FUEL INJECTION SYSTEM - BOSCH CIS-E
1986 Fuel Systems MERCEDES-BENZ CIS-E ELECTRONIC CONTROL SYSTEM
DESCRIPTION

The fuel injection system used on all Mercedes-Benz gasoline engine vehicles uses a basic CIS injection system for fuel delivery and electronic controls for mixture correction functions.

Electronic controls consist of airflow sensor position indicator (potentiometer), electro-hydraulic actuator, thermo time switch, coolant temperature sensor, Electronic Control Unit (ECU), transistorized ignition system, throttle valve microswitch, altitude sensor, lambda control and oxygen sensor.

If ECU malfunctions, CIS-E system will operate in back-up or "limp-home" mode until fuel system can be repaired. The failure codes are transmitted to the lambda measuring circuit of the diagnostic socket. These codes are displayed on a Bosch "On-Off" Ratio Tester (KDJE-P600). The fixed on-off ratio indicates possible malfunctions.

The EZL electronic breakerless ignition system has computer controlled electronic ignition timing (firing point) adjustment. Data about ignition characteristics for various engine loads is stored in the ignition control module and can be recalled according to actual engine operating conditions.

Fig. 1: CIS-E Fuel Injection Layout (190E/16)

Fig. 2: CIS-E Fuel Injection Layout (300E)

Fig. 3: CIS-E Fuel Injection Layout (420 & 560)
OPERATION
ON-BOARD DIAGNOSTIC READOUT SYSTEM

Various components of the CIS-E injection system are checked by a microprocessor in the control unit. The failure codes are transmitted by the lambda measuring circuit of the diagnostic socket and are displayed on the Bosch On-Off Ratio Tester (KDJE-P600).
FUEL PUMP RELAY

The fuel pump relay on 560 SL models is located behind the glove compartment. For 420 and all other 560 series, the relay is located on the left rear side of the engine compartment, in the relay component compartment. For 190E, 190E/16 and 300E series, the fuel pump relay is located in the engine compartment on the right rear firewall.

The fuel pump relay has the following functions: cold start valve activation, rpm limitation and kick-down shutoff.
COLD START VALVE ACTIVATION

Cold start valve operation depends on coolant temperature and cranking speed signal. Voltage is supplied by the fuel pump relay. The length of time during which the cold start valve injects fuel is

dependent on the coolant temperature.

If the engine starts before the cold-start valve completes its cycle, cold start injection is canceled.

FUEL ENRICHMENT

Cranking Enrichment

During cranking, enrichment signal is provided by terminal No. 50 of the enrichment circuit. The amount of enrichment depends on coolant temperature. A timing element regulates enrichment after one second to a basic warm-up value.The enrichment value will remain constant during cranking procedure.

After-Start Enrichment

This phase allows smooth running characteristics immediately after 1/2starting. When engine cranking is stopped, regulation of after-start enrichment begins. Enrichment will drop to basic warm-up value, which varies with temperature. Amount and duration of after-start enrichment depends on coolant temperature.

Warm-Up Enrichment

Fuel enrichment depends on coolant temperature. Lower coolant temperature results in higher current at actuator. This will provide greater fuel enrichment.

Maximum Engine Speed

ECU senses engine speed based on impulses from "TD" terminal of the ignition switching unit. Engine speed is limited by changing current to the differential pressure regulator from ECU. Lower chamber pressure is increased to system pressure and fuel supply to injection valves is interrupted.

Altitude Correction

Depending on altitude, the amount of fuel is changed based on a signal from the altitude correction capsule. With the ignition on or with the engine running, the altitude correction capsule will receive a constant voltage signal (about 5 volts) from the control unit.

If ECU operates in a fixed mode, correction for altitude will not take place. With increasing altitude (decreasing air pressure), the mixture will be leaned for that particular altitude by a reduction of voltage.

MAXIMUM RPM LIMITATION

If the fuel pump relay receives the number impulses corresponding to the maximum engine RPM, the contact between circuit 30 and 87 is interrupted and the fuel pump is turned off.

FUEL PUMP

The 420 and 560 models are equipped with 2 fuel pumps. All other models use one pump. On all models, the fuel pumps are located in front of the rear axle on the right side on the frame floor.

On all models, a diaphragm damper is integrated in the fuel pumps. On 420 and 560 models, the diaphragm damper is integrated in the fuel pump on the suction side.

DIAPHRAGM PRESSURE REGULATOR

The diaphragm pressure regulator keeps system pressure at 84 psi (5.8 bar). Pressure is set by the manufacturer and cannot be adjusted.

FUEL DISTRIBUTOR UNIT

Fuel is metered and delivered to individual cylinders dependent on air intake quantity which is metered by airflow sensor plate. FDU consists of fuel distributor with differential pressure regulator and airflow sensor plate with potentiometer (sensor position indicator).

COOLANT TEMPERATURE SENSOR

The coolant temperature sensor is located in the left cylinder head. The sensor has a 2-pin connector, one for Electronic Ignition System (EZL) and one for the CIS-E injection system.

ELECTRONIC CONTROL UNIT (ECU)

On 190 series, the ECU is located on right side of engine on the firewall. On 300E models the ECU is located in the component compartment on the right side. On 420 and 560 sedan models the ECU is located behind the right kick panel on the passenger side. On 560 SL models the ECU is located under the right kick panel on the passenger side.

With ignition switched on, the ECU is connected to battery voltage. To prevent voltage fluctuations when vehicle components are switched on, the ECU is provided with a voltage protection relay.

The ECU unit utilizes various input signals for control of fuel delivery and exhaust emissions. Input signals are converted into corresponding current values and are sent to the differential pressure regulator and to idle speed air valve.

IDLE SPEED CONTROL UNIT

The idle speed control unit processes the following information: engine speed signal (ignition terminal TD), coolant temperature, idle speed signal (throttle valve switch), vehicle speed signal (speedometer), automatic transmission shift lever position and A/C compressor cut-in signal.

At idle speed with the vehicle stationary (speed signal zero), the idle speed control unit scans the momentary input signals. From these signals, the microprocessor calculates the mean airflow volume and adjusts the control current to the idle speed air valve accordingly. In addition, the total control range is readjusted to the new control current so that the maximun control range is available when the engine load is increased.

IDLE SPEED AIR VALVE

190 & 300E Series

The idle speed air valve has the following functions:

* The electronic control unit supplies a specific voltage to the air valve which determines the respective valve opening and thereby the engine speed.
* The nominal idle speed is controlled depending on temperature, between 1200 RPM at about -23°F (-30°C) to 900 RPM at 158°F (70°C).
* With the ignition switched on (engine not running) the idle speed air valve is activated by a specific voltage. The port for the fixed operating mode is closed and the control port is opened.
* If the voltage supply fails, the port for the fixed operating mode is opened automatically.

420 & 560 Series

The idle speed air valve is an electro-magnetic disc valve. It has a 2-pin electrical connector. The idle speed air valve has the following functions:

* Without voltage, the valve is fully open. With the ignition turned on, the valve is also fully open.
* At idle speed (depending on engine load), the idle speed control unit supplies a current of less than 1000 mA to the idle speed air valve. This current determines the opening cross section and thereby the idle speed.
* The idle speed is controlled in steps depending on the coolant temperature.
* The idle speed air valve by-pass is open for the 420 engine and closed on the 560 engine.

VOLTAGE PROTECTION RELAY (VPR)

Voltage protection relay is used to protect the ECU from excessive voltage. There is a 10-amp fuse installed on top of the VPR, which is located on relay board at right side of engine compartment.

When ignition is switched on, terminal No. 15 receives battery voltage. Relay is activated and ECU is provided with battery voltage from terminal No. 87.

OXYGEN SENSOR

The oxygen sensor is heated to obtain a constant operating temperature of the sensor. The heating element receives voltage from terminal No. 87 of the fuel pump relay and is heated as long as the fuel pump operates.

The oxygen sensor system uses a malfunction indicator, which is located on the instrument panel. The malfunction indicator light will come on if a malfunction is present in the oxygen sensor circuit. The oxygen sensor malfunction indicator light receives voltage from the CIS-E control unit.

There are 2 versions of the malfunction light:

* Version 1: Lights up briefly when starting the engine.
* Version 2: Lights up as soon as the ignition is switched on and goes out when the engine is started. If an oxygen sensor failure is present, the malfunction indicator lights up after about 5 minutes of engine operation.

LAMBDA CONTROL

Lambda control is integrated in ECU and monitors input signals from sensors. After input signals are amplified, output signals for differential pressure regulator are determined.

Control range of differential pressure regulator current is 0-16 mA. Mean value at which control takes place is 8 mA.

Lambda control is made inoperative by signal from ECU under these conditions:

* Oxygen sensor not ready for operation or is defective.
* During deceleration shut-off.

* Under full load conditions.
* During acceleration enrichment or when starting engine at coolant temperatures below 60°F (15°C) until coolant temperature reaches 105°F (40°C).

CAUTION: With ignition turned on or the engine running, the plug on the CIS-E control unit must not be disconnected. Voltage or current peaks can destroy the control unit.

LOGIC CIRCUIT

Input signals from various sensors and switches are continuously monitored by the electronic control unit. With engine at operating temperature, a rapid temperature change is simulated by unplugging the coolant temperature sensor. The microprocessor in the control unit will compare this momentary temperature with the temperarture in its memory.

The control unit will recognize the abrupt temperature change as an open circuit, and is programmed to change the fixed operating mode. The control unit does not recognize gradual changes as malfunctions, and will continue to operate normally.

FIXED OPERATING MODE

In the event of an illogical signal received by the control unit (system malfunction, open or circuit) the control unit will automatically revert to a fixed operating mode. This means that the engine will continue to run but not at its optimum, electronically controlled performance level.

EZL IGNITION OPERATION

The ignition control module stores a number of ignition characteristics for typical engine load speed ranges, idle speed ignition, and full load ignition characteristics. The ignition timing is selected from values stored in the control module based on input regarding intake manifold vacuum, coolant temperature, engine speed and throttle valve position.

Activation of the electronic ignition system is by the position indicator, which senses 3 segments on the flywheel/flexplate which are offset 120°. The ignition control module recognizes the segment front edge as a negative signal and the rear edge as a positive signal.

When starting the engine, the ignition timing is fixed up to about 270 RPM through the rear edge of the segments. The transition from the fixed ignition timing to the computed timing (corresponding to operating conditions at the moment) takes place above 270 RPM.

The intake manifold vacuum sensor in the ignition control module senses the momentary load condition of the engine and makes the necessary adjustments. During warm-up, different ignition characteristics are blocked, depending on coolant temperature.

Ignition Control Module

The ignition control modules are made by Bosch and Siemens Corporations. The ignition control module has a microprocessor, and an intake manifold vacuum sensor.

Position Indicator

The position indicator (inductance transmitter) transmits an AC voltage signal for controlling the ignition timing (firing point) to the ignition control module depending on segment position on the

flywheel or flex plate.
Flywheel or Flexplate Segments

There are 3 segments (offset by 120°) on the flexplate or flywheel which are used for controlling ignition timing.
Coolant Temperature Sensor

The coolant temperature sensor is located on the side of the cylinder head. A 2-pin coolant temperature sensor is used for the ignition system and CIS-E injection system. Depending on coolant temperature, the sensor transmits a resistance value to the ignition control module where the respective ignition characteristics are processed.
Throttle Valve Switch

The throttle valve switch has idle and full load contacts. The idle contact controls the following: ignition at idle, ignition at deceleration and acceleration enrichment. The full load contact controls the fuel injection system.
High Voltage Distributor

The high voltage distributor is attached to the front cover of the cylinder head and is driven directly from the camshaft.
DIAGNOSTIC TESTING - 420 & 560 SERIES
TEST 1
Testing Voltage Supply to CIS-E Control Unit

1. Unplug CIS-E control unit. Turn on ignition and check voltage between terminal No. 1 (+) and terminal 2 (-). Voltage should be about 12 volts. If voltage is okay, check on-off ratio and oxygen sensor signal and adjust if necessary. If voltage is not okay, go to step 2).
2. Check voltage between terminal No. 1 (+) and ground (battery). Voltage should be about 12 volts. If voltage is not okay, check fuse on overvoltage protection relay. Check wire connections and wire routing according to wiring diagram. If voltage is okay, go to step 3).
3. Check wire from terminal No. 2 to ground for continuity. Resistance should be about zero ohms. If not okay, repair interruption. If okay, go to step 4).
4. Check wire between diagnostic socket, terminal No. 3 and CIS-E control unit plug (terminal No. 23) for continuity. Resistance should be zero ohms. If okay, go to step 5). If not okay, repair interruption.
5. Disconnect oxygen sensor plug and connect male part of plug to ground. Start engine. Test sensor voltage between female part of plug and ground. Voltage should be above 450 mV. If not okay, replace oxygen sensor. If okay, test is complete.

TEST 2
Testing Airflow Sensor Position Indicator

1. Loosen plug of airflow sensor position indicator so that voltage can be measured at the pins (do not disconnect plug). Start engine. Voltage at terminals No. 1-3 should be 4.5-5.5 volts. Voltage at terminals No. 1-2 should be .5-1.5 volts. If okay, go to step 2). If not okay, go to step 3).
2. Stop engine and turn on ignition. Slowly deflect airflow sensor plate. Measure voltage between terminals No. 1 and 2. Voltage should increase steadily to 4.5-5.5 volts. If not okay, replace airflow

sensor. If okay, test is complete.
3. Stop engine. Check wires between airflow sensor position indicator and CIS-E control unit plug for continuity. Check wire routing according to wiring diagram. Resistance should be about zero ohms. If okay, go to step 4). If not okay, repair interruptions.
4. Start engine. Run at idle speed (engine at operating temperature). Check on-off ratio at diagnostic socket, tester needle should oscillate. If not okay, check diagnostic socket. If okay, test is complete.

TEST 3
Testing Full Load Contact & Airflow Sensor Position Indicator

1. Disconnect plug of throttle valve switch. Measure resistance between terminals No. 3 and 2. The full load contact at idle position, should be infinity ohms. At full load, the full load contact should read about zero ohms. At partial load, the full load contact should read infinity. If not okay, adjust or replace throttle valve switch. If okay, go to step 2). See Fig. 4 .

Fig. 4: View of Throttle Valve Switch Plug
2. Check continuity of wires from throttle valve switch to CIS-E control unit and to engine ground. Resistance should be about zero ohms. If not okay, repair interruption. If okay, check airflow sensor position indicator.

TEST 4
Testing Coolant Temperature Sensor

1. Unplug coolant temperature sensor. Test resistance from sensor terminal to ground (idle speed okay with connection to ground or too high with interruption). For nominal value see OHM RESISTANCE CHART. If not okay, replace coolant temperature sensor. If okay, go to step 2). See Fig. 5 .

Fig. 5: Coolant Temperature Sensor Resistance
2. Check wire (Green/Red) between terminal No. 21 of CIS-E control unit plug to plug of coolant temperature sensor for continuity. Resistance should be about zero ohms. If not okay, repair interruption. If okay, test is complete.

TEST 5
Testing Airflow Sensor Position Indicator

1. Loosen plug of airflow sensor position indicator so that the voltage can be measured at the pins (do not disconnect plug). Start engine. Voltage at terminals No. 1-3 should be 4.5-5.5 volts. Voltage at terminals No. 1-2 should be .5-1.5 volts. If not okay, go to step 3). If okay, go to step 2).
2. Stop engine and turn on ignition. Slowly deflect airflow sensor plate. Measure voltage between terminals No. 1 and 2. Voltage should increase continuously to 4.5-5.5 volts. If not okay, replace airflow sensor. If okay, test is complete.
3. Stop engine. Check wires between airflow sensor position indicator and CIS-E control unit plug for continuity. Check wire routing according to wiring diagram. Resistance should be about zero ohms. If not okay, repair interruption. If okay, go to step 4).
4. Start engine. Run at idle speed (engine at operating temperature). Check on-off ratio at diagnostic socket. Tester needle should oscillate. If not okay, replace CIS-E control unit if necessary. If okay, test is complete.

TEST 6
Test Oxygen Sensor

NOTE: If oxygen sensor signal is not present, the oxygen sensor malfunction indicator on the instrument panel will light up.

1. Disconnect oxygen sensor plug and connect male part of plug to ground. Start engine. Test sensor voltage between female part of plug and ground. Sensor voltage should be around 450 mV. If not okay, replace oxygen sensor. If okay, go to step 2).
2. Stop engine. Check wire from oxygen sensor plug to CIS-E control unit (terminal No. 8) for continuity. Resistance should be about zero ohms. If not okay, repair interruption. If okay, test is complete.

TEST 7
Testing TD Signal

1. Disconnect CIS-E control unit plug. Start engine. Check voltage between terminal No. 25 (control unit plug) and ground. Voltage should be 6-12 volts. If not okay, go to step 2). If okay, test is complete.
2. Unplug fuel pump relay. Check wire between terminal No. 10 (relay plug) and terminal No. 25 on CIS-E control unit plug for continuity. Resistance should be zero ohms. If not okay, repair interruption. If okay, check wires to ignition control module for continuity.

TEST 8
Test Altitude Correction Capsule

1. Disconnect plug on altitude correction capsule. Turn on ignition. Check voltage between terminals No. 2 and 3. Voltage should be about 5 volts. If not okay, check power supply and ground according to wiring diagram. If okay, go to step 2).
2. Turn ignition off. Check wire between altitude correction capsule plug (terminal No. 1) to CIS-E control unit plug (terminal No. 11) for continuity. Resistance should be about zero ohms. If not okay, repair interruption. If okay, go to step 3).
3. Start engine and run at idle speed and at operating temperature. The on-off ratio needle should oscillate. If not okay, replace altitude correction capsule. If okay, test is complete.

TEST 9
Test On-Off Ratio

NOTE: If on-off ratio is 100% and idle speed is too high, check fuse on overvoltage protection relay and/or power supply and engine ground connection.

1. On-off ratio cannot be adjusted. If on-off ratio tester needle oscillates, go to step 2). If okay, test is complete.
2. Disconnect oxygen sensor plug and connect male part of plug to ground. Start engine and test sensor voltage between female part of plug and ground. Sensor voltage should be above 450 mV. If not okay, replace oxygen sensor. If not okay, go to step 3).
3. Stop engine. Check wire from oxygen sensor plug to CIS-E control unit (terminal No. 8) for

continuity. Resistance should be about zero ohms. If not okay, repair interruption. If okay, go to step 4).
4. Loosen plug of oxygen sensor heater so that voltage can be measured at the pins (DO NOT disconnect plug). Pull off fuel pump relay and bridge terminals No. 7 and 8. Reading should be about 12 volts. If not okay, repair interruption. If okay, go to step 5).
5. Unplug oxygen sensor heater plug. Connect Test Cable (102 589 04 63 00) with Adapter Plug (903 589 03 63 00). Measure current draw. Nominal value should be above .5 amps. If not okay, replace oxygen sensor. If okay, test is complete.

EZL IGNITION TESTING
Engine Not Running

1. Connect multimeter and Engine Tester (MCM-2110). Crank engine and check dwell angle. Nominal value should be 1-50% or 1-30° of dwell. If not okay, go to step 2). If okay, check ignition timing at cranking RPM. Timing should be about 1° BTDC. If not okay, go to step 4).
2. With ignition on, test voltage between terminal No. 5 of diagnostic socket (coil terminal No. 15) and ground. Nominal value should be 12 volts. If okay, go to step 3). If not okay, test voltage supply from ignition switch. Test voltage difference between terminals No. 5 and 4 of diagnostic socket (coil terminals No. 1 and 15). Nominal value should zero volts. Go to step 3).
3. Unplug ignition position indicator (Green wire) from ignition control module. Test resistance of sensor between connector terminals No. 7 and 31d with ohmmeter. Nominal value should be 730-910 ohms. If not okay, replace position indicator. If okay, go to step 4).
4. Measure dwell angle. If no dwell angle is indicated, replace ignition contol module.

Engine Running

1. Run engine at idle (operating temperature). Check ignition timing (firing point). Nominal value should be 7-11°. If not okay, go to step 2). If okay, go to step 4).
2. Pull plug from throttle valve switch connector. Test resistance of throttle valve switch on connector. Between terminals No. 1 and 2, idle speed position should be about zero ohms. Between terminals No. 2 and 3, full load position should be about zero ohms. Between terminals No. 1-2 and 2-3, partial load should be infinity ohms. If not okay, adjust or replace throttle valve switch. If okay, replace ignition control module.
3. Run engine at 3200 RPM. Check ignition timing (vacuum line connected). Nominal value should about 40-44° ATDC at 3200 RPM. If not okay, go to step 4). If okay, go to step 6).
4. Check vacuum line from intake manifold to ignition control module for leaks. If no leaks are present check resistance of reference resistor (EZL). Pull sensor signal input plug on ignition control module and check resistance with ohmmeter between connector terminal No. 3 and ground. Go to step 5).
5. Nominal value should be about 750 ohms. If the nominal value is obtained, replace ignition control module. If the nominal value is not obtained, check wire for interruptions or replace plug that has a resistor. Go to step 6).
6. Pull vacuum line from ignition control module and run engine at 3200 RPM. Check ignition timing. Nominal value should be about 27-31° at 3200 RPM. If okay, go to step 8). If not okay, go to step 7).
7. Unplug coolant temperature sensor. Test resistance from sensor terminal to ground. See Fig. 5 (Coolant Temperature Sensor Resistance chart). Test resistance at 2 different temperatures. If these

values are not okay, replace sensor. If values are okay, go to step 8).
8. Run engine at 3200 RPM (vacuum line connected). Check dwell angle. Nominal value should be 24-53°. If not okay, replace ignition control module. If okay, test is complete.

COMPONENT TESTING - 420 & 560 SERIES
LAMBDA CONTROL

1. With engine at operating temperature, pull off purge line to throttle valve housing. Plug valve line. Connect on-off ratio tester to diagnostic socket. Press "100%" IR button.
2. Test on-off ratio at 2500 RPM and read mean value. Compare this value with the idle speed value. The mean value at idle speed must be between 5-15% higher than the mean value measured at 2500 RPM. If not okay, go to step 3). If okay, test is complete.
3. If reading is constant, test oxygen sensor or repair interruption as necessary. See OXYGEN SENSOR test. If mean value is not 5 to 15% higher, adjust lambda control.

ELECTRONIC IDLE SPEED CONTROL

1. The idle speed control is independent of the airflow sensor position indicator. Run engine at operating temperature, with shift lever in position "P" or "N". Turn A/C compressor off.
2. Ensure air intake system has no air leaks. Check that idle speed contact, coolant temperature sensor and EGR system are functioning properly. At altitudes above 2000 feet, the current draw can fall below 700 mA.
3. Connect Test Cable (102 589 04 63 00) to idle speed air valve. Set multimeter to mA scale. Connect tachometer and start engine.
4. With idle speed set at 675 RPM. Current draw should be 700-1000 mA, if not, perform idle speed stabilization check. See ENGINE IDLE SPEED STABILIZATION. With idle at 675 RPM, current draw should be 70-700 mA. If not within specifications, enlarge air by-pass bore (420 engine only). See Fig. 6 .

Fig. 6: Idle Speed Control Unit Plug
5. If idle speed is too high, stop engine. Unplug idle speed control unit. Check wires between idle speed air valve and idle speed control unit for continuity. Resistance should about zero ohms. If not okay, repair interruption as necessary. If okay, go to step 6).
6. Check resistance of idle speed air valve. Resistance should be 3.5-4.5 ohms. If not okay, replace idle speed air valve. If okay, turn on ignition. Check voltage between terminals No. 9 and 11 of idle speed control unit plug. Voltage should about 12 volts. If not okay, check power supply and ground connection. If okay, replace idle speed control unit.

ENGINE IDLE SPEED STABILIZATION

1. With engine at idle speed and operating temperature, place selector lever in a driving position. On 420 engine, idle speed should be about 575 RPM. On 560 engine, idle speed should about 525 RPM. If not okay, go to step 2). If okay, test is complete.
2. Check input signal to idle speed control unit (between terminal No. 12 and battery. With selector lever in "P" or "N", engage into a driving position ("D"). Voltage should drop. If not okay, repair wire interruption. If okay, test is complete.
3. With engine at idle speed and operating temperature, turn A/C compressor on. Place selector lever

in "P" or "N" position. On 420 and 560 engine, idle speed should be about 675 RPM. If not okay, go to step 4). If okay, test is complete.
4. Connect test cable to idle speed air valve. Set multimeter to mA scale. Start engine and run at idle and operating temperature. Engage and disengage A/C compressor. When engaging A/C compressor the current at idle speed air valve jumps by about 60 mA. If not okay, repair interruption according to wiring diagram. If okay, test is complete.

COLD START VALVE ACTIVATION

1. With ignition turned off, pull plug on coolant temperature sensor. Unplug Green cable on ignition control module. Crank engine and check voltage at plug of cold start valve. Voltage should be 10 volts for about 9 seconds. If okay, test is complete. If not okay, go to step 2).
2. Check wire from cold start valve to fuel pump relay (terminal No. 4) and ground wire to engine for continuity. Resistance should about zero ohms. If not okay, repair interruption. Go to step 3). If okay, test is complete. See Fig. 7 .

Fig. 7: Cold Start Valve Plug
3. With coolant temperature sensor plug disconnected, check voltage between fuel pump relay plug (terminal No. 12) and TF circuit (terminal No. 2) and engine ground. Crank engine (do not start). Voltage at terminal No. 12 should about 10 volts. Voltage at terminal No. 2 should be about 3.5-5.0 volts. If not okay, repair interruption. If okay, replace fuel pump relay. End of test.

DECELERATION SHUTOFF

1. Connect on-off ratio tester to diagnostic socket. With engine at idle and operating temperature, tester needle should oscillate. If okay, test is complete. If not okay, go to step 2).
2. Drive vehicle on road test. With engine above 2500 RPM, place shift lever in position "2" and decelerate. When vehicle is decelerated (throttle valve closed) the on-off ratio should jump to about 80% and should restart the fuel injection below 1300 RPM (tester needle should oscilate). If not okay, check idle speed contact on throttle valve switch and TD signal. Go to step 3). If okay, test is complete.
3. Test speed signal (speedometer). Check wire between idle speed control unit plug and electronic speedometer for continuity. Resistance should be zero ohms. If not okay, repair interruption. If okay, test is complete.

IDLE & FULL LOAD CONTACT

1. Connect on-off ratio tester to diagnostic socket and turn on ignition. On-off ratio should be about 70%. Deflect airflow sensor plate about .79" (20 mm). On-off ratio should be 10%. Go to step 2).
2. If reading is 70%, throttle valve contact does not close or there's an interruption in wire to idle speed contact. Close airflow sensor plate. On-off ratio should be 40%. Go to step 3).
3. Open throttle valve fully. On-off ratio should be 20%. If not okay, replace full load contact. If okay, test is complete.

OVERVOLTAGE PROTECTION RELAY

1. Check fuse on overvoltage protection relay. If not okay, replace fuse. If fuse is okay, go to step 2).

2. Unplug overvoltage protection relay. Bridge terminals No. 1 and 2. Check voltage between terminal No. 1 of CIS-E control unit plug and ground. Voltage should be about 12 volts. If not okay, check power supply. If okay, go to step 3). See Fig. 8 .

Fig. 8: Overvoltage Relay Plug
3. Turn on ignition. Check voltage between terminal No. 5 (-) and terminal No. 6 (+) of overvoltage protection relay plug. Voltage should be about 12 volts. If not okay, repair interruption. If okay, replace overvoltage protection relay. End of test.

AIR INJECTION

1. With engine at operating temperature, disconnect coolant temperature sensor plug. Connect 2.5 k/ohm test resistor to simulate 68°F (20°C). Disconnect vacuum line from side connection of switchover valve and connect vacuum tester with "Y" fitting. Go to step 2).
2. Start engine. Disconnect suction hose at air pump filter and close with finger. Air pump should be running and vacuum should be about 20 in. Hg. Suction should be felt at end of hose to air pump. If not okay, go to step 4). If okay, go to step 3).
3. The air pump must disengage after about one minute and the vacuum drop to zero. If not okay, unplug air injection relay. If vacuum drops, replace air injection relay. If vacuum doesn't drop, check routing of vacuum lines and/or switchover valve. Repair or replace components as necessary.
4. Unplug air injection relay. Check voltage between terminals No. 4 and 5 at plug. Voltage should be about 12 volts. If not okay, check power supply and ground wiring. Check air shutoff valve function and air hoses for proper routing. If okay, go to step 5).
5. Check voltage between terminal No. 3 and terminal No. 1 at plug. Voltage should be 12 volts. If not okay, check power supply. If okay, replace air injection relay. End of test.

EGR SYSTEM

1. Apply about 12 in. Hg of vacuum to EGR valve. Disconnect vacuum line. The EGR valve should close (this can be felt). If not okay, replace EGR valve. If okay, go to step 2).
2. Run engine at idle speed. Apply about 12 in. Hg of vacuum to EGR valve. Engine runs rough at idle. If not okay, replace EGR valve. If okay, go to step 3).
3. Connect vacuum tester to EGR vacuum line using a "Y" fitting. Increase engine speed slowly to about 2500 RPM. Tester must indicate vacuum. If okay, test is complete. If not okay, go to step 4).
4. Disconnect vacuum line from thermovalve and connect vacuum tester with "Y" fitting to vacuum line and thermovalve. Increase engine speed slowly to about 2500 RPM. Tester should indicate vacuum. If okay, replace vacuum control valve. If not okay, go to step 5).
5. Disconnect both vacuum lines from thermovalve. Connect vacuum tester to angular connection of thermovalve and apply vacuum. With engine at operating temperature, thermovalve should be open. If not okay, replace thermovalve. If okay, go to step 6).
6. Check for vacuum at line from throttle valve housing. There should be no vacuum at idle. If throttle valve is opened (at about 1500 RPM) vacuum should be present. If okay, test is complete. If not okay, correct connection of vacuum lines.

COMPONENT TESTING - 190 & 300 SERIES
AIRFLOW SENSOR PLATE

1. Remove fuel pump relay. Bridge relay connector terminals No. 7 and 8 to build up fuel pressure. Center airflow sensor plate using feeler gauges of .002" (.05 mm) thickness between edge of sensor plate and housing. Airflow sensor plate should not bind even with slight lateral pressure eliminating any bearing play.
2. Tighten screw holding plate to lever. Push sensor plate down manually to check for smooth operation. Plate should not bind in housing bore. Release plate and allow it to return to rest position. Plate should not bind and should audibly knock against resilient stop. Check and recenter plate, if necessary.
3. Check rest position of sensor plate. Upper edge of plate should be flush with upper edge of cylindrical portion of housing. Upper edge of plate may be higher than edge in housing by maximum of .008" (.2 mm). See Fig. 9 .
4. Free play of .04-.08" (1-2 mm) should exist between rest position and point at which adjusting lever touches control piston. Gently drive guide pin down into housing if plate is high. If plate is low, remove mixture control unit. Gently drive guide pin out from below.

NOTE: Avoid repeated adjustments of press fitted guide pin as pin will loosen up in housing.

Fig. 9: Mercedes-Benz Sensor Plate Alignment Make sure moving plate does not bind in housing.
COLD START SYSTEM
Additional Air Valve

1. Check switch-off point of additional air valve. With coolant temperature below 70°F (20°C), engine should idle at 900-1200 RPM. Idle RPM should drop to normal when operating temperature reaches 160°F (70°C).
2. If cold start idle is too low, compress connecting hose between idle speed air distributor and additional air valve. If no RPM change occurs, additional air valve is seized and must be replaced.
3. If idle RPM is too high at operating temperature, pinch connecting hose between idle speed air distributor and auxiliary air valve. If idle speed changes, auxiliary air valve is sticking or is not electrically heated.
4. Check voltage and resistance of auxiliary air valve. Nominal voltage should be 12 volts and nominal resistance should be 40 ohms.

Cold Start Valve

1. Unplug connector from cold start valve. Connect multimeter to cold start valve connector. Remove ignition distributor transmitter plug from switching unit (Green cable) or install Protective Plug (102 589 02 21 00) on diagnostic socket.
2. Check voltage while cranking starter motor. Reading should be at least 10 volts. Disconnect fuel line on cold start valve. Remove cold start valve and reconnect fuel line. Hold cold start valve into container.
3. Disconnect electrical plug at thermo time switch. Connect terminal "W" on plug to ground with jumper wire. Below 45°F (5°C), it is not necessry to ground thermo time switch connector. Start engine. Fuel coming from cold start valve should be in shape of cone. Disconnect ground if used.
4. Dry any gasoline from nozzle of cold start valve. No drops should form. Remove jumper wire. Install cold start valve with new gasket. Reconnect wiring to cold start valve. Install relay and reconnect fuel line.

NOTE: During warm-up and at operating temperature, current to differential pressure regulator is determined by coolant temperature sensor, O2 sensor and ECU.

FUEL DELIVERY & SYSTEM PRESSURES

Visual Check - Fuel Leak

1. Remove air cleaner and check for any visible fuel leaks. Remove fuel pump relay from relay board. Bridge terminals No. 7 and 8 long enough to establish fuel pressure. Push airflow sensor plate down manually.
2. Uniform resistance should be felt throughout travel after slight amount of free travel. No binding should be felt if sensor plate is released quickly. If upward movement of sensor plate is slow, resistance from control piston closely following adjusting lever should be felt. No binding should be evident.
3. Push airflow sensor plate completely down and hold there briefly. Slight fuel see page past control piston is acceptable. If no fuel leaks have been found, go to next test.

Fig. 10: Mercedes-Benz 190E Fuel Distributor Use these ports for delivery volume testing procedures.

System Pressure

1. There are 2 versions of Fuel Pressure Gauge (100 589 00 21 00) available. First version has junction block with 2 valve handles on it, which are numbered "1" or "3" in following procedure. Hose exiting side of junction block by "1" valve handle is hose "1".
2. Second version has single valve handle on junction block. Hose leaving junction block 180° from valve handle is "B" and hose leaving junction block 180° from line to gauge is "A". When testing system pressure, close valve "1" and open valve "3" on first version or open valve on second version.
3. Remove threaded pipe plug from test port in lower chamber of fuel distributor. Connect fuel pressure gauge line "1" or "A" to test port in lower chamber of fuel distributor. Use M12 X 1.5/M8 X 1 Reducing Bushing (102 589 06 63 00) to connect hose to chamber port.
4. Remove fuel supply line for cold start valve from top of fuel distributor. Attach pressure gauge line "3" or "B" to cold start fitting on fuel distributor upper chamber. System pressure is checked with engine off. Engine temperature has no effect upon system pressure test. Remove fuel pump relay. Bridge terminals No. 7 and 8.
5. System pressure should be 76.9-79.8 psi (5.4-5.6 kg/cm 2). If pressure is not correct, check for defective fuel pump, restricted fuel return line or defective differential pressure regulator. Open pressure gauge valve "1". Remove fuel pump relay bridge.

Lower Chamber (Differential) Pressure

NOTE: During warm-up and at operating temperature, current to differential pressure regulator is determined by coolant temperature sensor, O2 sensor and ECU.

1. Connect Meter Adapter Cable (102 589 04 63 00) between differential pressure regulator and multimeter. Disconnect O2 sensor lead at connector located under right front floor mat. Turn ignition on. Meter reading for lower chamber pressure should be constant 7-9 mA. If reading is not correct, check lambda control.
2. Bridge fuel pump socket terminals No. 7 and 8. Check lower chamber pressure, which should be about 5.8 psi (.4 kg/cm 2) less than system pressure reading determined earlier. Unplug coolant

temperature sensor.
3. Note lower chamber pressure and differential pressure regulator current values. If coolant temperature sensor plug is disconnected, temperature sensor resistance should be zero ohms, differential pressure regulator current should be about 114-132 mA, and lower chamber pressure should be about 15.95-18.85 psi (1.1-1.3 kg/cm 2) less than system pressure. Reconnect coolant temperature sensor.
4. Check pressure and current values at coolant temperature of 64°F (20°C). Sensor resistance should be 2200-2800 ohms. Differential pressure regulator current 9-14 mA and lower chamber pressure should be about 5.8 psi (.4 kg/cm 2) less than system pressure.
5. Check pressure and current values at coolant temperature of 176°F (80°C). Sensor resistance should be 290-370 ohms, differential pressure regulator current 7-9 mA and lower chamber pressure should be about 5.8 psi (.4 kg/cm 2) less than system pressure.
6. Check pressure and current values at coolant temperature of 212°F (100°C). Sensor resistance should be 140-220 ohms, differential pressure regulator current 7-9 mA and lower chamber pressure should be about 5.8 psi (.4 kg/cm 2) less than system pressure.
7. If any readings are not in range, check coolant temperature sensor for malfunction. Coolant temperature sensor should also be checked if there are warm-up problems with vehicle. Test lambda control. If lower chamber pressure is over high point of range, check orifice in fuel distributor for restriction. Install fuel pump relay. Reconnect O2 sensor.

Deceleration Shut-Off Check

1. Start engine and bring it to operating temperature. Make sure control valve on fuel gauge is open. Briefly increase engine speed to 2500 RPM. As engine speed drops, lower chamber pressure should increase by 5.8 psi (.4 kg/cm 2).
2. Fuel delivery should start again at 900 RPM. If either pressure or engine speed reading is not correct, test throttle valve microswitch, test control current to differential pressure regulator, test ECU and test TD ignition signal.

Full Load Enrichment

1. Connect meter adapter cable between differential pressure regulator and multimeter. Start engine and bring it to operating temperature. Confirm that lambda control is working. Unplug connector from throttle valve switch. Bridge 2 leads on wiring to ECU.
2. Current reading should be constant at 7-9 mA. Lower chamber pressure should be about 5.8 psi (.4 kg/cm 2) less than measured system pressure. If pressure reading is not correct, test control current to differential pressure regulator and test TD ignition signal.

Acceleration Enrichment

1. In order to test acceleration enrichment function, cold engine operation must be simulated, as acceleration enrichment is not functional above 176°F (80°C). To simulate cold engine, connect a 25-k/ohm resistor wire between coolant sensor wiring connector and vehicle ground.
2. Start engine and bring engine speed up to 2500 RPM for short time. Lower chamber pressure should drop as engine speed increases. If lower chamber pressure does not drop, test airflow sensor potentiometer, test control current to differential pressure regulator and test ECU.

Residual Pressure & Internal Leak Testing

1. Run engine and check fuel pressures as described previously. Turn off engine and check residual pressure. Pressure should slowly drop below 41 psi (2.9 kg/cm 2), which is pressure required to open fuel injectors. If pressure drops rapidly to zero psi, replace check valve on fuel pump.
2. If pressure drops slowly to zero psi, disconnect fuel return line at diaphragm pressure regulator. There should be no flow of fuel, although slight see page is acceptable. Plug return line IMMEDIATELY if fuel flows heavily.
3. Pinch leak line at fuel accumulator. If pressure holds with line pinched, replace fuel accumulator. If no leaks have been found, remove cold start valve from manifold and check it for leaks under pressure. Replace valve if it leaks.
4. Disconnect pressure gauge and clean up any spilled fuel. Reconnect all fuel lines and run engine. Visually check all connections and lines for leaks.

Fuel Pump Delivery Volume

1. Remove fuel pump relay. Check current draw between socket No. 7 (terminal No. 87) and socket No. 8 (terminal No. 30). Draw of 6 amps indicates good fuel pump. Replace fuel pump with draw of more than 7 amps. Disconnect return line at diaphragm pressure regulator.
2. Attach locally made hose to fitting on regulator. Place other end of hose in measuring glass or beaker. Bridge sockets No. 7 and 8 with jumper wire to run fuel pump for 50 seconds. Nominal delivery volume should be one liter (.95 qt.) in 50 seconds with 11.5 volts supplied to fuel pump.
3. If actual delivery volume is low, make sure pump is receiving 11.5 volts. Check if dirty strainer in feed connection of fuel distributor is causing restriction. Check for pinched fuel lines causing restrictions.
4. Pinch leak line of fuel accumulator and repeat delivery volume test. If volume is now correct, replace fuel accumulator. If volume is still too low, replace fuel filter and repeat test. Replace fuel pump if volume remains low. Reconnect fuel return line and install fuel pump relay.

Fuel Distributor Delivery Volume

1. Unplug oxygen sensor lead under right front floor mat. Disconnect small fuel return line running between fuel distributor and diaphragm pressure regulator at fuel distributor end. Close line with proper sized plug. Connect locally made hose to open fuel distributor port.
2. Place other end of hose in measuring glass or beaker. Remove fuel pump relay. Bridge sockets No. 7 and 8 with jumper wire to run fuel pump for one minute. Nominal fuel delivery volume should be 4.4-5.0 ozs. (.13-.15L) per minute with 11.5 volts to fuel pump. If delivery volume is too low, replace either fuel distributor or differential pressure regulator.

ELECTRICAL COMPONENTS
Fuel Pump Relay

1. Remove fuel pump relay from board. Connect positive lead of multimeter to socket No. 8 (terminal No. 30) and negative lead to socket No. 11 (terminal No. 3) of connector. Measure voltage. If reading is 12 volts, go to step 3). If reading is zero volts, go to next step.
2. Remove negative lead of multimeter from socket No. 11 (terminal No. 3) and connect to vehicle ground. If reading is 12 volts, check Brown wire from terminal No. 31 for short. If voltage is zero,

check Red wire from terminal No. 30 for short. Repair wiring if necessary.
3. Switch on ignition and check voltage at socket No. 9 (terminal No. 15) of connector. If reading is zero volts, check Black/Red wire from terminal No. 15 to fuse box for short. Repair wiring if necessary. If reading is 12 volts, go to next step.
4. Using dwell meter, connect positive lead to socket No. 10 (terminal TD). Dwell angle should be 7-34°. If dwell is off, check Green/Yellow wire from jack 10 (terminal TD) to TSZ (transistor ignition) switching unit for short. If wiring is good, replace switching unit. If dwell reading is good, go to next step.
5. Bridge socket No. 7 (terminal No. 87) and socket No. 8 (terminal No. 30) with jumper wire. If fuel pump is running, test is completed. If fuel pump is not running, go to next step.
6. Check Black/Red/White wire from terminal No. 87 to fuel pump for short. If wiring is good, replace fuel pump relay. If fuel pump still does not run, replace fuel pump.

Coolant Temperature Sensor

1. Disconnect plug from coolant temperature sensor. Using ohmmeter, check resistance between sensor terminal and ground. Measure resistance at 2 different temperatures. If readings are not correct, replace coolant temperature sensor. If coolant temperature sensor is good, go to next step.
2. Connect meter adapter cable between differential pressure regulator and multimeter. Set meter to mA scale. Disconnect wire to O2 sensor. Turn ignition on and check current reading. At operating temperature, reading should be 7-9 mA.
3. At coolant temperature of 60°F (20°C), reading should be 9-14 mA. If wiring to temperature sensor is disconnected, reading should be 114-132 mA. If readings are correct, unit is okay and test is completed. If readings are not correct, go to next step.
4. Disconnect plug to differential pressure regulator. Resistance reading of regulator should be 18-21 ohms. If reading is not in range, replace differential pressure regulator. If reading is good, go to next step.
5. Check voltage at plug connector for coolant temperature sensor. Voltage should be 5 volts. If there is no voltage, repair wiring. If voltage is correct, go to next step.
6. Check wiring between ECU and differential pressure regulator for continuity. If continuity tests good, replace ECU. If no continuity, repair short in wiring.

Acceleration Enrichment

1. Disconnect airflow sensor potentiometer (position indicator). Make sure fuel pump is NOT running. Connect ohmmeter between terminals No. 14 and 18 of potentiometer. Reading should be 3200-4800 ohms with sensor plate in rest position.
2. Connect ohmmeter between terminals No. 14 and 17. Resistance should be 550-1050 ohms with sensor plate in rest position. With sensor plate at fully open position, resistance should be 3760-5640 ohms. If readings are not correct, adjust or replace potentiometer. If readings are correct, go to next step.
3. Connect meter adapter cable to differential pressure regulator. Set multimeter to mA scale. Connect 2500-ohm resistor wire between coolant sensor wire and ground to simulate coolant temperature of 60°F (20°C). Disconnect microswitch and turn ignition on. Current reading should be 9-14 mA. Deflect sensor plate to full open position and check that current reading increases. If readings are incorrect, go to step 5). If readings are correct, go to next step.

4. Disconnect differential pressure regulator. Measure resistance of regulator. If resistance is in range of 18-21 ohms, regulator is good and test is complete. If reading is out of specified range, replace differential pressure regulator.
5. Measure acceleration enrichment voltage between terminal No. 18 of sensor plate potentiometer and ground. Voltage reading should be 7.4-8.6 volts. If not, repair wiring circuit. If reading is correct, go to next step.
6. Measure voltage between terminals No. 18 and 14 of connector to airflow sensor potentiometer. Reading should be 8 volts. Also measure between terminals No. 17 and 14 of connector, which should give reading of 7.5 volts. If readings are not correct, repair wiring circuit. If readings are correct, go to next step.
7. Check wiring between ECU connector and differential pressure regulator connector. See 190E CIS-E WIRING DIAGRAM for wiring color and terminal numbers. If resistance reading is zero ohms, circuit is good and ECU should be replaced. If reading indicates open circuit (infinity), repair wiring.

After-Start Enrichment

1. Connect meter adapter cable to differential pressure regulator. Set multimeter to mA scale. Unplug O2 sensor under right front floor mat. Current reading at operating temperature should be 7-9 mA. If reading is not correct, test coolant temperature sensor as previously described. If reading is correct, go to next step.
2. Disconnect Green wire of ignition switching unit or install Protective Plug (102 589 02 21 00) into diagnostic socket. Simulate coolant temperature of 60°F (20°C) by connecting 2500-ohm resistor wire between coolant temperature sensor lead and ground. Crank engine for about 3 seconds and let key return to "ON" position. DO NOT turn ignition off.
3. After 4 seconds (including 3 seconds of cranking), current reading should increase to 24 mA. After 20 seconds, current reading should drop to 9-14 mA, which is basic warm-up current value. If readings are correct, test is complete. If readings are not correct, go to next step.
4. Connect voltmeter between ECU connector terminal No. 24 and ground. Crank starter motor. Cranking voltage signal (terminal No. 50 voltage) should be 10 volts. If not, check and repair wiring. If voltage is correct, go to next step.
5. Check wiring between ECU connector and differential pressure regulator connector. See 190E CIS-E WIRING DIAGRAM for wiring color and terminal numbers. If resistance reading is zero ohms, circuit is good and ECU should be replaced. If reading indicates open circuit (infinity), repair wiring.

Deceleration Shut-Off

NOTE: On vehicles with complaints of engine surging with cruise control engaged, check cruise control input to ECU.

1. Engine should be at operating temperature. Increase engine speed to 2500 RPM. Maintain constant RPM and actuate microswitch manually. If engine RPM fluctuates, check adjustment of slotted lever. If there is no surge, go to next step.
2. Using multimeter, check resistance of throttle valve microswitch. Resistance should be zero ohms. If free travel on lever is cancelled, resistance should read infinity. If resistance is not correct, replace

microswitch. If resistance is correct, go to next step.
3. Connect meter adapter cable to differential pressure regulator. Set multimeter on mA scale. Increase engine speed to 2500 RPM and then release throttle. Current reading should be at least 45 mA until restarting speed of 900 RPM is reached. Direction of current is negative to positive. If current is correct, test is complete. If current is not correct, go to next step.
4. With engine running, check RPM signal (TD) on Green/Yellow wire at ECU terminal No. 25. Set multimeter to volt scale. Reading should be 8.5 volts. If not, repair wiring circuit. If voltage is correct, go to next step.
5. Test wiring between ECU plug and differential pressure regulator for continuity. Resistance reading should be zero ohms. If not, repair wiring circuit. If reading is correct, replace ECU. Test is complete.

Full-Load Enrichment

1. Disconnect wiring between throttle valve switch and ECU. Check resistance of throttle valve switch at male plug. In idle speed position, resistance should be infinity. In full load position, resistance should be zero ohms. If readings are not correct, replace throttle valve switch. If readings are correct, go to next step.
2. Connect meter adapter cable to differential pressure regulator. Set multimeter to mA scale. Bridge connector of throttle valve switch that connects to ECU. Turn ignition on. Current reading should have constant nominal value of 7-9 mA. If current reading is correct, test is complete. If current reading is not correct, go to next step.
3. Check wiring between ECU and differential pressure regulator for continuity. Resistance reading should be zero ohms. If reading is correct, replace ECU. If reading is not correct, repair short in wiring.

Overvoltage Protection

1. Turn ignition on. Measure voltage between terminal No. 1 of ECU connector and ground. Reading should show battery voltage. If reading is correct, test is complete. If reading is incorrect, check fuse on overvoltage relay. Replace fuse if defective. Turn ignition on. If fuse does not blow, go to next step. If fuse blows, repair short in wiring.
2. Remove overvoltage protection relay. Bridge sockets No. 1 and 2 with jumper wire. Battery voltage should be present at terminal No. 1 of ECU. If not, repair wiring circuit. If battery voltage is present, go to next step.
3. Test voltage at sockets No. 6 and 5 on connector for relay. If battery voltage is present, replace overvoltage protection relay. If battery voltage is not present, repair wiring. Test is complete.

Altitude Correction

1. Connect meter adapter cable to differential pressure regulator. Set multimeter to mA scale. Disconnect O2 sensor and turn ignition on. Disconnect wiring from altitude sensor to simulate sea level operation. Current reading should be 7-9 mA.
2. Reconnect altitude sensor wiring. Check current reading. See ALTITUDE CORRECTION FACTOR table for correct current readings at different barometric pressures and different elevations above sea level. If current readings are correct, test is complete.
3. If readings are not correct, disconnect wiring plug from altitude sensor. Check that voltage between

socket No. 1 and ground is 6 volts. Voltage between sockets No. 2 and 3 should be 8 volts. If readings are correct, replace altitude sensor. If readings are incorrect, repair wiring.

ALTITUDE CORRECTION FACTOR
Altitude Above Sea Level Ft. (M) Barometric Pressure psi (kg/cm 2) Control Current mA
0 (0) 14.69 (1.0) 7-9
1640 (500) 13.85 (.97) 6-8
3281 (1000) 13.04 (.91) 5-7
6562 (2000) 11.53 (.81) 3-5
Lambda Control

1. Connect Bosch Lambda Control Tester (KDJE-P600) to vehicle. Unplug oxygen sensor. Run engine until operating temperature is reached. Read and record voltage on tester with engine idling. Reconnect O2 sensor. Push 12-volt button on tester.
2. Set engine speed to 2000 RPM. If engine is at operating temperature, voltage reading should continuously change. Reading should not vary from previously recorded voltage by more than .8 volts. If reading is correct, lambda control is working and test is complete.
3. If reading is constant instead of varying, replace oxygen sensor or repair wiring to sensor. If reading is higher than 4.8 volts or lower than 2.1 volts, adjust lambda control.

Oxygen Sensor

Oxygen sensor must be tested with engine running and at operating temperature. Unplug oxygen sensor under right front floor mat. Start engine and set speed at 2000 RPM. Check voltage of sensor between connector and ground. If reading is greater than 450 mV, oxygen sensor is good and test is complete. If reading is below 450 mV, replace oxygen sensor.
Lambda Control

1. Connect Bosch Lambda Control Tester (KDJE-P600) to vehicle. Unplug oxygen sensor. Run engine until operating temperature is reached. Read and record voltage on tester with engine idling. Reconnect O2 sensor. Push 12-volt button on tester.
2. Set engine speed to 2000 RPM. If engine is at operating temperature, voltage reading should continuously change. Reading should not vary from previously recorded voltage by more than .8 volts. If reading is correct, lambda control is working and test is complete.
3. If reading is constant instead of varying, replace oxygen sensor or repair wiring to sensor. If reading is higher than 4.8 volts or lower than 2.1 volts, adjust lambda control.

Oxygen Sensor Heater

1. Pull oxygen sensor heater wiring connector slightly but do not fully disconnect. Unplug fuel pump relay and bridge sockets No. 7 and 8 with jumper wire. Check voltage at connector to heater. If reading is not 12 volts, repair wiring. If reading is 12 volts, go to next step.
2. Disconnect oxygen sensor heater connector completely. Connect Test Cable (102 589 04 63 00) and read current value on multimeter. If current is not greater than .5 amps, replace defective oxygen sensor. If current is greater than .5 amps, oxygen sensor is good and test is complete.

Electronic Idle Speed Control

1. Connect test cable to Bosch Lambda Control Tester (KDJE-P 600) and to idle speed air valve. Push IR 100% button. Engine should be at idle speed and operating temperature. Nominal value reading should be 27-29% at 670-770 RPM. If reading is correct, test is complete. If reading is not correct, go to next step.
2. If reading is higher or lower, adjust valve to nominal value or test microswitch. If reading is 0%, test voltage at plug of idle speed air valve. Connect multimeter between socket No. 2 and ground. If reading is not correct, repair wiring circuit. Reading should be 12 volts. If reading is correct, go to next step.
3. Measure resistances of idle speed air valve. Between terminals No. 2 and 3 or 2 and 1, reading should be 12 ohms. If not correct, replace idle speed air valve. If correct, test is complete.

NOTE: If voltage at sockets No. 1 and 3 (tested individually to ground) is 12 volts, check Brown ground wire from terminal No. 20 to ECU for continuity. Repair wiring or replace ECU as necessary.
Idle Speed Stabilization (Automatic Transmission Engaged)

1. Set parking brake. Run engine at idle and warm up to operating temperature. Engine should idle between 570-670 RPM. If correct, test is complete. If not correct, go to next step.
2. Using multimeter, test input at ECU (terminal No. 16 to battery positive). With shifter in position "P" or "N", reading should be 12 volts. With shifter in "D", reading should drop below battery voltage. If reading is incorrect on either test, repair short in circuit. If reading is correct, test is complete.

Idle Speed Stabilization (A/C Compressor Engaged)

1. Set parking brake. Run engine at idle and warm up to operating temperature. Engine should idle between 670-770 RPM. If correct, test is complete. If not correct, go to next step.
2. Using multimeter, test input voltage at ECU between terminal No. 19 and gound. Readings should be 12 volts with A/C compressor on and zero volts with A/C compressor off. If reading is incorrect on either test, repair short in circuit. If reading is correct, test is complete.

Throttle Valve Switch

Set multimeter to read highest ohm scale. Check full throttle speed stop by pushing throttle valve against full throttle stop. Reading should be zero ohms. As throttle valve is turned slightly toward idle, reading should move to infinity. If readings are not correct, replace throttle valve switch.

Fig. 11: Wiring Diagram for 190E CIS-E Fuel Inj. Sys.

Fig. 12: Wiring Diagram for 300E CIS-E Fuel Inj. Sys.

Fig. 13: Wiring Diagram for 420 & 560 Series CIS-E Fuel Inj. Sys.

Fig. 14: Wiring Diagram for 560SL CIS-E Fuel Inj. Sys.
TROUBLE SHOOTING - 420 & 560 SERIES
DIAGNOSTIC READOUT

Connect Bosch Tester (KDJE-P600) to CIS-E diagnostic connector. All on-off ratio values are to be

checked with engine running at idle speed and operating temperature.

Fig. 15: View of Bosch CIS-E Diagnostic Tester

The fixed on-off ratio indicates a possible malfunction. The TROUBLE SHOOTING and DIAGNOSTIC TESTING sections will help in diagnosing problems with the CIS-E fuel injection system. If a problem cannot be solved using these sections, see COMPONENT TESTING.

NOTE: Some early 1986 production vehicles may not be equipped with the On-Board Diagnostic Readout System. Vehicles with CIS-E control units with manufacturing codes from 548 and later have built-in diagnostic readout system.
Reading "0"

Check CIS-E control unit for voltage. Check wire to diagnostic socket, terminal No. 3 or on-off ratio tester for being defective. Check oxygen sensor signal. If voltage is 12 volts, see TEST 1 in DIAGNOSTIC TESTING section.
Reading "10"

Check airflow sensor position indicator for being defective or if polarity is reversed. See TEST 2 in DIAGNOSTIC TESTING section.
Reading "20"

Check throttle valve switch plug connector for being incorrectly connected or short circuit (full load contact closed before engine reaches full load). See TEST 3 in DIAGNOSTIC TESTING section.
Reading "30"

Check for short circuit or wire interruption between CIS-E control unit and coolant temperature senor. If idle speed is too high, check for defective coolant temperature sensor. See TEST 4 in DIAGNOSTIC TESTING section.
Reading "40"

Check for short circuit or wire interruption to airflow sensor position indicator. Check for defective airflow sensor position indicator. See TEST 5 in DIAGNOSTIC TESTING section.
Reading "50"

Check oxygen sensor for not being at operating temperature. Check for wire interruption or for being defective. See TEST 6 in DIAGNOSTIC TESTING section.
Reading "60"

Not used.
Reading "70"

Check for interruption of TD signal. Check for defective wiring. See TEST 7 in DIAGNOSTIC TESTING section.
Reading "80"

Check for wiring interruption to altitude correction capsule or for being defective. See TEST 8 in

DIAGNOSTIC TESTING section.
Reading "90"

Not used.
Reading "100"

Check overvoltage protection relay for being defective (idle speed too high, about 1800 RPM). Check air/fuel mixture for being too lean. Check oxygen sensor for short circuit to ground. Check wiring between CIS-E control unit and EHA. Check EHA current (about 75 mA). See TEST 9 in DIAGNOSTIC TESTING section.

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