This electronic project manipulate the injector timing device, by extending the pulse width of the existing opening injector pulse or the opening time (or increasing the duty cycle). By other words; it lengthen the ordinary pulses by add a new pulse after the existing pulse to increase the fuel quantity. <u>The new pulse proceeds by a very short spike-equal voltage pulse (shorter than 50µS) and that seems not to have any bad influence of the functionality</u>. *This concept is similar and reminds of "piggyback" devices.*

IPE-GS intention is simply to convert petrol cars (fuel injection) for low energy fuels.

IPE measure the time of every injector pulse before itself creates a pulse that is proportional in width to the pulse width it just had measure. That mean consideration takes by variation of the pulse width. The condition concerning this concept is that your fuel injections computer or ECU (Electronic Control Unit) doesn't care if some add extra pulse width? Usually that is not a problem for any car.

The G-series is the third generation boards and modules I have develop, which is based on electronics that manipulate fuel injectors. I must admit that I am quite happy with the outcome. This time (the third) it was almost optimal, if not perfect?

"GS" stands for: General systems or general sequential fuel systems.

IPE-GS has all the advantages that the previous designs had.

• That means that IPE-GS can be used both in multi-point and sequential systems.
• Are in comparison to my other constructions relatively easy to build.
• Have high proportionality and precision.
• Only need to be connected to the injector cable - never cut or break any existing cables.
• It doesn't need a separate 12V supply cable since the power drawn from the injector cable.
• Only two cables are enough - one cable to an injector and one cable to ground (GND).
• Use a 4-pole USB-connection to communicate with the RCW-module.
• It don't need an expensive IGBT - only MOSFET (logic levels DPAK).
• The pulse width adjustment is controlled by voltage, not current as my other constructions.

That makes it possible to use <u>only one potentiometer</u>. One potentiometer is enough for controlling many independent units, only if you need to build a sequential fuel control - as much as seven units or more. This potentiometer is placed on the RCW-unit. RCW is the remote control (by wire) and the task is to control the IPE-unit from the dashboard, through a USB-cable.

For down pulling each injector, is an IGBT (Insulated Gate Bipolar Transistor) very suitable for these applications and they are constructed to cope with high voltage - up to 600V, but a MOSFET-transistor for 100V is enough.

This project make it possible to drive a car (with electronic fuel injector systems) on ethanol or a mixture of petrol/gasoline and ethanol in any possible mixture between them, or for another high- and low energy fuel in the commerce. If you not chosen to change the fuel quantity in some other way? Sometimes the ECU is able to adjust the amount very far from natural difference in the petrol qualities. But if that not is the circumstances with your car/ecu, then you may build this circuit in order to achieve this need of the quantity the engine require to function properly. The device only works for cars with a down pulling opening injection pulse, especially if the injection principle means that the opening of the pulses increase in frequency when the engine speed becomes higher.

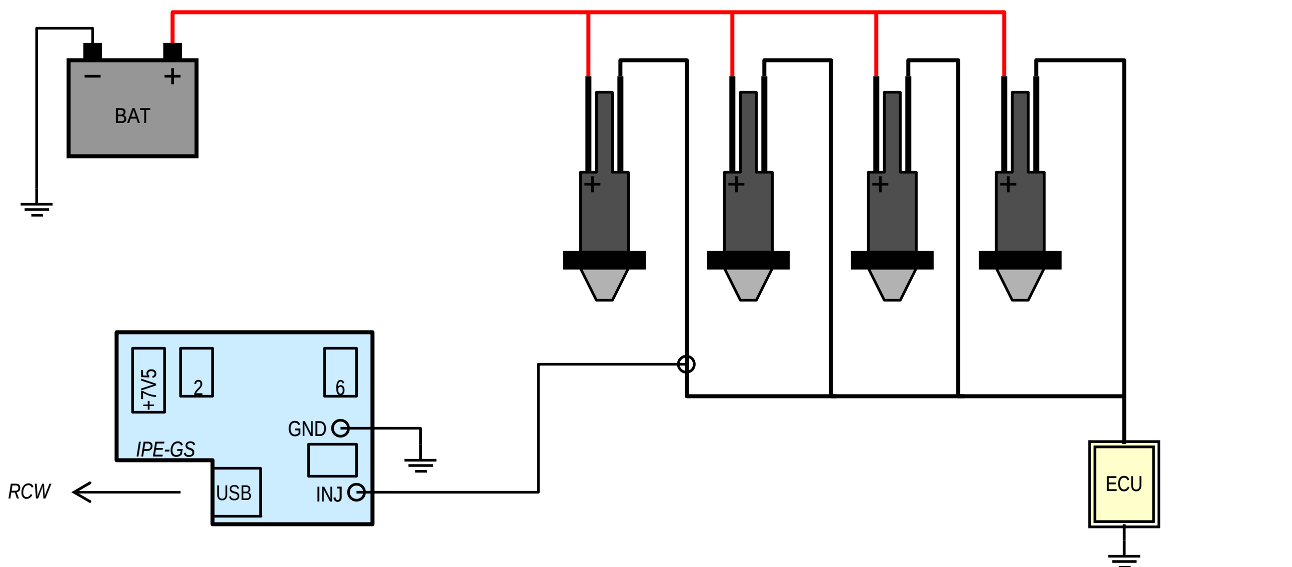
Another benefit with IPE-GS is that the power supply method only in a small way will affect the injectors - on and off - characteristics. When an injector turns off - a spike shaped voltage pulse will suddenly appear. For example, IPE-S eliminate this spike to zero but that can have a bad influence on the function for the injector timing device. IPE-GS allows the spike to rise up to 47V, which is the value for D1. T4 should withstand 100V and the PS-circuit (power supply circuit) should withstand at least 60V.

The supply voltage is chosen to 7.5 V. This is the standard value for every module that will be working together with IPE-GS. 7.5V is very optimal for 12V car applications. The PS-circuit are built to handle difficult voltage sources, like the pulse voltage from an injector cable and it is important to have some functionality even if the voltage drops, especially in the start procedure. It’s also possible to feed IPE-GS with an ordinary 9V battery. You can even feed IPE-GS from some 12V voltage source and then pass through the PS-circuit, but it’s also possible to skip the PS-circuit and connect a voltage through CN9, R13 and C2. Avoid feeding IPE-GS with a higher voltage then 7.5V. If you decide not to use the 7V5 PS-circuit device will the pulse width depend on small variations in voltage of the power source. Only make this arrangement if you are sure that you have a stable voltage source.

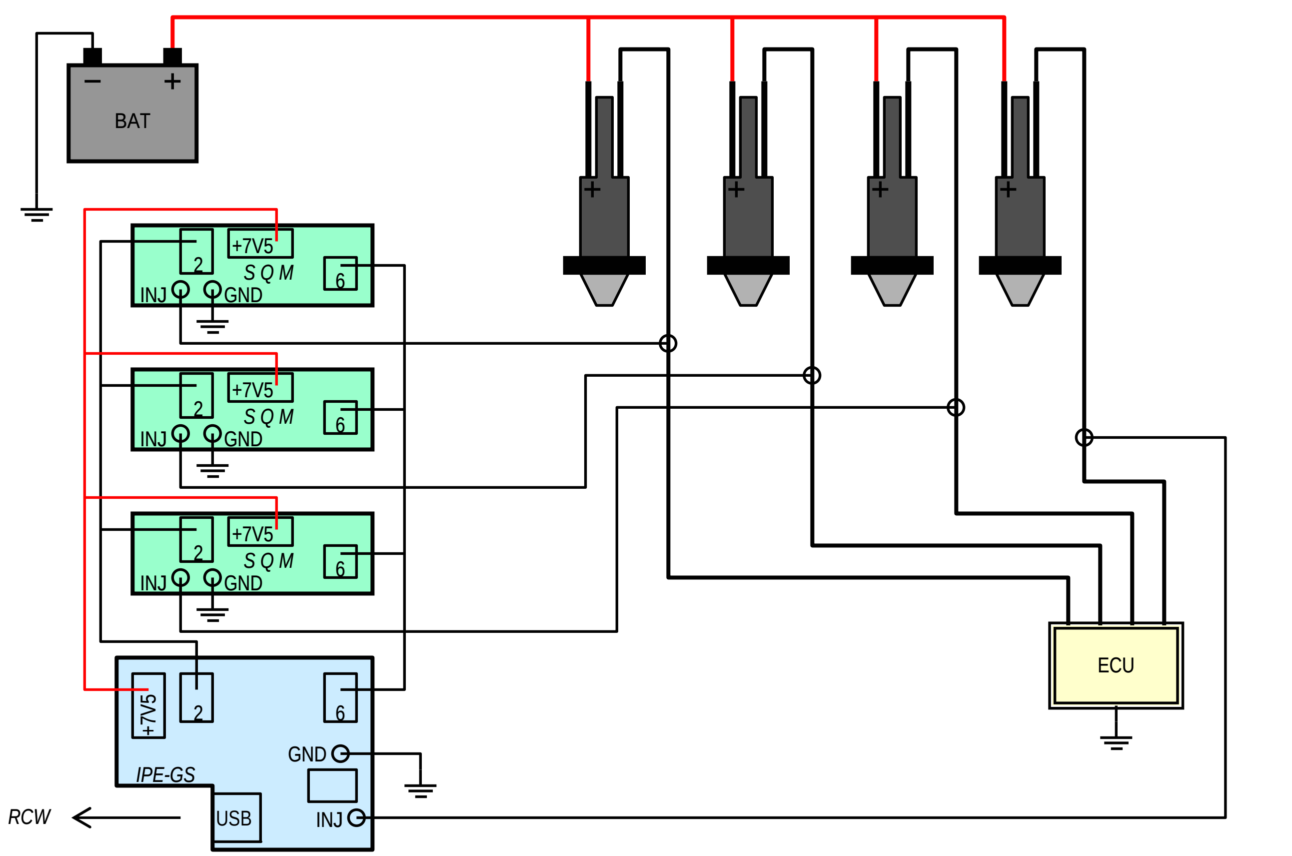
The PS-circuit can feed all types of modules connected to IPE-GS. For example, up to seven SQ-modules and the FFG-module at the same time. That will not consume more then 50mA. Only one PS-circuit is enough for that. That means it is always necessary to have at least one IPE-GS as a baseboard, even if you only have a *multipoint* fuel system. So if you have several channels or a sequential fuel system, then you need to have one IPE-GS and some SQ-modules - depending on how your car is configured.

With IPE-GS follows a new RCW-module - the control unit. It is designed to be connected through a USB equipped cable. This module is very similar to the RCW-module that works with the now obsolete IPEFF but it has two potentiometers: One for the adjustment of the fuel quantity during normal circumstances and one potentiometer for temporarily high fuel quantity needs, like a choke - which is useful for start of a cold car engine. P51 and P52 (as I said earlier) are able to control several independently IPE-devices simultaneously.

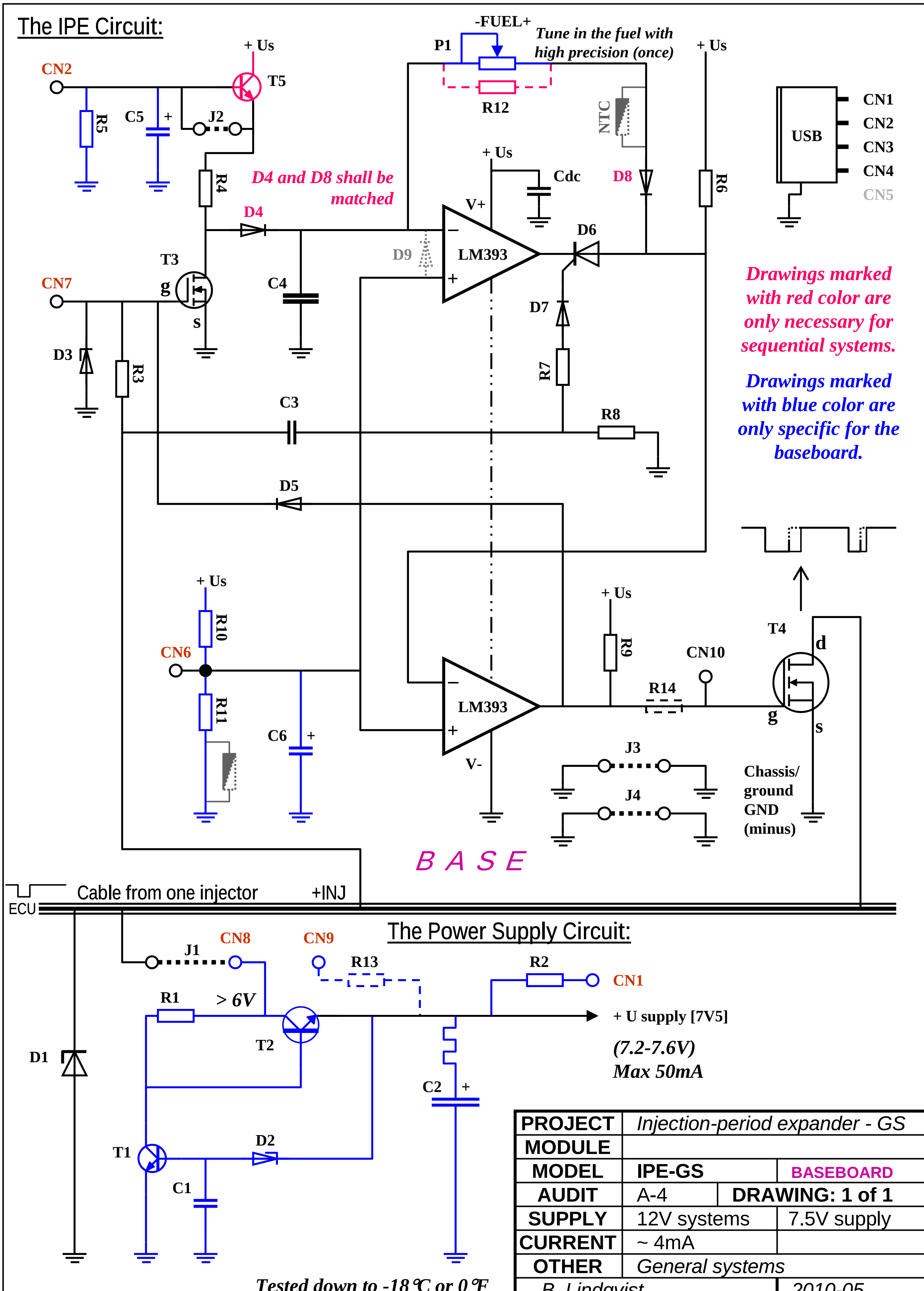
The principle to connect one IPE-GS unit to a multipoint fuel system (one channel):



The principle to connect one IPE-GS unit and three SQM-units to a sequential fuel system:

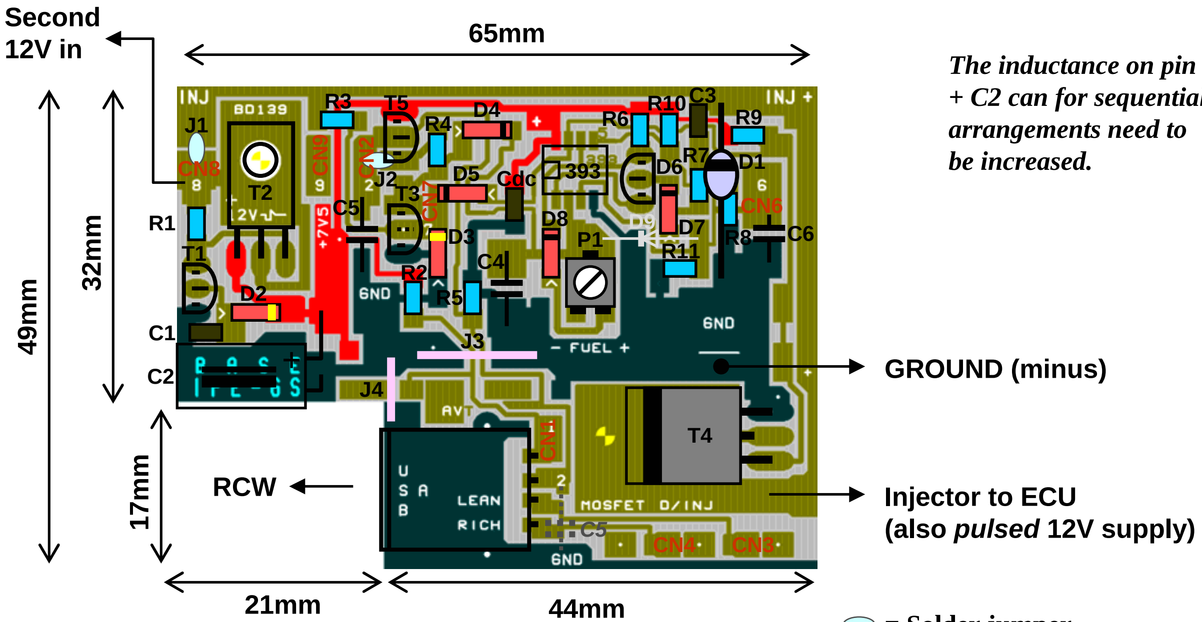


CIRCUIT DIAGRAM



PROJECT	Injection-period expander - GS		
MODULE			
MODEL	IPE-GS		BASEBOARD
AUDIT	A-4	DRAWING: 1 of 1	
SUPPLY	12V systems		7.5V supply
CURRENT	~ 4mA		
OTHER	General systems		
	B. Lindqvist		2010-05

PLACING OF COMPONENTS



The inductance on pin + C2 can for sequential arrangements need to be increased.

= Solder jumper

SMR1206:

R1 = 2k2
R2 = 100Ω
R3 = 100k
R4 = 33k
R5 = 2M2
R6 = 1k
R7 = 4k7
R8 = 470Ω
R9 = 4k7
R10 = 47k
R11 = 22k
R12 = 22k/12k < ***Instead of P1***

SMC1206:

C1 = 100n
C3 = 10n
Cdc = 100n

*** Different fuels have under specific loading conditions different needs in terms of its amount. In the case of ethanol (in a petrol car) seems the need be linear, i.e. the pulse width shall follow the load variations proportional over the whole range. If you choose C4 to 1000nF achieved good functional tonality, but if the adjustment is done after a lambda probe seems 2200nF be a better choice.***

Other Components:

R13 < 100Ω , hole mount
P1 = 50k , chiptrimpot 23B , SMD (or use R12)
C2 = 1000µ , 16V , E-lytic , hole mount
C4* = 100-2200nF , plastic (determine the linearity)
C5 = 10-47µ , 16V , E-lytic , hole mount or SMD
C6 = 22µ , 16V , E-lytic , hole mount or SMD
NTC = 220Ω (25ºC) , SMD (for over compensating)
USB-A = USB Connector , PCB/SMT ELFA 42-709-14

Semiconductors:

D1 = BZT03C47 , zener 47V , hole mount
D2 & D3 = BZV55-B6V8 , zener 6.8V , SMD
D4, D5, D7 & D8 = BAS32 , SMD
D6 = 2N5064 , thyristor , hole mount
T1 = BC546B , hole mount
T2 = BD139 , hole mount
T3 = BS170 , N-MOS , hole mount
T4 = IRLR3410 , 17A , 100V , logic DPAK (or better)
T5 = BC546B , hole mount
LM393M = Low power dual voltage comp , SMD

T3 is extremely ESD sensitive! Get broken if not the legs is shorted while you mount it.

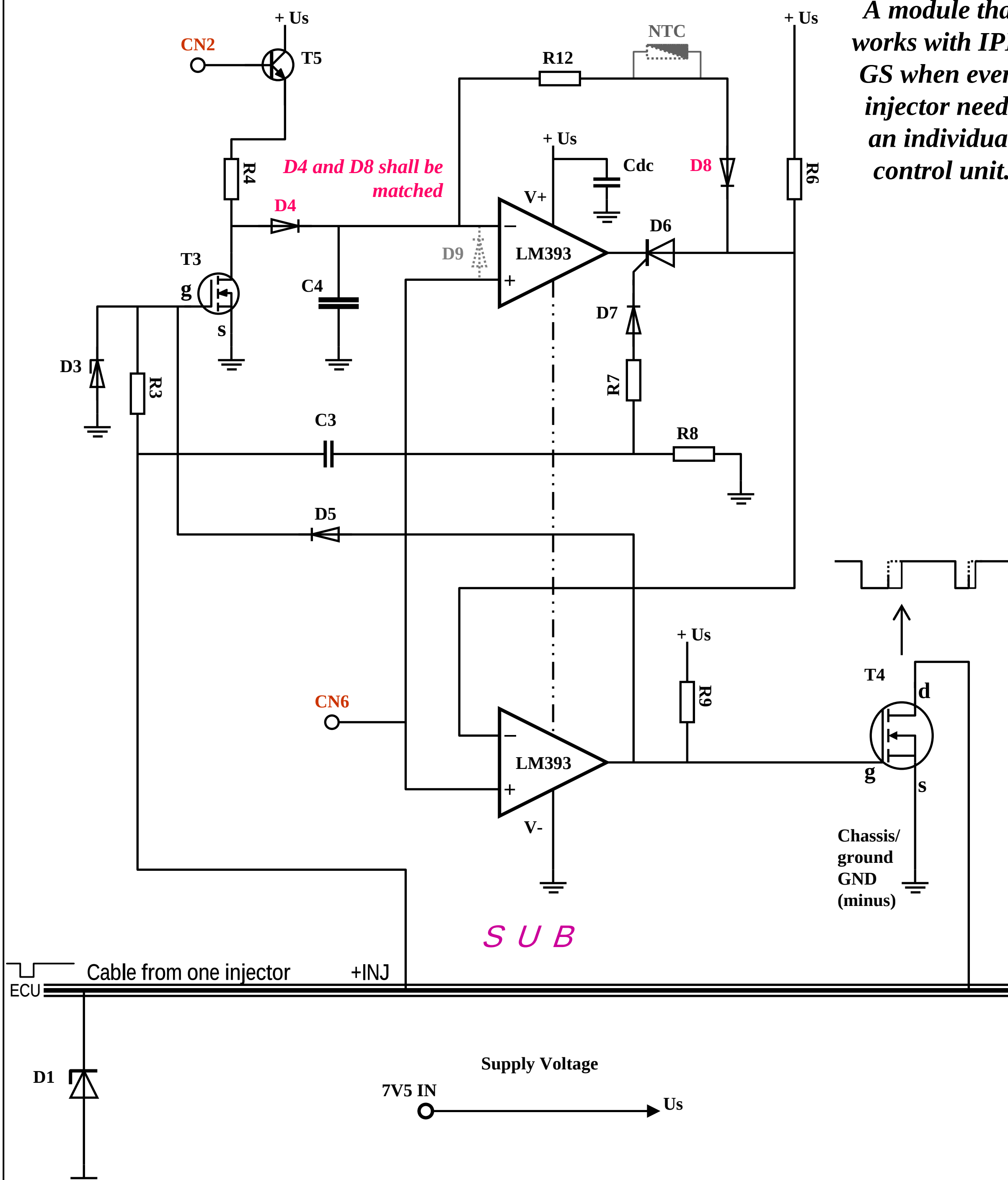
T5 is only necessary for sequential systems not in multipoint systems. Apply J2 instead of T5. R12=12k if T5 is in use!

A double side board is standard here but it works even with a single side too. Use a heat sink for T2 and/or T4 if they get to hot - low impedance injectors. To fix T4 us solder. Drill two via holes for the USB-device or six holes more if L/FF exists? All components shall be handled as SMD, thus all soldering take place on the same side, instead of T3 whose base shall be solder on both sides. The ground connections are insufficient if you forget J3 (and J4)!

PROJECT	*Injection-period expander - GS*	
MODULE		
MODEL	**IPE-GS**	**BASEBOARD**
AUDIT	A-4	**DRAWING: 1 of 1**
OTHER	*General systems*	
B. Lindqvist		*2010-05*

MODULE CIRCUIT DIAGRAM

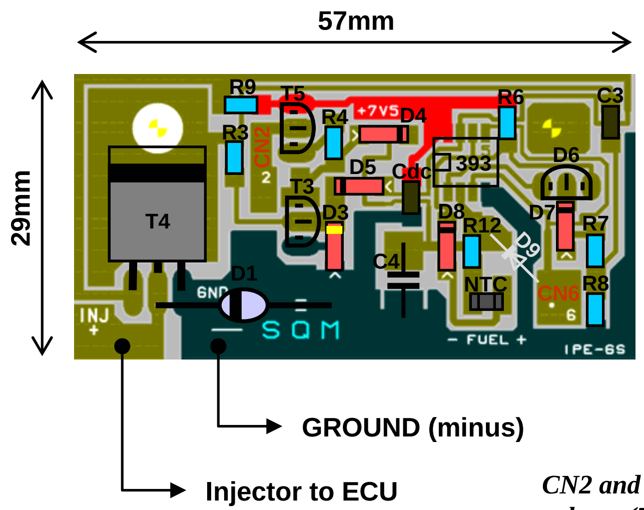
A module that works with IPE-GS when every injector needs an individual control unit.



Tested down to -18℃ or 0℉

PROJECT	*Injection-period expander - GS*		
MODULE	*Sub Sequential*		
MODEL	**SQM**	**SUB BOARD**	
AUDIT	A-4	**DRAWING: 1 of 1**	
SUPPLY	12V systems	7.5V supply	
CURRENT	~ 4mA		
OTHER	*Sequential systems*		
B. Lindqvist		*2010-05*	

MODULE PLACING OF COMPONENTS



Both the supply 7V5 and CN6 should be decoupled with e-lytic capacitors at SQM. 470u and 4u7 is enough.

CN2 and CN6 together with supply voltage (7V5) shall be connected via wires to the IPE-GS baseboard, beyond the two wires/cables INJ and GND.

SMR1206:
R3 = 100k
R4 = 33k
R6 = 1k
R7 = 4k7
R8 = 470Ω
R9 = 4k7
R12 = 12k

SMC1206:
C3 = 10n
Cdc = 100n

Other Components:
C4* = 100-2200nF , plastic (determine the linearity)
NTC = 220Ω (25ºC) , SMD (for over compensating)

Semiconductors:
D1 = BZT03C47 , zener 47V , hole mount
D3 = BZV55-B6V8 , zener 6.8V , SMD
D4, D5, D7 & D8 = BAS32 , SMD
D6 = 2N5064 , thyristor , hole mount
T3 = BS170 , N-MOS , hole mount
T4 = IRLR3410 , 17A , 100V , logic DPAK (or better)
T5 = BC546B , hole mount
LM393M = Low power dual voltage comp , SMD

** Different fuels have under specific loading conditions different needs in terms of its amount. In the case of ethanol (in a petrol car) seems the need be linear, i.e. the pulse width shall follow the load variations proportional over the whole range. If you choose C4 to 1000nF achieved good functional tonality, but if the adjustment is done after a lambda probe seems 2200nF be a better choice.*

T3 is extremely ESD sensitive! Get broken if not the legs is shorted while you mount it.

To speed up the start of the system; utilize D9 and change C5 to 10µF. A small C5 make the car a little more difficult to start when the engine is warm.

A single side board is enough but if you choice a double side board then you can print and get two SQM-units. Use a heat sink for T4 if it get to hot (low impedance injectors). To fix T4 us solder. No holes need to be drilled but the target marking over T4 is for an M3-screw. All components shall be handled as SMD, thus made, all soldering take place on the same side.

PROJECT	*Injection-period expander - GS*	
MODULE	*Sub Sequential*	
MODEL	**SQM**	**SUB BOARD**
AUDIT	A-4	**DRAWING: 1 of 1**
OTHER	*Sequential systems*	
B. Lindqvist		*2010-05*

The continuation beyond this and for this project can be omitted. You are now able to install IPE-GS (single side base board) onto your car, without the USB-device and then connect a resistance between CN1 and CN2. The extra fuel contribution can then be a reality.

But this would be a cheep solution here. It is good to know what the engine tells about the extra fuel, isn't? If you need that information, you then need to decide which method you want to use.

There are basically two methods:
1. Information from the pulse width.
2. Information from the lambda probe.

It is difficult to pronounce about the best solution for your needs but I can describe the alternatives and the advantage and disadvantage for every possibility here and now.

You can choose between three ways to control IPE-GS:
1. Manually.
2. Semi automatic.
3. Full automatic.

You can also start to test to control it manually and then completed it with more modules or merely with the AUTOG-module. There is only one method to use if you want to try full automatic and that must be based from the information of the lambda probe.

Summary, that can be described in this: If you use the module **FFGM** (pulse width), you can adjust the fuel quantity manually or semi automatic with a very high precision - on idle! If you use the module **LFFGM** (lambda probe) you can adjust the fuel quantity manually, semi automatic or full automatic, with enough precision even when you drive your car (in normal circumstances). The engine can actually have the right fuel quantity on idle but can have a lack or a surplus of fuel when the engine running over idle - LFF informs about this. **The standard solution is to use the FFG-module** but if you are able to get the terminals of the lambda probe and you are interested to make it with full automatic - use the LFFG-module. The reason why the lambda probe is the only alternative with full automatic is the engine temperature. The information of the right pulse width is only reliable in a small temperature range. The lambda probe function well over a certain temperature and reach it faster in comparison to the engine temperature. There is a possibility to make the FFG-module with full automatic and that is, if you compensate the pulse width with the engine temperature. That can be done if you use a NTC-resistance mount on the engine block and in serial with P20 - it’s untested.

You can also run both L/FF-GM in mix mode and get the benefits for each of them.

The FFG-module is an accurate instrument for adjusting the fuel quantity right.

It is not necessary to know the fuel concentration in order to regulate the fuel quantity. It is enough to look at the opening pulse width or the so-called duty cycle (but the duty cycle change if the frequency changes). If you read the opening pulse width/time, then you know: This is the right width and it shall not digress for any possible circumstances. *If we disregard from the engine load, the speed and above all;* ***engine temperature.***

That is what FFGM are doing. Once you adjusted the right pulse width, it tells when the pulse widths digress and also the direction of the digression. When you did that observation by the LED's, it is easy to adjust the fuel quantity. That adjustment is only necessary to perform after you have filled up the tank with fresh fuel (if you have a mixture of petrol and ethanol), so nothing happen until you fill up the next time.

FFGM don't affect on the control circuit (IPE-GS), it is only a measure instrument for visible detection followed by a manual adjustable action of the IPE-GS from the RCW-module. This is not something I've found on, in fact, it works and I've used it in my car for years without any hassle.

The problem to make this principle automatic is the change in pulse width that occurs when the engine load varies. So it is only a reliable method when the car is idling (and of course when the engine operating temperature is reached). For this reason, the LED's are off when the speed rises above a certain limit. This limit is determined by R21 and C21.

The function is as follows (on idle): The both LED's is black when the injectors opening pulse width/time is the same as the reference pulse width/time. When opening pulse width digress, one of the LED's begins to blink. If the engine needs more fuel flashes "LEAN", but if the engine is getting too much fuel is flashing "RICH".

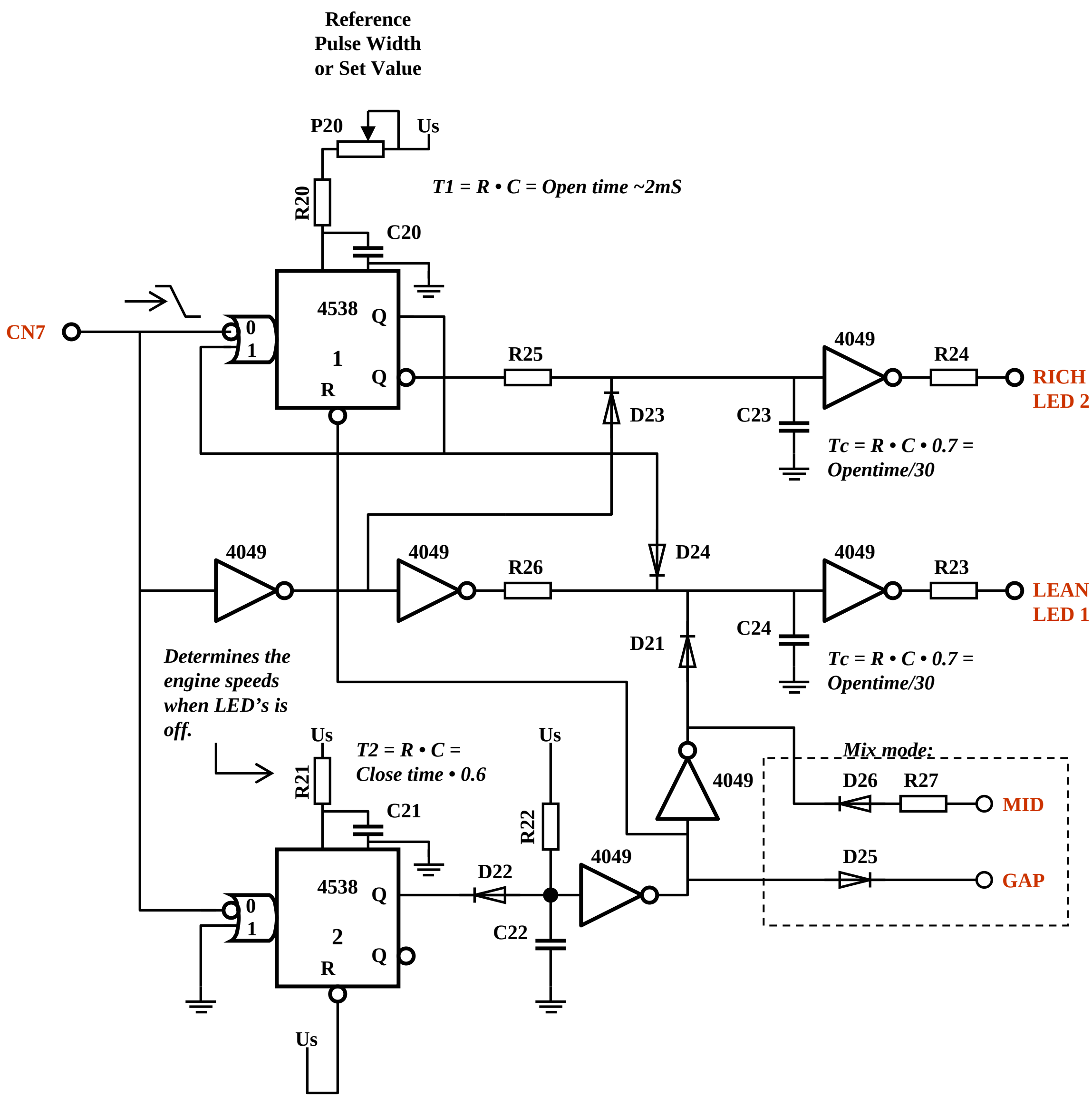
The adjustment is able through the RCW-module. Just turn P52 until the right fuel quantity will appear through the LED's or/and pay attention to the engine condition.

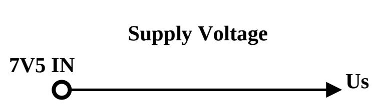
As you know the fuel injections computer (ECU) take care of the finest tune in, in co-operation with the lambda probe, for the best fuel quantity. The fuel injections computer is able to regulate the fuel quantity within certain limits.

FFGM are only available in one variant and are integrated onto the backplane that is valid to the IPE-GS baseboard. Even if you first will try without FFGM you should yet ought to make a double board with the circuit pattern (on the backplane). Perhaps in the future, you feel the need to have the FFG-module and you can quite easily incorporate FFGM with IPE-GS.

MODULE CIRCUIT DIAGRAM

Module to measure and indicate if the engine need more or less fuel through two LED's which are placed on the RCW-module.

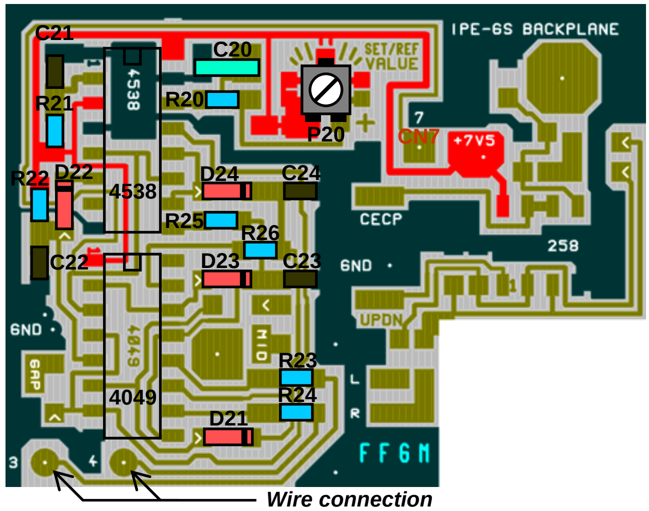




PROJECT	*Injection-period expander - GS*	
MODULE	*Flexible Fuel General*	
MODEL	**FFGM**	
AUDIT	A-4	**DRAWING: 1 of 1**
SUPPLY	12V systems	7.5V supply
CURRENT		
OTHER		
B. Lindqvist		*2010-01*

MODULE PLACING OF COMPONENTS

For semi automatic more components need to be mounted on the board, see the module AUTOGM and follow the instructions.



SMR1206:
R20 = 33k
R21 = 470k
R22 ≥ 2M2
R23 = 470Ω
R24 = 470Ω
R25 = 10k
R26 = 10k
R27* = 3k9

SMC1206:
C21 = 100n
C22 = 100n
C23 = 10n
C24 = 10n

Other Components:
C20 = 47n , plastic type , hole mount
P20 = 50k , chiptrimpot 23B , SMD
D21 - D24 = BAS32 , SMD
D25* & D26* = BAS32 , SMD

Integrated Circuits:
4538 = Dual monostable flip-flop , hole mount
4049B = Hex inverting buffer , hole mount

**** Only for mix mode operation***

This is the backplane of the IPE-GS board and that require a double side board. Four holes need to be drilled to make it work with IPE-GS (except for the USB-device, the M3-screws and the three ground holes). All components shall be handled as SMD, thus made, all soldering take place on the same side.

PROJECT	*Injection-period expander - GS*	
MODULE	*Flexible Fuel General*	
MODEL	**FFGM**	
AUDIT	A-4	**DRAWING: 1 of 1**
OTHER	*General and sequential systems*	
B. Lindqvist		*2010-01*

The LFFG-module tells us if the combustion is normal, lean or rich.

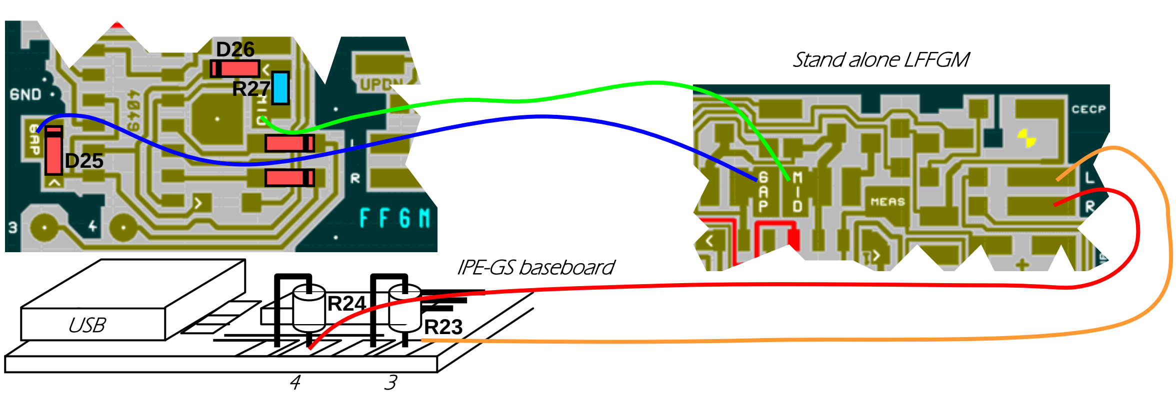
LFFGM must be connected to the lambda probe (also called "oxygen sensor"). If you not can find or use the terminals from the lambda probe, then you must use the other module named FFGM. Another benefit to use LFFGM is that you are able to get the information of the combustion efficiency even if you drive your car - beyond the idle speed limitation. The problem is to find the cable that is connected to the probe. In my case I have to open the ECU to be able to connect it.

The module taking the average value from the LP and display the information through the two LED's on the RCW-module. That means, if the engine gets enough fuel - LED's are blank but if the engine need more or less fuel - one LED illuminate.

Since the LP is sensitive and an expensive instrument, it is important to not disturb it with another clumsy measure instrument. For that reason I use a differential amplifier to measure its signal. It is not a good idea to force the negative connector on the probe to the ground because it is probably not grounded anyway. The Signal from the LP is typical 0.2-0.7V. A low voltage corresponds to a lack of fuel and a high voltage to a abundance.

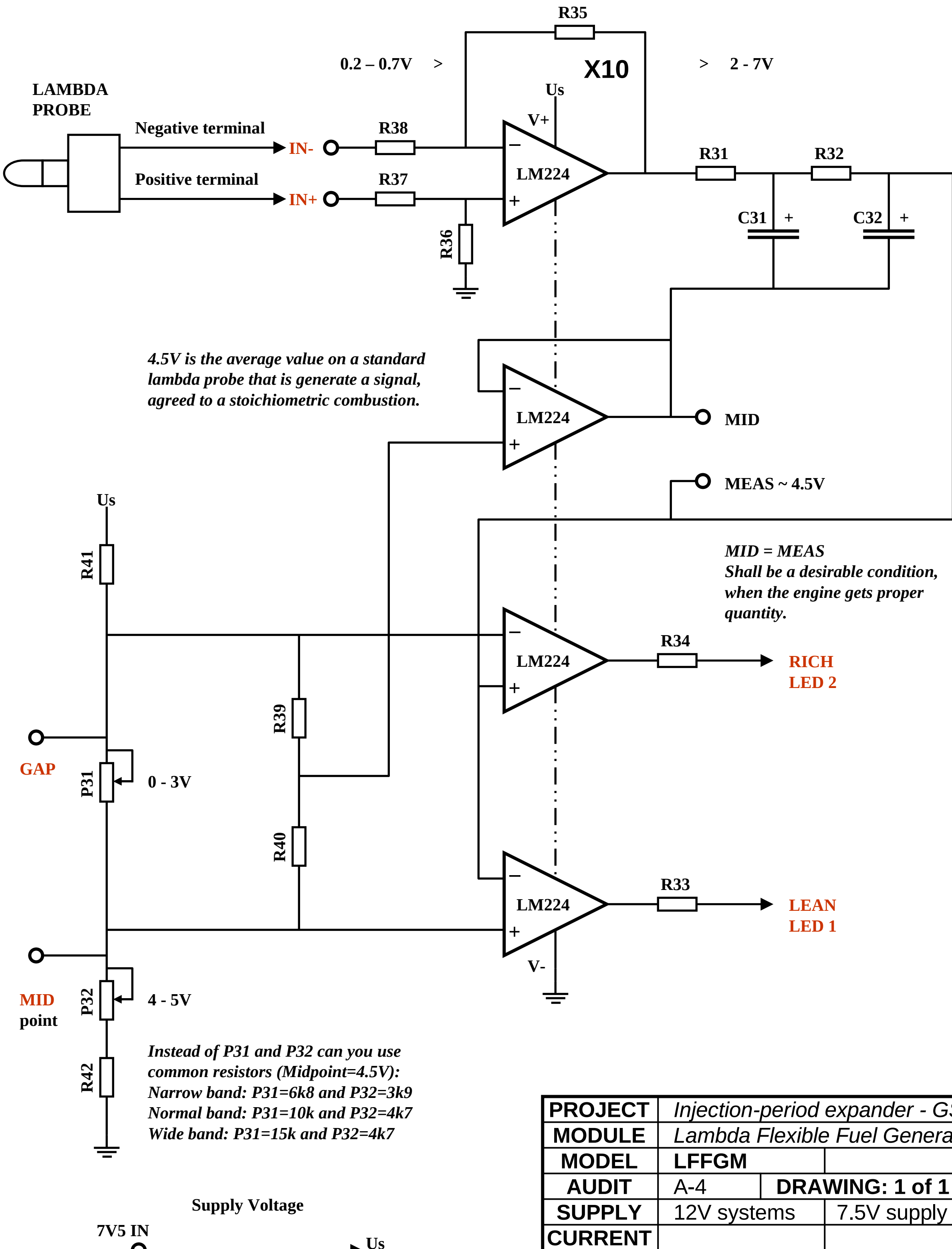
With LFFGM, you can test if the lambda probe is working? Loosen the C31 and C32 so that the signal goes directly through the LED's. The probe is intact, if the signal oscillates with approximately: 0.8Hz - when the engine speed is between 2-3000 rpm.

MIX MODE OPERATION:
It is possible to combine FFGM and LFFGM. If so, should FFGM operate at idle and the LFFGM over idle. It should be easier to adjust with more precision for this arrangement. Both modules send information to the same LED's. Two new diodes and a resistance must be mounted on the FFG-module. Resistors (R23 & R24) must be moved to the other side of the IPE-GS baseboard and this will be exchanged to two new diodes (BAS32). The value on R23 and R24 is unchanged but they must be hole-mounted resistors and the LED's terminals from a <u>stand alone LFFGM</u> shall be connected onto the R23/4 pads (3&4) with wires. Also connect wires between "GAP" and "MID" pads.



MODULE CIRCUIT DIAGRAM

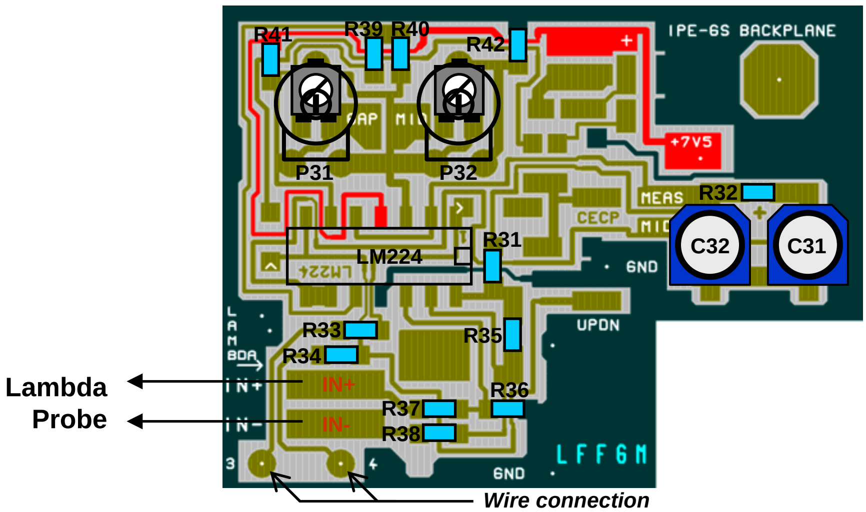
This circuit reads the signal from a standard lambda probe, transfer it to an average voltage value and then detect if it will increase or decrease - through two LED's.



PROJECT	*Injection-period expander - GS*	
MODULE	*Lambda Flexible Fuel General*	
MODEL	**LFFGM**	
AUDIT	A-4	**DRAWING: 1 of 1**
SUPPLY	12V systems	7.5V supply
CURRENT		
OTHER		
B. Lindqvist		*2010-01*

MODULE PLACING OF COMPONENTS

For semi or full automatic more components need to be mounted on the board, see the module AUTOGM and follow the instructions.

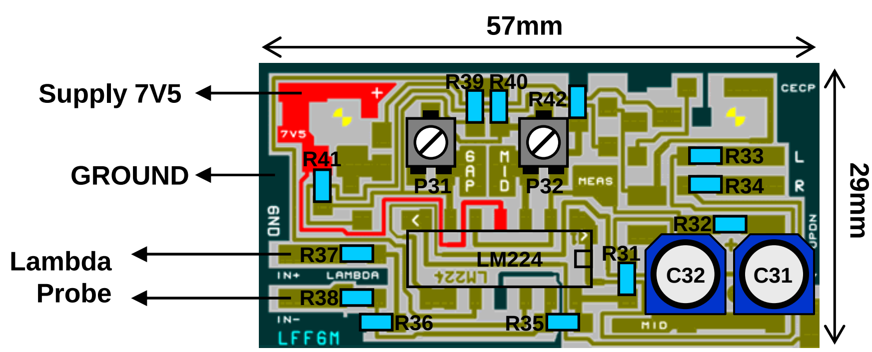


SMR1206:
R31 = 100k
R32 = 100k
R33 = 3k9
R34 = 3k9
R35 = 1M
R36 = 1M
R37 = 100k
R38 = 100k
R39 = 100k
R40 = 100k
R41 = 15k
R42 = 15k

Other Components:
C31 & C32 = 47μ , 16V , E-lytic , SMD
P31 = 20k or 10k , PT-10 hole mount / chiptrimpot 23B
P32 = 20k , PT-10 hole mount / chiptrimpot 23B

Integrated Circuits:
LM224N = Quad OP, hole mount (turn this ic)
LM324N is a possible substitute

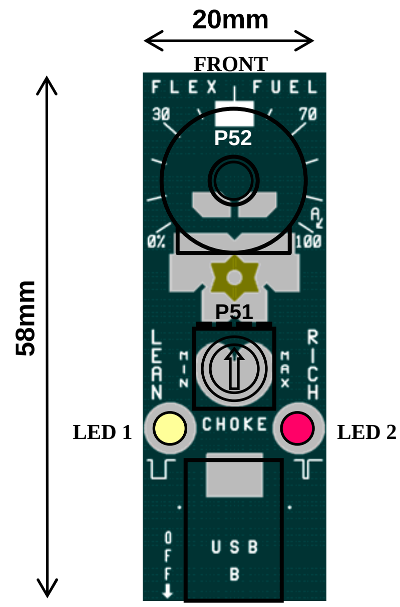
Stand alone LFFG-module:

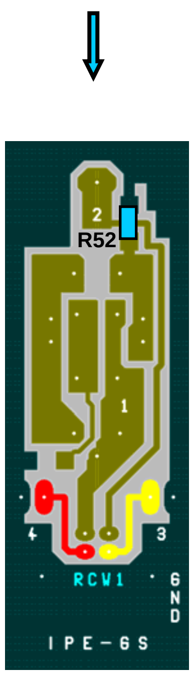


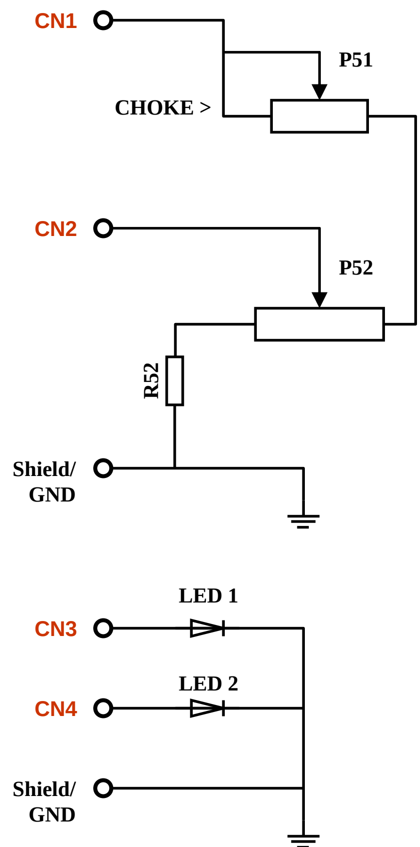
This is the backplane of the IPE-GS board and that require a double side board. Three holes need to be drilled to make it work with IPE-GS (except for the USB-device, the M3-screw and the three ground holes). All components shall be handled as SMD, thus all soldering take place on the same side. No holes need to be drilled on the stand alone module, except for the M3.

PROJECT	*Injection-period expander - GS*	
MODULE	*Lambda Flexible Fuel General*	
MODEL	**LFFGM**	
AUDIT	A-4	**DRAWING: 1 of 1**
OTHER	*General and sequential systems*	
B. Lindqvist		*2010-01*

MODULE PLACING OF COMPONENTS AND CIRCUIT DIAGRAM







MULTIPOINT

SMR1206:
R52 = 39k

J2 = on

SEQUENTIAL

SMR1206:
R52 = 22k

T5 in use
R12=12k

Other Components:
P51 = 20k , 72PT , hole mount
P52 = 10k , PT-15NV(17) , hole mount
Also PT-10 / PTC-10
USBB = USB Connector , PCB ELFA 42-708-98
LED1 = Yellow , EL1224UYC (or similar)
LED2 = Red , EL1224SURC (or similar)
LED's shall illuminate about 500 mcd.

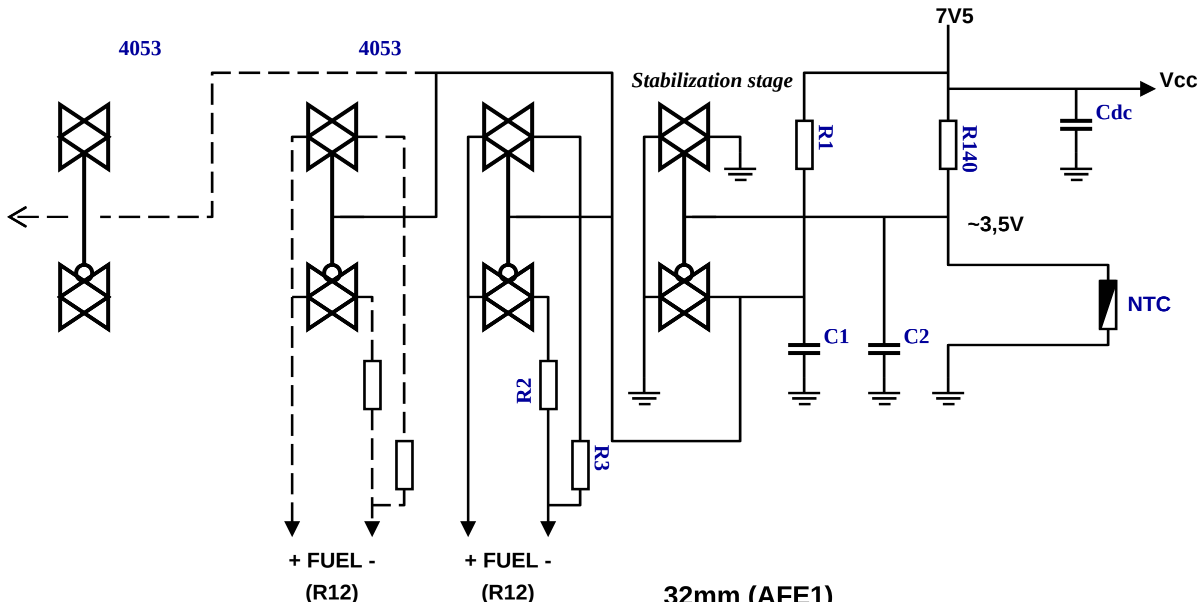
If one want to turn off the IPE-function, you only need to unplug the RCW-module from the USB-cable

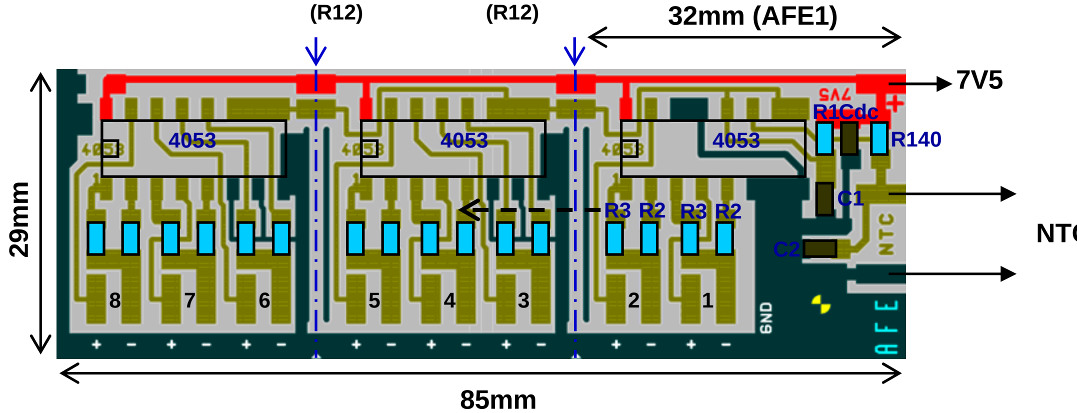
This module require a double side board and a number of holes must be drilled, since it contain both surface- and hole mount components.

PROJECT	*Injection-period expander - GS*	
MODULE	*Remote control by wire*	
MODEL	**RCW1**	
AUDIT	A-4	**DRAWING: 1 of 1**
OTHER	*Working with the baseboard*	
B. Lindqvist		*2010-01*

MODULE PLACING OF COMPONENTS AND CIRCUIT DIAGRAM

Automatic fuel enrichment, during the time the engine still not has reached the required operational temperature, is actually a requirement the fuel E85 have onto a converted petrol car, and this to avoid that it does not running lean before the engine become hot. A NTC resistor mounted on the engine block is controlling as much as three logic circuits (4053), for maximum seven SQ-modules (for sequential fuel systems).





SMR1206:
C1 = 100n
C2 = 100n
Cdc = 10n

SMR1206:
R1 = 1M
R2 = 22k
R3 = 30k (33//330)
Enrichment ~15%

When the engine reached 140 degrees Fahrenheit is it time to switch over to normal opening time and it is the value of R140 which determines when the shift will happens. The easiest is to use an ohm-meter and measure the NTC resistor and then choose the same shift value on R140.

Other components:
R140 ~ 15k (NTC47k) or 18k (NTC100k) , SMR1206
NTC = 47k-100k at 25°C (fixed on the engine block)
4053 = 2-channel analogue multiplexer , hole mount

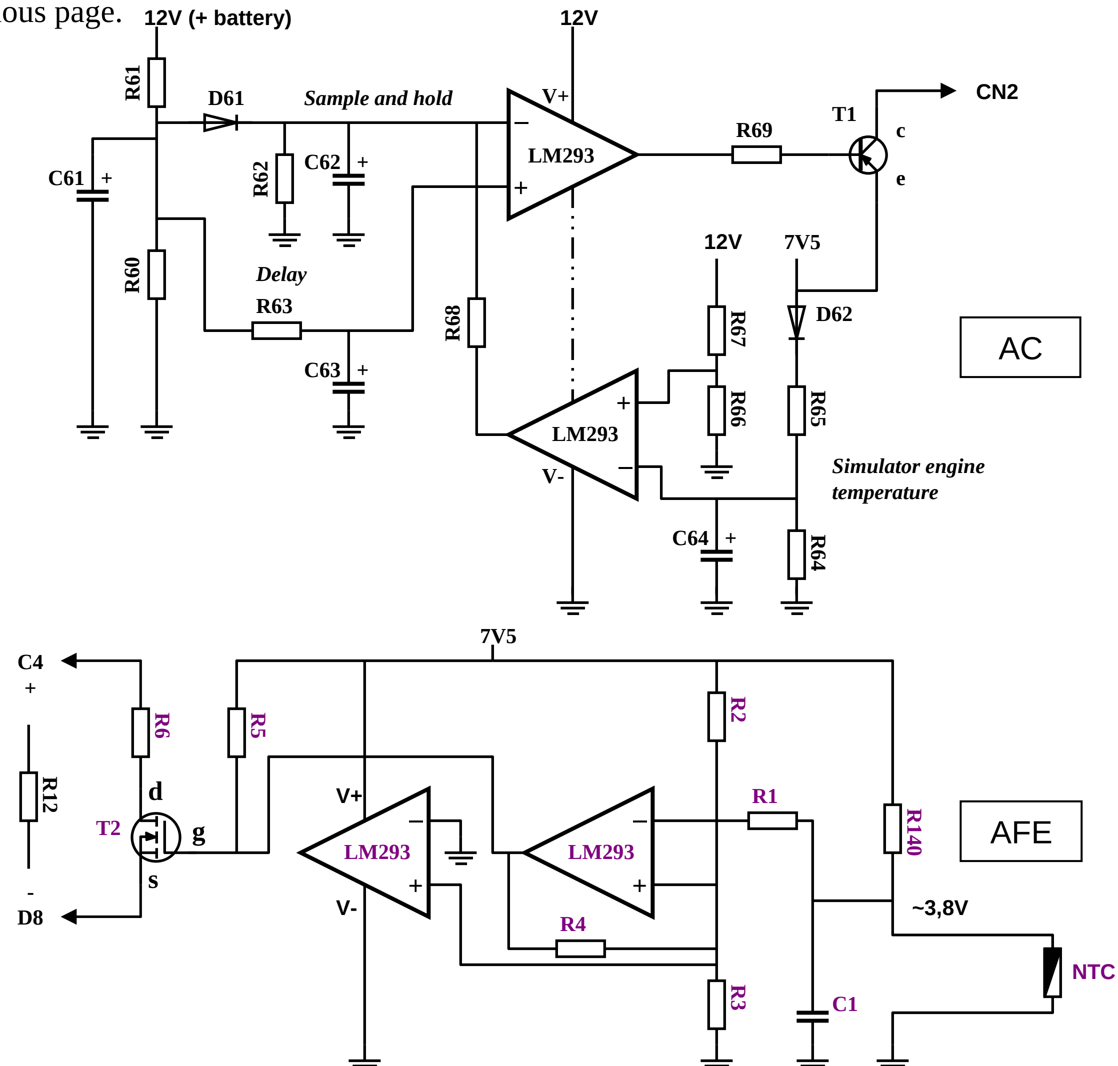
The module requires only a single side board.
No hole need to be drilled for any component.

PROJECT	*Injection-period expander - GS*	
MODULE	*Automatic Fuel Enrichment*	
MODEL	AFE	
AUDIT	A-4	DRAWING: 1 of 1
OTHER	*Tested!*	
B. Lindqvist		*2011-06*

MODULE CIRCUIT DIAGRAM

An automatic choke plus a temperature-controlled up-regulation of fuel before the engine is warm enough means that the car works almost flawlessly when running on E85. In principle required any additional measures to be taken despite that the fuel has other properties. The prerequisite to use this module is: That one not has a sequential system or more specific; AFE in ACF is only for them who utilize the multipoint principle.

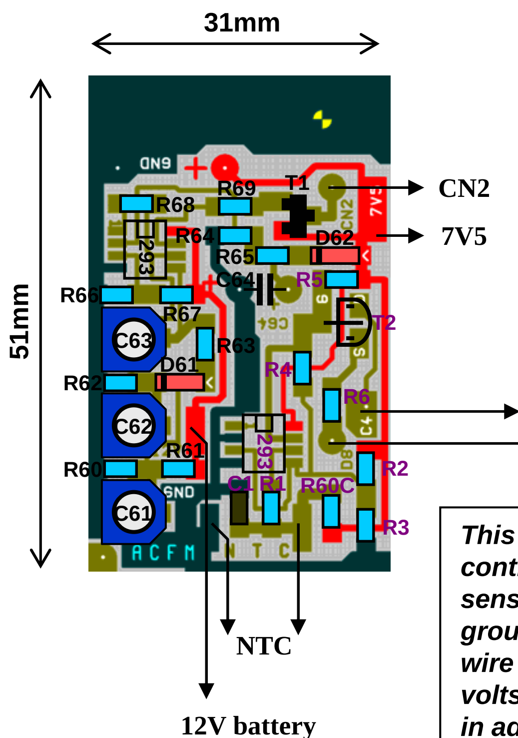
The circuit is almost identical to the module AC (autogm) and a bipolar version of AFE - here combined into one module. A mosfet (T2) open and close and in that way controls the fuel enrichment - instead of an analog switch, like the c-mos arrangement according to the previous page.



The module is also designed to operate in IPE-GP. Conversely, the same holds for that ACFM as belong to IPE-GP (who works with time instead of temperature).

PROJECT	*Injection-period expander - GS*	
MODULE	*Automatic choke & fuel*	
MODEL	**ACF**	
AUDIT	A-4	**DRAWING: 1 of 1**
SUPPLY	12 & 7,5V	
CURRENT	off state~0,6mA	
OTHER	*ACM and AFE implemented*	
B. Lindqvist		*2012-06*

MODULE PLACING OF COMPONENTS



To keep it compatible with IPE-GP is the module 2 mm wider (31) than the standard width for modules as belong to IPE-GS.

This ACF module is also adapted to be controlled by an ordinary engine temp sensor. Is it a type that is attached and grounded on the engine block with one wire to an ECU (via a pull up resistor to 5 volts) then can R140 and C1 be excluded, in addition is no minus connection (GND) necessary. To adapt the sensor to AFE must the resistors on the comparator plus input be weighted: R2 can remain 100k while R3 may be selected to 15k, R4 should be reduced - 560k instead of 1M. One 1M ohm resistor can be soldered in parallel across C1 or replace C1, so the input is drawn to ground if the sensor becomes disconnected.

SMR1206:
R60 = 330k
R61 = 100k
R62 = 10M
R63 = 220k
R64 = 10M
R65 = 100k
R66 = 100k
R67 = 470k
R68 = 2k2
R69 = 4k7

R12 = 30k (not 22k)

R1 = 4k7
R2 = 100k
R3 = 100k
R4 = 1M
R5 = 100k
R6 = 82k
Enrichment ~15%

SMC1206:
C1 = 100n

Other Components:
C61-C63 = 22µ , 16V , E-lytic , SMD/hole mount
C64 = 470µ , 16V , E-lytic , hole mount
D61 & D62 = BAS32 , SMD
T1 = BC857B , SMD
T2 = BS170 or 2N7000 , N-MOS , hole mount
LM293 x 2 = Low power dual voltage comparators , SMD
R140 ~ 15k (NTC47k) or 18k (NTC100k) , SMR1206
NTC = 47k-100k at 25°C (fixed on the engine block)

T2 is extremely ESD sensitive! Get broken if not the legs is shorted when you mount it.

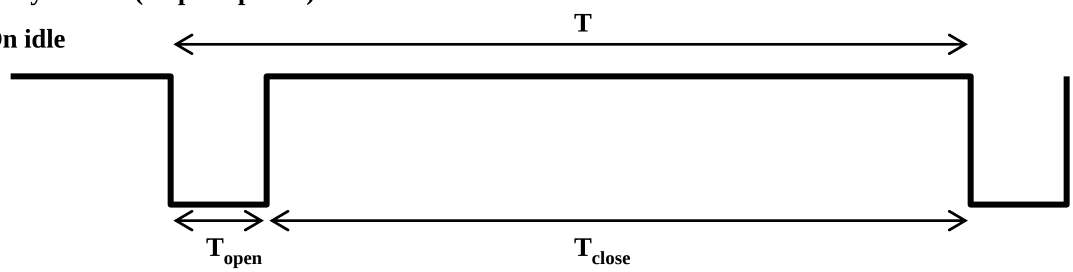
The module requires only a single side board.
No hole need to be drilled for any component.

PROJECT	*Injection-period expander - GS*	
MODULE	*Automatic choke & fuel*	
MODEL	**ACF**	
AUDIT	A-4	**DRAWING: 1 of 1**
OTHER	*Only for multipoint system*	
B. Lindqvist		*2012-07*

Preliminary investigation:

For your car (on pure petrol)

On idle



T_{open} = ________________________ (~2mS)

T_{close} = ________________________ (T_{open}•30±5)

$T = T_{open} + T_{close}$ = ________________

Duty Cycle = T_{open} / T = ________________

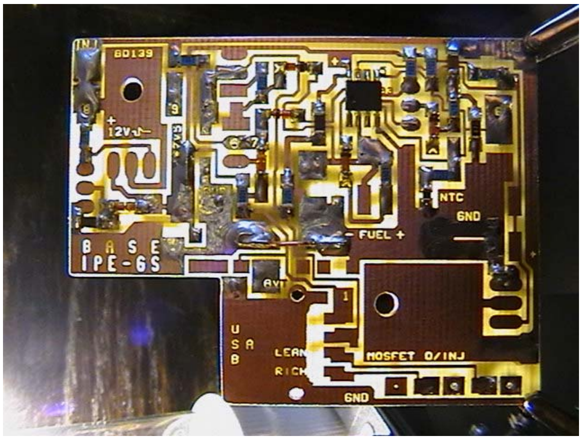
It is possible to use FFGM as a measure instrument to measure the opening time if you don't have an oscilloscope.
First: Adjust the potentiometers on the RCW-module full to left (zero).
Then: Adjust P20 (SET/REF VALUE) until the both LED's are down.
Finally: Measure the resistant on P20, add it with R20 and multiplicity the sum with C20.
The result is the opening time [seconds].

$T1 = T_{open}$ = ________________

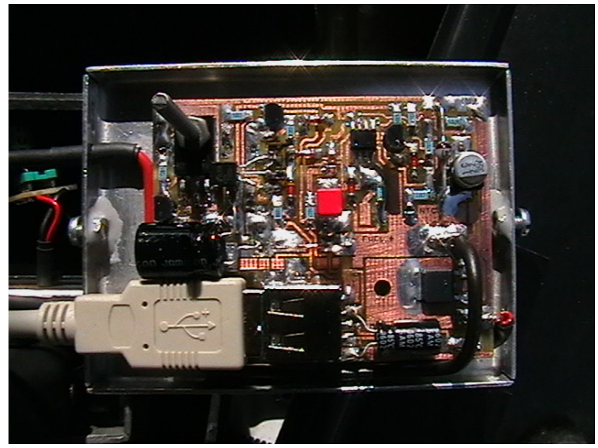
$T2 = T_{close} \cdot 0.6$ = ________________

$Tc = T_{open} / 30$ = ________________

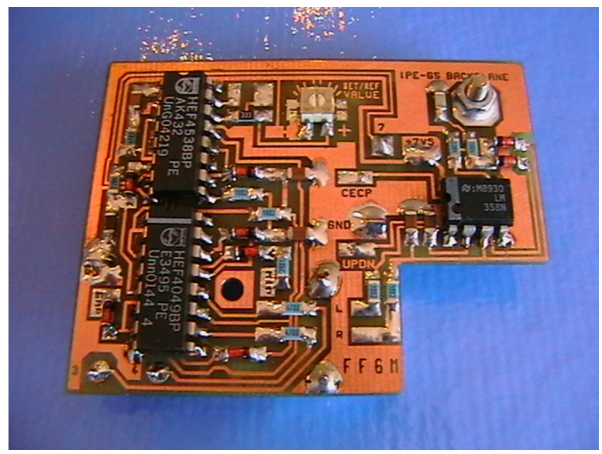
PHOTOS



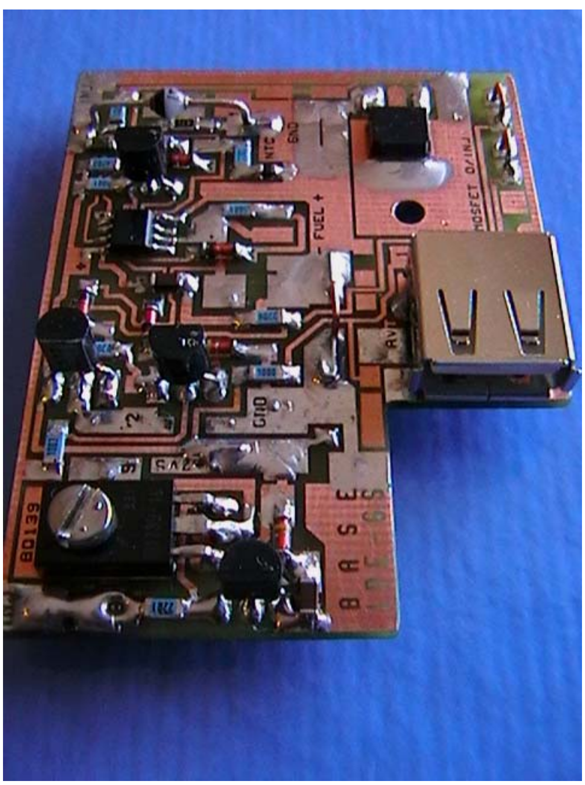
IPE-GS Base board



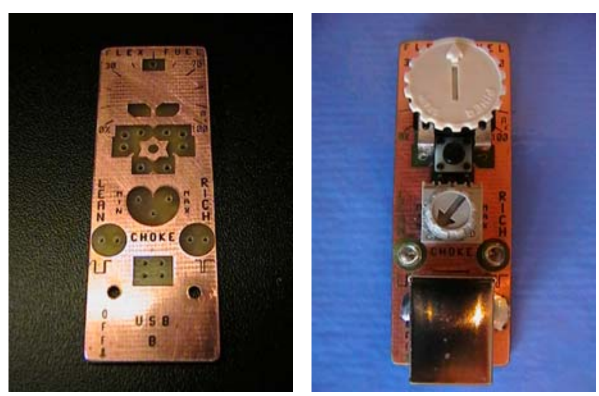
in a aluminum box



FFGM (the underneath of IPE-GS)



IPE-GS (the capacitances is missing)



RCW1