2008

Lab Scopes and Pressure Transducer Diognastics

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Lab Scopes and Pressure Transducer Diagnostics

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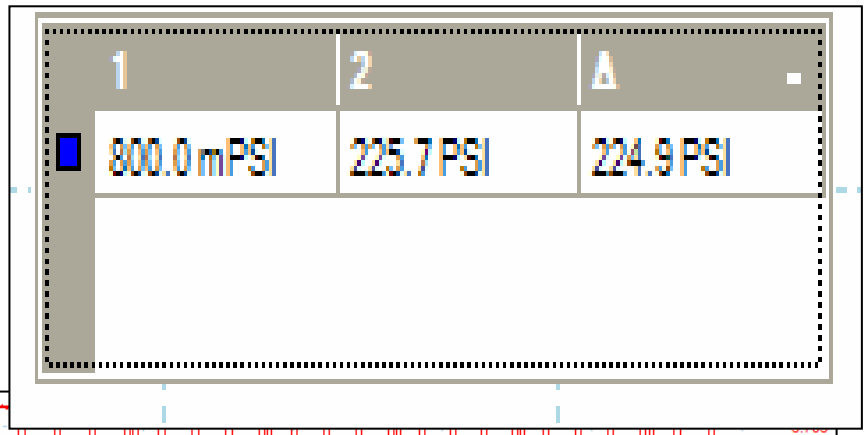
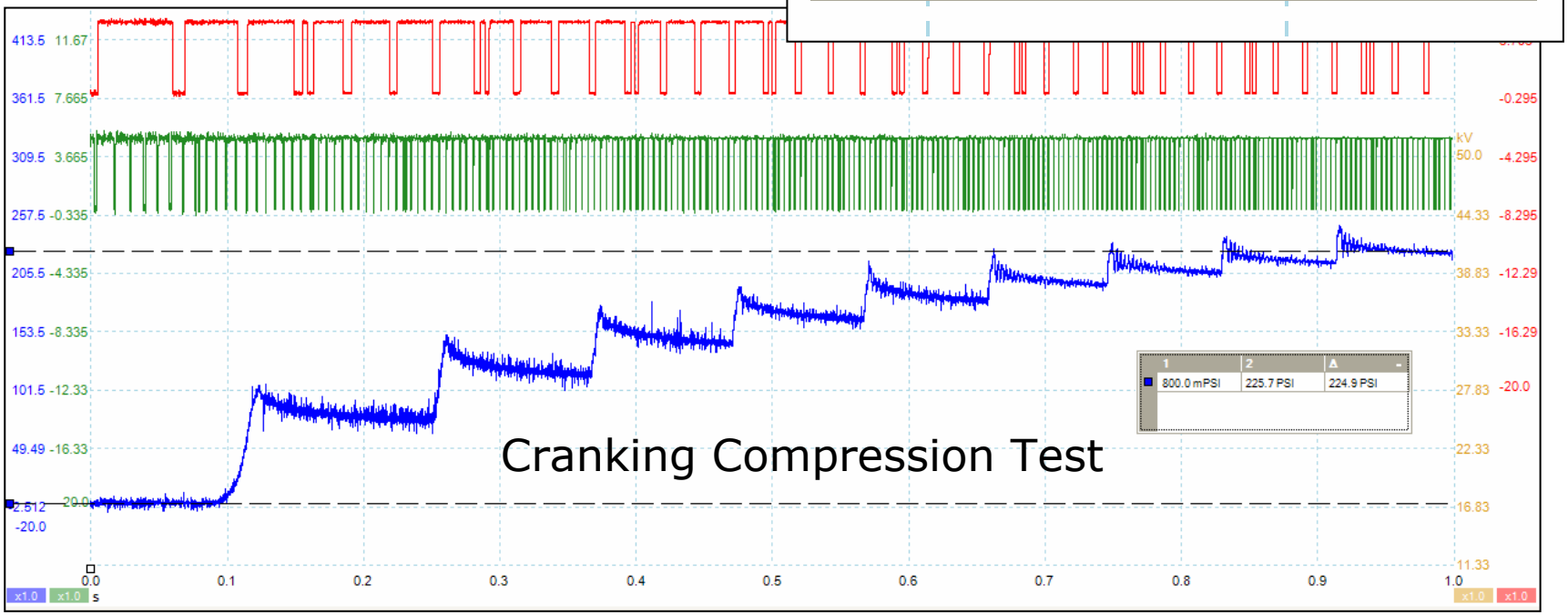
Southern Illinois University

Note: Hydraulic schematic illustrations are from Chrysler Corporation and GM Hydramatic

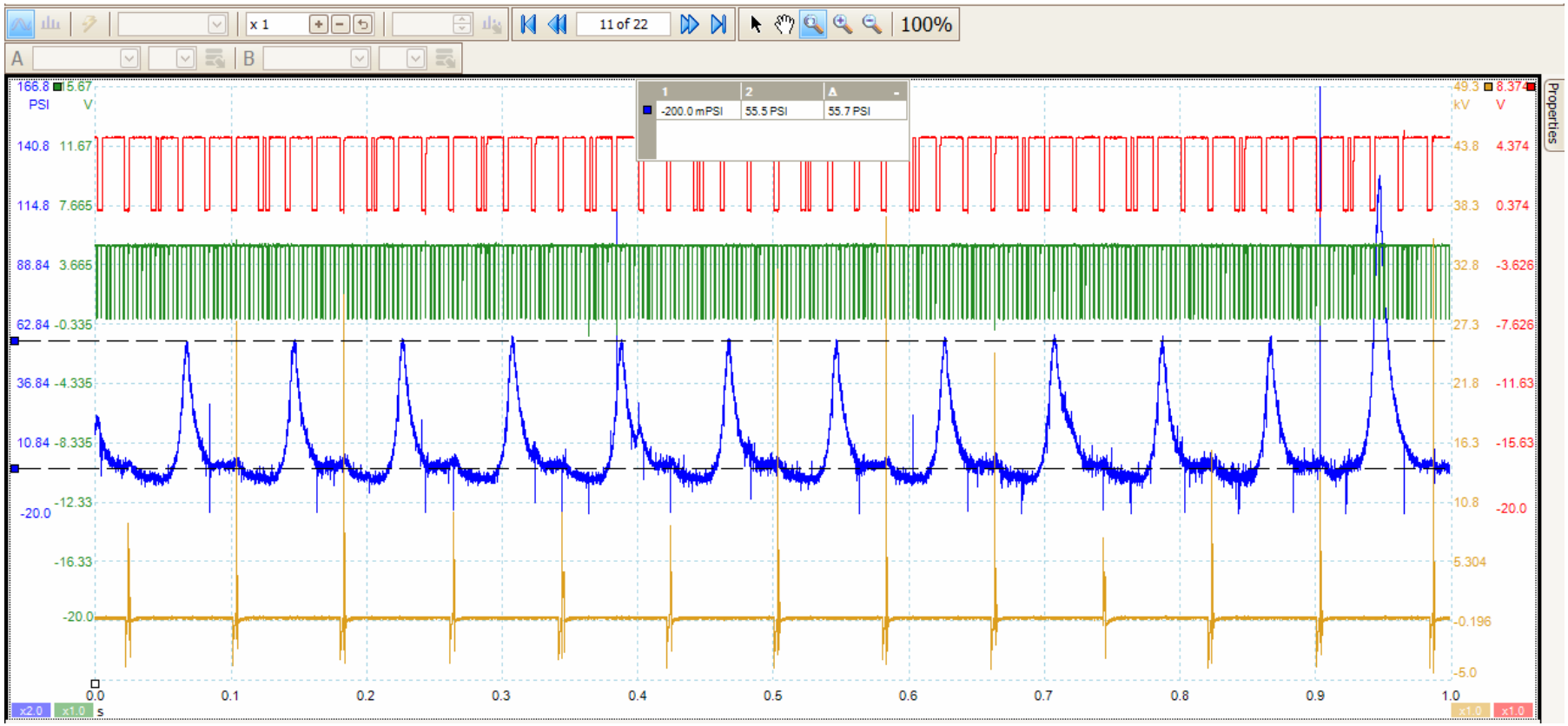
Engine Mechanical

- Four Stoke Cycle
  - Intake
  - Compression
  - Power
  - Exhaust



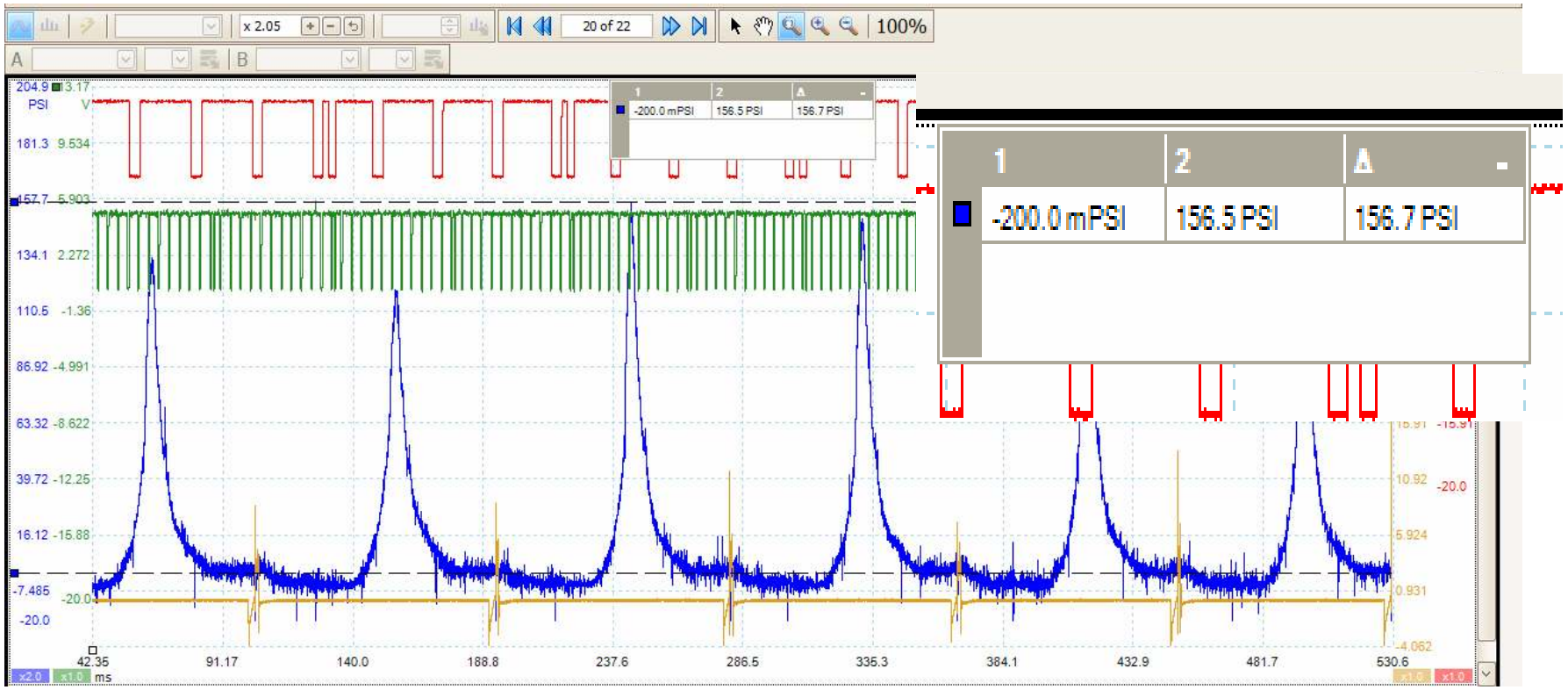


Engine Mechanical



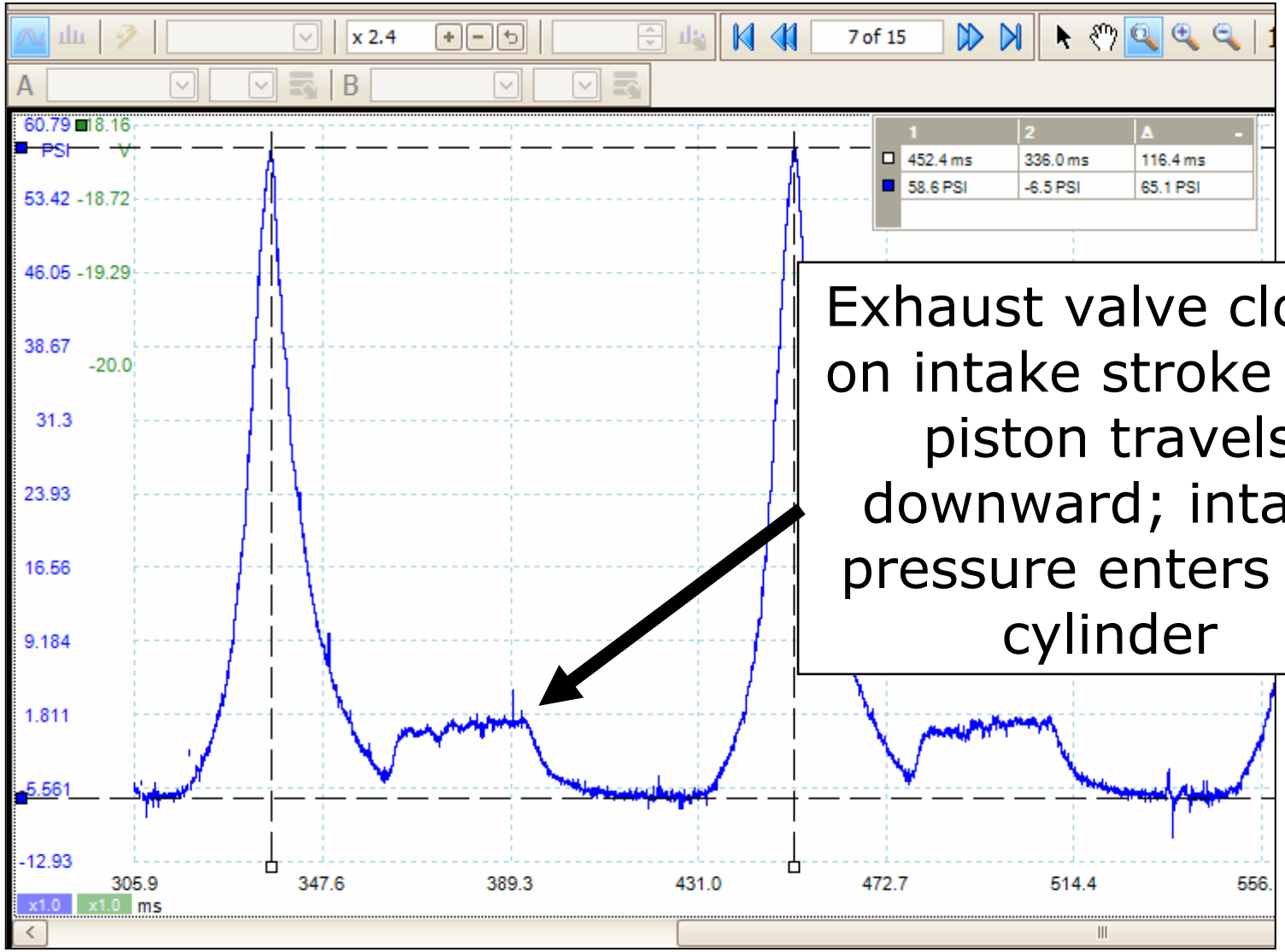
- Running (Dynamic) Compression Test
  - Less pressure than cranking compression due to engine speed and air restriction

Engine Mechanical



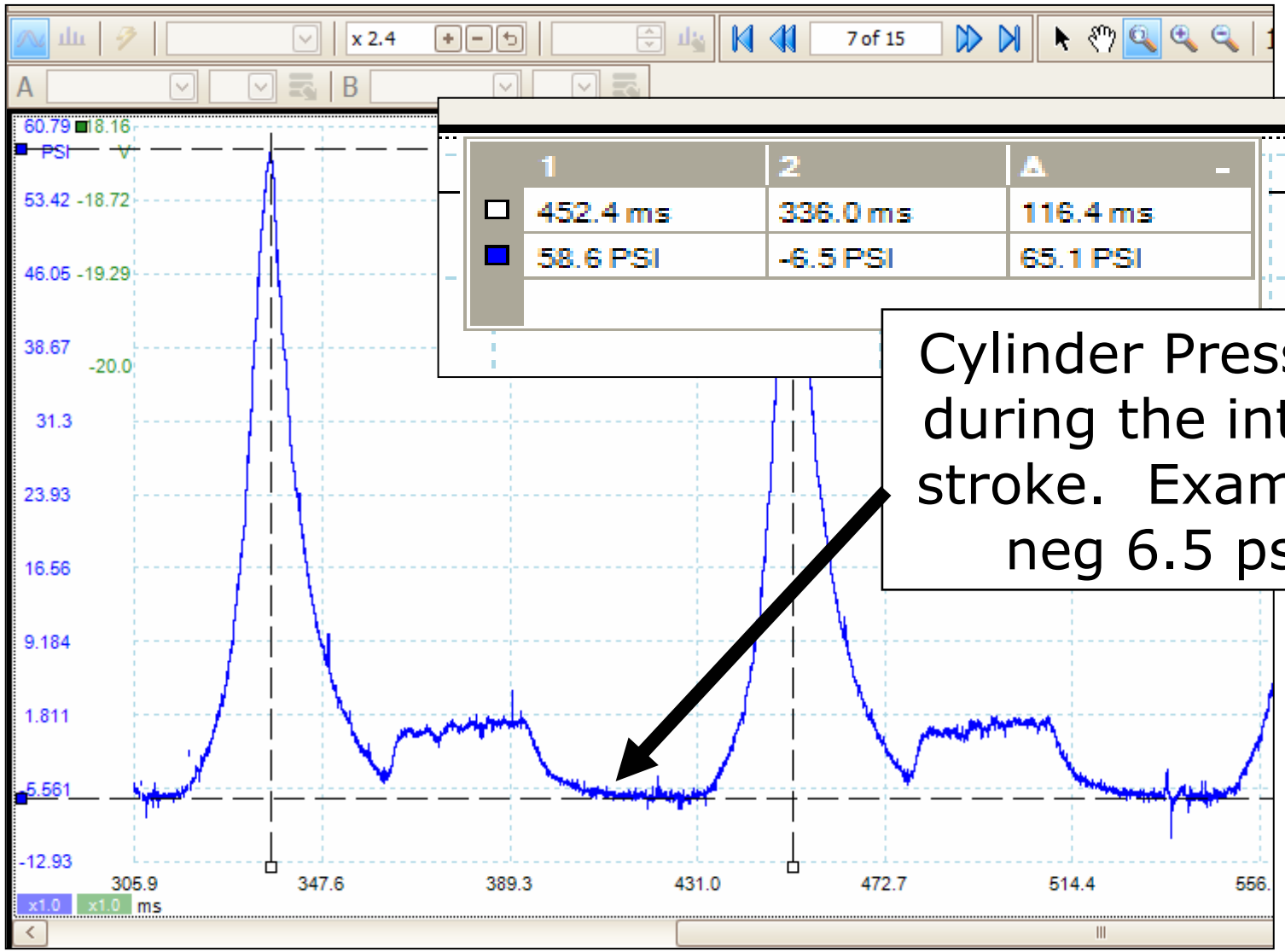
- Snap Throttle
  - Shows response to air entering and leaving the combustion chamber
  - The closest you'll ever get to cranking compression

Engine Mechanical: Four Strokes



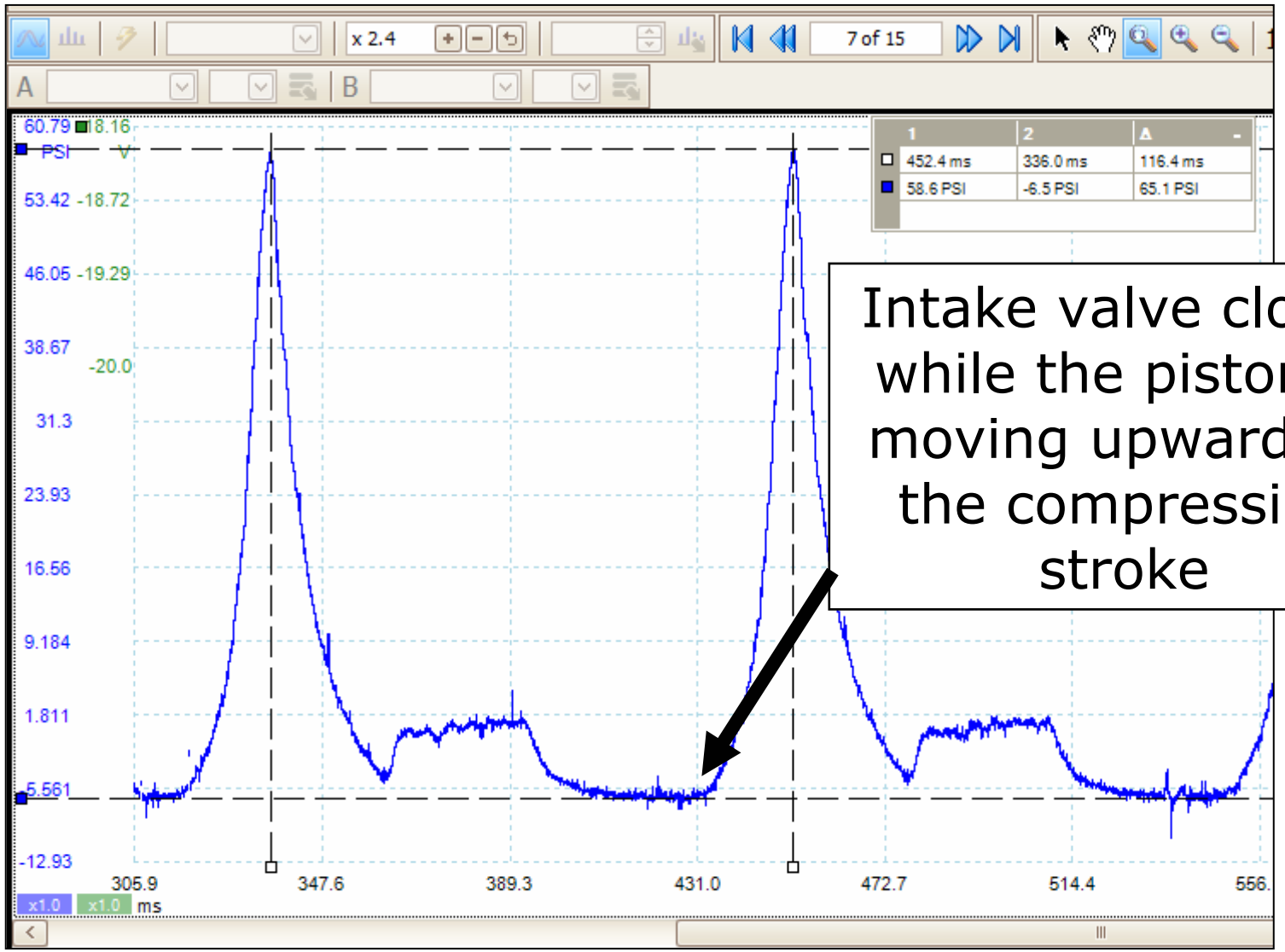
Exhaust valve closes on intake stroke and piston travels downward; intake pressure enters the cylinder

Engine Mechanical



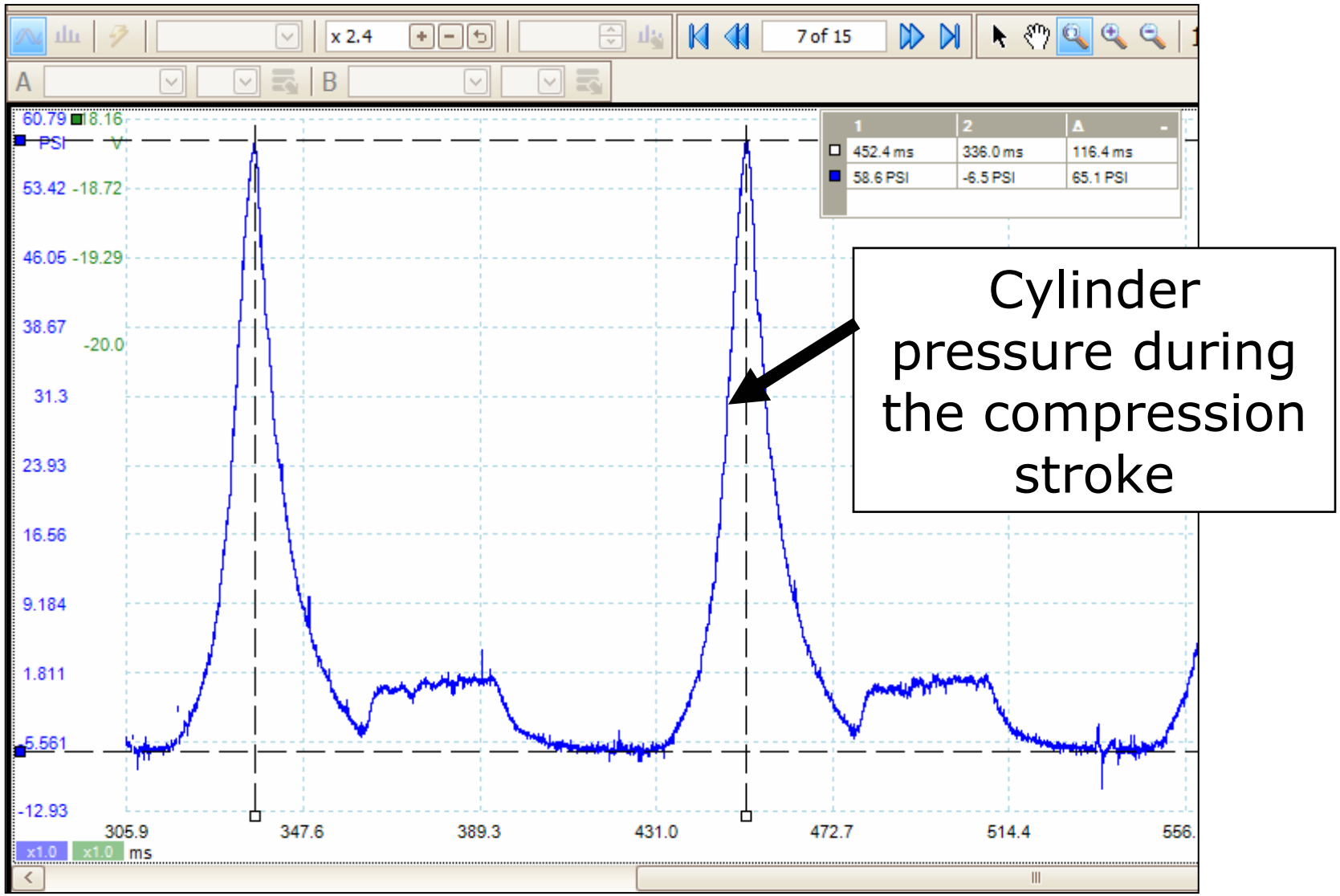
Cylinder Pressure during the intake stroke. Example, neg 6.5 psi

Engine Mechanical

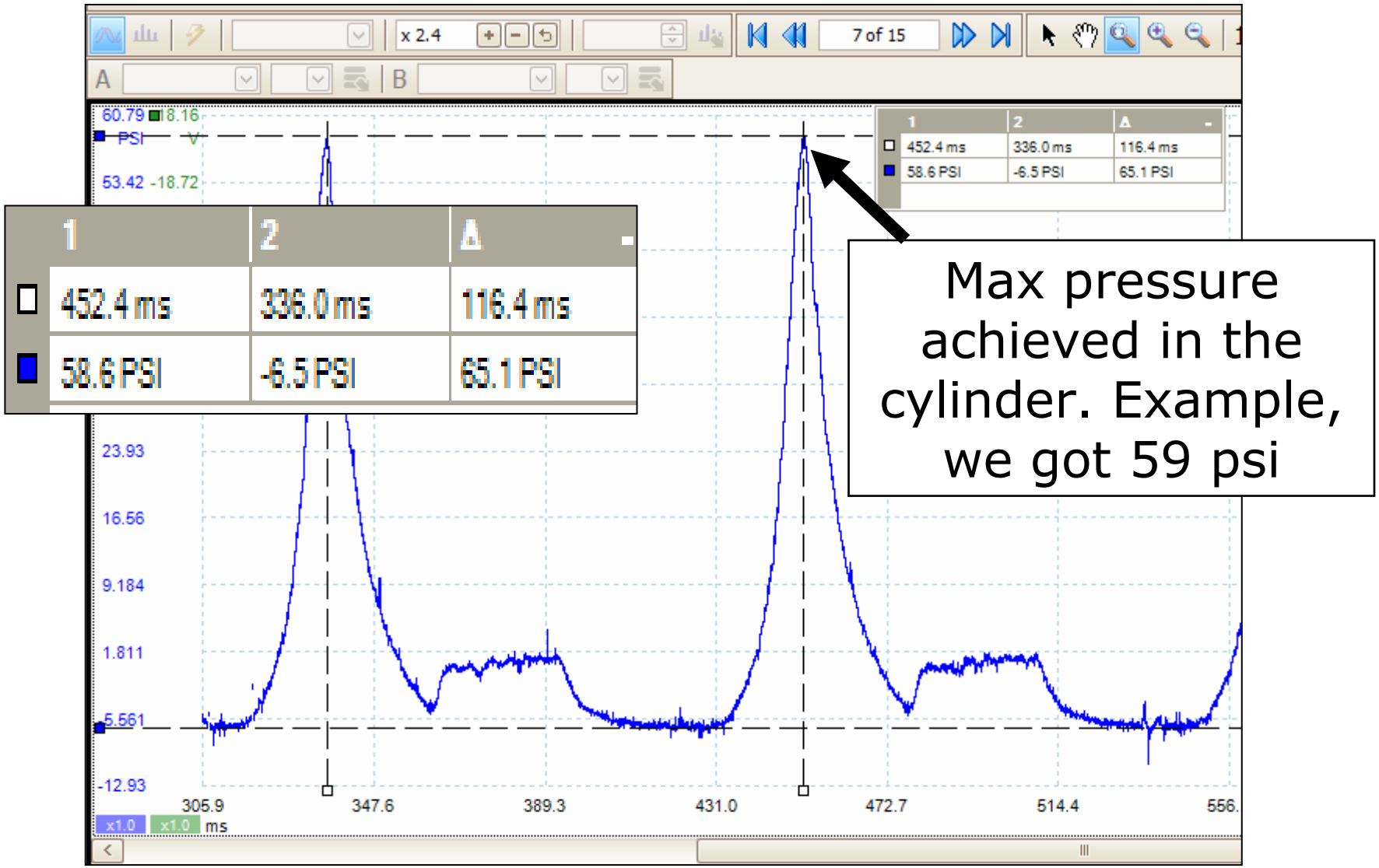


Intake valve closes while the piston is moving upward on the compression stroke

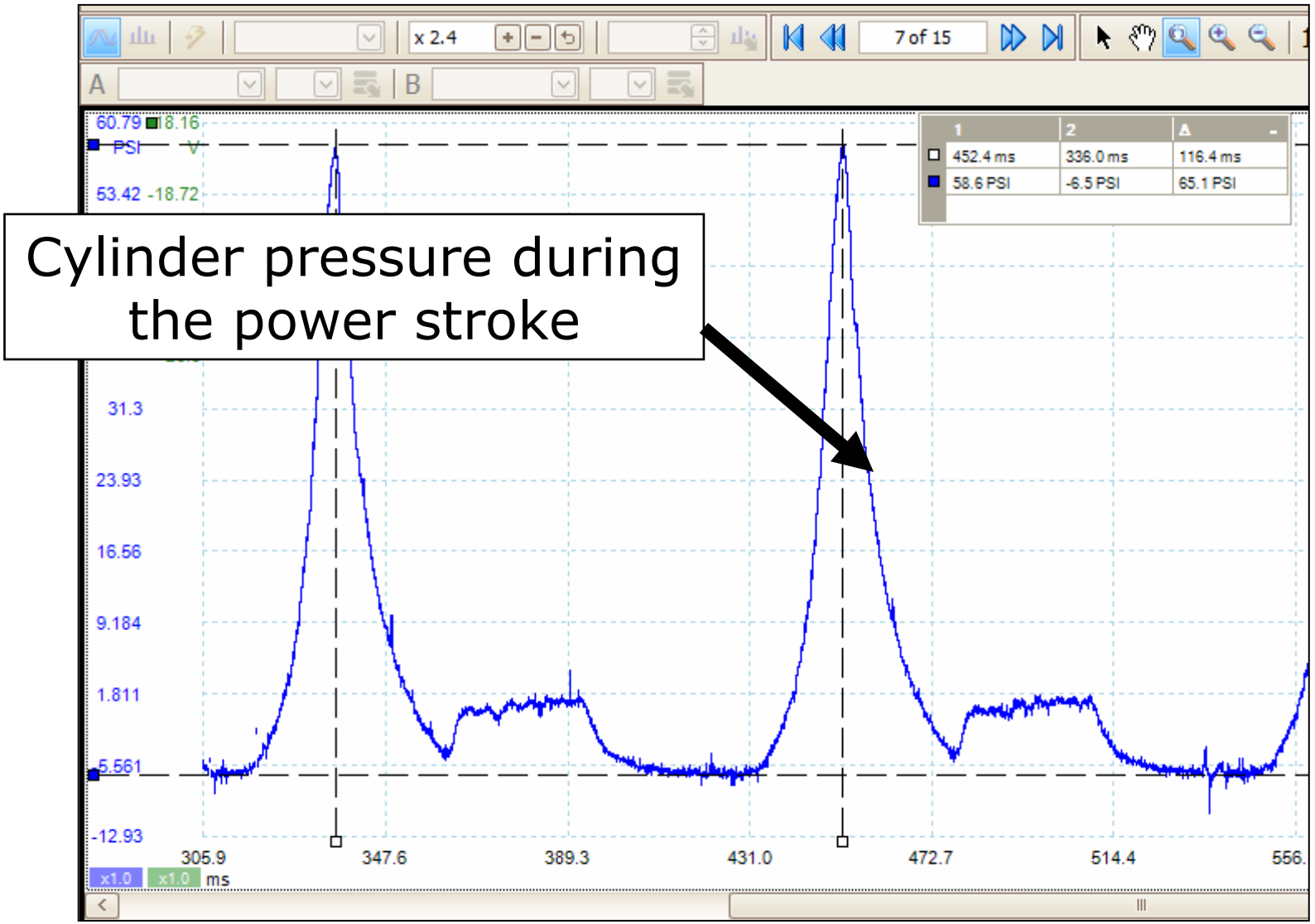
Engine Mechanical



Engine Mechanical

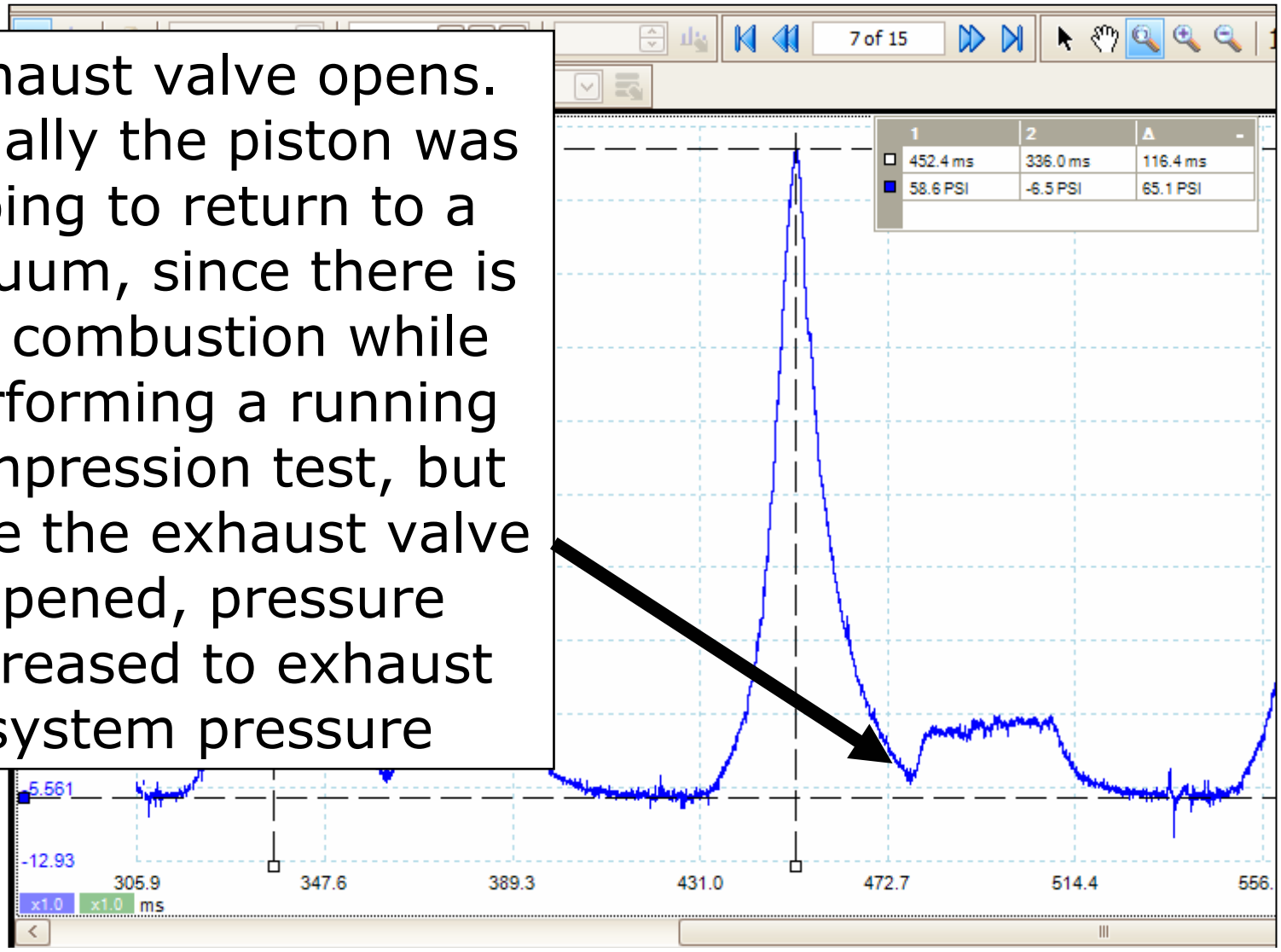


Engine Mechanical

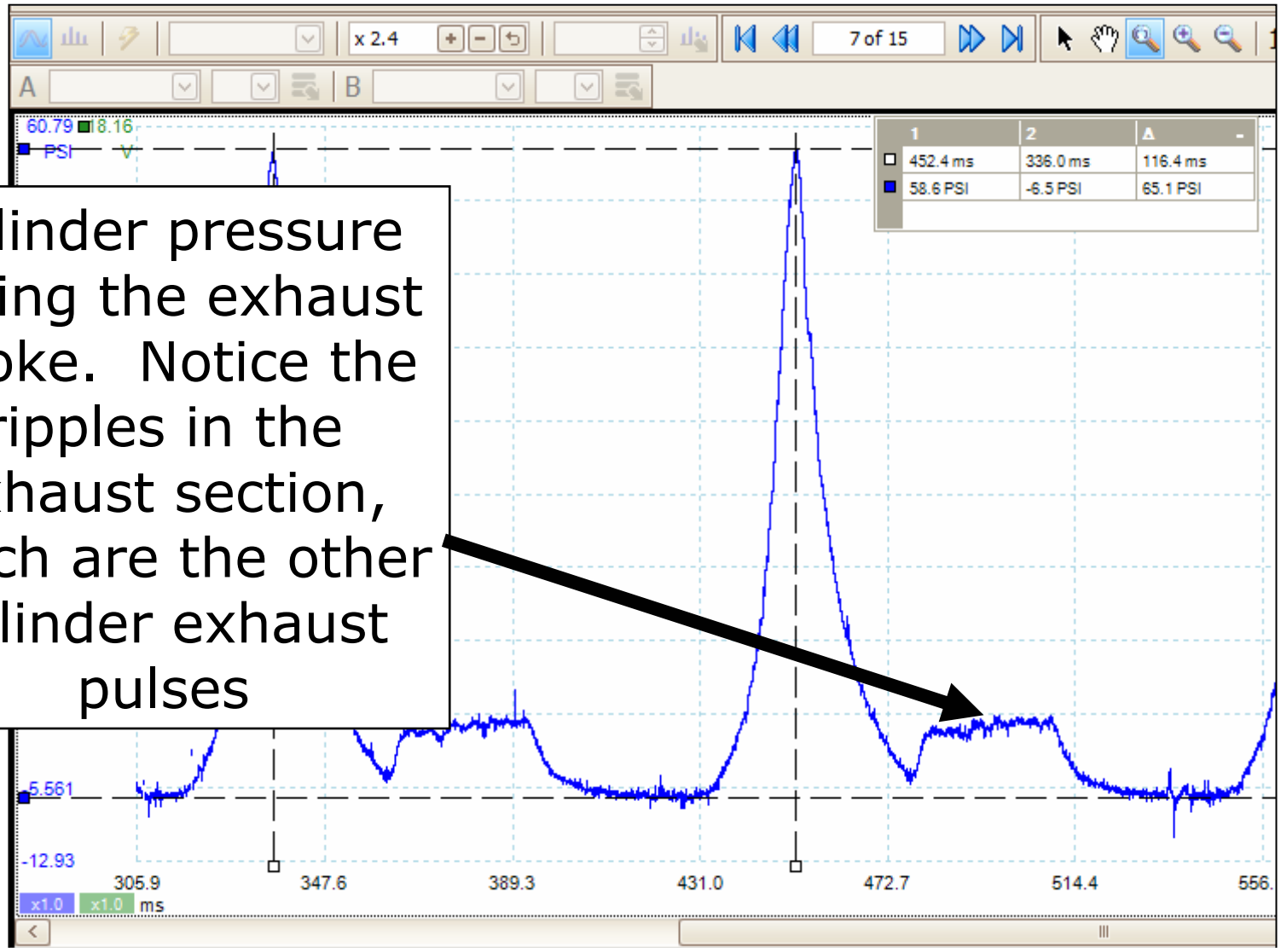


Engine Mechanical

Exhaust valve opens. Initially the piston was going to return to a vacuum, since there is no combustion while performing a running compression test, but since the exhaust valve opened, pressure increased to exhaust system pressure



Engine Mechanical



Cylinder pressure during the exhaust stroke. Notice the ripples in the exhaust section, which are the other cylinder exhaust pulses

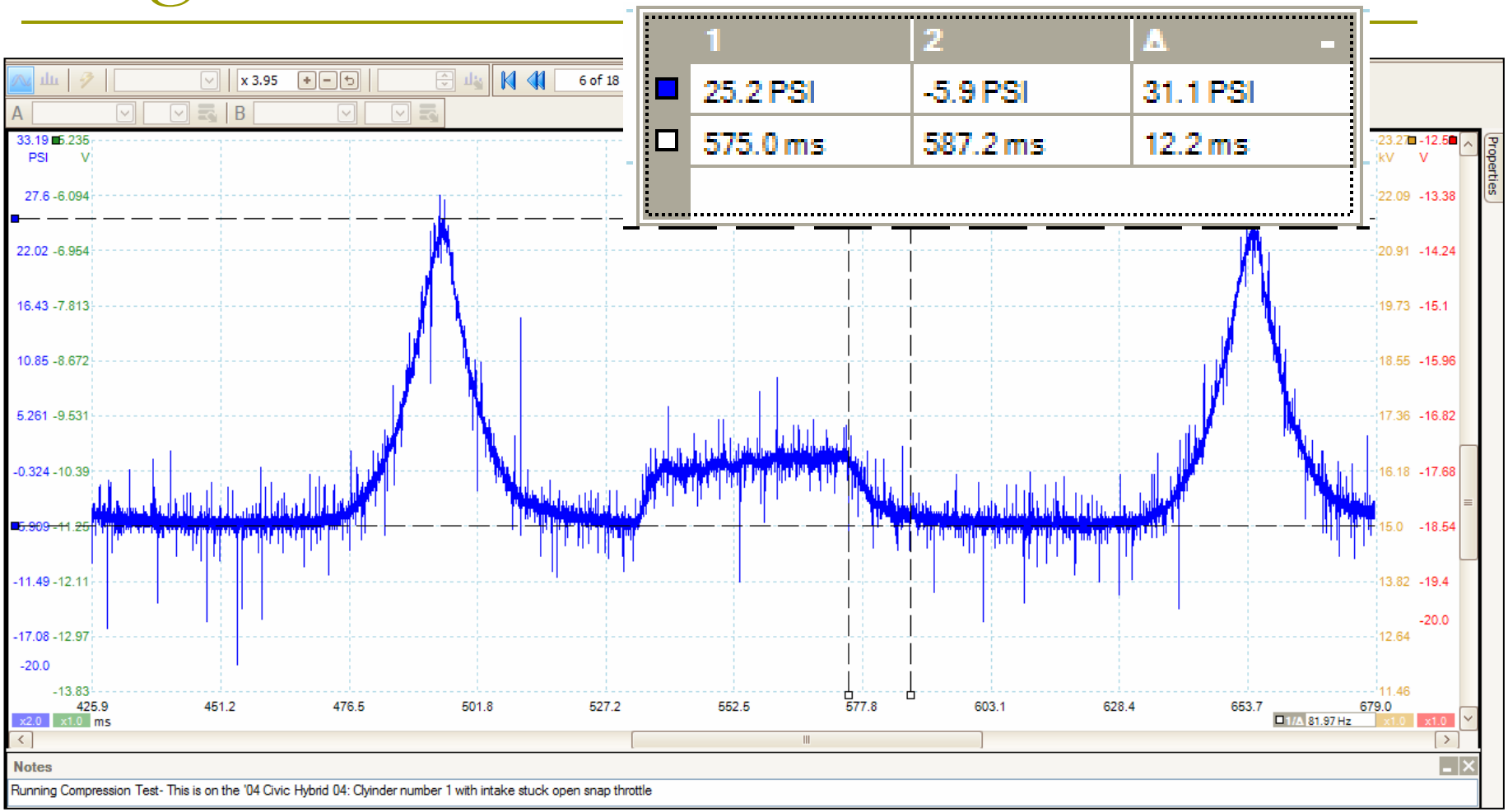
Engine Mechanical

- Why don’t we have real high compression numbers when the engine is running compared to when it cranking?
- Why doesn’t the “Snap Throttle” generate more than cranking on a properly running (naturally aspirated) engine?

Engine Mechanical

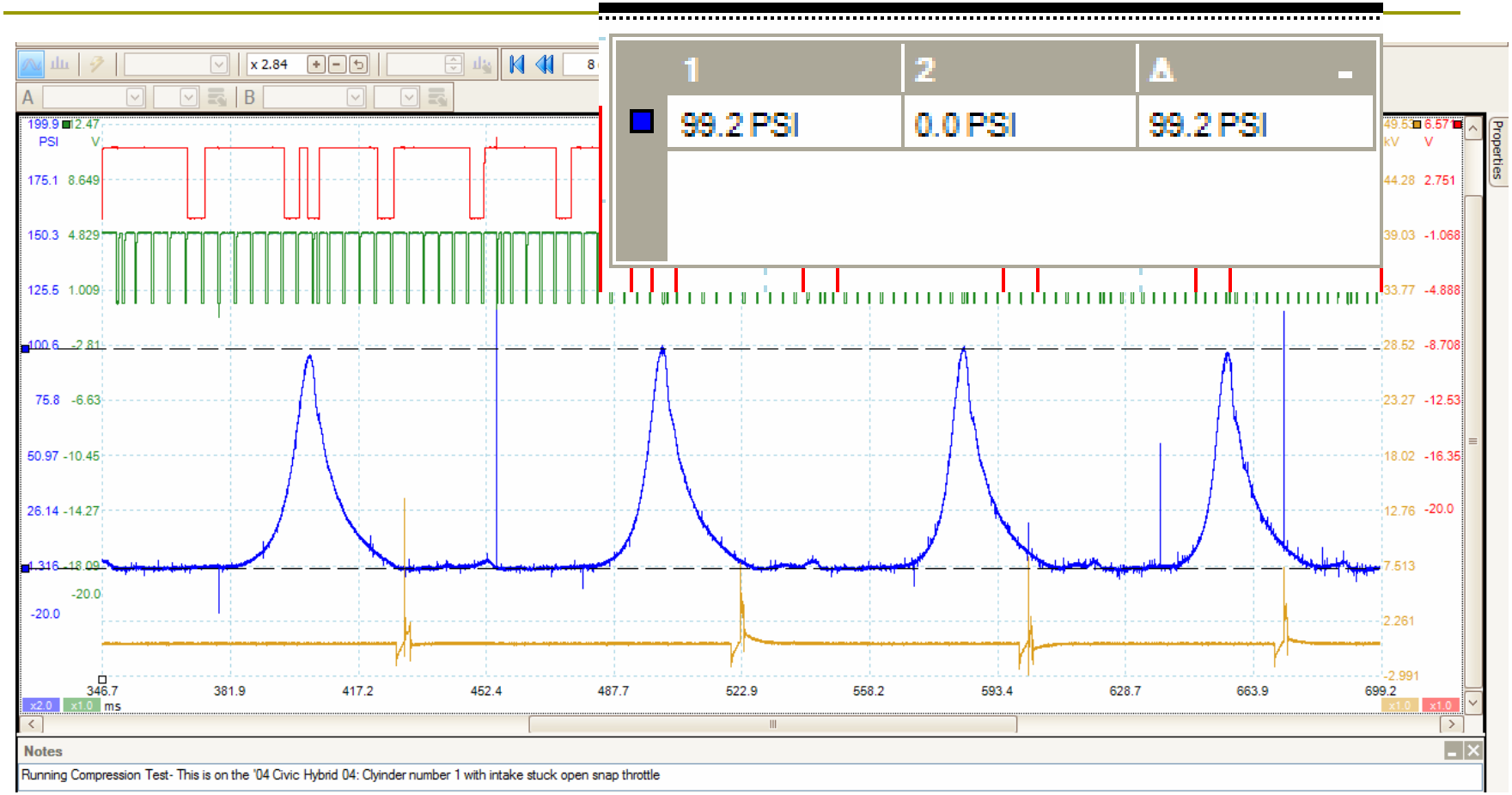
- Why don't we have real high compression numbers when the engine is running compared to when it cranking?
  - With the throttle closed and the nature of atmospheric air, the piston cannot draw in a "complete" charge
  - Volumetric efficiency: Which is how efficient an engine can fill its cylinder volume (displacement)
    - 75 – 80% at WOT is typical
    - 100% on supercharged or turbo charged vehicles

Engine Mechanical



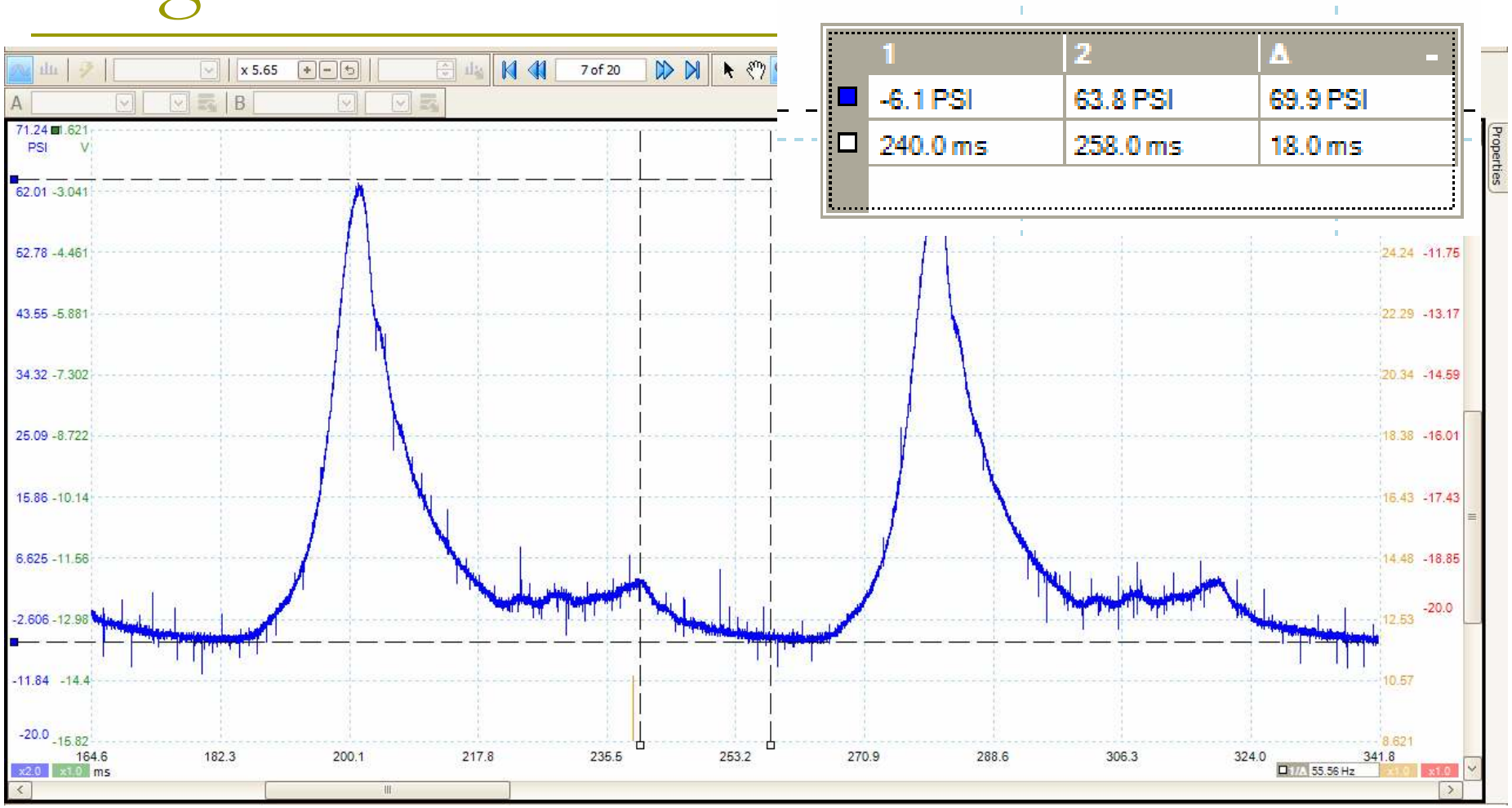
Intake valve leak: Idle

Engine Mechanical



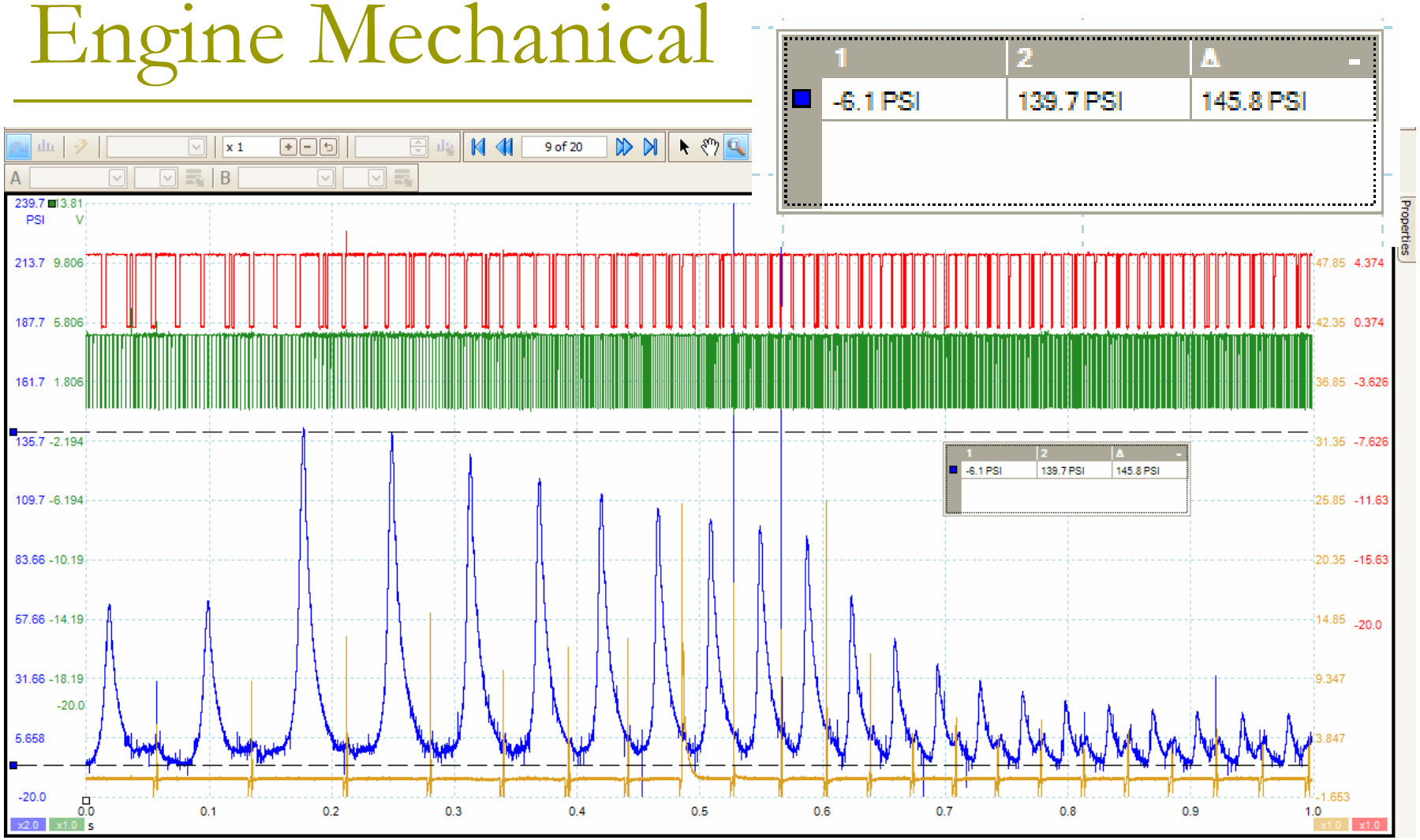
Intake valve leak: Snap Throttle

Engine Mechanical



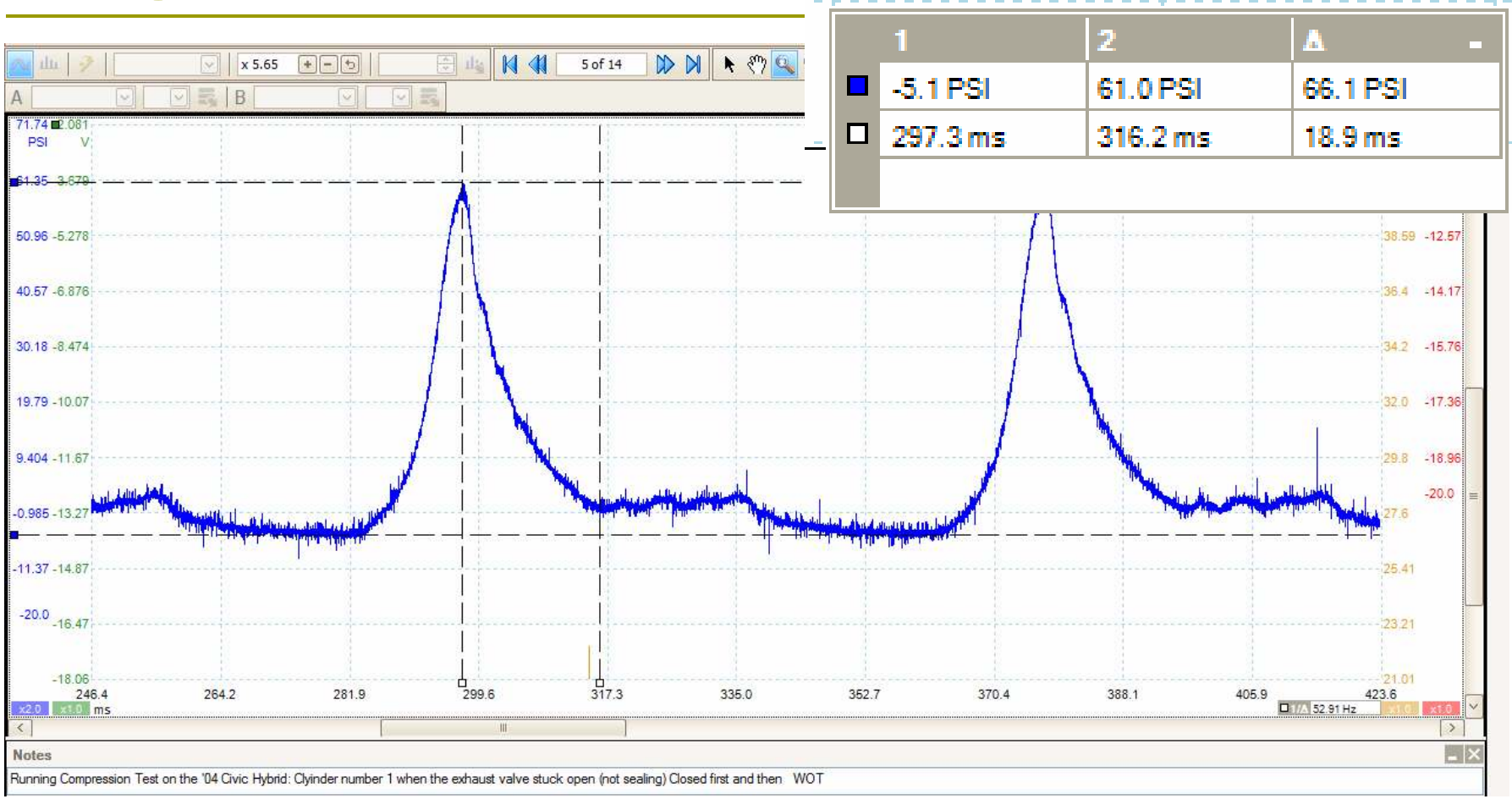
Intake valve not opening completely: idle

Engine Mechanical



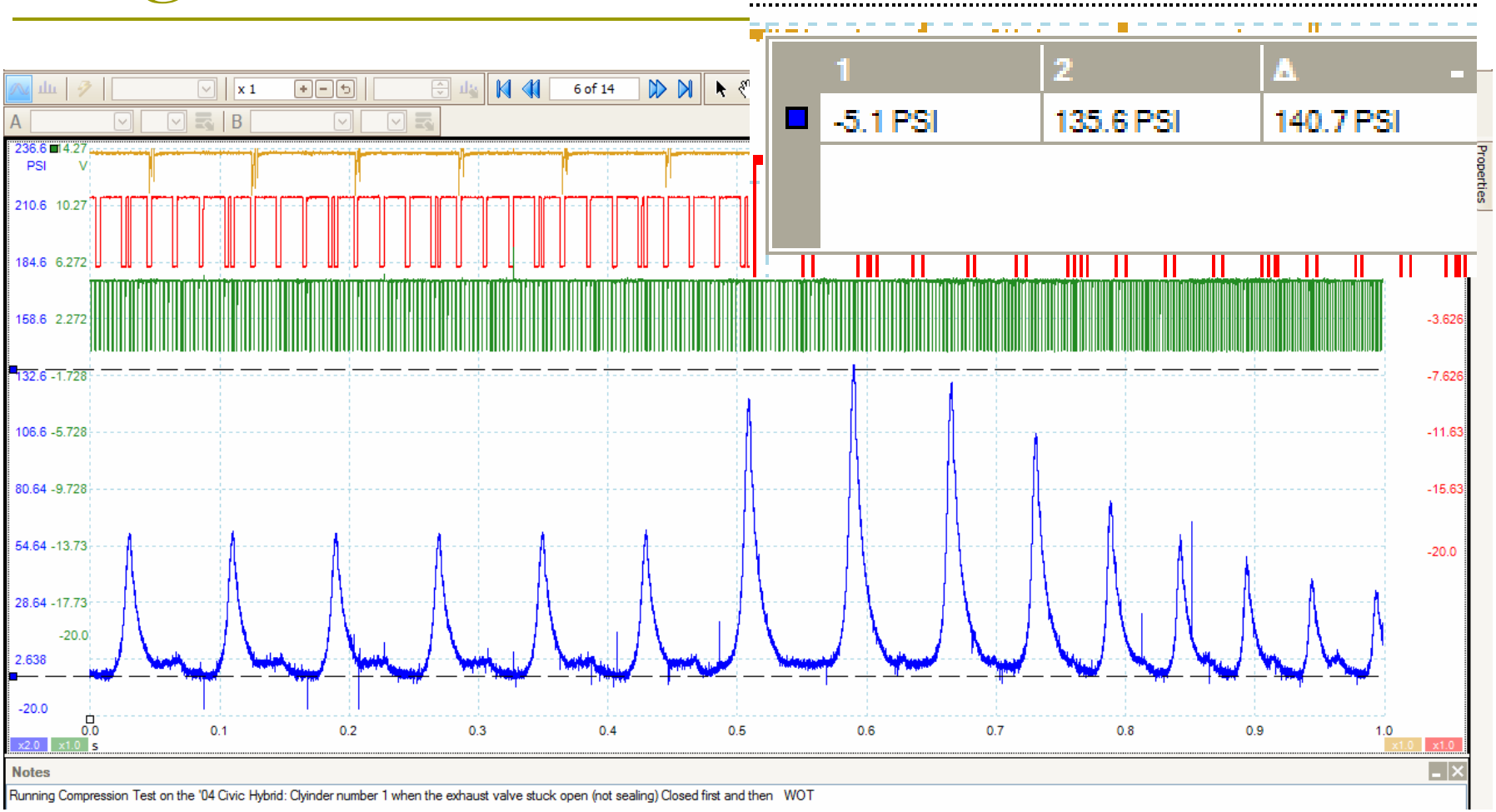
Intake valve not opening completely: snap throttle

Engine Mechanical



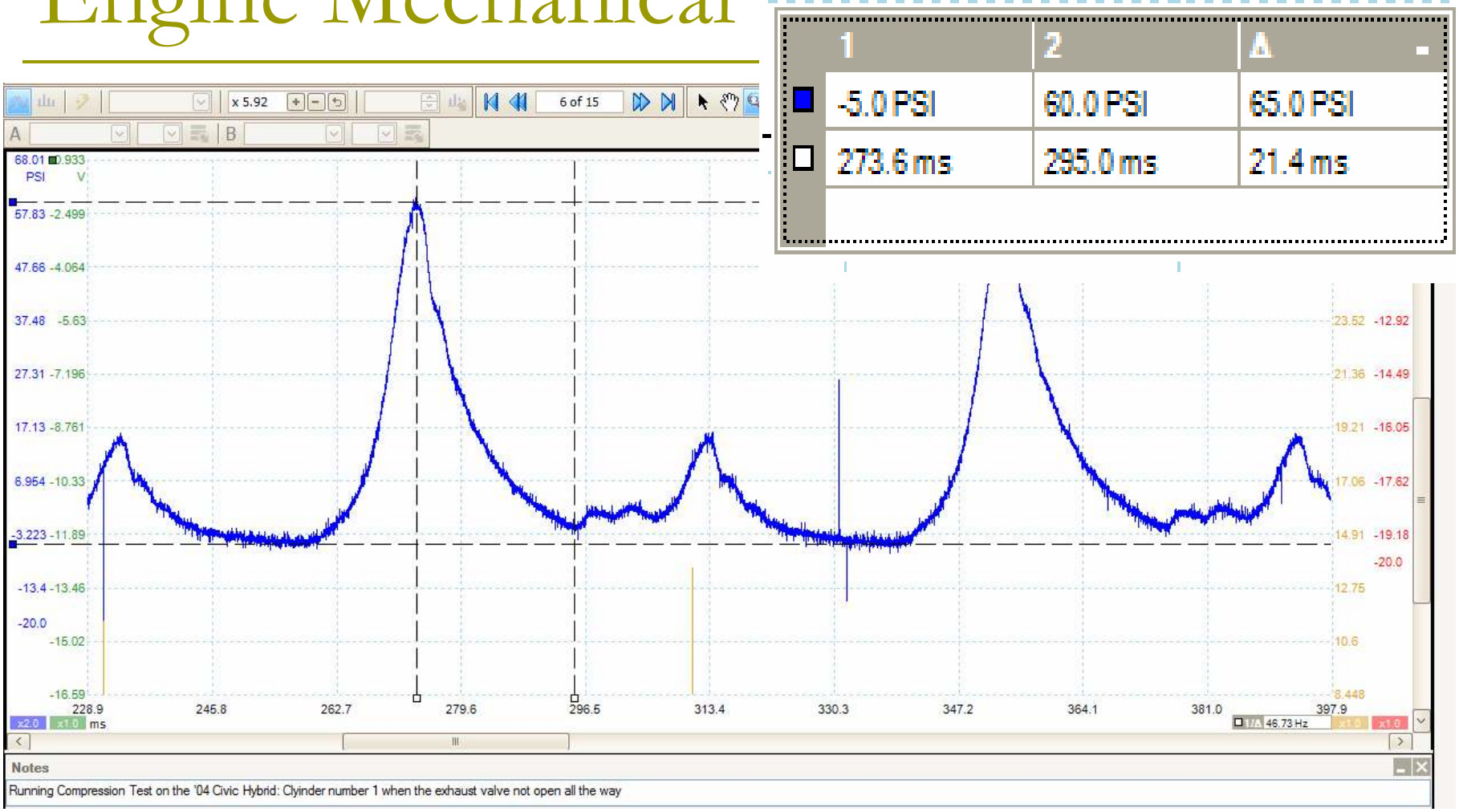
Exhaust valve leak: idle

Engine Mechanical



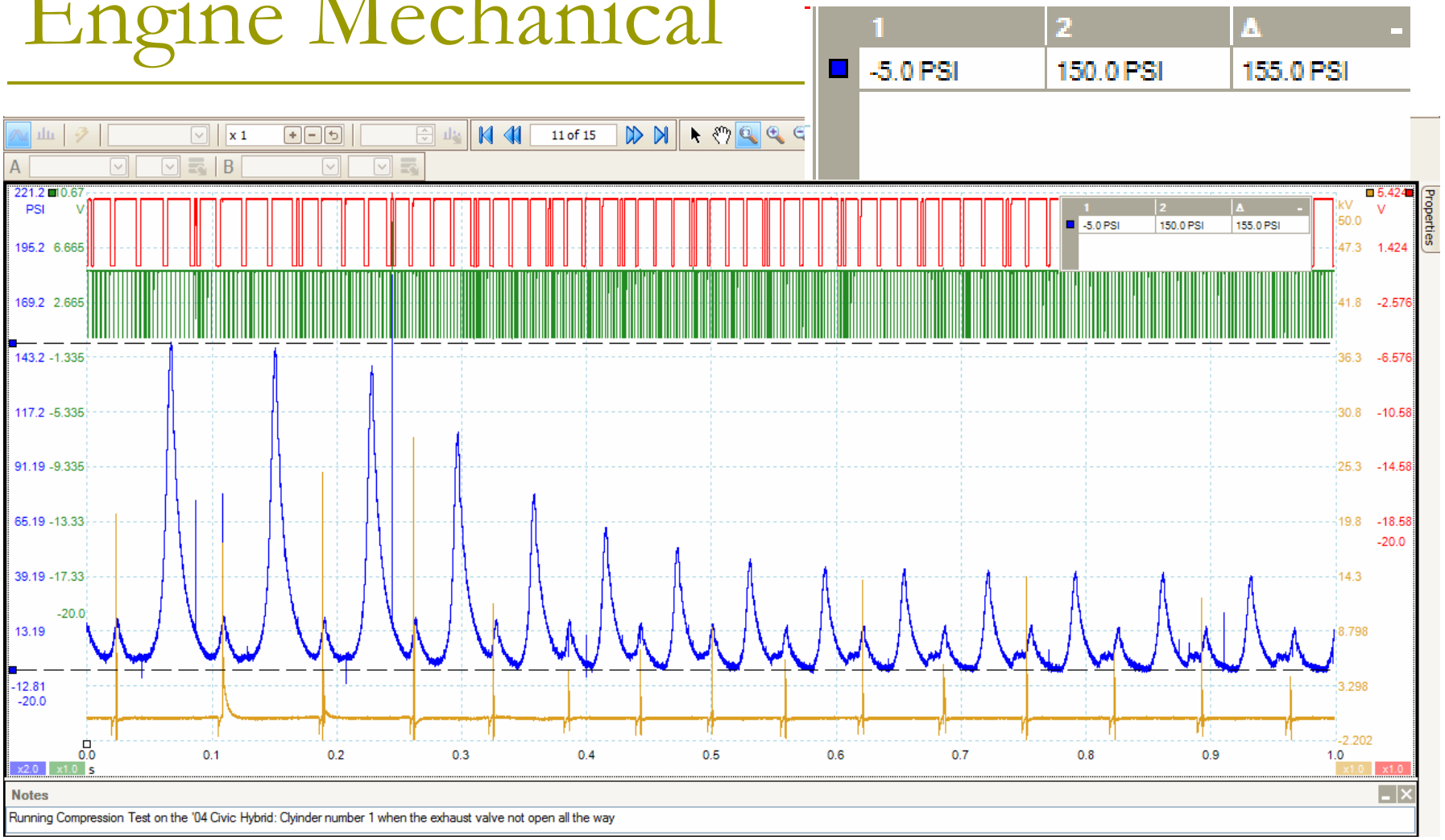
Exhaust valve leak: snap throttle

Engine Mechanical



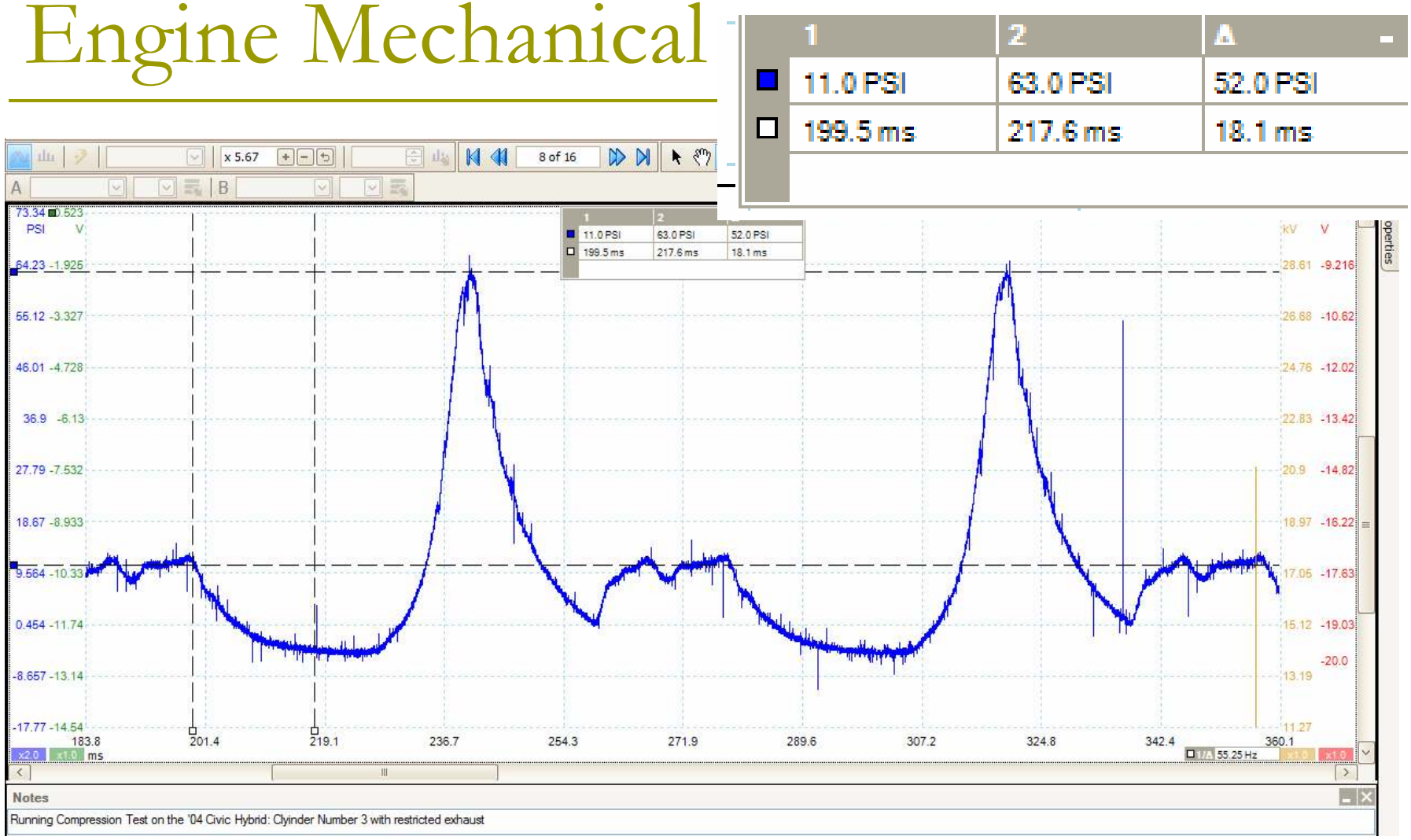
Exhaust valve not opening completely: idle

Engine Mechanical



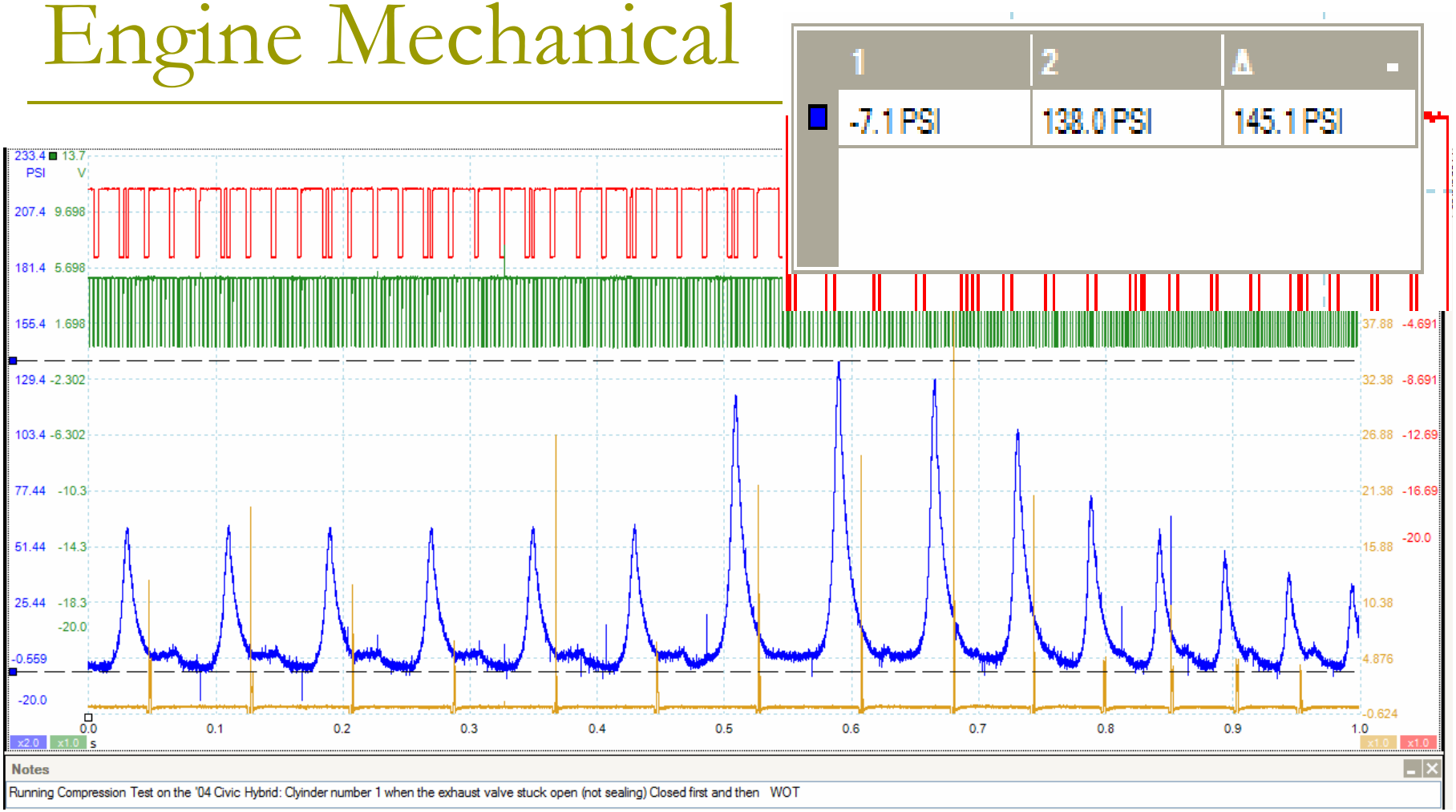
Exhaust valve not opening completely: snap throttle

Engine Mechanical



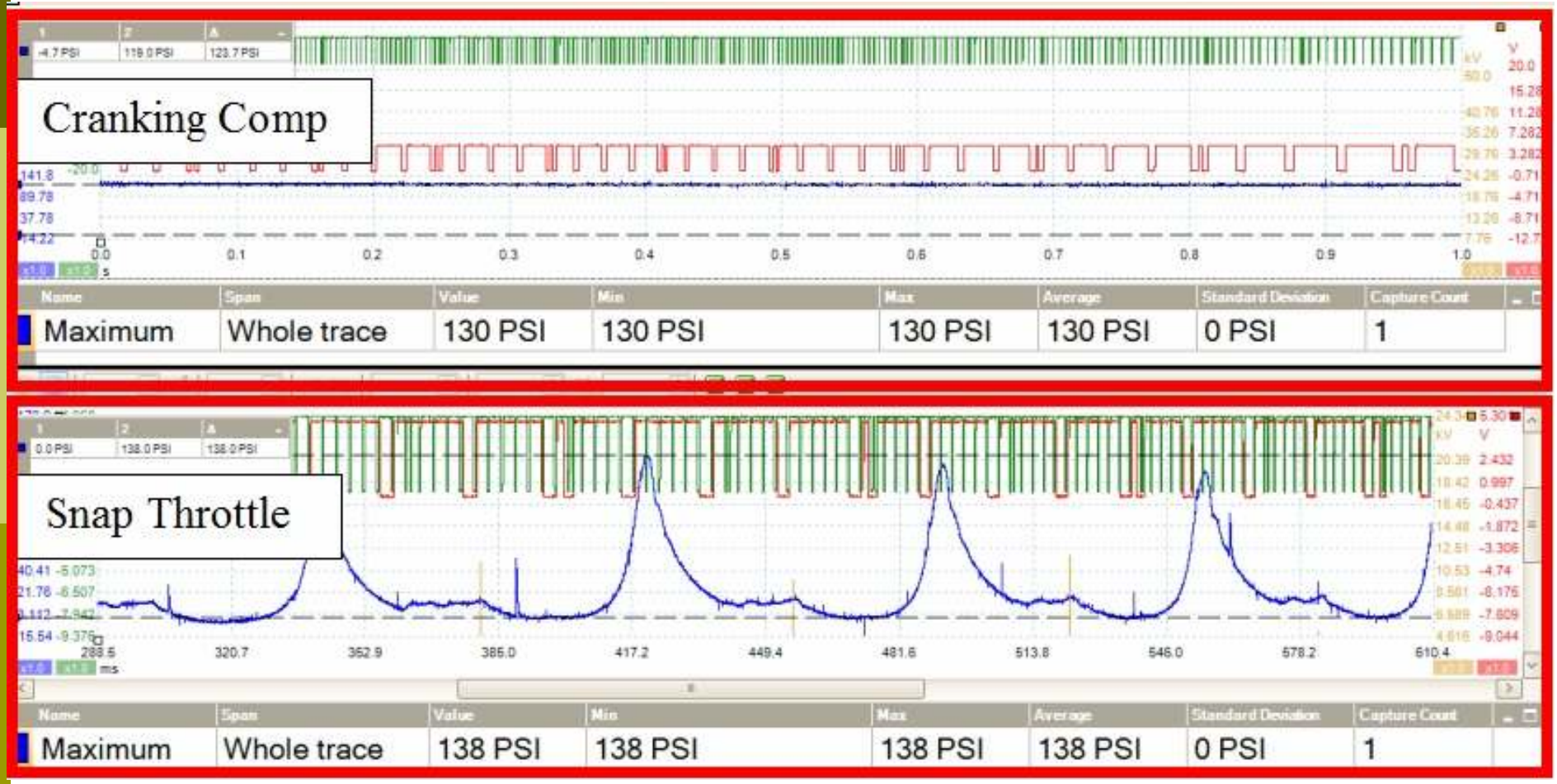
Restricted exhaust: idle

Engine Mechanical



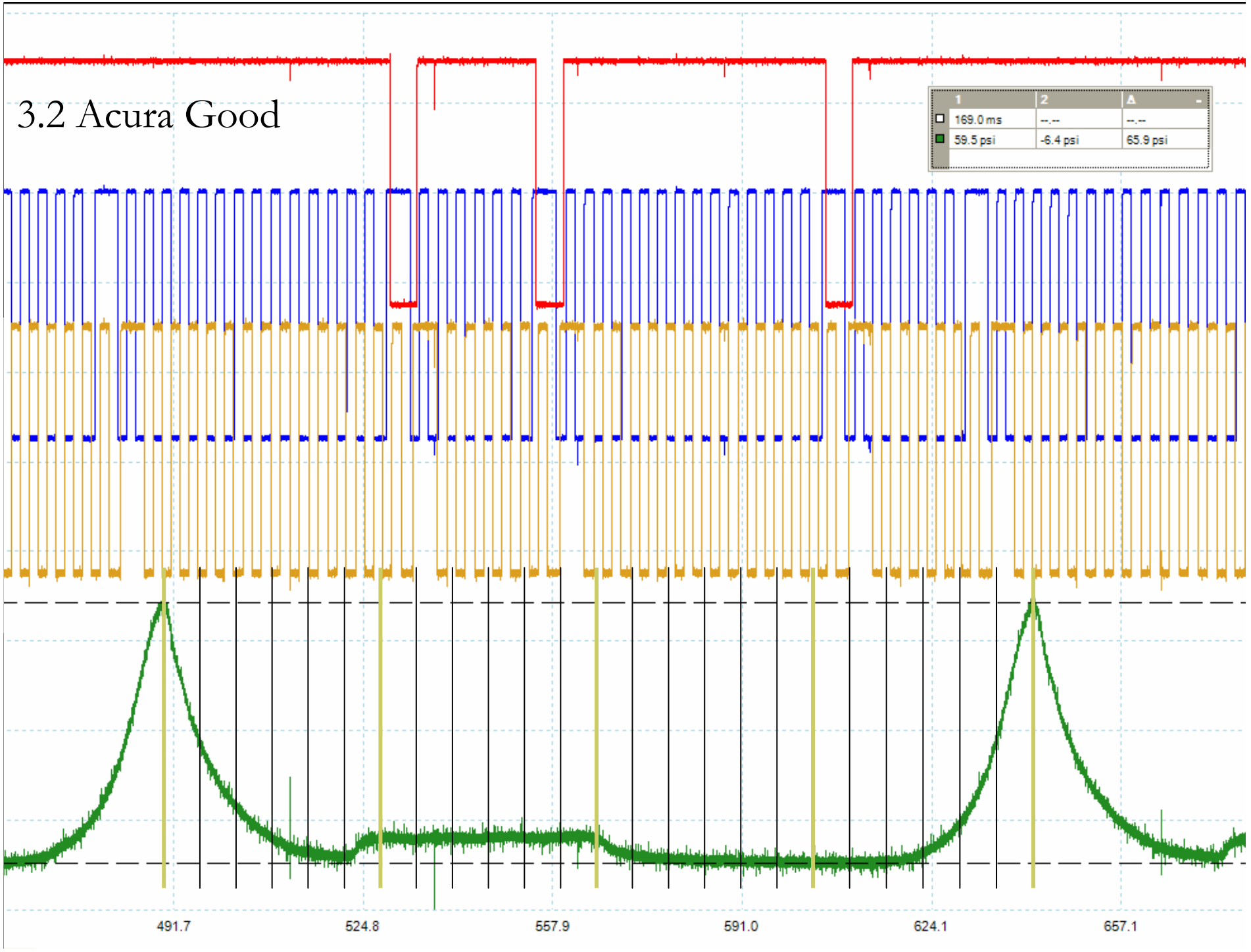
Restricted exhaust: snap throttle

Engine Mechanical

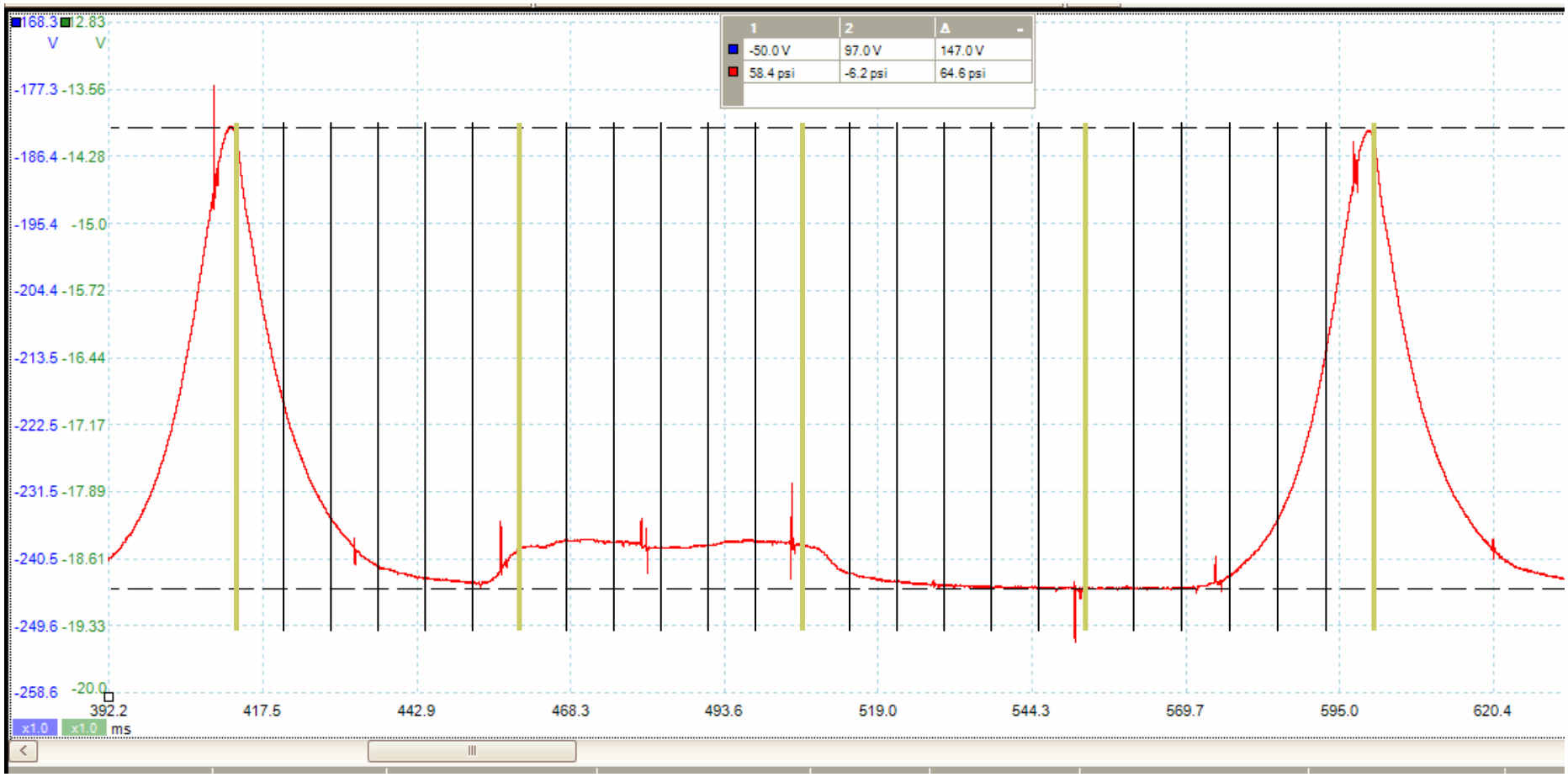


Restricted exhaust: comparison

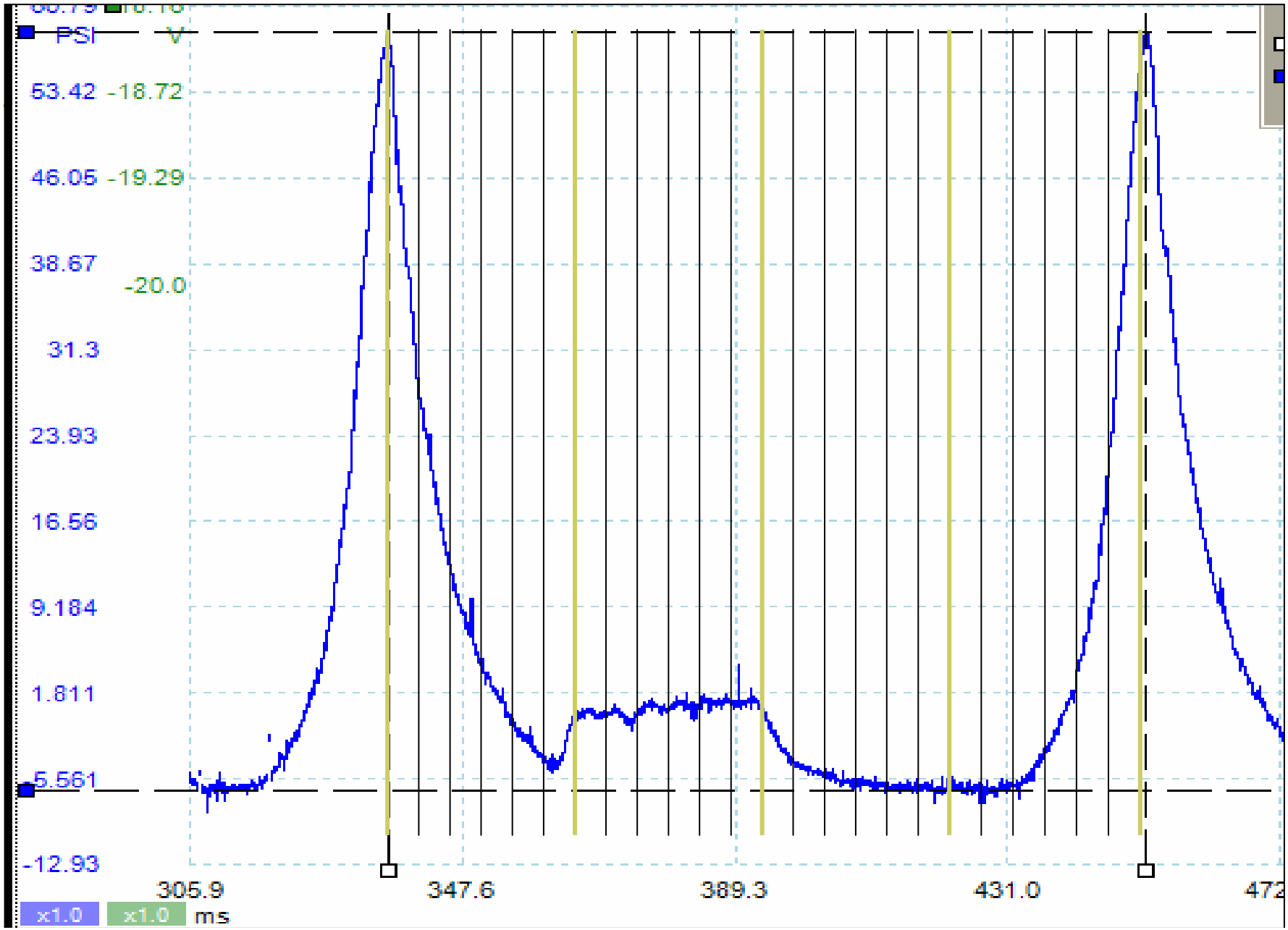
3.2 Acura Good



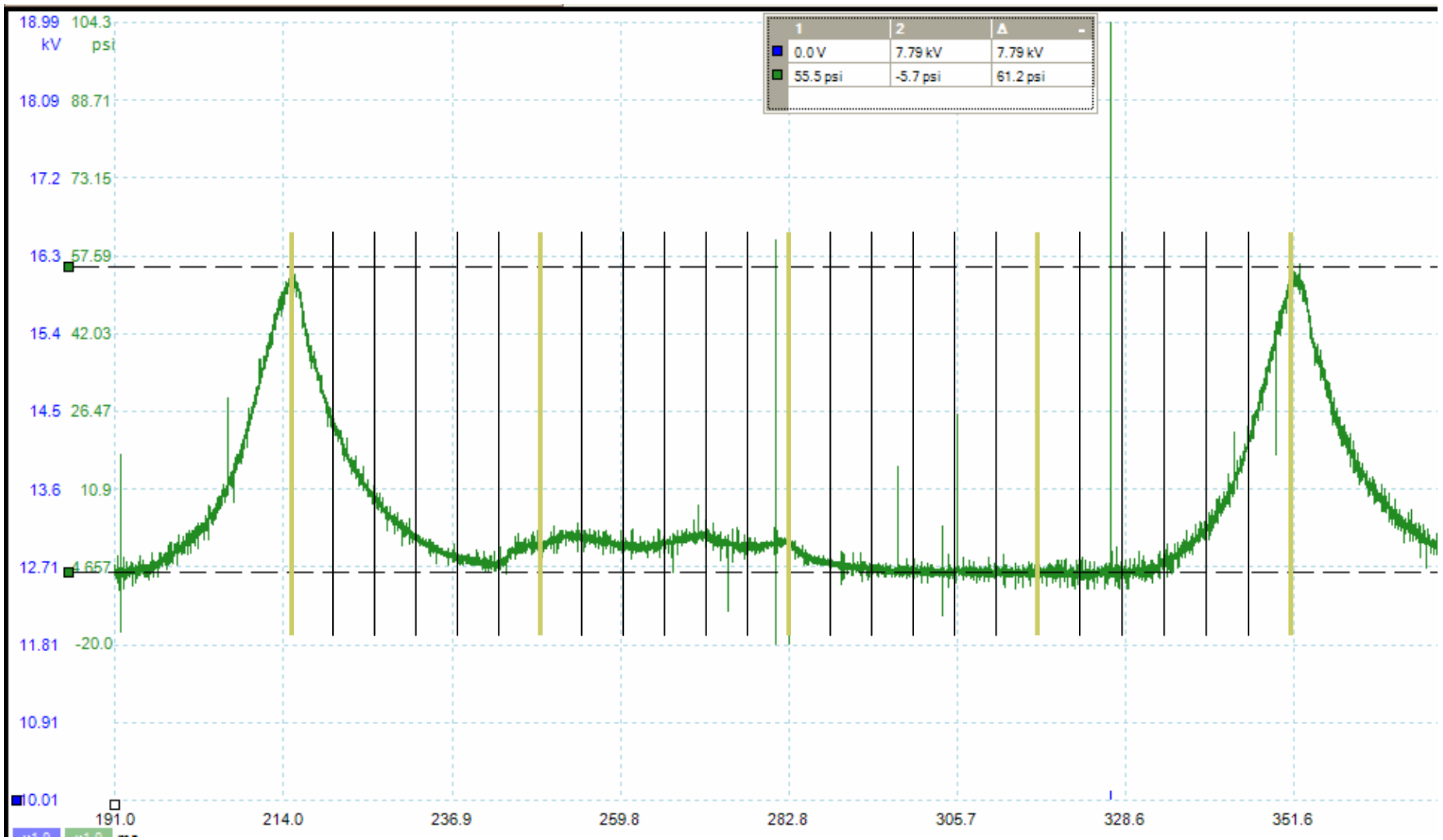
5.7 Hemi 300C 05’



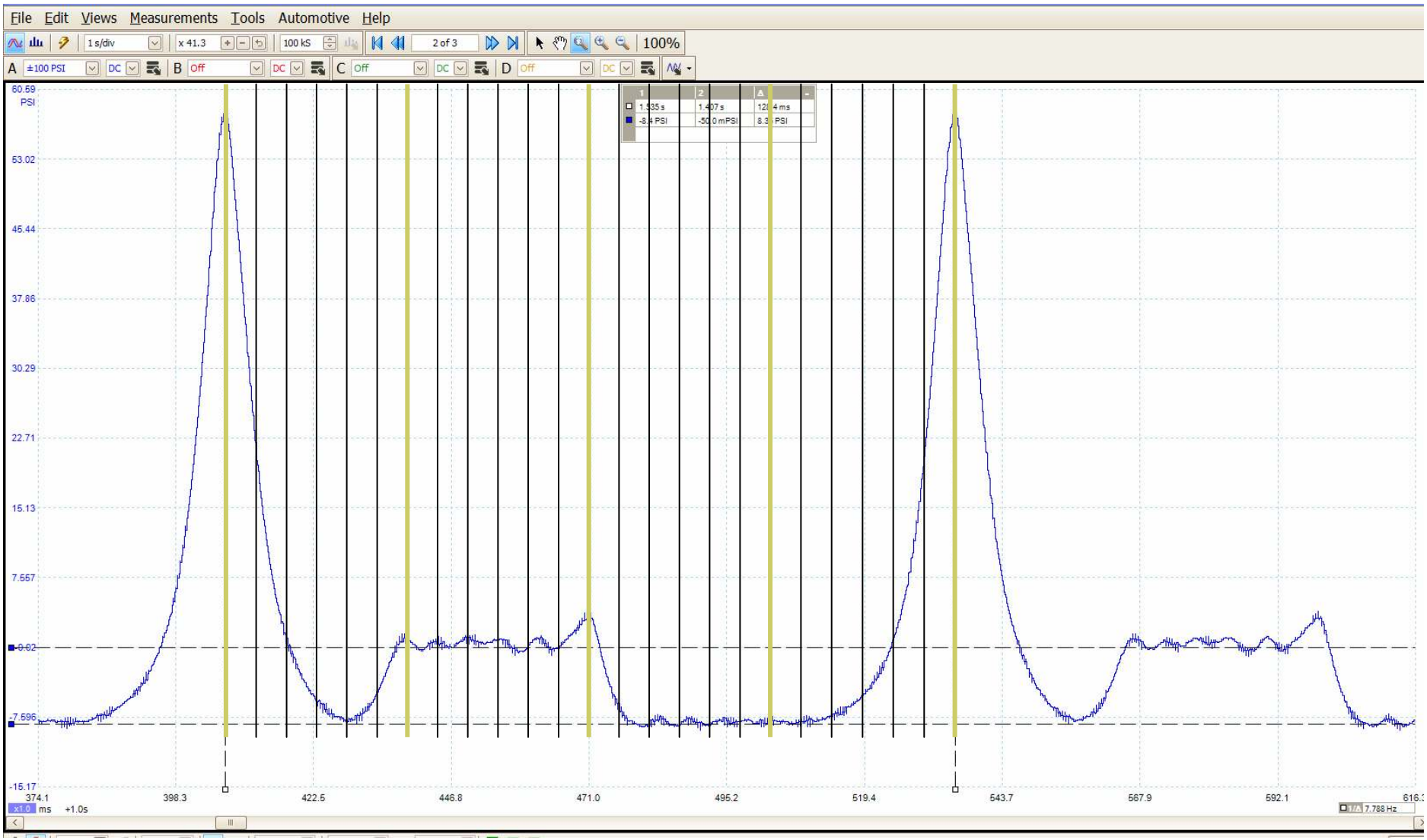
Good Civic Hybrid 1.5L



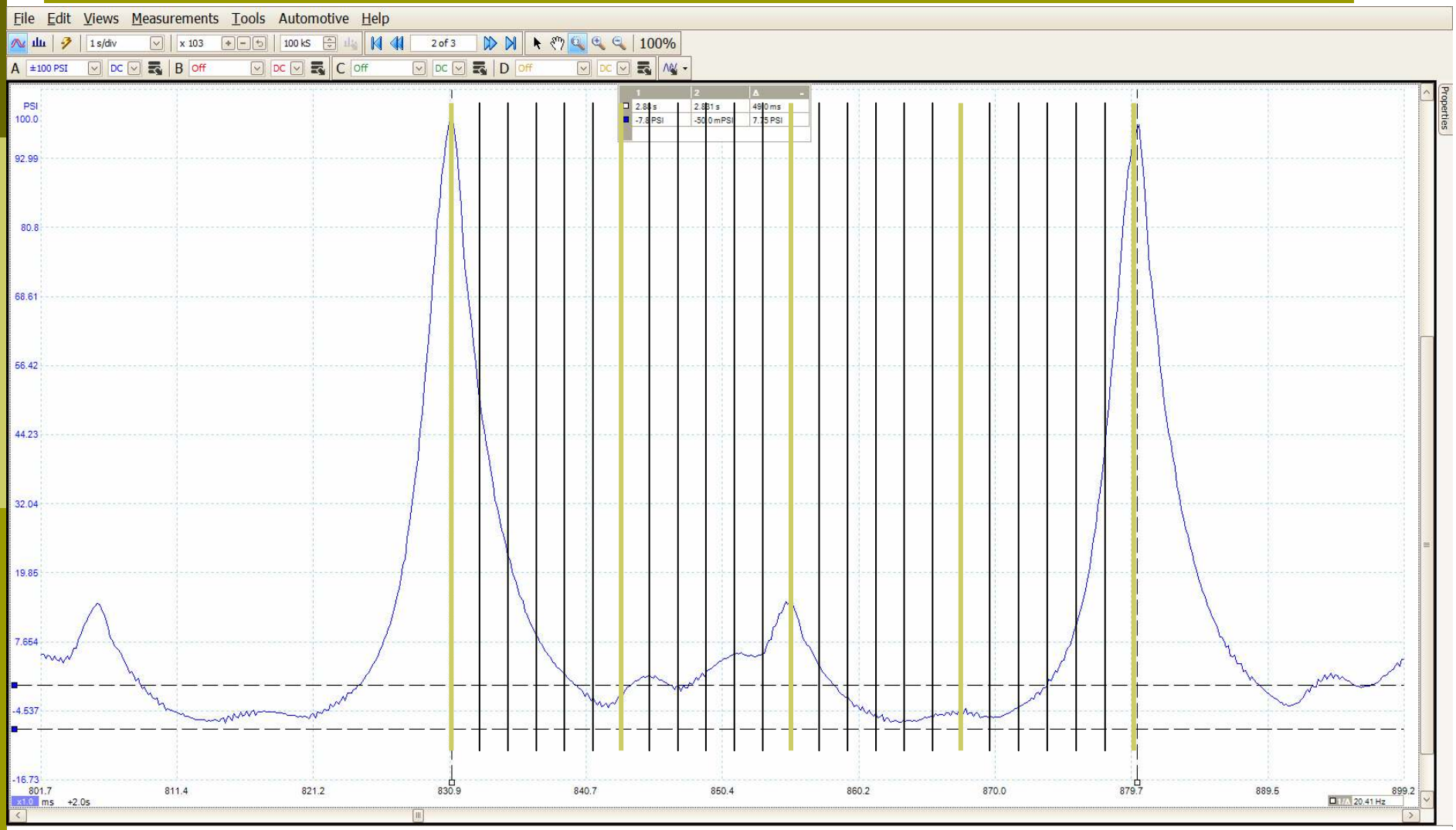
94 Blazer


18.99 kV
104.3 psi
18.09 88.71
17.2 73.15
16.3 57.59
15.4 42.03
14.5 26.47
13.6 10.9
12.71 -4.657
11.81 -20.0
10.91
10.01
191.0
214.0
236.9
259.8
282.8
305.7
328.6
351.6
1
2
Δ
0.0 V
7.79 kV
7.79 kV
55.5 psi
-5.7 psi
61.2 psi

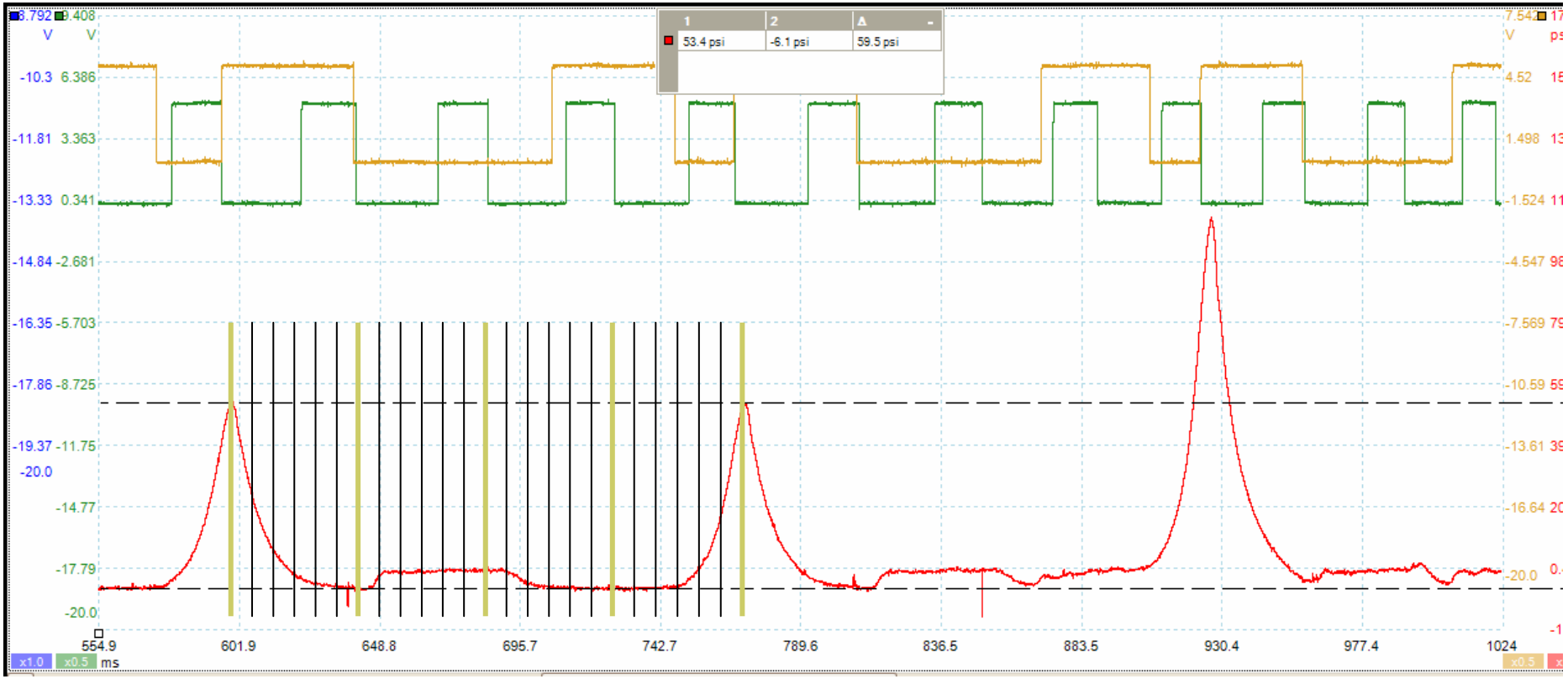
05 Envoy at about 937 RPM



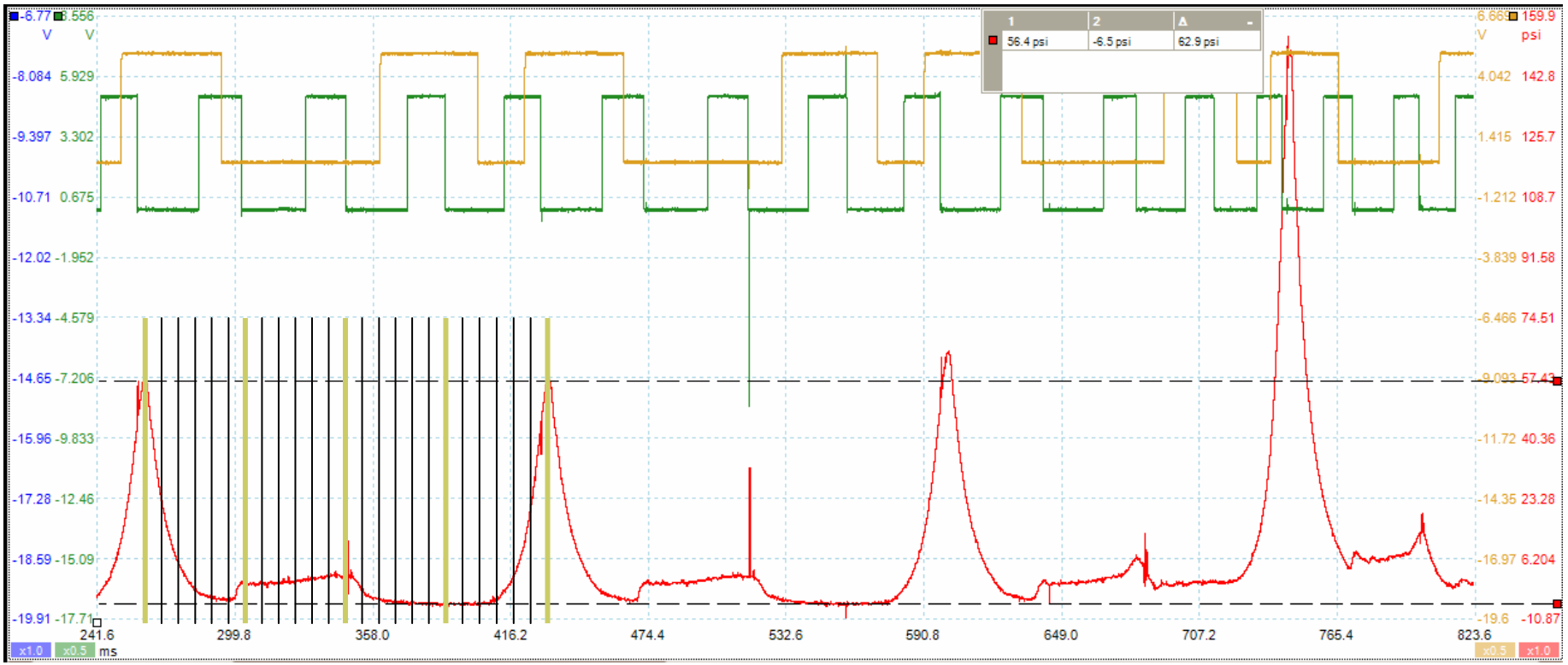
05 Envoy at about 2450 RPM

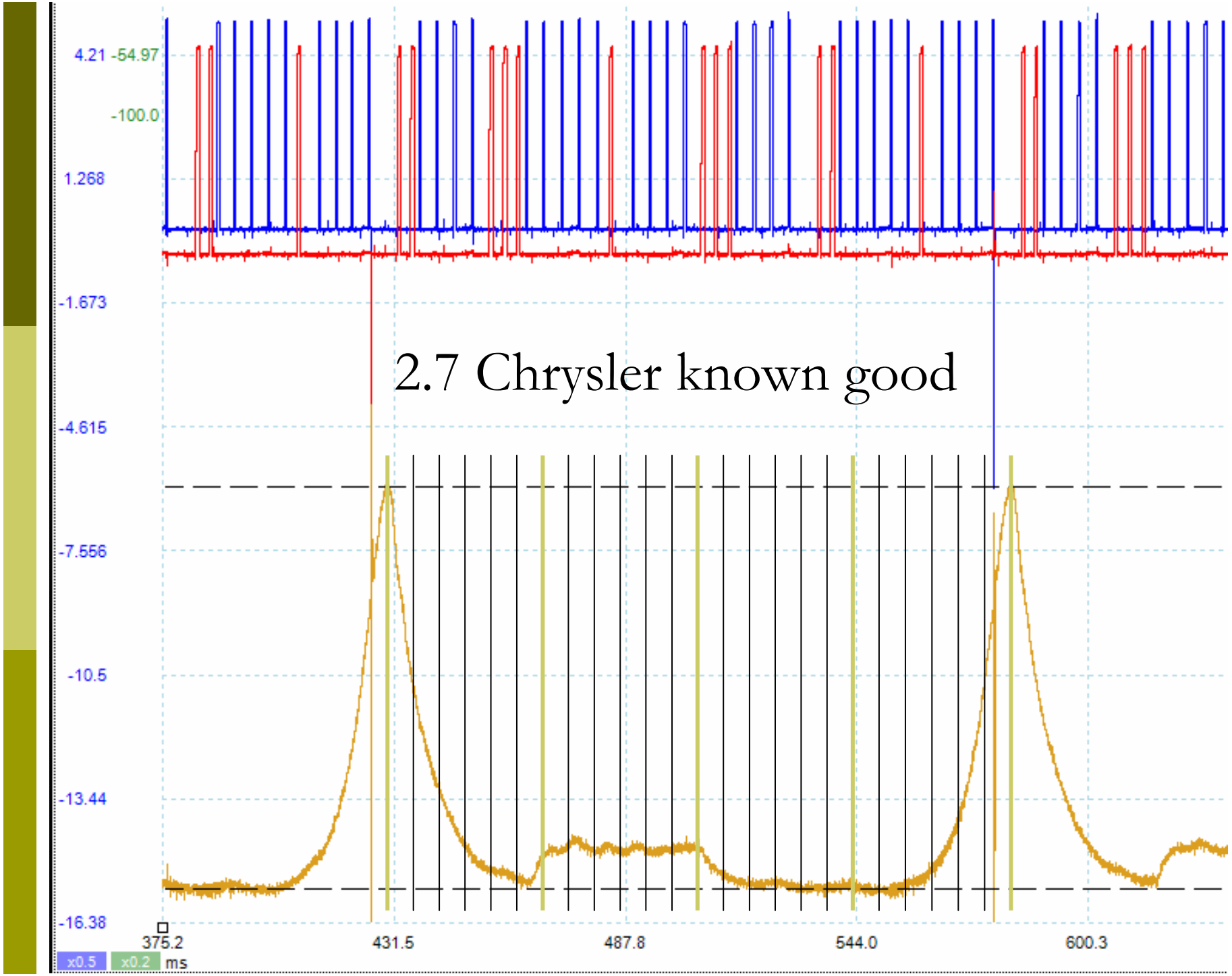


Mitsubishi 2.0 Cam Timing Retarded



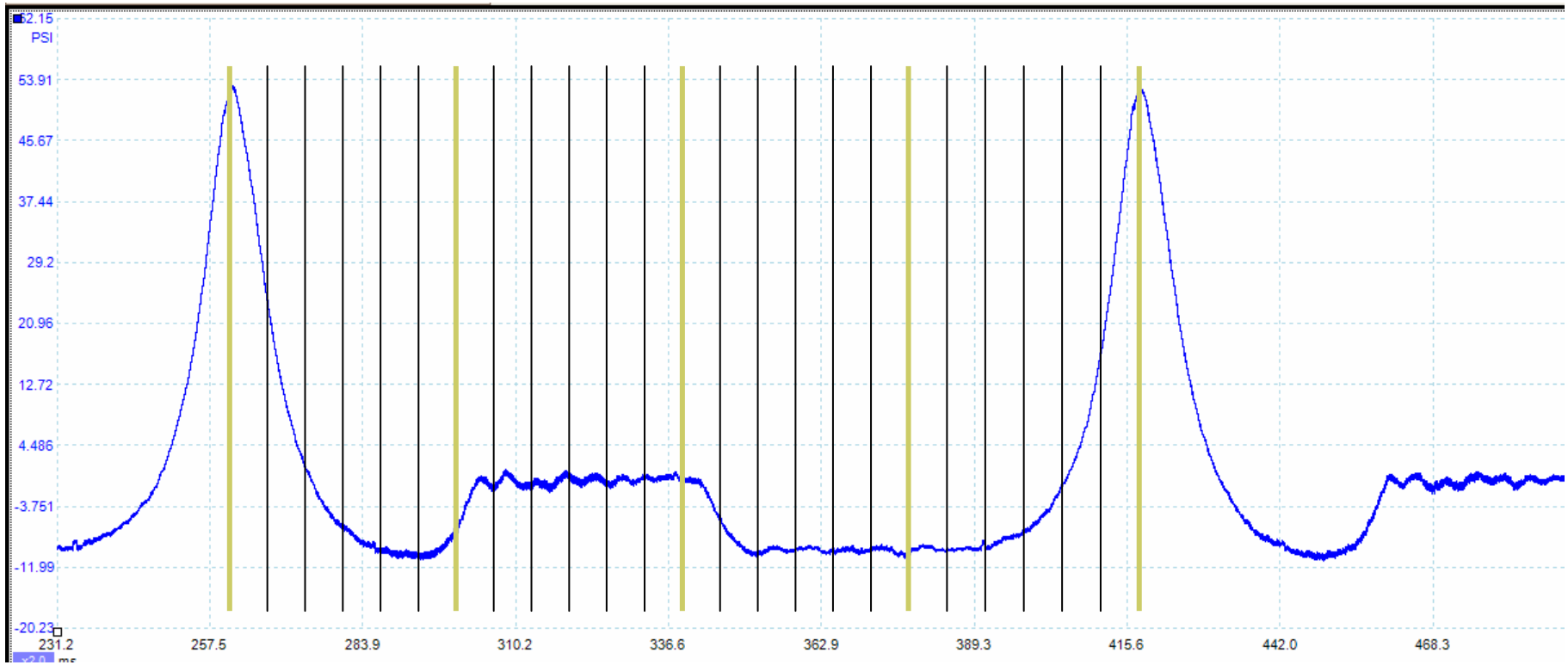
Exhaust Backpressure





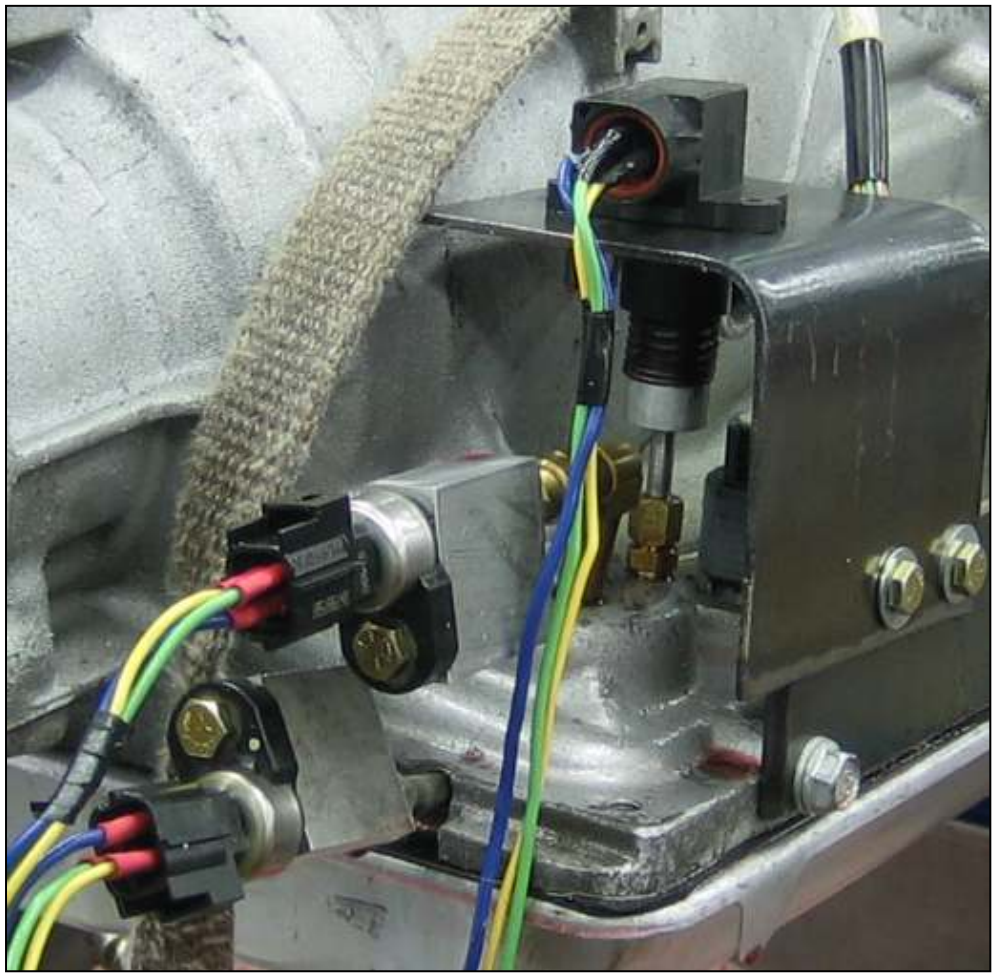
2.7 Chrysler known good

2.7 Chrysler: What do you think?



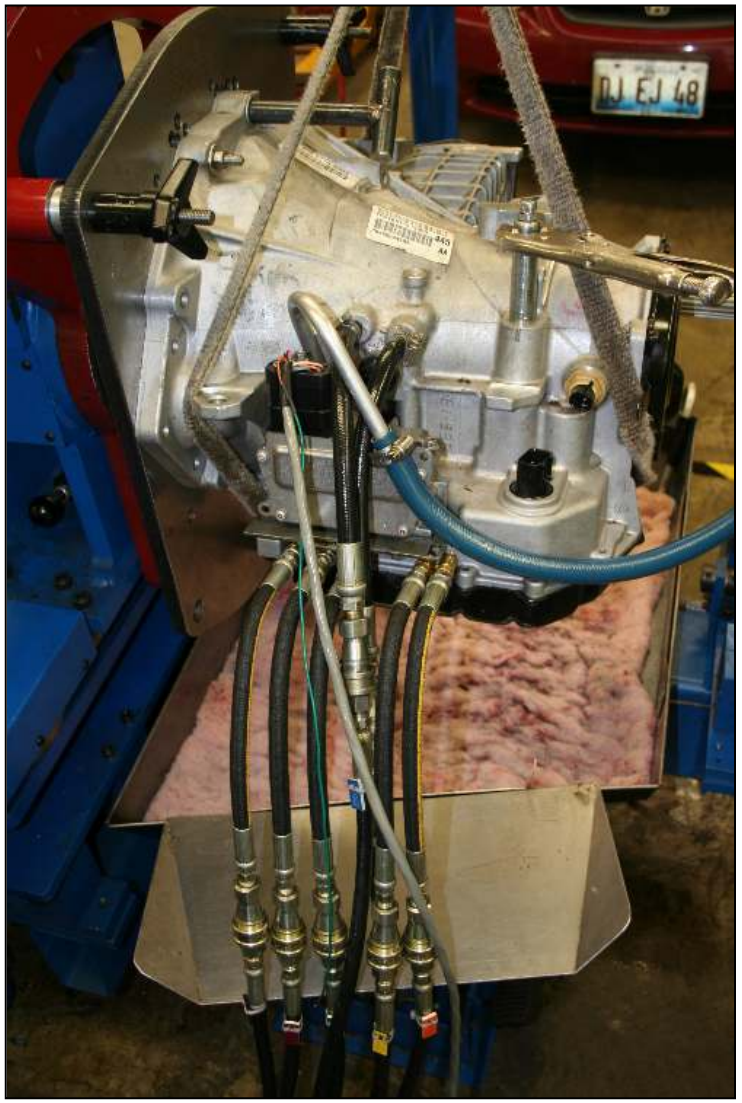
Applications in Transmissions

- Pressure diagnostics
  - Teaching
    - Pascal's law
    - Accumulator and element operation



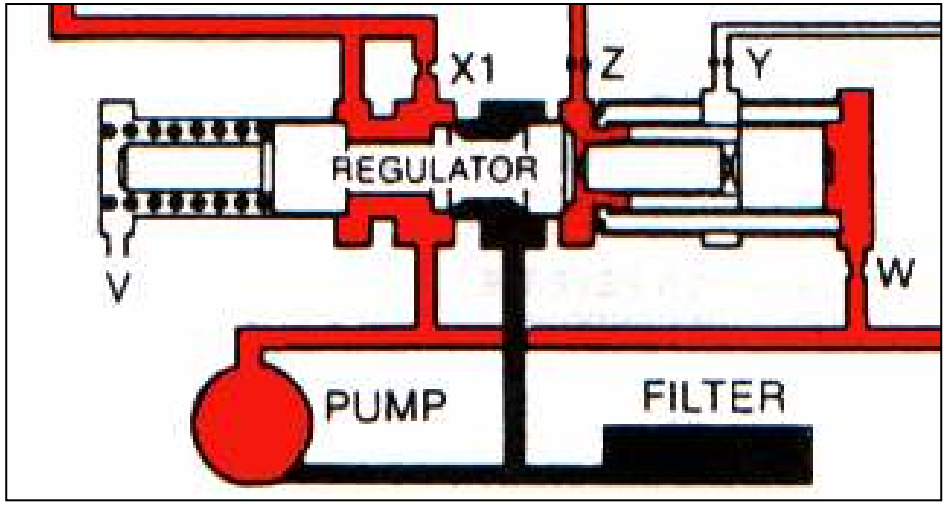
Proving Pascal's Law

- Hydraulic Principles
  - Pascals Law
    - F = P x A
    - Give the students examples and work them out on paper
    - When running the transmissions on the dyno, you can prove the effects.
  - Great Examples
    - Pressure Regulator Circuit on a 41TE
    - 4L60E accumulator circuits



Proving Pascal's Law

- Example
  - Pressure Regulator Circuit on a 41TE
    - Surface area at "W" equals .192"
    - Surface area at "Y" equals .119"
    - Surface area at "Z" equals .306"
  - The spring force is about 25lbs when the regulator is just uncovering the sump passage

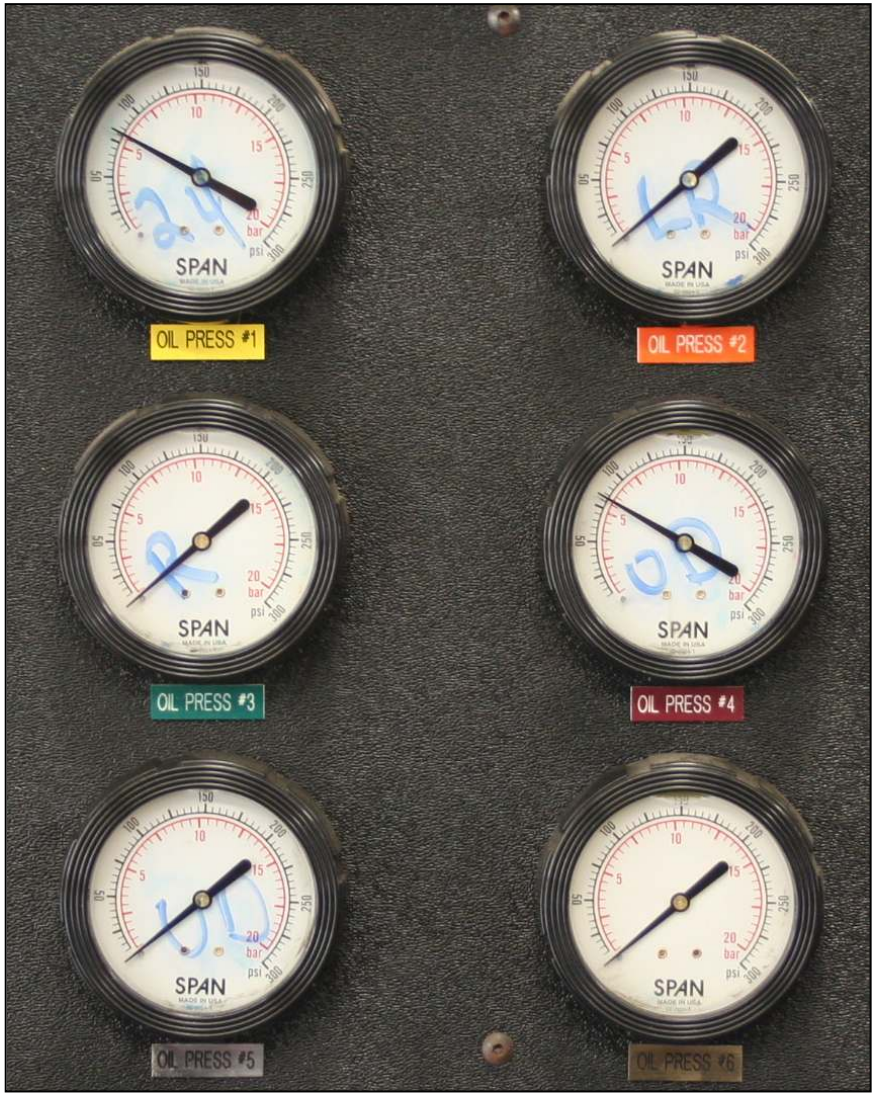


Proving Pascal's Law

- When in park, neutral, first and second, line pressure only exists in the "W" passage
- Using Pascal's Law
  - We need to overcome 25 pounds of spring force
  - We have .192 sq inches of surface area
  - The pump will have to generate 130 PSI before it moves the valve over enough to expose the pressure release.

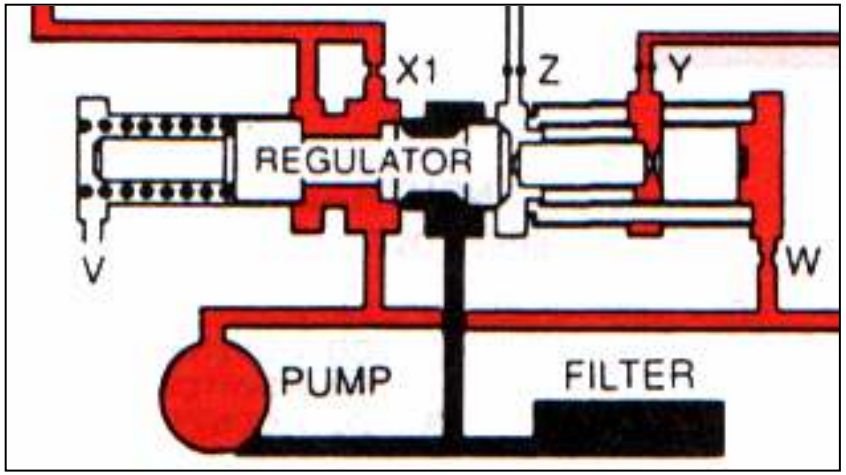
Proving Pascal's Law

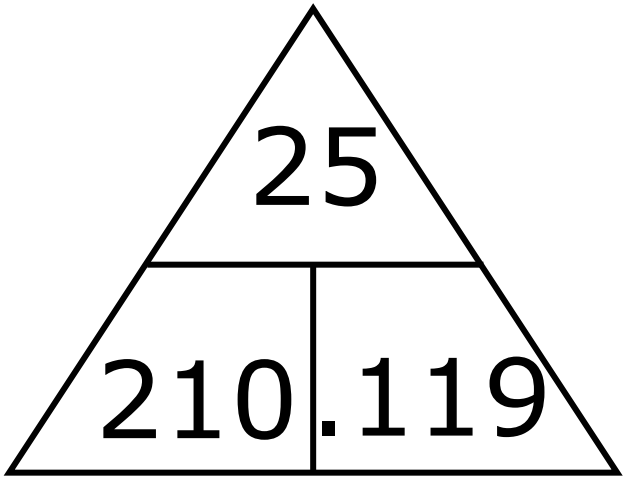
- While in 3rd and 4th gear
  - We still need to overcome 25 pounds of spring force
  - We have the following surface areas
    - Z "A" area = .306
    - Z "B" area = .192
    - W area = .192
  - The surface area on Z "B" and W is the same, so their force cancels each other out
  - Since we're only using the Z "A" area, the pump will have to generate 81 PSI before it moves the valve over enough to expose the pressure release



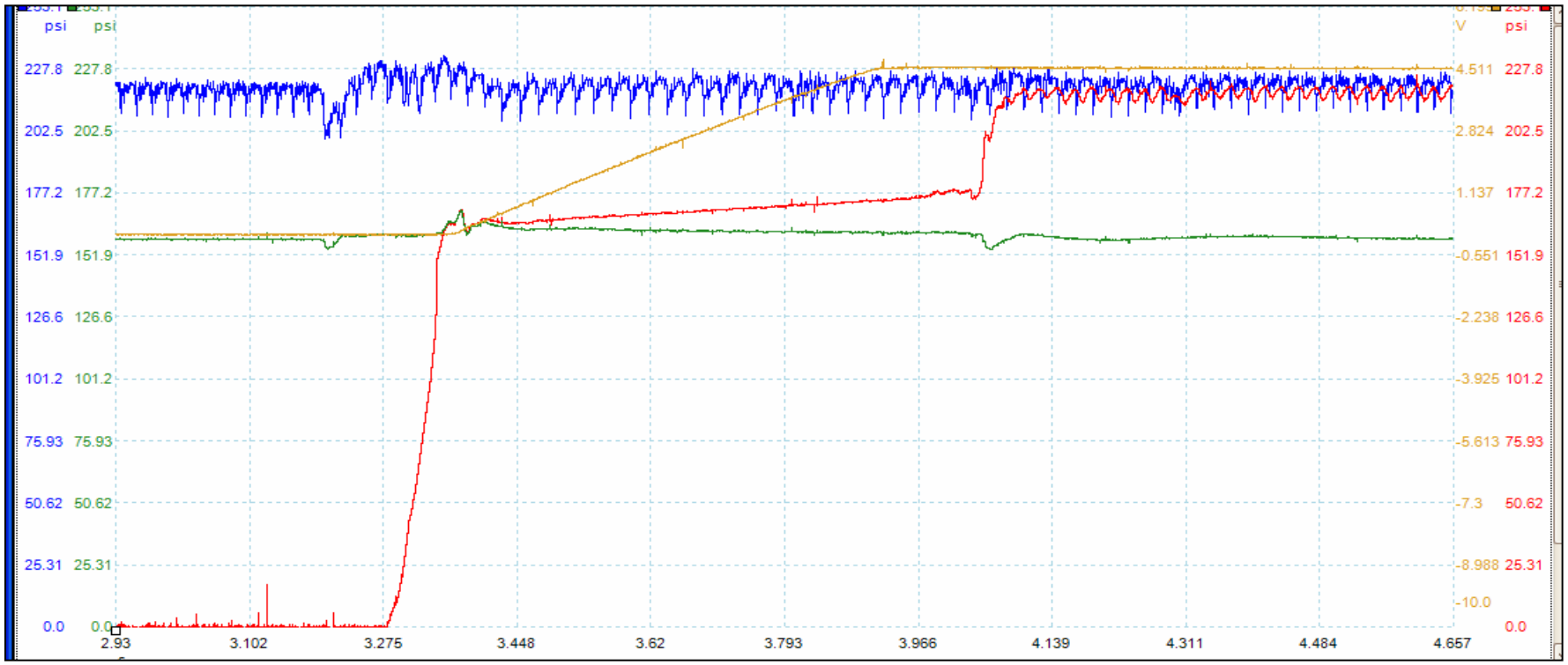
Proving Pascal's Law

- When in reverse
- Using Pascal's Law
  - We still need to overcome 25 pounds of spring force
  - We have the following surface areas
    - Y "A" area = .119
    - Y "B" area = .192
    - W area = .192
  - The surface area on Y "B" and W is the same, so their force cancels each other out
  - Since we're only using the Y "A" area, the pump will have to generate 210 PSI before it moves the valve over enough to expose the pressure release



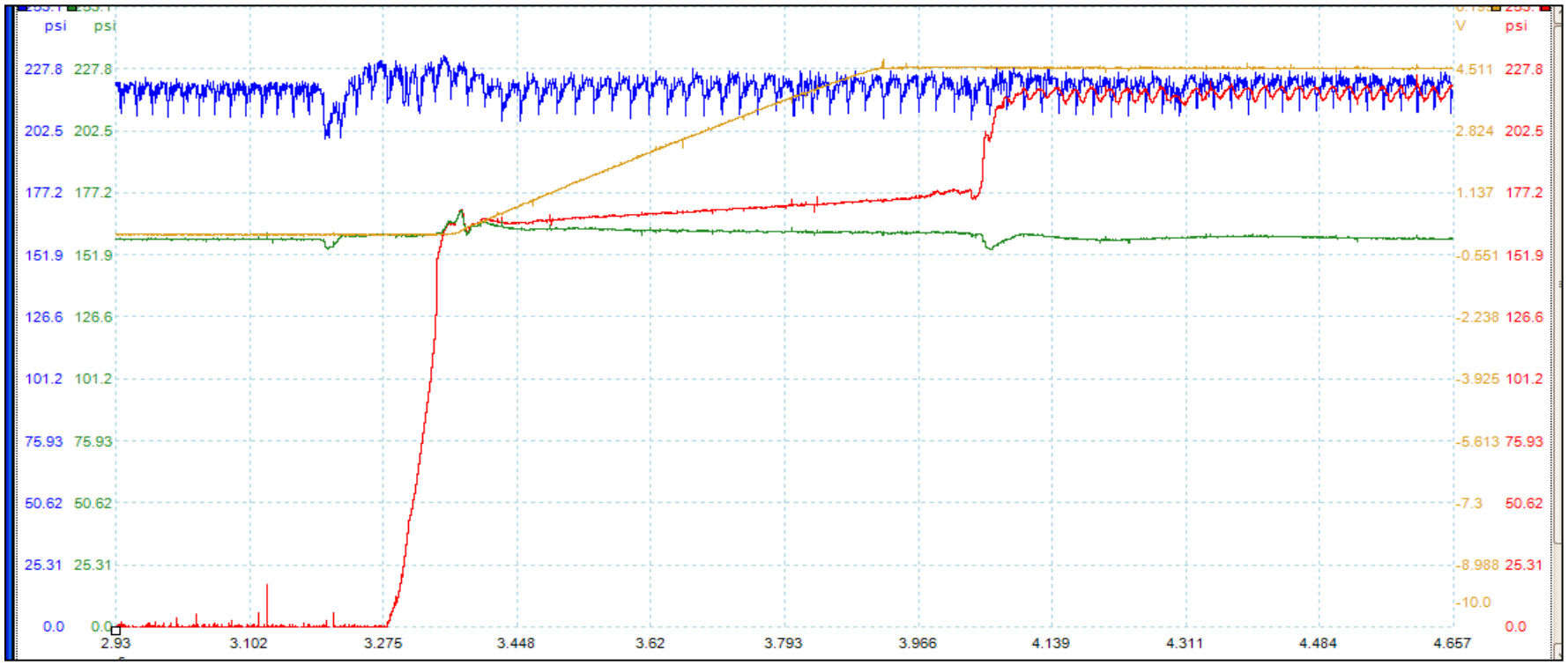


Accumulator Operation



- Accumulator operation is also another nice feature to share
- During shifts, and while monitoring the pressure gauges, you can actually see when an accumulator and apply piston strokes

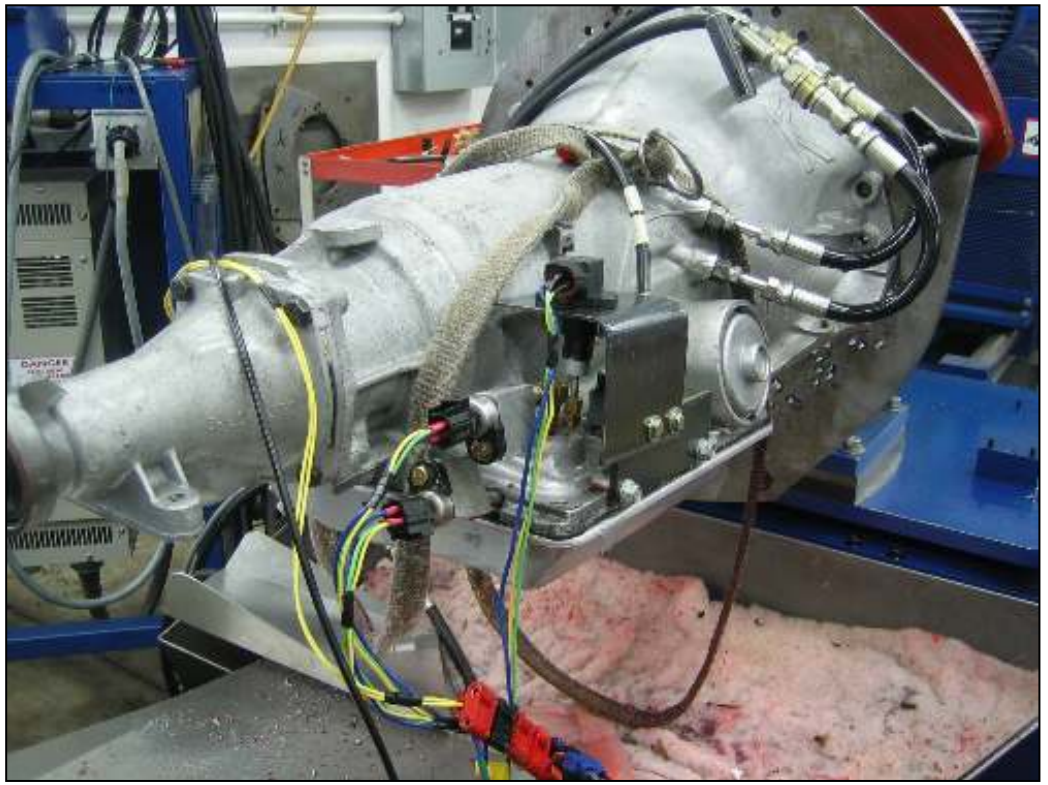
Accumulator Operation



- Watch for the pause, then the pressure rise
- This is nice to see AND hear, since the student gets to command the shift, watch the gauge, then hear the output speed up

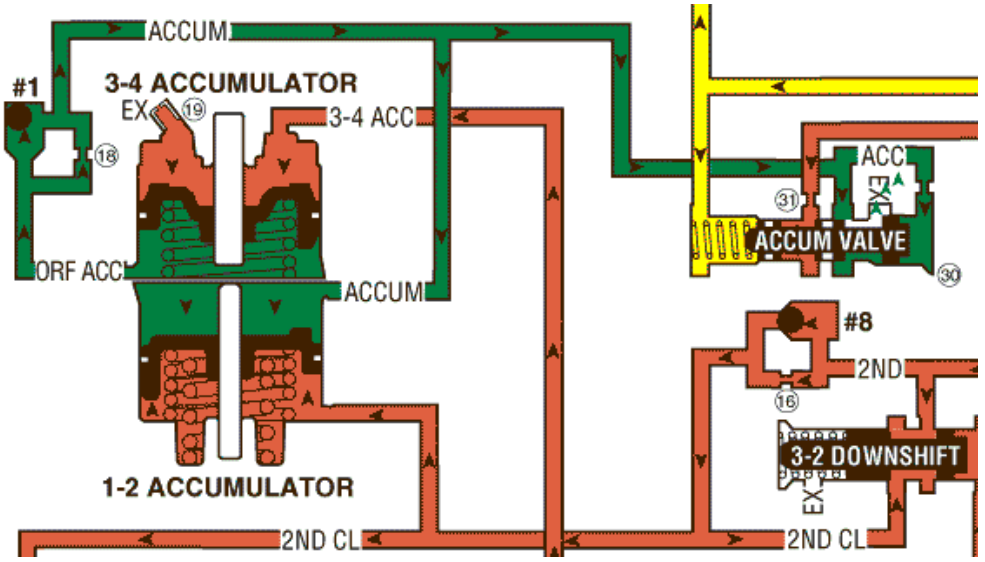
Accumulator Operation

- Run experiments with the dyno
  - Guinea pig a transmission or two
  - Modify and record results
  - Prove/disprove theories
  - Excellent exercise involves using the 4L60E to explain accumulator circuits



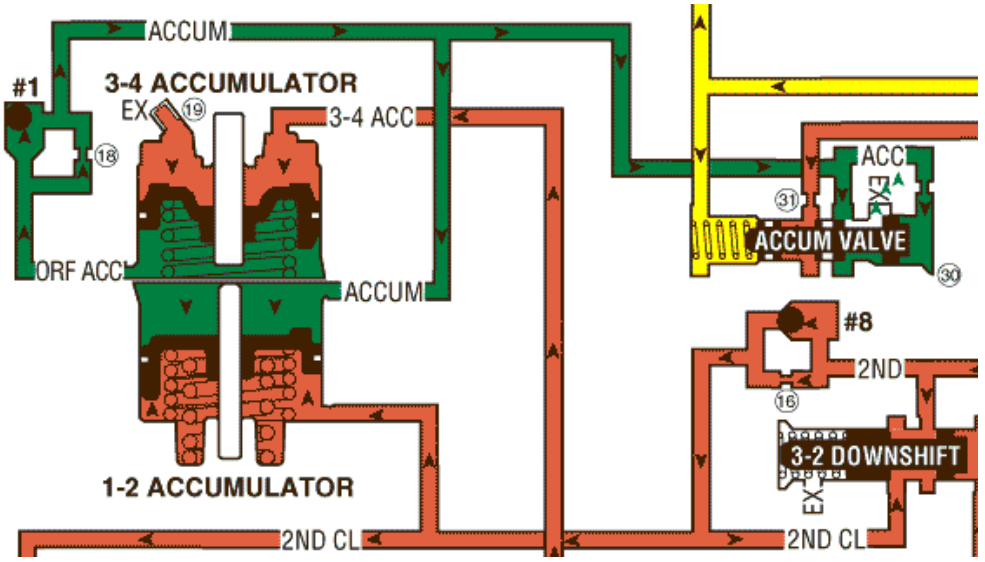
Accumulator Operation

- Accumulator Valve
  - Varies accumulator pressure by balancing torque signal and spring pressure against accumulator pressure
  - Spring pressure is constant
  - Torque signal pressure changes between 0psi and 115psi depending on PCS control



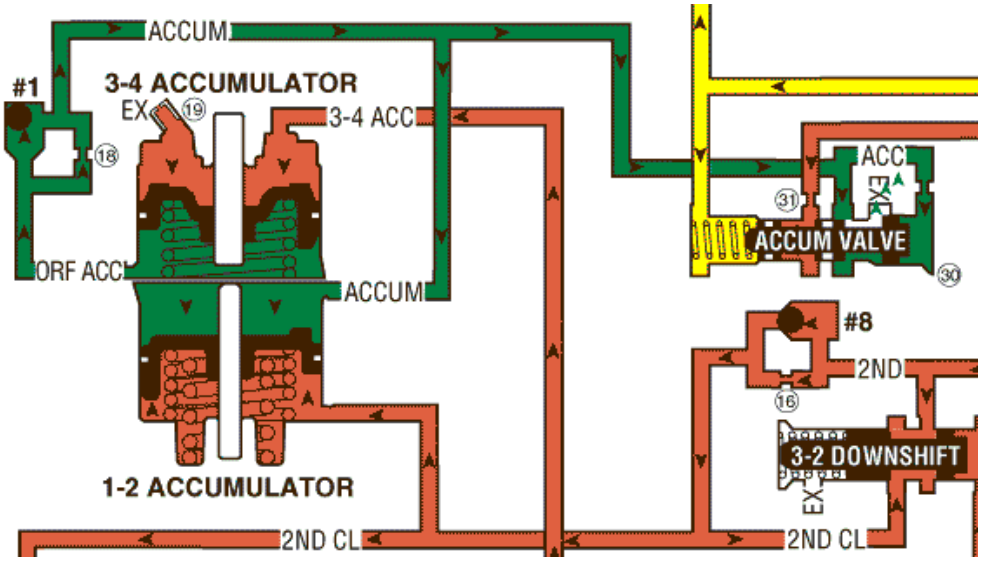
Accumulator Operation

- Accumulator Valve
  - Line pressure will enter the accumulator circuit until there's enough pressure to move the valve and cut off its own supply
  - Accumulator pressure and accumulator spring pressure opposes line pressure during the shift



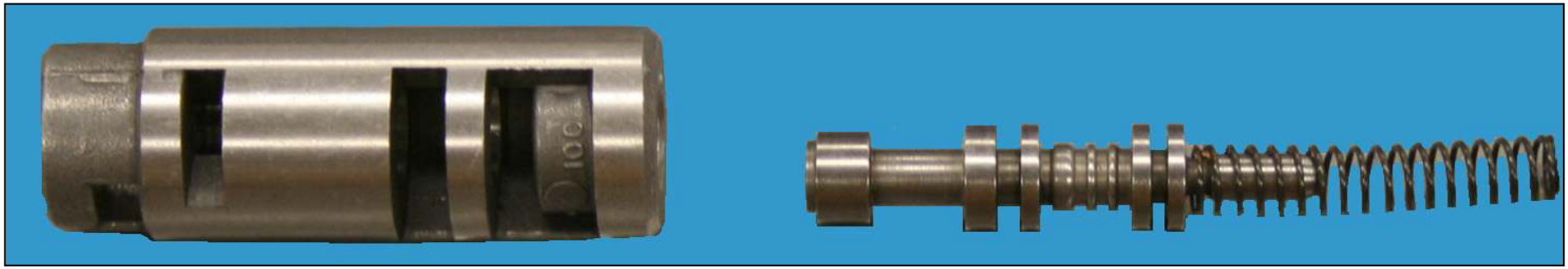
Accumulator Operation

- Accumulator Valve
  - Line pressure will have to at least match accumulator pressure before it will stroke the accumulator piston
  - Different valves and springs will alter the accumulator pressure, therefore they'll alter shift qualities



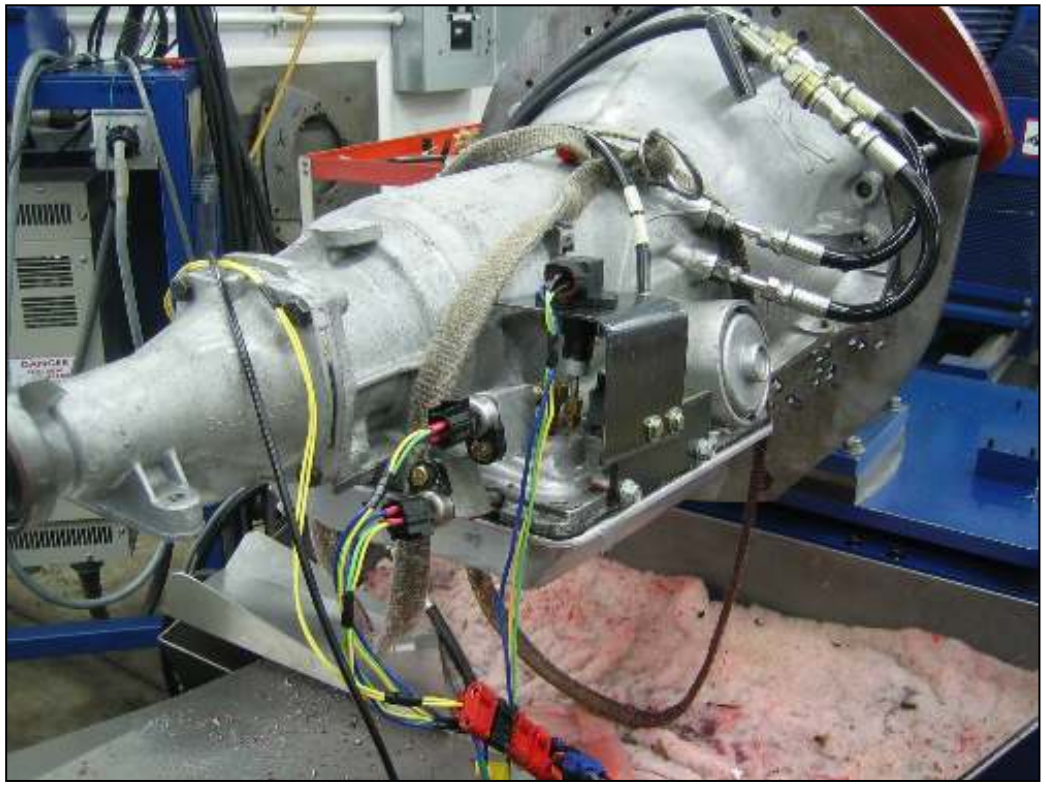
Accumulator Operation

- Accumulator Valve
  - Three valves available
    - .320” accumulator land
    - .345” accumulator land
    - .359” accumulator land
  - At least 5 different springs are available
    - Yellow
    - Red
  - Springs work with torque signal (PCS) on .397” land



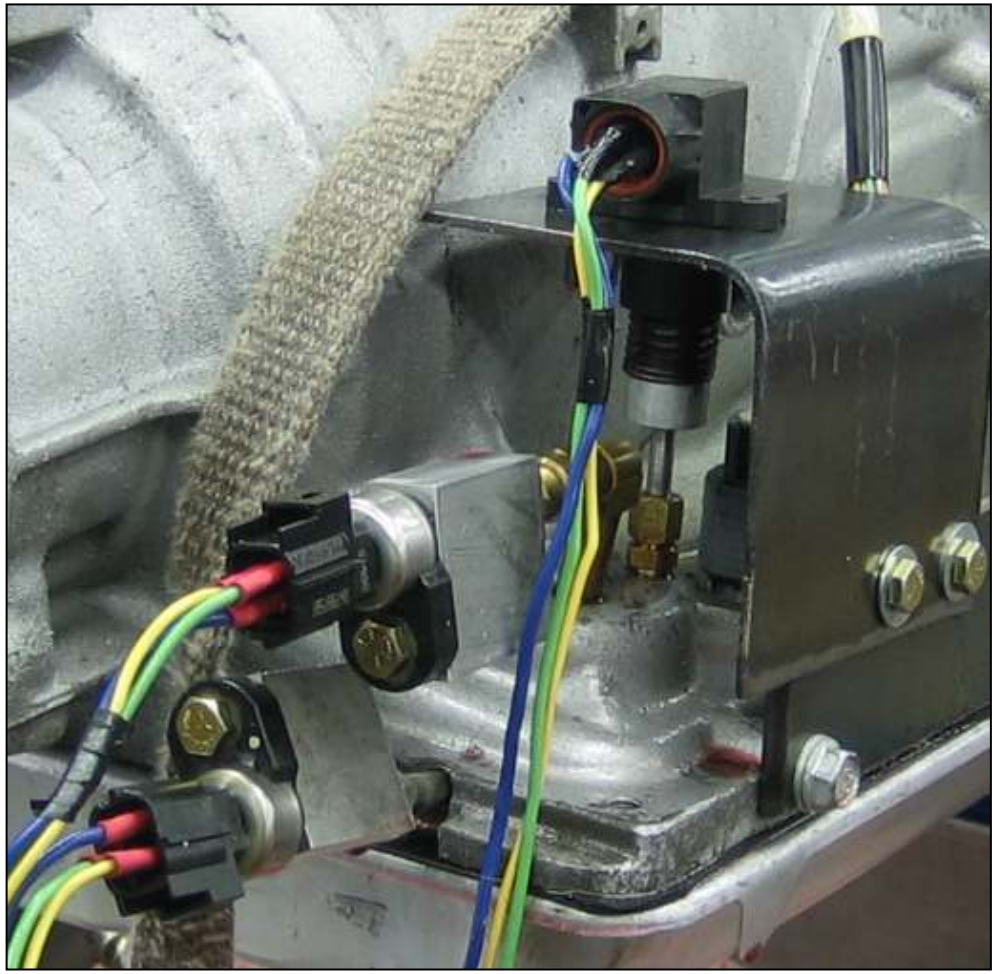
Accumulator Operation

- Accumulator Function on the 4L60E
  - 3-4 Accumulator
  - Plunger through the case contacting the back of the 3-4 accumulator
  - Ford EGR sensor measuring travel
  - 545RFE line pressure sensors used as pressure transducers for pico (set up custom probe)



Accumulator Operation

- Accumulator Function on the 4L60E
  - Line Pressure
  - Accumulator Pressure
  - 4th Servo Pressure
  - 3-4 piston travel

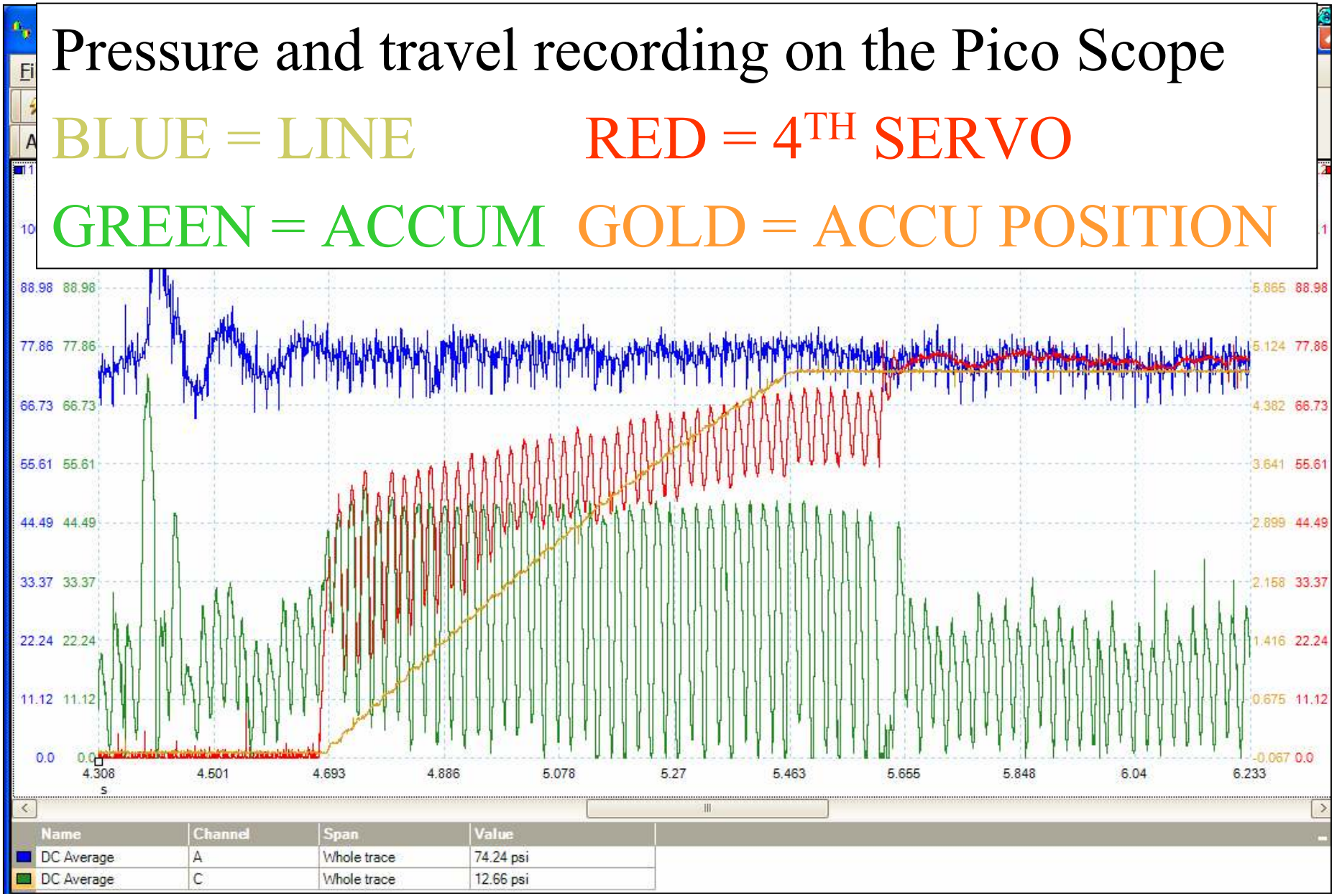


Accumulator Operation: 359 – Red – 75psi

Pressure and travel recording on the Pico Scope

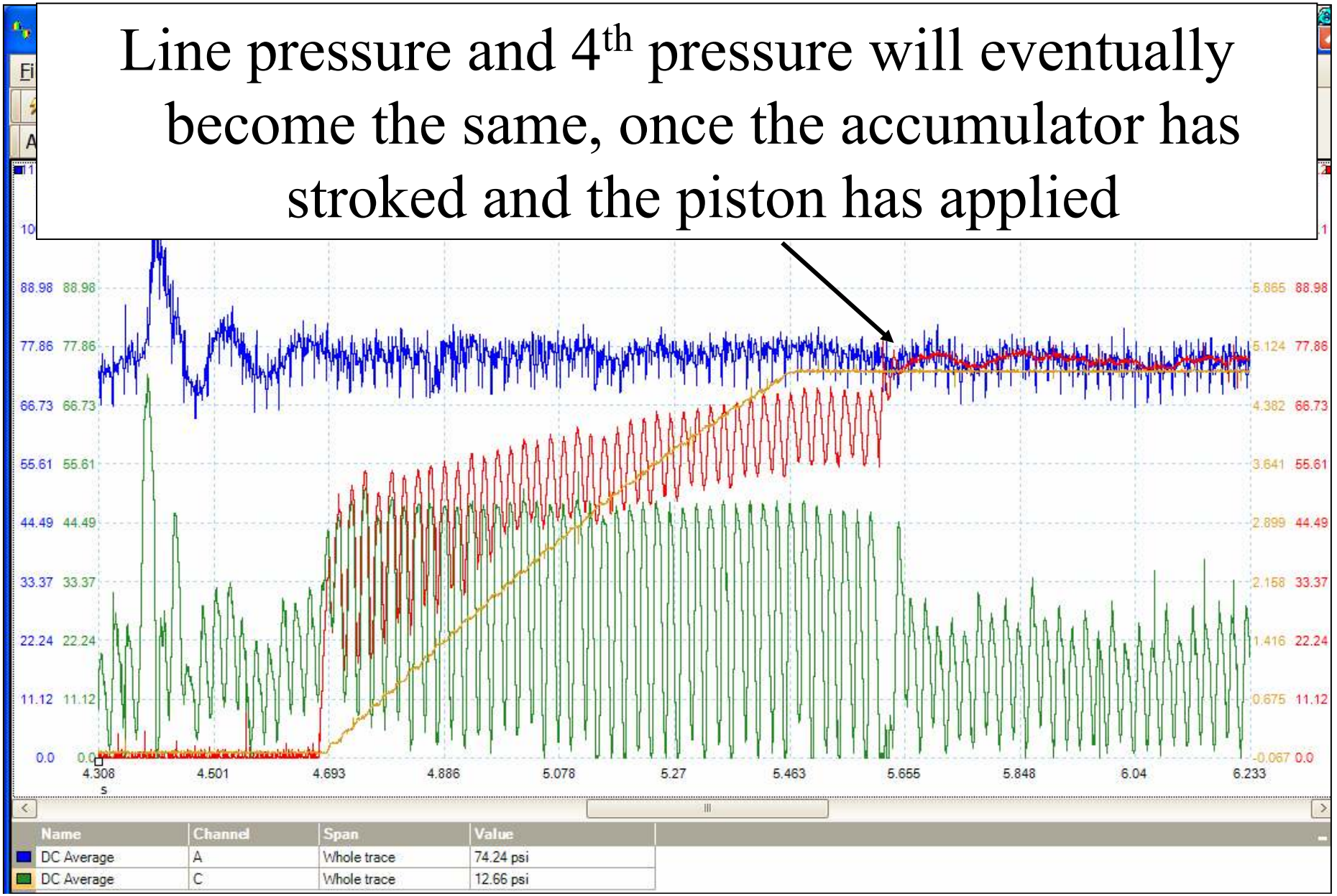
BLUE = LINE RED = 4TH SERVO

GREEN = ACCUM GOLD = ACCU POSITION



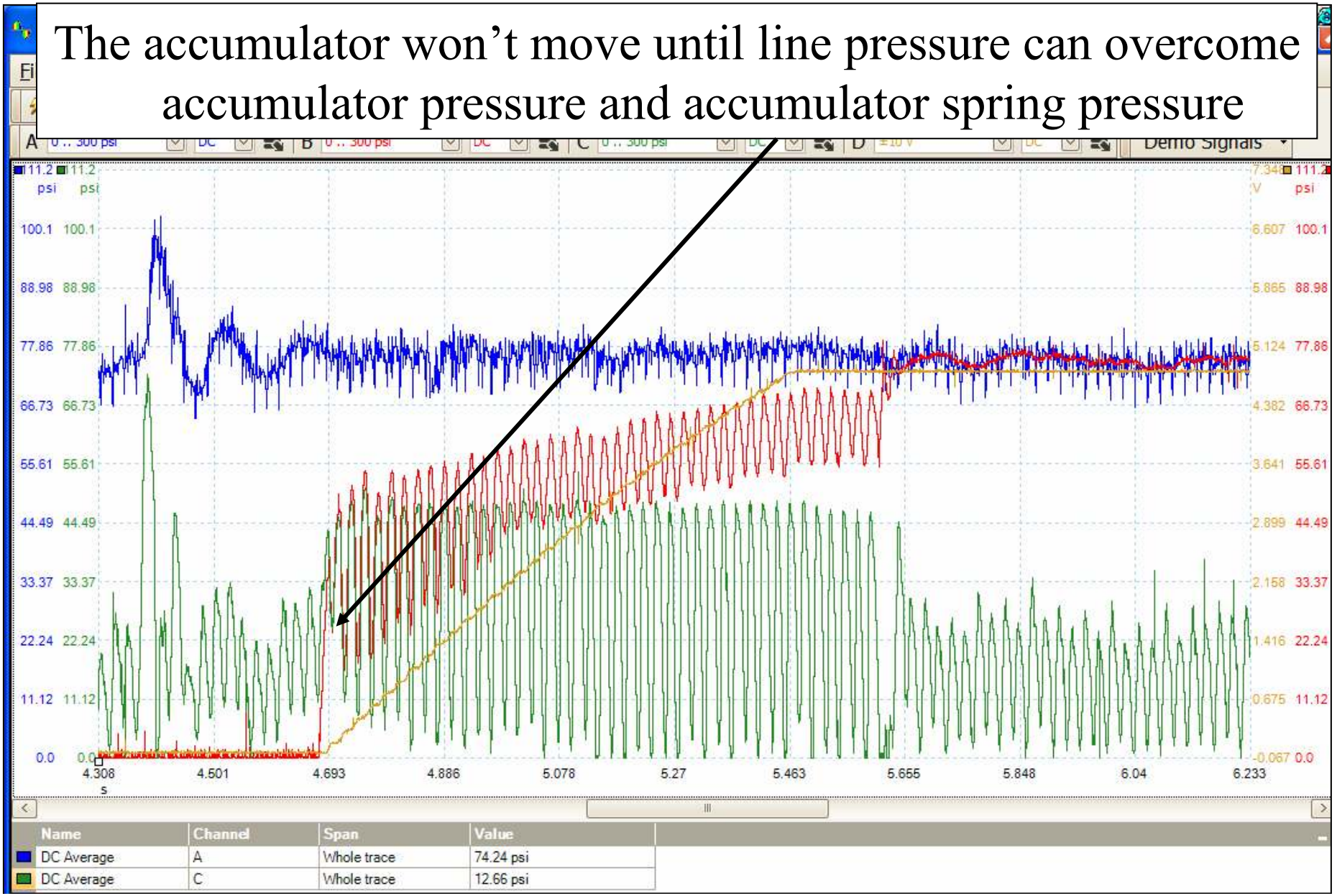
Accumulator Operation: 359 – Red – 75psi

Line pressure and 4th pressure will eventually become the same, once the accumulator has stroked and the piston has applied



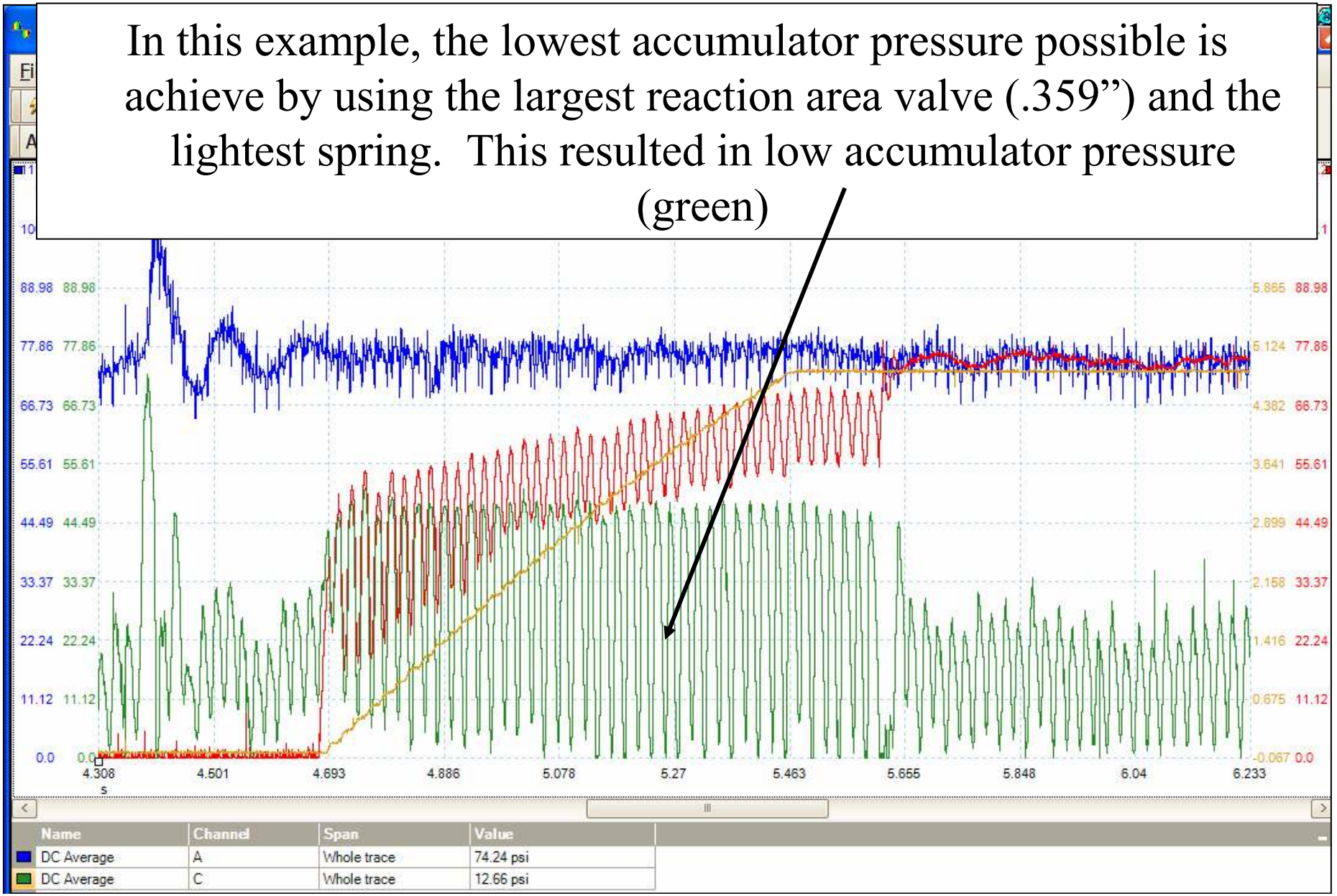
Accumulator Operation: 359 – Red – 75psi

The accumulator won't move until line pressure can overcome accumulator pressure and accumulator spring pressure



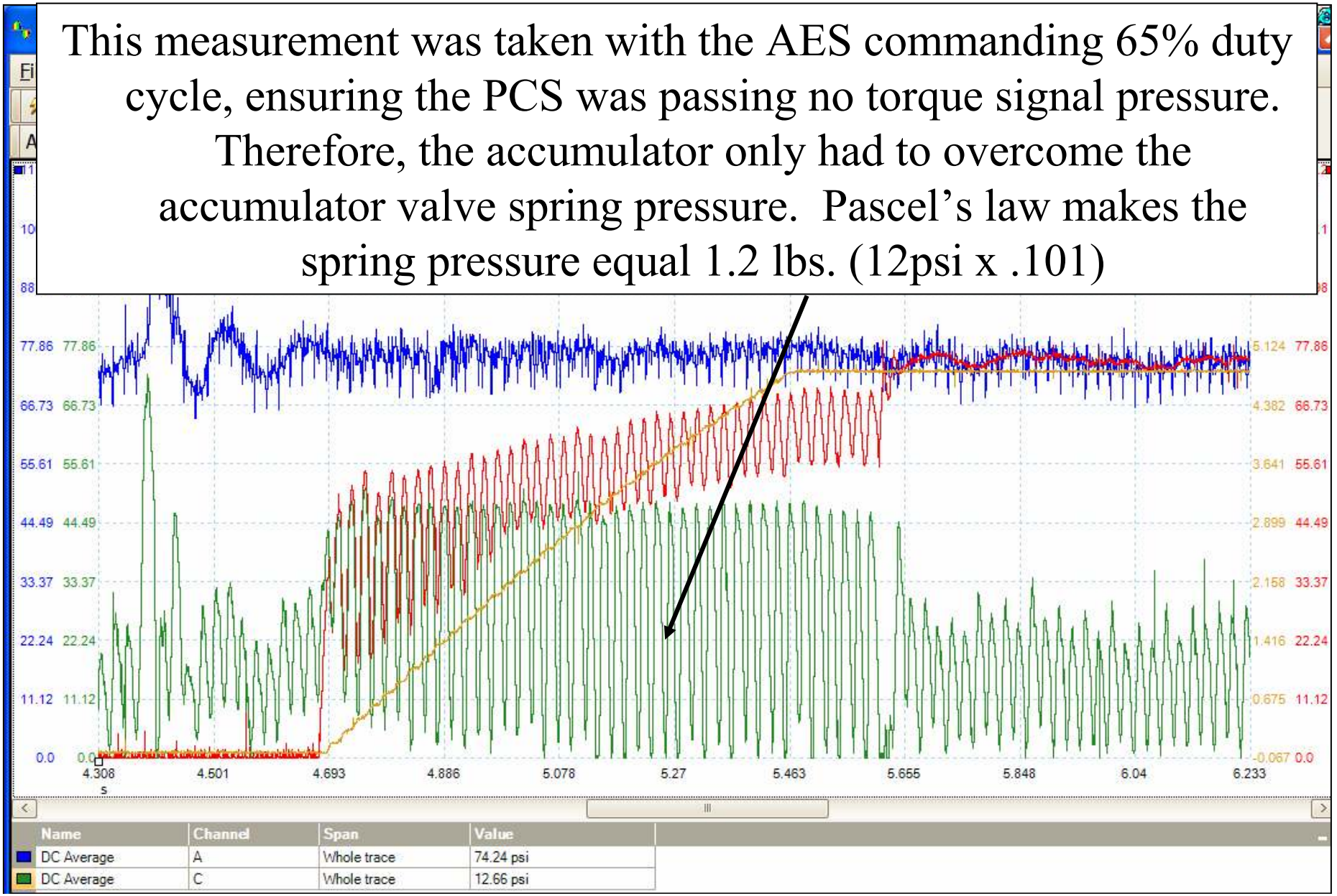
Accumulator Operation: 359 – Red – 75psi

In this example, the lowest accumulator pressure possible is achieve by using the largest reaction area valve (.359”) and the lightest spring. This resulted in low accumulator pressure (green)

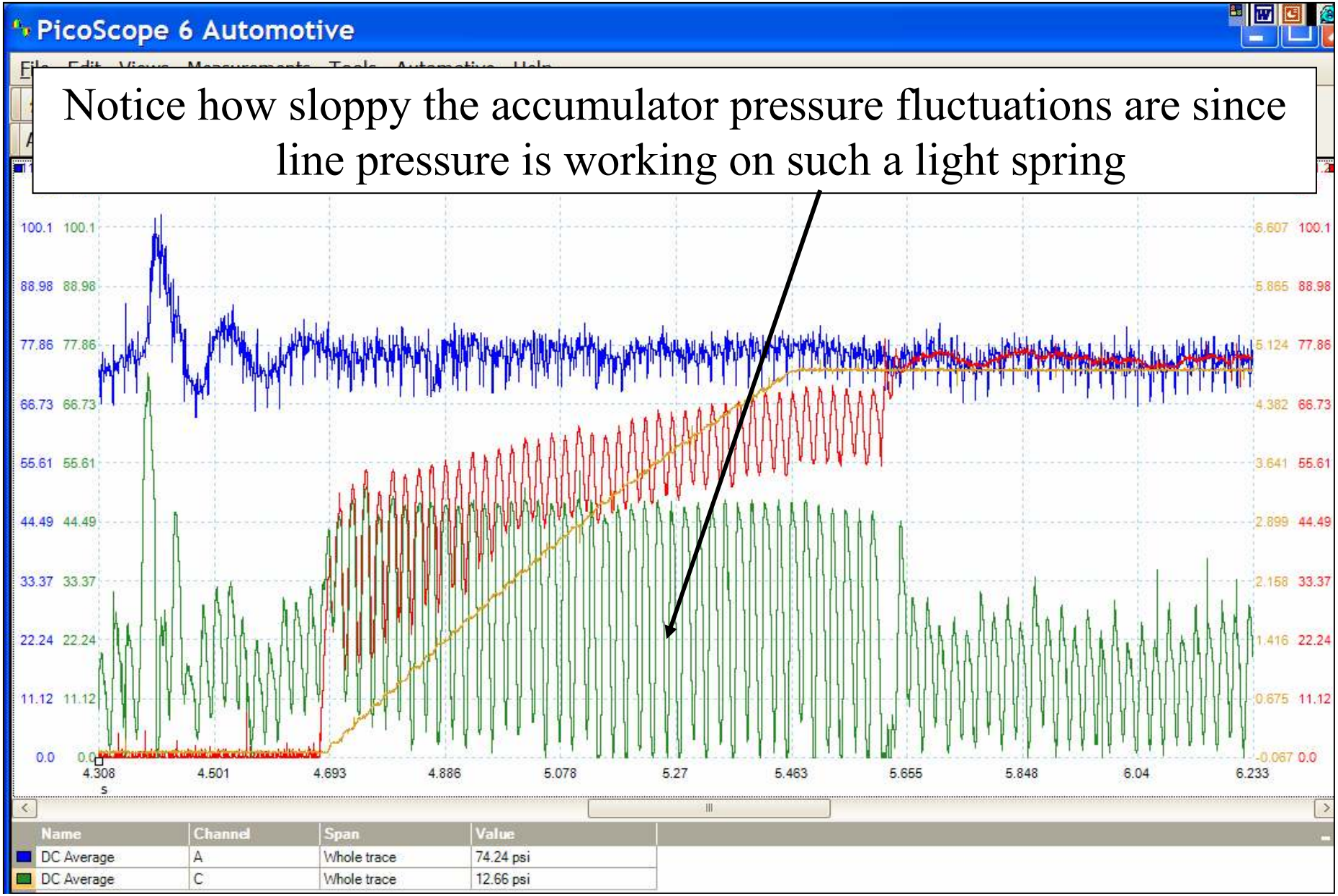


Accumulator Operation: 359 – Red – 75psi

This measurement was taken with the AES commanding 65% duty cycle, ensuring the PCS was passing no torque signal pressure. Therefore, the accumulator only had to overcome the accumulator valve spring pressure. Pascel's law makes the spring pressure equal 1.2 lbs. (12psi x .101)



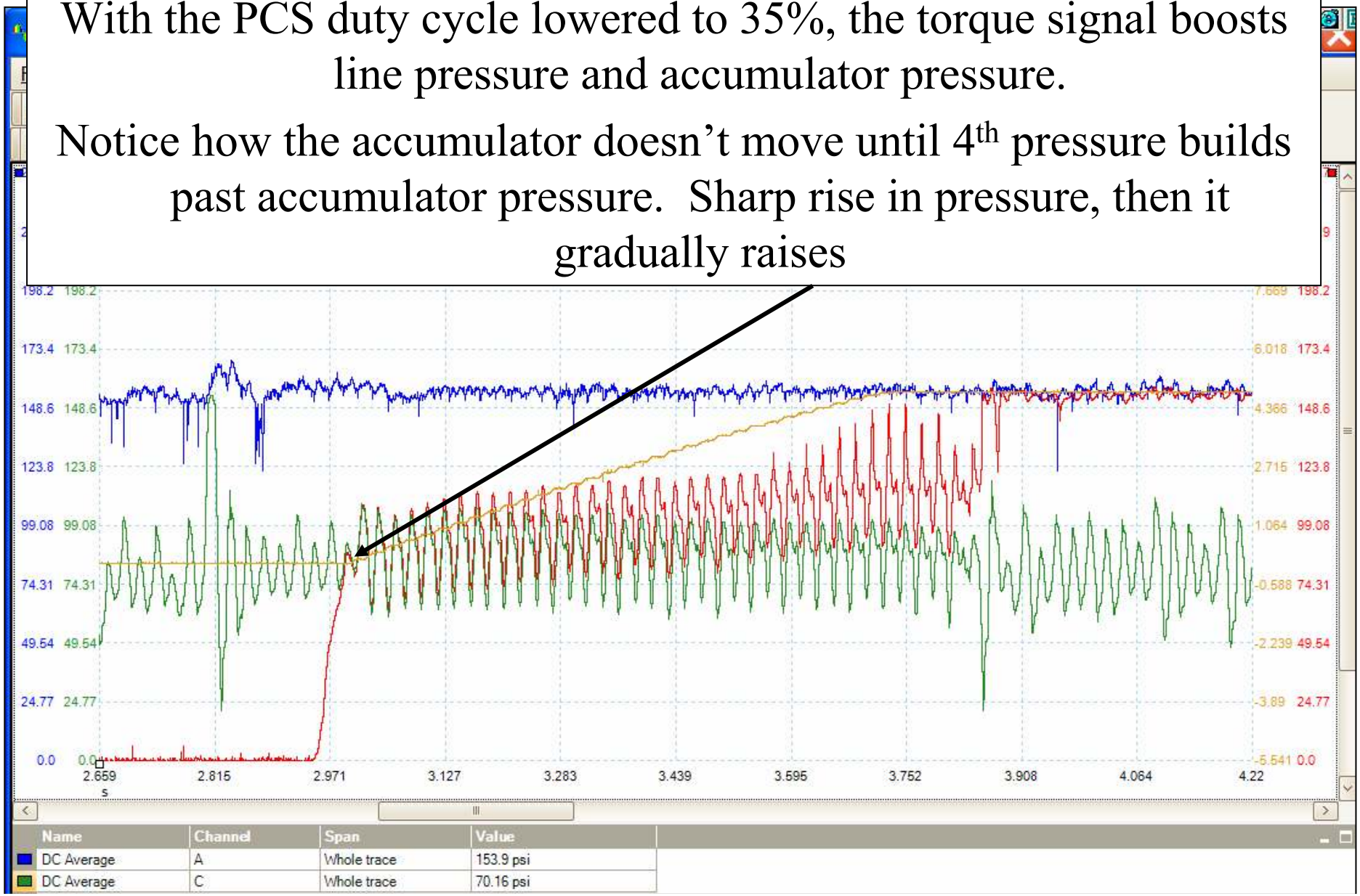
Accumulator Operation: 359 – Red – 75psi



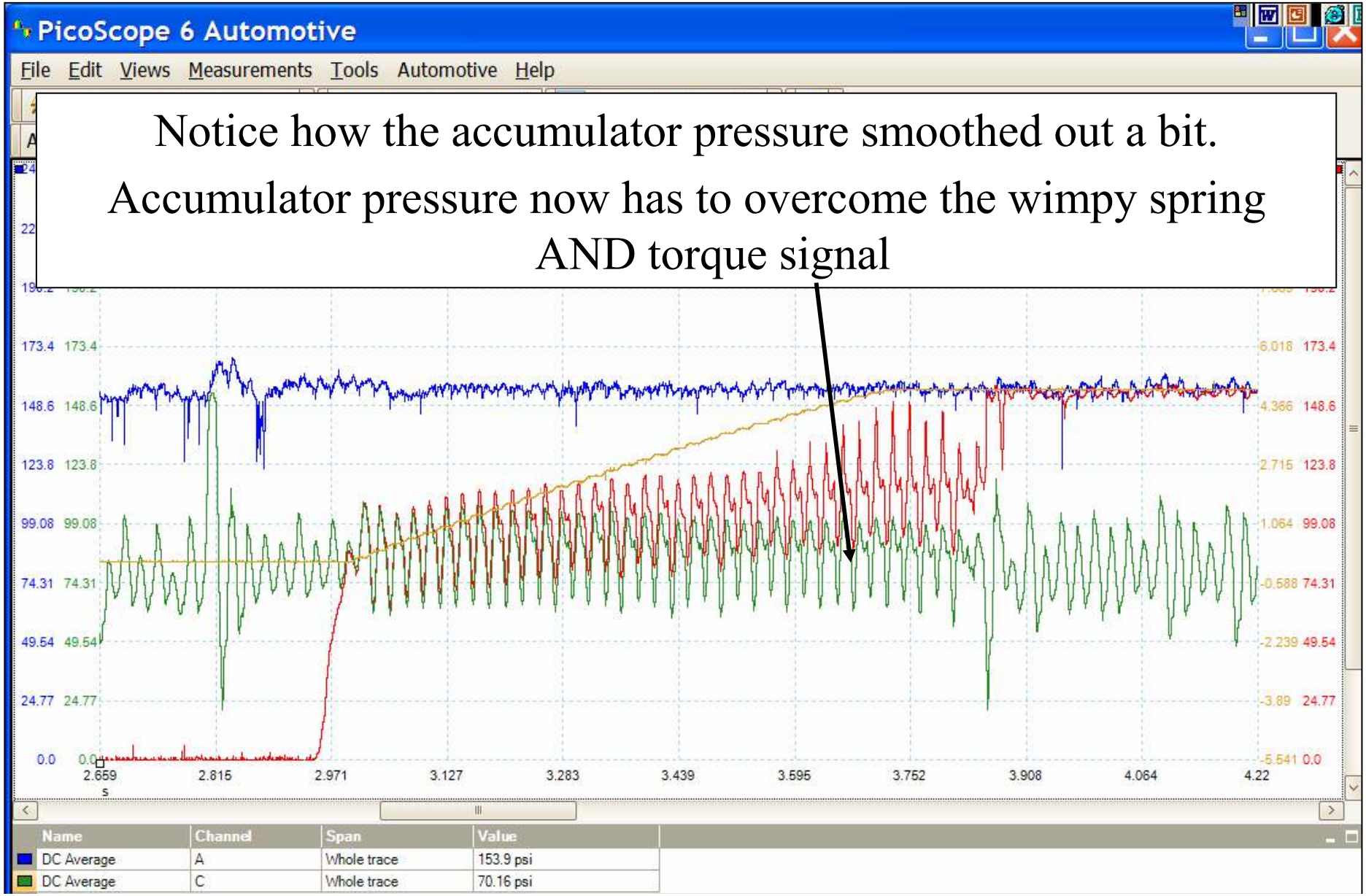
Accumulator Operation: 359 – Red – 150psi

With the PCS duty cycle lowered to 35%, the torque signal boosts line pressure and accumulator pressure.

Notice how the accumulator doesn't move until 4th pressure builds past accumulator pressure. Sharp rise in pressure, then it gradually raises



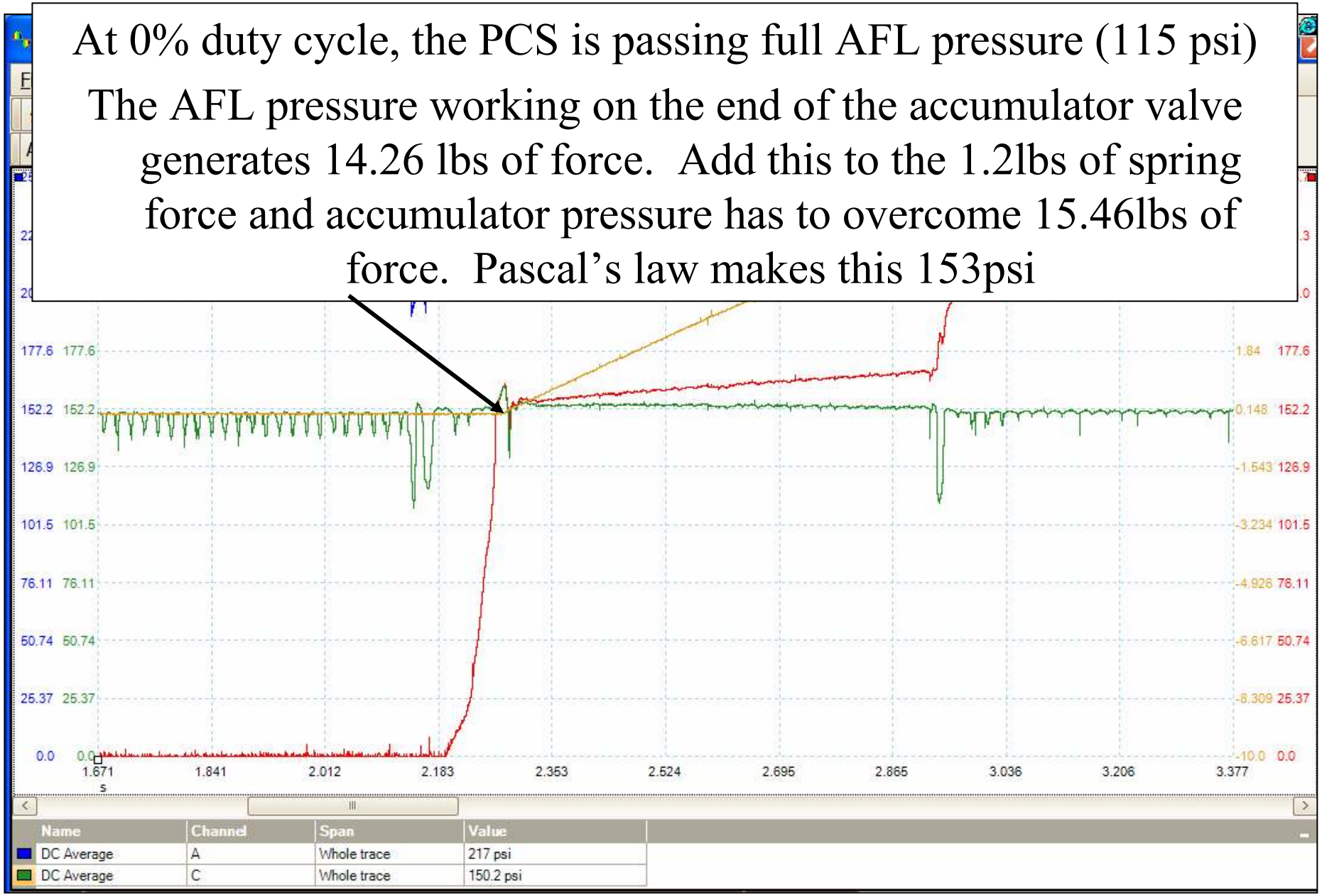
Accumulator Operation: 359 – Red – 150psi



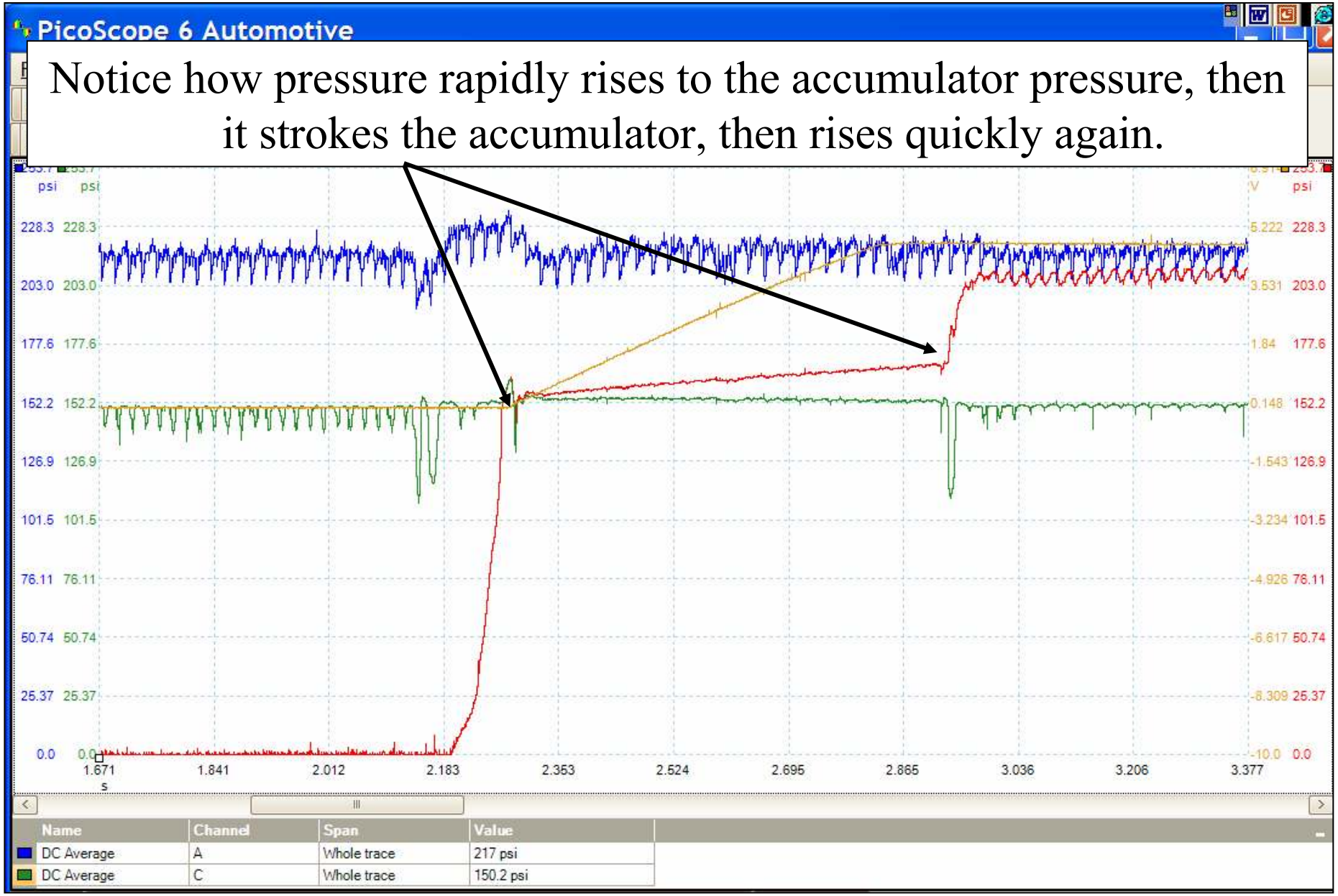
Accumulator Operation: 359 – Red – 220psi

At 0% duty cycle, the PCS is passing full AFL pressure (115 psi)

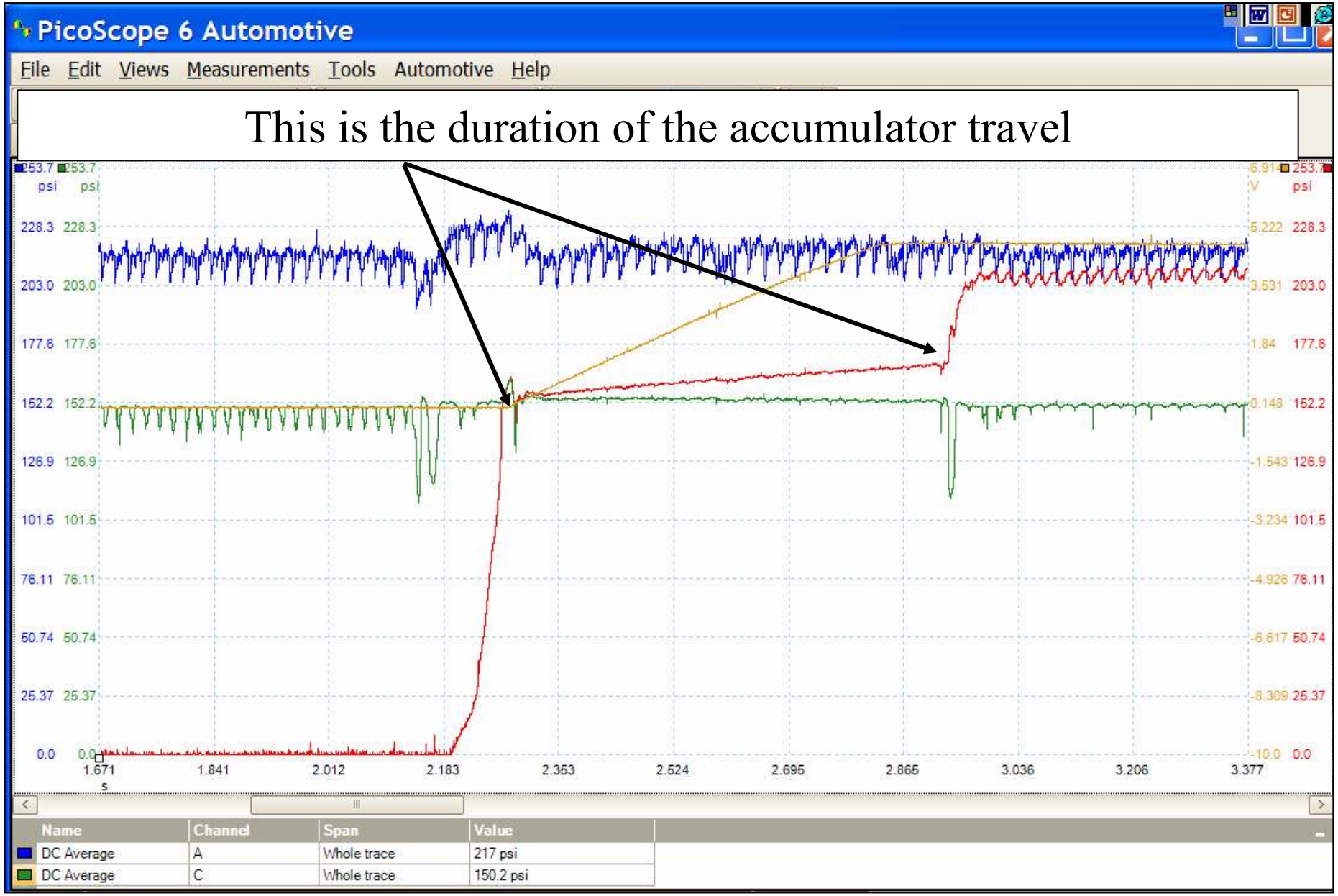
The AFL pressure working on the end of the accumulator valve generates 14.26 lbs of force. Add this to the 1.2lbs of spring force and accumulator pressure has to overcome 15.46lbs of force. Pascal's law makes this 153psi



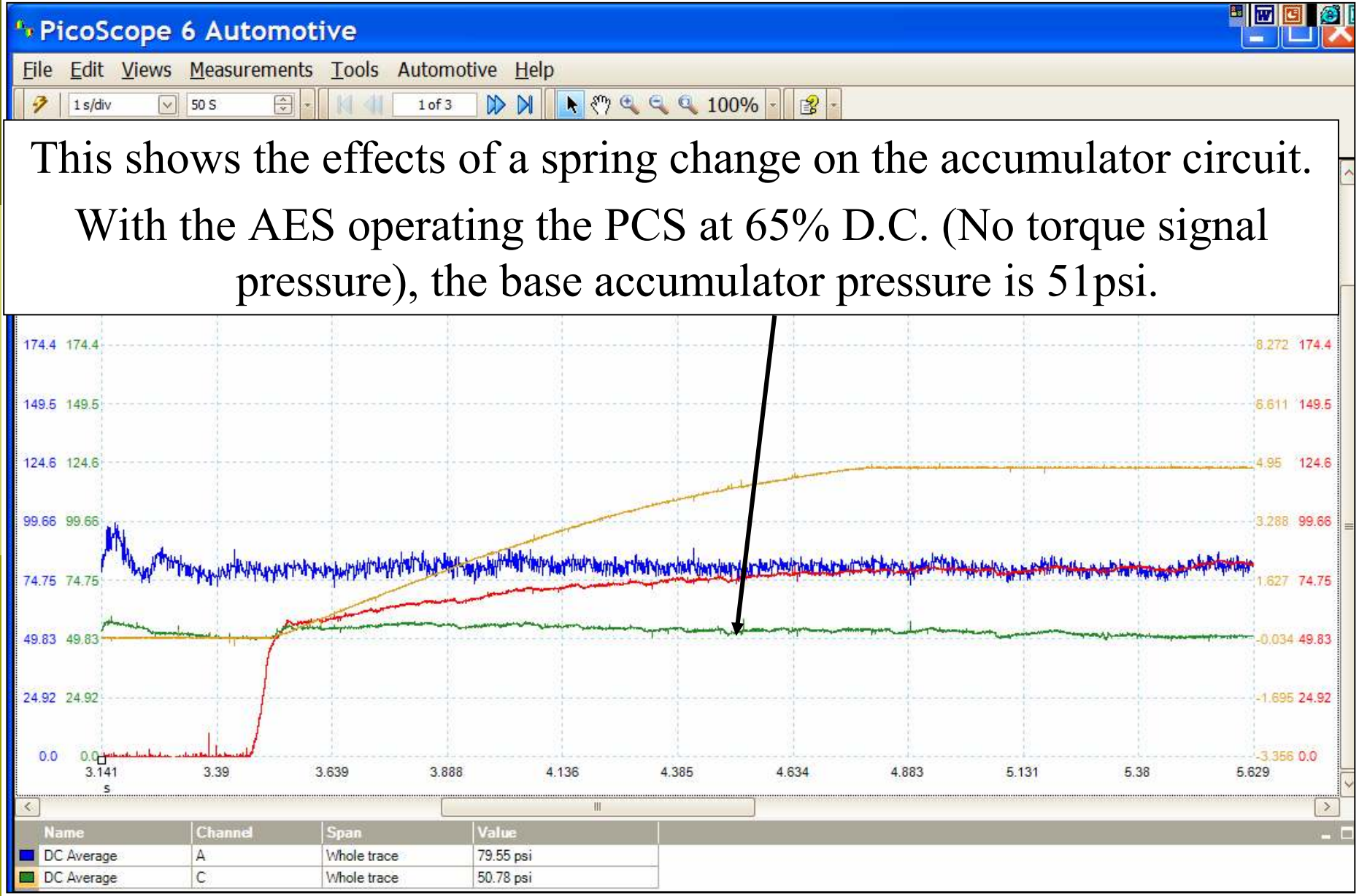
Accumulator Operation: 359 – Red – 220psi



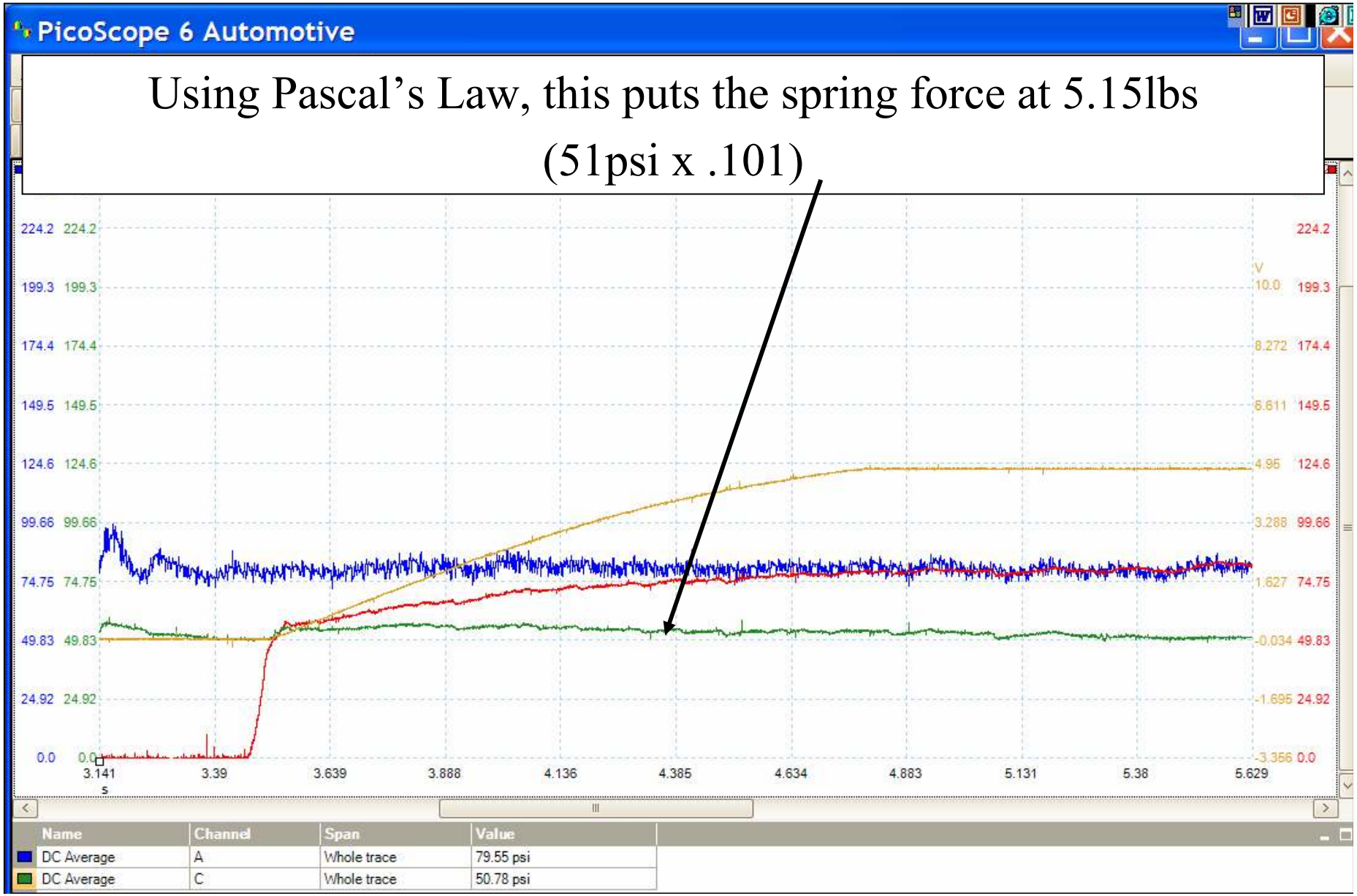
Accumulator Operation: 359 – Red – 220psi



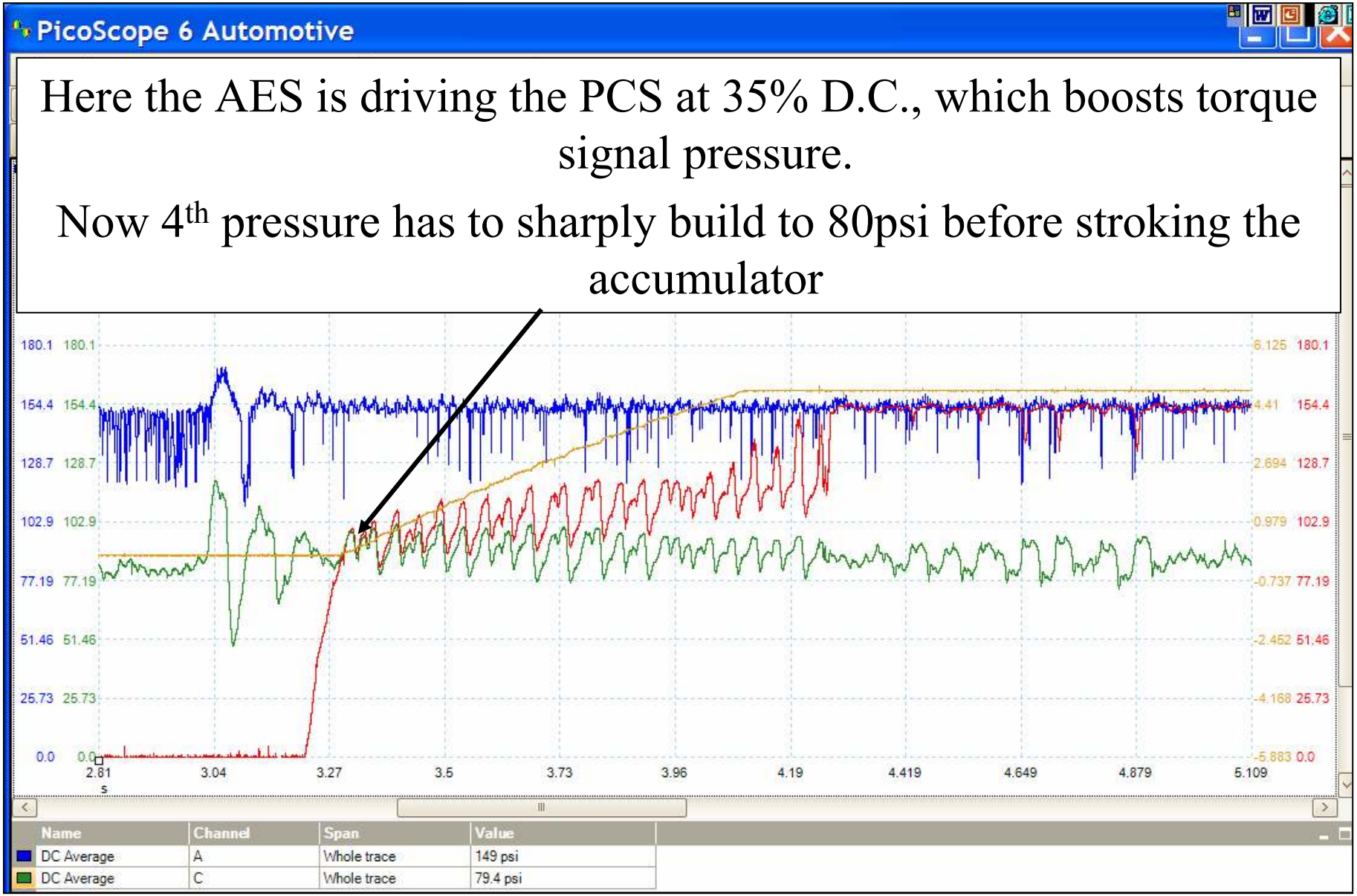
Accumulator Operation: 359 – Yellow – 75psi



Accumulator Operation: 359 – Yellow – 75psi

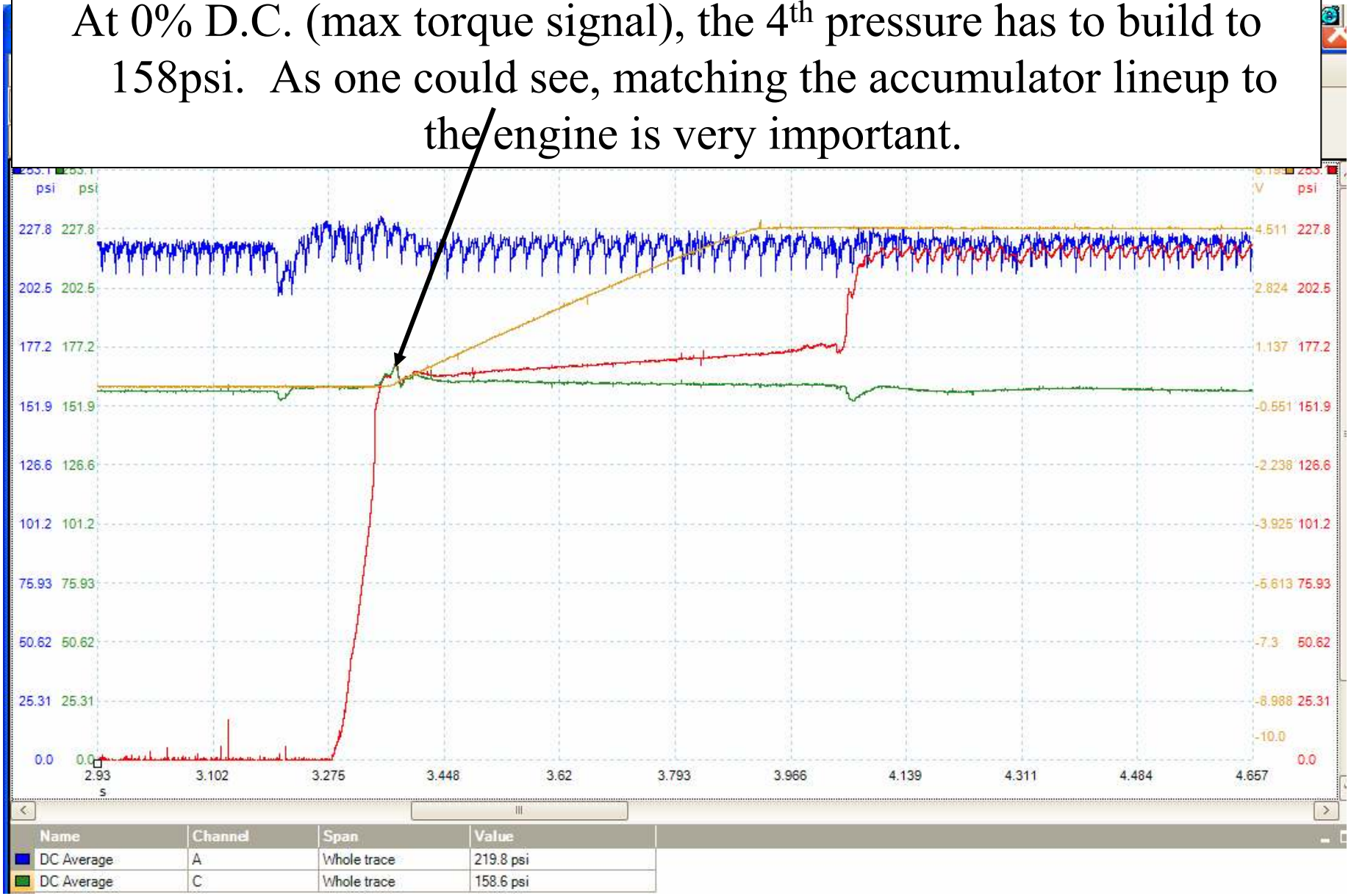


Accumulator Operation: 359 – Yellow – 150psi



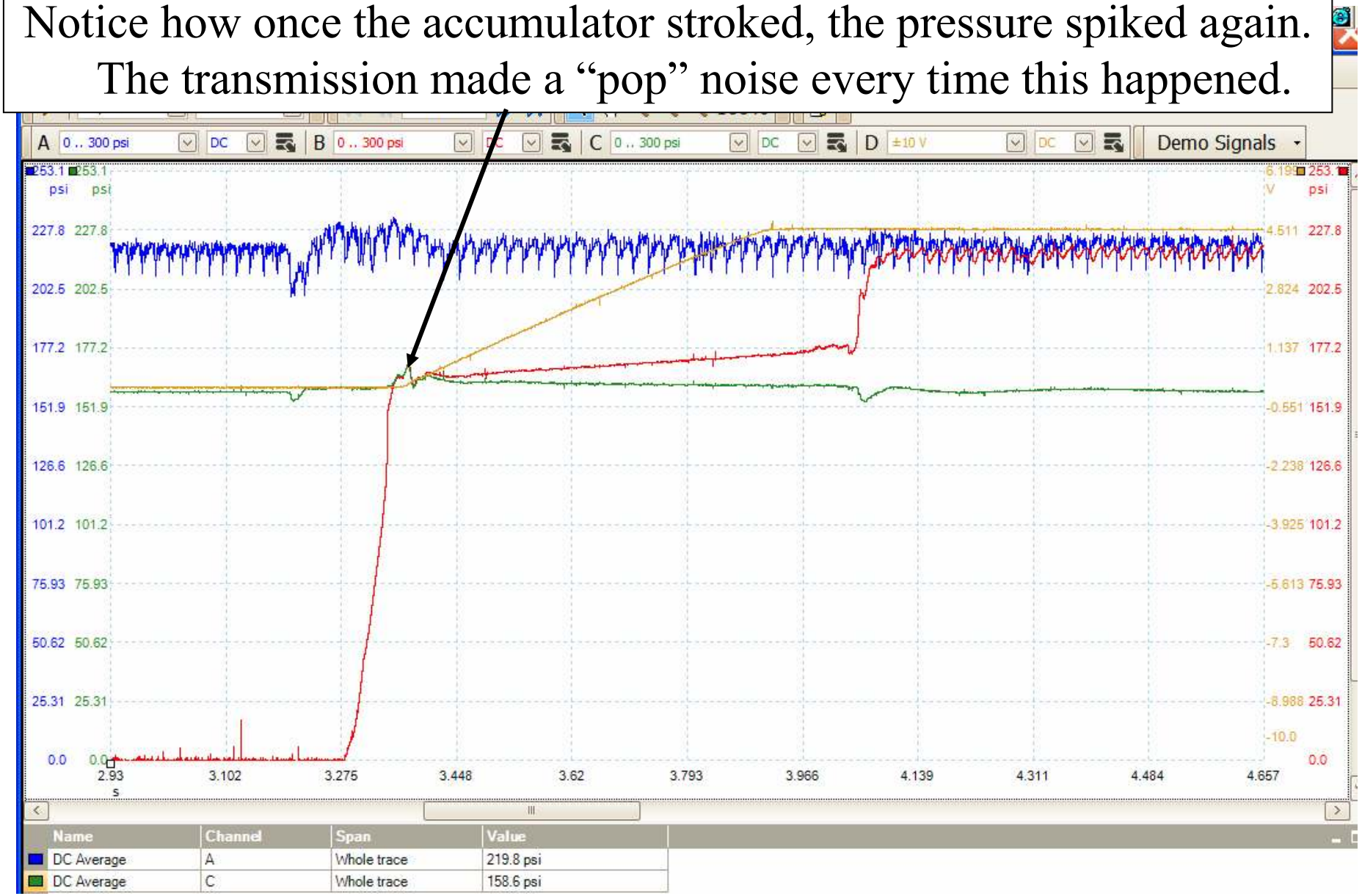
Accumulator Operation: 359 – Yellow – 220psi

At 0% D.C. (max torque signal), the 4th pressure has to build to 158psi. As one could see, matching the accumulator lineup to the engine is very important.

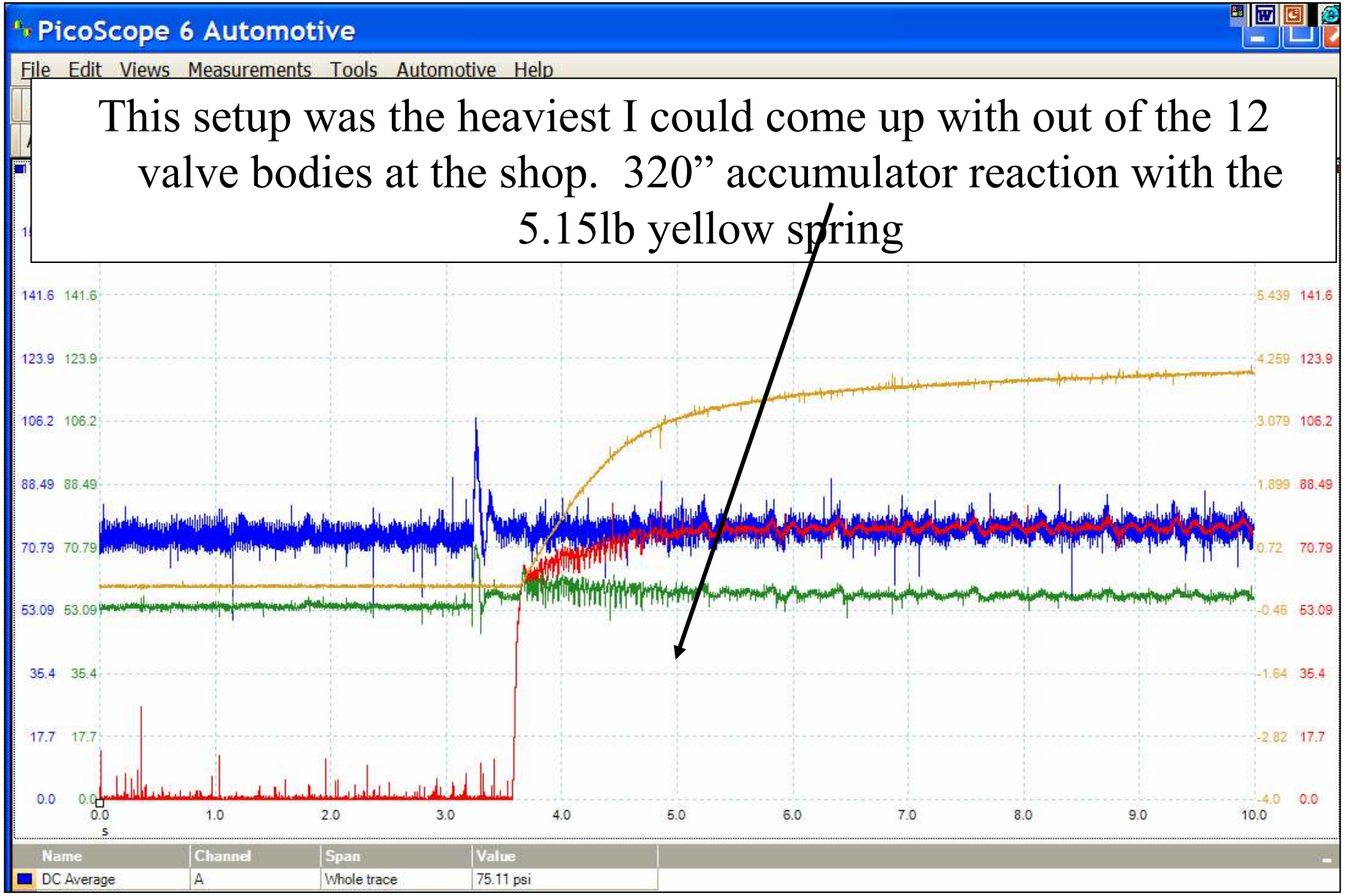


Accumulator Operation: 359 – Yellow – 220psi

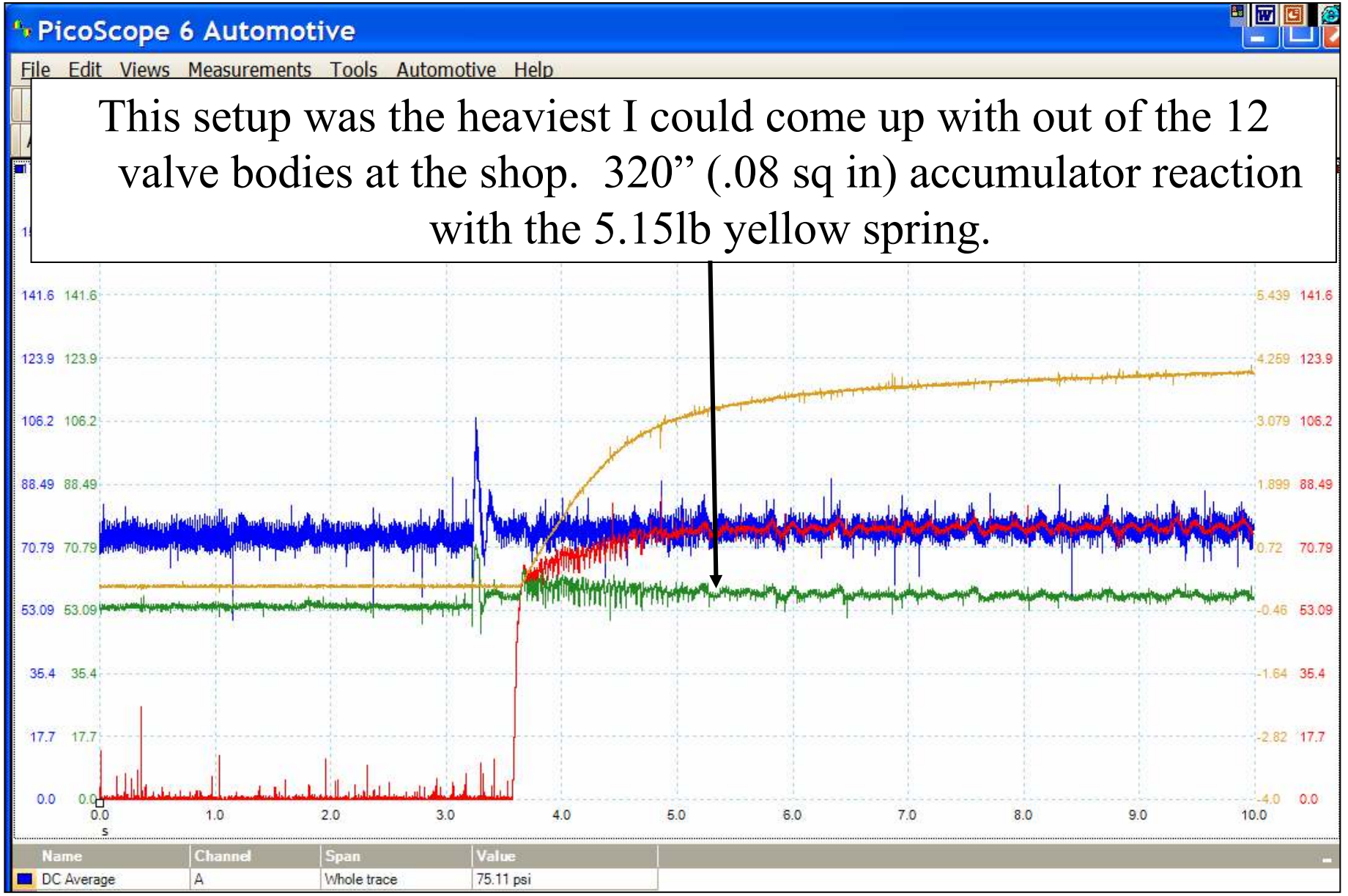
Notice how once the accumulator stroked, the pressure spiked again. The transmission made a "pop" noise every time this happened.



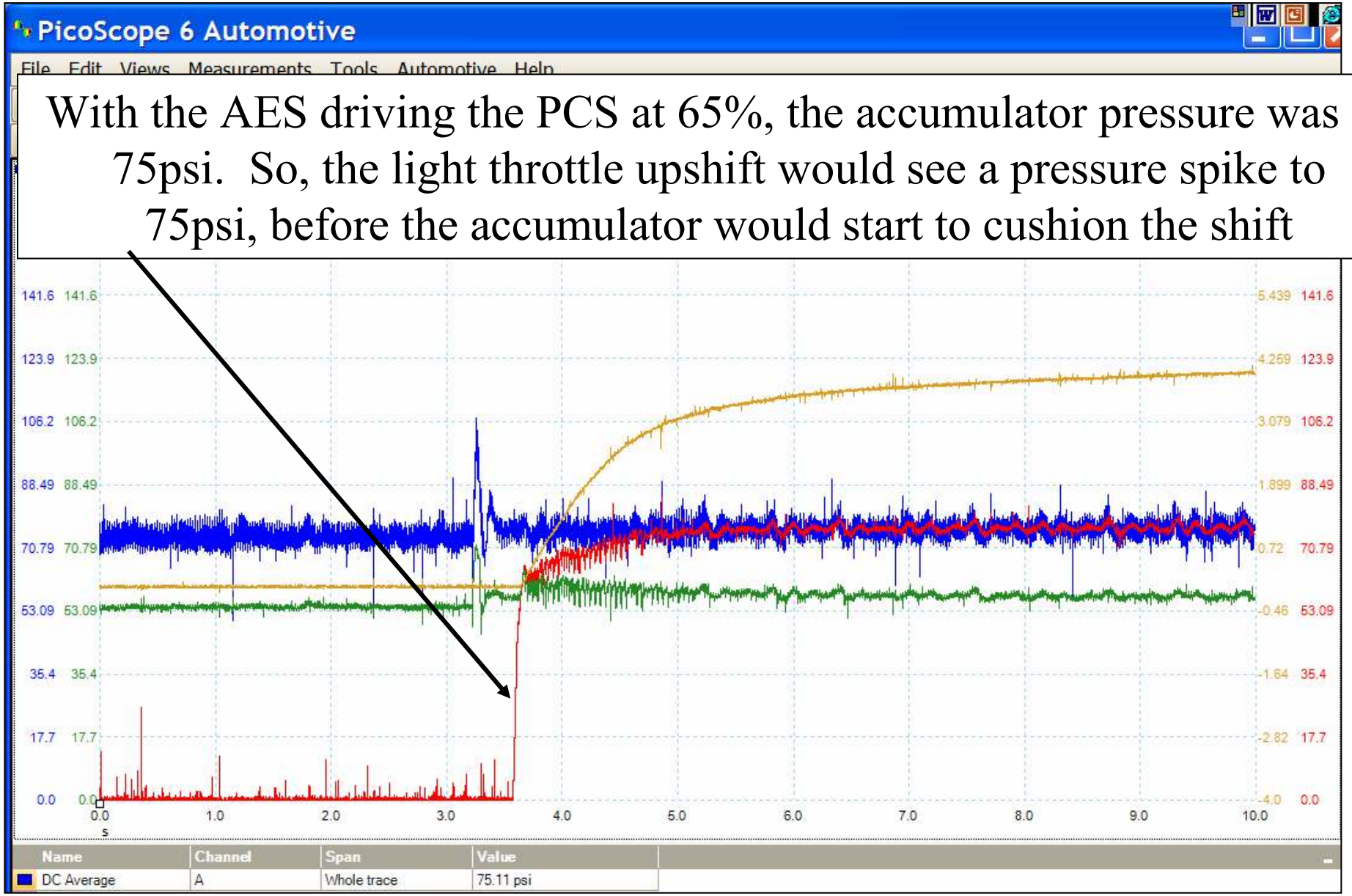
Accumulator Operation: 320 – Yellow – 75psi



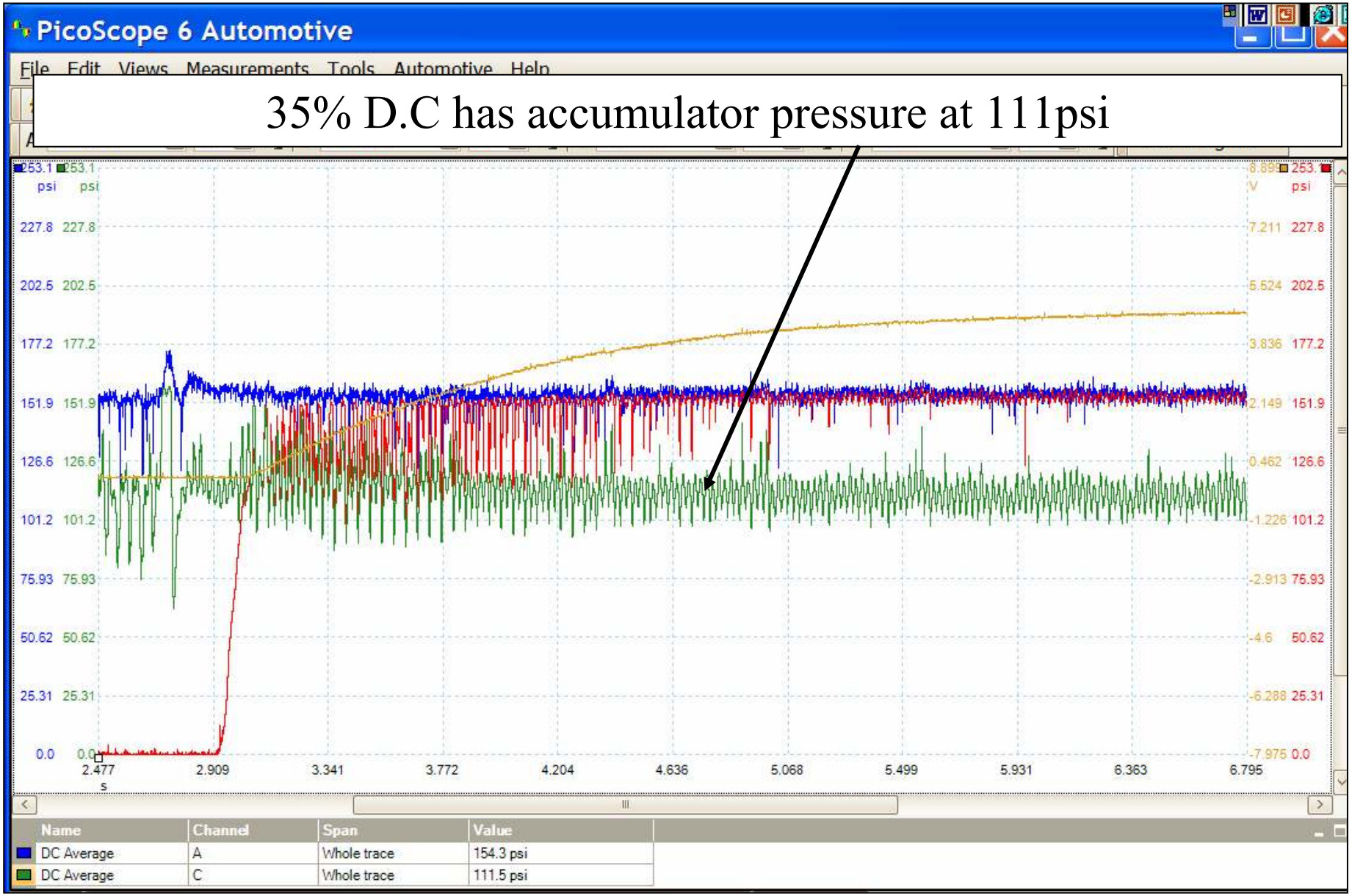
Accumulator Operation: 320 – Yellow – 75psi



Accumulator Operation: 320 – Yellow – 75psi



Accumulator Operation: 320 – Yellow – 150psi



Accumulator Operation: 320 – Yellow – 210psi