NevadaNano

MOLECULAR PROPERTY SPECTROMETER™ (MPS™)

A2L REFRIGERANT GAS SENSOR

EVALUATION UNIT USER MANUAL

NNTS Proprietary Information

SM-UM-0005-03

Notices

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1. System Overview

The Molecular Property Spectrometer™ (MPS™) A2L Refrigerant Gas Sensor Evaluation Unit is a user-friendly sensor system developed for assessing refrigerant gas detection performance. The evaluation system is shown in Figure 1. The sensor's pins connect to the provided evaluation PCB for communication with a PC (USB) or breakout to individual sensor signals (optional 5-wire harness). The sensor contains the MPS sensing element, environmental sensor, microprocessor, and supporting electronics. A quarter-turn plastic gas mask and housing is included to provide a sealed headspace above the sensor for test gas delivery.

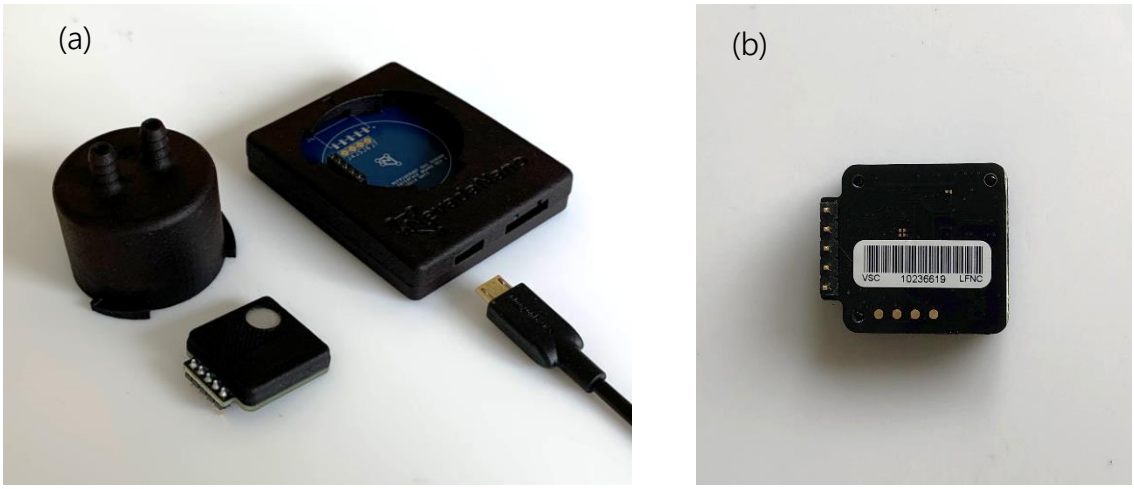

Figure 1 - (a) MPS™ A2L Refrigerant Gas Sensor, PCB with housing, gas-delivery mask, and USB A-to-micro-B cable. (b) Sensor bottom-side detail.

The complete MPS™ A2L Refrigerant Gas Sensor Evaluation Unit kit consists of:

- MPS™ Sensor Interface Software and Drivers
- Evaluation PCB + housing
- Gas delivery mask with integrated barbs
- USB A-to-micro-B cable
- 1/4" Tygon tubing (McMaster: 6516T17)
- Micro USB plug (not shown--optional)
- MPS™ A2L Refrigerant Gas Sensor (sold separately)

2. System Setup

The MPS™ A2L Refrigerant Gas Sensor Evaluation Unit receives power and interfaces either with a PC via USB (default configuration for evaluation) or by using the UART protocol through a 5-wire harness. The user interacts with the sensor while using the MPS™ Sensor Interface Software. With this application, the user can:

- establish communication with the sensor to start, pause, and end evaluation tests
- examine data in real-time
- record test notes
- save data to .csv file

The MPS™ Sensor Interface, accompanying drivers, and Firmware Upgrade Instructions are available at: https://www.nevadanano.com/downloads/

The user should first install the FTDI Driver, followed by a system restart, and then install the MPS™ Sensor Interface Software. The setup procedure follows:

1. It is recommended that the computer used to operate the MPS sensor be powered on prior to plugging the sensor in, since the MPS receives its power from the computer. Interruption in power to the sensor will result in a sensor fault.
2. Connect the micro-USB cable to the MPS, then connect the opposite end of the USB cable to a USB port on the computer. The MPS will automatically receive power from the computer.
3. If a gas delivery manifold is not required, proceed to Step 4. If a mixture of refrigerant and air is being used to interrogate the sensor, please note the following:
    a. Using the supplied ¼ -in tubing, connect the test gas system to one of the integrated barbed connectors on the MPS gas mask.
        - Test gas should be supplied to the sensor at rates no greater than 300 mL/min.
        - The use of Nafion [1] tubing is recommended to humidify the test gas stream.

[1] For more information on Nafion, including its permeability for various gases, refer to: http://www.permapure.com/products/nafion-tubing/

- The MPS should be initialized in the zero-air mixture used to dilute the refrigerant when the sensor is powered on.

b. Attach the gas mask to the housing by aligning the arrow on the gas mask at the 10 o'clock position and inserting the three tabs into the housing. Turn the mask clockwise until the arrows on the housing and mask align and the mask "clicks" into place. The barbs will be aligned across the horizontal axis of the housing.

Figure 2 – Proper gas mask attachment is achieved when the arrow points align and the barbs are in the horizontal position.

4. Open the MPS Sensor Interface application from the desktop icon:

5. Click the "Find MPS Devices" button and select the MPS A2L Refrigerant Gas Sensor connected to the computer (Figure 3). The sensor name is found on the sensor serial number in the form: Bxxxxxxxxx.

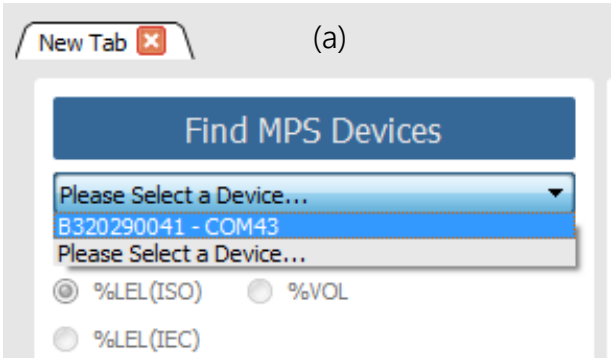

Figure 3 – Selecting the active MPS™ A2L Refrigerant Gas Sensor.

6. The MPS sensor is now ready for testing. Proceed to the A2L Refrigerant Gas Sensor User Manual (available at: https://www.nevadanano.com/downloads/), and read thoroughly before continuing.

3. Conducting a Test

When interrogating the sensor with pre-diluted mixtures of refrigerant, always start the flow of zero-air baseline gas over the MPS and wait ~1 minute for baseline gas to replace ambient air before proceeding. The Concentration Unit functionality is not available for A2L. It automatically reports in %LEL units, with %vol/%LEL per ISO 10156. Click Start to begin data acquisition. The unit will acquire 10 baseline readings (Figure 4, highlighted in green). After this stabilization period, the sensor is ready for testing.

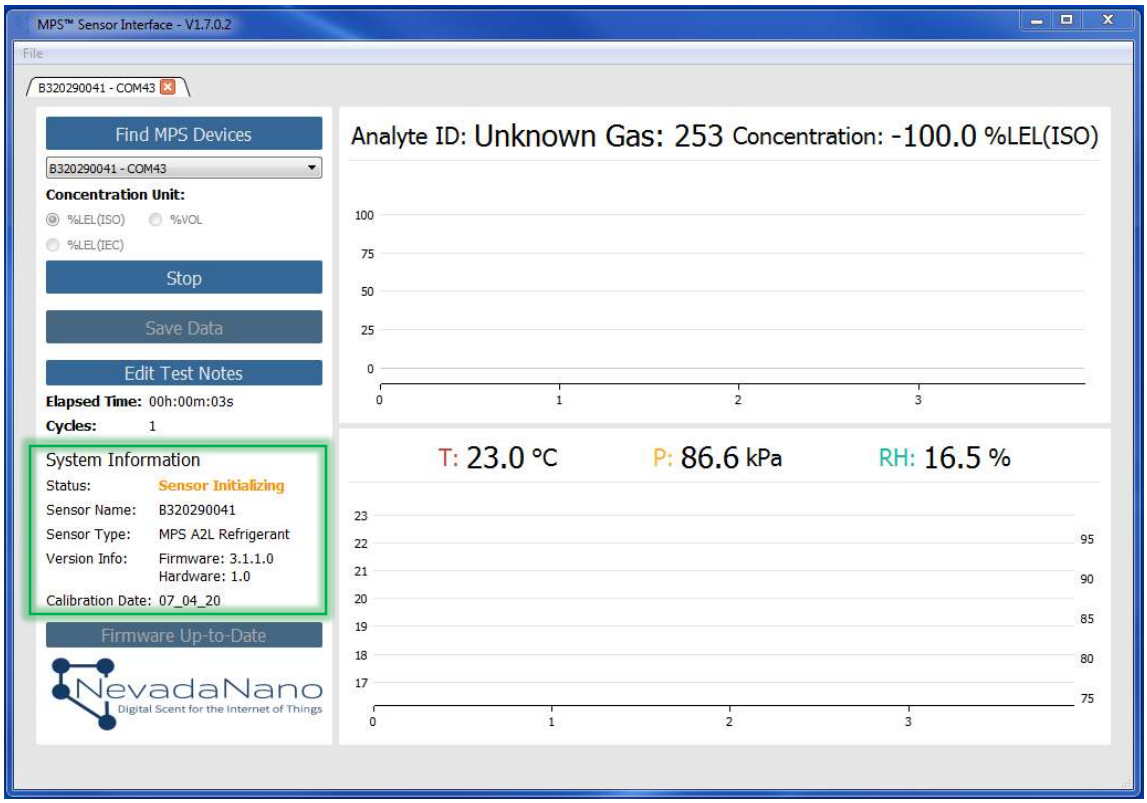

Figure 4 – Acquiring sensor environmental baselines at the beginning of a test.

During a test, the system generates a new data point every 2 seconds. Data can be visualized on the MPS™ Sensor Interface Software in real time throughout a test. Graphs can be resized and zoomed in and out while data are being collected. Graphs can be reset to auto-scale by double clicking on the desired axis.

The MPS™ A2L Refrigerant Gas Sensor must be in an idle state before shutdown. Pause the current test and wait for the system status dialogue to display "Idle", then save or clear the data. The USB cable can now be disconnected.

The user must enter test notes by clicking the "Edit Test Notes" button highlighted in green in Figure 5 any time prior to saving data.

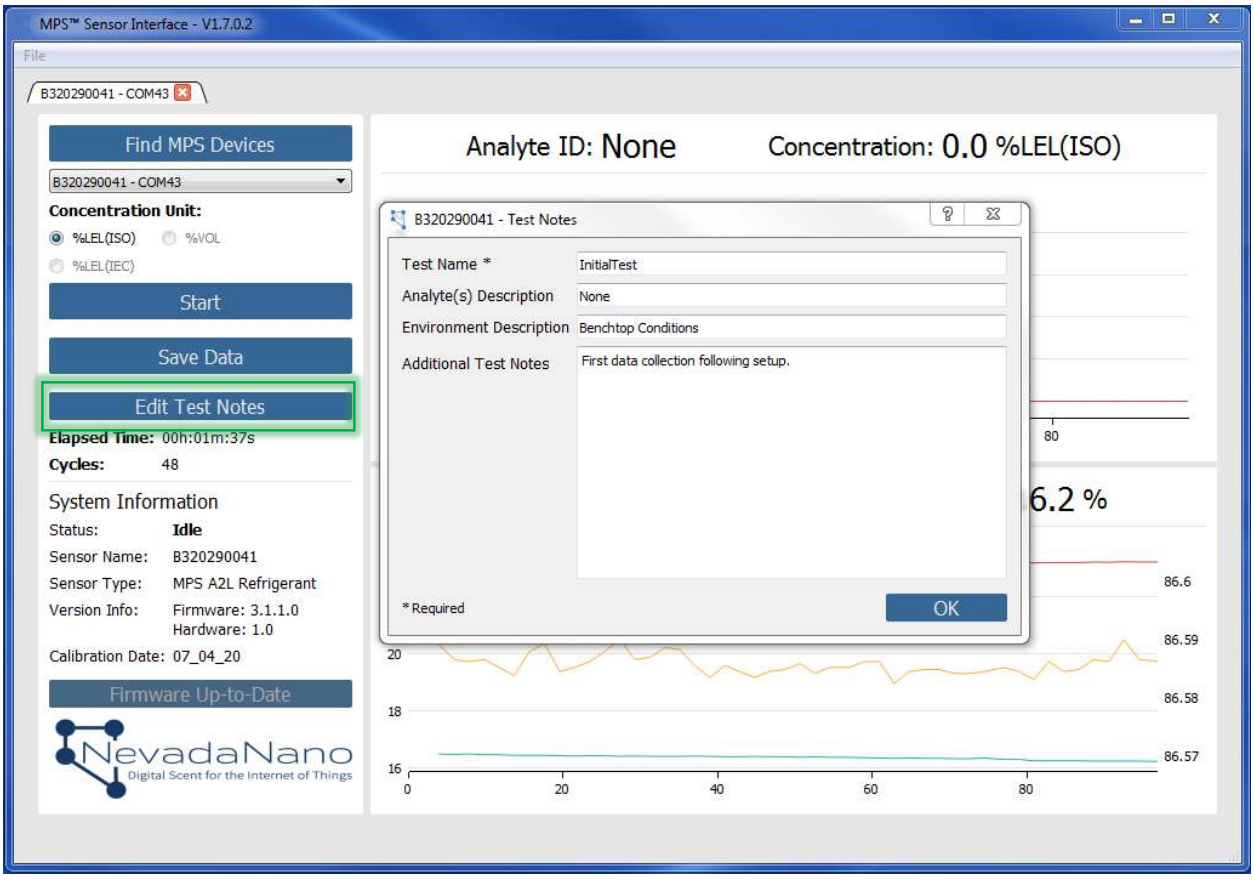

Figure 5 – Example test notes dialogue box.

After entering the experimental test notes, click "Save Data". A dialogue box will appear to prompt the user to select a directory for saved test data. After saving, the user can now clear the data and begin another test by clicking 'x' on the tab and going to File->New.

Throughout a test, data are continuously updated and stored in a temporary directory. Once a test is complete, data can be saved to a drive location specified by the user. The folder created in this step is named using the following format:

Year_Month_Day-Time SensorName_testName

Here is an example:

2019_07_24-173313 B320290041_InitialTest

Avoid using hyphen and special characters (- , \ , /, %, &) when saving data.

The data folder will contain:

1. timelog.txt – This file provides the start, pause, re-start, and end times of a test. Here is an example:
   2019_07_24 - 17_22_10: Started
   2019_07_24 - 17_28_00: Stopped
   2019_07_24 - 17_33_13: Data saved

2. mpsData.csv – This is a comma-separated-value formatted file that contains all the data from the test, organized in columns:

Time [s]	Cycle	T [C]	P [kPa]	RH [%]	Gas ID	Conc [%LEL]

3. testNotes.txt – This file provides a record of the test notes entered in the user dialogue box before saving.

Appendix A: Alternative Communication Configuration

An evaluation that requires direct communication to the MPS™ A2L Refrigerant Gas Sensor via UART is shown in Figure 6. This configuration requires that the optional micro USB plug be inserted into the unused USB port when actively interfacing with the sensor via the 5-pin header located on the sensor PCB. The recommended 5-Pin mating connector has a Molex P/N: 0050579205. Please consult with NevadaNano regarding communication or system integration issues.

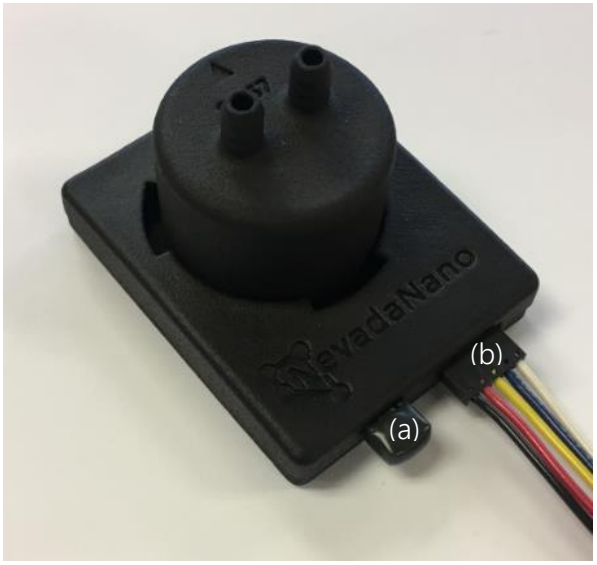

Figure 6 – Alternative communication configuration. The micro USB plug (a) is inserted prior to interfacing with the sensor via the 5-pin header (b)

Given the custom nature of this configuration, the following should be considered:

- Reversing the polarity of the input power will result in a damaged sensor
- Improper installation of the micro USB plug could result in interference on the communication line, corrupt or missing data, etc.
- The analog output of the sensor is available in all configuration scenarios

Table 1 details the pinout of the 5-pin header located on the MPS™ A2L Refrigerant Gas Sensor evaluation PCB.

Table 1: *5-pin header pinout*

Pin Number	Function
1	GND
2	V+ (3.3V to 5V ±5%)
3	Sensor TX
4	Sensor RX
5	Analog Out

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