SPLIT SECOND

Enricher
Universal Fuel Enrichment Module

Description:

The Enricher is an automotive electronic module that can facilitate richer engine operation while the ECU is in closed loop. It is primarily used as part of an overall fuel strategy on forced induction applications. It can be used in applications with up to four oxygen (O2) sensors. These sensors can be virtually any type of narrowband or wideband sensor.

The Enricher has an internal map sensor that can be used to activate the enrichment mode as function of manifold pressure. The enrichment mode can also be activated by a flexible combination of two external inputs. The threshold for activation on each input is independently adjustable. Activation can be based on one input or an AND combination of both. There is an invert function for each input which makes it possible to activate when inputs are either less-than or greater-than the threshold.

The Enricher is especially useful for forced induction conversions where a supercharger or turbocharger is fitted to an engine. Because modern ECUs operate in closed loop over most of the engine operating range, it is difficult to achieve enrichment in a way that is consistent and dependable. Fuel strategies such as larger injectors or additional injectors can provide extra fuel, but that is often countered by the ECU with fuel trim. The Enricher makes the ECU target a richer mixture so that additional fuel is not trimmed away.

Features:

- Implements enrichment on transition into boost
- Provides enrichment when ECU is in closed-loop
- Operates with narrowband or wideband O2 sensors
- Uses fuel trim to provide additional fuel
- Avoids faults caused by excess fuel trim
- Modifies up to four O2 sensors
- Flexible trigger options
- Internal pressure sensor
- Two outputs for indicators or external module activation
- Compatible with OBDII systems
- Jumper plug to return wiring to stock

Operation:

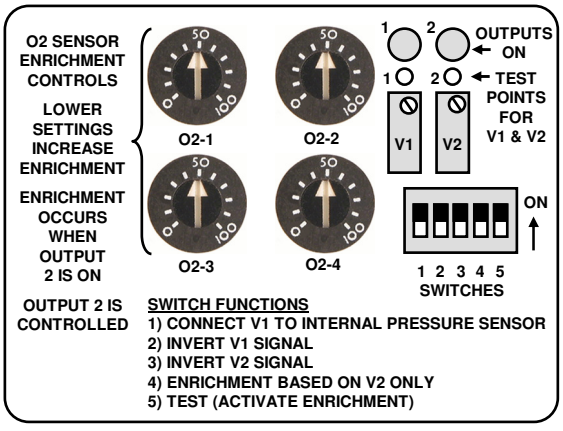
The Enricher is activated by a combination of two inputs: V1 and V2. The V1 input can come from an external voltage or the internal pressure sensor. Both V1 and V2 can be inverted so that the activation for either input can be made to occur as the input increases or decreases.

In the normal mode for activation, both V1 and V2 must exceed their thresholds. These thresholds are adjusted by the 20-turn potentiometers labeled V1 and V2. The threshold can be precisely adjusted by monitoring the corresponding test point for each input with a DVM. These thresholds can be set anywhere between zero and 5 volts.

The various modes of operation are controlled by a series of five dip switches. When switch 1 is on, V1 is provided by the internal 2.5 bar pressure sensor. When the V1 potentiometer is set to 2 V, the V1 threshold activates at approximately 1 psi of boost. Switches 2 and 3 invert the V1 and V2 signals, respectively. When switch 4 is on, the activation of the enrichment module is based on V2 only. Switch 5 activates the enrichment function directly for test purposes.

The Enricher has two switched outputs labeled VO1 and VO2. These are active-low outputs that pull to ground. They can provide up to one amp of current. They can be used to turn on indicators or activate relays to switch on external circuits. The VO1 output is turned on when the threshold for V1 is reached. The VO2 output is activated whenever the enrichment mode is activated.

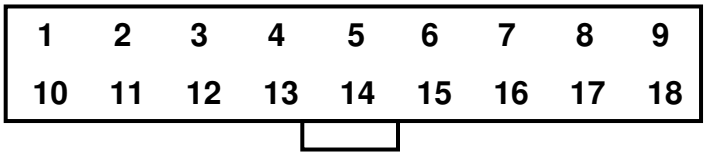
Once the enrichment function is activated, the readings for the O2 sensors are altered according to the four single-turn potentiometers. On the 100 setting there will be a minimum change to the reading and minimal enrichment. As the setting is turned down, the enrichment effect increases. The settings should be as high as possible while achieving the desired enrichment. Settings that are too low may result in a fault.



Internal Control Layout

Wire Assignments:

All wire connections to the Enricher are made through the 18-pin connector on the side of the unit. This diagram shows the pin numbers as they appear with the top of the unit facing up. In this orientation, the connector latch is on the bottom.



Connector pin assignments as viewed with the latch facing down

PIN	TYPE	LABEL	CONNECT TO	WIRE COLOR
1	Input	B-	Ground	Black
2	Output	MAPO	External system (optional)	Violet
3	Input	V1	External 0-5V	Green
4	Output	VO1	Indicator, relay. Etc.	Orange/Green
5	Input	O4I	O2-4 sensor output	White
6	Input	O3I	O2-3 sensor output	Pink
7	Input	O12R	O2-1 reference voltage	Tan/Black
8	Input	O2I	O2-2 sensor output	Tan
9	Input	O1I	O2-1 sensor output	Yellow
10	Input	B+	Switched battery positive	Red
11	Output	+5V	V1, V2 or external system	Blue
12	Input	V2	External 0-5V	Green/Yellow
13	Output	VO2	Indicator, relay. Etc.	Orange/Yellow
14	Output	O4O	ECU O2-4 sensor input	White/Green
15	Output	O3O	ECU O2-3 sensor input	Pink/Blue
16	Input	O34R	O2-3 reference voltage	White/Black
17	Output	O2O	ECU O2-2 sensor input	Tan/Yellow
18	Output	O1O	ECU O2-1 sensor input	Yellow/Green

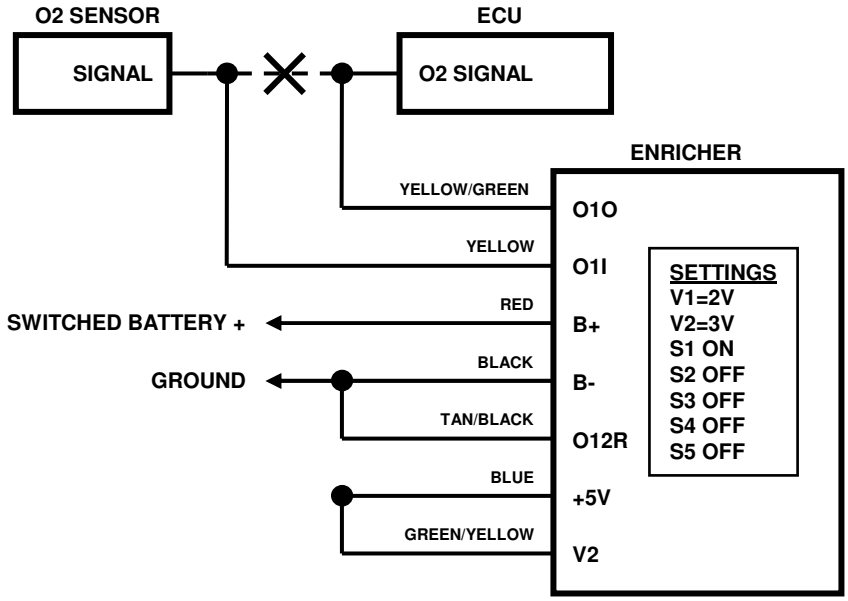
Connections:

The following diagrams show the typical connections required to use the Enricher. The Enricher can be used on applications that have between one and four sensors. On many applications it is only necessary to modify the pre-cat sensor(s). Some applications require modification of the post-cat O2 sensor(s) as well. Start with the front sensor(s) only and see if acceptable enrichment is achieved. If that works, the rear sensor(s) can be left alone. If not, connect to the rear sensor(s) as well.

The essential connection to narrowband sensors is made by cutting the O2 sensor signal wire and running the signal through the Enricher. The signal input is on the OXI terminal, where X refers to sensor 1 through 4. The output is on the corresponding OXO terminal.

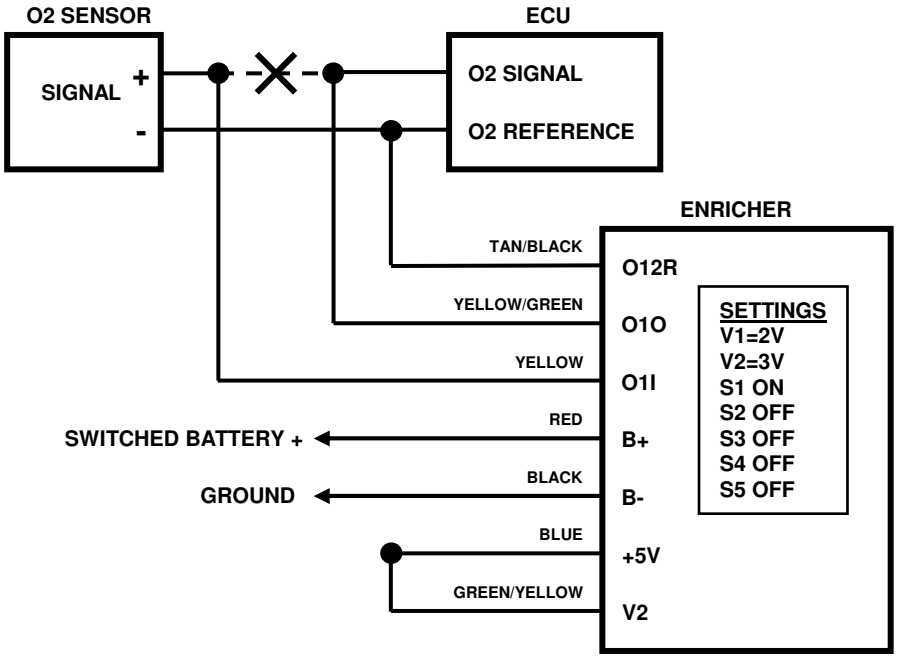
Minimum Connections:

This diagram shows the typical connections for a one-wire or three-wire sensor. This connection is typical for applications up through the 1995 model year. The O2 sensor signal wire is cut and the signal goes through the Enricher. The corresponding reference wire is tied to ground.



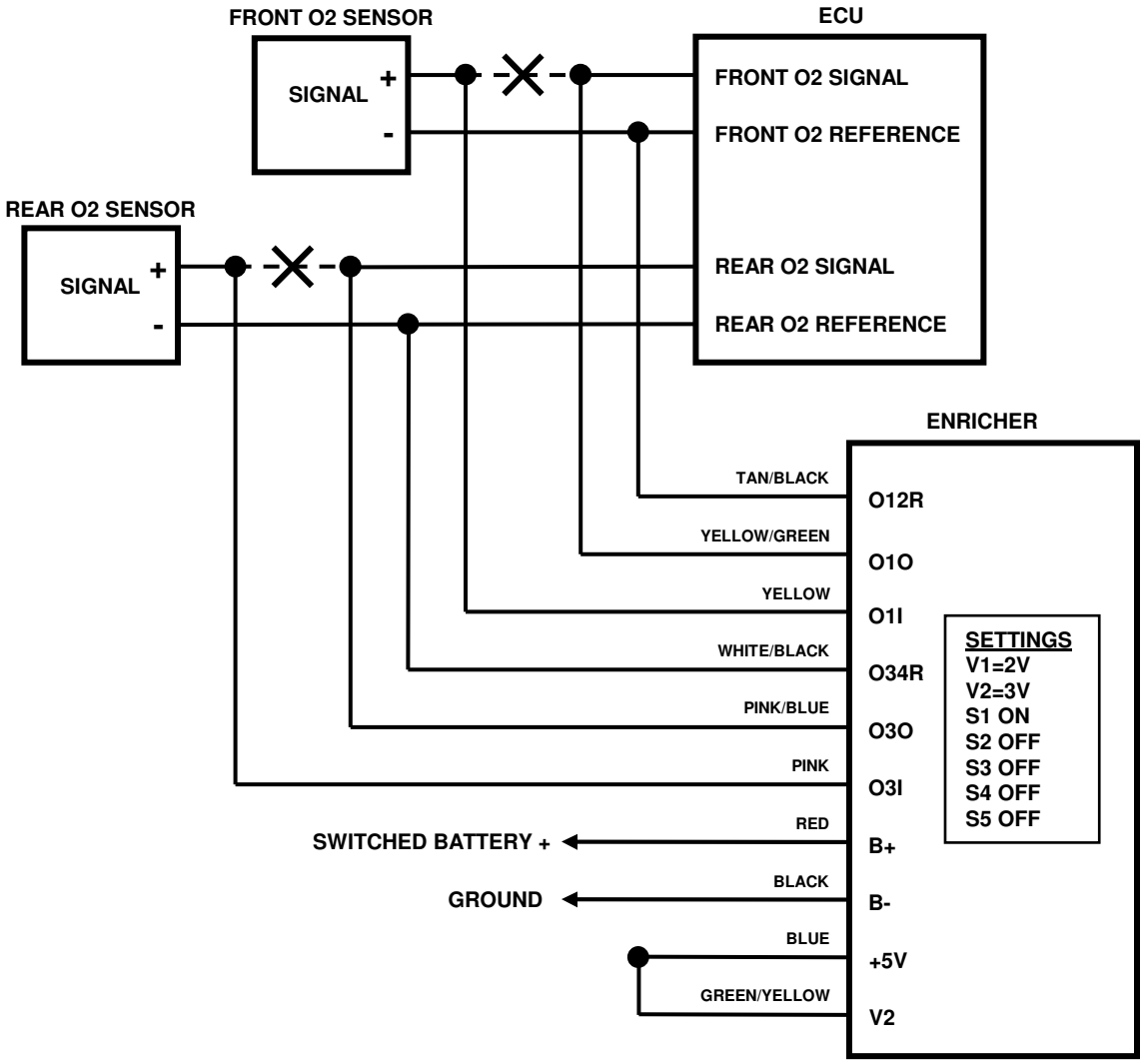
Connections with a 4-wire O2 Sensor:

Four-wire O2 sensors have a separate reference wire. It may be called a reference, sensor ground or return wire. On many applications the reference wire is at a voltage above ground. It can range as high as 2.5V. The O12R wire is connected as a T-tap connection to the O2 reference wire.



Connections to Front and Rear 4-wire O2 Sensors:

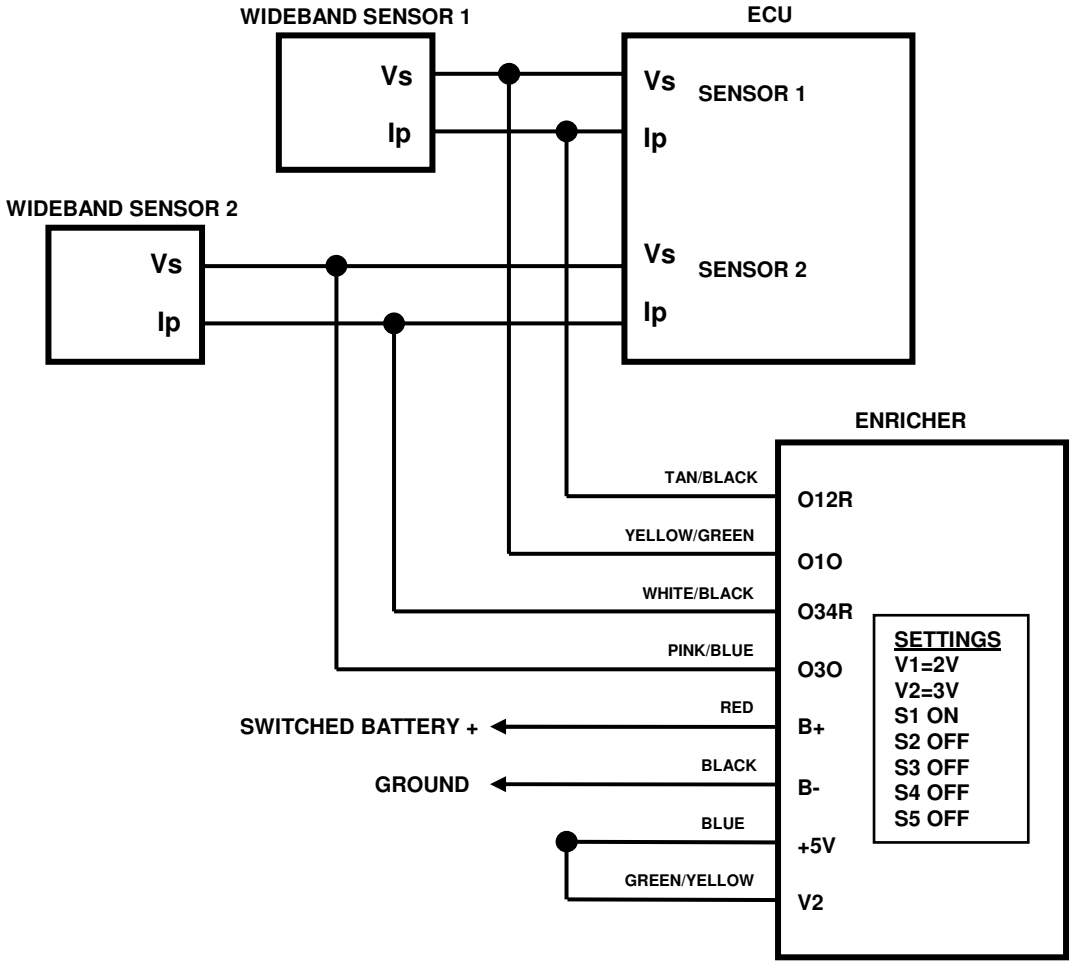
This diagram illustrates the connections for a single pre-cat and a single post-cat sensor. The Enricher can also be used in applications with two pre-cat and two post-cat sensors. In that case the second pre-cat sensor is intercepted by the O2I and O2O wire pair. The second post-cat sensor is intercepted by the O4I and O4O wire pair.



Connections to Bosch Wideband O2 Sensors:

The Enricher can be used with one or two Bosch LSU 4.x series O2 sensors. Bosch wideband sensors usually have five wires with the following colors; black, yellow, red, white and grey.

Instead of cutting and intercepting the O2 sensor signals, T-tap type connections are used on wideband sensors. Sensor 1 connections are O1O to the Vs lead and O12R to the Ip lead. Sensor 2 connections are O3O to the Vs lead and O34R to the Ip lead. On Bosch sensors the Vs lead is black and the Ip lead is yellow.



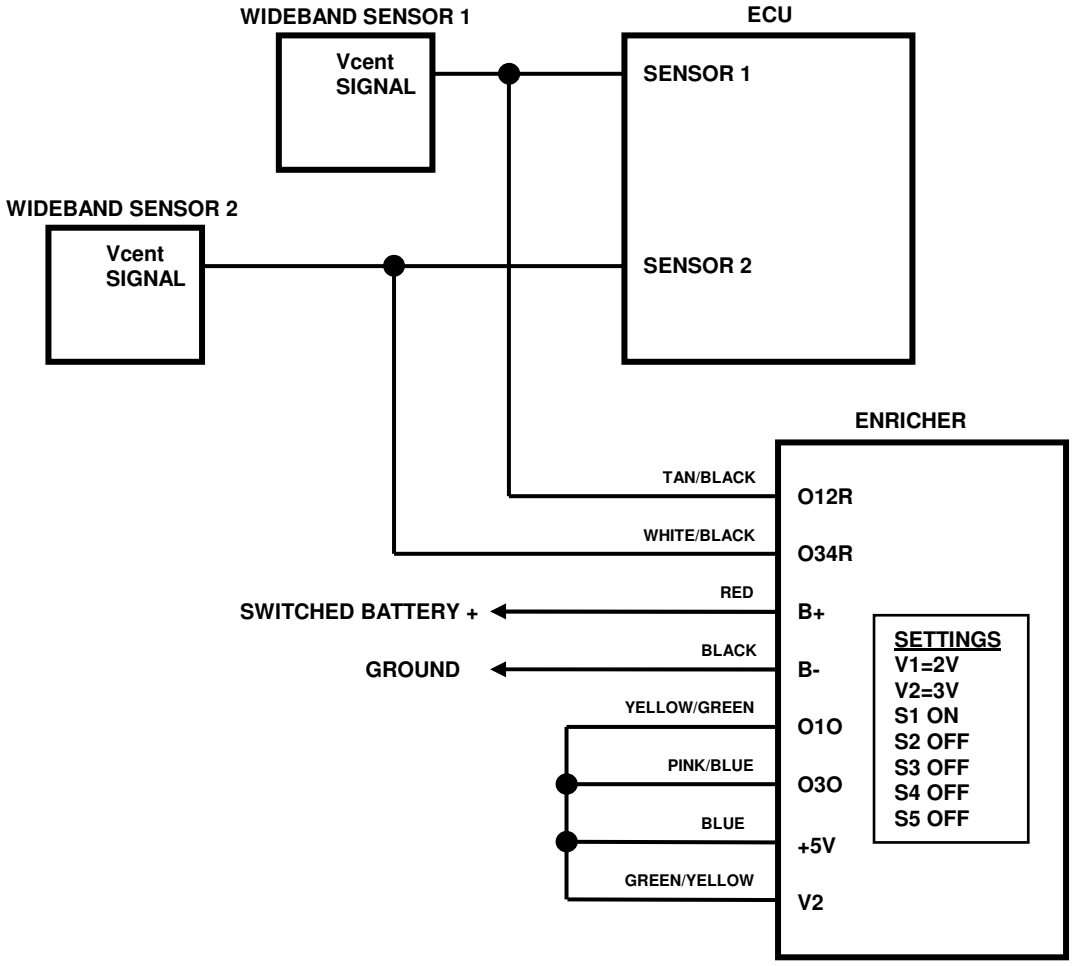
Use the O2-1 control to adjust the reading on sensor 1 and the O2-3 control to adjust the reading on sensor 2. Typical starting settings would be 60 on each control.

On some wideband sensors, the Enricher may shift the reading too much even with the setting on 100. If that happens, you can lessen the effect of the Enricher by adding a resistor in series with the wires that connect to the Vs leads. The optimum value will range between 10k and 100k ohm. A ¼ watt, 5% rating is fine for these resistors.

Connections to NTK Wideband O2 Sensors:

The Enricher can be used with one or two NTK L1H1 series O2 sensors. NTK sensors usually have five wires with the following colors; grey, black, white, yellow and blue.

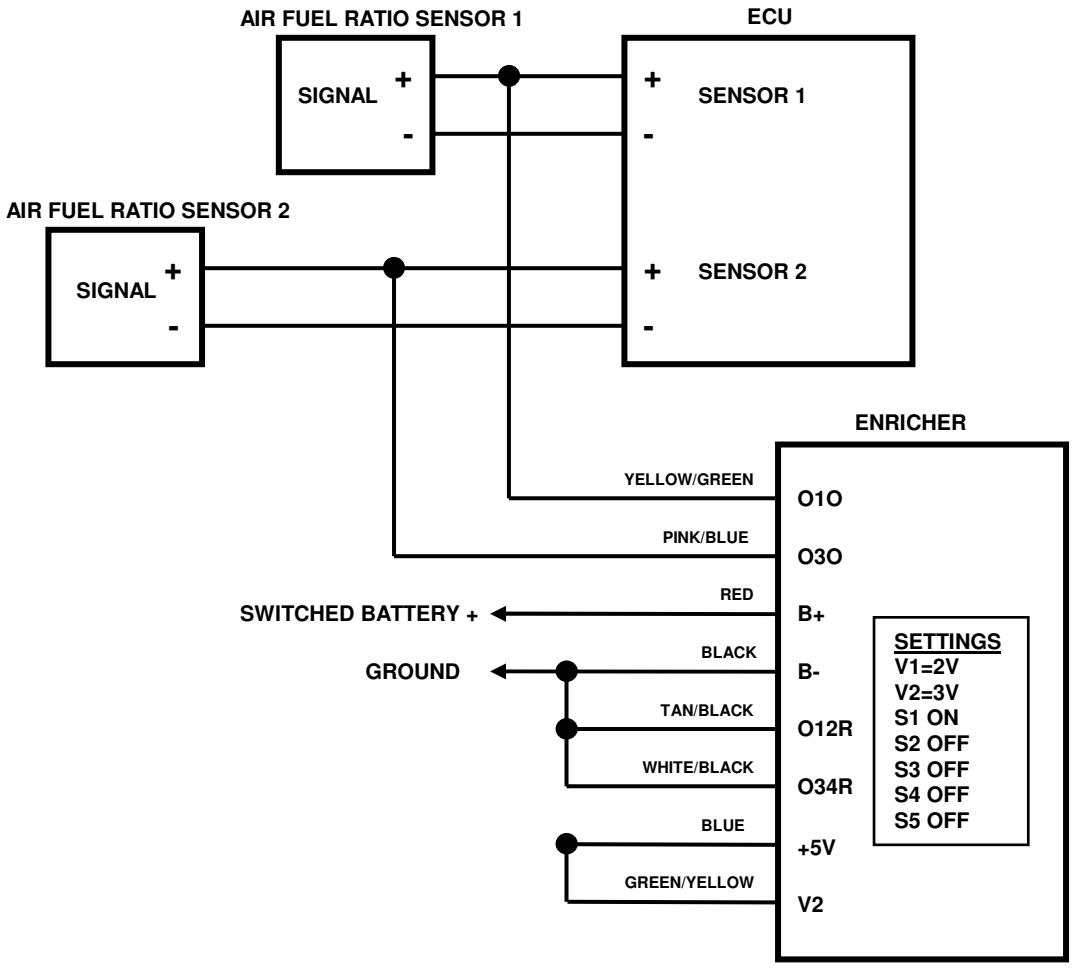
Instead of cutting and intercepting the O2 sensor signals, T-tap type connections are used on wideband sensors. Only one wire on the sensor requires a connection. Connect the O12R wire to the Vcent lead on sensor 1. If there are two wideband sensors, connect the O34R wire to the Vcent lead on sensor 2. On NTK sensors the Vcent lead is black.



Use the O2-1 control to adjust the reading on sensor 1 and the O2-3 control to adjust the reading on sensor 2. Typical starting settings would be between 10 and 15 on each control.

Connections to Toyota Air Fuel Ratio Sensors:

The Enricher can be used with up to four Toyota air fuel ratio sensors or a combination of two air fuel ratio sensors and two narrowband O2 sensors. T-tap type connections are used to the AFR (+) wires. The corresponding reference wires, O12R or O34R are grounded.



Typical starting settings would be 60 on each control.

If the Enricher causes the fuel mixture to go leaner when activated, you are probably connected to the AFR (-) leads. Simply connect to the other AFR signal wire and the Enricher should work correctly.

Adjustment:

To access the adjustments, remove the four corner screws and the cover. Once you determine how the Enricher is to be activated, wire the unit accordingly and select the correct switch settings. Adjustment is completed by setting the V1 and V2 potentiometers and the O2 sensor controls. In many cases the internal pressure sensor will be used to activate the unit. The internal 2.5 bar pressure sensor has the following transfer function. P in this expression is in the units of kPa.

$$Vo\ (V) = 5(.004P-.04)$$

The following table shows a few examples of pressures that may be used for activation and the corresponding voltage.

PRESSURE	(kPa)	V1 VOLTAGE (V)
-4 inHg	87.5	1.55
0 psi	101.0	1.82
1 psi	107.9	1.96
2 psi	114.8	2.10
4 psi	128.6	2.37
10 psi	169.9	3.20

The following table outlines several configurations that can be used and how they are set up. Activation refers to the way that enrichment is controlled. The connect-to columns indicate what the V1 and V2 inputs are tied to. The adjust-to columns indicate the settings for the V1 and V2 potentiometers. These voltages can be measured with a DVM connected to the corresponding test points next to the potentiometers. An entry of N/C in the table means no connection.

ACTIVATION	CONNECT-TO		ADJUST-TO (V)		SWITCH SETTING			
	V1	V2	V1	V2	S1	S2	S3	S4
Pressure above 1psi	N/C	+5V	2	2	on	off	off	off
1 psi and external 5V trigger	N/C	Ext. sig.	2	2	on	off	off	off
1 psi and external 0V trigger	N/C	Ext. sig.	2	2	on	off	on	off
Pressure 1 to 10 psi only	V2	V1	2	3.2	on	off	on	off
External 5V trigger only	N/C	Ext. sig.	2	2	off	off	off	on
V1<1V and V2>2.5V	Ext sig.	Ext. sig.	1	2.5	off	on	off	off

Turn on S5 to select the enrichment mode directly. When the enrichment mode is active the VO2 LED is illuminated. The relevant O2 sensor adjustments can be set for the desired enrichment. Start at 100 and turn down the settings until the desired enrichment is reached. Do not use a setting that is any lower than necessary. The enrichment can be observed as fuel trim on an OBDII scan tool and confirmed as air/fuel ratio measured in the exhaust.

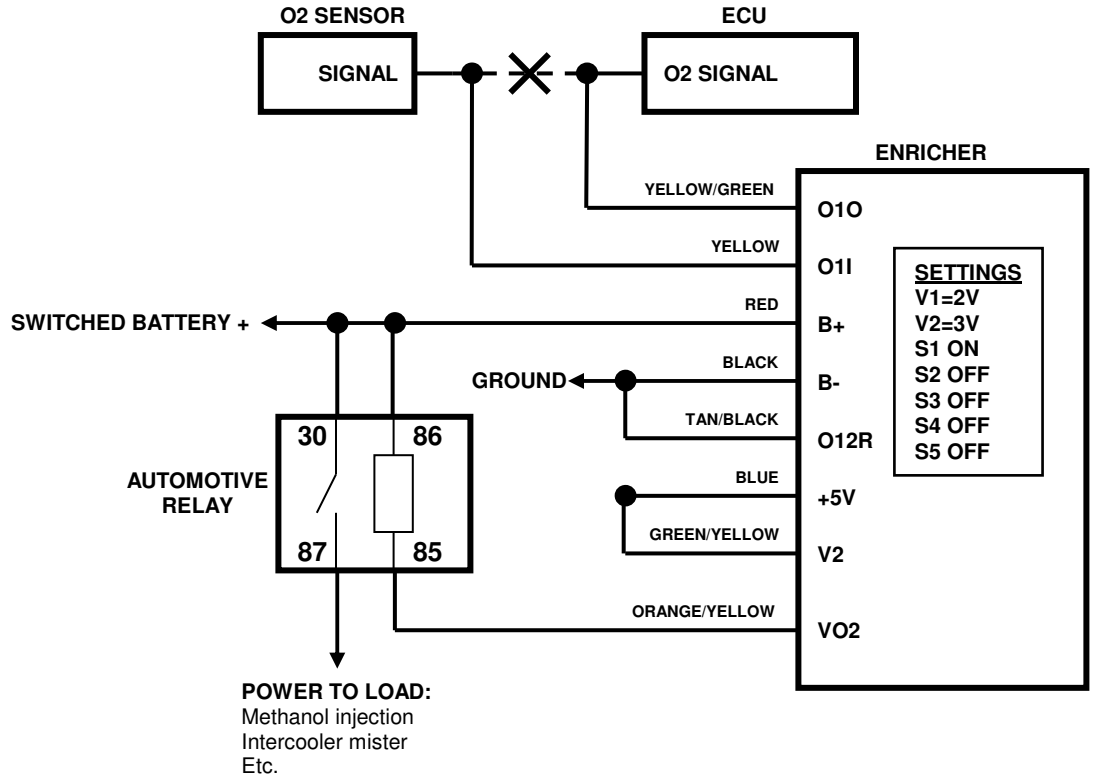
Using Switched Outputs VO1 and VO2:

IMPORTANT! DO NOT CONNECT THESE OUTPUTS DIRECTLY TO BATTERY +

Outputs VO1 and VO2 are generally used to turn on warning lights or external loads through a relay. These outputs are active low and usually connected to the low side of a relay coil. VO1 goes active when the voltage V1 (green wire) exceeds the threshold set by the V1 threshold control potentiometer. Note that switch 2 can be used to invert the signal on V1 which activate VO1 when the voltage on V1 goes below the activation threshold.

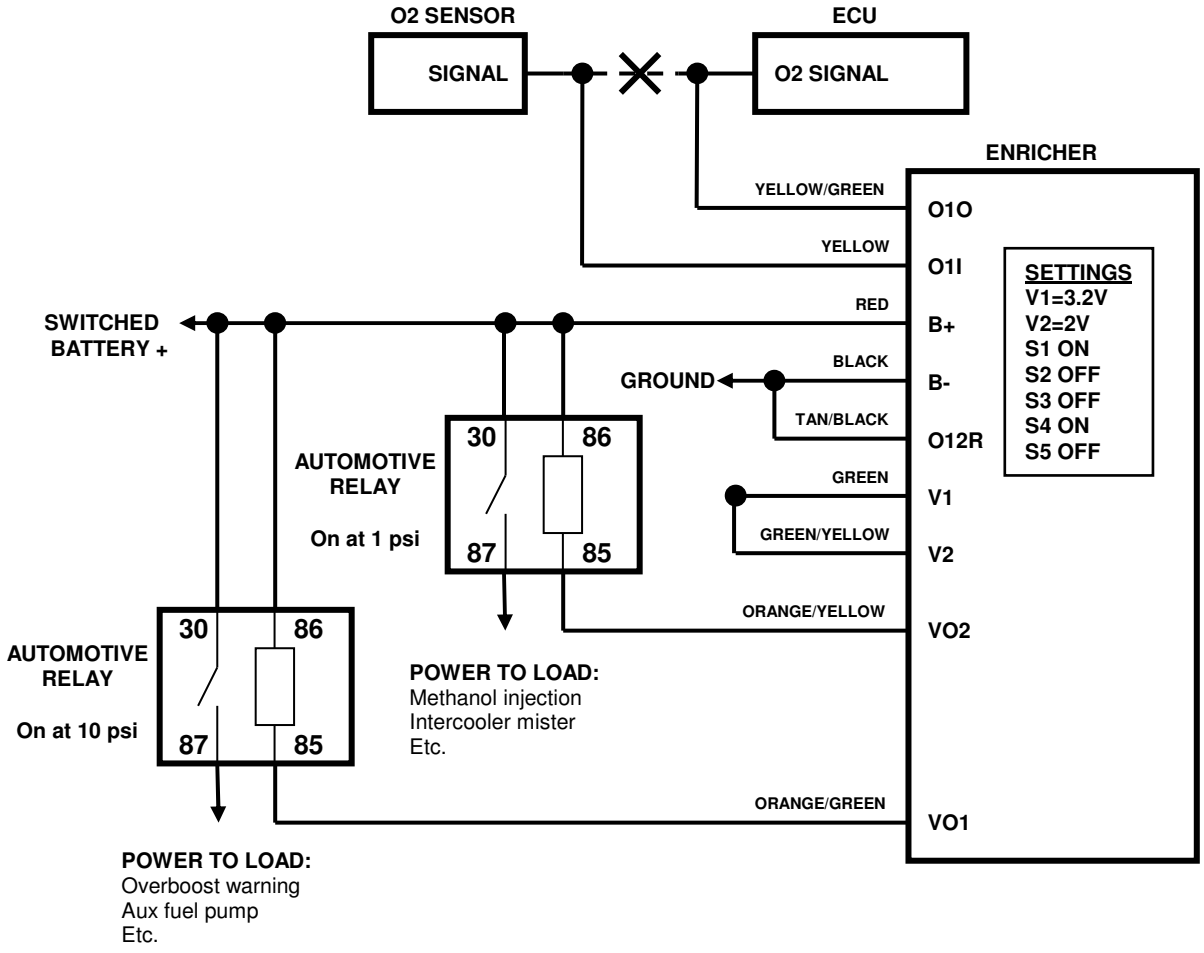
VO2 activation is based on an AND function of the V1 (green wire) and V2 (green/yellow wire) channels. That means VO2 goes active when the threshold for both V1 and V2 are exceeded. The exception to that rule is if switch 4 is on. In that case, VO2 is activated solely by the V2 threshold. Note that switch 3 can be used to invert the V2 signal which will activate VO2 when the voltage on V2 goes below the activation threshold.

The following circuit shows how to switch on an external load with the same threshold of activation as the enrichment threshold.



The Enricher can easily be configured to activate two outputs with one output activated along with enrichment and the other activated at a different pressure. The following circuit has switch 4 on which makes control of enrichment and the VO2 output based on V2 only. Switch 1 is on which connects the V1 to the internal map sensor. The green and green/yellow wires are tied together so V2 is also tied to the internal map sensor.

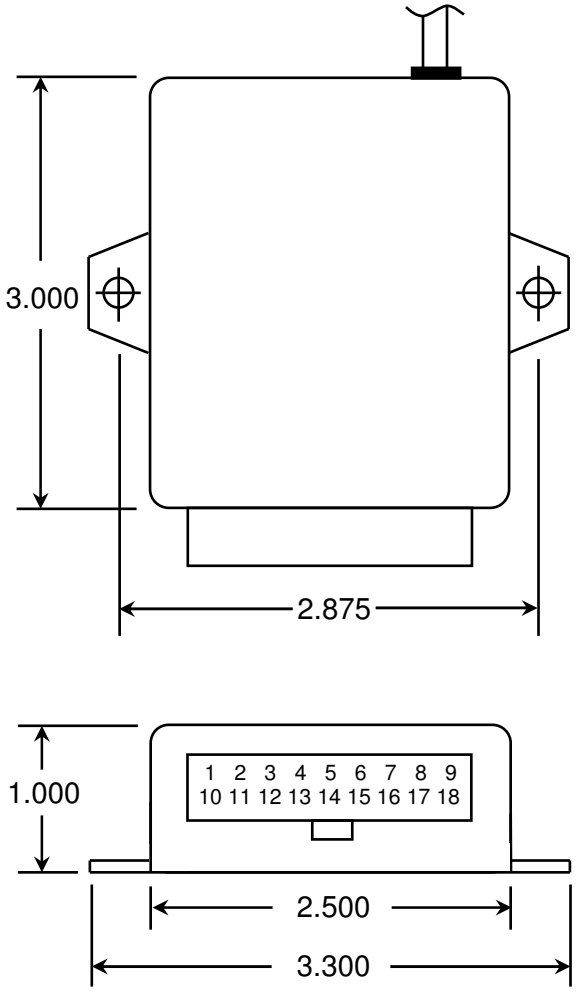
The enrichment threshold will be based on the voltage set by the V2 potentiometer. A voltage of 2V will set the activation at approximately 1 psi. The load driven by VO1 is controlled by the V1 threshold. In the following circuit the V1 voltage is set to 3.2V which sets activation at 10 psi. The VO1 output could be used to turn on an overboost warning light or any other load that you want to activate at a different pressure than the enrichment function.



Electrical Characteristics:

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	B+ to B-	10	13.5	15	V
Input Voltage V1 and V2	Signal Input to B-	0		5	V
Pressure Range	(Absolute pressure)	0		37	psiA
Output Current V01 and VO2	**Do not short to B+**			1	A
Output Current +5V		0		100	mA
Supply Current	B+ to B-		10		mA

Mechanical Characteristics:



(dimensions in inches)

SPLIT SECOND

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