

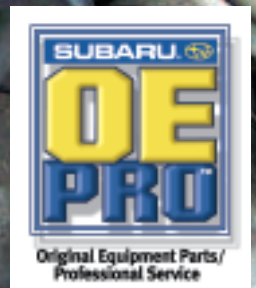
The End Wrench®

A Publication for Professional Repair Technicians from Subaru N.E.W. Horizons Dealers

SUBARU 

Spring 2002 Number 18 \$6

Subaru Fuel & Emissions



Information Inside

Talk about Genuine Customer Appeal!

For the enhanced driving experience and responsiveness that performance enthusiasts crave, Subaru Performance Tuning Components are now available in more applications than ever. You can offer your most avid Subaru customers quicker steering response, racing quality shift action and quicker acceleration, plus performance styling touches that ardent WRX or '98 and later Impreza 2.5 RS drivers will love.



Genuine Subaru Performance Parts

Up to 2001 Impreza 2.5 RS



Description	Part #	MSRP
Rear Differential Protector	B0310ASS000	\$ 68.95
Short Throw Shifter	C1010FA000	\$260.00
Titanium Shift Knob (Sti)	C1010FA100	\$ 149.95
Carbon Fiber Shift Knob-M/T	C1010FA140	\$ 175.00
Carbon Fiber Parking Brake Lever	C1010FC121	\$295.00
Strut Tower Brace (Steel)	E4010FA000	\$ 144.95
Strut Tower Brace (Carbon Fiber)	E4010FA100	\$629.00
Gauge Pack (Performance)	H5010FA034	} \$595.00
Gauge Pack Housing (Gray)	H0017FC9100E	
Carbon Fiber Patterned Trim A/T	J1310FA130	\$254.00
Carbon Fiber Patterned Trim M/T	J1310FA140	\$254.00
Carpeted Floor Covers	J5010FS0010E	\$ 69.95
Front End Cover-Hood	M0010FS111	\$ 44.95
Front End Cover-Full	M0010FS140	\$ 119.95
SPT Decal Set (Blue)	SOA588N400	\$ 59.95
SPT Decal (Silver/Blue)	SOA588N450	\$ 59.95
Intermediate Pipe and Muffler	SOA8377500	\$495.00
*SPT Struts from KYB®	SOA837Z1100	\$575.00
*SPT Springs from EIBACH®	SOA855Z1100	\$279.95

* Sold "as is" without any warranty coverage. Intended for off-highway application only. May bring vehicle out of compliance with safety and/or emissions standards. Can only be lawfully installed by end user. See dealer for complete details.

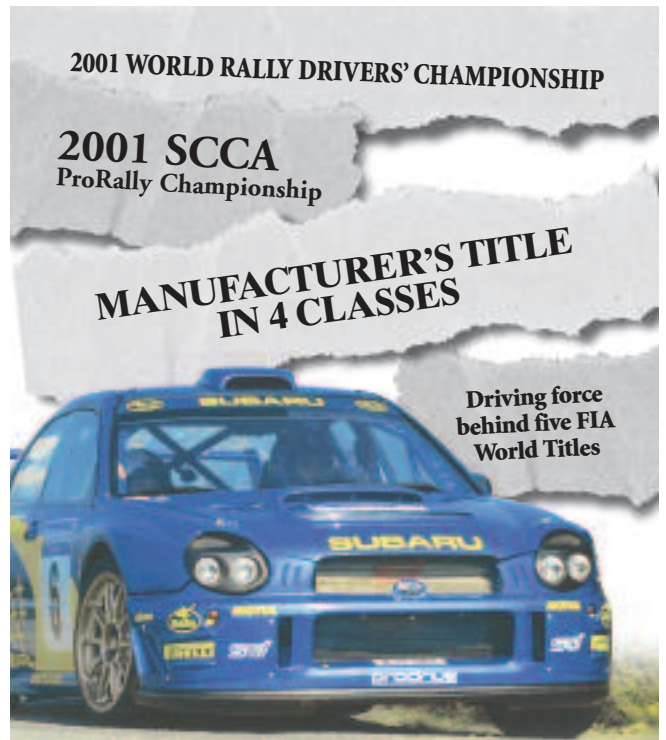
For additional details about the complete lineup of SPT parts and applications for WRX or '98 and later Impreza 2.5 RS models, contact your local authorized Subaru dealer.

Genuine Subaru Performance Mufflers

All Applications MSRP \$375.00



Application	Part #
96-99 LEGACY GT SEDAN	SOA8376300
96-99 LEGACY GT WAGON	SOA8376400
98-01 IMPREZA RS COUPE & SEDAN	SOA8376500
00-02 LEGACY GT SEDAN	SOA8377300
00-02 LEGACY GT WAGON	SOA8377400



2001 WORLD RALLY DRIVERS' CHAMPIONSHIP

2001 SCCA ProRally Championship

MANUFACTURER'S TITLE IN 4 CLASSES

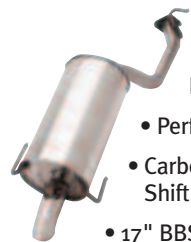
Driving force behind five FIA World Titles

Race Tested

Our growing line of performance parts is engineered specifically for the Subaru Impreza WRX or '98 and newer 2.5 RS.



- Strut Tower Braces
- Short-Throw Shifter
- Performance Mufflers and Intermediate Pipes
- Titanium Shift Knob
- Performance Suspension Parts Eibach® Springs, KYB® Struts
- Performance Gauges
- Carbon Fiber Trim Kits, Shift Knob and Brake Handle



- 17" BBS Forged and Subaru Pressure Cast Aluminum Alloy Wheels



- Rear Differential Protector
- Ground Effects Kits
- Front End Cover
- SPT Decals
- Rear Decklid Spoiler



To find your local dealer call 1-800-SUBARU3 or visit us online at www.subaru.com.

SUBARU
Genuine Parts

Not all parts applicable to all models/model years. See your local Subaru dealer for details.

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Caution:
Vehicle servicing performed
by untrained persons could
result in serious injury
to those persons or others.

Information contained in this newsletter is intended for use by trained, professional auto repair technicians ONLY. This information is provided to inform these technicians of conditions which may occur in some vehicles or to provide information which could assist them in proper servicing of these vehicles.

Properly trained technicians have the equipment, tools, safety instructions, and know-how to perform repairs correctly and safely. If a condition is described, DO NOT assume that a topic covered in these pages automatically applies to your vehicle or that your vehicle has that condition.

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The End Wrench®

A Publication for Professional Repair Technicians from Subaru N.E.W. Horizons Dealers

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This article provides information about the Subaru Legacy fuel injection and engine management systems.

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Our commitment to help you keep your customers satisfied and coming back to you for their Subaru service and repairs has not changed. In fact, there are more parts being offered under the Subaru O.E. PRO banner than ever.

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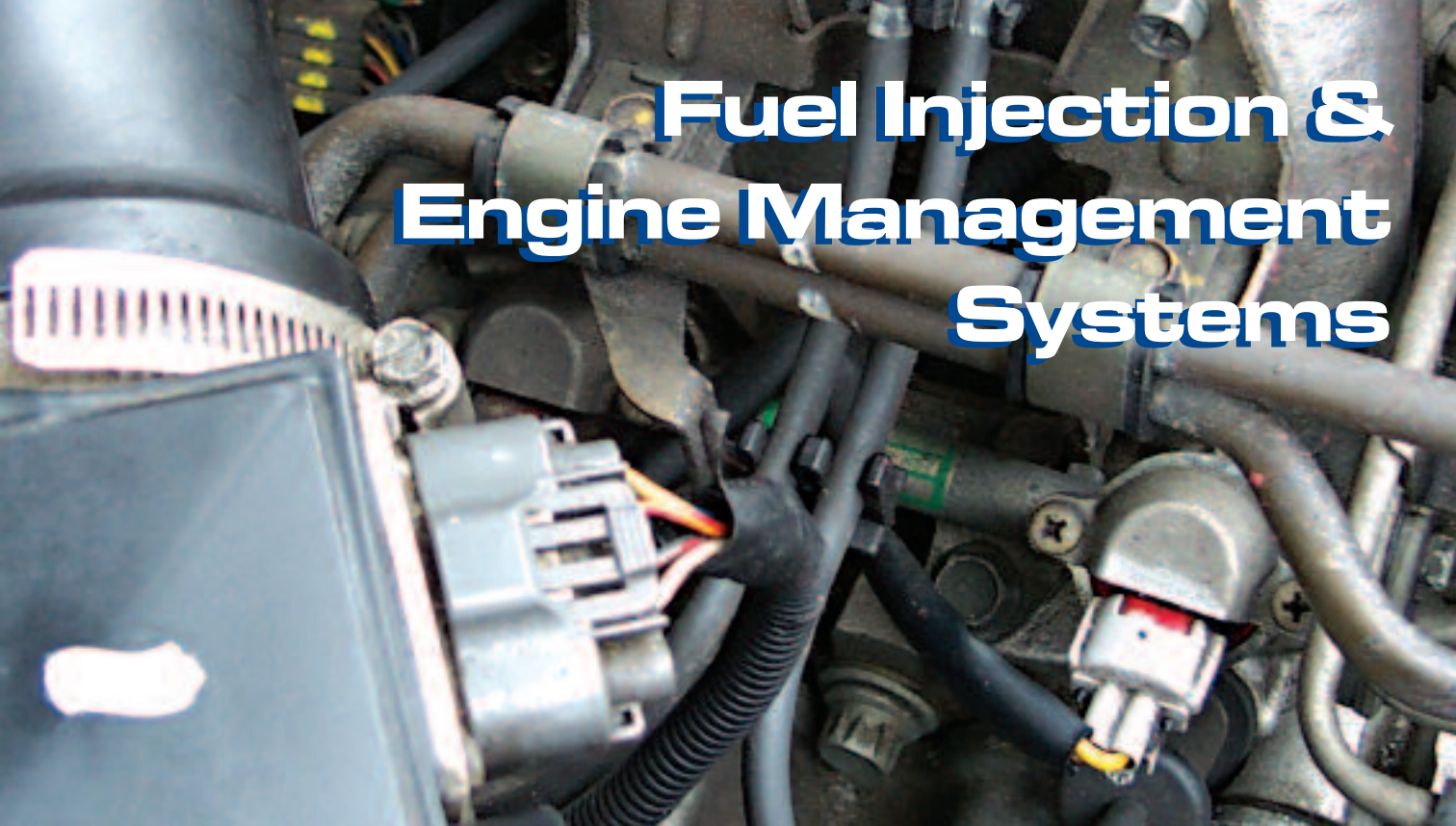
Subaru N.E.W. Horizons Dealers have been recognized for their outstanding performance in serving the wholesale market. They provide you with a direct wholesale parts hotline and also maintain a large inventory of competitively priced Genuine Subaru Parts.

www.endwrench.com

Whether you need quick reference to an article about Subaru repair or part numbers for the cylinder heads in a 1996 Subaru Legacy, you'll find the information you need when you visit the new *End Wrench* web site at www.endwrench.com.



Fuel Injection & Engine Management Systems



This article provides information about the Subaru Legacy fuel injection and engine management systems. The fuel injection and engine management systems on other Subaru models, while similar to the Legacy systems, contain key differences that will be addressed in a future *End Wrench*.

Air Induction System

The air induction system provides the correct amounts of air to the cylinders under a variety of operating conditions and performance demands. Components include:

- Air Induction Piping
- Mass Air Flow Meter
- Throttle Body
- Idle Air Control Valve

The air induction piping delivers air from the air filter to the throttle body, idle air control valve and the PCV system. Fittings to the components of the air induction system must be air-tight to prevent unmetered air from entering the intake manifold.

Mass Air Flow Meter

Monitoring the amount of air inducted is the main function of the mass air

flow meter. Described as a “hot wire” air flow meter containing no moving parts, the Subaru mass air flow meter obtains information by monitoring the voltage of a single wire which is exposed to the incoming air flow. There are actually two wires exposed to the air flow. The hot wire is positioned downstream of the cold wire to prevent any influence to the cold wire. The engine control module (ECM) logic monitors the temperature of both wires using stored information about their resistance values and the voltage in the wire. The ECM attempts to maintain a



Air Flow Meter

fixed difference in the temperature of these two wires. The amount of voltage applied to the hot wire is what finally determines the value of the signal generated or “Air Quotient.”

Air Quotient (QA), is one of the input signals to the ECM that determines the amount or length of time that fuel is injected. Two other inputs are the throttle position signal, generated by the throttle position switch (TPS) and engine speed (EREV), which is a processed signal determined by the ECM based on input from the crank and cam angle sensors.

Fail-Safe

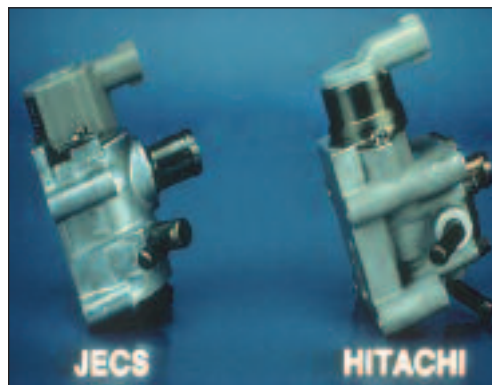
Fail-safe, the action taken by the ECM in the event a component is not operating within established parameters, forces the ECM to determine injection duration using TPS and EREV only.

Mass Air Flow Sensor Circuit Testing

Testing is performed by observing resistance and voltage values. The QA value can be monitored using the Select Monitor. The QA value should increase with engine speed and decrease to approximately 1 volt as engine speed approaches idle. A fail-safe value will result in a constant signal which is not affected by engine speed.

Replacement Parts

The installation of improper replacement parts will result in a driveability or no start condition. Verify with your parts department using Vehicle Identification and Production Date numbers as necessary. For example, early production Legacy vehicles were equipped

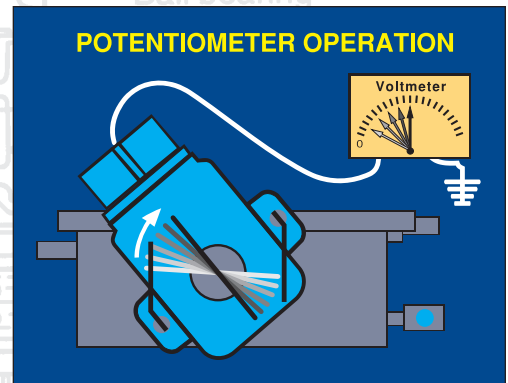


Idle Air Control Valves

with either a JECS or HITACHI produced air flow meter, depending on whether they were automatic or standard shift transmission vehicles.

Throttle Body

The throttle body regulates the amount of air into the intake manifold, controlling off idle engine speed. Operation of the throttle body is accomplished by movement of the accelerator cable. Coolant flows through the base of the throttle body to prevent ice from forming. The throttle body is factory set and no adjustment should be attempted to the throttle plate. Adjustment of the throttle cable is suggested during periodic vehicle maintenance.



TPS Potentiometer Operation

Throttle Position Switch

The throttle position switch (TPS) is mounted to the throttle body and engages the throttle shaft. Any movement of the throttle shaft results in the movement of a contact across a potentiometer. At idle the throttle position switch resistance value is high, so the voltage signal at the moveable contact is low. As the throttle is depressed, the resistance value decreases and the voltage at the moveable contact increases. The voltage signal, which ranges from 0.3 to 5 volts, is used by the ECM to determine the position of the throttle expressed in degrees of opening.

Some Legacy models were equipped with a TPS with an inverted voltage signal. Voltage was approximately 5 volts at idle and decreased as the throttle was depressed.

An idle switch is also included inside the TPS. The idle switch signals idle and off idle to the ECM. Adjust-

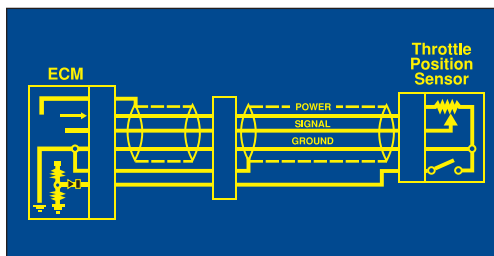
ment of the TPS is possible through the use of its elongated mounting holes.

Fail-safe operation results in a fixed TPS voltage signal while the ECM uses the idle switch, QA and EREV to control injection duration.

Testing of the TPS is performed by observing voltage and resistance values. The Select Monitor on earlier models will display THV or throttle voltage and illuminate an LED when the idle switch signal is present. Newer models will also indicate throttle opening in degrees.

Idle Air Control Valve

Idle Air Control Valve (IAC) operation controls all idle speeds. Construction includes an air cut valve, duty control valve, intake air passage and a coolant passage. These component parts create a dual control over the IAC. The air cut valve is influenced by the temperature of coolant flowing through the IAC. A bimetallic spring is utilized to act on the air cut valve, opening the valve when coolant temperature is low to increase air flow and idle speed. When coolant temperature is high, the bimetallic spring closes the air cut valve and decreases air flow and idle speed.



Throttle Position Sensor Circuit

Duty control valve operation is achieved via two electrical coils, one to open the valve and the other to close it. The ECM controls the ground circuits of the two coils and controls them with a duty signal which pulses the ground circuits.

IAC duty ratio can be monitored with the Select Monitor. A higher duty ratio will keep the valve open longer, increasing idle speed. A lower duty ratio provides lower idle speeds. Optimum idle speed for all engine conditions is part of the ECM logic and the ECM will increase or decrease the IAC duty ratio as necessary to maintain the correct idle speed.

Fail-safe results of the IAC can be

misleading. Failure of the bimetallic spring with the air cut valve in the more open position will not cause a problem when the engine is cold. But as the engine warms the duty ratio of the IAC will be lower than normal to close the duty control valve more to maintain proper idle speed. Failure of the bimetallic spring in the more closed position will result in higher IAC duty ratio with a cold engine but will be normal with a warm engine.



Idle Air Control Valve

Failure of the duty control valve or loss of duty signal will leave the duty control valve fully open. With a cold engine, the air cut valve is also fully open. This quantity of air flowing through the intake air passage would result in an improper high idle speed. To control this condition, the ECM turns off injectors to reduce idle speed. One injector will be disabled for a warm engine and two injectors for a cold engine.

The intake air passage can be contaminated with carbon, which reduces the air flow. This condition would result in a higher than normal IAC duty ratio. If this condition is suspected, clean the IAC valve following procedures outline in the service manual.

Fuel Supply

The fuel supply system supplies, regulates and monitors the flow of gasoline to the injectors. Components include:

- Fuel Tank
- Pump
- Rollover valve
- Separator
- Regulator
- Injectors

The fuel tank houses the fuel pump and a jet pump on AWD models. Interference with the rear differential is

Continued on page 10.

O.E.PRO Helps You Spring Into Action With Plenty of Seasonal Maintenance Opportunities

AS WARMER WEATHER STARTS TO SPREAD THROUGHOUT THE COUNTRY, the opportunities available to make extra revenue really begin to heat up. Nothing perks up a shop's bottom line more than a steady stream of vehicles coming through for routine springtime maintenance check-ups. The turnaround time is fast, the work is relatively easy and



THE BEST PROGRAM TO HELP YOU GROW IS O.E.PRO

the profits are good (especially when a visit leads to more substantial repair work or renews a relationship with a customer who had drifted away.)

Spring maintenance check-ups are also a great time to build customer relationships. Keeping your customers' vehicles operating at peak performance reinforces their driving enjoyment and satisfaction of being a Subaru owner.



Of course, installing only Genuine Subaru Maintenance Parts available in the O.E.PRO Program helps ensure that enjoyment and satisfaction, since these parts are specifically engineered to precise specifications for fit, performance and durability. What's more, they're backed by the Genuine Subaru Parts Limited Warranty.

With some eye-catching promotions and some simple organization, you can generate a constant flow of work through your service bays. Obviously, a spring check-up promotion is a strong event that draws a large number of customers annually. Marketing to your existing customer list via postcards, e-mail or phone should be your first step. But to build your business, try asking your existing customers for referrals. They may know other Subaru owners who they'd be willing to send your way for a token gift or discount in return. You can also advertise Subaru maintenance specials in local newspapers to help build up business.

Some independent repair shops try to create service traffic with specific parts promotions. With the new wiper blades that Subaru is introducing, now is the perfect time to run a "Check Your Blades" promotion. You can spur other fast-moving parts sales by focusing on them in your advertising. Running a "Buy 3 Get the 4th Free" spark plug sale can create interest from sources you may have not tapped recently. The idea is to be inventive and promote aggressively. That way, as the weather heats up, so can your sales.



Subaru Racing Season Gets Off to a Fast Start

The starting tree has been lit and the green has already flashed on brightly for the launch of the Subaru racing season. Drivers of the Subaru Impreza WRX and 2.5 RS have gotten off to a tremendous start. In the first D Stock race of the 2002 season for the Sports Car Club of America ProSolo Series held in Fort Meyers, Florida on February 16th and 17th, drivers of the new Subaru 2002 WRX finished in first, second, fourth and eighth positions. On the following week different Subaru 2002 WRX drivers came away with victories in the identical positions!

In other classes, such as Street Touring, Ladies Challenge and G Stock, Subaru drivers also finished first or were never far off the leading time.

This level of success is bound to generate a great deal of excitement among Subaru enthusiasts in your area. We hope you can take advantage of the wonderful opportunity such success breeds by offering Genuine Subaru Performance Tuning (SPT) Parts for the vehicles of avid Subaru drivers, from performance mufflers, struts and springs to the variety of sporty performance trim items. We suggest you race toward this opportunity to boldly promote Genuine Subaru Performance Parts in your shop. Don't forget, Subaru offers an extensive lineup for '98 and newer RS & WRX models.



Original Equipment Parts/
Professional Service

Subaru Clears the Way for Sales of New Metal Wiper Blades and Refills

Although it's one of the simplest and most apparently necessary maintenance jobs your customers can bring to you, a great many drivers don't change their windshield wipers nearly often enough. Some folks try to live with them a little longer than is generally considered safe and that's simply not necessary or wise.

Especially now, since Subaru is introducing a brand new line of competitively-priced Genuine Subaru Metal Wiper Blades and Refills designed to work on the family of Subaru vehicles.

These blades feature a steel constructed superstructure for strength and durability. The natural rubber wiping edge is the highest quality available and the rubber-booted winter blade helps prevent snow and ice clogging. They fit and function perfectly and are easy to install. And, naturally, they are backed by the Genuine Subaru Parts Limited Warranty.



So look for wear and tear on your customer's windshield wipers, run special "Wow! I Can See Again" windshield wiper check-up promotions and always recommend Genuine Subaru Metal Wiper Blades and Refills. They're specially engineered to wipe a clean, clear path across their windshields so they can drive their Subaru

vehicles in complete confidence through any storm.

A Site to Behold! The End Wrench Web Site Makes It Easy to Find O.E.PRO info

If you haven't logged onto the new End Wrench Web site yet, you're missing out on one of the most practical tools available to you as a Subaru repair professional. The site is chock full of valuable labor saving tips from archived articles going back several years. The detailed repair suggestions in these articles can really help cut your Subaru repair and maintenance work time.

www.endwrench.com

Plus, when you click on the O.E.PRO logo, you'll find a huge number of application charts on engine components, remanufactured parts, replacement mufflers, automotive chemicals and Subaru Performance Tuning (SPT) Parts.

And now there's even more. We've added application charts for a variety of the fastest-moving Genuine Subaru Maintenance Parts.

With the click of mouse, you can now easily locate part numbers and model years for air, oil and fuel filters, brake pads and shoes, belts and spark plugs – all conveniently organized by Subaru model. You'll even find the names of Subaru N.E.W. Horizon Dealers in your area so you can contact them and order the part right then and there.

If you're working on a Subaru vehicle and need anything from a quick part number to a specific repair technique, check out the Web site dedicated to helping Subaru repair professionals move through their work quickly and easily. Check out www.endwrench.com today.

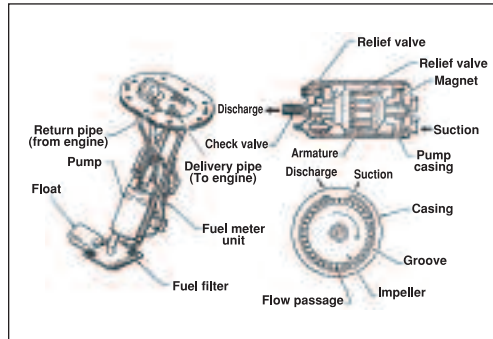
**Genuine Subaru Maintenance Parts
New Applications Charts Available**

- Oil Filters
- Air Filters
- Fuel Filters
- Timing Belts
- AC Belts
- Brake Pads and Shoes
- Spark Plugs
- Alternator Belts

avoided by shaping the tank in a saddle design. This design makes it necessary to supply a means of shifting fuel from one side of the tank to the other. The fuel pump is on the right side of the tank as viewed from the rear, with the jet pump pickup is on the left. The speed of the fuel returning to the tank is used by the jet pump to create a siphoning effect, transferring fuel from the left side of the tank to the right. The main fuel pump can then pick up the fuel.

The fuel sending units, one on each side of the tank, are wired in series to provide the fuel gauge with correct information to show correct fuel level.

The fuel pump creates pressure by moving the fuel through a series of impeller vanes and centrifugal force. Pressurized fuel flows through the clearance between the armature and the magnet of the motor to the discharge port of the pump. If the pressure output is too high a relief valve opens and the pressurized fuel exits the pump to the tank. When the pressure returns to normal, the relief valve will close.



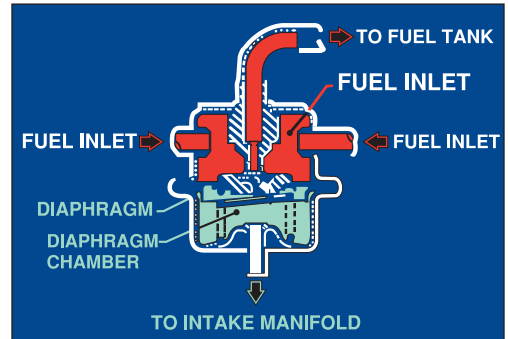
Fuel Pump

Fuel Pressure Regulator

The fuel pressure regulator uses spring tension and manifold pressure to control fuel pressure. Pressure is controlled by adjusting the size of a passage, which limits the amount of pressurized fuel that is allowed to return to the tank. When manifold pressure is high during acceleration the opening is small, and less fuel is allowed to return to the tank. This provides higher fuel pressure at the injectors. During conditions of low manifold pressure, the opening is large and more fuel returns to the tank, reducing the fuel pressure at the injectors. A check valve in the regulator maintains pres-

sure in the fuel system after the engine is turned off.

Caution: The fuel system is always under pressure. Disconnect the fuel pump and start the engine to remove the pressure. Allow the engine to run until it stalls and attempt to restart. Turn the key off. The system is now safe to open. Follow all safety procedures outlined in the appropriate Subaru service manual.



Fuel Pressure Regulator

Fuel Injector

The fuel injector, which delivers fuel to the intake manifold, is described as a galley or side-feed type.

The ECM controls the injectors by varying the ground signal. A magnetic field develops inside the injector when the ground is established. The magnetic field lifts a plunger off its seat and fuel under pressure enters the injector and exits through the tip of the injector. The design of the tip creates the proper spray pattern for the best mixing with air in the manifold.

The time or length of grounding of the injector circuit is referred to as injection duration. The select monitor will display injection duration as "TIM" (Injection Duration).

Crank Angle Sensor

Crank angle sensor operation determines crankshaft position and speed by sensing pulses created by a reluctor passing through a magnetic field. The reluctor is machined to the back side of the crankshaft timing belt sprocket. The shape of the reluctor teeth is very important to the strength and clarity of the signal produced. A chip or deformation on any tooth can result in a driveability or no-start condition. The signal generated is A/C and varies

The Odds Are In Your Favor!

from approximately .5 to 1.5 volts.

The crank angle sensor contains a permanent magnet and a coil of wire. Do not drop the crank angle sensor as the magnet or the shape of the sensor may be damaged, which can alter the signal generated.

The crank angle sensor retractor has six teeth arranged in pairs of two. The teeth are set at 10, 65 and 97 degrees BTDC.

The ECM uses the crank angle sensor input to influence or control the fuel and ignition systems. (Determines engine rpm, fuel injection timing, dwell and timing advance.)



Crank Angle Sensor

Cam Angle Sensor

The cam angle sensor functions in the same manner as the crank angle sensor. However, the value of the cam angle sensor A/C signal is slightly lower and the signal pattern is different. Cam angle sensor retractor teeth are located on the back side of the left camshaft sprocket.

The ECM uses the cam angle sensor to determine fuel injection sequence and to reference the #1 cylinder.



Cam Angle Sensor and Retractor

Fuel Injection Logic

The amount of fuel injected or duration is determined by the following:

Basic Duration + Correction Factors + Voltage Correction

Basic duration is determined by comparing QA and engine speed. Correction factors include:

- Start increment
- Coolant temperature
- After start
- Full increment
- Acceleration
- Air, fuel coefficient

Voltage correction compensates for the injectors time lag affected by battery voltage.

Learning Control

The amount of air monitored by the mass air flow meter or QA compared to the engine rpm is memorized by the ECM. This results in a representation of engine load. Engine load is used to update basic duration.

When you use Genuine Subaru Maintenance Parts, the odds are that everybody wins. That's because installing these competitively priced parts in your customers' vehicles keeps them running at peak performance, maintains Subaru owner satisfaction and ensures more Subaru cars are on the road than ever. And that's great for your bottom line.



Subaru Maintenance Parts are Best for Your Subaru Customers

Each part is specifically engineered to precise specifications to fit right, to perform better and to last longer. Take the materials in Genuine Subaru brake pads, for example. They're specially formulated to be



compatible with the rotor surface to help prevent brake judder, noise and excessive heat buildup, which can impair stopping effectiveness.

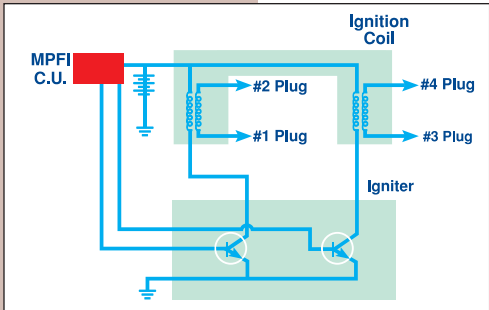
The hidden cost of off-brand parts

Why try to save a few pennies on non-genuine parts that can cost car owners a lot more over time in poor performance, faster wear and possibly even damage due to poor fit or not being up to OE specifications?

Whether you need belts, hoses and spark plugs or filters, brake pads and shoes, your local Subaru dealer keeps a ready supply of frequently needed parts at prices competitive with off-brand parts. Keep your customers' cars running smooth for years to come with Subaru Genuine Maintenance Parts.

Ignition System Control

The distributorless (direct ignition) system uses the crank and cam angle sensor inputs processed by the ECM to control ignition and ignition timing. This system uses a coil pack that houses two coils to separately supply secondary voltage to two cylinders.



Cylinders:

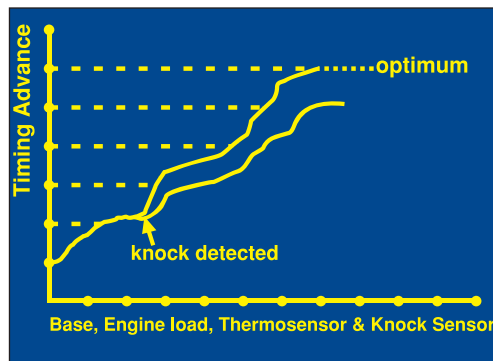
Forward coil #1 & #2
Rear coil #3 & #4

The secondary voltage is sent to the spark plugs of two cylinders simultaneously. One cylinder is on the power stroke and the other is on the exhaust stroke.

Ignition Coil Construction **Caution:** During cylinder power balance tests, do not allow fuel to enter the exhaust system. Always disconnect the appropriate fuel injector harness, do not short secondary voltage to the cylinder. Shorting the secondary voltage will allow fuel to enter the cylinder. The spark plug may fire on the exhaust stroke when ignition is restored. This may cause severe damage to the exhaust system. Never start the engine with the exhaust removed, as the cylinder firing on exhaust stroke may ignite unburned fuel.

Igniter

The coils are controlled by the igniter. Igniter construction is composed of two transistors that control the ground circuits of the primary windings of the coils. Transistors in the ECM control the igniter. The igniter is necessary because of the amperage flow through the primary windings would damage the ECM.



Timing Advance Logic

Signals from the cam and crank angle sensors are received by the ECM. At engine start the ignition timing is fixed at 10 degrees BTDC. After engine start, ignition timing is influenced by the mass air flow meter, coolant temperature, knock sensor and engine load.

Engine knock is detected by the Knock Sensor. The sensor contains a piezo electric element that generates a small A/C voltage signal when a vibration at the correct frequency is present on the engine block surface. The signal that is created is used by the ECM to influence ignition timing.

Self Diagnosis System

Self diagnosis has four modes:

U-Check - monitors components necessary for start up. The Check Engine Light will be illuminated during normal vehicle operation when a problem is detected.

Read Memory - Used to read past trouble codes. Activated by using the black connectors located under the driver side kick panel, and following the procedures outlined in the service manual.

D-Check - Used to check the present condition of all MPFI components. Activated by using the green connectors located under the driver side kick panel, and following the procedures outlined in the service manual.

Clear Memory - Clears all codes in ECM memory. Activated by using the green and black connectors located under the driver side kick panel, and following the procedures outlined in the service manual.

In both D-Check and Read Memory modes, the control unit outputs trouble codes by using the Check Engine Light. Long flashes equal 10 and short flashes equal 1. By adding together the numerical equivalent of the flashes, you can identify the correct trouble codes. Multiple trouble codes are outputted in chronological order. You will find a list of trouble codes in the service manual. Always refer to the appropriate service manual when identifying trouble codes.

If the self-diagnostic system does not output trouble codes indicating a fault in the MPI system, suspect components may be checked using the check procedures found in the appropriate service manual.



Genuine SUBARU ENGINE COMPONENTS



...offer superior fit, reliability and value.

Restoring an engine's performance with Genuine Subaru engine components is a smart decision. Our new components are far more reliable—and precise—than rebuilt alternatives. Rebuilt engine components are based on existing parts that have failed in service—for example, a rebuilt cylinder head from a core broker or junkyard. Why take chances with inferior aftermarket parts that not only don't meet the exacting standards met by Genuine Subaru Parts but that actually may fail again?

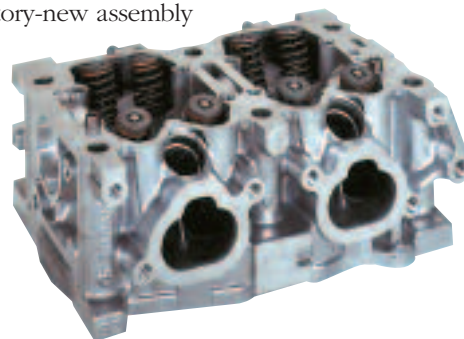
A wide selection of readily available parts

Whether you need an all-new replacement short block, oil or water pump, a clutch disk, camshaft or cam belt or other Genuine Subaru engine component, your local authorized Subaru dealer has a ready supply. You can order only those parts you need, restore an engine to

like-new performance and offer your customers faster turnaround.

Save time with pre-assembled cylinder heads

You can save on labor on your engine work by using pre-assembled Genuine Subaru cylinder heads. Each factory-new assembly is fully leak-tested and comes complete with all-new parts, including the cylinder head itself, valves, springs, seals and retainers. Plus, each assembly, like all Genuine Subaru engine components, is fully warranted and ready for installation. In fact, these components can save you time and money during installation compared to non-genuine parts that may require a force-fit. With Subaru Genuine Parts, you know you're getting the best—whether you're replacing a component or rebuilding an entire engine.



Genuine Subaru Engine Components

Years	Part #	Notes	MSRP
LEONE/LOYALE			
85-87	SOA4786060	RH Carb	\$ 333.25
85-87	SOA4786040	LH Carb	\$ 333.25
86-94	SOA4786070	RH SPI	\$ 333.25
86-94	SOA4786050	LH SPI	\$ 333.25
LEONE/LOYALE TURBO			
85-90	SOA4786090	RH	\$ 399.92
85-90	SOA4786080	LH	\$ 399.92
LEGACY			
90-94	SOA4786010	RH & LH	\$ 428.50
95	SOA4786010	RH A/T	\$ 428.50
95	SOA4786130	LH A/T	\$ 428.50
96	SOA4786140	RH & LH 2.2 M/T	\$ 428.50
96	SOA4786140	RH 2.2 A/T	\$ 428.50
96	SOA4786150	LH 2.2 A/T	\$ 428.50
96	SOA4786200	RH 2.5	\$ 457.07
96	SOA4786210	LH 2.5	\$ 457.07
97-98	SOA4786160	RH & LH 2.2 M/T	\$ 428.50
97-98	SOA4786160	RH 2.2 A/T	\$ 428.50
97-98	SOA4786170	LH 2.2 A/T	\$ 428.50
97-98	SOA4786180	RH 2.5	\$ 457.07
97-98	SOA4786190	LH 2.5	\$ 457.07
LEGACY TURBO			
91-94	SOA4786020	RH	\$ 671.36
91-94	SOA4786030	LH	\$ 671.36

All MSRPs are Net of Core

Years	Part #	Notes	MSRP
IMPREZA			
93	SOA4786100	RH 1.8 Calif. Spec.	\$ 399.93
93	SOA4786110	LH 1.8 Calif. Spec.	\$ 399.93
93	SOA4786120	RH 1.8 49 State Spec.	\$ 399.93
93	SOA4786110	LH 1.8 49 State Spec.	\$ 399.93
94-95	SOA4786100	RH 1.8	\$ 399.93
94-95	SOA4786110	LH 1.8	\$ 399.93
95	SOA4786010	RH 2.2 A/T	\$ 428.50
95	SOA4786130	LH 2.2 A/T	\$ 428.50
96	SOA4786120	RH & LH 1.8 M/T	\$ 399.93
96	SOA4786100	RH 1.8 A/T	\$ 399.93
96	SOA4786110	LH 1.8 A/T	\$ 399.93
96	SOA4786140	RH & LH 2.2 M/T	\$ 428.50
96	SOA4786140	RH 2.2 A/T	\$ 428.50
96	SOA4786150	LH 2.2 A/T	\$ 428.50
97-98	SOA4786160	RH & LH 2.2 M/T	\$ 428.50
97-98	SOA4786160	RH 2.2 A/T	\$ 428.50
97-98	SOA4786170	LH 2.2 A/T	\$ 428.50
98	SOA4786180	RH 2.5	\$ 457.07
98	SOA4786190	LH 2.5	\$ 457.07
FORESTER			
98	SOA4786180	RH	\$ 457.07
98	SOA4786190	LH	\$ 457.07



Subaru 4EAT Service

The Winter 2002 *End Wrench* contained an error which may cause confusion regarding the proper lubrication procedures for Subaru engines and transmissions. On page 14, “Subaru 4EAT Diagnosis and Service” incorrectly states that the differential on Subaru 4EAT transmissions is filled with Subaru factory fill AT/PS Fluid P/N SOA868V9240. The differential on these transmissions is filled with *GL-5 gear oil*. Installing the incorrect lubricant in the differential will cause differential damage. Please refer to the information below for the correct procedures.

When performing an oil change service on Subaru vehicles, don't confuse the drain plugs and filters located under the vehicle. Subaru models produced over the past several years feature an under-engine cover. This cover greatly reduces the accumulation of dirt and grime on the engine and also reduces the overall coefficient of drag of the vehicle. However, it does limit the access to the engine oil drain plug and engine oil filter.

Items to remember when performing services on Subaru vehicles:

- The engine oil filter is located at the front of the engine.
- The engine oil pan and 17 mm oil drain plug are painted black and are located directly under the engine — above the under-engine cover.
- The engine oil dipstick is located
- under the hood, on the front driver's corner of the engine.
- The transmission front differential is bright aluminum with a gold-colored 21 mm drain plug. This housing is bolted directly behind the engine and is filled with GL-5 gear oil.
- The differential dipstick is located under the hood near the firewall, on the passenger side of the differential housing.
- The transmission pan is black. Its 17 mm drain plug is located on the driver's side of the pan. The drain plug is normally silver in color, but black drain plugs have also been installed on occasion. The transmission is filled with Genuine Subaru factory fill AT/PS Fluid P/N SOA868V9240.
- 1999 and later Subaru vehicles equipped with automatic transmissions have a screw-on filter on the driver's side of the transmission. Do not confuse this with the engine oil filter. The transmission filter does not require service under normal conditions.
- The automatic transmission fluid dipstick is under the hood, on the driver's side of the car near the firewall.
- All three dipsticks have yellow handles for easy identification.
- Always confirm proper lubricant levels in each unit after performing any service.



Genuine SUBARU REPLACEMENT MUFFLERS



...offer perfect fit and function.

Unlike typical generic mufflers, ONLY Genuine Subaru Replacement and Performance Muffler Assemblies offer these unique advantages...

Welded, one-piece assembly

A Genuine Subaru Replacement Muffler Assembly is a complete, all-welded, one-piece unit that ensures easy and precise installation and fit—the same exact fit as the assembly supplied on the vehicle as original equipment. They eliminate the need to deal with the all-too-common combination of leak-prone pipe adapters; cumbersome multiple clamps; and adaptable hangers that never fit quite right.

Fully aluminized steel construction

A Genuine Subaru Replacement Muffler Assembly is a heavy-duty, integrated unit of thicker materials than typical aftermarket mufflers. Special corrosion-resistant

aluminized steel construction allows for long life. Sound absorbing materials help subdue sound without hampering performance—unlike typical replacement mufflers with few baffles to suppress exhaust noise.

Specifically designed for your customers' cars.

A Genuine Subaru Replacement Muffler Assembly is designed for each Subaru vehicle application—not “cross-fitted” to multiple makes and rigged with adapters. All mounting parts precisely match the original Subaru assembly for easy, safe, no-rattle replacement.

Competitively priced and backed by warranty from Subaru.

Each Subaru Muffler offers the quality of original equipment at a price that matches or beats aftermarket mufflers. And each is backed by the Genuine Subaru Parts Limited Warranty that covers the entire, integrated unit – not just the muffler itself—including welded-on pipes, clamps and hardware. Contact your dealer for complete warranty details.

Genuine Subaru Replacement Mufflers

Now Includes Performance Mufflers 1996–2001

Application	New Part Number	Previous Part Number	MSRP
82-87 BRAT	SOA8375100	SOA5225119	\$ 89.95
80-84 STATION WAGON & 4-DOOR SEDAN			
81-89 HATCHBACK	SOA8375200	SOA5225119	\$ 89.95
87-94 JUSTY	SOA8375300	744304451	\$ 89.95
85-93 LEONE/LOYALE SEDAN	SOA8375600	44301GA211	\$ 69.95
85-90 LEONE/LOYALE SEDAN-TURBO		44301GA221	
86-90 LEONE/LOYALE 3-DOOR	SOA8375600	44301GA211	\$ 69.95
86-90 LEONE/LOYALE 3-DOOR-TURBO		44301GA221	
85-94 LEONE/LOYALE WAGON	SOA8375700	44301GA231	\$ 69.95
85-90 LEONE/LOYALE WAGON-TURBO		44301GA241	
85-87 XT (THRU 12/86) INCL. TURBO	SOA8375800	44304GA321	\$ 129.95
87 XT TURBO (FROM 1/87)		44304GA341	
87-91 XT (FROM 1/87)		44304GA361	
87-91 XT6			
90-94 LEGACY (2WD) WAGON	SOA8375500	44304AA080	\$ 129.95
90-94 LEGACY (2WD) SEDAN	SOA8376000	44304AA110	\$ 129.95
90-94 LEGACY (4WD) SEDAN	SOA8375900	44304AA120	\$ 129.95
90-94 LEGACY (4WD) WAGON	SOA8375400	44304AA130	\$ 129.95
93-96 IMPREZA 1.8L (2WD)	SOA8376100	44305FA061	\$ 129.95
93-96 IMPREZA 1.8L (4WD)	SOA8376200	44305FA071	\$ 129.95
95-97 LEGACY (2WD) 2.2L WAGON	SOA8376800	44305AC110	\$ 129.95
95-97 LEGACY (2WD) 2.2L SEDAN	SOA8377100	44305AC090	\$ 129.95
95-97 LEGACY (AWD) 2.2L SEDAN	SOA8377000	44305AC100	\$ 129.95
95-97 IMPREZA (ALL) 2.2L; 97 1.8L (ALL)	SOA8377200	44305FA100	\$ 129.95
Genuine Subaru Performance Mufflers			
96-99 LEGACY GT SEDAN	SOA8376300	44305AC421	\$ 375.00
96-99 LEGACY GT WAGON	SOA8376400	44305AC411	\$ 375.00
98-01 IMPREZA RS COUPE & SEDAN	SOA8376500	44305FA100, 110	\$ 375.00
00-02 LEGACY GT SEDAN	SOA8377300	44300AE14A	\$ 375.00
00-02 LEGACY GT WAGON	SOA8377400	44300AE10A	\$ 375.00



IMPORTANT NOTE: Federal and California law prohibits use of these parts in making repairs covered under emissions-related warranties extended on the vehicle at the time of its original purchase. No claims under those warranties will be honored unless OEM parts are used.



OBD II Service

In compliance with federal regulations, On Board Diagnostics II was introduced to the Subaru line with the 1995 Legacy. This system has the ability to store engine and automatic transmission diagnostic trouble codes (DTCs) related to operating faults that could have an effect on vehicle emissions. The number of DTCs and the diagnostic procedures for these DTCs is constantly changing, due to the introduction of new components and constantly improving system operating logic. The key to diagnosing and repairing the OBD II system is an understanding of the components that are being checked. Only then will you be able to apply that understanding to the logic embedded in the OBD II system.

OBD II checks a component and its system for the ability to function (circuitry tests) and the result while functioning (performance tests) for key systems.

Enabling Criteria

Before OBD II can begin to work, the vehicle must meet the Enabling Criteria. This is the vehicle operating condition that must exist for the Engine Control Module (ECM) to begin diagnostics. The Enabling Criteria will not be the same for all diagnostics. For example, the ECM checks an EGR solenoid as

soon as the ignition is turned on.

The performance of the EGR system is checked after the following conditions are met:

- Engine has been operating for at least 190 seconds
- EGR Solenoid has been energized
- Engine coolant temperature is equal to or greater than 158°F (70°C)
- Engine speed is 2000-2600 RPM
- Injection duration is 4.1-6.92 ms
- Throttle angle is 5.76-24.96 degrees
- Throttle angle fluctuation during 100 milliseconds is less than 0.96 degrees.
- Barometric pressure is greater than 507mm HG

There can be no failures in the following components or circuits:

- Air Flow Sensor
- Crank Angle Sensor
- Cam Angle Sensor
- Throttle Position Sensor
- Coolant Temp Sensor, EGR Solenoid

Confirmation Driving Pattern

Generally speaking, the Enabling Criteria are not published for all DTCs. The logic that the ECM uses to determine if a DTC should exist also may not be available. What is published is the Confirmation Driving Pattern. This is a description of the exact way a vehicle is to be driven for the Enabling Criteria to be met. Driving a vehicle on a



Genuine SUBARU AUTOMOTIVE CHEMICALS



...provide protection and enhance performance.

When it comes to fluids and other chemicals you put in a car, there's only one way to be sure you're meeting the same high standards of original Subaru equipment: Use Genuine Subaru Automotive Chemicals.

Subaru now offers a full line of quality tested aerosols and fluids.

This line covers all the essential service chemicals. From coolant and automatic transmission fluid to brake fluid and fuel injector cleaner, these premium chemicals are all approved by Subaru for use in Subaru vehicles. Each automotive chemical is engineered to assure maximum performance and trouble-free driving. And because they're competitively priced, you can use them day in and day out on all your service work and make extra money at the same time.

All refrigerants are not created equal!

Genuine Subaru R-134a Refrigerant, unlike many after-market products, is manufactured and packaged to the stringent Air Conditioning and Refrigerant Institute (ARI) 700 standard. This means possible contaminants are meticulously controlled, including moisture and non-condensable gases that can cause premature compressor failure and result in costly repair.



Genuine Subaru Automotive Chemicals

ITEM	CONTENTS	CASE QTY.	PART #	NOTES	UNIT MSRP
AEROSOLS					
Brake Cleaner	18 oz. net wt.	12	SOA868V9100		\$ 3.15
N/C Brake Cleaner	14 oz. net wt.	12	SOA868V9110	Non-Chlorinated	\$ 3.15
Carburetor Cleaner	11.3 oz. net wt.	12	SOA868V9120		\$ 2.73
Glass Cleaner	18 oz. net wt.	12	SOA868V9130		\$ 2.73
Aerosol Fuel Injector Cleaner	7 oz. net wt.	12	SOA868V9140	Aerosol/Rail Applied	\$ 15.08
Application Tool for Fuel Injector Cleaner			SOA868V9410		\$ 232.22
Application Tool Adapters			SOA868V9420	Incl. Hose Adapters, Fuel Block-off Clamps, etc.	\$ 77.33
Pour Fuel Injector Cleaner	16 fl. oz.	12	SOA868V9150	Fluid/Gas Tank Additive	\$ 5.67
Top Engine Cleaner	11 fl. oz.	24	SOA868V9160		\$ 2.73
Application Tools for Top Engine Cleaner			SOA868V9430	Incl. Tubes, Connectors, etc.	\$ 33.72
Throttle Plate Cleaner	4 oz. net wt.	12	SOA868V9170		\$ 1.68
Silicone Lubricant	12.5 oz. net wt.	12	SOA868V9200		\$ 2.94
FLUIDS					
Factory Fill Coolant	1 gal.	6	SOA868V9210	Required for warranty repairs	\$ 12.32
Brake Fluid	12 fl. oz.	24	SOA868V9220	Required for warranty repairs	\$ 2.83
Factory Fill Windshield Washer Concentrate	16 fl. oz.	24	SOA868V9230		\$ 2.53
Factory Fill Auto Trans Fluid/Power Steering Fluid	32 fl. oz.	12	SOA868V9240	Required for warranty repairs	\$ 3.22
REFRIGERANT					
R-134a Refrigerant	30 lbs.	1	SOA868V9310		\$ 188.78

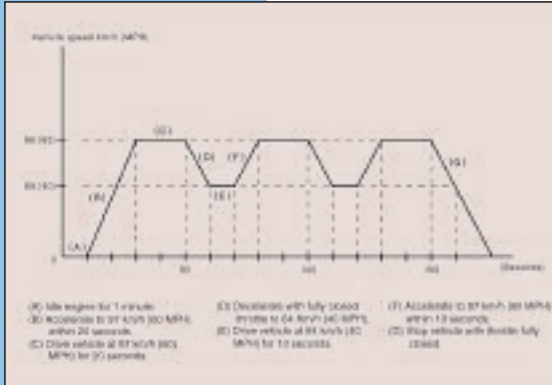
Subaru OB2 Service

lift will not substitute for actual on the road driving. A slight deviation in the confirmation driving pattern will usually cancel the diagnostics until the right conditions can be duplicated.

OB2 checks or monitors using two methods. The first method is called Continuous Monitoring. This process monitors for misfire, fuel system and electrical output devices any time the vehicle is operating. The second type is non-continuous monitoring. This process checks the condi-

tion of the catalyst, heated catalyst, evaporative system, secondary air system, a/c system refrigerant, oxygen sensor, oxygen sensor heater and EGR system once per "trip."

A trip is the completed when the vehicle has been driven in a manner which satisfies the enabling criteria and the ECM has powered down.



Confirmation Driving Pattern

vehicles default to incomplete when the ignition is turned off.) See State I/M Program Advisory Bulletin 11-49-97R. (Located in back of booklet.)

During the actual testing or diagnostics performed by the ECM, vehicle sensors send information to a testing area of the ECM. The information is evaluated to determine if the vehicle has met the enabling criteria and the results of the forced testing of systems are diagnosed.

Each system is assigned to trigger the illumination of the Check Engine Light in either a single fault or double fault occurrence (trip). The single fault trip DTCs will store a memorized DTC and record the vehicle operating conditions (Freeze Frame Data) when the ECM determines a fault exists. The Check Engine Light is also illuminating. Double fault trip DTCs will not illuminate the Check Engine Light when the first fault is detected. It will register the DTC as a temporary code and wait for the second consecutive failed trip to occur before illuminating the Check Engine Light.

Readiness Codes

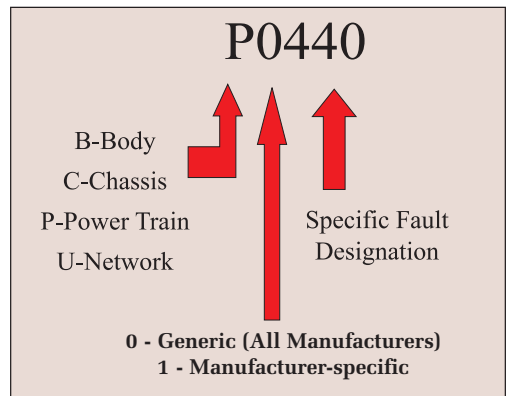
Readiness codes report the availability and status of the monitors through the Select Monitor. While viewing the OB2 section from the engine main menu, the first eight items will indicate No Support, Complete or Incomplete. No Support indicates that the vehicle is not equipped with that system. Complete indicates that the vehicle has this system but has not diagnosed this system, but will once the Enabling Criteria have been met. Complete indicates that the diagnostics have been performed for that system. These values will not default to incomplete once they are complete, unless the memory has been cleared or battery power has been removed for more than 10 minutes. (1996

MONITOR	OFF
Misfire monitoring	complete
Fuel system monitoring	complete
Component monitoring	complete
Catalyst diagnosis	incomplete
Heated catalyst	no support
Evaporative purge system	incomplete
Secondary air system	no support
A/C system refrigerant	no support
Oxygen sensor	incomplete
O2 Heater diagnosis	incomplete
EGR system	no support

Readiness codes after memory has been cleared

MONITOR	OFF
Misfire monitoring	complete
Fuel system monitoring	complete
Component monitoring	complete
Catalyst diagnosis	complete
Heated catalyst	no support
Evaporative purge system	complete
Secondary air system	no support
A/C system refrigerant	no support
Oxygen sensor	complete
O2 Heater diagnosis	complete
EGR system	no support

Readiness codes after meeting Enabling Criteria



DTC Structure

The exception to the second fault rule is any DTC that is related to Fuel Trim or Misfire. The second fault trip for these items must occur within 375 rpm and 20 percent of the engine load of the first fault. At that point the Check Engine Light will illuminate, and the DTC and Freeze Frame data will be memorized.

OB2 requirements state that all manufacturers standardize code assignments. Each code consists of five characters.



96^{OUT OF} 100

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People love their Subaru cars so much, they hold on to them longer than other cars. And they're willing to invest in them, even when high mileage necessitates engine and transmission replacement.

Fortunately, commitment for them means opportunity for you! And to help you meet your customers' needs (and budget), Subaru offers a broad line of competitively priced Genuine Subaru Engine components and Remanufactured Parts. To find your local dealer call **1-800-SUBARU3** or visit us online at **www.subaru.com**.

* Based on R.L. Polk & Co. Registration statistics as of 7/1/2001.

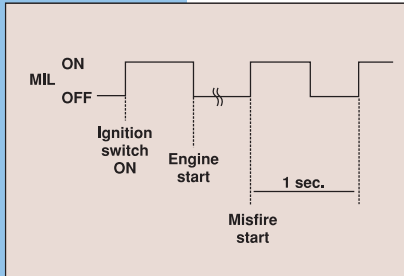
SUBARU 
Genuine Parts



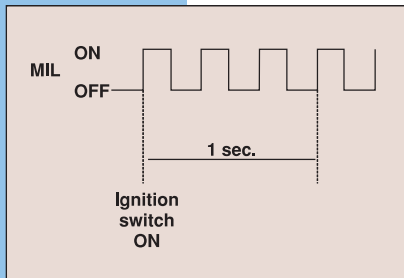
**New Cylinder Head Assemblies (1985-1998) • New Replacement Short Blocks and related engine parts (1985-2001)
Remanufactured parts including Automatic Transmissions (1990-2001) • Brake Calipers • Starters • Alternators • Front Drive Axles**

Malfunction Indicator Lamp Operation

The Check Engine Light, now called the Malfunction Indicator Lamp (MIL), provides communication to the driver and the technician. The steady illumination of the MIL with the engine running indicates an existing problem to the driver. A MIL that is flashing at 1 Hz indicates that a misfire which may cause catalyst damage presently exists (immediate service attention is recommended).



1 Hz



3 Hz

Technician communications via the MIL include three messages. The first is a 3 Hz flash which indicates the inspection mode connectors are connected. The second is a 1 Hz flash which indicates a misfire that will cause catalyst damage exists. The third MIL signal, steady illumination, indicates a problem exists or has recently occurred and a DTC has been set.

DTC Memory

Memory of a DTC (as it relates to illuminating the MIL) is maintained until three consecutive passing trips have been made (the enabling criteria were reached three times in a row and the tests were performed with good results). The MIL will turn off at this point.

The DTC will remain available for viewing with the Select Monitor and the freeze frame data associated with it will remain in memory for 40 warm up cycles.

The exception to this rule is if the DTC is associated to misfire or fuel trim. In this case 80 warm up cycles must be completed before full erasure will occur.

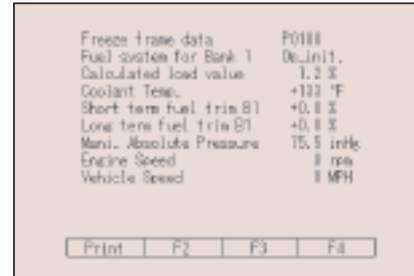
Warm Up Cycle

A warm up cycle occurs when the engine coolant temperature rises to at least 40°F (22.2°C) above the temperature at start up, and reaches a minimum of 160°F (71.1°C).

Freeze Frame

Freeze Frame is a record of the vehicle operating conditions at the moment a DTC is set. These include:

- Engine RPM,
- Engine Load,
- Fuel Pressure,
- Fuel Trim Values,
- Coolant Temperature,
- Intake Manifold Pressure,
- Loop Status,
- DTC causing the MIL to illuminate.



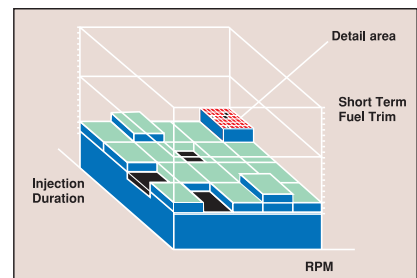
Freeze Frame

A DTC associated with misfire of fuel trim is considered a high priority. Therefore, the freeze frame data associated with a misfire or fuel trim DTC will overwrite the freeze frame data from all other DTCs.

Fuel Trim

Short-term and long-term fuel trim are visual interpretations of the current (short term) and historical (long term) corrections to the air fuel mixture required to give the vehicle the best driveability and lowest emission output.

The ECM continuously monitors the amount of fuel injected and places the information recorded into memory. The ECM places the memorized information into a position that is referenced by engine load and engine rpm. The next time the vehicle is in those same conditions, the memorized information is compared to the amount currently being injected. A DTC will be registered if the difference between the two is too great.



Fuel Trim Map

Rough Idle On MPFI Vehicles

If you encounter a rough idle complaint on any sequential injection MPFI vehicle, basic checks should be made to ensure that the correct injector wire connector is on the correct injector. Injector wiring will either be numbered or can be checked by comparing wire colors with the wiring diagrams. This may seem like an obvious check, but sometimes in your zeal to quickly diagnose a vehicle, the obvious can be overlooked. If two injector connectors have been inadvertently switched, the symptoms can be a slightly rough or irregular idle on a fully warmed up engine and a hesitation coming off the line.

Reading OBD Readiness Codes

Many states are now including an inspection of the OBD system as part of their emissions test procedure. This includes, but may not be limited to, inspection of the MIL or Check Engine Light for proper illumination, operation, and status of the Readiness Codes.

Readiness Codes can be checked with a generic scan tool and the New Select Monitor (NSM). Follow the tree below to access the Readiness Codes with the New Select Monitor:

- Each System Check
- EGI
- OBD System
- 12 Data Display

Any item that is a Readiness Code will have an indicator to the right that tells you whether it is Complete or Incomplete. Complete means that the system has been tested by the onboard diagnostic system. Incomplete means that the system has not been tested. In either case the results of the test are not indicated. No support indicates that this vehicle is not equipped with that system.

A vehicle must have all of the Readiness Codes reading Com-

plete before it can be inspected for proper emissions.

Misfire, Fuel System and Component Monitoring are continuously checked and will change from Incomplete to Complete while the ignition is turned from off to on.

The Readiness Codes will all indicate incomplete after the memory of an ECM has been cleared.

Follow the steps below to activate the Readiness Codes to complete:

- **1996 models:** Connect the Test Mode (inspection mode connector) and drive on a flat road (highway) at approximately 50 to 55 mph for 20 to 30 minutes.
- **1997 and later:** Drive on flat road (highway) at approximately 50 to 55 mph for 30 minutes for warm-up. Then perform 10 minutes at steady speed (without any throttle angle change) at 50-60 mph.

Blue Versus Gray Connectors During Diagnosis

When performing electrical diagnostics involving the fuel injection ECM on 1995 through 1997 Legacy and Impreza vehicles, pay particular attention to the color of the connector that mates to the engine control module. Some will be gray and some will be blue. The connectors are not the same and the pin terminal locations that correspond to the related systems in the car are different.

An example of where this could cause confusion would be diagnosing a TCM Code 23 (engine speed signal) on a 1996 Legacy vehicle. Looking in the 1996 Supplement Manual, you'll find that there is no Troubleshooting Section 3-2. This means the transmission control system has not changed since 1995 and is, therefore, not included in the Supplement. Opening the 1995 service manual, you will see that in Troubleshooting Section 3-2, the circuit pertaining to Trouble Code

23 consists simply of one wire from the ECM to the TCM. However, since this is a 1995 Manual, the pin terminal connection for the ECM referred to in the diagnostic flow charts is B84, pin 33, which is correct for only the gray connector of a 1995 ECM, not the blue connector on the 1996 vehicle you are working on. Referring to the engine control module (ECM) I/O (input/output) chart (Sec. 2-7, page 68-70) in the 1996 Legacy service manual Supplement, we find that the correct pin location for the engine speed signal for a 1996 blue connector is B84, pin terminal 64.

Without taking the extra step of looking in the 1996 Manual, the wrong wire would be checked at the ECM and the wrong diagnostic conclusion would be reached. To minimize the possibility for error, always double check the connector colors before attempting to locate the pertinent pins.

Legacy (Non Turbo), SVX and Impreza ISC Valves

If you encounter a vehicle with a driveability complaint (stalling, idle surge or a whistle noise) and you have determined that it is caused by the ISC valve, this condition may be due to carbon buildup inside the valve. In these cases, use the ISC cleaning procedures found in the 1995 Legacy service manual, Book 1, Section 2-7. Use Subaru Top Engine Cleaner (SOA868V9160). Products such as Brake Clean do not effectively remove the deposits.

White exhaust smoke during ISC valve cleaning is normal. An odor also may linger for a few days.

These valves are pre-set. Never try to adjust them in an attempt to repair a vehicle. If you find yourself working on a driveability concern, and this valve shows signs of tampering, the valve must be replaced. There are no procedures to return them to the factory settings.

insider info.

Impreza Throttle Position Switch Adjustment

When checking voltages for the Impreza throttle position switch, the engine must be at operating temperature and normal warm idle speed. If not, the readings you get will be incorrect and you may make an adjustment that is not necessary.

The throttle opener system which provides cold fast idle, mechanically opens the throttle valve and will cause your throttle position sensor readings to change. The Impreza service manual instructs you to be certain the engine is at normal operating temperature when making this adjustment. Changes when cold can affect driveability and vehicle emissions during cold engine operation.

DTC P0507 - Idle Control System RPM Higher Than Expected

If you find yourself diagnosing a DTC P0507 — Idle Control System RPM higher than expected — check to see if the accelerator or cruise control cables are adjusted properly.



DTC P0505

When following the diagnostic flow chart in the service manuals for DTC P0505, where the resistance of the idle air control valve has been measured to be 5 ohms or less, make the following revision to step #3 “Check Idle Air Control Solenoid Valve.” After checking the resistance of the Idle Control Solenoid valve for “5 ohms or less,” if the answer is “yes,” the service manual tells you to “Replace idle air control solenoid valve and ECM.” This conclu-

sion is premature. Instead, you should replace the idle air control solenoid, clear the memory and test drive the vehicle. Confirm proper operation of the air control valve and see that no Check Engine Light occurs. If the Check Engine Light illuminates again with DTC P0505, perform all the other checks for the code as detailed in the service manuals. If the checks are good but the code still occurs, only then should the ECM be replaced.

Remember: This only pertains to situations where the resistance of the idle air control valve has been measured to be 5 ohms or less.

2.2 Liter Impreza Fuel Senders

2.2 liter AWD Impreza vehicles have a dual fuel sending unit configuration similar to the system that has been used on Legacy vehicles. There are main and sub-senders that operate the fuel gauge. The senders are wired in series, just like the Legacy.

The sub-sender is listed in the parts books but not shown in the illustrations.

Understanding P0440

In order to understand Code P0440, Evaporative Emissions Control System Malfunction (EVAP), we must first understand that it is a performance code rather than an electrical circuit code. What this means is that to produce this code, the computer is not looking for any improper resistances, electrical opens, shorts, or sensor out of range situations. Rather, it uses information from various sensors to draw conclusions about the proper or improper physical operation of the Evaporative Fuel Emission System. Any electrical failures have different failure codes associated with them.

The job of the Evaporative Fuel Emissions System is to prevent evaporating fuel vapors from entering the atmosphere and contributing to air pollution. In order to keep this from happening, the entire fuel system needs to be able to be sealed from any access to the outside air. Vapors in the system are trapped in a charcoal canister, and those vapors are later purged into the

intake manifold to be burned during the next driving cycle.

Only vehicles with the Enhanced Evaporative Emissions system can produce Code P0400. To identify which vehicles have the enhanced system and which do not, look for the location of the charcoal canister. If it is small and under the hood, the vehicle does not have the enhanced system. If the canister is not under the hood but is large and under the right rear of the vehicle, the vehicle has the enhanced system.

In the enhanced system, evaporative vapors leave the fuel tank and pass through lines to an electrically controlled pressure control valve and a mechanical rollover valve (both by the passenger's side front of the fuel tank) heading to the canister. The canister has an electrically controlled vent valve (next to the can-

ister) and a line that goes to the front of the vehicle, where it is attached to the electrically controlled purge control valve (passenger's side of the engine compartment). Within the fuel tank, there are fuel level sensors (the same ones that are used for the dash gauge) and a fuel temperature sensor (attached to the passenger's side fuel sender). Tapped into the fuel filler neck air bypass pipe is a fuel tank pressure sensor (inside the trunk of a sedan or the luggage area of a wagon).

To test the integrity of the system, the system shuts off all access of the tank to the outside atmosphere. When the engine is running, gasoline is being delivered to the injectors and the excess unused fuel is returned to the tank. Since the injector rails are hot due to their proximity to the engine, the fuel returning to

the tank is warmer than the fuel in the tank. This returning warm fuel mixes with the tank fuel and gradually warms it up. As the fuel in the tank warms, its rate of evaporation increases. Because the tank and system are sealed, the pressure in the fuel tank increases.

The control unit looks for this pressure rise to determine if the system is sealed. If the desired pressure is achieved, the computer will continue on to the next part of the test. In this part, the control unit will close the canister vent valve, open the tank pressure control valve, and open the canister purge valve. This should draw a low pressure on the tank.

The computer monitors the fuel tank pressure sensor to determine whether the low pressure is achieved. If it is, it then proceeds to the next part of the test. In this

Continued on page 24.

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part, it repeats the first part of the test to watch the pressure rise in the tank.

After the pressure rises, the control unit does some math comparing the initial high pressure and the difference between the low pressure and the final high pressure. If the values fall within a specified range, the test passes. If the values are outside the specified range, the test fails. After two consecutive failures, the Check Engine Light is illuminated.

The testing of this system is only conducted once per drive cycle and only under very specific conditions:

- The fuel tank must contain less than 9.6 gallons of fuel.
- The fuel temperature must be less than 113°F.
- Engine speed must be over 1500 RPM.
- Vehicle speed over 28 MPH.
- Throttle position must be mid-range.
- Intake manifold vacuum must be equivalent to cruising vacuum.
- 455 seconds must have elapsed since engine start.

The vast majority of P0400 codes occur due to gas caps that have been left loose or the gas cap retaining tether has become caught under the cap during tightening. With the cap loose, no pressure rises or falls in the tank, so the test fails. If a loose cap can be positively eliminated as the cause of the code, follow the diagnostics in the service manual. If the diagnostics don't lead to a definitive failure, there are a few other steps that can be taken.

The Select Monitor has a screen that displays fuel tank pressure. After starting the vehicle, you should see a gradual pressure rise in the tank due to the warming of the fuel. If you open the cap, the pressure should drop immediately.

If you don't see a pressure rise, there must be a vapor leak to the outside. Closely inspect all lines and hoses. Physically check the operation of the pressure control valve solenoid, the purge control valve solenoid and the canister vent valve. The service manual instructs you to listen to these valves to click, but that does not necessarily mean they are closing completely.

Disconnect the hoses from each

valve, apply a hand vacuum pump to the valve and cycle the valve with the Select Monitor in the compulsory valve operation mode while confirming that the valve actually opens, fully closes and fully seals.

Note: The tank pressure control valve and the canister purge control valve should open when energized, but the canister vent valve is a normally open valve so it should close when energized.

If the valves work properly, try pressurizing the fuel tank (engine off) and evaporative system with air to check for leaks. Do not exceed 3 psi when pressurizing the tank or major fuel tank damage can occur. You can pressurize the system through the fuel return line or with a modified gas cap with hose attached. Close or block off the canister vent solenoid to seal the system.

Another situation can exist if you do see a pressure rise on the Select Monitor while conducting the first part of the tests when running the engine. In this case, you may have a situation where the pressure won't go high enough (due to a very small leak or a poorly seating valve) or the pressure won't go low enough (due to insufficient purging vacuum). A vacuum of -1.338 kpa in the tank is required to satisfy the test. A functional valve test and a check of the supply of purging vacuum would be required.

Remember, because a precise set of parameters must be met before the test is conducted and two trips are required to turn on the Check Engine Light, a considerable number of days can pass after a gas cap is left loose before a Check Engine Light may come on. This may convince a customer that the light could not possibly be due to their leaving the cap loose. Nevertheless, it may well be, and most likely is, the cause.

Enhanced Evaporative Emissions Test

When the car is first started and you begin to drive, the Pressure Control Solenoid comes on a few seconds later. The computer is looking for some pres-

sure change in the fuel tank to indicate that the system has been sealed and can be purged.

If the computer sees a change in the pressure, after about 40 seconds the Pressure Control Solenoid will turn off, and the vehicle will have passed the first part of the test for the Enhanced Evaporative Emission System.

If the computer doesn't see any pressure change, the Pressure Control Solenoid will remain on for the remainder of the drive cycle.

If the first part of the test passes, the computer will wait until you are driving in a cruising condition to perform the next three steps of the test. If the vehicle is cruising over 45 mph but under 80mph and has less than a half of a tank of fuel, the next part of the test will begin.

This second part of the test is the only time when you will ever

see the Pressure Control Solenoid and the Vent Solenoid come on at the same time. When the Pressure Control Solenoid comes on, the computer is looking for a pressure change in the tank. If it sees one, part two of the test has passed.

The Vent Solenoid then comes on to shut off the vent to the outside air. Since the Canister Purge Valve is also open at this time, the entire evaporative system is drawn down to a low pressure: If the pressure in the tank can be lowered to below -1.338kpa, part three of the test has passed and the Vent Solenoid shuts off, opening the vent to the outside air.

The low pressure in the tank should begin to recover toward atmospheric pressure. If the pressure rise in the tank is sufficient to satisfy the fault code formula, part four of the test has passed, the Pressure Control Solenoid shuts off and

the vehicle is judged to be okay.

More P0440 Information

With the introduction of the New Select Monitor (NSM), late model 1997 and newer vehicles with Enhanced Evaporative Systems can be diagnosed more easily for DTC P0440. The NSM can be set up to monitor the Pressure Control Solenoid with one LED and the Vent Solenoid with another LED while simultaneously reading the fuel tank pressure. With this setup, there is no necessity for the rapid button juggling that was necessary with the old Select Monitor to catch the changing pressures in the tank during the diagnostic phases of P0440. After the system does its tests, save the data. You can then graph the information on the screen.

LED 6 (on the old Select Monitor) corresponds to the Vent

Continued on page 30.

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Solenoid (on the new Select Monitor), and LED 8 (on the old Select Monitor) corresponds to the PCV (Pressure Control Valve) solenoid (on the new Select Monitor).

OBD II Cylinder Misfire Codes

If you encounter cylinder misfire codes on Subaru vehicles equipped with the OBD II system, check the past service history to see if the vehicle's fuel filter was recently changed.

There is a short period of time when the vehicle is first started, after the filter has been changed, when the cylinders may not get the fuel charge they should. This may translate into a slight cylinders misfire, which is enough to trigger a misfire DTC.



If the fuel filter was changed recently, clear the codes and test drive the vehicle. Chances are good that the codes will not return if the filter change was the cause of the problem.

Legacy and Impreza Engines with No Injection Pulse #1 Cylinder

Built into the fuel injection control unit is logic that will shut off the #1 injector if the computer believes that it can no longer control the Idle Air Control valve. Remember this while trying to diagnose a "hard" code for the Idle Air Control Valve or a dead miss in number one cylinder due to no injection at idle. A problem in the Idle Air Control valve circuit can be responsible. (Component testing shows that it is usually not the valve itself.)

Another unusual computer response is if the computer is deprived of its "back up power supply." If deprived of this power, some computers will generate a false code for the Idle Air Control valve and kill the injector for cylinder #1. The pin location of this power supply can be found in the Control Unit Module I/O Signal pages of the appropriate service manual.

1995 Subaru Legacy - DTC P0505 - Idle Control System Malfunction

If you encounter a 1995 Subaru Legacy with a DTC P0505 (Idle Control System Malfunction), check to see that the wire pins in connector B22 are securely fastened in the connector. If pin 13 (BY) has backed out of the connector, you will lose two grounds at the ECU.

Diagnostic Trouble Code P1507

If you are diagnosing a manual transmission-equipped vehicle with a DTC P1507 and can find nothing wrong after following the trouble tree in the appropriate service manual, inspect the Neutral Switch Circuit before replacing any parts. The Neutral Switch Circuit may cause this code to set. This could falsely indicate to the ECU that the transmission is in neutral when, in fact, it is actually in gear. This can cause the MIL to illuminate and set Code P1507.

Keep in mind that the problem can be intermittent and it may be necessary to pin test the connection and to shift into and out of neutral many times before the switch shows any problems.

1995 Subaru Legacy - DTC P0325 - Knock Sensor Circuit Malfunction

If you encounter a Check Engine Light with a DTC P0325 on a 1995 Subaru Legacy, check to see if the knock sensor mounting bolt has been torqued too tightly upon installation. Also check the threads of the sensor mounting bolt and the thread surfaces of the block to see that they are clean and not corroded. Any corrosion should be removed before installing the bolt.

The correct mounting bolt torque is 15-19 ft. lbs.

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