

**LM1 – Installation and Tuning Guide**  
**Apexi™ Power FC**  
**Dataloggit™ Logger**  
**13B Turbo Rotary**  
**And Other Applications**

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# LM-1 Installation and Tuning Guide

## Apexi™ Power FC

## Dataloggit™ Logger

## 13B Turbo Rotary

## And Other Applications

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### **Credits:**

Portions of this document show screenshots from Innovate Motorsports LM1 configuration software, as well as screenshots from the dataloggit FC-Edit software interface.

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## 1. LM-1 Install

### *Description*

This Tutorial will provide instructions for the wiring, programming and integration of the Innovate LM1 with an Apexi Power FC equipped with a Dataloggit logger. It will also cover the data logging instructions, data processing and guidelines for modification of the injection maps. This guide will not cover the physical installation of the LM1 sensor in the exhaust system. Details for this are covered in the LM-1 manual. Data logging and tuning will be performed with deactivation of the O2 feedback control on a 3<sup>rd</sup> generation Mazda RX7. For this you can replace the factory O2 sensor with the LM-1 sensor. **Please refer to manufacturer's manuals for details, warnings, and other specific information.**

### *Wiring the LM-1 Analog Output to the Dataloggit*

#### LM-1 Analog output connection

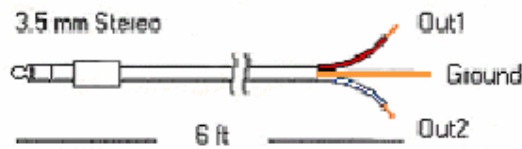


Figure 1. LM-1 Analog Output Cable

The LM-1 has 2 configurable analog outputs, and a common ground. Either of these outputs can be configured to output to the Dataloggit.

#### Dataloggit Analog Input Connections

The Dataloggit has up to 4 analog inputs. To reduce errors associated with electrical noise, and offsets in the grounds, it is best to connect the LM-1 power signal to AN1, and connect the LM-1 Ground to AN2. When configured the signal will be the difference between AN1, and AN2. You will lose an additional input however; you will improve the resolution of the signal and remove errors associated with the ground. If you do not have available open inputs, you can use the 0V as a common ground, and any AN input for the power.

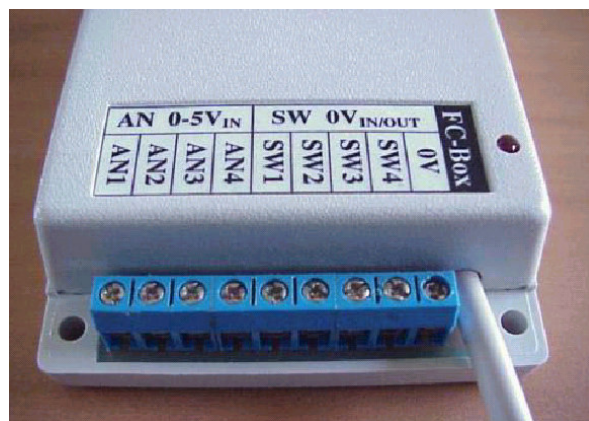


Figure 2. Dataloggit Analog Input Connections

## Programming LM-1 Analog Output

The LM-1 can be configured to output a linear 0-5 volt signal in proportion to the recorded air fuel ratio. It is best to configure the output in the useable range for a turbo rotary engine. Air fuel should not be outside of the 9 – 16:1 AFR. This section details configuration of the LM-1 analog output.

1. Connect the PC's serial connection to the serial port of the LM-1.
2. Turn the ignition switch to ON to power the LM-1.
3. Open the LM Programmer. The window, shown in Figure 3, should be displayed.

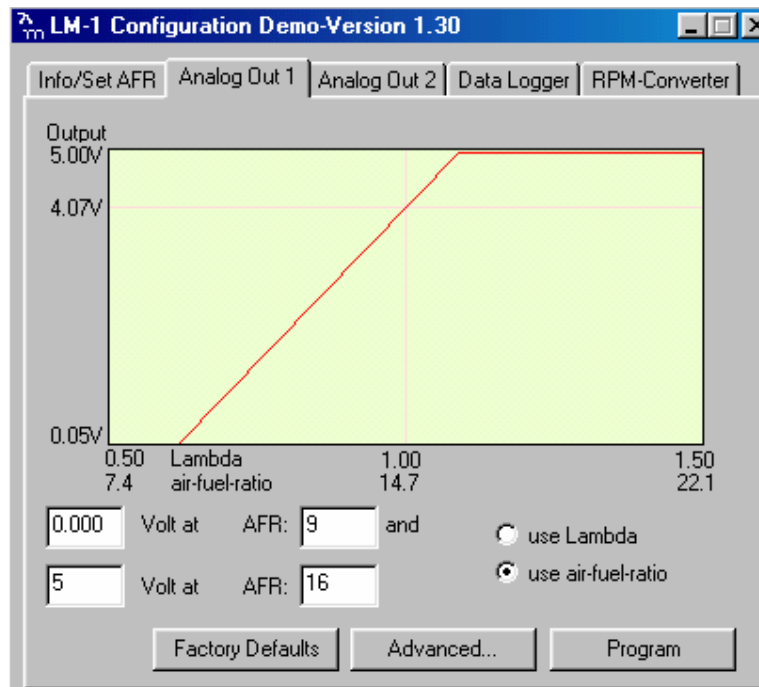


Figure 3. LM Manager Analog Output Configuration Tab

4. Click on the “Analog Out 1” tab.
5. Select “use air-fuel-ratio” option.
6. Set the “Analog Out 1” to the following:
  - a. 0 Volts at AFR: 9.0
  - b. 5 Volts at AFR: 16.0

The screen should look like Figure 3 when you are finished

7. Click the “Program” button to program these values into the LM-1.

**Please refer to the LM-1 Manual for further details on programming the LM-1.**

### Configuring FC Edit to read the LM-1 Analog Output

To properly interpret the analog output the FC Edit software for the dataloggit has to be configured to the same 0-5 volt signal as the LM-1 output.

1. Open the FC-Edit Software
2. Select - Setup – Auxiliary

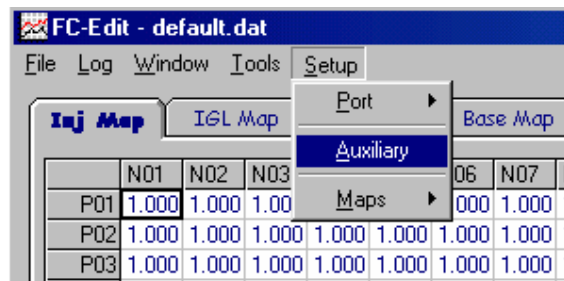


Figure 4. Select Auxiliary

The auxiliary menu is shown in figure 5. Depending on how you connected the LM-1 Analog output to the Dataloggit there are two possible configurations. If using AN1 for the power wire and AN2 for the ground, select Delta AN1 – AN2. Then enter in the numbers for Voltage and Value in the upper left section for AN1 – AN2. Change the name to Wideband, and the units to A/F. (The configuration will match figure 5). If using only AN1 do not select any boxes, and enter the values and the name for AN1.



Figure 5. Configured AN1 – AN2 Analog Input

## Logging Data Using the FC – Edit software and Map Watch

1. Power the LM-1 unit and switch it on
2. Turn the car to the power on position
3. Connect to the Dataloggit using the serial port connection (more details on this are available in the Dataloggit Manual.) Open the FC-Edit program to connect to the ECU.

If an error message “interface not responding” is displayed key the car off and on and try again.

4. To prevent the Factory O2 sensor from interfering with the injection map it is best to turn off the O2 feedback. This is also necessary if the factory O2 sensor has been removed and replaced with the LM-1 Wideband. In the FC-Edit program go to the settings 1 tab. Click the function select #4 “O2 F/B Control” to turn off O2 feedback.

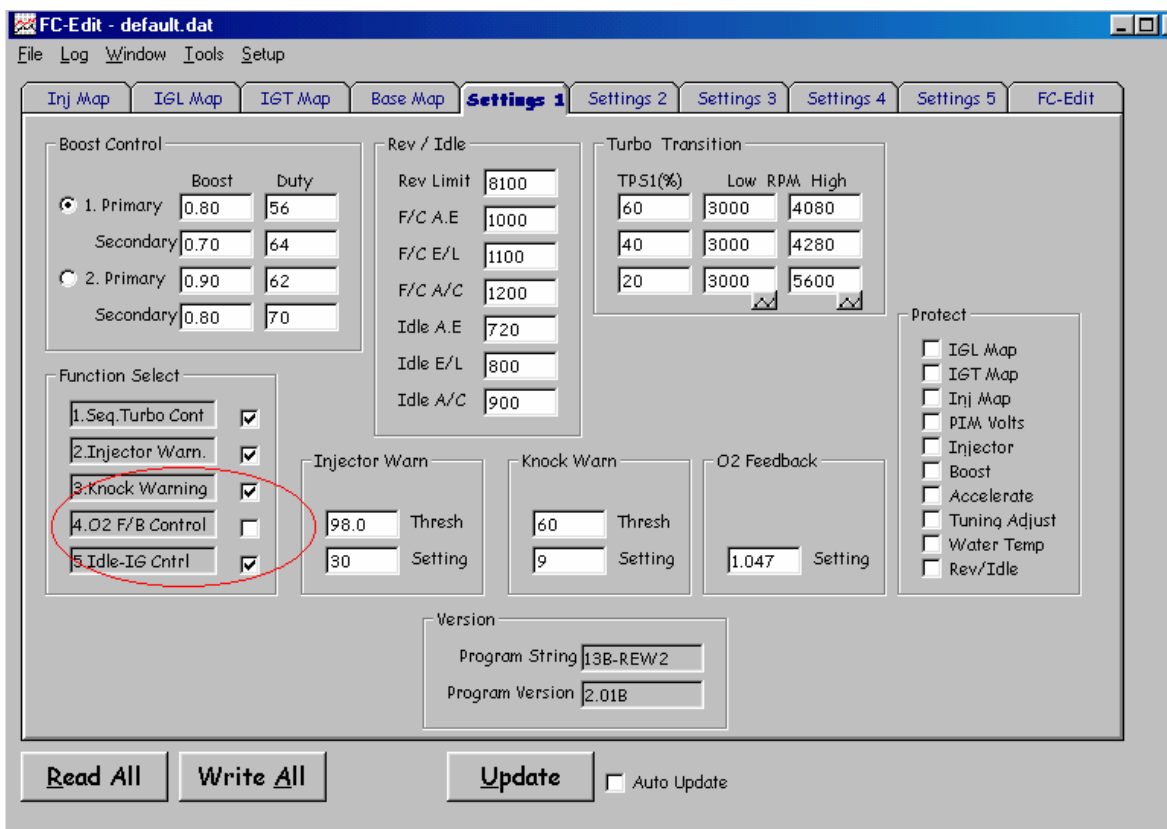


Figure 6. Settings 1 Tab – O2 Feedback Deactivation

5. Next, select - Window - “MAP WATCH”

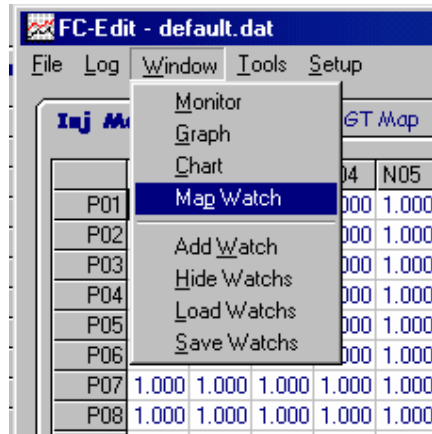


Figure 7. – Window map Watch

The map watch will open in another window. It is a 20 x 20 grid configured like the fuel tables in the FC edit. There are several important features of the map watch that must be configured to properly log the data.

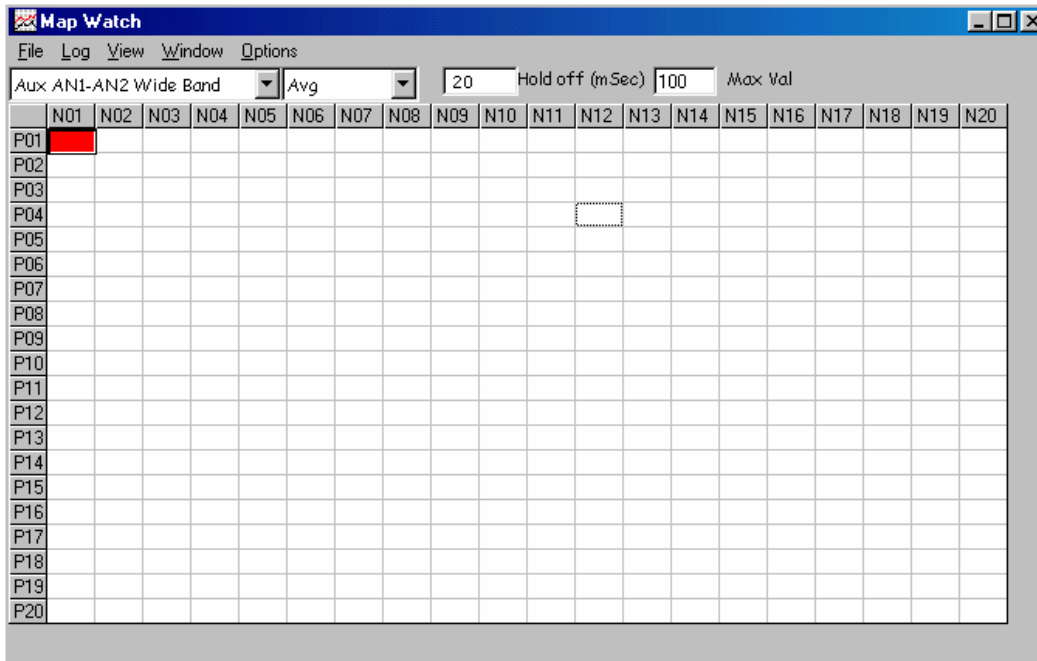


Figure 8. Map Watch Window

5. In the left pull down menu – scroll down to the input you would like to log. For AFR monitoring this with either be AUX AN1 Wide Band, or AUX AN1 – AN2 Wide Band (Depending how this was wired and configured)
6. The next pull down menu allows you to select Min/Max/Average/Num. The first three are just what you think they are. Average is best because there can be erroneous data from throttle transitions. The NUM is simply the number of data points collected. This will be explained later. Set this window to Average

7. The next section to the right labelled (hold off mSec) is an important feature. If you are making a rapid transition through a cell then the data is not very useful. If you do not stay in a particular cell for 20 milliseconds then it will not record a data point. I have found that 20 mSec works well. You can experiment with this number depending on what kind of operating conditions you intend to monitor. Leave this at 20 mSec to start.
8. The next section “max Val” is where you can set the max value you intend to view. For AFR the max value is 16, make sure you set this value 16 or higher.
9. Notice in the 20x20 grid that the upper left hand section is red and the cell has a border. This is the map tracer. This will highlight the cell that you are currently operating in. (with the car off it’s the upper left). To activate this map tracer go to View and select map trace, and Ghost.

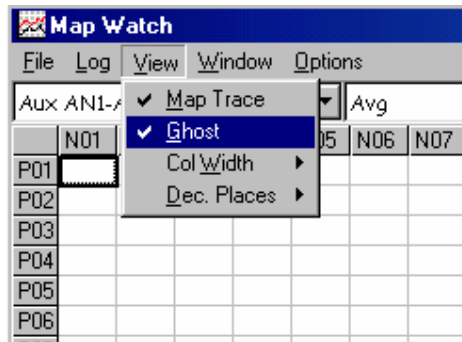


Figure 9. View - Map Tracer and Ghost

10. Start the Car and allow it to warm up to operating temperature. Cold start-up enrichment will give false rich data when logging.
11. Start the logging by selecting Log – Start or by pressing F1

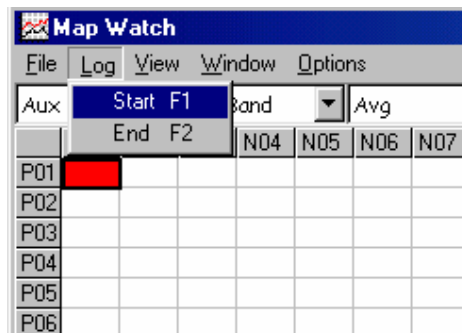


Figure 10. Log – Start

The log should highlight the cells that you are operating in the idle range, and will fill in the table with the AFR numbers. If the logging does not work you may need to check the monitor window to make sure that you are logging all the data needed. In the map watch go to – Window – Monitor. The monitor window will appear and display all inputs to the ecu. Select the boxes circled in red to log all data.

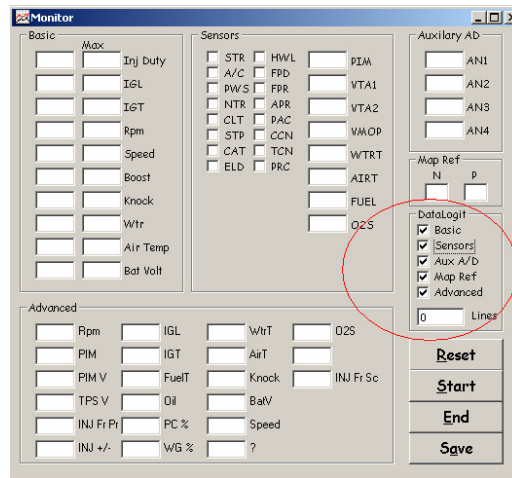


Figure 11. Monitor Window

12. With the Map Watch working and the data logging, now is a good time to verify that the logged data matches the AFR displayed on the LM1. If the numbers do not match, verify your electrical connections, and repeat the procedures above. When the logged data matches the Drive the car around to collect data. Try to use smooth pedal inputs with varying RPM and boost levels to fill in all the data. Avoid engine braking and rapid throttle inputs as this can record bad data points. Holding a constant throttle position from low to high RPM is best. Using 3<sup>rd</sup> gear and higher is best as you spend more time in each cell and collect smoother data. After driving for a while the data should look like figure 12. If you have selected “ghost” then the data fields will be highlighted in red.

|     | N01  | N02  | N03  | N04  | N05  | N06  | N07  | N08  | N09  | N10  | N11  | N12  | N13  | N14  | N15  | N16  | N17  | N18  | N19  | N20  |
|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| P01 |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 16.0 | 15.9 | 15.9 |      |      |      |
| P02 |      |      |      |      | 15.9 | 15.9 | 15.6 | 15.7 | 15.4 | 15.9 | 15.7 | 15.9 | 15.9 | 15.8 | 15.9 | 16.0 | 15.9 | 13.8 |      |      |
| P03 |      |      |      | 14.9 | 14.7 | 12.0 | 12.7 | 12.6 | 13.0 | 12.7 | 14.4 | 12.9 | 13.5 | 13.3 |      |      |      |      |      |      |
| P04 |      |      | 15.2 | 13.8 | 12.9 | 12.1 | 13.2 | 12.9 | 12.9 | 13.4 | 12.9 | 13.2 | 12.4 | 12.2 |      |      |      |      |      |      |
| P05 | 13.2 | 12.8 | 12.7 | 14.4 | 12.8 | 14.4 | 14.4 | 14.1 | 14.0 | 14.3 | 13.8 | 14.2 | 13.6 | 12.3 |      |      |      | 13.0 |      |      |
| P06 | 13.9 | 13.7 | 14.6 | 13.8 | 14.4 | 14.2 | 14.3 | 14.4 | 14.5 | 14.6 | 14.4 | 14.1 | 13.6 |      |      |      |      |      | 13.1 |      |
| P07 | 13.9 | 14.0 | 14.1 | 14.1 | 14.0 | 14.2 | 14.3 | 13.7 | 14.1 | 13.4 | 14.4 | 14.4 |      |      |      |      |      |      | 11.9 |      |
| P08 |      | 13.1 | 13.8 | 13.7 | 13.8 | 13.7 | 13.5 | 13.8 | 12.6 | 14.2 | 11.2 | 14.4 | 12.0 |      |      |      |      |      |      |      |
| P09 | 13.1 | 12.0 | 12.8 | 13.5 | 13.5 |      | 14.8 | 13.9 | 12.3 | 12.6 |      | 14.9 | 12.8 |      |      |      |      |      |      |      |
| P10 |      |      |      |      |      |      | 14.8 | 10.6 | 10.7 |      |      | 14.0 | 13.2 |      |      |      |      |      |      |      |
| P11 |      |      |      |      |      |      | 14.0 | 12.8 | 12.5 |      |      |      | 11.0 |      |      |      |      |      |      |      |
| P12 |      |      |      |      |      |      | 14.4 | 12.3 |      | 12.3 |      |      |      |      |      |      |      |      | 11.2 |      |
| P13 |      |      |      |      |      |      | 13.5 | 12.6 | 12.5 |      |      |      |      |      |      | 12.5 | 11.6 | 11.0 | 10.6 |      |
| P14 |      |      |      |      |      |      |      |      | 12.6 |      | 12.4 | 11.1 | 11.2 | 11.2 | 12.0 |      |      |      |      | 15.6 |
| P15 |      |      |      |      |      |      |      | 12.3 | 12.3 | 11.5 | 12.9 |      | 10.9 | 11.4 |      |      |      |      |      | 11.6 |
| P16 |      |      |      |      |      |      |      | 11.9 | 11.4 | 11.4 | 11.5 | 11.3 | 11.6 | 11.9 | 11.4 | 11.6 |      |      |      | 10.8 |
| P17 |      |      |      |      |      |      |      | 11.7 | 11.2 | 10.6 | 10.6 | 10.9 |      | 11.5 | 11.7 | 11.4 | 11.7 | 11.4 | 11.5 |      |
| P18 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 11.3 | 10.9 |      |      |      |
| P19 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| P20 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

Figure 12. Map Watch With logged AFR

Now that you have successfully logged the data, there are a few things you should know about the data.

### **Saving Data –**

It is important to save the data periodically to make sure that you do not lose the data. It is also important to make sure that you stop logging and restart logging after making any changes to the injection map in the ECU. With averaging the data, it will take some time for averages to clean out the old data.

### **Engine Braking –**

Rows P1, P2, and even part of P3 can be corrupted by engine braking. When lifting the throttle during engine braking, the ECU does not inject any fuel. The engine is effectively an air pump and the AFR will be off the scale lean. This is normal, however the data collected during engine braking is useless and often causes users to add and add fuel to try to correct this.

### **Missfires –**

When an engine miss-fires it will pump unburnt fuel and fresh air into the exhaust system. Because the Air fuel ratio is actually measured by an oxygen sensor, this shows up as a lean mixture due to the excess of oxygen. This will often show up on the LM1 display as a dancing AFR reading from rich to lean. On the logging this will be averaged out, so you won't see it. If you have misfires in a particular area, do not use the logged data at face value.

### **Erroneous Data –**

While logging, blipping the throttle, rev matching shifts, or engine braking can give bad data in various spots on the map. If there is an odd air fuel reading surrounded by reasonable numbers there is a good chance that it could be a bad number. To help identify these bad numbers the map watch has an option that let's you view the number of data points that were collected in a particular cell. In step 6 we set the logging to view the data. If we select NUM instead of average it will display the number of data points collected in that cell. If only 1 point was used to generate the data and the data is strange, it's likely a bad data point. It is still a good idea to check the injection maps to see if there is an unreasonable dip or spike in the numbers in that cell.

### **Data Interpolation –**

While driving, the car does not really run in any one particular cell. The car will run in between two or more cells. The ecu uses linear interpolation to calculate the values that the ECU should use to run the car. If you have a high value in the injection map it will tend to add fuel to the cells around it. For this reason tuning is a lengthy iterative process that requires several sessions of data collection and manual smoothing of the injection maps. After running some logging sessions and making changes based on AFR, go back to the MAP and look for strange spots in the MAP. Look for high values surrounded by low values, or dips in the curve. The fueling should increase with Boost, and should generally increase with RPM near the torque peak of the engine, and then drop off slightly.

### **Data Processing –**

With all the data in the 20 x 20 grid it is very tedious to change all of the points in the injection map. It is best to use a spreadsheet to process the data automatically, and then paste the changes into the injection correction map. Using a spreadsheet to process the data can often get the air fuel ratio within 5% in just a few logging sessions.

### Data Processing with MS-Excel

To process the data a relatively simple spreadsheet can be made. These spreadsheets are often available online for download, or you can make your own. Most excel users can create the spreadsheet based on the instructions below.

The spreadsheet consists of 3 sections.

#### INPUT –

This is a 20x20 grid where you paste in the logged AFR data. When using spreadsheets to tune you need to delete any bad data points. Engine braking, and erroneous points need to be removed. Rows P1 and P2 should be deleted. Often it is a good Idea to tune the idle manually, and to delete the idle region form the pasted AFR data as well. Delete these in the Input section.

| MEASURED AVERAGE AFR |     |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|----------------------|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                      | 400 | 800  | 1200 | 1600 | 2000 | 2400 | 2800 | 3200 | 3600 | 4000 | 4400 | 4800 | 5200 | 5600 | 6000 | 6400 | 6800 | 7200 | 7600 | 8000 |
| 0.1                  |     |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 0.2                  |     |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 13.8 |
| 0.3                  |     |      |      |      | 14.7 | 12   | 12.7 | 12.6 | 13   | 12.7 | 14.4 | 12.9 | 13.5 | 13.3 |      |      |      |      |      |      |
| 0.4                  |     |      |      |      | 12.9 | 12.1 | 13.2 | 12.9 | 12.9 | 12.9 | 13.4 | 12.9 | 13.2 | 12.4 | 12.2 |      |      |      |      |      |
| 0.5                  |     |      |      |      | 14.4 | 12.8 | 14.4 | 14.4 | 14.1 | 14   | 14.3 | 13.8 | 14.2 | 13.6 | 12.3 |      |      |      |      | 13   |
| 0.6                  |     |      |      |      | 13.8 | 14.4 | 14.2 | 14.3 | 14.4 | 14.5 | 14.6 | 14.4 | 14.1 | 13.6 |      |      |      |      |      | 13.1 |
| 0.7                  |     |      | 13.9 | 14   | 14.1 | 14.1 | 14   | 14.2 | 14.3 | 13.7 | 14.1 | 13.4 | 14.4 | 14.4 |      |      |      |      |      | 11.9 |
| 0.8                  |     |      | 13.1 | 13.8 | 13.7 | 13.8 | 13.7 | 13.5 | 13.8 | 12.6 | 14.2 | 11.2 | 14.4 | 12   |      |      |      |      |      |      |
| 0.9                  |     | 13.1 | 12   | 12.8 | 13.5 | 13.5 |      | 14.8 | 13.9 | 12.3 | 12.6 |      | 14.9 | 12.8 |      |      |      |      |      |      |
| 1                    |     |      |      |      |      |      |      | 14.8 | 10.6 | 10.7 |      |      | 14   | 13.2 |      |      |      |      |      |      |
| 1.1                  |     |      |      |      |      |      | 14   |      | 12.8 | 12.5 |      |      |      | 11   |      |      |      |      |      |      |
| 1.2                  |     |      |      |      |      |      | 14.4 |      | 12.3 |      | 12.3 |      |      |      |      |      |      |      |      | 11.2 |
| 1.3                  |     |      |      |      |      |      | 13.5 |      | 12.6 | 12.5 |      |      |      |      | 12.5 | 11.6 | 11   | 10.6 |      |      |
| 1.4                  |     |      |      |      |      |      |      |      | 12.6 |      |      | 12.4 | 11.1 | 11.2 | 11.2 | 12   |      |      |      | 15.6 |
| 1.5                  |     |      |      |      |      |      |      | 12.3 | 12.3 | 11.5 | 12.9 |      | 10.9 | 11.4 |      |      |      |      |      | 11.6 |
| 1.6                  |     |      |      |      |      |      | 11.9 | 11.4 | 11.4 | 11.5 | 11.3 | 11.6 | 11.9 | 11.4 | 11.6 |      |      |      |      | 10.8 |
| 1.8                  |     |      |      |      |      |      | 11.7 | 11.2 | 10.6 | 10.6 | 10.9 |      | 11.5 | 11.7 | 11.4 | 11.7 |      | 11.4 | 11.5 |      |
| 2                    |     |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 11.3 | 10.9 |      |      |      |
| 2.2                  |     |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2.4                  |     |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

Figure 13. Measured AFR Section of Spreadsheet

#### DESIRED AFR –

This is a 20 x 20 grid where you define the desired AFR. Desired AFR should consider the very different requirements for idle, cruising, midrange, high boost and high RPM. AFR is often a blend from a cruising range of 14.7:1 to a full boost value of ~11.0:1 for a turbo rotary. The idle AFR may vary depending on the engines state of tune. There is some debate on what is the best AFR and this should be researched carefully before tuning. A desired AFR graph used successfully on a single turbo street ported RX7 is shown below in figure 13.

|       |  | Desired target AFR |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-------|--|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Boost |  | 400                | 800  | 1200 | 1600 | 2000 | 2400 | 2800 | 3200 | 3600 | 4000 | 4400 | 4800 | 5200 | 5600 | 6000 | 6400 | 6800 | 7200 | 7600 | 8000 |
| 0.1   |  | 13.5               | 13.5 | 13.5 | 13.5 | 13.8 | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   |
| 0.2   |  | 13.5               | 13.5 | 13.5 | 13.5 | 13.8 | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   |
| 0.3   |  | 13.5               | 13.5 | 13.5 | 13.5 | 13.8 | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   |
| 0.4   |  | 13.5               | 13.5 | 13.5 | 13.5 | 13.8 | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   |
| 0.5   |  | 13.5               | 13.5 | 13.5 | 13.5 | 13.8 | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   |
| 0.6   |  | 13.5               | 13.5 | 13.5 | 13.5 | 13.8 | 13.8 | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   | 14   |
| 0.7   |  | 13.8               | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 | 13.8 |
| 0.8   |  | 13.5               | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 |
| 0.9   |  | 13.3               | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 |
| 1     |  | 13                 | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   |
| 1.1   |  | 12.8               | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 |
| 1.2   |  | 12.7               | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 |
| 1.3   |  | 12.5               | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 |
| 1.4   |  | 12.2               | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 |
| 1.5   |  | 12                 | 12   | 12   | 12   | 12   | 12   | 12   | 12   | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 12   | 12   | 12   | 12   | 12   | 12   |
| 1.6   |  | 12                 | 12   | 12   | 12   | 12   | 12   | 11.6 | 11.6 | 11.6 | 11.4 | 11.4 | 11.4 | 11.4 | 11.4 | 11.6 | 11.6 | 11.6 | 11.6 | 11.6 | 11.6 |
| 1.8   |  | 12                 | 12   | 12   | 12   | 12   | 12   | 11.5 | 11.5 | 11.5 | 11.2 | 11.2 | 11   | 11   | 11.1 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 |
| 2     |  | 12                 | 12   | 12   | 12   | 12   | 12   | 11.3 | 11.2 | 11.2 | 11.1 | 11   | 10.9 | 10.9 | 10.9 | 11   | 11.1 | 11.2 | 11.2 | 11   | 11   |
| 2.2   |  | 12                 | 12   | 12   | 12   | 12   | 12   | 11   | 10.9 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.9 | 11   | 11   | 11   | 11   | 11   | 11   |
| 2.4   |  | 12                 | 12   | 12   | 12   | 12   | 12   | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 |

Figure 13. Desired AFR – GT35/40 13B Street Ported

**CORRECTION MAP –**

This is another 20 x 20 grid where the Pasted AFR values are compared to the desired AFR values, and a correction factor is calculated. In MS excel the equation for these cells is as follows:  $CELL = IF(OR(ISBLANK(B3)), 1, ((B3/B27))$  Where B3 is the pasted AFR value and B27 is the desired AFR value. Should the input be blank, the value will be 1, otherwise it will simply divide the actual AFR by the desired AFR.

As an example if the AFR is 14.0 and the desired AFR is 10.0 then the correction factor is  $(14/10) = 1.4$ . The spreadsheet will add 40% more fuel to obtain the desired AFR.

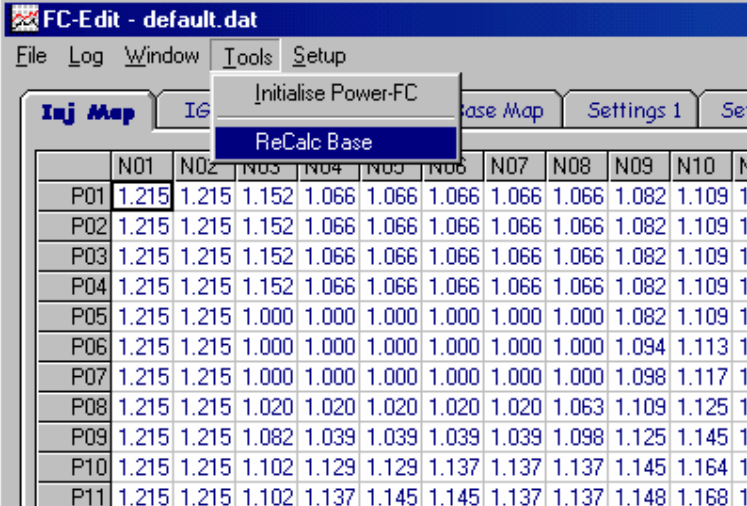
Figure 14 is the correction factor map based on the input data and the desired AFR grid.

|       |  | CORRECTION FACTOR CALCULATED |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-------|--|------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| BOOST |  | 400                          | 800  | 1200 | 1600 | 2000 | 2400 | 2800 | 3200 | 3600 | 4000 | 4400 | 4800 | 5200 | 5600 | 6000 | 6400 | 6800 | 7200 | 7600 | 8000 |
| 0.1   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 0.2   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.99 | 1.00 | 1.00 |
| 0.3   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.07 | 0.86 | 0.91 | 0.90 | 0.93 | 0.91 | 1.03 | 0.92 | 0.96 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 0.4   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 0.93 | 0.86 | 0.94 | 0.92 | 0.92 | 0.92 | 0.96 | 0.92 | 0.94 | 0.89 | 0.87 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 0.5   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.04 | 0.91 | 1.03 | 1.03 | 1.01 | 1.00 | 1.02 | 0.99 | 1.01 | 0.97 | 0.88 | 1.00 | 1.00 | 0.93 | 1.00 | 1.00 |
| 0.6   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.04 | 1.01 | 1.02 | 1.03 | 1.04 | 1.04 | 1.03 | 1.01 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 0.94 | 1.00 |
| 0.7   |  | 1.00                         | 1.00 | 1.01 | 1.01 | 1.02 | 1.02 | 1.01 | 1.03 | 1.04 | 0.99 | 1.02 | 0.97 | 1.04 | 1.04 | 1.00 | 1.00 | 1.00 | 1.00 | 0.86 | 1.00 |
| 0.8   |  | 1.00                         | 1.00 | 0.97 | 1.02 | 1.01 | 1.02 | 1.01 | 1.00 | 1.02 | 0.93 | 1.05 | 0.83 | 1.07 | 0.89 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 0.9   |  | 1.00                         | 0.98 | 0.90 | 0.96 | 1.02 | 1.02 | 1.00 | 1.11 | 1.05 | 0.92 | 0.95 | 1.00 | 1.12 | 0.96 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1     |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.14 | 0.82 | 0.82 | 1.00 | 1.00 | 1.08 | 1.02 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1.1   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.09 | 1.00 | 1.00 | 0.98 | 1.00 | 1.00 | 1.00 | 0.86 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1.2   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.13 | 1.00 | 0.97 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.88 | 1.00 |
| 1.3   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.08 | 1.00 | 1.01 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.93 | 0.88 | 0.85 | 1.00 |
| 1.4   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.03 | 1.00 | 1.02 | 0.91 | 0.92 | 0.92 | 0.98 | 1.00 | 1.00 | 1.00 | 1.00 | 1.28 |
| 1.5   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.03 | 1.03 | 0.97 | 1.09 | 1.00 | 0.92 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 |
| 1.6   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.03 | 0.98 | 0.98 | 1.01 | 0.99 | 1.02 | 1.04 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.93 |
| 1.8   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.02 | 0.97 | 0.92 | 0.95 | 0.97 | 1.00 | 1.05 | 1.05 | 1.02 | 1.04 | 1.00 | 1.02 | 1.03 | 1.00 |
| 2     |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.02 | 0.97 | 1.00 | 1.00 |
| 2.2   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2.4   |  | 1.00                         | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Figure 14. Correction Factor grid

## Using Processed LM1 Data with FC-Edit

1. To move the logged data from the Map Watch to the spreadsheet a simple copy and paste operation can be used. Highlight the 20x20 grid and press Ctrl+C to copy. Right clicking and selecting copy works on the newer revisions of the FC edit. Be sure to highlight all of the data. This can be done on the fly while tuning the car. Usually stopping the logging and copying the raw logged data is best. The logs can get rather large and difficult for a laptop to save and open later. Copying the data on the fly ensures you won't lose it.
2. Pasting the data into the 20 x 20 grid is just as simple. Highlight the 20 x 20 grid in excel and press Ctrl+V to paste the data, or right click and paste. Be sure to have the data aligned properly in the grid. If the data is shifted, it will seriously skew the results of tuning.
3. After pasting in the data it needs to be cleaned up to remove any bad data points, engine braking, and any areas that we do not want to modify (idle range perhaps).
4. To input the correction values into the FC edit file, we need to first reset the injection correction map to all 1's by recalculating the base map. The FC edit has 2 maps that are used to determine the fuel quantity provided to the engine. There is an Injection Correction map, and a Base Map. These two maps are multiplied to calculate the injected fuel. There are several other factors that get used to determine the actual fueling, however they are beyond the scope of this document. Using tools – Recalculate base map, the FC-edit software will perform this multiplication and adjust the base map while setting the correction map to 1.00 in all cells.



|     | N01   | N02   | N03   | N04   | N05   | N06   | N07   | N08   | N09   | N10   | N11   |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| P01 | 1.215 | 1.215 | 1.152 | 1.066 | 1.066 | 1.066 | 1.066 | 1.066 | 1.082 | 1.109 | 1.117 |
| P02 | 1.215 | 1.215 | 1.152 | 1.066 | 1.066 | 1.066 | 1.066 | 1.066 | 1.082 | 1.109 | 1.117 |
| P03 | 1.215 | 1.215 | 1.152 | 1.066 | 1.066 | 1.066 | 1.066 | 1.066 | 1.082 | 1.109 | 1.117 |
| P04 | 1.215 | 1.215 | 1.152 | 1.066 | 1.066 | 1.066 | 1.066 | 1.066 | 1.082 | 1.109 | 1.117 |
| P05 | 1.215 | 1.215 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.082 | 1.109 | 1.117 |
| P06 | 1.215 | 1.215 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.094 | 1.113 | 1.117 |
| P07 | 1.215 | 1.215 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.098 | 1.117 | 1.117 |
| P08 | 1.215 | 1.215 | 1.020 | 1.020 | 1.020 | 1.020 | 1.020 | 1.063 | 1.109 | 1.125 | 1.125 |
| P09 | 1.215 | 1.215 | 1.082 | 1.039 | 1.039 | 1.039 | 1.039 | 1.098 | 1.125 | 1.145 | 1.145 |
| P10 | 1.215 | 1.215 | 1.102 | 1.129 | 1.129 | 1.137 | 1.137 | 1.137 | 1.145 | 1.164 | 1.164 |
| P11 | 1.215 | 1.215 | 1.102 | 1.137 | 1.145 | 1.145 | 1.137 | 1.137 | 1.148 | 1.168 | 1.168 |

Figure 15. Tools - Recalculate Base Map

After recalculating the Base Map, the INJ MAP will look like figure 16.

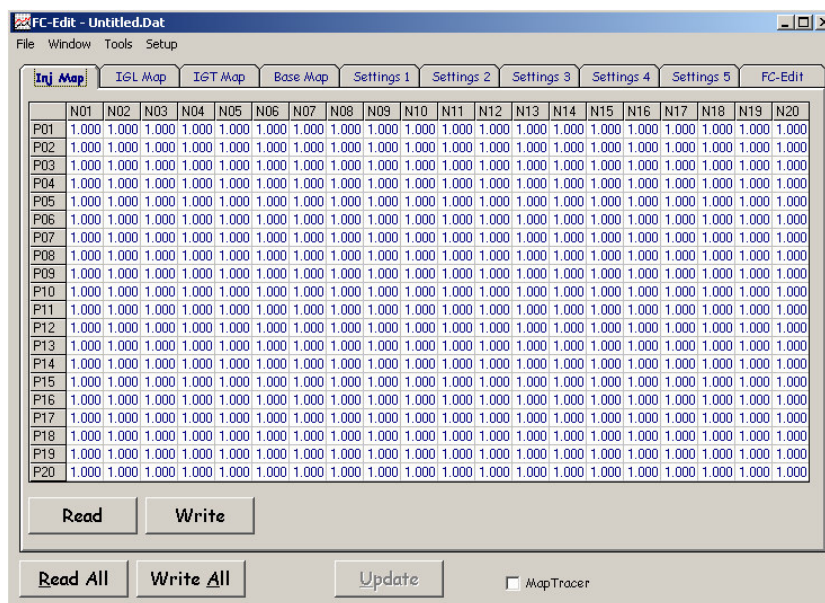


Figure 16. INJ MAP after recalculating Base Map

- Now that the INJ MAP is all 1's, we can paste in the correction values from our spreadsheet. Highlight the 20 x 20 correction values from the spreadsheet press Ctrl+C, or right click Copy.
- Highlight the 20 x 20 INJ MAP and paste in the data by pressing Ctrl + V, or right click paste. Be sure to have the complete grid highlighted. The new INJ MAP should look like figure 17. Be sure to verify that the numbers pasted are in fact the numbers from the spreadsheet. They should be numbers close to 1.00. A number of 1.10 will add 10% fuel ad a 0.90 will subtract 10% fuel. Unless the car is running really rough, try to avoid large changes of %30+.

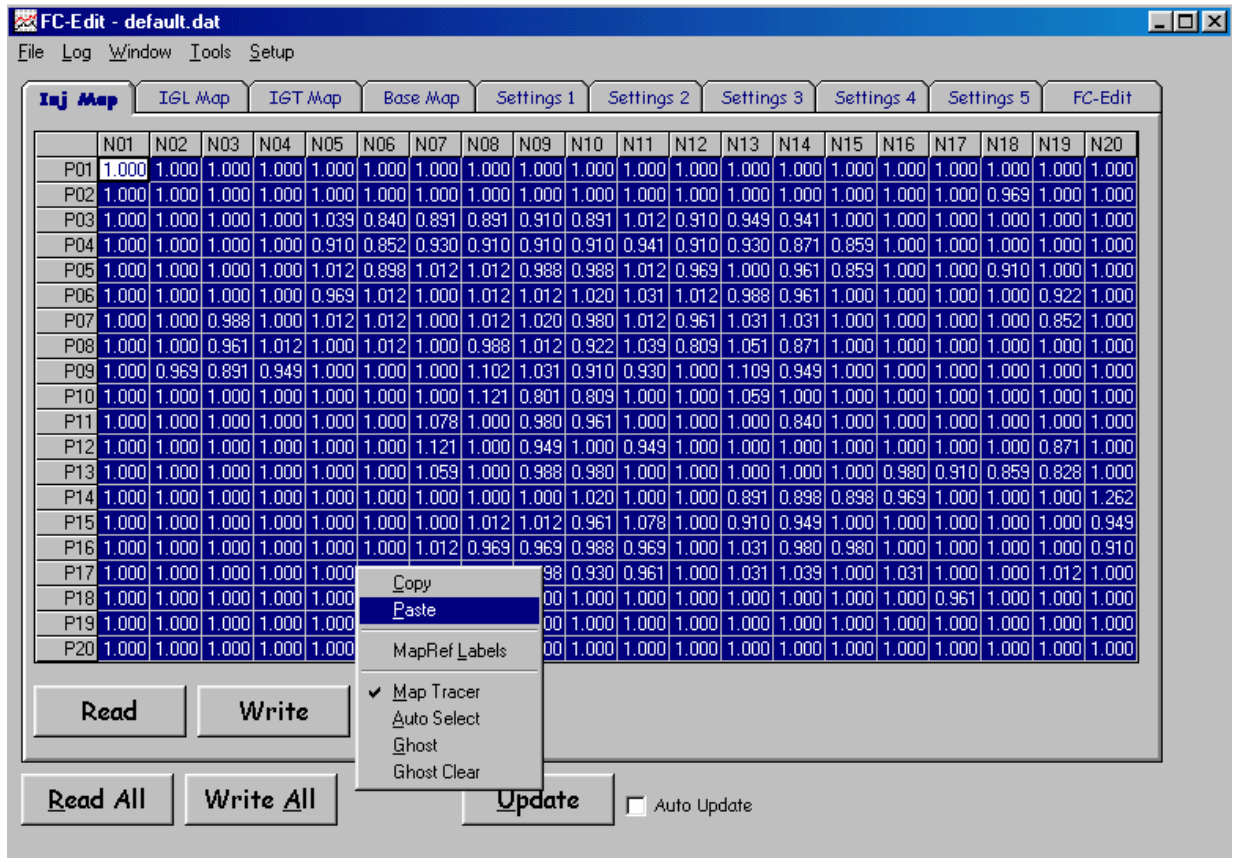


Figure 17. INJ MAP with Pasted Correction Values.

7. Save the new FC-Edit file and write it to the ECU by clicking Update.
8. You have now completed logging and correcting based on the logs. The AFR values should be quite close to the desired AFR after only 1 or 2 sessions. It is important to drive the car, or dyno test the car under all boost and RPM conditions where it will operate to ensure that all cells are modified. After each logging session the data collected needs to be pasted into excel for processing then copied and pasted back into FC-Edit. Each time data will be pasted into FC-Edit it is important to recalculate the base map and reset the INJ MAP to all 1's before pasting correction values.
9. It is often a good idea to start with a rich running car, and then remove fuel by tuning. Starting with a lean car can be dangerous because of engine knock, and high exhaust gas temperatures. Rotary engines are particularly sensitive to lean mixtures, and easy to damage. If you have a generally lean mixture, go into the INJ map and add fuel almost everywhere by changing all values to greater than 1. A general rule of thumb is that 10% extra fuel will lower your AFR by a full point.