EEC-IV ADAPTIVE CONTROL

YOUR BEST FRIEND OR YOUR WORST NIGHTMARE!

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Welcome to the wonderful world of EEC electronics! (pronounced "EEK") This is the first in a series of articles here on *The Mustang Works* dealing with the EEC. We will be discussing various aspects of the EEC in a Mustang. By understanding how the EEC controls the engine, hopefully you'll get a better idea of why some changes to your engine may or may not perform as you expected. Through a series of articles, we will go through major sections of the EEC and how they work with common aftermarket parts. Some of this might be old news to a few, but a lot of it goes way beyond what has ever been written before. In each issue we will go through sections like: Adaptive Control, MAFs and Injectors, Closed Throttle / Part Throttle / Wide Open Throttle, Sensors and what they do, Replace the EEC or Re-Calibrate, Fooling the EEC, Fuel Control, Spark Control, Speed Density Vs. Mass Air, Power Adders and the EEC, and EEC Transmission Control.

I'm sure you've all heard something about the EEC's Adaptive Control system, but what exactly is it, and what does it do? Before we get into the Adaptive Control system, let's define a few common terms:

SPEED	**Another term for RPM**
LOAD	**Roughly volumetric efficiency or how much air is entering the engine over how much it can hold.**
CLOSED LOOP	**Fuel control when the EEC is using the oxygen sensors as feedback to control the fuel injectors**
OPEN LOOP	**Fuel control when the EEC is relying on tables to control the fuel injectors**
WOT	**Wide Open Throttle**

The Adaptive Control system is used to correct changes in engine operation caused by variations in air metering and fuel delivery devices. The Adaptive Control system corrects the problems of variability by making changes to fuel flow based on what it has 'learned' about the system. If your engine is running leaner than it should, the Adaptive Control system can richen the system up automatically. The same thing if it is running a bit rich. The EEC has a special block of memory called the Keep Alive Memory where it stores information about how the engine is operating. By looking at the oxygen sensors, the EEC can tell if the amount of fuel it is delivering is the same amount actually going into the

cylinders at a given Speed / Load point. In the Keep Alive Memory, there is a table that represents Speed / Load points normally used during Closed Loop control. As the EEC reads the oxygen sensors, it updates this table if it finds any differences in the fuel delivered and the A/F ratio measured. As an example, we will look at how the Adaptive Control system works if fuel pressure is something other than stock.

From this example, you'll quickly see why an adjustable pressure regulator might not be a good investment of your money. Ford uses a fuel pressure of roughly 39 PSI to rate it's fuel injectors. The fuel regulator operates in conjunction with manifold pressure to keep the delta pressure across the fuel injectors at roughly 39 PSI at all times. In the EEC calibration, there is a number that represents the size of the injectors installed in the engine. This number represents how much fuel the injector will flow at 39 PSI. The EEC uses this number, along with airflow information to correctly calculate A/F ratio. Based on the airflow number and its target A/F ratio, the EEC pulses the fuel injector to give just the right amount of fuel to reach its target A/F ratio at any given Speed/Load point. Now if you were to increase the fuel pressure, the amount of fuel delivered for a given pulsewidth would go up since more fuel will be forced through the injector. As soon as the EEC goes into Closed Loop control, it will 'see' this increased fuel pressure. The reason for this is for any given pulsewidth, the A/F ratio as measured by the oxygen sensor will be richer than what the EEC wanted it to be since now there is more fuel delivered with the same pulsewidth. The EEC will calculate the difference from what it wanted and what it got and update the Adaptive table with a 'correction factor' and use this correction factor to reduce the injector pulsewidth the next time the injector fires. Eventually what happens is the EEC is able to 'dial out' the extra fuel that was added by increasing the fuel pressure. Now you can probably see why raising the fuel pressure is only a temporary 'fix' for a lean problem. Soon you will be right back where you started from. The EEC is continuously updating the Adaptive table anytime it is in Closed Loop.

"What about Open Loop?" you might ask. Well, it works there too. This fact alone is know by very few people. Most people think Adaptive only works when in Closed Loop. This is wrong! Adaptive is only UPDATED during Closed Loop. It would be silly to ignore changes in the air and fuel system in Open Loop and only correct them in Closed Loop. If you have a serious fuel problem, your car might not even start if the EEC didn't have some way of correcting things all the time. The way the EEC uses Adaptive in Open Loop is similar to Closed Loop except it doesn't update the table. This means it's not looking at the oxygen sensor for feedback. It is merely relying on the information stored in the table to make corrections. Since the Adaptive table only contains Speed / Load points normally seen during Closed Loop, where does the correction factor come from if I'm at WOT? Good question. The answer is; it uses the last value it was using while in Closed Loop. Since the Keep Alive Memory has power to it even when the ignition key is turned off, the Adaptive table retains it's information. The only

way to clear the Adaptive table is by disconnecting the vehicle's battery. Do that and you're back to working with a clean slate and the whole process starts over again. Now there are limits to how much the Adaptive Control system can change the calibrations. The adaptive system has a range of roughly +/- 25%. If you had an adjustable fuel pressure regulator installed, and you needed more fuel, you could keep cranking it up until the EEC could no longer dial the fuel back out. The problem with this is you will set a code and the 'Check Engine' light might come on.

A quick tip. When setting your fuel pressure, always check it with the vacuum reference DISCONNECTED! The pressure reading with the vacuum connected to the regulator depends on how much vacuum your engine pulls at idle. Depending on your camshaft, this can vary quite a bit. If you have a big cam and set your idle pressure to 32 PSI with the vacuum reference connected, you might only be getting 36 PSI at WOT. It's VERY important to set the idle pressure with the vacuum reference disconnected. This way you know for sure how much fuel pressure you get at WOT.