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GETTING THE **AIR/FUEL MIXTURE** JUST RIGHT CAN BE TRICKY, EXCEPT WHEN YOU USE A WIDE-BAND O<sub>2</sub> SENSOR WITH DATA-LOGGING CAPABILITIES LIKE THIS ONE FROM INNOVATE MOTORSPORTS.

BY STEVE BAUR

## POWER HANGS IN THE

# BALANCE

**T**HE HORSEPOWER war rages on the street and the track these days, and fuel injection has given a new meaning to streetable power. Every hot-rodder is pushing the envelope, but doing so without knowing what's going on in your engine is, well, just stupid. People spend all kinds of money on high-performance parts and gauges to "monitor" the engine, yet what may be the most important aspect of engine operation—the air/fuel ratio—is often neglected.

Keeping an eye on the all-important chemical mixture inside your engine can be the difference between making power and making the pistons pop out the sides of the block. Lean conditions and detonation conspire to kill engine-block components with great skill, but overly rich conditions can be just as hazardous. Too much fuel can reduce power and even ruin piston rings, as the fuel can wash away the thin barrier of oil between the piston ring and the cylinder wall, losing compression in the process.



**THE STAND-**alone gauge kit (\$399) comes complete with the patented LC-1 wide-band controller, the XD-16, the Bosch five-wire wide-band O<sub>2</sub> sensor, a bung/plug kit, a software CD, and a quick-start guide.



**THE DL-32** kit (\$499) includes the DL-32, mounting hardware, an SD memory card, a CD that includes software and manuals, a quick-start guide, a 6-foot thermocouple wire, an MTS 2.5mm to 2.5mm male cable, and a pushbutton and LED.

With the popularity of chassis dynamometers ever increasing, optional wide-band air/fuel meters provide a great way to optimize a tune-up, whether its through jets and spark plugs, or air, fuel, and spark tables within tuning software. Dyno time can be hard to come by, though, and it's expensive if you frequently tweak your tune-up or just like to take your time with it. Many dynamometers cannot provide real-world street driving dynamics either, so if you're tuning your combination from scratch, it's harder to tune for driveability.

### WHILE THE LC-1 IS READING THE EXHAUST GASES, THE XD-16 TELLS YOU WHAT'S GOING ON.

Aftermarket wide-band oxygen sensors have been available for some time now, and one of the leaders in wide-band tuning is Irvine, California-based Innovate Motorsports. The company's LM-1 wide-band meter led the way and evolved into a modular tuning system that includes stand-alone gauges, oxygen sensors, data loggers, and much more. Innovate also has great technical support for its products using its Web forum, dealers, installers, and end users.

For this test, we procured a supercharged, '04 Two-Valve Mustang GT owned by John McGuire of Palm Coast, Florida. Ninety percent of the time, he uses this Pony for drag racing, and it puts down over 400 hp to the wheels. Maguire is also a customer of HP Performance in Orange Park, Florida, which is where tech Jason Combs handled the installation of Innovate's modular tuning system, which included the XD-16 stand-alone gauge kit and DL32 data logger.

The stand-alone gauge kit comes with the LC-1 wide-band controller, an XD-16 gauge, a Bosch five-wire wide-band O<sub>2</sub> sensor, a bung/plug kit, a software CD, and a quick-start guide. According to Innovate, the LC-1 is more accurate than conventional designs, and its self-calibrating circuitry can compensate for changes in temperature, altitude, and sensor condition. The LC-1 is ideal for applications such as dynos, data acquisition, stand-alone ECUs, piggyback fuel controllers, OBD-II software or chip programmers, and gauges. The LC-1 Lambda cable is a complete wide-band controller built into a sealed cable and offers a digital input, output, and two user-programmable analog outputs.

While the LC-1 is reading the exhaust gases, the XD-16 tells you what's going on. The XD-16

ships as an air/fuel ratio gauge, but it can also be configured to display any channel in the modular tuning system chain, or it can be connected to the LM-1. The XD-16 features programmable LED colors and a remote-control button to start and stop log sessions, initiate calibrations, or view min/max values.

The XD-1 can be customized via a Web-based print, too. You can choose any unit of measurement, various fonts, upload a logo (or other graphic), and then print the high-resolution scaled image directly onto transparency paper. Use your included blank faces, overlay the clear cut-out, and you've got a custom gauge face.



**THE '04 Mustang** we used as our subject vehicle was no longer using its rear O<sub>2</sub> sensors, so we utilized one of the available bungs to house the Bosch O<sub>2</sub> sensor supplied with the stand-alone gauge kit. The oxygen sensor must be connected and operating with the LC-1 whenever the car is running, as an unpowered oxygen sensor will be quickly damaged when exposed to hot exhaust gases.

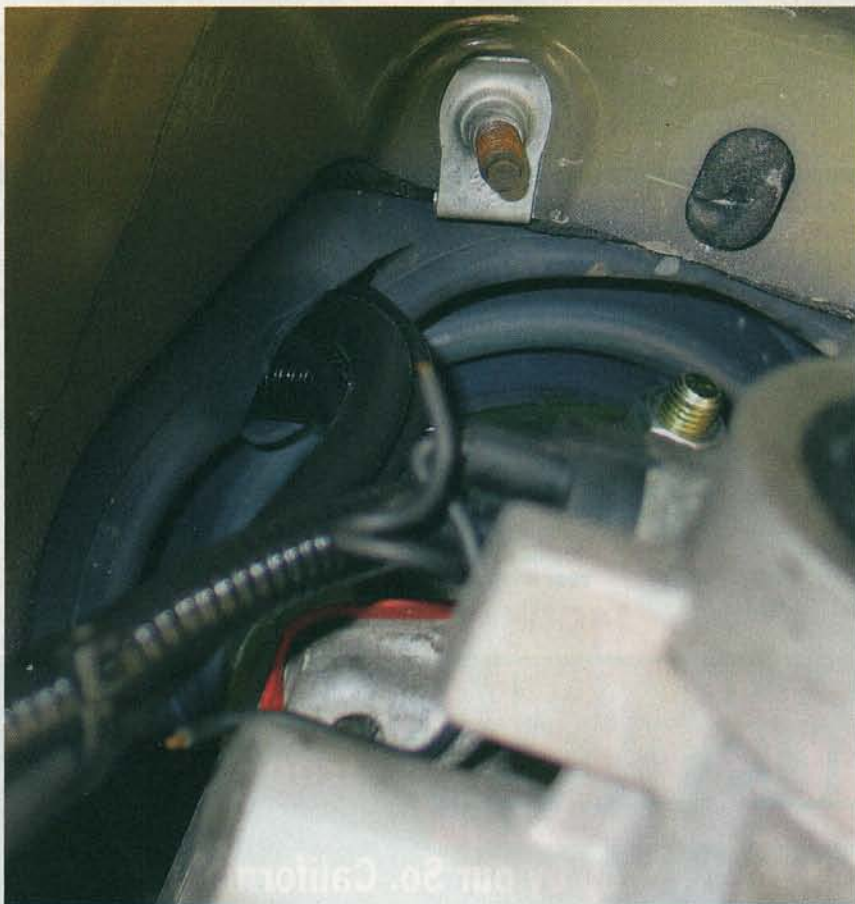


**THE LC-1** wire harness was routed and secured out of the way, and fed up to the shifter boot.

## POWER HANGS IN THE BALANCE



**THE LC-1** Lambda cable features a weatherpack-style connection to keep out the elements, which is good considering most wide-band installations inhabit the underside of the vehicle.



**THE SHIFTER** boot seemed as good a place as any to run the LC-1 harness through. The boots are easy and cheap to replace, and the rubber will protect the harness.

Using the XD-16's serial ports, you can daisy-chain other Innovate devices such as the LC-1, the AuxBox (LMA-3), the DL-32, the TC-4, and the SSI-4. And speaking of the DL-32, Innovate sent us one of those to try out as well.

The DL-32 data logger and sensor controller is a complete vehicle-mounted data-logging system for advanced engine tuning, and is capable of reading input from all sorts of sensors, including rpm, MAP, temperature, duty cycle, and analog inputs. There are 32 channels of data recording and 17 minutes of recording per MB of the included SD flash memory card, along with a built-in one-bar to three-bar pressure sensor (MAP, vacuum, boost, and so on).

The majority of your time for installation will be dedicated to deciding where to mount and route the various pieces of the modular tuning system. We spent a couple of hours on the install and were up and data logging in no time.

Make sure you have your LC-1 oxygen sensor operating before you run your engine,



**ACCORDING TO** the provided instructions, you're not supposed to install the O<sub>2</sub> bung below the 3 o'clock or 9 o'clock position, as condensation can form in the exhaust pipe and permanently damage the sensor. Since we're using an existing bung from one of the rear O<sub>2</sub> sensors, it looks like we'll be taking our chances.



**USING PLASTIC** tie straps, we routed the LC-1's cable over the transmission and up through the shifter boot. We then worked it up underneath the dashboard. Connect the RED wire from the back of the XD-16 to a switched 12V source in your car. A switched 12V source goes on as soon as the ignition on the car is on or the engine runs. Make sure the connection is fused with at least a 2-amp fuse.

## POWER HANGS IN THE BALANCE



**THE XD-16** is  $\frac{3}{8}$  inch thick, so it's possible to surface mount it, or you can stick it in a  $2\frac{1}{8}$ -inch (52mm) gauge pod.



**THE BASIC XD-16** kit ships with both black and silver bezels, and eight different faces: two each of AFR, pressure, temperature, and blank.



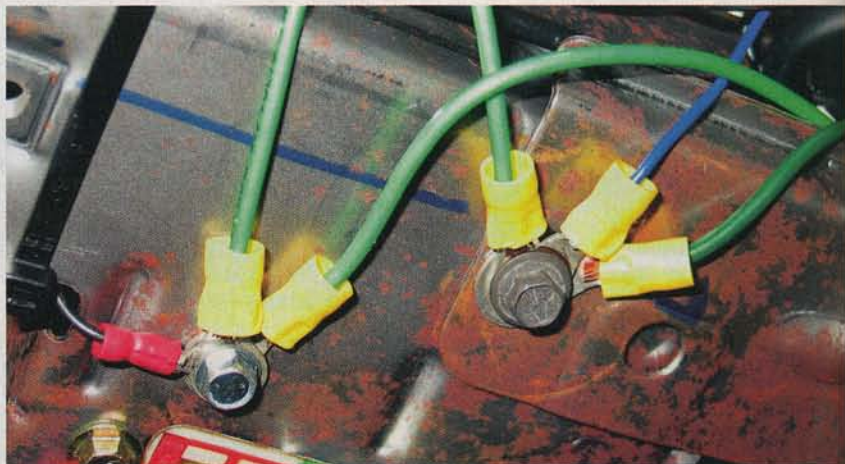
**WE MOUNTED** the XD-16 in a single A-pillar gauge pod and ran the wires under the dash.



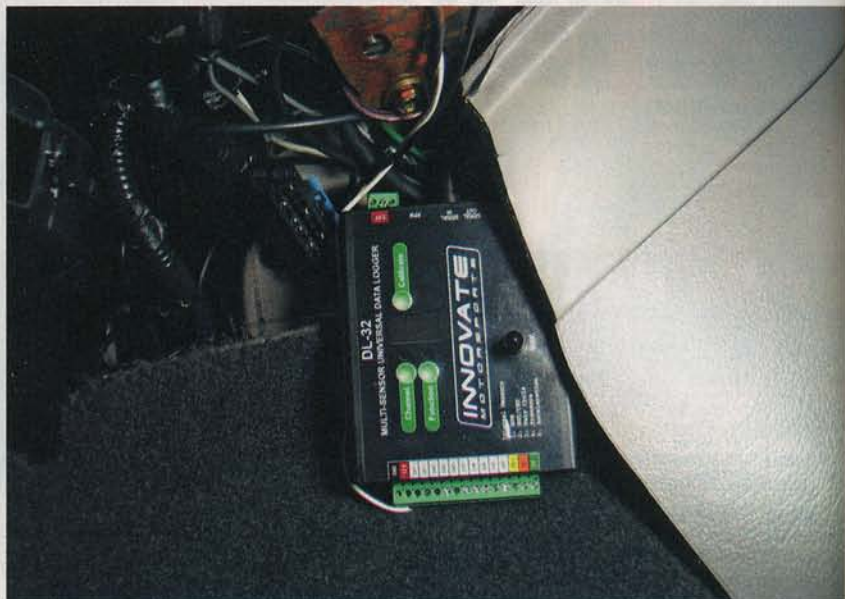
**THE BLUE** and white wires should all be grounded to the same ground source. Although these grounds are of the same source, the blue wire should be wired separately from the white wire to avoid analog ground noise. We ran two separate grounds from this source into the interior.



**INNOVATE USES** a daisy-chain setup with its modular tuning system. With it, you can connect many devices in a single line, all of which can be logged by the DL32.

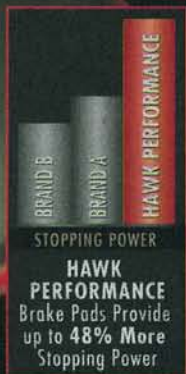


**BOTH OF** the grounds were then grounded again and the blue and white wires were connected separately.

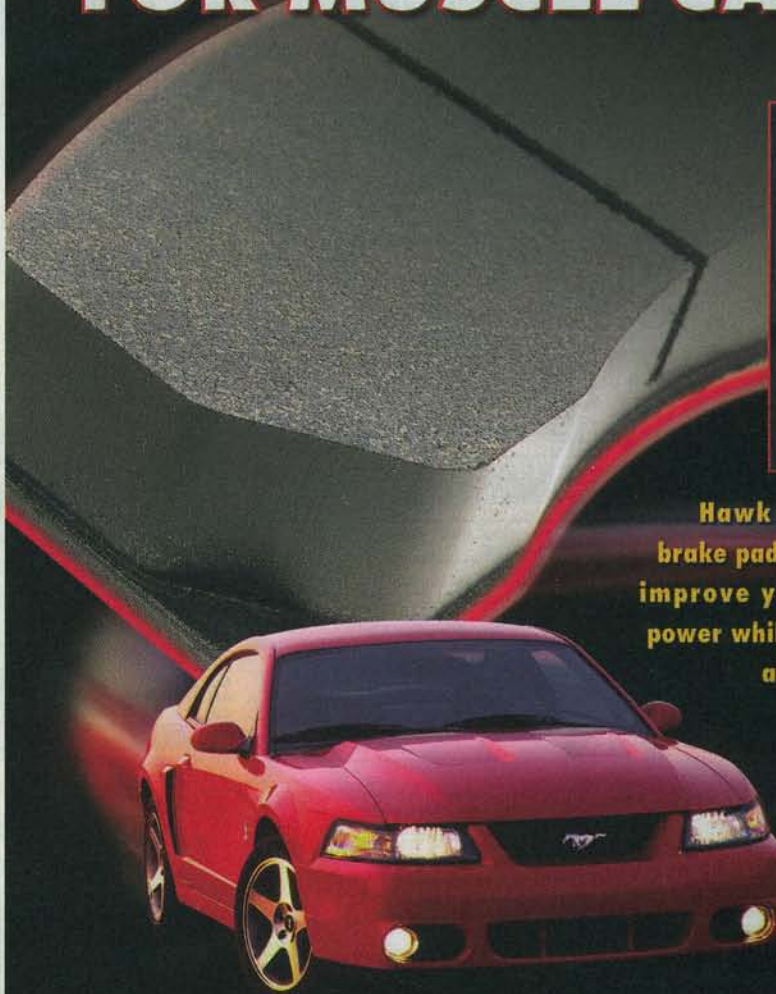


**WE MOUNTED** the DL-32 at the back of the console where we could easily access the flash card to download the data.

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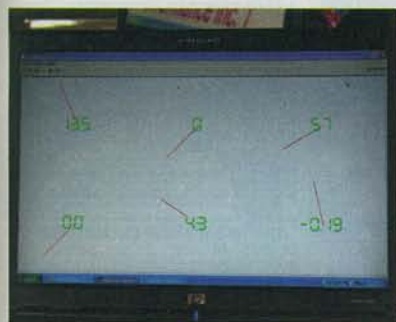
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otherwise the hot exhaust gases can damage it. Innovate also warns against using leaded gasoline, as the wide-band sensors were designed for unleaded. Using them with leaded gasoline significantly reduces the lifespan of the sensor. In most cases, a wide-band sensor provides accurate measurements somewhere between 50 and 500 hours with leaded fuel.

With that said, you'll have a lot of fun being more informed about what's going on in the combustion chambers, and the data-logging capability will help you nail down that tune-up every time. ///



**ONCE YOU'VE** loaded the software into your computer, you can insert the SD flash memory card from the DL32 and check out your logs. Here, you can see the AFR is already set up, and there are instrument graphics for other inputs.



**JUST LIKE** dynamometer software, you can review your car's performances by rpm, and overlay each one to compare run by run.

## SOURCES

### HP PERFORMANCE

Dept. MMFF  
329 Parkridge Ave.  
Orange Park, FL 32065  
904/276-7223  
[www.hp-performance.com](http://www.hp-performance.com)

### INNOVATIVE TECHNOLOGY

Dept. MMFF  
5 Jenner, Ste. 100  
Irvine, CA 92618  
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