MicroGard®
Portable Alarm

Instruction Manual

⚠ WARNING

THIS MANUAL MUST BE CAREFULLY READ BY ALL INDIVIDUALS WHO HAVE OR WILL HAVE THE RESPONSIBILITY FOR USING OR SERVICING THE PRODUCT. Like any piece of complex equipment, this product will perform as designed only if it is used and serviced in accordance with the manufacturer's instructions. **OTHERWISE IT COULD FAIL TO PERFORM AS DESIGNED AND PERSONS WHO RELY ON THIS PRODUCT FOR THEIR SAFETY COULD SUSTAIN SEVERE PERSONAL INJURY OR DEATH.**

The warranties made by Mine Safety Appliances Company with respect to the product are voided if the product is not used and serviced in accordance with the instructions in this manual. Please protect yourself and others by following them. We encourage our customers to write or call regarding this equipment prior to use or for any additional information relative to use or repairs.

In the U.S., to contact your nearest stocking location, dial toll-free 1-800-MSA-2222. To contact MSA International, dial 1-412-967-3000.

Manufactured by
MSA INSTRUMENT DIVISION
P.O. Box 426, Pittsburgh, Pennsylvania 15230

(L) Rev 12 478538

General Warnings and Cautions

⚠ WARNINGS

1. The MicroGard Portable Alarm is designed to measure combustible gas or vapor content in air. It will not indicate the combustible gas content in an inert gas background, furnace stack, in a reducing atmosphere or in atmospheres containing less than 10% oxygen. Further, this instrument should not be used where the oxygen concentration exceeds that of fresh air (oxygen enriched atmosphere).
2. Recharging must be done in a non-hazardous location, known to be free of combustible gases or vapors.
3. Certain materials such as silicone, silicates (such as in certain hydraulic fluids) and organic lead (such as in leaded gasoline) tend to poison the combustible gas sensor thereby giving erroneously low readings. Calibration checks should be made frequently if such materials are suspected to be present in the tested atmosphere.

   NOTE: See "Uses and Limitations" in Section 1, *Operation* for more detailed information.

4. The combustible gas indicator detects only combustible gases (and vapors) in the air. It will not indicate the presence of combustible airborne mists or dusts such as lubricating oils, coal dust or grain dust.
5. Pressurized or low pressure samples will give erroneous oxygen percent readings. For atmospheric sampling at higher or lower altitudes, the oxygen system should be calibrated at the elevation where sampling is to take place.
6. Obstruction of the sensor cover slots or dust screens in the case will cause erroneous readings. These slots must be kept open (clean).
7. Combustible gas readings, either negative or greater than 100% LEL*, may indicate an explosive concentration of gas beyond the accurate response range of the combustible gas sensor.

*NOTE: Combustible gases will burn or explode only when the fuel/air mixtures are within certain proportions. The minimum concentration of a particular combustible gas in air which can be ignited is defined as the lower explosive limit (LEL). The maximum concentration that can be ignited is defined as the upper explosive limit (UEL). In some references, the terms used are lower and upper limits of flammability (LFL and UFL). (See "Uses and Limitations" in Section 1, *Operation.)*

8. Do not use MSA Inhibitor Filters (P/N 47740) with this instrument. Loss of sensitivity may result.
9. Use only genuine MSA replacement parts when performing any maintenance procedures provided in this manual. Failure to do so may seriously impair instrument performance. Repair or alteration of the MicroGard Portable Alarm, beyond the scope of these maintenance instructions or by anyone other than a authorized MSA serviceman, could cause the product to fail to perform as designed and persons who rely on this product for their safety could sustain severe personal injury or death.

⚠ CAUTIONS

1. Acid gases, such as carbon dioxide, will shorten the service life of the oxygen sensor.
2. When sampling with accessory sampling lines, the shortest possible length of sampling line should be used to minimize
   a) the number of times the aspirator bulb must be squeezed to obtain a valid indication or
   b) the time the Pump Module (if used) must operate to obtain a valid indication.
3. When sampling over liquids, take care that the end of the sampling line does not touch surface of liquid.
4. Do not push on center of oxygen sensor: otherwise, damage to the sensor may result.
5. Calibrations should be performed before each day's use to ensure that the instrument operation is dependable and its indications are accurate. A calibration check should be included as a routine inspection of the instrument. Use the MSA Calibration Kit which has been specifically designed for the calibration of this unit.
6. Any substitution of components may impair intrinsic safety.

Table of Contents

Section 1
General Information

Introduction

This instruction manual contains general instructions for all models of the MicroGard Portable Alarm (TABLE 1-1).

- The basic instrument samples oxygen (0 to 25% O_2) and combustible gas (0 to 100% LEL). This instrument has been evaluated by Underwriters Laboratories for use in normal, non-oxygen enriched atmospheres (atmospheres containing less than 21% oxygen by volume) only.
- For those MicroGard models which sample methane (0 to 5.0% CH_4), manual references to "combustible gas" also refer to methane.
- For those MicroGard models which sample combustible gas only, disregard manual references to "oxygen" sampling.
- Each MicroGard model is equipped with either an Alkaline battery pack or a rechargeable, nickel-cadmium battery pack.

Table 1-1. MicroGard Model Identification

PORTABLE ALARM MODE OF OPERATION/SUPPLIED BATTERY PACK	GAS CALIBRATION			
	0-25% OXYGEN 0-100% LEL	0-25% OXYGEN 0-5.0% CH_4	0-5.0% CH_4	0-100% LEL
Diffusion/Rechargeable Nicad Battery Pack (478510)	478500	482250	482260	492501
Diffusion/Alkaline Battery Pack (482245)	485360	485359	485361	492502
Pump Module (478520)/Rechargeable Nicad Battery Pack (482255)	486913	487135	487470	492504
Pump Module (485693)/Alkaline Battery Pack (482259)	487137	487138	487471	492505

General Specifications		
Performance Characteristics (Per ANSI/ISA-S12.13, Part 1 for Combustible Gas Monitoring at 25°C ambient temperature after a 15-minute warm-up period)		
ACCURACY	**Oxygen**	±0.3% O_2 at constant atmospheric pressure & temperature ±0.5% O_2 with temperature changes from calibration temperature over the range 0°C to 40°C
	Combustible Gas	FOR % LEL INSTRUMENTS: ±3% LEL from 0% LEL to 50% LEL ±5% LEL from 51% LEL to 100% LEL
		FOR % CH_4 INSTRUMENTS: ±0.2% CH_4 from 0.0% CH_4 to 2.5% CH_4 ±0.3% CH_4 from 2.6% CH_4 to 5.0% CH_4
RANGES	**Oxygen**	1.0 to 25.0%
	Combustible Gas	0 to 100% LEL in air; 0 to 5.0% CH_4 in air
RESPONSE TIME (DIFFUSION MODE)	**Oxygen**	90% of final reading in 10 seconds at 32°F to 104°F (0°C to 40°C); 90% of final reading in 3 minutes at 0°F
	Combustible Gas	90% of final reading in 15 seconds
OXYGEN SENSOR LIFE	One year warranty when used at atmospheric pressure containing 20.8% O_2 or less without the presence of poisoning agents	
OPERATING TEMPERATURE RANGE	**Oxygen**	32°F to 104°F (0°C to 40°C) normal
		LOW LIMIT: 0°F (-18°C) when calibrated at temp. of use
		HIGH LIMIT: 122°F (50°C) when calibrated at temp. of use
	Combustible Gas	32°F to 122°F (0°C to 50°C)
		LOW LIMIT: 0°F (-18°C) when calibrated at temp. of use
STORAGE TEMPERATURE RANGE	**Instrument w Sensors**	-18°C to 30°C (to 50°C with reduced O_2 sensor life)
	Oxygen Sensor	-18°C to 30°C (to 50°C with reduced O_2 sensor life)
	Combustible Sensor	-35°C to 55°C
HUMIDITY RANGE	10% to 90% relative humidity, non-condensing	
ELECTROMAGNETIC SUSCEPTIBILITY	This equipment has been type-tested to determine its sensitivity to radio frequency interference and found to comply with ISA Specification S12.13 Part 1. This equipment has been further type-tested by exposure to radio frequency fields at levels defined in ANSI Specification C95.1-1982, "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields 300 kHz to 100 GHz" These levels specify the maximum power density limits for occupational exposure. When exposed to fields at or below these levels, this equipment continues to function within its basic accuracy specifications. Modifications to, or unauthorized maintenance of, this equipment may seriously degrade its performance in the presence of radio frequency interference and may result in reduced protection.	

Operating Characteristics		
POWER SUPPLY	**Diffusion Mode**	Rechargeable, 2.4-volt, 2.0 AMP-hour nickel-cadmium battery pack; 3-volt Alkaline battery pack with two "C" Cells (Duracell MN 1400 only)
	Pump Mode	Rechargeable, 2.4-volt, 4.0 AMP-hour nickel-cadmium battery pack; 3-volt Alkaline battery pack with four "C" cells (Duracell MN 1400 only)
OPERATING TIME	8-10 hours nominal continuous usage at normal ambient temperature with fully charged battery pack; 8 hours at 0°C, depending on battery condition; see Section 3, *"Battery Service"*	
READOUT	Liquid crystal displays with .5" high digits; LED Backlight with momentary actuation	

Physical Characteristics		
CASE CONSTRUCTION	**Instrument**	Flame-resistant "Noryl" plastic
	Pump	ABS plastic
DIMENSIONS	**Instrument**	2-3/4" wide x 5-3/4" high x 1-3/8" deep
	Pump	3-3/16" wide x 8-1/2" high x 2-5/8" deep
WEIGHT	**Instrument with Battery Pack**	14.30 ounces (.41 KG)
	Instrument with Pump Module	27.9 ounces (.79 KG)
PUMP FLOW RATE	Approximately 1 LPM	
SUPPLIED ACCESSORIES	Wrist strap and earphone	
SERIAL NUMBER	Located on inside of the Instrument front cover (remove battery pack to locate)	

Units marked with the CE approval mark must have a plug (P/N 802895) in the battery charger. CE approved units are not to be used with the optional ear phone. Both of these requirements must be followed to maintain the CE approval.

The instrument must be used by qualified personnel only. Do not operate the MicroGard Portable Alarm until the instructions, labels, cautions and warnings, and any other literature accompanying the instrument are carefully read and understood.

If you have any questions regarding the instrument, any procedure in this manual, or the location of the nearest MSA Repair Center and source of replacement parts, please call our toll-free number: ***1-800-MSA-2222.***

Initial Checks

To verify that the instrument operates properly and retains factory calibration, perform the following "Charging Battery Pack" and "Initial Operational Checks" procedures.

Charging Battery Pack

Upon receiving a new MicroGard Portable Alarm with rechargeable battery pack, fully charge the battery according to the following procedure:

1. Insert the plug of MSA Type F Charger (P/N 633548, 115 VAC input or P/N 478490, 12 VDC input) or MSA 5-Unit Charger (P/N 486686) into the MicroGard unit charging jack (FIGURE 1-1).

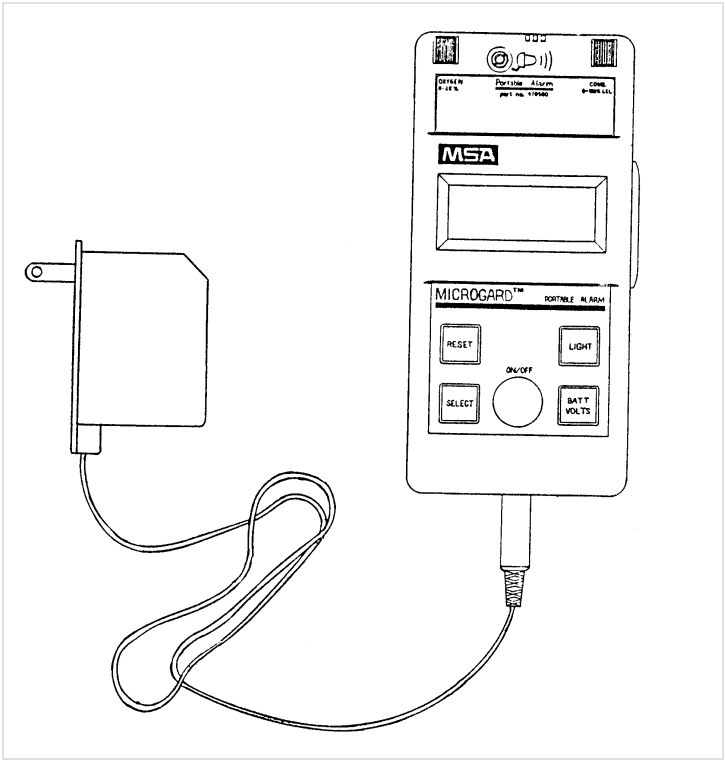

Figure 1-1.
MicroGard Portable Alarm Battery Charging

⚠ CAUTION

Use only the units specified above to charge the MicroGard Portable Alarm; otherwise, damage to the battery pack and/or instrument circuitry may result.

2. Make sure the MicroGard Portable Alarm is turned OFF. Attempting to charge the battery pack with the MicroGard unit turned ON will result in improper or no charging.

   NOTE: If a battery pack is totally depleted, it may be difficult to determine whether the instrument is ON or OFF; in this case, remove the battery pack and charge separately. With the rechargeable pump battery pack, a green LED inside the battery will light when the switch is in the OFF position and the batteries are on charge. This green LED can be seen through the cut-out around, or the hole near, the instrument connector.

3. Apply appropriate power to the battery charger:

   a. **If using Single Unit Charger (P/N 633548)**
   115 VAC input: Insert battery charger AC plug into a 115-VAC, 50/60 Hz outlet.

   b. **If using 12 Volt Adapter Charger (P/N 478490)**
   12 VDC input: Insert battery charger cigarette lighter adapter into 12 VDC cigarette lighter outlet. Use this charger only when the vehicle battery is fully charged and in good condition.

   c. If using 5-Unit Charger (P/N 486686):

      1. Select 115-VAC or 220-VAC input on the charger.

      2. Plug the appropriate power cord into the charger.

      3. Plug the AC plug of power cord into either a 115-VAC, 50/60 Hz or 220-VAC, 50/60 Hz outlet (whichever is appropriate).

      4. Charge the battery pack for 14 to 16 hours.

⚠ WARNING

Do not charge the battery pack in areas which may contain a flammable mixture of combustible gases, vapors or dust and air; otherwise, an explosion may occur since a source of ignition exists during charging.

The MicroGard rechargeable, nickel-cadmium battery pack (P/N 478510) is rated at 2.0 ampere-hours. The rechargeable Pump, nickel-cadmium Battery Pack (P/N 482255) is rated at 4.0 ampere-hours. The circuitry inside the battery packs automatically sets the appropriate charge current. Use of recommended MSA Type-F Chargers (P/Ns 478490, 486686 and 633548) provides optimum battery life, especially during extended overcharge conditions, while allowing a reasonable recharging time. The allowable temperature range for charging is -15° to 30°C. However, maximum charge capacity will be obtained in ambients from -5° to 25°C.

The recommended charging time of 16 hours is based on a 160% charge input to a totally depleted battery pack under worst case conditions. The MicroGard battery packs can be allowed to charge continuously without damaging the batteries, provided the ambient temperature does not exceed 30°C.

Continuous Instrument Operation

The MicroGard Portable Alarm features a removable battery pack. This allows the user to maintain a "spare," fully charged pack and simply switch packs when necessary to provide continuous instrument operation.

Membrane Switch Keypad Operation

Operator interface with the MicroGard Portable Alarm is achieved via a tactile membrane switch made up of three or four keypads, depending on the particular MicroGard model (TABLE 1-2). The "two-in-one" instruments have four keypads; the combustible-only models have three.

⚠ CAUTION

Push keypads with the pad of a finger; use of fingernails or foreign objects to activate keypads may damage the membrane switch.

Table 1-2. Membrane Switch Keypad Functions		
KEYPAD	FUNCTION	NOTE
RESET	Permits operator to reset audible and visual alarms when the gas concentration is within a predetermined safe level	*
SELECT	(When applicable) Permits operator to display the monitored concentration of either gas. Note that both gases are continuously monitored, regardless of which gas concentration is displayed	*
BATT VOLTS	Permits operator to display battery pack voltage	**
LIGHT	Back-lights the display for use in low-light applications	**

Initial Operational Checks (FIGURE 1-2)

NOTE: Run initial checks in ambient air, free of combustible gas.

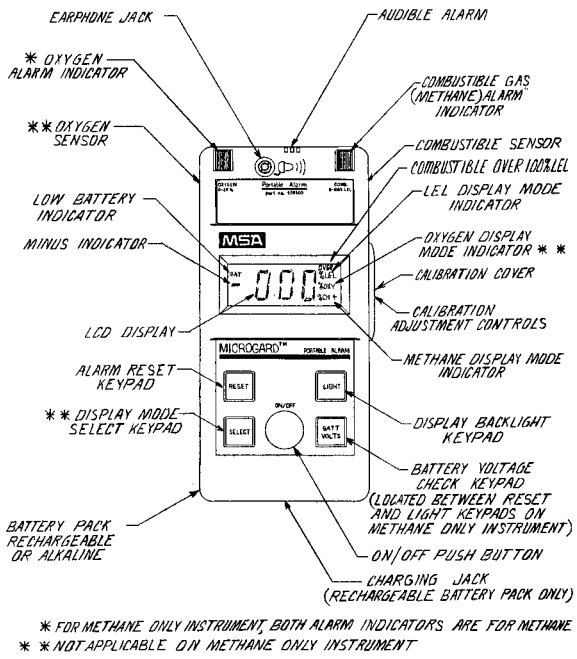

Figure 1-2.
Location of Controls, Indicators and Components

1. Depending on model, fully charge the battery pack or verify that instrument is fitted with fresh Alkaline battery.
2. If operating in the Pump Sample Mode, be sure sampling lines are disconnected. Remove filter cap, and inspect filter element and O-rings. Clean or replace as needed. Re-install filter cap.
3. Press the ON/OFF push-button to turn the instrument ON. Verify the display functions and does *not* indicate "BAT." If BAT appears, see Section 3, "Maintenance."
4. An audible Alarm will sound; The COMBUSTIBLE GAS ALARM Light will flash and % LEL or % CH_4 will be displayed. If in the Pump Sample Mode, the pump motor turns ON, and the flow indicator verifies air flow with a bouncing bead.
5. For Pump Sampling Mode, install a sampling line or probe and, if required, plug the end. The motor should noticeably stall. If it does not stall, look for leaks at connectors, and repeat this step.
6. The MicroGard Portable Alarm begins to stabilize in about 10 seconds.
   a. Press the RESET keypad; the display should indicate 000% LEL or 00.0% CH_4 and the alarm should silence (FIGURE 1-3).

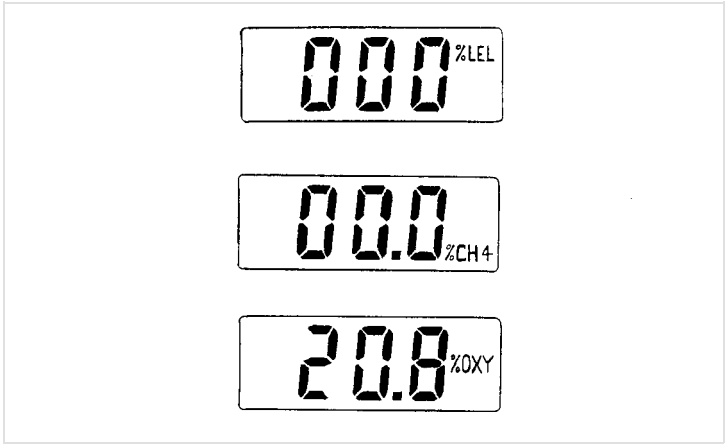

Figure 1-3.
% LEL, % Methane and % Oxygen Displays

b. If a reading other than 000% LEL or 00.0% CH_4 is obtained:

1. Loosen screws and pivot the calibration cover to expose calibration adjustments located below.

2. Adjust the COMB Z (ZERO) control to obtain a correct zero reading (FIGURE 1-4).

7. Press the SELECT keypad until the display indicates % OXY and release.

8. If required, adjust the OXY S (SPAN) control until the display indicates 20.8 (FIGURES 1-3 and 1-4). To obtain accurate % OXY indication, ALLOW SUFFICIENT TIME FOR THE MICROGARD TO STABILIZE. Do not breathe heavily near the instrument when adjusting the OXY S control; exhaled breath contains less than 20.8% oxygen and will affect the % OXY reading.

9. Calibrate the instrument per Section 4, "Calibration."

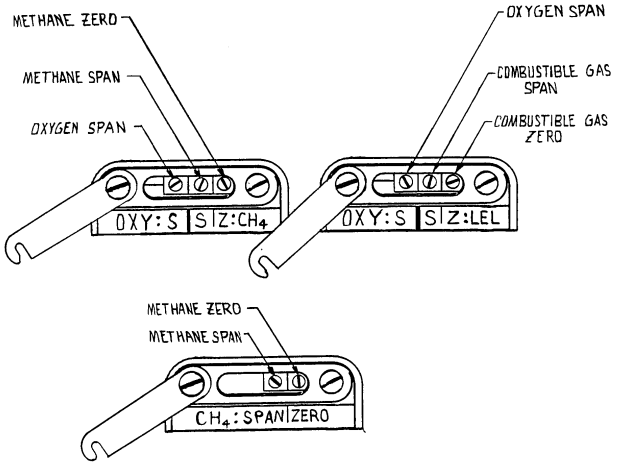

Figure 1-4.
Calibration Adjustment Controls

Instrument Operation

Oxygen Indication

The MicroGard Portable Alarm is ready to monitor oxygen content in the sampling area once the instrument reading stabilizes at the ambient temperature of operation and calibration is set in fresh air to 20.8%. Actual oxygen content can be continuously or intermittently monitored by using the SELECT keypad to display % Oxygen when monitoring. For remote sampling applications, perform procedure given under Section 1, Operation - "Optional Sampling Equipment."

The MicroGard Portable Alarm has a High Oxygen Alarm, factory pre-set at 22%, and Low Oxygen Alarm, factory pre-set at 19.5%. These alarm set-points are user-accessible; see Section 3, "Maintenance." Once the MicroGard Portable Alarm is turned ON, the oxygen alarm functions are always operable in either the % OXY or % LEL (% CH_4) display mode.

In sample areas where the temperature is not constant (changes by more than 30°F), or in sampling atmospheres that differ in temperature from that of the calibration air (by more than 30°F), the fresh air reading should be re-checked every hour to obtain the greatest accuracy capable of the indicator.

Sampling conditions that lead to condensation of moisture on the sensor face (i.e.: taking a cool sensor into a warm, moist atmosphere) will cause erroneously low oxygen readings. These conditions produce a film of water on the sensor face which reduces the transport of oxygen from the atmosphere to the inside of the sensor. To prevent moisture on the sensor face, keep the sensor as warm or warmer than the sample area before and in the intervals between sampling.

The oxygen sensor is free from interference from other chemical substances. Concentrations of carbon dioxide greater than 1% will reduce the sensor life.

NOTE: Digital displays like those used in the MicroGard Portable Alarm will show even the smallest sensor signal fluctuations and may therefore cause changes in the last digit ±2 units. These same fluctuations appear in analog instruments but are not as visible to the user.

This instrument has been evaluated by Underwriters Laboratories for use in normal, non-oxygen enriched atmospheres (atmospheres containing less than 21% oxygen by volume) only.

Combustible Gas Indication

After setting the combustible sensor ZERO in combustible free air, the MicroGard Portable Alarm is ready to monitor either:

- The presence of combustible gas in the sampling area (based on factory-calibration on pentane), or
- The presence of methane in the sampling area (based on factory- calibration on methane).

Check this calibration prior to each day's use (see Section 4, "Calibration"). Avoid sampling conditions that may clog the combustible sensor cover, screen or frit since this may cause erroneously low readings.

As long as the MicroGard Portable Alarm is turned ON, actual combustible gas content in the sampled area is always being monitored and can be displayed continuously or intermittently by using the SELECT keypad to display the % LEL (CH_4). The combustible alarm is active in both display modes and is factory pre-set at:

- 10% LEL or 1.0% CH_4 for the high combustible alarm.
- -10% LEL or -0.5% CH_4 for the combustible sensor zero fault alarm.

These alarm setpoints are user-accessible; see Section 3, "Maintenance."

NOTE: Digital displays like those used in the MicroGard Portable Alarm will show even the smallest sensor signal fluctuations and may therefore cause changes in the last digit ±2 units. These same fluctuations appear in analog instruments but are not as visible to the user.

Combustible gas readings greater than 100% LEL or 5.0% methane may indicate an explosive concentration of gas which is beyond the accurate response range of the combustible gas sensor. As a precaution, when the MicroGard display indicates 100% LEL (5.0% CH_4) the LockAlarm feature activates:

- Both the audible and visual alarms latch ON.
- The LEL (CH_4) display latches showing a 1—, % LEL and OVER.
- The oxygen display can still be monitored while the combustible alarm has latched.
- This above-scale latching alarm can only be reset as follows:

  1. Move the MicroGard Portable Alarm to an area free of combustible gas.
  2. Turn OFF the MicroGard unit.
  3. Turn ON the MicroGard unit.
  4. Use the RESET keypad to reset the alarms.
  5. Check the combustible gas reading, and verify that it indicates no combustible gas.

     NOTE: In order to provide time for the MicroGard Portable Alarm to stabilize, the LockAlarm alarm circuit does not operate during the first 30 seconds after turning the instrument ON, even if the sensor indicates +100% LEL (5.0% CH_4).

Downscale drift of the combustible zero may indicate sensor failure. If the combustible alarm sounds, and the display shows a negative (-) % LEL (%CH_4) reading, the combustible zero fault alarm may have activated.

1. Move to a safe area, free of combustible gases.
2. Re-calibrate the instrument per Section 4, "Calibration." If the instrument cannot be calibrated, refer to Section 3, Maintenance.

Low Battery Indication

An instrument with a fresh, fully charged Nicad battery pack typically displays in excess of 2.4 volts when the BATT VOLTS keypad is held down. An instrument with fresh Alkaline batteries will indicate approximately 2.9 volts. The MicroGard Portable Alarm has a two-level, low-battery indication. When the voltage of the battery pack reaches a level where the remaining time of accurate sampling is limited, a "BAT" indication appears on the display. This occurs at approximately 2.20 volts on the instrument display.

When BAT is indicated, display readings are still accurate, but preparations must be made to return the MicroGard unit to a safe atmosphere for battery pack recharging, or a fresh battery pack can replace the exhausted one.

When battery pack voltage is no longer sufficient to provide accurate readings (approximately 2.1 volts):

- The audible alarm latches ON, and sounds continuously (non-pulsing).
- The display blanks to prevent erroneous readings due to low-battery voltages.
- Operator must turn the instrument OFF. Move the MicroGard unit to a safe atmosphere for battery pack recharging, or replace the battery pack with a fully charged one.

NOTE: Nickel-cadmium batteries can be irreversibly damaged by excessive discharge. The MicroGard Portable Alarm provides a buffer against this excessive discharge by reducing power consumption after the second-stage low battery alarm sounds. However, the instrument should never be left on for more than 18 hours after the low battery alarm sounds.

Audible Alarms

The MicroGard Portable Alarm is equipped with an internal alarm buzzer mounted in the top end of the instrument. For applications where high noise levels could drown out the MicroGard alarm buzzer, two options exist to enhance worker awareness of an alarm situation:

Table 1-3. Summary Of Alarm Conditions

ALARM	CONDITION
Audible beeping; OXY LED flashing	Oxygen level outside of preset limits (high or low)
Audible beeping; COMB (CH_4) LED flashing	Combustible gas (CH_4) level outside of preset limits (high or low)
Audible beeping; COMB (CH_4) LED flashing; 1—- on display in COMB MODE	LockAlarm feature activated by over range combustible level; oxygen range still functions
"BAT" descriptor on display	First stage low battery level; readings are still accurate

1. The earphone (P/N 633722), included with the MicroGard Portable Alarm, can be used when the MicroGard unit is carried in a shirt pocket or with the carrying case attached to a worker's belt.
2. A remote alarm (P/N 496809), powered by a dedicated, 9-Volt battery, plugs into the earphone jack and is louder than the instrument buzzer. The remote alarm can be clipped onto a collar, pocket or belt.
   - While using either audible alarm option, the MicroGard buzzer remains active.
   - Unless the earphone or remote alarm are to be used, keep the plastic plug in the earphone jack to prevent dirt and water from entering the case.

Practical Methods Of Use

There are several practical methods for MicroGard Portable Alarm use. The clip on the back of the MicroGard unit is a pocket clip only. Its function is to hold the instrument securely in a worker's pocket while keeping the sensor area open to the diffusion of gases. Do not use the pocket clip as a belt clip or obstruction to the sensor area may result.

⚠ WARNING

The sensor area of the instrument must remain open to the air of the sampled environment. Obstruction of the sensor area could hamper the MicroGard Portable Alarm's ability to warn workers of a potentially dangerous condition.

When the MicroGard Portable Alarm is to be hand-carried, fasten the wrist strap to the pocket clip; this helps prevent accidental dropping.

When the MicroGard unit is carried on a worker's belt, the optional carrying case *must* be used. This carrying case provides protection from the environment and padding from accidental blows, while allowing for full instrument operation. Another carrying case is available for use with the pump module.

When the MicroGard Portable Alarm monitors an area such as a work bench, stand the instrument in an open area where air currents flow freely. However, if the MicroGard unit must be rested on its back cover, the sloping design of the sensor cover area enables effective sampling.

Optional Sampling Equipment

Sampling Lines

Sampling lines permit samples to be taken of remote or inaccessible locations. A pump module or a sampling/calibration adapter with aspirator sampling adapter are available which permit the use of standard MSA sampling lines. The available sampling lines, ranging in length from 5 to 50 feet, are made of a synthetic material specifically compounded to resist absorption of combustible vapors.

⚠ CAUTION

Do not use sampling lines made of ordinary rubber or any synthetic material which absorbs solvent vapors since the absorption will result in erroneous indications that are usually lower than the actual value.

Use the shortest possible length of sampling line to minimize the number of times that the aspirator bulb must be squeezed, or the time the pump module must be operated, in order to obtain a valid indication (TABLE 1-4).

Sampling/Calibration Adapter Installation and Manual Remote Sampling

1. Ensure that insert (P/N 10346) is in place in sampling/calibration adapter connection.
2. Attach the aspirator sampling adapter to the sampling/calibration adapter connection (FIGURE 1-5).

Table 1-4.
Sample Line Length/Aspirations

SAMPLE LINE LENGTH (IN FEET)	ASPIRATIONS FOR INITIAL RESPONSE	ASPIRATIONS REQUIRED FOR FULL RESPONSE
5	2	10
10	3	10
15	4	12
25	7	15
35	8	17

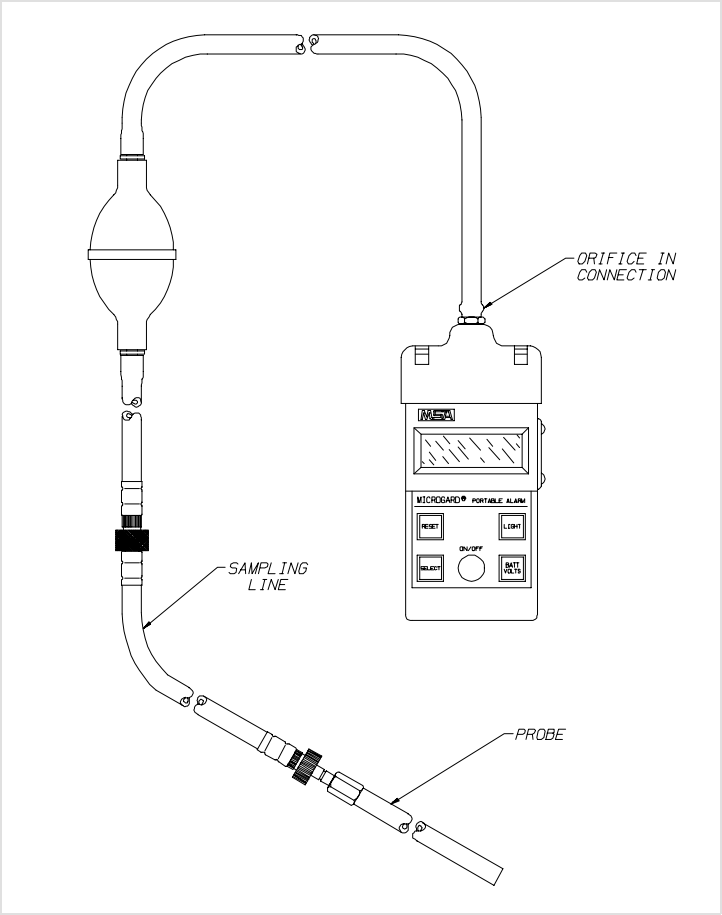

Figure 1-5.
MicroGard Sampling with Aspirator Bulb & Sampling Line

3. Attach sampling line to the threaded fitting on the aspirator bulb.

4. To ensure that sampling lines are intact and proper flow is established, perform the following checks each time manual remote sampling is used:

   a. Plug the free end of the sampling line or probe and squeeze aspirator bulb. The bulb should not inflate until the line is opened.

b. Pinch the tubing between the instrument and the aspirator bulb. Squeeze the aspirator bulb. The aspirator bulb should not deflate, but should continue to hold air until the tubing is released.

c. If either of these conditions is not met, look for leaks at the connections and inspect sampling line integrity. Do not use the aspirator for remote sampling unless both of these conditions are met.

5. Slide the sampling/calibration adapter over the sensor openings on the top rear of the MicroGard unit. The adapter can be flexed open to allow easier positioning by squeezing its sides with thumb and forefinger. Ensure that rubber manifold portion is sealed evenly against the instrument sensor cover.
6. Place end of sampling line or probe in area to be sampled.
7. To begin remote sampling, squeeze the aspirator bulb completely and allow to completely fill 10 to 20 times depending on sample line length (refer to TABLE 1-4). This will typically ensure the sample system has been purged and that the reading will be at least 90% of the actual sample.
8. Continue to squeeze the aspirator bulb slowly while watching the MicroGard display for no change in the reading, indicating a stable reading.

TABLE 1-4 can be used as a guide for the number of aspirations required for different lengths of sampling lines. In any case, squeeze the aspirator bulb until the reading on the display is stable.

Remote Sampling with the Pump Module (P/Ns 478520 and 485693 only)

1. If using a diffusion-type MicroGard Portable Alarm, remove the battery pack.
2. Verify that the electrical connectors between the pump battery pack and the motor are coupled. Tilt the top end of the instrument into the pump module and couple the instrument to the battery pack. Do not force the instrument to engage with the battery pack. Rock the instrument from side-to-side to encourage engagement.

   NOTE: If the pump module does not go in easily, do not force it. Loosen the two screws located

on either side and the two screws located on the back of the pump module top. Rock the top back to allow the MicroGard to be installed; then, reposition the top and tighten the screws.

3. Secure with screw (P/N 634188) from pump module.
4. To ensure that sampling lines are intact, and proper flow is established, perform the following checks each time pump sampling is used:
   a. Remove filter cap, and inspect filter element and O-rings. Clean or replace as needed. Re-install the filter cap.
   b. Install sampling line and/or probe.
   c. Turn the instrument ON, and plug the free end of the sampling line or probe. The motor should stall, and the flow indicator should drop. If this does not happen, look for leaks at connections and repeat.
5. Place end of sampling line or probe in area to be sampled.
6. Allow enough time for the sample to reach the instrument. For example, allow at least 30 seconds with a 50-foot sample line.

Remote Sampling with the P/N 802830 Pump Module

Refer to Instruction Manual P/N 804641 for usage of the High Efficiency/Low Flow Rate Version Pump.

Probes

Probes permit samples to be taken in areas that cannot be reached with a sampling line. Bar holes, manholes, sewers, and behind obstructions or areas accessible only through narrow openings can be examined by connecting the probe to a sampling line (FIGURE 1-5).

Four probes are available for use with the MicroGard Portable Alarm:

- 4-foot, solid probe rod.
- 3-foot, dielectric probe tube.
- 18-inch, dielectric probe tube.

Uses And Limitations

The MicroGard Portable Alarm provides an efficient and reliable method of testing atmospheres for sufficient oxygen content for life support and/or the presence of combustible gases or vapors posing a potential flammability hazard. Common examples of such locations are:

- Hazardous waste sites
- Manholes
- Storage Tanks
- Tank Cars
- Confined Spaces
- Pumping Stations
- Ships and Shipyards.

It is important that the instrument response be appraised by someone skilled or experienced in properly interpreting the instrument readings with respect to particular conditions, ongoing operations and safe practices. For example, an atmosphere that shows no flammability hazard can still be toxic to workmen. Also, a tank or vessel which is safe before work is started may be rendered unsafe by work activities causing a temperature increase, or by stirring or handling bottom sludge in tanks.

⚠ CAUTION

The MicroGard Portable Alarm will respond only to those concentrations of gases or vapors which are diffused into the combustible sensor. If the combustible is a high boiling point solvent or high flash point liquid, and is tested at normal ambient temperature, a relatively low vapor concentration will be shown by the instrument. Flash point of a liquid is the minimum temperature at which it gives off sufficient vapor to form an ignitable mixture with the air near the surface of the liquid or within the vessel used. If a container holding such high flash point solvents is subsequently heated as by welding and soldering, or by sunlight, it is to be expected that the vapor concentration will increase, and thus the atmosphere of a vessel which was originally shown to contain only a low concentration of vapors may be rendered EXPLOSIVE.

If an attempt is made to use the MicroGard Portable Alarm

for testing atmospheres contaminated with high boiling point or high flash point solvents, it is imperative that the actual boiling point or flash point of the contaminants in question be assessed against ambient temperature of the tested space.

Combustible gases burn or explode only when the fuel/air mixtures are within certain proportions. For most common hydrocarbon gases, this range of proportions runs from about 1% to as high as 15% by volume in air. The minimum concentrations of a particular combustible gas in air which can be ignited is defined as the lower explosive limit (LEL). The maximum concentration that can be ignited is defined as the upper explosive limit (UEL). In some references, the terms used are lower and upper limits of flammability (LFL and UFL).

The combustible measurement is dependent upon catalytic combustion of the flammable gas in combination with oxygen in the air. Conditions can exist in a closed space where not enough oxygen remains to provide a correct combustible gas reading. As a general rule, if there is less than 10% oxygen in the area tested, the combustible gas reading may be incorrect.

NOTE: This low oxygen level is far below that which is required for human life. In these instances, the % oxygen reading is most important. A low oxygen concentration in an enclosed atmosphere indicates that:

- Some other gas has displaced much of the air and/or
- Some process has consumed much of the available oxygen.

Certain materials in the sampled atmosphere affect the catalytic material on the Pelement™ filament and may cause the indicator to respond incorrectly. These materials include such compounds as:

- Leaded Gasoline and Silicone Compounds in the form of:
    - Silanes
    - Silicones
    - Silicates (often found in hydraulic fluids)

⚠ WARNING

When an atmosphere contaminated with leaded gasoline is tested, the lead produces a solid product of combustion which, upon repeated exposure, may develop a coating on the detector Pelement. This coating causes a loss of sensitivity; therefore, more frequent calibration checks must be performed.

⚠ WARNING

Silanes, silicones, silicates and other volatile compounds containing silicon in the tested atmosphere can seriously impair instrument response. Some of these materials rapidly "poison" the detector filament so that it will not function properly. When such materials are even suspected to be in the atmosphere being tested, the instrument calibration must be checked after each series of tests.

The combustible gas indicator portion of the LEL MicroGard Portable Alarm is normally calibrated on pentane which is representative of the flammability characteristics of many commonly encountered combustible gases. The LEL MicroGard Portable Alarm is calibrated from 0 to 100% LEL which corresponds to actual volume concentrations of 0 to approximately 1.5% pentane in air. To determine the instrument response for other combustibles, the response factors found in Section 5 should be used. For the methane MicroGard Portable Alarm, the combustible gas portion of the MicroGard unit is normally calibrated on methane. This latter instrument is calibrated from 0 to 5.0% CH_4 in air.

When initially opening and probing an enclosed area, move the probe into the area slowly while watching the display to provide the earliest possible indication of a potentially dangerous condition. **BE PREPARED TO VACATE THE AREA IF THE MICROGARD INDICATES THE POSSIBILITY OF A HAZARDOUS CONDITION.**

The oxygen sensor responds to the partial pressure of oxygen in the tested atmosphere. For this reason, changes in atmospheric or sample pressure will change the oxygen reading. Check and adjust the calibration in the same atmospheric conditions where the instrument is to be used.

Table 1-5. Sensor Life Reduction Due to CO_2 Exposure	
% CARBON DIOXIDE	SENSOR LIFE REDUCED TO:
1%	100 DAYS
5%	50 DAYS
100%	2 DAYS

For best performance when monitoring oxygen:

1. Turn the MicroGard Portable Alarm ON and allow it to stabilize in fresh air at the temperature of use.
2. Calibrate the instrument in fresh air to 20.8%.

The minimum and maximum calibrating and operating temperatures are $0^{o}F$ ($-18^{o}C$) and $122^{o}F$ ($50^{o}C$), respectively. The oxygen response time increases in temperatures beyond the compensated range, particularly at temperatures below $32^{o}F$ ($0^{o}C$); therefore, allow extra time to obtain accurate calibrations and measurement.

Use down to $0^{o}F$ ($-18^{o}C$) is possible when calibrated at that temperature and if more sampling time is allowed for slower sensor response (approximately 3 minutes without a sample line).

The life of the oxygen sensor is reduced by exposure to carbon dioxide (TABLE 1-5). The effect is cumulative; therefore, all tests of atmospheres containing excess concentrations of carbon dioxide should be stopped as soon as a constant reading is obtained. Abnormally slow recoveries to the air calibration point after exposure to high carbon dioxide is to be expected.

This instrument has been evaluated by Underwriters Laboratories for use in normal, non-oxygen enriched atmospheres (atmospheres containing less than 21% oxygen by volume) only.

Section 2
Theory Of Operation

Introduction

A block diagram of the MicroGard Portable Alarm is shown in FIGURE 2-1. The MicroGard unit simultaneously monitors O_2 and combustible gases via two separate visual alarms and a joint audible alarm that remains activated until the RESET keypad is pressed after the concentrations return to the predetermined safe level.

Oxygen Indication

The oxygen sensor is a galvanic type cell containing dissimilar metal electrodes in a special electrolyte. The cell is sealed with a membrane which allows oxygen to diffuse into the active area. The current generated by the cell is proportional to the oxygen partial pressure in the atmospheric sample passing over the membrane face. The generated current passes through a resistance to provide a voltage input signal for an amplifier. The output of the amplifier drives the oxygen display (through the multiplexer) and also serves as an input to the alarm decoder circuitry.

Combustible Gas Indication

The flammable properties of combustible gases are used as a basis of detection. The sensor consists of a pair of *Pelement*™ pelletized filaments arranged in an electrically balanced bridge circuit. The Pelement detector is treated with a special catalyst which causes the combustible gases to combine with O_2 at a much lower temperature than that required for normal burning. The Pelement inactive compensator is also exposed to the sample and acts to offset any changes due to flow conditions, sample temperature, pressure and/or humidity.

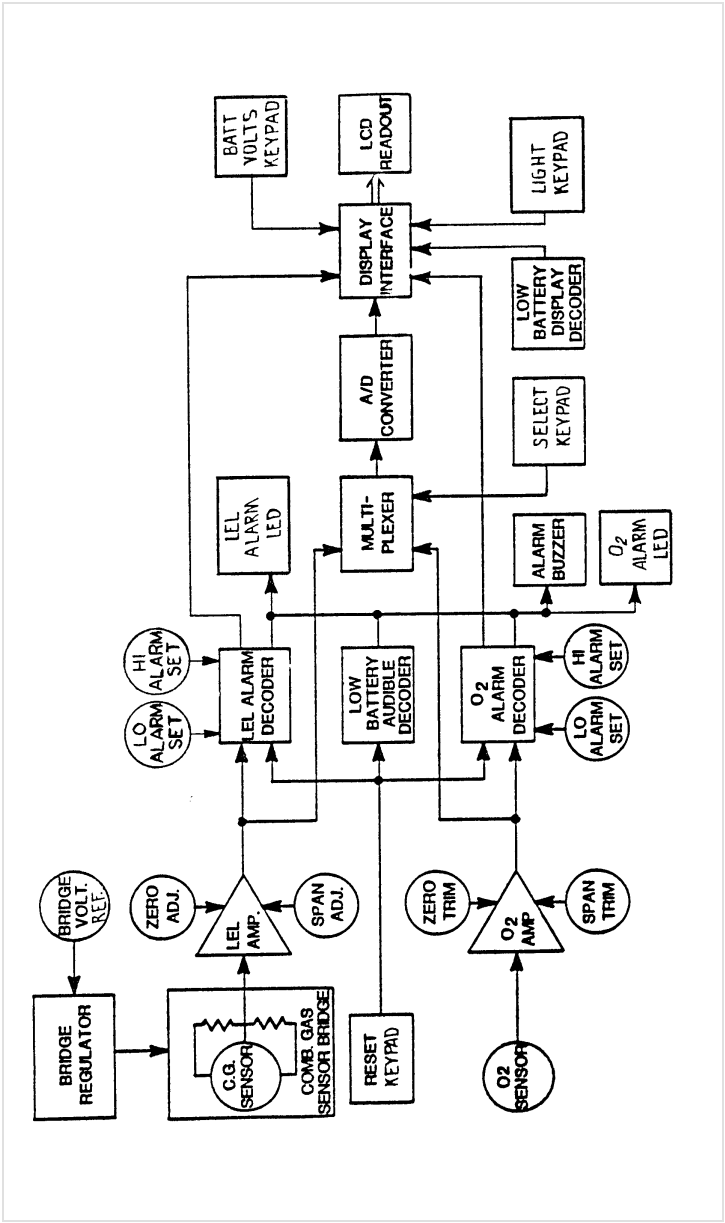

Figure 2-1.
MicroGard Functional Block Diagram

Combustible gases in the sample combine with oxygen at the surface of the catalyzed Pelement detector. Heat is liberated by this chemical reaction, increasing the temperature and the electrical resistance of the Pelement detector. This, in turn, unbalances the bridge circuit, thereby providing a voltage signal. This signal is applied to an amplifier which drives the combustible gas display (through the multiplexer) and also serves as an input to the LEL (CH_4) alarm decoder circuit.

Low-Battery Indication

The low-battery indication (BAT) is obtained by decoding circuits which run the LCD readout. The low-battery alarm is obtained by decoding circuits which run the audible alarm, visual LED alarms, and LCD readout.

Section 3
Maintenance

Introduction

The MicroGard Portable Alarm will perform as designed only if it is serviced in accordance with these instructions and by individuals who have the required skills and tools to follow these procedures.

⚠ WARNING

Use only genuine MSA replacement parts when performing any maintenance procedures provided in this manual. Failure to do so may seriously impair instrument performance. Repair or alteration of the MicroGard Portable Alarm, beyond the scope of these maintenance instructions or by anyone other than a certified MSA serviceman, could cause the product to fail to perform as designed and persons who rely on this product for their safety could sustain severe bodily injury or death. Any substitution of components may impair intrinsic safety requirements.

Instrument Cleaning

Periodically clean the MicroGard case with a soft cloth dampened with water. If the sensor dust screens are blocked with dirt:

1. Remove two screws, sensor cover and screens.
2. Clean cover with paper clip, piece of wire or similar device, or carefully blow particles free with clean compressed air.
3. Clean screens with compressed air, or replace screens.

⚠ CAUTION

Do not use compressed air to clean an assembled MicroGard unit because the thin, Teflon (Teflon is a registered trademark of the duPont Co.) oxygen sensor diaphragm may be damaged.

Troubleshooting

The Troubleshooting Guidelines (TABLE 3-1) list the symptoms, probable causes and corrective action required to eliminate the most commonly occurring problems in the MicroGard Portable Alarm. Use these troubleshooting guidelines if the MicroGard unit cannot be operated properly or calibrated according to the procedure given in Section 4, "Calibration."

If you have any questions regarding the instrument, any procedure in this manual, or the location of the nearest MSA repair center and source of replacement parts, please call our toll-free number: 1-800-MSA-2222

Corrective Maintenance

When an inoperative part is located by following the troubleshooting guidelines (TABLE 3-1), replace it according to one of the following procedures. See Section 5, "Parts List" for information on replacement parts.

Oxygen Sensor Replacement

The oxygen sensor is covered by a very thin plastic film which is easily damaged if touched with hard or sharp objects. If the sensor face requires cleaning, remove the sensor from the case and rinse the face with water and blot dry with tissue paper or cotton. When the oxygen sensor is removed, check the sensor cover and dust screen in the rear of the case at the sensor location. If any holes are blocked with dirt, clean the case as described under Section 3, Maintenance, "Instrument Cleaning."

Sensor life is terminated when the oxygen indicator reading can no longer be correctly adjusted during calibration. To replace the oxygen sensor (FIGURE 3-1):

Table 3-1. Troubleshooting Guidelines

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Instrument does not operate (i.e., no display and no audible alarm) or BAT is indicated on the display prematurely	Battery pack not charged	Charge battery pack. Verify instrument is OFF when charging or remove battery pack from instrument & charge separately
	Inoperative battery pack assembly	Remove pack from instrument. Charge as recommended. Connect a 15 to 18-ohm, 1-watt resistor across 2-pin con- nector terminals. Turn ON/OFF switch ON & measure volt- age across the resistor; it should be 2.4 volts. If measured voltage is lower than this value, battery pack is defective. **NOTE:** While this test will pinpoint a badly depleted battery pack, it does not measure battery pack capacity. Replace a Nicad battery pack when 8 hours or more of continuous operation cannot be achieved after a full charge
Instrument operates but pump does not	Electrical connector from battery pack to motor not connected	Mate connectors
	Inoperative pump & motor drive assembly	Replace inoperative motor and/or pump
	Flow line blockage	Inspect flow lines for blockage; clean & replace as needed
Audible alarm not sounding when instrument is in alarm condition	Audible alarm broken	Replace alarm
	Faulty jumper continuity	Verify jumper connections for continuity (see FIGURE 3-1)
Earphone not sounding when instrument is in alarm condition	Earphone plug not fully inserted	Fully insert plug
	Earphone broken	Replace earphone

Table 3-1. Troubleshooting Guidelines (cont.)

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Alarm cannot be reset with instrument in fresh air	Improperly adjusted alarm set-points	Check alarm set-points per the Printed Circuit Board Adjustments in Section 3, *Maintenance*
	Improper sensor calibration	Check sensor calibration per Section 4, *Calibration*
	Low battery	Check for BAT indication; recharge
	Failed sensors	Replace sensors
	Poor zebra strip continuity	Replace zebra strip
	Failed reset switch	Return instrument for factory service
SELECT, BATT VOLTS, or LIGHT switch cannot be activated	Poor zebra strip continuity	Replace zebra strip
	Failed SELECT switch	Return instrument for factory service
COMBUSTIBLE SENSOR		
Sensor will not reach full span even at maximum gain	Low battery	Charge or replace battery pack
	Clogged sensor cover slots or screens in case	Remove & clean cover and screens or replace screens
	Contaminated sensor	Replace combustible sensor
Sensor will not zero	Failed sensor	Replace sensor
OXYGEN SENSOR		
Slow response	Dirty or wet sensor	Remove & clean; re-calibrate
	Cold sensor	Allow sensor to warm up to proper operating temperature
Low reading	Dirty or wet sensor	Remove & clean; re-calibrate
Unable to zero	Circuit malfunction	Return instrument for factory service
Unable to span	Clogged sensor cover slots or dust screens in case	Remove & clean cover and screens or replace screens
	Sensor lost sensitivity	Replace sensor

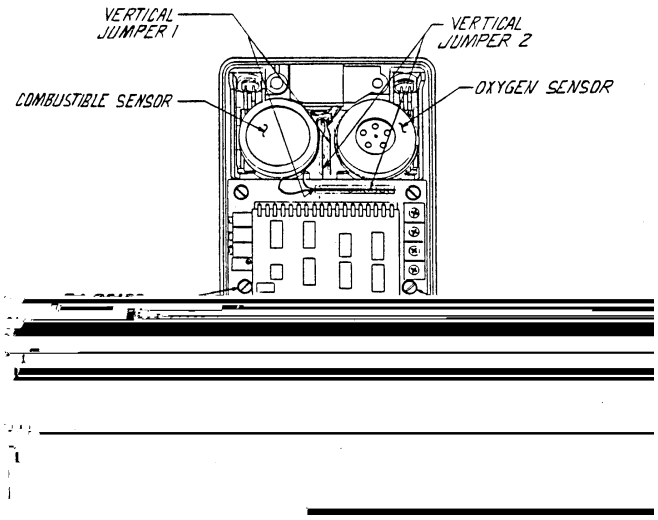

Figure 3-1.
Location of sensors

1. Turn OFF the MicroGard unit and remove the battery pack by loosening the screw until the battery pack can be lifted away.
2. Remove the rear case by loosening the four screws until the rear case can be lifted away.
3. Discard the old O-ring (a new O-ring is shipped with every replacement oxygen sensor). Ensure the new O-ring is securely seated in the grooves on the rear case. Also ensure that the combustible gas sensor's O-ring is in good condition; replace if necessary.
4. Remove sensor by pulling straight up.
5. Gently insert the new sensor by aligning pins with sockets and pressing on the outer edges of the sensor body.
6. Re-assemble the instrument.
7. Calibrate the oxygen sensor in fresh air, per Section 4, "Calibration."

⚠ CAUTION

Do not push on the center of the oxygen sensor. Damage to the sensor may occur by applying pressure to this area.

Spare oxygen sensors should be kept in their sealed bags until they are needed for use. Refrigeration of the sensors provides optimal storage; however, sensors may be stored at room temperature. Sensors should not be allowed to freeze. Storage temperature range is -18°C to 30°C. Storage above 30°C to 50°C is possible; however, sensor life will be reduced.

Combustible Sensor Replacement

Before each days use, check the combustible gas indicating portion of the MicroGard unit for operating accuracy with a known gas mixture (MSA supplies such calibration equipment as accessory items). Adjust as necessary. If proper calibration cannot be obtained and/or the indicator display cannot be zeroed, replace the sensor and calibrate the instrument as follows:

1. Turn OFF the MicroGard unit and remove the battery pack by loosening the screw until the battery pack can be lifted away.
2. Remove the rear case by loosening the four screws until the rear case can be lifted away.
3. Discard the old O-ring (a new O-ring is shipped with each replacement combustible sensor). Ensure the new O-ring is securely seated in the grooves on the rear case. Also ensure that the oxygen sensor's O-ring is in good condition; replace if necessary.
4. Lift the sensor from the instrument by pulling it straight up.
5. Align pins with sockets and insert the new sensor into the sensor well.
6. Re-assemble the instrument.
7. Calibrate the instrument according to Section 4, "Calibration."

Spare combustible sensors should be kept in their sealed bags until they are needed for use. Combustible sensors can be stored at temperatures from -35°C to 55°C.

Ambient temperature provides the optimal condition for storage of combustible sensors.

Printed Circuit Board Adjustments

The control printed circuit board contains the adjustment controls that are not accessible from the control cover (FIGURE 3-2 and TABLE 3-2). Adjustments to the printed circuit board assembly controls are made according to the following procedures:

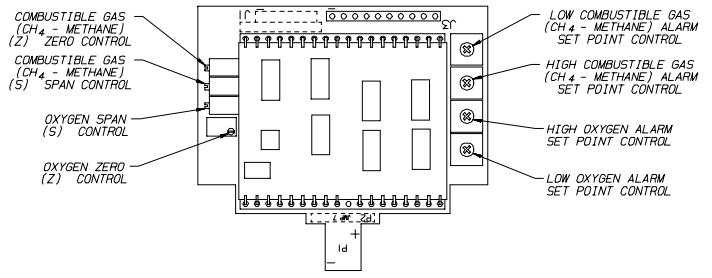

Figure 3-2.
Printed Circuit Board Assembly Controls

Table 3-2. Printed Circuit Board Assembly Controls

ADJUSTMENT CONTROL	FUNCTION
COMB ALARM HIGH	Combustible Alarm High is factory preset at 10% LEL or 0.5% CH_4
COMB ALARM LOW	Combustible zero fault Alarm is factory preset at -10% LEL or -0.5% CH_4 and is used to indicate possible sensor failure
O_2 ALARM HIGH	Oxygen Alarm High set-point control is factory preset at 22% oxygen
O_2 ALARM LOW	Oxygen Alarm Low set-point control is factory preset at 19.5% oxygen

Comb Alarm High

The combustible alarm high set-point is factory preset at 10% LEL (0.5% CH_4). To change this alarm set-point:

1. Use the LEL (CH_4) Z control (and the LEL (CH_4) S control if necessary) to produce a % LEL (% CH_4) readout indication equal to the desired alarm set-point
2. Adjust the HIGH COMBUSTIBLE GAS ALARM control to just activate the alarm.
3. Verify and "fine-tune" the setting:
   a. Turn the LEL (CH_4) Z control to produce a readout indication 1 to 2% LEL (0.1 to 0.2% CH_4) below the alarm setting.
   b. Press the RESET keypad. (alarm should de-activate).
   c. Turn the LEL (CH_4) Z control slowly back to the LEL (CH_4) alarm setting to verify the setting within $\pm$1% LEL ($\pm$0.1% CH_4).
4. Adjust the LEL (CH_4) Z control to zero.

⚠ CAUTION

Recalibration is required if the LEL S (CH4 S) control was adjusted; otherwise, the instrument will not perform as required.

Comb Alarm Low

The combustible zero fault alarm (low alarm) set-point is factory preset at -10% LEL (-0.5% CH_4). It should not be changed from this setting. If this setting is changed, to re-adjust to the factory setting of -10% LEL (-0.5% CH_4):

1. Use the LEL (CH_4) Z control (and the LEL S control if necessary) to produce a % LEL (% CH_4) readout indication of -10% LEL (-0.5% CH_4).
2. Adjust the LOW COMBUSTIBLE GAS ALARM control to just activate the alarm.
3. Verify and "fine-tune" the setting:
   a. Turn the LEL (CH_4) Z control to produce a readout indication 1 to 2% LEL (0.1 to 0.2% CH_4) above the alarm setting.
   b. Press the RESET keypad. (The alarm should deactivate).

c. Turn the LEL (CH_4) Z control slowly back to the LEL (CH_4) alarm setting to verify the setting within $\pm$1% LEL ($\pm$0.1% CH_4).

4. Adjust the LEL (CH_4) Z control to zero.

⚠ CAUTION

Recalibration is required if the LEL (CH_4) S control was adjusted; otherwise, the instrument will not perform as required.

O_2 Alarm High

The oxygen alarm high set-point is factory preset at 22% oxygen. To re-adjust:

1. Turn the OXY S control to obtain the desired upscale display reading.
2. Adjust the HIGH OXYGEN GAS ALARM control until alarm trips.
3. Verify the set-point:
   a. Turn the OXY S control to lower the reading to 1 to 2% below the HIGH OXYGEN GAS ALARM set-point.
   b. Reset the alarm and turn the OXY S control to increase the reading to check the set-point.

O_2 Alarm Low

The oxygen alarm low set-point is factory preset at 19.5% oxygen. To re-adjust:

1. Rotate the OXY S control to obtain the desired downscale display reading.
2. Adjust the LOW OXYGEN GAS ALARM control until alarm trips.
3. Verify the set-point:
   a. Turn the LOW OXYGEN GAS ALARM control to raise the reading to 1 to 2% above the O_2 LOW alarm set-point.
   b. Reset the alarm and turn the LOW OXYGEN GAS ALARM control to increase the reading to check the set-point.

O_2 Zero

The oxygen zero control is factory preset and should not require adjustment. If necessary to re-adjust:

1. Short the oxygen sensor input sockets on the printed circuit board with a short piece of wire.
2. Adjust the O_2 ZERO control for a display reading of 00.0% OXY.
3. Re-connect the oxygen sensor.

Battery Service

To recharge the battery, connect the charging cable from an MSA charger to the charging jack on the bottom of the MicroGard Portable Alarm. See Section 1, "Charging Battery Pack" for detailed charging information. If the instrument has not been used for 30 days, charge batteries before use.

⚠ CAUTION

Recharging must be done in a non-hazardous location. Battery packs must be charged for 14 to 16 hours or full power capacity will not be reached. Additionally, the batteries may not supply full power capacity after repeated partial use between chargings. For this reason, "exercise" the batteries at least once weekly. Run the MicroGard Portable Alarm until the low battery alarm sounds (about 8 to 10 hours), and then recharge.

If after 14 to 16 hours of recharging, the battery pack fails to deliver 8 hours of operation at ambient temperature, allow the instrument to run overnight or until the second stage low battery alarm becomes silent (but no more than 18 hours). Then, recharge the battery pack. This provides a deeper discharge of the battery pack and may erase the memory condition which Nicad batteries experience. This procedure may need to be repeated a few times for the batteries to regain full capacity. If, after four or five cycles of this deep discharge and subsequent recharge, the battery pack is still unable to provide 8 hours of operation, the pack must be replaced.

A decrease in operation temperature decreases the power capacity of Nicad batteries. Battery cell manufacturers state a capacity figure at 0°C of 80% of the capacity available at an ambient temperature of 25°C. Therefore, if

a battery pack in good condition provides 10 hours of operation at 25°C, 8 hours of operation may occur at 0°C. However, if a memory condition in the batteries has developed, which allows only 8 hours of operation at 25°C, the battery pack will not provide 8 hours of operation at 0°C. For this reason, when the instrument is to be operated for 8 hours at temperatures well below room temperature or ambient (25°C), a battery pack should be used which has a recent history of operation in excess of 8 hours at room temperature or ambient (25°C).

Similarly, lower operating temperatures decrease the power capacity of Alkaline batteries. The MicroGard Portable Alarm is designed to operate for at least 8 hours at 0□C with new Duracell MN 1400 Alkaline batteries in good condition. It is important to note that the condition of new Alkaline batteries will vary depending on length and temperature of storage, transportation, etc.

Operation of the instrument below 0°C is possible; however, 8 hours of operation at these temperatures is unlikely.

When the instrument is used with the pump option, recharge the battery pack with the same chargers and procedure as used with the standard MicroGard Portable Alarm battery pack.

Battery Pack Replacement (Diffusion Mode)

If the battery pack does not respond to recharging or does not "hold" a charge, replace the battery pack as follows:

1. Loosen the screw on the back of the instrument that secures the battery pack to the MicroGard unit .
2. Gently pull the battery pack away from the instrument.
3. Install the new battery pack.
4. Charge the new battery pack.

Alkaline Battery Replacement

To replace batteries when using the Alkaline battery pack:

1. Remove the battery pack.
2. Remove the thumb nut on the ON/OFF SWITCH.
3. Lift the battery cover to expose the Alkaline batteries.
4. Note the polarity markings inside the case and properly install only Duracell MN 1400 Alkaline batteries.

5. Always re-install the battery cover and thumb nut before attaching the battery pack to the instrument. Failure to replace the cover and thumb nut may violate intrinsic safety requirements and/or result in intermittent operation.

Battery Pack Replacement (Pump Mode) Pump P/N 478520 and Battery P/N 482225 Only

1. Remove the screw on the back of the pump that secures the instrument.
2. Gently pull the instrument away from pump module.
3. Disconnect the electrical connectors between the battery pack and the motor.
4. Remove the battery pack.
5. Install new battery pack, feeding the electrical connector through the slot in the pump case.
6. Install instrument into pump module.

Alkaline Battery Replacement (Pump Mode) Pump P/N 485693 and Battery P/N 482259 Only

1. Remove battery pack.
2. Loosen the captive screw on the label side of the battery pack.
3. Lift the cover (label side) away from the batteries, and remove batteries.
4. Note the polarity markings inside the case, and properly install fresh Alkaline batteries. MSA recommends Duracell MN 1400 Alkaline batteries to obtain rated operation.
5. Re-install cover, and secure with captive screw. Failure to secure cover to case with screw may violate intrinsic safety requirements and/or result in intermittent operation.

For instructions regarding Pump Module P/N 802830, see instruction manual P/N 804641 which accompanies the pump.

Electronic Component Replacement

(FIGURE 3-3)

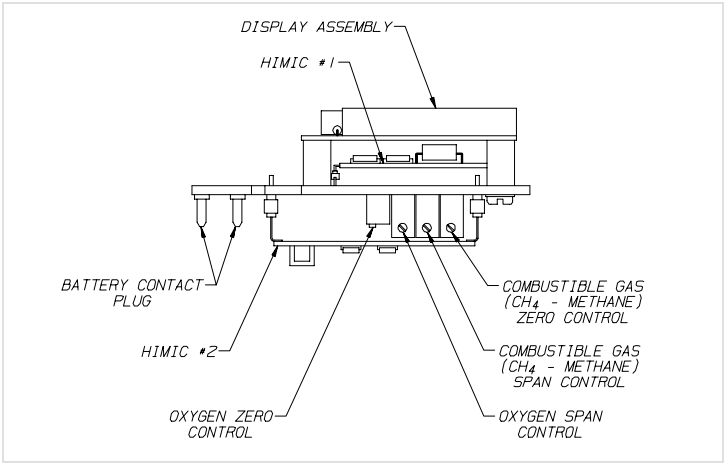

Figure 3-3.
Printed Circuit Board Assembly Controls

Users are discouraged from attempting board-level repair of MicroGard circuit boards. Improper substitution of components and/or repair procedures without proper test equipment may damage the board, impair performance, and void the intrinsic safety approval.

Users may exchange a salvageable circuit board for a rebuilt board for a nominal fee. Only repairs by MSA-authorized repair personnel will maintain both full performance and intrinsic safety approval.

Certain faulty components, such as potentiometers, can be replaced by qualified and trained repair personnel. Personnel performing any necessary removal and replacement of individual electronic components on the printed circuit boards should obtain formal training in repair techniques. Extreme care is required to avoid damaging the circuitry, base laminate or other components through excess heat application, improper usage of tools, inadequate training and rough handling of the circuit board assembly. See Section 5, *Parts List* for a list of replacement parts. If proper capability is unavailable, send the MicroGard Portable Alarm to the nearest MSA Service Center for repair. Call MSA toll free at 1-800-MSA-2222 for the location of the nearest MSA Service Center.

Printed Circuit Board Replacement

1. Turn the ON/OFF push-button OFF, and remove the battery pack.
2. Remove the four screws holding the rear case in place, and remove the rear case from the instrument.
3. Unplug the two vertical jumpers.
4. Remove the two screws securing the board (FIGURE 3-1).
5. Gently lift the printed circuit board assembly from the instrument front panel.
6. Replace the zebra strip as required.
7. Insert the new board assembly.
8. Replace the two screws holding the board assembly.
9. Plug the two jumpers back into the pc board assembly.
10. Calibrate the MicroGard unit according to Section 4, "Calibration."

Molded Rubber Manifold

The same molded rubber manifold is used with the calibration/sampling adapter and the pump. This manifold must be inspected periodically to ensure it is clean and in good condition. If necessary, replace:

Calibration/Sampling Adapter Manifold Replacement

1. Pull manifold away from calibration cap.
2. Pull plastic elbow from manifold.
3. Inspect tubing and replace if needed.
4. Insert plastic elbow into new manifold.
5. Place manifold in calibration cap.
6. Secure manifold by pulling two tabs to set the manifold against the calibration cap.
7. Cut off small parts of tabs.

Pump Module Manifold Replacement

1. Remove instrument from pump module.

2. Remove the four screws holding the pump body cover onto the pump body assembly.
3. Disconnect the electrical connector from the motor to the battery pack. Also disconnect the tubing from the pump at the plastic elbow in the manifold.
4. Pull manifold away from body assembly.
5. Pull elbow from manifold. Along with the tubing, inspect the elbow and replace if needed.
6. Insert plastic elbow into new manifold.
7. Place manifold in pump body. Secure by pulling two tabs, with needle nose pliers, to set the manifold against the pump body.
8. Install tubing, and insert connector from motor back through two slots to mate with connector from battery pack.
9. Install pump body cover with four screws.
10. Check pump operation to be sure no blockage exists in the tubing.

Pump and Motor Drive Assembly Replacement

1. Remove pump body cover. Disconnect electrical connector and tubing at the manifold.
2. Use needle nose pliers to disconnect tubing from flow indicator at pump and from manifold at pump.
3. Remove two screws holding pump and motor drive assembly.
4. Inspect all tubing and replace if needed.
5. Install 5" of tubing on pump outlet.
6. Align pump and motor drive assembly in cover and secure with two screws. Connect the tubing from the flow indicator to the pump inlet.
7. Verify pump operation. Leak test according to Section 1, "Initial Operational Checks."
8. Mate the free end of tubing with the fitting on the manifold. Insert connector from the motor back through two slots to mate with connector from battery pack.
9. Install pump body cover with four screws.

10. Check pump operation to be sure no blockage exists in the tubing.

Ordering Replacement Parts

See Section 5, "Parts List" for common replacement assemblies and components associated with the MicroGard Portable Alarm. If you have any questions regarding the instrument, any procedure in this manual, or the location of the nearest MSA Repair Center and source of replacement parts, please call our toll free number: ***1-800-MSA-2222***.

Section 4
Calibration

Read the entire MicroGard Portable Alarm calibration procedure before making any adjustments. To assure proper MicroGard operation, it must be checked on known concentrations of oxygen and pentane or methane. It is recommended that a calibration check be performed before each day of use. Allow the instrument to complete a warm-up period to stabilize sensors before calibration (typically 15 minutes).

Oxygen Calibration Test Procedure

Before using the MicroGard Portable Alarm:

1. Turn the MicroGard unit ON and allow it to stabilize in fresh air at the temperature of use.
2. Calibrate the instrument in fresh air to 20.8%.

   To calibrate the MicroGard unit:

   a. Press the SELECT keypad until % OXY appears on the display.

   b. Expose the instrument to fresh air until the display reading stabilizes.

   c. Set display reading to 20.8% by adjusting the OXY S control located under the calibration cover (FIGURE 1-4).

   d. Replace the sensor when the OXY S control can no longer be adjusted to yield the 20.8% reading.

   NOTE: If the calibration is done at an ambient temperature outside of the 32° to 104°F (0° to 40°C) range, allow the MicroGard Portable Alarm to stabilize at that temperature for about 1 hour before calibrating.

Oxygen calibration is stable over long periods of time and will not require large calibration control corrections during the life of a sensor. Near the end of its useful life (about 1 year), the calibration control requires more frequent and larger corrections to obtain the 20.8% fresh air reading. If the instrument cannot be adjusted to 20.8% in fresh air, the sensor must be replaced (see Section 3, "Maintenance").

If required, adjust the oxygen alarm circuit by using the procedure given under Section 3, "Maintenance", Printed Circuit Board Adjustments.

The MicroGard unit indicates the partial pressure of oxygen in the atmosphere or calibration gas tested. Therefore, if the instrument is calibrated at one barometric pressure and subsequently used to test atmospheres at another pressure (i.e.: at a different altitude) the change in oxygen partial pressure will be indicated as an equivalent change in volume percent. To use the MicroGard Portable Alarm for oxygen deficiency measurements, it should, therefore, be calibrated to read 20.8% OXY when sampling fresh air at the conditions of intended use. TABLE 4-1 shows the oxygen readings to be expected at various altitudes after calibrating at sea level.

Table 4-1. Volume Percent When Sampling Fresh Air

ALTITUDE (IN FEET)	OXYGEN INDICATION (PERCENTAGE)	ALTITUDE (IN FEET)	OXYGEN INDICATION (PERCENTAGE)
-1000	21.6	5000	17.3
-500	21.2	5500	17.0
sea level	20.8	6000	16.7
500	20.4	6500	16.4
1000	20.1	7000	16.1
1500	19.7	7500	15.7
2000	19.3	8000	15.4
2500	19.0	8500	15.2
3000	18.6	9000	14.9
3500	18.3	9500	14.6
4000	18.0	10000	14.3
4500	17.6		

Combustible Calibration Test Procedure

Check the combustible indicator before each day's use, using a cylinder mixture of pentane in air with an analysis in the range of 0.75% or a mixture of methane in air with an analysis in the range of 2.0%. (MSA supplies calibration equipment as accessory items.)

Diffusion Sample Mode

The calibration sample for a Diffusion Mode instrument can be taken directly from the cylinder only if it is equipped with a 0.25 LPM flow control.

Calibrate as follows:

1. In fresh air, with the instrument "warmed up," press the SELECT keypad until % LEL is displayed.
2. Adjust the LEL Z (CH_4 Z) control (FIGURE 1-4) until a zero reading is obtained.
3. Position sampling/calibration adapter over the sensor openings at the top of the MicroGard unit.

   NOTE: Do NOT have the aspirator bulb and the tubing attached to the adapter (FIGURE 4-1).

4. Attach the flow control to the calibration gas tank.

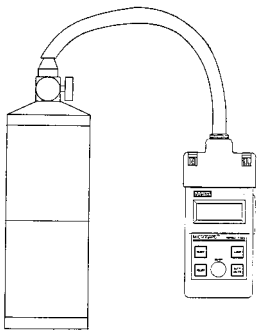

Figure 4-1.
Connection of Calibration Equipment

5. Attach the tubing furnished with the Calibration Kit between the flow control and the sampling calibration adapter connection.
6. Open the flow control valve on the gas tank to pass the gas through the MicroGard unit.
   - As the % LEL reading increases, note the reading at which the combustible alarm activates. This point is factory-set at 10% LEL (0.5% CH_4).
   - When the combustible display stabilizes, the reading for 0.75% pentane-in-air should be between 47% and 55%.
   - If the instrument samples *methane:* When the combustible display stabilizes, the reading for 2.0% methane-in-air should be between 1.8% and 2.2% CH_4.
7. If the calibration check reading is not within 47% and 55%, set the display reading to 50% by adjusting the LEL S control located under the calibration cover (FIGURE 1-4).

   If the instrument samples *methane:* If the calibration check reading is not between 1.8% and 2.2%, set the display reading to 2.0% by adjusting the CH_4 S control, located under the calibration cover (FIGURE 1-4).
8. Close the flow control valve.
9. Remove the sampling/calibration adapter from the MicroGard unit.
10. Recheck the zero reading in fresh air and repeat Steps 1 through 9 if fresh air reading is not equal to zero.
11. Remove the flow control from the calibration gas tank.

Pump Sample Mode

The calibration sample for a Pump Sample Mode instrument can be taken directly from the cylinder only if it is equipped with a 1.5 LPM flow control.

NOTE: This section applies only to pump part nos. 478520 and 485693.

Calibrate as follows:

1. In fresh air, with the instrument "warmed up," press the SELECT keypad until % LEL is displayed.

2. Adjust the LEL Z (CH_4 Z) control (FIGURE 1-4) until a zero reading is obtained.
3. Attach the flow control to the calibration gas tank.
4. Attach the tubing furnished with the Calibration Kit between the flow control and the pump inlet.
5. Open the flow control valve on the gas tank to pass the gas through the MicroGard unit.
   - As the % LEL reading increases, note the reading at which the combustible alarm activates. This point is factory-set at 10% LEL (0.5% CH_4).
   - When the combustible display stabilizes, the reading for 0.75% pentane-in-air should be between 47% and 55%.
   - If the instrument samples *methane:* When the combustible display stabilizes, the reading for 2.0% methane-in-air should be between 1.8% and 2.2% CH_4.
6. If the calibration check reading is not within 47% and 55%, set the display reading to 50% by adjusting the LEL S control located under the calibration cover (FIGURE 1-4).

   If the instrument samples *methane:* If the calibration check reading is not between 1.8% and 2.2%, set the display reading to 2.0% by adjusting the CH_4 S control, located under the calibration cover (FIGURE 1-4).
7. Close the flow control valve.
8. Remove the tubing from the MicroGard pump inlet.
9. Recheck the zero reading in fresh air, and repeat Steps 1 through 8 if the fresh air reading is not equal to zero.
10. Remove the flow control from the calibration gas tank.

Calibration and Response Test Procedure with Combination Gas

(For use with LEL instrument only)

Use a cylinder mixture of pentane in air with an analysis in the range of 0.75% pentane and 15% oxygen. This sample can be used to test the calibration of the

combustible gas function of the MicroGard Portable Alarm. Due to the wide tolerance of the oxygen sample, this sample can be used to test only the *response* of the oxygen function of the MicroGard Portable Alarm.

Test as follows:

1. Turn the MicroGard unit ON and allow it to stabilize in fresh air at the temperature of use.
2. Calibrate the instrument in fresh air to 20.8%.

   NOTE: Replace the sensor when the OXY S control can no longer be adjusted to yield the 20.8% reading.

3. Press the SELECT keypad until % LEL is displayed.
4. Adjust the LEL Z (CH_4 Z) control (FIGURE 1-4) until a zero reading is obtained.
5. Sampling:

   a. The sample for a Diffusion Sample Mode instrument can be taken directly from the cylinder only if it is equipped with a 0.25 LPM flow control. Position sampling/calibration adapter over the sensor openings at the top of the MicroGard unit.

   NOTE: Do NOT have aspirator bulb and tubing attached to the adapter (FIGURE 4-1).

   b. The sample for a Pump Mode instrument can be taken directly from the cylinder only if it is equipped with a 1.5 LPM flow control. No sampling/calibration adapter is required for calibration of a Pump Sample Mode instrument.

6. Attach the flow control to the calibration gas tank.
7. Attach the tubing, furnished with the Calibration Kit, between the flow control and the sampling/calibration adapter connection or pump inlet, if applicable.
8. Open the flow control valve on the gas tank to pass the gas through the MicroGard unit.
   - As the % LEL reading increases, note the reading at which the combustible alarm activates. This point is factory-set at 10% LEL.

- When the combustible display stabilizes, the reading for 0.75% pentane-in-air should be between 47% and 55%.

9. If the calibration check reading is not within 47% and 55%, set the display reading to 50% by adjusting the LEL S control located under the calibration cover (FIGURE 1-4).
10. Close the flow control valve.
11. Remove the sampling/calibration adapter from the MicroGard unit or the tubing on the pump inlet.
12. Allow the display to stabilize, and reset the alarms.
13. Press the SELECT keypad until % OXY is displayed.
14. Re-position the sampling/calibration adapter on the MicroGard unit or attach tubing to the pump inlet.
15. Open the flow control valve.
    - As the % OXY reading decreases, note the reading at which the oxygen alarm activates; this point is factory-set at 19.5%.
    - The reading for % oxygen should be between 14.0% and 16.0% oxygen.
16. If the calibration check reading is not within 14.0% and 16.0%, refer to Section 3, "Troubleshooting Guidelines."

    NOTE: Do not calibrate to 15% oxygen due to tolerances in the oxygen calibration gas sample.
17. Close the flow control valve.
18. Remove the sampling/calibration adapter from the MicroGard unit or the tubing from the pump inlet.
19. Recheck the zero readings in fresh air, and repeat steps 3 through 13 above if fresh air readings are not equal to 0% LEL (0.0% CH_4) and 20.6 to 21.0% oxygen.

If the response of the MicroGard Portable Alarm is not within the limits stated, re-calibrate the instrument. If, after calibration, the instrument fails to respond as outlined above, contact the nearest MSA Repair Center to return the instrument for factory service. If you have any questions, call our toll-free number **1-800-MSA-2222.**

⚠ DANGER

Calibration gas tank contents are under pressure. Use no oil, grease or flammable solvents on the calibration gas tank. To prevent injury from potential rupture, do not store calibration gas tank near heat or fire; keep out of reach of children. When the tank is exhausted, discard in a safe place such as burial in the earth or in a sanitary landfill. Do not throw into fire or incinerate. Do not puncture. It is illegal and hazardous to refill the gas tank. Do not attach the calibration gas tank to any apparatus other than that described in these instructions.

Section 5
Parts List

COMPONENT/ASSEMBLY	PART NO.
KEY: 1 = Use only with Part Nos. 478500, 485360, 486913 & 487137 2 = Use only with Part Nos. 482260, 485361, 487470 & 487471 3 = Use only with Part Nos. 492501, 492502, 492504 & 492505 4 = Use only with Part Nos. 482250, 485359, 487135 & 487138	
[1 & 4]Oxygen Sensor	480566
[1 & 4]Oxygen Sensor O-Ring	633092
[1 & 4]Oxygen Span Control	633083
[1 & 4]Oxygen Zero Control	633080
[1 & 4]PC Board Assembly Dual Sensor	485236
[1 & 4]Dual Sensor Cover	478535
[2 & 3]PC Board Assembly Combustible Sensor	485239
[2 & 3]Single Sensor Cover	482247
[2 & 3]Dust Plug	482249
[1]Printed Circuit Board Assembly	485658
[1]Printed Circuit Board Assembly (Less Display Module & Hybrid Circuits)	478505
[2]Printed Circuit Board Assembly	485681
[2]Printed Circuit Board Assembly (Less Display Module & Hybrid Circuits)	482266
[3]Printed Circuit Board Assembly	491902
[3]Printed Circuit Board Assembly (Less Display Module & Hybrid Circuits)	491903
[4]Printed Circuit Board Assembly	485200
[4]Printed Circuit Board Assembly (Less Display Module & Hybrid Circuits)	485709
Plug-In Display Module	485657
Hybrid Circuit (HIMIC #1)	482261
Hybrid Circuit (HIMIC #2)	482262
Combustible Sensor	478537
Combustible Sensor O-Ring	633092
Combustible Span Control	633081
Combustible Zero Control	633082
Alarm Set Point Control	633084

COMPONENT/ASSEMBLY	PART NO.
Rechargeable Battery Pack	478510
Alkaline Battery Pack	482245
Alkaline "C" Cell Battery	633546
Push Button Boot	473840
Calibration Control Cover	473835
Calibration Control Gasket	473837
Alarm Buzzer	629250
Buzzer Gasket	478536
Wrist Strap	474407
Earphone	633722
Pocket Clip	482248
Alarm LED	633719
Earphone Jack	633071
Jumper	482246
Zebra Strip	478514
Dust Screen	478534
Earphone Dust Plug	633748
Instruction Manual	478538
Mounting Hardware	
Screw, Case Assembly	63619
Screw, Calibration Control Cover	633090
Screw, Printed Circuit Board Mounting	633091
Screw, Display Board Mounting	66424
Screw, Pocket Clip	627601
Screw, Pump Mounting	634188
Screw, Pump Body Cover Mounting	59704
Screw, Pump and Motor Drive Mounting	629318

COMPONENT/ASSEMBLY	PART NO.
ACCESSORY PARTS	
Single-Unit Charger	633548
12 Volt Adapter Charger	478490
5-Unit Charger	478540
Gas Calibration Kit with 0.25 LPM Flow Control	477149
▪ Flow Control (0.25 LPM)	467895
▪ Adapter Hose (Diffusion)	485030
▪ Calibration Gases:	
▪ Pentane (0.75%:50% LEL) and Oxygen (15%)	478192
▪ Methane (2.5%)	491041
Sampling and Calibration Adapter	478530
Aspirator Sampling Adapter	485800

High Efficiency/Low Flow Rate Pump Accessory Parts List

NOTE: The following components and assemblies are NOT compatible or interchangeable with those listed in the previous Parts List Table.

COMPONENT/ASSEMBLY	PART NO.
High Efficiency/Low Flow Rate Pump	802830
Sample Line, 5 Foot	497332
Sample Line, 10 Foot	497333
Sample Line, 15 Foot	497334
Sample Line, 25 Foot	497335
Soft Carrying Case	805283
Probe, 1 Foot Teflon	497600
Probe, 1 Foot	800332
Probe, 3 Foot	800333
Probe, 3 Foot, Side Sampling	803561
Probe, 3 Foot, Handle Sampling	803962
Probe Filter (package of 3)	636244
Calibration Kit, Model RP with 0.25 Lpm Regulator	477149
Battery Pack, Rechargeable	478510
Battery Pack, Alkaline	482245
Battery, "C" Cell Alkaline	633546

Section 6
Microgard
(Calibrated On Pentane)
Conversion Factors

The standard MicroGard Portable Alarm is calibrated on pentane, and the meter indicates the % LEL of pentane mixtures in air. When using the MicroGard unit to measure the % LEL of other chemicals, the meter indication can be converted to the % LEL for the chemical by using the conversion factors (see the following TABLE).

1. Note the % LEL indication on the MicroGard display.
2. Multiply the indication by the conversion factor for the chemical.
3. The result is the approximate % LEL for the chemical in the test atmosphere.

These conversion factors are typical of a MicroGard unit calibrated on pentane. The response of a particular MicroGard unit may be higher or lower than the stated response. For this reason, an accuracy tolerance of ±25% should be applied in the interpretation of any meter response.

CHEMICAL	CONVERSION FACTOR
Acetone	1.1
Acetylene	0.7
Acrylonitrile	0.8
Ammonia*	2.75
Benzene	1.1
Butadiene, 1, 3	0.9
Butane, n	1.0
Butanol, n	1.8
Carbon Disulfide	2.2
Cyclohexane	1.1
2, 2 Dimethylbutane	1.2
2, 3 Dimethylbutane	1.2
Ethane	0.7
Ethyl Acetate	1.2
Ethyl Alcohol	0.8
Ethylene	0.7
Formaldehyde	0.5
Gasoline (unleaded)	1.3
Heptane	1.1
Hexane	1.3
Hydrogen	0.5
Isobutane	0.9

CHEMICAL	CONVERSION FACTOR
Isobutyl Acetate	1.5
Isopropanol	1.1
Isopropyl Alcohol	1.1
Methane	0.5
Methanol	0.6
Methylcyclohexane	1.1
Methyl Ethyl Ketone	1.1
Methyl Isobutyl Ketone	1.2
Methyl Tertiary Butyl Ether	1.2
Mineral Spirits	1.1
Naphtha, VM&P	1.6
Octane, iso	1.1
Pentane, n	1.0
Propane	0.8
Propylene	0.8
Styrene	1.9
Tetrahydrofuran	0.9
Toluene	1.1
Vinyl Acetate	0.9
Xylene, o	1.2
*Ammonia only reads in the range of 0-50% LEL.	