

Appendix A1 (FMS)

Additional information for fuel injected engines chapter “Mixture formation”.



Important: the chapter fuel injection (appendix A1) is only to be used in connection with the operating instruction and settings manual for Hirth engine serie 27, 32, 35 and 37. Each topic in the operating instructions, with the exception of the chapter for mixture formation in the carburetor, is still unrestricted and valid.

Read the operating instructions completely before the assembly of the engine or before starting the engine.

General directions:

In the interest of the ongoing developments of our products, we reserve the right to change the delivery volume in form, technique and supply. We also ask for your understanding that the data in this instruction manual gives no further claims.

For further info:

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1 Description of the fuel injection

1.1 General description of the fuel injection

The applied fuel injection system is a sequential multipoint fuel injection. The throttle body injection is installed instead of the carburetor. Both throttle body injection (TBI) units are connected at the bell crank and are synchronized with each other through the throttle body shaft.

The fuel pressure is 42 Lbs. PSI. This is produced through an electric fuel pump and stays consistent with the help of a pressure regulator.

To avoid interruption from contaminated fuel, a series of fuel filters are installed before and after the fuel pump.

The amount of fuel is controlled through the injector nozzle (governed by the throttle position-RPM).

The dosage is refined through different adjustment parameters.

The following parameters are used for the calculation of fuel ratio-amount of injection:

- Throttle position
- RPM
- Ambient air temperature
- Barometric pressure
- Engine crankcase temperature
- Acceleration rate
- Manual manipulation (optional)

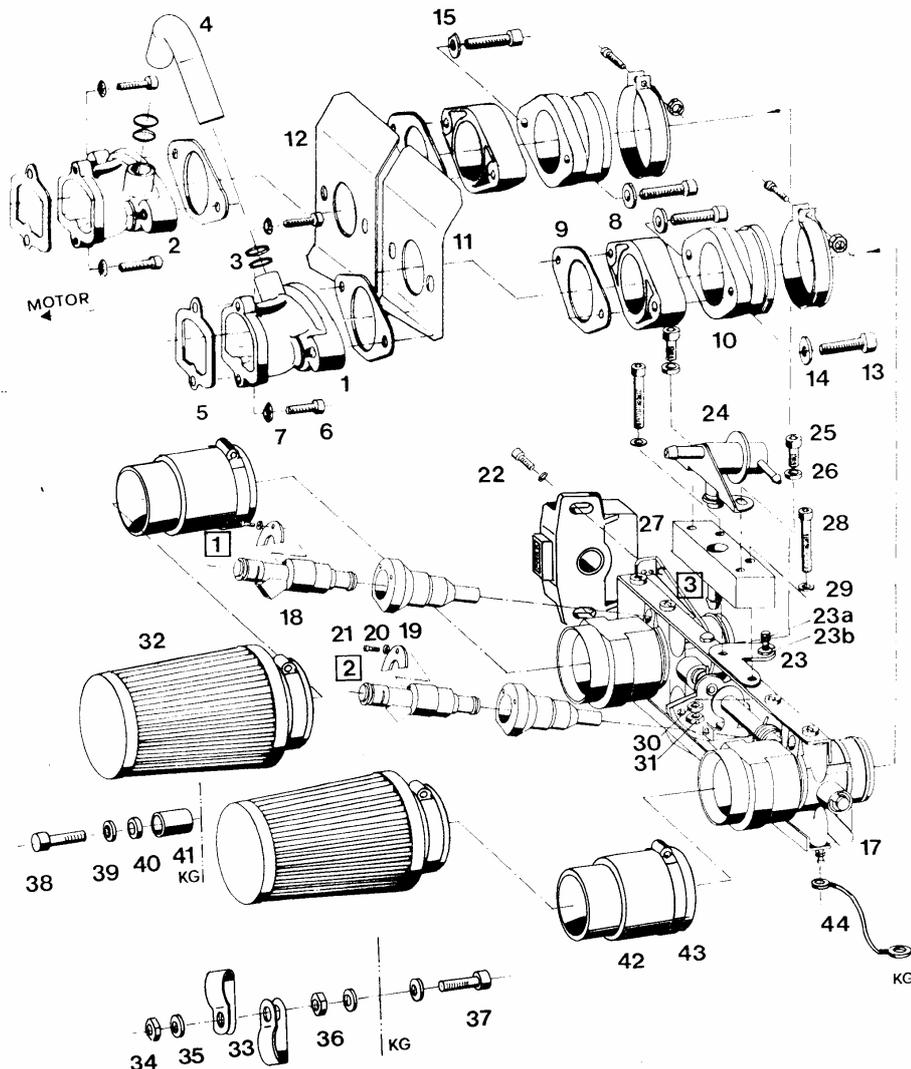
1.2 Nomenclature and description of each single component

- Throttle body injection (TBI): **(Picture 1 Position 17)**
Function: Performance regulator of the engine through operation of the throttle body.

The TBI consists of the following main components:

1. Throttle position sensor (potentiometer) **(Picture 1 Position 22)**
Function: To electronically transmit the analog angle of the throttle valve to the Injection system.
2. Injector valves **(Picture 1 Position 18)**
Function: Dosage and atomization of fuel.
3. Throttle cable and bell crank **(Picture 1 Position 23; 23a; 23b)**
Function: Throttle cable housing and the adjustment of the off idle motion of bell crank as well as attachment of throttle cable and idle adjustment.
4. Pressure regulator and pressure regulator housing. **(Picture 1 Position 24 & 27)**
Function: maintains 42 PSI fuel pressure to the injectors.

Picture 1: Throttle body injector (TBI)



- Fuel pump/filters

Function: To filter the fuel and to produce the injection system pressure.

The fuel pump/filter units consist of the following main components:

1. Fuel filters (**Picture 2 Position 3**)

Function: To protect fuel pump from pollutants greater than 60 microns.

2. Fuel pump (**Picture 2 Position 3**)

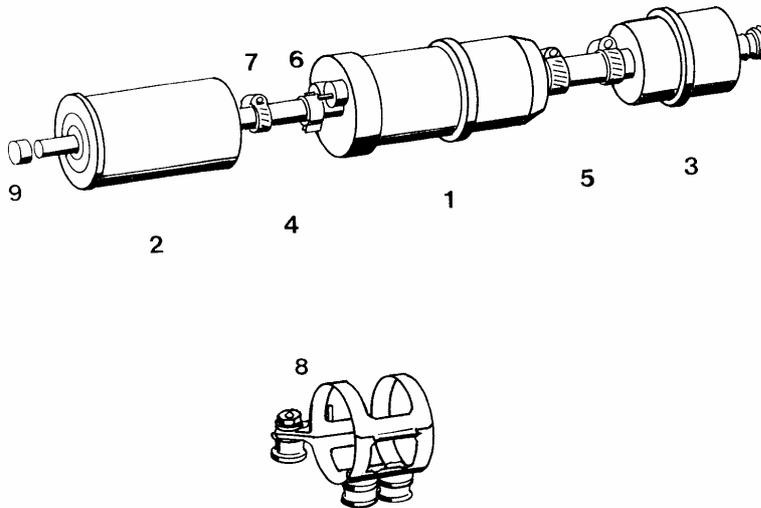
Function: To produce the system pressure and deliver fuel to the injection valve.

Warning Only connect the fuel pump power supply through the computer power supply. Never connect it independently. In case of accident it's not certain that the fuel pump will shut off with a nonrunning engine. (Fire danger)

3. Fuel Filter (**Picture 2 Position 2**)

Function: Protect the injector valves from pollutants greater than 10 microns

Picture 2: Fuel filter units



- **Wire harness (Picture 3 Position 2)**

Function: Electrical connection between the sensors/actuators and the computer power supply.

The wire harness consists of the following components:

Sensor/sensor connectors:

1. Air temperature sensor
2. Crankcase temperature sensor
3. Plug connector to throttle position sensor.
4. RPM connector

Actuator connectors:

1. Injector valve power supply
2. Fuel pump power supply

Other connectors:

1. Computer power supply connector
2. Power supply 12 Volt

- **Control Unit (Red box) (Picture 3 Position 1)**

Function: Processing of data from sensors. Power supply to the injector valves, the fuel pump, and houses the barometric sensor.

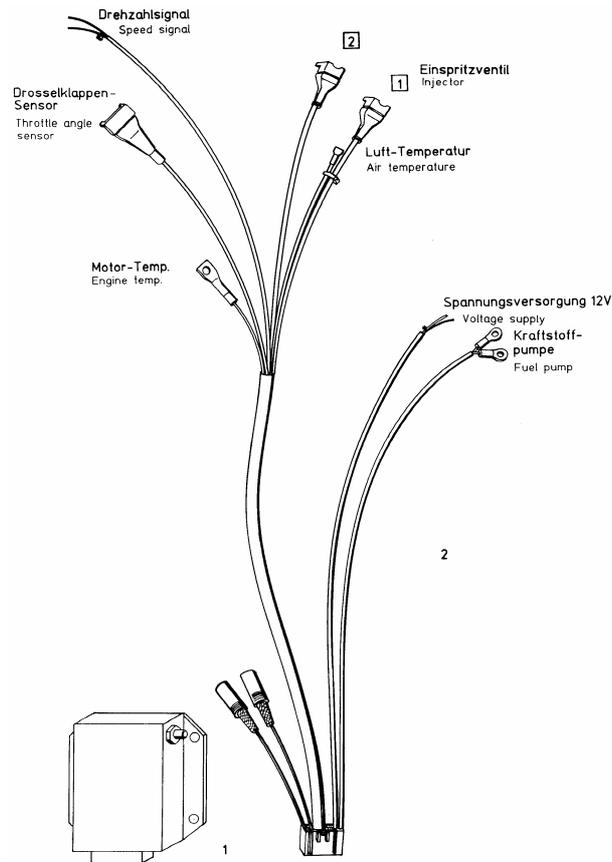
The control unit consists of the following main components:

1. Plug connector
2. Barometric pressure connector

Features: On the side of the control unit is a sticker with the number of the downloaded software.

Example (3203-11) Engine type-3203, version-11.

Picture 3: Wire harness with control unit



2. Installation instructions

Because of the fuel injection system it is possible to start and run the engine in any position. For a secure and trouble free operation you must pay attention to the installation instructions.

2.1 Electrical installation (read also the hirthinformation 0065 „Additional Information on voltage supply and ignition system):

- The 12 Volt power supply has to be connected separate, which means between the battery and the computer there cannot be any other electrical components (consumer) connected to it.
- The wire harness is to be installed in a way where the electrical cable cannot touch any ground during operation.
- The cable has to be installed in such a way that no chance of wear or breakage could occur.
- The control unit must not be exposed to water. All other electrical components are waterproof.
- The control unit has to be installed in an area where the air pressure sensor (nipple protruding from side of computer) cannot be influenced by turbulent air.
- The air pressure connector cannot be sealed off (rubber caps etc.).
- The electrical components cannot exceed an operation temperature of 80 degree Celsius, 176 degree Fahrenheit. (Short time maximum exposure of 100C, 212F)

- The wire harness has to be installed with a sufficient enough distance from all other electrical wires to prevent electromagnetic interference of the sensor and computer wires of the injection system.
- To avoid any possible interferences EMC to the wire harness it is not allowed to lay any other cables parallel in a distance of minimum 10 cm. Attention must be paid especially to the ignition input lines and to the lines from engine to governor and from governor to the battery since these are carrying big currents and / or high voltages.

The required wire diagram and applicable fuses are shown in the circuit diagrams.

2.2 Hydraulic Installation:

The maximum suction height for the electric fuel pump is 500mm or 19 inches. (Also pay close attention to extreme flying position i.e. takeoff).

The fuel pump should be installed close by the fuel tank, so the suction pipe stays short.

- The supply has to be dimensioned where the fuel pump can suck in a minimum of 120 L/H. (Recommended pipe diameter minimum 10mm or 0.39 inches).
- All fuel-carrying components have to be installed with enough distance from any hot component to prevent danger from fuel ignition or explosion. (i.e. exhaust system).
- Each fuel line has to have a pipe clamp installed for security.
- The fuel lines between the fuel filters and the engine must be made of fuel durable material and resist a pressure of min. 6 bar.
- The fuel return line to the fuel tank must have a diameter of 8mm or 0.312 inches to prevent backpressure.

With a double fuel tank system you must pay close attention that both fuel tanks are connected to each other in such a way that uneven fuel levels do not occur from fuel return.

On dual fuel tanks which are controlled separately, you must have an overflow connection installed, or it must have a fuel return valve that will direct fuel to the tank that is in operation so as not to deplete operational fuel tank or create an overflow situation.

Warning: It is not allowed to use an inline fuel metering system. Because this type of system restricts in a not acceptable amount the fuel flow. And these can cause heavy engine failures.

2.3 Installation Instruction

1. Install the engine according to the operation manual and the service information A.
2. Install the computer at a suitable place (pay attention to the length of the wire harness)
3. Install the wire harness according to the above-mentioned connections and connect the blue plug to the computer.
Attention: The blue plug can only be connected in one position with the computer.
4. Connect the power supply (red +) with the on/off switch. The supply line to the switch has to be installed according to the above named instructions. Connect the power supply ground (black -) to a ground or even better, directly to the (-) negative pole on the battery. muß den oben genannten Einbauvorschriften entsprechen.
5. Install the fuel pump (close by the fuel tank), and lay the pressure line from the fuel filter to the engine. Secure them with the pipe clamps (picture connection to the engine-connection to the filter).
6. Connect the supply line from the fuel tank to the suction connection of the fuel pump/fuel filter (big pipe connection) and secure them with the pipe clamps.

7. Please fit on suitable position the relay for fuel-pump-control .
8. The green and black wires from wire harness must be connected to clamp 85 and 86.
9. Connect the separate feed line (cable cross section 1,5 mm²) from the switch of the fuel injection (point 4) or directly with an 12amp. fuse from the battery (+) to clamp 30 of relay.
10. Join the clamp 87 of relay to the positive connection (+) of fuel pump (circlip 4,3 mm) (cable cross section 1,5mmA²).
11. Connect to earth the negative connection (-) of fuel pump.
Attention: please make safe that the connection to earth up to the battery is ensured at all events transmitting at least 8 Amp.
12. Hook the throttle cable to the bell crank of the TBI (**Picture 4 Position 5**). Adjust the throttle cable with the adjusting screw (**Picture 4 Position 2**) so that the throttle cable in the idle position has some play (2-4mm or 0.078-0.156 inches) and secure with the locknut (**Picture 4 Position 1**). You have to make sure that the idle stop (**Picture 4 Position 5**) nut is adjacent to the throttle stop (**Picture 4 Position 3**).
13. Function testing:
Turn on the fuel injection system (without starting the engine). In doing so the fuel pump must run 3-8 seconds.
Open the throttle valves completely. By doing so you must clearly hear a rattling noise from the injector valves approximately 1 second in duration.
14. After repeated openings and closings of the throttle you need to check the gasket of the fuel hydraulic while the system is turned on.

2.4 Additional Steps to Increase the Breakdown Security for the Unit:

The following steps are not necessary for a secure operation of the system. However, every technical device (equipment) can have troubles and even complete breakdown. To have a high security or even a redundancy in such cases the following measures can be built in.

1. A parallel fuel pump, with the require fuel filter in and fuel filter out which can be switched manually should the main fuel pump fail due to interruption of power or clogged filter.
2. To avoid interruption of the RPM signal. The signal line of the injection system must be only connected to the ignition system and not an additional RPM tachometer (factory installed). In case of interruption caused by a tachometer the RPM signal could be affected and possibly send a wrong signal to the computer.
Recommendation: Use an inductive tachometer, which gathers RPM pulses from the spark plug wires.
3. Control of the fuel injection system:
Control of the fuel injection system: To recognize interruptions of the hydraulic system early, the fuel pressure (operation pressure approximately 3 bar) should be monitored. Interruption can happen due to clogged filters or a defective pressure regulator, which can cause a change in the system pressure.

To recognize interruptions in the electrical system early, you should monitor the voltage and power supply to the injection system.

In case of defective regulators or a defective consumer component the battery voltage will slowly sink (battery discharge). This can be detected early and through proper measurements (turn off all consumers not necessary for the primary operation). The operation time can be prolonged in this method. The minimum voltage necessary to operate the fuel injection system is 10 Volts.

Power supply control:

Should, due to a damaged electrical component (injection valves, fuel pump) the power supply increase, you can detect this early through measuring the amperage.

2.5 Additional Steps For A More Effective Engine Operation:

1. RamAir Box

When operating in tractor configuration, you can use the airstreams and the developing backpressure in a ram air box to “charge” the engine. To avoid unnecessary leanness of the air/fuel mixture, you must have a hose connection from the computer barometric pressure sensor to the ram air box so the computer can compensate for the increase in air pressure.

2. Manual fuel enrichment (accessory)

Allows manual increase of fuel to normal program parameters. This would be used to richen the fuel mixture to cool the engine in special applications only. In normal engine operations this accessory is not used.

3. Computer interface and RS232 interface hardware.

With the software you can monitor the sensors and the return signal of the injection system. Beyond that you can download new programs to the control unit. These updates are available through authorized Hirth distributors or Gobler-Hirthmotoren via the Internet. With that, you will always have the newest software update.

3. Operation Of The Equipment

The injection system has automatic cold start compensation.

3.1 First time in operation:

1. Turn on the ignition system.
2. Turn on the injection system.
3. Open the throttle valves fully.
4. Turn the injection system on a second time for a total of 10 seconds of purge to allow the system to fully evacuate air from the system.
5. Close the throttle fully.
6. Engage starter to start the engine. Should the engine not start, you may need to open the throttle valves slowly during start up.
Comment: The starting sequence should be interrupted after a maximum of 20 seconds, if the engine doesn't start. After a short break repeat starting sequence.
7. As soon as the engine runs on it's own, turn off the starter and keep engine running with 2-3 short burst of acceleration.
8. Warm up the engine at 2000-3000 RPM under a light load. (See operation instruction Capital 2.2 “Warm up recommendation”).

9. If the engine is warm, adjust throttle to idle (see Capital 4 “Adjustments”).
10. During and after the first operation you have to do the following test on the injection system:
 - Check the fuel lines and connections for leaks.
 - Check fuel lines for cracks and signs of rubbing.
 - Check electrical lines for secure connections and signs of stress.
 - Check throttle cable for smooth operation and security.
 - Check idle speed and adjust if necessary.

Exchange any damaged parts, and install new parts in accordance to proper installation procedures to avoid damage.

3.2 Starting The Engine

3.2.2 Cold Engine

1. Turn on the ignition system.
2. Turn on the injection system.
3. Start the engine with throttle fully closed. Should the engine not start under those conditions, open the throttle slowly while starting the engine.
Comment: If engine doesn't start, stop the starting sequence after a maximum of 20 seconds. After a short break, repeat starting sequence.
4. If engine fails to start after repeated attempts with above procedure. Advance throttle to full open position. This will cause the injectors to spray at 100% for 1 second. Return throttle to closed position and repeat starting procedure. If engine fails to start do not repeat this step as engine will become flooded.
5. As soon as engine runs on it's own, turn off starter and keep engine running with 2-3 short accelerations.
6. Warm engine at 2000-3000 RPM under a light load.

3.2.3 Hot engine

1. Turn on the ignition system.
2. Turn on the injection system.
3. Start the engine with throttle slightly open. Should the engine not start under those conditions, open the throttle slowly while starting the engine.
Comment: If engine doesn't start, stop the starting sequence after a maximum of 20 seconds. After a short break, repeat starting sequence.
4. As soon as engine runs on it's own, turn off starter and keep engine running with 2-3 short accelerations.
5. Warm engine at 2000-3000 RPM under a light load.

3.3 Disassembly Of The Engine

1. Turn off the injection system.
2. As soon as the engine quits, turn off the ignition system.

Comment: You must absolutely not forget to turn off the ignition system, because it may cause damage to the ignition electronics. Furthermore, by touching the primary side, the remaining voltage may lead to a shock.

4. Adjustments

The system is adjusted at the factory.

The idle was adjusted to 1400-1500 RPM without any load (without propeller and gearbox).

The throttle valves and throttle position sensor are synchronized to each other and cannot be changed.

Attention: Don't twist the adjusting screw (**Picture 4 Position 4**) because the factory did the synchronization.

The only required adjustment is the idle. To do that you must pay attention to the following:

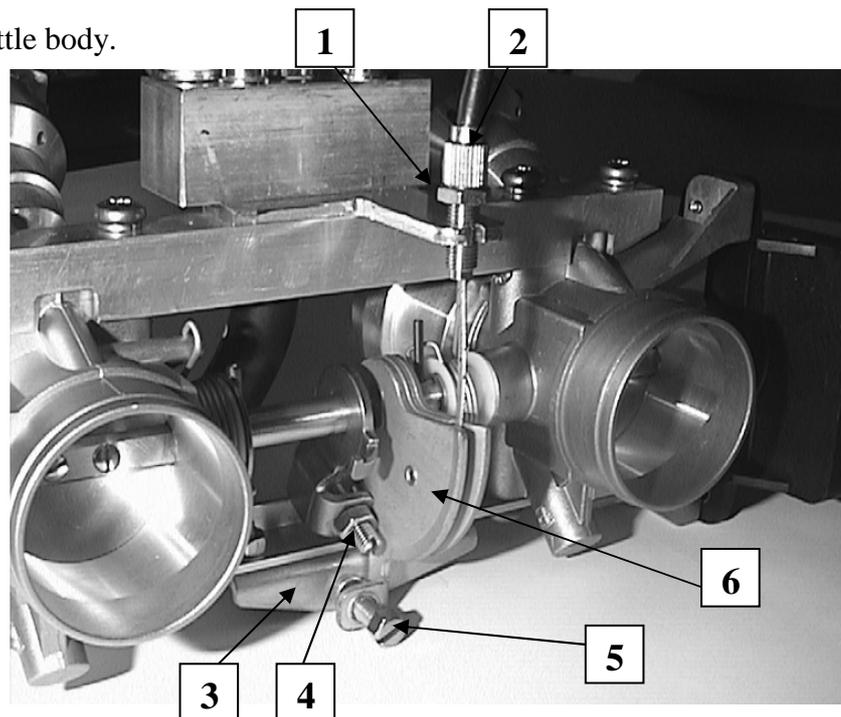
- Engine must be warm.
- The load, which impacts the engine in idle position, has to be installed (propeller etc.)
- The throttle cable must have a 2-4mm or 0.078-0.156 inches play while in idle position so the idle stop screw is adjacent to the throttle stop (**Picture 4 Position 3**).

An idle RPM is chosen so that the engine runs smooth and secure (recommendation: 1200-1800 RPM)

To make any necessary adjustment, turn the idle adjust screw in or out (**Picture 4 Position 4**). Clockwise turn increases RPM, counterclockwise decreases RPM.

Tip: Open throttle valves in order to better access adjustment screw.

Picture 4: Throttle body.



5. Maintenance/Service Intervals

The injection system is, except for the disciple components, maintenance free.
The following maintenance and control work has to be performed:

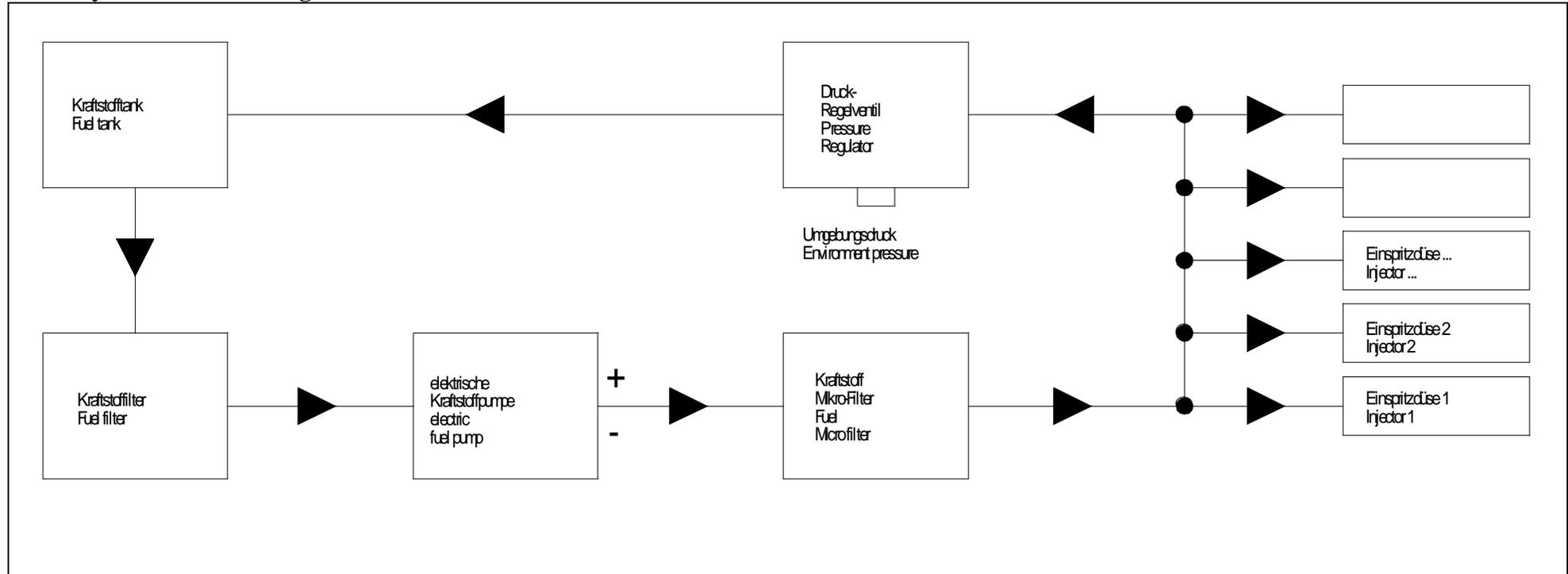
No.	Description	Interval				Then every (hours)
		After Beginning: (hours)				
		1	5	10	25	
1.	Check fuel system for damage (i.e. cracked lines)	X	X	X	X	25h
2.	Check electrical wires for damage	X	X	X	X	25h
3.	Check the condition and function of the throttle cable before.	each start up				
4.	Check the throttle cable for damage and lubricate.	X	X		X	50h
5.	Clean air filter or replace if necessary				X	25h
6.	Check fuel filter for contaminants and replace if necessary before replacement interval (change fuel filters together)			X		50h
7.	Check screws and nuts on the fuel pump, TBI, air filter, cable fastenings etc.	X	X	X	X	50h

The following parts must be replaced:

No.	Description	Replacement interval
1.	Inlet fuel filter	All 200h
2.	Outlet fuel filter	All 200h
3.	Air filter	All 250h
4.	Fuel pump	All 2000h
5.	Injector valves	All 2000h

6. Circuit Diagrams

6.1 Hydraulic circuit diagram



Kraftstoffleitungsquerschnitt: Innendurchmesser d=8 mm

Fuel line diameter: Inner diameter d=8 mm

Stabile Kraftstoffleitungen sind wegen der Pulsationen zu verwenden.

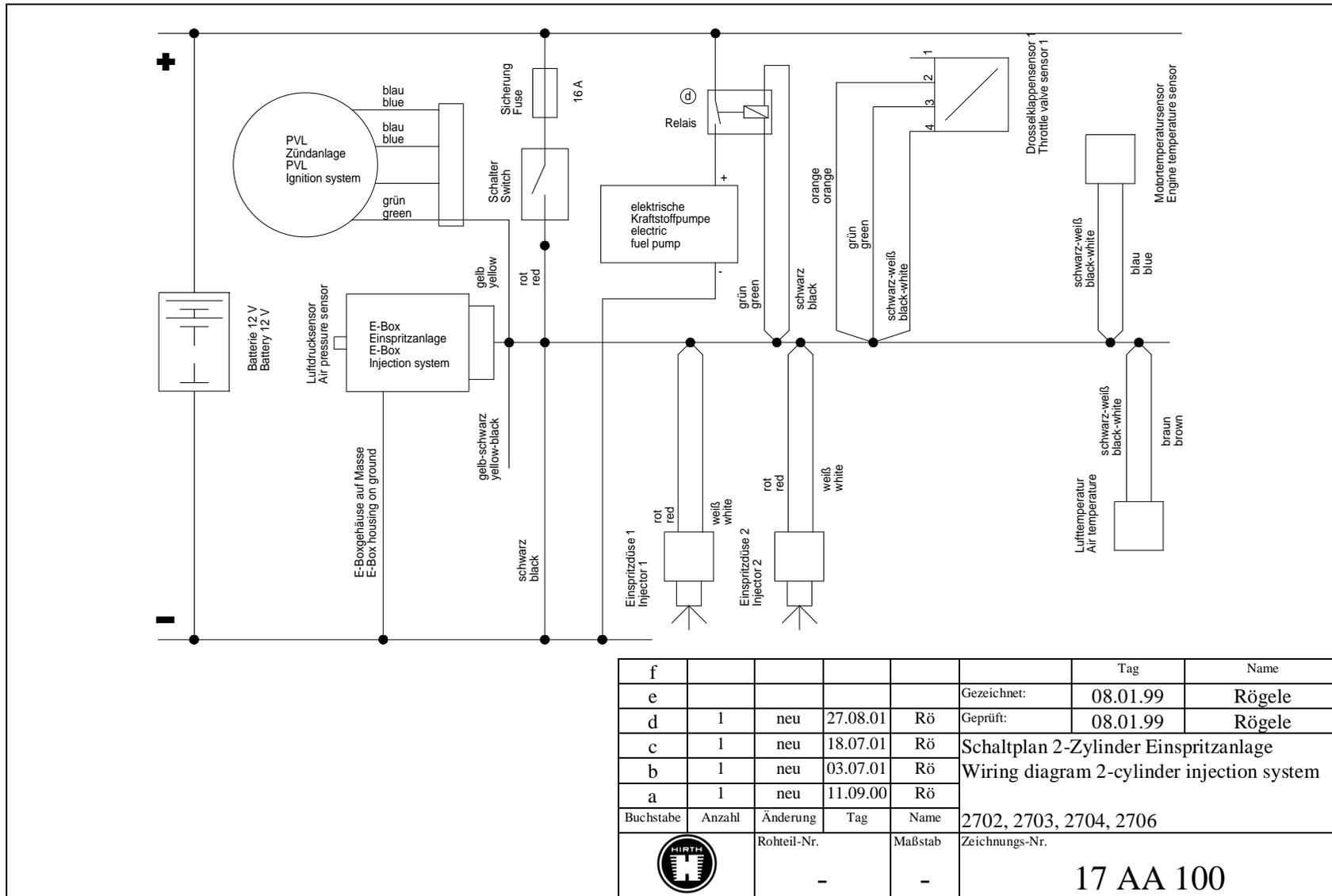
Use stable fuel lines because of the pulsation.

Druck-Regelventil markiert höchsten Punkt hinter der Kraftstoffpumpe.

Pressure regulator must be the highest point behind fuel pump.

f					Tag	Name
e					Gezeichnet:	08.01.99 Rögele
d					Geprüft:	08.01.99 Rögele
c					Kraftstoffleitungsplan für Einspritzanlage Fuel line diagram for Injection system 2702, 2703, 2704, 2706, F 30, F 40	
b						
a						
Buchstabe	Anzahl	Änderung	Tag	Name	Zeichnungs-Nr.	
		Rohteil-Nr.		Maßstab		
		-		-		

6.2 Electrical circuit diagram





Searching for Defects

Trouble	Cause	Control	Repair
Engine doesn't start	Power supply to computer interrupted	Check if computer has voltage	Reestablish connection
	Fuel pump not working. After the injection system is turned on you should hear the fuel pump after 3 seconds.	1. Check the electrical wires for connection. 2. voltage and reestablish connection.	1. Establish connection 2. Replace broken fuel pump
	No RPM signal	1. Connect a digital RPM meter to RPM signal terminal to verify signal 2. Reestablish connection after verification.	1. See capital ignition system 2. Establish connection
	Interruption of the injection electronics.	Must be inspected by factory.	
	Interruption of the ignition system.	See capital ignition system.	
Engine runs irregular; power deficit, and overheated engine, engine starts difficult.	Injection valve defective.	Disassemble I-valve and start engine. Compare the injection picture of the E-valves with different throttle valve positions.	Replace defective injection valves.
	Fuel pressure is incorrect.	1. Control fuel pressure. 2. Check fuel filters for contaminants.	1. Replace pressure regulator 2. Replace both fuel filters
	Defective sensors	Must be checked by factory or with help from software package accessory).	Replace defective sensor.
	Maladjustment of the throttle position sensor	Must be checked by factory or with help from software package accessory).	Restore the adjustment.
	Cable or plug connection defective.	Check plug connection and cable for transit or control the sensor signals with software package (accessory).	Replace defective cable or plug.
	Manual fuel enrichment is active.	Check throttle position sensor security.	Adjust TPS to "0"
	Also see capital ignition system and engine description.		