

HAZMATCADTM Plus

Users Manual

Version 2.0. (02-04)

P/N M100106M



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Introduction

HAZMATCAD™ Plus is a handheld instrument that detects and alarms to multiple chemical vapor threats such as chemical warfare agents and selected TIC's (Toxic Industrial Chemicals). HAZMATCAD™ Plus is fast to respond to a variety of chemical threat conditions, allowing the user to take immediate corrective action.

HAZMATCAD™ Plus is simple to operate and maintain. Press the "ON" button and the system will automatically perform a self-diagnostic check, purge its sampling system and begin analyzing ambient air for trace levels of chemicals. The instrument status is indicated by a combination of LED status lights and a 4 character LED alphanumeric display. HAZMATCAD™ Plus has two modes of operation. The Fast Mode requires 20 seconds to perform a sample analysis and the High Sensitivity Mode requires 120 seconds to complete an analysis. The electrochemical cells require 60 seconds warm-up before beginning continuous operation. HAZMATCAD™ Plus is equipped with a wireless infrared port for external communication and its large buttons and displays permit easy operation in a level A protective suit.

Principle of Operation

HAZMATCAD™ Plus uses a SAW microsensor array for the detection of nerve and blister agents and electrochemical cells to detect the blood or choking agents and selected TIC's. This combination of both SAW and electrochemical cell technology provides a comprehensive solution for the detection of the chemical warfare agents and selected TIC's for the HAZMAT first responder.

SAW Sensor Technology

SAW sensors are small solid state devices that are extremely sensitive to minute changes in mass. These devices are coated with different polymers that act as a sponge to selectively absorb air contaminants. The polymer surface responds rapidly and reversibly to air contaminants. Using an array of three different SAW sensors provide a response pattern or "fingerprint" that is unique to the chemical or a chemical class. This multi-sensor response pattern is one of the key reasons why HAZMATCAD™ Plus is highly specific to chemical agents and rejects other common environmental chemicals that could otherwise cause false alarms.

Electrochemical Sensor Technology

HAZMATCAD Plus™ uses four electrochemical cell sensors to detect hydrogen cyanide (AC), phosgene (CK) and other selected TIC's. TIC analysis is performed by a general chemical structure classification. These chemical classifications are “Hydride Gases”, “Halogen Gases”, “Blood Gas” and “Choking Gas”. The electrochemical cells are designed to provide semi-selective detection to chemicals in the above classifications.

The mechanism of detection of an electrochemical sensor involves the use of an aqueous electrolyte, sealed behind a hydrophobic (water-resistant) gas permeable membrane. As a gas diffuses through the permeable membrane, it dissolves in the electrolyte where it is oxidized or reduced. This oxidation/reduction reaction releases electrons that are collected by the measuring electrode. The resulting signal is proportional to the amount of gas reacted.

Sampling System

The HAZMATCAD™ Plus sampling system collects and concentrates a vapor (air) sample. This sampling technique enriches the sample and helps to reject potential vapor interferences. There are two independent sample flow systems used in HAZMATCAD™ Plus, one to support the SAW sensors and the other to support the electrochemical cells. The HAZMATCAD™ Plus flow system is illustrated in Figure 1 below.

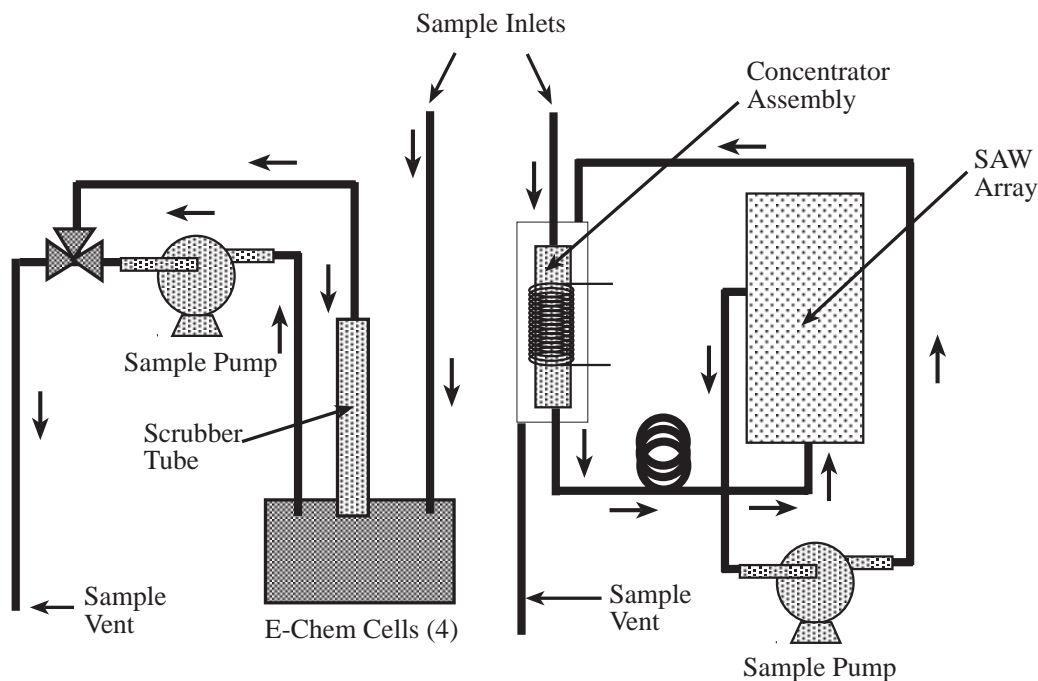


Figure 1 -Schematic of HAZMATCAD™ Plus Layout

System Specifications

Weight	1.5kg (52oz) including batteries
Dimensions	7.1 x 20 x 24.9cm (2.8" x 7.9" x 9.8")
CW Agents Detected	VX ¹ , GA, GB, GD, GF, HD, HN-3, AC, CG

SAW Sensors Alarm Levels

Fast Mode	G Agents- 0.2 to 0.9 mg/m ³ H Agents-1.2 to 1.4 mg/m ³
High Sensitivity Mode	G Agents- 0.13 to 0.25 mg/m ³ H Agents- 0.31 to 0.23 mg/m ³
Fast Mode Response Time	20 seconds
High Sensitivity Mode Response Time	120 seconds

E-Chem Detectors

Symbol	Chemical Name	Low Alarm Levels
“BLoD”	Hydrogen Cyanide	5.0ppm
“CHOK”	Phosgene	0.3ppm
‘HYdR”	Hydride gases	0.5ppm
“HALO”	Halogen gases	10.0ppm

Response Time for Low Alarm Levels 5 to 60 seconds
(Refer to figure 2 for additional E-Chem information.)

Warm Up Time	30 seconds @ 25°C SAWS 60 seconds @ 25°C Electrochemical Cells
Batteries	Li-Ion rechargeable (Sony NP-F550)
Audible Alarm	85dbA @ 1 meter
Visual Display	4 character alphanumeric and status LED's
Data Logging	8 hours time date alarm and level
Data Output	9600 baud Infrared or RS232c with adapter cable
Shelf Life	SAW sensors 5 years Electrochemical Sensors 1 year
Operating Temp.	0 to 40 °C
Operating Humidity	0 to 95% non condensing
Warranty	1 year's labor and material from ship date

¹ HAZMATCAD respond to an impurity in technical grade VX

The HAZMATCAD™ Plus package configuration is illustrated in Figure 3.

HAZMATCAD™ Plus E-Chem Alarm Table

Chemical Class	Alarm Type Classification	Chemical Name	Chemical Symbol	Low Alarm ² (ppm)	Response Time Low Alarm	Response Time Medium Alarm ¹	IDLH (ppm)	PEL (ppm)
Hydride Gas	"HYdR"	Arsine	AsH ₃	0.5	30	5	3.0	0.05
	"HYdR"	Diborane	B ₂ H ₆	3.0	30	5	15	0.1
	"HYdR"	Hydrogen Sulfide ³	H ₂ S	3.0	20	5	100	20
	"HYdR"	Hydrogen Cyanide ³	HCN	10.0	25	5	50	10
Halogen Gas	"HALO"	Chlorine	Cl ₂	10.0	30	15	10	1
	"HALO"	Bromine	Br ₂	10.0	30	15	3	
	"HALO"	Nitrogen Dioxide ³	NO ₂	70.0	30	15	20	
Phosgene Gas	"CHOK"	Phosgene	COCl ₂	0.3	60	20	2.0	0.1
		Hydrogen Cyanide ⁴	HCN	5.0	30	5	50.0	10.0
Hydrogen Cyanide	"BLod"	Hydrogen Cyanide	HCN	5	25	5	50	10

- 1 - MediumAlarm values are at two times the low level alarm concentration reported.
- 2 - Rapid changes in relative humidity of 20% or greater can cause a temporary false E-Chem alarm.
- 3 - Indicates alarm is outside of designated class.
- 4 - Sensor is not calibrated for HCN. Typical response is shown, assuming saturation of built in selectivity filter.

Figure 2- HAZMATCAD™ Plus E-Chem Alarm Table

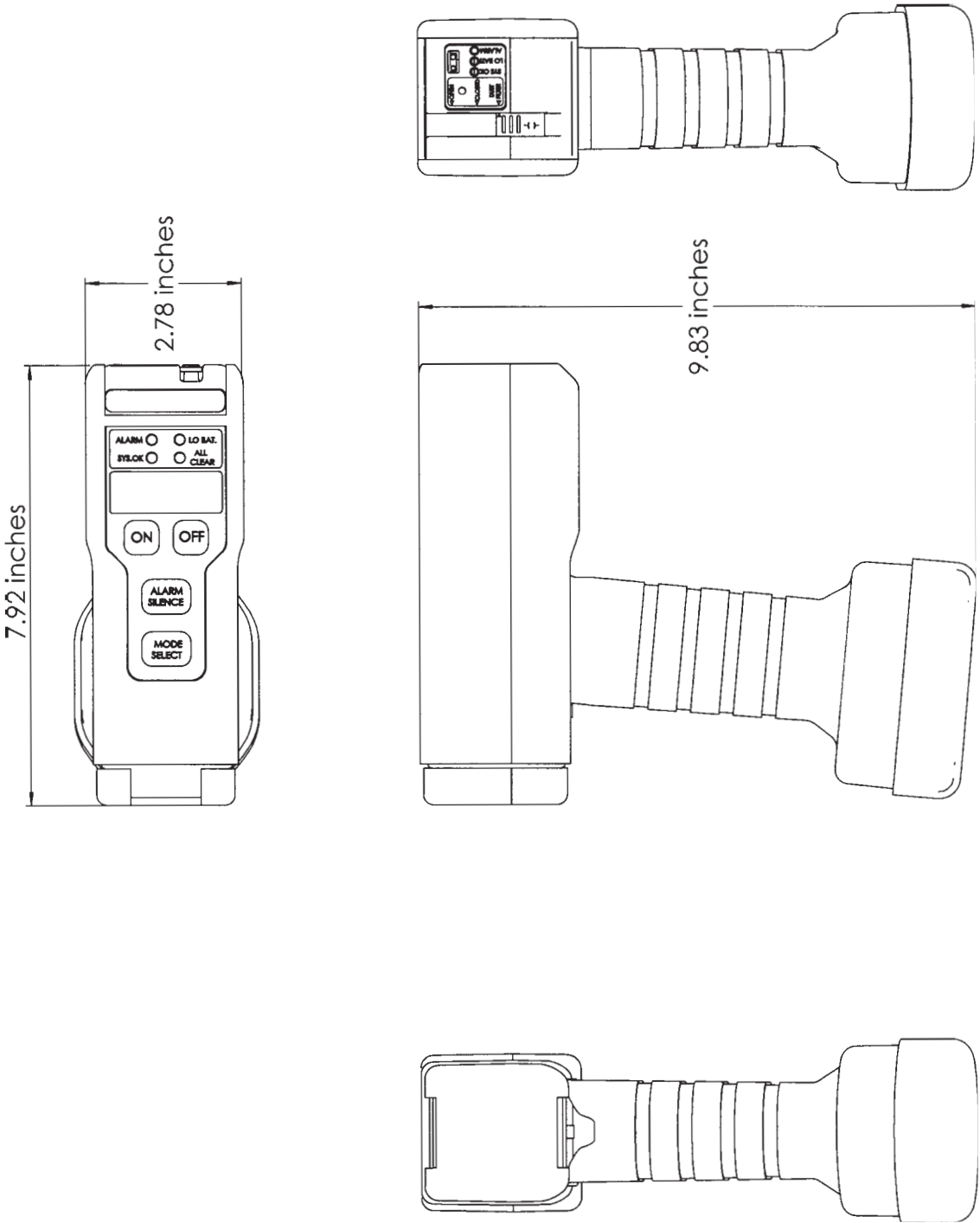


Figure 3- HAZMATCAD™ Plus Package Configuration

Description of HAZMATCAD™ Plus

Arrival and Unpacking of Instrument

HAZMATCAD™ Plus is shipped in a rugged plastic carrying case. This case is designed to provide a safe way to transport the instrument and keep the instrument and its accessories together in one convenient place. Please retain the outside shipping container for future use, should you need to return the instrument for service.

Inspect the contents received and verify the shipment is complete. Should there be any items missing, call Microsensor Systems, Inc. at (270) 745-0099 to report the shipment omission. If any item is damaged from shipment, report the occurrence to the shipping company and file a damage claim.

Instrument Controls

The main parts of the HAZMATCAD™ Plus control panel are illustrated in figure 4. Each item is described below.

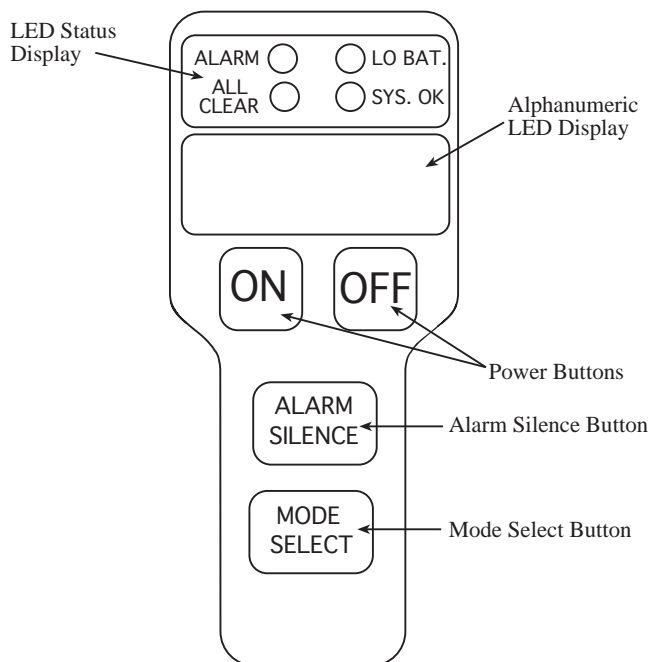


Figure 4 - HAZMATCAD™ Plus Keypad / Control Panel

Front Panel Keypad – Consists of four push button keys, which enable the functions defined below. These buttons are large and have tactile response when pushed.

1. Power On/Off Buttons – These buttons turn the instrument on and off.

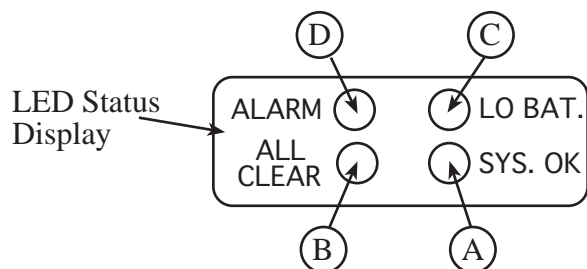
2. Mode Select Button, (Fast Mode) or (High Sensitivity) – This function toggles between the two instrument configurations. Pressing this button will display the current mode of operation as (HI S) (MODE) or (FAST) (MODE). The Electrochemical cells run automatically on power up and have no mode adjustment.

3. Silence Alarm Button – This button has two alarm functions, one to silence the alarm horn during a single analysis, and the other to enable or disable the alarm horn function.

LED Displays - Instrument status is indicated by discrete LED status lights as illustrated in Figure 5. The type and level of alarm is reported using the alphanumeric LED display.

1. Alphanumeric LED Display – This is a four character LED display which communicates the alarm classification and the concentration level, (low, medium or high). This display also presents start up test screens, remaining battery power and fault condition information.

2. The Status LED – These LED's indicate the HAZMATCAD™ Plus instrument status.



Status LED	Color	Meaning
A. SYS OK	Green (Blinking)	Indicates proper electrical operation of the instrument
B. ALL CLEAR	Green	Indicates that no threat vapors are present
C. LOW BATT.	Yellow	Indicates that battery power is running out
D. ALARM	Red (Blinking)	Indicates that a threat vapor has been detected

Figure 5 - LED Display Status and Definitions

3. Top Display Panel – This display consists of three status LED’s providing system information when viewing the sampling end of the instrument. The Top Panel system status LED’s are (SYS. OK), (LO BAT.) and (ALARM). The color of the LED’s follows the same profile as the status LED’s on the front keypad. The top display panel also provides information on the position of the HAZMATCAD™ Plus dust cover slide.

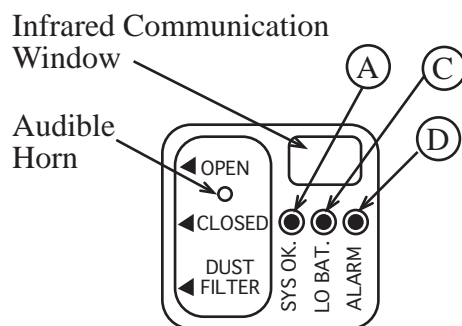


Figure 6 - HAZMATCAD™ Top Display Panel

Sample Inlet

HAZMATCAD™ Plus has a three-position sample port slide cover which is illustrated below.

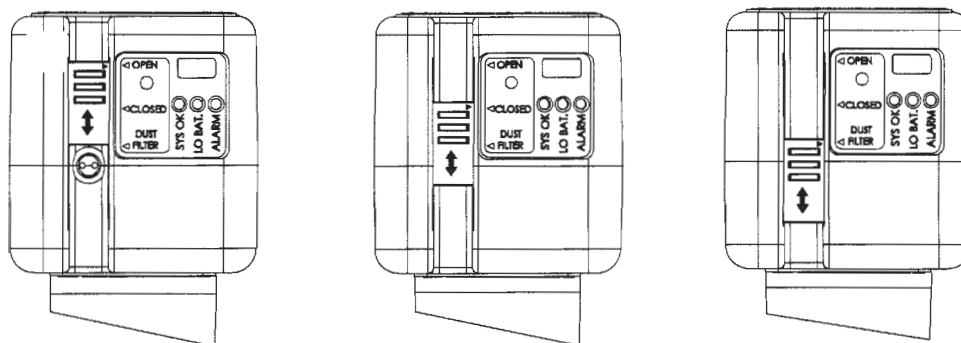


Figure 7 - HAZMATCAD™ Plus Sample Cover Slide

1. The (Open) position provides for direct access to the sample inlet. This position is used for check source (simulant) testing. For general operation HAZMATCAD™ Plus should be used in the (Open) position.

2. The (Closed) position secures the sample inlet. HAZMATCAD™ Plus should be stored with the sample inlet in the closed position.

3. The (Dust Filter) position enables a sample pathway that is designed to impede particulate matter and water from entering the sampling inlet. The (Dust Filter) position should be used in field operations.

Battery Compartment

Access to HAZMATCAD™ Plus battery compartment is illustrated in figure 8. The

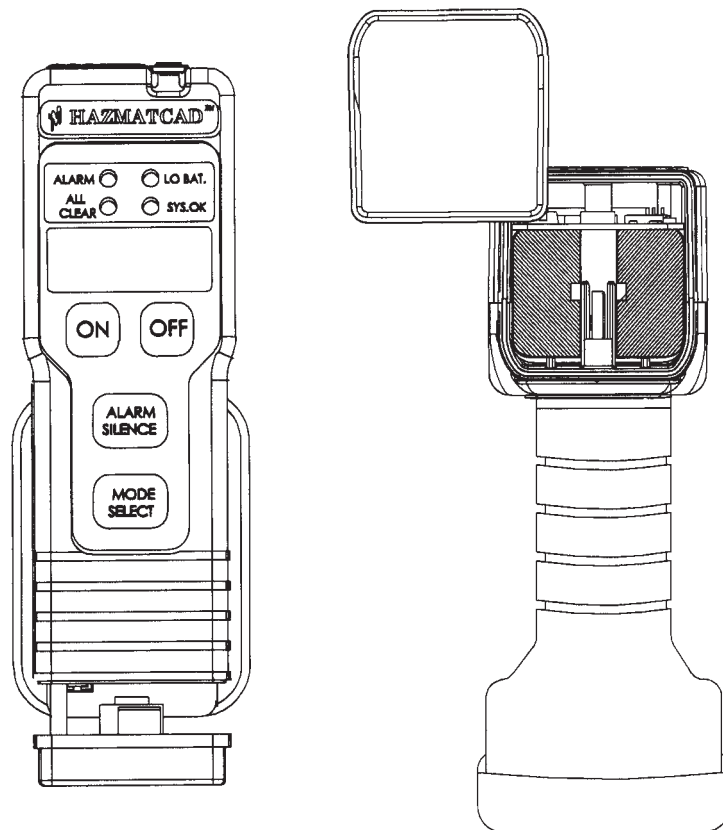


Figure 8 - HAZMATCAD™ Plus Battery Door Access

battery cover is located at the base of the instrument. By gently squeezing on the top and bottom of the instrument base and pulling it away from the case body the battery compartment door will release. The battery cover is attached to the instrument by an alignment rod. This alignment rod is designed to slide out approximately one inch. Rotating the battery door 180° provides clear access to the Li-Ion batteries. The Li-Ion batteries can be removed by sliding them away from the case. To reinsert the batteries reverse the removal procedure, face the battery terminals towards the battery compartment centerline (middle) opening and slide the batteries in until they meet the resistance of the male connector. Realign the battery compartment door and gently push closed until secure.

Lithium Ion Battery Pack

HAZMATCAD™ Plus uses a Sony Lithium Ion Battery NP-F550 (Part Number MS603002). One battery will power HAZMATCAD™ Plus for 4 to 6 hours depending on the mode of operation. Using HAZMATCAD™ Plus in the fast mode, one battery will last 4 hours; and in high sensitivity mode will last 6 hours. Two batteries can be used to obtain maximum mission life of 8 to 12 hours mode dependent. In cold temperature battery operation lifetime will be reduced.

Lithium Ion batteries are not subject to a memory effect and can be fully charged without being fully discharged.

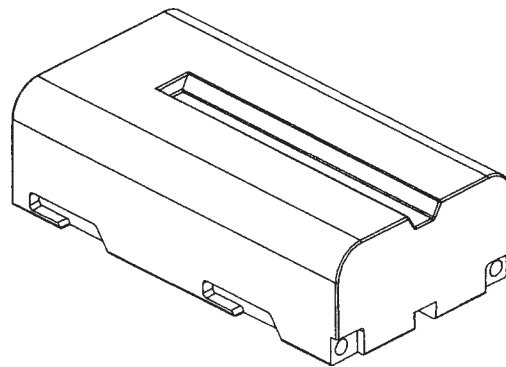


Figure 9 - HAZMATCAD™ Plus Lithium Ion Battery Pack



Warning! When using Lithium Ion batteries observe the following precautions:

1. Use only the specified charger SIMA Model SPM-13N when charging.
2. To prevent accidental shorts do not allow metal objects to come in contact with the battery terminals.
3. Do not expose the battery pack to temperatures above 60°C or (140°F)
4. Keep the battery pack dry and avoid unnecessary mechanical shock.
5. Do not attempt to disassemble or modify the battery pack.
6. Dispose of a used battery promptly and properly.



Warning! In some areas disposal of Lithium Ion batteries in household or business trash may be prohibited. Please recycle the Li-Ion battery by calling Sony Service Center at (800.222.SONY)

External Battery Re-Charger

HAZMATCAD™ uses an external battery re-charger for the lithium ion batteries. The charger is a SIMA Model SPM-13N. Please refer to the charger instruction booklet for up to date product information. This information is included in the HAZMATCAD documentation provided with the instrument.

When a battery is properly charging the green LED on the charger will flash. The battery charger will indicate a fully charged battery by a solid green LED when completed. The typical charge time for a Sony NP-550 battery is approximately four hours.

RS 232c (Hard Wire) Communication Port

HAZMATCAD's™ configured to use the hard-wire RS232c port are shipped with a special Communication Adaptor (MSI Part Number M2200090) transitioning from a flat ribbon cable to a male DB-9 connector. The flat ribbon cable plugs into a connector in the battery compartment (on the end of the PCB, accessible only when the battery door is open), with the black side of the flat ribbon cable toward the batteries. The communication parameters are the same as the Infrared using, 9600-N-8-1.

Infrared Communication Port (Optional)

HAZMATCAD™ configured to use the infrared communication port are shipped with an IR Wireless Transceiver Interface (NSI Part Number M1700010). This interface has an

integral cable that plug into a 9-pin serial port on a computer. The other end of the interface has an infrared transceiver which must be placed within several inches of the infrared port of the HAZMATCAD for data transmission. The computer should be configured to capture normal serial data at 9600 baud, 8 data bits, 1 stop bit and no parity. The data can be collected using a terminal emulation program such as Hyperterminal or ProComm.

HAZMATCAD™ Plus Accessories

Vapor Simulant Check Source

An optional vapor diffusion check source can be used to test HAZMATCAD™ Plus for a nerve “G” response (Part Number MS201112). This tube contains less than 50mg (a drop) of dimethylmethylphosphonate (DMMP), a nerve agent simulant.



Warning!

These tubes have an operational life of one year. Each check source is dated. Check expiration date before using.

Lithium Ion Battery Replacement

HAZMATCAD™ Plus is designed to use only one type of Sony Lithium Ion battery. It is recommended to have at least two Lithium Ion batteries for maximum performance. Additional Lithium Ion batteries (part number MS603002) can be purchased from Microsensor Systems.

Rubber Protective Boot

HAZMATCAD™ Plus has a protective rubber that is designed to provide additional protection from accidental mistreatment. This protective case is removable and should be discarded and replaced if the instrument has been exposed to a hazardous chemical.

E-Chem Scrubber

HAZMATCAD™ Plus has a replaceable scrubber that is used to zero the E-Chem cells in a contaminated background. This scrubber is located in the handle and can be replaced. The expected lifetime of the scrubber is dependent on the contamination encountered when using. The recommended replacement schedule is as follows: every 1000 hours of use or when the electrochemical cells are replaced (every 12 months).

HAZMATCAD™ Plus Operation



General Precautions and Warnings

1. HAZMATCAD™ Plus is a vapor (gas) detection instrument. If liquids are aspirated into the sample inlet the instrument will be damaged.
2. The inlet slide should be positioned in the (Dust Cover) position for general use.
3. HAZMATCAD™ Plus has not been tested for intrinsic safety and should not be used in environments having a potentially explosive atmosphere.
4. HAZMATCAD™ Plus is a very sensitive instrument which is intended for low level analysis. Sampling high concentration atmospheres (e.g. over pools of liquid) may overload the sampling system, increasing the clear down or recovery period.
5. HAZMATCAD™ Plus has been designed to minimize false alarms. However, high concentrations of some vapors can cause a false detection. These high concentration environments are usually associated with a strong smell of chemical vapors.
6. Should HAZMATCAD™ Plus be exposed to high concentration levels of chemical agents, it is possible that some of its internal components may become contaminated. Allow for an extended clear down period and handle the instrument using personal protection (e.g. protective mask and glove) following known exposures to high concentrations of CW agents.
7. The expiration of an e-chem cell is reported automatically on the LED display when cell replacement is required. The data format is “EXPR” / “XXXX” (where XXXX is the shortened cell identifier) which must be acknowledged by the operator. To acknowledge a cell expiration, the user must press the alarm silence button to continue the start up process. The E-Chem cells must be replaced within 2 to 3 months after the expiration warning is indicated.
8. HAZMATCAD™ Plus E-Chem alarm response is determined by the pattern generated by the cells. HAZMATCAD™ Plus examines the response data and provides a E-Chem alarm of the chemical class in the highest concentration. HAZMATCAD™ Plus will not report more than one E-Chem class alarm during a alarm.

User Interface

HAZMATCAD™ Plus has an easy to operate and understand user interface. Communication with HAZMATCAD™ Plus is accomplished by using the keypad function buttons. These function buttons are “ON”, “OFF”, “MODE SELECT” and “ALARM SILENCE”. HAZMATCAD™ Plus reports its analysis data by using LED status lights and a four-character LED alphanumeric display.

Preparing to use HAZMATCAD™ Plus

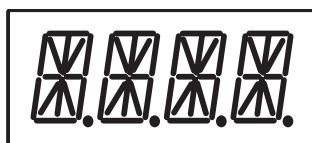


Warning! Before powering up HAZMATCAD™ Plus make sure the Li -Ion batteries are fully charged.

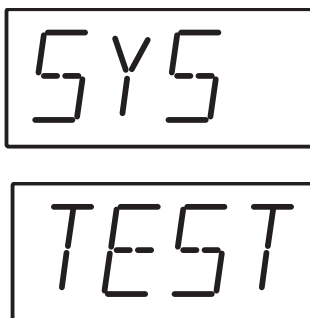


Warning! Open the sample inlet to the sample dust filter position.

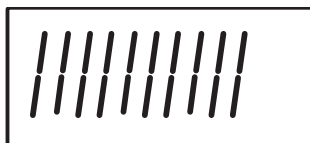
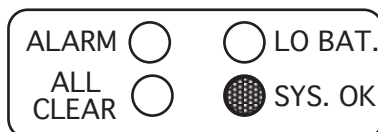
HAZMATCAD™ Plus will power up by pressing the “ON” button. HAZMATCAD™ Plus will start the microcomputer and begin a series of diagnostic self-checks. The instrument's alphanumeric display will activate and display (HCAD) and then display a visual segment test activating all LED segments.



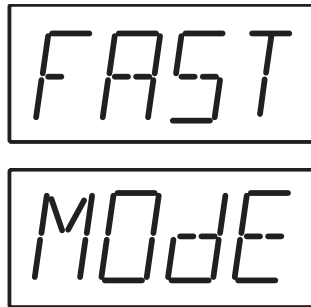
HAZMATCAD™ Plus will then display (SYS) (TEST) as the microprocessor completes its testing.



After a successful completion of the self-test the green (SYS. OK) status LED will begin flashing. The (SYS. OK) LED also functions as the system heartbeat of a normally operating HAZMATCAD™ Plus. This LED will remain flashing as long as HAZMATCAD Plus™ is operating properly. (Should a fault be detected HAZMATCAD™ Plus will display the fault information on the alphanumeric LED). The remaining battery power will then be indicated on the LED display. This is displayed as a 12-line bar graph indicating the relative amount of power remaining in the batteries.



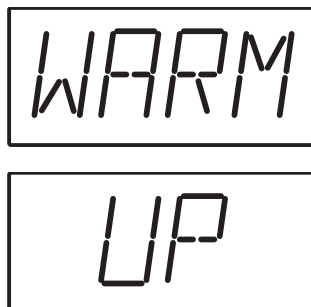
The current mode of operation will be displayed. The default mode for HAZMATCAD™ Plus is (FAST) (MODE). HAZMATCAD™ Plus is preset to begin sampling in Fast Mode analysis unless reprogrammed by the user.



The image shows two digital display boxes. The top box displays the word 'FAST' in a stylized, seven-segment font. The bottom box displays the word 'MODE' in the same font.

HAZMATCAD™ Plus will then begin a system clean down purge. During the initial start up of a non-thermally equilibrated instrument the LED display will flash (WARM) and (UP) during the purge cycle until thermal stability is achieved. The electrochemical sensors will begin a purge cycle using charcoal filtered air. This will adjust the baseline to a zero reference point before beginning continuous operation. This 60 second electrochemical cell purge cycle is repeated once every two hours during continuous operation.

HAZMATCAD™ Plus will begin sampling in the (FAST) (MODE), until stopped or the mode of analysis is changed.



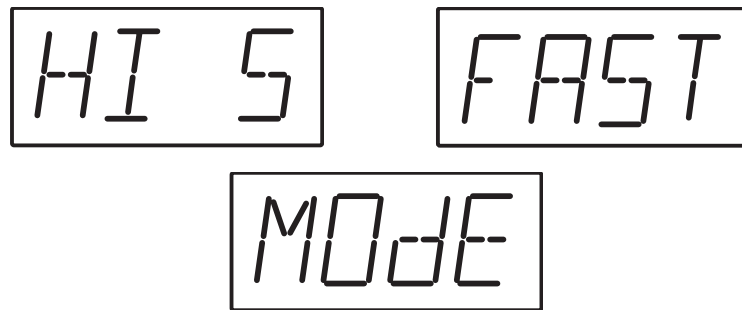
The image shows two digital display boxes. The top box displays the word 'WARM' in a stylized, seven-segment font. The bottom box displays the word 'UP' in the same font.

Mode Select

The mode select button commands HAZMATCAD™ Plus to operate in the (FAST) (MODE) or (HI S) (MODE). The (FAST) (MODE) analysis is the power up default position. Each (FAST) (MODE) sample analysis requires only 20 seconds to complete. The (HI S) (MODE) high sensitivity mode requires 120 seconds to complete a sample analysis. There is no mode select function for the electrochemical cells.

The analysis mode can be checked at any time by pressing the mode select button. The HAZMATCAD™ Plus alphanumeric LED will display the current mode. The operator can check this function at any time and this will not interrupt the current sample analysis.

To change the analysis mode, press the mode select button. HAZMATCAD™ Plus will respond by displaying the current mode of operation. This information will display for 5 seconds and turn off. To change the analysis mode the mode select button must be pressed again during the displaying of the current mode condition. This will cause HAZMATCAD™ Plus to terminate the current analysis cycle and start up in the other mode. This start up includes a sample purge cycle in preparation for the next analysis mode. The alphanumeric display will also flash the current analysis mode confirming the change.





Warning! Should HAZMATCAD™ Plus be turned off, upon re-powering, it will always start in the (FAST) (MODE).

Alarm Silence

Pressing the “ALARM SILENCE” button will disable the horn during an alarm. “ALARM SILENCE” only resets the current alarm and will not de-activate the alarm feature should future alarms occur. If there is an alarm condition on the next analysis the alarm horn will sound.

Pressing and holding the alarm silence button (approximately 3 seconds) will indicate if the audio alarm horn feature is enabled or disabled. The alphanumeric LED displays this information as (ALRM)/(ON) or (ALRM)/(OFF). When the function is activated, this information will be shown for five seconds. To change the alarm program function the alarm silence button must be pressed again while the LED is displaying the (ALRM)/(ON) or (ALRM)/(OFF) condition. Toggling the alarm silence button will activate or deactivate the audible alarm horn as desired. If the alarm is turned off the audible alarm will not sound on an alarm condition. The default condition is alarm on. The unit will power-up with the audible alarm function active.,



ALARM



OFF



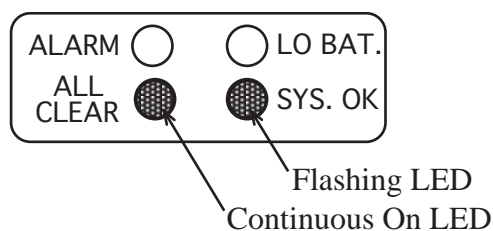
ON

Analysis Information

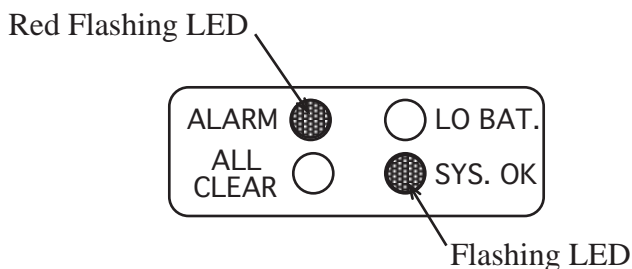
HAZMATCAD™ Plus indicates either the presence of a chemical agent or toxic gas by signaling an (ALARM) or it reports an (ALL CLEAR). HAZMATCAD™ Plus has preprogrammed alarm thresholds for the suite of chemical agents and toxic gases as defined in the system specifications. Should any of these concentration thresholds be exceeded the instrument will alarm until the concentration value returns below the set point value.

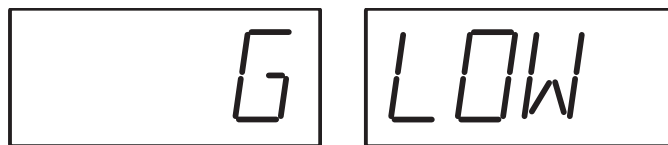
System Analysis Conditions

ALL CLEAR- All clear indicates that there was no chemical agent or toxic gas detected above the alarm concentration threshold. HAZMATCAD™ Plus reports this information by illuminating the green (ALL CLEAR) LED on the front panel keypad. This LED does not flash and will remain lighted as long as (ALL CLEAR) is reported. The alphanumeric LED display will remain blank.



ALARM- If an alarm occurs, HAZMATCAD™ Plus rapidly and dramatically reports this information to the user. Both of the alarm status LED's will begin flashing relative to the concentration. The Alarm status LED's will flash at a rate that is correlated to the alarm level. A low-level alarm will flash slower than a high level.





HAZMATCAD™ has several types of alarm classifications, Nerve “G”, Blister “H” and , Hydride “HYdR”, Halogen “HALO”, Blood “BLod” and Choking“CHOK” . There are three alarm concentration levels, low “LOW”, medium “MED” and high “HIGH” for each gas. On an alarm condition the classification message will toggle back and forth with the concentration level. The audible alarm horn will sound. The alphanumeric LED display will report the alarm classification and level.

<u>Chemical Agents (SAW)</u>	<u>TIC's (E-Chem)</u>	<u>Concentration Levels</u>
H	HALO	HIGH
G	HYdR	MEd
	CHOK	LOW
	BLod	

Performing a Simulant Test

Operational testing of the HAZMATCAD™ Plus can be performed by using a simulant check source provided as an instrument accessory. The check source is a Teflon diffusion tube which contains a small amount of DMMP (dimethylmethylphosphonate), a simulant for nerve “G” agent. The MSDS information for DMMP is contained in the appendix of this manual.

To use the vapor check source.

- a. Set the sample inlet position to open.
- b. Power the HAZMATCAD™ Plus in the Fast Mode and let run for 2 minutes.
- c. Prepare the DMMP diffusion tube by removing the vinyl end caps.
- d. Position the DMMP diffusion tube against the sample inlet as illustrated in figure 11.
- e. Hold the diffusion tube at the sample inlet for 4 to 5 seconds and remove.
- f. HAZMATCAD™ Plus should alarm during the next sample run, usually about 10 to 30 seconds after sampling. (If there is no alarm, repeat the procedure and hold the DMMP diffusion tube for 6 to 10 seconds.)
- g. HAZMATCAD™ Plus should alarm “G” and the concentration level will be displayed.
- h. Continue running HAZMATCAD™ Plus until the instrument reports (ALL CLEAR).
- i. Replace the vinyl caps on the ends of the diffusion tube and return to the plastic container.



Warning!

Do not leave the check source exposed to HAZMATCAD™ Plus for prolonged periods in excess of the recommended time. It will overload the sampling system and require a long clean down time to return to all clear.



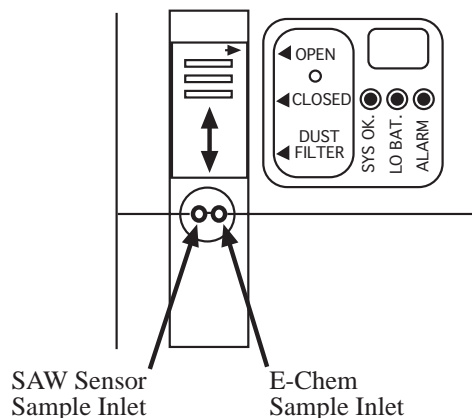
Warning!

Before ending the simulant test, make sure HAZMATCAD™ Plus returns to ALL CLEAR. Failure to allow the instrument to clean down could cause an alarm condition on the next power up.



Warning!

Make sure the DMMP diffusion tube is held against the SAW sensor inlet. Refer to Figure 10 for the exact location.



Position DMMP diffusion tube over SAW sensor inlet.

Figure 10 - HAZMATCAD™ Plus Sample Inlet Diagram

There is no need to test HAZMATCAD™ Plus for blister “H”. When the sensor array is working properly for nerve “G” it will yield a pattern response that indicates correct performance for “H”.

HAZMATCAD™ Plus Maintenance Test Intervals

Simulant Test Frequency

It is strongly recommended to perform a confidence vapor check on HAZMATCAD™ Plus whenever the instrument is used. This confirms the instrument performance and will yield the best performance.

Storage

Should HAZMATCAD™ Plus not be used on a regular basis, it is recommended that the instrument be tested at least once every month. This should include recharging the Li Ion batteries and performing a vapor confidence check test to assure satisfactory operation.

External Decontamination



Warning! HAZMATCAD™ Plus is not designed to be waterproof, and damage will result to the internal components if immersed in liquid.



Warning! While it is important to practice decontamination procedures, care must be taken not to draw liquids into the instrument.

- 1) Turn OFF HAZMATCAD™
- 2) Place the three position sample port slide cover to the closed position
- 3) Wipe the instrument completely with a moist soapy cloth.
- 4) Shake the HAZMATCAD™ briskly to remove residual liquids and to prevent any liquids from being drawn inside the instrument.
- 5) Place the three position sample port slide cover in the open position and place the HAZMATCAD™ in an inverted position for 2 minutes.
- 6) Wipe the instrument dry with a clean paper or cloth.
- 7) Place the HAZMATCAD™ in a sealed bag for at least one hour. This will allow any residual contamination to off gas.
- 8) Sample the headspace of the bag using another HAZMATCAD™, M256 Kit or other appropriate device to confirm there is no residual contamination.
- 9) If residual contamination is detected repeat steps 1 through 8.

If the instrument has been exposed to high levels of CW agent it may be advisable to remove and properly dispose of the external covering (rubber boot). The internal components that may be contaminated are the inlet sampling tube, SAW array, sampling pump, concentrator and the electrochemical cell pneumatic pathway. Often running the instrument in clean air for several hours will eliminate this contamination.

To check for internal contamination use the following procedure.

- 10) Place the operating HAZMATCAD™ in a large plastic bag.
- 11) Let the HAZMATCAD™ run for 60 minutes
- 12) Sample the headspace of the bag with another HAZMATCAD™, M256 Kit or other appropriate device for trace contamination.
- 13) If contamination is detected, run the HAZMATCAD™ in clean air for several hours and repeat steps 1 through 12 in a well ventilated area.

If the HAZMATCAD™ still shows traces of contamination contact Microsensor Systems or the appropriate Government Agency for further assistance.

Data Log

HAZMATCAD™ Plus has an internal data log that records each alarm or instrument fault detected. The data log is automatically enabled on power up. HAZMATCAD™ Plus has a maximum data storage of 1350 one-line alarm/fault reports. For example, if the HAZMATCAD™ Plus were detecting “G” agent only and running in the (FAST) (MODE), it could log all of these alarm reports for a period of 8 hours of continuous operation. If under the same condition HAZMATCAD™ Plus were running in the (HI S) (MODE) mode the reports could be logged for 45 hours.

The data log report follows the format described below:

Time	Hours & Minutes	1100
Date	Month, Day and Year	6/5/1 (June 5, 2001)
Alarm Status	Clear or Alarm	(HI, MED, LOW) (G, H, HALO TOX, CHOK, HYdR, ACId)
Mode	HS= High Sensitivity FM= Fast Mode	
Peak Signal	SAW Sensor 1 (Hz)	2200
Peak Signal	SAW Sensor 2 (Hz)	2400
Peak Signal	SAW Sensor 3 (Hz)	80
Array Temperature	Celsius	28
System Status	OK: Operating Correctly	
System Status	FAULT: XXXX	CONC = Concentrator PUMP = Sample Pump {S1, S2 or S3} = SAW Sensor's XXXX = Electrochemical Sensor Baseline Out of Range TRAINING = Training Mode Activated XECHEM = Electrochemical Sensor Baseline out of Range/Disconnected

Typical HAZMATCAD™ Plus Data Log

```

1052    6/8/2 HI H      FM    494   3482  3420  300   OK
1053    6/8/2 CLEAR    FM    136   500   541   300   FAULT XXXX

```

(CLEAR data reports are not put into the Data Log memory)

Electrochemical Cell Data Log Report

Electrochemical sensor alarms are logged into the data log every time there is a change in state of the sensor. For example if a MED “HYdR” was detected a report would be generated to the data log. That report would be updated when the MED “HYdR” changed reflecting the new condition. When an alarm condition goes away, an entry is placed in the data log indicating “CLR XECHEM”.

The format of the electrochemical sensor alarm report is as follows:

Time	Hours & Minutes	1100
Date	Month, Day and Year	6/ 5/ 2
Alarm Status	Alarm	(HI/MED/LOW) (HALO/BOLD/CHOK/HYDR)
Mode	FM = Fast Mode	FM
Dummy Field		0
Dummy Field		0
Dummy Field		0
Sensor Temperature Celsius		27

Following are some typical HAZMATCAD Plus electrochemical sensor alarm reports.

```

1059    6/8/2 HI BLoD      FM    0     0     0     28
10 1    6/8/2 CLR XECHEM  FM    0     0     0     28

```

Accessing the Data Log

The data log can be sent from a properly configured HAZMATCAD™ to an external computer over the infrared serial data link, using the IR Transceiver/Cable. The Transceiver converts the infrared signal to RS-232 (9600 baud, 8 data bits, one stop bit, no parity) that can be monitored and/or saved via a terminal emulation program (such as Procomm) on the external computer. Place the sampling end of the HAZMATCAD™ within 10 inches of the Transceiver. Turn the HAZMATCAD™ off. Then turn the HAZMATCAD™ back on while depressing the MODE SELECT button. The data log will automatically be transmitted to the external computer as an ASCII text file.

Low Temperature Operation

The HAZMATCAD™ is equipped with a sensor module heater that allows the detector to be operated at temperatures down to 0°C. Two temperature setpoints (T1 and T2, with T1 > T2) are stored in the detector.

Upon power up, if the sensor module temperature is below T1 the heater will come on. The sensor module must warm to above T2 before normal operation will commence. The alphanumeric display will show WARM/UP during this warm-up period.

During operation, if the sensor module temperature ever drops below T1, the heater will again come on. The instrument will continue normal operation unless the sensor module temperature drops below T2. If the temperature drops below T2, then the detector goes into WARMUP mode, where it remains until the sensor module temperature warms to T2. While the detector is in WARMUP mode, the sample pump does not run and neither the chemical agent nor the toxic chemical sensors are operative.

The E-Chem cells are also effected by low temperature operation. The cells will experience a 10% decline in overall sensitivity when operated under these conditions

Warm-up time for the HAZMATCAD™ Plus when the instrument has been stored at, and then is operated at 0°C, is approximately 5 minutes. The heater draws about 250 mA of current.

Low Battery Indication

An amber LED on the front panel, and another amber LED on the end face of the HAZMATCAD™ Plus, illuminate when the lithium-ion battery needs to be recharged/replaced. The HAZMATCAD™ Plus will continue to operate on the low battery for approximately 20 minutes, before shutting down. When the detector “shuts down”, the low battery LEDs remain illuminated, but all other functions are disabled.

Fault Conditions

Should the computer fail to start properly, HAZMATCAD™ Plus will indicate this failure by not activating the (SYS OK.) LED. The (SYS OK.) LED is the system heartbeat and serves as a continual monitor of system performance. This LED must remain flashing while HAZMATCAD™ Plus is being operated.

Should a fault condition be determined HAZMATCAD™ Plus will display the text (FAIL) and the fault. There are 4 fault conditions and they are displayed as follows:

These fault alerts will toggle back and forth. HAZMATCAD™ Plus will continue to operate under most fault conditions, though the fault may impact the validity of an alarm condition. A pump fault will cause the HAZMATCAD™ Plus to shut down.



SAW 1 – SAW Sensor (1), (2) or (3)

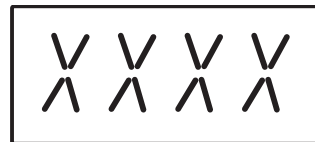


CONC – Concentrator Failure



PUMP – Pump Failure

There are two indications of electrochemical sensor warnings, expiration date of cell and electronic failure indication. The expiration date warning is indicated by the LED screen message “EXP” followed by the cell identification for example “HYdR”. This information will be indicated during the warm up sequence directly after power up. Each indication will remain displayed until acknowledged by the user. To acknowledge this information the user must press the alarm silence button.



XXXX= “HYdR”. “CHOK”,
“HALO” and “BLOd”



Press to continue

If an electrochemical cell fails or communication with the e-chem module fails, the HAZMATCAD™ Plus will indicate “FAIL XCHEM”. In some cases this information must be acknowledged by the user by pressing the alarm silence button. This will allow HAZMATCAD™ Plus to continue operation with the remaining sensors.



FAIL



XCHEM



ALARM
SILENCE

Press to continue

Special Applications

For special applications requiring unattended operation, long-term monitoring or diagnostic studies, the HAZMATCAD™ Plus can be configured to allow two-way hardwire or infrared RS232 communication. The following paragraphs describe the special capabilities that can be accessed in this special configuration.

Report at End of Each Analysis

A one-line ASCII text report is sent over the RS232 link at the end of each analysis cycle, reporting the status of the SAW detector. The format of this report is the same as that of the records placed in the data log, with the following changes:

- (1) Under “all clear” conditions a report documenting such is transmitted over the RS232 link, but not placed in the data log.
- (2) If the detector shuts down due to a low battery, a report is transmitted in the format: “LOW BATT xxxx”, where xxxx is the final battery voltage in mV.

Raw Data Points

All units are shipped with data points on. A one-line ASCII text report is sent over the RS232 link at a frequency of approximately twice per second, reporting the SAW sensor frequencies, and the sensor module temperature.

The format of this report is as follows:

```
= 63 1 DP S1 S2 S3 ECHEM TEMP
```

Each quantity is separated by a TAB. A CR/LF terminates each report. The variable fields are defined as follows:

DP- data point counter; starts at 1, increments by 1 each half-second.

S1,S2,S3 – SAW sensor frequencies (difference frequencies in Hz, with respect to a reference sensor)

TEMP – SAW sensor module temperature, in degrees Celsius.

To provide for the P.C. collection of both the plot data and online reports, Microsensor Systems, offers 2 software programs choices, “MSI- Vision” and “MSIDAQ”. These programs are designed to run using Microsoft Windows 98/95 operating system. For additional information regarding the data collection programs please contact MSI.

Data Log Dump and Clear

Typing <LOG><CR> (letters must be in all capitals) on the keyboard of an attached computer will cause the HAZMATCAD™ Plus to temporarily stop its analytical process, and export the data log via the RS232 port. The HAZMATCAD™ Plus will then execute a purge cycle and resume normal operation.

Typing <CLR> <CR> on the keyboard of an attached computer will cause the HAZMATCAD™ to clear its data log.

Holding down the “MODE SELECT” button on power up will also cause the HAZMATCAD™ Plus to send the data log out the RS232 port.

Should failure condition occur, contact Microsensor Systems, Inc. for assistance at (270) 745-0099 between 0900 and 1600 (Central Standard Time).

Troubleshooting

<u>Symptom</u>	<u>Possible Remedy</u>
Won't Power Up	<ol style="list-style-type: none"> 1. Check and or Replace Battery 2. Recharge Battery
"LOW BATT" On	<ol style="list-style-type: none"> 1. Recharge or Replace Battery
All Status LED'S Flashing	<ol style="list-style-type: none"> 1. Fault will be indicated on alphanumeric LED Display.
WARM/UP	<ol style="list-style-type: none"> 1. Instrument has not yet reached proper operating temperature. 2. (If WARM/UP persists), malfunction of temperature sensor or manifold heater. Call MSI for repair assistance/information.
Won't Alarm on Simulant Test	<ol style="list-style-type: none"> 1. Check expiration date of simulant tube, replace if expired. 2. Hold tube on sample inlet for twice as long as recommended. 3. Call MSI for assistance
SAW (1), (2) or (3)/ FAIL	<ol style="list-style-type: none"> 1. Failure of SAW Sensor to Oscillate. Call MSI for repair information. Sensor array may need to be repaired or replaced.
FAIL/XCHEM	<ol style="list-style-type: none"> 1. Electrochemical cell has failed. Call MSI for repair information. The Electrochemical cell must be replaced or repaired.
EXP/XXXX	<ol style="list-style-type: none"> 1. The electrochemical cells have expired. The E-Chem cell should be replaced with 2 to 3 months of the warning. {XXXX= "HYdR", "CHOK", "HALO" and "TOX".
CONC / FAIL	<ol style="list-style-type: none"> 1. Concentrator is not heating correctly. Call MSI for repair information. The concentrator may need to be replaced.
PUMP / FAIL	<ol style="list-style-type: none"> 1. Pump is not operating no flow. Check inlet for blockage, and sample slide position. Pump may need to be replaced

HAZMATCAD™ Plus Replacement Parts List

Part Number	Part Description
M3250170	Li Ion Battery NF 550
MS201112	Check Source
M3340140	Rubber Boot Cover
M3340150	Rubber Boot Battery Access Door
M3340410	Rubber Boot Handle Bottom
MS607131	Black Pelican Case Series
M3340320	Replacement Foam Insert
M2300070	Replacement Sample Pump
M2300030	Charcoal Scrubber
M3250030	Phosgene Sensor
M3250020	HCN Sensor
M3250110	Hydride Gas Sensor
M3250080	Halogen Gas Sensor
M1700010	Transceiver IR Wireless Interface
M100106M	HAZMATCAD™ Plus Manual

User Notes

Appendix A Training Mode Operation

The training mode allows the HAZMATCAD™ user to simulate chemical warfare agents by using commonly available chemicals. In this mode, the software bypasses the normal agent identification algorithm. Two useful chemical for this training mode are isopropyl alcohol and gasoline. Isopropyl alcohol will give a nerve “G” agent alarm. Gasoline will give a blister “H” agent alarm.

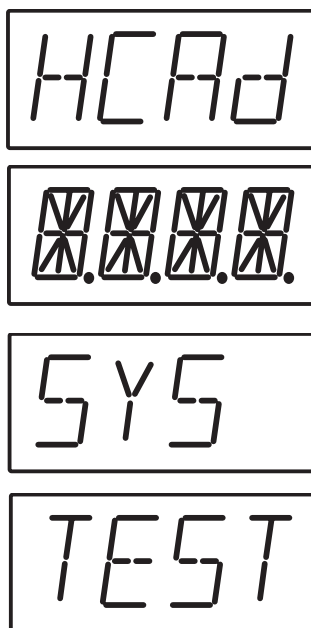


HAZMATCAD™ is designed to respond to trace amounts of chemical warfare agent. It only takes three or four drops of chemical to generate enough vapors to make the instrument respond.

Activating the Training Mode

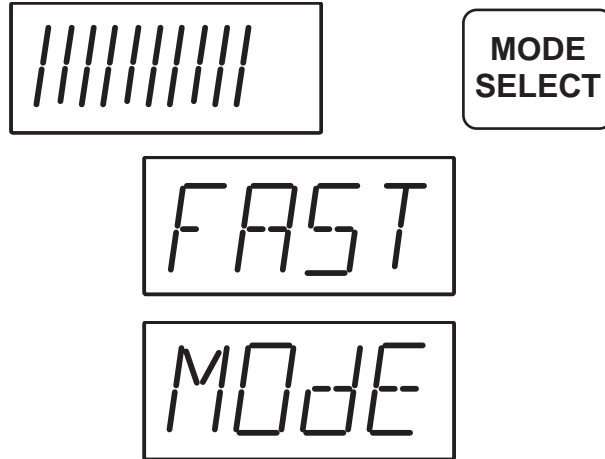
The training mode can be activated by following these steps.

1. Power up the HAZMATCAD™ by pressing the “ON” button.
2. The instrument will perform a self check. This is indicated by the following messages on the LED display.



3. After the (SYS) (TEST) message the LED display will display the battery life indicator.

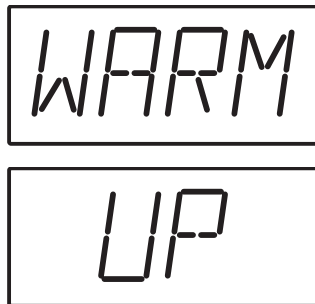
When the LED display indicates the first bars of the battery life indicator, press and hold the MODE button until the LED display shows the mode of operation (e.g. (MODE) (FAST)).



5. The audible alarm will activate (beep) during the (MODE) (FAST) display if the HAZMATCAD™ has been successfully placed in the Training Mode.



6. The HAZMATCAD™ will continue with its normal warm up sequence.



7. When the warm up is complete, the audible alarm will “**chirp**” approximately every 3 seconds to indicate that the HAZMATCAD™ is operating in the training mode.



Training Mode Algorithm

The training mode operates by adding the signals from all three SAW sensors. If the sum is higher than the preset alarm threshold, an alarm message is displayed. If the output of sensor one is higher a “G” alarm will be displayed. If the output from sensor two is higher an “H” alarm will be displayed. The total signal of the three SAW sensors will dictate the level of the alarm, “LOW” - “MEDIUM” or “HIGH” values.

De-Activating the Training Mode

To return to normal operation, press the “OFF” button and restart the instrument.

Using an External Computer to Activate the Training Mode

If the HAZMATCAD™ is connected to a computer via the RS232 or infrared port, pressing the “%” key will place it in the training mode. Pressing the “%” key a second time will return the HAZMATCAD™ to normal operation.

Alarms that occur while in the training mode will be DATA LOGGED with the following format:

Time, Date, Alarm Status, Sensor 1, Sensor 2, Sensor 3, Temperature, Status, Fail Tran

The (Fail) (Tran) message appended to the alarm report allows the user to distinguish between alarms logged in the training mode of operation from actual alarms.

Creating a Vapor Source for Operational Training in the Training Mode.

It only takes three or four drops of chemical to generate enough vapors to make the instrument respond. It is easy to create a “source vapor” by placing a few drops of liquid on paper towel. We recommend using isopropyl alcohol to give a nerve “G” agent alarm or gasoline to give a blister “H” agent alarm.

To sample the test chemical, place the HAZMATCAD™ in the training mode. Hold the HAZMATCAD™ sample inlet approximately 3 to 4 inches from the “source vapor” and wait for the unit to alarm. The alarm should occur in less than 60 seconds after exposure. Remove the HAZMATCAD™ from the proximity of the “source vapor” to a clean environment to clear the alarm.



Caution! The HAZMATCAD™ is a trace chemical analyzer! High concentrations of solvent vapors may damage the HAZMATCAD.



Caution! Consult applicable MSDS sheets and follow all safety precautions when handling solvents and flammable liquids