

Diagnosis – Diagnostic Trouble Code (DTC) Memory

Preliminary work: Engine Test and Adjustment, Engines, Volume 1

On-Off Ratio Test

The on-off ratio tests the operation of the O2S (Lambda) control system and additionally, recognizes certain malfunctions present during the test. Malfunctions are distinguished between those that occur with the **Ignition: ON** and those that occur with the **Engine: at CTP (idle)**.

The on-off ratio can be checked with the on-off ratio tester or with the engine analyzer. For this purpose, the purge line to the engine must be disconnected at the purge control valve and closed with a plug. Check on-off ratio at closed throttle speed and at 2500 rpm. A readout of 50% or an oscillating needle indicates that all input signals and the O2S control system are OK. Readouts of 10% to 90% or 95% refer to a particular malfunction source (see Malfunction Tables). In addition, after testing the on-off ratio, an impulse readout **must be performed** using the impulse counter scan tool.

Diagnostic Trouble Code (DTC) Readout with Impulse Counter Scan Tool.

Malfunctions which occur while starting or with the engine running are recorded by a malfunction counter. Malfunctions are assigned a specific value according to malfunction severity (e.g. hot wire MAF sensor 128, ECT sensor 32). The malfunction counter counts in stages up to a threshold value of 255. After reaching the threshold value of 128, intermittent malfunctions are stored into memory after switching off the ignition.

Malfunctions which affect engine operation (128) are immediately stored into DTC memory by the malfunction counter after switching off the ignition.

If a malfunction is no longer present during a subsequent engine start or engine operation, the total value recorded by the malfunction counter is reduced by 1 every time the engine is switched off. This procedure repeats itself until the malfunction counter is cleared.

Stored malfunctions (DTC's) can be read with the impulse counter scan tool at the data link connector (X11/4). (Also see DM, Engines, Volume 2, section 5.)



The DTC memory readout must be performed with the engine OFF and the ignition switched ON.

Malfunctions occurring in the following areas are stored immediately:

- CMP sensor,
- Hot-wire MAF sensor,
- Injectors.

A malfunction of the following is stored after more than 2 trips:

- TN-signal (input).

The memory remains active even if the vehicle's battery is disconnected.

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DTC's can be read with the impulse counter scan tool. Numbers ranging from 1 to 32 may appear on the display of the impulse counter scan tool.

The number 1 indicates: No DTC recognized in system.

All further numbers refer to a particular malfunction source. If there are multiple system malfunctions, the malfunction assigned with the lowest number will be displayed first.

If the DTC number indicated first reappears after more than two DTC readouts, then no further malfunctions are stored in the system's memory.

After eliminating all malfunctions, they must be **cleared individually and the ignition must be switched off for a minimum of 15 seconds.**

In case of engine running complaints, the DTC memory must be read and the malfunction must be eliminated before proceeding with any additional repairs.

LH-SFI Control Module Self-Adaptation Feature

A self-adaptation feature for the emission control system is incorporated into the LH-SFI control module.

If malfunctions of the:

- Hot-wire MAF sensor,
- Injectors,
- Purge control valve,
- Diaphragm pressure regulator,
- Purge valve

occur or if intake air leaks are present, the LH-SFI control module conducts a self-adaptation process whereby the correction factors are continuously calculated and permanently stored.

After eliminating the mentioned malfunctions or after trial installation of a LH-SFI control module from another vehicle, the LH-SFI control module's self-adaptation feature must be reset to its mean value (see "Resetting LH-SFI Control Module's Self-Adaptation Feature to Mean Value" 11/4 or with HHT menu selection 5 "Self-Adaptation").

The LH-SFI control module will also adapt itself during the course of vehicle operation.

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Notes for HHT

- Fault search with HHT.
Diagnostic trouble code (DTC) memory: Select “Current DTC’s”.
If the actual condition changes, e.g. when wiggling a connector, the change is reported optically and acoustically so that troubleshooting can be performed directly with the HHT.
- Loose connections.
Loose connections are stored if they occur several times in a certain time period. Therefore, they can appear only as “Stored DTC’s” and never as “Current DTC’s”.
- Nominal values.
All nominal values relative to the actual values as shown on the HHT are listed in the DM, Engines, Volume 1, section A.
- Actual values for ECT, IAT and MAF.
In case of an open or short circuit, the actual value is immediately replaced by a substitute value which is very close to the actual value. Therefore, a fault can not be recognized clearly. A readout of the fault is possible only via the diagnostic trouble code (DTC) memory.
- Actual value for engine rpm.
In case of the engine rpm’s, the HHT display shows the closed throttle (idle) speed nominal value calculated by the control module on the left, and on the right, the rpm actual value. Both values should differ from each other only slightly. The permissible tolerances are not known.

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Preparation for Test with Impulse Counter Scan Tool

- Connect impulse counter scan tool and on-off ratio tester according to connection diagram.
- **Reading Diagnostic Trouble Code (DTC) Memory**
 - a) Ignition: **ON**
 - b) Press start button for 2 to 4 seconds.
 - c) Read and record DTC readout.
 - d) Press start button again for 2 to 4 seconds.
 - e) Read and record DTC readout.
Repeat steps d) and e) until the first DTC reappears.

Clearing Diagnostic Trouble Code (DTC) Memory

- a) Press start button for 2 to 4 seconds (DTC readout appears).
 - b) Wait 3 seconds, press start button for 6 to 8 seconds, thereby clearing the previously displayed DTC from memory.
 - c) Each stored DTC must be cleared individually.
 - d) Ignition: **OFF** and wait 15 seconds.
- Check if all stored DTC's are eliminated.**
- e) Ignition: **ON**
 - f) Repeat DTC readout. The number "1" (no DTC stored) must appear.

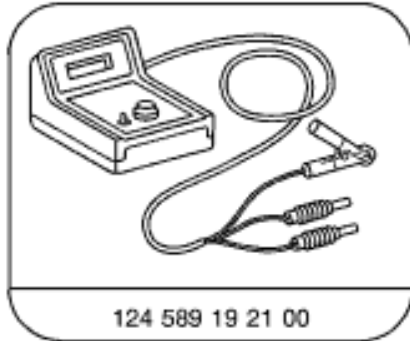
Resetting LH-SFI Control Module's Self-Adaptation Feature to Mean Value

After the number "1" appears on the display, press start button for 6 to 8 seconds.

Ignition: **OFF** and wait 30 seconds.

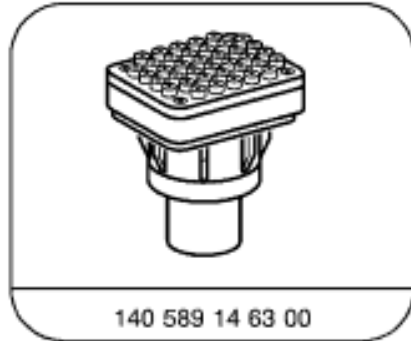
Diagnosis – Diagnostic Trouble Code (DTC) Memory

Special Tools



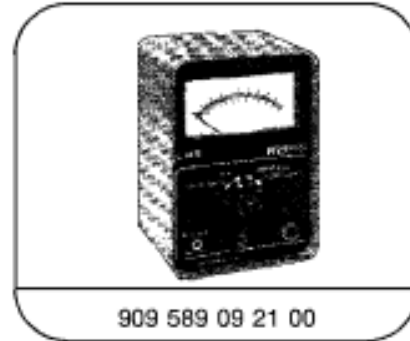
124 589 19 21 00

Pulse counter



140 589 14 63 00

Adapter



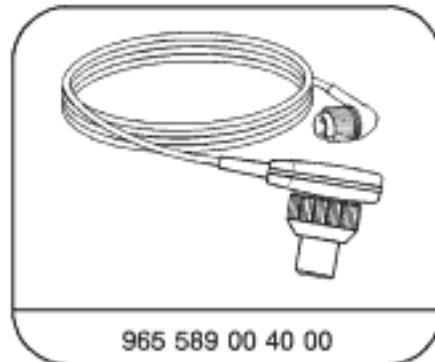
909 589 09 21 00

On-Off Ratio Tester



965 589 00 01 00

Hand-Held-Tester



965 589 00 40 00

Test cable

Diagnosis – Diagnostic Trouble Code (DTC) Memory

Connection Diagram - Impulse Counter Scan Tool and On-Off Ratio Tester or Engine Analyzer with Diagnostic Socket X11

Note:

Connect red wire of impulse counter scan tool to socket 3, black wire of impulse counter scan tool to socket 1, yellow wire of impulse counter scan tool as follows:

LH-SFI control module	Socket 4
DI control module	Socket 17
Base module	Socket 8
EA/CC/ISC control module	Socket 7
Diagnostic module	Socket 19

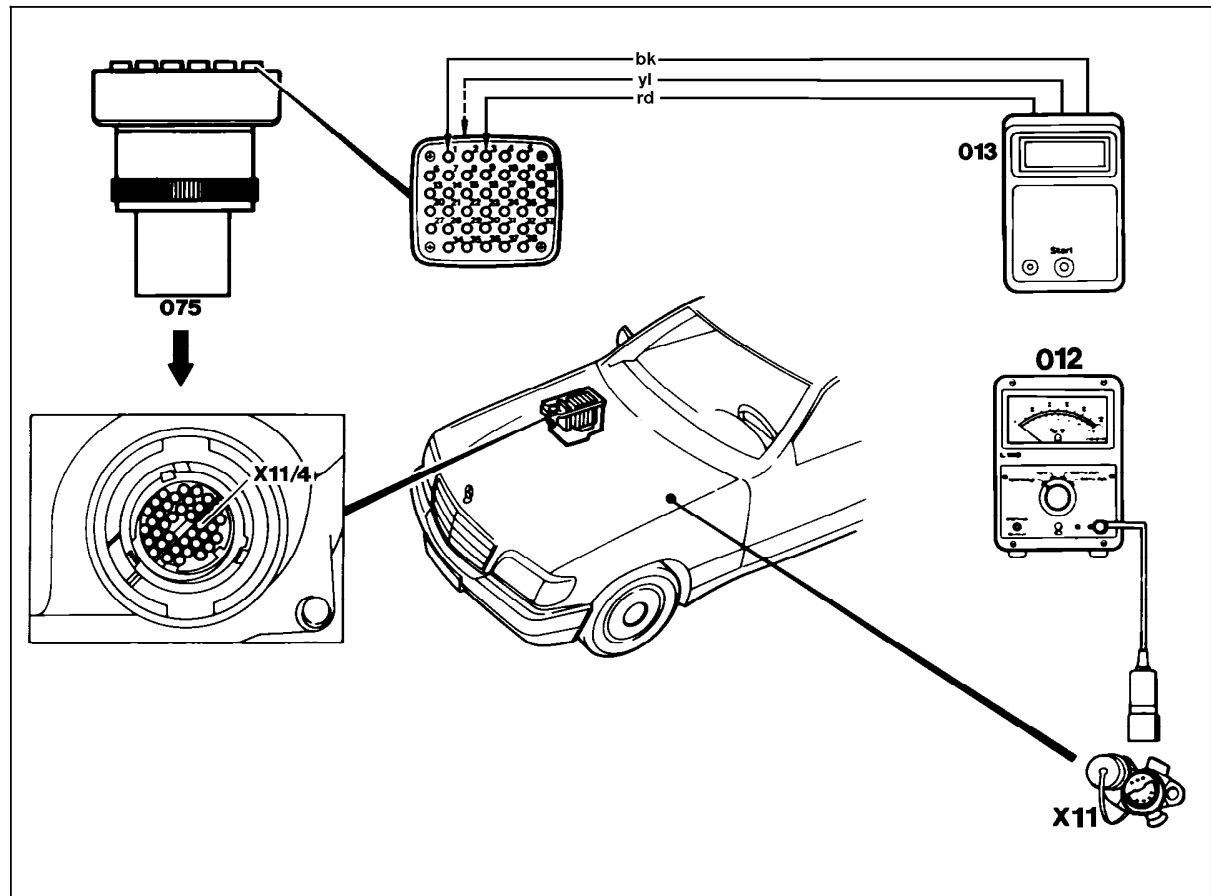


Figure 1

- 012 On-off ratio tester
- 013 Impulse counter scan tool
- 075 Impulse counter scan tool adaptor
- X11 Diagnostic socket (9-pole)
- X11/4 Data link connector (DTC readout)

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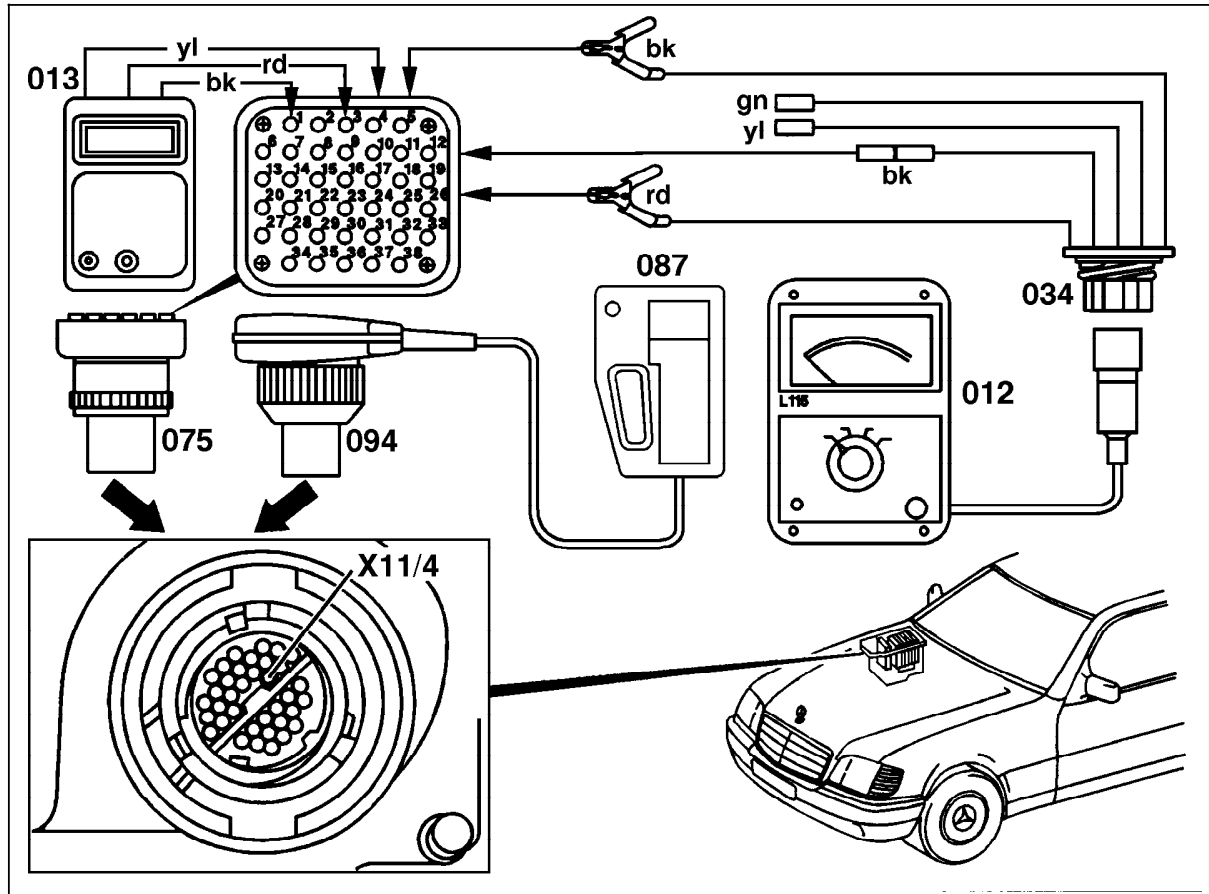
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Connection Diagram - Impulse Counter Scan Tool/
Hand-Held Tester and On-Off Ratio Tester
without Diagnostic Socket X11

Note:

Connect red wire of impulse counter scan tool to socket 3, black wire of impulse counter scan tool to socket 1, yellow wire of impulse counter scan tool as follows:

- | | |
|--------------------------|-----------|
| LH-SFI control module | Socket 4 |
| Base module | Socket 8 |
| EA/CC/ISC control module | Socket 7 |
| Diagnostic module | Socket 19 |
| RPM signal (TN output) | Socket 13 |
| On-off ratio readout | Socket 14 |
| Circuit 31 | Socket 1 |
| Circuit 30 | Socket 3 |



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Figure 2

- | | |
|-------|--|
| 012 | On-off ratio tester |
| 013 | Impulse counter scan tool |
| 034 | Test cable |
| | Red alligator clip to socket 3 |
| | Black alligator clip to socket 1 |
| | Black male plug to socket 14 |
| | Green male plug not connected |
| | Yellow male plug not connected |
| 075 | Impulse counter scan tool adaptor |
| 087 | Hand-Held Tester (optional with impulse counter scan tool) |
| 094 | Multiplex cable |
| X11/4 | Data link connector (DTC readout) |

Diagnosis – Diagnostic Trouble Code (DTC) Memory

a) On-Off Ratio Test, Ignition: ON

On-Off Ratio %	Possible cause	Test step/Remedy ¹⁾
0	Voltage supply from socket 3 of data link connector (X11/4) open circuit	Repair harness
10	CTP (idle) recognition inactive	23 ⇒ 15.0
20	WOT (full load) recognition active	23 ⇒ 15.0
30	Engine coolant temperature < 70 °C or >110 °C	23 ⇒ 9.0, 10.0
40	Not used	
50	Input signals OK	
60	TN-signal (rpm signal) or CMP sensor signal not present while starting	23 ⇒ 12.0 – 14.0
70	Starter engaged	23 ⇒ 8.1
80	CAN-data exchange defective	23 ⇒ 39.0
90	Fuel safety shut-off active	Check CC/ISC (see DM, Engines, Volume 3, Section 7.1) or Check EA (see DM, Engines, Volume 3, Section 6.2)

¹⁾ Observe Preparation for Test, see 22.

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b) On-Off Ratio Test, Engine: at CTP (idle)

On-Off Ratio %	Possible cause	Test step/Remedy ¹⁾
0	Short circuit to battery + in wire to data link connector (X11/4), socket 3	Repair harness
10	CTP (idle) recognition applied constantly	23 ⇒ 15.0
20	Output of fuel injectors or one or more fuel injectors have open circuit	23 ⇒ 32.0, 33.0
30	ECT sensor (B11/2)	23 ⇒ 9.0, 10.1
40	Hot wire MAF sensor (B2/2)	23 ⇒ 5.0, 6.0
50 ²⁾	O2S 1 (before TWC) (G3/2) not operational or defective, open circuit	23 ⇒ 18.0 – 19.1
60	CMP sensor (L5/1)	23 ⇒ 14.0
70	TN-signal (rpm signal)	23 ⇒ 12.0, 13.0
80	CAN-data exchange defective	23 ⇒ 39.0 – 40.0 Either EA/CC/ISC control module, CC/ISC control module or DI control module not transmitting.

1) Observe Preparation for Test, see 22.

2) Needle oscillates if all monitored signals are OK.

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
b) On-Off Ratio Test, Engine: at CTP (idle)

On-off Ratio %	Possible cause	Test step/Remedy ¹⁾
90	Vehicle speed signal (VSS)	Check CC/ISC (see DM, Engines, Volume 3, section 7.1) or Check EA (see DM, Engines, Volume 3, section 6.2)
95	Deceleration shut-off active	Check CC/ISC (see DM, Engines, Volume 3, section 7.1) or Check EA (see DM, Engines, Volume 3, section 6.2)
100	No voltage at LH-SFI control module (N3/1)	23 ⇒ 1.0 – 3.0

¹⁾ Observe Preparation for Test, see 22.

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c) LH-SFI Control Module DTC Readout

DTC 	Possible cause	Test step/Remedy ¹⁾
1	No malfunction in system	–
2	ECT sensor (B11/2) sensor circuit 1, open/short circuit	23 ⇒ 9.0
3	ECT sensor (B11/2) sensor circuit 2, open/short circuit	23 ⇒ 10.0
4 ²⁾	Voltage at hot wire MAF sensor (B2/2) insufficient or too high, or open circuit in ground wire at hot wire MAF sensor	23 ⇒ 5.0 – 6.0
5	Not used	–
6	Not used	–
7	TN-signal (rpm signal) incorrect or open/short circuit	23 ⇒ 12.0
8	CMP sensor (L5/1) signal, open/short circuit	23 ⇒ 14.0
9	Starter signal (circuit 50) missing, open/short circuit	23 ⇒ 8.1
10 ³⁾	CTP (idle) recognition from EA/CC/ISC control module (N4/1) or CC/ISC control module (N4/3), short circuit	23 ⇒ 15.0
11 ⁴⁾	Secondary air injection system, open/short circuit	23 ⇒ 23.0

1) Observe Preparation for Test, see 22.


2) DTC 4 can be displayed on vehicles up to 7/91 even if no fault is present.

3) DTC 10 can be displayed on vehicles up to 7/91 even if no fault is present.

4) DTC 11 can be displayed on vehicles up to 7/91 even if no fault is present.

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c) LH-SFI Control Module DTC Readout

DTC 	Possible cause	Test step/Remedy ¹⁾
12	Burn-off control for hot wire MAF sensor, open/short circuit	23 ⇒ 7.0
13	IAT sensor (B17/7), open/short circuit	23 ⇒ 11.0
14	Not used	–
15	Not used	–
16 ⁵⁾	EGR switchover valve (Y27), open/short circuit	23 ⇒ 20.0
17 ⁷⁾	No CAN data transmission with EA/CC/ISC control module (N4/1) or CC/ISC control module (N4/3)	23 ⇒ 39.0 or N4/1 or N4/3.
18 ⁶⁾	No CAN data transmission with DI control module (N1/3)	23 ⇒ 39.0 or N1/3.
19	Not used	–
20	No CAN data transmission from LH-SFI control module (N3/1)	23 ⇒ 40.0
21	O2S 1 (before TWC) (G3/2), open/short circuit	23 ⇒ 18.0

¹⁾ Observe Preparation for Test, see 22.


⁵⁾ DTC 16 can be displayed on vehicles up to 7/91 even if no fault is present.

⁶⁾ DTC 18 can be displayed on vehicles up to 7/91 even if no fault is present.

⁷⁾ DTC 17 can be displayed even if no fault is present.

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c) LH-SFI Control Module DTC Readout

DTC 	Possible cause	Test step/Remedy ¹⁾
22	O2S 1 heater, open/short circuit	23 ⇒ 19.0
23	Purge control valve (Y58/1), open/short circuit	23 ⇒ 24.0
24 (Engine 119 only)	Left adjustable camshaft timing solenoid (Y49/1), open/short circuit	23 ⇒ 27.0
25	Adjustable camshaft timing solenoid, engine 104 (Y49) or right adjustable timing solenoid, engine 119 (Y49/2), open/short circuit	23 ⇒ 26.0
26	Upshift delay switchover valve (Y3/3), open/short circuit	23 ⇒ 34.0
27	Injectors (Y62), open/short circuit	23 ⇒ 32.0
28	LH-SFI control module coding, open circuit	23 ⇒ 43.0
29 (Model 124.034 only)	1GR start relay module (K29/1), open/short circuit	23 ⇒ 44.0

¹⁾ Observe Preparation for Test, see 22.