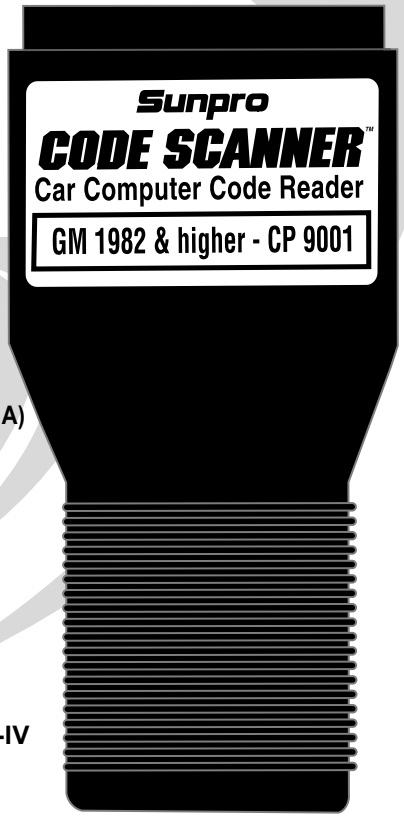
actron®
precision electronic solutions

CODE SCANNER™

FAVOR DE LEER INSTRUCTCTIVO ANTES DE USAR EL ARTICULO

Car Computer Code Reader

Domestic GM & Saturn



Lector de Códigos de Computadoras de Automóvil

GM y Saturn nacionales de EE.UU. con Systemas MCU y EEC-IV (para EUA)

Instrucciónes en español - página 99

Lecteur de code d'ordinateur automobile

GM y Saturn domestiques Étas-Unis avec Systèmes MCU ou EEC-IV

Instructions en français - page 199

Tensión: 14V
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Para Nombre, Domicilio y Telefono del Importador: Ver Empaque

CP9001

CP9001

actron® CODE SCANNER™

Congratulations on purchasing your Actron Code Scanner for accessing engine trouble codes required for repairing vehicles equipped with computers. Your Actron Code Scanner is made by Actron, the largest and most trusted name in automotive diagnostic equipment for the home mechanic. You can have confidence this product maintains the highest quality in manufacturing, and will provide you years of reliable service.

This instruction manual is divided into several key sections. You will find detailed steps on using the Code Scanner and important information about trouble code meanings, how a computer controls engine operation, and more!

Identifying the problem is the first step in solving that problem. Your Actron Code Scanner can help you determine by accessing the engine computer trouble codes. Armed with that knowledge, you can either refer to an appropriate service manual or discuss your problem with a knowledgeable service technician. In either event you can save yourself a lot of valuable time and money in auto repair. And feel confident that your vehicle's problem has been fixed!

CONTENTS

General Safety Guidelines to follow when working on vehicles

- Always wear approved eye protection.
- Always operate the vehicle in a well ventilated area. *Do not inhale exhaust gases – they are very poisonous!*
- Always keep yourself, tools and test equipment away from all moving or hot engine parts.
- Always make sure the vehicle is in **park** (Automatic transmission) or **neutral** (manual transmission) and that the **parking brake is firmly set**. Block the drive wheels.
- Never leave vehicle unattended while running tests.
- Never lay tools on vehicle battery. You may short the terminals together causing harm to yourself, the tools or the battery.
- Never smoke or have open flames near vehicle. *Vapors from gasoline and charging battery are highly flammable and explosive.*
- Always keep a fire extinguisher suitable for gasoline/electrical/chemical fires handy.
- Always turn ignition key OFF when connecting or disconnecting electrical components, unless otherwise instructed.
- Always follow vehicle manufacturer's warnings, cautions and service procedures.

CAUTION:

Some vehicles are equipped with safety air bags.

You must follow vehicle service manual cautions when working around the air bag components or wiring. If the cautions are not followed, the air bag may open up unexpectedly, resulting in personal injury. Note that the air bag can still open up several minutes after the ignition key is off (or even if the vehicle battery is disconnected) because of a special energy reserve module.

About Codes

Where do they come from and what are they for?

Engine computers can find problems.

The computer system in today's vehicles does more than control engine operation – it can help you find problems, too! Special testing abilities are permanently programmed into the computer by factory engineers. These tests check the components connected to the computer which are used for (typically): fuel delivery, idle speed control, spark timing and emission systems. Mechanics have used these tests for years. Now you can do the same thing by using the Actron Code Scanner tool!

Engine computers perform special tests.

The engine computer runs the special tests. The type of testing varies with manufacturer, engine, model year etc. There is no "universal" test that is the same for all vehicles. The tests examine INPUTS (electrical signals going IN to the computer) and OUTPUTS (electrical signals coming OUT of the computer.) Input signals which have "wrong" values or output circuits which don't behave correctly are noted by the test program and the results are stored in the computer's memory. These tests are important. The computer can not control the engine properly if it has bad inputs or outputs!

Code numbers give test results.

The test results are stored by using code numbers, usually called "trouble codes" or "diagnostic codes." For example, a code 22 might mean "throttle position sensor signal voltage is too low." Code meanings are listed in Section 4. Specific code definitions vary with manufacturer, engine and model year, so you may want to refer to a vehicle service manual for additional information. These manuals are available from the manufacturer, other publishers or your local public library. (See Vehicle Service Info on page 4.)

Read Codes with the Code Scanner.

You obtain trouble codes from the engine computer memory by using the Actron Code Scanner tool. Refer to section 2 for details. After you get the trouble codes, you can either:

- Have your vehicle professionally serviced. Trouble codes indicate problems found by the computer.

  or,

- Repair the vehicle yourself using trouble codes to help pinpoint the problem.

Trouble Codes and Diagnostics help you fix the problem.

To find the problem cause yourself, you need perform special test procedures called "diagnostics". These procedures are in the vehicle service manual. There are many possible causes for any problem. For example, suppose you turned on a wall switch in your home and the ceiling light did not turn on. Is it a bad bulb or light socket? Is the bulb installed correctly? Are there problems with the wiring or wall switch? Maybe there is no power coming into the house! As you can see, there are many possible causes. The diagnostics written for servicing a particular trouble code take into account all the possibilities. If you follow these procedures, you should be able to find the problem causing the code and fix it if you want to "do-it-yourself."

Actron makes it easy to fix computer vehicles

Using the Actron Code Scanner to obtain trouble codes is fast and easy.

Trouble codes give you valuable knowledge – whether you go for professional vehicle servicing or "do-it-yourself. " Now that you know what trouble codes are and where they come from, you are well on your way to fixing today's computer controlled vehicles!

Vehicle Service Information

The following is a list of publishers who have manuals containing trouble code repair procedures and related information. Some manuals may be available at auto parts stores or your local public library. For others, you need to write for availability and prices, specifying the make, style and model year of your vehicle.

Vehicle Service Manuals:

Chilton Book Co.
Chilton Way
Radnor, PA 19089

Haynes Publications
861 Lawrence Drive
Newbury Park, CA 91320

Cordura Publications
Mitchell Manuals, Inc.
P. O. Box 26260
San Diego, CA 92126

Motor's Auto Repair Manual
Hearst Company
250 W. 55th Street
New York, NY 10019

Suitable manuals have titles such as:

"Electronic Engine Controls"

"Fuel Injection and Feedback Carburetors"

"Fuel Injection and Electronic Engine Controls"

"Emissions Control Manual"

...or similar titles

Service Manuals from General Motors Corporation

Buick
Tuar Company
Post Office Box 354
Flint, MI 48501

Oldsmobile
Lansing Lithographers
Post Office Box 23188
Lansing, MI 48909

Cadillac, Chevrolet, Pontiac
Helm Incorporated
Post Office Box 07130
Detroit, MI 48207

Electronic engine control information for *all* GM manuals is located in "Additional Code Scanner Diagnostic Features", page 22.

Service Manuals from Saturn Corporation

Adistra Corporation
c/o Saturn Publications
Post Office Box 1000
Plymouth, MI 48170

When to Read Codes

Use the Code Scanner to read computer trouble codes if...

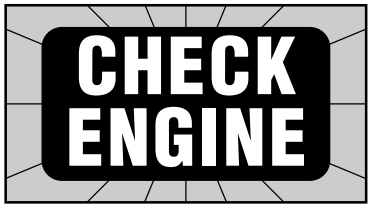
- The "Check Engine" light comes ON when the engine is RUNNING

  or,

- Vehicle engine is running poorly and "Check Engine" light is OFF.

The "Check Engine" light

The engine computer turns the "Check Engine" light on and off as needed.



This dashboard message light is either amber or red and labeled:

– "Check Engine" or,

– "Service Engine Soon" or,

– "Service Engine Now" or,

– marked with a small engine picture.

"Check Engine" light: Normal Operation

The "Check Engine" light is normally **OFF** when the engine is **RUNNING.**

NOTE: The light will come on when ignition key is in **ON** position, but the engine is **OFF**. (For example, before you start the engine.) This is a normal test of all the dashboard message lights.

*If the **"Check Engine"** light does not come on, you have an electrical problem which needs repair. Refer to the "Diagnostic Circuit Check" steps in the "Basic Diagnostic Procedures" section of your vehicle service manual. (Manual sources listed on page 4.)*

"Check Engine" Light: Problem Spotted!

Light **ON** and stays **ON** (when the engine is **RUNNING**)

– The computer sees a problem that does not go away. (A "hard" failure.)

– The light will stay on as long as the problem is present.

– A trouble code is stored in computer memory. (A "hard" code.)

– Use the Code Scanner at the earliest convenient time to obtain codes. Refer to section 3, "Reading Codes".

"Check Engine" Light: Intermittent Problem!

Light **ON** and then goes **OFF** (when the engine is **RUNNING**)

– The computer saw a problem, but the problem went away. (An "intermittent" failure.)

– A trouble code is stored in computer memory. (An "intermittent" code.)

– The light went out because the problem went away, but the code stays in memory.

– Use the Code Scanner at the earliest convenient time to obtain codes. Refer to Section 3, "Reading Codes".

NOTE: The computer will automatically erase codes after several restarts (typically 50) if the problem does not return.

A Poorly Running Engine (No "Check Engine" light)

Most likely this condition is not due to computer system failures - but reading codes can still be useful as part of a basic troubleshooting procedure. Review Section 4, "Using Codes" before proceeding to Section 3, "Reading Codes".

Reading Codes

Using the Code Scanner to Read Codes

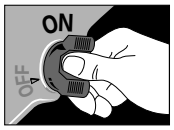
1) Safety First!

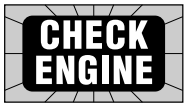
- Set the parking brake.
- Put shift lever in **PAR**K (automatic transmission) or **NEUTRAL** (manual transmission).
- Block the drive wheels.
- Make sure ignition key is in **OFF** position.

2) Test the "Check Engine" Light

(Also called "Service Engine Soon", "Service Engine Now" or labeled with a small engine picture.)

- Turn ignition key from OFF to ON position, **but do not start the engine.**
- Verify that the light turns on.





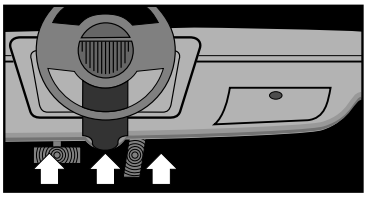
- If the light does not turn on, you have a problem with this circuit which must be repaired before proceeding. Refer to the "Diagnostic Circuit Check" procedure in your vehicle service manual. (See manual listings on page 4.)
- Turn ignition key OFF.

3) Have a Pencil and Paper Ready

This is for writing down all the codes.

4) Find the Computer Test Connector

- Service manuals call this connector the Assembly Line Diagnostic Link (ALDL) connector. It may also be called the Assembly Line Communication Link (ALCL) or simply test connector.



- The connecter is located under the dashboard on the driver's side.

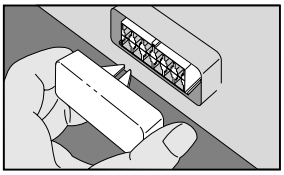
Exceptions:

– LeMans: Located behind passenger side kick panel. Remove snap-on cover for access.

– Fiero: Located in the center console behind cover panel.

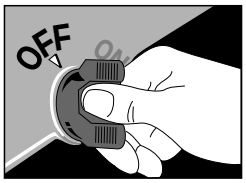
– Corvette: Sometimes located in centerconsole behind ashtray. Consult service manual for exact location.

- The connector may be in full view, or it may be recessed behind a panel. An opening in the panel allows access to recessed connectors.

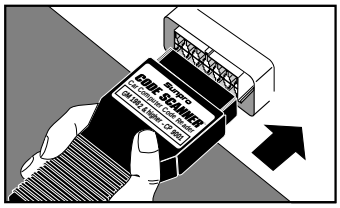


- The connector may have a slip-on cover labeled "Diagnostic Connector." Remove cover for testing. Replace cover after testing. Some vehicles require this cover in place for proper operation.

5) Verify Ignition Key is OFF



6) Plug the Code Scanner into the Test Connector. Put TEST switch on ENGINE.



- The Code Scanner only fits ONE WAY into the test connector.
- The Code Scanner will not harm the vehicle engine computer.

NOTE: The Code Scanner does not use all of the test connector contacts. Also, one Code Scanner pin may plug into an empty test connector position. This is normal.

7) Turn Ignition Key to ON Position but DO NOT START THE ENGINE

You may hear some clicking sounds coming from under the hood. This is normal.

WARNING: Stay away from the radiator cooling fan! It may turn on.

8) Get Codes from the Flashing "Check Engine" Light

NOTE: If the light does not flash, you have a problem which must be repaired before proceeding. Refer to "Diagnostic Circuit Check" chart in vehicle service manual.

Count flashes to get trouble codes.

Code 12 looks like:

PAUSE

FLASH (pause) FLASH FLASH

(FLASH = 1, FLASH FLASH = 2.

Put 1 and 2 together = code 12.)

Code 23 looks like:

PAUSE

FLASH FLASH (pause)
FLASH FLASH FLASH

- Each code is flashed three (3) times before the next trouble code is sent.
- After all codes are sent, the whole sequence is repeated. This continues until the ignition key is turned OFF (so you can double check your code list).

Example of code 12 only:

PAUSE

FLASH (pause) FLASH FLASH

(longer pause)

PAUSE

FLASH (pause) FLASH FLASH

(longer pause)

PAUSE

FLASH (pause) FLASH FLASH

(even longer pause, then start over again)

Example of code series 12 and 24:

PAUSE

FLASH (pause) FLASH FLASH

(longer pause)

PAUSE

FLASH (pause) FLASH FLASH

(longer pause)

PAUSE

FLASH (pause) FLASH FLASH

even longer pause, then go to next code)

PAUSE

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(longer pause)

PAUSE

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(longer pause)

PAUSE

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(even longer pause, then start all over from the very beginning)

- A code 12 is always sent even when the computer sees no problem. This tells you the computer diagnostic checks are working properly. If you do not get a code 12, or if the “Check Engine” light does not flash you have a problem which must be repaired. Refer to “Diagnostic Circuit Check” procedure in vehicle service manual. (See manual listing on page 4.)
- All codes are two (2) digits long.
- Codes are sent in numeric order from the lowest number to the highest.

Transmission Codes:

The engine computer can send trouble codes for transmission problems - if the vehicle has a computer controlled transmission.

NOTE: Some diesel powered trucks have a computer controlled transmission. These vehicles will only send transmission related codes since the the diesel itself is not computer controlled.

- GM Vehicles
  - –The “Check Engine” light flashes both engine codes and transmission codes.
- Saturn Vehicles
  - –The “Check Engine” light flashes engine codes.
  - –The “Shift to D2” light flashes transmission codes.

Look for a code 11 flashed on the “Check Engine” light. This is a signal telling you transmission codes will then be flashed on the “Shift to D2” light. Transmission codes are flashed in a way similar to engine codes.

9) Turn Ignition Key OFF

10) Remove Code Scanner and Re-install Connector Cover, if supplied.

The computer system is now back to normal operation.

11) Refer to “Test Results” chart on page 9

This completes the code reading procedure.

At this point you can either:

- Have your vehicle professionally serviced. Trouble codes indicate problems found by the computer.

  or,
- Repair the vehicle yourself using trouble codes to help pinpoint the problem.

TEST RESULTS	COMMENTS
No indication on "Check Engine" light **or,** **Did not receive Code 12.**	• You have a problem which needs repair before using the Code Scanner. • Refer to "Diagnostic Circuit Check" chart in vehicle service manual.
Code 12 only.	• Computer did NOT find a problem. • If a driveability problem persists, perform "Visual Inspection" and "Basic Mechanical Checks" (Section 4, "Using Codes".) • Refer to "Diagnosis by Symptom" charts in vehicle service manual. (Additional electrical and mechanical checks are listed.)
Received Code 12 along with other codes.	• Computer found problems in vehicle. • Follow steps in Section 4, "Using Codes". • Code definitions are in Section 5, "Code Meanings". – GM engine and transmission codes start on page 14. – Saturn engine codes start on page 14. • Saturn vehicles only: Code 11 means transmission codes are flashed on "Shift to D2" light. – Saturn transmission codes start on page 19.

Using Codes

Using Trouble Codes as Part of a Basic Troubleshooting Procedure

A driveability problem can have many possible causes which are not related to the computer system. Reading codes is one part of a good trouble-shooting procedure consisting of:

1) Visual Inspection

2) Basic Mechanical Checks

3) Reading Codes

4) Using the Vehicle Service Manual

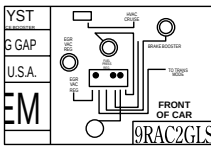
5) Erasing Codes

1) Visual Inspection

Doing a thorough visual and "hands-on" underhood inspection before starting any diagnostic procedure is essential!

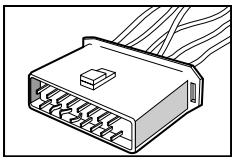
You can find the cause of many drivability problems by just looking, thereby saving yourself a lot of time.

- *Are routine maintenance items O.K.?*
  - – Clean air filter
  - – Correct fluid levels
  - – Recommended tire pressure
  - – Good ignition system components - spark plugs, wires and the like.
- *Has the vehicle been serviced recently?*
  - – Sometimes things get reconnected in the wrong place, or not at all.
- *Don't take shortcuts.*
  - – Inspect hoses and wiring which may be difficult to see because of location beneath air cleaner housings, alternators and similar components.
- *Inspect all vacuum hoses for:*
  - –Correct routing. (Hoses may be missing or misconnected.) Refer to vehicle service manual, or Vehicle Emission Control Information (VECI) decal located in the engine compartment.



  - –Pinches and kinks.
  - –Splits, cuts or breaks.
- *Inspect wiring for:*
  - –Contact with sharp edges. (This happens often.)

  - –Contact with hot surfaces, such as exhaust manifolds.
  - –Pinched, burned or chafed insulation.
  - –Proper routing and connections.
- *Check electrical connectors for:*
  - –Corrosion on pins.



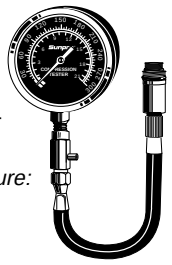
  - –Bent or damaged pins.
  - –Contacts not properly seated in housing.
  - –Bad wire crimps to terminals.

Problems with connectors are common in the engine control system. Inspect carefully. Note that some connectors use a special grease on the contacts to prevent corrosion. Do not wipe off! Obtain extra grease, if needed, from your vehicle dealer. It is a special type for this purpose.

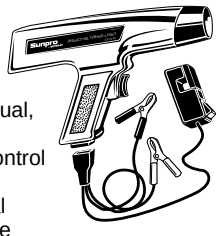
2) Basic Mechanical Checks

Don't overlook the basic checks listed on the next page. Mechanical problems by themselves can always create engine troubles. Even worse, these problems can make a good sensor send an incorrect signal to the computer. Then the computer runs the engine improperly or sets a trouble code.

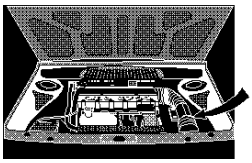
- *Cylinder compression:*
  - –Check for proper compression in each cylinder.
  - –Refer to vehicle service manual for specifications.



- *Exhaust backpressure:*
  - –Check for any restrictions in the exhaust system.
- *Ignition timing (If adjustable):*
  - –Verify timing is within specification.
  - –Refer to vehicle service manual, or Vehicle Emission Control Information (VECI) decal located in the engine compartment.



  - –Be sure to disable computer spark advance timing circuit, if used, when checking basic timing!
- *Air induction system:*
  - –Check for intake manifold vacuum leaks.
  - –Check for carbon or varnish build-up on throttle valve or idle speed control device.



3) Read Codes

Refer to Section 3, "Reading Codes". Remember there are two types of codes:

- "Hard" codes – codes for problems which are present now.
- "Intermittent" codes – codes for problems which happened in the past, but are not happening now.

Remember...

- –"Check Engine" light ON: You have at least one "hard" code stored in memory. (You may have more "hard" or "intermittent" codes stored, also.)
- – "Check Engine" light OFF: Stored codes are for "intermittent" problems. (Exception: sometimes there are minor "hard" faults which do not turn on the "Check Engine" light.)

How to Tell "Hard" Codes from "Intermittent" Codes

Do the following if you are not sure:

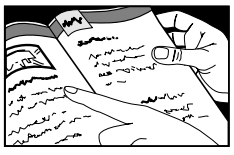
- Write down all codes (except code 12). For example: 15, 34.
- Erase codes from computer memory. (Refer to Step 5.)
- Drive vehicle for at least 10 minutes at normal temperature, cruise speed and load. (The computer may want to verify a fault for several minutes before storing a code.)
- Read codes again. Codes which return are "hard" faults. Codes which do not return are "intermittent" faults. For example, if you see code 15 (but not 34) then you know code 15 is a "hard" code and code 34 was "intermittent".

You troubleshoot the "hard" problems differently from the "intermittent" ones.

4) Use Vehicle Service Manual

Dealing with "Hard" Codes

- Refer to the vehicle service manual diagnostic code charts.



These will be in Section 6E in the GM manual. Other publications have this information in books or sections

called “Computerized Engine Controls”, “Electronic Engine Controls” or “Tune-Up Information.”

- Follow all the steps in the diagnostic procedure for the trouble code.
- Be sure to erase the trouble codes from computer memory after completing repair work. (See Step 5, “Erasing Codes from Computer Memory”.)
- Drive vehicle for at least 10 minutes at normal temperature, cruise speed and load.

– Read codes again to verify trouble code is gone (problem fixed). Other codes may have been repaired at the same time!

Dealing with “Intermittent” Codes

These codes are for problems which happened in the past, but are not present now.

- Usually these problems are due to loose connections or bad wiring. The problem cause can often be found with a thorough visual and “hands-on” inspection. (Refer to Step 1, “Visual Inspection”.)
- Refer to the vehicle service manual diagnostic code section. You can not use the code chart procedures because they are for “hard” problems - those which are present now. However, the charts have suggestions for dealing with intermittents and can tell you where bad connections, etc., might exist. You can also refer to the “Diagnosis by Symptom” charts.
- Be sure to erase the trouble codes from computer memory after completing repair work. (See Step 5, “Erasing Codes from Computer Memory”.)
- Drive vehicle for at least 10 minutes at normal temperature, cruise speed and load.

– Read codes again to verify trouble code is gone (problem fixed). Other codes may have been repaired at the same time!

Dealing with No Trouble Codes

Have a driveability problem, but only get code 12? Make sure you do Step 1, “Visual Inspection” and Step 2, “Basic Mechanical Checks”. If you did not find the problem, then refer to “Diagnosis by Symptom” charts in vehicle service manual.

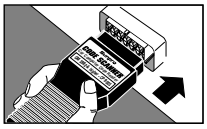
5) Erasing Codes from Computer Memory

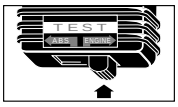
Erase codes from memory whenever you complete a repair or to see if a problem will occur again. Note: The computer will automatically erase codes after several restarts (typically 50) if the problem does not return.

GM

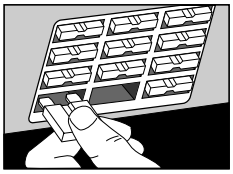
Proceed as follows:

- Observe all safety precautions. (See page 2.)
- Turn ignition key ON.
- Insert Code Scanner. Make sure TEST switch is in ENGINE position!





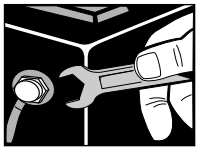
- Turn ignition key OFF.
- Remove the ECM fuse from the fuse block for 10 seconds.



- Replace fuse.
- Remove Code Scanner.

If ECM fuse cannot be located, then –

- Disconnect power to the computer. To do this:



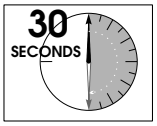
–Disconnect the positive battery terminal “pigtail”,

OR

– Open the in-line fuse holder going to the positive battery terminal, *OR*

– Disconnect negative battery terminal – but this will also erase other items too, such as digital clock settings and preset digital radio tuning.

- All the trouble codes are now erased from computer memory!
- Wait thirty (30) seconds.
- Reconnect power to the computer.



IMPORTANT: *The computer has a "learning" ability to take care of minor variations in engine control operation. Whenever you erase the computer memory by disconnecting power, the computer has to "relearn" various things. Vehicle performance may be noticeably different until it "relearns." This temporary situation is normal. The "learning" process takes place during warm engine driving.*

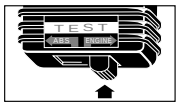
SATURN

Use the GM method, or proceed as follows:

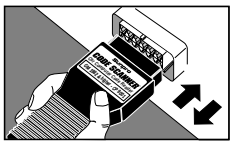
- Observe all safety precautions. (See page 2.)

  Warning: Stay away from the engine cooling fan. It may turn on during this procedure.

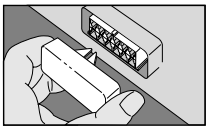
- Turn ignition key ON, but DO NOT START THE ENGINE.
- Put **TEST** switch on **ENGINE.**



- **Plug and unplug** the Code Scanner into the test connector 3 times within 5 seconds.



- All the trouble codes are now erased from computer memory!
- Turn ignition key **OFF**.
- Remove Code Scanner and re-install connector cover, if supplied.



NOTE:

- The engine control computer is usually called ECM (Engine Control Module) or PCM (Powertrain Control Module) in the vehicle service manuals.
- Information flags and "Intermittent" codes may not by erased using this procedure. The presence of these codes will not cause any driveability or future self-diagnostics problems.

Code Meanings

Note:

- Code meanings can vary with vehicle, model year, engine type and options.
- If a code number has more than one definition listed, note that that only one definition applies to your vehicle. Consult service manual to get the specific definition and troubleshooting procedure for your vehicle.
- Follow vehicle service manual procedures to find the cause of the code.

Remember:

1) Visual inspections are important!
2) Problems with wiring and connectors are common, especially for intermittent faults.
3) Mechanical problems (vacuum leaks, binding or sticking linkages, etc.) can make a good sensor send an incorrect signal to the computer. This can cause a Trouble Code.
4) Incorrect information from a sensor may cause the computer to control the engine in the wrong way. Faulty engine operation could even make a different good sensor send an incorrect signal to the computer and generate more trouble codes!

Code lists:

This page: (Codes from flashing “Check Engine” light.)

- GM engine codes
- GM electronic transmission codes
- Saturn engine codes

Page 19 (Codes from flashing “Shift to D2” light.)

- Saturn electronic transmission codes

Refer to Section 4, “Using Codes” for troubleshooting tips and steps to erase codes from computer memory.

GM/Saturn Engine Codes, GM Transmission Codes

(Saturn transmission code list begins on page 19)

11
Transaxle codes present (Saturn).

Whenever code 11 is sent, it means transmission codes will be flashed next on the “Shift to D2” light. Refer to page 19 for Saturn transmission code list.

12
Diagnostic test is working properly. (Engine computer verifies no RPM Reference Pulses are present during engine off testing.)

13
Oxygen (O2) sensor - signal stays low (“lean”) during warm engine cruise or sensor circuit is open or left sensor circuit is open (dual sensor models).

14
Coolant temperature sensor (CTS) - signal voltage is low.

15
Coolant temperature sensor (CTS) - signal voltage is high.

16
Battery or alternator problem - voltage too high or low.

OR

Direct ignition system (DIS) fault - line open or shorted to ground.

OR

Ignition system fault - Loss of 2X or Low Resolution Pulse signal.

OR

Transmission speed error.

17
RPM signal problem.

OR

Camshaft sensor - circuit problems.

OR

Electronic Control Module (ECM) computer circuit problem - Pull-up resistor (Saturn).

18
Camshaft or Crankshaft sensor - circuit problems.

OR

Fuel Injector circuit is not working properly - possible blown fuel injector fuse.

19
Ignition system fault - Intermittent 7X signal or loss of 58X signal or 6X signal (Saturn).

21
Throttle position sensor (TPS) - signal voltage is high during engine idle or deceleration.

22
Throttle position sensor (TPS) - signal voltage is low during engine idle.

OR

Fuel cutoff relay circuit - open or shorted to ground.

23
Manifold air temperature (MAT) sensor - signal voltage is low or high.

OR

Throttle position sensor (TPS) error.

OR

Mixture Control (M/C) solenoid - open or short circuit problems.

24
Vehicle speed sensor (VSS) - open or short circuit problems.

25
Manifold air temperature (MAT) sensor - signal voltage is low.

OR

Vacuum switching valve circuit - open or shorted to ground.

OR

ATS sensor - signal voltage is high.

26
Quad-Driver module or Quad-driver No. 1 error.

27
2nd gear switch.

OR

Quad-Driver module or Quad-driver No. 2 error.

28
3rd gear switch.

OR

Quad-Driver module or Quad-driver No. 3 error (Corvette).

OR

(Transmission) Fluid pressure switch assembly - open or short circuit problems.

29
4th gear switch.

OR

Quad-Driver module or Quad-driver No. 3 error.

OR

Secondary air injection system - circuit problems.

31
Manifold absolute pressure (MAP) sensor - signal voltage is low.

OR

Fuel injector.

OR

Park/Neutral switch - circuit problems.

OR

CAM sensor - circuit problems.

OR

Engine speed control governor malfunction. (Van)

OR

Turbocharger wastegate overboost.

OR

Wastegate electrical signal - open or shorted to ground.

OR

Purge solenoid voltage high (carburetor engines)

32
Barometric pressure (BARO) sensor circuit failure.

OR

Exhaust gas recirculation (EGR) valve diagnostic switch - closed during engine start-up or open when EGR flow requested by ECM.

OR

EGR/EVRV.

33
Mass air flow (MAF) sensor - signal voltage or frequency is high during engine idle.

OR

Manifold absolute pressure (MAP) sensor - signal voltage is high during engine idle. (Note: Engine mis-fire or unstable idle may cause this code.)

34
Mass air flow (MAF) sensor - signal voltage or frequency is low during engine cruise.

OR

Manifold absolute pressure (MAP) sensor - signal voltage is low during ignition on.

OR

Pressure sensor circuit - signal voltage too high or low (carburetor engines).

35
Idle air control (IAC) system problem - can not set desired RPM.

36
Mass air flow (MAF) sensor - burn-off circuit problem.

OR

Transmission shift problem (electronically controlled transmissions only).

OR

Direct ignition system (DIS) fault - loss of 24X signal or extra or missing pulses in electronic spark timing (EST) signal.

OR

Ignition system fault - loss of High Resolution Pulse signal.

37
Brake switch stuck “on”.

38
Brake switch circuit fault.

OR

Knock sensor (KS) - open circuit problem.

39
Torque converter clutch (TCC) circuit fault.

OR

Clutch switch circuit problems.

OR

Knock sensor (KS) - short circuit problem.

41

Cam sensor (CAM) failure.

OR

Cylinder select error.

OR

Tach input error - no reference pulses during engine run.

OR

Electronic spark timing (EST) circuit - open or shorted to ground during engine run.

OR

Direct ignition system (DIS) fault - bypass circuit open or shorted to ground during engine run.

OR

Ignition system fault - loss of 1X Reference Pulse signal.

42

Electronic spark timing (EST) circuit - open or shorted to ground during engine run.

OR

Direct ignition system (DIS) fault - bypass circuit open or shorted to ground during engine run.

OR

Fuel cutoff relay circuit - open or shorted to ground.

43

Electronic spark timing (EST) circuit - low voltage detected.

OR

Electronic spark control (ESC) - circuit problems.

44

Lean exhaust indication - oxygen (O_2) sensor voltage stays low after one or two minutes of engine run. (Left sensor on dual sensor engines.)

45

Rich exhaust indication - oxygen (O_2) sensor voltage stays high after one minute of engine run. (Left sensor on dual sensor engines.)

46

Vehicle anti-theft system (VATS) failure.

OR

Power steering pressure switch failure.

47

Electronic control module (ECM) computer circuit problems - universal asynchronous receiver/ transmitter (UART) link or data loss.

OR

Knock sensor module located in the computer is not working properly.

48

Misfire symptom.

OR

Mass air flow (MAF) sensor - open or short circuit MAF sensor signal.

49

High idle RPM or vacuum leak (Saturn).

51

Electronic control module (ECM) computer circuit problems - faulty programmable read-only memory (PROM), MEM-CAL, ECM or checksum errors.

52

Electronic control module (ECM) computer circuit problems - faulty or missing CALPAC or MEM-CAL, analog to digital converter (A/D) error or Quad-Driver module (QDM) fault.

OR

Oil temperature sensor - signal voltage is low (Corvette).

OR

System voltage high for a long period of time. (Electronic transmission note: this fault may cause other codes to be set.)

53

Over voltage condition. (Electronic transmission note: this fault may cause other codes to be set.)

OR

Exhaust gas recirculation (EGR) - system problems or EGR Solenoid No.1 problem.

OR

Voltage reference error.

OR

Vehicle anti-theft system (VATS) problems.

54

Low fuel pump voltage.

OR

Fuel pump relay.

OR

EGR Solenoid No. 2 failure.

OR

Quad-Driver module (QDM) output failure.

OR

Mixture Control (M/C) solenoid - circuit voltage too high.

55

Electronic control module (ECM) computer circuit problems - ECM failure, serial bus error, SAD error or fuel lean malfunction.

OR

EGR Solenoid No. 3 failure.

56

Corrosivity/add coolant.

OR

Port throttle system vacuum sensor problems.

OR

Quad-Driver “B” fault.

57

Boost Control problem.

58

Vehicle anti-theft system (VATS) problem.

OR

Transmission Temperature Sensor (TTS) - short circuit problem in sensor or wiring.

OR

Transmission fluid temperature high.

59

Transmission Temperature Sensor (TTS) - open circuit problem in sensor, connector or wiring.

OR

Transmission fluid temperature low.

61

Oxygen (O_2) sensor degraded.

OR

Port throttle system error.

OR

Cruise control problems - vent solenoid circuit.

OR

Air Conditioner (A/C) system performance problems.

62

Gear switch circuit problems.

OR

Oil temperature sensor - signal voltage is high (Corvette).

OR

Cruise control problems - vacuum solenoid circuit.

63

Manifold absolute pressure (MAP) sensor - signal voltage is high.

OR

Small EGR failure.

OR

Right oxygen (O_2) sensor failure (dual sensor engines).

OR

Cruise control system problem.

64

Manifold absolute pressure (MAP) sensor - signal voltage is low.

OR

Medium EGR failure.

OR

Right oxygen(O_2) sensor - lean condition indicated (dual sensor engines).

65

Large EGR failure.

OR

Fuel injector current low.

OR

Right oxygen (O_2) sensor - rich condition indicated (dual sensor engines).

OR

Cruise control position sensor problem.

66

Air Conditioner (A/C) pressure sensor - circuit problems or low A/C charge.

OR

Electronic Control Module (ECM) computer circuit problem - internal reset occurred.

OR

(Transmission) 3-2 shift control solenoid - circuit problems.

67

Cruise control - switch circuit problems.

OR

Air Conditioner (A/C) pressure sensor - circuit problems.

OR

Torque Converter Clutch (TCC) solenoid - circuit problems.

OR

Cruise control switches - circuit problems.

68

Cruise control - system circuit problems.

OR

Air Conditioner (A/C) clutch relay - short circuit.

OR

(Transmission) Overdrive ratio error - engine RPM greater than input speed.

69

Air Conditioner (A/C) system - pressure switch or A/C clutch relay circuit problems.

OR

Torque converter clutch stuck “on”.

70

Air Conditioner (A/C) pressure sensor - signal voltage too high.

71

Air Conditioner (A/C) evaporator temperature sensor - signal voltage too low.

72

Gear Select switch - circuit problems.

OR

Vehicle Speed Sensor (VSS) - loss of signal.

73

Air Conditioner (A/C) evaporator temperature sensor - signal voltage too high.

OR

(Transmission) Pressure control solenoid - circuit problems.

74

Traction control circuit voltage low.

75

Exhaust gas recirculation (EGR) system - Solenoid No.1 problem.

OR

System voltage low - charging system problems.

OR

Transmission voltage low - low system voltage possibly caused by generator voltage supply circuit or power train control module (PCM).

76

Exhaust gas recirculation (EGR) system - Solenoid No.2 problem.

77

Exhaust gas recirculation (EGR) system - Solenoid No.3 problem.

OR

Primary cooling fan relay driver circuit - circuit problems.

78

Secondary cooling fan relay driver circuit - circuit problems.

79

Vehicle Speed Sensor (VSS) - signal voltage too high.

OR

Transmission Temperature Sensor (TTS) - high temperature indicated.

80

Vehicle Speed Sensor (VSS) - signal voltage too low.

81

Brake switch circuit problems.

OR

Anti-Lock Brake System (ABS) message fault (Saturn).

OR

(Transmission) Solenoid "B" (3-2 shift solenoid) - open or short circuit problems.

82

Ignition system fault - 3X signal problem.

OR

Electronic control module (ECM) computer circuit problem - internal communications failure (Saturn).

OR

(Transmission) Solenoid "A" (1-2 shift solenoid) - open or short circuit problems.

83

Torque Converter Clutch (TCC) solenoid - circuit problems.

OR

Reverse Inhibit - open or short circuit in reverse inhibit solenoid coil.

84

3-2 Control solenoid - open or short circuit problems.

OR

Skip shift solenoid - open or short circuit problems.

85

Electronic control module (ECM) computer circuit problems - faulty programmable read-only memory (PROM).

OR

(Transmission) Input or output speed sensor - circuit problems. (Speed sensor signals do not agree with with selected gear range.)

OR

Torque converter clutch (TCC) - TCC is mechanically stuck on.

86

Electronic control module (ECM) computer circuit problems - faulty analog-to-digital (A/D) converter.

OR

(Transmission) Low gear error - transmission in 3rd or 4th gear when computer commanding 1st or 2nd gear.

87

Electronic control module (ECM) computer circuit problems - faulty electrically erasable programmable read-only memory (EEPROM).

OR

(Transmission) High gear error - transmission in 1st or 2nd gear when computer commanding 3rd or 4th gear.

88

Electronic control module (ECM) computer circuit problem - internal reset occurred.

91

Skip shift light - open or short circuit problems in skip shift light circuit.

93

Pressure control solenoid - transmission line pressure not at desired level.

95

Change oil light - wrong voltage is present in light circuit for more than 26 seconds.

96

Transmission voltage low - low system voltage possibly caused by generator voltage supply circuit or power train control module (PCM).

OR

Low oil light - wrong voltage is present in light circuit for more than 26 seconds.

97

Vehicle speed sensor (VSS) - output circuit problems.

99

Tachometer output circuit problems.

Saturn Transmission Codes

(GM/Saturn engine codes and GM transmission code list begins on page 14.)

Note: Code numbers labeled “Information Flag” may be sent along with the regular (unlabeled) trouble codes. The computer sends Information Flags to help you find the cause of a trouble code. Note that conditions which only cause an Information Flag will not turn on the “Check Engine” light. Refer to vehicle service manual troubleshooting charts.

13
(Information Flag)
Line pressure high.

14
(Information Flag)
Line pressure low.

15
(Information Flag)
Hot light.

16
No 1st gear.
OR
(Information Flag)
Electrical variable orifice (EVO) fault.

18
(Information Flag)
No gears available.

21
2nd gear stuck “on”.

22
No 2nd gear.

23
No 3rd gear.

24
No 4th gear.

25
No torque converter clutch.

26
Torque converter clutch stuck”on”.

27
(Information Flag)
Quick quad-driver output fault - open or short circuit on any of the qaud-driver module circuits (QDM) that lasts 5 seconds or longer.

31
Transaxle temperature circuit open.

32
Transaxle temperature circuit grounded.

34
(Information Flag)
Powertrain Control Module (PCM) computer circuit problem - communications failure.

35
No turbine speed signal.

36
Turbine speed signal noise.

41
Vehicle Speed Sensor (VSS) circuit - no signal.

42
Vehicle Speed Sensor (VSS) circuit - signal noise.

43
(Information Flag)
Master relay - open or grounded.

44
(Information Flag)
Master relay - shorted.

45
(Information Flag)
Gear selector switch circuit problem - no signal.

46
(Information Flag)
Gear selector switch circuit problem - invalid signal.

47
(Information Flag)
Powertrain Control Module (PCM) computer circuit problem - communication interrupt failure.

48
Hold mode voltage is too low.
OR
(Information Flag)
Reference input intermittent or noisy - missing or extra ignition reference pulses are detected by powertrain control module (PCM).

49
(Information Flag)
Gear selector error signal.

51
(Information Flag)
Powertrain Control Module (PCM) computer circuit problem - serial link data invalid.

52
Hold mode stuck “on”.
OR
(Information Flag)
Battery voltage out of range - battery voltage has dropped below 11 volts or has increased above 17 volts.

53
Hold mode stuck “off”.
OR
(Information Flag)
ESC (Knock present) - powertrain control module (PCM) can not reduce engine knock by retarding timing.

54
Powertrain Control Module (PCM) computer circuit problem - analog to digital (A/D) converter error.
OR
(Information Flag)
5-volt reference ground - flag will set if manifold

absolute pressure (MAP) sensor signal, handwheel sensor signal, throttle position sensor (TPS) signal are zero volts.

55

Transaxle temperature sensor failure.

56

(Information Flag)

Generic Field-Effect Transistor (FET) driver failure.

57

(Information Flag)

Powertrain Control Module (PCM) computer circuit problem - non volatile Random Access Memory (RAM) failure.

58

(Information Flag)

Battery voltage unstable - battery voltage changes more than 3 volts instantaneously.

61

(Information Flag)

Powertrain Control Module (PCM) computer circuit problem - Programmable Read-Only Memory (PROM) failure.

OR

(Information Flag)

6X Signal fault - 6X pulses do not occur between each reference pulse or a 6X pulse does not immediately follow a reference pulse. Possible open or intermittent in DIS module harness.

62

(Information Flag)

Powertrain Control Module (PCM) computer circuit problem - interrupt failure.

63

(Information Flag)

Powertrain Control Module (PCM) computer circuit problem - Random Access Memory (RAM) failure.

OR

(Information Flag)

Option check sum error - flag will be set if tire size and options do not compare with those stored in the powertrain control module (PCM).

64

(Information Flag)

Powertrain Control Module (PCM) computer circuit problem - Electrically Erasable Programmable Read-Only Memory (EE PROM) failure.

65

(Information Flag)

Ignition voltage problem - too high or low.

66

(Information Flag)

Clamp shorted.

67

(Information Flag)

Clamp open.

OR

(Information Flag)

Handwheel sensor circuit fault - handwheel sensor output voltage is out of tolerance.

68

(Information Flag)

Line circuit grounded or open.

69

(Information Flag)

Line circuit shorted.

71

(Information Flag)

2nd line circuit - grounded or open.

OR

(Information Flag)

Cooling system high temperature - engine coolant temperature is greater than 239°F (118°C).

72

(Information Flag)

2nd line circuit - shorted.

OR

(Information Flag)

Cooling system low temperature - engine coolant temperature is less than 32°F (0°C).

73

(Information Flag)

3rd line circuit - grounded or open.

OR

(Information Flag)

Coolant sensor signal unstable - coolant temperature sensor (CTS) indicates a change of more than 59°F (15°C) instantaneously.

74

(Information Flag)

3rd line circuit - shorted.

OR

(Information Flag)

Coolant/Transmission temperature sensor ratio error - indicates a degrading coolant temperature sensor (CTS) if transmission temperature sensor (TTS) is working properly.

75

(Information Flag)

3rd gear stuck “on”.

OR

(Information Flag)

Air temperature sensor signal unstable - air temperature sensor (ATS) indicates a change of more than 59°F (15°C) instantaneously.

76
(Information Flag)
4th line circuit - grounded or open.
OR
(Information Flag)
Throttle position sensor (TPS) to manifold absolute pressure (MAP) sensor voltage out of range - flag is set if TPS and MAP voltage readings dont agree with internal relational tables stored in the powertrain control module (PCM).

77
(Information Flag)
4th line circuit - shorted.

78
(Information Flag)
4th gear stuck “on”.

79
(Information Flag)
Torque Converter Clutch (TCC) circuit - grounded or open.

81
(Information Flag)
Torque Converter Clutch (TCC) circuit - shorted.

82
(Information Flag)
Transaxle temperature unstable.

83
(Information Flag)
Transaxle temperature low.
OR
(Information Flag)
Low coolant - coolant switch opens for 20 seconds with engine running.

84
(Information Flag)
Brake switch stuck open.

85
(Information Flag)
Brake switch stuck closed.

86
(Information Flag)
Engine speed invalid.

87
(Information Flag)
Torque Converter Clutch (TCC) hold circuit - grounded or open.

88
(Information Flag)
Torque Converter Clutch (TCC) hold circuit - shorted.

89
(Information Flag)
Master relay stuck “on”.

91
(Information Flag)
Assembly Line Diagnostic Link (ALDL) - serial communication link interrupt.

92
(Information Flag)
Clamp circuit - intermittent fault.

93
(Information Flag)
Torque Converter Clutch (TCC) hold circuit - intermittent fault.

94
(Information Flag)
Master enable relay circuit - intermittent fault.

95
(Information Flag)
Line circuit - intermittent fault.

96
(Information Flag)
Torque Converter Clutch (TCC) circuit - intermittent fault.

97
(Information Flag)
2nd gear circuit - intermittent fault.

98
(Information Flag)
3rd gear circuit - intermittent fault.

99
(Information Flag)
4th gear circuit - intermittent fault.

Other Features

Additional Code Scanner Diagnostic Features

This section contains...

Relay and Solenoid Circuit Test: You can switch on most of the computer controlled relay and solenoid circuits - for checking relay operation or making wiring voltage checks.

Field Service Test (Fuel Injected Engines Only): A quick check of the fuel control system to verify proper operation.

Become familiar with Code Scanner use (Section 3) before using the following procedures.

Relay and Solenoid Circuit Test

Computer controlled relay and solenoid coils are commonly wired as follows:

- One side of the coil is connected to a source of vehicle battery power.
- The other side of the coil is wired to the computer.

Inside the computer housing is a transistor switch (often called a "driver"). The computer energizes the coil by using the transistor switch.

Transistor ON:

– Transistor electrically connects end of coil to circuit ground.

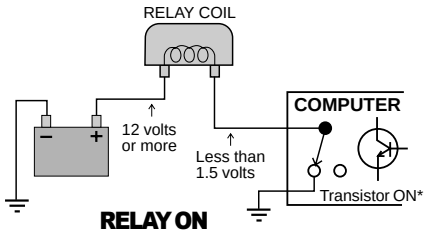
– Coil is ON because circuit is complete. (Coil connected to battery power and ground.)

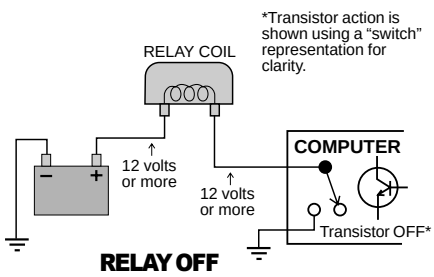
Transistor OFF:

– Transistor disconnects end of coil from circuit ground.

– Coil is OFF because circuit is open. (Coil not connected to circuit ground.)

You can switch on most of the computer controlled relay and solenoid circuits except the fuel pump relay and fuel injectors. This is helpful for checking relay operation or making wiring voltage checks. Do the following:

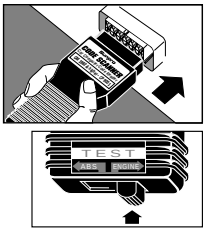




1) Safety First!

- Set the parking brake.
- Put shift lever in PARK (automatic transmission) or NEUTRAL (manual transmission).
- Block the drive wheels.
- Make sure ignition key is in OFF position.

2) Plug the Code Scanner into the Test Connector. Put TEST switch on ENGINE.

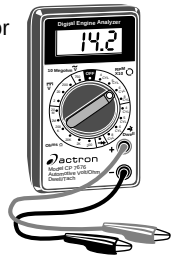


3) Turn Ignition Key to ON Position but DO NOT START THE ENGINE.

- ***WARNING:*** *Stay away from the radiator cooling fan! It may turn on.*
- Ignore the flashing Check Engine light.

4) Computer Controlled Relays and Solenoids are Turned ON

Exception: Fuel pump and fuel injectors are OFF. (Refer to vehicle service manual for any other exceptions.)



- Make any relay or solenoid circuit checks at this time. Note the following special circuit actions...

  – Fuel Injected Engines Only: The Idle Air Control (IAC) motor fully extends (most vehicles) or moves back and forth.

  – Carbureted Engines Only: The Idle Speed Control (ISC) motor, if used on vehicle, moves back and forth. Also, the Exhaust Gas Recirculation (EGR) solenoid is energized for 25 seconds.

5) Turn Ignition Key OFF.

- Remove Code Scanner and re-install connector cover, if supplied.
- The computer system is now back to normal.
- This completes the Relay and Solenoid Circuit Test.

Field Service Test – Fuel Injected Engines Only

This is a quick check of the fuel control system to verify proper operation - especially after repair work. Service manuals call this the “Field Service Mode”. Do the following:

1) Safety First!

- Set the parking brake.
- Put shift lever in PARK (automatic transmission) or NEUTRAL (manual transmission).
- Block the drive wheels.
- Make sure ignition key is in OFF position.

2) Test the “Check Engine” Light

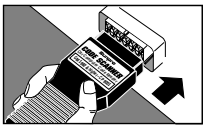
(Also called “Service Engine Soon”, “Service Engine Now” or labeled with a small engine picture.)

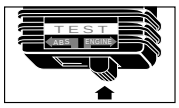
- Turn ignition key from OFF to ON position, **but do not start the engine.**
- Verify that the light turns on.
- If the light does not turn on, you have a problem with this circuit which must be repaired before proceeding. Refer to the “Diagnostic Circuit Check” procedure in your vehicle service manual. (See manual listings on page 4.)

3) Start the Engine

WARNING: Always operate vehicle in well ventilated area. Exhaust gases are very poisonous!

4) Plug the Code Scanner into the Test Connector. Put TEST switch on ENGINE.





The engine computer is now in the “Field

Diagnostic Mode." The flashing "Check Engine" light shows how the fuel control system is operating. See below.

Read Section 7, "Computer Basics" or Section 8, "Glossary" for an explanation of Open Loop and Closed Loop operation.

IMPORTANT: The oxygen sensor needs to be hot so the computer can check the signal for proper fuel delivery. Warm the engine by idling for 2 minutes at 2000 RPM. Then, gently rev the engine from idle to part throttle several times. (This creates a changing sensor signal for the computer.) Finally, keep the throttle steady, or at idle, for the rest of the test.

Light flashes 2 times a second

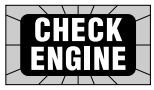
The computer is in **Open Loop** operation. The computer will run "open loop" if it does not see an oxygen sensor signal because...

– The oxygen sensor is not hot enough to operate (normal condition if engine too cold or sensor cooled down during idle)

or,

– Open circuit problems exist (bad sensor or wiring). Note that this condition will generate a trouble code.

Light flashes once a second



The computer is in **Closed Loop** operation. The oxygen sensor is sending a signal.

- *Light equally ON and OFF while flashing:* system is **running correctly** (proper air/fuel mixture).
- *Light mostly ON while flashing:* system is running "rich".
- *Light mostly OFF while flashing:* system is running "lean".

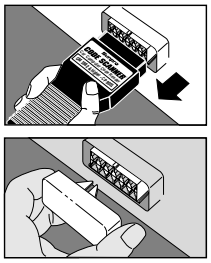
Various mechanical, electronic or wiring problems can cause the computer to sense a "rich" or "lean" running engine. Usually these conditions will generate a trouble code, such as 44 (lean exhaust) or 45 (rich exhaust). Follow vehicle service manual troubleshooting charts to find the cause. The Field Service Test lets you check to see if the problem was fixed. (Light flashing equally ON and OFF once a second.)

Note: While in the "Field Service Mode"...

– New trouble codes are not stored in computer memory.

– On some engines, the computer will send a signal for a fixed spark advance.

5) Turn Ignition Key OFF



- Remove Code Scanner and re-install connector cover, if supplied.
- The computer system is now back to normal.
- This completes the Field Service Test.

COMPUTER BASICS

What does the Engine Control Computer do?

This section further explains the engine computer control system, the types of sensors and how the computer controls fuel delivery, idle speed and timing.

The following is an introduction to computer controlled engine systems. Additional information may be found in books dealing with this subject available at your local library or auto parts store. The more you know about the computer system, the better and faster you can troubleshoot and fix problems.

Why Computers?

Computer controls were installed in vehicles to meet Federal Government regulations for lower emissions and better fuel economy. This all began in the early 1980's when purely mechanical control systems just were not good enough anymore. A computer could be programmed to precisely control the engine under various operating conditions and eliminate some mechanical parts making the engine more reliable.

Note that vehicle service manuals refer to the computer as either the ECM (Engine Control Module) or PCM (Powertrain Control Module).

What the computer controls

The main control areas of the computer are:

- Fuel delivery
- Idle speed
- Spark advance timing
- Emission devices (EGR valve, carbon cannister, etc.)

The changes made to the basic engine to allow a computer to control these tasks are the only differences between an older engine and a computerized one. A little later we will discuss just how the computer handles these tasks.

What has NOT changed?

A computer controlled engine is basically the same as earlier types. It is still an internal combustion engine with pistons, spark plugs, valves and cams. The ignition, charging, starting, and exhaust systems are almost the same, as well. You test and repair these systems the same way as before, using familiar tools. The instruction manuals for these tools show you how to perform the tests. Your compression gauge, vacuum pump, dwell-tach meter, engine analyzer, timing light, etc., are still valuable!

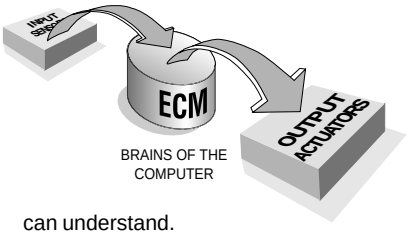
The Engine Computer Control System

The computer module is the "heart" of the system. It is sealed in a metal box and linked to the rest of the system by a wiring harness. The computer module is located in the passenger compartment, usually behind the dashboard or front kick panels. This protects the electronics from moisture, extreme temperatures and excess vibration, which are common in the engine compartment.

The computer is permanently programmed by factory engineers. The program is a complex list of instructions telling the computer how to control the engine under various driving conditions. To do its job, the computer needs to know what is happening and then it needs devices to control things.

Sensors give the computer information

The computer can only work with electrical signals The job of the sensor is to take something the computer needs to know, such as engine temperature, and convert it to an electrical signal which the computer



can understand.
You can think of sensors as “high tech” senders the devices found in older vehicles for gauges and dashboard message lights (oil pressure, fuel level, etc.) Signals running into the computer are referred to as “inputs.”

Sensors monitor such things as:

- Engine temperature
- Intake manifold vacuum
- Throttle position
- RPM
- Incoming air (temperature, amount)
- Exhaust gas oxygen content

Most engine computer systems will use the sensor types listed above. Additional sensors may be used depending upon the engine, vehicle type or other tasks the computer must do. Note that information from one sensor may be used by the computer for many different tasks. For example, engine temperature is something the computer needs to know when controlling fuel delivery, spark timing, idle speed and emission systems. The sensor information may be very important for one engine control function, but only used to “fine tune” a second one.

There are several types of sensors

- *Thermistor* – This is a resistor whose resistance changes with temperature. It is used to measure temperatures of coolant or incoming air. It has two wires connected to it.
- *Potentiometer* – This signals a position, such as throttle position or EGR valve position. It connects to three wires: one for power, one for ground and one to carry the position signal back to the computer.
- *Switches* – These are either ON (voltage signal to the computer) or OFF (no voltage signal to the computer). Switches connect to two wires and tell the computer simple things, such as whether or not the air conditioner is running.
- *Signal Generator* – These create their own signal to tell the computer of some condition, such as exhaust gas oxygen content, camshaft position, or intake manifold vacuum. They may have one, two or three wires connected to them.

The computer controls things with actuators

The computer can only send out electrical signals (referred to as “outputs”). Devices called actuators are powered by the computer to control things. Actuator types include:

- *Solenoids* – These are used to control a vacuum signal, bleed air, control fuel flow, etc.
- *Relays* – These switch high amperage power devices on and off, such as electric fuel pumps or electric cooling fans.
- *Motors* – Small motors are often used to control idle speed.

Other output signals

Not all of the computer outgoing signals go to actuators. Sometimes information is sent to electronic modules, such as ignition or trip computer.

How the computer controls fuel delivery

Good performance and low emissions depend upon precise fuel control. Early computer controlled vehicles used electronically adjustable carburetors, but fuel injectors were soon introduced.

The job of the computer is to provide the optimum mixture of air and fuel (air/fuel ratio) to the engine for best performance under all operating conditions.

The computer needs to know:

- ...what the engine operating condition is.

  Sensors used: coolant temperature, throttle position, manifold absolute pressure, mass air flow, RPM.

- ...how much air is coming into the engine.

  Sensors used: mass air flow or a combination of manifold absolute pressure, manifold air temperature, RPM.

- ...how much fuel is being delivered.

  The computer knows this by how long it turns on the fuel injectors. (The computer uses a "feedback control" or "duty cycle" solenoid on electronic controlled carburetors.)

- ...that everything is working the way it should.

  Sensor used: exhaust gas oxygen sensor.

Note: Not all engines use every sensor listed above.

Cold engine warm-up condition

An example of "Open Loop" operation...

The coolant temperature sensor tells the computer how warm the engine is. Factory engineers know what the best air/fuel mixture is for the engine at various operating temperatures. (More fuel is needed for a cold engine.) This information is permanently programmed into the computer. After the computer knows the engine temperature, it determines the amount of air coming in, then it will look at its programming to find out how much fuel to deliver and operate the fuel injectors accordingly. (Engines with electronic carburetors don't do any of this. They have a thermostatically controlled choke just like non-computer engines.)

This process is an example of "Open Loop" operation by the computer. The control system performs an action (expecting a certain result), but has no way of verifying if the desired results were achieved. In this case, the computer operates a fuel injector expecting a certain amount of fuel to be delivered. (The computer assumes everything in the fuel system is operating as expected.) In open loop operation, the computer has no way of checking the actual amount of fuel delivered. Thus, a faulty fuel injector or incorrect fuel pressure can change the amount of fuel delivered and the computer would not know it.

The computer system is forced to operate "open loop" because no sensor type is available which can measure air/fuel ratios when the engine is cold.

Hot engine cruise condition

An example of "Closed Loop" operation...

The computer watches the coolant temperature and throttle position sensors to tell when the engine is all warmed up and cruising. As before, the computer determines the amount of air coming into the engine, then delivers the amount of fuel that should provide the optimum air/fuel mixture. The big difference is that this time the computer uses the oxygen sensor to check how well its doing and re-adjust things, if needed, to make sure the fuel delivery is correct. For example: If the oxygen sensor indicates a "rich" condition, the computer will compensate by reducing fuel delivery until the oxygen sensor signals an optimum air/fuel ratio. Likewise, the computer will compensate for a "lean" condition by adding fuel until the oxygen sensor once again signals an optimum air/fuel mixture.

This is an example of "Closed Loop" operation. The control system performs an action (expecting a certain result), then **checks** the results and **corrects** its actions (if necessary) until the desired results are achieved.

The oxygen sensor only works when it is very hot. During cold engine warm-up, and sometimes at idle, the sensor will be too cool to operate (no signal sent). The computer must operate "open loop" during this time because it cannot use the sensor to check the air/fuel ratio.

Acceleration, deceleration and idle conditions

As long as the engine and oxygen sensor are hot, the computer can operate “closed loop” for best economy and least emissions. During the drive conditions listed on the left, the computer may have to ignore the sensor and run “open loop,” relying on internal programming for fuel delivery instructions. During idle, for example, the oxygen sensor may cool down and stop sending a signal. A different situation can occur during wide-open-throttle acceleration. The computer sometimes adds additional fuel (on purpose) for temporary acceleration power. The computer knows it is running “rich” so it ignores the sensor signal until the wide-open-throttle condition is over.

How the computer controls idle speed

Throttle position and RPM sensors tell the computer when the vehicle is idling. (Sometimes an idle position switch on the throttle is used.) The computer simply watches RPM and adjusts an idle speed control device on the vehicle to maintain the desired idle condition. Note that this is another example of “closed loop” operation. The computer performs an action (activating an idle control device), then watches the results of its action (engine RPM) and readjusts as necessary until the desired idle speed is achieved.

There are two types of idle speed control devices. The first is an adjustable throttle stop that is positioned by a computer controlled motor. The second method lets the throttle close completely. An air passage bypassing the throttle allows the engine to idle. A computer controlled motor adjusts air flow through the bypass to set idle speed.

Smaller engines can stumble or stall at idle when the air conditioner compressor turns on or the power steering is used. To prevent this, switches tell the computer when these demands are coming so it can increase the idle accordingly.

How the computer controls spark advance timing

You set spark timing in a non-computer engine by using a timing light and adjusting the distributor at idle RPM. During vehicle operation, timing is changed by either engine vacuum (vacuum advance function) or by engine RPM (centrifugal advance function.) These spark timing changes are done mechanically inside the distributor.

Computer controlled vehicles using a distributor still have you set spark timing by using a timing light and adjusting the distributor at idle RPM. The timing changes which occur during vehicle operation, however, are controlled electronically. The computer looks at sensors to determine vehicle speed, engine load and temperature. (RPM, throttle position, coolant temperature and manifold pressure or mass air flow sensors are used.) Then, the computer adjusts timing according to factory programmed instructions. Some vehicles have a “knock” sensor. The computer can “fine tune” the spark timing if this sensor signals an engine knock condition. A timing signal (“EST” - Electronic Spark Timing) is sent by the computer to an ignition module which eventually creates the spark. The computer uses a crankshaft position sensor to determine piston position, so it can send the spark timing (EST) signal at the proper moment.

Newer ignition systems use no distributor. There are several versions, such as Computer Controlled Coil Ignition (C3I), Direct Ignition System (DIS), Integrated Direct Ignition (IDI) and Opti-Spark. These systems use multiple ignition coils. (2 spark plugs are wired to each coil.) Sensors for crankshaft position or camshaft position (or both) are used by both the ignition module and computer to fire the correct coil at the proper time. The computer provides spark advance timing as before - by looking at vehicle speed, engine load and temperature. (RPM, throttle position, coolant temperature and manifold pressure or mass air flow sensors are used.) Refer to vehicle service manual for detailed ignition system descriptions.

Computer controlled emission systems

• EGR (Exhaust Gas Recirculation) Valve

The EGR valve lets exhaust gases re-enter the intake manifold and mix with the incoming air/fuel. The presence of exhaust gases reduces combustion temperatures in the cylinders and this reduces poisonous NOx emissions. The computer controls the flow of gases through the EGR valve. The EGR system is only used during warm engine cruise conditions. A partially open EGR valve at other times can cause stalling. Various types of EGR systems are used on different vehicles. The EGR valve may be operated by engine vacuum or with a computer controlled electrical (or vacuum) signal. See “EGR” in Glossary (Section 8) for more details.

• Air Injection System

This system reduces harmful carbon monoxide (CO) and hydrocarbon (HC) emissions. The computer takes outside air from an air pump and directs it to the exhaust manifold during engine warm-up. (The extra air helps partially burned exhaust gases to completely burn and reduce pollution.) After warm-up, depending upon vehicle, the air pump may send air down to the catalytic convertor or “dump” it back to the atmosphere. Various types of Air Injection systems are used on different vehicles. Refer to “Air Injection System” in Glossary (Section 8) for more explanation.

• Fuel Evaporation Recovery System

A special canister collects vapors evaporating from the fuel tank, preventing them from escaping into the atmosphere and causing pollution. During warm engine cruise conditions, the computer opens a connection between the cannister and the engine (by energizing the Purge solenoid.) Then, engine vacuum draws the trapped fuel vapors into the engine for burning.

Other computer functions

The computer often controls various other functions around the vehicle. Detailed explanations may be found in your vehicle service manual. Some typical examples are...

• Air Conditioner (A/C) Clutch

The computer can turn off the air conditioner to reduce engine loading. This is desirable during heavy acceleration, engine cranking or low speed steering maneuvering. The computer may also disable the air conditioner when refrigerant pressure is too low (or high) to prevent A/C damage. The computer stops the air conditioner by using a relay to disconnect voltage from the A/C clutch.

• Radiator Cooling Fan

The computer controls engine cooling fan (electric type) operation on most vehicles. Usually the fan is turned on when engine temperature exceeds a certain level or when the air conditioning system is used. The computer uses a relay to power the fan. Some vehicles have a second fan for extra cooling.

• Variable Assist Power Steering

Saturn Vehicles: This system delivers power steering assist based on vehicle speed - little assist during high speed straight steering, increased assist for low speed turns. The computer controls fluid flow in the power steering pump using an Electronic Variable Orifice (EVO) actuator (more fluid flow provides more steering assist). Refer to “EVO” in Glossary (Section 8) for more details.

• Torque Convertor Clutch

The computer can control the lock-up clutch in an automatic transmission torque convertor. The clutch is locked during steady, warm engine cruise

conditions. This improves fuel economy by eliminating power loss in the torque convertor. The computer energizes a solenoid to achieve lock-up. Signals from the engine coolant temperature, throttle position and vehicle speed sensors are used.

• Transmission Control

Some transmissions have computer controlled shifting. Two solenoids mounted in the transmission are energized singly, or in combination, to select a gear ratio. The solenoids direct the flow of fluid within the transmission to cause the shift. The computer uses throttle position, vehicle speed, engine loading and other sensor information to determine the optimum shift performance. The computer can also set the shift quality - anywhere from harsh to smooth. This is done using a “force motor” actuator in the transmission to adjust the internal fluid line pressure.

More information

The Glossary (Section 8) describes various sensors and actuators used in computer controlled engine systems. You can learn more by reading these definitions.

GLOSSARY

A/C
Air conditioner.

A/C Clutch relay
The ECM uses this relay to energize the A/C clutch - to turn the A/C system on or off.

A/C On (A/C Signal)
An input signal to the ECM indicating that either the A/C compressor is running or that A/C operation is being requested (depends upon vehicle). Then ECM adjusts idle speed to prevent engine stalling when the A/C system is engaged. The ECM may also turn on the engine cooling fan.

A/C Pressure sensor
This sensor is connected to the A/C refrigerant line. It measures refrigerant pressure and sends a voltage signal to the ECM. The ECM will turn off the A/C system (by de-energizing the A/C Clutch relay) to prevent compressor damage if the pressure is too high or low.

A/C Pressure switch
This is a mechanical switch connected to the A/C refrigerant line. The switch is activated (which sends a signal to the ECM) when the A/C refrigerant pressure becomes too low. The ECM will turn off the A/C system (by de-energizing the A/C Clutch relay) to prevent compressor damage. Some vehicles have a second switch activated when the refrigerant pressure is too high.

Actuator
Devices which are powered by the ECM to control things. Actuator types include relays, solenoids and motors. Actuators allow the ECM to control engine operation.

A/F
Air/fuel.

Air Injection Reaction (AIR) system
This is an emission control system operated by the ECM. During cold engine warm-up, an air pump injects outside air into the exhaust manifold to help burn hot exhaust gases. This reduces pollution and speeds warm-up of oxygen sensor and catalytic convertor. After the engine is warm, the air will either be “dumped” back to the atmosphere (or into the air cleaner) or sent into the catalytic convertor. There are various versions of the AIR system - depends upon vehicle.

The air pump is usually belt driven by the vehicle engine. The ECM controls air flow from the pump by operating two electrically powered solenoid valves. An Electric Air Divert Valve either “dumps” the air to atmosphere (valve unpowered) or sends the air further into the system (valve energized). A second control valve, the Air Switching Valve, routs the air to the catalytic convertor (valve unpowered) or to the exhaust manifold (valve energized). These two valves may be individual components or combined into one assembly.

The ECM normally sends air to the catalytic convertor during warm engine operation. The ECM will divert air away from the convertor to prevent overheating damage under certain operating conditions, such as decel, high RPM or “rich” air/fuel conditions.

Some vehicles have an electrically powered air pump controlled by the ECM. This system injects air into the exhaust manifold only when the pump is energized and running. No air is injected when the pump is off. (The air pump does not send air to the catalytic convertor in this version.)

ALDL
Assembly Line Diagnostic Link. This is the connector that the Code Scanner plugs into for testing purposes. The connector is wired to the ECM, and is usually located under the dashboard on the driver’s side.

BARO
Barometric Pressure Sensor. (See MAP sensor for explanation.)

Boost control solenoid
Used on certain supercharger equipped engines. This solenoid is normally energized by the ECM. (This allows the supercharger system to operate normally.) The ECM de-energizes the solenoid during higher engine speed and load conditions to reduce boost pressure.

Brake switch signal
An input signal to the ECM indicating that the brake pedal is being depressed. Vehicles with Cruise Control systems monitor the brake switch to determine when to engage (or disengage) the cruise control function. The brake switch may also have a circuit supplying power to the Torque Convertor Clutch (TCC) solenoid. This connection ensures the TCC solenoid will disengage when the brake pedal is depressed (see TCC definition).

C3
Computer Command Control. The name for the GM electronic engine control system used on most vehicles built since 1982.

CALPAK
A “spare tire” for the ECM. It is circuitry which can operate the vehicle fuel injectors in a limited fashion should the ECM malfunction. The CALPAK is hidden behind an access door on the ECM. The replaceable CALPAK module is only used on certain ECM’s.

CAM
Camshaft Position Sensor. This sensor sends a frequency signal to the ECM. Vehicles with sequential fuel injection (SFI) use this signal to synchronize the injector firing order. Some DIS type ignition systems use this signal to synchronize spark plug firing.

Closed Loop (C/L)
This is when a control system performs an action (expecting a certain result), then checks the results and corrects its actions (if necessary) until the desired results are achieved. Example: Fuel delivery. The ECM operates a fuel injector in a way which should deliver an optimum air/fuel mixture - if everything in the fuel system is operating as expected! In closed loop operation, the ECM uses the oxygen sensor to check the results. (Fuel delivery may be different than expected because of variations in fuel pressure or injector operation.) If the oxygen sensor indicates a “rich” condition, the ECM will compensate by reducing fuel delivery until the oxygen sensor signals an optimum air/fuel ratio. Likewise, the ECM will compensate for a “lean” condition by adding fuel until the oxygen sensor once again signals an optimum air/fuel mixture. Thus, closed loop operation means the ECM can “fine tune” control of a system to get an exact result providing the ECM has a sensor (or other means) to check results.

Continuity
An unbroken, continuous circuit through which an electric current can flow.

CPS
Crankshaft Position Sensor. This sensor sends a frequency signal to the ECM. It is used to reference fuel injector operation and synchronize spark plug firing on distributorless ignition systems (DIS).

CTS
Coolant Temperature Sensor. This sensor is a thermistor - a resistor whose resistance decreases with increases in temperature. The sensor is threaded into the engine block and contacts the engine coolant. The ECM uses this signal for control of fuel delivery, spark advance and EGR flow.

Digital Signal
An electronic signal which has only two (2) voltage values: a “low” value (close to zero) and a “high” value (usually 5 volts or greater). Sometimes the low voltage condition is called “Off” and the high voltage condition is called “On”. Signals which can have any voltage value are called “analog” signals.

DIS
Distributorless Ignition System or Direct Ignition System. A system which produces the ignition spark without the use of a distributor.

Driver
A transistor “switch” inside the ECM used to apply power to an external device. This allows the ECM to control relays, solenoids and small motors.

Duty Cycle
A term applied to frequency signals - those which are constantly switching between a small voltage value (close to zero) and a larger value (usually 5 volts or greater). Duty cycle is the percentage of time the signal has a large voltage value. For example, if the signal is “high” (large voltage) half of the time then the duty cycle is 50%. If the signal is “high” only one fourth of the time, then the duty cycle is 25%. A duty cycle of 0% means the signal is always at a “low” value and not changing. A duty cycle of 100% means the signal is always at a “high” value and not changing. The engine control computer uses duty cycle type signals when it wants more than just “on-off” control of an actuator. This is how it works: A 50% duty cycle signal going to a vacuum switching solenoid means the solenoid will be “on” (passing full vacuum) half the time and “off” (passing no vacuum) half the time. The average amount of vacuum passing through the solenoid will be one half the full value because the solenoid is only “on” for one half the time. (The signal switches at a rapid rate, such as ten times a second.) Thus, the computer can get a vacuum controlled actuator to move half way between “no vacuum” position and “full vacuum” position. Other positions can be achieved by changing the duty cycle of the control signal which in turn changes the average amount of control vacuum.

DVM
Digital Volt Meter. An instrument using a numeric readout to display measured voltage values as opposed to a moving needle on a gauge face. Usually the instrument has other measuring capabilities, such as resistance and current, and may be called a DMM

(Digital Multi-Meter). Most DVM's have 10 Megohm input impedance. This means the circuit under test will not be electronically disturbed when the DVM is connected for a measurement.

ECM

Electronic Control Module. The "brains" of the engine control system. It is a computer housed in a metal box with a number of sensors and actuators connected with a wiring harness. Its job is to control fuel delivery, idle speed, spark advance timing and emission systems. The ECM receives information from sensors, then energizes various actuators to control the engine. The ECM is sometimes called PCM (Powertrain Control Module) in vehicles having other computers. These other computers are used for climate control, entertainment systems, etc.

EFI

Electronic Fuel Injection. A term applied to any system where a computer controls fuel delivery to an engine by using fuel injectors.

EGR

Exhaust Gas Recirculation. The EGR system recirculates exhaust gases back into the intake manifold to reduce NO_x emissions. The EGR valve controls the flow of exhaust gases back into the intake manifold. Some EGR valves are operated with a vacuum signal while others are electrically controlled. The amount of EGR valve opening determines the flow through the valve. EGR recirculation is only used during warm engine cruise conditions. EGR flow at other times can cause stalling or no starts. There are three types of EGR systems controlled by the ECM.

One system uses exhaust backpressure to operate the EGR valve. The ECM does not control the EGR valve in this case, but it can switch off the valve completely when desired. (The ECM operates a solenoid switch to cut off the backpressure control signal to the valve.)

The second system uses an EGR valve entirely controlled by the ECM. This valve contains three individual flow passages: small flow, medium flow and large flow. Each passage has an electric solenoid. (Passage closed when solenoid off - passage open when solenoid energized.) The ECM energizes one or more solenoids in combination to set up different flow rates through the valve as required.

The third system is also directly controlled by the ECM. This EGR valve is vacuum operated (the normally closed valve opens as vacuum is applied). The ECM applies control vacuum to the EGR valve using a solenoid connected to a vacuum source. The ECM uses a duty cycle type signal to vary the amount of vacuum passing through the solenoid. (See "Duty Cycle" definition.)

EMI

Electromagnetic Interference. Undesired signals interfering with a needed signal. For example: static on a radio brought about by lightning flashes or closeness to high voltage power lines.

ESC

Electronic Spark Control. This is an ignition system function which works on vehicles having a knock sensor mounted on the engine block. The knock sensor is wired to circuitry in a separate module (early version) or inside the ECM (later version). If the sensor detects engine knock, the ESC function alerts the ECM which will immediately retard the spark to eliminate the knock condition.

EST

Electronic Spark Timing. An ignition system where the ECM controls the spark advance timing. A signal called EST goes from the ECM to the ignition module which fires the spark coil. The ECM determines optimum spark timing from sensor information - engine speed and RPM, throttle position, coolant temperature, engine load, vehicle speed, Park/Neutral switch position and knock sensor condition.

EVO

Electronic Variable Orifice actuator. This is a solenoid mounted in the power steering pump. It is used in some variable assist power steering systems. The solenoid controls the amount of fluid passed to the steering gear. Increasing fluid flow generates more power steering assist. The ECM controls the solenoid by using a duty cycle type signal (see "duty cycle" definition). The ECM uses information from the vehicle speed sensor (VSS) and the handwheel sensor (which sends a signal related to the rate of steering wheel turning). During low speed turns, the ECM increases the EVO solenoid opening to provide additional steering assist. The ECM decreases steering assist during straight line driving by reducing fluid flow through the EVO solenoid.

EVRV

Electronic Vacuum Regulator Valve. This actuator is controlled by the ECM and is used to vary the amount of vacuum applied to a vacuum operated device - usually the EGR valve.

FBC

Feedback Carburetor. This is used on early versions of computer controlled engines. It is a carburetor which can have its fuel

delivery modified by an electronic signal from the ECM. The signal controls a “mixture control solenoid” (MCS) attached to the carburetor body.

Frequency

The frequency of an electronic signal is a measure of how often the signal repeats a voltage pattern in a one second time span. For example: suppose a signal starts at zero volts, goes to five volts then returns to zero again. If this pattern repeats itself 100 times in one second, then the signal frequency is 100 cycles per second - or 100 Hertz.

Fuel Injector

An electronically controlled flow valve. Fuel injectors are connected to a pressurized fuel supply. (The pressure is created by a fuel pump.) No flow occurs when the injector is off (not energized). When the injector is powered, it opens fully allowing the fuel to flow. The ECM controls fuel delivery by varying the amount of time the injectors are turned on.

Fuel Pump Relay

The ECM energizes this relay to apply power to the vehicle fuel pump. For safety reasons, the ECM removes power from the fuel pump when ignition signals are not present.

Fuel Pump signal

This is a wire between the ECM and the fuel pump motor power terminal. The ECM uses this signal to verify when voltage is at the fuel pump (for diagnosing fuel pump problems).

Gear switches

These are switches (usually two) located inside certain automatic transmissions. The ECM monitors the switches to determine what transmission gear is engaged. The switches are activated by hydraulic pressure and may be normally open or closed, depending upon vehicle. The ECM uses gear information for control of the torque convertor clutch, some emission systems and for transmission diagnostic purposes.

Ground

The return path for current to flow back to its source. (Usually the negative battery terminal.) It is also the reference point from which voltage measurements are made. That is, it is the connection place for the minus (-) test lead from the voltmeter.

Hall Effect sensor

This sensor is a three wire type containing electronic circuitry. Two wires supply power and ground. The third wire carries the sensor signal back to the ECM. The sensor consists of a permanent magnet and a small module containing a transistorized Hall Effect switch. A small air gap separates the sensor and the magnet. The magnetic field causes the Hall switch to turn on and send out a low voltage signal. If a metal strip (iron or steel) is placed in the gap, it will block the magnetic field from reaching the Hall device. This causes the Hall switch to turn off and send a high voltage signal out on the signal wire.

The metal strips (blades) are part of a cup or disk attached to a rotating component such as the crankshaft or camshaft. As the blades pass through the sensor gap. the signal voltage will switch high and low creating a series of pulses. The ECM determines the speed of rotation by measuring how fast pulses appear. Hall Effect type sensors may be used to measure speed and position of the crankshaft or camshaft - for spark timing or fuel injector control.

Handwheel sensor

This is a three wire sensor (power, ground and signal wires). It is used in some Variable Assist Power Steering systems. The ECM uses the sensor signal to determine how fast the steering wheel is being turned. Then the ECM can apply the correct amount of power steering assist based on vehicle speed. See “EVO” (Electronic Variable Orifice) actuator definition for more information.

HEI

High Energy Ignition. Ignition system which pulses the spark coil by using transistor switches instead of mechanical breaker points. The electronics are in a module which use a reference signal coming from a magnetic pick-up coil driven by the camshaft.

Hertz (Hz)

A term for frequency - cycles per second.

IAC

Idle Air Control. This is a device mounted on the throttle body. It adjusts the amount of air bypassing a closed throttle so that the ECM can control idle speed. The IAC is a stepper motor which moves a pintle within the air bypass passage. When the ECM wants to change idle speed, it will move the pintle backwards, for more air and faster idle, or it will move it forward for less air and slower idle. (See Stepper Motor definition.)

Idle switch

This is a switch built into the tip of the ISC (Idle Speed Control) motor spindle. (See “ISC” definition.) During idle, the throttle rests against the ISC spindle and activates the switch. The ECM uses this switch signal to identify closed throttle condition, then operates the engine in an “idle” or “deceleration” mode.

Inputs
Electrical signals running into the ECM. These signals come from sensors, switches or other electronic modules. They give the ECM information about vehicle operation.

ISC
Idle Speed Control. This refers to a small electric motor mounted on the throttle body and controlled by the ECM. The ISC motor moves a spindle back and forth. When the throttle is released during idle, it rests on this spindle. The ECM can control idle speed by adjusting this spindle position. The ECM determines the desired idle speed by looking at battery voltage, coolant temperature, engine load and RPM.

Knock sensor
This sensor is used to detect engine detonation (knocking). When spark knock occurs, the sensor sends a pulsing signal. Depending upon vehicle, this signal goes either to the ECM or a separate ESC (Electronic Spark Control) module. Then the spark advance is retarded to eliminate detonation. The sensor contains a piezoelectric element and is threaded into the engine block. Vibrating the element generates the signal. Special construction makes the element only sensitive to the engine vibrations associated with knocking.

MAF
Mass Air Flow sensor. This sensor measures the amount of air entering the engine and sends a frequency or voltage signal (depends upon sensor type) to the ECM. The signal voltage or frequency increases when the amount of incoming air goes up. This gives the ECM information required for control of fuel delivery and spark advance.

MAP
Manifold Absolute Pressure sensor. This sensor measures manifold vacuum and sends a frequency or voltage signal (depends upon sensor type) to the ECM. This gives the ECM information on engine load for control of fuel delivery, spark advance and EGR flow.

MAT
Manifold Air Temperature sensor. This sensor is a thermistor - a resistor whose resistance decreases with temperature. It is threaded into the intake manifold so the ECM can determine the temperature of the incoming air. This is used for fuel delivery calculations.

MCS
Mixture Control Solenoid. Used on computer controlled vehicles having carburetors. Built into the carburetor, it allows the ECM to “fine tune” fuel delivery during warm engine cruise.

MEMCAL
A small electronic assembly containing the the functions of both the PROM and CALPAK. It is hidden behind an access door on the ECM and is replaceable. Only some ECM’s have MEMCAL.

MFI
Multi-Port Fuel Injection. (See MPFI definition.)

Mode
A type of operating condition, such as “idle mode” or “cruise mode.”

MPFI
Multi-Port Fuel Injection. A fuel injection system using one injector for each cylinder. The injectors are mounted in the intake manifold. The injectors are fired in groups rather than individually.

Open (circuit)
A break in the continuity of a circuit such that no current can flow.

Open Loop (O/L)
This is when the control system performs an action (expecting a certain result), but has no way of verifying if the desired results were achieved. Example: the ECM operates a fuel injector expecting a certain amount of fuel to be delivered. (The ECM assumes everything in the fuel system is performing as expected.) In open loop operation, the ECM has no way of checking the actual amount of fuel delivered. Thus, a faulty fuel injector or incorrect fuel pressure can change the amount of fuel delivered and the ECM would not know it.

In general, a control system operates “open loop” only when there is no practical way to monitor the results of an action. Example: Fuel delivery during cold engine warm-up. The computer runs “open loop”because the oxygen sensor is not ready to send a signal. Without the sensor signal, the computer can not check the actual amount of fuel delivered.

O_2
Oxygen sensor. The oxygen sensor is threaded into the exhaust manifold, directly into the stream of the exhaust gases. The ECM uses the sensor to “fine tune” fuel delivery. The sensor generates a voltage of 0.6 to 1.1 volts when the exhaust gas is rich (low oxygen content). The voltage changes to 0.4 volts or less when the exhaust gas is lean (high oxygen content). The sensor only operates after it reaches a temperature of 349°C (660°F).

Outputs
Electrical signals sent from the ECM. These signals may activate relays or other actuators for control purposes around the vehicle. The signals can also send information from the ECM to other electronic modules, such as ignition or trip computer.

P/N

Park/Neutral switch. This switch tells the ECM when the gear shift lever is in the Park or Neutral position. Then the ECM will operate the engine in an "idle" mode.

Pressure Control solenoid

This solenoid is located inside certain automatic transmissions. The ECM uses this solenoid to vary the internal line pressure, as required, based on engine load condition

PROM

Programmable Read-Only Memory. A small, replaceable electrical component hidden behind an access door on the ECM. The PROM contains permanent programming information the ECM needs to operate a specific vehicle model. Included are vehicle weight, engine and transmission type, axle ratio and other specifics.

PS

Power steering switch. This tells the ECM when power steering is being used. The ECM can prevent stalling on a small, idling engine by watching this switch and increasing idle speed if power steering is being used.

Purge solenoid

This device controls the flow of fuel vapors from the carbon canister to the intake manifold. The canister collects vapors evaporating from the fuel tank, preventing them from escaping into the atmosphere and causing pollution. During warm engine cruise conditions, the ECM energizes the Purge solenoid so the trapped vapors are drawn into the engine and burned.

Quad Driver

An electrical device inside the ECM. It functions as four separate electronic "switches" allowing the ECM to energize relays or solenoids.

Relay

A mechanical device for switching high current circuits on and off. It is electronically controlled by a low current circuit. Relays allows a low power ECM signal to control a high power device such as an electric cooling fan.

Reluctance sensor

This sensor type consists of a permanent magnet with a coil of wire wrapped around it. Nearby the sensor is a toothed "reluctor" ring made of iron or steel. The ring is attached around a rotating component such as the crankshaft. Whenever a tooth from the ring passes by the sensor, it attracts the magnetic field lines surrounding the magnet. As the field lines move, they pass through the wire coil which generates a small voltage pulse (magnetic induction principle). Thus, a voltage pulse is generated every time a tooth passes by the sensor coil. The ECM determines the speed of rotation by measuring how fast pulses appear. Reluctance sensors may be used for:

Crankshaft or Camshaft – speed, position (spark timing or fuel injector control).

Driveshaft – vehicle speed (transmission or torque convertor control, cooling fan use, variable assist power steering and "cruise control").

Wheel Speed – anti-lock brake or traction control systems.

Sensor

Device which give the ECM information. The ECM can only work with electrical signals. The job of the sensor is to take something the ECM needs to know, such as engine temperature, and convert it to an electrical signal which the ECM can understand. The ECM uses sensors to measure such things as throttle position, coolant temperature, engine speed, incoming air and the like.

SFI or SEFI

Sequential Fuel Injection or Sequential Electronic Fuel Injection. A fuel injection system using one injector for each cylinder. The injectors are mounted in the intake manifold. The injectors are fired individually in the same sequence as the spark plug firing sequence.

Shift solenoid

Used in computer controlled transmissions. The solenoids (usually two) are located in the transmission housing and are controlled by the ECM. The ECM energizes the solenoids individually, or in combination, to select a specific gear. (The solenoids control the flow of hydraulic fluid to the transmission shifting valves.) The ECM selects the appropriate gear ratio and shift point based upon engine operating conditions.

Short (circuit)

A fault condition: an unwanted connection of one electric circuit to another causing a change in the normal current flow path.

Solenoid

A device to convert an electrical signal to mechanical motion. It consists of a coil of wire with a movable metal rod in the center. When power is applied to the coil, the resulting electromagnetism moves the rod and performs some mechanical action. The ECM often uses solenoids to switch vacuum lines on and off. This allows the ECM to control vacuum operated devices such as an EGR valve. Fuel injectors are another type of solenoid.

Stepper Motor

A special type of electric motor with a shaft that rotates in small “steps” instead of a continuous motion. A certain sequence of frequency type signals is required to step the motor shaft. A different signal sequence will step the shaft in the opposite direction. No signals keeps the shaft still in position. A constant signal drive will continuously rotate the shaft. The shaft is usually connected to a threaded assembly which moves back and forth to control things such as idle speed bypass air flow (see IAC). The engine computer sends the correct signals to the motor for control.

TBI

Throttle Body Injection. A fuel injection system having one (or two) injectors mounted in a centrally located throttle body, as opposed to positioning the injectors close to an intake valve port.

TCC solenoid

Torque Convertor Clutch solenoid. The ECM uses this solenoid to control the lock-up clutch in the transmission torque convertor. (When activated, the lock-up clutch directly connects the engine to the transmission.) During warm engine cruise conditions, the ECM energizes this solenoid to eliminate transmission slippage and increase fuel economy. The ECM releases the lock-up action when driving conditions require the transmission to operate as normal.

TDC

Top Dead Center. When a piston is at its uppermost position in the cylinder - maximum compression.

Thermistor

A resistor whose resistance changes with temperature. Thermistors are used as sensors for vehicle coolant and manifold air temperature. The resistance decreases as temperature goes up.

TPS

Throttle Position Sensor. This is a rotary type potentiometer connected to the throttle shaft. It has a voltage signal output which increases as the the throttle is opened. This sensor is used by the ECM for idle speed, spark advance, fuel delivery, emission system and automatic transmission (electronic type) control.

TTS

Transmission Temperature sensor. This sensor is a thermistor - a resistor whose resistance decreases as temperature rises. It is mounted within the transmission housing. The ECM uses this sensor to monitor transmission operating temperature.

VSS

Vehicle Speed Sensor. This sensor sends a frequency signal to the ECM. The frequency increases as the vehicle moves faster to give the ECM vehicle speed information.

WOT

Wide Open Throttle. The vehicle operating condition brought about when the throttle is completely (or nearly so) open. The ECM will typically deliver extra fuel to the engine at this time for acceleration purposes. The ECM uses the Throttle Position Sensor to identify the WOT condition.

ABS BASICS

A General Description of ABS Systems

The following is an overview of Anti-Lock Brake Systems (ABS). There are several different types and versions. **Refer to vehicle service manual for specific details.**

IMPORTANT: To service ABS systems safely and effectively, you **must** obtain a service manual for **your** vehicle and carefully follow all procedures.

What is ABS?

ABS is a safety feature designed to minimize accidents during braking. When engaged, ABS stops the vehicle in the shortest distance possible while giving the driver the greatest amount of steering control.

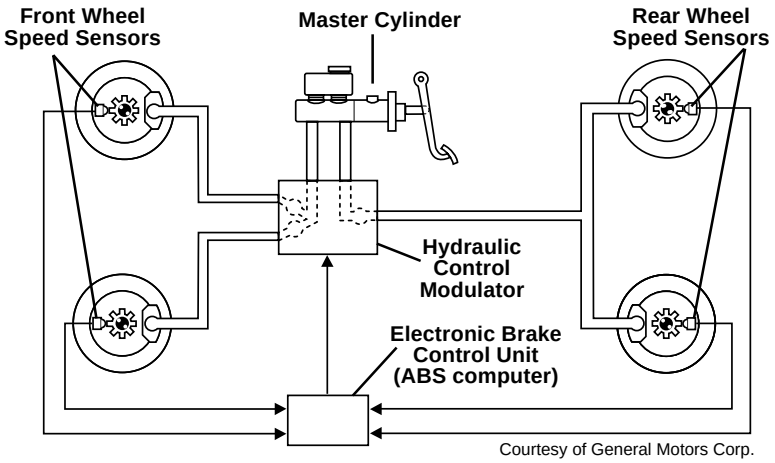
Heavy braking on non-ABS vehicles often causes wheels to lock up. This leads to a wheel skid condition resulting in loss of maneuverability and a long stopping distance. The job of ABS is to prevent wheel lock-up.

The ABS System

An ABS system combines a conventional hydraulic braking system along with additional components including:

- An ABS computer (separate from the engine computer)
- Wheel speed sensors
- Hydraulic control unit

The computer module controls the ABS system. This module is called Electronic Brake Control Module (EBCM), or similar. The computer monitors wheel speed, acceleration and deceleration using signals sent by the wheel speed sensors. If the computer determines wheel lock-up is likely during braking, it will control brake pressure using the Hydraulic Control Modulator. ABS components and braking operation will be detailed later in this section. As a safety feature, the system reverts to normal hydraulic braking operation if the ABS computer cannot operate.



Courtesy of General Motors Corp.

Typical 4-Wheel Anti-Lock Brake System

ABS Types

There are three basic types...

• RWAL (Rear Wheel Anti-Lock)

This is the simplest ABS system (mostly used on small rear-wheel-drive trucks). Only the rear wheels are ABS controlled – not the front. This version stops the vehicle in a straight line but does not allow the driver to maneuver because the front wheels may lock.

A single speed sensor (usually mounted in the differential) monitors driveshaft rotation. The ABS computer examines changes in shaft speed to predict rear wheel lock-up. Both rear brakes are operated by a single hydraulic channel. The ABS computer controls rear hydraulic performance, when necessary, using a single channel Hydraulic Control Modulator (described later).

• 3 Channel

This ABS system is a higher performance version of the RWAL version just described. Used on rear wheel drive vehicles, this system delivers short stopping distance and maneuvering control during heavy braking. All four wheels are ABS controlled.

Three hydraulic braking channels are used: right front wheel, left front wheel and a single channel for both rear wheels. The ABS computer uses a three channel Hydraulic Control Modulator (described later) to operate the individual brake circuits as necessary.

The two rear wheels are monitored with a single speed sensor (usually mounted in the differential). This is similar to the RWAL system described before. Two more speed sensors individually monitor each of the front two wheels.

• 4WAL (4 Wheel Anti-Lock) also called "4 Channel"

This ABS system is similar to the 3 channel version previously described, but is designed for front wheel drive vehicles. The main difference is that four speed sensors are used, instead of three, to individually monitor all four wheels. The hydraulic portion is the same as the 3 Channel system. The ABS computer uses a three channel Hydraulic Control Modulator to control the right front wheel, the left front wheel and both rear wheels.

ABS Components

Electronic Brake Control Module (EBCM)
May also be called Electronic Control Unit (ECU), or similar.

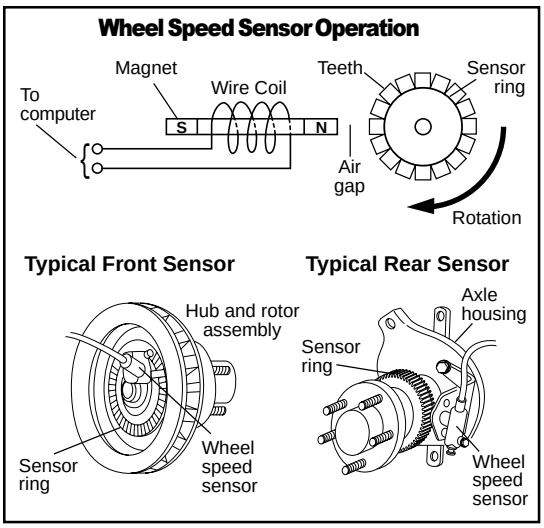
This is a computer module - the "brains" of the ABS system. The module is located either in the passenger compartment, or close to the ABS hydraulic controller in the engine area. The module monitors wheel speed sensors to determine if lock-up is about to occur when brakes are applied. If so, the module will operate the ABS hydraulic solenoids to control brake pressure and prevent lock-up. (This process is described later. Refer to "How ABS Controls Brakes.") The EBCM also performs checks of itself, and other ABS components, during vehicle operation. If problems are found, the ABS system is disengaged, the dashboard warning light is energized and a diagnostic trouble code is stored in ABS computer memory.

Brake Light Switch

This is the usual switch which energizes the rear brake lights when the brake pedal is applied. The ABS computer is sometimes connected to this switch - depends upon system. (Note: The engine control computer may also be connected to this switch.) Some ABS systems are active continuously. Other types wait for the brake light switch to close before operating.

Wheel Speed Sensor

This is a reluctance sensor (a 2-wire type). It consists of a permanent magnet with a coil of wire wrapped around it. Nearby the sensor is a toothed ring made of iron or steel (sometimes called a reluctor, sensor ring, exciter ring, pick-up ring or tone

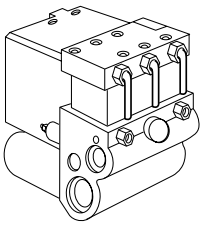


wheel). The ring is attached to the wheel, drive axle or transmission shaft. Whenever a tooth from the ring passes by the sensor, it attracts the magnetic field lines surrounding the magnet. As the field lines move, they pass through the wire coil and generate a small voltage pulse (magnetic induction principle). Thus, a voltage pulse is generated every time a tooth passes by the sensor coil. This voltage signal is sent to the ABS computer.

The ABS computer determines wheel speed by measuring how fast pulses appear. The faster the wheel spins, the more quickly pulses will appear. Note: The voltage pulses get larger as the wheel speeds up. (The computer ignores pulse size.) Values can range from a fraction of a volt (low speed) to several volts (high speed).

Hydraulic Control Modulator

This is an assembly containing solenoid operated hydraulic valves. It is usually mounted close to the master cylinder. (Some systems combine the hydraulic control modulator and the master cylinder into one complete unit.) The valves are connected in the brake lines between the master cylinder and the wheel caliper (or wheel cylinder). The ABS computer controls brake line pressure by operating one, or more, of these solenoid valves. (In ABS systems, the process of varying brake pressure is called "modulation." This is why the solenoid assembly is called a "modulator.")



Hydraulic Control Modulator (Typical)

Some modulator types use two solenoid valves per brake circuit: an "isolation" valve and a "dump" valve. Other types use a special "two-stage" solenoid per brake circuit. This "two stage" solenoid provides the same brake fluid control as the "isolation" and "dump" solenoids.

The "isolation" and "dump" solenoids have two positions: coil off and coil fully energized. The "two stage" solenoid has an additional position: coil off, coil *partially* energized and coil fully energized. ABS computers controlling "two stage" type solenoids have special built-in switching circuits to energize the solenoid properly.

Refer to "How ABS Controls Brakes" (later in this section) for a description of how the modulator is used.

Accumulator and Electric Pump

These two components work together. Depending upon system, their use (and construction) will differ a great deal.

• **Low Pressure type:** Accumulator and pump only used during ABS operation.

– Accumulator acts as a reservoir. It collects hydraulic fluid "bled" from

brake circuit during ABS operation. (ABS relieves brake line pressure to avoid wheel lock-up.) Four wheel ABS systems use two accumulators: one for the rear wheel circuit and the other for the front wheel circuit.

The accumulator contains a moveable diaphragm which separates the inside into two chambers. One chamber collects the hydraulic fluid. The other side contains a spring pressing against the diaphragm. Because of the spring, accumulator hydraulic pressure is about 150 PSI.

– The electric pump operates to remove fluid from the accumulators and return it to the master cylinder.
– Some systems have no pump. The spring driven diaphragm in the accumulator pushes brake fluid back into the master cylinder through a compensation port.

• High Pressure type: Accumulator and pump used for both ABS and normal brake operation.

– Accumulator stores fluid under very high pressure (up to 2600 PSI). The accumulator contains a moveable diaphragm which separates the inside into two chambers. One chamber holds the hydraulic fluid. The other side is filled with high pressure Nitrogen gas. The gas acts as a very strong spring keeping the hydraulic fluid under great pressure. The pressurized fluid is used during normal and ABS braking.
– The electric pump is a special high pressure hydraulic type. It runs as needed to maintain high hydraulic pressure in the accumulator. The pump is not controlled by the ABS computer. A pressure activated switch threaded into the accumulator fitting turns the pump on and off as required.

Warning Light

All vehicles have a red “BRAKE” light on the dashboard to warn of problems in the normal braking system. Some ABS systems use this “BRAKE” light to warn of ABS problems as well. Other vehicles have a separate amber “ANTILOCK” dashboard light to warn of ABS problems. The ABS computer controls the warning light.

Relays

Various relays are used by ABS - depends upon system. Refer to ABS circuit schematics in vehicle service manual. Typical relays include:

• ABS Power relay: Supplies power to the electronic brake control module (ABS computer). Note: This relay may have built-in diodes to protect the computer against voltage surges or reverse voltage conditions.

• Electric Pump relay: Used by the ABS computer to operate the electric pump. (This is the pump associated with the accumulator previously described.)

• ABS Solenoid relay: Connects vehicle battery voltage to the solenoid circuits in the Hydraulic Control Module. Note: This does not turn on the solenoids. The ABS computer controls individual solenoids by completing each circuit as required.

Digital Ratio Adapter Controller (DRAC)

This is a small electronic module used on some rear wheel drive vehicles. It works with the speed sensor mounted in the differential. The DRAC receives the sensor signal, processes it, then sends it to the ABS computer, speedometer and cruise control (if installed). The DRAC is matched to a specific rear axle ratio and tire size. Any change to the rear axle ratio or tire size requires recalibrating (or replacing) the DRAC.

Lateral Acceleration Sensor

This sensor is only used on Corvette ABS systems. It is a small module used to monitor the amount of sideways force exerted on the vehicle during a hard turn. The module sends a voltage signal to the ABS computer. The computer uses this signal to modify ABS control of the rear brakes.

How ABS Controls Brakes

Depending upon system, the ABS computer will either:

– continuously monitor wheel speed or...
– wait for brake pedal application before monitoring wheel speed.

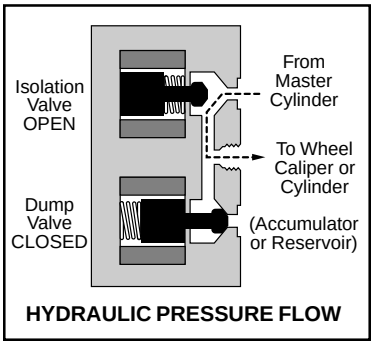
The ABS computer controls braking action when wheel speed acceleration or deceleration indicates lock-up is about to occur.

Four-Wheel Drive Vehicle Note: The ABS computer will not allow ABS braking during four-wheel drive operation. (A switch in the four-wheel drive powertrain sends a signal to the ABS computer.)

The ABS computer controls brake line pressure by operating one, or more, solenoid valves in the Hydraulic Control Modulator. Some systems use two solenoid valves per brake circuit: an “isolation” valve and a “dump” valve. Other systems use a special “two-stage” solenoid per brake circuit. Either system controls brake line pressure in the same way.

Normal Braking (no ABS action)

ABS computer sees normal wheel speed changes. No ABS action is necessary.



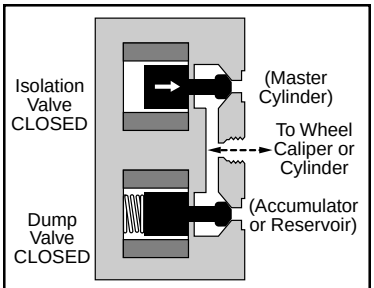
HYDRAULIC PRESSURE FLOW

– *Isolation valve is OPEN (not energized).* Brake circuit operates normally. Hydraulic pressure from master cylinder passes through isolation valve to wheel caliper/cylinder.
– *Dump valve is CLOSED (not energized).* This valve has no effect on the brake pressure when it is closed.

(Systems using two-stage solenoid: Solenoid is not energized. Hydraulic flow same as described above.)

ABS Braking – Pressure Maintain

Wheel speed signals indicate lock-up is about to occur. ABS computer takes first step in brake control cycle: isolate wheel caliper/cylinder from master cylinder – maintain fluid pressure to wheel.



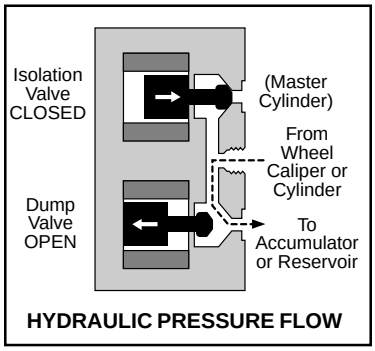
HYDRAULIC PRESSURE FLOW

– *Isolation valve is CLOSED (energized).* Pressure flow between master cylinder and brake caliper/cylinder is blocked because of closed valve. Existing pressure to wheel is maintained because hydraulic fluid is trapped between isolation valve and wheel. Closed isolation valve also prevents any increases in master cylinder pressure from reaching wheel caliper/cylinder.
– *Dump valve is CLOSED (not energized).* This valve has no effect on the brake pressure when it is closed.

(Systems using two-stage solenoid: Solenoid is partially energized. Hydraulic flow same as described above.)

ABS Braking – Pressure Decrease

Wheel speed signals indicate lock-up is still about to occur. ABS computer takes next step in brake control cycle: decrease hydraulic pressure to wheel caliper/cylinder.



HYDRAULIC PRESSURE FLOW

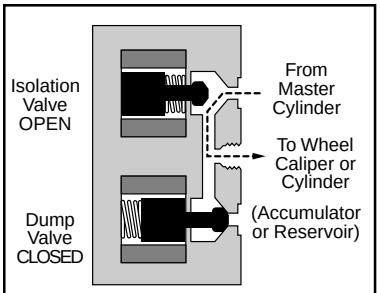
– *Isolation valve is CLOSED (energized).* Pressure flow between master cylinder and brake caliper/cylinder remains blocked because of closed valve. Closed isolation valve still prevents changes in master cylinder pressure from reaching wheel caliper/cylinder.

– *Dump valve is OPEN (energized).* Hydraulic pressure to wheel caliper/cylinder is reduced. The open dump valve relieves pressure by "bleeding" some fluid out of the wheel circuit. The fluid travels either: back to the brake reservoir or to an accumulator - depends on system. Fluid collected in the accumulator is returned to the master cylinder. Some systems use an electric pump to move the fluid. Other systems briefly pause the ABS brake cycle. Then, the spring driven diaphragm inside the accumulator pushes the fluid back to the master cylinder.

(Systems using two-stage solenoid: Solenoid is fully energized. Hydraulic flow same as described above.)

ABS Braking – Pressure Increase

Wheel speed signals indicate absence of lock-up condition. ABS computer takes last step in brake control cycle: increase hydraulic pressure to wheel caliper/cylinder.



HYDRAULIC PRESSURE FLOW

– *Isolation valve is OPEN (not energized).* Master cylinder is reconnected to wheel caliper/cylinder. Once again, hydraulic pressure from master cylinder passes through isolation valve to wheel.

– *Dump valve is CLOSED (not energized).* This valve has no effect on the brake pressure when it is closed.

(Systems using two-stage solenoid: Solenoid is not energized. Hydraulic flow same as described above.)

The ABS system is capable of repeating the brake cycle at a rapid rate - up to 15 times a second.

Other ABS Uses

On some vehicles, the components of ABS are shared with another system: Anti-Slip Regulation (ASR) also known as traction control. This system prevents wheel slip during acceleration on slick road surfaces.

The ASR system is controlled by a computer module. This ASR computer is connected to the same wheel speed sensors and hydraulic control modulator used by ABS. If one drive wheel slips excessively during acceleration, power will be transferred to the other drive wheel by applying brake pressure to the slipping wheel. (The ASR computer may try to stiffen throttle movement or retard engine timing before applying brake action.)

ABS SAFETY

General Safety Guidelines to Follow When Working on ABS Vehicles

WARNING: To avoid personal injury, DO NOT open a bleeder valve or loosen a hydraulic line while ABS is pressurized. Always follow vehicle manufacturer's procedures to depressurize ABS before servicing.

- Always use specially designed ABS brake hoses and fittings when replacing these parts.
- Always use ABS recommended brake fluids. DO NOT use silicone brake fluids in ABS systems.
- Always wear approved eye protection.
- Always operate the vehicle in a well ventilated area. *Do not inhale exhaust gases - they are very poisonous!*
- Always keep yourself, tools and test equipment away from all moving or hot engine parts.
- Always make sure the vehicle is in park (Automatic transmission) or neutral (manual transmission) and that the parking brake is firmly set. Block the drive wheels.
- Never lay tools on vehicle battery. You may short the terminals together causing harm.
- Never smoke or have open flames near vehicle. Vapors from gasoline or charging battery are highly explosive.
- Never leave vehicle unattended while running tests.
- Always turn ignition key OFF when connecting or disconnecting electrical components, unless otherwise instructed.
- Always follow vehicle manufacturer's warnings, cautions and service procedures.

CAUTION: Some vehicles are equipped with safety air bags, also known as Supplemental Inflatable Restraint (SIR) system. You ***must*** follow vehicle service manual cautions when working around the air bag components or wiring. If the cautions are not followed, the air bag may open up unexpectedly, resulting in personal injury.

ABS TIPS

Useful Hints to Know When Troubleshooting ABS Systems

IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs. (Manual listings on page 4.)

- *Do a thorough visual and "hands-on" inspection first. You can often find the cause of many problems by just looking.*

- *ABS systems rely on accurate wheel sensor signals. Anything which interferes with the wheel sensor can create intermittent problems or set trouble codes. Note the following:*
  - –Do not mix tire sizes. Rolling diameter must be the same for all four tires. Differently sized tires (or using a "compact" spare) can cause inaccurate wheel speed sensor operation.
  - –Do not tap the speed sensor or toothed sensor ring. Tapping these parts can disturb their magnetic properties and upset wheel speed sensor operation. Press (do not hammer) toothed sensor ring onto hub, if service is required.
  - –Do not overtighten wheel lug nuts. (Specifications are in vehicle service manual.) Brake drum or rotor may bend causing inaccurate wheel speed sensor operation.
  - –Do not coat wheel speed sensor parts with grease. Refer to vehicle service manual for recommended material.
  - –Check spacing between wheel speed sensor and toothed ring, especially after servicing. Incorrect spacing can cause faulty sensor operation. Specifications are in vehicle service manual.
  - –Check for cracked or missing teeth on the wheel speed sensor ring.

- *Spinning tires (or axle) on a stationary vehicle during a service procedure may set ABS trouble codes.*

- *Radio transmitters can interfere with operation of ABS computer. Keep antenna wiring from a CB radio or portable telephone away from ABS wiring*

- *Check ABS power circuits:*
  - –Make sure vehicle alternator and voltage regulator are working properly.
  - –Make sure vehicle battery is fully charged.
  - –Make sure all ABS fuses, fusible links and relays are good

- *Inspect wiring for:*
  - –Contact with sharp edges. (This happens often.)

  - –Contact with hot surfaces, such as exhaust manifolds.
  - –Pinched, burned or chafed insulation.
  - –Proper routing and connections.

- *Check electrical connectors for:*
  - –Corrosion on pins.
  - –Bent or damaged pins.
  - –Contacts not properly seated in housing.
  - –Bad wire crimps to terminals.

Problems with electrical connectors are common.

Inspect carefully. Note that some connectors use a special grease on the contacts to prevent corrosion. Do not wipe off! Obtain extra grease, if

needed, from your vehicle dealer. It is a special type for this purpose.

- *Make sure any recommended system flushing has been performed. Corrosion or dirt in ABS valving can result in poor pedal performance.*

- *Some body and chassis work procedures can harm the ABS computer:*

– Disconnect vehicle computer modules when using electric welding equipment.

– Do not expose the ABS computer to high heat for a long time (for example, during vehicle painting). Keeping temperature below 185°F (85°C) for less than 2 hours is usually safe.

READING CODES

How to Use the Code Scanner to Read ABS Codes

1) Use the chart to find the ABS system used on your vehicle.

2) Refer to the page listed where you will find...

- preliminary checks you need to make before reading codes,
- the code reading procedure,
- the procedure for erasing codes from ABS computer memory,
- a list of code definitions.

1988

Model	System	Page
Blazer	7	84
C Series Pickup Truck	7	84
K Series Pickup Truck	7	84
Sierra	7	84

1989

Model	System	Page
98 Regency	5	74
Astro	7	84
Blazer	7	84
Bonneville	5	74
Bonneville SSE	5	74
C Series Pickup Truck	7	84
Delta 88	5	74
DeVille	5	74
Eldorado	6	79
Electra	5	74
Fleetwood	5	74
Jimmy	7	84
K Series Pickup Truck	7	84
Park Avenue	5	74
Reatta	6	79
Riviera	6	79
S Series (2WD) Pickup Truck	7	84
Safari	7	84
Seville	6	79
Sierra	7	84
Toronado	6	79

1990		
Model	**System**	**Page**
98 Regency	5	74
Astro	7 or 8	See note p. 50
Blazer	7	84
Bonneville	5	74
Bonneville SSE	5	74
Brougham	2	56
C Series Pickup Truck	7	84
Corvette	1	51
Delta 88	5	74
DeVille	5	74
Eldorado	6	79
Electra	5	74
Fleetwood	5	74
G Series (RWD) Van	7	84
Jimmy	7	84
K Series Pickup Truck	7	84
Park Avenue	5	74
R Series Truck	7	84
Reatta	6	79
Riviera	6	79
S Series Pickup Truck	7	84
Safari	7 or 8	See note p. 50
Seville	6	79
Sierra	7	84
Suburban	7	84
T Series Pickup Truck	7	84
Toronado	6	79
Trofeo	6	79
V Series Truck	7	84

1991		
Model	**System**	**Page**
Astro	7 or 8	See note p. 50
Blazer	7 or 8	See note p. 50
Bravada	8	88
Brougham	3	62
C Series Pickup Truck	7	84
Caprice	2	56
Corvette	1	51
Custom Cruiser	2	56
Eldorado	3	62
G Series (RWD) Van	7	84
Jimmy	7 or 8	See note p. 50
K Series Pickup Truck	7	84
R Series Truck	7	84
Reatta	3	62
Riviera	3	62
Roadmaster	2	56
S Series Pickup Truck	7 or 8	See note p. 50
Safari	7 or 8	See note p. 50
Seville	3	62
Sierra	7	84
Sonoma	8	88
Suburban	7	84
Syclone	8	88
T Series Pickup Truck	7 or 8	See note p. 50
Toronado	3	62
Trofeo	3	62
Typhoon	8	88
V Series Truck	7	84

1992		
Model	**System**	**Page**
Astro	7 or 8	See note p. 50
Blazer	7 or 8	See note p. 50
Bravada	8	88
Brougham	2	56
C Series Pickup Truck	7 or 8	See note p. 50
Eldorado	3	62
G Series (RWD) Van	7	84
Jimmy	7 or 8	See note p. 50
K Series Pickup Truck	7 or 8	See note p. 50
Riviera	3	62
S Series Pickup Truck	7 or 8	See note p. 50
Safari	7 or 8	See note p. 50
Seville	3	62
Sierra	7 or 8	See note p. 50
Sonoma	8	88
Suburban	7 or 8	See note p. 50
Syclone	8	88
T Series Pickup Truck	7 or 8	See note p. 50
Toronado	3	62
Trofeo	3	62
Typhoon	8	88
Yukon	8	88

1993		
Model	**System**	**Page**
Astro	8	88
Blazer	7 or 8	See note p. 50
Bravada	8	88
C Series Pickup Truck	7 or 8	See note p. 50
Eldorado	4	12-38
G Series Van	8	88
Jimmy	7 or 8	See note p. 50
K Series Pickup Truck	7 or 8	See note p. 50
Riviera	3	62
S Series Pickup Truck	7 or 8	See note p. 50
Safari	8	88
Seville	4	12-38
Sierra	7 or 8	See note p. 50
Sonoma	8	88
Suburban	7 or 8	See note p. 50
Syclone	8	88
T Series Pickup Truck	7 or 8	See note p. 50
Typhoon	8	88
Yukon	8	88

1994		
Model	**System**	**Page**
Astro	8	88
Blazer	7 or 8	See note below
Bravada	8	88
C Series Pickup Truck	7 or 8	See note below
DeVille	4	68
Eldorado	4	68
G Series Van	8	88
Jimmy	8	88
K Series Pickup Truck	7 or 8	See note below
S Series Pickup Truck	7 or 8	See note below
Safari	8	88
Seville	4	68
Sierra	8	88
Sonoma	8	88
Suburban	8	88
T Series Pickup Truck	7 or 8	See note below
Yukon	8	88

NOTE: Two different ABS systems were available for this vehicle. Each system has a different code reading procedure. Do the following to identify which system is installed:

- Examine the Electro-Hydraulic Control Unit (EHCU). This assembly has both electrical and hydraulic connections. It is installed between the master cylinder and the wheel caliper (or cylinder).
  - –If there are **5 hydraulic connections** (2 inlet, 3 outlet), then vehicle has **System 8.** Go to page 88.
  - –**Less than 5 hydraulic connections** means vehicle has **System 7**. Go to page 84.

SYSTEM 1: Bosch 2S

1990 Corvette • 1991 Corvette

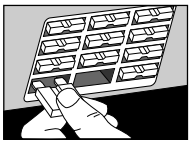
Pre-Diagnostic Visual Inspection

Complete all steps before reading trouble codes!

1) Check that all ABS system grounds are clean and tight

2) Check power sources which supply various parts of ABS system

• 1990, 1991 Corvette:



– Check the **AIR BAG** fuse in the underdash fuse block.

– Check the **BRAKE** fuse in the underdash fuse block.

– Check the **STOP/HAZ** fuse in the underdash fuse block.

– Check the **CLSTR** fuse in the underdash fuse block.

– Check rust colored fusible link **"J"** on the positive junction block.

3) Check that pump motor relay, EBCM relay (Electronic Brake Control Module), solenoid valve relay, and EBCM connectors are properly installed (not loose)

This completes the visual inspection. Perform FUNCTIONAL CHECK before reading codes!

Functional Check – Corvette

1) Start the engine. The brake warning lamp should come **ON** during engine cranking, and turn **OFF** shortly after the engine starts. If it does not, check the brake warning lamp circuit in accordance with vehicle service manual instructions.

2) Turn the engine **OFF**. Turn the ignition key to the **ON** (RUN) position, but do not start the engine. The anti-lock lamp should illuminate for about 2 seconds and then turn **OFF**, if no trouble codes are currently stored, however "history" trouble codes may be stored. Proceed to Step 3 below. If the anti-lock lamp stays **ON**, trouble codes are stored. Proceed directly to **READING ABS CODES**, page 52. If the anti-lock lamp does not turn **ON** at all or flashes very briefly (less than 1/2 of a second), a problem exists in the anti-lock lamp circuitry. See your vehicle service manual.

3) Drive the vehicle at least 20 MPH. If the anti-lock lamp turns **ON**, proceed to **READING ABS CODES**, page 52.

Reading ABS Codes – Bosch 2S

IMPORTANT: Perform all steps in PRE-DIAGNOSTIC VISUAL INSPECTION and FUNCTIONAL CHECK before reading ABS codes!

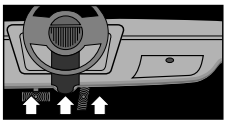
1) Take Safety Precautions

- Set parking brake, block drive wheels.
- Put shift lever in PARK (automatic transmission) or NEUTRAL (manual transmission).
- Make sure ignition key is in OFF position.

2) Have a Pencil and Paper Ready

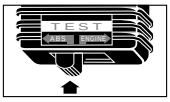
This is for writing down all the codes.

3) Find the Computer Test Connector



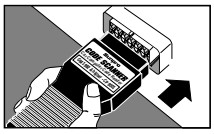
- Service manuals call this connector the Assembly Line Diagnostic Link (ALDL) connector. It may also be called the Assembly Line Communication Link (ALCL) or simply test connector.
- The connecter is located under the dashboard on the driver's side.
- The connector may be in full view, or it may be recessed behind a panel opening.
- The connector may have a slip-on cover labeled "Diagnostic Connector." Remove cover for testing. Replace cover after testing. Some vehicles require this cover in place for proper operation.

4) Verify Ignition Key is OFF



5) Put the TEST switch on ABS

6) Plug the Code Scanner into the test connector



- The Code Scanner only fits ONE WAY into the test connector.
- The Code Scanner will not harm the vehicle computer.

Note: The Code Scanner does not use all of the test connector contacts. This is normal.

7) Turn Ignition Key to ON Position but DO NOT START THE ENGINE

WARNING: Stay away from the radiator cooling fan! It may turn on.

8) Get Codes from the Flashing "Anti-Lock" Light

- Count flashes to get trouble codes. (Flashes begin after a few seconds.)

Code 12 looks like:

FLASH (pause) FLASH FLASH

(FLASH = 1, FLASH FLASH = 2.

Put 1 and 2 together = code 12.)

Code 23 looks like:

FLASH FLASH (pause)
FLASH FLASH FLASH

- Each code is flashed three (3) times before the next trouble code is sent.
- After all codes are sent, the whole sequence is repeated. This continues until the ignition key is turned OFF (so you can double check your code list).

Example of code 12 only:

FLASH (pause) FLASH FLASH

(longer pause)

FLASH (pause) FLASH FLASH

(longer pause)

FLASH (pause) FLASH FLASH

(even longer pause,
then start over again)

Example of code series 12 and 24:

FLASH (pause) FLASH FLASH

(longer pause)

FLASH (pause) FLASH FLASH

(longer pause)

FLASH (pause) FLASH FLASH

(even longer pause,
then go to next code)

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(longer pause)

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(longer pause)

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(even longer pause, then start all over
from the very beginning)

- A code 12 is **always** sent even when the computer sees no problem. This tells you the computer diagnostic checks are working properly.
- All codes are two (2) digits long.

9) Turn Ignition Key OFF

10) Remove Code Scanner and Re-install Connector Cover, if supplied

The computer system is now back to normal operation.

11) Refer to ABS Code Meanings on page 55. (Bosch 2S)

This completes the code reading procedure.

At this point you can either:

- Have your vehicle professionally serviced. Trouble codes indicate problems found by the computer.

  or,

- Repair the vehicle yourself using trouble codes to help pinpoint the problem.

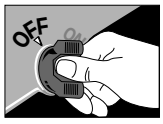
  IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

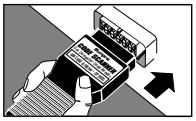
Erasing ABS Codes from Computer Memory – Bosch 2S

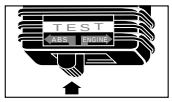
Erase codes from memory whenever you complete a repair or to see if a problem will occur again. Note: The computer will automatically erase codes after several restarts (typically 100) if the problem does not return.

Proceed as follows:

1) Turn the ignition switch to the OFF position.

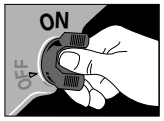






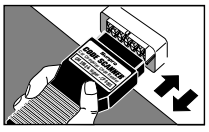
Plug the Code Scanner (make sure the TEST switch is in the ABS position) into the test connector.

2) Turn the ignition switch to the ON position. Then...



- *1990 Corvette:*

  When the anti-lock lamp begins to flash codes, remove the Code Scanner from the connector for about 1 second, then reinstall the Code Scanner for about one second. Repeat this procedure 3 times within 10 seconds. Leave the Code Scanner inserted in the connector the 3rd time.

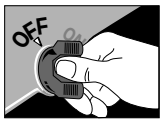


- *1991 Corvette:*

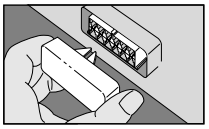
  When the anti-lock lamp begins to flash codes, remove the Code Scanner from the connector for about 1 second, then reinstall the Code Scanner for about 1 second. Repeat this procedure 4 times within 10 seconds. Leave the Code Scanner inserted in the connector the 4th time.

3) Wait 15 seconds, then observe the anti-lock indicator lamp. Code 12, the "diagnostic system operational" code should flash indicating that all trouble codes have been erased from memory.

Turn the ignition switch to the **OFF** position.



Remove the Code Scanner, and reinstall the test connector cover (if used on vehicle).



ABS Code Meanings – Bosch 2S

IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs!

(Manual listings on page 4.)

12
Diagnostic System Operational.

21
Right Front Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

22
Right Front Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mismatched tire sizes, or use of the temporary (mini) spare tire may set this code.

25
Left Front Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

26
Left Front Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mis-matched tire sizes, or use of the temporary (mini) spare tire may set this code.

31
Right Rear Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

32
Right Rear Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mismatched tire sizes, or use of the temporary (mini) spare tire may set this code.

35
Left Rear Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

36
Left Rear Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mis-matched tire sizes, or use of the temporary (mini) spare tire may set this code.

41
Right Front Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

45
Left Front Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

55
Rear Wheel Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

61
Pump Motor or Motor Relay circuit. This code will set if the position of the motor relay contacts do not match the commanded position of those contacts as given by the EBCM (Electronic Brake Control Module). There is a motor monitoring circuit in the EBCM which will detect a defective relay or pump motor.

63
Solenoid Valve Relay circuit. This code will set if the position of the valve relay contacts do not match the commanded position of those contacts as given by the EBCM (Electronic Brake Control Module). There is a motor monitoring circuit in the EBCM which will detect a defective relay or a failure in the associated circuitry.

71
EBCM (Electronic Brake Control Module) failure. This code will set if there is an internal failure of the Electronic Brake Control Module.

75
Lateral Accelerometer circuit. This code will set if there is a short or open circuit problem in the associated circuitry.

76
Lateral Accelerometer signal error. This code will set if the accelerometer signal indicates greater than 0.6g for 2 minutes or more.

SYSTEM 2:
Bosch 2U (Version A)

1990 Brougham
1991 Caprice, Custom Cruiser, Roadmaster
1992 Brougham

Pre-Diagnostic Visual Inspection

Complete all steps before reading trouble codes!

1) Check that all ABS system grounds are clean and tight.

• 1990 Brougham:

– Check the ground that is located on the right front corner of the right fender.

– Check the ground that is located near the cruise control servo on the fender.

• 1991 Caprice, Custom Cruiser, Roadmaster:

– Check the 2 grounds that are located near the left headlight. One is on the headlight support in front of the vapor canister, the other is close to the wiring harness.

– Check the ground that is located near the center of the left rear quarter panel.

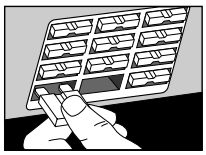
– Check the ground that is located near the thermostat housing.

• 1992 Brougham:

– Check the ground that is located on the right front corner of the right fender.

– Check the ground that is located near the cruise control servo on the fender.

2) Check power sources which supply various parts of ABS system.



• 1990 Brougham:

– Check the **GA-TRANS** fuse in the underdash fuse block.

– Check the **ABS** fuse in the underdash fuse block.

– Check the **STOP/HAZ** fuse in the underdash fuse block.

– Check the rust colored fusible links on the positive junction block.

• 1991 Caprice, Custom Cruiser, Roadmaster:

– Check fuse number **3, 17** and **19** in the main fuse block.

– Check the rust colored fusible link **D** on the positive junction block.

• 1992 Brougham:

– Check the **GA-TRANS** fuse in the underdash fuse block.

– Check the **ABS** fuse in the underdash fuse block.

– Check the rust colored fusible link **E** on the positive junction block.

3) Check that the over-voltage relay, ABS 6-way connector, and EBCM (Electronic Brake Control Module) connectors are properly installed (not loose).

4) Check that the parking brake switch is functioning properly.

This completes the visual inspection.

Perform FUNCTIONAL CHECK before reading codes!

Functional Check

Brougham

1) Start the engine. The brake warning lamp should come **ON** during engine cranking, and turn **OFF** shortly after the engine starts. If it does not, check the brake warning lamp circuit in accordance with vehicle service manual instructions.

2) Turn the engine **OFF**. Turn the ignition key to the **ON** (RUN) position, but do not start the engine. The anti-lock lamp should illuminate for about 4 seconds and then turn **OFF**, if no trouble codes are currently stored. However "history" trouble codes may be stored. Proceed directly to Step 3 below. If the anti-lock lamp stays **ON**, trouble codes are stored. Proceed directly to READING ABS CODES.

3) Drive the vehicle at least 20 MPH. If the anti-lock lamp turns **ON**, proceed to READING ABS CODES.

Caprice, Custom Cruiser, Roadmaster

1) Start the engine. The brake warning lamp should come **ON** during engine cranking, and turn **OFF** shortly after the engine starts. If it does not, check the brake warning lamp circuit in accordance with vehicle service manual instructions.

2) Turn the engine **OFF**. Turn the ignition key to the **ON** (RUN) position, but do not start the engine. The anti-lock lamp should illuminate for about 2 seconds and then turn OFF if no trouble codes are currently stored, however "history" trouble codes may be stored. Proceed to Step 3 below. If the anti-lock lamp stays **ON**, trouble codes are stored. Proceed directly to READING ABS CODES. If the anti-lock lamp does not turn **ON** at all or flashes very briefly (less than 1/2 of a second), a problem exists in the anti-lock lamp circuitry. See your vehicle service manual.

3) Drive the vehicle at least 20 MPH. If the anti-lock lamp turns **ON**, proceed to READING ABS CODES.

Reading ABS Codes: Bosch 2U (Version A)

IMPORTANT: Perform all steps in PRE-DIAGNOSTIC VISUAL INSPECTION and FUNCTIONAL CHECK before reading ABS codes!

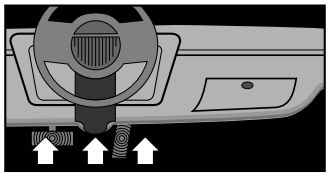
1) Take Safety Precautions

- Set parking brake, block drive wheels.
- Put shift lever in PARK (automatic transmission) or NEUTRAL (manual transmission).
- Make sure ignition key is in OFF position.

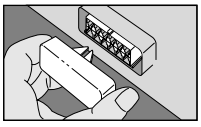
2) Have a Pencil and Paper Ready. This is for writing down all the codes.

3) Find the Computer Test Connector

- Service manuals call this connector the Assembly Line Diagnostic Link (ALDL) connector. It may also be called the Assembly Line Communication Link (ALCL) or simply test connector.
- The connector is located under the dashboard on the driver's side.

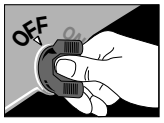


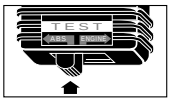
- The connector may be in full view, or it may be recessed behind a panel opening.
- The connector may have a slip-on cover labeled "Diagnostic Connector." Remove cover for testing. Replace cover after



testing. Some vehicles require this cover in place for proper operation.

4) Verify Ignition Key is OFF

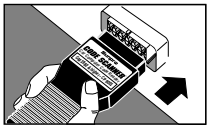




5) Put the TEST switch on ABS

6) Plug the Code Scanner into the test connector

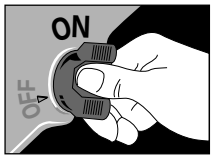
- The Code Scanner only fits ONE WAY into the test connector.



- The Code Scanner *will not harm* the vehicle computer.

Note: The Code Scanner does not use all of the test connector contacts. This is normal.

7) Turn Ignition Key to ON Position but DO NOT START THE ENGINE



WARNING: Stay away from the radiator cooling fan! It may turn on.

8) Get Codes from the Flashing "Anti-Lock" Light

- Count flashes to get trouble codes. (Flashes begin after a few seconds.)

Code 12 looks like:

FLASH (pause) FLASH FLASH
(FLASH = 1, FLASH FLASH = 2.
Put 1 and 2 together = code 12.)

Code 23 looks like:

FLASH FLASH (pause)
FLASH FLASH FLASH

- Each code is flashed three (3) times before the next trouble code is sent.
- After all codes are sent, the whole sequence is repeated. This continues until the ignition key is turned OFF (so you can double check your code list).

Example of code 12 only:

PAUSE

FLASH (pause) FLASH FLASH

(longer pause)

PAUSE

FLASH (pause) FLASH FLASH

(longer pause)

PAUSE

FLASH (pause) FLASH FLASH

(even longer pause, then start over again)

Example of code series 12 and 24:

PAUSE

FLASH (pause) FLASH FLASH

(longer pause)

PAUSE

FLASH (pause) FLASH FLASH

(longer pause)

PAUSE

FLASH (pause) FLASH FLASH

(even longer pause, then go to next code)

PAUSE

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(longer pause)

PAUSE

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(longer pause)

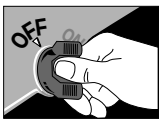
PAUSE

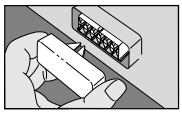
FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(even longer pause, then start all over from the very beginning)

- A code 12 is **always** sent even when the computer sees no problem. This tells you the computer diagnostic checks are working properly.
- All codes are two (2) digits long.

9) Turn Ignition Key OFF





10) Remove Code Scanner and Re-install Connector Cover, if supplied

The computer system is now back to normal operation.

11) Refer to ABS Code Meanings on page 61. (Bosch 2U, Version A)

This completes the code reading procedure.

At this point you can either:

- Have your vehicle professionally serviced. Trouble codes indicate problems found by the computer.

  or,

- Repair the vehicle yourself using trouble codes to help pinpoint the problem.

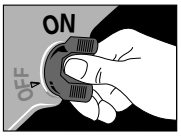
IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

Erasing ABS Codes from Computer Memory: Bosch 2U (Version A)

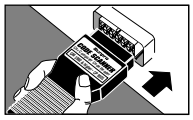
Erase codes from memory whenever you complete a repair or to see if a problem will occur again. **Note:** The computer will automatically erase codes after several restarts (typically 100) if the problem does not return.

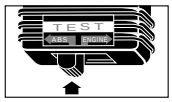
Proceed as follows:

1) Turn the ignition switch to the **ON** position. The anti-lock lamp should turn **OFF** after 3 to 4 seconds. If it does not, a failure still currently exists which must be corrected before its corresponding trouble code will clear.

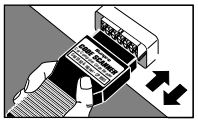


2) Plug the Code Scanner **(make sure the TEST switch is in the ABS position)** into the test connector.

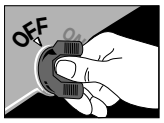


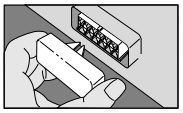


3) Remove the Code Scanner for about 1 second then reinstall Code Scanner into the connector. Repeat this procedure 4 times within 10 seconds. Leave the Code Scanner inserted in the connector after the 4th time.



4) Observe the anti-lock indicator lamp. Code 12, the "diagnostic system operational" code should flash indicating that all trouble codes have been erased from memory. Wait at least 15 seconds before turning the ignition switch **OFF**. Remove the Code Scanner, and reinstall the test connector cover (if used on vehicle).





ABS Code Meanings: Bosch 2U (Version A)

IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

12
Diagnostic System Operational. This code is always sent.

21
Right Front Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

22
Right Front Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mis-matched tire sizes, or use of the temporary (mini) spare tire may set this code.

25
Left Front Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

26
Left Front Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mis-matched tire sizes, or use of the temporary (mini) spare tire may set this code.

35
Rear Axle Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

36
Rear Axle Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mis-matched tire sizes, or use of the temporary (mini) spare tire may set this code.

41
Right Front Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

45
Left Front Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

55
Rear Axle Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

61
Pump Motor or Motor Relay circuit. This code will set if the position of the motor relay contacts do not match the commanded position of those contacts as given by the EBCM (Electronic Brake Control Module). There is a motor monitoring circuit in the EBCM which will detect a defective relay or pump motor.

63
Solenoid Valve Relay circuit. This code will set if the position of the valve relay contacts do not match the commanded position of those contacts as given by the EBCM (Electronic Brake Control Module). There is a motor monitoring circuit in the EBCM which will detect a defective relay or a failure in the associated circuitry.

71
EBCM (Electronic Brake Control Module) failure. This code will set if there is an internal failure of the Electronic Brake Control Module.

SYSTEM 3: Bosch 2U (Version B)

1991 Brougham, Eldorado, Reatta, Riviera, Seville, Toronado, Trofeo
1992 Eldorado, Riviera, Seville, Toronado, Trofeo
1993 Riviera

Pre-Diagnostic Visual Inspection

Complete all steps before reading trouble codes!

1) Check that all ABS system grounds are clean and tight.

• 1991 Brougham, Eldorado, Reatta, Riviera, Seville, Toronado, Trofeo:

– Check the ground that is located behind the right headlight.

– Check the ground that is located near the parking brake pedal on the left side of the dash.

• 1992 Eldorado, Seville:

– Check the ground that is located on the engine near the alternator.

– Check the ground that is located on the rear seat brace.

• 1992 Riviera, Toronado, Trofeo:

– Check the ground that is located behind the right headlight.

– Check the ground that is located in the right front engine compartment.

• 1993 Riviera:

– Check the ground that is located behind the right headlight.

– Check the ground that is located on top of the left shroud.

2) Check power sources which supply various parts of ABS system.

• 1991 Brougham:

– Check the **GA-TRANS** fuse in the underdash fuse block.

– Check the **ABS** fuse in the underdash fuse block.

– Check the rust colored fusible link **E** on the positive junction block.

• 1991 Eldorado, Seville:

– Check fuse number **7** in the interior relay center.

– Check the black and blue colored fusible links on the positive junction block.

• 1991 Reatta, Riviera:

– Check fuse number **4** in the interior relay center.

– Check the black and blue colored fusible links on the positive junction block.

• 1991 Toronado, Trofeo:

– Check fuse number **18** in the underdash fuse block.

– Check the black **M** and blue **U** colored fusible links on the positive junction block.

• 1992 Eldorado, Seville:

– Check the **A1** fuse in the trunk compartment fuse block.

– Check fuse number **5** in the RIGHT MAXI fuse block.

– Check fuse number **6** in the RIGHT MAXI fuse block.

• 1992 Riviera:

– Check fuse number **4** in the interior relay center.

– Check the black and blue colored fusible links on the positive junction block.

• 1992 Toronado, Trofeo:

–Check fuse number **18** in the underdash fuse block.

–Check the black and blue colored fusible links on the positive junction block.

• 1993 Riviera:

–Check fuse number **4** in the interior relay center.

–Check fuse number **6** and **9** in the underdash fuse block.

–Check the black colored **M** and **P** fusible links on the positive junction block.

3) Check that all ABS/TCS connectors, and EBCTM (Electronic Brake and Traction Control Module) connectors are properly installed (not loose).

4) Check that the parking brake switch is functioning properly.

5) Check that the brake pressure modulator valve ground stud is clean and tight.

6) Check the over-voltage protection relay and its connector.

This completes the visual inspection. Perform FUNCTIONAL CHECK before reading codes!

Functional Check

1) Start the engine. The brake warning lamp should come **ON** during engine cranking, and turn **OFF** shortly after the engine starts. If it does not, check the brake warning lamp circuit in accordance with vehicle service manual instructions.

2) Turn the engine **OFF**. Turn the ignition key to the **ON** (RUN) position, but do not start the engine. The anti-lock lamp should illuminate for about 4 seconds and then turn **OFF**, if no trouble codes are currently stored. However "history" trouble codes may be stored. Proceed to Step 3 below. If the anti-lock lamp stays **ON**, trouble codes are stored. Proceed directly to READING ABS CODES, page 64.

3) Drive the vehicle at least 20 MPH. If the anti-lock lamp turns **ON**, proceed to READING ABS CODES, page 64.

Reading ABS Codes: Bosch 2U (Version B)

IMPORTANT: Perform all steps in PRE-DIAGNOSTIC VISUAL INSPECTION and FUNCTIONAL CHECK before reading ABS codes!

1) Take Safety Precautions

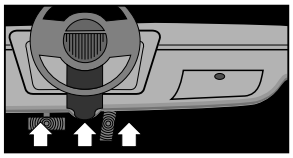
- Set parking brake, block drive wheels.
- Put shift lever in PARK (automatic transmission) or NEUTRAL (manual transmission).
- Make sure ignition key is in OFF position.

2) Have a Pencil and Paper Ready

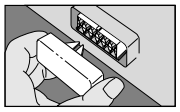
This is for writing down all the codes.

3) Find the Computer Test Connector

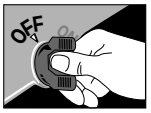
- Service manuals call this connector the Assembly Line Diagnostic Link (ALDL) connector. It may also be called the Assembly Line Communication Link (ALCL) or simply test connector.
- The connector is located under the dashboard on the driver's side.



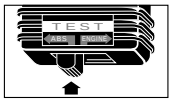
- The connector may be in full view, or it may be recessed behind a panel opening.
- The connector may have a slip-on cover labeled "Diagnostic Connector." Remove cover for testing. Replace cover after testing. Some vehicles require this cover in place for proper operation.

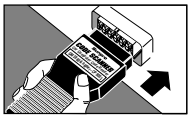


4) Verify Ignition Key is OFF



5) Put the TEST switch on ABS



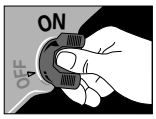


6) Plug the Code Scanner into the test connector

- The Code Scanner only fits ONE WAY into the test connector.
- The Code Scanner *will not harm* the vehicle computer.

Note: The Code Scanner does not use all of the test connector contacts. This is normal.

7) Turn Ignition Key to ON Position but DO NOT START THE ENGINE



WARNING: Stay away from the radiator cooling fan! It may turn on.

8) Get Codes from the Flashing "Anti-Lock" Light

- Count flashes to get trouble codes. (Flashes begin after a few seconds.)

Code 12 looks like:

FLASH (pause) FLASH FLASH

(FLASH = 1, FLASH FLASH = 2. Put 1 and 2 together = code 12.)

Code 23 looks like:

FLASH FLASH (pause) FLASH FLASH FLASH

- Each code is flashed three (3) times before the next trouble code is sent.
- After all codes are sent, the whole sequence is repeated. This continues until the ignition key is turned OFF (so you can double check your code list).

Example of code 12 only:

PAUSE

FLASH (pause) FLASH FLASH

(longer pause)

PAUSE

FLASH (pause) FLASH FLASH

(longer pause)

PAUSE

FLASH (pause) FLASH FLASH

(even longer pause, then start over again)

Example of code series 12 and 24:

PAUSE

FLASH (pause) FLASH FLASH

(longer pause)

PAUSE

FLASH (pause) FLASH FLASH

(longer pause)

PAUSE

FLASH (pause) FLASH FLASH

(even longer pause, then go to next code)

PAUSE

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(longer pause)

PAUSE

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(longer pause)

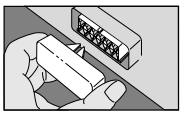
PAUSE

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(even longer pause, then start all over from the very beginning)

- A code 12 is ***always*** sent even when the computer sees no problem. This tells you the computer diagnostic checks are working properly.
- All codes are two (2) digits long.

9) Turn Ignition Key OFF



10) Remove Code Scanner and Re-install Connector Cover, if supplied

The computer system is now back to normal operation.

11) Refer to ABS Code Meanings on page 67 (Bosch 2U, Version B)

This completes the code reading procedure.

At this point you can either:

- Have your vehicle professionally serviced. Trouble codes indicate problems found by the computer.

  or,

- Repair the vehicle yourself using trouble codes to help pinpoint the problem.

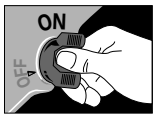
  IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

Erasing ABS Codes from Computer Memory: Bosch 2U (Version B)

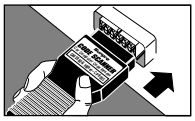
Erase codes from memory whenever you complete a repair or to see if a problem will occur again. **Note:** The computer will automatically erase codes after several restarts (typically 100) if the problem does not return.

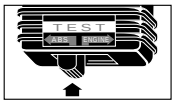
Proceed as follows:

1) Turn the ignition switch to the **ON** position. The anti-lock lamp should turn **OFF** after 3 to 4 seconds. If it does not, a current failure still exists which must be corrected before its corresponding trouble code will clear.

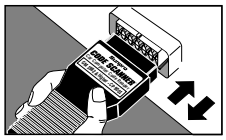


2) Plug the Code Scanner **(make sure the TEST switch is in the ABS position)** into the test connector until the anti-lock lamp turns **ON**. Remove the Code Scanner. The anti-lock lamp will turn **OFF**.



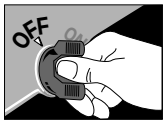


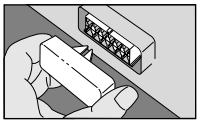
3) *Without* turning the ignition switch **OFF**, repeat the sequence outlined in Step 2, 2 more times.



4) All diagnostic trouble codes should now be cleared. Confirm this by turning the ignition switch **OFF**, installing the Code Scanner, and turning the ignition switch back to the **ON** position (do not start the engine). Code 12, the "diagnostic system operational" code should be the only code displayed.

5) Turn the ignition switch **OFF**. Remove the Code Scanner, and reinstall the test connector cover (if used on vehicle).





ABS Code Meanings: Bosch 2U (Version B)

IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

12
Diagnostic System Operational. This code is always sent.

21
Right Front Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

22
Right Front Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mis-matched tire sizes, or use of the temporary (mini) spare tire may set this code.

25
Left Front Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

26
Left Front Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mis-matched tire sizes, or use of the temporary (mini) spare tire may set this code.

31
Right Rear Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

32
Right Rear Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mis-matched tire sizes, or use of the temporary (mini) spare tire may set this code.

35
Left Rear Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

36
Left Rear Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mis-matched tire sizes, or use of the temporary (mini) spare tire may set this code.

41
Right Front Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

45
Left Front Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

55
Rear Axle Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

61
Pump Motor or Motor Relay circuit. This code will set if the position of the motor relay contacts do not match the commanded position of those contacts as given by the EBCM (Electronic Brake Control Module). There is a motor monitoring circuit in the EBCM which will detect a defective relay or pump motor.

63
Solenoid Valve Relay circuit. This code will set if the position of the valve relay contacts do not match the commanded position of those contacts as given by the EBCM (Electronic Brake Control Module). There is a motor monitoring circuit in the EBCM which will detect a defective relay or a failure in the associated circuitry.

71
EBCM (Electronic Brake Control Module) failure. This code will set if there is an internal failure of the Electronic Brake Control Module.

SYSTEM 4: Bosch 2U (Version C)

1993 Eldorado, Seville

1994 DeVille, Eldorado, Seville

Pre-Diagnostic Visual Inspection

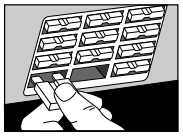
Complete all steps before reading trouble codes!

1) Check that all ABS system grounds are clean and tight.

– Check the ground that is located on the bottom left side of the engine block, near the transaxle.

– Check the ground that is located on the left rear seat brace.

2) Check power sources which supply various parts of ABS system.



– Check fuse **A1** (10 amp) in the trunk compartment fuse block. This fuse provides switched power to the EBCM.

– Check fuse **B3** (20 amp) in the engine compartment fuse block. This fuse provides continuous power to the brake light switch.

– Check fuse **A3** (10 amp) in the engine compartment fuse block. This fuse provides switched power to the amber anti-lock indicator lamp.

– Check fuse **# 5** (50 amp) in the right MAXI fuse block. This fuse provides continuous power to the relays in the brake pressure modulator valve assembly.

– Check the fusible links on the junction block.

3) Check that all ABS/TCS connectors, and EBTCM (Electronic Brake and Traction Control Module) connectors are properly installed (not loose).

4) Check that the parking brake switch is functioning properly.

5) Check that the brake pressure modulator valve ground stud is clean and tight.

This completes the visual inspection. Perform FUNCTIONAL CHECK before reading codes!

Functional Check

DeVille, Eldorado, Seville

1) Start the engine. The anti-lock lamp should come **ON** during engine cranking, and turn **OFF** shortly after the engine starts. If...

– The lamp does NOT turn OFF after engine start, *or*

– The “ANTILOCK DISABLED” message appears, *or*

– The “TRACTION DISABLED” message appears,

then proceed to READING ABS CODES, page 69.

Reading ABS Codes: Bosch 2U (Version C)

IMPORTANT: Perform all steps in PRE-DIAGNOSTIC VISUAL INSPECTION and FUNCTIONAL CHECK before reading ABS codes!

1) Take Safety Precautions

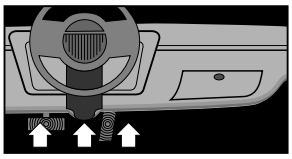
- Set parking brake, block drive wheels.
- Put shift lever in PARK (automatic transmission) or NEUTRAL (manual transmission).
- Make sure ignition key is in OFF position.

2) Have a Pencil and Paper Ready

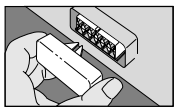
This is for writing down all the codes.

3) Find the Computer Test Connector

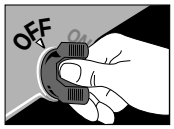
- Service manuals call this connector the Assembly Line Diagnostic Link (ALDL) connector. It may also be called the Assembly Line Communication Link (ALCL) or simply test connector.



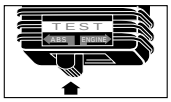
- The connector is located under the dashboard on the driver's side.
- The connector may be in full view, or it may be recessed behind a panel opening.
- The connector may have a slip-on cover labeled "Diagnostic Connector." Remove cover for testing. Replace cover after testing. Some vehicles require this cover in place for proper operation.

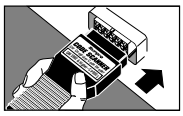


4) Verify Ignition Key is OFF



5) Put the TEST switch on ABS



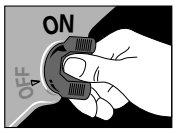


6) Plug the Code Scanner into the test connector

- The Code Scanner only fits ONE WAY into the test connector.
- The Code Scanner *will not harm* the vehicle computer.

Note: The Code Scanner does not use all of the test connector contacts. This is normal.

7) Turn Ignition Key to ON Position but DO NOT START THE ENGINE



WARNING: Stay away from the radiator cooling fan! It may turn on.

8) Get Codes from the Flashing "Anti-Lock" Light

- Count flashes to get trouble codes. (Flashes begin after a few seconds.)

Code 12 looks like:

FLASH (pause) FLASH FLASH
(FLASH = 1, FLASH FLASH = 2.
Put 1 and 2 together = code 12.)

Code 23 looks like:

FLASH FLASH (pause)
FLASH FLASH FLASH

- Each code is flashed three (3) times before the next trouble code is sent.
- After all codes are sent, the whole sequence is repeated. This continues until the ignition key is turned OFF (so you can double check your code list).

Example of code 12 only:

FLASH (pause) FLASH FLASH

(longer pause)

FLASH (pause) FLASH FLASH

(longer pause)

FLASH (pause) FLASH FLASH

(even longer pause, then start over again)

Example of code series 12 and 24:

FLASH (pause) FLASH FLASH

(longer pause)

FLASH (pause) FLASH FLASH

(longer pause)

FLASH (pause) FLASH FLASH

(even longer pause, then go to next code)

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(longer pause)

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(longer pause)

FLASH FLASH (pause)
FLASH FLASH FLASH FLASH

(even longer pause, then start all over from the very beginning)

- A code 12 is **always** sent even when the computer sees no problem. This tells you the computer diagnostic checks are working properly.
- All codes are two (2) digits long.

9) Turn Ignition Key OFF

10) Remove Code Scanner and Re-install Connector Cover, if supplied

The computer system is now back to normal operation.

11) Refer to ABS Code Meanings on page 72 (Bosch 2U, Version C)

This completes the code reading procedure.

At this point you can either:

- Have your vehicle professionally serviced. Trouble codes indicate problems found by the computer.

  or,

- Repair the vehicle yourself using trouble codes to help pinpoint the problem.

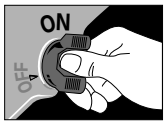
IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

Erasing ABS Codes from Computer Memory: Bosch 2U (Version C)

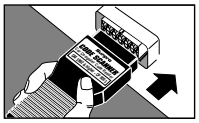
Erase codes from memory whenever you complete a repair or to see if a problem will occur again. **Note:** The computer will automatically erase codes after several restarts (typically 100) if the problem does not return.

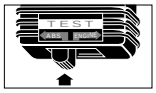
Proceed as follows:

1) Turn the ignition switch to the **ON** position. The anti-lock lamp should turn **OFF** after 3 to 4 seconds. If it does not, a current failure still exists which must be corrected before its corresponding trouble code will clear.

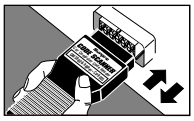


2) Install the Code Scanner **(make sure the TEST switch is in the ABS position)** into the test connector until the anti-lock lamp turns **ON**. Remove the Code Scanner. The anti-lock lamp will turn **OFF**.



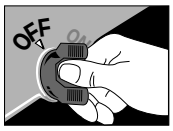


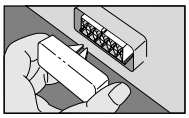
3) ***Without*** turning the ignition switch **OFF**, repeat the sequence outlined in Step 2, 2 more times.



4) All diagnostic trouble codes should now be cleared. Confirm this by turning the ignition switch **OFF**, installing the Code Scanner, and turning the ignition switch back to the **ON** position (do not start the engine). Code 12, the “diagnostic system operational” code should be the only code displayed.

5) Turn the ignition switch **OFF**. Remove the Code Scanner, and reinstall the test connector cover (if used on vehicle).





ABS Code Meanings: Bosch 2U (Version C)

IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

12
Diagnostic System Operational. This code is always sent.

21
Right Front Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

22
Right Front Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mismatched tire sizes, or use of the temporary (mini) spare tire may set this code.

23
Right Front Wheel Speed Sensor Continuity fault. Checks for open, or shorted condition in subject circuit. The ignition must be on, and the vehicle **not** moving for this code to set.

25
Left Front Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

26
Left Front Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mis-matched tire sizes, or use of the temporary (mini) spare tire may set this code.

27
Left Front Wheel Speed Sensor Continuity fault. Checks for open, or shorted condition in subject circuit. The ignition must be on, and the vehicle **not** moving for this code to set.

31
Right Rear Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

32
Right Rear Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mismatched tire sizes, or use of the temporary (mini) spare tire may set this code.

33
Right Rear Wheel Speed Sensor Continuity fault. Checks for open, or shorted condition in subject circuit. The ignition must be on, and the vehicle **not** moving for this code to set.

35
Left Rear Wheel Speed Sensor circuit. Checks for open, shorted or intermittent condition in subject circuit. Vehicle speed must be equal to or greater than 4 MPH for this code to set.

36
Left Rear Toothed Wheel Frequency Error. Checks for excessively dirty, or damaged toothed wheel (sensor ring). Mis-matched tire sizes, or use of the temporary (mini) spare tire may set this code.

37
Left Rear Wheel Speed Sensor Continuity fault. Checks for open, or shorted condition in subject circuit. The ignition must be on, and the vehicle **not** moving for this code to set.

41
Right Front Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

44
Right Front Traction Control System Pilot Valve fault. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBTCM (Electronic Brake and Traction Control Module).

45
Left Front Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

48
Left Front Traction Control System Pilot Valve fault. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBTCM (Electronic Brake and Traction Control Module).

51

Right Rear Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

55 (Vehicles with Traction Control)

Left Rear Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBTCM (Electronic Brake and Traction Control Module).

55 (Vehicles without Traction Control)

Rear ABS Solenoid Valve circuit. This code will set if the physical position of the subject valve does not match the commanded position as given by the EBCM (Electronic Brake Control Module).

61

Pump Motor or Motor Relay circuit. This code will set if the position of the motor relay contacts do not match the commanded position of those contacts as given by the EBCM (Electronic Brake Control Module). There is a motor monitoring circuit in the EBCM which will detect a defective relay or pump motor.

63

Solenoid Valve Relay circuit. This code will set if the position of the valve relay contacts do not match the commanded position of those contacts as given by the EBCM (Electronic Brake Control Module). There is a motor monitoring circuit in the EBCM which will detect a defective relay or a failure in the associated circuitry.

67

Brakelight Switch circuit (Vehicles with Traction Control). This code will set if the brakelight switch signal is not received.

71

EBCM or EBTCM (Electronic Brake Control or Traction Control Module) failure. This code will set if there is an internal failure of the Electronic Brake Control Module.

73

EBTCM (Electronic Brake and Traction Control Module) PWM (Pulse Width Modulated) Signal failure (4.6 Liter engine only). This code will set if there is a desired torque level signal communication failure between the EBTCM (Electronic Brake and Traction Control Module)and the PCM (Powertrain Control Module).

83

Low Brake Fluid Level (Vehicles with Traction Control). This code will set if the brake fluid level is low, or there is a problem with the brake fluid level sensing system.

SYSTEM 5:
Teves Mark II (Version A)

1989 Bonneville, Bonneville SSE, Delta 88, DeVille, Electra, Fleetwood, 98 Regency, Park Avenue

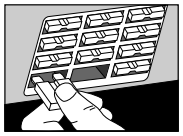
1990 Bonneville, Bonneville SSE, Delta 88, DeVille, Electra, Fleetwood, 98 Regency, Park Avenue

Pre-Diagnostic Visual Inspection

Complete all steps before reading trouble codes!

1) Check brake fluid level

2) Release the parking brake if it is set



3) Check all ABS system fuses

4) Check system electrical connections

- –Wheel speed sensor connectors.
- –EBCM (Electronic Brake Control Module) connectors.
- –System relay connectors.
- –System grounds.

This completes the visual inspection. Perform FUNCTIONAL CHECK before reading codes!

Functional Check

1) Turn the ignition key to the **ON** position, but do not start the engine.

2) The anti-lock lamp should illuminate for at least 3 seconds. If it does not, refer to the proper diagnostic chart in the vehicle service manual.

3) Observe the anti-lock and brake lamps while starting the engine (ignition key is in the cranking position). Both the anti-lock and brake lamps should be **ON** during cranking. If they are not, refer to the proper diagnostic chart in the vehicle service manual.

4) When the engine starts, allow it to run for 30 seconds, and then turn it **OFF** for 10 seconds.

5) Return the ignition key to the **ON** position (do not start the engine) and wait 10 seconds. Observe the condition of the anti-lock and brake warning lamps:

- –If the anti-lock lamp is **ON**, and the brake warning lamp is **OFF**, proceed to READING ABS CODES, page 75.
- –If the anti-lock lamp is **OFF**, and the brake warning lamp is **ON**, refer to the proper diagnostic chart in the vehicle service manual.

– If the anti-lock lamp is **ON**, and the brake warning lamp is **ON**, refer to the proper diagnostic chart in the vehicle service manual.

– If the anti-lock lamp is **OFF**, and the brake warning lamp is **OFF**, then this indicates normal system operation, or an intermittent problem. Intermittent trouble codes may or may not be stored.

Reading ABS Codes: Teves Mark II (Version A)

IMPORTANT: Perform all steps in PRE-DIAGNOSTIC VISUAL INSPECTION and FUNCTIONAL CHECK before reading ABS codes!

1) Safety First!

- Set the parking brake.
- Put shift lever in PARK (automatic transmission) or NEUTRAL (manual transmission).
- Block the drive wheels.
- Make sure ignition key is in OFF position.

2) Verify Codes are Stored

- Turn the ignition key to the **ON** position, but do not start the engine.
- Wait 30 seconds.
- Observe anti-lock light...

– Light ON: Codes are stored. Proceed with testing.

– Light OFF: No codes are stored. Stop testing.

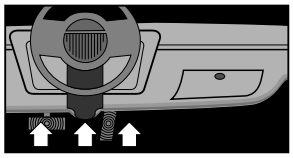
- Turn ignition key OFF.

3) Have a Pencil and Paper Ready

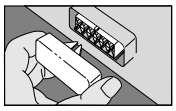
This is for writing down all the codes.

4) Find the Computer Test Connector

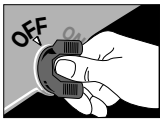
- Service manuals call this connector the Assembly Line Diagnostic Link (ALDL) connector. It may also be called the Assembly Line Communication Link (ALCL) or simply test connector.
- The connector is located under the dashboard on the driver's side.



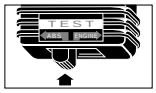
- The connector may be in full view, or it may be recessed behind a panel. An opening in the panel allows access to recessed connectors.
- The connector may have a slip-on cover labeled "Diagnostic Connector." Remove cover for testing. Replace cover after testing. Some vehicles require this cover in place for proper operation.

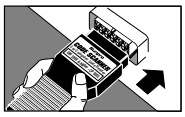


5) Verify Ignition Key is OFF



6) Put TEST switch on ABS





7) Plug the Code Scanner into the test connector

- The Code Scanner only fits ONE WAY into the test connector.
- The Code Scanner will not harm the vehicle engine computer.

Note: The Code Scanner does not use all of the test connector contacts. Also, one Code Scanner pin may plug into an empty test connector position. This is normal.

8) Turn Ignition Key to ON Position but DO NOT START THE ENGINE

WARNING: Stay away from the radiator cooling fan! It may turn on.

9) Get a Trouble Code from Flashing "Anti-Lock" Light

- All codes are two (2) digits long.
- Count flashes to get trouble codes. Flashes start after about a 4 second delay.

  – The first digit is flashed, then...

  – there is a 3 second pause, then...

  – the second digit is flashed, then...

  – the anti-lock light turns ON and stays ON. Do not count this steady light as a "flash."
- EXAMPLES:

Code 12 looks like:

FLASH (3 second pause) FLASH FLASH

(then light stays on.)

(FLASH = 1, FLASH FLASH = 2. Put 1 and 2 together = code 12.)

Code 23 looks like:

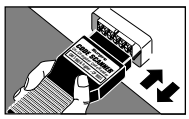
FLASH FLASH (3 second pause) FLASH FLASH FLASH

(then light stays on.)

10) Get More Codes (if any) from Flashing "Anti-Lock" Light

- Do this step after first code has been flashed and anti-lock light is ON steadily.
- Do NOT turn ignition switch off.

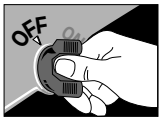
  – Remove Code Scanner from test connector. Then...



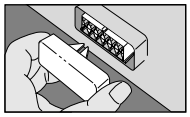
  – Re-install Code Scanner into test connector.

  – The next ABS trouble code (if any) will be flashed in the same manner as the first code.
- Repeat this step until all trouble codes have been read. The ABS computer can store up to 7 trouble codes.

11) Turn Ignition Key OFF



12) Remove Code Scanner and Re-install Connector Cover, if supplied



The computer system is now back to normal operation.

13) Refer to ABS Code Meanings on page 77 (Teves Mark II, Version A)

This completes the code reading procedure.

At this point you can either:

- Have your vehicle professionally serviced. Trouble codes indicate problems found by the computer.

  or,
- Repair the vehicle yourself using trouble codes to help pinpoint the problem.

  IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

Erasing ABS Codes from Computer Memory: Teves Mark II (Version A)

Erase codes from memory whenever you complete a repair or to see if a problem will occur again.

1) IMPORTANT! - Trouble codes cannot be cleared until they have been read! Refer to READING ABS CODES, page 75.

2) Drive the vehicle at a speed of greater than 18 MPH. Trouble codes should automatically clear.

ABS Code Meanings: Teves Mark II (Version A)

IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

11
EBCM (Electronic Brake Control Module) Failure. In most cases, this code indicates an EBCM failure. Follow the appropriate chart to check the ground circuit.

12
EBCM (Electronic Brake Control Module) Failure. In most cases, this code indicates an EBCM failure. Follow the appropriate chart to check the ground circuit.

21
Main Valve. Checks for open, shorted or intermittent condition in the main valve solenoid and its circuitry.

22
Left Front Inlet Valve. Checks for open, shorted or intermittent condition in the left front inlet valve solenoid and its circuitry.

23
Left Front Outlet Valve. Checks for open, shorted or intermittent condition in the left front outlet valve solenoid and its circuitry.

24
Right Front Inlet Valve. Checks for open, shorted or intermittent condition in the right front inlet valve solenoid and its circuitry.

25
Right Front Outlet Valve. Checks for open, shorted or intermittent condition in the right front outlet valve solenoid and its circuitry.

26
Rear Inlet Valve. Checks for open, shorted or intermittent condition in the rear inlet valve solenoid and its circuitry.

27
Rear Outlet Valve. Checks for open, shorted or intermittent condition in the rear outlet valve solenoid and its circuitry.

31
Left Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

32
Right Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

33
Right Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

34
Left Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

35
Left Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

36
Right Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

37
Right Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

38
Left Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

41
Left Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

42
Right Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

43
Right Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

44
Left Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

45
Left Front Wheel Speed Sensor Signal Missing. Checks for missing signal in the subject circuit

46
Right Front Wheel Speed Sensor Signal Missing. Checks for missing signal in the subject circuit.

47
***Either* Rear Wheel Speed Sensor Signal Missing.** Checks for missing signal in *either* of the rear wheel speed sensor circuits. (Note that it is impossible to determine which of the rear wheel speed circuits is causing the problem.) This code will set if the front wheels spin while the rear wheels are stationary.

48
***Any three* Wheel Speed Sensor Signals Missing.** There are missing signals in three (3) of the four (4) wheel speed sensor circuits.

51

Left Front Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 71, which has the same meaning.

52

Right Front Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 72, which has the same meaning.

53

Right Rear Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 73, which has the same meaning.

54

Left Rear Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 74, which has the same meaning.

55

Left Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

56

Right Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

57

Right Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

58

Left Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

61

Shorted Low Fluid, or Hydraulic Pressure Switch, or shorted ABS diode, or associated circuitry. This code will set if the low fluid switch, the hydraulic pressure switch, or the ABS diode or any of the associated circuitry exhibits a short circuit condition.

71

Left Front Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 51, which has the same meaning.

72

Right Front Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 52, which has the same meaning.

73

Right Rear Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). Note: This code may also be sent along with Code 53, which has the same meaning.

74

Left Rear Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 54, which has the same meaning.

75

Left Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

76

Right Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

77

Right Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit

78

Left Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

SYSTEM 6:
Teves Mark II (Version B)

1989 Eldorado, Reatta, Riviera, Seville, Toronado
1990 Eldorado, Reatta, Riviera, Seville, Toronado, Trofeo

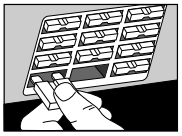
Pre-Diagnostic Visual Inspection

Complete all steps before reading trouble codes!

1) Check brake fluid level

2) Release the parking brake if it is set

3) Check all ABS system fuses

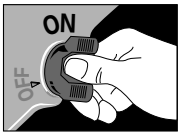


4) Check system electrical connections

- –Wheel speed sensor connectors.
- –EBCM (Electronic Brake Control Module) connectors.
- –System relay connectors.
- –System grounds.

This completes the visual inspection. Perform FUNCTIONAL CHECK before reading codes!

Functional Check



1) Turn the ignition key to the **ON** position, but do not start the engine.

2) The anti-lock lamp should illuminate for at least 3 seconds. If it does not, refer to the proper diagnostic chart in the vehicle service manual.

3) Observe the anti-lock and brake lamps while starting the engine (ignition key is in the cranking position). Both the anti-lock and brake lamps should be **ON** during cranking. If they are not, refer to the proper diagnostic chart in the vehicle service manual.

4) When the engine starts, allow it to run for 30 seconds, and then turn it **OFF** for 10 seconds.

5) Return the ignition key to the **ON** position (do not start the engine) and wait 10 seconds. Observe the condition of the anti-lock and brake warning lamps:

- –If the anti-lock lamp is **ON**, and the brake warning lamp is **OFF**, proceed to READING ABS CODES, page 80.
- –If the anti-lock lamp is **OFF**, and the brake warning lamp is **ON**, refer to the proper diagnostic chart in the vehicle service manual.
- –If the anti-lock lamp is **ON**, and the brake warning lamp is **ON**, refer to the proper diagnostic chart in the vehicle service manual.
- –If the anti-lock lamp is **OFF**, and the brake warning lamp is **OFF**, then this indicates normal system operation, or an intermittent problem. Intermittent trouble codes may or may not be stored.

Reading ABS Codes: Teves Mark I (Version B)

IMPORTANT: Perform all steps in PRE-DIAGNOSTIC VISUAL INSPECTION and FUNCTIONAL CHECK before reading ABS codes!

1) Safety First!

- Set the parking brake.
- Put shift lever in PARK (automatic transmission) or NEUTRAL (manual transmission).
- Block the drive wheels.
- Make sure ignition key is in OFF position.

2) Verify Codes are Stored

- Turn the ignition key to the **ON** position, but do not start the engine.
- Wait 30 seconds.
- Observe anti-lock light...

– Light ON: Codes are stored. Proceed with testing.

– Light OFF: No codes are stored. Stop testing.

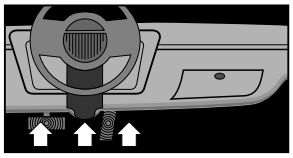
- Turn ignition key **OFF**.

3) Have a Pencil and Paper Ready

This is for writing down all the codes.

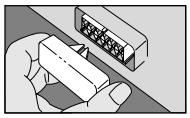
4) Find the Computer Test Connector

- Service manuals call this connector the Assembly Line Diagnostic Link (ALDL) connector. It may also be called the Assembly Line Communication Link (ALCL) or simply test connector.
- The connector is located under the dashboard on the driver's side.
- The connector may be in full view,

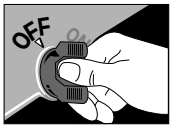


or it may be recessed behind a panel. An opening in the panel allows access to recessed connectors.

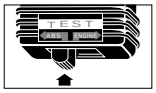
- The connector may have a slip-on cover labeled "Diagnostic Connector." Remove cover for testing. Replace cover after testing. Some vehicles require this cover in place for proper operation.

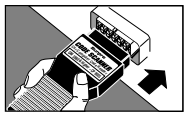


5) Verify Ignition Key is OFF



6) Put TEST switch on ABS

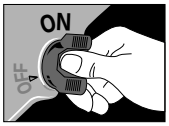




7) Plug the Code Scanner into the Test Connector

- The Code Scanner only fits ONE WAY into the test connector.
- The Code Scanner will *not harm* the vehicle engine computer.

Note: The Code Scanner does not use all of the test connector contacts. Also, one Code Scanner pin may plug into an empty test connector position. This is normal.



8) Turn Ignition Key to ON Position but DO NOT START THE ENGINE

WARNING: Stay away from the radiator cooling fan! It may turn on.

9) Get a Trouble Code from Flashing "Anti-Lock" Light

- All codes are two (2) digits long.

- Count flashes to get trouble codes. Flashes start after about a 4 second delay.
  – The first digit is flashed, then...
  – there is a 3 second pause, then...
  – the second digit is flashed, then...
  – the anti-lock light turns ON and stays ON. Do not count this steady light as a "flash."

  • EXAMPLES:

Code 12 looks like:

PAUSE

FLASH (3 second pause) FLASH
FLASH

(then light stays on.)

(FLASH = 1, FLASH FLASH = 2.

Put 1 and 2 together = code 12.)

Code 23 looks like:

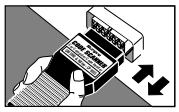
PAUSE

FLASH FLASH (3 second pause)
FLASH FLASH FLASH

(then light stays on.)

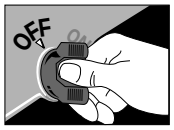
10) Get More Codes (if any) from Flashing "Anti-Lock" Light

- Do this step after first code has been flashed and anti-lock light is ON steadily.
- Do NOT turn ignition switch off.

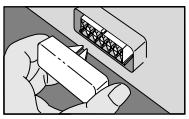


  – Remove Code Scanner from test connector. Then...
  – Re-install Code Scanner into test connector.
  – The next ABS trouble code (if any) will be flashed in the same manner as the first code.
- Repeat this step until all trouble codes have been read. The ABS computer can store up to 7 trouble codes.

11) Turn Ignition Key OFF



12) Remove Code Scanner and Re-install Connector Cover, if supplied



The computer system is now back to normal operation.

13) Refer to ABS Code Meanings on page 82 (Teves Mark II, Version B)

This completes the code reading procedure.

At this point you can either:

- Have your vehicle professionally serviced. Trouble codes indicate problems found by the computer.

  or,
- Repair the vehicle yourself using trouble codes to help pinpoint the problem.

  IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4)

Erasing ABS Codes from Computer Memory: Teves Mark II (Version B)

Erase codes from memory whenever you complete a repair or to see if a problem will occur again.

1) IMPORTANT! - Trouble codes cannot be cleared until they have been read! Refer to READING ABS CODES, page 80.

2) Drive the vehicle at a speed of greater than 20 MPH. Trouble codes should automatically clear.

ABS Code Meanings: Teves Mark II (Version B)

IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

11
EBCM (Electronic Brake Control Module) Failure. In most cases, this code indicates an EBCM failure. Follow the appropriate chart to check the ground circuit.

12
EBCM (Electronic Brake Control Module) Failure. In most cases, this code indicates an EBCM failure. Follow the appropriate chart to check the ground circuit.

21
Main Valve. Checks for open, shorted or intermittent condition in the main valve solenoid and its circuitry.

22
Left Front Inlet Valve. Checks for open, shorted or intermittent condition in the left front inlet valve solenoid and its circuitry.

23
Left Front Outlet Valve. Checks for open, shorted or intermittent condition in the left front outlet valve solenoid and its circuitry.

24
Right Front Inlet Valve. Checks for open, shorted or intermittent condition in the right front inlet valve solenoid and its circuitry.

25
Right Front Outlet Valve. Checks for open, shorted or intermittent condition in the right front outlet valve solenoid and its circuitry.

26
Rear Inlet Valve. Checks for open, shorted or intermittent condition in the rear inlet valve solenoid and its circuitry.

27
Rear Outlet Valve. Checks for open, shorted or intermittent condition in the rear outlet valve solenoid and its circuitry.

31
Left Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

32
Right Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

33
Right Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

34
Left Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

35
Left Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

36
Right Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

37
Right Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

38
Left Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

41
Left Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

42
Right Front Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

43
Right Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circuit.

44
Left Rear Wheel Speed Sensor circuit. Checks for an open, short or intermittent condition in subject circui

45
Left Front Wheel and One (1) Rear Wheel Speed Sensor Signal Missing. Checks for missing signal in the subject circuits.

46
Right Front Wheel and One (1) Rear Wheel Speed Sensor Signal Missing. Checks for missing signal in the subject circuits.

47
***Either* Rear Wheel Speed Sensor Signal Missing.** Checks for missing signal in *either* of the rear wheel speed sensor circuits. (Note that it is impossible to determine which of the rear wheel speed circuits is causing the problem.) This code will set if the front wheels spin while the rear wheels are stationary.

48

***Any three* Wheel Speed Sensor Signals Missing.** There are missing signals in three (3) of the four (4) wheel speed sensor circuits.

51

Left Front Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 71, which has the same meaning.

52

Right Front Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 72, which has the same meaning.

53

Right Rear Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 73, which has the same meaning.

54

Left Rear Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 74, which has the same meaning.

61

Shorted Low Fluid, or Hydraulic Pressure Switch, or shorted ABS diode, or associated circuitry. This code will set if the low fluid switch, the hydraulic pressure switch, or the ABS diode or any of the associated circuitry exhibits a short circuit condition.

71

Left Front Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 51, which has the same meaning.

72

Right Front Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 52, which has the same meaning.

73

Right Rear Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). **Note:** This code may also be sent along with Code 53, which has the same meaning.

74

Left Rear Wheel Hydraulic Pressure Reduction fault. This code is the result of an incorrect response to a hydraulic circuit pressure reduction command as sent by the EBCM (Electronic Brake Control Module). Note: This code may also be sent along with Code 54, which has the same meaning.

SYSTEM 7: Kelsey-Hayes RWAL (Rear Wheel Anti-Lock)

1988 Blazer, C & K Series Pickup Truck, Sierra

1989 Astro, Blazer, C & K Series Pickup Truck, Jimmy, S Series (2 WD) Pickup Truck, Safari, Sierra

1990 Astro, Blazer, C & K Series Pickup Truck, G Series (RWD) Van, Jimmy, R & V Series Truck, S & T Series Pickup Truck, Safari, Sierra, Suburban

1991 Astro, Blazer, C & K Series Pickup Truck, G Series (RWD) Van, Jimmy, R & V Series Truck, S & T Series Pickup Truck, Safari, Sierra, Suburban

1992 Astro, Blazer, C & K Series Pickup Truck, G Series (RWD) Van, Jimmy, S & T Series Pickup Truck, Safari, Sierra

1993 Blazer, C & K Series Pickup Truck, Jimmy, S & T Series Pickup Truck, Sierra

1994 Blazer, C & K Series Pickup Truck, S & T Series Pickup Truck

Diagnostic Circuit Check

Complete all steps before reading trouble codes!

1) Block the wheels, and release the parking brake. Do not step on the service brake!

2) Turn the ignition key to the **ON** position, but do not start the engine. Observe the instrument panel brake warning light:

- If the brake light turns **ON**, and then **OFF** after about 2 seconds, the self-diagnostic circuitry has found NO current problems with the ABS system.

  – **DO NOT perform ABS code reading procedure!** A false code 9 will be stored in ABS computer memory if the code reading steps are followed when no faults currently exist. (This is a quirk of the RWAL ABS system.)

  – Do this additional check: Step on the service brake. If the brake warning light comes **ON**, there is a problem with the combination valve. (This valve is part of the normal braking system, not part of the anti-lock braking system.) Release the service brake.

- If the brake light turns **ON** and stays **ON** (or turns **ON** after the bulb check), proceed to the diagnostic procedure outlined in your vehicle service manual for the brake light **ON** symptom.
- If the brake light stays **OFF**, proceed to the diagnostic procedure outlined in your vehicle service manual for the brake light **OFF** symptom.
- If the brake light is **FLASHING**, proceed to READING ABS CODES, page 85.

3) Turn the ignition key to the **OFF** position.

Reading ABS Codes: Kelsey-Hayes RWAL

IMPORTANT: Perform all steps in DIAGNOSTIC CIRCUIT CHECK before reading ABS codes!

1) Take Safety Precautions

- Set parking brake, block drive wheels.
- Put shift lever in PARK (automatic transmission) or NEUTRAL (manual transmission).
- Make sure ignition key is in OFF position.

2) Verify ABS Problem Currently Exists

- Turn the ignition key to the **ON** position, but do not start the engine.

WARNING: Stay away from the radiator cooling fan! It may turn on.

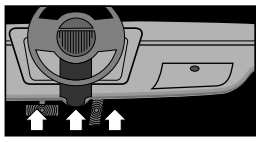
- Wait 5 seconds, and then observe the brake warning light.

  – Brake light **OFF**: ABS computer does NOT detect a current problem. Do not proceed with this test! A false code 9 will be stored in ABS computer memory if the code reading steps are followed when no faults currently exist! Turn the ignition key **OFF** and stop testing.

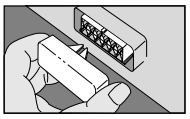
  – Brake light **ON**: An ABS problem currently exists. At least one trouble code is stored in computer memory. Go to step 3 and continue code reading procedure.

3) Find the Computer Test Connector

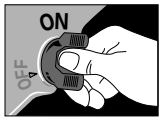
- Service manuals call this connector the Assembly Line Diagnostic Link (ALDL) connector. It may also be called the Assembly Line Communication Link (ALCL) or simply test connector.
- The connector is located under the dashboard on the driver's side.



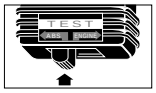
- The connector may be in full view, or it may be recessed behind a panel opening.
- The connector may have a slip-on cover labeled "Diagnostic Connector." Remove cover for testing. Replace cover after testing. Some vehicles require this cover in place for proper operation.

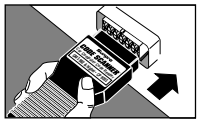


4) Verify Ignition Key is ON and Engine is OFF



5) Put the TEST switch on ABS





6) Plug the Code Scanner into the Test Connector

- The Code Scanner only fits ONE WAY into the test connector.
- The Code Scanner will *not harm* the vehicle computer.

  Note: The Code Scanner does not use all of the test connector contacts. This is normal.

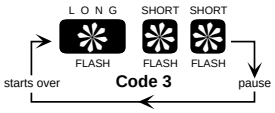
7) Get the Code from the Flashing "Brake" Light

- Count flashes to get the trouble code.

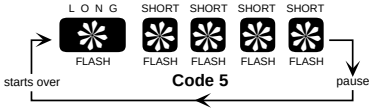
  – Flashes begin after 20 seconds, or more.

  – The code starts with one long flash and is followed by several short flashes. Count the long flash along with the short flashes to get the code number. After a pause, the code is repeated.

Code 3 looks like:

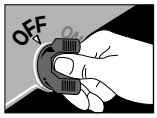


Code 5 looks like:

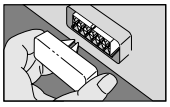


- The same code is flashed over and over again. Note that the long flash helps you tell when the code is being repeated.
- **Important:** The code may be flashed *incorrectly* the *first* time. The code will be flashed correctly the rest of the time. Count the flash sequences a few times to verify the code.
- Code flashing continues until the ignition key is turned OFF or the Code Scanner is unplugged.

8) Turn Ignition Key OFF



9) Remove Code Scanner and Re-install Connector Cover, if supplied



The computer system is now back to normal operation.

10) Refer to ABS Code Meanings on page 87 (Kelsey-Hayes RWAL)

This completes the code reading procedure.

At this point you can either:

- Have your vehicle professionally serviced. Trouble codes indicate problems found by the computer.

  or,

- Repair the vehicle yourself using trouble codes to help pinpoint the problem.

  IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

NOTE (multiple trouble code storage):

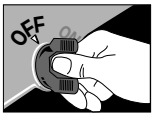
This ABS system is only capable of displaying one code at a time. Repair the failure which generated the displayed trouble code, and then repeat the READING ABS CODES procedure to see if any more codes are stored. Continue repeating the procedure until all codes are displayed, diagnosed, and repaired.

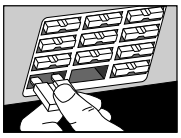
Erasing ABS Codes from Computer Memory: Kelsey-Hayes RWAL

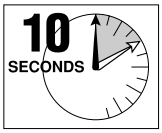
Erase codes from memory when you complete all repairs or to see if a problem will occur again.

Proceed as follows:

1) Turn the ignition key to the OFF position.







2) Remove the indicated fuse from the fuse block and wait at least 10 seconds.

- *1988–93 C & K Trucks:* Remove the **STOP/HAZ** fuse.
- *1989–92 Astro/Safari:* Remove the **HORN/DM** fuse.
- *1989 S Series Trucks:* Remove the **ECM B** fuse.
- *1990–92 G Series RWD Vans:* Remove the **TAIL LPS** fuse.
- *1990–91 R & V Series (Suburbans etc.):* Remove the **STOP/HAZ** fuse.
- *1990–93 S & T Series Trucks:* Remove the **ECM B** fuse.

3) Replace fuse. Trouble codes are now erased from computer memory!

ABS Code Meanings: Kelsey-Hayes RWAL

IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

1

ECM (Electronic Control Module) Failure. This code indicates an anti-lock brake system control module failure, or a mis-read code.

2

Open Isolation valve or defective ECM (Electronic Control Module). This code indicates an open circuit in the isolation valve or associated wiring. The anti-lock brake system control module may also have failed.

3

Open Dump valve or defective ECM (Electronic Control Module). This code indicates an open circuit in the dump valve or associated wiring. The anti-lock brake system control module may also have failed.

4

Grounded anti-lock valve Reset Switch. This code indicates a grounded circuit in the anti-lock valve reset switch or associated wiring

5

Excessive actuation of the Dump valve during an anti-lock stop. On 2 wheel drive vehicles, this code indicates probable failure of the isolation/ dump valve assembly. On 4 wheel drive vehicles, this code indicates either possible failure of the isolation/dump valve assembly, or a failure in the front axle transfer case switch or its associated wiring and/or connectors.

6

Erratic Vehicle Speed Sensor signal. This code indicates either a defective or erratic vehicle speed sensor (check for engine diagnostic trouble code 24), defective DRAC (Digital Ratio Adapter Controller) or its circuitry, or any associated wiring. An open battery feed fuse to the ABS electronic control module could also cause this code to set.

7

Shorted Isolation valve or defective ECM (Electronic Control Module). This code indicates a shorted circuit in the isolation valve or associated wiring. The anti-lock brake system control module may also have failed.

8

Shorted Dump valve or defective ECM (Electronic Control Module). This code indicates a shorted circuit in the dump valve or associated wiring. The anti-lock brake system control module may also have failed.

9

Open circuit to the Vehicle Speed Sensor signal. This code indicates a defective vehicle speed sensor (check for engine diagnostic trouble code 24), defective DRAC (Digital Ratio Adapter Controller) or its circuitry, or any of its associated wiring. An open battery feed fuse to the ABS electronic control module could also cause this code to set.

10

Stop (Brake) Light circuit. This code indicates a missing stop light signal from the stop light switch. The stop light switch may be mis-adjusted or defective, or there may be a problem with its associated wiring.

11

ECM (Electronic Control Module) Failure. This code indicates an anti-lock brake system control module failure, or a mis-read code.

12

ECM (Electronic Control Module) Failure. This code indicates an anti-lock brake system control module failure, or a mis-read code.

13

ECM (Electronic Control Module) Failure. This code indicates an anti-lock brake system control module failure.

14

ECM (Electronic Control Module) Failure. This code indicates an anti-lock brake system control module failure.

15

ECM (Electronic Control Module) Failure. This code indicates an anti-lock brake system control module failure.

SYSTEM 8: Kelsey-Hayes 4WAL (4 Wheel Anti-Lock)

1990 Astro, Safari

1991 Astro, Bravada, S & T Series Blazer, Jimmy, Pickup, Safari, Sonoma, Syclone, Typhoon

1992 Astro, Bravada, C & K Series Blazer & Pickup, S & T Series Blazer, Jimmy, Pickup, Safari, Sierra, Sonoma, Suburban, Syclone, Typhoon, Yukon

1993 Astro, Bravada, C & K Series Blazer & Pickup, G Series Van,

S & T Series Blazer, Jimmy, Pickup, Safari, Sierra, Sonoma, Suburban, Syclone, Typhoon, Yukon

1994 Astro, Bravada, C & K Series Blazer & Pickup, G Series Van,

S & T Series Blazer, Jimmy, Pickup, Safari, Sierra, Sonoma, Suburban, Yukon

Diagnostic Circuit Check

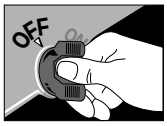
Complete all steps before reading trouble codes!

1) Block the wheels, and release the parking brake. Do not step on the service brake!

2) Turn the ignition key to the **ON** position, but do not start the engine. Observe the instrument panel amber anti-lock light:

- If the anti-lock light turns **ON**, and then **OFF** after about 2 seconds, the diagnostic circuit check is successful. Proceed to Step 3.
- If the anti-lock light turns **ON** and stays **ON**, or turns **ON** after the bulb check, proceed to the diagnostic procedure outlined in your vehicle service manual for the anti-lock light **ON** symptom.
- If the anti-lock light stays **OFF**, proceed to the diagnostic procedure outlined in your vehicle service manual for the anti-lock light **OFF** symptom.

3) Turn the ignition key to the **OFF** position. Proceed to READING ABS CODES, page 89.



Reading ABS Codes: Kelsey-Hayes 4WAL

IMPORTANT: Perform all steps in DIAGNOSTIC CIRCUIT CHECK before reading ABS codes!

Note (1990, 1991 only): *Codes 21, 22, 25, 26, 31, 32, 35, and 36 will disable ABS system, but are not stored in computer memory. They are erased when ignition is turned off. All other codes are stored in memory when they occur.*

1) Take Safety Precautions

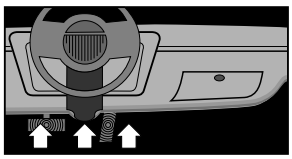
- Set parking brake, block drive wheels.
- Put shift lever in PARK (automatic transmission) or NEUTRAL (manual transmission).
- Make sure ignition key is in OFF position.

2) Have a Pencil and Paper Ready

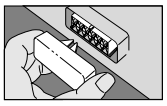
This is for writing down all the codes.

3) Find the Computer Test Connector

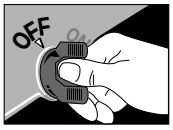
- Service manuals call this connector the Assembly Line Diagnostic Link (ALDL) connector. It may also be called the Assembly Line Communication Link (ALCL) or simply test connector.
- The connector is located under the dashboard on the driver's side.

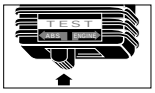


- The connector may be in full view, or it may be recessed behind a panel opening.
- The connector may have a slip-on cover labeled "Diagnostic Connector." Remove cover for testing. Replace cover after testing. Some vehicles require this cover in place for proper operation.



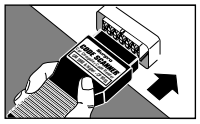
4) Verify Ignition Key is OFF





5) Put the TEST switch on ABS

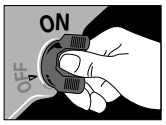
6) Plug the Code Scanner into the Test Connector



- The Code Scanner only fits ONE WAY into the test connector.
- The Code Scanner will *not harm* the vehicle computer.

Note: The Code Scanner does not use all of the test connector contacts. This is normal.

7) Turn Ignition Key to ON Position but DO NOT START THE ENGINE



WARNING: Stay away from the radiator cooling fan! It may turn on.

8) Get Codes from the Flashing "Anti-Lock" Light

- Count flashes to get trouble codes. (Flashes begin after a few seconds.)

Code 12 looks like:

PAUSE

FLASH (pause) FLASH FLASH

(FLASH = 1, FLASH FLASH = 2. Put 1 and 2 together = code 12.)

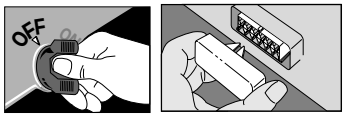
Code 23 looks like:

PAUSE

FLASH FLASH (pause) FLASH FLASH FLASH

- After all codes are sent, the whole sequence is repeated. This continues until the ignition key is turned OFF (so you can double check your code list).
- All codes are two (2) digits long.

9) Turn Ignition Key OFF



10) Remove Code Scanner and Re-install Connector Cover, if supplied

The computer system is now back to normal operation.

11) Refer to ABS Code Meanings on page 91 (Kelsey-Hayes 4WAL)

This completes the code reading procedure.

At this point you can either:

- Have your vehicle professionally serviced. Trouble codes indicate problems found by the computer.

  or,

- Repair the vehicle yourself using trouble codes to help pinpoint the problem.

  IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

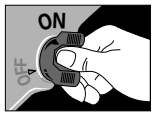
Erasing ABS Codes from Computer Memory: Kelsey-Hayes 4WAL

Erase codes from memory whenever you complete a repair or to see if a problem will occur again.

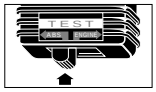
Proceed as follows:

• 1990, 1991:

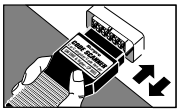
1) Turn the ignition switch to the **ON** position.



2) Put the Code Scanner **TEST** switch in the **ABS** position.



3) Plug the Code Scanner into the test connector for 2 seconds. Remove the Code Scanner for 2 seconds. Repeat this procedure 5 more times.

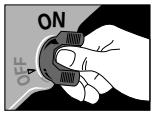


Important: A false code 65 may be created if the plug/unplug procedure is only done twice. You must complete all of step 3 in order to erase trouble codes.

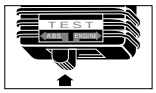
4) Turn the ignition switch to the **OFF** position. Reinstall test connector cover (if used on vehicle).

• 1992 and newer:

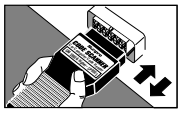
1) Turn the ignition switch to the **ON** position.



2) Put the Code Scanner **TEST** switch in the **ABS** position.



3) Plug the Code Scanner into the test connector for 2 seconds. Remove the Code Scanner for 1 second. Repeat this procedure once more. Trouble codes are erased when the anti-lock and brake lights turn on, then turn off. Repeat the plug/unplug procedure if necessary.



4) Turn the ignition switch to the **OFF** position. Reinstall test connector cover (if used on vehicle).

ABS Code Meanings: Kelsey-Hayes 4WAL

IMPORTANT: Always follow vehicle service manual procedures for any ABS repairs! (Manual listings on page 4.)

12

ABS System functional, 2WD, service brake not applied. This code indicates that the anti-lock brake system as installed on a *2 wheel drive* vehicle is functioning normally. As indicated above, this code should appear *without* the service brakes applied.

13

ABS System functional, 2WD, service brake applied. This code indicates that the anti-lock brake system as installed on a *2 wheel drive* vehicle is functioning normally. As indicated above, this code should appear *with* the service brakes applied. If, with the service brakes applied, the anti-lock lamp continues to indicate a code 12, it is likely that there is a problem with the stop (brake) lamp switch circuit. Assistance is available under the diagnostic chart for diagnostic trouble code 81.

14

ABS System functional, 4WD, service brake not applied. This code indicates that the anti-lock brake system as installed on a *4 wheel drive* vehicle is functioning normally. As indicated above, this code should appear *without* the service brakes applied.

15

ABS System functional, 4WD, service brake applied. This code indicates that the anti-lock brake system as installed on a *4 wheel drive* vehicle is functioning normally. As indicated above, this code should appear *with* the service brakes applied. If, with the service brakes applied, the anti-lock lamp continues to indicate a code 14, it is likely that there is a problem with the stop (brake) lamp switch circuit. Assistance is available under the diagnostic chart for diagnostic trouble code 81.

21

Right Front Wheel Speed Sensor Circuit resistance is incorrect. This code is indicative of high resistance in this particular wheel speed sensor circuit. The resistance of the wheel speed sensor may be out of specification, or there may be loose, corroded, or dirty connections in this circuit.

22

Right Front Wheel Speed Sensor Voltage Output is incorrect. This code indicates a problem in the wheel speed sensor or its associated tone (toothed) wheel. Check for the proper air gap between the wheel speed sensor and tone wheel, missing or broken teeth on the tone wheel, a loose, improperly mounted, or mis-adjusted wheel speed sensor. An intermittent connection in the associated wiring can also set this code.

23

Right Front Wheel Speed Sensor Voltage Output is erratic. Erratic voltage output usually indicates a loose, dirty, or corroded connection. Check the connections at the wheel speed sensor connector, the wheel speed sensor harness, and the EHCU (Electro-Hydraulic Control Unit). There may also be a problem in the wheel speed sensor or its associated tone (toothed) wheel. Check for the proper air gap between the wheel speed sensor and tone wheel, missing or broken teeth on the tone wheel, a loose, improperly mounted, or mis-adjusted wheel speed sensor.

25

Left Front Wheel Speed Sensor Circuit resistance is incorrect. This code is indicative of high resistance in this particular wheel speed sensor circuit. The resistance of the wheel speed sensor may be out of specification, or there may be loose, corroded, or dirty connections in this circuit.

26

Left Front Wheel Speed Sensor Voltage Output is incorrect. This code indicates a problem in the wheel speed sensor or its associated tone (toothed) wheel. Check for the proper air gap between the wheel speed sensor and tone wheel, missing or broken teeth on the tone wheel, a loose, improperly mounted, or mis-adjusted wheel speed sensor. An intermittent connection in the associated wiring can also set this code.

27

Left Front Wheel Speed Sensor Voltage Output is erratic. Erratic voltage output usually indicates a loose, dirty, or corroded connection. Check the connections at the wheel speed sensor connector, the wheel speed sensor harness, and the EHCU (Electro-Hydraulic Control Unit). There may also be a problem in the wheel speed sensor or its associated tone (toothed) wheel. Check for the proper air gap between the wheel speed sensor and tone wheel, missing or broken teeth on the tone wheel, a loose, improperly mounted, or mis-adjusted wheel speed sensor.

28

One or Two Wheel Speed Sensor Voltage Output Signals are erratic. Trouble codes 23, 27, 33, or 37 may be set along with code 28. If one or more of these 4 codes are present, use that code(s) to diagnose the failure. If trouble code 28 is the only code set, it is advisable to drive the vehicle an additional period of time until one of the 4 listed codes does set, and then use that code chart for diagnosis. If code 28 persists as the only trouble code, it indicates that an intermittent connection exists somewhere in the system. All connections will have to be checked.

29

All Wheel Speed Sensor Voltage Output Signals are erratic. Trouble code 29 is usually caused by an improperly seated 8 way connector at the EHCU (Electro-Hydraulic Control Unit). Check for corrosion or dirty contacts, and that the connector is properly installed in the EHCU.

31

Right Rear Wheel Speed Sensor Circuit resistance is incorrect. This code is indicative of high resistance in this particular wheel speed sensor circuit. The resistance of the wheel speed sensor may be out of specification, or there may be loose, corroded, or dirty connections in this circuit.

32

Right Rear Wheel Speed Sensor Voltage Output is incorrect. This code indicates a problem in the wheel speed sensor or its associated tone (toothed) wheel. Check for the proper air gap between the wheel speed sensor and tone wheel, missing or broken teeth on the tone wheel, a loose, improperly mounted, or mis-adjusted wheel speed sensor. An intermittent connection in the associated wiring can also set this code.

33

Right Rear Wheel Speed Sensor Voltage Output is erratic. Erratic voltage output usually indicates a loose, dirty, or corroded connection.Check the connections at the wheel speed sensor connector, the wheel speed sensor harness, and the EHCU (Electro-Hydraulic Control Unit). There may also be a problem in the wheel speed sensor or its associated tone (toothed) wheel. Check for the proper air gap between the wheel speed sensor and tone wheel, missing or broken teeth on the tone wheel, a loose, improperly mounted, or mis-adjusted wheel speed sensor

35

Left Rear Wheel Speed Sensor Circuit resistance is incorrect. This code is indicative of high resistance in this particular wheel speed sensor circuit. The resistance of the wheel speed sensor may be out of specification, or there may be loose, corroded, or dirty connections in this circuit.

36

Left Rear Wheel Speed Sensor Voltage Output is incorrect. This code indicates a problem in the wheel speed sensor or its associated tone (toothed) wheel. Check for the proper air gap between the wheel speed sensor and tone wheel, missing or broken teeth on the tone wheel, a loose, improperly mounted, or mis-adjusted wheel speed sensor. An intermittent connection in the associated wiring can also set this code.

37

Left Rear Wheel Speed Sensor Voltage Output is erratic. Erratic voltage output usually indicates a loose, dirty, or corroded connection. Check the connections at the wheel speed sensor connector, the wheel speed sensor harness, and the EHCU (Electro-Hydraulic Control Unit). There may also be a problem in the wheel speed sensor or its associated tone (toothed) wheel. Check for the proper air gap between the wheel speed sensor and tone wheel, missing or broken teeth on the tone wheel, a loose, improperly mounted, or mis-adjusted wheel speed sensor.

38

Speed Sensor Voltage Signal Output is erratic. When this code appears, it is usually accompanied with code 23, 27, 33, or 37. If it is accompanied with one or more of the listed codes, use the trouble chart for that code to diagnose the system. If trouble code 38 appears by itself, all connections between the wheel speed sensors and the EHCU (Electro-Hydraulic Control Unit) will need to be checked for looseness, dirt, corrosion, etc

41

Right Front Isolation Valve Solenoid, open circuit. Double check to make sure that the code has been properly read. If it has, clear all trouble codes by following the **ERASING ABS CODES FROM COMPUTER MEMORY** procedure on page 12-83. Thoroughly road test the vehicle. Check for trouble codes again. If this code returns, the EHCU (Electro-Hydraulic Control Unit) is defective and should be replaced. The EHCU is a costly part! Your dealer may offer an exchange policy in which case your defective unit has value (core credit) towards the purchase of the replacement. Securely attach a tag to your defective unit clearly indicating the trouble code(s) reported by the defective EHCU.

42

Right Front Pulse Width Modulation Valve Solenoid, open circuit. Refer to the explanation under trouble code 41.

43

Right Front Isolation Valve Solenoid, short circuit. Double check to make sure that the code has been properly read. Carefully check all power and ground connections at the EHCU. If the code has been properly read, and there are no problems in the power or ground circuits, clear all trouble codes by following the **ERASING ABS CODES FROM COMPUTER MEMORY** procedure on page 12-83. Thoroughly road test the vehicle. Check for trouble codes again. If this code returns, the EHCU (Electro-Hydraulic Control Unit) is defective and should be replaced. The EHCU is a costly part! Your dealer may offer an exchange policy in which case your defective unit has value (core credit) towards the purchase of the replacement. Securely

attach a tag to your defective unit clearly indicating the trouble code(s) reported by the defective EHCU.

43, 44, 47, 48, 53, 54, & 68 all at the same time.

If all of these codes appear simultaneously, carefully check all power and ground connections at the EHCU (Electro-Hydraulic Control Unit).

44

Right Front Pulse Width Modulation Valve Solenoid, short circuit. Refer to the explanation under trouble code 43.

45

Left Front Isolation Valve Solenoid, open circuit. Refer to the explanation under trouble code 41.

46

Left Front Pulse Width Modulation Valve Solenoid, open circuit. Refer to the explanation under trouble code 41.

47

Left Front Isolation Valve Solenoid, short circuit. Refer to the explanation under trouble code 43.

48

Left Front Pulse Width Modulation Valve Solenoid, short circuit. Refer to the explanation under trouble code 43.

51

Rear Isolation Valve Solenoid, open circuit. Refer to the explanation under trouble code 41.

52

Rear Pulse Width Modulation Valve Solenoid, open circuit. Refer to the explanation under trouble code 41.

53

Rear Isolation Valve Solenoid, short circuit. Refer to the explanation under trouble code 43.

54

Rear Pulse Width Modulation Valve Solenoid, short circuit. Refer to the explanation under trouble code 43.

61

Right Front Reset Switch, open circuit. Refer to the explanation under trouble code 41.

62

Left Front Reset Switch, open circuit. Refer to the explanation under trouble code 41.

63

Rear Reset Switch, open circuit. Refer to the explanation under trouble code 41.

65

Pump Motor Relay, open circuit. Refer to the explanation under trouble code 41. **IMPORTANT** - This code may be **FALSELY** set by an improperly performed trouble code clearing procedure.

66

Pump Motor Relay, short circuit. Refer to the explanation under trouble code 41.

67

Pump Motor Circuit, open circuit. This code indicates an open circuit in the connection between the pump motor, and the EHCU (Electro-Hydraulic Control Unit).

68

Pump Motor Circuit, shorted circuit. This code indicates a shorted circuit in the connection between the pump motor, and the EHCU (Electro-Hydraulic Control Unit). Carefully check all power and ground connections at the EHCU.

71

EHCU (Electro-Hydraulic Control Unit) has a RAM (Random Access Memory) error. Refer to the explanation under trouble code 41.

72

EHCU (Electro-Hydraulic Control Unit) has a ROM (Read Only Memory) error. Refer to the explanation under trouble code 41.

73

EHCU (Electro-Hydraulic Control Unit) has an internal circuit error. Refer to the explanation under trouble code 41.

74

EHCU (Electro-Hydraulic Control Unit) has an internal circuit error which is causing excessive isolation time. Refer to the explanation under trouble code 41.

81

Brake (Stop Lamp) switch circuit is shorted or open. This code indicates a malfunction in the stop lamp switch circuit. Note that this code can be set by a driver who rides the brake pedal.

85

Anti-lock indicator lamp circuit is open. This code if present, will be flashed by the *brake warning lamp*, **not** the anti-lock lamp, and indicates an open circuit in the anti-lock lamp circuit.

86

Anti-lock indicator lamp circuit is shorted. This code if present, will be flashed by the *brake warning lamp*, **not** the anti-lock lamp, and indicates a short circuit in the anti-lock lamp circuit.

88

Brake warning indicator lamp circuit is shorted. This code indicates a short circuit in the brake warning indicator lamp circuit.

1982-93						
BUICK	**CADILLAC**	**CHEVROLET**	**OLDSMOBILE**	**PONTIAC**	**SATURN**	**TRUCKS & VANS**
Century Electra Electra Wagon Estate Wagon Le Sabre Le Sabre Wagon Park Avenue Reatta * Regal Regal Grand National Riviera * Roadmaster Skyhawk Skylark Somerset	Cimarron	Beretta Camaro Caprice Cavalier Celebrity Chevette Citation Corsica Corvette El Camino Impala Lumina Monte Carlo	Achieva Calais Custom Cruiser Cutlass Calais Cutlass Ciera Cutlass Cruiser Cutlass Cruiser Wagon Cutlass Supreme Cutlass Supreme Classic Delta 88 Eighty-Eight Firenza Ninety-Eight Omega Toronado * Touring Sedan Trofeo *	6000 6000 STE Bonneville Fiero Firebird Grand Am Grand Prix J2000 LeMans Parisienne Phoenix Safari Safari Wagon Sunbird T1000	All models	All gasoline burning vehicles 1 ton capacity or less
1994						
Roadmaster 5.7L		Camaro 3.4L, 5.7L Cavalier 3.1L Lumina 3.1L		Firebird 3.4L, 5.7L Sunbird 2.0L, 3.1L	All models	All gasoline burning vehicles 1 ton capacity or less
1995						
		Caprice 4.3L			All models	

*** Code Scanner is only applicable if vehicle DOES NOT HAVE a climate control computer**

GM ABS Applications

CARS

MAKE	YEAR	MODEL
Buick	1989-90	Electra
	1989-90	Park Avenue
	1989-91	Reatta
	1989-93	Riviera
	1991	Roadmaster
Cadillac	1990-92	Brougham
	1989-90	DeVille
	1989-93	Eldorado
	1989-90	Fleetwood
	1989-93	Seville
Chevrolet	1991	Caprice
	1990-91	Corvette
Oldsmobile	1989-90	98 Regency
	1991	Custom Cruiser
	1989-90	Delta 88
	1989-92	Toronado
	1990-92	Trofeo
Pontiac	1989-90	Bonneville
	1989-90	Bonneville SSE

VANS

MAKE	YEAR	MODEL
Chevrolet GM Van	1989-93	Astro
	1990-93	G Series

TRUCKS

MAKE	YEAR	MODEL
Chevrolet	1988-93	Blazer
	1990-93	Suburban
GM	1988-94	C Series
	1988-94	K Series
	1990-91	R Series
	1989-94	S Series
	1990-94	T Series
	1990-91	V Series
GMC	1989-93	Jimmy
	1989-93	Safari
	1988-93	Sierra
	1991-93	Sonoma
	1991-93	Syclone
	1992-93	Typhoon
	1992-93	Yukon
Oldsmobile	1991-93	Bravada

Vehicles not listed may be tested for engine/transmission trouble codes only.

ONE (1) YEAR LIMITED WARRANTY

Actron Manufacturing Company ("Actron") warrants to the original purchaser that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of original purchase. Any unit that fails within this period will be replaced or repaired at Actron's discretion without charge. If you need to return product, please follow the instructions below. This warranty does not apply to damages (intentional or accidental), alterations or improper or unreasonable use.

DISCLAIMER OF WARRANTY

ACTRON DISCLAIMS ALL EXPRESS WARRANTIES EXCEPT THOSE THAT APPEAR ABOVE. FURTHER, ACTRON DISCLAIMS ANY IMPLIED WARRANTY OF MERCHANTABILITY OF THE GOODS OR FITNESS OF THE GOODS FOR ANY PURPOSE. (TO THE EXTENT ALLOWED BY LAW, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR OF FITNESS APPLICABLE TO ANY PRODUCT IS SUBJECT TO ALL THE TERMS AND CONDITIONS OF THIS LIMITED WARRANTY. SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THIS LIMITATION MAY NOT APPLY TO A SPECIFIC BUYER.)

LIMITATION OF REMEDIES

IN NO CASE SHALL ACTRON BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES BASED UPON ANY LEGAL THEORY INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR LOST PROFITS AND/OR INJURY TO PROPERTY. SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THIS LIMITATION OR EXCLUSION MAY NOT APPLY TO A SPECIFIC BUYER. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.

TO USE YOUR WARRANTY

If you need to return the unit, please follow this procedure:

1. Call Actron Tech Support at (800) 253-9880. Our Technical Service representatives are trained to assist you.
2. Proof of purchase is required for all warranty claims. Please retain your sales receipt.
3. In the event that product needs to be returned, you will be given a Return Material Authorization number.
4. If possible, return the product in its original package with cables and accessories.
5. Print the RMA number and your return address on the outside of the package and send to the address provided by your Customer Service representative.
6. You will be responsible for shipping charges in the event that your repair is not covered by warranty.

OUT OF WARRANTY REPAIR

If you need product repair after your warranty has expired, please call Tech Support at (800) 253-9880. You will be advised of the cost of repair and any freight charges.