SLC Free Manual

14POINT7
CUTTING EDGE IN MOTION

Warning:

- **Do not connect or disconnect the Lambda Sensor while SLC Free is powered, only do so when SLC Free is unpowered.**
- **The Lambda Sensor gets very hot during normal operation, be careful when handling it.**
- **Do not install the Lambda Sensor in such a manner that the unit is powered before your engine is running. An engine start can move condensation in your exhaust system to the sensor, if the sensor is already heated this can cause thermal shock and cause the ceramic internals inside the sensor to crack and deform.**
- **While the Lambda Sensor is in an active exhaust stream, it must be controlled by SLC Free. Carbon from an active exhaust can easily build up on an unpowered sensor and ruin it.**
- **Lambda sensor life when used with leaded fuels is between 100-500 hrs. The higher the metal content the shorter the life of the Lambda sensor.**

Important Stuff:

- SLC Free A and SLC Free B is compatible with the LSU 4.9 Sensor only
- SLC Free C is compatible with the LSU 4.2 Sensor only
- **Please refer to** https://groups.google.com/forum/#!category-topic/14point7/slc-free/--EVdTw8O-U **for latest updates to the build instructions and the latest tips before proceeding**
- On the PCB, R15 value is labeled as 1.2k, it is recommended that a 750 ohm resistor (included in kits post Aug 1 2014) be used instead. If you find the LCD contrast to be too dark, an additional 1k and 1.2k is included for you to experiment with.
- Kits shipped after Aug 1 2014 no longer include molex connectors, cable/wires should be soldered directly to the PCB.

Parts List:

Item #	Qty needed	Qty Provided by 14Point7 kit	Description	PCB Name	Note
1	1	1	28 Pin IC Socket - Narrow	IC2	
2	1	1	5 Pin .100 Right-Angle Male Polarized Headers	JP1	Kits shipped after Aug 1 2014 no longer include this
3	1	1	6 Pin .100 Right-Angle Male Polarized Headers	JP2	Kits shipped after Aug 1 2014 no longer include this
4	1	1	5 Pin .100 Polarized Header Connector		Kits shipped after Aug 1 2014 no longer include this
5	1	1	6 Pin .100 Polarized Header Connector		Kits shipped after Aug 1 2014 no longer include this
6	11	15	Crimp Pin for Header Connector		Kits shipped after Aug 1 2014 no longer include this
7	1	1	40 Pin .100 Straight Male Headers	JP3,JP5	Break into 5 pin,6 pin, and 16 pin, sections. Use 16 pin on 16x2 character LCD, Item #26
8	1	1	16 Pin .100 Straight Female Single Headers	JP4	
9	4	4	10mm M3 Round Standoff + Screws		
10	1	1	IRF3710 MOSFET N Channel Transistor	IC3	Bend pins 90 degree before soldering. Solder tab to PCB is optional
11	1	1	7805T - 5V 1A Positive Regulator (LM7805)	IC1	Bend pins 90 degree before soldering. Solder tab to PCB is optional
12	2	2	1N4004 400V 1A General Purpose Diode	D1,D2	
13	1	1	P6KE24A - 20.5V Standoff Voltage - TVS 600W DC	D3	

14	2	3	47uF 50V Radial Electrolytic Capacitor	C2,C3	Additional Capacitor supplied
15	8	9	0.1uF 50V Ceramic Capacitors	C1,C4,C5,C7,C8, C9,C10,C11	Additional Capacitor supplied
16	1	1	100ohm 1/4W 1% Metal Film Resistor	R16	
17	2	2	10kohm 1/4W 1% Metal Film Resistor	R4,R10	
18	1	1	10ohm 1/2W 5% Carbon Film Resistor	R1	
19	1	1	4.7kohm 1/4W 1% Metal Film Resistor	R14	
20	8	9	1kohm 1/4W 1% Metal Film Resistor	R2,R5,R6,R8,R9, R11,R12, R13	Additional Resistor supplied to set LCD contrast if required, R15
21	1	1	1.2kohm 1/4W 1% Metal Film Resistor		Additional Resistor supplied to set LCD contrast if required, R15
22	1	1	120kohm 1/4W 1% Metal Film Resistor	R7	For LSU 4.9 sensor, populate R7 with a 120K resistor. For LSU 4.2 sensor, leave empty.
23	1	1	61.9 ohm 1/4W 1% Metal Film Resistor	R3	
24	1	1	1uf 50V Ceramic Capacitor	C6	
25	1	1	Printed Circuit Board		
26	1	1	16x2 character LCD		Solder 16 pin section, item #7
27	1	1	CY8C24423A-24PXI	IC2	Use Socket; Item #1
28	1	1	Lambda Sensor Connector		
29	6	6	Lambda Sensor Connector Pins		
30	1	1	Small Heat Shrink		
31	1	1	Large Heat Shrink		LSU 4.2 only
32	1	1	Orange LSU Rubber Gasket		LSU 4.9 only
33	1	1	Purple LSU Lock Connector		LSU 4.9 only
34	1	1	Fuse		Use fuse on 12v supply
35	1	2	5 Amp fuse		Replacement Fuse is included
36	1	1	750ohm 1/4W 1% Metal Film Resistor	R15	Only included in kits shipped after Aug 1 2014. R25 is used to the set the LCD contrast, 750ohms is usually the best value, an additional 1.2k resistor and 1k resistor is included for you to experiment with.

PCB Assembly:

Read First:

- For the LSU 4.9 sensor R7 has to be populated with a 120k resistor, only SLC Free A and SLC Free B is compatible with the LSU 4.9
- For the LSU 4.2 sensor leave R7 empty, only SLC Free C is compatible with the LSU 4.2 sensor
- R15 sets the contrast of the LCD, depending on the tolerance of the supplied LCD R15 may need to be changed from its nominal 1.2k value. If the contrast is too light, you will need to change R15 to a lower value. An extra 1k resistor is included for you to experiment with. If the contrast is still too light with a 1k resistor then you must get a hold of lower value resistors and experiment.
- Bend the pins on IC1 and IC3 90 degrees and test to make sure everything looks good before you solder the pins.
- It is optional to solder the tab on IC1 and IC3 to the PCB, it is suggested that you solder the tabs to the PCB only if you notice the ICs getting hot to the touch, otherwise leave the tab unsoldered as this will make replacing the ICs easier if they ever develop a problem.
- An additional 0.1uF ceramic has been included just in case you lose one of them during assembly
- An additional 47uF electrolytic capacitor has been included in case you need to change the capacitor. I hate using electrolytic capacitors in an automotive environment, I only use them for the SLC Free design because they are cheap and the through-hole variety is easy to replace.
- Try to solder the 47uF electrolytic capacitors, C2 and C3, as flush to the PCB as possible otherwise it may interfere with the LCD.

PCB Assembly Instructions:

Assembly is straight-forward, all components except R7 are marked with the component value on the PCB.
The best technique for assembly is to solder the components lowest in height first:

1. Resistors
2. Diodes
3. IC1, IC3, IC2 socket
4. Ceramic capacitors
5. JP1, JP2
6. JP3,JP4,JP5

On the LCD you must solder a 16 pin male header to it.

Installing the LCD:

The 16 pin male pins you have soldered to the LCD PCB inserts into the 16 pin female header you have soldered to the SLC Free A PCB. You may need to twist the metal tabs on the back of the LCD PCB so that they do not get in the way of the electrolytic capacitors. Use the included standoffs and screws to secure the Display PCB to the SLC Free PCB.

Pinout:

Kits shipped after Aug 1 2014 no longer include molex connectors, cable/wires should be soldered directly to the PCB.

JP1 Pinout, Power + Output

Pin # Beige Molex	Name	Connects to	Note
1 (top)	12v	12v	Use 5A Fuse
2	Electronics Ground	Ground	Ground where Linear Output interfacing device is grounded
3	LSU Heater Ground	Ground	Ground to chasis
4	Linear Output	Gague, ECU, datalogger	0.68 Lambda @ 0v linear to 1.36 Lambda @ 5v
5 (bottom)	Simulated Narrowband Output	Stock ECU if required	Switch point @ 1 Lambda

JP2 Pinout, Lambda Cable

Pin # Beige Molex	Name	Connects to Pin # LSU 4.2 Connector, SLC Free C	Connects to Pin # LSU 4.9 Connector, SLC Free A/B	Note
1 (top)	LSU Heater +ve	4	3	Pin# marked on LSU connector
2	LSU Heater –ve	3	4	Pin# marked on LSU connector
3	LSU Virtual Ground	5	2	Pin# marked on LSU connector
4	LSU Nernst	1	6	Pin# marked on LSU connector
5	LSU Ia	2	5	Pin# marked on LSU connector
6 (bottom)	LSU Ip	6	1	Pin# marked on LSU connector

Power + Output Cable Construction:

Use the 5 Pin beige Molex connector and contacts to construct the Power + Output Cable. It is recommended that you use 20 AWG cable, any thicker of a cable and you may have problems fitting it into the Molex connector. You can either crimp or solder the cable to the contacts, if you solder you may need to trim the insulation tab to fit into the connector.

LSU 4.2 Lambda Cable Construction:

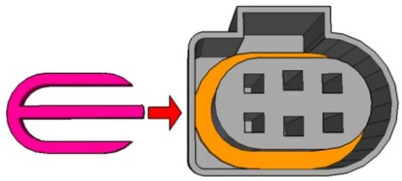
Warning: The heatshrink has a layer of glue inside, when the heatshrink is hot, the glue will act as a lubricant and the heatshrink may move. I suggest that initially; you just want to heatshrink to be shrunk to the general target diameter, let it cool and then apply more heat if required.

Use the 6 Pin beige Molex connector, Molex contacts, black LSU connector, LSU contacts, small heat shrink, and large heat shrink to construct the Lambda Cable. It is recommended that you use 20 AWG wire, any thicker of a wire and you may have problems fitting it into the Molex connector. Connect the LSU connector to the Molex connector according to table "**JP2 Pinout, Lambda Cable**". Use the large heat shrink where the wires enter the LSU connector, then use the small heat shrink to seal the large heat shrink to the cable, it is very important to have a good seal against dirt and water. You can either crimp or solder your wire to the contacts, if you use solder you may need to trim the insulation tab to fit into the connectors.

LSU 4.9 Lambda Cable Construction:

Warning: The heatshrink has a layer of glue inside, when the heatshrink is hot, the glue will act as a lubricant and the heatshrink may move. I suggest that initially; you just want to heatshrink to be shrunk to the general target diameter, let it cool and then apply more heat if required.

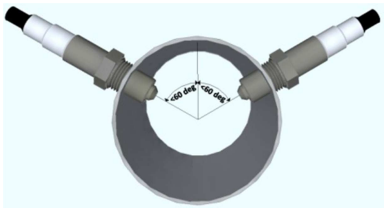
Use the 6 Pin beige Molex connector, Molex contacts, black LSU connector, LSU contacts, and heat shrink, to construct the Lambda Cable. It is recommended that you use 20 AWG wire, any thicker of a wire and you may have problems fitting it into the Molex connector. Connect the LSU connector to the Molex connector according to table "**JP2 Pinout, Lambda Cable**". Use the heat shrink where the wires enter the LSU connector, it is very important to have a good seal against dirt and water. You can either crimp or solder your wire to the contacts, if you use solder you may need to trim the insulation tab to fit into the connectors.



The Final step is to insert the orange rubber gasket, and the purple locking mechanism. This will ensure that the plug is waterproof and the contacts stay in place.

Exhaust Installation:

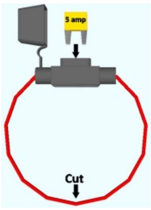
- **The Lambda Sensor should be installed between the 10 o'clock and the 2 o'clock position, less than 60 degrees from vertical, this will allow gravity to remove water condensation from the sensor.**
- **For all Oxygen sensor installations the sensor must be installed before the catalytic converter.**



For normally aspirated engines the sensor should be installed about 2ft from the engine exhaust port. For Turbocharged engines the sensor should be installed about 3ft from the engine exhaust port after the turbocharger. For Supercharged engines the sensor should be installed 3ft from the engine exhaust port. Installing the sensor too close to the engine exhaust port may overheat the sensor, installing the sensor too far from the exhaust port may leave the sensor too cool, both will cause damage to the sensor and lead to wrong measurements.

Fuse:

Insert 5 amp fuse into fuse holder, cut wire at midpoint, and secure lid. One end of the fuse holder connects to the red wire on the grey cable, the other end of the fuse holder connects to a switched 12[v] source.



SLC Free B/C LCD:

The top row of the LCD displays Lambda, the range is 0.68 to 1.36 Lambda.

The bottom row of the LCD displays sensor temperature, SLC Free B displays a sensor temperature range of 740C to 820C, SLC Free C displays a sensor temperature range of 670C to 828C. The normal operating temperature of the Bosch LSU 4.9 (SLC Free A/B) is 780C, the normal operating temperature of the Bosch LSU 4.2 (SLC Free C) is 750C. Lambda Accuracy is heavily dependent on sensor temperature, only when the sensor is at proper temperature is Lambda accurate, -/+ 25C from normal operating temperatures is considered acceptable. If the Lambda sensor is too cool; readings will tend to look “leaner”, if the sensor is too hot; readings will tend to look “richer”. If you notice that the Lambda sensor is consistently too hot, then it is a good idea to move the sensor location farther from the engine exhaust port. If you notice that the Lambda sensor is consistently too cool, it is a good idea to move the sensor location closer to the engine exhaust port, it may also indicate that your electrical system/wiring is weak. When SLC Free is initially powered on, it will go through a sensor heatup routine to gently bring the Lambda sensor to proper temperature, this takes approximately 1 minute. It is normal during the heatup routine for the sensor temperature to exceed normal operating temperature, the temperature should quickly drop to normal operating temperature once the heatup routine is over.

SLC Free A – Open Source:

SLC Free A is the Open Source version of SLC Free, SLC Free A supports the LSU 4.9 only. SLC Free A and SLC Free B differ in how the LCD displays Lambda and sensor temperature, everything else is the same, all sections of this manual are also applicable to SLC A. SLC Free A source code and PCB Design files are available here, http://www.14point7.com/pages/software-and-documentation

SLC Free A Display:

SLC Free A uses the top row of the LCD as a bargraph to display Lambda and the bottom row as a bargraph to display sensor temperature. Each row of the LCD has 80 columns. The first column in the top row represents 0.60 Lambda, each column represents 0.01 Lambda, SLC Free can read exhaust gas as rich as 0.68 Lambda-> the first 8 columns will be illuminated. The first column in the bottom row represents 740C, each column represents, 1C, the normal operating temperature of the Bosch 4.9 LSU is 780C-> the first 40 columns will be illuminated.

The LCD used is an industry standard 2x16 character LCD based on the Hitachi HD44780 driver chip.

Compiling SLC Free A:

SLC Free A is built using PSOC Designer 5.3, download it at www.cypress.com, included in the PSOC Designer package is a copy of the Imagecraft C compiler, SLC Free A is compiled using the Imagecraft C compiler included in PSOC Designer 5.3. SLC Free A has not been tested with other PSOC Desinger Versions and it's associated C compiler, it is suggested that you use PSOC Designer 5.3 and it's associated C compiler. Once you download and install PSOC Designer you should be able to immediately open the SLC Free A project and compile, no additional settings/addons should be required.

Programming SLC Free A:

The target chip for SLC Free A is the Cypress Cy8C24423A, the suggest programmer is the CY3217-MiniProg1 available here http://www.cypress.com/?rID=37459. The "Prog header" on the SLC Free PCB is where you plug your programmer into to program the Cy8C24423A.

SLC Free A PCB:

All SLC Free versions use the same PCB. The PCB is designed using Eagle layout editor. Included in the download is a zip of the PCB gerber files, you should be able to submit this zip file to any PCB fabrication company and get PCBs made.

Warranty:

14Point7 provides no warranty for SLC Free.

Disclaimer:

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