



University  
of Idaho



IDAHO  
CSC

# CSC Pi-Innovo OpenECU

TEAM MEMBERS: Alex Kiss, Colin Parke, Zac Avelar and Hayden Hulse  
CLIENT: UICSC – Daniel Cordon

# CURRENT STATE

- Engine controller has fixed number of sensors/systems
- Can't add new functionality for engine controls
- Extra systems added with microcontrollers
- Holds back innovation



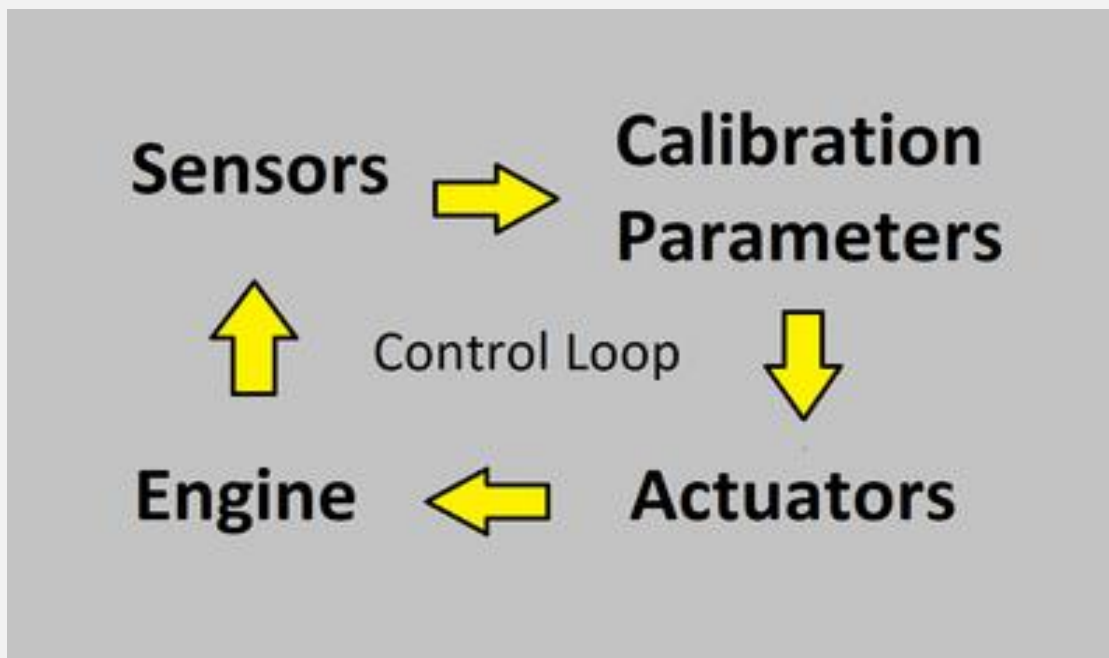
# Value Proposition

- Replicate and expand existing ECU functionality
- Allow space for extra sensors and systems
- Allow more advanced control



# Objective

- Develop connectivity between sensor inputs and a control system using a Pi-Innovo OpenECU
- Evaluate the functionality of the engine control unit (ECU) using a simulated engine
- Create meaningful long-term documentation in the process



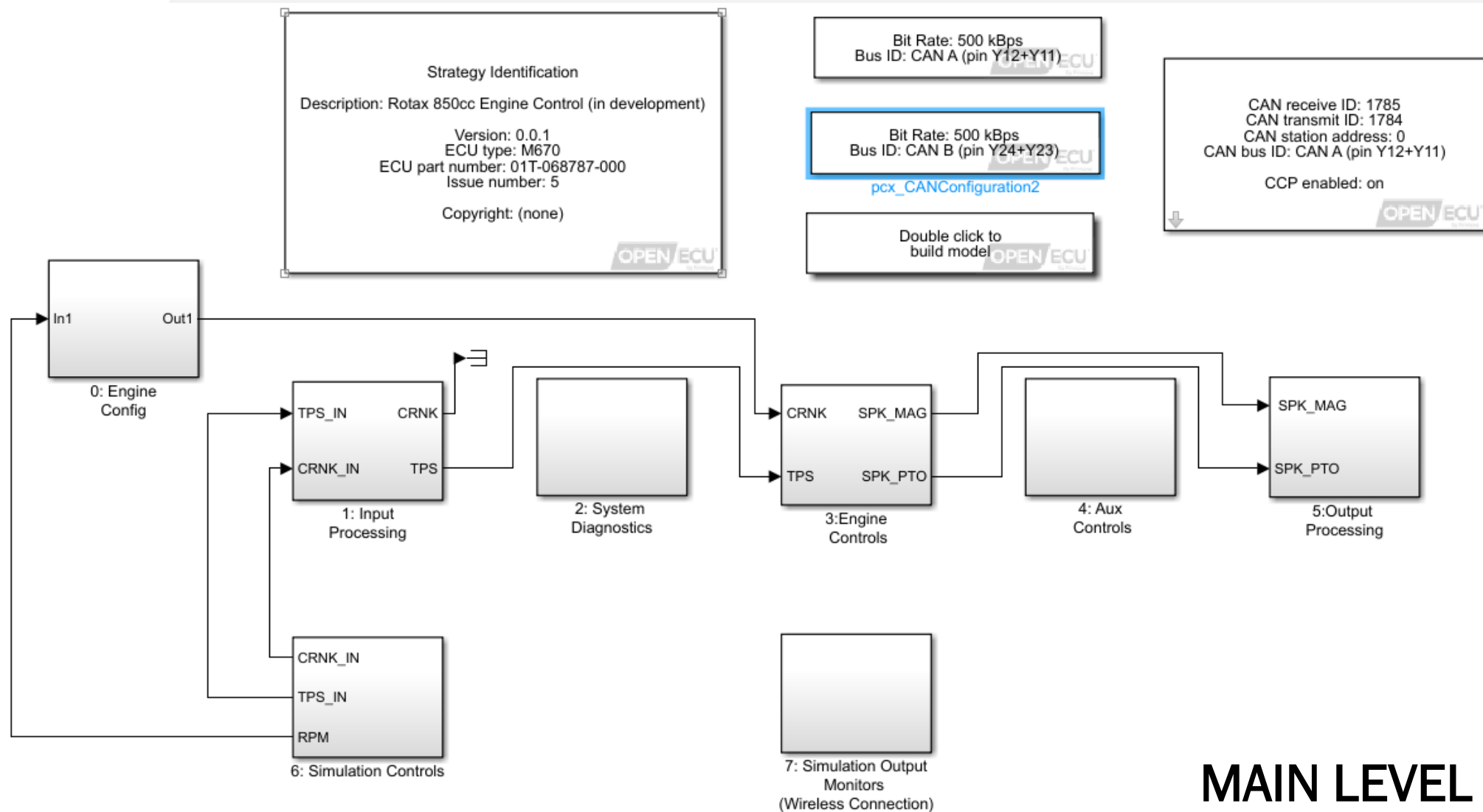
Basic Signal Flow Diagram

# Product Requirements

- Framework for how to integrate future modifications/functions
- Streamlined documentation



# DESIGN

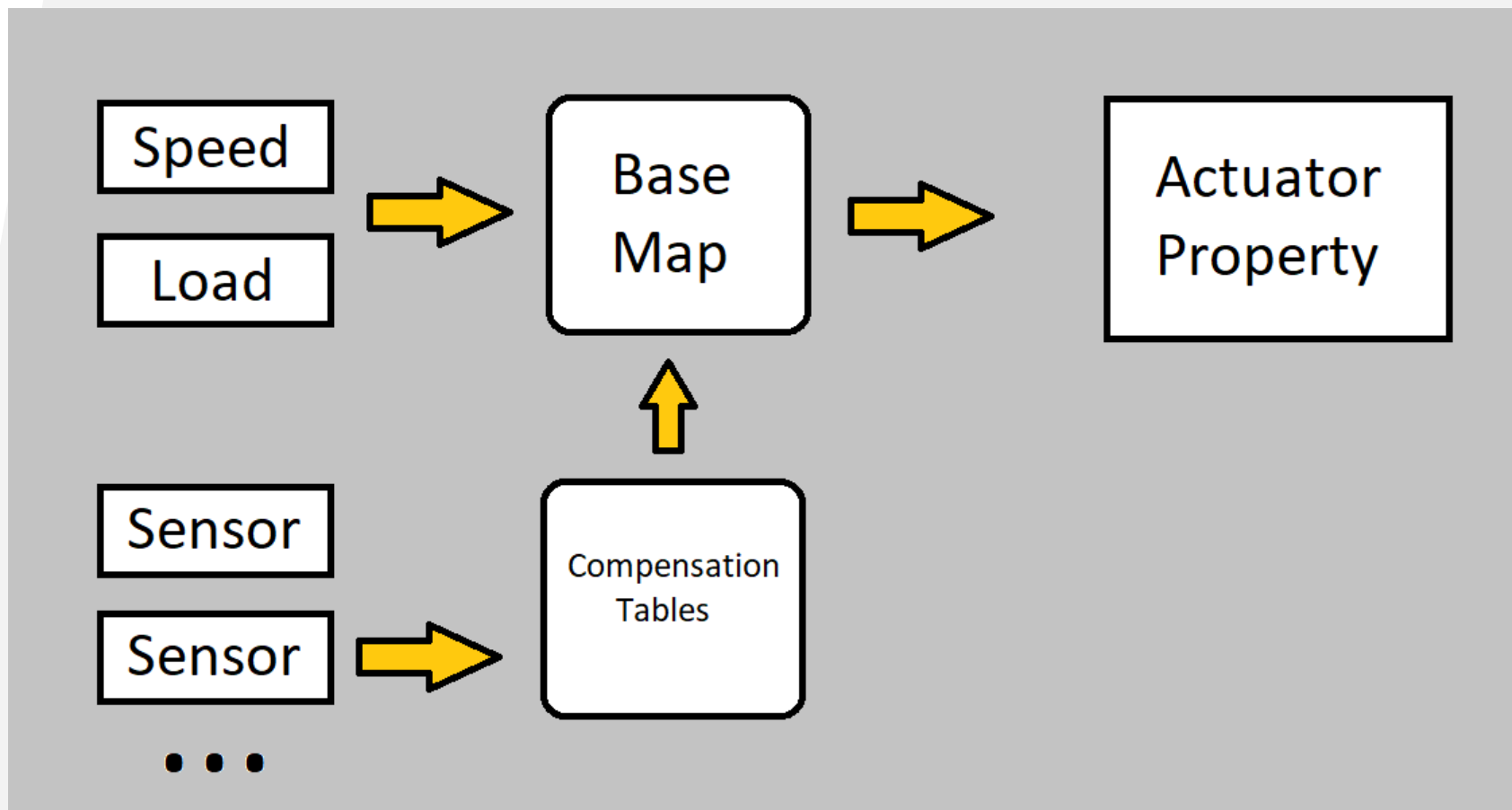


MAIN LEVEL



# DESIGN

## CALCULATING OUTPUTS





# DESIGN

## LOOKUP TABLE EXAMPLE

Speed / Load	100	500	1000	2000	3000	4000	5000	6000	7000
0	61.07	65.10	70.56	80.68	90.74	100.05	110.99	120.56	130.27
10	66.64	70.41	75.20	85.55	95.35	105.86	115.13	125.67	135.61
20	71.06	75.74	80.76	90.46	100.03	110.49	120.92	130.37	140.82
30	76.66	80.18	85.99	95.28	105.52	115.47	125.15	135.38	145.01
40	81.65	85.12	90.81	100.27	110.38	120.59	130.82	140.73	150.81
50	86.69	90.60	95.39	105.97	115.27	125.08	135.58	145.49	155.31
60	91.18	95.13	100.08	110.69	120.42	130.24	140.65	150.48	160.27
70	96.53	100.98	105.75	115.37	125.05	135.41	145.61	155.49	165.99
80	101.47	105.05	110.63	120.67	130.10	140.12	150.65	160.44	170.19
90	106.78	110.11	115.88	125.38	135.12	145.85	155.84	165.59	175.71
100	111.83	115.74	120.58	130.27	140.71	150.50	160.05	170.53	180.54

- Values for injection timing/quantity, spark timing, etc. are determined using 2D maps



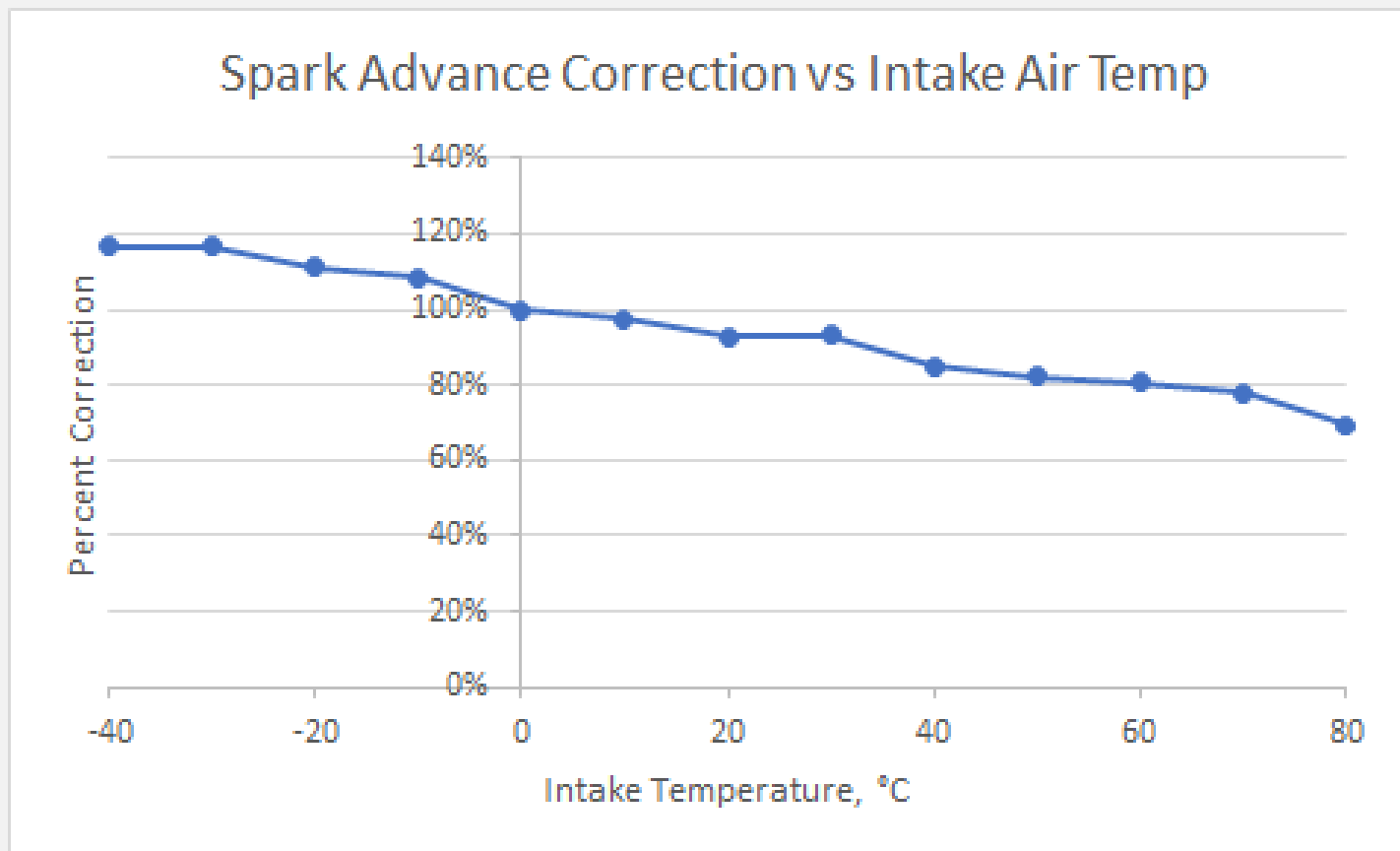




# DESIGN

## CORRECTION/COMPENSATION TABLE EXAMPLE

- 1D lookup tables modify the nominal value of the main 2D lookup table
- Allows the engine to adapt to ambient or adverse conditions



# Validation Procedure

1. Input and output signals are connected and communicating to each other
2. Input signal reads as expected
3. Output signal reads as expected
4. Signal processing properly converts input signal to usable output signal
5. Input and output signals properly resolve to crank timing when applicable
6. Run signal(s) in virtual engine to ensure functionality under realistic conditions

## Signal

Throttle Position Sensor

Injection

Spark (Coil Pack)

Crank pos

RAVE act

RAVE pos

MAPTS

Lamda

Knock

EGT

Coolant

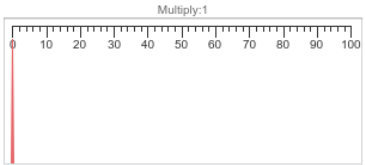
Oil

Mag in

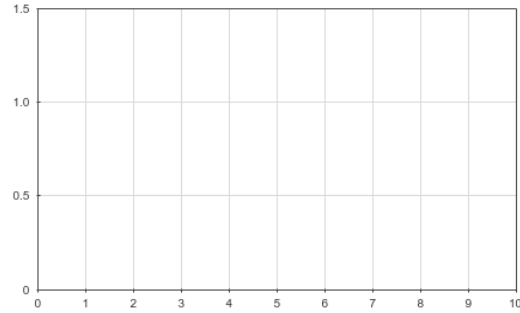
# Virtual Simulation



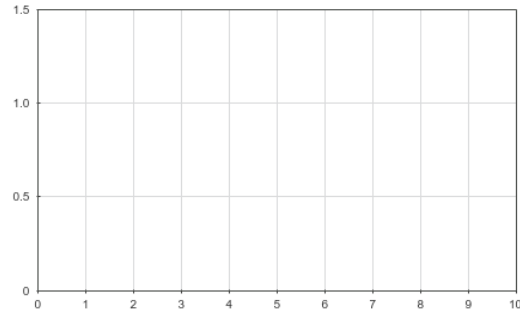
Engine Speed



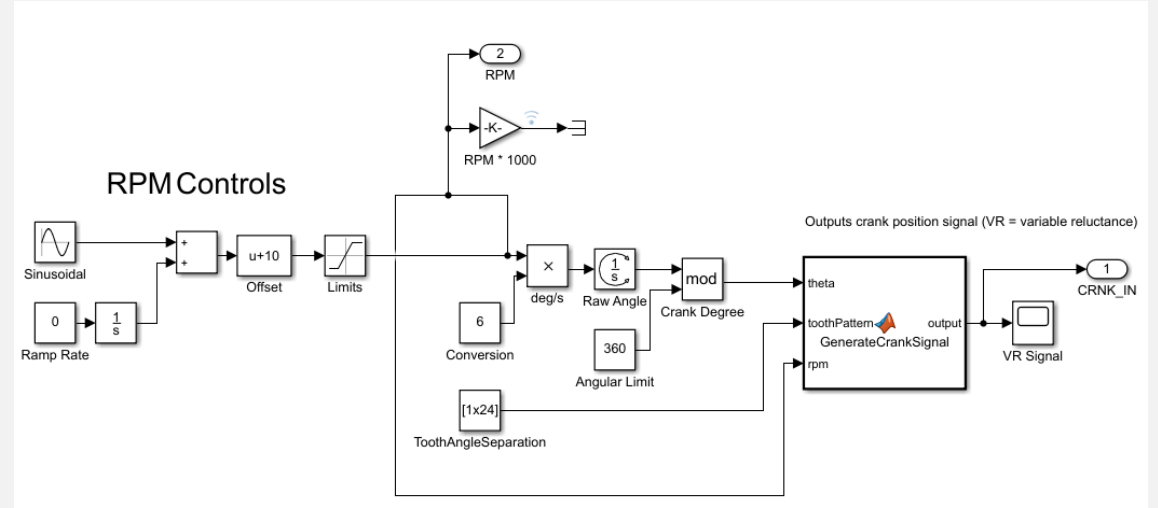
Throttle



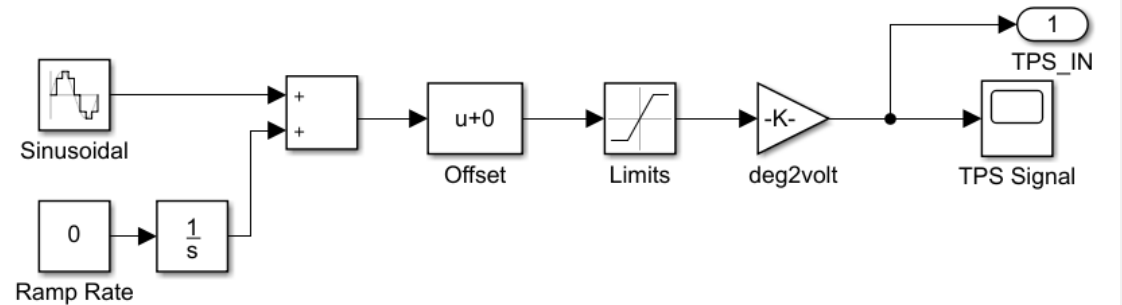
Crank Position



Spark



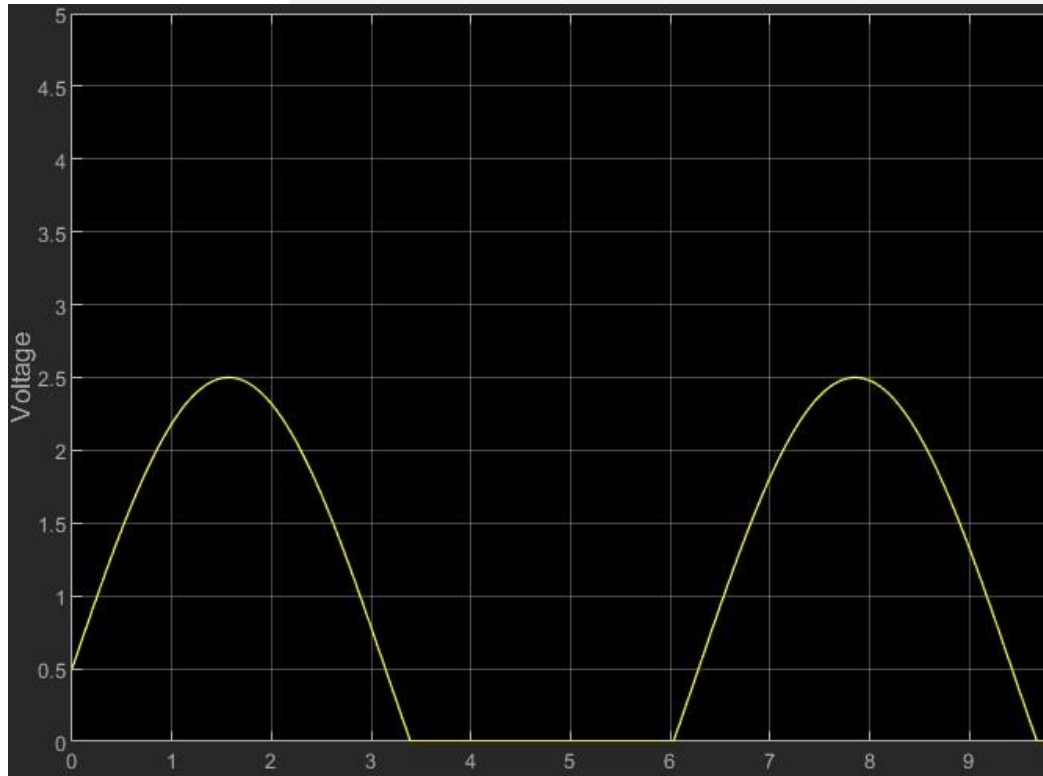
## Throttle Position Controls



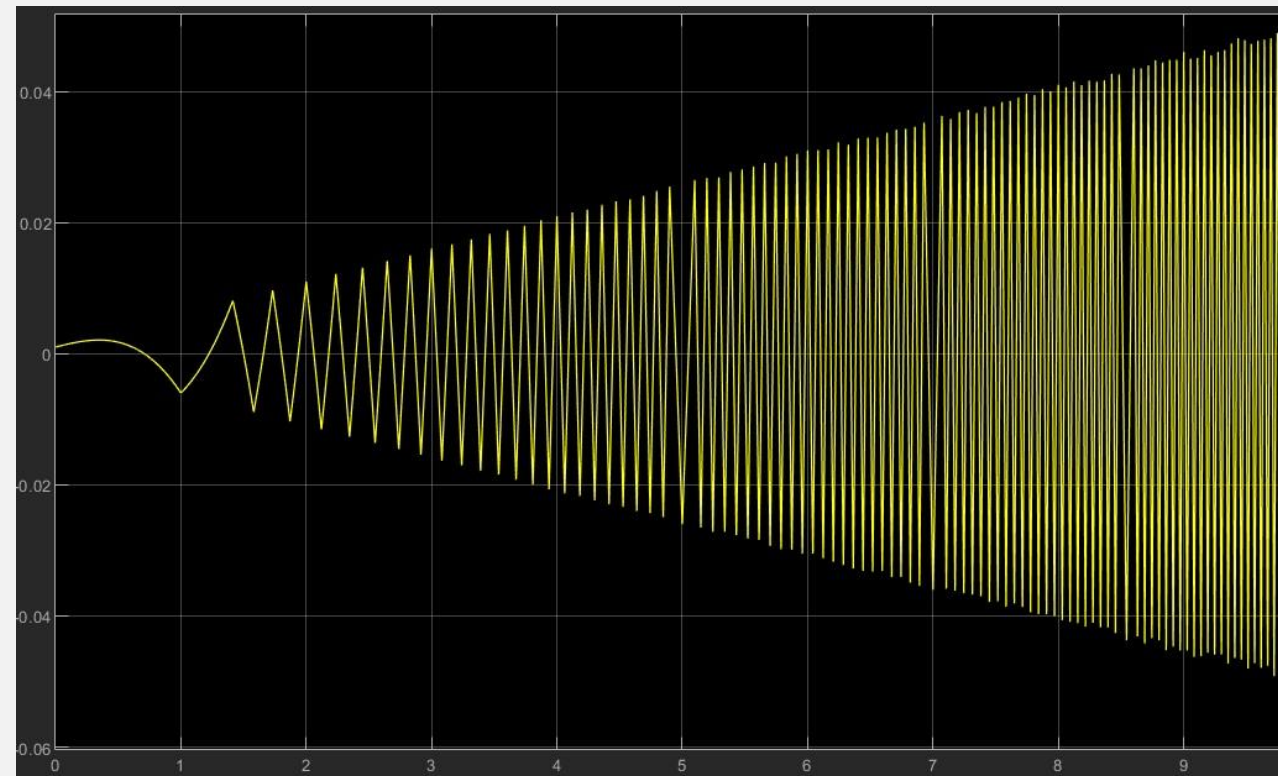


# Simulated Signal Inputs

Throttle Position (oscillating)



Crank Position (RPM ramp)





# Documentation

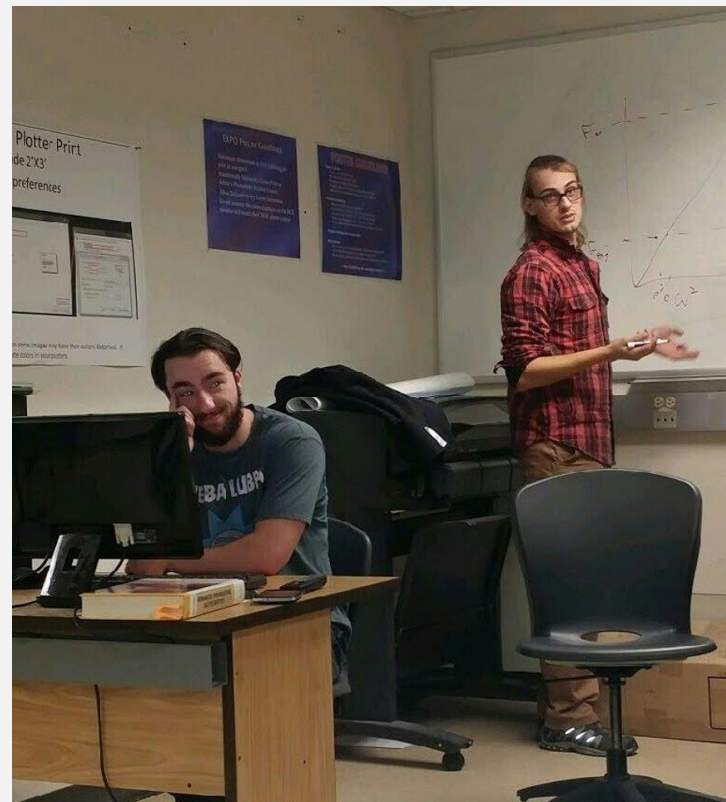
- User manual for future CSC members
- Continued in fall by Colin
- Living Document

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# Future Development

- Colin (Fall Semester)
  - Teach underclassmen how to use software
  - Update documentation to further help underclassmen
  - Develop fully functioning simulation for dyno operation
  - Import current calibration maps
  - Begin hardware testing
  - Setup CAN and CCP communication





# QUESTIONS?



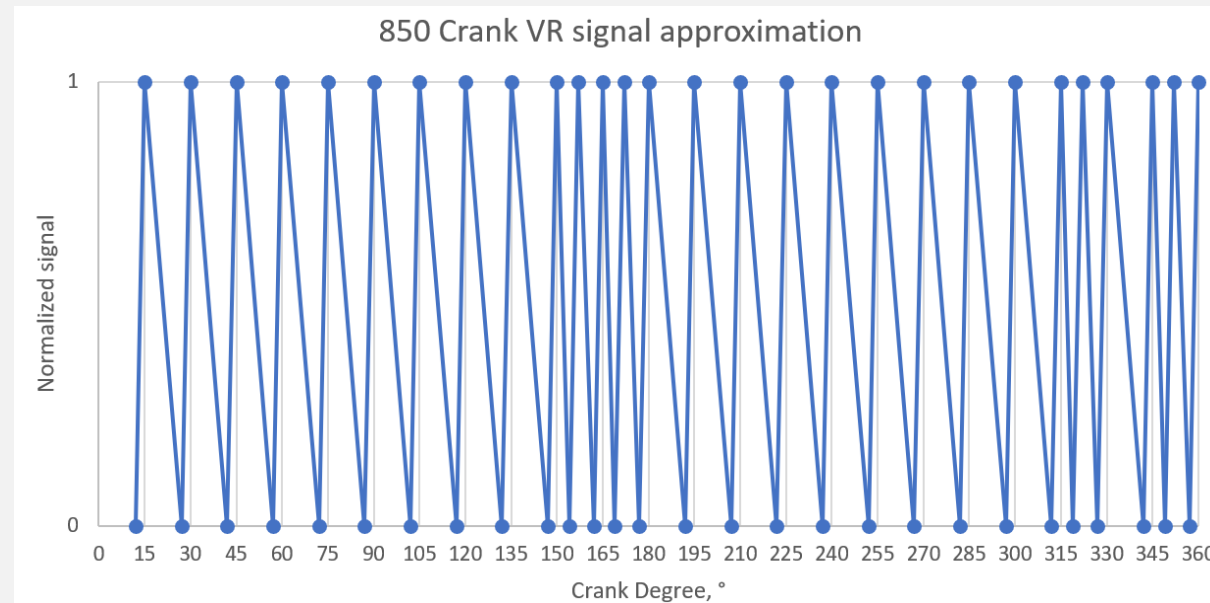
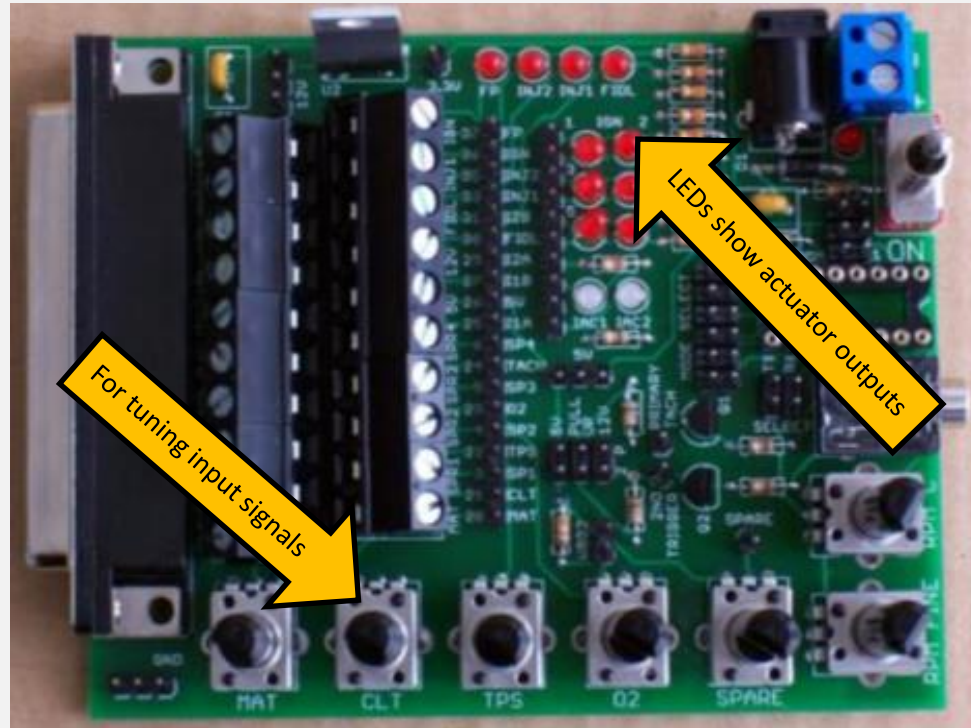
# CALIBRATION

- Sweep these parameters
  - Injection timing
  - Injection quantity
  - Injection ratio between E-TEC and throttle body injection
  - Spark timing

$$f(x) = M * \frac{\left( \frac{(UHC + NO_x)}{1.5} + \frac{CO}{4} \right)}{\dot{W}}$$



# JimStim



← Simulated crank position signal





# Schedule

- Project timeline
- Task completion tracking
- Integrated schedule and Gantt Chart

## University of Idaho Capstone Summer 2020

Project: HYPEIT  
 Project Start Date: 6/15/2020 (Monday)  
 Display Week: 1

						Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
						6 / 15 / 20	6 / 22 / 20	6 / 29 / 20	6 / 20	7 / 13 / 20	7 / 20 / 20
3.10	<i>[Insert Rows above this one, then Hide or Delete this row]</i>			Sat 1/00/00	0%	0					
<b>4</b>	<b>Class Due Dates</b>	Team									
4.1	Team Contract	All	Mon 6/15/20	Mon 6/22/20	100%	6					
4.2	Client Interview Plan	All	Mon 6/15/20	Mon 6/22/20	100%	6					
4.3	Initiate Contact with Client	Colin Parke	Mon 6/15/20	Mon 6/22/20	100%	6					
4.4	DRAFT Budget Estimates	All	Mon 6/15/20	Mon 6/22/20	100%	6					
4.5	Client Visit and Interview	All	Mon 6/15/20	Thu 6/25/20	100%	9					
4.6	Product Requirements	All	Mon 6/15/20	Thu 6/25/20	100%	9					
4.7	Project Schedule	Hayden Hulse	Mon 6/15/20	Thu 7/02/20	45%	14					
4.8	Design Validation Plan	All	Mon 6/15/20	Fri 7/10/20	100%	20					
4.9	Portfolio, Wiki, & Logbooks (w/ review form)	All + Individual	Mon 6/15/20	Fri 7/10/20	100%	20					
4.10	Design Review	All	Mon 6/15/20	Mon 7/20/20	0%	26					
4.11	Value Proposition	All	Mon 6/15/20	Mon 7/20/20	100%	26					
4.12	Snapshot Storyboard	All	Mon 6/15/20	Thu 8/06/20	0%	39					
4.13	Technical Presentation	All	Mon 6/15/20	Thu 8/06/20	0%	39					
4.14	Portfolio, Wiki, Team Member Citizenship, & Logbook (w/ review form)	All + Individual	Mon 6/15/20	Fri 8/07/20	0%	40					
4.15	Final Hardware & Software, Design Report, Work Area Checkout, Electronic File Archive	All	Mon 6/15/20	Fri 8/07/20	0%	40					

