The fire in your ATV

VDI ECU vs. Fuel Controller
White Paper

We've had a lot of customers ask us the fundamental differences between our replacement ECU and the other fuel controllers on the market. This white paper is meant to identify those fundamental differences and to outline why the replacement ECU is the optimum solution to your EFI tuning.

To fully understand the problem, we need to explain the basis behind the EFI system. The EFI system replaces the carburetor with a fuel injector for fuel metering, an ECU to control the injector, various sensors to inform the ECU the system status, and allow for it to increase/decrease the fuel delivery as required.

The EFI systems contains the following sensors:

1) MAP (Manifold Absolute Pressure). Reads in the actual air pressure in the throttle body. When the engine is not running, it will be reading barometric pressure. When the engine is running, it will read the pressure inside the throttle body. Typically readings are between 45 kPa at idle and 100 kPa at WOT (Wide Open Throttle) at sea level.
2) IAT (Intake Air Temperature). Used to determine the temperature of the air entering the engine. Hotter air is less dense, and requires less fuel. Colder air is more dense, and requires more fuel.
3) ECT (Engine Coolant Temperature). Used to determine the engine temperature to richen the mixture when the engine is cold.
4) TPS (Throttle Position Sensor). Used to determine how much throttle is being applied to add extra enrichment should the user jab the throttle.
5) RPM (Revolutions Per Minute). The speed that the engine is turning over.

In the MAP governed EFI system, the sensors can be grouped into three (3) groups:

1) Main metering (MAP and RPM)
2) Compensation (IAT and ECT)
3) Acceleration Enrichment (TPS)

The ECU takes information from the MAP and RPM, and then pulls a value out of the VE (Volumetric Efficiency) table for the amount of fuel required for the engine at the particular RPM and engine load (MAP). That value is modified with the compensation to make it accurate for the current engine condition. Should the ECU detect a rapid change on the TPS reading, then it will add extra fuel on top of this value to deal with the lean condition that happens when you rapidly open the throttle.

Our ECU continuously monitors this data to ensure the ECU delivers the proper amount of fuel at any engine load, RPM or throttle position.

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The problem with other aftermarket fuel controllers is they just read the TPS sensor, and mount between the fuel injector to increase/decrease fuel delivery based on this reading. This technique works fine for a particular air filter and altitude. Unfortunately, since the VE map isn't dependent on TPS (only MAP readings), changes in air filters (a more plugged one for example), or changes in riding altitude will guarantee that the fuel controller is adding the incorrect amount of fuel and your power output dies off. This technique basically merges the need to continuously tune your engine (like in the days of the carburetor) with the dynamic nature of the EFI which takes away that need.

Let me explain to clear this up:
Here in Calgary, AB, we are situated around 3500 feet above sea level. Our barometric pressure is typically 89 kPa (or 890 mb). This value will go up and down slightly due to changing weather patterns. At sea level, the pressure will typically be around 100 kPa.

So, when we ride, 100% throttle only lets us reach 89% of the fuel table, where riders at sea level can hit 100%. We typically loose 11% of the HP just because of the altitude.

And then you need to add the air filter in there. A typically clean, stock air filter is 4% restrictive, which leads to a 4 kPa drop in air pressure in the throttle body. So, if the barometric reading was 89 kPa, and you pin the throttle, the engine can now only hit 85 kPa, or 85% of the fuel table. This is now a 15% power loss from maximum.

So, if you take your stock ECU, and hook up an aftermarket fuel controller, consider this:
You live in Florida, and you take your bike to the dyno to tune it and the new controller with a clean filter. You tweak the controller and find, for example, that you need 5% more fuel at 100% throttle. Dyno is showing you're getting maximum power, and you're happy. The ECU would be reaching the 96% section of the fuel table (because the air filter is 4% restrictive), and the controller will be tagging an addition 5% more fuel on that value.

Ok, you and your buddies' load up your bikes, and you head for Denver to do a little riding in the mountains. By now, your filter is getting a little plugged (yeh, you should have cleaned it before the ride, but things came up). So, it's now 8% restrictive. Due to the altitude, the air pressure is now 84 kPa, and since you got sloppy and forgot that filter, the bike can now only pull 76 kPa or the 76% portion of the fuel table.

This is where the problem starts to happen. Now, 100% throttle isn't the 96% portion of the fuel map you tuned for in Florida, it's the 76% fuel map that the bike is seeing in Denver. And the fuel controller is adding that extra 5% fuel to this value. There is a really good chance that the bike needs more or less fuel at the MAP reading now. How many times have you heard "I tossed on a fuel controller, downloaded the recommended fuel maps from the manufacturers site, and it ran REALLY rich. I re-tuned the maps and it worked good." There is a good chance that the map was tuned for an altitude that isn't yours.

When you run our ECU on your machine, the fuel map is calibrated for all of the pressure changes. We allow you to tune the VE table based on MAP reading and RPM, to GUARANTEE you get repeatable HP numbers out of your machine, regardless of altitude. The TPS sensor is ONLY used for acceleration enrichment, because the MAP sensor is the sensor that governs the fuel maps (VE table). The reason is simple: that's how the ECU is determining fuel delivery for different engine loads. And, just like in the example above, you can see that the VE table doesn't need to be adjusted for different air filters, as the MAP reading compensates for that.

So, in addition to delivering the proper fuel regardless of altitude and intake air restriction, we also give the customer the following benefits:

- Eliminates the low speed lag, which is caused by a lean fuel condition and retarded timing issue below 3000 RPM. This eliminates the overheat condition that your machine experiences, and gives you wheel standing performance.
- Plug and play installation allows for quick installation, with no wiring modifications to the machine.
- Dual timing maps and configurations. Have one map for inexperienced riders, and one performance map to unleash the power of your machine. Both maps are fully configurable via our optional USB Memory Interface
- Repetitive fire ignition delivers hotter spark with longer spark duration for maximum power and virtually eliminates misfires, while giving you easy starts and crisp throttle response.
- Using the performance map allows the machine to run cooler, produce more horsepower and more torque, while minimizing fuel consumption. Also, you'll benefit from better throttle response.
- Incorporates part throttle timing advance that increases the part throttle horsepower by over 40%!
- Replaceable harness allows for platform changes with a simple harness change and a firmware upgrade using our USB Memory Interface (sold separately). This may be the last ECU you'll ever need to buy!

The Copperhead® ECU is shipped with map #1 set to an "original type configuration" which is similar to the stock ECU. Map #2 is shipped with a performance type configuration for 87-octane fuel, which raises the revolution limiter, and disables the reverse and forward speed limiters. Additional timing and fuel maps for other standard configurations (i.e. higher grade fuel or aftermarket exhaust) are downloadable from our website. *Note: Air filter changes do not require any changes to the ECU.*

In addition, the Copperhead® ECU comes equipped with six (6) optional connections:

1) Engine kill tether switch connection. Active high input.
2) Tachometer output interfaces to off the shelf, 12V input tachometers that require one (1) pulse per revolution.
3) Four (4) configurable outputs to control shift lights, NOS controllers, or any other RPM sensitive outputs. Requires optional USB Memory Interface for configuration.

At the end of the day, it's up to you to determine what you're going to spend your hard earned money on. Hopefully this white paper was successful in outlining the differences between your options, and the benefits our unit has over any other product on the market.

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