

LH Jetronic Swap

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With the introduction of the 16v engine, Saab switched from Bosch CIS injection (a type of mechanical fuel injection) to fully electronic Bosch LH (for Lambda-Hotwire) injection. Bosch LH injection incorporates a hotwire-type airflow measuring device, an oxygen sensor for emissions control, and electronically controlled, batch-fired fuel injectors.

Saab employed two basic varieties of Bosch LH injection - version 2.2 on 1985 through 1988 16v turbos and 1986 through 1987 16v non-turbos, and LH 2.4 on 1989 through 1993 16v turbos and 1988 through 1993 16v non-turbos. (Note: A subrevision - LH 2.4.2 - was employed on 1991 through 1993 non-turbos with the 2.1l engine - this document does not cover 2.4.2)

Although both versions of LH function in approximately the same way, version 2.4 includes a number of useful improvements:

- Self-calibrating Air Mass Meter - On startup, the 2.4 air mass meter (AMM) runs a self-calibration to adjust for age and wear. On earlier versions, this adjustment was made manually with a trim screw, and required the use of several specialized tools (including an exhaust gas analyzer) to be done properly. The self-calibrating AMM results in longer functional life and improved emissions.

- True Automatic Idle Control - Early versions of LH fuel injection relied on a throttle plate adjustment to set base idle, and employed the automatic idle control (AIC) valve only to correct for engine load which affected idle speed. LH 2.4 uses a fully automatic idle control system, including a "last position" memory to enhance idle after startup. This design results in a more reliable idle and a more reliable AIC valve.

- Improved diagnostics - LH 2.4 incorporates a number of component self checks and self-diagnosis to help isolate running problems.

LH 2.4 is a clear improvement over its predecessor in terms of refinement, reliability, and especially emissions control. With that in mind, I've retrofitted a number of cars originally built to use LH 2.2 with later LH 2.4. This document details the fuel injection retrofit.

LH 2.2 to 2.4 swap:

This swap is remarkably straightforward, and should be doable on an LH 2.2 car, turbo or non. These instructions detail everything you need to do the swap, with the exception of:

1. Cruise control. The later speedometers which contain the road-speed sensor necessary to run LH 2.4 lack the road speed sensor necessary to output to earlier cruise control systems. I have not yet investigated what is necessary to fully power the earlier cruise control, or swap the cruise control modules.
2. Air conditioning. Air conditioning should not be affected by this swap, but wiring does change between different versions of LH. As my project car has the A/C system removed, I have no way to verify whether or not it does in fact work.
3. Shift-Up light: Earlier shift-up lights are powered by vacuum switches in the engine bay. This circuit is left untouched but non-functional. Later shift-up lights are powered by the LH ECU. The two circuits are NOT compatible. Earlier systems provide +12v to turn on the shift up light, while later systems provide ground. Obviously the two are not swappable without more work than they're worth. If you really need your shift-up light back, just wire the temperature sensor in the intake manifold (between runners 1 & 2) to the 2-pin connector under the throttlebody. Or, just remove the system (relay, switch, fuse).

NOTE: After the swap is complete, you will have up to three unused connections:

1. The 2-pin speed sensor output to the cruise control (as above). Zip tie it up behind the dashboard so it doesn't rattle around.
2. The 2 1-pin connectors near the LH ECU (turbos only) - LH 2.2 relies on an overboost switch for fuel cutoff; LH 2.4 derives this information from the AMM. You can remove the overboost switch and its wiring & vacuum hoses after the swap to save weight. :)
3. The 1 2-pin connector under the throttlebody. This connector bridges the shift-up light indicator temperature switch with the shift-up chassis wiring. The LH 2.4 harness doesn't have provisions for the external shift-up function.

These unused connections are exclusive of an unused yellow wire and unused blue wire near the combined instruments cluster. Per below, the yellow wire is the unused provision for the shift-up light, and the blue wire is the unused provision for a cruise control road speed sensor.

IMPORTANT NOTE: This swap will require replacement of your speedometer and odometer. In most states, this is considered tampering and may be illegal or require special documentation or notification to future buyers.

FINAL NOTE: This swap involves modifications to your car's fuel injection system. This system is sensitive to physical trauma and important to your car's proper operation. I have tried to ensure these instructions are accurate, based on my own fuel injection swap and verified with several more. You should only proceed down this road if you are comfortable making fundamental changes to your car. At each step be sure you do a basic sanity check to verify I haven't steered you wrong, and what you're doing makes sense to you. If you have doubt or uncertainty, please do not proceed. And, most importantly, please be fully aware that if you proceed with this swap, you do so at your own risk!

Parts list (the easy way):

1. LH 2.4 ECU (1989-1990 900/S or 1989-1993 900T) with mounting bracket. You can use LH harnesses from earlier LH 2.4 cars, but there may be subtle differences (that you'll have to work out yourself). Don't forget the mounting bracket - the LH 2.4 ECU will not mount on the earlier bracket. Be sure you use an ECU appropriate to your engine - turbo or non-turbo. Ideally, find the latest ECU you can - that is, use a 1990 900S ECU when working on a non-turbo, or a 1993 900T ECU when working on a turbo. The latest ECUs incorporate the latest software and most refined features.
2. Idle Control Valve (AIC) (1989-1990 900/S or 1989-1993 900T) with mounting bracket from thermostat housing. Don't forget the mounting bracket - the later AIC valves have a larger diameter. AIC valves are not engine specific.
3. Air Mass Meter (AMM) (1989-1990 900/S or 1989-1993 900T). The AMM must match the ECU - try to get them from the same car if possible.
4. Evaporative Loss Control Device (ELCD/charcoal canister) (1989-1993 900/S/T). ELCD valves are not engine specific.
5. Speedometer (1989-1990 900/S or 1989-1993 900T). Speedometers are not engine nor transmission specific.

(You can actually use any year speedometer as long as it includes the correct road speed sensor. The correct road speed sensor will have a small circuit board on the back; you can easily remove it from the speedometer by removing the two retaining screws to verify you have the right one. If you grab the speedo from a 1992+ 900, you'll be tempted to also grab the tachometer and the combined gauge so that typefaces match. The tachometer, speedometer, turbo gauge, and engine temperature gauge are universal, but the fuel gauge is NOT. Later fuel gauges have a small circuit to eliminate fuel level fluctuations ("anti slosh") on the gauge; without this circuit you will fry the new fuel gauge!)

6. Speedometer cable (1989-1993 900/S/T)

Wiring components needed:

1. LH 2.4 wiring harness. Note: LH 2.2 wiring harnesses are unique between turbo and non-, turbo harnesses do not have provisions for EZK ignition. LH 2.4 harnesses are all the same and all have provisions for EZK, even if they're unused. That said, you may use any harness from any 2.4 car.
2. Pigtail from road speed sensor on the back of the speedometer.

(If possible, trace the green and yellow wire all the way back to the FI ECU - it terminates in a 5-pin connector of which 4 are used. One green/white wire should be removed from the 14-pin connector on the combined instruments cluster in the donor car and *not* cut. The other three wires (blue, green/white, black) may be cut. Leave at least 3-4" of extra wire. Below is a sample of what that harness ideally should look like) (Click image for a larger version)

3. Pigtail from ELCD

4. Male 2-pin plastic shroud

(You can grab this shroud from anywhere - from door lock motor wiring or foglight wiring, for example. Just flip open the trap door and neatly withdraw the existing wiring.)

5. Female 2-pin connector with 8' of wire

(You can grab this from anywhere. The connected 8' of wire is not explicitly necessary, but it will simplify your wiring job. The real key here is to have the female 2-pin connector and 8' of wire. Ensure your wire is insulated - I suggest using scrap black insulation from another Saab. You do not want grease, oil, and heat eating your wires!)

6. 5-pin (4 used) connector matching the 5-pin connector on the LH 2.4 wiring harness near the ECU. See item #2, road speed sensor, above.

Prep the car by removing old fuel injection components:

1. Unplug the battery
2. Remove the horizontal and vertical kick plates on the passenger side, pull the carpeting away from the side of the car, exposing the ECU.
3. Remove the seats (to makes things easier), the lower dash pad, the fascia, existing instrument cluster
4. Remove the screws holding the ECU to its mounting bracket and remove the existing ECU
5. Remove the ECU mounting bracket
4. Remove the AIC (including bracket), AMM, ELCD. You may need to remove the EZK or APC control unit to get the ELCD out.
6. Unbolt the p/s fluid reservoir and pull it away from the car as much as possible - do NOT damage the lines or you will end up with a huge mess.

Remove the old fuel injection harness:

1. Starting at the AMM, disconnect the engine wiring harness from the engine components, and cut/remove all the tiewraps securing it to the car. Don't miss the 3-pin (non-turbos only) and 6-pin connector under the cabin air intake, the 1-pin and 2-pin connectors for the O2 sensor, the 2-pin connector for the shift up light temperature sender, and the lug at the power distribution block. Leave it hanging over the passenger side fender.
2. Cut the tiewrap surrounding the boot that the harness passes through the side panel into the cabin.
3. Unbolt the fuel injection relay block from the car.
4. Disconnect the 2-pin connector and the two 1-pin connectors (the latter on turbos only) and the 1-pin connector (automatics only) near the fuel injection relay block
5. Carefully pass through the wiring harness through the passenger side panel (from inside to outside). It will fit. Remove the old wiring harness from the car.

Modify & Install the new fuel injection harness

1. For non-turbos: Cut the 3-pin connector (with blue/red, grey, and black wires) previously located under the cabin air intake on the old fuel injection harness. Leave 3" or so to give adequate room for soldering. Find the 6-pin connector on the new harness where Pins 1, 2, and 3 are blue/red, grey, and black. Open the 6-pin connector and remove the pins. Grab wires 1, 2, and 3 (leaving behind 4 (blue/red) and 5 (grey/white) and 6 (yellow/red)). DO NOT CONFUSE PIN 1 AND PIN 4 - the pins are labeled on the connector itself. Cut the ends off the 3 wires, and solder those leads to the matching leads on the 3-pin connector - black to black, etc. These leads are for the EZK ignition system. Note: It is advisable to complete this step even if you do not run EZK. Securing the ends in a connector will help prevent shorts or other damage to the wiring & components

2. Grab the freed #4 (blue/red) pin from 6-pin #2 on the new harness, and cut the end off. You must splice this wire onto the grey/red wire on the 6-pin #1 connector. This lead will provide power to the O2 sensor preheater. If you like, you may solder an inline fuse though this is not strictly necessary.
3. Clip the male 2-pin plastic shroud (from your parts inventory) onto the remaining two wires (grey/white and yellow/red). These wires are for the electric purge valve on the ELCD.
4. Run the new LH 2.4 wiring harness along the engine bay. Pass the harness (AMM connector first) through the hole in the passenger side fenderwall (be cautious of the power steering lines) under the cabin air intake, and across the engine. Do not twist or crimp the harness anymore than necessary to avoid breaking wires or shearing insulation.
5. Using spare wire and a 2-pin female connector (from your parts inventory), connect this 2-pin connector to the 2-pin connector prepared in step #3. Run this wire along the firewall and down the driver's side fender to the location of the ELCD. You can pass the wire through the windshield wiper bracket and through the cutout in the fenderwall by the fusebox. Solder or crimp the ELCD 2-pin pigtail onto the end of the wire. Secure the wire in place.
6. Pass the FI ECU connector and relay block through the opening to the passenger compartment (outside to inside).
7. Cut the end off the 2-pin connector on the car-side wiring by the fuel injection relay block. The connector will have a purple/white and a blue wire. Using the 5-pin (4 used) connector and its pigtail, solder the matching purple/white and blue wires together, and run the remaining green and yellow wires behind the dashboard to the combined instruments cluster.
8. Install the new FI ECU bracket and relay block to the side of the car.
9. Connect the FI ECU to the wiring harness and bolt the ECU to the bracket.
10. Run the FI ECU diagnostic connector along the passenger-side sill and under the back seat. Secure the 8-pin connector in an accessible location. Depending on the year of the target car, you may be able to use the original mounting bracket for this connector.

Install new fuel injection components:

1. Slide the ELCD into the retaining bracket on the driver's side fender
2. Connect the AMM to the fresh air intake
3. Attach the new AIC mounting bracket to the thermostat housing and install the AIC
4. Connect the new fuel injection harness to the newly-installed components

Modify & Install the new combined instrument cluster:

1. Remove the combined instrument cluster, being careful not to damage wires or the speedometer cable. The speedometer cable is secured to the cluster using (normally) a Phillips-head screw.
2. Unbolt the tachometer and combo gauge from both combined instrument clusters. On each cluster, lift the two gauges out together, to be sure you do not damage the flexible circuit that links them together. Be cautious not to damage the rheostat or clock adjustment knob. Remove the speedometer from each, and swap them. Reassemble the original combined instrument cluster. If you are brave, you may be able to adjust the mileage on the new odometer to match the old; doing so requires some talent and you risk damaging the odometer. If you go this route, you're on your own! Please note, in many states tampering with the odometer is illegal, or requires special paperwork.
3. From underneath the car, disconnect the speedometer cable from the transmission final drive. Carefully remove the speedometer cable from the car. There should be two metal clips - one in the engine compartment, and one inside the car - keeping the speedometer cable in place. Feed the cable into the engine bay, then remove from the top. It's easiest if you remove the rubber grommet from the firewall rather than try and feed the cable through it; you can remove the grommet once the cable is out of the car. Install the new speedometer cable (installation is reverse of removal) and connect it to the transmission final drive. Do not forget to clip the cable into the metal clips - failure to do so may allow the cable to shift during operating and hit the drive belts!

3. Remove (do not cut!) the tachometer signal wire from the left-hand (gauge faces facing you) 14-pin connector in the dash area. This wire may be blue, or may be green/white. I believe the Bentley manual is wrong for several model years. This wire should be Pin 10 or Pin 11 (depending on year) on your 14-pin connector. Splice that wire onto the cut green/white wire on the road speed sensor pigtail. Replace the wire removed from the 14-pin connector with the intact green/white wire from the road speed sensor pigtail. Splice the black wire from the road speed sensor pigtail onto a ground wire (always black, often pin #2) on the left-hand 14-pin connector. The blue wire is output to the cruise control, and may be ignored. The yellow wire is input for the shift-up light, and may be ignored. Be sure to insulate the ends of the unused wires to prevent shorting. (Click image for a larger version)

4. Connect the speedometer cable to the speedometer, connect the newly-spliced road speed sensor, and reconnect the two 14-pin connectors. Reinstall the combined instrument cluster.

5. Connect the 5-pin (4 used) connector at the passenger footwell to the LH harness

6. Connect the 1-pin connector at the passenger footwell to the LH harness (automatics only)

Verify all electronic connections:

1. Speedometer cable (at the speedometer & transmission)
2. Road-speed sensor (3-pin connector at the speedometer)
3. Combined instrument cluster interface to fuel injection ECU (5-pin (4 used) connector at the passenger footwell)
4. Connect the 1-pin connector at the passenger footwell to the LH harness (automatics only)
5. 6-pin connector at the cabin air intake (fuel injection interface to chassis wiring)
6. 3-pin connector at the cabin air intake (fuel injection interface to EZK ignition system) (non-turbo) only
7. 1-pin and 2-pin connector at the cabin air intake (O2 sensor output and preheater circuit)
8. Lug at power distribution block (fuel injection main power)
9. Engine sensors and components (AIC, AMM, injectors, coolant temperature (NTC) sensor, air conditioning compressor and temperature switch)

Put your car back together! :D