# Official MBI Analog CDI Tuning Guide

*Written by Sean Davis - Revision 1*

# Analog CDI - MK2.2M

All MK2.2M CDIs come pre-adjusted and pre-wired for bolt on “plug and play” operation. The MK2.2M CDI was originally adjusted for “mostly stock” 2 stroke ‘Motorized Bicycle Kit’ engines. It has also been tested on numerous configurations of “performance modified” 2 stroke ‘Motorized Bicycle Kit’ engines. This testing demonstrated improved performance with the “out of the box” settings when compared to all the commonly available “non-adjustable” ‘Performance Ignitions’ available across the Motorized Bicycle Industry.

Any major engine modification like aftermarket heads, aftermarket ‘Expansion Chamber’ exhaust systems, cylinder port map modification, switching to Race Gas from Pump Gas, etc. may require adjustment of the ignition timing curve in order to achieve the full performance potential of the modifications. The following is a guideline for adjusting the Analog MK2.2M CDI. Perform adjustments in the order given below.

Any change to any component in the complete “Ignition Path” (magneto, magnet, coil or plug) will have an effect on the resulting ignition curve with the SAME CDI settings. The ignition curve images presented within this document were all recorded using “stock” Avenger85 Magneto and Magnet; OEM Honda CR80 Ignition Coil; and NGK XR5IX Spark Plug.

## Section 1: Wiring Instructions

The MK2.2M CDI comes pre-wired with the correct terminals for “plug and play” operation. There are 2 pairs of wires that exit the CDI’s 3d printed case. Both pairs of wires are 1x red wire and 1x black wire. One pair of wires is terminated with “Double Female Bullet Connectors”. This pair of “Double Female Bullet Connectors” is wired to the Magneto AND to the Kill Switch if installed. The white Magneto wire is left unused. The other pair of wires is terminated as follows: 1x black wire terminates in a “Loop Terminal”, 1x red wire terminates in a “Female Blade Connector”. This pair of “Loop Terminal” and “Female Blade Connector” is wired to the included Ignition Coil that came with the MK2.2M CDI.

**The connections are as follows (Kill Switch is Optional):**

**MK2.2M CDI** - Black - Double Female Bullet → **Stock Magneto** - Black - Male Bullet
**MK2.2M CDI** - Red - Double Female Bullet → **Stock Magneto** - Red (or Blue) - Male Bullet
**MK2.2M CDI** - Black - Double Female Bullet → **Kill Switch** - Green - Male Bullet
**MK2.2M CDI** - Red - Double Female Bullet → **Kill Switch** - Yellow w/Green - Male Bullet
**MK2.2M CDI** - Black - Loop Terminal → **Ignition Coil** - Ground Post (-) - Secured with Bolt/Nut
**MK2.2M CDI** - Red - Female Blade → **Ignition Coil** - Positive (+) - Male Blade

# Section 2: Tuning Method

If you already know the exact timing curve your engine requires, then you will need a "Timing Light" and some form of 'TDC/Timing Degree Indicator'. In this case, you will not be "tuning" the CDI, but instead merely "setting" the CDI to the pre-determined ideal timing curve that has -already- been "tuned" for the engine. In this case, the timing light is REQUIRED to confirm the actual timing curve output from the 'Adjustable CDI' matches exactly the pre-determined ideal timing curve. As this is a "Tuning Guide", it will NOT focus on this method of "setting" the CDI to some pre-determined set of absolute values.

If you DO NOT already know the exact timing curve your engine requires, then you do not necessarily need a "Timing Light" and some 'TDC/Timing Degree Indicator'. In this case, you will be "tuning" the CDI to determine what settings result in the most ideal timing curve for your engine.

This guide will focus on detailing a method for "tuning" the CDI in very much the same fashion as you would "tune" a carburetor. For example: An Air-to-Fuel Ratio (AFR; Lambda) Sensor (O2 Sensor) is not necessarily required to properly "tune" a carburetor. Observation of how the engine responds to changes in carburetor settings provides sufficient feedback to the tuner to determine the required "jetting" for a specific engine and carburetor combination.

The most basic method followed to "tune" a carburetor is to "sweep" a range of adjustment for each individual "circuit" in the carburetor from "too rich" to "too lean". It is advisable to start "too rich" because this is "safe" for the engine. ****Running the engine with a "too lean" setting can result in permanent damage to the engine**.** As the adjustment is "swept" from being too rich to the "lean" direction; at each step: Engine response is evaluated, and various methods for monitoring the engine for "overheating" are employed. A good tuner will "read" the tell-tale signs on the spark plug and the crown of the piston for signs of being "too lean". Each circuit in the carburetor is successively "swept" in this manner, starting from the lowest RPM range (idle circuit) to the highest RPM range (main jet circuit). The adjustment settings that result in "best" engine performance and "safe" piston crown/spark plug temps is the "correct jetting" for the engine.

This guide will follow the same basic principles. The user will "tune" the CDI by "sweeping" the range of adjustment for each individual "adjustable value" in the CDI from "too retarded" to "too advanced". It is advisable to start "too retarded" because this is "safe" for the engine. ****Running the engine with a "too advanced" setting can result in permanent damage to the engine**.** As the adjustment is "swept" from being too retarded to the "advanced" direction; at each step: Engine response is evaluated, and various methods for monitoring the engine for "overheating" are employed. A good tuner will "read" the tell-tale signs on the spark plug and the crown of the piston for signs of being "too advanced". Each tunable value in the CDI is successively "swept" in this manner, starting from the lowest RPM range (Initial Advance) to the highest RPM range (Retard Curve). The adjustment settings that result in "best" engine performance and "safe" piston crown/spark plug temps is the "correct timing" for the engine.

# Section 3: Initial Advance (Base Timing)

**Adjustable Value = Potentiometer "RV1"**
**Stock Value = 16 Ohms**
**Effective Range = 10 – 40 Ohms**

Initial Advance or "Base Timing" will affect the entire timing curve equally. Adjusting this value will not significantly change the "shape" of the curve, but instead will change every single point along the curve by the same amount. Increasing the value (higher Ohms) will "lift" the entire timing curve by 1 degree for every 1 Ohm of increase. Decreasing the value (lower Ohms) will "drop" the entire timing curve by 1 degree for every 1 Ohm of decrease. Adjusting this value is the same as using an off-set woodruff key (timing key) or a timing plate to advance/retard the physical position of the Magneto Rotor Magnet relative to the Magneto Stator Coil.

The stock value of 16 Ohms should be "safe" for most engine combinations when using a stock crankshaft and magnet with standard woodruff keys (NOT off-set). To determine the ideal value for your engine, it is advised to connect the MK2.2M CDI following the instructions from 'Section 1: Wiring Instructions' and to run the engine using the stock "out of the box" values.

****This first "run test" is ideally done with a brand-new spark plug of the appropriate heat range and with a carburetor "tune" that is close to ideal****

The engine should be run long enough to come up to operating temperature and if the engine is responding favorably to the stock settings at least 1-3 WOT runs should be completed. If the engine is NOT responding favorably to the stock settings (wont rev, hard starting, pinging/knocking, etc.) then shut the engine down immediately.

After the first "run test" has been completed with the stock "out of the box" values, the spark plug should be removed and evaluated. The most important indicator for timing analysis is what is referred to as the "timing mark" (see: Section 6: Tips and Tricks; 'How to Read a Spark Plug'). Evaluate the location of the "timing mark" on the 'ground strap' of the spark plug to determine how much timing is optimal for your engine. If the "timing mark" is burned all the way down to the shell/first thread of the spark plug then there is TOO MUCH timing and RV1 should be adjusted DOWN. If the "timing mark" has not yet burned past the mid-point of the "J-Strap/ Ground Strap" of the spark plug then there is NOT ENOUGH timing and RV1 should be adjusted UP.

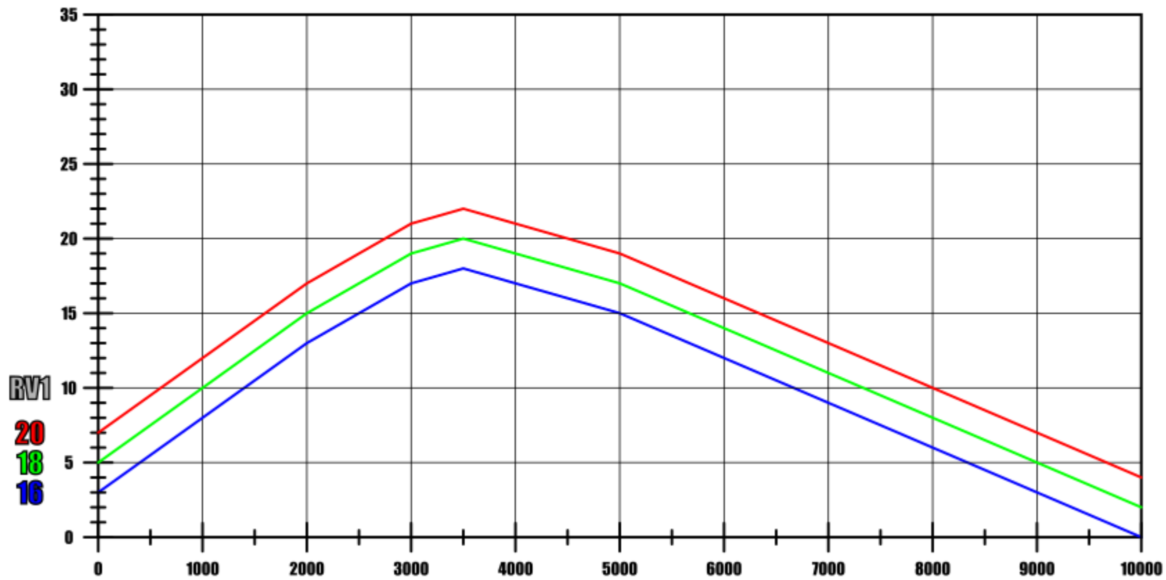
This will be your STARTING POINT for the 'Adjustable Value' "RV1". The next sections of the tuning guide will detail a method for tuning the SHAPE of the timing curve. After adjusting the SHAPE of the timing curve, it may be necessary to "re-tune" the Initial Advance/ Base Timing again to ensure "best" engine performance AND "safe" piston crown/spark plug temps across the entire RPM range.

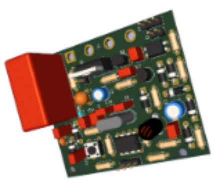
# Example Curves – Adjusting RV1:

-as measured with Avenger85 Stock Magneto Stator and Magnet

-Magnet installed in “advanced” position

-Installed magnet position can vary “Base Timing” by as much as 10 degrees



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# Section 4: Curve Peak (Crossover Point)

**Adjustable Value = Potentiometer “RV3”**
**Stock Value = 760 Ohms**
**Effective Range = 350 – 950 Ohms**

The “curve” created by the MK2.2M CDI can be imagined as a simple “bell curve”. At 0 RPM the timing value is very low. From 0 RPM’s, the curve will “advance” as RPM’s rise, up to a peak at a specific RPM. The adjustable value “RV3” controls at what RPM the “peak” of this timing curve occurs. After the “Curve Peak”, ignition timing begins to “retard” back the other direction as RPM’s continue to rise.

Thus, RV3 controls the specific RPM of the “Crossover Point” between the “rising” section of the timing curve and the “falling” section of the timing curve. Increasing the value (higher Ohms) will “shift” the Crossover Point ~250 RPM’s lower for every ~100 Ohms of increase. Decreasing the value (lower Ohms) will “shift” the Crossover Point ~250 RPM’s higher for every ~100 Ohms of decrease.

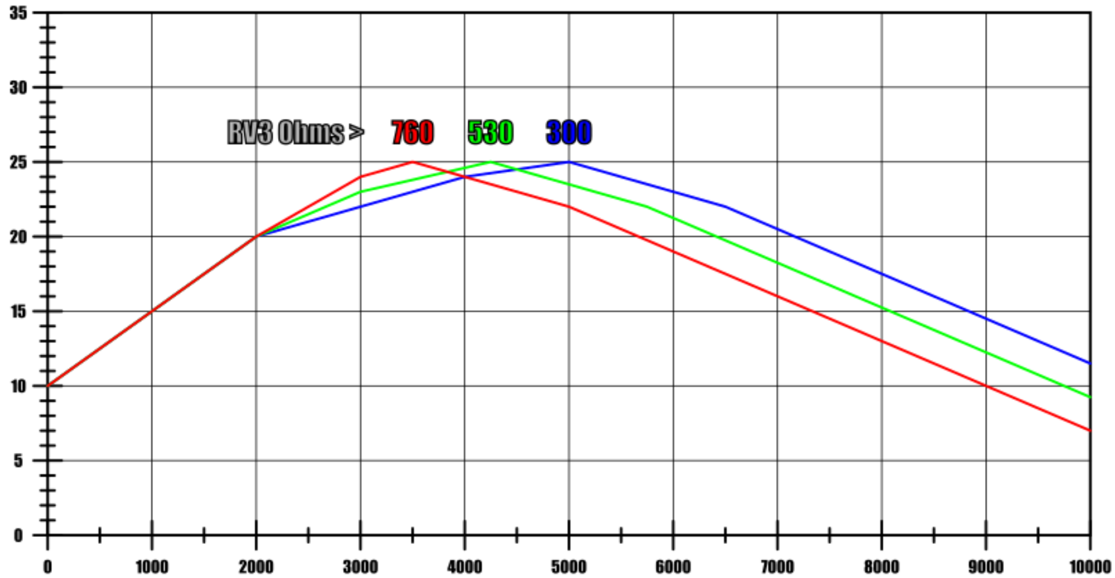
The ideal RPM for this “Crossover Point” will be determined mostly by the RPM where the engine makes peak torque and (if fitted with one) the resonant frequency of the expansion chamber exhaust. A higher peak Torque RPM/ higher pipe resonant frequency will favor a higher RPM “Crossover Point”.

The stock value of 760 Ohms should be “safe” for most engine combinations to start with. This will result in a “Crossover Point” at ~3,500 RPM with the stock 5.17 uF Capacitance value. To determine the ideal value for your engine, it is advised to REDUCE the value of “RV3” in ~100 Ohm steps and test the engine. At each step: evaluate the response of the engine and examine the spark plug for signs of over-heating/ too much timing advance. Continue testing in this manner until “best” engine performance with “safe” piston crown/spark plug temps are obtained.

After adjusting this “Crossover Point” of the timing curve to the ideal value, it may be necessary to “re-tune” the Initial Advance/ Base Timing (“RV1”) again to ensure “best” engine performance AND “safe” piston crown/spark plug temps across the entire RPM range.

## Example Curves – Adjusting RV3:

-as measured with Avenger85 Stock Magneto Stator and Magnet

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# Section 5: Retard Curve (Shape)

**Adjustable Value = "Capacitor Bank"**

**Stock Value = 5.17 uF**

**Effective Range = 0.47 – 5.64 uF**

The "falling" section of the timing curve (also called the "Retard Curve") will affect the "tail" of the timing curve; everything AFTER the "Curve Peak/ Crossover Point". Increasing the value (higher Capacitance) will "pull" the retard curve down more sharply as RPM's rise. Decreasing the value (lower Capacitance) will "pull" the retard curve down less sharply as RPM's rise.

Adjusting the capacitance value WILL influence the "Crossover Point" RPM. Lower Capacitance will "shift" the "Crossover Point" to a higher RPM. A 0.47 uF change in capacitance will "shift" the "Crossover Point" up/down about ~400 RPM. Because of this, any change to the Capacitance Value of the "Capacitor Bank" will require an adjustment of RV3 to restore the ideal "Crossover Point" RPM that was determined in Section 4: Curve Peak (Crossover Point).

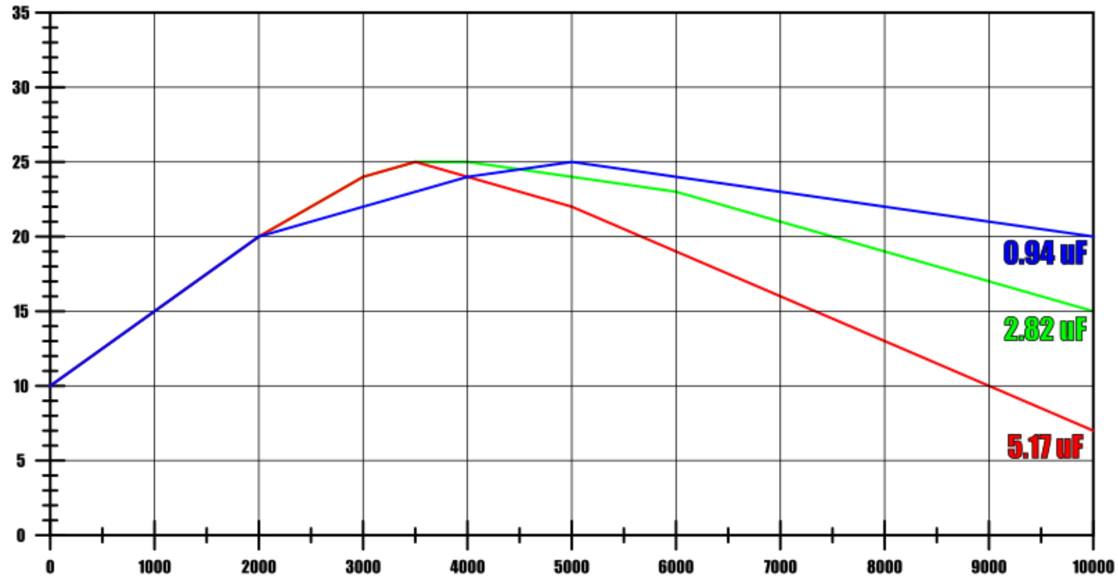
The ideal "shape" for this "Retard Curve" will be determined mostly by the design of the combustion chamber within the head. A slower burning head will need more ignition advance and thus will favor lower capacitance values that do not pull timing as sharply. A faster burning head will need less ignition advance and thus will favor higher capacitance value that pull timing more sharply.

The stock value of 5.17 uF should be "safe" for most engine combinations to start with. To determine the ideal value for your engine, it is advised to REDUCE the value of the "Capacitor Bank" in ~0.47 uF steps and test the engine. Every time Capacitance is changed, the value of RV3 should be adjusted to restore the ideal "Crossover Point" RPM that was determined in Section 4: Curve Peak (Crossover Point). Each 0.47 uF reduction in Capacitance should require a ~200 Ohm increase to the value of RV3 to restore the ideal "Crossover Point" RPM. At each step: evaluate the response of the engine and examine the spark plug for signs of over-heating/ too much timing advance. Continue testing in this manner until "best" engine performance with "safe" piston crown/spark plug temps are obtained.

After adjusting the "Retard Curve" to the ideal capacitance value AND restoring the ideal "Crossover Point" RPM ("RV3"), it may be necessary to "re-tune" the Initial Advance/ Base Timing ("RV1") again to ensure "best" engine performance AND "safe" piston crown/spark plug temps across the entire RPM range.

# Example Curves – Adjusting Capacitance:

-as measured with Avenger85 Stock Magneto Stator and Magnet

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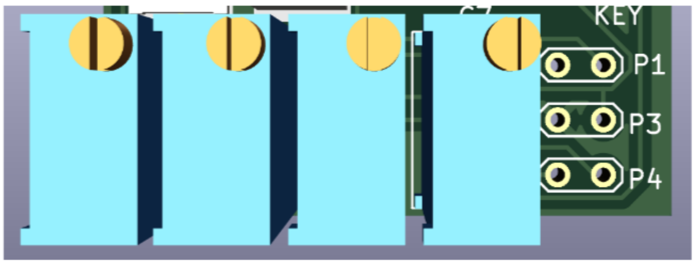
# Section 6: Tips and Tricks

## Mk2.2M

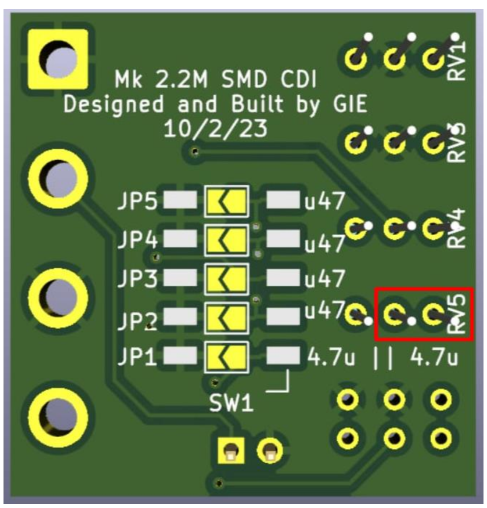
There are 4 adjustment potentiometers. From left to right they are RV1, RV3, RV4, RV5. These are also labeled on the bottom of the PCB.




There are 3 test points on the right. They correspond to the first 3 potentiometers. You will need a multimeter to measure them, flip the probes both ways and take the higher of the two resistances. The final potentiometer will need to be measured from the bottom of the board from the two leads that are closest to the edge.

The stock resistances are as follows: RV1 - 16 Ohms, RV3 - 760 Ohms, RV4 - 390 Ohms, RV5 - 33 Ohms.

RV1, 3, and 4 increase resistance when turned clockwise and decrease when turned counterclockwise. RV5 is the opposite.

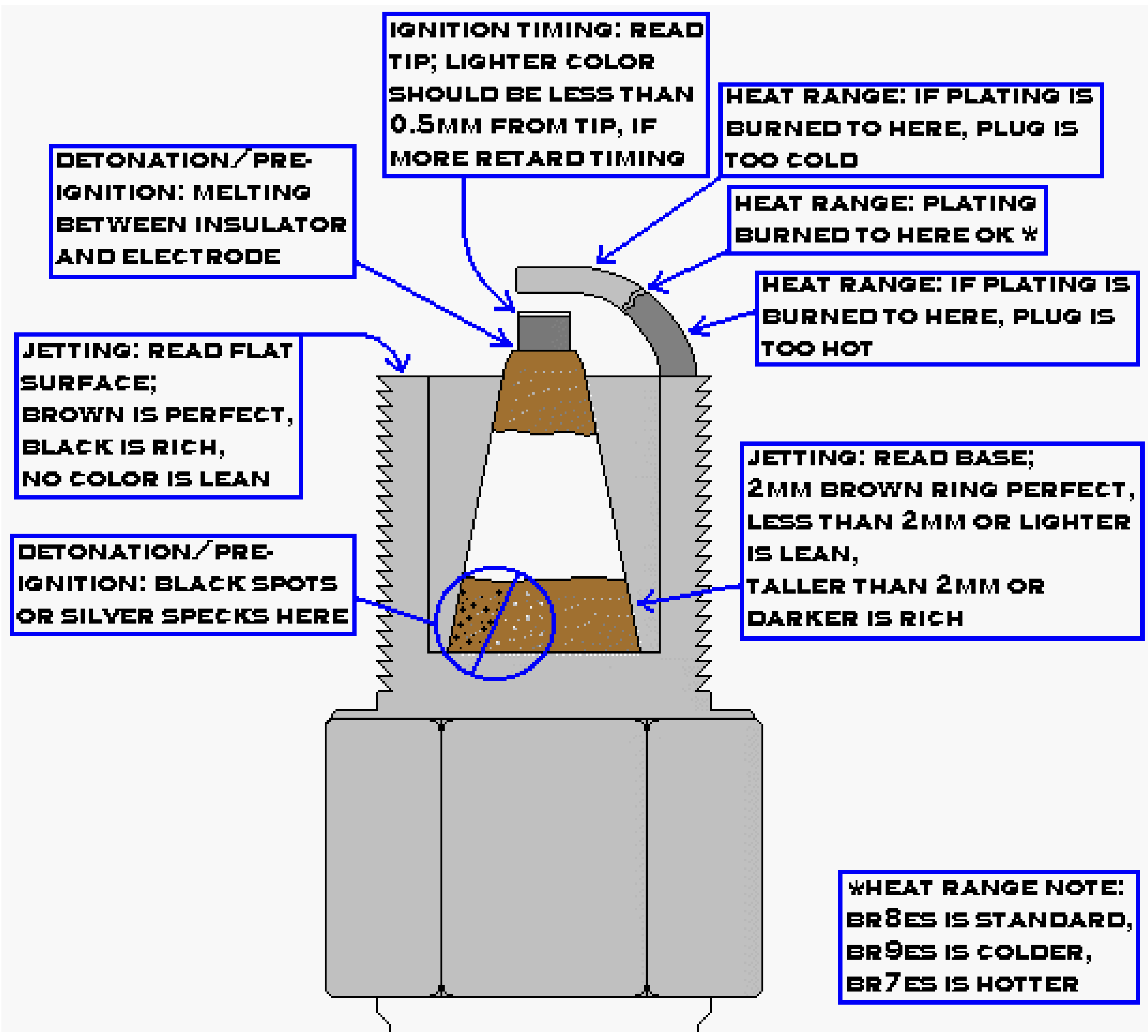



**MK2.2M Analog CDI Turn – to – Ohms:**

- RV1 = ~1/2 turn = 1 Ohm
- RV3 = ~2 1/2 turns = 100 Ohms
- RV4 = ~2 1/2 turns = 50 Ohms
- RV5 = ~1/2 turn = 1 Ohm

**How to read a Spark Plug:**

The spark plug's strap, also known as the ignition timing mark, has two marks on a 90-degree bend that indicate the base timing and the total timing. The first mark is the base timing, and the second mark is the total timing. The strap will burn a color change in these two spots. If the strap is burned all the way down to the base thread, it has too much timing. If the strap burns all the way down to the middle of the band, it has too little timing. The strap will burn cleaner as you add timing to it. The base of the strap is usually a good spot for peak torque and horsepower.



**How to read Piston Crown:**

The piston crown on a perfectly tuned engine will have a faint “wash pattern” burnt on to it. This “wash pattern” is the result of the oil in the 2-stroke pre-mix burning hot enough to turn to carbon and “stick” to the aluminum surface of the piston crown. As the piston crown gets hotter and hotter on the way to “overheating” this wash pattern will become a deeper and deeper black, and will encroach out to the edges of the piston, eventually covering the entire piston crown in an even layer of black soot. This is not yet truly over-heated, but it is hotter than ideal. As the piston is run hotter and hotter, this deep black soot will start to lighten, becoming an “ashy” gray color. This will start in a small circle at the very center of the piston crown. When you can see the “ashy” gray color begin to form on the top-side of the piston, you are VERY CLOSE to burning a hole right through the piston crown. If you start to see the “ashy” gray circle form in the center of your piston crown or on the exhaust edge of the piston, you can be 100% sure you are over-heating your piston. If the carburetion is known to be “good” then this is most likely caused by TOO MUCH ignition advance.

**Figure 1. Full radius dome pistons.**
Left: too rich - Center: perfect - Right: too lean