C32A ECM MODIFICATION

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PAUL LIN, INSTRUCTOR
HAL BROBERG, ADVISOR

APRIL 29, 2016

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- Executive Summary
- Introduction
- Problem Statement and Solutions
- System Requirements and Validation
- System Analysis
- System Design
- Simulation
- System Integration and Testing
- Validation
- Conclusion and Lessons Learned

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- **Mid 1990s Honda C32A Engines**
- **Fuel Economy**
- **Increased Power**
- **No aftermarket programs available**
- **Start from Scratch**
- **Wanted to see if it could be done!**

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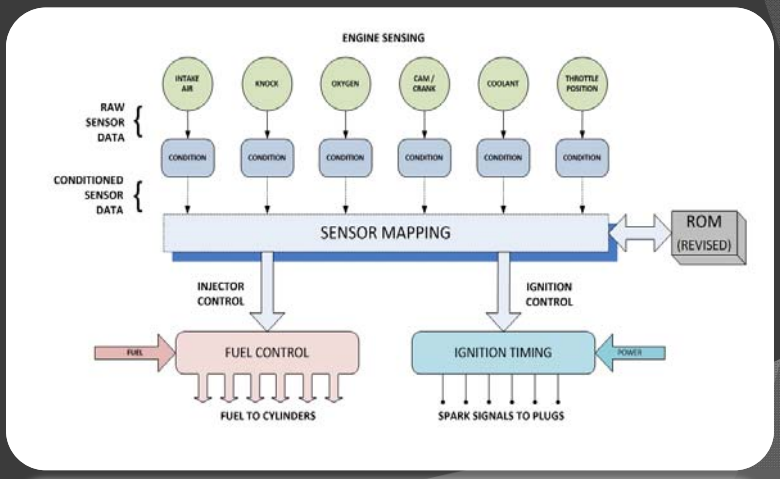
FUNCTIONAL BLOCK DIAGRAM



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PROJECT REQUIREMENTS

	A	B	C	D	E
1	**Project:**	C32A ECM Modification			
2	**Revision:**	4			
3	**Date:**	20-Apr-16			
4					
5		**Requirement Data**		**Verification Pl**	
6	**ID**	**Requirement Type**	**Requirement (Shall or Should statements)**	**Verification Method**	**Date Verifi**
7	1	Operational	The system shall increase the H.P. of the C32A Acura engine	Test	16-Apr-16
8	2	Operational	The system shall increase the torque of the C32A Acura engine	Test	16-Apr-16
9	3	Operational	The system shall not change normal emissions of the C32A Acura engine	Test	16-Apr-16
10	4	Operational	The system should increase the fuel efficiency of the C32A Acura engine	Demonstration	16-Apr-16
11	5	Operational	The system shall not change the shift controls of the C32A Acura transmission	Demonstration	16-Apr-16
12	6	Functional	The system shall control the Fuel/Air ratio of the C32A Acura engine	Test	16-Apr-16
13	7	Functional	The system shall control the Ignition Timing of the C32A Acura engine	Test	16-Apr-16
14	8	Functional	The system shall read the engine RPM from the ECM	Test	16-Apr-16
15	9	Functional	The system shall read the engine temperature from the ECM	Test	16-Apr-16
16	10	Functional	The system shall read the engine throttle position from the ECM	Test	16-Apr-16
17	11	Functional	The system shall read the engine mass air flow sensor from the ECM	Test	
18	12	Performance	The system shall not hinder the vehicle's normal ECM processing speed	Test	16-Apr-16
19	13	Performance	The system shall not hinder the vehicle's normal ECM functionality	Test	16-Apr-16
20	14	Performance	The system should increase the fuel efficiency by %15	Test	16-Apr-16
21	15	Performance	The system should increase HP by %10	Test	
22	16	Performance	The system should increase torque by % 10	Test	
23	17	Physical	The system shall occupy the same amount of memory as the stock code	Inspection	20-Mar-16
24	18	Physical	The system shall replace stock ECM PROM with removable PROM	Inspection	20-Mar-16
25	19	Environmental	The system shall run at temperatures up to 120°F	Demonstration	16-Apr-16
26	20	Environmental	The system shall run at temperatures down to -20°F	Demonstration	16-Apr-16
27	21	Environmental	The system shall function in normal automotive S/V conditions	Demonstration	16-Apr-16
28	22	Environmental	The system should be able to be implemented into all C32A Acura egine ECMs	Demonstration	

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REQUIREMENT 4

The system should increase the fuel efficiency of the C32A Acura engine.

Fuel Economy Tests			
Test Run	Gas Usage	Miles Driven	Miles/Gallon
Stock	1.4	31	22.14285714
Modified	0.9	30.95	34.38888889
	Difference:		12.24603175

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PROJECT DESIGN & IMPLEMENTATION

- **ECM disassembly**
- **De-soldering PROM chip**
- **Soldering new socket in place**
- **Programming stock calibration onto new PROM chip**

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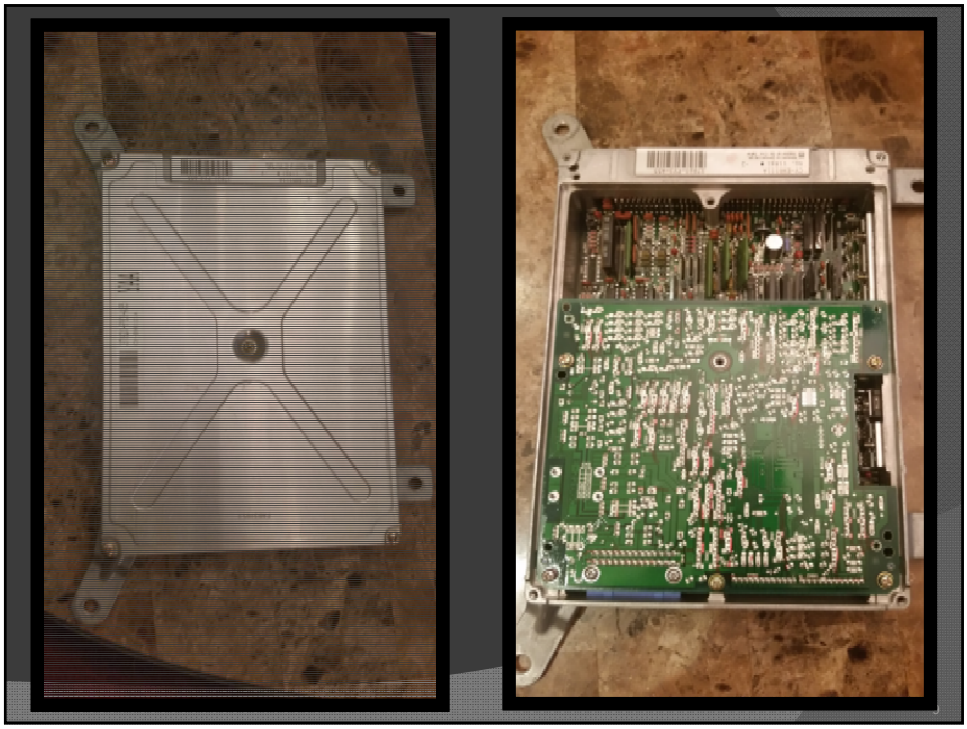
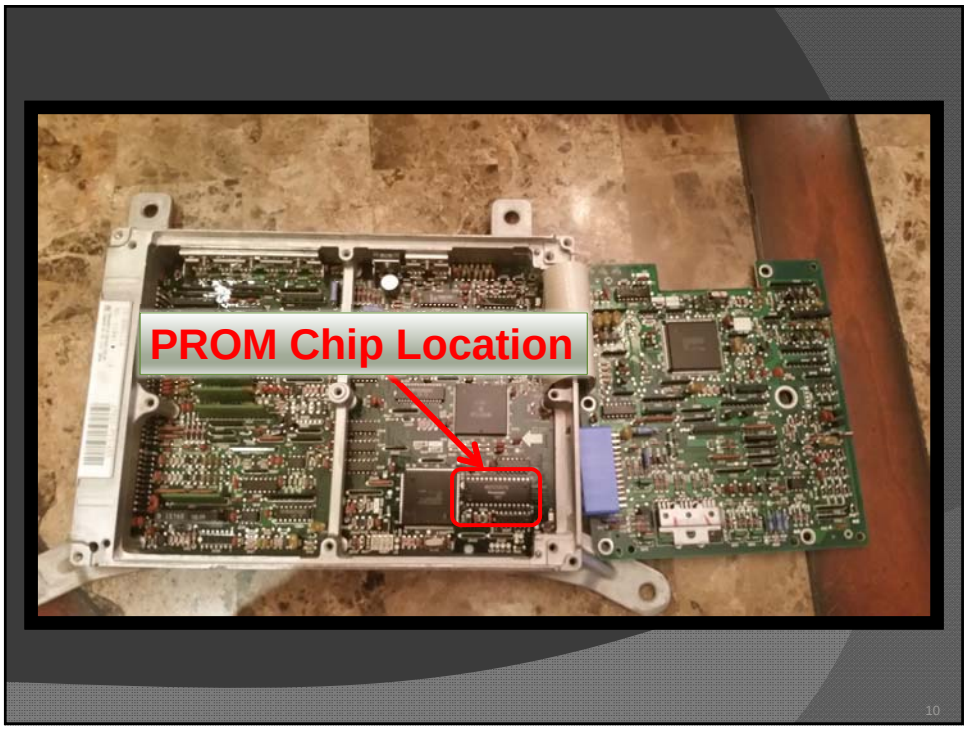
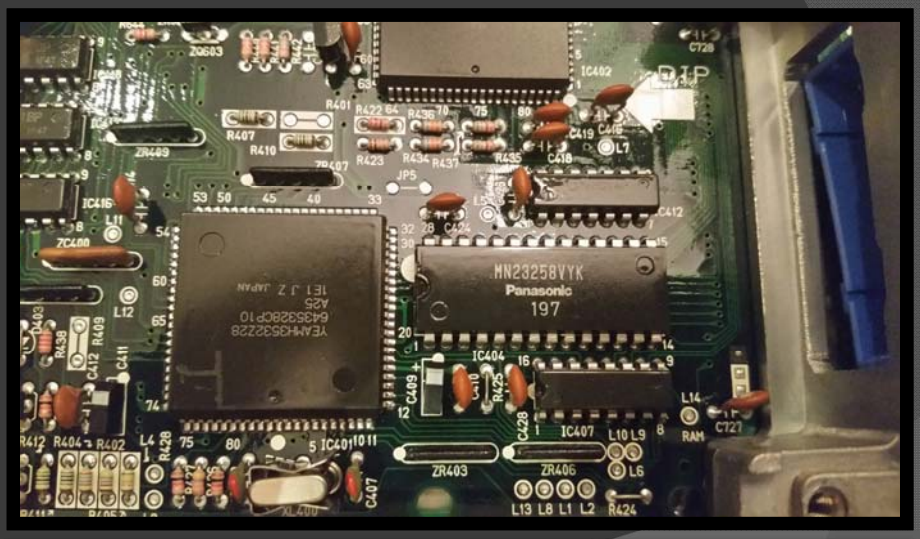
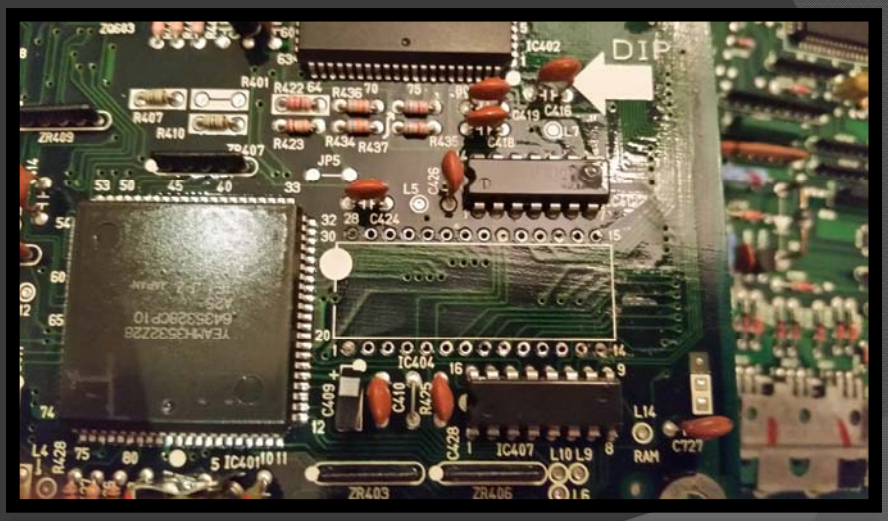



PROM Chip Location


MN23258VYK
Panasonic
197
IC402
IC404
IC407
ZR403
ZR406
RAM

PROM Solder Joints


DIP
IC402
IC404
IC407
ZR403
ZR406
RAM

13

DIP
IC407
ZR403
ZR406
RAM

14

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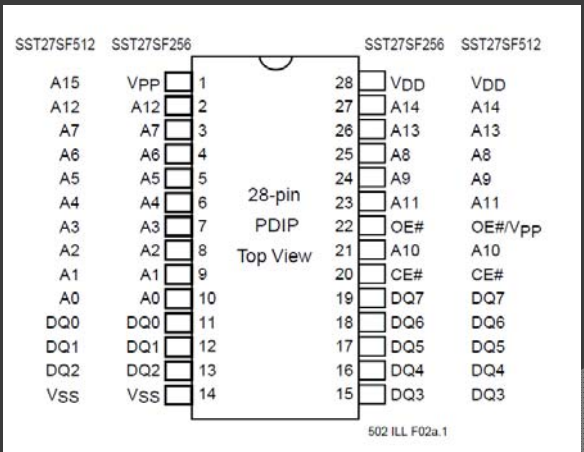
SOFTWARE DESIGN & IMPLEMENTATION



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STOCK ECM PROM CALIBRATIONS

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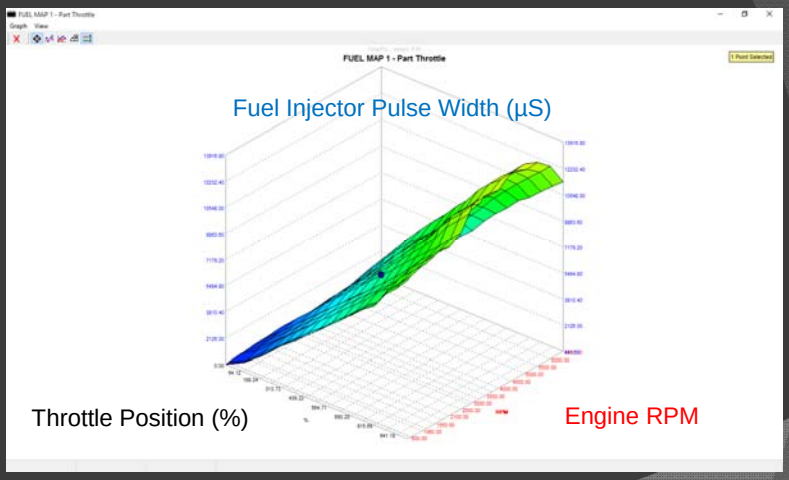
FUEL MAP 1 – PART THROTTLE



$$Inj.P.W. = f(T.P\%/RPM)$$

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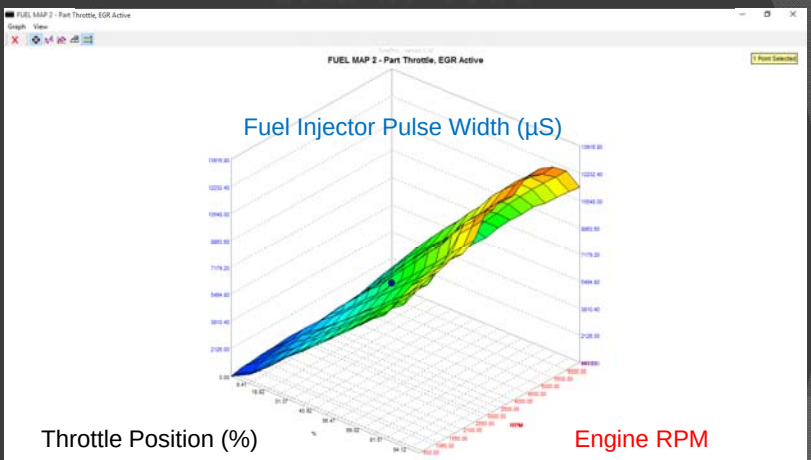
FUEL MAP 2 – PART THROTTLE EGR ACTIVE



$$Inj.P.W. = f(T.P\%/RPM)$$

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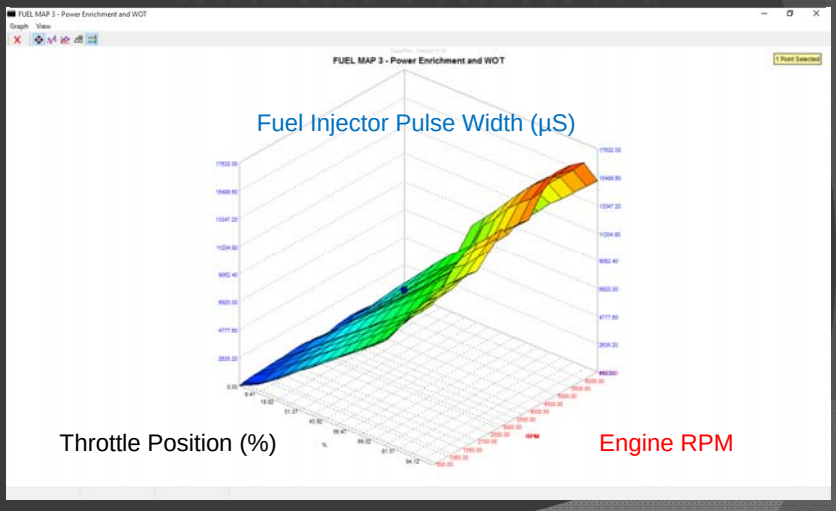
FUEL MAP 3 – POWER ENRICHMENT & WIDE OPEN THROTTLE



$$Inj.P.W. = f(T.P\%/RPM)$$

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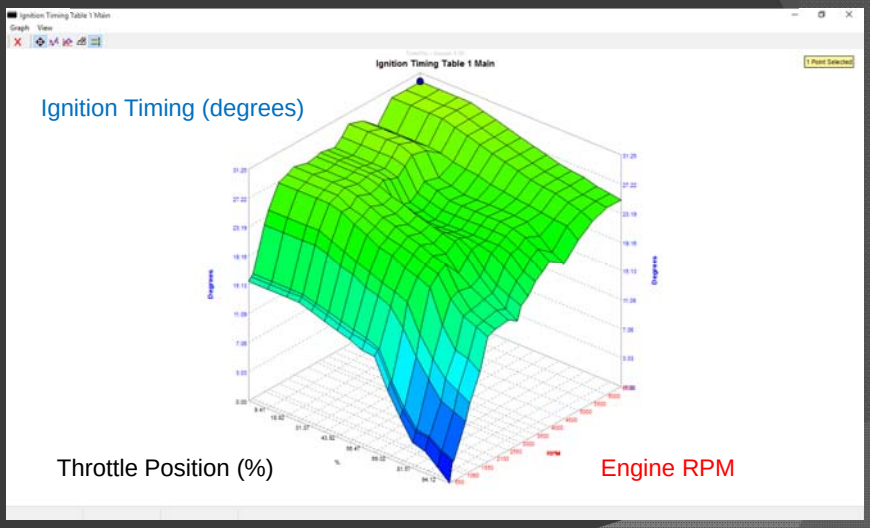
IGNITION TIMING TABLE 1 - MAIN



$$I.T. = f(T.P\%/RPM)$$

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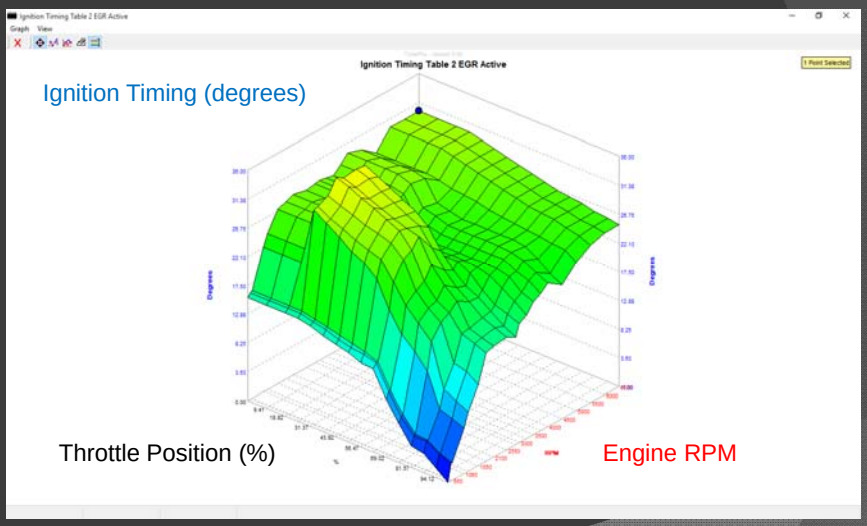
IGNITION TIMING TABLE 2 – EGR ACTIVE



$$I.T. = f(T.P\%/RPM)$$

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MODIFIED ECM PROM CALIBRATIONS

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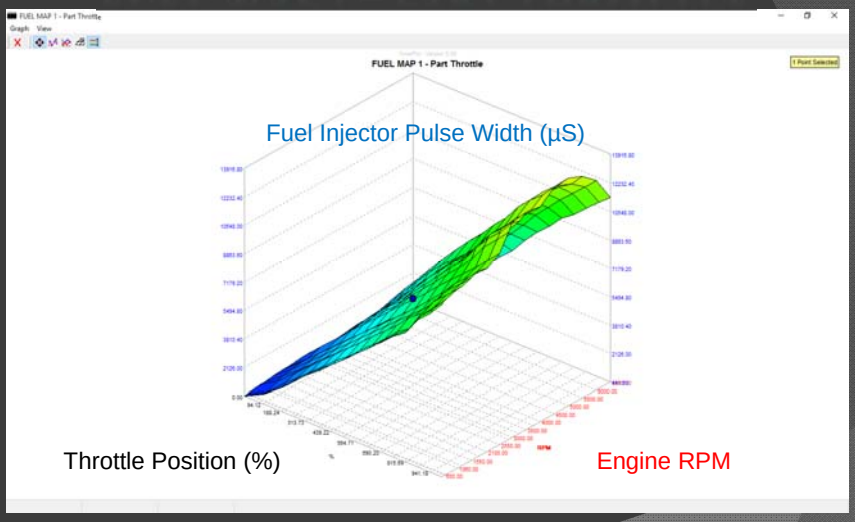
FUEL MAP 1 – PART THROTTLE



$$Inj.P.W. = f(T.P\%/RPM)$$

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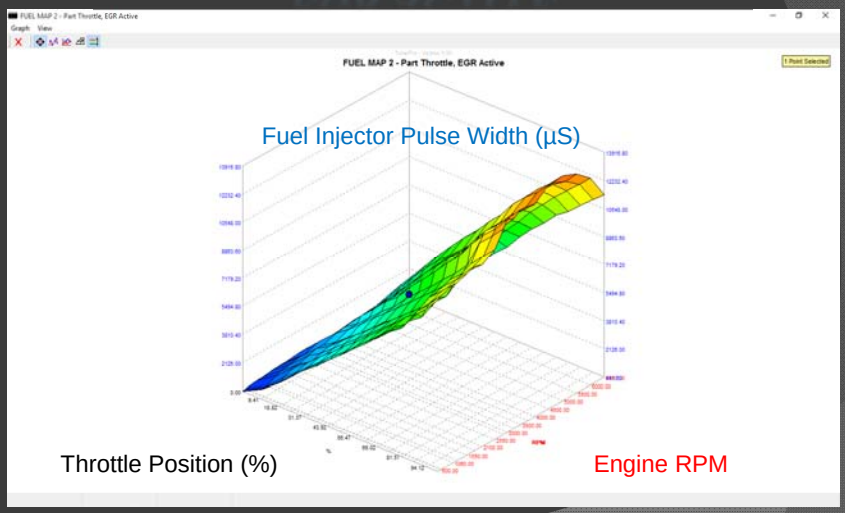
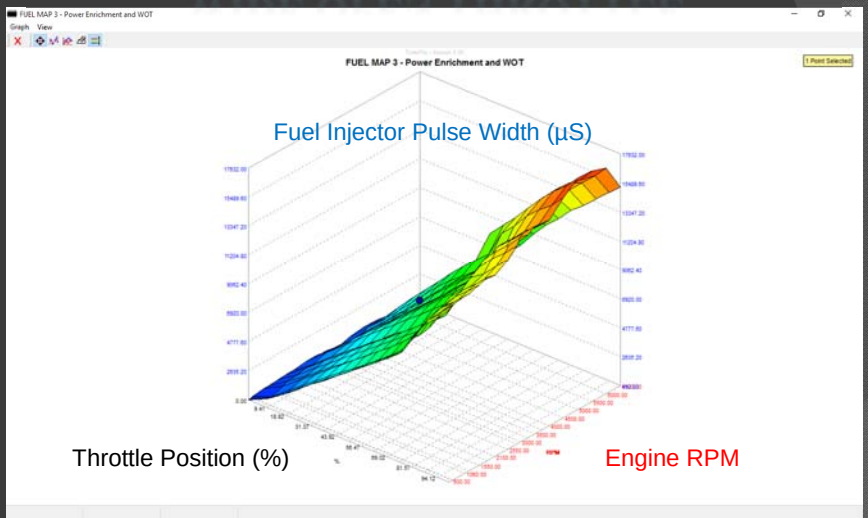
FUEL MAP 2 – PART THROTTLE EGR ACTIVE



$$Inj.P.W. = f(T.P\%/RPM)$$

25

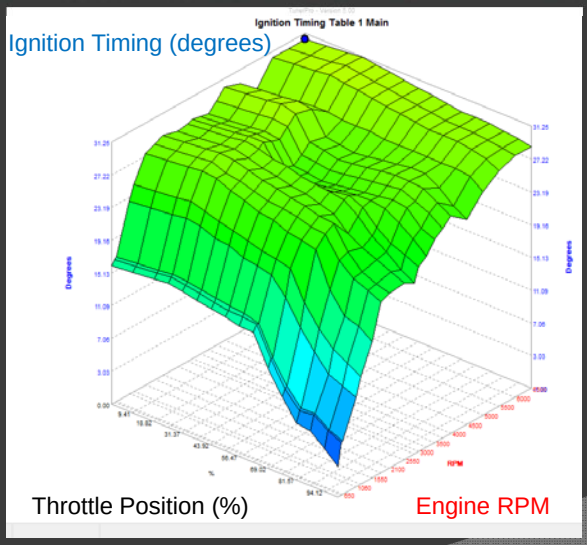
FUEL MAP 3 – POWER ENRICHMENT & WIDE OPEN THROTTLE



$$Inj.P.W. = f(T.P\%/RPM)$$

26

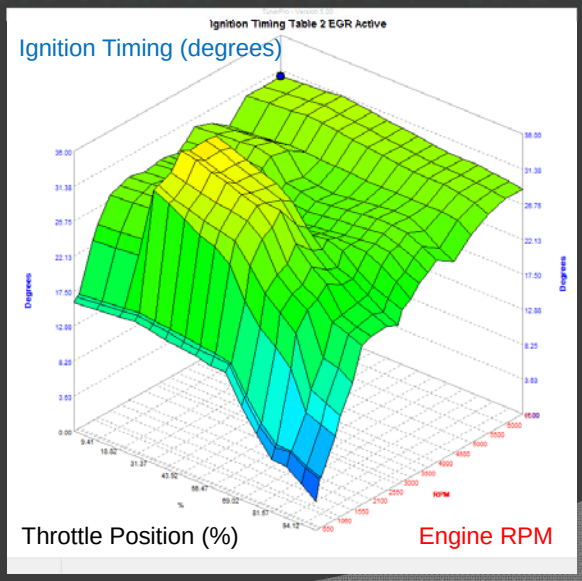
IGNITION TIMING TABLE 1 - MAIN



$$I.T. = f(T.P\%/RPM)$$

27

IGNITION TIMING TABLE 2 – EGR ACTIVE



$$I.T. = f(T.P\%/RPM)$$

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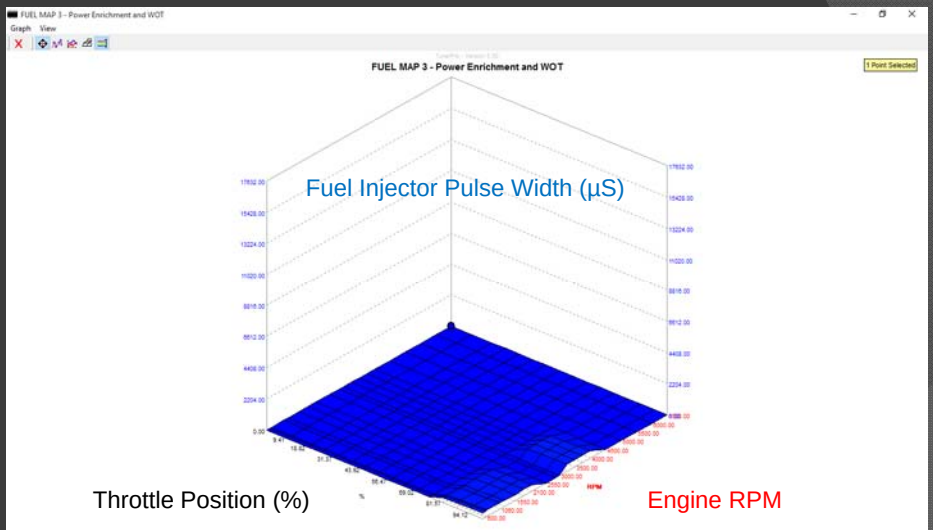
DIFFERENCE IN FUEL MAPPING



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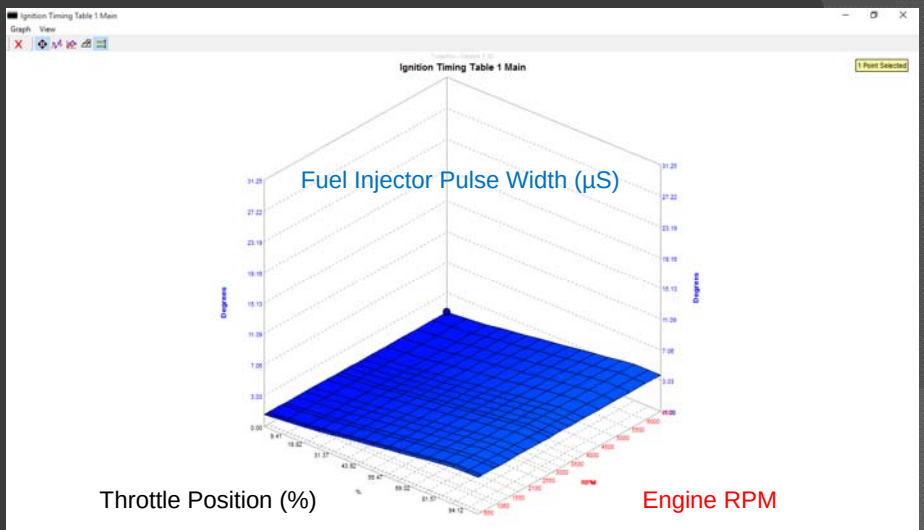
DIFFERENCE IN MAIN IGNITION TIMING



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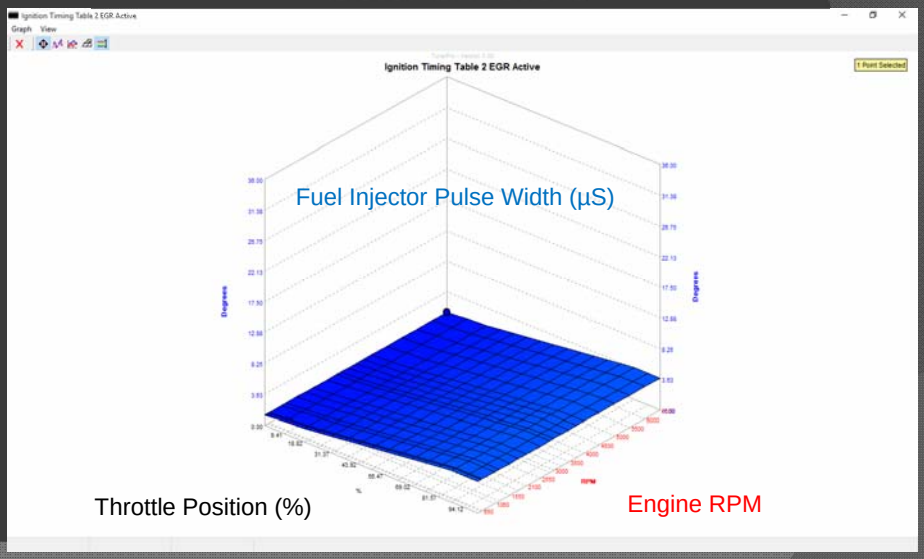
DIFFERENCE IN IGNITION TIMING EGR ACTIVE



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SYSTEM INTEGRATION & TESTING

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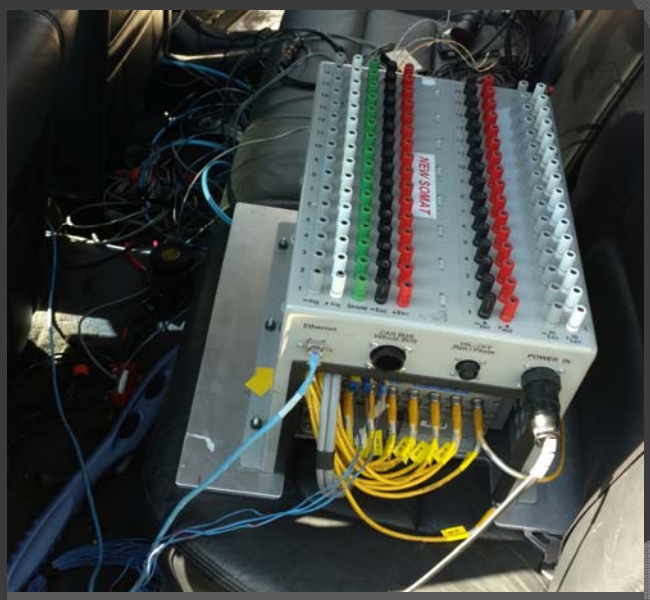

SOMAT DAQ SYSTEM

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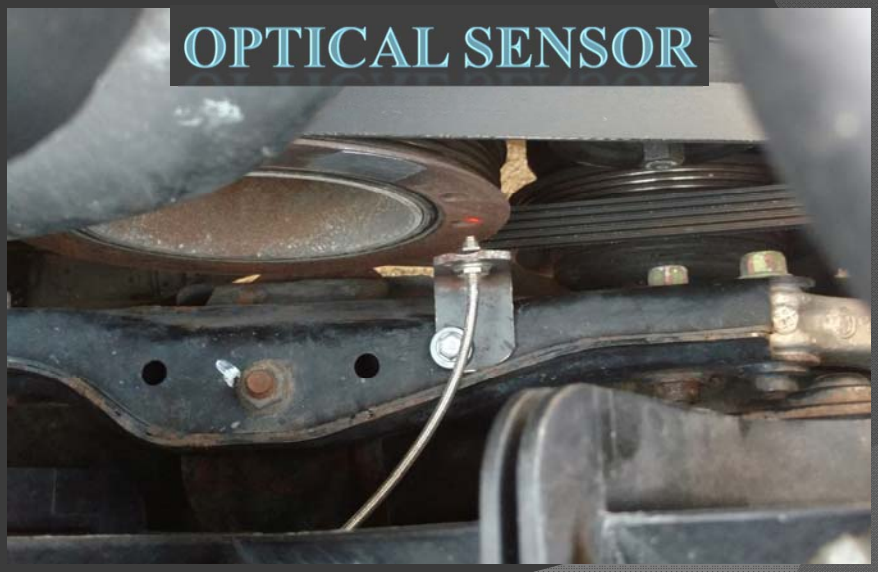
OPTICAL SENSOR



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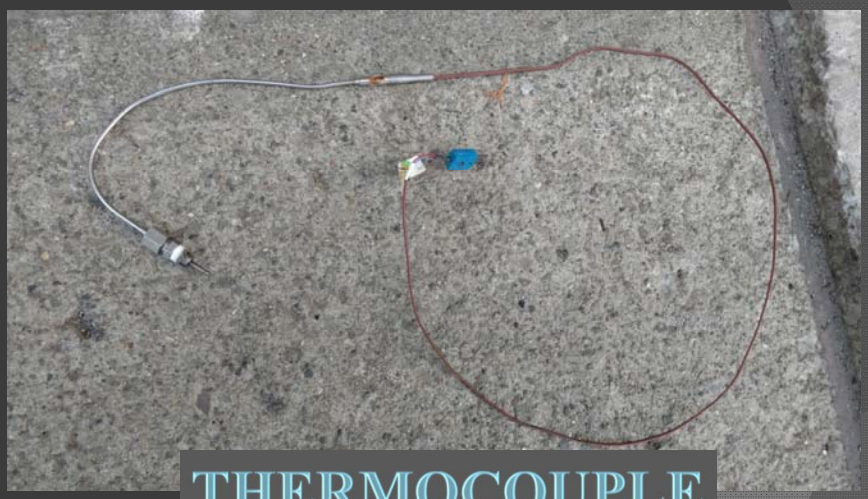

THERMOCOUPLE

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GPS SPEED SENSOR

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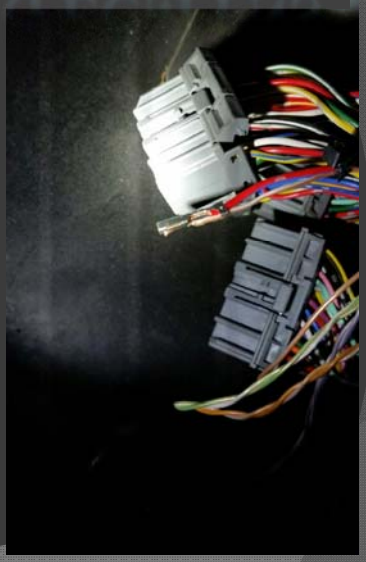
BACKFEEDING ECM PNS



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1.3 MILE TEST TRACK

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CONCLUSION

- Success!
- Increased Fuel Efficiency
- Increased Engine Power
- Project Went Smoothly the Whole Way Through
- Lessons Learned

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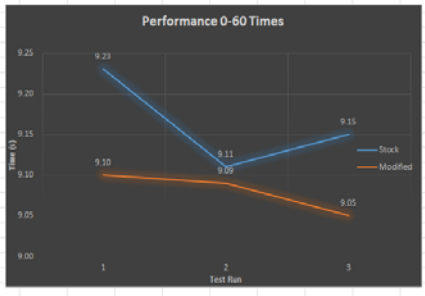
Fuel Economy Tests			
Test Run	Gas Usage	Miles Driven	Miles/Gallon
Stock	1.4	31	22.14285714
Modified	0.9	30.95	34.38888889
		Difference:	12.24603175

	A	B	C	D
1		Performance		
2	Test Run	End Time	Start Time	0-60 Time
3	Stock 1	11.18s	1.95s	9.23
4	Stock 2	10.82s	1.71s	9.11
5	Stock 3	10.98s	1.83s	9.15
6	Modified 1	10.79s	1.69s	9.10
7	Modified 2	10.69s	1.60s	9.09
8	Modified 3	10.57s	1.52s	9.05
9				
10	Stock Average	9.16s		
11	Modified Average	9.08s		
12	Average Increase	0.08s		



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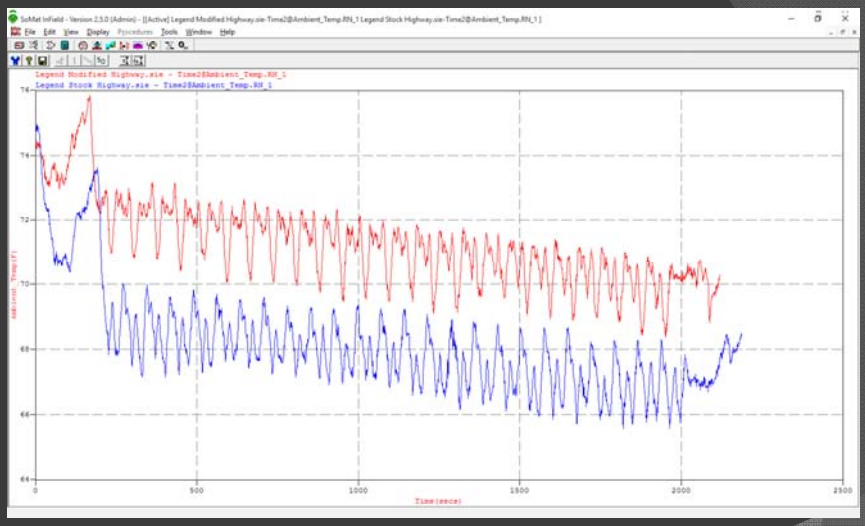

AMBIENT AIR TEMP.
STOCK CAL. – BLUE
MOD. CAL. - RED

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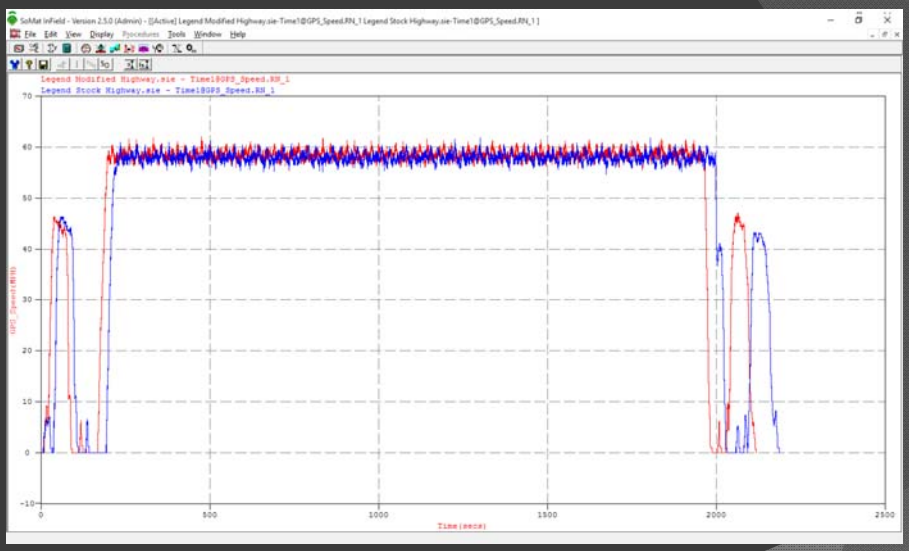

VEHICLE SPEED
STOCK CAL. – BLUE
MOD. CAL. - RED

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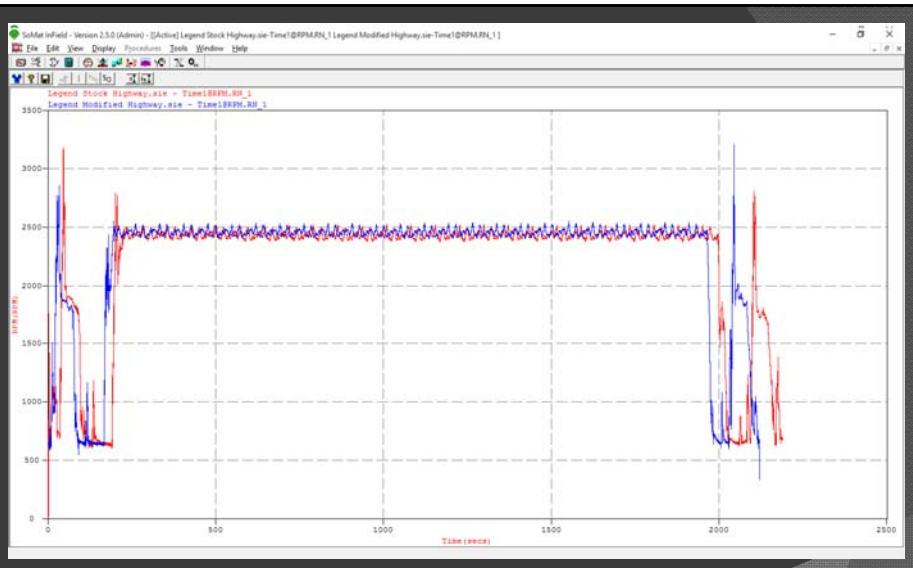

ENGINE RPM
STOCK CAL. – RED
MOD. CAL. - BLUE

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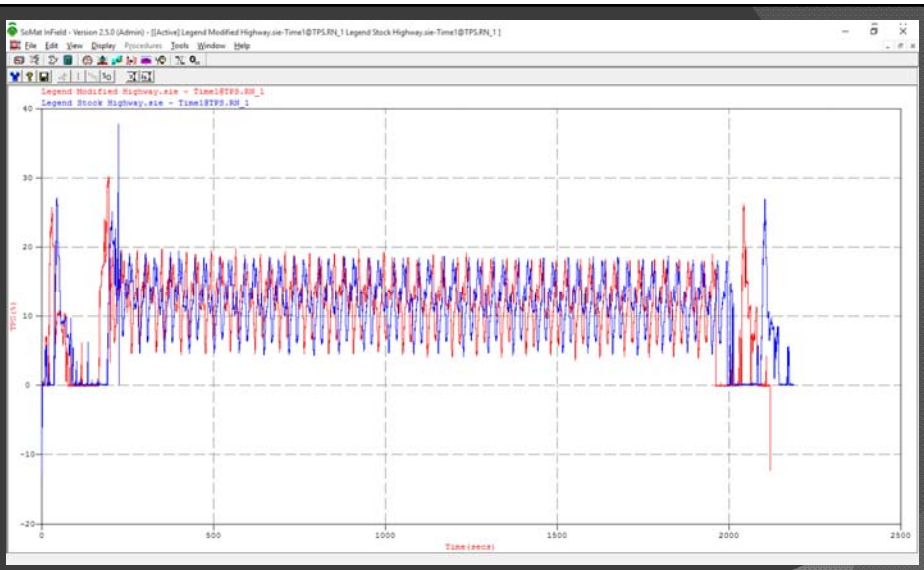
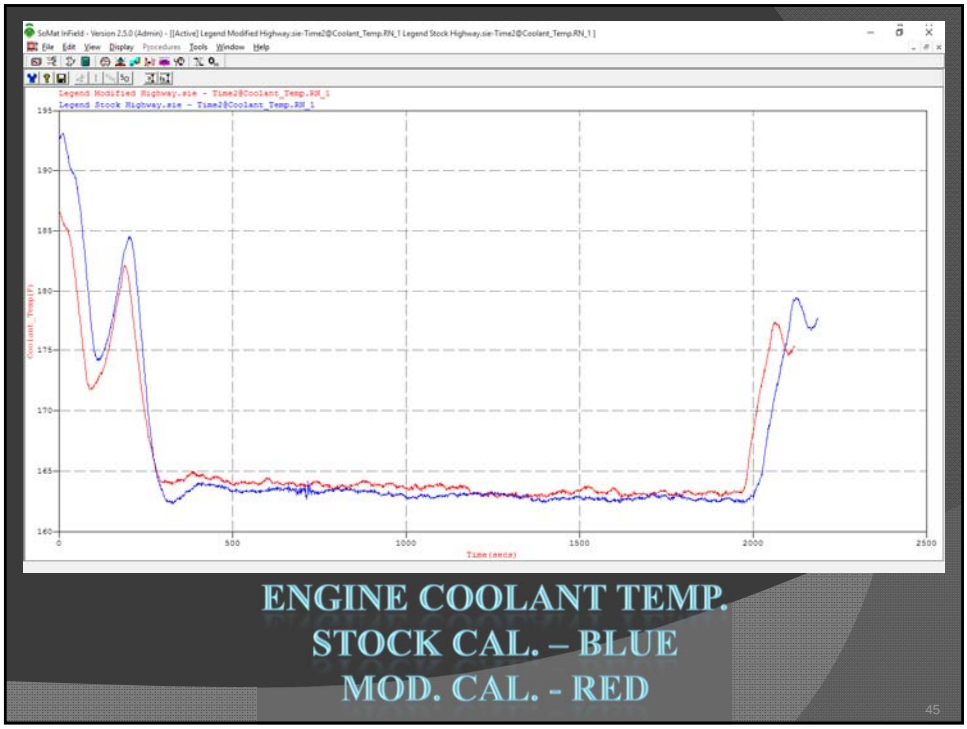


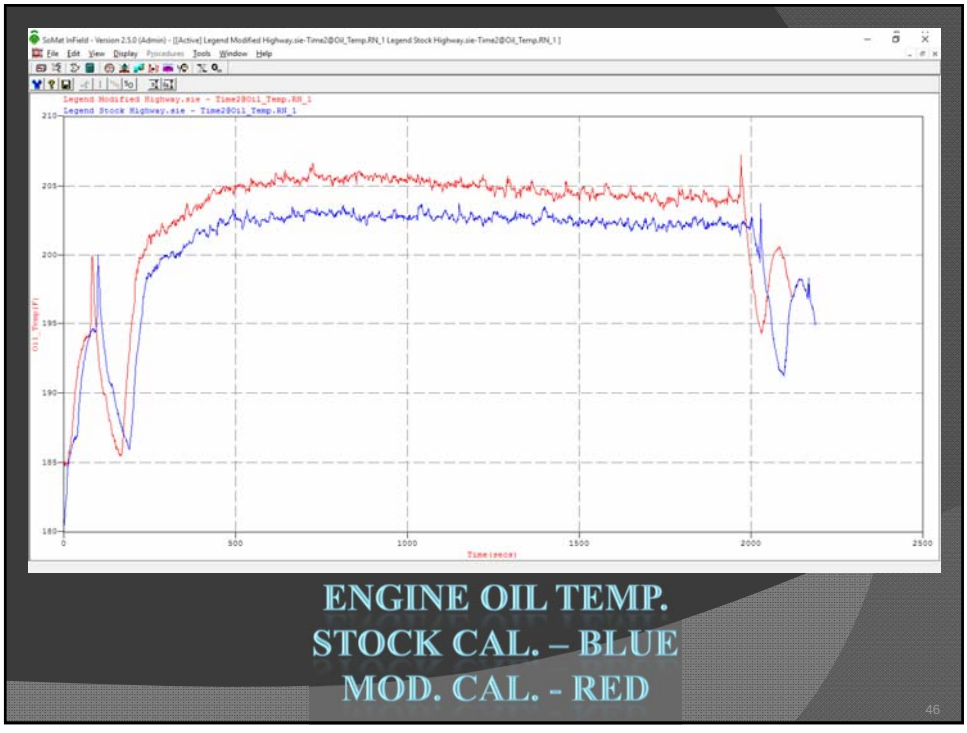
THROTTLE POSITION
STOCK CAL. – BLUE
MOD. CAL. - RED

44



ENGINE COOLANT TEMP.
STOCK CAL. – BLUE
MOD. CAL. - RED

45



ENGINE OIL TEMP.
STOCK CAL. – BLUE
MOD. CAL. - RED

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QUESTIONS?

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DEMO

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