

Computerized Engine Controls

BMW MOTRONIC EMISSION CONTROL SYSTEM

528e, 633CSi, 733i

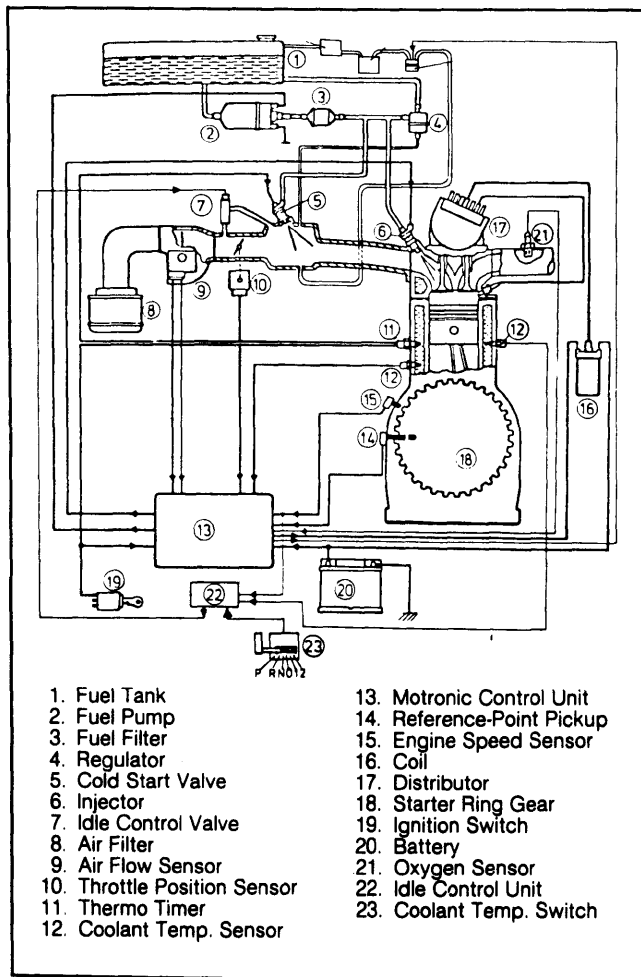
DESCRIPTION

The Motronic Emission Control System is an electronically controlled, computerized engine system which controls fuel injection and ignition timing as well as air/fuel ratio. It is used on all models except 320i.

The Motronic Control Unit (MCU) is the "brain" of the system. Various data sensors supply the MCU with operating information including air flow, air temperature, throttle position, coolant temperature, engine speed, piston position and oxygen content of exhaust gases.

The MCU uses this information to determine engine operating conditions, and adjusts timing and fuel ratio accordingly. The MCU is located behind the speaker in the right kick panel of 633CSi and 733i models and in the glove compartment of the 528e.

Fig. 1: Motronic Emission Control System Schematic



OPERATION

MOTRONIC CONTROL UNIT (MCU)

The MCU receives electronic input signals from several engine sensors. Information supplied by these sensors is used to determine optimum ignition and fuel injection timing under various engine operating conditions.

An ideal air/fuel ratio of 14:1 is maintained under most driving conditions. This is the ratio at which the catalytic converter operates most efficiently to reduce exhaust emissions.

DATA SENSORS

Oxygen Sensor

Oxygen content of exhaust gases is detected by the oxygen sensor located in the exhaust manifold. This sensor converts the percentage of oxygen present in exhaust gases into an electrical signal which is transmitted to the MCU. MCU uses this information to determine air/fuel ratio and adjusts injection pulse width to obtain the desired 14:1 ratio.

Air Flow Sensor

Intake air flow is detected by the air flow sensor. It is located in the intake passage between the air filter and the intake manifold and informs the MCU of rate of air intake.

Incorporated into the air flow sensor is the air temperature sensor. This sensor informs the MCU of ambient temperature of incoming air.

Throttle Position Sensor

The throttle position sensor is located on the throttle linkage at the intake butterfly valve where it detects position of the throttle valve. This information is converted into an electrical signal and sent to the MCU. The MCU interprets the signal as either full throttle, idle or normal operating condition and makes adjustments accordingly.

Engine Speed Sensor

The engine speed sensor (ESS) is mounted on the bellhousing, adjacent to the starter ring gear. A steel ball, embedded in the ring gear, causes an electronic pulse in the ESS with each engine revolution. These pulses are converted into an electrical signal which is sent to the MCU. The MCU uses this information to determine engine RPM.

Reference Point Pick-Up Sensor

This sensor is located in the bellhousing, next to the ESS. It supplies the MCU with piston position information. When the MCU has determined optimum ignition timing (based on input from various sources) information supplied by the reference point pick-up sensor is used to signal ignition firing.

Coolant Temperature Sensors

There are 3 components which supply coolant temperature information to the MCU. They are the coolant temperature switch, coolant temperature sensor and the thermo timer. All 3 devices are located in the water jacket of the engine block.

These devices supply coolant temperature information to the MCU in the form of electrical signals. The MCU interprets these signals as cold or normal operating temperatures. When the MCU has determined optimum ignition timing (based on input from various sources) information supplied by the reference point pick-up sensor is used to signal ignition firing.

During cold operating conditions, the air/fuel mixture is enriched by the cold start valve. This valve is located in the intake manifold, downstream from the butterfly valve. It supplies additional fuel to the inlet charge when signaled by the MCU. Extra rich conditions are maintained until normal operating temperature is attained.

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TESTING

NOTE: All test procedures are from 528e information. 633CSi and 733i information not available.

PRELIMINARY TESTING

The Motronic system may be suspected when problems arise which are related to driveability, fuel economy or excess emissions. However, before beginning diagnosis ensure that all other systems are operating properly.

Any engine system which would normally be checked in a vehicle not equipped with the Motronic system should be checked and approved before beginning Motronic testing. When all other engine systems have been checked out, Motronic diagnosis may begin.

Determine which component or area is the most probable source of performance difficulty and begin testing there. Many component failures may be traced to faults in the wiring circuit. Therefore, before beginning other diagnostic procedures, check the appropriate circuit for breaks or shorts and be sure that all electrical connections are clean and tight.

TEST EQUIPMENT

In addition to a standard volt/ohm meter, jumper wires and connectors, some special testing equipment is required for proper diagnosis of the Motronic system. The "BMW Service Test" kit, Bosch L-Jetronic Fuel Injection testing procedures, and BMW Test Meter 22 13 100 are required to properly test Motronic systems.

This equipment will be referred to throughout the following test procedures and must be used as indicated. Failure to do so may result in unnecessary replacement of good component parts.

TEST 1: FUEL PRESSURE

No Fuel Pressure

1) Check fuel pump fuse and replace if broken.

If fuse is okay, pull off electrical connector on fuel pump. Connect voltmeter between the 2 wires in connector and start engine. Voltmeter should read battery voltage. If voltage is correct, replace pump.

2) If voltage reading is incorrect, check ground (Brown) wire: Connect ohmmeter between wire and ground. Resistance should be zero. If not, repair wire. If resistance is correct, check power (Green/Violet) wire: Disconnect Relay 1 and connect ohmmeter between power wire and connector 87 of relay socket. Resistance should be zero. If value is incorrect, repair wire.

3) If resistance is correct, check power supply from Relay 1: Connect voltmeter between wire 30 (Green/Yellow) on relay socket and ground. Turn ignition on. Meter should read battery voltage. If not, repair wire.

4) If voltage is correct, check power supply to Relay 1: Connect voltmeter between wire 86 (Red/White) of plug and ground. Start engine. Voltmeter should show battery voltage. If not, connect a voltmeter between wire 87 (Red/White) of Relay 2 and ground (relay still connected). Turn on ignition. Voltmeter should read battery voltage. If reading is incorrect, repair wire.

5) If power supply to Relay 1 is correct, check Relay 1 ground: Connect ohmmeter between wire 85 (Brown/Green) on socket and ground. Start engine.

Resistance should be about zero. If resistance is correct, replace Relay 1.

6) If voltage in last part of step 4) is correct, or if resistance is incorrect in step 5), check resistance of Brown/Green wire between connector 85 on Relay 1 plug and pin 20 of MCU connector. Resistance should be about zero. If not, repair wire. If resistance is correct, go to Test 3 for Motronic Control Unit.

Fuel Pressure Too High

1) Check the vacuum connection of the fuel pressure regulator and vacuum hoses for leaks or kinks. Repair or replace as needed.

2) Check for defective pressure regulator and replace if faulty. Check the fuel return line for bends, pinches or clogs. Repair or replace as needed.

Fuel Pressure Too Low

Fuel feed is probably restricted. Check for kinked, bent or clogged fuel line. Repair or re-route as needed. Check fuel filter for excessive restriction and replace if dirty. Clean filter screen in fuel intake. Check pressure regulator operation and replace if defective.

TEST 2: FUEL INJECTORS

1) Check for fuel delivery at injectors. If one or more injectors is not operating correctly, start engine and check for movement of needles in injectors. Movement can be felt with finger.

2) If no movement is detected, check power lines and coil of fuel injectors according to procedures in BMW Service Test, L-Jetronic step 5. If test value is incorrect, check wiring for shorts, breaks or poor connections and repair as needed. If wiring is okay, replace defective fuel injectors.

3) If test value is correct, check power supply to injectors: Connect a voltmeter between wire 87 (Red/Blue) on Relay 2 and ground (relay plugged in). Meter should read battery voltage. If not, go to Test 3 for Motronic Control Unit.

4) If voltage is correct, check activation of injectors (BMW Service Test, L-Jetronic step 2). If test value is incorrect, replace MCU.

TEST 3: MOTRONIC CONTROL UNIT

1) Check power supply to Motronic Control Unit (MCU): Connect BMW Service Test unit and perform L-Jetronic Test step 1. If values are correct, replace MCU.

2) If voltage value between wire 18/35 and 5, or 4 and 5 is insufficient or incorrect, connect voltmeter between wire 4 on disconnected MCU plug and ground. Start engine. If voltmeter does not show battery voltage, trace circuit and repair wiring. See Fig. 2.

3) Check wire 18 and 35 for breaks or poor connections. Connect ohmmeter between wire 5 on MCU plug and ground. Resistance should be zero. Connect ohmmeter between wire 18 or 35 on MCU plug, and wire 87 on plug of Relay 2. Resistance should be zero. If either test shows resistance, repair wiring.

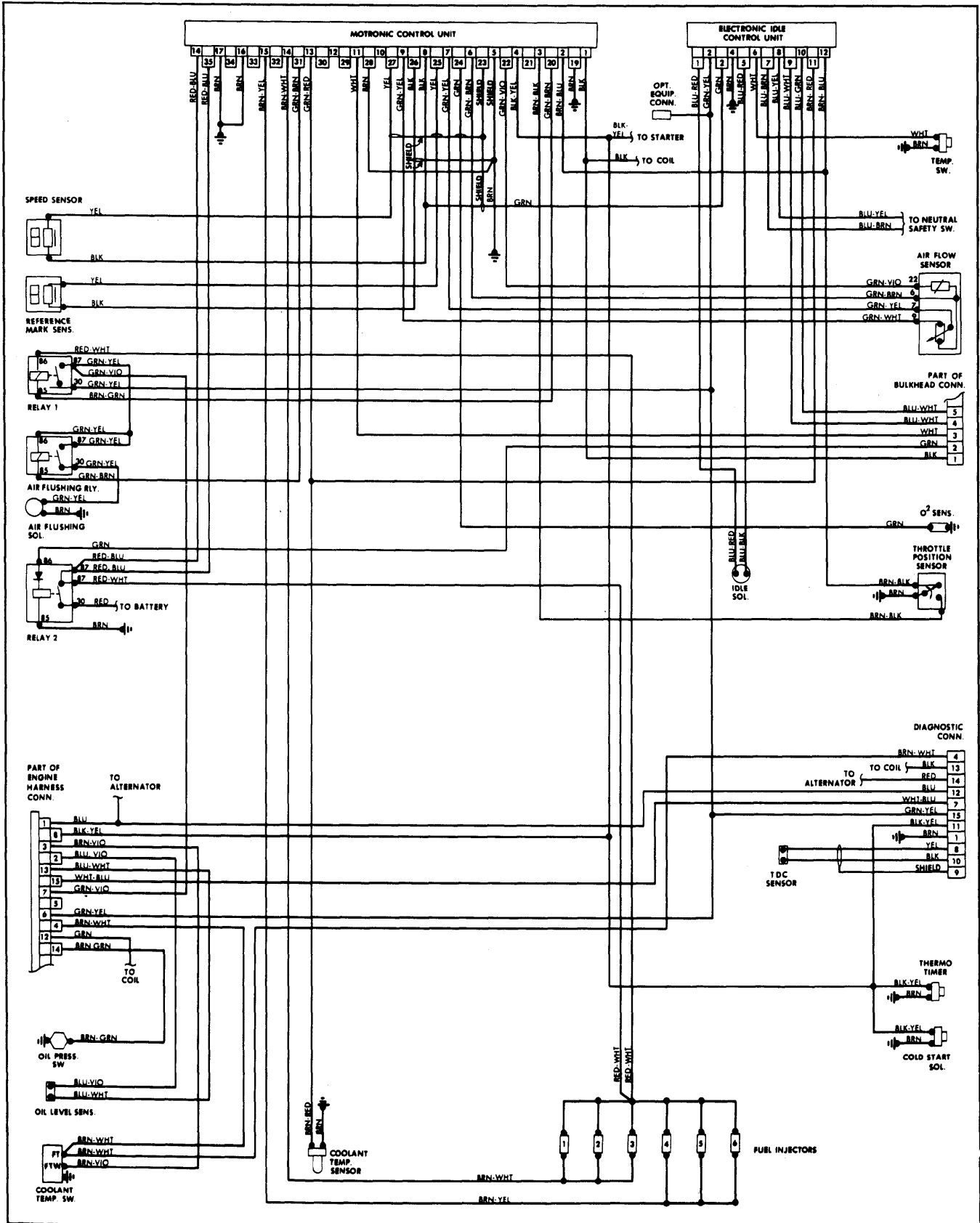
4) If resistance values are correct, check power supply to Relay 2: Disconnect Relay 1 and connect voltmeter between terminal 86 on relay socket and ground. Turn ignition on. Voltmeter should read battery voltage. If not, trace circuit and repair wiring. See Fig. 2.

5) If voltage is correct, check ground of Relay 2: Pull off relay and check resistance between connector 85 and ground. Resistance should be zero. If not, trace circuit and repair wiring. See Fig. 2.

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Fig. 2: BMW Motronic Emission Control System Wiring Diagram



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6) If resistance is correct, check power supply of Relay 2: Pull off relay and connect voltmeter between connector 30 of relay socket and ground. Voltmeter should read battery voltage. If not, trace circuit and repair wiring. If voltage reading is correct, replace Relay 2.

TEST 4: COLD START VALVE

Valve Does Not Open

1) Remove valve, leaving fuel lines connected. Supply battery voltage to valve with jumper wire and be sure valve is properly grounded. Pull off Relay 1. Apply battery voltage to connector 87 in relay plug and check that fuel pump runs. Cold start valve should deliver fuel. If not, replace valve.

2) If valve functions properly, check power supply to valve: Pull plug off valve and connect voltmeter between wires of plug. Start engine. Meter should read battery voltage while cranking engine. If not, trace circuit and repair wiring. See Fig. 2.

3) Check thermo timer as in Test 12 and replace if resistance values are not correct.

Valve Leaks

Check valve operation as in first cold start valve test. If valve operates properly (fuel is delivered), remove jumper wire to battery voltage and check that fuel delivery stops. If fuel is still delivered, or leaks or seeps out, replace valve.

TEST 5: IDLE CONTROL VALVE

1) Valve should be open when vehicle is at rest (no voltage to valve). When voltage is applied to valve (engine on), valve should close. Remove 2 valve hoses and observe valve operation. If valve does not operate as described, replace valve.

2) If valve operates properly, pull off connector plug and connect voltmeter between the 2 wires in plug. Start engine and turn A/C on. Voltmeter should read battery voltage. If it does not, see Test 6 for idle control unit.

TEST 6: IDLE CONTROL UNIT

1) Check power supply to idle control unit (ICU): Pull connector plug off of ICU and connect voltmeter between terminal 2 of plug and ground. Start engine. Voltmeter should read battery voltage. If not, repair circuit.

2) If voltage is correct, check ground connection of ICU: Connect ohmmeter between terminal 4 of plug and ground. Ohmmeter should read zero. If not, trace circuit and repair wiring.

3) If resistance is correct, check speed signal to ICU at terminal 3 of plug with BMW test meter (22 13 100). If signal is not correct, trace circuit and repair wiring.

4) If signal is correct, check for ground at terminal 6 of ICU: connect ohmmeter between terminal 6 of ICU plug and ground. With coolant temperature below 106°F (41°C), resistance should be zero. With coolant temperature above 117°F (47°C), resistance should be infinite. If values are incorrect, check coolant temperature switch. See Test 11. If switch is good, trace idle control unit circuit and repair wiring. If resistance values are correct, go to next step.

5) On automatic transmission equipped vehicles, check for battery voltage at terminal 7 of plug with ignition on and transmission shift lever in "N". If voltage is absent, trace circuit and repair wiring. If voltage is present at terminal 7, check for battery voltage at terminal 8 with

shift lever in "P". If voltage is absent, trace circuit and repair wiring. If reading is correct, go to next step.

6) On vehicles with air conditioning, check for battery voltage at terminal 9 of plug with air conditioner "ON". Trace circuit and repair wiring if voltage is incorrect. If reading is correct, go to next step.

7) On all models, check for battery voltage at terminal 10 of ICU plug with ignition on. Voltage should be present with air temperature below 41°F (5°C), and absent at higher temperatures. If values are incorrect, check air temperature sensor. See Test 13. Replace if faulty. If sensor is okay, repair wiring.

8) If voltage readings are correct, check for ground at terminal 12 of ICU: Connect ohmmeter between terminal 12 of plug and ground. Resistance should be zero with throttle closed, and infinite with throttle open. If values are incorrect, check throttle position sensor. See Test 9. Replace or adjust as needed. If switch is good, repair wiring.

9) If resistance values are correct, check ground connection at terminal 11 of ICU: Connect ohmmeter between terminal 11 and ground. Resistance value should be zero. If not, check coolant temperature sensor. See Test 10. Replace sensor if faulty. If sensor is good, repair wiring.

10) If resistance values are correct, and idle control valve is good (Test 5), replace idle control unit.

TEST 7: ENGINE SPEED SENSOR & REFERENCE POINT PICK-UP

1) Check sensor and pickup general condition. Ensure that they are installed in the proper position and firmly seated. Electrical contacts must be clean and tight. Check that sensor plugs are not reversed. Plugs are color coded for identification.

2) Install BMW test meter (22 13 100). Connect terminals 8 and 27 and check for speed signal. Connect terminals 25 and 26 and check for reference signal. If signals are not correct, repair wiring. Remove terminal connections and recheck signals. If either signal is absent, replace sensor and/or pick-up as needed.

TEST 8: AIR FLOW SENSOR

1) Check that sensor is properly installed and firmly seated. Ensure that sensor plate moves freely.

2) Run L-Jetronic test 4 to check air flow value. If value is incorrect, repair wiring. Check resistance at terminals 7 and 9 of sensor. Resistance should be checked with sensor plate in several different positions.

TEST 9: THROTTLE POSITION SENSOR

Check that sensor is properly installed and firmly seated. Run L-Jetronic Test 3 to determine throttle sensor values. If values are incorrect, adjust or replace sensor as needed.

TEST 10: COOLANT TEMP. SENSOR

Check that sensor is properly installed and firmly seated. Check that cooling system is full. Bleed system. Check resistance between switch connections. If resistance is incorrect, replace sensor. If resistance is correct, trace sensor circuit and repair wiring.

TEST 11: COOLANT TEMP. SWITCH

Switch must be tightly installed. Check that cooling system is full. Bleed system. Check resistance

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between switch contacts. Resistance below 106°F (41°C) should be zero. At higher temperatures, resistance should be infinite. If values are correct, trace circuit and repair wiring. If values are incorrect, replace switch.

TEST 12: THERMO TIMER

1) Check that timer is properly installed and firmly seated. Check radiator for correct coolant level. Bleed cooling system.

2) Disconnect timer and check resistance values between plug terminals "G" and "W", "G" and ground, and "W" and ground. If values are correct, trace timer circuit and repair wiring. If values are incorrect, replace timer. See *Thermo Timer Resistance Specifications*.

THERMO TIMER SPECIFICATIONS

Circuit Tested	Ohms
G to Ground	40-70
G to W & W to Ground	
Above 60°F (15°C)	Infinite
Below 60°F (15°C)	Zero

TEST 13: AIR TEMPERATURE SENSOR

1) Check electrical connections on sensor. Use L-Jetronic test 4 to check Air Temperature Sensor values. If values are incorrect, remove connector from sensor and attach ohmmeter. Check resistance between terminals 22 and 6 and compare with table. See *Air Temp. Sensor Resistance Specifications*.

2) If resistance values are correct, trace sensor circuit and repair wiring. If values are incorrect, replace air flow sensor.

AIR TEMP. SENSOR SPECIFICATIONS

Air Temperature °F (°C)	Ohms
66-70 (19-21)	2280-2720
120-124 (49-51)	760-910

MAINTENANCE

OXYGEN SENSOR

1) After 30,000 miles of vehicle operation, a warning light in the dash will come on, indicating that oxygen sensor servicing is required. Trace wire from oxygen sensor to plug and disconnect. On 528e, pull off protective metal plate.

2) On all models, remove oxygen sensor. With a light coat of copper paste applied to threads, install new sensor. On all except 528e, reset interval switch by pressing White button. On 528e, switch cannot be reset. Bulb must be removed from display panel to deactivate oxygen light.