ENMET **Corporation**
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SPECTRUM Series

Instrument Manual

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1.0 Introduction

The SPECTRUM is a small portable battery operated single channel gas detection instrument. Depending on the sensor supplied with the instrument, it can detect one of a number of potential target gases. An electrochemical cell detects the gas, and the gas concentration is displayed on an LCD. Audio and visual alarms occur when the target gas concentration exceeds a preset alarm point. At relatively low concentrations of the gas, an alarm can be acknowledged, which results in the temporary cessation of the audio alarm. Operation and maintenance procedures are managed with three pushbutton switches. Appropriate warnings are issued when remaining battery energy is low. For ruggedness and EMF protection, the instrument enclosure is an aluminum die casting. The instrument is shown in Figure 1.

Several sensors have been qualified for target gases, the list is found in Table 1.

A CO SPECTRUM, for the detection of carbon monoxide, is described in a separate manual.

NOTE: *All specifications stated in this manual may change without notice.*

1.1 Unpack

Unpack the **SPECTRUM** and examine it for shipping damage. If such damage is observed, notify both ***ENMET*** customer service personnel and the commercial carrier involved immediately.

Regarding Damaged Shipments

NOTE: **It is your responsibility to follow these instructions. If they are not followed, the carrier will not honor any claims for damage.**

- This shipment was carefully inspected, verified and properly packaged at our company and delivered to the carrier in good condition.
- When it was picked up by the carrier at ***ENMET***, it legally became your company's property.
- If your shipment arrives damaged:
  - Keep the items, packing material, and carton "As Is." Within 5 days of receipt, notify the carrier's local office and request immediate inspection of the carton and the contents.
  - After the inspection and after you have received written acknowledgment of the damage from the carrier, contact ***ENMET*** Customer Service for return authorization and further instructions. Have your Purchase Order and Sales Order numbers available.
- ***ENMET*** either repairs or replaces damaged equipment and invoices the carrier to the extent of the liability coverage, usually $100.00. Repair or replacement charges above that value are your company's responsibility.
- The shipping company may offer optional insurance coverage. ***ENMET*** only insures shipments with the shipping company when asked to do so in writing by our customer. If you need your shipments insured, please forward a written request to ***ENMET*** Customer Service.

Regarding Shortages

If there are any shortages or questions regarding this shipment, please notify ***ENMET*** Customer Service within 5 days of receipt at the following address:

ENMET Corporation
680 Fairfield Court
Ann Arbor, MI 48108
734-761-1270 734-761-3220 Fax

1.1.1 Check Order

Check, the contents of the shipment against the purchase order. Verify that the **SPECTRUM** is received as ordered. Each **SPECTRUM** is labeled with its target gas. If there are accessories on the order, ascertain that they are present. Check the contents of calibration kits. Notify ***ENMET*** customer service personnel of any discrepancy immediately.

1.1.2 Serial Numbers

Each **SPECTRUM** is serialized. These numbers are on tags on the equipment and are on record in an ***ENMET*** database.

1.2 Turn Instrument ON

Turn the instrument ON, by pressing and holding the POWER / BACKLIGHT pushbutton for two seconds. In *uncontaminated* air, for most instruments the display should read 0000 within ten seconds of turn-on. For an oxygen Spectrum, the display reads near 20.9%.

NOTE: Instruments using biased sensor, this time is extended to 4 minutes, stabilization may take as long as 1 hour. See Table 1.

1.2.1 Verify

The SPECTRUM is calibrated prior to shipment. However, if there is access to a source of the target gas, such as a calibration kit, expose the sensor to the gas, and observe that the instrument is responsive.

1.2.2 Acknowledge Alarm

If the concentration of the target gas is greater than the alarm set point, the instrument indicates an alarm condition. Acknowledge the alarm by pressing and releasing the right hand pushbutton, SELECT; this silences the audio alarm for four minutes unless the concentration of the target gas is greater than the upper alarm limit. See Table 1 for a list of alarm set points and upper alarm limits for various target gases.

1.2.3 Remove Gas

Remove the source of the target gas. After the display reads zero or close to it, turn the instrument OFF, by pressing and holding the POWER / BACKLIGHT pushbutton for approximately three seconds. The display flashes "OFF" and then goes blank after the pushbutton is released.

1.2.4 Contact *ENMET*

If the instrument doesn't operate as described, contact ***ENMET*** customer service personnel immediately.

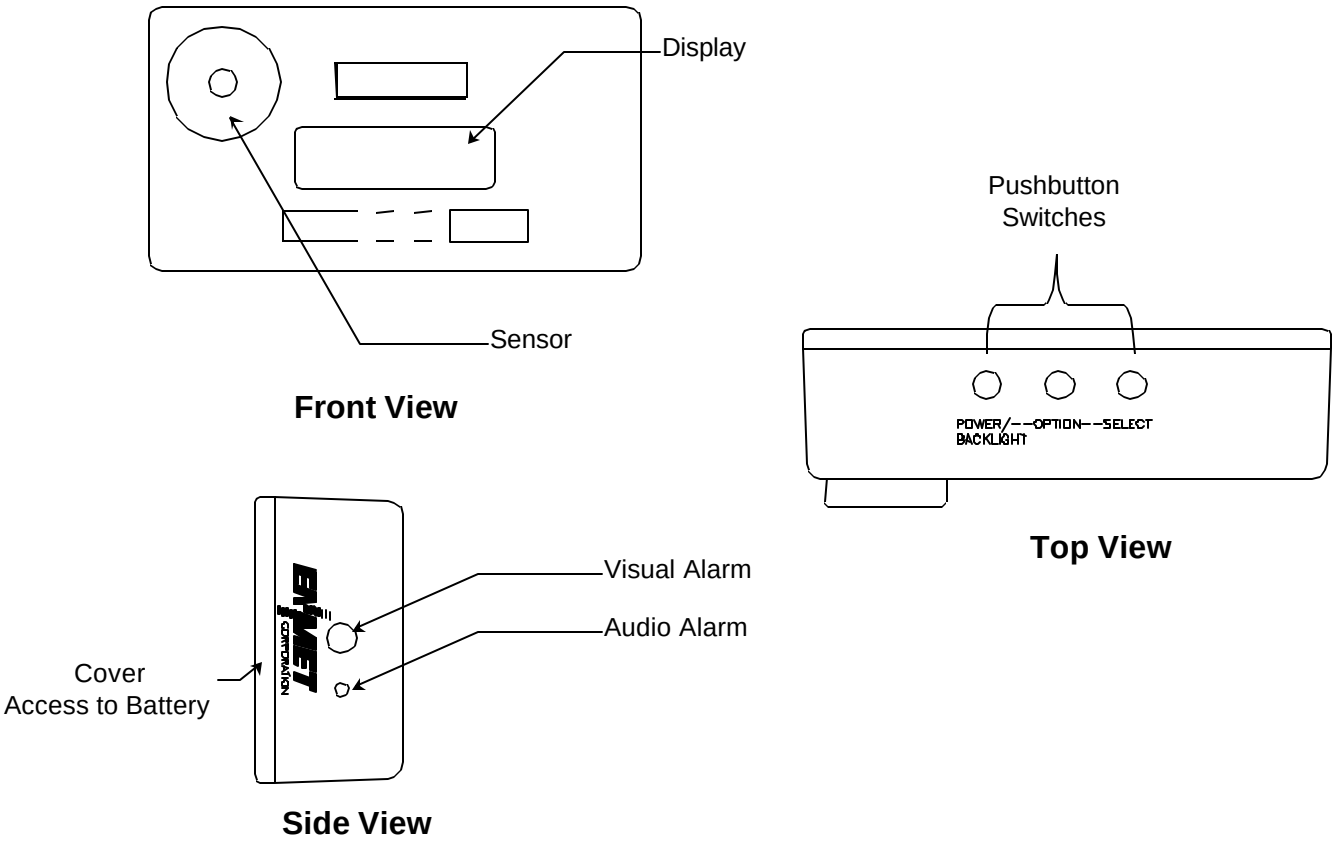


Figure 1: SECTRUM Features

2.0 Features and Operation

The features of the SPECTRUM are shown in Figure 1. These are:

DISPLAY	An LCD upon which either the gas concentration, or prompts for the operational and maintenance menus, are given.
PUSHBUTTON SWITCHES	There are three of these, as follows:
- **POWER / BACKLIGHT**	The left hand switch when the instrument is held upright with the display facing the user.
- **OPTION**	The middle switch.
- **SELECT**	The right hand switch.

These switches are used to access and utilize the operational and maintenance menus.

SENSOR HOUSING	A small cylindrical turret on the display surface; the membrane of the electrochemical sensor is exposed to the atmosphere through the hole in the turret.
VISUAL ALARM	A red LED which is ON whenever the target gas concentration is above the alarm point, and also blinks periodically with the confidence beep.
AUDIO ALARM	A small horn which is ON whenever the gas concentration is above the alarm point, until the alarm is acknowledged. This horn also furnishes a confidence beep
COVER	Retained with four screws, and removed to change the battery.
BATTERY	The power source of the instrument, which is removed and replaced when depleted.

2.1 Operation

2.1.1 Operational Menu

The operation menu flow diagram is shown in Figure 2. This menu is accessed with the OPTION pushbutton switch, the middle switch of the three. Successive displays are achieved by repeatedly pushing the switch, as indicated by "O" in the menu flow diagram. The alarm acknowledgement function, and displays and function in the "see DATA" area, are accessed with the SELECT pushbutton, indicated by "S" in the operation menu flow diagram.

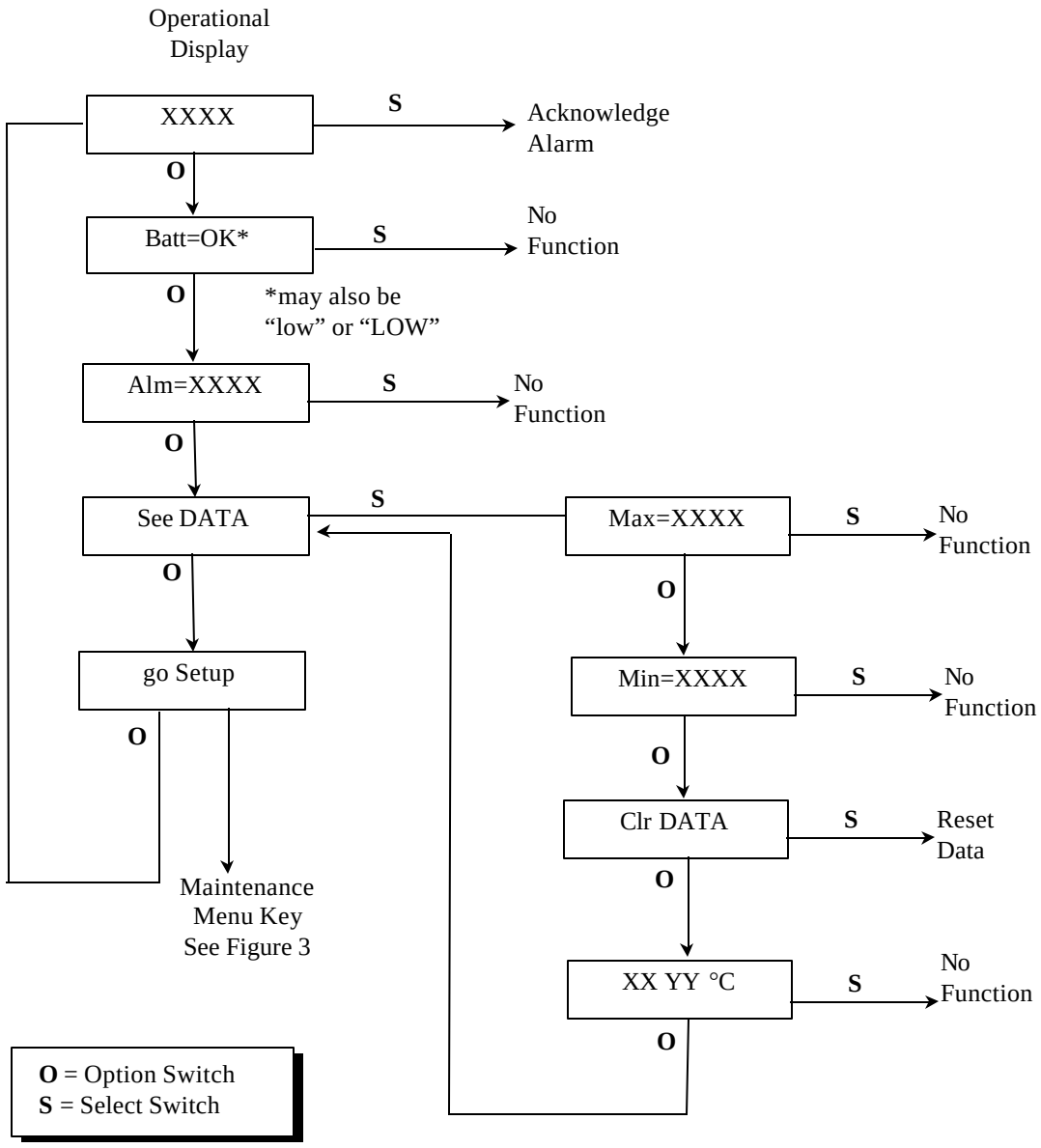


Figure 2: Operation Menu Diagram

2.1.2 Turn ON and OFF

Turn the instrument ON by pressing the POWER / BACKLIGHT pushbutton for two seconds. For most instruments, the display should read "0000" or near 20.9 within ten seconds when the instrument is in *uncontaminated* air.

NOTE: Instruments using biased sensor, stabilization time is extended to 4 minutes. Complete stabilization may take as long as 1 hour. When instrument is turned on it may display **XXXX +** . If instrument has been off for an extended amount of time it may be necessary to "cycle" (turn on and off) the instrument several times. See Table 1 for identification of biased sensors.

Turn the instrument OFF by pressing and *holding* the POWER / BACKLIGHT pushbutton for three seconds. The display flashes "OFF" and then fades out after the pushbutton is released. The instrument can be turned OFF from any location in the operational or maintenance menus.

2.1.3 Gas Concentration Display and Alarms

The LCD furnishes a numerical display of the target gas concentration from 0000 to the upper limit of the range, shown in Table 1 on page 17. The display of the target gas concentration is termed the "operational display". If the target gas concentration exceeds the upper limit of the range, the display is the numerical upper limit and a plus sign, for example,"0200+", for hydrogen sulfide. When the concentration of the target gas exceeds the alarm set point, the audio and visual alarms are activated. The gas concentration continues to be displayed during alarm. The alarm point is adjustable between a lower and upper alarm limit by accessing the maintenance menu; these and the factory setting of the alarm point are also given in Table 1. A user should have a justifiable application-based reason for setting the alarm point higher than the factory setting. When the target gas concentration drops below the alarm point, the audio and visual alarms cease operation. The alarm point setting can be observed on the display by pushing the OPTION pushbutton twice.

For the oxygen SPECTRUM, the zero gas display is 20.9% oxygen, and the two alarm points are at 19.5% (adjustable) and 23.5% (fixed).

If an alarm concentration is encountered when the display is at a location in the operational menu other than the operational display, the audio and visual alarms are activated and the alarm cannot be acknowledged.

If the display is left idle at a location other than the operational display for 45 seconds it automatically transfers to the operational display.

2.1.4 Alarm Acknowledge

When the instrument is in alarm, and the target gas concentration is below the upper alarm limit, the alarm can be acknowledged by pressing and releasing the SELECT pushbutton, but only when the instrument is at the operational display. The acknowledgement causes the temporary cessation of the audio alarm; the red LED continues to be ON. The audio alarm is OFF for a period of four minutes, after which it is reactivated, if the gas concentration is still above the alarm point. The alarm can again be acknowledged. However, acknowledgement of the alarm at gas concentrations above the upper alarm limit does not result in audio alarm cessation, and if the gas concentration rises above the upper alarm limit during an alarm condition which has been acknowledged, the audio alarm resumes operation.

The alarms are high energy users. The LED alone uses twice as much energy as the non-alarming instrument. Prolonged use of the instrument while it is in the alarm condition causes a marked decrease in battery life.

2.1.5 Confidence Beep

During normal operation, with no alarm conditions, the audio and visual alarms are activated once every thirty seconds.

2.1.6 Battery Status and Low Battery Alarms

The battery status display is accessed by pressing the OPTION pushbutton once. When this display is "Batt=OK", the battery energy level is sufficient for operation of the instrument. In this condition, the confidence beep occurs every thirty seconds when the instrument is not in alarm.

When the battery energy level is low and the battery should be replaced with a new or recharged one, the battery status display reads "Batt=low", and the instrument beeps once every five seconds to alert the user to the battery condition. *Stop Using The Instrument And Exit An Area That Could Be Hazardous To Safety Or Health.* When the battery energy level is critically low, and battery failure is imminent, the battery status display reads "Batt=LOW", and the instrument beeps once every two seconds. An alarm condition at this point could cause the instrument to completely shut off. Replace the battery immediately. The user cannot go past the battery status display until the depleted battery is replaced with a fresh one.

When the battery energy level drops below the critically low point, the instrument automatically shuts off, and cannot be used until the battery is replaced.

Two types of batteries are available for use with the SPECTRUM: alkaline and rechargeable Nicad. They have different end-of-life discharge characteristics. Either replace a battery with the same type, or go to the "set BATT" portion of the maintenance menu, and select the new type being used.

CAUTION: If the "set batt" selection is not identical with the battery being used, incorrect low battery indications are furnished.

2.1.7 Data

The SPECTRUM retains the maximum and minimum gas concentration values encountered since turn-on, or since the data was cleared and reset. To access this press the OPTION pushbutton three times; "see DATA" is displayed. Press the SELECT pushbutton; the maximum concentration since turn-on or last reset is displayed. Press the OPTION pushbutton again; the minimum concentration since turn-on or last reset is displayed. Press the OPTION pushbutton again; "clr DATA" is displayed. Pushing the SELECT pushbutton clears the data and resets it to the current concentration.

Pushing the OPTION pushbutton once more results in a display of both the countdown to the confidence beep and the internal temperature of the instrument in degrees centigrade. Push the OPTION pushbutton three more times to return to the operational display.

2.1.8 Backlight

To backlight the display for observation in a dark area, press and quickly release the POWER / BACKLIGHT pushbutton. The LCD backlight comes ON for a period of 45 seconds and then turnes OFF automatically. The backlight can be turned off sooner than 45 seconds by pressing the POWER / BACKLIGHT pushbutton a second time. Use the backlight feature sparingly; it is a relatively high energy user, and extensive use rapidly depletes the battery.

2.2 Interference Gases

For each target gas, some gases other than the target gas cause a sensor response, and thus are termed "interference gases". A compilation of known interference gases for the various target gases is given in Appendix B, along with gases that are known to not cause a sensor response.

3.0 Maintenance

3.1 Maintenance Menu

From the operational display, press the OPTION pushbutton four times; "go SETUP" is displayed. This is the entrance to the maintenance menu. The maintenance menu flow diagram is shown in Figure 3.

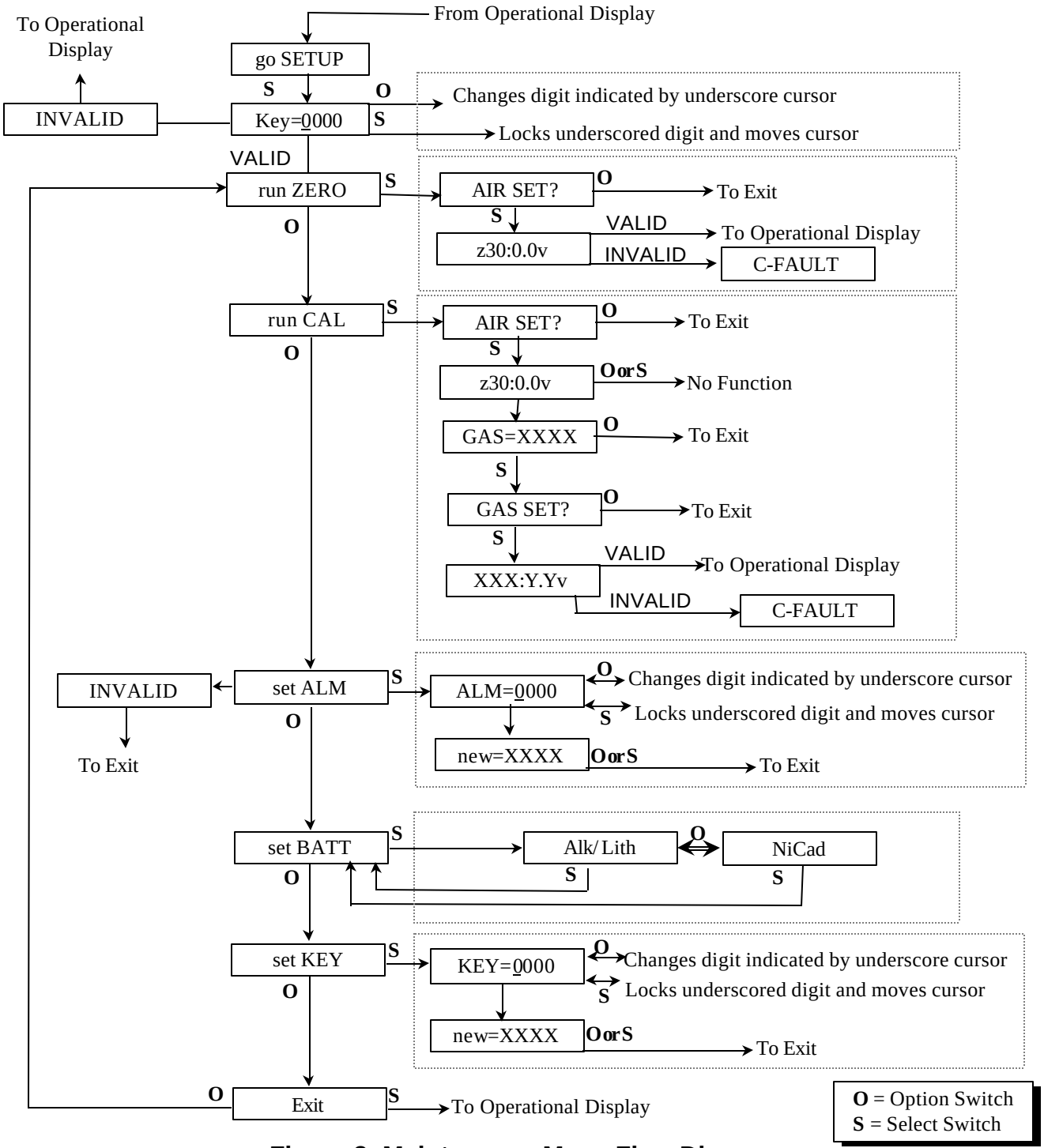


Figure 3: Maintenance Menu Flow Diagram

3.1.1 Key

Entrance to the maintenance menu is guarded with a four digit numerical key. The factory default setting of the key is 1270*. When the valid numerical key is inserted, the user is allowed to enter the maintenance menu

When in the "go SETUP" location, press the SELECT pushbutton; "Key=0000" is displayed. The underscore cursor is under the left hand digit. To insert the key, press the OPTION pushbutton to change the left hand digit, and choose the correct digit; then press the SELECT pushbutton, which locks in the chosen left hand digit and moves the underscore cursor one space to the right. Continue this process until the four digit key is complete. When the valid key is inserted in this manner, the display is transferred to the "run ZERO" portion of the maintenance menu. When an invalid key is inserted, "INVALID" is briefly displayed, and the instrument returns to the operational display.

*The process by which a different key is set is given in section 3.1.6.

3.1.2 Zero

A valid key entry sets the instrument at the "run ZERO" location, of the maintenance menu, which enables the setting of the zero gas concentration point. This is desirable if the zero reference of the gas sensor has drifted over a period of time, indicated by a persistent gas concentration reading in a clean environment. Note that the calibration sequence given below also includes setting the zero point. If a full calibration is required, instead of setting just the zero point, push the OPTION button once; "run CAL" is displayed. See section 3.1.3.

To set the zero point without performing full calibration, from the "run ZERO" location press the SELECT pushbutton; "AIR SET?" is displayed. Be certain that the instrument is in clean air, uncontaminated by the target gas. If uncertain of the environment, use pure compressed air from a pressurized cylinder, and flow it over the sensor at a low rate.

With the instrument in “AIR SET?”, press the SELECT pushbutton again. "z30:0.0v" is displayed; this is a counter that counts down in seconds from 30 to 0. The validity of the new zero setting is then examined; if it is with in preset parameters, the display is transferred to the operational display in the operation menu.

If the new zero setting is not between preset parameters, "C-FAULT" is displayed. Turn the instrument OFF, then ON again. This re-boots the system with the most recent valid zero setting.

3.1.3 Calibration

NOTE: Calibration must be performed at normal room temperature (20-25°C) for optimal performance. If the instrument is exposed to temperature extremes just prior to calibration, allow it to stabilize to room temperature. The internal temperature of the instrument is verified by cycling through the "see DATA" menu.

In order to calibrate the instrument, it is first zeroed in a procedure similar to the one described section 3.1.2. Then the sensor is presented with a known concentration of the target gas, in air or an inert gas such as nitrogen, called the "span gas". After an appropriate interval, which is timed, the new span setting is examined for validity.

A valid key entry sets the instrument at the "run ZERO" location of the maintenance menu. Press the OPTION pushbutton once to access the "run CAL" display, then press the SELECT pushbutton; "AIR SET?" is displayed. Zero the instrument as described in paragraph 3.1.2. When the zero timer is complete, the display indicates "GAS=XXXX", where the numbers indicate the correct span gas concentration the instrument is equipped to detect; for a CO SPECTRUM the span gas is 100 ppm CO, for Cl2 SPECTRUM the span gas is 5 ppm chlorine, and so forth. The correct span gas is in the ***ENMET*** calibration kit for the instrument, and is given in Table 2 for various target gases.

At the “GAS=XXXX” display:

1. Assure that the correct span gas is available.
2. Connect the calibration adapter to the cylinder.
3. Open the calibration valve so that the span gas flows gently.
4. Press the SELECT pushbutton; "GAS SET?" is displayed.
5. Connect the span gas to the instrument so the calibration gas flows gently over the sensor.
6. Press the SELECT pushbutton; "XXX:Y.Yv" is displayed until countdown is complete.
7. Remove span gas.

The **XXX** is a counter that counts down in seconds to zero from the correct starting time to provide the proper time interval for calibration; this time interval may vary depending on your target gas. The **Y.Y v** indicates a sensor signal that is used during the sensor replacement procedure. When the timer reaches zero, the new calibration and zero gas settings are examined for validity. If the value is within preset parameters, the display is transferred to the gas operational display in the operations menu.

NOTE: After calibration the audio alarm is disabled up to 2.5 minutes.

If the new setting is not within preset parameters, "**C-FAULT**" is displayed. Turn the instrument OFF, then ON again. This re-boots the system with the most recent valid zero and calibration settings. Recalibrate. If after recalibration the instrument still displays “**C-FAULT**” the sensor may be expired. Replace sensor in accordance with section 3.2.2.

3.1.4 Changing the Alarm Level

A valid key entry sets the instrument at the "run ZERO" location of the maintenance menu. Press the OPTION pushbutton twice to access the "set ALM" display, then press the SELECT pushbutton; ALM=0000" is displayed. This is called the alarm update window, and the value displayed is the present alarm setpoint. The underscore cursor is under the far left digit. Press the OPTION pushbutton to change the underscored digit; select the desired digit, and press the SELECT pushbutton to lock in the desired digit and move the underscore cursor one position to the right. When the desired new alarm point is set “new=XXXX” is displayed. Press either the OPTION or SELECT pushbutton to exit the alarm update window. If the new alarm setting is valid, "exit" is displayed. Press the OPTION pushbutton to return to the operational display, or the SELECT pushbutton to return to “run ZERO”.

For the safety of the user, there are upper and lower limits past which the alarm setting is invalid, and the instrument does not accept them. If an invalid alarm setting is attempted, after the numerical value is inserted in the "ALM=0000" window, pressing the OPTION or SELECT pushbutton results in a momentary display of "INVALID" after which the display returns to the alarm update window. Exiting the alarm update window at this point results in an alarm point setting unchanged from the value present when the procedure was begun.

Factory default alarm setpoints and alarm limits are shown in Table 1.

3.1.5 Setting the Battery Type

A valid key entry sets the instrument at the "run ZERO" location of the maintenance menu. Press the OPTION pushbutton three times to access the "set BATT" display, then press the SELECT pushbutton; "Alk/Lith" is displayed. Press the OPTION pushbutton to cycle the display among the two types of batteries which are valid, "Alk/Lith" and "NiCad". Choose the battery type that is being used to power the instrument by pressing the SELECT pushbutton; doing so returns the display to "set BATT" location. Push the OPTION pushbutton three times to return to the maintenance menu.

CAUTION: If the "set batt" selection is not identical with the battery being used, incorrect low battery indications are furnished.

3.1.6 Setting a New Key

A valid key entry sets the instrument at the "run ZERO" location of the maintenance menu. Press the OPTION pushbutton four times to access the "set KEY" display. Press the SELECT pushbutton once; "KEY=0000 is displayed. A new key can be set by changing the underscored number with the OPTION pushbutton and moving the underscore cursor with the SELECT pushbutton. After the new key is entered "new-XXXX" is displayed, press the OPTION or SELECT pushbutton to display to "exit", then press the OPTION pushbutton to return to "run ZERO".

NOTE: Four digit key numbers should be selected carefully and recorded. Without the correct key, the maintenance menu cannot be accessed. If a four digit key number is lost, call ***ENMET*** customer service personnel.

3.2 Changing Components

Changing the battery, the sensor, or the display requires that the back cover of the instrument to be removed; remove the four phillips head screws and then the back cover. See figure 4.

3.2.1 Battery Removal and Replacement

Lift the battery out of the cavity and disconnect the battery clip. Connect a new battery to the clip, and slide it back into the cavity. If the new battery is of a different type than the one being replaced, change the battery type using the maintenance menu; see section 3.1.5.

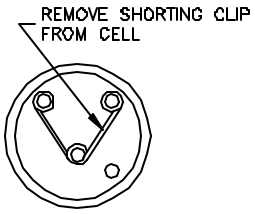
3.2.2 Sensor Removal and Replacement

A sensor must be replaced when it no longer responds adequately to the target gas. This is indicated by a low gas concentration reading when exposed to a known concentration of the target gas, and the inability to calibrate the instrument, with a "C-FAULT" display after calibration. Expected sensor lifetimes in normal environments are given in Table 1.

After removing the back of the enclosure, remove the circuit board and battery together, by sliding the circuit board away from the switch surface while rotating it upward. Unplug the sensor from the circuit board.

CAUTION: New sensors may come with a shorting clip that must be removed for proper operation.

Remove the shorting clip (if present) from the new sensor and plug the new sensor in its place. Allow the sensor to stabilize in the instrument with the power on for one hour before recalibrating.



Sensor Bottom View

The initial calibration of a new sensor must be performed with electronics removed from the instrument enclosure. Follow the procedure for calibrating the instrument as outlined in Section 3.1.3 of this manual with the following modification.

NOTE: During this procedure make sure the RED calibration cup, 02552-008, stays centered over the sensor.

During the application of the span gas, the counter counts down from an upper value given in Table 2. When the counter gets down to 60, adjust the potentiometer located behind the horn on the instrument PC board, so that the display to the right of the counter reads a little above the calibration voltage given for the target gas in Table 2. As the counter continues, turn the pot so that the calibration voltage is reached when the counter reaches 30. This is a one-time adjustment to align the sensor output with the instrument electronics. It should only be performed upon sensor replacement. All future calibrations should follow the procedure in Section 3.1.3.

Replace the circuit board in the enclosure by sliding the switches into their holes while rotating the circuit board downward; replace the battery in its cavity. Replace the back cover of the instrument. Calibrate the instrument according to the procedure in section 3.1.3.

NOTE: that the sensor must be replaced with a sensor for the same target gas; the instrument cannot be changed to detect a different target gas without modifications in addition to changing the sensor type.

3.2.3 Charging the NiCad Battery

When a NiCad battery must be recharged, remove it as described in paragraph 3.2.1. Clip the discharged battery to the leads of an appropriate 110vac charger, and charge the battery. Replace the battery in the instrument as described in paragraph 3.2.1. Two NiCad batteries can be rotated so that a charged battery is always available. If the NiCad battery is replaced with an alkaline battery, change the battery type using the maintenance menu, see section 3.1.5.

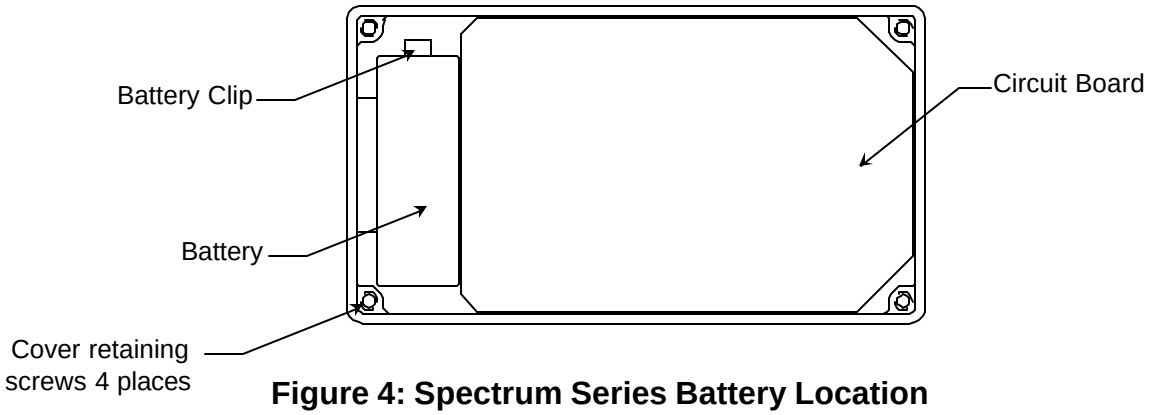


Figure 4: Spectrum Series Battery Location

4.0 Replacement Parts and Accessories

ENMET part numbers for replacement parts and accessories:

Calibration Kits:

Calibration kit, chlorine	04815-0100
Calibration kit, hydrogen sulfide	04815-0200
Calibration kit, hydrogen cyanide	04815-0300
Calibration kit, sulfur dioxide	04815-0500
Calibration kit, hydrogen	04815-1500
Calibration kit, ammonia	04815-2400
Calibration adapter	03700-023
Calibration cup	03620-011 (White)
Calibration cup	02552-008 (Red)

Other calibration kits are available, contact ***ENMET*** for details.

Calibration Gas:

Calibration gas, chlorine	03231-005
Calibration gas, hydrogen sulfide	03214-020
Calibration gas, hydrogen cyanide	03203-010
Calibration gas, sulfur dioxide	03215-015
Calibration gas, ammonia	03218-025
Ozone generator	04055-0800

Other calibration gases are available, contact ***ENMET*** for details.

Replacement Sensors and parts:

Replacement chlorine sensor	67020-0100
Replacement hydrogen sulfide sensor	67020-0200
Replacement hydrogen cyanide sensor	67020-0300
Replacement hydrogen chloride sensor	67020-0400
Replacement sulfur dioxide sensor	67016-0504
Replacement phosgene sensor	67020-0600
Replacement hydrogen fluoride sensor	67020-0700
Replacement ozone sensor	67020-0803
Replacement oxygen sensor	67016-1104
Replacement carbon monoxide sensor	67020-1200
Replacement fluorine sensor	67020-1400
Replacement hydrogen sensor	67020-1500
Replacement nitrogen dioxide sensor	67020-1700
Replacement nitrous oxide sensor	67020-1750
Replacement ammonia sensor	67020-2400
Replacement hydrazine sensor	67020-2500
Replacement arsine sensor	67020-4000
Replacement silane sensor	67020-4003
Display Assembly	62022-007
Batteries:	
Alkaline	67012-001
NiCad	67011-003
Lithium (oxygen instruments only)	67012-002

5.0 WARRANTY

ENMET warrants new instruments to be free from defects in workmanship and material under normal use for a period of one year from date of shipment from ***ENMET***. The warranty covers both parts and labor excluding instrument calibration and expendable parts such as calibration gas, filters, batteries, etc... Equipment believed to be defective should be returned to ***ENMET*** within the warranty period (transportation prepaid) for inspection. If the evaluation by ***ENMET*** confirms that the product is defective, it will be repaired or replaced at no charge, within the stated limitations, and returned prepaid to any location in the United States by the most economical means, e.g. Surface UPS/RPS. If an expedient means of transportation is requested during the warranty period, the customer is responsible for the difference between the most economical means and the expedient mode. ***ENMET*** shall not be liable for any loss or damage caused by the improper use of the product. The purchaser indemnifies and saves harmless the company with respect to any loss or damages that may arise through the use by the purchaser or others of this equipment.

This warranty is expressly given in lieu of all other warranties, either expressed or implied, including that of merchantability, and all other obligations or liabilities of ***ENMET*** which may arise in connection with this equipment. ***ENMET*** neither assumes nor authorizes any representative or other person to assume for it any obligation or liability other than that which is set forth herein.

NOTE: When returning an instrument to the factory for service:

- Be sure to include paperwork.
- A purchase order, return address and telephone number will assist in the expedient repair and return of your unit.
- Include any specific instructions.
- For warranty service, include date of purchase
- If you require an estimate, please contact ***ENMET*** Corporation.

There is Return for Repair Instructions and Form on the last pages of this manual. This form can be copied or used as needed.

Appendix A: Calibration Data Tables

Table 1: Gas Ranges, Alarm Points and Sensor Life

Gas	Range	Alarm lower limit	Alarm upper limit	Factory Alarm Set Point	Expected Sensor Lifetime
Ammonia	0-100ppm	15ppm	50ppm	25ppm	2-3 yr
Arsine	0-0.99ppm	0.03ppm	0.10ppm	0.05ppm	.5-1 yr
Carbon Monoxide	0-1000ppm	5ppm	200ppm	35ppm	2-3 yr
Chlorine	0-10ppm	0.5ppm	5.0ppm	1.0ppm	2-3 yr
Fluorine	0-10ppm	0.5ppm	5.0ppm	1.0ppm	1-2 yr
Hydrogen	0-1000ppm	200ppm	750ppm	200ppm	1-2 yr
Hydrogen Chloride ①	0-20ppm	3.0ppm	10.0ppm	5.0ppm	1-2 yr
Hydrogen Cyanide	0-20ppm	3.0ppm	10ppm	4.7ppm	2-3 yr
Hydrogen Fluoride	0-10ppm	2.0ppm	6.0ppm	3.0ppm	0.5-1 yr
Hydrogen Sulfide	0-200ppm	5.0ppm	25ppm	10ppm	2-3 yr
Nitric Oxide ①	0-100ppm	15ppm	50ppm	25ppm	1-2 yr
Nitrogen Dioxide	0-10ppm	1.0ppm	5.0ppm	3.0ppm	1-2 yr
Oxygen	0-25%	16%	23.5%	19.5% & 23.5%	1-2 yr
Ozone	0-0.99ppm	0.05ppm	0.20ppm	0.1ppm	1-2 yr
Phosgene	0-0.99ppm	0.05ppm	0.2ppm	0.1ppm	1 yr
Silane	0-30ppm	3ppm	5ppm	5ppm	3 yr
Sulfur Dioxide	0-20ppm	2.0ppm	10ppm	5ppm	2-3 yr

NOTE: *All specifications stated in this manual may change without notice.*

① **Biased Sensors:** Instruments using biased sensor, stabilization time is extended to 4 minutes. Complete stabilization may take as long as 1 hour. When instrument is turned on it may display **XXXX +** . If instrument has been off for an extended amount of time it may be necessary to "cycle" (turn on and off) the instrument several times.

See Appendix C for Hydrazine

Table 2: Spectrum Calibration Voltage and Countdown Times

NOTE: The following are values used for production calibration. Not all gases are available for field calibration; contact ***ENMET*** customer service personnel.

Gas	Calibration Gas	Calibration Voltage	Countdown Time
Ammonia	25ppm	0.67	240 sec
Arsine	0.38ppm	0.10	90 sec
Carbon Monoxide	100ppm	1.70	120 sec
Chlorine	5ppm	1.40	180 sec
Fluorine	5ppm	1.40	180 sec
Hydrogen	800ppm	2.20	180 sec
Hydrogen Chloride	10ppm	2.10	180 sec
Hydrogen Cyanide	10ppm	2.10	240 sec
Hydrogen Fluoride	5ppm ②	1.30	180 sec
Hydrogen Sulfide	20ppm	0.46	120 sec
Nitric Oxide	25ppm	1.10	240 sec
Nitrogen Dioxide	5ppm	1.40	120 sec
Oxygen	20.9%(air)	2.80	120 sec
Ozone	0.3ppm	0.91	240 sec
Phosgene	0.66ppm	0.16	240 sec
Silane	5ppm	0.42	120 sec
Sulfur Dioxide	10ppm	2.10	90 sec

NOTE: *All specifications stated in this manual may change without notice.*

② Correlation Gas 3 ppm Chlorine 2

Appendix B: Interference Gases

Interference Table for Selected Spectrum Sensors

SPECTRUM Series for AMMONIA (3E-100 sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
ethanol	1000	1
isopropanol	450	1
hydrogen sulfide	14	10
methanol	1200	3
hydrogen	1000	80
carbon monoxide	300	100
sulfur dioxide	25	-21
nitrogen dioxide	50	25
hydrogen cyanide	10	-18

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
chlorine	5
unsaturated hc (ethylene)	1.0 %
saturated hydrocarbons	abundant

SPECTRUM Series for CARBON MONOXIDE (3E sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
hydrogen	1000	450
nitrogen oxide	100	25

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
ammonia	100
chlorine	5
hydrogen cyanide	10
ethylene	2.0 % *
carbon dioxide	5,000
methane	10,000
sulfur dioxide	10 *
hydrogen sulfide	10 *
nitrogen dioxide	10 *
isopropanol	1,025 *
gasoline vapor	saturated *

*with onboard filter; continuous high level exposure may reduce the filter efficiency

SPECTRUM Series for CHLORINE (3E sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
hydrogen sulfide	10	-0.3
sulfur dioxide	5	-1.2
nitrogen dioxide	5	0.1
bromine	1	1.0
chlorine dioxide	0.32	0.3
ammonia	1,000	-1.1

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
carbon monoxide	300
carbon dioxide	100,000
nitrogen	100. %
hydrogen chloride	20
hydrocarbons, general	% range
hydrogen	1,000
ethanol	6.6 %
ammonia	65

SPECTRUM Series for HYDROGEN SULFIDE (3E sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
carbon monoxide	100	3
chlorine	20	-1
ethylene	500	2
hydrogen	100	5
hydrogen	20,000	100
hydrogen cyanide	10	1
sulfur dioxide	10	3

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
ammonia	100
carbon dioxide	5,000
methane	10,000
sulfur dioxide	3
nitrogen dioxide	10

SPECTRUM Series for Hydrogen Chloride (3E 30 sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Readilng in ppm
hydrogen bromide	5	5
hydrogen sulfide	14	30
sulfur dioxide	5	3.5
chlorine	5	1
hydrogen cyanide	14	1
arsine	330 ppb	.4
ethanol	6.6%	6

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
carbon monoxide	300
carbon dioxide	5000
nitrogen	100%
Hydrocarbons	% range
hydrogen	1000
phosgene	.5
chlorinated hydrocarbons	% range
ammonia	300

SPECTRUM Series for Hydrogen Fluoride (3E 10 sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
chlorine or bromine	5	3
sulfur dioxide	2	2
hydrogen chloride	5	.75

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
alcohols (i.e. IPA)	1000
ammonia	100
hydrogen	1000
carbon monoxide	50
carbon dioxide	10%
unsaturated HC(ethylene)	1%
hydrogen sulfide	20

SPECTRUM Series for Fluorine (3E 10 sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
chlorine	1	2
hydrogen sulfide	10	-1
sulfur dioxide	5	-3.2
nitrogen dioxide	5	.5
bromine	1	3
ammonia	1000	-3.1

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
carbon monoxide	300
carbon dioxide	100000
nitrogen	100%
hydrogen chloride	10
hydrocarbons	% range
hydrogen	1000
hydrogen cyanide	10
ethanol	4%

SPECTRUM Series for Hydrogen (2E 2000 sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
carbon monoxide	50	.06
ethylene	500	.28
sulfur dioxide	2	.06
isopropanol	1090	180

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
ammonia	100
carbon dioxide	1000
chlorine	5
hydrogen cyanide	10
hydrogen sulfide	10*
methane	10000
nitrogen dioxide	10
sulfur dioxide	2

*with onboard filter; continuous high level exposure may reduce the filter efficiency

SPECTRUM Series for Nitric Oxide (3E 100 sensor)

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
chlorine	5
nitrogen dioxide	100
hydrogen	1000
carbon monoxide	1000
carbon dioxide	10000
saturated HC, alcohols	abundant
sulfur dioxide	50

SPECTRUM Series for Nitrogen Dioxide (3E sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
chlorine	1	3
ozone	1	0.7

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
hydrogen chloride	5
nitrogen oxide	100
hydrogen	1000
carbon monoxide	1000
carbon dioxide	10000
saturated HC, alcohols	abundant
sulfur dioxide	50
ammonia	30

SPECTRUM Series for Hydrazine (2E sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
ammonia	200	0,4
methyl hydrazine	1	0,72
1.1 dimethyl hydrazine	1	0,45
chlorine	3	–0,02
hydrogen sulfice	20	0,1

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
ethanol	1000
Isopropanol	450
hydrogen peroxide	10
hydrogen chloride	7
methanol	1200
hydrogen	2000
carbon monoxide	1000
carbon dioxide	5000
unsaturated HC (ethylene)	1%

SPECTRUM Series for Ozone (3E 1 sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
chlorine	1	0.80
fluorine	100ppb	0.07
germane	1	1
nitrogen dioxide	1	0.09

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
hydrogen sulfide	1
sulfur dioxide	2
phosphine	100 ppb
carbon monoxide	300
carbon dioxide	5000
nitrogen	100%
nitrogen monoxide	10
hydrocarbons	% range
hydrogen	1000
hydrogen cyanide	10
ammonia	10
hydrogen fluoride	3.8
hydrochloric acid	10

SPECTRUM Series for Hydrogen Cyanide (2E 30 sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
hydrogen sulfide	15	40†
chlorine	5	-1
nitrogen dioxide	100	-40†

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
hydrogen chloride	10*
methane	2000
carbon monoxide	300
carbon dioxide	10 %
freon 12	5000
petrol	300
sulfur dioxide	50*
nitrogen	100 %
nitrogen monoxide	100
cholrinated hydrocarbons	<200

† Long term exposure may destroy the sensor.

*with onboard filter; continuous high level exposure may reduce the filter efficiency

SPECTRUM Series for Sulphur Dioxide(4S sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
carbon monoxide	300	<3
hydrogen sulphide	15	0
nitric oxide	35	0
nitrogen dioxide	5	≈-5

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
chlorine	1
hydrogen	200
hydrogen cyanide	10
hydrogen chloride	5
ethylene	100

SPECTRUM Series for Arsine (2E sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
phosphine	100 ppb	110
chlorine	5	-400
hydrogen cyanide	10	100
ammonia	100	10
diborane	100	35
silane	1	100
germane	1.1	100
hydrogene selenide	50 ppb	5

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
hydrogen sulfide	1*
sulfur dioxide	2
hydrochloric acid	5
carbon monoxide	300
carbon dioxide	5000
nitrogen	100 %
hydrocarbons	% range
hydrogen	1000

*with onboard filter; continuous high level exposure may reduce the filter efficiency

SPECTRUM Series for Phosgene (3E sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
ammonia	50	5, drops to 0 in short time
abundant change in humidity		yes

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
hydrogen sulfide	1*
sulfur dioxide	2
hydrochloric acid	5*
carobn monoxide	300
carbon dioxide	5000
nitrogen	100%
chlorine	1
hydrocarobons	% range
hydrogen	1000
sulfuric acid	5

*with onboard filter; continuous high level exposure may reduce the filter efficiency

SPECTRUM Series for Silane (3E 50 sensor)

The following gases cause a reading:

Interferant Gas/Vapor	Interferant Concentration in ppm	Instrument Reading in ppm
chlorine	0.5	-4
hydrogen cyanide	10	1
ammonia	100	<1
diborane	100	0.4
arsine	1	0.7
germane	1	1
disilane	5	yes
phosphine	300ppb	0.2

The following gases or vapors have been tested and do not cause a reading:

Interferant Gas/Vapor	Concentration in ppm
hydrogen sulfide	1*
sulfur dioxide	2
hydrochloric acid	5‡
carobn monoxide	300
carbon dioxide	5000
nitrogen	100%
chlorine	1.5
hydrocarobons	% range
hydrogen	1000
hydogen fluoride	3.8
hydrogen selenide	50ppb

*with onboard filter; continuous high level exposure may reduce the filter efficiency
‡short term gas exposure (min.)

APPENDIX C SPECTRUM for Hydrazine

SPECTRUM For Hydrazine

The detection of hydrazine, N_2H_4, is a specialized application. Generally, hydrazine gas blended in air or nitrogen in known verified amounts is not available to use as calibration gas in the field. Also, the sensor is not responsive to any other gas which could be used as a correlation gas. The sensor itself has a relatively short operating life, and should be replaced every six months. Typically, the instrument is returned to the factory every six months for sensor replacement.

A sensor can be replaced in the field by using a current source to set up the instrument for the particular sensor being installed. Each sensor has an individual sensitivity to hydrazine, expressed in nanoamps per ppm. This sensitivity is given on the sensor label and the container in which the sensor is shipped.

A stable voltage of -5 vdc is available on pin 11 of IC4. The instrument is set up for a calibration gas of 0.3 ppm hydrazine. So the voltage is used with a resistor sized to give the current output of the sensor when exposed to 0.3ppm hydrazine. This resistor is typically in the 6 to 8 megohm range. The value of the resistor is calculated by:

R = 5.0/ (0.3) (S), where S is the sensitivity of the sensor

For a sensor with a sensitivity of 2250 nanoamps per ppm, for example:

R = 5.0/ (0.3) (0.000002250) = 7 400 000 ohms = 7.4 megohms

Remove the old sensor, and run through the zero portion of the calibration procedure, then stop. With the sensor still removed, connect the resistor between pin 11 of IC4 and the sensor output, pin 3, on the circuit board. Then resume the calibration procedure. When it is complete, remove the resistor, and install the new sensor.

For warranty purposes, the hydrazine sensor is considered an expendable item with a warranty life of six months.