



# H50TICD Diagnose

with Hatz HDS<sup>2</sup> Tool



## Diagnose function with the Hatz Diagnose Software 2 (HDS<sup>2</sup>)

The screenshot shows the Hatz Diagnose Software 2 (HDS<sup>2</sup>) interface. The window title is "Diagnose - Identification". The left sidebar contains a menu with the following items: Identification (selected), Current values, Error memory, Actuator test, Diagnostic tests, Data set, Engine protocol, Data recording, Help, and Settings. The main area displays the "Identification" data for a Hatz 4H50TICD engine with serial number 1651019000065. The data is presented in a table with two columns: "Description" and "Current Values".

Description	Current Values
Operating hours	21
Hardware-Version	EDC17_C81
Software-Version	P1715_V600R
Engine number	1651019000065
Manufacturing date	..
Remaining time to service	479
Last programming date	08.08.19
Dataset description	D165C81##V600R03###

Below the table, there is a 3D rendering of the engine.



## Current Values

HDS<sup>2</sup> 1651019000065

- Identification
- Current values
- Error memory
- Actuator test
- Diagnostic tests
- Data set
- Engine protocol
- Data recording
- Help
- Settings
- Not connected

### Current Values

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Description	Current value	Raw value	Nominal value	
Operating hours	21 h			
Limp home mode	0			
Engine speed	0 rpm			<div style="width: 100%; height: 10px; background: linear-gradient(to right, green, yellow, red);"></div>
Torque	0 Nm			
Iner torque	0 Nm			
Friction torque	899 Nm			
Injection quantity	0 mg/H			
Total injection quantity	0.0 mg/H			
Fuel consumption	0.0 l/h			
Battery	12.48 V			<div style="width: 100%; height: 10px; background: linear-gradient(to right, green, yellow, red);"></div>
Coolant temperature	58 °C	1612 mV		<div style="width: 100%; height: 10px; background: linear-gradient(to right, green, yellow, red);"></div>
Coolant level switch	1216 mV	1216 mV		
Oil temperature	58 °C	1627 mV		<div style="width: 100%; height: 10px; background: linear-gradient(to right, green, yellow, red);"></div>
Oil pressure	0.0 bar	508 mV		<div style="width: 100%; height: 10px; background: linear-gradient(to right, green, yellow, red);"></div>
Boost pressure	1.0 bar			<div style="width: 100%; height: 10px; background: linear-gradient(to right, green, yellow, red);"></div>
Boost temperature	32 °C			
Fuel temperature	1684 °C	1798 mV		<div style="width: 100%; height: 10px; background: linear-gradient(to right, green, yellow, red);"></div>
Fuel low pressure	0.0 bar	493 mV		<div style="width: 100%; height: 10px; background: linear-gradient(to right, green, yellow, red);"></div>
Fuel pre supply pump	195			
Water in fuel	0			
Rail pressure	5 bar	510 mV		<div style="width: 100%; height: 10px; background: linear-gradient(to right, green, yellow, red);"></div>
Air filter differential pressure	mbar	825 mV		<div style="width: 100%; height: 10px; background: linear-gradient(to right, green, yellow, red);"></div>
Ambient pressure	1005 mbar			<div style="width: 100%; height: 10px; background: linear-gradient(to right, green, yellow, red);"></div>
Glow plug	0			



## Current Values

HDS<sup>2</sup> 1651019000065
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- Identification
- Current values
- Error memory
- Actuator test
- Diagnostic tests
- Data set
- Engine protocol
- Data recording
- Help
- Settings
- Connected

Description	Current value	Raw value	Nominal value
Starter relay	0		
Cl. 15	0		
Cl. 50	0		
Air mass	kg/h		
Derating status	0		
Derating DPF & EGR Stage 1	0 s		
Derating DPF & EGR Stage 2	0 s		
Regeneration inhibit	0		
EGR valve	0 %	772 mV	5 %
Throttle valve	60 %	663 mV	100 %
DOC/DPF differential pressure	0 mbar	478 mV	
Temperature Oxi Cat upstream	79 °C	977 mV	
Temperature DPF upstream	85 °C	508 mV	
Active cylinders	24		
Engine operation mode	Ready to start		
Engine operation stage	Normal operation		
Exhaust heater	0		
Particulate filter load	10 %		
Soot load	3 g		
Measured soot load	3 g		
Simulated soot load	81 g		
Ash volume	38.60 L		
Regeneration aborted due to brake switch	0		
Regeneration aborted due to neutral switch	0		





### Current Values

Description	Current value	Raw value	Nominal value
Multi state switch	0	4999 mV	
Maintenance lamp	0		
Air filter lamp	0		
Engine running lamp	0	0	
Diagnostic lamp	0	0	
Oil pressure lamp	1		
Over temperature lamp	0		
Pre Glow lamp	0		
Main Brake Switch	1		
Redundant Brake Switch	1		
Brake Switch	3		
Parking brake switch	1		
Gear neutral switch	1		
Engine start/stop switch	0		
Vehicle speed	0 km/h	9 mV	
Engine speed control "-" MPV	0		
Engine speed control "OFF" MPV	0		
Engine speed control "+" MPV	0		



## Read error memory

1. Connect diagnostic device.
2. Start the vehicle and select the diagnosis function HDS<sup>2</sup>.
4. Read out fault memory, eliminate the error number with the description
5. Only replace components after excluding all test options!



## Read error memory

The screenshot shows the HDS² software interface. On the left is a dark sidebar with navigation icons and labels: Identification, Current values, Error memory (highlighted), Actuator test, Diagnostic tests, Data set, Engine protocol, Data recording, Help, Settings, and Connected. The main window title is "Error memory" and shows engine ID "1651019000065". At the top right of the main area are three buttons labeled 3, 2, and 1. Below them is a table with the following data:

Engine hours	SPN	FMI	State	Error description
0			Passive	No failure entry

Below the table is a large grey box containing the text: "Error memory 1 displays the active errors. They can be deleted by clicking on the 'X'." At the bottom right of the main area are navigation icons: a mouse cursor, a right arrow, a refresh icon, and an 'X' icon.



## Read error memory

The screenshot shows the HDS² software interface. On the left is a dark sidebar with a menu containing: Identification, Current values, Error memory (highlighted), Actuator test, Diagnostic tests, Data set, Engine protocol, Data recording, Help, Settings, and Connected. The main window title is "Error memory" and the ID "1651019000065" is visible. A table with columns "Engine hours", "SPN", "FMI", "State", and "Error description" is present. The table contains one entry with a text description: "In fault memory 2 all errors are displayed after switched off the control unit (shutdown time approx. 20s). They can be deleted by clicking on the 'X'." In the bottom right corner of the window, there are icons for refresh and delete (X).

Engine hours	SPN	FMI	State	Error description
				In fault memory 2 all errors are displayed after switched off the control unit (shutdown time approx. 20s). They can be deleted by clicking on the "X".



## Read error memory

The screenshot shows the HDS² software interface. On the left is a navigation menu with options: Identification, Current values, Error memory (selected), Actuator test, Diagnostic tests, Data set, Engine protocol, Data recording, Help, Settings, and Connected. The main window title is 'Error memory'. At the top right of the main window, there are three buttons labeled 1, 2, and 3. Button 3 is highlighted with a mouse cursor. Below the buttons is a table with the following data:

Engine hours	SPN	FMI	State	Error description
0	< '\$SPN_P06D F_4' >	< '\$FMI_P06DF _4' >	1	< '\$DTC_P06DF_4' >
0	< '\$SPN_P0001 _0' >	< '\$FMI_P0001 _0' >	1	< '\$DTC_P0001_0' >
0	< '\$SPN_P0650 _11' >	< '\$FMI_P0650 _11' >	1	< '\$DTC_P0650_11' >
0	< '\$SPN_P301 D_0' >	< '\$FMI_P301D _0' >	1	< '\$DTC_P301D_0' >
0	524064	12	1	[DFC_MoCSOPErrMMRespByte] Loss of synchronization sending bytes to the MM from CPU.
0	< '\$SPN_P302 C_0' >	< '\$FMI_P302C _0' >	1	< '\$DTC_P302C_0' >

**In the error memory 3, all errors are displayed after the controller was off (shutdown time about 20s). They can not be deleted**

## Actuator test

The screenshot shows the HDS² diagnostic software interface. The window title is "HDS²" and the device ID is "1651019000065". The left sidebar contains the following menu items: Identification, Current values, Error memory, Actuator test (highlighted), Diagnostic tests, Data set, Engine protocol, Data recording, Help, Settings, and Connected. The main area is titled "Actuator test" and lists the following components: Fault lamp, Pre glowing lamp, Electric fuel pump, Metering Unit (MEU), Pre glow system, Pressure Control Valve (PCV), EGR valve, Throttle valve, and DPF heating system. On the right side of the main area, there is a 3D model of the Hatz H50TICD engine.

## Pre glowing lamp

The screenshot shows a software window titled 'HDS²' with a sub-header '1651019000065'. On the left is a dark sidebar menu with icons and labels: Identification, Current values, Error memory, Actuator test (highlighted), Diagnostic tests, Data set, Engine protocol, Data recording, Help, Settings, and a green 'Connected' indicator at the bottom. The main content area is titled 'Pre glowing lamp' and contains three sections: 'Technical data' with two bullet points, 'Location' with two bullet points, and 'Test description' with two bullet points. A blue toggle switch is positioned below the test description. To the right of the text is a 3D rendering of a rectangular lamp with a black face and a yellow '00' symbol.

**Technical data**

- To display the active pre-glow time, a separate lamp / LED can be wired.
- There is no dependence on an instrument box.

**Location**

- The installation of the lamp is an option.
- The location of the lamp may vary, but experience has shown that it is close to the machine control.

**Test description**

- With the following test it is possible to check the pre glow lamp, this only works with an hard wired lamp.
- Use the button below to control the pre glow lamp.

## Electric fuel pump

The screenshot shows the HDS² diagnostic software interface. On the left is a dark sidebar menu with icons and text for: Identification, Current values, Error memory, Actuator test (highlighted), Diagnostic tests, Data set, Engine protocol, Data recording, Help, Settings, and a green 'Connected' indicator at the bottom. The main content area is titled 'Electric fuel pump' and contains the following sections:

- Technical data**
  - The pressure side of the pump is located at the electrical connections.
  - The fuel system has to be free from copper, zinc and existing alloys (e.g. brass).
- Location**
  - The pump is located between the fuel pre- and main filter.
  - Chassis side attachment.
- Test description**
  - With the following test it is possible to check the electrical fuel pump.
  - Use the button below to control the electrical fuel pump.
  - Test result: the is activated for approx. 30 seconds.

Below the test description is a blue toggle switch that is currently turned on. To the right of the text is a 3D cutaway illustration of the electric fuel pump, showing its cylindrical metal body, electrical terminals, and a mounting bracket.



## Metering Unit (MEU)

**Metering Unit (MEU)**

**Technical data**

- Metering unit + high pressure pump = one unit
- The high pressure pump is the same throughout the H series.
- The maximum pressure is 1800 bar.
- Under normal conditions, the metering unit primarily takes over the pressure control.

**Location**

- The metering unit is part of the high pressure pump.
- The CP4 is located on the maintenance side near the flywheel.

**Test description**

- With the following test it is possible to check the Metering unit.
- Use the slider below to control the MEU.
- Test result: buzz- / click noise

40 %

## Pre glow system

The screenshot shows the HDS² diagnostic software interface. On the left is a dark sidebar with a menu containing: Identification, Current values, Error memory, Actuator test (highlighted), Diagnostic tests, Data set, Engine protocol, Data recording, Help, Settings, and a green 'Connected' indicator at the bottom. The main content area is titled 'Pre glow system' and contains the following sections:

- Technical data**
  - The inrush current is approx. 25 A per glow plug.
  - 20 seconds after switching on, the current per glow plug is reduced to approx. 5-7 A.
  - At a coolant temperature of + 35 ° C, approx. 5 seconds are preheated.
  - The maximum pre-heat time is 30 seconds at -20 ° C.
- Location**
  - The glow plugs are located in the cylinder head near injectors.
  - The glow plug control unit is mounted in the electric panel (OPU).
- Test description**
  - With the following test it is possible to check the pre glow system.
  - Use the button below to control the pre glow system.
  - Test procedure: use a current clamp to check the preheating current.
  - Test results see technical information.

Below the test description is a blue toggle switch that is currently turned on. To the right of the text is a 3D illustration of a red glow plug.

## Pressure Control Valve (PCV)

The screenshot shows the HDS² diagnostic software interface. On the left is a dark sidebar with navigation options: Identification, Current values, Error memory, Actuator test (highlighted), Diagnostic tests, Data set, Engine protocol, Data recording, Help, Settings, and Connected. The main area displays the title 'Pressure Control Valve (PCV)' and technical data:

- Pressure control valve + rail = one unit
- In the whole H-engine range the rail is only distinguished between 3 and 4 cylinder.
- The maximum pressure is 1800 bar.
- While cold starting or in case of a malfunction (MEU malfunction) the pressure is controlled by the PCV.

Below this is the 'Location' section:

- The pressure control valve is part of the rail.
- The rail is located on the maintenance side on the cylinder head.

The 'Test description' section includes:

- With the following test it is possible to check the pressure control valve.
- Use the slider below to control the PCV.
- Test result: buzz- / click noise.

To the right of the text is an image of the PCV component, a metal rail with a red cap.

At the bottom, a slider control is shown with a hand cursor, indicating the current test level is 52%. The slider has '0 %' on the left and '100 %' on the right.

## EGR valve

The screenshot shows the HDS² diagnostic software interface. On the left is a dark sidebar with navigation options: Identification, Current values, Error memory, Actuator test (highlighted), Diagnostic tests, Data set, Engine protocol, Data recording, Help, Settings, and Connected. The main area displays the 'EGR valve' test page. It includes a title 'EGR valve', a 'Technical data' section with two bullet points explaining the valve's function, a 'Location' section with one bullet point, and a 'Test description' section with three bullet points. A 3D model of the red EGR valve is shown on the right. At the bottom, a slider control is set to 41%, with a hand cursor over the slider knob. The slider has '0 %' and '100 %' markers.

### EGR valve

**Technical data**

- The EGR-valve controls the recirculated amount of exhaust gas.
- This process causes a reduction in the combustion temperature, with the result that the nitrogen oxides are reduced.

**Location**

- The EGR valve is located in the upper area between exhaust and fan side.

**Test description**

- With following test it is possible to check the EGR-valve.
- Use the slider below to control the EGR valve.
- Test result : buzz- / beep noise.

**41 %**

0 % 100 %

HDS<sup>2</sup> 1651019000065

- Identification
- Current values
- Error memory
- Actuator test**
- Diagnostic tests
- Data set
- Engine protocol
- Data recording
- Help
- Settings
- Connected

## Throttle valve

### Technical data


- The throttle valve controls the amount of charge air supplied.

### Location


- The throttle valve is located in the charge air hose between intercooler and cylinder head.

### Test description

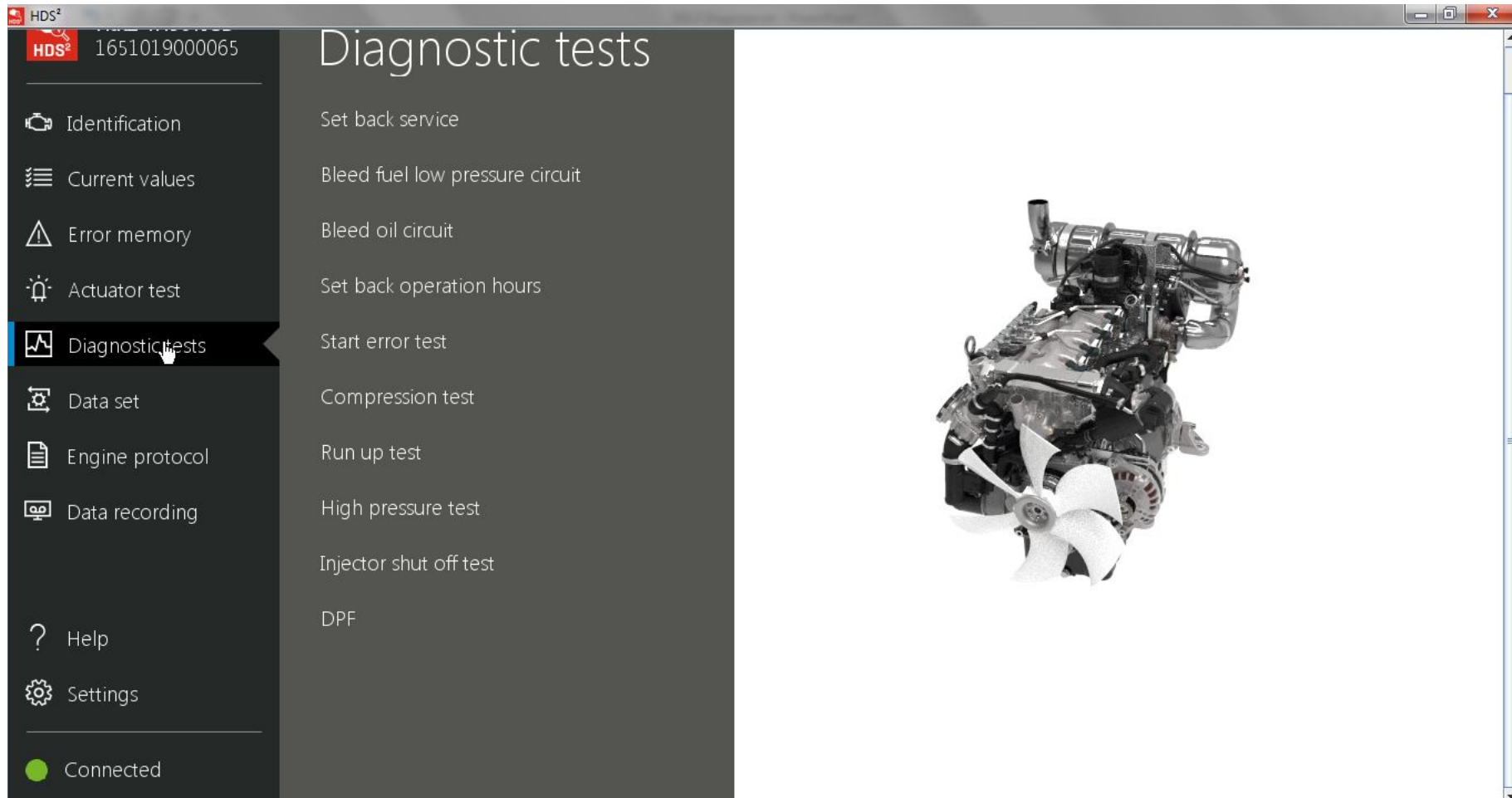
- With following test it is possible to check the throttle-valve.
- Use the slider below to control the throttle valve.
- Test result : buzz- / beep noise.



48 %



## Diagnose function with the Hatz diagnose software





## Bleed fuel low pressure cicuit

The screenshot shows a software window titled 'HDS' with a sub-header '1651019000065'. On the left is a dark sidebar menu with the following items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar is a green circle and the text 'Connected'. The main content area is titled 'Bleed fuel low pressure cicuit' and contains the following sections:

- Preconditions**
  - Engine off
  - Ignition on
- Description**

This function allows the low pressure circuit to be vented after a filter replacement or any work on the fuel system.

At the bottom of the main area, there are two buttons: a blue 'Start' button and a grey 'Cancel' button.



## Bleed fuel low pressure cicuit

HDS² 1651019000065

- Identification
- Current values
- Error memory
- Actuator test
- Diagnostic tests**
- Data set
- Engine protocol
- Data recording
- Help
- Settings

Connected

### Bleed fuel low pressure cicuit

With this function the fuel pump is triggered until achieving a pressure of 4,0 bar.

Current pressure: 3,636 bar

3.636

**Not working currently, because 4bar are expected**

Cancel





## Bleed oil cicuit

The screenshot shows the HDS² diagnostic software interface. On the left is a dark sidebar with a menu containing: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar is a green 'Connected' indicator. The main area displays the test title 'Bleed oil circuit' and the following sections: 'Preconditions' with a bulleted list: 'Engine off' and 'Igniton on' (with a mouse cursor over it); and 'Description'. At the bottom of the main area are two buttons: a blue 'Start' button and a grey 'Cancel' button.



## Bleed oil circuit

The screenshot shows a software window titled "HDS²" with a sub-header "1651019000065". On the left is a dark sidebar menu with the following items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar is a green circle and the text "Connected". The main area of the window is titled "Bleed oil circuit" and contains the text "Please start the engine until a result is shown!" and "Current pressure: 0,02 bar". In the center of the main area is a circular progress indicator with the text "7s" inside. At the bottom right of the window is a grey "Cancel" button.



## Bleed oil circuit

The screenshot shows the HDS diagnostic software interface. On the left is a dark sidebar menu with the following items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted in blue), Data set, Engine protocol, Data recording, Help, Settings, and Connected. The main area displays the text 'Bleed oil circuit' at the top and 'Bleeding successful' in the center. At the bottom of the main area, there are two buttons: a blue 'Back' button with a mouse cursor over it, and a grey 'Cancel' button. The top of the window shows the HDS logo and the vehicle ID '1651019000065'. The Windows taskbar at the bottom shows the Start button, 'Bilder' folder, HDS application, and a diagnostic file '9.0.3 Diagnose en - P...'. The system clock shows 14:30.



## Set back operation hours

The screenshot shows a software window titled "Set back operation hours" with a sidebar on the left. The sidebar contains a menu with the following items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar, it shows "Connected" with a green dot. The main content area of the window is titled "Set back operation hours" and contains the following sections:

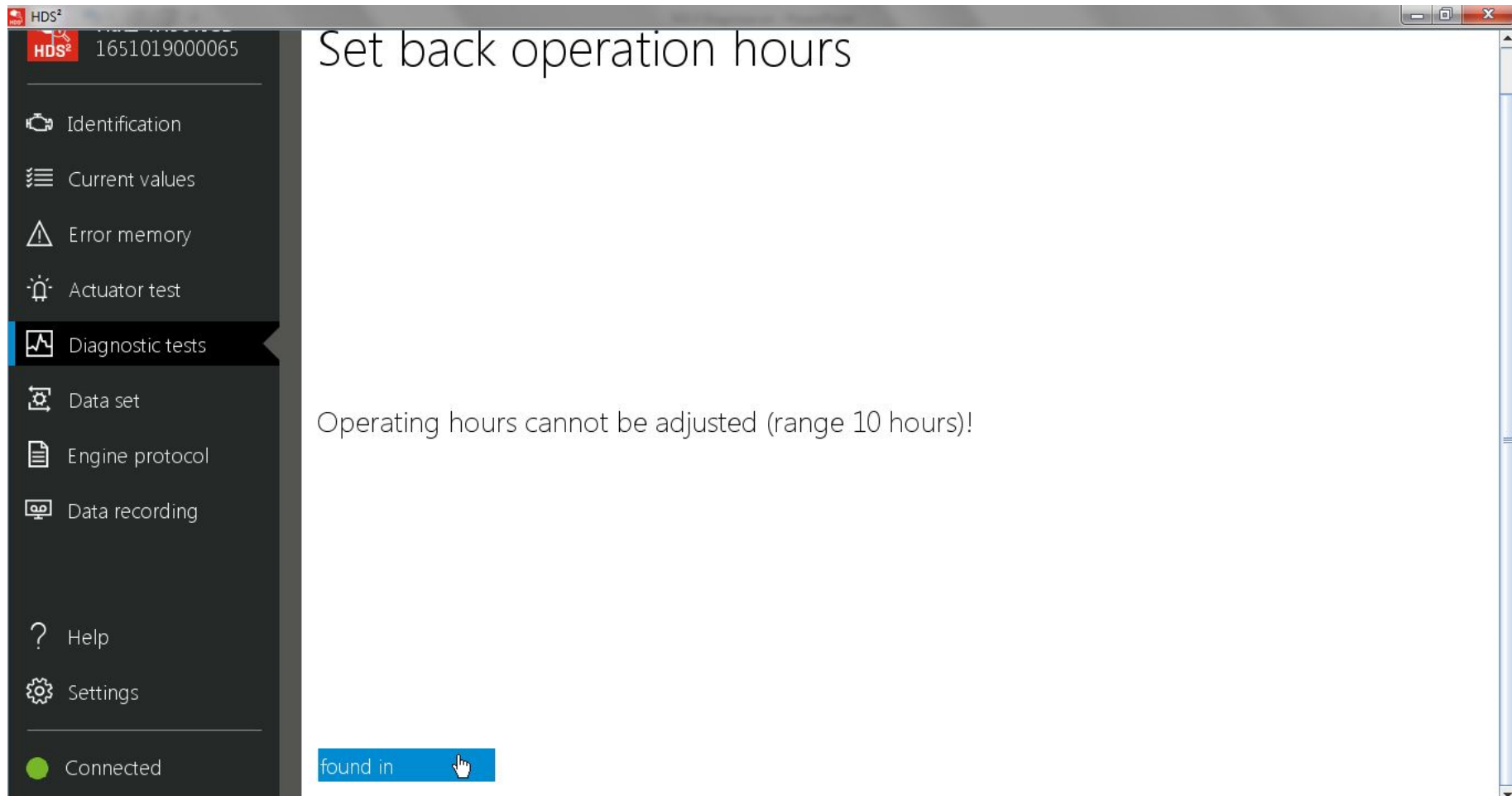
- Preconditions**
  - Engine off
  - Ignition on
- Description**

With this function, after a replacement of the control unit, the operating hours and remaining time for service can be adapted to the engine again.

At the bottom of the window, there are two buttons: a blue "Start" button and a grey "Cancel" button.



## Set back operation hours



The screenshot shows a software window titled "HDS²" with a sidebar menu on the left. The menu items are: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar, there is a green circle and the text "Connected". The main content area of the window displays the title "Set back operation hours" and a message: "Operating hours cannot be adjusted (range 10 hours)!". At the bottom of the main area, there is a blue button labeled "found in" with a mouse cursor over it.



## Start error test

The screenshot shows the HDS² diagnostic software interface. The window title is 'HDS²' and the device ID is '1651019000065'. The left sidebar contains the following menu items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar, it shows 'Connected' with a green dot. The main content area is titled 'Start error test' and contains the following sections:

- Preconditions**
  - Engine off
  - Ignition on
  - Perform test only in case of a non starting engine
- Description**

After starting the test, the various values are read from the control unit. The cause for not starting the motor is displayed.

At the bottom of the main content area, there are two buttons: a blue 'Start' button and a grey 'Cancel' button. The Windows taskbar at the bottom shows the Start button, 'Bilder', 'HDS²', and '9.0.3 Diagnose en - P...' with the system clock at 14:40.



### Start error test

Start error test

	Status
Rail perssure	OK
Speed	OK
Synchronization	NOK
Fault entry	OK
Start approval	NOK

Back Cancel

## Start error test

Start trouble Information



### Detectable defects

- ▶ Status starter approval
- ▶ Set shut off requirements
- ▶ Missing/too low engine speed signal
- ▶ No rail pressure generation
- ▶ Optional/ customer specific: Fuel low pressure sensor defect

### Advantages

- ▶ Quick localization of failure in case of start problems
- ▶ Analysis of starting conditions across systems

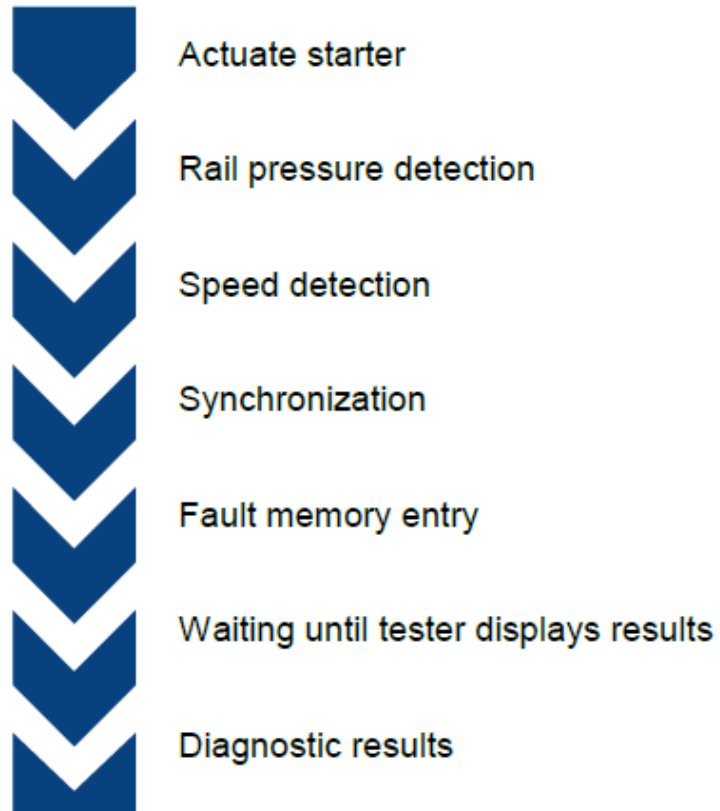
### Experience level

- ▶ Applied in high volume productions





## Start error test



**Detection:** Reason for start problems

Purpose:

Display of the start conditions in bit coded label.

Examples of bits set:

- 0 – no pressure increase
- 1 – no speed detection
- 2 – synchronization problems
- 3 – shut off request
- 4 – no starter release (optional)



## Start error test

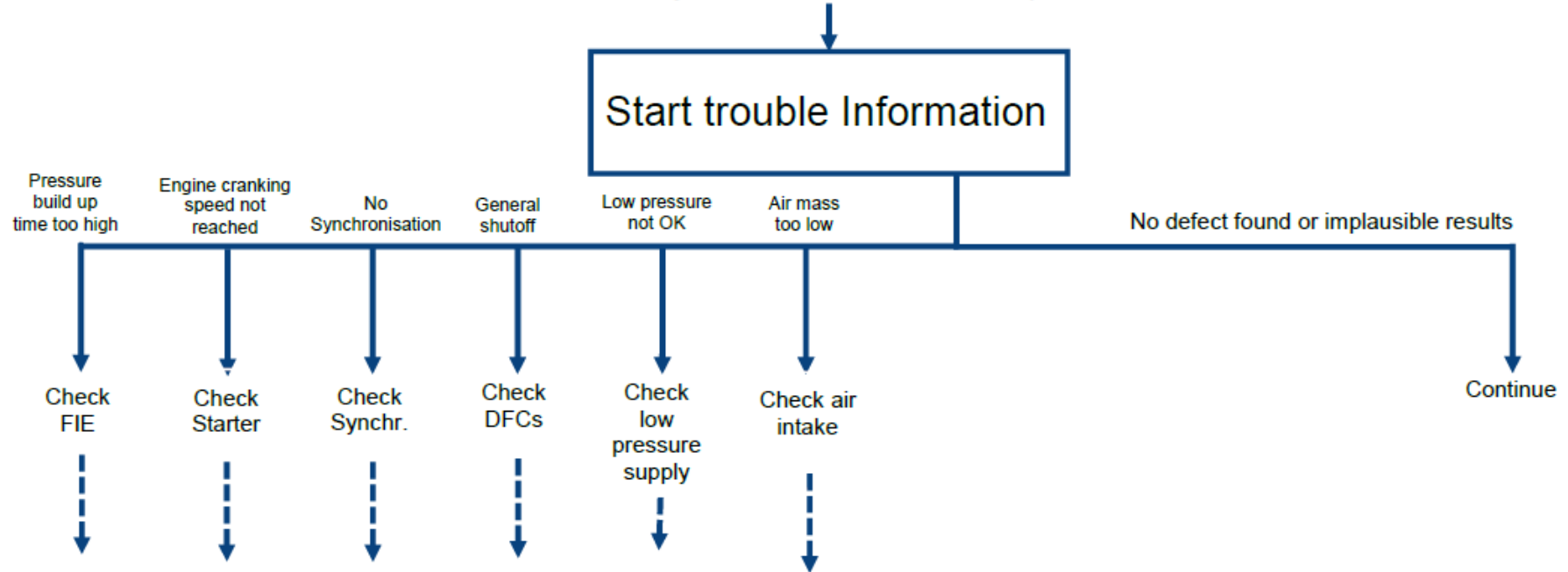
### Symptoms

→ Engine does not start

Additional use case by DFC:

→ Engine did not start in the past

→ Goal: analyze reason for no start in the past





## Compression test

The screenshot shows the HDS² diagnostic software interface. The window title is 'HDS²' and the vehicle ID is '1651019000065'. The left sidebar contains a menu with the following items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar, a green dot indicates the vehicle is 'Connected'. The main content area is titled 'Compression test' and contains the following sections:

- Preconditions**
  - Engine off
  - Ignition on
  - Parking brake (if existent) active
  - Transmission (if existent) in P or N position
- Description**

Engine start is prohibited by the test.  
While the test the deviations of all cylinders are analyzed.  
The starter has to be triggered as long as a result is shown.  
The test lasts about 10 seconds.

At the bottom of the main area, there are two buttons: a blue 'Start' button and a grey 'Cancel' button.



## Compression test

The screenshot shows a software window titled "HDS²" with a sub-header "1651019000065". On the left is a dark sidebar menu with the following items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar is a green circle and the text "Connected". The main area of the window is titled "Compression test" and contains the text "Please start the engine until a result is shown!" and "Current pressure: 0,02 bar". In the center of the main area is a circular progress indicator with the text "8s" in the middle. At the bottom right of the window is a grey "Cancel" button. A mouse cursor is visible near the bottom left of the window.



## Compression test

The screenshot shows the HDS² software interface. On the left is a dark sidebar with navigation icons and labels: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, Settings, and Connected. The main area displays the title 'Compression test' and a table with the following data:

		Result
Cylinder 1	297 rpm	OK
Cylinder 2	299 rpm	OK
Cylinder 3	299 rpm	OK
Cylinder 4	299 rpm	OK
Oil pressure	2.256 bar	OK

At the bottom of the main area, there are two buttons: a blue 'Back' button and a grey 'Cancel' button. The Windows taskbar at the bottom shows the Start button, taskbar icons for 'Bilder', 'HDS²', and '9.0.3 Diagnose en - P...', and the system tray with the time '14:42'.

## Compression test

### Compression Test



#### Detectable defects

- ▶ Reduced compression by mechanical defects at cylinder (e.g. piston ring abrasion)
- ▶ Detection of deviation between cylinders

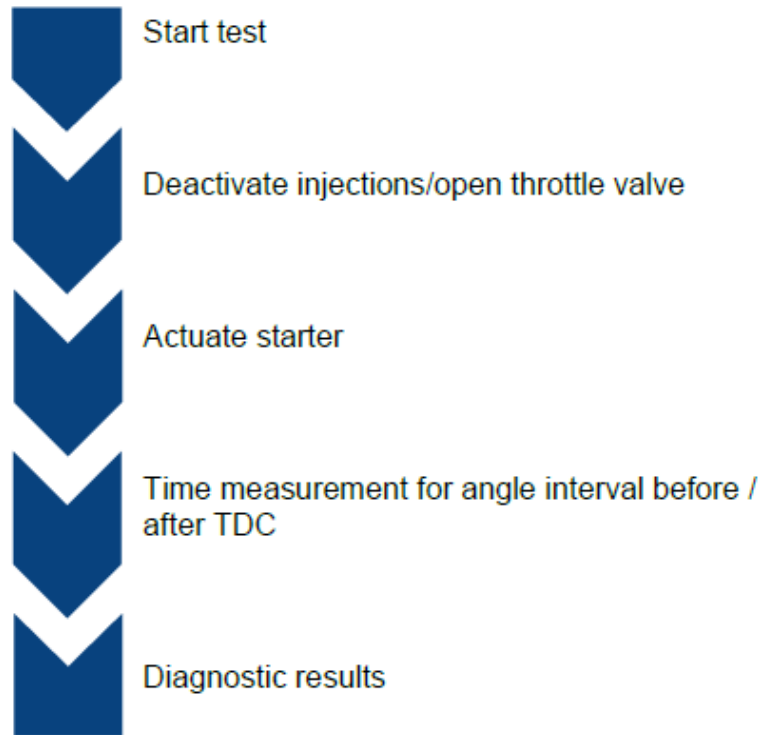
#### Advantages

- ▶ No mechanical work necessary
- ▶ Quick test with simultaneous measurement of all cylinders

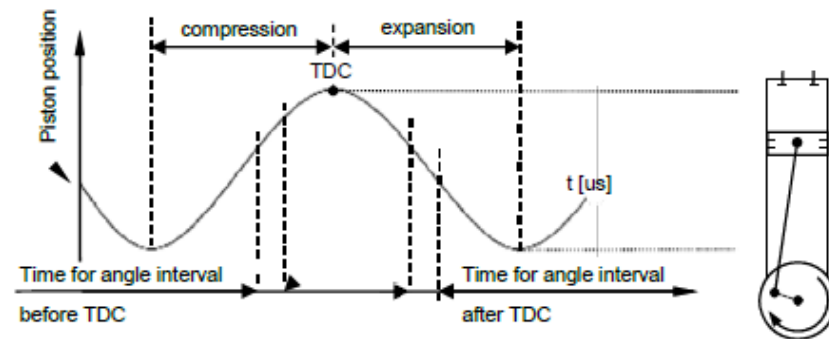
#### Experience level

- ▶ Applied for combustion engines with up to 6 cylinders and compression ratio > 12

## Compression test



TDC = Top Dead Center



### Method:

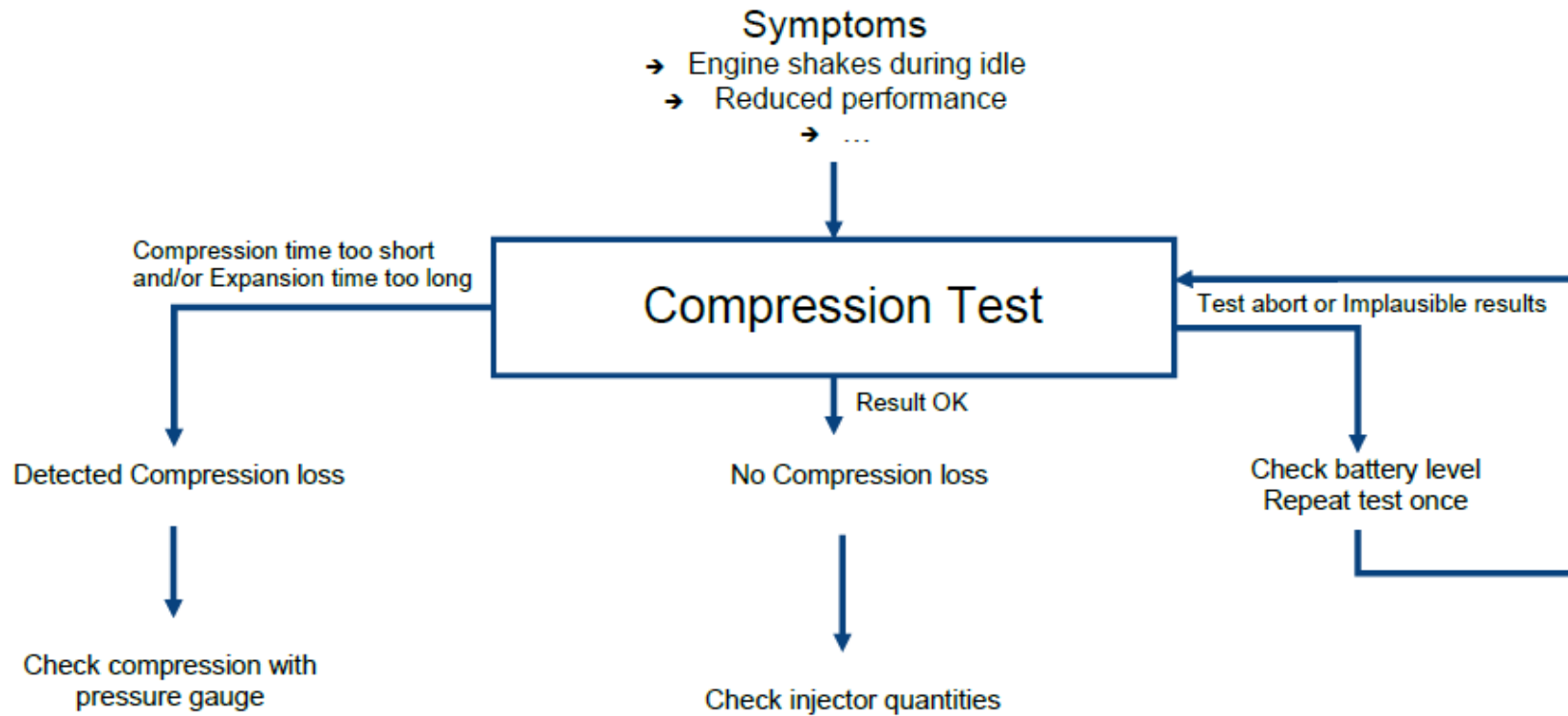
- ▶ Capture times of expansion and compression:
- ▶ In case of leakage faster piston stroke before TDC
- ▶ In case of leakage slower piston stroke after TDC

### Interpretation:

- ▶ Relative comparison of cylinder individual times



## Compression test







## Diagnosefunktionen mit Hatz Diagnose Software

**For some diagnostic functions, the idle speed must be reduced to 900 rpm before using the Hatz diagnostic tool. Adjust the Idle speed with the Hako diagnostics under System / Adjustment of working hydraulics / engine speed**



## Change idle speed into 900rpm

For some diagnostic functions, the idle speed must be reduced to 900 rpm before using the Hatz diagnostic tool. For the adjustment the engine must run in idle speed ca. 1150rpm. Adjust the Idle speed with the Hako diagnostics under System -> Adjustment of working hydraulics.

The screenshot shows the Hako diagnostic software interface for a CM600 machine. The window title is "CM600 - Übersicht". The main menu includes "Information", "Arbeitshydraulik", "Hydrostat", "Konfiguration", and "System". The "System" menu is open, showing options like "Aktive Diagnose", "Neue Steuerung", and "Anpassung Arbeitshydraulik".

**Maschinendaten:**

Hako Seriennummer:	149115900032
Software Version:	1491.00.000.027.000
Software Version HS:	400000001
Seriennummer Platine:	24300104958
Hardware Version:	1.40
Basisssoftware:	2.05
Fahrzeugtyp:	CM 1650
Sitztyp:	Komfort-Sitz
Gewählter Radtyp:	255/65 R16 (Universalreifen)
Winterdienst:	0
Option Servicewecker:	0 /
Option Passwortschutz:	1
Option Überlastsensor:	1
Option Fleetrecorder:	1
Option Komfortlenksäule (Nur 1600):	1
Option FGT-Andruck (nur 1600):	0
Datum, Uhrzeit:	08-08-2019 11:00:54
Bugcodierung:	0 Keine Codierung
Heckcodierung:	1 -

**Spannungsversorgung:**

Versorgung Kl. 30, Elektronik	12.18 V
Versorgung Kl. 15	12.14 V
Versorgung Pumpe, -F07	12.18 V
Versorgung DigOut, -F05, -K10, -F03	12.20 V
Versorgung DigOut, -F08	12.13 V
Versorgung Blinker, -F14	12.23 V
Versorgung 5V Encoder	4.94 V

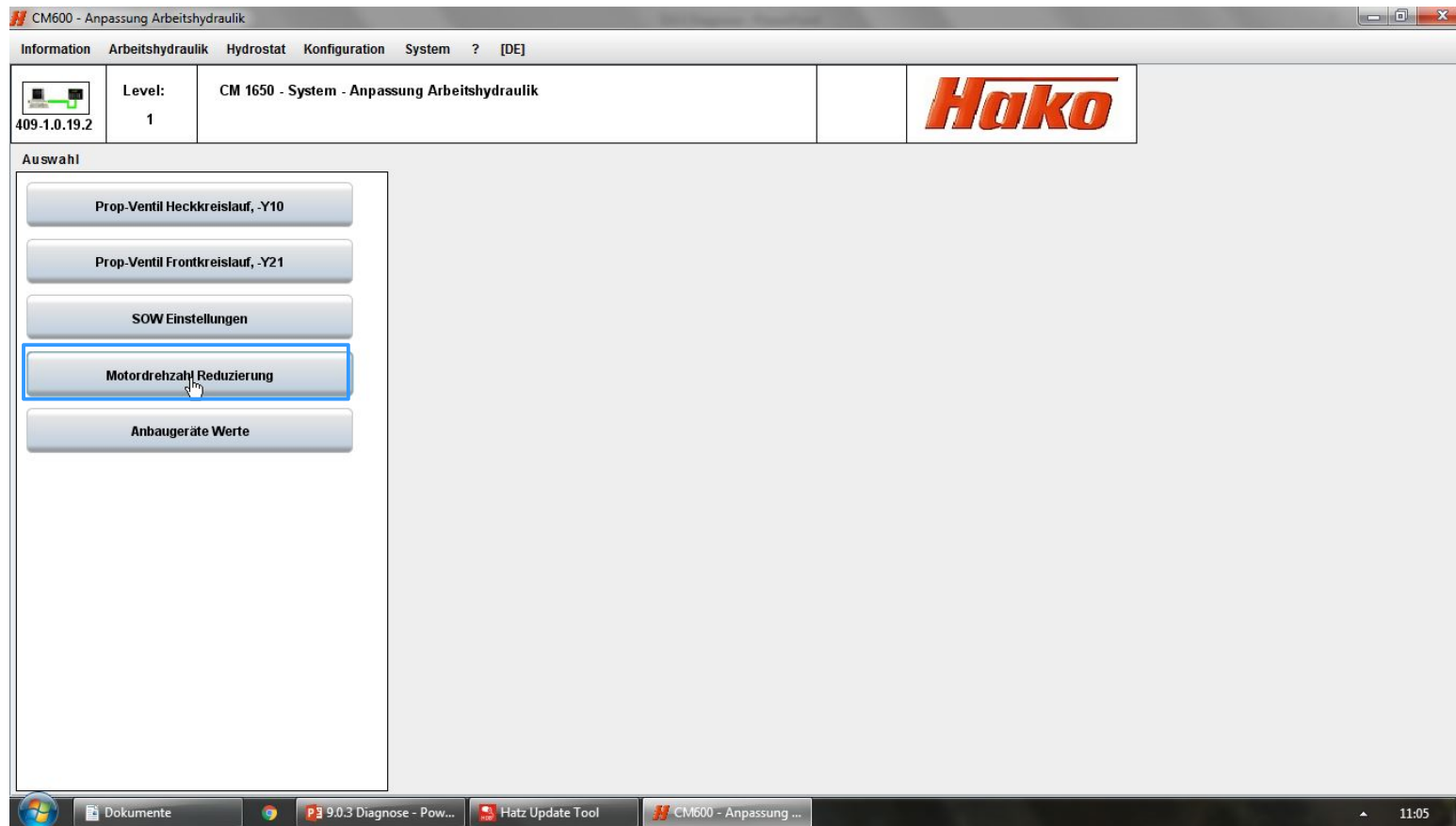
**Startfreigabe:**

- Pedalschalter vorwärts -S25
- Pedalschalter rückwärts -S27
- Bremspedal
- Startfreigabe von Software
- Sitzkontakt okay
- Fahrfreigabe von Software
- Fleet Freigabe Fahren
- Fleet Freigabe Arbeiten
- Generator läuft, -G02:D+



## Change idle speed into 900rpm

Choose reduce engine speed





## Change idle speed into 900rpm

Choose 900 rpm to reset the idle speed tp 1050 rpm choose the button 150 rpm or switch of the engine.

The screenshot shows the Hako diagnostic software interface. At the top, there is a navigation bar with the following menu items: Information, Arbeitshydraulik, Hydrostat, Konfiguration, System, and ? [DE]. Below the navigation bar, there is a header area containing a small icon and the text '409-1.0.19.2', a 'Level:' field with the value '1', and a title bar that reads 'CM 1650 - System - Anpassung Arbeitshydraulik'. The Hako logo is displayed on the right side of the header. The main content area is titled 'Auswahl' (Selection) and contains several buttons: 'Motordrehzahl Reduzierung' (Engine speed reduction), '900 rpm' (with a mouse cursor hovering over it), and '1050 rpm'. Below these buttons, the text 'Motordrehzahl' is followed by '0 rpm'. At the bottom of the selection area, there is an 'Abbrechen' (Cancel) button.



## Run up test

The screenshot shows the HDS² diagnostic software interface. On the left is a dark sidebar with a menu containing: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar is a green 'Connected' indicator. The main window title is 'Run up test' and the vehicle ID is '1651019000065'. The 'Preconditions' section lists: engine runs 900 U/min, Coolant temp > 55°C, All consumers shut off, No fault entry, Parking brake (if existent) active, and Transmission (if existent) in P or N position. The 'Description' section states: 'The test will perform a defined number of injections with increased fuel amount. This leads to short speed peaks. With every run up a cylinder is switched off (noisy engine behaviour). The test lasts about 1 minute.' At the bottom of the main window are 'Start' and 'Cancel' buttons. The Windows taskbar at the bottom shows the 'Dokumente' folder, a Chrome browser window titled '9.0.3 Diagnose en - P...', the HDS² application window, and the system clock showing 13:20.



## Run up test

The screenshot shows the HDS² diagnostic software interface. The main window is titled "Run up test" and displays a circular progress indicator with "58s" in the center. A "Cancel" button is located in the bottom right corner of the window. The left sidebar contains the following menu items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. The bottom status bar shows "Connected" and a taskbar with "Dokumente", "9.0.3 Diagnose en - P...", and "HDS²".



## Run up test

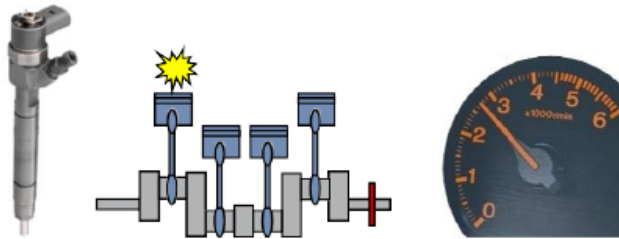
Run up test

		Result
Cylinder 1	1197 rpm	OK
Cylinder 2	1189 rpm	OK
Cylinder 3	1127 rpm	OK
Cylinder 4	1124 rpm	OK

This test is a return flow measurement of the injectors . This can be used to check the injectors.

Back Cancel

## Run up test



### Application – ECU based function

- Check of injector hydraulic behavior
- Diagnostic module for solenoid and piezo injectors

### Detectable defects

- Detection of torque-effective injector defects (e.g. caused by quantity defects, altered spray pattern) under load
- Detection of defects of individual injectors

### Conditions

- Reliable (constant) engine compression necessary
- Engines with 3 cylinders or more

### Exemplary symptoms

- Reduced power
- Irregular engine running under load

### Diagnostic method

- Sequentially shut off single injectors
- Set rail pressure, injection quantity and numbers of segments for all active injectors
- Measure maximum reached engine speed
- Repetition for each injector
- Evaluation of captured values

### Advantages

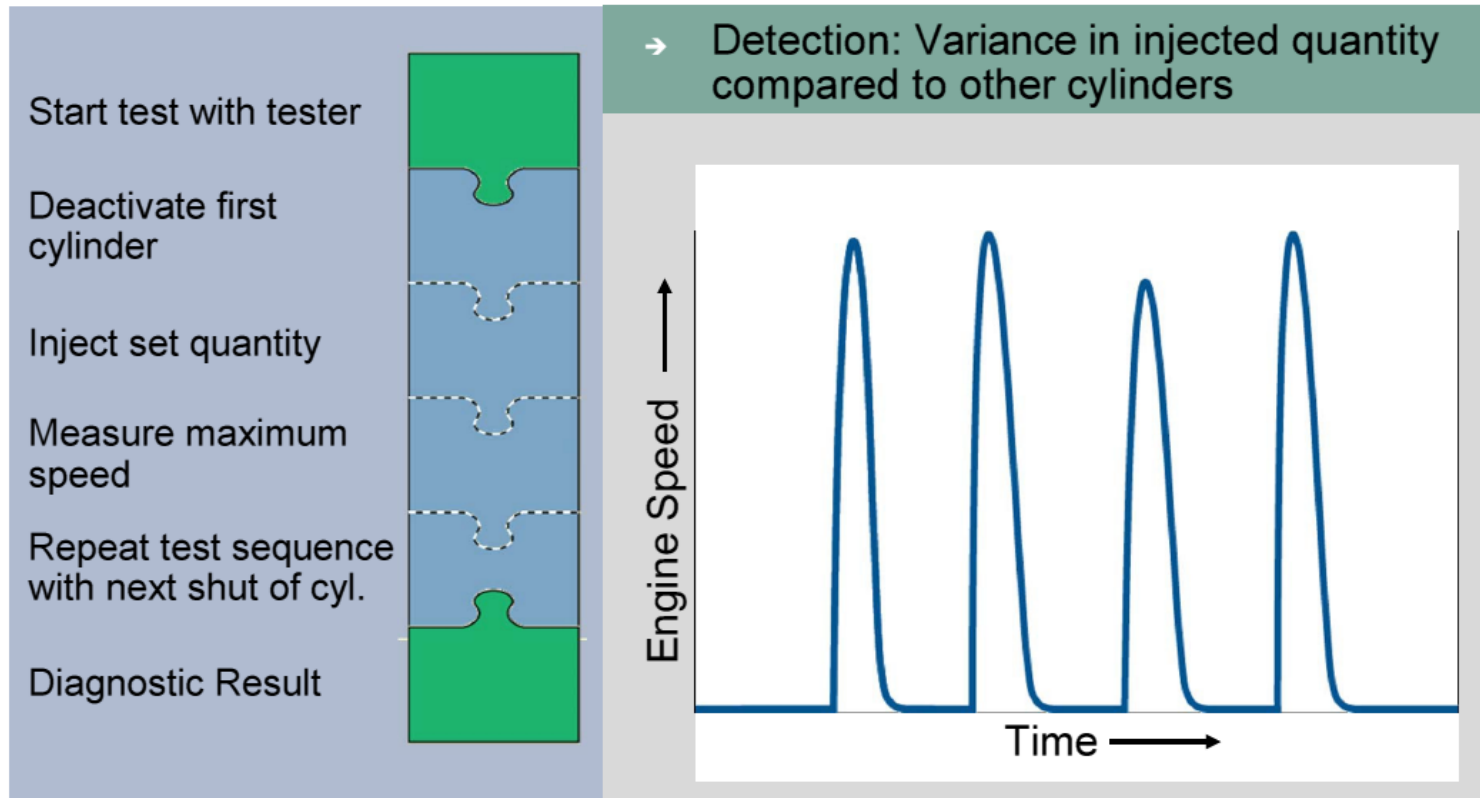
- Detection of injector defects in partial load during idle
- Check without disassembling of parts
- No further offboard tools necessary

### Maturity level

- Applied in high volume productions
- Please consult DS/EPD before quotations



### Run up test



The run-up test mainly serves to check the function of the injectors (injection quantity, spray pattern, etc.). This requires reliable compression, i.e. the compression test should be performed first at diagnosis. After "starting" the engine is accelerated with an increased injection quantity shortly for conditioning (same boundary conditions). Subsequently, this process is repeated with one cylinder turned off. In this process, the number of injections and the time are fixed. The result is only the briefly reached speed peak of each individual cylinder.



## High pressure test

The screenshot shows the HDS² diagnostic software interface. On the left is a dark sidebar with a menu containing: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, Settings, and Connected. The main area displays the 'High pressure test' configuration screen. It includes a title bar with 'HDS²', 'HATZ H50TICD', and '1651019000065'. The main content is divided into sections: 'Preconditions' with a bulleted list of requirements (engine runs 900 U/min, Coolant temp > 55°C, All consumers shut off, No fault entry, Parking brake active, Transmission in P or N position), 'Description' with a paragraph explaining the test (speed and rail pressure modification, engine noise change, engine shut off, 1-minute duration), and two buttons at the bottom: 'Start' and 'Cancel'. The Windows taskbar at the bottom shows the Start button, 'Dokumente', and open applications including '9.0.3 Diagnose en - P...' and 'HDS²'. The system clock shows 13:21.



### High pressure test

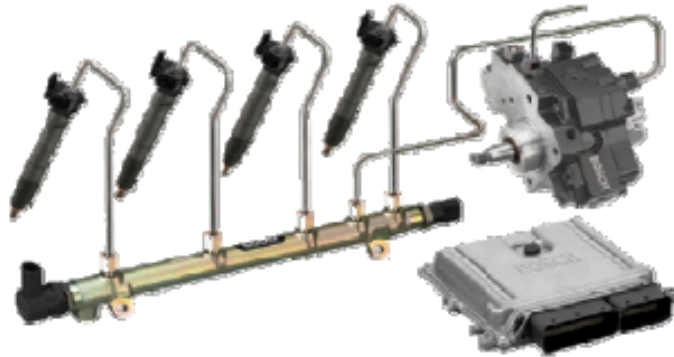
High pressure test

Test cannot be started. Preconditions are not fulfilled.

Event	Event
<input checked="" type="checkbox"/> Fault entry existend	<input checked="" type="checkbox"/> Coolant temp. < 55°C 78 °C
<input checked="" type="checkbox"/> Clutch active or transmission not in	<input checked="" type="checkbox"/> DPF regeneration active
<input checked="" type="checkbox"/> Vehicle speed > 0 km/h	<input checked="" type="checkbox"/> Deviation injection amount out of
<input checked="" type="checkbox"/> <b>Brake pedal active</b>	<input checked="" type="checkbox"/> Speed deviation out of range
<input checked="" type="checkbox"/> Throttle pedal active	<input checked="" type="checkbox"/> Rail pressure too high before pressure
<input checked="" type="checkbox"/> Metering unit out of range	<input checked="" type="checkbox"/> Rail pressure too low before pressure
<input checked="" type="checkbox"/> No constant engine speed	901 rpm

Buttons: Cancel, Repeat

## High pressure test



### Detectable defects

- ▶ Internal/external leakage in the high pressure circuit
- ▶ Efficiency of high pressure build up (if applicable)

### Advantages

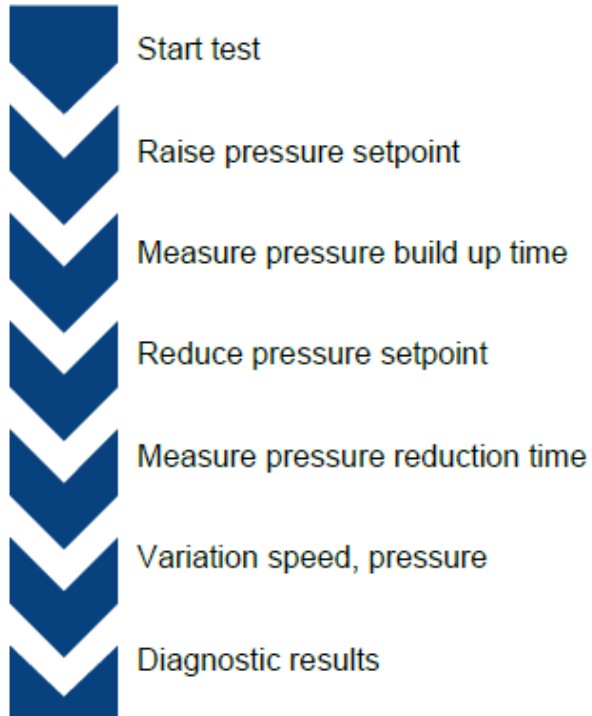
- ▶ Quick system check to exclude defects in the injection system without additional tools
- ▶ The fuel injection system has not to be opened for diagnostic purpose

### Experience level

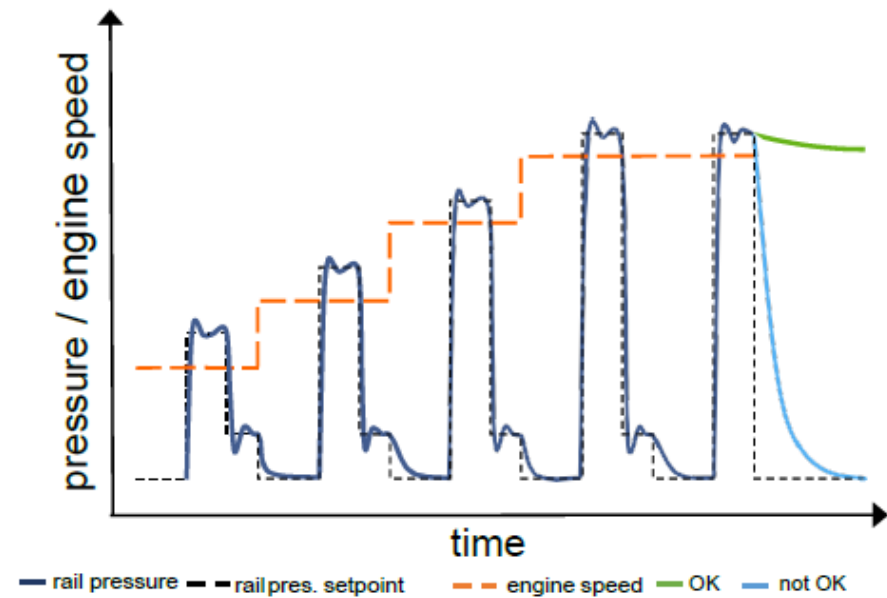
- ▶ Applied in high volume productions



## High pressure test

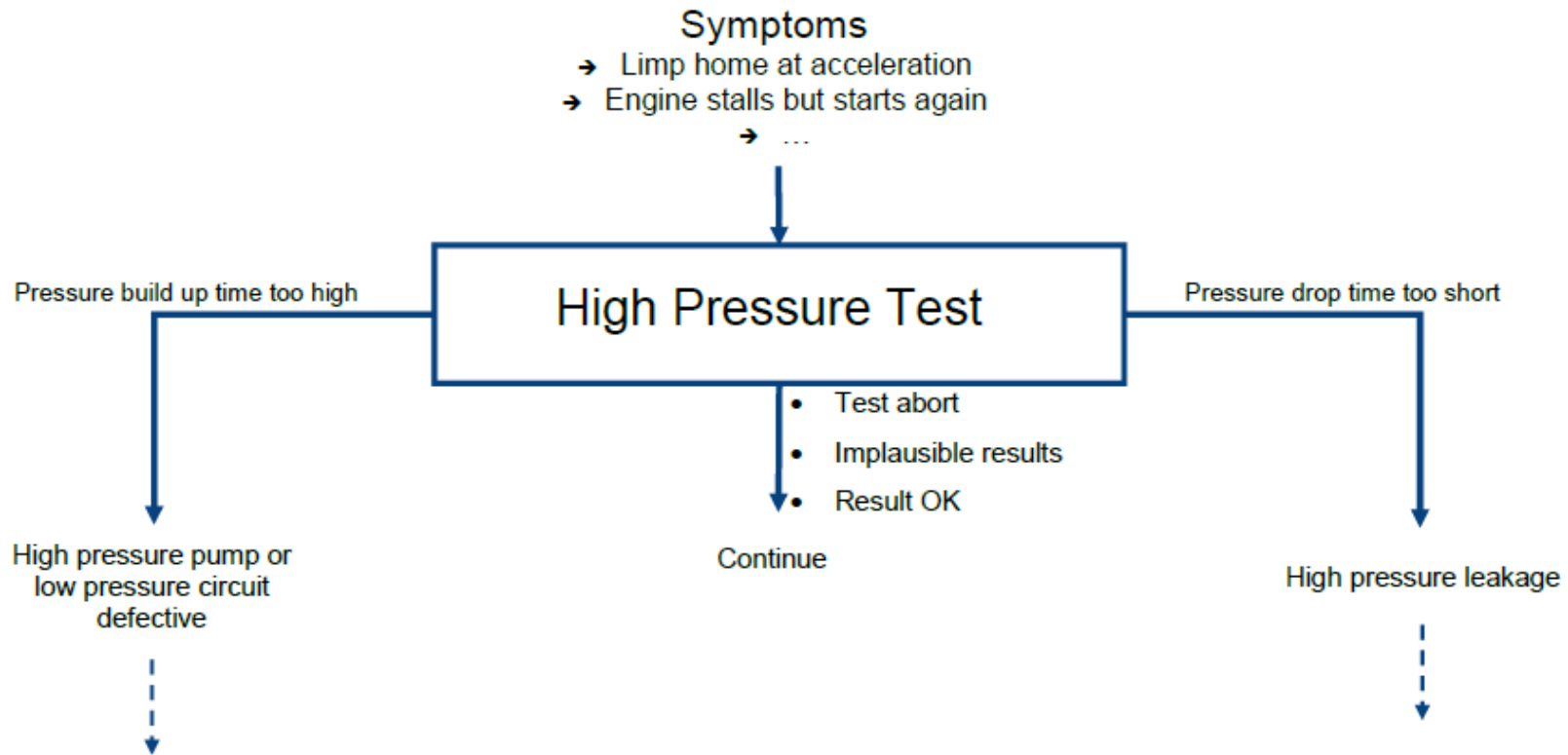


Detection: Leakage and efficiency of high pressure generation





## High pressure test





## Injector shut off test

The screenshot shows the HDS² diagnostic software interface. The window title is 'HDS²' and the vehicle information is 'HATZ H50TICD 1651019000065'. The left sidebar contains the following menu items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar, it shows 'Connected' with a green dot. The main content area is titled 'Injector shut off test' and contains the following sections:

- Preconditions**
  - engine runs 900 U/min
  - Coolant temp > 55°C
  - All consumers shut off
  - No fault entry
  - Parking brake (if existent) active
  - Transmission (if existent) in P or N position
- Description**

The chosen injector is switched off for 5 seconds. This leads to a changing engine noise and a noisy engine behaviour.  
Task of the operator is to watch the engine behaviour and noise.  
If there are noticeable problems: please continue with the next injector.  
If there are no changes: check the chosen injector.

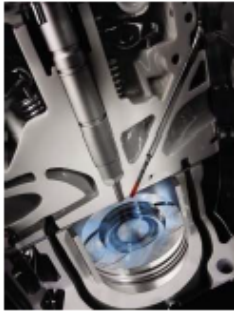
At the bottom of the main area, there are two buttons: 'Start' (blue) and 'Cancel' (grey). The Windows taskbar at the bottom shows the time as 13:23 and includes icons for 'Dokumente', '9.0.3 Diagnose en - P...', and 'HDS²'.

### Injector shut off test

The screenshot shows the HDS² diagnostic software interface. On the left is a dark sidebar menu with the following items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted with a blue bar), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar, a green dot and the text 'Connected' are visible. The main window area is titled 'Injector shut off test' and features a 3D cutaway illustration of an engine. A red vertical bar highlights the central injector. A mouse cursor is positioned over this red bar. In the bottom right corner of the window, there is a grey 'Cancel' button. The Windows taskbar at the bottom shows the Start button, a 'Dokumente' folder, and several open applications including '9.0.3 Diagnose en - P...' and 'HDS²'. The system clock in the bottom right corner shows '13:23'.



## Injector shut off test



### Detectable defects

- ▶ Detection of missing injection by non-recognizable changes in noise or engine behavior when shut off

### Advantages

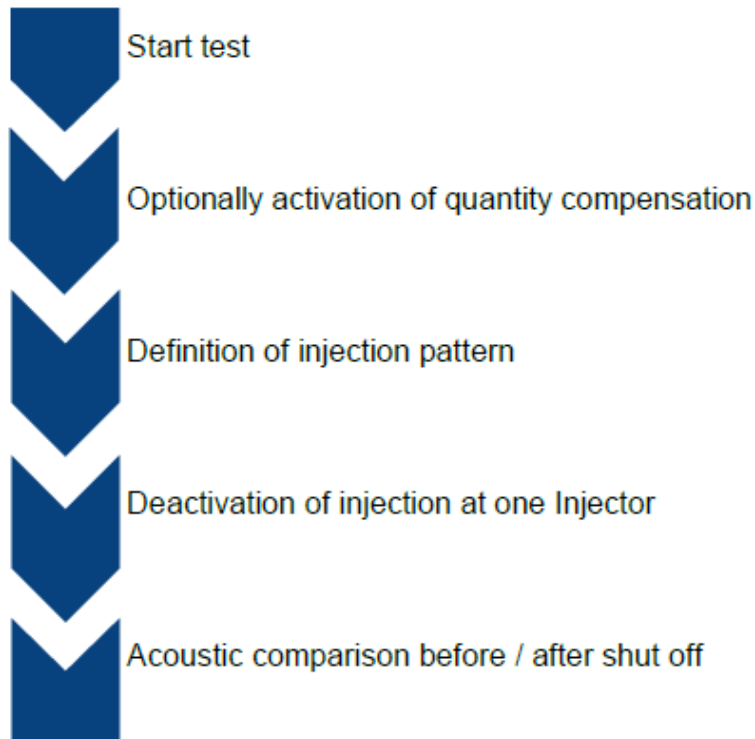
- ▶ Fast detection of missing injections
- ▶ Very low calibration effort
- ▶ No fault memory entry due to unplugging of injectors

### Experience level

- ▶ Applied in high volume productions

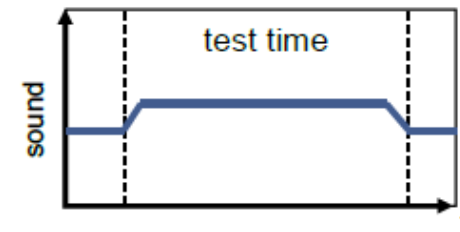


## Injector shut off test

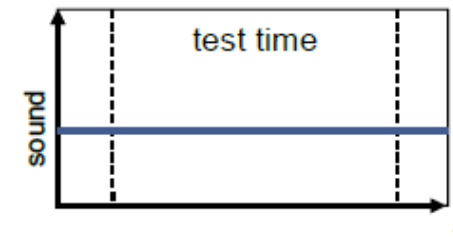


Detection: Missing injections

pilot-) injection deactivated at OK injector



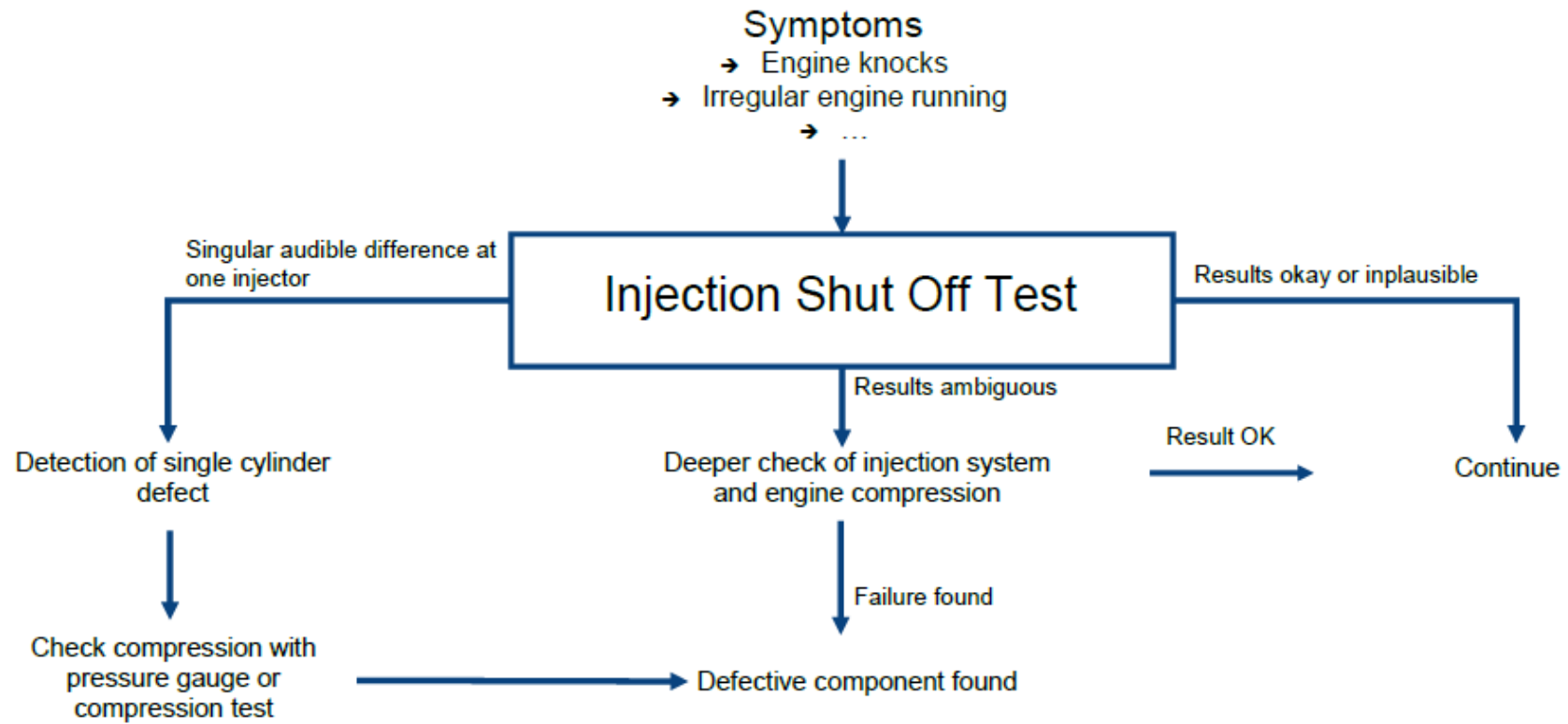
(pilot-) injection deactivated at not OK injector



Comparison of engine behavior before and during the test



## Injector shut off test



## Diesel particle filter

The screenshot shows the HDS² diagnostic software interface. The window title is 'HDS²' and the vehicle information is 'Hatz H50TICD 1651019000065'. The left sidebar contains the following menu items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, Settings, and Connected. The main area is titled 'Diagnostic tests' and lists the following options: Set back service, Bleed fuel low pressure circuit, Bleed oil circuit, Set back operation hours, Start error test, Compression test, Run up test, High pressure test, Injector shut off test, DPF (highlighted), Increase soot load, ECU replacement without value transfer, DPF replacement, and DPF regeneration. A detailed image of a diesel engine is displayed in the background of the main area. The Windows taskbar at the bottom shows the Start button, 'Dokumente', '9.0.3 Diagnose en - P...', 'HDS²', and the system clock '13:24'.



## Diesel particle filter

The screenshot shows the HDS² diagnostic software interface. The window title is 'HDS²' and the vehicle information is 'HATZ H50TICD' and '1651019000065'. The left sidebar contains the following menu items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar, it shows 'Connected' with a green dot. The main content area is titled 'Increase soot load'. Under 'Preconditions', there is a list: 'Engine off' and 'Igniton on'. Under 'Description', it says: 'This feature increases soot loading for dynamic and stand regeneration testing.' At the bottom of the main area, there are two buttons: 'Start' (blue) and 'Cancel' (grey). The Windows taskbar at the bottom shows the Start button, 'Dokumente', and several open applications including '9.0.3 Diagnose en - P...' and 'HDS²'. The system clock shows '13:25'.



## Diesel particle filter

The screenshot shows the HDS² software interface. On the left is a dark sidebar with a menu containing: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar, a green circle indicates 'Connected'. The main window title is 'HDS² HATZ H50TICD 1651019000065'. The main content area is titled 'Replace ECU without transfer'. Under 'Preconditions', there is a list: Engine off, Igniton on. Under 'Description', it says 'ECU replacement with default values'. At the bottom of the main area are two buttons: 'Start' (blue) and 'Cancel' (grey). The Windows taskbar at the bottom shows the Start button, a 'Dokumente' folder, and open applications including '9.0.3 Diagnose en - P...' and 'HDS²'. The system clock shows 13:25.



## Diesel particle filter

The screenshot shows the HDS² software interface for a Hatz H50TICD engine. The window title is "HDS² HATZ H50TICD 1651019000065". The left sidebar contains a menu with the following items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar, it shows "Connected". The main content area is titled "DPF replacement" and contains the following sections:

- Preconditions**
  - Engine off
  - Igniton on
- Description**

This function resets the DPF learned values.

At the bottom of the main area, there are two buttons: "Start" (blue) and "Cancel" (grey). The Windows taskbar at the bottom shows the Start button, a "Dokumente" folder, and several open applications: "9.0.3 Diagnose en - P...", "HDS²", and a system tray showing the time "13:25".



## Diesel particle filter

The screenshot shows the HDS² diagnostic software interface. The window title is "HDS²" and the vehicle information is "HATZ H50TICD" and "1651019000065". The left sidebar contains the following menu items: Identification, Current values, Error memory, Actuator test, Diagnostic tests (highlighted), Data set, Engine protocol, Data recording, Help, Settings, and Connected. The main content area is titled "DPF regeneration" and contains the following sections:

- Preconditions**
  - engine runs 900 U/min
  - Coolant temp > 55°C
  - All consumers shut off
  - No fault entry
  - Parking brake (if existent) active
  - Transmission (if existent) in P or N position
- Description**

In the heating phase, a cylinder shutdown takes place.  
This leads to a changing engine noise and a noisy engine behaviour.  
The air supply is reduced by the throttle.  
The regeneration takes about 20 minutes.

At the bottom of the main content area, there are two buttons: "Start" (blue) and "Cancel" (grey). A mouse cursor is visible over the "Start" button.





## Software flashen

HDS<sup>2</sup>
1651019000065

- Identification
- Current values
- Error memory
- Actuator test
- Diagnostic tests
- Data set
- Engine protocol
- Data recording
- Help
- Settings

● Connected

### Data set

Flash file

Description	ECU	Server
Governor	Variable speed	variable speed
Output curve	2800 rpm 55,4 kW	2800 rpm 55,4 kW
Rotational frequency change	CAN	CAN
P-Degree	0%	0%
Error reaction	Limp home	limp home
DPF standby regeneration	2300rpm optiheat active	2300rpm optiheat active
Power supply	12V & 24V optiHEAT Active	12V & 24V optiHEAT Active
Coolant level & Alternator monitoring	With CLS and alternator	With CLS and alternator
Drive application	No	No
Remote Start	Only key starting	Only key start
MSS Stage 2	900.000000	900
MSS Stage 3	900.000000	900
MSS Stage 4	900.000000	900
IQA code cylinder 1	AS81C1D	AS81C1D
IQA code cylinder 2	BKHSCWC	BKHSCWC
IQA code cylinder 3	B2RYP1G	B2RYP1G
IQA code cylinder 4	CKAIE5C	CKAIE5C

Write dataset



## Software flashen

The screenshot shows the HDS² software interface. On the left is a dark sidebar menu with the following items: Identification, Current values, Error memory, Actuator test, Diagnostic tests, Data set (highlighted), Engine protocol, Data recording, Help, Settings, and a green 'Connected' indicator at the bottom. The main area is titled 'Data set' and displays a 'Softwareupdate' screen. It features a circular progress indicator at 0% and the text '\$ACTION\_STATUS\_SERVICE\_STARTDIAGNOSTICSESSION' and 'The process may take some time.' A mouse cursor is visible at the bottom center of the window.



## Software flashen

The screenshot shows the HDS² software interface. On the left is a dark sidebar menu with the following items: Identification, Current values, Error memory, Actuator test, Diagnostic tests, Data set (highlighted), Engine protocol, Data recording, Help, Settings, and a green 'Connected' indicator at the bottom. The main window title is 'Data set'. The central area displays 'Softwareupdate' with a progress bar at 50%. Below the progress bar, the text reads: `!ACTION_STATUS_OK` and 'The process may take some time.'



## Software flashen

The screenshot shows the HDS² software interface. On the left is a dark sidebar menu with the following items: Identification, Current values, Error memory, Actuator test, Diagnostic tests, Data set (highlighted), Engine protocol, Data recording, Help, Settings, and a green 'Connected' indicator at the bottom. The main area is titled 'Data set' and displays 'Softwareupdate' with a progress indicator showing 100% completion. Below the progress bar, the text reads 'Please wait...' and 'Please wait. Coding...'. A mouse cursor is visible in the lower center of the main area.



## Software flashen

The screenshot shows the HDS² software interface. On the left is a dark sidebar menu with the following items: Identification, Current values, Error memory, Actuator test, Diagnostic tests, Data set (highlighted with a blue bar), Engine protocol, Data recording, Help, and Settings. At the bottom of the sidebar is a green circle and the text 'Connected'. The main area of the window is titled 'Data set' and displays a large 'Softwareupdate' message. Below this, it shows '100%' and the text 'The coding was executed successfully!'. The window title bar at the top reads 'HDS²' and includes standard minimize, maximize, and close buttons.



## Engine protocoll

HDS<sup>2</sup> 1651019000065

- Identification
- Current values
- Error memory
- Actuator test
- Diagnostic tests
- Data set**
- Engine protocol
- Data recording
- Help
- Settings
- Connected

### Identification

Description	Current Values
Operating hours	21
Hardware-Version	EDC17_C81
Software-Version	P1715_V600R
Engine number	1651019000065
Manufacturing date	..
Remaining time to service	479
Last programming date	08.08.19
Dataset description	D165C81##V600R03###



## Engine protocoll

Motorenfabrik Hatz GmbH & Co. KG  
Ernst-Hatz-Str. 16  
94099 Ruhstorf a. d. Rott



+49 8531 319 -4372



[www.hatz-diesel.de](http://www.hatz-diesel.de)



[hds@hatz-diesel.de](mailto:hds@hatz-diesel.de)



Motornummer 1651019000065 Datum 08.08.2019 Zeit 13:49:09

### Identifikationsdaten

<b>Herstellungsdatum</b>	--	<b>Betriebsstunden</b>	20
<b>Hardware Nummer</b>	EDC17_C81	<b>SW Versionsnummer</b>	P1715_V600R
<b>Restzeit zum Service</b>	480	<b>Datum letzte Programmierung</b>	02.05.19
<b>Datensatz Bezeichnung</b>	165023.hex000000000		

### ECU Einstellungen

<b>Leistungskurve</b>		<b>Kühlmittelstandsensord</b>	
<b>Spannung</b>	12V & 24V optiHEAT Acti	<b>Fahrerwendung</b>	Ja
<b>Abgas-Nachbehandlung</b>	2300rpm optiheat active	<b>Fernstart</b>	
<b>P-Grad</b>	0%	<b>Drehzahlverstellung</b>	Kein Aktor
<b>Fehlerersatzreaktion</b>		<b>MSS Stufen</b>	9, 9, 10

### Fehlerspeicher

— 0  
Kein Fehlereintrag vorhanden



## Data recording

The screenshot shows the HDS software interface. The top left corner displays 'HDS²' and the engine ID '1651019000065'. A sidebar on the left contains navigation options: Identification, Current values, Error memory, Actuator test, Diagnostic tests, Data set, Engine protocol, Data recording (with sub-options 'Choose setup...' and 'User defined...'), Help, and Settings. A 'Connected' status indicator is at the bottom of the sidebar. The main area is titled 'Identification' and contains a table with the following data:

Description	Current Values
Operating hours	21
Hardware-Version	EDC17_C81
Software-Version	P1715_V600R
Engine number	1651019000065
Manufacturing date	..
Remaining time to service	479
Last programming date	08.08.19
Dataset description	D165C81##V600R03###

To the right of the table is a 3D model of the engine. The Windows taskbar at the bottom shows a 'Report' icon, the HDS² application, and two instances of '9.0.3 Diagnose en - P...'. The system clock shows 15:01.





## Data recording

The screenshot shows the HDS² software interface. The main window is titled "Identification" and displays the vehicle ID "1651019000065". A sidebar on the left contains navigation options: Identification, Current values, Error memory, Actuator test, Diagnostic tests, Data set, Engine protocol, Data recording (highlighted), Help, and Settings. A "Configuration" dialog box is open, showing settings for data recording. It includes a "Count of Y-Axes" dropdown set to "1" and a "Range Y1" dropdown. Below these are two tables. The left table has columns for Name, Unit, and Y-Axis. The right table lists various engine parameters with their descriptions and units. At the bottom of the dialog are "Save" and "Cancel" buttons. The Windows taskbar at the bottom shows the Start button, a "Report" icon, and several open applications including HDS², Configuration, and diagnostic tools. The system clock shows 15:02.

Name	Unit	Y-Axis

Description	Unit
Air intake pressure	mbar
Boost pressure	mbar
Boost air temperatur	°C
Coolant temperature	°C
Environment pressure	mbar
Fuel consumption	l/h
Fuel low pressure	mbar
Fuel temperature	°C
Injection quantity	mg/stroke
Oil pressure	mbar
Oil temperature	°C
Rail perssure	mbar
Operating hours	hours
Engine speed	rpm
Torque	Torque



## Data recording

**Configuration**

Count of Y-Axes: 3

Range Y1: 0-100

Range Y2: 0-100

Range Y3: 0-500

Name	Unit	Y-Axis
Coolant temperature	°C	y1
Fuel low pressure	mbar	y1
Rail perssure	mbar	y1

Description	Unit
Air intake pressure	mbar
Boost pressure	mbar
Boost air temperatur	°C
Coolant temperature	°C
Environment pressure	mbar
Fuel consumption	l/h
Fuel low pressure	mbar
Fuel temperature	°C
Injection quantity	mg/stroke
Oil pressure	mbar
Oil temperature	°C
<b>Rail perssure</b>	<b>mbar</b>
Operating hours	hours
Engine speed	rpm
Torque	Torque

Buttons: Save, Cancel



## Data recording

The screenshot shows the HDS software interface. On the left is a navigation menu with options: Identification, Current values, Error memory, Actuator test, Diagnostic tests, Data set, Engine protocol, Data recording, Help, Settings, and Connected. The main window is titled 'Identification' and contains a table with the following data:

Description	Current Values
Operating hours	21
Hardware-Version	EDC17 C81
Software	
Engine	
Manufa	
Remain	
Last pro	
Dataset	

A file selection dialog box is open over the table, showing the 'Graph\_Setups' folder containing a file named 'Test.cfg'. The dialog has a 'Dateiname:' field with 'Test' entered and a 'Dateityp:' dropdown menu. At the bottom, there are two buttons: 'ID 'SaveAsConfiguration' not found in languagefile' and 'Abbrechen'. A 3D model of an engine is visible on the right side of the software window.



## Data recording

**Sampling rate in ms:**

set Load configuration New configuration

d1  
d2

y1 y2 y3  
100.0 100.0 500.0

00.000 10.000

■	Coolant temperature	°C	y1	▼	0
■	Fuel low pressure	mbar	y1	▼	0
■	Rail perssure	mbar	y1	▼	0

AA  
<<  
>>  
VV

Coolant temperature  
Fuel low pressure  
Rail perssure