

Wide-Band TUNING

Tuning our 2005 Cobra with Innovate Motorsports' LM-1 Wideband Controller & Aux-Box Data Logger

By Jake Amatisto

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Photos by Author and the Manufacturer

Let's face it—technology makes our cars cleaner, safer, and more importantly, faster. Since the beginning of hot rodding in the 1940's, people relied on visually checking spark plugs, whiffing exhaust, and quarter-mile testing as tuning aids to determine optimum air/fuel ratio. In the '80's, expensive and large air/fuel ratio test meters began to hit the hot rod scene in engine dyno shops, but they were out of the reach cost-wise from the average enthusiast, not to mention their large bulk. That has all changed with the introduction of low-cost, hand-held air/fuel meters that use commonly available wide-band oxygen sensors and are ultra-accurate. Finally, tuning your engine to optimum air/fuel is easy and accurate.

The Innovate Motorsports LM-1 air/fuel meter is the next generation of these air/fuel meters, incorporating a data-logger into it's palm-size package. Since it is just as accurate as the higher-end a/f meters, it being relatively affordable for most racer/enthusiasts at a \$349 street price is revolutionary. Also, Innovate has released the LMA-3 Aux Box, which is a 6-channel data logger that sells for under \$600. We decided to test the Innovate LM-1 & Aux Box on our project 2003 Cobra and see how just how accurate and helpful a data-logging wideband controller system is!



On our first run, the Innovate LM-1 screen revealed at WOT a mild lean condition with an air/fuel ratio of 13.2:1-12.5:1, which is on the borderline of unsafely lean for a supercharged pump gas street car.

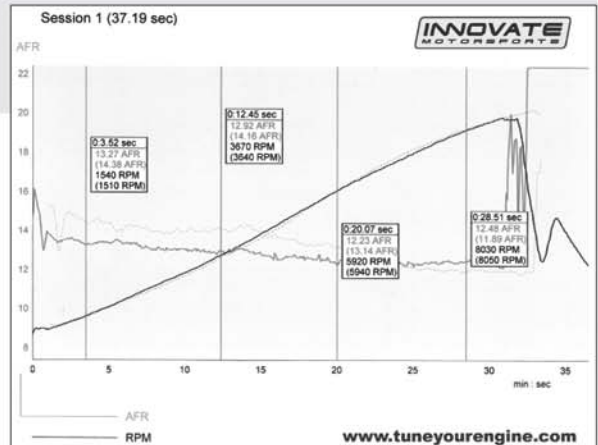
LM-1: THE BASICS

The Innovate LM-1 offers tons to the racer, as well as to your average street car enthusiast: precise air/fuel measurement, ease of use, a small size, and simple installation—all the things gearheads appreciate. The LM-1 is also cool because it can data log runs up to 44 minutes by simply pressing record. As well, you can download each run into your PC to evaluate lean or rich conditions.

With the LM-1, a very precise air/fuel ratio measurement allows the user to correctly adjust many variables, including carburetor jetting, fuel maps, etc., without long and expensive dyno sessions. The meter's digital signal processing technology provides data on exactly how rich or lean an engine is running at any load. As well, the LM-1's self-calibrating circuitry also compensates for changes in temperature, altitude, and sensor condition.

In terms of data-logging, the LM-1 can sample and store the air-fuel-ratio and the other sensor data internally in operation for later analysis on a personal computer, up to 44 minutes. Also, the data can be downloaded to a personal computer using a standard serial port and viewed by Innovate's included logging software.

There are a couple of different LM-1 kits available, the basic kit, the RPM kit, and the premium kit which includes the Aux Box. We installed the RPM Kit, which is slightly more expensive (retails for \$429), but allows you to data log rpm versus air/fuel ratio with the addition of the LMA-2 Auxiliary input capable. This cable contains a circuit to convert a tach signal into an analog RPM single. In addition, because our 2003 Cobra has a coil-on-plug system, we needed to purchase and install FRPP's tach adapter for the 2003-2004 Mustang to log rpm.



Here is a sample air/fuel ratio curve as logged versus RPM with the Innovate's LM-1 data logging capability. With the LM-1, you can see exactly where your engine is rich or lean in the power band, and in each different gear. This curve is from a dyno run, not a race track pass.



We tested the Innovate LM-1 on our '03 Cobra. The motor features an Apten-ported supercharger, SCT/Amazon Racing software, and 2.75-in blower pulley—it makes 490 whp. The LM-1 was very accurate, and revealed a slight lean condition at W.O.T.

Wide-Band TUNING

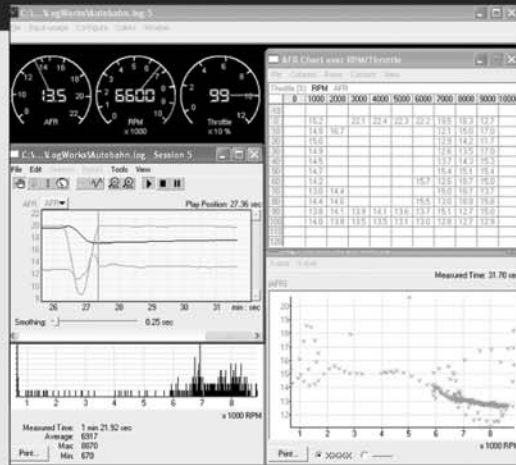
What is the LMA-3 AuxBox?



Innovate also manufactures a cool auxiliary logging system that compliments the LM-1, the AuxBox. The LM-1 is basically a tape recorder for your car that measures and records air/fuel ratio and rpm. The AuxBox on the other hand can be compared to extra microphones for the LM 1 recorder. You can datalog: RPM, Exhaust Gas or Cylinder Heat Temperature, Duty Cycle or Dwell, Boost/Vacuum, and Acceleration.

The internal MAP sensor is a 3-bar absolute pressure sensor, providing accurate data up to 44 psi. The temperature measurement circuit features a K-type thermocouple, and the internal accelerometer features 2 axis measurements for a variety of mounting options. The AuxBox also includes 5 external inputs for connecting external sensors in lieu of the internal sensors. This allows users to log data from external sensors like TPS or suspension data. Each input can also be configured with additional thermocouples, allowing multiple EGT channels.

Not only can the LM-1 and AuxBox combination record, but it can also transfer. For example, you could make a dyno pull, or a run down the dragstrip, and the whole time the AuxBox and LM-1 will record nearly every aspect of what your engine is doing. After your pass, you'll go back to the pits, download the info, and see everything your engine did. It's good for finding problems, freeing horsepower, or simply for tuning for safety. We ran out of time in our installation to actually test the AuxBox, but we'll be using it for future dyno testing and logging.



The LM-1 and AuxBox allows the use of LogWorks, Innovate's viewing and editing performance data log software. It allows you to do a real time-display (as shown), playback data logs, and x-y plot any input over any input.



Innovate ships the LM-1 with the Bosch LSU-4.2 wideband, a 5-wire oxygen sensor. The LM-1 ignores the calibration resistor present in some sensors, but instead calibrates digitally.



We had Superior Automotive weld the Innovate-supplied bung in for the Bosch wide band sensor. You can, also use the factory O2 bungs and run the LM-1 through the factory computer.



The kit comes with a 12-volt power wire that can be wired to the cigarette lighter, or it can be tapped into an ignition source. We chose to wire into the 12-volt source since we plan on permanently mounting it in the car. If you do it this way be sure to remember to turn it off after use.

NARROW VERSUS WIDE BAND

Oxygen sensors found in OEM stock Mustangs are narrow band, and can only produce rough air/fuel ratio measurements. These sensors produce a rough electrical signal which causes the sensor to function almost like an on/off switch. They can detect whether an engine is rich or lean, but not to a fine degree of accuracy. A few years back, Honda worked with NGK and Bosch to develop a lower cost

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—Kenny Duttweiler

"wide-band" oxygen sensor for use in OEM applications like the Honda Civic, and it has lowered the cost of this type of oxygen sensor across the board.

A wide band oxygen sensor produces a signal with a very fine output across a wider voltage range, which produces a more accurate, more linear reading. In other words, instead of the oxygen sensor simple showing a rough rich or lean, you get a much more accurate and specific voltage to calcu-

late air/fuel ratio. If a standard narrow band sensor can be classified as an on/off switch, then a wide band oxygen sensor is more like a dimmer switch.

The sensor that comes with the LM-1 kit is a Bosch LSU 4.2 wide-band oxygen sensor which can deliver accurate air/fuel reading from a pig-fat 9:1 to a very lean 22:1. This sensor is compatible with both race fuel and pump gas, although with leaded racing fuel you can expect a somewhat reduced sensor life. Replacement sensors run about \$50 from Innovate.

HOW ACCURATE?

Turbo god Kenny Duttweiler is actually a strong believer in the LM-1, and the main reason is the accuracy. "We use Innovate's LM-1 on the dyno,"

said Duttweiler. "We had an engine where we had a sensor in each header tube and each collector. It works great. You could watch the air/fuel ratio change as it went through the running cycle, and they have a quick enough response time."

According to Duttweiler, the LM-1 is better than an EGT sensor because you get a much quicker update. His dyno is actually set up to where he has the capability to run anywhere from one to ten LM-1s at once, and they use it as their

dedicated air/fuel meter. "Our dyno is high-end enough to where we could about anything on there, but the LM-1's the one we like," added Duttweiler. "They've definitely got their game together." Engine builders and tuners like Duttweiler are fans of the LM-1, not only the versatility of the unit, but also the cost.

INSTALLATION

The installation process went smoothly in our 2003 Cobra. Our goal was to run the Cobra on the dyno at Superior Automotive with the Innovate LM-1, log the air/fuel ratio, and then re-dyno using Superior's Motec air/fuel tester as a base line. Once the Cobra was warm, we made a pass on the dyno and recorded the run by pressing the "record" button.

The Innovate LM-1 screen revealed at WOT a mild lean condition with an air/fuel ratio of 13.2:1-12.5:1, which is on the borderline of unsafely lean for a supercharged pump gas street car. Next, Superior unhooked the LM-1 and installed their dyno's high-end Motec air/fuel meter to get a solid base line to compare the LM-1 to. There was no difference, both the LM-1 and Motec wide band were within a few tenths of a point of each other at almost every point in the rpm band, starting from 2,000 rpm on up. With this kind of accuracy, we'd say Innovate's LM-1 is a great addition to any performance car—street or race.

What is the target air/fuel ratio?

According to Innovate—it depends. "There are many factors that can affect the air/fuel ratio for your vehicle," Innovate explains. "Particularly at idle, many engines will show a lean air/fuel ratio, greater than 14.7:1, where this is perfectly OK. For example, diesel engines run this way. Other engines, at low speed, experience "valve overlap" where the intake valves are opening while the exhaust valves are closing. This will cause oxygen to "leak" into the exhaust, raising the observed air/fuel."

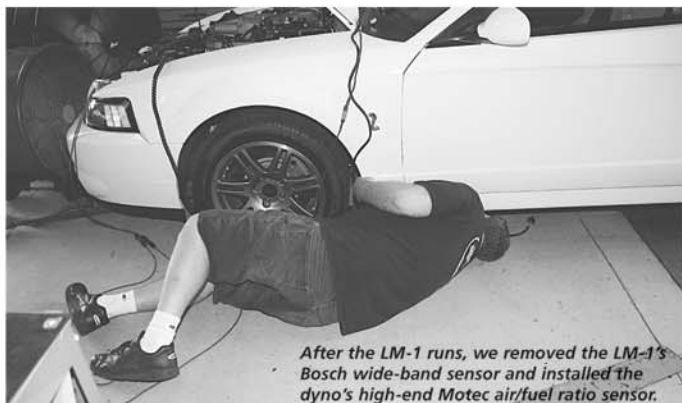
However high air/fuel values can also signal that the oxygen sensor is not fully immersed in the exhaust gases. For example, Innovate has seen measurements on motorcycles yield false lean readings due to the low exhaust pressure. By covering the exhaust, and eliminating outside oxygen from crossing the sensor, accurate air/fuel readings were gathered. In general, however, optimum horsepower is achieved between 12.45 to 13.2 air/fuel ratio using regular gasoline. This may or may not be "safe" for your engine, so it's best to check with your tuner or engine builder for an exact 'target' air/fuel.



Before using, switch on and let the LM-1 warm up. Then, it's time to calibrate the sensor. Simply expose it to fresh air, and then press the 'calibrate' button. With all the wiring hooked up, we velcro'd the LM-1 to the center console for easy viewing



On the dyno at Superior we tested the LM-1 initially by viewing the meter as the engine accelerated through the RPM curve on the dyno, and simultaneously data-recording the runs through the LM-1's 'record' function. This indicated an air/fuel ratio as lean as 13.2:1 at WOT.



After the LM-1 runs, we removed the LM-1's Bosch wide-band sensor and installed the dyno's high-end Motec air/fuel ratio sensor.



Both the LM-1, and the high-end Motec air/fuel sensor, were pretty damn close—there were only minimal differences starting at 2,000 rpm and through the entire curve. Impressive for a less than \$350 data logger.

RP

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