Harley Power Vision

High Performance EFI Calibration/Tuning Training

Theory

Presented by Daniels Media

Harley Power Vision Theory

Use this book with the videos to help understand how to use a Power Vision to tune a Harley

If you have questions, please use the question form accessible from your membership profile page on Dynotuner.com.

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Lesson 1:

What Is Power Vision?

Introduction

This online class is an introduction to tuning Harley's with a Dynojet Power Vision.

To get the most from this training, it is recommended you have:

- Dyno experience
- Computer experience
- Motorcycle repair experience
- Motorcycle riding experience

What is Power Vision?

Power Vision is a FLASH TUNER.

- Changes the data on the reference (look-up) tables in the ECM.
- Used to calibrate the air reference tables to match the new airflow of a modified engine.
- Used to tune for engine modifications and customers riding style.

Objective for using Power Vision?

- **Calibrate the ECM!**
  - This ensures the bike will run its best under ever changing air conditions caused by weather and altitude changes.
- Better Overall Vehicle Performance
  - Better Mileage
  - Better Drivability
  - Higher Power Output
- Happy Customers
- Improve Sales & Service

Power Vision Positives

- Will not damage the motorcycle
  - Improper Tuning can cause damage
- Can easily be returned to starting point
- Adjust **air** values and ignition timing for each cylinder
- Pick desired Air-Fuel ratios
- Accelerator Enrichment
- Adjust RPM limit, Injector Size and Displacement
- Adjust Warm Up & Cranking Fuel
- Monitor & Record Data on Dyno and Track
- Read & Clear Codes from the ECM

Power Vision Positives, *continued*

- Enable or disable Knock Sense, Heat Management, ACR's, Active Intake, Active Exhaust
- Oxygen Sensors remain intact.
  - Closed loop target can be "adjusted"
- Does not ride along (no piggyback – no water intrusion)
- Throttle Progressivity Table
- Air-Fuel & spark tables reference Manifold Absolute Pressure (Engine Load)
- Base cal set up for any cam
- Calibrate speedometer

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Lesson 2:
What Is EFI?

What is EFI?

- EFI is an acronym of “Electronic Fuel injection.”
- Electronic fuel injection system is a digital precise way to meter fuel into an internal combustion engine.
- It does this by having a fuel pump deliver pressurized fuel to a Fuel Injector, which is an open or closed valve. When it is open, the fuel flows at a specific rate that Harley measures in Grams per second. I.e. 4.35 injector with the correct fuel pressure will flow 4.35 grams of fuel by weight for every second it is left open.
- The Harley ECM (**Electronic Control Module**) calculates how long to open the injector to get the right amount of fuel for the current running condition.
- The Harley ECM also controls timing, and most new bikes it controls the throttle as well.

What's the advantage of EFI

- Does it improve Fuel Economy?
  - Yes. Through better atomization.
- Does it Improve emissions?
  - Yes. Through better atomization.
- Does it increase Peak Power?
  - Not really.
- Does it correct for Altitude?
  - **Absolutely!** One of the biggest benefits of EFI is its ability to correct the mixture for ever changing air conditions. Pressure, Temperature, and Humidity.

Electronic Fuel Injection

- Very good fuel atomization
  - Injectors produce a fine spray under pressure
  - Fuel is injected just ahead of the intake valve
    - Hottest part of the intake track helps atomization
  - Improved cold drivability and warm up
- Volume of fuel is controlled by how long the injector is open measured in MS (milliseconds) Called Pulse Width
  - The longer the Pulse Width the richer the mixture
- ECM controls the Acceleration Fuel
- ECM controls the Warmup Fuel
- Very accurate fuel targeting in every throttle position and engine load
- Ability to map for power AND economy at the same time
- **Ability to correct mixture for ever changing air conditions (If properly calibrated)**

How Does EFI Work?

Inputs →	ECM →	Outputs
• Throttle Position • RPM • Manifold Absolute Pressure (MAP) • Intake Air Temp • Barometer • Crank Position	• AFR Table • **VE Tables** • **CID** • Injector Size • Spark Tables	• Injector Pulse Width • Spark Advance

Our Speed Density Electronic Fuel Injection system is just a computer with a handful of sensors!

It has inputs used to gather information. Data or reference tables to use with the inputs to make calculations which lead to the outputs.

If the inputs function correctly and the data tables are accurate the outputs provide a great running motorcycle everywhere you ride regardless of altitude or weather.

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Lesson 3:
How Does It Work?

Engines Work By Combus ting Air

What is air?

- According to NASA Under Standard Air Conditions* , the air around us is made up of about 78 percent nitrogen, 21 percent oxygen (O2), with traces of water vapor, carbon dioxide, argon, and various other components.**
- We are all aware that pressure and temperature of the air depend on your location on the earth and the season of the year.
- Even though it is hotter in some seasons than others, pressure and temperature change day to day, hour to hour, sometimes even minute to minute.
- As altitude increases, air density, “pressure”, decreases.

** 59 degrees Fahrenheit, 14.7 pounds/square inch*

*** Trace gases include krypton, methane, neon, helium and hydrogen.*

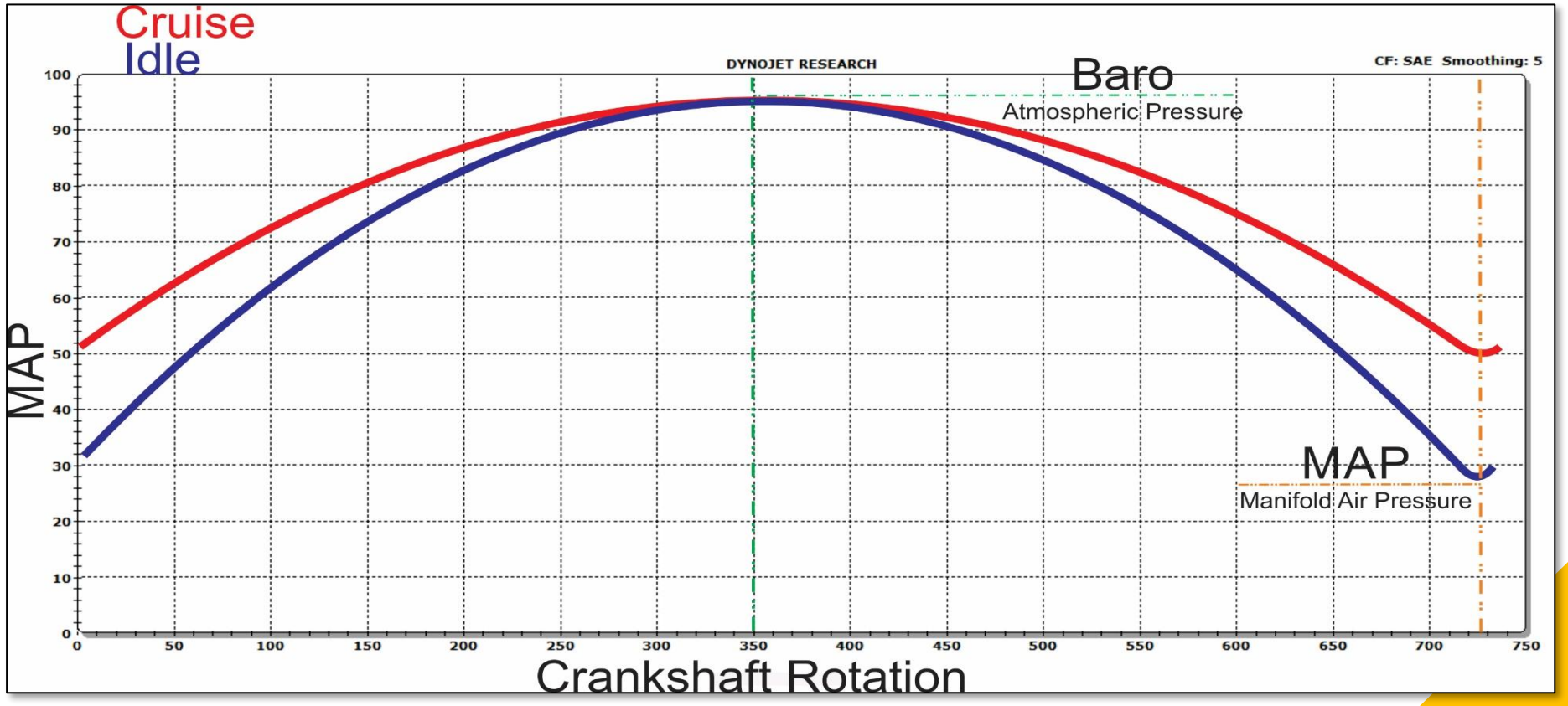
Atmosphere

What does it all mean?

- The Air Temperature, Pressure, and Humidity constantly change around us which means the amount of **O2 (Oxygen)** in the air is constantly changing with it.
- Internal combustion engines burn these **oxygen (O2)** molecules by mixing them with the proper ratio of fuel molecules.
- Using the Intake Air Temp and Baro Sensors the ECM is constantly calculating how much Oxygen is in the air being feed into the engine.

The Baro (outside air pressure) is read by the MAP sensor during the high-pressure wave in the throttle body.

MAP & Baro Read



By reading the MAP sensor at different crank positions,
the ECM can track the engine load as well as the outside air pressure.

Air Fuel Ratio (AFR) 14.7:1

- Parts of air to parts of fuel by weight.
- Example: 14.7 means that for every 1 gram (gm) of fuel, we have 14.7 grams of Air.
- Thousands of times a second, the ECM references the VE table to determine the volume of air flowing through the engine at that exact moment. Having calculated the oxygen content from the outside air, it knows how many grams of O2 is running through the combustion chamber. Referencing the injector size table, it calculates the exact millisecond of injector pulse width to achieve the desired AFR target - based on the air fuel table.
- Every time the injector is fired, the pulse width is calculated*

* *Except at start up*

VE Tables

- ECM needs to know actual air movement through ***each*** cylinder at different Throttle Position and RPM intersections.
  - The system doesn't measure air flow through our engine (air pump), we must determine what the airflow at each throttle position vs RPM is and tell the ECM via the VE/CID tables.
- Total (max) volume of air an engine can move through it is represented by the "Engine Displacement" table.
- Air movement through the engine at each throttle position vs RPM is programed into the ECM on the VE tables.
- When you change Pipes, heads, cams… the air movement in the engine changes.
- The VE tables, and sometimes CID need corrected to match these changes.

THE BIG SECRET

We must *calibrate* the VE tables to our new engine configuration.

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Lesson 4:

How Do We Calibrate Air Flow?

Air flow is represented in the ECM as VE. What is VE?

VE stands for Volumetric efficiency, which is the amount of air a cylinder can hold versus how much air that is in it at any given time.

Let's look at this a bit more closely.

- If you had an empty mason jar that holds 100 cubic inches (CI) and you took the lid off, how much air flows into the jar? It's a safe bet that atmospheric pressure would push 100 cubic inches of air into the jar very quickly. Simple enough.

Now think about this.

- Same empty jar, but the lid has a 2-inch hole with a valve, like a Harley head has, sealing the hole.
- Now, push the valve into the jar opening .500 (a half inch) and then close it in .006 seconds (6 thousands of a second)*. How much air flows into the jar? It is safe bet that it will be less than 100CI. If 80 CI flows into 100CI jar before the valve closes, then the VE is 80%.

* *We refer to 6 thousand of a second as 6MS where MS means Millisecond. 1 MS is .001 or one thousandth of a second.*

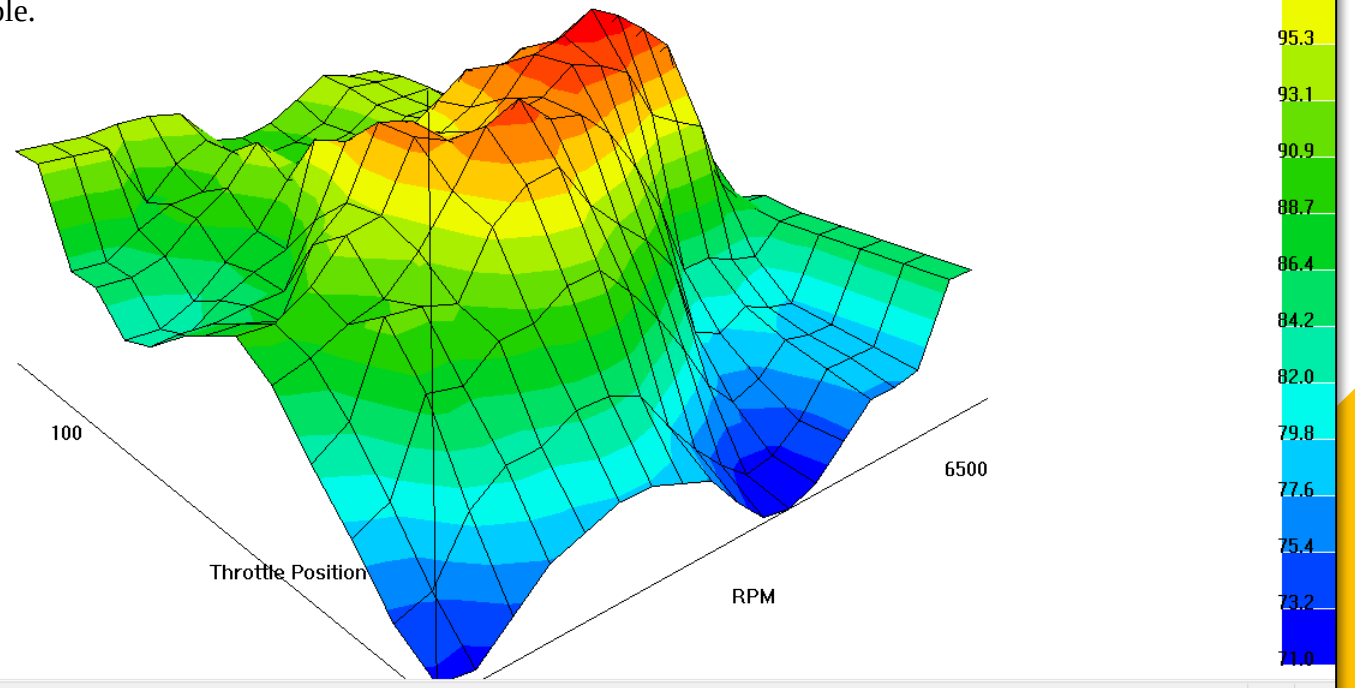
What is VE?

- What determines how much air goes into our jar, or cylinder, is how fast the air moves in the 6MS window of time the valve is open.
- In an internal combustion engine, the speed of the air going past the valve is referred to as port velocity. There are several things that affect port velocity: Of course, exhaust, throttle body, cam… but also Piston Speed (RPM) and intake hole size (throttle position).
- At any given Throttle Position (hole size) vs RPM (Piston Speed), a specific volume of air flows into the cylinder creating the VE for that point.
- This is why RPM and Throttle Position are the left axis and top axis of most of our VE tables.

Calibrating VE tables

The VE table is the main table that models engine airflow so AFR can be accurately calculated. This table is influenced by the camshaft, exhaust system, head design, engine displacement and air filter. This is the most critical item that must be correct in order to make the bike run correctly. To increase fuel make the values larger. to decrease fuel make the values smaller

- As we've discussed, changing pipes, cams, heads, etc., changes the air flow through the engine. But not the same amount everywhere. It may be more at one (Throttle Position) TP/RPM, less at another.
- Theoretically, we need to be able to measure the air flow at each cell on the front VE Table TP vs. RPM.
- And the Rear VE Table.



Measuring Air Flow

- With the equipment we have, it is nearly impossible to measure airflow through a Harley-Davidson V-twin engine. We know the ECM is constantly looking at the VE table and calculating to determine how much air is flowing through a cylinder at any given moment and using that to calculate injector pulse width to match the target AFR (Air Fuel Ratio).
- If the actual airflow through the cylinder matches the number on the VE table, then the target AFR and the actual AFR match.
- By knowing what the AFR target is – and measuring the actual AFR via a Wide Band O2 (oxygen) sensor in the pipe, we are checking the ECM's math. If they match, the VE number is correct. If not, then the VE number is incorrect.
- If the VE is correct, we should see the desired AFR on the Dyno's AFR gauge.
- If the Dyno's AFR gauge doesn't match the desired AFR from the AFR-table, the VE cell is wrong and needs to be changed.

VE Math Check

- As an example, if the Air fuel ratio target is 13.0:1, and you are running the bike at 60% throttle 2500RPM, and the VE cell for the front cylinder has 90 in it:
- If the AFR measured on the Dyno reads 14.5:1, it means the engine is pumping more air than the 80 VE represents. So, we have to make the VE number in that cell bigger.
- A general rule is 10 VE equal 1 AFR point, 14.5 is one and a half AFR points leaner, so we will add 15 to the 90 making it 105.

VE (TPS based/Front Cyl)

19T107a00101.pvt

RPM	Throttle Position (Percent)													
	3	4	5	7	10	15	20	25	30	40	60	80	90	100
700	72.5	74.5	78.5	82.0	86.0	88.0	86.5	85.0	82.5	81.5	84.5	84.5	92.5	92.5
850	72.0	75.5	80.0	84.0	87.0	88.0	86.5	85.0	82.5	81.5	84.5	84.5	92.5	92.5
1000	74.5	80.1	86.7	90.6	88.5	89.9	85.8	85.5	84.5	83.0	85.5	86.5	92.5	92.5
1125	77.0	82.2	86.2	90.4	89.5	92.9	90.9	85.8	86.0	85.5	88.0	88.0	87.0	93.0
1250	78.0	82.4	88.5	89.7	92.2	93.6	93.4	90.8	87.1	87.4	89.9	88.4	89.8	93.1
1500	79.0	84.0	88.8	94.5	95.9	98.8	98.9	96.4	95.5	91.0	93.2	91.3	91.3	92.7
1750	79.0	84.0	90.7	96.8	100.0	97.9	98.4	96.7	94.6	90.6	90.2	89.4	89.2	89.6
2000	78.0	83.0	91.0	97.4	101.4	96.3	96.2	94.8	93.5	89.1	88.4	88.8	88.8	89.2
2250	77.0	79.5	88.5	93.9	99.3	98.8	96.3	95.2	94.5	89.7	88.9	89.7	89.2	90.0
2500	74.0	76.5	85.5	91.6	99.0	99.4	98.4	96.7	96.3	90.6	90.0	90.5	90.4	91.7
2750	71.5	74.0	82.0	89.5	96.9	101.4	101.4	99.7	98.4	93.2	92.4	92.5	93.2	93.5
3000	71.0	72.0	78.0	86.5	93.5	100.8	102.4	99.5	97.5	93.2	92.6	92.7	93.2	92.9
3500	72.0	72.5	75.5	80.0	89.3	99.7	104.1	100.7	99.2	95.1	92.3	93.0	93.2	92.9
4000	74.5	74.5	76.5	79.0	83.3	95.6	103.1	99.5	98.1	92.5	90.5	91.3	91.6	91.1
4500	77.0	78.0	79.0	80.5	83.5	94.4	101.5	97.4	95.4	90.5	87.1	87.6	87.4	86.6
5000	77.0	78.0	78.5	79.5	82.5	93.4	99.6	96.2	93.0	87.9	82.3	82.4	82.8	82.5
5500	77.5	78.0	78.5	79.0	82.0	87.6	92.1	91.2	88.3	84.5	78.3	77.4	78.5	78.6
6000	84.5	84.5	84.5	84.5	84.5	85.0	88.6	89.4	85.3	82.2	76.1	75.2	75.0	75.0
6500	84.5	84.5	84.5	84.5	84.5	85.0	83.6	83.8	81.8	78.6	74.9	76.5	79.0	79.0

VE Math Check, continued

When all the cells on the VE table are calibrated to (match) the actual air flow through our engine, then we can go to the Air Fuel Ratio (AFR) table and request any AFR target we want in a cell and get that AFR at the exhaust as we ride through that cell.

When the VEs are correct, you can change the tune (desired AFR) quickly by just changing the AFR table.

Then presto! You get what you ask for!

Calibrating VE tables

Basically, while sampling the AFR (Air Fuel Ratio) of each cylinder, we do a Dyno run for each Throttle position represented on the VE table.

Using the Dyno graph displaying the AFR, we adjust the VE cells that don’t match the target/requested AFR from the AFR table.

Then we do the runs again to check are results and repeat as necessary until the actual AFR matches the requested AFR.

More about this in a future lesson.

I hope this information has been useful for you.

Keep an eye out for more to be added to this manual and tech tips on the membership site.

Please use the question form for any questions, comments or suggestions.

Thank you for taking the time to view this material!
Mike