M2 Motorsports

The LC-1 from Innovate Motorsports is an excellent low cost wide band oxygen sensor. It can be used alone, or daisy-chained to an LM-1 for multi point (or cylinder) readings. It has two analog outputs for ECU use or wide band meters, as well as a DB-9 serial bus connection to update its firmware and log with the Logworks software.



This article will demonstrate how to terminate the wiring for easy installation in your car. I assume you are using an OBD1 Honda ECU with Crome Pro software. The end of the LC-1 will be fitted with a few connectors, and two pigtails will connect to them. This setup is also good for a tuner, because the ease of installation in a customer's car and simplicity. If you plan to permanently install the LC-1, skip down to "Summary of Connections" and go from there.

I originally had the wiring go to and from a 3 x 5 project box, with the LED and calibration button installed in the cover panel, but that required me to hang the wiring through the window, and under the cowl of the hood! So I rewired it and took pictures. With the use of connectors, the pigtails can be disconnected, and fed through a hole in the firewall fairly easy.

INNOVATE MOTORSPORTS

Parts list:
LC-1 kit
super glue
solder & flux
heat-shrink tubing of various size and/or electrical tape
Cigarette lighter solder type adapter
LED included with the LC-1
Push button that comes with LC-1
2 – six feet pieces of 18 gage wire (I used black and red)
3 – six feet pieces of 22 ~ 26 gage wire
1 – mono 1/8" male and female solder tail connector (or any 2 conductor connector pair... RCA, Barrel, etc.)
1 – battery connector (like for a 9.6v RC car battery) (or a barrel connector)
ECU pigtail option 1: (best for semi-permanent installs)
1 – bullet connector, male and female
2 – spare ECU wires one small terminal and one big (this may be hard to find for some... improvise if necessary)
2 – PCB jumper pins
ECU pigtail option 2: (this option best for a tuner, or if you want to easily remove it quickly)
1 – broken ECU for OBD1 socket (or a Honda OBD1 ECU socket)
1 – ECU harness section D (about 6" of wire is sufficient)

New training videos are available at InnovateMotorsports.com:
Innovate Motorsports Training Videos

Lets start with the cigarette-lighter power adapter plug. Some may say that is is not a great source of power, but I have used it with no problems and it makes things more convenient. As you will see in a bit, the *System Ground* and *Analog Ground* **DO NOT** use the power adapter ground. For permanent installations, I recommend feeding off a switched 12v from the fuse panel, and grounding to the chassis and mounting the LED and button somewhere on the dash.

Step one: Take apart the power adapter. In the top of the main housing, drill a hole for the supplied mini LED just above the main wire hole. The spec sheet indicates a 5/32 hole. Drill the hole at a slight inward angle, then super-glue the LED in place. Feed the switch wires, 1of the 22 gage wires, and 2 - 18 gage wires in through the body of the plug. Solder the LED cathode, one switch wire, and the Black 18 gage wire to the Ground prong of the power plug. Solder the Red 18 gage wire to the Tip. Solder the other switch wire, anode and 22 gage wire together. Cover this with tape or heat-shrink. I used heat-shrink, leaving about 3/8 of an inch excess, then folded this over and applied another piece of heat-shrink (see picture). Then, carefully assemble the cigarette plug. The other end of the 18 gage wires need the battery connector soldered on, and the 22 gage wire needs the male part of the bullet connector.



Illustration 1: Hole drilled in housing



Illustration 2: LED glued in place



Illustration 4: Assembled power adapter with button

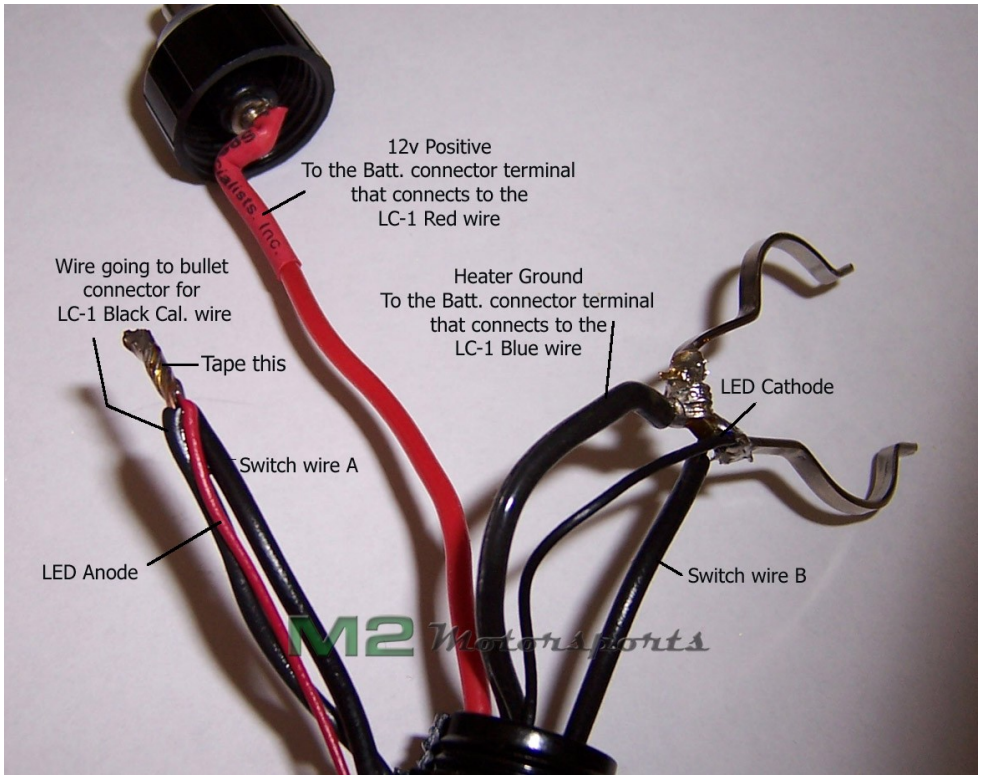


Illustration 3: Labeled wires. Shown soldered before assembly.

Step Two ECU pigtail option 1: Take the two PCB jumper pins, solder them together side by side, and solder them to a small piece of wire, about 6". Next, solder the other end of this to the ECU wire with the big terminal, as well as one of the 22 gage wires. This should form a "Y". Heat-shrink this connection. The other ECU wire, with the small terminal, solder it to the last piece of 22 gage wire. Now on the other end of these two wires that now have ECU terminals on them, you will need to solder the male 1/8" connector to them. The wire with the small terminal, solder to the Tip and the wire with the Y obviously goes to the Sleeve. This completes the ECU pigtail option 1.



Illustration 5: PCB jumper pins soldered together to form a fatter pin to fit the ECU D22 wire

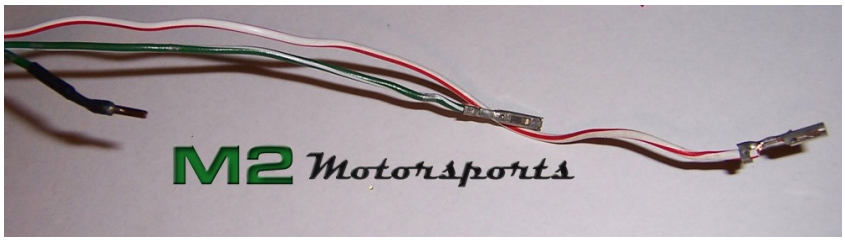


Illustration 6: ECU Pigtail option 1 showing ECU harness wires


Illustration 7: ECU harness wires showing one big and one small

Step Two ECU pigtail option 2: Desolder the wire harness socket from a dead ECU. Take the D section of a spare wire harness, leaving D14 and D22 as long as possible, cut the remaining wires to about 4" ~ 6" long. Put about 1" of heat-shrink (2.5mm/1.25mm) tubing on each wire. Solder the D22 wire to the D22 pin on the socket. Splice in a wire going to the Green and White from LC-1 to the D22 (this should go to the SLEEVE of the 1/8" mono connector). Solder all the remaining wires to the corresponding pin on the socket except for D14. Solder D14 to wire going to the *Yellow* wire from the LC-1 (this should go to the TIP of the 1/8" mono connector).

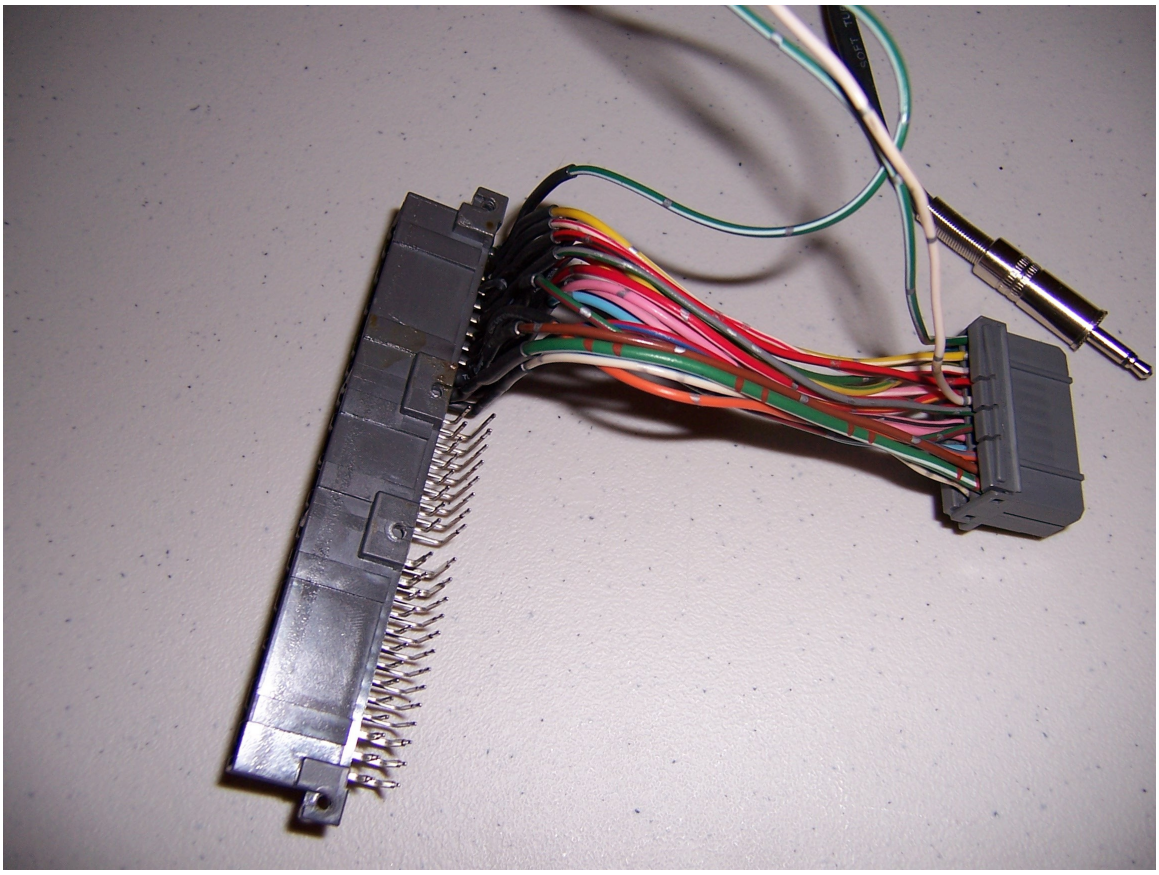


Illustration 8: ECU Pigtail option 2

Step Three: Now it is time to wire the end of the actual LC-1. The BLUE wire is heater ground and the RED wire is 12V. These go to the other part of the battery connector. BLUE goes to Ground and RED goes to the wire soldered to the tip of the cigarette plug. The BLACK wire gets the other half of the bullet connector. The WHITE System Ground and GREEN Analog Ground wire gets soldered together and on the Sleeve of the female 1/8" connector. The YELLOW wire is Analog 1, and this goes to the Tip of the 1/8" connector. The BROWN wire is Analog 2, which I do not use yet (stay tuned for another guide with how to make and add a LM3914 10 segment LED meter). Fold this over and tape or heat-shrink the end.

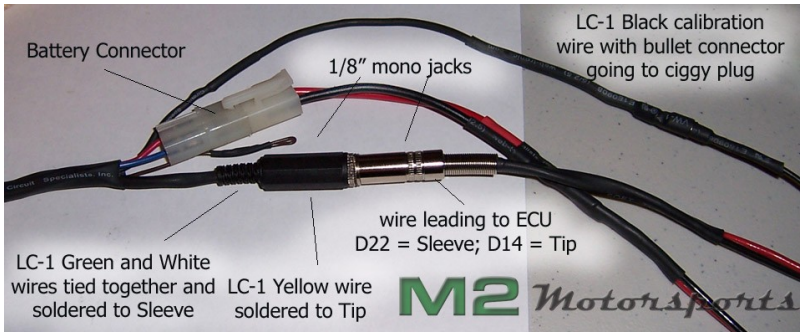


Illustration 9: This picture shows how the pigtails connect to the LC-1 wiring

Now the LC-1 is done! Your plug connectors may be different, but I hope you get the idea of what I was trying to accomplish. With the pigtails removable, the LC-1 cable can be fed through a grommet in the firewall easily. You could even wire it all direct, and if you have a hole big enough for the cig. power plug then great! Or, you can feed the wire in under the hood and through the window if you absolutely have to.

Summary of connections:

Red	12V supply	switched source in car (cigarette lighter plug)
Blue	Heater Ground	Chassis ground (cigarette lighter plug)
Black	Calibration wire	NO (Normally Open) pushbutton (button tied to ground), and anode of LED (ground the cathode)
White	System ground	OBD1 ECU pin D-22 (tapped into, not removing original wire)
Green	Analog ground	OBD1 ECU pin D-22 (tapped into, not removing original wire)
Yellow	Analog 1	OBD1 ECU pin D-14 (directly to ECU, remove original wire)
Brown	Analog 2	No connection

Initializing the Sensor:
Before using a new sensor, you need to initialize the heater circuit to the LC-1. Connect the sensor, the calibration wire and the power plug pigtails. Plug in the power, lay the sensor somewhere safe (it gets hot) and turn on your key. The LED should be blinking. Follow Innovate's instructions for initializing a new sensor. You will also want to do a free air calibration.

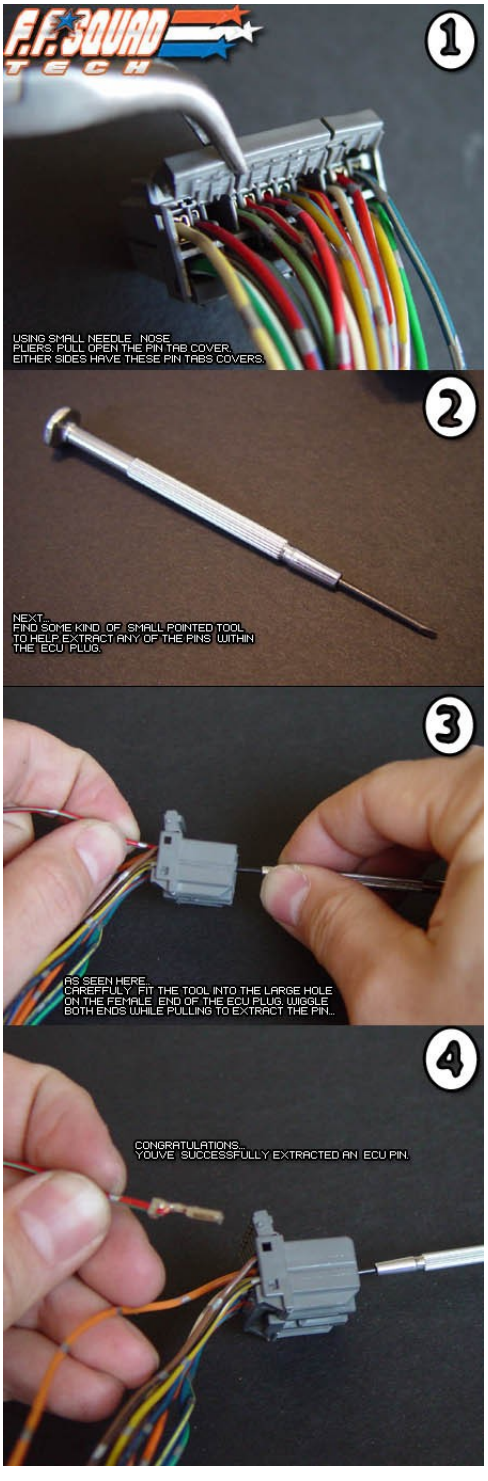
Installing in the car:
First off, good luck getting your stock O2 out. If it is stuck, you may apply some heat from a torch to the bung in the exhaust, but be careful! Parts stores sell a special socket for O2 sensors, but I think they suck. A good quality line crow's foot works great. I removed my pipe and put it in a vice and torched it to get mine out, and it still worked after reinstalling it later!

The wide band sensor wire is fairly long. I was able to feed it up behind the intake, plug it in to the LC-1, and zip tie the LC-1 body to something on the firewall. Find a rubber grommet in the firewall, remove it, and feed the LC-1 wire harness in it. Inside the car, attach your pigtails to the LC-1.

ECU pigtail option 1: Unplug the D section of the ECU harness from the ECU. Using the illustration on the right, extract D-14 and D-22 from the gray connector. Install the small terminal of the Analog 1 pigtail where you removed D-14, and install the big one in D-22. The wire with the PCB pins soldered to it, gets connected to the vehicle wire from D-22. Wrap this connection with electrical tape. This completes the ECU connections.

ECU pigtail option2: Unplug the D section of the ECU harness from the ECU. Plug in the adapter harness to the ECU and plug the car harness into the adapter... done!

Direct wiring (for permanent install only): Splice the system ground (*White*) and analog ground (*Green*) into D-22. Cut D-14 about 6" from the ECU and connect the *Yellow* analog 1 wire to the wire in the ECU. Tape the end of the cut wire in the harness.



CROME Pro setup:
First off, you have to have Pro to datalog... I hope you know that already.
Click File, then Settings, then click the Tuner Logging tab. Select *Innovate* under Lambda Conversion Table.
The ECU (without modification) can only read up to 3.8volts on the O2 input. I use 0.10 volts for 7.35 AF (0.500 Lambda), and 3.50 volts for 22.05 AF (1.500 Lambda). You will want to connect your Serial cable to the LC-1 and program the Analog 1 to the same settings.
In the ROM, check the box "Disable oxygen sensor (open loop)"

Tip: In the PGMFI.org wiki, there is instructions on how to modify the ECU and make the O2 input read up to 5 volts!
http://www.pgmfi.org/twiki/bin/view/Library/O2InputMod

Free Air Calibration:
A free air calibration should be done on a somewhat regular basis or if the readings get wacky (like going full lean to full rich... or just all over the place). There are two ways that I know to do a free air calibration without removing the sensor. One, is to let the car sit for several hours, then turn the key to Acc. (not run), wait for the heater to heat the sensor (LED goes solid) and then push the button. The other, is what I call, the Rolling Free Air Calibration (read this somewhere... not my original idea... I just gave it a name). Find a nice hill that you can coast down. Get up some speed, leave it in gear and turn the key back to Accessory (so the ignition is off, but the cig. lighter still has power). Now floor it! This allows fresh air to pump through the motor and out the exhaust, and because the key is not in run, the injectors are off. After about 10 seconds, push the button. After the LED goes back to solid, let off the gas, and turn the key back to run, and the motor should be running, and you have a fresh calibration! If you can see your screen, make note of what voltage the full lean voltage value is after the calibration and before you turn the key back on. If it is different than 3.500 volts (mine was 3.48) then go back in the settings and make this the full lean voltage value. About the best way to find the full rich value, is douse the removed sensor with a little gas.