SIMTEK

00X85

GENERAL ENGINE MANAGEMENT SYSTEMS LIMITED

CRABTREE ROAD

EGHAM

SURREY

TW20 8RN

ATTENTION

To Firmware update:

NOTE if moving from version prior to 00X80 to newer version, first update to 00X80, or 00Z73.

ECU: Clear calibration, with Set values to defaults where defined UNTICKED

ECU: Store changes in ECU “Ctrl-K”
If this fails check *ISP Enable Code* = 1 or 170, *Safety Time* = 0
Re-try

Check parameters *Stat Prog EE* and *Error EE Checksum* = Off, this can take 12seconds!

ECU: Upload Firmware with Clear Calibration UNTICKED

This will be resolved in later .GIN files and GWv4

Cal Upload

Check EE flag in bottom right hand of GWv4 window goes red indicating calibration is being written to non-volatile memory, if not ECU: Store changes in ECU “Ctrl-K”

And a reminder to Set ***Auto EE*** or Auto Store on GWv4 pane to Off, followed by a Ctrl-k and wait for *Error EE Checksum* = Off at end of calibration session.

REVISION HISTORY

00X85

Individual transmission rates on CAN1 with options ***CTele1 M0n Rate***, 10mS is a reasonable base setting .
Sync Check A Tooth if not satisfied (29 with current Subaru high data rate crank timing pattens) else *Sync A Tooth Error* counts, will detect damage to crank wheels.
Gear Ratio Raw invert, since ***Gear Ratio Simple*** table requires an increasing signal to decode into *Gear*, this option added to compliment signal 255 – X, rather than rewire pot.
VVC(X)1or2 Offset 0-3 allow correction of damaged or miss placed cam teeth. Data log *Cam(X)1or2 Angle no*, with *CAM(X)1or2 Offset No*, and identify faulty teeth, then adjust associated option to apply correction shown in *Cam(X)1or2 Angle*.

Act T Target PWM Out allows the routing of the throttle target signal to a PWM channel for use as “throttle kicker” or single output idle valve. The 3 ALS related throttle targets, with idle correction and Blip, with ***Act T Pedal max Error*** (*Pedal Raw* units) set limits the pedal control range for use as follower mode for idle speed control, if exceeded activates ***Act T Pedal Default***, so that when blip is activated a suitable position may be defined in the 3 ***Act T Target*** tables. Note ***Act T Pedal max Error*** should be zero if normal DBW throttle is used.
Primary Accel Fuel Only will attempt to put all acceleration fuel enrichment through the primary injectors unless they are filled up.

00X84

Higher resolution CAN bus telemetry now 1mS.
Count 50mS parameter for CAN bus.
MAP for Load Scalar the usual internally calculated value for ***Load Scalar***, if working in kPa absolute, then ***Load Offset*** = 0.

00X83

Internally calculated *MAP for Load Max.*
Restructured boost control. May control *Boost*, *PRP* Post Restriction Pressure, *Turbo Speed,* or WGTU any parameter selected with WGTU.
NOS feature added.
Extended logging for 6 fast, 8 medium, 31 slow parameters.
Bigger program space, see warning for via 00X80 upgrade path.
Injector and Coil routing using ***ECU Target name***.
Switch A renamed ***Cal Switch*** table.
ALS condition may drive output, for throttle jacker.
Limp mode if oil or fuel pressure out of range.
2 Low speed output pin selectable PWMs 9 and 10.
2 High speed output pin selectable PWMs 11 and 12.
Injectors 5-8 and ***Fuel Difference*** map to control split, and ***Injector Volts comp 2nd*** for these injectors, ***Primary Size*** how much lower fuel flow-rate of Primary/Secondary injectors, ***Sec Inj min Pulse*** if less then fuel to primaries, ***Injector Duty Max*** if primaries exceed this then excess to secondary.
Reduced size ALS limiter maps just 6 sites, note assumed zero at next Pedal breakpoint entry.
Many input parameters rationalised with own sensor tables: Barometer (was *Air Pressure* or *Baro*....), Lambda1, Oil Pressure, Fuel Pressure.
GWv4 axis selector feature used for ***VVC target***, ***Boost Target***, ***Fuel***, ***Ignition*** etcetera. Using ***MAP***, ***MAF***, or *Fuel Map Pedal* selectors.

00X73

Resolved issues with *Cal Launch*, *Cal Valve Cal VVC* selection.

00X71

Gear+ Retard max Absolute and ***Gear+ Ign Cut*** options extended into *Gear* related tables. Also bug fix with of code 47, used only in 2008 tumble valve control.

00X70

Idle Offsets parameter name replaces *IDLE*. ***Idle ALS No FB*** option to inhibit idle feedback if in ALS. Launch modes activated by Cal switch if ***Launch in pin*** = 0, rather like ALS with Cal switch.

00X68

Gear Pot, to enable use of potentiometer to measure early termination of gear change. ***Main Relay input***, back in for "Kill Switch". ***Gear Ratio Default***, condition for out of range signal. ***Gear Retard Inhibit time*** now up to 2Seconds.

00X67

Gear changing assistance re-worked. Now composed of various features,
Gear- Retard... , Gear- Advance....., Gear- Blip.... , Gear+ Act T Lift.... ,Gear+ Pot... , Gear- Pot..... , Reuse of *Gear Ratio* for sensing a gear position sensor,
Gear Ratio Max and ***Min***, along with ***Gear Ratio Scalar***, typically 0.3905 for conversion into percentage.

00X66

Lambda FB Speed min, added to support oversized injectors.

00X65

Feature control added, to check if available see parameters *Feature Pro*, and *Feature ALS*. Also the GEMS *Product Id*, and Serial Number in GWv4.
3rd alias table ***Lambda Sensor A03 *2***, to be used if ***Lambda1 x2 = On***, Since the differential input *Analogue 03*, is now -0.45 to 4.55 Volts, for easy substitution of wideband lambda sensor.

00X64

Simple ***Wastegate FB*** option to aid testing. Small ALS limiter Pedal axis.
Pedal Fuel mod map option to enable this feature. Hardware to be -0.45 to 4.45V scaling on *Analog 03*, used for wideband lambda sensors with amplified output. Feature control, *Serial Number* and *Product Id*.

00X61

High accuracy Knock Window.
Cal1 to Cal8 mode selection switch, for selecting combination of Fuel, Ignition, Valve Timing and waste-gate maps, and associated modes.
Combination of *Rev Light* and *Error Light* to single output.
Note ***WGT Scalar*** and ***WGT Offset*** should be set to ***Load Scalar*** and ***Load Offset*** if MAP or Boost pressure are used for control rather than *Turbo Speed*.
Lambda FB Temp Disable tuning aid to turn off temporarily turn off Lambda feedback, this prevents the correction appearing in Fuel.

00X53

Idle feedback, more like other PI control loops, with proportional table,
Idle FB Proportional, integral clamped with ***Idle FB Int+*** and ***Idle FB Int-***, also potentially long delay with ***Idle FB Delay***.
Accel Pedal Timebase, alternative extension of acceleration trigger sensitivity by comparing current *Pedal* with one up to 48mS old, in ***Accel Post Filter*** mode.
Delay Time +3/16 Tooth, instead of old ***Ign +1/4 Tooth***, this adds an offset to allow all timing calculations to complete. Set to On for high tooth count crank wheels where a ¼ of *Tooth Time* is safe, or Off for low tooth count wheels use 1/16 of a tooth offset. Note old calibrations will require adjustment of ***Fuel Sync***, and ***Spark Sync***.
Also note in ***Lambda Error Rich*** table must all have same sign.

00X49

Return of Auto EE, but requires main relay that will not shut down if non-volatile write is in progress.
Engine Speed now calculated (reasonably) before synchronisation, and less teeth than ***Wheel Teeth*** specifies. And must wait for more than ***Start Crank Teeth*** of *A Teeth* after *Stat Sync'd* = On before moving to TPER00-23 Tooth table based calculation.
Lambda Filter for noisy sensors typically 50%. ***Lambda FB rate***, as before, but also ***Lambda FB rate rev*** the number of engine revolutions before integral component is accumulated. This deals nicely with transport time latency with sensor distance from injector.

00X46

CAN1 receive messages increased to 8. Small 17 element ***Engine Speed*** table user defined. Full ALS names consistently used, to differentiate with ALS Mild and None.
Enhancements to Lambda Integral with error compensation. Accel Limit with both *Engine Speed* and *Coolant*. More flexible wastegate control.

00X43

Hardware change pending SimTek core design pull-down for MAF to be 2k2 not 10k, for reuse as temperature input.

Coolant temperature compensation of fuelling now from maps.
Start Coolant modifier map, with coolant and engine revolutions since crank synchronisation.
Warm-Up Fuel modifier map used once start is completed, indicated by *Stat Cranking* going Off. Uses time since crank exit for axis.
The output Coolant Fuel has the ability to increase fuelling 5 fold. This may be required for E85 fuels.

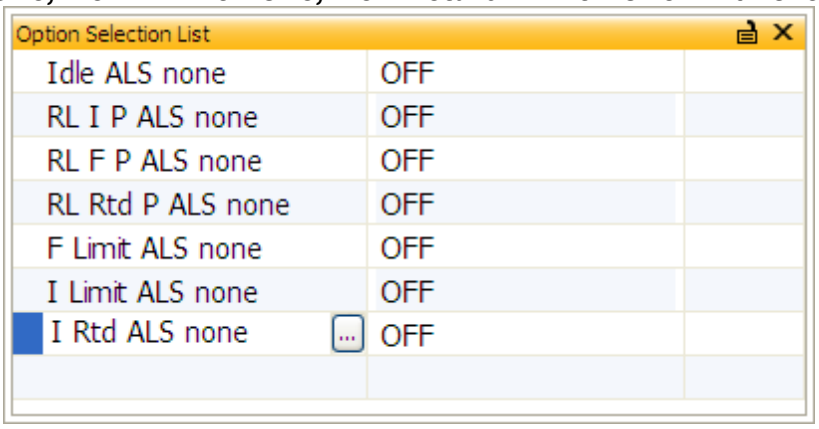
Active Throttle control improved with rest position correction using ***Act T Damp*** options and tables.

Retard Excess tables to help reduce torque if ***Retard Limit*** exceed.

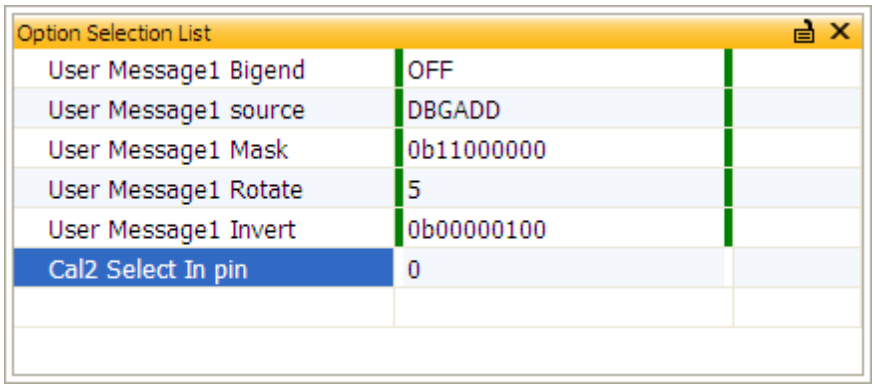
EGT

00X41

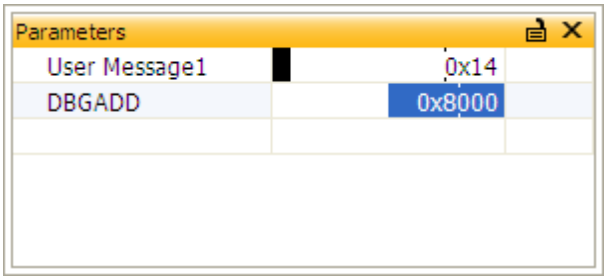
Pedal Retard Absolute, this is the spark advance after TDC to be used with no effect from any other spark modifications, tables, or maps.
Pedal Retard Absolute Max, should be set to zero.
Alternative ***Fuel2***, ***Lambda Target***, ***Ignition2***, ***Wastegate Duty2***, and *Boost Target2* maps may be activated with the Cal2 Select In pin.
Another set of Limiter maps: ***Fuel Limit None, Spark Limit None, Pedal Retard None Absolute, Pedal Fuel mod None***; Engine speed limiter tables: ***Rev F Limit None, Rev I Limit None, Rev Retard Limit None***. With enable switches:



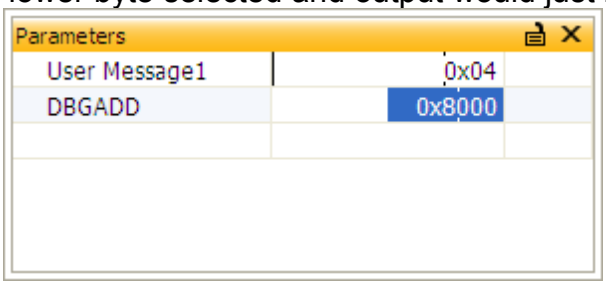
Ensure these are set safe; maps to zero, rev limiter speeds to say 8000rpm, as the full pedal setting of None tables will now be default rev limit.
So that on vehicles without throttle jack, or DbW Throttle, 3 ALS levels are available: *ALS Full, ALS Mild, and ALS None* .
3 more User-defined tables User2 – User3, with User message.



Takes the 2 most significant bits of selected parameter byte and rotates them 5 times to the left and forces bit2 on.



If Bigend were on then lower byte selected and output would just be:



RECOMMENDATIONS

Whilst tuning set ***GEMSEC1*** = 255, or Clear Password, do not forget to set password at end of session.
Set ***Safety Time*** = 10 Sec, ***Main Relay Safety*** = On and ***Main Relay if Cal Write*** = On
This will ensure any write of calibration initiated with “Ctrl-K” Store changes in ECU will not be interrupted by the main relay shutting down.

Knock Dec and Knock inc to be non-zero, even if Knock control not used.

Always: "download internal data log" after changing "ECU internal data log". Or at the start of an event to ensure a clean empty memory. And check *Log Memory used* = 0.00%.

Beware importing settings across target vehicles, many input and output assignments are only for particular SimTek PCBs and can be more complicated with mix and match engines say with different cylinder head and cam timing sensors.
The option ***ECU Target*** alias ***ECU Target name*** may not be a true guide but may be better than nothing. The calibration notes should record those differences from standard.

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's 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. The all plastic case has a poor screening characteristic and the use of resistive plugs is necessary.

All ECU variables or parameters are displayed in *Italics*, for example, *Pedal raw.* All programmable options, tables and maps are display in ***bold Italics***, for example, ***Accel Amount***.

SECURITY

Current versions of embedded software are only available with user security using dongled GWv4 and *.Gin installations. Check http://www.gems.co.uk for latest versions.

SENSORS

Pedal position is measured using a pair potentiometers mounted on the accelerator pedal. This input is used for starting, acceleration and deceleration fuel and control of the ALS system. There are two user programmable options that scale the accelerator pedal position sensor. These are ***Pedal min*** and ***Pedal max***. These must be set to ensure correct operation of the throttle parameters. ***Pedal min*** must be set to the value of *Pedal raw* at "closed throttle" and ***Pedal max*** set to the value of *Pedal raw* at "full throttle". However the unit to unit variation is very small, and base calibrations have sufficient tolerance for most instances; only if *Error Pedal* goes on should this be adjusted.
Act Throttle position is measured using a pair potentiometers mounted on the drive-by-wire throttle in the active (drive-by-wire) throttle assembly. This input is used for starting, acceleration and deceleration fuel and control of the ALS system.
There are two user programmable options that scale the throttle position sensor. These are ***Act Throttle min*** and ***Act Throttle max***. These must be set to ensure correct operation of the throttle parameters. ***Act Throttle min*** must be set to the raw throttle value *Act T raw* at closed throttle and ***Act Throttle max*** set to the value of *Act T raw* at full throttle, this requires moving throttle plate by hand with the ***Act T Rly pin*** output disabled. However the unit to unit variation is very small, and base calibrations have sufficient tolerance for most instances; only if *Error Act Throttle* goes on should this be adjusted.

Since both Pedal and active Throttle, have duplicated sensors, these must first be configured, with their active invert, and add together options:

Pedal1 / Pedal2 / Throttle1 / Throttle2 active On unless failed sensor.
Pedal1 / Pedal2 / Throttle1 / Throttle2 invert As appropriate for more open then higher value of raw parameter.
Pedal1 + Pedal2 / Throttle1 + Throttle2 If On then both used for best resolution.

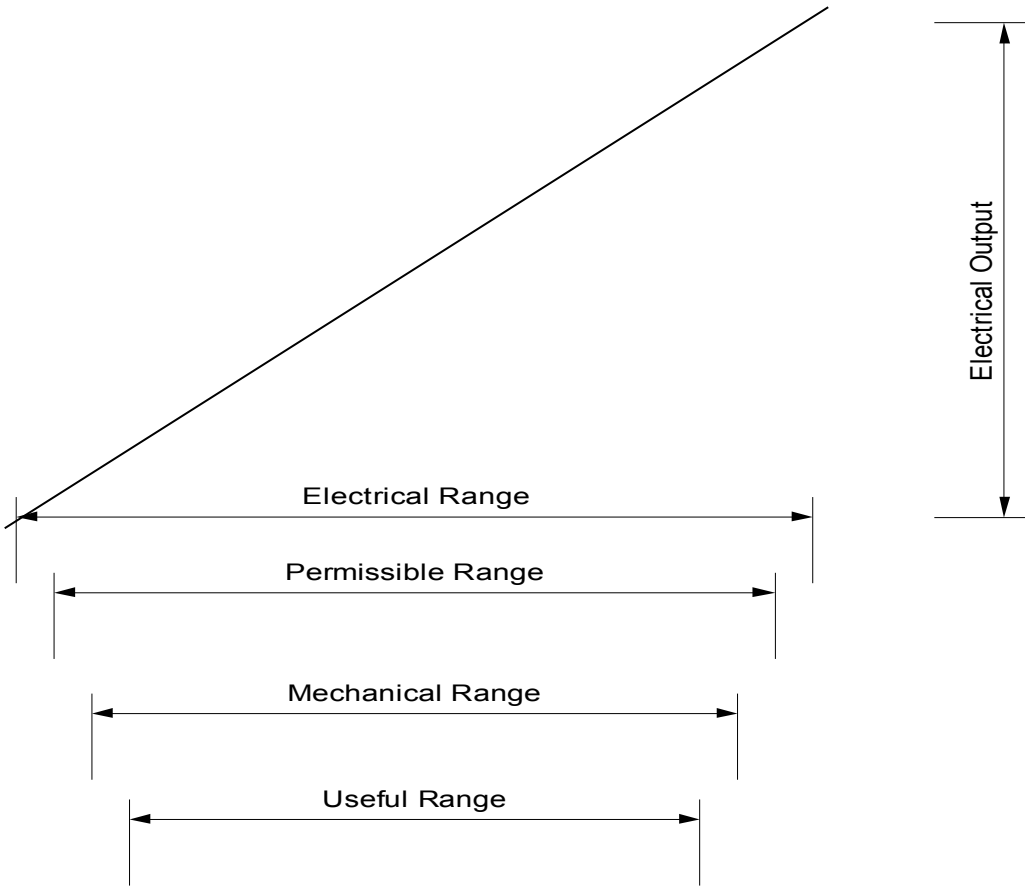
Note The Active Throttle feature uses some of these setting but it's demand setting uses percentages, as it can include corrections from idle speed control and traction control.

Pedal is made from *Pedal Raw* which in turn is usually the sum of *Pedal1 raw* and *Pedal2 raw*, using ***Pedal min*** and ***Pedal max***. If *Pedal Raw* is outside these bounds *Error Pedal* is active, and ***Act T Pedal Default*** is used as the *Pedal* value.

Act T Demand is made in a similar way but also includes an input from the idle speed control system *Act T Idle mod*.
Act T Demand =
(*Pedal Raw* – ***Act T Pedal min***) / (***Act T Pedal max*** - ***Act T Pedal min***) + *Act T Idle mod*

Since this calculation is in percentages *Pedal Raw* is also shown as *Act T Demand Raw* with units of %.

PEDAL



Permissible range defined by ***Pedal Max*** and ***Pedal min***, measured with Pedal raw, a combination of both duplicated pedal position sensors. If out of range then flag *Error Pedal = On*, and ***Pedal Default*** active in place of normal control.
Useful Range defined by ***Act T Pedal max*** and ***Act T Pedal min***, to produce *Act T Demand raw*.

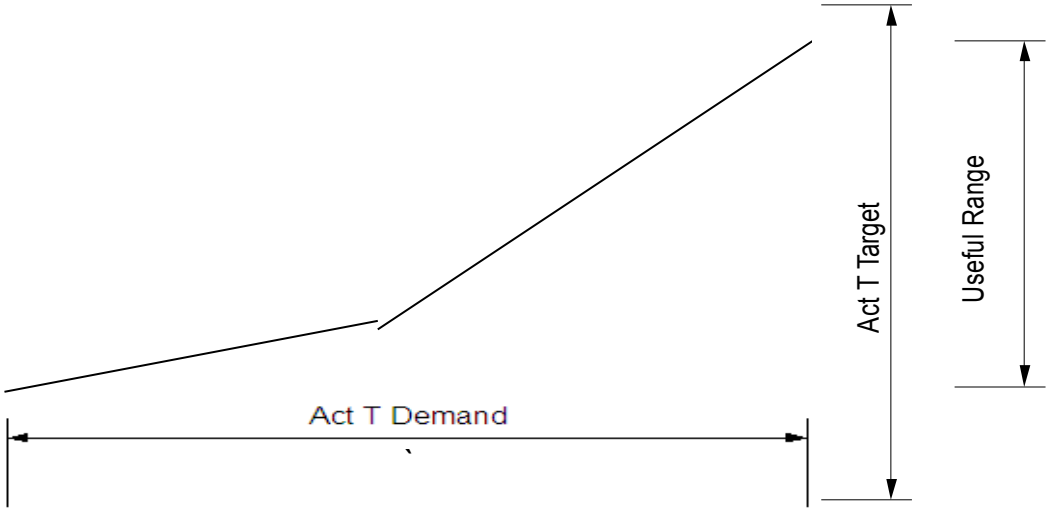
Act T Demand is used to select the desired position of the throttle using the ***Act T Target***, or ***Act T ALS Target*** table in anti lag modes.

Act T Target Max if set to 0 is ignored, otherwise it is used to limit *Act T Target,* this may be used to prevent engine "bogging down", at low engine speeds if pedal is

pressed to maximum. The out put of this table is shown in parameter *Act T Demand max*.

The active throttle control system works to minimise the difference between *Act T Target* and *Act T Position*, called *Act T error*. The target tables allow for adjustment of throttle position with pedal position, and to give maximum usable control range.
Act T Position is shown as a percentage although it is unscaled, and is the same data as *Act T Raw*. However *Act T Raw* is scaled with ***Act Throttle min*** and ***Act Throttle max*** to make *Act Throttle*, this is a rarely used parameter, but when out of range the *Error Act Throttle* flag is set, and the default throttle motor drive ***Act Default1*** and ***Act Default2*** drive duties are activated.

Act T Target Table



Act T Demand, is derived from *Act T Demand raw*, the *Pedal* and input from the idle speed controller shown in *Act T Idle mod*.
The calibration defines 3 different relationships between demand and target in the tables: ***Act T Target***, ***Act T ALS Target***, and ***Act T ALS Mild Target***, these are selected with the ALS modes.
Useful Range limited by ***Act T Target max*** and ***Act T Target min***.

Act T Raw like *Pedal Raw* is made using the selector settings from *Act T1 raw* and *Act T2 raw*.

Checking the Throttle response.

First check *Act T raw* values, with ***Act T Rly Pin*** = -15, then motor is unpowered.

Measure *Act T Raw* and *Act T position* with throttle manually fully open 90degree and over open 95degree and pushed fully closed.

The *Act T raw* maximum +5, and *Act T raw* minimum -5, can be used to set the error limits in ***Act Throttle min*** and ***Act Throttle max*** options. Typical EvoX values of 22 and 215.

The *Act T position* maximum +2%, and *Act T position* minimum -2%, can be used to set safe limits in ***Act T Target min*** and ***Act T Target max***, option and table version 00V26.

The base calibration has *Act T Position* for 90deg open throttle as 85% see ***Act T Target*** tables. To test this value, make sure the normal limits ***Act Throttle min***, ***Act Throttle max***, ***Act T Target min*** and ***Act T Target max***, options and table are moved to their extremes. Then adjust the relevant table typically ***Act T Target***, monitor *Act T position* as the table value is increased or decreased. Note when the limits are reached the signal will be unstable and the throttle will make a clattering noise! Do not stay in this mode for long! Then adjust all the options and tables to NOT within 2% of these limits for safety.

The typical range of values for the target tables is 10% to 85% these relate to *Act T Position* which is the raw signal from the throttle position sensors. Currently this is not scaled to minimise errors. Other corrections in ALS modes for Road Speed with Pedal to prevent push-on effects. When in ALS the; ***Act T ALS Full Road Speed*** ***Act T ALS Mild Road Speed*** ***Act T ALS Full Road Pedal*** ***Act T ALS Mild Road Pedal*** , and ***Act T Load/Pedal*** tables are active. The Road Speed tables produce *Act T ALS Road Speed,* and Road Pedal tables *Act T ALS Road Pedal mod*, dependant on ALS mode Full or Mild.

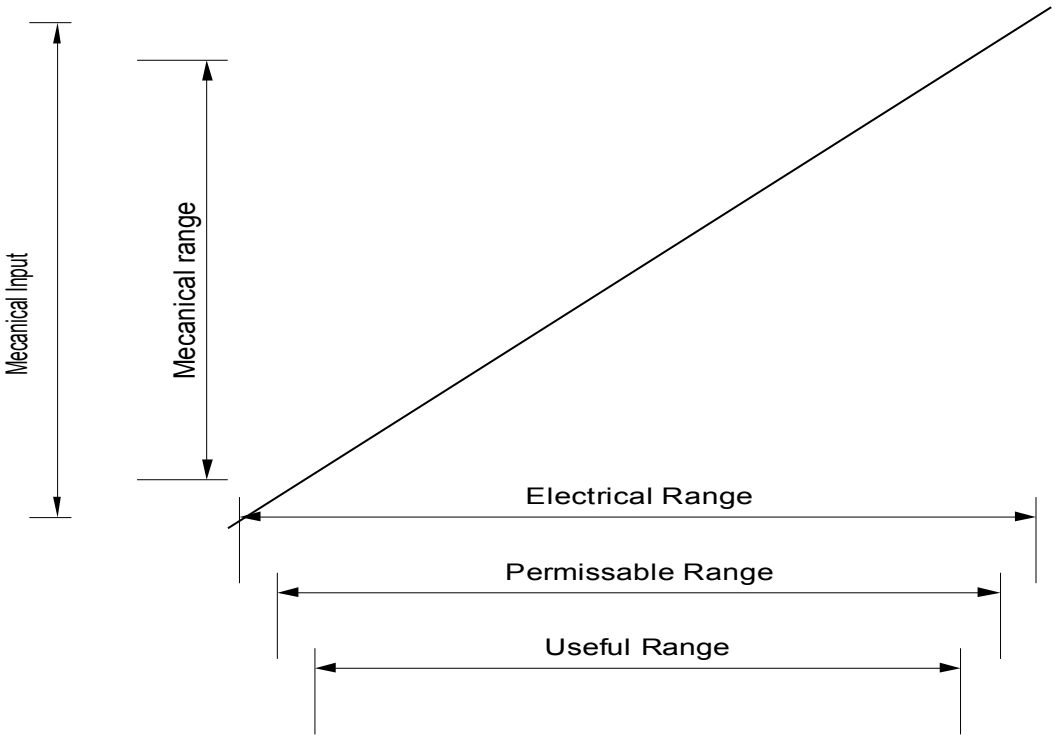
These are combined to make: Act T ALS mod =

(*Act T ALS Road Speed * Act T ALS Road Pedal mod) + Load/Pedal mod*

So the effective excess opening of the throttle may be reduced at low road speed and this in turn reduced at higher pedal values. Note the reduced range of Pedal, as in limiter maps, the 8th site not shown in table contains 0, so that outside of jacked open region these controls have no effect.

ALLWAYS SEEK GUIDANCE FROM GEMS FOR POTENTIALLY SAFETY CRITICAL CHANGES

ACTIVE THROTTLE



Electrical Range is shown in *Act T Position*, and compared with *Act T Target* to derive *Act T error*, for the controller.
Permissible range defined by ***Act Throttle Max*** and ***Act Throttle min***, measured with *Act T raw*, a combination of both duplicated Act T position sensors, and shown in parameter *Act Throttle*. If out of range then flag *Error Act Throttle = On*, and ***Act Default 1*** and ***Act Default 2*** control the throttle motor in place of normal control.
Useful Range relates back to *Act T Target*, defined in the target table.

Air temperature is measured using a sensor mounted in the intake after the air filter (*AIT temp*), or in the inlet plenum at boost pressure after the turbo (*Plenum Temp)* . The sensor is a negative coefficient thermistor in an automotive compatible package. Ideally this should be the temperature where the Boost or MAP sensor is fitted, since it is used for fuel correction. The other air temperatures plenum and AIT are also sensed to

measure the performance of the intercooler shown in *Plenum excess* or *Plenum - AIT*.

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

Engine speed (*Engine speed*) and timing are measured using a sensor pointing at timing marks on the flywheel, in the Timing unit. Additionally all the cam positions are measured relative the crank. All the timing sensors are mounted on the engine in their standard positions. For cam position is measured using logic level sensors with 5Volt output, the crank sensor of the Mitsubishi also uses logic level, however the Subaru uses variable reluctance type, and has a sensitivity switch option called, ***Crank Low Sens Above*** aliased with ***T1 Low Sense above***. Any intrinsic timing drift can be compensated using ***Pickup comp*** . A number given by ***Wheel Teeth***, of internal teeth times are captured to produce *Rev Time*. This is reciprocated and multiplied by ***Speed Mul*** to give *Engine Speed*. Before the internal teeth can be correctly identified, a number given by ***Start Actual Teeth*** of real crank teeth times are captured, and shifted with ***Start Actual Teeth <2***, to give *Rev Time* until *T1 Count* exceeds ***Start Crank Teeth***.

	Old 6 crank teeth	New 36 -2 -2 -2
Start Actual Teeth	3	7
Start Actual Teeth <2	1	2
Start Crank Teeth	13	33
	No errors	Under reads by up to 30%

A manifold absolute pressure sensor fitted to the inlet plenum (*MAP raw*) may also be used as the primary load sensor. Note the sensor is sampled typically 12 times per engine revolution, these results are shown in *RMAP00* to *RMAP11*.

Airflow is measured using the standard hot wire mass airflow meter sensor that is housed in the air filter box and connected to the inlet of the compressor housing. This is usually the system's major parameter for monitoring load. However for competition the MAP or boost sensor is often has a better response.
A mass airflow sensor (*MAF raw*) fitted to the inlet between the air filter and throttle may also be used as the primary load sensor, and linearised with ***MAF Sensor*** table. Note the sensor is sampled typically 12 times per engine revolution, these results are shown in *RMAF00* to *RMAF11*.

A knock microphone is used to detect Knock and other noise, this may be used to add additional fuel and retard the spark to quench knocking, see (*Knock Raw*). The Knock

sensor (*Knock*) may be monitored for active knock control. Although it is often best to disable this feature while running on a gravel road surface.

The exhaust gas oxygen (*Lambda raw*) sensor can also be monitored as a mapping aid and may be used as a weak mixture alarm. Note to aid testing a wideband Lambda sensor, may be connected directly to the ECU using normally unused pins The exhaust gas temperature (*EGT temp*) may also be monitored as a tuning aid. The conversion of the raw value may be user specified using the ***EGT Sensor*** table.

Internal to the ECU, barometric pressure, battery voltage, primary oxygen sensor heater current are sensed.

Secondary sensors for Fuel Temperature, Fuel tank pressure are measured but normally not used.
An external multi position switch with various resistor combinations, may be decoded with the ***A Switch*** feature to select ALS and Launch modes, this pin is called Modeswitch.

TIMING PATTERN

N14 Subaru 4 Cylinder pattern, 36 crank teeth with 6 missing, 2 cam teeth 180degrees apart.
Tooth control =

0	0	1	0	0	1	0	0	1	0	0	1	0
0	1	1	1	0	0	1	0	0	1	0	0	1
0	0	1	1	4	4	5	4	4	5	4	4	5
4	4	5	4	4	5	5	5	4	4	5	4	4
5	4	4	5	4	4	5	5	(3)				

Sync Cam Count = Off, Sync Crank S Count = Off, Sync MX = On
Sync Teeth = 1, Sync cycle = On, Sync Crank Test All = On MX Sync Test = 13 (15),
MX Time = 75, Missing = 1, Test not sync'd = On

Lancer 4 Cylinder pattern, 36 crank teeth with 3 missing, 1 cam tooth 720degrees apart.
Tooth control =

0	0	1	0	0	1	0	0	1	0	0	1	0
	4	5	4	5	0	0	1	0	0	1	0	0
	1	4	4	5	4	4	5	5	3			

Sync Cam Count = Off, Sync Crank S Count = Off, Sync MX = On
Sync Teeth = 1, Sync cycle = Off, Sync Crank Test All = On MX Sync Test = 15,
MX Time = 71, Missing = 1, Test not sync'd = On

OUTPUTS

All as standard as appropriate for a group N rally specification.
Although there are extra inputs and outputs that allow for expansion in different vehicles, and other classes of racing.

LOAD SENSING

There are 3 possible sources for load; MAP (boost pressure), MAF Mass airflow from a hot wire type, and Pedal. Either Airflow or MAP may use a back-up derived from *Pedal* if either should fail.

MAP as Load = ((*MAP raw* ***– MAP min***)/ (***MAP max – MAP min***))

There will be a suitable set of ***Load Scalar*** and ***Load Offset*** for each type of know MAP or Boost sensor, contained in an aspect file.
Note out of range MAP sensor is detected with ***MAP max error*** and ***MAP min error***, when outside this range *Error MAP* = On.

When engine is running normally *MAP raw* is the sum of the last n captured values of MAP signal, n is set in ***MAP Cal*** option, typically 12 for the last engine revolution.

If ***Fuel Map Pedal*** is On, then a correction, *Boost Correction* from the ***Boost Correct*** table is used to correct for the change in air pressure entering the engine. This promotes a more responsive Pedal. Note the ***Fuel Pedal*** map is used instead of ***Fuel*** map as the base fuelling.

MAF as Load = *MAF* ***lin***

As long as *MAF raw* is between ***MAF min*** and ***MAF max***

FUEL METERING

The amount of fuel injected each cycle is dependent on the time the injector is open. This time period, or pulse width (*Fuel pulse*), is calculated by the ECU using factors for volumetric efficiency, air temperature, airflow, warm-up enrichment, injector flow rate and battery voltage.

Volumetric efficiency, 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 *Engine Load* along one axis and *Engine speed* along the other. If ***Fuel Map Pedal*** is on use ***Fuel pedal*** map instead of ***Fuel*** map. Note these are the same physical memory space accessed with *Pedal* rather than *Engine load* (Boost).

The *Engine Load* range internally is from 0 to 100%, option user scalar may be used, click configure/units on tool bar in GWv4 user interface, and adjust option user scalar ***Load Scalar and Load Offset*** for desired range. The load axis has 14 sites. *Engine Load* may be derived from *Pedal*, *Air flow* or MAP (*Map as load*). The exact value for any load is adjustable either by editing ***Load*** table, or editing the map or table axis. The engine speed axis has 21 sites, these may be adjusted using the ***Speed*** table or *Engine Speed* axis with 50rpm resolution.

At each intersection of an engine speed site and load site there is a grid value. This holds the raw, or volumetric efficiency value or *VE(MAP)* . This is scaled using ***MicroSec/bit*** and is directly proportional to the pulse width and therefore the amount of fuel injected. The scaling of the ***Fuel*** map (or ***Fuel pedal*** map) may be displayed scaled or as a duty cycle by GWv3.

These values are determined by running the engine on a dynamometer at each obtainable point and adjusting the raw or *VE(MAP)* values to obtain optimal 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:

		Load			
		100	110	120	130
Engine Speed	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 115 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 which is shown in *VE(MAP)*.

The base fuel pulse width is then calculated by multiplying *VE(MAP)* from the ***Fuel*** map with the injector flow rate option, ***microsec/bit***. The value for ***microsec/bit*** is dependent on the expected horsepower of the engine and the injector flow-rate. It should be set so that the maximum VE value is around 220, for best resolution. Note there is an optimise feature using ***LD0MPC*** available in the GW user interface while the Fuel map is open.

Fuel no c = VE (MAP) × ***microsec/bit***

Air Temp F is the air temperature correction factor and is set by a 2D-user lookup table named ***Air Comp***. The table has 20 sites one every 10 degrees from -30° to 120°C. *Air Temp F* has a range of +/- 50%. Note in ***MAF*** mode this correction is applied to *airflow* load. Similarly *Baro Fact* the barometric correction may be applied dependant on the condition of set-up bits ***Bar*** and ***MAF***.

A coolant temperature factor *Cool Tmp F* is used to give enrichment for a cold engine. The value of *Cool Tmp F* is determined from a user-defined table. The ***Warm Up*** table has a 0% to 250% increase in fuelling capability.

VE (comp) = VE (mod) × *Cool Tmp F*

Now *Pedal Fuel mod* obtained from the ***Pedal Fuel mod*** map if in anti-lag mode is applied so that more pedal feel can be obtained; if not in full anti-lag then the ***Pedal Fuel Mild mod*** map is used. Or if ***Pedal Fuel*** option on: ***Boost mod*** and

Boost Mild mod become the valid names and actions for these maps. Any additional *Knock Fuel* is applied here when a *Knock* voltage is detected. *OX FB* oxygen feedback fuel may be applied here when enabled. *Baro Fuel* is applied here.

Finally the individual fuel trims from the four Fueln mod options are applied. These allow for a fine balance between cylinders. Note the "n" applies to firing order and not the cylinder number, so these are named A, B, C, and D.

The final fuel pulse width is then calculated 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, ***Battery Comp***). 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 engine, a value of *VE (MAP)* is obtained from the 2 dimensional lookup table ***Crank Fuel*** controlled by scaled Pedal position *Pedal*. *Pedal* is scaled to 0 for closed pedal to 100% for full pedal, and the sites may be adjusted in the ***Pedal*** table. The value for VE is then controlled as for normal running. However the base fuel pulse is multiplied by a cold start factor obtained from the ***Warm-up*** table which allows up to 2.5 times the normal fuelling while starting. Exit to main map now controlled by ***Crank Exit*** option. ***Start Fuel Teeth*** for injection events while cranking if half or quarter of ***Fuel Teeth***, used in conjunction with ***Start microsecond/bit*** to compensate for more fuelling events. So typically:

Start microsec/bit = (***Start Fuel Teeth / Fuel Teeth)× microsec/bit***

DFCO FUELLING

Deceleration Fuel Cut-Off can save a lot of wasted fuel. When the following conditions are met then the closed throttle table is used to obtain the value of *Fuel no c*:

Pedal < ***DFCO Pedal***

Engine Speed > ***DFCO speed***

When the anti–lag is active then the ***DFCO ALS*** table is used to obtain *Fuel no c*.

ACCELERATION/DECELERATION ENRICHMENT

When there is a large change in Pedal position, sampled every 4 milliseconds, then some additional time is added to the base fuel pulse width. When in the FAF area defined by the options ***FAF Pedal*** and ***FAF Speed*** then a *FAF pulse* fuel pulsewidth is used instead of *Fuel Total*.

when *Pedal delta+* > ***Accel Trip*** (Pedal Trip)
(Pedal delta+×***Accel M***)+***Accel C***)×Pedal Accel mod×Gear Accel mod×Pedal Accel Am ount×*Fuel Pulse*

when *Pedal delta-* > ***Decel Trip*** *(Pedal Trip neg)*
(Pedal delta-×***Decel M***)+***Decel C***) ×Pedal Accel mod×Pedal Decel Amount×*Fuel Pulse*

when *delta MAP* > + ***Load Trip*** option
(*delta MAP*)×*MAP Accel mod*×*MAP Amount*×*Fuel Pulse*

These three potential sources of transient fuel are summed together with any Accel Fuel from the previous calculation.

Accel Fuel is decayed every injection engine cycle, and may be delayed for a number of cycles specified by ***Accel Decay Delay*** .

Accel Fuel = Accel Fuel × *Accel Decay*, (or *Decel Decay* if *Accel Fuel* is negative)

The ***Pedal Filter*** filter for Pedal allows for detection of smaller *Pedal* changes; the minimum filter value is 0% with 99% giving maximum filter, and more sensitivity, 25% is typical.

FUEL INJECTION ANGLE

The sequential fuel injection opening angle may be adjusted using ***Inj Angle*** map. The feature works in conjunction with the ***fuel sync*** option to determine the relative to the 720 degrees of crank position. This feature can be used to improve both fuel economy and throttle response.

REV LIMIT

The rev limit function works by cutting the fuel injection and/or ignition if the *Engine speed* is greater than ***Fuel cut*** and/or ***Ignition cut***. The depth of cutting is set by ***Fuel cut rate*** and ***Ign cut rate***. The cuts are obtained from the ***Spark Limit*** *and* ***Fuel Limit*** *Tables* depending on ALS status.

FUEL AUDIT

Source	Condition	range/modifier	Output
Crank Fuel Table	cranking	0-255	VE(MAP)
Fuel Map	Running	0-255	VE(MAP)
VE(MAP)	Always	× microsec/bit	Fuel no c
Fuel no c	Always	Load Fact Boost Correct	
Fuel comp	Always	Fuel mod	Fuel (Mod)
Fuel (Mod)		Air Temp F	Fuel Air
Fuel Air		Cool Tmp F/Cold Tmp F	Fuel warm-up
Fuel Warm-up		Pedal mod	Fuel Pedal mod
Fuel Pedal mod		Baro Fact	Fuel Baro/boost
Fuel Baro/boost		Start Fuel	Fuel Start
Fuel Start	If modes active	Alt Fuel Swt TB Fuel mod Act T swt Fuel mod Knock Fuel	Fuel Alt
Fuel Alt		CT Fuel mod	Fuel Closed Throttle
Fuel Closed Throttle		VVC Fuel mod	Fuel VVC
Fuel VVC		VVCX Fuel mod	Fuel VVCX
Fuel VVCX		Boost Correct	Fuel Total
Fuel Pulse/sec/prim		Fuel ModA OX FB 1(2) +Knock Fuel1 Fuel	Fuel A PW
Fuel A PW		+ Fuel Pulse Extra	Fuel PW A
Fuel Pulse/sec/prim		Fuel ModB OX FB 1(2) +Knock Fuel2 Fuel	Fuel B PW
Fuel C PW		+ Fuel Pulse Extra	Fuel PW B
Fuel Pulse/sec/prim		Fuel ModC OX FB 1(2) +Knock Fuel3 Fuel	Fuel C PW
Fuel C PW		+ Fuel Pulse Extra	Fuel PW C
Fuel Pulse/sec/prim		Fuel ModD OX FB 1(2) +Knock Fuel4 Fuel	Fuel D PW
Fuel D PW		+ Fuel Pulse Extra	Fuel PW D
Bat comp Fuel	+Accel Fuel	+Start Pulse	Fuel Pulse Extra

Fuel Pulse/sec/prim is either: Fuel Pulse, Fuel Secondary, or Fuel Primary dependant on FuelnPrimary and FuelnSecondary options setting, where n=A,B,C,or D.

IGNITION TIMING

Ignition timing is controlled in the same way as for fuel using *Engine speed* and *Engine load*. At each site the timing can be set from -64 to 63.5 degrees BTDC. Interpolation is used for values between sites to ensure smooth curves.
The ignition advance value *Spark Adv map* from the main lookup table is modified by a user controlled value *Spark mod*. *Spark mod* is variable from -64° to +63.5° used when calibrating the engine to obtain optimum values for the ADV table. It can also be set to a pre-set value using the *Ign Offset* option. At power on *Ign Offset* is copied into *Spark mod*, so it operates as an overall advance/retard setting.

Spark Adv map = *Spark Adv* + *Spark Mod*

The modified ignition advance is further modified by the air and water temperature retard or the Pedal position advance modifier *Retard Mod* whichever is the more retarded.

Air Temp Retard is set by a table called ***Air Temp Retard*** . The modified ignition timing:

ADV (mod) = ADV (mod) – Air Temp Retard + Pedal rtd (m)

Water temperature retard is simpler and set by ***Cool Rtd Strt*** and ***Cool Rtd Rate***.

If ALS is enabled then *Air Retard* is set by a 3 dimensional look up table addressed by Pedal and Engine Speed. The Pedal axis has 14 sites, *Pedal* = 0 to *Pedal* = 100%), points set by ***Pedal Angle*** table. The Speed axis has 21 sites determined by the ***Speed*** table. The values from the table are interpolated. The map will accept values in the range 0 to 63.5°, where larger values more absolute retard after TDC . The output from the table *Pedal Retard Absolute* is then modified by the use modifier *Retard mod* such that:

Pedal rtd(m) = Pedal retard + Retard mod
If *Pedal rtd(m) < Air Temp Retard* then,
ADV (mod) = ADV(mod) + Pedal rtd(m)
ADV(r) = ADV(m) + Air Temp Retard

Baro Spark is applied here. *Knock Rtd* is applied here if any Knock voltage is detected.
A compensation due to current gear called *Gear Spark mod* is applied, and if TC Ign Retard table setting is exceeded then ***TC Ign Retard*** is also subtracted.

Finally the four individual ignition trims are applied to the spark outputs. These are taken from the four ***Ign#n mod*** tables, and should be kept to a few degrees. When the idle conditions are met then the 'Spark scatter' features may be used to stabilise idle. The ***Idle Spark*** table will produce a modification related to the difference from the idle set points. BEWARE this will make a nonsense of the timing indicated by a timing light.

The maximum retarded spark is limited by the ***EGT Rtd Limit*** table accessed using the exhaust mounted thermocouple. Even if no EGT sensor used this limit is still active.

GEAR CHANGE ASSISTANCE

These features are often used to facilitate gear shifting.

Gear+ Retard

This feature may be used for full throttle up shifting. The engine torque may be reduced by activating ***Gear+ Retard In Pin*** switch, or gear change switch. When the switch is active *Gear+ Retard* is increased up to the value of ***Gear+ Retard max Absolute*** to reduce torque, at the ***Gear+ Retard*** rate, until the switch is deactivated or the Gear+ *Time* has expired, then *Gear+ Retard* is decreased to zero at the ***Gear+ Retard Restore*** rate. The maximum value of ***Gear+ Retard time max*** is just over 1 second, if the triggering switch is still active after this time the retard is reduced, and the triggering event can on be reactivated by going Off . Once the maximum retard is achieved then an additional ignition cut ***Gear+ Retard Ign Cut*** may be invoked, this condition is shown in *Gear + max* flag parameter.

The *Gear+ Time* and *Gear+ Retard* parameters may be monitored to test the action of the switch.

Gear+ Retard Inhibit Time ,may be used to ensure a gap between Gear+ Retard events.

Gear- Advance

This feature may be used for down shifting, and attempts, to achieve an engine speed, given by ***Gear-Advance Target*** table but constrained by ***Gear- Advance Rev Limit*** table, by adjusting ignition timing *Gear- Advance mod*, to achieve *Gear- Advance Target*. When ***Gear- Advance Retard pin*** is satisfied *Gear- Advance mod*, is increased by ***Gear- Advance*** if below *Gear- Advance Target* speed up to a maximum given by ***Gear- Advance Max Absolute***, if over target reduced by ***Gear- Advance Restore***. ***Gear- Fuel Cut*** and ***Gear- Ign Cut*** are invoked if *Engine Speed* exceeds *Gear- Advance Limit* by their respective offsets ***Gear- Fuel Rev Limit Offset*** and ***Gear- Ign Rev Limit Offset*** . Note there is NO time-out feature so this must be triggered with a switch that does time-out.

Gear- Pot

Swt Gear- Pot 24, is initiated with ***Gear- Pot Start pin***, and terminates if either time given by ***Gear- Pot Time out*** table is exceeded or value in ***Gear- Pot End*** is exceeded by *Gear Ratio Scaled* parameter. This is switch may then used to trigger other gear change assist features. The parameter *Gear- Pot Change Time remaining* may be monitored to determine a reasonable ***Gear- Pot Time out*** time.

Gear+ Pot

Swt Gear+ Pot 8, is initiated with ***Gear+ Pot Start pin***, and terminates if either time given by ***Gear+ Pot Time out*** table is exceeded or value in ***Gear+ Pot End*** is reached below by *Gear Ratio Scaled* parameter. This is switch may then used to trigger other gear change assist features. The parameter *Gear+ Pot Change Time remaining* may be monitored to determine a reasonable ***Gear+ Pot Time out*** time.

Note the symmetry of the two Gear* Pot features allows for potentiometers that increase or decrease *Gear Ratio Scaled* .

Gear- Blip

When requested with ***Gear- Blip In pin*** an active throttle is opened to value in ***Gear- Blip Act T Demand*** table, this demand may be corrected to achieve *Gear- Target* engine speed. Separate opening and closing rates are given by ***Gear- Blip increase*** and ***Gear- Blip Restore*** options. Note no time-out feature. And may be used in conjunction Gear- Advance feature with it's extra limiters .

Gear+ Act T Lift

When requested with ***Gear+ Act T Lift In pin*** an active throttle is closed to value in ***Gear+ Act T Lift Target*** table. When turned off ***Gear+ Act T Lift Restore*** option is used to return throttle to normal behaviour. Note no time-out feature.

SPARK AUDIT

Source	Condition		Output
Spark Map	Running		Spark adv (map)
Start	Cranking		
Spark adv	Running	Spark mod	Spark (mod)
		Coolant Retard	
		Pedal Retard	
		Spark Idle or Act T spark mod	
		Accel rtd	
		Air Temp Retard	
		Gear+ Retard or Gear- Advance mod	
		Baro Retard	
		TC Ign Retard	
		Gear Spark mod	
	If *Alt mode*	Alt Spark	
	If *Swt TB* mode	Swt TB Ign Limit	
		Rev Retard limiter	Spark Total
Spark Total	Constrained by	EGT Rtd Limit	Spark Output

		Or Swt TB Rtd Limit	
Spark Output		Ign1 mod Knock1 Retard	Spark1 Out
Spark Output		Ign2 mod Knock2 Retard	Spark2 Out
Spark Output		Ign3 mod Knock3 Retard	Spark3 Out
Spark Output		Ign4 mod Knock4 Retard	Spark4 Out

*Spark*n *Output* is constrained to be greater than *EGT Retard Limit.*

Ign#n mod is obtained from the relevant *Engine Speed* related tables.

KNOCK SUPPRESSION

The knock microphone responds to frequencies between 2 and 20kHz this is processed in the ECU to an energy value sampled immediately after ignition. Each cylinder is processed separately. A window over a typical range 20deg BTDC to 30deg ATDC is defined, only between these setting is knock is expected, elsewhere the microphone is turned off. Typical Base settings:

With ***Knock Window Options*** = On

timing pattern	Old 90 60 10	New 36-2-2-2
Knock Window Teeth	0	6
Knock Window Off	0	0
Teeth Scalar	-180	-30
Teeth Offset	55	31.9

Knock Attn	0.5
Knock Filter	5.9kHz
Knock Integ	250
Knock Lock	0
Knock Mode	0
Knock prescale	1

The software processing first adjusts any positional sensitivity with ***Knock n Gain***, allowing for ±50%, adjustment of *Knockn Raw*, and shown in *Knockn Raw Scaled*. Then any background noise set in the ***Knock Threshold*** table is removed.

The remainder shown in *Knockn Above Threshold*, if there is any energy left this is used to determine the extra fuel and ignition retards employed to recover from the knock condition. As a development aid *Knock Peak* will hold the peak value of *Knock Above Threshold,* and keep it non-zero until the ***Knock Peak Hold*** time has expired. The ignition channel that caused the peak is shown in *Knock Peak Channel*.
The ***Knock Threshold*** table should be filled with values from the *Knock Raw* parameter to set the normal back ground level, or tolerable level of knock.
If ***Knock Peak No Restore*** is exceeded the retards are maintained, and only removed after a power cycle.

Algorithm Ignition on per channel basis

Knock Above Threshold = *Knock raw* - ***Knock Threshold***

If not 0 Knocking and *Error Light* and *Rev Light* are flashed for the ***Knock Peak Hold*** time.
Knock Retard = *Knock Retard* $_{old}$ + ***Knock Retard*** table
Knock Fuel = *Knock Fuel* $_{old}$ + ***Knock Fuel*** table

Else 0 no knock then every engine revolution.
Knock Retard = *Knock Retard* $_{old}$ + ***Knock Retard Restore***
Knock Fuel = *Knock Fuel* $_{old}$ - ***Knock Retard Decay***

Knock Retard is constrained not to exceed ***Knock Retard Max***
Knock Fuel is constrained not to exceed ***Knock Fuel Max***

If however *Knock Peak* is greater than ***Knock Peak No Restore***, then the restore process is stopped, and only stopping the engine and turning off will remove the retard and fuel enrichment. ***Knock Excess*** is set on and both *Error Light* and *Rev Light* are illuminated.

Note, other sounds apart from “Knock” may be miss recognised, such as; stones hitting engine block, and gear engagement in the gear box.

IGNITION KEY

The ignition key sends power to ECU when on and cranking, the Main Relay options control the actions for starting and re-starting engine and shutting system down.

When ignition switch power is supplied:

Then *Main Relay* is On, and *Main Relay Off timer* = 0
If engine is not running *Stopped* timer counts up to 33Seconds.
If just powered on:
Run Time timer will count from 0.
The *Fuel Pump* will be On and run for ***Fuel Pump Prime*** seconds.
Start Pulse Pending will be On.
The main relay can be shut off for safety reasons after *Stopped* exceeds *Safety Time* if *Main Relay Safety* is On, this will disable fans for instance.

STARTING

The engine is ready to crank. When ignition switch is moved to cranking position a switch input may be detected with ***Start Pulse pin*** that will fire all injectors simultaneously with a *Start Pulse* duration of fuel.
The starter will turn the engine, and crank and cam timing signals detected, a valid *Engine Speed* will only be calculated after the crank has seen ***Start Crank Teeth***.
When start synchronisation is satisfied indicated by Stat Sync'd = On, the ignition and fuel injection events will be allowed. Note if ***Start Pulse pin*** was not detected the first cycle of injections will be extended by *Start Pulse* duration. *After Start rev* counter will increment till ***Start Exit*** speed is exceeded and normal running established, where upon the *After Start* timer will start.

STOPPING

The ignition key is turned to Off, the *Main Relay Off timer* starts, and performs the following tasks in sequence:
Main Relay Stop Eng, fuel injection stopped, may take seconds for engine to run down.
Main Relay Park IAC, resets and parks idle stepper motor.
Main Relay Kill Power, turns off M***ain Relay Output***, and ***Main Relay Out 2***.
This time must be long enough for idle motor to complete parking.
Main Relay Safety will delay the turn off if there is non-volatile write of calibration data indicated by *Error EE Checksum*, and setting ***Cal Write Main Relay*** alias ***Main Relay if Cal write*** is On.

RE-STARTING

If however ignition key is returned to on position, after *Main Relay Off* exceeds ***Start Pulse Rearm Time***, and ***Start Pulse Rearm*** and ***Main Relay Off Restart*** are On, the fuel pump will run again and *Start Pulse Pending* will go On.

SPARK

The starting ignition timing is set by the teeth on the crankshaft timing disc if in ***Crank Alt Fire*** = On, and crank transitions defined in the ***Crank Fire A Crank Fire B*** tables. Otherwise when ***Crank Alt Fire*** = Off, ***Crank Adv*** is used but may not be as precise as the tooth control mode. Over all timing can be adjusted and the resulting timing error can be adjusted out using ***Spark Sync*** this will move the ignition events relative to there triggering teeth on the crank timing wheel. Note that this may require unobvious setting of ***Start Ignition***. ***Start Spark Teeth*** for wasted spark ignition while cranking if half of ***Spark Teeth***. Also see ***Idle Start*** and ***Idle Start decay*** for active throttle control why starting.

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 comp*** option. The value of ***Pickup comp*** is 166666/deg/rpm. So, assuming *pickup comp* is initially 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 =2 × 166666/4000
Pickup comp = 84 (83) µS

IGNITION COIL CHARGE TIME

The ignition coil charge time is calculated from battery voltage and engine speed. Different coils require different charge times. ***Coil Factor*** adjusts *Charge time* that in turn controls the level of charge held in the coil. The higher the value the more charge. It is important that the value is neither too low, weak spark, or too high, over heated coils and amplifier will result. There are now user compensations tables for battery voltage and engine speed, called; ***Dwell vs. Battery*** and ***Dwell vs. Speed***.

Charge Time = ***[Dwell vs. speed]*** × [***Dwell vs. Battery***] × ***Coil Factor***

This is constrained by the options ***Dwell min*** and ***Dwell max*** in crank teeth to give:

Dwell Angle in teeth and *Dwell Time* in microSeconds.

TORQUE CONTROL Anti-Lag System

ENABLE CONDITIONS

The ALS system will be enabled if all of the following conditions are met:

ALS in pin condition satisfied
Air temperature is < ***ALS Air max***
Coolant temperature is < ***ALS Coolant max***
Engine Speed is > ***ALS On Speed***

If ALS is enabled the ignition timing is modified by the *Pedal Retard Absolute* factor. And a proportion of injection events and of sparks are disabled by the limiter functions. The values for the limiters are obtained from the ***Pedal Retard Absolute***, ***Spark Limit*** and ***Fuel limit*** maps. When the ALS Mild mode is On then the ***Pedal Retard Absolute Mild , Spark Limit Mild , Fuel Limit Mild*** maps are usually used.

Each map or table is individually activated with ALS mode switch options.

There are 3 basic modes of operation of the anti-lag system:

ALS Full Active = Off *ALS Mild Active = Off*
None of the extensive turbo anti-lag features available. So *Pedal retard* from a calibration map will always be zero. Known as none not to be confused with “Mild” mode.

ALS Full Active = Off *ALS Mild Active = On*
Mild mode or safe anti-lag mode, if milder settings in “Mild” mode maps and tables. So *Pedal retard* from a calibration map would if requested be taken from the ***Pedal Retard Mild*** calibration map.

ALS Full Active = On *ALS Mild Active = Off*
Full anti-lag mode, only mode for Launch feature to be active. So *Pedal retard* from a calibration map would if requested be taken from the ***Pedal Retard*** calibration map. If Launch is also active, only possible in this mode, then the highest speed lines rather than the actual speed line are used in the active maps.

These are subdivided by optional *Road speed* settings.

Full Active and Road Speed = 0 or Road Speed < ALS On Full Spd
F Limit ALS Full
I Limit ALS Full
I Rtd ALS Full
Idle ALS Full
RL F P ALS Full
RL I P ALS Full
RL R P ALS Full

ELSE
Full Active and Road Speed > ALS On Full Spd
F Limit ALS Full Speed
I Limit ALS Full Speed
I Rtd ALS Full Speed
Idle ALS Full Speed
RL F P ALS Full Speed
RL I P ALS Full Speed
RL R P ALS Full Speed

Mild Active and Road Speed = 0 or Road Speed < ALS Off Mild Speed
F Limit ALS Mild
I Limit ALS Mild
I Rtd ALS Mild
Idle ALS Mild
RL F P ALS Mild
RL I P ALS Mild
RL R P ALS Mild

ELSE
Mild Active and Road Speed > ALS Mild Mild Speed
F Limit ALS Mild Speed
I Limit ALS Mild Speed
I Rtd ALS Mild Speed
Idle ALS Mild Speed
RL F P ALS Mild Speed
RL I P ALS Mild Speed
RL R P ALS Mild Speed

None neither Full or Mild mode
F Limit ALS none
I Limit ALS none
I Rtd ALS none
Idle ALS none
RL F P ALS none
RL I P ALS none
RL R P ALS none

PARAMETERS
Conditions shown in:

ALS Fuel Limit *ALS Ign Limit* *ALS Ign Rtd* *ALS Idle Active*
Rev Limit Fuel P *Rev Limit Ign P* *Retard Limit P*

Notes

F Limit	***Fuel Limit*** map or ***Fuel Limit Mild*** map or ***Fuel Limit None*** map
I Limit	***Spark Limit*** map or ***Spark Limit Mild*** map
I Rtd	***Pedal Retard Absolute*** map or ***Pedal Retard Absolute Mild*** map

Rev Limit Fuel P ***Rev F Limit, Rev F Limit Mild***, or ***Rev F Limit L*** table selected
Rev Limit Ign P ***Rev I Limit, Rev I Limit Mild***, or ***Rev I Limit L*** table selected
Retard Limit P ***Rev Rtd Limit, Rev Rtd Limit Mild***, or ***Rev Rtd Limit L*** table selected

The actions of these switches are shown in the following parameters:
ALS Fuel Limit
ALS Ign Limit
ALS Ign Retard
Rev Limit Fuel P
Rev Limit Ign P
Retard Limit P

Mode matrix Launch = Off

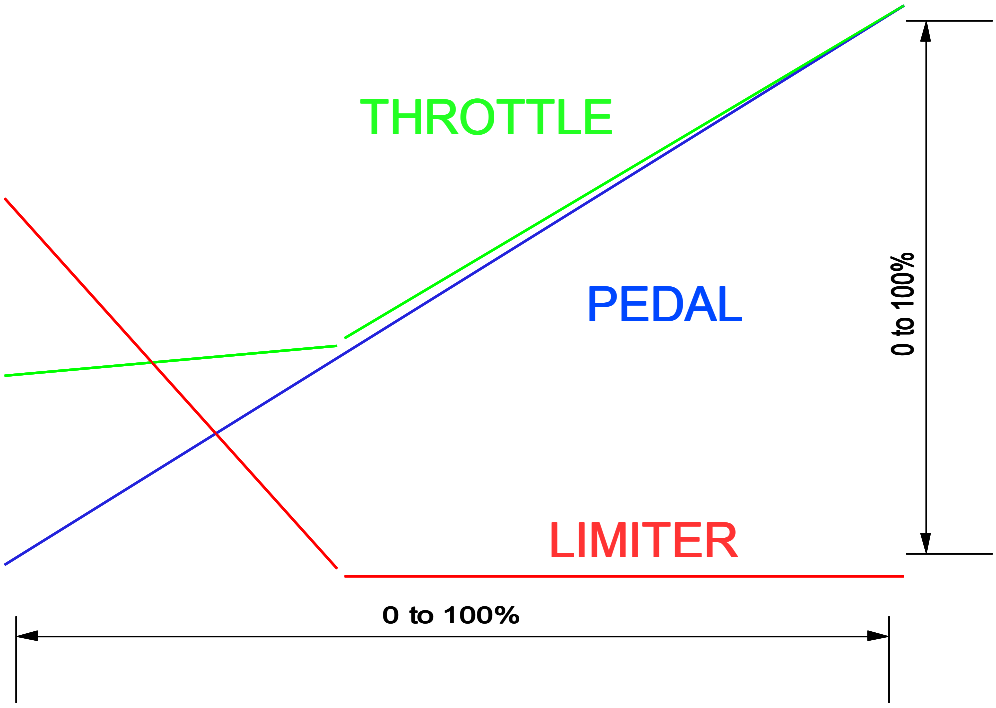
Post amble Pre-amble		ALS Full	ALS Full Speed	ALS Mild	ALS Mild Speed	None
		ALS switch satisfied		ALS Mild switch satisfied		none
F Limit	Fuel Limit	Fuel Limit map		Fuel Limit Mild map		Fuel Limit None map
I Limit	Ign Limit	Ign Limit map		Ign Limit Mild map		Ign Limit None map
I Rtd	Ign Retard limit	Pedal Retard Absolute map		Pedal Retard Absolute Mild map		Pedal Retard Absolute None map
RL F P	*Rev Limit Fuel P*	Rev F Limit table		Rev F Limit Mild table		Rev F Limit None table
RL I P	*Rev Limit Ign P*	Rev I Limit table		Rev I Limit Mild table		Rev I Limit None table
RL R P	*Retard Limit P*	Rev Rtd Limit table		Rev Rtd Limit Mild table		Rev Rtd Limit None table

Mode matrix Launch = On

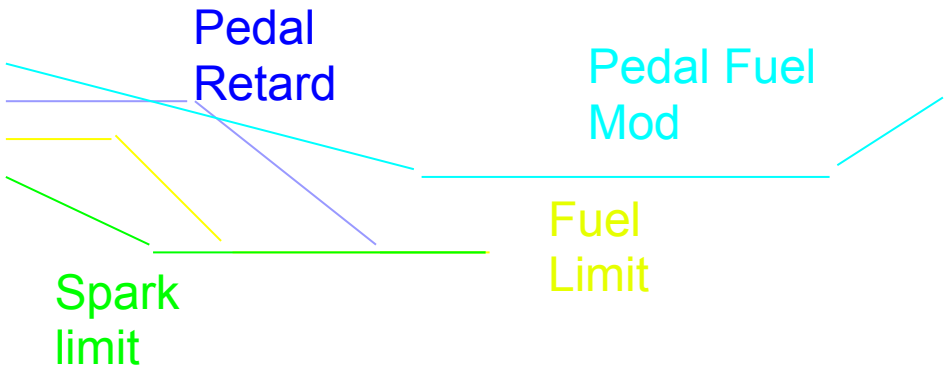
Post amble Pre-amble		ALS Full	ALS Full Speed	ALS Mild	ALS Mild Speed	None
		ALS switch satisfied		ALS Mild switch satisfied		none
F Limit	Fuel Limit	Fuel Limit map highest speed line		Fuel Limit Mild map		Fuel Limit None map
I Limit	Ign Limit	Ign Limit map highest speed line		Ign Limit Mild map		Ign Limit None map
I Rtd	Ign Retard limit	Pedal Retard Absolute map highest speed line		Pedal Retard Absolute Mild map		Pedal Retard Absolute None map
RL F P	*Rev Limit Fuel P*	Rev F Limit L table		Rev F Limit Mild table		Rev F Limit None table
RL I P	*Rev Limit Ign P*	Rev I Limit L table		Rev I Limit Mild table		Rev I Limit None table
RL R P	*Retard Limit P*	Rev Rtd Limit L table		Rev Rtd Limit Mild table		Rev Rtd Limit None table
Act Throttle		Act T Launch1 max Act T Launch1 min		Act T Launch2 max Act T Launch2 min		

Note Launch only effective in Full ALS mode.

ALS CONTROL



With Anti-Lag turbo boost enhancement, the throttle is open even with no accelerator pedal depression. There is an effective gap between throttle and pedal, this must be accommodated with the limiters. The limiters will consist of a combination of fuel cutter, spark cutter, and ignition retard, often some additional fuel is required.



A combination of different limiters are employed to both build boost and limit engine torque.

The Spark Limiter 3D lookup table controls this:
Inputs *Engine Speed* and *Pedal limiter* a reduced range of *Pedal* just covering the lowest 7 sites of the ***Pedal Angle*** table..
Output Limiter 0% to 99.6%, no cut to almost total cut.

To increase the control four rev limiter tables: ***Rev I Limit, Rev I Limit Mild, Rev F Limit***, and ***Rev F Limit Mild***, these increase the depth of the limiters when the engine speed is exceeded. The Mild tables are active if *ALS full active* is Off, and *ALS Mild active* is On.

Ign Limit = [*Spark Limit(Mild)*] + *Ign Cut* + *Ign Cut+*

Ign Cut is active when *Engine speed = Rev Limit Fuel*
Ign Cut + *Ign Cut+* is active when *Engine speed > Rev Limit Fuel*

Ignition Cut is obtained from ***Rev I Limit*** table accessed with *Pedal*.

Similarly for Fuel:
Fuel Limit = [*Fuel Limit(Mild)*] + *Fuel Cut* + *Fuel Cut+*

Fuel Cut is active when *Engine speed = Rev Limit Ign*
Fuel Cut + *Fuel Cut+* is active when *Engine speed ≥ Rev Limit Ign*

Fuel Cut is obtained from ***Rev F Limit*** table accessed with *Pedal*.

TIMED ALS Timer

If ***ALS Full Time*** is not zero then when *ALS Full active* is On, the timer *ALS F Time* will count up to ***ALS Full Time***, if *ALS F recover* is zero, and *Pedal* is less than ***ALS Full On Pedal***. When timer matches the ALS mode will be forced to *ALS Mild active* = On. While in Mild mode the *ALS F recover* timer preloaded with ***ALS F R Time*** is decremented, when zero the system will return to *ALS Full active* mode. If *ALS Full active* is On, and *Pedal* is greater than ***ALS Full Off Pedal***, the timer *ALS F Time* will be decremented to zero, so preventing an unstressed engine being forced into Mild mode.

Swt TB

The Swt TB mode may be invoked by any switch, but the *Timed Switch2* and its switches *Switch Timed2A 22* (or *Switch Timed*2B 23), is a useful choice, which in turn could be triggered by *Swt Comparator,* connected to *Pedal*. Then some temporary limiters may be invoked, with or the requirement of *ALS Full Active*, using the ***Swt TB full*** option.
Swt TB Ign Retard, can add up to 128degrees of retard, so it may be necessary to increase effective retard limit with ***Swt TB Rtd Limit***.

Additional fuel limiting from ***Swt TB Fuel Limit*** fuel event cutter may be added with a compensating ***Swt TB Fuel mod***, option. Also additional spark cutting may be achieved with ***Swt TB Ign Limit*** option.

Road Speed Limiter

A four position switch or potentiometer can be specified by the Switch A feature, to select one of 4 Road Speed Limits, note if 0 rpm then it is ignored.
If *Road Speed limit* is greater than *Road Speed* then the parameter *Road Speed Act T* is increased by ***Road Speed Act T+*** and subtracted from the current *Act T Demand* to reduce throttle opening. When *Road Speed limit* is no longer greater than *Road Speed* then the parameter *Road Speed Act T* is decreased by ***Road Speed Act T-*** ,until reduced to zero.
If *Road Speed* is greater than *Road Speed Limit* and any ***Road Speed limit Hy*** then the option ***Road Speed Fuel Cut*** is added to any current *Rev Limit Fuel Duty,****Road Speed Ign Cut*** *is added to any current Rev Limit Ign Duty*, and ***Road Speed WG*** Duty is subtracted from any current *WG Duty* to reduce engine power.

ELECTRONIC WASTEGATE CONTROLLER

The electronic wastegate controller uses a 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 *Pedal* and *Engine Speed* and any *Baro Wastegate Duty* from the ***Baro Wastegate duty*** table. 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* and *Wastegate Pedal mod*, from the ***Wastegate Pedal mod*** map if ***WG Pedal mod*** = On.
To give the waste gate output value *WG msr(m)*. This allows the user to calibrate the waste gate duty cycle table.

WG msr (m) = WG msr + WG mod + Baro WG + Gear WG 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.

To prevent over boost a parameter *Boost mod* is added when *Load* exceeds the value in the ***Boost Limit*** table. *Boost mod* will increase after the ***WG max time*** is exceeded, at the ***WG max Force*** rate, until ***WG max Limit*** is reached. When the boost returns to an acceptable value the waste-gate drive is restored back to zero at the ***WG max Back*** rate.

If ***WG Feedback*** = On, then an error *Wastegate Error* derived from the difference between *Wastegate Target input* and *Wastegate Target Total* is used to correct the wastegate PWM drive.
The source for the controlled wastegate parameter is selected with ***Wastegate FB input***. Typical values could be boost pressure using *MAP as Load*, Post Restictor Pressure, from an additional pressure sensor, depending on sensor type absolute or differential the internal Baro(metric) may be used to correct duty and or target. Another potential source could be Turbo Speed. Note a suitable unit and scaling is selected with GWv4 and ***GWT scalar***.
The proportional correction is taken from ***Wastegate Error Proportional***, and integral at the ***WG FB rate***, from the ***Wastegate Error Integral*** table, when *Engine Load* exceeds ***WG FB load*** and *Pedal* exceeds ***WG FB Pedal*** options. *Wastegate Target Total* is made from the 3D ***Wastegate Target*** map, ***Baro Wastegate Target*** table, and *Gear Wastegate mod* from ***Gear Wastegate mod table***.

The final output *WG duty* can be sent to a PWM channel with ***WG PWM#1*** out.
If ***WG#1 mul*** = 0% then
WG#2S duty = *WG duty* can be sent to a PWM channel with ***WG PWM#2*** out.

WASTE GATE SECOND VALVE

There is provision for a second wastegate solenoid valve controlled by the ***WG#2*** map. The pin used to act on these settings is defined by ***WG#2 pin***.

Wastegate duty can be modulated by Pedal position if ***WG feedback*** = Off, then the ***Wastegate Pedal mod*** map is active.

If ***WG#1 mul*** =/= 0% Then:
WG duty = (*WG MSR (C)* - ***WG#2S level***)x ***WG#1 mul*** and
WG#2S duty = ***WG#2S level*** which if non zero can control an output pin specified by ***WG#2 Pin***.

IDLE CONTROL

The idle control is a compensation for engine temperature as measured by the coolant sensor, and *Engine speed*, and the four optional factors ***Idle Start, Power Steer Idle***, ***A/C Idle*** and ***Idle >12volt*** . These go to make *Idle*, which is then presented to the active throttle controller as an offset *Act T Idle*, which is the fractional multiplication of *Idle* by ***Act T Idle M***.

The base target value specified in the ***Idle speed*** table. *Idle FB* is a slow proportional control parameter that is activated when *Pedal* < ***Idle Pedal*** option, and constrained not to exceed ***Idle FB+, Idle FB-*** options, when engine speed is not equal to *Idle target* speed. *Idle mod* the user variable may be adjusted to optimise the table. Idle Set Deadband will prevent *Idle Set* from changing if *d idle speed* is in it's dead band.

Idle =
Idle Coolant +*Idle mod* +*Idle speed* +*Idle FB* + *Idle Start* + ***A/C Idle*** + ***Idle >12volt*** + ***Power Steer Idle*** + ***Idle Fan Fast*** + ***Idle Fan Slow***.

OR
Act T Idle mod = from ***Idle Speed Duty*** table +idle *FB*

Idle >12volt is added to the current *Idle* value when the battery supply voltage is less than 12.5volts.

A/C Idle is added if the air conditioning request is active, likewise the fans can increase idle when *Fan Fast* = On, with ***Idle Fan Fast***, similarly for *Fan Slow* with ***Idle Fan Slow*** option.

Power Steer idle is added if the power steering pressure switch is active.

Idle Start, is starting aid by increasing throttle opening by the ***Idle Start***, once the engine has started by exiting cranking, then this factor is reduced to zero by ***Idle Start Decay***.

IDLE SPEED CONTROL

When *Pedal* is less than ***Idle Pedal*** option the *Idle Target* parameter from the ***Idle FB Target*** option added to ***Idle Hi Add*** option, is used to derive *d Idle speed* until the Hi Idle time option has expired then just ***Idle FB Target*** is used. The *d Idle speed* is used to access the Idle Spark table to find *Spark Idle* to modify the ignition angle. Meanwhile a slower process is moving the value of *Idle* towards a condition suitable for the target ***Idle FB*** options using the Idle FB parameter constrained by the ***Idle FB+*** and ***Idle FB–*** options. There is a ***Hi Idle*** option that will open the idle bypass valve for the high idle condition, while *Idle Hi count* counts down.

A low value for *Idle* will request a more closed throttle and a high value a more open valve.

The amount to change the drive-by-wire throttle, is controlled by option ***Act T Idle M***. If ***Idle New*** is On, then highest *Act T Demand* either *Act T idle mod* or Pedal is used. To aid starting the throttle can be opened with ***Idle Start*** and ***Idle Start decay*** for active throttle control why starting.

The active throttle requires some reduced drive when below the natural unpowered rest position The options ***Act T Damp*** and ***Act T Damp TP*** are used to reduce the current to the motor. If ***Act T Auto*** is On, then the active throttle rest is captured at power on, and saved in *Act T Rest*, and *Act T Rest* is used in place of ***Act T Damp TP.***

LAMBDA FEEDBACK

The oxygen sensor signal when functioning is allowed to modulate the fuel pulse width within the limits of options ***Lambda FB +v***e and ***Lambda FB -ve***. The proportional and integral controller iteration rate and error scaling are set by options ***Lambda FB Gain*** and ***Lambda FB Rate***. The error signal *Lambda error* is derived from the oxygen switching history *Lambda History* and the ***Lambda Error table***. Or from the difference between *Lambda* and the current *Lambda Target*, derived from the ***Lambda target*** map, if ***Lambda FB wideband*** is on. Otherwise if ***Lambda FB wideband*** is off, then *Lambda History* the record of comparisons between *Lambda* and *Lambda target* , where the most significant bit is the most recent condition. The four most significant bits are presented to the table and a raw error returned. The raw error is scaled by ***Lambda FB Gain***. The error is then processed by the proportional and integral controller, using the proportional and integral coefficients ***Lambda FB P*** and *Lambda FB integral* from speed related table, respectfully. If the *Coolant* temperature exceeds ***Lambda FB Coolant*** then the feedback signal modulates the fuel pulse width. To disable Lambda feedback set rate to zero.

Lambda may be displayed in AFR units, using User Scalars, see GWv4 user manual.

LAUNCH CONTROL

If Launch is activated by the specified input switch ***Launch in pin*** or ***Launch 2 in pin*** and *ALS full active* = On, then the launch control is active and the highest speed line is used irrespective of actual engine speed. Or if *Launch 2* = On as well, then the 2nd highest speed line is used, *Launch 2* only selects the mode, not the feature. If ***Launch once*** is on then after power on and entering *Launch* or *Launch 2* and exceeding ***Launch Off*** road speed, launch can not be restarted. If ***Launch push switch*** is on, then a momentary switch may be used to enter launch mode, then only exit is to change ALS mode, or exceed ***Launch Off*** road speed.
In addition there are 3 Pedal based launch tables: *Rev F Limit L* , *Rev I Limit L* , and *Rev Rtd Limit L* . And for the active throttle ***Act T Launch1 min*** and ***Act T Launch1 max***, or, ***Act T Launch2 min*** and ***Act T Launch2 max*** limit the range of throttle opening or closing while relevant launch mode active.

ALT MODE

Alt mode often used for switching between fuel types, pump fuel and race fuel. When enabled ***Alt Fuel*** and ***Alt Spark*** options are active, and modify fuel and ignition, and the parameter *ALT Switch* shows On.
All the Alt options must be met:
Alt ***Function input*** switch is satisfied,
Pedal must be greater than ***Alt On Above Pedal***,
Engine Speed between ***Alt On Above rpm*** and ***Alt Off Above rpm***,
Engine Load greater than ***Alt On Above Load*** and less than ***Alt Overboost Off*** .
If *Pedal* is less than ***Alt Off below Pedal*** , affording a user defined hysteresis, ensure ***Alt Off below Pedal*** is significantly less than ***Alt On Above Pedal***.

IC SPRAY

The intercooler spray can work in the following modes, only when engine is running:

Spray IC Auto = On
Then If any ***IC Spray air***, ***IC Spray Coolant*****,** ***IC Plenum*****, or** ***IC Plenum excess*** temperatures and ***IC Spray Load*** are exceeded the intercooler spray will activate, additionally if ***IC Spray ALS Only*** option is set on then the anti-lag mode *ALS Full Active* is On is required as well. When active the sprayer will pulse on and off in accordance with ***IC Spray On*** and ***IC Spray off*** times. At any time the spray can be made continuous with the switch defined by ***IC Spray Now pin*** without the engine running requirement.

Spray IC Auto = Off
The spray mode is determined by the condition indicated by the parameter *IC Auto*, controlled by presses of the pin defined by ***IC Auto/Man pin***. When in Auto mode the pin defined by **IC LED pin** will activate. If any ***IC Spray air, IC Spray Coolant*****,** ***IC Plenum*****, or** ***IC Plenum excess*** temperatures and ***IC Spray Load*** are exceeded the intercooler spray will activate, additionally if ***IC Spray ALS Only*** option is set on then the anti-lag mode *ALS Full Active* is On is required as well. When active the sprayer will pulse on and off in accordance with ***IC Spray On*** and ***IC Spray off*** times. At any time the spray can be made continuous with the switch defined by ***IC Spray Now pin*** without the engine running requirement.

RAD SPRAY

The radiator spray can work in the following modes:

Then when both ***Rad Spray AIR, Rad Spray Cool*** temperatures and ***Rad Spray Load*** are exceeded the intercooler spray will activate, additionally if ***Rad Spray ALS Only*** option is set on then the anti-lag mode *ALS Full Active* is On is required as well. When active the sprayer will pulse on and off in accordance with ***Rad Spray On*** and ***Rad Spray off*** times.

VARIABLE VALVE TIMING

There are separate controls for inlet (VVC) and (VVCX) outlet control valves, on the Subaru there are additional channels for left and right hand side of engine.
The Cam signal(s) is used to detect the cam position and a PWM signal *VVC out* control it's position.
User Scalar options ***VVC Advance Scalar*** and ***VVC Advance Offset*** may be used to rescale the underlying 0-80deg scaling for a more meaning full range. Note if ***Cam(1 or 2) Start*** or ***VVC Range*** options are changed then the user scalars should be adjusted accordingly.

The control system consists of ***VVC*** map to hold the target valve position, used by the feedback PI loop. The open loop *VVC out* is taken from the ***VVC Duty*** table. Note often the control valves have a small off condition where equal pressure is diverted either side of shuttle, this may be used as the reference point.

The cam positions are determined by capturing the relevant cam timing edge and scaling it into degrees:

Cam#n Angle = *Sync Tooth n* + (*Cam#n - Crank*)/*Tooth time* in teeth.

Cam#n ADV = (*Cam#n Angle - Cam#n Start*) × ***Cam range*** in degrees.

Cam range = (degrees/tooth)/Cam control range %.

Note raw range is 80deg, but scaled with ***VVC advance scalar*** and ***VVC advance offset*** user scalar for more flexibility.

When the VVC feedback is active; above VVC min speed, and VVC min Coolant, possibly Oil pressure switch and both cam sensors OK. If not OK then the ***VVC#n Default*** is output, or if below ***VVC min speed*** then ***VVC#n Stopped***.
While oil pressure is low and during starting and low engine speed, the variable Cams should be at there rest condition, minimum over lap.
The valves would naturally default to this condition if the power was removed from the oil control valves, so ***VVC Stopped*** should be set accordingly to give this condition.
VVC min speed and ***VVC min coolant*** should be set so that this unsafe low oil pressure condition is avoided.

The feedback PI loop is augmented by ***VVC Error*** table output.

VVC#n out = [***VVC Duty*** table] + [***VVC Error*** table] + *VVC#n FB*

VVC#n FB (new) = *VVC#n err* × ***VVC#n FB P*** + *VVC#n Int* (old) × ***VVC#n FB I***

The range of the feedback control is constrained by ***VVC FB min*** and ***VVC FB max***.

This output duty is constrained by ***VVC Out min*** and ***VVC Out max***.

If the difference between successive cam samples exceeds the option ***Cam dADV max***, in degrees the *Cam#n bad count* is incremented, and no change is made to output duty, if *Cam1 – Cam2 Error* count exceeds ***Cam dADV Max*** count the output is forced to the default setting option ***VVC default,***, this too should be set to the safe condition

The VVC two outputs are directed to the PWM output channels using ***VVC#n PWM Out***, like other PWM channels.

VVC TUNING

1.Set ***VVC#n Error*** table to 0, ***VVC Out min*** to 0 and ***VVC Out max*** to 100%. If ***VVC#n Duty*** table is all 50%, and block manipulated to vary the output duty *VVC#n Out*.
2.Find the range of the *Cam#n Angle*, the one moved by the ***VVC valve*** table.
3.Set ***Cam#n Start*** so that the useful range is before the lowest *Cam#n Angle*.
4.Set ***Cam range*** to give good resolution of *Cam ADV*. Note the scaling need not be in actual degrees, the user scalar might help here.
5.Check, log the relationship between *VVC#n Out* (Duty) and *Cam#n ADV*. Note this may exhibit large hysteresis.
6.Average the values obtained increasing duty with those reducing duty for the same *Cam#n ADV*. And fill the ***VVC#n Duty*** table with the duty values.
7.Fill in the ***VVC#n*** map with a first pass estimate of required advance. Check, log the relationship between *VVC#n* map, *VVC#n Out* (Duty) and *Cam#n ADV*. Note this may exhibit large hysteresis.
8.Now fill in the ***VVC#n Error*** table with a restoring function, Check that the response has improved, you may need to change the ***VVC FB min*** or ***VVC FB max***.
9.Now increase from zero the ***VVC#n FB P*** and ***VVC#n FB I*** PI control loop settings. Note these may be minus.
10.Adjust the ***VVC#n Error***, ***VVC#n Duty***, tables and PI control constants until acceptable control is achieved. Usually a bell error curve will result with a standard deviation of less than 2 degrees is achievable.
11.Now tune the VVC map for best torque or efficiency. Set the ***VVC#n Stopped*** and ***VVC#n Default*** appropriately for cranking and safe (rich) conditions. You may wish to constrain *VVC Out* with ***VVC Out min*** and ***VVC Out max***, minimise valve heating.
12.To aid tuning a table ***VVC Fuel mod***, may be used to correct the fuelling, for actual cam position. The output *VVC Fuel mod* with a range of ±50%.
13.*VVC target mod*, a user adjustable modification of target position with a nominal range ±40°, may be used to quickly asses the VVC performance.

TRACTION CONTROL

This system measures engine acceleration and if it exceeds previously determined limits acts to limit engine power. The maximum permitted engine acceleration is dependant on the gear selected, so this must also be determined by calculating the gear by comparing engine speed to road speed. Use internal logging of Gear Ratio to find the usual spread for this parameter.
Engine acceleration is measured by comparing crank tooth segment times between successive crank revolutions. *Engine Accel raw* is always calculated, and may be used in normal gravel conditions to gauge surface.

ENGINE ACCELERATION

Engine Acceleration calculation, note only positive acceleration is measured all decelerations are set to zero.

$$\textit{Engine Accel Raw} = \frac{\textit{Crank Tooth period}\ (\text{latest}) - \textit{Crank Tooth period}\ (1\ \text{rev old})}{\textit{Crank Tooth period}\ (\text{latest})}$$

The option ***Engine Accel Cal*** gives the sampling interval and should represent either an engine revolution or cylinder event.

Engine acceleration is scaled:

Engine Accel = (*Engine Accel Raw* × *TC Accel Mod*)/ ***TC Max***

where *TC Accel Mod* = [*TC sensitivity RPM/mph*] × [***TC Adjust Input***]
If (*Engine Accel Raw* × **TC Accel Mod**) > ***TC Max*** then set to 100.

TC Accel Mod may be selected using the ***TC Adjust Input*** option to modify either the ***TC sensitivity RPM*** or ***TC sensitivity Speed*** tables. If none selected then only the sensitivity table is active. If ***TC vs Road Speed*** = On then ***TC sensitivity Speed*** is used instead of ***TC sensitivity RPM***.

GEAR DETERMINATION

The ***Gear Ratio*** table is searched to see if the ratio is between the specified limits for the gear starting with the low bound limit for *Gear* = 0, then the upper bound limit for *Gear* = 0, and so on up to the maximum gear ratio for *Gear* = 7. Thus Gear is calculated. Typical values: 68,86,44,51,29,38,22,28,18,21,8,10,0,0.

Gear is used to select a different *Rev Light Speed High*, from ***Gear Rev Light High*** table, or active if below *Rev Light Speed low*, from ***Gear Rev Light low*** *table if engine running.* .
Gear is used to select a different *Gear Spark mod*, from ***Gear Spark mod*** table.
Gear is used to select a different *Gear Accel mod*, from ***Gear Accel mod*** table.
Gear is used to select a different *Gear WG mod*, from ***Gear WG mod*** table.
Gear is used to select a different *Gear Boost mod*, from ***Gear Boost mod*** table.

PREVENTING LOSS OF TRACTION

This requires the reduction of engine power, often the best way is to retard the ignition advance, but more drastic action my require the cutting of sparks and fuel injection pulses.
The reduction method is invoked when the compensated engine acceleration exceeds the trip value for the relevant gear.

If *Engine Accel* > [***TC Ign Cut Trip***] for selected gear the an ignition cut set by ***TC Ign Cut*** option is requested. When the acceleration returns to within limits the cut is restored using ***TC Ign Cut Restore*** every engine revolution.
If *Engine Accel* > [***TC Fuel Cut Trip***] for selected gear the an injection cut set by ***TC Fuel Cut*** option is requested. When the acceleration returns to within limits the cut is restored using ***TC Fuel Cut Restore*** every engine revolution.
If *Engine Accel* > [***TC Ign Retard Trip***] for selected gear the an ignition cut set by ***TC Ign Retard*** option is requested. When the acceleration returns to within limits the retard is restored using ***TC Ign Retard Restore*** every engine revolution.

VVS Vehicle Speed, *Road Speed* must exceed ***TC min Road Speed***.

TC TUNING

1.Log *Engine Accel raw*, and *Gear ratio*, in ideal conditions.
2.Select an appropriate ***TC max***, set the ***Gear Ratio*** table if all gear ratios readily distinguishable. Adjust the sensitivity table to compensate for the changing sensitivity with speed. Log again with Engine Accel included in log This should be a flat line versus engine speed, if traction maintained.
3.If last log is acceptable, say *Engine Accel* is 50% flat to ±10%, then set the TC trips with the retard triggered first and fuel cut highest. Try a retard of 25degrees and a restore of 2 degrees, 30% cuts and 5% restores.
4.Log again and find a poor or slippery surface to confirm action.

TUMBLE CONTROL FOR SUBARU

The two independent inlets on the Subaru N14 have additional motorised inlet port throttles, these must be fully open for full engine power.

If ***TGV active*** is On then the ***TGV*** map, is used to determined the required TGVR and TGVL conditions.

If ***TGV Out Pin1*** and ***TGV Out Pin2*** are not zero then the pin conditions on ***TGV Out Pin1-4*** are set as specified, note if ***TGV Out Pin3*** and ***TGV Out Pin4*** are zero then full power is sent to the motors used to position the inlet port throttles.

If ***TGV Out Pin1*** and ***TGV Out Pin2*** are zero then the four ***TGV(L / R) (On / Off) Duty*** options are fed to DAC#1 and DAC#2 and drive the port throttle motors. Additionally the ***TGV Battery Duty*** table is used to modulate the motor drive current to minimise overheating, the ***TGV Out Pin3*** and ***TGV Out Pin4*** options must be configured accordingly.

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 GWv3 at 115,000Baud.
To connect the IBM PC to the ECU a special serial cable is required.

Serial is numbered anti-clockwise from the key:		9 way
1 E.C.U. TX	PC RX	PIN 2
2 E.C.U. GROUND	PC GND	PIN 5
3 E.C.U. RX	PC TX	PIN 3

USB
A higher speed alternative to the RS-232C comm port is the USB port, which is typically 12 times faster at downloading internal log files. Note “Update ECU firmware” is not currently supported.

IN SYSTEM PROGRAM

Disconnect Coils and Injectors. Ensure PC is running from mains power with charged batteries, and that vehicle battery is also charged. Disconnect Fans in Evo X.
GW must also be in “inhibit telemetry until reset” mode.

Internal ISP
It is possible to “Update ECU firmware” without opening ECU if it is already running 00V10 or later with no JP2, *MISC* = 0x0F. Do not attempt to load older versions of .FIN files.
This must use the 3pin UART “COM PORT” communications channel, not the USB port.

Set *OKISP* = $AA or *ISP OK* = 170, automated with GWv3.19r00 or later.

Then “Update ECU firmware”

Best to cycle power to reboot.

CALIBRATION

Road Speed Scalar	UOS		User scalars
Load Scalar & Offset	UOS		
AFR Scalar & Offset	UOS		
Pedal Scalar & Offset	UOS		
Fuel Fuel Pedal	Map		Dual use map see Fuel Pedal
Ignition	Map		
Inj Angle	Map		
Wastegate	Map		
Boost Target/ Wastegate Pedal Mod	Map		Dual use map see WG Feedback output *Target Boost* is aliased with *Target Turbo speed*
Lambda Target	Map		
Pedal Retard Absolute	Map		
Spark limit	Map		
Fuel limit	Map		
Pedal Fuel mod Boost mod	Map		Dual use dependant on Load source
Pedal Retard Absolute Mild	Map		
Spark limit Mild	Map		
Fuel limit Mild	Map		
Pedal Fuel Mild mod	Map		
WG#2	Bit Map		
Switch#9	Bit Map		Defines Switch 9 condition against engine load and speed.
VVC VVC Pedal	Map		Used by VVC control as source of VVC Target Note the aliased spaces VVC is shared with VVC Pedal
VVC Mild VVC Mild Pedal	Map		
Speed	Table	rpm	Map speed sites
Load	Table		Map load sites
Pedal Angle Pedal Angle Limiter	Table		Map Pedal sites Reduced size for part used by limiter maps
Accel Amount	Table	%	Acceleration modification vs. speed
Accel MAP	Table	%	Acceleration modification vs. Load
Decel Amount	Table	%	deceleration modification vs. speed
Injector Volts comp	Table		Injector opening time vs. battery voltage

Idle Cool	Table	%	Idle motor position vs. coolant temperature
Idle speed	Table	%	Idle motor correction with engine speed.
Idle Spark	Table	°	Spark advance correction vs. deviation from target idle speed while in idle condition.
Idle Road Speed	Option	km/h	If above this road speed then no idle condition
Idle Hi Road Speed	Option	km/h	If above this road speed then Hi idle condition
Start Decay	Table	S	Time to decay Start Extra to zero
Start Extra	Table	%	Extra fuel to help start a cold engine, that decays away after engine started.
Start Pulse	Table	VE	One off pulse of fuel added to the normal first injector squirt for adding engine start.
AIT Retard	Table	°	Spark advance correction vs. Plenum air temperature.
Tacho Edge	Table		If value set On then tacho drive will change state, typically 4 ons will be required per rev. Compare with Tooth control table for guidance.
MAP Sensor	Table	V	Correction of MAP sensor, usually straight line.
Gear+ In pin	Option		See Gear+ section
Gear+ Rtd	Option	°	
Gear+ Max	Option	°	
Gear+ Adv	Option	°	
Gear+ Time	Option	mS	
Gear+ Speed min	Option	rpm	
Gear+Road Speed min	Option	km/h	
Gear+ Ign Cut	Option	%	
Gear- In pin	Option		See Gear- section
Gear- Restore	Option	°	
Gear- Max	Option	°	
Gear- Adv	Option	°	
Gear- Time	Option	mS	
Gear- Speed max	Option	rpm	
Gear- Ign Rev Limit	Option	rpm	
Gear- Ign Cut	Option	%	
Gear- Fuel Rev Limit	Option	rpm	
Gear- Fuel Cut	Option	%	
Gear- Blip time	Option	mS	
Gear- Adv Rev Limit	Option	rpm	
Knk Fuel Max	Option	%	
Knk Rtd Max	Option	°	See Knock suppression
Knock rate	Option	rev	
Knock Rtd	Option	°/V	Important Knock inc Knock dec not Zero
Knock inc	Option	°	
Knock Rich	Option	%/V	
Knock gain x4	Option		

Knock dec	Option	%	
Fan Slow	Option	˚C	Minimum Coolant temperature to activate slow fan relay.
Fan Slow request Hex Mask Fan Slow request bit Mask	Option		Selects a bit in message that must 1 for external slow fan request to activate Fan Slow. Evox GSR = 0x20
Fan Slow request source	Option		EvoX typically CAN1 RX2 W2 with this channel set to receive CAN ID = 0x412 Bigend=On
Fan Fast	Option	˚C	Minimum Coolant temperature to activate fast fan relay.
Fan Fast request Hex Mask Fan Fast request bit Mask	Option		Selects a bit in message that must 1 for external slow fan request to activate Fan Slow. Evox GSR = 0x40
Fan Fast request source	Option		EvoX typically CAN1 RX2 W2 with this channel set to receive CAN ID = 0x412 Bigend=On
Fan Fast request dly	Option	S	Delay between activating ***Idle Fan Fast*** jack and turning on Fan Fast. Indicated by *Fan Fast Requesting* flag.
WG max Time	Option	S	To prevent over boost a parameter *Boost mod* is added when *Load* exceeds the value in the *Boost Limit* table. *Boost mod* will increase after the ***WG max time*** is exceeded, at the ***WG max Force*** rate, until ***WG max Limit*** is reached. When the boost returns to an acceptable value the waste-gate drive is restored back to zero at the ***WG max Back*** rate.
WG max Force	Option	%	
WG max Back	Option	%	
WG max Limit	Option	%	
WG PWM#1 Out	Option		Selects an output for the wastegate signal. Typical = 3. Ensure relevant PWM channel is enabled (On) and appropriate timebase set.
WG PWM#2 Out	Option		Not used = 0, None.
Out Idle PWM#1	Option		Not used = 0, None.
Out Idle PWM#2	Option		Not used = 0, None.
ALS Full Time ALS F R Time ALS Full on Pedal ALS Full off Pedal	Option		Activated the ALS timer that can force Mild mode, See ALS Timer.
MAP source	Option		Selection of input for MAP signal
MAP Cal	Option	Teeth	The number of internal teeth for MAP signal integration, 6 typical.
Light time	Option	S	The engine check lamp will flash on for this period of time on change of *ALS Full active* or *ALS Mild active*.
MicroSec/bit	Option		Fuelling overall scaling factor
Start MicroSec/bit	Option		Fuelling overall scaling factor while *Stat cranking* = On
Fuel Sync	Option	teeth	Overall offset for fuel injection timing.
Sync Err R/S	Option		Number of sync errors till *Stat Sync'd* goes off and ignition and injection cease
Missing	Option	teeth	1 for Lancer | 1 Subaru
Ign Range	Option	teeth	4.266 for 128deg (+) 63.5 BTDC till (-) 64degATDC
MX Time	Option	%	70% for Lancer | 80% Subaru
Start MX Time	Option	%	0% MX time while Stat Cranking = On
MX Sync Test	Option	tooth	3 for Lancer

Wheel Teeth	Option		Number of internal teeth over which to calculate engine speed.
Fuel Teeth	Option		Number of internal teeth for fuel cycle to repeat
Start Fuel Teeth	Option		Number of teeth for fuel cycle to repeat while Stat Cranking = On
Sync Teeth	Option		Sync strategy. Typical = 0.
Sync ignore	Option	rpm	The sync strategy is ignored above this speed, if 0 then synchronisation is always tested.
Spark Sync	Option	teeth	Overall offset for ignition timing.
Spark Fire	Option		Processes ignition point calculation more often
Spark Teeth	Option		Number of internal teeth for ignition cycle to repeat.
Start Spark Teeth	Option		Number of internal teeth for ignition cycle to repeat while Stat Cranking = On
Accel comp	Option		Used to compensate for acceleration and deceleration effects on spark placement.
Sync Cycle	Option		Allows for only Sync detect over engine cycle, Subaru only.
Sync Crank Test All	Option		Force sync test in tooth control table while cranking.
Pedal min	Option		The minimum value of *Pedal raw,* gives Pedal =0, below this value *Error Pedal* = On.
Pedal max	Option		The maximum value of *Pedal raw*, gives Pedal = full scale, above this value *Error Pedal* = On.
Act T Pedal min	Option		The minimum value of *Pedal raw,* gives Act T Demand =0.
Act T Pedal max	Option		The maximum value of *Pedal raw*, gives Act T Demand = full scale.
Act Throttle max	Option		The maximum value of *Act Throttle raw*, gives throttle = full scale, above this value *Error Act Throttle* = On.
Act Throttle min	Option		The minimum value of *Act Throttle raw,* gives throttle =0, below this value *Error Act Throttle* = On.
Act T Target Max	Table		Used to limit throttle opening at low engine speeds, maximum typically 85%
Act T Target min	Option		Absolute limit on throttle closing, typically 9%
Act T ALS Target	Table		Control or Pedal (*Act T Demand)* to *Act T Target* throttle value, in ALS full mode.
Act T ALS Full Road Pedal	Table		Correction of Act T ALS Full Road with Pedal position
Act T ALS Mild Road Pedal	Table		Correction of Act T ALS Mild Road with Pedal position
Act T ALS Mild Target	Table		Control or Pedal (*Act T Demand)* to *Act T Target* throttle value, in ALS mild mode.
Act T ALS Mild mod	Option		Fine control offsetting of Act T ALS Target table
Act T ALS Mild mod axis	Option		Act T Demand where Act T ALS mod has no effect
Act T Launch1 max	Option		Used to limit throttle opening with Launch1 active, maximum typically 65%
Act T Launch1 min	Option		Used to limit throttle closing with Launch1 active typically 25%
Act T Launch2 max	Option		Used to limit throttle opening with Launch2 active, maximum typically 50%
Act T Launch2 min	Option		Used to limit throttle closing with Launch2 active typically 20%
Act T Target	Table		Control or Pedal (*Act T Demand)* to *Act T Target* throttle value, in ALS off mode.
Act T ALS Road	Option		Enables road speed correction of Act T Target in ALS modes.
Act T ALS Full Road Speed	Table		Road speed correction of Act T ALS Target ± 24%

Act T ALS Mild Road Speed	Table		Road speed correction of Act T ALS Mild Target ± 24%
Act T Load/Pedal	Table		Correction of Act T Target in ALS modes of up to +/-24% with the ratio of Engine load to Pedal
Act T swt pin			Act T swt mode switch 1-40 selector.
Act T swt speed			"Idle" target speed to use if Act T swt mode active.
Act T swt Demand			Act T demand target in Act T swt mode.
Act T swt Rtd			Retard engine speed limiter in Act T swt mode.
Act T swt Fuel cut			Fuel cut engine speed limiter in Act T swt mode.
Act T swt Spark cut			Spark cut engine speed limiter in Act T swt mode.
Act T swt Spark mod			Spark advance modification to use in Act T swt mode.
Act T swt Fuel mod			Fuel modification to use in Act T swt mode.
Act T swt VVC			VVC target advance to use in Act T swt mode.
Act T swt VVCX			VVCX target advance to use in Act T swt mode.
Act T swt WG			Wastegate duty to use in Act T swt mode.
Act T FB rate			How fast Act T Demand is adjusted for Act T swt speed
E85 warm & Start	Option		Doubles the effect of warm-up and start fuel
Rev Light pin	Option		Select an external output for additional gear change light.
Error Light pin	Option		
MAP min	Option	V	Minimum voltage for MAP as load = 0
MAP max	Option	V	Maximum value for MAP as load = full scale.
Pedal Filter	Option	%	Increases the sensitivity of ***Pedal Trig*** / ***Accel Trig***.
Accel Post Filter			*Pedal Filter* after ***accel trig*** test.
Pedal trig/ Accel Trig	Option		Minimum change in Pedal position to initiate an acceleration fuelling correction.
Pedal trig neg Decel Trig	Option		Minimum change in Pedal position to initiate an deceleration fuelling correction.
MAP Trig	Option		Minimum change in *Engine Load* to initiate an acceleration fuelling correction
Accel C	Option		Converts the raw change in Pedal *Pedal delta+* to scaled *Pedal delta Z+*.
Accel M	Option		
Decel C	Option		
Decel M	Option		Converts the raw change in Pedal *Pedal delta-* to scaled *Pedal delta Z-*.
Accel Limit	Option	%	Maximum extra fuel introduced due to acceleration event.
Accel Decay	Option	%	The decay rate of acceleration per engine cycle event. 80% typical.
Decel Decay	Option	%	The decay rate of deceleration per engine cycle event.

			70% typical.
Decel Decay Delay	Option	Cyc	Number of engine cycles to wait prior to decaying accel fuel.
Ign Tooth#1	Option	teeth	Reference point for ignition events. Determines firing order.
Ign Tooth#2	Option	teeth	One for each cylinder, new for Lan85 V0.56
Ign Tooth#3	Option	teeth	
Ign Tooth#4	Option	teeth	
F Tooth A	Option	teeth	Reference point for injector to start flowing fuel. Determines firing order
F Tooth B	Option	teeth	
F Tooth C	Option	teeth	
F Tooth D	Option	teeth	
Ign#1	Option	Ign#1	on
Ign#2	Option	Ign#2	
Ign#3	Option	Ign#3	
Ign#4	Option	Ign#4	
PWM#1	Option	PWM#1	Usually on
PWM#2	Option	PWM#2	
PWM#3	Option	PWM#3	
PWM#4	Option	PWM#4	
PWM#5	Option	PWM#5	
PWM#6	Option	PWM#6	
PWM#7	Option	PWM#7	
PWM#8	Option	PWM#8	
PWM ClkA Pre PWM78 ClkA Pre	Option		
PWM ClkB Pre	Option		
PWM ClkA div PWM78 ClkA div	Option		
PWM ClkB div	Option		
PWM16#01	Option		Leave Off for maximum number of PWM channels.
PWM16#23	Option		
PWM16#45	Option		
PWM1&2 period	Option	µS	paired PWM channel timebase.
PWM3&4 period	Option	µS	
PWM5&6 period	Option	µS	
PWM#1 invert	Option		
PWM#2 invert	Option		
PWM#3 invert	Option		
PWM#4 invert	Option		
PWM#5 invert	Option		
PWM#6 invert	Option		

PWM#7 invert	Option		Used to invert PWM channel
PWM#8 invert	Option		
Ign#1 mod	Table		Individual ignition trims, enabled with ***Spark mods***.
Ign#2 mod	Table		
Ign#3 mod	Table		
Ign#4 mod	Table		
Spark mods	Option		Activates Ign#n mod tables
Fuel Diff	Option		Activates Fuel Difference map
Injector Duty Max	Option	%	95% typical, although no limit. Used to detect when injector control lost.
OX FB Gain	Option		Oxygen Error 2s exponent scalar 1 typical
OX FB Rate	Option	sec	Update rate of oxygen feedback calculation.
OX Min A-Fuel	Option	µS	While accel fuel exceeds this value the oxygen feedback is frozen.
Start speed	Option	rpm	50rpm typical
Crank Exit	Option	rpm	500rpm typical
OX raw min	Option	V	Minimum voltage from lambda sensor for valid signal, typical 0. Wideband 0.5V
OX Load	Option	(Load)	If engine speed and load below these options then oxygen feedback may be active.
OX Speed	Option	rpm	
OX Heater Pin (1,2)	Option		Output pin selector.
OX Heat Coolant	Option	˚C	The coolant temperature above which the lambda sensor heater is turned off. Set to 127 if using wideband type.
Idle >12Volt	Option	%	Increase in idle position if battery voltage is loss than 12Volts.
Idle A/C	Option	%	Increase in idle position if A/C is active.
Idle Fan Fast	Option	%	Increase in idle position if *Fan Fast* is active.
Idle Fan Slow	Option	%	Increase in idle position if *Fan Slow* is active.
Idle Hi Duty Decay	Option	%	Decay rate of Idle Hi duty to match the decay of Idle Target.
Idle Hi Decay M	Option		Increases the 0.1S step down from Hi Idle to standard idle.
Idle Step Duty Max	Option		Fully open position of idle motor.
Idle FB Target	Option	rpm	Target idle speed if in normal idle condition
Idle Hi FB Offset	Option	rpm	Increase in target idle speed if in high idle condition.
Idle Pedal	Option		Maximum Pedal position for idle condition.
Act T Idle M	Option	%	Fractional multiplication of Idle to be used as modification of Act T Demand for idle speed control.
Idle FB+	Option	%	The range of the idle feedback (or Set) control system.
Idle FB-	Option	%	
Idle Hi Coolant	Option	˚C	Minimum coolant temperature for normal idle condition.
Idle Hi time	Option	S	Time to stay in high idle after high idle no longer required.
Idle Hi	Option	%	Increase in idle position when in high idle condition.

Idle Max speed	Option	rpm	Maximum engine speed for idle condition.
Idle Hi ALS switch	Option		Use Idle Hi feature when changing ALS modes
T1 SWT On Crank low Sens Above	Option	rpm	0 logic signal. Lancer 500 rpm Subaru typical
Dwell min	Option	teeth	0.1 typical
Dwell max	Option	teeth	10 typical
Alt Function Input	Option		Selects input pin to activate Alt function
Alt On Above Pedal	Option	(Pedal)	Minimum *Pedal* for Alt Function active
Alt Off Below Pedal	Option	(Pedal)	Maximum *Pedal* for Alt Function to deactivate
Alt On Above Load	Option	(Load)	Minimum *Engine Load* for Alt Function active
Alt Overboost Off	Option	(Load)	Maximum *Engine Load* for Alt Function active
Alt On Above rpm	Option	rpm	Minimum *Engine Speed* for Alt Function active
Alt Off Above rpm	Option	rpm	Maximum *Engine Speed* for Alt Function active
Alt Fuel	Option	%	Change in fuelling if Alt Function active
Alt Spark	Option	°	Change in ignition advance if Alt Function active
Main Relay Stop Eng	Option	S	Time from moving key to Off, till engine stopped.
Main Relay Kill Pwr	Option	S	Time from moving key to Off, till all power turned off.
Main Relay Output	Option		Output pin selector. Must be 33, to enable Main Relay function.
Crank Falling Edge	Option		
Crank Rising Edge	Option		
T2 Falling Edge	Option		
T2 Rising Edge	Option		
T3 Falling Edge	Option		
T3 Rising Edge	Option		
T4 Falling Edge	Option		
T4 Rising Edge	Option		
T5 Falling Edge Road Falling Edge	Option		
T5 Rising Edge Road Falling Edge	Option		
Idle FB Invert	Option		Changes direction of *Idle Set* the idle speed feedback controller.
Barometric min	Option	kPa	45kPa typical
Barometric max	Option	kPa	107kPa typical
Barometric Default	Option	kPa	101.7 kPa typical
Baro Filter	Option		Filters the raw barometric TC = 700mS
Barometric M	Option		28000
Barometric c	Option		3000
ALS Idle	Option	%	Setting for Idle motor if ALS Full active = On.

Rev Limit Coolant	Option	˚C	If *coolant* lower than ***Rev Limit coolant*****,** Rev Limit = ***Rev Limit Cold***, ignored if 0.
Rev Limit Cold -	Option	rpm	
Rev Limit Cold Abs	Option		If on and *Coolant* less than ***Rev Limit Coolant*** then the fuel and ignition limiters are set to ***Rev Limit Cold***, else the limit is the warm limit plus ***Rev Limit Cold***
Idle Dead Band	Option	rpm	The minimum deviation above *Idle Target* to provoke a change in Idle feedback.
Idle Set Rate	Option	mS	Update rate for Idle speed feedback system, typically 150mS.
MAF source	Option		
MAF min	Option		
MAF max	Option		
Err Mask MAP	Option		
Err Mask Air	Option		
Err Mask Coolant	Option		
Err Mask Baro	Option		
Err Mask Crank	Option		
Err Mask Lambda#1	Option		
Err Mask EE checksum	Option		
Err Mask Inject dty	Option		
Err Mask Knock	Option		
Err Mask Lambda#2	Option		
Err Mask MAF	Option		
Err Mask IO	Option		
Err Mask Rom	Option		
Err Mask Flash	Option		
Fuel Pump Pin	Option		Output pin selector.
OX FB I const	Table		Selects oxygen feedback integrator dependant on engine speed.
Lambda	Table	(AFR)	Scales raw oxygen 1 signal.
Lambda 2nd	Table	(AFR)	Scales raw oxygen 2 signal.
Tacho pin	Option		
Air Temp min	Option	˚C	If the scaled temperature falls outside the normal min to max range then the *Error AIT* signalled and the default used as the working value.
Air Temp max	Option	˚C	
Air Default	Option	˚C	
Plenum min	Option	˚C	If the scaled temperature falls outside the normal min to max range then the *Error Plenum T* signalled and the default used as the working value.
Plenum max	Option	˚C	
Plenum Default	Option	˚C	
AIT Temp min	Option	˚C	If the scaled temperature falls outside the normal min to max range then the *Error Air Temp* signalled and the default used as the working value.
AIT Temp max	Option	˚C	
AIT Default	Option	˚C	
Coolant min	Option	˚C	

Coolant max	Option	˚C	If the scaled temperature falls outside the normal min to max range then the *Error Coolant* signalled and the default used as
Coolant Default	Option	˚C	
CAN telemetry	Option		On to activate CAN Buses, so set to ON
CAN No recover	Option		If a CAN bus goes “bus off” no recover to normal running
CANn RXIDn			See Telemetry
Air Comp	Table	%	Fuel correction with air temperature .
Coolant Sensor	Table	˚C	Scales raw coolant temperature sensor.
AIT Sensor	Table	˚C	Scales raw air temperature sensor, and Plenum temperature.
Tooth Control	Table		Determines the action of crank timing edges.
Crank Alt Fire	Option		Use teeth defined in tooth control table for cranking ignition.
Ign +1/4 Tooth	Option		Off
Test Not Sync'd	Option		Can speed crank processing.
No Sync Cranking	Option		Off Not used
Crank Alt Invert	Option		Off
Crank Inject All	Option		Enables Start pulse table.
Sync Cam Count	Option		Off
Sync Crank S Count	Option		Sync strategy Lancer = on, Subaru=Off
Sync MX	Option		Off Lancer, On Subaru2002
Dwell vs. Battery	Table	%	Charge time correction due to *Battery* voltage.
Dwell vs. Speed	Table		Base Charge time calculation, multiplied by ***Coil Factor*** to give
Boost Correct	Table	%	Corrects fuelling due to *MAP as Load*, if ***Fuel map Pedal*** = On, else set to 0%
Rev I Limit	Table	rpm	The engine speed for Fuel limiter with each ALS mode.
Rev I Limit Mild	Table	rpm	
Rev I Limit L	Table	rpm	
Rev F Limit	Table	rpm	The engine speed for Fuel limiter with each ALS mode.
Rev F Limit Mild	Table	rpm	
Rev F Limit L	Table	rpm	
Rev Rtd Limit	Table	rpm	The engine speed for ignition retard limiter with each ALS mode.
Rev Rtd Limit Mild	Table	rpm	
Rev Rtd Limit L	Table	rpm	
Launch push switch	Option		Only an switch edge is required to enter launch mode.
Launch Rtd +	Option	˚	Additional value of Ignition retard when engine speed exceeds table speed, in Launch modes
Launch Rtd	Option	˚	Additional value of Ignition retard when engine speed exceeds table speed in Launch modes
Ign Retard +	Option	˚	Additional value of Ignition retard when engine speed exceeds

			table speed.
Ign Retard	Option	°	Initial value of Ignition retard when engine speed exceeds table speed.
Ign Cut +	Option	%	Additional value of Ignition cutting when engine speed exceeds table speed.
Ign Cut	Option	%	Initial value of Ignition cutting when engine speed exceeds table speed.
Fuel Cut +	Option	%	Additional value of fuel injection cutting when engine speed exceeds table speed.
Fuel Cut	Option	%	Initial value of fuel injection cutting when engine speed exceeds table speed.
Oxygen Toggle	Option	cyc	If oxygen sensor does not detect a crossing of target value for this number of feedback cycles, the sensor is assumed to have failed.
Baro Fuel	Table	%	Correction of fuelling due to barometric pressure.
User#1 source	Option		Used for USER1 control.
User#1 PWM Out	Option		
User#1 Duty	Table	%	
OX FB Delay	Table	S	Time to allow heater to warm up oxygen sensor so valid results may be obtained.
Cam#1 Start	Option	teeth	Reference position for calculating CAM#1 advance referred to internal teeth.
Cam#2 Start	Option	teeth	Reference position for calculating CAM#2 advance referred to internal teeth.
VVC FB min	Option	%	Maximum negative FB control
VVC FB max	Option	%	Maximum positive FB control
VVC#1(2) FB I	Option		VVC feedback integral
VVC#1(2) FB P	Option		VVC feedback proportional
VVC Out min	Option	%	Maximum normal PWM VVC drive duty.
VVC Out max	Option	%	Minimum normal PWM VVC drive duty.
VVC coolant min	Option	°C	Minimum coolant temperature before active VVC control permitted.
VVC min speed	Option	rpm	Engine speed above which there is adequate oil pressure to drive VVC.
VVC modulo div	Option	teeth	Allows all four VVC positional cam teeth to be processed.
Cam Range	Option	°/t	Number of internal teeth to give nominal 80deg valve range. Usable range 10-70deg.
VVC Duty	Table	%	First approximation for VVC PWM drive from VVC map
VCC#2 Duty	Option	%	
VVC Error	Table	%	Correction in VVC PWM drive due to current error from target
VVC stopped	Option	%	VVC PWM drive when engine speed less than ***VVC min speed***.

VVC default	Option	%	If either an engine load, or cam error detected then the VVC valves will be driven with this PWM duty.
VVC Fuel mod	Table	%	Fuel compensation for Cam position, see *VVC Fuel mod*.
VVC VVC pedal	MAP	˚	Target for VVC against both Engine load and speed, if full Anti-lag active
VVC Mild VVC Mild Pedal	MAP	˚	Target for VVC against both Engine load and speed, if Full Anti-lag Not active
VVC Pedal map	Option		Choice of y-axis Engine Load or Pedal for inlet cam control
VVC#1 PWM Out	Option		Output assignment to PWM drive channel
VVC#2 PWM Out	Option		Output assignment to PWM drive channel
Cam dADV max	Option	˚	The maximum value of *Cam1 – Cam2* before *Cam dADV Error* counts.
Cam dADV max Error	Option		The maximum consecutive *Cam1 – Cam2* Errors before ***VVC default*** activated.
CamX#1 Start	Option	teeth	Reference position for calculating CAMX#1 advance referred to internal teeth.
CamX#2 Start	Option	teeth	Reference position for calculating CAMX#2 advance referred to internal teeth.
VVCX FB min	Option	%	Maximum negative FB control
VVCX FB max	Option	%	Maximum positive FB control
VVCX#1(2) FB I	Option		VVCX feedback integral
VVCX#1(2) FB P	Option		VVCX feedback proportional
VVCX Out min	Option	%	Maximum normal PWM VVCX drive duty.
VVCX Out max	Option	%	Minimum normal PWM VVCX drive duty.
VVCX coolant min	Option	˚C	Minimum coolant temperature before active VVCX control permitted.
VVCX min speed	Option	rpm	Engine speed above which there is adequate oil pressure to drive VVCX.
VVCX modulo div	Option	teeth	Allows all four VVCX positional cam teeth to be processed.
CamX Range	Option	˚/t	Number of internal teeth to give nominal 80deg valve range. Usable range 10-70deg.
VVCX Duty	Table	%	First approximation for VVCX PWM drive from VVC map
VCCX#2 Duty	Option	%	
VVCX Error	Table	%	Correction in VVCX PWM drive due to current error from target
VVCX stopped	Option	%	VVCX PWM drive when engine speed less than ***VVCX min speed***.
VVCX default	Option	%	If either an engine load, or cam error detected then the VVCX valves will be driven with this PWM duty.
VVCX Fuel mod	Table	%	Fuel compensation for Cam position, see *VVCX Fuel mod*.
VVCX VVCX Pedal	MAP	˚	Target for VVCX against both Engine load and speed, if full Anti-lag active
VVCX Mild VVCX Mild Pedal	MAP	˚	Target for VVCX against both Engine load and speed, if Full Anti-lag Not active
VVCX Pedal map	Option		Choice of y-axis Engine Load or Pedal for exhaust cam control
VVCX#1 PWM Out	Option		Output assignment to PWM drive channel
VVCX#2 PWM Out	Option		Output assignment to PWM drive channel
CamX dADV max	Option	˚	The maximum value of *Cam1 – Cam2* before *Cam dADV Error* counts.
CamX dADV max Error	Option		The maximum consecutive *Cam1 – Cam2* Errors before ***VVCX default*** activated.

Baro Spark	Table	°	Barometric pressure correction of spark advance.
Coolant Retard	Table	°	Coolant temperature correction of spark advance.
MAF Sensor	Table		Linearisation of MAF signal.
FuelA O2 FB2	Option		off
FuelA O2 FB1	Option		on for oxygen feedback
FuelB O2 FB2	Option		off
FuelB O2 FB1	Option		on for oxygen feedback
FuelC O2 FB2	Option		off
FuelC O2 FB1	Option		on for oxygen feedback
FuelD O2 FB2	Option		off
FuelD O2 FB1	Option		on for oxygen feedback
VVC Advance Scalar	UOS	°	For inlet valve timing
VVC Advance Offset	UOS	°	For inlet valve timing
VVCX Advance Scalar	UOS	°	For exhaust valve timing
VVCX Advance Offset	UOS	°	For exhaust valve timing
;?Ign Advance Scalar	UOS	°	
;?Ign Advance Offset	UOS	°	
Load Scalar	UOS		
Load Offset	UOS		
AFR Scalar	UOS		
AFR Offset	UOS		
Log Code 1			Internal Logging Options
Log Rate			
Log Code 2			
Log Code 3			
Log Code 4			
Log Code 5			
Log Code 6			
Log Code 7			
Log Code 8			
Log Code 9			
Log Code 10			
Log Code 11			
Log Code 12			
Log Code 13			
Log Code 14			
Log Code 15			
Log Always			
Log ALS			
Log Wrap			
Log Switch			
Log Switch Input			
Log Load			

Log engine speed		rpm	
Log Throttle			
Log Road Speed		km/h	
Turbo speed Source	Option		Parameter that carries raw turbo speed data, if not used then wastegate feedback from Target boost, not Target turbo speed.
Turbo speed bigend	Option		To swap bytes in word, for turbo speed
Turbo speed scalar	UOS		Scales raw turbo speed for krpm
Road Speed M	Option		For Evo X with: CAN1 RXID1 b10-03 = 42 CAN1 RXID1 b03-00 = A0 Then road speed in CAN1 RX1 W1 @ 0.008km/Hr per bit So Road_Speed_Source = CAN1 RX1 W1, Road_Speed_bigend = Off Road_Speed_M = 1.9336
Road speed limit	Table	Km/Hr	*Road speed limit* selection from *Switch A low*. When active *Road Speed limit* flag = On May be increased with **Road Speed limit Hy**
Road Speed Source	Option		Parameter that carries raw road speed data
Road Speed bigend	Option		To swap bytes in word, often for Subaru N14
Road Speed Fuel Cut	Option	%	Additional fuel limiter value to reduce road speed.
Road Speed WG	Option	%	Subtracted from WG duty to reduce road speed, by reducing boost.
Road Speed Ign Cut	Option	%	Additional fuel limiter value to reduce road speed.
Road Speed limit Hy	Option	%	Offset to limiter road speed above throttle reduction
Road Speed Act T-	Option	%	Closing rate for throttle when road speed limiter activated
Road Speed Act T+	Option	%	Restoring rate for throttle when road speed limiter deactivated
F Limit ALS Full	Option		Activates ***Fuel/Ignition/Pedal Retard Limit*** maps in *ALS Full active* mode. Pedal based Rev Limit Tables
I Limit ALS Full	Option		
I Rtd ALS Full	Option		
RL F P ALS Full	Option		
RL I P ALS Full	Option		
RL R P ALS Full	Option		
F Limit ALS Mild	Option		Activates ***Fuel/Ignition/Pedal Retard Limit*** maps in *ALS Mild active* mode. Pedal based Rev Limit Tables
I Limit ALS Mild	Option		
I Rtd ALS Mild	Option		
RL F P ALS Mild	Option		
RL I P ALS Mild	Option		
RL R P ALS Mild	Option		
F Limit ALS Full Speed	Option		If ***ALS Full (F) Speed*** =/= 0 *Road Speed* > ***ALS Full (F) Speed*** Activates ***Fuel/Ignition/Pedal Retard Limit*** maps in *ALS Full active* mode. Pedal based Rev Limit Tables
I Limit ALS Full Speed	Option		
I Rtd ALS Full Speed	Option		
RL F P ALS Full Speed	Option		
RL I P ALS Full Speed	Option		
RL R P ALS Full Speed	Option		

F Limit ALS Mild Speed	Option		If ***ALS On (Mild) Speed*** =/= 0 *Road Speed* > ***ALS On (Mild) Speed*** Activates ***Fuel/Ignition/Pedal Retard Limit*** maps in *ALS Mild active* mode.	
I Limit ALS Mild Speed	Option			
I Rtd ALS Mild Speed	Option			
RL FTP ALS Mild Speed	Option			
RL I P ALS Mild Speed	Option			
RL RTP ALS Mild Speed	Option			
F Limit ALS none	Option		Activates ***Fuel/Ignition/Pedal Retard Limit*** maps if *ALS Full active and ALS Mild active* are both off. Pedal based Rev Limit Tables	
I Limit ALS none	Option			
I Rtd ALS none	Option			
RL F P ALS none	Option			
RL I P ALS none	Option			
RL R P ALS none	Option			
IC Spray Cool	Option	˚C	If either temperature exceeded then Inter Cooler spay active.	
IC Spray Air	Option	˚C		
IC Spray Plenum	Option	˚C		
IC Spray Plenum excess	Option	˚C		
IC Spray on	Option	Sec	Active on duty time	
IC Spray off	Option	Sec	Inactive off duty time	
IC Spray Load	Option	(Load)	Minimum load	
IC Spray ALS	Option		IC spray active only if in full anti-lag mode	
Fans Inhibit pin	Option		Input pin selector for fans inhibit	
Fans Inhibit	Option	S	Time to inhibit Fans for.	
ALS Air max	Option	˚C	If air temperature exceeds this value then go from Full to Mild ALS mode	
ALS Coolant max	Option	˚C	If coolant temperature exceeds this value then go from Full to Mild ALS mode	
ALS Off speed	Option	rpm	Minimum speed to deactivate *ALS Full Active*	
ALS On speed	Option	rpm	Minimum speed to activate *ALS Full Active*	
F Pump Pedal	Option	(Pedal)	Above either of these conditions, fuel pump high speed activated.	
F Pump speed	Option	rpm		
CT Speed	Option	rpm	CT Closed Pedal fuelling mode active if Pedal is less and engine speed above these options.	
CT Pedal	Option	(Pedal)		
CT Fuel Norm	Table	%	Fuel amount active in CT closed Pedal mode, when *ALS Mild active*.	
CT Fuel ALS	Table	%	Fuel amount active in CT closed Pedal mode, when *ALS Full active*.	
Pedal to Load	Table	(Load)	When the usual load input is faulty then a value of Load is taken from this table.	
Boost Error	Table	MSR%	Waste gate duty correction with boost error.	

Purge Output Pin	Option		Output Selector for carbon canister purge function.	
Rad Spray Cool	Option	˚C	If both temperatures and load exceeded then the radiator spay active	
Rad Spray AIT	Option	˚C		
Rad Spray ALS	Option		Active only in Full anti-lag mode	
Rad Spray on	Option	Sec	Active on duty time	
Rad Spray off	Option	Sec	Inactive off duty time	
Rad Spray Load	Option	(Load)	Minimum load	
Accel rtd	Option	˚	If accel trigger exceeded then retard ignition by this many degrees.	
Accel R Dk		˚	After Accel retard event return spark advance to normal at this rate per rev.	
A/C request Hex Mask A/C request bit Mask	Option		Selects a bit in A/C message that must 1 for air condition to turn on compressor.	
A/C request source	Option		Only active if simple switch selector A/C in pin = 0 Data shown in parameter *A/C message* EvoX typically CAN1 RX2 W1 with this channel set to receive CAN ID = 0x412	
A/C request Bigend	Option		EvoX set On for lower Byte	
A/C in pin	Option		Defines pin for A/C (air conditioning) request input.	
A/C Off Pedal	Option	(Pedal)	A/C is turned off if Pedal exceeds this value.	
A/C#1 Pin	Option		Output pin selector	
A/C#2 Pin	Option		Output pin selector	
A/C#3 Pin	Option		Output pin selector	
A/C out delay	Option		Time in Seconds from request to outputs active	
EGT Rtd limit	Table	˚	Maximum permitted ignition after TDC vs. EGT.	
EGT source	Option		Comm code any suitable parameter	
EGT bigend	Option		Swap high and low byte	
EGT raw min	Option		Safe minimum for EGT source raw	
EGT raw max	Option		Safe maximum for EGT source raw	
EGT default	Option	˚C	If EGT source raw is out of bounds default value	
EGT	Table	˚C	Converts *EGT raw* into scaled units.	
Oil Temp source	Option		Comm code any suitable parameter for *Oil Temp raw*	
Oil Temp bigend	Option		Swap high and low byte	
Oil Temp table	Table		Accessed by *Oil Temp raw* to make *Oil Temperature.*	
Fuel Temp source	Option		Comm code any suitable parameter for *Fuel Temp raw*	
Fuel Temp bigend	Option		Swap high and low byte	

Fuel Temp table	Table		Accessed by *Fuel Temp raw* to make *Fuel Temperature.*	
Fuel pressure source	Option		Comm code any suitable parameter for *Fuel pressure raw*	
Fuel pressure bigend	Option		Swap high and low byte	
Fuel pressure scalar	Option		Multiply for scaled *Fuel Pressure*.	1.25
Fuel pressure offset	Option		Offset for scaled *Fuel Pressure*.	-1.25%
Oil pressure source	Option		Comm code any suitable parameter for *Oil Pressure*	
Oil pressure bigend	Option		Swap high and low byte	
Oil pressure scalar	Option		Multiply for scaled *Oil Pressure*.	
Oil pressure offset	Option		Offset for scaled *Oil Pressure*.	
Boost Limit	Table	(Load)	Boost / Load value to trigger over boost condition.	
Lambda#1(2) X2	Option		Doubles the sensitivity of the raw data used to access the respective Lambda (2^{nd}) tables.	
Fuel Pump Speed Pin	Option		Output pin selector	
Fan Fast Pin	Option		Output pin selector	
Fan Slow Pin	Option		Output pin selector	
Rad Spray Pin	Option		Output pin selector	
Rad Fan Fast2	Option		Output pin selector	
Rad Fan Fast3	Option		Output pin selector	
Oil Fan out pin	Option		Output pin selector from Olin Temperature	
Plenum-AIT Out pin	Option		Output pin selector	
Spray IC Auto	Option		Use IC Spray settings.	
OX FB wideband	Option		Obtain oxygen feedback error signal from wideband linearised sensor, not switching history and ***OX Error*** table.	
IC Spray ALS only	Option		Spray only if *ALS Full active* = 0n	
Rad Spray ALS only	Option		Spray only if *ALS Full active* = 0n	
Launch Once	Option		Only one launch event after power on.	
IC Spray Pin	Option		Input pin selector	
Eng Check Pin	Option		Output pin selector	
IC LED Pin	Option		Output pin selector	
IC Spray Now pin	Option		Input pin selector	
Launch In pin	Option		Input pin selector	
IC Auto/man pin	Option		Input pin selector	
ALS in pin	Option		Input pin selector	
Launch 2 In pin	Option		Input pin selector for second selection of speed lines in Launch mode.	

Time switch1 pin	Option		Input pin selector	
Time Switch1A on	Option	S	As the *Time Switch1 Count* is incremented by a valid switch condition for ***Time Switch1 pin***: *Switch Time 1A 19* is set to On when count exceeds ***Time Switch 1A On*****,** likewise, *Switch Time 1B 20* is set to On when count exceeds ***Time Switch 2B On***	
Time Switch1B on	Option	S		
Time Switch1 Disable	Option	S	If *Time Switch Count* reaches this value then count will stop counting.	
A/C In pin	Option		Input pin selector, to activate *Air Condition*.	
WG#2 Pin	Option		Output pin selector for WG#2 map	
WG#2S Pin	Option		Used to route *WG#2s Duty* to simple output, usually not used.	
			Used to split wastegate signal to 2 valves, one PWM on On/Off. See Waste gate second output section.	
WG#1 mul	Option			
WG#2S level	Option			
WG Default	Option		If *Error Load* = On then this is used for *WG Duty*	
WG PWM#1 Out	Option		PWM routing	
WG PWM#2 Out	Option		PWM routing, must be 0 for split wastegate drive.	
FAF Pedal	Option	(Pedal)		
FAF Speed	Option	rpm		
FAF Fuel	Table	VE		
Launch Off	Option	km/h	Launch condition(s) deactivated if road speed exceeds this option.	
Baro Boost Target	Table	(Load Error)	Change in boost target due to barometric pressure.	
Baro Boost	Table	%	Change in wastegate duty due to barometric pressure.	
ALS Mild in pin	Option		Input selector for *ALS Mild active*	
Auto EE	Option		ECU will preserve all changes	
WG feedback	Option		Wastegate corrected by barometric and boost error. Or if Off wastegate Pedal mod map active.	
MAF	Option		Correct load calculation with air temperature and Barometric compensations.	
MAP	Option		Use a MAP signal for Load calculation.	
BAR	Option		Use Barometric sensor.	

Hand Brake in	Option		Selects from input list Hand Brake input.	
Foot Brake in	Option		Selects from input list Foot Brake input.	
DAC Test 1	Option		Test value for Diff DAC output	
DAC Test 2	Option		Test value for Testing only	
TGV pin in	Option		Not used Set to Switch#9	
TGV out pin1	Option		Define pin output	
TGV out pin2	Option			
TGV out pin3	Option			
TGV out pin4	Option			
AIT source	Option		See Analogue input assignment	
Coolant source	Option			
Plenum source	Option			
Baro source	Option			
Battery source	Option			
EGT source	Option			
T4 Freq divisor	Option		*T4 Frequency = T4 Freq divisor / T4 Period*	
T4 low speed	Option		*T4 Frequency = T4 Freq divisor/T4 Period MSB*	
T5 Freq divisor	Option		*T5 Frequency = T5 Freq divisor / T5 Period*	
T5 low speed	Option		*T5 Frequency = T5 Freq divisor/T5 Period MSB*	
Traction Control	Option		Used to enable traction control	
TC Max	Option		Sets value of Engine Accel Raw to give Engine Accel = 100%	
TC min Road Speed	Option	Km/h	Road speed below which no traction control is applied.	
TC vs. Road Speed	Option		Used to select TC sensitivity table against *Road Speed* in stead of *Engine Speed* (RPM).	
TC Adjust input	Option			
TC Sensitivity Speed	Table	%	Dual use table, axis selected with TC vs. Road Speed Only one table used to control the sensitivity of the traction control against either; Road Speed or Engine Speed	
TC Sensitivity RPM	Table	%		
TC Fuel Cut	Option	%	Strength of torque limitation, active when Gear related table tripped.	
TC Ign Cut	Option	%		
TC Ign Retard	Option			
TC Fuel Restore	Option	%	How quickly to restore torque after traction regained, by subtracting the restore every engine cycle.	
TC Ign Restore	Option	%		
TC Retard Restore	Option			
TC Fuel Cut	Table	%	Holds the maximum value Engine Accel before the relevant torque reducer is instigated	
TC Ign Cut	Table	%		
TC Ign Retard	Table			
Gear Ratio	Table		Turns Gear Ratio in to Gear	
Gear Accel mod	Table	%	Gear related correction tables for Acceleration fuel, Boost/WG, and ignition timing.	
Gear WG mod	Table	%		
Gear Boost mod	Table			
Gear Spark mod	Table			

Gear+ time	Table	S	Different Gear+ Time per Gear	
Gear- time	Table	S	Different Gear- Time per Gear	
Gear Rev Light High	Table		Produces different rev light speeds for each gear	
Gear Rev Light Low	Table			
VVC map Pedal	Option		VVC target controlled by Pedal, not Engine Load.	
Comparator1 source	Option		Parameter measured, for *Swt Comparator1*	
Comparator1 min	Option	%	Parameter to be measured off condition	
Comparator1 max	Option	%	Parameter to be measured on condition	
Comparator1 out	Option		Pin number to follow *Swt Comparator1*	
Comparator2 source	Option		Parameter measured, for *Swt Comparator2*	
Comparator2 on below	Option	%	Parameter to be measured on condition	
Comparator2 off above	Option	%	Parameter to be measured off condition	
Comparator2 out	Option		Pin number to follow *Swt Comparator2*	
Comparator3 source	Option		Parameter measured, for *Swt Comparator3*	
Comparator3 on below	Option	%	Parameter to be measured on condition	
Comparator3 off above	Option	%	Parameter to be measured off condition	
Comparator3 out	Option		Pin number to follow *Swt Comparator3*	
Time switch2 pin	Option		Input pin selector	
Time Switch2A On	Option	S	On time after trigger for Switch Timed2A 22	
Time Switch2B On	Option	S	On time after trigger for Switch Timed2B 23	
Power Steer in pin	Option		Defines input pin for power steering pressure switch for idle valve adjustment.	
Power Steer idle	Option		Idle valve adjustment when power steering pressure switch active.	
Switch A source	Option		The parameter used to make Switch A	
Switch A	Table		The comparator points for making *Swt A 32* to *Swt A 40*.	

UOS a user option scalar, converts ECU internal units to PC display scaling, does not affect ECU behaviour. Units within brackets have an option user scalar, so may need changing to your preferences.

PIN ASSIGNMENT

For increased flexibility some functions can be trigged or enabled by a user defined input pin. The user option typically named …… ***Out...*** requires a number, either positive or negative to activate or enable the function to a particular pin. See IO code column of Pin-out listings in appendix.

Timed Switches

The most complex use of configured inputs are the Timed Switch functions.
There are 2 timers, both up counting *Time Switch1 Count* and *Time Switch2 Count*.
They generate 2 switches each *Switch Timed1A 19*, *Switch Timed1B 20, and Switch Timed2A 22*, *Switch Timed2B 23* respectively.
The important difference between switches is that the 1st set become active after a user specified time, whilst the Switch2s are active immediately and turn off after a user specified time.
So *Time Switch1 Count* is a delayed On timer and *Time Switch2 Count* is a delayed Off time.
So the Time Switch2 counter can be used to active the full anti-lag system for a limited period, or to trigger the Alt feature just at the start of activating full anti-lag.

Timed Switch 1, here a momentary push switch specified by ***Time Switch1 pin*** is used to increment a counter *Time Switch1 Count,* when particular option ***Time Switch1A on*** and ***Time Switch1B on***, values are exceeded then an internal soft switch is set to the on condition. These soft switches are called *Switch Timed1A 19* and *Switch Timed1B 20*. If the counter reaches the time value set in ***Time Swt disable***, the counter is reset and the switch outputs turned off before testing to turn on switches, so can be used in testing, otherwise this should be set to maximum. These can then be used to control other functions such as Anti-Lag modes.

Timed Switch2, is a little like Timed switch1, it has an input selector ***Time Switch2 pin***, that starts a counter *Timed Switch2 Count*. However while the count is less than ***Time Switch2A on***, then the *Switch Timed2a 22* will be On, and while the count is less than ***Time Switch2B on***, then the *Switch Timed2B 23* will be On, when the input switch is no longer active the Switch Timed outputs are reset to their initial conditions.

The Gear+ options are used to detect a rate of decrease in *Pedal*, by comparing ***Pedal delta-*** with the option ***Gear+ Rate***, if it exceeded and *Pedal* is less than ***Gear + Pedal***, then the Gear+ *Time On* counter will count up till *Gear+ Time* obtained from the ***Gear + Time*** table, and *Swt Gear+ 21* will be On. Once exceeded the On condition will be inhibited while the *Gear+ Time Off* loaded with ***Gear + Time Inhibit*** counts down to zero. This then provides a useful switch for the Gear+ feature often used for a full throttle gear change, or means to help spool the turbocharger.

The Gear+ options are used to detect a rate of decrease in *Pedal*, by comparing ***Pedal delta-*** with the option ***Gear+ Rate***, if it exceeded and *Pedal* is less than ***Gear + Pedal***, then the Gear+ *Time On* counter will count up till *Gear+ Time* obtained from the ***Gear + Time*** table, and *Swt Gear+* will be On. Once exceeded the On

condition will be inhibited while the *Gear+ Time Off* loaded with ***Gear + Time Inhibit*** counts down to zero. This then provides a useful switch for the Gear+ feature often used for a full throttle gear change, or means to help spool the turbocharger.

The Comparator options are used to produce *Swt Comparator1 24*, by selecting a parameter with ***Comparator1 source***, then a minimum value for the On condition is specified with ***Comparator1 On***, and a maximum value for the Off condition with ***Comparator1 Off***. There should be some difference to ensure a reasonable noise margin and hysteresis. Similarly for Comparator2, except this is designed to be active low.

For example if a load cell on a sequential gear box is selected with both comparator sources, then the following restrictions are required:

Comparator1 On must be greater than ***Comparator1 Off***
Comparator2 On Below must be less than ***Comparator2 Off Above***
Assuming rest condition of Load Cell input = 50%
Comparator2 On Below = 20%
Comparator2 Off Above = 30%
Comparator1 On = 80%
Comparator2 Off = 70%

These trigger the gear related timers:

So ***Gear- Time in pin*** or ***Gear+ Time in pin*** set to *Swt Comparator1 Off* or
Swt Comparator2 Off, to initiate timers, that in turn trigger the Gear+ Gear- and Gear-+ functions.
So ***Gear+ in pin***, ***Gear- in pin***, set to *Swt Gear+ 21* or *Swt Gear- 1.*

The Comparator1 options are used to produce *Swt Comparator1 24*, by selecting a parameter with ***Comparator1 source***, then a minimum value for the On condition is specified with ***Comparator1 On***, and a maximum value for the Off condition with ***Comparator1 Off***. There should be some difference to ensure a reasonable noise margin and hysteresis. Likewise for Comparator2 and Comparator3.

Also the condition of the Pedal is captured at power on, to provide 2 more switches
Swt Pedal Hi Pwr On and *Swt Pedal Mid19 Pwr On*.

The important point here is that these switches allow communication amongst the many features of system. Perhaps the most flexible is the comparator, it can use any parameter to generate *Swt Comparator1 24*.

INPUT ASSIGNMENT

Many features may be enabled or trigged by external or internal conditions, show in the switch parameters.

Making the pin number negative will invert the condition from active high to active low.
Note avoid using pins used for other duties. 0 is always off , -128 is always active.

For external pins, see Switch in relevant pinout appendix column “IO code”.

Switch A

This is used to convert a parameter in to switches *Switch 33* to *Switch 40*.
Switch A Source is used to select a parameter to be used to access the ***Switch A*** table with *Switch A raw* to determine where it falls with in the range 0-7, as defined by the table.
Say the entries in the table are equally spaced at 12,25,37,50,62,75,82; then the following conditions are produced on the Swt A n parameters.

Swt A Raw	40	39	38	37	36	35	34	33
83-100	On	On	On	On	On	On	On	On
75-82	On	On	On	On	On	On	On	Off
62-75	Off	On	On	On	On	On	Off	On
50-62	Off	Off	On	On	On	On	Off	Off
37-50	Off	Off	On	On	On	Off	On	On
25-37	Off	Off	Off	On	On	Off	On	Off
13-24	Off	Off	Off	Off	On	Off	Off	On
0-12	Off	Off	Off	Off	Off	Off	Off	Off

Note *Swt A 33* and *Swt A 34* are often used to encode the 4 conditions in the road speed limiter. If road speed limiter is unused road speeds set to zero, then these switches could have other uses such as encoding ALS, ALS Mild, Launch and none for the ALS modes. ***Switch A Bigend*** is useful in selecting upper or lower bytes of a CAN message.

A simple centre off switch may be used for encoding the ALS switches. With
Switch A Source set to Analogue *17* the external mode switch input, ***Switch A Table*** = On and filled with :20,21,22,77,78,79,80, then with ALS in pin = 40 and
ALS Mild in pin = 38.
Will give *ALS Full active* = On with switch to 5volts (pin 9 AS pink)
ALS Mild active with switch in centre off (no connection pin 8 AS yellow)
No ALS with switch to ground (pin 2 AS black)

See Modeswitch configuration in appendix

Calibration Selection with Cal Switch

With *Cal Switch A* = On the 3 lower bits of the decoded *Switch A Low* 0-7 are read as Cal1-Cal8
Or if the individual *CalX Select In Pins* are used the first valid switch is used for Calibration selection.

Up to 8 combinations of settings may be defined.

Cal Fuel	Fuel map selection 0=1 along with Lambda Target
Cal Ignition	Ignition map selection 0=1
Cal Wastegate Target	Wastegate Target map selection 0=1 along with Wastegate Duty 0 to 3
Valve control	VVC VVCX map 0 = Mild
Cal DFCO	Is Deceleration Fuel Cut active
Cal Road Speed Limiter	Activates relevant Road Speed Limit
Cal ALS Full/Mild	Activates ALS modes Full or Mild if available. Is Ored with and ***ALS In pin*** or ***ALS Mild In pin*** condition
Cal Launch	Select 1 or 2 ***Launch Target*** table

The 3 comparator features make 3 switches:

Comparator1	*Swt comparator1 24*	code 24
Comparator2	*Swt comparator2 1*	code 1
Comparator3	*Swt comparator3 2*	code 2

The gear change assist features make 2 switches

Gear + Time table	*Swt Gear+ 21*	code 21
Gear - Time *table*	*Swt Gear- 3*	*code 3*

OUTPUT ASSIGNMENT

Similarly an output function may be assigned output pins. Typically the option is named …….Out, and also named Out ……, the option list should be checked for conflicts by inspecting all options starting Out …… and checking that only 0 is used more than once. See the relevant pinout lists at end of this document the code highlighted in bold is for outputs.

If the old 3 pin UART communications TX output line is required for use as a user configured function such as a change gear lamp. Then it may be set-up:
Tele1 Baud 0
Tele1 Enable On
Eng Check pin 34
Note this will only reflect *Rev Light*, if no serial device is connected, and 30seconds have expired since power on.

Tacho may be disabled by setting ***Tacho pin*** = 0 , or ***Tacho Edge*** table to all “Off”. To activate Tacho output, for 2 pulses per rev then for every third 1 or 5 in ***Tooth control*** table enter an “On” in the ***Tacho Edge*** table, and set ***Tacho pin*** = 8 (or 255).

PWM ASSIGNMENT

PWM Clkx Pre	Frequency	Divide
0	93k7Hz	1
1	16kHz	2
2	12kHz	4
3	3kHz	8
4	1k5Hz	16
5	750Hz	32
6	375Hz	64
7	287Hz	128

If the pre-scale is activated to slow period further then

timebase = 93k7Hz/ (***PWM Clkx Pre*** × ***PWMn Clk Div***)

PWM Period x2 option.

DISPLAY PARAMETERS

Pedal delta+		Change in Pedal reading
Pedal delta Z+		Change in Pedal reading scaled
A Tooth		Used to access ***Tooth control*** table
Accel Fuel	µS	Is the amount of accel/decel fuel currently used, note this has the range +/- 65,500 µSec
Accel Fuel Base	µS	
Accel mod	%	
Accel rtd	°	The Pedal delta+ triggered ignition retard.
Accel Trig		Counts Acceleration events
Act T swt		Act T swt mode active
ADR00 ADR17		Analogue to digital conversion results
After Start	S	Time after engine started
After Stop	S	Time after ignition switch goes off
Air Condition		Air conditioning active
Air Pressure	kPa	Barometric pressure
Air Temp	°C	Inlet air temperature AIT from ***AIT sensor*** table
Air Temp F	%	From ***Air Comp*** table
AIT raw		Used to access ***AIT sensor*** table
AIT Retard	°	From ***AIT Spark*** table
ALS switch		Condition of Anti-lag activating signal
ALS F time	S	ALS full timer
ALS recover time	S	ALS recovery timer
Alt mode		Indicates Alt mode active
AREVCNT		Counts engine cycle
Baro Fact	%	From ***Baro Fuel*** table
Baro raw		Raw signal used to make Barometric pressure
Baro Retard	°	From ***Baro Spark*** table
Baro WG	%	From ***Baro Boost*** table
Bat Comp Fuel	µS	From ***Battery comp*** table and ***Battery k*** option
Battery	(Battery)	Battery supply voltage
Battery raw		Raw signal used to make *battery* voltage
Fan Slow		Indicates Slow fan active
Boost Correct	%	From Boost Correct table, 0 if ***Fuel Pedal*** = Off
Boost Error	(Load Error)	Difference between *Boost Target Total* and *MAP as Load* , effective actual boost pressure.
Boost Limit	(Load)	From ***Boost Limit*** Table
Boost mod	%	From ***Boost mod*** map
Boost Target Total	(Load)	From ***Boost target*** map and ***Baro Boost Target*** table
Cam Tooth Count		Used by Sync Cam Count synchronisation strategy
Cam1 – Cam2	°	Difference in position unsigned between both VVC cams, Subaru Only.
Cam1 – Cam2 Error		Counts consecutive excessive differences between both VVC cams, Subaru Only.
Cam Tooth#1		Value of *Wheel Tooth* when cam transition detected
Cam Tooth#2		Value of *Wheel Tooth* when cam transition detected
Cam#1 ADV	°	Cam position
Cam#1 Angle	teeth	Cam position
Cam#2 ADV	°	Cam position
Cam#2 Angle	teeth	Cam position
CamX1 – CamX2	°	Difference in position unsigned between both VVC cams, Subaru Only.
CamX1 – CamX2 Error		Counts consecutive excessive differences between both VVC cams, Subaru Only.
CamX Tooth#1		Value of *Wheel Tooth* when cam transition detected

CamX Tooth#2		Value of *Wheel Tooth* when cam transition detected
CamX#1 ADV	°	Cam position
CamX#1 Angle	teeth	Cam position
CamX#2 ADV	°	Cam position
CamX#2 Angle	teeth	Cam position
CAN RXn Wn		Received CAN telemetry
Charge time	µS	Expected coil charging time
CHKSM		Check sum for calibration
Coil On 1	teeth	Position in internal teeth to open or start charging a coil
Coil On 2	teeth	
Coil On 3	teeth	
Coil On 4	teeth	
COMOK		If non zero serial communication error detected
Cool raw		Used to access ***Coolant Sensor*** table
Cool Temp F	%	From ***Warm-up*** table
Coolant	°C	Coolant temperature
Coolant Retard	°	From ***Coolant Retard*** table
Crank Count		
Crank time		
CT Fuel mod	%	
d Idle Speed	rpm	Difference between *Idle Target* and *Engine speed*.
d tooth time	µS	Used for missing crank teeth detection
delta MAP	%	Change in MAP/Boost reading
Pedal delta-		Change in Pedal reading
Decel Trig		Counts Deceleration events
Dwell A time	µS	Coil charging time
Dwell angle	teeth	Coil charging time measured in internal teeth.
Dwell time	µS	Coil charging time
Pedal delta Z-		Change in Pedal reading scaled
EGT	°C	Exhaust Gas Temperature from ***EGT sensor*** table
EGT raw	Volts	Used to access ***EGT*** sensor table
EGT raw Volts	V	Used to access ***EGT*** sensor table scaled
EGT Rtd Limit	°	From ***EGT limit*** table
Engine Load	(Load)	Used extensively to access tables maps and options
Engine Spd 25rpm	rpm	*Engine speed* a low resolution for 8bit logging
Engine Spd 50rpm	rpm	*Engine speed* a low resolution for 8bit logging
Engine Speed	rpm	Used extensively to access tables maps and options
ERROR		Error Flags indicate faults, not all errors are important dependant on configuration.
Error AIT		Individual error flags
Error Baro		
Error Battery		
Error Code		
Error Coolant		
Error EE checksum		
Error Flash		
Error Inject dty		
Error IO		
Error Knock		
Error Plenum		
Error Lambda#1		
Error Lambda#2		
Error Load		
Error MAF		
Error MAP		

Error Rom		
Error Pedal		
Error CAN1		
Error CAN2		
Error#1		Carries eight error flags
Error#1 Masked		Shows the effect of mask options on Error#1
Error#2		Carries eight error flags
Error#3		Carries Error Load
F Tooth No		Internal tooth counter used to place injection events
FAF Pulse	µS	From ***FAF Fuel*** table
Fan Fast		Fast Fan is active
Fan Slow		Slow Fan is active
Fan Plenum-AIT		Intercooler Fan is active
Fan Oil		Oil Fan is active
Fans I Time	S	Count down timer for Fan and Bay Fan inhibit
Fans Inhibited		Fans are stopped
Fuel (Mod)	µS	See Fuel Audit
Fuel A PW	µS	
Fuel Air	µS	
Fuel Alt	µS	
Fuel B PW	µS	
Fuel Baro/boost	µS	
Fuel C PW	µS	
Fuel Closed Pedal	µS	
Fuel comp	µS	
Fuel D PW	µS	
Fuel Diff	%	Not Used
Fuel Diff L	%	Not Used
Fuel limit	%	Amount of Fuel injection events cut
Fuel Mod	%	See Fuel Audit
Fuel no c	µS	
Fuel Pulse Extra	µS	
Fuel Pump		Fuel Pump is active
Fuel Pressure F		CAN signal for logging only from CD24
Fuel Pressure	Bar	Uses Fuel Pressure options
Fuel PW A	µS	See Fuel Audit
Fuel PW B	µS	
Fuel PW C	µS	
Fuel PW D	µS	
Fuel Start	µS	
Fuel Pedal mod	µS	
Fuel Total	µS	
Fuel Warm-up	µS	
Fuel#A not Ign#3		Should be On
Fuel#B not Ign#4		
Fuel#C not Ign#5		
Fuel#D not Ign#5		
Function#1		Status Flags
Function#2		Status Flags
Gear Ratio	%	Used to access Gear Ratio table
Gear		Current Gear if Road Speed valid, from Gear Ratio Table
Gear Accel mod	%	Gear related corrections of acceleration fuelling, Boost/WG control, and ignition timing.
Gear WG mod	%	
Gear Boost mod	%	

Gear Spark mod	°	
I Tooth No		Internal tooth counter used to place ignition events
IC Spray		Inter Cooler Spray is active
IC Spraying		Inter Cooler Spray is spraying
Idle Hi count	S	Count down timer for transition to idle condition
Idle Hi Target Offset	rpm	Current increase over *Idle Target* speed
Idle Mod	%	User modification of idle valve position, writeable
Idle set	%	Change in idle valve position due to feedback
Idle speed	%	From ***Idle Speed*** offset table
Idle Target	rpm	Desired Idle Speed if in idle
Ign limit	%	Amount of Fuel ignition events cut
Ign Retard Limiter	°	Amount of ignition retard used to restrain engine power from ***Rev Rtd limit*** tables
Inj Adv Max	teeth	
Inj Adv Mod	°	User modification of injection advance position writeable
Inj Angle	°	From ***Inj Angle*** map
Inject A Open	teeth	Position in internal teeth to open or start injection
Inject B Open	teeth	
Inject C Open	teeth	
Inject D Open	teeth	
Injector Duty	%	Amount of engine cycle used by fuel injection pulse
Knock	V	Knock signal scaled
Knock Cyl1-4	V	Knock signal scaled for each cylinder. EvoX category.
Knock Fuel	%	Extra fuel requested by knock detection
Knock raw		Raw Knock signal prior to correction by ***Knock noise*** table
Knock rtd	°	Ignition retard requested by knock detection
Lambda Heater		Oxygen sensor heater is active
Lambda Target	(AFR)	From ***Lambda target*** table
Lambda#1	(AFR)	Scaled lambda signal from ***Lambda sensor*** table
Lambda#2	(AFR)	Scaled lambda signal from ***Lambda sensor*** table
Launch		Launch condition is active
Launch2		Launch2 condition is active if *Launch* is also on.
Launch has run		The launch exit condition of road speed has occurred
Light Count	S	Timer for light flash
Log Reset		May be set to On to clear internal log memory
Log Size	MB	Size of internal log memory, If reads zero, then try Log Reset and cycle power.
Logging		Logging Flags
LOGWTSTAT		Logging Flags
Log Memory used	%	How much of internal data log memory consumed
M Tooth No		Crank teeth since missing tooth
MAF as Load	(Load)	MAF signal scaled for use as *Engine Load*
MAF Linear		From ***MAF Sensor*** table
MAF raw		Used to access ***MAF Sensor*** table
Main Relay		Main Relay is active
MAP as Load	(Load)	Boost signal scaled for use as *Engine Load*
MAP raw		Used to access ***MAP Sensor*** table
Max +AFuel	mS	Current working maximum acceleration fuel
Max -AFuel	mS	Current working maximum acceleration fuel
Max Fuel PW	µS	Fuel pulse constrained by ***Injector Duty***
Miss time	µS	Last missing tooth time
Miss Tooth Count		Counts missing teeth
Missing		
MX Count		Counts teeth since last missed tooth
MX Tooth No		Crank teeth between missing

MX Tooth time	µS	Time between crank teeth in ***MX Sync*** strategy
not Ign#1		
not Ign#2		
Oil Pressure F		CAN signal from CD24 logging only
Oil Pressure	Bar	Uses Oil Pressure options
Over Boost	S	Counts while in over boost
OX Error#1	(AFR error)	Difference between target and actual lambda reading
OX Error#2	(AFR error)	Difference between target and actual lambda reading
OX F.B.#1	%	The amount of oxygen feedback applied
OX F.B.#2	%	The amount of oxygen feedback applied
OX FB Delay	S	*After start* time till oxygen feedback permitted
Ox#1 History		Used to access *OX Error* Table
Ox#1 No Toggle	cyc	Number of oxygen rate counts since actual lambda equalled target
Ox#2 History		Used to access *OX Error* Table
Ox#2 No Toggle	cyc	Number of oxygen rate counts since actual lambda equalled target
Oxygen raw#1		Used to access *Lambda* Table
ALS Fuel Limit		Mode dependant selection of *Fuel Limit* from ***Fuel Limit*** map
ALS Full active		A main mode indicator
ALS Idle Open		Mode dependant selection of ***ALS Idle*** valve
ALS IG F		Not available
ALS Ign Limit		Mode dependant selection of *Spark Limit* from ***Spark Limit*** map
ALS Ign Rtd		Mode dependant selection of *Pedal Retard Absolute* from ***Pedal Retard Absolute*** map
ALS MODE		Shows all bits carries various flags
ALS Mild active		A main mode indicator
ALS status		Carries various flags
ALSSTAT		Carries various flags
Pickup Dly	teeth	Rescaled Pick-up delay
Processor Time	µS	Spare processor time
Plenum	°C	Plenum temperature
Plenum excess Plenum - AIT	°C	Plenum temperature above AIT
Qtr time	µS	Quarter of internal tooth time
Reset Type		
Retard Limit	rpm	From ***Rev Retard Limit*** tables dependant on main modes: *ALS Full active*, *ALS Mild active* or, *Launch*.
Rev Light		Indicates engine speed exceeded *Rev Limit Ign*
Rev Limit Fuel	rpm	From ***Rev F Limit*** tables dependant on main modes: *ALS Full active*, *ALS Mild active* or, *Launch.*
Rev Limit Fuel Duty	%	The depth of cutting from ***Fuel Cut (+)*** if tripped
Rev Limit Ign	rpm	From ***Rev I Limit*** tables dependant on main modes: *ALS Full active*, *ALS Mild active* or, *Launch*.
Rev Limit Ign Duty	%	The depth of cutting from ***Ign Cut (+)*** if tripped
Rev Time	µS	Time for 1 engine cycle
Road Speed	km/h	
Road Speed Test	km/h	Allows for dynamometer testing without CAN bus supplied or real road speed signal write into parameter your test value.
Road Speed Act T	%	Throttle reduction due to road speed limiter
Run Time	S	Time since power up
S Tooth No		
SECSTAT		zero if not secured
sigma MAP	%	
SMWTSTAT		
Spark (mod)	°	See Spark Audit
Spark adv (map)	°	

Spark Idle	°	
Spark Mod	°	
Spark MODS	°	
Spark Out 1	teeth	
Spark Out 2	teeth	
Spark Out 3	teeth	
Spark Out 4	teeth	
Spark Output	°	
Spark Total	°	
SPDBYT		For logging
Spray Auto		Spray auto mode active
SS Tooth No		Used by Sync S count sync strategy
Start Fuel	%	From ***Start Extra*** and ***Start Decay*** table
Start Pulse	µS	From ***Start Pulse*** table
STAT (STAT1)		Status flags
Stat Cranking		
Stat Idle		
Stat Prog EE		
Stat Running		
Stat Sync'd		
STAT2		Status flags
STAT3		
STAT5		
STATT		
Status #1		
Switch #1		Input Switch conditions
Switch #10		
Switch #11		
Switch #12		
Switch #13		
Switch #14		
Switch #15		
Switch #16		
Switch #2		
Switch #3		
Switch #4		
Switch #5		
Switch #6		
Switch #7		
Switch #8		
Switch #9		
Switches#1		Switches with all 8 bits encoded Switches#1 Switch 1-8, Switches#2 9-16, Switches#3 Pedal power on and timed
Switches#2		
Switches#3		
Swt Rtd Rtd	°	Amount of ignition retard mainly due to ***Swt Rtd max*** if triggered
Swt Rtd Time	mS	Swt Rtd switch active time, used to time out
Swt Timed 1A		Derived Switch conditions
Swt Timed 1B		
Swt Timed B 22		
Swt Timed B 23		
Swt Pedal Hi Pwr On		
Swt Pedal Mid Pwr On		
Swt Comparator		
Sync Error		Synchronisation errors

Sync good Count		
T2 Period	µS	Period between transitions on timed inputs
T3 Period	µS	
T4 Period	µS	
T4 Period MSB	S	
T4 count		Free running count of road speed pulses
T4 Frequency		Uses T4 Freq Divisor and T4 low speed
T5 Frequency		Uses T5 Freq Divisor and T5 low speed
Target Boost	(Load)	From ***Boost Target*** map
Target Boost Baro	(Load Error)	From ***Baro boost target*** table
TCNTL		Tooth control flags
Temp AFuel	µS	Part of *Accel Fuel* calculation.
TC Ign Cut	%	Strength of Traction control torque limiting
TC Ign Retard	°	
TC Fuel Cut	%	
Pedal	(Pedal)	Pedal value used to access tables maps and options
Pedal Filt	%	Filtered Pedal signal
Pedal mod	%	From ***Pedal Fuel (Mild) mod*** map
Time Switch1 Count	S	Counter controlled by ***Time Switch1 pin***
Time Switch2 Count	S	Counter controlled by ***Time Switch2 pin***
Timing Error		Sync not detected by end of ***tooth control table***, accumulator
Tooth Skip	teeth	
Tooth time	µS	Time between Internal teeth
Tooth Width	µS	
Turbo speed	Krpm	Turbo speed may be used for wastegate feedback
Pedal Fuel mod	%	From ***Pedal mod*** map
Pedal Retard Absolute	°	From ***Pedal Retard Absolute*** map
Pedal raw	V	raw unscaled signal from Pedal potentiometer
Pedal Volts raw	V	Like Pedal raw but in scaled units
User#1 Duty	%	From ***USER#***1 table
User#1 raw		Used to access ***USER#***1 table, selected with ***USER#1 source***
VE(MAP).		See Fuel Audit
VVC#1 (2) error	°	Difference between VVC target and actual CAM#1(2) position.
VVC#1 (2) FB	%	Correction to VVC1(2) drive due VVC#1(2) FB I and P
VVC#1(2) correct	%	Correction for ***VVC error*** table
VVC#1(2) Out	%	PWM signal sent to VVC valves
VVC Fuel mod	%	Fuel correction for *Cam#1 ADV*, may be 0.
VVCX#1 (2) error	°	Difference between ValveX target and actual CAMX#1(2) position.
VVCX#1 (2) FB	%	Correction to VVCX1(2) drive due VVC#1(2) FB I and P
VVCX#1(2) correct	%	Correction for ***VVCX error*** table
VVCX#1(2) Out	%	PWM signal sent to VVCX valves
VVCX Fuel mod	%	Fuel correction for *Cam#X1 ADV*, may be 0.
WG Duty	%	The primary signal output to the wastegate valve
WG Mod	%	Is the user key adjustable modifier for the waste gate control.
WG MSR	%	From the ***Waste Gate*** map
WG MSR (C)	%	The waste gate modification from the ***Boost error*** table
WG MSR (err)	%	Is the waste gate drive after modification from the ***Boost error*** table
WG MSR (m)	%	Is the waste gate drive after modification by Waste mod.
WG#2s Duty	%	The secondary signal output to the wastegate valve

CAN TELEMETRY

There are two CAN bus ports CAN1 (***Ctele1...***) for vehicle use, CAN1 (***Ctele2***...) for user use, typically for external data loggers such as GEMS DA1 or CD25 co-driver display, LDS4 for dash in non-group-N type applications.

There are 12 words or 24 byte parameters spread over 3 CAN messages are transmitted at up to 250Hz, for user set-up on both buses.

CANn Bit Rate is hexadecimal encoded (for present) or as scaled CTelen Speed, n = 1 or 2 for the 2 buses.

Bit15-14 Synchronization jump width in Tsegs, typically %11
Bit 13-8 Baud rate clock divide ,%000001 for 500kb/S
Bit 7 Samples %0 one, %1 three
Bit 6-4 Sample point in Tsegs
Bit 3-0 Tsegs per bit time

Bitrate = (((Bit 13-8) +1) + ((Bit 3-0) +1))+1 × 125nS

Typical setting $C149 For more detail See CANBTR0-1 in Freescale document MSCAN block guide V02.14, for Lancer, or Bosch CC770, Intel AN82257 datasheet for Subaru. Note for the Subaru the code must run from flash, see in system programming.

CTele ID bn-bn (or CAN n ID) sets the signalling identifier for (n= 1 to 3) for the 3 CAN messages.

Bit 15-5 11bit identifier
Bit 4 RTR
Bit 3 Must be 0 (else used for 29bit extended identifier using CAN n ID X)

CTelen Mn (or CAN n Data x) Sets the “comm code” for message n (n 1-3) data (1-4), Note some very low level parameters such as TCNT can not be transmitted.

The number of bytes to be transmitted after the identifier is specified in the option ***CTelex Mn Bytes*** note 0 is valid, this may be automatically calculated by GWv3.
CTelex rate for update interval for CAN message transmission.

CAN RECEIVER

Up to 32 words on 8 user messages on each CAN bus. Control or logging data may be received by the CAN interface, at the same bit rate defined in the ***C Tele1 speed***, see CAN Telemetry. If more are required contact GEMS.

The receiver works with 2 identifier filters. With an ID bit pattern and a “don’t care” mask, those bits in the ID must match in coming messages unless set to don’t care in mask. No further filtering takes place so the mask should normally be left as all zeros. Note on some buses the word data is swapped between the bytes, use the ***Bigend***

switch provided to enable this swap. The hexadecimal “comm code” may also be edited to select the lower byte in a word.

The received data is held in the following parameters.
CANn RXn Wn, RXn is filter 1-4, and Wn is word 1-4 for bytes 1-8 in message content.
CANn RXn Time is a time stamp.
CANn RXn DP most significant byte is the number of message content bytes received.

The Show Info tab in the CAN Telemetry window is useful is setting up external devices such as loggers or displays.

UART TELEMETRY

Defined Options for Telemetry

The only required fields for serial telemetry are the parameter count and each parameter. All serial telemetry fields begin Telex where x indicates the channel starting from 1.

Serial Telemetry

Option Name	*Description*	*Required*
Tele1 New	Use new flexible telemetry rather than old fixed method.	
Tele1 Baud	Used to define the serial baud rate. This is specific to the ECU and must be defined using an option list. Furthermore, each string of the option list must be purely an integer corresponding to the baud rate required (e.g. Value = 52, String = “9600”). Default is 9600.	No
Tele1 Checksum Inv	Inverts the checksum. Single bit field. Default is uninverted.	No
Tele1 Header	Header byte sent out before parameter stream. Byte. Scalar 1 offset 0. Default is 0x55	No
Tele1 Check All	Checksum is sum of data and header, old format was Off	No
Tele1 Count	Count of parameters used. Byte. Scalar 1 offset 0.	Yes
Tele1 Mode 9bit	If 9-bit transmission should be used. Single bit field. Set => 9bit transmission.	No
Tele1 Mode Odd	If odd parity is required. Set => odd parity. Only effective if 9bit and parity are set. Single bit field.	No
Tele1 Mode Parity	If parity is required. Set => use parity. Only effective if 9bit is set. Single bit field.	No
Tele1 Chan(nel)	Indicates which serial channel to use. 0 indicates telemetry is off, 1 indicates serial channel 1, 2 indicates serial channel 2. This must be defined using an option list as the number of channels is ECU dependent. If On serial receive from	No

Option Name	*Description*	*Required*
	ACD is not possible.	
Tele1 UART Enable	Whether to issue telemetry from the serial port. When 'Tele Chan' exists this is not used. Set => enabled. Single bit field.	No
Tele1 Disable	Opposite logic to Tele1 UART Enable	
Tele1 Data 01-20	Parameter name in stream. Value 1 for x must exist. Only the most significant byte of a word is transmitted.	Yes

Note that for the 3 parity options the following combinations are allowable and are interpreted as and set in the ECU by GWv3. All 3 fields must exist for parity to be selectable by the user.

Tele 9bit	*Tele Parity*	*Tele Odd*	*Effect*
0	x	x	No parity
1	1	0	Odd parity
1	1	1	Even parity
1	0	x	Ignore parity

Here x implies the field is irrelevant and is not set by GWv3 in this condition.
Up to 20 channels may be specified. The count is always set between 1 and the number of data channels available by Gwv3. Do not use '***Tele Chan 0'*** and '***Tele UART Enable***' together. The checksum transmitted does not include the header byte, unless the option ***Tele1 Checksum all*** = On

From GWv3.19r00 there is a tick box under ECU called Inhibit Telemetry until Reset, this will stop the telemetry breaking through into the PC communications. Typically you must establish communications with the ECU in 16 seconds, also it may necessary to tick the background load feature.

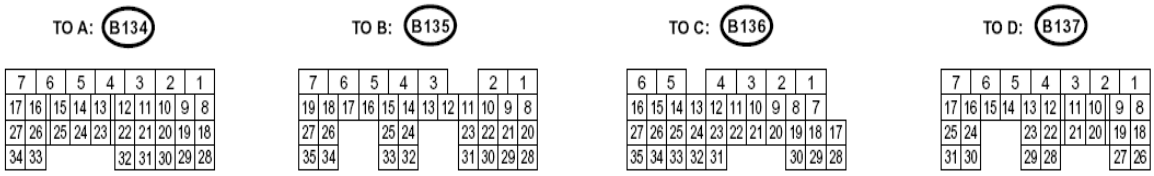
INTERNAL DATA LOGGING

All 15 logged parameters 7 fast and 8 slow must be set in the log list, reached via internal logging on GWv4. Also see GWv4 users manual.
If any the logging conditions; ***Log engine speed, Log Pedal, Log Load, Log Road Speed*** (vehicle speed) are exceeded; Or any of the switches ***Log always***, ***Log ALS***, ***Log Switch*** satisfied then logging will occur.

Avoid ***Log always***, this is for instances such as investigating starting or problems that can be analysed with a stationary engine. Also ***Log ALS*** (anti-lag) if set will prevent logging if *ALS Full Active* = Off, so not useful if the system is dropping from full to Mild mode so if mild logging required set ***Log ALS mild*** = On. The unloading of the logging must be done with the engine stopped. If ***Log Switch*** = On then the input specified by ***Log Switch input*** option will control logging. ***Log wrap*** will enable only the newest data to retained in log, note new version of GWv4 required.

Log Reset must be cycled Off-On-Off to clear the internal log buffer, or the log read using GWv4. However always: "download internal datalog" after changing "ECU internal datalog". Or at the start of an event to ensure a clean empty memory. And check *Log Memory used* = 0.00%.

APPENDIX



		GEMS Name	Primary	Secondary	Test Procedure No.
A1		NOT USED			
A2		NOT USED			
A3	1	RTN			6
A4	2	PLTEMP	A06	S47	9,16
A5	3	RTN			6
A6	4	MAP	A08	S49	9,16
A7	5	MAIN 12V	A05	S46	10,16
A8		NOT USED			
A9		NOT USED			
A10		NOT USED			
A11	6	CAM1/ Inlet Right	T3	S9	13,16
A12	7	CAM3/ Exhaust Right	T5	S11	13,16
A13	8	Crank +	T1		13
A14	9	Crank -	TGND		6
A15	10	KNOCK	A0		14
A16	11	TGVLP	A14	S55	9,16
A17		NOT USED			
A18	12	ACTTP1	A02	S43	9,16
A19	13	TPSPWR1	5V		8
A20		NOT USED			
A21	14	CAM2/ Inlet Left	T4	S10	13,16
A22	15	GND			6
A23		NOT USED			
A24	16	RTN			6
A25	17	RTN			6
A26	18	TGVRP	A15	S56	9,16
A27	19	SECAIRPR	A19	S60	9,16
A28	20	ACTTP2	A01	S42	9,16
A29	21	AGND			6
A30	22	BLOWBY	A21	S62	9,16
A31	23	CAM4/ Exhaust Left	T6	S12	13,16
A32		NOT USED	T2		13
A33	24	PWRSTR	S26		16
A34	25	CTEMP	A13	S54	9,16,12
B1	26	SHIELD			6

B2	27	MAIN 12V	A05	S46	9,16
B3	28	OXA1 WB YL	A20		9,12
B4	29	OX2	A04	S45	9,16,12
B5	30	NOT USED			
B6	31	OXA2 WB RD	A20		9,12
B7	32	OXA3 WB BLK			12
B8	33	LGND1	A03		9
B9	34	OX1	A03	S44	9,16,12
B10	35	OXA4 WB VI Res			12
B11		NOT USED			
B12	36	CRUISE1	T9	S15	13,16
B13		NOT USED			
B14	37	SECAIR2	O41		18
B15	38	SECAIR1	O42		18
B16		NOT USED			
B17	39	FTEMP	A17	S58	9,16
B18	40	AIT	A16	S57	9,16
B19	41	IGNSWT	A22	S63	9,16
B20	42	BRAKE	T7	S13	13,16
B21	43	TPSPWR2	5V		8
B22	44	TPSPWR2	5V		8
B23	45	ACCEL1 Pedal	A12	53	9,16
B24	46	CRUISE2	T8	S14	13,16
B25		NOT USED			
B26	47	MAF	A10	S51	9,16
B27		RX			
B28	48	STOP LIGHT		S25	16
B29	49	GRND	GND		
B30	50	RTN			6
B31	51	ACCEL2 Pedal	A11	S52	9,16
B32	52	F TANK Ppressure	A18	S59	9,16
B33	53	Fuel Pump HS	O21	100R source	19
B34	54	AGND			6,12
B35	55	RTN			6
C1	56	ACT T PWR			17
C2	57	FOXHEATO	O33	RK1	19
C3	58	FOXHEATO	O33		19
C4	59	ROXHEATO	O34		19
C5		NOT USED			
C6	60	RTN			6
C7	61	PURGE2	O20		19
C8	62	SECAIRPMP	O43		19
C9	63	AC OUTO	O32		19
C10		NOT USED			
C11	64	LED0	O35		19

C12	65	Fuel Pump speed 5V	O40		19
C13		NOT USED			
C14		NOT USED			
C15	66	RTN	RTN		6
C16		TX			
C17	67	DRAIN	O18		19
C18	68	FAN2	O30		19
C19		NOT USED			
C20	69	START RLAY	O28	Link issue A	19
C21	70	ACT T RLY	O22		19
C22	71	TACHO	O7		19
C23	72	MAIN 12V RLY	O23		19
C24	73	ACIN	S27		16
C25	74	CLUTCH	S30		16
C26		NOT USED			
C27	75	CANH	CAN1H		11
C28	76	PRCVALVE	O29		19
C29	77	FAN1	O31		19
C30		NOT USED			
C31	78	NEUTRAL	S29		16
C32	111	Start Request	T10	S16	16
C33	79	ACPRSW	S27		16
C34		NOT USED			
C35	80	CANL	CAN1L		11
D1	81	RTN			6
D2	82	RTN			6
D3	83	WASTE2	O12	P5	19
D4	84	ACTBRG2/ACTTBRG2	O9	P2	17
D5	85	ACTBRG1/ACTTBRG1	O13	P6	17
D6	86	RTN	RTN		6
D7	87	RTN	RTN		6
D8	88	INJA	O6		15
D9	89	INJB	O5		15
D10	90	INJC	O4		15
D11	91	INJD	O3		15
D12	92	TGVL+	O47		18
D13	93	TGVL-	O46		18
D14	94	VVC2	O11	P4	19
D15	95	12V PWR OUT	12V		7
D16	96	VVC1	O10	P3	19
D17	97	12V PWR OUT	12V		7
D18	98	COIL1	O1	MUX11	15
D19	99	COIL2		MUX12	15
D20	100	COIL3		MUX21	15
D21	101	COIL4		MUX22	15

D22	102	TGVR +	O47		18
D23	103	TGVR-	O46		18
D24	104	VVC3	O14	P7	19
D25	105	12V PWR OUT	12V		7
D26	106	RTN	GND		6
D27	107	WGATE	O8	P1	19
D28		NOT USED			
D29	108	PURGE	O16		19
D30	109	VVC4	O15	P8	19
D31	110	12V PWR OUT			7

		GEMS Name	Primary	Secondary
A1		NOT USED		
A2		NOT USED		
A3	1	RTN		
A4	2	PLTEMP	A06	S47
A5	3	RTN		
A6	4	MAP	A08	S49
A7	5	MAIN 12V	A05	S46
A8		NOT USED		
A9		NOT USED		
A10		NOT USED		
A11	6	CAM1/ Inlet Right	T3	S9
A12	7	CAM3/ Exhaust Right	T5	S11
A13	8	Crank +	T1	
A14	9	Crank -	TGND	
A15	10	KNOCK	A0	
A16	11	TGVLP	A14	S55
A17		NOT USED		
A18	12	ACTTP1	A02	S43
A19	13	TPSPWR1	5V	
A20		NOT USED		
A21	14	CAM2/ Inlet Left	T4	S10
A22	15	GND		
A23		NOT USED		
A24	16	RTN		
A25	17	RTN		
A26	18	TGVRP	A15	S56
A27	19	SECAIRPR	A19	S60
A28	20	ACTTP2	A01	S42
A29	21	AGND		
A30	22	BLOWBY	A21	S62
A31	23	CAM4/ Exhaust Left	T6	S12
A32		NOT USED	T2	
A33	24	PWRSTR	S26	
A34	25	CTEMP	A13	S54

B1	26	SHIELD		
B2	27	MAIN 12V	A05	S46
B3	28	OXA1 WB yellow	A20	
B4	29	OX2	A04	S45
B5	30	NOT USED		
B6	31	OXA2 WB red	A20	
B7	32	OXA3 WB black		
B8	33	LGND1	A03	
B9	34	OX1	A03	S44
B10	35	OXA4 WB violet		
B11		NOT USED		
B12	36	CRUISE1	T9	S15
B13		NOT USED		
B14	37	SECAIR2	O41	
B15	38	SECAIR1	O42	
B16		NOT USED		
B17	39	FTEMP	A17	S58
B18	40	AIT	A16	S57
B19	41	IGNSWT	A22	S63
B20	42	BRAKE	T7	S13
B21	43	TPSPWR2	5V	
B22	44	TPSPWR2	5V	
B23	45	ACCEL1 Pedal	A12	53
B24	46	CRUISE2	T8	S14
B25		NOT USED		
B26	47	MAF	A10	S51
B27		RX		
B28	48	STOP LIGHT	PJ.0	S25
B29	49	GRND	GND	
B30	50	RTN		
B31	51	ACCEL2 Pedal	A11	S52
B32	52	Fuel Tank Pressure	A18	S59
B33	53	Fuel Pump HS	O21	100R source
B34	54	AGND		
B35	55	RTN		
C1	56	ACT T PWR		
C2	57	FOXHEATO	O33	RK1
C3	58	FOXHEATO	O33	
C4	59	ROXHEATO	O34	
C5		NOT USED		
C6	60	RTN		
C7	61	PURGE2	O20	
C8	62	SECAIRPMP	O43	
C9	63	AC OUTO	O32	
C10		NOT USED		

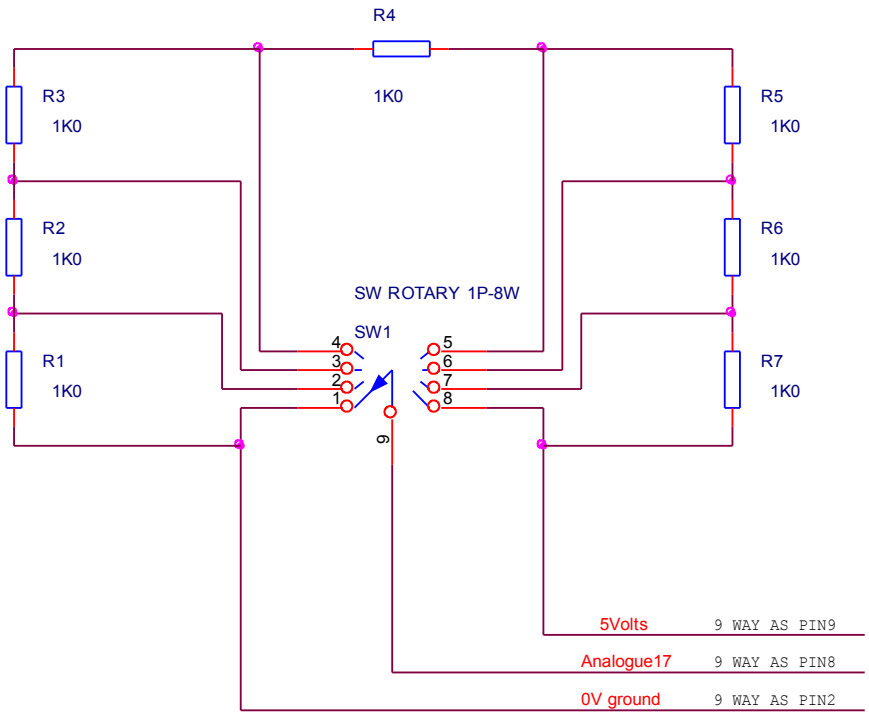
C11	64	LED0	O35	
C12	65	Fuel Pump speed 5V	O40	
C13		NOT USED		
C14		NOT USED		
C15	66	RTN	RTN	
C16		TX		
C17	67	DRAIN	O18	
C18	68	FAN2	O30	
C19		NOT USED		
C20	69	START RLAY	O28	
C21	70	ACT T RLY	O22	
C22	71	TACHO	O7	
C23	72	MAIN 12V RLY	O23	
C24	73	ACIN	S27	
C25	74	CLUTCH	S30	
C26		NOT USED		
C27	75	CANH	CAN1H	
C28	76	PRCVALVE	O29	
C29	77	FAN1	O31	
C30		NOT USED		
C31	78	NEUTRAL	S29	
C32		Start Request	T10	S16
C33	79	ACPRSW	S27	
C34		NOT USED		
C35	80	CANL	CAN1L	
D1	81	RTN		
D2	82	RTN		
D3	83	WASTE2	O12	P5
D4	84	ACTBRG2/ACTTBRG2	O9	P2
D5	85	ACTBRG1/ACTTBRG1	O13	P6
D6	86	RTN	RTN	
D7	87	RTN	RTN	
D8	88	INJA	O6	
D9	89	INJB	O5	
D10	90	INJC	O4	
D11	91	INJD	O3	
D12	92	TGVL+		RC17
D13	93	TGVL-		RC16
D14	94	VVC2	O11	P4
D15	95	12V PWR OUT	12V	
D16	96	VVC1	O10	P3
D17	97	12V PWR OUT	12V	
D18	98	COIL1	O1	MUX11
D19	99	COIL2		MUX12
D20	100	COIL3		MUX21
D21	101	COIL4		MUX22

D22	102	TGVR +		RC18
D23	103	TGVR-		RC19
D24	104	VVC3	O14	P7
D25	105	12V PWR OUT	12V	
D26	106	RTN	GND	
D27	107	WGATE	O8	P1
D28		NOT USED		
D29	108	PURGE	O16	
D30	109	VVC4	O15	P8
D31	110	12V PWR OUT		

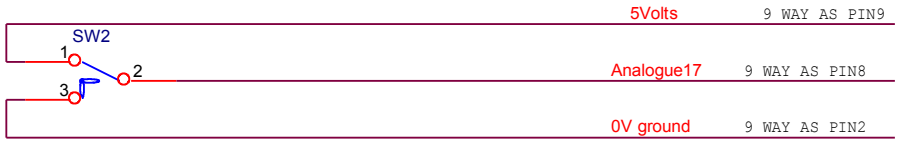
BARO
HEATER CURRENT A20

IN LFT
IN RHT
EX LFT
EX RHT

MODESWITCH CONFIGURATIONS



MODESWITCH 8 conditions



SW Single Pole Centre Off

MODESWITCH 3 conditions