

2002 ENGINE PERFORMANCE

Basic Diagnostic Procedures

INTRODUCTION

The following diagnostic steps will help prevent overlooking a simple problem. This is also where to begin diagnosis for a no-start condition.

The first step in diagnosing any driveability problem is verifying the customer's complaint with a test drive under the conditions the problem reportedly occurred. For a no-start condition, verify events at time of failure to start.

Before entering self-diagnostics, perform a careful and complete visual inspection. Most engine control problems result from mechanical breakdowns, are, poor electrical connections or damaged/misrouted vacuum hoses. See **VACUUM DIAGRAMS** article to assist in identifying improperly routed vacuum hoses which cause driveability and/or computer-indicated malfunctions. Before condemning the computerized system, perform each test listed in this article.

NOTE: Perform all voltage tests with a Digital Volt-Ohmmeter (DVOM) with a minimum 10-megohm input impedance, unless stated otherwise in test procedure.

PRELIMINARY INSPECTION & ADJUSTMENTS

VISUAL INSPECTION

Visually inspect all electrical wiring, looking for chafed, stretched, cut or pinched wiring. Ensure electrical connectors fit tightly and are not corroded. Inspect condition of battery and fuses. Ensure vacuum hoses are properly routed and are not pinched or cut. To verify routing and connections (if necessary), see **VACUUM DIAGRAMS** article. Inspect air induction system for possible vacuum leaks.

MECHANICAL INSPECTION

Compression

Ensure battery is fully charged. Turn ignition off. Disconnect ignition coils. Check engine compression with engine at normal operating temperature at specified cranking speed, all spark plugs removed, and throttle wide open. See **COMPRESSION SPECIFICATIONS** table.

COMPRESSION SPECIFICATIONS

Application	(1) Specification - psi (kPa) @ RPM
Optima	
2.4L	178 (1227) @ 250-400
2.7L	(2) 170 (1200)

Rio	184 (1275) @ 300
Sedona	⁽²⁾ 170 (1200)
Spectra	193 (1331) @ 300
Sportage	163 (1124) @ 270

(1) Maximum difference between cylinders is not to exceed 14 psi (100 kPa).

(2) At cranking speed. Cranking RPM not available from manufacturer.

Exhaust System Backpressure

Exhaust system can be tested with a vacuum or pressure gauge. If using a pressure gauge, remove HO2S or air injection check valve (if equipped). Connect a 0-5 psi pressure gauge and run engine at 2500 RPM. If exhaust system backpressure is greater than 2 psi, exhaust system or catalytic converter is plugged. Repair as necessary.

If using a vacuum gauge, connect vacuum gauge hose to intake manifold vacuum port. Start engine. Observe vacuum gauge. Open throttle part way and hold steady. If vacuum gauge indication slowly drops after stabilizing, inspect exhaust system for restriction and repair as necessary.

FUEL SYSTEM

WARNING: ALWAYS relieve fuel pressure before disconnecting any fuel injection-related component. DO NOT allow fuel to contact engine or electrical components.

WARNING: After repairs have been completed, using fuel pump check connector terminal, activate fuel pump and check for leaks. Repair any leaks as necessary.

CAUTION: When battery is disconnected, vehicle computer and memory system may lose memory data. Driveability problems may exist until computer system have completed a relearn cycle. See **COMPUTER RELEARN PROCEDURES** article in **GENERAL INFORMATION** before disconnecting battery.

NOTE: If fuel pressure is not as specify, perform fuel filter inspection. For fuel filter location, removal & installation, see **FUEL FILTER** under **FUEL SYSTEM** in **REMOVAL, OVERHAUL & INSTALLATION** article. If fuel filter check okay, check fuel pump. See **FUEL PUMP OPERATION** .

FUEL PRESSURE RELEASE

Except Optima

To release fuel pressure, remove rear seat cushion. Locate access to fuel pump harness connector. Disconnect fuel pump harness connector. Start engine and allow to idle until it stalls. Turn ignition off. Disconnect negative

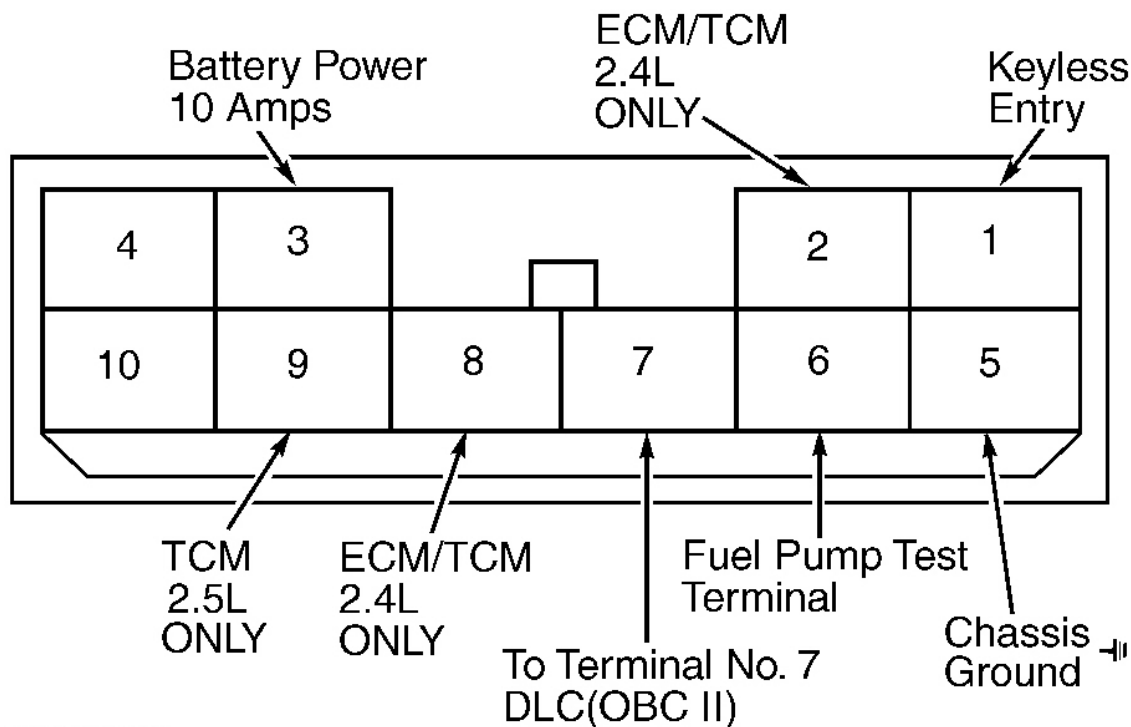
battery cable. When testing or repair is complete, reconnect fuel pump connector and negative battery cable. Install rear seat cushion. Prime fuel system. See **PRIMING FUEL SYSTEM**.

Optima

To release fuel pressure, locate access to fuel pump harness connector in trunk. Disconnect fuel pump harness connector. Start engine and allow to idle until it stalls, turn ignition off. Disconnect negative battery cable. When testing or repairs are complete, reconnect fuel pump harness connector and negative battery cable. Prime fuel system. See **PRIMING FUEL SYSTEM**.

PRIMING FUEL SYSTEM

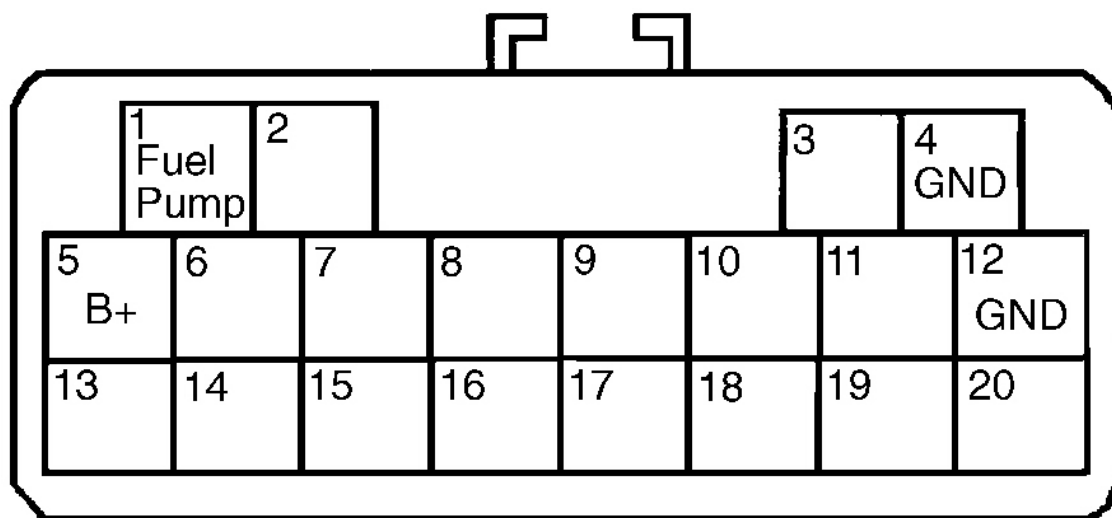
After performing any operation that requires releasing fuel pressure, fuel system should be primed to prevent long cranking times. To prime fuel system, jumper Data Link Connector (DLC) terminal FUEL PUMP and (B+). On Optima, DLC is located on left side under dash. On models except Optima, DLC is located on left side of engine compartment. See **Fig. 1** , **Fig. 2** or **Fig. 3** . Turn ignition on for no longer than 10 seconds to run pump and pressurize fuel system. Turn ignition off and remove jumper wire. Check for leaks. Repair any leaks as necessary.



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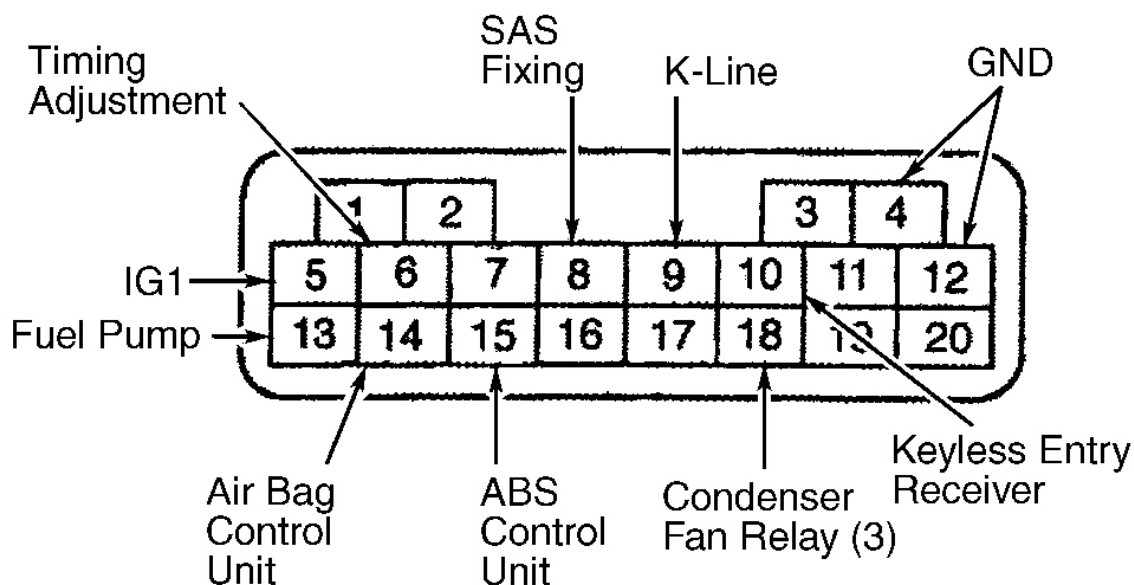
Fig. 1: Identifying Underdash Data Link Connector Terminals (Optima)

Courtesy of KIA MOTORS AMERICA, INC.



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Fig. 2: Identifying Underhood Data Link Connector Terminals (Rio, Spectra & Sportage)
 Courtesy of KIA MOTORS AMERICA, INC.



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Fig. 3: Identifying Underhood Data Link Connector Terminals (Sedona)
 Courtesy of KIA MOTORS AMERICA, INC.

FUEL PRESSURE

WARNING: ALWAYS relieve fuel pressure before disconnecting any fuel injection related component. DO NOT allow fuel to contact engine or electrical components.

1. Release fuel pressure. See **FUEL PRESSURE RELEASE** . Disconnect high-pressure fuel hose from fuel delivery pipe. Cover hose connection using rags to avoid spraying of fuel.
2. Using Fuel Pressure Gauge Adapter (09353-38000), install fuel pressure gauge to fuel delivery pipe. See **Fig. 4** or **Fig. 5** . Torque fuel gauge adapter bolts to 18-26 ft. lbs. (24-35 N.m). Connect negative battery cable.
3. Using fuel pump check terminal connector, activate fuel pump and ensure no fuel leakage is present at pressure gauge or connection. See **PRIMING FUEL SYSTEM** . If no leaks are present, start engine and allow to idle.
4. Disconnect vacuum hose from fuel pressure regulator, and plug hose end. Measure and record fuel pressure at idle. Reconnect vacuum hose, and again measure and record fuel pressure. See **FUEL PRESSURE SPECIFICATIONS** table. If fuel pressures are not within specification, go to next step. If measurements are okay, go to step 8 .
5. If fuel pressure is less than specified, check following conditions:
 - Restricted fuel filter.
 - Fuel pressure regulator leaking fuel to fuel return side.
 - Leaking in-tank fuel pick-up hose.
 - Low fuel pump discharge pressure.

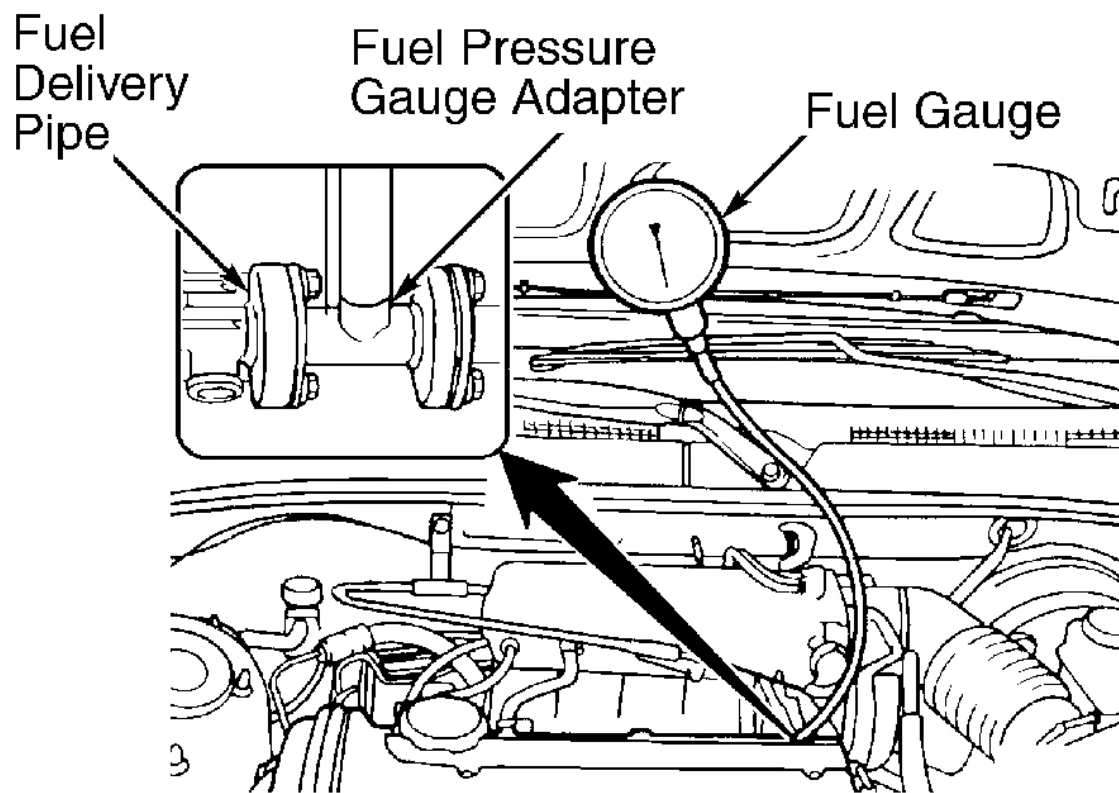
Repair or replace as necessary. Recheck fuel pressure.

6. If fuel pressure is greater than specified, check for sticking fuel pressure regulator, or a restricted or bent fuel return hose or pipe. Repair or replace fuel hose or pipe and fuel pressure regulator. See **FUEL PRESSURE REGULATOR** under FUEL SYSTEM in REMOVAL, OVERHAUL & INSTALLATION article.
7. If fuel pressure does not change when regulator vacuum hose is connected and disconnected, check for following conditions:
 - Restricted or damaged vacuum hose.
 - Restricted manifold vacuum port.
 - Sticking or poorly seated fuel pressure regulator valve.

Repair or replace as necessary. Recheck fuel pressure.

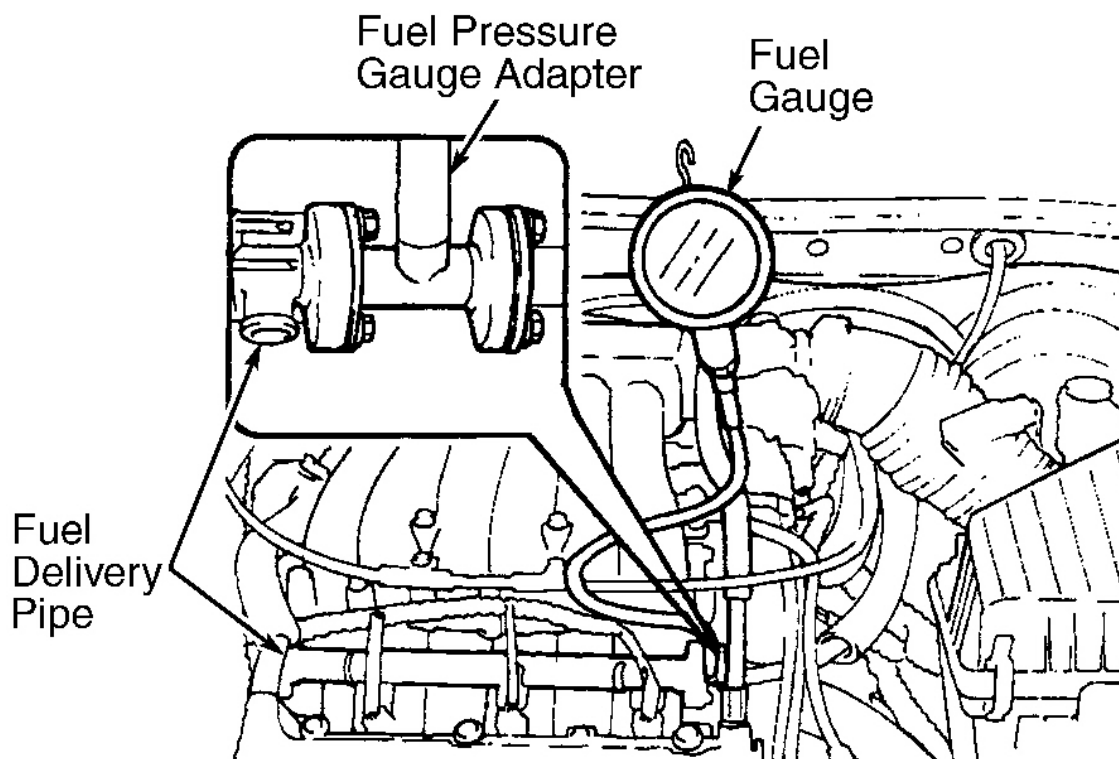
8. If fuel pressures are as specified, stop engine and check for decrease in fuel pressure gauge. Fuel pressure should hold for approximately 5 minutes. If fuel pressure decreases slowly after engine is stopped, check for leaking injector. See **FUEL INJECTOR LEAKAGE TEST** under FUEL INJECTORS. Replace as necessary. If fuel pressure decreases immediately after engine is stopped, check-valve inside fuel pump is not working. Replace fuel pump. To replace fuel pump, see **FUEL PUMP** under FUEL SYSTEM in REMOVAL, OVERHAUL & INSTALLATION article. After repairs are completed, recheck fuel pressure.
9. After testing is completed, release fuel pressure. See **FUEL PRESSURE RELEASE** . Disconnect fuel pressure gauge from adapter. Ensure hose connection is covered by shop towel to prevent fuel spray. Remove adapter bolts and adapter. Install NEW "O" ring, and reinstall fuel line with original bolts. Apply battery voltage to fuel pump drive connector terminal. See **Fig. 1** . Check for fuel leaks. Repair any leaks

as necessary.



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Fig. 4: Installing Fuel Pressure Gauge (Optima 2.4L)
Courtesy of KIA MOTORS AMERICA, INC.



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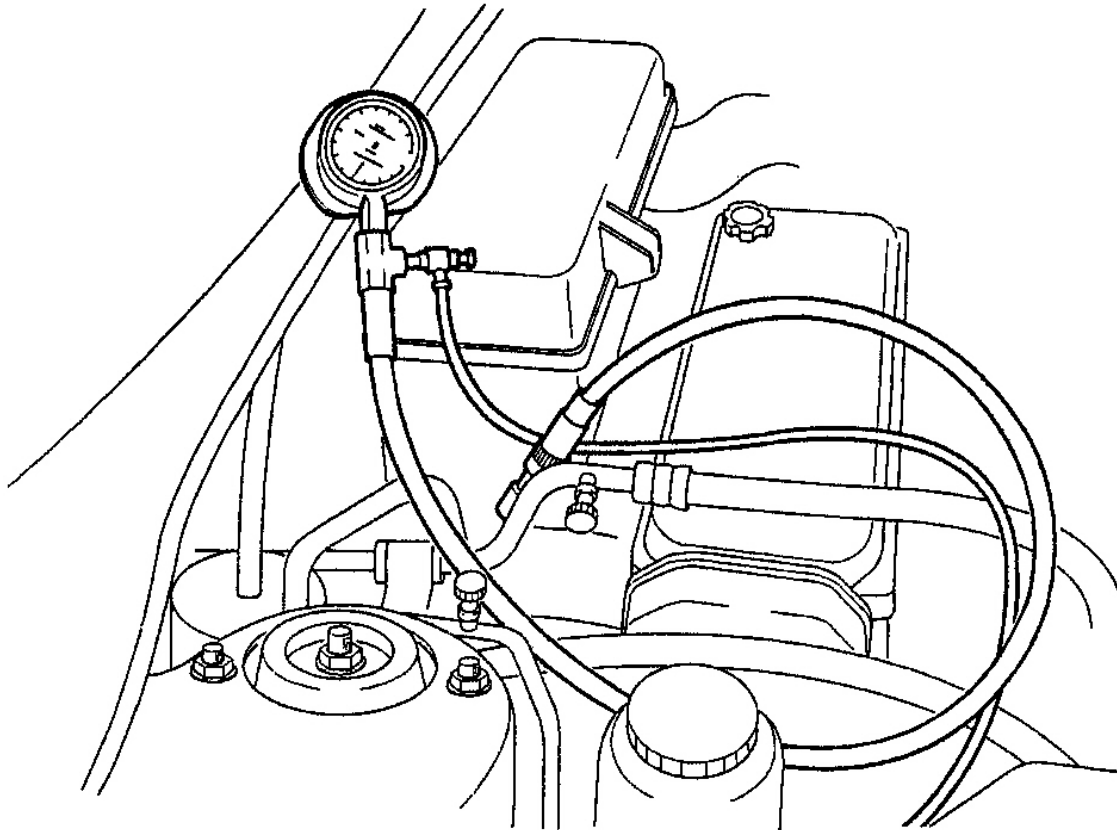
Fig. 5: Installing Fuel Pressure Gauge (Optima 2.7L)
 Courtesy of KIA MOTORS AMERICA, INC.

Fuel Pressure (Rio)

1. Release fuel pressure. See **FUEL PRESSURE RELEASE**. Disconnect high-pressure fuel hose from fuel delivery pipe. Cover hose connection using rags to avoid spraying of fuel. Disconnect battery negative cable. Install fuel pressure gauge (0K2A1 131 001A) on to high-pressure fuel line. See **Fig. 6**. Connect battery negative cable.
2. Using fuel pump check terminal connector, operate fuel pump and ensure no fuel leakage is present at pressure gauge or connection. See **PRIMING FUEL SYSTEM**. If no leaks are present, check fuel pressure. See **FUEL PRESSURE SPECIFICATIONS** table.
3. If fuel pressure is greater than specified, check for sticking fuel pressure regulator or a restricted or bent fuel return hose or pipe. Repair or replace fuel hoses or pipes and fuel pressure regulator as necessary. See **FUEL PRESSURE REGULATOR** under FUEL SYSTEM in REMOVAL, OVERHAUL & INSTALLATION article. If fuel pressure is less than specified, go to next step.
4. Clamp return line and check if fuel pressure rises. If pressure does rise, replace fuel pressure regulator. See **FUEL PRESSURE REGULATOR** under FUEL SYSTEM in REMOVAL OVERHAUL & INSTALLATION article. If pressure does not rise, measure fuel pump maximum pressure. See **MAXIMUM FUEL PRESSURE (RIO & SPECTRA)**.
5. Stop engine and check for decrease in fuel pressure gauge. See **HOLDING FUEL PRESSURE (RIO & SPECTRA)**. Fuel pressure should hold for approximately 25 minutes. If fuel pressure decreases slowly after engine is stopped, check for leaking injector. See **FUEL INJECTOR LEAKAGE TEST** under FUEL INJECTORS. Replace fuel injectors as necessary. If fuel pressure decreases immediately after

engine is stopped, check-valve inside fuel pump is not working. Replace fuel pump. To replace fuel pump, see **FUEL PUMP** under FUEL SYSTEM in REMOVAL, OVERHAUL & INSTALLATION article. After repairs are completed, recheck fuel pressure.

6. After testing is completed, release fuel pressure. See **FUEL PRESSURE RELEASE** . Disconnect fuel pressure gauge from adapter. Ensure hose connection is covered by shop towel to prevent fuel spray. Remove adapter bolts and adapter. Replace any old seals with NEW seals, and reinstall fuel line. Apply battery voltage to fuel pump drive connector terminal. See **Fig. 2** . Check for fuel leaks. Repair any leaks as necessary.



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Fig. 6: Installing Fuel Pressure Gauge (Rio)
Courtesy of KIA MOTORS AMERICA, INC.

Fuel Pressure (Sedona)

1. Release fuel pressure. See **FUEL PRESSURE RELEASE** . Disconnect high-pressure fuel hose from fuel delivery pipe. Cover hose connection using rags to avoid spraying of fuel.
2. Using Fuel Pressure Gauge Adapter (09353-24100), install fuel pressure gauge to fuel delivery pipe, See **Fig. 7** . Connect negative battery cable.
3. Using fuel pump check terminal connector, operate fuel pump and ensure no fuel leakage is present at pressure gauge or connection. See **PRIMING FUEL SYSTEM** . If no leaks are present, start engine and allow to idle.
4. Disconnect vacuum hose from fuel pressure regulator, and plug hose end. Measure and record fuel

pressure at idle. Reconnect vacuum hose, and again measure and record fuel pressure. See **FUEL PRESSURE SPECIFICATIONS** table. If measurements are not within specification, go to next step. If measurements are okay, go to step 8 .

5. If fuel pressure is less than specified, check following conditions:

- Restricted fuel filter.
- Fuel pressure regulator leaking fuel to fuel return side.
- Leaking in-tank fuel pick-up hose.
- Low fuel pump discharge pressure.

Repair or replace as necessary. Recheck fuel pressure.

6. If fuel pressure is greater than specified, check for sticking fuel pressure regulator. A restricted or bent fuel return hose or pipe. Repair or replace fuel hose or pipe as necessary, or replace fuel pressure regulator. See **FUEL PRESSURE REGULATOR** under FUEL SYSTEM in REMOVAL OVERHAUL & INSTALLATION article.

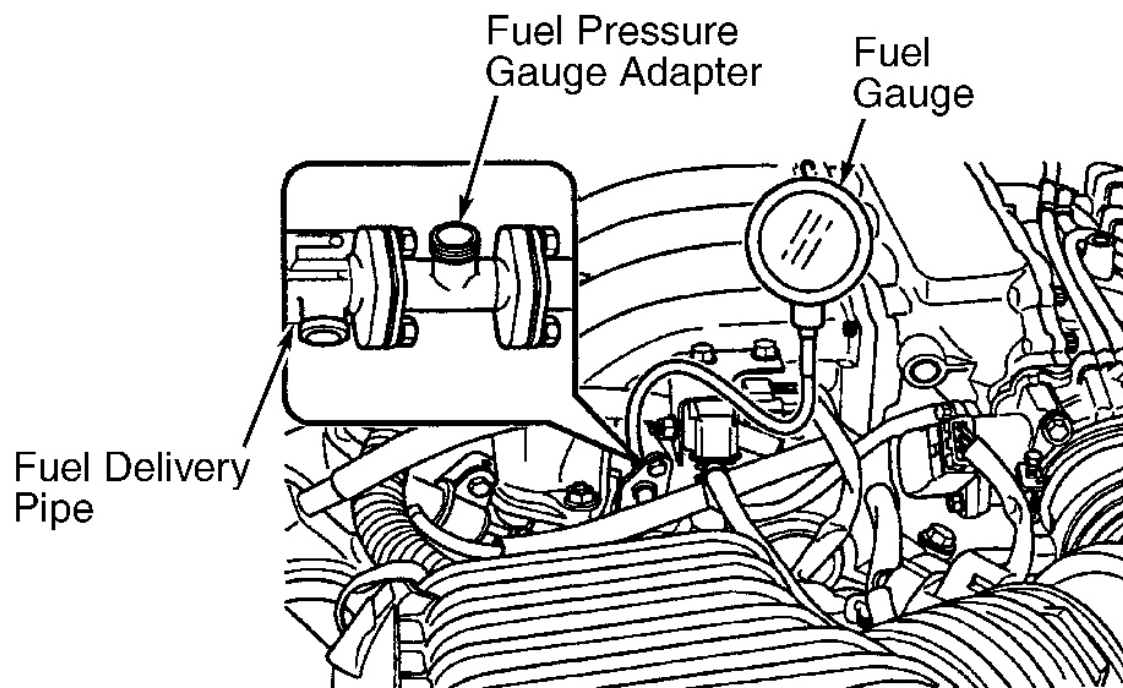
7. If fuel pressure does not change when regulator vacuum hose is connected and disconnected, check for following conditions:

- Restricted or damaged vacuum hose.
- Restricted manifold vacuum port.
- Sticking or poorly seated fuel pressure regulator valve.

Repair or replace as necessary. Recheck fuel pressure.

8. If fuel pressures are as specified, stop engine and check for decrease in fuel pressure gauge. Fuel pressure should hold for approximately 5 minutes. If fuel pressure decreases slowly after engine is stopped, check for leaking injector. See **FUEL INJECTOR LEAKAGE TEST** under FUEL INJECTORS. Replace as necessary. If fuel pressure decreases immediately after engine is stopped, check-valve inside fuel pump is not working. Replace fuel pump. See **FUEL PUMP** under FUEL SYSTEM in REMOVAL, OVERHAUL & INSTALLATION article. After repairs are completed, recheck fuel pressure and go to next step.

9. After testing is completed, release fuel pressure. See **FUEL PRESSURE RELEASE** . Disconnect fuel pressure gauge from adapter. Ensure hose connection is covered by shop towel to prevent fuel spray. Remove adapter bolts and adapter. Install NEW "O" ring, and reinstall fuel line with original bolts. Torque bolts to 27-35 INCH lbs. (3-4 N.m). Apply battery voltage to fuel pump drive connector terminal. See **Fig. 3** . Check for fuel leaks. Repair any leaks as necessary.

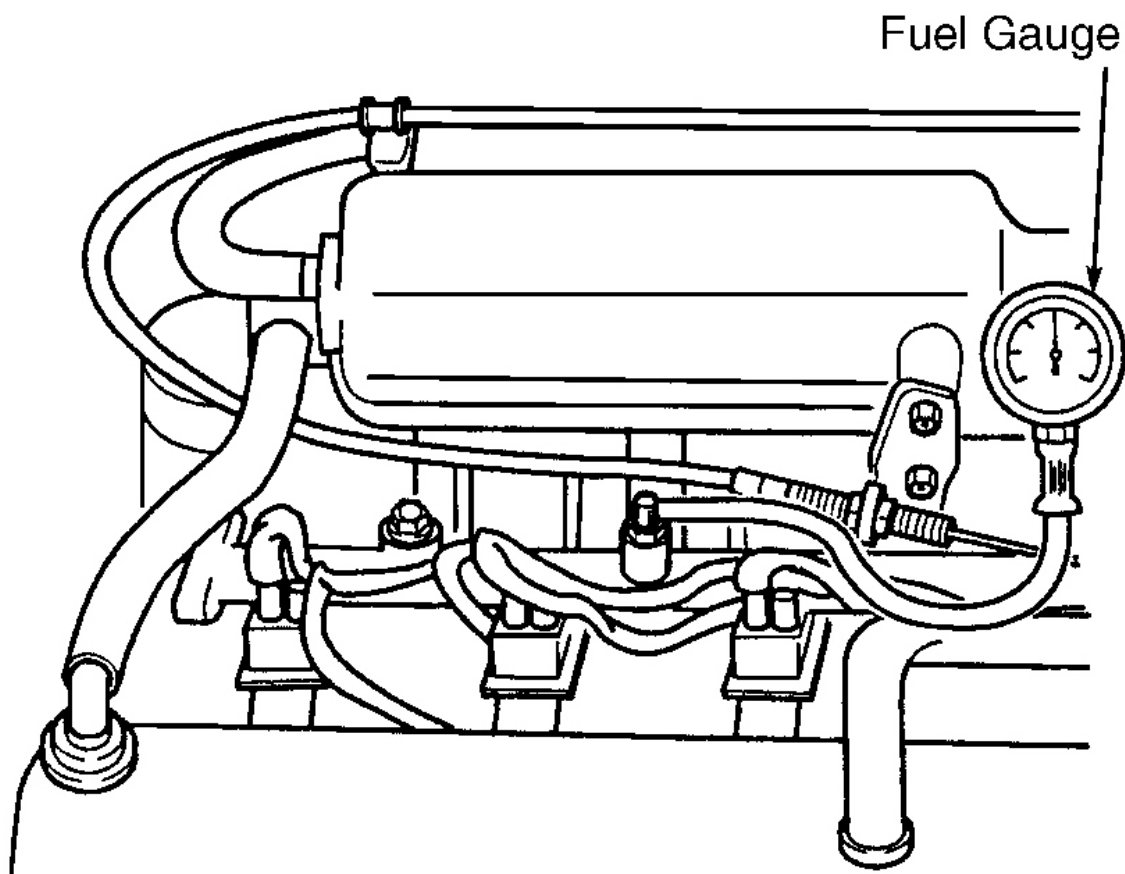


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Fig. 7: Installing Fuel Pressure Gauge (Sedona)
 Courtesy of KIA MOTORS AMERICA, INC.

Fuel Pressure (Spectra)

1. Release fuel pressure. See **FUEL PRESSURE RELEASE** . Disconnect battery negative cable. Install Fuel Pressure Gauge (0K2A1 131 001) on service port at center of fuel rail. See **Fig. 8** .
2. Connect battery negative cable. To operate fuel pump, jumper DLC terminals FUEL PUMP and (B+). DLC is located on left side of engine compartment. See **Fig. 2** .
3. Turn ignition on for 10 seconds or less. Check fuel pressure. See **FUEL PRESSURE SPECIFICATIONS** table. Turn ignition off and remove jumper wire.
4. If fuel pressure is too high, check for restricted return line. If return line is open, replace pressure regulator. See **FUEL PRESSURE REGULATOR** under FUEL SYSTEM in REMOVAL OVERHAUL & INSTALLATION article.
5. If fuel pressure is too low, block return line. Operate fuel pump again and see if pressure rises. If pressure rises, replace fuel pressure regulator. See **FUEL PRESSURE REGULATOR** under FUEL SYSTEM in REMOVAL OVERHAUL & INSTALLATION article. If pressure does not rise, check fuel pump maximum pressure. See **MAXIMUM FUEL PRESSURE (RIO & SPECTRA)** .

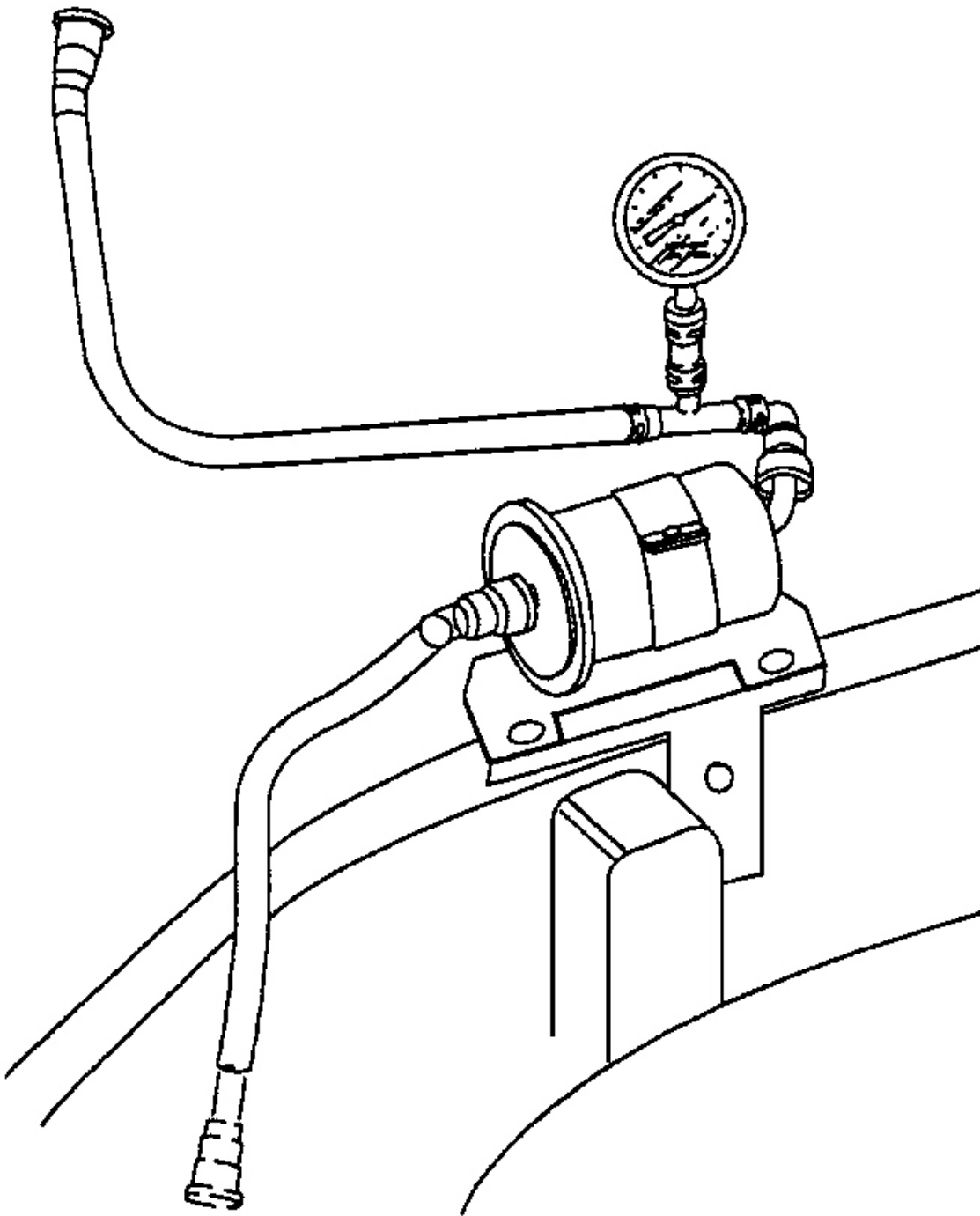


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Fig. 8: Installing Fuel Pressure Gauge (Spectra)
 Courtesy of KIA MOTORS AMERICA, INC.

Fuel Pressure (Sportage)

1. Release fuel pressure. See **FUEL PRESSURE RELEASE** . Disconnect battery negative cable. Install fuel pressure gauge on service fuel rail near fuel filter. See **Fig. 9** . Connect battery negative cable.
2. Using fuel pump check terminal connector, operate fuel pump and ensure no fuel leakage is present at pressure gauge or connection. See **PRIMING FUEL SYSTEM** .
3. Start engine and allow it to idle. Disconnect vacuum hose from pressure regulator, and plug hose end, Measure and record fuel pressure at idle. Reconnect vacuum hose, and again measure and record fuel pressure. See **FUEL PRESSURE SPECIFICATIONS** table. If pressure is not as specified, check fuel line and filter for restrictions. For fuel filter location, removal & installation, see FUEL FILTER under FUEL SYSTEM in REMOVAL, OVERHAUL & INSTALLATION article. Also check holding fuel pressure and maximum fuel pressure. See **HOLDING FUEL PRESSURE (SPORTAGE)** and **MAXIMUM FUEL PRESSURE (SPORTAGE)** test.



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Fig. 9: Installing Fuel Pressure Gauge (Sportage)
Courtesy of KIA MOTORS AMERICA, INC.

HOLDING FUEL PRESSURE

Holding Fuel Pressure (Rio & Spectra)

1. Release fuel pressure. See **FUEL PRESSURE RELEASE** . Disconnect battery negative cable. Install fuel pressure gauge on to high-pressure fuel line. For Rio, see **Fig. 6** or **Fig. 8** . Connect battery negative cable.
2. Jumper DLC terminals FUEL PUMP and (B+). DLC is located on left side of engine compartment. See **Fig. 2** . Turn ignition on for 10 seconds or less to operate fuel pump and pressurize system. Turn ignition off and remove jumper wire.
3. On Rio, check fuel pressure after 25 minutes. On Spectra, check fuel pressure after 15 minutes. See **FUEL PRESSURE SPECIFICATIONS** table. If pressure is not as specified, check fuel pump, pressure regulator and injectors.

Holding Fuel Pressure (Sportage)

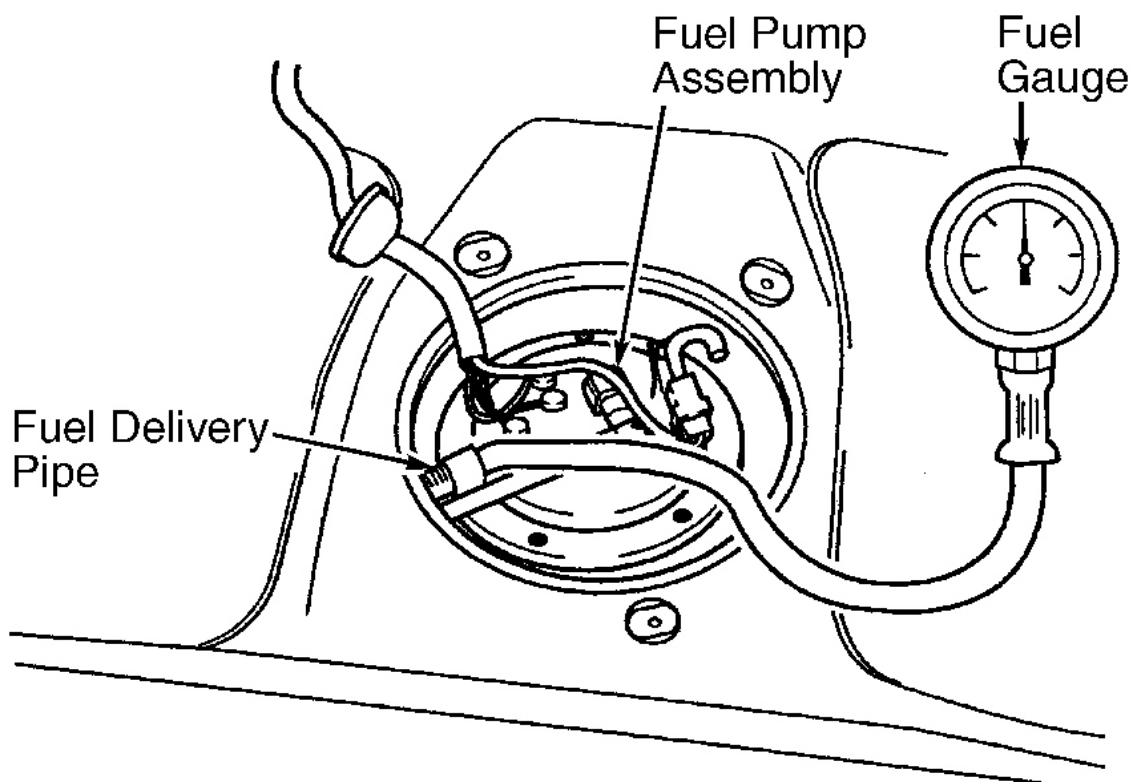
1. Release fuel pressure. See **FUEL PRESSURE RELEASE** . Disconnect battery negative cable. Install fuel pressure gauge on service port at front of fuel rail. Connect battery negative cable.
2. Jumper DLC terminals FUEL PUMP and (B+). DLC is located on left side of engine compartment. See **Fig. 2** . Turn ignition on for 10 seconds or less to operate fuel pump and pressurize system. Turn ignition off and remove jumper wire.
3. Pinch off fuel return hose at pressure regulator. Observe fuel pressure for 5 minutes. It should stay above specified pressure. See **FUEL PRESSURE SPECIFICATIONS** table. If pressure drops below specification, replace pressure regulator. See **FUEL PRESSURE REGULATOR** under FUEL SYSTEM in REMOVAL OVERHAUL & INSTALLATION article. Also check fuel pump and injectors.

MAXIMUM FUEL PRESSURE

NOTE: **Maximum fuel pressure specifications and test procedures for Optima and Sedona are not available from manufacturer.**

Maximum Fuel Pressure (Rio & Spectra)

1. Release fuel pressure. See **FUEL PRESSURE RELEASE** . Disconnect battery negative cable. Remove rear seat cushion. Connect Fuel Pressure Gauge (0K2A1 131 001) to main fuel line at fuel tank. See **Fig. 10** . Connect battery negative cable.
2. To operate fuel pump, jumper DLC terminals FUEL PUMP and (B+). DLC is located on left side of engine compartment. See **Fig. 2** . Turn ignition on. Check maximum fuel pressure. Do not run fuel pump longer than necessary to check fuel pressure. See **FUEL PRESSURE SPECIFICATIONS** table. If fuel pressure is not as specified, replace fuel pump. See **FUEL PUMP** under FUEL SYSTEM in REMOVAL, OVERHAUL & INSTALLATION article.

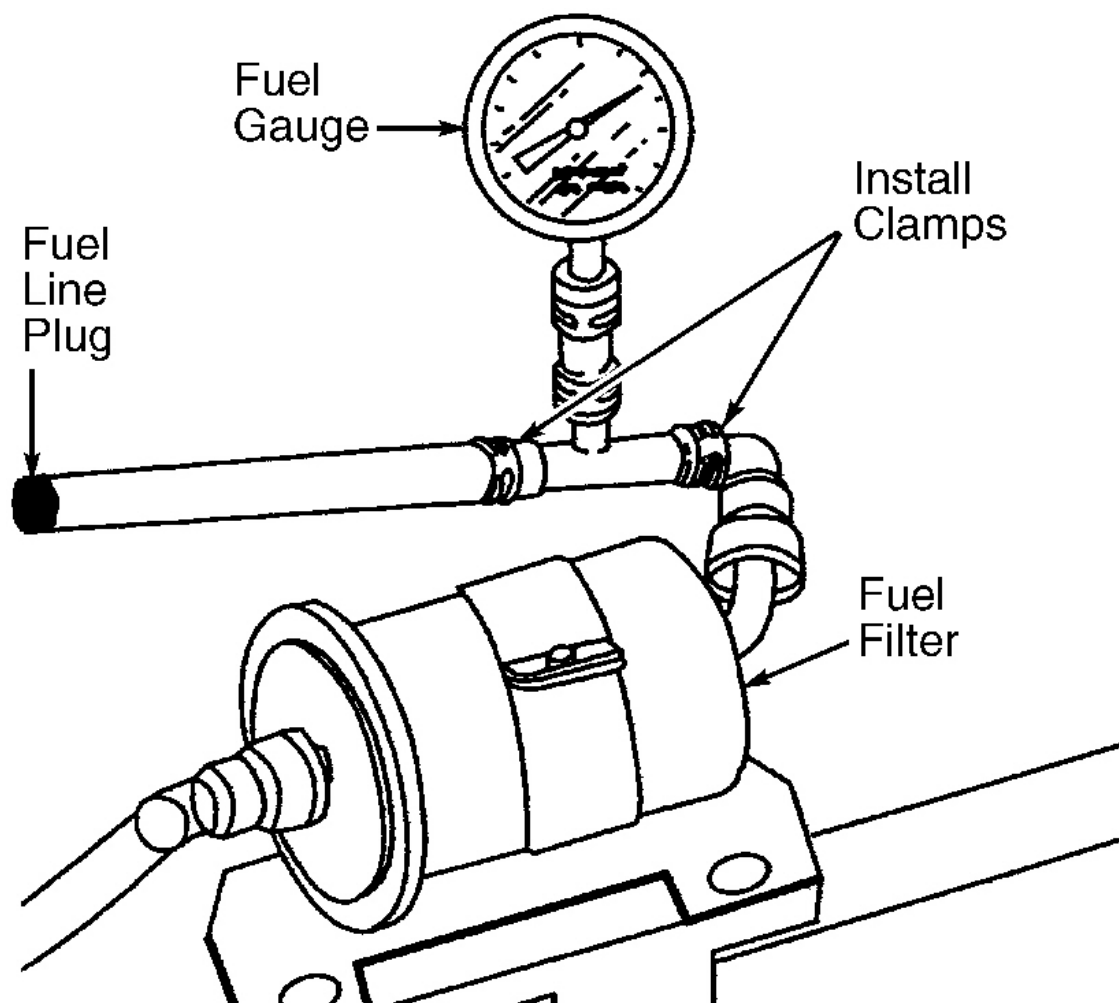


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Fig. 10: Installing Fuel Pressure Gauge at Fuel Tank (Rio & Spectra)
Courtesy of KIA MOTORS AMERICA, INC.

Maximum Fuel Pressure (Sportage)

1. Release fuel pressure. See **FUEL PRESSURE RELEASE** . Disconnect battery negative cable. Connect fuel pressure gauge to fuel filter and plug outlet of gauge, install clamps as shown, see **Fig. 11** . Connect battery negative cable.
2. To operate fuel pump, jumper DLC terminals FUEL PUMP and (B+). DLC is located on left side of engine compartment. See **Fig. 2** . Turn ignition on. Measure maximum fuel pressure. Do not operate fuel pump longer than necessary to check fuel pressure. See **FUEL PRESSURE SPECIFICATIONS** table. Turn ignition off and remove jumper wire. If pressure is not as specified, replace fuel pump. See **FUEL PUMP** under FUEL SYSTEM in REMOVAL, OVERHAUL & INSTALLATION article.



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Fig. 11: Installing Fuel Pressure Gauge At Fuel Filter (Sportage)
 Courtesy of KIA MOTORS AMERICA, INC.

FUEL PRESSURE SPECIFICATIONS

Application	psi (kPa)
Optima	
Fuel Line Pressure ⁽¹⁾⁽²⁾	
Regulator Vacuum Connected	37 (255)
Regulator Vacuum Disconnected	46-49 (320-340)
Rio & Spectra	
Maximum Pressure ⁽¹⁾	65-94 (450-650)
Fuel Line Pressure ⁽³⁾	46-51 (320-350)
Holding Pressure ⁽⁴⁾	Minimum 25 (180)
Sedona	

Fuel Line Pressure ⁽¹⁾⁽²⁾	
Regulator Vacuum Connected	39 (270)
Regulator Vacuum Disconnected	46-49 (320-340)
Sportage	
Maximum Pressure ⁽⁵⁾	Minimum 43 (340)
Fuel Line Pressure ⁽²⁾⁽⁶⁾	
Regulator Vacuum Connected	34 (235)
Regulator Vacuum Disconnected	42 (292)
Holding Pressure ⁽⁷⁾	Minimum 21 (150)
<p>(1) With pressure gauge connected to main fuel line with adapter.</p> <p>(2) Engine at idle.</p> <p>(3) With pressure gauge connected to fuel rail service port.</p> <p>(4) With pressure gauge connected to fuel rail service port. Minimum pressure 15-25 minutes after ignition is turned off.</p> <p>(5) With pressure gauge connected to fuel filter and pressure gauge outlet hose plugged.</p> <p>(6) With pressure gauge connected to fuel rail service port.</p> <p>(7) With pressure gauge connected to fuel rail service port. Minimum pressure 5 minutes after ignition is turned off.</p>	

FUEL PUMP OPERATION

NOTE: **Ensure battery is fully charged, and all related fuses in fuel system are in good condition before starting any fuel system diagnosis.**

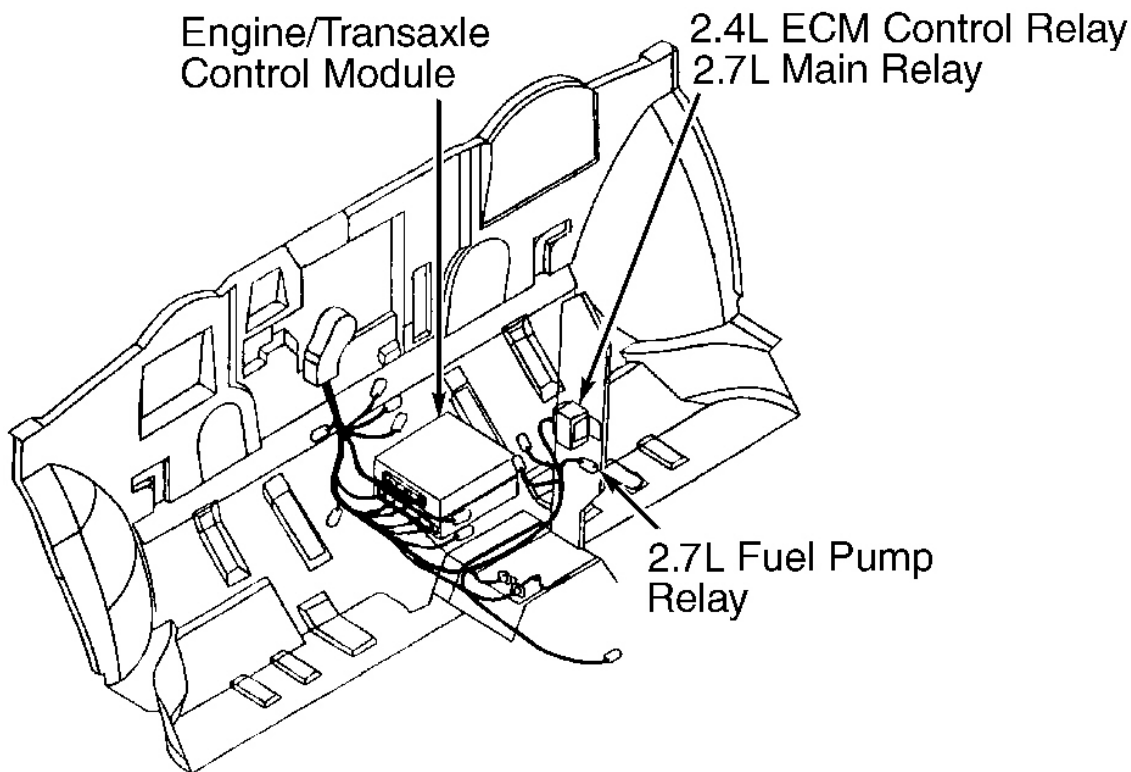
Fuel pump is electric in-tank type. Remove fuel filler cap. To operate fuel pump, jumper DLC terminals FUEL PUMP and (B+). On Optima, DLC is located on left side under dash. On models except Optima, DLC is located on left side of engine compartment. See **Fig. 1 -Fig. 3** . Turn ignition on and listen at fuel filler neck for fuel pump operation sound. If fuel pump operation sound is not heard, do the following:

1. Check fuel system relays. See **FUEL SYSTEM RELAYS** for proper relay operation. If relays are operating properly, go to next step. If relays are not operating properly, replace relays as necessary.
2. Check for battery voltage and good ground at fuel pump harness connector. For fuel pump harness connector identification, location and circuit testing, see **WIRING DIAGRAMS** article. If battery voltage and ground are found acceptable, go to next step. If battery voltage or ground is not found acceptable, repair or replace wiring and connectors as necessary.
3. After fuel system fuses, relays, wiring and connectors check at good operating condition, replace electric in-tank type fuel pump. For fuel pump replacement, see **FUEL PUMP** under FUEL SYSTEM in REMOVAL, OVERHAUL & INSTALLATION article.

FUEL SYSTEM RELAYS

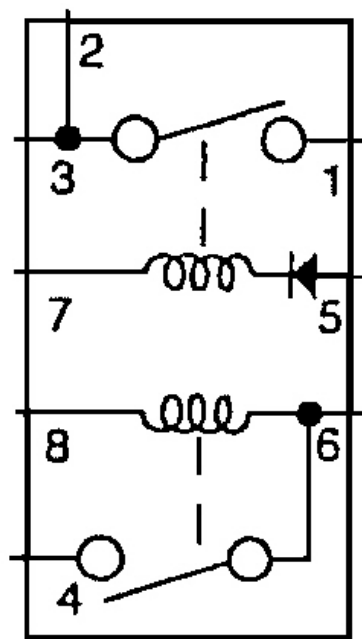
ECM Control Relay (Optima 2.4L)

1. Remove ECM control relay located in vehicle right side of dash. See **Fig. 12** . Check for continuity between relay terminals No. 1 and No. 3. See **Fig. 13** . If continuity does not exist, go to next step. If continuity exists, replace relay.
2. Check for continuity between relay terminals No. 4 and No. 6. See **Fig. 13** . If continuity does not exist, go to next step. If continuity exists, replace relay.
3. Connect a jumper wire between positive battery terminal and relay terminal No. 5. Connect another jumper wire between negative battery terminal and relay terminal No. 7. Check continuity between relay terminals No. 1 and No. 3. If continuity exists, go to next step. If continuity does not exist, replace relay.
4. Connect a jumper wire between positive battery terminal and relay terminal No. 6. Connect another jumper wire between negative battery terminal and relay terminal No. 8. Check for battery voltage at terminal No. 4. Voltage should exist. If battery voltage does not exist, replace relay.



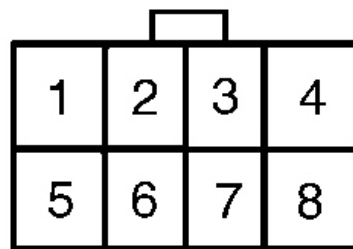
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Fig. 12: Locating ECM Control, Fuel Pump & Main Relays (Optima 2.4L & 2.7L)
Courtesy of KIA MOTORS AMERICA, INC.



ECM CONTROL RELAY

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ECM CONTROL RELAY CONNECTOR

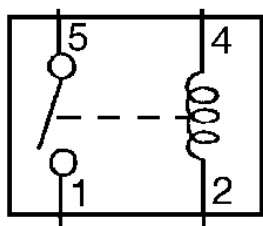
- | | |
|--------------|----------------|
| 1. Pink | 5. Orange |
| 2. Orange | 6. Pink |
| 3. Orange | 7. Tan |
| 4. Gray/Gray | 8. Green/White |

Fig. 13: Identifying ECM Control Relay, Connector & Terminals (Optima 2.4L)
Courtesy of KIA MOTORS AMERICA, INC.

Fuel Pump & Main Relays (Optima 2.7L)

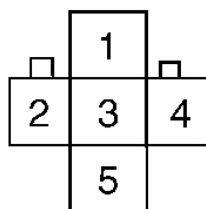
NOTE: Use same procedure to check fuel pump or main relay.

1. Remove fuel pump or main relay, located in vehicle right side of dash. See **Fig. 12** . Check for continuity between relay terminals No. 1 and No. 5. See **Fig. 14** . If continuity does not exist, go to next step. If continuity exists, replace relay.
2. Connect a jumper wire between positive battery terminal and relay terminal No. 4. Connect another jumper wire between negative battery terminal and relay terminal No. 2. Go to next step.
3. Check continuity between relay terminals No. 1 and No. 5. Continuity should exist. If continuity does not exist, replace relay.

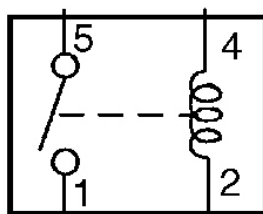


1. Gray
2. Green/White
3. Not Used

FUEL PUMP RELAY

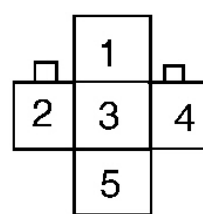


4. Pink
5. Red



1. Pink
2. Blue
3. Not Used

MAIN RELAY



4. Orange
5. Orange

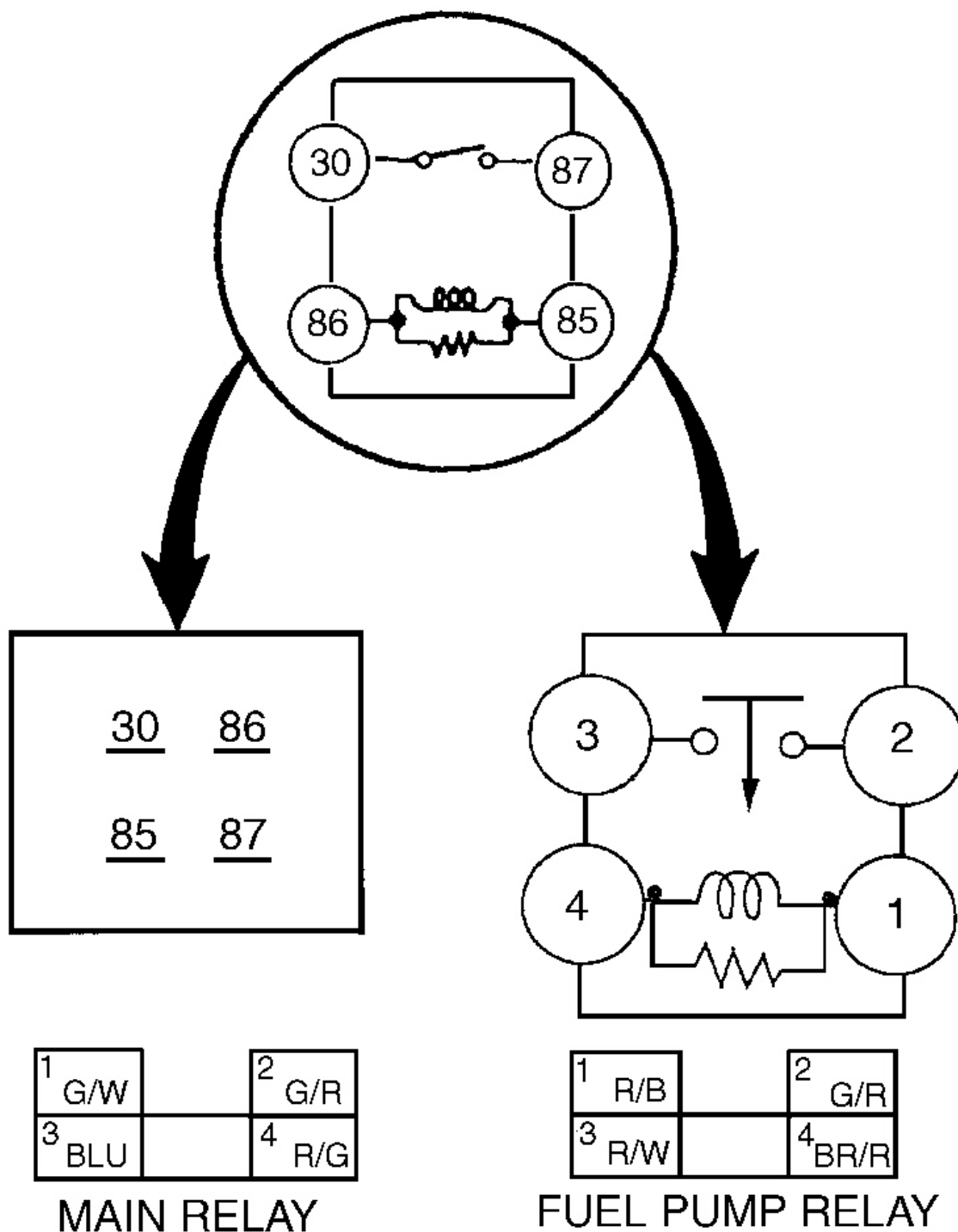
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Fig. 14: Identifying Fuel Pump & Main Relays, Connector & Terminals (Optima 2.7L)
 Courtesy of KIA MOTORS AMERICA, INC.

Fuel Pump & Main Relays (Rio)

NOTE: Use same procedure to check fuel pump or main relay.

1. Remove fuel pump or main relays from fuse/relay box. Located at left side of engine compartment. Check for continuity between relay terminals No. 2 and No. 3. See **Fig. 15** . If continuity does not exist, go to next step. If continuity exists, replace relay.
2. Connect a jumper wire between positive battery terminal and relay terminal No. 1. Connect another jumper wire between negative battery terminal and relay terminal No. 4. Go to next step.
3. Check continuity between relay terminals No. 2 and No. 3. Continuity should exist. If continuity does not exist, replace relay.



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Fig. 15: Identifying Fuel Pump & Main Relays, Connector & Terminals (Rio)
 Courtesy of KIA MOTORS AMERICA, INC.

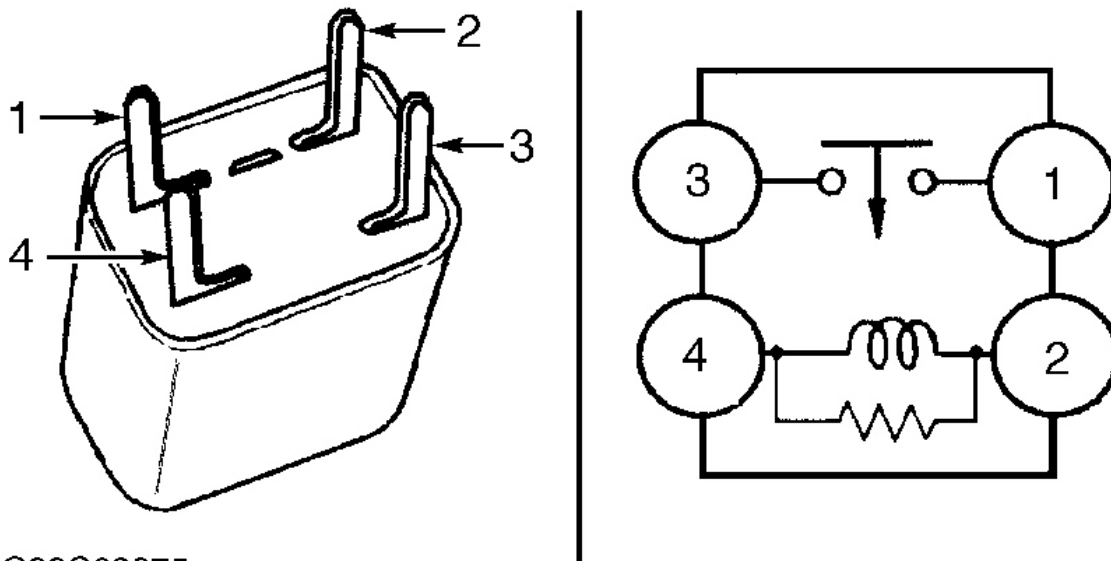
Fuel Pump & Main Relays (Sedona)

NOTE: Testing for fuel pump and main relays for Sedona is not available from manufacturer.

Fuel Pump & Main Relays (Spectra)

NOTE: Use same procedure to check fuel pump or main relay.

1. Remove fuel pump or main relay from fuse/relay box. Located at left side of engine compartment. Check for continuity between relay terminals No. 1 and 3. See **Fig. 16** . If continuity does not exist, go to next step. If continuity exists, replace relay.
2. Connect a jumper wire between positive battery terminal and relay terminal No. 2. Connect another jumper wire between negative battery terminal and relay terminal No. 4.
3. Check continuity between relay terminals No. 1 and 3. Continuity should exist. If continuity does not exist, replace relay.



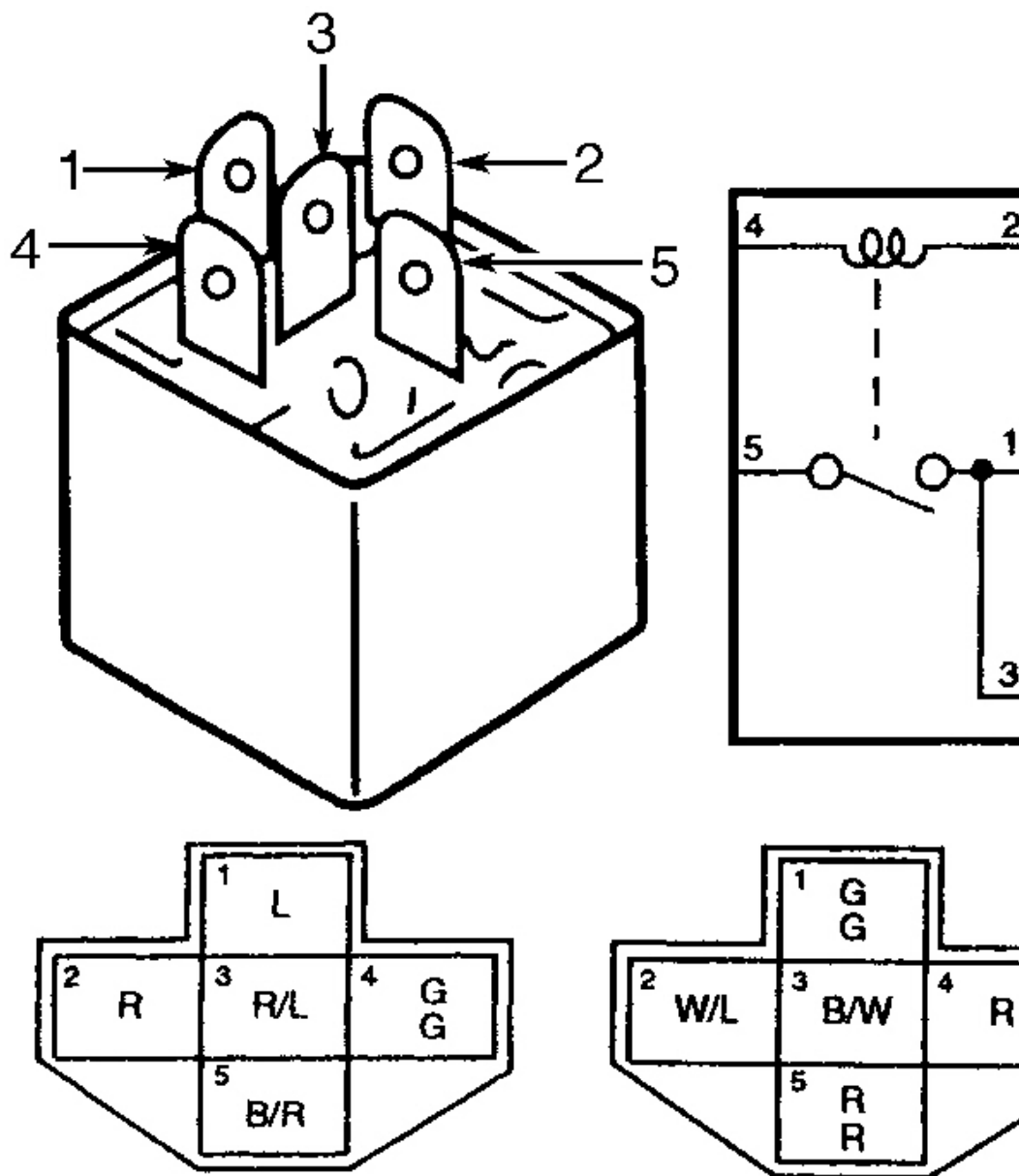
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Fig. 16: Identifying Fuel Pump & Main Relays Terminals (Spectra)
Courtesy of KIA MOTORS AMERICA, INC.

Fuel Pump & Main Relays (Sportage)

NOTE: Use same procedure to check fuel pump or main relay.

1. Remove fuel pump or main relay from fuse/relay box. Located at right side of engine compartment. Check for continuity between relay terminals No. 1 and 5. See **Fig. 17** . If continuity does not exist, go to next step. If continuity exists, replace relay.
2. Connect a jumper wire between positive battery terminal and relay terminal No. 4. Connect another jumper wire between negative battery terminal and relay terminal No. 2.
3. Check continuity between relay terminals No. 1 and 5. Continuity should exist. If continuity does not exist, replace relay.



FUEL PUMP RELAY

MAIN RELAY

G00082406

Fig. 17: Identifying Fuel Pump & Main Relays, Connector & Terminals (Sportage)
 Courtesy of KIA MOTORS AMERICA, INC.

FUEL INJECTORS

Fuel Injector Inspection

1. Warm up engine and let idle. Using screwdriver or stethoscope, listen to each injector. Clicking sound should be heard. If no sound is heard, measure resistance of each injector. See **Fig. 18** . Replace injectors

that do not meet specification. To replace injectors, see appropriate FUEL DELIVERY PIPE & FUEL INJECTORS under **FUEL SYSTEM** in REMOVAL, OVERHAUL & INSTALLATION article. If injectors are okay, and no operational sound is heard. Go to next step.

2. Check wiring to injectors. Ensure electrical connectors fit tightly and are not corroded. For circuit testing, see **WIRING DIAGRAMS** article.

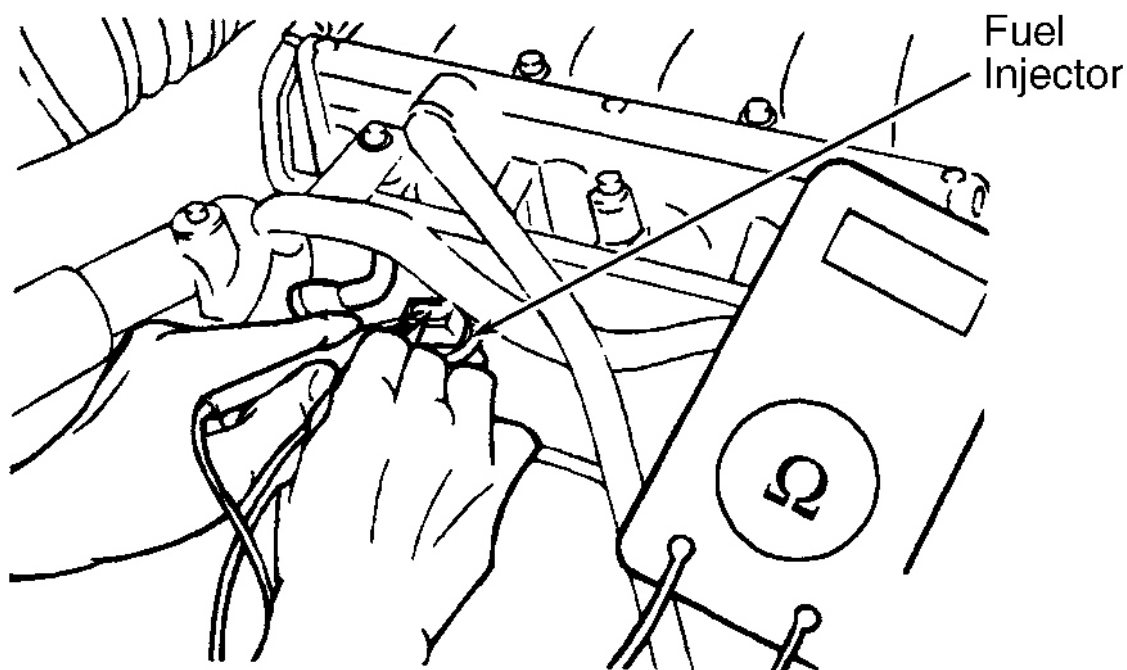
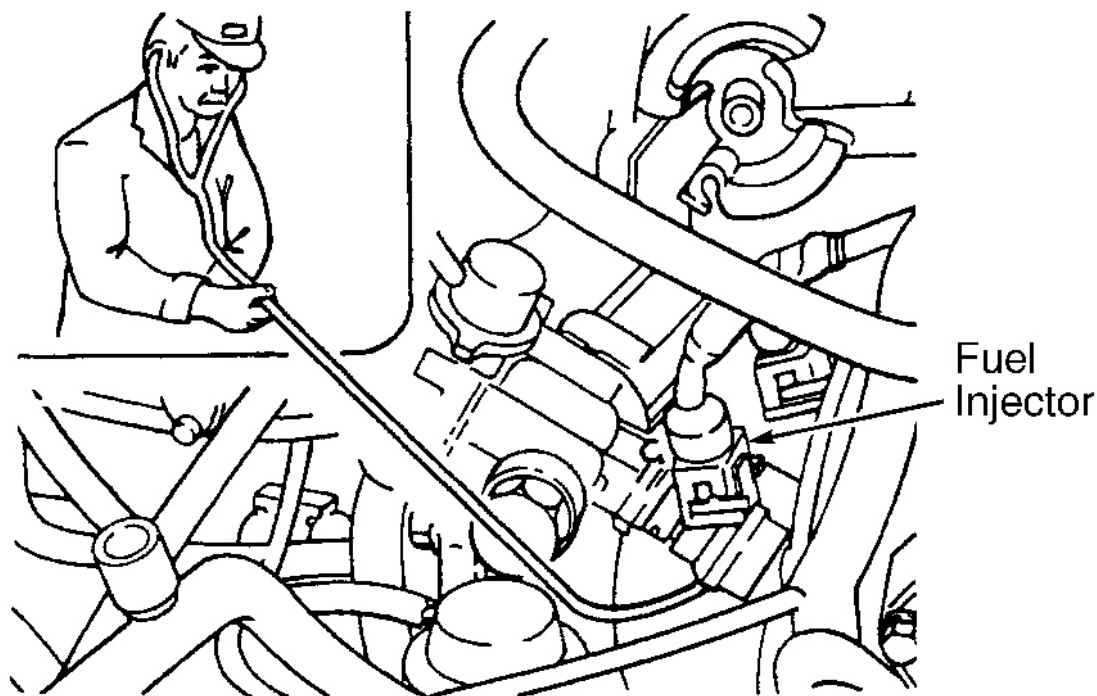
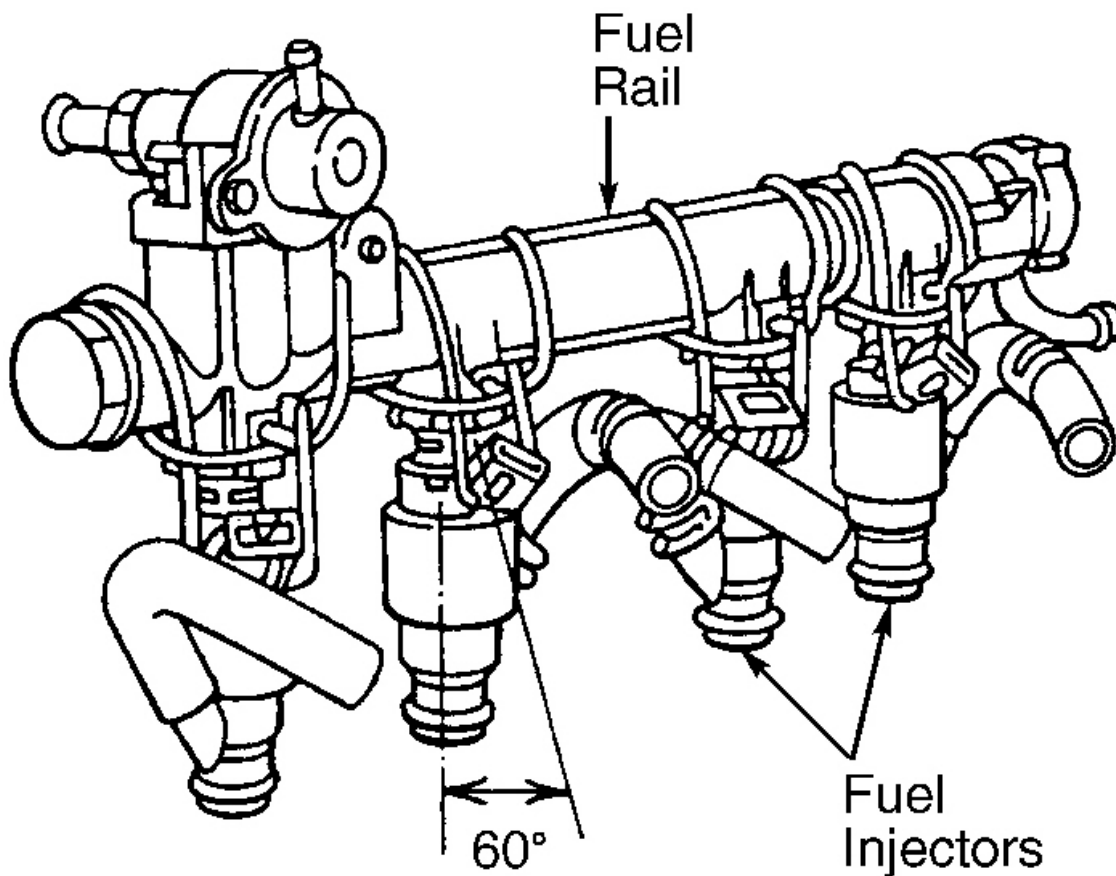


Fig. 18: Checking Fuel Injector Operation & Resistance
Courtesy of KIA MOTORS AMERICA, INC.

Fuel Injector Leakage Test

1. Remove fuel injectors together with fuel rail. For fuel injectors removal, see appropriate FUEL DELIVERY PIPE & FUEL INJECTORS under **FUEL SYSTEM** in REMOVAL, OVERHAUL & INSTALLATION article. Using wire, secure fuel injectors to fuel rail. See **Fig. 19** . Leave harness connected to fuel injectors.
2. Ensure fuel hoses are connected to fuel rail. To operate fuel pump, jumper DLC terminals FUEL PUMP and (B+). On Optima, DLC is located on left side under dash. On all other models, DLC is located on left side of engine compartment. See **Fig. 1 -Fig. 3** .
3. Turn ignition on. Tilt injectors 60 degrees and watch for leaks. Replace any injectors that leak. Use new "O" rings when installing injectors.



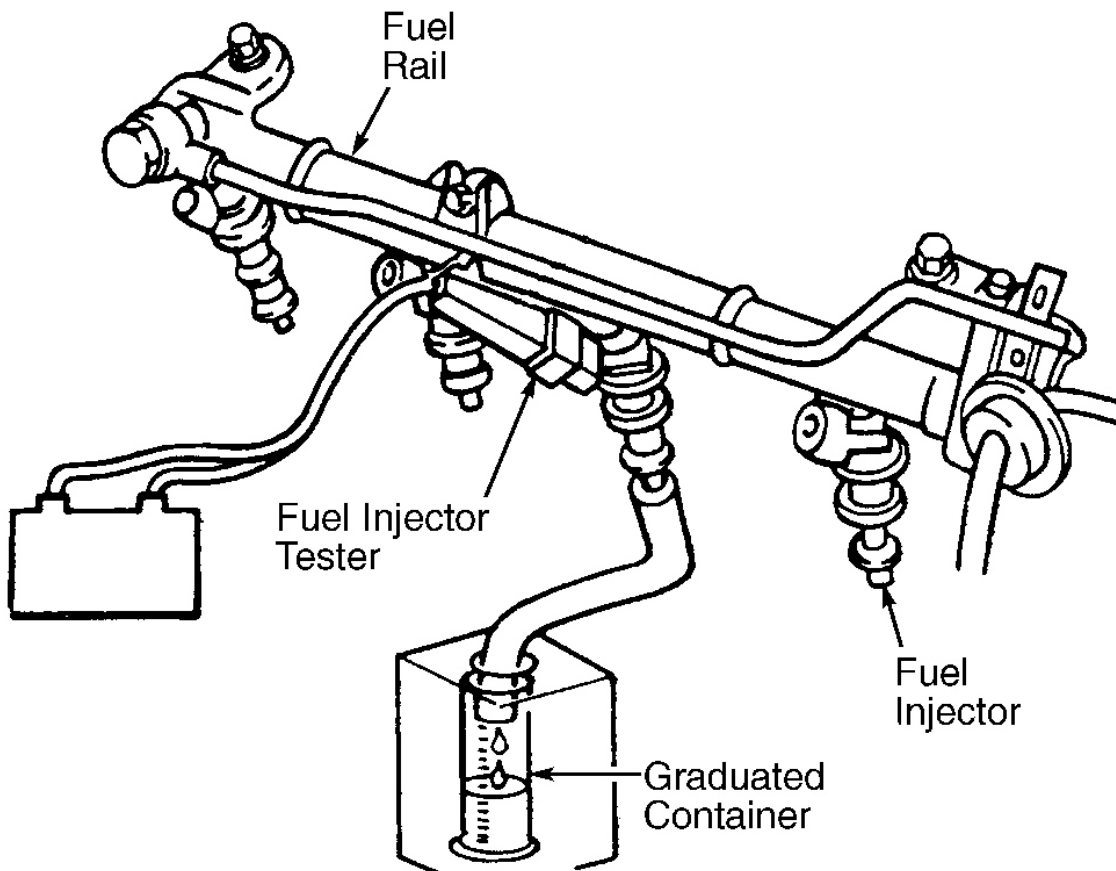
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Fig. 19: Securing Fuel Injectors To Fuel Rail Assembly
Courtesy of KIA MOTORS AMERICA, INC.

Fuel Injector Volume Test

NOTE: Injector volume specification for Optima, Rio and Sedona is not available from manufacturer.

1. Remove fuel injectors together with fuel rail. For fuel injectors removal, see appropriate FUEL DELIVERY PIPE & FUEL INJECTORS under **FUEL SYSTEM** in REMOVAL, OVERHAUL & INSTALLATION article. Secure fuel injectors to fuel rail. See **Fig. 19** . Place end of injector to be tested in graduated cylinder.
2. If using injector tester, connect injector tester between battery and injector. See **Fig. 20** . If not using injector tester, reconnect injector connectors. Connect jumper wire between injector to ECM wire and ground. See **WIRING DIAGRAMS** article for wire colors.
3. Turn ignition on. Time injector flow and measure volume. Injector flow should be 4.4 oz. (130 ml) per minute. If volume is not as specified, replace injector. Use NEW "O" rings when installing injectors.



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Fig. 20: Performing Fuel Injector Volume Test
Courtesy of KIA MOTORS AMERICA, INC.

IGNITION CHECKS

SPARK

NOTE: All models are equipped with a Distributorless Ignition System (DIS).

NOTE: Ensure high tension leads are routed properly after removal and installation.

Check for spark at each spark plug wire using a high output spark tester. Check spark plug wire resistance on suspect wires. High tension wire resistance should not exceed 16,000 ohms per 3.3 feet.

CAMSHAFT POSITION SENSOR

Camshaft Position Sensor (CMP) sensor detects No. 1 piston at TDC of compression stroke. ECM uses input for fuel and ignition control. For CMP sensor testing, see **CAMSHAFT POSITION SENSOR** under SENSORS & SWITCHES in SYSTEM & COMPONENT TESTING article.

CRANKSHAFT POSITION SENSOR

Crankshaft Position Sensor (CKP) sensor detects crankshaft angle. ECM uses input to determine engine speed, misfire detection, and for fuel and ignition control. For CKP sensor testing, see **CRANKSHAFT POSITION SENSOR** under SENSORS & SWITCHES in SYSTEM & COMPONENT TESTING article.

IGNITION COIL POWER SOURCE

Ensure ignition is off. Disconnect ignition coil harness connectors. Turn ignition on. Check for battery voltage at ignition power source wire. To identify wire, see **IGNITION COIL POWER SOURCE** table. On all models, if battery voltage is not present, check battery feed circuit, main fuse, ignition switch and wiring harness.

IGNITION COIL POWER SOURCE

Application	Coil (+) Terminal Wire Color
Optima	Pink/Black
Rio	
Coil 1	Yellow/Green
Coil 2	Yellow
Sedona	Red
Spectra	Yellow
Sportage	White/Red

IGNITION COIL RESISTANCE

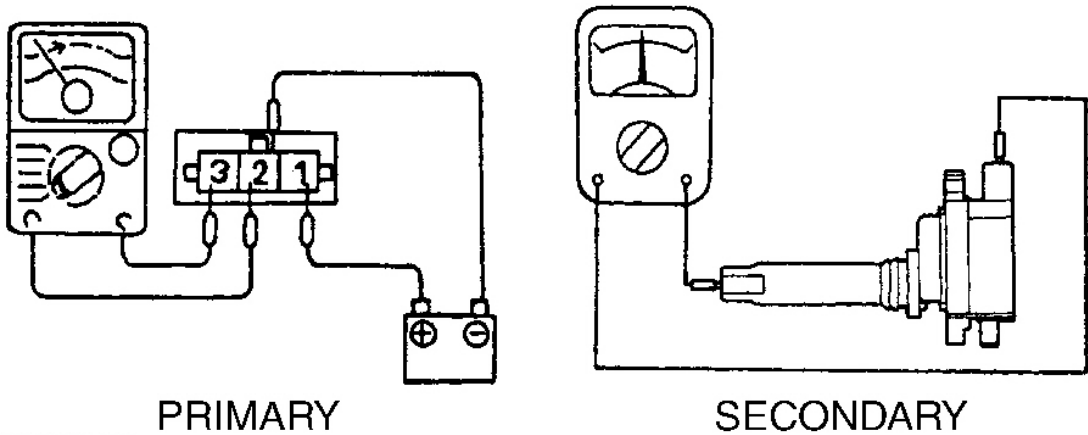
Optima 2.4L & Sedona

NOTE: Power transistor is built into ignition coil.

To perform primary coil resistance check, connect negative (-) terminal of a 3 volt power supply to terminal No. 2 of power transistor. See **Fig. 21** . Check for continuity, about .78 Ohm, between terminals No. 2 and 3.

Continuity should exist when terminal No. 1 is connected to 3 volt power (+) supply. When 3 volt power supply is removed, continuity should no longer exist. If problem exists, replace power transistor/ignition coil. To test secondary resistance measure resistance between high-voltage terminals of ignition coil, see **Fig. 21** . For resistance specification, see **IGNITION COIL RESISTANCE** table.

Terminal 1 and (+) terminal	Terminal 3 and terminal 2
Connected	Continuity (Approximately 0.78Ω)
Disconnected	No continuity

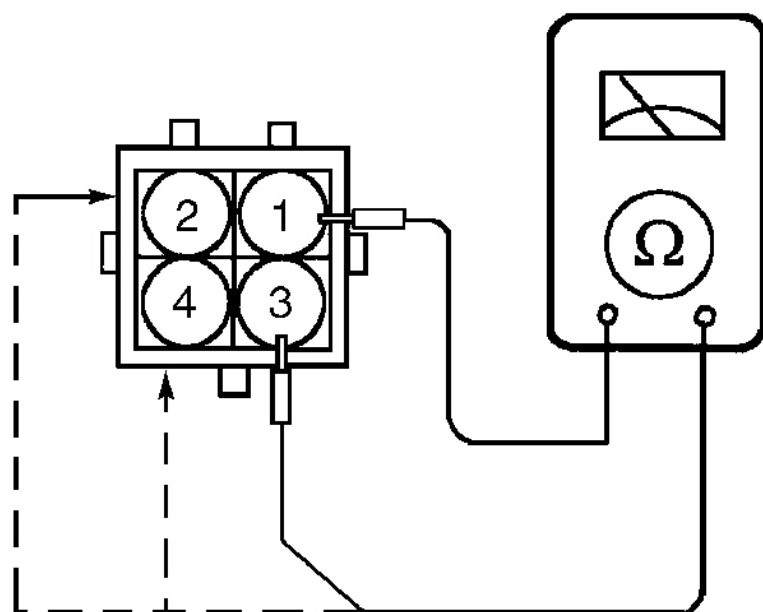


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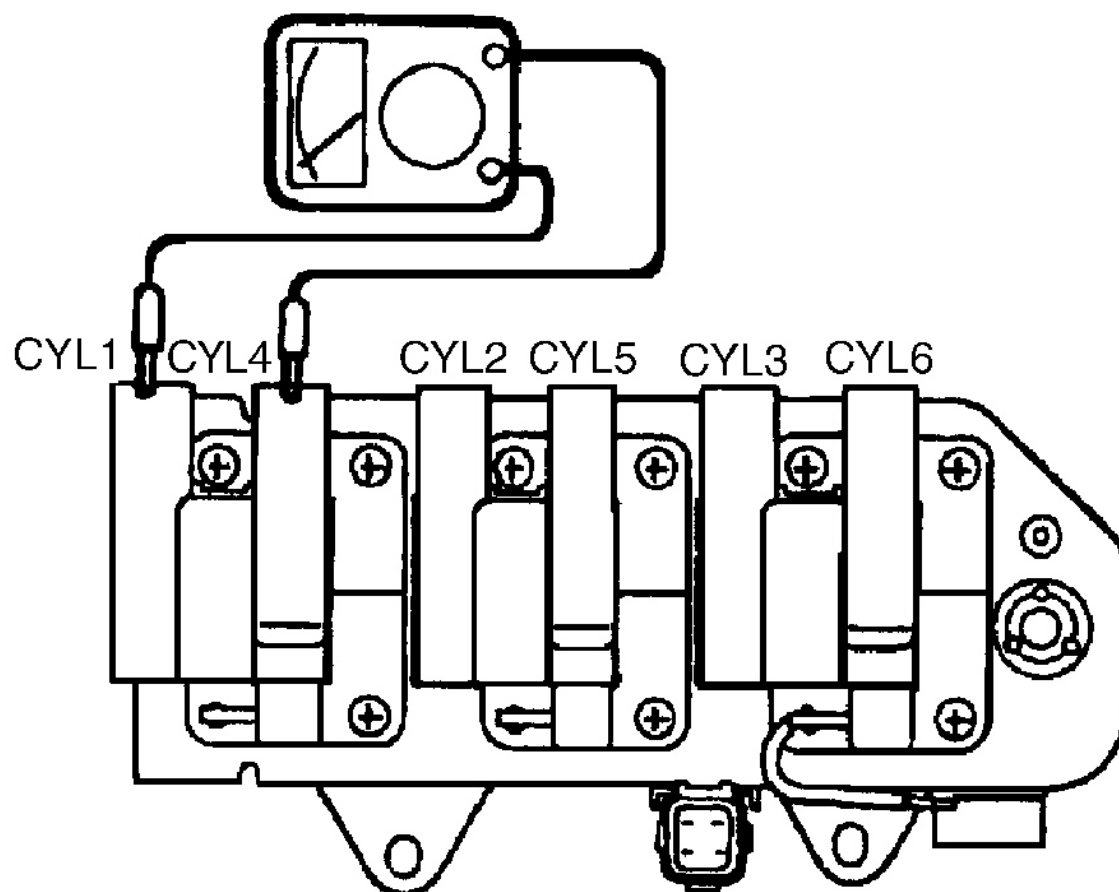
Fig. 21: Checking Primary & Secondary Coil Resistance (Optima 2.4L & Sedona)
Courtesy of KIA MOTORS AMERICA, INC.

Optima 2.7L

Measure resistance between connector terminals No. 1 and 2, 1 and 3 and 1 and 4. See **Fig. 22** . For ignition coil resistance, see **IGNITION COIL RESISTANCE** table. If resistance is not as specified, replace coil pack.



PRIMARY

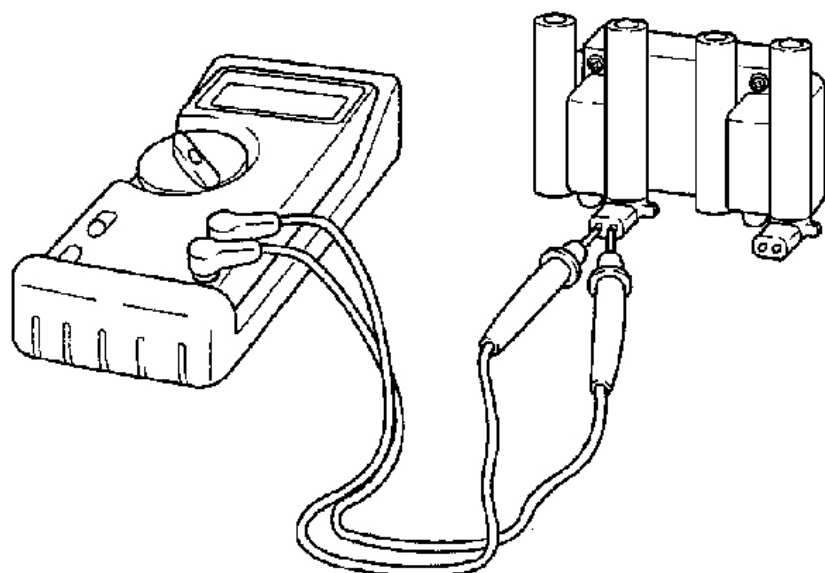


SECONDARY

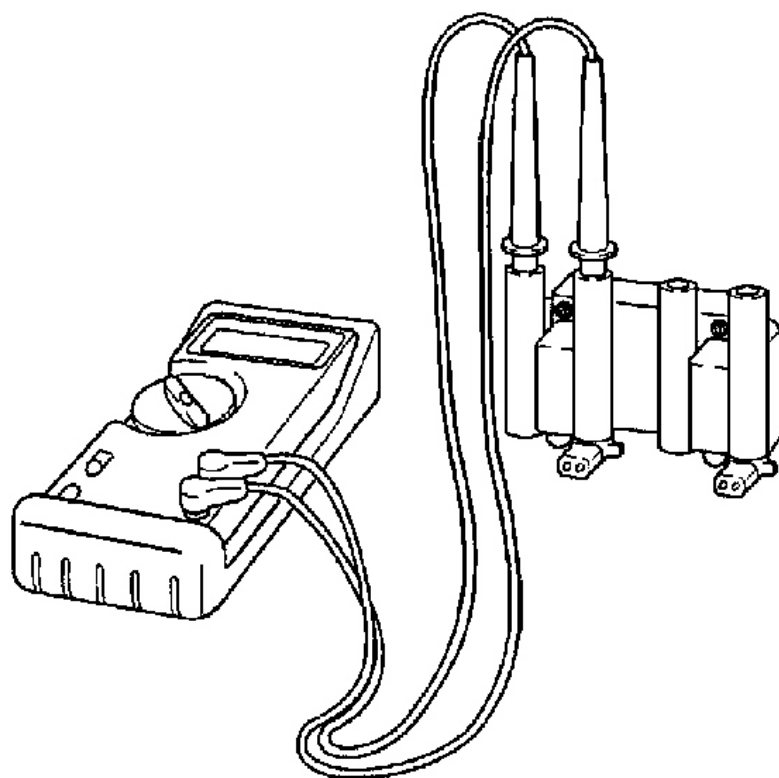
Fig. 22: Checking Primary & Secondary Coil Resistance (Optima 2.7L)
Courtesy of KIA MOTORS AMERICA, INC.

Rio, Spectra & Sportage

To check primary coil resistance, disconnect ignition coil harness connector. Using ohmmeter, check primary resistance between positive (+) and negative (-) terminal of coil or coil pack. Check secondary resistance between coil towers. For resistance check procedure on Rio, see **Fig. 23** . For Spectra and Sportage resistance check procedure, see **Fig. 24** . And see **IGNITION COIL RESISTANCE** table for resistance specification. If readings are not within specification, replace ignition coil(s).



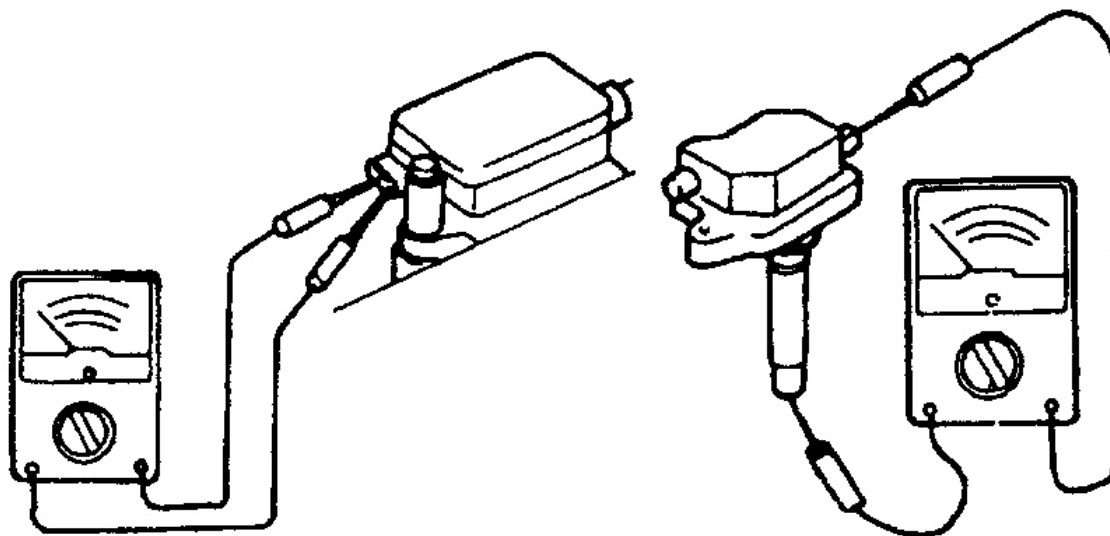
PRIMARY



SECONDARY

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Fig. 23: Checking Primary & Secondary Coil Resistance (Rio)
Courtesy of KIA MOTORS AMERICA, INC.



PRIMARY

SECONDARY

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Fig. 24: Checking Primary & Secondary Coil Resistance (Spectra & Sportage)
 Courtesy of KIA MOTORS AMERICA, INC.

IGNITION COIL RESISTANCE - Ohms @ 68°F (20°C)

Application	Primary	Secondary
Optima		
2.4L	.78	20,000
2.7L	.74-.81	13,300-15,300
Rio	.60-.80	11,000-15,000
Sedona	.78	13,000
Spectra & Sportage	.45-.55	13,000-15,000

BASE IDLE SPEED & BASE IGNITION TIMING

BASE IDLE SPEED INSPECTION/ADJUSTMENT

NOTE: Base idle speed is not adjustable (except Sedona). The following procedure is for checking base idle speed only. If base idle speed is not within specification, check for dirty throttle bore(s), faulty Intake Air Control (IAC) motor or defective Engine Control Module (ECM).

NOTE: Before base idle speed inspection or adjustment, ensure base ignition timing is within specification. See BASE IGNITION TIMING table under BASE IGNITION TIMING INSPECTION.

NOTE: **Base idle speed inspection procedure for Optima is not available from manufacturer.**

Rio, Spectra & Sportage

Ensure engine is at normal operating temperature. Turn off all electrical loads. Set transaxle or transmission in Park or Neutral and steering wheel on straight forward position. Connect non-inductive tachometer positive lead to terminal No. 3 of underhood Data Link Connector (DLC), or tachometer inductive pick-up on spark plug wire. See **Fig. 2** . Start engine and allow it to idle. Check idle speed. See **IDLE SPEED SPECIFICATIONS** table.

Sedona

Ensure engine is at normal operating temperature. Turn off all electrical loads. Set transaxle in Park or Neutral and steering wheel on straight ahead position. Loosen the accelerator cable. Connect tachometer to spark plug wire. Ground No. 8 and ignition timing adjustment terminals of underhood Data Link Connector (DLC). See **Fig. 3** . Run engine for 5 seconds at 2000-3000 RPM. Let engine idle for 2 minutes. Check engine base idle speed. See **IDLE SPEED SPECIFICATIONS** table. If base idle speed is out of specification, adjust using the idle speed adjustment screw, located on throttle body assembly. Turn ignition off. Disconnect ground lead wires from DLC. Run engine for 10 minutes. Recheck engine idle speed. Adjust accelerator cable.

IDLE SPEED SPECIFICATIONS

Application	(1) RPM
Optima	
2.4L	700-900
2.7L	600-800
Rio	700-800
Sedona	600-800
Spectra	750-850
Sportage	770-870
(1) With engine at normal operating temperature and all electrical loads off.	

BASE IGNITION TIMING INSPECTION

NOTE: **Base ignition timing is not adjustable. The following procedure is for inspection only.**

NOTE: **Before base ignition timing inspection. Ensure base idle speed is within specifications. See IDLE SPEED SPECIFICATIONS table under BASE IDLE SPEED INSPECTION/ADJUSTMENT.**

Optima

Base ignition timing inspection procedure for Optima is not available from manufacturer.

Rio & Spectra

Ensure engine is at normal operating temperature. Turn off all electrical loads. Set transaxle in Park or Neutral and steering wheel on straight forward position. Remove provided inspection rubber plug on plastic coils cover, over number one spark plug wire. Connect timing light inductive pick-up to number one spark plug wire. If timing light inductive pick-up is too large, plastic coils cover have to be removed. Start engine and allow it to idle. Check base ignition timing. Timing mark on crankshaft pulley and mark on timing belt cover should be aligned to specification. See **BASE IGNITION TIMING** table. If timing is not within specification, check for faulty sensor or incorrect camshaft timing. Check power and grounds. If camshaft timing, sensors, power and grounds are okay, replace Engine Control Module (ECM).

Sedona

Ensure engine is at normal operating temperature. Turn off all electrical loads. Set transaxle in Park or Neutral and steering wheel on straight forward position. Ground ignition timing adjustment terminal of underhood Data Link Connector (DLC). See **Fig. 3** . Start engine and allow it to idle. Check base ignition timing. Timing mark on crankshaft pulley and mark on timing belt cover should be aligned to specification. See **BASE IGNITION TIMING** table. If timing is not within specification, check for faulty sensor or incorrect camshaft timing. Check power and grounds. If camshaft timing, sensors, power and grounds are okay, replace Engine Control Module (ECM).

Sportage

Ensure engine is at normal operating temperature. Turn off all electrical loads. Set transmission in Park or Neutral and steering wheel on straight forward position. Connect timing light inductive pick-up to number one spark plug wire. Start engine and allow it to idle. Check base ignition timing. Timing mark on crankshaft pulley and mark on timing belt cover should be aligned to specification. See **BASE IGNITION TIMING** table. If timing is not within specification, check for faulty sensor or incorrect camshaft timing. Check power and grounds. If camshaft timing, sensors, power and grounds are okay, replace Engine Control Module (ECM).

BASE IGNITION TIMING

Application	Degrees BTDC @ Idle
Optima	
2.4L	3-7
2.7L	7-17
Rio	1-11
Sedona	8-12
Spectra	(1)
Sportage	0-12
(1) 5 degrees ATDC to 15 degrees BTDC.	

SUMMARY

If no faults were found while performing **BASIC DIAGNOSTIC PROCEDURES** , proceed to appropriate SELF-DIAGNOSTICS article. If no hard codes are found in self-diagnostics, proceed to **TROUBLE SHOOTING - NO CODES** article for diagnosis by symptom (i.e., ROUGH IDLE, NO START, etc.) or intermittent diagnostic procedures.