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Safety Warnings and Cautions

Read and understand the following safety information before using the kV Module with the MT2400 Vantage Unit. Do not operate the kV Module or the Vantage Meter if either is damaged. Do not use any accessory that is damaged.

- Electrical shock hazard.
- Use only approved kV Module adapters.
- Ignition secondary circuits produce high voltages.
- Connect kV Module to Vantage meter before making any connection to engine.
- DO NOT operate without the Vantage meter 'COM' connected to engine electrical ground.
- Do not allow clip or adapter to come into direct contact with ignition secondary conductors.
- Electrical shock can cause injury.

WARNING: Electric shock from secondary ignition system components can be very dangerous! When working near ignition system components observe the following safety warnings:

- Always use extreme caution when working around high voltage spark plugs, spark plug wires, and coil terminals.
- Never puncture a secondary ignition wire to connect test equipment.
- Never use any capacitive pickup or adaptor, other than those designed to be used with the kV Module for testing in the secondary ignition circuit.
Introduction

In many cases, kv module secondary ignition readings will differ from readings seen on traditional automotive scopes, or even labscopes. This is due to the accuracy achieved with today’s microprocessors, as well as the uniqueness of the kv module design. In tandem with the Vantage meter, the kv Module provides the most accurate secondary ignition readings available from any automotive tool. However, since nearly all secondary ignition diagnosis is based on comparative kv readings, this accuracy does not necessarily provide an advantage over scopes. Probably the most significant advantage the kv module provides is speed and ease-of-use.

In tandem with the Vantage® Power Graphing Meter, the kv Module provides a simple, fast, and effective way to focus on one distinct part of the secondary ignition waveform, the firing section. This gives you the power to look at the individual characteristics of the secondary waveform: Firing kv, Spark kv, and Burntime.

To perform ignition tests using the kv Module you simply select MULTI-METER, followed by the type of ignition system you want to test (Conventional, DIS or Coil-on-plug), and then the preferred secondary ignition measurement. For a quick overall view of all cylinders on conventional systems select Power kv, Spark kv, or Burntime and connect the appropriate adapter to the coil wire, or distributor cap.
Connecting The kV Module

Attach the kV Module to Vantage and connect the leads to the ignition system as follows, Figure 1:

1. Lay the two open clips of the kV Module on the top side of Vantage and pull the other clip under bottom side of Vantage towards the front of the unit until securely fastened.

2. Connect RED lead on kV Module to Vantage CH1 input.

3. Connect BLK mini-DIN lead on kV Module to Vantage CH3/CH4 input.

4. Connect black Vantage test lead from Vantage COM input to a known good ground.

5. For cylinder triggering or DIS system testing the RPM pickup must be installed in the mini-DIN jack on the kV Module.

![Diagram of KV module connections]

*Figure 1. KV module connections.*
6. For conventional and DIS ignition systems attach clip-on wire adapter and cable to the kV Module black sampling cable.

7. For coil on plug and coil in cap ignition systems the special capacitive pickup adapters will be used. (See the Adapter Application Guide that came with your adapter(s) to select the proper adapter).

8. Attach clip-on wire adapter to ignition coil wire or attach coil in cap adapter to distributor cap. If testing a coil on plug ignition system, attach appropriate COP adapter to the selected ignition coil.

9. The last step is selecting a specific cylinder to test by attaching the RPM pickup to the cylinder’s secondary cable. On DIS waste spark systems the clip-on wire adapter and RPM pickup should be clipped onto the same wire.

**Using The kV Module**

To perform ignition tests using the kV Module select MULTI-METER from the MAIN MENU. For best results a histograph view is recommended. From the function list, select the type of ignition system being tested. (Conventional, DIS or Coil on plug).

In the next dialog box select the preferred secondary ignition measurement. For a quick overall view of all cylinders on conventional systems select Power kV and connect the appropriate adapter to the coil wire or the distributor cap.

If upwards or downwards spikes are seen, suspect a problem in 1 or more cylinders. To isolate a specific cylinder clip the RPM pickup to each individual spark plug wire while viewing measurements. A “T” symbol appears at top of screen when signal is triggered with the RPM Pickup.

When a good cylinder is isolated, the measurement remains the same and the spikes go away. When a problem cylinder has been isolated 1 of 2 things can happen. If there is current flow through the spark plug wire (“T” symbol appears) a new value, higher or lower, for the individual cylinder is displayed.

If there is no current flow through the spark plug wire (“T” symbol does not appear) then the measured value will not change and still represents an overall view of all cylinders (including the spikes of the problem cylinder). This makes it clear that a problem cylinder has been found.

Snap throttle tests should be performed on individual cylinders. The “T” symbol is used to indicate that an individual cylinder has been triggered.

On DIS or Waste Spark systems, measured values apply only to individual cylinders. To measure a companion cylinder move the clip-on wire adapter and RPM pickup to the companion cylinder.

On Coil on Plug ignition systems it is important to remember that Power kV values are relative. Power kV values from each cylinder on the vehicle should be compared to each other for diagnostic value.
Ignition Analysis

The kV Module focuses on one distinct part of the secondary ignition waveform, the firing section.

The firing section consists of the firing line and the spark line, also known as Power kV and Spark kV. The duration of the spark line is often called the burn time, and is measured in milliseconds.

Power kV

The firing line (power kV) is measured in kilovolts and represents the amount of voltage required to start a spark across the spark plug gap. Firing voltage must overcome secondary circuit resistance including secondary cables (if present), rotor gap (if present) and the spark plug. Remember that the spark plug air gap is typically the highest resistance in the circuit.

Here’s some examples of ignition patterns on a Vantage histograph.

Note that the Power kV graph of all the cylinders should remain relatively stable at a steady engine speed.

By triggering on an individual cylinder we can see that it is normal for firing voltage to vary in any single cylinder.

High spikes or kV readings indicate high secondary circuit resistance. This can be caused by a lean air/fuel mixture, a wide spark plug gap, or a high resistance or open spark plug wire. The high spikes above are caused by an open in only one of the spark plug wires. The other spark plug wires appear to be good. Spark finding a high resistance path to ground outside the cylinder (ign wire arcing to ground) could also create high firing voltage.
Low spikes or kV readings indicate low secondary circuit resistance. This can be caused by a rich A/F mixture, a narrow spark plug gap, low resistance or shorted spark plug wire, or low compression. The low spikes shown are caused by a short in only one of the spark plugs. The other spark plugs appear to be good. Spark finding a low resistance path to ground outside the cylinder (ign wire shorted to ground) could also create low firing voltage.

**Spark kV**

Spark kV represents the voltage required to maintain spark for the duration of the spark event.

Normal Spark kV should be between 1 and 4 kV. High Spark kV readings indicate high secondary circuit resistance.

Low Spark kV readings indicate low secondary circuit resistance.

**Burn Time**

Burn time represents the duration of the spark event and should normally measure between 1 and 3 milliseconds. Burn Time is directly affected by Firing kV. If Firing kV increases, Burn Time decreases. If Firing kV decreases Burn Time increases.

In a DIS or Waste Spark ignition system it is important to remember that each cylinder has a companion cylinder. For each pair of cylinders a single ignition coil fires both cylinder’s spark plugs simultaneously. Power kV is measured on a cylinder when on the compression stroke. Waste kV is measured on a cylinder when on the exhaust stroke. The polarity of each pair is such that one spark plug fires positively and the other one fires negatively. The voltage measurements will typically be slightly higher on the positively fired cylinders.
Using The kV Adapters

Various kV adapters are used for connecting the kV module to the vehicle. The adapter you use will depend on the type of ignition system you are testing. All of the kV adapters connect to the module through the black RCA connector. The clip-on wire adapter is used for conventional and DIS systems.

The coil-on-plug (COP) and coil-in-cap (CIC) adapters have mounting clips that properly position the adapter to ensure accurate readings and repeatable mounting. A few of the adapters have thumbscrews for adjusting one of the mounting clips. Typically, COP system testing will require that you compare readings from one coil to the next. When using a COP adapter with an adjustable mounting clip, it is imperative that you adjust the clip for the first coil only, and then leave the clip in the same position until testing on all coils is complete for that vehicle. Again, this will ensure accurate readings and repeatable mounting.

Presently, there are two CIC and 5 COP adapters available:

- EETM306A06 GM HEI Coil-in-cap (CIC-1)
- EETM306A05 Import Coil-in-cap (CIC-2)
- EETM306A03 Ford Coil-on-plug (COP-1)
- EETM306A04 Chrysler Coil-on-plug (COP-2)
- EETM306A07 VW and Audi Coil-on-plug (COP-3)
- EETM306A08 Honda and Isuzu Coil-on-plug (COP-4)
- EETM306A09 Volvo Coil-on-plug (COP-5)

Refer to Table 1 on the next page for coil-on-plug and coil-in-cap vehicle applications. The pages that follow show you how to mount the COP and CIC adapters on the vehicle.
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<td>COP-4</td>
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Table 1. Vehicle applications for coil-on-plug and coil-in-cap adapters.
GM HEI CIC-1

The CIC-1 adapter is used on GM HEI coil-in-cap systems, Figure 2. This adapter has an adjustable clip to accommodate HEI systems with and without a spark plug wire retainer ring installed. The spark plug wire retainer ring is a plastic ring that mounts on top of the spark plug wires. A thumbscrew on top of the adapter is used to adjust the clip. The thumbscrew slot is marked W/RING and W/O RING. When a spark plug wire retainer ring is installed, the clip should be adjusted to the side marked W/RING. When a spark plug wire retainer ring is not installed, the clip should be adjusted to the side marked W/O RING. The adapter mounts flat on top of the coil cover.

Figure 2. The CIC-1 adapter is used on GM HEI coil-in-cap systems.
**Import CIC-2**

The CIC-2 adapter fits several different import coil-in-cap applications, Figure 3. A thumbscrew is used to adjust one of the side-mounting clips. Adjust the adapter for a snug fit on the coil side of the distributor cap. The two indexing tabs on the top of the mounting clips should be flat against the top of the cap, and the adapter should contact the flat side of the cap.

![Figure 3. The CIC-2 adapter fits several different import coil-in-cap applications.](image)

**Ford COP-1**

The COP-1 adapter is used on Ford coil-on-plug applications, Figure 4. The adapter mounts onto the coil at the primary connector. Looking at the top of the coil, notice the flat area next to the primary connector. The two long adapter clips fit down the side of the coil on the flat area, and straddle the primary connector. The adapter signal wire can be shaped to reach around components that might otherwise interfere with coil access. However, the signal wire should face away from the center of the coil. The adapter-indexing tab should contact the top of the coil. For best results, the adapter must be indexed in the same position on each coil.

![Figure 4. The COP-1 adapter is used on Ford coil-on-plug applications.](image)
Chrysler COP-2

The COP-2 adapter is used on 2.7L, 3.2L, and 3.5L Chrysler coil-on-plug applications, Figure 5. The adapter mounts onto the flat area on top of the coil. The arrow on the adapter should point to the raised area of the coil, and the adapter edge should seat against the raised area. For best results, the adapter must be indexed in the same position on each coil.

Volkswagen and Audi COP-3

The COP-3 adapter, Figure 6, is used on Volkswagen and Audi coil-on-plug applications through 1999. The adapter must seat flat on top of the coil with all three metal clips in contact with the sides of the coil. For best results, the adapter must be indexed in the same position on each coil.
Isuzu and Honda COP-4

The COP-4 adapter is used on 3.2L, and 3.5L Isuzu and Honda coil-on-plug applications, Figure 7. The adapter must seat flat on top of the coil with all three metal clips in contact with the sides of the coil. For best results, the adapter must be indexed in the same position on each coil.

![Figure 7. The COP-4 adapter is used on 3.2L, and 3.5L Isuzu and Honda Coil on Plug applications.]

Volvo COP-5

The COP-5 adapter is used on Volvo coil-on-plug applications, Figure 8. The adapter mounts onto the top of the coil. The adapter is mounted correctly when it is centered on the flat area of the coil. A thumbscrew is used to adjust one of the side-mounting clips. When the thumbscrew is all the way toward the inside of the adapter it is adjusted to fit late model coils. When the thumbscrew is all the way toward the outside of the adapter it is adjusted to fit early model coils. For best results, the adapter must be indexed in the same position on each coil.

![Figure 8. The COP-5 adapter is used on Volvo coil-on-plug applications.]

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