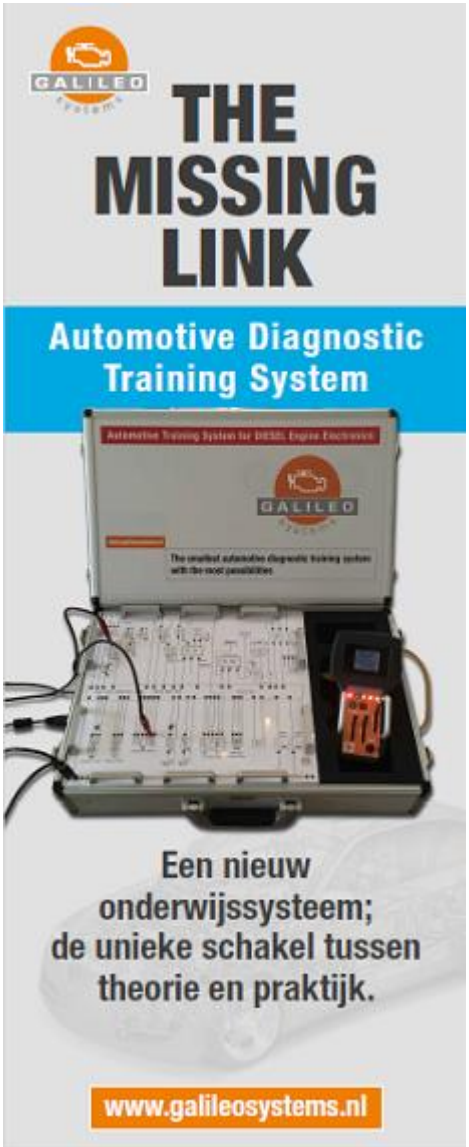
GALILEO Ford Fiësta Common Rail Description

The Galileo training system was developed out of the need to get as high a return as possible from Automotive (Diagnostic) Trainings with as few resources as possible.



The Galileo system is ideal for gathering the right basic knowledge on levels 2, 3 and 4 as effectively as possible but also for finding the very difficult problems in the electronic control systems during the Diagnosis Specialist training.

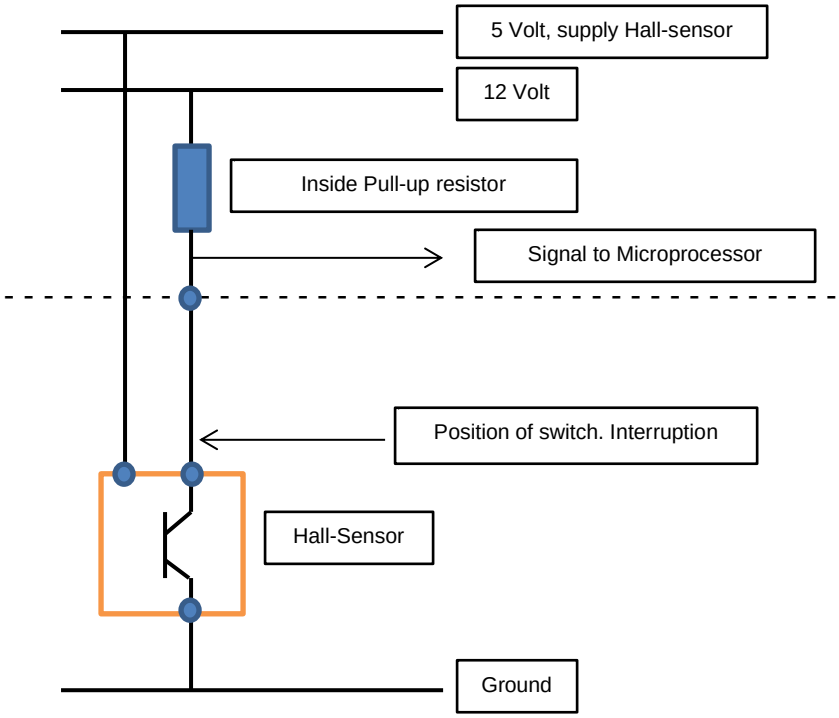
V1.04

Subject: *Page*

Crankshaft sensor (HALL)

The HALL sensor signal switches between battery voltage and earth. Variable battery voltage can cause the height of the pulse voltage to deviate from a sample signal. Measuring this signal in combination with the signal from an injector can be seen that the injector injection is advanced at higher speeds. Advance is approximately 30-40 degrees at maximum speed. What is special is that the supply of this sensor is 5 Volts while the signal switches between battery voltage and ground.

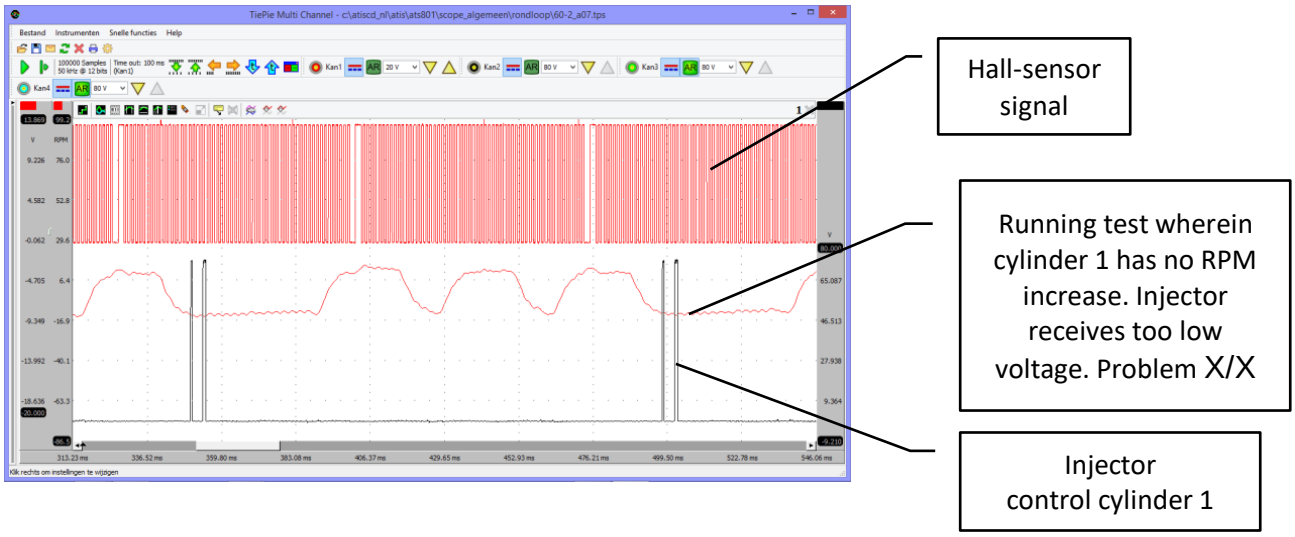
This Hall sensor signal receives the voltage from the ECU that comes out via an internal resistor.



Specials:

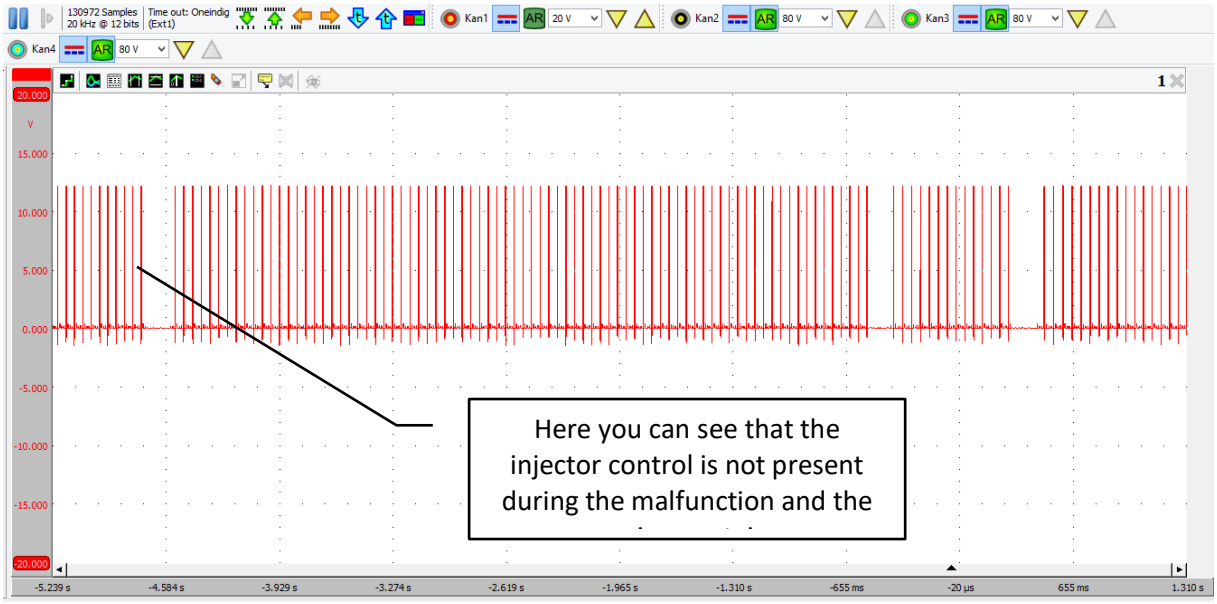
A switch is placed in the signal wire in the diagram. This switch simulates an interrupted wire to discover the operation of a HALL sensor. This option only works with ignition ON and motor OFF (so no effect when the engine is running). Place a measuring device between signal wire (on sensor) and ground. Switch on the ignition and press the “open circuit” button. The measured voltage will fall from battery voltage to zero. Now measure on the signal wire on the ECU and with the button pressed, signal voltage will remain. This proves that the signal voltage comes from the ECU and not from the sensor. Sensor only switches the signal voltage to ground and does not output voltage.

Engine Running test: Galileo is like a real engine so the "run-around" of the engine is simulated and can be measured on this crankshaft sensor. This means that the engine speed increases with the ignition in a cylinder and decreases with the compression stroke. If the scope is equipped with walk-around test software, the walk-around can be made clearly visible. In the event of a malfunction X/X or X/X switched on, this deviation can be clearly seen in the walk-through test.

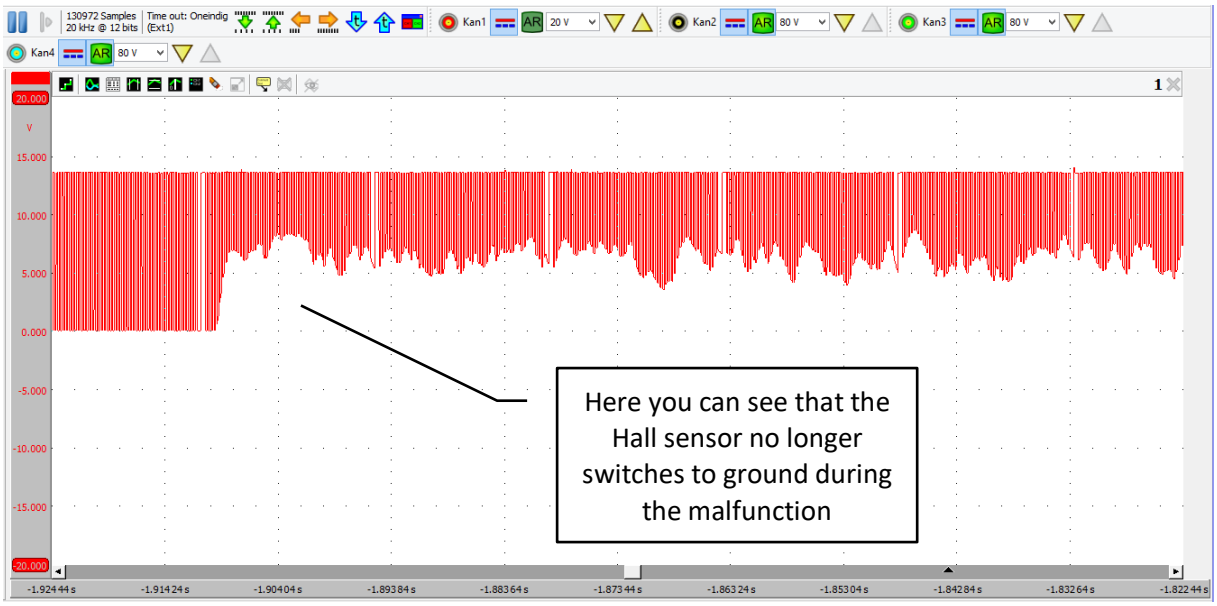


In the event of malfunction X/X, the malfunction light comes on and the motor has clearly less power. If the engine is stopped, it will no longer want to run while starting. The defect code is Pxxxx, which indicates a problem with the crankshaft sensor. If the signal from the crankshaft sensor is then measured, the signal remains on battery voltage and does not switch to 0 volts. This can have a number of reasons. The ground on the sensor is not present, the sensor is defective or the 5 Volt power supply on this sensor is not present. After measurements it appears that the 5 Volt power supply is not present on this sensor.

In the event of malfunction X/X, the engine occasionally stops when the car is traveling at speeds of around 60 km / h. First, the signal from the injectors can be measured. In the following scope view, the signal from injector cylinder 1 is measured.

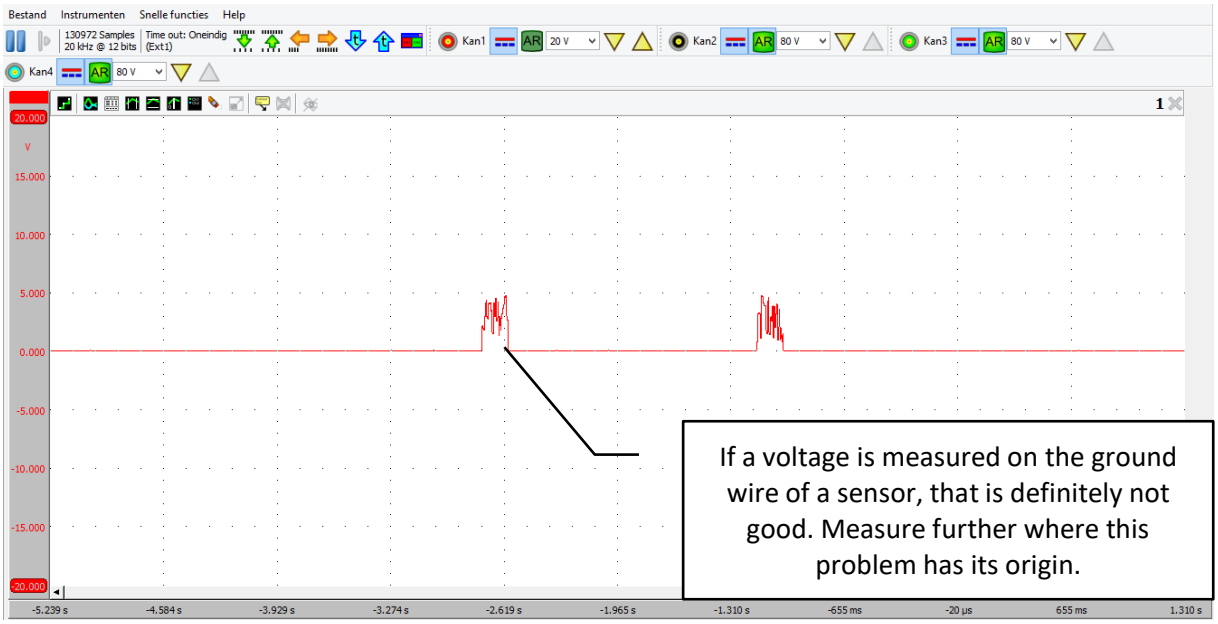


It must be determined whether a sensor is responsible for this. One of the most important sensors is the crankshaft sensor. After measuring this sensor we get the following scope image.



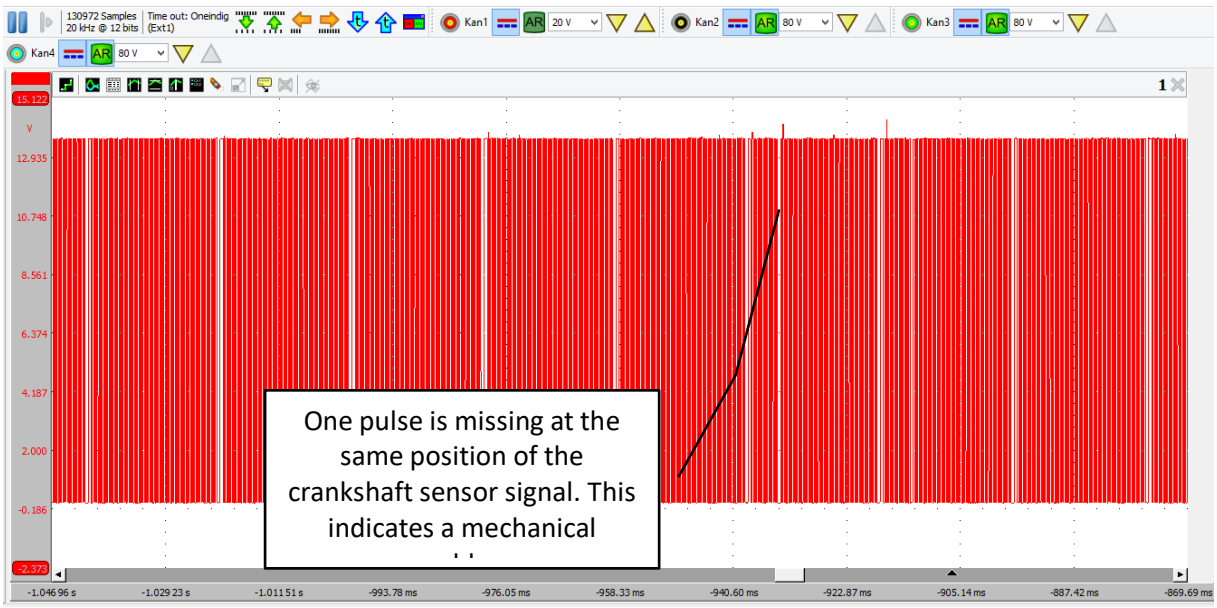
It can be seen that the crankshaft signal occasionally does not switch to ground. This may be due to the following malfunctions. Sensor defective, the ground wire of this sensor is not OK or the power supply is not correct. The sensor mass is measured in

the following scope image, normally a mass-mass measurement is 0 volts. This is not the case in this scope image.



Measuring voltage on a ground wire indicates a bad ground. It must be determined whether the mass from the ECU is the problem. After measurements it appears that the mass from the ECU is correct (remains 0 Volts during the malfunction). The problem is therefore with the ground wire or its connections between the ECU and the Hall sensor. Replacing or bridging ground wire is probably the best solution.

Fault X/X is also an occasional fault where no defect code is issued. Here too, it has been found that the injector injections occasionally fail. When checking the crankshaft signal and with a scope that can be used to look "back in time", we find the following imperfections.



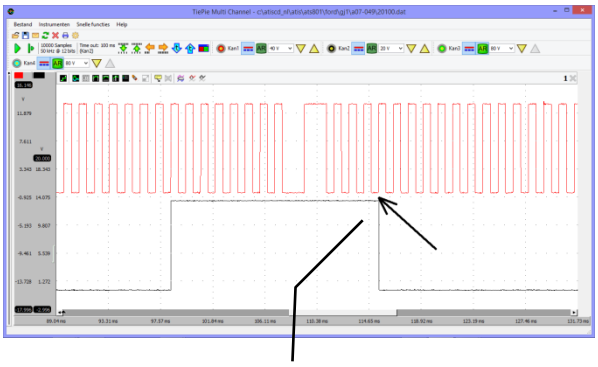
After zooming in this crankshaft signal, one missing pulse can always be seen at the same position of the crankshaft sensor signal. This indicates a mechanical problem of the sprocket. It is possible that the tooth in question is damaged.

Camshaft sensor (HALL)

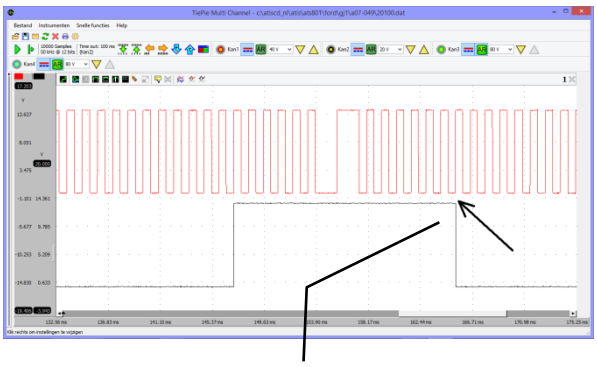
The HALL sensor signal switches between battery voltage and earth. Variable battery voltage can cause the height of the pulse voltage to deviate from a sample signal.

Specials:

The camshaft timing can be checked by measuring this signal (with a scope) in combination with the signal from the crankshaft sensor. Freeze the scope image and magnify the image where the camshaft signal switches close to the signal mark in the crankshaft signal. Count the crankshaft pulses until the camshaft signal change (about 5 pulses). Switch on fault X/X. Perform the same measurements as described above. Determine the camshaft timing. Now you can see that the camshaft has 3 crankshaft pulses (teeth) LATER (mechanical problem, distribution string).



Normally running engine with camshaft signal drop on pulse 4



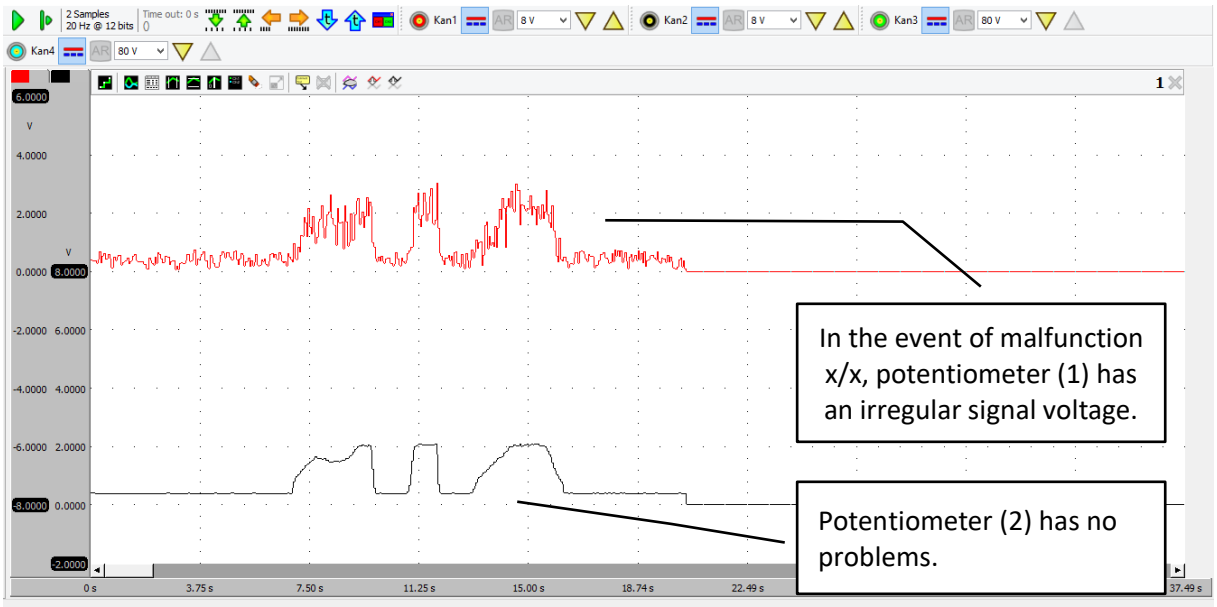
Poorly running engine with camshaft signal drop on pulse 7. Camshaft timing is to late

Accelerator pedal sensor

The signal from the accelerator pedal sensor is formed with two potentiometers. When moving the accelerator pedal, both signals vary from low to high. The signal voltage on connection 3 (potentiometer 1) is double the signal voltage on connection 6 (potentiometer 2).

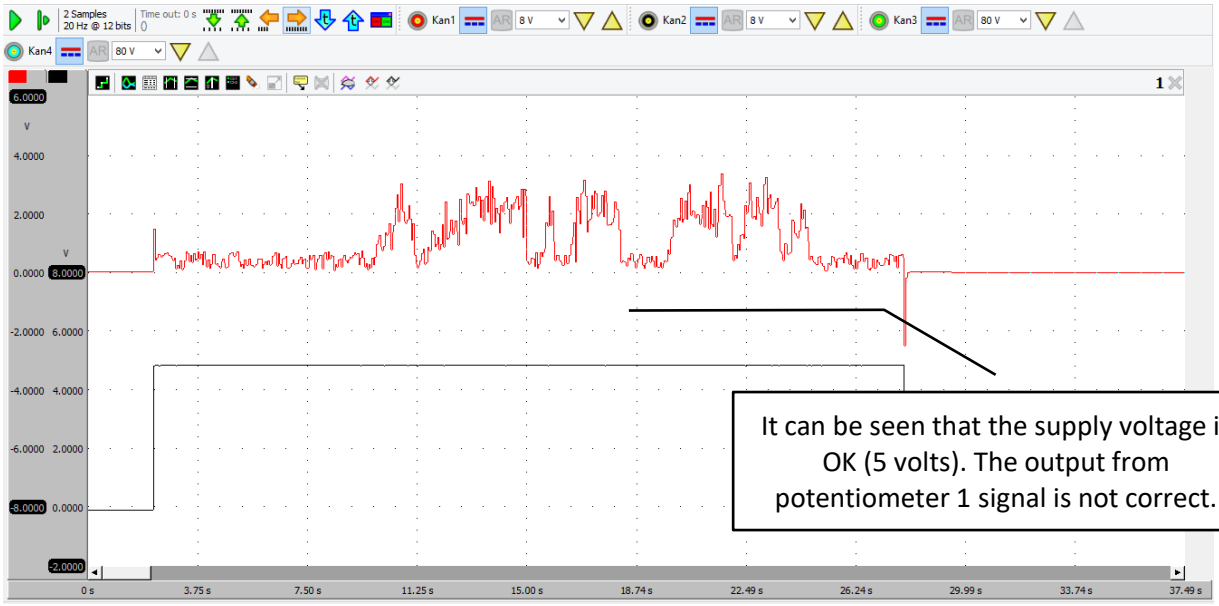
In case of malfunction X/X, the motor has little power and there is a defect code Pxxxx that indicates that there is a problem in potentiometer 1 (connection 3).

After having done a scope measurement, the following image emerges.



This erratic signal voltage can be caused by a bad plus or a bad mass. Case to measure the power supply of this potentiometer.

In the following scope view, the signal voltage was measured with channel 1 and with channel 2 the 5 Volt power supply was measured over the plus and minus. This way the entire circuit has been tested in one go and a good diagnosis can be ordered.



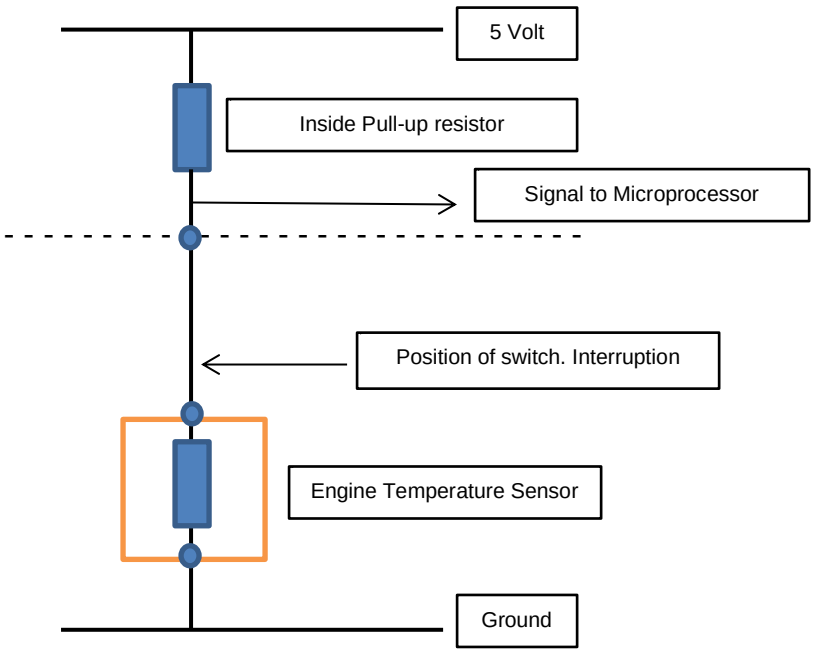
The power supply is good, so the only conclusion is that the potentiometer is defective and the voltage cannot properly branch off from the potentiometer carbon path.

In the event of malfunction X/X, the engine sometimes does not run properly, but no defect code is issued. During this malfunction, the injectors stop injecting. It is now again searching for a sensor that goes wrong so that the ECU does not do anything. Arrived when measuring the accelerator pedal sensor (83), it can be seen that the signal voltage from potentiometer 1 sometimes peaks briefly to 5 volts. See the following scope image.

When measuring at the ECU, the mass to the potentiometer 1 is good. So here a problem with the ground wire between ECU and sensor. The scope can also be used to measure over the ground wire to detect this problem. Because, measuring voltage OVER a wire indicates a bad wire or connection

Engine temperature sensor

The signal from the temperature sensor is formed by a series connection of two resistors. A fixed resistor in the ECU in series with a variable resistor as the temperature sensor implemented as an NTC element. This circuit has a supply voltage of 5 volts. The connection wire between the fixed ECU resistor and the variable temperature resistor is the signal wire. The ECU is connected to the microprocessor on this signal wire.



Specials:

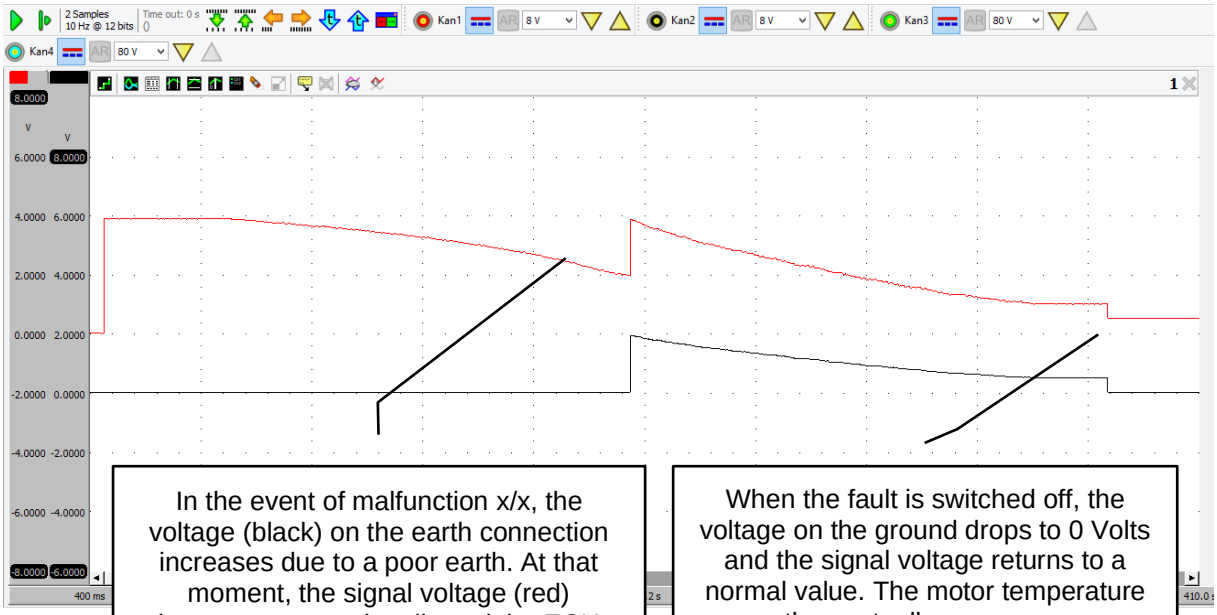
A push button is placed in the signal wire. With this push button the signal wire can be interrupted to discover the operation of this circuit. Turn the ignition on but do not run the engine. Connect the measuring instrument to the signal wire (sensor side) and the ground. Press the "Open Circuit" button. It can be seen that the voltage drops to 0 volts.

Now place the test lead on the ECU side signal lead. Press the button again. The voltage now goes to 5 volts. It is clear that if the series circuit is interrupted, the voltage on the ECU goes to 5 Volts (despite the internal resistance, but no current is flowing) and on the sensor to 0 Volts.

In the event of malfunction X/X, the motor temperature sensor has a poor mass. The customer's indication is that the front light bulb often actually lights up when the ignition is switched on. Only when the engine is really hot there is no more annealing. No defect code is saved. With the sensor it always applies that if the ground has a bad connection, the signal voltage ALWAYS goes up.

In the following scope view, the error X/X during heating is switched on (above 45 degrees in live data). No error code is stored because the signal is within the voltage limits. If the engine is cold and fault X/X is switched on, a defect code Pxxxx is issued. The signal voltage goes to 5 Volts. In this situation, an increase in the engine temperature is displayed in the live data, but that is a calculated value from the ECU. With software version V2.D80 or higher (in the bottom right of the display after applying voltage) this above situation, lower versions there is never an error code issued.

CH1 is connected to the signal wire and CH2 to the ground of the temperature sensor. It can be seen that there is a voltage on the ground and the signal voltage increases with the same values.

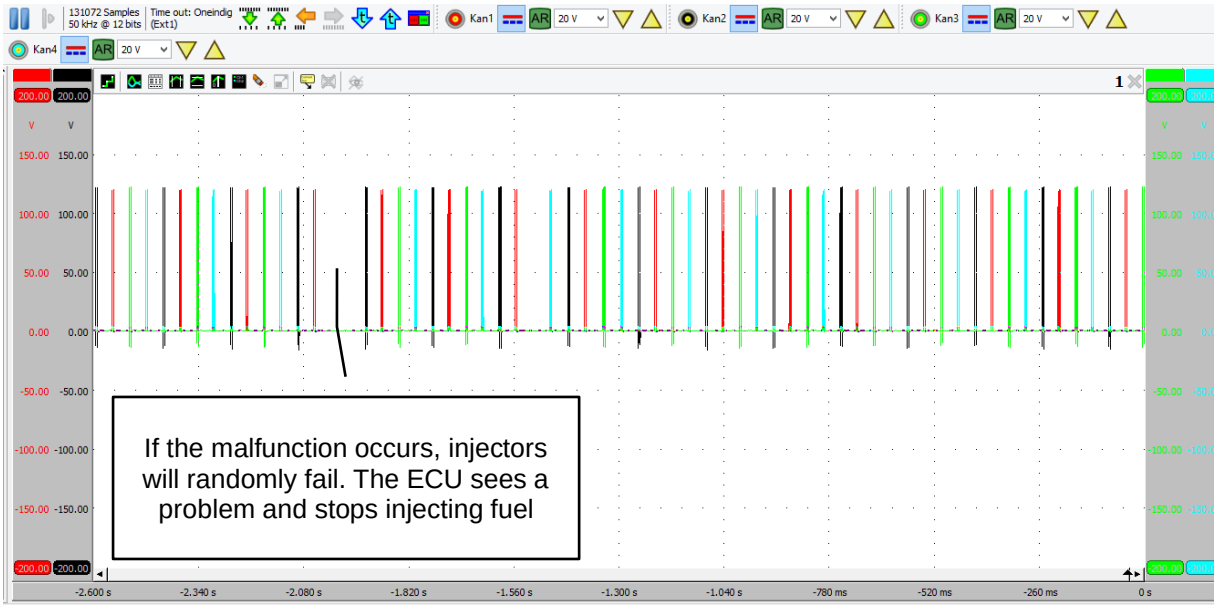


In the event of malfunction x/x, the voltage (black) on the earth connection increases due to a poor earth. At that moment, the signal voltage (red) increases proportionally and the ECU and "colder" engine temperature will then measure.

When the fault is switched off, the voltage on the ground drops to 0 Volts and the signal voltage returns to a normal value. The motor temperature then actually measures.

The motor temperature sensor is interrupted in the event of malfunction X/X. Defect code is Pxxxx. The customer's indication is that the pre-light bulb is always on when the ignition is switched on. The signal voltage for this fault is 5 volts and therefore too high.

In the event of malfunction X/X, the motor occasionally means that no defect code is issued, so this malfunction can only be detected with measurements. To begin with, we can measure the operation of the injectors in such a case (4-channel measurement on all injectors). The following scope view shows that various (random) injectors are no longer controlled during this malfunction.

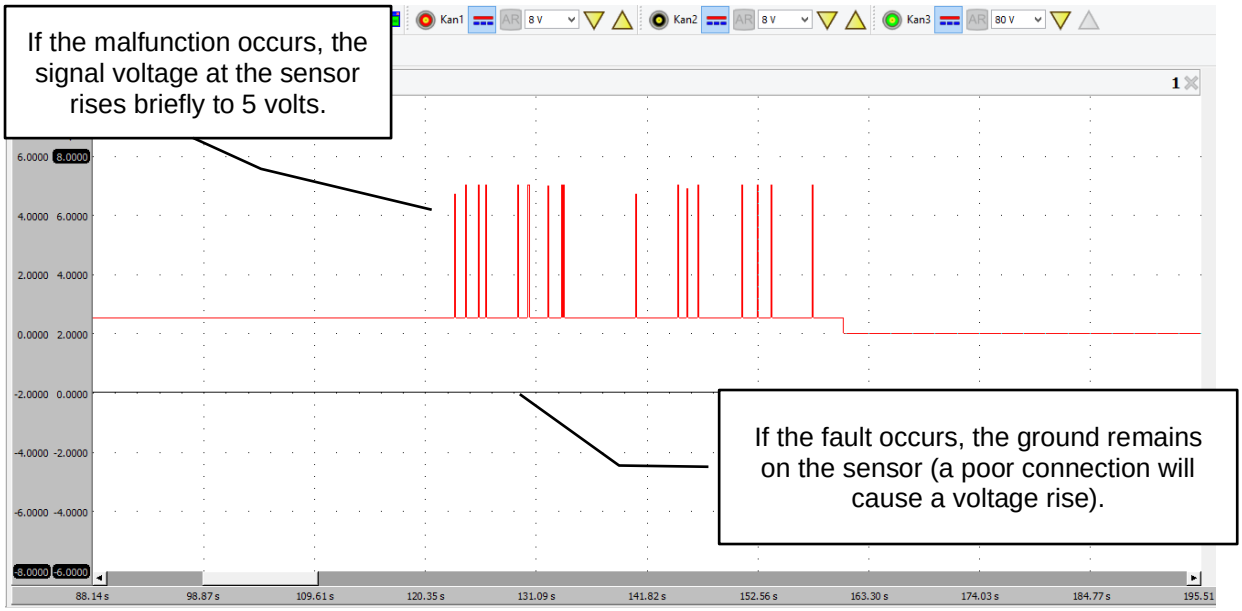


In this case we can state that the problem lies with the sensors. Measuring the most important inputs such as crankshaft camshaft sensors, air mass sensor, common rail pressure sensor and accelerator pedal sensor, we finally arrive at the engine temperature sensor.

In the Live Data readout on the engine temperature sensor, there is no definite answer. Measure with the scope on the signal wire of the sensor (sensor plug and not the ECU side) and observe the following. The sensor ground (black) was also measured in this scope image, which means that the signal voltage does not rise due to a ground problem.

Why the conclusion can be made that the motor temperature sensor is occasionally interrupted is due to the fact that the signal voltage rises to 5 volts. So the connection to the ECU is in order (the voltage source), the ground is in order so what remains is an interrupted sensor. Not to be measured with an ohmmeter, so a certain observation.

Hold the engine for a while because the ECU recognizes the fault and is in the process of switching to an emergency running situation (content), but before that happens the fault has already disappeared and the engine is running normally again.



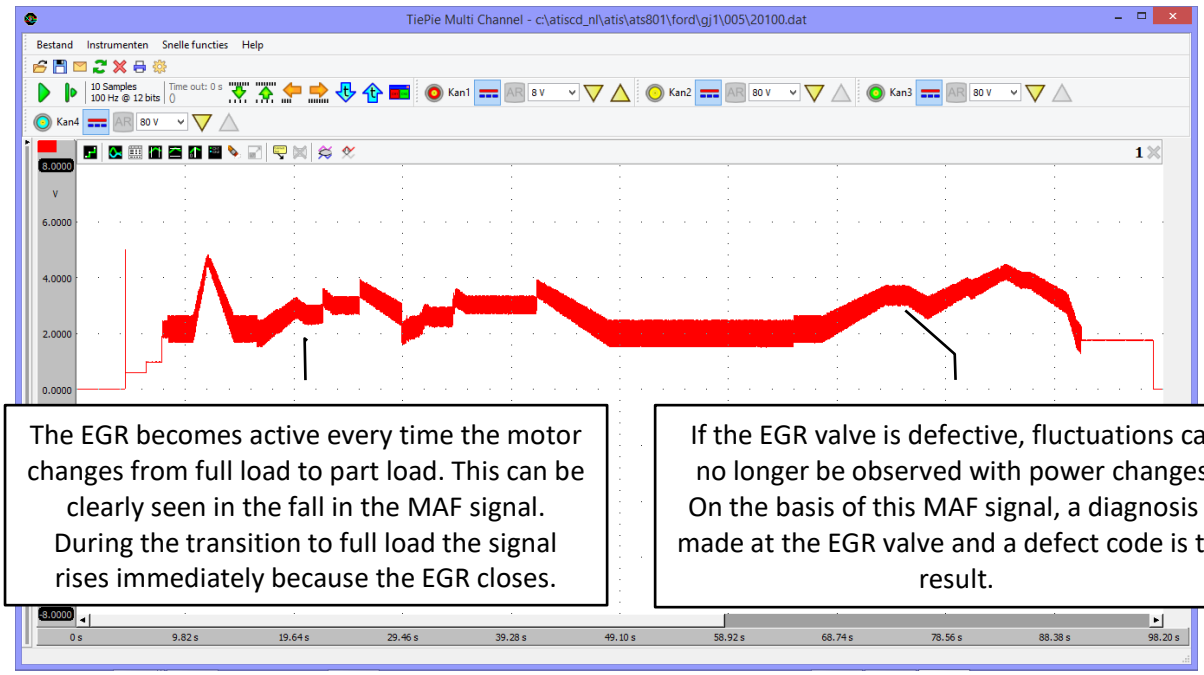
Air mass sensor

The signal from the air mass sensor (MAF), with this diesel, varies widely. This is because the intake manifold does not contain a gas valve and each cylinder sucks in a complete air filling. This gives a very pulsating air flow through the MAF and can also be seen in this signal.

Specials:

The operation of an EGR valve can be observed by measuring the signal from the MAF and observing it at partial load. The EGR valve usually only works while driving and not with no-load throttle. Drive in a gear and let the engine accelerate to partial load. You can clearly see from the MAF signal that it drops slightly when the motor reaches the partial load range.

This is because the EGR valve opens and part of the exhaust gas flows to the engine at the expense of the amount of outside air measured by the MAF. The EGR valve closes immediately when the gas is released again and the MAF signal jumps up again. In case of malfunction X/X, the EGR valve does not work due to a poor power supply on this valve. With this malfunction it can be seen that there is no change in the signal from the MAF when transitioning from full load to part load (see last part of the scope image).



The EGR becomes active every time the motor changes from full load to part load. This can be clearly seen in the fall in the MAF signal. During the transition to full load the signal rises immediately because the EGR closes.

If the EGR valve is defective, fluctuations can no longer be observed with power changes. On the basis of this MAF signal, a diagnosis is made at the EGR valve and a defect code is the result.

In the event of malfunction X/X, the power supply of the MAF is no longer present. The defect code is then Pxxxx. The problem is an interrupted supply wire between system relays (87) and connection 4 of the MAF. The sensor signal of this MAF is therefore 0 volts. With Live Data readout, a zero signal is also seen.

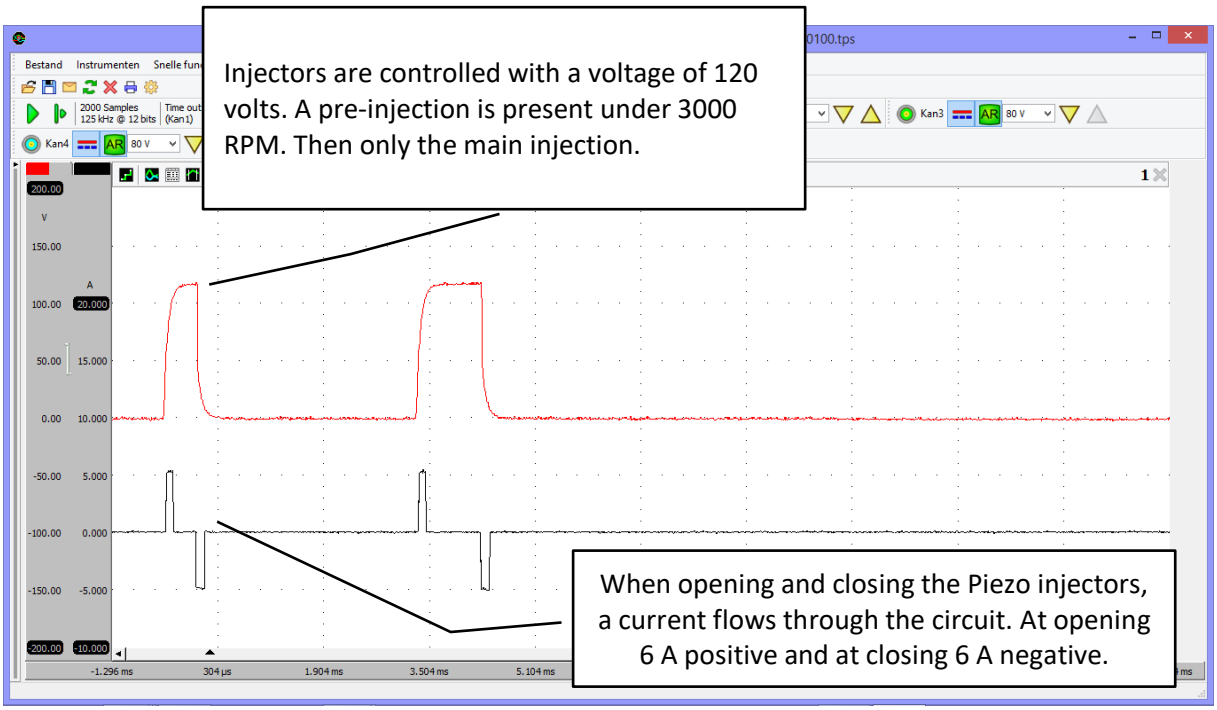
Injector(s)

The injectors are of the piezo type. You should see this type of injector as a capacitor. If the injector needs to be opened, a (high) voltage is applied. In this case it is 120 volts. The voltage is harmless because there is a protection in the form of a very high series resistance (500 kOhm) in this circuit of the simulator. This voltage remains on the injector during the "open" period. The injector current can also be measured on the simulator. For this, two “Amp” + and - measuring points are present in the injector circuit (this is a voltage measurement with a measuring factor of 100 mV / A).

When measuring the current, it can be seen that a current pulse of about 6 A can be seen when the injector is opened.

During the further "open" period, the current is 0 A. During the closing of the injector, a current pulse of 6 A negative (discharge current) becomes visible.

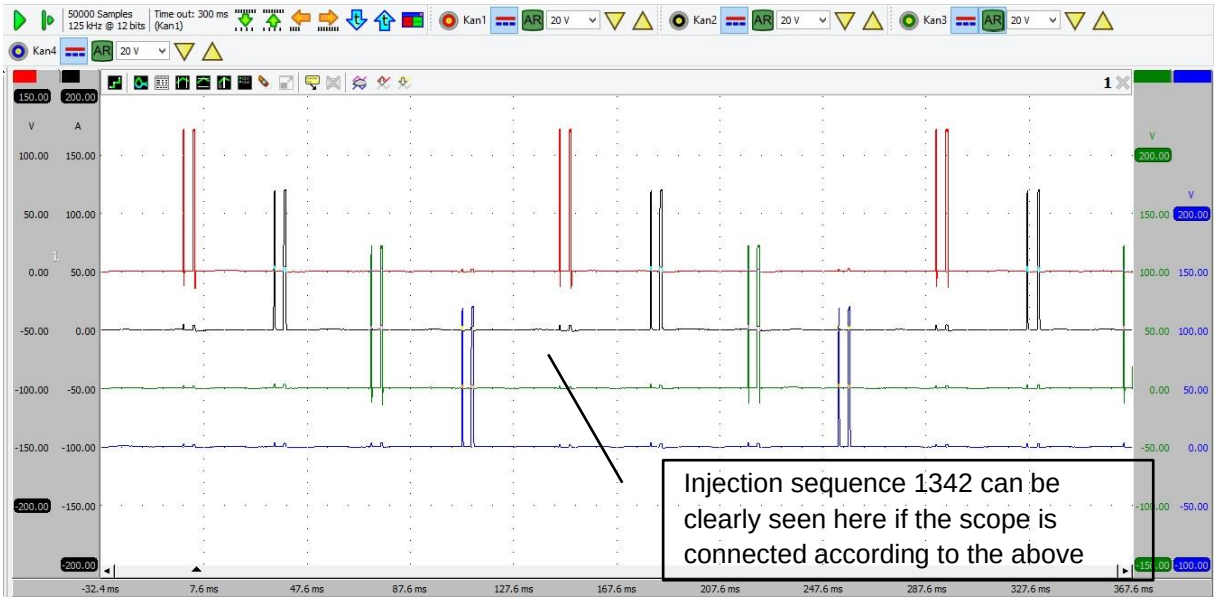
This can all be measured with the scope. Measuring both signals simultaneously is only possible with a Differential scope. For the injector with an attenuator 10: 1 at the relevant scope input required. The current can be measured equal to an Amp-tang setting with an output of 100 mV / A.



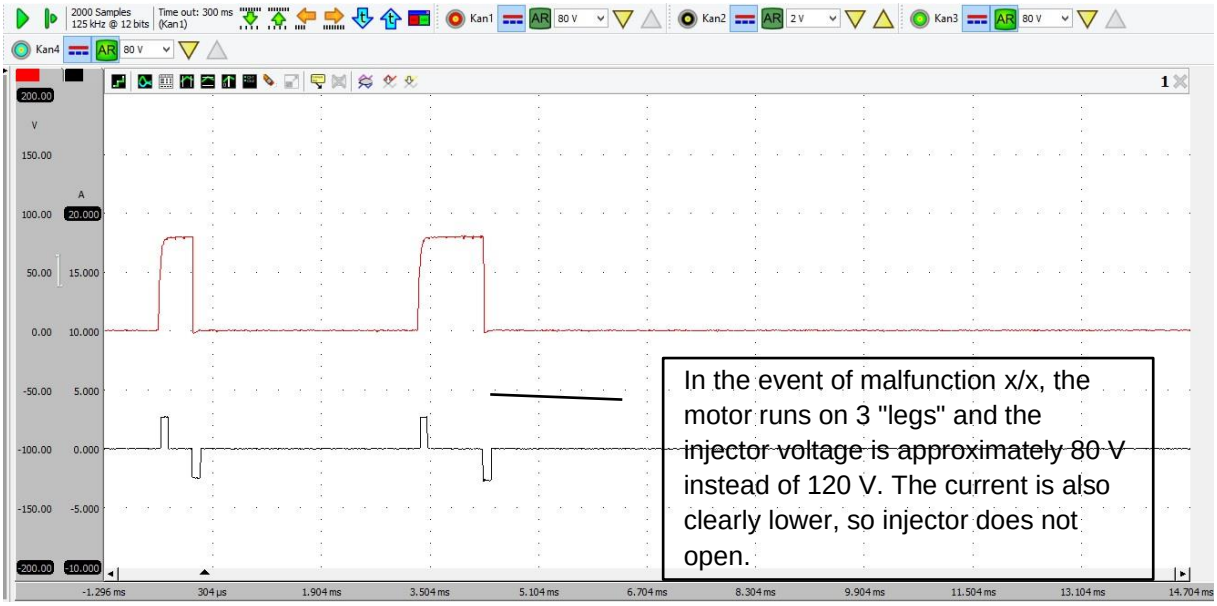
Specials:

The controls on the 4 injectors are measurable with a four-channel scope and have the injection order of 1-3-4-2. With this measurement, put all minus measurement connections from the scope to the ground. To measure the four injectors, place Ch1 on cylinder 1, Ch2 on cylinder 3, Ch3 on cylinder 4, Ch4 on cylinder 2.

The following scope image will now be obtained.



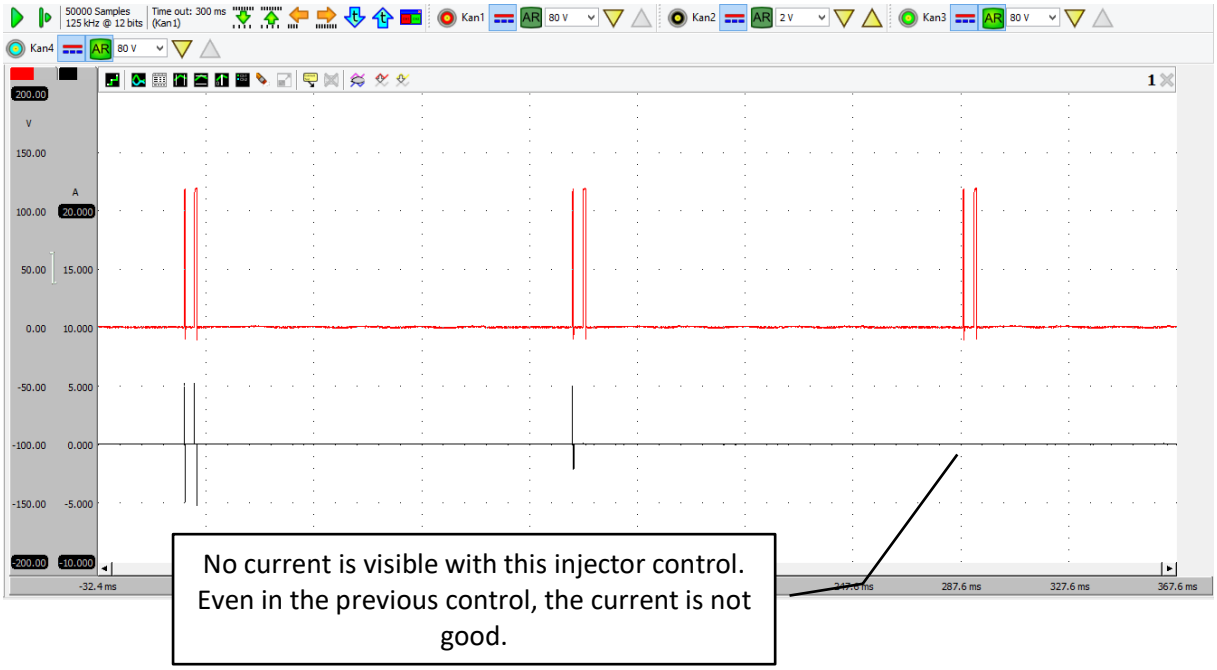
In the event of malfunction X/X, the voltage on the injector of cylinder 1 is too low, so that the injector does not open. Also note the current that has dropped to 2.5 Amps.



After switching on fault X/X, the motor runs on 3 "legs". A defect code (error light) is not immediately available. After a while the diagnostic light comes on and code Pxxxx is issued. The ECU has attempted to extend the injector time of cylinder 1 via the adaptive control (learning process) in order to try to obtain a properly rotating engine. This was not successful and when reading the "Cylinder Adaption" (Live Date) it will be seen that the ECU has increased the adaptation on cylinder 1 to above Plus 22%. With a 30% increase, the ECU stops this adjustment.

The fault code Pxxxx can be read out in the event of malfunction X/X. This indicates that the ignition of cylinder 1 is occasionally not present. The injector of cylinder 1 probably does not work occasionally. Scope measurements of this injector signal show that the voltage is present and the current is not. If the cylinder in question does not participate in the cylinder run (also measures the circulation test), it cannot be otherwise that this injector is not internally defective.

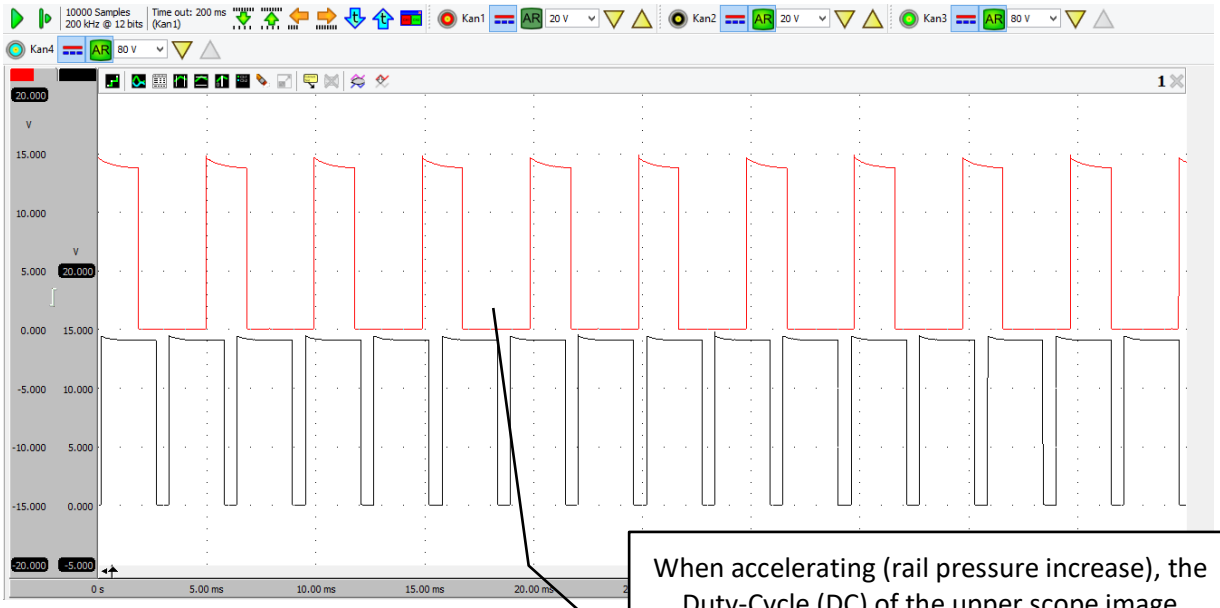
This situation can be seen in the following scope image.



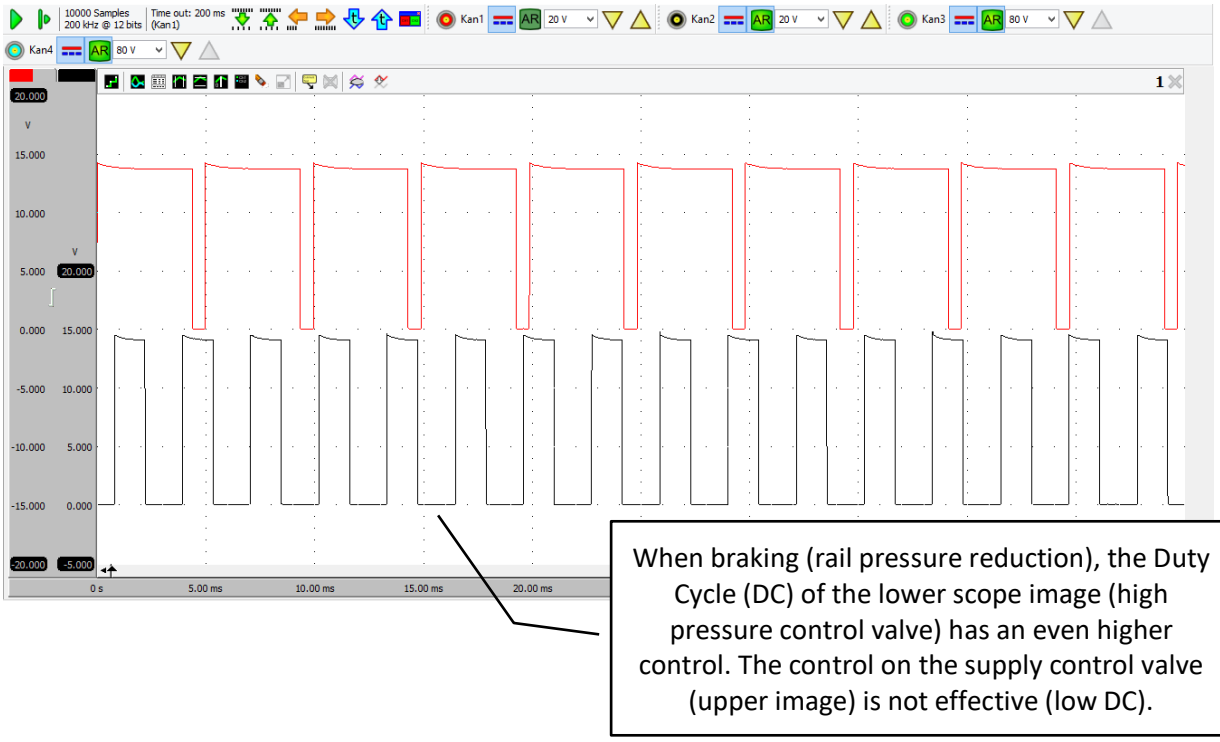
Fuel supply control valve

The high pressure pump used with this Common Rail (CR) system has two control valves. A fuel supply control valve (270) and a high pressure control valve (203). In general, the fuel supply control valve is used to control the rail pressure. Only if the pressure has to fall quickly will the high-pressure control valve be triggered.

The following scope view shows that when the rail pressure is raised and raised, the upper duty cycle signal from the fuel supply control valve is switched to ground longer than the high pressure control valve (no opening of this valve).



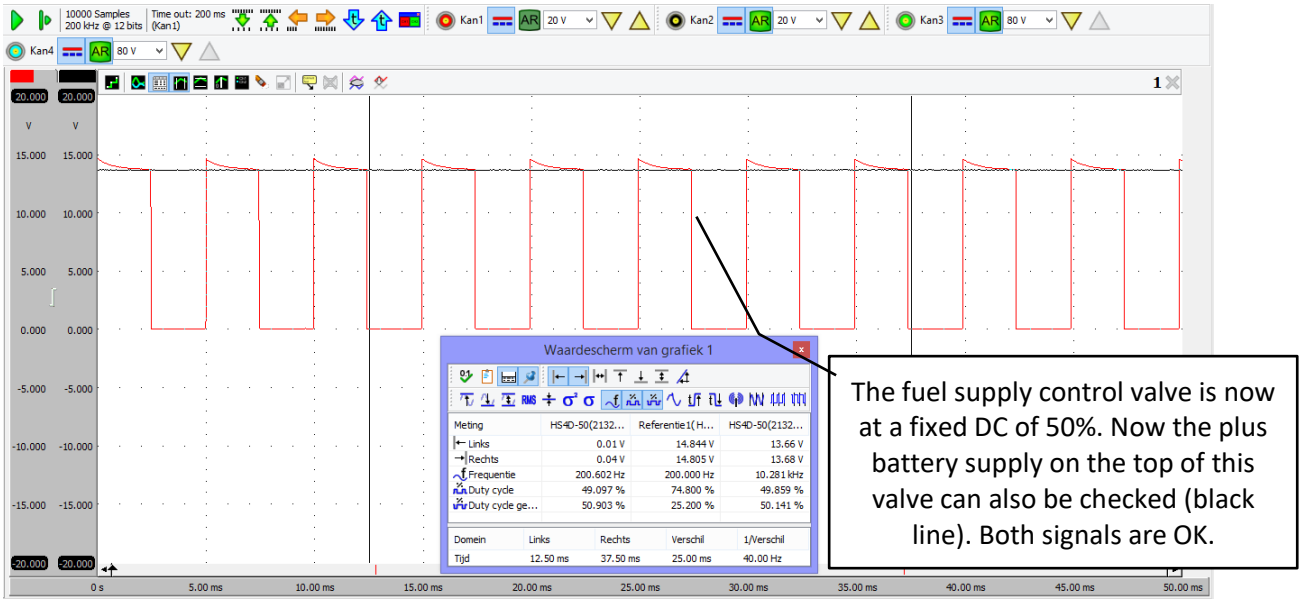
During the lowering of the CR pressure, the high-pressure control valve is, however, momentarily actuated to rapidly reduce the pressure. The fuel supply control valve will not open in this situation. See this situation in the following scope image.



In the event of malfunction X/X, the fuel supply control valve is defective. This causes the defect code Pxxxx to be issued. The motor stops and can no longer run. Normally the rail pressure during starting is around 200 Bar.

If the rail pressure is viewed during this malfunction, it will not exceed 70 Bar, too low for starting (the latter only from version V2.D80). otherwise no reduction in pressure.

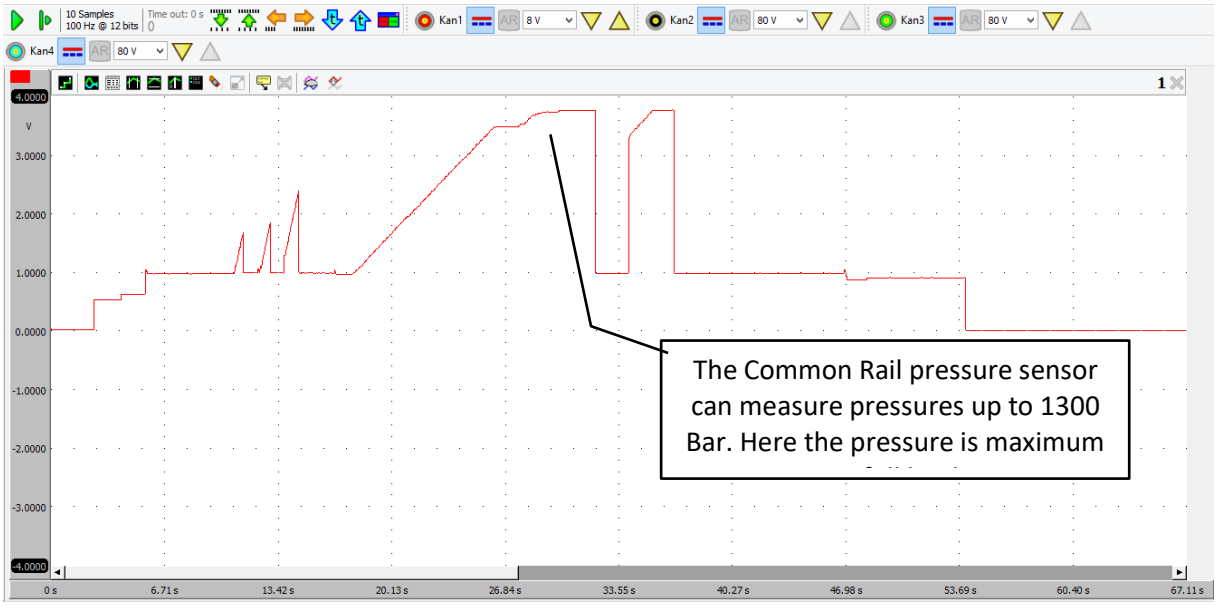
In these cases, a special measuring precursor is available in the diagnostic tester, namely the "Actuator test". This way, valves of this kind can be placed on a fixed Ducy Cycle to take measurements. This Actuator test can only be performed with the engine stopped. In the diagnostic tester select the item “Supply valve”. This valve will now be controlled with a DC of 50% (see the scope image).



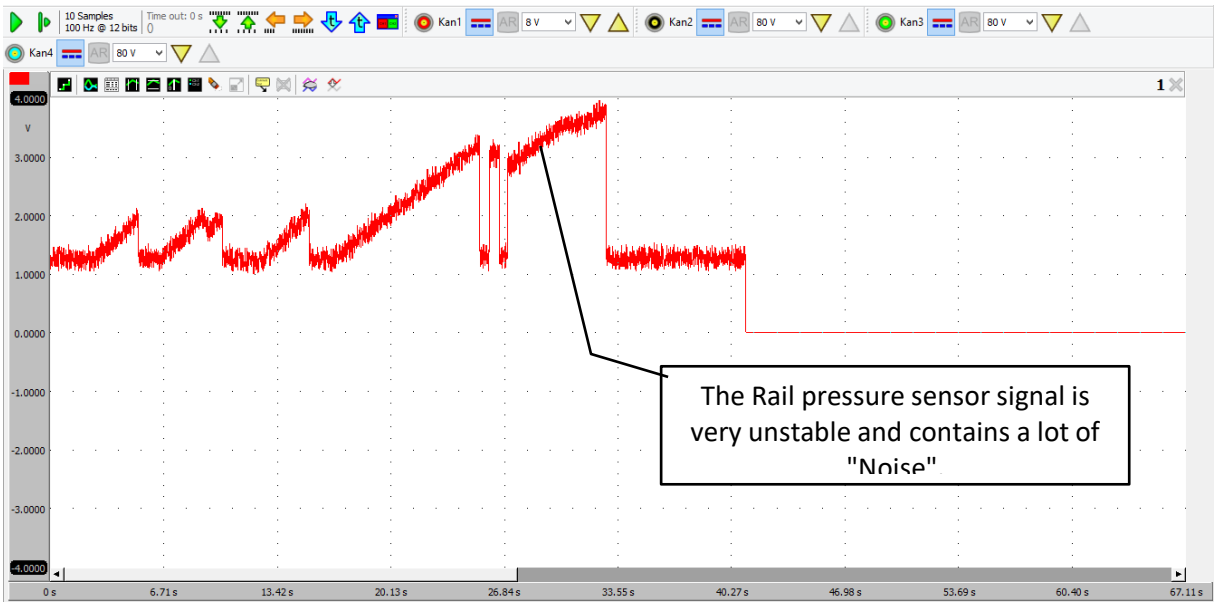
The conclusion with this malfunction must be that the control of this valve is OK, but the valve itself does not function and therefore does not allow fuel in the CR high-pressure pump.

Common Rail pressure sensor

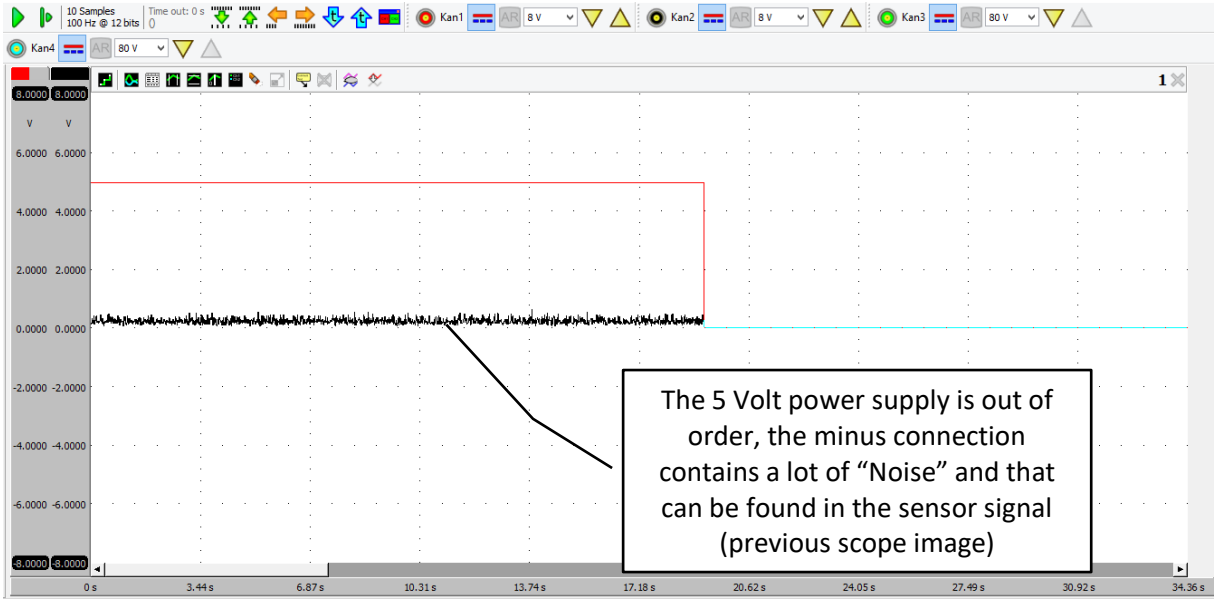
The Common Rail pressure sensor (204) measures the pressure in the CR line. The pressure in this rail can rise to 1300 Bar at full load. The course of the sensor voltage can be seen in the following scope image.



In the event of malfunction X/X, the motor has too low a power and defect code Pxxxx is present. The following scope image can be seen when measuring this sensor signal.



There is a lot of "noise" on the signal. Also in "Live Data" there is a lot of unstability to be seen with the Rail pressure. This may indicate a defective sensor, but before the sensor is replaced, it is advisable to measure the supply voltages. In the following scope view, the 5 Volt power supply (3) connection was measured with CH1 and the minus connection (1) was measured with CH2.

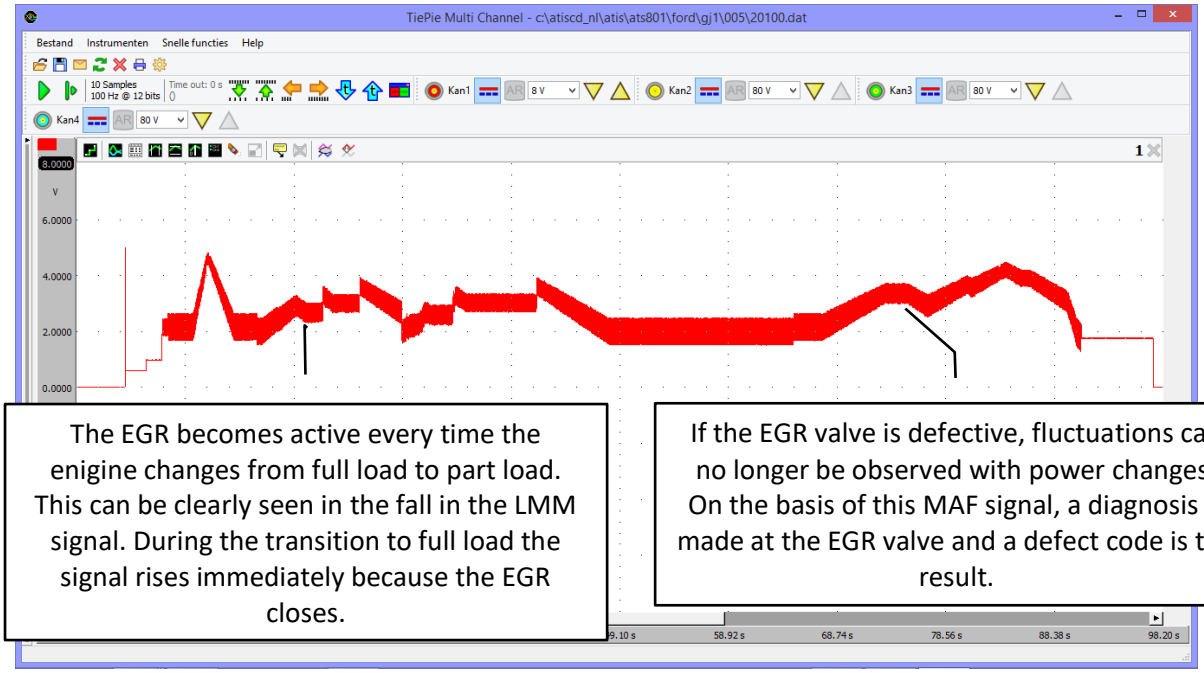


EGR control valve

The EGR control valve (34) allows part of the exhaust gas to flow back into the intake manifold. The ERG is only active in partial load areas and only when driving. At full load it is closed because this results in a reduction of the power. At idle speed, the engine will not run properly if the EGR is open.

If the scope image of this EGR valve is viewed, it will be noticed that the Duty-Cycle is low and only slowly increases at partial load and the valve will then open. If acceleration then occurs, this valve closes immediately.

In case of malfunction X/X this valve no longer works and a defect code Pxxxx is present. That this valve no longer works can be seen from the scope image of the Air Mass Meter.

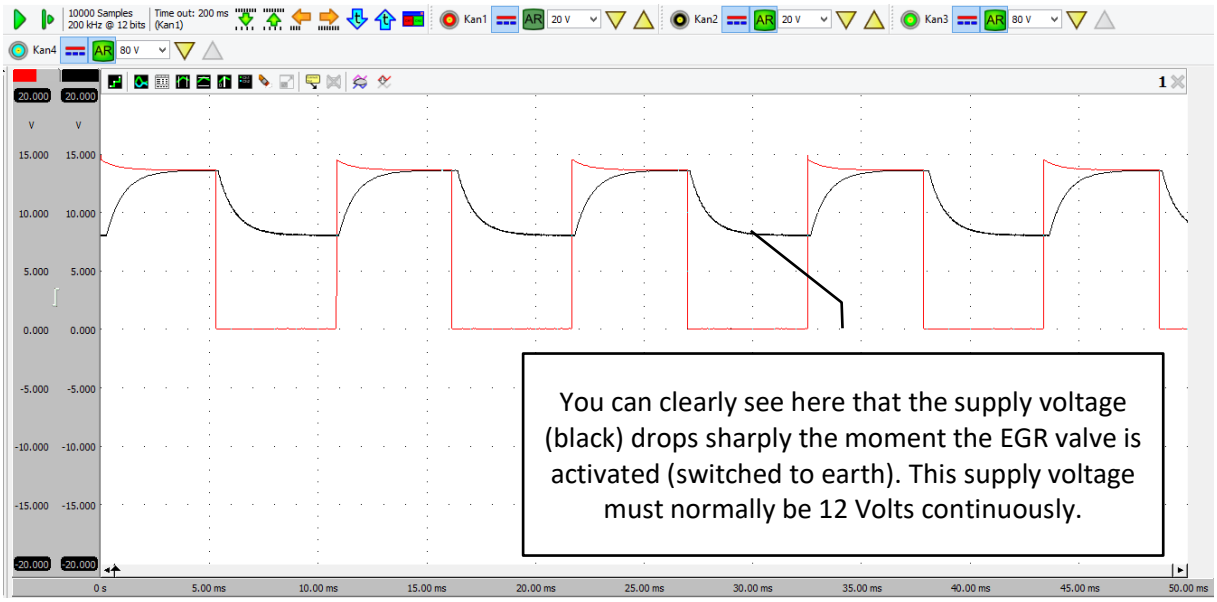


The EGR becomes active every time the enigine changes from full load to part load. This can be clearly seen in the fall in the LMM signal. During the transition to full load the signal rises immediately because the EGR closes.

If the EGR valve is defective, fluctuations can no longer be observed with power changes. On the basis of this MAF signal, a diagnosis is made at the EGR valve and a defect code is the result.

Because the EGR valve does not work, a thorough measurement must be made. The "Actuators" test can also be selected for this in the diagnostic tester. This test only works with the engine stopped and the ignition on. The Duty-Cycle voltage on this valve is then fixed at 50%.

With CH1 (red) measured on the Duty-Cycle and CH2 (black) on the battery supply on this valve. This measurement can be seen in the following scope image.



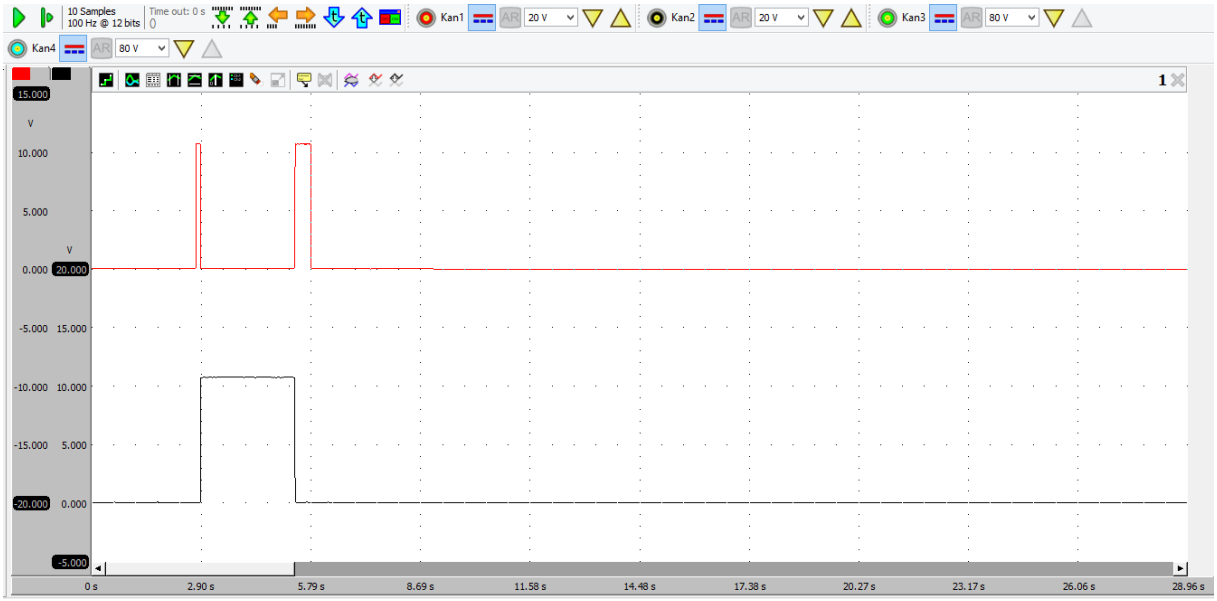
You can clearly see here that the supply voltage (black) drops sharply the moment the EGR valve is activated (switched to earth). This supply voltage must normally be 12 Volts continuously.

A poor power supply can only be measured when current flows through the circuit. By performing the "Actuator" test, a circuit can be measured quietly and with the motor stopped.

Glow system

The glow plug system is switched on with a directly injected diesel at a lower engine temperature. This temperature is below 0 degrees with this engine.

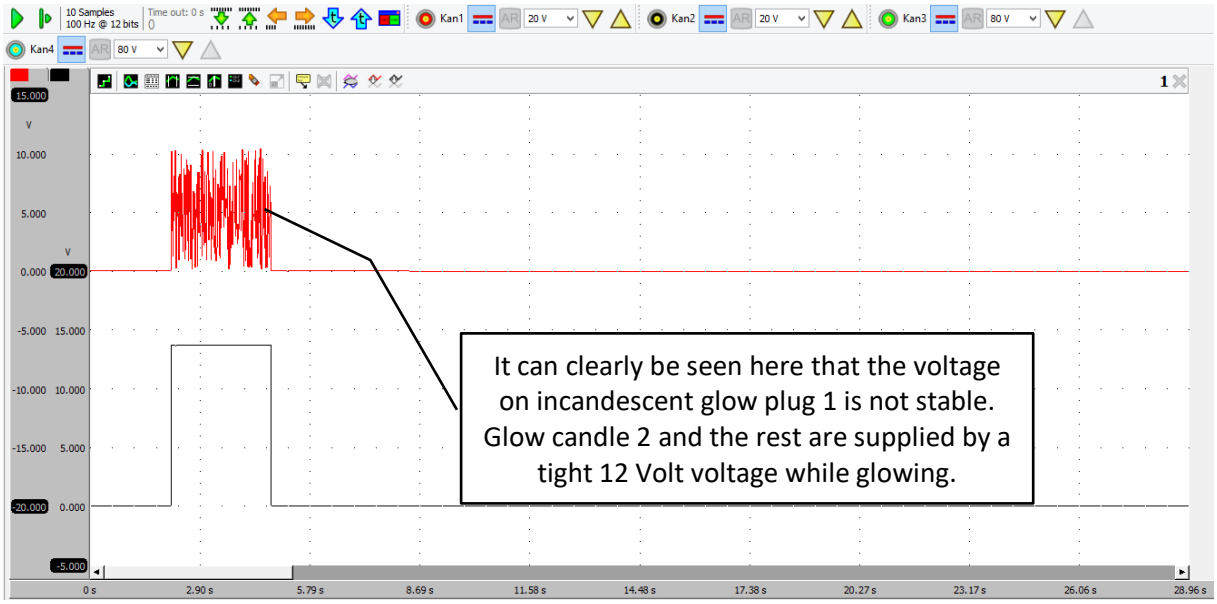
The instruction to glow comes from the ECU. The following scope view shows how the two control signals behave. CH1 on # 4 and Ch2 on # 5.



These signals may also include. Diagnosis reports regarding glowing.

In the event of malfunction X/X, the motor initially runs on 3 “legs” and defect code Pxxxx is issued. To get the engine really cold, switch off the power supply of the case. The starting temperature is then at -11 degrees. Switch on fault 3/4 and let the engine run. Start the engine. The engine starts poorly and runs unstable and white smoke comes out of the exhaust. After a short walk, the engine runs stably again.

If the Glow Plugs are measured, the following is observed.

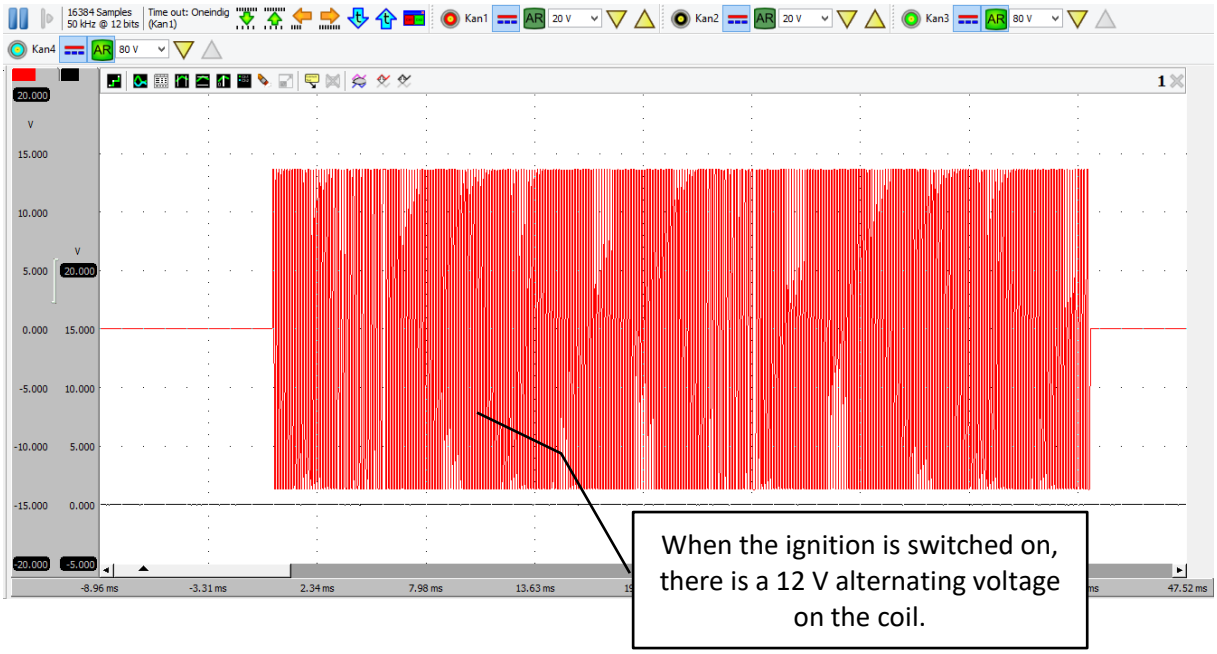


The problem must be found in the wire connection or connections to incandescent candle number 1. Because this cylinder does not glow, the engine first runs unstable and emits white smoke. But soon the compression temperature in this cylinder is sufficient to ignite the fuel and the engine runs well again.

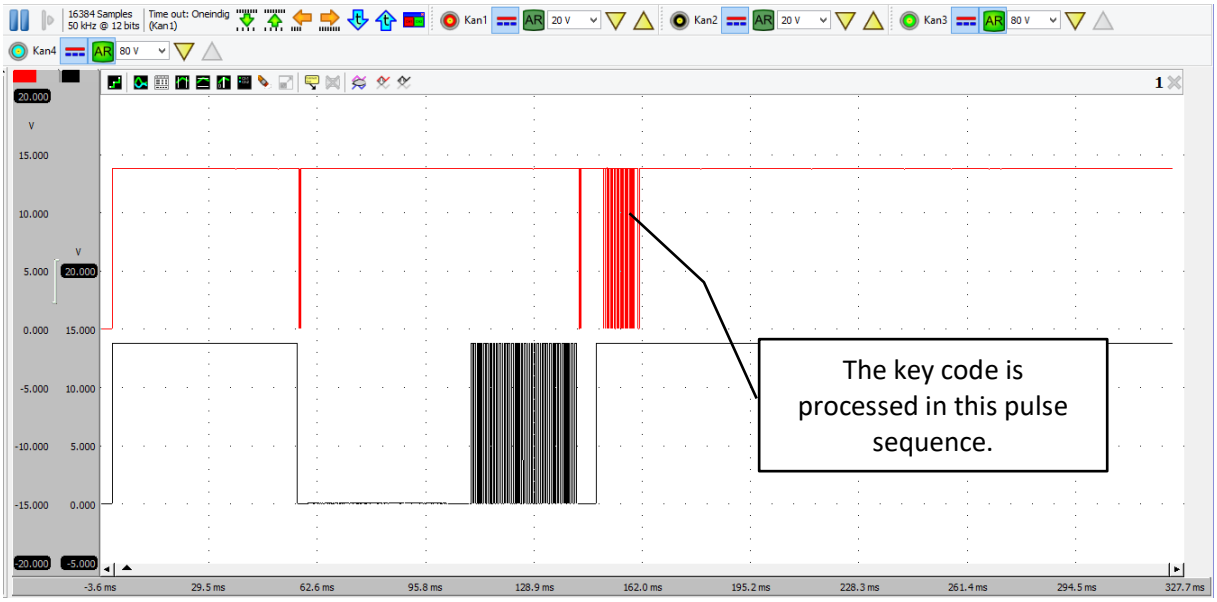
Immobilizer

The immobilizer system with a coil around the ignition is the security system through the ECU. The immobilizer module briefly places an alternating schedule on the coil when the ignition is switched on. This coil provides a magnetic field for which the chip in the key responds. This in turn transmits a code that picks up the same coil (antenna). The immobilizer module then sends a rolling code to the ECU.

The alternating voltage across the coil can be seen in the following scope image.



If a code is received via the coil, this code will be passed on to the ECU. When measuring with CH1 on # 4 and CH2 on # 3, the following signals will appear with ignition on.

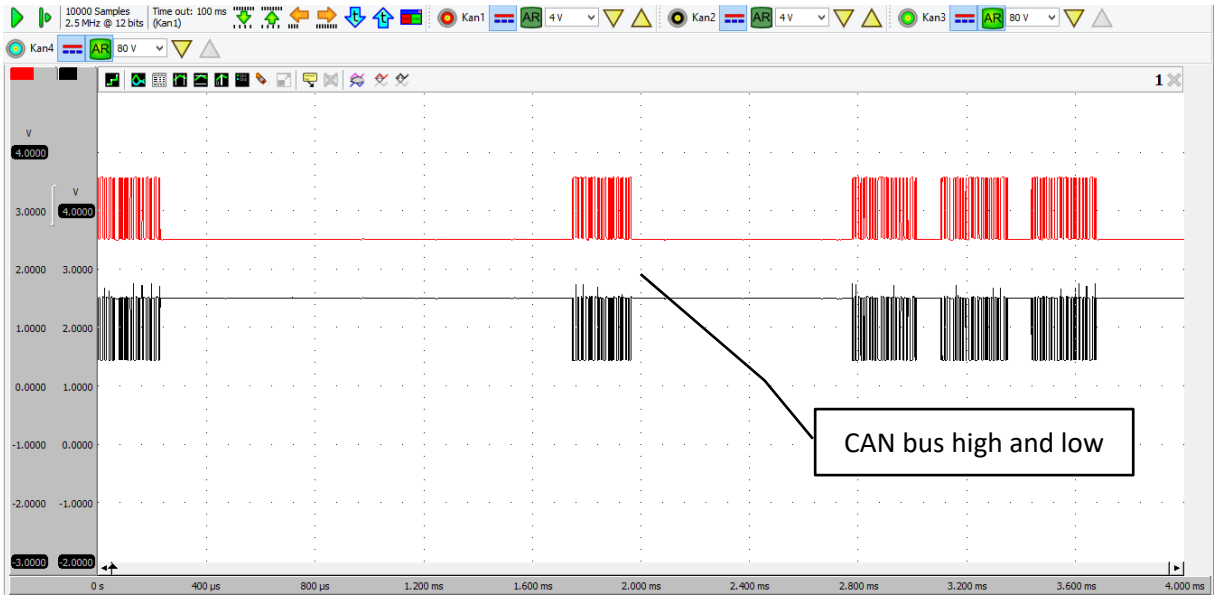


The unique code can be found in the last part of the signal from CH1.

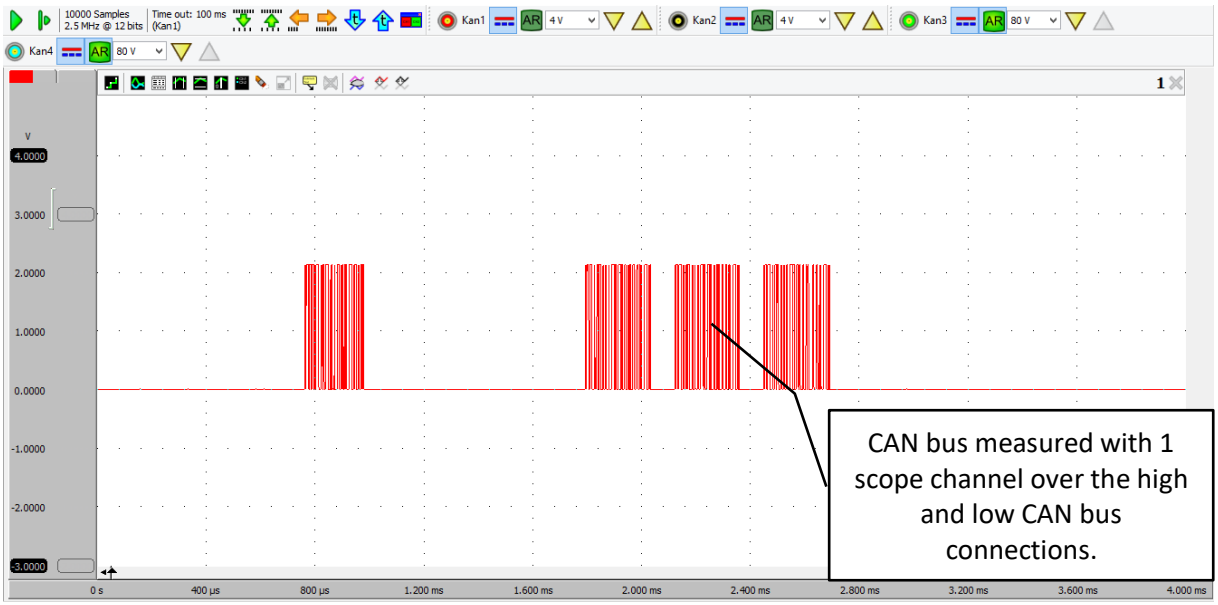
CAN-Bus

The CAN bus is a high speed bus of 500 Kbit / s. The bit time in this case is 1.8 µsec. The CAN-bus high switches between 2.5 and 3.5 volts. CAN bus low between 1.5 and 2.5 volts. All CAN-Bus systems actually only "look" between the high and low CAN-Bus wires, so the difference between these signals.

The signals against the ground are shown in the following scope image.

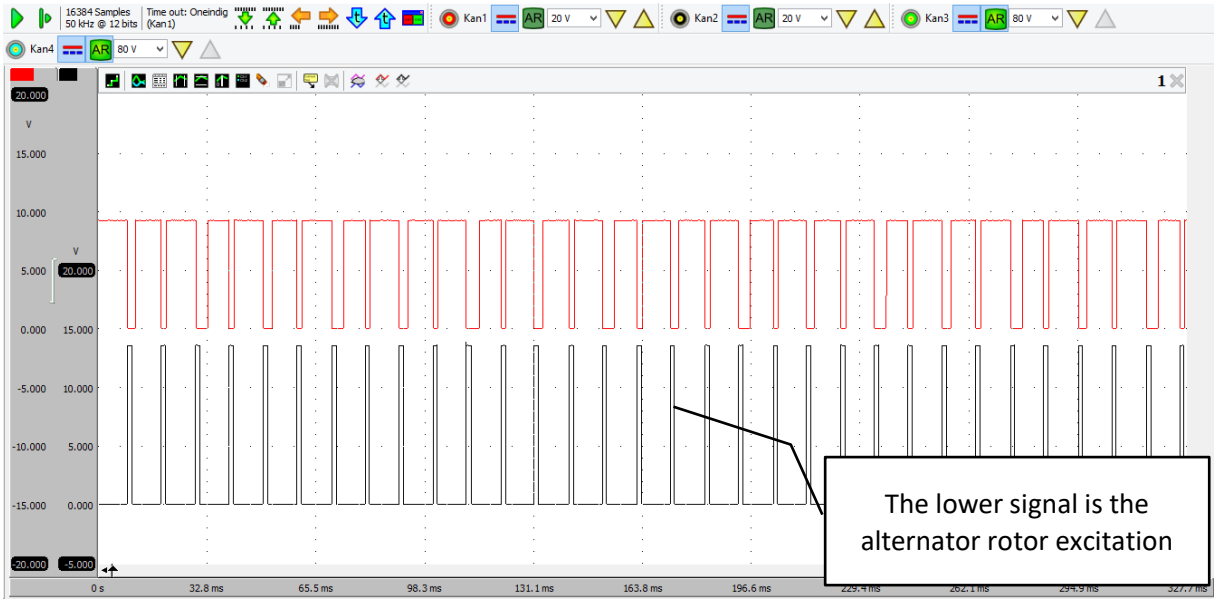


If across wires are measured, the following signal will appear. The voltage pulses are then 2 volts (difference between 1.5 and 3.5 volts). This is actually the signal used by the ECUs.

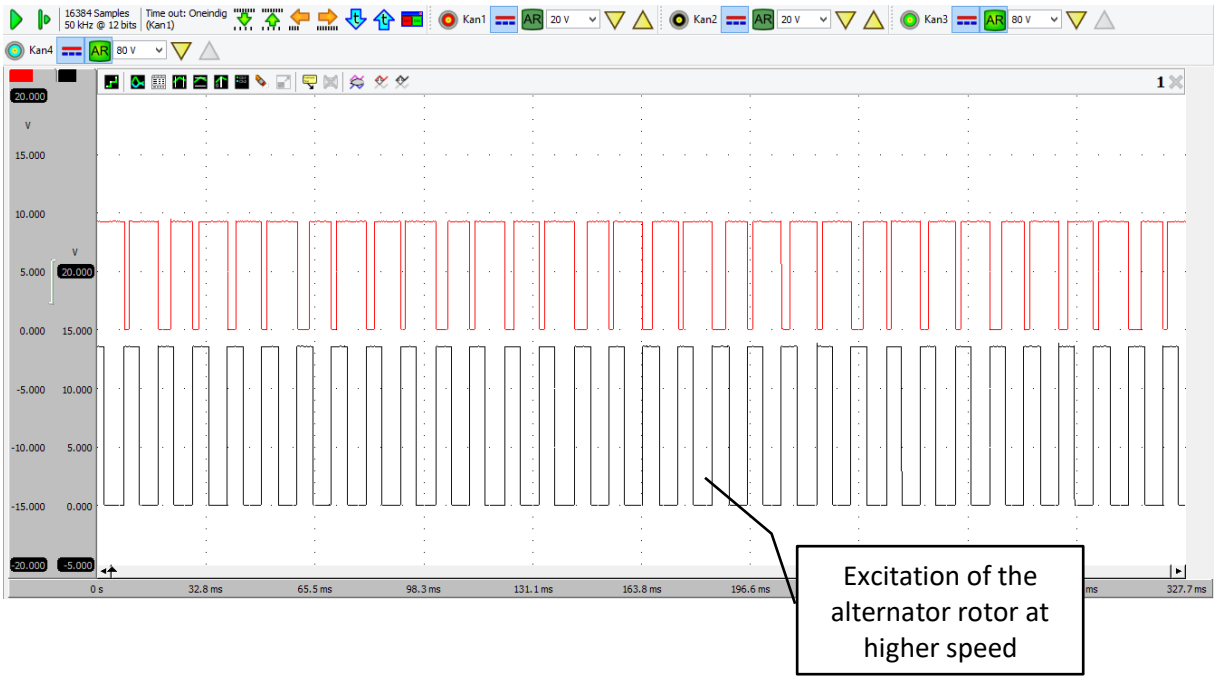


Alternator

The charging voltage of the alternator is controlled from the ECU. There are two communication wires for this. In the following scope view, these signals can be seen with the engine running at idle speed. CH1 on # 1 and CH2 on # 2. The signal on connection 2 is a duty cycle and it will decrease in% with no increasing speed.

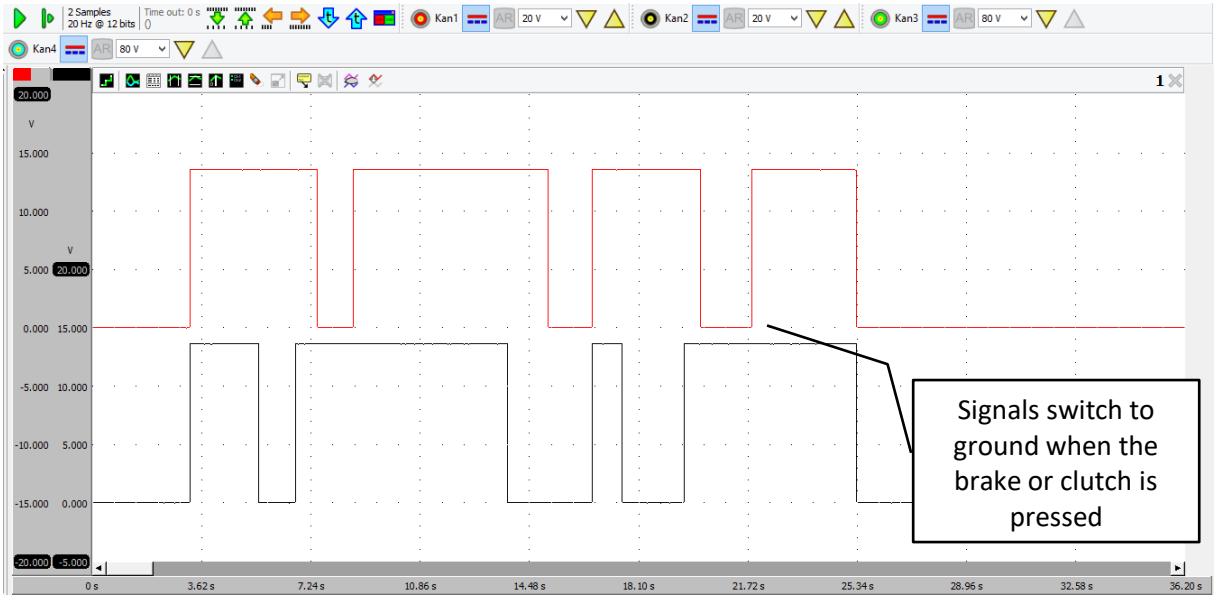


At a higher speed the alternator must be adjusted and this change in the signals can be seen in the following image. Pay particular attention to the lower signal.



Brake and clutch pedal

These signals are mass-switched and can best be measured at the ECU. CH1 on the Brake switch and CH2 on the clutch switch. The following scope image is created when the brake and clutch are pressed repeatedly.



Het Galileoteam.