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FEATURES

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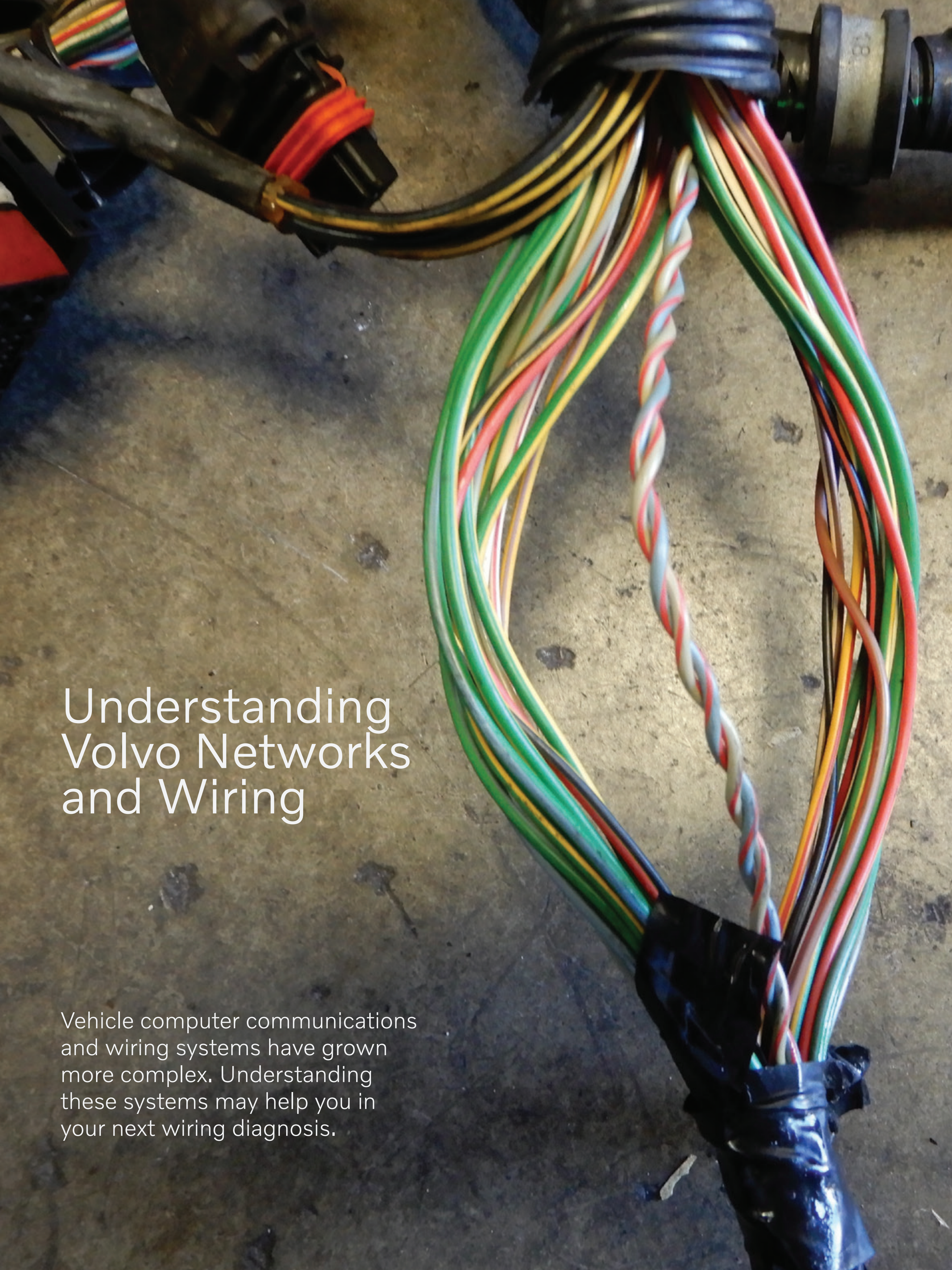


Understanding Volvo Networks and Wiring

Vehicle computer communications and wiring systems have grown more complex. Understanding these systems may help you in your next wiring diagnosis.

Through the years, Volvo vehicles have changed not only in appearance and capabilities but also with the vehicles' computer communication and the wiring system.

Electrical circuits have become more complex with the addition and interconnection of various systems in Volvos and other vehicles.

In the early years, the electrical system was relatively simple with just a few functions. Most systems operated on a 12 volt system and were operated by a switch, by adding or removing 12 volts.

You can imagine how complex the systems with wiring and control modules have become. There was a time when you could have a wiring diagram on one or two pages. Today each system is on one or two pages. The number of fuses, wires, and components have increased due to the variety of electrical functions in the vehicles today.

Control modules, sometimes called computers or even nodes, are used in the modern electrical system. Each function has a different module, such as alarm systems, cruise control, and other electrical functions. In a network, the various units are known as modules. Most functions don't have a separate control module but rather use the control module they are close to. There are slave modules that are of smaller capacity and only operate when told by a master module. Here are some of the control modules and their abbreviations.

- ECM – Engine Control Module
- TCM – Transmission Control Module
- CEM – Central Electronic Module
- BCM – Brake Control Module
- DIM – Drivers Information Module
- DDM – Drivers Door Module
- PDM – Passenger Door Module
- REM – Rear Electronic Module
- UEM – Upper Electronic Module

Electrical system of the past compared to the network of today

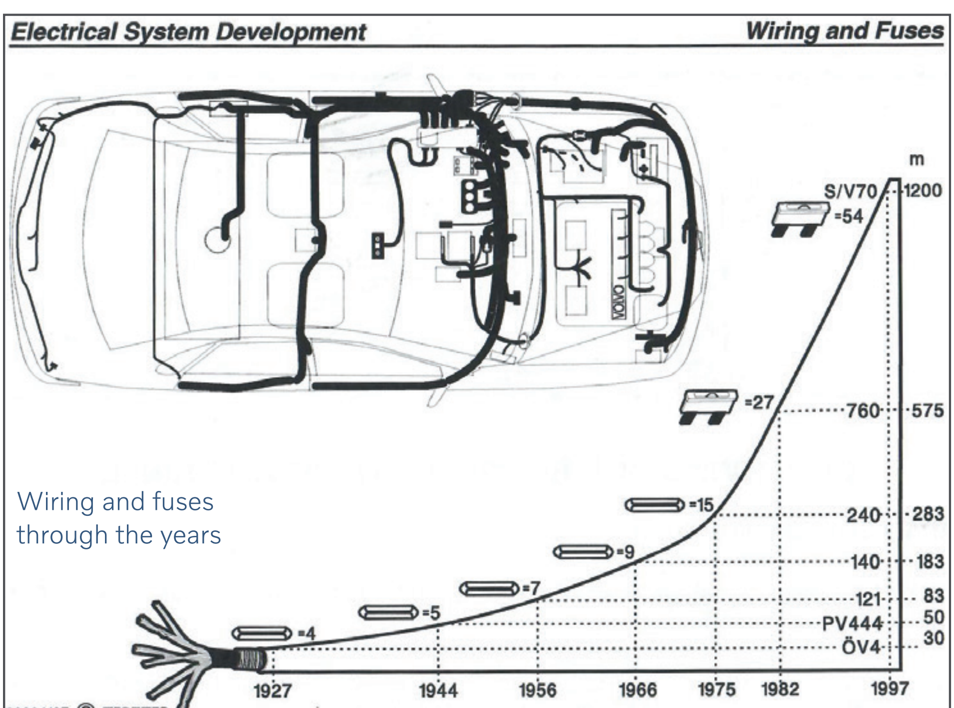
The older systems (pre-1999 models) had a number of circuits for each system. Each system would have relays, switches, and a number of leads. The current in each circuit was controlled by a switch and/or relay.

The network system was all about modules. These modules contained microprocessors and/or relays and fuses.

The Central Electronic Module (CEM) is found inside the cabin area, usually near the kick panel on either side (driver's or passenger's).

The Rear Electronic Module (REM) is in the rear of the vehicle, primarily in the left wheel panel.

These control modules communicate with each other depending on the function applied in the vehicle.



Wiring and fuses through the years

Previous Page: The twisted wires connecting each module

Using a network system can have many advantages, especially when adding or removing functions and programming function in certain control modules, such as when adjusting the interior light to stay on for different lengths of time. Being able to change and add functions can eliminate unnecessary wiring and components.

In the above example the ECM, TCM, and BCM all control their own functions. The other functions work off of these three modules. All are connected by two wires that are twisted together.

The network has two different data speeds: 250 and 125 kbps (kilobits per second). The faster speed is for the modules that require fast updating like the ECM, and the lower speed is for the electric windows. The CEM adapts the data speed between the two sections.

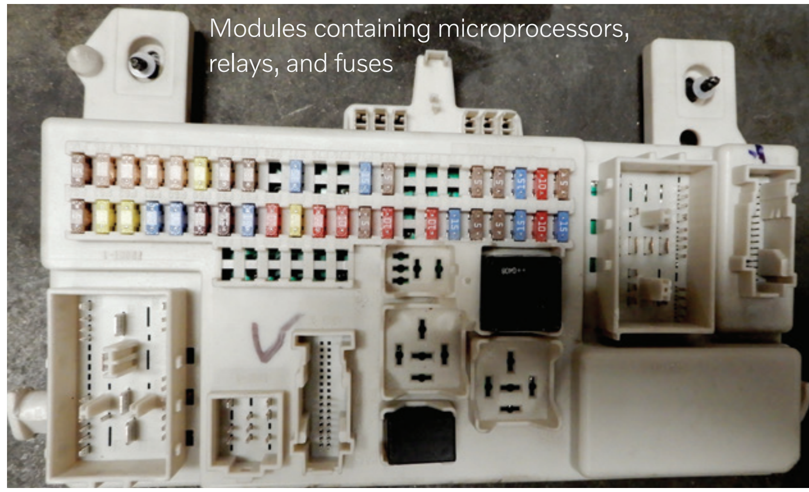
Messages are transmitted from all modules in order of priority. The messages are available to all modules, and the module that needs the information uses it while the other modules ignore it.

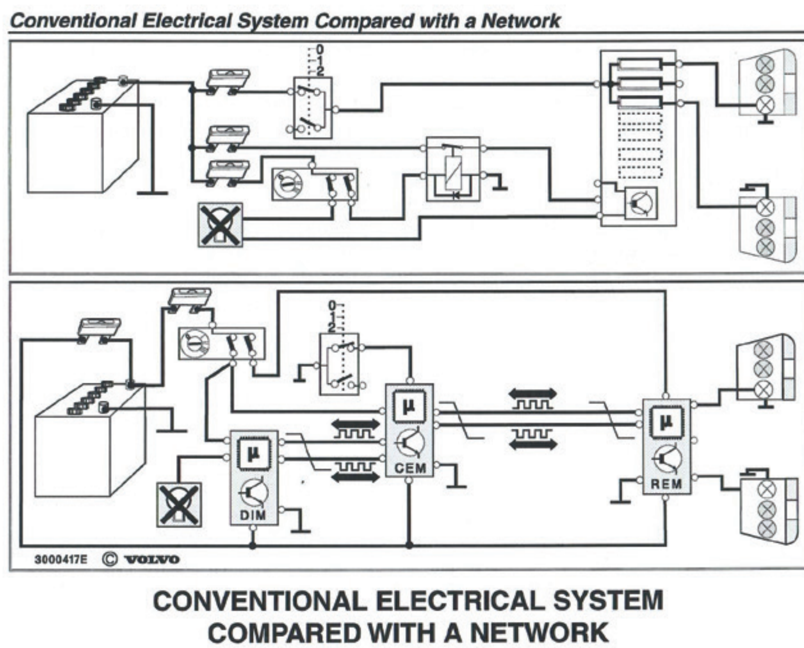
The example on the next page shows the ECM transmitting three messages in order of priority — RPM, ECT, and fuel injection quantity.

The TCM receive RPM and ECT messages and uses them for shifting points and gear selection.

The CEM receives all three messages and adapts the speed before forwarding them.

The DIM receives the messages and calculates the values for the DIM display, tachometer, and temperature gauge.


Modules containing microprocessors, relays, and fuses



The difference shown from the older electrical system to the new network system

Network Changes

In 2005, Volvo changed its network to a new version. The new version had faster processors, higher quality, and lower production costs.

There is higher speed on the high speed network which is now 500 kbps instead of the previous 250.

Diagnostic communication through VIDA is now on the high speed side through the CEM.

The CEM now has two connectors — one from the engine compartment and one from the passenger compartment.

Alarm responsibility now goes through REM module and not through the CEM module.

The SWM and the SAS are now combined into one module.

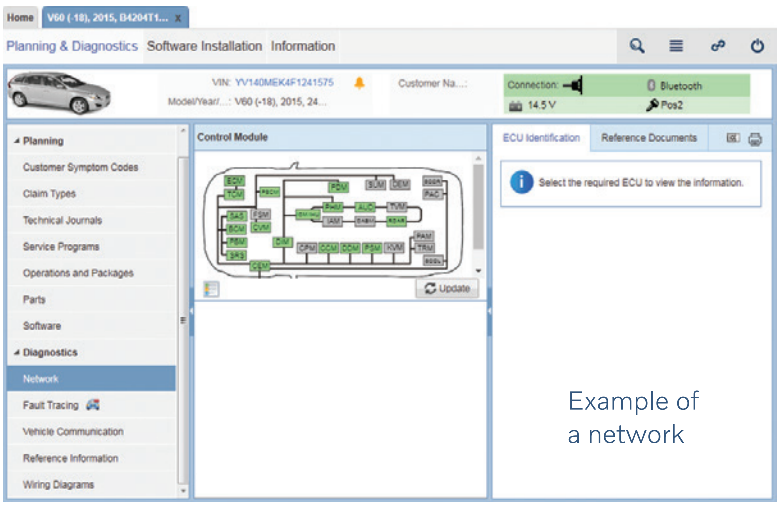
The DDM and PDM now have new hardware, processors, and software.

Controller Area Network (CAN) System

The CAN System is divided into two systems — one is high speed that controls driveline and chassis functions, and one is lower speed for comfort and body functions.

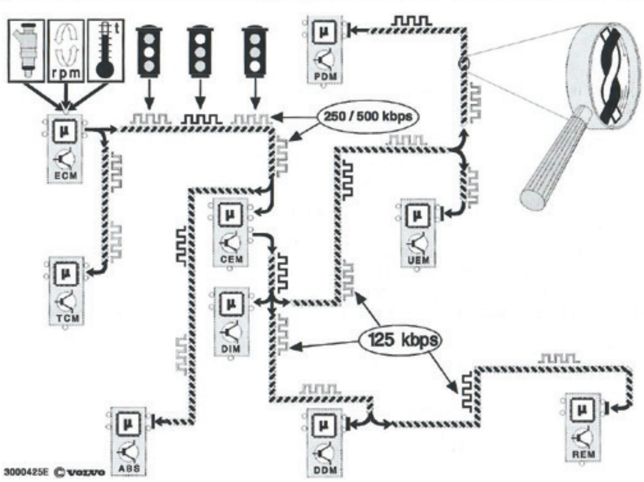
The granddaddy of all modules in the network is the CEM. This master module has two processors. One is connected to both the high and low side, and the other is only for the low side. The CEM is under the dash on the passenger side for P1 S40/V50 models, behind the glove compartment. This module contains the blueprint of the vehicle.

The CEM communicates with other control modules and components via LIN and CAN communications. The CEM is connected to the data link on both high and low sides and can communicate via VIDA.



Example of a network

Control Module - Module - Node



ECM transmitting messages to RPM, ECT, and fuel injection quantity

High side CAN modules include:

- BCM – Brake Control Module
- EPS – Electric Power Steering Control Module
- TCM – Transmission Control Module
- ECM – Engine Control Module
- CEM – Central Control Module
- SWM – Steering Wheel Module
- BSC – Body Sensor Cluster

High side transfer speed is 500 kbps.

Low side CAN modules include:

- AEM – Accessory Electronic Module
- CCM – Climate Control Module
- CEM – Central Electronic Module
- DDM – Drivers Door Module
- PDM – Passenger Door Module
- DIM – Drivers Information Module
- ICM – Infotainment Control Module
- OWS – Occupant Weight Sensor
- PSM – Power Seat Module
- SRS – Supplemental Restraint System
- TRM – Trailer Module

Low side transfer speed is 125 kbps.

Most functions on a P1 platform S40/ V50 are controlled through the CEM.

The standard type of serial communication in the automotive family is the Local Interconnect Network (LIN). Volvo has used serial communication between modules on the CAN network which are able to communicate for diagnosing problems with the vehicle. The control modules on the LIN bus communicate with the other networks via one of the control modules connected to the CAN bus.

Local interconnect means that a number of control modules build a local network using their own data bus. Several LIN buses can be connected to a CAN control module. The CAN control module also controls diagnostic functions and stores all the diagnostic trouble codes. The network P1 platform S40 contains ten LIN buses and can cover up to 22 control modules when activated.

Listed below are the slave modules. These units have a smaller computer capacity and only operate when told to by a master control unit. Each slave is matched up to a master control module.

Slave	Master
Air Quality Sensor	CCM
Wiper Motor Module	CEM
Damper Motor Module	CCM
Left Rear Door Module	DDM
Right Rear Door Module	PDM
Remote Entry Receiver	CEM
Steering Column Lock	CEM
Start Control Unit	CEM
Gas Discharge Lamp	CEM
Gear Selector Module	TCM
Rain Sensor Module	CEM
Siren Control Module	CEM
Seat Heating Module	CCM
Steering Wheel Switch	SWM

The communication speed between these module is approximately 10 kbps.

When using VIDA for diagnostics, it is critical that all control modules in the vehicle are connected and respond to the VIDA connection. When a vehicle is read out, some of the control modules may not respond. In this case you need to correct the issues with the control modules before proceeding with the actual fault tracing. The Network page helps you identify issues on the network in the vehicle. Such an issue could be a connection issue, or it could be that the hardware itself is malfunctioning.

The Control Module panel in VIDA is set up in graph form. The graph reflects the vehicle's network with all control module status at the latest readout. The color of the control modules varies depending on the status.

Green means active and the control module is responsive to communication.

Red means not responding, no communication.

Gray means the control module is not part of this vehicle's configuration.

All related documents for the selected control module are listed in the Reference Information panel. Identification detail parameters are presented under the ECU Identification tab. These details are only accessible when selecting a control module that is responsive to communication in green.

Circuit failures are usually, but not always, due to corrosion at an electrical connection or a loose wire at a connector. Use a corrosion inhibitor to clean connections and replace the connector if wires are broken.

Engine computers and body grounds should be checked first, especially if the vehicle has been in an accident.

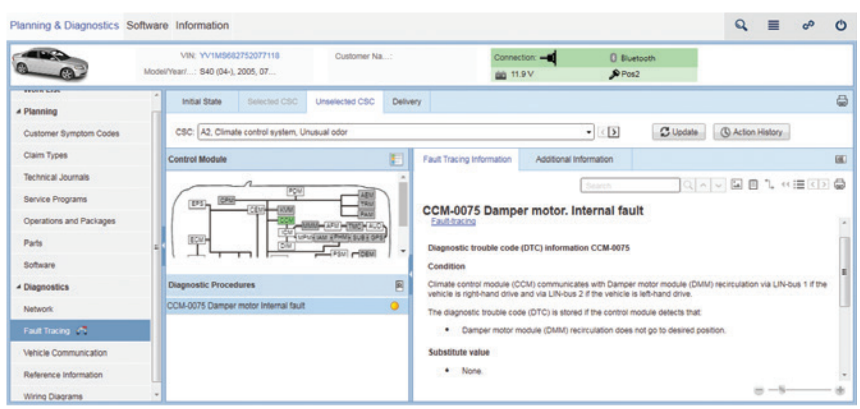
Keep in mind that most electrical systems, when left untouched, perform very reliably. When they do fail the failure will be predictable, such as a bad current or ground connection. A blown fuse is often the problem. Most predictable failures can be solved within a couple of hours. Then, on the other hand, testing a fuel pump relay or a cooling fan switch can create multiple failures with unpredictable outcomes.

A burning wire within a wiring harness can be a problem. Obvious tampering should always create a red flag. Electrical red flags may include newly installed sound systems, electrical accessories, trailer brakes, and auxiliary lighting.

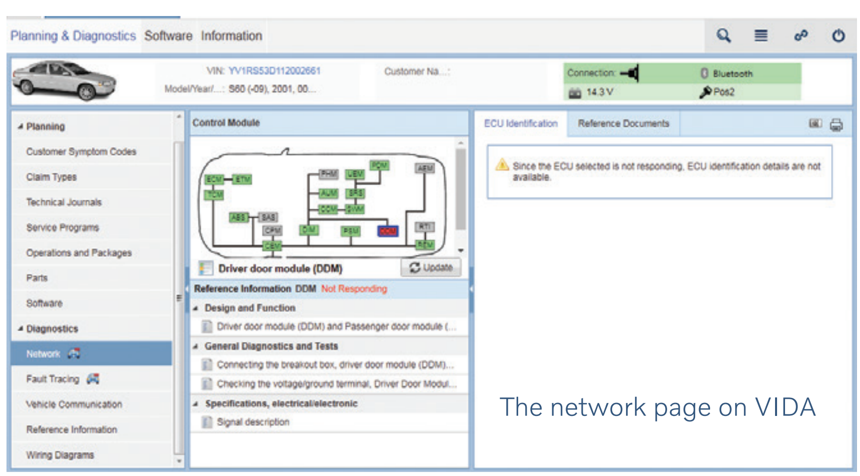
Many circuits serve more than one accessory or function. Recently it was discovered that a burned brake light fuse was caused by a loose courtesy light in the ashtray. Without a good magnetic short detector

Let's get back to wiring diagnostics. Before wasting hours of expensive diagnostic time, test all fuse circuits with a multimeter or approved test light. Remember that fuses can fail without showing signs of an obvious burnout. Since a loose or corroded fuse connector may also cause many intermittent circuit failures, thoroughly inspect and clean the fuse circuits before proceeding with your diagnosis.

When diagnosing intermittent failures, remember that suspect turn signal flashers, fuses, bulbs, and relays can be replaced more cheaply than they can be diagnosed. When diagnosing an intermittent lighting failure, for example, begin by cleaning the bulb sockets and installing new bulbs. This is much faster and easier than spending a bunch of time diagnosing the problem, especially considering that a light bulb costs a couple dollars and is probably old and needs replacing any way.



Network with slave control units displayed on VIDA



The network page on VIDA

the problem would have been difficult to solve, since a relationship between a brake light and an ashtray light isn't immediately logical. In other unlikely cases, it was learned that an instrument cluster fuse also supplies field current to the alternator. The moral of the story is to never rule out the effect of one circuit on another.

In fact, it's not a bad idea to avoid using test lights altogether. When testing fuses, for example, you should use an LED-type test light that you can get from any tool distributor. This will indicate open or grounded fuse circuits and voltage availability. This eliminates guesswork and protects ground-sensitive electronic circuits like those used for air bag sensors.

Use a professional digital multimeter with a min/max voltage feature and alarm to test intermittent failures. The min/max feature will record the highest voltage reached in the circuit and will sound an alarm each time a higher voltage is reached.

For the technician working alone, this feature is a real time saver, especially when performing a wiggle test on an intermittent wiring problem. This is the same way lab scopes are particularly useful in finding loose ground connections. During a wiggle or vibration test, loose ground connections will show up as a voltage spike.

You know how hard it is to find a pinched wire from a bolt or screw hidden under the dash. A good short detector will help you quickly locate concealed short-to-ground circuits. For about 60 dollars, it's a great time saver for you and your customer alike.


Frayed wires at connector


LED-type test light

Tips on Finding Open Circuits

An open circuit is the opposite from one that is shorted because it is similar to a cut wire that is not connected to anything. This can be tricky to find since, in an open circuit, there is no electricity flowing to help you locate the spot with a meter or short finder.

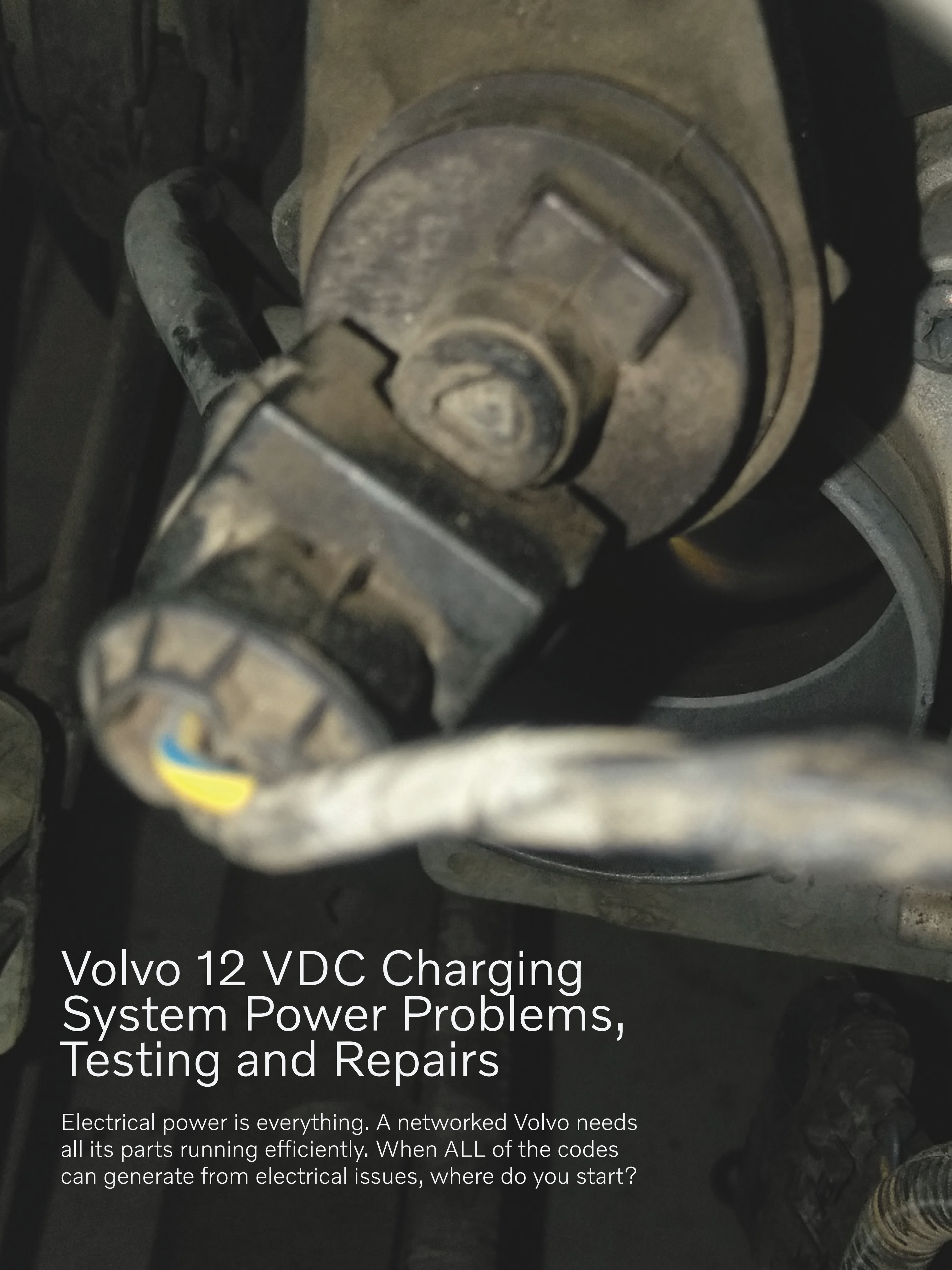
This diagnostic trick uses the car's radio and any device with a large LCD display, like a calculator, to find an open circuit but only if the car's antenna mast is metal. Let's say the brake lights are not working due to an open positive feed from the brake light switch. You have already found the wire to be open somewhere by using an ohmmeter, but you don't know where and would like to shorten the search.

Before you go ripping up the carpet and pulling interior trim out of the vehicle looking for the broken wire, grab your calculator. Start by disconnecting both ends of the line. Unplug the wiring at the light's end and also at the brake light switch, then consult a wiring diagram to make sure any other devices attached to that circuit are disconnected.

Connect an insulated jumper wire between the antenna mast and one end of the offending wire. Tune the car radio to a quiet unused AM channel. Turn on the device you are using with the LCD display, like your calculator, and pass it down the offending wire. You will hear the Radio Frequency (RF) noise generated by the LCD display in the car's radio speakers as you pass the good sections of wire, and this noise will fade out as you pass the break. You can demonstrate this test by tuning any radio to a quiet AM station and passing an LCD display device over the antenna.

To say the least, troubleshooting networking and wiring problems can be very overwhelming, but stick to the basics and try not to overthink them. ●

Digital meter



Volvo 12 VDC Charging System Power Problems, Testing and Repairs

Electrical power is everything. A networked Volvo needs all its parts running efficiently. When ALL of the codes can generate from electrical issues, where do you start?

Today, more than ever, a healthy and fully functioning electrical system is one of the most important parts of the modern car.

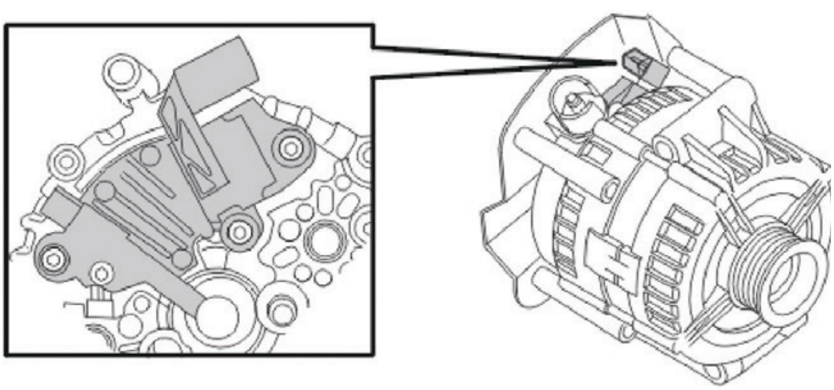
And, of course, it all starts with the power supply system. Today's modern cars have some of the most sophisticated electrical systems on the planet, and some of these systems even outpace some of the latest military systems.

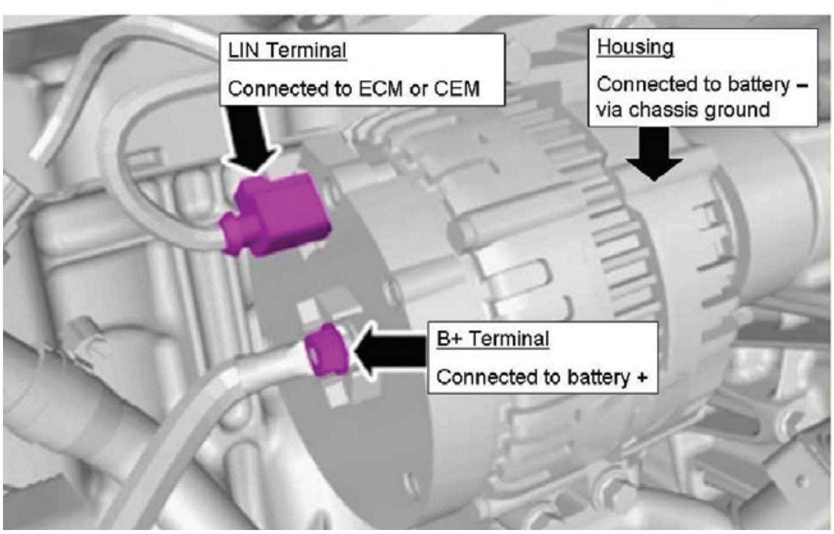
Yes, the advances in automotive technology are coming at us faster than ever, but some things have not changed. The cars still have tires, they don't fly yet and, for the most part, still use a 12 volt DC battery in their starting and charging systems.

The battery voltage has not changed much, but most everything else has.

On a modern Volvo, electrical power is everything. Think of the modern Volvo's electrical system as a small city. Just like a city, a networked Volvo needs all its parts to run efficiently.

How many codes can be generated by electrical issues on a modern vehicle?





B+ connection

The best answer is "ALL OF THEM."

We don't always remember that, but the truth is that every single trouble code could be generated by an electrical fault somewhere in the system.

The moral of the story is that a battery and charging system test should be one of the first steps in any diagnostic jobs that come through your shop.

One of our best diagnostic tools we have today is information, and with the sophistication of these systems, we need all the help we can get.

It all starts with the customer interview; ask the right questions.

A lot of Volvos with charging system problems get towed into our shops with a complaint of a dead battery.

If the battery is not totally dead, and even if it is, hooking up a scan tool like Volvo's VIDA software system will help you determine if there are any stored codes or data that will point you in the right diagnostic direction.

Some cars will not show any symptoms, but we still have to ask the customer the right type of questions — "How long?" and "How often?" are the basic ones. Of course a good service writer can get the right answers out of the customer the first time.

If the car was towed in with a dead or fully drained battery, the car's network may have lost some or all of the stored codes and freeze-frame data. So a thorough customer interview can be critical and help you take the right diagnostic path.

Check those TSBs. Volvo calls them TJs or Technical Journals. There are a lot of them that cover battery drain and charging issues.

One of the more common ones is TJ 26188.1.12 which deals with a Key Off drain caused by the RDAR (satellite radio tuner) module not having the latest software update. This applies to most Volvo models 2008-2012.

The battery can drain voltage with the key off, due to the RDAR module staying awake or trying to locate a satellite radio signal, even when the ignition key is removed and the car has been locked.

The fix for this is to use Volvo's VIDA and DICE tools to download the latest software update to the RDAR module.

Volvo Technical Journal Case Study: 2012 XC60 3.2L 81K MILES

Power System Service Warning on Dash Display and Low Voltage at Battery While Engine was Running

This car came into the shop with a customer complaint of having to jump start the battery several times in the last few days and a warning message being displayed (Power System Service Urgent) intermittently in the past few weeks.

During the initial testing, the technician performed a battery and charging system test with a Midtronics tool. The battery failed the load test (124 CCA out of 600 CCA), and the initial result of the alternator output test was low voltage (12.3 VDC) at idle.

The technician determined that the battery was over six years old and recommended that it be replaced.

We all know that a fully charged 12 VDC battery is needed to accurately test a vehicle's charging system.

The technician then hooked up the car to Volvo's VIDA software system and checked for codes and any stored data. The technician also used VIDA to check and see if any software updates were available for this car. The software was up to date and no relevant software updates were available.

To use VIDA to perform a charging system test, go to Vehicle Communication and select the Central Electric Module (CEM) in the Advanced tab. Click the Manual or Automatic Alternator test function and press Start after the following conditions are met.

Start the engine and allow it to idle for approximately one minute.

- Make sure that no extra electrical consumers are connected. Turn off functions that consume a great deal of power, such as the ventilation fan, heated rear window/door mirrors, heated seats, lighting, radio system, etc.
- Start the automatic test by clicking the Start button.

Values for battery temperature and voltage are read and displayed continually during the test. A number of tests are performed in which various battery temperatures are used from -30 degrees C to +90 degrees C.

Between each battery temperature, there is a delay of approximately five seconds before the voltage is read. This allows the alternator to have time to set the right voltage in relation to the set battery temperature.

The entire test takes approximately one minute. A message is displayed when the test is complete. Compare the values from the readout of battery temperature (T) and voltage (U) with the values in the table.

Battery temperature (T)(°C)	Voltage (U), lower limit (V)	Voltage (U), upper limit (V)
+60 °C, +70 °C, +80 °C, +90 °C	12.80 V	13.60 V
+50 °C	12.95 V	13.75 V
+40 °C	13.27 V	14.07V
+30 °C	13.58 V	14.38 V
+20 °C	13.89 V	14.69 V
-30 °C, -20 °C, -10 °C, 0 °C, +10 °C	14.20 V	15.00 V

If the voltage values generally lie below the lower limit (low voltage), redo the test at an engine speed of 2,500 rpm.

If the voltage is within the tolerances this time, alternator function is OK, but the test indicates that the battery is not fully charged. If voltage still deviates, there is a fault in the charging system.

Note: The readout voltage is read internally from the Central Electronic Module (CEM) and differs slightly from the alternator's actual output voltage due to a voltage drop in the cable harness.

A lot of the modules in the car's network had stored codes that pointed to low supply voltage. This can be normal if the battery is allowed to discharge below 9.5 VDC.

The technician recorded the stored data and codes by using VIDA to create a report and printed it out.

The technician then got permission from the customer to replace the old battery and retested the charging system. The results were improved for the battery but the charging system voltage output was still low.

The technician then performed voltage drop tests on the battery cables and alternator wiring harness, and all the wires passed.

Volvo recommends that an alternator circuit voltage drop test be performed as follows:

Using a good volt/ohmmeter, measure the voltage drop between the alternator body and the negative battery post.

Next, measure the voltage drop between the alternator B+ terminal and positive battery post.

How many times have you used a volt/ohmmeter or test light that was malfunctioning or broken that caused you to take a wrong turn in your diagnosis of a problem?

Everyone's been there. Even the best test tools can fail from time to time, so make it a habit to regularly check your test tools and electrical leads.

A good way to do this is to compare the readings of your meter against other test equipment in your shop.

Test leads don't last forever so when in doubt, throw them out and get new ones. Some of these test leads can be quite expensive, but if they are not reliable any more how much are they costing you?

Make sure to regularly check and maintain your test equipment. It can be very common to get inaccurate readings and make repair decisions based on poor connections and malfunctioning testing tools.

The total charging system voltage drop should be less than 0.07 volts. This is the total of two measurements:

- Voltage drop from the alternator housing to the negative battery post
- Voltage drop from the alternator B+ terminal to the positive battery post

The technician made the decision that the alternator was the culprit and informed the service writer.

While the service writer was preparing the estimate for the customer, he noticed that Volvo had issued a Technical Journal TJ 26897.3.0 that talked about replacing just the voltage regulator unit. Volvo calls it an Alternator Control Unit (ACU) and not the whole alternator assembly on this year and model Volvo.

The service writer went back to the technician and brought the TJ to the technician's attention.

The technician and the service writer decided to tell the customer that there is the possibility that they may only have to replace the voltage regulator assembly, but also told the customer that there is a chance that the whole alternator assembly would be needed and that they would know only after the alternator was removed and disassembled for inspection.

Here is How They Did it...

Alternator Removal 2012 XC60 3.2L SI 6

Of course, as with any electrical repairs, the first step is always to disconnect and isolate the negative battery terminal.

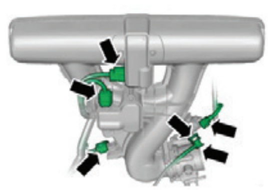
You will be removing the intake manifold plenum assembly, so you should order new intake manifold gaskets from your Volvo parts department.

You will also need a new throttle body gasket too.

The next step will be to remove the plastic engine cover and air cleaner box. After removing the large clamp from the intake pipe, pull the air cleaner top cover off.

Next, use care and remove the vacuum connector at the top of the manifold by depressing the quick release fitting.

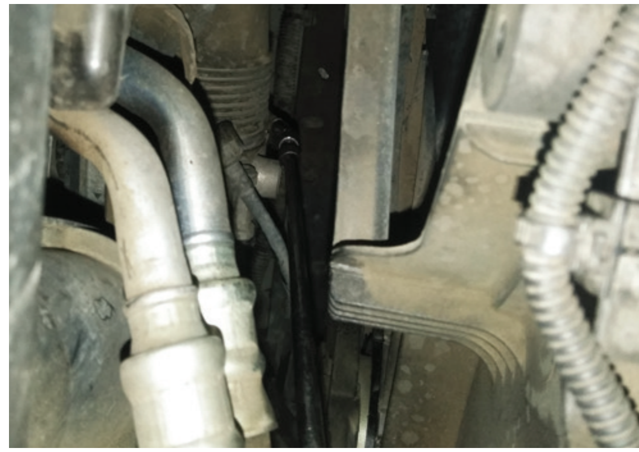
The next step will be to carefully disconnect the electrical connectors that attach to the various sensors on the intake manifold assembly.



Manifold sensor connectors

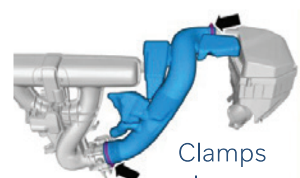
The fuel pressure sensor is not attached to the manifold assembly, but if you don't disconnect it, the connector will get in the way when the manifold is removed.

Next, loosen the two large hose clamps on the top and bottom of the main intake pipe. You can use a swivel



When you work on a lot of Volvos, a ¼ inch drive 7 mm swivel socket and long extension can come in handy when dealing with hard-to-reach factory hose clamps.

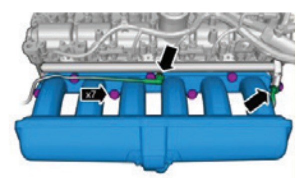
7 mm socket with a long extension to reach the lower clamp easily.



Clamps plenum

Remove the plastic intake tube and set it aside.

After the intake pipe is removed and the sensors that are attached to the intake plenum are disconnected, it's time to remove the manifold bolts.



Seven manifold bolts and lower Plenum clamps

Remove the two bolts that hold the lower part of the plenum first.

Do not try to move the throttle plate manually at any time. This can cause damage to the Electronic Throttle Module.

Next, to make it easy to lift out and remove the intake plenum assembly, you will need to remove the four long bolts that hold on the Electronic Throttle Module (ETM).

Carefully remove the ETM and store it on a clean, dry surface.

Next, remove the seven bolts that hold down the upper part of the intake manifold. You should now

be able to lift out the intake plenum, giving you easy access to the alternator assembly.

Removing the Alternator

Remove the nut holding down the main B+ connector at the back of the alternator.

Next, carefully remove the LIN bus connector on the ACM or voltage regulator.

There are only four bolts that mount the body of the alternator. Start by removing the two on top first.

Don't worry about the alternator falling off the side of the engine when you remove all four mounting bolts, because the lower bolt holes have aligning sleeves that will hold the alternator in place until you pry it away from the block. You will also be fighting the little circular belt when removing it.

Inspecting the ACM Voltage Regulator

Take the alternator over to a work bench and set it up so the back of the alternator is facing up.

Start by removing the three T25 screws that hold down the plastic dust cover.

Next step is to remove the four T25 screws that secure the ACM. These screws are different lengths, so keep track of where they came from.

Now you can remove the ACM and inspect the contact brushes and the alternator slip rings for wear and damage.

When you compare a new ACM and a malfunctioning one, you will usually see that the contact brushes are uneven and well worn. This is also a good opportunity to evaluate the condition of the alternator drive clutch. These clutches can stick or even fail completely. As a result, the gear on the engine side can loosen, so that the alternator no longer spins or charges. Replacement drive clutches have reverse threads and are not usually included with replacement alternators.

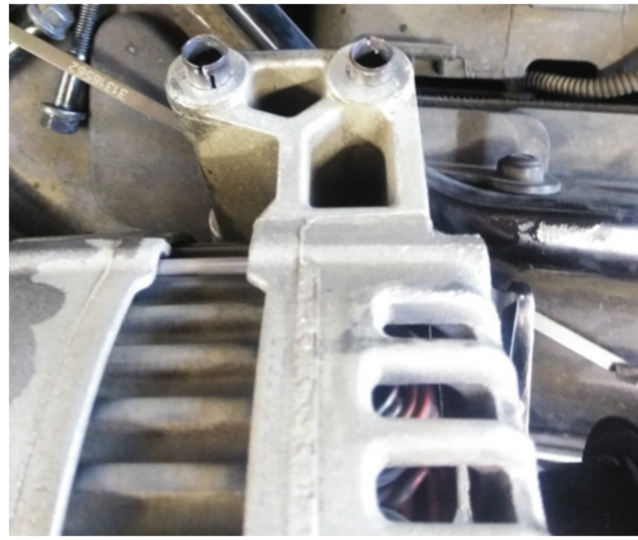
Install a new Volvo ACM unit and reinstall the four T25 screws and torque to 15 Nm.

Next, install the alternator dust cover and three screws.

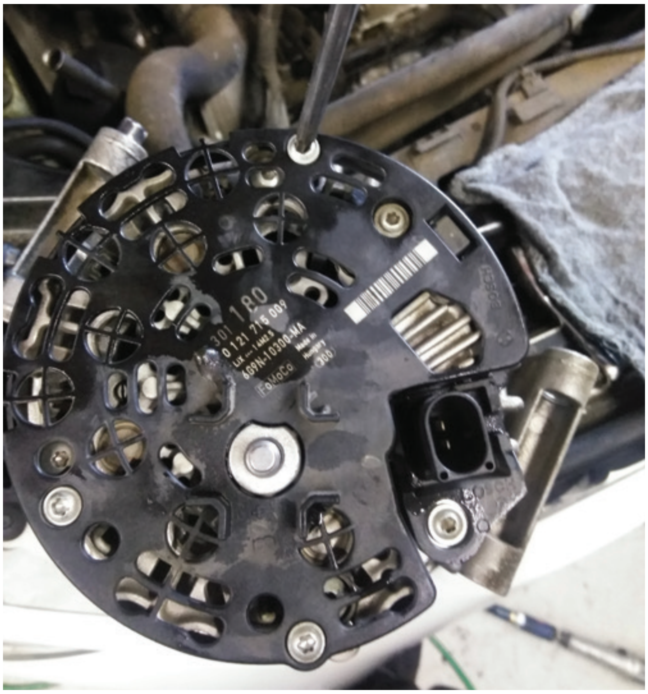
Tighten to 15 Nm.

Install new belt on the alternator input drive gear.

You will have to slide the alternator onto the belt gear on the engine while lining up the lower bolt holes with



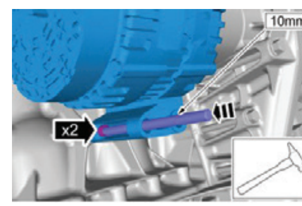
It doesn't hurt to replace the little drive belt every time it is removed during repairs. The OE recommended replacement interval is every 15 years or 150,000 miles.



When you inspect the alternator slip rings, a little wear is OK, but if they look like this, replace the whole alternator.

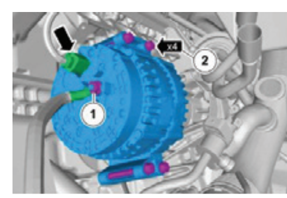
the alignment sleeves. This can be challenging.

You can use a 10 mm dowel to help line up the alternator body.



Locating dowel

Be patient and take your time in this step. Make sure to start all four alternator mounting bolts before you tighten them to avoid cross threading them.



Alternate bolt torque

Tighten #2 to 24 Nm.

Tighten #1 to 15 Nm.

Install and tighten the nut for the B+ cable and then plug in the harness connector to the regulator ACM.

You can now reassemble the intake manifold and air cleaner assembly. Make sure to use new gaskets and torque the seven manifold bolts to 15 Nm.

Make sure that the car's battery is fully charged before you hook up the negative battery clamp.

Retest the charging system output to check your work.

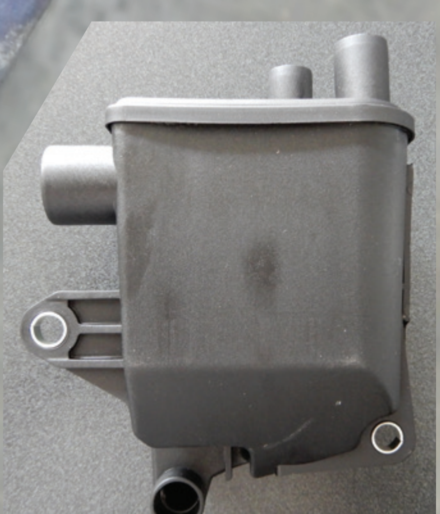
Reset the clock if needed and test drive the car.

In some cases, you may need to use VIDA to reinitialize the power window positions. ●

Replacing the Volvo Oil Trap and Oil Pan Sump

Understanding What it Does and How to Replace it

This oil trap system allows the engine to breathe properly during operation. Here's what it does and how to replace it.



Different oil trap units and part numbers 1271988, 31338685

Volvo has been using an oil trap for Positive Crankcase Ventilation (PCV) on Volvos for many years. The oil trap sits under the intake manifold and is connected to the block via hoses and clamps. A few exceptions are when the oil trap is actually built into the oil filter housing on Volvo C30, C70 2006-up, S40 2004.5 - up, and V50 models. This oil trap system allows the engine to breathe properly during operation.

A PCV breather system, or oil trap, is designed to reduce the volume of hazardous fumes from a vehicle. As the engine runs, combustion gases escape from the combustion chamber, finding their way into the crankcase. This unused combustion gas, also referred to as blow-by, can be a huge cause of smog. A PCV system prevents pollutants from escaping into the environment.

Why does a Volvo engine need to breathe? Well, not to get too technical, but similar to fire, the combustion engine needs three things: oxygen, fuel, and spark. It gets oxygen by drawing air into the combustion chamber intake manifold. Once the air gets inside the engine most of it exits via the exhaust, but some of it gets trapped into the crankcase and needs to get out. The problem is, it is no longer clean air because it has picked up oil residue and gunk along the way. So it has to be cleaned or burned before leaving via the exhaust.

The oil trap is part number 1271988. This genuine Volvo PCV valve oil trap is an essential component of your Volvo's power train. It allows internal pressure built up in the engine to be released safely instead of popping seals or gaskets that could be costly and timely to replace.

In naturally aspirated engines, the oil trap is connected from the crankcase to the intake manifold, and on turbo models, it is connected from the crankcase to the turbo as well as to the intake.

What causes the engine oil to thicken and leave behind deposits or sludge in an engine?

- Wrong oil grade, quality, and/or viscosity
- Too many miles between oil changes
- Vehicle frequently driven short distances with many cold starts
- Excessive idling
- Fuels of low quality or with a high alcohol content
- Additives added to oil or fuel
- High ambient temperature
- High air humidity

What are some of the symptoms you can expect if the breather system is clogged?

- **Illuminated oil pressure lamp.** This is due to a clogged oil suction strainer to the oil pump or oil filter.
- **Illuminated check engine lamp.** This is due to incorrect engine fuel trim level parameters.
- **Noise like a whistling.** Noise due to high pressure in the crankcase. This noise will stop if the oil filler cap is removed.
- **Poor drivability.** This is from a clogged crankcase ventilation system and can reduce engine performance.
- **Uneven/oscillating idling.** Caused by clogged crankcase ventilation.
- **Oil leak.** From engine seals due to restricted crankcase ventilation.
- **Noise Knocking.** Low oil pressure can cause premature bearing wear and lead to internal engine component failure.
- **High oil consumption and noise from the turbo.** Damaged bearings or seals in the turbo can cause these symptoms. Chances are the customer will know they have a problem at this point as the vehicle will either have little to no boost, or blue smoke will be pouring out of the tailpipe, or both, potentially.

Checking for a clogged oil trap and possible clogged oil pan sump

The first step is to inspect the oil filter to see if it is abnormally dirty. An abnormally dirty filter is easily recognized by its thick black deposits.

If the engine has a problem with carbon deposits, the passageways in the engine block and oil trap may be completely or partially clogged. Remove and check the oil trap, hoses, and their passageways in the engine block. There shouldn't be any major collections of carbon deposits in the hoses or in the passageways in the block.

Use Volvo special tool number 9997514 to check for positive pressure through the dipstick tube.

Drain the engine oil. Remove the oil pan and check the oil pan and crankcase for deposits. Normally there should not be any deposits. Also, check the oil suction strainer on the oil suction line for contaminants and deposits.

You probably want to know how to replace the oil trap and what parts are required. It varies slightly, but most often you need an oil trap, intake gasket, oil trap to valve cover hose, oil trap to block seal, and any hose that, upon inspection, looks cracked, brittle, or has holes already caused by hot burning oil and air trying to escape.

In most cases you will need to remove the intake manifold just to reach the oil trap, and then the actual removal of the oil trap and parts is very easy. The job only requires a ratchet and socket to remove the four or five screws and a screwdriver for the hose clamps.

The oil trap and hoses should be replaced at 100,000 miles. Here are some reasons why to change the oil trap.

1. **It's a filter.** Filters only last so long and therefore should be replaced on regular intervals. The factory recommended interval for cleaning the PCV system is 120,000 miles, and can be replaced as necessary.
2. **It's a relatively inexpensive repair.** To replace the oil trap is a pretty straightforward job for any technician, especially when you consider how much repairs will cost if you don't replace it.
3. **Major engine damage.** A plugged up oil trap can do major damage to the engine, so even if you catch it soon the damage may be done which can drastically reduce the life of the engine.
4. **Costly repairs if not replaced.** If the engine can't breathe it starts to look for the weakest place to release built up air pressure. That means a hose could get a crack in it or even blow off. It can also compromise a seal like rear main and cam seals.
5. **Engine runs rough.** If your Volvo engine idles rough and appears to have a misfire it could be a clogged oil trap or even a clogged oil pan. Suppose a customer comes in looking for a hose but doesn't know which one. How does he know it needs a hose? He says it blew off. Well, there must be a reason for that. So he makes an appointment, brings it in, and the oil trap is plugged. After the system is cleaned and the oil trap is replaced with new Volvo parts, the vehicle runs better and has better fuel economy.
6. **Bad fuel economy.** As mentioned earlier, a clogged oil trap can cause poor gas mileage because the engine has to work much harder due to the pressure buildup inside the crankcase. The funny thing is, many customers report back saying that gas mileage has been restored and is even better than they remember once the oil trap has been replaced.
7. **Oil leaks.** A clogged oil trap will build up air pressure, and the pressure will look for the path of least resistance which is often the cam seals or crank seals, and both are very costly repairs. Once the oil trap is replaced, the pressure in the block will come down and possibly some of the oil leaks might go away.

Clogged oil trap

Volvo tool to check pressure in crankcase

8. **Turbo damaged.** When pressure builds up in the crankcase, it starts throwing junk (like clogs of old oil residue and debris) into the oil pan, which the engine picks up and distributes throughout the oil system. The turbo requires oil to stay cool, but it has small tubes that feed oil to it. These are the most common places for debris and oil clogs to land which clogs up the pipes and restricts oil to the turbo. Once oil is restricted, the turbo gets hot and burns up. Most turbos are very expensive, not including labor and other parts.
9. **Oil dipstick problems.** One of the common signs that notify you the oil trap may need to be replaced is the oil dipstick keeps popping up causing oil leaks. This doesn't happen every time,

VOLVO

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but if it does, it means the engine is blowing the dipstick up out of the tube so it can breathe.

10. **Engine Failure.** Like mentioned before, a clogged oil trap can cause a lot of problems, from oil leaks to damaged parts, etc. But you need to know that if a Volvo is driven long enough with a clogged oil trap it can cause engine failure. No doubt it will reduce the life of the engine, and it's very common that other parts are destroyed in the process. If the engine struggles long enough against internal air pressure, it will cause seize and cause bearing failure.

Replacing the oil trap and removing oil pan to clean and reseal sump in a 2007 XC70

The chart below shows the parts and part numbers to do this job correctly.

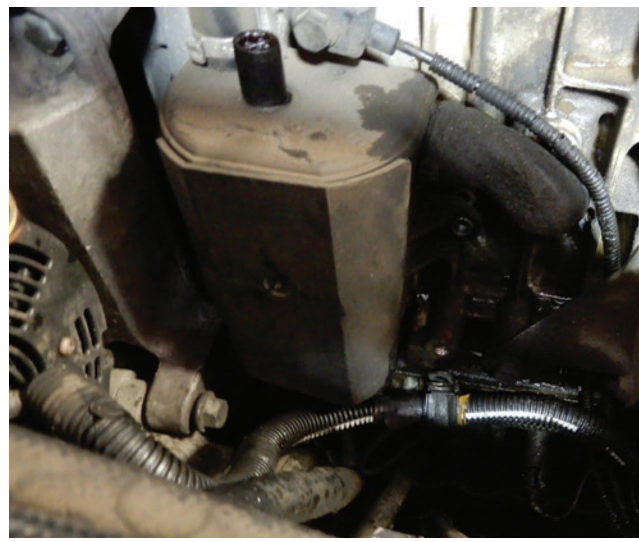
Drain coolant from the vehicle via the drain plug at the bottom of the radiator. Disconnect the battery in the trunk area. Remove two bolts that hold the injector rail. Remove the air filter assembly and move it out of the way. Disconnect the main fuel line into the injector rail. Disconnect the electrical connectors at each injector. Pull up on the injector rail to remove it and set it aside.

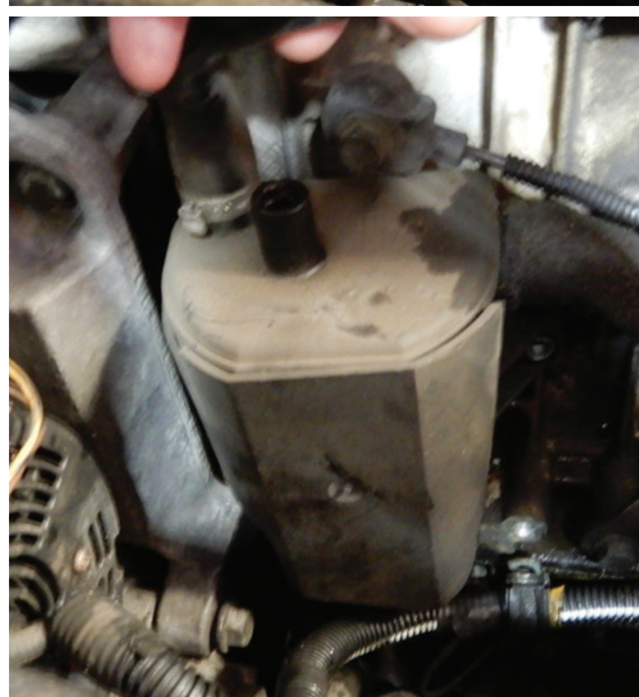
Disconnect the intake manifold and all its hoses and connected parts. The banjo fitting on the bottom of the intake can be challenging. To make this a little less painful it helps to remove the power steering pump.

Removing the front fan assembly can definitely give you more room to complete the job. Just remove all electrical connectors and set them aside.

Part	Part Number
Oil trap	8692211
Breather hose from oil trap to top of valve cover	8692217
Oil trap breather hose from back of oil trap to cylinder block	8653339
Breather hose at side of box to block (this could be two different ones depending on the VIN)	30677388 or 1271653
The hose with the pipe that goes from intake to oil trap and also to turbo "medusa" part number	30731068
Intake manifold gasket	32213805
Oil pickup tube o-ring	30637867
Oil sump o-rings	8642560 8642559
Intake banjo bolt	31325709

5 cylinder Volvo engine





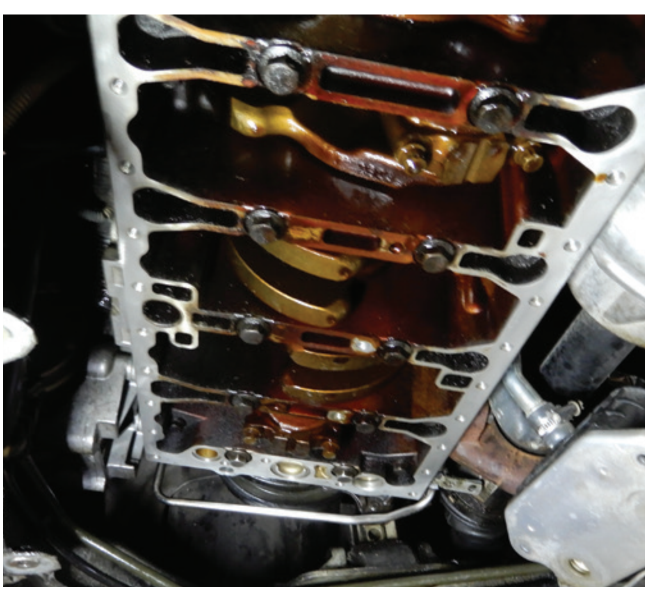
Volvo engine with intake removed and oil trap easy to see

Disconnect the throttle housing module hard plastic hose that goes to the intercooler. Remove the intake manifold from the vehicle. The oil trap will now be visible and easy to remove.

Once the oil trap is removed, clean out all of the passages at the engine. If the bottom passages are plugged and the oil trap looks really plugged, you will have to remove the oil pan and clean it out. This usually occurs from not changing the oil regularly.

So now let's say the bottom passage to the oil pan is plugged and we need to clean it out. We will need to remove the oil pan. Lift the vehicle into the air on a hoist and drain the oil. After the oil is drained, you will need to remove all bolts around the oil pan that secure it to the block. Also remove the oil cooler on the side of the oil pan.

Engine mount with bolt in bottom mount threaded hole to lift engine up



Oil pan removed and block surface cleaned

Remove the bolts from the mount near the front of the engine. Lift the engine up just enough to insert the top mount bolt into the bottom engine mount threaded hole.

Remove the oil pan. Set the oil pan in your parts washer and clean it thoroughly. If the passages in the oil pan are too restricted and you can't get the passages opened, you will need to install a new oil pan. Make sure the passages are very clean. Now clean out the block passages up to the oil trap. Use a small brush that will reach all the way to the oil trap.

Remove the pickup tube and clean out the metal mesh. This can become very dirty and plugged up, and if this tube is plugged, oil pressure will be bad and could cause series engine problems.

Now that everything is clean, use chemical gasket and roller it onto the oil pan surface lightly, using Volvo part number 1161059. Make sure to use a new o-ring for the pickup and secure it. Install new o-rings for the sump and secure it so the oil pan can be lifted into place. Hold it up in place and insert all of the bolts around the oil pan surface and torque down. Put a dab of silicone onto the threads of the three longer front oil pan bolts so no oil will leak through. Install a new Volvo oil filter and secure.

Install the oil cooler on the side of the oil pan and secure. Remove the front engine mount bolt, lower the engine down and install the two bolts and tighten.

Lower the vehicle down and install the hoses and oil trap. Make sure to clean the banjo fitting and all hoses or replace them if needed.

Install the two bolts that will hold the intake gasket in place. Set the intake manifold into place with all its bolts and tighten. Secure the banjo fitting underneath the intake. It's a good idea to replace the banjo bolt at this time since they can break and be sucked into the engine, causing cylinder and turbo damage.

Connect the throttle housing hard plastic pipe and secure it with a hose clamp. Connect all vacuum hoses, and run the hose from the oil trap to the valve cover through the intake manifold. Secure both ends with clamps. It's a good idea to use clamps on all hoses at the oil trap and on the hoses. Do not use plastic ties for clamps.

Install the power steering pump and install the belt. Install the injector rail. Attach all electrical connectors and connect the fuel line to the rail. Install the auxiliary fan assembly, including all electrical connectors. Tie wrap the wires to look factory. Set the air cleaner assembly into place and secure it, tightening the hose at the air mass meter.

Add coolant to the system until full. Fill the engine with engine oil to specs. Connect the battery and start the vehicle. Let it idle until it warms up and top off the coolant. Test drive and check all fluids again just to be sure everything is full and there are no leaks.

The oil pan sump and oil trap go hand in hand, so it's very important that both are clean and all o-rings are in good shape. The proper pressure inside an engine makes for a well-oiled machine. ●


Oil pickup from engine


Banjo fitting at bottom of intake manifold

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VOLVO


How
Volvo
Turbo
Systems
Work

The turbocharger boost pressure in Volvos is controlled by the Boost Pressure Control (BPC) valve whose pressure regulator is affected by the pressure from the turbocharger.

The Engine Control Module (ECM) determines current throttle angle and boost pressure to achieve the calculated engine torque output.

The Engine Control Module (ECM) affects the controlling pressure using the turbocharger control valve.

When the pressure increases, the Boost Pressure Control (BPC) valve pressure regulator is affected. When boost pressure has increased to the maximum permissible value, the boost pressure control valve opens and part of the exhaust gases bypass the turbocharger's turbine which limits the boost pressure. Turbocharger control takes place constantly by measuring the current boost pressure and comparing it to the requested boost pressure.

Controlling turbocharger boost pressure

When the engine control module determines that a higher boost pressure is permissible, the turbocharger control valve opens further and a proportion of the pressure acting on the boost pressure control valve pressure servo is allowed through to the turbocharger inlet.

In this way the control pressure is reduced, the boost pressure control valve opens later, and turbocharger pressure can increase. The engine control module affects the turbocharger control valve by grounding one of the terminals with a fixed frequency, where the signal's duty cycle determines how much the valve should open and therefore how much the boost pressure can increase.

Boost pressure reduction

The charge pressure is reduced when driving in first gear and reverse with engine speed rpm below 3,000 rpm to reduce the risk of wheel spin. If the engine has an automatic transmission, the transmission receives information from the TCM about when reduced charge pressure is required, for example, when shifting.

Opposite Page: If you have a car that has low turbo boost, make sure to test and visually check the turbo's bypass valve (sometimes called a blow off valve). The vacuum diaphragm inside can crack and leak, causing some of the intake pressure to go around the turbo fan.

If the car has a manual transmission, the ECM determines which gear is selected based on the transmission and final drive gear ratios, engine speed (rpm), and vehicle speed.

On cars with automatic transmission there is also boost pressure reduction in the winter mode.

Boost pressure can also be reduced to protect the engine from damage. If the knock sensors detect that the engine is knocking above a given threshold value, and if ignition has been retarded and the air/fuel ratio has been enriched, the ECM will reduce the boost pressure until knock ceases.

A reduction in boost pressure also takes place if there is a risk of the engine overheating. If the Engine Coolant Temp (ECT) sensor indicates that the temperature has exceeded 118 degrees C (244 degrees F), the ECM lowers the boost pressure to reduce heat generation.

Automatic high altitude compensation

Because the ECM determines boost pressure using the signal from the intake air pressure sensor, there is automatic boost pressure control compensation when driving at altitude and in different temperatures. The engine power is not, therefore, noticeably affected by air density or temperature.

When altitude exceeds around 6,000 feet above sea level, the ECM cannot compensate boost pressure any further because the air is too thin.

Boost pressure monitoring

The ECM constantly monitors boost pressure using the Mass Air Flow (MAF) sensor and the intake air pressure sensor.

If boost pressure exceeds permitted levels, the ECM closes the turbocharger control valve so that the engine torque can only be controlled through limiting the throttle opening. A Diagnostic Trouble Code (DTC) is stored at the same time.

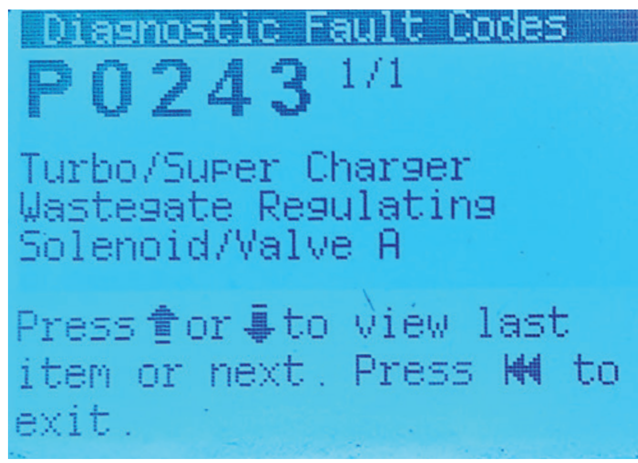
If the calculations display too low boost pressure, a diagnostic trouble code is stored.

If a fault occurs in a component that affects boost pressure calculation, the ECM will always limit throttle opening.

If there is a fault in any of the sensors, the boost pressure control goes over in an open loop. This means that it is controlled by fixed duty cycle which is a direct function of accelerator pedal position sensor and engine speed (rpm).

You can check for wear in the turbine fan bearing by trying to wiggle the shaft; a little play is normal, a lot is cause for concern.

One of the most common turbo control issues you will see on older Volvos is caused by small leaks in rotted vacuum control hoses.



When checking for stored codes and data on a Volvo, the best tool to use is Volvo's VIDA software system because most generic scan tools will only give you part of the story.

CASE STUDY
2000 VOLVO C70 2.4 L TURBO
WITH LOW TURBO BOOST COMPLAINT

This car is an early model turbo system, but most of the Volvo turbo control systems have remained similar up until the last few years.

The customer that brought this car in said that the car had been losing power when the car was accelerating onto the freeway, and the Check Engine light had just come on in the last week.

The customer stated that the car seemed to perform normally on city streets.

The technician took the car on a test drive to confirm the customer's complaint.

As the technician was accelerating on city streets, the car seemed to perform normally, but once the technician was able to go onto the freeway and accelerate past 30 mph, the power problem became clear.

The car felt like it was falling on its face.
The tech experienced a loss of power around 2,500-3,000 rpm, and he had to hold the pedal down to get up to freeway speeds.

It almost felt like a transmission slipping symptom.

The tech drove the car back to the shop to start the diagnosis.

He started with a visual inspection of the engine compartment to check for any obvious issues like loose or broken hoses or wiring; on first look there were no smoking guns.

The technician hooked up a laptop that had Volvo's VIDA software program and read the stored data and trouble codes.

The ECM had stored the codes ECM 6806 and ECM 6800.

The setting criteria for ECM 6806 is as follows:

Condition

If engine speed (rpm) is above 3,500 rpm and the engine is operating at a high load, the control signal to

If you have to repair a wire connection in a Volvo wire harness, your Volvo parts department can provide new replacement pigtails and repair kits that will fit right the first time.

the turbocharger control valve is at maximum and the boost pressure (from the boost pressure sensor) is lower than a designated value [approximately 20 kPa (2.9 psi) under normal boost pressure — signal too low].

If the air mass (from mass air flow sensor) is higher than a desired value (signal too high), it is interpreted as a fault and DTC ECM-6806 is stored.

Substitute value

Reduced boost pressure

Possible source

Signal too high:

- Air leakage after turbocharger

Signal too low:

- Hoses between the turbocharger and the turbocharger control valve, or between the turbocharger control valve and the pressure servo, are loose or are blocked/damaged
- Faulty turbocharger control valve
- Faulty boost pressure control valve pressure servo
- Sticking boost pressure control valve

The ECM 6800 code was for a signal missing, permanent fault, and the data pointed to an open circuit or a defective turbo control valve.

Volvo's test procedure for this code is as follows:

Check turbocharger control valve connector for intermittent contact resistance or oxidation. Check signal cable between engine control module #A38 and turbocharger control valve #2 for an intermittent open circuit according to Checking Wiring and Terminals.

Intermittent faults

Check power supply turbocharger control valve between turbocharger control valve #1 and system relay for an intermittent open circuit according to Checking Wiring and Terminals. Intermittent faults.

Remedy as necessary.

After an initial visual inspection of the engine compartment, the tech could not find any obvious signs of damage to the turbo control system or hoses.

Since the code ECM 6806 could be caused by an air leak or unmetered air in the intake system, the tech decided to perform a smoke test to see if there were any leaks in the system.

The most effective way to try to isolate the intake system during a smoke machine test is to disconnect and seal the intake tube right behind the air mass sensor. This will ensure that you can build enough pressure in the intake system to find even the smallest air leaks.

After running the tests for both the ECM 6800 and ECM 6806, the problem turned out to be a loose wire connector in the turbo control valve harness connector. One side was pulling out of the connector.

Below is one of the few turbo related TSBs or TJs that Volvo has issued: TJ22295. ●

Temperature-Manifold Air Pressure (T-MAP) sensor, poor performance

Ref No: US22295.2.2 en-US
Partner: 3 US 7510
Volvo Cars North America

Func Group: 2380
Func Desc: control system
Status: Released

Status Date: 12-21-2011
Issue Date: 12-19-2011
Reference: VIDA, VSTG

Note: If using a printed copy of this Retailer Technical Journal, first check for the latest online version.

Note: THIS DOCUMENT SUPERSEDES THE PREVIOUS TECHNICAL JOURNAL 22295 DATED 07-13-2010. DTCs ECM P009A00 and P009600 have been added to the DTC list. PLEASE UPDATE YOUR FILES.

Description:

A faulty T-MAP sensor, located at the outlet of the intercooler on turbo engines, can cause poor performance and the DTCs listed in this TJ header.

Product Modificaiton:

A new T-MAP sensor was introduced into production after the final chassis numbers in this TJ header. The spare part stock has been scrapped and only the new type is available.

Service:

If the DTCs in this TJ header are set and fault tracing leads to a faulty T-MAP sensor, replace the T-MAP sensor. Look at sticker on T-MAP for P/N. The old P/N 30622083 is replaced by P/N 31303975.

Note: Always refer to the chassis ranges in the VIDA Parts Catalog for the correct T-MAP sensor. Earlier vehicles call for a different part number UNLESS the symptoms and DTCs in this TJ are exhibited. On these earlier vehicles, use P/N 31303975 only if the symptoms and DTCs in this TJ are exhibited.

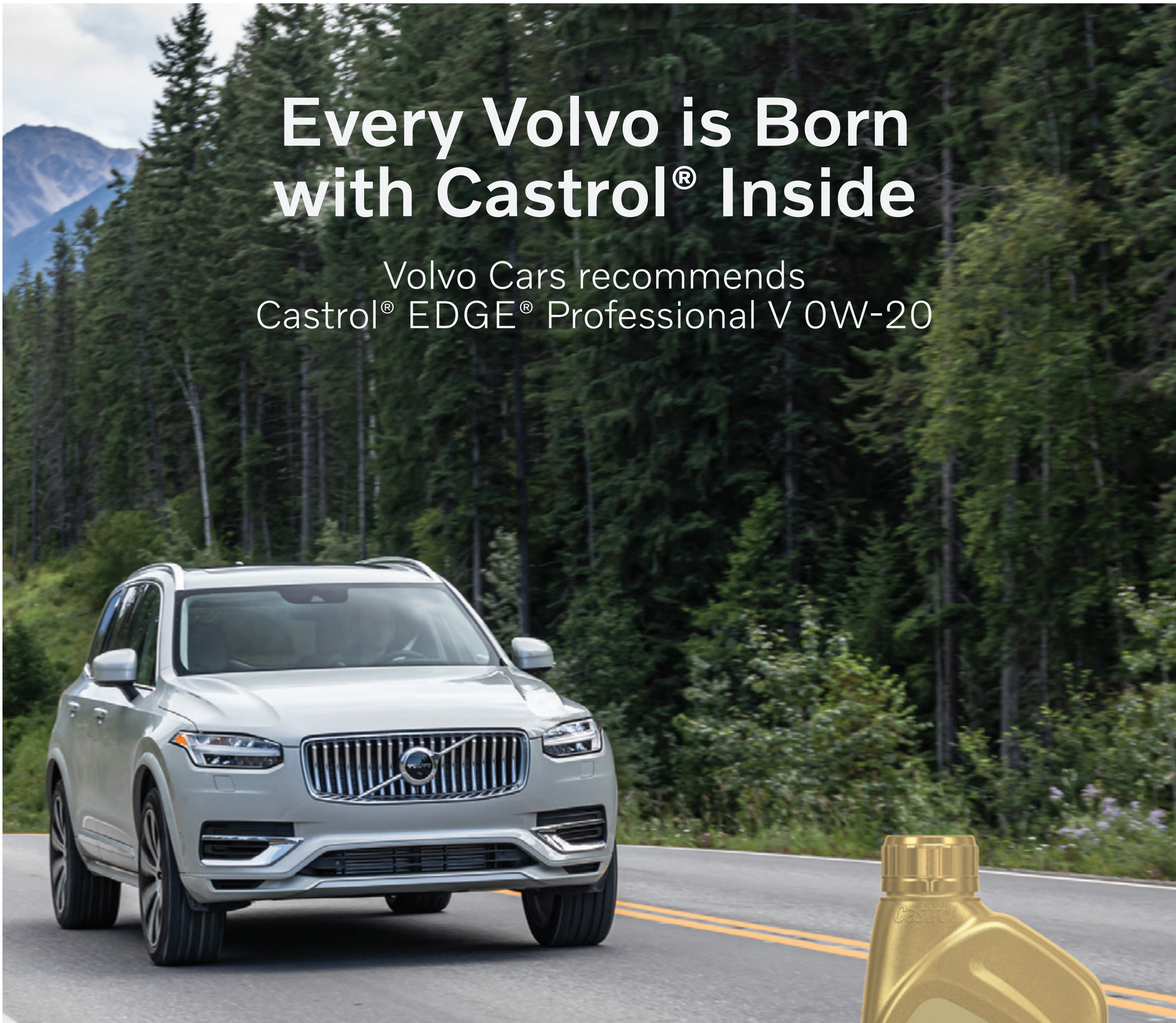
Volvo Standard Times Guide (VSTG) Info:

Operation number 28424 - Temperature/ Pressure sensor intake air replace (See VSTG). ●

Control Module	Code	Fault Type
ECM	P009A00	Permanent
ECM	P009600	Permanent
ECM	P023400	Permanent
ECM	P023500	Permanent
ECM	P023600	Permanent
ECM	P023700	Permanent
ECM	P023800	Permanent
ECM	125C	Permanent
ECM	125D	Permanent
ECM	1260	Permanent
ECM	126B	Permanent
ECM	126C	Permanent
ECM	126D	Permanent
ECM	1600	Permanent
ECM	P004600	Permanent
ECM	P004700	Permanent
ECM	P004800	Permanent
ECM	P004900	Permanent
ECM	P004A00	Permanent
ECM	P004B00	Permanent
ECM	P004C00	Permanent
ECM	POO4D00	Permanent

Code	Description
AJ	Driving/Poor performance/lacks power
CR	Gauges/Ambient temperature gauge not accurate/does not work
DL	Warning lights and chimes/Malfunction Indicator Light ("Check engine" light) indication/no indication

Type	Eng	Eng Desc	Sales	Body	Gear	Steer	Model Year	Plant	Chassis range	Struc Week Range
124							2007-2010	21	0000850-0123254	200620-200948
135							2008-2010	21	0000395-0142445	200720-200948
136							2008-2010	21	0000400-0082543	200720-200948
156							2010-2010	22	0000212-0087501	200905-200948
533							2007-2010	22	0000261-0191941	200637-200948
542							2006-2010	38	0000590-0097415	200549-200948
544							2004-2010	22	0000295-0500922	200339-200948
545							2005-2010	22	0000133-0549751	200420-200948



Castrol EDGE Professional V 0W-20 is exclusively engineered in collaboration with Volvo Cars for use in Volvo Drive-E engines. Every litre is certified CO_2 neutral according to the highest global standard.

Engineered with patented **FLUID TITANIUM**, Castrol EDGE Professional transforms to be stronger under pressure and reduces metal-to-metal contact to unlock the true performance of the engine.

Castrol EDGE Professional V 0W-20 is exclusively available for Volvo Cars authorized dealerships.

Castrol EDGE PROFESSIONAL

A Look Inside Volvo Turbo Technology

A Little History

The exhaust-driven turbocharger was invented back in 1905 by Swiss engineer Dr. Alfred Büchi in Germany. And the first mass produced turbocharged car engine was used in the Oldsmobile turbo Jetfire in 1962. This turbocharger was fitted to a 215 cubic inch V-8 engine and was a small-diameter Garrett T5 model with an integrated wastegate.

Turbochargers were originally called turbo superchargers when all forced induction devices were classified as superchargers.

This could be confusing. Of course today, the term "supercharger" is usually only applied to mechanically driven forced induction devices. The main difference between a turbocharger and a conventional supercharger is that a supercharger is mechanically driven by the engine, often by a belt or gear driven by the crankshaft pulley.

The turbocharger, on the other hand, is powered by a turbine which is driven by the engine's exhaust gases.

There are pros and cons to both systems.

The one thing that almost all turbochargers have in common is a wastegate valve to divert exhaust gas around the turbo fan, which causes the turbo fan to slow down, thus reducing boost pressure.

Turbocharger systems tend to be overall more efficient but are not as responsive at lower speeds. This is because that little turbine fan needs a lot of exhaust pressure to bring it up to speed; hence the dreaded turbo lag. Of course advances in turbo control systems over the years have all but eliminated this turbo lag.

Engines equipped with a mechanically driven supercharger can produce a lot of power at lower rpms. This is because the supercharger does not need that much engine speed to do its job. And since it's driven directly off the crankshaft, there is no waiting for power.

Using a supercharger can also cost the engine some horsepower due to the extra load on the crankshaft pulley that is used to drive it. Since a turbocharger is driven off the engine's exhaust pressure, there is very little loss of horsepower.

These days Volvo and some other automakers have found out that using both systems on the same engine can give the best of both worlds. For example, the Volvo 2.0 L T6 (twin charged) turbocharged and supercharged engine uses these devices sequentially. The supercharger is used by the engine from 0 to 3,000 rpm. After that, at 3,000 rpm, a large diverter valve in the intake manifold is opened to let the pressure from the exhaust driven turbocharger take over.

Turbo Control Systems

In the early days of turbocharging, the systems were fairly simple; engine exhaust would spin the compressor wheel on one side and the connected turbine compressor wheel would produce positive intake pressure on the other side.

This pressure needed to be regulated because, as the engine produces higher rpms, the engine produces more exhaust pressure, and some turbochargers' compressor fans can spin at speeds of 80,000 to 250,000 rpm. Left unchecked the turbocharger's potential pressure output can be more than the engine can take.

The most common type of turbo control is a vacuum-controlled wastegate valve.

The wastegate is used to divert excess exhaust gases away from the turbine wheel.

The primary function of the wastegate valve is to control the maximum amount of boost pressure that the turbo can deliver to the engine's induction system. Wastegates can be external or internal, but pretty much do the same thing.

When the wastegate is commanded to open by either engine vacuum or the ECM, depending on the age of the car you are working on, a little flapper valve is opened and allows some or all of the exhaust gases to bypass the turbine. This causes the turbine wheel to slow down and reduces the positive pressure delivered to the intake manifold.

Overall, these systems work pretty well, but over time just like any other engine part, heat, vibration, and age will start to take a toll on them.

Here is how most of the turbo control systems work on the Volvos commonly seen in independent shops today.

The boost pressure in the intake manifold is controlled by the Boost pressure Control Valve (BCV).

The Engine Control Module (ECM) receives information about the actual throttle position via the Throttle Position Sensor (TPS) in the Electronic Throttle Module, or ETM.

The boost pressure is measured by the boost pressure sensor. That data is sent to the control module which, in turn, sends a command to the Boost Control Valve (BCV). This valve regulates the control pressure by using the turbocharger wastegate and bypass valves. The ECM also uses signals from the Intake Air Temperature (IAT) sensor, the engine coolant temp sensor, and the map sensor to help keep the boost pressure consistent during altitude and temperature changes.

Volvo Has Been an Innovator

Volvo was not the first automotive manufacturer to use turbochargers on a mass produced scale, but they were among the first to use forced induction systems.

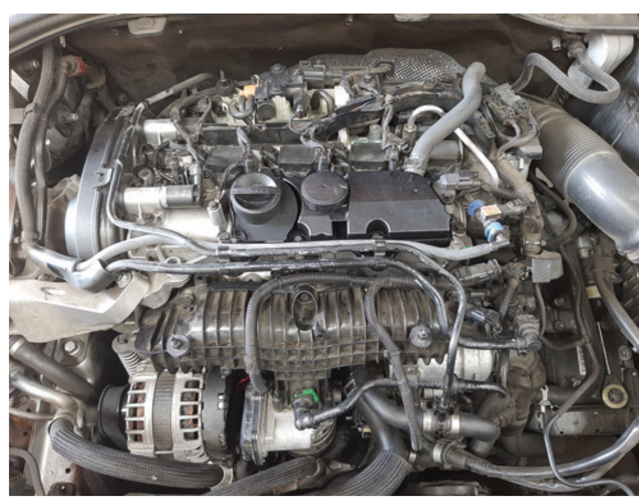
The first Volvos to come with a turbocharger option were the legendary 240 series (1980-1984). These cars had a 2.1 L 4-cylinder engine with a mechanical fuel injection system (K-Jetronic).

These early Volvo turbocharged cars were not very powerful by today's standards, putting out a whopping 131 to 163 horsepower, depending on year. But at the time these cars were pretty fast, and these cars represented Volvo taking baby steps into the high performance market. You might say the early Volvo 240 turbo cars were the grandparents of today's R and Polestar series of Volvos.

If you have been around Volvos for a long time, you know that Volvo has gone through many engine variants over the years, some more successful than others.

About 40 percent of the Volvos produced after 1980 came equipped with a turbocharger, but after 2003 the number of turbocharged Volvos on the road has increased exponentially.

The latest Volvos are available with not only a turbocharger, but some variants come with both a turbo and a supercharger to maximize the potential power output of these relatively small 2.0 L engines. ●



The latest Volvos sold in the US are using the same engine on all of their models. The 2.0 L modular block comes with a variety of power-adding options, and some even come with a turbo and a supercharger combination.

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