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Fiat MultiAir System: Operation, Diagnosis, & Service

Blaine M. Heisner

Southern Illinois University Carbondale, bheisner@siu.edu

Andrew M. Croxell

Southern Illinois University Carbondale, dcroxell@siu.edu

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The image shows the front engine compartment of a white car. The central focus is the black plastic engine cover, which has a red 'FIAT MultiAir' logo. To the left of the engine is a red coolant reservoir. To the right is a black battery. Various hoses, wires, and mechanical components are visible throughout the engine bay. The car's headlights are visible at the bottom corners.

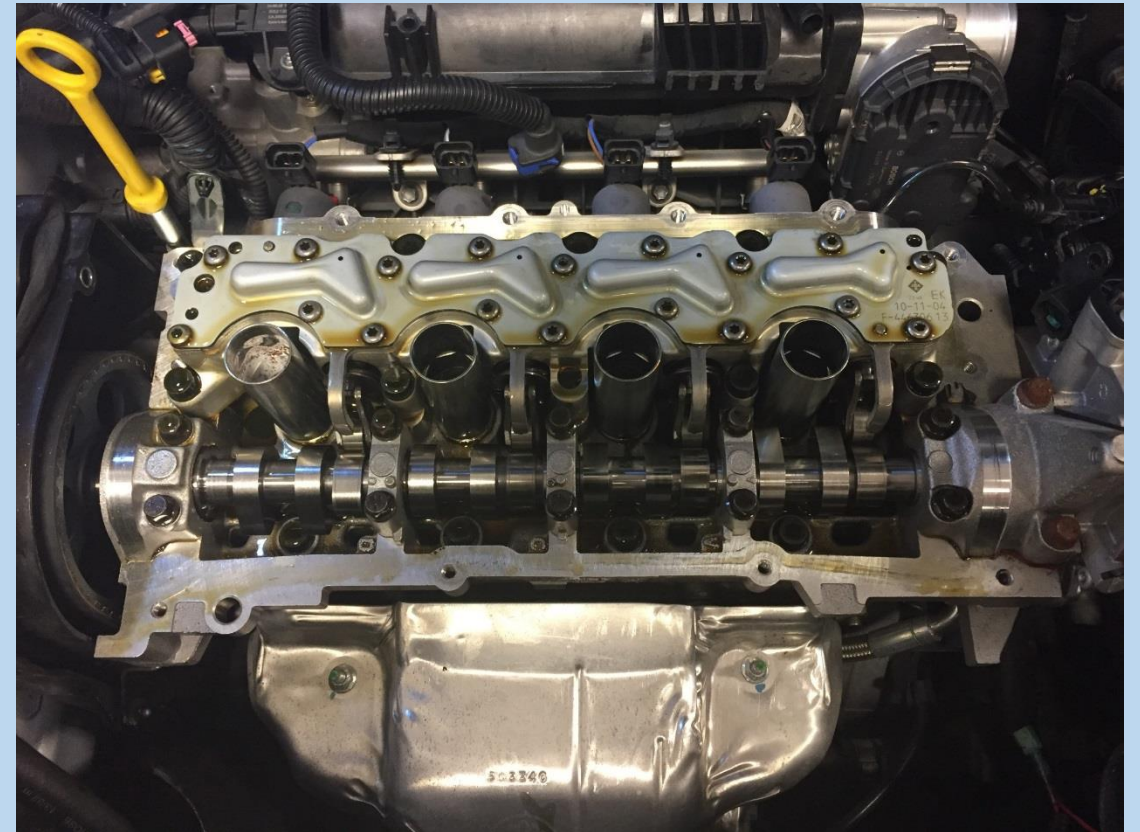
FIAT MULTI-AIR SYSTEM

Operation, Diagnosis, & Service

**Drew Croxell & Blaine Heisner
SIUC Automotive Technology**

Fiat Multi-Air System

- Electro-Hydraulic Variable Valvetrain System
 - Intake valves variable
 - Exhaust valves conventional
 - Modifies Volumetric Efficiency
- Uses a Single Overhead Camshaft
 - One lobe for intake valves
 - Two lobes for exhaust
- 1.4L Fiat and 2.4L Chrysler Engines
 - 1.4L-MultiAir 1
 - 2.4L “Tigershark”-MultiAir 2



FCA Vehicles

Fiat 500



Jeep Cherokee



FCA Vehicles

Chrysler 200



Dodge Dart



FCA Vehicles

Fiat Doblo/Ram Grand Master



Jeep Renegade



Capabilities

- Increased Torque and Horsepower
- Fuel Consumption/CO2 Emission Reduction
- Reduction in HC
- Reduction in NOx
- Governing Engine Speed



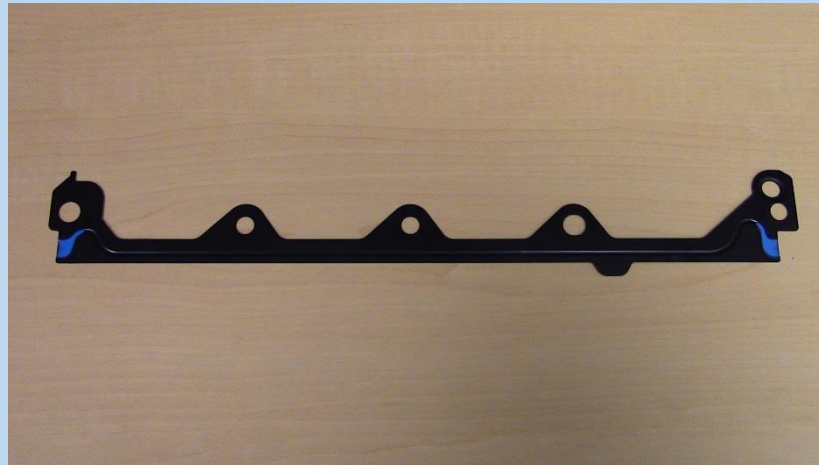
MultiAir “Brick”

- Upper Pumping Elements
- Oil Chamber
- Solenoid Valves
- Accumulator
- Brake Pumping Elements

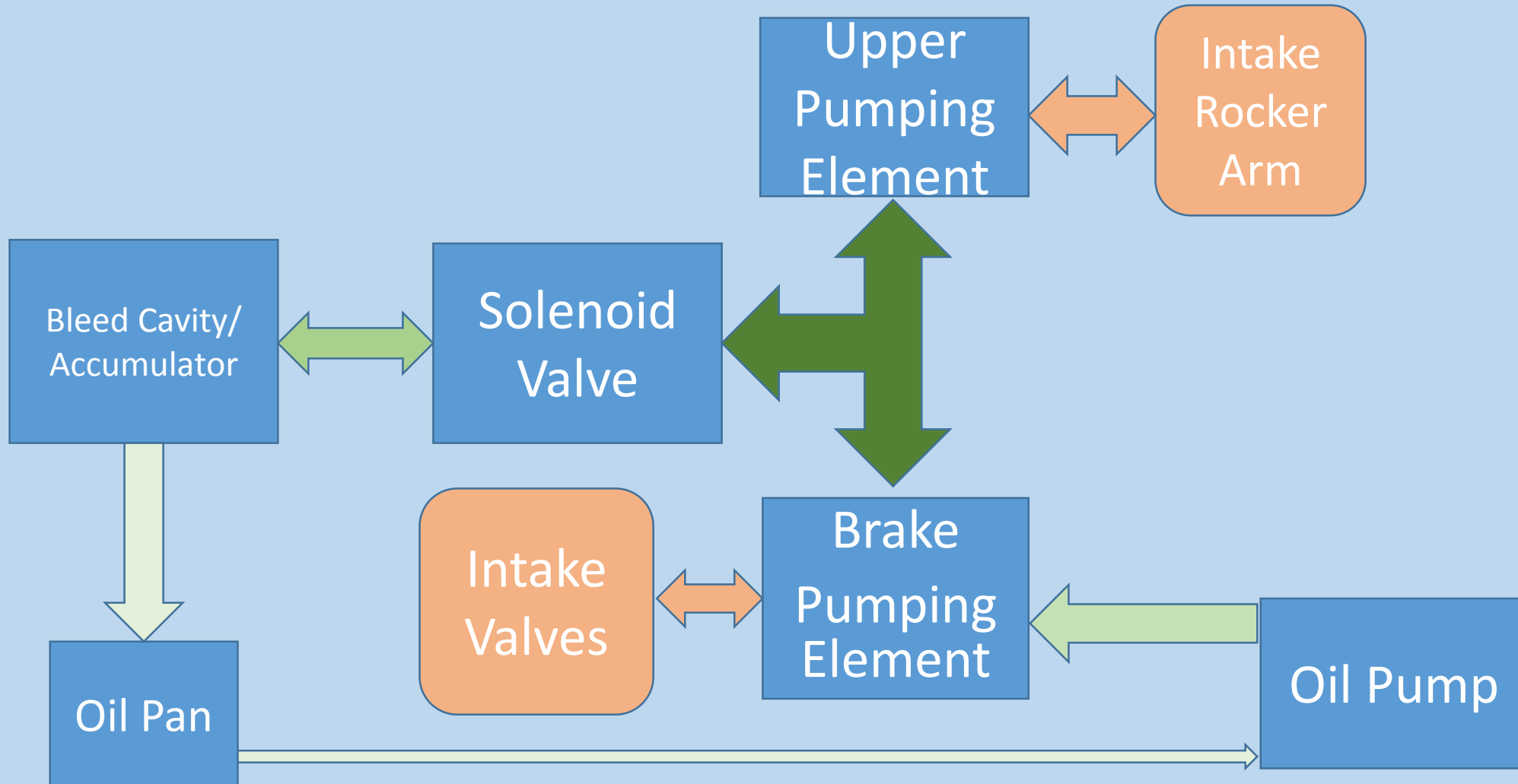


Other Components

- Oil Temperature Sensor
- Roller Rocker Arm
- O-Ring
- MultiAir Gasket
- Camshaft



Operation



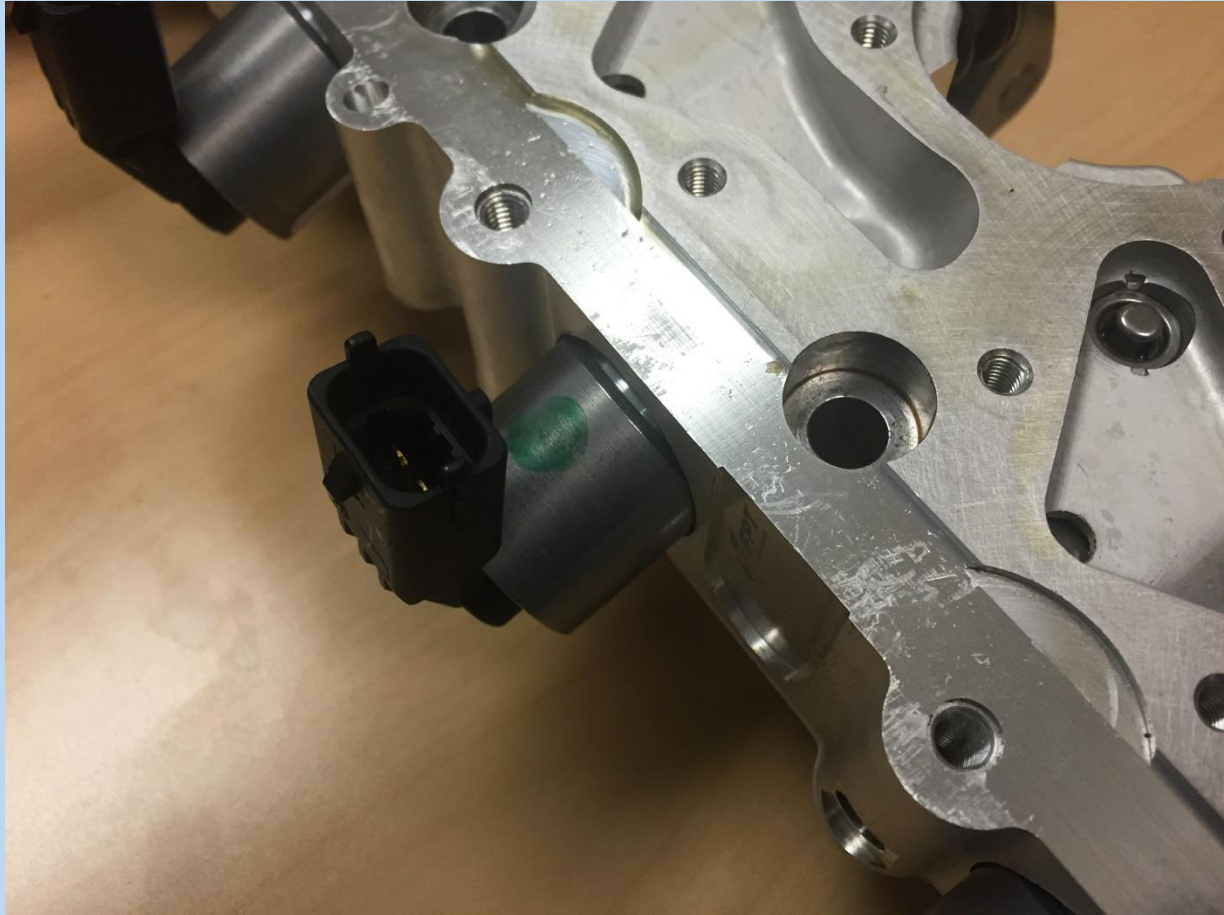
Oil Chamber



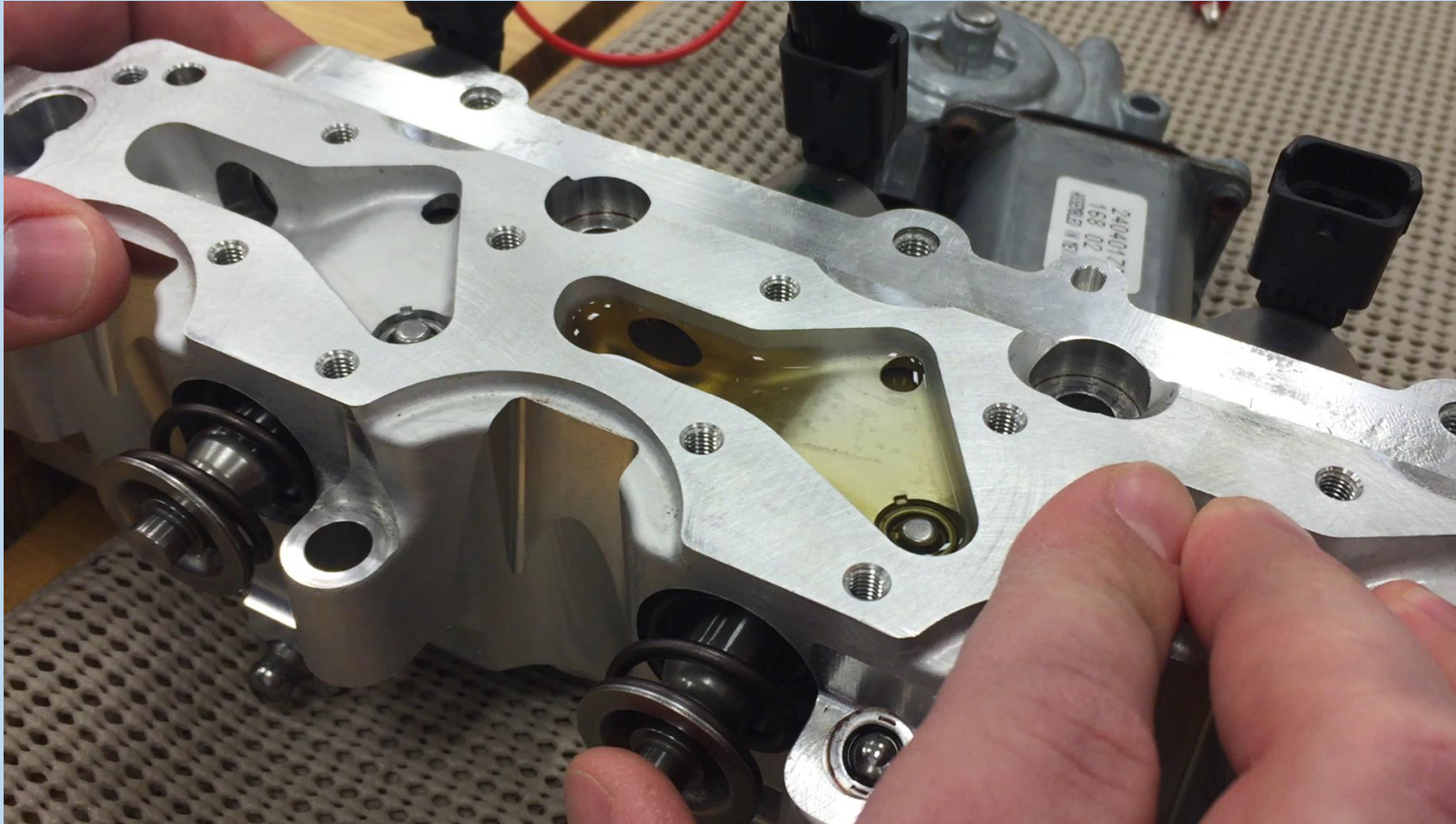
Upper Pumping Elements



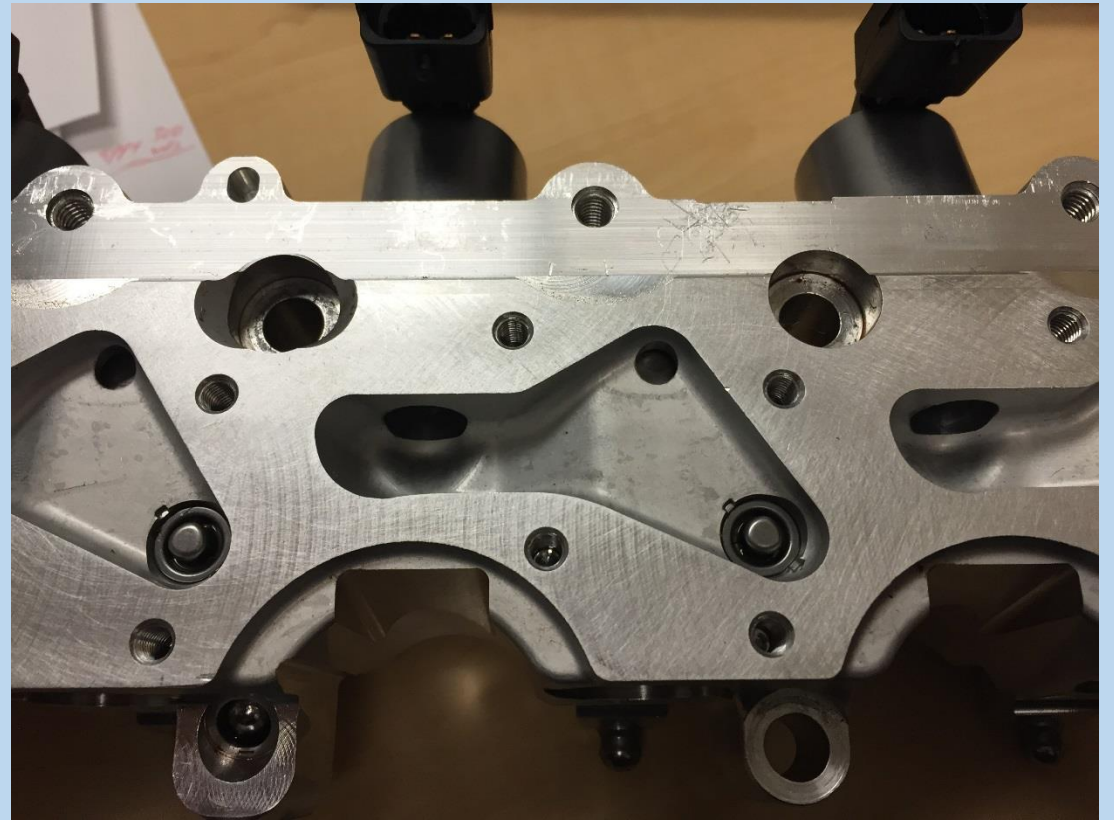
Solenoid Valves



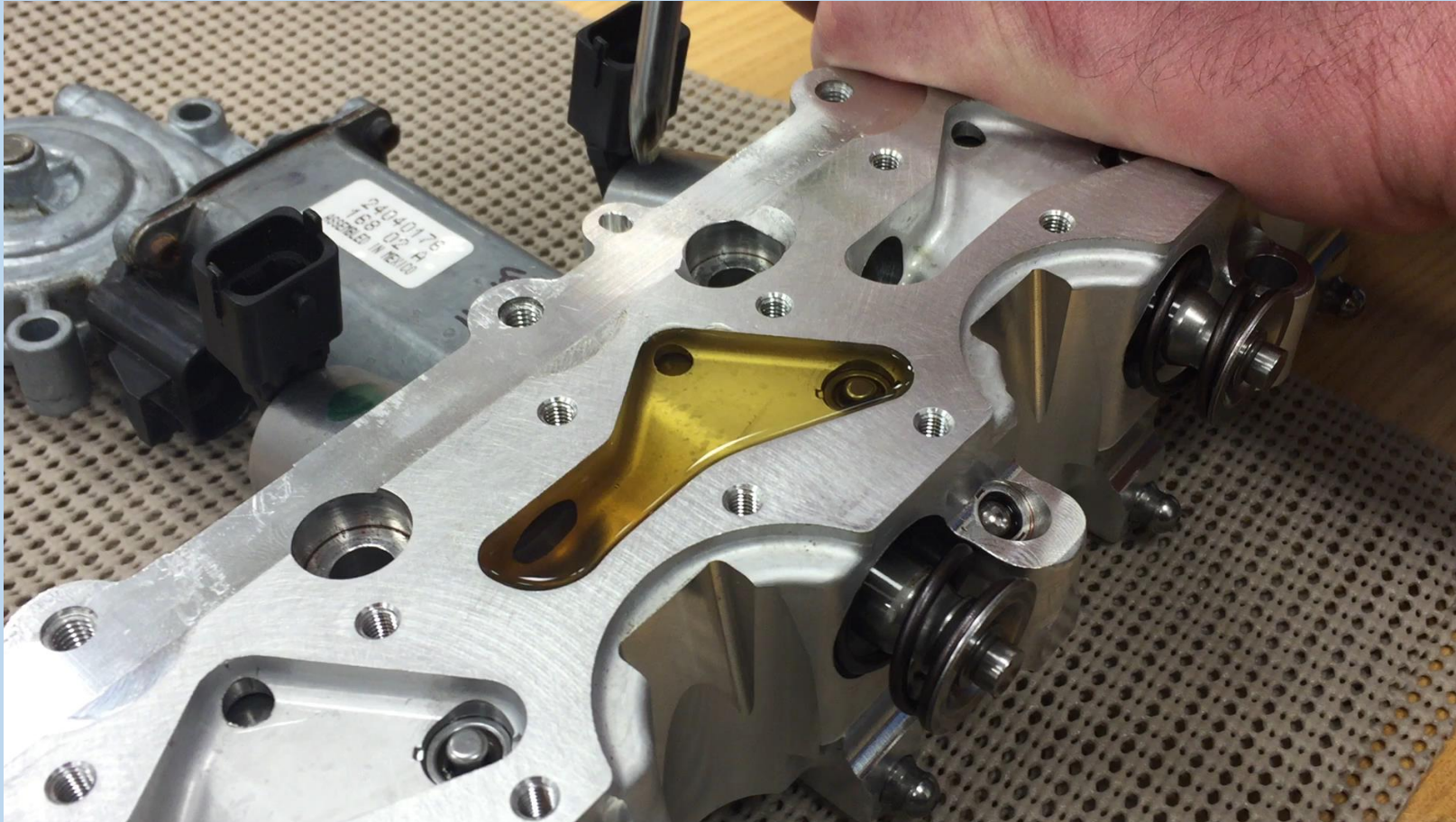
Solenoid Valve Operation (Video)



Accumulator



Accumulator Operation (Video)



Brake Pumping Elements

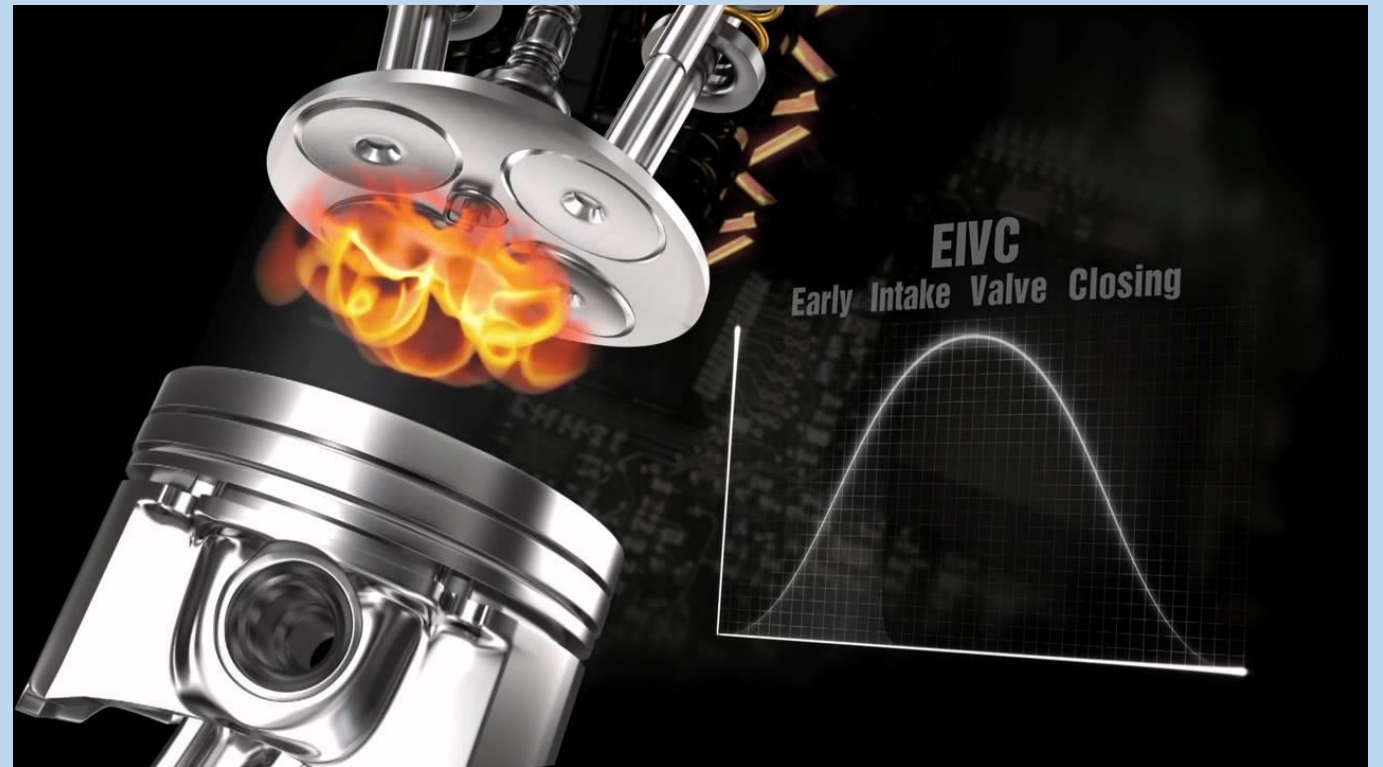


Pumping Element Disassembled

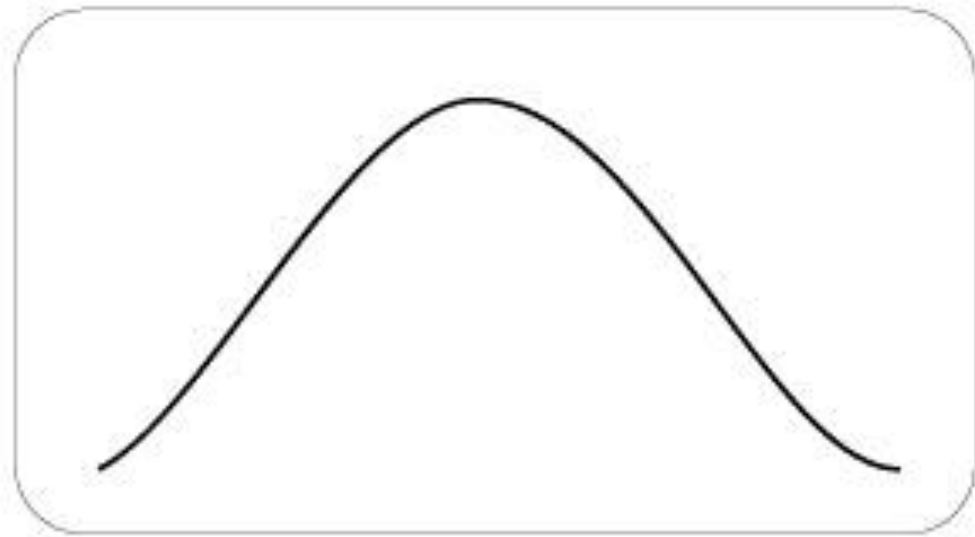


Phases of Operation

- Full Lift
- Early Intake Valve Closing
- Late Intake Valve Opening
- Multi-Lift
- Closed



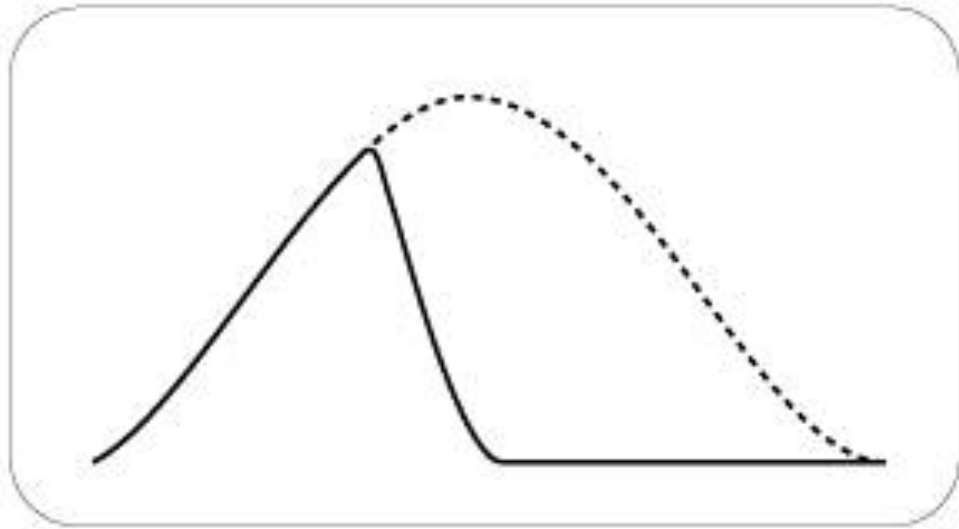
Full Lift



3250421

- Solenoid valve on 100%
- No bleed
- High load, high RPM

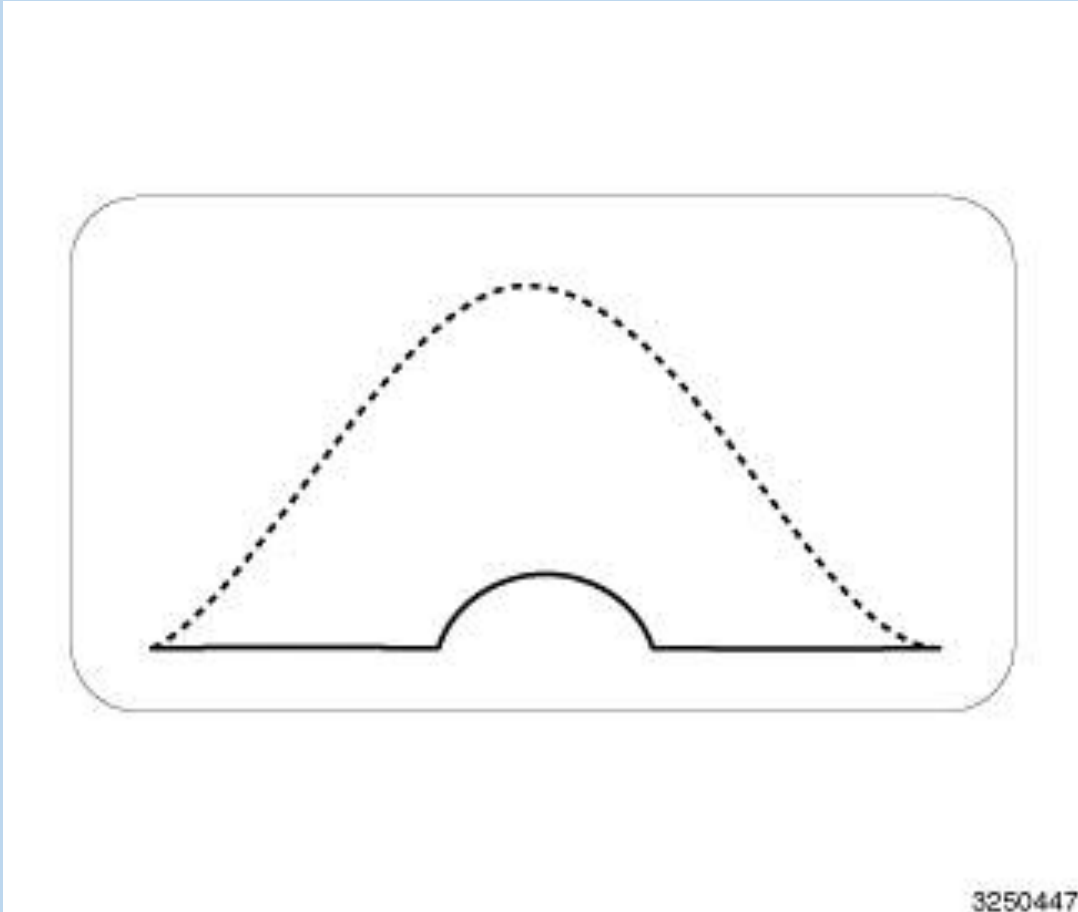
Early Intake Valve Closing (EIVC)



3250433

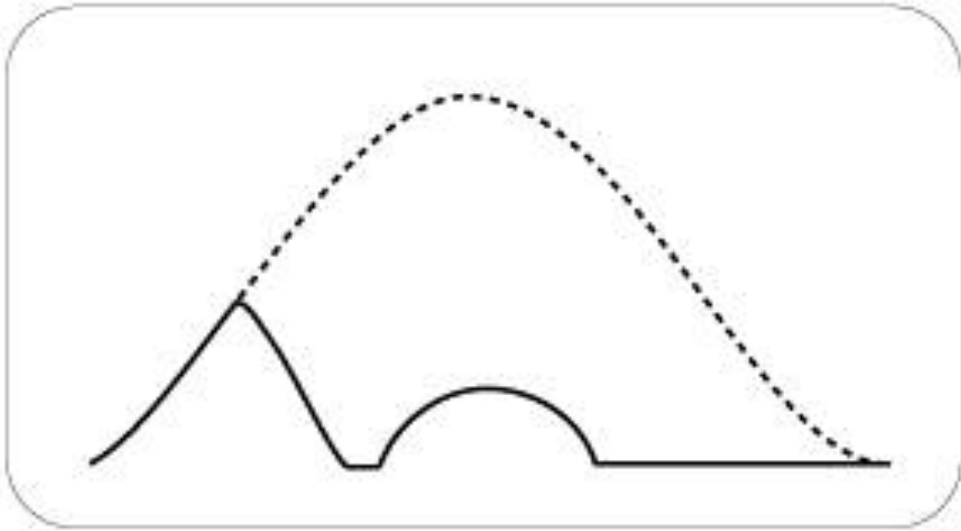
- Solenoid de-energized on opening ramp
- More V.E. at lower RPM
- Variable amount of lift/duration based on solenoid duty cycle

Late Intake Valve Opening (LIVO)



- Solenoid energized on opening ramp
- Lower VE for idle, lower RPM
- Variable amount of lift/duration based on solenoid duty cycle

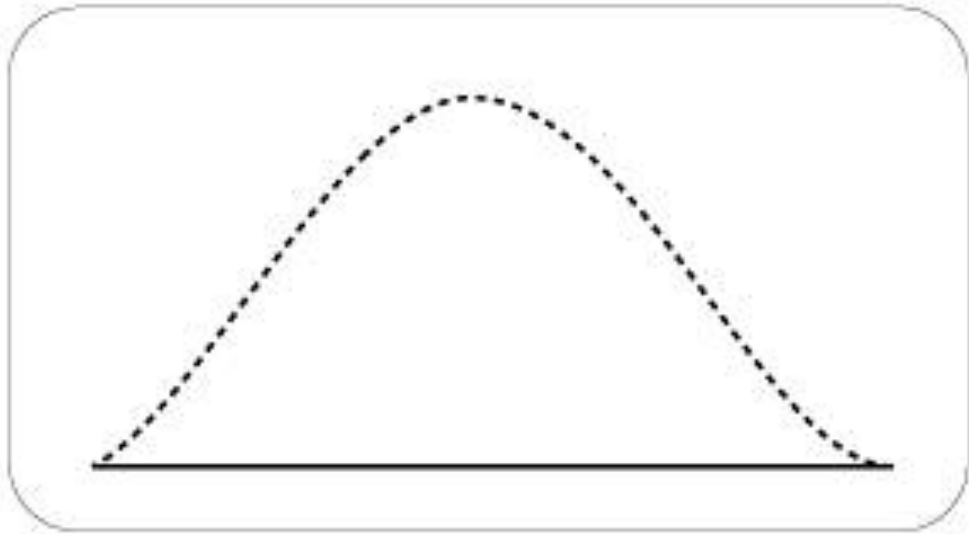
Multi-Lift



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- EIVC and LIVO together
- Longer valve duration/low lift
- Higher intake air velocity
- Moderate RPM

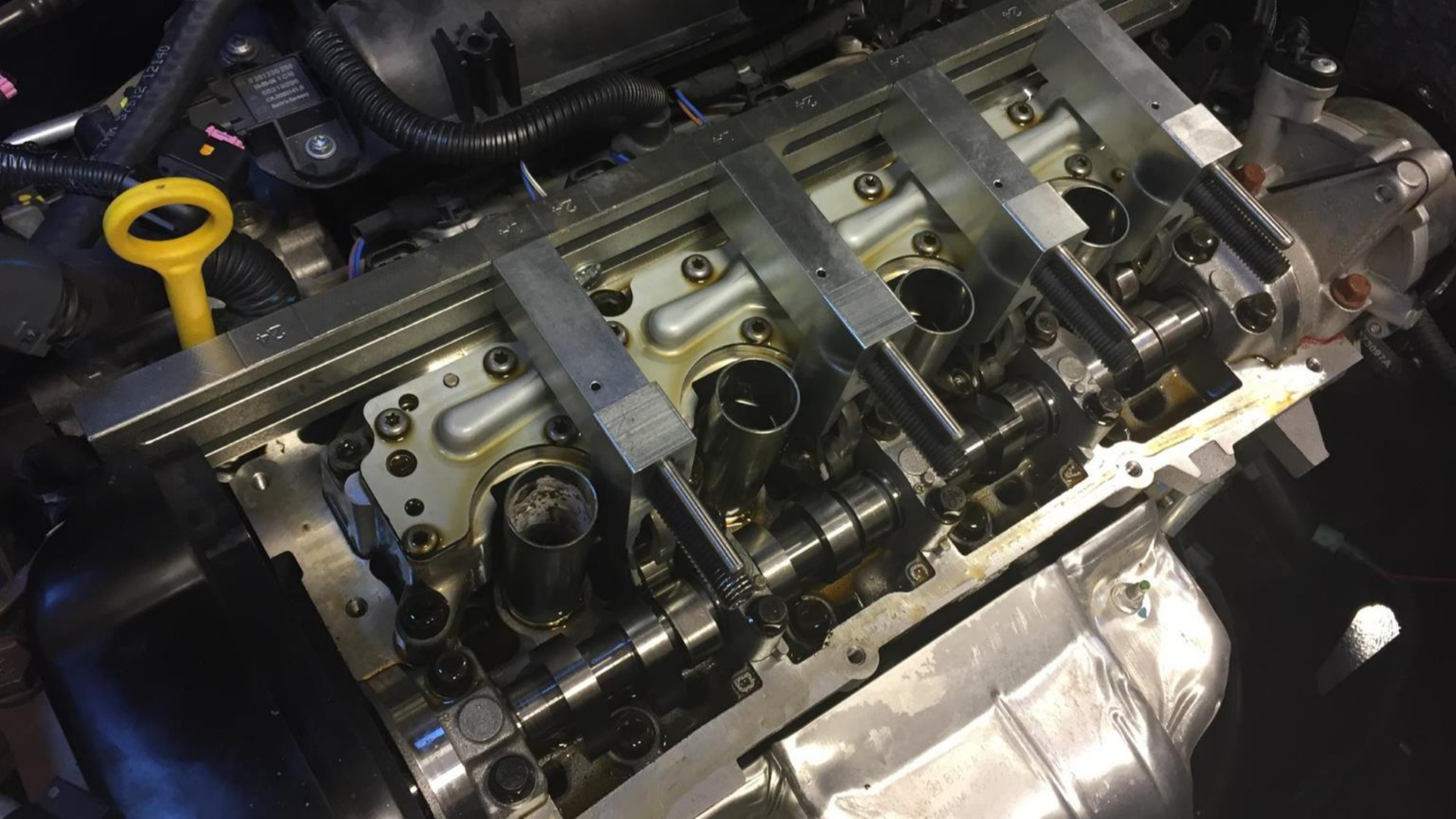
Closed



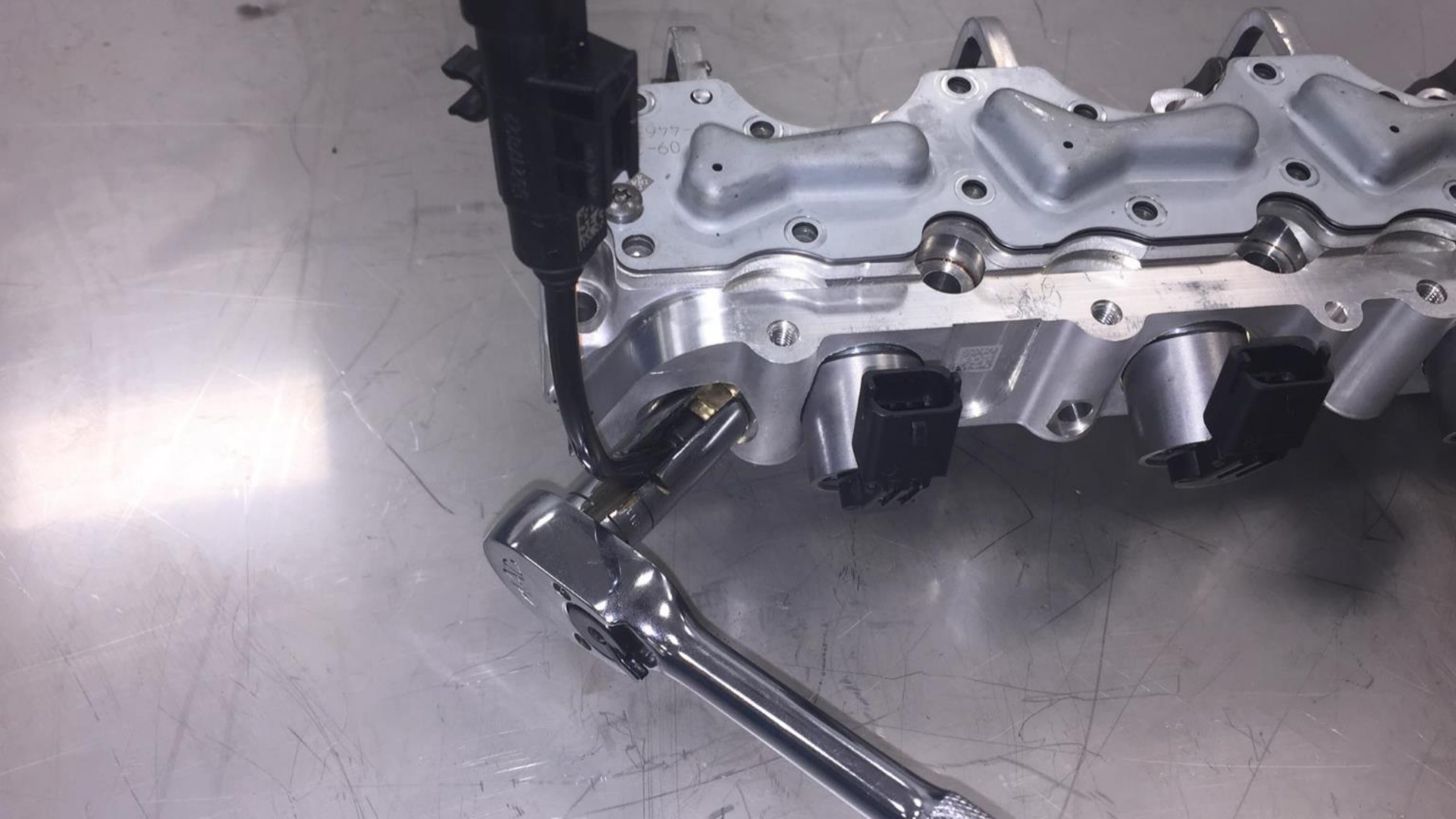
3250466

- Solenoid valve on 0%
- All high psi bled off
- Capability of system
- ASD relay?









Timing Belt Service

- 152,000 Mile interval



152,000 Miles (247,000 km) or 114 Months Maintenance Service Schedule

- ☐ Change the engine oil and engine oil filter.
- ☐ Rotate the tires, rotate at the first sign of irregular wear, even if it occurs before 152,000 miles (247 000 km).
- ☐ Flush and replace engine coolant.
- ☐ Replace the timing belt.

Odometer Reading

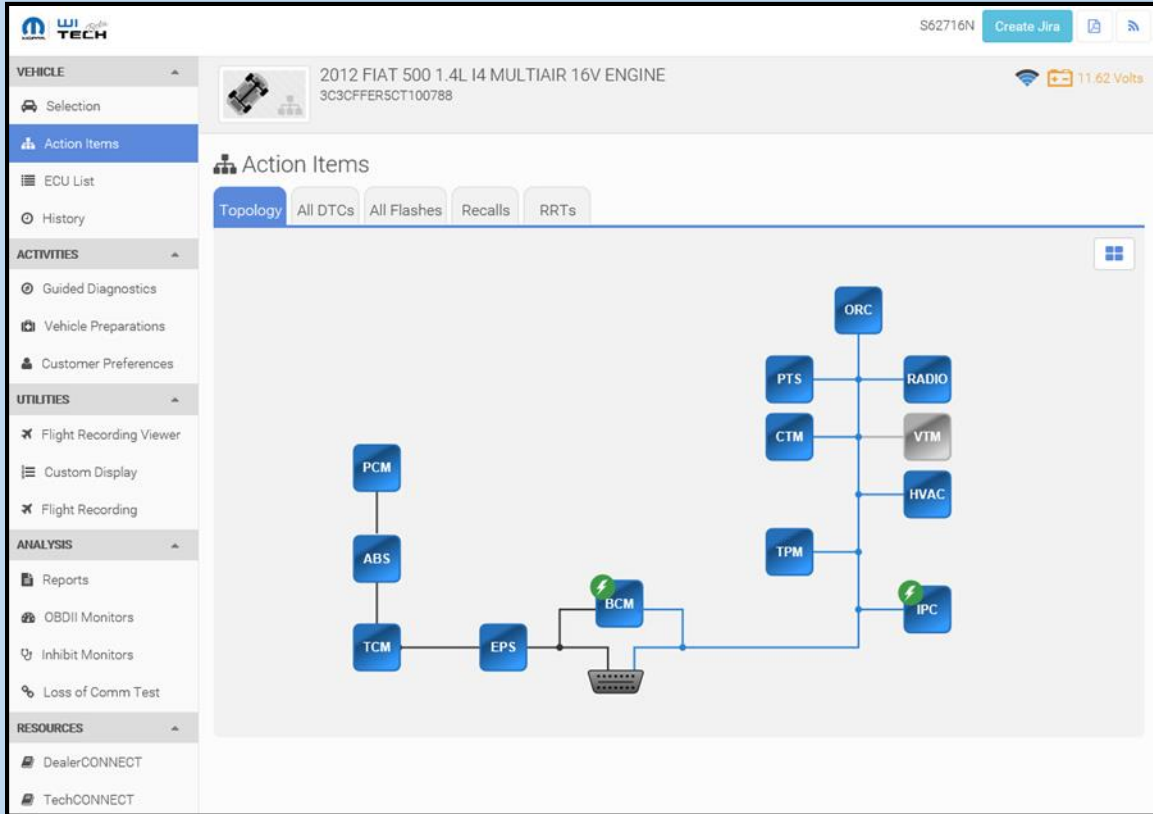
Date

Repair Order #

Dealer Code

Signature, Authorized Service Center

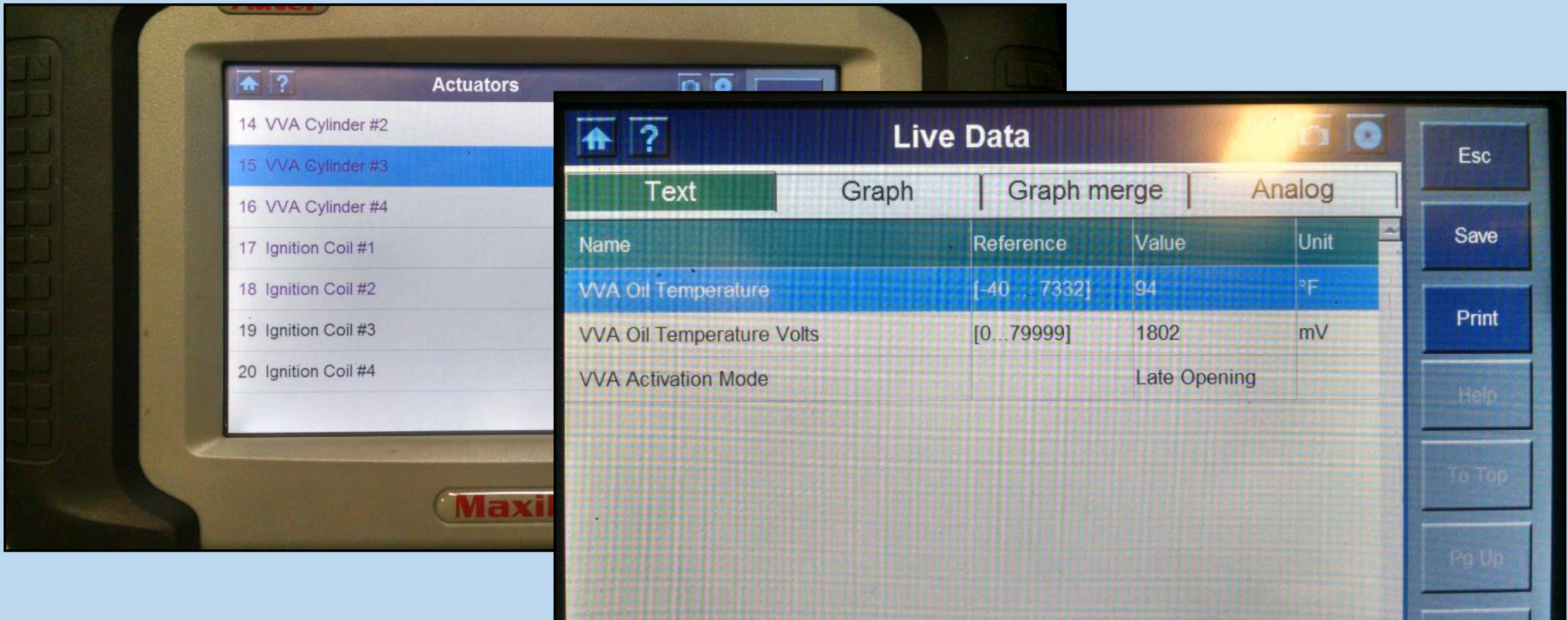
Factory Scan Tool



Ignition Coil #2	
Ignition Coil #3	
Ignition Coil #4	

Engine Oil Pressure Sensor Fault Present	Not Present
--	-------------

Generic Scan Tool



Underhood (Intake Manifold Bracket)



J-Lo commercial



- <https://youtu.be/X0lkmstjZes>

Owner's Manual - Oil Change

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Engine Oil

Checking Oil Level

To assure proper engine lubrication, the engine oil must be maintained at the correct level. Check the oil level at regular intervals, such as every fuel stop. The best time to check the engine oil level is about five minutes after a fully warmed engine is shut off. Do not check oil level before starting the engine after it has sat overnight. Checking engine oil level when the engine is cold will give you an incorrect reading.

Checking the oil while the vehicle is on level ground, and about five minutes after a fully warmed engine is shut off, will improve the accuracy of the oil level readings. Maintain the oil level between the range markings on the dipstick. The safe range is indicated by a crosshatch zone. Adding 1 qt (1L) of oil when the reading is at the low end of the indicated range will result in the oil level at the full end of the indicator range.

Engine Oil Selection

For best performance and maximum protection for all engines under all types of operating conditions, the manufacturer recommends engine oils that are API Certified and meet the requirements of Chrysler Material Standard MS-6395.

American Petroleum Institute (API) Engine Oil Identification Symbol



This symbol means that the oil has been certified by the American Petroleum Institute (API). The manufacturer only recommends API Certified engine oils.

CAUTION!
Do not overfill the engine with oil. Overfilling the engine with oil will cause oil aeration, which can lead to loss of oil pressure and an increase in oil temperature. This loss of oil pressure and increased oil temperature could damage your engine.

Change Engine Oil

The oil change indicator system will remind you that it is time to take your vehicle in for scheduled maintenance. Refer to the "Maintenance Schedule" for further information.

NOTE: Under no circumstances should oil change intervals exceed 8,000 miles (13 000 km) or six months, whichever occurs first.

CAUTION!
Do not use chemical flushes in your engine oil as the chemicals can damage your engine. Such damage is not covered by the New Vehicle Limited Warranty.

Engine Oil Viscosity (SAE Grade)

SAE 5W-30 engine oil is recommended for all operating temperatures. This engine oil improves low temperature starting and vehicle fuel economy. Your engine oil filler cap also states the recommended engine oil viscosity grade for your engine.

Lubricants which do not have both the engine oil certification mark and the correct SAE viscosity grade number should not be used.

The engine oil filler cap also shows the recommended engine oil viscosity for your engine. For information on

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MAINTENANCE SCHEDULE

The Scheduled Maintenance services listed in this manual must be done at the times or mileages specified to protect your vehicle warranty and ensure the best vehicle performance and reliability. More frequent maintenance may be needed for vehicles in severe operating conditions, such as dusty areas and very short trip driving. Inspection and service should also be done anytime a malfunction is suspected.

The oil change indicator system will remind you that it is time to take your vehicle in for scheduled maintenance.

Based on engine operation conditions the oil change indicator message will illuminate, this means that service is required for your vehicle. Have your vehicle serviced as soon as possible, within the next 500 miles (805 km).

NOTE:

- The oil change indicator message will not monitor the time since the last oil change. Change your vehicles oil if it has been 6 months since your last oil change even if the oil change indicator message is NOT illuminated.
- Change your engine oil more often if you drive your vehicle off-road for an extended period of time.
- Under no circumstances should oil change intervals exceed 8,000 miles (13,000 km) or 6 months, whichever comes first.

Your authorized dealer will reset the oil change indicator message after completing the scheduled oil change. If a scheduled oil change is performed by someone other than your authorized dealer, the message can be reset by referring to the steps described under "Electronic Vehicle Information Center (EVIC)/Change Engine Oil" in "Understanding Your Instrument Panel" for further information.

MAINTAINING YOUR VEHICLE 307

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engine oil filler cap location, refer to "Engine Compartment" in "Maintaining Your Vehicle" for further information.

Synthetic Engine Oils

You may use synthetic engine oils provided the recommended oil quality requirements are met, and the recommended maintenance intervals for oil and filter changes are followed.

Materials Added To Engine Oils

Do not add any supplemental materials, other than leak detection dyes, to your engine oil. Engine oil is an engineered product and its performance may be impaired by supplemental additives.

Disposing Of Used Engine Oil And Oil Filters

Care should be taken in disposing of used engine oil and oil filters from your vehicle. Used oil and oil filters, indiscriminately discarded, can present a problem to the environment. Contact your authorized dealer, service

station, or governmental agency for advice on how and where used oil and oil filters can be safely discarded in your area.

Engine Oil Filter

The engine oil filter should be replaced with a new filter at every engine oil change.

Engine Oil Filter Selection

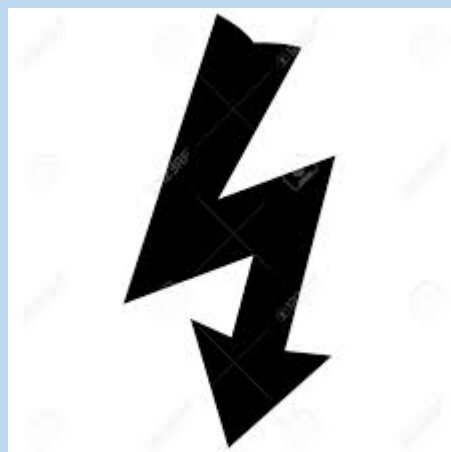
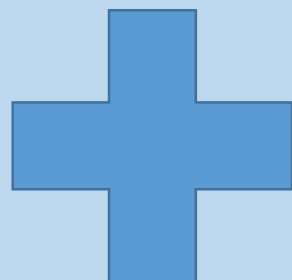
All of this manufacturer's engines have a full-flow type disposable oil filter. Use a filter of this type for replacement. The quality of replacement filters varies considerably. Only high quality filters should be used to assure most efficient service. MOPAR® engine oil filters are high quality oil filters and are recommended.

Engine Air Cleaner Filter

Refer to the "Maintenance Schedule" for the proper maintenance intervals.

Owner's Manual - Oil Change

- 8,000 mile (or 6 months) oil change interval
- Oil must meet Chrysler material standard MS-6395
- 4 quarts of 5W-30
- Cartridge style filter
- Oil consumption specification is <1 quart per 1,000 miles (below 80k miles)



So what happens when J-Lo fails to properly maintain her vehicle?



Oil Pressure Specification

OIL PUMP

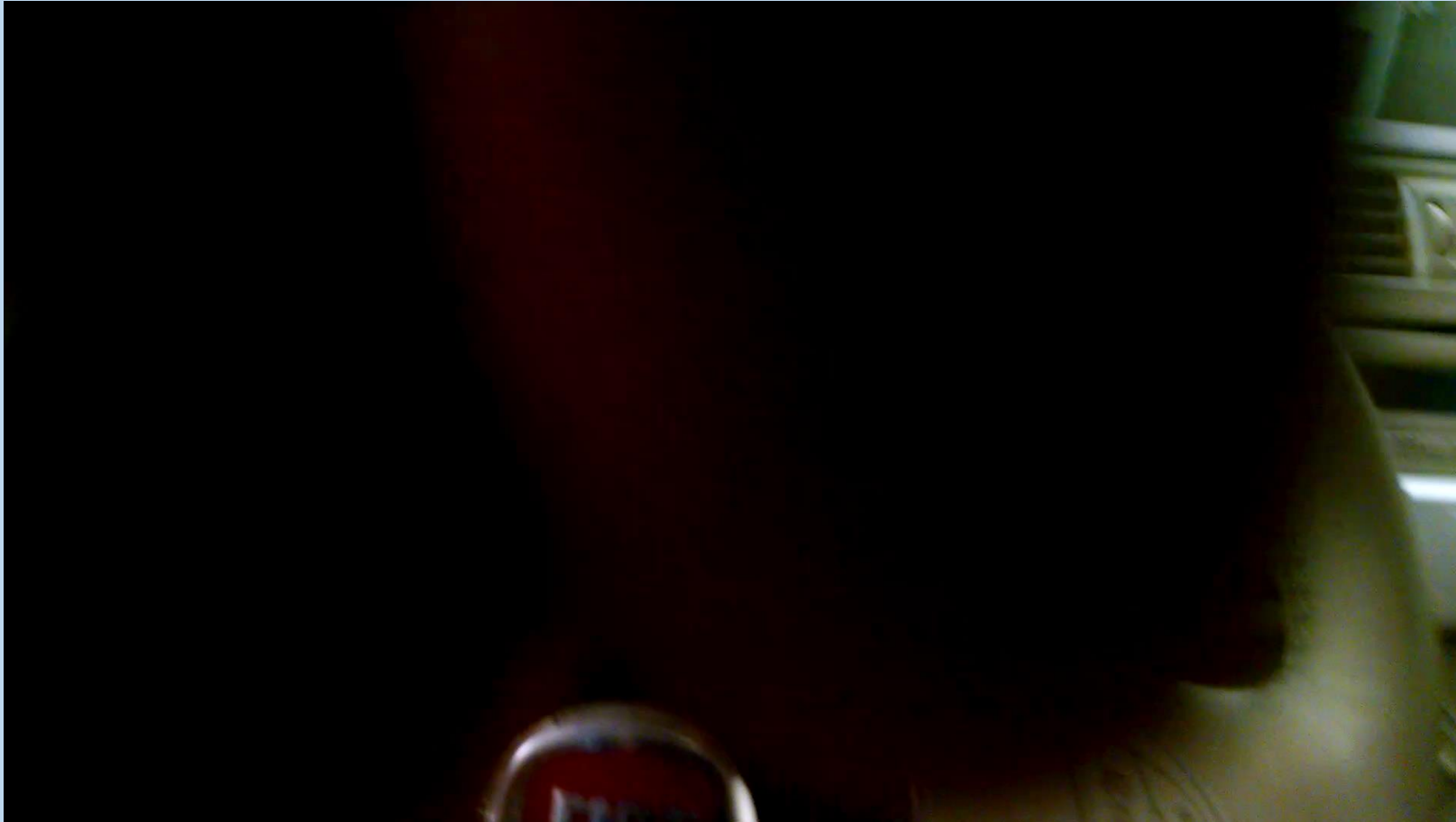
Description	Specification	
	Metric	Standard
Pressure @ Curb Idle Speed*	> 0.7 bar	> 10 psi
Pressure @ 4000 RPM*	> 4.0 bar	> 58 psi
*At Normal Operating Temperatures		

Low Oil Level (Video)



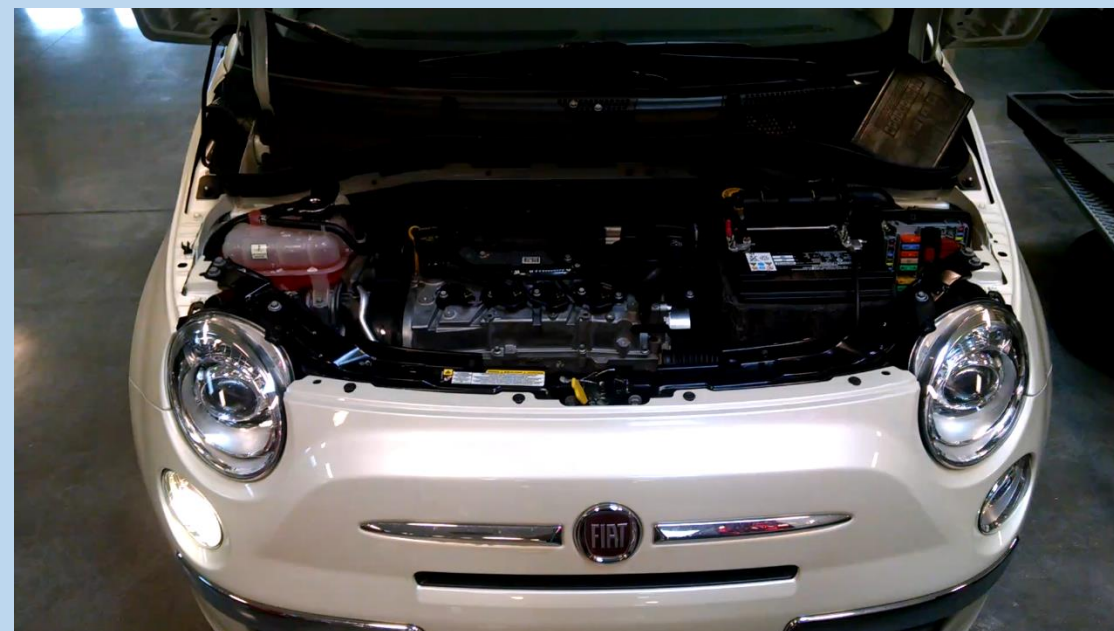
Vehicle has
approximately $\frac{1}{2}$
quart of oil in the oil
pan at this time

Startup after 2 weeks (Video)



Cavity	Maxi Fuse	Mini Fuse	Description
F08	30 Amp Green		Blower Motor
F09		10 Amp Red	Powertrain
F10		10 Amp Red	Horn
F11		15 Amp Blue	Powertrain
F11		10 Amp Red	Powertrain (Multi-air – If Equipped)
F14		5 Amp Tan	High beam (Shutter)
F15		15 Amp Blue	Cigar Lighter
F16		7.5 Amp Brown	Transmission

Cavity	Maxi Fuse	Mini Fuse	Description
F17		25 Amp White	Powertrain (Multi-air – If Equipped)
F17		15 Amp Blue	Powertrain
F18		15 Amp Blue	Powertrain
F18		5 Amp Tan	Powertrain (Multi-air – If Equipped)
F19		7.5 Amp Brown	Air Conditioning
F20		15 Amp Blue	Heated Seats – If Equipped
F21		15 Amp Blue	Fuel Pump
F23		20 Amp Yellow	Anti-Lock Brake Valves



Compression Testing

- Minimum 100psi cranking compression with no more than 25% variation
- Remove fuel pump fuse and not the ASD

Cylinder Leakage

- No more than 25% leakage

Diagnostic Trouble Codes

- P0009-64 VVA Blocked to Repose
- P0010-11 VVA Electrovalve Circuit short to ground
- P0010-12 VVA Electrovalve Short to battery
- P0010-13 VVA Electrovalve Circuit open
- P0011-64 Position Error VVA
- P0012-84 VVA Speed too slow
- P0012-66 VVA Speed too high
- P0520-67 Engine oil pressure circuit
- P1523-00 VVA Low oil pressure
- P1524-00 Oil pressure out of range – Camshaft Advance/Retard disabled
- P106A-00 Oil supply solenoid valve OFF time out of range
- P106B-00 Oil supply solenoid valve ON time out of range

Testing Guidelines

- Experiments:

1. Baseline
2. Clogged air filter
3. Thicker engine oil – 20w-50

- Operating Conditions:

- A. Idle – Park
- B. Idle – Drive – Crawl Speed
- C. Low throttle run up
- D. Mid throttle run up
- E. Max throttle run up
- F. Cruising – Highway speed

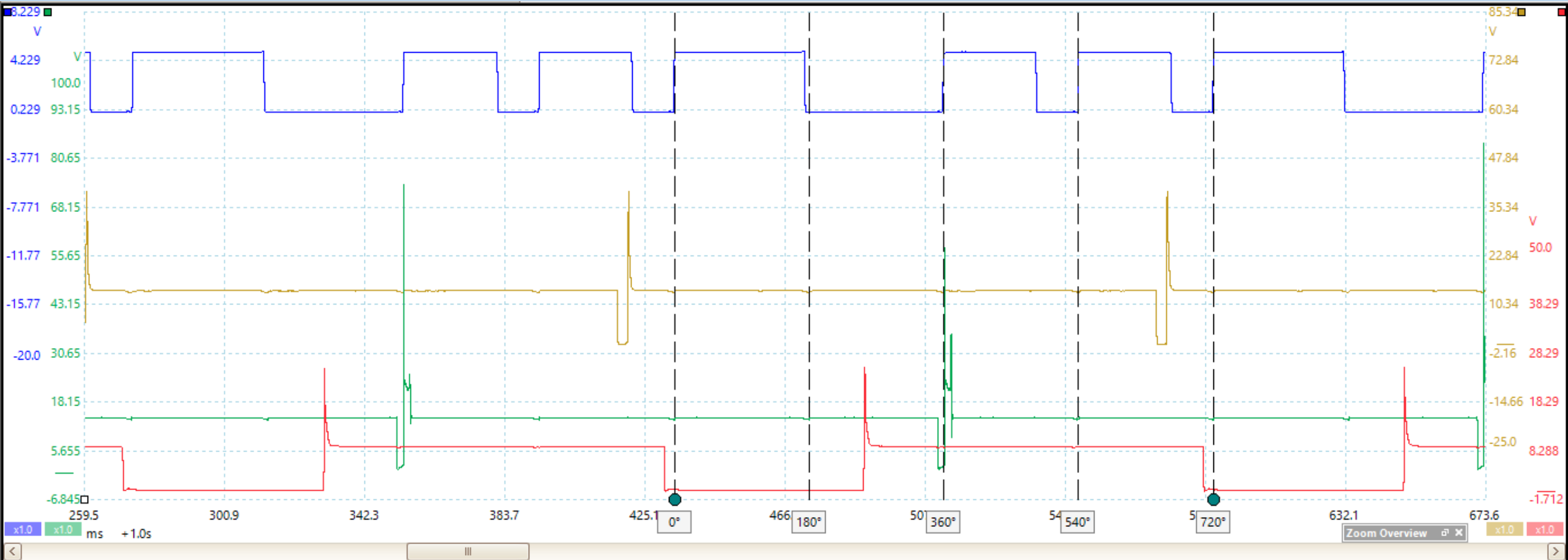


Setup

- Pico Scope 6
- PV350
- Mustang Dyno



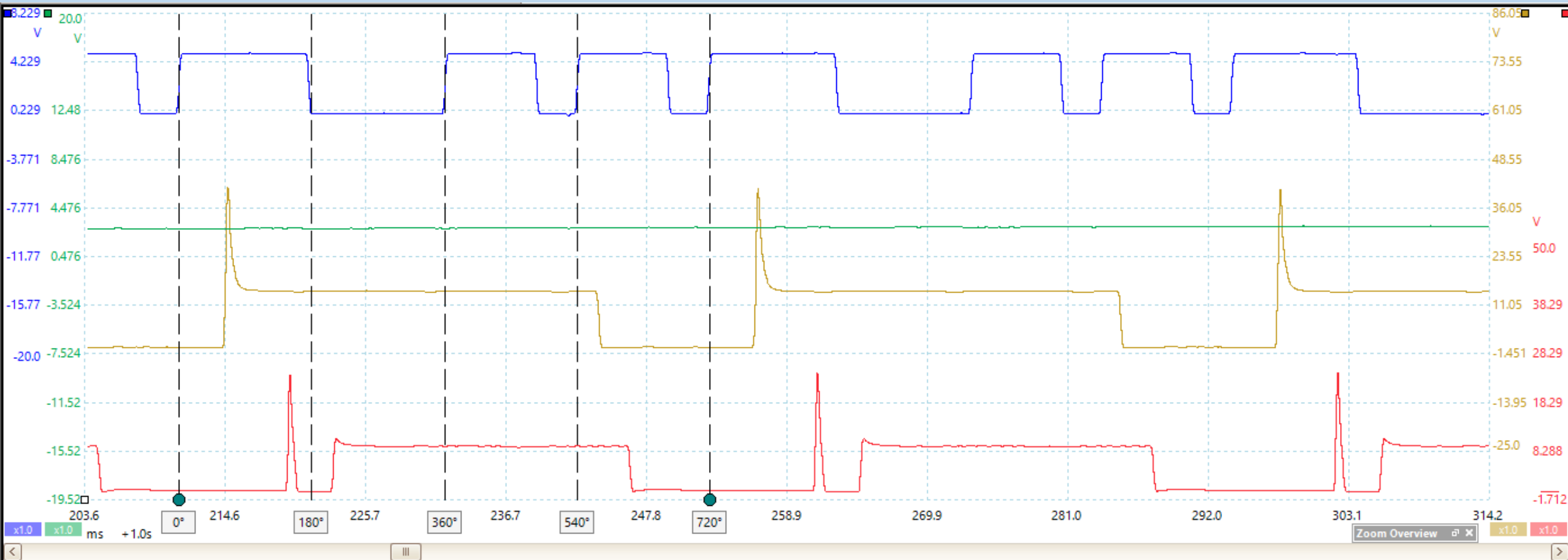
Timing at Idle



Timing

Blue - Camshaft Signal
Green - Ignition Coil 1 Control
Yellow - Injector 1
Red - MultiAir Solenoid 1 Return

Timing at WOT



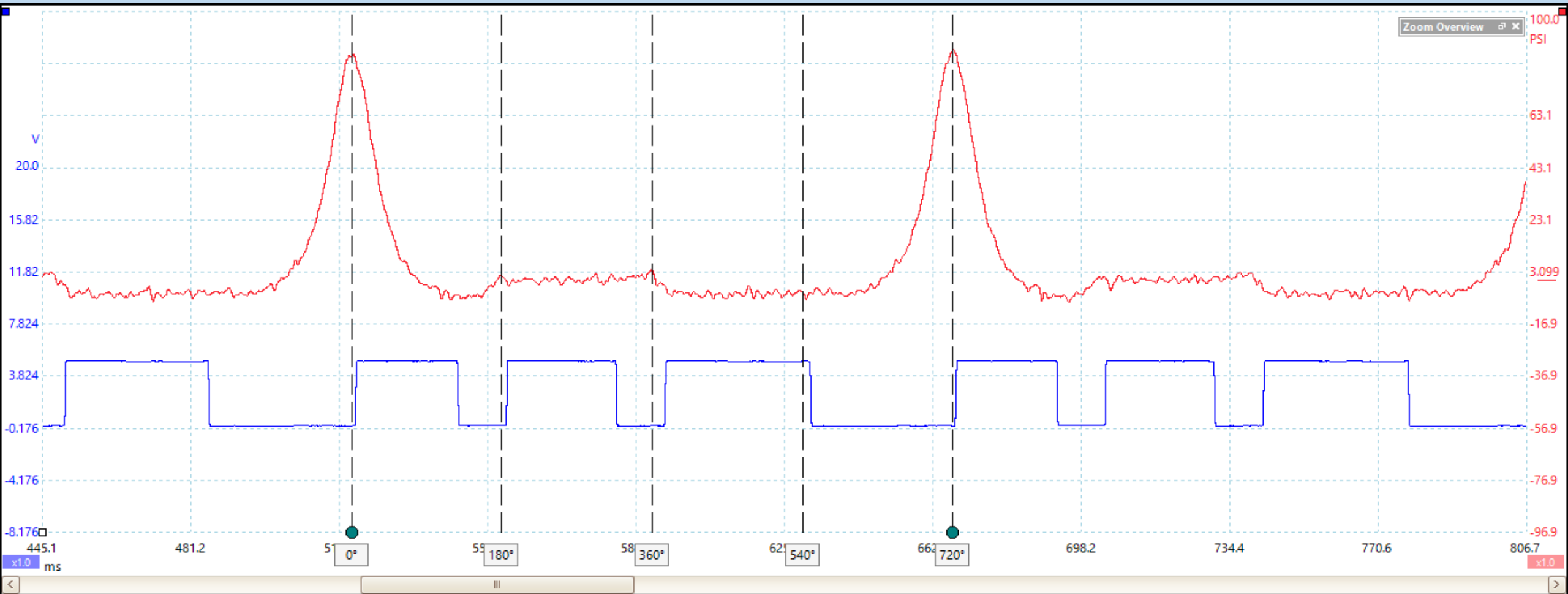
Notes

Timing WOT

Blue - Camshaft Signal
Red - MultiAir Solenoid 1 Return
Green - Throttle Position Signal 1
Yellow - Injector 1

Stopped Trigger Measurements Rulers Notes Channel Labels

PV350 Compression Test



Notes

PV350 Test

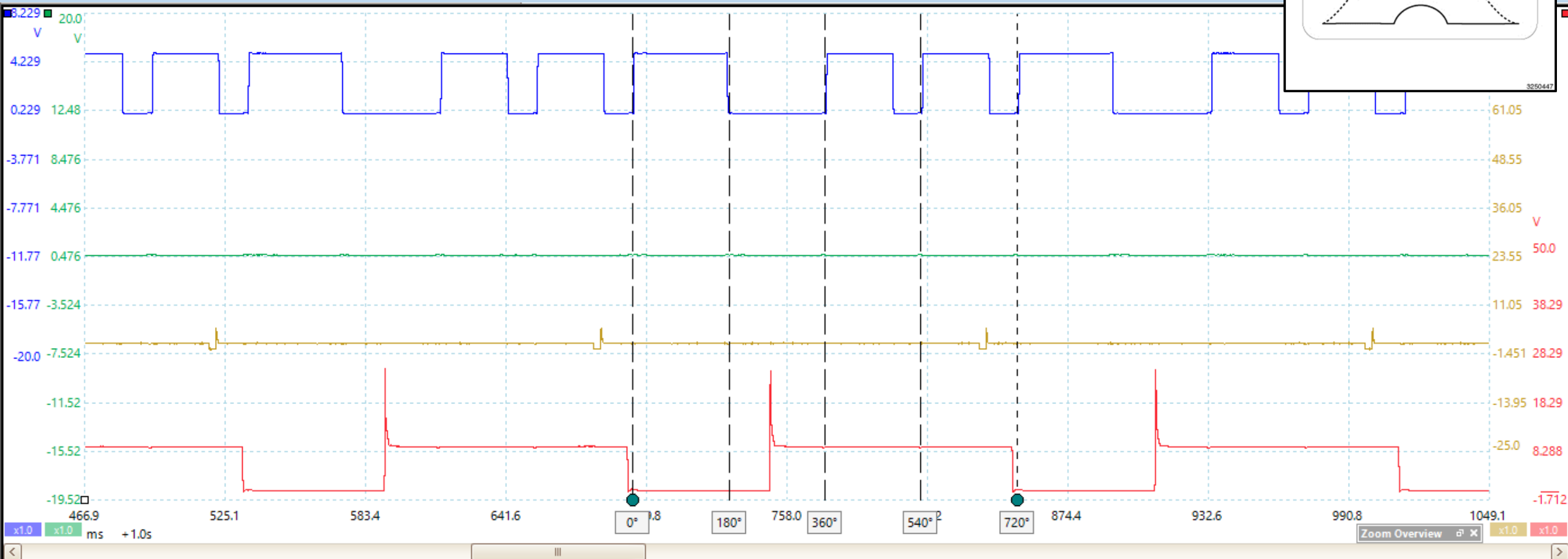
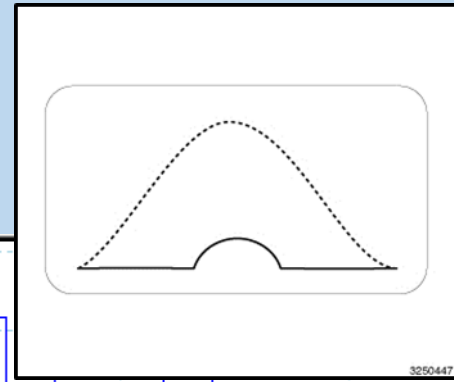
Blue - Cam Position

Red - Cylinder 1 Compression

Stopped Trigger

Measurements Rulers Notes Channel Labels

1A – “Control” at Idle-Park



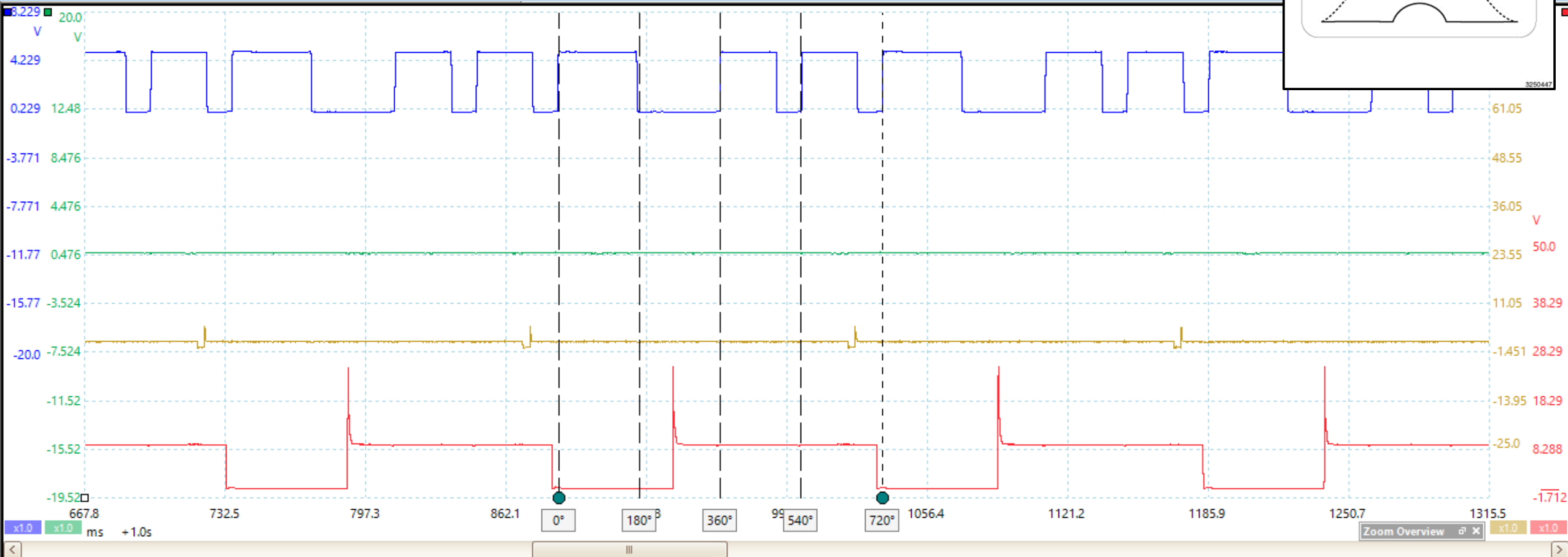
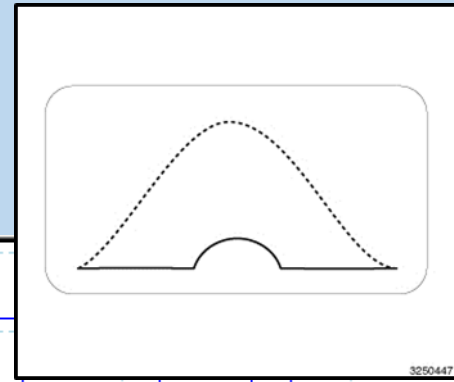
Notes

Experiment 1A

Blue - Camshaft Signal
Red - MultiAir Solenoid 1 Return
Green - Throttle Position Signal 1
Yellow - Injector 1

Stopped Trigger Measurements Rulers Notes Channel Labels

1B – “Control” at Drive-Crawl Speed



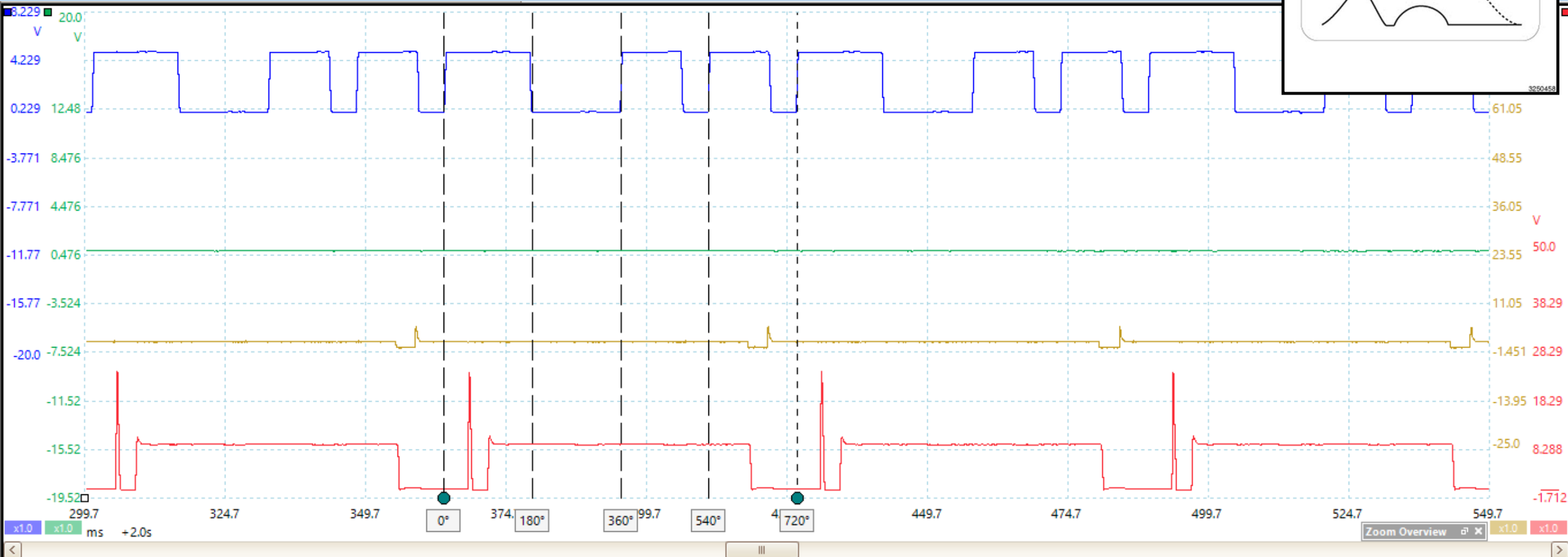
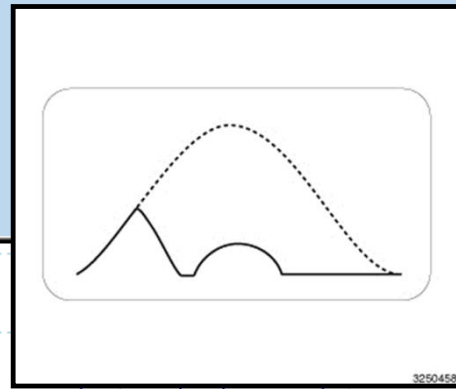
Notes

Experiment 1B

Blue - Camshaft Signal
Red - MultiAir Solenoid 1 Return
Green - Throttle Position Signal 1
Yellow - Injector 1

Stopped Trigger Measurements Rulers Notes Channel Labels

1C – “Control” at Low Throttle Run Up



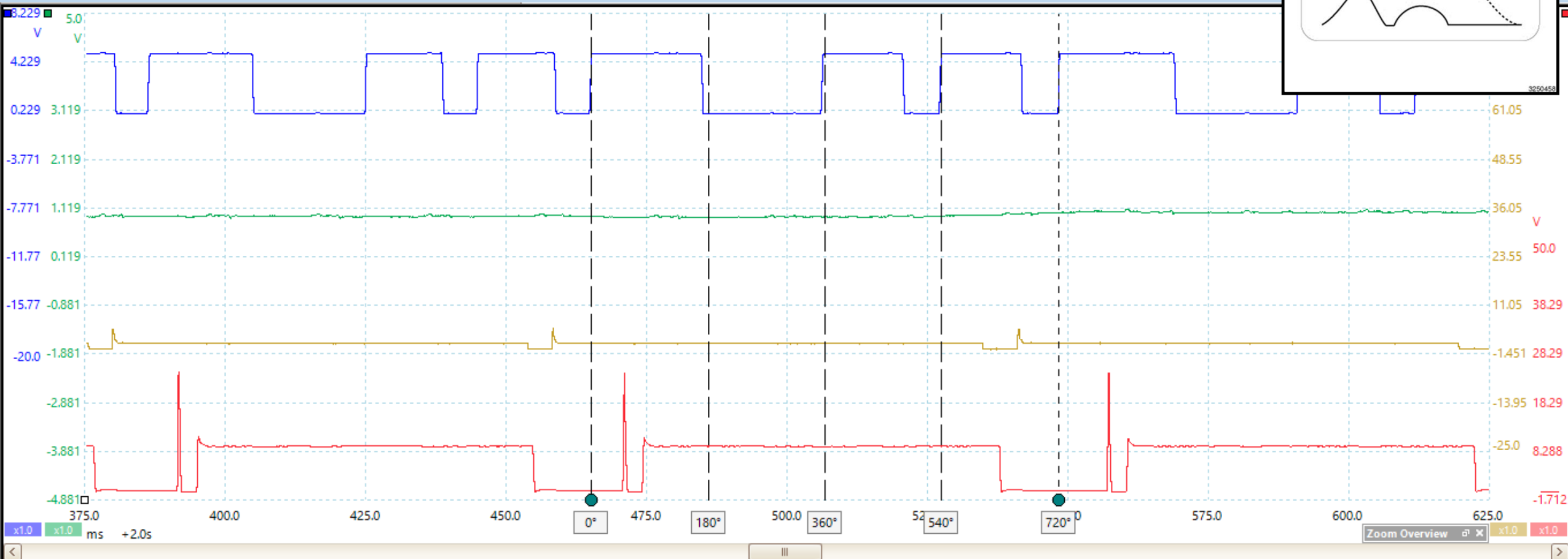
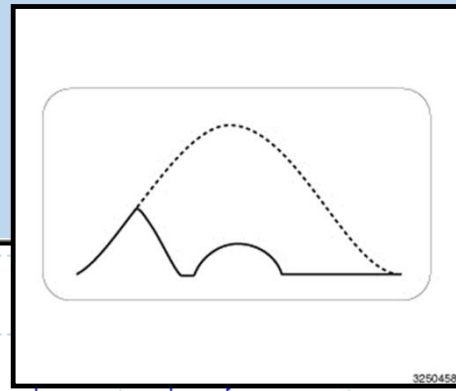
Notes

Experiment 1C

Blue - Camshaft Signal
Red - MultiAir Solenoid 1 Return
Green - Throttle Position Signal 1
Yellow - Injector 1

Stopped Trigger Measurements Rulers Notes Channel Labels

1D – Baseline at Mid Throttle Run Up



Notes

Experiment 1D

Blue - Camshaft Signal
Red - MultiAir Solenoid 1 Return
Green - Throttle Position Signal 1
Yellow - Injector 1

Stopped Trigger Measurements Rulers Notes Channel Labels

Experiment 1E

Red - MultiAir Solenoid 1 Return

Green - Throttle Position Signal 1
Yellow - Injector 1















Stopped Trigger Measurements Rulers Notes Channel Labels







Trigger Measurements Rulers Notes Channel Labels




Measurements Rulers Notes Channel Labels





Measurements Rulers Notes Channel Labels

Measurements    Rulers  Notes  Channel Labels 

Measurements    Rulers  Notes  Channel Labels 

Measurements    Rulers  Notes  Channel Labels 

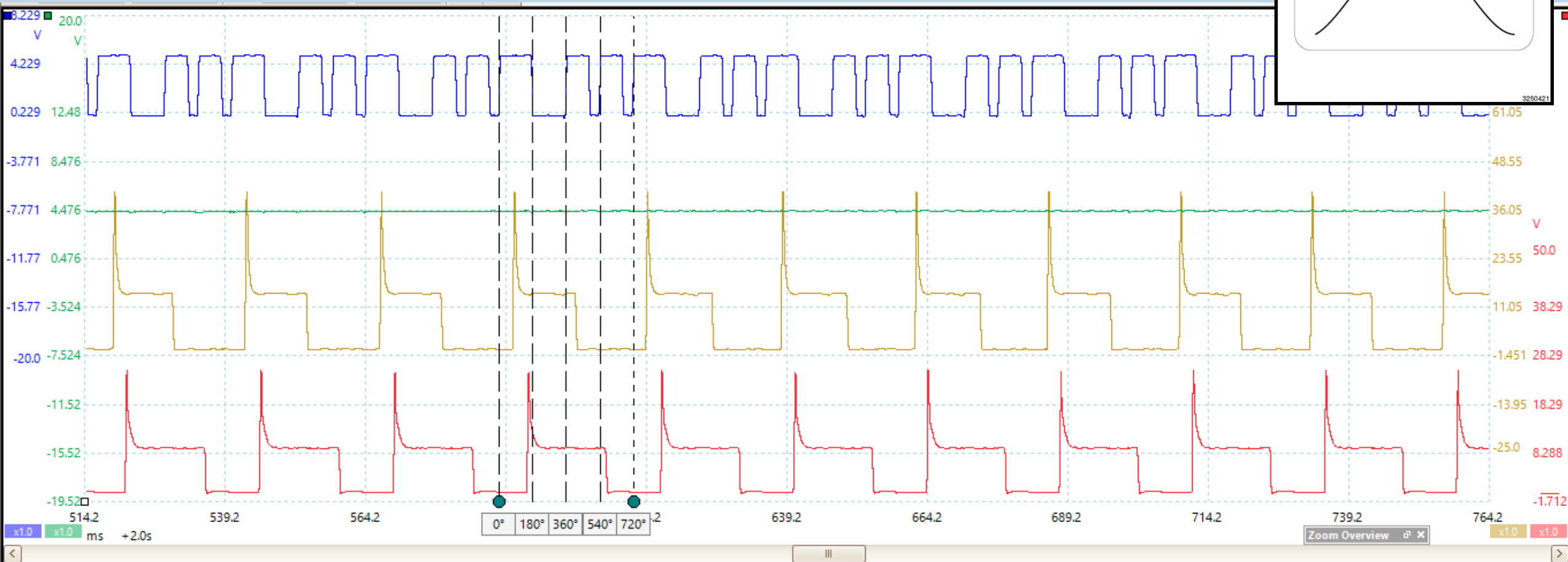
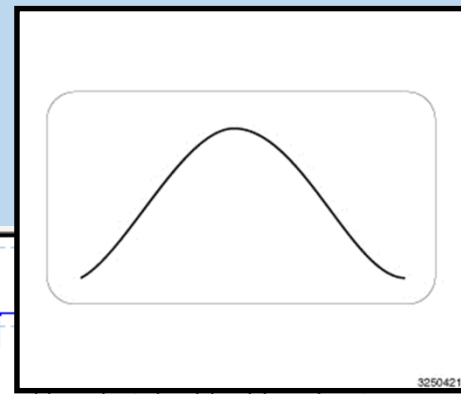
Measurements    Rulers  Notes  Channel Labels 

   Rulers  Notes  Channel Labels 

Rulers  Notes  Channel Labels 

 Channel Labels

2E – Clogged Air Filter at Max Throttle



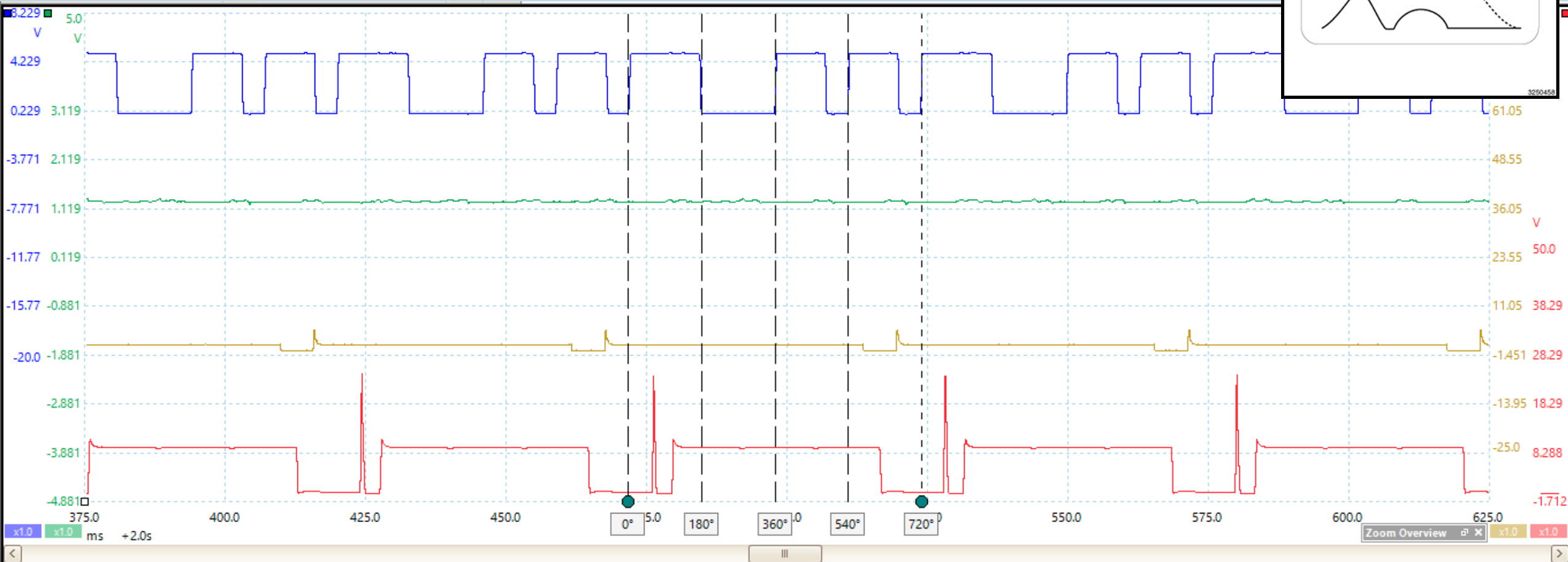
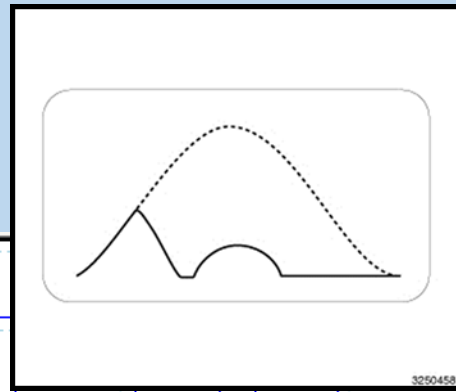
Notes

Experiment 2E

Blue - Camshaft Signal
Red - MultiAir Solenoid 1 Return
Green - Throttle Position Signal 1
Yellow - Injector 1

Stopped Trigger Measurements Rulers Notes Channel Labels

1F "Control" at Cruising-Highway Speed



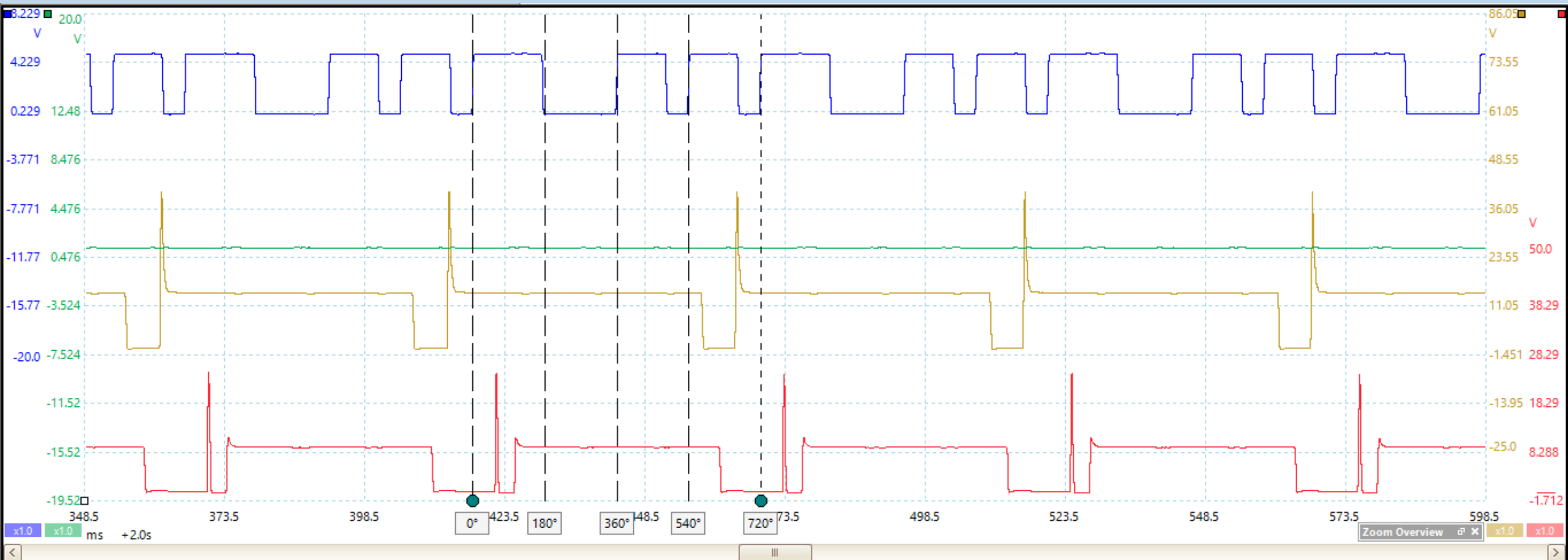
Notes

Experiment 1F

Blue - Camshaft Signal
Red - MultiAir Solenoid 1 Return
Green - Throttle Position Signal 1
Yellow - Injector 1

Stopped Trigger Measurements Rulers Notes Channel Labels

2F – Clogged Air Filter at Cruising-Highway



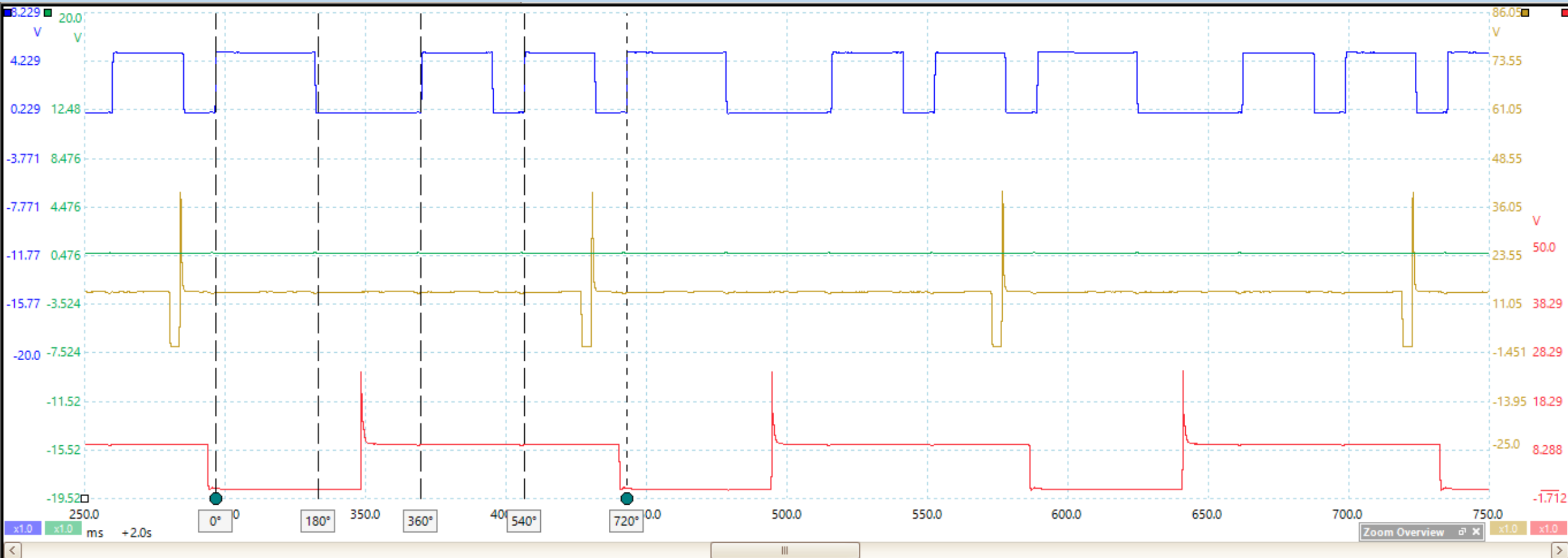
Notes

Experiment 2F

Blue - Camshaft Signal
Red - MultiAir Solenoid 1 Return
Green - Throttle Position Signal 1
Yellow - Injector 1

Stopped Trigger Measurements Rulers Notes Channel Labels

3A – Thicker Oil at Idle-Park



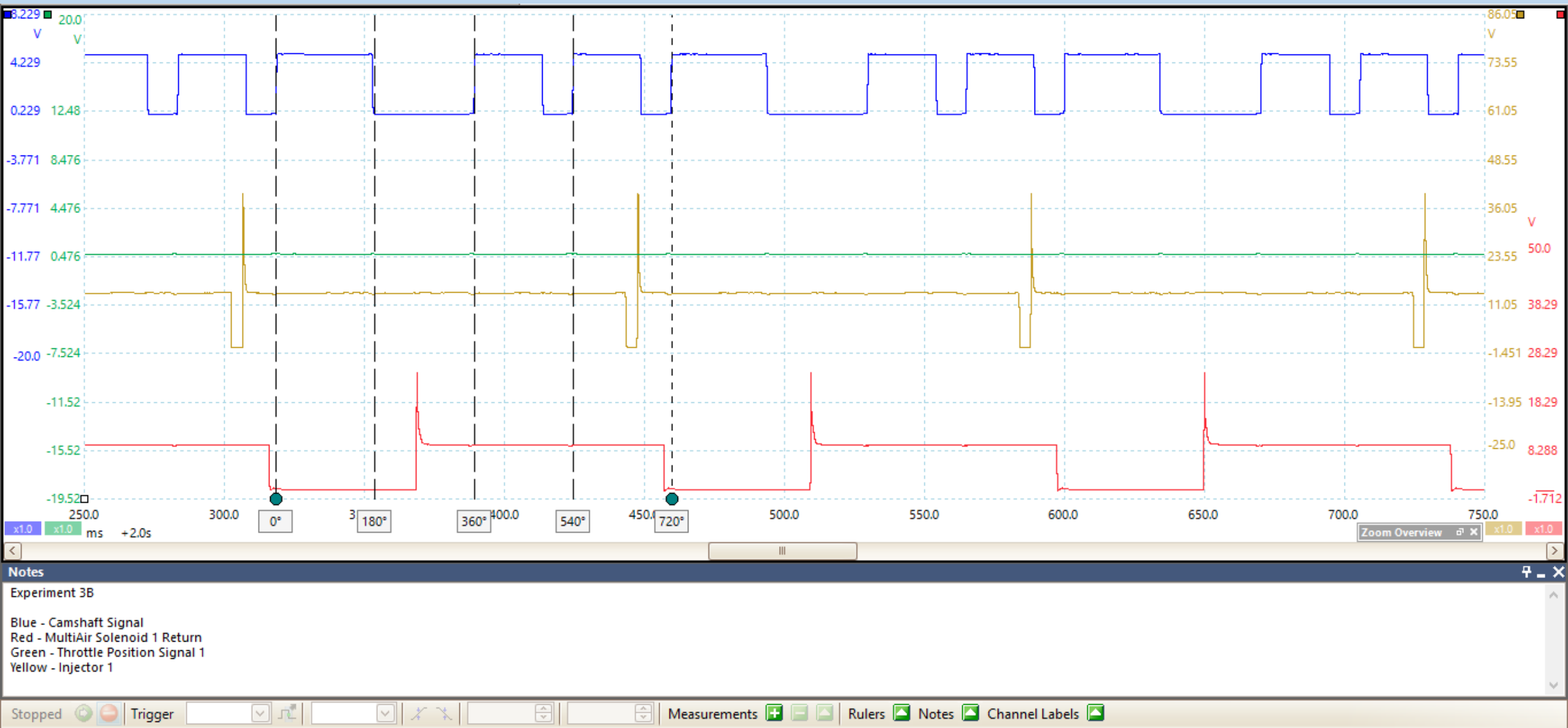
Notes

Experiment 3A

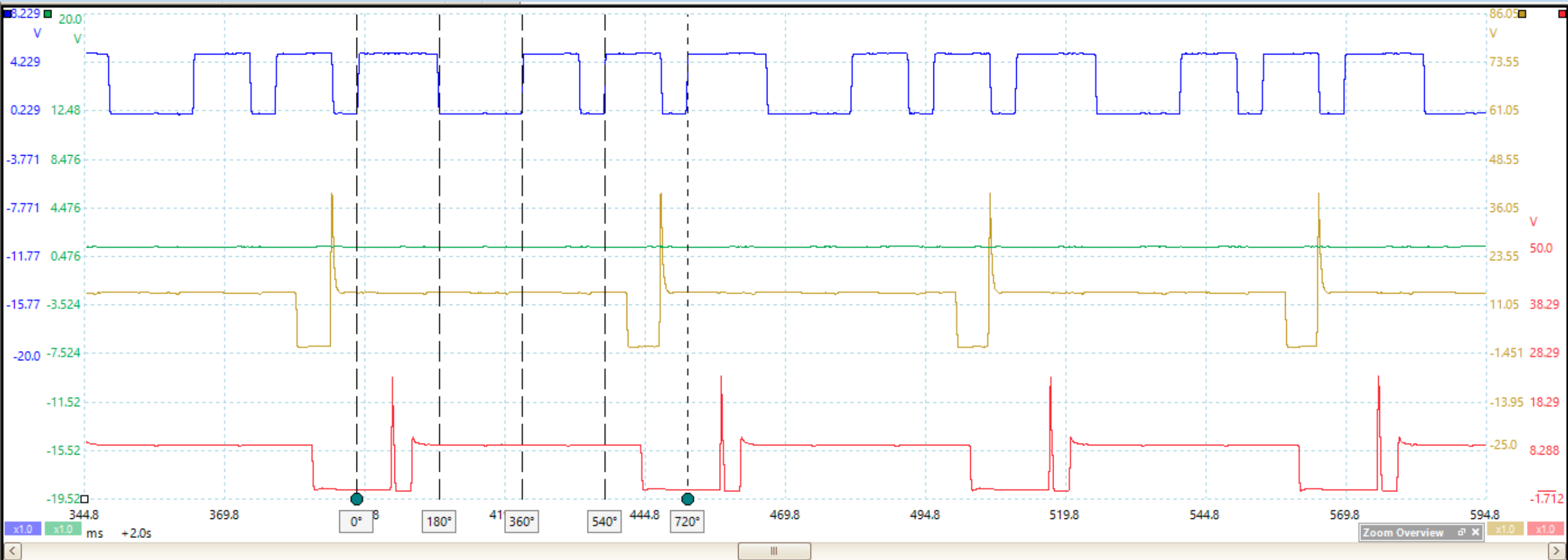
Blue - Camshaft Signal
Red - MultiAir Solenoid 1 Return
Green - Throttle Position Signal 1
Yellow - Injector 1

Stopped Trigger Measurements Rulers Notes Channel Labels

3B – Thicker Oil at Idle-Crawl Speed



3C – Thicker Oil at Low Throttle Run Up



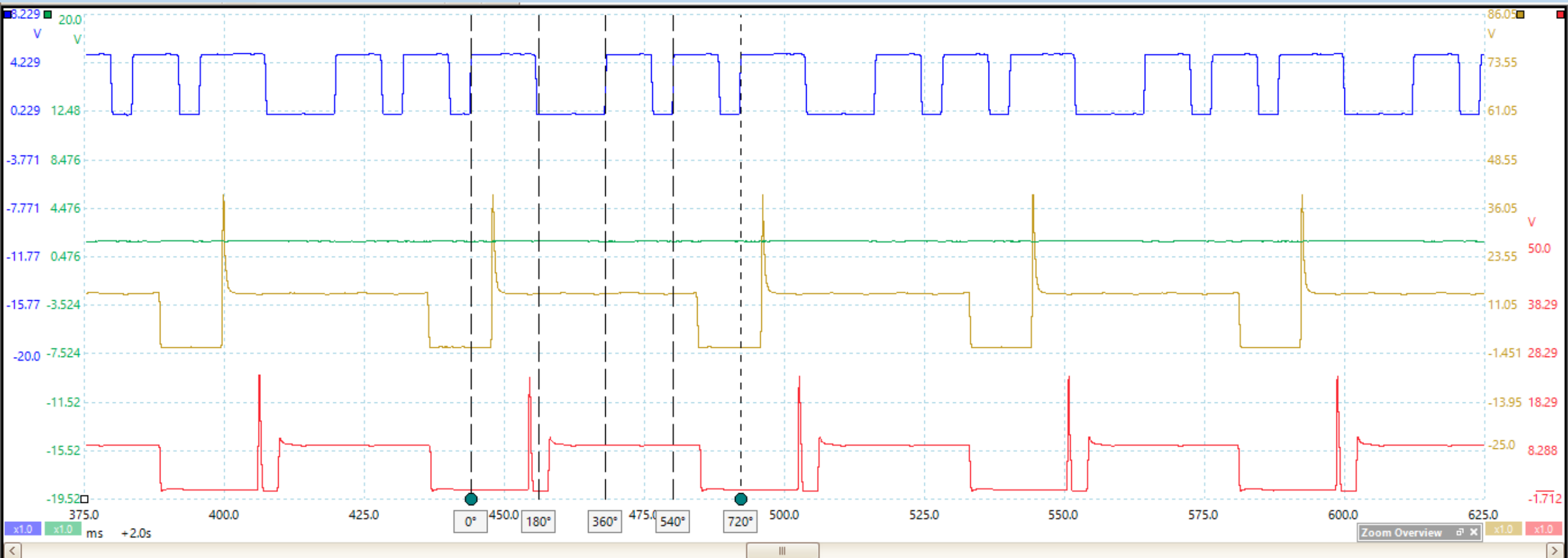
Notes

Experiment 3C

Blue - Camshaft Signal
Red - MultiAir Solenoid 1 Return
Green - Throttle Position Signal 1
Yellow - Injector 1

Stopped Trigger Measurements Rulers Notes Channel Labels

3D – Thicker Oil at Mid Throttle Run Up



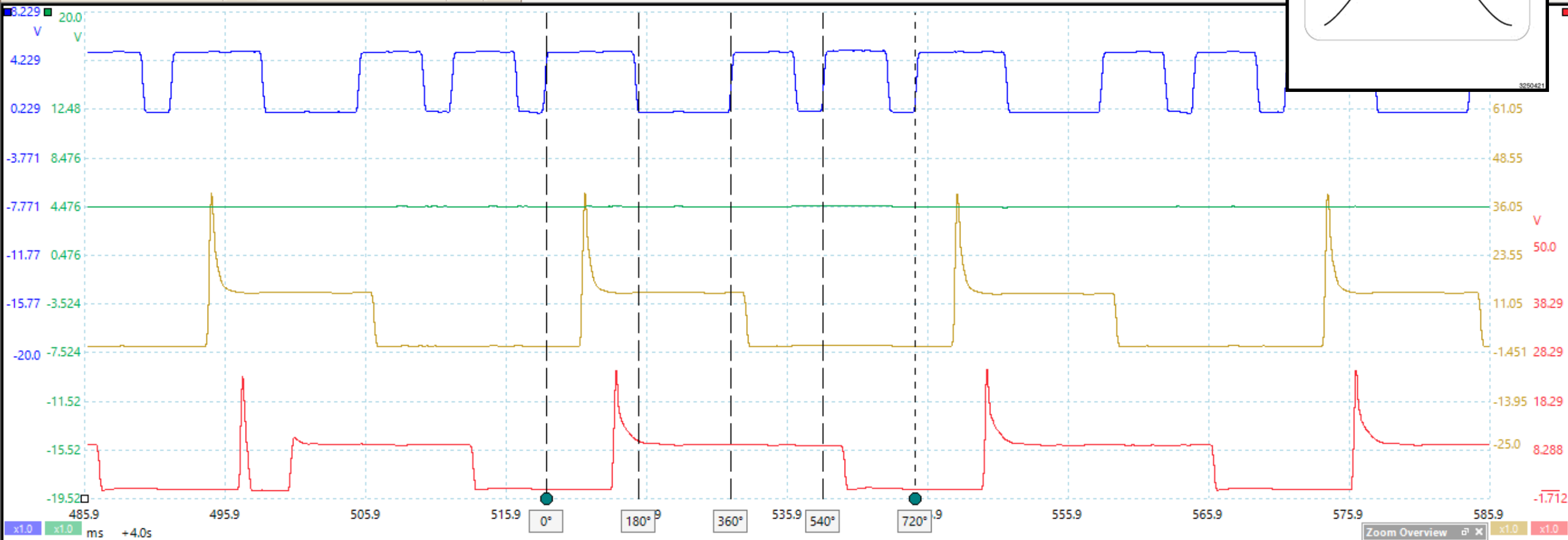
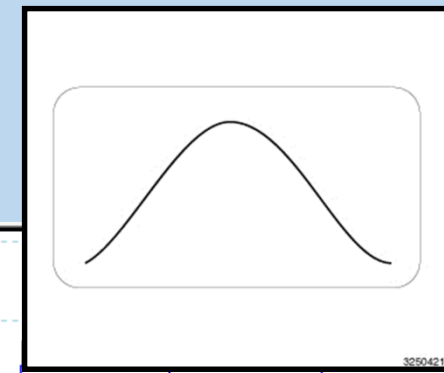
Notes

Experiment 3D

Blue - Camshaft Signal
Red - MultiAir Solenoid 1 Return
Green - Throttle Position Signal 1
Yellow - Injector 1

Stopped Trigger Measurements Rulers Notes Channel Labels

3E – Thicker Oil at Max Throttle Run Up

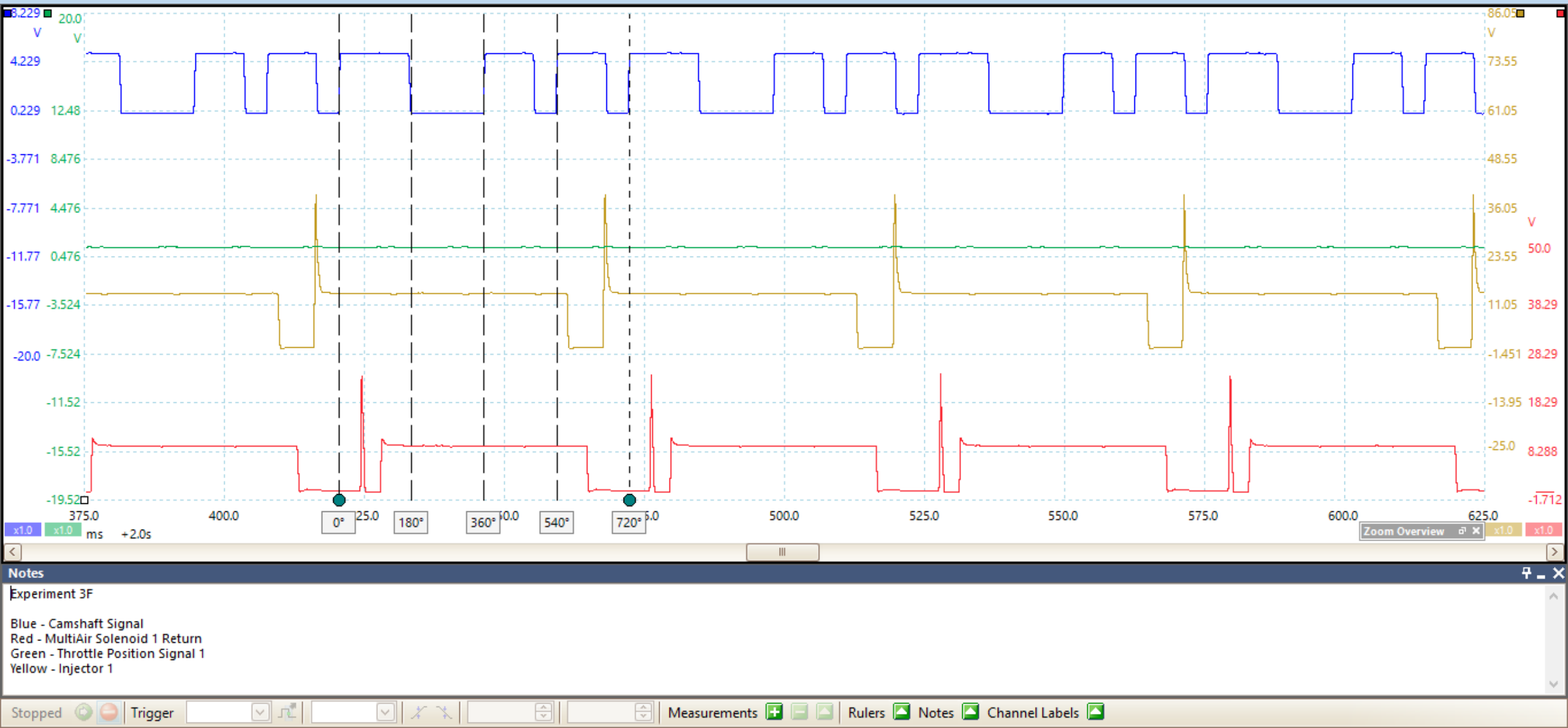


Notes

Experiment 3E

Blue - Camshaft Signal
Red - MultiAir Solenoid 1 Return
Green - Throttle Position Signal 1
Yellow - Injector 1

3F – Thicker Oil at Cruising-Highway Speed





6 Multiair variable valve timing system is modular and can be retro fitted to existing engines as well as new ones. Works on petrol and diesel

3

Electronic solenoid opens bleed valve in chamber, releasing oil pressure to alter inlet valve timing and lift

2

Inlet cam acts on roller rocker which in turn open inlet valves through oil filled pump

4

Oil filled chamber connected to hydraulic valve actuators which lift the valves

1

Exhaust cam acts directly on exhaust valves so exhaust timing and lift is fixed

5

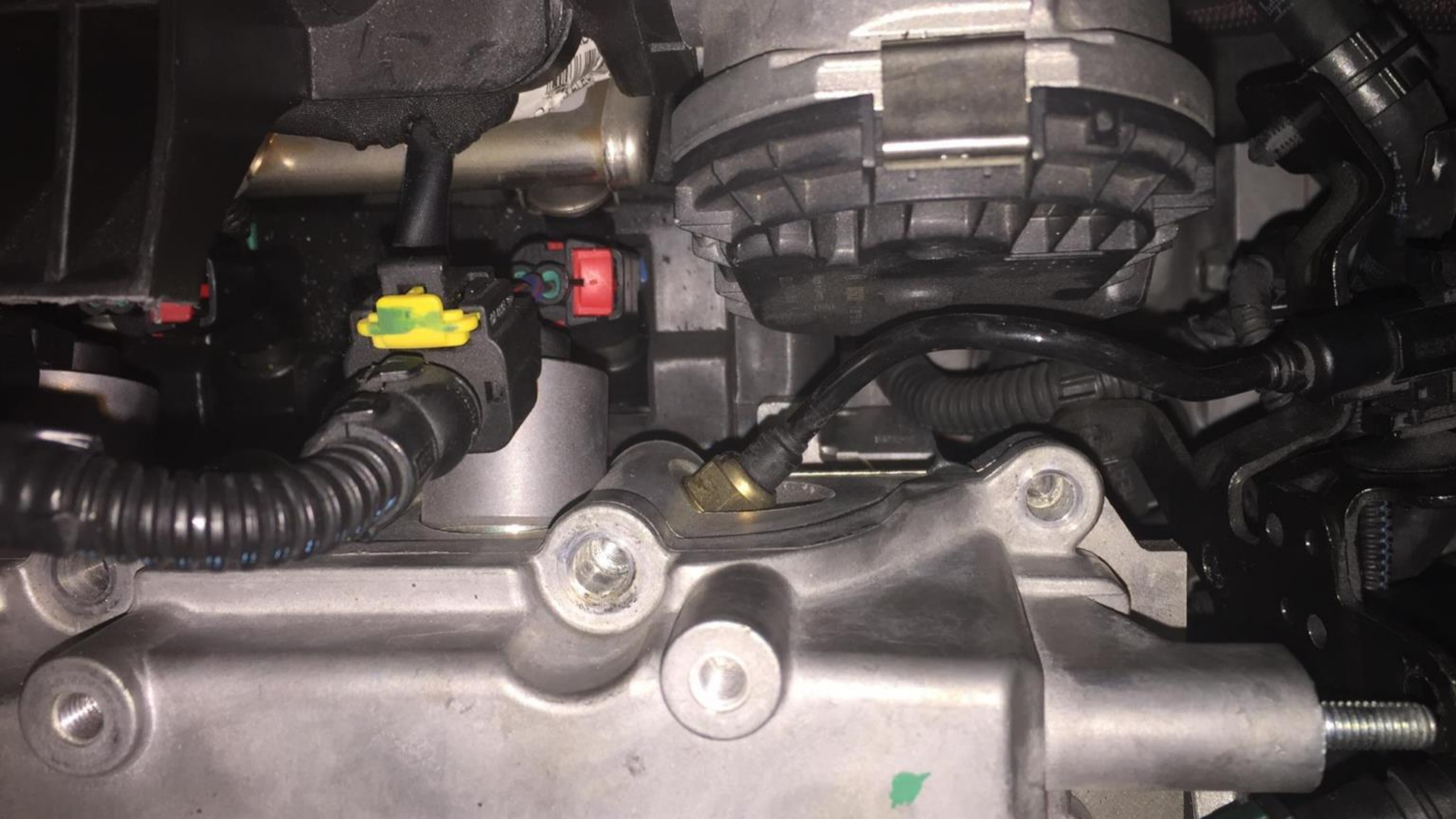
Inlet valves have variable valve timing and lift. Valve springs are omitted for clarity



“Brick” Exposed











valve actuation but the camshaft is in the standard position of an exhaust camshaft in a Double Over Head Camshaft (DOHC) engine. The camshaft has five bearing journal surfaces and three cam lobes per cylinder. The camshaft is built up on a hollow tube with cam lobes, bearing journals and end caps pressed into position. The front end cap includes the camshaft sprocket mounting and front bearing journal with end play thrust walls. The rear end cap is the camshaft position sensor pick-up wheel and also drives the vacuum pump.

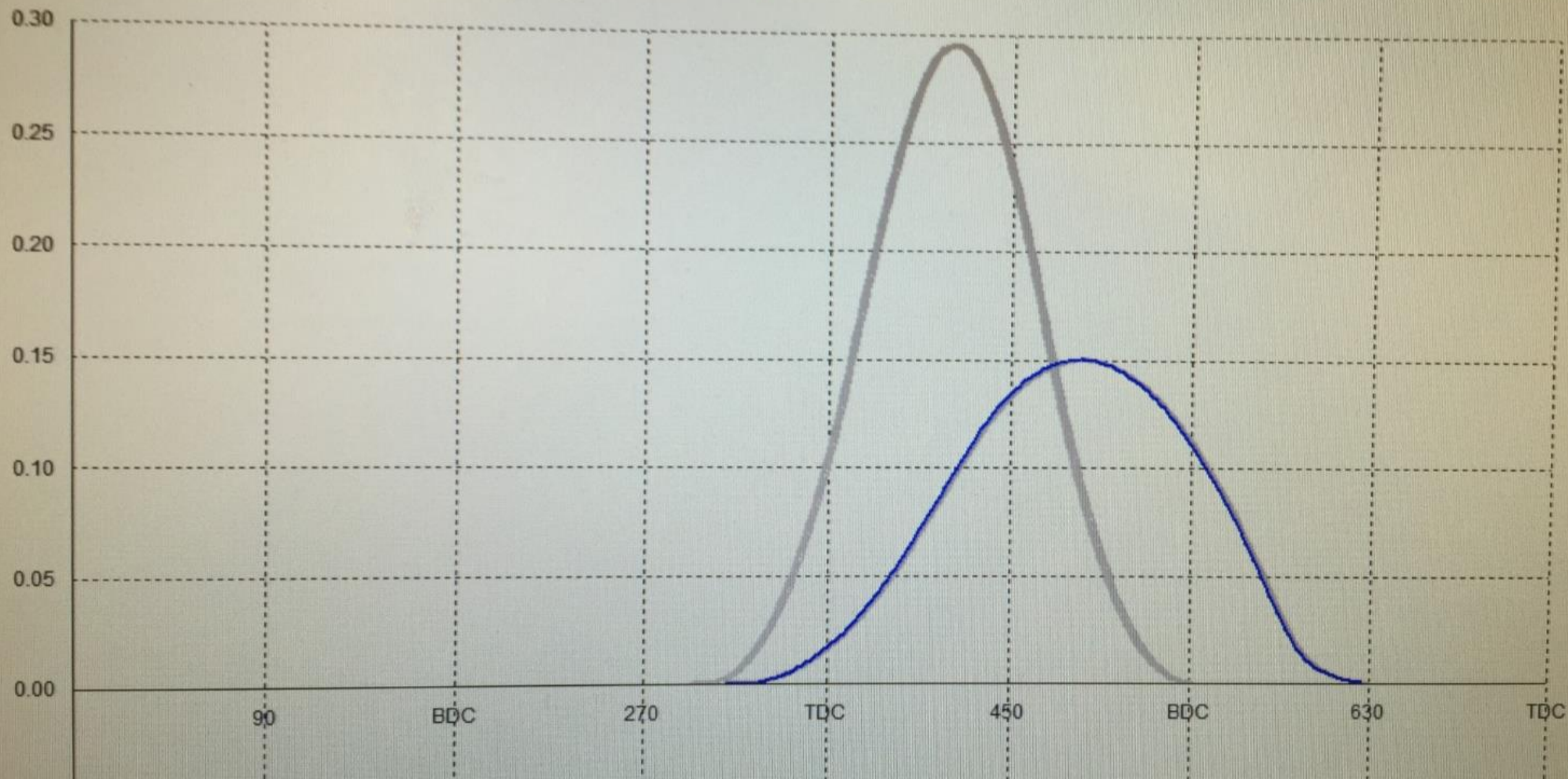
Camshaft specifications:

LOBE LIFT - Intake 3.81 mm 0.145 in. **LOBE LIFT** - Exhaust 7.5 mm 0.295 in.

VALVE TIMING - MULTIAIR PUMPING ELEMENTS Specification Opens 11° (BTDC) Closes 58° (ABDC) Duration 249° Centerline 125° Note: Units are in crank degrees.

VALVE TIMING - EXHAUST VALVES Specification Opens 34° (BBDC) Closes 2° (ATDC) Duration 216° Note: Units are in crank degrees.

Lift measured by Actual Follower



Dedications

- Special thanks go out to Dennis Moiceanu, our research assistant, whose efforts contributed substantially to this project.
- Thank you to FCA for the loan of the visual aides, special tools, and for access to technical publications. We hope to continue our cooperation on future projects.