

Direct Link Basic Tuning Guide (Delphi)

This Guide is intended to answer basic Direct Link tuning questions and to act as a Quick Start Guide. It is not intended to be the “Gospel” on the tuning process - only to answer basic questions about Direct Link. This Guide will give some example tables that have proved to work in the past but the tuner/dealer is ultimately responsible for the final tune on any bike.

First Tables to check before first flash:

1. AFR Ratio Table

The values in the AFR (Air-Fuel Ratio) table are calculations that the ECU (Engine Control Unit) uses to determine the injector pulse width. It does not and cannot control the AFR because there aren't any wide-band Oxygen Sensors in the system.

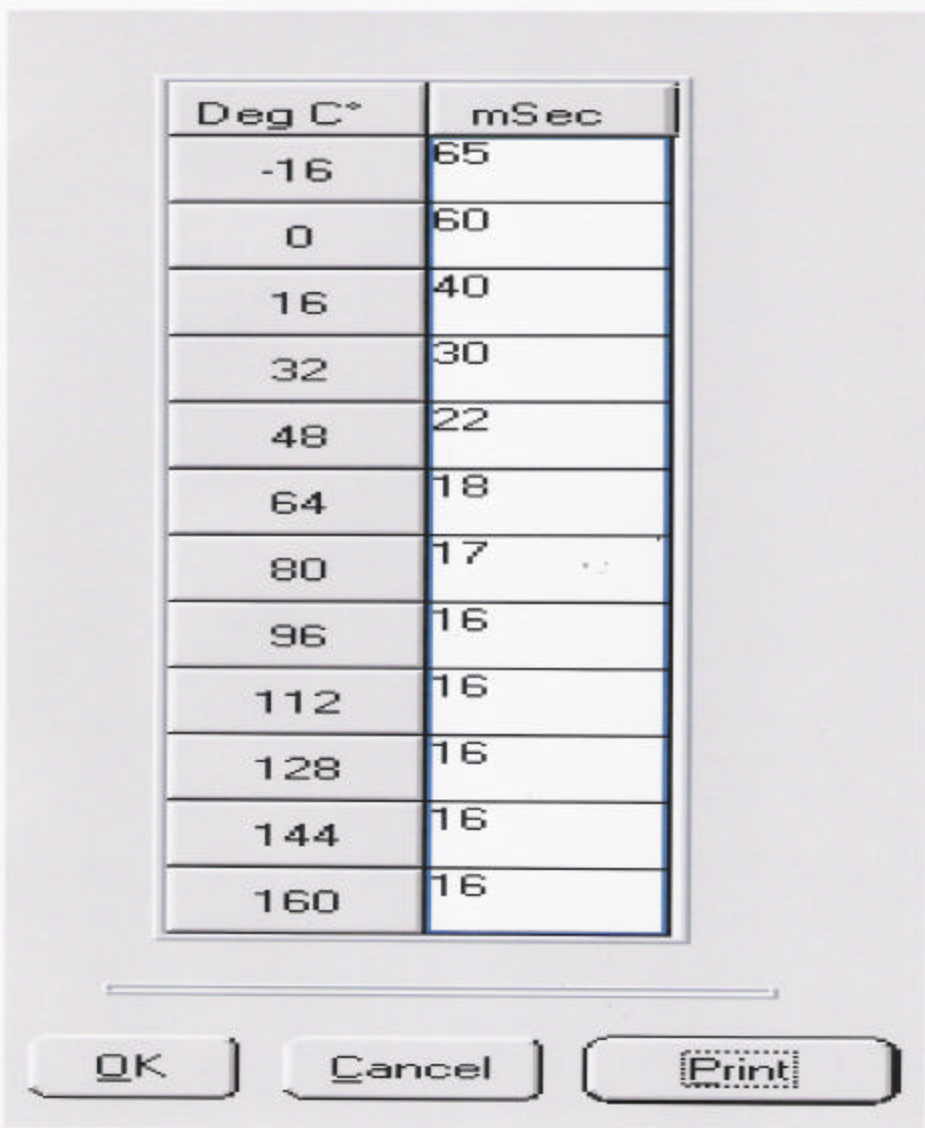
The point of all the tuning is to make the VE (Volumetric Efficiency) tables match the AFR values, not the other way around.

In order to accomplish this, it is helpful to set all the values in this table to the same AFR. This value can be anything, but 13.4 is a safe AFR value. Click on the Apply button then the OK button.

When working on the 'closed-loop' models, changing the AFR value to anything other than 14.6 disables closed-loop operation which makes VE table tuning possible.

2. Cranking Fuel

Make sure to check this table. The cold temperature numbers should have more fuel than the hot temperature numbers. Double click on a mSec cell and use the up and down arrow to adjust. The values above a temperature of 112C may have to be adjusted up or down to get the bike to start quickly. Click OK. See this example as a typical Cranking Fuel table:

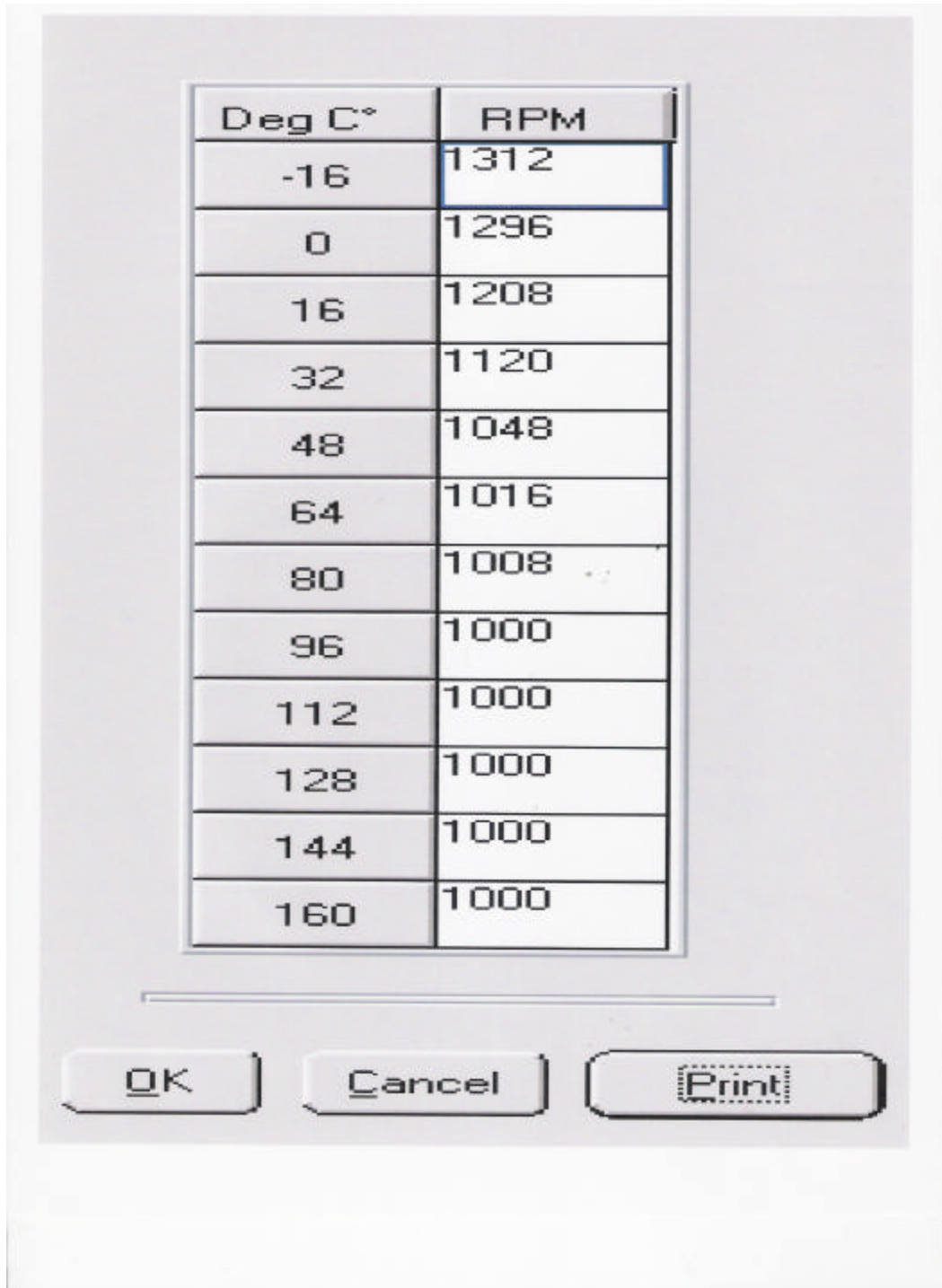


Deg C°	mSec
-16	65
0	60
16	40
32	30
48	22
64	18
80	17
96	16
112	16
128	16
144	16
160	16

OK Cancel Print

3. Idle Table

Make sure to check this table. Double click on a RPM cell and use the up and down arrow to adjust. Click OK. See this example of a typical Idle table:



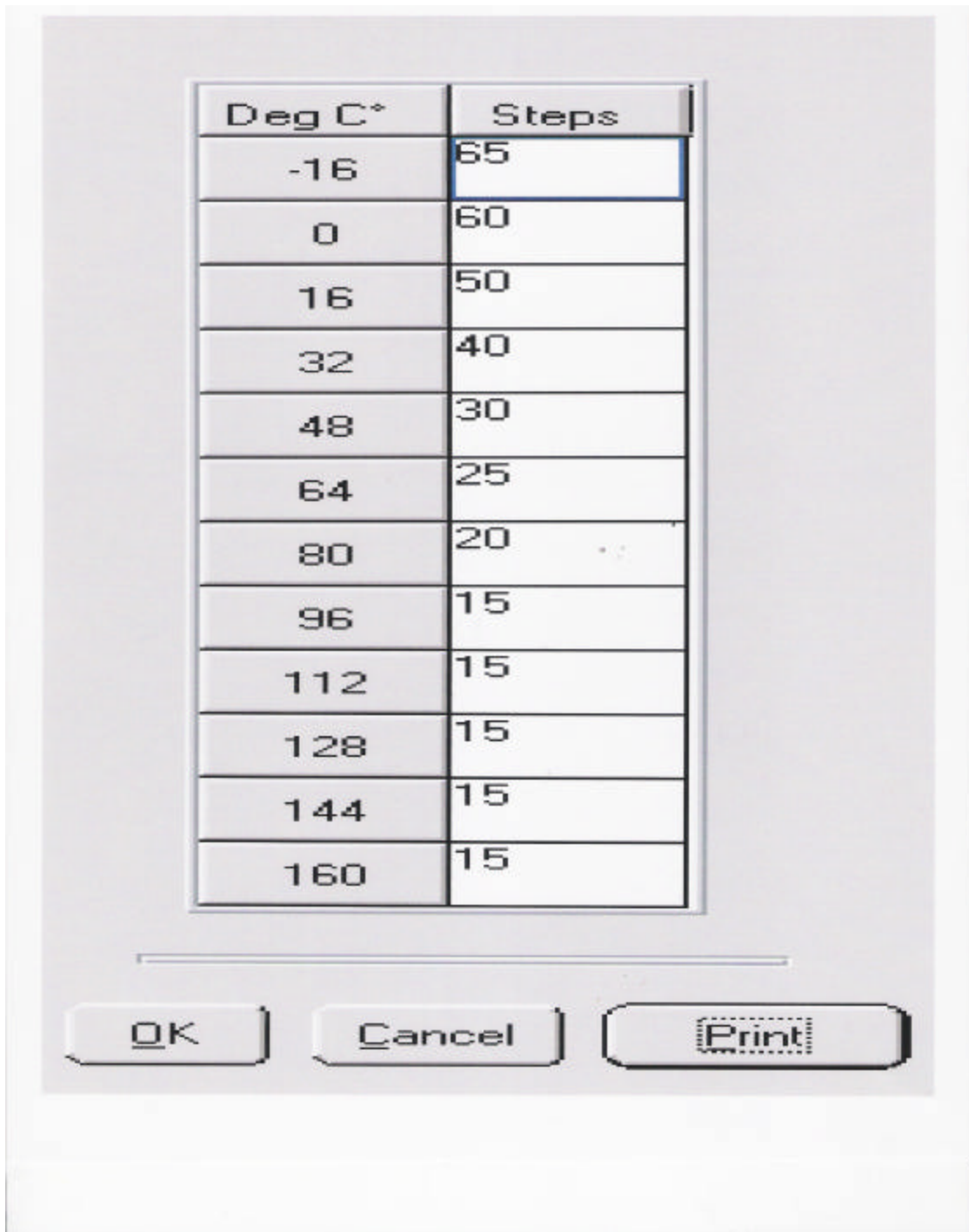
The image shows a screenshot of a software interface for an Idle Table. It features a table with two columns: 'Deg C°' and 'RPM'. The table contains 13 rows of data. Below the table is a horizontal scrollbar. At the bottom of the interface are three buttons: 'OK', 'Cancel', and 'Print'.

Deg C°	RPM
-16	1312
0	1296
16	1208
32	1120
48	1048
64	1016
80	1008
96	1000
112	1000
128	1000
144	1000
160	1000

OK Cancel Print

4. IAC Table

Make sure to check this table. This table may need to be adjusted while tuning to make sure bike is idling up on startup and when at operating temperature the idle is stable. Check live data and verify the actual stepper counts are not lower than the programmed stepper counts. The actual Steps should be the same or slightly higher than the programmed values. Double click on a STEPS cell and use the up and down arrow to adjust. Click OK. See this example of a typical Idle Table:



The image shows a screenshot of a software interface for an Idle Air Control (IAC) table. It features a table with two columns: 'Deg C*' and 'Steps'. The table contains 13 rows of data. Below the table are three buttons: 'OK', 'Cancel', and 'Print'. The 'Print' button has a dotted border.

Deg C*	Steps
-16	65
0	60
16	50
32	40
48	30
64	25
80	20
96	15
112	15
128	15
144	15
160	15

OK Cancel Print

5. Accel Table

Make sure to check this table. The accel table needs to be adjusted during tuning so the bike will have crisp response when blipping the throttle and no black smoke coming out of the exhaust. This table can be set to zero for tuning. Double click on a STEPS cell and use the up and down arrow to adjust. Click OK.

6. Decel Table

Make sure to check this table during tuning if decel popping is occurring. This table allows the removal of a small amount of fuel during a decrease in throttle position, or during a decrease in manifold pressure. This fuel gets subtracted from the base pulse width calculation.

- Larger values increase the fuel removed.
- Smaller values decrease the fuel removed.

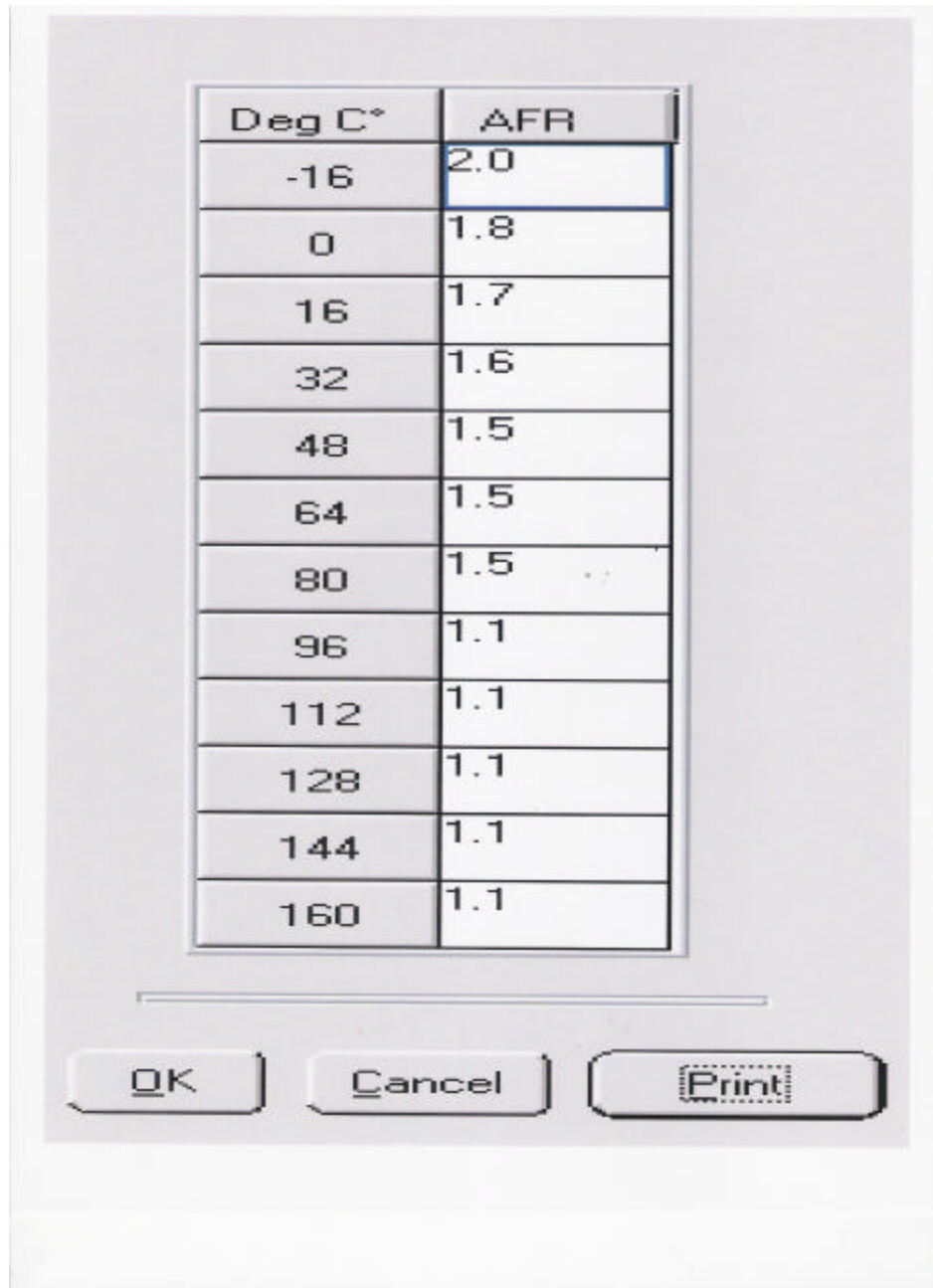
Double click on a STEPS cell and use the up and down arrow to adjust. Click OK

7. Closed Loop

This table can be left alone for tuning as the AFR Table has been set to 13.2 or 13.4 so the bike will always now be in open loop and not be using the factory Oxygen sensors. Only when the AFR table is at 14.6 will this table be active and used.

8. Warm-up Fuel table

Make sure to check this table. This table needs to be minimized as much as possible so gas is not being wasted on warm-up. Double click on a AFR cell and use the up and down arrow to adjust. Click OK. See this example of a typical Warm-up Fuel Table:



The image shows a software window titled "Warm-up Fuel table". It contains a table with two columns: "Deg C°" and "AFR". The table lists temperatures from -16 to 160 in increments of 16, with corresponding AFR values. Below the table are three buttons: "OK", "Cancel", and "Print".

Deg C°	AFR
-16	2.0
0	1.8
16	1.7
32	1.6
48	1.5
64	1.5
80	1.5
96	1.1
112	1.1
128	1.1
144	1.1
160	1.1

OK Cancel Print

Also check the following before first flash:

a. Knock Sensor

This should be turned on when the timing table is being adjusted and click OK to save.

b. Engine Parameters

The settings for Engine size and injector size should be set to match what the engine really is. These parameters may need to be adjusted to move the VE tables off of maximum values. Double click on a parameter and use the arrows to adjust. Click OK to save.

c. Calibration Note

It is a good idea to detail what modifications the engine has...CAMs, pipes, air box, etc.

FIRST ECU FLASH

All of the tables have been checked and it is time to flash the ECU for the first time. We will be flashing many times once the tuning of the VE tables starts and the adjustment of the spark tables. The first flash has to be done to get all of the changes just made, after this we start the tuning process.

A re-flash is always necessary for any changes to take effect.

THE TUNING PROCESS

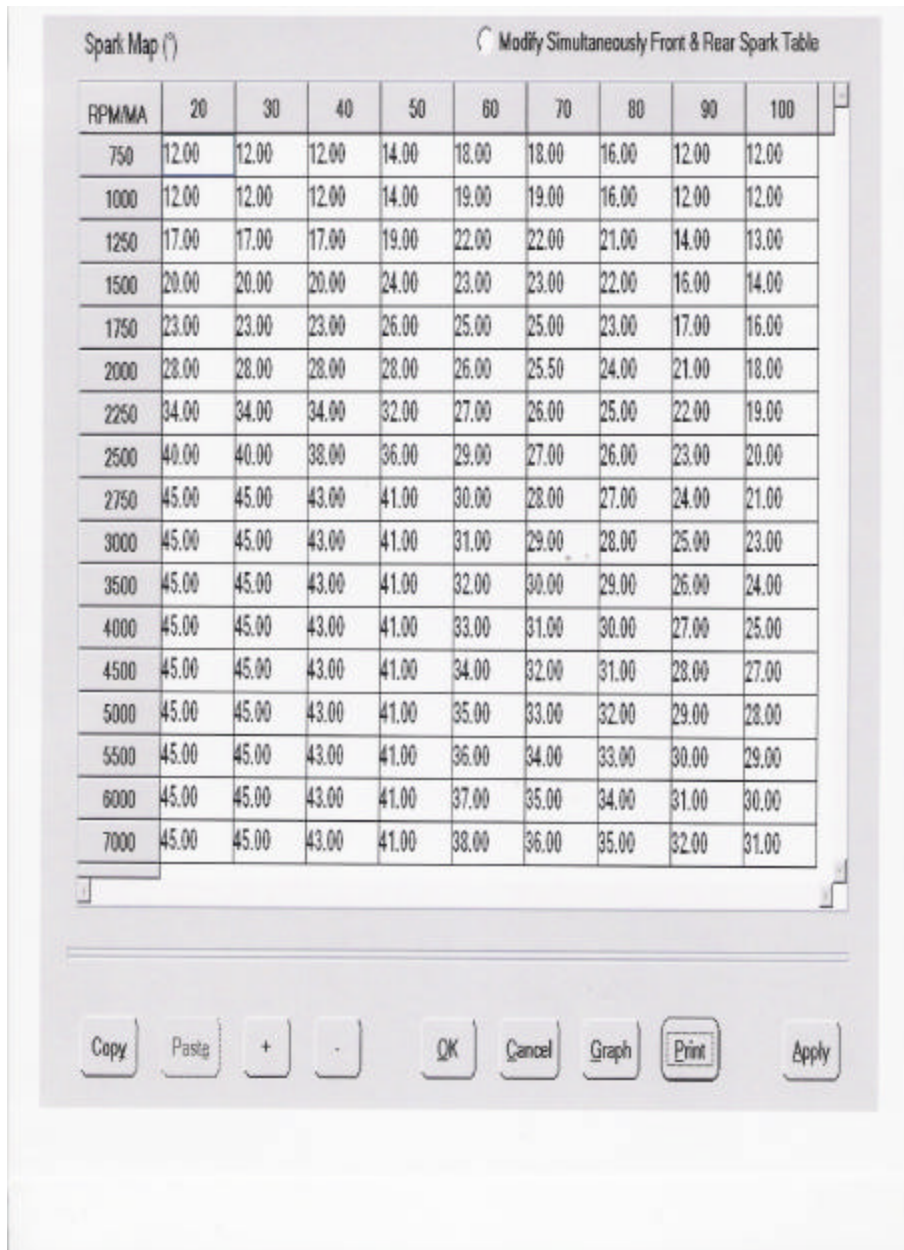
VE Tables

To accomplish this task you need a dynamometer and Wide Band AFR probes. There are many available AFR probes on the market. Direct Link is unique in that the software will allow for auto-tuning the VE tables both front and rear. There is also the manual way of tuning; which ever you decide to do it is important to stay consistent with the technique for tuning. The AFR data that is collected will have to be entered into the VE tables as an offset. This is the point where engine parameters and injector sizing may need to be adjusted so the VE tables are not at their maximum limit. This is the reason the AFR Table is set to a constant value so that all cells are the same and you now can offset the VE values to achieve the AFR command you have set in the table. An example is if you set the AFR to 13.2, then the VE for each cell in the VE tables needs to be calibrated to that 13.2 value.

Each time you change VE table values you need to press apply and press OK. Then you will need to re-flash the ECU with the new VE values.

Spark Tables

The Spark or ignition tables need to be setup for maximum torque and efficiency. This means no spark knock activity or no “pinging”. If the spark values are changed by a large amount the VE table values will need to be verified. Here is an example of an ignition table that will work for most stock bikes or slightly modified bikes. If you get a highly modified bike then this table will need to be modified.



Spark Map (°) Modify Simultaneously Front & Rear Spark Table

RPM/MA	20	30	40	50	60	70	80	90	100
750	12.00	12.00	12.00	14.00	18.00	18.00	16.00	12.00	12.00
1000	12.00	12.00	12.00	14.00	19.00	19.00	16.00	12.00	12.00
1250	17.00	17.00	17.00	19.00	22.00	22.00	21.00	14.00	13.00
1500	20.00	20.00	20.00	24.00	23.00	23.00	22.00	16.00	14.00
1750	23.00	23.00	23.00	26.00	25.00	25.00	23.00	17.00	16.00
2000	28.00	28.00	28.00	28.00	26.00	25.50	24.00	21.00	18.00
2250	34.00	34.00	34.00	32.00	27.00	26.00	25.00	22.00	19.00
2500	40.00	40.00	38.00	36.00	29.00	27.00	26.00	23.00	20.00
2750	45.00	45.00	43.00	41.00	30.00	28.00	27.00	24.00	21.00
3000	45.00	45.00	43.00	41.00	31.00	29.00	28.00	25.00	23.00
3500	45.00	45.00	43.00	41.00	32.00	30.00	29.00	26.00	24.00
4000	45.00	45.00	43.00	41.00	33.00	31.00	30.00	27.00	25.00
4500	45.00	45.00	43.00	41.00	34.00	32.00	31.00	28.00	27.00
5000	45.00	45.00	43.00	41.00	35.00	33.00	32.00	29.00	28.00
5500	45.00	45.00	43.00	41.00	36.00	34.00	33.00	30.00	29.00
6000	45.00	45.00	43.00	41.00	37.00	35.00	34.00	31.00	30.00
7000	45.00	45.00	43.00	41.00	38.00	36.00	35.00	32.00	31.00

Copy Paste + - OK Cancel Graph Print Apply

New AFR Table for Drivability and Gas Mileage

Once the tuning process is complete the VE tables are calibrated, and there is no spark knock or pinging, and you have accomplished maximum efficiency for HP/TQ, then the AFR Table needs to be changed so the bike will get decent gas mileage as well as maximum performance. Once the AFR Table is modified then click on apply, then click OK. Now we need to re-flash the bike with this latest change.

Here is an example of an AFR Table that usually yields 38-42 MPG if the tuning is accurate and the bike is ridden in a sane manner and not at WOT (wide open throttle) all the time:

RPM/MAP	20	30	40	50	60	70	80	90	100
750	13.5	13.5	13.5	13.5	13.5	13.4	13.3	13.2	13.1
1000	13.5	13.5	13.5	13.5	13.5	13.4	13.3	13.2	13.1
1250	13.5	13.5	13.5	13.5	13.5	13.4	13.3	13.2	13.1
1500	13.7	13.7	13.7	13.6	13.5	13.4	13.3	13.2	13.1
1750	13.7	13.7	13.7	13.6	13.5	13.4	13.3	13.2	13.1
2000	13.7	13.7	13.7	13.6	13.5	13.4	13.3	13.2	13.1
2250	13.7	14.1	14.1	14.0	14.0	13.6	13.3	13.2	13.1
2500	13.7	14.1	14.1	14.1	14.0	13.7	13.3	13.2	13.1
2750	13.7	14.1	14.1	14.1	14.0	13.7	13.3	13.2	13.1
3000	13.7	14.1	14.1	14.1	14.0	13.7	13.3	13.2	13.1
3500	13.7	14.1	14.1	14.1	14.0	13.7	13.3	13.2	13.1
4000	13.7	14.1	14.1	14.0	14.0	13.7	13.3	13.2	13.1
4500	13.7	13.7	13.7	13.6	13.5	13.5	13.3	13.2	13.1
5000	13.2	13.2	13.2	13.2	13.2	13.2	13.3	13.2	13.1
5500	13.2	13.2	13.2	13.2	13.2	13.2	13.3	13.2	13.1
6000	13.2	13.2	13.2	13.2	13.2	13.2	13.3	13.2	13.1
7000	13.2	13.2	13.2	13.2	13.2	13.2	13.3	13.2	13.1

Copy Paste + - OK Cancel Graph Print Apply All @ AFR:13.4

Summary

All of the above example tables are just that - examples. They will work but if you have your own tables, then by all means use them. It is always good advice that after the ECU is re-flashed that the bike is run to make sure the flash was accepted and the bike is performing as planned. An example would be to flash the above AFR table and then run the bike in live data mode through the gears and at cruise. Run the bike on the dyno at a 60, 65, 70, 75mph constant speed. The live AFR values should be real close to 14.0/14.1 as programmed. If the VE tables were calibrated correctly then the ECU will drive to the programmed AFR value. If the values are not close to the programmed value in the example then the tuning process was not done properly and the VE tables will need further tuning.

You should be able to achieve a bike that has increased in HP/TQ and has much better drivability than when you started.

If there are still questions then call TechnoResearch and they can put you in touch with a Master Tuner to answer questions or they can be commissioned to come to your site for live training.

Direct Link Basic Tuning Guide (Magneti Marelli IAW26H)

This guide assumes that you have a dynamometer, you no how to operate it and understand the M&M fuel injection. This guide also assumes you know how to use the Direct Link program and how to setup the Gauge Screen in Direct link.

Step 1

Follow Harley-Davidson service Bulletin M-1105 or M-1101 and make sure the throttle body, the TPS, cold idle and warm idle are all setup correctly. This bulletin can be found doing a web search. This has to be done first and remember Warm idle adjustments are when STEP counts are "0". Set the hot idle Throttle Blade opening to 2.5-3.5 degrees. The TPS may have to be adjusted to get the zero hot throttle blade opening to read 2.5-3.5 degrees. Anytime you move the Throttle blade the ECU needs to be reset by taking power away from it for 10-15 minutes. Make sure you set the idle speed between 1000 and 1050.

Step 2

Start the bike cold and fill in the tables for TPS Opening Versus Heat Index (Engine Temp). This needs to manually be done while monitoring the AFR values at the engine Temp points of the Table. Then adjust this table to achieve the correct AFR for engine temp. Cold bike 12-12.5, hot bike should maintain desired AFR 13.5 to 14.0 or so. The AFR values should go leaner to 13.5-14.0 as the bike warms. Do not adjust the Air Temp Fuel Correction @ TPS closed. Make all the warm up adjustments with TPS Opening Versus Heat Index (Engine Temp).

Step 3

You are now ready to tune the AFR Tables remembering that the front cylinder is the main fuel table for both cylinders and the rear is an offset from the main (front) fuel table. You

need to collect AFR data for as much of the Tables as possible. You should not collect any data until the Step counts are "0". It is very important to make sure that after the AFR data collection that the Warm idle settings for Voltage and Throttle Blade opening are stable to where you had them set in Step 1. If they are not then one of the components in the M&M Throttle Blade assembly is failing.

Step 4

Tune ignition tables. That means bike under a load and listening for pinging. The main table is ignition setting for the front and the rear cylinder. You also have to adjust the @Idle table so the bike will idle down correctly and you have to adjust the @Full Load table. The @ Idle should match the Front/Rear at the hot motor closed idle setting and the @Full Load should match the WOT ignition line.

Step 5

If the bike is hard to start the Cranking Fuel table should be adjusted so it will start quickly. Set the Rev limit to where you want it.

Step 6

Update the calibration note in the software so that the bike specs are correct and the hot idle Voltage/TPS opening are recorded. This way you can always get back to the starting point if things in the TB move.