

## AUTOMOTIVE PRESSURE PULSE SENSOR

### GENERAL DESCRIPTION

Since 2004, widely used in the diagnosis of engines is a method called "First Look diagnostics for initial inspection".

This sensor can be encountered under several different names but in the end it comes to the same device.

Some of the most commonly used names are:

- First Look Sensor;
- Automotive Pressure Pulse Sensor (PPS);
- Intake manifold sensor (Датчик разряжения).

**Note: Pressure Pulse Sensor is suitable for measuring pressure fluctuations in gas only! It is not suitable for measuring fluid pressure fluctuations!**

Some of the advantages of the Pressure Pulse Sensor are:

- Fast and easy connection;
- Locate cylinder problems thru the exhaust pulses;
- Detect valve leakage, cylinder compression;
- Find injector problems.

**Note:** Pressure Pulse Sensor (PPS) doesn't measure the static pressure. It can be used only to display the pressure changes. It's a transducer that converts changes in the gas pressure to an electrical signal.

In internal combustion engines during normal operation, pulsating pressure waves are generated in various car systems. All engines produce such waves and their shape can be predicted. Any change in the shape or asymmetry of these pulses, indicate an engine problem.

The Pressure Pulse Sensor is unique because it looks at pulses in engine airflow, allowing you to display "engine pulse" on standard oscilloscope. Engine analyzers tell us what the ignition system or sensors are doing, but it is difficult to see what actually happens in the engine without intrusive tests. With the Pressure Pulse Sensor it is possible to see what is dynamically occurring in your engine.

With the Pressure Pulse Sensor you can now have a more complete picture of an engine's performance, quickly and easily. Once you have learned to use the sensor combined with the timing chart you will be able to observe the real-time operation the valves, cylinders and injectors and thereby find burnt valves, bad (dirty) injectors, wrong timing and other engine performance problems without major disassembly of the engine. By using the first cylinder for synchronization, a faulty cylinder can be determined.

Engine problems will always cause a fluctuation of the waveform that extends above or below the average of the other cylinders. This is where comparative analysis of cylinders becomes important. In general the more symmetrical the waveform and distribution above and below the zero reference line, the better the condition of the engine.

Pressure Pulse Sensor does not need an external power supply and it can be used with most of the modern digital storage oscilloscopes (motor testers).

With this sensor you can also determine the degree of contamination of the injectors without having them dismantled. For this purpose, the pulse sensor must be connected to the fuel pressure vacuum regulator.

This method can only be applied to systems with sequential injection, and cannot be used in systems with double-parallel and parallel-injection.

In the fuel injection system, fuel pressure is maintained relatively constant with the help of the fuel pressure regulator. It maintains a constant pressure by returning part of the fuel back in the fuel tank. Operation principle is based on a membrane which on one side is pushed by a tarred spring and from the other side is applied the fuel pressure.

Once the fuel pressure exceeds the force of the spring, membrane diaphragm moves and opens the valve to return the fuel in the tank, which reduces the fuel pressure. Thus, the pressure is maintained at a normal operating value. When injector opens part of the fuel passes through it, which leads to reduction of the pressure in the fuel rail. The membrane of the pressure regulator inclines in the other direction and thus closing the return valve partly and thus compensating the fuel pressure. This process requires some time. By how much the membrane has been moved to compensate the fuel pressure reduction at the opening of the injectors depends on the amount of fuel passed through the injector. When the injector closes the reverse process begins, the membrane is tilted in the opposite direction to compensate the emerging high pressure that enters the fuel pump.

These constant fluctuations of the membrane during normal engine operation can be displayed on the oscilloscope screen.

## DITEX PRESSURE PULSE SENSOR

Technical specifications	
Min. Pressure	0.2 bar (-0.8 bar in vacuum)
Max. Pressure	4.5 bar absolute pressure (3.5 bar atmospheric pressure)
Minimum conversion rate*	1 Hz
Maximum conversion rate*	5000 Hz
Output signal type	Voltage pulses
Output range	±0.5V; ±1V; ±2V; ±5V; ±10V
Power supply	Not needed
Electrical connector	BNC 50 ohm connector for RG58 cable
Pressure connector	6mm (1/4 inch) bronze hose nozzle
Weight (main unit)	Approximately 0.1 kg
Weight (basic set)	Approximately 0.4 kg

\* Conversion rate means how fast the input pressure is converted to an output electrical signal.

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**Note:** Ditex Pressure Pulse Sensor (PPS) doesn't measure the static pressure. It can be used only to display the pressure changes. It's a transducer that converts changes in the gas pressure to an electrical signal.

## HOW THE PPS DIFFERS FROM THE OTHER PRESSURE SENSORS

■ Conventional electronic pressure sensors are very similar to ordinary pressure gauges. They measure the static pressure to which they are exposed. Their output is a variable voltage corresponding to this static pressure. This voltage out is displayed using a digital voltmeter and calibrated so that the meter indicates the static pressure. For example, an electronic pressure sensor used with a digital scope would result in an output similar to the one below.

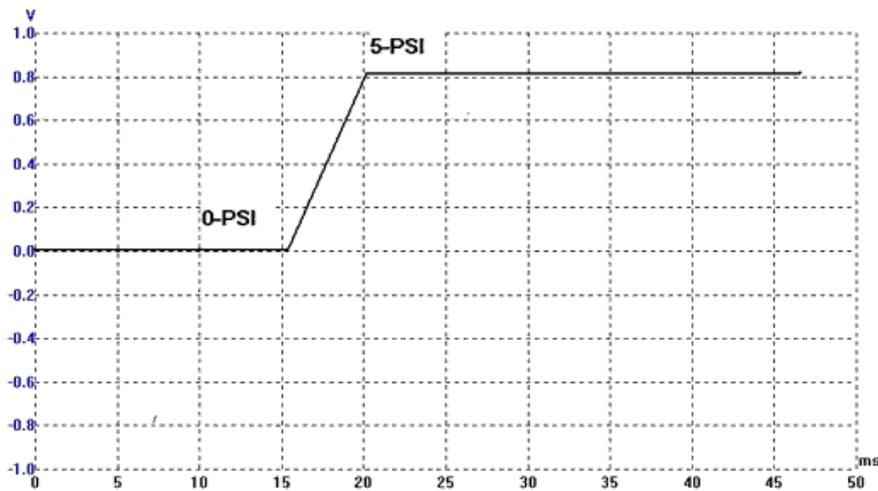


Fig.1

■ The First look Pulse Sensor is designed to look at variations in pressure and ignore the average, or static, pressure in any given environment. In other words, it only sees the changes in pressure from the recent average pressure. For example, the Pressure Pulse Sensor in response to the pressure trace in the above examples would look like this:

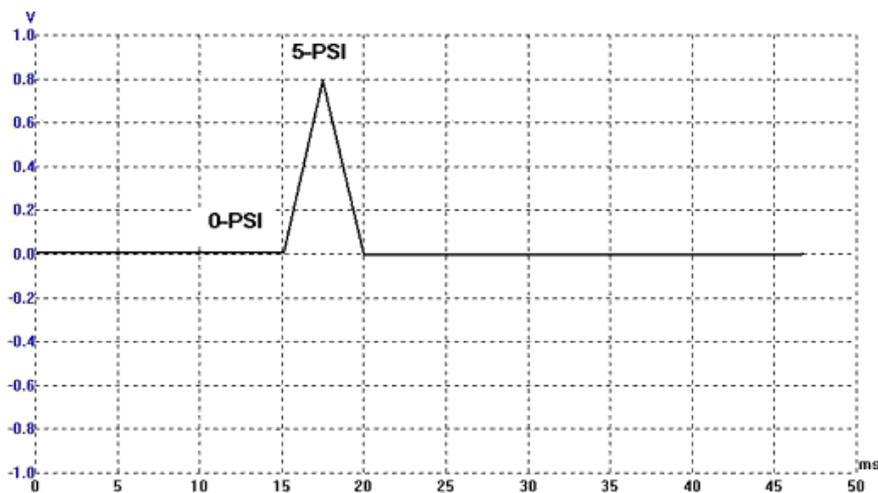


Fig.2

## TYPICAL APPLICATION

By using the "Pressure Pulse Sensor" you can observe:

- Exhaust gases pulsation
- Changes in the intake manifold gases pressure
- Fluctuations of the membrane in the fuel pressure regulator
- Crankcase gases etc.

## REFERENCE WAVEFORMS

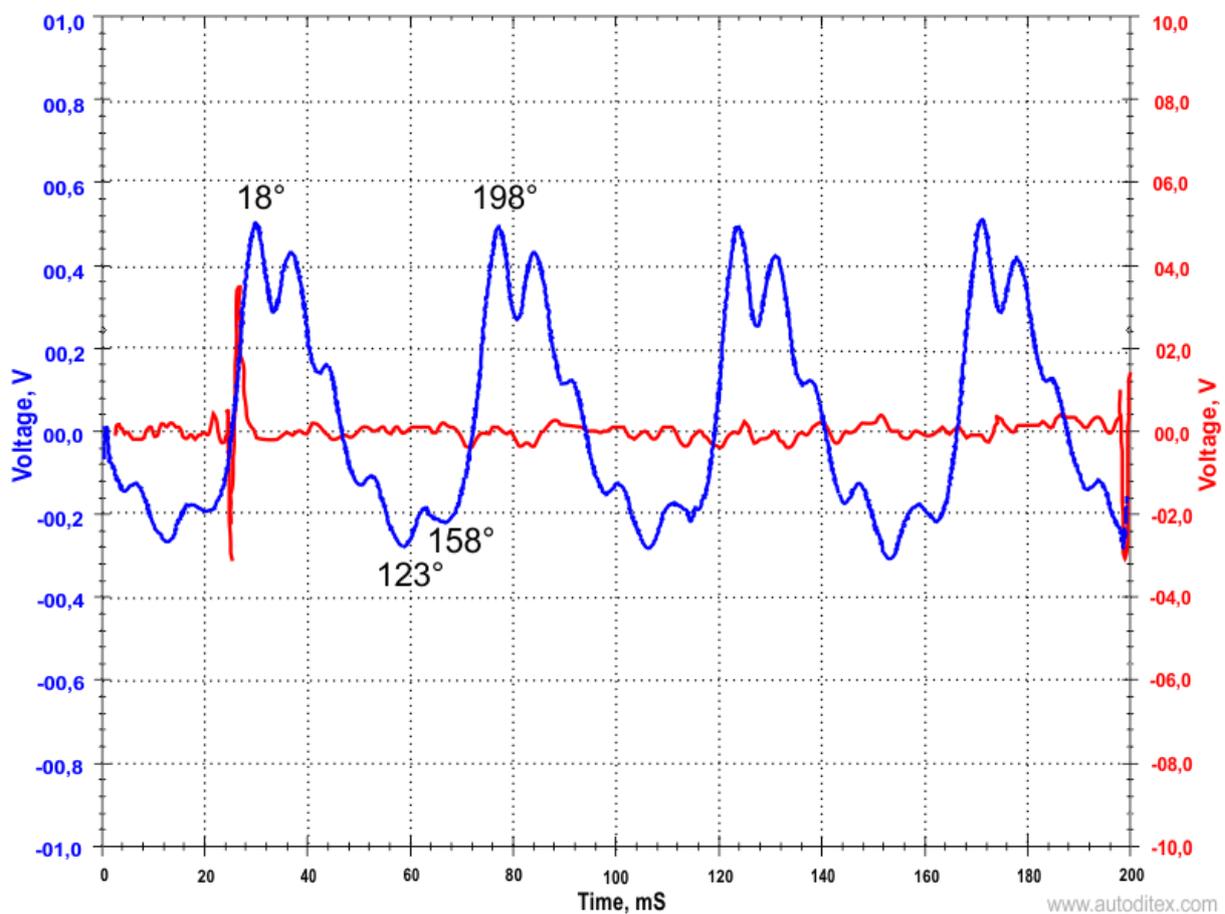


Fig.3. Pressure Pulse Sensor intake manifold pulses and the first cylinder sync signal.

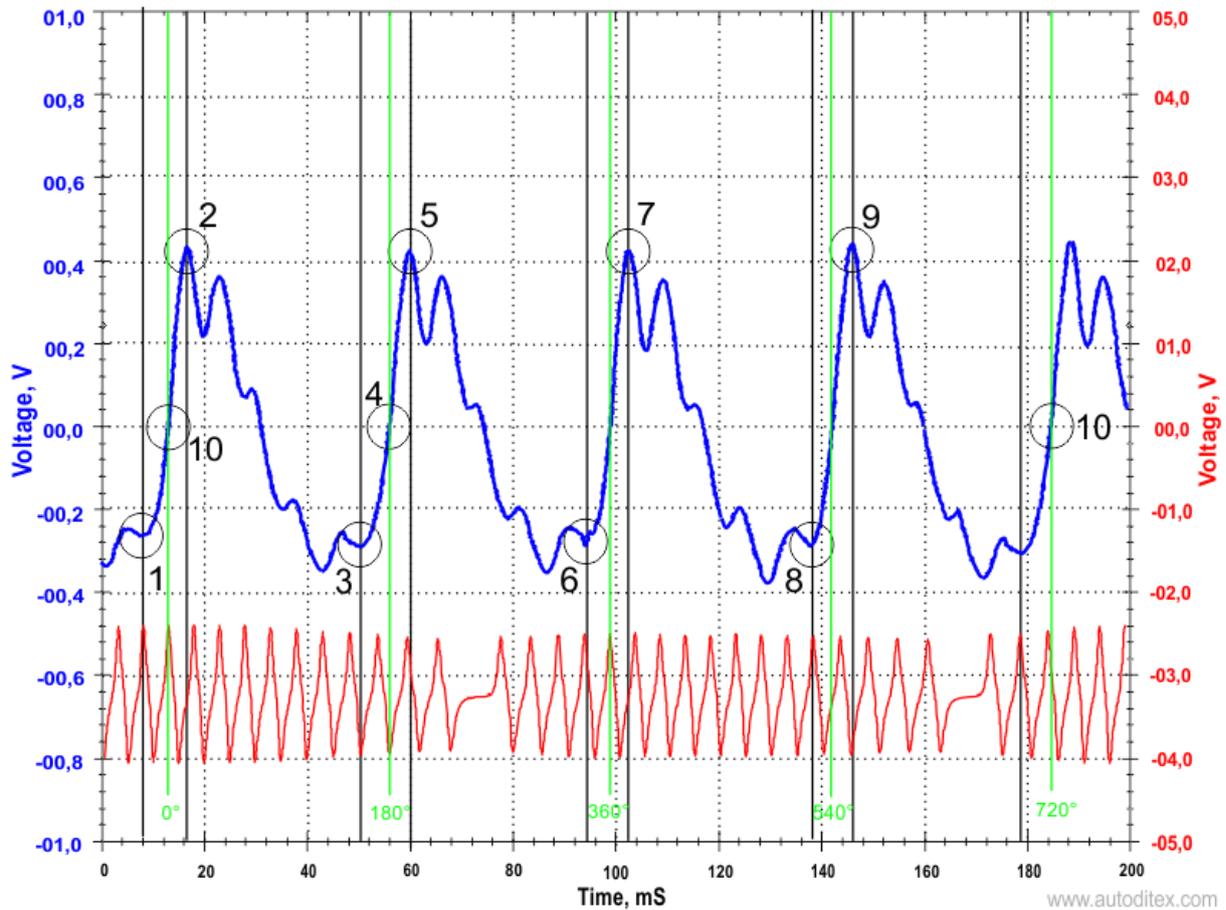


Fig.4. Pressure Pulse Sensor intake manifold pulses and the crankshaft signal

*Figure 4 graph point's description:*

1. Opening of the 4<sup>th</sup> cylinder intake valve;
2. Closing of the 4<sup>th</sup> cylinder exhaust valve;
3. Opening of the 2<sup>nd</sup> cylinder intake valve;
4. Top dead center (TDC) point;
5. Closing of the 2<sup>nd</sup> cylinder exhaust valve;
6. Opening of the 1<sup>st</sup> cylinder intake valve;
7. Closing of the 1<sup>st</sup> cylinder exhaust valve;
8. Opening of the 3<sup>d</sup> cylinder intake valve;
9. Closing of the 3<sup>d</sup> cylinder exhaust valve;
10. At this point the first cylinder pulse occurs.

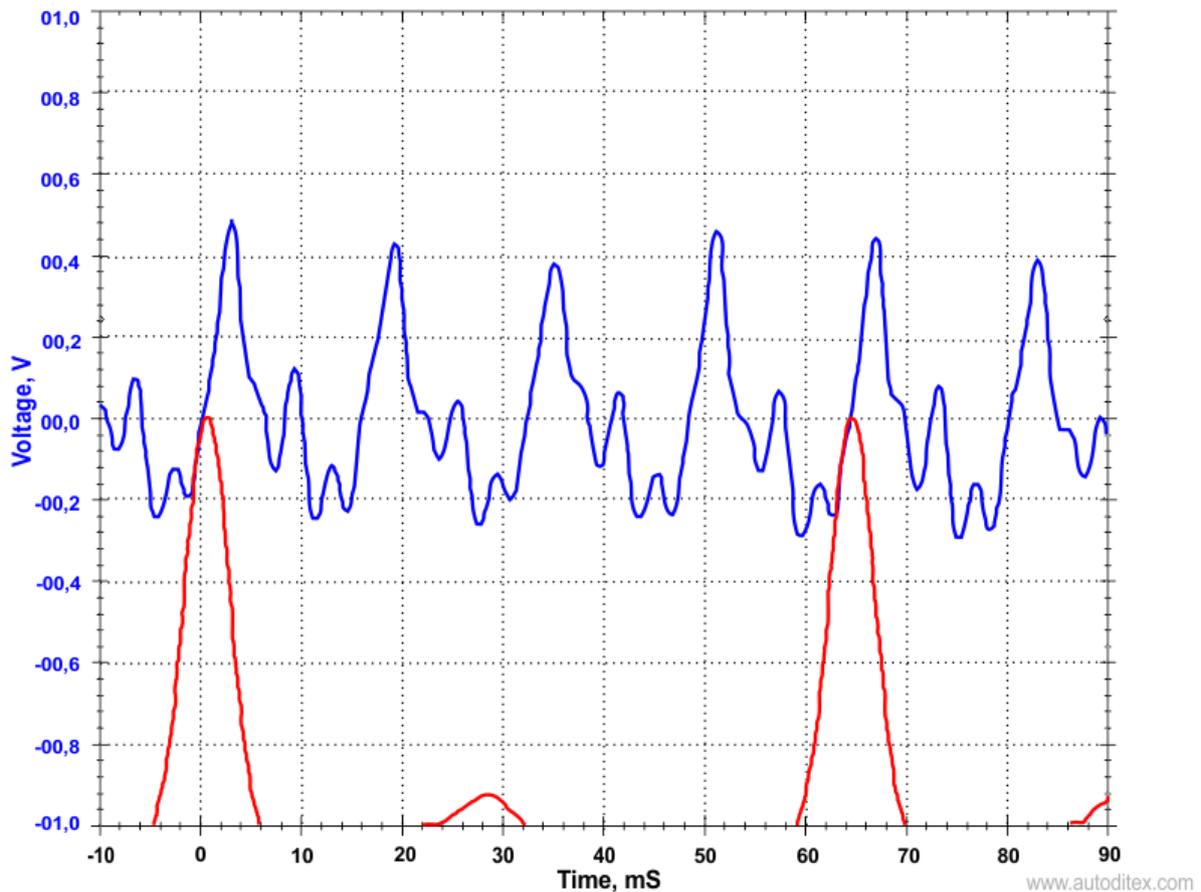


Fig.5. Pressure Pulse Sensor intake manifold and Cylinder pressure sensor

## PRACTICAL EXAMPLES

■ Reference waveforms obtained when the sensor displays the absolute pressure pulsations of the exhaust gases and the intake manifold pulsations for properly operating engines.

**Note:** When cranking PPS output signal is sinusoidal and when the engine is idling, the signal is a curve. The peaks and troughs show engine mechanical condition.

**Note:** More detailed picture of the engine condition can be obtained only if the PPS sensor is connected to the intake manifold.

**Note:** Graphs depend on the car being tested and may differ. Below mentioned factors have a significant influence on the waveform:

- Engine speed
- Duration of the injection pulses (warm/cold engine)
- Length and shape of the fuel rail
- Fuel pump mechanical construction
- The presence of pulsation dampener (damper)
- The structure and the volume of the vacuum chamber of the fuel pressure regulator
- The area of the membrane fuel pressure regulator
- Length of the tube connecting the pressure regulator with fuel sensor pulses
- System fuel pressure

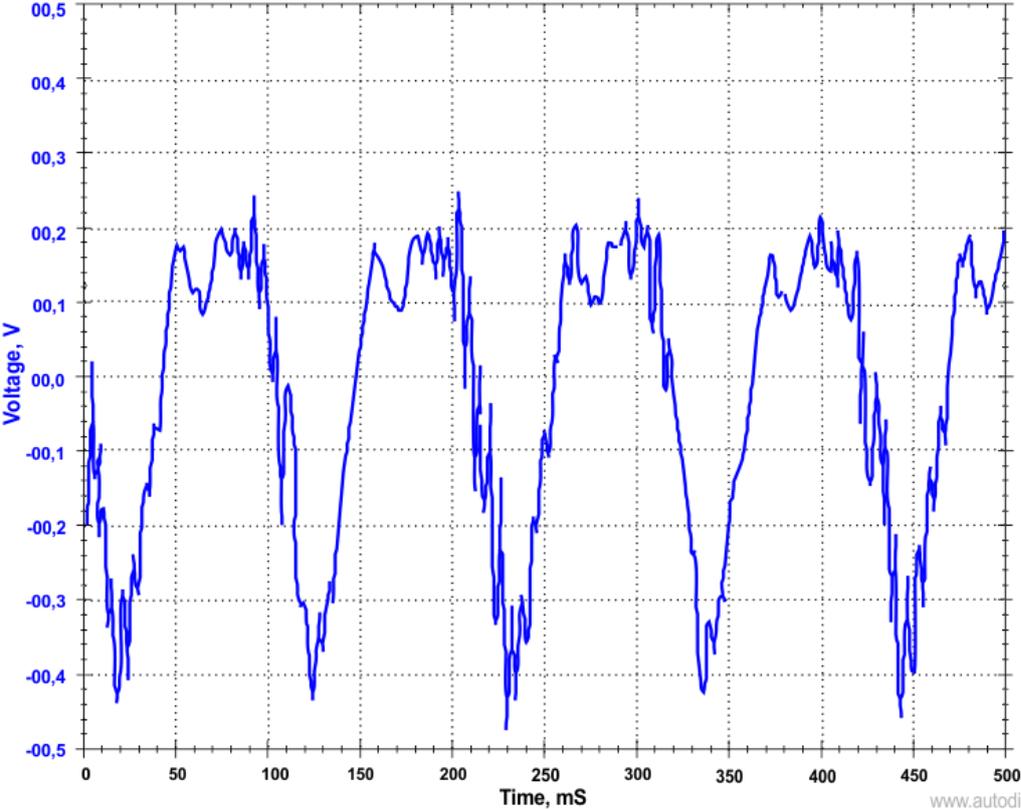


Fig.6. Exhaust gases pulsation signal Toyota Rav4. Engine is cranking (engine not started)

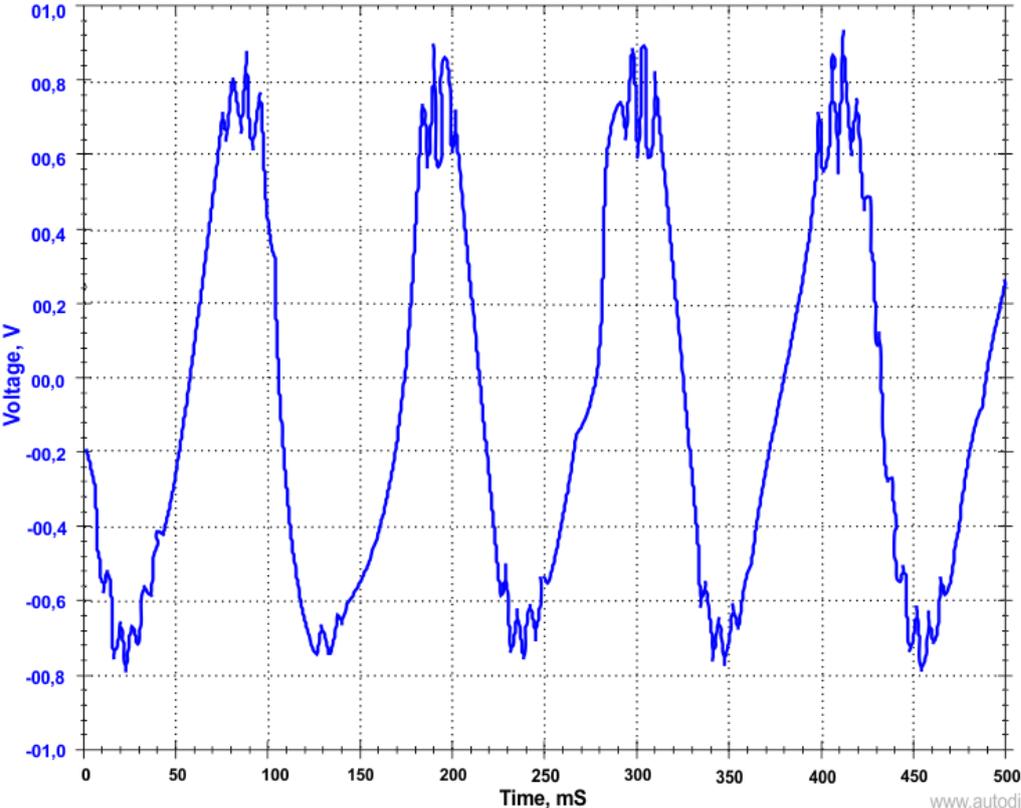


Fig.7. Intake manifold pulsation signal Toyota Rav4. Engine is cranking (engine not started)

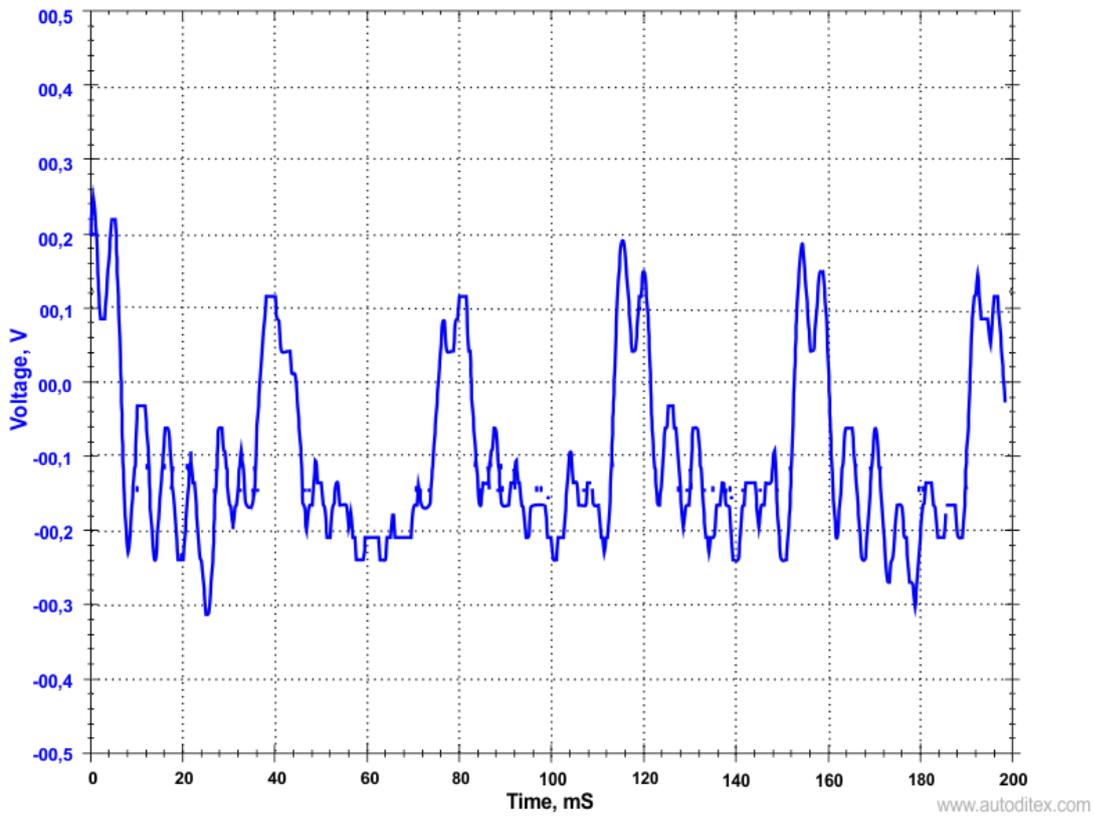


Fig.8. Exhaust pulses on 2009 Toyota Auris 1.4 VVT-I

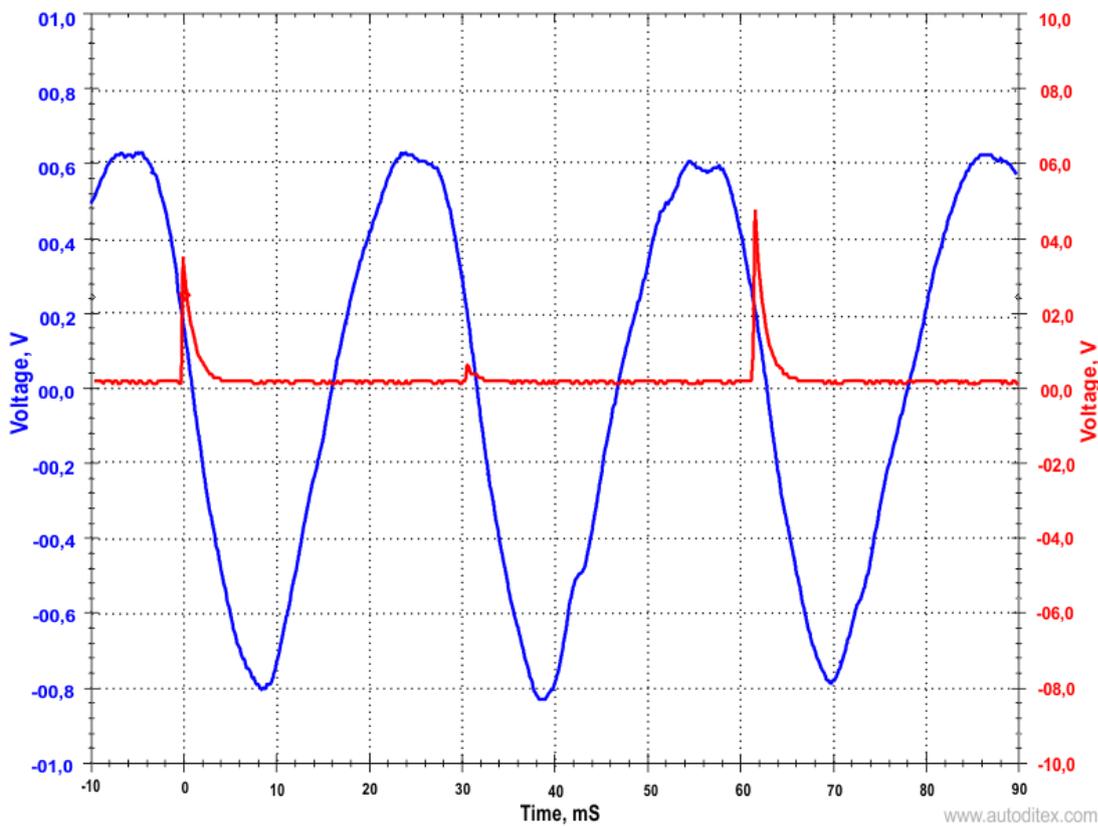


Fig.9. Exhaust pulses and 1<sup>st</sup> cylinder sync signal, 1997 Opel Astra F 1.8 16V, DIS ignition

### WAVEFORMS SHOWING ENGINE MECHANICAL PROBLEMS

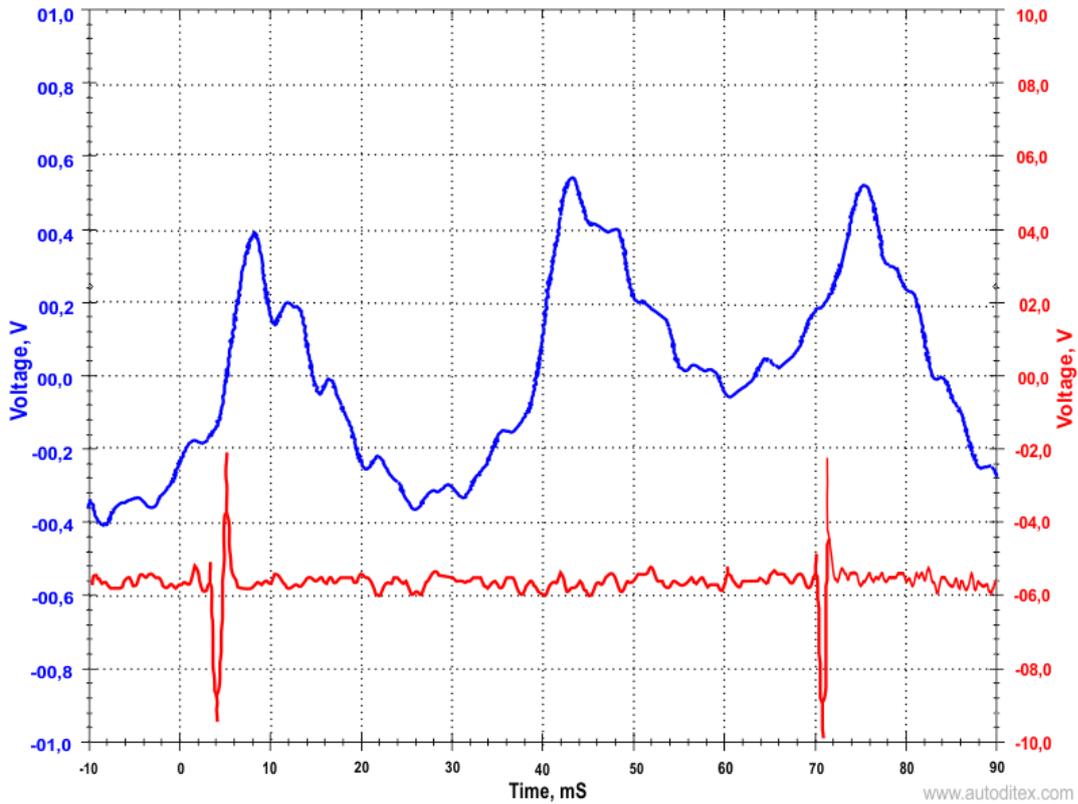


Fig.10. Graphic shows a burned valve (PPS is connected to the intake manifold)

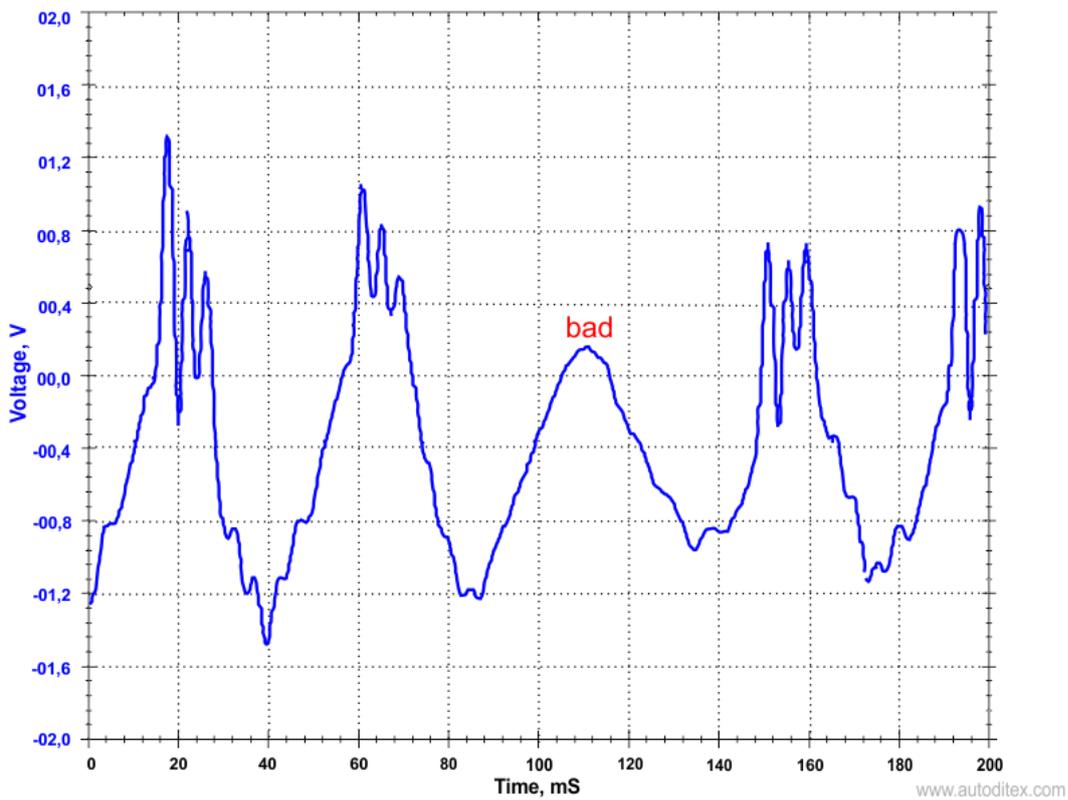


Fig.11. Bad injector on Honda Accord 2, PPS is connected to the fuel pressure regulator