The BEGi Mazda
XEDE Tuning Manual

Applicable to all Mazda Miatas, MazdaSpeed Miatas, and MazdaSpeed 3s.

Revised 9-21-10
Rev 1.1

Thank you for purchasing the *XEDE* Engine Management System. We regard your installation and tuning as a mutual project and will be pleased to offer help at any time. If clarification of these instructions is required, please call BEGi at 830-438-2890. Suggestions for improvements of these instructions are welcome. Send an e-mail to info@bellengineering.net. Or, write notes on the instruction set and mail / fax to: BEGi, 203 Kestrel Dr., Spring Branch, Texas. 78070. Fax: 830-438-8361

The success of this installation will be determined by a variety of factors. These instructions MUST be adhered to unless reasonable cause for deviation exists. The vehicle must be in excellent condition and proper tune prior to starting the installation. Care and attention to detail by the tuner is of extreme importance.

It is desirable, but not necessary that the installer has any previous experience with engine management computers. The basic principles of tuning with the *XEDE* will be covered. This is a guide and recommended procedures. BEGI accepts no liability for any changes made, results, and/or damage.

These instructions and the operational requirements for this system must be reviewed with the owner-driver prior to delivery of the vehicle to the end user. Please read the statement of warranty at the end of these instructions prior to starting the installation and tuning process.

Tool and Equipment Requirements
The following tools and equipment will be required to conveniently accomplish this install:

Laptop Computer

XMAP Software

6 ft Serial Cable - MS3 and MX5

USB to Serial Adapter Cable - 6 ft long

OBD II Scan Tool w/ Live Data Read Out

ACKNOWLEDGMENTS
This manual was written by Stephanie Bell-Turner with permission from ChipTorque, Pty. Ltd. of Australia.

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WARNING
Modifying engines and tuning can be dangerous. With incorrect tuning, it is possible to destroy engines. We strongly recommend the use of a professional tuner. Care must be taken not to do damage to the motor. Tuning is not something that should be attempted by anyone not knowledgeable and experienced in the field. Read this entire manual before beginning the tuning process. Proceed at your own risk.

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Preliminary

To reiterate, follow these instructions unless significant reason for deviation exists. We strongly recommend that clarification should be sought prior to making changes not mentioned.

Return the car to stock timing specs. On the 1994-1997 Miatas, adjust the base timing back to stock. If there is a timing wheel installed on a 1999-2004 Miata, please remove it. Very bad things will result if the car is not running base timing settings.

Install the *XEDE* and all related hardware, per the application instructions. Install XMap and OBD II software on your computer. **Please** use the serial to USB adapter from Radio Shack. Follow the installation instructions for the cable. **Do Not plug the cable into the computer yet**. Follow the instructions to install the drivers on the CD. Once installation is complete, then you may plug the USB / Serial cable into the computer. Plug the serial end of the cable into the *XEDE* Serial port. If the installation is not done in the correct order, the cable will not work, and the installation process will have to be restarted.

The *XEDE* is a MAF based tuning solution. It works with the stock ECU, but modifies the fueling, timing, and open loop/closed loop functions. While simple in design and easy to use, the *XEDE* is very powerful in allowing for the use of larger injectors. MAF meters do have a power limit to them as it has a maximum output voltage. Once that voltage has been reached, the adjustment capability of the *XEDE* has been reached. Most applications the *XEDE* can be installed on, will work to the limits of the stock motor and a little beyond. The *XEDE* can be used on motors with forged internals and over bored motors. Remember that if the stock ECU will take exception to the changes, the *XEDE* can only compensate so much. Some MIL/CEL may appear during the tuning process. Keep track of them as they will aid in the tuning process. Refer to the CEL/MIL codes section for more information.

The *XEDE* can be tuned to pass OBD II inspection, on all applications. Some applications will illuminate the Malfunction indicator lamp (MIL) or Check Engine Light (CEL). The car must be tuned well in order to pass. Refer to the section on passing OBD II testing at the end of this manual.

It is of utmost importance that the spark plugs be gapped properly. Anything between 0.030 and 0.035 is acceptable. Anything else may induce engine knock and poor timing control. *NO EXCEPTIONS*.

Terminology
> AFR - Air/Fuel Ratio as measured by a Wideband O2 sensor
> Map - The *XEDE* table that can be edited
> MAP - Manifold Absolute Pressure. Measured by the MAP Sensor
> MX-5 - Refers to the 2006-2010 Mazda Miatas
> Speed3 - Refers to the MazdaSpeed3
> MSM - Refers to MazdaSpeed Miata
> LTFT - Long Term Fuel Trim
> STFT - Short Term Fuel Trim
> TPS - Throttle Position Sensor, a.k.a. Load Predict Map in XMap.
> MAF - Mass Air Flow Meter
> ECT - Engine Coolant Temperature
> ECU/PCM - Engine Control Unit/Powertrain Control Module - the car's computer
> CEL - Check Engine Light
> MIL - Malfunction Indicator Lamp, a.k.a. CEL

Uploading Maps - loads the Maps shown in the XMap software on the PC screen to the *XEDE* unit. The *XEDE* will run these Maps while the serial connection is retained and the *XEDE* is powered up. If the serial connection is lost temporarily (if you kicked the cable by mistake) or the ignition key is switched OFF and then back ON, the *XEDE* returns to whatever Maps were last "Burned" into it and the XMap software will ask the user to "Write" or Upload again, "Read" the Maps back from the *XEDE*, or "Ignore" the different values and keep the *XEDE* (and engine) running the maps with differences between the *XEDE* and the data on the screen.

Burning Maps - stores the maps previously uploaded (and are currently being run by the *XEDE*) into the EEPROM memory of the *XEDE* unit. These are the Maps that the *XEDE* will run if there is no valid serial connection with a PC running XMap software.

Section 1: XMAP Setup

Loading Software

Attached to the *XEDE* harness is a serial port. The serial cable or a Serial/USB adapter will install here, after the drivers and XMap software is installed. If a Serial/ USB adapter cable is going to be used, ___WE STRONGLY RECOMMEND___ that the Radio Shack cable # 26-949 be used. It includes the cable and a CD with the drivers. If a good cable, with the proper drivers is not installed, the maps will corrupt! Before proceeding, the software and cable drivers must be installed in a specific order. Please proceed according to the directions.

XMap will not work on MAC computers or operating systems.

XMap Version 3.2

This version will come on a CD with the *XEDE* unit. Install XMap version 3.2.0.24 from the CD. Or it can be downloaded from:

http://www.bellengineering.net/templates/BEGi/images/Manuals/XMap3 V3_2_0_24.zip

> Copy the version 3.2.0.24 zip file from the CD to your desktop.
> Double click on it and extract all files. Extract the folder and place it on your desktop.
> Open the folder and double click on the application file to start the install process.
> Follow the prompts to install the software.
> When complete, click on Start> All Programs > XEDE > XMap 3.2.
> Right click on the XMap 3.2 file, and place a shortcut on your desktop.
> Delete the zip file and zip folder from the desktop.

Note: All European *XEDE* applications must use the XMap 3.2.0.21. Otherwise, it will not work for the EU time zone settings. North American *XEDE* users can use software 3.2.0.19 or 3.2.0.24.

Serial Cables

Plug in serial cable to *XEDE* harness and computer. Open XMap. Turn the ignition key to the "ON" position. All serial cables will use the COM1 port. The *XEDE* status will display in the lower left hand corner of the XMAP window. Once the key is turned on, the status should read connected. If not, turn key off and back on. If still not connected, click on the connect to *XEDE* icon at the top of the XMap window. (The icon has two arrows on it, facing opposite directions) If that fails to work, reboot computer, double check that all cables are plugged in, turn key on, and open XMap. If this does not work, please call for assistance.

USB / Serial Cables

Insert the CD that came with the USB / Serial cable into your computer. **Do Not plug the cable into the computer yet**. Follow the instructions to install the drivers on the CD. Once installation is complete, the USB / Serial cable may be plugged into the computer. Plug the serial end of the cable into the *XEDE* Serial port.

To determine which Port the USB / Serial cable will be connected to, open the device manager. Click on:
> Start
> Control panel
> Switch to classic view (on blue bar)
> System
> Hardware tab

> Device manager
> + sign next to "Ports/LPT". The USB / Serial cable will be listed here with the recognized COM port at the end. (For now we will use the example COM5). Note: this is only visible when the USB/serial cable is installed correctly and plugged in to the computer.
> Close the device manager and control panel.

Open XMAP. If any other USB cables are plugged in, an error message that says the COM port is in use may pop up. Click on "okay" and ignore for now.

In XMap, click on:
> Options.
> Comm Port Setup.
> From the drop down menu click on the appropriate COM port. (For example, COM5)
> Click on Okay.

Turn the ignition key to the "On" position. Look to the lower left hand corner of the XMAP window for the *XEDE* status. It should read connected. If not, turn key off and back on. Click on the click on the connect to *XEDE* icon at the top of the XMap window. (The icon has two arrows on it, facing opposite directions) If that fails to work, reboot computer, double check that all cables are plugged in, turn key on and open XMAP. If it is still not connected, you will need to manually reset your COM port. Turn key off.

To Manual Reset the COM Port:
> Go back to the device manager from the directions above.
> Right click on the USB to Serial Comm. Port.
> Click on properties.
> Click on port settings tab
> Click on Advanced. In the advanced settings window at the bottom there is a drop down menu at COM port number. From the drop down menu choose COM1 (or any other available COM port).
> Click OK here and at the serial cable properties window.
> Close device manager and control panel.

Open XMAP. Click on Options >> Comm Port Setup. From the drop down menu click on COM1. Click on Okay. Turn key back on and check *XEDE* status in lower left part of the window. It should now read connected. If not, Click on the connect to *XEDE* icon at the top of the XMap window. (The icon has two arrows on it, facing opposite directions)

The same USB Port (on the computer)and USB cable must be used every time. The computer installs the drivers for that USB port only.

1.1   Setting Default Printer

XMap has a few prerequisites in the software. One of them is that a printer must be installed on the computer in order for the software to run and operate correctly. Even if you do not use a printer, please install a driver for any printer, and set it as the default printer. Do this by simply selecting 'add a printer' in the printers and faxes tab of the start menu, and selecting any printer listed.

1.2   Windows Vista Users

To make XMap run on Windows Vista:
> Install XMap (from CD or download)
> Double click My Computer
> Double click on C:

> Double click on Program Files
> Double click on *XEDE* folder
> Double click on the XMap3_2 folder
> Right click on the XMap3_2_0_24.exe icon
> Click on properties
> Click on select compatibility
> Select Windows XP
> Click OK

This will run the compatibility wizard and XMap will work with the Vista operating system.

1.3   Windows 7 Users

To make XMap run on Windows 7, you must install the USB to serial cable drivers for Windows Vista. The Gigaware cable referenced above will work on Windows 7 applications. Install the drivers for the Vista operating system though. Install XMap.

> Open the control panel
> Double click on Add Programs
> Click on Programs and Features
> Click on Run programs made for previous versions of Windows
> Click on Next
> Let it detect the programs with issues
> Click on XMap 3.2
> Click on Next
> Click on Troubleshoot options
> View the options listed. Choose the one that most resembles "worked on previous versions of Windows
> Click on start program
> XMap 3.2 will go thru set up again. Click on Next until it says it is successfully installed.
> Click on Finished

Check the COM port on the USB/Serial cable. Open XMap. Verify COM port settings. Click on "connect to *XEDE*" icon. It may be necessary to repeat this step a few times or restart the computer in order to complete installation and compatibility wizard.

1.4   File Backup

It is highly recommended that the files sent with the *XEDE* be saved to the computer used to do the tuning. The CD will contain the installation instructions, tuning instructions, wiring diagrams, software, base maps, timing pattern file, and also any other relevant information. Each CD will be different as different base maps are used for different applications.

Create an *XEDE* folder on the computer. For those organized individuals, we suggest subfolders that contain pattern files, maps, software, and instructions.

In case more than one map has been sent, also save a copy of the map loaded on the *XEDE* unit prior to making any changes to it.

Section 2: *XEDE* Setup

2.1   Firmware

The Firmware for the *XEDE* unit is already loaded. Firmware updates happen every couple of years. Only the *XEDE* units sold prior to 2008 may have the older firmware loaded. Firmware updates must be done, in house, by BEGi. We will not walk you thru the firmware update over the phone. It is too complicated, time sensitive, and voltage sensitive to attempt in the field. No Exceptions. Please check with BEGi to see if the firmware loaded on the *XEDE* unit is the current one.

2.2   Downloading Maps (from the XEDE to the PC and screen)

Once Xmap is open and connected to the *XEDE* unit, hit the 'F8' & 'Enter' buttons. This is the short cut to Download and Show maps. The long way is to click on:

> Maps
> Download and Show Maps.

The maps will download and automatically display on the screen.

If a map or maps are missing off of the screen, hit the 'F10' button. This is the short cut to "Tile Maps". This will arrange all of the maps for view within the desktop area.

If the maps display with no content, very small, or numeric symbols in them - they have become corrupt. Maps will corrupt when using a bad USB/ Serial cable and/or drivers. Again, Radio Shack Cable # 26-949 is a known good cable and driver. Once the new cable and/or drivers is installed, reload the maps to the *XEDE* unit from the *XEDE* CD or previously stored during tuning.

2.3   Loading a Map (from the PC to the *XEDE* Unit)

In order to load a map, you must have one saved to the computer already. Open XMap. Connect to the *XEDE* unit. Open the map to be uploaded and burned. XMap will ask to upload the map. Click on yes. After the map has uploaded, XMap will ask to burn the map. Click on yes. XMap will confirm that the maps stored correctly.

Maps may be viewed "offline" - without the *XEDE* connected, or online without uploading the data to the *XEDE* unit.

If the maps only need to be opened to view content, and not necessarily save them to the *XEDE* unit, click on 'No' when asked to upload and burn maps. If the recently opened maps should be saved to the *XEDE* unit, click on "yes" to upload maps. Click on "yes" to burn maps. Note: The XMap software may continue to prompt you to Upload/Read/Ignore if an *XEDE* is detected on the serial port while changes are made on the screen.

Detailed Instructions to load a map:

> Click on File
> Open. Find and click on the new map you want to upload.
> Xmap will ask if you want to upload the Map. Click on Yes.
> Xmap will ask if you want to Burn the Map. Click on Yes. Once the map is burned, a small window will pop up and say the store was successful or not.

If it takes longer than two minutes to upload the new map, chances are the cable is bad, or information can get "hung up" in the Serial to USB converter part of the cable. The loading process will stall out if this is the case. If this occurs, close the window, turn the car off, turn the key back on, then try re-loading the maps without the engine running. If this does not work, stop the transfer and purchase a RADIO SHACK cable! from the Maps on the XEDE CD or previously stored during tuning.

<p style="color:red; text-align:center">Maps must be Uploaded <u>AND</u> Burned to the XEDE unit in order to store correctly.</p>

If both processes are not done, the maps will not save correctly to the *XEDE* unit. Maps can be uploaded and burned with the ignition on and engine not running, or with the engine running. While uploading and burning maps with the engine running, expect the car to act different and/or badly. This is normal, due to the *XEDE* passing all signals through (effectively setting all Maps to Zero values) while the new maps are loaded. Do not upload and burn maps when the car is in boost. If the upload and burn process does not complete in a timely manner with the engine running, turn the engine off, turn the key to "ON" position, then try uploading and burning maps. Sometimes information can get "hung up" in the serial to USB converter unit.

If changes are made to maps, XMap will display a window warning that the maps are not synchronized. This is a frequent reminder to save the maps and changes made. Click on upload maps or ignore as needed. Just remember, it is reminding of different maps for a reason! Also remember that maps must be uploaded *AND* burned to be saved on the *XEDE* unit. Refer to figure 4.
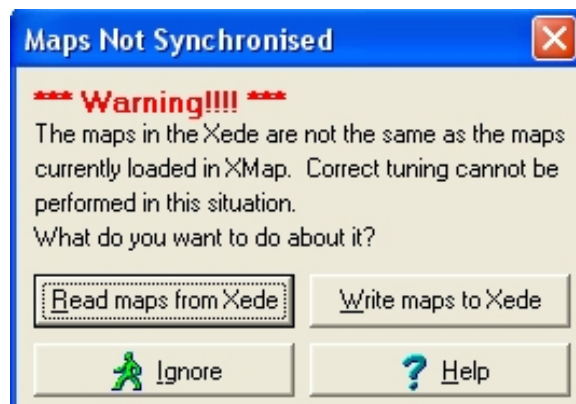
Figure 4

2.4   Timing Pattern File
This is <u>not</u> the Timing Map. It does not retard or advance ignition timing. It is a waveform pattern file from the crank sensor, that the *XEDE* must recognize in order for it to control the ignition timing. The correct timing pattern file must also be loaded in order for the *XEDE* unit to turn on (LED turns green).

From XMap screen click on 'Setup' and 'Configure Timing Signal'. Refer to Figure 5.
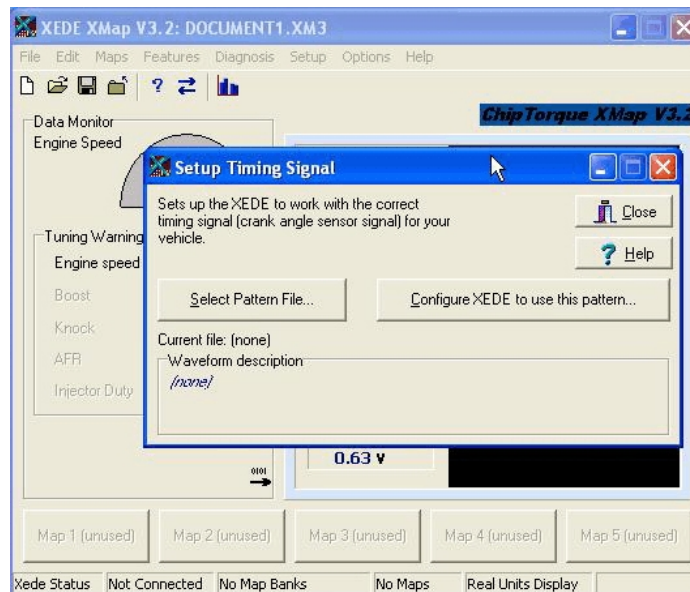
Figure 5

Click on 'Select pattern file'. Open the pattern file for this car. If unsure, please verify with BEGi prior to using. A chart of the correct timing pattern files for each application can be seen on page 13. Once the pattern file has been selected, click on 'ok'. XMap will return to the screen pictured in Figure 6.
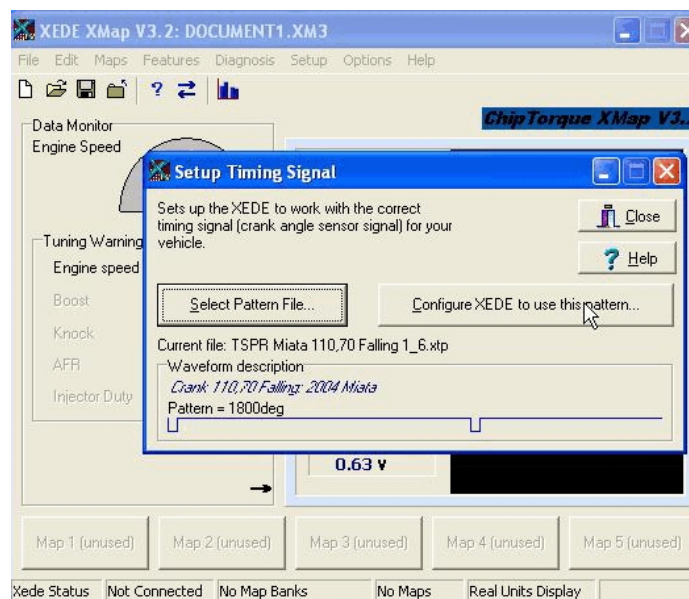
Figure 6

Notice the name of the file now displays in the lower portion of the window. Also there is a waveform pattern displayed at the bottom of the window. Click on 'Configure *XEDE* to use this Pattern'. Another window will pop up asking if you want to continue. Select 'Yes'. It will tell you if the configuration was successful or if the data was not stored.

Mazda has a long history of using the same crank angle sensors, across many applications. It is no cause for concern if the pattern file name refers to a different vehicle. For example, the MX-5s will use a file name that references an RX8.

It never hurts to verify that the pattern file being used is correct, there a few methods of doing so.

First Method: Connect the *XEDE* to the computer via cable and turn the ignition key to the 'On' position. When you open XMap look at the first screen that pops up. In **YELLOW** letters it will display the timing pattern file being used. Refer to Figure 7.

Figure 7

Second Method: From the main Xmap screen, click on 'Diagnosis' and '*XEDE* Information'. The serial number, map name, and timing pattern file will be displayed. The timing pattern will be listed under the vehicle info. Refer to Figure 8.
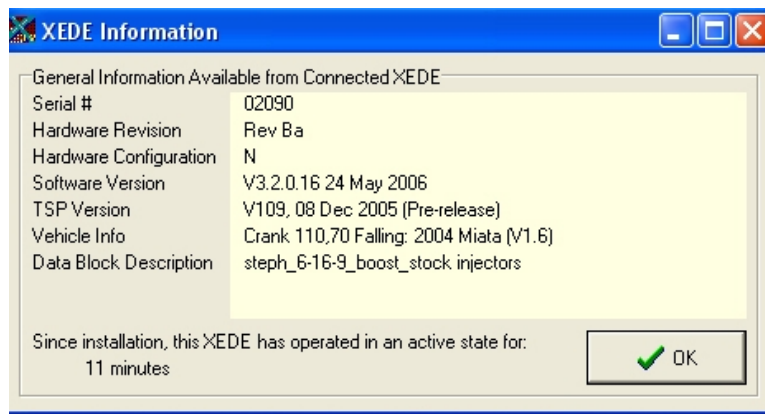
Figure 8

Pattern File Applications and Names: All timing pattern files will end in .xtp. These will not change. Some Miatas will use a file name with 1000 or 1100 rpm in it also.

1994-1997 Miata	97_TSPR 4 Even2.xtp
1999-2005 Miata	04TSPR Miata 110,70 Falling 1_6_800rpm_0,5sec.XTP
2004-2005 MazdaSpeed Miata	04TSPR Miata 110,70 Falling 1_6_800rpm_0,5sec.XTP
2006-2010 Miata	TSPR RX8 V1_0.xtp
MazdaSpeed 3	TSPR 60-2 symmetrical-MS3.xtp

Section 3: Using XMAP

3.1   Shortcut Keys

While you do not have to use the shortcut keys, it is recommended. Navigating this software will be much easier if they are used.

Ctrl + U = Upload a Map

Ctrl + B = Burn Map to EEPROM

F8 = Download and Show all Maps loaded on the *XEDE* unit, for that map bank.

F10 = Tile Maps. Use this if a map does not display on the desktop screen.

Less and More Buttons ** the best shortcut you will use for small corrections!!** Refer to figure 9 & 10.

Figure 9

Figure 10

3.2   Map Descriptions

For use if the Menu Bar does not contain the name of the map and the map number. Click on the map in question. Right click on this map. Click on 'Edit the Map'. In the first and fifth tabs, type in the Map description (MAF, Timing, O2 Offset, Load Predict, Boost, etc). Click on 'Ok'. Refer to Figure 11.

3.3   Map Details

Each map has a load point, rpm point, input variable, load variable, output variable, math function, and an adjustment range. The details can be viewed by right clicking on the map. Click on 'Edit this Map'. Figure 11 will pop up.

The RPM points specify the rpm intervals to be displayed on the X axis of the map (bottom of map). Usually an interval of 500 rpm works best. Being too specific is not always a good thing. The *XEDE* works best when it can average the cell contents. If the map contains large changes within a small RPM band, the car may run badly. Small RPM increments can also makes steady state tuning more difficult. For the technically minded, the *XEDE* runs a proportional interpolation of the values between the nearest 4 Map X and Y Axis points to generate the smoothest transitions possible between adjacent points or cells.

The Load Points specify the engine loads to be displayed on the Y axis of the map (vertical side of map). Depending upon the load area, being more specific is tolerable. At idle, load points should be about 5% apart. At cruise, load points can be between 2% and 5% apart. When under boost, load variables should not be any more specific than 5%. The *XEDE* works best when it can average the cell contents. If the map is too specific the car will run badly. It also makes steady state tuning difficult.

The Load variable is the incoming signal that determines the changes made. Since the *XEDE* is a MAF based solution, the load variable is usually AN0 or MAF. The timing map, MAF map, MAP map, O2 Map, and Load Predict Map should have the load variable set to AN0 In. Do not deviate from the default settings.

Special maps, such as the SMART Fuel and Timing maps, will make changes bases upon a secondary load variable. i.e. Wideband O2 voltage. See the Wideband O2 and Smart Timing section for more information.
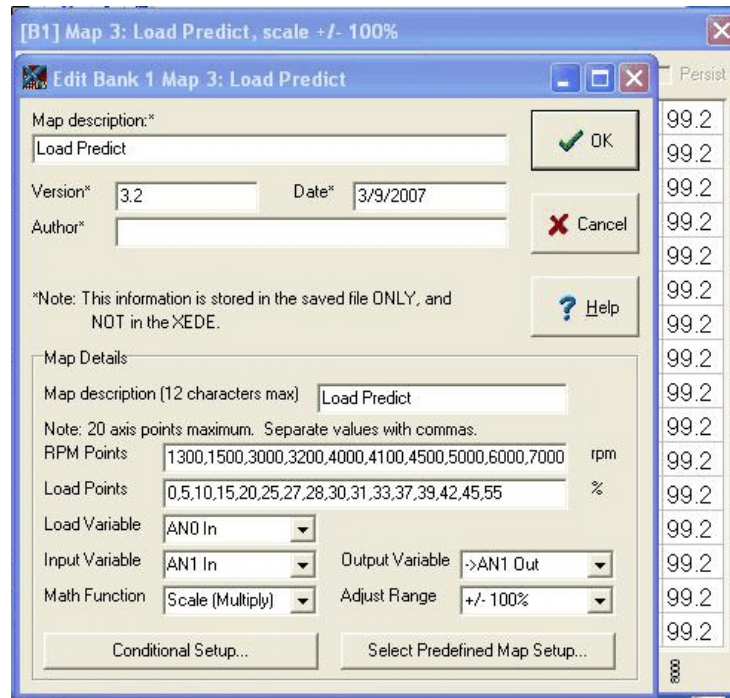
Figure 11

The Input Variable will change from one map to another based upon were the signal is coming from. See the table below to see what each Input Variable is. Do not deviate from the default settings in the base map.

	1994-2004 Miata	2004-2005 MSM	2006-2010 MX5	MazdaSpeed3
AN0	MAF	MAF	MAF	MAF
AN1	O2	TPS	MAP	MAP
AN2	Wideband O2	Wideband O2	Wideband O2	Wideband O2
Timing	Timing	Timing	Timing	Timing
PWM0	Boost	Boost	Boost	Boost

The output variable will be the same as the input variable, except it will be labeled as 'out'. Do not deviate from the default settings.

The math function is how the map modifies the incoming signal. Do not deviate from the default settings without consulting with BEGi.
▸ The offset (add) setting will add the value in the map onto the incoming signal.
▸ The Scale (multiply) setting will multiply the incoming signal by the amount specified in the map.
▸ Timing change is made by a 0.1 degree change. The degrees of ignition timing will be changed by the value in the map.
▸ The pulse width math function is not currently used on the Mazda application.
▸ The Absolute output function will send a completely new signal for that port, ignoring the incoming signal. This math function should only be used in certain circumstances. For example, the MSM works best when the *XEDE* sends a "fake" TPS signal to the ECU. Since it is ignoring the incoming TPS voltage, this is an absolute output.
▸ The Timing Offset math function is not currently used on the Mazda application.

The adjustment range specifies the range of changes that can be made within the map. Do not deviate from the default settings.

Anytime changes are made in this window, it will upload all the changes automatically. If power is lost during upload, it will be necessary to upload all changes again. Losing power during the upload or burning process is another way to corrupt the maps. Use the throttle pedal as necessary to ensure that power loss does not occur.

3.4   Preferences

The "refresh" speed of the *XEDE* can be altered in the preferences window. Click on File > Preferences.

On the General tab, make sure the option for "show all maps immediately after downloading" is clicked on. The Map Value Format should also remain set to "Percentage Change/Advance". Refer to figure 12. Even though the screen will display an RPM gauge redline, it will not change the redline / rev limiter on the engine. This redline note is for display purposes in the main XMap screen only.

On the Maps tab, the update/ refresh rate is listed as "Operating Point Update Rate". Typical settings are 100 ms for most PC / USB-serial transfer rates. The initial default value is 3000ms (a bit slow for most late model PCs and laptops). The Map Value Format must remain set to percentage change/advance. Refer to figure 13.
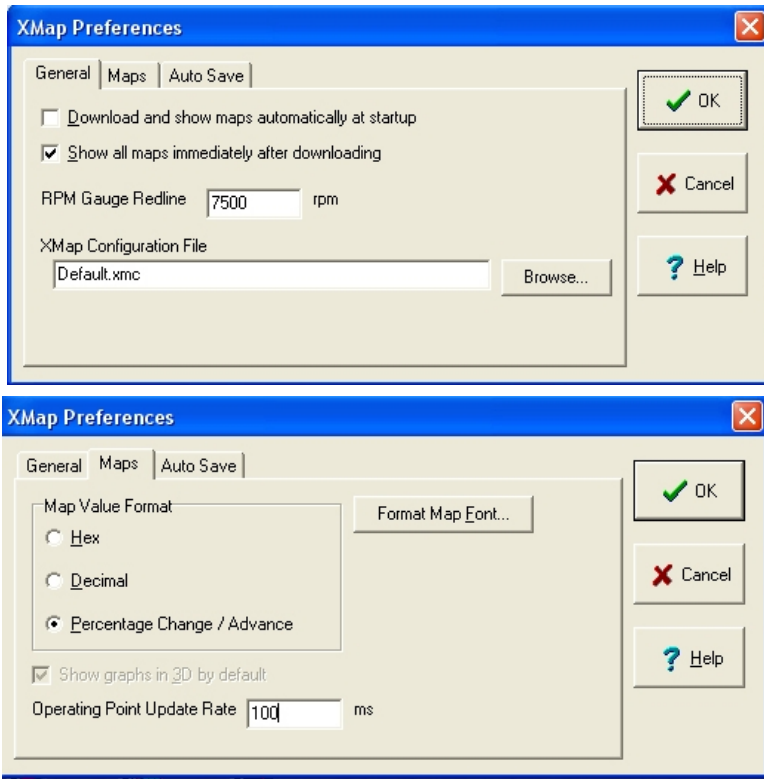
Figure 13

When changes are complete, click on 'Ok' to save changes and return to the main Xmap screen.

3.5 Colored Maps

The different maps can be color coded for faster recognition. It will change the outside area, around the table, to a bright color. Right click on the map, click on map color, then select the color. Refer to figure # 14 & 15.
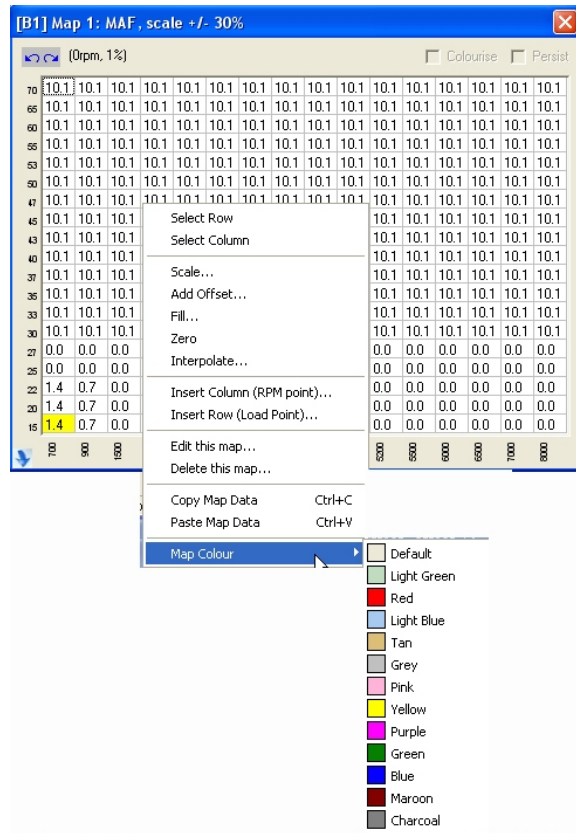
Figure 14
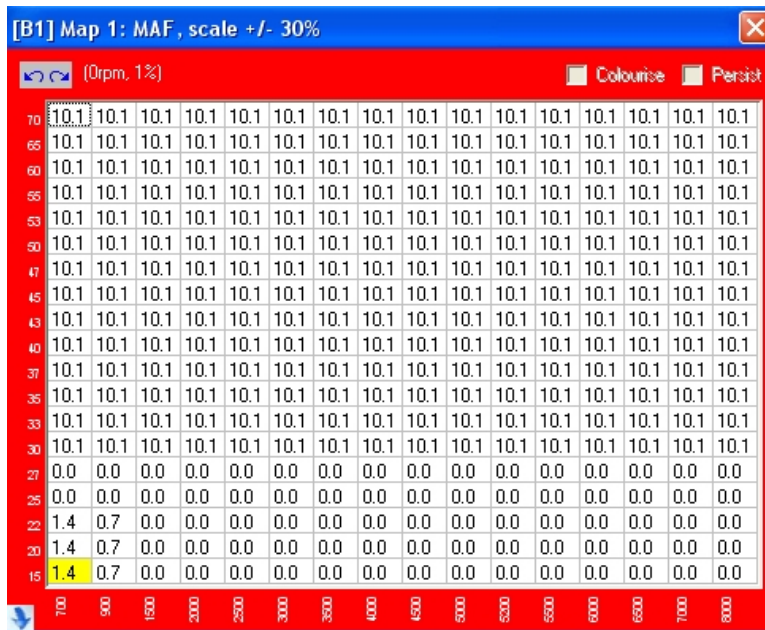
Figure 15

3.6   Tracing

The yellow cells, in any given map, are the active cells. These are the cells that the *XEDE* is immediately looking at to determine the corrections made. Remember, the *XEDE* will average all four cells to determine changes made.

To highlight the map, click an hold the mouse button over one corner of the map. Drag it to the opposite corner. The active cells are yellow. As the active cells move throughout the table, the text in the cells will remain yellow. This is called 'tracing'. For example a lean spot is noticed at 4000 rpm. Highlight the entire map. Make a run. If the lean spot is at about 4000 rpm, see which cells remained yellow in the 4000 rpm range on the table. Alter those cells. Once you click on the map, all the yellow traces will disappear though.

Tracing is your friend! Use it frequently, and on all maps, at the same time. Just make sure that the XMAP is the active program on the desktop.

3.7   Output Scaling

If you call for assistance with the *XEDE*, we *WILL* ask what the output scaling/injector scaling is along with what type of injector is being used. We need to verify that it is correct prior to making any changes in the map. The AN0 output scaling will vary from the different injectors available. If OEM/Bosch/Denso style injectors are used, the output scaling will be less. If RC injectors are used, the output scaling will be more. AN1 and AN2 output scaling will never be changed.

Click on 'Features' then 'Output Scaling'. Refer to figure 16 & 17. AN0 scaling will vary. See the chart below for typical scaling settings.

Again, AN1 and AN2 output scaling will never be changed. Freq0 should display '1.0'.
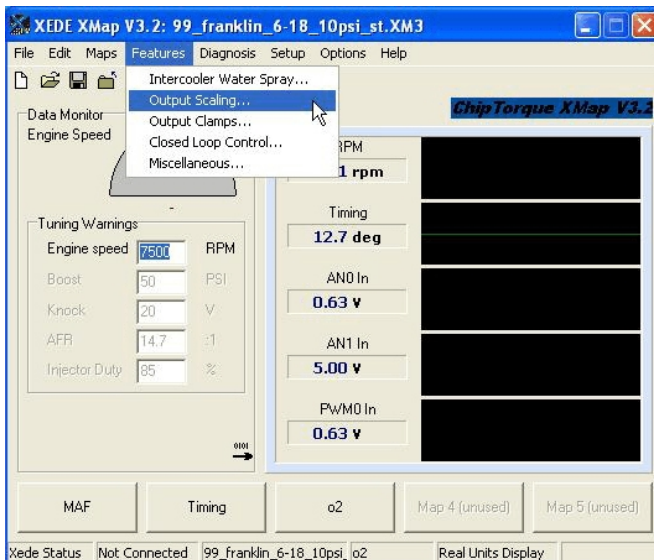
Figure 16
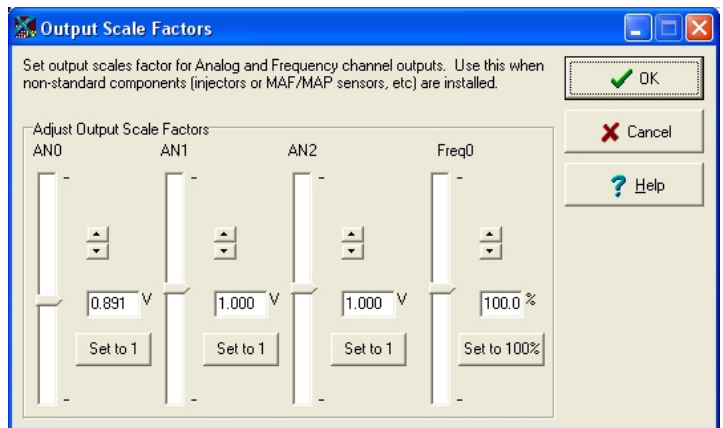
Figure 17

Typical Output Scaling Settings

	1994-1997 Miata	1999-2004 Miata	1999-2004 MazdaSpeed Miata	2006-2010 MX-5 Miata	MazdaSpeed 3
RC Injectors	0.891-0.851	0.891-0.851	0.91 - 0.891	0.891-0.849	n/a
Bosch/Denso Injectors	0.960-0.910	0.980-0.921	0.980-0.921	0.980-0.940	n/a

MazdaSpeed 3 - If a larger than stock diameter MAF tube is used, the AN0 output scaling may need to be higher. Typical settings for this would be 1.090 - 1.140.

When tuning for the MAF / fuel table, it is important to keep in mind how the output scaling works. The output/injector scaling is the amount of fuel being removed right off the bat. This is to compensate for larger than stock injectors. Then the MAF map is a fine tune adjustment, on top of the output scaling.

For example, The ECU calculates the amount of fuel for say a 1.000 Volt MAF signal. The Output scaling used for RC Injectors is 0.891. What comes into the XEDE (from the MAF) at 1.000 Volt will leave the XEDE (to the ECU) at 0.891 Volts, without any fine tune adjustment for what is in the MAF map. For the whole process then, look at the MAF map in figure # 13 on page 15. The lower left hand cell has a value of 1.4. So the fuel delivered, for this cell, would be calculated on :

(Incoming signal)   x   (Injector scaling)   x   (MAF fine adjustment %)

   1.000   x   0.891   x   1.014 (100% + 1.4% from the MAF map)

1.000 x 0.891 x 1.014 = 0.903. So what comes in a 1.000 V will leave at 0.903 V - for that cell.

3.8   Output Clamps
The *XEDE* has the ability to clamp a signal. Click on Features > Output Clamps. This sets an upper limit to a voltage, on an analog output. With a voltage clamped, an outgoing signal (to the ECU) would not exceed the clamp value, regardless of the how high the input is. For example, if the MAF had a clamp on it at 3.000V, the incoming signal could read 4.300 volts, but the *XEDE* will only send 3.000V worth of fuel. Output clamps are not typically used on the Mazda applications. Refer to figure 18 for typical output clamps set up. All ports should be set to 5V.
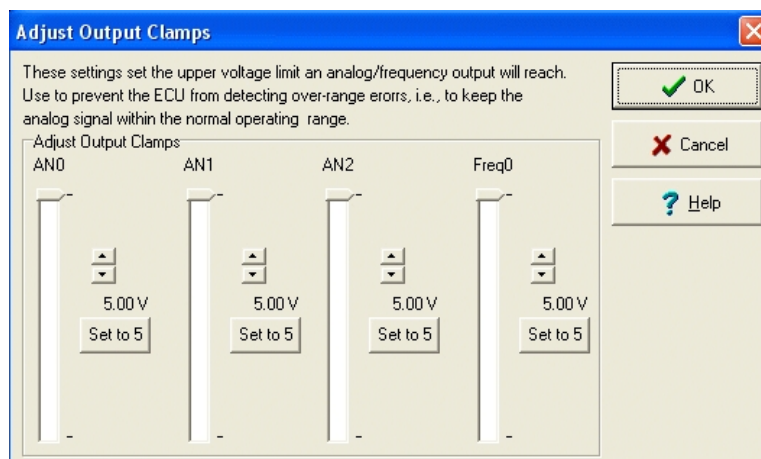
Figure 18

3.9   Injector Types

While the RC injector is a good one for the Miata application, it does have its drive ability issues. On light loads they tend to cause a cut out or shut off. On the 1994-2004 Miatas we can compensate for it, but on the newer MX-5s we cannot. The OEM/Bosch/Denso style injectors do have better drive ability because of the spray pattern inherent to that injector. Those injectors have the ability to scale down the spray. They can spray at 10% and 100%. Whereas the RC injector is on or off, 100% or nothing.

On the MS3 applications, because the stock injector injects the fuel directly into the combustion chamber at high pressure rather than into the intake port as other injection systems do, we use different methods to control fuel delivery.

3.10   3D Map Graphical View

To view the 3D graph of the Map, click on the Blue arrow in the bottom left corner of the map. Refer to figure # 19. Note the red circle in the picture below. Click on that blue arrow, and the 3D map will display below. To return the map to normal, click on the same arrow. As you can see, the map below shows a spike in it. Find the spike (incorrect content in a cell) and correct as required.
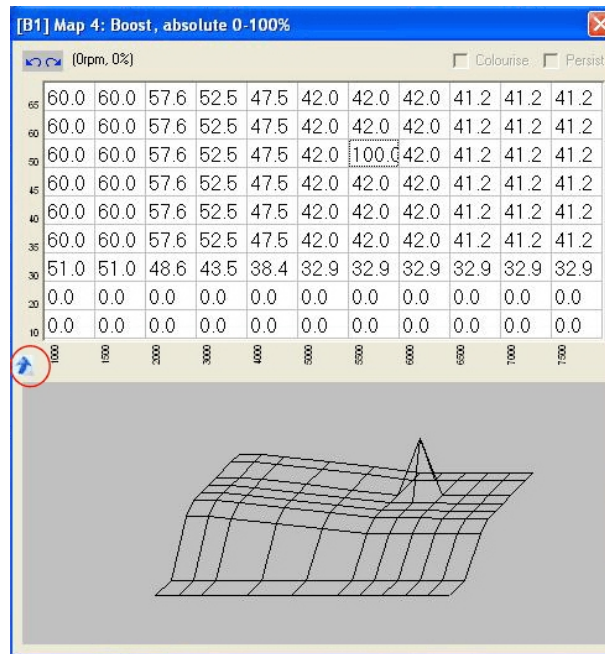
Figure 19

3.11   Undo / Redo

In the upper left hand corner of the map, there are two blue arrows. The left arrow is the undo button. The right arrow is for redo. As for an MS Windows style operation, the actions can be undone or redone for as many iterations as the XMap software has recorded in the current tuning operation, however, once a set of XEDE maps has been saved to a file on the PC or burned to the XEDE unit, the undo/redo counter is reset. Refer to figure 19.

3.12   Direct Map Value Entry and Offsets

There are many ways to change the cell contents. Cells can be changed individually, in groups, or the whole map - at one time.

If a cell or block of cells need to have the same content - highlight the area to be changed (with the left mouse button and dragging -or- with the shift and arrow keys combination). Type in the number that it needs to be changed to. Hit the enter button. All highlighted cells will change to the same number. For example - if all four lower cells need to display 5. Highlight all four cells. Hit the "5" button. Hit enter.

A second method is better for changing all cell contents to a higher or lower value. Highlight the area to be changes. Use the shortcut keys of "<" ">" to add or subtract to all highlighted values.

Another method is to add an offset. Highlight the area of the map to be changed. Right click on the map, and click on 'add offset'. Type in the amount of offset you want to *ADD*. If a lower value is desired, or to subtract, remember to add in a negative number. Click on 'OK'. Refer to figure # 20 & 21.
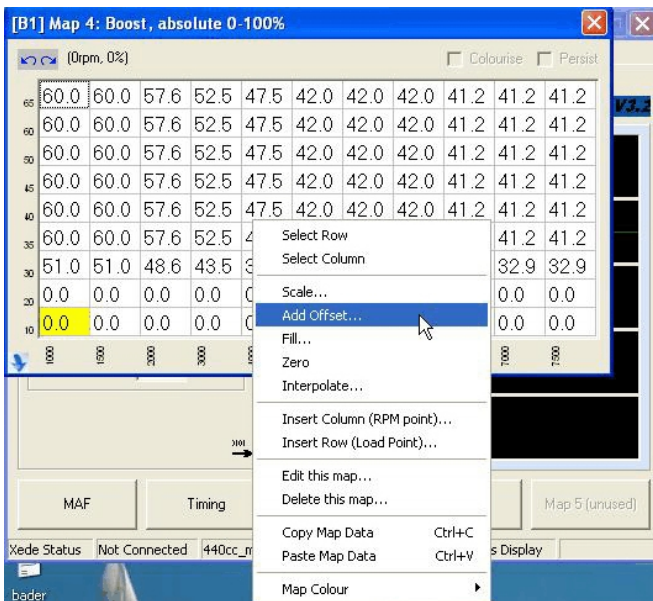
Figure 20
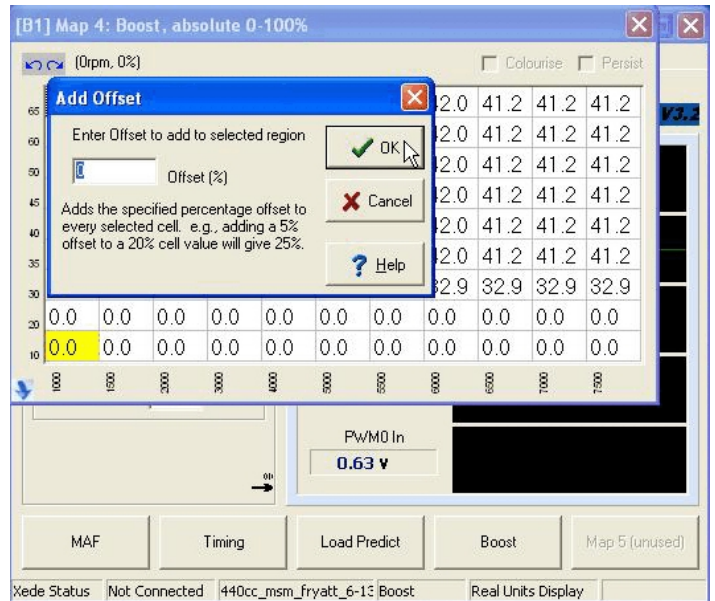
Figure 21

Certain areas of the map can also be scaled by a certain percentage. If a region needs to be changed by 5%, right click on the map. Click on scale. Enter the amount the value should be scaled by, i.e +/- 5%.

3.13   Interpolate

Next to the shortcut keys, the Interpolate function will be your second best friend. Interpolate will average the cells, on either axis, to even gaps between the selected cells. The interpolation works independently in each direction. If the map is interpolated on the y-axis, it interpolates only in the y direction (bottom to top). If the map is interpolated on the x-axis, it interpolates only in the x direction (left to right). The interpolate function helps to smooth out transitions.

Look at figure 22. To smooth the transition into boost, a section of the map has been highlighted. Refer to figure 23. Figure 24 has been interpolated on the 'y' axis. Notice the interpolation result. The cells now display a more even step upward.
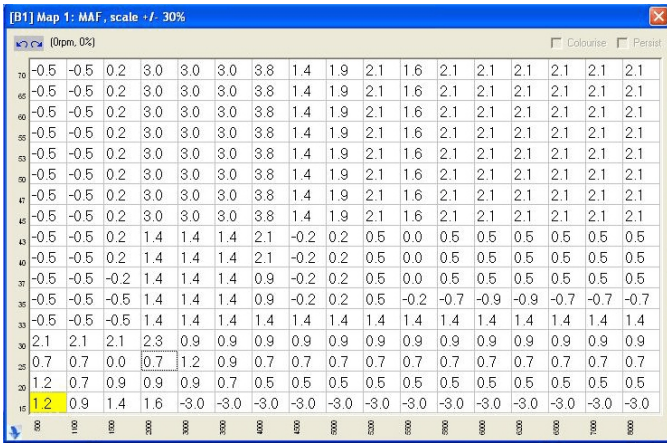
Figure 22
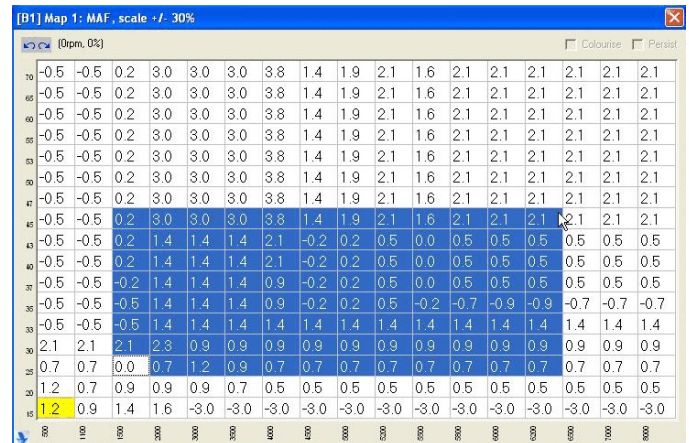
Figure 23
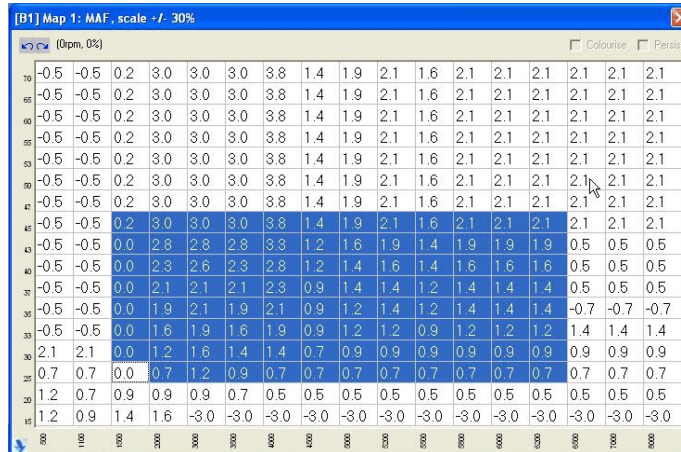
Figure 24

To interpolate a specific area, highlight the area to alter. Right click on the map, in the highlighted area. Click on 'Interpolate'. Select the axis / direction that interpolation is needed. Click on 'OK'.

3.14 Load & RPM Values

The Y axis is the engine load value. The X Axis is the engine rpm. There are two ways of adding rpm and load values into a map. The first is to right click on the map. Click on 'edit this map'. There is a line for RPM points and Load Points. Add in or subtract values, then click on ok. Refer to figure 11 on page 12. An error message will pop up if the numbers are not in numerical order or a comma is misplaced.

The second method is to click on the cell above the rpm or load value you want to add. Right click on the map, and click on 'Insert Column' or 'Insert Row'. If the small window does not show up on the screen, press the 'Esc' key twice, move the original map up on the desktop, then try again. Refer to figure 25.

Remember - being too specific is not always a good thing. The *XEDE* works best when it can average across the cell contents. We have found that if the map is too specific the car will run badly. It also makes steady state tuning difficult.
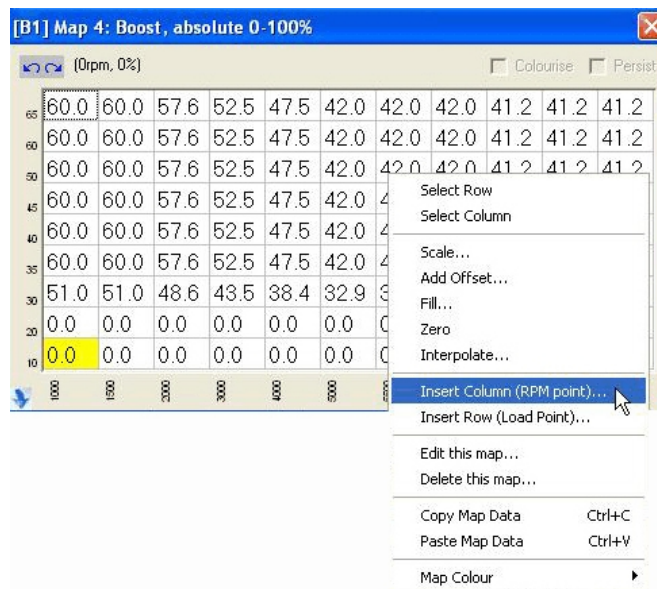
Figure 25

The Y axis is the engine load value. The X Axis is the engine rpm. The *XEDE* will internally calculate the engine load based on the percentage of the total possible value of the input which has been set as the Load Variable for that map. For example, a 2.00 Volt input would be 40% Load for a signal which has a possible 0.00 V - 5.00 V. Load would usually be % of MAF but (theoretically) could set to any of the various inputs wired into the XEDE - MAF, MAP sensor, TPS sensor, etc. The 1994-2005 Miatas will very rarely see an engine load of 100%. Whereas, it is quite normal for the newer MX-5s and the Speed3s to reach an engine load of 100%. Remember, the engine load value that the XEDE is using, at any given time, will be displayed in the upper left hand corner of any map table, right next to the engine rpm. We do not recommend using increments smaller than 5% or 500 rpm, unless it is the tip in area to boost or gear ratios have changed

At any given time, the current engine load and rpm can be viewed in the blue menu bar, next to the undo and redo buttons.

3.15   Live Data Display

The Live Data Window will visually display the changes being made by the *XEDE*. Below is a chart of what each analog port is.

	1994-2004 Miata	2004-2005 MSM	2006-2010 MX5	MazdaSpeed3
AN0	MAF	MAF	MAF	MAF
AN1	O2	TPS	MAP	MAP
AN2	Wideband O2	Wideband O2	Wideband O2	Wideband O2
Timing	Timing	Timing	Timing	Timing
PWM0	Boost	Boost	Boost	Boost

It will show the incoming voltage and the outgoing voltage as a percentage of the total possible signal value (usually 5.00 V). If the in and out voltages are the same, very little or no changes are being made to that analog port/signal. Refer to figure 26. For example: On the AN0 bar graph, if the incoming signal is say 10%. And the map indicates a change of -7%. So the live data display of AN0 Out should read 0.7% *LESS* than the incoming signal. The value would be 9.3%, but the live data display will only show whole values of either 9 or 10%, so in this case, 9% would be displayed.
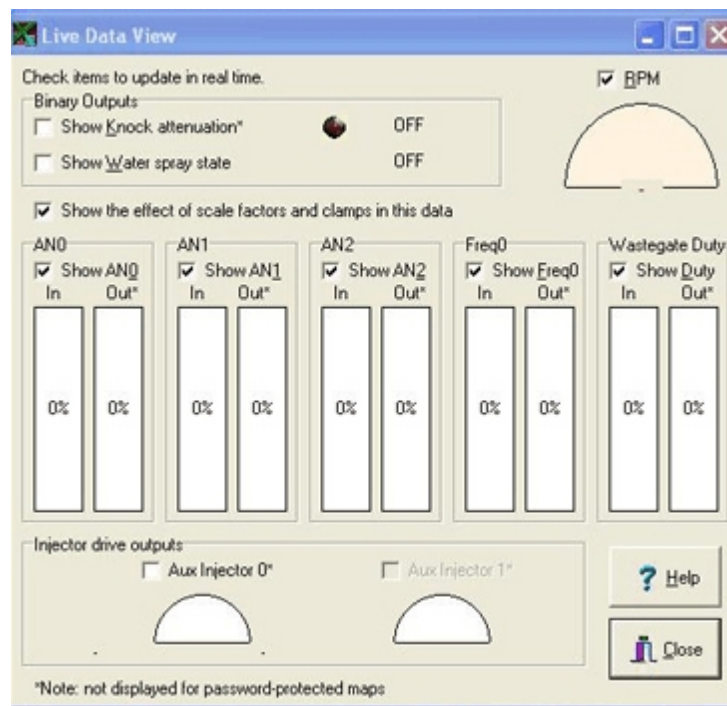
Figure 26

If an output clamp is set and has been reached, the bar graph for that port will turn red (on the out bar).

3.16 Wideband 02 Map

If the wideband O2 sensor has an Analog Out wire, it can be wired into the *XEDE* to make additional corrections. This is a safety feature only. Not an auto tune function. Prior to integrating a Wideband O2 fuel map (known as the SMART Fuel Map), the car *MUST* be tuned very well.

The SMART Fuel map is set up as a "nested map". A map within a map. The MAF voltage will come into the *XEDE*. Corrections will be made based on the MAF map. The signal will then pass thru the SMART Fuel Map, and make corrections based on the new input variable. (Which is the voltage from the wideband O2 sensor.) The modified MAF signal will then be sent to the stock ECU.

To set up a SMART Fuel map - please tune the car well at cruise, idle, and under boost. Send a copy of the map to BEGi. We will set up the map for the SMART Fuel function, then return it.

The Wideband O2 Sensor's analog output wire can be wired into the *XEDE* at any time. The WB O2 analog out wire will connect to the yellow wire in the *XEDE* harness. For example, the analog out wire on the LC-1 Wideband is yellow. Connect the two yellow wires.

If, for any reason, there is not a solid yellow wire in the harness, the WB O2 wire will connect to pin # 11 on the grey *XEDE* connector. Refer to figure 27.
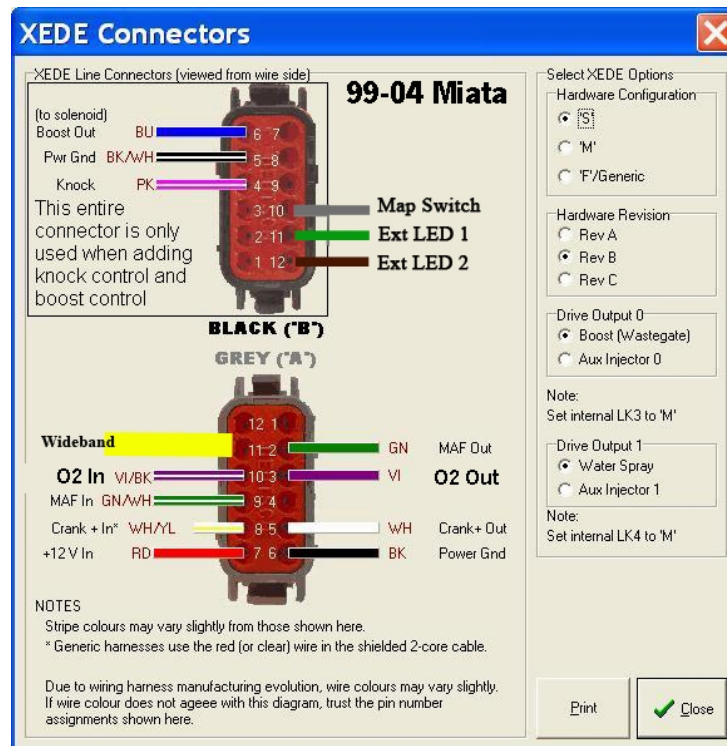
Figure 27

3.17   Knock Buffer

The knock buffer is an external sensor wired into the ECU to pick up on the stock knock sensor activity. The knock buffer is a safety feature only. Not an auto tune function. Nor should it be relied upon to provide accurate ignition timing control. The car's ignition timing *MUST* be tuned very well.

The knock buffer will display as a SMART Timing map. It is also set up as a "nested map". A map within a map. The Timing signal will come into the *XEDE*. Corrections will be made based on the Timing map. The signal will then pass thru the SMART Timing Map and make corrections (if needed) based on the new input variable. (Which is any signal picked up by the knock buffer.) The modified timing signal will then be sent to the stock ECU.

The knock buffer will need to be wired in by BEGi. BEGi will also set up the map as well.

3.18   Water / Methanol Injection Kit

The *XEDE* can control a Water / Methanol Injection kit. We suggest that you set it up with the Map Switch so that when the reservoir empties, the switch will ground, and go back to a non water/meth injection map automatically. This is possible, but only when the Meth/Water Injection pump has the feature independently of the *XEDE*. The AEM Methanol Injection Kit is an easy one to install and be controlled with the *XEDE*.

Wire in a rocker/toggle switch. See below for instructions. We suggest that the Meth / Water Injection map be loaded on the map bank associated with the illuminated side of the rocker switch. Please call us for assistance with this feature.

3.19   Map Switch

The *XEDE* has the ability to switch between two sets of maps "on the fly". The *XEDE* harness does come pre-wired for this feature, however the end user will need to install the toggle switch and ground the signal.

Find the wire that goes to pin # 10 on the black connector on the *XEDE* unit. Refer to figure 27. Find and install a rocker or toggle switch. From the rocker switch, one wire will connect to pin # 10. The other wire must go to pin # 6 on the grey connector. Use a T-Tap or scotch lock overlap connector to tap into the wire at pin # 6. Cover all wire connections with heat shrink or electrical tape.

Red Illuminated switches are very user friendly, and aid in quickly identifying which map bank the car is running on. A good place for the rocker switch is some where out of sight. The center console is a good place, or some where under the dash. Passengers or temporary drivers will fiddle with switches if they are in the line of sight.

3.20   Map Banks

The *XEDE* has the ability to switch between two sets of maps, "on the fly". Without turning the car off and/or reloading new maps with the computer. In order to utilize this feature, there must be a rocker switch installed, and the second map bank must be set up. There are two ways to set up the map banks.

First, In XMap you will need to set up the second map bank. The main map bank is label as "Map Bank 0". The second map bank is labeled as "Map Bank 1". The *XEDE* Configuration Settings window will also tell you how many map banks are set up. Place the rocker switch in the position you want for the first map bank. In XMap, click on 'Maps'. Click on 'New Map Bank'. Click on 'OK'. In the New: Map Bank window, click on Ok. Refer to figure 28. The Copy Maps window will pop up. Click on 'Go, copy Maps'. This will copy the maps from Map Bank 0 to 1. Refer to figure 29. It will copy the maps, and a window will pop up when it is complete. Click on 'OK'. Another set of maps will display. Click on the main XMap window. Look at the bottom row, it will now show "Map Bank 1" instead of the map file name. Alter the maps as needed.
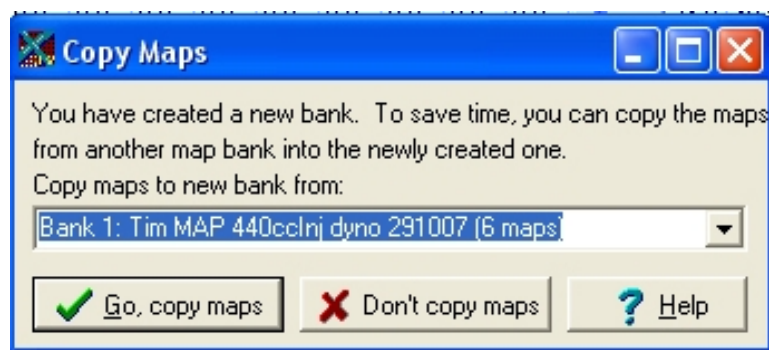
Figure 28
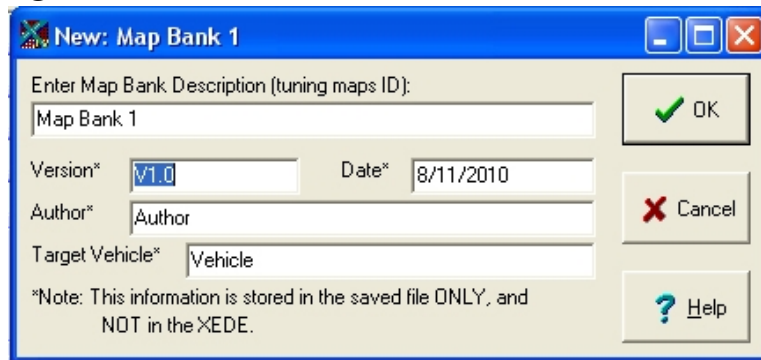
Figure 29

The second way to load maps is to connect to the *XEDE* unit, after a rocker switch is installed. Open XMap. Place the rocker switch in the "main" position. Turn the ignition key on. Upload and burn a copy of the maps to the *XEDE* unit again. Once complete, close all screens except the main XMap window. Flip the rocker switch to the new position. Upload and burn maps for the new map bank. Once done, the map bank will be shown in the lower left hand corner of the main XMap window.

3.21   Disable the Car

It is very easy to intentionally disable an *XEDE* tuned car. Unplug the *XEDE* unit from the wire harness. The car will crank but will never start. This comes in handy if you are parking the car at the airport.

3.22   Map Password / Security

A quirk of the *XEDE* software is the occasional pop up window that asks for a password. No maps from BEGI will contain a password. Unless the password is set by the user, ignore this pop up window. Click on ok and continue with tuning. Refer to figure 30.

3.23   Data Logging

The XMap software can datalog while the car is running. It will save it in a file format that can be accessed via a Microsoft Excel Spreadsheet.

From the main XMap window, click on "Diagnosis". Click on "Data Logging". Refer to figure 31. A window will pop up. Click on the box for the various analog inputs that need to be data logged. Use the chart on page 12 for reference. Refer to figure 32. In the lower right hand corner of the window, click on "Browse". Select a folder for the data log to be saved in. Give the file a name. Click on "OK". The file name will now display in the log filename line. When you click on the box for "Data Log Enabled", the data logging will commence. Refer to figure 33. It will continue to log data until you un-click this box. The file will automatically save. Open Microsoft Excel to view the data log file.
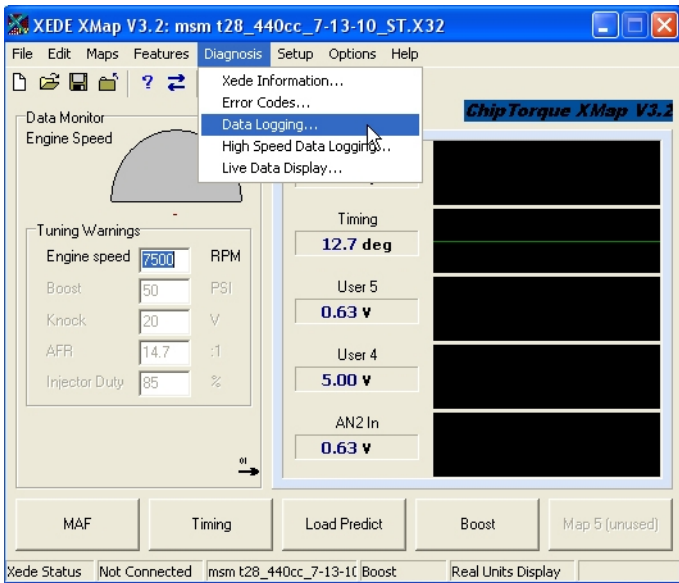
Figure 31
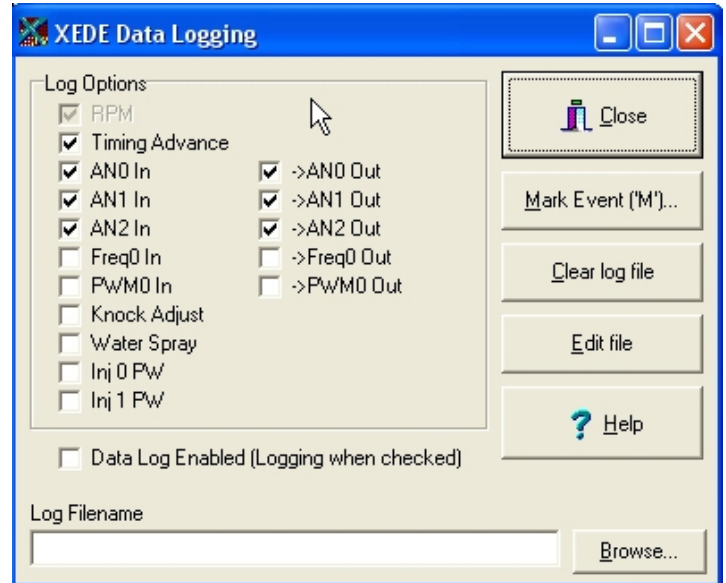
Figure 32

Figure 33

29
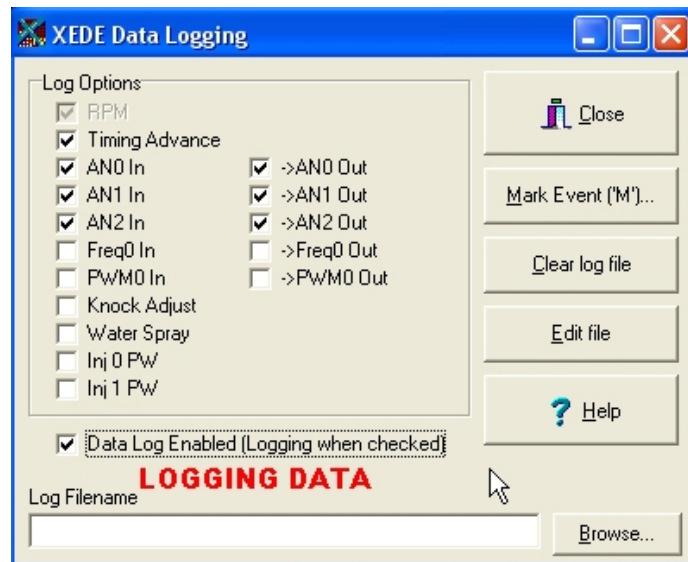
If you program either one of the LM-1's analog outputs as follows:

0V=10 AFR

5V=20AFR

The table looks like this:

Voltage	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
AFR	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	11.0	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8	11.9

Voltage	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80	1.85	1.90	1.95
AFR	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.8	13.9

Voltage	2.00	2.05	2.10	2.15	2.20	2.25	2.30	2.35	2.40	2.45	2.50	2.55	2.60	2.65	2.70	2.75	2.80	2.85	2.90	2.95
AFR	14.0	14.1	14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.9	15.0	15.1	15.2	15.3	15.4	15.5	15.6	15.7	15.8	15.9

Voltage	3.00	3.05	3.10	3.15	3.20	3.25	3.30	3.35	3.40	3.45	3.50	3.55	3.60	3.65	3.70	3.75	3.80	3.85	3.90	3.95
AFR	16.0	16.1	16.2	16.3	16.4	16.5	16.6	16.7	16.8	16.9	17.0	17.1	17.2	17.3	17.4	17.5	17.6	17.7	17.8	17.9

Voltage	4.00	4.05	4.10	4.15	4.20	4.25	4.30	4.35	4.40	4.45	4.50	4.55	4.60	4.65	4.70	4.75	4.80	4.85	4.90	4.95	5.00
AFR	18.0	18.1	18.2	18.3	18.4	18.5	18.6	18.7	18.8	18.9	19.0	19.1	19.2	19.3	19.4	19.5	19.6	19.7	19.8	19.9	20.0

NOTE: Be sure to ground the analog output ground to the same ground as your ECU or measurement device/datalogger. If ground offset does exist, you can either fix it or correct for it by subtrating the ground voltage offset from the table.

Figure 34

If the Wideband O2 is wired into the *XEDE* harness, it can log the WB O2 Voltage from the AN2 In port. It will not log AFR values. Refer to figure 34 for a voltage to AFR conversion.

Section 4: Starting The Car

If there is any part of the software that is confusing, please call to clarify. Once the software is familiar, the parts all installed, the car can now be started. No sensors need to be calibrated or added. The *XEDE* will run off of the stock sensors already installed.

When starting a 1997 to 2005 Mazda Miata with an *XEDE* installed, the engine must be rev'd above 1000 rpm for 3-5 seconds in order for the *XEDE* to turn on.

<u>Every Time!</u>
<u>NO EXCEPTIONS!</u>

The *XEDE* must recognize the waveform timing pattern file before it will turn on. Usually blipping the throttle a few times will be sufficient.

Please make sure the following has occurred prior to starting the car:

▸ Replace the gas cap.
▸ Turn ignition on, do not start the car. A red light will illuminate on the *XEDE* unit, then start to blink. It is easier to use a mirror to view the LED light, if the *XEDE* is installed under the dash.
▸ Start the car. Rev the engine to 1200-1500 rpm for 2 to 4 seconds. The light on the *XEDE* will briefly flash red, then turn solid green. If the light does not turn green, review the instructions and make sure all items are installed properly. If that does not turn the LED green, reload the timing pattern file. If that does not work, call the office for more help.
▸ It is normal if it takes a few more cranks than normal for the engine to turn over.
▸ Drive the car for a few miles before applying boost. If the car idles well and runs smoothly you may start applying boost. Verify that there is plenty of fuel when under boost. If the fuel mixture is too lean, lift off of the throttle so that no engine damage occurs.

4.1   The Car Will Not Start

Another quirk of the *XEDE* is to blow the fuel injection fuse, on the Miata. This will not happen to every car. It may even take a few years for the fuse to break too. We strongly recommend that an extra 30Amp fuse be purchased and kept in the car at all times. When this fuse breaks, the car will crank and crank, but never turn over.

In the 1994-2005 Miata, the fuel injection fuse is located under the hood. It is the 30 amp, pink fuse. Refer to figure 35 & 36.
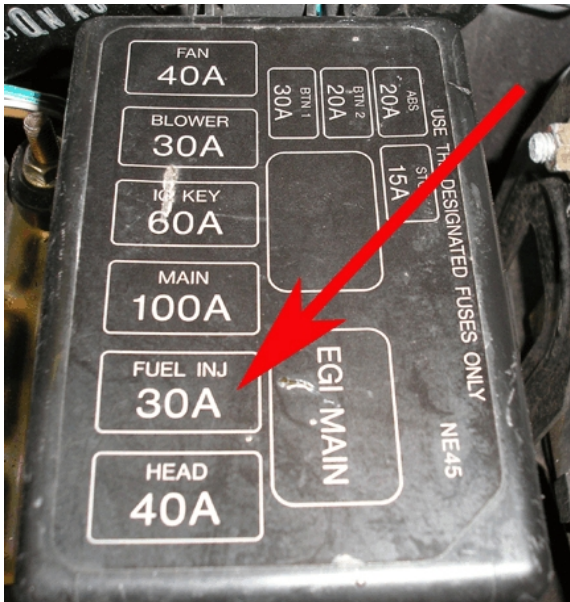
Figure 35
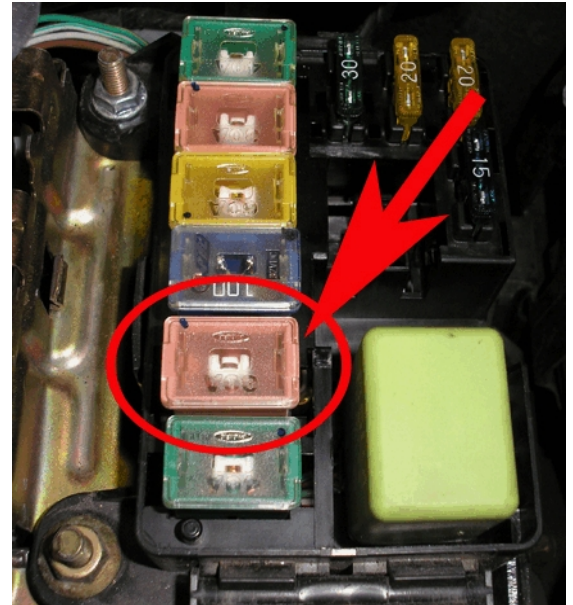
Figure 36

If the fuse is intact, make sure the *XEDE* is plugged in properly, then look at a mechanical reason the car will not work. Only 1% of the time will the failure to start be *XEDE* related.

Here are some places to start looking for problems:
*   If the red light does not illuminate, recheck all connections at ECU and *XEDE*.
*   If the LED on the *XEDE* Unit does not turn green, reload the timing pattern file.
*   If the car starts to act differently, remember that the stock ECU still reads and compensates for environmental and some driving conditions. If the problem persists for a few days, please call for assistance.

When the car operates with the *XEDE*, please remember:
*   Some check engine light codes are normal. If illuminated, have the codes read to see if it is a mechanical problem or the *XEDE*. Most problems with the car will not be *XEDE* related.
*   A P0300 MIL / CEL code is NORMAL! The *XEDE* maps advance the timing beyond what the stock ECU "thinks" is "normal". It sees this as abnormal and throws out the Random Cylinder Misfire code. To get rid of the code, simply zero out any timing advance (any positive number) in the Timing map. If the code persists, see the troubleshooting section.
*   Some check engine light codes are normal. If illuminated, have the codes read to see if it is a mechanical problem or tuning related. Please call or email for clarification.

More troubleshooting will be discussed at the end of this manual.

Section 5: Tuning

5.1 Overview

In this section, tuning will be broken down into four categories. Idle, Cruise, Boost, and Transitions. Each section is tuned slightly different. Figure 37 is a sample of the areas of the map you will address. The red lines would be representative of the transition areas. Start off tuning at idle and cruise. The OBD II code reader will be necessary to determine fuel trims and timing advance. The Wideband O2 gauge is also necessary for boost tuning. The base maps provided are a good place to start, however each map should be tuned for that car. What works best on one car will not necessarily work well on another car. Each car is broken in differently and the engine worn differently. Elevations change, air densities change, temperatures, etc.. Too many variables from one car to another to say one map is a 'one size fits all' type of thing.
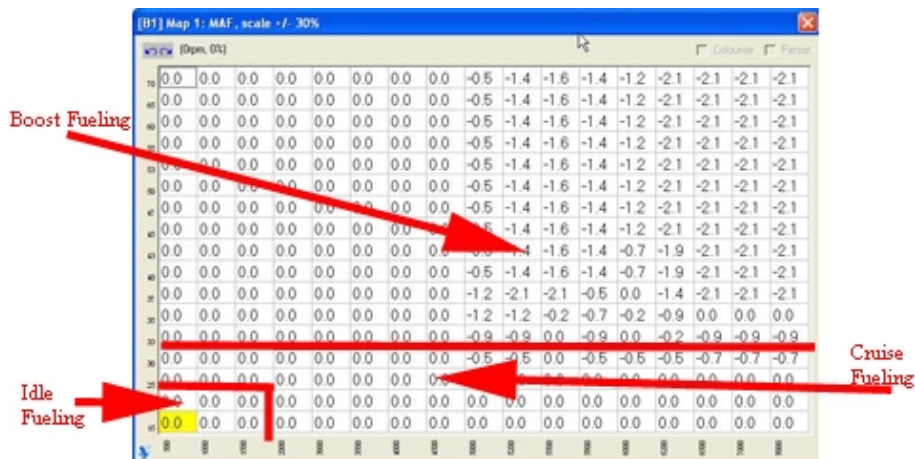
Figure 37

When using the OBD II code reader, the live data values and sensors to monitor should include the following:

- Long Term Fuel Trim
- Short Term Fuel Trim
- O2 Sensor, B1S1 (O2 Wide Range on MS3 & MX5)
- O2 Sensor, B1S2
- Engine RPM
- Calculated Load
- Intake Air Temperature
- Ignition Timing Advance
- Engine Coolant Temperature
- MAF Flow Rate
- Absolute Throttle Position
- Manifold Air Pressure

The Mx-5 and Speed3 can also view the following information to aid in tuning:
- Manifold Air pressure - in kPa
- Air Fuel Ratio
- Knock Sensor

BEGI uses Dyno Scan from www.auterraweb.com. It works well, however the DashDAQ is necessary to get knock sensor monitoring. Live data can be recorded and e-mailed to BEGi for viewing.

There are a few other OBD II readers with live data available. Scan Gauge II is popular, but it only displays four parameters at one time. It does not allow for data logging.

www.dashdaq.com The Dash DAQ is very handy and also great for track use. It also has an alarm feature that will go off if a viewed parameter exceeds a specified limit or signal.

www.autoenginuity.com. OBD II scan tools from the auto parts store will not work. It must be able to read live data or give sensor information.

Fuel trims are of utmost importance as they are the tuning reference and what the car is tuned for. If the O2 sensor voltages get stuck or are not constantly changing, it is a clear indication the car is out of tune. The calculated load is good to compare to the *XEDE* calculated load. The intake air temperature is of importance in heat soak conditions. The Ignition Timing advance is imperative to know. If the timing advance is not normal or abnormally retarded, mechanical issues should be looked at closely. The Engine Coolant Temperatures are also if significant importance. If the operating temperatures are too high, engine damage may result. ECT's should be monitored closely, especially when boost tuning. MAF flow rate is something for reference. The throttle position is important to know, especially on the MazdaSpeed Miata. Even if the *XEDE* does not control the TPS, it is important reference for open loop and closed loop settings. The Manifold air pressure is also used for reference.

It is quite normal to run a winter and summer map each year. The changes in temperatures and air densities necessitate different fueling needs.

5.2   Map Setup

In order to tune each map, it is important to understand how each map is set up, why it is that way, and what it does. That said, each map has been set up in a manner that should not need to be changed. Please consult with BEGI prior to changing maps. Each map has a description, rpm and load reference, input and output parameters, and a math function. Most of this has been discussed in the previous section. The math function of that map will also be easily seen in the blue menu bar at the top of the map. If the need for deviation exists, please consult with BEGi prior to doing so. Below is the typical set up for each map. Reference the chart on page 32 for more information also. Any of the following settings are acceptable. Not all applications will have each map. Use the maps provided with the base map.

▸   MAF - Should be set at +/- 0-30%, Scale (Multiply). No reason for deviation exists. This is the fuel tuning map. A 30% adjustment will probably never be used, as the MAF voltage would be exceed first.

▸   O2 Offset - Should be set at +/- 0-10%, Scale (Multiply) or +/- 0-20%, Scale (Multiply). Either is perfectly acceptable. No value less than -10 will really do any good as stock O2 sensors use a 0V -1.15V range. -10% is plenty to "turn off" the O2 sensor feed back. This is the open loop / closed loop control map for the 1994-2005 Miatas

▸   MAP - Should be set at +/- 0-30%, Scale (Multiply). No reason for deviation exists. A Value of -25% is plenty to "turn off" the sensor feedback. In some cases, on the 2006-2010 Miata, the MAP map can be left with all values set at zero. Some testing will be needed to determine if the car goes open loop sooner with -25 in the map, or a value of 0 in the map. Either value is perfectly acceptable. This is the open loop / closed loop control map for the 2006-2010 Miatas and MazdaSpeed 3s.

▸ TPS - 0-100%. Absolute Output. Used on MazdaSpeed Miata (MSM) ONLY! This is the best setting to eliminate the infamous MSM Bog. It sends a "fake" TPS signal to the ECU. This will result in two MIL/CEL's. This is the open loop / closed loop control on the 2004-2005 MazdaSpeed Miata.

▸ Boost - Should be set at 0-100%. Absolute Output. Some reasons for deviation exist, such as a valet boost map. This is the map to control the Duty Cycle of the boost solenoid. The values in this map do not specify the boost level to be achieved.

To run a valet boost map, the map set up can be changed to an offset or scale +/- 100%. To run a no boost or low boost map, the values in the map can be negative.

▸ Wideband O2 - Should be set at +/- 0-10%. Scale (Multiply). As small corrections will be made in the this map, no reason for deviation exists.

▸ Timing - +/- 10 degrees. Timing Change. No reason for deviation exists. If the timing cannot be controlled with a 10 degree change advanced or retarded, changes will need to be made to the fueling map. That will be explained later in the tuning of transitions and cruise section. This is the map that controls the ignition timing.

	1994-2004 Miata	2004-2005 MSM	2006-2010 MX5	MazdaSpeed3
AN0	MAF +/- 0-30% Scale (Multiply)	MAF +/- 0-30% Scale (Multiply)	MAF +/- 0-30% Scale (Multiply)	MAF +/- 0-30% Scale (Multiply)
AN1	O2 +/- 0-10% Scale (Multiply) or +/- 0-20% Scale (Multiply)	TPS 0-100% Absolute Output or +/- 0-20% Scale (Multiply)	MAP +/- 0-25% Scale (Multiply)	MAP +/- 0-25% Scale (Multiply)
AN2	Wideband O2 +/- 0-10% Scale (Multiply)	Wideband O2 +/- 0-10% Scale (Multiply)	Wideband O2 +/- 0-10% Scale (Multiply)	Wideband O2 +/- 0-10% Scale (Multiply)
Timing	Timing +/- 10 degrees Timing Change	Timing +/- 10 degrees Timing Change	Timing +/- 10 degrees Timing Change	Timing +/- 10 degrees Timing Change
PWM0	Boost 0-100% Absolute Output or +/- 0-100% Offset (Add)	Boost 0-100% Absolute Output or +/- 0-100% Offset (Add)	Boost 0-100% Absolute Output or +/- 0-100% Offset (Add)	Boost 0-100% Absolute Output or +/- 0-100% Offset (Add)

5.3   Idle Tuning
Fuel:

Idle tuning will vary from injector type, i.e. RC Injector or Denso/Bosch style. Ideally, the car should stay in closed loop at idle. However, if it goes open loop at idle it is perfectly acceptable as long as the car idles well and transitions from idle okay. The car should idle just like stock, even with larger injectors. Do not be surprised if fuel is added at idle to make the car happy. That is quite common.

Again, there is no reason it should not idle just like stock. If it does not idle like stock, please work on it more or look for a mechanical failure.

It is necessary to tune for hot start with the *XEDE*, on all applications. The cold start fueling needs of the engine will be met by the longer open loop start up. The car will not stay in open loop as long upon hot start. All cars should idle between 800-1000 rpm with the a/c off. All cars should idle between 1000 and 1200 rpm with the a/c on.

Cold start AFRs should be rich. It is open loop, so no fuel trims will be reported during this period. AFR should be about 12.0:1 to 13.0:1. This is completely normal, even on a stock Mazda. Most people do not have an AFR gauge on their OEM Mazda, so it is not something the average driver would know. The car should switch over to closed loop fueling mode within 3 -5 miles.

Hot start AFR should be stoich 14.7:1 or slightly richer. The more load the engine is under, the more fuel it will need. If it is desired to start the car with the a/c on, more fuel will be needed than if the car is started with the a/c off. A richer hot start, as long as it will transition out of idle okay and cold start okay. Some HD headlights will draw a lot of current on the car. It may be necessary to increase the fuel delivered to compensate for that electrical draw on the system.

Regardless of application, the RC injectors will need to be tuned for a long term fuel trim (LTFT) at idle. This will ensure that the car will idle on hot start, decelerate to idle well, and idle when warm but not moving. On the 1994-2005 Miatas and MX-5s, a LTFT of -10 to -16 is needed. That will typically provide for a good cold start, hot start, and the use of a/c at idle.

For Bosch or Denso style injectors, the idle will need to be tuned for a LTFT of -2 to +2, on hot start.

As you make changes in the map, blip the throttle a few times. Give the fuel trims a minute to settle down, then evaluate the changes just made. The engine rpm must be changed in order for changes made to be reflected in the LTFT. Be patient. Over correction leads to more time spent tuning.

O2 Offset

It is very important that the O2 offset map is *not altered* at idle. If the car needs to run open loop, it will do so without any assistance from the O2 map.

TPS

On the MazdaSpeed Miata it is completely normal for the TPS/Load Predict map to show a value of 11-13, depending upon the math function of the map. If the map is set up as an "absolute" math function, it is sending out a fake TPS signal. This allows us to control when the car goes open and closed loop. Alter the TPS signal as needed to get a smooth and consistent idle.

If the math function is "scaled" then the values in the map are being added on to the incoming sensor voltage. In order to pass OBD II inspection, the math function will need to be set to "scaled" and tuned for that. It is normal to see an offset of 2-5 at idle in the this type of map. If the value is higher,

that is ok. Tune for a stable idle.

MAP
On the Mazda Speed 3 and MX5s, the MAP sensor map needs to have a value of zero in the idle area. This signal does not need to be altered at idle.

Timing:
The idle quality will be greatly improved if you advance the timing at idle, on all applications. It will also help the car to tun slightly leaner at idle and have better throttle response. When the car runs rich, the ECU will automatically pull ignition timing. Which necessitates the addition of timing via the timing map. Usually a value of 4-5 is seen the idle area of the timing map. Do not advance the timing more than 6 degrees at idle.

Some supercharged applications should never see timing advance at idle or cruise, but only if engine knock is induced. In this instance, remove the timing advance to eliminate the engine knock. If the map has values of zero and it still produces engine knock, there is a mechanical issue that needs to be addressed. I.e. spark plugs, wires, timing belt, etc.

Do not retard the ignition timing at idle either. If ignition timing retard at idle is needed to make the car run well, the car has mechanical issues that need to be addressed. Start at the timing belt, camshaft, and crankshaft sensors.

On most Mazda applications, any advance to the timing map will cause a check engine light/ malfunction indicator lamp (CEL/MIL). This is because the car is running a timing advance that is outside what the ECU "thinks" is "normal". A P0300, random cylinder misfire, is completely normal if the timing is advanced. If the car were truly misfiring, it can be felt when sitting in or driving the car. To get rid of the CEL/MIL, simply remove the timing advance. However, it will be necessary to go back to the MAF map and remove some fuel (since the timing advance helps it to run leaner).

Boost:
It is important that the bottom two rows of the boost map read zero. The boost solenoid should be "turned off" at idle. Obviously, boost is not needed at idle. If these cells display a value, a clicking noise can generally be heard from the boost solenoid. This will also cause premature failure of the boost solenoid. The load values should be low for the bottom two rows. Granularity is not necessary in this map. See figure 38 for a typical boost map. Notice that the bottom two rows have a value of 0.

[B1] Map 4: Boost, absolute 0-100%

(0rpm, 0%) ☐ Colourise ☐ Persist

	1000	1500	2000	3000	4000	5000	5500	6000	6600	7000	7500
65	52.2	52.2	49.8	44.7	39.6	38.8	38.8	38.8	38.0	38.0	38.0
60	52.2	52.2	49.8	44.7	39.6	38.8	38.8	38.8	38.0	38.0	38.0
50	52.2	52.2	49.8	44.7	39.6	38.8	38.8	38.8	38.0	38.0	38.0
45	52.2	52.2	49.8	44.7	39.6	38.8	38.8	38.8	38.0	38.0	38.0
40	52.2	52.2	49.8	44.7	39.6	38.8	38.8	38.8	38.0	38.0	38.0
35	52.2	52.2	49.8	44.7	39.6	38.8	38.8	38.8	38.0	38.0	38.0
30	43.1	43.1	40.8	35.7	30.6	29.8	29.8	29.8	29.8	29.8	29.8
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 38

Returning to Idle:
Adjust fuel and timing as needed to ensure a smooth deceleration. The injectors should close when throttle is not applied, resulting in an AFR of 20+. Fuel can be added to increase the engine load, ensuring a smoother transition.

Sometimes the 1994-2005 Miatas have a problem returning to idle from cruise or boost conditions. Usually, the car will return to idle too quickly and cause it to stall. In this instance, you will need to alter the Idle Air screw in order to slow down the rate of deceleration. This screw is located on the passenger side of the throttle body. Turn it counter clockwise a 1/4 of a revolution until the car can return to idle normally or a little slower. This will not alter the rpm at which the car idles, only the rate at which the engine decelerates. Refer to figure 39.
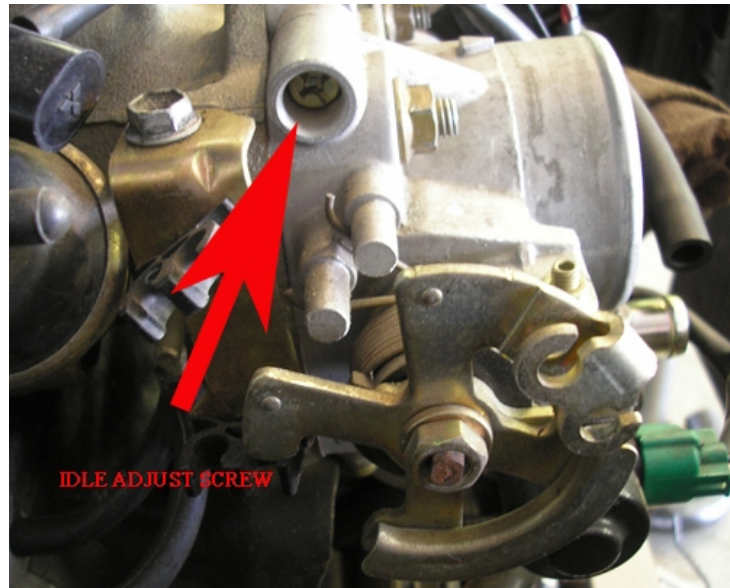
Figure 39

The *XEDE* will work on cars with built motors/forged internals, however it is not always the best solution available. If the cylinders have been over bored, the idle will probably need to be adjusted at the throttle plate. Remove the nut on the set screw and use an allen wrench to adjust the throttle plate until the desired idle speed is achieved. Re-tighten nut. Refer to figure 40.
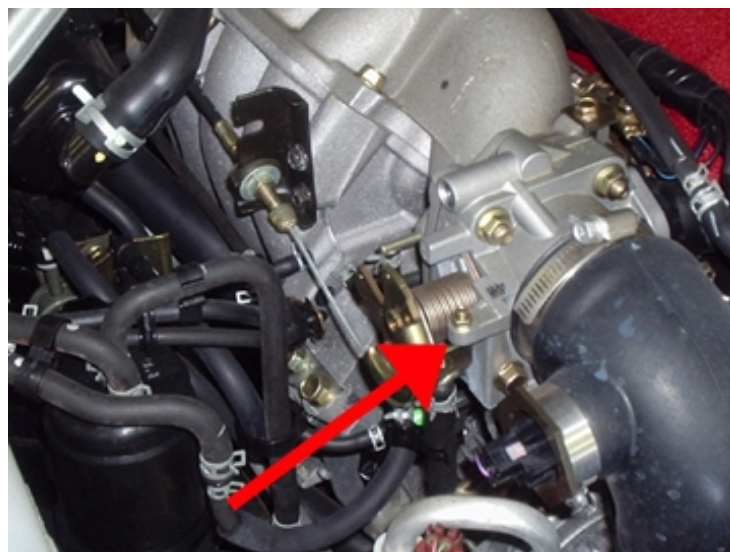
Figure 40

As the throttle is electronically controlled on the MazdaSpeed 3 and 2006-1020 Miatas, usually no changes are needed.

5.4   Cruise Tuning

This is anytime the wheels are moving on the car but the car does not see boost. At cruise, the car will need to be tuned for a LTFT of "0", zero. The LTFT works on a scale of -25 to +25. Negative meaning the ECU is pulling out fuel - over the long term. This means the car is running too rich. A positive number means the ECU is adding fuel over the long term. This means the car is running lean. The STFT (short term fuel trim) will be ignored unless it appears to be "stuck". If it goes to +25 or -25 and does not move, it needs to be addressed. At cruising speeds, the Wideband O2 readout is a reflection of the STFT. The values will constantly be moving.

Run the car up to 1 psi. Take note of where the engine load is. This is the boost threshold. This will be useful in knowing the cruise, boost, and transition areas that will be tuned. Each car will have a slightly different boost threshold.

Timing:
It is recommended that you set the timing map prior to the fuel map, at cruise only. Advancing the timing 0-3 degrees is completely normal. It will make the car run slightly leaner, have good throttle response, and faster spool up. If, at any point, engine knock is heard, reduce the timing advance. Typically 2 degrees is enough to get rid of engine knock. Advancing the timing beyond 5 degrees is not recommended at cruising engine loads and rpms.

It is also perfectly acceptable to have no timing advance at cruise. Just set the timing prior to doing the fuel tuning. *Any* changes to the timing map will affect the fuel trims. Refer to figure 37 for a typical timing map.

[B1] Map 2: Timing, timing +/- 10deg   (0rpm, 0%)   ☐ Colourise ☐ Persist

	50	1000	2000	3000	4000	5000	5300	5500	5700	6000	6300	6500	7000	7500
65	-6.4	-6.4	-6.4	-6.4	-6.4	-6.1	-6.1	-6.1	-6.1	-6.3	-6.3	-6.4	-6.5	-6.5
60	-6.4	-6.4	-6.4	-6.4	-6.4	-6.1	-6.1	-6.1	-6.1	-6.3	-6.3	-6.4	-6.5	-6.5
55	-6.4	-6.4	-6.4	-6.4	-6.4	-6.1	-6.1	-6.1	-6.1	-6.3	-6.3	-6.4	-6.5	-6.5
50	-6.4	-6.4	-6.4	-6.4	-6.4	-6.1	-6.1	-6.1	-6.1	-6.3	-6.3	-6.4	-6.5	-6.5
45	-5.4	-5.4	-5.4	-6.6	-6.6	-6.3	-6.1	-6.1	-6.1	-6.3	-6.3	-6.4	-6.5	-6.5
43	-5.4	-5.4	-5.4	-5.1	-5.1	-5.1	-5.1	-4.4	-6.7	-6.9	-6.9	-7.0	-7.1	-7.1
40	-4.7	-4.7	-4.7	-4.7	-4.8	-4.8	-4.9	-4.9	-4.9	-4.9	-4.9	-4.9	-4.9	-5.0
36	-2.5	-3.7	-3.7	-3.8	-3.8	-3.9	-3.9	-3.6	-3.6	-3.6	-3.6	-3.7	-3.7	-3.7
33	-2.1	-2.1	-2.1	-2.3	-2.3	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1
30	-2.5	-2.5	-2.5	-2.5	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9
27	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
25	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
20	6.0	6.0	6.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
10	6.0	6.0	6.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0

Figure 40

The Speed3s and MX-5 Miatas are equipped with fairly good knock sensor. Getting an OBD II code reader that can read the stock knock sensor is very helpful. 9 times out of 10 when the knock sensor will pick up that frequency, the driver cannot hear it. To avoid damage to the pistons - the timing must be retarded in the particular area (usually 7 - 9 degrees), and fuel must be added - in that particular spot. The newer vehicles run a lot of ignition timing advance. If the LTFT is made to be richer, the ECU will pull ignition timing automatically. If the ECU pulls timing, and the *XEDE* pulls timing, that will reduce the ignition timing advance so that there is no engine knock present. Remember any and all engine knock is destructible.

> For example, a 2007 Miata came in for tuning. It presented with the knock sensor pulling timing at 2500 to 3000 rpm, when not in boost. Engine knock was audible also. The LTFT was set to -1, in this area of the map. To make the engine knock go away, those cells added fuel to run a LTFT of -9 to -12. Then pull 5-9 degrees of timing. Refer to figure 41 & 42 for examples of how the MAF and timing maps were altered to solve the problem.

[B1] Map 1: MAF, scale +/- 30% (0rpm, 0%)

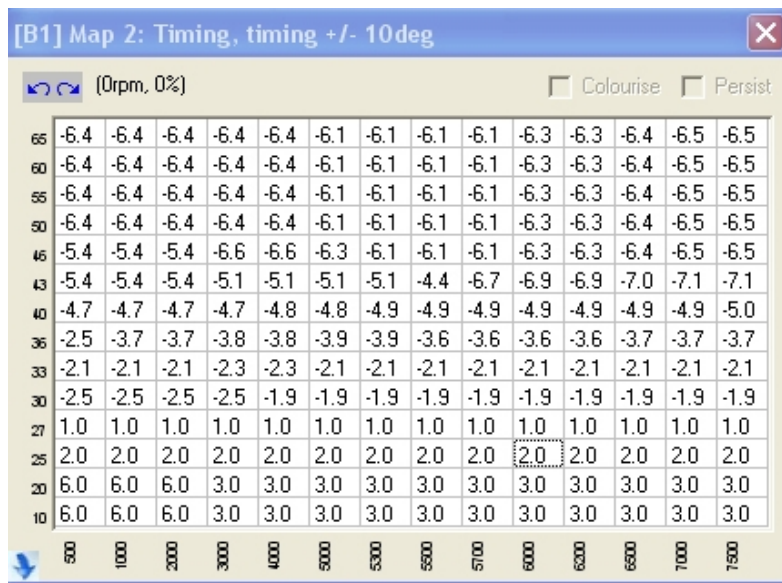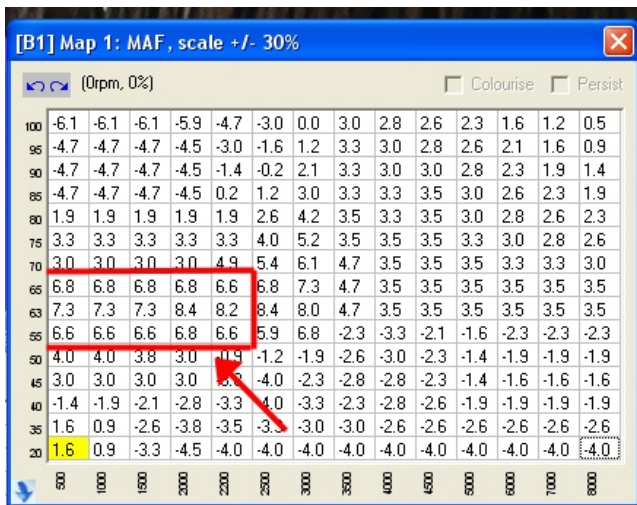|	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	7000	8000
100	-6.1	-6.1	-6.1	-5.9	-4.7	-3.0	0.0	3.0	2.8	2.6	2.3	1.6	1.2	0.5
95	-4.7	-4.7	-4.7	-4.5	-3.0	-1.6	1.2	3.3	3.0	2.8	2.6	2.1	1.6	0.9
90	-4.7	-4.7	-4.7	-4.5	-1.4	-0.2	2.1	3.3	3.0	3.0	2.8	2.3	1.9	1.4
85	-4.7	-4.7	-4.7	-4.5	0.2	1.2	3.0	3.3	3.3	3.5	3.0	2.6	2.3	1.9
80	1.9	1.9	1.9	1.9	1.9	2.6	4.2	3.5	3.3	3.5	3.0	2.8	2.6	2.3
75	3.3	3.3	3.3	3.3	3.3	4.0	5.2	3.5	3.5	3.5	3.3	3.0	2.8	2.6
70	3.0	3.0	3.0	3.0	4.9	5.4	6.1	4.7	3.5	3.5	3.5	3.3	3.3	3.0
65	6.8	6.8	6.8	6.8	6.6	6.8	7.3	4.7	3.5	3.5	3.5	3.5	3.5	3.5
63	7.3	7.3	7.3	8.4	8.2	8.4	8.0	4.7	3.5	3.5	3.5	3.5	3.5	3.5
55	6.6	6.6	6.6	6.8	6.6	5.9	6.8	-2.3	-3.3	-2.1	-1.6	-2.3	-2.3	-2.3
50	4.0	4.0	3.8	3.0	0.9	-1.2	-1.9	-2.6	-3.0	-2.3	-1.4	-1.9	-1.9	-1.9
45	3.0	3.0	3.0	3.0	3.3	-4.0	-2.3	-2.8	-2.8	-2.3	-1.4	-1.6	-1.6	-1.6
40	-1.4	-1.9	-2.1	-2.8	-3.3	4.0	-3.3	-2.3	-2.8	-2.6	-1.9	-1.9	-1.9	-1.9
35	1.6	0.9	-2.6	-3.8	-3.5	-3.3	-3.0	-3.0	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6
20	1.6	0.9	-3.3	-4.5	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0

Figure 41

[B1] Map 3: Timing, timing +/- 10deg (0rpm, 0%)

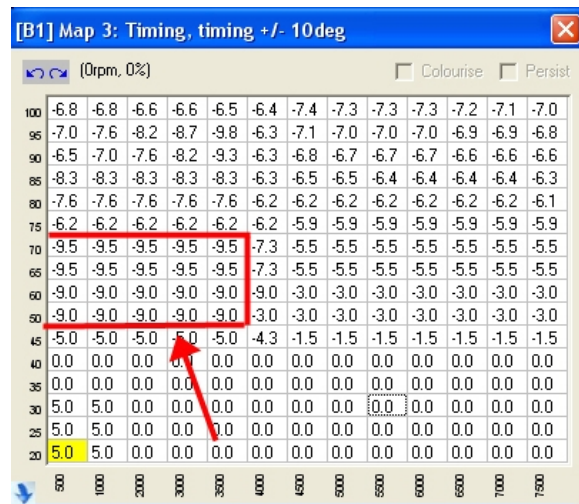|	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500
100	-6.8	-6.8	-6.6	-6.6	-6.5	-6.4	-7.4	-7.3	-7.3	-7.3	-7.2	-7.1	-7.0		
95	-7.0	-7.6	-8.2	-8.7	-9.8	-6.3	-7.1	-7.0	-7.0	-7.0	-6.9	-6.9	-6.8		
90	-6.5	-7.0	-7.6	-8.2	-9.3	-6.3	-6.8	-6.7	-6.7	-6.7	-6.6	-6.6	-6.6		
85	-8.3	-8.3	-8.3	-8.3	-8.3	-6.3	-6.5	-6.5	-6.4	-6.4	-6.4	-6.4	-6.3		
80	-7.6	-7.6	-7.6	-7.6	-7.6	-6.2	-6.2	-6.2	-6.2	-6.2	-6.2	-6.2	-6.1		
75	-6.2	-6.2	-6.2	-6.2	-6.2	-6.2	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9		
70	-9.5	-9.5	-9.5	-9.5	-9.5	-7.3	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5		
65	-9.5	-9.5	-9.5	-9.5	-9.5	-7.3	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5		
60	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0		
50	-9.0	-9.0	-9.0	-9.0	-9.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0		
45	-5.0	-5.0	-5.0	-5.0	-5.0	-4.3	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5		
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
30	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
25	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
20	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Figure 42

<u>Fuel:</u>
Again, tune the car for a LTFT of 0. This will ensure good response and fuel economy. Make small changes in the active cells, as needed, based upon the LTFT. If the LTFT is a positive number, then add fuel in the MAF map, and vice versa. All four active cells can be changed at one time, but it usually recommended that small changes, to individual cells, be made first so that the tuner can get a feel for what that change will result in.

The car will need to be driven at a steady state in order to see the changes reflected faster. If a load bearing dyno is not available, find a place (off road) that allows for slower, steady state driving. It is recommended that one person drive and a second person tunes the car. One way to tune it quickly is to hold a certain speed thru all the gears. That will usually cover all the cells that need to be tuned. *Be patient.* The changes will not be instant, give the car a few miles for the fuel trims to stabilize. This will take some time. Quick or Over corrections will lead to fixing the incorrect tuning just created.

> For example, drive 30 mph in 3rd gear. Hold the car at a steady speed and load. The active cells should be steady. Read the LTFT, make adjustments as needed. Give the car a few miles to reflect the changes made. Once those cells are as close to a LTFT of 0, move on. Run the car at 40 mph in 3rd gear, and tune for those cells. Run the car at 50 mph in 3rd gear. Run the car at 35 mph in 4th gear, 40 mph in 4th gear, 50 mph in 4th gear, 60 mph in 4th gear,

70 mph in 4th gear, and so on. Until many cells are tuned. Not every cell in this map will be tuned.

At lower speeds and lower gears, the car needs to run a little rich - on the RC injectors. Usually a LTFT of -5 to -10 is sufficient. On Bosch/Denso style injectors a LTFT of 0 to -5 is recommended.

The car should be able to pull itself in first and second gear, with no throttle, and no bucking. Adjust the low speed cells, by adding fuel, as needed to achieve this. When sitting in slow moving traffic, you will thank me for this. :)

Upon decelerating from cruise, it is normal for the fuel trims to 0 out or even go lean. The injectors usually shut off and no fueling changes are needed. Make sure that the fuel maps are not tuned for this load value. The ECU controls already in place usually work well.

With the RC injectors, it is sometimes necessary to add fuel upon a constant speed and light load conditions. For example, if the car is driven in the mountains or the hill country, the car will shut the injectors off when going down a hill. If this is annoying, fuel can be added to those cells in order to prevent the injector shut off. By adding fuel, the engine load is being increased, and the car will cruise steadier. Do not be surprised if large amounts of fuel are needed, in the bottom two rows. Typically, the Denso/Bosch style injector will scale back the spray to compensate for the lighter loads.

If the situation arises that the STFT is "stuck" rich or lean, then you need to adjust fuel as indicated, as the car is very "unhappy". For example, if the STFT is stuck at +25, then you need to add fuel. Even if the LTFT reads -20.

The injector scaling should only be changed as a last resort, and not done often. If the MAF map has values in excess of -10 or +10, then changing the output scaling is warranted. Do not randomly change the output scaling to get the desired LTFT. For example, if the MAF map contains more than five cells with +12, then changing the output scaling from 0.96 to 0.97 is warranted. It obviously needs a little bit more fuel. Remember the MAF map is for fine adjustment.

Cars can be tuned slightly lean at cruise conditions. This would be done for optimal fuel economy. Use caution when doing this in warmer ambient temperatures. Leaner fuel conditions and warm ambient conditions will make the coolant temperatures more likely to be higher. Monitor ECTs closely.

MAP and O2 Offset:
It is very important that the O2 offset map and the MAP map *are not altered* at cruise conditions also. The cell values should be 0. The car will run better and see better fuel economy if it stays in closed loop fueling conditions at cruising speeds. Again, cruising speeds is when the car is moving, but not in boost.

TPS:
Altering the TPS map will depend upon the math function of the map. If the math function is set to absolute, the *XEDE* is sending it's own TPS signal, and more configuration is needed. While it is slightly more effort, the car will run better in this mode. If the map's math function is set to scale or offset, it will be adding onto the TPS voltage passing thru the *XEDE*. This works well also, but will not eliminate the "MSM Bog", like the absolute output will.

Figure 43 is a typical TPS absolute output map. Deviation, in small amounts, is perfectly acceptable - at cruising speeds and idle. *DO NOT* deviate when under boost. The car must see a 100% TPS voltage in order to go open loop in a timely manner. Make sure that the TPS voltage is 100% at the boost threshold, and significantly less at cruise.

[B1] Map 3: Load Predict, offset +/- 100%

(0rpm, 0%)   ☐ Colourise   ☐ Persist

	700	1000	1500	2000	2500	3000	4000	4500	5000	6000	7000
55	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
45	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
42	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
39	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
37	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
33	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
31	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
30	25.0	25.0	25.0	25.0	25.0	25.0	25.0	99.2	99.2	99.2	99.2
28	10.2	10.2	10.2	10.2	10.2	10.2	10.2	99.2	99.2	99.2	99.2
27	6.3	6.3	6.3	6.3	6.3	6.3	6.3	99.2	99.2	99.2	99.2
25	4.7	4.7	4.7	4.7	4.7	4.7	4.7	99.2	99.2	99.2	99.2
22	3.1	3.1	3.1	3.1	3.1	3.1	3.1	99.2	99.2	99.2	99.2
20	4.7	4.7	3.1	3.1	3.1	3.1	3.1	99.2	99.2	99.2	99.2
18	4.7	4.7	3.1	3.1	4.7	5.5	7.0	99.2	99.2	99.2	99.2
15	4.7	4.7	3.9	3.1	3.1	3.1	3.1	99.2	99.2	99.2	99.2

Figure 43

Below is a typical TPS scale/offset output map. Deviation, in small amounts, is perfectly acceptable - at cruising speeds and idle. *DO NOT* deviate when under boost. The car must see a 100% TPS voltage in order to go open loop in a timely manner. Make sure that the TPS voltage is 100% at the 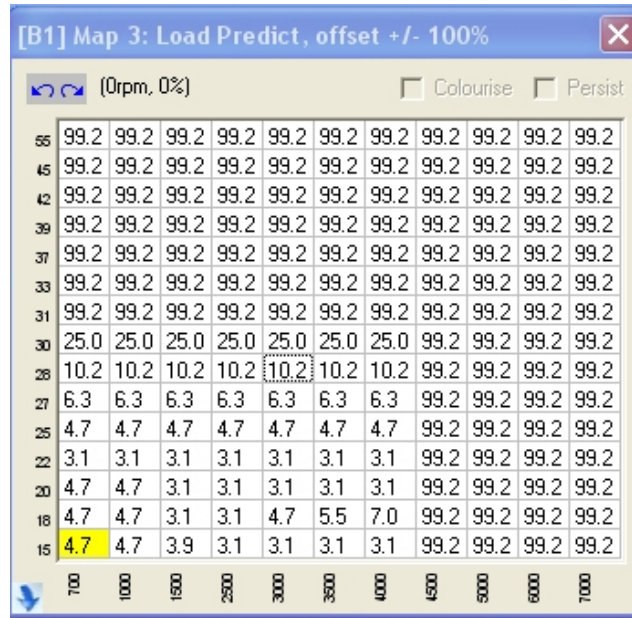boost threshold, and significantly less at cruise. Notice the smaller offsets in the cruise portion of the map. This is fairly typical. Refer to figure 44.
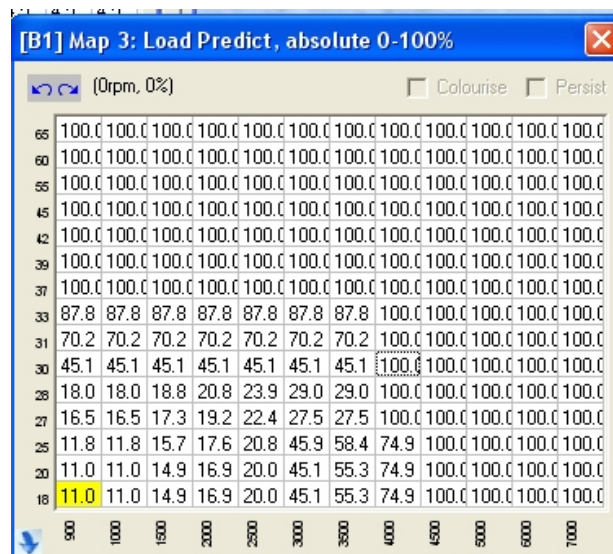
[B1] Map 3: Load Predict, absolute 0-100%

(0rpm, 0%)   ☐ Colourise   ☐ Persist

	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	6000	7000
65	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
60	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
55	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
45	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
42	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
39	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
37	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
33	87.8	87.8	87.8	87.8	87.8	87.8	87.8	100.0	100.0	100.0	100.0	100.0
31	70.2	70.2	70.2	70.2	70.2	70.2	70.2	100.0	100.0	100.0	100.0	100.0
30	45.1	45.1	45.1	45.1	45.1	45.1	45.1	100.0	100.0	100.0	100.0	100.0
28	18.0	18.0	18.8	20.8	23.9	29.0	29.0	100.0	100.0	100.0	100.0	100.0
27	16.5	16.5	17.3	19.2	22.4	27.5	27.5	100.0	100.0	100.0	100.0	100.0
25	11.8	11.8	15.7	17.6	20.8	45.9	58.4	74.9	100.0	100.0	100.0	100.0
20	11.0	11.0	14.9	16.9	20.0	45.1	55.3	74.9	100.0	100.0	100.0	100.0
18	11.0	11.0	14.9	16.9	20.0	45.1	55.3	74.9	100.0	100.0	100.0	100.0

Figure 44

In order to pass OBD II inspection with the *XEDE*, it will be necessary to set the TPS map math function to scale or offset. See the OBD II inspection section, at the end of this manual, for more details.

<u>Boost:</u>
The duty cycle of the boost solenoid will be altered to achieve a specific boost level. If the car experiences boost creep or spikes, that will need to be taken into consideration when setting up this map. Duty cycle values differ from one boost solenoid to another. Start with the base map provided and adjust as necessary to reduce or increase the boost level. Even though the car may not be in boost at cruise, the car will pass thru this range when under boost. All cells, except the ones on the bottom two rows, will need to have a value of some kind in it. Remember, these values are for duty cycle. Not specifying the boost level. See figure 34, on page 34, for an example.

5.5   Boost Tuning
This is anytime the car is *in boost*, 1 psi or higher. It is extremely important to make sure the car goes open loop, in a timely manner, when going in the boosted areas. If the car remains in closed loop, the O2 sensor will continue to provide feedback on fueling needs, resulting in a lean fueling condition. The Speed3s and the MX-5 Miatas are programmed to achieve a specific AFR when in closed loop. If the car remains in closed loop, then the *XEDE* and ECU will be fighting for fueling control, and consequently run too lean as it is targeting a stoich 14.7 AFR. If the car goes open loop, when desired, problems can be averted. Each car uses a different method to achieve open loop fueling status.

When in boost, the car will be tuned for Air Fuel Ratio and timing retard only. The mechanism of open loop / closed maps should not be altered very much, or from winter to summer, or at all. When the car is in open loop, it will be tuned for AFR, and not fuel trims. The values in the MAF map, alone, will determine the fueling / AFR.

The MX-5 Miatas and Speed3s do have a stock Wideband O2 sensor (WB O2). You can use it to determine fueling, but *ONLY* after it is determined to read accurately. Place a tailpipe wideband O2 on the car and compare the values seen with the stock WB 02 sensor. If they match or read closely, the stock sensor can continue to be used. The tailpipe WB O2 will read about 0.5 AFR leaner than the stock sensor. That is completely normal due to placement of sensors. The closer the sensor is to the turbo, the richer it will read. It is perfectly acceptable to tune via a tailpipe WB O2. It will leave a nice AFR "cushion" should it ever be needed.

On 1994-2005 Miatas, typically, but not set in stone by any means, the car will transition into boost about a load value of 30-35. On 2006-2010 Miatas, the area will transition into boost about a load value of 50 and 60. Same for the MazdaSpeed 3.

Air/Fuel Ratio ranges vary when the car is in open loop and closed loop. Here is a general list of AFRs and when they should be targeted:
▸   15.0 AFR or Greater - lean. AFRs should never be consistently above 15 in closed loop or open loop.
▸   14.7 AFR is Stoich. This should be the average AFR when in closed loop.
▸   12.5 AFR to 10 AFR is acceptable when in boost and open loop.

<u>MAP</u>
The MX-5 Miata and the Speed3s will go open loop via the MAP sensor. On the Speed3s, the MAP map also keeps the ECU from controlling the boost solenoid. Typically, at a load value of 65 to 70, all cells should contain a value of -19. This will turn off the MAP sensor and it will no longer provide feedback. Refer to figure 46.

Some MX-5 Miata applications do okay with a value of 0 in the entire map. If the map with all zeros

goes open loop quickly, it is fine. If not, put the -19 values in the map to determine which works better. Reference figure 45 & 46 for example MAP sensor maps. Again, the Mx-5s can use maps like figure 45 or 46. The Speed3s must use a map like figure 46.
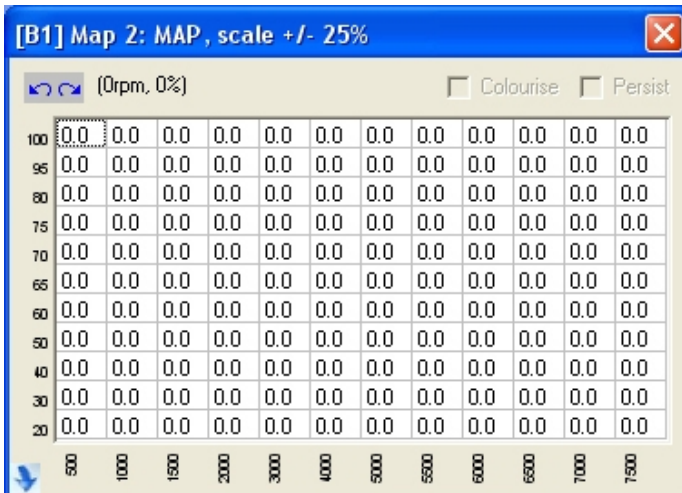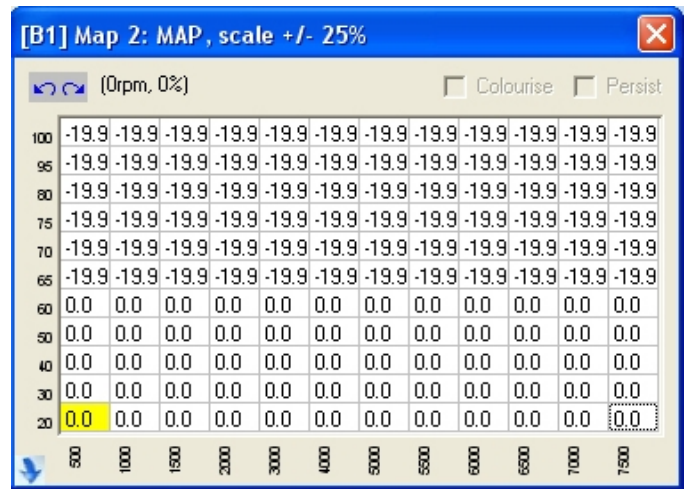

Figure 45

Figure 46

O2 Offset
The 1994 to 2005 Miatas will go open loop via the O2 sensor. Turning off the O2 sensor will achieve the desired open loop conditions. The O2 offset map should read -10 to -20 between load values of 30 to 100, and 1000-7000 rpm. Refer to figure 47.
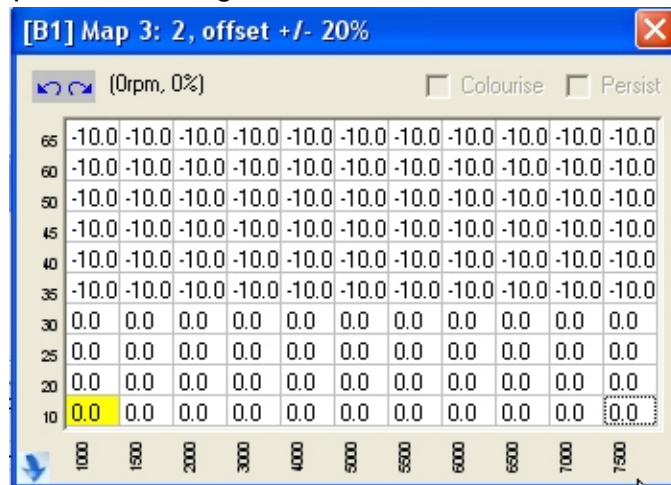
Figure 47

TPS
The Mazda Speed Miata goes open loop via the throttle position sensor. This map can be set up two different ways, as discussed in the cruise tuning section. See figures 41 & 42 on page 39 for examples.

Fuel
Once open loop, the fuel will be determined solely on the MAF map, in the boosted areas. Adjust the cell values, as needed, to achieve the desired AFR. Tune for an AFR between 11.0 to 12.5.

Using the tracing feature can be helpful when needing to know where to add fuel at a given rpm. Fuel maps will vary greatly between cars. Some will take out fuel when in boost, some will add some fuel

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when in boost. It is not possible to predict what injector will do what, and what the maps should look like. Tune for a good AFR on this particular vehicle.

Do not be surprised if the cruise area of the map is varied in cell contents. Then the boost area has constant numbers. Once the car is open loop, averaging across the four cells is less important.

Timing
Adjust the timing so that there is no engine knock present. Engine knock is only audible if the a/c is off, convertible top up, and windows closed. If knock is heard, retard the timing by 0.5 degrees until gone. Then retard an additional 1.0 to 1.5 degrees to give a knock threshold/barrier.

Timing maps will also vary greatly between cars. Some will retard more ignition timing than others. It is not possible to predict what the timing maps should look like. That said, a map with less than 5 degrees of ignition retard is considered a fairly aggressive map. Keep listening for engine knock as it is the motor's "kiss of death".

If circumstance are such that there is one rpm range where engine knock happens consistently, no matter the AFR, and with a full10 degrees of retard - there are two approaches to take. First, change the fuel filter. Ninety percent of the time this will solve the problem. Secondly, add fuel in the previous cells and rows. Make the LTFT richer so that it will have more fuel present when it transitions into boost. If neither approach works, the engine has mechanical issues to be addressed. Or, the base timing has not been returned to stock settings.

Boost:
Adjust the duty cycle of the boost solenoid, as needed, to achieve the desired boost level.

The Mazda Speed Miata uses a restrictor pill in the boost solenoid vacuum line. This pill must be used or the MSM will over boost. Some other electronic boost solenoids will require the use of a restrictor pill as well. When testing a boost solenoid, use caution until it is known whether or not a restrictor pill is needed.

5.6   Transitions Tuning
This is anytime the car is transitioning from idle to cruise, cruise to boost, or boost to idle. The car should transition smoothly without any hiccups or hesitations. Use the tracing and interpolation features to make transitions tuning easier.

From Idle to Cruise:
> Fuel: The car will need to run a slightly rich LTFT coming off of idle. Adjust the LTFT until needed until it is smooth. Use the interpolate feature to average the cell contents for a smoother transition. Hesitations are usually indicative of a lean spot.

> Timing: Typical timing settings is the same as idle, or one degree less of advance.

> MAP and O2 Offset: Cell values should be zero.

> TPS: Cell values vary based on the map set up. If running an absolute value, the TPS should be about 11-13 at idle. At cruise, the TPS should be about 18-20. Use interpolate to smooth transitions.

> Boost: Add in boost solenoid duty cycle beyond the two bottom rows. That way the car can

make boost in the lower gears when accelerating from a stop.

From Cruise to Boost: (aka tip in)

MAP and O2 Offset: The cell contents need to be altered to make the car go open loop as soon as one 1 psi is achieved.

TPS: The cell contents must be 100% as soon as 1 psi is achieved.

Fuel: Some cars do better with a leaner AFR to boost tip in. Some cars do better with more fuel. Adjust as needed for better turbo spool and AFR. A Lean tip in to boost is acceptable as long as there is no engine knock present. Transition should be smooth. Hesitations are usually indicative of a lean spot.

Timing: Upon tip in to boost, the timing should start to be retarded. Some cars will need an immediate ignition retard of 3 to 5 degrees. Some cars do well with 1 to 2 degree of retard. Either is acceptable as long as there is no engine knock present or picked up. Ignition timing retard should become more negative as the rpm and engine load increases. See figure 37 on page 36 for an example.

Boost: The cell contents should already have a value. Adjust as needed to help with turbo spool and quicker onset of boost. If any boost spikes or creeps occur, be sure to account for that. Do not let the creep or spike go beyond the capabilities of the stock motor. Do not be surprised if the cell values are higher mid range than they are at higher rpms. That is normal for some electronic solenoids.

From Boost to Cruise:

MAP and O2 Offset: This area of the map should also be 0. The car needs to revert to closed loop at cruise.

TPS: Revert to normal cruising TPS values. Use interpolate if needed to smooth the downward transition.

Fuel: The downward transition should also be smooth and linear. Ensure the car reverts to closed loop again and has sufficient fuel. Adjust cell contents as needed. Hesitations are usually indicative of a lean spot. Slow response to the throttle is indicative of a rich spot. It is normal for the right hand side of the MAF map to have more fuel than the "cruise" area of the map.

Timing: The timing should also revert back to cruise settings.

Boost: The cell contents should already have a value. Adjust as needed to help with turbo spool and quicker onset of boost should the car be accelerated again.

From Boost to Idle:

MAP and O2 Offset: This area of the map should also be 0, below the boost threshold. The car needs to revert to closed loop, at cruise, smoothly.

TPS: Revert to normal idle TPS values. Use interpolate if needed to smooth the downward transition. The map does need values in the lower rows to hold a minium idle. Cell contents can increase slightly, on the bottom row, when returning to idle. This is sometimes necessary

to maintain idle.

Fuel: When the foot is lifted off the accelerator pedal, it is normal for the injectors to shut off and AFRs to show lean. The car also goes open loop upon deceleration. Once the car returns to idle it should change to closed loop fueling. Even though the car will be open loop, if too lean, it can cause a bog when lifting off of the throttle. There needs to be values in those cells. Copy the last tuned column, at cruise, over to the upper rpm range of the map (for the same load values). Refer to figure 38 on page 37. The values add fuel in the higher rpm goes.

Timing: No timing advance is necessary upon deceleration. However, if the car is too rich timing can be added back in to lean it out some.

Boost: The bottom two rows of the boost map should be empty.

From Cruise to Idle:
Fuel: Typically, a little fuel is added upon deceleration. The car tends to run smoother when there is a little extra fuel and engine load.

Timing: No timing advance is necessary upon deceleration, however if the car is too rich timing can be added back in to lean it out some.

MAP and O2 Offset: This area of the map should also be 0. The car will still be in closed loop at cruise.

TPS: Revert to normal idle TPS values. Use interpolate, if needed, to smooth the downward transition. The map does need values in the lower rows to hold a minium idle. Cell contents can increase slightly, on the bottom row, when returning to idle. This is sometimes necessary to maintain idle.

Boost: The bottom two rows of the boost map should be empty.

Section 6: Passing OBD II Inspection

1994-2005 Miata - The timing map will need all of the ignition timing advance removed. Change any positive number to a zero. Fuel will need to be removed from the MAF map also. The car must be tuned well to avoid MAF meter CEL/MILs.

MazdaSpeed Miata - The timing map will need all the ignition timing advance removed. Fuel will need to be removed from the MAF map also. The car must be tuned well to avoid MAF meter CEL/MILs. The boost solenoid will need to be rewired back to the stock configuration.

The math function of the TPS map will have to be changed. Change it to +/- 0-20%. Scale (Multiply). Change the cell contents for all load values below 50 to zero. This will allow the stock TPS signal to pass thru the *XEDE*, unmodified. It will also not send the car open loop sooner. Do not drive the car in boost with this map set up. Obvious reasons dictate that when under boost closed loop fueling = lean conditions = broken motor.

2006-2010 MX-5 Miata - The timing map will need all the ignition timing advance removed. Fuel will need to be removed from the MAF map to compensate. The car must be tuned well to avoid MAF meter CEL/MILs.

MazdaSpeed 3 - The timing map will need all the ignition timing advance removed. Fuel will need to be removed from the MAF map also. The car must be tuned well to avoid MAF meter CEL/MILs.

Section 7: CEL / MIL Codes

It is not abnormal for the car to throw various CEL/MILs during the tuning process. Various codes will be indicative of certain problems. Here are a few common codes and problems seen. If in doubt, please call BEGI for assistance.

MAF codes
▸ MAF Voltage too Low - indicative of the car being out of tune, somewhere in the MAF map.
▸ MAF Voltage too High - indicative of reaching the upper adjustment range of the MAF voltage.
  ▸ If this occurs, and the car is too lean as a result, reduce the boost level to ensure that the car has plenty of fuel. Make sure the AFRs under boost are below 12.0.

O2 Sensor Codes
▸ O2 Sensor No Signal - the stock O2 sensor has failed or has been disconnected. Check wires and/or replace the sensor. Bosch wire in sensors work just as well as OEM replacement sensors.
▸ O2 Sensor Stuck Rich or Lean - usually the sensor is okay, but the car is badly out of tune. If tuning does not result in normal operation, the sensor may be failing. Try tuning it out first.
▸ Too rich or lean off or at idle - usually the sensor is okay, but the car is badly out of tune.
▸ Catalyst below efficiency - the Catalytic convertor has been removed and the rear O2 Sensor does not show enough of a voltage change (from the front sensor). Either install an O2 sensor modifier or re-install a catalytic converter. This can also be a symptom of a soon to fail O2 sensor or catalytic converter.
▸ O2 Sensor Heater Error - usually indicative of a failing sensor or a voltage/power issue on the car. The O2 sensor will use the most power when warming up and then again maintaining a specific operating temperature (during colder weather). O2 sensors must maintain a specific operating temperature in order to work well. For example, the stock O2 sensor typically needs to be about 600* F in order to operate properly. The Heater circuit maintains this temperature. If the voltage supplied to the sensor cannot allow the heater circuit to maintain 600*F, then a code will ensue. This can be from a defective heater circuit or improper voltage supplied to the sensor (i.e. bad battery).

TPS Codes
▸ TPS Voltage High or Low - Normal codes when the *XEDE* sends a fake TPS signal. Applies to MSM only.

Boost Solenoid Codes
▸ Wastegate Duty Cycle High or Low - normal codes when the *XEDE* controls the boost solenoid. Applies to MSM only.

Misfire Codes
▸ P0300 - Random Cylinder Misfire - normal code when the ignition timing map shows a positive number.
  ▸ If a car persistently throws a P0300 code, with no timing advance present, that means something mechanical is causing the timing to be out of spec. Things that cause the timing to be out of spec are the timing belt, bad crank sensors (which is rare), bad knock sensors, or most likely a bad coil pack.
▸ P0301 - Cylinder 1 Misfire - when a specific cylinder code pops up it, it is not *XEDE* related. That is a mechanical issue. Check spark plugs for proper, and consistent among all cylinders, gap specs. Next check the spark plug wires, coil packs, then injectors, and injector seals.

Camshaft / Crankshaft sensor codes
▸ Camshaft / Crankshaft performance range malfunction - this code pops up occasionally. Usually when the maximum ignition timing retard has been achieved. Unless engine knock is heard or the car bogs/hesitates, the code can be ignored.

Idle Higher than Expected Codes
▸ This is fairly typical if the motor has been over bored or has forged internals. The idle plate will manually have to be adjusted. The code may go away, it might not.
▸ Check for intake / vacuum leaks.
▸ The car can also idle higher if the Idle Air control valve (IAC) has issues. Sometimes cleaning the IAC will result in normal operation, sometimes it needs to be replaced.

Section 8: Troubleshooting

8.1 Starting / Idle Issues

- If the red light does not illuminate, recheck all connections at ECU. Especially the power and ground wires.
- If the car stalls frequently, check the LED light on the *XEDE* Unit. If the LED is green, more fuel may be needed. Or a mechanical issue needs to be addressed.
- Turning the key to the on position for a few seconds for smoother starting.
- If the car idles above 1300 rpm, do a thorough check for vacuum / air leaks. Start at injector seals and intercooler tubes. Un-metered air (air not measured by the MAF) will cause a high idle.
- If the car surges at idle clean the MAF with MAF Cleaner. If that does not work, clean your idle air controller. It is located beneath the throttle body. If that does not work, chances are the IAC is bad. It would not hurt to clean the throttle body and EGR solenoid/tube.
- If the rpm oscillates at idle, that is usually a bad or dirty IAC valve. Clean, and if necessary replace it. An oscillating idle will vary from 600 to 1300 rpm rapidly.
- If the car misfires at idle - replace spark plugs, wires, and coil packs if necessary or as indicated by a CEL/MIL.
- On the MX-5s, if the car will not idle or return to idle well check the injector seals. As this car has wired throttle control, a vacuum leak is not always evident with a higher idle.

8.2 Cruise Issues

- If the car starts to act differently, remember that the stock ECU still reads and compensates for environmental and some driving conditions. If the problem persists for a few days, check the engine codes to see if a new code or a pending code has come up. If knock is present, immediate action is needed. If needed, please call BEGi for assistance.
- If the car misfires at cruise - replace spark plugs, wires, and coil packs if necessary.
- Sometimes infrequent misfires are the camshaft sensor going bad or a bad camshaft sensor o-ring. Usually a CEL will come up for this failure. An oily residue around the sensor is an indication that attention is needed there. Another typical symptom is a bad hot start. If the car will not idle, without excessively high rpm's, on hot start only.
- Hesitations are usually indicative of lean spots. Slow throttle response is indicative of a rich spot.

8.3 Boost Issues

- ▸ Lean spikes in AFR curve usually indicate a misfire. Re-gap the spark plugs and/or replace them. Replace wires and coil packs if necessary. Make sure the engine ground strap makes good contact.
- ▸ Engine knock when under boost can also be improperly gapped spark plugs. Check the plugs for an even 0.030 to 0.035 gap.
- ▸ If changing the spark plugs does not eliminate the engine knock, change the fuel filter. A typical symptom of a clogged fuel filter is engine knock, in a very consistent rpm range, upon acceleration.
- ▸ If the AFR curve leans out at the upper rpm range - reduce the boost level to ensure that there is sufficient MAF voltage to tune with. If a lean spot persists and 5V has not been reached on the MAF *must be measure on the actual MAF sensor), replace the fuel pump (in the tank)

with a higher volume/high pressure one.

▸ If the situation occurs where fuel is added and added, but no change is seen in the AFR curve - there are four possibilities:

1. Vacuum Leak - usually at injectors, intake manifold, or intercooler tubing. Leaks typically occur between the MAF and engine. Intercooler tubing, intake manifold, injector seals, etc.

2. Bad fuel pump

3. The MAF voltage has been reached. Verify by measuring the voltage (not the air flow rate), at the MAF, while on the dyno.

4. Severe exhaust leak prior to the O2 sensor.

If the *XEDE* controls fuel at idle and cruise, it is impossible that it would not work when under boost, unless there was a mechanical reason for not doing so.

Section 9: General Rules of Operation & Warranty Information

9.1 General Rules

- Do not remove the *XEDE* unit unless absolutely necessary. Remember to uninstall the larger injectors.
- If your car quits operating normally, please take note of the lights & patterns illuminated on the *XEDE* unit.
- Also, if your car quits operating normally, it is usually do to a mechanical failure not an *XEDE* failure. Getting the codes read off of the OBD II port can help to diagnose the problem. Certain MIL codes are normal with the *XEDE* unit. If any other codes exist, please call for assistance or clarification.
- If engine knock is heard, stay out of boost until the tuning can be properly adjusted or the mechanical problem fixed.
- If a lean spot occurs, stay out of boost until the tuning can be properly adjusted.
- Use premium fuel at all times. If 93 octane fuel is not available, retard the timing about 1 degrees for each octane less of fuel used.
- Don't leave town without the laptop and tuning tools.
- ## PROPERLY GAP THE SPARK PLUGS!!!

9.2 Warranty Information

- All items made by BEGi are warranted for workmanship and function for one year from the date of receipt. All other items are subject to manufacturer's warranty.
- If problems arise from using a BEGi part in a manner other than intended, or a part is installed incorrectly, BEGi reserves the right to refuse warranty coverage for damages.
- BEGi will not warranty any kits, parts or items purchased thru an online auction that is not purchased from an authorized dealer. The customer must be able to provide proof of purchase for any warranty repairs.
- BEGi reserves the right to inspect any item before any warranty will be granted. BEGi will not reimburse for any labor charges on warranty items that occur without prior, written consent.
- BEGi extends no warranty nor accepts liability to any original, stock, or replacement components on the vehicle.
- BEGi does not pay any towing expenses.
- Warranty will not transfer.
- Shipping / freight charges are the responsibility of the end user for all warranty consideration.

9.3 Terms of Sale

- All shortages from the parts list must be reported to BEGi within 20 days of receipt.
- BEGi does not pay any towing expenses.
- All returned items are subject to a 25% re-stocking fee.
- BEGi accepts no liability for death or injury to any person or persons under any circumstance.
- The re-seller assumes all responsibility for the end user's knowledge of this warranty.
- Turbo Kits sold by BEGi or by a BEGi authorized distributor must be registered with BEGi within twenty days of receipt by the end user.
- BEGi does not guarantee that turbo kits will pass smog tests. For California residents, some BEGI kits have been provided a C.A.R.B. Executive Order Number. However, BEGi does not guarantee that the end user's car will pass.
- Acceptance, re-sell, or use of any BEGi part constitutes full agreement by the re-seller/end user, that the terms of sale and warranty are fully understood and accepted in full.