

LC-1 Installation Tutorial

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> First published Oct 16, 2005

Revised Nov 29, 2005

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Credits:

Portions of this document show screenshots from Innovate Motorsports' LC-1 configuration software.

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1. LC-1 Install

Description

This Tutorial will provide general instructions for the installation, programming and integration of the Innovate LC-1 with EFILive Scan Tools. **Please refer to manufacturer's manuals for details, warnings, and other specific information.**

Both Analog outputs ("Analog Out 1"- Yellow wire and "Analog Out 2"- Brown wire) from the LC-1 are programmable. Either can be used for any application or display as long as the application/display uses a linear 0-5 Volt analog signal. The LC-1 and EFILive/FlashScan must be programmed or calibrated to be compatible with each other.

A typical LC-1 from the manufacturer will have "Analog Out 1" programmed to simulate a narrowband O2 sensor. The example in this guide reprograms the LC-1 "Analog Out 1" output to send a compatible signal to the FlashScan/EFILive Software. The LC-1's "Analog out 2" will not be used.



Picture 1: LC-1



Picture 2: EFILive

Weld Bung into exhaust.

A bung is easy for any exhaust shop to weld into the exhaust pipe (for ~\$10 bucks). For naturally aspirated cars, weld the bung before the catalytic converters. If your car does not have catalytic converters, WBO2 Sensor should be at least 2-3 feet from end of tailpipe exit. The WBO2 Sensor should be oriented between the 10 o'clock and 2 o'clock position, with 12 o'clock being the best position. **Please refer to literature that was included with your LC-1 for details on correct installation.**

The picture below is of a non-cat car where the WBO2 Sensor is installed under the rear passenger's seat before the exhaust turns up over the rear axle.



Picture 3: WBO2 Sensor Bung/Installation

Route wires

- 1. Suggestion: Wrap the wires/cables with wire loom and wrap tape around loom for protection.
- 2. Use tie wraps to secure the cables sufficiently.
- 3. One option is to run the cables up through the shifter rubber boot into the console. See Picture 4 below.



Picture 4: LC-1 Cable Routing (Cables in Wire Loom)

Electrical Connections

LC-1 Interface and power cables with 7 wire version:

- a. Red 12V supply
- b. Blue Heater Ground
- c. White System Ground
- d. Yellow Analog out 1
- e. Brown Analog out 2
- f. Green Analog Ground
- g. Black Calibration wire

Note: Reference LC-1 manufacturer's manual and display instructions for warnings and further details on installation.

Connecting to EFI Live External Connector

The FlashScan External Pin-outs are listed below in Picture 5.

FlashScan Pin-outs

Elost dela Los	Pin	(PID)	Description
Parties (D)	Α	{EXT.EGT}	Alumel lead of type-k thermocouple
12 2 2 2 C	в		Chromel lead of type-k thermocouple
	С	{EXT.AD2}	Analog voltage 0 to 4.8 volts only
AB	D	-	Analog voltage common ground
DE	Е	{EXT.AD1}	Analog voltage 0 to 4.8 volts only

Picture 5: FlashScan Pin-Outs

1. 12V supply:

Connect the LC-1 Red Wire to a switched 12V supply from your car. It must turn on (12V) when the ignition switch is ON and turn off (0V) when the ignition switch is turned OFF.

1. LC-1 Analog Out 1:

Connect the LC-1 Yellow to either the C or E location of the FlashScan External connector. C and E are on the outside locations of the three-wire connector.

2. Signal Grounds:

Connect the LC-1's Blue, Green, and White wires ground connection to the D location of the EFILive External connector. D is in the middle of the 3-wire connector.



Picture 6: External Connection to EFILive.

Note: The green wire used in Picture 7 is connected to Yellow wire "Analog Out 1" from LC-1 and is connected to the FlashScan Pin E {EXT.AD1}. The black wire is connected to same Signal ground location as the LC-1 (Blue, Green, White wire) and is connected to the FlashScan Pin D "Common Analog Ground".

Programming LC-1 for EFI Live

EFILive version 7.3 has an LC-1 calculation in the "sae_generic.txt" file. The LC-1's programmable settings in this section are based on these calculations. If your file is different, different input values will be needed for the LM Programmer.

# Innovate LC- # ===========	1 WBO2			
" *CLC-00-926				
V	0.0	5.0	.1	"{EXT.AD1}"
AFR	10.0	20.0	.2	"({EXT.AD1}*3)+7.35"
*CLC-00-927				
factor	0.0	2.0	.1	"{CALC.AFR_LC11.AFR}/{GM.AFR}"
*CLC-00-928				
V	0.0	5.0	.1	"{EXT.AD2}"
AFR	10.0	20.0	.2	"({EXT.AD2}*3)+7.35"
*CLC-00-929				
factor	0.0	2.0	.1	"{CALC.AFR_LC12.AFR}/{GM.AFR}"

- 1. Connect the PC's serial connection to the serial OUT of the LC-1. The terminator plug should be connected to the serial IN of the LC-1.
- 2. Turn the ignition switch ON to power the LC-1.
- 3. Open LM-1 Programmer.
- 4. Select the "Analog Out 1" tab.
- 5. Select "use air-fuel-ratio" option.
- 6. Set the Analog Out 1 to the following:
 - a. 0.88333 Volts at AFR: 10.00
 - b. 4.21667 Volts at AFR: 20.00

The Window should look similar to the Figure 3.





7. Click the "Program" button. When the LC-1 is programmed, the "Program" button will be greyed out.

Verifying EFILive LC-1 Operation

Selecting PIDs

Please Reference the EFILIVE AutoVE Tuning Tutorial for PID selection.

Select the PIDs from the AutoVE tutorial, also add PIDs {EXT.AD1} and {EXT.AD2}.

By logging both {EXT.AD1} and {EXT.AD2}, you can verify correct voltage readings from the LC-1 are being recorded in EFILive. The unconnected {EXT.ADx} may show a voltage, but it will not change as much as the {EXT.ADx} that the LC-1 is connected. After verifying which {EXT.ADx} is used, delete the unused {EXT.ADx} from PID selection.

Logging and Checking Data from LC-1

- 1. Connect the LC-1 to FlashScan via the external connector and connect the FlashScan to your car.
- 2. Start and drive car: For the first few miles, your LC-1 will read very lean due to the AIR injecting air into the exhaust. Drive ~5 miles to bring the car up to operating temperature and to get past the AIR before recording data.
- 3. Start Logging.
- 4. Click the "Data" tab and see which {EXT.ADx} is connected. See Figure 4 for example.

😫 EFILive Scan	EFILive Scan V7.3 (postAutoVEtunewbworks10-23-050835.efi)													
File Edit View Info Dashboard Charting LS1/LS6 Bidirectional FlashScan Window Help														
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📓 OBD II (F7) 🥤	🖞 PIDs (F8) 🧱 Data (F9) 🍘 Dashboard (F1	0) 🔣 Map	os (F11)	🗧 Console	(F12)									
Priority/Caption	Description	Value	Units	Min	Avg	Max	Parameter							
1 AFR_LC11	Wide Band AFR 1 - LC-1	14.64	AFR	13.58	14.82	15.94	CALC.AFR_LC11							
1 AFR_LC11	Wide Band AFR 1 - LC-1	2.4	V	2.1	2.5	2.9	CALC.AFR_LC11							
1 BEN_LC11	Base Efficiency Numerator 1 - LC-1	1.0	factor	0.9	1.0	1.1	CALC.BEN_LC11							
1 CYLAIR	Air mass per cylinder	0.02	Gram	0.02	0.03	0.06	CALC.CYLAIR							
1 INJDC1	Injector Duty Cycle Bank 1	9	%	2	3	9	CALC.INJDC1							
1 INJDC2	Injector Duty Cycle Bank 2	9	%	2	3	9	CALC.INJDC2							
1 POWER_RW	Power at rear wheels	0	HP	0	0	0	CALC.POWER							
1 AD1	External Analog Voltage 1	2.43	V	2.08	2.49	2.86	EXT.AD1							
1 AD2	External Analog Voltage 2	3.59	V	3.55	3.57	3.59	EXT.AD2							
1 AFR	Commanded Air Fuel Ratio	14.63	:1	14.63	14.63	14.63	GM.AFR							
1 FTC	Fuel Trim Cell Number	22	Cell#	20	21	22	GM.FTC							
1 H02S11	Heated 02 Sensor Voltage Bank 1 - Sensor 1	0.729	V	0.013	0.254	0.842	GM.H02S11							
1 H02S21	Heated 02 Sensor Voltage Bank 2 - Sensor 1	0.304	V	0.074	0.446	0.903	GM.H02S21							
1 IBPW1	Injector Base Pulse Width Bank 1	5.142	ms	1.694	3.221	6.851	GM.IBPW1							
1 IBPW2	Injector Base Pulse Width Bank 2	5.081	ms	1.740	3.230	6.790	GM.IBPW2							
1 KR	Retard Due to Knock	0.0	Degre	0.0	0.0	0.0	GM.KR							
1 MAFFREQ	Mass Air Flow Raw Frequency	0	Hz	0	0	0	GM.MAFFREQ							
1 FUELSYS-A	A Status	OL					SAE.A							
1 FUELSYS-B	B Status	OL					SAE.B							
1 ECT	Engine Coolant Temperature	196	۴F	190	194	196	SAE.ECT							
1 IAT	Intake Air Temperature	73	۴F	73	78	81	SAE.IAT							
1 LONGFT1	Long Term Fuel Trim - Bank 1	4.7	%	-1.6	1.0	4.7	SAE.LONGFT1							
1 LONGFT2	Long Term Fuel Trim - Bank 2	3.9	%	-1.6	1.3	3.9	SAE.LONGFT2							
1 MAF	Air Flow Rate from Mass Air Flow Sensor	0.31	Lbs/	0.31	0.31	0.31	SAE.MAF							
1 MAP	Intake Manifold Absolute Pressure	13.9	inHq	5.9	10.1	18.3	SAE.MAP							
1 RPM	Engine RPM	2031	RPM	614	1133	2031	SAE.RPM							
1 SPARKADV	Ignition Timing Advance for #1 Cylinder	37.5	Degre	16.0	28.3	39.5	SAE.SPARKADV							
1 TP	Absolute Throttle Position	20.0	%	0.0	6.7	20.4	SAE.TP							
1 VSS	Vehicle Speed Sensor	24	MPH	0	9	25	SAE.VSS							
Scan mode: Dynamic	e PIDs: 27 (pri 1:27, 2:0, 3:0)		Chann	els: 26 (pri	1:26/36, 2	0/6, 3:0/6	5)							
<							>							
Frame: 363	🛠 🛠 HH 🛛 🕂 II 🔴 🔴 🖬				₩ 0		Time: 07:52:29.894							
	Not connected 2FV22G0	V2xxxxx][N	fanual][0:	5: (N										

Figure 4: Sample Data Log

As seen during log above, {EXT.AD1} is logging values that are changing and reflected in the {CALC.AFR_LC11} value of 14.64. Look at the values to verify that it matches the DynoTune display or Logworks software monitored values. {EXT.AD2} is showing a voltage, but it is not changing significantly during drive. {EXT.AD2} is not connected and can be deleted from the PID selection.

5. Click the [Map] tab. If your previous map selections from the AutoVE Tutorial is using the correct {EXT.ADx}, the map should be logging the average values of the AFR. The AutoVE tutorial's Map should show correct AFR values and can be used with confidence.

Please Reference the EFILIVE AutoVE Tuning Tutorial for Map creation.

The following map can help when the comparing the dynotune display or LC-1 Logging software AFR values to the EFILive AFR scanned values.

- 1. Click on an empty map in EFILive Scan.
- 2. Click on "Data" Tab.
- 3. Select as data shown in Figure 5.

	Map p	rope	rtie	5																	×
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				N	lames	:			🗹 S	electe	ed										
			Title:	AFR	LC1	1							She	ow un	its						
Precision: 2																					
	V Display type																				
	AFR_LC11 AFR (Average - "empty" cells are hidden)																				
							Ì		M	, AP I	ĸРа		Č.,						<i>.</i>		
		15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	^
	400																				
	800		5.26	5.53	5.79	6.05	6.32	6.58	6.84	7.11	7.37	7.63	7.89	8.16	8.42	8.68	8.95	9.21	9.47		
⋝	1200		10.26	10.53	10.79	11.05	11.32	11.58	11.84	12.11	12.37	12.63	12.89	13.16	13.42	13.68	13.95	14.21	14.47		
ď	1600		15.26	15.53	15.79	16.05	16.32	16.58	16.84	17.11	17.37	17.63	17.89	18.16	18.42	18.68	18.95	19.21	19.47		
ш	2000		20.26	20.53	20.79	21.05	21.32	21.58	21.84	22.11	22.37	22.63	22.89	23.16	23.42	23.68	23.95	24.21	24.47		
	2400		20.26	20.03	25.79	26.05	20.32	20.56	20.64	27.11	27.37	32.63	32.89	28.16	28.42	25.55	28.95	29.21	29.47		
	3200		35.26	35.53	35.79	36.05	36.32	36.58	36.84	37.11	37.37	37.63	37.89	38.16	38.42	38.68	38.95	39.21	39.47		
_																_					×
	Save		Sa	ave a:	s	afr.m	ар									Ok Cancel					

Figure 5: AFR Map Creation - Data

4. Click on "Column" tab.

5. Select as data shown in Figure 6.

	Map properties															×					
Da	ata C	olumn	Ro	w	Cells	C	olor	Emp	oty												
		Co	olumn:	(0)	ntake	Man	ifold A	Absolu	ite Pre	essure	e (kPa	i)								1	~
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Title: MAP <-> Show units																					
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Col labels: ,15,20,25,30,35,40,45,50,55,60,65,70,75,80,85,90,95,100,105																					
	AFR_LC11 AFR (Average - "empty" cells are hidden)																				
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		15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	^
	400																				E
	800	_	5.26	5.53	5.79	6.05	6.32	6.58	6.84	7.11	7.37	7.63	7.89	8.16	8.42	8.68	8.95	9.21	9.47		
5	1200		10.26	10.53	10.79	11.05	11.32	11.58	11.84	12.11	12.37	12.63	12.89	13.16	13.42	13.68	13.95	14.21	14.47		
Ę,	1600		15.26	15.53	15.79	16.05	16.32	16.58	16.84	17.11	17.37	17.63	17.89	18.16	18.42	18.68	18.95	19.21	19.47		
Ľ	2000		20.26	20.53	20.79	21.05	21.32	21.58	21.84	22.11	22.37	22.63	22.89	23.16	23.42	23.68	23.95	24.21	24.47		
	2400		25.26	25.53	25.79	26.05	26.32	26.58	26.84	27.11	27.37	27.63	27.89	28.16	28.42	28.68	28.95	29.21	29.47		
	2800		30.26	30.53	30.79	31.05	31.32	31.58	31.84	32.11	32.37	32.63	32.89	33.16	33.42	33.68	33.95	34.21	34.47		
	3200		35.26	35.53	35.79	36.05	36.32	36.58	36.84	37.11	37.37	37.63	37.89	38.16	38.42	38.68	38.95	39.21	39.47		~
	Save Save as afr.map															Ok		Ca	ncel		

Figure 6: AFR Map Creation – Column

6. Select "Row" Tab.

7. Select as data shown below:

	🔢 Map properties															×					
Da	ata Co	olumn	Ro	w	Cells	C	olor	Emp	oty												
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-	AED I C11 AED (Average, "eventul" celle are bidden)																				
	AFR_LC11 AFR (Average - "empty" cells are hidden)																				
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		15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	^
	400																				
	800		5.26	5.53	5.79	6.05	6.32	6.58	6.84	7.11	7.37	7.63	7.89	8.16	8.42	8.68	8.95	9.21	9.47		
⋝	1200		10.26	10.53	10.79	11.05	11.32	11.58	11.84	12.11	12.37	12.63	12.89	13.16	13.42	13.68	13.95	14.21	14.47		
Ĕ,	1600		15.26	15.53	15.79	16.05	16.32	16.58	16.84	17.11	17.37	17.63	17.89	18.16	18.42	18.68	18.95	19.21	19.47		
ш	2000		20.26	20.53	20.79	21.05	21.32	21.58	21.84	22.11	22.37	22.63	22.89	23.16	23.42	23.68	23.95	24.21	24.47		
	2400		25.26	25.53	25.79	26.05	26.32	26.58	26.84	27.11	27.37	27.63	27.89	28.16	28.42	28.68	28.95	29.21	29.47		
	2800		30.26	30.53	30.79	31.05	31.32	31.58	31.84	32.11	32.37	32.63	32.89	33.16	33.42	33.68	33.95	34.21	34.47		
	3200		35.26	35.53	35.79	36.05	36.32	36.58	36.84	37.11	37.37	37.63	37.89	38.16	38.42	38.68	38.95	39.21	39.47		~
	Save		Sa	ave a:	s	afr.m	ap										Ok		Ca	ncel	

Figure 7: AFR Map Creation – Row

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		15	20	25	30	35	40	45	50	55	60	60	70	/5	00	05	90	95	100	105	Ī
	400																				
	800			14.59	14.60	14.47	14.59	14.41	14.65	14.70	14.79	14.31	14.75								
	1200		14.39	14.56	14.51	14.76	14.59	14.46	14.40	14.28	14.29	14.16	14.21	13.29	13.07	13.44	13.71	13.22	12.61		
	1600	13.87	14.57	14.76	14.65	14.79	14.62	14.55	14.24	14.19	14.45	14.31	14.41	13.43	13.48	13.93	14.31	13.24	12.44		1
	2000	13.84	14.74	14.83	14.39	14.56	14.42	14.43	14.32	14.20	14.36	14.21	14.11	13.48	13.52	13.54	13.50	12.59	12.23		1
	2400	13.53	15.12	15.08	14.81	15.03	14.61	14.54	14.34	14.29	14.50	14.21	13.77	13.38	13.77	13.73	13.84	13.04	12.69		
	2800	13.53	13.81	14.44	14.31	14.65	14.37	14.28	14.21	14.34	14.34	14.33	14.16	13.39	13.53	13.95	13.82	13.44			1
	3200	13.65	15.81	15.25	14.41	14.64	14.59	14.66	14.47	14.46	14.47	14.50	14.22	13.43	13.36	13.25	13.39				
	3600	13.57	14.18	14.79	14.83	15.30	14.70	14.61	14.55	14.42	14.45	14.26	14.17	13.27							1
PM	4000	13.99	13.85	14.69	14.15	14.12	13.98	14.18	14.54	14.31	13.96	13.93					12.41				1
	4400	12.93	12.66	12.16	12.00		12.14	11.60				11.07					11.19	11.69	11.44		-
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8. If everything is setup correctly, you can now interpret a more familiar AFR map...

Figure 8: AFR Map