What is a Wideband, and why do I need it? And Basic tuning tips

By: **linuxman51**
BrickSpeed Vendor

This is another in the "this frequently comes up, so let's get some information out there to make it easier for folks" series.

Everyone tells everyone else "go get a wideband" if you're experiencing running problems, or "you should get a wideband before turning the boost up", Let's explore why that is and why you should have one (or perhaps should not).

What exactly is a wideband? In short, it's a relatively high precision Oxygen sensor. Most of our volvos come from the factory equipped with the ubiquitous narrow band oxygen sensor, which has a very small window of accuracy and after that it drops off in both directions. Most OE's use narrowband sensors to allow the ecu to modify the fueling requirements to get the car to run "stoich", which with gasoline is 14.7 : 1. That's 14.7 air molecules to one fuel molecule. Typically, anything over 14.7 : 1 is considered lean, and anything below that is considered rich, and it is in determining how lean or how rich that a wideband comes in extremely handy. the narrowband spreads the spectrum out over 1 volt, and it's not particularly linear in it's 0-1v sweep either, the closer to the ends of the voltage range you get, the more extreme the variations are (and let's be honest here, at that point, small fluctuations in the car's electronics can skew the results to either extereme and leave you with completely un-useable information).

Widebands are not quite as susceptible to this, or perhaps, that should read: Widebands do not suffer as great a loss of data accuracy due to voltage and ground fluctuations. This is due in part to their spreading their range of accuracy over 5 volts typically, from 10:1 to 20:1.

So, now you know what it is, why do you need it? (or not need it, as the case may be). For most people bombing around in the volvo world, it serves as a cheap diagnostic device/warning device. If you're rocking the factory LH computers, there are hundreds of ways you can affect the air/fuel ratio, but that's about it. So keeping an eye on that is one way to keep your engine intact. It is certainly not the only way. Knowing what your air/fuel ratios are will go a long way to narrowing down problem areas, but the data isn't always concrete and isn't always trustworthy.

If you're going the route of aftermarket mods, bigger turbos, high boost, etc, you should absolutely invest in one, they can be had for well under $200 these days (or even less than $100 depending), the sensors aren't very expensive, it should be considered cheap insurance even though once everything is set up you probably won't look at it again until problems arise.

Understanding the output and how to use it

Again, common wisdom here says "you need to be lean at cruise and rich in boost, and stoich at idle". Some people will toss numbers around instead, but the basic concept remains the same. So, what does this mean exactly? If you read all the above, you'll at least have a working understanding of what it means, but maybe not why and probably not what you should be looking for.

in general that info is true, in practice it may not be.
If you're not in an emissions state, the only reason(s) to shoot for lean at cruise and stoich at idle would be out of courtesy to the environment and to lessen the impact on your wallet. Emissions state people should already understand why they need things a certain way.
How lean is lean and how lean is too lean? Again, this varies by setup, but IN GENERAL 15.5 to 16:1 cruise AFRs will produce good fuel economy. It depends as much on the amount of ignition timing you're running at cruise as it does the air fuel ratio. I got 32mpg including track time in my 16v car with 15.5 cruise afr's, and the car drove great. With leaner afr's you'll need to increase timing (usually) to get the car to behave.

Stoich at idle: this will depend mainly on timing advance at idle and what kind of cam/headwork you have.

some things demand more fuel, others are fine being lean. I tune all of my cars to idle well (except the evo, the choppy idle with the a/c off makes it sound mean) and generally don't worry about the afr's.

In boost:
haha, here's where you'll get 100 different answers from 100 different people.
A rule of thumb: rich is safe (to a point), but what does this mean exactly?
for boost levels at or below 7psi, usually I don't worry greatly about the afr's as long as they're on the rich side of stoich, but a good target power-wise is low 13's (eg. 13.3-12.9). The reason for this is, you're probably not leaning on the turbo too hard at that boost level, the pressure variance in the engine is relatively minimal, and additional fueling probably won't get you anything but peace of mind (and that's not a bad thing). the other reason I shoot for this is so that you don't immediately start chugging through gas if you go to pass someone on the interstate at part throttle with a little pressurized assistance.

For moderate boost levels (7-15 or 16) I generally shoot for about 12:1, maybe a little lower depending on the particular setup. At this point, if you want to run it down to mid 11's, that's fine as well.

for high boost levels (16+), it's mid to low 11's. Anything richer than that and you run the risk of a couple of things happening: Engines can and will knock under excessively rich conditions, it makes it far more likely to foul out spark plugs (although a leaner air fuel is more likely to cause spark blowout), you're going to be leaving a lot on the table, and you're going to be blowing through gas depending. Also, depending on what wideband you're using, you won't know "how rich" you're running.

As far as getting the most out of your setup, these guidelines will put you well on the path, at least for pump gas. Timing plays a heavy factor in power and efficiency as well, but that's not in the scope of this, and due to the nature of that subject you probably won't find me writing an article about it.

As a diagnostic tool

Earlier I mentioned using it as a diagnostic tool, I'd like to expand on that a bit, because really: if the car is running great, not using excessive amounts of fuel (for the given setup), falling on it's face in boost, etc, what do you need a wideband for? well.. really, in that instance you don't, unless there's something specific you're trying to achieve.

So we'll assume your car is doing something stupid and aggravating and the chorus has goaded you into buying a wideband. here's what you might see, and some things to check as a result (this is for LH equipped cars. if you're running aftermarket anything, well, you should know most of this by now):

1) Reads rich all the time, car idles like shit, won't accelerate, might not stay running at all. Classic symptoms of a boost leak, or a stuck FPR or a bad MAF. That is the order I would personally check things.

2) Reads rich in boost, car stops pulling, falls on it's face, no skip apparent: Boost leak. not as likely to be a bad maf, but still possible.

3) Car idles fine, drives fine, reads rich for a second in boost, then goes back lean-ish **with what sounds like a miss**. Spark blowout. The neat thing about a wideband is that it needs complete(ish) combustion to work right. if your plugs are gapped too large for the boost/tune you're running, unburned fuel mixture will go out the tailpipe, the sensor will see all this air in the exhaust, and read lean. Gap down your spark plugs and/or consider looking at the tune (if possible)

4) Car boosts fine, goes lean at higher boost and/or RPMS: Couple of possibilities here: You're out of fuel (injectors or fuel pump), if you're unsure, ask and provide specifics on your fuel system (age, what injectors, what pumps, turbo, cam, boost, etc) and mods. Could be a dying fuel pump as well. If all of these things are in order, you should (re)consider the tune/chip you're using.

5) car idles fine, afr's look good, goes lean at cruise, won't boost, etc: MAF but only if it starts driving fine

(and really rich). won't go into boost really with the maf unhooked. if this is the case, you probably have a fuel flow issue: either the primary pump is dead or the fuel filter is clogged. There are two: one under the car by the high pressure pump, and a pre-pump "sock" in the tank. if these are good, consider a collapsed line, junk buildup in the rail somewhere, or other fuel-flow related problem

6) goes lean in boost, all boost levels. occasionally lean at cruise as well, struggles to make it into boost due to lean-ness, etc. Check the maf-turbo hose. post maf pre turbo air leaks will allow unmetered air in, and cause it to go lean.

Which wideband should I get?

Whichever one matches your handbag the best. Get one with a programmable output if you're using LH (or at least a narrowband output), other than that, whichever one you think looks the best, or has gotten good reviews from others.