SUBARU IMPREZA 99 V2.30 & SUBARU96 V2.20

GEMS Implant ECU user manual DRAFT 4

SYSTEM OPERATION

The ECU uses the sensors to determine the correct fuelling, ignition timing, and boost pressure. It then controls the injectors, ignition amplifiers, wastegate actuator valve, water spray, and cooling fans. It also interfaces with the monitoring system to allow the user to monitor and control the engine management operation.
The control functions are set by various user programmable lookup maps, tables and options, with the aid of a PC running a GEMS supplied user interface.
Installation may require the removal of the old standard PCB from the ECU case and fitting of the GEMS implant PCB. Note the safety and RFI filter grounds are through the case to chassis.
This GEMS ECU will fit in place of the standard Subaru Impreza ECU for 1999 or 1996 vehicles. It is very important that the case is in good electrical contact with the chassis, less than 0.1 Ohms.

OUTPUTS

2 twin coil drives SUBARU99, individual coil drivers SUBARU96.
4 low current injector drives.
4 wire stepper motor SUBARU99, 3 wire push pull valve SUBARU96.
2 Push pull wastegate control.
1 Water spray for intercooler.
1 Fuel pump relay.
2 Radiator Fan relays.

Future Enhancements

The CAN bus could carry more data SUBARU99 only.
Internal data logging using an internal 128kByte battery backed memory.
Brake information in conjunction with road speeds to control active centre differential, SUBARU96 only.

SENSORS

Airflow is measured using the standard mass airflow sensor which is housed in the air filter box and connected to the inlet of the Compressor Housing. This is not usually the systems major parameter for monitoring load for boosted engine. This has been improved with the transition to a more powerful implant micro-processor.

Throttle position (TPS) is measured using a rotary potentiometer mounted on the throttle actuating mechanism. This input is used for starting, acceleration and deceleration fuel and control of the PBW system.
There are two user programmable options which scale the throttle position sensor. These are TPS_min and TPS_max. There is an option invert_TPS to invert the reading of the sensor standard on SUBARU96.
These must be set to ensure correct operation from the throttle controlled parameters.
TPS_min must be set to the raw throttle value TPS_raw at closed throttle and TPS_max is set to the value of TPS_raw at full throttle.

Air temperature is measured using a sensor mounted in the intake manifold. The sensor is a negative coefficient thermistor in an automotive compatible package.

Coolant temperature is measured using a sensor mounted in the water jacket of the engine.

Engine speed and timing are measured using two variable reluctance sensors.

Manifold absolute pressure (MAP) may also be used as the primary load sensor, and with the sensor disconnected from the inlet may be scaled for use as a barometric sensor. Mass Airflow (MAF) may also be used as the primary load sensor. There is a software switch option MAP_swap in SUBARU96 to swap the group N boost sensor into MAP_raw for load.

The Knock sensor may be monitored; embedded software implements active knock control and a second sensor.

The exhaust gas oxygen sensor can also be monitored as a mapping aid and may be used as a weak mixture alarm.

Exhaust gas temperature can be monitored, see Thermo.

Both front and rear road speeds may be used within control strategies, for the active centre differential in the SUBARU99.
Both hand and foot brakes may be monitored, and used by control strategies for the differential controller.

Power steering and air conditioning status may be monitored.

FUEL METERING

The amount of fuel injected each cycle is dependent on the time the injector is open. This time period, or pulse width is calculated by the ECU using factors for volumetric efficiency, air temperature, air flow, cold start enrichment, injector flow rate and battery voltage.

Volumetric efficiency V.E., the major factor, is determined by the engine load and engine speed using a three dimensional lookup table. This 3D table is a simple grid with Load along one axis and engine speed along the other.

The Load range is from 0 to 130. The load axis has 14 sites. Load may be derived from throttle, Air flow, or MAP. The engine speed axis has 21 sites, one every 400 RPM from 800 to 8000 RPM.

At each intersection of an engine speed site and Load site there is a grid value. This is the volumetric efficiency value or V.E. and is directly proportional to the pulse width and therefore the amount of fuel injected.

These values are determined by running the engine on a dynamometer at each obtainable point and adjusting the V.E. values to obtain optimum performance. Values for unobtainable points, such as high speed low load and low speed high load, are normally selected to blend in with the obtainable values.

If the engine is running at an exact engine speed site and an exact Load site then the VE value at the intersection of these two sites will determine the amount of fuel injected.
So using:

Part of V.E Table

Speed/load	100	110	120	130
4800	130	130	130	133
5200	135	135	135	135
5600	142	143	144	145
6000	150	152	155	160
6400	165	170	175	180

If the engine speed is 5600 rpm and the load is 110 then the VE value will be 143.

If the engine is running at a speed and load between sites then the VE value is determined by interpolating the four grid values around the engine running conditions. So using fig 4.2 if the engine speed is 5850 rpm and the manifold load is 125 then the four grid values are:

143 @ 5600 rpm 110 load
144 @ 5600 rpm 120 load
152 @ 6000 rpm 110 load
155 @ 6000 rpm 120 load

Then the interpolated value is 149.

Closed Throttle fuelling
When the following conditions are met then the closed throttle table is used to obtain the value of VE:

Throttle < Max closed throttle, CT_TPS option.
Engine_Speed > Min speed closed Throttle, CT_speed.

The VE value obtained from the grid is then modified by the operator variable factor Fuel_mod, so that :

VE (mod) = (VE + (VE × Fuel_mod))×MSPB

Fuel_mod is set by the operator using the monitoring and display system and is used to determine the optimum VE values. Under normal conditions Fuel_mod = 0%.

Fuel_(map) is then modified with factors for Air_pressure, Baro_Fact; Air_Temp, Air_Temp_F air temperature factor; engine coolant temperature factor Cool_Tmp_F, an optional exhaust oxygen factor OX_F.B. and user settable overall factor option called Fuel_offset that is loaded into Fuel_mod at power on; and while starting Crank_Fuel.

Fuel_(map) = VE(MAP) × MicroSec/bit
Fuel_comp = Fuel_(map) × (100%+Fuel_mod), ±50%.
Fuel_Air = Fuel_comp × (100%+Air_Temp_F), ±50% ± 10% typical.
Fuel_Warm_up = Fuel_Air × (100%+Cool_Tmp_F), +0 to +250%, 0% typical.
Fuel_OX_FB = Fuel_Warm_up × (100%+OX_F.B)., ±50%, see optional limits.
Fuel_Baro = Fuel_OX_FB × (100%+Baro_Fact), ±50%, ±10% typical.
Fuel_Crank = Fuel_Baro × (100%+Start_Fuel), +0 to +100% start fuel.
Fuel_Pulse = Fuel_Start × (100%+Throttle_mod), ±100% .

Then two individual pulse-widths are calculated: INJxPW = Fuel_Pulse × Inj_#x_mod

Inj_#x_mod are the four individual offsets for the four injection pulses they are scaled +/-50% .If there is no difference then the INJ_#x_mod option may be set to zero. The x in the INJx and INJ_#x_mod is related to the two injector outputs.

BPW = VE × microsec/bit

The final fuel pulse width is then calculate by adding a factor determined by battery voltage (Bat_Comp_F) and any acceleration or deceleration fuel (Accel_Fuel).

Total Pulse width = Pulse_width + Bat_Comp_F + Accel_Fuel

This ensures the accuracy of the fuel metering at all battery voltages.

Battery_Fact is set by a 2D look up table (Battery Voltage Compensation).
This table has 10 sites, one every 1 volt from 6 volts to 15 volts. The value obtained from the table is Battery_Fact in microseconds.

CRANK FUEL

When starting the value of VE is obtained from 2 dimensional lookup table controlled by scaled throttle position Throttle, called Crank Fuel table. Throttle is scaled to 0 for closed throttle to 130 for full throttle. The value for VE is then controlled as for normal running. Note while starting the start extra and start decay will be active untill the decay has expired even though the engine has exited the cranking condition.

ACCELERATION FUEL

When there is a large change in throttle position measured every 4 milliseconds, then some additional time is added to the base fuel pulse width.

when +dThrottle > TPS_Trip option then Temp A_Fuel =

(+dThrottle×Acel_M)+Accel_C)×TPS_Accel_mod×TPS_Accel_Amount×Fuel_Pulse

when –dThrottle > TPS_Trip option then Temp A_Fuel =

(-dThrottle×Acel_M)+Accel_C)×TPS_Accel_mod×TPS_Decel_Amount×Fuel_Pulse

If No_Accel_add is on then:

Accel_Fuel = last Accel_Fuel + Temp A_Fuel

If No_Accel_add is off then:

Accel_Fuel = last Accel_Fuel or Temp A_Fuel which ever is bigger.

Accel_Fuel is decayed every injection event or every 5 milliseconds back-ground event.

Accel_Fuel = Accel_Fuel × Accel_Decay, (or Decel_Decay if Accel_Fuel is negative)

The decay action is applied every injection event. The filter for TPS allows for detection of smaller throttle changes; the minimum filter value is 0% with 93% giving maximum filter.

Accel Fuel is a signed 16 bit value with the range +/-65 milliseconds and is composed of the sum of both the positive acceleration fuel and negative deceleration fuel. If the Alt Accel switch in options is set on then an acceleration only fuel enrichment is used that uses a filtered throttle signal and is less sensitive to false triggering.

REV LIMITERS

The fuel rev limit function works by cutting a percentage (Fuel cut rate option) of the fuel injection pulses if the engine speed is greater than Fuel cut option.

The ignition rev limit function works by cutting a percentage (Ign cut rate option) of the fuel coil pulses if the engine speed is greater than Ignition cut option.

An other limiter may be installed to protect the engine in a jacked open throttle anti-lag but at present this would appear unnecessary, since the idle stepper motor can flow enough air.

IGNITION TIMING

Ignition timing is controlled in the same way as for fuel using speed and load. There are 21 speed sites, one every 400 rpm from 800 to 8000 rpm and 14 load sites one every 10 load from 0 to 130. At each site the timing can be set from -64 to 64 degrees BTDC. Interpolation is used for values between sites to ensure smooth curves.
The ignition advance value ADV from the main lookup table is modified by a user controlled value Spark mod.
Spark mod is variable from -64° to +63.5° it used when calibrating the engine to obtain optimum values for the ADV table. It can also be set to pre-set value for switch on which then acts as an overall retard/advance factor.

ADV(m)=Spark adv + Spark mod

The modified ignition advance is further modified by the Air and water temperature retard or the throttle position advance modifier Retard mod whichever is the more retarded.

Air Retard is obtained from the Air Adv comp table. The modified ignition timing:

ADV (mod) = ADV (mod) - Air Retard + TPS_rtd (m)

Water temperature retard is made using: Coolant < Retard_start then Air Retard = 0

Cool Retard = (Coolant – Cool Rtd strt) × Cool Rtd Rate

Since the TPS retard is usually greater than either the air or water retards the TPS retard has twice the power of the TPS retard map value. TPS retard is zero unless PBW is enabled. If PBW is enabled then Air Retard is set by a 3 dimensional look up table addressed by Throttle and Engine Speed. The Throttle axis has 14 sites one every 10 points from Throttle = 0 to Throttle = 130 (WOT). The Speed axis has 21 sites one every 400 rpm from 800 to 8800 rpm. The values from the table are interpolated. The map will accept values in the range -64° to +63.5°. The output from the table TPS retard is then modified by the use modifier Retard mod such that:

TPS_rtd (m) = TPS retard + Retard mod

If TPS_rtd (m) < Air Retard then,

ADV_(mod) = ADV(mod) + TPS Rtd (m)

ADV(r)= ADV(m) Air Retard + Idle ADV

Individual ignition trim options (ADV_x_mod) are added to provide cylinder compensations, since there are detectable differences between nominally identical cylinders. Later the individual trims may incorporate knock control corrections.

MONITORING AND DISPLAY SYSTEM (IBM PC configuration)

To allow the user to monitor the operation of the engine management system and to reprogram the user data, the system interfaces with any IBM PC or compatible computer using GEMSCOM.EXE.
To connect the IBM PC to the ECU a special cable is required. Three wires are required, the lid must be removed to access the internal serial connector JP2 :

JP2 is numbered clockwise from the key:		9 way	25 way
1 E.C.U. GROUND	PC GND	PIN 5	PIN 7
2 E.C.U. RX	PC TX	PIN 3	PIN 3
3 E.C.U. TX	PC RX	PIN 2	PIN 2

Alternatively the RX and TX lines are available on the loom connector.

Setting up the IBM PC.
Place the GEMS floppy disc in drive A: and copy the contents to a directory and sub-directory on your hard disc. Then type GEMSCOM to run the application. Note the gems directory should be pathed.

The Directory structure should be:

C:/GEMS This contains GEMSCOM.EXE and GEMS.EXE.

With at least one sub-directory:

C:/GEMS/SUBARU97
This contains

GEMSCOM.CFG	Configuration file lists files use.
SUBARU97.INI	Initialisation list Parameters, Maps, Tables.
SUBARU97.KEY	User key files keyboard functions.
????????.HEX	Calibration file.
????????.SCR	Screen file of display parameters.
SUBARU97.POT	Optional "pot box" alternative to keyboard.

PARAMETER DISPLAY
Up to 20 parameters may be displayed, use F3 to select parameters, and F2 to save the screen configuration.

USER CONTROL

There are various functions and modes that can be initiated by the IBM PC, that allow the user to control the operation of the management system and to reprogram the calibration data, the F10 function will show the .Key file functions. Typically the following are used:

← ↑ → ↓ Ignition advance and fuel mixture can be controlled using the arrow keys. F10 will list the functional keys. The "up arrow" and "down arrow" keys control the fuel mixture by modifying the volumetric efficiency value using a factor called Fuel mod. One press of the up arrow key will increase Fuel mod by 0.39% and one press of the down arrow key will decrease Fuel mod by 0.39%. If the SHIFT key is pressed at the same time as the up and down arrow keys then Fuel mod will be increased or decreased by 3.9%.

The "left arrow" and "right arrow " keys control the ignition timing by modifying the advance using a factor called Spark mod. One press of the right arrow key increases Spark mod by 0.18° and one press of the left arrow key decreases Spark mod by 0.18°.

s The ignition advance curve is reprogrammed using s. With the engine running at a speed site, pressing s will program the advance value in Spark(mod) into the curve at that site. Spark mod is reset to zero. If the engine speed is not within 100 rpm of a speed site then it will not be reprogrammed and the PC will give an audible warning.

F The fuel map can similarly be programmed using the f key, with Fuel mod being adjusted.

C The checksum, which is used to check that the calibration data has not been corrupted, is reprogrammed by pressing c. This will recalculate the checksum using the present calibration data and will program this value into the checksum location. If any changes are made to the calibration then c should be used to correct the checksum.

If changes to Maps, Tables, or Options are made with the ECU powered and connected to the PC, then these changes will alter the ECU. Care must be taken while altering values especially if the engine is running!
If there is no serial communications then the off-line flag is set and only the WORKMAP.HEX is altered.

Cal_Name allows the end user to set up to eight alpha-numeric characters to identify the ECU and or its’ calibration.

INJECTOR BATTERY COMPENSATION TABLE

The value of the Battery comp option is the scalar for the Battery comp table. If this option is zero then the old table in ROM (not a user variable) is used. If you wish to view the shape of the table, press F5. The injector battery compensation table is determined by the model and type of injector you are using. If you change injectors or fuel pump pressure you may need to change this table and or microsecond/bit, and re-scale the VE tables, this may also effect the optimum settings for injection open angle.

Battery comp F= table value $\times$ Battery comp (option)

If we use the Weber IW 058 (43005.010) as an example of a contemporary high impedance injector:

R = 14.5 ohms   L = 7.2 mHenrys
Flow rate 384 mlitre per minute at 300kPa

Battery Volts	Offset time mSec
6.0	5.387
8.0	2.028
10.0	1.217
12.0	0.806
14.0	0.558
16.0	0.391

If 8 volts is the minimum battery supply for normal operation, then we can scale the system thus:

2.028 mSec/255 for finest resolution = 8 µSec per bit

With the overall scaling of 2µSec per bit then we may chose 5 (10µSec/bit) for convenience.

Battery Volts	Offset time E.C.U. units
8.0	255
10.0	153
12.0	101
14.0	70
16.0	49

The missing values for odd voltages are best blended using the graphical editor (F3) in the mod program.

The original internal table would look like this for 18 µSec multiplier option

8.0	255
9.0	139
10.0	79
11.0	52
12.0	30
13.0	20
14.0	11
15.0	9
16.0	7

TIMING SENSOR DELAY COMPENSATION

Some timing sensors, especially variable reluctance magnetic sensors have an in built drift with speed. This causes the ignition timing to retard as the engine speed increases.

This is compensated for with the Pickup delay compensation. The value of Pickup_comp is 166666/deg/rpm. So with Pickup_comp set to 0, if for a fixed value of ADV(m) the measured timing at 2000 RPM is 2 degrees different at 6000 RPM then

Pickup_comp = 33333/4000 = 84µS

TURBO ANTI–LAG CONTROL (PBW)

The idea here is to maintain a relatively high airflow through the engine to keep the exhaust mounted turbine compressor running at speed to avoid turbo lag and hence improve throttle response.

Enable conditions

The PBW system will be enable if all of the following conditions are met:

TPS_ALS is OFF then PBW active if all following met:

ECU PBW Pin is at 0v (Drivers Switch)
Air temperature is < PBW_Temp
Engine_Speed > PBW_ON_Speed

TPS_ALS is OFF then PBW inactive if any:

ECU PBW Pin is at not 0v (Drivers Switch)
Air temperature is < PBW_Temp
Engine_Speed > PBW_OFFSpeed

TPS_ALS is ON then PBW active if all following met:

TPS_raw > 128 at power on
Air temperature is < PBW_Temp
Engine_Speed > PBW_ON_Speed

TPS_ALS is OFF then PBW inactive if any:

TPS_raw > 128 at power on

Air temperature is < PBW_Temp
Engine_Speed > PBW_OFFSpeed

If PBW is enabled the ignition timing is modified by the TPS Retard factor and a proportion of sparks are disabled by the Ignition Limiter function and fuel injection events are skipped in the fuel limiter.
This controlled by the TPS Retard, Spark and Fuel Limiter 3D lookup tables with Inputs Engine Speed and Throttle. Speed Axis 21 sites 800 to 8000 rpm,400 steps. Throttle Axis 14 site 0 to 130 Throttle, 10 steps. Output Limiter 0% no cut to 99.6% almost total cut.

ELECTRONIC WASTEGATE CONTROLLER

The electronic wastegate controller uses an solenoid air bleed valve to control the load supplied to the waste gate actuator capsule. This allows the manifold pressure to be accurately controlled. This is an open loop system, the old active feedback has been deleted as it offered marginal performance improvement for considerable mapping and engine stress.

Load and Engine Speed are then used to address a 3D look up table to give the base waste gate valve duty cycle WG msr. The WG msr is taken from the Waste Gate map, accessed using Throttle and Engine Speed. The output has the range 0% to 99.6%. The output duty value WG msr is then modified by a user controlled factor WG mod to give the waste gate output value WG msr 1. This allows the user to calibrate the waste gate duty cycle table.

WG msr (m) = WG msr + Waste mod

The final drive value of WG msr (m) is limited in range to produce WG msr (c) that is used to drive the valve.

IDLE CONTROL

There are three conditions for idle speed control;

1 Engine_speed < Idle_speed and Throttle < max_Idle_TPS; then the Idle cool and Idle speed tables are active.

2 Engine_speed > Idle_speed or Throttle > max_Idle_TPS and PBW is off, then Idle_High is active.

3 Engine_speed > Idle_speed or Throttle > max_Idle_TPS and PBW is on, then Idle_PBW is active.

KNOCK CONTROL

Although only a single knock microphone is fitted as standard a second sensor can be fitted see knock1 in pin–out list appendix. A twin sensor arrangement should provide better discrimination of knock in a noisy environment. The audio signal or signals are processed to measure energy in a particular frequency band, during compression of a particular cylinder. This energy is used to produce an additional fuel amount, to cool the offending cylinder and an ignition retard to prevent recurrence. The standard conditions are restored by the Knock_Dec and Knock_Rtd options.

Knock Volt#n = Knock_raw – Knock_noise

Knock_noise is the background noise with no Knock, typically 60. This parameter is obtained from the Engine_Speed related Knock Noise table.

Knock Fuel#n = (Knock Volt#n)×(Knock_Rich)+(old Knock Fuel#n)×(Knock_Dec)
Knock Rtdl#n = (Knock Volt#n)×(Knock_Rtd)+(old Knock Rtd#n)+(Knock_Inc)

This is performed on a cylinder by cylinder basis. These outputs are limited by Knk_Fuel_Max and Knk_Rtd_Max respectively. To prevent miss triggering two Knock events must occur within Knock_rate events.

The Knock filter frequencies are best chosen using a spectrum analyser to determine peak response at the knock frequency, it is expected that this is about 6kHz. Code 37.
For single channel system set Knock gain=0 and Knock mode=3 then use Knock_Int to tune the sensitivity of the system, smaller values more sensitive.

Knock Mode 0	Channel#0 Attenuate Channel#0
Knock Mode 1	Channel#0 Attenuate Channel#1
Knock Mode 2	Channel#1 Attenuate Channel#0
Knock Mode 3	Channel#1 Attenuate Channel#1

Knock Configuration Table

Value	Centre Frequency kHz Knock Filt 0 Knock Filt 1	Attenuation Balance/gain Knock Gain	Integrator Time constant μS Knock Int
0	1.22	1.000	40
1	1.26	0.960	45
2	1.31	0.923	50
3	1.35	0.889	55
4	1.40	0.857	60
5	1.45	0.828	65
6	1.51	0.800	70
7	1.57	0.774	75
8	1.63	0.750	80
9	1.71	0.727	90
10	1.78	0.706	100
11	1.87	0.686	110
12	1.96	0.667	120
13	2.07	0.649	130
14	2.18	0.632	140
15	2.31	0.615	150
16	2.46	0.600	160
17	2.54	0.576	180
18	2.62	0.554	200
19	2.71	0.533	220
20	2.81	0.514	240
21	2.92	0.497	260
22	3.03	0.480	280
23	3.15	0.465	300
24	3.28	0.450	320
25	3.43	0.436	360
26	3.59	0.424	400
27	3.76	0.411	440
28	3.95	0.400	480
29	4.16	0.389	520
30	4.39	0.379	560
31	4.66	0.369	600
32	4.95	0.360	
33	5.12	0.346	
34	5.29	0.333	
35	5.48	0.320	
36	5.68	0.309	
37	5.90	0.298	
38	6.12	0.288	

39	6.37	0.279
40	6.64	0.270
41	6.94	0.262
42	7.27	0.254
43	7.63	0.247
44	8.02	0.240
45	8.46	0.234
46	8.95	0.228
47	9.50	0.222
48	10.12	0.217
49	10.46	0.208
50	10.83	0.200
51	11.22	0.193
52	11.65	0.186
53	12.10	0.179
54	12.60	0.173
55	13.14	0.168
56	13.72	0.163
57	14.36	0.158
58	15.07	0.153
59	15.84	0.149
60	16.71	0.144
61	17.67	0.141
62	18.76	0.137
63	19.98	0.133

MONITORING AND DISPLAY SYSTEM (IBM P.C. configuration)

To allow the user to monitor the operation of the engine management system and to reprogram the user data, the system interfaces with any IBM P.C. or compatible computer using a special terminal emulation program available from GEMS. To connect the IBM P.C. to the ECU a special cable is required.

Setting up the IBM P.C.

The GEMS floppy disk with the user interface program GEMSCOM.EXE and the SUBARU97.INI,SUBARU97.KEY should be loaded on to your computers hard disk. A .POT file is required if the potbox or potboxes are required to control the ECU as an aid to mapping.

Type "Gemscom" at the DOS prompt.

Refer to the GEMSCOM manual for details, note the F1 key will give context sensitive on screen help.

BACKWARD COMPATIBILITY

Although new features have been added such as improved Accel/Decel features old configuration files .DO may be read and altered with GEMSCOM, so when converting an old calibration particular attention should be taken when checking the options as the scaling is now predominantly in engineering units, and some options such as Accel Amount is now a table.

The PBW mode on and off are the torque controls used above the PBW temp and below respectfully. I_LMT (bit 1) is the spark cut function, F_LMT (bit 0) is the fuel cut function and IRTD (bit 2) is the TPS ignition retard function. By displaying PBW mode the 3 least significant bits can be interpreted.

MAP min and MAP max are used when load is derived from a MAP sensor and are the appropriate unscaled values of the raw MAP signal. The full scale Air Pressure signal is assumed to be 3.4 Bar shown as 338.7 Bar%.

The wastegate control is simpler as there is no boost table only the Waste Gate map to be set.

The user controls are listed from the .KEY file using the F10 key. Note the write through to the ECU while running must be used thoughtfully.

Mass Air Flow to Load Calculation.

When MAF is set ON, MAP and BAR must be set OFF, then the MAF_signal is used to derive Load.

First The MAF_signal is filtered then linearized using an internal table to make Air_flow. Air_flow is then corrected for engine speed to produce MAF_raw which in turn is converted to MAF_as_Load using the options MAF_min and MAF_max.

MAPS

FUEL MAP

The base fuel VE is derived from this map, Load may be selected from the three possible sources Throttle, MAP, and Airflow.

IGNITION MAP

The base ignition Spark adv is derived from this map with the same functionality as the Fuel map.

TPS RETARD MAP

The base throttle controlled ignition retard, TPS retard is derived from this map, active if IRTD is set.

SPARK LIMIT MAP

This is the spark cutting percentage that will be used if ILMT is activated.

WASTE GATE MAP

The duty or force applied by the waste gate valve, WG MSR is derived from this map.

FUEL LIMIT MAP

This is the fuel cutting percentage that will be used if FLMT is activated.

BOOST TARGET AND LOAD TARGET MAP

This is the same information presented with different scaling. This table holds the desired or target boost pressure or Load to be achieved at a particular throttle position and engine speed, used by the wastegate feedback option if active.

THROTTLE MOD MAP

This map holds a signed fractional modifier for the fuel related to throttle position and engine speed.

TABLES

CRANK FUEL TABLE

While cranking the base fuel, VE is obtained from this throttle related table.

AIR COMP TABLE

The amount fuel may be corrected for different air temperatures with this table. The change from standard is +/-50%. Note the minus should be entered after the value.

BATTERY COMP TABLE

The injector dead time correction against battery voltage is derived from this table.

TPS TO LOAD TABLE

If the MAP or MAF Airflow derived Load is out of range then a Load value derived from the current Throttle signal, this will allow a more appropriate Load to be used compared to the default Load of 130.

WARM UP TABLE

This is the normal fuel correction versus engine Coolant temperature with a range of 0% to 255%.

ACCEL AMOUNT TABLE

This is the amount of additional fuel to be added to the current fuel if Accel Trip is exceeded, dependent on Engine Speed.

DECEL AMOUNT TABLE

This is the amount of fuel to be subtracted from the current fuel if Decel Trip is exceeded, dependent on Engine Speed.

CT FUEL PBW TABLE

When the Throttle is less than CT TPS and Engine Speed is greater than CT Speed then the base fuel is taken from this table, if the anti-lag feature is active. Note the table is also displayed as CT % PBW table relivant when CT Fuel % option is on.

CT FUEL NORM TABLE

When the Throttle is less than CT TPS and Engine Speed is greater than CT Speed then the base fuel is taken from this table, if the anti-lag feature is inactive. Note the table is also displayed as CT % Norm table relivant when CT Fuel % option is on.

IDLE COOL TABLE

The idle duty controls the amount of by-pass air when the idle conditions are met: Engine_speed less than Idle_speed.

IDLE SPEED TABLE

When the idle conditions are met then an engine speed related modifier is added to the Idle cool table value to determine the idle valve position.

BOOST ERROR/LOAD ERROR TABLE
When wastegate feedback (WG FB) option is on this table is used to alter the wastegate duty cycle so that Boost/Load reaches the Target Boost/Load value.

WARM-UP TABLE
This is a table that controls how much additional fuel to use at any engine temperature from -40°C to 120°C.

START EXTRA TABLE
This is an additional amount of fuel added, dependent on coolant temperature, while the engine is starting.

START DECAY TABLE
This table determines how quickly the additional start extra fuel is decayed over time. This decay is a linear decay in seconds after cranking commences.

CRANK PULSE TABLE
This is a single shot of fuel that may be injected into the engine at the start of cranking. The value in the table selected dependent on temperature is multiplied by the microsec/bit option to give the parameter Start_Pulse in micro-seconds.

LAMBDA TABLE
This table is used to convert Oxygen_raw into Lambda a more useful parameter, it may be possible to use the exhaust mounted thermocouple to improve the accuracy of this conversion.

BARO CORRECT TABLE
When Bar is On and MAF is Off then this table may be used to correct the fuel delivery using a Barometric sensor mounted inside the ECU, consult GEMS for details.

KNOCK NOISE TABLE
This is a measure of the background noise detected using the Knock microphone(s) against Engine_speed, typically 60 dependant on sensitivity.

AIR ADV COMP TABLE
This will generate a modification to the ignition timing due to the air inlet temperature. Note the scaling of this table is dependant on the exact position of the sensor.

OPTIONS

Timing sw	Above this engine speed the sensitivity of the timing input signals will be decrease
Inj*mod	These are the four individual fuel modifiers.
MAF_min/max	Are used to scale the MAF_raw signal to the 0 to 130 range of MAF_as_Load. Typical values are 70 for MAF_min and 10050 for MAF_max.
IGN offset	This is an overall ignition advance/retard option with the range +/-64°.
FUEL offset	This is an overall fuel amount modifier with the range +/-50%.
Fuel Sync	Is the fuel synchronisation control and determines the injector firing relative to a synchronising point in the 720° engine cycle range 0 to 7. Note old calibrations before G1.15 should have this value doubled.
TPS min/max	Are used to scale the TPS raw signal to the 0 to 130 range of Throttle.
MicroSec/Bit	Or k is the major scaling factor for converting VE in the Fuel map to the injector Fuel Pulse.
Fuel Cut	Is the engine speed at which the fuel cutting engine speed limiter will activate to protect the engine.
Accel Trig	The minimum positive increase in throttle to provoke additional acceleration fuel.
Accel Decay	The acceleration must eventually die away, this option controls the rate at which this is achieved.
Decel Trig	The compliment to Accel Trip for deceleration fuel.
Decel Decay	As above for Accel Decay.

FLMT PBW ON	Enables the Fuel Limiter when PBW active.
ILMT PBW ON	Enables the Ignition Limiter when PBW active.
IRTD PBW ON	Enables the ignition retard when PBW active.
IDLO PBW ON	Enables the Idle motor to open when PBW is active
IG F PBW ON	If cylinder is fuelled always ignite.
FLMT PBW OFF	Enables the Fuel Limiter when PBW inactive.
ILMT PBW OFF	Enables the Ignition Limiter when PBW inactive.
IRTD PBW OFF	Enables the ignition retard when PBW inactive.
IDLO PBW OFF	Opens the Idle motor to open when PBW is inactive
IG F PBW OFF	If cylinder is fuelled always ignite.

Spray start — This is the minimum Air temperature at which the water spray is activated.

Spray Load — This is the minimum Load at which the water spray becomes active.

Spray on — Is the on time in seconds for the water spray.

Spray off — Is the off time in seconds for the water spray.

Fans#1 start — This is the minimum coolant temperature to turn on the primary radiator fans.

Fans#2 start — This is the minimum coolant temperature to turn on the secondary radiator fans.

TPS_ALS — If this is set on then the anti-lag system is enabled if the throttle is depressed at power on, none of the PBW features will be enabled until PBW_ON_speed is exceeded. Else the dashboard switch is activated.

Pickup comp — This is used to correct for systematic delays in the sensors and ignition coils used with the ECU.

Delay Angle — This is used to determine the nominal ignition reference point by adding an angular delay to the timing signal.

Coil Factor — This adjusts the charging time for the coils used with the system. Typical value for ford Zetec coil pack is 24.

BAR — This will activate the air pressure correction factor calculation, to be used if the pressure sensor is measuring ambient air pressure, for MAP and MAF set to OFF.

MAP	The Load parameter will be derived from a pressure sensor sampling the engine inlet pressure, else Load will come from the airflow sensor or Throttle, Air Pres F will be 0%.
MAF	The Load parameter will be derived from the mass airflow sensor, else Load will come from MAP or Throttle.
Alt Accel	Uses a filtered throttle signal to trigger a fuel enrichment, and Accel Trip is typically 25 rather than 5 for the unfiltered trigger.
Auto EE	will reprogram the EEROM rather than just writing to the volatile memory, "c" must still be used to update the checksum. This mode of programming may be more prone to producing slight miss fires.
PBW_Air	This is the minimum air temperature to activate PBW so that the ON settings for ILMT,FLMT,IRTD are used. Note if this forces the system out of PBW mode then the error light will be illuminated.
PBW_ON_Speed	This is the minimum engine speed at which the anti-lag features are possible.
PBW_OFFSpeed	This is the maximum engine speed at which the anti-lag features are disabled after being activated.
Idle speed	This is the maximum Engine Speed for the Idle duty table to still to be active.
max Idle TPS	This is the maximum Throttle for the Idle duty table to still to be active.

MAP min	This is the value of the MAP raw signal to give the Load value of 0 when MAP is used to generate Load, below this value the TPS to Load table is used.
MAP max	This is the value of the MAP raw signal at full load for a MAP derived load, if this value is exceeded the TPS to Load table will be used. A typical value is 0 to 3 for a 3Bar system. 5 to 10 for a 1 bar system.
MAP mBar m	This scales the MAP pressure signal for use as a scaled MAP pressure parameter.
MAP mBar C	This scales the pressure signal for use as a scaled MAP pressure parameter. Range +/-32,767.

$$\text{Air Pressure} = (\text{MAP\_raw} \times \text{MAP\_mBar\_m}) + \text{MAP\_mBar\_c}$$

CT Speed	This is the minimum speed to activate the closed Throttle fuel tables.
CT TPS	This is the maximum Throttle value to activate the closed throttle fuel tables.
CT Fuel %	When on then the closed throttle fuel is determined as a percentage of base fuel from the main Fuel Map.
WG period	Is the cycle time for the pulse width modulated drive of the waste gate, typical value 10mS.
Air Temp min	The minimum valid air temperature.
Air Temp max	The maximum value air temperature.
Air Default	The value of air temperature to use when the previous limits are exceeded.
Coolant min	The minimum valid coolant temperature.
Coolant max	The maximum value coolant temperature.
Cool Default	The value of coolant temperature to use when the previous limits are exceeded.

Idle_High	This is the idle position applied the idle valve when not in idle and PBW is not active, should normally hold a closed value.
Idle_PBW	This is the duty idle position applied the idle valve when not in idle and PBW is active, normally open for anti–lag operation.
ALS Arm	When in TPS_ALS mode this is the time in seconds that engine speed must be between 500 and 800 rpm for the ALS to be activated. ALS will not function till PBW_ON_speed speed is exceeded.
ALS Release	When in TPS_ALS mode this is the time in seconds that engine speed must be below PBW_OFFspeed for the ALS to be turned off.
NO ALS arm	If set ON, then the ALS will not require engine speed to be held at 700 rpm to become active in TPS ALS mode.
TPS ALS SWT	If set on then the anti-lag system is enabled by depressing the accelerator pedal at ignition key on.
No Accel Add	If set on then the accumulation of acceleration fuel is enabled and the higher of the two potential acceleration fuels is selected.
Invert TPS	Some wiring implementations have the throttle potentiometer produce an increasing signal with depression, but SUBARU96 is inverted, so set this option to ON.
Alt no PSTR	The power steering demand input may be used to select a set of alternative fuel and ignition settings, called Alt Fuel and Alt Spark.
MAP swap	SUBARU96 only, the boost sensor for some group N implementations may be fitted and used instead of the standard MAP sensor.
CAT Rtd Lmt	This option is the maximum permitted ignition retard, must be a negative number. Use –20 for road applications, anti-lag may require –50.
Accel rtd	This is an ignition retard applied if Accel_trig is exceeded.
Accel R Dk	This restores the acceleration retard back to zero.
ALS Air	Is the maximum permitted AIT for the anti-lag system to be active.
ALS On speed	The minimum engine speed for anti-lag to become active.

Idle Period	The repetition rate for the SUBARU96 push pull idle valve.
Idle speed	The maximum engine speed for the idle condition.
Max Idle TPS	The maximum throttle value for the idle condition.
MAP mBar m/c	Used to scale the MAP_raw signal for display parameter MAP_pressure.
Knock Filt 0	See Knock control, primary filter selection 0 to 63.
Knock Filt 1	Filter selection 2nd Channel 0 to 63.
Knock Gain	Filter balance/gain 0 to 63
Knock Int	Filter integrator 0 to 31.
Knock Mode	Filter mode 0 to 3, 3 typical
Knock rate	Knock noise reject typically 100.
Knock Rtd	The magnitude of Knock triggered ignition retard.
Knock inc	The restoring factor per cylinder event.
Knock Rich	The magnitude of the Knock triggered fuel enrichment.
Knock dec	The restoring factor for cylinder quenching fuel.
Knk Fuel Max	The maximum permitted additional fuel due to knock suppression.
Knk Rtd Max	The maximum permitted ignition retard due to Knock suppression.
Fuel cut	This is the engine speed above which the fuel cut will activate.
Fuel cut rate	This is the depth of cutting for the Fuel cut.
Ignition cut	This is the engine speed above which the ignition cut will activate.
Ign cut rate	This is the depth of cutting for the ignition cut
ADV x mod	Individual ignition modifiers.
REV Light	Turn dash mounted error light on if engine speed exceeds this value.
DACTST	For testing DAC output.
Accel M	Scalar multiplier for acceleration fuel.
Accel C	Scalar constant for acceleration fuel.
Accel Limit	The maximum amount of acceleration fuel permitted as a percentage of current normal fuelling.
OX FB Gain	Is a multiplier applied to the values from the OX Error table to produce the OX error value, this is scaled as a binary mantissa, so 0 gives 1 and 4 give 16.
OX FB Rate	Is how often the feedback PI loop is run in milliseconds the lower numbers mean faster so the gain may need to be adjusted accordingly. Zero will disable this function giving an OX Feedback of 0%.
OX Switch	Or Stioch is the value of OX raw the raw value of the exhaust oxygen sensor at which the transition between lean and rich occurs. A typical value is 70, but is best found by halving the maximum (rich) value of display variable OX raw.
OX FB P	The oxygen feedback integrator proportional constant.

new OX_FBK = ((old OX_FBK + (OXERR x INTCON)) + OXERR OXPCON

OX FB +ve /-ve	Are the limits for oxygen feedback control, OX_FB_+ve must be a positive number, OX_FB_-ve must be a negative number.
Engine ok	Or Coolant Ok this the minimum warmed up engine temperature used to enable the deceleration fuel cut-off feature and Oxygen feedback.
Ox Load	The maximum load at which the oxygen feedback will still operate.
Ox Speed	The maximum speed at which the oxygen feedback is still active.
OX Step	A positive value added to OX_FB when the sensor first switches lean, +5% typical.
Min A-Fuel	If acceleration fuel falls below this amount then the acceleration event is considered complete.
Log Code	Temporary options for internal logging development.
Alt Fuel	Alternative fuel modifier active with power steering demand input if Alt no PSTR set on.
Alt Spark	Alternative ignition modifier active with power steering demand input if Alt no PSTR set on.

DISPLAY PARAMETERS

Accel Fuel	Is the amount of accel/decel fuel currently used, note this has the range +/-65,500 µSec.
ADV (mod)	Is the base ignition after being summed with Spark mod.
Air Flow	Is the currently calculated value of airflow no units.
Air Pressure	Is the scaled value for air pressure in Bar%, with a range of 0 to 127.5 Bar%.
Air Prsr F	Is the fuel correction due to air pressure, see BAR switch option.
Air Retard	Is the amount ignition retard produced due to air temperature, see Air start and Air Slope options.
Air Temp	Is current air temperature.
Air Temp F	Is the output of the Air comp table.
ALS On/off	Is the time in seconds for the ALS enable and disable options ALS on time and ALS off time.
Alt Fuel mod Alt Spark mod	These show the current modifiers either Alt Fuel and Alt spark, or Fuel offset, ignition offset and any modification.
Bat Comp F	Is the output of the Battery Comp table.
Battery	Is the supply voltage to the ECU if this is significantly different to the battery voltage while running check for poor wiring or bad battery.
Charge Time	Is the time that the coils are filled with current.
Coolant	Is the current coolant temperature.
Cool Temp F	Is the fuel correction due to the Warm Up or Start Fuel tables.

ERROR	Is a binary encoded byte that carries fault information, if all bits are zero there are no errors, a one indicates a fault, the most significant bit (bit7) is the left most and the least significant bit (bit0) is right most. Bit7 Checksum not correct, press c to recalculate and set value. Bit6 Mass Airflow over-speed, TPS to Load table active. Bit5 Crank timing fault, not functional. Bit4 Sync timing fault, not functional. Bit3 Coolant sensor fault. Bit2 Air sensor fault. Bit1 MAP pressure sensor fault. Bit0 TPS throttle sensor fault.
Fuel Limit	Is the output of the Fuel Limit map used if FLMT PBW is active.
Fuel Lmt (m)	Shows the effect of Fuel Limit after Fuel Lmt mod has been applied.
Fuel Lmt mod	The key adjustable modifier of the fuel cutter, FLMT PBW function.
Fuel mod	The key adjustable modifier of the Fuel map value.
Fuel Pulse	This is the amount fuel calculated for the current conditions with no Accel Fuel or Bat comp F.
Fuel_PW_#*	These are the four individual injector fuel pulses after modification by the Inj*mod options.
Inj_PW_#*	These are the total pulsewidths applied to the injectors.
Ign limit	Is the output of the Spark Limit map, used if ILMT PBW is active.
Ign lmt (m)	Is the ignition cut after Ign lmt mod has taken effect.
Ign Lmt mod	Is the key adjustable modifier of the ignition cutter, ILMT PBW function.
LMTSTAT	Is the current status of the fuel and ignition limiters. From left to right: Injectors limiters cylinders 4 to 1, bits 3 and 2 are not used, bit1 cylinders 2&3 ignition cutting, bit0 cylinders 1&4 ignition cutting.
Knock	Is the raw unscaled Knock microphone signal.
Lambda	Is the scaled exhaust gas oxygen signal 100 = Stoichimetric fuelling, this will need further refinement but is a useful logging parameter. This value is obtained from the lambda table using Oxygen raw.

LOAD	Is the parameter used to access the Fuel, Spark and Waste Gate maps. See MAP AFLW switch options.
MAP AS LOAD	Is the current MAP derived signal scaled for Load.
MAP raw	Is the unscaled pressure signal used for MAP and barometric compensation, see MAP min and MAP max options.
MAF AS LOAD	Is the current MAF derived signal scaled for Load.
MAF raw	Is the unscaled pressure signal used for MAP and barometric compensation, see MAF min and MAF max options.
MAF_signal	Is the mass airflow sensor output scaled in volts.
Oxygen raw	Is the unscaled oxygen signal 0 to 255 = 0 to 5 volts.
PBW MODE	The eight bits are shown B7 to B0. These bits are determined by the action of the PBW switch and PBW start options. When active the bit will show 1, zero is inactive. Bit7 TPS ALS mode Bit6 Bit5 Bit4 Bit3 IDLO idle control. Bit2 IRTD ignition retard. Bit1 ILMT ignition cutter. Bit0 FLMT fuel cutter.
Retard mod	Is the Key adjustable modifier for the IRTD ignition retard PBW function.
Spark adv	Is the output of the Ignition map.
Spark mod	Is the key adjustable modifier of the ignition map value.
Throttle	Is the scaled value of throttle position.
TPS raw	Is the unscaled value of throttle position.

TPS retard	Is the output of the TPS retard map, used if IRTD PBW is active.
TPS rtd (m)	Is the TPS retard after Retard mod has taken effect.
VE (comp)	Is the VE (mod) fuel calculation after compensation by coolant and air temperature and optionally air pressure have been included.
VE (mod)	Is the VE value from the Fuel map adjusted by Fuel mod.
Vol. eff.	VE or volumetric efficiency out of the Fuel map.
Waste mod	Is the user key adjustable modifier for the waste gate control.
WG MSR	Is the output of the Waste Gate map.
WG MSR (m)	Is the waste gate drive after modification by Waste mod.

SUBARU99 Pin No	9	8	7	6	5	4	3	2	1
Entry view	18	17	16	15	14	13	12	11	10
	25	24	23			22	21	20	19
	32	31	30			29	28	27	26

	No.	COLOUR	I/O		NAME	COMMENT
A01	007	NC	O		NO CON.	ALT FUEL PUMP
A02	006	NEW	O	IG3/COIL3 Q11	COIL#3	*WATER INJECTOR*
A03	005	NEW	I	IG4/COIL4 Q12	COIL#4	*ROAD SPEED FRONT*
A04	004	RD/BL	O	P23/OPD Q14	RAD FAN 2	1ST RADIATOR FAN
A05	003	BL/WH	O	P02/IDLE2 Q8	IDLE#2	IDLE SIGNAL 2
A06	002	WH/BK	O	P01/IDLE1 Q7	IDLE#1	IDLE SIGNAL 4
A07	001	YL/BL	O	IG1/COIL1 Q28	COIL#1	IGNITION 1&2
A08	102	BK/WH		RTN	GND	POWER GND
A09	101	BK/YL		RTN	GND	INJECTOR GND
A10	014	GN	O	P26/RADS Q17	SPRAY	WATER SPRAY
A11	013	NEW	O	WG2/WGATEI Q23	WGATEI	WASTE GATE INVERT
A12	012	NC				
A13	011	YL/RD	O	P27/RADF Q18	RAD FAN 2	2nd RADIATOR FAN
A14	010	BK/BL	O	P03/IDLE3 Q26	IDLE#3	IDLE SIGNAL 1
A15	009	BK/RD	O	P04/IDLE4 Q27	IDLE#4	IDLE SIGNAL 3
A16	008	LGN/WH	O	IG2/COIL2 Q29	COIL#2	IGNITION 3&4
A17	104	BK	I	RTN	GND	IGN GND
A18	103	BL/BK	O	INJ4/INJD Q1	INJ4	INJECTOR 4
A19	019	BK/WH	O	WG1/WGATE Q5	WGATE	WASTE GATE
A20	018	BL	O		NO CON.	
A21	017	LGN/BK	O	P24/FPUMP Q15	FPUMP	FUEL PUMP
A22	016	BN/RD	O	I03/ACOUT Q10	ACOUT	AIR CON ENABLE.
A23	015	NEW	I	P21/OPB Q19	SPARE	*HAND BRAKE*
A24	106	NEW	O	PW4/OPA Q20	DIFF	CENTRE DIFF
A25	105	BL/RD	O	INJ2/INJB Q3	INJ3	INJECTOR 3
A26	024	GN/YL	O	I01/PEX Q22	PEX	PRESSURE EXCHANGE
A27	023	RD/GN	O		NO CON	2 WAY GN TST MODE
A28	022	RD/WH	O	P25/LED Q16	CHK LIGHT	INSTRUMENTCHECK LIGHT
A29	021	NEW	I	P22/OPC Q13	SPARE	*FOOT BRAKE*
A30	020	NC			NO CON	NO CON.
A31	108	BN	O	INJ1/INJA Q4	INJ1	INJECTOR 1
A32	107	LGN	O	INJ3/INJC Q2	INJ2	INJECTOR 2
B01	031	OR/BK	I	I06/PWRSTR R52	PWRSTR	POWER STREEING *ABTEMP* *Also Alt Switch*
B02	030	WH/BK			NO CON	IGN SWT CRANKING
B03	029	NEW	I	I04/IPA R60	IPA	(TORQUE CONTROL SIG1) *ANTI LAG SWITCH*
B04	028	GN/WH	I	OXGND	GND	LNK P119 OX GND IGN COIL
B05	027	NEW	B	CANL	NO CON.	*CANL COMMS*
B06	026	NEW	B	CANH	NO CON.	*CANH COMMS*
B07	025	WH/BL	O	CANP/PURGE Q6	PURGE	CARBON CANISTER PURGE
B08	110	NC			NO CON.	
B09	109	NC			NO CON	
B10	038	GN/RD	I		NO CON.	(AC) CLEAR 4 WAY PLUG
B11	037	PK/BK	I	ACIN	NO CON	(A/C SWT) GY 16 WAY HEATER CNT
B12	036	NC		GND	NO CON.	(TORQUE CONTROL SIG2)
B13	035	RD/BK			NO CON.	(READ MEM) GN 2 WAY TST MODE
B14	034	OR/WH	O	I02/TACHO Q21	TACHO	TACHO
B15	033	NEW	O	RDD/RX R17	RX	(TORQUE CONTROL) RECEIVE COMMS
B16	032	NEW	O	TXD/TX Q9	TX	TRANSMIT COMMS

					RECORD
B17	112	BK/BN	I		PERM	PERMENANT POWER
B18	111	NC	O		NO CON.	
B19	043	BK	I		NO CON.	HEATED SCREEN 20 WAY BK
B20	042	NEW	I	T3/TSPEED	TSPD	TURBO SPEED
B21	041	BK/WH	I		NO CON.	(MAIN/TAIL LIGHTS) 32 WAY WH
B22	040	OR	I		NO CON.	(TEST MODE CON)
B23	039	NC			NO CON.	
B24	114	NC			NO CON.	
B25	113	NC			NO CON.	
B26	048	GN/YL	I	T4/SPEED0 R7	VSPD(R)	ROAD SPEED REAR
B27	047	NC	I	GND	GND	
B28	046	NC			NO CON.	
B29	045	GN/OR	I	I07/NEUTRAL R56	NEUTRAL	6 WAY NEUTRAL SWT
B30	044	NC			NO CON.	
B31	116	NC			NO CON.	
B32	115	NC			NO CON.	
C01	055	GN	I	MAF	MAF	MASS AIRFLOW METER(BARO)
C02	054	NEW	I		DIFF NE-	(AT CONTROL) DIFF POT GND
C03	053	NEW	I		DIFF VE+	(CHK CON) DIFF POT SUPPLY
C04	052	NEW	I		DIFF POT	(MT/AT IDENIF.) DIFF POT SIGNAL
C05	051	RD	I	T2/CAM R8	T2	CAM/CRANK SENSOR
C06	050	WH	I	T1/CRANK R9	T1	CRANK/CAM SENSOR
C07	049	YL/BK	I	MAP	MAP	MAP SENSOR
C08	118	YL/BL	I	INJPWR	ECU SUPPLY	12V
C09	117	YL/BL	I	INJPWR	ECU SUPPLY	12V
C10	062	WH/RD	I	GND	NO CON.	*GND*DIODE/OR INT CLUSTER
C11	061	NC	I	GND	NO CON.	GND
C12	060	LBL	O	TPSPWR	VTPS	5 VOLT SENSOR POWER
C13	059	LGN/BK	I		NO CON.	(DATA LINK) GND
C14	058	NEW	I	EX GAS TEMP	THEMO	EXHAUST GAS THERMOCOUPLE
C15	057	NEW	O	COLD	COLDK	COLD JUNCTION TEMP
C16	056	NEW	I	PE9/AUX	SPARE	(IMMOB) SPARE ANAL INPUT
C17	120	GN/WH	O	GND	GND	OX CHASSIS GND
C18	119	GN/WH	O	GND	GND	CONTRL SYSTEM GND
C19	067	BL/WH	I	ATEMPB	ATEMPB	INLET AIR TEMP.
C20	066	LGN	I	TPS/PE0	TPS	THROTTLE POT SIGNAL
C21	065	WH	I	OX/PE4	OX	OXYGEN SENSOR SIGNAL
C22	064	NC	O		NO CON.	(IMMOB) GND
C23	063	LGN/WH	O		0V	TIMING GROUND
C24	122	RD/GN	O		0V	ANALOGUE GROUND
C25	121	GN/RD	I	12V2	IGN KEY	12V COIL FEED
C26	072	YL	I		KNOCK#1	KNOCK STANDARD INT=PK3
C27	071	NEW	I		KNOCK#2	2^{ND} KNOCK
C28	070	BK/YL	I		COOLANT	WATER TEMP SIGNAL
C29	069	GY	O		0V	KNOCK SCREEN GROUND
C30	068	GY/RD	O		0V	TIMING SCREEN
C31	124	BK/GN	O		GND	AIRMETER GND
C32	123	LGN	O		MRLY	HIGH-SIDE RELAY

SUBARU96 ECU connection list

The layout of the connectors is viewed from the wire side looking in at the ECU. The Largest plug has been named "D" Moving From left to right we then have "C","B","A".

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 -----~-----      -----~-----     -----~-----     -----~-----

|D13|~|D01|     |C08|~|C01|    |B06|~|B01|    |A11|~|A01|

|D26|~|D14|     |C16|~|C09|    |B12|~|B07|    |A22|~|A12|

 -----~-----      -----~-----     -----~-----     -----~-----
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PIN NO. DESCRIPTION

A01	132	
A02	131	power 12v from main relay
A03	52	boost pressure sensor +5V (****Pin C of Map Sensor****)
A04	51	boost MAP pressure signal (****Pin B of Sensor****)
A05	50	*(intake air temp signal)******
A06	49	oxygen sensor signal
A07	48	Coolant water temp signal
A08	47	air flow sensor supply
A09	46	MAF air flow sensor signal
A10	45	air flow sensor 0V not used
A11	121	Earth control unit
B01	38	throttle sensor 0V
B02	37	throttle sensor sig
B03	36	throttle sensor 5V
B04	35	crank angle signal
B05	34	crank angle sensor 0V
B06	33	crank angle shield GND
C01	24	cam sensor signal
C02	23	cam sensor 0V
C03	22	cam sensor shield GND
C04	21	knock sensor screen
C05	20	knock signal
C06	19	idle switch not used
C07	18	serial comms RX
C08	17	serial comms TX
D01	112	idle speed control
D02	111	idle speed control
D03	8	wastegate solenoid
D04	7	Rad fan
D05	6	eng diode main relay

D06	5	purge ****(water injection /water spray relay)*****
D07	4	igniter pin 1
D08	3	igniter pin 2
D09	2	igniter pin 3
D10	1	igniter pin 4
D11	103	injector 3
D12	102	injector 2
D13	101	injector 1
A12	134	not used
A13	133	power 12v from main relay
A14	60	insulation check
A15	59	permanent power supply
A16	58	Barometric altitude sensor not used
A17	57	oxygen sensor screen 0V
A18	56	not used
A19	55	0v screen air meter
A20	54	detection of transmission not used
A21	53	sensors 0V barometric air (**** pin A of map sensor ****)
A22	122	earth
B07	44	not used
B08	43	atmos 2 sig
B09	42	parking switch Anti-Lag (PBW) switch active when grounded
B10	41	neutral switch not used
B11	40	speedo signal
B12	39	ign key switch
C09	32	*9 AC switch not used
C10	31	starter switch not used
C11	30	accel not used
C12	29	diagnosis read memory not used
C13	28	diagnosis test mode not used
C14	27	not used
C15	26	trouble code output not used
C16	25	engine speed output
D14	114	earth
D15	113	earth ignition
D16	16	Power steering swt
D17	15	Rad fan
D18	14	ti monitor not used
D19	13	malfunction light oil press warning not used
D20	12	press exchange solenoid
D21	11	********Wastegate invert******
D22	10	rad fan AC Relay
D23	9	fuel pump relay
D24	106	inj earth
D25	105	inj earth
D26	104	injector 4

1		HEADER	$55
2	Engine Speed	ERPM	50 rpm/bit
3	LOAD	LOAD	0–208
4	Throttle	TPSVAR	0–208
5	Air Temp	ATEMP	signed degree/bit
6	Coolant	CTEMP	signed degree/bit
7	Battery	BATT1	0–16 Volt
8	Accel Fuel	AFUEL	MSB 512µS/bit
9	Fuel Pulse	RESULT	MSB 512µS/bit
10	Spark (mod)	ADV2	0.39 degree/bit
11	Error	ERROR	bit encoded
12		check sum	

When the ECU is started without a P.C. connected to RX a data logging stream will be generated with one character every 4.1 milliseconds transmitted at 9600 Baud 8bits no parity two stop bits. This stream is suitable for most GEMS ltd data loggers such as the DA50.

SUBARU97

The layout of the connectors is viewed from the wire side looking in at the ECU. The Largest plug has been named "A" Moving From left to right we then have "C","B". An Air temperature sensor can be wired into B15 signal and B13 ground. There is a relatively easy way of modifying the loom to accept an air temperature sensor. Move the power steering wire in C01 which is red/white to B15. This wire terminates at a 12 way connector on the engine harness by which time it has changed colour to pink pin 8. The ground for the sensor can be spliced into a green wire in pin 10.

-----------	01.green/white	07.No con.
01 02 03 04	02.white/green	08.pink
-----------	03.black	09.No con.
05 06 07 08	04.white/black	10.green/red
-----------	05.black/white	11.red
09 10 11 12	06.No con.	12.l green/white

-----------	01.green/white	07.No con.
01 02 03 04	02.white/green	08.green
-----------	03.yellow	09.No.con = Air signal
05 06 07 08	04.blue	10.green = ground
-----------	05.black/yellow	11.red
09 10 11 12	06.No con.	12.white

Map Sensor 3 way	black plug	GM Map sensor
1.red	5v	Pin C
2.yellow/black	signal	Pin B
3.blue	ground	Pin A

The water Spray/injection control can be wired to the ECU using Pin A21 is used to activate a relay to turn the water pump on and off active low.

The ALS input is activated by switching pin C10 to ground active low.

```
   -----~-----      -----~-----       -----~-----
 |A13|~|A01|  |C08|~|C01|    |B11|~|B01|
  -----~-----      ----~------       -----~-----
 |A26|~|A14|  |C16|~|C09|    |B22|~|B12|
   -----~-----      -----~-----       -----~-----
```

Wire entry view

PINOUT SUBARU97

		Use	Function
A01	108	Y	IDLE AIR VALVE
A02	107	Y	IDLE AIR VALVE
A03	008	Y	WASTEGATE CONTROL SOL.
A04	007	Y	×**WASTEGATE INVERT×**
A05	006	N	
A06	005	N	PRESSURE EXCHANGE SOL
A07	004	Y	FUEL PUMP RELAY WITHOUT IMMOBILISER
A08	003	N	MALFUNCTION LAMP
A09	002	Y	IGNA CYL 3 & 4
A10	001	Y	IGNB CYL 1 & 2
A11	103	Y	INJ4
A12	102	Y	INJ3
A13	101	Y	INJ2
A14	110	Y	TRANNY GND
A15	109	Y	MAIN PWR 12V
A16	016	N	
A17	015	Y	FUEL PUMP WITH IMMOBILISER
A18	014	N	
A19	013	N	
A20	012	N	
A21	011	Y	AIR CON ×***WATER SPRAY/INJECTION×****
A22	010	N	×** IGN ×***
A23	009	N	×** IGN ×***
A24	105	Y	IGN GND
A25	106	Y	INJ RTN
A26	104	Y	INJ1

C01	024	N	PWR STEERING
C02	023	Y	STARTER
C03	022	N	VEHICLE SPEED INPUT JOINT CONNECTOR
C04	021	Y	CHECK CONNECTOR RX
C05	020	Y	CHECK CONNECTOR TX
C06	019	N	
C07	018	N	
C08	017	Y	RAD FAN
C09	032	N	NEUTRAL SWT
C10	031	Y	AIR CON ×**ALS SWT×***
C11	030	N	
C12	029	N	IMMOBILISER
C13	028	N	IMMOBILISER
C14	027	Y	TACHO
C15	026	N	PURGE
C16	025	Y	RAD FAN

B01	114	Y	PWR 12V FROM MAIN RELAY
B02	113	Y	PWR 12V FROM MAIN RELAY
B03	040	Y	COOLANT TEMP INPUT
B04	039	N	KNOCK SIGNAL
B05	038	N	SIG OX
B06	037	N	SIG AIRMETER
B07	036	N	0V AIRMETER
B08	035	Y	CAM SIGNAL IMMOBILISER SWAP WITH CRANK
B09	034	Y	0V SPEED SENSORS PIN 4 JOINT CONNECTOR
B10	033	Y	CRANK SIGNAL IMMOBILISER SWAP WITH CAM
B11	111	Y	PWR 12V
B12	116	Y	PWR RTN
B13	115	Y	SENSOR 0V JOINT CONNECTOR
B14	048	Y	SENSOR SUPPLY 5V
B15	047	N	*****Air temp Input*******
B16	046	Y	TPS SIGNAL
B17	045	Y	BOOST MAP SIGNAL
B18	044	N	
B19	043	N	
B20	042	N	
B21	041	N	
B22	112	Y	ACTIVATE MAIN RELAY