NAW_OEM User Manual

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Important Stuff:

Do not cut off the sensor plug and try to wire the sensor directly to the NAW_OEM module, there is a laser cut calibration resistor inside the plastic connector of the Bosch LSU Sensor.

The NAW_OEM module will only work with the Bosch LSU 4.2 sensor. The Bosch part # is 17053 and 17014. The only difference between the 17053 and the 17014 is the length of the cable between the plug and the actual sensor.

To construct the wiring harness, please refer to "Wideband Cable Construction Guide". There are 2 guides, one using official Bosch parts and one using the contacts I included in your shipment.

You can either solder wires directly to the NAW_OEM module or you can solder on 7 position 0.1" pitch Molex connectors that I sell on my site.

Be sure to place NAW_OEM in a well ventilated place, something like a glove compartment will not be sufficient.

Do not swap the left plug for the right plug and power on NAW_OEM, doing so will burn out the microcontroller. Both Molex plugs on each side have the same 7 pin connector and it is quite easy to mistakenly swap the plugs. Symptoms of a burnt micro due to swapped plugs are; the led display turns on briefly and then turns off, TP_5v is much lower than 5v.

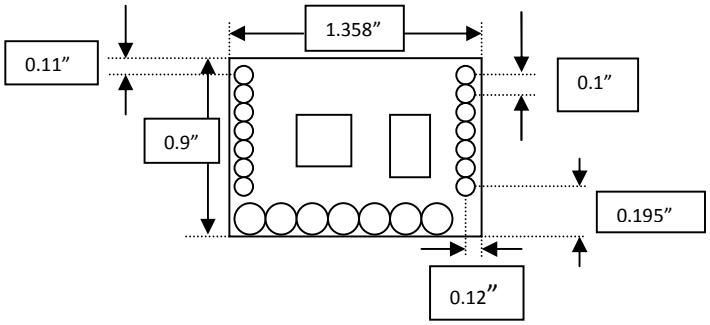
NAW OEMs sold prior to 2010 have a linear output that is 9-19 AFR, 0.61 to 1.29 Lambda.

NAW OEMs sold in 2010 have a linear output that is 10-20 AFR, 0.68 to 1.36 Lmbda

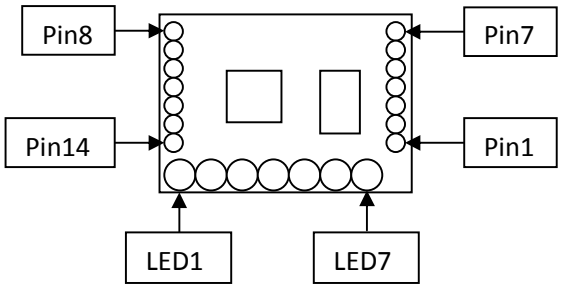
NAW_OEM Module Features:

- Smallest wideband controller in the world
- Lowest priced wideband controller in the world
- 99% assembled
- 0.01 Lambda accuracy
- 7 LED display of AFR/Lambda
- Supports dual LED display of LSU temperature
- Simulated Narrowband output
- Digital PID temperature controller
- Digital PID pump cell controller
- Built in 5v regulator
- Over voltage and reverse voltage protected
- Onboard self resetting thermal fuse for over current protection

NAW_OEM Dimensions:



NAW_OEM Pin Out Diagram:



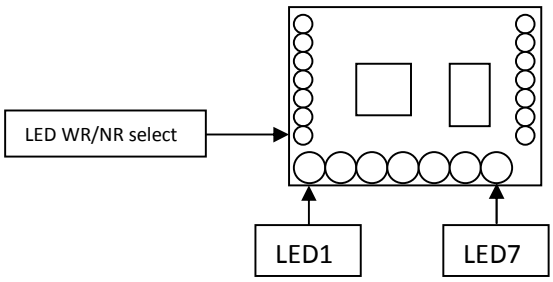
NAW_OEM Pin Out Table:

Pin #	Name	Connects to	Note
1	Power	10-18v Positive supply	Should be “live” when key is “on”, close to +ve battery terminal. 50ma typical, 100ma max.
2	System Ground	–ve battery terminal	Close to battery –ve terminal. 50 ma typical, 100 ma max.
3	LSU Heater Ground	–ve battery terminal	Atleast 30cm farther away from where Pin2 is connected. 1 amp typical, 3 amp max.
4	LSU Heater –ve supply	LSU Terminal 4	1 amp typical, 3 amp max.
5	LSU Virtual Ground	LSU Terminal 5	25ma max
6	LSU Sensor Feedback	LSU Terminal 1	25ma max
7	LSU Sensor Ia	LSU Terminal 2	25ma max

8	LSU Sensor Ip	LSU Terminal 6	25ma max
9	0-5v Linear Output	Datalogger, Aftermarket ECU, etc…	Can source/sink 25ma max.
10	Heater Status 0	LED	Optional. TTL output
11	Heater Status 1	LED	Optional. TTL output
12	Simulated Narrowband Output	Stock ECU	Can source/sink 25ma max.
13	Not Used	Not Used	
14	LED WR/LR Select	Ground for LED Display Wide Range, unconnected for Narrow Range	TTL, do not connect this to a voltage source more than 5v above System Ground.

**The LSU Heater +ve Supply, LSU Terminal 3, connects directly to switched 12v.

LED Display:



The 7 LEDs showing AFR/Lambda are optional, solder on the LEDs if you want a display. Any “3mm round LED” should work. Chose the color of LEDs you feel is appropriate. The “Cathode”, shorter lead, of the LED goes into the “left” hole. The “anode”, longer lead, of the LED goes into the “right” hole.

Normally the LEDs are mounted vertically, in that case the LEDS will be most visible when looking at the module directly from above. You can also mount them horizontally, so that you can lay the module flat on your dashboard and be able to clearly see the LEDs while in the driver’s seat. To mount them horizontally you should make a 90 degree bend on the LED leads and then solder the LEDs to the module.

There are 2 display modes for the 7 LED display; WR (Wide Range) and NR (Narrow Range). Ground the “LED WR/NR” pin for Narrow Range. For Wide Range leave the pin unconnected. Be sure to never attach a voltage source greater than 5v above System Ground to the “LED WR/NR” pin, doing so will destroy the module.

In Wide Range each LED represents a resolution of 1 AFR, in Narrow Range each LED represents a resolution of 0.5 AFR.

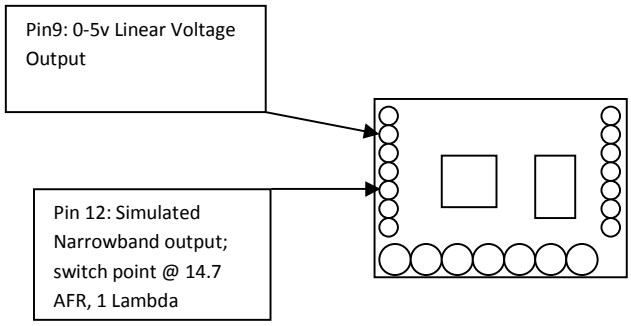
Wide Range LED Output:

AFR	Lambda	LED1	LED2	LED3	LED4	LED5	LED6	LED7
AFR<11	Lambda<0.748	On	off	Off	Off	off	Off	off
11<AFR<12	0.748<Lambda<0.816	Off	On	Off	Off	off	Off	off
12<AFR<13	0.816<Lambda<0.884	Off	off	On	Off	off	Off	off
13<AFR<14	0.884<Lambda<0.952	Off	off	Off	On	off	Off	off
14<AFR<15	0.952<Lambda<1.020	Off	off	Off	Off	On	Off	off
15<AFR<16	1.020<Lambda<1.088	Off	off	Off	Off	off	On	off
16<AFR	1.088<Lambda	Off	off	Off	Off	off	Off	On

Narrow Range LED Output:

AFR	Lambda	LED1	LED2	LED3	LED4	LED5	LED6	LED7
AFR<11	Lambda<0.748	On	off	Off	Off	Off	Off	off
11<AFR<11.5	0.748<Lambda<0.782	Off	On	Off	Off	Off	Off	off
11.5<AFR<12	0.782<Lambda<0.816	Off	off	On	Off	Off	Off	off
12<AFR<12.5	0.816<Lambda<0.850	Off	off	Off	On	Off	Off	off
12.5<AFR<13	0.850<Lambda<0.884	Off	off	Off	Off	On	Off	off
13<AFR<13.5	0.884<Lambda<0.918	Off	off	Off	Off	Off	On	Off
13.5<AFR	0.918<Lambda	Off	off	Off	Off	Off	Off	On

Linear and Simulated Narrowband Output:

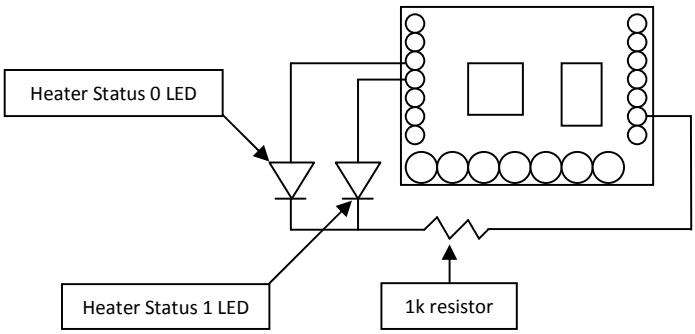


Pin 9 is the 0-5v Linear Output, the output is linear to the AFR/Lambda of the exhaust gas. For units purchase prior to 2010 the range is 9-19 AFR, 0.6122-1.293 Lambda. For units purchased in 2010 the range is 10-20 AFR, 0.68-1.36 Lambda

Whenever the NAW_OEM module is powered up the module goes through a 30 second heatup routine to gently bring the Bosch LSU sensor up to proper temperature. During the first 15 seconds the Linear output is programmed to output 5/3=1.66667 [volts]. From 15 to 30 seconds the output is programmed to output 10/3=3.33333[volts]. For advanced users, this information allows you to determine what offset and linear errors there are on the voltage output. During programming I calibrate the voltage output to remove majority of the offset and linear errors, what errors are left over is due to temperature and your vehicle's electrical system, supply voltage.

Pin 12 is the Simulated Narrowband Output, the switch point is 14.7 AFR, 1 Lambda.

Heater Status LEDs:



The Heater Status LEDs are optional. The LEDs are connected externally, they are not soldered to the NAW_OEM board.

Heater Status LED 0	Heater Status LED 1	Sensor Temperature
On	Off	Cold
Off	On	Perfect
On	On	Too hot

During normal operations the Heater Status LEDs should almost always show that the sensor temperature is “perfect”.

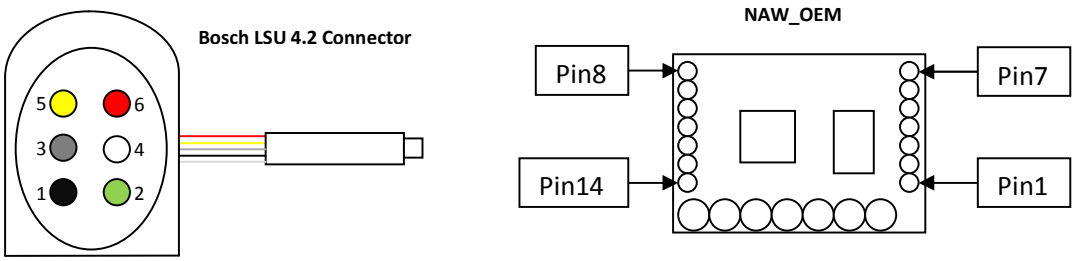
Whenever the NAW_OEM module is powered up the module goes through a 30 second heatup routine to gently bring the Bosch LSU sensor up to proper temperature. If you connected the Heater Status LEDs, it will show that the sensor is “cold” during the heatup routine. After 30 seconds the Heater Status LEDs should show that the sensor temperature is “perfect”.

If you did not connect the Heater Status LEDs, you can use a voltmeter to test the Heater Status Pins to determine the sensor’s temperature, “On” = 5v and “Off” = 0v.

Enclosure:

To keep cost low, the NAW_OEM module was not designed with a specific enclosure in mind. However a “Tic Tac” breath mints box looks to be the perfect case. If you use an enclosure, please make sure that there are ventilation holes at the top and bottom of the enclosure to reduce heat buildup.

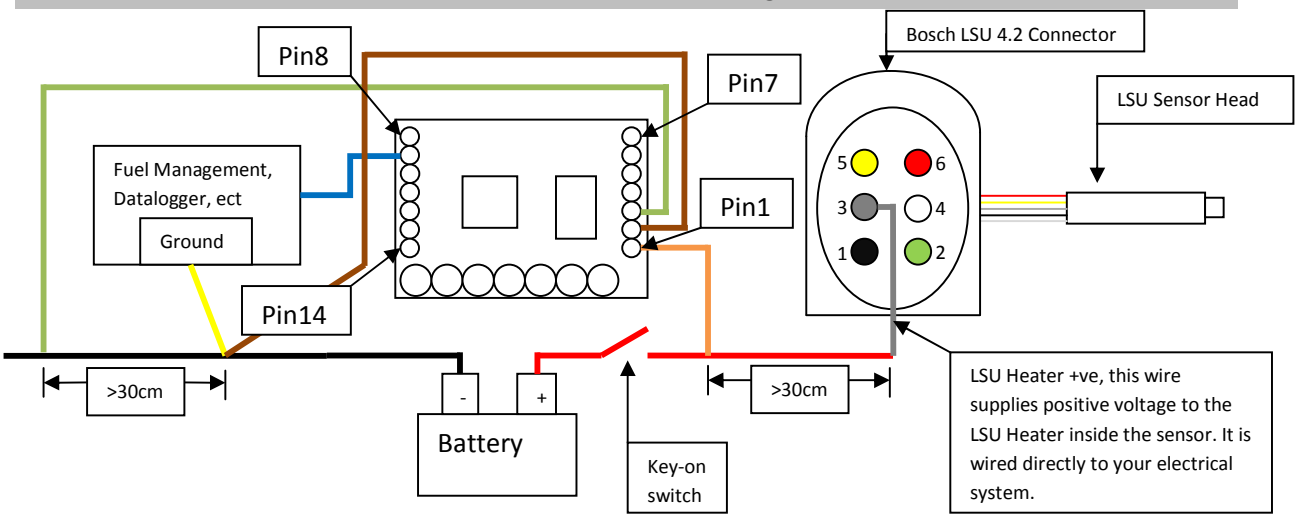
Bosch LSU 4.2 Connection Table



*On the Bosch connector the terminals are numbered just like in the picture.

Bosch LSU Terminal #	Connects to	Note
1	NAW_OEM Pin 6	
2	NAW_OEM Pin 7	
3	Switched 12v	Provides 10-18v only when 'key-on"
4	NAW_OEM Pin 4	
5	NAW_OEM Pin 5	
6	NAW_OEM Pin 8	

Power and Ground Wiring:



Use Wires that are "multi-stranded" and rated for atleast 3 amps, AWG of 20 or lower.

Refer to the "Wideband Cable Construction Guide" for how to make the Bosch LSU sensor harness.

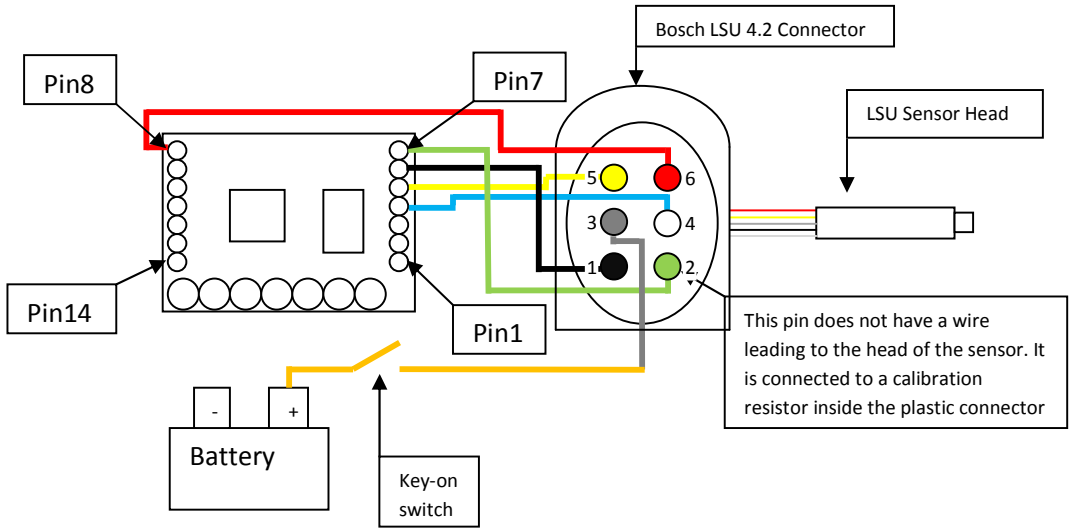
In the diagram above, the "blue" wire is not part of the Power and Ground wiring, it is there for illustration purposes only to show a device connected to the Linear Output.

In the diagram above, the “Grey” wire, LSU Heater +ve, connects directly to “key-on” voltage. The connection should be atleast 30cm farther away from the battery with respect to where the “Orange” wire, NAW_OEM Power Pin, is connected.

In the diagram above, the “Brown” wire, NAW_OEM System Ground, should connect to the same point as the device connected to the Linear Output pin of NAW_OEM. This will minimize any voltage offsets seen by the device connected to the Linear Output pin. If no device is connected to the Linear Output then connect the NAW_OEM System Ground close to the –ve battery terminal as possible.

In the diagram above, the “Green” wire, LSU Heater Ground, connects directly to Ground, -ve battery terminal. The connection should be atleast 30cm farther away from the battery with respect to where the “Green” wire, NAW_OEM System Ground, is connected.

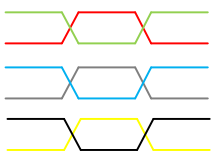
LSU Sensor Wiring:



Use Wires that are “multi-stranded” and rated for atleast 3 amps, AWG of 20 or lower.

Refer to the “Wideband Cable Construction Guide” for how to make the Bosch LSU sensor harness.

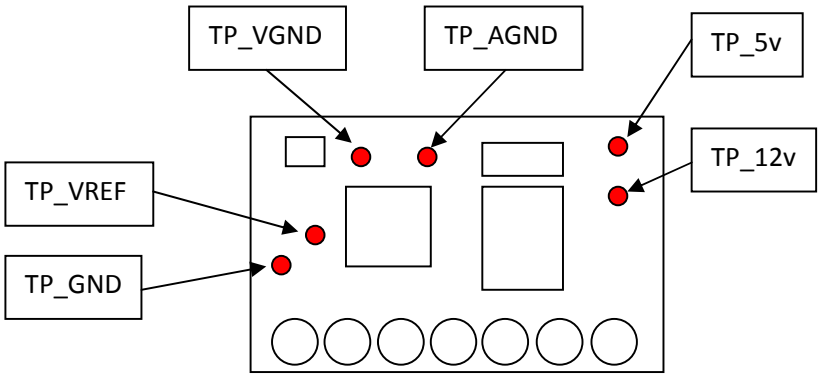
It is a good idea to twist the “Green” and “Red” wires together, “Blue” and “Grey” wires together, “Yellow” and “Black” wires together, this will add some noise immunity.



Testing the unit before installation:

There are 2 tests; a “power on test” without the sensor connected and a “lighter test” with the sensor connected. Perform the “power on” test first to verify that the unit is functional before performing the “lighter test”. Performing the “lighter test” is very important before you install the LSU sensor into your exhaust, you must verify that the module is correctly heating up the sensor or the sensor will be “fouled” due to carbon build up.

There are several test points to help you test the unit with a voltmeter. “TP_GND” and “System Ground”, Pin 2, are the same potential, it maybe easier to use “System Ground” instead of “TP_GND”



Power On test:

This test is performed without the sensor attached to verify that the module is functional. It is recommended that you use a power source that can supply atleast 100 ma of current, a 9v battery should be ok.

1. Attached a 9v-18v power source to Pin1 of the NAW_OEM module
2. Attached ground to pin2 of the NAW_OEM module
3. If you soldered on the LED display you should see that one of the LEDs is light
4. With a voltmeter, check the voltage between the 2 test points on the module; “TP_5v” and “TP_GND”, the voltage should be between 4.75v to 5.25v. The closer to 5v the better.
5. With a voltmeter, check the voltage between the 2 test points on the module; “TP_Vref” and “TP_GND”, the voltage should be between 2.40 to 2.66v. The closer to 2.53v the better.
6. With a voltmeter, check the voltage between the 2 test points on the module; “TP_AGND” and “TP_GND”, the voltage should be between 2.05v to 2.11v. The closer to 2.08v the better.
7. With a voltmeter, check the voltage between the 2 test points on the module; “TP_VGND” and “TP_AGND”, the voltage should be between -0.1 to 0.1v. The closer to 0v the better.

Lighter Test:

This test makes use of the cigarette lighter to supply the sensor with rich gas to simulate rich exhaust gas.

1. Install and wire everything up according to the “Power and Ground Wiring” and “LSU Sensor Wiring” section of this user manual. If you have a benchtop power supply that is capable of supplying 3 amps @ 10v-18v, you can use that rather than your automobile’s electrical system.
2. Ensure that the LSU sensor is in free air, away from exhaust gases.
3. Power up the NAW_OEM module, but do not start your engine.
4. If you connected the Heater status LEDs, it should show that the sensor is “cold”. If you did not connect the Heater Status LEDs, you can use a voltmeter; Heater Status Pin0 should be 5v and Heater Status Pin1 should be 0v.
5. Wait 30 seconds, if you connected the Heater status LEDs, it should show that the sensor is “perfect”. If you did not connect the Heater Status LEDs, you can use a voltmeter; Heater Status Pin0 should be 0v and Heater Status Pin1 should be 5v.
6. Measure the Linear voltage output Pin with a voltmeter, it should be very close to 5v.
7. If you soldered the LED display, LED 7 should be on, LED1-LED6 should be off.
8. Use a lighter and give the “head” of the Bosch LSU sensor some gas, do not light the gas, be careful the sensor is very hot. You should see that Linear Voltage Output drop close to 0v and that the LED display cycles from lean to rich.

Troubleshooting:

If you have problems with the NAW_OEM module, please perform “Troubleshoot Test1” and “Troubleshoot Test2”, this will help me diagnose the problem.

Troubleshoot Test1:

1. Install and wire everything up according to the “Power and Ground Wiring” and “LSU Sensor Wiring” section of this user manual.
2. Ensure that the LSU sensor is in free air away from exhaust gases.
3. Power up the NAW_OEM module using your car battery, do not start the car, you do not want electrical interference.
4. If you connected the Heater status LEDs, it should show that the sensor is “cold”. If you did not connect the Heater Status LEDs, you can use a voltmeter; Heater Status Pin0 should be 5v and Heater Status Pin1 should be 0v.
5. Wait 30 seconds , if you connected the Heater status LEDs, it should show that the sensor is “perfect”. If you did not connect the Heater Status LEDs, you can use a voltmeter; Heater Status Pin0 should be 0v and Heater Status Pin1 should be 5v.
6. Measure the Linear voltage output Pin with a voltmeter, it should be very close to 5v.
7. If you soldered the LED display, LED 7 should be on, LED1-LED6 should be off.
8. With a voltmeter, check the voltage between the 2 test points on the module; “TP_5v” and “TP_GND”, the voltage should be between 4.75v to 5.25v. The closer to 5v the better.
9. With a voltmeter, check the voltage between the 2 test points on the module; “TP_Vref” and “TP_GND”, the voltage should be between 2.40 to 2.66v. The closer to 2.53v the better.
10. With a voltmeter, check the voltage between the 2 test points on the module; “TP_AGND” and “TP_GND”, the voltage should be between 2.05v to 2.11v. The closer to 2.08v the better.
11. With a voltmeter, check the voltage between the 2 test points on the module; “TP_VGND” and “TP_AGND”, the voltage should be between -0.1 to 0.1v. The closer to 0v the better.
12. With a voltmeter, check the voltage between Pin 6 and “TP_VGND”, the voltage should be very close to 0.45v.
13. With a voltmeter, check the voltage between Pin 6 and “TP_GND”, the voltage should be very close to 2.53v.

Troubleshoot Test2:

This test is almost the same as the "Troubleshoot Test1", except that this time the LSU sensor is installed into your exhaust stream and the engine started.

1. Install and wire everything up according to the "Power and Ground Wiring" and "LSU Sensor Wiring" section of this user manual.
2. Install the LSU sensor into the exhaust stream.
3. Power up the NAW_OEM module by starting your engine.
4. If you connected the Heater status LEDs, it should show that the sensor is "cold". If you did not connect the Heater Status LEDs, you can use a voltmeter; Heater Status Pin0 should be 5v and Heater Status Pin1 should be 0v.
5. Wait 30 seconds , if you connected the Heater status LEDs, it should show that the sensor is "perfect". If you did not connect the Heater Status LEDs, you can use a voltmeter; Heater Status Pin0 should be 0v and Heater Status Pin1 should be 5v.
6. Measure the Linear voltage output Pin with a voltmeter, it should be very close to 5v.
7. If you soldered the LED display, LED 7 should be on, LED1-LED6 should be off.
8. With a voltmeter, check the voltage between the 2 test points on the module; "TP_5v" and "TP_GND", the voltage should be between 4.75v to 5.25v. The closer to 5v the better.
9. With a voltmeter, check the voltage between the 2 test points on the module; "TP_Vref" and "TP_GND", the voltage should be between 2.40 to 2.66v. The closer to 2.53v the better.
10. With a voltmeter, check the voltage between the 2 test points on the module; "TP_AGND" and "TP_GND", the voltage should be between 2.05v to 2.11v. The closer to 2.08v the better.
11. With a voltmeter, check the voltage between the 2 test points on the module; "TP_VGND" and "TP_AGND", the voltage should be between -0.1 to 0.1v. The closer to 0v the better.
12. With a voltmeter, check the voltage between Pin 6 and "TP_VGND", the voltage should be very close to 0.45v.
13. With a voltmeter, check the voltage between Pin 6 and "TP_GND", the voltage should be very close to 2.53v.