GE Energy

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All engine types: Knocking signals and valve noises Trouble-shooting with separate knock sensor and oscilloscope

Knocking in the combustion chambers comes up if self ignition of the mixture happens in margin areas. An overheating of some areas (especially the piston area) can happen because of higher heat transfer between combustion and combustion chamber due to pressure peak because of the knocking.

Knocking monitoring systems are mounted to protect combustion chambers from temperature damages.

Figure: heat damages on the edge of the piston top.

Knocking events are transmitted as structure-borne / resonating noise and are piezo-electronically monitored with knock sensors. Thereby other “noises” which create structure-borne / resonating noise are unfortunately detected as well.

For trouble-shooting a modified knock sensor with a direct mV-signal is used to have a better differentiation resp. to find the source of the signal. With that and if you pay attention on some criteria a good changes of differentiation is present.

The method of measurement is rather simple and can be carried out fast.

Necessary parts for the measurement:

1) Knock sensor with connected signal transformer for direct measurement of the mV-signal (similar to knock sensor with coaxial connection) P/N 474234 Fixing screw P/N 100418 Adapter... ...P/N 216446 for Type 2 and 3 engines ...P/N 396976 for Type 4 engines ...P/N 196470 for Type 6 engines up to 2004 (afterwards no adapter)	
2) Oscilloscope Fluke 123 P/N 312359	
3) Pliers for ignition voltage measurement P/N 340369	

The modified knock sensor is mounted onto cylinders where mechanical interference is assumed. An individual positioning of the knock sensor is possible. Pay attention on the correct mounting of the sensor (20Nm and a minimum distance of 10cm/4inch to the ignition cables because of risk of heavy electrical interference, which would cause measurement failures).

The trigger on canal “A” comes from the ignition signal of the monitored cylinder and is measured with the high voltage clamp-on probe.

Base settings and trigger-level for the ignition signal on channel A:

- According to Technical Instruction TI 1400-0151.

Base settings for structure-borne / resonating noise – channel B:

- „Probe on B” for this measurement should be adjusted on 1:1.
- The scale for voltage, adjusted via the V/V button, should be chosen between 200mV/div and 1V/div depending on the amplitude of the knock sensor signal.

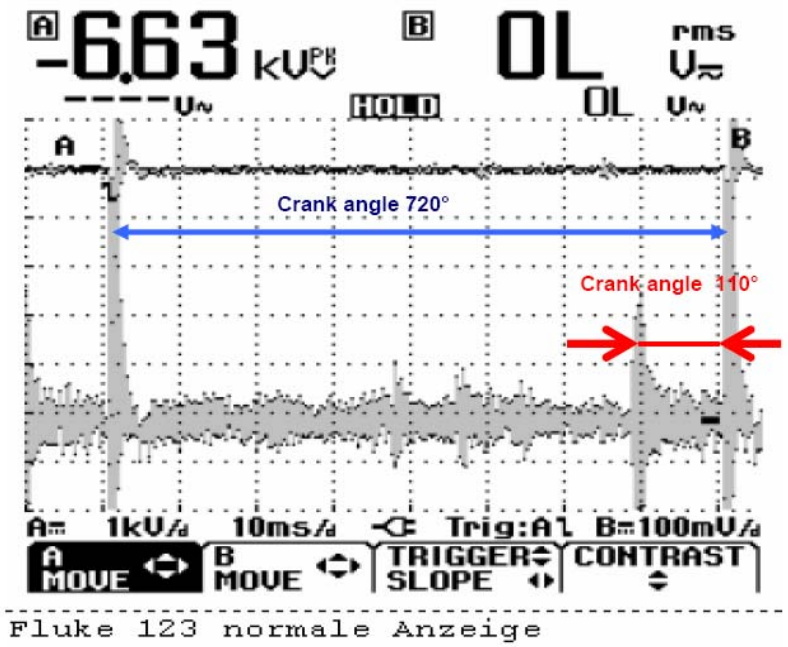
The adjustment of the time scale is normally 10ms/div. Therefore 720° crankshaft angle (that equals one combustion cycle) can be displayed. One division equals **around 90°** crankshaft rotation with 1500rpm.

For overview reasons it might be necessary to select different time scale adjustments. Keep in mind that the conversion of milliseconds into crankshaft position is depending on crankshaft speed (rpm).

1.500 rpm 1ms equals 9 ° crankshaft-angle
1.200 rpm 1ms equals 7,2° crankshaft-angle
1.800 rpm 1ms equals 10,8° crankshaft-angle

Figure: a typical oscilloscope picture.

Note: You can see little “valve noise” form the closing of the inlet valve (app. 110° before ignition pulse).



Fluke 123 normale Anzeige

Relevant crankshaft positions for the signal:

Combustion: 30° crankshaft position after ignition-pulse.

Operation with too cold engine oil and high jacked water temperatures can cause **piston rocking** because of bigger running fit: impulses on 200° **and** 560° (resp. 160°) crankshaft position after ignition-pulse.

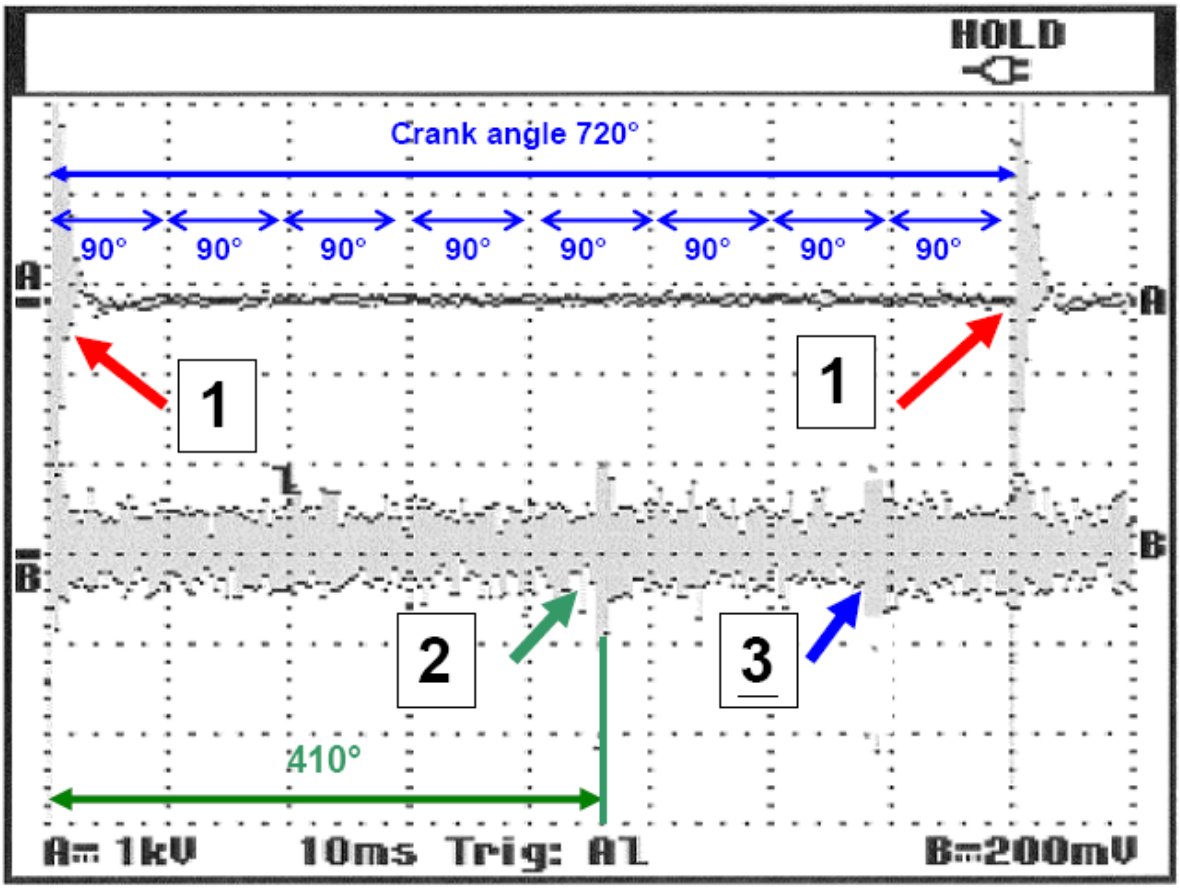
Exhaust gas valve closing: on 410° crankshaft position after (or 310° prior) ignition-pulse.

Inlet valve closing: 110° crankshaft position prior to ignition-pulse.

NOTE: Engine timing (angles) may vary (depending on engine, camshaft,...).

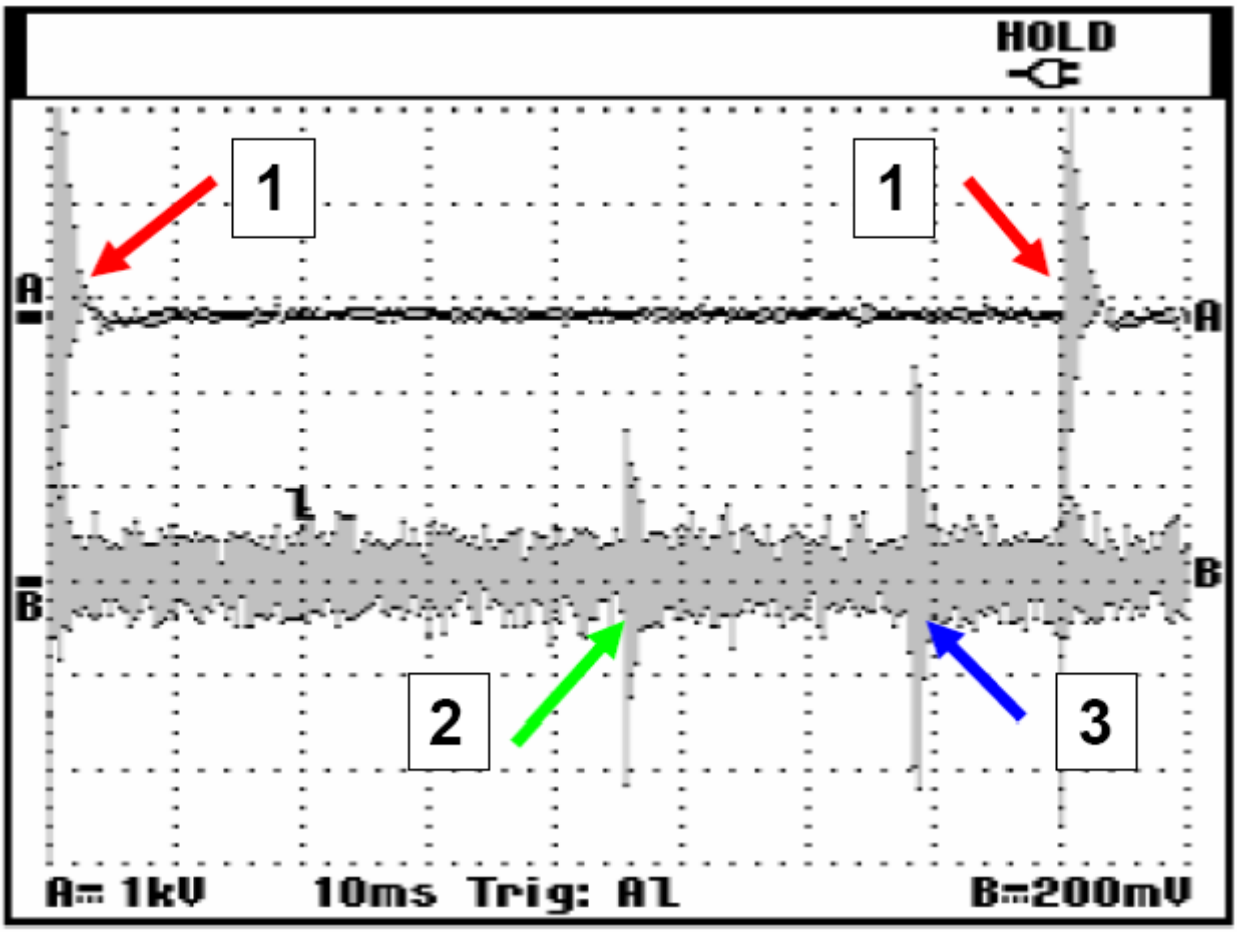
Figure: normal picture without „interference:

The red arrows (1) on channel "A" show the ignition-pulses. The green arrow (2) indicates little noise form the closing of the exhaust gas valve. The blue arrow (3) shows the closing of the inlet valve.



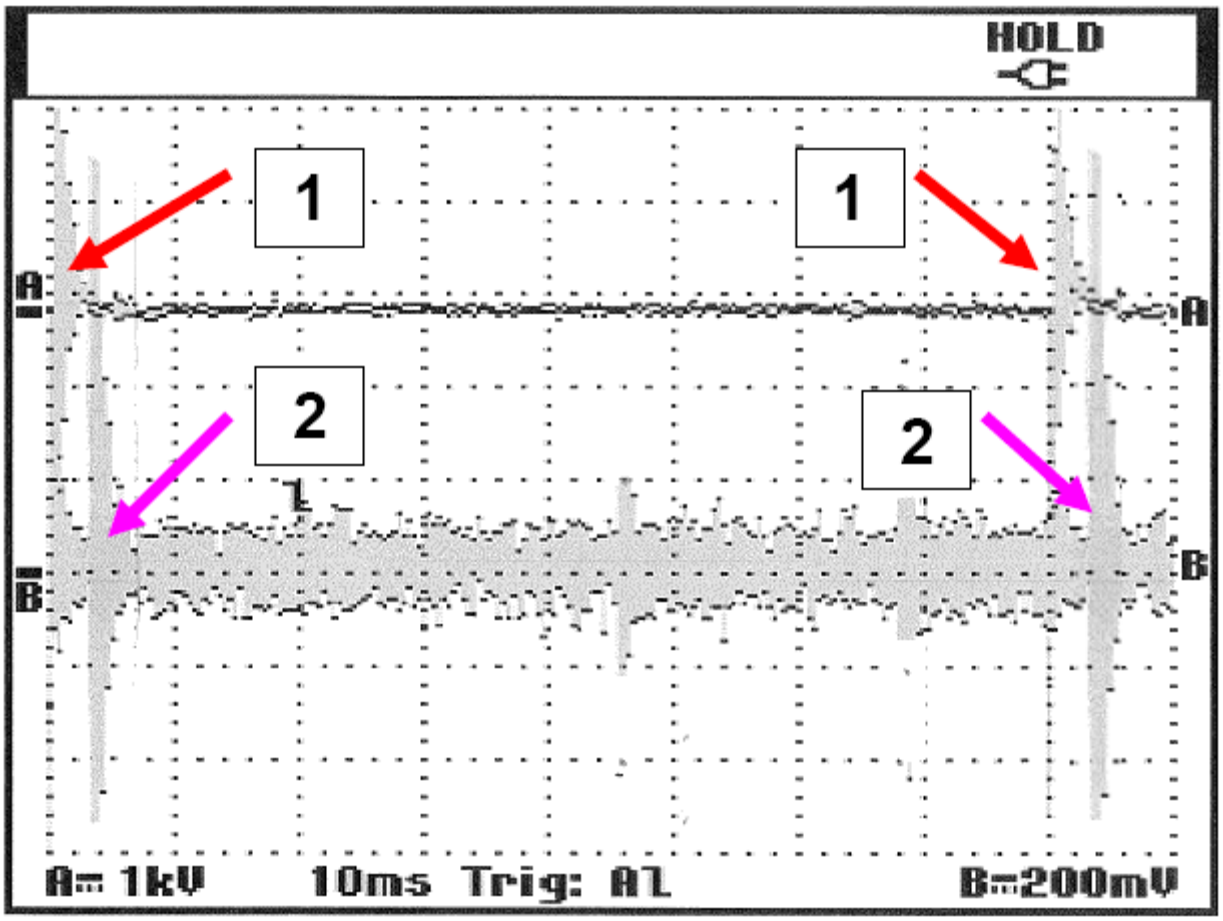
Example of „cold start“: The push rods expand less than the engine block because of cold oil in the push rods and warm water which is circulating in through the engine block. Therefore the valve play increases which causes slight “valve noise”. As the operational temperature is reached that signal decreases. The valve play must be checked if the signal is still present after the engine operates for a while.

Indicated with red arrows **[1]** are the impulses of the ignition, the green arrow **[2]** shows the outlet valve closing and the blue arrow **[3]** is the closing of the inlet valve.



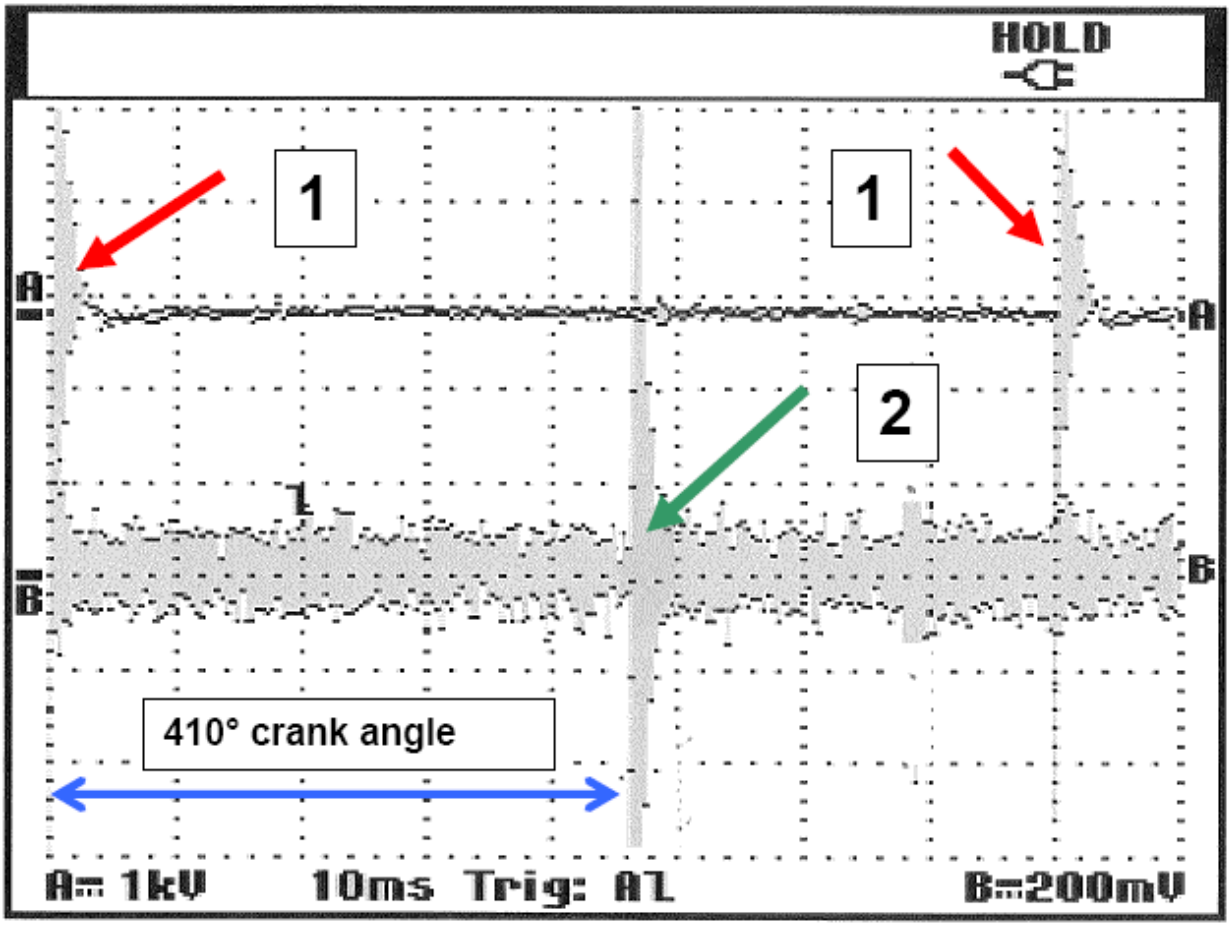
Example of a real knocking event: The signal **[2]** comes up app. 30° after the ignition pulse **[1]** (shortly after ignition T.D.C.).

Real knocking from the combustion can be reproduced very well. You see a reduction of the signal by shifting the ignition point by 2° crankshaft angle in direction TDC or by reducing the power output by app. 10%.



Example of „valve noise“, green arrow **[2]**: The outlet valve play is too big here. The signal is app. at a position of 410° crankshaft angle after (or 310° crankshaft angle before) the ignition pulse.

Corrective action: reduce the outlet valve play of that cylinder.



Another example operation:

Attention: Time scale adjustment is **20 mS/DIV** (that equals 180° crankshaft angle /DIV). You see the ignition pulses of the cylinder on canal **A** (marked with red arrows). On canal B position **[1]** you see slight knocking signals on app. 30° crankshaft angle position (that is app. 10° crankshaft angle after T.D.C). Canal B point **[2]** shows signal-interference. That is a knocking signal of a neighbouring cylinder. Point **[3]** shows mechanical interference (in that example very little) of the closing of the outlet valve. The signal on position **[4]** is a little bit stronger and shows the closing of the inlet valve. You can also see that the ignition pulse on canal **A** causes interference on canal **B** (the sensor cable is too close to the ignition cable).