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The fire in your ATV

VDI Copperhead® GEN2 CDI Installation Instructions (Yamaha Rhino 700 EFI)

Revision 1.7

Parts Included,
VDI Copperhead® GEN2 CDI:

- VDI Copperhead® GEN2 ECU and installed harness (1)
- #4x4-40 x ¼" Machine Screw (2), located in the DB44 connector

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Time Required:

- Less than an hour.

Difficulty:

- 1/10

Tools Required:

- Philips screwdriver (#PH1) to install harness screws.
- 10 mm wrenches to remove OEM ECU mounting bolt.

Supported Machines:

- 2008-2011 Yamaha Rhino 700 EFI

Introduction:

The Copperhead® GEN2 is the world's most advanced and expandable Capacitance Discharge Ignition (CDI). The Copperhead® CDI was designed around our DPM-550 Copperhead® core for ease of use and maximum flexibility while providing years of trouble free service. Each Copperhead® is shipped with a machine specific harness to be used right out of the box, and requires no additional configuration. Additional harnesses sold separately to allow for the unit to be installed on other supported models.

Several of the key features are:

- 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.
- Fully integrates with the factory speedometer.
- Speedometer can be recalibrated for different tire sizes via optional USB interface.
- 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!

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Use of Velocity Devices Inc. products may make your ATV operate in a manor, which the original manufacturer had not designed for. VELOCITY DEVICES INC., SHAREHOLDERS AND EMPLOYEES SHALL NOT BE LIABLE FOR ANY DAMAGES (WHETHER CONSEQUENTIAL, INCIDENTAL OR OTHERWISE) FROM THE USE OF VELOCITY DEVICES INC. PRODUCTS. EXCEPT, AS SET FORTH IN THIS LIMITED WARRANTY, VELOCITY DEVICES INC. MAKES NO OTHER WARRANTIES, EITHER EXPRESS OR IMPLIED.

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Overview:

The front panel contains the following items:

1) Toggle switch: The switch toggles between two user programmable maps. The Copperhead® ECU is shipped with a safety type configuration in map location #1, and a performance configuration in map location #2. See the "Operation" section for more details. The switch is only read when the key is turned on.
2) Status LED: The status LED serves as a system status and error indicator. Should the ECU detect an error, the LED will flash the particular error code(s). See the "Error Code" section for more details. The machine's EFI indicator will turn on to indicate that there is an error. Check the status LED for the error code. The matching Yamaha error code will be displayed on the speedometer display. The status LED also functions as a reluctor pickup indicator. It will remain on when the engine is not running. Once the engine is cranked, and the ECU detects crankshaft pulses, the LED will turn off.
3) Interface connector: The interface connector is used to load new user programmed timing maps and configurations as well as re-program the ECU should new updates become available. Under normal operation, this needs to be connected to the mating connector on the Copperhead® ECU harness for the speedometer to function correctly. **NOTE: THE INTERFACE CONNECTOR IS TO BE CONNECTED TO THE VELOCITY DEVICES INC. USB MEMORY INTERFACE ONLY. CONNECTING THIS PORT TO ANY OTHER DEVICE OR DIRECTLY TO A COMPUTER WILL DAMAGE THE ECU AND VOID YOUR WARRANTY**.
4) Connectors: The 18 pin and 26 pin connectors connect directly to the stock wiring harness when the factory ECU is removed. There are six optional wires that can be used to control additional devices. See the "Installation" section for more details.

NOTE:
DO NOT TRY TO OPERATE THE MACHINE WITH A HIGH CURRENT BATTERY CHARGER CONNECTED. PERMANENT DAMAGE TO THE COPPERHEAD® ECU MAY OCCUR. USING A 2 AMPERE TRICKLE CHARGER OR BATTERY TENDER IS ACCEPTABLE.

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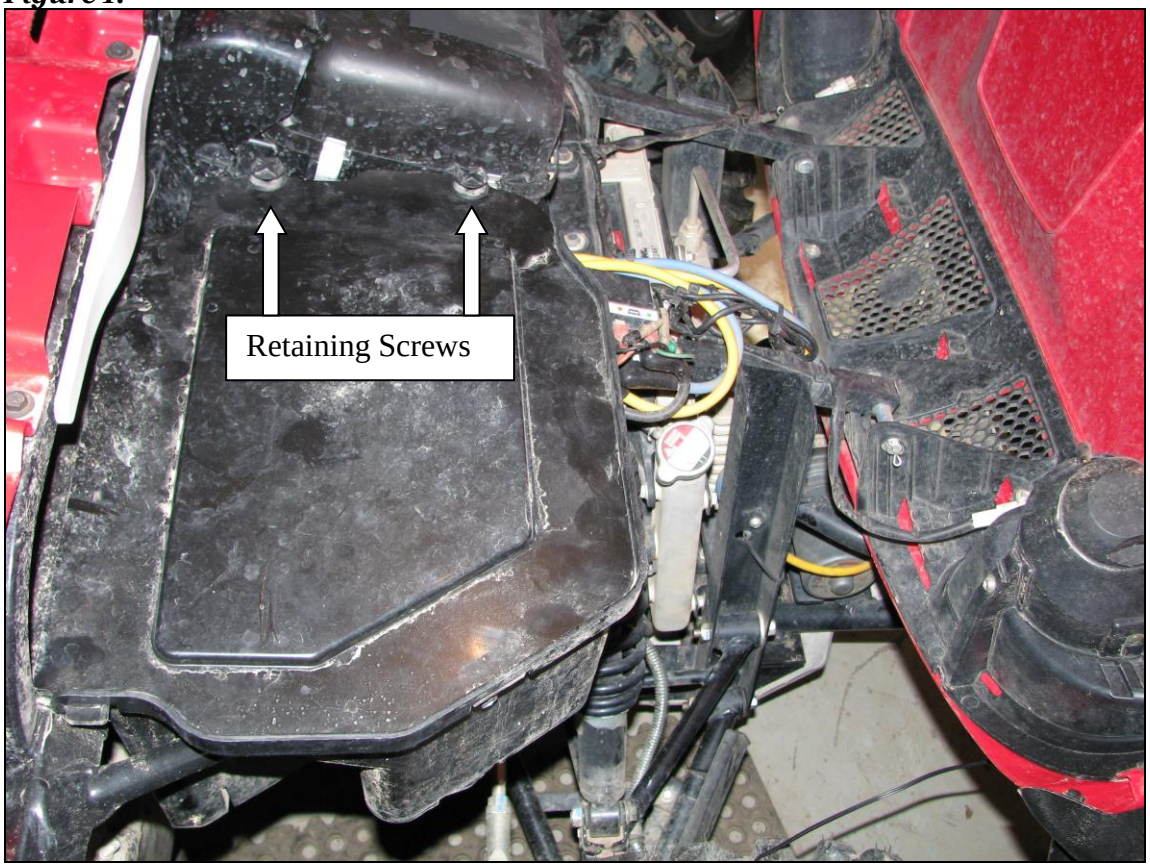
Installation:

Step 1:

Open the hood, and locate the battery box cover and its two retaining screws. See Figure 1. Unscrew the plastic clips. Once they are loose, pull gently upwards to remove them and then remove the plastic cover. Disconnect the negative battery cable.

NOTE: If your machine has had a timing offset key installed (aftermarket equipment), then the timing maps need to be adjusted using the optional USB Memory Interface. Increasing the timing with an offset key without compensating the maps may lead to engine damage.

Figure 1:



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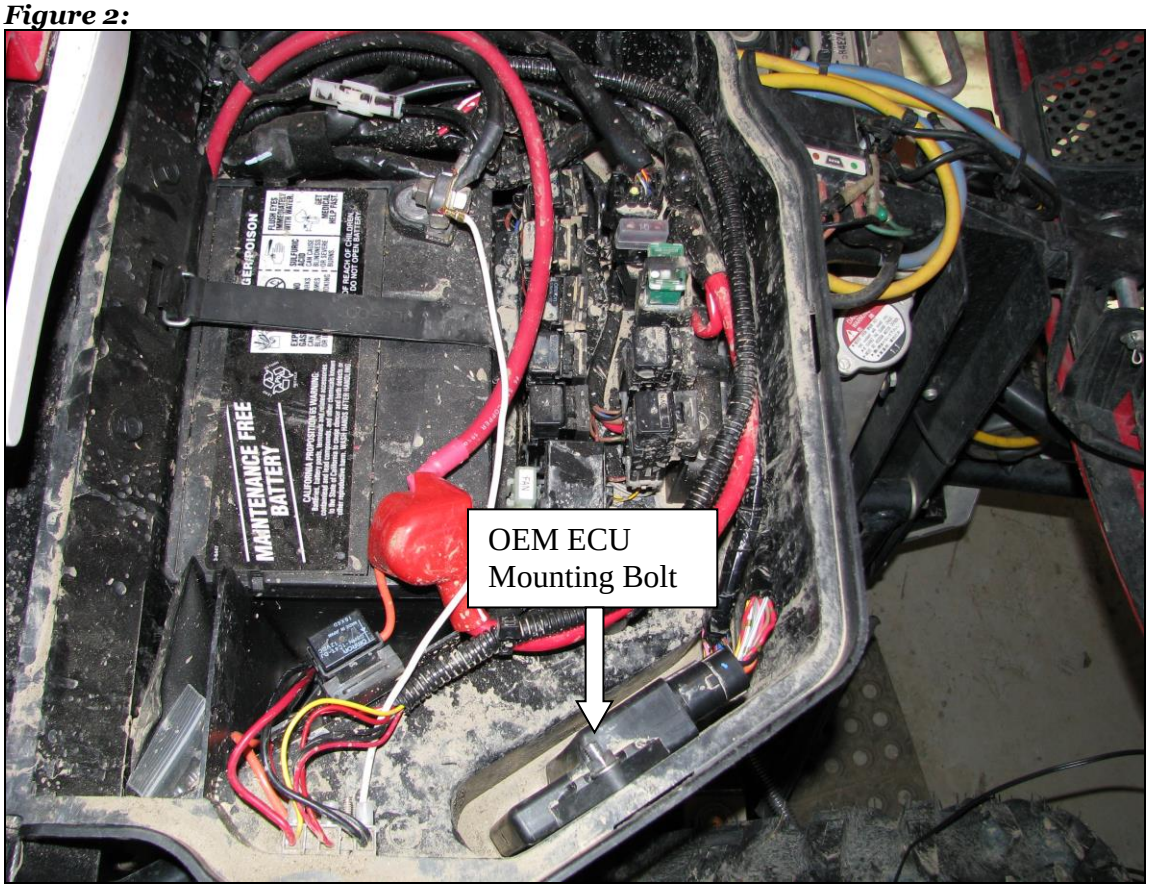
Step 2:

Locate the stock ECU and mounting bolt. See Figure 2. Remove the bolt, and pull straight up on the stock ECU to remove it. Disconnect the two connectors from the ECU.

Figure 2:



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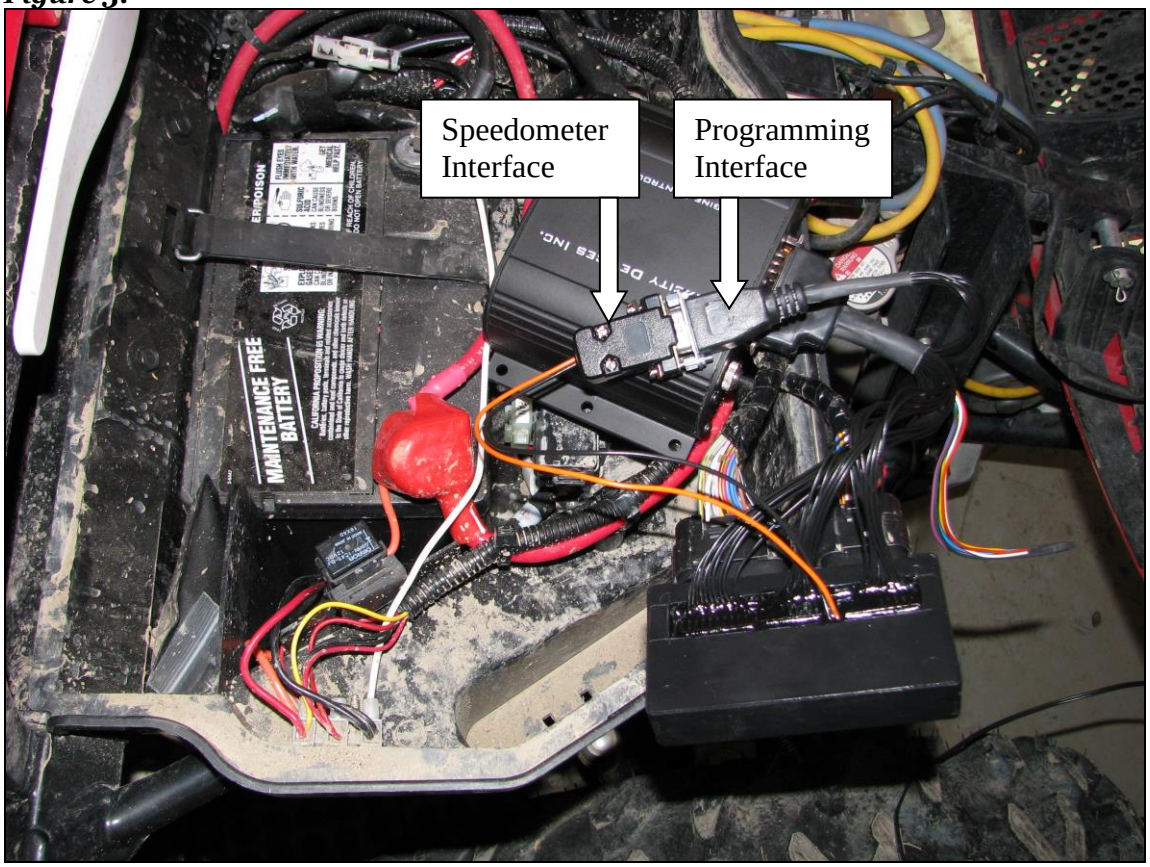
Step 3:

Remove the two #4x4-40 screws from the DB44 connector at the front of the Copperhead® ECU. The connector is filled with dielectric grease for water resistance after installation. Plug the Copperhead® wiring harness into the DB44 connector, and secure with the two #4x4-40 screws. The screws should be snug, but do not over tighten. The DB44 connector is filled with waterproof dielectric grease which will be dispersed when the connector is connected. Plug the two additional connectors into the mating connectors on the Rhino wiring harness. Ensure the speedometer and programming interface cables are connected together. See Figure 3.

Figure 3:



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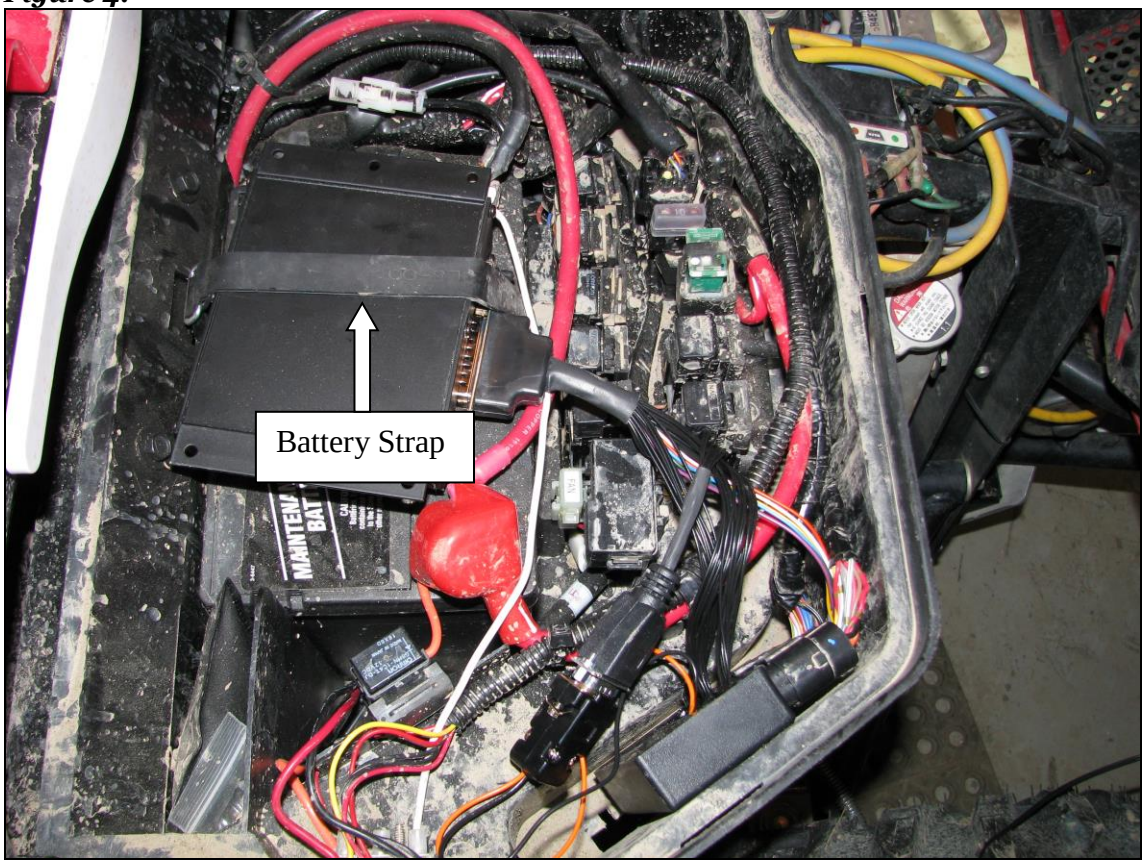
Step 4:

Reconnect the negative battery cable, and position the ECU upside down (done purely for ease of installation), under the rubber battery strap. Position the ECU so the battery strap is between the DB44 connector and toggle switch on the Copperhead® ECU. This will prevent the unit from sliding into the positive battery terminal. See Figure 4.

Figure 4:



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Step 5:

Due to variances between factory setups on the engines, the machine may exhibit high idle, stalling when stopping, poor hole shot performance and hard starting. Following this procedure will force the ECU to determine the optimum value for the machine it is installed on. Locate the orange tether wire in the bundle of loose wires held together with heat shrink.

To calibrate and use the optimum value:

1) Warm up the engine until the fan cycles, and then turn off the key.
2) Begin with the key off. Put the toggle switch to position #1. Put the transmission in neutral.
3) Connect the orange tether input to the +12V battery terminal. Turn on the key, and once the ECU detects it connected for one second, it will turn on the status light, and start pulsing out a L-L-L-L (L = 1 second flash) error code to indicate it is waiting to/calibrating the step value. You can now disconnect the orange wire.
4) Start the engine.
5) The ECU will idle the engine until it reaches operating temperature (still flashing the L-L-L-L code). Once the engine is warmed up, the ECU will idle the engine down, and save the optimum value. The engine will then return to normal idle, and the status light will flash continuously at 1/4 second intervals to indicate it is done.
6) Next time the key is turned on, it will use this new value instead of the value stored in the "idle step" location of the map.

To clear the optimum value, and default back to the map value (only required should you not find the optimum value good):

1) Begin with the key off. Put the toggle switch to position #1. Put the transmission in neutral.
2) Connect the orange tether input to the +12V battery terminal. Turn on the key, and once the ECU detects it connected for one second, it will turn on the status light, and start pulsing out a L-L-L-L (L = 1 second flash) error code to indicate it is waiting to/calibrating the step value. You can now disconnect the orange wire.
3) Turn off the key.
4) Next time the key is turned on; it will use the value from the map.

Step 6:

The Copperhead® ECU also has five (5) **optional** wires that are bundled together. Four wires are used to provide ground to a device when a certain RPM is reached (this is configured with the optional USB Memory Interface). Potential uses are shift lights, external controllers, NOS solenoid triggers. The white wire can be connected to an off the shelf tachometer that requires 1 pulse per revolution. The orange wire is a tether switch input that will kill the engine when connected to +12V.

Blue – Output #1 (grounds when triggered, 500mA MAX.)
Yellow – Output #2 (grounds when triggered, 500mA MAX.)
Green – Output #3 (grounds when triggered, 500mA MAX.)
Purple – Output #4 (grounds when triggered, 500mA MAX.)
Orange – Tether Switch (connect to +12V to kill engine)

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There is also a tachometer wire that is connected to the harness. Tapping into this will give a tachometer output:
White – +12V Tachometer Output (1 pulse per revolution)

Step 7:

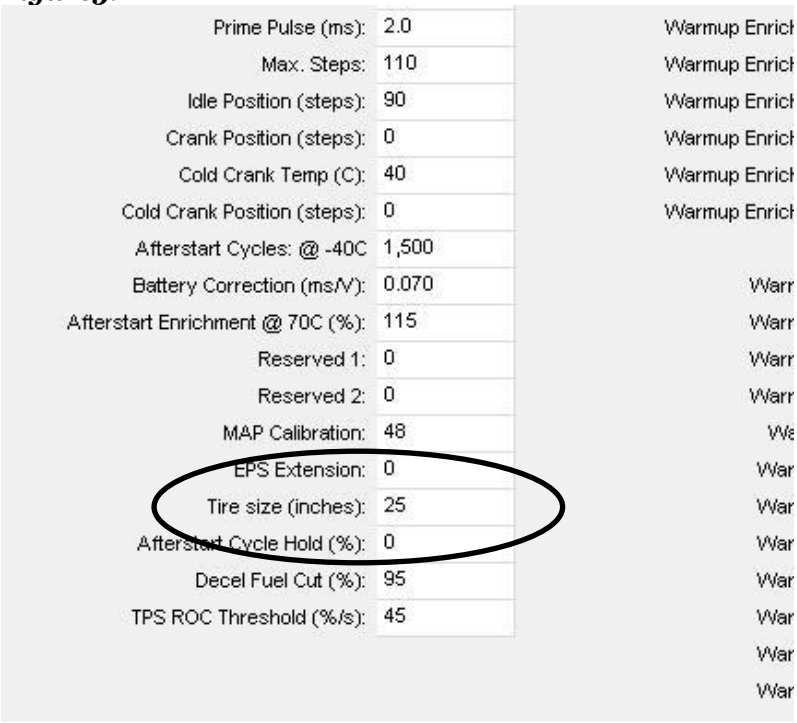
If you have an aftermarket muffler installed, the fuel maps will need to be modified for more fuel delivery, using our optional USB interface.

IF IN DOUBT, PLEASE CONTACT AN EXPERIENCED ENGINE BUILDER FOR ADVICE. PROLONGED OPERATION WITH A LEAN CONDITION CAN CAUSE SERIOUS ENGINE DAMAGE.

Step 8:

The Copperhead® ECU can also adjust the acceleration enrichment and speedometer for proper operation with non-stock sized tires. Open up a map with the optional USB interface, and change the value in the "Tire size (inches)" field to match the diameter of your tires in inches. The default value is 25 inches. The ECU will accept tire sizes from 20 to 40 inches. See Figure 5. Save the map, and then write the map to the USB interface. To load in the map or change any programming in the ECU, unscrew the two screws that hold the DB9 connectors together and connect the USB programmer to the interface connector on the Copperhead® harness.
See Figure 3.

Figure5:



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Step 9:
Go riding!

Typical Issues:
1) Worn/fouled spark plug will cause starting/operational issues. Replace if necessary.
2) Battery voltage should be above 12VDC when the engine is running. If it is 12VDC or lower, it indicates a problem with the battery or charging system.
3) Engine will not fire if the battery voltage drops below 11VDC. Turn off any additional battery loads when starting (I.E. lights, hand warmers, etc.)
4) If the engine floods, pinning the throttle while cranking will turn off the fuel, and clean out the cylinder.
5) Turning the key on and instantly hitting the starter can cause the box to read a bad barometric reading, causing the machine to run poorly. If this does happen, just turn the key off and then back on to reset it. Wait a second after turning on the key before hitting the starter.
6) Speedometer will not display properly if the DB9 connectors on the Copperhead® harness are not connected together.

Troubleshooting:

High Idle:
The idle speed is set by a combination of the throttle blade position as well as the ISC (Idle Speed Control) valve. If your throttle cable has no slack in it, then it will allow more air around the throttle blades, which will increase the idle speed. When you first start to press on the throttle, the tip of the throttle should move 1/8”-1/4” before you feel resistance from the throttle cable. If you have not already done so, follow the directions in step 5, above.

Bogs/Soft Launch:
The Copperhead ECU has the acceleration enrichment tuned to make the majority of machines operating perfectly with no modification. If you your machine has heavy/large tires, or is heavier than normal, then you may encounter a rich bog off the line. If your machine is lighter, or has light clutching, then you may encounter a lean flat spot off the line. Both conditions can be fixed using our USB Memory Interface (sold separately).

Note:
It is normal to have a ½-1 second hesitation when you snap the throttle. This is due to the weight of the machine and the low power output of the single cylinder engine at idle.

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Operation:

The Copperhead® was designed to be used right out of the box. No additional configuration is required. The unit is shipped with the following default configurations (***UNLESS OTHERWISE SPECIFIED WHEN ORDERED***):

Map #1 (Safety type configuration):
Timing: 12 degrees BTDC @ 1600 RPM to 35 degrees BTDC @ 3000 RPM, with additional part throttle and altitude timing compensation.
Revolution Limiter: 6600 RPM
Differential Lock Low Speed Retard: Enabled (Forward speed when differential is locked is limited to 20KPH/12MPH. Forward speed when differential is unlocked is restricted to 40KPH/25MPH.)
Restrict Reverse Speed: Enabled (Engine speed in reverse is limited to 4000 RPM.)

Map #2 (Optimized for 87 octane gasoline):
Timing: 12 degrees BTDC @ 1600 RPM to 35 degrees BTDC @ 3000 RPM, with additional part throttle and altitude timing compensation.
Revolution Limiter: 8000 RPM
Differential Lock Low Speed Retard: Disabled
Restrict Reverse Speed: Disabled

Both maps and configurations can be changed using USB Memory Interface (available separately).

NOTE: Map 2 was optimized for 87 octane. If 91+ octane is utilized, then the timing can be increased an additional 2 degrees by loading in one of the 91 octane maps.

Install the Copperhead® ECU, and turn on the key. If the ECU detects an error, it will turn on the EFI indicator. The status light with flash to indicate the detected error (see the "Error Code" section for more details). In addition, the speedometer will display the matching Yamaha error code.
NOTE: The engine must rotate a minimum of 2 times before the ECU will start firing the cylinders. This is required to properly synchronize the system.

The toggle switch on the unit is used to toggle between two programmed timing maps and configurations. The ECU will only read the switch when the key is turned on.

If the engine floods, fully depress the throttle and crank the engine. It will clean out the excess fuel. Should the engine become substantially flooded, the stock ECU may be required to get the engine restarted due to a limitation of the Multi-Spark Discharge ignition not being able to light an excessively rich condition.

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Error Codes:

The unit status light serves as a diagnostic indicator. Should the ECU detect an error, it will turn on the EFI indicator, and display an error code on the status light. The speedometer will also indicate the Yamaha diagnostic code shown below.

Error codes are displayed by first turning off the indicator lights for 1 second. Each error code is displayed, with ¼ second blank between each code. The process is repeated (including the 1 second blank). NOTE: Short pulse is 1/2 second, long pulse is 1 second

Error Code #:	Pulse Structure	Yamaha Speedometer Code	Description	Outcome
0	S-S-S-S	14	Barometer reading error	Engine will start, but operation will be poor. Cycle power, wait a second and then crank the engine.
1	S-S-S-L	44	EEPROM CRC error	Engine will not start due to questionable data. Reload configurations with USB interface.
2	S-S-L-S	0	RESERVED	RESERVED
3	S-S-L-L	42	No Speed Sensor Input	Engine will run, but speedometer will display error code until corrected.
4	S-L-S-S	0	RESERVED	RESERVED
5	S-L-S-L	0	RESERVED	RESERVED
6	S-L-L-S	99	Kill Switch	Engine stops when triggered (ORANGE wire is connected to 12V).
7	S-L-L-L	46	Voltage Error	Engine may run, but battery voltage is low, or overcharging.
8	L-S-S-S	15	Throttle Position Sensor Error	Defaults to 0% throttle, and engine will still run, but will experience poor throttle response and possible lean stalls. This can be caused by a faulty or miss-adjusted TPS sensor.
9	L-S-S-L	21	Engine Coolant Sensor Error	Defaults to 80 Degrees Celsius, and engine will still run.
10	L-S-L-S	22	Intake Air Temperature Error	Defaults to 40 Degrees Celsius, and engine will still run.
11	L-S-L-L	13	Manifold Absolute Air Pressure Sensor Error	Defaults to 100 kPa, and engine will still run.
12	L-L-S-S	0	High Temperature	ECU has detected an engine overheat condition.
13	L-L-S-L	12	Crank Position Sensor Error	Engine won't start.
14	L-L-L-S	0	RESERVED	RESERVED
15	L-L-L-L	0	ISC Calibrating	See Step #5, above.

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Frequently Asked Questions

Below are typical questions that are asked. They are organized as Q for question, A for answer, and S for solution.

Q: The engine is cold, and is cranking a little slower than normal, and won't fire. Why?
A: The Copperhead® requires a minimum of 11VDC to start the engine. If the battery is drained, it will drop below 11VDC when cranking, which is insufficient to generate spark.
S: Charge the battery if low, replace if necessary in these circumstances. Minimize battery loads by turning off lights, radio, etc.

Q: The CDI seems to be hot, is this normal?
A: Yes, the operation of the ECU can make the metal case fairly hot.
S: None.

Q: I've flooded the engine. How do I get it going again?
S: Fully depress the throttle, and crank the engine. It will turn off the fuel and allow for the engine to clear the flood condition. In extremely flooded conditions, it may be required to re-install the factory ECU to get the engine to start. This is due to a limitation of the multi-spark discharge the Copperhead uses.

Q: Do I need to give it some gas to start?
A: No. Unless the engine is partially flooded, never use the throttle when cranking. The ECU uses a fixed starting curve to derive the starting fuel. It will not compensate for air pressure changes caused from opening the throttle. The throttle petal doesn't add extra fuel. It only adds extra air when it is pressed.
S: None.

Q: What is starter kickback caused from?
A: Starter kickback is caused by pre-ignition. That is, the cylinder fired before the piston reached top dead center. This causes the engine to spin backwards, and forces the starter into the engine.
S: Sometimes if the engine is partially flooded, the engine may kick back when starting.

Q: When I accelerate in reverse, the engine stumbles and runs rough.
A: You have reached the reverse revolution limiter.
S: To enable full reverse power, use toggle position #2. Alternatively, turn off the reverse power limiter utilizing the optional USB Memory Interface.

Q: When I accelerate in forward, and am going pretty fast, the engine stumbles and runs rough.
A: You have reached the revolution limiter.
S: You have reached the maximum safe operation speed of the engine. If your engine has had modifications that can support higher RPMs, then the revolution limiter can be raised using the optional USB Memory Interface. NOTE: Increasing the revolution limiter on engines that have not had the proper modifications can lead to fatal engine damage.

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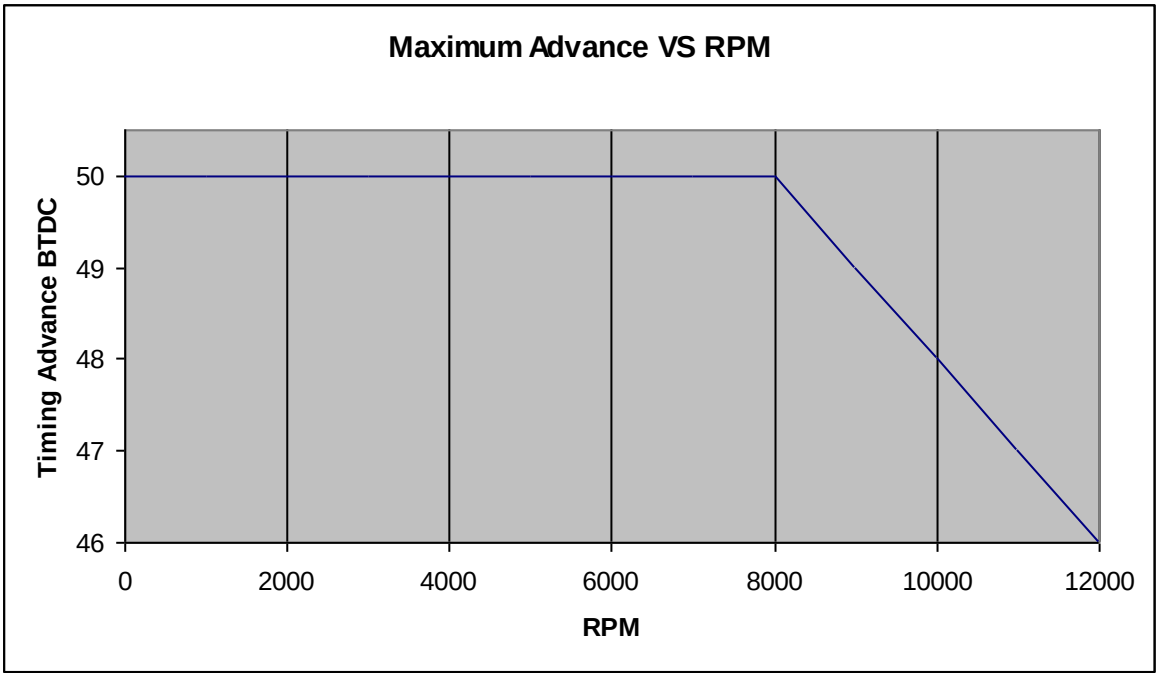
Specifications:

Subject to change without notice.

Dimensions (without wiring harness) (LxWXH):	145mm x 115mm x 42mm
Weight:	500 grams
Input Voltage:	9 VDC to 15 VDC **(minimum of 11 VDC required to start)**
Input Current (engine not running):	330mA RMS @ 25°C
Input Current (engine running):	1.7A RMS @ 25°C
Input Current (key off):	No Current Draw
Output Voltage (to coil):	+/- 175 V Peak
Output Energy (per coil):	14.5 mJ
Firing Technique:	Multi-Spark Discharge
Firing Duration:	15 degrees
Maximum Operating Temperature:	-55°C to +100°C
Maximum engine speed:	12000 RPM
Maximum advance:	50 degrees BTDC @ 8000 RPM, with software roll off to 46 degrees BTDC@ 12000 RPM



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The maple leaf found on the bottom of your Copperhead® CDI is a symbol of the pride we take in each and every unit we manufacture.

Every unit is assembled, tested and packaged locally by one of our trained technicians, or approved ISO9001 registered manufacturing firms.

Should have any questions or concerns with this product, contact us immediately, and one of our courteous representatives will deal with your concerns in a prompt fashion.

We appreciate your business, and hope you enjoy your purchase.

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