VDI Copperhead® GEN2 CDI Installation Instructions (Yamaha)

Revision 1.12

Parts Included,
VDI Copperhead® GEN2 CDI:

- VDI Copperhead® GEN2 CDI and installed harness (1)
- #8 x ½" Self Drilling Screws (4)
- #4x4-40 x ¼" Machine Screw (2), located in the DB44 connector

Telephone: (403) 668-7470
Facsimile: (403) 668-7471
Webpage: www.velocitydevices.com
Email: tech@velocitydevices.com

Time Required:
- Less than an hour.

Difficulty:
- 1/10

Tools Required:
- Robertson screwdriver (#2, red) to install mounting screws
- Philips screwdriver (#PH1) to install harness screws.

Supported Machines:
- 2002-2006 Yamaha Grizzly 660
- 2004-2007 Yamaha Rhino 660

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.
- Expansion port for a future Electronic Fuel Injection (EFI) upgrade.
- 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 CDI you'll ever need to buy!

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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® CDI is shipped with a stock type configuration in map location #1, and a performance configuration in map location #2. See the "Operation" section for more details. The switch can be changed at any time, and does not require the engine to be off.
2) Status LED: The status LED serves as a system status and error indicator. Should the CDI detect an error, then the LED will flash the particular error code(s). See the "Error Code" section for more details. The machine's reverse light will come on solid to indicate that there is an error. Check the status LED for the error code. The status LED also functions as a reluctor pickup indicator. It will remain on when the engine is idle. Once the engine is cranked, and the CDI 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 CDI should new updates become available. **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 CDI AND VOID YOUR WARRANTY**.
4) Connectors: The connectors connect directly to the stock wiring harness when the factory CDI 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 BATTERY CHARGER CONNECTED. PERMANENT DAMAGE TO THE COPPERHEAD® CDI MAY OCCUR.

NOTE:
RE-JETTING IS TYPICALLY NOT REQUIRED, IF THE MACHINE IS PROPERLY JETTED BEFORE INSTALLATION.

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Installation:

Step 1:
Remove the seat to allow access to the factory CDI. Disconnect the negative battery cable. Locate the stock CDI (located under the seat). Disconnect the connectors from the CDI, and remove the CDI.

Step 2:
Remove the two #4x4-40 screws from the DB44 connector at the front of the CDI. 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. Plug connectors from the Copperhead® CDI to their corresponding connector on the chassis wiring harness. The Copperhead® CDI will be mounted to the left side of the storage box under the seat, with the wiring harness facing up.

Step 3:
Grizzly: Fasten the Copperhead® CDI to the machine using the enclosed self-tapping screws. The best location is the inside of the toolbox, on the left side of the machine. The wires will protrude from the top, and pass over the plastic, and connect to the stock wiring harness. Before installing the self-drilling screws, ensure that they will not contact any wires or hoses behind the mounting location. Ensure the seat mounts will not pinch the wiring, when the seat is installed. You may need to use additional cable ties or electrical tape to ensure this will not happen.
Rhino: Plug the Copperhead® CDI into the stock wiring harness. Position it under the bungie that holds the battery in place.

Step 4:
The Copperhead® CDI also has six (6) **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.)
White – +12V Tachometer Output (1 pulse per revolution)
Orange – Tether Switch (connect to +12V to kill engine)

Step 5:
Re-connect the negative battery cable, and re-install the seat.

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Step 6:

Warm up the engine until the fan cycles.

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Once the engine is warm, take the machine for several full throttle runs. If the engine misses or backfires through the carburetors, then it is jetted lean. In the majority of the cases, you will only need to increase the main jet size, and not have to adjust the needles.

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

Step 7:

Go riding!

Typical Issues:

1) Engine will not fire if the battery voltage drops below 11VDC. If the battery is low, and the engine isn't firing, use the recoil. Turn off any additional battery loads when starting (I.E. Lights, hand warmers, etc.)
2) If the engine stalls or stumbles when idling, or after jabbing the throttle from a dead stop, adjust the idle mixture screws.
3) If the engine runs poorly and backfires through the carburetor under full throttle acceleration, then the main jets are too lean, and they will need to be increased.
4) If the engine runs poorly and backfires through the exhaust under full throttle acceleration, then the main jets are too rich, and they will need to be decreased.

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:

Map #1 (Original type configuration):
Timing: 12 degrees BTDC @ 1500 RPM to 50 degrees BTDC @ 6200 RPM
Revolution Limiter: 7600 RPM
Low Speed Retard (limits speed when differential is locked): Enabled
Restrict Reverse Speed: Enabled

Map #2 (Optimized for 87 octane gasoline):
Timing: 12 degrees BTDC @ 1500 RPM to 50 degrees BTDC @ 6200 RPM
Revolution Limiter: 8600 RPM
Low Speed Retard (limits speed when differential is locked): Disabled
Restrict Reverse Speed: Disabled

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

NOTE: The CDI fixes the timing advance at 12 degrees BDTC until 1500 RPM (regardless of what is programmed in the unit). Between 1500 RPM and 2000 RPM, the CDI will ramp up the timing to ensure the timing advance loaded in the maps is used at 2000 RPM. This prevents any stumbles and misses caused from stabbing the throttle from a dead stop.

Install the Copperhead® CDI, and turn on the key. If the CDI detects an error, it will turn on the reverse light to indicate an error The status light with flash to indicate the detected error (see the "Error Code" section for more details).
NOTE: The engine must rotate a minimum of 1 times before the CDI will start firing the cylinders. This is required to properly synchronize the system.

Should the unit detect a data error in the onboard software, the CDI will not boot, and if possible, will display the error code.

Should the unit detect a data error in the onboard maps and configurations, it will display the particular error code, and default to a pre-programmed, stock type configuration, regardless of the position of the toggle switch.

The toggle switch on the unit is used to toggle between two programmed timing maps and configurations. It can be changed at any time.

Error Codes:

The unit status light serves as a diagnostic indicator. Should the CDI detect an error, it will turn on the belt light, and display an error code on the status light.

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).

First pulse organizes the error. Short pulse (error codes 0-7) are CDI errors.

NOTE:
Short pulse is 1/2 second, long pulse is 1 second
If the onboard software is corrupt, it is possible that error code #0 will not be displayed.

Error Code #:	Pulse Structure	Description	Outcome
0	S-S-S-S	Flash CRC error	CDI hangs, and engine will not start since software in CDI is questionable. Call tech support.
1	S-S-S-L	EEPROM CRC error	CDI ignores programmed maps and configurations, and defaults to stock type configuration. Reprogram the timing maps with the supplied USB memory interface.
2	S-S-L-S	Vehicle Down	Engine Stops
3	S-S-L-L	No speed sensor input	Power output is continuously restricted if low speed retard is enabled. No effect if low speed retard is disabled.
4	S-L-S-S	Engine Stop	Engine Stops. Move engine stop switch to "RUN".
5	S-L-S-L	RESERVED	RESERVED
6	S-L-L-S	Kill Switch	Engine Stops
7	S-L-L-L	RESERVED	RESERVED

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Frequently Asked Questions / Troubleshooting:

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. If I use the recoil starter, it fires up fine. 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, or use the recoil in these circumstances. Minimize battery loads by turning off lights, hand warmers, etc.

Q: The CDI seems to be hot, is this normal?
A: Yes, between the operation of the CDI, and it's location near the exhaust pipes, the metal case gets hot.
S: None. The CDI is approximately the same temperature as the metal ATV frame below it.

Q: I just drove through a waterhole and now the engine runs rough or has stalled.
A: Water vapor slows the burning time of the air/fuel mixture. The CDI cannot compensate for air density changes, and therefore cannot correct timing issues.
S: Avoid in jesting water or slow operation through deep water holes. Steam from the engine will effect operation.

Q: I backup up hard, put it into forward and pinned it. The engine died.
A: The engine flooded. This can be caused by improper jetting and/or dirty (or wet) air filter.
S: Ensure the jetting is correct for your elevation. Clean the air filter if dirty.

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, hold the reverse override button. Alternatively, turn off the reverse power limiter utilizing the optional USB Memory Interface.

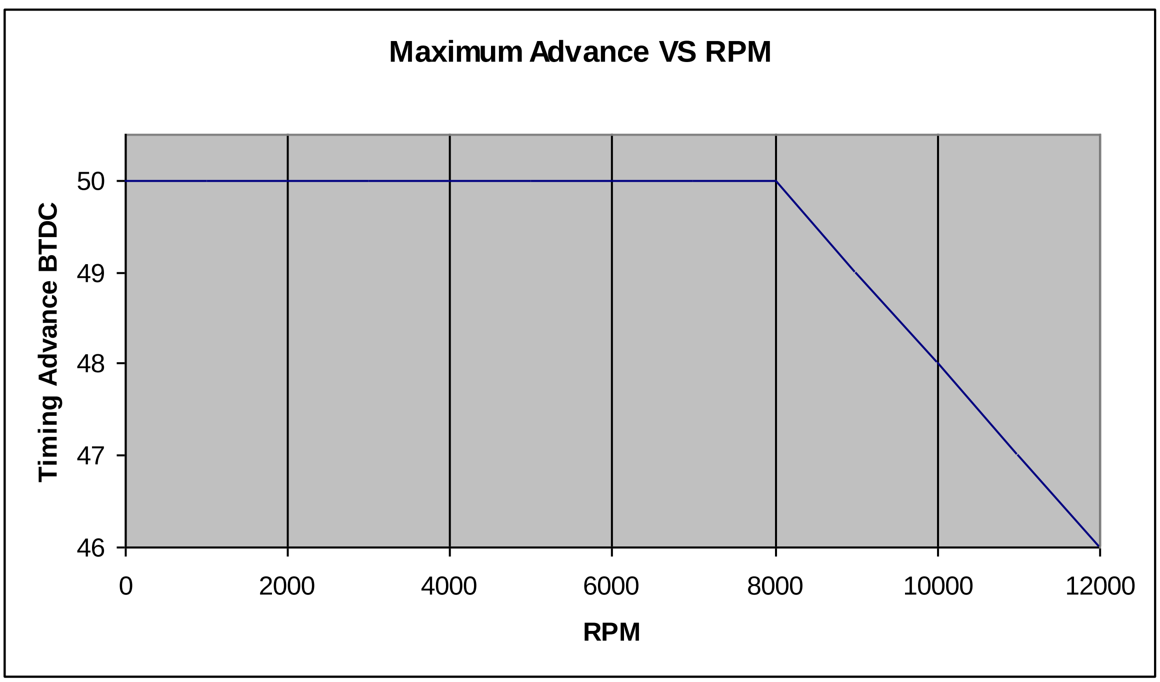
Q: When I accelerate in forward, and am going pretty fast, the engine stumbles and runs rough.
A: You have reached the revolution limiter.
S: You have reached the maximum safe operation speed of the engine. If your engine has had modifications that can support higher RPMs, then the revolution limiter 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.

Q: When I accelerate in forward, with the differential locked, the engine stumbles and runs rough and may backfire.
A: You have reached the low speed retard limiter. This prevents loss of control when operating with the differential locked by limiting the forward speed to 35 KPH or 22 MPH.
S: Reduce speed or unlock the differential. Alternatively, turn off the reverse power limiter utilizing the optional USB Memory Interface. NOTE: Operating the machine with the differential locked at high speeds may lead to loss of control and serious injury or death.

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 @ 25ºC
Input Current (engine running):	1.7A RMS @ 25ºC
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:	-55ºC to +100ºC
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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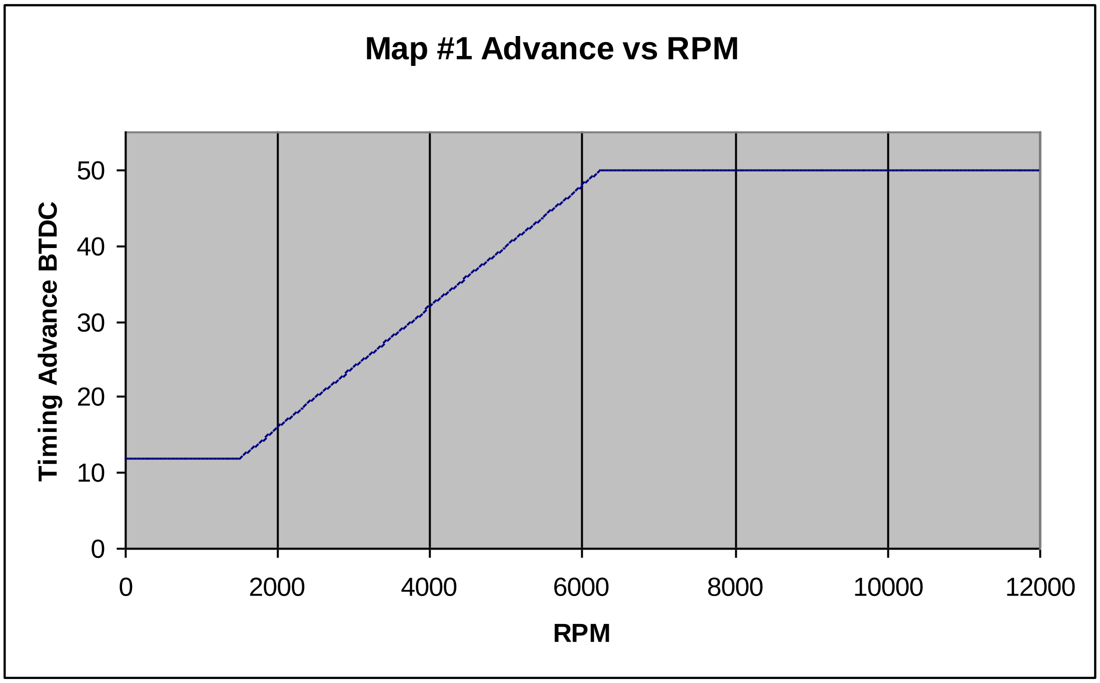

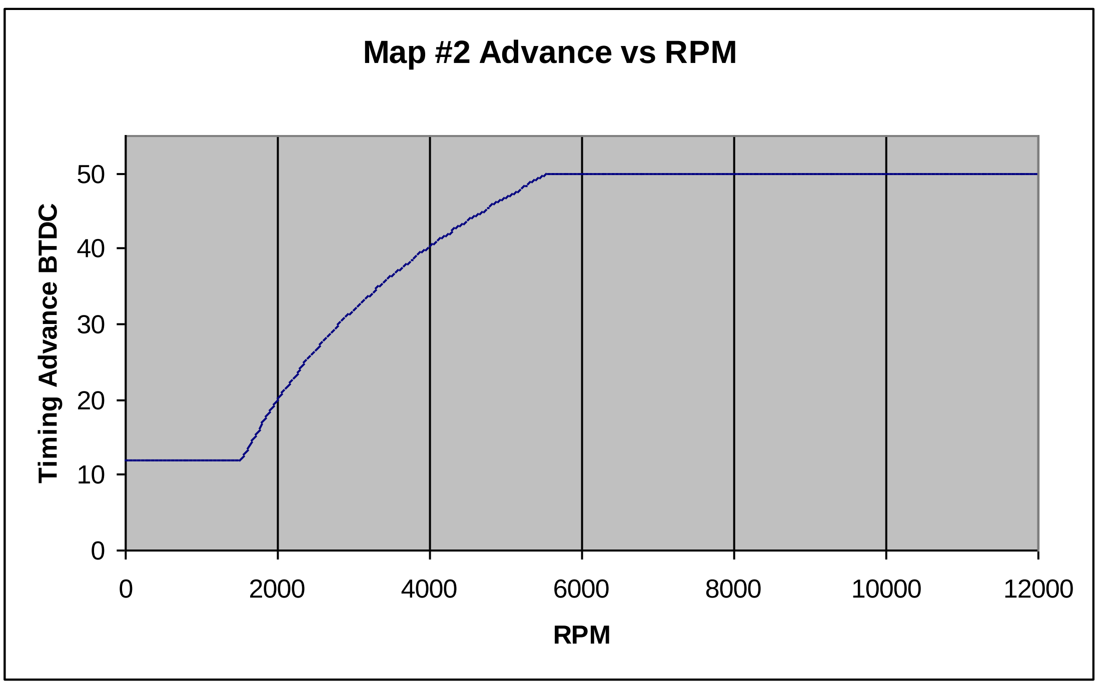

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Timing Advance Primer:

The gasoline combustion engine requires three elements in order to produce horsepower:

1) Air
2) Fuel
3) Source of ignition (i.e. spark plug)

Key Terms and Acronyms:

Stoichiometric Ratio	14.7 parts air to 1 part fuel, where during combustion 100% of the fuel is burned (theoretical combustion)
A/F	Air / Fuel mixture
TDC	Top Dead Center
BTDC	Before Top Dead Center
ATDC	After Top Dead Center
WOT	Wide Open Throttle
Pre-ignition (pinging)	A/F mixture ignites slightly early, and combustion tries to push the piston backwards just as it reaches TDC.
Detonation	Advanced stage of pre-ignition where combustion finishes before the piston reaches TDC. The combination of the combustion and the compression stroke can cause piston damage in extreme cases.

For proper ignition the ratio of air to fuel must be controlled. Ideally, 14.7 parts of air are mixed with 1 part of fuel (14.7:1, or stoichiometric ratio). This gives a 100% burnt mixture. For maximum power, the ratio is typically dropped to 12.5:1. This gives a richer mixture that generates more power, and is less prone to detonation. The leaner the mixture, the better the fuel economy. If the mixture becomes too lean, then you get “lean surge”, and it extreme cases, misfiring.

In the ideal world, the spark plug would be fired when the piston reached TDC on the compression stroke. The combustion would force the piston down, and power would be generated.

Unfortunately, in the real world, there is a finite amount of time required for the A/F mixture to light and for combustion to be complete. For maximum power, maximum cylinder pressure from the combustion occurs ATDC. If it happens too soon, detonation occurs. If it happens too late, the combustion doesn’t fully translate into power, and is lost as heat.

The crucial point is that for each RPM, we must fire at a specified time BTDC to ensure that maximum cylinder pressure occurs at the optimum time ATDC. The time before TDC is the critical component, and gets translated to timing advance, as we can measure angular markings on the crankshaft.

Several factors affect the need for timing advance.

1) Compression Ratio: Ratio of cylinder volume at BDC to the cylinder volume at TDC. Compression ratio is measured at WOT. During part throttle driving, the cylinders are

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only partially full of A/F. The effective compression ratio is lower, and more timing advance is required, since lower A/F mixtures burn slower. (Increase advance for low compression)

2) Octane level: Higher octane fuel burns slower and is less prone to detonation. (Increase advance for higher octane)
3) Air/Fuel Ratio: Leaner mixtures burn slower since the ratio is not optimum. (Increase advance for lower A/F ratio)
4) Temperature: Cooler engines are less prone to detonation. (Increase advance for lower temperature)

NOTE:
Constant Velocity (CV) carburetors utilize vacuum operated slides in the throttle body to regulate the airflow. The airflow rate through the carburetor remains constant, regardless of RPM. This allows for more consistent metering of fuel.

Maximum power out of an engine occurs when the timing advance is set so that for every RPM, the timing advance is picked so that it is approximately 4 degrees before the detonation point of the engine.

Running less than optimum advance will make the engine run hotter, and will decrease the power output. Running more than required advance will lead to pre-ignition, which makes the engine run hotter, and decreases the power output of the engine at a larger rate than lower advance. For example, if a particular engine generates 100 HP at optimum advance. Running 2 degrees below optimum may give you only 95 HP. Running 2 degrees above optimum may give you 85 HP. Reason being is pre-ignition occurs, and it forces the engine backwards acting like a brake.

For optimum operation of an engine, the proper timing advance curve must be applied. Too much timing advance can be catastrophic to the pistons and bearings. Timing advance is typically set at less than optimum, because increases in outside temperature, engine load, etc. will cause the engine to heat up, and makes the engine more prone to detonation. Also, the cooling system is less optimum at lower speeds, which also causes a temperature increase of the engine.

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Email: tech@velocitydevices.com

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Proud to be Canadian!

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.

Email: *tech@velocitydevices.com*

Telephone: *1.403.668.7470*

Or regular mail:
Velocity Devices Inc.
Attn: Concerns Dept.
P.O. Box 47052
RPO Creekside
Calgary, AB
T3P 0B9