FUNDAMENTALS OF THE AUTOMOTIVE RELATIVE COMPRESSION TEST

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General description

Correct functioning of the engine depends on many factors like correct sensor readings and proper functioning actuators. The Engine itself also needs to be in good condition and with the relative compression test you can easily determine whether all cylinders have about the same compression. The relative compression analysis does not measure the actual pressure, but just compares one cylinder to the next. Hence the term "relative".

Principle of operation

The principle of the relative compression test is based on tracking the battery current/voltage changes during cranking to determine the compression values of all cylinders. Analysis of the current/voltage changes gives the comparative compression values of all cylinders. An engine with poor compression in one or more cylinders can be quickly identified using the relative compression test. To perform the relative compression test, the fuel system must be disabled to prevent the engine from starting.

There are two methods to perform the relative compression test – current and voltage:

• The current method is based on tracking the starter motor current changes during engine cranking. The oscilloscope then analyses the compressions by monitoring the current in each cylinder compression stroke. The better the compression, the higher the current, and vice versa. It is important that you have an equal current draw on all cylinders. The current required to crank the engine depends on several factors, fuel type - gasoline or diesel, including the engine volume, number of cylinders, viscosity of the oil, condition of the battery, the starter motor, condition of the starter motor's wiring circuit, the compression in each of the cylinders and the mechanical condition of the cylinder. The typical current of a four-cylinder gasoline engine is about 100A to 200A. The initial peak current up to 500A is the current required to overcome the continuous friction and inertia to rotate the engine. Once the engine starts rotating, this current lower.

• Voltage method is based on tracking the battery voltage changes during engine cranking to determine the compression values of all cylinders. The oscilloscope then analyses and compares the compressions by monitoring the battery voltage drops in each cylinder compression stroke. The better the compression, the lower the voltage, and vice versa. It is important that you have an equal voltage drops on all cylinders.

Advantages of the Relative Compression Test:

- quick test to confirm if there are significant engine mechanical issues or not;
- all cylinders can be tested at once;
- no pressure sensors are needed to check each cylinder;
- no need to remove spark plugs, glow plugs, injectors or disconnect spark plug leads;
- suitable for any vehicle, regardless of manufacturer - cars, trucks, buses and etc.
- suitable for gasoline and diesel engines;
- only an oscilloscope with a specific mode for this test and a current clamp are needed;
- irrespective of the number of cylinders (up to 12).

Disadvantages of the Relative Compression Test:

- only shows relative difference in cylinder's compression expressed as percentage;
- if all of the cylinders have about the same loss of compression due to wear of cylinder parts, the relative compression test would not detect this condition;
- typical error is about 10% but in some cases, if specific engine units are not functioning correctly, it can rise up to 20%;
- specific oscilloscope knowledge is needed to perform this test;
- cannot be used on rotary Wankel engines;

Oscilloscope measurements

Measurements could be done without synchronization, but if a problem is detected, synchronization can be added to determine the faulty cylinder(s).
As a synchronization, the signal from cylinder 1 or any cylinder you choose, can be used to sync with the current/voltage trace. The coil firing could be used as a synchronization signal and a marker is placed on the screen against the hooked with a capacitive pick-up clamp cylinder indicating it on the waveform. Other cylinders can be quickly identified on the waveform by following the firing order.

Important note: Before performing the Relative Compression Test, you must disable the fuel system to prevent the engine from starting! On some vehicles disabling the fuel system does not have an immediate effect because of the residual fuel in the lines. The engine will try to fire up while cranking until the remaining fuel burns but once you crank long enough and use up the fuel in the rails, then you can perform the test!

Note, that the relative compression test results depend on the battery, starter motor and wiring condition. To get good and reliable results from the relative compression test the battery and starting system have to be in good shape.

AC voltage method

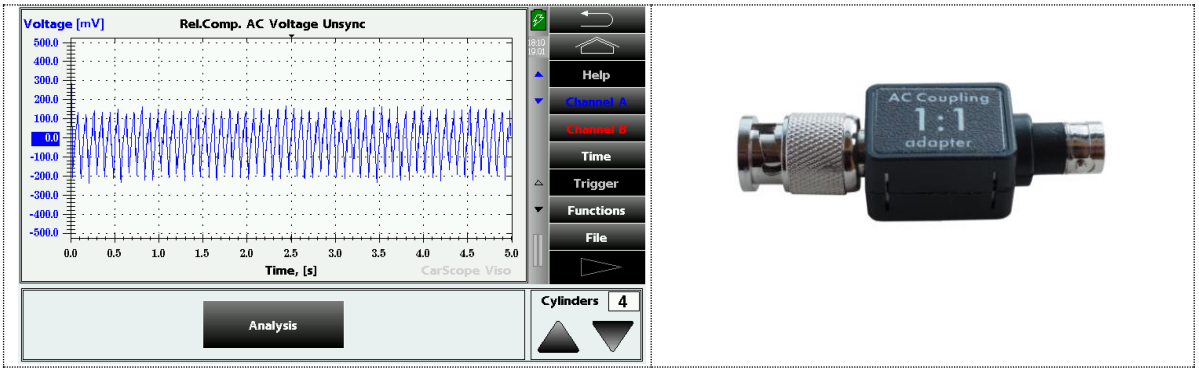
This test requires an oscilloscope with an AC coupled input!

Usually a lab scope with a single input is needed, but if a synchronization is needed to determine the cylinder firing order, then two oscilloscope inputs are needed.

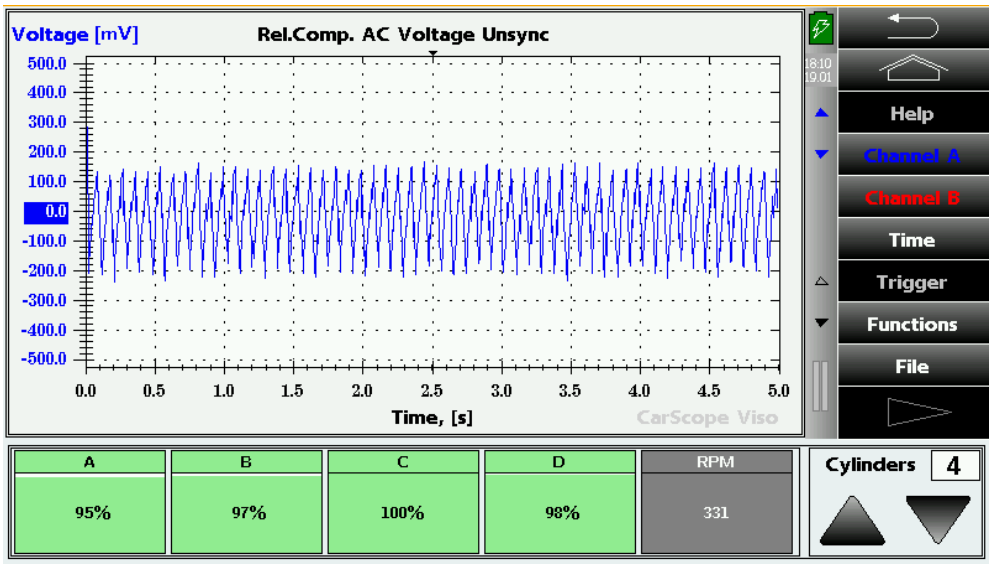
Note: If there is no cylinder synchronization signal the results do not allow exact cylinder number identification!

If the contribution of all cylinders is above 80%, then the engine compression is said to be normal. If a cylinder or cylinders are below that value, then you can investigate further.

After completing the Relative Compression Test, a waveform like the one below should be obtained:



In the example below from a CarScope family lab scope is the result after the received waveform analysis (<Analysis> button has been pressed):



DC Current method

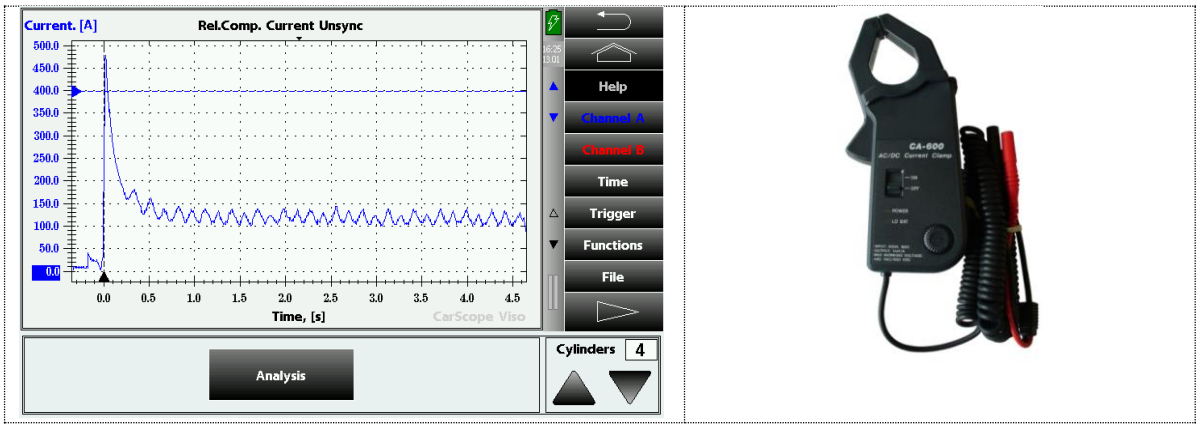
This test requires using an AC/DC current clamp with an operating range between 500A and 1000 amperes. In this case can be used both an oscilloscope with DC input and AC coupled input.

Usually a lab scope with a single input is needed, but if a synchronization is needed to determine the cylinder firing order, then two oscilloscope inputs are needed.

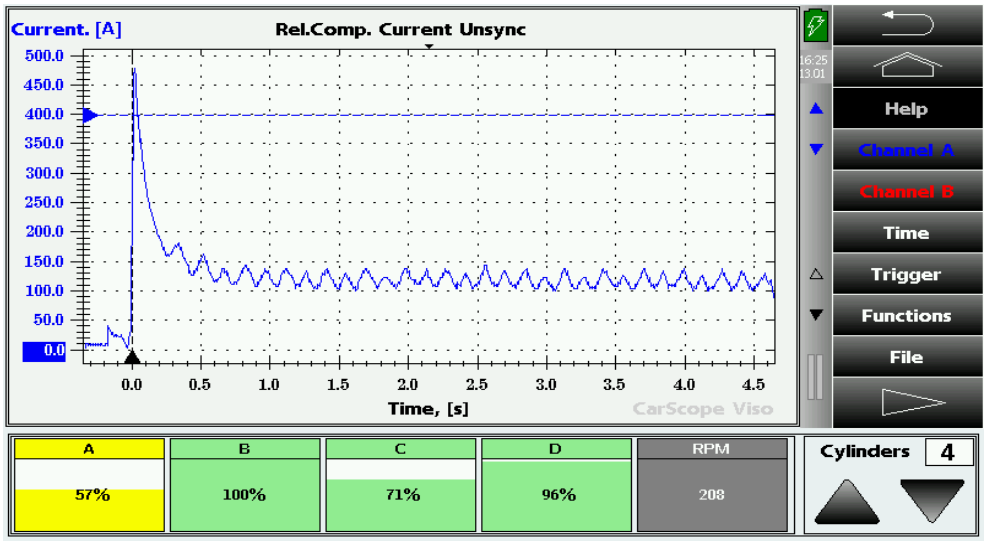
Note: If there is no cylinder synchronization signal the results do not allow exact cylinder number identification!

If the contribution of all cylinders is above 80%, then the engine compression is said to be normal. If a cylinder or cylinders are below that value, then you can investigate further.

After completing the Relative Compression Test, a waveform like the one below should be obtained:



In the example below from a CarScope family lab scope is the result after the received waveform analysis (<Analysis> button has been pressed):



Summary and conclusion

After performing the Relative Compression Test on multiple cars by using both the current and the voltage methods, we have concluded that the more reliable method, should be the "DC Current" method. Disadvantage of this method is the requirement for more expensive equipment like the AC/DC current clamp. On the other hand, the "AC Voltage" method does not have this flaw but it is not always possible to achieve the same accuracy.

CarScope Viso is a professional automotive component tester with touch screen color display and it is the single solution to all your engine analysis needs. The Viso automotive digital storage oscilloscope provides you with affordable performance in a compact design. It's packed with useful features such as: USB connectivity, component tester with built-in preset configurations, primary and secondary ignition capabilities with presets, dual graphing voltmeter, frequency counter and context sensitive help menu. The Viso oscilloscope helps you get more done, in less time.