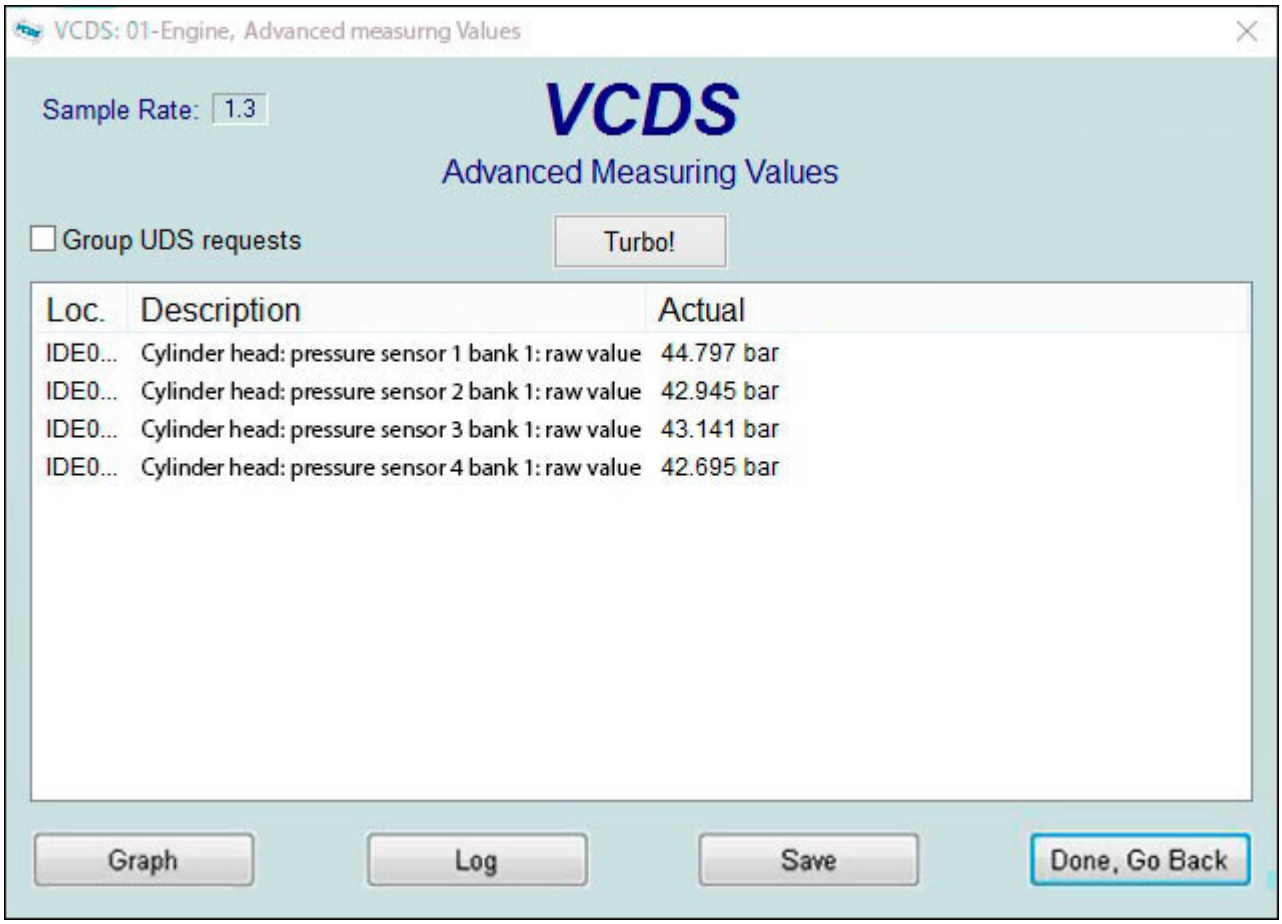
Pressure sensing Beru PSG glow plugs.

Using Beru glow plugs to measure cylinder pressure in a diesel engine

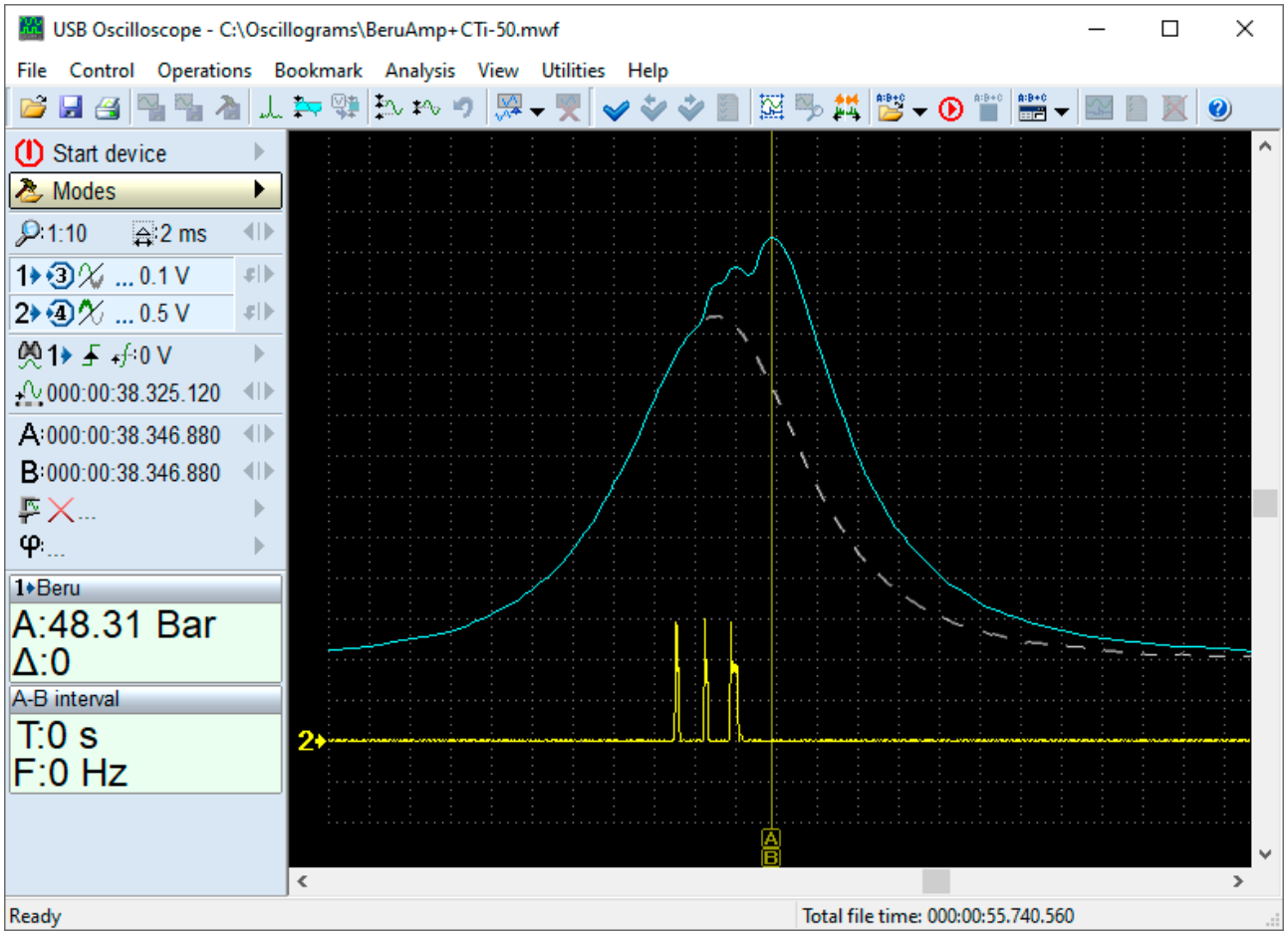
Many modern diesel engines are equipped with special BERU (or Champion) glow plugs with a built-in pressure sensor, which allows measuring the gas pressure in the cylinder during engine operation. These plugs differ from the classic ones by the presence of a sensor.

In some engines, only one cylinder is equipped with a glow plug with a pressure sensor, and the rest are equipped with conventional glow plugs. However, their dimensions and threads are always similar to classic glow plugs.

When connecting a scanner to the diagnostic connector of such a vehicle, the technician can see the peak pressure value in the cylinder with the sensor.



Using the signal from the pressure sensor built into the Beru glow plug, it is possible not only to measure the peak pressure, but also to display a graph of the pressure in the diesel cylinder on the screen of an oscilloscope or motor tester. Such a graph contains information that can be used to search for complex faults in a diesel engine.



The yellow trace is the control current of the fuel injector of the cylinder being tested. The blue trace is the pressure graph in this cylinder. The dashed white line shows what the pressure graph would look like if no fuel was supplied to the cylinder. It is clear that in this case, the peak pressure in the cylinder reached 48 Bar. Additionally, it is visible how the pressure curve from the air compression by the piston is overlaid by the pressure from fuel combustion. It is noticeable that the pressure in the cylinder increased three times due to fuel combustion — twice by a small amount and once more significantly. The first two pressure increases were caused by the combustion of very small amounts of fuel, known as pre-injection. The final pressure increase in the cylinder resulted from the combustion of the main fuel dose.

Upon closer examination, it can be seen that just before the pressure increase from fuel combustion, the cylinder pressure initially decreased slightly, and only after that did ignition occur, leading to a rise in pressure. This happens because after diesel fuel is injected into the cylinder, it first undergoes "preparation" for ignition. Immediately after being injected into the cylinder, the fuel begins to absorb the thermal energy of the compressed air, which is used to heat the fuel to its boiling point and then for its vaporization. As a result of the thermal energy absorption, the temperature of the pre-compressed air decreases slightly, leading to a drop in cylinder pressure. Only after the fuel vapor and the air mix at the necessary temperature does ignition occur, causing a rise in cylinder pressure.

The value of pressure increase depends on the amount of fuel burned. However, this does not mean that it is directly proportional to the amount of injected fuel. For example, if a fault causes too large

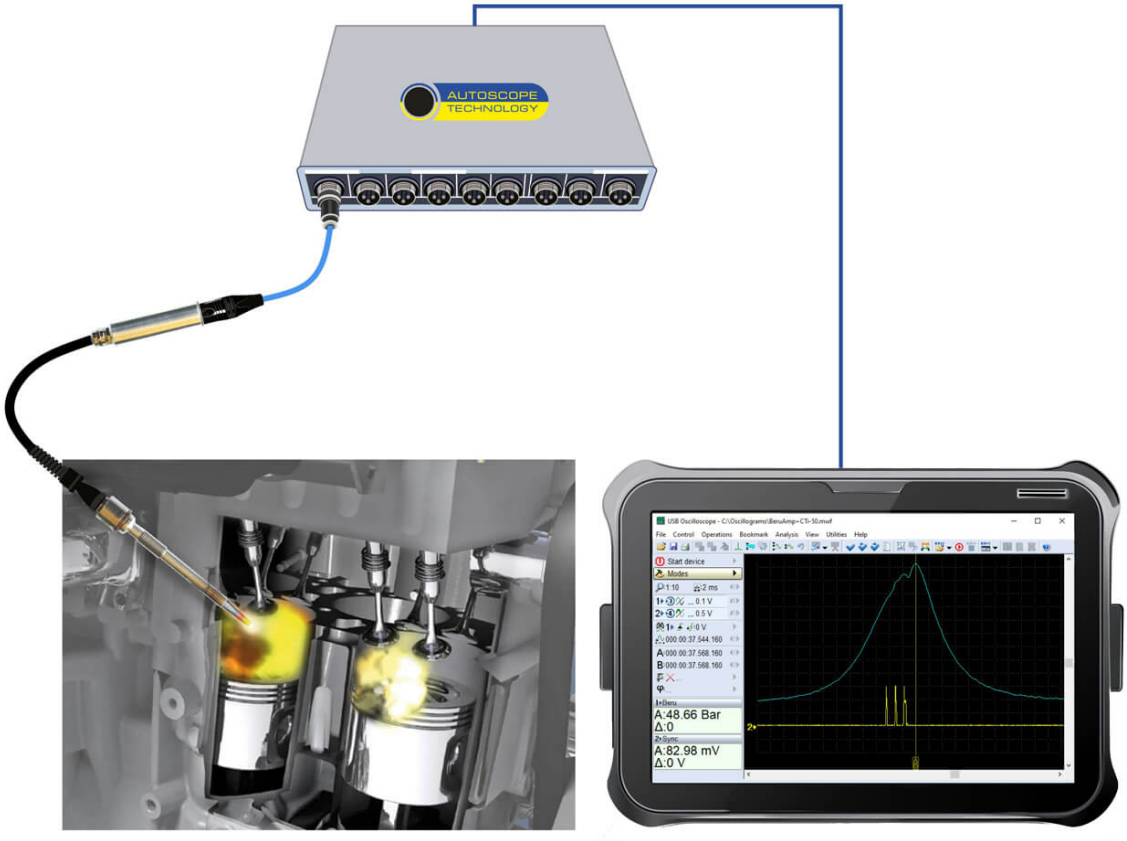
a dose of fuel to be injected into the cylinder, instead of a large pressure increase, the opposite effect might occur. In such cases, the energy required to heat a large amount of fuel to its boiling point might be so great that the temperature in the cylinder drops below the ignition temperature of the diesel fuel. As a result, the fuel vapor may not ignite, leading to a missed ignition and the expulsion of diesel vapor into the exhaust system as bluish smoke. Such situations can arise either due to incorrect pre-injection fuel dosing (resulting from mechanical wear of the injector or incorrect injector coding, which could lead to excessive or completely absent pre-injection), or due to reduced cylinder filling with air (caused by malfunctioning of the turbocharger or EGR system), or due to reduced compression ratio (due to low compression or reduced compression resulting from a hydrostatic impact and bending of the connecting rod).

This is just one example of how the pressure graph can help a technician better understand the processes occurring in the cylinder of the diesel engine being diagnosed and make a diagnosis more quickly and accurately. Similar measurements can also be conducted on vehicles equipped with traditional glow plugs that do not have built-in pressure sensors. To do this, you need to replace the traditional glow plug with one that has a built-in pressure sensor. If the dimensions of your existing Beru glow plug do not match the dimensions of the plugs used in the test engine, you can use an adapter.

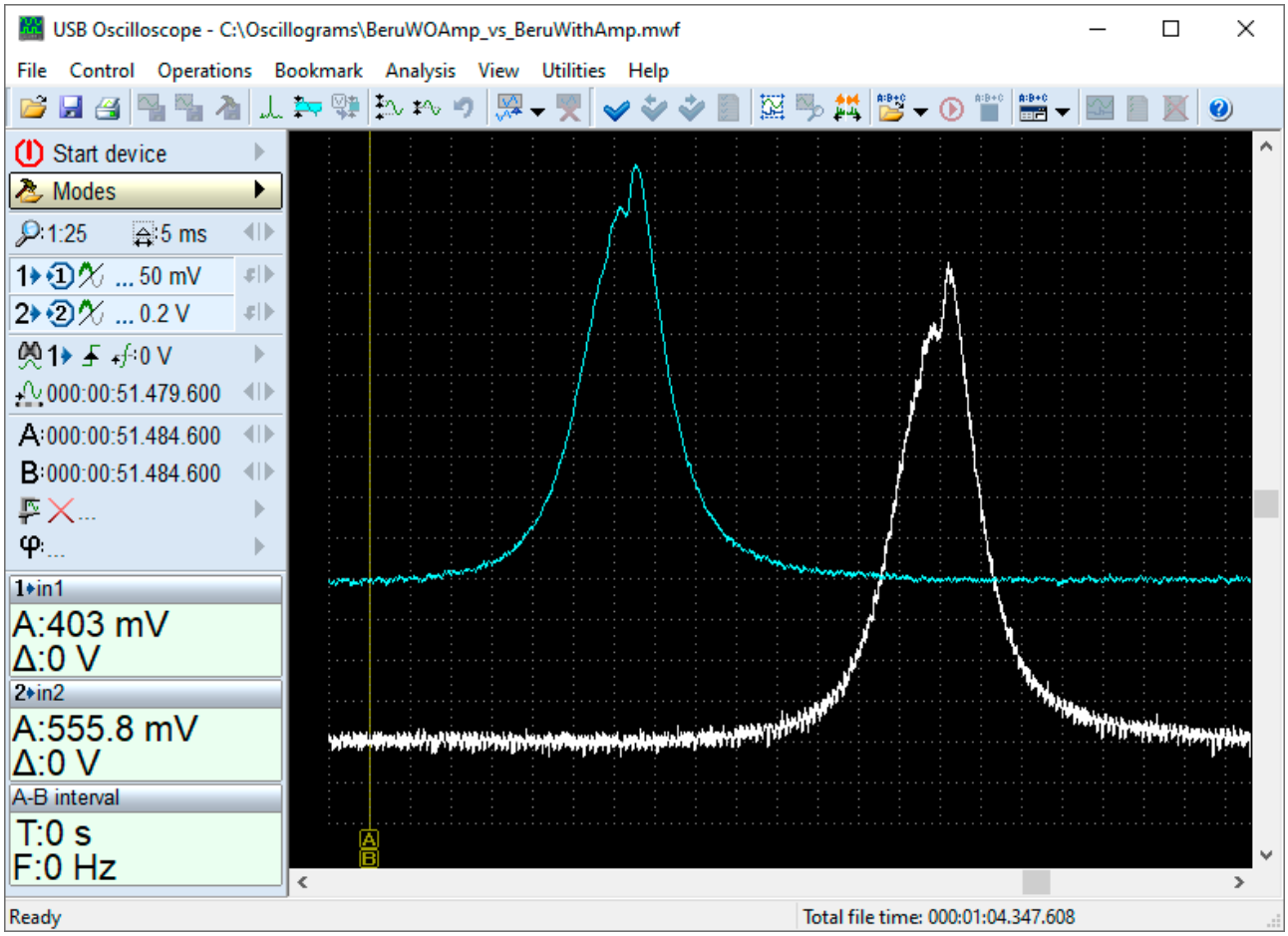
The most commonly used types of adapters for different glow plug sizes are:

M9x1, M10x1, M10x1.25

If you have installed a special Beru glow plug on an engine originally equipped with classic plugs, you need to provide power to the pressure sensor built into the plug. The most convenient way to do this is with the BeruAmp amplifier.

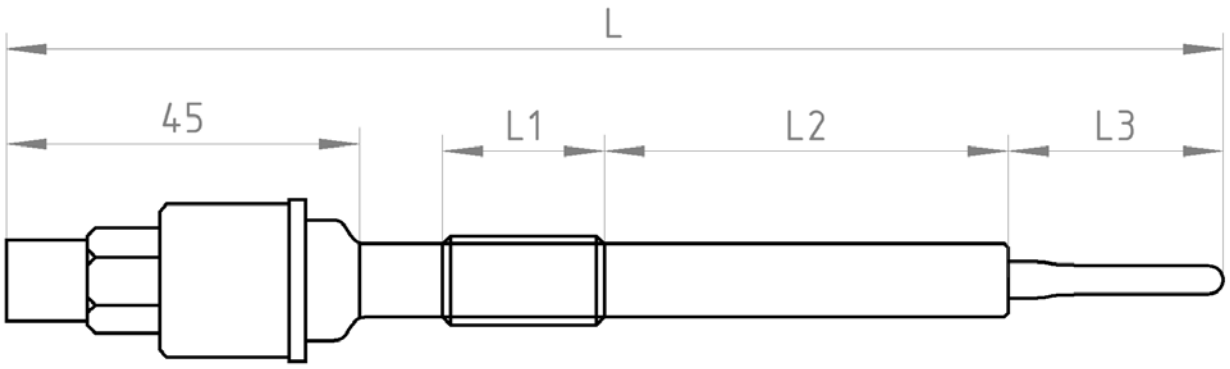


If the engine being tested is equipped with a Beru glow plug with a pressure sensor as standard, then the signal can be read from it using a regular oscilloscope probe. But in this case, the received signal may have an increased noise level, which complicates the process of investigation such a signal. For clarity, below is an picture showing the differences in the noise level of the pressure graph recorded using the BeruAmp amplifier (blue trace) and the graph recorded without an amplifier (white trace).



Therefore, to obtain the most accurate and detailed signal from the Beru glow plug pressure sensor, it is recommended to always use the BeruAmp amplifier.

Table of the main dimensions of Beru PSG (Champion) glow plugs.



PSG	L, mm	Thread	L1, mm	L2, mm	L3 Fitting Depth, mm
001	180	M9x1	15	75	35
002	149	M10x1	15	55	28
003	132	M9x1	15	35	28
004	150	M10x1.25	20	55	24
005	158	M10x1	15	55	31
006	180	M9x1	15	75	35
007	149	M10x1	15	55	28
008	149	M10x1	15	55	28
009	150	M10x1	15	55	29