RSR Dual / Single O2 Meters rbracing-rsr.com

Dual O2 Wiring Sequence:

Red	(12VDc switched positive).
Black	(GND to Battery Negative Terminal).
Dark Blue	(Rear O2 oem narrowband signal wire [pink or Blue]).
Dark Green	(Front O2 oem narrowband signal wire [pink or Blue]).
Orange	(12V bottom green warning light).
Grey	(GND bottom green warning light).
Pink	(12V top red warning light).
Light Blue	(GND top red warning light).

Single O2 Wiring Sequence:

Red	(12VDc switched positive).
Black	(GND to Battery Negative Terminal)
Dark Green	(Front Cyl. O2 narrowband signal wire).
Orange	(12V red warning light).
Grey	(GND warn light).

Gauges are correctly installed when green lights are to the left (as pictured). There are one or two additional round red 12V event based lights. These can be activated by either a 12VDc event or a ground event.

Red Wire: 12VDc is usually tied to the coil+ or to ignition kill circuit so it is only positive with the key “on” and the kill switch “off”. Activating the kill switch kills the 12V power.

Typically one warn light is tied into the oil pressure sending unit with a ground (GND) wire. The light’s 12VDc partner is tied into the red wire switched 12VDc. When oil pressure rises the connection is broken and the light goes out. A second warn light is provided on the dual O2 meter and can be used for any number of purposes.

A 5/16 x 18 stainless socket head cap screw is provided for attaching the gauges to a mount. The gauge is waterproof and can be exposed to the elements.

Mounting

Two bolts are provided. 5/16” x 18 x 1 3/4” and 5/16” x 18 x 2”. The longer bolt is typically used on triple clamps and the shorter one on headlight nacelle bolts. The bracket can be assembled in a number of ways for left or right mounting. A spacer is provided to raise the bracket above the recessed mount surface. Bracket 06-1024.

Dual O2 Meter mounted on headlight nacelle. Single O2 below.

Single O2 meter mounted on triple clamps.

Tuning

Computer or no computer, developing a fuel map for a motor is a difficult process. There are hundreds of points to calibrate in a “digitized” system which, when totaled, comprise the Base Fuel Map. This mapping process must be approached systematically with an understanding of the engine’s fuel needs. If you do not have a “target” or a plan you just aren’t going to get anywhere. The gauge will tell you where you are in the process.

Air Fuel Ratios

The mixture of the air and fuel can be expressed in three ways, all based on a common point called stoichiometry. Stoichiometry is the chemically correct point at which the most complete combustion takes place, which is 14.7 parts of air to one part of fuel by weight. This is also the point, or perhaps a bit leaner, where your exhaust temperatures will be the highest. Expressed in ratios we offer a chart with three correlations.

You will find it easier to remember colors. It’s a hell of a lot easier especially at 200mph.

It will also save your engine when you suddenly see something going wrong and you can react to save things. Like at 15 psi and you see the lights headed for the “greens”.

Air Fuel Ratio	Fuel/Air Ratio	Fuel Ratio (Actual/stoich)
9.80:1	.1020	1.5
10.50:1	.0952	1.4
11.30:1	.0885	1.3
12.25:1	.0816	1.2
13.36:1	.0748	1.1
14.70:1	.0680	1.0
16.33:1	.0612	.9
18.37:1	.0544	.8
21.00:1	.0476	.7
24.50:1	.0408	.6

Take a quick look at these numbers and ponder what all the digits mean for your application. The simple answer is that a sea of digital information is a confusing place to wade into. In our own experience with closed loop efi, open loop efi, and carburetion, it is far simpler to deal with an easy to read and remember display.

Mixture Requirements:

The proper air/fuel ratio for each particular set of operating conditions is most conveniently broken down into the two categories of steady state running and transient operation. Steady state running is taken to mean continuous operation at a given speed and power output with normal engine temperatures. Transient operation includes starting, warming up, and the process of changing from one speed or load to another.

Idle: Due to low port velocity, volumetric efficiencies of about 30%, and frictional losses, idle mixtures at normal operating temperatures are typically set slightly rich at fuel ratios of 13.2:1 to 12.7:1. If in closed loop the computer will remove 11% fuel (13.2:1) with an idle correction of .89.

Steady State Requirements:

Steady State Throttle: At a given RPM under steady state load conditions the tuning strategy is different for closed loop EFI, open loop EFI, or carbureted systems.

For Open Loop EFI or Carbs under steady load the air fuel ratio is best set between 14.7:1 and 13.2:1 (11% richer than 14.7). 14.7:1 is the most complete burn and where the greatest economy will occur. Exhaust gas temperatures will be highest at or just below (leaner than) this ratio. 13.2:1 is where the peak steady state power or torque will occur.

For Closed Loop EFI it gets a bit more complicated as the underlying base map needs to be set to differing air fuel ratios. This does not mean the computer will try to target these ratios, it just means the computer will still have the authority to add or subtract fuel so while in closed loop the engine will run at an average of 14.7:1. At idle you might program a base map 11% richer and let the computer subtract fuel. In a higher rpm no load cruise you might program 15% leaner than stoichiometry (14.7:1) and let the computer add 15%. As you go up the fuel map these base map ratios will increase to the peak torque value of 13.2:1 i.e. sudden transitions to higher load will have base map figures already at the correct peak torque values. Under high rpm deceleration with the throttles closed some systems completely shut off the fuel injectors...If they do not, you might program these areas at 17.1:1.

As you can see a closed loop fuel strategy is different. The reason for letting the computer add fuel in most of the normal operation has to do with the wide differences in fuel requirements based on altitude and temperature variations. The fuel required at 10,000 feet on a hot day and at sea level on a cool day can be 25% or more. If you program for 12.5:1 you could be as much as 40% off at the higher altitude. Your ECM/ ECU might not have the authority to make this kind of correction or it might throw an error code.

Transient Fuel Requirements

The principal transient conditions are starting, warm up, acceleration (sudden increase of load), and deceleration.

Starting and Warming Up: Abnormally rich mixtures are required to start a very cold engine. The air / fuel ratios must be progressively reduced from this point during the warm-up period until the engine will run satisfactorily with normal steady-running air fuel ratios. Starting or cranking fuel is also a temperature dependent variable with more cranking fuel required for lower temperatures. Air Fuel ratios on initial start-up in cold weather can easily be 30 to 50% greater than stoichiometry i.e. equal to or greater than the 10.3:1 air fuel range.

Acceleration: When the throttle is opened for acceleration, thus increasing the load, additional fuel,must be supplied to prevent misfiring, backfiring, or even complete stopping of the engine. Injection of this acceleration fueling must take place simultaneously with the opening of the throttle. The optimum amount of acceleration fueling is that which will result in the best power ratio in the cylinders.

In general, this varies with the engine speed and with the throttle position at the start of the acceleration, as well as fuel volatility, mixture temperature, and rate of throttle opening. Since partial or slow opening of the throttle requires less than the full acceleration fueling, the amount of fuel is usually made roughly proportional to the throttle opening and the angle through which the throttle moves. Mixture strength under these conditions may be as rich as 12.7:1 on warm engines and greater on cold engines. When an engine reaches normal operating temperature we should not see acceleration fueling richer than 12.7:1.

Deceleration: Under closed throttle, deceleration fuel must be controlled to prevent rich conditions or lean induced backfires. This can be monitored with the RSR Air Fuel meter. Deceleration fueling should not be leaner than 17.1:1.

RSR Digital Air/Fuel Ratio Meter

The RSR Air/Fuel Ratio Meter displays digitally via 10 l.e.d.s your exact, real time, air fuel ratio. The ten lights are divided into four color divisions: three green, three yellow, two orange, and two red l.e.d.s. Each of the ten l.e.d.s indicates a range, i.e. a bandwidth, of air/fuel ratios.

The display is an interface issue. You have to correlate load/rpm and look at the display. Digital numbers are next to useless as you really need an exact point left to right and associate this with a color to make your decision. It is very easy to remember 1st red @ 4000 rpm, full throttle...or 1st orange 3200 rpm no load light cruise. If you are looking for some numbers to associate with the colors: Left to Right (10 lights):

Green	17.1:1
Green	16.5:1
Green	16.0:1
Yellow	15.4:1
Yellow	14.9:1
Yellow	14.4:1
Orange	13.8:1
Orange	13.2:1
Red	12.7:1
Red	12.1:1

The display has ambient light sensors that automatically regulate display brightness.

Be Aware

Your O-sensors must reach 600 degrees Fahrenheit (315 deg C) for the display to become active. This is why we place O2 sensors near the exhaust ports.

Your O-Sensors will become contaminated if you run leaded racing gas and the display will give false “lean” readings. Using unleaded pump gas the sensor is easily reliable for 50,000 miles.

Nitrous Oxide will confuse the sensor because the Lambda)-Sensor reads free oxygen content and the nitrous will add oxygen to the system giving false readings on your meter.

Battery voltage is critical. Unless your charging system can sustain the 13.8 VDc and not to drop under any circumstances below 12VDc your fuel pump and injectors will alter fuel delivery beyond your ECM/ECU voltage correction tables.

“Reading” the Meter

The meter can be used on a dyno or when you actually drive the machine. Real world loads are different than dyno loads so we suggest you real world it, then go to the dyno to satisfy your curiosity. If you have paid attention to that last orange light and the first red light you won’t make any more power. Do not attempt to “sniff” the exhaust system as this is far more inaccurate than a real time O2 display.

The display can go blank if the mixture is way too lean but the last red light will stay lighted no matter how rich the mixture is beyond 12.1:1.

If the lights go out under anything except hard deceleration you are too lean. Some fuel injection systems shut off the fuel injectors under closed throttle hard deceleration beyond a certain rpm. In this case the lights will go out.

If the engine is at normal operating temperatures the last red light is simply “too rich” under all conditions.

Stoichiometry is at the center of the gauge or essentially in the 6th light from the left (yellow)

You should concentrate around the two orange lights and the first red light. The first red light is acceleration enrichment and the last yellow and two orange lights are your operating range.

Hard deceleration should be not below the first green l.e.d. i.e. “lights out”.

Testing Procedures

Steady/Full Load: To do different steady state load readings at the same RPM use different gears and vary your test route by using level ground and by going up and down constant grades. This is to establish base map values.

Full load readings can be done in the lower RPM ranges by placing the vehicle in a higher gear. Stabilize the RPM and then go to full throttle (load).

During your full load or during any transitional load (i.e. shifts) you should look at your acceleration fueling. If the meter goes lean you should increase your acceleration fueling. If you see a rich stumble (last red light) decrease your acceleration fueling.

On RSR Fuel Injection Systems you can adjust both your timed (synchronous) and untimed (asynchronous) acceleration fueling to meet these requirements.

Deceleration fueling: Adjusting the closed throttle fueling at various RPMs is important for three reasons: Prevent an over-rich condition. Prevent lean induced backfires. Meter the correct amount of fuel so there are no “lean spots” in the fuel map when the throttle is rolled back on. Using the air fuel meter you want to keep the lights out of the red and orange lights under hard deceleration. You also want avoid having the lights “go out” where lean induced backfires will occur. The deceleration fueling in each RPM range will have to be evaluated to provide instantaneous throttle response when “getting back on the gas”. Increase the fueling in these ranges if the vehicle hesitates.

As a side note, people have different driving styles. Some people “feather” the throttle on shifts and other snap the throttle blades shut. One person may see an hesitation and the other driver may not.

Absolutes

Use fresh spark plugs before beginning testing.

Don’t let a warm engine go richer than the first red l.e.d.

The Black Wire must go to battery negative to avoid picking up stray millivolts.

Testing to develop base maps or jetting should be done at normal operating temperatures, not in any warm-up phase.

Do not use race gas with the O2 sensors. Use unleaded fuel for development and then switch to race gas.

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