

**ECM** ENGINE CONTROL  
AND MONITORING

# **NH<sub>3</sub> 5250**

**Single/Dual NH<sub>3</sub> Analyzer**

## **Instruction Manual**

2/25/15

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## Introduction

### The NH<sub>3</sub> 5250

The NH<sub>3</sub> 5250 is a compact, ceramic sensor-based NH<sub>3</sub> analyzer for the development of engine aftertreatment systems. Its features include:

- Single or dual channel NH<sub>3</sub> sensor operation
- 0 to 2000 ppm range (for lean mixtures only)
- Calibration data for NH<sub>3</sub> sensor stored in sensor's connector
- Six programmable 0 to 5V or 0 to 1V analog outputs
- CAN output and .dbc generation software
- Up to 100 m between NH<sub>3</sub> sensor and display possible
- "Lockout" feature for front panel of display
- Power on/off can be controlled by external "key" signal
- 11-28 VDC and 95-250 VAC<sup>1</sup> operation

It is important to realize that when in the exhaust of a running engine, the NH<sub>3</sub> sensor is seeing H<sub>2</sub>O as just another gas. Therefore, it will report "wet" NH<sub>3</sub> ppm numbers. Classical gas analysis equipment typically (but not always) has the water removed from the gases before they reach the analyzer. Thus classical gas analyzers will report "dry" numbers which are always greater than "wet" numbers. When comparing "wet" to "dry" numbers, make sure to correct for the removed water.

The NH<sub>3</sub> sensor is designed to be used downstream of a SCR (Selective Catalytic Reduction) catalyst or where there are not significant amounts of CO (carbon monoxide). This is due to the sensor's cross-sensitivity to CO (i.e. 40 ppm CO appears as 1 ppm NH<sub>3</sub>).

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<sup>1</sup> With optional P/N 04-01 AC/DC Power Supply.

## **NH<sub>3</sub> 5250 Kit Contents**

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The following items are included with a single-channel, NH<sub>3</sub> 5250 kit:

<b>Item No.</b>	<b>Description</b>	<b>Part Number</b>
1.	NH <sub>3</sub> 5250 Display Head	01-10
2.	NH <sub>3</sub> CAN Module	02-12
3.	NH <sub>3</sub> Sensor	06-07
4.	Ceramic Sensor Cable, 1 m	10-02
5.	Eurofast 12 mm Cable, 4 m	09-01
6.	Eurofast 12 mm Cable, 2 m	09-02
7.	Flexi-Eurofast 12mm Cable, 0.3 m, (3 required)	09-04
8.	Eurofast “T”, (4 required)	09-05
9.	Eurofast Termination Resistor, (3 required)	09-06
10.	DC Power Cable, Banana Plugs	11-16
11.	Female Eurofast to DB9F	11-05
12.	Key-on Cable, 2 m	11-08
13.	5200 Series Analyzer and Module Manuals and Configuration Software, CD	13-01
14.	Boss & Plug for NH <sub>3</sub> sensor	12-02

For a dual-channel kit, these additional items are included:

1.	NH <sub>3</sub> CAN Module	02-12
2.	NH <sub>3</sub> Sensor	06-07
3.	Ceramic Sensor Cable, 1m	10-02
4.	Eurofast 12mm Cable, 2 m	09-02
5.	Flexi-Eurofast 12mm Cable, 0.3 m	09-04
6.	Eurofast “T”	09-05
7.	Boss & Plug for NH <sub>3</sub> sensor	12-02

Optional Items:

1.	Ceramic Sensor Cable, 2m	10-03
2.	Ceramic Sensor Cable, 3m	10-37
3.	Eurofast cable, 10m	09-03/10
4.	AC/DC Power Supply, Universal 24VDC @ 4.2A	04-01
5.	Pressure Measurement Kit	
	i. Pressure Sensor, 0-75 psia, 517 kPa	07-05 (USA) or 07-07 (metric)
	ii. Pressure Sensor Tubing	12-08A (USA) or 12-11A (metric)
	iii. Pressure Extension Cable	10-04 (1m)
	iv. Module Y Cable	10-21

## **Safety Warnings**

In installation and use of this product, comply with the National Electrical Code and any other applicable Federal, State, or local safety codes.

The NH<sub>3</sub> sensor is heated, gets hot, and can burn you.

Always wear eye protection when working near engines, vehicles, or machinery.

During installation, turn off the power and take all other necessary precautions to prevent injury, property loss, and equipment damage. Do not apply power until all wiring is completed.

Never work on a running engine.

When installing the NH<sub>3</sub> 5250s cabling and sensor(s) on a stopped engine, it is best to think-out your moves before you make them.

Route and cable-tie all cables away from hot, moving, sharp, or high voltage (spark) objects.

Take into consideration the movement of the engine, chassis, and wind buffeting when instrumenting the engine.

Clear tools away from the engine before starting.

Operate the engine only in a well ventilated area and never when you or one of your co-workers is tired.

When operating the NH<sub>3</sub> 5250 in a moving vehicle, the operator should keep his or her eyes on the road.

One measure of professionalism is how much you and your co-workers can accomplish without an injury. Always be at your professional best. Think and act with safety in mind.



## How to Use

### Hooking up the NH<sub>3</sub> 5250

The NH<sub>3</sub> 5250 kit consists of 4 parts:

1. The display head
2. The module(s)<sup>1</sup>
3. The sensor(s)
4. Cabling

The NH<sub>3</sub> 5250 is unique in that it puts a control module close to the NH<sub>3</sub> sensor. There are several advantages of doing this; the main ones are: improvements in signal-to-noise ratio, multi-channel capability, simplified cabling, and an almost unlimited sensor-to-display head distance.

The cable between the display head and module(s) is called the EIB (ECM Instrument Bus) and carries signal and power. There must be a termination resistor at each end of the EIB. The EIB can be powered at either the module end (Figure 1) or the display head end (Figure 2). To minimize the power voltage drop on the EIB, it is preferable to power the EIB from the end closest to the module(s) because that is where most of the power is being consumed (by the NH<sub>3</sub> sensor).

Branches/drops to display head(s) and module(s) are made from tees attached to the EIB. Up to 32 display heads and modules (total) can exist on the same EIB. The EIB cable, tees, and termination resistors are industry-standard Eurofast 12 mm. The EIB can be extended to a length of 100 m.

The NH<sub>3</sub> 5250 can be turned on and off by the PWR button on the front of the display head or by a voltage signal (2.7 - 32 V) applied to the KEY connector on the back of the display head. The current requirements of this voltage signal are very low (100 µA).

After being turned on, the display head will test both displays and all leds and then show:

1. The display head's serial number
2. The version of the display head's software
3. The calibration date of the display head (MM.DD YYYY)
4. The serial number (see Figure B1) of the NH<sub>3</sub> module assigned to the upper channel and the serial number of the NH<sub>3</sub> module assigned to the lower channel.  
“...” means no NH<sub>3</sub> module has been assigned to the channel.
5. Parameter data from the NH<sub>3</sub> module assigned to that channel.

Figures 3 through 5 show details and part numbers of components in Figures 1 and 2. Optional components are also shown.

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<sup>1</sup> Modules can be setup in EIB Mode or Stand-alone Mode. When the modules are used with a display head, they must be in EIB mode. See Appendix B for more information.

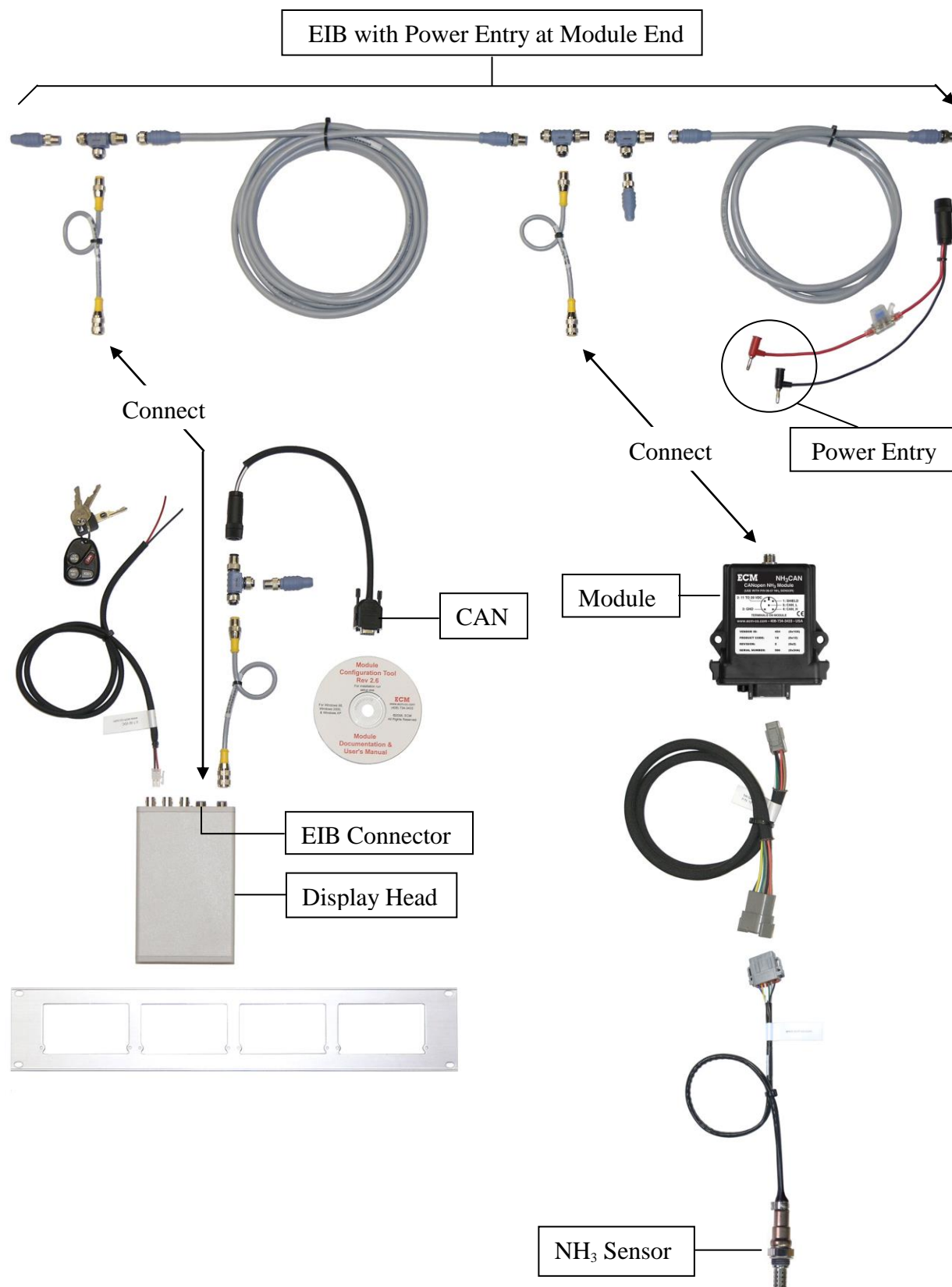


Figure 1: NH<sub>3</sub> 5250 with Power Entry at Module End



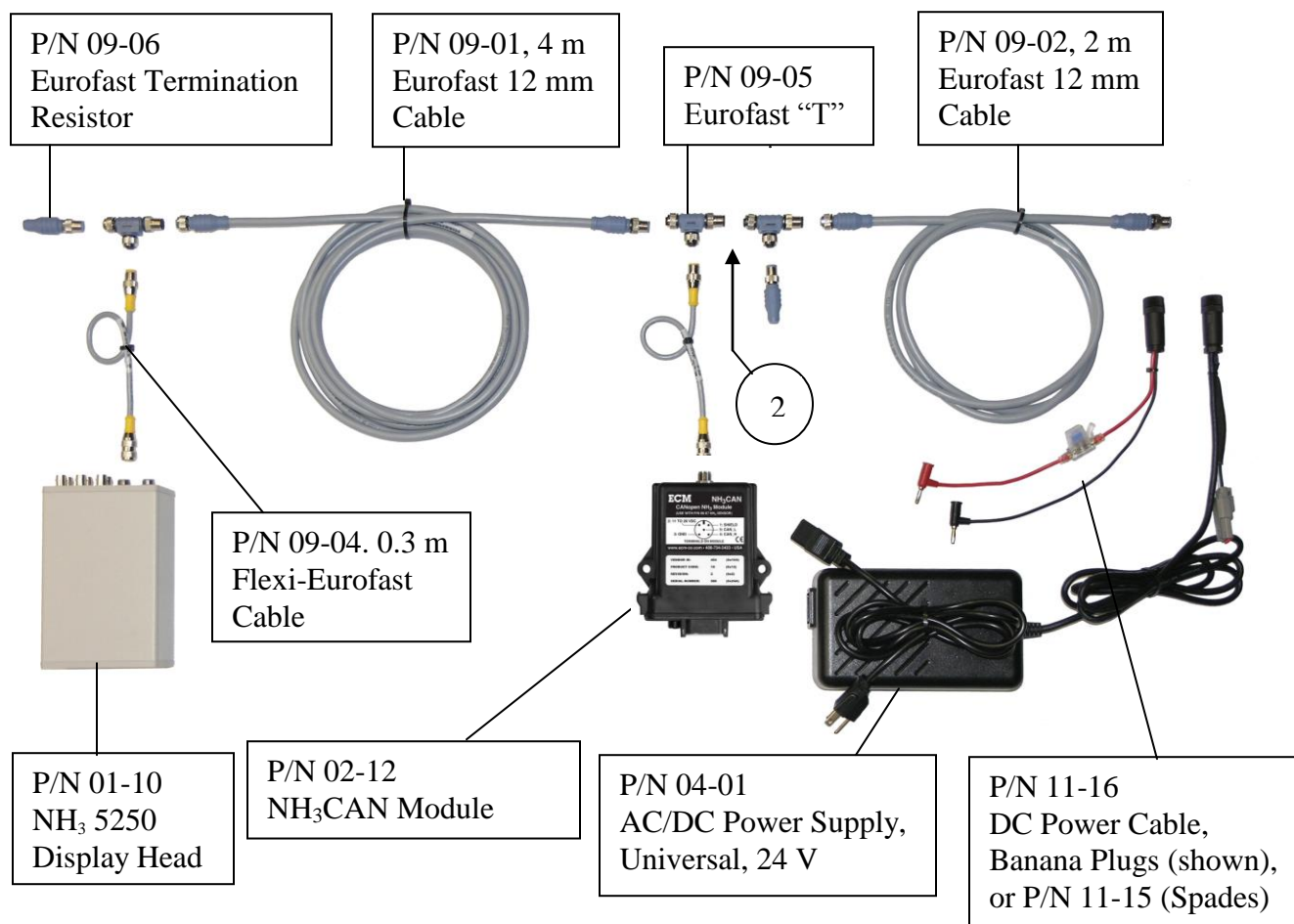


Figure 3a: Part Numbers of Components on EIB

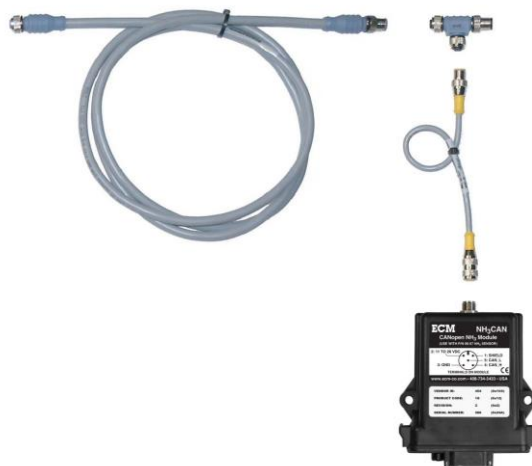


Figure 3b: Add above in Location "2" for Second NH<sub>3</sub> Channel

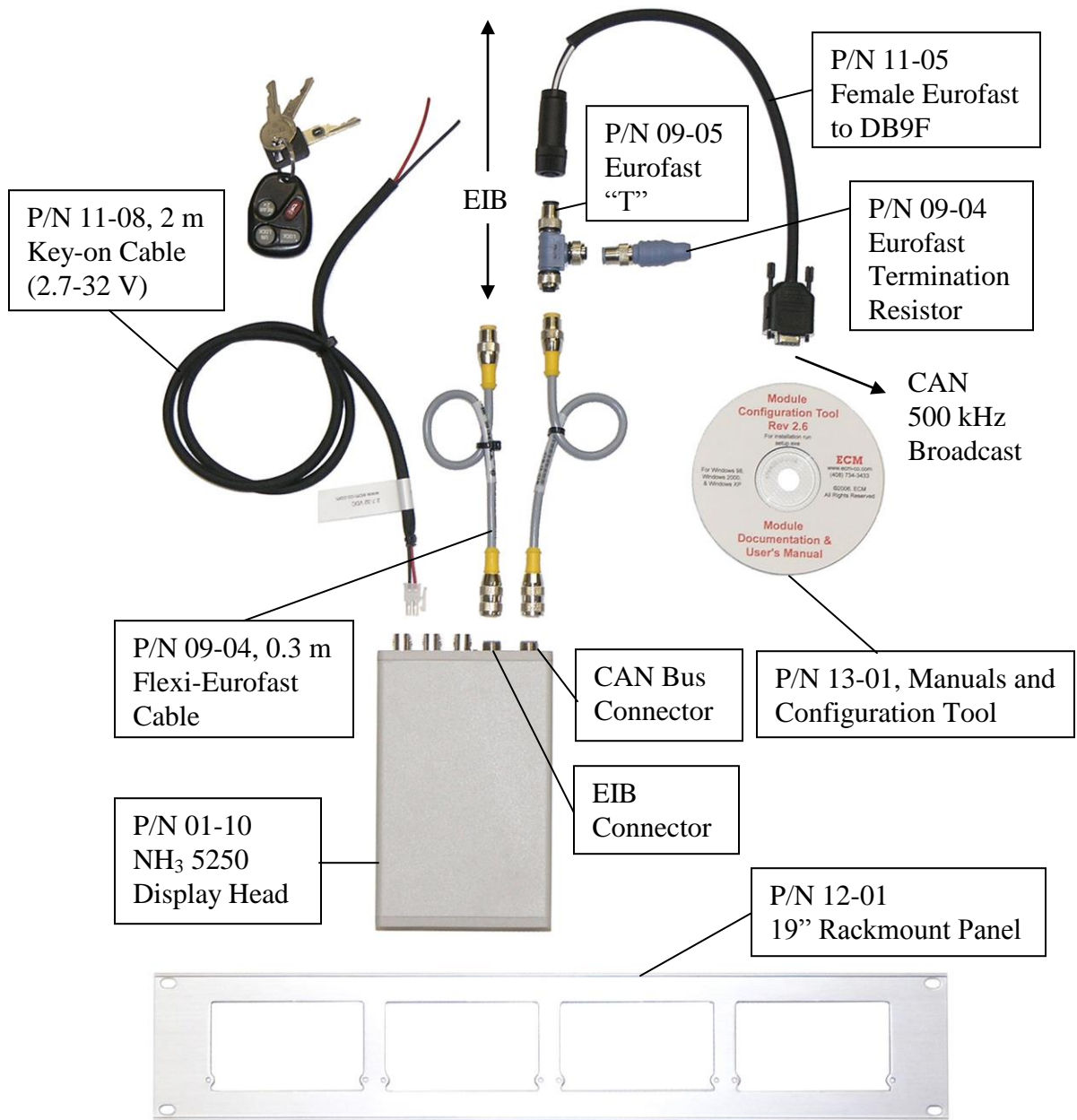


Figure 4a: Part Numbers of Components near Display Head



Figure 4b: Front and Back of Display Head

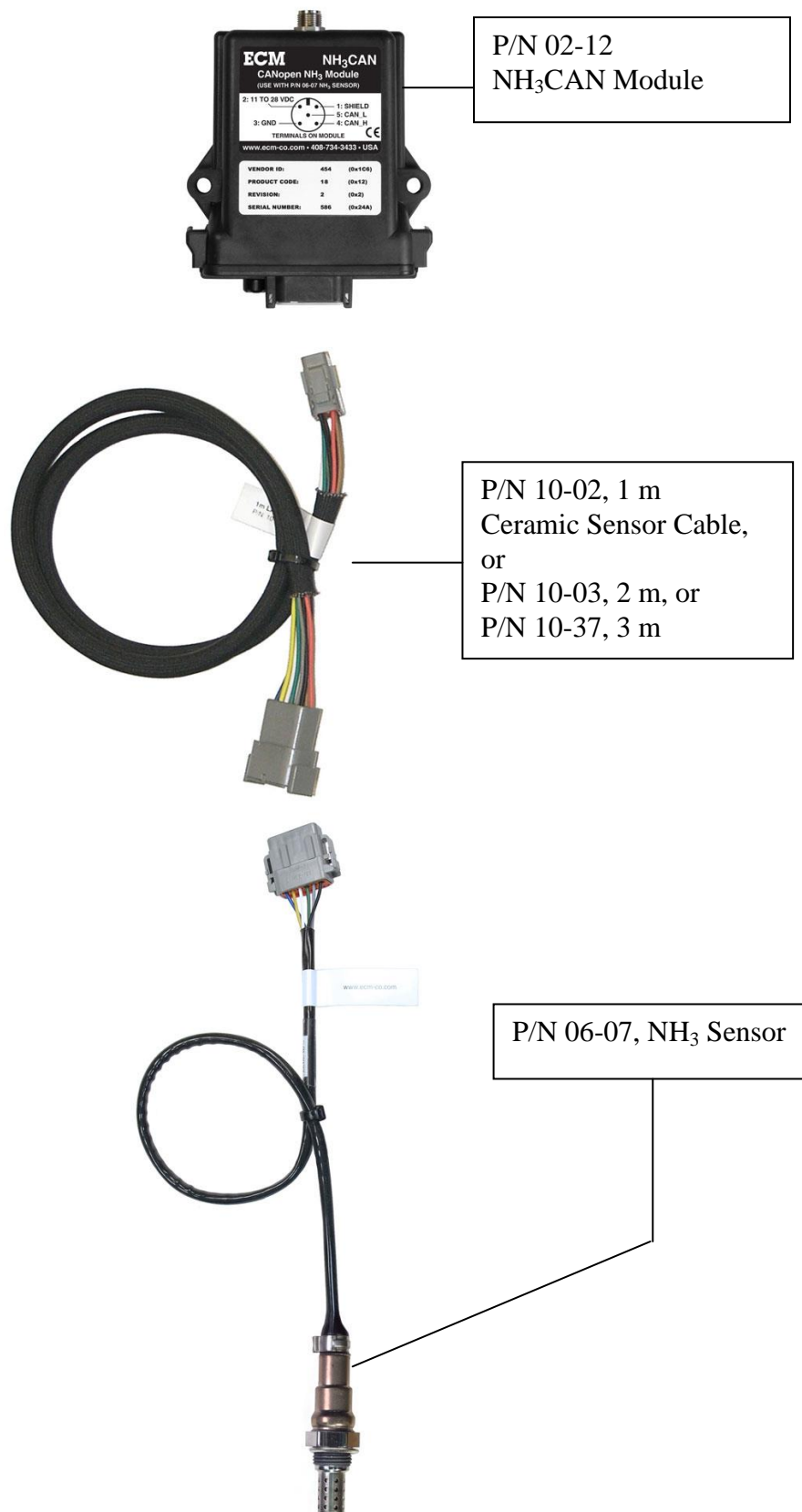


Figure 5: Part Numbers of Components near Module

## Mounting the NH<sub>3</sub> Sensor

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### ◆ NH<sub>3</sub> Sensor

- Thread is 18mm x 1.5mm
- Mount downstream of the SCR (Selective Catalytic Reduction) catalyst or where there are not significant amounts of CO (carbon monoxide). This is due to the sensor's cross-sensitivity to CO. To avoid reversion effects, mount at least ten exhaust diameters upstream of exhaust end.
- Do not exceed 450 °C exhaust gas temperature at location of sensor.
- Mount where condensed material will not collect on the sensor (ex. if the section of exhaust pipe where the sensor is to be mounted is parallel to the ground, the sensor should be mounted on the upper half of the pipe).
- Run tap into thread of mounting boss before screwing in sensor.
- Put antiseize on threads and lightly tighten sensor.
- Occasionally run tap through mounting boss to clean threads.
- Occasionally clean threads on sensor with small metal brush.
- Do not operate engine with NH<sub>3</sub> sensor not being powered.
- Route NH<sub>3</sub> sensor cable away from hot, moving, sharp, or high voltage (spark) wires.



## Front Panel and the “SYS” Key

The NH<sub>3</sub> 5250 display head can be thought of as two single-channel display heads in one package. One NH<sub>3</sub> module can be assigned (via the **Mod Setup Option**) to the upper display, upper four leds, and analog outputs 1, 2, 3 (i.e. the upper channel) and a second NH<sub>3</sub> module can be assigned to the lower display, lower four leds, and analog outputs 4, 5, 6 (i.e. the lower channel). Or one NH<sub>3</sub> module can be assigned to both channels. If no module is assigned to a channel, “...” appears on that channel’s display. More than two NH<sub>3</sub> modules can exist on the EIB but a given display head can only show data from two of them. Adding another display head to the EIB will allow data from another two NH<sub>3</sub> modules to be displayed.

The display head has two modes of operation: RUN (when measurements or error codes are displayed) and SYS (where the instrument is set-up). The SYS key toggles between the modes.

When in RUN mode, the parameter being displayed is indicated by leds to the right of the display. There are four leds for each display and each led can be red or green. One parameter (NH<sub>3</sub>) is fixed and seven (P1 to P7 or P8 to P14) are programmable from the list of parameters in Table 2. The ↑ and ↓ keys select which of the eight parameters are displayed (unless the display is LOCKed, see below).

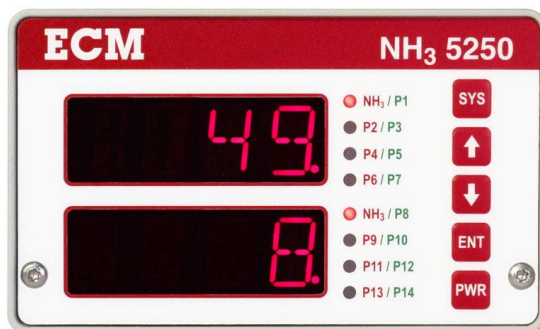
While in RUN mode, pressing the ENT key will toggle between the ↑ and ↓ keys changing parameters on one channel’s display to changing parameters on the other channel’s display.

In RUN mode, four things other than data can be displayed:

1. “ERR” and “####” where “####” is an error code. See **Appendix C**.
2. “...” which means that a NH<sub>3</sub> module has not been assigned to that channel. See **MOd Setup Option**.
3. “----” which means that the display head has an internal problem.
4. “XXXX” which means that the display is not receiving any data.
5. “Rotating wheels” and sensor countdowns.

When first entering SYS mode, either “MOd” will be on the upper display or “LOCK” will be on the lower display. If “MOd” is displayed, the ↑ and ↓ keys will roll through the setup options (see Table 1). First the options for the upper channel are shown on the upper display, followed by identical options for the lower channel on the lower display, ending with the global CONF (Configuration) setup. Pressing the ENT key will select the displayed setup option and allow its programming.

If “LOCK” is displayed, the display head has been locked and neither the parameters displayed nor the instrument setup can be changed until it is unlocked. Appendix D describes how to LOCK and unLOCK the display head.





Setup Option	Level 1	Level 2	Level 3	Function
MOd				Select module s/n [NONE]
RATE				Set display update rate [FAST]
AOUT	A1 (upper channel)			Program analog output 1 [NH3,0,2000]
	A2 (upper channel)			Program analog output 2 [VH,0,15.00]
	A3 (upper channel)			Program analog output 3 [P,0,500]
	A4 (lower channel)			Program analog output 4 [NH3,0,2000]
	A5 (lower channel)			Program analog output 5 [VH,0,15.00]
	A6 (lower channel)			Program analog output 6 [P,0,500]
dISP	P1 (upper channel)			Program upper display parameter P1 [RPVS]
	P2 (upper channel)			Program upper display parameter P2 [VHCM]
	P3 (upper channel)			Program upper display parameter P3 [VSW]
	P4 (upper channel)			Program lower display parameter P4 [VH]
	P5 (upper channel)			Program lower display parameter P5 [VS]
	P6 (upper channel)			Program lower display parameter P6 [P]
	P7 (upper channel)			Program lower display parameter P7 [TEMP]
	P8 (lower channel)			Program upper display parameter P8 [RPVS]
	P9 (lower channel)			Program upper display parameter P9 [VHCM]
	P10 (lower channel)			Program upper display parameter P10 [VSW]
	P11 (lower channel)			Program lower display parameter P11 [VH]
	P12 (lower channel)			Program lower display parameter P12 [VS]
	P13 (lower channel)			Program lower display parameter P13 [P]
	P14 (lower channel)			Program lower display parameter P14 [TEMP]
CAL	NH3	ZERO		Calibrate NH <sub>3</sub> sensor zero
		SPAN		Calibrate NH <sub>3</sub> sensor span
		FACT		Reset NH <sub>3</sub> sensor (zero and span) to factory calibration for NH <sub>3</sub>
	P	UNIT		Choose pressure units [KPA]
		N, C		Enter pressure sensor calibration numbers
	AVG	NH3		Program NH <sub>3</sub> averaging [0.375]
		P		Program Pressure averaging [0.375]
	SKEW	NH3		Program gain and offset modifier [1,0]
		P		Program gain and offset modifier [1,0]
CONF	LEdS			Set display intensity [3333]
	1V4V			Check analog outputs at 1V and 4V
	CAN	IdS		Program CAN addresses and produce .dbc file [1~5]
		RATE		Program CAN transmit rate [5 ms]
		BAUd		Program CAN baud rate [500k]
	LOCK			Lock display
	FACT	RST		Reset analyzer to factory defaults (see “[ ]”) values but... any user NH3 cal is retained

MOd ~ CAL appear on the upper or lower display for the upper or lower channel. CONF is for global setup. All entries must be followed by pressing the ENT key. Default values shown in square parentheses.

Table 1: Menu Tree for NH<sub>3</sub> 5250

## **MOd (Module) Setup Option**

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In MOd setup, the serial number of the NH<sub>3</sub> module assigned to the upper or lower channel is entered. The serial number is written on a label on the module (see Figure B1). The module assigned to the upper channel will send information to the upper display and the analog outputs 1, 2, and 3. The module assigned to the lower channel will send information to the lower display and the analog outputs 4, 5, and 6. The same module can be assigned to both channels.

After entering MOd (i.e. press ENT when “MOd” is displayed), the serial numbers of the available modules on the EIB will displayed. Select using ↑ and ↓ followed by the ENT key.

## **RATE Setup Option**

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Different display update rates can be assigned to the upper and lower displays. The selected display update rate does not affect the analog output update rate or the CAN transmission rate.

## **AOuT (Analog Output) Setup Option (A1 to A6)**

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The display head has six programmable analog outputs. Each output can be programmed as 0 to 5V or 0 to 1V. The analog outputs are updated every 5 ms based on information sent to it by a NH<sub>3</sub> module every 5 ms. 5 ms is the maximum rate and is not programmable. The module averages the data before it is sent at this 5 ms rate. There is programmable averaging filter for NH<sub>3</sub> and one for pressure. See **CAL Setup Option** (AVG Suboption) for more information.

Parameter information from the module assigned to the upper channel can be sent to analog outputs 1, 2, and 3. Parameter information from the module assigned to the lower channel can be sent to analog outputs 4, 5, and 6.

The parameter selected to drive an analog output can be anything from Table 2.

Here is an example of setting the analog output 2 (i.e. A2):

1. Press the SYS key until “MOd” is displayed.
2. Press the ↓ key until “AOuT” is on the top display. Then press the ENT key.
3. Press the ↓ key until “A2” (analog output 2) is on the display. Then press the ENT key.
4. Press the ↑ and ↓ keys until the parameter (see Table 2) that will drive A2 is displayed. Then press the ENT key.
5. Press the ↑ and ↓ keys to select 0V to 5V or 0V to 1V output. Then press the ENT key.
6. When 0V is displayed, press ENT. Using the ↑, ↓, and ENT keys, set the parameter value that you want to result in an analog output voltage of 0V on analog output 2. The first time you do this, it may be a little tricky. You are setting one digit at a time and for some numbers, the display will shift to the left so you can set the right-most digits. If you get into trouble when programming, press the SYS key twice to exit and re-enter setup to try again.
7. When 5V (or 1V) is displayed, press ENT. Using the ↑, ↓, and ENT keys, set the parameter value that you want to result in an analog output voltage of 5V (or 1V) on analog output 2.

8. When “AOUT” is displayed, press SYS to return to RUN mode.

For analog outputs 4, 5, and 6, your entries will be shown on the bottom display.

Name	Parameter Description
NH3R	NH <sub>3</sub> before the addition of Delta NH3 Table (ppm)
CEL1	Cell 1 voltage (mV)
CEL2	Cell 2 voltage (mV)
RPVS	NH <sub>3</sub> sensor internal Vs cell resistance (Ohms)
VHCM	Desired heater voltage commanded by the module (V)
VS	NH <sub>3</sub> sensor internal Vs cell voltage
VSW	Supply voltage at the module (V)
VH	Actual heater voltage at the module (V)
TEMP	Temperature of the module circuit board (deg C)
C1R	Cell 1 raw bits (bits)
C2R	Cell 2 raw bits (bits)
ERFL	Module error flags (unsigned long format)
ERCd	ECM CANOpen Error Code (unsigned integer)
PR10	10 bit Pressure sensor output voltage (unsigned integer format)
P	Pressure sensor measured pressure (absolute) in mmHg
MODE	NH <sub>3</sub> measurement mode (hex)
RCL	NH <sub>3</sub> cal constant (no units)
SCF	NH <sub>3</sub> scale factor (no units)
NH3	NH <sub>3</sub> after addition of Delta NH3 Table (ppm)
PVLT	Raw volts from pressure sensor (V)
PKPA	Pressure sensor measured pressure (absolute) in kPa
PBAR	Pressure sensor measured pressure (absolute) in bar
PPSI	Pressure sensor measured pressure (absolute) in psi

Table 2: Parameter List for the NH<sub>3</sub> 5250

## **dISP (Display) Setup Option (P1 to P14)**

Parameter information from the NH<sub>3</sub> module assigned to the upper channel can be displayed as parameters P1 through P7. Parameter information from the NH<sub>3</sub> module assigned to the lower channel can be displayed as parameters P8 through P14.

The parameter selected as P1, P2, etc can be anything from Table 2.

Here is an example of setting displayed parameter P2:

1. Press the SYS key until “MOd” is displayed.
2. Press the ↓ key until “dISP” is on the top display. Then press the ENT key.
3. Press the ↓ key until “P2” is on the display. Then press the ENT key.
4. Press the ↑ or ↓ key until the parameter (see Table 2) that will be P2 is displayed. Then press the ENT key.
5. When “dISP” is displayed, press SYS to return to RUN mode.

If in the above example, displayed parameter P8 was being programmed, dISP, P8, and your entries will be shown on the bottom display.

## **CAL (Calibrate) Setup Option**

NH<sub>3</sub> sensors supplied with the NH<sub>3</sub> 5250 are factory calibrated. This factory calibration is stored in a memory chip inside the sensor's connector. With use, NH<sub>3</sub> sensors can age requiring recalibration to maintain measurement accuracy. Recalibration can be performed by the user or by sending the sensor back to ECM.

The NH<sub>3</sub> ZERO and SPAN functions are for the recalibration of the NH<sub>3</sub> sensor. This recalibration is stored in the sensor's memory chip and is used instead of the factory calibration. The FACT function cancels the user calibration and reverts the sensor back to using the factory calibration.

### **ZERO**

To perform a ZERO:

1. A zero should be performed after the NH<sub>3</sub> sensor and pressure sensor (if so equipped) have been on for at least 20 minutes.
2. Put the NH<sub>3</sub> sensor and pressure sensor (if so equipped) in ambient, stationary air or in the exhaust of an engine with zero NH<sub>3</sub>.
3. Press the SYS key until “MOd” appears.
4. Press the ↓ key until “CAL” is on the display of the channel to be calibrated. Then press the ENT key.
5. Press the ↓ key until “NH3” appears. Then press the ENT key.
6. With “ZERO” on the display, press the ENT key.
7. Using the ↑ and ↓ keys, change the display to read 0 ppm. Press the ENT key.
8. Press SYS to return to RUN mode.
9. The user calibration is written into the memory chip in the NH<sub>3</sub> sensor's connector and will be used to calculate NH<sub>3</sub>. If the NH<sub>3</sub> sensor is removed and installed on

another module, this user calibration will go with the sensor and be used with the new module.

## SPAN

To perform a SPAN:

1. A span should be performed after the  $\text{NH}_3$  sensor and pressure sensor (if so equipped) have been on for at least 20 minutes.
2. Put the  $\text{NH}_3$  sensor and the pressure sensor (if so equipped) in the model gas calibration apparatus shown in Figure 6 or in the exhaust of an engine.
3. For the case of the model gas calibration apparatus, adjust the flowrates to get approximately 15%  $\text{O}_2$ , 1.5%  $\text{H}_2\text{O}$ , your target calibration  $\text{NH}_3$  ppm (typically 100), balance  $\text{N}_2$ . For the  $\text{NH}_3$  tank concentration shown and a target of 100 ppm  $\text{NH}_3$ , the flowrate through flowmeter #2 will be about  $1/9^{\text{th}}$  that through the bubbler. This will give the approximate 1.5%  $\text{H}_2\text{O}$  required. To set the % $\text{O}_2$  and  $\text{NH}_3$  ppm level, use a NOxCANt or NOx 5210T analyzer. With the Type T NOx sensor used in these devices,  $\text{NH}_3$  will be read as NOx. The  $\text{NH}_3$  must not be bubbled nor should there be any condensed water from the output of the bubbler to downstream of the  $\text{NH}_3$  sensor. Otherwise, the condensed water will absorb the  $\text{NH}_3$  and the span process will be problematic.
4. For the case of using the exhaust of an engine to span the  $\text{NH}_3$  sensor, you must know the wet  $\text{NH}_3$  concentration from another instrument.
5. Press the SYS key until "MOd" appears.
6. Press the  $\downarrow$  key until "CAL" is on the display of the channel to be calibrated. Then press the ENT key.
7. Press the  $\downarrow$  key until " $\text{NH}_3$ " appears. Then press the ENT key.
8. Press the  $\downarrow$  key until "SPAN" appears. Then press the ENT key.
9. Using the  $\uparrow$  and  $\downarrow$  keys, change the display to read the actual  $\text{NH}_3$  ppm.
10. Press SYS to return to RUN mode.
11. The user calibration is written into the memory chip in the  $\text{NH}_3$  sensor's connector and will be used to calculate  $\text{NH}_3$ . If the  $\text{NH}_3$  sensor is removed and installed on another module, this user calibration will go with the sensor and be used with the new module.

## FACT (return to factory $\text{NH}_3$ calibration)

To return to the factory calibration for the  $\text{NH}_3$  sensor:

1. Make sure the  $\text{NH}_3$  sensor is attached to the module.
2. Press the SYS key until "MOd" appears.
3. Press the  $\downarrow$  key until "CAL" is on the display of the channel to be calibrated. Then press the ENT key.
4. Press the  $\downarrow$  key until " $\text{NH}_3$ " appears. Then press the ENT key.
5. Press the  $\downarrow$  key until "FACT" is on the display. Press the ENT key. The user  $\text{NH}_3$  ZERO and SPAN calibration of the  $\text{NH}_3$  sensor is erased and the factory calibration will be used to calculate  $\text{NH}_3$ .

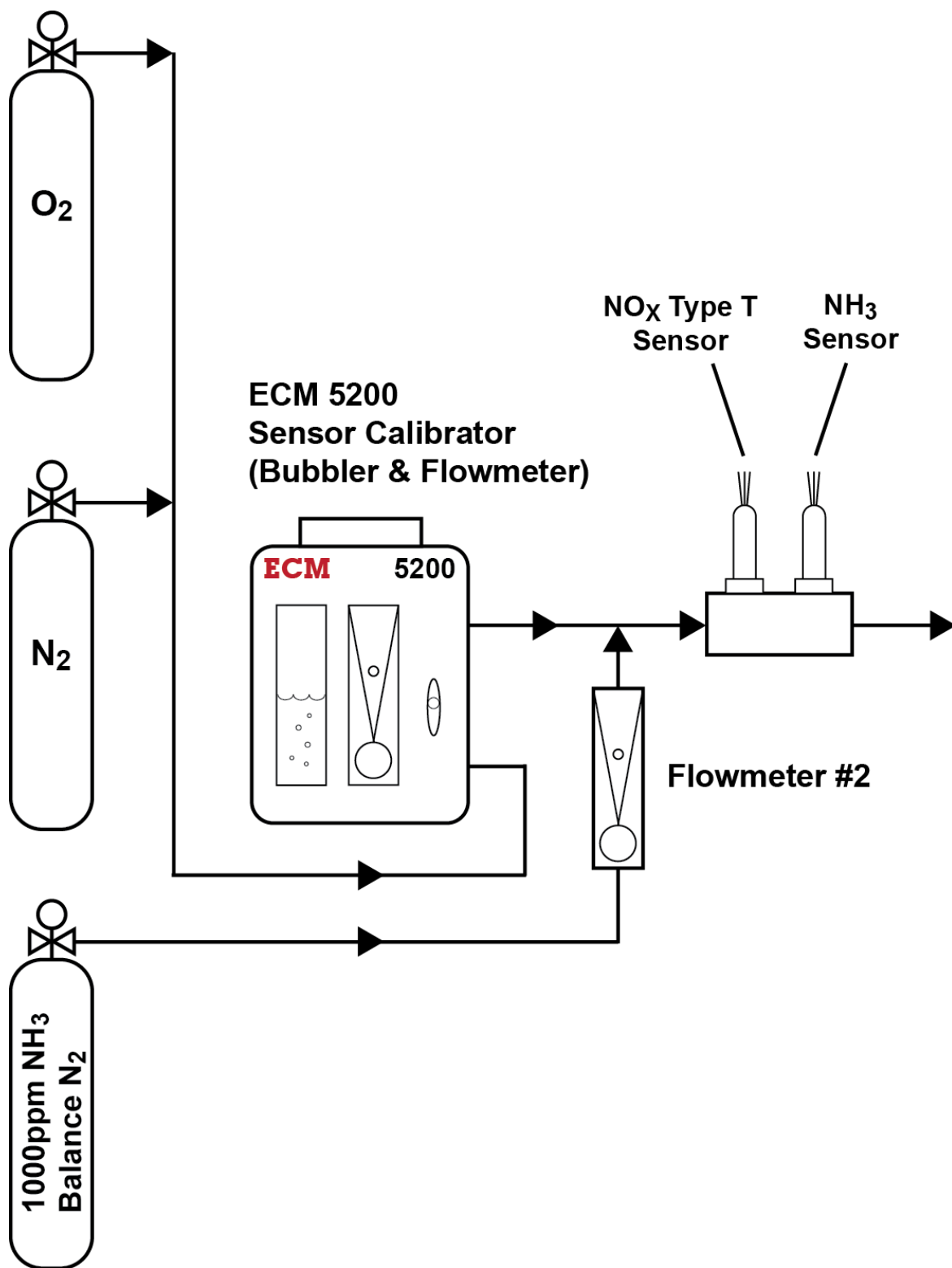


Figure 6: Model Gas Calibration Apparatus

## **CAL (Calibrate) Setup Option (AVG, SKEW)**

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### **◆ AVG**

Raw data is sampled from the NH<sub>3</sub> sensor and the pressure sensor every 5 ms. This data is averaged by the NH<sub>3</sub> module every 5 ms before being sent to the display head every 5 ms. This averaging is programmable. There is one averaging filter for NH<sub>3</sub> and one for pressure. How the averaging filters are used is shown by Equation 1. The averaging filters are user-programmable and can be assigned values from 0.001 (heavy averaging) to 1.000 (no averaging).

$$\text{ParameterAverage}_{t+5\text{ms}} = \alpha \times \text{Parameter}_{t+5\text{ms}} + (1 - \alpha) \times \text{ParameterAverage}_t \quad [\text{Equation 1}]$$

where:

$\text{ParameterAverage}_{t+5\text{ms}}$  = the parameter average at time “t+5ms”

$\alpha$  = These user-programmable filters range from 0.001 (heavy averaging) to 1.000 (no averaging).

$\text{Parameter}_{t+5\text{ms}}$  = the parameter value at time “t + 5ms”

$\text{ParameterAverage}_t$  = the parameter average at time “t”

The default averaging filter values are given within square parentheses in Table 1. These values and the length of the pressure line assembly should not be modified without first consulting ECM.

### **◆ SKEW**

SKEW allows the parameters NH<sub>3</sub>, and P to be modified by a programmable transform of the form:

$$\text{ParameterSkewed} = M \times \text{Parameter} + B \quad [\text{Equation 2}]$$

where:

$\text{ParameterSkewed}$  = NH<sub>3</sub> or P value after being skewed.

$\text{Parameter}$  = NH<sub>3</sub> or P measurement before being skewed.

$M$  = Skewing gain. The default values for  $M$  are 1.000.

$B$  = Skewing offset. The default values for  $B$  are 0.000.

The skewed parameters are displayed and output (i.e. analog outputs, CAN).

## **CONF (Configure) Setup Option**

---

CONF setup appears at the end of the setup list for the lower channel. To enter CONF, press the SYS key until “MOd” appears on the upper display, press the ↓ key until “CONF” appears on the bottom display, and then press the ENT key. CONF relates to display head (as opposed to lambda module or sensor) setup.

### **◆ LEdS**

The display intensity is programmable. Press the ENT key when “LEdS” appears on the lower display, press the ↑ or ↓ keys until the display intensity is suitable, press ENT, and press SYS to return to RUN mode.

### **◆ 1V4V**

This feature commands a 1 V (when “1V” is on lower display) or 4 V (when “4V” is on lower display) output on all six analog outputs. This feature is useful when troubleshooting the interface with an external data acquisition device.

### **◆ CAN**

Figure 1 shows cabling connected to the back of the display head for CAN communication. Depending on where the display head appears in your CAN bus, the termination resistor may have to be present or removed.

The CAN data communicated is:

1. What is being sent to analog output 1
2. What is being sent to analog output 2
3. What is being sent to analog output 3
4. What is being sent to analog output 4
5. What is being sent to analog output 5
6. What is being sent to analog output 6
7. What is being sent to the upper display (but not averaged by display)
8. What is being sent to the lower display (but not averaged by display)
9. An error code for the upper channel. See **Appendix C**.
10. An error code for the lower channel. See **Appendix C**.
11. An auxiliary code for the upper channel.
12. An auxiliary code for the lower channel.

It is important to note that if a parameter that is being displayed is changed (by pressing the ↑ or ↓ key), the CAN data will be changed also to that newly displayed parameter for 7 or 8 (above). Similarly for an analog output. LOCKing the display head can be used to avoid this problem.



The CAN data is broadcast at 500 kHz in the following format:

CANid	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
CID1	What is being sent to analog output 1				What is being sent to analog output 2			
CID2	What is being sent to analog output 3				What is being sent to analog output 4			
CID3	What is being sent to analog output 5				What is being sent to analog output 6			
CID4	What is being sent to upper display				What is being sent to the lower display			
ERCd	Error code for upper display/channel				Error code for lower display/channel			
	Error Code Low	Error Code High	Aux. Code	Pressure Err Code Low <sup>1</sup>	Error Code Low	Error Code High	Aux. Code	Pressure Err Code Low <sup>1</sup>

<sup>1</sup> For LambdaCANp modules only.

Each of the eight parameters in CID1 to CID4 is a single-precision 32 bit floating point number that conforms to the IEEE-754 standard. All eight of these parameters are transmitted on the CAN bus least significant byte first (Intel format). Parameters 1 through 8 (everything except error codes) sent on the CAN bus are averaged (“AVG”d, see **CAL Setup Option**).

Error codes are transmitted with address ERCd. The error codes are 16 bit integers that refer to those listed in Appendix C. The error codes are transmitted on the CAN bus least significant byte first (Intel format). The auxiliary code is the countdown number appearing on the channel’s display. If there is no error or active countdown, an error message is not broadcast.

Addresses CID1 through CID4 and ERCd are user programmable. Refer to **Appendix E** on how to program them and how to produce a .dbc file (which requires a PC running the supplied Configuration Tool Software”). This .dbc file can be used with programs accepting the VectorCAN .dbc format.

The rate at which CAN data is sent can be programmed via the “RATE” parameter under “CAN”. The allowable range is 5ms to 9999ms with 5ms being the default.

The CAN baud rate is programmed via the “BAUD” parameter under “CAN”. 500K is the default.

#### ◆ LOCK

“LOCK” locks the selection of displayed parameters and instrument setup. When locked, the display head can just be turned on and off. It cannot be modified unless unlocked. Refer to Appendix D for more information.

#### ◆ FACT

“FACT” (in the **CONF Setup Option**) resets the NH<sub>3</sub> 5250 to the default setup. The default setup is shown [in square parentheses] in Table 1. “FACT” (in the **CONF Setup Option**) does not cancel a user calibration of the NH<sub>3</sub> sensors. To cancel a user calibration of an NH<sub>3</sub> sensor use “FACT” in the CAL Setup Option.

## Specifications and Limits

### Measurements and Accuracies

Parameter	Range	Response Time	Accuracy
NH <sub>3</sub>	0 to 2000 ppm <sup>1</sup>	< 1 s <sup>2</sup>	±5 ppm (0 to 200 ppm)
Pressure	0 to 517 kPa, 75 Psia	< 5 ms <sup>3</sup>	±5.2 kPa ±0.75 Psia

<sup>1</sup> NH<sub>3</sub> measurement for lean stoichiometries only (i.e.  $\lambda > 1$ ).

<sup>2</sup> The response time is affected by the programmable averaging filter for NH<sub>3</sub>.  
See **CAL Setup** for more information.

<sup>3</sup> The response time is affected by the programmable averaging filter for P.  
See **CAL Setup** for more information.

### Sensor Limits and Specifications

#### ◆ NH<sub>3</sub> Sensor

Maximum Exhaust Temperature: 450 °C, 842 °F

Maximum allowable levels of fuel "Impurities":

Lead: 0.012 gm/gal., 0.003 gm/ltr.

Phosphorous: 0.0008 gm/gal., 0.00027 gm/ltr.

Sulfur: 0.035% by weight

Do not use the NH<sub>3</sub> sensor in a heavily-sooting or crankcase-oil-burning engine because these conditions will shorten the life of the sensor.

Thread Size: 18mm x 1.5mm

Lightly coat with non-lead containing antiseize compound.

The NH<sub>3</sub> sensor's thread size is identical to that of the exhaust gas oxygen sensors used in production automobiles with 3-way exhaust catalysts.

Hex Size: 22 mm

Tightening Torque: 40 ±4 Nm, 30 ±3 ft-lbf

### ◆ Pressure Sensor

Note: Must attach to engine via ECM-supplied pressure sensor tubing only!  
Do not directly attach to the exhaust or pressure sensor damage will result.

Diaphragm Material: Stainless steel

Maximum Pressure: 200 Psia, 1379 kPa (absolute)

Operating Temperature Range: -40 to 105 °C

Thread on Pressure Sensor: 1/4" NPT

Fitting on Pressure Sensor: Swagelok SS-400-7-4 to mate with 1/4" tube (USA) or  
Swagelok SS-6MO-7-4 to mate with 6 mm tube (Metric)

### ◆ Pressure Sensor Tubing

Note: Stainless steel end of tubing towards engine. Teflon end towards pressure sensor.

Mating Thread with Engine: 1/4" NPT (USA) or 1/4" ISO tapered (Metric)

Tubing Assembled Length: 19" (USA) or 483 mm (Metric)

Tubing Diameter: 1/4" (USA) or 6mm (Metric)

Nut, Front Ferrule, Back Ferrule at Pressure Sensor end of Tubing:  
Swagelok SS-402-1, SS-403-1, SS-404-1 (USA) or  
Swagelok SS-6M3-1, SS-6M4-1, SS-6M2-1 (Metric)

Union between Stainless Steel and Teflon Tubing: Swagelok SS-400-6 (USA) or  
Swagelok SS-6MO-6 (Metric)

Fitting on Engine End of Tubing: Swagelok SS-400-1-4, 1/4" tube to 1/4" NPT (USA) or  
Swagelok SS-6MO-1-4RT, 6 mm tube to 1/4" ISO tapered (Metric)

## **Output Specifications**

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### **◆ Analog Outputs**

Output Range (linearized in displayed units): 0 to 5V, 0 to 1V, 20 mA max.

Output Impedance: 2.66 k $\Omega$

Bits Resolution: 12 bits

Update Rate: 5 ms

Isolation: Electrically isolated from power supply ground.  
All analog output grounds common.

### **◆ CAN**

Protocol: Broadcast.

Broadcast Rate: Programmable 5 to 9999ms. 5ms default.

Speed: Programmable, 500 kHz default.

Isolation: Electrically isolated from power supply ground.

## General Specifications

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### ◆ Power

DC: 11 to 28 VDC

Current Draw: 0.5 A (display), 1.2 A steady-state (NH<sub>3</sub> sensor and module),  
On start-up, NH<sub>3</sub> sensor and module may draw as much as 4 A for 30 s.

Case Ground: The NH<sub>3</sub> 5250 display head case is connected to power ground via a 2.15 kΩ resistor.

### ◆ Key-on Signal

“ON” Voltage Level: 2.7 to 32 VDC

Current Draw: 100 μA

### ◆ Environment

Display Head: -40 to 85 °C, 100% humidity non-condensing, display head is not sealed

Module: -55 to 125 °C, 100% humidity, module is sealed, IP67

### ◆ Dimensions and Weight

Display Head: 108 mm x 64 mm x 178 mm, 4 ¼” x 2 ½” x 7”, (W x H x D)  
676 gm, 24 oz

Module: 120 mm x 37 mm x 143 mm, 4 ¾” x 1 ½” x 5 ¾”, (W x H x D)  
244 gm, 8.7 oz

## Appendix A: 5200 Series Instruments Parts List

### 01 Display Heads (Just display head. Must add cables, etc.)

- 01-01 NOx 5210 (just head, no module, no cable, no sensor)
- 01-02 Lambda 5220 (just head, no module, no cable, no sensor)
- 01-03 EGR 5230 (just head, no module, no cable, no sensor)
- 01-04 dashCAN (includes cable and T)
- 01-05 dashCAN+ (big box, 6 analog outputs)
- 01-06 dashCANc
- 01-07 NOx/NH3 5240 (just head)
- 01-08 dashCAN2 (blue box, 2 analog outputs, includes cable and T)
- 01-09 NOx/NH3 5241 (just head)
- 01-10 NH3 5250 (just head)

### 02 CAN Modules (just module)

- 02-01 LambdaCAN (just module, no sensor, no cables)
- 02-02 NOxCAN (for original sensor, just module, no sensor, no cables)
- 02-03 NOxCAN-G (for "G" sensor just module, no sensor, no cables)
- 02-04 LambdaCANc (just module, no sensor, no cables)
- 02-05 appsCAN (just module, no cables)
- 02-06 baroCAN (just module, no sensors, no cables)
- 02-07 NOxCAN-T (for "T" sensor, just module, no sensor, no cables)
- 02-08 LambdaCANp (just module, no sensor, no cables)
- 02-09 LambdaCANd (just module, no sensor, no cables)
- 02-10 gpCAN (just module, no cables)
- 02-11 COCO2CAN (just module, no sensor, no cables)
- 02-12 NH3CAN (just module, no sensor, no cables)

### 03 Simulators, Heater

- 03-01 LambdaCAN Sensor Simulator (just module, no cable)
- 03-02 NOx Sensor Simulator (just module, no cable)
- 03-03 Ceramic Sensor Heater (just module, no cable)
- 03-04 NOxg Sensor Simulator (just module, no cable)
- 03-05 NOxt Sensor Simulator (just module, no cable)
- 03-06 LambdaCANp Sensor Simulator (just module, no cable)

### 04 Power Supplies

- 04-01 AC/DC Power Supply, Universal, 24V
- 04-02 Vboost Supply, 10~14VDC to 24VDC @ 14.5A
- 04-03 30A AC/DC Power Supply, 15V, 100~240VAC
- 04-04 15A AC/DC Power Supply, 15V, 120VAC
- 04-05 60A AC/DC Power Supply, PWR 60, 15V, 120VAC

## **05 Linear O2 (Lambda) and CO/CO2 Sensors**

05-01 NTK 6 mA  
05-02 Bosch LSU4.2  
05-03 Bosch LSU4.9  
05-04 NTK 4 mA  
05-05 Bosch LSU4.2, Type P  
05-06 Delphi OSL  
05-07 NTK 4mA Cofired (ZFAS-U2)  
05-08 Bosch LSU4.9, Type P  
05-09 Bosch ADV  
05-10 NTK, 6mA, Type P  
05-11 Bosch LSU4.2, Type PI (Intake)  
05-12 CO, CO2

## **06 NOx and NH3 Sensors**

06-01 NOx Original (use with NOxCAN)  
06-02 NOx Type "G" (use with NOxCANg)  
06-05 NOx Type "T" (use with NOxCANT)  
06-06 NOx/NH3 Sensor  
06-07 NH3 Sensor

## **07 Sensors**

07-01 Pressure, 0-75 psia, 1/4", (USA)  
07-02 Pressure, 0-517 kPa, 6mm, (Metric)  
07-03 Pressure, Type P, 0-75 psia, 1/4", (USA)  
07-04 Pressure, Type P, 0-517 kPa, 6mm, (Metric)  
07-05 Pressure, Type KP, 0-75 psia, 1/4", (USA)  
07-06 Pressure, Type KP, 0-517 kPa, 6mm, (Metric)  
07-07 RH (Humidity) Sensor, 1/4" NPT  
07-08 Pressure (Lp,C,bCAN only), 0-75 psia, 1/4", (USA)  
07-09 Pressure (Lp,C,bCAN only), 0-517 kPa, 6mm, (Metric)  
07-10 Pressure (Lp,C,bCAN only), Type KP, 0-75 psia, 1/4", (USA)  
07-11 Pressure (Lp,C,bCAN only), Type KP, 0-517 kPa, 6mm, (Metric)  
07-12 Pressure (bCAN optional), Type KP, 10-20 psia, 1/4", (USA)  
07-13 Pressure (bCAN optional), Type KP, 70-140 kPa, 6mm, (Metric)

## **08 Actuators**

08-01 Ceramic Sensor Heater Mount for NTK Sensors

## **09 Eurofast Cables, Ts, Term. Resistors, Connectors**

09-01 4m Eurofast 12mm Cable  
09-02 2m Eurofast 12mm Cable  
09-03/n "n"m, Eurofast 12mm Cable

09-03/10 10m, Eurofast 12mm Cable  
09-03/20 20m, Eurofast 12mm Cable  
09-04 Flexi-Eurofast Cable, 0.3m  
09-05 Eurofast "T"  
09-06 Eurofast Termination Resistor  
09-07 Eurofast Male Connector  
09-08 8 Channel Eurofast Hub Block  
09-09 Termination Resistor for Hub Block  
09-10 CSM-Type Lemo Terminating Resistor  
09-11 Flexi-Eurofast-Lemo Cable, 2m

## **10 Sensor Cables**

10-01 Module Y Cable (Superseded by -21)  
10-02 1m L/N/C/bCAN Cable, (12 term.)  
10-02/25' L/N/C/bCAN Cable, (12 term., teflon), 3 x (\$3/ft + \$10 +\$20)  
10-03 2m L/N/C/bCAN Cable, (12 term.)  
10-04 1m Pressure Cable (LCAN, NCAN, not Lp,C,bCAN), (4 term.)  
10-05 2m Pressure Cable (LCAN, NCAN, not Lp,C,bCAN), (4 term.)  
10-09 Adapter to use P/N 05-01 with AFM1000, M1200, etc  
10-10 Adapter to Lambda Wires (Bosch wire colors)  
10-11 Adapter to Original NOx Wires (NTK wire colors)  
10-12 Adapter to Pressure Sensor Wires  
10-14 Adapter to use P/N 2400E-1 sensor (CPC) with LCAN  
10-16 Adapter to use P/N 2400E-1S sensor (Fischer) with LCAN  
10-17 Adapter to use P/N 1001A-2 (Deutsch) with LCAN  
10-21 Module Y Cable (for all except Lp, C, and bCAN)  
10-26 1m Humidity Cable (bCAN), (6 term.)  
10-27 2m Humidity Cable (bCAN), (6 term.)  
10-30 Module Y Cable (for bCAN only)  
10-31 1m Extension Cable for 12 terminal Deutsch  
10-32 2m Extension Cable for 12 terminal Deutsch  
10-34 Module Y Cable (for Lp and CCAN only)  
10-35 1m Pressure Cable (Lp,C,bCAN only), (8 term.)  
10-36 2m Pressure Cable (Lp,C,bCAN only), (8 term.)  
10-37 3m L/N/C/bCAN Cable, (12 term.)  
10-38 3m Pressure Cable (Lp,C,bCAN only), (8 term.)  
10-39 1-to-4 Pressure Sensor Adapter (for /P kits only. Not for /PB kits)  
10-40 3m Pressure Cable (LCAN, NCAN, not Lp,C,bCAN), (4 term.)  
10-41 3m Humidity Cable (bCAN), (6 term.)  
10-42A 1.5m LambdaCANp Cable, Lemos at Midpoint, Controller Side  
10-42B 1.5m LambdaCANp Cable, Lemos at Midpoint, Sensor Side

## **11 Cables**

11-01 DC Power Cable, DB9F, Spades  
11-02 DC Power Cable, DB9F, Banana Plugs  
11-03 DB9M to CSM Lemo F Adapter (CSM Upstream)



- 11-04 DB9M to ETAS Lemo Adapter
- 11-05 Female Eurofast to DB9F
- 11-06 Male Eurofast to CSM Lemo F Adapter (CSM Downstream)
- 11-07 In-Line Power Entry Cable
- 11-08 2m Key-on Cable
- 11-09 2m Heater Cable
- 11-10 2m Hub Power/Eurofast Harness
- 11-11 Simulator (SIM300, 400, 500, 600, 700, 800) Cable
- 11-14 BNC to Banana Cable
- 11-15 DC Power Cable, Spades
- 11-16 DC Power Cable, Banana Plugs
- 11-17 Deutsch DTM3M to DB9F
- 11-18 3m DB9 Cable, M-F
- 11-19 EIB Power Tap to Ceramic Sensor Heater Controller
- 11-20 25' DB9 M-F Cable
- 11-21 SIM-200 Calibration Kit
- 11-22 Left (gray) appsCAN Connector with 300mm Pigtail Wires
- 11-23 Right (blk) appsCAN Connector with 300mm Pigtail Wires
- 11-24 Connector Kit: 2 connectors, 24 terminals, 12 plugs
- 11-25 Male Eurofast to Braided Shield Ground
- 11-26 Boom Box Cable for CAN Products (80' CAN, 30' Power)
- 11-27 Boom Box to Hub Springy Cable (1m relaxed, 2m stretched)
- 11-28 Male Eurofast to DB9F
- 11-29 Simulator Power Cable
- 11-30 Simulator LSU4.9 Adapter Cable
- 11-31 Lemo to Eurofast Adapter Cable for LCANc
- 11-32 M-F Eurofast Panelmount Connector
- 11-33 1m CSM F Lemo to DB9F
- 11-34 1m CSM Power Lemo to Male Eurofast
- 11-35 Termination Resistor for in F Lemo Package
- 11-36 1m DC Power Cable, DB9F, Banana Plugs
- 11-37/18" Eurofast Female to Lemo 5-terminal male
- 11-37/30" Eurofast Female to Lemo 5-terminal male

## **12 Mounting Panels, Bosses, Probes, and Hardware**

- 12-01 19" Rackmount Panel. Holds up to 4 Displays
- 12-02 18mm x 1.5mm MS Boss and SS Plug
- 12-03 18mm x 1.5mm SS Boss and SS Plug
- 12-04 18mm x 1.5mm Tall Al Boss, Cu Gasket, Al Plug
- 12-05 1/4" NPT MS Boss and Brass Plug, (USA)
- 12-06 1/4" NPT SS Boss and Brass Plug, (USA)
- 12-07 1/4" NPT Al Boss and Brass Plug, (USA)
- 12-08 Pressure Line Assembly, 1/4" dia, 19", (USA)
- 12-08A Pressure Line Assembly, 1/4" dia, 27" (USA)
- 12-09 Inconel Shield
- 12-10 18mm Cu Gasket
- 12-11 Pressure Line Assembly, 6mm dia., 483mm, (Metric)

12-11A Pressure Line Assembly, 6mm dia., 686mm (Metric)  
 12-12 1/4" ISO tapered MS Boss and Brass Plug, (Metric)  
 12-13 1/4" ISO tapered SS Boss and Brass Plug, (Metric)  
 12-14 1/4" ISO tapered Al Boss and Brass Plug, (Metric)  
 12-15 15A Fuse  
 12-16 Bifurcated Intake Sample Probe, 8mm  
 12-17 Replacement Bifurcated Tube, 8mm  
 12-18 Aluminum Sensor Mounting Block, 18mm (not for Type T NOx)  
 12-19 Individual Cylinder Exhaust Probe, 18mm Sensor (USA)  
 12-20 Individual Cylinder Exhaust Probe, 18mm Sensor (Metric)  
 12-21 Rolling Cart to Support 8 LCAN or NCANs (Pwr & Suc)  
 12-22 Sampling-Type Exhaust Probe (USA)  
 12-23 Sampling-Type Exhaust Probe (Metric)  
 12-24 Small Heated Alum Sensor Heater Block, 18mm (not for Type T)  
 12-25 1/4" UNC Module Stacking Standoff  
 12-26 Small Alum Sensor Mounting Block, 18mm (not for Type T NOx)  
 12-27 Cu Gasket for 20mm x 1.5mm Boss and Plug  
 12-28 20mm x 1.5mm SS Boss and SS Plug for NGK NOx  
 12-29 18mm x 1.5mm (male) to 1/4" NPT (female) Plug  
 12-30 Carrying Case, Medium  
 12-31 Alum Sensor Mounting Block, 20mm & 18mm (not for Type T NOx)  
 12-32 Small Alum Sensor Mounting Block, 20mm & 18mm (not Type T)  
 12-33 Pressure Line Assembly (for baroCAN), 1/4", (USA)  
 12-34 Pressure Line Assembly (for baroCAN), 6mm, (Metric)  
 12-35 Carrying Case for SIM300  
 12-36 Carrying Case for SIM400  
 12-37 Carrying Case for SIM500  
 12-38 Carrying Case for SIM600  
 12-39 Carrying Case for SIM700  
 12-40 Individual Cylinder Exhaust Probe, 20mm Sensor (USA)  
 12-41 Individual Cylinder Exhaust Probe, 20mm Sensor (Metric)  
 12-42 Aluminum Mounting Plate for 8-ch Block and Modules  
 12-43 Carrying Case for SIM800  
 12-44 Multi-channel Cart  
 12-45 Sample Line Assembly, 1/4" dia., 1.3m (USA)  
 12-46 Sample Line Assembly, 6mm dia., 1.3m (Metric)  
 12-47 remoteSAMPLER 1000 (add /P for P-comp Option)  
 12-48 External Mounting Block (add /P for P-comp Option)  
 12-49 Aluminum Sensor Mounting Block for Type T NOx Sensor  
 12-50 18mm Crush Gasket

### **13 Software, CAN Adapters, and Manuals**

13-01 5200 Series Manuals and Config Software (CD)  
 13-02 Kvaser Leaf Light CAN Adapter  
 13-Product Name (Manual)

## **14 Tools**

- 14-01 18mm x 1.5mm Tap
- 14-02 18mm x 1.5mm Die
- 14-03 1/4" NPT Tap
- 14-04 1/4" ISO Tapered Tap
- 14-05 Antiseize
- 14-06 Metal Brush
- 14-07 Lambda Sensor Calibration System
- 14-08 20mmx1.5mm Bottoming Tap
- 14-09 Filler Bottle
- 14-10 Cupric Sulfate (3gm to add to 150cc water)
- 14-11 NOx/NH3 5240 Calibration Kit
- 14-12 Calibrator (Bubbler)

## Appendix B: Module Stand-alone Mode and EIB Mode

NH<sub>3</sub>CAN modules can be used in conjunction with an analyzer (EIB mode) or on its own (Stand-alone mode). When used as part of an analyzer (ex. NH<sub>3</sub> 5250), the module is setup in EIB mode. When delivered to be used alone, the module is setup in Stand-alone mode.

In EIB mode, the module communicates to the display head of an analyzer via a special high-speed communication protocol. The module must be EIB mode when on the EIB with a display head. When in Stand-alone Mode, the module communicates via the common 500 kHz CAN broadcast protocol. This is the default rate and it is programmable.

The module must be properly configured in EIB mode or Stand-alone mode depending on how it will be used.

To convert from one mode to the other requires software reprogramming of the lambda module followed by the removal (set to EIB) or installation (set to Stand-alone) of a jumper inside the module.

### ◆ To convert a module from Stand-alone to EIB Mode

1. Connect the module to a power supply and a PC via a supported USB-to- CAN communication adapter (Kvaser, ETAS, Peak VectorCAN CAN adapter card) using the cabling shown below. A sensor does not have to be connected to the module. Note that only one module is connected and the display head is not involved.

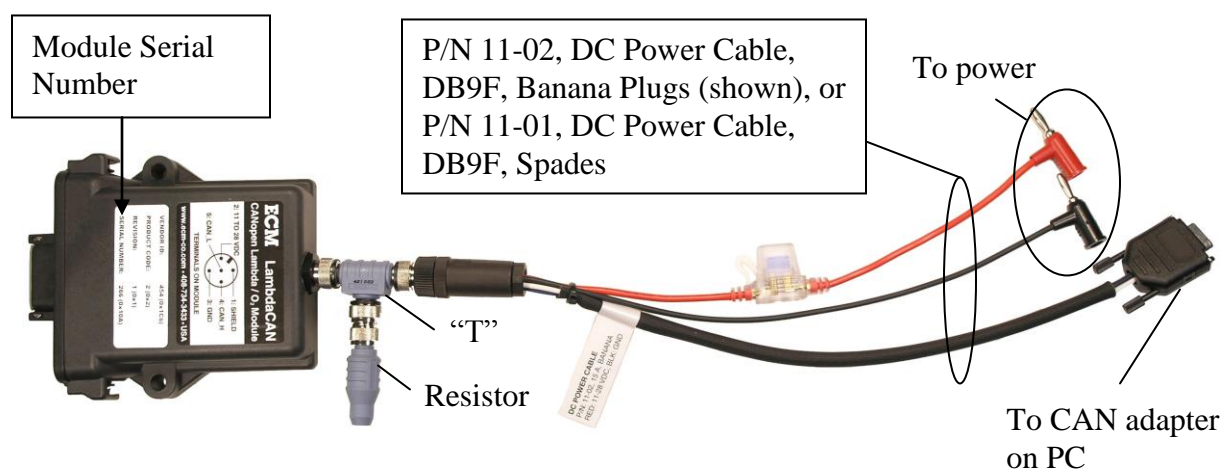
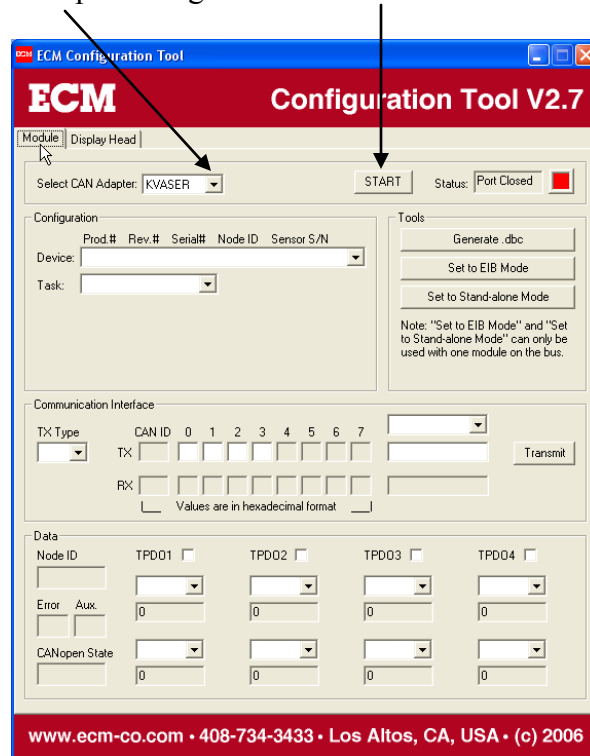
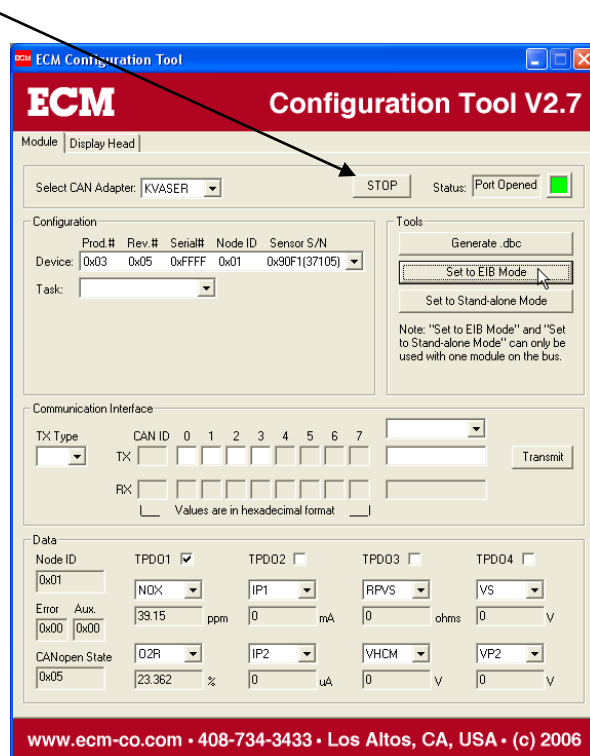


Figure B1: Module prepared for Reprogramming

2. Start the Configuration Tool (software). Click on the “Module” tab. Select the CAN adapter being used. Then start the communication.



3. Click on the “Set to EIB Mode”. Wait for “Done” Message. Stop communication and exit program.



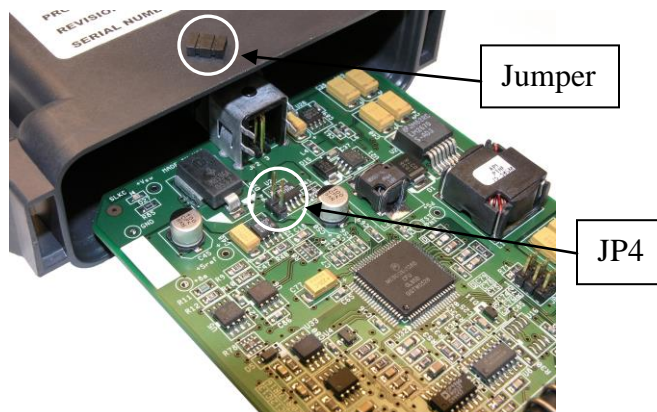
4. Take the nut off the end of the module. Use an 18mm socket without the wrench.



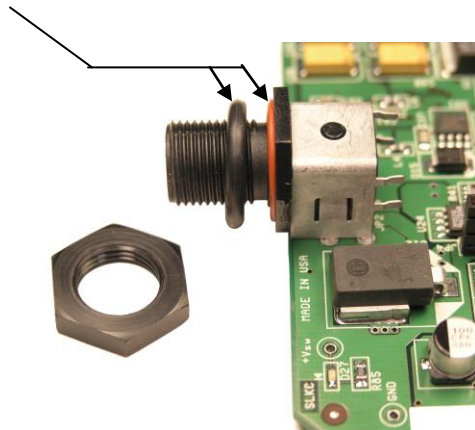
5. Release the two tangs at each side of the module.



6. Slide the PCB out. Remove the jumper from JP4. You can hang it on one pin of JP4 when "off".



7. Make sure both O-rings are on the threaded connector.



8. Slide the PCB into the enclosure until the two tangs “click”.
9. Put the nut on and tighten ONLY  $\frac{1}{2}$  turn from where it is seated. If this nut is tightened too much, the connector will crack and the enclosure will not be sealed.
10. The module is now in EIB mode and can be on the EIB with a display.

#### ◆ To convert a module from EIB to Stand-alone Mode

The process is similar to the previously-described procedure. Note that in EIB mode, the module will not show up in the device list of the Configuration Tool.

1. Use the Configuration Tool (software) to “Set to Stand-alone Mode”.
2. Install the jumper on JP4 in the module.
3. In Stand-alone Mode, the module will continuously broadcast data via 500 kHz CAN (programmable). For more information, refer to the NH<sub>3</sub>CAN Module Instruction Manual.

## Appendix C: Error Codes and Troubleshooting

If one of the NH<sub>3</sub> 5250's displays flashes "ERR" followed by "####" (the Error Code), an error has been detected in that channel's module (or attached sensors). The below table lists the errors. The errors are also flashed on the module's LED.

Error Code	Module LED Action	Description of Error
0000	Green ON	All OK, (green LED constantly on)
0001	Flashing Green 10hz	Sensor warm-up period
0002	Green/Both/Red 2s	Power on reset / Init hardware
0011	Pulse Red 1x/2s	16 bit ADC failed to init. Internal module error. Contact ECM.
0012	Pulse Red 1x/2s	+Vsw shorted. Internal module error. Contact ECM.
0013	Red ON	NH <sub>3</sub> sensor turned off (red LED constantly on)
0014	Pulse Red 1x/2s	NH <sub>3</sub> sensor heater or cable open, or NH <sub>3</sub> sensor not connected.
0015	Pulse Red 1x/2s	NH <sub>3</sub> sensor heater or cable shorted. Bad NH <sub>3</sub> cable or sensor.
0021	Pulse Red 2x/2s	Memory chip in NH <sub>3</sub> sensor's shorted. Bad NH <sub>3</sub> cable or sensor.
0022	Pulse Red 2x/2s	No memory chip in NH <sub>3</sub> sensor detected. Bad NH <sub>3</sub> cable or sensor.
0023	Pulse Red 2x/2s	CRC16 error. Bad NH <sub>3</sub> cable or sensor.
0024	Pulse Red 2x/2s	Invalid NH <sub>3</sub> sensor memory chip parameter. Wrong sensor.
0025	Pulse Red 2x/2s	Non-compatible NH <sub>3</sub> sensor memory chip format (old Rev.)
0031	Pulse Red 3x/2s	Vsw < 6 for > 7 sec. Supply voltage too low.
0032	Pulse Red 3x/2s	Vsw > 32 V. Supply voltage too high.
0041	Pulse Red 4x/2s	VS too high. Bad NH <sub>3</sub> cable or sensor.
0051	Pulse Red 5x/2s	RPVS too high. Sensor too cold, bad, or battery voltage too low.
0052	Pulse Red 5x/2s	(VH Commanded – VH Measured) > 0.5 V for > 10 sec. Battery voltage too low.
0065	Pulse Red 6x/2s	User data (span) in NH <sub>3</sub> sensor memory chip corrupted. User must reperform NH <sub>3</sub> sensor span.

The two most common problems are a damaged NH<sub>3</sub> sensor and a low supply voltage (less than 11 V). When the NH<sub>3</sub> sensor is damaged, it must be replaced. It cannot be repaired.

Three other displays of interest are:

1. "...." which means that a NH<sub>3</sub> module has not been assigned to that channel.  
**See M0d Setup Option.**
2. "----" which means that the display head has an internal problem.
3. "XXXX" which means that the display is not receiving any data. The lambda module is disconnected, dead, or the EIB cable is broken.



## **Appendix D: LOCKing and unLOCKing Display Head**

When the display head is locked, the parameters displayed and instrument setup cannot be modified. The display head can just be turned on and off.

### **◆ To LOCK the display head**

1. Press SYS until “MOd” is displayed.
2. Press ↓ until “CONF” is displayed. Then press ENT.
3. Press ↓ until “LOCK” is displayed. Then press ENT.
4. “50” will be displayed. Press ↑ until “60” is displayed. Then press ENT.  
Display is now LOCKed.

### **◆ To unLOCK the display head**

1. Press SYS until “LOCK” is displayed. Then press ENT.
2. “50” will be displayed. Press ↑ until “60” is displayed. Then press ENT.  
Display is now unLOCKed.

If an unauthorized person learns that 60 is the key number, contact ECM.

## Appendix E: Using the Configuration Tool Software

ECM's Configuration Tool runs on a PC and is for use with ECM's analyzers and modules. The Configuration Tool is supplied on a CD with each analyzer and module and is available for download on [www.ecm-co.com](http://www.ecm-co.com).

The Configuration Tool can be used for the following:

1. To produce a .dbc file for one or more analyzers on the same CAN bus.
2. Real-time display of data from analyzers. Only one analyzer's data is shown at a time.
3. Log data from one or more analyzers.

To connect a PC to the CAN connector on the back of an analyzer requires the supplied cables (see Figure 2) and a USB-to-CAN adapter. Make sure the CAN bus is properly terminated. The following adapters are supported: Kvaser, ETAS, Peak USB to CAN adapters, and the VectorCAN CAN adapter card. Driver software for one of these adapters must be installed prior to using the Configuration Tool. Driver software will be supplied with the adapter or be available on-line.

Once the analyzer(s) are connected to the CAN bus and turned on, leave "Exclusive" checked, start the Configuration Tool, select the "Analyzers" tab, select the CAN Adapter, leave "Exclusive" checked, and then press the start button. "Status:" should change to "Port Opened".

### ◆ Producing a .dbc File

Devices receiving CAN messages from one or more analyzers must understand the format of the messages. A .dbc file is used to describe the format. Using the Configuration Tool, a .dbc file describing the format of messages from one or more analyzers on the same CAN bus can be created.

Each analyzer communicates eight pieces of data, two error codes, and two auxiliary codes. The eight pieces of data are: what is being sent to the six analog outputs and what is sent to the upper and lower displays. Before producing a .dbc file for the analyzer(s), each analyzer on the CAN bus should have its displays and analog outputs programmed for the desired data. It is important to note that if a parameter that is being displayed is changed (by pressing the ↑ or ↓ key), the CAN data will also be changed to that newly displayed parameter. Similarly for an analog output. LOCKing the display head can be used to avoid this problem.

Once the analyzer(s) have been programmed, send (one analyzer at a time) each analyzer's message format to the Configuration Tool.

To do this:

1. In the software, press “Add Device”. A “Waiting for Analyzer...” window will appear. Leave it open.
2. On an analyzer, press SYS, arrow down to CONF, press ENT, arrow down to CAN, press ENT, and with “IdS” on the display, press ENT.

Five CAN ids need to be entered: one each for CID1, CID2, CID3, CID4, and ERCd. These are entered in decimals. The allowable range is 1 to 2047. If analyzers and modules are on the same CAN bus (not EIB bus), be careful to avoid using the CAN ids used by the modules. The CAN ids used by the modules are: 0x00, 0x80 + Module NID, 0x180 + NID, 0x280 + NID, 0x380 + NID, 0x480 + NID, 0x580 + NID, 0x600 + NID, 0x700 + NID, 0x7E4, and 0x7E5. Note that these module CAN ids are given in hex. CID1 is the CAN id for the data going to analog outputs 1 and 2. CID2 is for analog outputs 3 and 4. CID3 is for analog outputs 5 and 6. CID4 is for the upper and lower displays. ERCd is for the error codes and auxiliary codes. After entering the CAN id for ERCd, “.dbc” will appear on the display. Press ENT, you’ll get some “spinning wheels” on the analyzer and the format of the messages for that analyzer will be sent to the Configuration Tool.

3. Each analyzer’s serial number will appear in the “Device:” window list (open window to see all present) after its message format has been received by the Configuration Tool. When an analyzer’s serial number is in the “Device:” window, its data will appear at the bottom of the Configuration Tool’s screen.
4. After the last analyzer on the CAN bus has sent its message format to the Configuration Tool, that list of analyzers can be saved using “Save List” and later recalled using “Load List”. This saves having to resend message formats to the Configuration Tool next time the tool is used.
5. A .dbc file for all analyzers in the “Device:” window list is produced by pressing “Generate .dbc”.
6. The analog parameters are called A#\_sn where “#” is the analog output number and “sn” is the serial number of the display head (ex. A1\_45405300). The serial number is the first thing that is displayed on startup on the display head. The display parameters are called TopDisp\_sn, and BtmDisp\_sn. The error codes are called TopErr\_sn, TopAux\_sn, BtmErr\_sn, and BtmAux\_sn. During O<sub>2</sub> sensor warm-up when the display is counting down, TopAux\_sn or BtmAux\_sn will contain the countdown number.

#### ◆ Real-Time Display

When an analyzer’s serial number is in the “Device:” window, its data will appear at the bottom of the Configuration Tool’s screen.

## ◆ Logging Data

Analyzers whose serial numbers are in the “Device:” window list can be data logged. Press the “Log Data” button and follow the instructions. Data is saved in .csv format.

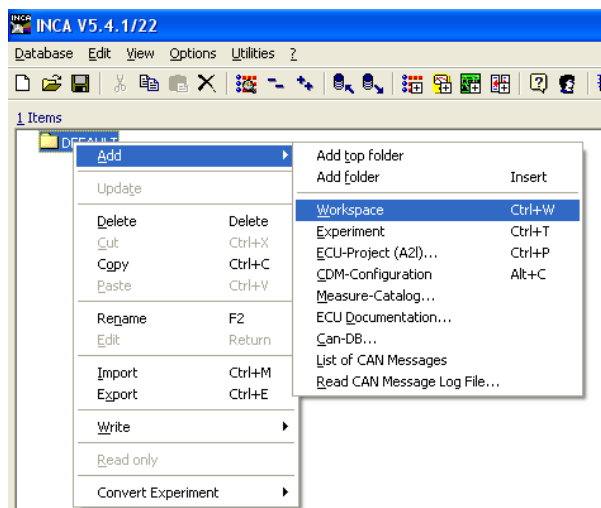
## Appendix F: Setting Up ETAS INCA for ECM Modules

### Hardware Setup: Using ETAS ES591.1

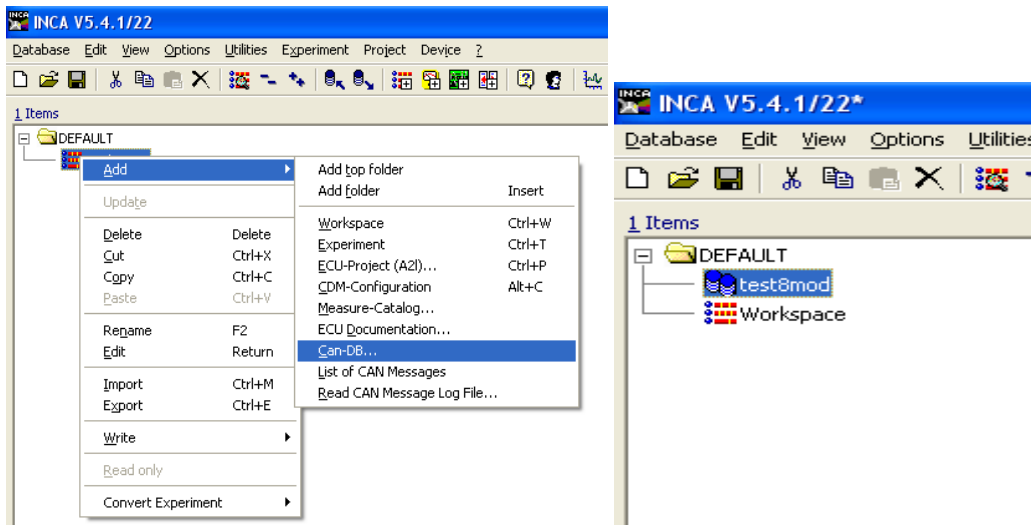
1. Connect the power port to a power source between 6V and 32V.
2. Connect the Ethernet port directly to the Ethernet port on your PC. This port does not use an internet/intranet connection like a router.
3. Connect either the CAN1 or CAN2 port to a CAN network (i.e. ECM analyzer(s) and/or module(s)).

### Software Setup: Using ETAS INCA V5.4.1, Hotfix 22, GM Install

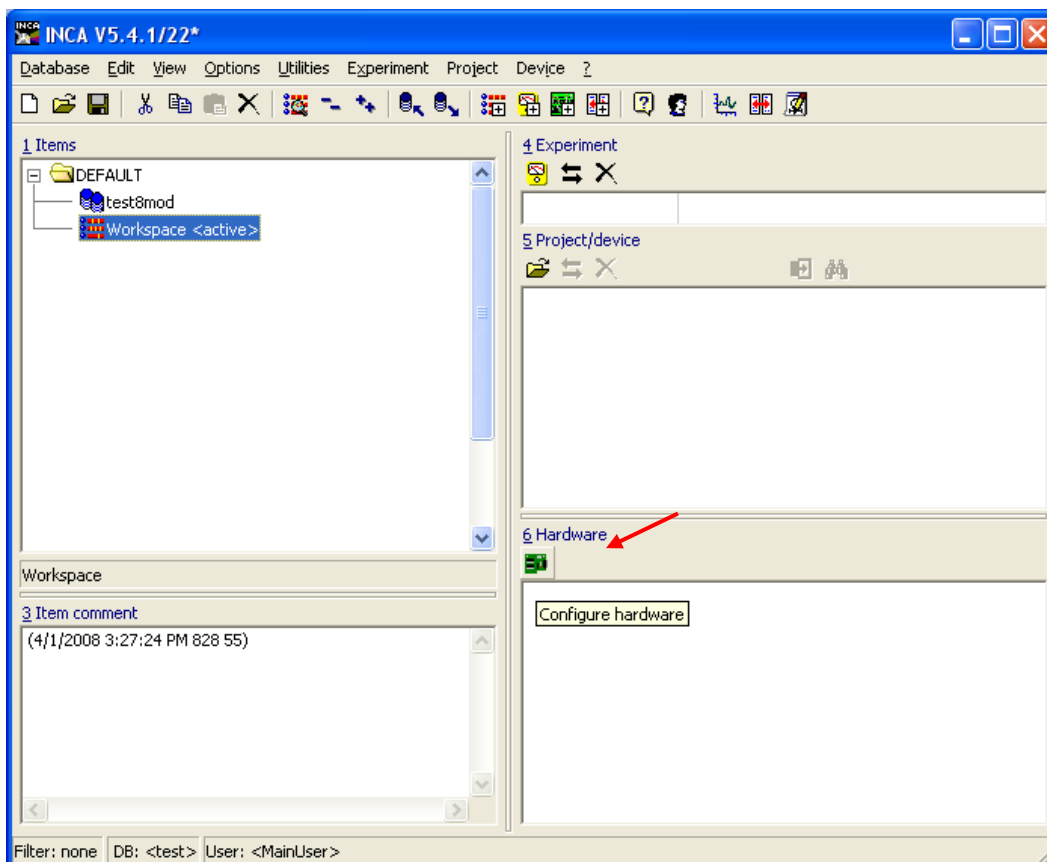
1. Double click the INCA V5.4 icon to open the software.
2. **Create a new Database.** In the Database menu, select New. Give your database a name (i.e. a folder name). In INCA, a Database means the current working directory. Each project is created in a unique directory. When INCA is opened, it will default to the last Database that was used.
3. **Add a new Workspace.** Right click on the “DEFAULT” folder icon, select Add > Workspace. You can rename it to whatever you want.



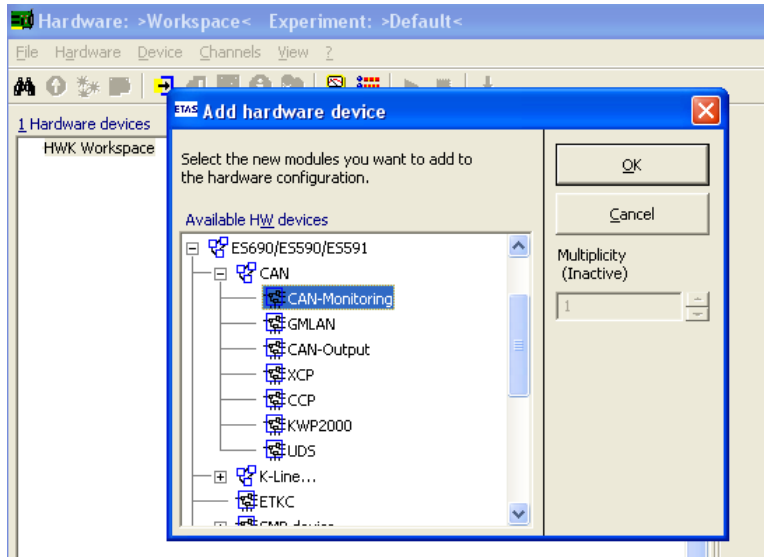
4. **Add a new dbc file for your project.** Right click on the workspace you created in step 3, select Add > Can-DB. Browse to your dbc file and click open. Appendix F describes how to produce this .dbc file. In this example, we are using a file named test8mod.dbc. An INCA log window will pop up. You can ignore this.



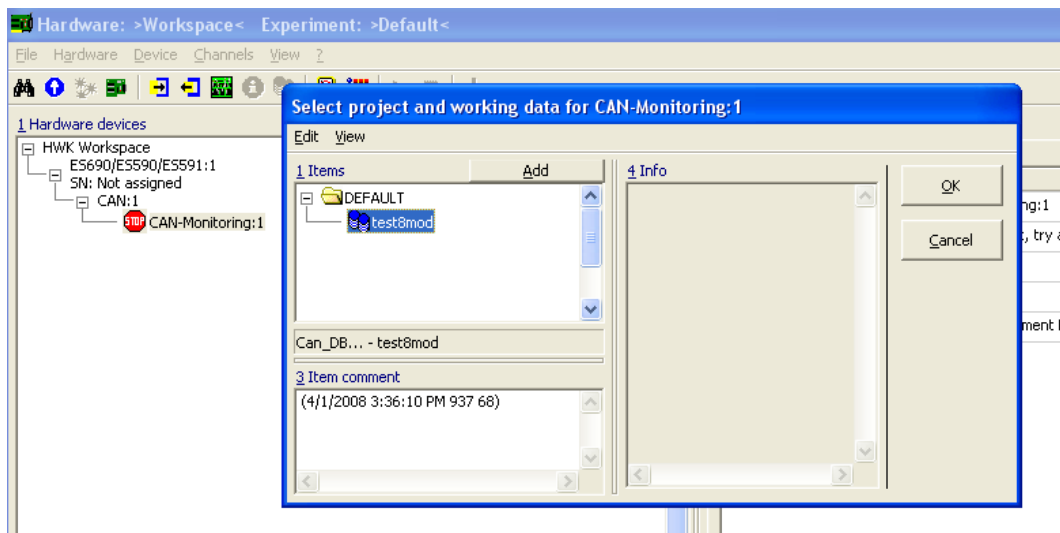
5. **Configure the hardware.** Click on the icon for the workspace you created in step 3. Open the Hardware Configuration icon under the section text “6. Hardware”. A hardware configuration window will open.



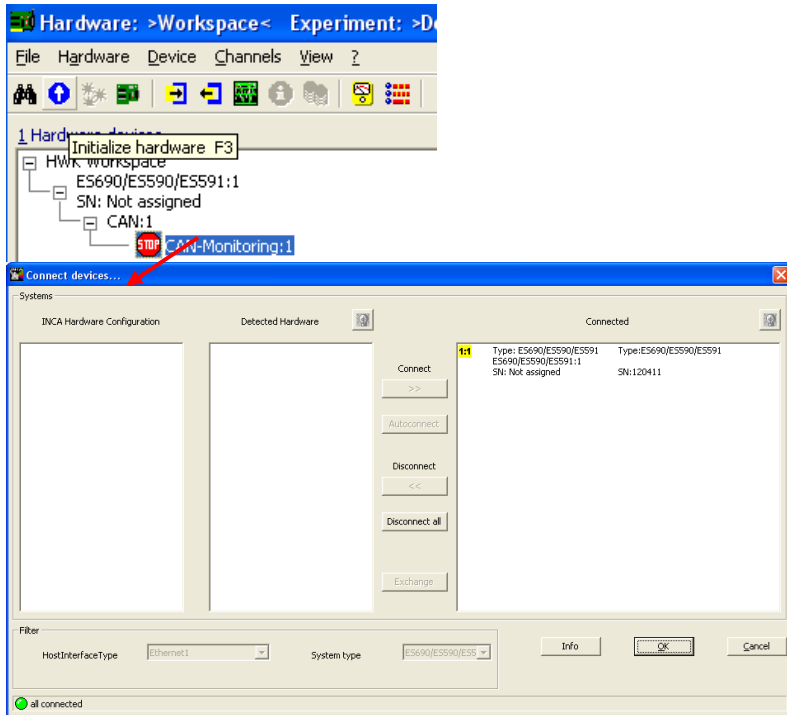
6. **Select the hardware.** In the hardware configuration window, right click the “HWK Workspace” listed under the section text “1. Hardware Devices”, and select Insert. Select the ETAS device you wish to use. In this example, we are using an ETAS ES591.1. Expand the selection tree by clicking the “+” next to the hardware device model. Expand the CAN selection and select CAN-Monitoring. Click OK.



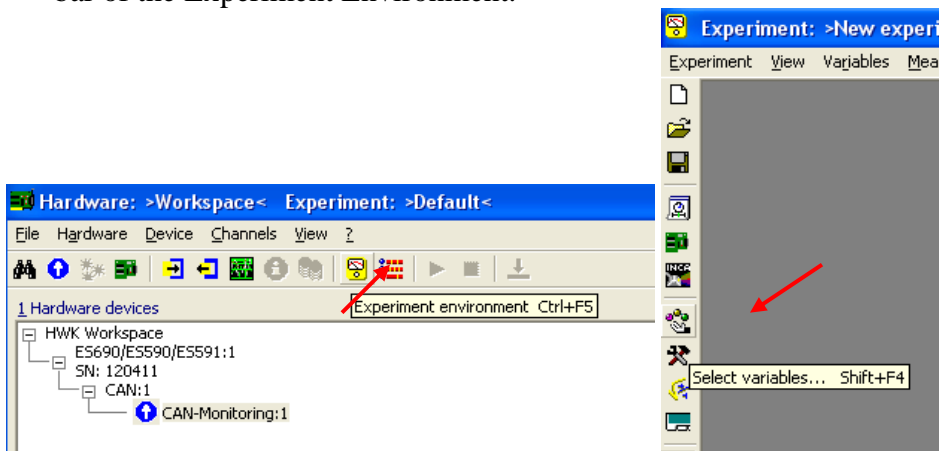
7. **Associate the dbc.** When you clicked OK in the last step, another window will pop up that will allow you to select a dbc that you have added to your workspace from step 4. Expand the selection tree, select your dbc file, and click OK.



8. **Initialize hardware.** The hardware is currently stopped, as indicated by the red stop sign icon next to the selected hardware. You must initialize it before you can use it to collect data. Click on the Initialize Hardware button on the upper tool bar and wait for the hardware to complete its initialization. Another window will pop up to confirm the device to connect to. Click OK.

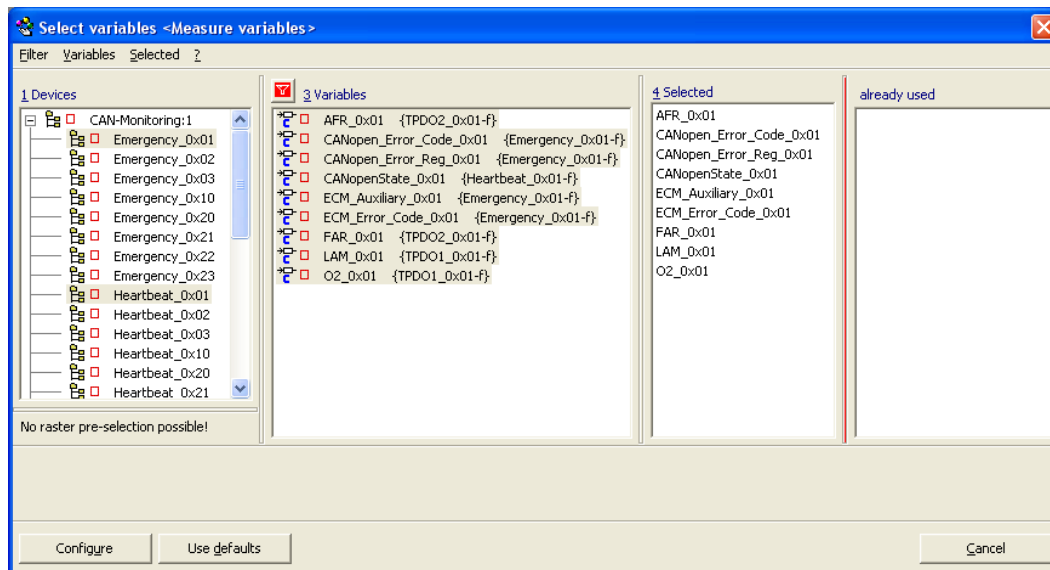


9. **Open an Experiment Environment.** Click on the Experiment Environment button on the upper tool bar to open an Experiment Environment. The Experiment Environment is where you can setup the monitoring of the CAN bus. By default, the Experiment Environment will be blank. You must select the variables from the dbc file that you wish to monitor. Click on the Select Variables icon in the left hand tool bar of the Experiment Environment.

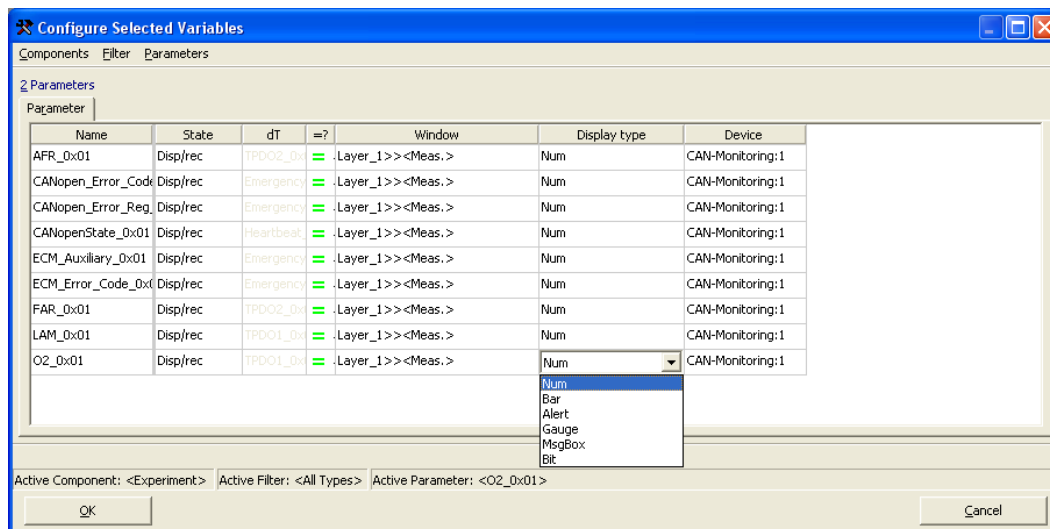




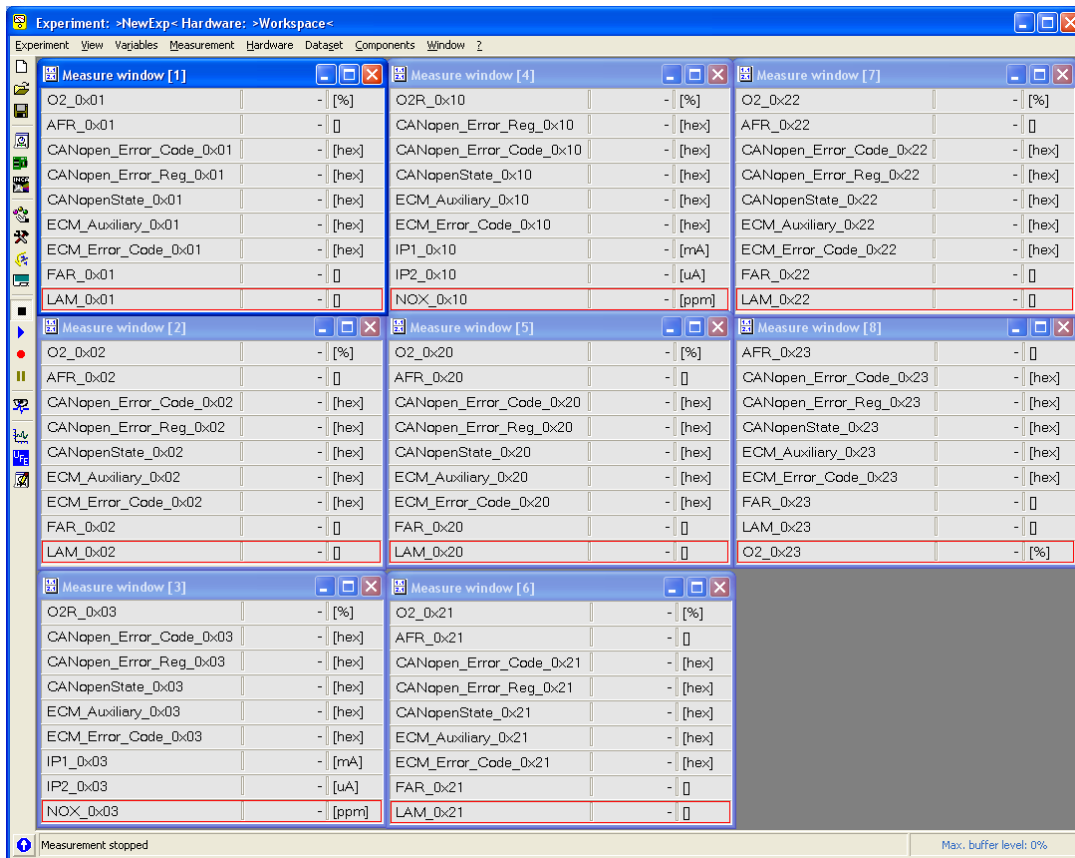
10. **Select and Configure Variables.** Select the variables that you wish to monitor in the Experiment Environment. These variables names are based on the data found in the dbc file. Click Configure.



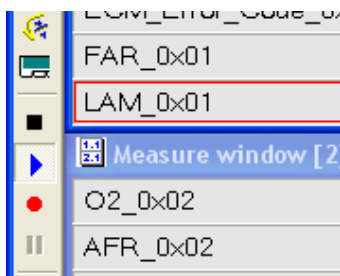
11. Another window will pop up to configure each selected variable. You can configure, for each variable, whether to record or simply display the data, how the data will be displayed (graphs, charts, gauges, numeric, etc.). When complete, click OK. We have left all configurations at default for this example.



12. A new sub-window will be added to the Experiment Environment. You do not need to select all the variables you want to monitor all at once. You can click on the Select Variables icon again at a later time to add more variables. Each set of variables you add will be placed in a new sub-window unless it is configured to join an existing sub-window. In this example, we have created a sub-window for each of the eight modules in the dbc file.



13. **Start CAN monitoring.** Right now there is no data displayed. That is because the CAN monitoring is stopped. To begin CAN monitoring, click on the Start Visualization icon (blue triangle) on the left hand tool bar. To stop CAN monitoring, click the Stop Measuring icon (black square) on the left hand tool bar. To begin recording the data, click on the Start Recording icon (red circle) on the left hand tool bar.



## Appendix G: Setting Up ATI Vision for ECM Modules

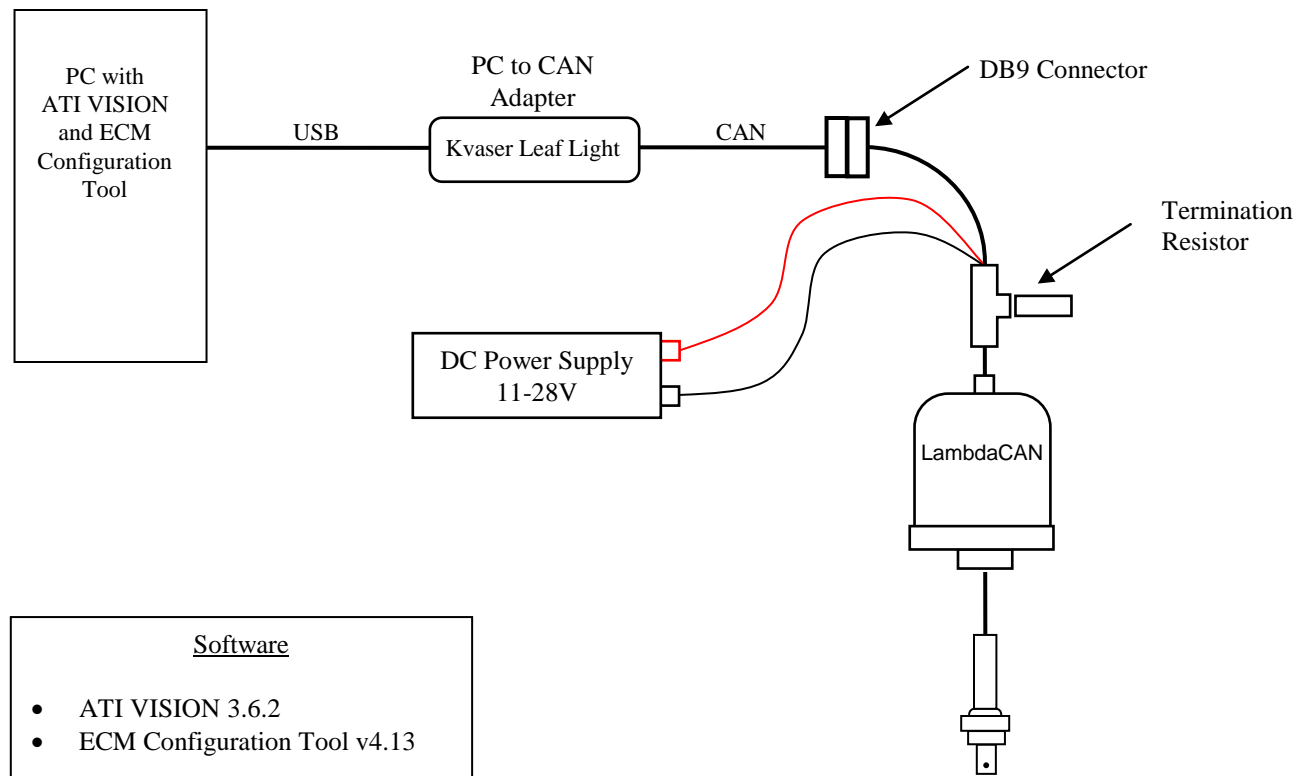
**NOTE:** While shown here for a single LambdaCAN\* module, the same procedure applies for any of ECM's CAN-based devices (i.e. Analyzers or Modules) as well as for multiple device simultaneously connected on the same bus.

### Introduction

Connecting ECM LambdaCAN hardware to ATI VISION software is simple and does not require any third-party software interface. Using the ECM Configuration Tool software to produce a .dbc database file, and the ATI VISION CANMonitor interface, any available hardware CAN interface can be used to read LambdaCAN data.

### Hardware Setup

A typical hardware configuration is shown in Figure 1. In this example, a Kvaser Leaf Light CAN-USB adapter is used. Other supported adapters have a similar procedure. Connect the DB9 CAN connector of the LambdaCAN to the PC to CAN adapter. Supply 11-28V DC (5A min. supply) to the LambdaCAN. For the case of an ECM analyzer (ex. Lambda 5220), connect to CAN port on display head. Do not directly connector to modules.



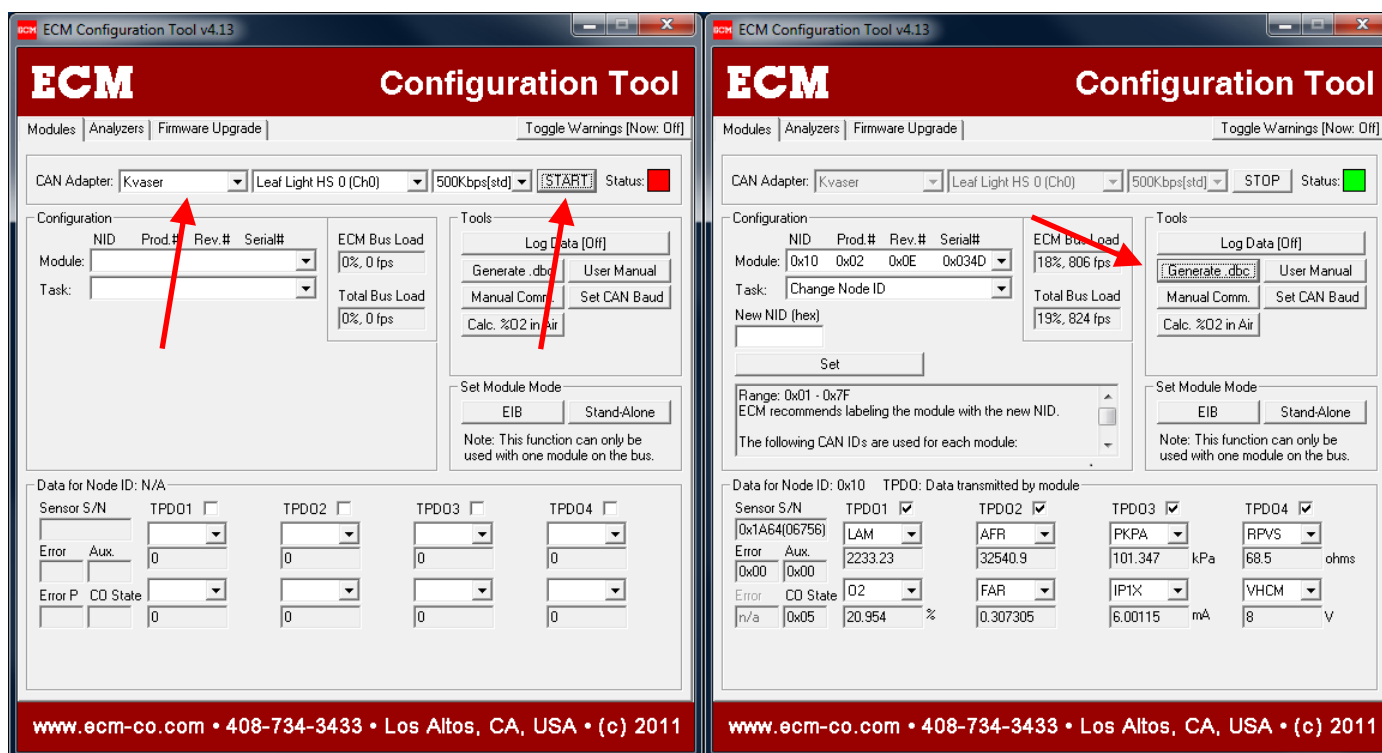
**Figure 1: Equipment Schematic Layout**

## Creating a .dbc File

The ECM Configuration Tool is used to create a .dbc database file for describing the CAN messages broadcast from an analyzer or module. All ECM products with a CAN interface use the CANopen protocol at 500kHz by default. To generate a .dbc file from an analyzer, refer to Appendix F. To generate a .dbc file for a module (ex. LambdaCAN module):

1. Connect hardware as shown in Figure 1. Ensure LambdaCAN bi-color LED indicator near sensor connector is visible (green during normal operation, flashing red without sensor attached).
2. Run ECM Configuration Tool software, and select the Modules tab (or the Analyzers tab if connecting to 5200 series analyzers).
3. Select CAN adapter from drop down menus as shown in Figure 2, and click START.
4. After LambdaCAN module(s) have initialized, select desired parameters to transmit from the TPDO drop down menus for each module.
5. Click Generate .dbc, and save this file in a location such as the VISION Projects folder.
6. Click STOP to end CAN connection.

**NOTE:** Whenever TPDO's are modified, a new .dbc file must be created.

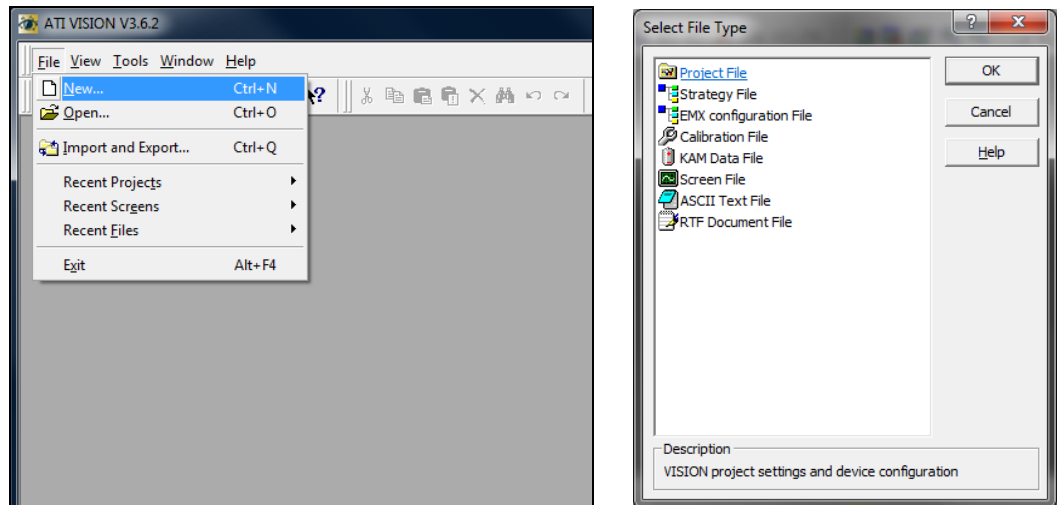


**Figure 2: ECM Configuration Tool**

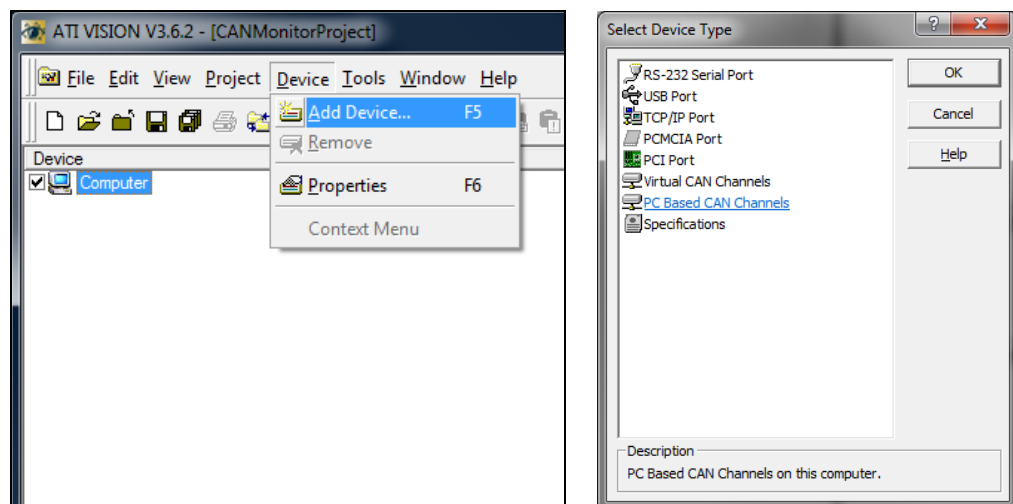
## Setup CANMonitor using ATI VISION

ATI VISION CANMonitor provides a method of reading general purpose information from any available CAN channel. The .dbc file generated by the ECM Configuration Tool is used to describe the format of the information available to VISION. To setup a CANMonitor in ATI VISION:

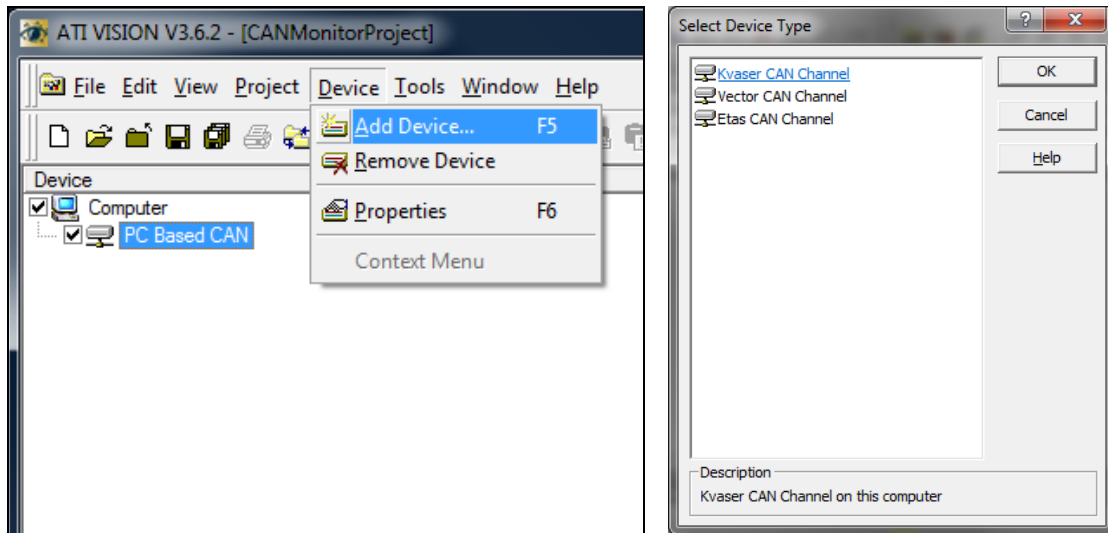
1. Run ATI VISION and open an existing Project File or create a new one by clicking File → New → Project File. In this example the Project has been named CANMonitorProject.



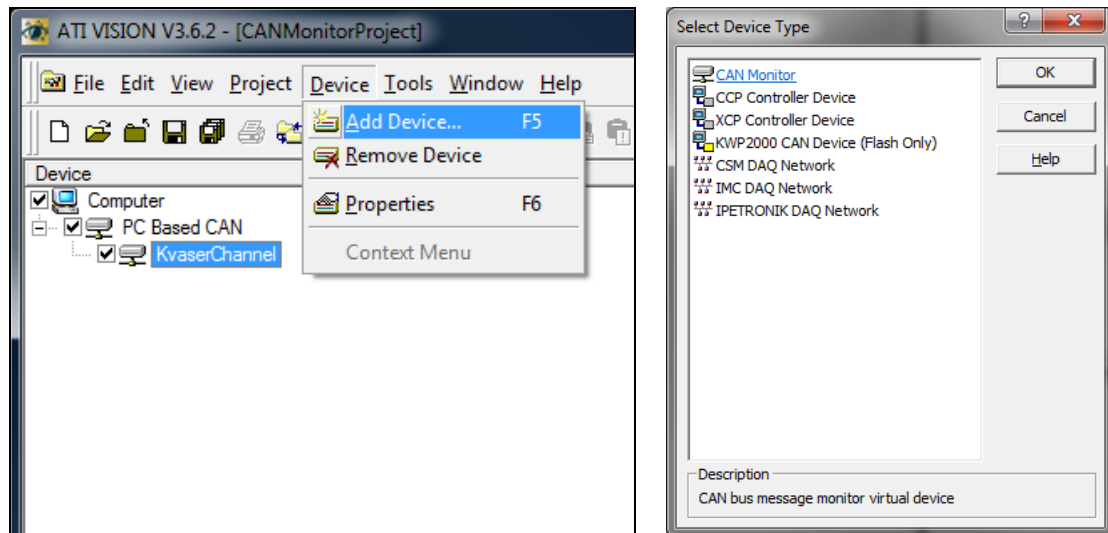
2. Add a Device by clicking Device → Add Device, select PC Based CAN Channels from the list.



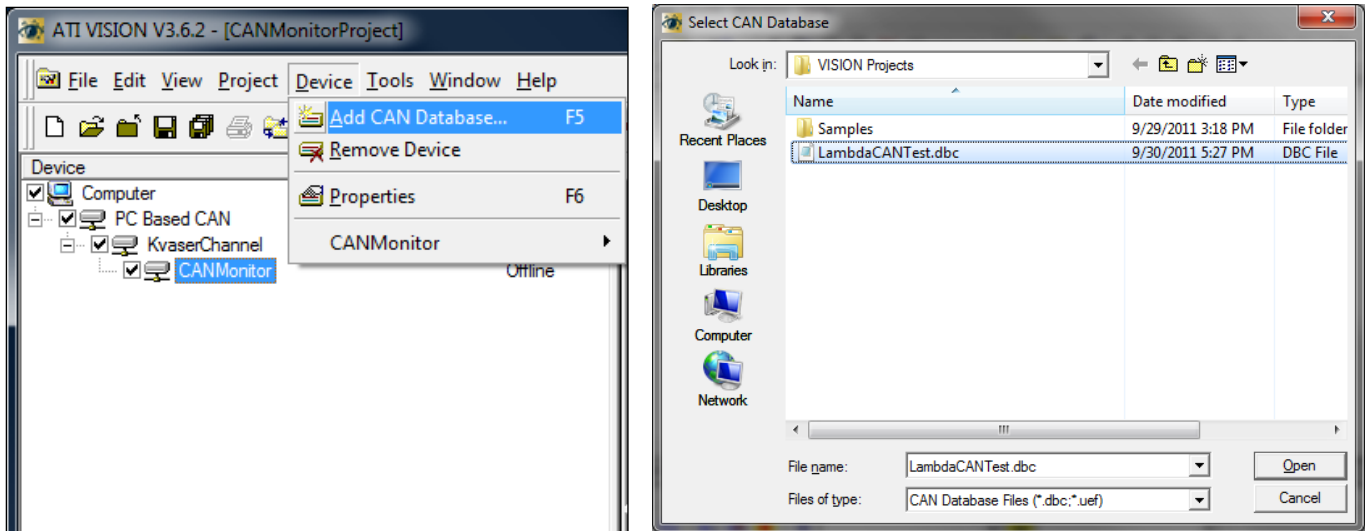
3. Add a physical hardware device by clicking Device → Add Device, and select Kvaser CAN Channel.



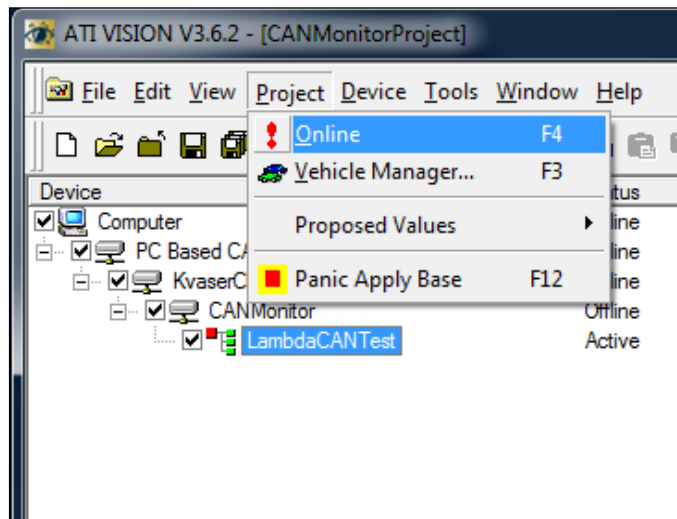
4. Select a CANMonitor device by again clicking Device → Add Device, and select CANMonitor.



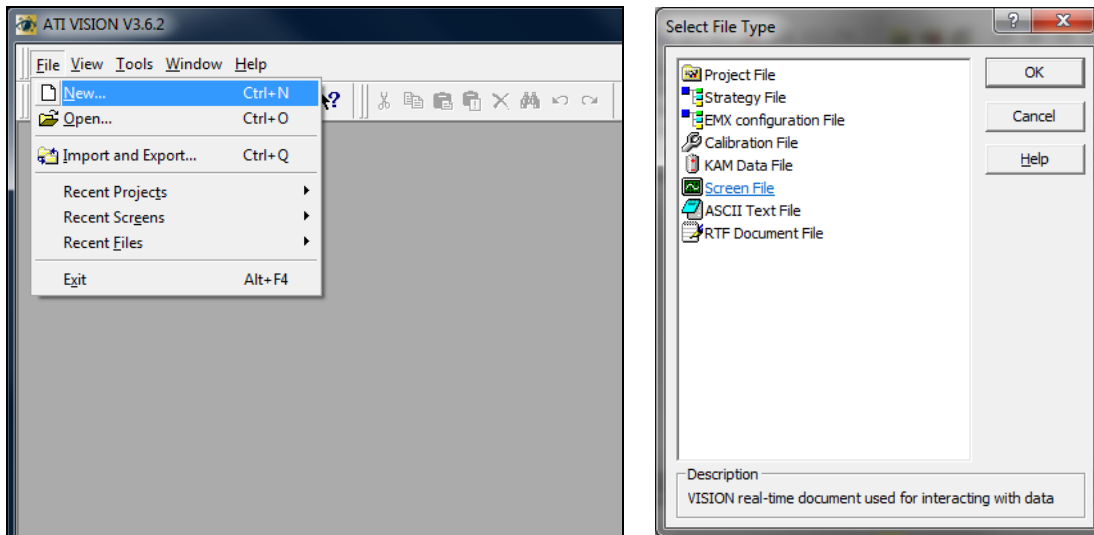
5. Add the .dbc file generated from the ECM Configuration Tool to CANMonitor by clicking Device → Add CAN Database and browsing to the previously created .dbc file.



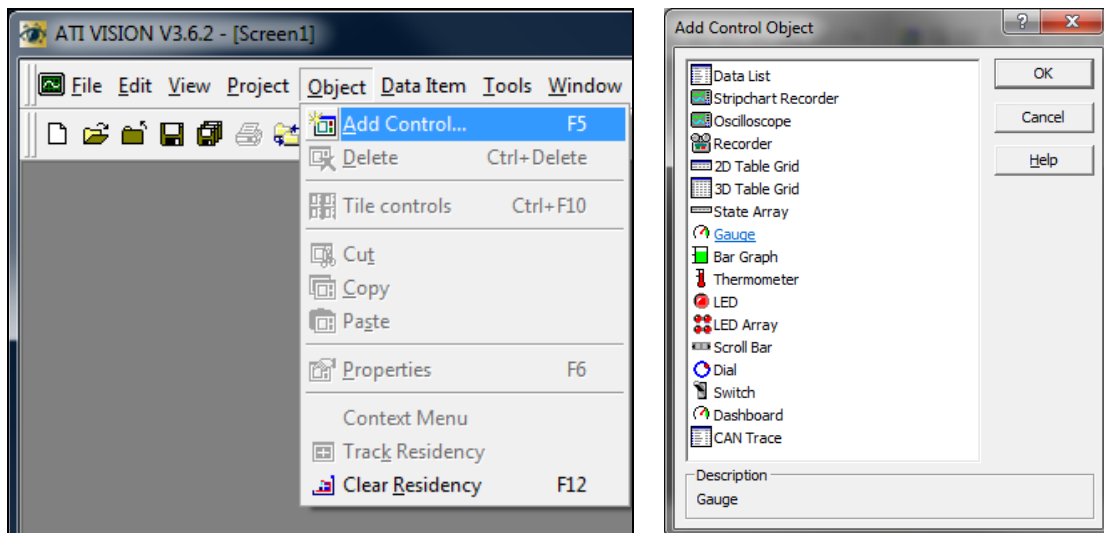
6. Enable the hardware by clicking Project → Online. The status of all of the devices should now show a Status of Online, and a value should appear in the Data Rate column of the Project window.



7. To view data, create a new Screen File and add a Control. Click File → New → Screen File

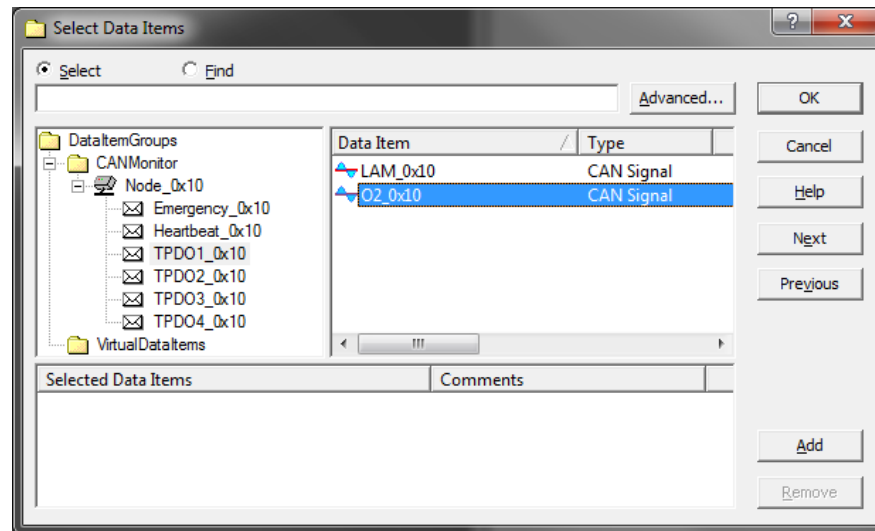


8. Select Object → Add Control → Gauge

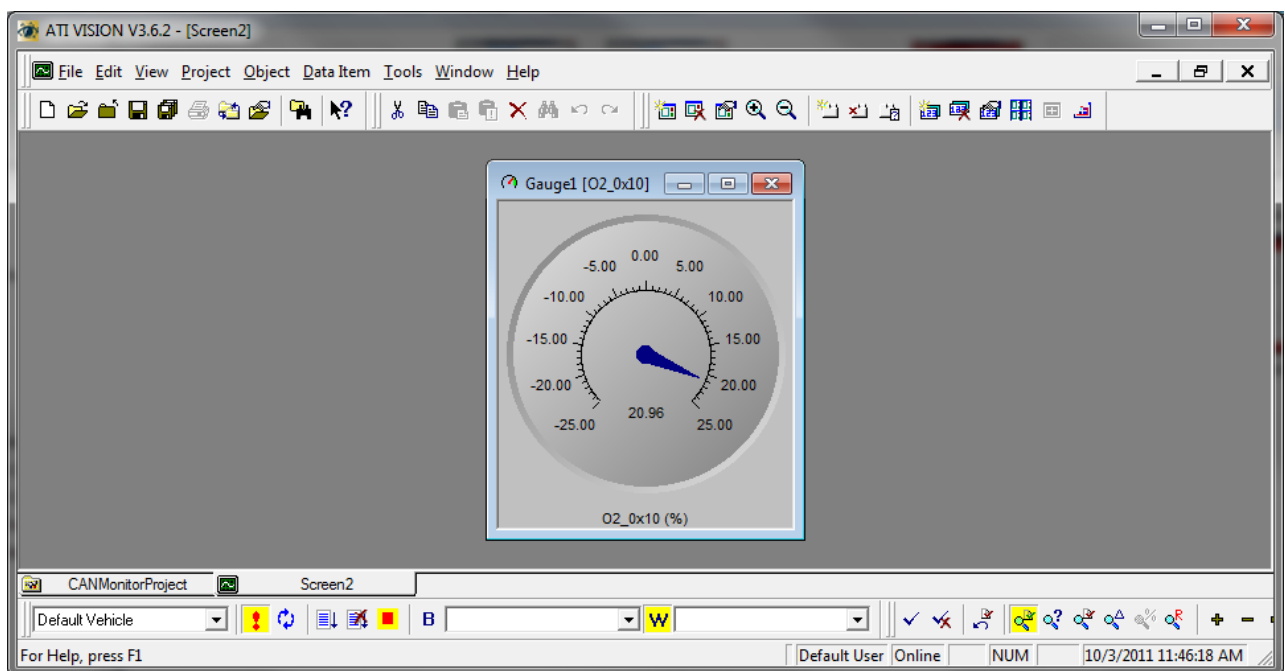




9. In the Select Data Items window open the CANMonitor file tree to view all of the available signals. Here the O2% from Node 0x10 has been selected. Click OK to add the Data Item to the Control.



10. Data should be visible on the gauge.



## **Warranty and Disclaimers**

### **WARRANTY**

The products described in this manual, with the exception of the NH<sub>3</sub> and pressure sensors, are warranted to be free from defects in material and workmanship for a period of 365 days from the date of shipment to the buyer. Within the 365 day warranty period, we shall at our option repair such items or reimburse the customer the original price of such items which are returned to us with shipping charges prepaid and which are determined by us to be defective. This warranty does not apply to any item which has been subjected to misuse, negligence or accident; or misapplied; or modified; or improperly installed.

The NH<sub>3</sub> and pressure sensors are considered an expendable part and as such cannot be covered by a warranty.

This warranty comprises the sole and entire warranty pertaining to the items provided hereunder. Seller makes no other warranty, guarantee, or representation of any kind whatsoever. All other warranties, including but not limited to merchantability and fitness for purpose, whether express, implied, or arising by operation of law, trade usage, or course of dealing are hereby disclaimed.

The warranty is void if a module or the display head is opened.

### **LIMITATION OF REMEDY**

Seller's liability arising from or in any way connected with the items sold and/or services provided shall be limited exclusively to repair or replacement of the items sold or refund of the purchase price paid by buyer, at seller's sole option. In no event shall seller be liable for any incidental, consequential or special damages of any kind or nature whatsoever, including but not limited to lost profits arising from or in any way connected with items sold and/or services provided to buyer, whether alleged to arise from breach of contract, express or implied warranty, or in tort, including without limitation, negligence, failure to warn or strict liability. In no event shall the company's liability to buyer arising out of or relating to the sale of any product or service exceed the purchase price paid by buyer to the company for such product or service.

### **PRODUCT CHANGES**

We reserve the right to discontinue a particular product or to make technical design changes at any time without notice.

## EC DECLARATION OF CONFORMITY

We declare under our sole responsibility that the products:

**NOx 5210 Analyzer**  
**Lambda 5220 Analyzer**  
**EGR 5230 Analyzer**  
**NOx/NH3 5240 Analyzer**  
**NH<sub>3</sub> 5250 Analyzer**  
**LambdaCAN, LambdaCANc, LambdaCANd, LambdaCANp Lambda Modules**  
**NOxCAN, NOxCANg, NOxCANt, NOx1000 NOx Modules**  
**NH<sub>3</sub>CAN Module**  
**baroCAN Module**  
**dashCAN, dashCANc, dashCAN+, dashCAN2**  
**appsCAN**  
**SIM300, SIM400, SIM500, SIM600, SIM700, SIM800**  
**BTU200**  
**EGR 4830 Analyzer**  
**AFM1540 Lambda Module**  
**AFM1600 Lambda and O<sub>2</sub> Analyzer**  
**DIS1000 Display Head**

To which this declaration relates are in conformity with the essential requirements of the following standards:

**EN61326: 1997/A2: 2001 (Class A & Annex A)**

**EN61010-1: 2001 (Electrical Safety)**

And therefore conform to the requirements of the following directives:

**89/336/EEC Electromagnetic Compatibility (EMC)**

**72/23/EEC Low Voltage Directive (LVD)**



Ronald S. Patrick  
Vice President Sales  
November 11, 2014





**ECM** ENGINE CONTROL  
AND MONITORING

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