



Hot and Cold-start kits for Bosch CIS and LH fuel injection systems

In an ideal world, fuel injection systems would be able to magically adjust to every possible condition or situation. In the 21st century systems like Saab's Trionic are approaching that ideal. Theoretically, you could drive a Saab 9⁵ from northernmost Sweden, south through Europe, across the Middle East, and into the Sahara, and the motor wouldn't miss a beat.

Back in the early days of fuel injection, this was not always the case. Computer control was nonexistent or minimal, and when present, the available memory was tight. The systems were not able to cope with the wide variety of environments, seasons and weather that made up Saab's markets.

This column will attempt to show what Fuel Injection kits were available for the Bosch CIS (K-Jetronic) and LH-Jetronic systems for USA-market cars. I would cover the Bosch D-Jetronic system on the Saab 99 up through 1974, but the service bulletins that I have available don't go back that far.

First, a short description of each system. Note: These descriptions are meant to be simplistic, and not detailed. Each system could well warrant it's own article!

Bosch CIS (K-Jetronic)

CIS is a mechanical fuel injection system used on Saab 8-valve motors from 1975 through 1988. A fuel pump mounted in the fuel tank pressurizes the system. As air flows into the motor, a disc, mounted on a lever, rises in proportion to the airflow. At the other end of the lever is the fuel regulation system. The higher the plate goes, the more fuel is injected. The injectors are spring-loaded, and open when the fuel pressure is sufficiently

high. Cold start fuel is provided by a solenoid injector mounted in the throttle body. Regulation of the fuel pressure is accomplished by a temperature-sensitive regulator mounted near the thermostat.

CIS is an abbreviation for 'Continuous Injection System'. The 'Continuous' comes from the fact that fuel is injected continually, not in pulses. Later cars have Lambda control of the fuel mixture, regulated by a signal from an oxygen sensor mounted in the exhaust system, and a catalytic converter. This system is essentially an 'add-on' to the CIS system. By 'bleeding off' some of the control pressure, the system can adjust the mixture in response to the signal from an oxygen sensor mounted in the exhaust.

Bosch LH-Jetronic

LH-Jetronic (LH) is a true electronic fuel injection system. The ECU (Electronic Control Unit) takes signals from a hot-wire air mass meter, the ignition system, an oxygen sensor, throttle position sensor and engine temperature sensor, applies them to a 'map' stored in EPROM memory, and that determines how much fuel should be injected. This is done by varying the time the injectors are open. All injectors are pulsed open at the same time. This is called 'bank-firing'.

LH is a German abbreviation for 'Luftmassenmesser Hitzdraht', or hot-wire air mass meter (AMM). The AMM allows a much more precise metering of the air entering the motor than the disc and lever of the CIS system. Air flowing over a heated, fine, platinum wire cools the wire. A bridge circuit (Wheatstone bridge) main-

tains the temperature of the wire. The amount of current it takes to maintain that temperature is processed by the ECU as an indication of the mass of the intake air. A temperature sensor corrects the output for ambient air temperature.

There were three versions of the LH system fitted to the Classic 900, LH 2.2, 2.4 & 2.4.2. Identification of which version is on your car is pretty easy. All you need to do is look at the AMM and the connection to the idle control valve (also called AIC valve) mounted above the thermostat. Alternately, you can go by model year and motor variant (non-turbo or turbo):

The former is somewhat more reliable, as it accounts for owner's upgrades.

The 'kits'

What follows is a brief description of each kit, the service bulletin or recall that details the application, and how you can tell if it has been done to your car. Please consult the full service bulletin for the details, and before considering if it is appropriate to your car. Some are appropriate to a very limited number of vehicles within a model year.

SI 7/77-282

'Improving driveability after cold start'
All 1975 99s with CIS

Description: An 'acceleration enrichment kit' p/n 83 28 569 consisting of a vacuum impulse switch and appropriate wiring. The impulse switch senses an opening throttle, and provides a short burst of extra fuel via the cold-start injector. Also, warm-up regulator with code 521 or lower should be

"LH" Revision	2.2	2.4	2.4.2
AMM material	Metal	Plastic	Plastic
AIC connector	3 pin	2 pin	3 pin

Model Year	Non-Turbo	Turbo (Including SPG)
1985	N/A	2.2
1986-1987	2.2	2.2
1988	2.4	2.2
1989-1990	2.4	2.4
1991-1993 & 1994 CV	2.4.2 (B212 2.1 Liter motor)	2.4

Classic Corner

replaced with the 1976-spec regulator of code 522 or later. On California cars (only) the thermo-time switch must be replaced with the 1976 version.

Identification: If your 1975-99 does not have the impulse contact mounted alongside the ignition coil (vacuum hose at the top, two wires out the bottom), you may need this kit. 1976 & later 99s and all 900s do not take this kit, as its function is standard.

SI 06/79-375

'Shut-Off valve kit - Improving warm start characteristics'
CIS-equipped 99s 1975-1977

Description: Kit 93 04 460. A solenoid valve is inserted in the return line from the warm-up regulator. This prevents rest pressure loss that results in a hard-to-start condition.

Identification: a solenoid valve mounted to the lifting eye bracket.

Summary: Use the kit in extreme circumstances only. Modern fuels and filters usually eliminate the need for this kit.

SI 07/80-431

'Hot Start Kit for fuel-injected (CIS) engines'

1975-1980 with hard starting when hot.

Description: Kit p/n 78 73 458. Normally, when starting the motor 'hot', the cold-start injector is not used. This kit will pulse the cold-start injector if the motor will not start after approximately 1.4 seconds. A 0.1 second pulse is followed by a 0.3 second rest until the motor starts.

Identification: A relay is clipped to the inner fender near the fuse box. A small cable with green and yellow wires is spliced into the wiring to the thermo-time switch.

Summary: The function of this kit is built-in to 1981 and later CIS-equipped Saab 900s. The relay is mounted in the CIS relay box in the left front fender.

SI 12/81-536

'Service Campaign no. 502. Replacement of Acceleration Enrichment Time Relay'
All 1981 900s up to VIN B1023405

Description: The internal circuitry of one of the CIS relays was changed. The ensures relay operation and warm start function over longer cooldown periods.

Identification: The large relay (covering relay places 'B' and 'C') is replaced with

part # 85 71 606. The new relay will have a yellow dot on the top of the relay.

Summary: Because this is a service campaign, it will be on record with Saab Cars USA as to whether the previous owner had it completed or not. Being that this campaign is over 20 years old, it is unlikely, in this writer's opinion, that Saab will honor the campaign.

SI 06/84-692

'Service kit to improve driveability with cold engine - certain M82 and all M83 naturally-aspirated 900 (900, 900S)'

Applies to M82 normally-aspirated cars with Lambda controller p/n 93 45 216 (Bosch # 0280-800 054) and all M83

Description: Kit p/n 85 46 921. An additional temperature switch is mounted in the thermostat housing. It is wired to relay E in the relay box. The kit delays the mixture regulation by the Lambda system until the motor has stabilized on its own.

Identification: Additional temperature switch in the thermostat housing, close to the control pressure regulator.

Summary: If you don't have an 82 or 83 non-turbo with the aforementioned Lambda controller, you can't use this kit.

SI 09/85-784

'Improving cold engine driveaway warm weather'

M84-85 900 models with 8 valve engines

Description: Service Kit p/n 88 18 015. Kit consists of an additional thermo-switch and wiring. Also requires rearrangement of two existing temperature switches.

Identification: Thermo-Time switch moved to the thermostat housing. Additional thermo-switch mounted in the housing, near the warm-up regulator.

Summary: Useful if you are experiencing problems with starting and moving the car 'cold' at 'warm' ambient temperatures in the 60s & low-mid 70s. Easy to install. Before installing, make sure the injection system is otherwise operating properly.

SI10/89-1179

'Service Kit for cold weather starting problems'

1985-88 900 models with LH 2.2 Fuel System

Description: Service Kit 88 18 338. This kit consists of components to add a CIS-style 'cold start injector' to the throttle body,

move one AIC hose connection (in some cases), and provide the electrical system to actuate the cold start injector. A thermal switch closes its contacts below 20°F and opens the cold start injector.

Identification: LH 2.2 system with CIS-style 'cold start injector' in the throttle body; fuel line from cold start injector to fuel rail; and a thermal switch mounted in the block drain hole on the exhaust side.

Summary: For cold start problems in temperatures below 20°F (-7°C). Limited availability of this kit. The District Service Manager must approve.

SI 12/90-0073

'Service kit for cold weather starting problems in extreme cold weather'

1988-91 900 models with LH 2.4

1991-900 models with LH 2.4.2

Description: Service kit p/n 88 19 070. This kit adds a CIS-style 'cold start injector' to the throttle body. In temperatures below 5° F (-15° C), the LH controller opens the valve, allowing more fuel into the inlet airstream.

Identification: Cold start injector mounted in throttle body; fuel line from cold start injector to fuel rail. Jumper installed in wiring near LH ECU.

Summary: If your car sees these extreme temperatures, this kit may be warranted. Other procedures must be undertaken to ensure applicability.

SI 11/92-0270

'Driveability improvement: CIS with heated oxygen sensor'

1988 900 model (B201 engine) only

Description: Not a kit, but a service procedure for 1988 '900' cars. The procedure makes maximum use of the adjustment specifications, and then, if the problem persists, installing new components. At first, proper tune-up specs must be met. If they cannot be achieved, or driveability problems persist, the components are replaced as follows:

1. Auxiliary Air Valve p/n 91 14 869 (only approved for the 1988 B201 engine)
2. Remove the spring from the vacuum impulse contact
3. Fit new Viton injectors p/n 78 56 354
4. Install new warm-up regulator p/n 75 15 554

Identification: No obvious signs. Set correct tune-up specs, and test driveability.

Summary: Proper tune-up is essential before installing these parts or any of the kits listed here.

In all of the service bulletins, Saab emphasizes that the rest of the system must be brought up to good working order before installing any of these kits. This includes checking the condition of the spark plugs, checking for proper fuel pressures, making sure that the filters have been changed, and the timing has been set properly.

For the best value in service manuals, I recommend the Bentley books. There are two, one covering the 8-valve from 1981 to 1988, and the second covering the 16 valve from 1985 through 1993. These are available from bookstores, including Amazon.com & Barnes & Noble online.

Some of the cold start kits also tell the technician that in extreme cold weather, a 'lighter' grade of oil should be used, i.e. 5W30. (Usually Saab recommends that 5W or 0W oil, when used, must be synthetic or semi-synthetic formula. NINES is preparing a story explaining why! -Ed.) If you seem to be having a consistent temperature-related problem with your car, check the list and see if there is something that may help you out. There is really no reason that a fuel injected 99 or 900 should not be reliable through all temperatures.

Next time, a guest columnist! Gary Stottler will offer advice on purchasing a 99

Happy Saabing!

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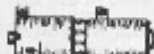
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Advanced Technology

Some of you may know that I was working on a pet project for quite a time. This project finally came to fruition this summer. The project was to install a Saab Direct Ignition system in a Classic 900.

My 1986 900 turbo Convertible (yes one out of 352) became the test bed after I disposed of my red 86 900T, which had rusted rather badly. My main purposes in making the conversion were to bring the advanced technology to one of my 900s, and to prove to myself that it is feasible. Whether it is all "worth it" is quite another discussion.

Performance was the bottom of the list. There are plenty of options for a Saab with Hall Effect ignition, and indeed, an aftermarket, stand-alone system that replaces the ignition, injection and boost control is probably cheaper, and easier to install.

How it Works

Saab Direct Ignition (DI) is a coil-on-plug ignition system. There are no secondary spark wires, and there is no distributor. Ignition timing is controlled by the Electronic Control Unit (ECU), which receives a signal from a crankshaft-mounted sensor. There is one coil for each spark plug. These are mounted in a "cassette" which fills much of the valley between the cams, and is screwed to the valve cover.

The cassette also sends signals back to the ECU. In particular the cassette, via the spark plugs, can sense when and whether combustion actually took place in the combustion chamber. This tells the ECU on startup which cylinder is firing, and synchronizes the timing. On cars with Trionic, the cassette also functions as the knock sensor).

The original DI system replaced only the hall-effect ignition system. Later systems (and the only ones imported to the USA) included Saab's Automatic Performance Control (APC) boost control, creating DI/APC. The advantage here is

that the system has two avenues available to it to attempt to eliminate knocking.

The first thing a DI/APC system does is to retard the ignition timing. Often, this is all that is needed. If not, however, the DI/APC can also bleed off boost. As a last resort, the ECU sends a signal to the LH to enrich the mixture.

What's Involved

Making the conversion required a lot of research, much hunting for parts, a myriad of electrical connections, and some mechanical work as well. The research was what made it all possible. Without the hours spent poring over manuals, parts fiche, and service bulletins, the job would have been a lot harder. One benefit to doing this type of conversion with a Saab is that Saab has been such a small company, that they tend not to change things unless absolutely necessary. I concentrated on locating the common areas in certain systems between the 900 and 9000.

To give you an example, the shutter wheel that controls the DI was one area that I needed to research. The 900, not having a

DI system, doesn't have a DI shutter wheel. But, I recalled that both the 900 and 9000 used EZK ignition on the B202 non-turbo engines. Starting in 1989, the EZK was triggered by a crankshaft sensor and shutter wheel.

Hunting through the parts books, I found that the 900 and 9000 used the same shutter wheel for the EZK system. Since the B202 turbo with DI in the 9000 uses the same pulley as the non-turbo B202, the DI shutter wheel from a 9000 should bolt right up to, and work with, a main pulley from a B202 non-turbo.

The only thing of concern to me was that Saab made a change in the DI shutter wheel about the time they went with the B234 motor. This was of concern because I had looked at the two pulleys and there was a disparity in the drilled holes that mount the shutter wheel, when looked at in relation to the crank keyway. I solved this mystery by looking at the oil pump covers. The crank pickup sensor was rotated (relative to the cylinder centerline) on the B234. This rotation corresponded to the rotation of the holes in the pulleys.

Collecting the parts can be easy or difficult, cheap or expensive. I was very lucky in my parts gathering, picking up used DI cassettes for \$10, ECUs for \$20, etc. Still, I probably spent on the order of \$600 to \$700 just for the used parts (but I also have almost enough parts to do it again). That included \$150 for a 195 HP 1990 9000 'red box' ECU, and \$150 for two wiring harnesses.

At this point some may be wondering if it's worth the cost. Admittedly, other systems can be bought that have greater controllability, so unless you're like me and just like the challenge, another aftermarket system is probably a better 'deal'.

Injection

Though the LH 2.2 should be able to work with the DI/APC, I opted to also upgrade the injection system to LH 2.4. The main impetus behind this was improved troubleshooting ability through the electronic tools. The LH 2.2 has no 'codes' to be read. The LH 2.4 does, though they are not always helpful. But this would match well with the ability of the DI to store codes and tell the technician what is going on.

Probably the biggest challenges were in making the LH 2.4 happen in a car built for LH 2.2. There is extra wiring, different circuitry, and relocated circuits. Fortunately, most of the LH wiring is contained in a completely self-contained harness. I only needed to deal with the interface between the car and the LH harness.

Wiring

I was able to work with the LH 2.4 harness off of the car to integrate it with the DI. Making the DI work was easy, as I tracked



Saab DI Cassette installed on a Classic 900.

down some DI wiring from two 9000s. In the 9000 with DI/APC, the DI harness is completely separate from the rest of the car wiring. It's not exactly easy to get out (especially from a junkyard car without power), but it takes care of most of the wiring needed to make DI/APC work in a 900. Once the DI was integrated with the LH 2.4 harness, and the car was prepared to accept the harness, it took less than a weekend to remove the LH 2.2 and the old ignition, and install the LH 2.4 and DI.

The LH 2.4 fired right up on the original ignition, but it took me a few starts and a check of the

wiring to get the DI to fire. There was no problem with my wires, but an ignition amplifier that was still installed in the fuse box was pulling down the ignition pulses, so the LH would not give and fuel! Removing that relay solved the problem.

Next Time

In the next Classic Corner, I'll go over in more detail the parts needed, and begin to delve into their installation. This series should run 3 or 4 columns. I hope I'll keep your interest!

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DI/APC Conver- sion Part 2 Parts



Converting a Classic 900 B202 16 valve motor to Direct Ignition (DI) is made fairly easy by virtue of Saab having used DI on B202 9000s. Some parts will come

1992 B234 DI/APC. Aside from the extra 0.3 liters of displacement, the 1990 system uses a manifold pressure sensor, where the 1991 system uses an inlet air temperature sensor, and on the same ECU pins!

Pull all the bits from a single car, and you should be fine. The actual DI cassette, though, is interchangeable.

The list

-DI "Cassette"-

The part that is most noticeable on the motor. There have been several "upgrades"

-Crank Position Sensor-

Two pieces make up the crank sensor, and two other pieces need to be acquired. The sensor pieces are a shutter wheel with three slots (as opposed to the EZK shutter wheel with two slots) that mounts to the back of the main pulley, and a hall sensor that mounts to the oil pump cover.

You must use a main pulley from a 1989 or later non-turbo 900. Some seem to believe that this pulley can't handle the power of the turbo, but I have seen no ill effects in several thousand miles of driving, with a used pulley.

The 1989 or later non-turbo 900s use an EZK ignition with the same crank pickup arrangement as the DI, only with a different shutter wheel.

The oil pump cover has a place to mount the hall sensor that the shutter wheel passes through. This place is found only on the oil pump covers from 1989 and later. Both turbos and non-turbos should have this mounting place.

The sensor is electrically identical on both the 900 with EZK and the 9000 with DI, the only differences being length of wires and the body of the connector. Change from the 900 3-place connector body to the 9000 4-place body and it will mate up to the harness.

-Knock sensor-

A different knock sensor is used for DI. It still screws into the same place on the block.



Parts you'll need for the swap

from there, others from 900s which have EZK from about 1989.

The basic parts that you need forms a long list, and unless you have a good, cheap scrapyard nearby, the prices can be rather high.

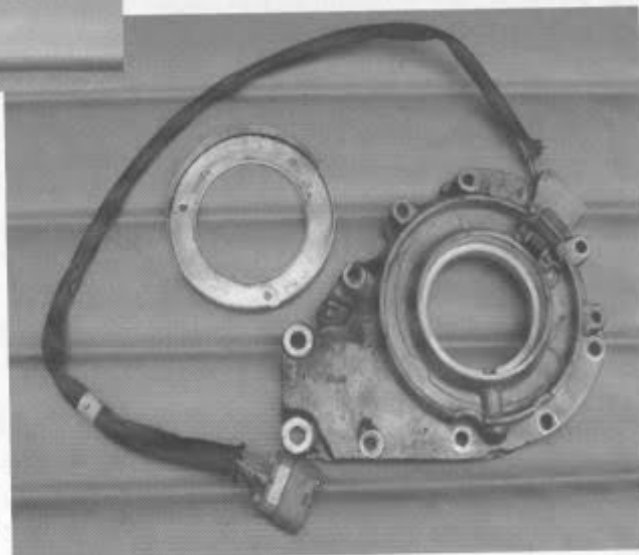
Subtle differences

When acquiring parts, it is essential that you get a set of parts that come from the same year range. The 1990 B202 DI/APC works slightly differently than the 1991-

over the years, the latest being part # 91 78 955. The only issue with this is the need for an adapter harness, part # 93 21 787.

-DI ECU-

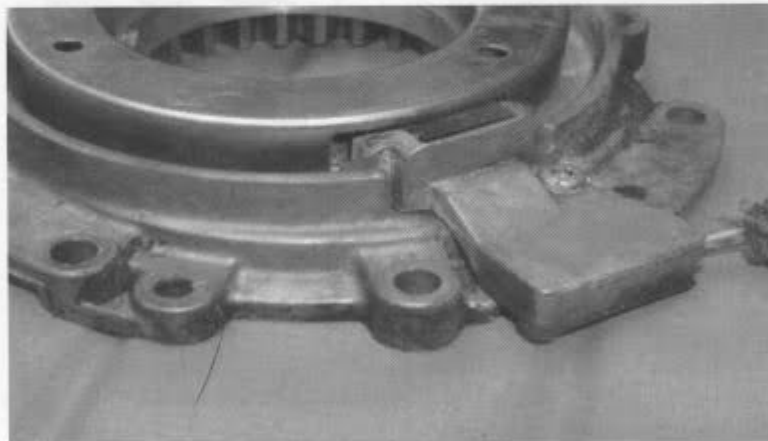
This is the "brains" of the operation. It connects to the LH system, and all of the DI components. For the USA, the 1990 ECUs are different from the 1991 & 1992 ECUs.



Crank sensor, oil pump cover and shutter wheel

-APC Valve-

The APC valve is different. It is more robust, and operates differently. You'll need one from a 9000 with DI/APC.



Crank sensor and shutter wheel

Photos by the author

-Manifold Absolute Pressure (MAP) Sensor (1990 & earlier)-

The MAP sensor on the 1990 9000s is located under the steering column in the passenger compartment.

The inlet air temp sensor (1991 & 1992) is located on the upper aluminum inlet pipe. You'll need to have one spot welded onto

one of the 900s pipes if you choose to go with the later system.

-Wiring Harness-

While not strictly needed, having a 9000 harness can make life a lot easier. Fortunately, the DI/APC harness is completely separate from the rest of the car wiring. The harness begins at the ECU under the driver's seat. You will need to remove, or at least move the driver seat to ac-

cess the engine bay.

Disconnect the DI cassette, the knock sensor, the APC valve, the crank sensor and the inlet temp sensor under the hood, then go under the seat & dash & pull the harness into the footwell.

Next time

Next time, I'll expand on the connections needed to make it all work. There's a lot to go over. If you are serious about doing this, get yourself copies of the 9000 manuals for DI and LH.

I would like to take some space here and thank Steve Goldberger for the fine work he has done in pulling NINES up by the bootstraps a few years back, and making it into a marquee magazine to be proud

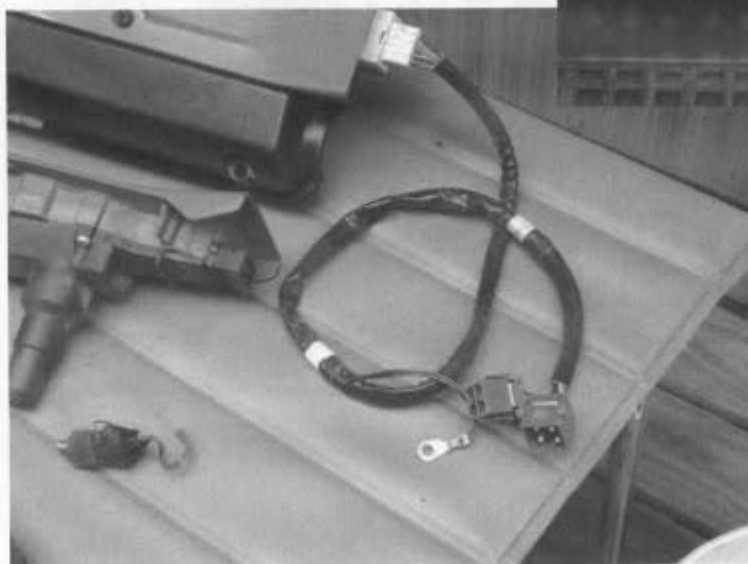


Part number for latest DI cassette

cess the ECU and harness. The harness runs from the ECU to the left door sill (remove the kick plate), forward along the sill, up behind the kick panel, branching to the manifold sensor (1990 & earlier), then through a rubber grommet into

of. Steve devoted a lot of time to producing each issue, and I hope now that he is "retiring" we will see more of his in-depth technical articles in Nines.

And congratulations to Seth Bengelsdorf on his assuming the editorship of NINES. I have worked with Seth on The NEWS (North East Writings on Saab), and I am sure that the legacy Steve left is in good hands.



Adapter harness for DI cassette