

# Dyno Data

Monday, February 8, 2021 5:24 PM

This subpage contains all data related to dyno sessions and data on dyno calibration

# Dyno Basics

Monday, February 8, 2021 7:53 PM

## What is a dyno meter?

A dyno uses two drums to create a rolling resistance against the tires of a car. The weight and acceleration of the drums can then be used to calculate the amount of power that an engine produces.

## How to set up the dyno:

Hopefully the first time you are trying to dyno a car someone has shown you but if not then this should help.

First you need to get the WinPEP7 software off dynojet's website:

<https://www.dynojet.com/downloads/dynamometer/software-firmware/>

After you download that you need to go and place this config file in the Program files (x86)>WinPEP7 directory

If you use the data7 (new).cfg rename it to data 7.cfg



data7 (new)



data7

This will allow your computer to connect with the towers that power some of the dyno components.

Next you need to power on those towers.

Then plug the computer in.

To read AFR through WinPEP7 you need to put the O2 sensor connected to the tower in the exhaust

To read RPM on the software you will want to take the clamp that is also connected to the towers and clamp it around the coil wires and clamp the other on the cars ground.

## Putting a car on the dyno:

This should seem easy but if you mess up it would be a real bad day.

First roll the car STRAIGHT on the dyno then start ratcheting back till the car is in about the middle of the drum.

Then ratchet the front and back at the same time.

Most importantly roll the dyno with your foot in the direction the car will turn it and ensure that the car tracks straight.

This last step insures the car wont crab walk off.

## Getting a graph:

Make sure no one is around the tires or behind the dyno and that the exhaust gasses have proper ventilation.

The driver also needs to understand that he should not slam on the breaks after the run to eliminate extra stress on the straps.

Next get someone in the car and wearing the proper equipment (full racing suit, shoes, helmet, gloves, etc).

Once the driver gets the wheels turning give them a signal to give it the beans.

When you give this signal press the green button on the control connected to the towers to start a sample.

They will need to make sure to give it full throttle.

The most accurate results will be the gear ratio closet to 1:1. However, you can rip through all the gears if you want.

After the driver hits redline or lets off press the green button to end the sample.

The graph will then be displayed on the laptop and saved in the directory mentioned earlier.

The previous style of run is a normal dyno that gives an accurate dyno graph

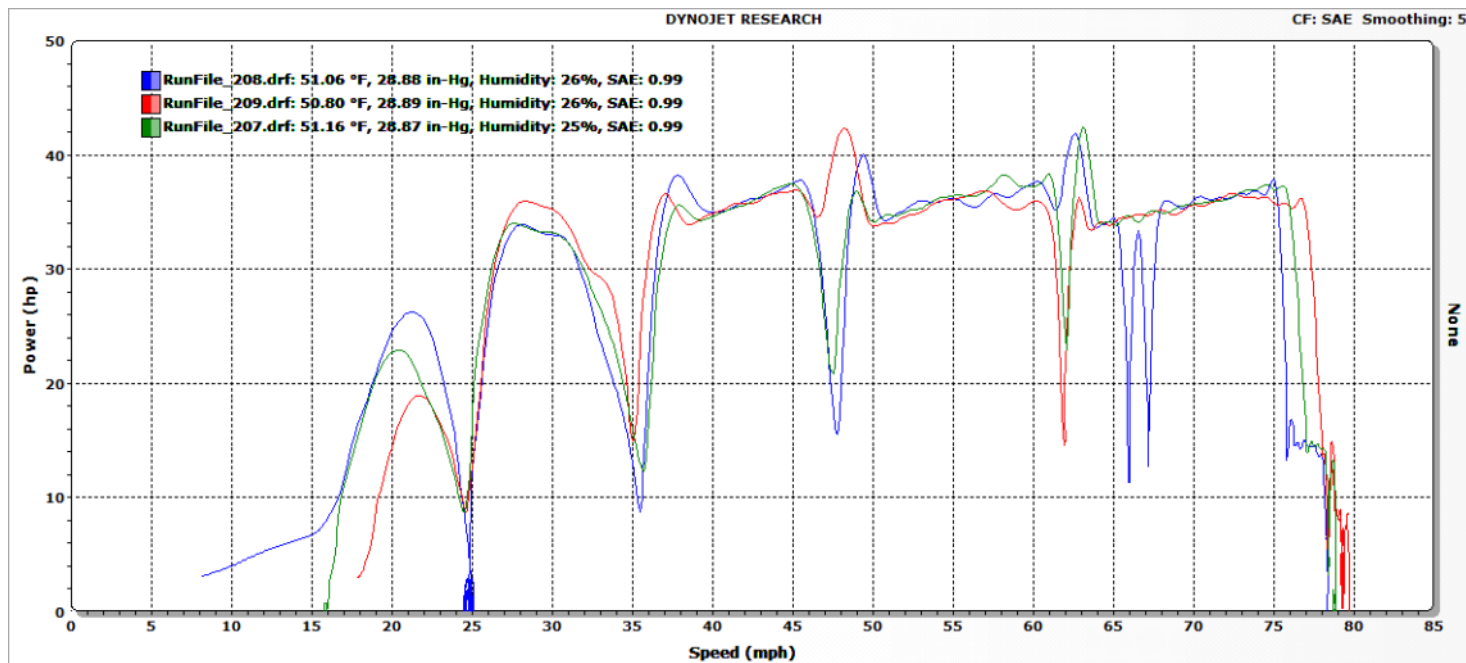
The other kind of run you can do is steady state.

This run will just put load on the engine with the brake and keep the engine at a specific RPM allowing for more tuning precision.

ADDED 12-16-22

The load can be enabled through the pendent by holding the green button while rolling. The amount can then be set in the software by either the value in the bottom left, or by dragging the white arrow on the outside of the load gauge.

## Reading a graph:



This is a dyno graph of the 700cc Raptor that was in KS4-R  
 As you can see we took these graphs going through each gear.  
 Also you can see the Power (Y-axis) and Speed (X-axis).

So what are you looking for in this graph.

You want to look for highest power but also a graph that keeps that high power pretty uniformly.

If you have a design that makes 5 more horsepower but only at a small range where the other makes 4 more horsepower through the whole graph then the later design is clearly better.

You also want to run the car until you acquire consistent results.

The graphs used in design decisions should also be recorded and clearly documented.

#### Troubleshooting

If you are having trouble connecting to the dyno, and have followed all the steps above, check the lights that are on the tower. If there are not two yellow blinking lights, the battery in the bottom stack may be dead. If you were unaware that the tower blinked yellow lights the photo below should help.



If the yellow lights are not flashing then this PDF attached below should also help you change the battery.



EX\_Battery  
\_Replace...

beans

# Tune information

Thursday, January 12, 2023 10:35 PM



2023-01-1  
2\_18.57.08  
KSU TS Project backup as of 1/12/2023



DYNORUN\_  
008



DYNORUN\_  
001



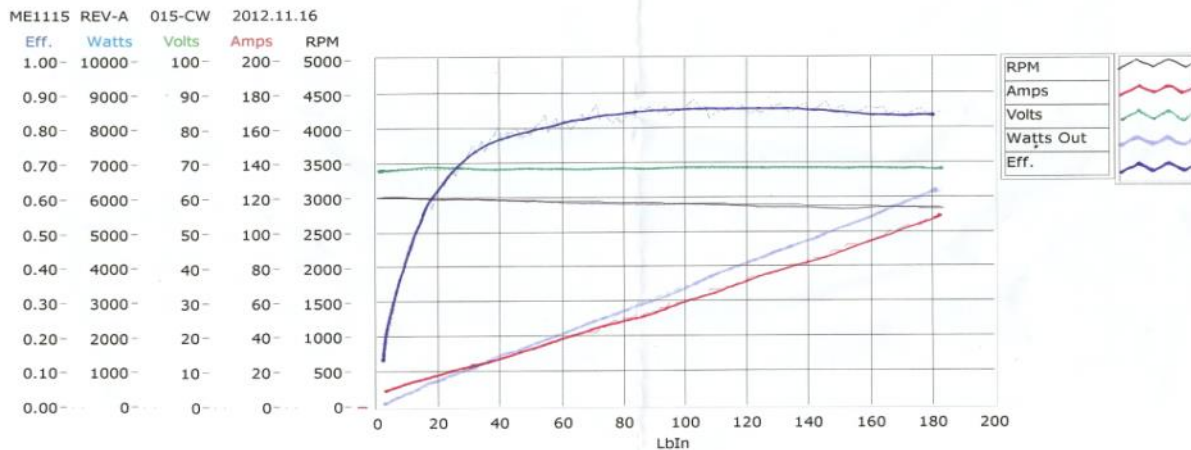
# Dyno Testing With EVT

Monday, February 8, 2021 5:07 PM

Link to drive [https://docs.google.com/document/d/1T-TF2vl-NGyTpBtPx4aurg\\_8mM\\_NhH8l4f7jzXFJWyg/edit?usp=sharing](https://docs.google.com/document/d/1T-TF2vl-NGyTpBtPx4aurg_8mM_NhH8l4f7jzXFJWyg/edit?usp=sharing)

## JESSE DAVIS WORKING NOTES 2/7/21

Torque constant of ME1115 = .15  
Confirmed from graph and website



Peak Motor Current RMS(watched live on laptop)=476A

Motor RPM @ 476A on Run=3130 RPM

Dynojet Peak Power=**21.9hp**

### MOTOR CALCS

Calc NM=.15\*476=71.4NM

RPM @3130RPM

AT MOTOR CALC POWER =**31.39HP**

### GEARING CALCS

GEARING OF CART 11TEETH TO 46TEETH

.239:1

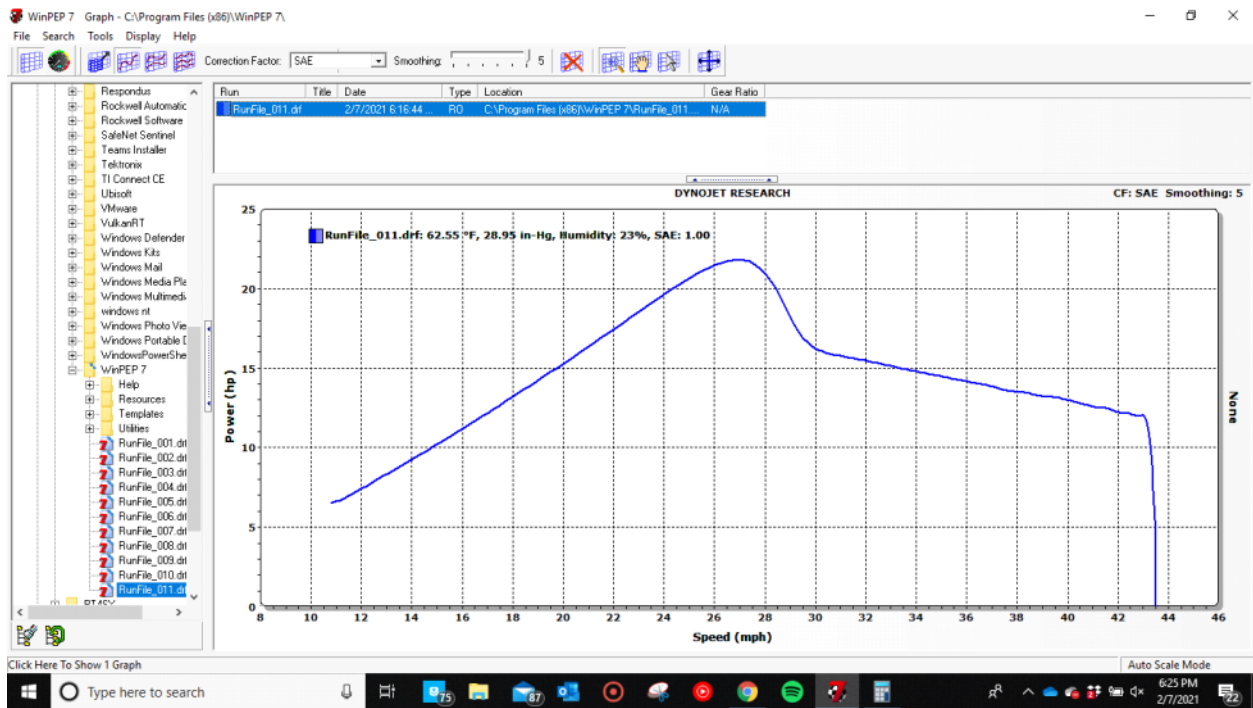
MOTOR @3130RPM→ SPROCKET@748RPM

MOTOR TORQUE =71.4 NM → SPROCKET @ 298.74 NM

POWER CALC AT WHEELS= **31.38 HP**

File Name on Dynojet= Runfile 11

**43.33% DIFFERENCE**



STEADY STATE

800rpm

500a

50%

Torque=98.75NM

kW=8.27

# First Raptor Dyno

Monday, February 8, 2021 5:25 PM



RunFile\_2  
00



RunFile\_2  
01



RunFile\_2  
02



RunFile\_2  
03



RunFile\_2  
04



RunFile\_2  
05



RunFile\_2  
06



RunFile\_2  
07



RunFile\_2





RunFile\_2  
08



RunFile\_2  
09

# EVT Kart Dyno

Monday, February 8, 2021 10:33 PM



EVT 1



EVT 2



EVT 3

# Tuning

Monday, February 8, 2021 5:24 PM

This subpage contains all things related to tuning basics and the decisive tuning process

# Tuning Basics

Monday, February 8, 2021 7:52 PM

## What is a tune

A tune is a reference for the engine control unit (ECU)

The ECU controls almost everything on the engine

When fuel or spark events should happen

Where are the sensor data is sent to and processed

How much fuel should be injected for certain parameters

This is essential to any electronic fuel injected (EFI) engine since most everything is done electronically.

This also helps insure that you are achieving a good volumetric efficiency (VE)

## How to tune

The ECU uses a software called tuner studio.

This software has a premium version to allow for some auto tune features I will get into later.

First there are a few things you should check.

What is the firing order for that engine.

What is the size of the fuel injectors and engine.

What is the redline set at and how comfortable are you with the current tune if you are unsure bring the redline down anyways.

What is the trigger wheel settings for that engine and is there any reason those would be wrong

What timing are you on for an initial startup try running a fixed timing instead of the table

Do you have a cam, map, TPS, or O2 sensor.

Are the injectors and coils in the right order (check this with the test mode)

Are your sensors calibrated correctly do those values make sense for what the car is doing when not running.

If the engine is not hitting check to see if the cam and crank are logging in the high speed logger.

## Tuning fundamentals

Once the car is running you should check your AFR (air to fuel ratio) if this is not within 12.7-14.8 after warming up you should adjust the VE table until the AFR is within those ranges. (this can be done with auto tune).

After this you will want to let the car cool down and see if the WUE (warm up enrichment) looks like a gradual slope and that the AFR offset goals look adequate.

Assuming you are running a fixed timing you will want to start implementing the timing table. You will have to make an educated guess on what the timing should be and keep below 6k until the timing values are worked out well.

After that you will want to up the rev limit 1k at a time this gives you a little more safety from damaging the motor. To start you will want to duplicate the timing from the column to the left to the new column. Then edit according to sound again. At some point you will need to stop and get knock sensors because once you can here the knock something is already damaged. So progress at your own risk and level of knowledge.

## More advanced tuning

Run the car with sequential injection and spark, this will require a CAM sensor so the ECU know the exact events to do these rather than just wasted spark and fuel.

To achieve more accuracy you should also run the car off the MAP (mass airflow pressure) this will tell the ECU exactly how much air it can get rather than how open the throttle is.

The AFR will very per each cylinder so at some point you should put an O2 in each runner.

Jesse D. Notes and possible stuff to add

Tuning Basics add-

Set up and searching for port aka connection problems, making new project, concept of "Burning", saving tunes

Specific parameters of motors we have aka firing order, injector size, etc.

Where key setup parameters are stored, which situations call for which settings etc

Which Key parameters and systems should be turned off to avoid problems?

Setting up and calibrating sensors inputs, values, displaying them on gauge cluster

Testing sensors aka Composite logger for cam and crank, Logging to MegaLog viewer

Possible troubleshooting process for if car will not run on initial startup

# Tuning Notes 11/16/20

Sunday, October 11, 2020 9:24 PM

JESSE DAVIS

CADE SKINNER

## **TUNING KS5**

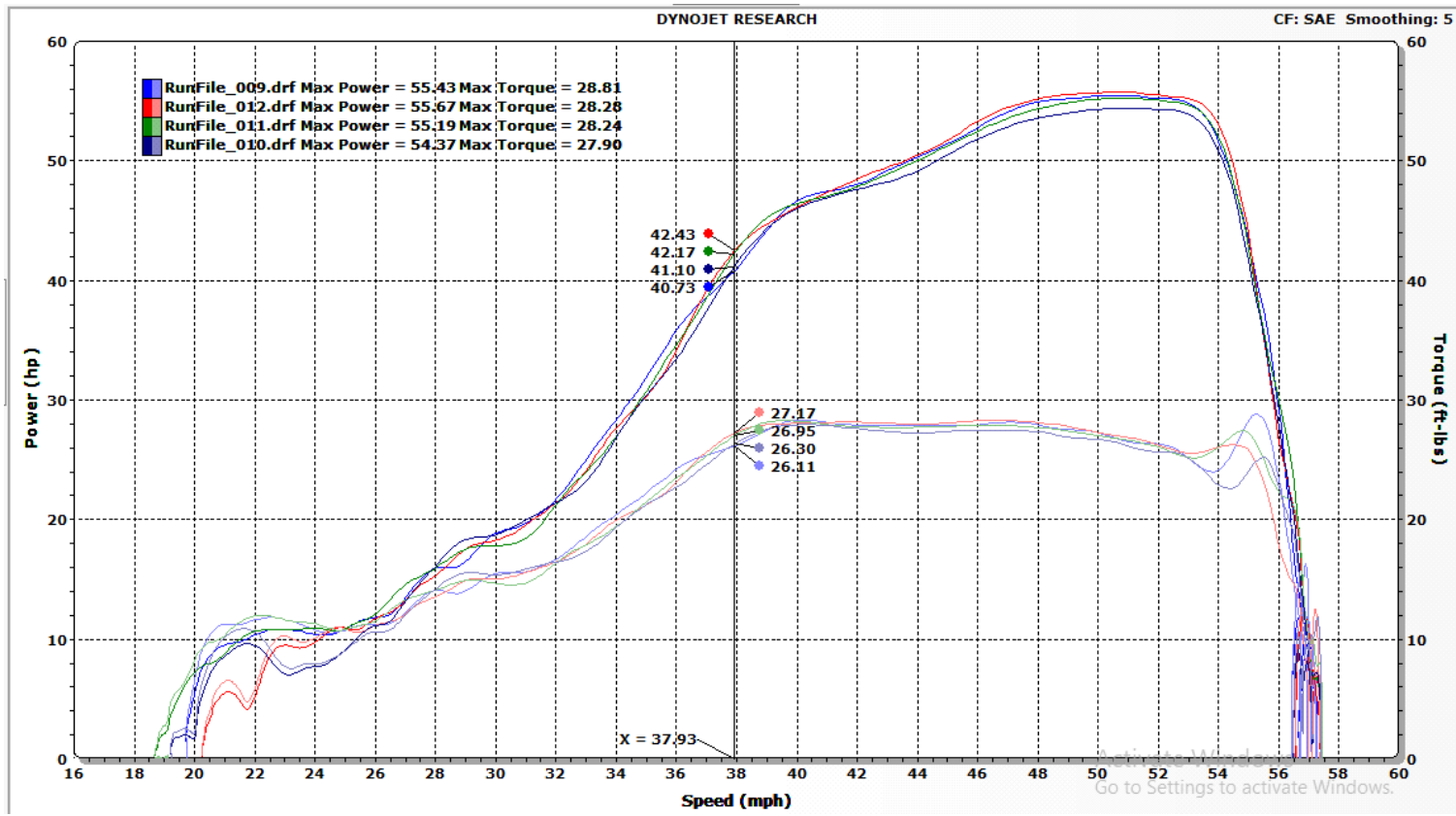
KS5

TUNE

11/16/20

- FULLY SEQUENTIAL
- RUNNING OFF TPS
- CHANGED OIL PAN, CONFIRMED OIL PSI
  
- STARTED AUTO TUNE ON WARMUP ENRICHMENT
- RAN 2 MIN COOLANT GOT UP TO 100F
- ENGINE DIED OFF
- TUNING
- V1
  - AUTOTUNE WITH WARMUP ENRICHMENT TOOL
  - CAN NOTICE GRAPH CHANGING WARM UP ENRICHMENT
  - AT TIME 8 MIN, CAR RUNNING GOOD, AFR AT 14.1 STILL ADJUSTING TABLE
  - RAN TO 13 MIN TEMP MAXED OUT AROUND 140F WITH FAN AND PUMP ON.
  - APPLIED ENRICHMENT TABLE. WILL LET COOL DOWN THEN TUNE AGAIN.
- V2
  - COOLED MOTOR DOWN TO AROUND 84F
  - CRANKED UP NO PROBLEM, IDLE SOUNDS GOOD
  - AT 8 MIN, TEMP LEVELS AROUND 150, COVERED UP LITTLE OVER HALF OF RADIATOR WITH PAPER AND CUT OFF EXTERNAL FAN BLOWING TO SEE IF TEMP WILL GET UP TO OPERATING TEMP(AROUND 190-200)
  - AT 11MIN, TEMP CLIMBED TO 168F
  - AT 15MIN , TEMP IS AT 186F
  - AT 17 MIN TEMP UP TO 188F
  - CUT OFF MOTOR, LETTING COOL
- V3 (FILE NAME=First Real Tune)
  - CHANGING TUNE
    - CONTROL ALGORITHM FROM ALPHA N TO SPEED DENSITY
    - PRIMARY FUEL LOAD FROM ALPHA N TO SPEED DENSITY
    - PRIMARY IGNITION LOAD ALPHA N TO SPEED DENSITY
  - AFTER LETTING ENGINE COOL, CHANGED ECU TO BE RUNNING OFF MAP, WILL GO THROUGH AND RE TUNE ENRICHMENT TABLE.
    - STARTING CAR AT 76F
    - EXTERNAL FAN ON AND RADIATOR IS UNCOVERED
    - AUTOTUNING WARMUP FUEL ENRICHMENT, CHANGING GOOD
    - AT 7 MIN, TEMP AT 148, COVERED HALF OF RADIATOR AND CUT OFF EXTERNAL FAN
    - AT 16 MIN, TEMP ON ECU READ 192, TEMP ON COOLANT WCAP READ

- 210F,
  - WAS AT END OF WARMUP ENRICHMENT TABLE, AFR WAS READING AROUND 16
  - CUT OFF CAR
  - SAVED TUNE AS "First Real tune V2"
  - WILL LET CAR COOL
- NOW ATTEMPTING TO TUNE FUEL TABLE
  - SAME SETTINGS AS BEFORE, JUST DOING AUTOTUNE ON FUEL TABLE NOW.
  - TEMP AT 100F
  - STARTING AUTOTUNE OF FUEL TABLE
  - IDLING AROUND 2000 RPM, AFR AT ~14.1
  - AT 4 MIN, AFR ~14, TEMP =150F
  - WILL REV LITTLE TO SEE CHANGE
- CAR NOW ON DYNO
  - ATTEMPTING TO TUNE FUEL TABLE
  - AS CAR IS LOADED IT BOGS DOWN
  - WILL SEE IF AUTOTUNE CORRECTES THIS
  - WILL BE IN FIRST GEAR
- TROUBLE SHOOTING VE TABLE
  - THE FUEL LOAD WAS NOT RESPONDING TO MAP VALUES WHEN RUNNING SPEED DENSITY
  - THE 1/3VE MULTIPLIER NEEDED TO BE TURNED ON
- VE TABLE TUNE
  - AFTER SETTING UP THE FUEL LOAD CORRECTLY THE VE TABLE IS VERY RESPONSIVE
  - THE DYNO LOAD WAS SET TO 20% AND THE CAR BOGGED INITIALLY BUT PICKED UP AFTER RUNNING AROUND THE TABLE
  - I CHANGED THE IGNITION TIMING TO REFERENCE THE TABLE AND USE A PREDICTION TO HELP THE CAR AGAINST LOADS
  - THE CAR BEGAN TO RUN SMOOTHLY SO I INCREASED REV LIMIT BY 1000 INCREMENTS
  - I STOPPED AT 10K
- ISSUES BEGAN TO DEVELOP
  - I CHANGED TO 12K AND NEVER GOT TO TEST UNDER LOAD
  - THE CAR WAS RUNNING SMOOTHLY BUT ABRUPTLY SHUT OFF AND WOULD NOT CRANK
  - PULLED THE PLUGS AND REALIZED THEY WERE FOULED SO WE LET THE ENGINE AIR OUT AND PUT NEW ONES BACK IN
  - THE CAR CRANKED BACK UP BUT WE COULD NOT RUN UNDER LOAD ANYMORE SINCE THE DIFF WAS OFF
- ENDING OF THE DAY
  - WE FINISHED OFF LEAVING THE 12K REGIONS UNTESTED UNDER LOAD AND STILL NEEDING TO PUT THE DIFF BACK ON BEFORE TESTING WITH LAPS



# BM Tuning Plan 3/20/23

Monday, March 20, 2023 7:09 PM

## Questions to ask before tuning

- Are we looking for more low-end torque or high-end power?
- Where should the start of the power band be?
- What is the probable limiting factor



# Testing

Monday, February 8, 2021 5:24 PM

This subpage contains all data related to tests carried out and other information

# Dyno Day 3/23/23

Thursday, March 23, 2023 12:46 AM

## Problems:

- AFR on the car is not working
- The amp clamp from dyno is getting shaky readings, probably because of the wire carrying power running next to the ignition triggers.
- The intake got some cracks in it, cause unknow will update

## Notes:

Using the AFR from Dyno

## Tuning:

- Running very rich with the new coils so interpolated the ve table from 18 to 100.
- Still running rich so advanced ignition from ranges 1100 - 4700 then interpolated the rest of the graph
- Started to get pop tune so interpolated entire ignition graph from 19 to 33
- Reverted to the original tune, but then realized the car ran like shit from cracks in intake



# Sensor Calibrations- CLT, Oil

Friday, December 9, 2022 2:44 AM

12/9/2022

Recalibrated coolant temp sensor as we noticed it was reading 171°F while the water was actually 194°F (read from IR gun), so we grabbed 3 points for the coolant temp sensor for a new calibration.

Here are the values updated in the tune on the car as of today:

Bias resistor value was chosen from an assumed 2490ohm pullup to 5V resistor as standard.

(update as of 2/28/2023, this should not be a "assumed" 2490ohm pullup as the curve is different with different resistor values. The curve given to us by syltech uses a 1k pull up, but math can be done to correct the curve.)

Calibrate Thermistor Tables...

Sensor Table  
Coolant Temperature Sensor

Table Input Solution  
3 Point Therm Generator

Thermistor Measurements  
Common Sensor Values Select a Common Sensor

Bias Resistor Value (Ohms) 2490

☒ Fahrenheit ☐ Celsius

Temperature(°F)	Resistance (Ohms)
194	298
72.5	2100
30.2	5920

Write Complete!

Write to Controller

Close

12/14/22

Installed Syltech combo pressure & temp sensor. Used custom INC file under the thermistor/custom#1 curve to calibrate the temp sensor. Pressure is a simple linear sensor.

Used data sheet below for wiring, calibration, etc. Also found online, but note the wiring pins & colors noted.



PN: MSCS-4P-G10-N8  
Rev 1.02 202201  
www.syltech.com.au

# Data Sheet: Combo Pressure & Temperature Sensor

Part No: MSCS-4P-G10-N8

Series: MSCS  
Pressure Reference: Gauge  
Housing: 304L Stainless Steel  
Operating Voltage: 5 VDC  
Input: 0 to 10 BAR  
Output: 0.5-4.5 VDC  
Accuracy:  $\pm 1.0\%$  FS  
NTC Specifications: 2.7k $\Omega$   
Temperature Range: -40 to 140°C  
Thread: 1/8" -27 NPT Male  
Connection: Deutsch DTM04-4P  
Mating Connector: DTM06-4S

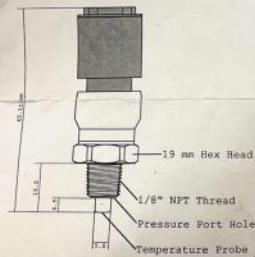
## Linear Pressure Calibration:

Volts:	BAR	PSI:
0.5	0	0
4.5	10	145

## Temperature Calibration:

Temperature (°C/°F)	Resistance ( $\Omega$ )	Voltage 1k $\Omega$ Pull-Up @ 5VDC
-40 / -40	45660	4.893
-35 / -31	35170	4.862
-30 / -22	25840	4.814
-25 / -13	19730	4.759
-20 / 4	15210	4.692
-15 / 5	11830	4.610
-10 / 14	9270	4.513
-5 / 23	7322	4.399
0 / 32	5826	4.268
5 / 41	4662	4.117
10 / 50	3757	3.949
15 / 59	3049	3.765
20 / 68	2490	3.567
25 / 77	2046	3.359
30 / 86	1691	3.142
35 / 95	1405	2.921
40 / 104	1174	2.700
45 / 113	965	2.481
50 / 122	831	2.269
55 / 131	704	2.066
60 / 140	599	1.873
65 / 149	512	1.693
70 / 158	439	1.525
75 / 167	378	1.372
80 / 176	327	1.232
85 / 185	283	1.103
90 / 194	246	0.987
95 / 203	214	0.881
100 / 212	187	0.788
105 / 221	164	0.704
110 / 230	144	0.629
115 / 239	127	0.563
120 / 248	112	0.504
125 / 257	99	0.450
130 / 266	87	0.400
135 / 275	78	0.362
140 / 284	70	0.327

## Side Sensor View:



Note: Obstructing temperature probe & pressure port hole will disrupt output accuracy.

## Rear Sensor View:



Pinout:  
1. Pressure Output 17  $\pm$  7  
2. Temperature Output 21  $\pm$  5  
3. Signal Ground  
4. Power 5VDC

NOTE: To ensure the lifespan of the sensor, avoid mounting locations subject to high vibrations or harmonics that may alter the output and increase internal diaphragm wear. Off-road use only.

1. Line/Pink, 17, Arg. in 7
2. Green/white, 21, Arg. in 3
3. Green/white (TPS) Gnd
4. Yellow/Orange (TPS) 5V

Here's the current generic sensor settings in TS, also under tune 2022-12-14\_Current tune on car with Sensors

Generic Sensor Inputs

File View Tools Help

Generic Sensor Inputs

Sensors 1-8

Sensor - Source	Field Name	Transformation	0V value	5V value	Lag Factor
01 O2 In	Sensor 01	Linear	7.3	22.4	50
02 Analog In 4	Fuel PSI	Linear	-20.0	160.0	50
03 Analog In 1	Sensor 03	Linear	1.1	315.0	50
04 Analog In 7	Oil Pressure	Linear	-17.5	163.0	50
05 Analog In 3	Oil Temp	Custom#1	0.0	5.0	100
06 Off	Sensor 06	Linear	0.0	5.0	100
07 Off	Sensor 07	Linear	-180.0	180.0	100
08 Off	Sensor 08	Raw	0.0	102.3	100

Sensors 9-16

Sensor - Source	Field Name	Transformation	0V value	5V value	Lag Factor
09 Off	Sensor 09	Raw	0.0	102.3	100
10 Off	Sensor 10	Raw	0.0	102.3	100
11 Off	Sensor 11	Raw	0.0	102.3	100
12 Off	Sensor 12	Raw	0.0	102.3	100
13 Off	Sensor 13	Raw	0.0	102.3	100
14 Off	Sensor 14	Raw	0.0	102.3	100
15 Off	Sensor 15	Raw	0.0	102.3	100
16 ECU temp	Sensor 16	Default calibration	-11.0	102.3	100

Allow Input Sharing On CLT/MAT Units degF

Burn Close

Sensor calibration curve



KSU\_Syltec  
h\_Temp\_...



KSU\_Syltec  
h\_Temp\_...

(also updated the firmware on the car's ECU to 1.5.2., the latest)

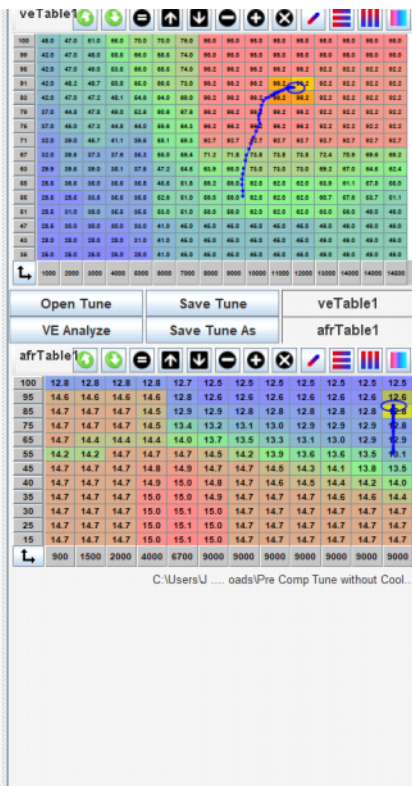
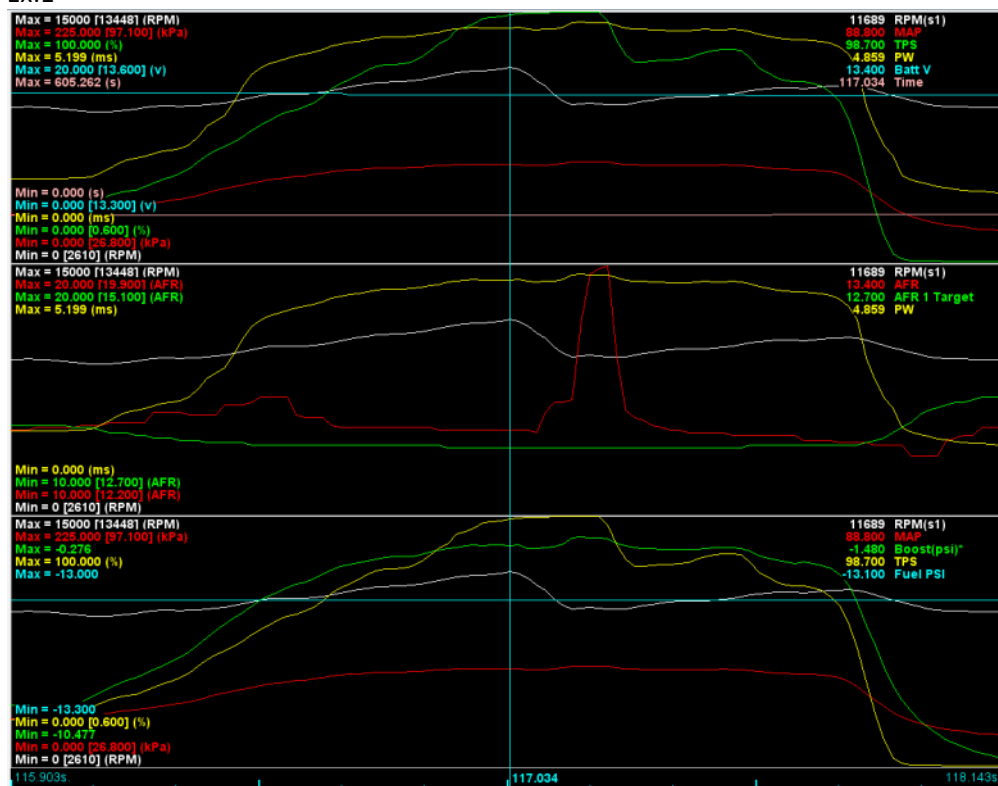
Wednesday, September 21, 2022 1:00 AM

Specifically LOG2687



3\_00.17.4...

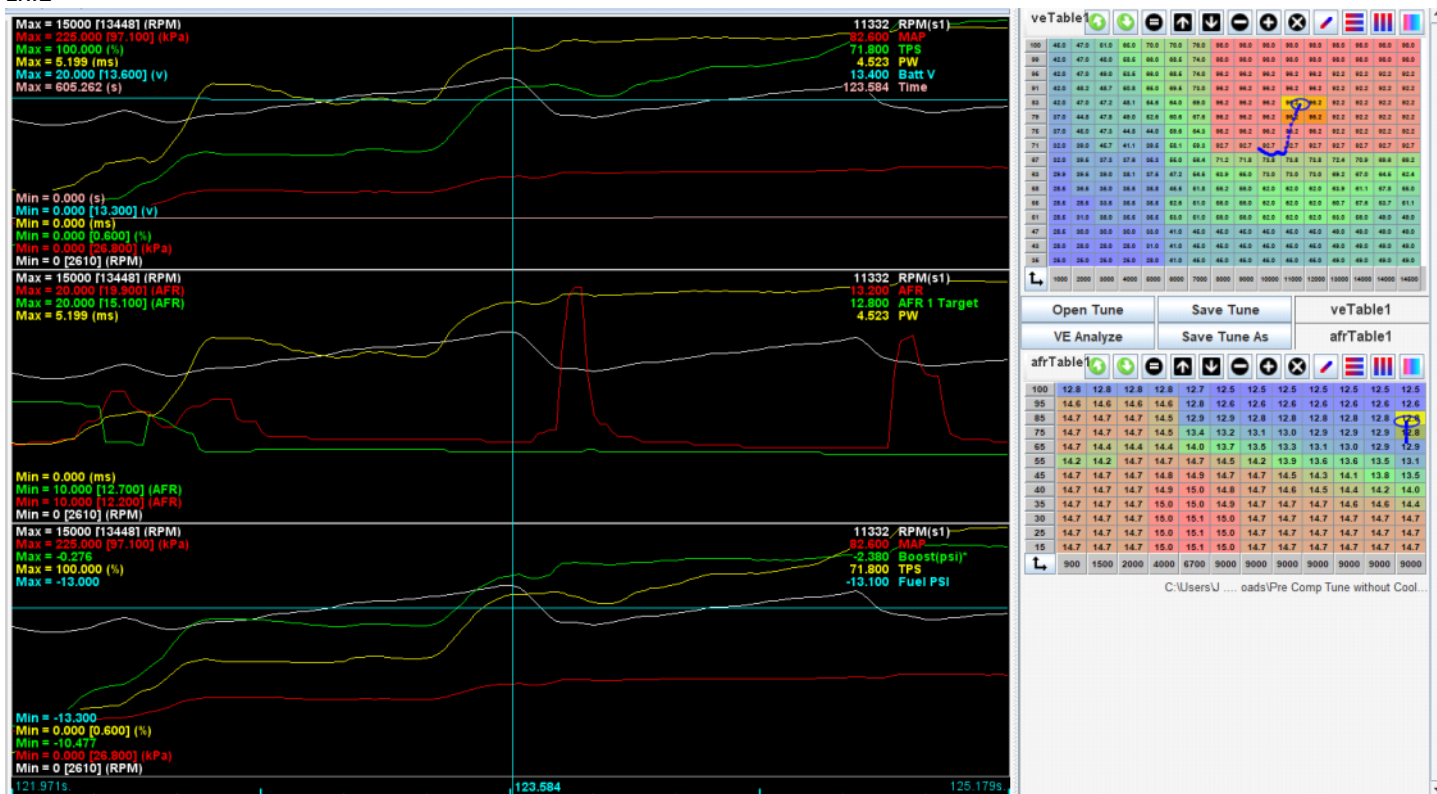
Ex:1





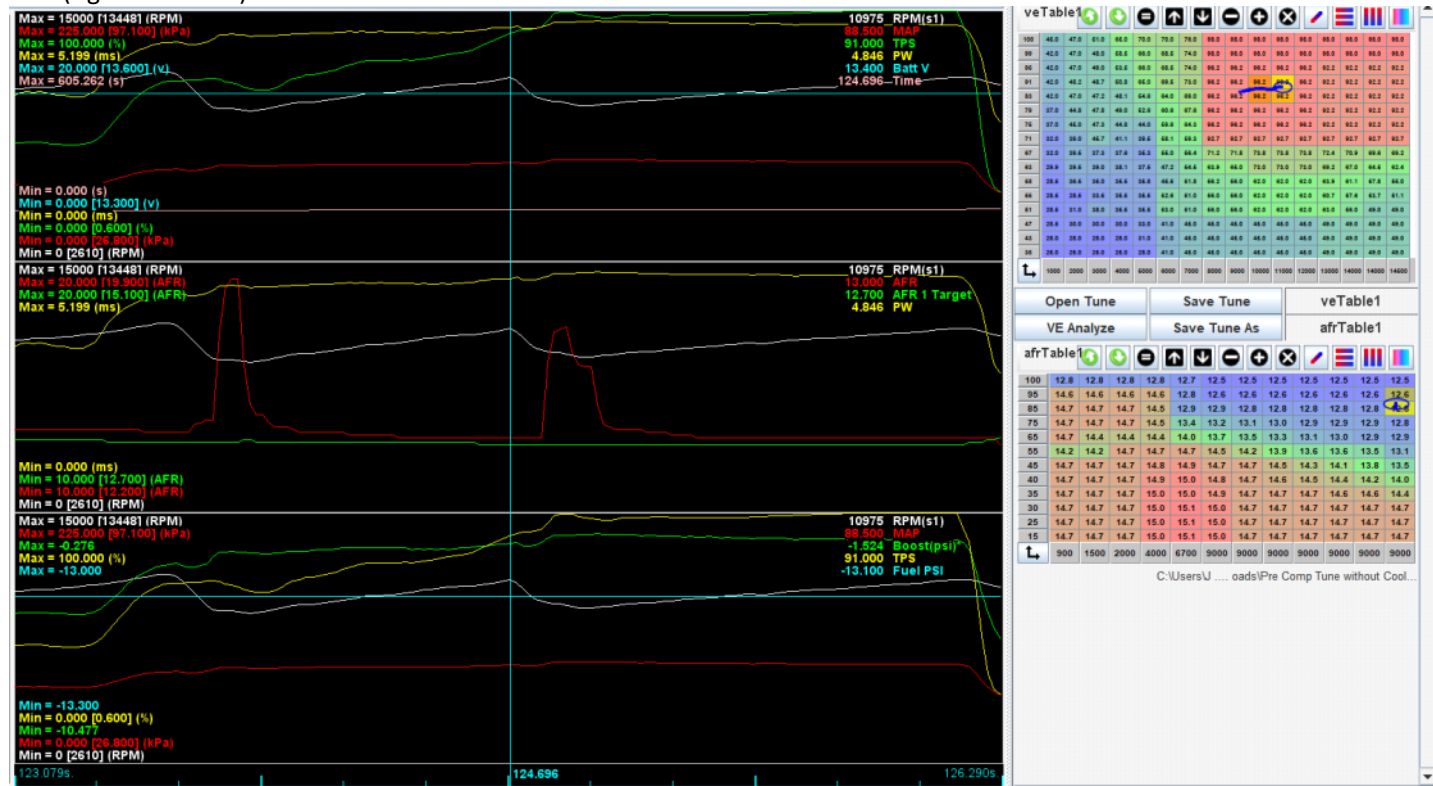
×

Ex:2

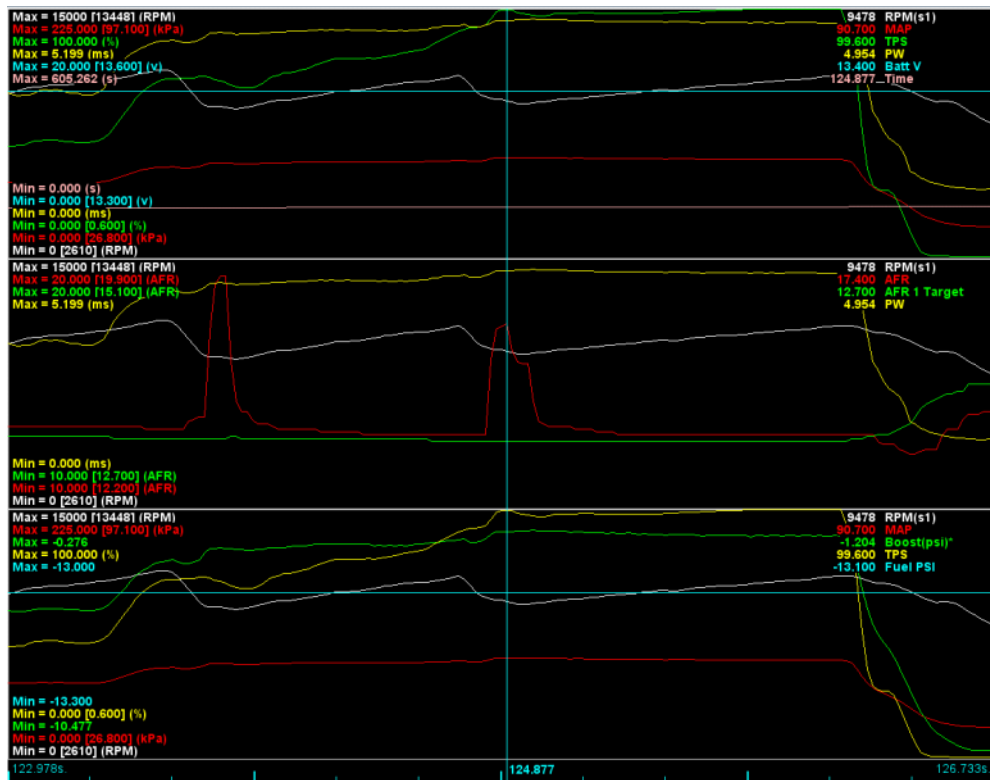


×

Ex:3 (right after Ex:2)







veTable1

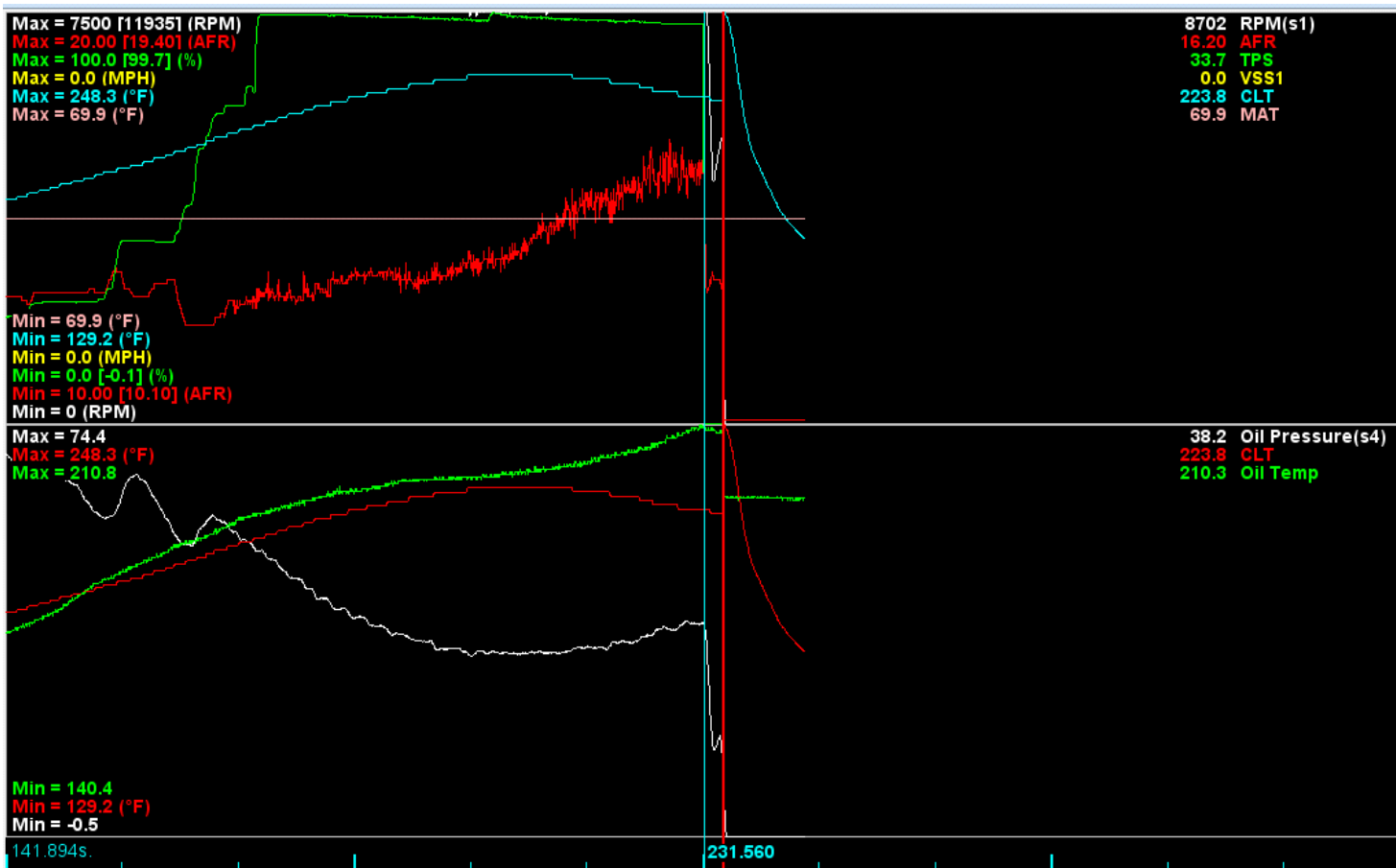
100	96.5	97.4	91.6	96.5	73.2	75.3	74.7	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5
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# Oil Cooler test 12/16/22

Monday, December 19, 2022 2:40 PM

Put car on dyno to complete oil cooler test as per procedure. Took a bit to get running as noted in the car log, but we were able to get it going on the dyno. The following logs were taken while figuring out the dyno brake and other factors. The first log, \_On, has a recorded event of the burst place popping near the end of the log at the small RPM spike. The final log, \_On3, is the final and actual test run we conducted. We were able to get 57.6 seconds into the test under 100% TPS before the muffler started shooting sparks/cat material all over dyno, and then the test was stopped. The video below shows the aftermath of the muffler immediately after. The current theory is the built in cat in the muffler got super heated and started burning. It may have been possible to continue running, but it was decided to stop the run.

With such a short run time, the test is inconclusive and thus the oil cooler should be kept on until further testing is done. The oil temps did reach 210°F by the end of the 57.6 seconds, with coolant at 225°F, however this does not mean too much as the CLT temps were still higher than the oil, and thus the oil was still coming up to temperature.



2022-12-16

\_Oil Coole...



2022-12-16

\_Oil Coole...



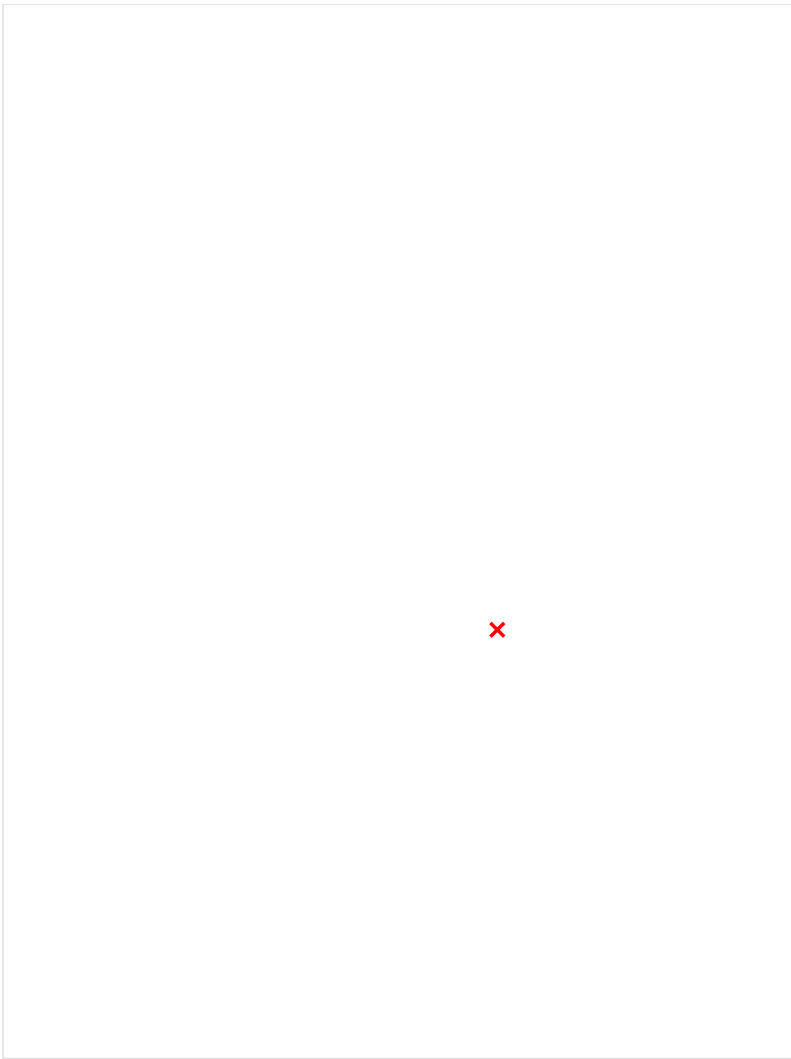
2022-12-16

\_Oil Coole...



2022-12-16  
\_Oil Coole...





# Headers Testing 1/13/23

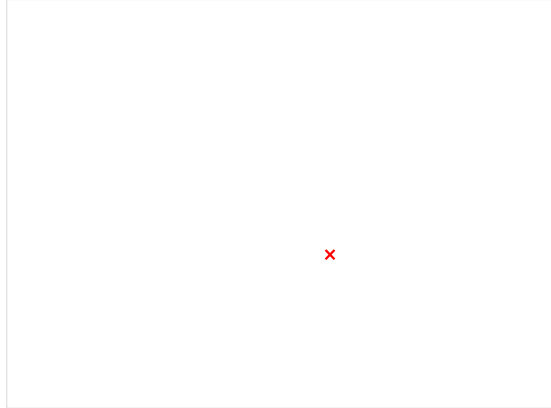
Friday, January 13, 2023 9:46 AM

## Problems encountered:

See google photos for failures

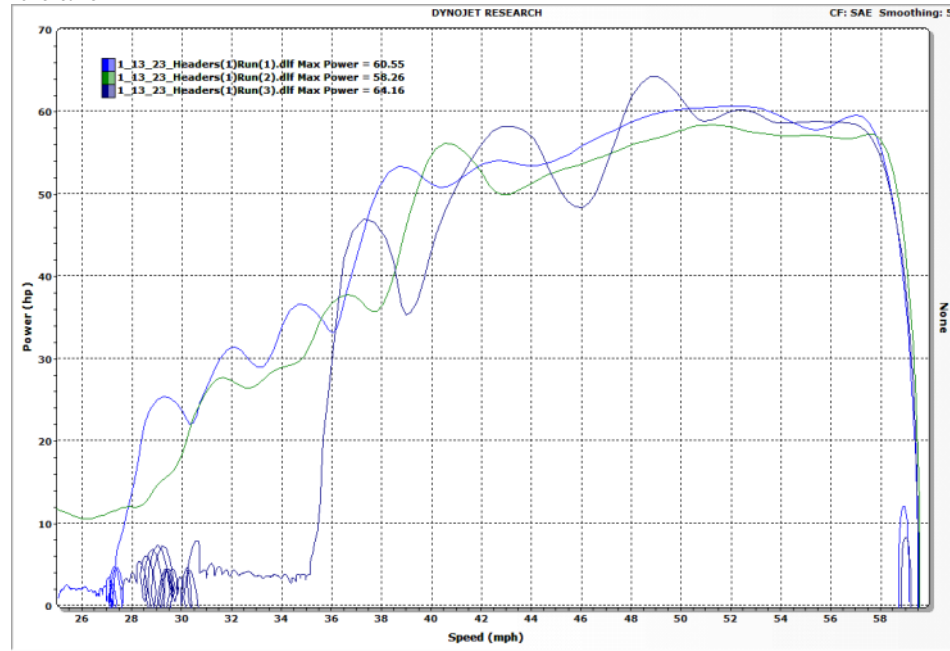
- Spark plug snapped off in cylinder head
- Spark plugs fouled
- Engine in car had clutch/oil starvation issues, swapped engine from car to ETS
- Engine had cam gear slip & mess up timing and scored cam gears due to loss of oil pressure
- Put stand originally on ETS back onto ETS
- Battery kept dying & required tender
- Wiring for switches was incorrect
- Oil & fuel pressure sensor broke
- Flex in the stand
  - Cut out bad support
  - Welded in better support for the stand itself
  - Welded the Engine Mounting Plate to the stand
- Torque snapped the two bottom "Engine Mounts"
  - Welded 3/4in x 2in steel bars onto the stand to connect to the upper engine mounts
- Electronic throttle body
  - Mounting bracket was not manufactured correctly
  - Initial setup used DC power from ETS battery with buck converter for 5V Supply, controlled with Arduino
  - ETB servo voltage would drop during crank, causing it to reset and close along with other funky behavior
  - Switched power supply to a separate 5V power supply which fixed the issues with the ETB
  - Had issues with servo & calibrating the range of motion
  - Tried a 9G servo from microcenter, but the gears had too much slop & would cause the idle to surge 10% up and down
    - <https://www.microcenter.com/product/647077/leo-sales-ltd-plastic-gear-servo-180>
  - New proper servo from HobbytownUSA fixed the sloppiness and should help remedy most of the other issues with the ETB. A proper bracket should be made in the future
- Chain jumped and the sprocket between engine and dyno on the dyno side was destroyed. This marks the end of Headers testing on ETS.
- Log manifold would not fit due to the supports added to brace the engine
- USB to Serial adapter originally on dyno kept messing up, so we replaced & duct taped the new adapter in (because it would fall out otherwise)
- Dyno software kept crashing randomly (fix computer)

Headers 1:



Headers 2:

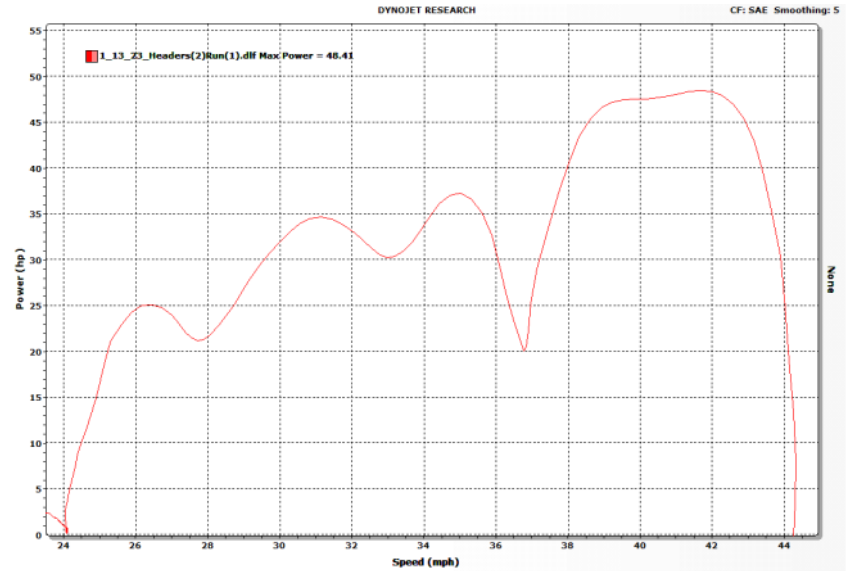
Power Curve



Power Curve:



Notes:  
Chain Jumped and the sprocket between engine and dyno on the dyno side was destroyed. This marks the end of Headers testing on ETS.



Final notes on test:  
The VEAL and afr aspect of the test was negated as there were no mufflers which would fit each set of headers. The sound recording was omitted as each header went beyond the limits of the sound meter's measuring device. Data was collected on the two sets of headers, with the second set of headers only having one run. We attempted to test the log, but the reinforced mounts we added prevented the headers from being mounted. All in all, some useful data was collected from the runs and can be used to design the new sets of headers. It would have been good to test more sets of headers, but considering the situation of the test we are satisfied with the testing.

Dyno Graph Files:

- 1\_12\_23\_P retesting(...)
- 1\_12\_23\_P retesting(...)
- 1\_13\_23\_H eaders(1)...
- 1\_13\_23\_ Headers(1)...
- 1\_13\_23\_H eaders(1)...
- 1\_13\_23\_H eaders(1)...
- 1\_13\_23\_H eaders(2)...

Datalog Files

- run
- Header 1 Run 1
- Header 1 Run 2
- Header 1 Run 3
- Header 2 Run 1

Tune Used

- 2023-01-1 3\_Headers

Dyno Test 2/17/23

Friday, February 17, 2023 2:16 PM

This is the page for the first dyno test of the KS6-C. This test will be used to determine the reliability of the driveline and initial testing of the car unpiloted.

Driveline Test:

Setup:

- ☒ ETB
- ☒ Diff Safety
- ☐ Intake Leak(maybe)
- ☒ Dyno Tires
- ☒ Tie Downs

Initial Tune:

Make sure that we are not too rich or too lean through entire RPM range. This should be fine for intial testing, but no good results will come from tune with intake leaks.

Notes:

- Problems:
- We do occasionally have a voltage drop that causes the O2 sensor to turn off
  - We blew the fuel pump fuse because the new pump needs a 20 amp and we had a 15- Replaced Fuse
  - The main relay got too hot(probably due to muffler ) and broke - Replace with ets relay and remounted PDU

Tuning Notes:

- The idle can be lower with less intake leaks but sitting at about 4k.
- The warmup enrichment is not the greatest but it seems to work all right
- The Afterstart enrichment is working but needs more consideration
- After 7k the vacuum pulls too much air through intake leak, so it runs really lean, so we might be able to dump fuel.
- Fully closed the car has a weird idle surge likely due to intake leaks

Initial Tune:



IntialTune

Current Tune:



2023-02-1  
9\_02.32.0...

Logs:

I have read through logs from 1/17/23 but all the rest need to be assessed.

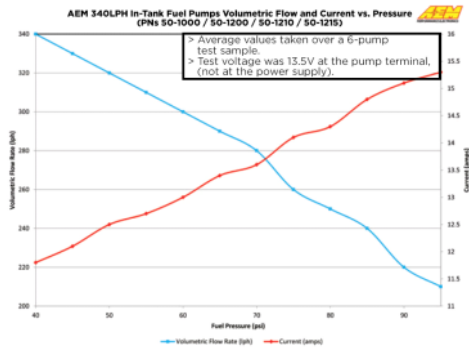


Tune logs

Driveline Testing:

02-19-2023

I am concerned about the fuel pump requiring a 20. needs investigation.



**VOLTAGE SPECS:**  
**Connector Terminal:** 6 mm Spade (pos/neg)  
**Min Voltage Input:** 6 volts  
**Max Voltage Input:** 18 volts  
**Current Draw (40 psi):** 12 amps (13.5v)  
**Current Draw (80 psi):** 15 amps (13.5v)  
**Fuse:** 20 amps (13.5v)

From <<https://www.aemelectronics.com/products/fuel-delivery/high-flow-fuel-pumps/340lph-high-flow-in-tank-fuel-pump-offset-inlet>>

<https://www.aemelectronics.com/products/fuel-delivery/high-flow-fuel-pumps/340lph-high-flow-in-tank-fuel-pump-offset-inlet>

# ETS

Monday, December 19, 2022 2:21 PM



# To-Do List

Monday, December 19, 2022

2:22 PM

- ☒ Remove motor from KS5
- ☒ Remove blown motor from ETS
- ☒ Install running motor onto ETS
  - ☒ Double check wiring harness
  - ☒ Double check fuel level
  - ☒ Fix throttle cable
  - ☒ Check for intake leaks
  - ☒ Clean up wiring
  - ☒ Organize tools & shop
  - ☒ Attach chain to dyno & motor
  - ☒ Attach chain guard
  - ☒ Hook up & wire shifting
  - ☒ Fix fuel leak at fuel rail
  - ☒ Safety wire exhaust duct on
  - ☒ Fix up ETB?
  - ☒ Install the full version of TS on computer
  - ☒ Check display port cable on computer
- ☒ Complete headers testing
  - ☒ Fix loose chain on sprocket
  - ☒ Double check dyno stack & software
  - ☒ Fix flex on stand
  - ☒ Tape/fix intake?
- ☐ Work on the tune some??
- ☐ Build replacement motor
- ☐

# ETB stuff

Tuesday, August 23, 2022 8:48 PM

- <https://github.com/jstri114/BennesawBateETB>
- Electronic throttle body
  - Mounting bracket was not designed correctly
  - Initial setup used DC power from ETS battery with buck converter for 5V Supply, controlled with Arduino
  - ETB servo voltage would drop during crank, causing it to reset and close along with other funky behavior
  - Switched power supply to a separate 5V power supply which fixed the issues with the ETB
  - Had issues with servo & calibrating the range of motion
  - Tried a 9G servo from microcenter, but the gears had too much slop & would cause the idle to surge 10% up and down
    - <https://www.microcenter.com/product/647077/leo-sales-ltd-plastic-gear-servo-180>
  - New proper servo from HobbytownUSA fixed the sloppiness and should help remedy most of the other issues with the ETB. A proper bracket should be made in the future.
    - <https://www.hobbytown.com/ecopower-wp110t-cored-waterproof-high-torque-metal-gear-digital-servo-ecp-110t/p734713>

Generic sensor inputs

Sensors 1-8	Sensor - Source	Field Name	Transformation	0V value	5V
01	Q2 In	Sensor 01	Linear	7.3	
02	Analog In 4	Sensor 02	Linear	-20.0	
03	Analog In 1	Sensor 03	Linear	1.1	
04	Analog In 5	Sensor 04	Linear	-20.0	
05	Analog In 3	heading	Linear	0.0	
06	Analog In 7	roll	Linear	-180.0	
07	Analog In 6	pitch	Linear	-180.0	
08	Off	Sensor 08	None	0.0	

Version 0.16

Code is on github

Random thought while looking over OneNote- ETB probably shits itself while cranking due to voltage drop while cranking, resetting the position back to 0, add a battery backup/intermediate pack so it doesn't die while cranking? Or better EMI filtering?

Notes from that day:  
Oil pressure sensor continuity check

Needs mounting (not my scope-mathew aka chief electronicist)

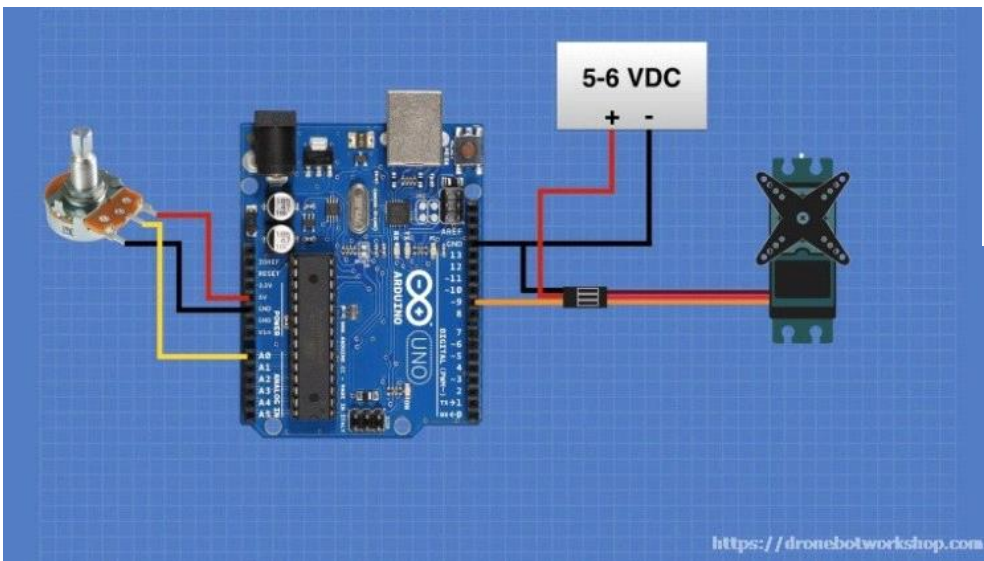
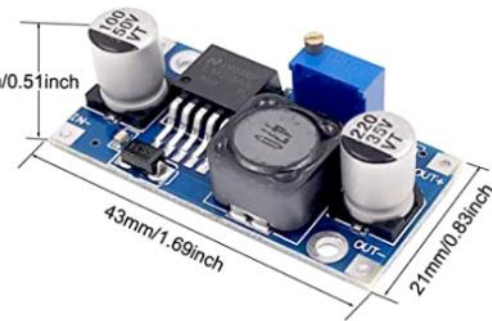
Need some cables

Cable 1

- From servo to the ETS control bench
  - 3 wires-->+5v, Servo PWM, GND
- From PDU to ETS control bench buck boost
  - 12v and GND

Supply external 5v using a buck converter from main shop

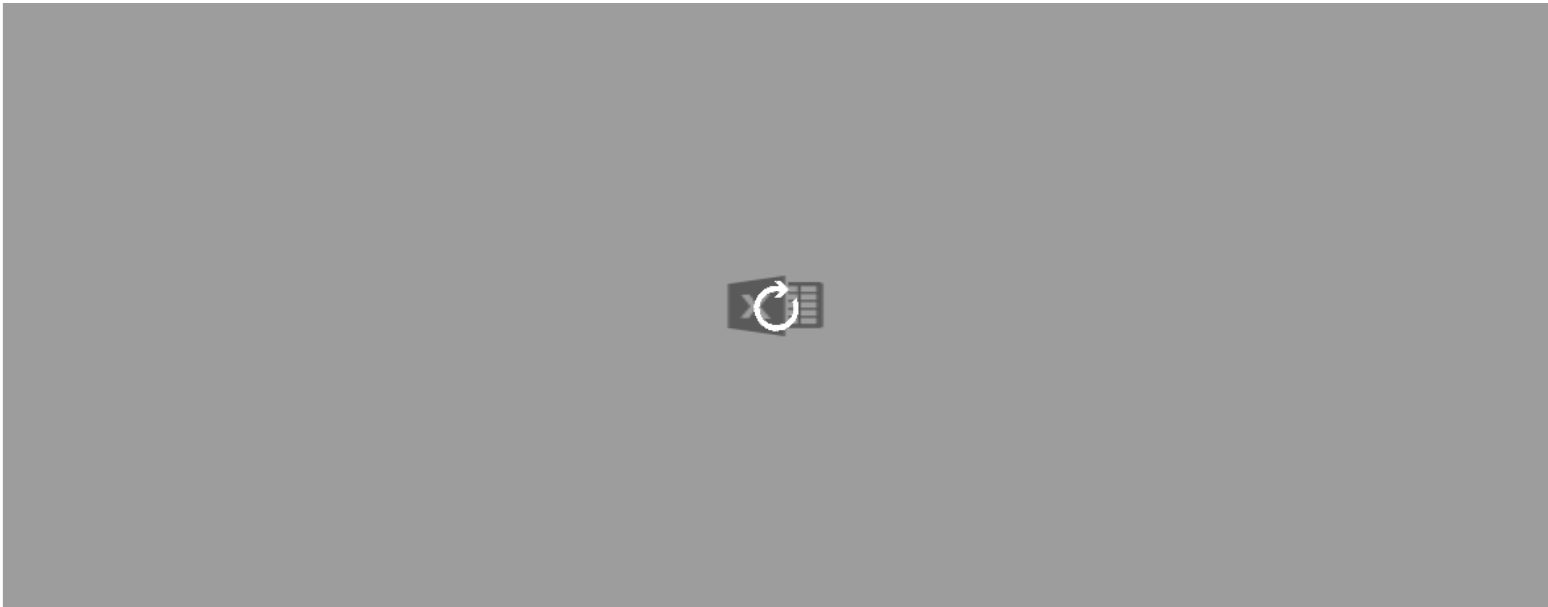
Power the buck converter using the same 12v that goes to ETS



Lap Sim Data

Monday, February 8, 2021 7:54 PM

Engine Drivetrain Goals 2020.xlsx



North IC 2019

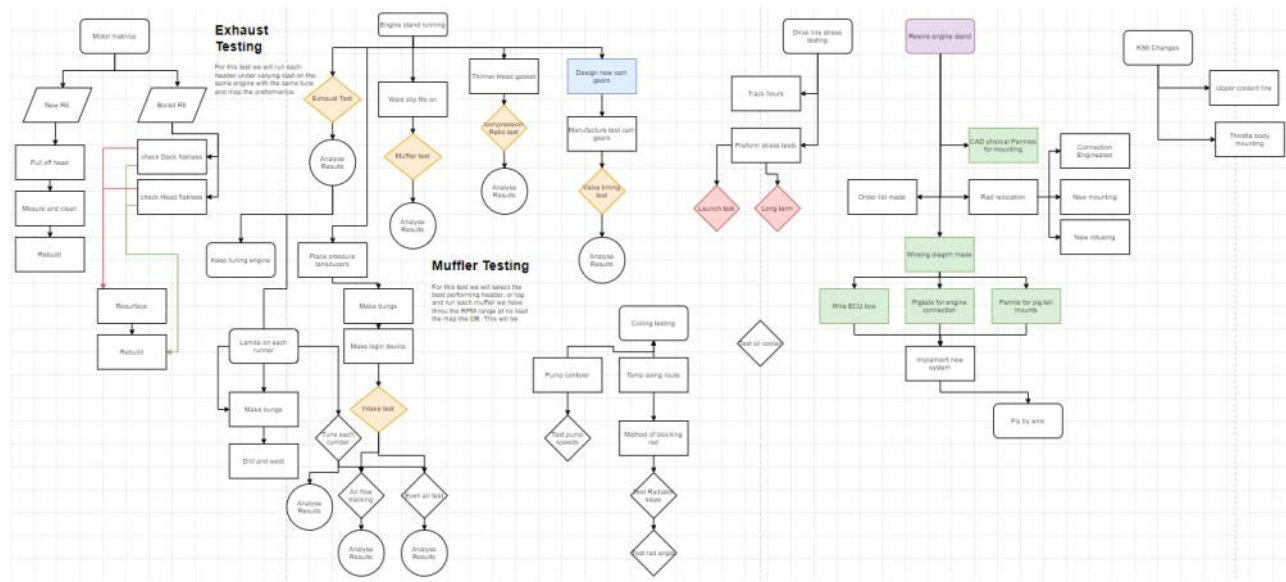
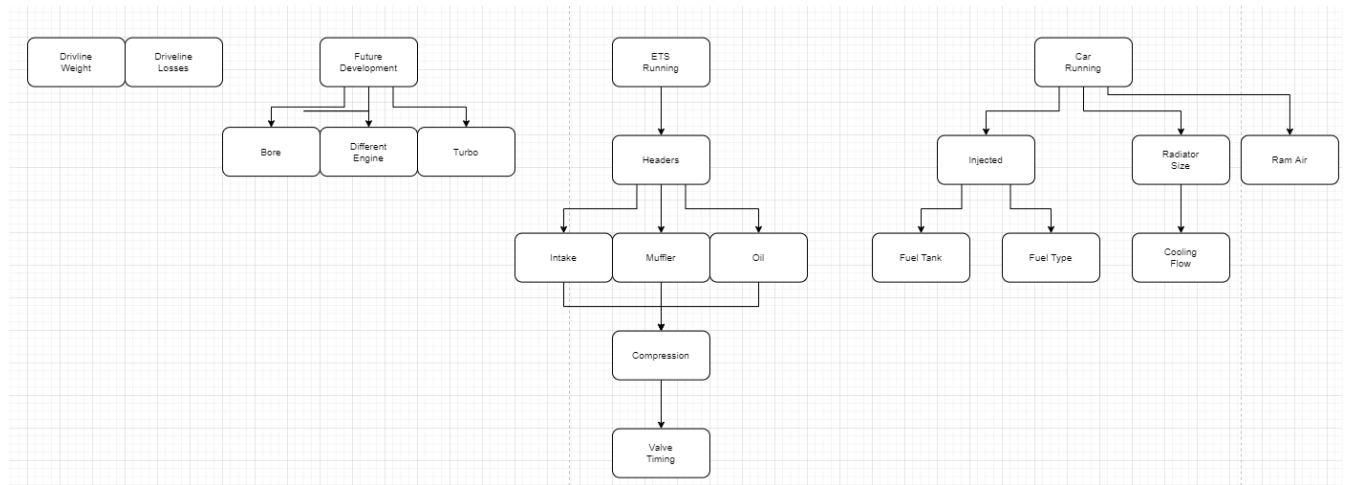
Acceleration Event Results



Minimum Time (seconds) 4.049  
Maximum Time (seconds) 6.074 150% Cone Penalty (seconds) 2

Place	Car Num	Team	Run #1			Run #2			Run #3			Run #4			Final	
			Time	Cones	Adj Time	Time	Cones	Adj Time	Time	Cones	Adj Time	Time	Cones	Adj Time	Best Time	Penalty Score
1	17	Univ of Michigan - Ann Arbor	4.906		4.906	4.844		4.844	4.049		4.049	4.059		4.059	4.049	100
2	25	Univ of Connecticut	4.315		4.315	4.306		4.306	4.301		4.301	4.221		4.221	4.221	88.33
3	27	Univ of South Florida	4.251		4.251	4.255		4.255	4.251		4.251	5.331		5.331	4.251	86.39
4	28	Univ of Pittsburgh - Pittsburgh	4.319		4.319	5.963		DNF			DNF			DNF	4.319	82.09
5	36	Ecole De Technologie Supereure	4.437		4.437	4.474		4.474	4.531		4.531	4.360		4.360	4.360	79.56
6	18	Ryerson Univ	4.710		4.710	4.463		4.463	4.476		4.476	4.411		4.411	4.411	76.49
7	32	The Ohio State University	4.527		4.527	4.454		4.454	15.062		DNF			DNF	4.454	73.95
8	20	Univ of Waterloo	4.637		4.637	4.600		4.600	4.695		4.695	4.503		4.503	4.503	71.12
9	16	Rochester Institute of Technology	4.793		4.793	4.613		4.613	5.218		5.218	5.524		5.524	4.613	64.97
10	24	Oakland University	4.794		4.794	4.652		4.652	4.716		4.716	4.875		4.875	4.652	62.86
11	35	Carleton Univ	4.800		4.800	4.711		4.711			DNF			DNF	4.711	59.74
12	47	Ecole Polytechnique Montreal	4.769		4.769	4.952		4.952	4.807		4.807	4.746		4.746	4.746	57.92
13	34	Rutgers Univ	4.749		4.749	4.814		4.814			DNF			DNF	4.749	57.77
14	12	Cegep du Vieux - Montreal	4.945		4.945	4.806		4.806	4.819		4.819	4.786		4.786	4.786	55.88
15	37	Univ of Cincinnati	5.181		5.181	5.304		5.304	4.792		4.792	4.886		4.886	4.792	55.58
16	29	Univ of Alberta	5.387		5.387	5.008		5.008	4.930		4.930	5.120		5.120	4.930	48.8
17	30	Iowa State Univ	5.404		5.404	13.082		13.082	5.403		5.403	5.406		5.406	5.403	28.2
18	23	Univ of Louisiana - Lafayette	6.597		DNF	7.000		7.000	6.588		6.588	5.431		5.431	5.431	27.1
19	31	Univ of Toledo	6.001		6.001	6.127		6.127	6.068		6.068	6.253		6.253	6.001	6.81
	11	Univ of Massachusetts - Lowell			DNF			DNF			DNF			DNF	DNF	
	13	Univ of Windsor			DNF			DNF			DNF			DNF	DNF	
	19	Queen's Univ			DNF			DNF			DNF			DNF	DNF	
	21	Univ of Illinois - Chicago			DNF			DNF			DNF			DNF	DNF	
	26	Central Michigan Univ			DNF			DNF			DNF			DNF	DNF	

Tuesday, February 9, 2021 2:42 AM



# Header Design Review Example

Monday, February 22, 2021 6:49 PM

## Project Proposal: Header Selection

Purpose – Selecting headers will increase power

- The engine will pick up ~ 10 HP
- This will increase our acceleration time by .204039 seconds in an ideal world.
- Changing the header will increase header size affecting a few parts of the car
  - The heatshield
  - Get closer the water pump so might reduce the efficiency of the cooling system
  - The exhaust might become louder since the header isn't capturing as many vibrations and sound since the flow is increased
- The goals
  - Acquire data for each header we have
  - Learn what style header is the best
  - Make more power
  - Improve our validation and design process for future headers

## Concept validation:

- Better headers will improve exhaust gas flow increasing scavenging and heat evacuation
- We will use or modify the header from a previous year so that is why we will use this material
- That we will pick up power
- Time of wave pulse
- Why a 4 to 1 vs double y

## Component validation:

- (insert dyno graphs)
- Math on wave pulse

## Component finalization:

- List of interactions
  - Heat shield
  - Cooling
  - Exhaust
- Manufacturing plan
  - Acquire the best header and modify to fit in the car
- Cost and order list
  - Things to fix test stand
- Clear and numerical of how component meets goals
  - The header increased power by x amount seen in the dyno graph

# 2021-2022 Plan

Wednesday, July 21, 2021 6:03 PM

## Goals

Jesse

70-75 while passing sound  
Reliability  
Drivability

Cade

75

More development Research

2 Shift Times\*

1 Launch Control\*

14 450cc

6 Fuel Type

12 Testing Intake

9 Mass Air

5 Cylinder Tuning

24 Cylinder Pressure

3 Fuel Temp

4 Exhaust Temp

8 Headers

7 CAMs

13 Pipe MAX

23 Ricardo Wave

21 Lotus engine

20 CAD engine

16 Different ECU

15 Dry Sump

10 Compression

17 Pull a Gear or Four

18 Electric Turbski

22 Twin Supercharged Quad Turbo 400 Shot of Nitrous R6

19 Test Boost With Charged Tank

11 Muffler

11.5 Freddy's Flow Bench

0 Injector data

10.5 Coolant Data

24

7 Shift Times

6 Launch Control

25 450cc

15 Fuel Type

9 Testing Intake

13 Mass Air

11 Cylinder Tuning

12 Cylinder Pressure

8 Fuel Temp

4 Exhaust Temp

3 Headers

14 CAMs  
2 Pipe MAX  
22Ricardo Wave  
21 Lotus engine  
16 CAD engine  
Different ECU  
24 Dry Sump  
5 Compression  
20 Pull a Gear or Four  
18 Electric Turbski  
Twin Supercharged Quad Turbo 400 Shot of Nitrous R6  
19 Test Boost With Charged Tank  
1 Muffler  
17 Freddy's Flow Bench  
10 Injector data

# Diff Cad update

Tuesday, December 7, 2021 5:05 PM

With the switch to the Drexler we decided to make the diff carriers a 2d part. With this we are going to jet the component.

Problems with cad:

Lower bolt mount OD has surfacer errors

WTF is the fillet near the upper diff bolt

Need fillet on lower bolt mount

Final cad is complete and ready to be water jetted, since the final design is a flat piece of 6061 T6 aluminum with a thickness of 0.5in



# EnD To-Do List

Thursday, January 19, 2023 10:37 PM

This is a list of to do to get the KS6-C finished. Add and cross out as needed. There is no order of prioritization

- ☒ Fix Intake
  - ☒ Fix cracks
  - ☒ Add springs to burst plate (Goon shit)
- ☒ Remove ETB from intake
- ☒ Change Oil Pan
- ☒ Anerobic Sealant on Crankcase Cover(RTV now Bozo)
- ☒ Replace the oil dipstick(replacement in dyno)
- ☒ Shave oil plug
- ☒ Cooling loop needs to be revamped. (pat/bren)
  - ☒ Top
  - ☒ Bottom
  - ☒ Pump Tab
  - ☒ Oil Cooler fitting needs to be welded
- ☒ Finish Fuel tank cad and manufacturing
  - ☒ Filler Neck
  - ☒ Lid
  - ☒ Fuel pump mount
  - ☒ Sight tube
  - ☒ Tabs
    - ☒ Manufactured
    - ☒ Welded
- ☒ Clutch handle mounting needs to designed and manufactured. (emil)
- ☒ Axles, tripods, and tension caps needs to inspected for defects. Replace as needed
  - ☒ Replaced Tripod
  - ☒ Groove on hub side right axel needs to be .003 bigger and the cup side by a couple thou (marco)
- ☒ Verify the fitment of headers (probably will have to cut and weld them to get them to fit.)
- ☒ Need to pull the stock water pump off
- ☒ Log need to be Welded
  - ☒ Welded to fit Chassis
  - ☒ Welded to fit Muffler
- ☐ Mufflers need to be manufactured
  - ☒ Muffler One
  - ☒ Muffle Two
  - ☒ In between
  - ☒ Have to figure how to seal the packing access(gasket)
- ☒ Smog machine
- ☒ Verify Sensor Connectors(exchange as needed)
- ☒ Wire Engine
- ☐ Fix Powertrain CAD Ketchup and Mustard
  - ☒ 02
  - ☒ Exhaust
    - ☒ Need Heatshield CAD
  - ☒ Driveline Assembly
  - ☒ Oil System
- ☒ Change clutch Lever out

- ☒ Add Throttle Body to Intake
- ☒ Add pneumatic system
  - ☒ Tabs for pneumatic need to added
  - ☒ Verify integrity of pneumatic solenoids
  - ☒ Make sure they are wired right
  - ☒ Make sure plumbing is correct
- ☒ 'Replace Oil Filter (Goon shit)
- ☒ Pull Fuel Pump pass through out the old Tank
- ☒ Replace ECU blown fuse
- ☒ Add chain and guard
  - ☒ Chain
  - ☒ Guard
  - ☒ Might try to add a tiny spacer to make a little bit more clearance for axel
- ☒ Fix wheel studs
- ☒ Address leak down test results
  - ☒ Throttle Body
  - ☒ Cylinder D runner to engine connection (add 222 o ring)
  - ☒ Burst plate (oring)
  - ☒ Blow out intake
  - ☒ Leakdown test again (Leak from throttle body brass bushing only)
- ☒ Dyno Controls
  - ☒ Throttle Control
  - ☒ Pneumatics Control
  - ☒ Tie Up the Diff
- ☒ Fuel System
  - ☒ Install the Fuel Pump and mount
  - ☒ Weld in the fittings
  - ☒ Run the Fuel lines
  - ☐ Swap to AN lines
- ☒ Dyno test
  - ☒ Preliminary Tune(Idle)
  - ☒ Need to make a test sheet for initial runs
    - ☒ Axel clearance
    - ☒ Diff carriers testing
    - ☒ Make sure the carriers don't explode when doing a clutch dump. (probably will)
  - ☒ Need to make a Tuning Sheet
- ☒ Help other sub-groups
  - ☒ Finish Pedal Box(Bray)
  - ☒ Finish Bleeding the brakes
  - ☒ Insert a firewall
  - ☒ Verify that suspension is tight
  - ☒ Brake Light
  - ☒ Add body panels
  - ☒ Finish IC dash