Enduring Solutions

ESL Live Remapping / Flash Memory Board
For 92-96 Subaru Impreza Turbo 2000 / WRX / STi

Test and Evaluation Prototypes

The board and serial link provided are for tuners to test and evaluate the latest tuning aid for early model Subaru Imprezas. Please read the following notes carefully before use!

You should find enclosed:

- 1x Prototype ECU Daughterboard and socket
- 1x CD-ROM containing mapping software and help files
- 1x USB to Select Monitor serial comms link

All of these items are on loan to you, the tuner, and remain the property of Enduring Solutions Limited. We reserve the right to recall these items at any time, with the exception of the IC socket (we wouldn't expect you to desolder this and send it back!)

If you choose to map a customer's car with one of these prototype devices, the customer must be made aware of the fact that this is a prototype version and may still have some bugs, and that at some stage the board will be recalled. Of course, in this situation, we will aim to supply the customer an alternative daughterboard (either using fixed ROMs or a full production Flash board). The customer would be expected to pay for this (a discount may be negotiable)

Whilst we have made every effort to provide examples reasonably close to the end product, the boards and software provided are prototypes and may still have some undiscovered bugs. With this in mind, we recommend the following:

Take great care when live mapping on public roads. The protocol has been designed to be robust, but an erroneous write command could result in the engine stalling and not restarting. It is the responsibility of the mapper to ensure the driver is aware of this risk, and map updates are written at times when an engine stall would not result in a serious accident.

If the software does result in the ECU being unable to run the engine, rejoin the J1 link in the ECU which should enable the car to be driven safely off boost. If the vehicle has substantially larger injectors or a non-standard MAF sensor, the vehicle may not drive with the standard ECU settings.

SOFTWARE INSTALLATION

There are 2 stages to the software installation, the mapping software and the serial port driver. The serial port driver can be installed without needing to be connected to the car.

- Start your computer and log in as a user with installation privileges.
- Plug the USB cable into a spare USB socket on your computer.
- Your computer may already have the drivers in place; if so, it should recognise and install the serial port automatically.
- If not, you will need to select a driver. Insert the provided CD-ROM into the computers CD drive. At the prompt, request Windows installs from a specific location. Browse to the CD-Drive, and select the folder appropriate to your operating system under "SerialPortDriver". (Note x64 is for 64-bit platforms)

To confirm the system can "see" the serial port, select "Settings", "Control Panel" from the Start menu. Double click on "System", the click the "Hardware" tab, and "Device Manager". In the "Device Manager" window, open the list "Ports (COM & LPT)". The new serial port should be visible under here.

If required, more detailed instructions can be found in a Word document under the "SerialPortDriver" folder.

The second stage is to install the mapping software. This is simply a case of installing the software at www.enduringsolutions.co.uk/software to a suitable location on your computer. Copy esl_live5a.exe and Serialdll.dll into the same location (change the extension from the 'xex' it ships with to get through mail filters).

To run the software, open the folder containing the new copy of the software in Windows Explorer, and double-click on the file "esl_live5a.exe". (To simplify this process in the future, you can right-click on the esl_live.exe file, and select "Create Shortcut". This shortcut can be copied somewhere convenient, such as the desktop, for future use).

A command window should appear, with a copyright notice, and shortly afterwards, the main application window should appear. Do not close the command window – it will force the application window to close without warning, causing loss of any data or changes since the last save or write.

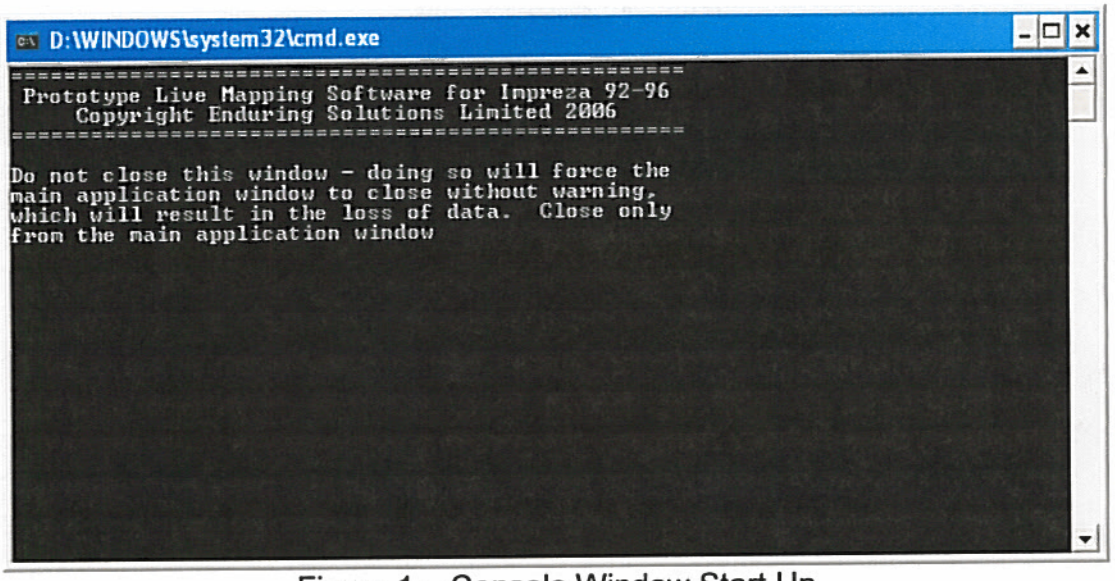


Figure 1 – Console Window Start Up

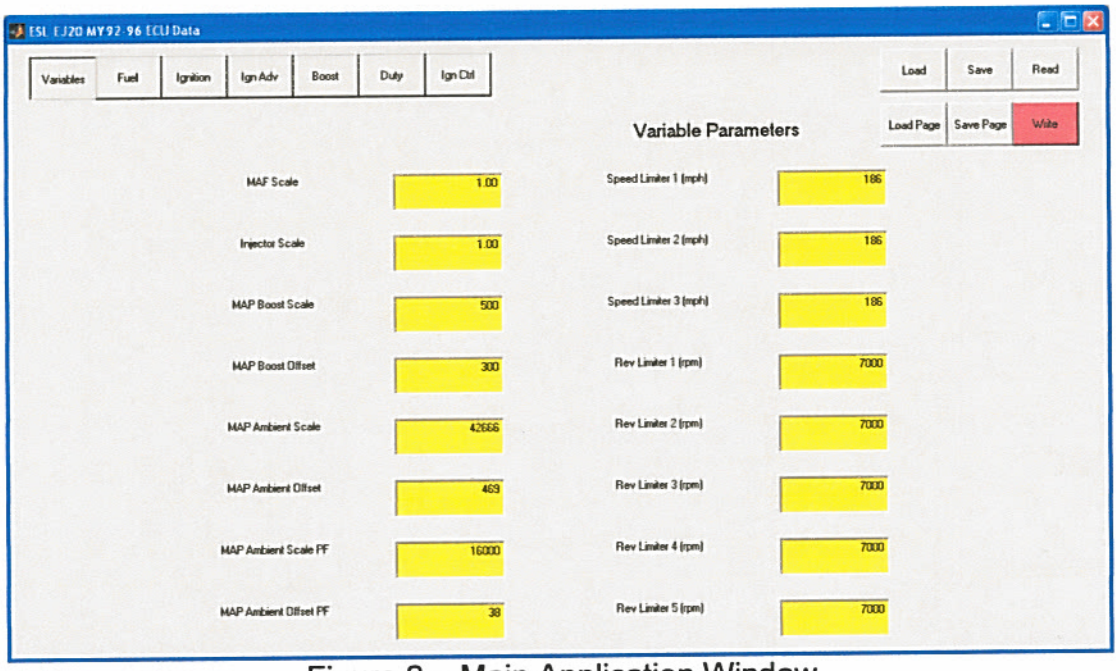


Figure 2 – Main Application Window

Current Software Limits and Bugs

The hardware and software provided are close to what we expect the final product to be like, but there are a few issues (particularly with the software) which are yet to be resolved. There are probably one or two more we haven't stumbled across yet as well!

Generally, the software should be quite stable, the most likely area to hit bugs will be in the communications protocol. Generally, protocol problems will only cause the PC software to fail, and is not likely to cause any problems with the car running.

Any "hitch" in the communications – such as a cable becoming disconnected during communication, or an error on the serial link, should result in the software identifying the error and informing the user. I have had one or two cases where the software locks up (because the fault is not correctly detected by the PC software).

While the communications link is active, the user is prevented from carrying out additional actions until the communications are finished (or when logging, the trace is stopped). There remain a few ways in which the user can interrupt communications, which can cause the software problems. These include – moving or resizing a window whilst communications are in progress, or bringing up a menu (e.g. right-click menus or the drop-down menu on the window icon in the top right corner). Closing the progress bar window can also allow the user to do things that should be blocked.

There is currently no warning or check on the "Write" command – which uploads the current map on the PC to the car – to ensure the user did intend to carry out that action. For example, when the software first loads up, the map is not initialised to "sensible" defaults; pressing write from the beginning will result in the entire map being transferred to the car. The only way to stop this is to close the application, or disconnect the cable!

Communication times at the moment are reasonable for the complete map download (from car to PC) and for small, incremental writes. Substantial map changes, at present, take quite a long time. The final software version should be quicker (hopefully by a factor of approx. 3x when writing). At present, the software would take the best part of 15-20 minutes to upload a complete map, so this is worth avoiding! It takes just under 2 minutes to download the map, and once the map is downloaded, the PC only writes what has changed, making the operation much quicker.

Some parts of the data stored in the software represent one single location in the ECU memory, but are held more than once in the software. An example of this is the load and rpm scales in the ignition maps. In the ECU, these are just one location and are always the same. The current version of the software allows the user to modify these such that they are different in the

ignition and ignition advance maps. The user should take care with the prototype software to ensure these two scales are always modified at the same time, to give the same reading.

Hardware Installation

In order to install the Ecu upgrade, please perform the following steps:

a. Disconnect the battery. Remove any aftermarket boost control devices from the car.

b. Remove the kickplate from beneath the carpet in the passenger footwell, exposing the ECU.

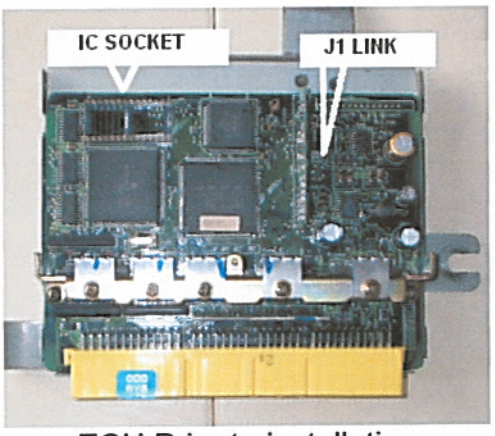
c. Disconnect the 4 plugs from the ECU. A wide flat bladed screwdriver may be used to ease the connectors out if they are stiff.

d. Remove the 3 nuts which hold the ECU in position. Withdraw the ECU.

e. With a fine tipped Philips screwdriver remove the 6 brass screws from the ECU top cover. NB. If the ECU has not been opened before they will have threadlock on them and can be difficult to turn. Care is required so as not to strip the screwhead.

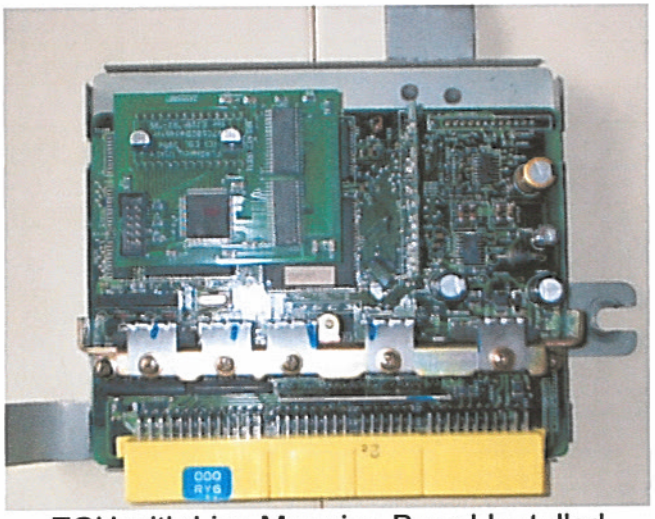
f. Remove the ECU cover.

g. You should now be able to see the spare IC socket on the ECU board. If there is no socket present, solder the IC socket included with the kit into the 2 lines of 14 solder dots in the motherboard. We recommend using an electrical repair shop to do this for a small fee if you do not have soldering experience.



ECU Prior to installation
(NB J1 has already been removed in this picture)

h. Plug the ECU adapter into the socket and ensure all pins are properly located and the fit is tight to the socket.



ECU with Live Mapping Board Installed

i. Cut the 'Brown' vertically mounted resistor labelled 'J1'. DO NOT cut the resistor labelled 'L1'.

j. Refit the ECU lid and ECU to the car.

k. Re-connect the Car Battery and start the vehicle to ensure correct running.

l. Perform an ECU reset as detailed below. (NB: the ecu resets itself if it has been disconnected from the car battery for a few hours)

ECU Reset

a. With engine at operating temperature, turn ignition off. Place gear shift lever into park (auto transmission cars only).

b. Locate the two ECU check connectors, for most cars they are located under the steering column and consist of a black plastic male and female connector, and a green male female connector. The exact location of the connectors varies with the different year models, but generally they are located under the steering column on the drivers side.
NB. sometimes they are still taped over with some small amount of plastic tape.

c. With the ignition OFF connect black to black and green to green.

d. Turn on ignition, do not start the engine, (and for auto transmission, cycle the gearshift lever from park to neutral and back to park), depress the accelerator pedal to full throttle and hold for a few seconds, and then release.

e. Start engine and then drive for at least one minute, keeping road speed above 11 Km/h.

f. At this point the check engine light should start to flash the all clear signal (steady 1/2 second interval flashes). If the check engine light does not flash,

or indicates some other sequence, there is a fault present in the system. Refer to the section below for reading fault codes.

g. Stop the car and turn off the engine.

h. Disconnect the plugs.

Fault Codes

This won't be caused by the upgrade but is a handy check if you have a sensor failure. Follow the procedure detailed below:

Turn ignition OFF and connect black connectors under steering column.

Turn ignition ON (Engine OFF); Engine Check lamp turns on.

Any codes are indicated by a flashing lamp.

If Code is OK then Turn ignition OFF & Disconnect Connectors.

Turn ignition OFF & Disconnect Connectors. If there is a fault code check in the table below to see which sensor the code relates to.

Reading the code: The long pulses (1.3 Seconds) indicate Tens and the short pulses (0.2 Seconds) indicate ones. Pulses are separated by Short Pauses (0.2 Seconds), multiple codes are separated by a Long Pause (1.8 Seconds). The codes are cycled.

11 Crankshaft position sensor
12 Starter switch
13 Camshaft position sensor
21 Engine coolant temperature sensor
22 Knock sensor
23 Mass air flow sensor
24 Idle air control solenoid
31 Throttle position sensor
32 Oxygen sensor
33 Vehicle speed sensor
35 Purge control solenoid valve
42 Idle switch
44 Wastegate control solenoid valve
45 Pressure sensor
51 Neutral position switch

Mapping with the Software

This is a short outline of how the software was designed to operate.

HEALTH AND SAFETY WARNING – take great care when mapping cars on the public highway. Whilst care has been taken to ensure the mapping protocol is robust, it is possible for a write error to change the ECU data in such a way that the engine stalls and cannot be restarted. The mapper should take care to only write to the ECU at times when a sudden loss of power (or change in engine behaviour) would not result in a collision.

Setting Up

Plug the Serial Port Cable into the Subaru Select Monitor port at one end, and the USB connection on your computer. The Subaru Select Monitor port can be found under the dashboard, close to the steering column. It is a yellow 9-pin socket. The serial port cable hangs down from this close to the pedal box, which may tangle with the drivers feet; we recommend using a cable tie or similar to hold the cable away from the pedals.

Start the software. You should see the windows in Figure 2 appear. Ensure the car has its' ignition switched ON, with the key in position 2. The first task when mapping should be to download the current maps on the car. This typically takes around 100 seconds (a progress bar will appear). During this time, the engine can be started, or the car driven, but the ignition must not be switched to the "OFF" position or the download will fail.

To download the map data, press the "Read" button in the top left corner of the window. If this is the first time the serial communications has been accessed during this session, the software will prompt you to select which serial port the car is connected. Select the appropriate port from the drop-down box, then press OK. The software will then send some test signals to determine whether the ecu is responding; if it is, the map data will be downloaded.

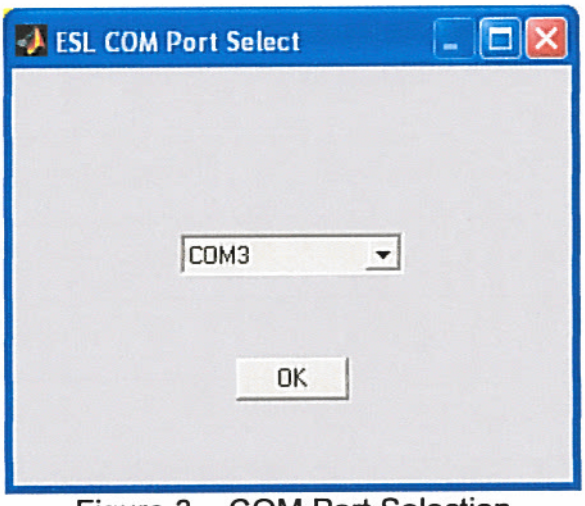


Figure 3 – COM Port Selection

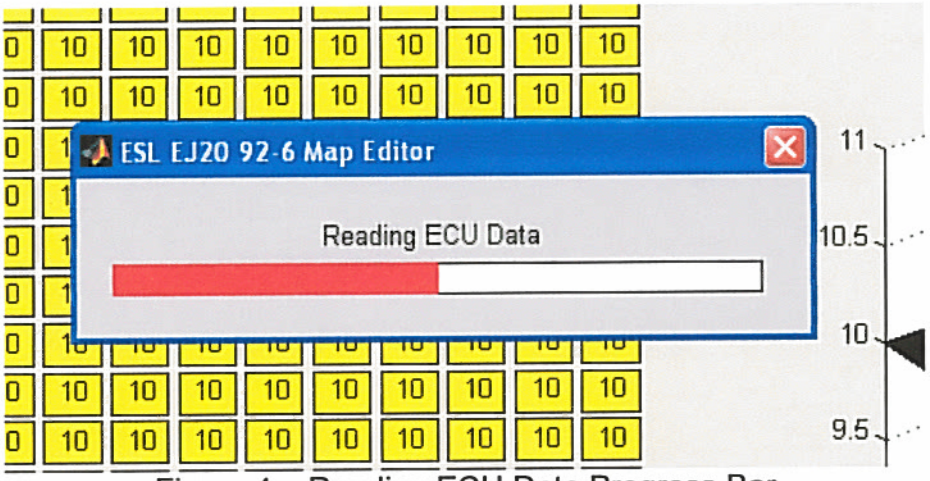


Figure 4 – Reading ECU Data Progress Bar

Once the data on the map is downloaded, the boxes containing the ECU settings will change to white, indicating that they are synchronised with the car. Note: the boards arrive pre-loaded with the Z4 map, which has been modified to remove the speed limiter. This map is suitable for vehicles with TD05 equipped vehicles with standard engine, sensors etc.

TIP: If you have a previously saved file, from another mapping session of a car with a similar specification, you can use the "LOAD" button to retrieve this file. The parameters will be loaded in from file, but only those that differ from the car parameters will be highlighted in yellow. This will reduce the time required to write the data to the car. For example, if the car is fitted with 440cc injectors, you can now load in the Z4_440cc.mat stored file. This will highlight only the injector constant. Pressing the "write" button will upload just this value in around 1 second!

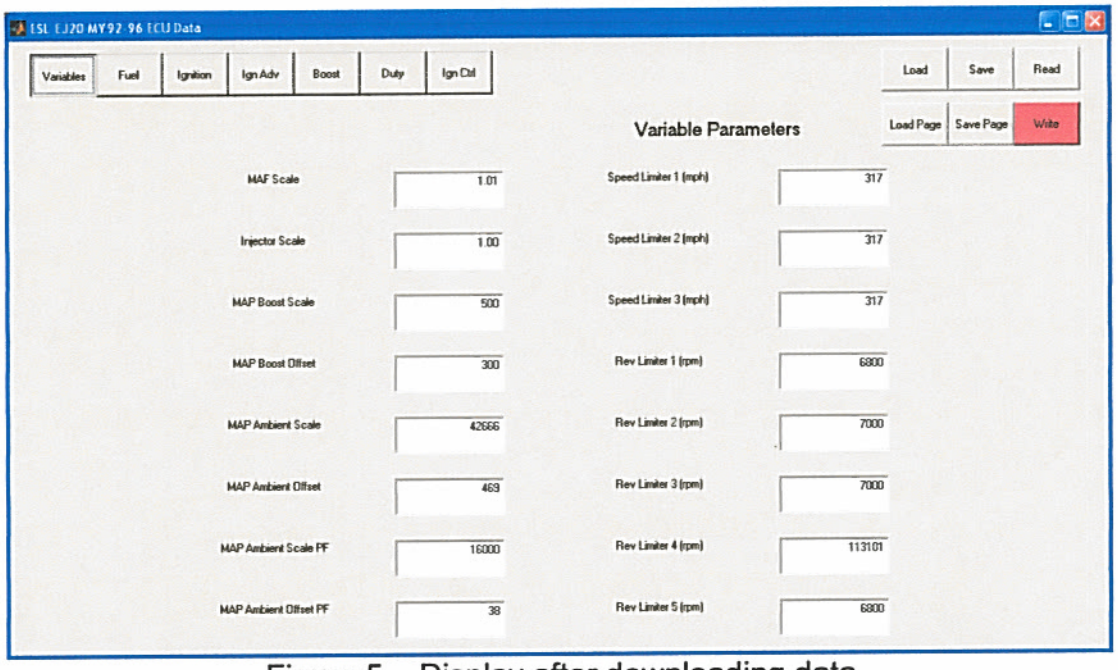


Figure 5 – Display after downloading data

Changing the ECU Values

The row of buttons in the top left hand corner of the screen select different ecu parameter pages. This starts of on the "variables" page, which contains a number of scaling factors, limits etc. These can be changed by moving the cursor to the required field, clicking on the field, and using the keyboard to enter a new value. When the user selects another field, the value is checked, and "snapped" to the nearest valid value that can be entered into the ECU. If this is different to what is stored in the car, the field becomes yellow, indicating there is a parameter ready to write.

The next five buttons ("Fuel", "Ignition", "Ign Adv", "Boost" and "Duty") describe ecu maps, rather than parameters. These are handled slightly differently by the software.

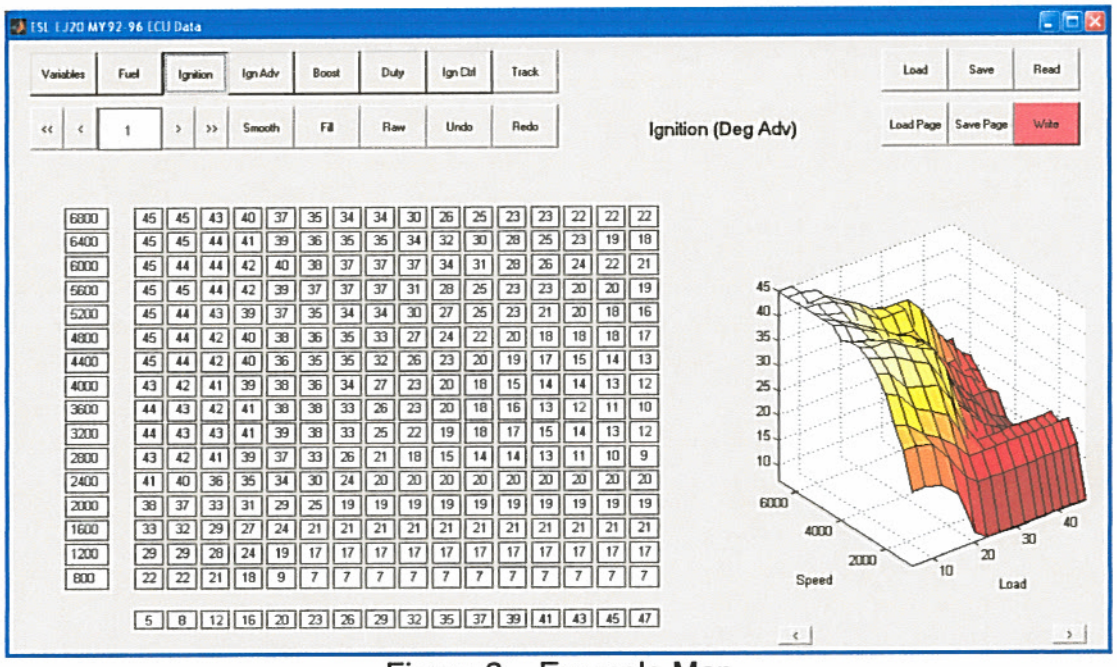


Figure 6 – Example Map

Regions of the map are selected by moving the mouse pointer over the map, and left-clicking on a part of the map. When the left button is clicked, the entry under the pointer changes colour to magenta. The user can then "drag" the mouse pointer to a different part of the table, and release the left button. The selected portion of the map is highlighted in magenta.

Once an initial selection has been made, the user can navigate around the map using the cursor keys.

The user may also select the scales of the map by selecting them in the same way. The user cannot select both a portion of the map and scale simultaneously.

There are several ways in which the user can modify the selected (magenta) portion of the map. The keyboard can be used, plus the additional row of buttons that has appeared at the top left of the window.

A summary of the operation of different keyboard and mouse actions:

Press '+' or '=' button on the keyboard or press the '>' button with the mouse:
Increment the selected data points in the map.

Press '-' button on the keyboard or press the '<' button with the mouse:
Decrement the selected data points in the map.

NOTE: the raw data value is incremented or decremented. On some maps, this results in a reduction of the content.

Press the '>>' button with the mouse:
Change the selected values by +10

Press the '<<' button with the mouse:
Change the selected values by –10

Press the 'Smooth' button with the mouse:
This pins the four corners of the selected region, and linearly interpolates values between the four corners

Press the 'Fill' button with the mouse:
Sets all selected values to be the same as the value in the fill box (between the '<' and '>' buttons)

Note you can select the fill box and change this value as if it were a map value.

The other three buttons do not change the selection, but perform the following operations:

'Raw' toggles the data point between the natural data form in the ECU (typically an 8-bit integer) and a converted value into common units; for example, the fuel map is switched into air/fuel ratio.

'Undo' allows the user to undo all of the changes since the map page was selected. On selecting a different page, the "undo" and "redo" buffers are cleared.

'Redo' allows a previously undone change to be redone. When a value is modified, the redo buffer is cleared.

Monitoring the ECU

The final two buttons on the top row, "Ign Ctrl" and "Track", are not modifiable maps, but retrieve data from the ECU.

The ignition control button retrieves the ignition correction data based on the ECU knock measurements. This takes two forms; the Ignition Advance Multiplier "IAM", and the fine correction map. The IAM is a value 0-16, and represents sixteenths of the Ignition Advance map added to the base ignition map. The ECU modifies this value, reducing it in the presence of knock, and increasing it in the absence of knock.

When knock is detected, as well as the IAM (which represents a "global" correction factor), a "local" correction factor is also applied to the ignition. Small ignition corrections are integrated over time into this table. The table takes time to develop, so may not be meaningful if the car has been modified immediately prior to the mapping session.

The "Track" buttons opens a data logging session. The first time this button is pressed, the data log table is written to the ECU. This defines the sequence of parameters which are monitored by the data logger.

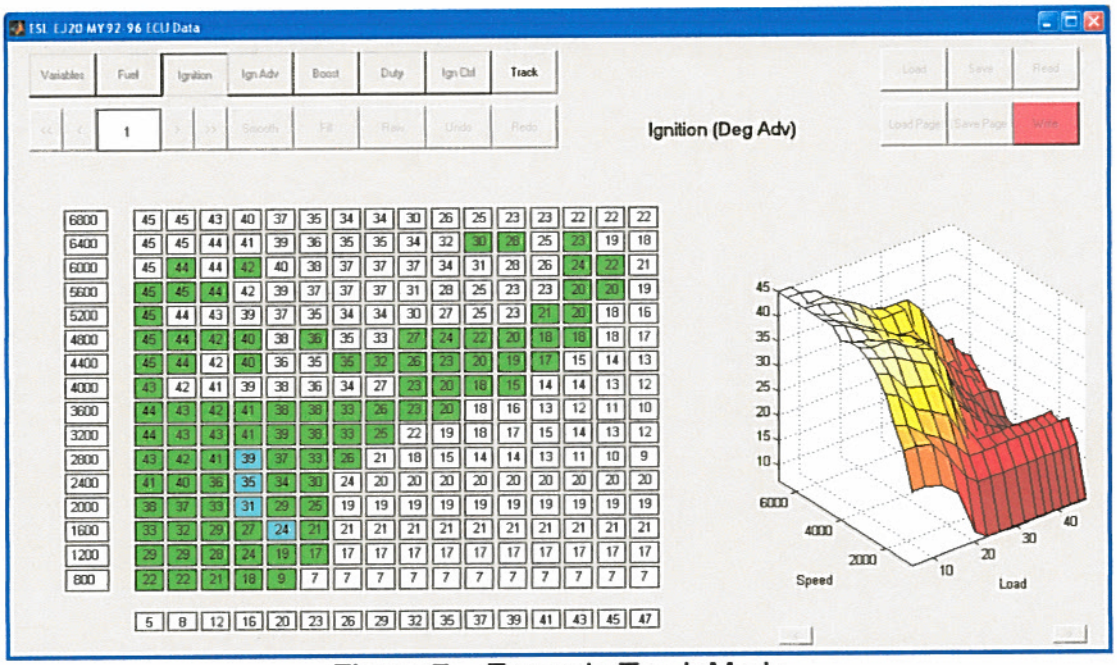


Figure 7 – Example Track Mode

The track button moves a cursor around the currently selected map, showing which zone the car is currently operating within by shading light blue, previously visited zones are shaded green. If the internal knock sensor detects knock, the zone is switched to red.

All other software functions are disabled whilst in track mode. To exit track mode, press the "Track" button once. The software will then disconnect from the ecu and return to normal operation.

The track remains on the screen until a value is selected or modified.

> *Tip: the TRACK function uses the graph positions set in the software, not the values stored in the ECU. To see in more detail what the load and throttle positions are doing, set a higher maximum value, then smooth the scale. DO NOT WRITE THIS TO THE ECU! Then use the track command to see where the value goes to. After track has finished, use the "Undo" command to revert the scales to their original values.*

File Storage

The LOAD and SAVE buttons allow the currently stored data to be read from, or written to file respectively. Note these store the currently map status on the software, NOT the map currently running in the car.

The LOAD PAGE and SAVE PAGE allow you to save just one map. If you have (for example) a "standard" first cut TD04 boost map, and a "standard" first cut TD05 boost map, you can load these separately to other parameters.

The READ button reads the parameter data from the ECU into the software. This always takes around 100 seconds. The WRITE button writes the data back to the ECU, but only writes the values highlighted in yellow. This takes approximately 1 second per parameter to write.

If the cable is disconnected during a write command, or another error occurs, or the ignition is switched off, the write values up to that point will be written to the ECU, but the software will not reflect that. It should not affect the operation of the ECU, which will continue as normal.

NOTES on the Z4 MAP

The Z4 is the standard map for WRX impreza saloons from the period 94-96. The map is reasonably safe on good quality super unleaded fuels, and should give ~260bhp.

The standard car should accept a little more boost than the Z4 map is set up for. To adjust the boost, a number of changes are required:

The boost target map should be modified to contain the desired boost value for each given (throttle position, rpm) entry.

The boost limit fuel cut table – 8 values at the top of the boost target table – will need to be raised.

The limit of the standard MAP sensor is approximately 1.23 to 1.26 bar (varies from car to car). If the MAP sensor from a later model is used (e.g. 97/98), this limit is raised to 1.7 bar.

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 ignition and fuel maps can then be adjusted

A 1.1 bar target, with boost fuel cut set to 1.2 bar, and careful fine tuning of the duty map, is a reasonable goal on the standard car. Much beyond this, the stock injectors become a limiting factor (380 cc as standard), the small intercooler and the MAP sensor also prevent much further advance.

The MAF sensor on the early cars reaches FSD at around 320-330bhp. The final version of the software will support alternative sensors, such as the Z32 or later 97/98 model units.

APPENDIX – DESCRIPTION OF PARAMETERS

Variables Page

MAF Scaling factor – direct scaling factor relative to standard unit. If the unit was modified to read a twice air flow per volt, the MAF scaling would be set to 0.5. Note changing this without changing the MAF sensor will cause the load values to be computed incorrectly within the ECU; the software does not, at present, compensate for this.

Injector Scaling factor – direct scaling factor relative to standard 380cc injectors. For example, the setting for 440cc injectors would be 380/440 or 0.86.

MAP Scaling factors and offsets – a series of scaling factors and offsets used to set the MAP sensor. Different scales are used when barometric pressure is measured, compared to the boost pressure measurement. The barometric measurement also includes a final post-filter scale and offset. The 92-96 MAP sensor reads to approximately 1.26 bar at full scale. 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 below.

Parameter	92-96	97-98
Boost Scale	500	643
Boost Offset	300	414
Ambient Scale	42666	54857
Ambient Offset	469	542
Ambient Scale (post filter)	16000	12380
Ambient Offset (post filter)	38	52

The Speed Limit and Rev Limits introduce different measures to limit the speed of the vehicle or engine speed. Speed limits 1-3 should be increasing, with speed limit 3 being the highest. The Rev Limit 1-4 should be increasing, with Rev Limit 5 having a lower value (being the point at which the rev limit is "switched off" as the revs drop).

Fuel Page

Vertical Axis – engine speed (RPM). This should be increasing from the bottom to the top of the page. Horizontal Axis – engine load, measured as mass air flow divided by engine speed. This should be increasing from left to right.

Each entry in the table gives the target air/fuel ratio.

Ignition Pages

Vertical Axis – engine speed (RPM). This should be increasing from the bottom to the top of the page. Horizontal Axis – engine load, measured as mass air flow divided by engine speed. This should be increasing from left to right.

Each entry in the table is the number of degrees advance relative to TDC. It is important to note that the ignition is calculated based on this value, plus a proportion of the Ign Adv map, depending on the IAM value.

Boost Page

Vertical Axis – engine speed (RPM). This should be increasing from the bottom to the top of the page. Horizontal Axis – throttle position, measured as a percentage opened (0 closed). This should be increasing from left to right.

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

Note the additional row of data at the top of this page indicate the boost limit fuel cut values.

Duty Page (Boost Solenoid Duty Cycle)

Vertical Axis – engine speed (RPM). This should be increasing from the bottom to the top of the page. Horizontal Axis – throttle position, measured as a percentage opened (0 closed).

The map gives the maximum boost solenoid duty cycle (0 = actuator pressure only)

Ignition Control (page downloads on pressing button)

IAM = Ignition Advance Multiplier, 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)

Fine control map: 8x8 grid based on RPM and engine load, giving the number of degrees of correction for that zone on the map.

At present, these values are not modifiable.

Should you find any bugs or problems, we would be most grateful if you could make a note of the circumstances under which the problem occurred, and pass this information back to us, to enable us to improve the final software release. It is likely that the software will undergo continuous development, with new fixes and new features being provided periodically; we welcome feedback of ideas to enhance the software.

The rest of this document is split into the following sections:

1. Software installation (prior to mapping session)
2. Current Software Limits and Bugs (worth familiarising prior to mapping)
3. Hardware installation
4. Mapping with the software

Appendix – notes on the Z4 map, description of parameters and maps

Service available from

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