

## Engine: FI and Ignition Computers

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#### Abbreviations:

AMM	Air Mass Meter
ECT	Engine Coolant Temperature sensor
ECU	Engine Control Unit computer (either fuel injection or ignition)
FI	Fuel Injection
FBR	Fuel Pressure Regulator
IAC	Idle Air Control solenoid valve
TB	Throttle Body
TPS	Throttle Position Sensor
VSS	Vehicle Speed Sensor

**Symptoms of Bad LH 2.4 ECU.** See also [Engine Failure/No Start: Bad ECU](#)

#### Common symptoms of a failing LH injection module:

- Engine will not run at idle
- Air-fuel mixture is too rich (this can damage catalytic converters)
- No fuel pump operation, but the fuel pump operates when its relay is jumpered between pins 30 and 87/2
- The engine will not rev higher than 3000 RPM
- Engine will not start, spark plugs are dry and the ignition system produces spark.

- Multiple error codes, sometimes randomly generated, despite using known good sensors and components.

**ECU Diagnosis.** First check the [fuel injection](#) system and [radio suppression relays](#). Check all the [sensor](#) inputs to the ECU at the connector: you can remove the small screw and wire tie on the cover, pull it off, and remove the little "haircomb" plastic piece on the side which exposes all connectors without actually disconnecting the ECU itself. All grounds, power and sensor inputs should be tested at this plug before the ECU is condemned. Is the ECU getting a signal from the ignition system? How about power from the ignition? Only after a complete diagnosis should you condemn the ECU.

This note is from [Car Electronic Service](#) in the UK and applies to: 1988 to 1992 740 and 740 GLE with Bosch Jetronic LH 2.4 fuel injection ECUs part numbers 590/591/594/595. Symptoms...No prior warning, car usually breaks down on road or fails to start when warm through loss of fuel pump relay control. Diagnostic checklist: ACCURATELY Identify fuel pump relay and remove. Now take a small piece of wire to jumper terminals 30 and 87/2 on the relay board (the terminals are identified on the relay module pins). USE CARE. The 2 terminals are the nearest left and middle right pins on the relay board). This +12V jumper should make the car act like the fuel pump relay is ON. If car now starts and runs, take for road test to confirm OK (put on exhaust gas analyser first with catalyst equipped vehicles). IT IS NOT OK to continue to use the car with this fixed jumper feed to fuel pump. If the car runs, then the ECU fuel pump control circuit is bad.

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### ECU Failure Modes.

**Pattern Failure ECUs.** [Robert Haire] This info is from pulling and running dozens of ECUs of each number discussed. The bad ones are all LH 2.4 including the 561, with few pink label ECUs surviving. Typically, this is a no start failure. However, I have had two white label 561s that failed recently so they are not a sure thing. I have never had a bad 951 that I can recall. The 16 valve ECUs 928, 571 seem to work fine in these cars too. The LH 2.4 California emission with EGR 556 Volvo original must be atrocious too. Every one I have seen lately is a Fuel injection or Programma rebuild with the old Volvo ECU long dead. The rebuilds seem to be just fine. The only turbo ECU that causes problems is the LH 2.4 563. That one has a steady demand so failure must be fairly common, though not like the non-turbo counterparts as far as I can tell. Possible replacement units are 937 and 967. Other ECU failures may rarely occur but they are much more unusual than those listed above.

**ECU Circuit Chip Failure Mode.** [Tips from Richard at Elektronik Repair] The main cause of failure in the LH-Jetronic fuel injection ECU is the hybrid circuit. To understand the function of the hybrid, please envision it as a type of interface that converts the 5 Volt signals of the microprocessor to 12 Volts, or 12 Volt signals of the controller to the level lower 5 Volts for the microprocessor. Additional functions such as Lambda regulation, resets and reference voltages are also integrated. The hybrid circuit contains two integrated circuits (ICs) and several discrete components which provide these functions. The ICs are protected by a silicone covering. Over the course of the time, oxygen and water molecules diffuse through the silicone covering and cause oxidation at the chip which eventually leads to a loss in functionality. Unfortunately, the loss of the hybrid circuit functions can lead to the complete loss of controller functionality and thus the engine stops running. When asked how the failure occurred and how it affects the car, nearly 95 % of the time the answer is: it worked properly when turned off, afterwards the engine would no longer start. Beyond oxidation and turning off your engine you need to understand these two facts. 1. The age of the controller is the main enemy here, not the actual hours of operation 2. The controller will fail mostly after turning the off the engine. As Murphy's law dictates, it will fail most often at the place where it will cause you the highest possible inconvenience. If your controller fails, never buy a used or repaired controller that contains an old hybrid chip because then it will get you again. The record that one customer holds is three successive failures when purchasing used controllers, each failure came approximately 6 months apart. More information available at [info@elektronikrepair.com](mailto:info@elektronikrepair.com)

[Richard Keys] One cause for ECU failure is due to excessively high stray high voltage levels within the engine compartment or by unusual signals being seen by the ECU's sensor inputs. If this situation occurs, then it is strongly recommended to replace the high voltage system with new genuine parts (i.e spark plug leads, distributor cap, rotor, coil) and the main engine to body and battery grounds are renewed before fitting a replacement engine management ECU. [Editor] Electrical welding on the body or exhaust can cause these stray currents and result in an ECU failure. Disconnect engine and SRS computers before doing any electrical welding on the car. Tell shop personnel (especially muffler shops) to do the same if they work on your car.

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### Intermittent stalling in 89 760T.

The owner of the shop hinted that late 80s and early 90s 760s have had problems with their computer chips -- something like \$800 plus labor -- OUCH! Has anyone heard of this?]

[Response 1:] Yes, very much so...LH 2.4 modules from 1989-1991, maybe 1992 too, have been very troublesome. However, as far as I know, 1989 Turbos still used LH2.2 modules, so I'm not sure that this applies to your car. Also, often when the modules fail, they fail rather radically, such as the car running very rich, or a no-start or cases like that.

[Response 2:] I experienced almost identical symptoms for several years. They went away when the ECU on my 760 Turbo had to be replaced because the AC enrichment circ

When mine died it got stuck in diagnostic mode 3, pulsing the injectors every second, which was enough fuel to start the car but not much more. Other cases I've heard of has the adaptive rich code getting set permanently.

[Yet Another Opinion:] As a general rule, ECU's don't go half bad, and don't work intermittently: they work fine or they don't work at all. It is wires and connectors that have off days

[JKordzi]The 561 ECUs have had very high failure rates. Used 951 ECUs (the replacement model) are pretty reasonable now and may be had on EBay or in wreckers' yards for US\$50 or so.

[Editor] In my case, my 556 ECU vintage 1990 failed in such a way that the car would idle, but any application of throttle to raise rpms above about 1,200 would suddenly cause total injector failure: they would just stop pulsing until the rpms dropped. Changing the ECU solved it.

### ECU Fuel Pump Control Circuit Repair.

[Tips from Michael Craig] My 940GL with B230F and LH2.4 suffered from a secondary fuel pump relay supply failure, caused by faulty ECU. This problem apparently required a new ECU - VERY expensive. As I am an electronic engineer by profession, I do not believe there is such a thing as 'beyond repair' - atleast for electronics! After a lot of web searching, I managed to gather a small amount of information about the Bosch ECU. Armed with this and an oscilloscope, I was able to diagnose that the circuit within the ECU that controls the fuel pump relay had failed. Further research led me to believe this was a fairly 'standard' fault, as there are a couple of companies here in the UK who specialise in this particular fault, however the prices quoted for repair are still very high - in the order of £200. This motivated me to re-design the relay control circuit, the details of which I will share with you!

The pump relay control circuit functions as follows:

- When the ignition is initially switched on, the pump runs for about 1 - 2 seconds, in order to 'prime' the fuel rail. If the engine is not started within that time, the pump must stop. You should be able to hear the pump running, so you can test this function by listening! If the engine is not started and the ignition left on, the pump will not run again (see next).
- When the engine is started, the EZK ignition unit sends a series of pulses to the ECU, the rate of which is proportional to the engine speed. When these pulses start, so must the pump. This is how the pump control logic knows if the engine is either starting, running or stopped.
- When the engine is stopped, the pulses from the EZK cease and the pump also stops. If the engine stops for any other reason, it must be assumed that the EZK will also stop, therefore so will the pump.

The 555 timer IC is operated as a slightly modified 'missing pulse' detector. Pulses from the EZK are used to hold the timing capacitor (22uF) in a discharged state. Should these pulses cease, the timing capacitor will charge through 390k and the timer output will change state, turning off the relay drive transistor BC140. The LED and 2k2 are a visual indication of the output state for testing purposes, and could be omitted. The 1uF capacitor ensures that the timer runs on power up, which gives the initial ignition on pump run. The transistor BC107 is really just a switch, and the zener 6v8 limits any spikes from the EZK.

It is possible to construct the circuit using stripboard about the size of a matchbox, which will fit inside the ECU, making a really neat repair. None of the components are particularly critical - most any transistors could be used, however the pump relay draws about 20mA. (This pump relay is actually part of a double relay - two relays in one case - often referred to as the 'LH Jetronic' relay). MOST IMPORTANT - Always disconnect the car battery before removing any ECU connectors. These ECU's are not well protected, and spikes will kill them.

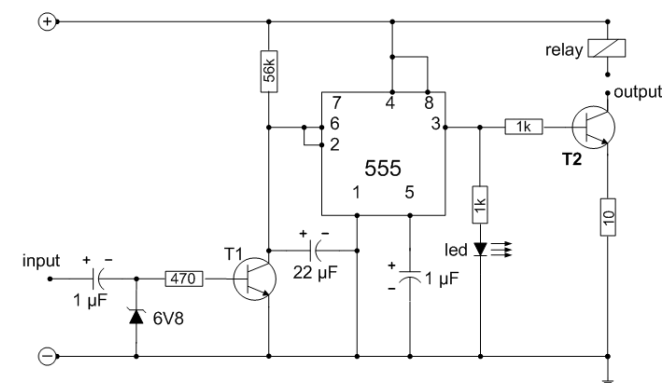
### ECU Missing Pulse Detector Workaround [Ed Pennings]

I have been able to test the self-built replacement fuel-pump-relay control unit in my Volvo 940 from November 1990. My car has the OEM Bosch LH Jetronic 2.4 part no. 0 280 000 595. The loss of fuel pump relay control is a well known problem of the Jetronic 2.4 with part numbers 0 280 000 59x. This replacement control unit is the size of a match box and can easily be built inside the ECU housing. I found out that I had to change a few components in order for the unit to function properly: pump on after contact on - then fall off after one second - then on again when starting and motor running (= obtaining pulses from the ignition unit) - and fall off when engine stops running while contact on (for example after a car crash). It is basically according to what Michael Craig wrote above but with a few adjustments. The unit is basically a missing pulse detector. My Volvo is running OK now with the fix installed inside the original Jetronic.

[Tip from Steve] Applies to a 1989 240, with similar electronics as a 740 with a failed Bosch 556:

A lot of folks [do this](#) because of a failed fuel computer. I am not sure what model you have so I will tell you how I did it for my 89 240DL. Mine has a White fuel pump relay located under the right front kick panel. I installed another relay to switch ground to the connector on the Fuel Pump relay. This ground source normally comes from the crank sensor or the fuel computer and senses that the engine is rotating; hence the fuel pump will run. You must install another relay. Connect a switched 12-volt source to pin 85 on the New relay and a good ground to pin 86 and 30. Then connect a wire to provide the ground when the relay receives a power source to pin 87 on the new relay. This wire will need to be connected to 86/2 on the Fuel pump relay. You should be able to test this before you install the relay with a test light or a ground source, just turn the key on and touch the ground source to the 86/2 pin on the Fuel Pump relay...You should hear the fuel pump humming. Then just install a relay to provide the ground you need. [Editor] This is hazardous since the fuel pump will run anytime the ignition key is "on", even when the car is upside down after an accident. Far better to install a good ECU.

Missing pulse detector for fuel pump relay control



T1: BC107, BC337 etc.	input: pin 1 of Jetronic 2.4
T2: BC140, 2N2219 etc.	output: collector of BC140 to pin 20 of Jetronic 2.4
zener diode: 6V8	power (+): pin 35 of Jetronic 2.4
relay: fuel pump relay	earth (-): pin 5 of Jetronic 2.4

## Repairing Your Own LH 2.2 ECU

[Tip from Vroom] I have a 1988 765 turbo which uses the LH jetronic 2.2 system, ECU # (bosch) 0 280 000 541. I had an idle problem which was very thoroughly traced to the ECU. The following is what worked for me:

We traced pins 10 and 23 to two transistors: one is the middle one of the three on the heat sink, the other stands alone in a black plastic holder directly in front of the first one. Only one was blown. We looked the part numbers up and cross referenced to a Motorola power transistor (Part # 2N6488 (229)) which seemed to fit the bill and installed it. To remove the transistors from the heatsink I drilled out the peened pins (start small 1/32 then up to 1/8) and used 1/8 aluminum pop rivets to reinstall. It has been working flawlessly for a week now. Again this worked FOR ME on this model ECU; I would hate to cause anybody any problems with info that doesn't work for their particular situation. I suggest that you consult with an electronics whiz before trying this.

**561 ECU Workaround: Swap the Relay and Not the ECU.** [Tip from Colin ] It has been suggested that it may be possible to overcome the failure of the 561 ECU to operate the fuel pump relay by replacing the (white) L-Jet relay with the (green) K-Jet relay. This type of relay senses engine rotation internally instead of using the ECU. The relay fits the same relay base as the (white) L-Jet one but is wired differently. Reading my latest edition of the UK. V.O.C Technical Driver magazine I found an article by Peter Suchy on how to do just this. With the permission of Jack Cluer (the editor) I have reproduced the relevant part below.

First remove fuse one! Then remove the wires from the fuse/relay unit, with a slim spike pushed down between the housing and connector release the barb then push the connector out, you will need to bend the barb back out so that it locks when you refit the connector. Then put them back as follows making sure they correspond with the numbers on the relay thick blue/yellow wire to 87b, pink to 87, brown to 30. Run a (blue/red) wire from terminal 15 to to fuse 13. (an ignition controlled source) Run a ground (black) wire from the negative bus on the fuse box to 31 Run a (red/white) wire from the single Red/white wire on the tach to terminal 31b. You will now be left with the black/yellow, red and a looped blue/yellow and brown and white wires. Insulate these and tie them neatly away in the loom where they can be accessed if needed. Tape the wire from the instrument panel firmly to the loom and make sure that all wires are neatly fitted. This is to prevent the wires pulling out next time you remove the fuse box! Now refit the relay making sure all the connectors are firmly pushed into the relay base and start the engine! The relay is now powered by an ignition pulse from the coil when the engine is turned over. The above is a bit more work than fitting a new ECU but a hell of a lot cheaper and it retains the original safety feature of cutting off the fuel supply if engine rotation ceases.

**Buying a Used ECU.** [Suggestions:] It now appears that the lifetime of these ECUs is around 14-15 years: beyond that and the hybrid chips are at risk as noted [above](#). When you buy a used unit, take that into consideration. And get at least a thirty-day or no-DOA ("dead on arrival") guarantee when you do buy the used unit. Paying over \$150 for a used ECU is not wise; you can buy a [rebuilt unit](#) for \$400. To locate units and price them, check out <http://www.car-part.com> for US and Canada yards.

**Buying a Remanufactured ECU.** Remanufactured computers are available for most cars including Volvo. Several companies specialize in remanufacturing computers. Most are priced around \$400 with guarantees ranging from one year to life-of-the-car. See also the [FAQ notes](#) in Parts.

- [Micro-Tech](#), in Louisville, Kentucky (800-688-1588). (sold through NAPA). 12 month warranty.
- [ECUDoctors](#) in Fort Lauderdale (305.989.0724). 5 year warranty and good prices.
- [Standard Motor Products](#).
- [Elektronik Repair.Com](#) in Mesa, AZ. 3 year warranty
- [Programa](#) in Boca Raton, FL specializing in Bosch for euro cars: 561-338-8843. 3 year warranty
- [Python Injection](#) in Las Vegas, NV 800-959-2865. 12 month warranty.
- [Fuel Injection Corporation](#) in Santa Ana, CA 925-371-6551. 18 month warranty
- [ECU Doctor](#) in Ft. Lauderdale: 305-989-0724
- United Kingdom: [ATP Electronics](#) in Cannock, Staffordshire, UK 44 (0)1543 46746. 12 month warranty
- United Kingdom: [Car Electronics Services](#) in Southampton, UK 44 23 80777748. 24 month warranty
- Europe, Africa, Scandinavia: [ACM Elektronik Repair.Com](#) in Ravenstein, Germany +49 (0)6297/929462

**760T Engine Stops Dead at 60MPH; Bad Power Stage .**

[Inquiry: driving down the highway at @ 60mph with 1/4 tank of gas in 100 degree temp in well kept 84 760 Turbo; car just dies, engine turns over but will not start]



[Response:] When my '84 760 Turbo died for no apparent reason as you describe, it was in the freezing dark, going over Donner Pass. Everything on the car worked except no spark and the engine wouldn't run. It turned out to be the ignition amplifier or "[power stage](#)" module, which is mounted on the inner driver's side(LHD) fender well behind the headlight. It's easy to get to and replace. If that turns out to be the culprit, shop around before buying the new part. Volvo dealers charge several hundred \$\$\$ for this thing, but I found one from an independent parts distributor for about \$80 - the identical part made by BOSCH with the same part number on it.

**700/900 ECU/AMM Reference Chart.** The following ECU and AMM information was supplied by Zachary Zaletel, Bob Haire, Bill Garland, Art Benstein and many others. Many thanks. Note as well that 556/561 ECUs are for cold start valve-equipped cars; 933/951 ECUs eliminated circuit for the cold start valve. The [Volvo Pocket Data Book](#) also lists a variety of ECUs for 700/900 models.

This table is a continuous work in progress. While every effort has been made to ensure that this table is accurate, there are undoubtedly errors included within. Please post in the 200 section of [Brickboard](#), attention ZJZ to flag any corrections.

In general, EGR ECUs of a similar LH number should work in a non-EGR application. The reverse may not necessarily be true, though it might allow you to limp somewhere in a pinch. Turbo ECUs of the same LH number likewise should work in non-turbo applications, however non-turbo ECUs may run, but will at best only provide marginal performance, if they run at all on a turbo engine.

Jetronic Version	Bosch AMM part #	Bosch ECU Part #	Engine	240 years	740 years	940 years	Acceptable substitutes
LH ?	?	0 280 000-500	-	1982	-	-	-
LH 2.0	-002	0 280 000-503	B23F	1983-1984	-	-	-
LH 2.0	-002	0 280 000-507(?)	B23FT	1982-1984	1983-1984	-	-
LH 2.2	-007(?)	0 280 000-511	B230F	1985-1988	1985-1988	-	-
LH 2.2	-007	0 280 000-541	B230FT	-	1987-1989 (turbo) 1987-1989 (760) 1989 (780)	-	-

LH 2.2	-007	0 280 000-544	B230F	1985-1988	8/1984-7/1987	-	-541, -544, -554
LH 2.2	-007	0 280 000-554	B230F	1988	8/1987-7/1988	-	-541, -544, -554
LH 2.4	-016	0 280 000-556	B230FD	1989 (EGR)	1989-1990 (EGR)	-	California / EGR Model: -937, -967 and -954 are suitable.
LH 2.4	-016	0 280 000-560	B230FT	-	-	1990-1991 (turbo)(egr)	-563; -967(?)
LH 2.4	-016	0 280 000-561	B230F	1989-1992(?)	1989-1990	-	Pink label models problematic. White label 561 less problem prone. -933, -935 and -951 known good substitutions.
LH 2.4	-016	0 280 000-562	B234F	-	1991 (16 valve)	-	-928
LH 2.4	-016	0 280 000-563	B230FT	-	8/1989-7/1991 turbo 8/1989-07/1991 (760 Turbo) 1990-1992 (780)	1991 (turbo)	-937, -939, -954, -962, -975, -976, -977 should all be compatible with B230FT engine setups.
LH 2.4	-016	0 280 000-571	B234F	-	? - 1991 (16 valve)	-	-928
LH3.1	-001, 4-pin	0 280 000-572	B230F	1990-1992	-	-	May have also been installed in 1993 240s.
LH 2.4	-016(?)	0 280 000-911	B230G	-	1991(?)	1991(?)	-
LH 2.4	-016	0 280 000-928	B234F	-	1991-1992 (16 valve)	-	-
LH 2.4	-016(?)	0 280 000-930	B230G	-	1992(?)	1992(?)	-
LH 2.4	-016	0 280 000-933	B230F	-	1991-1992 (EGR?)	California-spec turbo models(?)	Eliminated use of cold start injector.
LH 2.4	-016	0 280 000-935	B230F	-	-	6/1991-8/1995	-
LH 2.4	-016	0 280 000-937	B230FT	-	1991-1992(?) (turbo)	1992-1993 (turbo)	Should work in 8-valve non-turbo.
LH 2.4	-016	0 280 000-939	B230F	-	-	1992	-
LH 2.4	-016	0 280 000-943	B230FD	1993(EGR?)	-	1994(?) -1995	-946. Should work for EGR and non-EGR models.
LH 2.4	-016	0 280 000-946	B230FD	1993(EGR?)	-	1991-1995 NA	-
LH 2.4	-016	0 280 000-951	B230F	1993	-	-	Good substitute for non-turbo, non-EGR LH2.4 ECUs above. Eliminated use of cold start injector.
LH 2.4	-016	0 280 000-954	B230FT, B230FK	-	-	1995 (turbo)	Should work in non-turbo, non-EGR models.
LH 2.4	-016	0 280-000-962	B230FT	-	-	1994 (turbo)	Possibly for EGR models(?)
LH 2.4	-016	0 280-000-967	B230FT	-	-	1993-1994 (turbo)	-
LH 2.4	-016	0 280-000-975	B230FT, B230FK	-	-	1995 (turbo)	-
LH 2.4	-016	0 280-000-976	B230FT, B230FK	-	-	1996 (turbo)	Uncertain if with EGR or without.
LH 2.4	-016	0 280-000-977	B230FT,	-	-	1996 (turbo)	Uncertain if with EGR or without.

			B230FK				
LH 2.4	-016	0 280-000-984	B230ET	-	-	1997-1998 (Euro)	Reputed to be the best LH2.4 Turbo ECU.

**Regina Notes.** We do not yet have a table of Regina components. Anecdotal notes are below:

[Jason R] Regina ECU S101590102A WILL NOT Swap in place of S101590202A or visa versa. Idle will hunt.

[Volvo Maintenance FAQ for 7xx/9xx/90 Cars](#)

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