

## Ignition system, checking

### General notes on ignition system

- ◆ Always switch off the ignition before connecting or disconnecting the battery, otherwise the engine control module may be damaged.
- ◆ The engine control module is equipped with On Board Diagnostic (OBD).
- ◆ For trouble-free operation of the electrical components a voltage of at least 11.5 V is necessary.
- ◆ During some of the tests it is possible that the control module will detect and record a malfunction. The DTC memory must therefore be checked and if necessary erased when all tests and repair work have been completed.
- ◆ After completing troubleshooting, repairs or component tests, it is possible that the engine will start, run for a short period and then cut out. If this happens it may be that the immobilizer is blocking the engine control module. In such cases the DTC memory must be checked and if necessary the control module must be adapted.

## Safety precautions

To prevent injuries to persons and/or damage to the fuel injection and ignition system, the following must be noted:

### **WARNING!**

***Be alert when working on or near the engine. High ignition secondary voltage can cause serious personal injury and damage vehicle components.***

- ◆ ***DO NOT touch or disconnect ignition wiring when the engine is running or being turned at starter speed.***
- ◆ ***DO NOT operate the starter if fuel injectors are removed.***
- ◆ ***Always switch off the ignition before connecting or disconnecting the battery, otherwise the engine control module may be damaged.***
- ◆ ***The ignition must be switched off before connecting or disconnecting injection or ignition system wiring or tester cables.***
- ◆ ***In order to run the engine at starting speed***

***without actually starting it (e.g. to test compression), disconnect the connectors from the output stages of the ignition coils and from all the fuel injectors. After completing the work, check and erase the DTC memory.***

- ◆ ***The ignition must always be switched off when cleaning the engine.***


**CAUTION!*****Before disconnecting the battery:***

- ◆ ***Stop the engine.***
- ◆ ***Be sure of proper radio code (for vehicles equipped with coded anti-theft radio).***

***When connecting and disconnecting electrical test equipment (LED voltage tester, multimeter, etc.):***

- ◆ ***Be sure the ignition is switched OFF.***
- ◆ ***Use correct adapters from VAG1594 connector test kit***

## Technical data, ignition system

Engine code	<b>APB (TLEV engine)</b> <b>BEL (LEV engine)</b>
Engine idle RPM  Not adjustable - controlled by Idle Air Control (IAC)	650 - 750 RPM
RPM limit  ◆ Operates by closing throttle valve  ◆ Operates by shutting off fuel injectors	approx. 6800 RPM
Ignition timing is determined by the control module.  Ignition timing cannot be adjusted.	
Ignition system	Single-coil system with 6 ignition coils located above spark plug connectors and installed directly on spark plugs. On  PB engine power output stages are located as separate components in air cleaner housing. On BEL engine power output stages are integrated into ignition coils.
Spark plugs connectors	Resistance approx.: 2k Ohm

Firing order	1-4-3-6-2-5
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## Ignition coils, checking

### Note:

- ◆ *The following procedure is for vehicles with engine code APB. The procedure for vehicles with engine code BEL is on ⇒ [Page 28-11](#) .*
- ◆ *Misfiring is recognized by the On Board Diagnostic (OBD). This means a non-working cylinder is stored with the cylinder number in the DTC memory. This has an advantage in case of a malfunction the trouble shooting procedure can be started at a certain cylinder. Check the DTC memory of the Engine Control Module (ECM) before commencing trouble shooting.*

### Test conditions

- No DTCs stored relating to any of the fuel injectors

Determine a non-working or misfiring cylinder as follows:

- With engine running disconnect harness connectors in sequence from fuel injectors, and observe engine performance.

or

- Compare spark plugs of all cylinders with each other and check for soot on electrodes.

When the faulty cylinder has been identified:

- Connect hand-held multimeter (resistance measurement) to spark plug connector:

**Note:**

*The spark plug connector can be disconnected from the ignition coil.*

Specification: approx.: 2k Ohm.



If specification is not obtained:

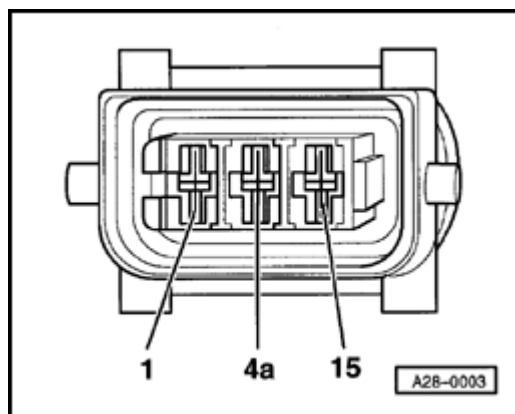
- Replace spark plug connector.

If specification is obtained:

- Exchange spark plug from faulty (misfiring) cylinder with one from another cylinder. Visually check spark plug for damage, e.g. cracks on ceramic body of spark plug.
- If malfunction (misfire) occurs now on other cylinder, replace spark plug.

If the malfunction remains at the same cylinder:

- Exchange ignition coil from faulty (misfiring) cylinder with one from another cylinder. Visually check ignition coil for damage (ignition coil could be cracked or bursted)
- If malfunction occurs now on other cylinder, replace ignition coil.



If malfunction remains at the same cylinder.

- Disconnect harness connector from ignition coil.

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- Check Ground (GND) connection between socket 4a and engine Ground (GND) for open circuit and short circuit to B+.

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations*

- Repair any open/short circuit as necessary.

If the Ground (GND) connection is OK.

- Connect hand-held multimeter (voltage range) to terminal 15 of harness connector and Ground (GND).
- Disconnect harness connector from fuel injector of cylinder to be tested.
- Operate starter.

Specification: approx. battery voltage

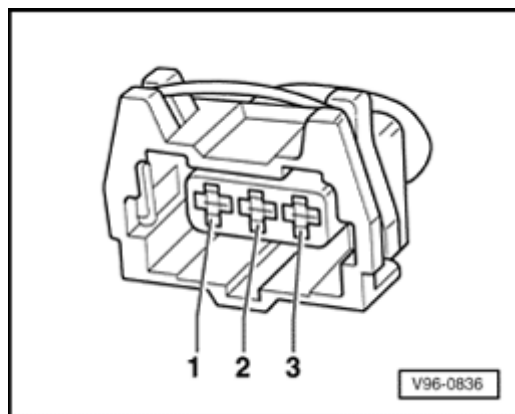
If the specification is not obtained:

- Check wiring.

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations*

If the specification is obtained:

- Disconnect 3-pin harness connectors on power output stages for ignition coils; component locations overview ⇒ [Page 24-5](#) .
- Connect LED voltage tester to 3-pin connectors for both output stages.



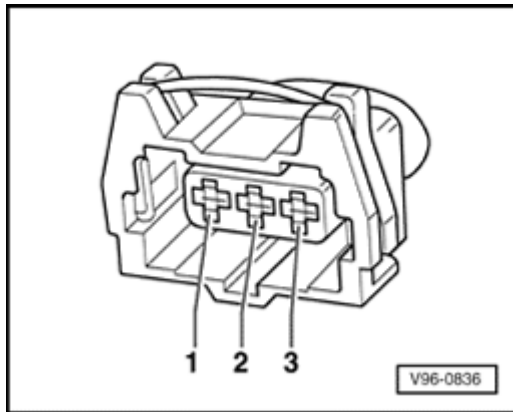
A

- Connect LED voltage tester VAG1527 to following contacts on connectors for power output stages:

3-pin harness connector terminal	Specification (with starter activated)
1 + Ground (GND)	LED voltage tester must light up
2 + Ground (GND)	
3 + Ground (GND)	

If the specifications are not obtained:

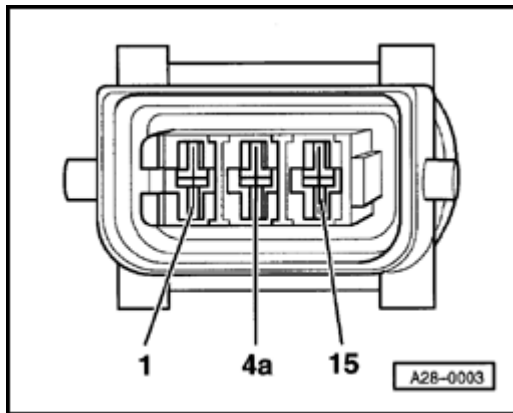
- Switch ignition off.



A

- Check following wiring connections for open circuits and/or short to B+ or Ground (GND).

Black 3-pin connector on power output stage, terminal	3-pin connector on ignition coil, terminal
1	1 (cylinder 1)
2	1 (cylinder 2)
3	1 (cylinder 3)



A

- Check following wiring connections for open circuits and/or short to B+ or Ground (GND).

Brown 3-pin connector on power output stage, terminal	3-pin connector on ignition coil, terminal
1	1 (cylinder 4)
2	1 (cylinder 5)
3	1 (cylinder 6)

- Eliminate any open/short circuit as necessary.

## Ignition coils, checking, Engine code BEL

### **Note:**

*The ignition coil and the power output stage are integrated in one component.*

### **Requirements**

- No DTCs stored relating to any of the fuel injectors

Determine a non-functional or misfiring cylinder as follows:

- Check misfire recognition, ⇒ [Page 28-66](#)

If a misfire is recognized:

- Continue with cylinder displayed using test "If a misfire is recognized".

If no misfire is recognized:

- With engine running, disconnect connectors from injectors one at a time and observe how engine is running.

or

- Compare spark plugs of all cylinders with each other and look for corroded electrodes.

If the faulty cylinder is found:

- Exchange spark plug from faulty cylinder with one from another cylinder.

If problem cylinder moves with the spark plug:

- Replace spark plug.

If the fault remains with the cylinder:

- Exchange ignition coil from faulty cylinder with one from another cylinder.
- If fault now appears in another cylinder, replace ignition coil.

If the fault remains with the cylinder:

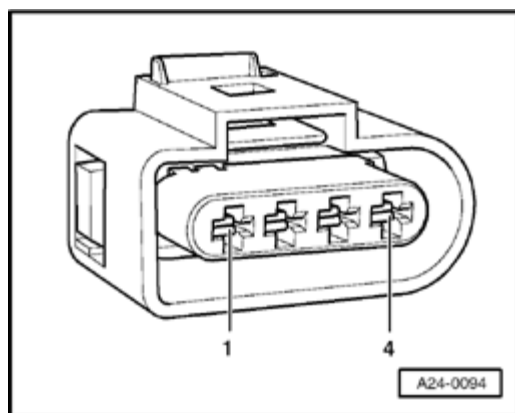
- Check Ground wiring of ignition coil.

#### Checking Ground wiring of ignition coil

- Disconnect 4-pin connector on respective ignition coil.
- Check Ground wiring on socket 4 of 4-pin connector after engine Ground for open circuit or short circuit to B+.
- Eliminate any open or short circuits.

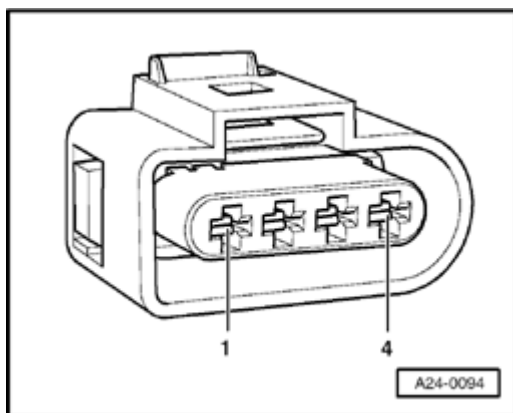
If Ground wiring is OK:

- Check voltage supply to ignition coil ⇒ [Page 28-14](#) .



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### Checking voltage supply of the ignition coils

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- Connect multimeter for measuring voltage to following sockets on connector:
- Switch ignition on.

4-pin harness connector terminal	Specification
1 + Ground (GND)	Battery voltage

Specified value: approx. battery voltage

If the specified value is not attained:

- Check wiring connection for socket 1 via fuse to Motronic (ECM) power supply relay -J271- for continuity and repair if necessary.  
⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations*
- Check ECM power supply relay -J271- ⇒ [Page 28-24](#) .

If the specification is not obtained:

- Check power output stage ⇒ [Page 28-15](#) .

## Power output stages for ignition coils, checking

### **Note:**

- ◆ *The following procedure is for vehicles with engine code APB. The procedure for vehicles with engine code BEL is on ⇒ [Page 28-20](#) .*
- ◆ *Power Output Stage -N122- (black connector) activates the ignition coils for cylinder bank 1 (cylinders 1 to 3).*
- ◆ *Power Output Stage 2 -N192- (brown connector) activates the ignition coils for cylinder bank 2 (cylinders 4 to 6).*

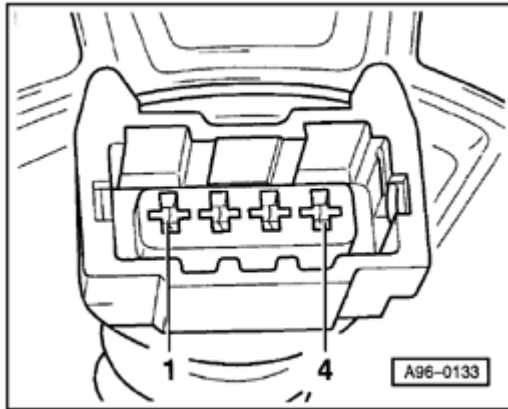
### **Checking activation of power output stages**

- Disconnect harness connectors from all six fuel injectors.

### **Note:**

*It is important to ensure that no fuel is injected during the test as this would damage the catalytic converter. The harness connectors on the fuel injectors must therefore be disconnected.*

- Disconnect 4-pin harness connectors on power output stages Component locations overview, => [Page 24-5](#) .



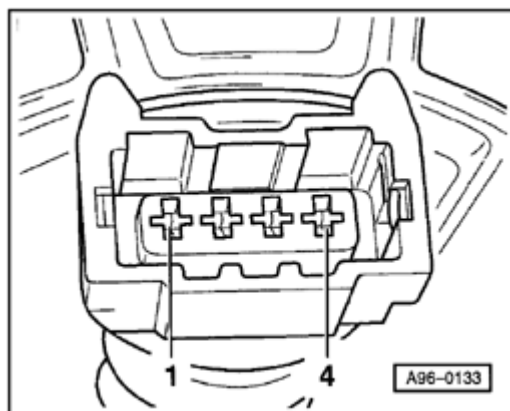
A

- Connect LED voltage tester VAG1527 in turn to following contacts on two 4-pin connectors for power output stages.
- Operate starter for a few seconds.

6-pin connector on wiring harness, terminal	Specification
1 + Ground (GND)	LED voltage tester must
3 + Ground (GND)	flash (brief impulse)
4 + Ground (GND)	

If the specifications are not obtained:

- Switch ignition off.
- Connect test box VAG 1598/31 to wiring harness for engine control module. Do not connect to engine control module itself. ⇒ [Page 24-20](#) .



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- Check following wiring connections for open circuits and/or short to B+ or Ground (GND):

<b>Black 4-pin connector on wiring harness, terminal</b>	<b>VAG1598/31 test box, socket</b>
1	94
3	110
4	102
<b>Brown 4-pin connector on wiring harness, terminal</b>	<b>VAG1598/31 test box, socket</b>
1	95
3	111
4	103

- Correct any open/short circuit as necessary.

If no wiring malfunction is detected:

- Connect 4-pin connectors to power output stages.
- Disconnect 3-pin connectors from power output stages.
- Connect LED voltage tester VAG1527 to battery (B+) and to one of 3 terminals on power output stage.
- Operate starter for few seconds.

LED voltage tester should flash.

- Perform test with all 3 terminals on each of 3-pin connectors for power output stages.

LED voltage tester should flash each time.

If the LED voltage tester does not flash when testing one or more of the contacts:

- Check the Ground (GND) connections for the power output stages as follows:
  - Disconnect 4-pin connector from power output stages.
  - Connect LED voltage tester VAG1527 to battery (B+) and terminal 2 of each 4-pin connector in turn.

LED voltage tester should light up.

If LED voltage tester does not light up,

- Test for open circuit in wiring using wiring diagram.

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations*

If the LED voltage tester lights up:

- Replace power output stage.

**Note:**

*Before installing new power output stage coat metal side with heat paste (part no. G 052 170 A1). The heat paste is used to prevent corrosion between the power output stage and the fastening point and to transfer heat from the power output stage.*

**CAUTION!**

***Part numbers are only for reference. Always check with your parts department for the latest information.***

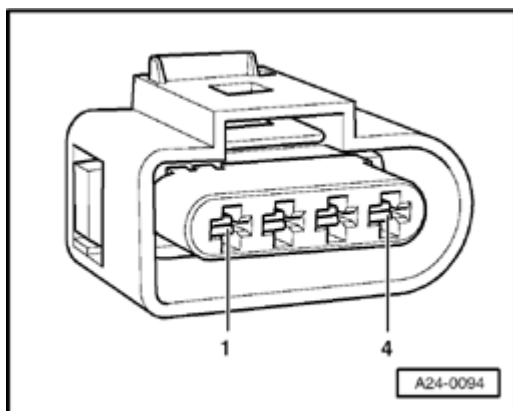
### Power output stages for ignition coils, checking, Engine code BEL

#### **Note:**

*The ignition coils and the power output stages  
are contained in one component*

#### **Checking Ground supply for power output stages**

- Disconnect 4-pin connector for each ignition coil.



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- Check wiring connection from socket 2 of 4-pin connector after body Ground for open circuit or short circuit to Ground.
- Repair open or short circuit as necessary.

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations*

If Ground wiring is OK:

- Check activation of power output stages ⇒ [Page 28-21](#) .



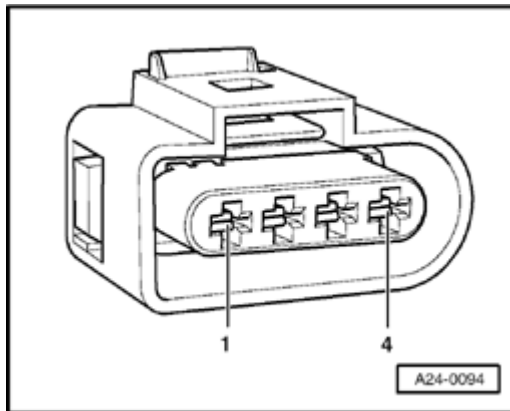
### Checking activation of power output stages

- Disconnect harness connectors from all six fuel injectors.

**Note:**

*It is important to ensure that no fuel is injected during the test as this would damage the catalytic converter. The harness connectors on the fuel injectors must therefore be disconnected.*

- Disconnect 4-pin for each ignition coil.



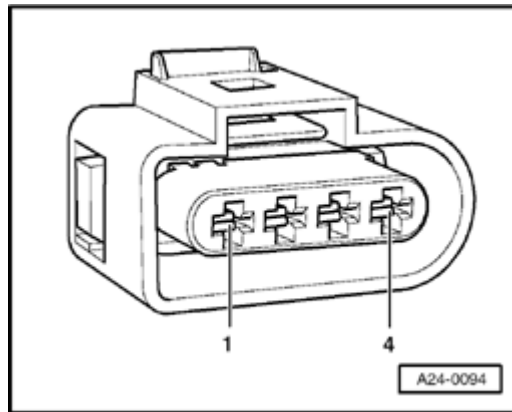
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- Connect LED voltage tester V.A.G 1527 to following contacts on connectors for ignition coils.
- Operate starter for a few seconds.

4-pin connector on wiring harness, terminal	Specification
3 + 2	LED voltage tester must flash (brief flash)

If the specified value is not attained:

- Switch ignition off.



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- Connect test box V.A.G 1598/31 to wiring harness for engine control module. Do not connect to engine control module itself, ⇒ [Page 24-20](#) .
- Check wiring connection from 4-pin connector on ignition coil and power output stages....
- .....to engine control module for open circuits and shorts circuits to B+ and Ground

4-pin connector	VAG1598/31 test box, socket
Cyl. 1	102
Cyl. 2	110
Cyl. 3	94
Cyl. 4	103
Cyl. 5	111
Cyl. 6	95

Wire resistance: max. 1.5 Ohm

- Repair any open circuits and short circuits.

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations*

If there is no fault in the wiring:

- Replace ignition coil with power output stage.

## Motronic ECM power supply relay -J271- , checking

Location of relay:

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations*

### **Note:**

*The Motronic ECM power supply relay -J271- supplies the ignition coils with power output stages and also supplies the ECM on pin 3 and some other components with voltage. When the ignition is on, there must be 1 - 12 Volts on contact at the respective ignition coil.*

### **Check activation wiring from power supply relay to ECM**

- Switch ignition on.
- Remove Motronic ECM power supply relay - J271- from 3-position relay panel.
- Connect V.A.G 1598/31 test box to wiring harness for engine control module. Do not connect to engine control module itself, ⇒ [Page 24-20](#) .

- Check following wiring connections for open circuit or short circuit:

VAG1598/31 test box, socket	Power supply relay terminal
23	4 <i>⇒ Electrical Wiring Diagrams, Troubleshooting &amp; Component Locations</i>

Wire resistance: max. 1.5 Ohm

- Correct any open/short circuits as necessary.

*⇒ Electrical Wiring Diagrams, Troubleshooting & Component Locations*

If no wiring fault is found:

- Check voltage supply for power supply relay, ⇒ [Page 28-26](#) .

### Checking voltage supply to power supply relay

- Switch ignition off.
- Connect multimeter for voltage measurement between terminal 1 on relay socket and Ground.
- Connect multimeter for voltage measurement between terminal 2 on relay socket and Ground.

Specified value: approx. battery voltage

If the specified value is not attained:

- Check voltage supply according to wiring diagram.

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations*

If the specified value is attained:

- Check wiring connection between power supply relay and engine control module, ⇒ [Page 28-27](#) .

### Checking wiring connection between power supply relay and engine control module

- Check fuse.

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations*

If no fault is found with fuse:

- Check following wiring connections for open circuit or short circuit:

VAG1598/31 test box, socket	Power supply relay terminal
3	8 ⇒ <i>Electrical Wiring Diagrams, Troubleshooting &amp; Component Locations</i>

Wire resistance: max. 1.5 Ohm

- Correct open circuit or short circuit as necessary.

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations*

If no fault is found in any of the tests:

- Replace Motronic ECM power supply relay - J271-.



## Intake Air Temperature (IAT) sensor - G42-, checking

Location of sensor and connector ⇒ [Page 24-5](#) .

- Connect vehicle diagnostic, testing and information system VAS 5051 or VAG1551 scan tool and select engine electronics control module by entering address word "01" ⇒ [Page 01-8](#) . Ignition must be switched on.

Rapid data transfer      HELP  
Select Function XX

⚠ Indicated on display

- Press buttons -0- and -8- to select function "Read Measuring Value Block" and confirm entry with -Q- button.

Read Measuring Value Block      HELP  
Input Display Group Number XXX

⚠ Indicated on display

- Press buttons -0-, -0- and -4- to select "display group 004" and confirm entry with -Q- button.

Read Measuring Value Block 4      →  
1      2      3      4

⚠ Indicated on display (1...4 = display fields)

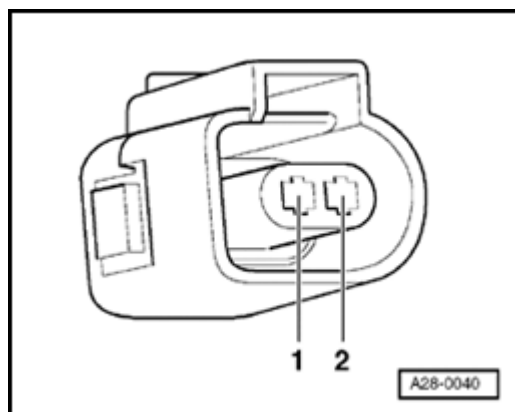
- Check display value for intake air temperature sensor (display field 4):

	Display fields			
	1	2	3	4
<b>Display Group 004: Intake air temperature with engine idling</b>				
<b>Display</b>	xxxx RPM	xx.xxx V	xxx.x °C	xxx.x °C
<b>Indicates</b>	Engine speed	Battery voltage	Coolant temperature	<b>Intake air temperature</b>
<b>Work range</b>	min.: 650 RPM	min.:10.000 V	min.: -48.0 °C	<b>min.: -48.0 °C</b>
	max.: 6800 RPM	max.: 15.000 V	max.: 143.0 °C	<b>max.: 143.0 °C</b>
<b>Specified value</b>	xxxx RPM	12.000...15.000 V	80.0...110.0 °C	<b>Between ambient temp. and 120 °C <sup>1)</sup></b>

<sup>1)</sup> If there is a large difference between the temperature displayed and the ambient temperature at the sensor, check the sensor and sensor wiring for contact resistance and open circuit.

**Checking wiring:**

- Switch ignition off.
- Connect test box VAG1598/31 to wiring harness for engine control module. Do not connect to engine control module itself. ⇒ [Page 24-20](#) .



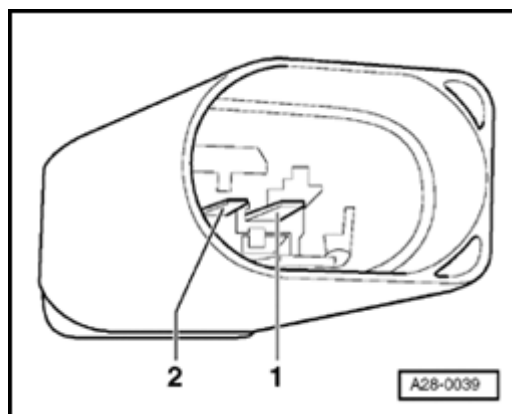
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- Check for open circuit in wiring between test box and 2 pin harness connector using wiring diagram.

Specification: max. 1.5  $\Omega$

Terminal on 2-pin harness connector	Contact on control module connector or test box
1	85
2	108

- Check wiring for short circuits to each other between contacts 1 and 2 on 2-pin connector. Also test for short circuits to B+ or Ground (GND).



If no malfunction in wire is detected:

### Checking sensor

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- Measure resistance between contacts 1 (signal) and 2 (Ground) on connector for Intake Air Temperature (IAT) sensor -G42-.

Temperature °C	Resistance kΩ
-20	approx. 13.8
0	approx. 5.5
20	approx. 2.4
40	approx. 1.1
60	approx. 0.6

If value does not match the specification:

- Replace intake air temperature sensor.

### Note:

*In order to install the new sensor, the intake manifold must first be removed ⇒ [Page 24-15](#) .*

## Engine speed (RPM) sensor -G28-, checking

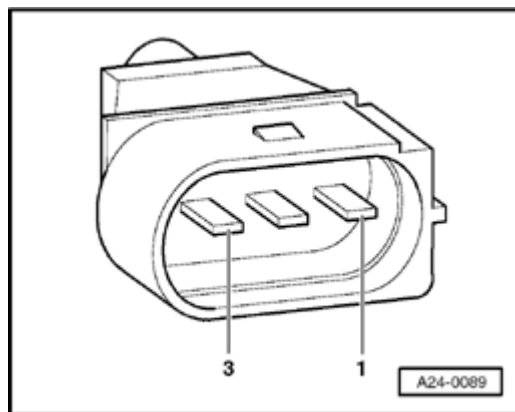
### **Note:**

*The engine speed sender is a combined speed sensor and reference mark sensor. Without a signal from the Engine Speed (RPM) sensor - G28- the engine cannot be started. If the signal from the Engine Speed (RPM) sensor -G28- fails while the engine is running, the engine will cut out immediately.*

### **Checking Engine Speed (RPM) sensor**

Component location of sensor and connector ⇒  
[Page 24-5](#) .

- Before performing test, make sure that sensor is correctly installed and firmly seated.
- Disconnect harness connector for Engine Speed (RPM) sensor (gray connector).



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- Connect multimeter (Fluke 83 or equivalent) (resistance test range) to terminals 2 and 3 on connector for engine speed sensor using test lead from VAG1594 connector test kit.

Specification: approx. 730 - 1000 Ohm

**Note:**

- ◆ *The resistance value for the engine speed sensor is based on a temperature of 20° C.*
- ◆ *The resistance increases as the temperature rises.*

If the specification is not attained:

- Replace Engine Speed (RPM) sensor.

If the specification is attained:

- Connect multimeter (Fluke 83 or equivalent) (resistance test range) between terminals 2 and 1 (Ground) and between terminals 3 and 1 (Ground).

Specification: R  $\Omega$  (infinite Ohms / open circuit) in each test

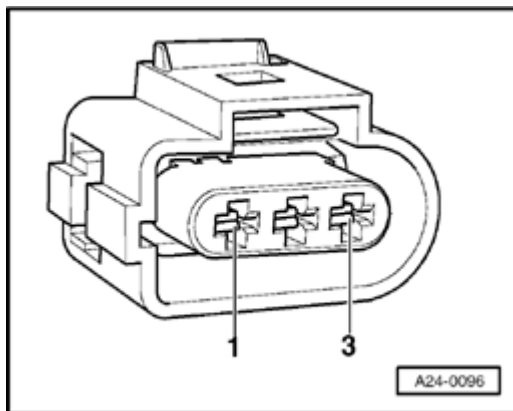
If the specification is not attained:

- Replace Engine Speed (RPM) sensor.

If the specification is attained:

- Check wiring between sensor connector and engine control module as

follows:



A

- Connect VAG1598/31 test box to wiring harness for engine control module. Do not connect to engine control module itself ⇒ [Page 24-20](#) .

- Test continuity of screening (shielded wire) between contact 1 on engine speed sensor connector and socket 108 on test box.

Specification: max. 1  $\Omega$  .

- Test continuity of negative wire from contact 2 on sensor connector to socket 90 on test box.

Specification: max. 1  $\Omega$  .

- Test continuity of signal wire from contact 3 on sensor connector to socket 82 on test box.

Specification: max. 1  $\Omega$  .



If the values are not as specified:

- Correct short or open circuit in wiring between sensor connector and control module connector.

Terminal on sensor connector	Terminal on control module connector
1	108
2	90
3	82

- If no open circuits or short circuits are identified, replace Engine Control Module (ECM) ⇒ [Page 24-24](#) .

## Engine Coolant Temperature (ECT) sensor -G62-, checking

### **Note:**

*Component location of coolant temperature sensor ⇒ [Page 24-5](#) .*

### **Test conditions**

- Engine cold
  
- Connect vehicle diagnostic, testing and information system VAS 5051 or VAG1551 scan tool to vehicle and select engine electronics control module by entering address word "01" ⇒ [Page 01-8](#) . Engine must be at idle.

Rapid data transfer      HELP  
Select function XX

↖ Indicated on display

- Press buttons -0- and -8- to select function "Read Measuring Value Block" and confirm entry with -Q- button.

Read Measuring Value Block  
Input display group number XXX

↖ Indicated on display

- Press buttons -0-, -0- and -4- to select "display group 004" and confirm entry with -Q- button.

Read Measuring Value Block 4      →  
1      2      3      4

↖ Indicated on display

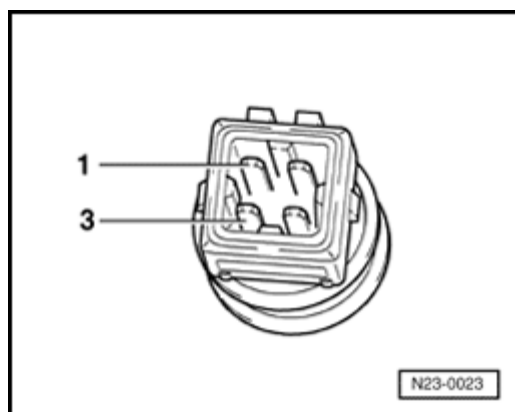
- Check specification in display field 3.

	Display fields			
	1	2	3	4
<b>Display Group 004: Coolant temperature with engine idle</b>				
<b>Display</b>	xxxx RPM	xx.xxx V	xxx.x °C	xxx.x °C
<b>Indicates</b>	Engine speed RPM	Battery voltage	<b>Coolant temperature</b>	Intake air temperature
<b>Specified value</b>	XXXX RPM	12.0...15.0 V	<b>Temperature must increase evenly</b>	Ambient temperature up to 120 °C

If display field 3 does not display a realistic value:

- Disconnect harness connector from coolant temperature sensor.

#### **Coolant temperature sensor with square connector**

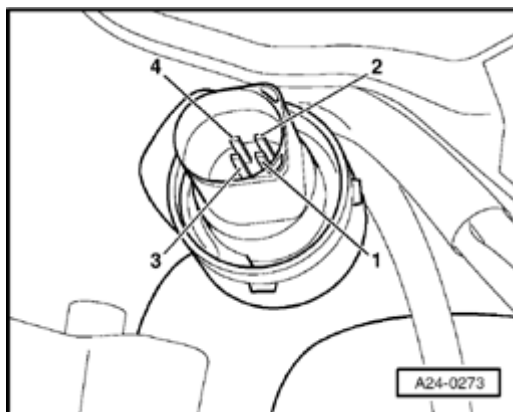


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- Connect multi-meter (resistance measurement) between terminals 1 and 3 of sensor.

28-40

### Coolant temperature sensor with oval connector

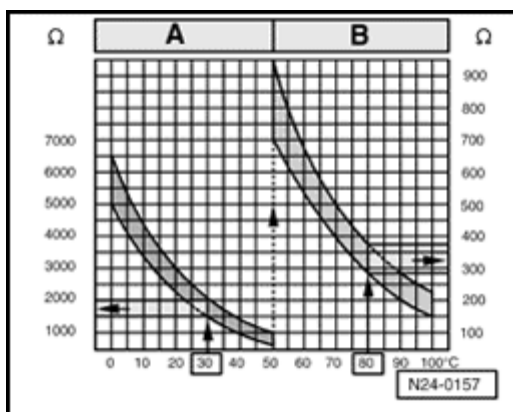


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- Connect multi-meter (resistance measurement) between terminals 3 and 4 of sensor.

### All

Scale A shows resistance values for temperature range 0 - 50 °C and scale B the values for temperature range 50 - 100 °C.



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Examples:

- ◆ 30 °C corresponds to a resistance from 1500...2000 Ω
- ◆ 80 °C corresponds to a resistance from 275...375 Ω

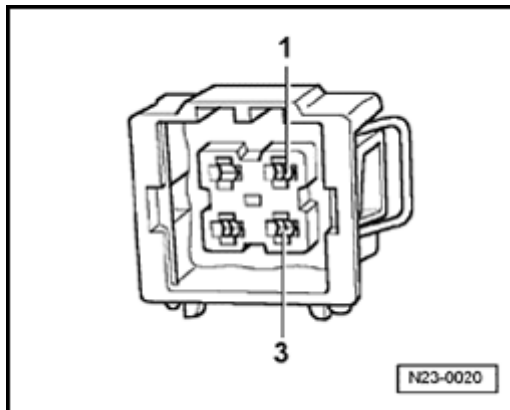
If value does not match the specification:

- Replace coolant temperature sensor.

If the value does match the specification:

- Connect test box VAG1598/31 to wiring harness for engine control module. Do not connect to engine control module itself. ⇒ [Page 24-20](#) .

**Coolant temperature sensor with square connector**

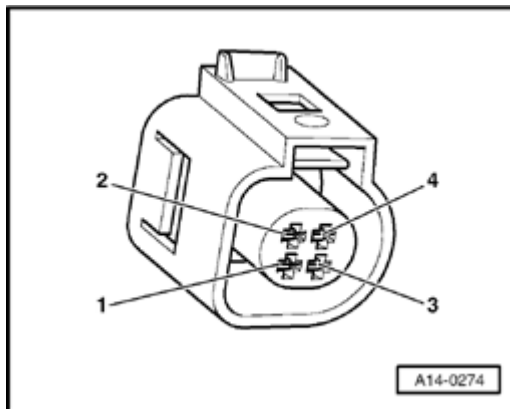


A

- Check following wiring connections for open circuits and short circuits to B+ or Ground (GND)

Harness connector	VAG1598/31 test box
Terminal	Socket
1 (Signal)	93
3	108

**Coolant temperature sensor with oval connector**



A

- Check following wiring connections for open circuits and short circuits to B+ or Ground (GND)

Harness connector	VAG1598/31 test box
Terminal	Socket
3	108
4 (Signal)	93

**All**

- Check wires for short circuits to each other.
- If necessary eliminate open circuit or short circuit.

If no malfunction is identified in the wiring:

- Replace Engine Control Module (ECM) ⇒ [Page 24-24](#) .



## Control module voltage supply, checking

Procedure is valid for engines with Engine code. Procedure for Engine code BEL ⇒ [Page 28-45](#)

### Test requirements

- Fuse for Engine Control Module (ECM) OK

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations.*

- Battery voltage at least 11 V
- Generator OK
- Connect test box VAG1598/31 to wiring harness for engine control module. Do not connect to engine control module itself. ⇒ [Page 24-20](#) .
- Switch ignition on.

### Note:

- ◆ *The B+ voltage supply for the engine control module comes via terminal 3 (terminal 15) and terminal 62 (terminal 30).*

- ◆ *The Ground (GND) connection for the engine control module is via terminals 1 and 2.*

- Connect multimeter VAG1526 (voltage measurement range) to following contacts on test box:

Contact	Specification
3 + 2	approx. battery voltage
3 + 1	approx. battery voltage
62 + 2	approx. battery voltage

If the specifications are not obtained:

- Check wiring.

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations.*

## Control module voltage supply, checking, Engine code BEL

### Test requirements

- Engine control module fuse OK

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations*

- Battery voltage 11 V minimum
- Generator OK
- Connect V.A.G 1598/31 test box to wiring harness for engine control module. Do not connect to engine control module itself, ⇒ [Page 24-20](#) .
- Switch ignition on.

### **Note:**

- ◆ *The B+ voltage supply for the engine control module travels via connector terminal 3 (from Motronic ECM power supply relay -J271-), connector terminal 21 (terminal 15) and connector terminal 62 (terminal 30).*

- ◆ *Ground (GND) supply of the engine control module is via connector terminals 1 and 2.*

- Connect multimeter for voltage measurement to following contacts on test box:

Contact	Specification
3 + 2	approx. battery voltage
3 + 1	approx. battery voltage
21 + 1	approx. battery voltage
62 + 2	approx. battery voltage

If the specifications are not obtained:

- Check wiring connections.

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations*

If the specifications on terminal 3 are not obtained:

- Check Motronic ECM power supply relay, ⇒ [Page 28-24](#) .

### Knock sensor control limit, checking

If the malfunction message "Knock control regulation reached" is recorded in the DTC memory the following tests must be carried out. See also measuring value blocks 20, 21, 22, 23 and 24 ⇒ [Page 28-48](#)

	Possible cause of malfunction	Corrective action
Malfunction message relating to all cylinders or malfunction message relating to all cylinders in one bank	◆ Poor fuel quality	- Change to higher quality fuel (see Owner's Manual)
	◆ Incorrect tightening torque on knock sensor	- Loosen knock sensor, then tighten to 20 Nm (15 ft lb)
	◆ Knock sensor faulty	- Check knock sensor ⇒ <a href="#">Page 28-54</a> .
	◆ Corrosion on connector	
	◆ Loose components on engine	- Secure loose components
Malfunction message relating to one cylinder	◆ Mechanical engine damage	- Check compression pressure
	◆ Loose components on engine	- Secure loose components

**Measuring value blocks for ignition timing angle retard**

Display Group 020 -Ignition- Knock control					
• Driving mode					
Read measuring value block 20 → xx.x ° KW xx.x ° KW xx.x ° KW xx.x ° KW				◀ Indicated on display	
1	2	3	4	◀ Display fields	<b>Specified value</b>
Ignition timing retard via knock control: cylinder 4					<b>Evaluation</b>
Ignition timing retard via knock control: cylinder 3					⇒ <a href="#">Page 28-53</a>
Ignition timing retard via knock control: cylinder 2					⇒ <a href="#">Page 28-53</a>
Ignition timing retard via knock control: cylinder 1					⇒ <a href="#">Page 28-53</a>

**Note:**



*The displayed digit values in display fields 1 to 4 reflects the actual "ignition timing retard" via knock control from the individual cylinders. The ignition timing retard occurs via ° KW (crankshaft angle).*

Display Group 021 -Ignition- Knock control						
• Driving mode						
Read measuring value block 21 →				◀ Indicated on display		
xx.x ° KW		xx.x ° KW		◀ Display fields		
1	2	3	4	Specified value	Evaluation	
Ignition timing retard via knock control: cylinder 6				0...12 ° KW (crankshaft angle)	⇒ <a href="#">Page 28-53</a>	
Ignition timing retard via knock control: cylinder 5				0...12 ° KW (crankshaft angle)	⇒ <a href="#">Page 28-53</a>	

**Note:**

The displayed digit values in display fields 1 and 2 reflects the actual "ignition timing retard" via knock control from the individual cylinders. The ignition timing retard occurs via ° KW (crankshaft angle).

Display Group 022 -Ignition- Knock control						
• Driving mode						
Read measuring value block 22 →				◀ Indicated on display		
xx.x RPM	x.x %	xx.x ° KW	xx.x ° KW	◀ Display fields		
1	2	3	4	Specified value		Evaluation
Ignition timing retard via knock control: cylinder 2				0...12 ° KW (crankshaft angle)		⇒ <a href="#">Page 28-53</a>
Ignition timing retard via knock control: cylinder 1				0...12 ° KW (crankshaft angle)		⇒ <a href="#">Page 28-53</a>
Engine load				15 - 175 %		
Engine speed RPM				650 - 6800 RPM		

**Note:**

The displayed digit values in display fields 3 and 4 reflects the actual "ignition timing retard" via knock control from cylinders 1 and 2. The ignition timing retard occurs via ° KW (crankshaft angle).

Display Group 023 -Ignition- Knock control						
• Driving mode						
Read measuring value block 23 →				◀ Indicated on display		
xx.x RPM    x.x %    xx.x ° KW    xx.x ° KW						
1	2	3	4	◀ Display fields	<b>Specified value</b>	<b>Evaluation</b>
Ignition timing retard via knock control: cylinder 4					0...12 ° KW (crankshaft angle)	⇒ <a href="#">Page 28-53</a>
Ignition timing retard via knock control: cylinder 3					0...12 ° KW (crankshaft angle)	⇒ <a href="#">Page 28-53</a>
Engine load					15 - 175 %	
Engine speed RPM					650 - 6800 RPM	

**Note:**

The displayed digit values in display fields 3 and 4 reflects the actual "ignition timing retard" via knock control from cylinders 3 and 4. The ignition timing retard occurs via ° KW (crankshaft angle).

Display Group 024 -Ignition- Knock control						
• Driving mode						
Read measuring value block 24 →				◀ Indicated on display		
xx.x RPM	x.x %	xx.x ° KW	xx.x ° KW			
1	2	3	4	◀ Display fields		Specified value
			Ignition timing retard via knock control: cylinder 6			0...12 ° KW  (crankshaft angle)
			Ignition timing retard via knock control: cylinder 5			0...12 ° KW  (crankshaft angle)
		Engine load				15 - 175 %
	Engine speed RPM					650 - 6800 RPM

**Note:**

The displayed digit values in display fields 3 and 4 reflects the actual "ignition timing retard" via knock control from cylinders 5 and 6. The ignition timing retard occurs via ° KW (crankshaft angle).

### Evaluation display groups 20/21/22/23/24, - Ignition timing angle retard

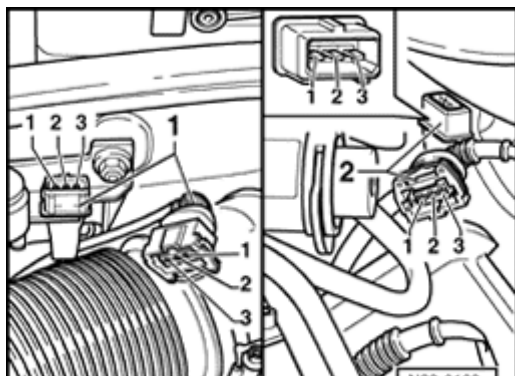
Indicated on display	Malfunction cause	Corrective action
All cylinders greater than 12 ° KW	◆ Knock sensor faulty	- Check knock sensor ⇒ <a href="#">Page 28-54</a> .
	◆ Corroded connection	
	◆ Knock sensor incorrect tightening torque	- Loosen and tighten knock sensor with 20 Nm (15 ft lb)
	◆ Components on engine loose	- Tighten components
	◆ Low fuel grade	- Change fuel grade
One cylinder deviates clearly from others	◆ Corroded connection	- Check knock sensor ⇒ <a href="#">Page 28-54</a> .
	◆ Engine damage	- Check compression pressure: ⇒ <a href="#">Repair Manual, 2.7 Liter V6 5V BiTurbo, Engine Mechanical, Engine Code(s): APB, BEL, Repair Group 15; Cylinder head removing, check compression pressure</a>
	◆ Components on engine loose	- Tighten components

## Knock Sensor (KS) 1 -G61- and Knock Sensor (KS) 2 -G66-, checking

### Notes:

- ◆ *It is not possible to perform an electrical test of the knock sensors themselves.*
- ◆ *Use only gold-plated terminals when repairing the terminals in the plug connectors for the knock sensors.*
- ◆ *To ensure that the knock sensors function properly it is important to keep exactly to the specified tightening torque of 20 Nm (15 ft lb)*
- ◆ *Check for corrosion in connection between knock sensor and wiring harness.*

### Checking knock sensors



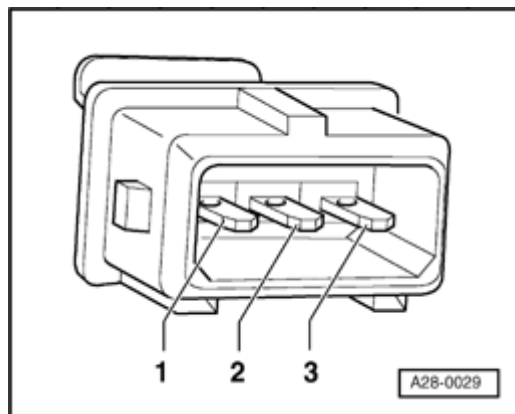
- A**
- Disconnect harness connector for relevant knock sensor in engine compartment.

### Note:

- ◆ *Component location overview ⇒ [Page 24-5](#) .*
- ◆ *In order to reach the connector for the knock sensor for cylinder bank 2, first remove the bolts securing the coolant reservoir and move the*

*coolant reservoir to one side. Coolant hoses remain attached.*





Assignment of connectors for engines with engine code BEL ⇒ [Page 28-56](#) .

**A**

- Check for short circuits between all three terminals in knock sensor connector (terminals 1 + 2, 1 + 3 and 2 + 3).

Specification: There must be no contact between the wires (infinite  $\Omega$ ).

If there is a connection between the terminals.

- Replace knock sensor.

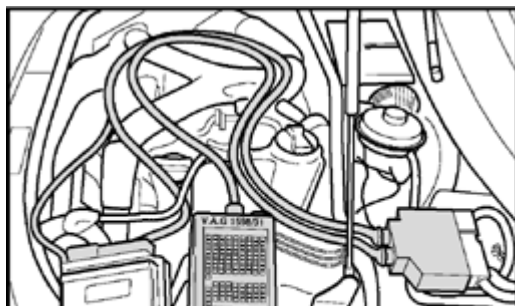
**Note:**

- ◆ *In order to reach the knock sensors, first remove the air duct ⇒ [Page 24-52](#) .*
- ◆ *Use special tool 3247 to remove the knock sensors.*

If there is no short circuit

- Check wiring for knock sensors.

**Checking wiring between knock sensors and engine control module**

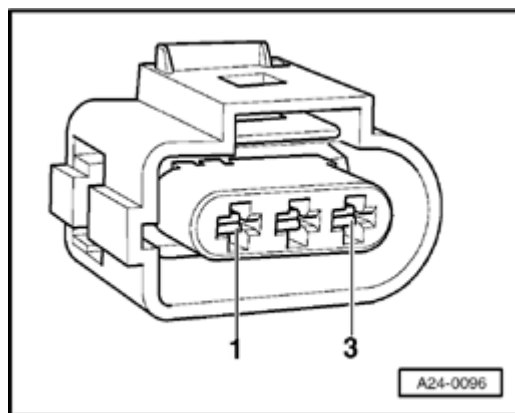


**A**

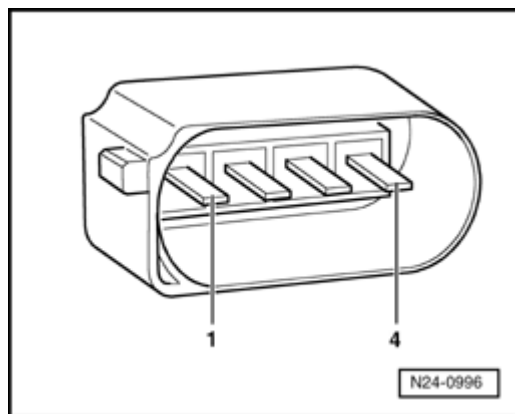
- Connect VAG1598/31 test box to wiring harness for engine control module. Do not connect to engine control module itself ⇒ [Page 24-20](#) .

### Connectors for Engine code BEL

- ✦ Assignment of connector wiring in vehicles with engine code BEL

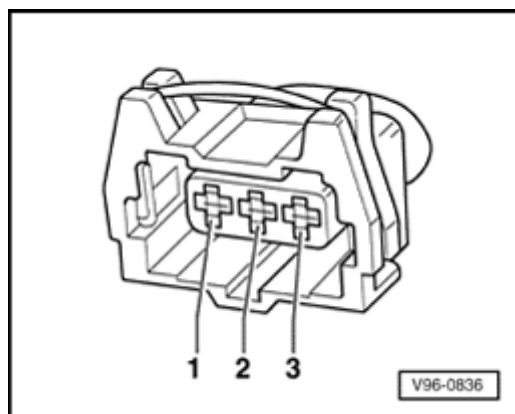


- ✦ Assignment of 4-pin connectors on knock sensors in vehicles with engine code BEL



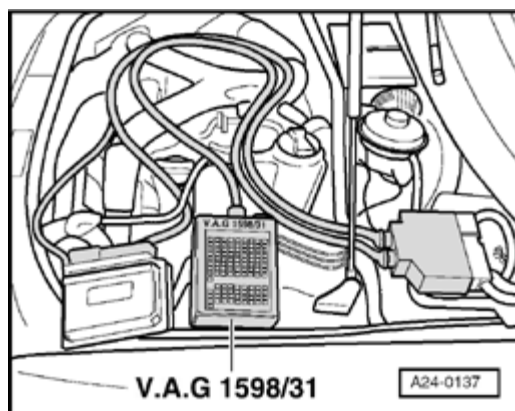
28-57

Assignment of connectors for engines with engine code BEL ⇒ [Page 28-56](#)



A

- Check wiring connection from relevant sensor connector to...



A

- ....Engine Control Module (ECM) for open circuit and/or short to B+ or Ground (GND).

<b>Knock Sensor (KS) 1 -G61- (Bank 1)</b>	
<b>3-pin connector on wiring harness, socket</b>	<b>VAG1598/31 test box, socket</b>
1 (Ground)	99
2 (signal)	106
3 (shielded)	108
<b>Knock sensor (KS) 2 -G66- (Bank 2)</b>	
<b>3-pin connector on wiring harness, socket</b>	<b>VAG1598/31 test box, socket</b>
1 (Ground)	99
2 (signal)	107
3 (shielded)	108

Resistance in wiring: max. 1.5 ohm

- Repair any open/short circuit as necessary.

## Camshaft Position (CMP) sensor 2 - G163- and Camshaft Position (CMP) sensor 1 -G40-, checking

### Notes:

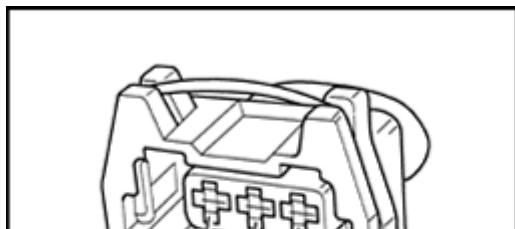
- ◆ *Component locations of CMP sensors ⇒ [Page 24-5](#).*
- ◆ *The Camshaft Position (CMP) sensor 2 -G163- is located at the rear of the left-hand cylinder head (Bank 2).*
- ◆ *The Camshaft Position (CMP) sensor 1 -G40- is located at the front of the right-hand cylinder head (Bank 1).*

### Checking activation of CMP sensor

Use test leads VAG1594 connector test kit when performing the following tests.

- Push back rubber grommet on relevant CMP sensor connector.
- Connect VAG1527 LED voltage tester to terminals 1 and 2 of CMP sensor connector from behind (without disconnecting connector from sensor).

### Note:



A

*The connector terminals are numbered on the back of the connector.*

- Operate starter for few seconds.

LED voltage tester should blink briefly once every two engine revolutions.

**Note:**

*LED voltage testers with a low current draw continue to glow faintly between impulses from the engine control module (rather than going out completely) and become much brighter when receiving an impulse.*

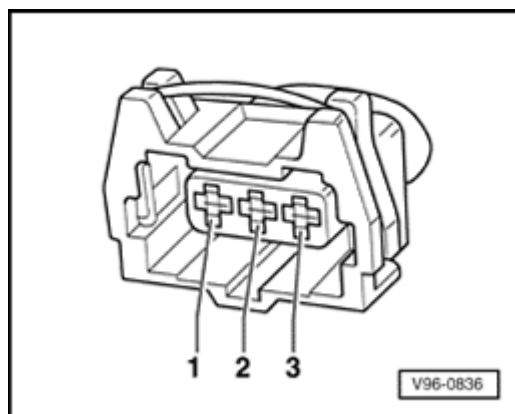
If the LED voltage tester does not blink:

- Check voltage supply.

**Checking voltage supply for CMP sensor**

- Disconnect harness connector from relevant CMP sensor.
- Switch ignition on.

28-61



A

- Connect multimeter (Fluke 83 or equivalent) (voltage measurement range) between engine Ground (GND) and socket 1 of connector.

Specification: approx. 5 V

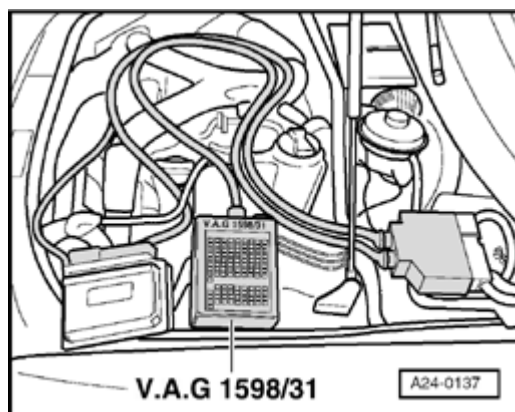
#### Checking signal wire for CMP sensor

- Connect multimeter (Fluke 83 or equivalent) (voltage measurement range) between engine Ground (GND) and socket 2 of relevant connector.

Specification: approx. battery voltage

#### Checking Ground (GND) wire for CMP sensor

- Connect VAG1598/31 test box to wiring harness for engine control module. Do not connect to engine control module itself ⇒ [Page 24-20](#) .



A

- Connect multimeter (Fluke 83 or equivalent) (resistance measurement range) between socket 3 on relevant connector and contact 108 of test box.

Specification: Continuity

Resistance in wiring: max. 1.5 Ohms



If all specifications are reached but the LED voltage tester does not blink (measurement taken between terminals 1 and 2 without unplugging connector and while operating starter):

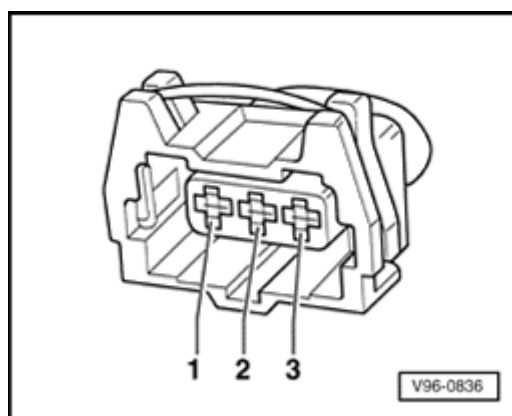
- Replace relevant CMP sensor.

If specifications are obtained:

- Check wiring.

#### Checking wiring between CMP sensor and Engine Control Module (ECM)

- Connect VAG1598/31 test box to wiring harness for engine control module. Do not connect to engine control module itself ⇒ [Page 24-20](#) .



A

- Check wiring connection from CMP sensor to engine control module for open circuit and/or short circuit to B+ or Ground (GND).

<b>Camshaft Position (CMP) sensor 2 -G163- (Bank 2)</b>	
<b>3-pin connector on wiring harness, socket</b>	<b>VAG1598/31 test box, socket</b>
1 (B+)	98
2 (signal)	86
3 (Ground (GND))	108
<b>Camshaft Position (CMP) sensor 1 -G40- (Bank 1)</b>	
<b>3-pin connector on wiring harness, socket</b>	<b>VAG1598/31 test box, socket</b>
1 (positive)	98
2 (signal)	87
3 (Ground (GND))	108

Resistance in wiring: max. 1.5 ohm

- Repair any open/short circuit as necessary.

If all the test results so far have been OK but a malfunction related to the camshaft position sensor (Hall sensor) is displayed again after erasing the DTC memory as a test measure, the following might be the cause:

- Rotor ring (trigger wheel) for camshaft position sensor (Hall sensor) misaligned; test phase position.

### Checking phase position of CMP sensor

- Connect vehicle diagnostic, testing and information system VAS5051 or VAG1551 scan tool and select engine electronics control module by entering address word "01" ⇒ [Page 01-8](#) . Engine must be idling.

Rapid data transfer

HELP

Select function XX



Indicated on display

- Press buttons -0- and -8- to select function "Read Measuring Value Block" and confirm entry with -Q- button.

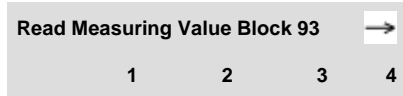
Read Measuring Value Block

Input display group number XXX



Indicated on display

- Press buttons -0-, -9- and -3- to select "display group 093" and confirm entry with -Q- button.



Indicated on display

- Check specified display values for CMP sensors.

	Display fields			
	1	2	3	4
<b>Display Group 093: Phase positions of Hall sensors (Bank 1 and Bank 2) with engine idling</b>				
<b>Display</b>	xxx RPM	xx %	$0 \pm 6^\circ$ KW	$0 \pm 6^\circ$ KW
<b>Indicates</b>	Engine speed (RPM)	Engine load	Phase position Bank 1	Phase position Bank 2
<b>Work range</b>	min.: 750 RPM max.: 6800 RPM	min.: 15 % max.: 175 %	-20.3 to 14.8 ° KW	-20.3 to 14.8 ° KW
<b>Specified value</b>	650 - 850 RPM	15...25%	$0 \pm 6^\circ$ KW	$0 \pm 6^\circ$ KW
<b>Note</b>			<p>If readouts do not match specifications, unbolt CMP sensor and check whether rotor ring is properly mounted on camshaft. If it is incorrectly mounted, the locating lug will be flattened when the securing bolt is tightened. Also check valve timing.</p> <p>⇒ <a href="#">Repair Manual, 2.7 Liter V6 5V BiTurbo Engine Mechanical, Engine Code(s): APB, BEL, Repair Group 13; Crankcase ventilation, Ribbed belt removing and installing, Timing belt removing and installing</a></p>	

## Misfire recognition, checking

### Test sequence

- Connect vehicle diagnostic, testing and information system VAS5051 or VAG1551 scan tool and select engine electronics control module by entering address word "01" ⇒ [Page 01-8](#) . Engine must be at idle.

Rapid data transfer      HELP  
Select function XX

↖ Indicated on display

- Press buttons -0- and -8- to select function "Read Measuring Value Block" and confirm entry with -Q- button.

Read Measuring Value Block  
Input display group number XXX

↖ Indicated on display

- Press buttons -0-, -1- and -4- to select "display group 014" and confirm entry with -Q- button.

Read Measuring Value Block 14      →  
1      2      3      4

↖ Indicated on display

- Check misfire recognition.

	Display fields			
	1	2	3	4
<b>Display Group 014: Misfire recognition</b>				
<b>Display</b>	xxx / RPM	xx.x %	xxx	---
<b>Indicated</b>	Engine speed (RPM)	Load	Total misfires	Misfire recognition
<b>Work range</b>	min.: 650 RPM max.: 6800 RPM	min.: 0 max.: 175		activated locked
<b>Specified value</b>	650 - 720 RPM	15.0 - 25.0 %	0...15	activated
<b>Note</b>	---	---	If specified value is not reached: Evaluation display field 3 ⇒ <a href="#">Page 28-68</a> see also ⇒ <a href="#">Page 28-69</a>	---

If specified value is reached:

- Press →button.



Indicated on display (select function)

Rapid Data Transfer	HELP
Select function XX	

**Evaluation display group 014, display field 3**

Display field: 3	Possible cause	Corrective action
greater than 15	<ul style="list-style-type: none"> <li>◆ Spark plug faulty</li> <li>◆ Spark plug connector faulty</li> <li>◆ Ignition coil or power output stage faulty</li> </ul>	<ul style="list-style-type: none"> <li>- Check spark plug and ignition cable with connector</li> <li>- Check ignition coil ⇒ <a href="#">Page 28-5</a> .</li> <li>- Check power output stages ⇒ <a href="#">Page 28-15</a></li> </ul>
	<ul style="list-style-type: none"> <li>◆ Fuel injector faulty</li> <li>◆ Crankshaft housing leaking</li>    <li>◆ Compression of one or more cylinders weak</li> </ul>	<ul style="list-style-type: none"> <li>- Check fuel injectors ⇒ <a href="#">Page 24-48</a></li> <li>- Check hose setup of crankcase ventilation for secure seating and proper seal.</li> <li>- Check compression pressure</li> </ul>

The following measuring value blocks display misfiring of individual cylinders:

	Display fields			
	1	2	3	4
<b>Display Group 015: Misfire recognition from cylinder 1, 2 and 3</b>				
<b>Display</b>	xxx	xxx	xxx	---
<b>Indicates</b>	Amount of misfires cylinder 1	Amount of misfires cylinder 2	Amount of misfires cylinder 3	<b>Misfire recognition</b>
<b>Work range</b>				<b>activated</b> <b>locked</b>
<b>Specified value</b>	0...15	0...15	0...15	<b>activated</b>
<b>Note</b>			If specification is not obtained: Evaluation ⇒ <a href="#">Page 28-71</a> .	---



28-70

	Display fields			
	1	2	3	4
<b>Display Group 016: Misfire recognition from cylinder 4, 5 and 6</b>				
<b>Display</b>	xxx	xxx	xxx	---
<b>Indicates</b>	Amount of misfires cylinder 4	Amount of misfires cylinder 5	Amount of misfires cylinder 6	<b>Misfire recognition</b>
<b>Work range</b>				<b>activated locked</b>
<b>Specified value</b>	0...15	0...15	0...15	<b>activated</b>
<b>Note</b>			<b>If specification is not obtained: Evaluation ⇒</b> <a href="#">Page 28-71</a> .	---

### Evaluation display groups 015 and 016

Display field: 1,2 and 3 from measuring value block 15 and 16	Possible cause	Corrective action
greater than 15	<ul style="list-style-type: none"> <li>◆ Spark plug faulty</li> <li>◆ Spark plug connector faulty</li> <li>◆ Ignition coil or power output stage faulty</li> </ul>	<ul style="list-style-type: none"> <li>- Check spark plug and ignition cable with connector</li> <li>- Check ignition coil ⇒ <a href="#">Page 28-5</a> .</li> <li>- Check power output stages ⇒ <a href="#">Page 28-15</a></li> </ul>
	<ul style="list-style-type: none"> <li>◆ Fuel injector faulty</li> <li>◆ Check compression of one or more cylinder weak</li> </ul>	<ul style="list-style-type: none"> <li>- Check fuel injectors ⇒ <a href="#">Page 24-48</a></li> <li>- Check compression pressure</li> </ul>