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IH: Engine Control - Sub-01D

Magnavox Electronic Ignition Systems

(1980 to 2003) Components include a timing rotor (timing cup), sensor plate or inductive pickup, ignition control module, ignition coil and spark plugs. For electronic advance, the inductive pickup generates TDC pulses that are sent to the solid state Ignition Control Module (ICM). The ICM computes ignition timing advance and coil dwell. In 1983, a Vacuum-Operated Electric Switch (VOES) was added to switch between 2 different spark advance curves built into the ICM. [1)]

- This uses a Dual-Fire Spark system, using only one coil trigger wire to produce a spark on both plugs at the same time. (See coil information)
- The spark advance start point can be altered by physically moving the sensor plate in the “nosecone”.

- **In May of 1980**, the MoCo issued a Service Bulletin in response to having some owners of 1000cc and 1340cc engines, built since January 1, 1978, experience a knocking and / or pinging due to the unavailability of fuels with high enough octane ratings. Although retarding the spark advance will help to eliminate the knocking / pinging in an engine, a slight loss of power and fuel economy may be noticed by the owner. [2)]
  - However, reducing the spark advance on these engines a small amount, anywhere between 1°-10°, can help to eliminate this problem.
  - Check the ignition timing to make sure it is set properly as described in the Service Manual.
  - Set the timing if necessary:
  - Start the engine and set the idle speed at 2000 rpm.
  - Retard the timing by shifting the timer plate counter clockwise in 2-1/2° increments until the problem is correct. Do not retard the timing more than 10°.

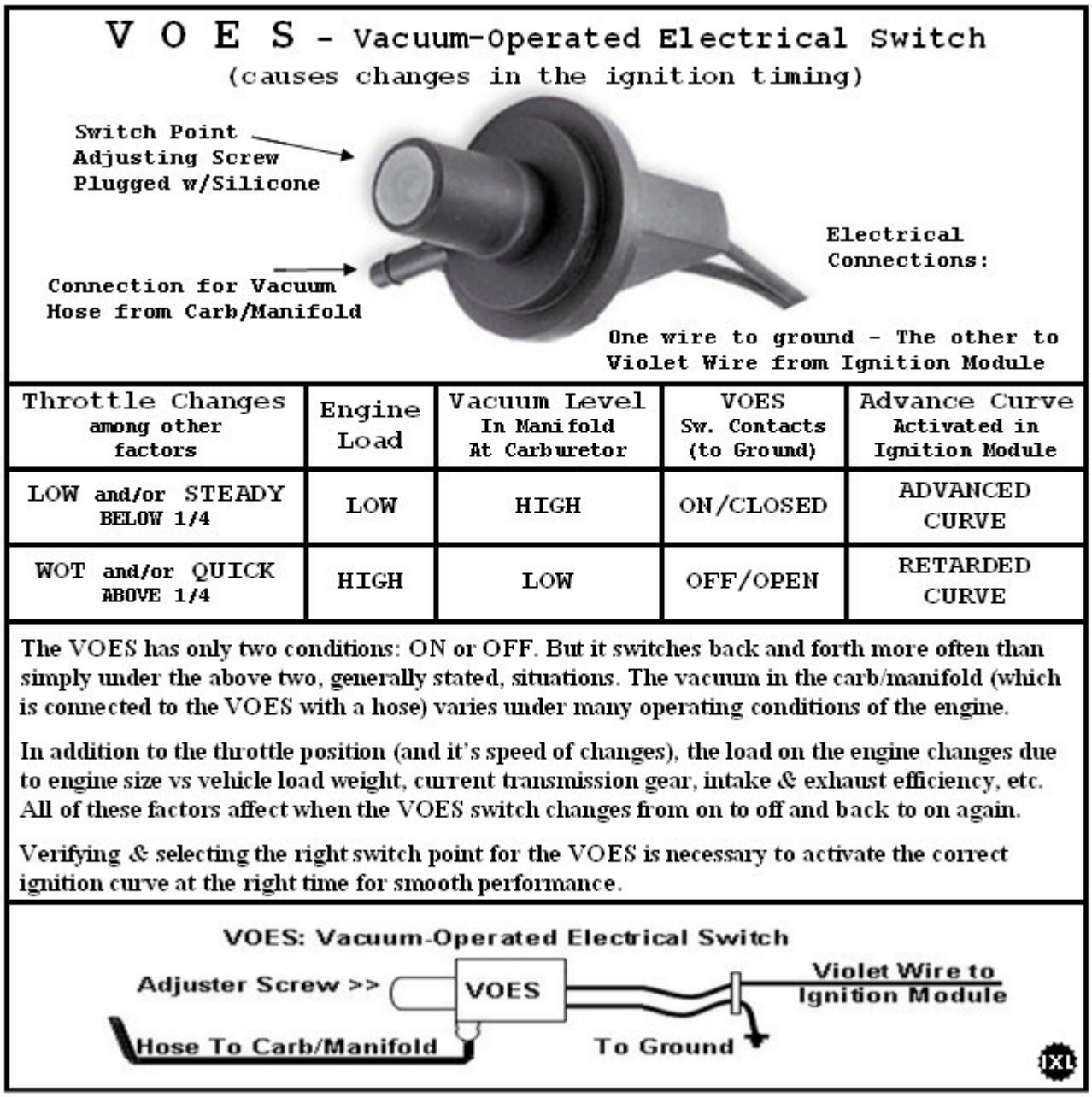
- **In February of 1981**, the MoCo issued a Service Bulletin regarding the time intervals for initial firing with the ignition module. [3)]
  - The electronic ignition modules have a protective control circuit that stops current flow to the ignition coil, if the engine is not running. This prevents overheating the ignition coil and limits the drain on the battery.
  - 1980 and E1981 ignition modules, with the part number suffix -80 (Sportster part number 32410-80 [4)]), have a 4 second delay and will only start firing on the second or third stroke. This causes a problem on kick-start motorcycles, where there may be a pause between kicks.
  - Newer modules, with part number suffix -80A (Sportster part number 32410-80A [5)]), have a 6 second delay and will fire on the first compression stroke.
  - Either module can be reset, if the protective circuit shuts off current flow, by turning the ignition switch or engine·stop switch off, then back on again.
  - The new modules will work in 1980 and E1981 applications without modification.

VOES - Vacuum-Operated Electric Switch

- The computerized, microprocessor ignition module is programmed with two spark advance curves to meet varying engine loads. The system includes a vacuum operated electric switch (VOES). [6)]
- The ignition module selects the proper curve when it receives an open or closed electrical signal from the VOES. This system ensures correct timing to suit starting, low speeds and highway speeds. [7)]
- The VOES was first installed on Sportsters in 1983 (and used on most models thru 2013). The unit senses intake manifold vacuum through an opening in the carburetor body via a vacuum hose and requests from the Ignition Control Module switches between one of two different spark advance curves. The switch is closed at high vacuum operation (low engine load), utilizing a more advanced spark curve and it is open at low vacuum operation (high engine load), utilizing a less advanced (retarded) spark curve to minimize engine knock and still maintain performance. The VOES is installed above the intake manifold. [8)]
    - The high vacuum curve selected for maximum spark advance under normal light load conditions provides improved fuel economy and performance.
    - The low vacuum curve (retarded spark) minimizes spark knock, while maintaining performance under high load conditions.
- On 1986 1100cc Sportsters, a mid-year production change has rerouted the VOES ground wire to a different mounting location.
  The new location for anchoring the ground wire improves electrical conduction to ground.
  All 1100cc vehicles produced after VIN 1HD1CAN10GY115548 have this change. Motorcycles with an earlier VIN may also require this change. Improper grounding of the VOES will cause erratic idle, poor low speed operation or difficulty in locating the ignition timing mark. [9)]

- **VOES: Its Operation & Adjustment.** (Article by IXL2Relax of the XLFORUM)[10)]
    - There are many discussions on the XLForum and elsewhere regarding the VOES unit. While there are many helpful posts among those discussions, there is still much confusion due to posts that are inaccurate. I hope to clarify the VOES operation with this post and a reference diagram.
    - The VOES unit was used on the Sportster from about 1983 (Ironhead) to 2003 (Evos). But, note that the 1998 to 2003 Sport models did not have a VOES but rather pioneered the use of a MAP sensor like that used on 2004 and later model Sportsters. Those models have Engine Control Modules which can micro-manage the ignition advance based on multiple conditions.

Here's what the VOES looks like with a quick reference chart of it's operation:



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- .
  - **What it does and how.**
    - The VOES works in conjuction with the ignition module to control ignition timing. The ignition module has two timing curves - one is for idling or cruising and the other is for WOT and/or for powering up for high loads (like steep hills). The VOES switches the ignition module between these two pre-programmed advance curves based on manifold vacuum.
    - The VOES has two connections and one adjusting screw. The VOES is connected to the carb (manifold side) through a vacuum hose and monitors the manifold vacuum level. It is also connected to the ignition module. It has two black wires from the internal switch. From the inline connector, there is a (purple or purple/white) single wire sent to the ignition module and a second wire sent to ground. The VOES switching point is set by a concealed screw. This causes the ignition module to switch between the two advance curves based on a set point level of manifold vacuum.

        - The adjusting screw is inside a sealed opening on the VOES. You must dig out the silicone sealing compound in order to make any adjustments. Remember - When testing your adjustments, you must also seal that opening with your thumb (or other air-tight sealing compound or tape) in order to prevent air leakage through the screw adjuster.
        - The only function of the VOES is to switch between the two advance curves that are programed into the ignition module. Different ignition modules have different curves. Those curves have anywhere from 5 to 18 degrees difference in the advance settings between them. But that's another discussion.
        - The manifold vacuum directly controls the VOES, but the throttle position (and/or it's aggressive changes) indirectly alters the VOES (thru changes in the manifold vacuum) by altering the carburetor throttle plate.
        - When the engine is running at idle, when lightly accelerating or when using a steady cruise throttle, manifold vacuum is high (the throttle plate is mostly closed) and the VOES switch is ON, causing the ignition module to use the MORE ADVANCED CURVE.
        - When the engine is not running or when the throttle is quickly opened to accelerate or to satisfy a heavy load (steep hill, extra weight, etc.), the manifold vacuum drops and the VOES switch goes OFF, causing the ignition module to use the RETARDED (OR LESS ADVANCED) CURVE. If you let off the throttle (when you reach your speed or top the hill), the manifold vacuum rises again. The VOES senses this and will again switch ON, causing the ignition module to return to the MORE ADVANCED CURVE as the load on the engine becomes lighter.
        - Running without a VOES causes the ignition to run on ONLY the less-advanced power curve. The ignition module cannot switch curves. Unless you have a highly modified engine, this will hamper smooth engine operation on light acceleration and reduce fuel savings during cruising.
        - Also note, if the VOES switching point is set too low, it will remain on the more advanced curve too long under mid-load acceleration and pinging will occur. This is the reason that engines with upgraded performance should have their VOES switch point increased (switch at a higher vacuum level) to better match the capabilities of the engine.

- **Testing the VOES Operation**
    - Method #1 [12)]
        - After the engine timing has been properly checked / adjusted, perform the following check:
        - With the engine idling, remove the vacuum hose from the carburetor and momentarily plug the carburetor fitting. Timing will retard and engine speed should decrease. Reinstall the vacuum hose to the carburetor. The timing mark should reappear and engine speed should increase to the preset speed. If the engine speed does not decrease and increase as described, check the VOES wiring connection to the computer module and ground wire. VOES must be replaced if malfunctioning.
    - Method #2 [13)]
        - You will need a vacuum pump (with gauge) to create the desired vacuum level and an ohm meter.
        - Remove the air cleaner, disconnect the switch wire from the computer module connector under the fuel tank and remove the switch vacuum hose from the carburetor. The rear of fuel tank may have to be raised to disconnect the switch lead

connector from the computer module connector.
    - Attach the ohmmeter leads to the switch wire and to ground. Attach the vacuum pump hose to the switch vacuum hose.
    - The ohmmeter should indicate the switch closed with 3.5 to 4.5 in. of mercury vacuum applied. If more or less vacuum is required to close the switch, replace it.

- **Testing the VOES Switch Point**
    - To test your VOES unit (or adjust it to a specific switching point), you will need a vacuum pump (with gauge) to create the desired vacuum level and an ohm meter to test whether the VOES has switched on (causing a short between it's wires).
    - To work on the VOES, remove the vacuum hose from the vacuum line tee where it branches to the vacuum-operated petcock. If you don't have a vacuum-operated petcock, and have no tee, you need to remove the vacuum hose from the carb. Then remove the VOES from it's mount under the fuel tank and disconnect the wires.
    - Connect your vacuum pump to the hose and connect your meter (set on ohms) to both wires. As you slowly pump up the vacuum, there will come a point where the meter will switch from infinity to zero ohms. This is the switch point. Write down the indicated vacuum (inches of mercury). Release the vacuum and do the test again, just to be sure you get a consistant reading.
    - If the reading is right (according to the manual or chart above) for your bike, you can leave it as it is. If your bike is stock or only upgraded to Stage 1 level, you probably do not need to alter the factory VOES setting. But if you've gone farther with your mods, you might have one of those engine builds where the combination of ignition curves, cams, heads, etc., leaves you with some pinging near the VOES switch point. If you want to make your VOES switch at a different point, read on.
- **Adjusting the VOES Switch Point**
    - Dig out the original sealing compound which fills the opening where the adjusting screw is located. Do this carefully so as not to damage the internal screw or diaphragm or the VOES housing. Remember - When testing your adjustments, you must also seal that opening with your thumb (or other air-tight sealing compound or tape) in order to prevent air leakage through the screw adjuster which will skew your readings.
    - To adjust the VOES to switch at a higher vacuum, turn the adjuster screw 1/4 turn clockwise. Now repeat the test from above to see where (in inches of mercury) the new switch point occurs. If you want it to switch at a lower vacuum level, turn the adjuster screw 1/4 turn counter-clockwise. Keep adjusting the screw (carefully) to raise or lower the switch point. You should not go more than 1 or 2 full turns from the initial setting. If you turn the screw too far clockwise, you'll damage the internal diaphragm and need to replace the unit.
    - When you are done making adjustments, you'll need to plug up that hole. But do this very carefully - Be sure you DON'T GET ANY SILICONE DOWN NEAR THE SCREW. Use only enough to plug the end of the opening and then set it aside to fully cure (probably 24 hours) before reinstalling on your bike.

- **Variety of VOES**
    - From the book '101 HD Evo Performance Projects by Kip Woodring & Kenna Love', HD installed VOES on different models with their adjustment set for different switching points. These vacuum settings are measured in inches of mercury. The VOES are color-coded at the sealed end to indicate what setting was used on a particular unit. (I have seen very few with colors other than the natural greyish white - so perhaps HD did not keep up this practice)

    - No Color - - - 7.0 in. Mercury – Early Evo FLT (1984)
    - RED Color- - - 5.5 in. Mercury – Late Evo FLT
    - WHITE Color - 4.0 in. Mercury – Evo FXR & XL
    - BLUE Color - - 4.0 in. Mercury – Evo Softail
    - All of these VOES should be adjustable to other settings. As far as I know, there is no difference in the various VOES units themselves other than their predefined factory settings.
- **READER BEWARE!!! …NOT EVERYTHING YOU READ ONLINE IS VALID INFORMATION…**
    - There's a lot of MIS-information about the VOES & its operation!
    - There are many threads with references to the VOES and how it works, or how it should be adjusted, or what effect it will have. I've only posted above some of the information that is valid. But there is so much confusion surrounding the VOES that you must read all statements carefully to keep from being misled.
    - There is a Sticky Thread in the 'Engine Conversion' section titled 'VOES ADJUSTMENT' - Be careful of the information presented there regarding the VOES. “This is the most confusing conglomeration of instructions I have ever read. There is some bad info, some completely wrong info, and some very dangerous info.” (A comment from Post# 113)
    - That thread has some information about connecting an LED light to the VOES-to-Ignition wire to see the VOES switching modes while riding. If you try this, just be careful to read the information thoroughly and understand what you're doing before proceeding. This is the link to that thread: http://xlforum.net/forums/s...ad.php?t=57534
    - For the sake of not repeating what can be looked up directly, the following links have VOES discussions (as well as other info).

- **Additional References:** [14)]
    - https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-engine-conversions/3868-voes-adjusting?t=5945
    - https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-era-specific-and-model-specific/frame-mount-evo-sportster-talk-1986-2003-models/80961-my-1st-h-d-please-help-with-issues?t=594019 - Thread not all VOES related
    - These posts from the above thread are most applicable:
    - . . https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-era-specific-and-model-specific/frame-mount-evo-sportster-talk-1986-2003-models/80961-my-1st-h-d-please-help-with-issues/page12?postcount=173#post1716395
    - . . https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-era-specific-and-model-specific/frame-mount-evo-sportster-talk-1986-2003-models/80961-my-1st-h-d-please-help-with-issues?p=1716405#post1716405
    - . . https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-era-specific-and-model-specific/frame-mount-evo-sportster-talk-1986-2003-models/80961-my-1st-h-d-please-help-with-issues/page12?postcount=180#post1716472
    - This post has some great pictures of the inside of the VOES:
    - . . https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-era-specific-and-model-specific/frame-mount-evo-sportster-talk-1986-2003-models/80961-my-1st-h-d-please-help-with-issues/page12?postcount=175#post1716427
    - http://www.mklsportster.com/xlvoes.htm

- http://www.wildwestcycle.com/f_voes.html

Nosecone Ignition Seal

This is a steel shell radial shaft seal (HD# 11124) installed in the cam cover.
It surrounds and seals #2 cam when the cover is installed. Also used on 1986-2003 model Sportster cam covers.
Dims per XLForum member, Fizzle:
OD 1.570“ (39.878mm) ID 1.050” (26.67mm) W 0.248“ (6.2992mm)

Other brands include James (JGI-11124), Cometic (C9355), Athena (51-A210), Custom Chrome (54-043).
The rubber shell HD Genuine double lip version is part number (11124-DL).
Other brands include James (JGI-11124-DL).
NOTE: SKF makes a radial shaft seal with a part number of 11124 but that IS NOT AN HD PART NUMBER. SKF 11124 IS TOO BIG TO FIT THE COVER and they don't show a compatible seal in their catalog for this application.

HD Seal (11124):

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1)
1959-1985 Clymer Sportster Repair Manual pg 229
2)
HD Service Bulletin #M-780
3)
HD Service Bulletin #M-814 dated February 6, 1981
4)

1979-1980 HD Sportster Parts Catalog pg 23
[5]

1979-1982 HD Sportster Parts Catalog pg 31
[6] [7] [8] [12]

HD Service Bulletin #M-856 dated August 6, 1982
[9]

HD Service Bulletin #M-910 dated 9-17-1985
[10]

http://xlforum.net/forums/showthread.php?t=1863153
[11]

Illustration created by IXL2Relax at the XLForum
[13]

HD Service Bulletin #M-858 dated October 7, 1982
[14]

Article by IXL2Relax of the XLFORUM.net
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-electrical/sportster-motorcycle-electrical-and-ignition/173626-voes-its-operation-adjustment?t=1863153
[15]

photo by Hippysmack