MSA

FiveStar® Alarm

Technical Manual

⚠ WARNING

THIS MANUAL MUST BE CAREFULLY READ BY ALL INDIVIDUALS WHO HAVE OR WILL HAVE THE RESPONSIBILITY FOR SERVICING THE PRODUCT. Like any piece of complex equipment, this instrument 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.

⚠ CAUTION

For safety reasons, this equipment must be operated by qualified personnel only. Read and understand the instruction manual completely before operating.

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 or 1-800-MSA-7777.

This manual pertains to:

   North American approved instruments with Serial Number prefix "F" and "G"
   Australian approved instruments with Serial Number prefix "A"
   EN approved instruments with Serial Number prefix "A".

Manufactured by

MSA INSTRUMENT DIVISION
P.O. Box 427, Pittsburgh, Pennsylvania 15230

(L) Rev 9   **710440**

MSA Portable Instrument Warranty

1. **Warranty-**

ITEM	WARRANTY PERIOD
Chassis and electronics	Lifetime (MSA will support product for five years after production ends)
All sensors, unless otherwise specified	Two years
Pump and drive unit	Two years
Rechargeable batteries	Two years

This warranty does not cover filters, fuses, etc. Certain other accessories not specifically listed here may have different warranty periods. This warranty is valid only if the product is maintained and used in accordance with Seller's instructions and/or recommendations. The Seller shall be released from all obligations under this warranty in the event repairs or modifications are made by persons other than its own or authorized service personnel or if the warranty claim results from physical abuse or misuse of the product. No agent, employee or representative of the Seller has any authority to bind the Seller to any affirmation, representation or warranty concerning this product. Seller makes no warranty concerning components or accessories not manufactured by the Seller, but will pass on to the Purchaser all warranties of manufacturers of such components. **THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, AND IS STRICTLY LIMITED TO THE TERMS HEREOF. SELLER SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.**

2. **Exclusive Remedy-** It is expressly agreed that Purchaser's sole and exclusive remedy for breach of the above warranty, for any tortious conduct of Seller, or for any other cause of action, shall be the repair and/or replacement at Seller's option, of any equipment or parts thereof, which after examination by Seller is proven to be defective. Replacement equipment and/or parts will be provided at no cost to Purchaser, F.O.B. Seller's Plant. Failure of Seller to successfully repair any nonconforming product shall not cause the remedy established hereby to fail of its essential purpose.

3. **Exclusion of Consequential Damages-** Purchaser specifically understands and agrees that under no circumstances will seller be liable to purchaser for economic, special, incidental or consequential damages or losses of any kind whatsoever, including but not limited to, loss of anticipated profits and any other loss caused by reason of nonoperation of the goods. This exclusion is applicable to claims for breach of warranty, tortious conduct or any other cause of action against seller.

Table of Contents

Chapter 1
Set-up and Configuration

The user must be familiar with the procedures in the FiveStar Alarm Instruction Manual, including all cautions and warnings. The FiveStar Alarm can be configured in many ways to meet your changing gas detection needs. There are four means for making instrument configuration changes (the first two are described in the instruction manual, the third is described in this chapter, and the fourth is accessible only with FiveStar LINK):

1. At instrument turn-ON,
    the following setup option is available:

    - Fresh Air Setup (if enabled).

2. When attaching the battery to the instrument,
    the following setup options are available:

    - Language for displays (if enabled)

    - Operating Beep

    - Peak / STEL / TWA displays (all/none)

    - Set time and date

    - Sensor configuration.

3. During Sensor setup or sensor autoconfiguration,
    the following setup options are available:

    - LEL versus CH_4 combustible display

    - Gas sensors installed

    - Reset alarm settings to factory defaults.

4. FiveStar Link is a separately-supplied software package for communicating to the FiveStar instrument with a personal computer. To operate, FiveStar Link requires a set of software and an Infrared adapter. These components may be purchased together (as P/N 710988) or separately.

    With FiveStar Link software, the following options can be reset:

- Eight-character instrument "name" shown on instrument startup (default is "PASSPORT")

- Change alarm setpoints

- Set backlight time-out (1 minute to 20 minutes)

- Operating beep

- Individually turn ON/OFF Peak, STEL and/or TWA pages

- Disable Fresh Air Setup (available only in instruments with software V1.2 or higher)

- Set Time and Date (available only in instruments with software V1.2 or higher)

- Disable Autoconfigure (available only in instruments with software V1.2 or higher)

- Enable or disable Data Tagging (software V2.0 or higher)

- Enable or disable the "display alarms" on start-up option (software V2.01 or higher)

- Enable or disable the multilingual function (English/Spanish/Canadian French software V2.01 or higher)

- Disable Autocalibration capability (software V3.0 or higher)

- Change Periodic Datalog intervals (software V3.0 or higher).

Sensor Autoconfiguration and Replacement

When a sensor is replaced, when a new type of sensor is installed or when a sensor is removed, the FiveStar Alarm steps the user through an "autoconfiguration" program. All instruments leave the factory with the autoconfigure feature enabled. The FiveStar Link program may be used to disable this feature if the user desires.

The autoconfiguration feature allows the user to change the instrument sensor configuration as the user's gas sensing needs change. The unit steps through the autoconfiguration sequence (listed later in this chapter) when the instrument recognizes that:

- a new serial number sensor is installed (a replacement)
- a sensor is removed
- a new type of gas sensor is added.

⚠ CAUTION

When removing or installing the combustible gas sensor, remove the battery pack. Otherwise, the sensor pins may short to the case and cause an "ERROR 5" message (damage to the combustible sensor circuit).

Replacing a Sensor

To replace a sensor in your FiveStar Alarm:

1. Verify that instrument is OFF; remove the battery pack.
2. Remove sensor cover screws and cover.
3. Gently lift out and properly dispose of sensor to be replaced.
4. Inspect the condition of electrical contact "Zebra Strip" located below the sensor.

    - The "Zebra Strip" is a small, black conductive elastomer which makes contact to the sensor memory chip on the bottom of the sensors (see Chapter 4, FIGURE 4-1).

    - If this is not in place or is not making good contact, the instrument will not properly recognize the installed sensors.

5. If the Zebra Strip is damaged or missing, replace it with a new Zebra Strip (P/N 655188) before installing new sensor.

6. If replacement sensor is equipped with a shorting plate, clip or wire attached to its pins, remove plate, clip or wire before inserting the replacement sensor.

7. Carefully align the new sensor contact pins with the sockets on the Sensor Board.
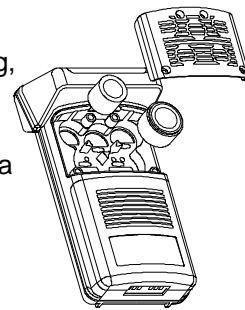
Figure 1-1.
Sensor Replacement

8. Press the new sensor into place.

9. Replace the sensor gasket and sensor cover.

10. Re-install screws to hold down the sensor cover.

⚠ CAUTION

Do not operate the instrument without the sensor cover fully installed. The zebra strips require pressure to enable proper contact. Without proper contact, data may be written improperly to the sensor memory and the data may become corrupted, rendering the sensor unusable.

> **NOTE:** NO, Cl_2, ClO_2, and NH_3 sensors are "biased" sensors. As such, they require approximately 12 hours once installed (with battery pack attached, but turned OFF) for the output to stabilize. Allow the unit to stabilize before calibrating and using in the field.

11. Replace cover before turning instrument back ON to verify configuration.

   • The sensor cover holds the sensors down firmly against the Zebra Strips to ensure proper electrical contact.

12. Turn the instrument ON and proceed through sensor setup.

   • The instrument proceeds to a sensor update mode similar to that for adding or deleting a sensor. See "Sensor Autoconfiguration" later in this chapter for instructions.

   • If instrument autoconfiguration is disabled, the instrument shows an error message. See "Manual Sensor Configuration" later in this chapter for instructions on manual configuration.

⚠ WARNING

Verification of calibration response is required; otherwise the instrument will not perform as required and persons who rely on this product for their safety could sustain serious personal injury or death.

Installing a New Type of Sensor

1. Verify that unit is OFF.

2. Remove battery.

3. Remove sensor cover screws and sensor cover (FIGURE 1-2).

4. Verify that the electrical contact Zebra Strip below sensor is not missing or damaged.

    • The Zebra Strip is a small, black conductive elastomer which makes contact to the sensor memory chip on the bottom of the sensors (FIGURE 4-1).

    • If Zebra Strip is not in place or making good contact, the unit will not properly recognize the installed sensors.

    • If the Zebra Strip is damaged or missing, replace it with a new Zebra Strip (P/N 655188) before installing the sensor.
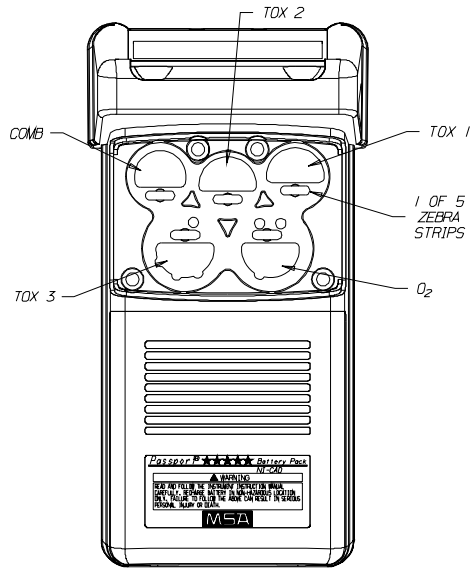
Figure 1-2. Sensor and Zebra Strip Locations in Sensor Cavity

5. Install new sensor in appropriate location noted in TABLE 1-1.

Table 1-1. Allowable Sensor Installation Locations		
SENSOR TYPE	**BIASED**	**ALLOWABLE POSITIONS**
Combustible	NO	Comb. ONLY
Oxygen	NO	O_2 ONLY
Carbon Monoxide	NO	Tox 1, 2, 3
Hydrogen Sulfide	NO	Tox 1, 2, 3
Nitric Oxide	YES - SEE NOTE	Tox 3 ONLY
Nitrogen Dioxide	NO	Tox 1, 2, 3
Sulfur Dioxide	NO	Tox 1, 2, 3
Phosphine	NO	Tox 1, 2, 3
Ammonia	YES - SEE NOTE	Tox 3 ONLY
Chlorine	YES - SEE NOTE	Tox 3 ONLY
Chlorine Dioxide	YES - SEE NOTE	Tox 3 ONLY

NOTE: Biased sensors must be factory installed in units with Serial No. Prefixes of "F" or lower. For units with
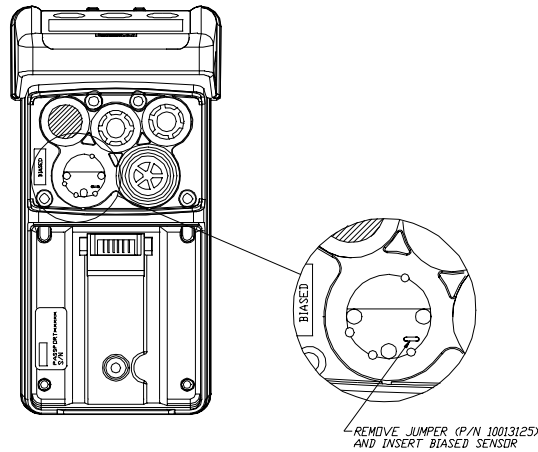
Figure 1-3.
Removing the Jumper

Serial No. Prefixes of "G" or higher, be sure to remove the jumper pin from the Tox 3 position (See FIGURE 1-3) before installing sensor.

⚠ WARNING

Be sure to remove the sensor cover label covering the new location if there was no sensor in that position before. Failure to remove this label prevents the sensor from detecting gases which may result in serious personal injury or death.

6. Carefully align the contact pins of the new sensor with the Sensor Board sockets; press the new sensor into place.

7. Replace the sensor gasket and sensor cover.

8. Re-install screws to hold down sensor cover.

⚠ CAUTION

Do not operate instrument without the sensor cover fully installed. The zebra strips require pressure to enable proper contact. Without proper contact, data may be improperly written to the sensor memory and data may become corrupted, rendering the sensor unusable.

- The sensor cover holds the sensors down firmly against the Zebra Strips to ensure proper electrical contact.

9. Install battery pack. Instrument will turn ON. Proceed through sensor setup.

   NOTE: NO, Cl_2, and NH_3 sensors are "biased" sensors. As such, they require approximately 12 hours once installed (with battery pack attached, but turned OFF) for the output to stabilize. Allow the unit to stabilize before calibrating and using in the field.

   - When turned ON, the instrument now proceeds to a sensor update mode similar to that for adding or deleting a sensor. See "Sensor Autoconfiguration" later in this Chapter for instructions.

   - If the instrument autoconfiguration is disabled, the instrument shows an error message. Refer to "Manual Sensor Configuration" later in this chapter for instructions on how to enter the configuration manually.

Removing a Sensor

To remove a sensor from the instrument:

1. Verify that the instrument is turned OFF.
2. Remove battery pack.
3. Remove the sensor cover screws and sensor cover.
4. Gently lift out the sensor that is no longer required.
5. Place the "Missing Sensor" label (P/N 710478) on the underside of the sensor cover for the position where the sensor was removed.

⚠ CAUTION

Failure to install the "Missing Sensor" label exposes the sensor cavity to dirt and water, may lead to instrument damage and can also increase instrument response and clear times when operated in pumped mode.

6. Replace sensor gasket and sensor cover.
7. Re-install the screws to hold down the sensor cover.

   - The cover should be in place before turning the instrument back ON to verify configuration.

   - The sensor cover holds the sensors down firmly against the Zebra Strips to ensure proper electrical contact.

8. Install battery pack.

9. Turn the instrument ON and proceed through sensor setup.

- If the instrument autoconfiguration is disabled, the instrument shows an error message. Refer to "Manual Sensor Configuration" later in this chapter for instructions on how to enter the configuration manually.

Sensor Autoconfiguration

If the Sensor autoconfiguration is enabled, the following occurs after replacing a sensor, installing a new type of sensor or removing a sensor; the instrument:

- automatically enters configuration mode when turned ON
- proceeds through the following sequence to verify and store the new configuration into instrument memory:

Turn the instrument ON by pressing the **ON/OFF** button:

- Instrument display flashes the "welcome" screen; FIGURE 1-4 appears on the display.
- Screen changes to FIGURE 1-5.
- Pressing the skip **PAGE** (SKIP) button exits the autoconfiguration sequence.
- Instrument displays an error message; an alarm sounds.
- Instrument must be turned OFF to silence the alarm.
- Pressing the **RESET** (YES) button causes instrument to re-read sensor memories.
- FIGURE 1-6 screen appears.
- Instrument now allows user to select format for the combustible display.

Figure 1-4.
New Sensor Setup

Figure 1-5.
Sensor Update? Yes/No
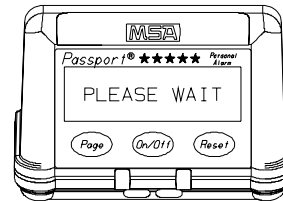
Figure 1-6.
Please Wait
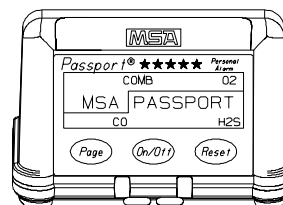
Figure 1-7.
Units Measured

- Pressing **PAGE** (LEL) button causes the combustible readings to display as 0-100% LEL.
- Pressing the **RESET** (YES) button causes the instrument to display combustible readings as direct 0-5% Methane.
- Instrument stores this data and reads the remainder of the sensor memory chips "Please Wait" displays.
- Screen then flashes the units of gases measured (FIGURE 1-7).
- Display flashes the sensors that the instrument recognizes (FIGURE 1-8).
- Instrument displays alarm setpoints for the installed sensors.
- The screen automatically scrolls from gas to gas in five-second intervals (FIGURES 1-8 through 1-10).
- To hold an alarm setpoint reading for more than five seconds, press and hold the **RESET** button.
- To continue, release **RESET** button.
- To skip through alarm displays faster, press the **PAGE** button.
- The instrument then asks user to verify that alarm setpoints are acceptable (FIGURE 1-12).
- Pressing the **PAGE** (RESET) button causes the instrument to restore the default alarm values stored in the sensor memories.
  - After resetting the alarm setpoints, the instrument again scrolls through the alarms pages.
  - Once the alarm setpoints are reset, the "Accept Alarms" screen no longer reappears.
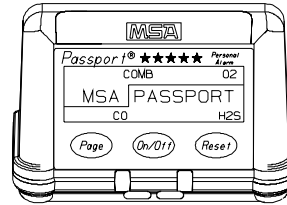
*Figure 1-8.
Gases Measured*
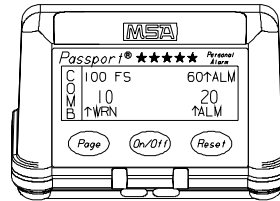
*Figure 1-9. Sample
Combustible Alarm
Setpoints*
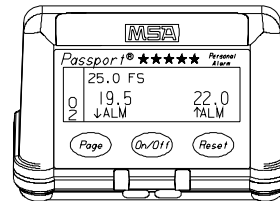
*Figure 1-10. Sample
O_2 Alarm Setpoints*
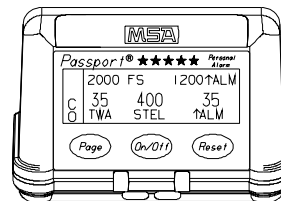
*Figure 1-11.
Sample Toxic Alarm
Setpoints*
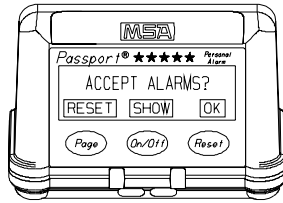
Figure 1-12. Accept Alarms
Reset/Show/OK

Table 1-2. Default Factory Alarm Setpoints				
SENSOR TYPE	**EXPOSURE WARN**	**LOW ALARM**	**HIGH ALARM**	
COMBUSTIBLE	LEL - N/A 0.5% CH$_4$	10% LEL or 1.0% CH4	60% LEL or 3.0 CH4	
	DEFICIENCY	**ENRICHMENT**		
OXYGEN	19.5	22.0		
	LOW ALARM	**HIGH ALARM**	**STEL**	**TWA**
CARBON MONOXIDE	35	1200	400	35
HYDROGEN SULFIDE	10	100	15	10
NITRIC OXIDE	25	100	25	25
NITROGEN DIOXIDE	5	20	5	2
SULFUR DIOXIDE	5	90	5	2
PHOSPHINE	-	0.3	1	0.3
AMMONIA	-	25	35	25
CHLORINE	-	2.0	1.0	0.5
CHLORINE DIOXIDE	-	0.5	0.3	0.1

- Pressing the **ON/OFF** (SHOW) button allows the user to scroll through the "Show Alarm Setpoints" screens again.

- Pressing the **RESET** (OK) button accepts the alarm setpoints.

- The instrument now returns to the "Sensor Update?" Query screen.

- Pressing **RESET** (YES) returns the instrument to the autoconfiguration sequence above.

  - During autoconfiguration, if the instrument did not recognize a sensor installed in the unit, recheck the sensor Zebra Strip condition. Also ensure that the sensor cover is screwed down tight to obtain a solid contact between the sensor memory board and the sensor board.

Figure 1-13. Check Sensor Cover/
Label Empty Slots / Quit - OK

- Pressing **PAGE** (SKIP) exits the autoconfigure sequence.
- The instrument displays the FIGURE 1-13 screen to remind the user to:
    - check the sensor cover to ensure that "missing sensor" labels (P/N 710478) cover slots where sensors are not installed
    - verify there are no "sensor missing" labels over any position where a sensor is installed.

⚠ CAUTION

Failure to install the "Missing Sensor" label exposes the sensor cavity to dirt and water and may lead to instrument damage. This can also increase instrument response and clear times when operated in pumped modes.

- Pressing the **PAGE** (QUIT) button powers down the instrument.
- Pressing the **RESET** (OK) button sends the unit into the calibration mode.
- See Chapter 2 for "Calibration Procedure."

NOTE: Once the instrument has performed the autoconfiguration procedure, any newly installed sensor must be calibrated prior to use.

NOTE: For instruments with software versions lower than 1.2, all calibration data will be reset to the default values in the sensor memories; the entire instrument must be recalibrated.

It is recommended that all sensor calibrations be checked after autoconfiguration is run and prior to instrument use.

Manual Sensor Configuration

For instruments with the autoconfiguration feature disabled, the sensor setup sequence can be entered manually. A variation of this sequence must also be used for instruments with software versions lower than 1.2.

To Enter the Sensor Setup Mode Manually

1. Make sure the instrument is turned OFF.
2. Remove the battery pack.
3. Press and hold the **RESET** button.
4. Re-install the battery pack while holding the **RESET** button.
   - The instrument enters the Sensor Setup mode.

To enter the setup mode with instruments containing software versions lower than 1.2:

1. Make sure the instrument is turned OFF.
2. Remove the battery pack.
3. Press and hold the **RESET** button.
4. Re-install the battery pack while holding the **RESET** button.
   - The instrument screen turns black.
5. Immediately press and hold the **PAGE** button until the setup query page appears.
   - The instrument enters the Sensor Setup mode.

Chapter 2
Calibration

Optional Fresh Air Setup

The FiveStar Alarm can be set to allow the user to automatically zero the measurement systems and calibrate the oxygen system when the unit is turned ON.

Activating the Fresh Air Setup Option

Configuration of the Fresh Air Setup is done by way of the MSA LINK program. See instructions in the MSA LINK program software for this information.

When this feature is activated and the instrument is turned ON, the FiveStar Alarm completes its self-tests and asks if a Fresh Air Setup is desired (FIGURE 2-1).
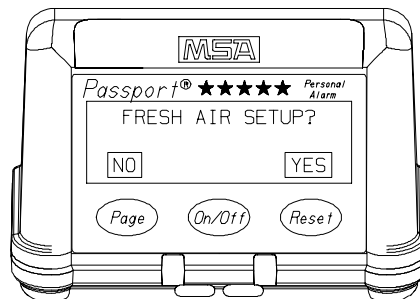
Figure 2-1.
Fresh Air Setup?

To Cancel Fresh Air Setup

- If the **PAGE** (NO) button is pressed or if no button is pressed within five seconds, the instrument does not perform a Fresh Air Setup. Instead, it goes on to operate in the normal measure mode and displays the Exposure page.

To Perform Fresh Air Setup

Press the **RESET** (YES) button within five seconds.

- The FiveStar Alarm begins to perform a Fresh Air Setup.
- Oxygen is set at 20.8 percent.
- All other gases are set at zero.

NOTE: If the Fresh Air Setup feature is activated and an error message is displayed, press the **RESET** button to exit the Fresh Air Setup and enter the Measure mode. This may occur if the original readings were outside of the limits for the Fresh Air Setup feature. This is to protect the user from zeroing out potentially hazardous gases.

Persons responsible for the use of the FiveStar Alarm must determine whether or not the Fresh Air Setup option should be used. The user's abilities, training, and normal work practices must be considered when making this decision.

Calibration Adjustment

FiveStar Alarm calibration can be adjusted easily by using gases of known mixtures and concentrations.

Preparing to Calibrate

Before starting, be certain that the instrument is in normal fresh air, free of combustible or toxic gases. If the ambient air has contaminants, use bottled zero air (20.8% oxygen in nitrogen) when applying fresh air. To prepare to calibrate:

1. Turn OFF the FiveStar Alarm.

2. Allow the instrument to stabilize for several minutes in fresh air at the temperature and air pressure of intended use.

⚠ WARNING

The FiveStar Alarm does not provide any protection while the calibration is being adjusted. Do not rely on the instrument for protection at this time; otherwise, serious personal injury or death could result.

Calibration Procedures

1. Press the **ON/OFF** button; immediately and simultaneously press and hold the **PAGE** and the **RESET** buttons.
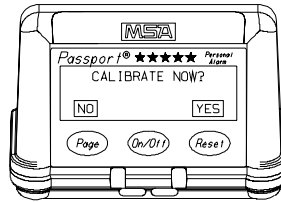
Figure 2-2.
Calibration - No/Yes?

- An alternative method is to push and hold the **PAGE** and the **RESET** buttons; then, press the ON/OFF button.
- The instrument turns ON (FIGURE 2-2):

To Cancel Calibration:

Press the **PAGE** (NO) button or wait five seconds.

- The FiveStar Alarm begins warming up and enters the Exposure display page.

To Continue Calibration:

2. Press the **RESET** (YES) button.

- Display prompts you for Fresh Air (FIGURE 2-3).

Apply fresh air if this was not done in step 1.
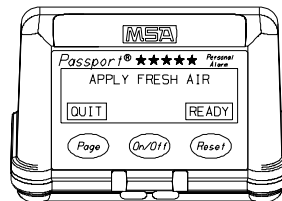
Figure 2-3.
Apply Fresh Air

To Cancel:

Press the **PAGE** (QUIT) button.

- Instrument beeps and automatically shuts OFF.

To Proceed:

4. Press the **RESET** (READY) button.

5. Wait approximately 15 seconds for the FiveStar Alarm to complete the fresh air adjustments.

   • During this time, the FIGURE 2-4 display appears.
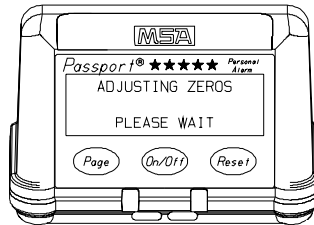
Figure 2-4.
Adjusting Zeroes

After the fresh air adjustments are made, the FiveStar Alarm is ready to complete span calibration.
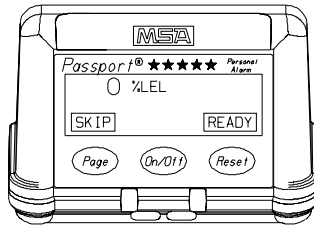
Figure 2-5.
Combustible Gas Calibration Display

   • The display appears (FIGURE 2-5):

The user can calibrate the gas sensors in the following order:

   • Combustible Gas
   • Oxygen
   • Toxic Gas #1
   • Toxic Gas #2
   • Toxic Gas #3

Press the **PAGE** (SKIP) button to skip calibration for any gases you do *not* want to change.

6. There are three means to supply gas to the FiveStar instrument for calibration:

   • Metal Calibration Cap (P/N 710572): To attach the Metal Calibration Cap:

      a. Align the screw heads in the Cap with the holes for the sensor cover screws (FIGURE 2-6).

      b. Holding the Calibration Cap in place, wrap the strap around the unit and through the strap slot; pull the strap snug.

   • Plastic Calibration Cap (P/N 710824): To attach the Plastic Calibration Cap:

      a. To properly secure the Cap, it is necessary for the sensor cover to have the snap-on features on the two sides.

      b. Position the Calibration Cap label "Front" indicator towards the instrument display and snap the Cap on the sensor cover (FIGURE 2-7).
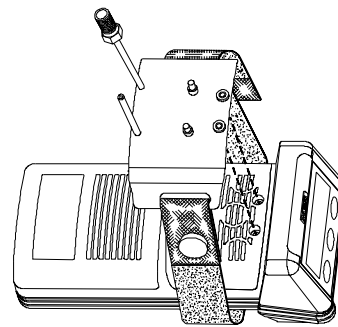
Figure 2-6.
Calibration Cap Installation
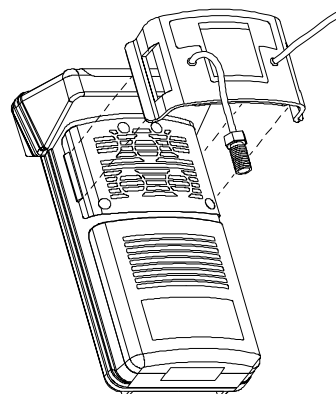
Figure 2-7.
Snap Calibration Cap Installation

- Add-on Pump Module:
  To attach the Add-on Pump Module, refer to FiveStar Instruction Manual (P/N 710436), FIGURE 2-47.

Once the calibration sampling device is attached, apply calibration gas at 0.25 lpm flow rate.

a. Attach a 0.25-lpm (liters-per-minute) Flow Controller to the gas tank.
b. Attach calibration tubing to the Five Star calibration cap inlet.
c. Attach the other end of the calibration tubing to the 0.25-lpm Flow Controller.
d. Turn the knob on the gas tank in a counterclockwise direction.

7. Press the **RESET** (READY) button.
8. Wait for the readings to stabilize.

   NOTE: During calibration, the display reading may appear more unstable than normal. The display's digital filtering has been disabled to provide the most rapid reading possible.

9. After the display stabilizes, adjust the display reading to agree with the known amount of calibration gas.

   a. Push the **PAGE** (DOWN) button to lower the reading.
   b. Push the **RESET** (UP) button to raise the reading.

      - Holding either button causes the reading to change continuously.
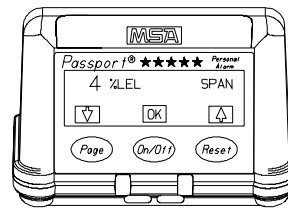
Figure 2-8. Combustible Gas Span Adjustment

10. Push the **ON/OFF** (OK) button to accept the reading.

   - The new reading is stored in memory, and the FiveStar Alarm automatically moves to next reading.

Oxygen Sensor Calibration Check

After the combustible gas calibration is completed, the instrument automatically moves to the oxygen sensor calibration check. The zero adjustment previously calibrated the oxygen sensor to

20.8%. Do not adjust the oxygen reading to the cylinder value, as slight variations may occur; however, verify that the oxygen reading is within the limits stated on the cylinder. Software version 2.11 and higher only allows the user to review the oxygen reading. After verifying that the reading is within the limits stated on the cylinder, simply press the **PAGE** (SKIP) button to continue to the toxic gas calibration.

Toxic Gas Sensor Calibration

After the oxygen calibration check is completed, the FiveStar Alarm automatically moves to the toxic gas page. Each toxic gas calibration can be completed in the same way as the combustible gas calibration. It may be necessary to change gas samples to provide the proper gas.

*Figure 2-9.
Remove Cal Cap*

- When all of the selected calibrations are set, a long beep sounds and the display reads (FIGURE 2-9):
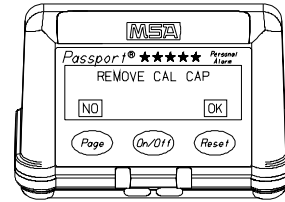
To repeat calibration procedure:

Press the **PAGE** (NO) button.

*Figure 2-10.
Saving Calibration
Please Wait*

To end calibration procedure:

Remove the calibration cap and press the **RESET** (YES) button.

- The (FIGURE 2-10) display appears:

- Calibration gases clear from the sensors (about 30 seconds).

*Figure 2-11.
Power OFF*

- For instruments with software versions 1.2 or higher, the instrument automatically turns ON and goes into the normal operation mode.

- For instruments with software versions lower than 1.2, A long beep sounds and the FiveStar Alarm turns OFF automatically (FIGURE 2-11):

Special Instructions for Instruments with Chlorine Dioxide Sensors

Calibration

FiveStar Alarms equipped with chlorine dioxide sensors may be calibrated directly, using s third party-supplied chlorine dioxide generator, or using cylinders of chlorine gas.

When calibrating with a chlorine dioxide generator you must either ensure the flow supplied by the generator exceeds the FiveStar pump draw (typically between 0.25 and 0.40 lpm) or you can supply the gas directly through a calibration cap. Hooking the pump directly to the generator may result in altering the concentration supplied; therefore, a "Tee" must be used to bleed
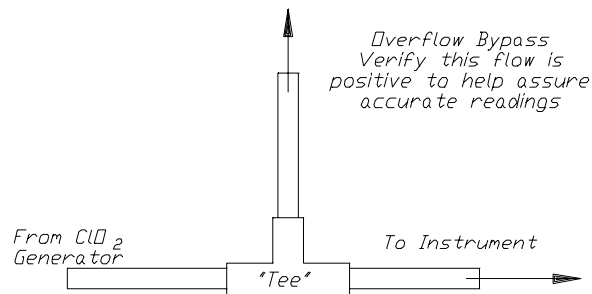
Figure 2-12.
Setup for Chlorine Dioxide Generator Bypass

off the excess flow (FIGURE 2-12).

If a "Tee" is used, you must make sure the flow through the free leg of the tubing is positive to be sure no air is being drawn in, reducing your sample concentration. Once set up, follow the instructions in the Technical manual (P/N 710440) for calibrating the FiveStar Alarm and set the chlorine dioxide reading to the known concentration from the generator.

When using a cylinder of chlorine gas, set the reading to one-half the known concentration of the cylinder (e.g., for MSA P/N 710331, 2 ppm, set the reading to 1.00 ppm chlorine dioxide).

Chapter 3
Troubleshooting and Maintenance

Troubleshooting

The FiveStar Alarm will operate reliably for years when cared for and maintained properly. If the instrument becomes inoperative, follow the Troubleshooting Guidelines in TABLE 3-1. These represent the most likely causes of a problem. You may return inoperative instruments to MSA for repair.

> **MSA Instrument Division**
> **Repair and Service Department**
> **1000 Cranberry Woods Drive**
> **Cranberry Township, PA 16066-5207**
> **1-800-MSA-INST**

To contact MSA International, please call:

> **1-412-967-3000   or   1-800-MSA-7777**

The instrument displays an error code if it detects a problem during startup or operation. See TABLE 3-1 for a brief description of the error and proper corrective action. When an inoperative component is located by using the guidelines, it may be replaced by using one of the following procedures:

	REPLACE			
PROBLEM	**BATTERY PACK***	**DISPLAY MODULE**	**SENSOR**	**MAIN ELECTRONICS MODULE**
Does not turn ON	√			√
Does not complete Self-Tests				√
Display segments missing or stuck		√		
"ERROR" message after battery installation				√
"ERROR" message during use				√
Battery pack does not hold charge	√			
Combustible sensor does not calibrate			√	
Oxygen sensor does not calibrate			√	
Toxic sensor does not calibrate			√	
Clock not holding time.				√

Table 3-1. Troubleshooting Guidelines

*Recharge or replace the cells before replacing battery pack.

In all of the above cases and for any other problems, you may return the FiveStar Alarm to MSA for repairs.

**Table 3-1. Troubleshooting Guidelines (continued)**
ERROR CODE	**DESCRIPTION**	**CORRECTIVE ACTION**
1	Sensor board error	Check/replace sensor board
2	EEPROM error	Reinitialize the instrument (follow procedure for manual sensor configuration and answer yes to query to reinitialize the EEPROM)
3	Pressure sensor error	Replace the main board
4	unused	
5	Combustible sensor error	Check/replace combustible sensor; if this does not clear the error, replace the sensor board (In an Australian approved instrument, check the fuse on the main board if replacing the sensor does not clear the error.)
6	Oxygen Sensor error	Check/Replace the oxygen sensor
7	Combustible sensor zero error	Check/replace the combustible sensor
8	Cannot write EEPROM	Check/replace the main board
9	Battery type failure	Replace battery pack
10	No sensors detected	Check to see if sensors and Zebra strips are in place
11	Multiple sensors removed from instrument	Check to see if sensors and Zebra strips are in place
12	Combustible sensor missing	Check combustible sensor and zebra strip
13	Oxygen sensor missing	Check Oxygen sensor and zebra strip
14	Toxic 1 sensor missing	Check Toxic 1 sensor and zebra strip
15	Toxic 2 sensor missing	Check Toxic 2 sensor and zebra strip
16	Toxic 3 sensor missing	Check Toxic 3 sensor and zebra strip
17	Multiple new sensors detected	Run through sensor configuration
18	New combustible sensor installed	Run through sensor configuration
19	New oxygen sensor installed	Run through sensor configuration
20	New Toxic 1 sensor installed	Run through sensor configuration
21	New Toxic 2 sensor installed	Run through sensor configuration
22	New Toxic 3 sensor installed	Run through sensor configuration
23	Multiple sensors installed in illegal sites	Check sensor placement against TABLE 1-1
24	Improper sensor installed in combustible site	Check sensor placement against TABLE 1-1
25	improper sensor installed in oxygen site	Check sensor placement against TABLE 1-1
26	Improper sensor installed in Toxic 1	Check sensor placement against TABLE 1-1

Table 3-1. Troubleshooting Guidelines (continued)

ERROR CODE	DESCRIPTION	CORRECTIVE ACTION
27	Improper sensor installed in Toxic 2 site	Check sensor placement against TABLE 1-1
28	Improper sensor installed in Toxic 3 site	Check sensor placement against TABLE 1-1
29	Biased sensor installed in illegal site	Check sensor placement against TABLE 1-1
30	Multiple sensor memories corrupted	Check and replace sensors one at a time to isolate failed sensors
31	Combustible sensor memory corrupt	Replace Combustible sensor
32	Oxygen sensor memory corrupt	Replace Oxygen sensor
33	Toxic 1 sensor memory corrupt	Replace Toxic 1 sensor
34	Toxic 2 sensor memory corrupt	Replace Toxic 2 sensor
35	Toxic 3 sensor memory corrupt	Replace Toxic 3 sensor
36	Multiple sensor memories incompatible with instrument software	Check and replace sensors one at a time to isolate incorrect sensors
37	Combustible sensor memory incompatible with instrument memory	Replace Combustible sensor
38	Oxygen sensor memory incompatible with instrument memory	Replace Oxygen sensor
39	Toxic 1 sensor memory incompatible with instrument memory	Replace Toxic 1 sensor
40	Toxic 2 sensor memory incompatible with instrument memory	Replace Toxic 2 sensor
41	Toxic 3 sensor memory incompatible with instrument memory	Replace Toxic 3 sensor
99	Battery Error	Check battery on another instrument; replace battery if the error follows the battery; otherwise, replace the main board

For messages 11 to 22, instruments with software version 1.2 or higher will enter the autoconfiguration mode directly at turn-ON, if autoconfiguration is enabled. If autoconfiguration is disabled or your instrument software is earlier than version 1.2, the user must run through the key sequence on battery attachment given in Chapter 1, "Manual Sensor Configuration."

Repair Procedures

Battery Pack Replacement

Remove the Battery Pack

1. Turn battery mounting screw on the back of the instrument in a counterclockwise direction until screw turns freely.

Figure 3-1.
Battery Pack Removal

2. Pull out the battery pack by gripping it at the edge of the battery pack case and pulling it away from the unit (FIGURE 3-1).

Replace the Battery Pack

3. Insert the front of the battery pack under the lip on the case and snap the bottom of the battery pack into the case.

4. Turn the battery mounting screw on the back of the instrument in a clockwise direction until screw is tight.

Sensor Replacement

See Chapter 1, "Replacing a Sensor" for instructions.

Main Electronics Board Replacement

⚠ CAUTION

Before handling the PC boards, ensure you are properly grounded; otherwise, static charges from your body could damage the electronics. Such damage is not covered by the warranty. Grounding straps and kits are available from electronics suppliers.

1. Turn power OFF.

2. Remove the Calibration Cap, if installed.

3. Turn the battery mounting screw on the back of instrument in a counterclockwise direction until screw turns freely.

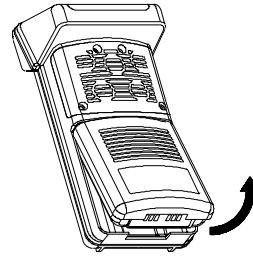4. Pull out the battery pack by gripping it at the edge of the battery pack case and pulling it away from the unit.

5. Remove the six case mounting screws from back of the case.

6. Carefully remove the back of the case.

⚠ CAUTION

When removing the back of the case, be careful not to pull the buzzer wire from the connector. This is a fragile connector; use minimum force necessary to prevent breakage; breakage of this wire is not covered under warranty. If removing the connector, place a flat screwdriver at the back of the connector and gently pry connector loose.

7. Remove the buzzer connector.

8. Disconnect the white ribbon connector from the main board socket by CAREFULLY lifting up the brown locking tabs until they stop (FIGURE 3-2).

9. Locate the edge of the main pc board that is furthest from the display; grasp this edge and gently lift the board straight up and away from the unit until it is free.

10. Holding the white connector, gently rock the main pc board and pull it away from the connector.

    NOTE: Retain foam rubber gasket accompanying pc board.

11. Connect the new main pc board to the white ribbon connector by gently rocking the pc board into place; latch down the two tabs located on either side of the ribbon socket.

12. Replace gasket and insert the new main pc board into position; gently press down until the board snaps into place.

13. Reconnect the buzzer wire.

14. Replace the main pc board, ensuring gasket is appropriately placed around the entire perimeter of the instrument.

⚠ CAUTION

When replacing the back of the case, tuck the buzzer wire between the display board and the main board to prevent damage to the wire.

15. Replace back of the case and tighten the six case-mounting screws securing the back of the case in the
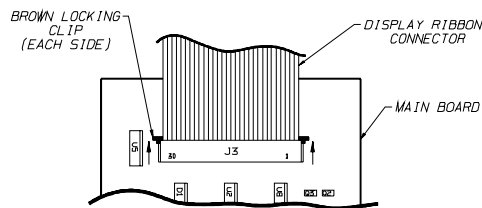
Figure 3-2.
Display Connector

sequence shown in FIGURE 3-3.

NOTE: Do not over-tighten screws.

16. Reconnect battery pack.

17. Completely recalibrate the FiveStar Alarm.

*Figure 3-3.
Sequence for
Tightening Screws*

⚠ WARNING

Verification of calibration response is required; otherwise, the instrument will not perform as required and persons who rely on this product for their safety could sustain serious personal injury or death.

Sensor Board Replacement

1. Turn power OFF.

2. Remove the Calibration Cap, if installed.

3. Turn the battery mounting screw on the back of the instrument in a counterclockwise direction until the screw turns freely.

4. Pull out the battery pack by gripping it at the edge of the battery pack case and pulling it away from the unit.

5. Remove the four screws retaining the sensor cover.

6. Remove the sensor cover and retain the gasket.

7. Remove all sensors by gently rocking them back and forth and lifting them from their sockets.

8. Turn the unit over and remove the six screws from the bottom plate.

9. Carefully remove the back of the case.

⚠ CAUTION

When removing the back of the case, be careful not to pull the buzzer wire from the connector. This is a fragile connector. If removing connector, use minimum force necessary to prevent breakage; breakage of this wire is not covered under warranty. If removing connector, place a flat screwdriver at the back of the connector and gently pry connector loose.

10. Remove the white ribbon connector from the main board socket by CAREFULLY pulling up the brown tabs (located on the sensor side) until they stop.

11. Locate the edge of the main pc board furthest from the display; grasp this edge and gently lift the board away from the unit until it is free.

12. Hold the white connector; gently rock and pull the main pc board away from the connector; retain foam rubber gasket accompanying main pc board (replace gasket, if needed).

13. Remove the two white plastic retaining rings located near the top portion of the sensor board; remove and retain the two screws or black rubber bumpers at bottom portion of board.

14. Place fingers on the other side (top side) of unit and gently rock and push the sensor board out and away from the case; retain the orange bottom gasket.

15. Insert new sensor board and reverse the above procedure for complete sensor board replacement.

    NOTE: When replacing the sensor board, this board must slide in under the keyboard ribbon cable.

16. Calibrate the FiveStar Alarm.

⚠ WARNING

Verification of calibration response is required; otherwise the instrument will not perform as required and persons who rely on this product for their safety could sustain serious personal injury or death.
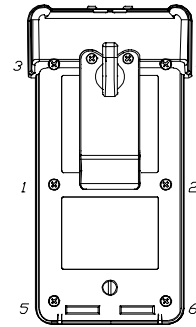
Display Module Replacement

1. Turn power OFF.

2. Remove the Calibration Cap, if installed.

3. Turn the battery mounting screw on the back of the instrument in a counterclockwise direction until the screw turns freely.

4. Pull out the battery pack by gripping it at the edge of the battery pack case and pulling it away from the unit.

5. Remove the four screws retaining the sensor cover.

6. Remove the sensor cover and retain the gasket.

7. Remove all sensors by gently rocking them back and forth and lifting them from their sockets.

8. Turn unit over and remove the six case-mounting crews from the back of the case.

9. Carefully remove the back of the case.

⚠ CAUTION

When removing the back of the case, be careful not to pull the buzzer wire from the connector. If removing the connector, place a flat screwdriver at the back of the connector and gently pry loose; otherwise the connector may be damaged. When replacing the back of the case, tuck the wire between the display board and the main board to prevent damage to the wire.

10. Remove the white ribbon connector from the main board socket by CAREFULLY pulling the brown tabs on the sensor side up gently until they stop.

11. Locate the edge of the main pc board that is furthest from the display; grasp this edge and gently lift the board away from the unit until it is free.

12. Holding the white connector, gently rock the main pc board and pull it away from the connector; retain foam rubber gasket accompanying the main pc board.

13. Remove the two white plastic retaining rings located near the top portion of the sensor board.

14. Remove and retain the two screws at the bottom portion of the board.

15. Place fingers on the other side (top side) of unit and gently rock and push the sensor board out and away from the case; retain orange bottom gasket.

16. Using a pair of needle nose pliers, remove keypad cable from the socket located on the right side of the display board.

17. Pull keypad cable away from the unit.

18. Grasping the display module, gently rock and pull it up and away from case.

19. To re-assemble, gently place new display module into unit and rock module firmly into place.
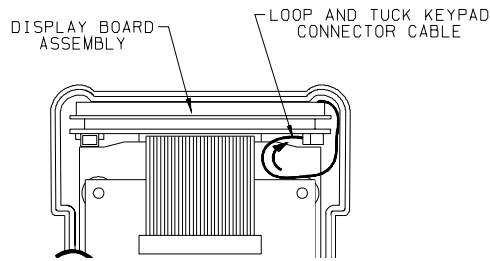
Figure 3-4.
Keypad Ribbon Cable Replacement

20. Grasp keypad ribbon cable, form cable into loop and insert ribbon edge into socket on the right-hand corner (FIGURE 3-4).

21. Replace sensor board and gasket removed in step 15 above.

    NOTE: Ensure sensor board is oriented so sensor socket pins face the sensor area.

21. Replace the white retaining rings and the two sensor board screws.

22. Reconnect the main pc board back to the white ribbon connector by gently rocking the pc board into place and latching down the two tabs located on either side of the ribbon socket.

23. Replace gasket and insert the new main pc board into position; gently press down until the board snaps into place.

24. Reconnect the buzzer wire.

⚠ CAUTION

When replacing the back of the case, tuck the wire between the display board and the main board to prevent damage to the wire.

25. Replace the main pc board, ensuring gasket is appropriately placed around the entire perimeter of the instrument.

26. Replace the six screws securing the back of the case.

27. Ensure zebra strips are included in their appropriate locations.

28. Place sensors into their appropriate positions.

29. Replace gasket and sensor cover and attach with four screws.
30. Reconnect battery pack.
31. Completely recalibrate the FiveStar Alarm.

⚠ WARNING

Verification of calibration response is required; otherwise the instrument will not perform as required and persons who rely on this product for their safety could sustain serious personal injury or death.

Chapter 4
Parts List

| Table 4-1. North American/Australian Common Accessory Parts List			
PART	**NORTH AMERICAN APPROVED PART NO.**	**AUSTRALIAN APPROVED PART NO.**	**EN APPROVED PART NO.**
Calibration Cap	710824	710824	710824
Probe - 1 ft.	800332	800332	*
Probe - 3 ft.	800333	800333	*
Sampling Line - 5 ft.	497332	497332	*
Sampling Line - 10 ft.	497333	497333	*
Sampling Line - 15 ft.	497334	497334	*
Sampling Line - 25 ft.	497335	497335	*
Replacement Filter, Probe (pkg. of 10)	801582	801582	801582
Charge Stand, Omega	710570	N/A	N/A
Charger, Omega 120 VAC, 50/60 Hz	494716	N/A	N/A
Charger, Omega 220 VAC, 50/60 Hz	495965	N/A	N/A
Charger, Omega 110/220 VAC, Five Unit, 50/60 Hz	801759	N/A	N/A
Charger, Omega, 8-28 VDC	800525	N/A	N/A
Universal Fast Charger Kit	10065553	*	10065556
Universal Stand, Fast Charger	10065552	*	N/A
Universal Power Supply, Fast Charger	710774	*	10013426
Protective Jacket, Orange Nylon, Diffusion	711242	711242	N/A
Protective Jacket, Orange Nylon, Pumped	711120	711120	N/A
Leather Carrying Case, Diffusion	710864	227722	710864
Leather Carrying Case, Pumped	711119	711119	711119
Calibration Kit Model RP with 0.25 lpm Regulator	477149	477149	477149
Calibration Gas - 58% LEL pentane simulant / 15% O_2	478192	478192	478192
Calibration Gas - 58% LEL pentane simulant / 15% O_2; 60 ppm CO	478191	478191	478191
Calibration Gas - 10 ppm H_2S	467898	467898	467898
Calibration Gas - 58% LEL pentane simulant / 15% O_2; 300 ppm CO	10010162	10010162	10010162
Calibration Gas - 10 ppm NO_2	808977	808977	808977
Calibration Gas - 50 ppm NO	812144	812144	812144
Calibration Gas - 10 ppm SO_2	808978	808978	808978
Calibration Gas - 58% LEL pentane simulant / 15% O_2; 300 ppm CO and 10 ppm H_2S	804770	804770	804770
Calibration Gas - 58% LEL pentane simulant / 15% O_2; 10 ppm H_2S	804769	804769	804769
*These accessories may vary according to the country of use; please contact your nearest MSA Distributor Office for details.			
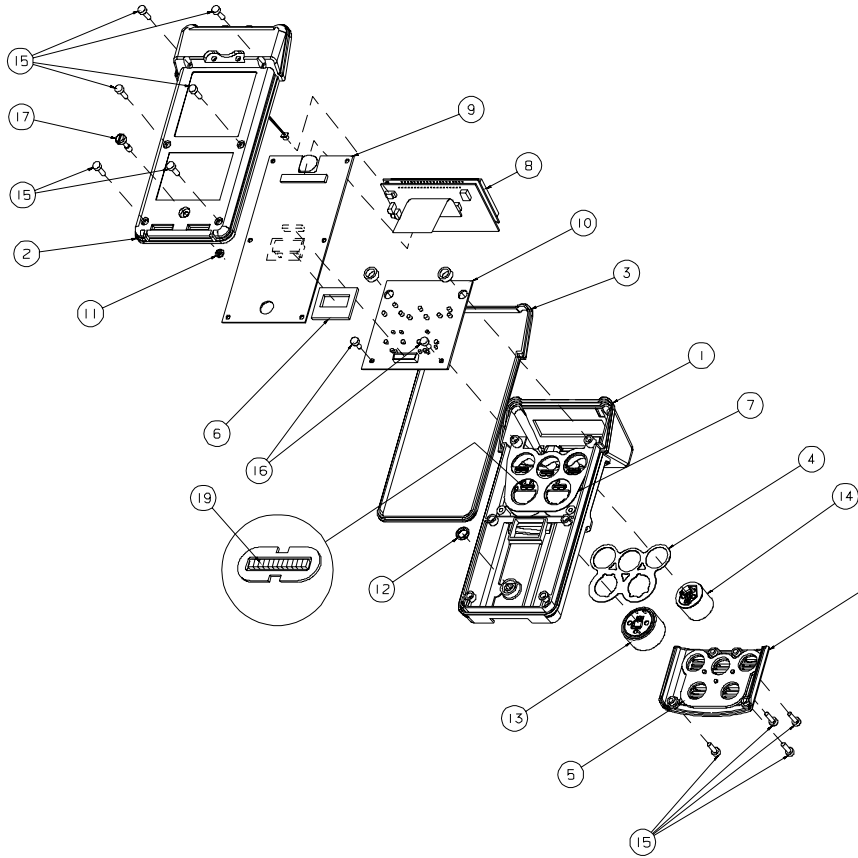
Figure 4-1.

North American (through Serial Number Prefix "E") Replacement Parts
NOTE: *This version does not have the sealing gasket around the sensor cover*
(Item 18).

FIGURE 4-1 ITEM NO.	PART/COMPONENT	NORTH AMERICAN APPROVED INSTRUMENT PART NO.
	Table 4-2. North American (through Serial Number Prefix "E") Replacement Parts List	
1	Case Assembly, Main, Top	non-saleable
2	Case Assembly, Main, Bottom	non-saleable
3	Case Gasket	710307
4	Sensor Gasket (under sensors)	710395
5	Sensor Cover Gasket (above sensors)	710428
6	Main PC Board Gasket	710397
7	PC Board Sensor Gasket	710396
8	Display PC Board	815475
9	Main PC Board	815473
10	Sensor PC Board	815477
11	O-Ring, Battery Screw Retaining	637519
12	O-Ring, Sealing	59676
15	Screw (4-40 x 3/8, black)	636227
16	Screw (4 x 1/4, self-threading)	655087
17	Captive Screw (6-32 x 17/32)	638457
	Sensor Cover Labels (for missing sensors)	710487
18	Sensor Cover	710309
19	Zebra Strip	655188
	NO, NO$_2$, SO$_2$ Diffusion Barrier (pkg. of five)	711290
20	Sensor Area Cover Gasket	711358
	Battery Pack, Standard Ni-Cd Rechargeable	710427
	Battery Pack Assembly, Replaceable	710955
	Pump Assembly, Add-on	710790
	Aspirator Assembly	710959

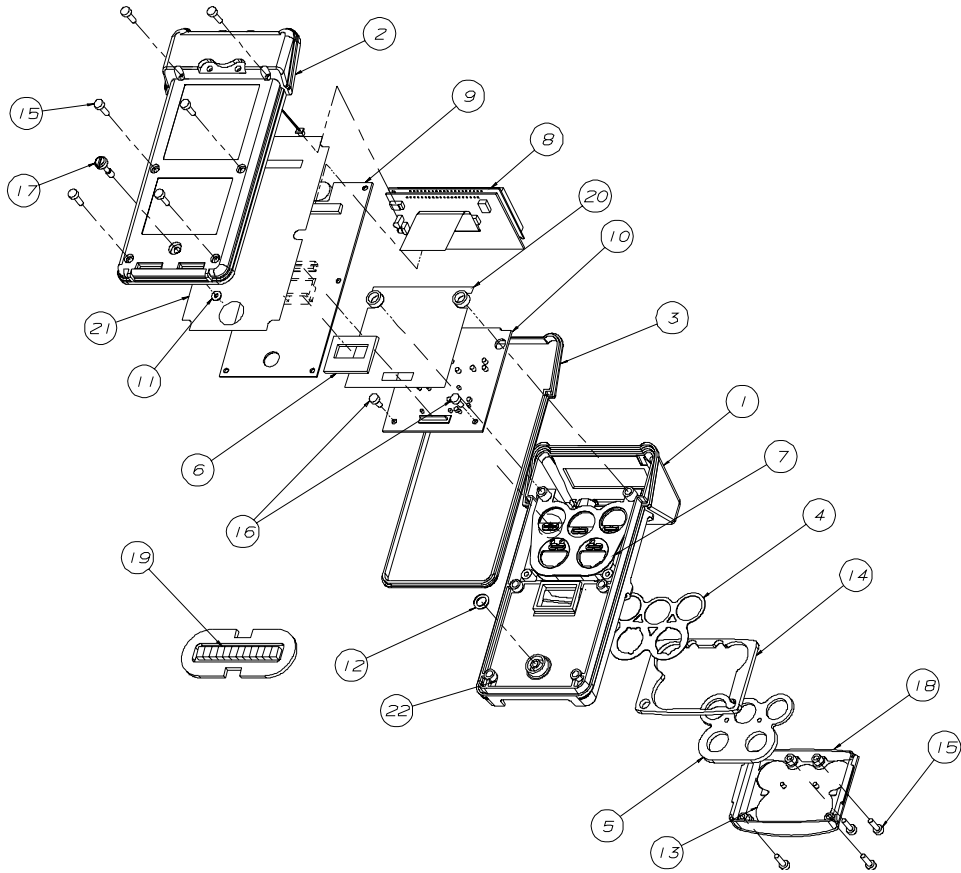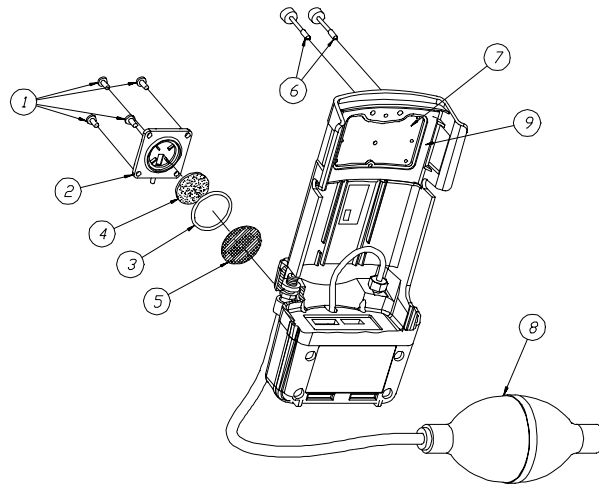| PART	NORTH AMERICAN APPROVED PART NO.	AUSTRALIAN APPROVED PART NO.	EN APPROVED PART NO.	MSHA APPROVED PART NO.
		Table 4-3. Replacement Sensors		
Oxygen Sensor	815333	815333	815333	815333
Combustible Sensor	710317	710317	710317	10047557
CO Sensor	710656	710656	710656	710656
H$_2$S Sensor	710657	710657	710657	710657
NO Sensor	710662	710662	710662	710662
NO$_2$ Sensor	710663	710663	710663	710663
SO$_2$ Sensor	710664	710664	710664	710664
PH$_3$ (Phosphine) Sensor	10011530	10011530	10011530	10011530
NH$_3$ (Ammonia) Sensor	10012286	10012286	10012286	10012286
Cl$_2$ (Chlorine) Sensor	10012282	N/A	N/A	10012282

Figure 4-2.
Australian and European Approved Replacement Parts
and North American (Serial Number Prefix "F" or Higher) Replacement Parts
NOTE: *New version has the updated sensor cover and new sealing gasket*
(Item 14).

FIGURE 4-2 ITEM NO.	PART/COMPONENT	SERIAL # PREFIX "F" BLACK STYLE	SERIAL # PREFIX "G" OR HIGHER PLATED STYLE	SERIAL # PREFIX "G" OR HIGHER BLACK STYLE
	Table 4-4. North American (Serial Number Prefix "F" or "G") Replacement Parts List			
1	Case Assembly, Main, Top	non-saleable	non-saleable	non-saleable
2	Case Assembly, Main, Bottom	non-saleable	non-saleable	non-saleable
3	Case Gasket	710307	710307	710307
4	Sensor Gasket (under sensors)	710395	710395	710395
5	Sensor Cover Gasket (above sensors)	10005104	10005104	10005104
6	Main PC Board Gasket	710397	710397	710397
7	PC Board Sensor Gasket	710396	710396	710396
8	Display PC Board	815475	815475	815475
9	Main PC Board	815473	10014273	10014273
10	Sensor PC Board	815477	10013453	10013453
11	O-Ring, Battery Screw Retaining	637519	637519	637519
12	O-Ring, Sealing	59676	59676	59676
13	Filter, Sensor Cover	10005181	10005181	10005181*
14	Sensor Area Cover Gasket	10005101	10005101	10005101
15	Screw (4-40 x 3/8)	636227	633290	636227
16	Screw (4 x 1/4, self-threading)	655087	655087	655087
17	Captive Screw (6-32 x 17/32)	638457	638457	638457
18	Sensor Cover	10005186	10008610	10005186*
19	Zebra Strip	655188	655188	655188
20	Insulator, PCB/PCB	N/A	N/A	N/A
21	Insulator, PCB/Case Bottom	N/A	10006521	N/A
22	Insulator, PCB/Case Top	N/A	10011218	N/A
	Sensor Cover Labels (for missing sensors)	710487	710487	710487
	Pump Module	710790	10008609	710790
	Aspirator Module	710959	10008608	710959
	Battery Pack, Standard Ni-Cd Rechargeable	710427	10008606	710427
	Battery Pack Assembly, Replaceable	710955	10008607	710955
	Standard Belt Clip	710953	710953	710953
	Toxic Channel 3 Bias Jumper	N/A	10013125	10013125

*   For chlorine compatible instruments, refer to FiveStar Instruction Manual (P/N 710436), Chapter 4 - "Special Instructions."

		Table 4-5. Australian/European Replacement Parts List	

FIGURE 4-2 ITEM NO.	PART/COMPONENT	AUSTRALIAN/EUROPEAN APPROVED INSTRUMENT PART NO.	
		AUSTRALIAN APPROVED	**EN APPROVED**
1	Case Assembly, Main, Top	non-saleable	non-saleable
2	Case Assembly, Main, Bottom	non-saleable	non-saleable
3	Case Gasket	710307	710307
4	Sensor Gasket (under sensors)	710395	710395
5	Sensor Cover Gasket (above sensors)	10005104	10005104
6	Main PC Board Gasket	710397	710397
7	PC Board Sensor Gasket	710396	710396
8	Display PC Board	10005335	711241
9	Main PC Board	10005333	see below
	• German, Dutch and English	N/A	10011592
	• Spanish, Italian and English	N/A	10011593
	• German, French and English	N/A	711152
	• French, Dutch and English	N/A	10019220
10	Sensor PC Board	10005337	711154
11	O-Ring, Battery Screw Retaining	637519	637519
12	O-Ring, Sealing	59676	59676
13	Filter, Sensor Cover	10005181	10005181
14	Sensor Area Cover Gasket	10005101	10005101
15	Screw (4-40 x 3/8, black)	636227	633290
16	Screw (4 x 1/4, self-threading)	655087	655087
17	Captive Screw (6-32 x 17/32)	638457	655797
18	Sensor Cover	10005186	10008610
19	Zebra Strip	655188	655188
20	Insulator, PCB/PCB	10006394	10006394
21	Insulator, PCB/Case Bottom	10006521	10006521
22	Insulator, PCB/Case Top	10011218	10011218
	Sensor Cover Labels (for missing sensors)	710487	710487
	Pump Module	10007440	10008724
	Aspirator Module	10009305	10008608
	Battery Pack, Standard Ni-Cd Rechargeable	711024	10013094
	Battery Pack Assembly, Replaceable	10007351	N/A
	Standard Belt Clip	710794	710794

Table 4-6. Pump and Aspirator Assembly Replacement Parts List

FIGURE 4-3 ITEM NO.	PART	PART NO. DATE CODED G99 (JULY '99)	PART NO. DATE CODED H99 (AUG. '99) OR NEWER	PART NO. (CHLORINE-COMPATIBLE PUMP)
1	Filter cover screws	636418	636418	636418
2	Filter cover housing	811722	811722	811722
3	Filter O-ring	637009	637009	637009
4	Dust filter (package of 5)	808935	808935	N/A
5	Inlet water filter	710917	710917	636258
6	Thumbscrew	655553	655553	655553
7	Manifold	710666	10005222	10005222
8	Aspirator and fittings	711149	711149	N/A
9	Manifold Gasket	N/A	10007340	10007340
-	Pump and drive (North American version)	711195	711195	711195
	Pump and drive (Australian version)	10011686	N/A	N/A
	Pump and drive (EN version)	10011686	N/A	N/A
-	Internal backup filter	634261	634261	634261

Figure 4-3.
Replacement Parts

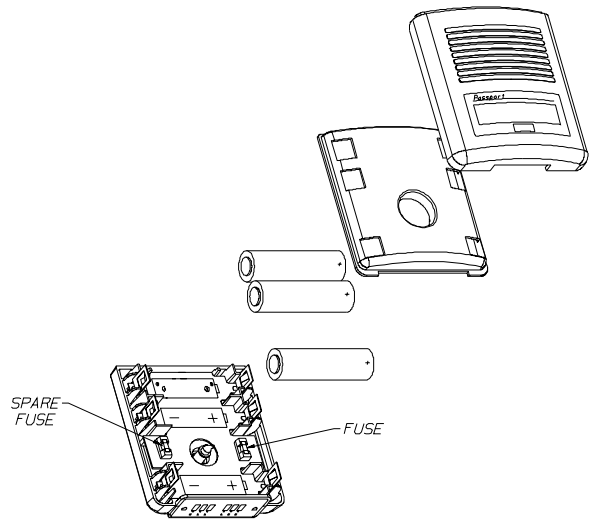| Table 4-7. Replaceable Battery Pack Parts List			
PART	**NORTH AMERICAN**	**NORTH AMERICAN PLATED**	**AUSTRALIAN**
	APPROVED INSTRUMENT PART NO.	**APPROVED INSTRUMENT PART NO.**	**APPROVED INSTRUMENT PART NO.**
Replaceable Battery Pack	710955	10008607	10007351
Spare Fuses	655836	655836	10006582
Replacement Internal Gasket	710958	710958	710958

Figure 4-4. Battery and Fuse Location