

ESL 92/8 Live Mapping Software Manual

Warning: ESL does not warranty against improper tuning by a third party which may result in damage to the target vehicle.

By using the ESL ECU System you agree to our Terms and Conditions. See www.enduringsolutions.com/terms.pdf for further details.

Summary

The software is available by download. To connect to an ESL ECU, a cable will be required, which may be purchased by contacting service@enduringsolutions.com

Installation

Unzip the downloaded folder and double click on setup.exe. Ensure an internet connection is available as the .NET 4 framework is a requirement and will be automatically downloaded if necessary.

Cable Drivers

Drivers are available from: www.ftdichip.com/Drivers/D2XX.htm

An installation guide is available at:

www.ftdichip.com/Support/Documents/InstallGuides.htm

Ensure the drivers are installed correctly before attempting connection.

Starting

Start the program from Start menu-All Programs-ESL.

Overview

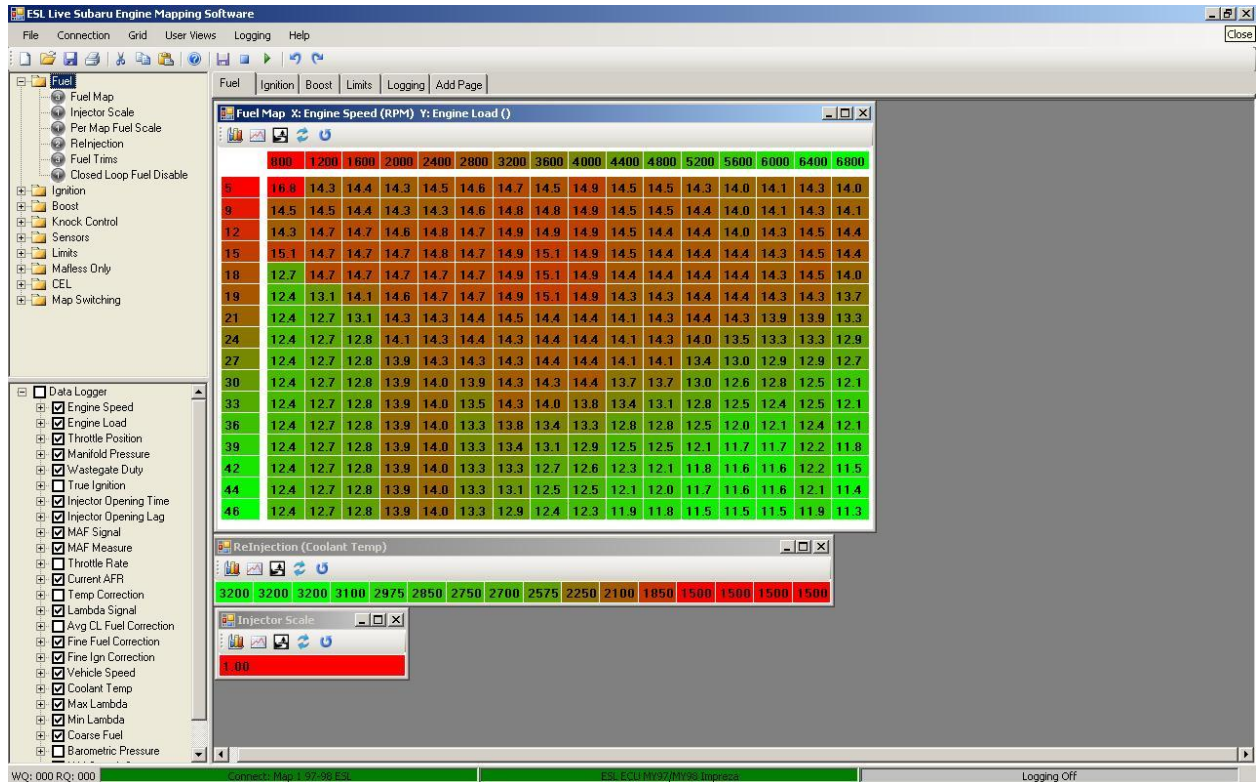


Figure 1: GUI

The software is divided up into layout panels. Top left is the ECU Parameter Tree, Bottom Left is the Logging Parameter Tree, and the rest of the screen is devoted to pages controlled by a tab strip that the User can position Grid Views, Graphs and Logging objects. The User Views can be saved and reloaded.

After an ECU has been connected (Connection-Connect To Car), an offline file loaded (File-Load) or a new file created (File-New), parameter and log trees will appear that expose parameters relevant to that type of ECU (a different set of boost parameters will be exposed for an Impreza when compared to a Twin Turbo Legacy, for example). Please note that the software connects to the currently selected map. If the user changes map during the mapping session, the PC software remains connected to the original map and any changes will be reflected in the original map and not in the map running the engine.

Top Level Menus



Figure 2: Top Level Menu and Toolbar

New	File-New
Open	File-Load
Save ECU File	File-Save
Print	
Cut	
Copy	
Paste	
Help	
Save Log File	Logging-Save Log
Stop Logging	Logging-Stop Log
Start Logging	Logging-Start Log
Undo	Grid-Undo
Redo	Grid-Redo

Table 1: Toolbar Functions

File	New
	Load
	Save
	Exit
Connection	Connect To Car
	End Session
Grid	Undo
	Redo
	Trace Off (Global)
	Clear Trail (Global)
User Views	Trail Off (Global)
	Load View
	Save View
Logging	Start Log
	Stop Log
	Save Log
Help	About

Table 2: Menu Functions



Figure 3: GUI Bottom Bar

WQ	Write Queue: How many bytes left to Write
RQ	Read Queue: How many bytes left to Read
Connection	Online or Offline, Map 1 or Map 2
ECU type	Detected ECU or offline file type.
Logging	Logging On or Off, amount of time current log has run in seconds.

Table 3: Bottom Bar Information

Editing ECU Files

ECU Files may be edited online or offline. If edited online, changes are made to the ECU with immediate effect. If edited offline, files may be saved for later use. If a file is loaded while a connection is live, that file will be immediately downloaded to the ECU. You cannot connect while in offline mode.



Figure 4: Parameter Tree

The Parameter Tree is divided into top level nodes, such as Fuel, Ignition, Boost, Knock Control, etc. Clicking on the plus sign brings unrolls user level objects (eg. Fuel map, injector scale, fuel trims, closed loop fuel disable, etc).

Clicking on the object produces a grid view of that object in the main panel. Objects can be positioned by dragging the title bar and sized by dragging the corner. The Grid Font will size in sympathy with the grid.

Grid View

The Grid View is the most commonly used object. It has a toolbar, hotkeys, full copy and paste functionality and a right click menu. It also has a colour temperature representing the value, green is high and red low.

Page Up	Fine Increment
Page Down	Fine Increment
Ctrl- Page Up	Coarse Increment
Ctrl- Page Down	Coarse Increment
Ctrl-C	Copy
Ctrl-V	Paste
Ctrl-I	Interpolate
Ctrl-H	Horizontal Interpolate
Ctrl-E	Vertical Interpolate

Table 4: Grid View Hotkeys

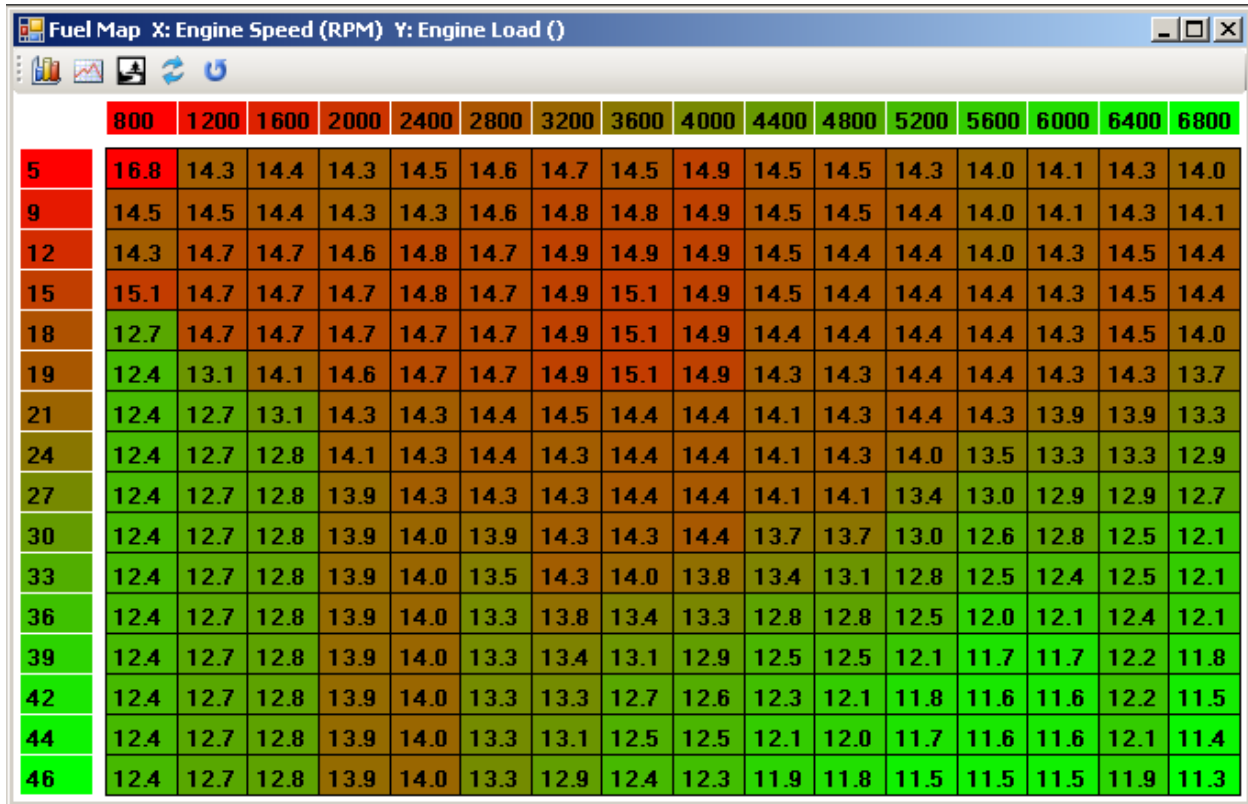


Figure 5: Grid View

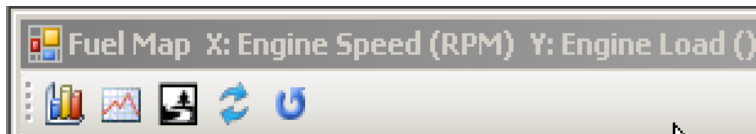


Figure 6: Grid View Toolbar

Graph	Display Graphical representation (if available)
Trace	Toggle Trace (default on)
Trail	Toggle Trail (default off)
Convert	Convert to raw data (default converted)
Refresh	Manual refresh

Table 5: Grid View Toolbar Icons (left to right):

Graph	Display Graphical representation (if available)
Convert	Convert to raw data (default converted)
Copy	Windows copy

Paste	Windows Paste
Interpolate	2D Interpolation
Interpolate (H)	Horizontal Interpolation
Interpolate (V)	Vertical Interpolation
Select All	Select All Cells
Trace Off	Toggle Trace (default on)
Clear Trace	Refresh Grid Colours
Trail Off	Toggle Trail (default off)
Add	Add a specified amount to selected cells
Scale	Apply a specified scaling factor to selected cells
Fill	Copy a specified value to all selected cells

Table 6: Grid View Right Click Menu

Logging

Logging is the key to developing a good map. As an example, to develop an accurate boost profile, logs should be taken of manifold pressure, wastegate duty, throttle position and engine speed. Use the latter two traces to determine where in the boost duty map to adjust the duty value to achieve the required boost.

Collect further logs and repeat this feedback process until the boost profile is as required.

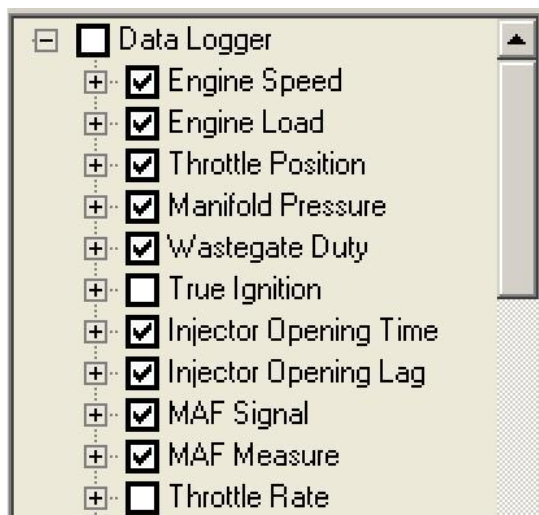


Figure 7: Log Tree

The Log Tree is automatically populated with the logging parameters relevant to the connected ECU. To log a parameter, enter a tick into the adjacent checkbox. To open a watch window, double click on the parameter name. To open an instant log window, expand the tree node and select Graph.

Starting, stopping and saving the log is controlled by the Top level menu and toolbar (page 4).

On Saving, the log is automatically given a name associated with the time it was generated (this may be changed if required). The log is saved in CSV format and can be viewed with any CSV viewer. Ecuteks' Demo DeltaDash is highly recommended and free of charge.

NB. Trace and Trail on grid view depend on the correct parameter being logged to work. (E.g. Engine Speed and Engine Load for the Fuel map).

MAFless Load Basis

To switch between MAP and MAF based load, open "MAFless Only" on the ECU Tree and switch MAFless Enable from 0 to 1. Ensure the engine is off when you make the switch! When mapping MAFless, switch the fuel map values to raw, as there will be an error at Idle and the AFRs will not be correctly represented.

Map Switching

The ESL ECU contains two complete calibrations. These should be treated as two separate ECUs. In order to switch maps, follow these instructions:

97/8:

1. Throttle up, Ignition On.
2. Ignition Off, wait 5 seconds.
3. Throttle down, Ignition On.
4. CEL will flash once or twice at you.

92/6:

1. Throttle up, Ignition On, wait 5 seconds.
2. Ignition Off.
3. Throttle down, Ignition On.
4. CEL will flash once or twice at you.

On switching ECUs, start a New ESL software session.

Parameter Introduction

The parameter maps enable the ESL board to be tuned to specific vehicle requirements. Note that correct map values for one car may be damaging to another car. To offer a complete tuning solution, the software cannot prevent values being entered into a map that can cause damage. In this respect, it is the tuners responsibility to ensure parameter values entered into the map will not cause damage.

Each map can be 1D, 2D or 3D. 1D parameters are single values which are fixed in the software. 2D maps are based on a look up table which is a function of another parameter. 2D map are looked up against a fixed scale. The look up routine uses linear interpolation, i.e. values will be smoothed between entries in the map.

3D maps are a table dependent on two other parameters, specified as "X" (horizontal) and "Y" (vertical) axes. These axes are not fixed, and can be adjusted by the user. The axes do not require uniform spacing, allowing detail to be added where it is required; however, the axes must be monotonically increasing. If the user enters values which are not monotonically increasing, the results of the interpolation may not be correct. As with 2D maps, the entries are linearly interpolated between the axes points, smoothing values between table entries.

2D and 3D maps can display the currently "used" cell in the table by using the trace function. The trace function highlights the nearest cell to the current one being used and does not indicate interpolation between cells. For the trace to operate, it is essential that the axis parameters (one for 2D, two for 3D) are checked on the data logging list, and data logging is switched on. Note some parameters (e.g. coolant temperature) have more than one log parameter, one general value and one for tables. If only one is selected, the correct parameter must be chosen to highlight the current cell.

For systems with twin maps, the majority of maps are duplicated between map 1 and map 2. Note that some sensor and actuator parameters are not duplicated as it is assumed these would not be changed when switching maps. Parameters associated with map switching and some other high level functions (e.g. MAFless enable) are not duplicated.

Most maps are editable. There are some maps which are presented for information only; these are either read-only maps, or volatile maps. Read only maps, such as "Total Ignition", do not exist as a true map in the system, and is generated by combining two maps for tuner convenience, and so is not editable. Volatile maps, such as fuel trims, are internally generated tables from ECU learning. These

parameters are not designed to be modified by the tuner, but are provided to the tuner for information.

Engine Load Calculation, MAF and MAFless operation

The key difference between the MAF and MAFless operation is the computation of the engine load. During normal MAF based operation, the MAF sensor is used to compute the engine load. This is calculated by linearisation using the MAF calibration table, scaling and dividing by the engine speed. The MAP sensor is switched using the Pressure Sources Switch. When not needed and sufficient time has passed since the last measurement, the pressure sources switch uses the MAP sensor to measure barometric pressure. Otherwise, the MAP sensor is used to measure manifold pressure.

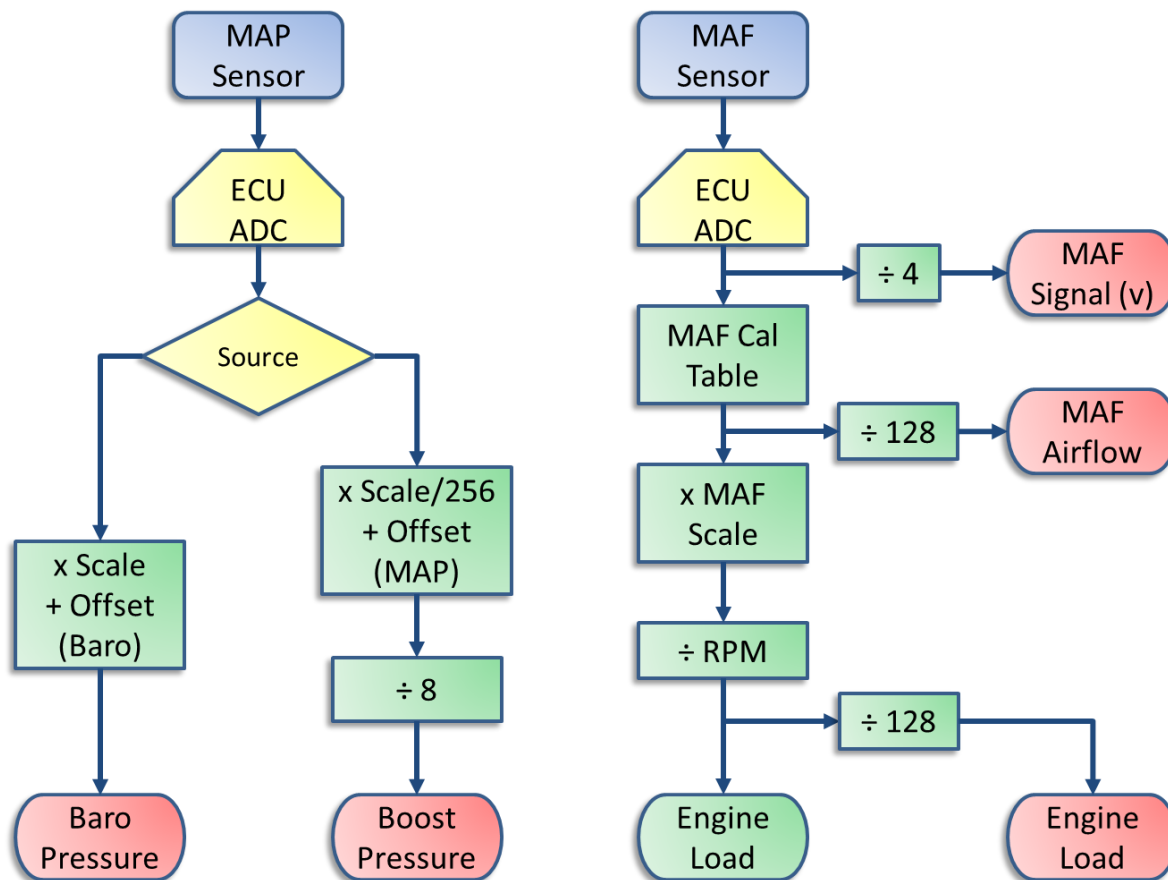


Figure 8 Load Computation - MAF based Operation

In Figure 8, the blue blocks indicate analogue hardware, the yellow blocks 10-bit operations (0-1023), the green block 16-bit operations (0-65535) and the red blocks 8-bit operations (0-255). The square blocks are processing operations and

the blocks with rounded ends are outputs available either as data logging parameters or parameters used elsewhere by the ECU.

The engine load output has an internal unit defined and it is essential that the scaling is made consistent to ensure correct operation of the ECU. The load figure should scale to around 24 units per bar of manifold pressure on a 2-litre engine.

When moving to MAFless operation, the calculations are modified as shown in Figure 9. The MAP sensor is no longer used to measure barometric pressure, as it is required to give continuous readings for engine load, so the barometric pressure calculation is replaced with a constant. The computed 16-bit pressure value is then multiplied by the MAF scale parameter. This must be used to rescale the MAP sensor output to ensure the engine load internal units are a close match to those that would have been generated by the MAF computation.

Note that due to linearity of the pressure sensor and the volumetric efficiency of the engine, at low engine speeds and load the VE is very low and the fuelling table will need significant amounts of fuel taken out of it. This region of the map should not be used to set the MAF scale factor; this should be set based on how the load evolves when VE is much higher and the load figure more representative.

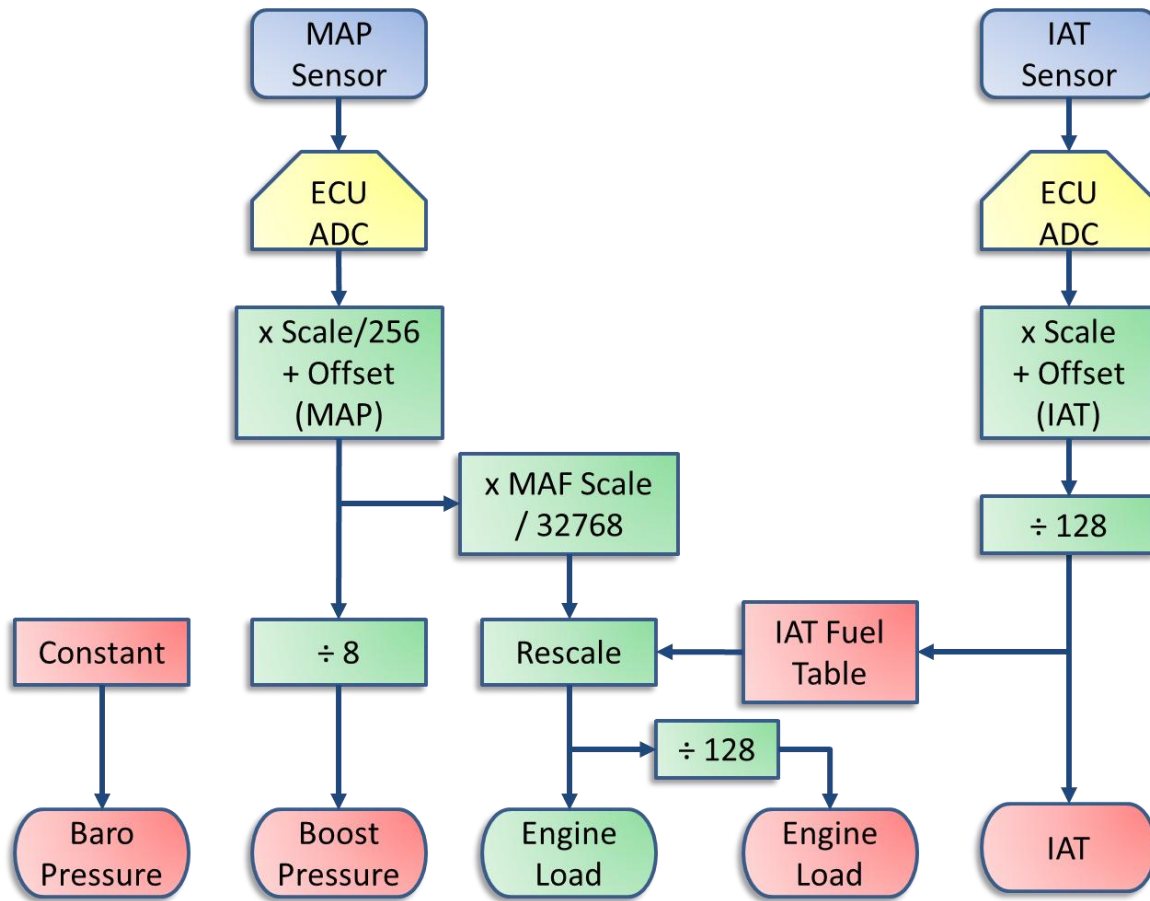


Figure 9 Load Computation - MAFless Operation

Sensor Configuration

MAF Sensor

The MAF sensor input measures a signal from 0 to 5 volts and converts this into an airflow figure (mass of air per unit time). This figure is then converted to mass of air per engine revolution by dividing by the engine speed.

The output of MAF sensors are typically highly non-linear so a 64-element look up table is used to convert from voltage to a linearised mass airflow figure. This table is a 16-bit table of normalised airflow values; the normalisation is defined by setting the maximum desired airflow to the maximum 16-bit value (65535).

Figure 10 shows the standard calibration table for the turbo 2000 MAF. The curve can be seen to clip at high voltages; the table has been normalised to an airflow below the maximum level. To approximate the expected response beyond this, a fifth-order polynomial was fitted to the curve excluding the clipped points. The extrapolated curve is shown in Figure 11.

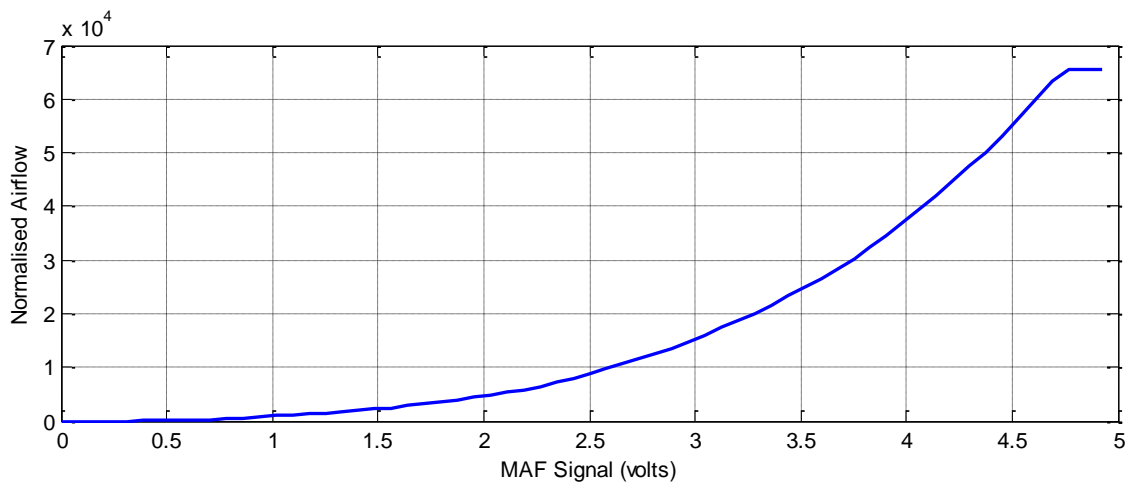


Figure 10 Original MAF Scale

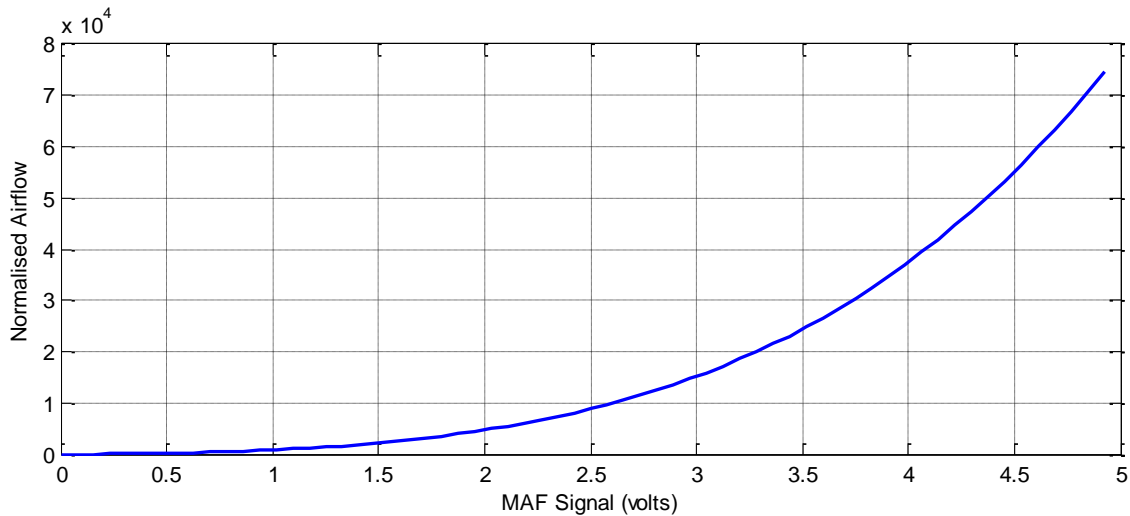


Figure 11 Missing Values Extrapolated by Curve Fitting

The extrapolated curve now extends to a value of 74767, above the maximum value of 65535 that can be stored in the table. To renormalise the curve, every point in the curve is multiplied by a value of $(65535/74767)$ resulting in the graph shown in Figure 12.

However, as seen from the calculations in Figure 8, this change in calibration normalisation must be compensated for. This is achieved by changing the MAF Scale by the reciprocal correction, i.e.

$$\text{New MAF Scale} = \text{Old MAF Scale} \times (74767/65535)$$

In this way, a MAF sensor can be extended to measure a higher airflow level. The modification to the MAF scale will ensure the rescaled calibration curve is converted correctly into load. Alternatively, if a different sensor is required, a calibration can be set up; if a known airflow level can be measured between the two at a single point, the scaling can be computed as well. If not, the scale must be estimated by adjusting the scale until the load figures are computed correctly.

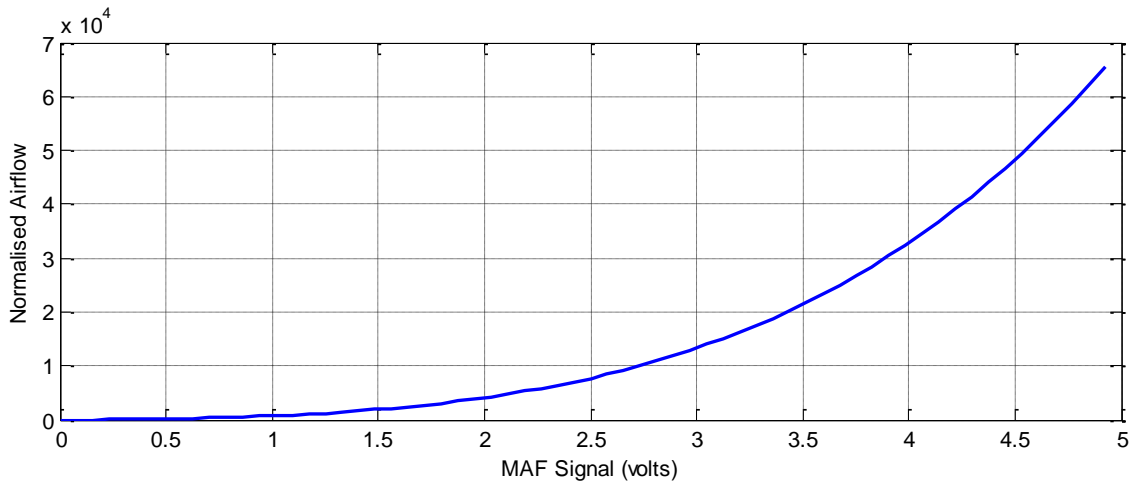


Figure 12 MAF Scale Renormalised

MAP Sensor

The MAP sensor is assumed to have a linear response with pressure, so a simple scale and offset is used to convert from voltage into a pressure reading.

If running a MAF based configuration, both the manifold pressure and barometric pressure scale and offset values will need to be configured. If running the ECU in a MAFless configuration, only the manifold pressure calculations are needed.

The boost sensor gradient can be derived given the specification of the sensitivity of the pressure sensor. Given a sensitivity of S volts per bar, the scale factor should be set to:

$$\text{MAP Gradient} = 1280 / (1.369 \times S)$$

The MAP Offset can then be calculated by the expression

$$\text{MAP Offset} = \text{MAP Gradient} \times C \times 0.8$$

Where C is the voltage of the MAP sensor at absolute vacuum.

IAT Sensor

If MAFless and using an IAT, make sure the MAF is disconnected, and connect a resistive temperature sensor as follows (a 0-5V signal must be delivered down the MAF Signal wire):

1. Wire from 5 volt line on throttle pot (make sure 5 volt line is chosen and not the signal line) to pin 1 of the temp sensor. Do not disconnect the throttle pot 5 volt line from the throttle pot.

2. Wire from pin 2 of temp sensor to MAF signal wire.
3. Connect a 1 k ohm resistor from MAF signal wire to MAF signal ground. (This can be in the engine bay or in the footwell etc.)

Set the parameters as follows (as a guide, fine tuning may be required):

IAT Sensor Gradient: 16724

IAT Sensor Offset: 56

These values are typical for common IAT sensor types with calibrations from approx. 14k ohm at -20 degrees C to around 340 ohm at +100 degrees C.

Parameter List

Fuel

Fuel Map

- Map Type – 3D Editable
- Description – Master fuel map lookup table
- Raw Units – 0-255, 128 “stoichiometric”
- Converted Units – Air-Fuel Ratio, 14.7 “stoichiometric”
- X Axis – Engine Speed (RPM)
- Y Axis – Engine Load (ECU Internal Units)
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

Each entry in the table gives the nominal fuelling correction as a function of engine speed and load. It is important to note this is not a “target” and ideally should be modified to a value which yields the required fuelling as measured by a wideband lambda sensor. The tuner should not expect an entry of 14.7 to necessarily achieve such a value. This is particularly true when running in MAFless mode, as there is no separate Volumetric Efficiency table, the fuelling value must account for the breathing efficiency of the engine at the specified table location.

Note that the fuelling achieved is modified by the closed loop lambda sensing. Where possible, this should be monitored to ensure it is close to nominal (no correction) or, where available, tested with closed loop fuelling disabled.

Injector Scale

- Map Type – 1D Editable
- Description – Fuelling correction for injector size
- Raw Units – 0-32768, 32768 nominal
- Converted Units – no units, ratio (1=standard injector size)
- Available on – All ESL Systems
- Twin Map Support – No, actuator, use per map fuel scaling

Mapping Notes

This parameter is used to correct for the selected injector size. The value defaults to 1.0 for the standard car injectors. The ratio entered should be lower for larger

injectors, e.g. for injectors that can supply 25% greater volume of fuel over standard, a ratio of $(1/1.25) = 0.8$ should be entered. Note this parameter should ideally not be set to a value greater than 1 (although it is allowed).

Per Map Fuel Scale

- Map Type – 1D Editable
- Description – Fuelling correction for injector size
- Raw Units – 0-65535, 32768 nominal
- Converted Units – no units, ratio (1=standard fuelling)
- Available on – All ESL Systems with twin maps
- Twin Map Support – Yes

Mapping Notes

This parameter is designed to be used to rescale maps when a fuel with a different stoichiometric ratio on each map is required (e.g. petrol vs. methanol maps). A value of greater than 1 implies more fuel is required to achieve stoichiometry; less than one if less fuel is required. To maintain resolution and accuracy, this parameter should be limited to values in the range 0.5 to 1.99.

Re Injection

- Map Type – 2D Editable
- Description – Engine speed at which injectors are enabled on the overrun to prevent stall
- Raw Units – 0-255, engine speed/25
- Converted Units – RPM, 0-6375
- Fixed Axis – Coolant Temperature for Tables
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

During the overrun, to improve fuel economy, the ECU normally cuts fuel to the cylinders. This is then switched on again as the engine slows to prevent stall; this table describes the engine speed at which the injectors are re-enabled. High values in this table can result in small amounts of unburnt fuel entering the exhaust causing “pops” and “bangs” in the exhaust off throttle.

If the trace is used to monitor the currently used cell by the ECU, make sure that “coolant temperature for tables” is checked rather than just “coolant temperature”, or the trace will not operate.

Fuel Trim

- Map Type – 3D Read only, volatile
- Description – Learned fuel correction table
- Raw Units – 0-255, 128 no correction
- Converted Units –Ratio, 1.0 no correction
- X Axis – Engine Speed (RPM)
- Y Axis – Engine Load (ECU Internal Units)
- Available on – All ESL Systems
- Twin Map Support – No (N/A – learned data)

Mapping Notes

The fuel trim describes the 3D fine fuelling correction “learned” by the ECU from the lambda sensor readings. This table cannot be written to by the user, and lives in volatile (RAM) memory in the processor. Performing an ECU reset will reset the table back to nominal values (1.0). By default, the software will display the last read values in this table, which may differ from the current values. To see the current values, press the “refresh” button on the map toolbar. This will trigger the ECU to read the latest values.

Closed Loop Fuel Disable

- Map Type – 1D Editable
- Description – Disables closed loop fuelling and forces fuelling corrections to nominal
- Raw Units – 0-1, 0 default (enabled)
- Converted Units – N/A
- Available on – ESL 97/98 Systems
- Twin Map Support – Yes

Mapping Notes

The closed loop fuelling disable allows the mapper to check the sensor scaling and fuelling of the car without interference from the closed loop fuel control. This helps to enable sensor and actuator scales to be accurately set. This is not designed for general running of the vehicle. A value of “0” indicates closed loop fuelling enabled, a value of “1” disables closed loop fuelling. No other value should be entered into this parameter.

Note that when disabled, the check engine light may illuminate to indicate a lambda sensor fault.

Ignition

Ignition Base

- Map Type – 3D Editable
- Description – Master ignition lookup table
- Raw Units – 0-45 degrees advance
- Converted Units – 0-45 degrees advance before Top Dead Centre (TDC)
- X Axis – Engine Speed (RPM)
- Y Axis – Engine Load (ECU Internal Units)
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

The base ignition map defines the basis of the ignition timing. It is used in combination with the ignition advance map to determine the total ignition advance. The equation used to compute the total ignition advance is:

$$\text{Total Ignition Advance} = \text{Ignition Base Map} + \text{IAM} * \text{Ignition Advance Map} / 16$$

Ignition advance is constrained by the ECU under normal operation to being between 0 and 45 degrees BTDC after summation, although values outside of this range can be entered into the map. Note the ignition base map should represent the ignition map that would be used with a poor quality fuel. This is essential to ensure correct operation of the closed loop knock control.

The axes defined in this map are common across all ignition maps; changing the axis values in one map will automatically change the axis for the other ignition maps in harmony.

Ignition Advance

- Map Type – 3D Editable
- Description – Ignition advance lookup table
- Raw Units – 0-45 degrees advance
- Converted Units – 0-45 degrees advance before Top Dead Centre (TDC)
- X Axis – Engine Speed (RPM)
- Y Axis – Engine Load (ECU Internal Units)
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

The ignition advance map is added to the ignition base map to give the total ignition advance. The combined maps should give the ignition advance for the nominal fuel used for that map. See ignition base map for more information.

Total Ignition

- Map Type – 3D Read only
- Description – Ignition advance lookup table
- Raw Units – 0-45 degrees advance
- Converted Units – 0-45 degrees advance before Top Dead Centre (TDC)
- X Axis – Engine Speed (RPM)
- Y Axis – Engine Load (ECU Internal Units)
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

This map is not a true system map, but a combination of the ignition base and advance maps. As such it is read only and cannot be directly edited. Changes to this map should be made via the ignition base or advance maps directly. The map will automatically update to reflect any changes as they are written to the ECU.

Boost

Boost Target

- Map Type – 3D Editable
- Description – Boost target look up table
- Raw Units – 0-255, 0 = vacuum
- Converted Units – -1 (vacuum) to +1.73 Bar relative to sea level atmospheric pressure
- X Axis – Engine Speed (RPM)
- Y Axis – Throttle (% , 0 closed)
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

The target boost pressure, in bar relative to atmosphere, used by the closed loop boost controller.

In principle, this should be sufficient to enable the closed loop boost controller to achieve the desired boost, but in practice it will not. The “Duty” map limits the maximum boost solenoid duty cycle. This tends to have a far greater effect on the peak boost than the boost target! The values in this map should be carefully raised until the desired boost level is met.

The converted range of this map can be adjusted to enable control beyond the upper limit of 1.73 bar, using alternative pressure sensors. Please contact ESL for more information.

Maximum Boost Duty

- Map Type – 3D Editable
- Description – Wastegate solenoid duty maximum value
- Raw Units – 0-255
- Converted Units – 0-100%
- X Axis – Engine Speed (RPM)
- Y Axis – Throttle (% , 0 closed)
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

The map gives the maximum boost solenoid duty cycle (0 = actuator pressure only). This restricts the closed loop control loop of the wastegate solenoid duty cycle and is the most important factor in controlling maximum boost levels.

Minimum Boost Duty

- Map Type – 3D Editable (97/98), 1D Editable (92/96)
- Description – Wastegate solenoid duty minimum value
- Raw Units – 0-255
- Converted Units – 0-100%
- X Axis – Engine Speed (RPM)
- Y Axis – Throttle (% , 0 closed)
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

This parameter defines the minimum value the wastegate solenoid duty cycle can be set to. Raising this can improve the response time of the closed loop boost control, but can also lead to creeping boost at partial throttle opening. This is a single parameter on early cars, but a complete map for later cars.

MAP Sensor Parameters

- Map Type – 1D Editable collection
- Description – Scaling parameters to convert MAP sensor voltage to pressure
- Raw Units – 0-65535
- Converted Units – varies (see table)
- Available on – All ESL Systems
- Twin Map Support – No (sensor parameter)

Mapping Notes

MAP Scaling factors and offsets are a series of parameters used by the ECU to calibrate the MAP sensor voltages and convert to pressure readings. Different scales are used when barometric pressure is measured, compared to the boost pressure measurement. The 92-96 MAP sensor reads to approximately 1.26 bar at maximum voltage. The 97/98 MAP sensor reads to approximately 1.86 bar at full scale (although the software “clips” this to 1.7 bar). The parameters required for these two sensors are listed in the table below.

Parameter	92-96 Sensor	97-98 Sensor
MAP Sensor Boost Gradient	500	643
MAP Sensor Boost Offset	300	414
MAP Sensor Baro Gradient	42666	54857
MAP Sensor Baro Offset	469	542
MAP Sensor Baro SSM Gradient	16000	12380
MAP Sensor Baro SSM Offset	38	52

When MAFless operation is enabled, only Boost Scale and Offset are used by the ECU, and a fixed barometric setting is applied.

Boost Limit

- Map Type – 2D Editable
- Description – Boost level at which overboost fuel cut occurs
- Raw Units – 0-255, vacuum = 0
- Converted Units – Bar relative to sea level atmospheric pressure, -1 (vacuum) to +1.73
- Fixed Axis – Barometric Pressure for Tables
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

The boost limit specifies the value at which the ECU cuts fuel to protect the engine. The values are indexed by barometric pressure. When mafless operation is enabled, the value in the right most cell in the table determines boost cut.

Knock

Knock Control

- Map Type – 3D Read only, volatile
- Description – Knock control learned ignition correction data
- Raw Units – -128 to +127 in quarter degree steps
- Converted Units – -32 to +32 degrees advance
- X Axis – Engine Speed (RPM)
- Y Axis – Engine Load (ECU Internal Units)
- Available on – All ESL Systems
- Twin Map Support – No (N/A – learned data)

Mapping Notes

Fine control map: 8x8 grid based on RPM and engine load, giving the number of degrees of correction for that zone on the map. Correction can be positive (advance) or negative (retard). The correction values are continually adjusted to ensure they do not exceed the bounds defined by the ignition base map (lower bound) and total ignition (upper bound). If values in this map become too large, the IAM is reset and the correct IAM is recovered by a search process.

Note the values in this table are generated by the ECU and are not designed to be edited by the mapper. Also, the map displayed reflect the last values read and may not be the current values used. The current values can be obtained by pressing the refresh button on the toolbar.

IAM

- Map Type – 1D Read only, volatile
- Description – Ignition advance multiplier, fuel octane rating estimator
- Raw Units – 0-16
- Converted Units – 0-16, 0 – lowest octane, 16 – highest octane
- Available on – All ESL Systems
- Twin Map Support – No (N/A – learned data)

The IAM is the Ignition Advance Multiplier, defining the number of sixteenths of the ignition advance map added to the base ignition map to give the total ignition advance. Note that for low values of the IAM, the ECU might modify fuelling and boost of the car. (Typically fuelling is modified for IAM < 7, and boost for IAM < 2)

Note the value of this parameter is generated by the ECU and is not designed to be edited by the mapper. Also, the map displayed reflect the last values read and may

not be the current value used. The current values can be obtained by pressing the refresh button on the toolbar or by actively data logging the IAM.

IAM Control

- Map Type – 1D Editable collection
- Description – Closed loop knock control search parameters
- Raw Units – 0-255
- Converted Units – no units
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

The IAM control parameters are used to define the operation of the IAM search phase. When the learned data is reset, or the closed loop ignition correction becomes large, the IAM is reset to the value defined in this table (which should lie between 0 and 16, ideally between 8 and 12). Under high load conditions, any knock is used to revise the value of the IAM until a stable value is reached. The ECU determines “high load conditions” from the amount of ignition advance specified in the ignition advance map. If this is greater than the threshold specified in this table, then the opportunity is taken to “learn” the IAM. Note if the threshold is greater than any value in the ignition advance map, the IAM will never “learn” its correct value and the closed loop knock control will not operate.

Sensors

MAF Sensor Scale

- Map Type – 1D Editable
- Description – Scaling factor to convert linearised MAF readings to airflow
- Raw Units – 0-65535
- Converted Units – N/A
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

The MAF sensor scale is applied differently depending on whether the ECU is configured for mapping using a MAF based load, or a MAP based load (“mafless”).

For MAF based operation, the MAF scale is effectively defines the full scale deflection (FSD) of the normalised calibration curve.

For MAFless operation, the MAF sensor scale is used to rescale the pressure output to produce a surrogate engine load figure. The engine load figure should be rescaled to ensure the range of values used is consistent with internal ECU units.

For more information on configuring the MAF and MAP sensor, see the MAF and MAP sensor calculation section of this document.

MAF Calibration

- Map Type – 2D Editable
- Description – Normalised calibration curve for the MAF sensor
- Raw Units – 0-65535, air flow, normalised to FSD at 65535
- Converted Units – as raw
- Fixed Axis – MAF sensor signal in volts
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

The MAF calibration curve is only used in MAF based load mode. As MAF the output is not linearly proportional to airflow, this look up table is used to linearise the output of the MAF sensor to produce a figure directly proportional to mass airflow.

The curve is normalised to a nominal mass airflow maximum, represented by 65535 in the table. Since values above this cannot be represented, the curve is clipped above this level. If the MAF voltage exceeds the point at which the curve levels off

to 65535, engine load will be underestimated and the car will begin to lean the air/fuel mixture.

The curve can be renormalised if additional headroom is available for the MAF sensor. For example, if the curve is initially normalised to 300g/s mass airflow, but the sensor is capable of reading up to 450g/s, the values below 65535 can be rescaled by a factor of (300/450); the curve extrapolated to higher values. The MAF scale, which converts values back to airflow, should be rescaled by (450/300) to retain consistent computation of the airflow values.

MAF / MAP Blending

- Map Type – 2D Editable
- Description – Percentage of MAF or MAP sensor data used to compute engine load
- Raw Units – 0-255, percentage of MAP sensor data used
- Converted Units – as raw
- Fixed Axis – Engine speed (2400–5400 rpm in 200rpm steps)
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

The ECU can use a mixture of MAF and MAP sensor output to produce engine load. This calculation is only applied under a limited set of conditions; it is dependent on coolant temperature and the length of time the ECU has been switched on. These conditions effectively disable the table on Imprezas, but the table is used on Legacy models.

As the ESL boards are delivered with standard maps, the map is populated and used on Legacy models to ensure the vehicle behaves exactly as designed by the factory prior to mapping. If the standard sensors are being used in MAF mode, this feature can be retained, even if the MAF calibration is changed. If either the MAF or MAP sensors are changed for non-standard items, or the car is operated in MAFless mode, it is recommended that this table be effectively disabled by setting all entries to zero. A value of zero in MAF mode uses MAF only; in MAFless mode it uses the surrogate engine load only.

Limits

Engine Speed Limit

- Map Type – 1D Editable collection
- Description – Engine speed limiter
- Raw Units – 0-65535, 120x106/RPM
- Converted Units – RPM
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

The engine speed limiter is a staged fuel cut triggered by a sequence of engine speeds. The order of the fuel cuts must be retained, as they are chosen to provide some hysteresis in the fuel cut and prevent on/off oscillation of the cut that could lead to detonation or unexpected behaviour.

For the impreza, five engine speeds are listed, engine speeds 1-4 should be increasing, with engine speed 5 being the lowest (this being the speed at which the limiter is “switched off” as the engine speed drops)

Vehicle Speed Limit

- Map Type – 1D Editable collection
- Description – Vehicle speed limiter
- Raw Units – 0-255, $\sqrt{2}$ in km/h
- Converted Units – MPH
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

The vehicle speed limit applies a staged fuel cut to prevent the vehicle from exceeding a factory defined speed. This should be disabled unless it is required for a specific purpose (e.g. valet mode).

Load Limit

- Map Type – 2D Editable
- Description – Maximum engine load as a function of engine speed
- Raw Units – 0-255, internal ECU units
- Converted Units – 0-127.5, mapped to be consistent with the load axis of fuel/ignition tables

- Fixed Axis – Engine speed (0-6400 rpm)
- Available on – All ESL Systems
- Twin Map Support – Yes

Mapping Notes

The load limit is applied as a cap to the engine load at a given engine speed. Considerable care is required when setting this value up; if the engine load exceeds the level indicated, it is clipped to the value in this table. This will cause the engine to lean out at high airflow or boost levels.

Although it might be tempting to maximise the values in this table, this can cause unexpected problems. When there is no airflow over the MAF sensor, it reads a very high value. The load cap in the first two cells is important for defining the correct fuelling at start up.

Boost Limit

See boost limit in the Boost section.

MAFLess

MAFLess Enable

- Map Type – 1D Editable
- Description – Selects method for computing engine load
- Raw Units – 0-1, 0 default (disabled)
- Converted Units – N/A
- Available on – All 97/98 Systems, v2 92-96 boards
- Twin Map Support – No, a single value controls both maps

Mapping Notes

This parameter is used to select MAF or MAP based operation. Early versions of the software used either 0 (MAF) or 1 (MAP) to select, later versions use a drop-down list to choose from.

DO NOT CHANGE THIS PARAMETER WHILE THE ENGINE IS RUNNING

The maps required to operate the car in MAF or MAP based operation are quite different, and the other maps must be set up properly. If the engine is running when the load calculation is changed, it will most likely stall or respond unexpectedly.

IAT Sensor Parameters

- Map Type – 1D Editable collection
- Description – Scaling parameters to convert MAP sensor voltage to pressure
- Raw Units – 0-65535
- Converted Units – as raw
- Available on – All ESL Systems
- Twin Map Support – No (sensor parameter)

Mapping Notes

The IAT sensor parameters define the scale and offset applied to convert the measured voltage from the IAT sensor into a temperature value. The IAT value is only computed in MAFLess mode, and can be used to correct the engine load for air density and retard ignition.

For a sensor set up as described in configuring IAT sensors, an IAT sensor gradient of 16724 and scale of 56 should give a good first approximation for intake temperature.

IAT Ignition Retard

- Map Type – 2D Editable
- Description – Ignition retard as a function of Intake Temperature
- Raw Units – 0-255, degrees retard
- Converted Units – as raw
- Fixed Axis – Intake Air Temperature (-28 to +100 deg C)
- Available on – All 97/98 ESL Systems, v2 92-96 Systems
- Twin Map Support – Yes

Mapping Notes

This map is only used in MAFless mode, and provides additional protection by allowing the tuner to retard ignition at extreme temperatures. The table contains all positive values and only allows ignition retard.

IAT Fuel Enrichment

- Map Type – 2D Editable
- Description – Load Correction as a function of Intake Temperature
- Raw Units – 0-255, 128=no correction
- Converted Units – 0-2.0, 1=no correction
- Fixed Axis – Intake Air Temperature (-28 to +100 deg C)
- Available on – All 97/98 ESL Systems, v2 92-96 Systems
- Twin Map Support – Yes

Mapping Notes

This map is only used in MAFless mode, and provides a scaled correction to the engine load calculation to correct for the density of air entering the engine. As a scaling factor, values less than one indicate less dense air, greater than one indicate more dense air.

CEL

Length of CEL Pulse on Map Switch

- Map Type – 1D Editable
- Description – Length of the CEL flash on switching maps
- Raw Units – 1-255
- Converted Units – seconds
- Available on – All 97/98 Systems, v2 92-96 boards
- Twin Map Support – No (map switching parameter)

Mapping Notes

The length of the CEL flashes when switching maps.

SSM Error Table

- Map Type – Collection, read only, volatile
- Description – Current and historic error codes
- Available on – All 97/98 Systems, v2 92-96 boards
- Twin Map Support – No (learned data parameter)

Mapping Notes

The SSM error table allows the user to view the current and historic fault codes logged on the ECU. The historic errors codes can be cleared by pressing the “clear” button, although note any current codes will immediately reappear in the historic code list. The currently active codes cannot be cleared; the fault causing the code must be rectified to clear the code.

Map Switching Parameters

Current Map

- Map Type – 1D Read Only
- Description – Index of the selected map
- Raw Units – 0-1
- Converted Units – 1-2
- Available on – All 97/98 Systems, v2 92-96 boards
- Twin Map Support – No (map switching parameter)

Mapping Notes

This parameter may not reflect the current map, but the map at the time the parameter was read. Refresh is not currently supported by the software for this parameter.

Map Switch Enable

- Map Type – 1D Editable
- Description – Enable / Disable map switching
- Raw Units – 0-1
- Converted Units – 0-1
- Available on – All 97/98 Systems, v2 92-96 boards
- Twin Map Support – No (map switching parameter)

Mapping Notes

Enables or disables twin map switching. Default value is 1 (enabled), but setting to 0 disables the user map switching mechanism.

Reset On Map Switch

- Map Type – 1D Editable
- Description – Force learned data reset on map switch
- Raw Units – 0-1
- Converted Units – 0-1
- Available on – All 97/98 Systems, v2 92-96 boards
- Twin Map Support – No (map switching parameter)

Mapping Notes

This feature allows the learned data in the ECU to be reset on a map switch (default is 1, enabled). This feature should be enabled depending on how the twin maps are to be used. If the maps are used for very different fuel or ignition configurations,

the learned data may not read across between maps and in this case it would be appropriate to reset and force a relearning of the ECU data. If the fuel and ignition maps are identical there is no requirement to relearn on switching. Some users may appreciate the ability to reset their learned data easily even if the second map is not used.

Length of CEL Pulse on Map Switch

See entry in CEL section.

MAP Switch TP Thresholds

- Map Type – 1D Editable Collection
- Description – Throttle thresholds for map switching
- Raw Units – Varies
- Converted Units – Throttle ratio (0 closed, 1 open)
- Available on – All 97/98 Systems, v2 92-96 boards
- Twin Map Support – No (map switching parameter)

Mapping Notes

These parameters define the throttle position thresholds used to determine whether the maps should be switched at start up. Care should be taken when choosing these; some settings can result in the map switching every time the ignition is turned on.

It has been observed that some cars take a while for the throttle signal to reach its nominal level on power up, so two thresholds were included; the first threshold causes a short delay followed by the application of the second higher threshold. Both thresholds must be passed to cause the map switch.