Installation Manual

BECIN - 2000
BECIN - 3000
BEC - 1500
BEC - 2500

ABSOLUTENERGIES
2015

CONTENTS

Safety Precautions

Important Information

Read and follow these safety precautions to avoid hazards. If you do not understand these instructions or do not like to work on vehicles, please have a qualified mechanic do the installation for you. Incorrectly installing or using the HHO System may result in serious damage to you and/or your vehicle.

It should take approximately 3 hours to install this unit, so ensure that you have enough time to complete the installation. Be sure to work outside, no smoking at any time during the installation; make sure the engine is off and very importantly, not hot.

Your HHO System does not store hydrogen, subsequently there is no fire hazard when installed properly. However water electrolysis generates Hydrogen, an explosive gas, which means that you should **never light a match or smoke near or in front of the generators output** - the water tank could blow up!

Be careful with the generator working when the car is not moving. A small amount of hydrogen can accumulate in the air intake of the motor and could explode if you smoke or use an open flame near it.

Safety Equipment

Be sure to wear goggles and rubber gloves and only use professional tools; use common sense and general safety procedures used for any work carried out on automotive installations and maintenance.

Enjoy your new system

Be safe and enjoy your new Hydrogen on Demand Dual Fuel Generator System, read and understand these instructions before and during the installation and you will benefit from your new system for years to come.

Installation of the hydraulic components

General configuration

Please refer to the illustration below for typical configuration of the mechanical and hydraulic parts of the HHO system. In the end pages of this manual you will be able to check each one of the individual connections to be made regarding the installation of the components. We will now only focus on the main aspects of the installation.

Positioning the Dry-Cell

You will need to find a good place in your engine compartment to mount your new HHO system. Please remember that the water tank should preferably be placed at least 20 cm above the generator Dry-Cells in order to guarantee a sufficient water head for the water/hydrogen to flow. But in some cases with not too much space available to make the installation we just need to make sure that the bottom of the water tank is a little bit higher than the top of the dry-cell.

Install your new HHO Dry-Cell as far away from the heat of your engine as possible. Normally the best place to install the dry-cell is in the space between the front grill and the radiator as it is closest to the air entering the engine compartment and often the largest space available.





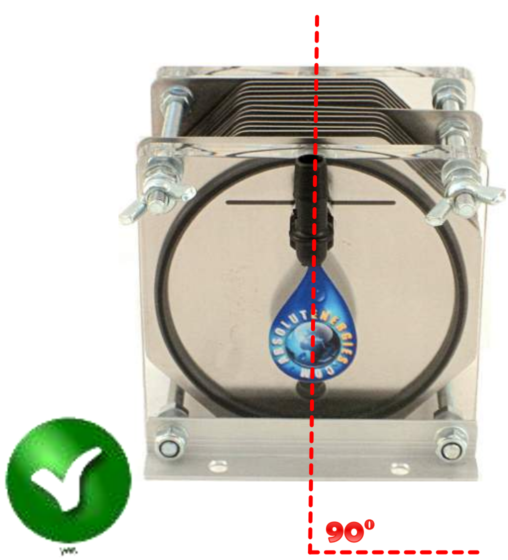
Make sure to install the Dry-Cell in a place that can easily be accessed and cleaned or inspected from time to time. It should be mounted and secured in such a manner as to ensure it does not move or bounce around while the vehicle is in motion, even over rough terrain. Securing it with a permanent metal bracket (see photos above – metal bracket not included in the kit) should be sufficient to secure it to the engine chassis and to operate perfectly.

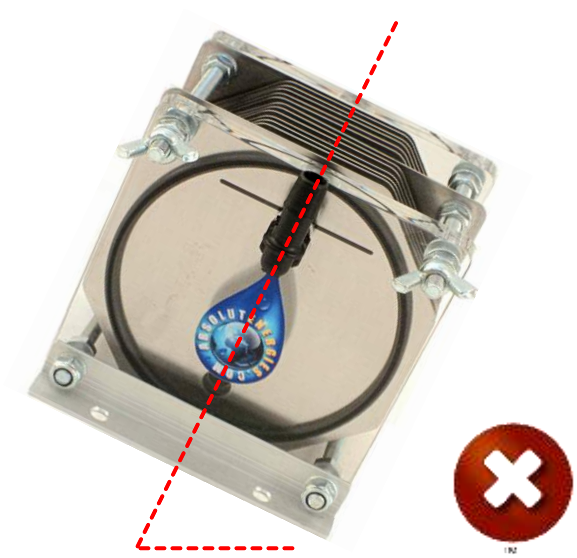
Important Information:
When making the installation never make any type of changes in the dry-cell. Never open it, loosen/tighten the nuts or cut the screws. ***You will damage the dry-cell and it will not work properly after.*** *Changes made in the cell are not covered by the warranty.*

The dry-cell can be mounted in horizontal or vertical position.

The **vertical position** does not require any special remarks. The water intake is connected in the bottom and HHO output will be in the top of the cell. You just need to make sure that the HHO output hose is always above the top of the cell. If not the HHO gas will have difficulties moving outside the cell and the production will be reduced.

The **horizontal position** requires more care in the installation. **The cell has to be positioned upright and leveled to the ground with the tube fittings facing directly to the sky.** If you look carefully the cell has 2 openings, one higher than the other. The lower opening is for the water intake and the upper opening for HHO gas output. We must make sure that the cell is not placed with an angle/rotation that reduces the distance between the two openings. Please take a look at the pictures below.





If the Dry-Cell is placed as shown in the image on the right you will not use 100% capacity of the generator to produce HHO gas. Also the HHO gas will have problems getting out of the cell being released gulps. You can verify this problem if fluctuation of the amperage is very high.

Positioning the Water Tank

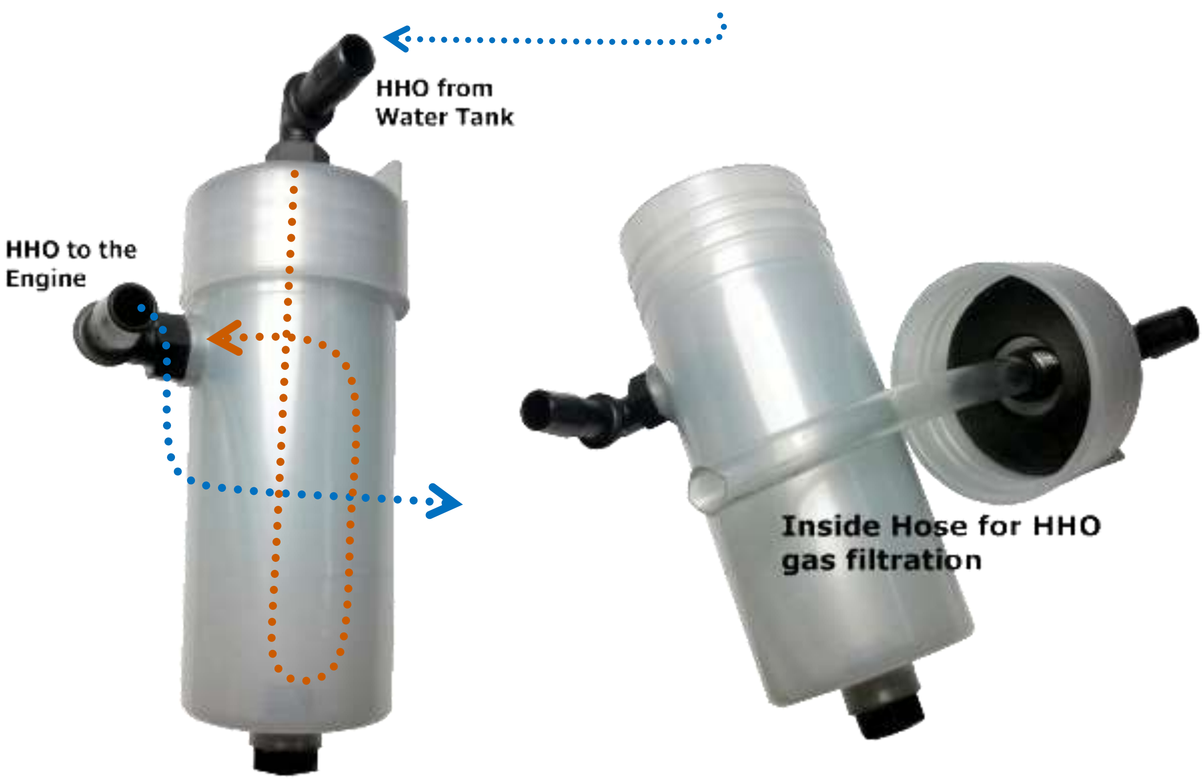
Make sure that water tank is installed with the same care as described before for the generator. The water tank needs preferably to be placed 20 cm above the HHO dry-cell to accomplish the gravity head needed for the water/hydrogen to flow into the generator. But in some cases with not too much space available to make the installation we just need to make sure that the bottom of the water tank is a little bit higher than the top of the dry-cell. Please take a look at the pictures below:

Positioning the Bubbler

The bubbler will serve two purposes: cleaning the HHO gas and act as a safety barrier. When HHO gas is produced from the dry cell, some small water vapor is produced as well because the water will get a little bit hot with the passage of current. This water vapor can carry tiny particles of electrolyte which can cause damaging corrosion. As the HHO bubbles rise up the column of water inside the bubbler they are "scrubbed" of any electrolyte particles that were attached to the water vapor. The result is much cleaner HHO gas.

In the event of a flashback, the bubbler also acts as a safety barrier. If a flame reaches the bubbler and ignites the HHO that has accumulated at the top, the water column will prevent the HHO from going on to the dry cell because the flame cannot skip from bubble to bubble.

Make sure that bubbler is installed above the water tank to accomplish the gravity head needed for a correct “filtering” of the HHO gas. Please take a look at the pictures below:



Positioning the water and HHO hoses

The hose connections on **vertical position of the dry-cell** do not require any special remarks. The water intake is connected in the bottom and HHO output will be in the top of the cell. You just need to make sure that the HHO output hose is always above the top of the cell. If not the HHO gas will have difficulties moving outside the cell and the production will be reduced.

The hose connections on **horizontal position of the dry-cell** require only that the positioning of the HHO output hose be made also always on an uprising position without ups and downs. If this happens, the HHO gas will have problems moving into the water tank and will also be released gulps reducing the efficiency of the system. You may verify this problem if fluctuation of the amperage on your system is very high. Please refer to the illustration below for typical installation of the hoses coming and going from the water tank:

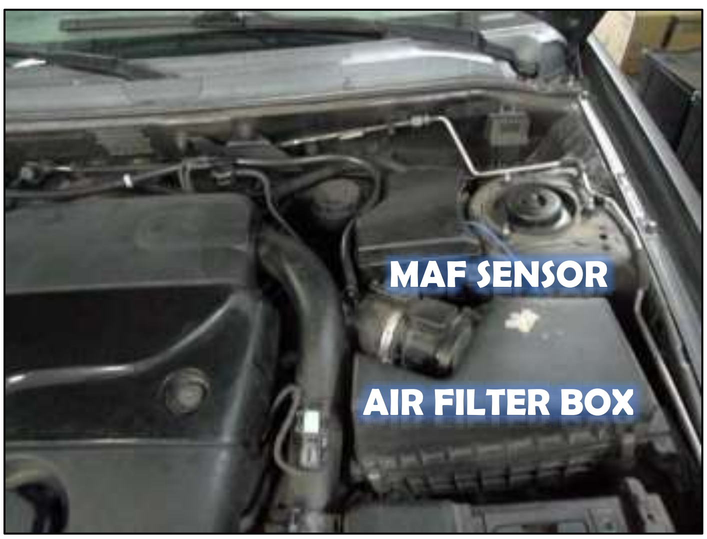
HHO injection point

The system is operated by vacuum suction from your car's air intake which takes the HHO directly to the combustion chamber mixing it with the air/fuel. The injection point must be done right after the air filter box and, in modern cars, after the MAF/MAP sensor (air flow sensor) and before the Turbo. Never make the injection point after the Turbo or Intercooler because the pressure will not allow the best results with the HHO system.

You will need to remove the air duct, to ensure that you do not leave any residue from the drilling you are about to do. Drill an 8 mm hole close to the intake manifold. Clean out any drill shavings, insert the high pressure fitting using goop glue or teflon tape and tighten. Connect the high pressure hose.


MAF SENSOR


VOLVO

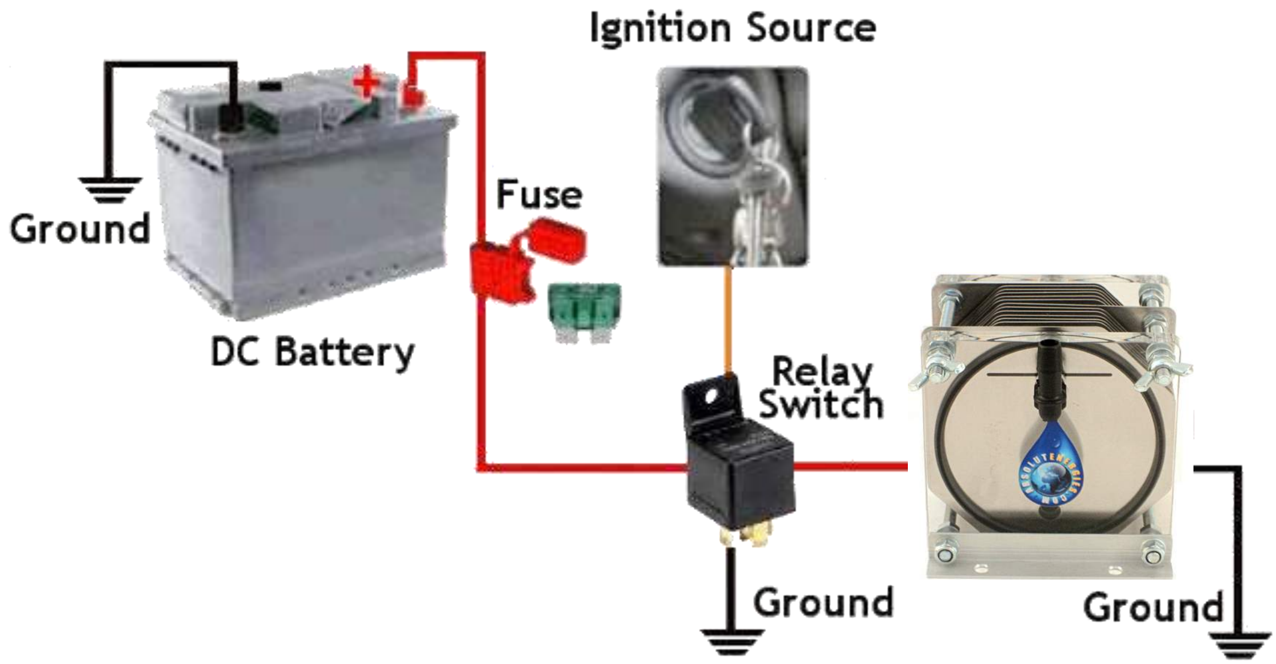

MAF SENSOR
AIR FILTER BOX


NON RETURN VALVE

Installation of the electrical components

General configuration

Please refer to the illustration below for typical wiring configuration for powering the system: In the end pages of this manual you will be able to check each one of the individual connections to be made regarding the installation of the electrical circuits. We will now only focus on the main aspects of the installation now.



Battery

The system is powered by the 12V battery and controlled by the relay switch. The system will only work if there is a signal from the ignition source. The positive circuit (red wire) should be connected to the Relay Switch **position 30**.

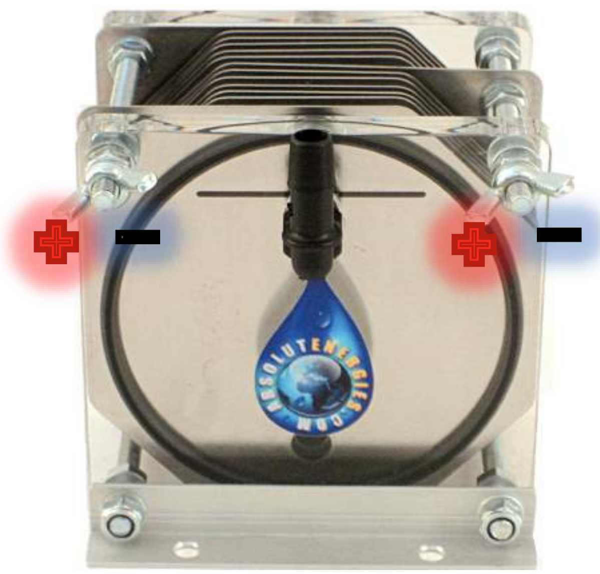
Identifying the ignition source

This is an important connection to be made in order **to have the generator working only when the engine is also working**. Identify a point in your vehicle's electrical system which has 12 Volts (positive) present only when the engine is running. **The most secure connection is to excitement signal of the alternator**. If you do not know how to do this connection please ask you mechanic to do it for you. Connect this electric source to the **Relay Switch position 85.** This circuit will control the HHO production.

This electric connection can also be made to a circuit controlled by the ignition key (position 2), but there is a risk of hydrogen being produced when the engine is not running if you leave the key permanently in that position. Try never to make this kind of connection because it increases the risk of some explosion to happen.

Dry-Cell electric connections

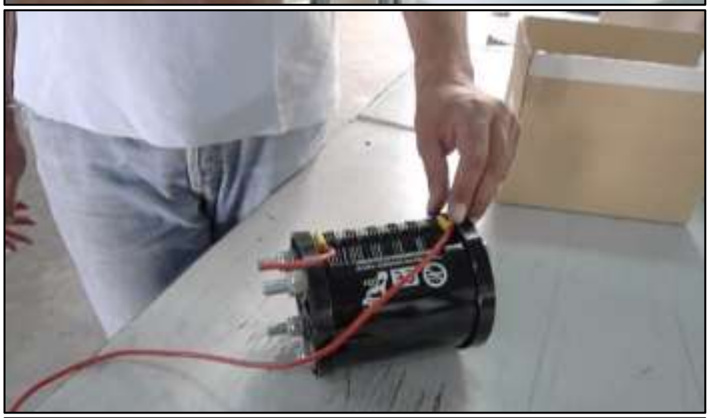
Inside each one of the Dry Cells we have 13 plates, 3 of those with a configuration of 2 connectors. **Not all of the plates are connected because electrolysis would, in this case, be very intense and damage the surface of the plates.** We have to leave between the positive (+) and the negative (-) some plates without connections – **Neutral plates** - in order to break the voltage and increase the electrolysis efficiency with less heat production. Please refer to the picture below for typical wiring connection of the dry-cells using 12v:

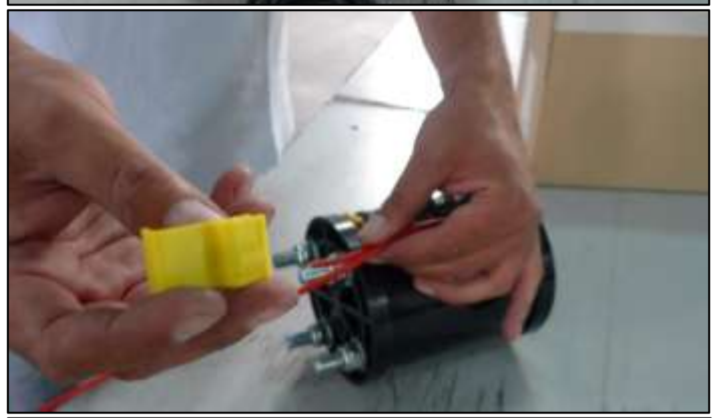


There is no difference in which sequence will be connected the positive circuit (red wire) and the negative circuit (black wire).

In the next page you can check some photos showing the right way to make the electric connections in the dry-cell:


3000





Water and electrolyte setup

Principles of the water electrolysis

Electrolysis of water is the decomposition of water molecule (H_2O) into oxygen (O_2) and hydrogen (H_2) gases due to an electric current passing in the water.

An electrical power source is connected to two electrodes, or two plates (typically made from some inert metal such as stainless steel) which are placed in the water. In a properly designed cell, hydrogen will appear at the cathode (the negatively charged electrode, where electrons enter the water), and oxygen will appear at the anode (the positively charged electrode). The amount of hydrogen generated is twice the number of moles of oxygen, and both are proportional to the total electrical charge.

Electrolysis of pure water requires excess energy in the form of potential to overcome various activation barriers. Without the excess energy the electrolysis of pure water occurs very slowly or not at all. This is in part due to the limited self- ionization of water. The efficacy of electrolysis is increased through the addition of an electrolyte (such as a salt, an acid or a base).

Electrolyte concentration

The electrolyte should be added to the water the first time that you use the system, and also when refilling, but in lower quantities. Amperage should be measured to ensure the right operative conditions according to the table below.

The electrolyte concentration to use in the HHO system depends on the type of electrolyte and the purity of the product. The best electrolytes are KOH (Potassium hydroxide) and NaOH (caustic soda).

Water is getting a brown color after only a few hours working?

You have too much electrolyte in the system that is "eating" the generator plates too fast. Remove the water immediately and start all over again.

The more electrolyte you add to the water, the more amperage you will have in the system and also more HHO gas will be produced. But, **It is false to assume that a higher HHO gas production will mean a higher fuel savings**. There is an optimum point for all internal combustions engines. In diesel cars the system should provide around 0,25 liter/min of HHO gas per each 1000 cm^3 of engine displacement. You will be meeting this standard running your generator with:

Engine Size	HHO (liter/min)	Start Amperage (A)	Final Amperage (A)
1 600 cc	0,40	5,5	6,5
1 800 cc	0,45	6,5	7,5
2 000 cc	0,50	7,0	8,0
2 200 cc	0,55	7,5	9,0
2 400 cc	0,60	8,0	10,0

*** The values presented in the table may have a variation of ±15% according to the different driving and mechanical conditions of each car.**

For example, using KOH as electrolyte, with 90% purity, we should start using a concentration of **2% in the water solution (20 g/liter)**. You should right after measure the current intensity going into the generator and increase slowly the concentration until you reach the first standard operation amperage:

7,0 A 12V (example for a 2 liter engine – see table above)

The HHO generator will start producing HHO gas and temperature will increase with time making higher the electric conductivity of the solution and amperage until we reach the final standard operation:

8,0 A 12V (example for a 2 liter engine – see table above)

Warning: Do not fall in the temptation of not measuring the current or increase the electrolyte concentration more than is advised in this manual, because in long term, the generator will not work properly and you may also not save any fuel.

Important

Remember that we are not changing diesel fuel for another type of fuel. We just want to put enough HHO gas inside the engine to allow the normal diesel fuel to burn better thus increasing fuel economy. ***If we put too much hydrogen we may not have any positive results because we will be forcing the alternator and engine without increase in fuel efficiency.***

Another thing that should consider is steam. Some of the early cell developers run their units with so much amperage that the unit was producing more steam than HHO. If your unit runs hot to the touch, you must suspect that at least part of your output is steam. One way to test for steam is to run your gas outlet over some ice. If you get significant amounts of fog forming (water droplets), you know that at least part of your output is steam.

Water levels in the tank

Once you have your mixture ready, pour it into the top of the water tank, up to the water level line shown in the picture bellow. Try to only fill your unit about 70% full. This is imperative to allow the HHO produced to enter the gap left in the Tank and avoid any risks of some water getting into the engine.

The standard water tank is a 1,2 liters unit which will provide you with approximately 800 kilometers of driving. Be sure to make your maintenance plan with that in mind and refill the tank when it is required. Try to refill as often as it is possible for you in order to keep the generator running cool.

In our store we have a product that can help you to control better the water levels in the water tank and reduce the problems with the management of the system. It is called the **water level control switch**.

Amperage variation in the system

When operating the system the water molecule will be "brocken" into HHO gas to be used by the engine. The water level in the tank will slowly go down but the electrolyte will continue in the system with an increase of the concentration and, therefore, amperage being drawn into the generator. This means that when you start using the system, with the tank full (Max level), you have 8,0A and after some time when the tank is at the lower point (Min level) you will have 10,0A

If you put too much electrolyte, there are a combination of heating factors at work and can cause a situation called Thermal Runaway, where an increase in ambient temperature combined with excess electrolyte mix leads to overheating in the generator shortening the “life” of system.

When applying a direct current to the HHO generator, a high resistance will be present in the water (electrolyte mixture). High resistance generates heat causing the water to heat up. As the temperature rises, the resistance in the water goes down, allowing more current to pass through the fuel cell. By the end of the day, the current will be higher than the value you started with at the beginning of the day. One way to control this is using a PWM – Pulse Width Modulator

PWM PULSE WIDTH MODULATOR

Pulse Width Modulation, is a method of transmitting information on a series of pulses, changing the frequency, rather than a continuously varying analog signal. It will allow you to control the amperage going into the generator in a very easy way. This ability keeps the cell running at cool operating temperatures and prolongs the life of the cell while increasing the HHO output

Efficiency: HHO generators will run cooler than standard linear power amps, requiring substantially less heat sink mass;

Amperage control: the control of the amperage going into the generator will be very easy to control. The ability to control the amperage keeps the cell running at cool operating temperatures and prolongs the life of the cell while increasing the HHO output.

Electronic fuel injection

Basic Information

When adding a HHO gas to the engine of an old car, we will see immediate economies in fuel consumption. However, this is not the case for some modern electronic fuel injected vehicles equipped with an engine control unit (ECU), because the fuel burned inside the cylinders has significantly improved, but the sensors continue expecting the same amount of unburned oxygen to come out of the exhaust of the engine.

This causes a signal to be fed back to the ECU, that after will give orders to inject more fuel increasing the air/fuel mixture (Richer), which will counter act the fuel gains you may be expecting.

So we need to make some changes according to the cars*1. The different possibilities are:

1.1 Petrol Engines – Carburetor (before 1992)

Fuel savings: 30 – 45%
Requirements: Right amount of HHO inside the engine. Tune the carburetor.

1.2 Petrol Engines – Electronic Injection (1992-2001)

Fuel savings: 20 – 30%
Requirements: Right amount of HHO inside the engine. Reset the ECU. Install the lambda sensor extender. Isolate the body of the lambda sensors;
Optional: MAF/MAP Sensor Enhancer to increase fuel savings

1.3. Petrol Engines – Electronic Injection (2001-2012)

<u>Option 1</u>
Fuel savings: 20 – 30%
Requirements: Right amount of HHO inside the engine. Reset the ECU. Install the lambda sensor extender. Isolate the body of the lambda sensors;
Optional: MAF/MAP Sensor Enhancer to increase fuel savings

<u>Option 2</u>
Fuel savings: 25 – 35%
Requirements: Right amount of HHO inside the engine. Reset the ECU. Install the HEC Chip

2.1. Diesel Engines – Mechanic Pump (before 1998)

Fuel savings: 20 – 35%
Requirements: Right amount of HHO inside the engine. Tune the injection rate of the fuel pump.

---

[1] The dates can change according to each country and manufacturers.

2.2 Diesel Engines – Electronic Injection (1998-2003)

Fuel savings: 20 – 30%
Requirements: Right amount of HHO inside the engine. Reset the ECU.
Optional: MAF/MAP Sensor Enhancer to increase fuel savings

2.3. Diesel Engines – Electronic Injection (2003-2012)

Option 1
Fuel savings: 20 – 30%
Requirements: Right amount of HHO inside the engine. Reset the ECU. Install the lambda sensor extender. Isolate the body of the lambda sensors;
Optional: MAF/MAP Sensor Enhancer to increase fuel savings

Option 2
Fuel savings: 25 – 35%
Requirements: Right amount of HHO inside the engine. Reset the ECU. Install the HEC Chip

We advise the installation of the **HEC Chip whenever it is possible because it will maximize the results.** Please consult us for full details (absolutenergies@gmail.com) or go to our store.

Components of the electronic injection

An Electronic Control Unit (ECU) controls the internal combustion operation of the engine. The simplest ECUs only control the quantity of fuel injected into each cylinder per engine cycle. The more advanced ECUs also control the ignition timing, variable valve timing (VVT), the level of boost maintained by the turbocharger, and other engine peripherals.

ECUs determine the quantity of fuel, ignition timing, and other parameters by monitoring the engine through sensors. **In cars the most important sensors are: MAP/MAP sensor and Lambda sensors**

MAP/MAF sensor

For an engine with electronic fuel injection, the ECU will set the quantity of fuel to inject based on a number of parameters. For example: If the accelerator pedal is pressed further down, this will open the throttle body and allow more air to be pulled into the engine. The ECU will inject more fuel according to how much air is passing into the engine.

The Manifold Absolute Pressure (MAP) or the Mass Air Flow (MAF) are the two sensors normally found in cars responsible for giving information to the computer (ECU - Environmental Control Unit) regarding the quantity of air being aspirated by the engine and, in this way, be able to calculate the quantity of fuel needed to be injected in order to maintain the predetermined air/fuel ratio. If more air is going into the engine then more fuel will be injected in the engine and vice-versa.

The MAF/MAP sensor pick a 5 volt signal from the ECU, and returns a lower voltage signal in accordance with the aspiration in the engine and the quantity of air going inside. A higher output voltage means more air passing, which is then calculated as "more fuel is needed". Lower output signal indicates higher engine vacuum, which requires less fuel.

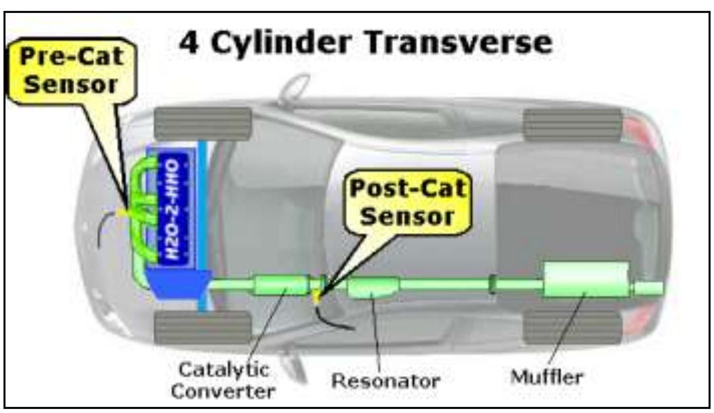
It's not just fuel control. The MAF/MAP sensor signal gives the computer a dynamic indication of engine load. The computer then uses this data to control not only fuel injection, but also gear shift and cylinder ignition timing.

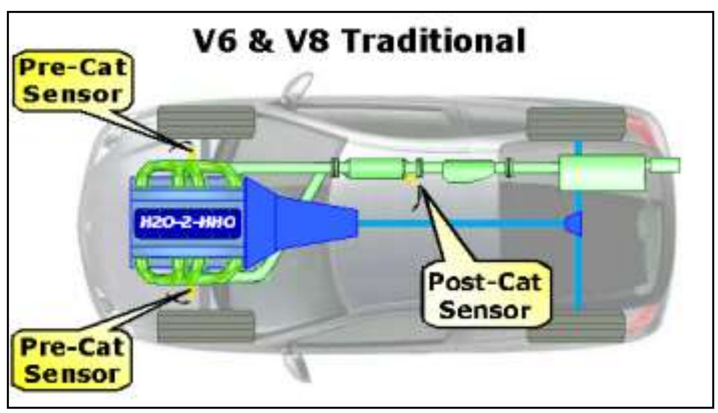
Lambda sensors

Also called oxygen sensors as it measure the amount of the oxygen in the exhaust gases. This information is used by the engine´s computer system to control engine operation. There are few types of lambda sensors available, but here we will consider most commonly used - voltage-generating type.

Normally the lambda sensors are presented in all petrol cars after 1992. In diesel cars only in the last years these sensors have been installed.

The lambda sensors can be found in a variety of places, depending on the vehicle make, model and engine type. The accompanying illustrations depict some of the more common locations. As a general rule, each exhaust manifold has at least one pre-cat sensor. Most vehicles manufactured since the early 1980s are equipped with pre-cat sensors. With the advent of Onboard Diagnostic Systems II (OBDII) in the mid-1990s, Lambda sensors were positioned both upstream and downstream of the catalytic converter.





Front (upstream) lambda sensor

Front or upstream lambda sensor located in the exhaust manifold or in the downpipe before catalytic converter. It monitors the amount of oxygen in the exhaust gases and provides the "feedback" signal to the engine computer. If the sensor senses high level of oxygen, the engine is running too lean (not enough fuel).

The engine computer adds more fuel. If the level of oxygen in the exhaust is too low, the computer decides that the engine is running too rich (too much fuel) and subtracts fuel accordingly.

This process is continuous - the engine computer constantly cycles between slightly lean and slightly rich to keep the air/fuel-ratio at the optimum level. If you look at the front lambda sensor voltage signal, it will be cycling somewhere between 0.2 and 0.8 Volts (see lower picture)

For these sensors we should install the lambda sensor extender and also isolate the sensor body.

Rear (downstream) lambda sensor

Rear or downstream lambda sensor is located after catalytic converter. It monitors the efficiency of the catalytic converter. In the past, and in most cases the downstream sensors are not used in air/fuel ratio calculations. Therefore they do not need to be treated. But we are finding quite a few cases where that's not true anymore. Some car manufacturers are using the rear sensors as part of their air/fuel ratio calculations. It is now a primary suspect when fuel mileage is not being achieved when the steps above are all found to be in.

So we advise you to also isolate the sensor body

Resetting the ECU

The ECU of your car is the brain using mapped data to work out the optimum control conditions for the engine. According to the day to day driving conditions the ECU builds a memory data base that helps it to decide the course of action that should be taken by the engine to ensure an ideal drive.

Even though you have made modifications in your car, the ECU still continues to get an input of the old data which is stored in its memory. This old data no longer is credible as it pertains to conditions that existed before the modification. The input data to the ECU should pertain to the post modification situation of the components and parts introduced, while making the modification.

This means that you have to erase the old data from memory and new data pertaining to post modification should be logged into the ECU memory by mapping in new readings. **This is the reason why ECU resetting is essential for optimum performance after any modification has been carried out in your car**. The moment you have carried out the modification you should purge out existing data in your ECU's memory. You should then feed in fresh data pertaining to the conditions that have come into existence post modification. The ECU has to operate on the newly acquired data as this new data reflects the true conditions post modification.

Resetting the ECU when you choose to boost Octane with HHO gas becomes necessary because your ECU has a memory bank for octane. This means that if you've been using lower octane, the response of ECU will correspond to lower octane with the booster matching lower octane performance. The ECU response will continue to correspond to lower octane even though you have started using higher-octane fuel. This is because the ECU has not been reset for higher octane. Thus even though higher octane is in actual use, the data in ECU memory still corresponds to that of lower octane. This mismatch affects performance, as you are unable to derive the benefits of boosting the octane. Therefore you should reset your ECU periodically after filling up full tank in order to ensure that ECU adjustments for its octane memory are made afresh corresponding to the octane actually in use.

Option 1

To reset the ECU you simply have to unplug the negative battery cable connection. Theoretically it is best to leave it in this disconnected condition for as long as you can. Practically leaving it disconnected overnight is more than enough. After having left the cable disconnected for sufficient time you have to connect back the cable. Start the car and keep it running so that it warms up. This would not take more than 10 minutes at the most in summers. Once you have done this you have accomplished the ECU resetting. Shut off the engine. You can now use your car whenever you feel like. ECU resetting is over.

Option 2

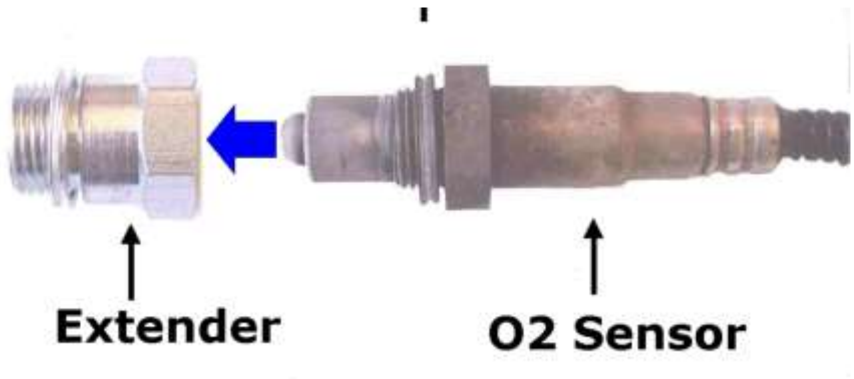
You may also reset the ECU by simply unpluging both the negative and positive battery cable connections and after connect them both together. Leave them connected around 40 minutes and then connect back the cables to the battery. Start the car and keep it running so that it warms up. This would not take more than 10 minutes at the most in summers. Once you have done this you have accomplished the ECU resetting. Shut off the engine. You can now use your car whenever you feel like. ECU resetting is over.

Installing the lambda sensor extender - Pre-Cat Sensor

Lambda sensor extenders are used in conjunction with HHO systems. In this type of system the extenders effects a correction voltage back to the vehicle ECU, so that the ECU does not deliver excess fuel to the engine as it tries to compensate for the increase of oxygen in the exhaust - which is a result of burning clean fuels, such as hydrogen.

In practice, this extender stands-off the Lambda sensor from its normal position making the sensor less sensitive to the increased level of oxygen in the exhaust that results from the burning of supplemental (HHO) gas. Only first lambda sensors located between the engine and the first catalytic converter, in each exhaust pipe, needs to be fitted with an extender.

Each Lambda sensor upstream of the catalyzer needs to be mounted on an extender as shown here.



1. Before installation of the extender you should disconnect the battery, making sure any radio and security codes are available to re-enable affected systems once power is restored. If unavailable, the codes are obtainable from a dealership. Disconnect the negative (black) cable from the battery like when you reset the ECU.

2. Unscrew the pre-cat Lambda sensor from the exhaust using an lambda sensor socket or a 22mm wrench. Be careful not to lose the compression washer. Apply penetrating oil around the threads to loosen a stubborn sensor. Inspect the sensor probe. If it is cracked or contaminated, replace it with a new one.

3. Thread the extender into the exhaust, in place of the sensor. Tighten to 50 Nm (37 ft-lbs) maximum. If a torque wrench is not available, tighten until the compression washer starts to crush.

4. Reconnect the negative battery cable. Re-enter any codes. It may take a few days of driving for the ECU to relearn the new sensor position. It is okay if the check engine light comes on while the ECU relearns.

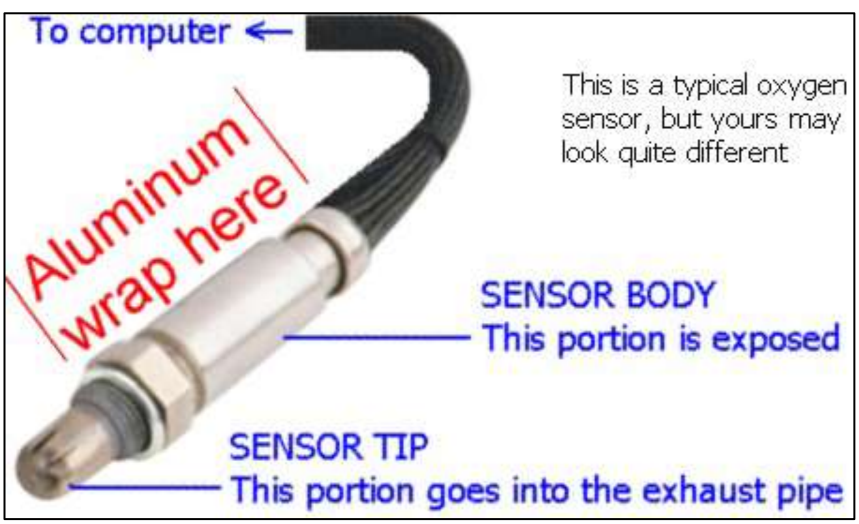
Note: It is good practice to apply a small amount of anti-seize compound (available at most auto parts stores) to the threads of both the extender and sensor before installation. Use great care in handling Lambda sensors to avoid damage; do not touch, or otherwise contaminate the sensor probe, or element, with compound, oil, etc. Proper sensor function is crucial to good performance and fuel economy.

Isolating the lambda sensor body - Pre-Cat and Pos-Cat Sensors

In the past the downstream lambda sensors were not used in air/fuel ratio calculations. But we are finding quite a few cases where that's not true anymore. Car manufacturers they are using now also the rear sensors as part of their air/fuel ratio calculations and to control the good performance of the first lambda sensor. So we will need also to make some changes in these sensors.

The idea in this method is to seal the warmth inside the body portion of the Oxygen Sensor. We do this by insulating the sensor and creating a "mini-oven". The goal is to fool the fuel injection computer into sensing too warm a sensor, thus signaling the computer: "The mixture is too rich!". The computer then compensates with a leaner mixture and possibly a slight advance in timing. The result is smoother engine operation and much better economy. This method is especially important in cold winter conditions and high altitudes, since then the Oxygen Sensor is too cold.

To perform this operation just wrap several layers of **aluminum foil tape** around the body of the lambda sensors. The pictures below illustrate the area to be wrapped.



Test run and checking your work

Start by checking all your connections. Make sure your inline fuse has been installed and everything is in the right position. Now start your engine. While it's running, watch for bubbling action inside the hose coming from the dry-cell and back to the water tank.

Please check the amperage in your system. The generator was made to run at 22,5A without overheating. If you have a higher amperage values you must remove some water+electrolyte from the water tank and add only water, in order to reduce the concentration and, consequently, the amperage. **Please verify the starting amperage settings presented previously according to your engine size**.

If there is a high variation of the amperage readings then there is some problem causing hydrogen to have difficulties getting out of the cell. Please verify the cell and hoses good positioning.

Please verify if there is not too much foam being produced. In the beginning you may need to change the water after sometime having the generator working.

If you have done everything right, within a short time, you will notice that the engine starts to sound different. It will sound smoother and quieter. Your RPM's may be unstable for a couple of seconds. This is normal, the HHO is starting to change the combustion cycle and the engine is now adjusting to the addition of the mixture. Your RPM's should now normalize after a couple of minutes.

Maintenance

Regular Maintenance: depending on your driving, every week you should check the water level inside the water tank and also the amperage. Refill with water and add a little more electrolyte to allow amperage to be at normal operational values. Verify that all parts are of the system are perfectly placed and in good working conditions.

Winter Maintenance: If temperatures drop below -4ºC you should add 20-25% isopropyl alcohol to the water solution in order to avoid water from freezing, even with the more severe temperatures. Don´t use another type of alcohol or you risk damaging the stainless steel plates.

Annual Maintenance: Every year you should clean the water tank and drycell and remove all deposits. Add 50% isopropyl alcohol to the water solution and leave it in the system without working for 24 hours. Flush the system and add some fresh water to remove all deposits.

Check-list for HHO system debugging

Important information

HHO will improve combustion efficiency. This is a scientific fact. When introduced into the engine along with the petroleum based fuel, it causes the flame speed to increase. This allows more of the fuel to burn during the power stroke. This will just happen. And it will be a dramatic increase over the combustion without the HHO. After the combustion efficiency is improved, the ECU is often fooled by the reduced quantity of unburned hydrocarbons and increased oxygen content, and often will add fuel to compensate. This can ruin your mileage gains.

The simplicity of what we have to do to have a successful HHO installation is get some HHO into the engine and adjust the sensor inputs as necessary so the ECU is not blocking the gains. That's all.

If we can do those 2 things, we will always get vastly improved fuel economy and vastly improved (decreased) emissions. While this checklist was written with HHO users in mind, it will work for any other technology that improves combustion efficiency. You will find that you can adapt many of these steps to apply to whatever technology you are using to debug your project. Other combustion technologies include (but are not limited to): water vapor injection, fuel preheating, fuel vaporizers/atomizers, fuel cracking technologies (using additives to break down the fuel), etc.

You should check out these items working from the top down. They have been ordered this way on purpose so that the most likely problems are higher on the list. Also, the problems that are the easiest to test appear higher on the list than those that are difficult and/or expensive to test for.

The thing you have to realize is that the technology works. And because it does, all vehicles can be solved. If you are having a hard time getting the results you should, you just need to go through these items and find the reasons your gains are being blocked. If you keep at it, you will find the problem and you will get the gains you are seeking.

Check-List

1. Is your device making HHO? The most common bug we encounter trying to debug systems is that HHO is not being produced, or is not getting into the engine for some reason. Check your system. Measure the output of your HHO cell by doing a water displacement test. Remember that the system should provide 0,2 liters/min of HHO per each 1000 cc in the engine. See if you are meeting that standard.

2. Is the HHO gas getting into the engine? We have seen cases where a leak in the system was keeping the hydrogen from getting into the engine. A split hose can cause this, or one that is not attached at all. A check valve oriented in the wrong direction can block the HHO from getting to the engine. One time we found that the lid to a dry cell's reservoir had a leak and when this was fixed the situation resolved completely. Spray your hoses and connections with soapy water to expose any leaks in your system. Check if the water cap is tight (Main reason for problems). Fix any that you find.

3. Is the amperage on your generator to high? Another thing that should be checked here is whether your unit is making HHO or steam. Some of the early cell developers would run their units with so much amperage that the unit was producing more steam than anything else. If your unit runs hot to the touch, you must suspect that at least part of your output is steam. One way to test for steam is to run your gas outlet over some ice. If you get significant amounts of fog forming (water droplets), you know that at least part of your output is steam.

4. Have you reset the ECU? Old cars do not require any special changes besides tuning the fuel injection pump. But all other fuel injected engines will need to have it's electronics handled to get the gains of an HHO system installation. Normally reseting the ECU will allow good fuel savings. But you may need to handle also the MAF/MAP sensor enhancer and/or the oxygen sensors upstream and downstream of the catalytic converter.

Some computers are able to "learn" and adapt to the conditions that exist in your engine. Since you have made a major change by adding an HHO system and EFIEs, you may need to reset the computer to erase what it learned about the system when it was inefficient, and start over again with the new improvements installed. You can reset your computer by disconnecting your battery ground wire from the car, and leaving it off overnight, then reconnecting it again.

8. Is there something else mechanically wrong with your engine? If your engine is working properly, adding an HHO system will not correct that. You will often find that if your engine is not working properly, just fixing it can give you a dramatic increase in fuel savings all by itself. If you had any kind of check engine light before starting the project, you should get this fault explored and handled. If you're not sure, reset your computer, turn off all of your HHO, extender and any other added modifications, and see if you still get a fault code. If so, get it fixed first, before adding your modifications.

All vehicles can be solved. Some of them are a little tougher than others due to the way the ECU was programmed. But they can all be solved. The technology works. If you have gotten to this point and your vehicle is still not been solved, one of the above steps is still out. You need to find it and get it corrected. And then your results will shine through.

Parts positioning

HHO connection from the water tank to the bubbler

Materials to make the connection

1
High pressure hose

2
Barb to port fitting threaded elbow

Sequence of parts to make the connection

+

+

Extra materials

Teflon tape

Plastic clamps

HHO connection from the bubbler to the air intake manifold

Materials to make the connection

1
High pressure hose

1
Security check-valve

1
Barb to port fitting

1
Barb to port fitting threaded elbow

Sequence of parts to make the connection


+

+

+

+


Extra materials

Teflon tape

Plastic clamps

Water connections between the water tank and the dry-cell

Materials to make the connection

1
Cristal pvc hose

1
Barb to port fitting

1
Barb to port fitting
threaded elbow

Sequence of parts to make the connection

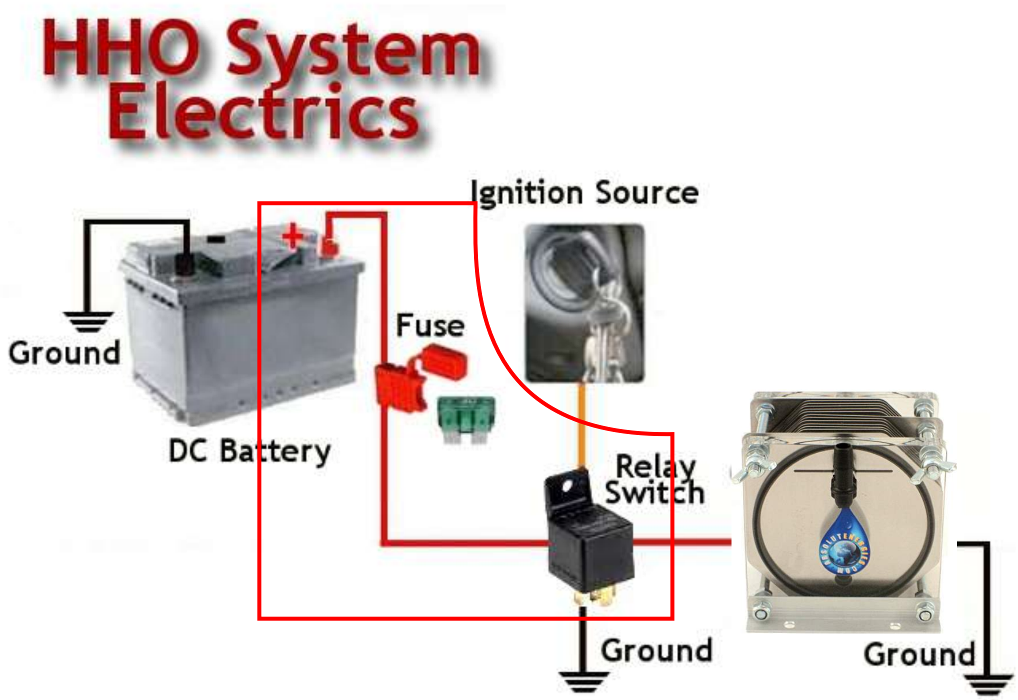
 +  + 

Extra materials

Teflon tape

Plastic clamps

Electric connection from the battery to the relay (Position 30)

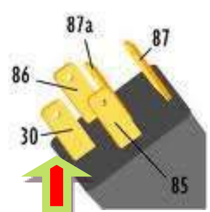


Materials to make the connection


1
Ring crimp terminal


1
Red electric cable


1
Female crimp

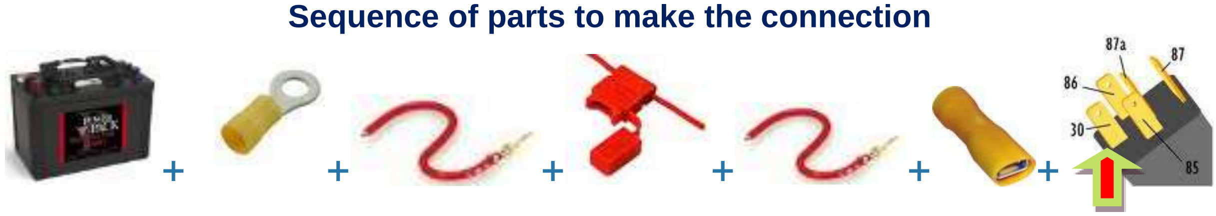


1
Relay

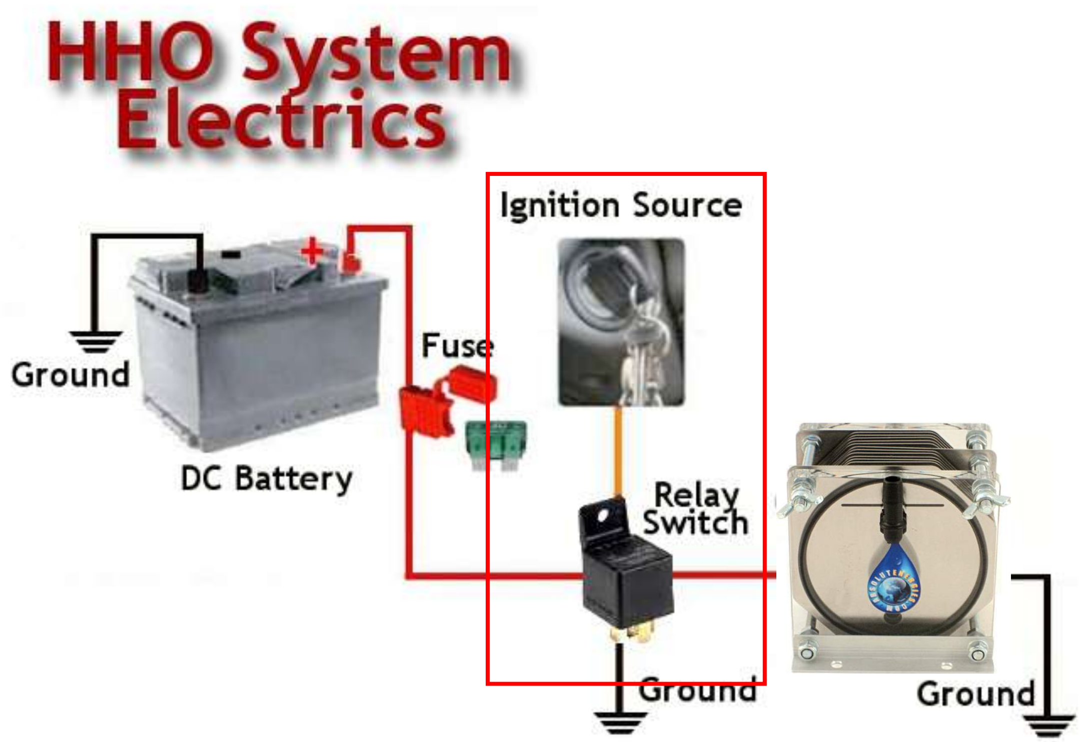

1
Blade type car fuse


1
Blade fuse-holder

Sequence of parts to make the connection



Electric connection from the ignition source to the relay (Position 85)

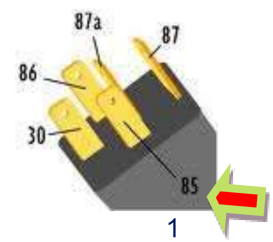


Materials to make the connection

1
Female crimp terminal

1
Red electric cable

1
Female crimp terminal



1
Relay

Sequence of parts to make the connection

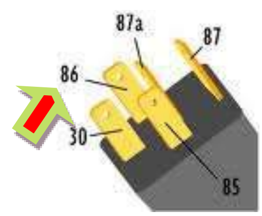
Electric connection from the relay (Position 86) to the Ground

Materials to make the connection

1
Female crimp terminal

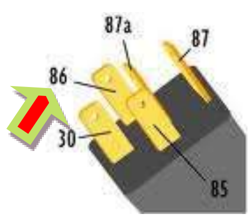
1
Red electric cable

1
Ring crimp terminal



1
Relay

Sequence of parts to make the connection



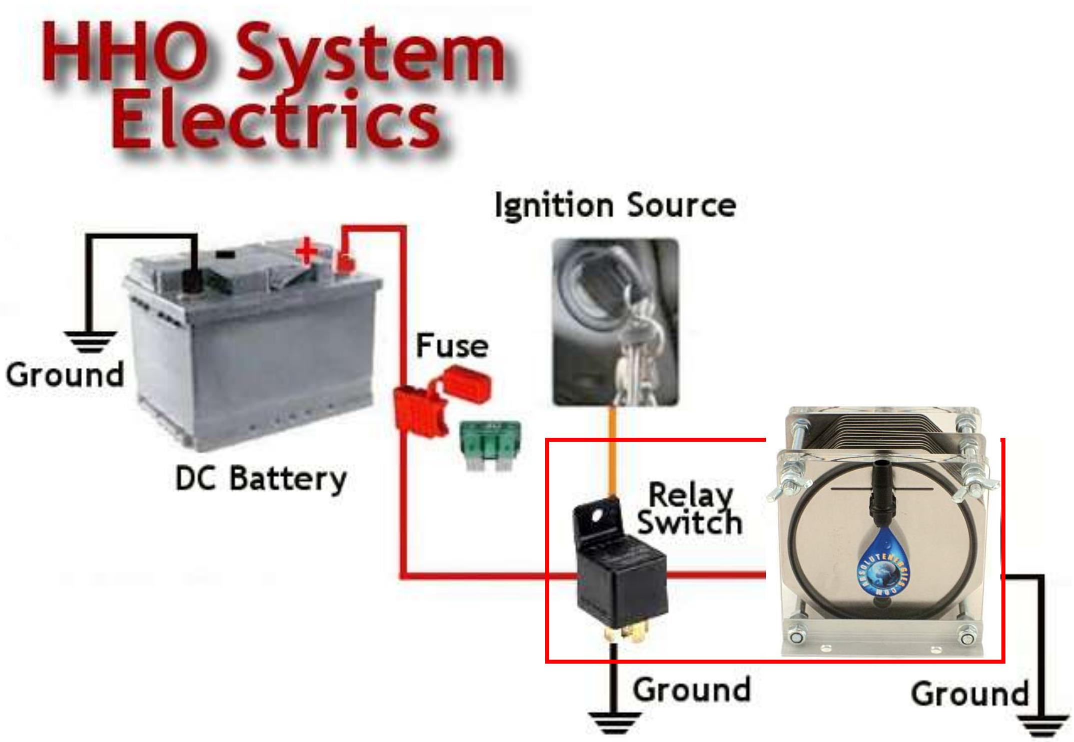
+

+

+

+

Electric connection from the relay (Position 87) to the dry cell

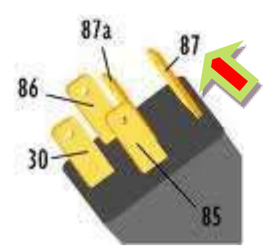


Materials to make the connection

1
Female crimp terminal

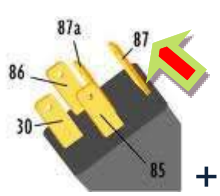
1
Red electric cable

1
Snap lock splice connector



1
Relay

Sequence of parts to make the connection



+

+

+

+

Electric connection from the dry cell to the ground

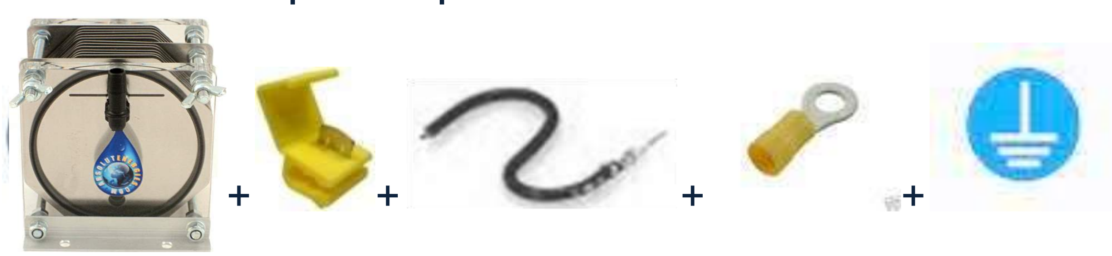
Materials to make the connection

1
Ring crimp terminal

1
Black electric cable

1
Snap lock splice connector

Sequence of parts to make the connection



How Much HHO Should I Use?

First of all, let me start out by making a bold statement: Nearly all users of HHO systems are using too much HHO.

I frequently get asked about how much HHO will yield the best mileage gains for a particular car or truck. Years ago, we used the following formula: **1/4 liter per minute for each liter of engine size.** For example, if you have a 2 liter engine, you need .5 LPM of HHO. In practice this is a pretty good formula to use, because most people measure HHO using ball meters or pop bottle test. These tests are not particularly accurate, and tend to read higher flow rates than actual. So with this in mind, the formula will work pretty well.

We have since found that the correct amount of HHO to use is closer to 1/8 of a liter per minute per liter of engine size. But the measurement of HHO flow must be made with more precise equipment calibrated for HHO. We have a flow meter from Alicat Scientific. It costs $1,500 retail, and has been calibrated for HHO specifically (as well as about 40 other gasses). It compensates the flow reading for 72 degrees Fahrenheit, no matter what the actual gas temperature is. When we compare the readings from the Alicat, to a ball meter, we find that the ball meter shows approximately double the flow rate as the Alicat. Pop bottle testing will also show higher flow rates than actual.

Now while it's true that some cells are more efficient than others, the difference isn't really very much, despite the wide divergence in reports from the manufacturers. In most cases, the difference is due to inaccuracies in the measurement process. In some cases, manufacturers will report wildly high flow rates. They probably aren't lying about what they read on their flow meters. However, in these cases you will find that they are over-driving their cells and making very hot output gas that includes a lot of steam. Just the fact of being hot will fool the flow meter, and can double the "flow rate". But this isn't actually more HHO. Its just a hotter gas which, because its expanded, will show an apparently higher volume. That coupled with the steam makes the gas much less effective at improving mileage than another cell producing 1/4 of the volume, but more HHO per amp. If you can't comfortably hold you hand on your cell after it has warmed, then it's a steamer.

So, given that the cell isn't being overdriven (we call these cells "steamers"), you can actually get pretty close to the correct amount of HHO by the amount of amps you draw. If the cell is drawing about 5 amps, that will work on a 1.5 to 1.8 liter engine. 12 amps will work fine on a 5 Liter engine, and 15 amps will work on larger 6 and 7 liter engines. For 15 liter semi trucks, we use 1.25 - 1.5 LPM, and we run at about 25 amps to get it.

In actual practice you should try adjusting your amperage to see which gives you the best mileage gains. There can be some variance in cell efficiency. But you will find that the correct amount of HHO will give you the best gain in MPG, and that more HHO will start to reduce that mileage. Add more and more HHO, and you can end up with lower mileage than when you started. We'll explain why further on in this article.

As another note, some suppliers get their cells tested and certified by the IHHOI (International HHO Institute). You can use the 1/8th LPM formula with these results, because they use an Alicat Scientific flow meter as described above for all of their flow testing. The results posted by the IHHOI people are the only ones I've seen that aren't inflated. Nearly all suppliers feel they have to show inflated numbers because otherwise their cell "isn't as good" as the other suppliers with inflated numbers. The whole industry is currently working on false standards of flow rate and efficiency. But you can undercut that in 2 ways: 1) Deal with suppliers who are certified by the IHHOI, or 2) Use amperage as your gauge of how much HHO to use, provided that the cell doesn't run hot to the touch after running for a while.

More Is Better, Right?

People new to this subject think that if some HHO is good, more is always going to be better. Others believe that the electricity used to make the HHO is actually "free energy" since the engine is turning anyway. Both of these statements are false, as I will describe below.

First lets look at the alternator. When the engine is running it transfers rotational energy, via a belt to the alternator, which then generates electricity. This energy is actually a measurable drag on the rotational energy of the engine, and it costs fuel to counter this drag. Even if you're coasting down hill, the distance you will coast will be less before you have to add gas again to maintain your speed. The bottom line? The electrical energy from your alternator costs you gas to create.

Now lets look at the gas. HHO, when burned, does not give back as much energy as the energy that was used to create it. There are several energy conversions involved. Since there is no such thing as 100% efficiency, energy is lost at each conversion. The conversions are: mechanical to electrical (alternator), electrical to chemical (electrolyser), and chemical to mechanical (burning the HHO). By the time all 3 of these conversions have taken place, when the HHO burns you'll get back about 20-25% of the energy used to create it. But don't despair just yet. Awesome gains in mpg are still achievable using this technology.

Where we get our gains is the fact that the HHO causes the gas to burn more efficiently. The majority of the energy in our petroleum fuel is wasted due to incomplete combustion during the power stroke. The HHO causes some of this waste to be used in the combustion process. We're not actually getting it all back either. It's just that there's so much waste, that even getting part of it recovered makes a large change in our mileage. This is what makes HHO so valuable in our engines.

However, only so much HHO will give us more efficiency in this way. If you add more HHO after that, you'll then start to lose mileage because of the efficiency losses described above. Now, as you add more and more HHO, your mileage gains will start to dwindle away. Now you'll be drawing more and more horsepower to make amperage, than you get back when the HHO burns. Since you've already tapped the latent power in the petroleum fuel, and since more HHO doesn't help you recover any more of the petroleum fuel's power, the overall result is that your mileage will diminish.

How Much HHO?

Since good accurate measurement of HHO flow is not available to the average user, we have provided an alternate way to work with this data. All things being equal, the HHO production is directly proportional to the amps.

What do I mean by "all things being equal"? There are a number of factors that have to be true in order for the chart below to be valid. First of all, you have to have a cell that is sized for the size of engine you have. For instance if you have a 6" dry cell with 7 plates and try to put it on a 25 liter engine, you will need to over-drive it to get the amps you need. You will be making a lot of steam. It will be inefficient. The chart will not work in that circumstance. Or another example: You build a home made cell from switch plate covers that you found online, and it has 2 neutral plates and some partial shorting across the plates. This is an inefficient cell and the chart below will not apply. But given a good reputable dry cell from a manufacturer that knows what he's doing, the charts below will apply. These charts work for our cells, and most good reputable cell manufacturers make a cell that is comparable.

Therefore this chart can be used to get your starting amp draw. Use this as a starting point. Test with more amps. Test with less amps. Let it run for a while so your engine can clean itself out, and then try again with more and less amps. Run for a full tank with each setting. Adjust to maximize your fuel mileage gains. Over time you will find the ideal amount of amps for your engine, driving conditions and driving habits.

Engine Size Liters	12V Amps	24V Amps	LPM
1.6	2.7	1.3	0.18
1.8	3.0	1.5	0.20
1.9	3.2	1.6	0.21
2	3.3	1.7	0.23
2.3	3.8	1.9	0.26
2.5	4.2	2.1	0.28
2.8	4.7	2.3	0.32
3	5.0	2.5	0.34
3.3	5.5	2.8	0.37
3.5	5.8	2.9	0.39
4	6.7	3.3	0.45
4.5	7.5	3.8	0.51
5	8.3	4.2	0.56
5.5	9.2	4.6	0.62
6	10.0	5.0	0.68

8	13.3	6.7	0.90
10	16.7	8.3	1.13
12	20.0	10.0	1.35
14	23.3	11.7	1.58
15	25.0	12.5	1.69
16	26.7	13.3	1.80
18	30.0	15.0	2.03
20	33.3	16.7	2.25
25	41.7	20.8	2.81

Summary

So, by trial and error of many years, many researchers in the HHO industry have adopted the formulas above. I hope I have helped you in your quest to get the best mileage from your vehicle.