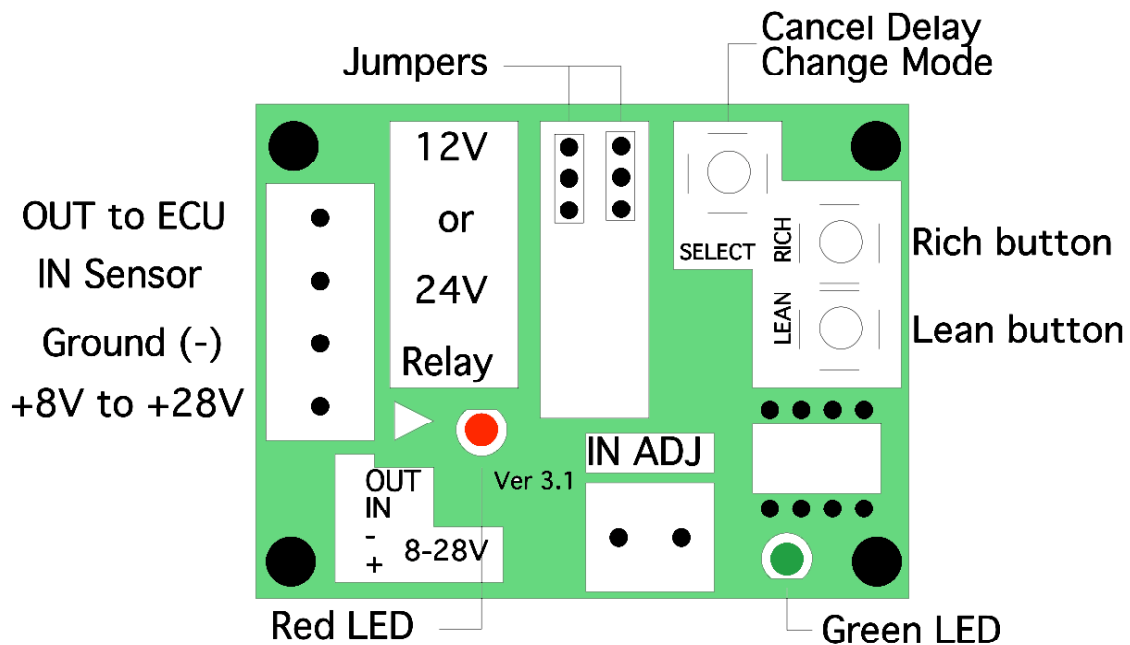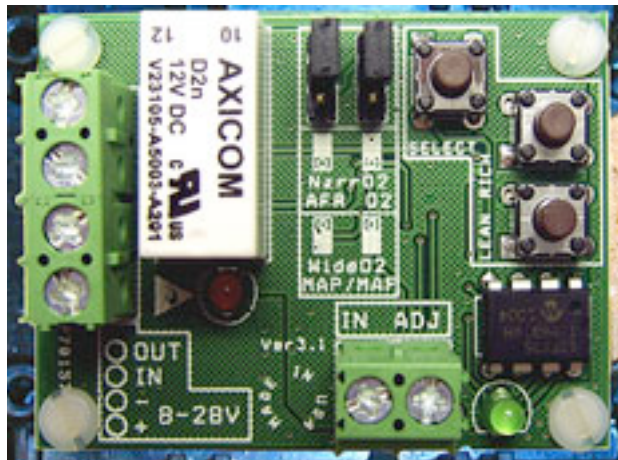# The Digital Electronic Fuel Injector Enhancer Version 3.1 by Hydrogen Garage (D-EFIE)

Introduction

After I read all the literature that I could find on the Hydrogengarage.com web sight, I came to the conclusion I still didn't know how the Digital Electronic Fuel Injector Enhancer (D-EFIE) functioned. So after the D-EFIE arrived in the HHO kit, I set out to understand the operation of the circuit from what instructions I downloaded from the web site.

Theory of operation of the D-EFIE

The D-EFIE is an electronic circuit that is used to generate an offset voltage for use with the oxygen sensors or the MAF/MAP sensors in order to provide the ECU, the on board computer, in the car or truck with some other voltage than that output by the sensor in order to improve the gas/fuel mileage.

This D-EFIE has a relay that is used to switch the input voltage from the sensors to the ECU or to the D-EFIE circuit. When the D-EFIE is off, the input voltage from the sensors are routed through the relay and out to the ECU with the normally closed relay contacts. This action is as though the D-EFIE was not even there.
The D-EFIE is programmed with a Soft Start Feature of 5 minutes from the manufacturer. Also the offset voltage is programmed at 200 mv which can be measured at the "ADJ" (screw #5) after the 5 minute Soft Start Feature has expired. The voltage at the "ADJ" screw can be observed to climb from 0 volts to 200 mv during the 5 minutes of the Soft Start. If the offset voltage is set at some other voltage, the "ADJ" voltage will climb to that voltage.

Bench testing the D-EFIE

When I tested the D-EFIE circuit for operation with an oxygen sensor, I connected the circuit to the bench power supply and applied 13.8 V. The two jumpers were in the Narrow O2/AFR O2 positions. I found the output voltage (screw #1) has voltage greater than the input voltage (screw #2) by the amount of the offset voltage.

I made a voltage divider circuit to step down another adjustable power supply voltage (second power supply) to a manageable level and adjustability. Please refer to the diagram. I placed 450mv on the "IN" sensor screw # 2. I measured the same voltage on the "IN" screw #5. I measured the voltage at the "OUT" to ECU screw #1 and found it to be 200mv greater than the "IN" sensor screw # 2. I then changed the adjustable 450mv power supply, the "OUT" to ECU screw #1 followed the "IN" voltage but it was 200mv greater.
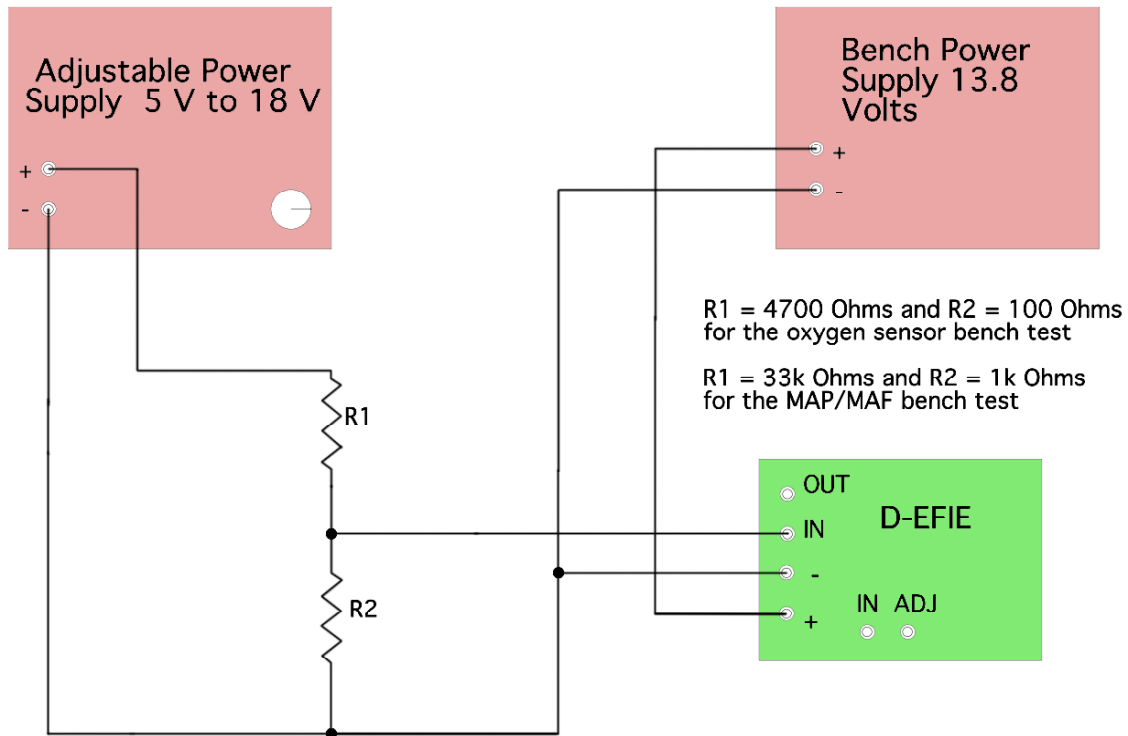
Next I tested the D-EFIE for the 5V MAP sensor and Voltage output MAF sensor configuration. The tests were completed to determine the operation of the D-EFIE for use on the manifold absolute pressure (MAP) sensor or a mass air flow (MAF) sensor. Both jumpers were set to the inner most position as directed in the manual. A voltage of 13.8 volts from a bench power supply was connected to the voltage supply terminal screws #3 and #4. A second adjustable power supply capable of adjusting a range of 5 V to 18 V was used as a substitute for the MAP output voltage. A voltage divider circuit was used on this adjustable power supply to decrease the voltage so that the output voltage of the adjustable power supply of 15 V would produce about 5 V for the input to the D-EFIE. Please refer to the bench setup diagram.

 The D-EFIE generates an offset voltage which can be measured at the "ADJ" screw #5. The default adjustment is 200 mv from the manufacturer and can be adjusted with the Lean and Rich push button switches on the PC board. The offset voltage is subtracted from the sensor "IN" voltage (screw #2). When the substituted "IN" sensor voltage is varied, the "OUT" to the ECU voltage follows that voltage at the offset difference.

Use of the Jumpers

The two jumpers on the PC board are used to change the output voltage above or below the "IN" sensor voltage. With the jumpers installed on the outer pins, the output voltage in greater than the input voltage by the amount of the "ADJ" offset voltage. With the jumpers installed on the inner pins, the output voltage is less than the input voltage by the amount of the "ADJ" offset voltage.

Programming Instructions

After I read and attempted to follow the programming instruction, I quickly determined these instructions could be expanded to include much needed information that would make programming the D-EFIE a lot easier. I believe that if I know what I needed to do before I started programming, the easier the programming would be and that I would know the programming results was what I wanted for my application.

I believe the term "adjustment voltage" does not define that voltage well as it was really the offset voltage generated by the D-EFIE, so I wrote the following instruction using the term "offset voltage" in the place of "adjustment voltage". The following instructions are an expansion of the instruction found on page 9, section 5, Operation, in the Digital Electronic Fuel Injector Enhancer Installation & Operation Instructions manual that came with the D-EFIE.

The Soft Start Feature will step up the offset voltage in small steps to the programmed offset voltage setting when the D-EFIE is powered "ON" (if the D-EFIE is in mode #1 through mode #6) to allow the ECU (the car computer) time to adjust for changes as the oxygen sensor heats to its operating temperature. In program modes #0 and #7 the D-EFIE will go immediately to the programmed offset voltage without waiting.

Note: This D-EFIE has a red LED and a green LED. They can not be ON or OFF at the same time. When the red LED is ON, then the green LED is OFF and when the green LED is ON, the red LED is OFF.

When the D-EFIE is powered "ON":
   1. The green LED will light for about 2 seconds and then shuts off.

2. After the green LED shuts off, the red LED will immediately light for about 4 seconds. Cover the red LED; you may use your finger to see only the green LED. This LED displays the Soft Start Feature mode number.
3. The green LED will blink the number of times the Soft Start Feature mode is programmed and then repeats the series of these sequences until the Soft Start Feature time expires. For example, if the Soft Start Feature mode is #5, then the green LED will blink a series of 5 times for 5 minutes. The offset voltage can be observed to climb during this time until it reaches the programmed offset voltage, default 200 mv. Please note: If the mode is #0 or #7, the red LED will not blink and the offset voltage will be set to the programmed offset voltage setting instantly. There is no Soft Start Feature time in these two modes to expire.
4. You can wait the Soft Start Feature time or you may cancel this time by pressing the "SELECT" push button switch and the offset voltage will rise to the programmed offset voltage setting instantly.
5. The red light will turn on and stay on for the duration of time the D-EFIE is on.
6. Reprogramming the offset voltage and mode number can be accomplished as follows:
    - Offset Voltage: To reprogram the offset voltage setting, press the RICH or LEAN push button switches. The offset voltage can be monitored with a digital volt meter (DVM) connected to the "ADJ" (screw #5) and ground (car frame) and it will change when the push button switches are pressed. Factory default is 200 mv. After the offset voltage has been changed, the D-EFIE will wait about 5 seconds and then it will write the new setting into the internal memory. This writing process can be seen by watching the green LED. It will light momentarily.
    - Mode Number: To reprogram the Soft Start Feature mode, momentarily press the SELECT push button switch. The green LED will light and stay on, then press the SELECT push button switch for a longer time until the red LED lights. The red LED will stay on as long as the SELECT push button switch is pressed. When the SELECT push button switch is released, the green LED lights. This places the D-EFIE in the mode programming state. In about 4 seconds, the red LED will blink the number of times for the number of the mode programmed into the D-EFIE. After about 4 seconds the red LED will blink this sequence again.

About every 4 seconds, it will continue blinking these sequences until the mode programming state has been exited. During this time, reprogramming of the mode number can be accomplished by pressing the RICH or LEAN push button switches. During the next sequences of blinks of the red LED will show the new number of the mode the D-FIE is programmed. There are 8 modes, #0 - #7. In the 0 (zero) mode the red LED will not blink. Programming of the modes will not wrap around. That is, programming will not go from mode 7 to mode 0 or from mode 0 to mode 7.   To exit the programming state, simply momentarily press the SELECT push button switch.