F-900 Controller Software and Calibration Instructions

Pre-Calibration Preparation

The following is a listing of the total standard gases/materials needed to calibrate ALL sensors available in the F-900 (Not all F-900's come equipped with all sensors, see graph to verify which calibration gases to purchase for the sensors in your instrument) **Every F-900** is equipped with C_2H_4 ppm sensor and C_2H_4 ppb sensor , **optional sensors** are: CO_2 PCT sensor , CO_2 ppm sensor, O_2 sensor:

- Ethylene calibration gas for C_2H_4 ppm sensor (20 ppm recommended)
- Ethylene verification gas for C_2H_4 ppm sensor (10 ppm recommended)
- Ethylene calibration gas for C_2H_4 ppb sensor (1.5 ppm recommended)
- Ethylene verification gas for C_2H_4 ppb sensor (1 ppm recommended)
- CO_2 calibration gas for CO_2 PCT sensor (16% recommended)
- CO_2 verification gas for CO_2 PCT sensor (5% recommended)
- CO_2 calibration gas for CO_2 ppm sensor (2,000 ppm recommended)
- CO_2 verification gas for CO_2 ppm sensor (1,000 ppm recommended)
- O_2 calibration gas (21% recommended)* can use ambient air instead
- 100% Nitrogen (N_2) gas for CO_2 PCT sensor and O_2 sensor
- Potassium Permanganate ($KMnO_4$) granules
- Soda Lime (NaOH, KOH, $Ca(OH)_2$) granules
- Flow Meter Capable of Measuring 300 mL/min and lower
- Tubing with low outgassing properties (Viton)

*The listed gases can be replaced with similar concentrations as long as the gas used is of a standard, consistent value. The following is a chart displaying the use of each gas to the appropriate sensor:

Standard Gas Needed for Each Sensor:

	20 ppm (C_2H_4) gas	10 ppm (C_2H_4) gas	1.5 ppm (C_2H_4) gas	1.0 ppm (C_2H_4) gas	16% (CO_2) gas	5% (CO_2) gas	2,000 ppm (CO_2) gas	1,000 ppm (CO_2) gas	21% (O_2) gas **	100% (N_2) gas	Flow Meter (≤300 mL/min)	Soda Lime (NaOH-KOH…)	Potassium Permanganate ($KMnO_4$)
C_2H_4 ppm sensor	✓	✓									✓		✓
C_2H_4 ppb sensor			✓	✓							✓		✓
CO_2 PCT sensor					✓	✓				✓	✓		
CO_2 ppm sensor							✓	✓		✓	✓	✓	
O_2 sensor									✓	✓	✓		

** Can use ambient air instead of purchasing 21% (O_2) gas

Calibration Schedule for F-900:

Calibration	C_2H_4 ppm sensor	C_2H_4 ppb sensor	CO_2 PCT sensor	CO_2 ppm sensor	O_2 sensor
Set Zero	Daily	Daily	6 months	Weekly	6 months
Set Span	6 months	Weekly	6 months	6 months	6 months

Controller Software

*not required for calibrations involving Potassium Permanganate (KMnO4):

1. If you have not already done so, download the package setup software from http://www.felixinstruments.com/support/f-900-support/software and install it on your computer. This package includes the latest firmware updates for the F-900, as well as the controller software needed for real time monitoring and calibration of the F-900.
2. Turn on the F-900.
3. Connect the F-900 to computer via a USB cable.
4. On the F-900, from the main menu, go to Setup > Measure and change the "Mode" setting to "Monitor". Return to the main menu by pressing the left arrow.
5. Open the controller software.
6. In the top left of the window, select the F-900 unit listed.
7. Click the "Calibration" tab and select the "900" sub-tab.

Ethylene (C_2H_4) PPB Sensor Calibration:

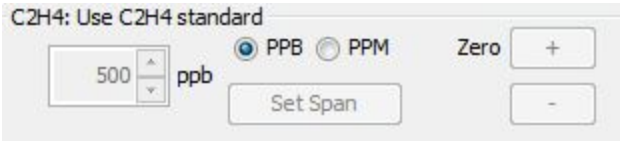
Setting the Zeroes (Offset) with Potassium Permanganate (KMnO4) *daily

1. Place fresh potassium permanganate (KMnO4) in Chamber Out (Solids Chamber).
2. Power on the instrument and allow adequate warm-up time (3 min or more).
3. Press the Right arrow when Measure is highlighted to begin a measurement.
4. Let the sensor automatically "Environment Stabilize"
5. Once the measurement begins, press the right arrow until you access the "settings" menu.
6. Scroll down to "Set Zero"
7. Press the Right arrow to highlight "C2H4"
8. Press Enter.
9. A message appears asking "zero selected sensors?"
    a. Press enter to confirm.
10. A message appears asking to "Place KMnO4 in CH_Out.'"
    a. If KMnO4 is in Chamber Out, press enter to confirm
11. The display will switch to Monitor mode and "correcting offset" is shown at the bottom.
    a. The settings will automatically change to turn on Chamber Out, turn off Chamber In and turn on the Close loop.

12. The instrument will wait until no more than a 40 ppb change is detected for 10 minutes before setting the zero calibration point.
13. The instrument will make a “beep” sound twice to indicate that the offset correction is complete. The entire set zero process takes about 25 minutes.
14. The measurement will continue with the original settings for the conditioning chambers and close loop on/off.

Ethylene (C_2H_4) PPB Sensor Set Span *Weekly

1. Connect the high resolution flowmeter, ethylene calibration gas for the ppb sensor, and F-900 intake ports together using a T-junction of tubing.
2. On the F-900, begin Measure mode.
3. Set the flowrate on the C_2H_4 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a “Flow Blocked” error, then increase the flow on the meter by 10 mL/min and begin measure mode on the 900 again. If the error persists, contact tech support.
4. Let the F-900 read the gas for five minutes.
5. In the controller software, in the C2H4 field, select PPB and set the concentration to the value of the calibration gas being used. Then hit the “Set Span” button.



6. The concentration on the F-900 should now read the same as the calibration gas 7% ± 25 PPB.

**An alternate method for C_2H_4 PPB span calibration is available with purchase of the F-900 calibration kit. For instructions on this method, see pg. 44 of the F-900 user manual entitled “C2H4 PPB Re-Calibration (Manual)”.*

Ethylene (C_2H_4) PPB Sensor Verification *After Set Span

Perform this process immediately after calibrating the ethylene ppb sensor on the F-900.

1. Connect the high resolution flowmeter, ethylene verification gas for the ppb sensor, and F-900 intake ports together using a T-junction of tubing.
2. On the 900 begin measure mode.
3. Set the flowrate on the C_2H_4 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a “Flow Blocked” error, then increase the flow on the meter by 10 mL/min and begin measure mode on the F-900 again. If the error persists, contact tech support.

4. Let the F-900 read the gas for five minutes.
5. The F-900 should read the same value as the verification gas within 7% ± 25 PPB . If it does not, repeat the “Ethylene Sensor Calibration” section above.

Ethylene (C_2H_4) PPM Sensor Calibration

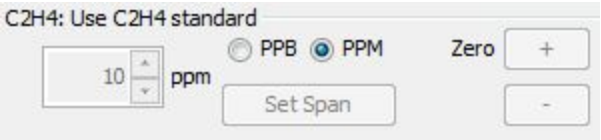
Setting the Zeroes (Offset) with Potassium Permanganate (KMnO4) *daily

1. Place fresh potassium permanganate (KMnO4) in Chamber Out.
2. Power on the instrument and allow adequate warm-up time (3 min).
3. Press the Right arrow when Measure is highlighted to begin a measurement.
4. Let the sensor automatically “Environment Stabilize”
5. Once the measurement begins, press the right arrow until you access the “settings” menu.
6. Scroll down to “Set Zero”.
7. Press the Right arrow to highlight “C2H4”.
8. Press Enter.
9. A message appears asking “zero selected sensors?”
    a. Press enter to confirm.
10. A message appears asking to “Place KMnO4 in CH_Out.’”
    a. If KMnO4 is in Chamber Out, press enter to confirm
11. The display will switch to Monitor mode and “correcting offset” is shown at the bottom.
    a. The settings will automatically change to turn on Chamber Out, turn off Chamber In and turn on the Close loop.
12. The instrument will wait until no more than a 40 ppb change is detected for 10 minutes before setting the zero calibration point.
13. The instrument will make a “beep” sound twice to indicate that the offset correction is complete. The entire set zero process takes about 25 minutes.
14. The measurement will continue with the original settings for the conditioning chambers and close loop on/off.

Ethylene (C_2H_4) PPM Sensor Set Span *6 months

1. Connect the high resolution flowmeter, ethylene calibration gas for the ppm sensor, and F-900 intake ports together using a T-junction of tubing.
2. On the F-900, begin measure mode.
3. Set the flowrate on the C_2H_4 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a “Flow Blocked” error, then increase the flow on the meter by 10 mL/min and begin measure mode on the 900 again. If the error persists, contact tech support.

4. Let the F-900 read the gas for five minutes.
5. In the controller software, in the C2H4 field, select PPM and set the concentration to the value of the calibration gas being used. Then hit the “Set Span” button.



6. The concentration on the 900 should now read the same as the calibration gas 5% ± 0.5 PPM .

Ethylene (C_2H_4) PPM Sensor Verification *After Set Span

Perform this process immediately after calibrating the ethylene ppm sensor on the F-900.

1. Connect the high resolution flowmeter, Ethylene verification gas for the ppm sensor, and F-900 intake ports together using a T-junction of tubing.
2. On the F-900 begin measure mode.
3. Set the flowrate on the C_2H_4 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a “Flow Blocked” error, then increase the flow on the meter by 10 mL/min and begin measure mode on the F-900 again. If the error persists, contact tech support.
4. Let the F-900 read the gas for five minutes.
5. The F-900 should read the same value as the verification gas within 5% ± 0.5 PPM. If it does not, repeat the “Ethylene Sensor Calibration” section above.

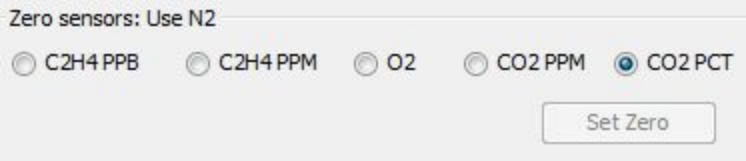
Carbon Dioxide (CO_2) PCT Sensor Calibration

*CO_2 PCT Sensor is optional

Setting the Zeroes (Offset) with Nitrogen Gas (N_2) *6 months

1. Connect the high resolution flow meter, N_2 gas, and F-900 intake ports together using a T-junction of tubing.
2. On the F-900, begin measure mode.
3. Set the flowrate on the N_2 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a “Flow Blocked” error, then increase the flow on the meter by 10 mL/min and begin measure mode on the F-900 again. If the error persists, contact tech support.
4. Let the F-900 read the gas for five minutes.

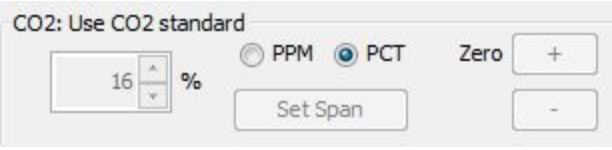
5. In the controller software, select CO2 PCT in the “Zero sensors” field, then click the “Set Zero” button.



6. The F-900 should now read 0 for the CO_2 PCT sensor.
7. Set Span should take place directly following the Set Zero process for the CO2 PCT sensor!

Carbon Dioxide (CO_2) PCT Sensor Set Span *6 months

1. Set Span should take place directly following the Set Zero process for the CO2 PCT sensor.
2. Connect the high resolution flow meter, CO_2 calibration gas for the PCT sensor, and 900 intake ports together using a T-junction of tubing.
3. On the F-900, begin measure mode.
4. Set the flowrate on the CO_2 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a “Flow Blocked” error, then increase the flow on the meter by 10 mL/min and begin measure mode on the 900 again. If the error persists, contact tech support.
5. Let the F-900 read the gas for five minutes.
6. In the controller software, in the CO2 field, select PCT and set the concentration to the value of the calibration gas being used. Then hit the “Set Span” button.



7. The concentration on the 900 should now read the same as the calibration gas ± 5%.

Carbon Dioxide (CO_2) PCT Sensor Verification *After Set Span

Perform this process immediately after calibrating the carbon dioxide sensor on the F-900

1. Connect the high resolution flow meter, CO_2 PCT sensor verification gas, and F-900 intake ports together using a T-junction of tubing.
2. On the F-900, begin measure mode.
3. Set the flowrate on the CO_2 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a “Flow Blocked” error, then increase the flow on the meter by 10 mL/min and begin measure mode on the 900 again. If the error persists, contact tech support.
4. Let the F-900 read the gas for five minutes.

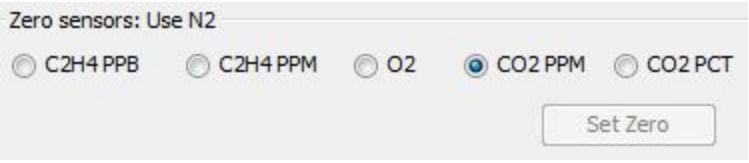
5. The F-900 should read the same value as the verification gas ± 5%. If it does not, repeat the "Carbon Dioxide PCT Sensor Calibration" section above.

Carbon Dioxide (CO_2) PPM Sensor Calibration

*CO_2 ppm Sensor is optional

Setting the Zeroes (Offset) with Soda Lime or Nitrogen Gas (N_2) *Weekly

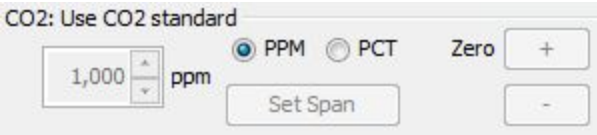
1. Place granular Soda Lime in the solids chamber of the F-900, **or** if using nitrogen gas, connect the high resolution flow meter, N_2 gas, and F-900 intake ports together using a T-junction of tubing.
2. On the F-900, begin measure mode.
3. If using Soda Lime, run the instrument on closed loop, otherwise, set the flowrate on the N_2 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a "Flow Blocked" error, then increase the flow on the meter by 10 mL/min and begin measure mode on the 900 again. If the error persists, contact tech support.
4. Let the F-900 measure for five minutes.
5. In the controller software, select CO2 ppm in the "Zero sensors" field, then click the "Set Zero" button (it will display "Use N2" when utilizing both Soda Lime or N2 gas).



6. The 900 should now read 0 for the CO_2 ppm sensor.

Carbon Dioxide (CO_2) PPM Sensor Set Span *6 months

1. Connect the high resolution flow meter, CO_2 calibration gas for the ppm sensor, and F-900 intake ports together using a T-junction of tubing.
2. On the F-900, begin measure mode.
3. Set the flowrate on the CO_2 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a "Flow Blocked" error, then increase the flow on the meter by 10 mL/min and begin measure mode on the F-900 again. If the error persists, contact tech support.
4. Let the F-900 read the gas for five minutes.
5. In the controller software, in the CO2 field, select ppm and set the concentration to the value of the calibration gas being used. Then hit the "Set Span" button.



6. The concentration on the F-900 should now read the same as the calibration gas ± 5%.

Carbon Dioxide (CO_2) PPM Sensor Verification *After Set Span

Perform this process immediately after calibrating the carbon dioxide PPM sensor on the F-900.

1. Connect the high resolution flow meter, CO_2 ppm sensor verification gas, and F-900 intake ports together using a T-junction of tubing.
2. On the F-900, begin measure mode.
3. Set the flowrate on the CO_2 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a “Flow Blocked” error, then increase the flow on the meter by 10 mL/min and begin measure mode on the F-900 again. If the error persists, contact tech support.
4. Let the F-900 read the gas for five minutes.
5. The F-900 should read the same value as the verification gas ± 5%. If it does not, repeat the “Carbon Dioxide ppm Sensor Calibration” section above.

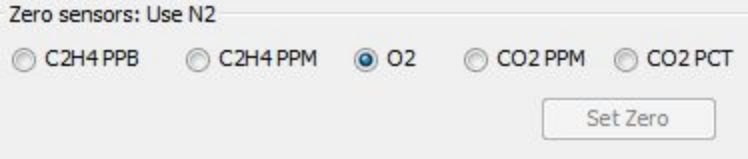
Oxygen (O_2) Sensor Calibration

*Oxygen sensor is optional

Setting the Zeroes (Offset) with Nitrogen Gas (N_2) *6 months

1. Connect the high resolution flow meter, N_2 gas, and F-900 intake ports together using a T-junction of tubing.
7. On the F-900, begin measure mode and measure for 5 minutes
8. Set the flowrate on the N_2 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a “Flow Blocked” error, then increase the flow on the meter by 10 mL/min and begin measure mode on the 900 again. If the error persists, contact tech support.
9. Let the F-900 read the gas for five minutes.
10. On the F-900, navigate to Setup > Mode > USB > Controller, to enable connection to the controller software
11. Connect the F-900 to a computer via USB and launch the controller software
1. Select the appropriate F-900 serial number in the upper left of the controller software screen

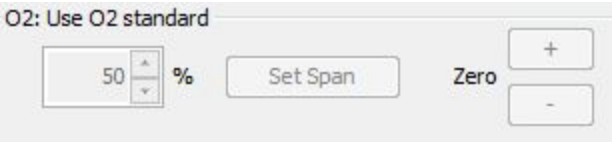
2. In the controller software, select O2 in the “Zero sensors” field, then click the “Set Zero” button.



3. The F-900 should now read 0 for the O_2 sensor.

Oxygen (O_2) Sensor Set Span *6 months

1. Connect the high resolution flow meter, O_2 calibration gas, and F-900 intake ports together using a T-junction of tubing.
2. On the F-900 begin measure mode.
3. Set the flowrate on the O_2 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a “Flow Blocked” error, then increase the flow on the meter by 10 mL/min and begin measure mode on the 900 again. If the error persists, contact tech support.
4. Let the F-900 read the gas for five minutes.
5. In the controller software, in the O2 field, set the concentration to the value of the calibration gas being used. Then hit the “Set Span” button.



6. The concentration on the F-900 should now read the same as the calibration gas ± 5%.

Oxygen (O_2) Sensor Verification *After Set Span

Perform this process immediately after calibrating the oxygen sensor on the F-900.

1. Connect the high resolution flow meter, O_2 verification gas, and F-900 intake ports together using a T-junction of tubing.
2. On the F-900 begin measure mode.
3. Set the flowrate on the O_2 gas tank so that the flow meter reads between 70 and 200 mL/min. If the F-900 gives a “Flow Blocked” error, then increase the flow on the meter by 10 mL/min and begin measure mode on the F-900 again. If the error persists, contact tech support.
4. Let the F-900 read the gas for five minutes.
5. The F-900 should read the same value as the verification gas ± 5%. If it does not, repeat the “Oxygen Sensor Calibration” section above.

Monitor Mode Verification

The following procedure is to check whether the sensors were calibrated to read within spec of the actual gas value.

It is highly recommended that this step be performed after one full day has passed since the calibration was performed. If this step is not performed, accuracy of the calibration cannot be verified.

Repeat the verification sections from above for each gas and record the results here after three minutes (at least) of measure time. If any of the values are out of specification, check your procedure and recalibrate the sensor again.

Gas	900 Results	Spec: ±5%
Air (Air is ~20.9% O2)		☐Yes ☐No
CO_2 PCT Verification Gas		☐Yes ☐No
CO_2 PPM Verification Gas		☐Yes ☐No
O_2 Verification Gas		☐Yes ☐No

Gas	900 Results	Spec: 7%, ± 25 PPB
C_2H_4 PPB Verification Gas		☐Yes ☐No

Gas	900 Results	Spec:5%, ± 0.5 PPM
C_2H_4 PPM Verification Gas		☐Yes ☐No

For information on sourcing known gases required for calibration, please refer to the following website to inquire about your region: https://www.airliquide.com/group/where-we-operate