte Data, 2 Byte Handshake, 2 Byte State of Frame
- D+ and D- allow for low noise signals

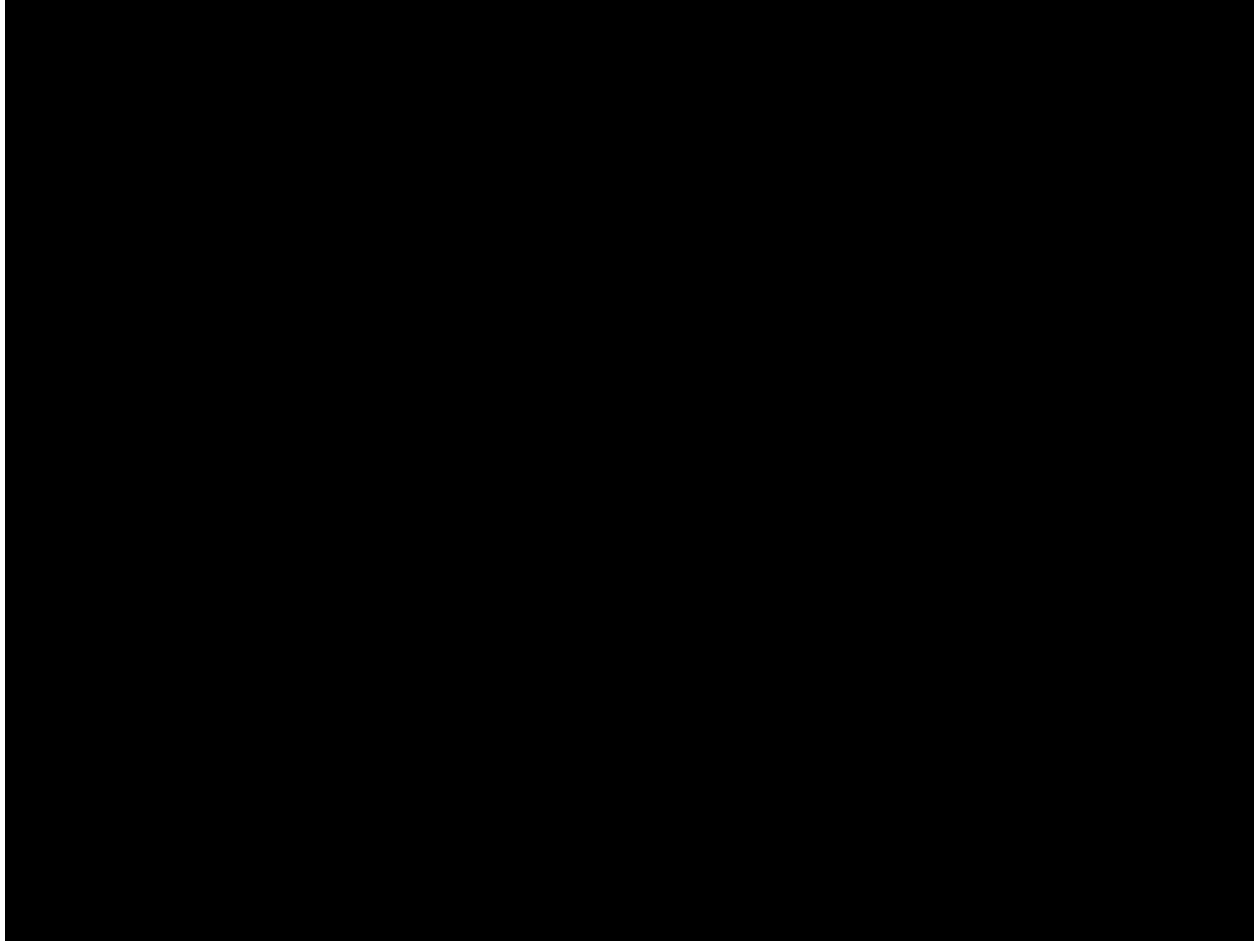


UART Protocol

- Universal Asynchronous Receiver/Transmitter
- 2-Signal Bus
- No Clock



USB Transmission



Bluetooth and Antenna

- Bluetooth IC intakes SPI protocol from microcontroller
- Sends signal to the antenna for wireless transmission
- Connects to compatible device within 10m
- Immediate transfer of small data sets



Challenges

- Developing software for UART, SPI, and I2C
- Integrating all the modules together through software



Shortcomings

- Supercapacitor system short circuited
- Incapable Bluetooth functionality



Future Work

- Integrate Bluetooth
- Integrate the logger into testing/racing environment
- Software on laptop to parse and display data in a readable format





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Questions?